New Opportunities in the Physics Land

Abstracts book

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Abstract ID : 0

Search for heavy neutral leptons

Content :
The search for 'sterile' neutrinos has been done in the past looking for decays of heavy states in a neutrino beam (PS191 experiment) With much higher luminosities available at future machines, the search could be repeated both at the PS (to improve the present limits for masses up to the K mass) and at the SPS (where masses up to the B can be investigated) The recent nuMSM model which tries to explain the active neutrino masses gives a new interest in such searches.

Summary :
Heavy neutrinos if they exist are produced in admixture with any neutrino beam. Kinematically the allowed mass range depends on the emission process, pion or kaon or D or B decays. These states will decay through weak interactions, giving a characteristic decay vertex in an empty volume. The experiment consists in looking for such a signature with a calorimeter ending an empty tank.

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Deeply Virtual Compton Scattering at HERA and perspectives at CERN

Content :
Standard parton distribution functions contain neither information on the correlations between partons nor on their transverse motion, then a vital knowledge about the three dimensional structure of the nucleon is lost. Hard exclusive processes, in particular DVCS, are essential reactions to go beyond this standard picture. In the following, we examine the most recent data in view of the dipole model predictions and their implication on the quarks/gluons imaging (tomography) of the nucleon. Essential perspectives exist at CERN within the COMPASS experimental setup to complete this picture and quest for GPDs. A discussion is given for both short and long terms physics expectations.

Summary :
Standard parton distribution functions contain neither information on the correlations between partons nor on their transverse motion, then a vital knowledge about the three dimensional structure of the nucleon is lost. Hard exclusive processes, in particular DVCS, are essential reactions to go beyond this standard picture. In the following, we examine the most recent data in view of the dipole model predictions and their implication on the quarks/gluons imaging (tomography) of the nucleon. Essential perspectives exist at CERN within the COMPASS experimental setup to complete this picture and quest for GPDs. A discussion is given for both short and long terms physics expectations.

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This abstract is complementary to submissions from the COMPASS experiment itself. If accepted, I could focus the dis

Status : WITHDRAWN

Track judgments :

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Proton Driven Plasma Wakefield Acceleration (PDPWA)

Content :
A new scheme of plasma wakefield accelerator was recently proposed (A. Caldwell et al., arXiv, acc-ph: 0807.4599). The idea is to use existing high-energy proton bunches to drive a plasma wakefield. The strong plasma field then accelerates a trailing electron bunch to high energies. 2D and 3D Particle-in-Cell simulations show that a proton bunch with particle energy of 1 TeV, a bunch length of 100 μm, and 1011 protons can accelerate an electron bunch to beyond 500 GeV in a single plasma channel. A key element in realizing PDPWA is the production of a very short proton bunch. This is currently under study and recent results will be presented. A proof- of-principle experiment based on PDPWA is then proposed for consideration as a future CERN project. A proton bunch extracted from the PS or SPS would first be compressed through conventional magnetic compression and then enter into the plasma channel to exciting the plasma wakefield. In a first stage, the properties of the plasma wave could be studied without an electron bunch. Upon success of this stage, an electron bunch could be injected in the plasma and acceleration gradients demonstrated. Properties of the electron bunch would be studied in detail. A general facility for plasma wakefield studies could be envisaged.

Summary :
Plasma wakefield driven by the high energy, high intensity and short proton bunch may accelerate the electron bunch to the energy frontiers. Simulation results show that a single stage of plasma channel can bring the electrons to beyond 500 GeV. By using the conventional magnetic compressor, we can achieve the short proton bunch which can drive high electric field to accelerate the witness electron bunch.

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Storage Ring EDM method applied to proton and deuteron EDM at the 10^-29 e cm level

Content :
The storage ring EDM method, where polarized protons or deuterons are stored and have their spins monitored continuously as a function of time, provides the stage for the next generation EDM searches with a sensitivity below $10^{-29}\, {\rm e \cdot cm}$. At this level they will be sensitive to new physics mass scale of order of 300 TeV. If there is SUSY-like new physics at the LHC scale, the sensitivity to CP-violating phase is at the 10^{-5}~rad scale; a sensitivity level unparalleled by any other experiment.

Summary :
New CP-violation, beyond that observed in the kaon and B-systems in the SM is needed to explain the baryon-antibaryon asymmetry observed in our Universe (BAU). With the storage ring EDM method, applied to both the proton and deuteron EDM, we will have the greatest sensitivity in search of the BAU source. Electric dipole moments couple to electric fields and the spin precession rate is given by ds/dt = d \times E. In storage rings, where longitudinally polarized beams are stored, one achieves the greatest sensitivity when the spin is kept “frozen” in the forward direction. If there is an EDM it will manifest itself as a spin precession linearly as a function of time out of the storage plane, i.e. in the vertical direction. Recent advances in obtaining high electric field gradients between two parallel stainless steel plates using high pressure water rinsing make possible (affordable) the construction of an electric ring capable of storing 0.7 GeV/c protons. At this momentum the proton spin in the electric ring is always aligned with the momentum resulting to a very high sensitivity experiment. For the deuteron case the combination of electric and magnetic fields has the same result, i.e. it keeps the spin aligned with the momentum during storage time. Assuming an electric field gradient of 15MV/m for a 2cm plate separation the required ring radius is 28m for the proton magic momentum of 0.7 GeV/c and a third of that for the combined E for the deuteron case of 1 GeV/c momentum. To achieve the stated sensitivity R needs to be done on the following main items: 1) The E-field strength and its support system 2) The polarimeter detector and systematic errors associated with it 3) The spin coherence time (SCT) possible to achieve After the R period of about two years we will be ready to design the ring.

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Proposed Application of the LHC and SPS to Study High Energy Density Matter and Plasma Physics

Content :

The Large Hadron Collider (LHC) will generate two counter rotating 7 TeV proton beams, each containing 362 MJ energy that is sufficient to melt 500 kg copper. Safety of operation is an extremely important issue when working with such powerful beams. Any uncontrolled release of a small fraction of the beam energy can cause considerable damage to the equipment. A worst case scenario could be that the entire beam is lost at a given point. In order to study the consequences of such an accident, extensive numerical simulations have been carried out over the past few years. First, the energy loss of the 7 TeV protons is calculated using the FLUKA code [1] that is a fully integrated Monte Carlo particle simulation model capable of treating all components of the particle cascades, up to multi-TeV energies. This data is used as input to a 2D computer code, BIG2 [2], that is used to study the hydrodynamic and thermodynamic response of a solid copper cylindrical target that is facially irradiated with the full LHC beam. It has been found that the LHC protons will penetrate about 35 m in solid copper [3] and the target will be severely damaged. A very interesting outcome of this work has been that the target material will be converted into a huge sample of High Energy Density (HED) matter. In fact the specific energy deposition by the LHC beam in the target is of the same order as is expected at a dedicated facility, FAIR (Facility for Antiprotons and Ion Research) [4-6]. It has therefore been proposed that HED physics studies could be an additional application of the LHC [7]. It is also interesting to note that according to our simulations, the SPS has also the potential to generate HED states in matter. References [1] A. Fasso et al., "FLUKA: A Multi-Particle Transport Code", CERN-2005-10, INFN/TC-05/11, SLAC-R-773 (2005). [2] V.E. Fortov et al., Nucl. Sci. Eng. 123 (1996) 169. [3] N. A. Tahir et al., J. Appl. Phys. 97 (2005) 083532. [4] W.F Henning, Nucl. Inst. Meth. A 214 (2004) 211. [5] N.A. Tahir et al., Phys. Rev. E 63 (2001) 016403. [6] N.A. Tahir et al., High Energy Density 2 (2006) 21. [7] N. A. Tahir et al., Phys. Rev. Lett. 94 (2005) 135004.

Summary :

High Energy Density (HED) Physics is a very important subject as it has very wide applications to numerous areas of basic and applied physics. In addition to that, it has great potential for many lucrative inductrial applications. In tense particle beams have recently been proposed as an excellent tool for studying this subject. One facility that is being constructed at Darmstadt is the FAIR which will generate intense particle beams suitable to study HED matter. LHC is another international facility that will generate extremely powerful particle beams that can be used to study HED matter. This could be an additional, very important application of the LHC.

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Track : Possible future developments

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Abstract ID : 6

What will be the shape of the nucleus at HIE-ISOLDE ?

Content :
The shape of an atomic nucleus is a fundamental properties of the nuclear interaction as well as its lifetime, its spin and its parity of the ground state. At high excitation energy and/or high angular momentum, the nucleus can present a large variety of shapes (prolate,oblate, Jacobi shape etc ...). All of these shape correspond to a symmetry breaking of the nuclear interaction in the nucleus. In radioactive nuclei, far from the stability, such new symmetries could be observed in the ground state. Up to now, looking for such deformation in radioactive nuclei close to the stability lead to unexpected scenario : well deformed elongated shape coexist with flatten configuration in a range of few hundred keV for a total energy of few GeV in the system. In very neutron rich nuclei produced at HIE-ISOLDE, more complicate shape and scenario are expected. Opportunity of studying such exciting nuclei will be discussed.

Summary :
The shape of an atomic nucleus is a fundamental properties of the nuclear interaction. Each of this shape correspond to a symmetry breaking of the nuclear interaction in the nuclei. In radioactive nuclei, far from the stability, such new symmetries could be observed in the ground state. In very exotic nuclei produced at HIE-ISOLDE, very exotic shape and scenario are predicted : Rigid triaxial shape, egg nuclei, neutron skin. All these exiting opportunity will be presented.

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Track : ISOLDE

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Abstract ID : 7

A new technique for charting the reordering of quantum states in exotic nuclei

Content :
Recent and forth coming improvements to ISOLDE as part of the HIE-ISOLDE project will open up new regions of the nuclear chart previously inaccessible to the nuclear community. While this work aims at increasing the intensity of the produced beams, the yields of the most exotic rare isotopes will still remain at the periphery of experimental scope. In order to uncover new physics in these exotic systems, new techniques must be developed to which will provide higher sensitivity and better background suppression. A new innovation in laser spectroscopy, which combines the high resolution and sensitivity of two well established techniques (Collinear laser spectroscopy and resonant ionization spectroscopy) has demonstrated an improvement in detection efficiency by more than three orders of magnitude. Through studying the hyperfine structure with laser spectroscopy it is possible to extract the nuclear observables, such as the spin and electromagnetic moments, without introducing model dependence. Such measurements therefore allow the evolution of nuclear quantum states to be unambiguously studied far from stability. This technique also offers the ability to suppress isobaric contamination by more than 6 orders of magnitude, facilitating the production of extremely clean ion beams for decay spectroscopy.

Summary :
A new technique in laser spectroscopy for studying the reordering of quantum states in rare isotopes will be presented. The ability of this technique to dramatically reduce the detected background and record weak signals will be discussed.

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Track : ISOLDE

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Abstract ID : 8

NA62: New Opportunities in Rare Kaon Decays

Content :
There are currently three main directions in elementary particle physics. On the one hand experiments at the highest possible energies are searching for the origin of electroweak breaking and direct evidence of New Physics (NP); a second line of attack aims to study the properties of neutrinos, both of accelerator and cosmic origin, and of other astro-particle messengers. The third strategy is to explore the precision frontier looking for deviations from the Standard Model (SM) predictions in rare or forbidden processes. In this latter case, the sensitivity to NP originates from the virtual contributions that can involve all discovered and not yet discovered particles in higher order quantum loops and therefore can address, indirectly, energy scales even beyond those accessible at colliders. Some of the most interesting rare decays are those Flavour Changing Neutral Currents (FCNC) that can be predicted with small hadronic uncertainties in the SM. There are only very few observables where there is both sensitivity to NP and a well calculable expectation within the SM. A very prominent example is given by the K --> pi nu nubar decays and it is on precisely this subject that the CERN kaon physics strategy has been developed. The NA62 experiments plans to address first the charged kaon decay by exploiting the current performance of the SPS. Possible future studies of the neutral kaon ultra- rare decays could be envisaged in the framework of an upgraded proton accelerator complex. The CERN proton complex is unique. The Super Proton Synchrotron (SPS) will remain in operation for the foreseeable future as LHC injector. This injection task should occupy only a few hours per day, leaving the SPS available to feed primary protons to fixed target experiments for most of the time. We shall present the physics sensitivity of the CERN-NA62 experiment to study ultra-rare decays at the CERN-SPS and its present status. In addition to the very rare decays, the proposal offers a rich physics programme ranging from precision tests of lepton universality to the study of strong interactions at low energy. An outlook will be presented for possibilities in the upgraded accelerator complex.

Summary :
The physics impacts and the plans for construction of the NA62 experiement to study ultra-rare kaon decays at the SPS are presented.

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Track : SPS Rare K-decays and CNGS

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Abstract ID : 9

The CLOUD experiment; interdisciplinary research at CERN

Content :
The CLOUD experiment, PS215, will study the possible influence of cosmic rays on clouds. The experiment is currently being installed in the T11 beam line at the CERN PS and will begin its first measurements later this year. CLOUD is motivated by the long-standing and increasing evidence for solar-climate variability, and by recent satellite observations which - although disputed - suggest that cosmic rays may affect cloud amount. The physical mechanism, however, remains unclear. CLOUD has attracted considerable interest since the cosmic ray-cloud question bears on a possible new indirect solar contribution to climate change which is not included in present climate models. The CLOUD collaboration is a multidisciplinary scientific team comprising aerosol and atmospheric physicists and chemists, cosmic ray and solar physicists, and particle physicists. This talk will present the scientific motivation for the experiment, its current status and future plans. We will also discuss the special opportunity CLOUD represents for CERN to apply its unique facilities and knowledge to address an important question for science and global society outside its traditional field, and the lessons for similar opportunities in future.

Summary :
(see abstract)

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Track classification : PS and Non-accelerator Experiments

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Track judgments :

Track : PS and Non-accelerator Experiments

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Abstract ID : 10

Mono-energetic electron and gamma-ray beams at CERN.

Content :

A new method of delivering a monochromatic electron beam to the LHC interaction points is proposed. This method could enlarge the scope of the research programme of the present LHC detectors, by including the research programme of the electron- proton and electron-ion collisions. The carrier of the electron beam, over the full acceleration cycle, is the heavy ion beam. The storage of such a hybrid beam, in the LHC storage rings, could lead to a new exiting possibility of forming a mono- energetic, high-intensity, and highly-collimated gamma-ray beam at CERN - with higher efficiency than the present inverse-Compton-scattering gamma-ray sources. It could open up many new possibilities for basic research and applications, including photo-transmutation of nuclear isotopes, gamma-ray transmission radiography, cancer therapy and positron beam production.

Summary :

M.W. Krasny: "Electron beam for LHC", NIM A540 page 222-234.

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Track classification : Possible future developments

Contribution type : --not specified--

Submitted by : KRASNY, Mieczyslaw

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Track : Possible future developments

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Abstract ID : 11

Solving the neutrino mass and baryon asymmetry puzzles with experiments at SPS

Content :
The Standard Model cannot explain neutrino masses and oscillations, does not provide a candidate for dark matter particle and does not explain why the universe contains more matter than antimatter. A unified solution of these problems appears if the neutral fermion sector of the Standard Model is constructed in analogy with the structures we have in quarks or in charged leptons. Namely, every left-handed fermion can be required to have its right-handed counterpart. The properties of the new particles - relatively light neutral leptons, can be severely constrained by existing experiments and cosmology. Their mass is expected to be in a few GeV region, while their couplings to ordinary leptons are bounded both from above and from below. We will argue that the dedicated experiments with the use of intensive SPS and PS beams can provide an excellent opportunity for sensitive searches for these new particles.

Summary :
The same as abstract

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Abstract ID : 12

The measurement of the W mass at the LHC: shortcuts revisited

Content :
The claim that the W mass will be measured at the LHC with a precision at the 10 MeV level is critically reviewed. It is argued that in order to achieve such precision, a considerably better knowledge of the u-valence, d-valence, s and c structure functions of the proton is needed. An experimental programme is suggested that will deliver the missing information. The core of this programme is a dedicated muon scattering experiment on a hydrogen/deuterium target at the CERN SPS.

Summary :
An experiment is proposed that is designed to measure with higher precision than in the past the structure functions of the up and down quarks in the nucleon.

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Dark matter search with continuously sensitive bubble chambers

Content :
Recently the continuously sensitive bubble chamber technique has been shown to be a simple and viable method in searching for Dark Matter. One of the advantages of this device is that it can be made to be insensitive to minimum ionising radiation,which is normally a background in other types of detectors.At present only freons have been used as the detector liquids,but it is feasible to use argon or xenon. In order to increase the sensitivity of this type of detector it is necessary to improve the deadtime, sensitive mass and also to combine it with the detection of scintillation light. Some work on these topics is in progress.

Summary :
The possibilities of using and developping the bubble chamber technique to detect WIMP particles are reported.

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Track classification : PS and Non-accelerator Experiments

Contribution type : --not specified--

Submitted by : NEGRI, Pietro

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Track judgments :

Track : PS and Non-accelerator Experiments
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Abstract ID : 14

Production and study of exotic nuclei in few-particle transfer reactions.

Content :
In this presentation, the advantages and disadvantages involving the use of few- particle transfer reactions for the study of exotic nuclei will be considered.

Summary :
One of the methods for the production and study of exotic nuclei involves the transfer of small numbers of particles. To study neutron-rich nuclei, such process involve the addition of one or more neutrons or the removal of one or more protons, each of which produces nuclei that have higher isospin that the starting nucleus. Recent experiments with stable beam will be discussed, along with the special considerations that are associated with the use of radioactive ion beams.

Primary authors : Prof. WALTERS, William (University of Maryland)

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Presenter : Prof. WALTERS, William (University of Maryland)

Track classification : ISOLDE

Contribution type : --not specified--

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Track judgments :

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Judgment :
Judged by :
Date :
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Abstract ID : 15

Test beam needs for neutrino detector R-and-D projects

Content :
Future neutrino experiments will require very large scale detectors with increased resolution and ability to reduce backgrounds, associated with matched near detector systems for neutrino flux and cross-section measurements. A variety of technologies are being developed to respond to these needs, with typical detection medium made of: liquid or solid scintillator; water Cherenkov; or gas and noble liquids (Liquid Argon) based TPCs. A number of important questions need to be answered by beam tests to assess the intrinsic physics performance in terms of particle identification and energy resolution. Examples are: charge misidentification of 0.5-5 GeV muons in a magnetized iron calorimeter; interactions and stopping properties of pions and muons in detector material; electron to pi-zero separation. Initial requirements on the test beam characteristics and associated infrastructure are described.

Summary :
This will be based on the work that was done in preparation for the EU infrastructure proposal DevDET. It has been prepared in collaboration with the detector-specialists involved in the design studies EUROnu and Laguna as well as the EUCARD network NEU2012. Reference: International Scoping Study detector working group report: T. Abe et al, "Detectors and flux instrumentation for future neutrino facilities" arXiv:0712.4129v1 [physics.ins-det] accepted for publication in JINST.

Primary authors : BLONDEL, Alain (Departement de Physique Nucleaire et Corpusculaire (DPNC))

Co-authors :

Presenter : BLONDEL, Alain (Departement de Physique Nucleaire et Corpusculaire (DPNC))

Track classification : Test Beams & Irradiation facilities ; Possible future developments

Contribution type : --not specified--

Submitted by : BLONDEL, Alain

Submitted on Wednesday 25 March 2009

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Comments :

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Track judgments :

Track : Test Beams & Irradiation facilities
Judgment :
Judged by :
Date :
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Track : Possible future developments
Judgment :
Judged by :
Date :
Comments : ""

Abstract ID : 16

Measurement of the Spin–Dependence of the pbarp Interaction at the AD–ring

Content :

We propose to use an internal polarized hydrogen storage cell gas target in the AD−ring to determine for the first time the two total spin−dependent pbarp cross sections σ1 and σ2 at antiproton beam energies in the range from 50 to 450 MeV [1]; a Technical Proposal will be submitted at the beginning of April to the SPS committee at CERN. The data obtained are of interest in itself for the general theory of pbarp interactions and will provide a first experimental characterization of the spin- dependence of the nucleon-antinucleon potential. They are furthermore required to define the optimum parameters of a dedicated Antiproton Polarizer Ring (APR) that shall be used to feed a double−polarized asymmetric pbarp collider with polarized antiprotons. Such a machine has been recently proposed by the PAX collaboration for the new Facility for Antiproton and Ion Research (FAIR) at GSI in Darmstadt, Germany [2]. The availability of an intense beam of polarized antiprotons will provide access to a wealth of single− and double−spin observables, thereby opening a new window to QCD spin physics. A recent measurement at COSY revealed that ep spin−flip interactions provide insufficiently small cross sections to depolarize a stored proton beam [3]. This measurement rules out the use of polarized positrons to polarize an antiproton beam by e+pbar spin−flip interactions. Our approach to provide a beam of polarized antiprotons is based on spin filtering using an internal polarized hydrogen gas target — a method known to work for stored protons [4]. We are aiming to improve intensities of polarized antiproton beams by at least ten orders in magnitude compared to what has been achieved hitherto. Provided antiproton beams with a polarization around 20% can be obtained with the APR, the antiproton machine at FAIR (the High Energy Storage Ring) could be converted into a double−polarized asymmetric pbarp collider by installation of an additional COSY−like ring. In this setup, antiprotons of 3.5 GeV/c collide with protons of 15 GeV/c at c.m. energies of sqrt(s) ~ srqt(200) GeV with a luminosity in excess of 10^31 cm−2s−1. The PAX physics program proposed for FAIR [2] has been highly rated by various committees [5]. It includes foremost a first direct measurement of the transversity distribution of the valence quarks in the proton, and a first measurement of the moduli and the relative phase of the time−like electric and magnetic form factors GE,M of the proton. References [1] Letter−of−Intent for Measurement of the Spin−Dependence of the pbarp Interaction at the AD-Ring, PAX Collaboration, spokespersons: P. Lenisa (Ferrara University, Italy) and F. Rathmann (Forschungszentrum Juelich, Germany), available from http://lanl.arxiv.org/abs/nucl-ex/0512021. The proposals of the PAX collaboration can be found at the PAX website at http://www.fz-juelich.de/ikp/pax. [2] Technical Technical Proposal for Antiproton−Proton Scattering Experiments with Polarization, PAX Collaboration, spokespersons: P. Lenisa (Ferrara University, Italy) and F. Rathmann (Forschungszentrum J¨ulich, Germany), available from http://lanl.arxiv.org/abs/hep-ex/0505054. An update of the proposal is available from the PAX website at http://www.fz-juelich.de/ikp/pax. [3] D. Oellers et al., Polarizing a stored proton beam by spin flip?, accepted for publication in Phys. Lett. B, http://xxx.lanl.gov/abs/0902.1423. [4] F. Rathmann et al., Phys. Rev. Lett. 71, 1379 (1993). [5] Reports from different committees can be found in the News section of the PAX website at http://www.fz-juelich.de/ikp/pax.

Summary :

We propose to use an internal polarized hydrogen storage cell gas target in the AD−ring to determine for the first time the two total spin−dependent pbarp cross sections σ1 and σ2 at antiproton beam energies in the range from 50 to 450 MeV. A Technical Proposal will be submitted at the beginning of April to the SPS committee at CERN.

Primary authors : Dr. LENISA, Paolo (Universita di Ferrara and INFN) ; Dr. RATHMANN, Frank (Forschungszentrum Juelich)

Co-authors :

Presenter : Dr. LENISA, Paolo (Universita di Ferrara and INFN) ; Dr. RATHMANN, Frank (Forschungszentrum Juelich)

Track classification : Antiproton Decelerator (AD)

Contribution type : --not specified--

Submitted by : RATHMANN, Frank

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Track judgments :

Track : Antiproton Decelerator (AD)

Judgment :
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Abstract ID : 17

Reflections about EXChALIBUR, the exclusive 4pi detector

Content :
This provocative title is intended to call for the attention, emphasizing the brainstorming nature of this proposal. The acronym means: EXClusive HAdron and Lepton Instrument for Basic Universal Research. One tries to identify the technical limits which could be reachable within 5 to 10 years in the quest for the ideal particle physics detector.

Summary :
The aim of this detector is to provide full 4pi coverage which can be assured only by fixed target arrangements, by definition. This proposal is an implicit continuation of large acceptance detectors as NA61/SHINE at SPS and CBM at FAIR, which provide almost full coverage for the forward hemisphere. The proposal intends to build in a not far future a 10th ("X") generation detector applying technologies like: Diamond-TPC, high-grain Silicon calorimetry, GEMs, n-XYTER type read-out technology,interactions in high intensity beam with full online pattern recognition,based on data-driven massively parallel SIMD computing architecture, producing data on the EXA-byte scale per year. One should use as many type of beams as possible: nuclei also can include any element of the periodic table. We assume the application of small size (not exceeding 1 cm) solid targets. The detector should be able to record and reconstruct in full phase-space particle types: gamma, electron, muon, pion, charged Kaon, Kshort, proton, neutron (together with Klong), deuteron, lambda (ksi, omega minus). What are the physics plusses gained by this miraculous detector? Due to the unsolvability of QCD we don't have explicit solution for any hadron-hadron or lepton-hadron process. Practically all the knowledge in experimental QCD is based on inclusive measurements, which of course gives only the fraction of the possible information. The situation is similar to the Human Genome problem. The first experiments revealed, that the genetic information is coded in the nucleid acids (DNA), inclusive measurements revealed that only 4 amino acids are used in the coding. One can make this "inclusive" measurements by simply breaking the double-helix chain and count the end products. The real understanding of the code came after "exclusive" mapping along the chain, where we are now. Which is, of course, still not the end of the story. An other aspect which calls for this "stamp collecting" exclusive procedure is represented by the GPS example. The GPS idea is perfect for military purposes if one interested in the correct positioning of the flying warhead. But it became a universal tool for the mankind only after Google made the meticulous work of mapping every street and house in the data base. Why should it be built at SPS? The SPS energy range is full of mysteries which were completely forgotten after the closure of ISR. One can just enumerate few examples: Myterious transition of inclusive spectra around 80 - 90 Gev energy from convex to concave form. Emergence of Cronin-effect in pA interactions is completely unknown: energy -, centrality - and particle type dependence, particle correlations. Practically no medium or high pT data betwen beam energies 24 and 200 GeV. Is there a Critical Point on the phase diagram? (Hopefully the YES/NO answer will be given soon by NA61/SHINE experiment, but the finer details calls for deeper studies.) Is there threshold for Jet-quenching? How the jets are emerging??? Due to the fact that in this region the multiplicities are still relatively modest one have more chance to identify characteristic features. Bohr was using the spectral lines of Hydrogen and not the ones of Lead. In summary: We need the Lyman and Balmer series for QCD. Due to the fact that QCD is so many times more complicated than QED we need EXA-Bytes instead of the few Bytes of Bohr. Pessimists can say: There is no such information. But I ask: Please prove it without trying to measure it! calls for deeper studies.) particle type dependence, particle correlations. Why should it be built at SPS? The SPS energy range is full of mysteries which were mapping along the chain, where we are now. Which is, of course, still not the end of the story. An other aspect which calls for this "stamp collecting" gamma, electron, muon, pion, Kaon, proton, deuteron, alfa, and any heavy ion, which are readily available in the North Area between 10 and 300 GeV with reasonable intensity characteristic to each type of beam particle. The target

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Track classification : SPS Hadrons and Ions ; Possible future developments

Contribution type : --not specified--

Submitted by : VESZTERGOMBI, Gyoergy

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Track judgments :

Track : SPS Hadrons and Ions

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Date :
Comments : ""

Track : Possible future developments

Judgment :
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Date :
Comments : ""

Abstract ID : 18

Probing the heart of triple-shape coexistence at ISOLDE

Content :
In very neutron deficient Pb isotopes, both experimental and theoretical evidence for shape coexisting configurations has been achieved [1,2]. This phenomenon becomes transparent particularly at the neutron midshell, where the competing structures intrude down to energies close to the spherical ground state. These structures can be associated with proton 2p-2h and 4p-4h configurations across the Z=82 shell gap. Together with the spherical ground state, they form a unique triplet of 0+ states in Pb-186, each of which can be associated with a different shape [3]. The low-lying 0+ states can be populated in the decay of parental nuclei, and in-beam gamma-ray spectroscopy is used to investigate rotational bands build on top of 0+ states [4]. These methods provide information on transition energy and multipolarity, whereas life-time measurements are requested to determine the collectivity of the bands and to extract the absolute value for nuclear deformation [5]. However, in order to establish a complete picture of shape coexistence in this region, the knowledge of transition probabilities and quadrupole moments of nuclear states assigned with different shapes is essential. These properties can be determined in Coulomb excitation experiments and REX-ISOLDE is the only facility where such studies are feasible. [1] J.L. Wood et al., Phys. Rep. 215, 101, (1992). [2] R. Julin, K. Helariutta and M. Muikku, J. Phys. G: Nucl. Part. Phys. 27, R109, (2001). [3] A. N. Andreyev et al., Nature, Vol 405, 430, (2000). [4] J. Pakarinen et al., Phys. Rev. C, Vol 72, 011304(R), (2005). [5] T. Grahn et al., Phys. Rev. Lett. 97, 062501 (2006).

Summary :
The REX-ISOLDE facility enables to post-accelerate heavy radioactive beams and makes possible to employ Coulomb excitation method for the investigations of Pb isotopes close to the N=104 neutron midshell. These studies will shed light on shape- coexistence, nuclear collectivity and mixing of the low-lying states in neutron- deficient Pb nuclei. The advent of HIE-ISOLDE will bring additional boost to these studies and will prepare the way to probe Pb isotopes further towards the proton dripline.

Primary authors : Dr. PAKARINEN, Janne (University of Liverpool) ; Dr. GRAHN, Tuomas (University of Liverpool)

Co-authors :

Presenter : Dr. PAKARINEN, Janne (University of Liverpool)

Track classification : ISOLDE

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Comments :
On behalf of the P-260 collaboration

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Abstract ID : 20

Laser polarized beams for precision measurements of nuclear moments and for measuring nuclear spins

Content :

The COLLAPS collinear laser spectroscopy beam line at ISOLDE is since more than 30 years a unique facility worldwide for measuring fundamental properties of nuclei in a precise, accurate and model-independent way. Over the years, improvements in the experimental set-up and in the surrounding detection systems have progressively lead to improving the sensitivity and the precision for measurements of nuclear moments, nuclear charge radii and nuclear spins. A particularly interesting feature of collinear resonant laser excitation is the possibility to produce highly-polarized radioactive nuclei (typical polarization > 30 %). After implantation in a suitable crystal such polarized nuclei can be used for precision studies based on the asymmetric nuclear beta-decay. While such polarized beams were used at COLLAPS for nuclear structure studies, they can also be used in solid state physics [1] or for weak-interaction physics investigations [2]. beta- Nuclear magnetic resonance measurements on polarized nuclei allow obtaining very high precision for the determination of nuclear magnetic and quadrupole moments [3], and in combination with measurements of the hyperfine structure, it is possible to measure the spin of nuclei even if not all hyperfine structure components can be resolved (typically for the lighter nuclei) [4]. The variety of radioactive beams available at ISOLDE allows such detailed investigations on the nuclear structure and the nuclear forces in many different regions of the nuclear chart and over a wide range of isotopes. With the higher beam intensities that will become available with the HIE-ISOLDE project, even more exotic cases will now become accessible for detailed ground state properties studies. Recent highlights from measurements with polarized radioactive beams at COLLAPS are the high-precision measurements of the nuclear moments of halo nuclei like 11Be and 11Li [5,6], revealing an increase of the 11Li quadrupole moment with respect to that of 9Li. This is a clear signature for the polarizing effect induced by the halo neutrons on the 9Li core, and at the same time it illustrates the disappearance of N=8 as a magic number for isotopes with Z=3. Another magic number which disappears in nuclei with exotic neutron-to-proton ratios is N=20. Measurements of the ground state spin and magnetic moments of the Mg isotopes around the N=20 shell closure revealed an anomalous ground state configuration for the N=19 and N=21 isotopes, being dominated by neutron excitations across a reduced N=20 shell gap [7,8]. [1] T.A. Keeler et al., Phys. Rev. B77, 144429 (2008) [2] N. Severijns et al., Rev. Mod. Phys. 78, 991 (2006) [3] D. Borremans et al., Phys. Rev. C72, 044309 (2005). [4] M. Kowalska et al., Phys. Rev. C77, 034307 (2008). [5] W. Geithner et al., Phys. Rev. Lett. 83, 3792 (1999). [6] R. Neugart et al., Phys. Rev. Lett. 101, 132502 (2008) [7] G. Neyens et al., Phys. Rev. Lett. 94, 022501 (2005) [8] D.T. Yordanov et al., Phys. Rev. Lett. 99, 212501 (2007)

Summary :

Precision studies using nuclear magnetic resonance methods with polarized beams require at least 5.10^3 ions per second. The availability of higher radioactive beam intensities from HIE-ISOLDE will open up further the already wide range of exotic isotopes that are available at ISOLDE. Therefore, also in the next 10 years (and probably more) COLLAPS at ISOLDE will remain a leading facility in this field of research.

Primary authors : Prof. NEYENS, Gerda (K.U. Leuven)

Co-authors :

Presenter : Prof. NEYENS, Gerda (K.U. Leuven)

Track classification : ISOLDE

Contribution type : --not specified--

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Abstract ID : 21

Bremsstrahlung emission from relativistic heavy ions

Content :
We propose to measure the bremsstrahlung emission from relativistic ($\gamma=170$), fully stripped Pb nuclei penetrating various amorphous targets. In contrast to earlier expectations, recent investigations have shown that the bremsstrahlung emission from heavy, relativistic particles does not appear with constant power for all photon energies up to the end-point given by the energy of the incident ion, but instead the spectrum has a peaked shape, due to the finite size of the nucleus. Beyond an energy of about $2\gamma\hbar\omega_1$, where $\hbar\omega_1$ corresponds to the energy transfer above which the Z protons in the nucleus can be considered quasi-free, the power-spectrum falls off quite steeply, eventually leaving pair production as the dominant energy loss mechanism for sufficiently high values of the Lorentz-factor.

Summary :
We propose to measure the bremsstrahlung emission from relativistic heavy ions penetrating various amorphous targets.

Primary authors : UGGERHOJ, Ulrik (Department of Physics and Astronomy, Aarhus University)

Co-authors : Dr. SøRENSEN, Allan (Department of Physics and Astronomy, Aarhus University) ; Dr. KNUDSEN, Helge (Department of Physics and Astronomy, Aarhus University) ; Prof. SONA, Pietro (INFN and Florence Institute of Physics, Italy) ; Mr. BALLESTRERO, Sergio (INFN and Florence Institute of Physics, Italy) ; Mr. PETERSEN, Steffen Videbæk (Department of Physics and Astronomy, Aarhus University) ; Prof. SCHEIDENBERGER, Christoph (GSI, Germany)

Presenter : UGGERHOJ, Ulrik (Department of Physics and Astronomy, Aarhus University)

Track classification : Test Beams & Irradiation facilities

Contribution type : --not specified--

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Abstract ID : 22

KM3NeT: A future neutrino telescope in the Mediterranean Sea

Content :
KM3NeT is a future research infrastructure in the Mediterranean Sea, hosting a cubic- kilometre sized neutrino telescope and nodes for marine and earth research. The neutrino telescope targets the detection and measurement of neutrinos of astrophysical origin. KM3NeT will complement the hitherto most sensitive neutrino telescope, IceCube - currenty under construction at the South Pole - in its field of view and exceed it in sensitivity by a substantial factor. It will exploit the scientific potential of neutrino astronomy. This challenging project will necessitate the installation of thousands of photon detectors with their related electronics and calibration systems several kilometres below the sea level; its construction will require the solution of technological problems common to many deep submarine installations, and will help pave the way for other deep-sea research facilities. Building on the experience of the Mediterranean pilot projects ANTARES, NEMO and NESTOR, the KM3NeT design is currently worked out in a 3-year, EU-funded Design Study; as a first major milestone, the Conceptual Design Report (CDR) for the KM3NeT research infrastructure was published in April 2008. The project is endorsed by the astroparticle (ASPERA Roadmap) and astronomy (ASTRONET roadmap) scientific communities and is included in the 2006/08 Roadmaps of the European Strategy Forum for Research Infrastructures (ESFRI).

Summary :
The objectives, status and plans of the KM3NeT project will be presented.

Primary authors : Prof. KATZ, Uli (Erlangen Centre for Astroparticle Physics)

Co-authors :

Presenter : Prof. KATZ, Uli (Erlangen Centre for Astroparticle Physics)

Track classification : PS and Non-accelerator Experiments ; Possible future developments

Contribution type : --not specified--

Submitted by : KATZ, Uli

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Comments :

Since the KM3NeT Design Study is a running project, "PS and Non-accelerator Experiments" may be more appropriate

Status : SUBMITTED

Track judgments :

Track : PS and Non-accelerator Experiments

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Date :
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Track : Possible future developments

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Abstract ID : 23

Dark Matter Search with EURECA, the European Underground Rare Event Calorimeter Array

Content :

The European Underground Rare Event Calorimeter Array (EURECA) will be an astro- particle physics facility in the Laboratoire Souterrain de Modane (LSM) in France, aiming to directly detect WIMP galactic dark matter. The EURECA collaboration unites CRESST, EDELWEISS and the Spanish-French experiment ROSEBUD, thus concentrating European effort on dark matter detection with cryogenic calorimeters into a single large-scale facility. The goal of EURECA is to explore WIMP–nucleon scalar cross sections with sensitivity two orders of magnitude better than existing experiments, i.e. as low as 10E−10 pb. This requires a target mass in the region of one ton - arranged in EURECA as multi-element target to enhance its WIMP identification capability. Aiming to directly detect supersymmetric (SUSY) dark matter particles, EURECA complements the LHC programme at CERN, which will study the production mechanisms of these particles. The expertise of the Technology and Engineering departments at CERN would be most useful for the design, construction and implementation of the large EURECA apparatus and shielding into LSM. CERN's Cryolab is ideally placed for equipping the experiment with powerful dilution refrigerators capable of cooling the EURECA dark matter detector array at ~10 millikelvin.

Summary :

Experimental data on the cosmic microwave background, combined with other astronomical and astrophysical data, give to high precision values for the fundamental parameters in our cosmological model. Much of the matter density of the Universe seems to comprise non-luminous, non-baryonic particles. Supersymmetry provides weakly interacting massive particles (WIMPs) as appealing and well-motivated candidates for this dark matter. The LHC programme and direct dark matter searches aim to detect such particles with complementary methods. The WIMP-nucleon cross section appears to be at or below the electroweak scale and the expected event rates are correspondingly low. Thus, identification of WIMP interaction in a detector requires ultra-low background levels, i.e. a deep underground laboratory, sufficient shielding and radio-pure detector materials. In addition, the recoil energies produced by elastic WIMP-nucleus scattering are very small, in the range of a few keV to a few tens of keV. In order to address the experimental challenges mentioned above, a new generation of cryogenic detectors has been developed, exhibiting powerful background discrimination in combination with unprecedented energy threshold and resolution. Such detectors are installed in the running experiments EDELWEISS-II and CRESST-II, allowing high- precision identification of nuclear recoils by eliminating electron recoils due to radioactivity. The EURECA collaboration consists of teams from 16 institutes in France, Germany, Spain, UK and Ukraine, and teams from CERN and JINR (Dubna), some 100 physicists altogether. EURECA aims for a target sensitivity a factor >100 better than is currently projected by the above experiments. Although a discovery at WIMP-nucleon cross sections above 10E−8 picobarn is not unlikely, the range covered by EURECA (extending to 10E−10 picobarn) is currently the most favoured one. At the sensitivity limit, this translates to only few events per ton per year in typical targets. The EURECA detectors are solid-state calorimeters operating in the millikelvin temperature range. Event type discrimination is achieved with detectors based on charge-phonon discrimination (EDELWEISS), where the thermal signal induced by energy deposition in a germanium detector crystal is measured with a high-impedance thermistor attached to its surface. Simultaneously, the ionization signal is read out via electrodes on the crystal surface. The ratio between measured ionisation and heat signals provides an efficient method for the identification of the event type. A complementary discrimination method is implemented in detectors based on scintillation-phonon discrimination (CRESST and ROSEBUD). In CRESST, the thermal signal is measured with a superconducting transition edge sensor (TES) on the crystal surface. Simultaneously, the scintillation signal is detected by thin calorimeters with TES sensors, optimized for the detection of light. A significant advantage of cryogenic detectors is their modularity, scalability and independence from their cryogenic container. For increasing the size of the detector array, a successful design of an individual module can be replicated many times, allowing the mass production, assembly, commissioning and quality control to be shared out among suppliers and many of the tasks to be carried out in parallel. The detector arrays will of course have to be cooled to milli-kelvin temperature for operation, requiring a suitable dilution refrigerator unit. Accommodating a larger target array requires (only) a larger vacuum container, increased cooling power of the cryostat and readout channels, neither of these having

direct impact on detector operation. The question of a sizeable increase of detector channels is being addressed in the context of the currently running medium-sized arrays of the EDELWEISS-II and CRESST-II experiments. A further important feature of EURECA is its multi-material target. Having several targets within one common volume is highly desirable for establishing a true WIMP signal by testing for the correct A-scaling of the recoil energy spectrum due to WIMP-nucleon scattering. EURECA is beginning a design study, which will produce a Technical Design Report during 2011. In parallel to the preparations of new underground laboratory space at the LSM, components for EURECA will be constructed, pre-assembled and commissioned at the laboratories of the participating institutes. The detector array should operate in the (by then finished) extension at the LSM from 2014, reaching one ton active mass in 2017. Websites: EURECA: http://www.eureca.ox.ac.uk EDELWEISS: http://edelweiss2.in2p3.fr CRESST: http://www.cresst.de LSM: http://www-lsm.in2p3.fr/

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Track : PS and Non-accelerator Experiments

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Abstract ID : 24

DOUBLE-LAr: sterile neutrinos at the CERN-PS ?

Content :

The development of the Liquid Argon Imaging TPC has been actively pursued by the ICARUS Collaboration during the last two decades. The technology has reached its fully mature level and a first underground experiment with some 600 tons of sensitive mass, the ICARUS T600 detector is now in its final phase of installation underground at the LNGS. First of its kind, it will become fully operational during 2009 and initiate the first full scale underground physics experiment based on LAr-Imaging technology (CNGS-2). It will also realistically open the way to future more massive detectors for accelerator and without accelerator driven phenomena (see for instance MODULAr) . The present LOI describes another very important physics domain in which the LAr Imaging should be extended with a detector of the approximate size of the T600 (about 200x the volume of Gargamelle, but comparable resolutions) associated with availability of a low energy neutrino beam (with L/E ~ 0.5 Km/GeV) within the CERN premises and reactivating the traditional PS driven neutrino beam. This project will benefit of the already developed and well tested technology of ICARUS T600, without the need of any major R activity. The PS beam is the one originally used by the BEBC-PS180 at 19.2 GeV/c, extracted from the PS via the transfer tunnels TT2, TT1 and TT7. The magnetic horn is designed to focus particles of momentum around 2 GeV/c. The decay tunnel is about 50 m long, followed by an iron beam stopper. The main location (far position) is at about 850 m from the target in the existing BEBC hall.

Summary :

For 2.5 x 10^{20} POT, corresponding to 2 years of PS shared operation, the detector will accumulate more than 8.5 x 10^{5} unbiased, “bubble chamber like” neutrino events, at the rate of 0.12 ev/burst. The superior quality of the LAr imaging TPC and its unique electron–pizero discrimination allow full rejection of the NC background, without efficiency loss for electron neutrino detection. These results will be complementary to the one from ICARUS T600, exposed at CNGS, which will detect $\nu_\mu \rightarrow \nu_e$ oscillations at much larger L/E but with smaller statistics and therefore larger $\sin^2(2\theta_{e\mu})$. In order reduce the systematic errors in the search for $\nu_\mu \rightarrow \nu_e$ oscillations data should be compared to the event rates in a closer position, at a distance of 127 m from the target. A NEAR, small mass detector (10 ton) is implemented in the old ISR Hall 193. In absence of oscillations, because the close and far detectors have an identical structure, any background contribution is cancelled in the difference of the ratios. A deviation would be a direct indication for neutrino oscillations. Both neutrino and anti-neutrino channels should be experimentally explored. The most relevant physics issues relate to the possible existence of sterile neutrinos. As well known the classic CERN result sets to 3 the sum of the strengths of neutrinos, but >3 neutrinos are possible if their strengths are shared. The LSND experiment at Los Alamos took data from 1993–1998 and observed an excess of (87.9 ± 22.4 ± 6.0) events in the ⊠$\nu_\mu \rightarrow$ ⊠ν_e appearance channel, corresponding to a transition probability (P = 0.264 ± 0.067 ± 0.045 %), ~ 3.3 σ away from zero. To explain this signal requires a mass-squared difference $\Delta m^2 \approx 1$ eV2. Such a value is inconsistent with the mass-squared differences required by the standard atmospheric and long-baseline experiments and should relate to a new fundamental property of neutrinos in contrast with the Standard Model. The FNAL experiment MiniBooNE, designed to test LNSD and operated at the FNAL Booster since many years, has been so far inconclusive, mainly because of the chosen technology. MiniBooNE has observed a low-energy excess in the neutrino mode; although the magnitude of the excess is what is expected from the LSND signal, the energy shape is not consistent with a simple 4 neutrino oscillations. Their recent antineutrino data (LNSD was antineutrino) are consistent with both the LSND best-fit point (χ^2=17.6/16, P=34.6%) and the null point (χ^2=22.2/16, P=13.7%). Their conclusion, as presented at the Venice 2009 conference, has been: “sofar LSND is alive & well”. As it will be shown in our oral presentation, the DOUBLE-LAr experiment, because of its Gargamelle like resolution, should conclusively settle this very fundamental question.

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Abstract ID : 25

A new, very massive modular Liquid Argon Imaging Chamber to detect low energy off-axis neutrinos from the CNGS beam. (Project MODULAr)

Content :

The present ICARUS with its 600 tons now in the CNGS beam, represents the real core of the experimental LAr neutrino physics and a necessary prerequisite for reaching many kton masses either at CERN (to LNGS), at Fermilab, or perhaps elsewhere. It is the result of about two decades of unique R developments in which the ICARUS team has had a dominant role. Our next step, called MODULAr has been amply described in two published papers, one scientific, the other technical to which we refer for details. MODULAr is based on the present neutrino beam from CERN to LNGS, but with a new LAr detector with about a 20 kton fiducial mass, located off-axis from the neutrino beam. The main request from CERN, beside machine time, are the already known improvements in the number of accelerated protons, already foreseen in parallel with the LHC related beam improvement programmes, although it assumes a dedicated operation of the fixed target use of the SPS, in parallel with LHC.

Summary :

The 20 kton MODULAr detector will be (at least initially) located on the surface at a position which is about 7 km off-axis, most likely on the very same premises of the present LNGS laboratory. It is worth recalling that, as already demonstrated by the test in Pavia with the T300, surface performance of LAr is possible in view of the tightly bunched SNGS neutrino beam. Instead both proton decay and cosmic neutrinos need an underground detector which requires excavating of a new tunnel off- axis, away from the GranSasso protected area, with a corresponding delay and increased costs, safety and complexity of the experiment. In other words, MODULAr on surface will be an "ordinary" experiment. We believe that (1) only minor developments are needed to the present neutrino beam, (2) all needed surface space in the LNGS laboratory is already available, (3) the technology is a direct extrapolation of the mature technology developed for the present ICARUS experiment (4) the cost of the 20 kton detector is relatively modest. For instance the cost of liquid Argon delivered at the LNGS is about 20 MEuro. Many of the infrastructures of ICARUS, like the cryogenic cooling, the purification systems and so can be brought over from ICARUS to Modular. Since most of the preparatory R has either been done or is on the verge of being so, it is to believe that an experimental proposal can be formulated during this year. Estimates by many people have shown that the sensitivity of LAr for theta_13 is at least 4 times greater than NOVA for a given active mass and almost every event can be reconstructed in view of the “bubble chamber” nature of the LAr. We are in the process of extending the collaboration (after the successful operation of ICARUS has been proven) inviting an adequate participation of international collaborators from Europe and elsewhere. The actual construction time of MODULAr (much easier than ICARUS since on surface), if approved and funded, will be of the order of about 3 years, plus the preparatory time. It could therefore coincide roughly with the end of the present CNGS1/CNGS2 experimental phase. Needless to say MODULAr requires that the European neutrino programme is continued along the lines of the exploitation of the present CNGS beam. We are convinced that the next step for long path-line neutrino beams are not the super-massive ultimate dreams of hundreds of kilotons, which have been amply discussed in many reports, but rather an intermediate but realistic detector of an acceptable cost and with a total mass in the region of 20 kton of LAr and, for Europe, the permanence of the existing CNGS beam. Of course the physics outcome on the observation of the CP violating phase will be strongly dependent on the actual value of theta_13, which will be presumably measured by the ongoing reactor experiments. However an easily expandable detector with the innovation of MODULAr could be operated as well in connection with other, more advanced neutrino beams like for instance beta-beams and super beams in the far future and eventually installed (like it has happened for ICARUS) in a future new location deep underground in order to exploit as well proton decay and cosmic neutrino events.

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Measurements of transverse spin asymmetries on a transversely polarized proton target with the high energy muon beam at the SPS

Content :

Large transverse spin effects in pp scattering have been known since many years and are still largely unexplained. A new approach to these phenomena was initiated in the early 90's, when it was shown that at leading twist a third parton distribution is necessary to describe the nucleon, the so-called transversity distribution. Being chiral odd, it cannot be measured in inclusive DIS processes, thus its measurement is more difficult than the measurement of the unpolarized and of the longitudinally polarized quark densities. In parallel, the role of the parton intrinsic transverse momentum, usually neglected in collinear QCD, has been thoroughly investigated, and a complete description of semi-inclusive DIS processes is now available in terms of transverse momentum dependent (TMD) PDF's and fragmentation functions. One of the most famous TMD PDF's is the so-called "Sivers function", whose importance lies in its connection with the quarks orbital angular momentum, which is still under intense theoretical scrutiny. The first measurements of transverse spin effects in SIDIS have been performed by COMPASS and by HERMES, with lepton beams of 160 GeV/c and 28 GeV/c momenta respectively. Most important, from these SIDIS data and from the BELLE data it has been clearly shown that transversity can be measured. First results on the Sivers function have also been obtained from the HERMES and COMPASS data. Also, a large effort is devoted to interpret in the same theoretical framework the large effects observed in hadron physics and which are again been observed at RHIC, with the transversely polarized proton beams. In these first years of data taking with the muon beam COMPASS has performed important exploratory measurements using both deuteron and proton targets to assess the physics reality of transverse spin phenomena in SIDIS and their measurability. In particular, the preliminary results from the 2007 data have shown that the effects are there also at the COMPASS energy, and are measurable. Still, more accurate SIDIS data are urgently needed to solve some ambiguities and to better constrain the theoretical calculations. After the shut down of HERA, in 2007, COMPASS is the only experiment in the world that can carry on these measurements at high energy. In order to achieve the necessary accuracy for the first complete mapping of the properties of these new PDF's and fragmentation functions COMPASS asks to resume data taking with the 160 GeV/c muon beam and the transversely polarized NH3 target. Our beam time request amounts to a total of 9x10**13 muons on tape, which correspond roughly to 5.8x10**18 protons delivered on the T6 target, i.e. about one full year (six calendar months) of data taking in the present conditions. The new COMPASS data will measure at higher energy and with the same precision the valence region covered by HERMES, allowing to disentangle higher twist effects and to test the present understanding of evolution. COMPASS will also cover the very low x region, down to x=0.003, which is necessary for the evaluation of the first moments and the tensor charge, which is only accessible at high energies. In the framework of the planned upgrade of the SPS, more measurements of transverse spin effects with higher precision and at higher energy are also being envisaged.

Summary :

Transverse spin and transverse momentum effects are important tools to understand the nucleon structure. Relevant progress has been recently done thanks to the SIDIS measurements on transversely polarized targets performed by COMPASS and HERMES. Further measurements with the 160 GeV/c muon beam and the transversely polarized proton target are presently being proposed by COMPASS, the only experiment in the world capable of answering important open questions in this new and exiting field. The expected physics outcome from one year of running in the present conditions is presented. The interest for further measurements in the framework of the planned upgrade of the SPS is also briefly addressed.

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Study of Generalized Parton Distributions using high energy muon beams at COMPASS

Content :

Generalized Parton Distributions (GPDs) unify the momentum-space parton densities measured in inclusive deep-inelastic scattering with the position-space densities (form factors) measured in elastic scattering and in addition describe correlation between these observables. GPDs provide information on the transverse localisation of a parton at a given fraction it carries of the nucleon's longitudinal momentum. This description is sometimes referred to as 3-dimensional "nucleon tomography". GPDS attracted yet more attention after it was shown that the GPD E can reveal the quark orbital angular momentum in the decomposition of the total proton spin among its constituents: 1/2 = 1/2\Delta\Sigma + \Delta G + L_q + L_g where \Delta\Sigma and \Delta G are the contributions of the quarks and gluons respectively and L_q,g are their orbital angular momenta. The last results of the COMPASS Collaboration give a very accurate determination of \Delta\Sigma and the first results on \Delta G may be too small to fulfil the total nucleon spin, so GPDs can disentangle the nucleon spin puzzle. Constrains on GPDs will be provided by a global analysis of exclusive processes such as Deeply Virtual Compton Scattering (DVCS) or Meson Production (DVMP) through a mapping in x_Bj , Q^2 and t the invariant momentum transfer to the target, in a broadest possible kinematic range. The COMPASS apparatus is located in the unique high energy polarised μ± beam of the CERN SPS and uses a high-resolution forward spectrometer in conjunction with a fixed target. By installing a recoil detector around the target to ensure exclusivity of DVCS and DVMP processes, it can be converted into a facility measuring these reactions within a kinematic domain of x_Bj between 10^-2 and 10^-1, that cannot be explored by any other existing or planned facility. DVCS is identified as the straightforward way for accessing GPDs. It interferes with the Bethe-Heitler (BH) process, the pure electromagnetic effect of radiation of photon by the muons. With the high energy of the muon beam available at COMPASS, we can identify different kinematic domains where either the known BH contribution is dominant in order to provide a good control of the experiment, or the pure DVCS process is maximized in order to measure the t-slope of the DVCS cross section and to perform a direct extraction of the shrinkage parameter \alpha' to constrain GPDs. A substantial increase in energy will still open the x_Bj domain and the potential to favour almost pure DVCS contributions. It has to be underlined that with polarised muon beam of both charges, COMPASS is the only place to separate real and imaginary parts of the DVCS process amplitude in the interference term. In the "COMPASS Medium and Long Terms Plans" LoI submitted on 21/01/2009 to the SPSC we propose to measure DVCS in 2 successive phases. The first (or second) one using an unpolarised (or transversely polarised) proton target will be used to constrain mostly the dominant GPD H (or the proton helicity-flip GPD E). However the investigated range in Q2 remains limited by the luminosity. In this Q^2 range, DVMP, recorded in parallel to DVCS, suffer from NLO corrections. GPDs studies will benefit directly from every improvement of the muon flux. High energy polarised μ± beam are the determining assets for the COMPASS experiment, which could be nicely completed by a substantial increase of luminosity by a factor around 5 to get comfortable domain up to Q^2 larger than 10 GeV^2. This would make definitely the COMPASS experiment as a must.

Summary :

High energy polarised μ± beam available at CERN are decisive assets for performing a Deeply Virtual Compton Scattering and studying Generalized Parton Distributions in a kinematic domain of x_Bj between 10^−2 and 10^−1, that cannot be explored by any other existing or planned facility.

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Abstract ID : 28

Longitudinal Spin Structure of the Nucleon at COMPASS

Content :

The COMPASS experiment has explored the spin structure of the nucleon, and in particular, how its spin 1/2 is shared among the partonic constituents quarks and gluons. Precise measurements of the gluon polarization \Delta g/g(x_g), realized on a polarized deuteron target, show value compatible with zero in the region of the Bjorken variable x_g around 0.1. The first moment \Delta G of the gluon distribution cannot be determined model independently from the present measurements. However, large values of \Delta G, i.e. above 0.4, are now excluded, ruling definitely out a scenario explaining the smallness of the measured axial charge a_0 via the axial anomaly. Moreover, very precise data on the spin structure of the deuteron, obtained in parallel, completely changed our knowledge on the low x part of its first moment, hence reducing drastically the dominant uncertainty on the quark spin contribution \Delta\Sigma. These progresses could be achieved at CERN only, thanks to the muon beam, which is by far the highest energetic polarized lepton beam in the world. Past COMPASS measurements were mainly focused on deuteron data, since the corresponding factor of merit happened to be much higher for direct gluon polarization study. A first set of data taken on a polarized proton target in 2007 provides an important input for the extraction of the proton spin structure g_1^p, the non-singlet spin structure g_1^NS and the precise measurement of the Bjorken sum rule. Preliminary estimations show that an extraction of the constant g_A/g_V with a reasonable statistical error will already be possible from the COMPASS data alone. Nevertheless, more proton data are needed to achieve a similar precision on the first moment \Gamma_1^p as obtained on \Gamma_1^N from the deuteron data. The dominant uncertainty on all proton observables comes from the limited amount of data at x<0.01 showing the necessity of running at the highest possible energy. We know from our experience on the deuteron spin structure how the high sensitivity reached in today's experiment can change present assessments based on older data. By combining deuteron and proton data, the flavor dependent helicity distributions can be extracted. The advantage of COMPASS is the possibility to access x regions where the sea is dominant. In particular the question whether the polarized non strange sea is symmetric or not will be studied in a region where neither JLab nor Rhic can access, and the open question on the consistency of inclusive and semi inclusive data on the polarized strange sea will certainly progress. The ultimate goal is the extraction of all partonic helicity distributions. This can be achieved via global QCD NLO analyses realized inside the COMPASS collaboration, and incorporating all world data, polarized pp as well as polarized inclusive and semi-inclusive DIS data. CERN is now the only place where high energy polarized DIS experiments can be realized, and this will remain so until many years, when the awaited polarized electron ion collider EIC is eventually built. As a consequence we should provide in a short term all missing proton data of importance. For the longer term, the possibility of accessing even higher muon energies should be studied seriously, in conjunction with all possible ways of increasing the luminosity. Such upgrades would open a new kinematic range benefiting especially to the precise x and Q^2 mapping of g_1, to both indirect and direct measurements of \Delta g, and to the more complex studies of the angular momentum.

Summary :

The CERN high energy polarized muon beam offers the unique place where to measure polarized deep inelastic observables. Data on longitudinally polarized proton target are still rare in the very low x region (x<0.01) and are needed to constrain global NLO QCD fits which provide all helicity parton distributions.

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Drell-Yan Physics with COMPASS

Content :
The study of Drell-Yan (DY) processes involving the scattering of an pion/(unpolarized) antiproton beam on a (un)polarized (proton) target can result in a fundamental improvement of our knowledge of Transverse Momentum Dependent (TMD) parton distribution functions (PDFs). The COMPASS set-up allows to explore the x-valence region of the target, and as pion/antiproton beams select valence quarks in the target, these are very favourable conditions for a Drell-Yan measurement. The case of pion beam is discussed in details in the 'COMPASS Medium and Long term Plans' LoI submitted to the SPSC on 21/01/2009. Pion beam of high intensity (up to 6x10^7/s) is already available in COMPASS. In the unpolarized case the study of the cos(2\phi) azimuthal dependence can give us information about the product (for each flavour) of two unknown Boer-Mulders TMD functions. In antiproton-proton scattering this reduces to only one unknown function (contrary to the pion induced DY), since proton and antiproton functions are related by charge conjugation. In the polarized DY we can access two kinds of single spin asymmetries: the Sivers, and the Boer-Mulders \otimes transversity asymmetries. In what concerns Sivers, the main advantage of antiproton as compared to pion beam, is that the antiproton unpolarized PDFs (whose knowledge is necessary for the extraction of the Sivers function) are much better known than the corresponding pion PDFs. The study of the Boer-Mulders \otimes transversity asymmetry in antiproton-proton scattering, together with the study of the unpolarized cos(2\phi) azimuthal asymmetry, allow to extract the transversity from single polarized Drell-Yan data. To achieve meaningful statistical precision in the asymmetries measurement, a p-bar flux of ~2x10^7/s is required. Preliminary estimates show that such beam rates are within reach of Radio Frequency (RF) separated beams in the M2 tunnel (SPS North Area extracted beam). An upgraded version of the existing COMPASS apparatus will be used. Another very interesting possibility for COMPASS-DY is the study of DY processes with K^- beams. This implies a systematic study of the very poorly known unpolarized kaon PDFs. From the point of view of TMDs, a kaon beam strongly selects u-quarks in the target, enhancing the flavour separation capability with respect to the pion beam.

Summary :
A measurement of the Drell-Yan dimuon production with (anti)pion is proposed to study the Boer-Mulders and Sivers functions of the pion and proton respectively. A antiproton beam would considerably enlarge the physics potential.

Primary authors : Dr. DENISOV, Oleg (INFN Turin)

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AMS-02 : particle physics in space

Content :
The AMS-02 experiment is a state of the art superconducting spectrometer which will be placed during 2010 on the International Space Station to operate for 5 or more years. The SOC (Science Operation Center) and POCC (Payload Operation Control Center) will be located at CERN, as well the raw data processing. AMS-02 will represent a unique opportunity for the CERN community to access to highest quality data on the composition of the Cosmic Rays, to study fundamental physics questions as the disappearance of nuclear Anti Matter and the origin of Dark Matter. At the same time AMS-02 will be the first superconducting magnet in space: its operation will teach us a great deal about the usage of superconductivity in space. For application like human exploration , propulsion, energy storage, superconductivity is of essence for the future of space exploration. CERN has the most important background in superconductivity and would be the ideal place for a program to develop new space borne application of superconductivity in collaboraiton with ESA, the national Space Agencies and the European Industries.

Summary :
We discuss the physics potential of the AMS-02 experiment during its mission on the ISS as well as the technology potential for the development at CERN of superconducting magnet for space borne applications, starting from the experimence of AMS-02.

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Study of the very neutron deficient rare-earth isotopes by the laser ion source resonance ionization spectroscopy

Content :

The method of photoionization spectroscopy inside the laser ion source (RILIS) has been successfully applied at the IRIS facility to the investigation of the ground state properties of the rare-earth isotopes at and below neutron magic number N=82 [A.E. Barzakh et al, Phys. Rev.C 61, 034304 (2000); Phys. Rev. C 72, 017301 (2005)]. It is of great importance to continue these investigations further inside the deformation region at (58<Z<68, 70<N<80), toward the proton drip-line. The main aim is to compare the character of shape transition (i. e. smooth vs. jump-like behaviour) with the theoretical predictions, which seem to contradict to the experimental data at least for 137Eu. The wealth of information on energies of the low lying rotational (or decoupled) bands, transition probabilities for, e. g. Sm isotopes with N down to 70, gives the possibility to find some "non- deformational" effects in the changing of the slope of the isotopic charge radius dependence. The efficient photoionization schemes for Dy, Gd, Eu, Sm and Nd atoms have been tested in our previous experiments. Detection of the photoion current can be provided by beta-, X-rays or gamma- counting.

Summary :

Measurement of the changes of rms charge radius and magnetic moments for 134-138Sm, 140-145Gd, 135-137Eu, 144-148Dy and 128-132Nd with the aid of RILIS method is proposed. The possibilities of the different registration methods for various isotopes are discussed. The newly obtained data will shed light on the shape transition regime near the deformation region at (58<Z<68, 70<N<80).

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Extra Low Energy ring (ELENA) for post decelerating antiprotons

Content :
A small ring for post decelerating antiprotons after AD is proposed. Equipped with an electron cooler, it would allow delivery of antiprotons with kinetic energy of around 100 keV and emittances of a few π mm mrad to the AD users. Due to significant reduction of beam energy and emittances it will allow an increase in number of antiprotons for physics of up to one to two orders of magnitude. The possible ring layout in AD Hall is given together with cost and manpower estimation.

Summary :
An extra ring for further deceleration of antiprotons from AD is proposed with aim to increase the number of pbars delivered to experiments more than one order of magnitude.

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Track judgments :

Track : Antiproton Decelerator (AD)
Judgment :
Judged by :
Date :
Comments : ""

Abstract ID : 33

Transfer reactions at REX-ISOLDE: status and opportunities towards HIE-ISOLDE

Content :
Light-ion induced particle transfer reactions are a well-established method to investigate the single-particle structure of nuclei. For radioactive isotopes, such reactions have to be performed in inverse kinematics using light targets. As the reaction mechanism works at beam energies of a few MeV/u, the method is ideally suited for post-accelerated beams from REX-ISOLDE. In order to study transfer reactions, a new array of position-sensitive Si detectors covering a large angular range has been especially designed and built for experiments at REX-ISOLDE which allows to detect and identify light target-like recoils (p,d,t,alpha) [1]. In coincidence, the gamma-rays are measured with the MINIBALL spectrometer. The first experiments successfully performed in the last two years addressed the nuclear structure of neutron-rich nuclei at the shore of the "island of inversion". Further proposals to study neutron-rich Ni and Zn isotopes are already approved. In particular, the demonstration that two-neutron transfer experiments utilising a tritium target are feasible at REX-ISOLDE opens a wide field for investigations of phenomena like shape coexistence and pairing correlations in exotic nuclei. The higher beam energies available at HIE-ISOLDE will allow to extend such studies towards heavier nuclei up to the A approx. 200 region which are as low-energy beams unique to ISOLDE. [1] V. Bildstein et al., Prog. Part. Nucl. Phys. 59, 386 (2007).

Summary :
The status of the programme and future plans to study the structure of exotic nuclei by nucleon transfer reactions at REX- and HIE-ISOLDE will be presented.

Primary authors : Prof. KROELL, Thorsten (TU Darmstadt)

Co-authors :

Presenter : Prof. KROELL, Thorsten (TU Darmstadt)

Track classification : ISOLDE

Contribution type : --not specified--

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Track judgments :

Track : ISOLDE

Judgment :
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Date :
Comments : ""

Abstract ID : 34

Integrated detector test facility for a future linear collider

Content :
The physics potential at future electron positron linear colliders demands detectors with excellent precision. In the recent years new technologies have been developed, low mass silicon tracking systems, micro-pattern gas detectors for TPC readout and ultra-compact and highly granular calorimeters for particle flow reconstruction. They were established in first proof-of-principle prototypes. In the next stage larger and more realistic prototypes are being prepared, so system aspects need to be addressed. They range from seamless and scalable mechanical design, electronics integration and power management to the interplay of different sub-detector components, their alignment, common data acquisition and combined use in the reconstruction of particle flow objects. We propose to create a generic test beam facility for integrated detector tests. The set-ups comprise vertexing, tracking and calorimetric components together, such that the performance of the entire system can be tested. The facility should provide beams of different types and energies, the necessary infrastructure in terms of mechanical, thermal and electrical services, and magnetic fields. To test and compare different sub-detector technologies, each component in the set-up must be exchangeable.

Summary :
The talk will present the detectors currently being developed and constructed for such tests. The potential to further develop and test particle flow techniques in multi-particle environments created by a beam target will be discussed.

Primary authors : Dr. SEFKOW, Felix (DESY)

Co-authors :

Presenter : Dr. SEFKOW, Felix (DESY)

Track classification : Test Beams & Irradiation facilities

Contribution type : --not specified--

Submitted by : , Felix Sefkow

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Track judgments :

Track : Test Beams & Irradiation facilities
Judgment :
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Comments : ""

Abstract ID : 35

Fixed target charmonium production with proton and lead beams at LHC

Content :
The possibility to study the production of J/ψ mesons in the fixed target experiments with proton and lead beams at LHC has been investigated. At SPS energies the normal nucleus suppression of J/ψ in proton-nucleus collisions and anomalous suppression in central lead-lead collisions was observed in NA50 experiment. The anomalous suppression for central indium-indium events at SPS was confirmed by NA60 experiment. PHENIX experiment at RHIC shows that the J/ψ suppression in Au-Au and Cu-Cu collisions at 200 GeV in nucleon-nucleon centre of mass system is of the same order as the suppression at SPS energies. There is no theoretical models now that could reproduce all the data. Future experiments at much higher energies at ALICE, LHC could produce the charmonium and bottomonium families and possible suppression pattern can be studied. However an energy interval between SPS, RHIC and LHC is very important to study the mechanism of quarkonium production and suppression, to investigate medium effects and conditions for Quark Gluon Plasma formation. We suggest to plan at LHC fixed target experiment for charmonium production at the energy range between SPS and RHIC in p-A and A-A collisions with planning proton beam at T=7 TeV (sqr s = 114.6 GeV) and Pb beam at 2.75 TeV (sqr s = 71.8 GeV). This is unique possibility to clarify the mechanism of charmonium, J/ψ and ψ' production, to separate two possibilities: i): hard production and suppression in QGP and/or hadronic dissociation or ii): hard production and secondary statistical production with recombination, since the probability of recombination decreases with decreasing energy of collision in thermal model. As it was already used for the experiment on a collider with a fixed target at HERA-B, the target in the form of thin ribbon could be placed around the main orbit of LHC. The life time of the beam is determined by the beam-beam and beam-gas interactions. Therefore after some time the particles will leave the main orbit and will interact with target ribbon. So for the fixed target experiment at LHC only halo of the beam will be used. Hence no deterioration of the main beam will be introduced. The experiments at different interaction points will not feel any presence of the fixed target. The geometrical acceptances for the J/ψ production, luminosity and counting rate estimations for measurement at LHC with the fixed target are calculated and discussed.

Summary :
The possibility to study the production of J/ψ mesons in the fixed target experiments with proton and lead beams at LHC has been investigated. We suggest at LHC a fixed target experiment for charmonium production at the energy range between SPS and RHIC in p-A and A-A collisions with planning proton beam at T=7 TeV (sqr s = 114.6 GeV) and Pb beam at 2.75 TeV (sqr s = 71.8 GeV). This is unique possibility to clarify the mechanism of charmonium, J/ψ and ψ' production.

Primary authors : KUREPIN, Alexeii (Institute for Nuclear Research (INR))

Co-authors : TOPILSKAYA, Natalia (Institute for Nuclear Research (INR)) ; GOLUBEVA, Marina (Institute for Nuclear Research (INR))

Presenter : KUREPIN, Alexeii (Institute for Nuclear Research (INR))

Track classification : Possible future developments

Contribution type : --not specified--

Submitted by : KUREPIN, Alexeii

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Status : SUBMITTED

Track judgments :

Track : Possible future developments

Judgment :
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Date :
Comments : ""

Abstract ID : 36

Possible links of CERN to Astroparticle Physics

Content :

The European Astroparticle Community has developed a strategy for the field over the next ten years, together with a list of priority projects ("Astroparticle Physics - the European Strategy" - see the ASPERA web page http://www.aspera-eu.org <http://www .aspera-eu.org/>). The links between projects in this strategy and European Particle Physics are many. There is a strong connection already in the 2006 European Strategy for Particle Physics where the links to ApPEC are emphasized and further connections are encouraged. Projects being considered by both strategies are for example dark matter searches or neutrino mass experiments. Other large endeavors with similar connections are KM3NeT, a cubic kilometer neutrino telescope in the Mediterranean, and an underground detector for low-energy neutrino astronomy, proton decay and oscillation physics. The talk gives a overview over the most relevant projects with common scientific interests.

Summary :

The talk gives a overview over the most relevant projects with common scientific interests between the astroparticle and the particle communities. The links between projects in the ApPEC strategy and the European Particle Physics strategy are many. They range from dark matter searches or neutrino mass experiments to cubic kilometer neutrino telescopes or large underground detectors for low-energy neutrino astronomy, proton decay and oscillation physics. The talk gives a overview over the most relevant projects with common scientific interests. On the organisational side ApPEC now has a representative present in the European Strategy Sessions of Council, and formal links between the ApPEC Peer Review Committee and the European Strategy Secretariat are also established to help preparing discussions in Council of issues related to Astroparticle Physics. A list of project that fall in the common sphere of Particle and Astroparticle Physics will be identified and possibly included as, in addition to their ApPEC connection, projects that are officially part of the implementation of the European Strategy for Particle Physics. While the above connection are related to the roadmaps of European Strategy Sessions of Council and ApPEC, several astroparticle physics projects have in the past been given status as Recognized Experiments at CERN (http://committees.web.cern.ch/committees/RB/TableRecognizedExpts.html), which give members of these experiment possibilities to be users at CERN and use, with limited priority, some CERN facilities. Further involvement of CERN in astroparticle physics projects can vary from modest to substantial and will also be briefly discussed in the talk. One can consider offering status as recognized experiment for all astroparticle physics projects that will be identified to also be a part of the European Particle Physics Strategy implementation. CERN could also consider to increase the involvement in some of these projects to include scientific participation, increased use of technical facilities and expertise for in specific key areas, or increased use of management and finance systems. CERN could also consider to "host" a small subset of such projects, providing host services similar to particle physics experiments at CERN, even though the project/experiment is installed somewhere else. Last but not least, a European Centre for Astroparticle Physics Theory, has been proposed. It could be implemented in a single-site or network mode, with CERN as a candidate to be the host or central node.

Primary authors : SPIERING, Christian (DESY)

Co-authors :

Presenter : SPIERING, Christian (DESY)

Track classification : PS and Non-accelerator Experiments ; Possible future developments

Contribution type : --not specified--

Submitted by : SPIERING, Christian

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Date :
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Track : Possible future developments

Judgment :
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Abstract ID : 37

Measurement of magnetic moments of charmed baryons using an extracted beam at LHC

Content :

High energy external beams at LHC offer unique opportunities for specialized experiments. Besides providing beams of charmed mesons which may be used for total charm cross section measurements one such experiment is the determination of the magnetic moment of charmed baryons. We will present the physics and a possible technique for such a measurement, which constitutes a challenge in experimental physics. These experiments are based on crystal channeling of polarized charmed baryons at TeV energies allowing to observe sufficient spin rotation for a measurement of their magnetic moment.

Summary :

Magnetic moments of baryon have played a vital role in understanding the internal structure of baryons. However, measurements have been restricted to light and strange baryons only. Heavy baryons have been studied in the last 10 years and precision spectroscopy has been allowed to determine the mass of all charmed baryons and excited states. Also lifetimes of all charmed baryons have by now been determined with small uncertainties showing harmed baryons to be the shortest living weakly decaying states with their lifetimes in the order of a few hundred femtoseconds. Magnetic moments of baryons are typically measured by their spin rotation in magnetic fields. For short living particles high effective magnetic fields can be produced by channeling of particles through bent crystal planes, causing spin rotation. This principle has been shown at an experiment in the 1990's at FNAL. However, the field scales with Lorentz Gamma and thus requires very high energy particles. High energies are in addition needed to provide large Lorentz boosts allowing the particle to traverse crystals of suitable length. Such energies can only be obtained using TeV beams, obtainable from an extracted LHC beam. Provided that transverse particle polarization as observed for hyperons at large transverse momenta can also be assumed for charmed baryons, spin procession could be observed using two body decays of charmed baryons offering sufficient analyzing power.

Primary authors : Prof. PAUL, Stephan (Physik Department - Technische Universitaet Muenchen)

Co-authors :

Presenter : Prof. PAUL, Stephan (Physik Department - Technische Universitaet Muenchen)

Track classification : Possible future developments

Contribution type : --not specified--

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Date :
Comments : ""

Abstract ID : 38

ASACUSA - future opportunities

Content :
The presently approved physics programme of ASACUSA (Atomic Spectroscopy and Collisions using Slow Antiprotons) includes 1) precision laser and microwave spectroscopy of antiprotonic helium atoms (tests of CPT invariance), 2) atomic and nuclear cross section measurements at very low energies using the RFQD (~100 keV) and the MUSASHI ultra low energy (~100 eV) beamline, and 3) a measurement of the antihydrogen ground-state hyperfine splitting using an anti-Helmholtz (cusp) trap and/or a super-conducting radio-frequency trap. Of these, the laser spectroscopy of antiprotonic helium (in which we aim at an improvement of a factor >>10 over the current precision) and the antihydrogen ground-state hyperfine splitting measurements (under development) will both require about 10 weeks of beamtime for the next 5-10 years in order to reach their design precision goals. We expect to complete the "kinematically complete" collision experiments within the next 5-6 years by adding an electrostatic antiproton recycler downstream of the MUSASHI beam line (CERN-SPSC-2009-005 /SR-040). If the ELENA ring is constructed, both antiprotonic helium and antihydrogen spectroscopy will benefit from the increased beam intensity and brightness. In addition, the slow extraction of antiprotons from MUSASHI should also increase with ELENA (by about a factor 5 relative to the RFQD plus possibly another factor of 2 due to beam stability), which may make it possible to perform antiprotonic x-ray experiments [1] and other nuclear physics experiments [2] which have hitherto been impossible with the fast extracted antiprotons at the AD. [1] Gotta et al., in the abstract book. [2] Zmeskal et al., in the abstract book.

Summary :
same as above.

Primary authors : Prof. HAYANO, Ryugo (University of Tokyo)

Co-authors :

Presenter : Prof. HAYANO, Ryugo (University of Tokyo)

Track classification : Antiproton Decelerator (AD)

Contribution type : --not specified--

Submitted by : Prof. HAYANO, Ryugo

Submitted on Tuesday 31 March 2009

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Comments :

for the ASACUSA collaboration at CERN AD

Status : SUBMITTED

Track judgments :

Track : Antiproton Decelerator (AD)

Judgment :
Judged by :
Date :
Comments : ""

Abstract ID : 40

An European Centre for Astroparticle Theory at CERN

Content :
The European Research Area network ASPERA has published a roadmap ('Status and Perspective of Astroparticle Physics in Europe') which identifies priorities in this field for the next decade, and is seeking to coordinate funding for key projects from European national research councils. In contrast to the centralised facilities in astronomy or particle physics, astroparticle experiments are widely spread all over the globe, often in rather inhospitable locales; correspondingly there are presently no equivalents of ESO or CERN. Nevertheless, an initial focus can usefully be provided by a Centre for Astroparticle Theory - which often motivates experimental projects, links distinct sub-fields, and is indispensable for the interpretation of experimental results. The roadmap suggests that CERN would be a natural choice for hosting such a Centre, especially in view of the synergy between beyond-Standard- Model physics at the LHC and astroparticle issues such as the nature of the dark matter. Moreover CERN has close links with several astroparticle experiments and many others are CERN ‘recognised experiments’. This center could be implemented in a single-site or in network mode, with CERN as a candidate to be the host or central node.

Summary :
It is proposed that CERN should host a Centre for Astroparticle Theory relating to key experiments concerning dark matter and energy, neutrino physics, ultrahigh energy cosmic rays, gamma rays and neutrinos, gravitational waves etc, with support from the European Union.

Primary authors : Prof. SARKAR, Subir (Rudolf Peierls Centre for Theoretical Physics - University of Oxford)

Co-authors :

Presenter : Prof. SARKAR, Subir (Rudolf Peierls Centre for Theoretical Physics - University of Oxford)

Track classification : PS and Non-accelerator Experiments ; Possible future developments

Contribution type : --not specified--

Submitted by : Prof. SARKAR, Subir

Submitted on Tuesday 31 March 2009

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Comments :

Discussions are being held concerning the proposed Centre with ASPERA committee members - the status will be pres

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Track : PS and Non-accelerator Experiments

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Date :
Comments : ""

Track : Possible future developments

Judgment :
Judged by :
Date :

Comments : ""

Abstract ID : 41

Rare probes of Quark-Gluon Matter at SPS: high-pt di-hadron correlations and open charm

Content :
The goal of high-energy heavy ion experiments is to study strongly interacting matter at high density and temperature. The expected transition from a hot hadron gas to a deconfined Quark Gluon Plasma is of particular interest in this context. Indications so far are that the this transition already takes place in fixed target experiments at 30-60 AGeV beam energy, which in the SPS energy range. We suggest perform high-statistics measurements of two low cross section observables in Pb+Pb collisions: open charm production and high-pt di-hadron correlations, which have provided significant insight at higher energies (RHIC, sqrt(s)=200 GeV), at two SPS energies: one above and one below the expected deconfinement phase transition. Exploratory di-hadron measurements at SPS have found a transition from correlation structures very similar to those found at RHIC at the highest SPS energy (158 AGeV) to a striking depletion of the 'near-side' structure at the lower SPS energies (20 and 30 AGeV). We propose a more detailed study of this transition to unravel its origin. A data sample of 50-100M events which can be collected in two dedicated runs (one at each energy) of about 3 months with the NA61 experiment would represent a signicant (factor 10-100) increase of the currently available data sample. Charm production is a good probe of hot QCD matter because the mass of the charm quark is much larger than the expected temperatures of the medium, so that charm quarks are expected to be dominantly from hard scatterings between initial state partons in heavy ion collisions. Measurements of yields and spectra will provide unique new insight in the nature of the hot QCD matter at SPS. So far, no direct charm measurement has been performed at SPS. We will present performance estimates for charm detection with NA61 with an additional microvertex detector.

Summary :
Proposal to perform high-statistics measurements of heavy ion collisions with NA61 at two energies

Primary authors : VAN LEEUWEN, Marco (Utrecht University)

Co-authors : COLLABORATION, Na61 (CERN)

Presenter : VAN LEEUWEN, Marco (Utrecht University)

Track classification : SPS Hadrons and Ions

Contribution type : --not specified--

Submitted by : VAN LEEUWEN, Marco

Submitted on Tuesday 31 March 2009

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Track judgments :

Track : SPS Hadrons and Ions

Judgment :
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Abstract ID : 42

FLAIR, a next-generation low-energy antiproton facility

Content :

The Antiproton Decelerator at CERN is currently the only low-energy antiproton facility in the world, providing antiproton beams at 5 MeV kinetic energy for experiments using trapped antiprotons or antiprotons stopped in dilute gases to study CPT symmetry or perform atomic collision experiments. The energy, however, is still high for efficient trapping and the availability of only fast extraction strongly limits the variety of physics experiments that can be performed. The features of a next generation facility have been developed by the community which resulted in the proposal for FLAIR (Facility for Low Energy Antiproton and Ion Research) for the FAIR facility under preparation at Darmstadt. FLAIR goes far beyond the scope of the AD by providing slow and fast extracted beams at energies from 400 MeV down to a factor 100 below the AD energy using two storage rings with electron cooling (LSR to 300 keV and USR to 20 keV) as well as the HITRAP deceleration system consisting of a linear decelerator and a Penning trap from which antiproton beams can be extracted at energies in the keV range. The physics program of FLAIR encompasses the precision spectroscopy of antiprotonic atoms and antihydrogen, which would benefit from the factor 100 higher rate of stopped antiprotons from the low-energy beams. Using an internal target int he USR, fully differential cross section measurements of atomic collision processes can be performed. The availability of high quality, cooled, slow extracted beams over a wide range of energies with intensities of 10^7 to 10^5 antiprotons per second will make many nuclear and particle physics experiments possible that cannot be performed anywhere at the moment. The availability of a broad range of beams of unstable exotic nuclei at FAIR will enable synergies by using antiprotons as hadronic probes for e.g. determining neutron halos or skins. An overview on the currently envisaged physics possibilities can be found in E. Widmann, PHYSICA SCRIPTA 72, C51–C56 (2005) and the FLAIR Letter of Intent and Baseline Technical Report available from http://www.oeaw.ac.at/smi/flair/. With a time scale for a possible start up of FLAIR around 2015/16 a natural transition from the AD to FLAIR becomes possible.

Summary :

A next-generation low-energy antiproton facility FLAIR is planned at the FAIR facility in Darmstadt from the year 2015/16. FLAIR will go beyond the AD by providing fast and slow extracted cooled beams down to 100 times lower energies at up to a factor 100 higher rates. The physics possibilities consist of a continuation of the AD program while at the same time enabling new experiments that are currently not possible.

Primary authors : Prof. WIDMANN, Eberhard (Stefan Meyer Institute Vienna)

Co-authors :

Presenter : Prof. WIDMANN, Eberhard (Stefan Meyer Institute Vienna)

Track classification : Antiproton Decelerator (AD)

Contribution type : --not specified--

Submitted by : , Eberhard Widmann

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on behalf of the FLAIR collaboration

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Track judgments :

Track : Antiproton Decelerator (AD)

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Date :
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Abstract ID : 43

Double-strangeness production with antiprotons at the AD

Content :
One of the outstanding fundamental problems in hadron physics today is the question of the origin of the large hadron masses made up of light quarks. A possible way to gain information is to study how the meson mass changes in a nuclear medium. The mass shift of a meson in a nuclear medium will provide evidence of the partial restoration of spontaneous broken chiral symmetry. The use of antiprotons for the production of double-strangeness was recently discussed by Weise and Kienle [Int. Jour. Mod. Phys. A 22 (2007) 365] and indeed, it would be very challenging to produce and study such "double-strange nuclei" in the view of the prediction of Akaishi and Yamazaki [Phys. Lett. B 535 (2002) 70] that double-antikaon bound nuclear systems with strangeness (S = -2) will be formed with binding energies up to 200-300 MeV. Such binding energies might result in an increase of the average density to more than 3 times the average nuclear density. If such dense systems really exist they will indeed represent ideal conditions to investigate how the spontaneous and explicit symmetry breaking pattern of low-energy QCD changes in a dense nuclear medium. First results on events with the production of two K+ mesons were reported by the DIANA collaboration [Nucl. Phys. A 558 (1993) 361] and recently a reanalysis of part of the OBELIX data measured at LEAR [Nucl. Phys. A 797 (2007) 109] was published, giving a probability of ~10-4 for the production of two K+ mesons. Based on this observation we plan a dedicated experiment to search for double strange nuclear cluster formation following antiproton annihilation at rest in various targets using missing mass and invariant mass spectroscopy. One possible target might be helium, where the antiproton is stopped and a double strange tri-baryon system is produced: pbar +4He ⟶ K+ + K+ + pnnK-K- To investigate such systems a detector system with three different detector components are planned with almost 4π coverage and excellent particle identification and spectroscopy capabilities. As central detector, an essential part of this experimental setup, a Time Projection Chamber (TPC) for charged particle tracking is foreseen. Within a Joint Research Activity of the FP7 program HadronPhysics 2, the study and development of a similar prototype TPC is already planned. A first experiment could be performed at the CERN/AD using the MUSASHI trap (ASACUSA), which provides slow extraction. In future more detailed studies are planned at FLAIR.

Summary :
A dedicated detector system will enable us studying in detail the whole reaction mechanism involved in the production of multi-baryon systems with strangeness S=-2 and searching for antikon-mediated deeply bound nuclear clusters, which is a very interesting topic in the study of chiral restoration in a nuclear medium.

Primary authors : Dr. ZMESKAL, Johann (Stefan Meyer Institute Vienna)

Co-authors : Prof. KIENLE, Paul (SMI Vienna & TU Munich) ; Dr. MARTON, Johann (Stefan Meyer Institute Vienna) ; Prof. WIDMANN, Eberhard (Stefan Meyer Institute Vienna) ; Prof. FABIETTI, Laura (TU Munich) ; Dr. CURCEANU, Catalina (LNF-INFN Frascati) ; Dr. GUARALDO, Carlo (LNF-INFN Frascati) ; Prof. YAMAZAKI, Yasunori (University of Tokyo) ; Dr. KURODA, Naofumi (University of Tokyo) ; Prof. GOLSER, Robin (University of Vienna) ; Prof. BRESSANI, Tullio (Università di Torino)

Presenter : Dr. ZMESKAL, Johann (Stefan Meyer Institute Vienna)

Track classification : Antiproton Decelerator (AD)

Contribution type : --not specified--

Submitted by : , Eberhard Widmann

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Abstract ID : 44

Production of rare radioisotopes for bio-medical research and medical applications

Content :

The unique strength of ISOLDE is the production of intense mass-separated radioactive ion beams of almost all elements. At present beams of over thousand different radioactive isotopes and isomers are available. It is only in conjunction with the high-energy driver beam that this technique provides the possibility to access a large variety of rare radioisotopes in one production run. In addition, the method intrinsically fulfills the now much demanded high quality requirement of isotopic purity including the absence of a stable carrier isotope. In the past ISOLDE's bio-medical research program has demonstrated how powerful these aspects are for modern radiopharmaceutical development. The new approaches in systemic radio immunotherapy (RIT) demand new uncommon radio nuclides as alpha emitters (example 149-Tb), beta emitters of a large variety of beta energy (example 47-Sc) and Auger electron emitters (example 165-Tm). The simultaneous application of various tracer molecules labeled with several dedicated radio nuclides of various elements allows making R in the field much more efficient. This unique access to a broad range of exotic nuclei has allowed ISOLDE to pioneer new approaches in cancer therapy (e.g. targeted alpha therapy using 149-Tb) and given rise to CERN patents. It is now high time that this potential is exploited in a more general medical isotope production program. This would enable research with those high quality products needed in cancer therapy. After a short review of radioisotopes for bio-medical research and applications we will discuss what medical applications are possible already today with the present ISOLDE facility and what applications will become possible with the LINAC4 construction and later upgrades of the driver beam intensity (SPL). A proposal for a possible future pilot-program of bio-medical research at CERN will be outlined.

Summary :

The unique strength of ISOLDE is the production of intense mass-separated radioactive ion beams of almost all elements. At present beams of over thousand different radioactive isotopes and isomers are available. It is only in conjunction with the high-energy driver beam that this technique provides the possibility to access a large variety of rare radioisotopes in one production run. In addition, the method intrinsically fulfills the now much demanded high quality requirement of isotopic purity including the absence of a stable carrier isotope. In the past ISOLDE's bio-medical research program has demonstrated how powerful these aspects are for modern radiopharmaceutical development. The new approaches in systemic radio immunotherapy (RIT) demand new uncommon radio nuclides as alpha emitters (example 149-Tb), beta emitters of a large variety of beta energy (example 47-Sc) and Auger electron emitters (example 165-Tm). The simultaneous application of various tracer molecules labeled with several dedicated radio nuclides of various elements allows making R in the field much more efficient. This unique access to a broad range of exotic nuclei has allowed ISOLDE to pioneer new approaches in cancer therapy (e.g. targeted alpha therapy using 149-Tb) and given rise to CERN patents. It is now high time that this potential is exploited in a more general medical isotope production program. This would enable research with those high quality products needed in cancer therapy. After a short review of radioisotopes for bio-medical research and applications we will discuss what medical applications are possible already today with the present ISOLDE facility and what applications will become possible with the LINAC4 construction and later upgrades of the driver beam intensity (SPL). A proposal for a possible future pilot-program of bio-medical research at CERN will be outlined.

Primary authors : Dr. KOESTER, Ulli (Institut Laue Langevin)

Co-authors : Dr. BEYER, Gerd (European Scientific Institute Archamps and Isotope Technologies Dresden) ; Dr. RAVN, Helge (formerly CERN)

Presenter : Dr. KOESTER, Ulli (Institut Laue Langevin)

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Abstract ID : 45

Testing Parity and Time Reversal Violations with Radioactive Atoms

Content :

Fundamental symmetries are at the core of the Standard Model of the electroweak interactions. They can be tested at low energies in atomic physics precision measurements complementary to high energies which are available at accelerators such as LHC. Parity and time reversal symmetry violations effects are enhanced in heavy elements. Furthermore, such experiments require isotope chains of heavy elements to quantify nuclear and atomic structure effects in P and T violating processes. The large range of different isotopes, in particular neutron rich isotopes, make (HIE-)ISOLDE an ideal place for such activities. At several different facilities there are ongoing activities to precisely measure atomic parity violation effects in heavy atoms. We are focussing on the exploitation of the sensitivity of radium isotopes. Firstly, Ra+ offers a unique sensitivity to Atomic Parity Violation (APV) with a single trapped radium ion [1]. The efforts aim at a measurement of the weak charge, which is proportional to the number of neutrons and the determination of the Weinberg angle with precision of 0.1% as an independent check of the result achieved with Cs [2]. To exploit the full sensitivity of the experiment the APV effects should be measured in several isotopes with a large difference in neutron number. Secondly, time reversal and parity violating permanent electric dipole moments are strongly enhanced in neutral Ra due to its nuclear and atomic structure [3]. Experimental activities have started at Argonne National Lab, Il, USA [4] and at the KVI, Groningen, NL [5], where sufficient beam time is available for debugging of the apparatus and studies of systematics. The experiment requires a large numbers of laser cooled and trapped atoms and the ISOLDE facility delivers the highest rates worldwide. At KVI we have developed a novel and efficient laser cooling and trapping scheme suited for heavy alkaline earth metals [6]. The dedicated TRImP facility offers an ideal environment for the development of the experimental techniques. An experimental program on trapped radioactive neutral atoms and ions expands the exploitation of ISOLDE towards a very active field of fundamental physics which has the potential to steer theoretical model building in a significant way. [1] L.W. Wansbeek et al, Phys. Rev. A 78,050501(R) (2008). [2] S.C. Bennett and C.E. Wieman, Phys. Rev. Lett. 82, 2484 (1999). [3] V.V. Flambaum, Phys. Rev. A 60, R2611 (1999). [4] J.R. Guest et al., Phys. Rev. Lett. 98, 093001 (2007) [5] H.W. Wilschut et al., Hyperfine Interact. 174, 97 (2007). [6] S. De et al. Phys. Rev. A 79 (2009) Rapid Communications (in print).

Summary :

Th capabilities of HIE-ISOLDE are excellently suited to study fundamental symmetries (P, T) in isotopic chains of heavy elements. The prospects for experimental approaches utilizing radium isotopes at ISOLDE will be presented.

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Contribution type : --not specified--

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Abstract ID : 46

Requirements on the proton source for future neutrino facilities

Content :
All proposed future options for second generation neutrino facilities that have been considered in Europe request a high power proton accelerator to produce the neutrino parents. This is in particular the case for those studied in the EUROnu design study. The more specific requirements in terms of proton energy and time structure are described. -- for the first option studied in EUROnu, a conventional neutrino superbeam, the physics performance of the project requires typically a 4 MW proton driver with a pulse rate of the order of 50 Hz. To minimize the energy consumption by the corresponding hadron collecting system and increase its lifetime, the proton pulse duration must remain as short as possible and not exceed 5 microseconds. -- the specification for the Neutrino Factory proton driver is that it will deliver a beam power of 4 MW at an energy of 10±5 GeV in one to three bunches of 2 ns duration at a repetition rate of 50 Hz. This challenging specification can be met using a super-conducting linac feeding a system of accumulator and compressor rings or by a novel non-scaling FFAG. - finally for the beta-beams, the use of spallation neutrons for indirect production of beta emitters 6He and 8Li is a valuable option within the capability of a superconducting proton linac. Increasing the production ability of other important candidates for beta beams, such as 18Ne, which is today insufficient, is actively pursued within the EURISOL program. It is noted finally that challenging muon physics, such as search for rare decays predicted in supersymmetric theories in particular, can be performed at a high intensity proton accelerator taking advantage of the flexible time structure of the SPL, especially with an accumulator ring.

Summary :
This paper summarizes the requirements on a proton driver for future neutrino facilities. It is based on studies carried out under the auspices of ECFA since 1998, the most recent being the International Scoping Study. Presently the EUROnu design study encompasses the superbeam, beta-beam and neutrino factory.

Primary authors : BLONDEL, Alain (Departement de Physique Nucleaire et Corpusculaire (DPNC)) ; DRACOS, Marcos (CNRS-IN2P3/Universite Louis Pasteur Strasbourg FRANCE) ; LONG, Kenneth (Imperial College London (UK)) ; WILDNER, Elena (CERN) ; LINDROOS, Mats (CERN)

Co-authors :

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Track classification : Possible future developments ; New Proton drivers at CERN

Contribution type : --not specified--

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Track judgments :

Track : Possible future developments

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Track : New Proton drivers at CERN

Judgment :
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Date :
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Abstract ID : 47

Critical Point and Onset of Deconfinement - Ion Program of NA61/SHINE at the CERN SPS

Content :

The NA61/SHINE experiment at the CERN SPS aims to discover the critical point of strongly interacting matter and study properties of the onset of deconfinement. These goals will be reached by measurements of hadron production properties in nucleus-nucleus, proton-proton and proton-lead interactions as a function of collision energy and size of the colliding nuclei. Furthermore, NA61/SHINE will perform numerous precision measurements needed for neutrino (T2K) and cosmic-ray (Pierre Auger Observatory and KASCADE) experiments. This contribution summarizes physics arguments for the NA61/SHINE ion program and presents the status and plans of the experiment for the next 5 years.

Summary :

The NA61/SHINE experiment at the CERN SPS aims to discover the critical point of strongly interacting matter and study properties of the onset of deconfinement. These goals will be reached by measurements of hadron production properties in nucleus-nucleus, proton-proton and proton-lead interactions as a function of collision energy and size of the colliding nuclei. Furthermore, NA61/SHINE will perform numerous precision measurements needed for neutrino (T2K) and cosmic-ray (Pierre Auger Observatory and KASCADE) experiments. This contribution summarizes physics arguments for the NA61/SHINE ion program and presents the status and plans of the experiment for the next 5 years.

Primary authors : GAZDZICKI, Marek (Frankfurt University)

Co-authors : NA61/SHINE, Collaboration (CERN)

Presenter : GAZDZICKI, Marek (Frankfurt University)

Track classification : SPS Hadrons and Ions

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Track judgments :

Track : SPS Hadrons and Ions

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Date :
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Abstract ID : 48

The OSQAR Experiments at CERN for Low Energy Laser-based Particle/Astroparticle Physics

Content :
A collaboration between eight European Institutes and CERN is working on a new "2-in-1", laser-based Particle Physics experiments for Optical Search of QED vacuum magnetic birefringence, Axions and photon Regeneration (OSQAR). Since its prediction in 1936 by Euler, Heisenberg and Weisskopf in the earlier development of the Quantum Electrodynamic (QED), the Vacuum Magnetic Birefringence (VMB) is still a challenge for optical metrology. Contributions to the VMB could also arise from new light scalar/pseudo-scalar particles like axions that couple to photons and this would manifest itself as a sizeable deviation from the pure QED prediction. On one side the interest in axion, providing the most plausible solution to the so-called strong-CP problem, lies beyond Particle Physics and overlaps with Cosmology since such particle is also considered as a serious dark matter candidate. On the other side, the domain of Physics that will be investigated is guaranteed by the QED, which aimed to be tested down to the 10^-22 level by measuring the relative difference of the vacuum refractive indices in a 9.5 T field. The measurement for the first time of this "vacuum anomaly" of the refraction index is in the same line than the measurement of the anomalous magnetic moment of the muon performed in the early years of CERN by G. Charpak et al. (1961). By re-using major achievements of the Large Hadron Collider (LHC), like superconducting dipoles and test infrastructure, OSQAR offers a unique opportunity to launch at CERN an innovative research programme in the emerging field of laser-based Particle/Astroparticle Physics.

Summary :
The status of the OSQAR project will be reported together with the theoretical background, first results (published in Phys. Rev. D 78, 092003, 2008) as well as short and long term perspectives.

Primary authors : Dr. PUGNAT, Pierre (CERN) ; Prof. MEISSNER, Krzysztof A. (University of Warsaw, Poland) ; Dr. SIEMKO, Andrzej (CERN) ; Prof. DUVILLARET, Lionel (IMEP-LAHC, CNRS-INPG, France) ; Dr. BARBARA, Bernard (Institut NEEL, CNRS, France) ; Dr. BALLOU, Rafik (Institut NEEL, CNRS, France) ; Dr. FINGER, Michael (Charles University, Czech Republic) ; Prof. FINGER, Miroslav (Charles University, Czech Republic) ; Dr. HOSEK, Jan (Czech Technical University) ; Prof. JOST, Remy (LSP, CNRS-UJF, France) ; Dr. ROMANINI, Daniele (LSP, CNRS-UJF, France) ; Dr. KRAL, Miroslav (Czech Technical University) ; Dr. SCHOTT, Matthias (CERN) ; Dr. SRNKA, Ales (ISI, Czech Republic) ; Dr. SULC, Miroslav (Technical University of Liberec, Czech Republic) ; Dr. VITRANT, Guy (IMEP-LAHC, CNRS-INPG, France) ; Prof. ZICHA, Josef (Czech Technical University)

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Track classification : PS and Non-accelerator Experiments

Contribution type : --not specified--

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Track : PS and Non-accelerator Experiments

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Abstract ID : 49

Shock Tests of a Solid Target for High Power Proton Beams

Content :
In the design of a number of high power proton driver projects, such as a neutrino factory, neutrino superbeam, pulsed spallation source (e.g. ESS), etc, a pulsed proton beam of 4-5 MW mean power bombards a target to produce secondary particles such as pions and neutrons. Several target designs have been proposed including liquid metal and solid targets. Currently, we are investigating the feasability of a solid tungsten target for a Neutrino Factory. The target is cooled by thermal radiation at ~1500 K. The target is subject to severe thermal shock by the high energy density deposited in a short time. A simple calculation reveals that the stress from a single pulse will exceed the strength of the material by several times and hence tha target is likely to suffer machanical damage after one pulse. However, experience of similar targets at high stress, such as the Pbar targets at FNAL indicate that they do not fail. We have carried out tests by passing high current fast pulses through thin (0.5 mm diameter) tungsten wires at temperatures at up to 1800 K. The wires have survived tens of millions of pulses at the same stress levels expected in the target. In addition, the properties of the material under both shock and high temperature conditions are being investigated by measuring the surface motion of the wires using VISAR and Vibrometer techniques. It is now essential to confirm the lifetime and material properties of a more representative sized bar of tungsten - and ideally a full size bar, 1-2 cm diameter, 20-25 cm long. For this about 50-100 thousand pulses would be required at an appropriate energy density. We believe this energy density can be achieved at ISOLDE or a dedicated target tet facility.

Summary :
An experiment is proposed using the pulsed proton beam from one of the CERN accelerator facilities to examine a tungsten bar target of 1-2 cm diameter to confirm measurements of lifetime and mechanical properties at high temperature under thermal shock conditions carried out on a 0.5 mm diameter tungsten wire. This experiment would provide important information for EUROnu FP& Design Study.

Primary authors : Dr. BENNETT, James (STFC/RAL) ; Dr. EDGECOCK, Rob (STFC/RAL)

Co-authors : Dr. SKORO, Goran (Sheffield University) ; Dr. BOOTH, Chris (Sheffield University) ; Dr. BACK, John (Warwick University)

Presenter : Dr. BENNETT, James (STFC/RAL)

Track classification : ISOLDE ; Test Beams & Irradiation facilities

Contribution type : --not specified--

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Track : Test Beams & Irradiation facilities

Judgment :
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Comments : ""

Abstract ID : 50

Antiprotonic atom X-ray studies at AD from selected elements with low Z

Content :

The study of light antiprotonic atoms gives access to various phenomena both of strong interaction and cascade effects originating from the interplay of the electron shells with the antiproton during the de-excitation cascade occurring after capture. The performance of fast read-out CCDs can be exploited to measure X-rays in the energy range of about 1 – 50 keV. This requires a DC beam of low-energy antiprotons which may be provided by slow extraction from traps like MUSASHI operated in the ASACUSA experiment at AD. Examples for measurements feasible at AD with its present performance are given below. Ultimate resolution studies with crystal spectrometers, however, will require in the majority of cases intensities comparable to the ones obtained from LEAR during its last years of operation and, thus, are subject to the forthcoming FLAIR facility. The strong antiproton-nucleus interaction shows up in an energy shift and broadening of the low-lying atomic levels and is obtained from energy shift and line width of the feeding X-ray transitions. Because of the very strong annihilation already from states with non vanishing angular momentum, the ground-state transition (2p-1s) is observable only for the hydrogen isotopes. In particular, only here the spin-spin interaction at threshold can be studied by means of the 1s hyperfine splitting. The lowest level accessible with X-rays is 2p in the case of helium and lithium and 3d for carbon, nitrogen and oxygen. The broadening of the upper level (3d or 4f), which is small compared to a semiconductor detector resolution, can be obtained from the intensity balance of the feeding transitions to the last observable transition (□(nf-3d)/(3d-2p) or □(ng-4f)/(4f-3d). The strong interaction isotope effects in light antiprotonic atoms give access to the relative strengths of the annihilation of antiprotons on protons and neutrons and is relted to neutron halo studies in heavy nuclei. As a first step the investigation of the Li isotopes is proposed by using solid targets and slow antiprotons extracted continuously from MUSASHI (ASACUSA). As a second step, an extension to gaseous targets is planned by installing a low pressure gas cell with an ultrathin window. In particular for the helium isotopes, more precise data are highly desirable. In addition, isotope effects in nitrogen and oxygen and neon isotopes can be studied with small amounts of enriched isotopes. In the case of neon, the measurement of the upper level may become feasible. The low density of the gas and the low detection threshold of the fast CCDs down to energies of less than 1 keV are especially suited to determine the upper level width from the intensity balance. With the same set-up, because of the low energy threshold, the depletion of the high- lying levels in antiprotonic noble gases can be studied for very high-lying states revealing the interplay of Auger emission and radiative de-excitation. Chemical effects can be studied by comparing, e.g., the atomic cascade of various CnHm or NOx compounds. Selected references: D.Gotta, Prog. Part. Nucl. Phys. 52 (2004) 133 (review low Z), http://asacusa.web.cern.ch/ASACUSA/ (ASACUSA/MUSASHI), M. Schneider et al., Z. Phys. A 338 (1991) 217 (pbarHe), H. Poth et al., Nucl. Phys. A466 (1987) 667 (pbarLi), Th. Köhler et al., Phys. Lett. B 176 (1986) 327; D. Rohmann et al., Z. Phys. A 325 (1986) 261 (pbarO), D. Gotta et al., Eur. Phys. J. D47 (2008) 11 (noble gases), H.Gorke et al., AIP conf. proc. 793 (2005) 341 (fast CCDs).

Summary :

see above

Primary authors : GOTTA, Detlev (Research Center Juelich)

Co-authors :

Presenter : GOTTA, Detlev (Research Center Juelich)

Track classification : Antiproton Decelerator (AD)

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Track : Antiproton Decelerator (AD)

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Abstract ID : 51

An Experiment to Measure Antihydrogen Free Fall

Content :

In our Letter of Intent of 2007 [1], we expressed our interest to use the CERN antiproton beam for a measurement of the acceleration of antihydrogen atoms in the gravity field of the Earth. The first step is to produce the Hbar+ ion, which can be manipulated and cooled down to μK temperatures (i.e. m/s velocities) according to Walz and Hänsch [2]. The excess positron can then be laser detached in order to recover the neutral and slow Hbar atom. Production involves a dense target made of positronium through the charge exchange process pbar + Ps ⟶ Hbar + e-, followed by Hbar + Ps ⟶ Hbar+ + e-. The antiprotons must be accumulated from the AD into a Penning trap such as developed in the ASACUSA collaboration. The high number of antiprotons needed would also benefit from an increased flux at low energies such as envisaged in the ELENA project. The positronium target is obtained by dumping 10**10 to 10**11 positrons, also from a Penning trap, onto a material that converts them into Ps. We have fabricated nanoporous SiO_2 layers and measured their high efficiency to produce slow Ps [3]. An intense positron source is necessary to produce the required Ps density. We are developing a positron source based on a small electron linac, which is presently being commissioned at Saclay. Such a source could be placed in the AD hall and should produce of the order of 10**8 slow e+ per second. Distribution of these slow positrons to other experiments could be considered. [1] A new path to measure antimatter free fall, P. Pérez et al. CERN-SPSC-2007-038, CERN-SPSC-I-237, December 2007. [2] A Proposal to Measure Antimatter Gravity Using Ultracold AntihydrogenAtoms, J. Walz and T. Hänsch, General Relativity and Gravitation 36 (2004) 561. [3] Positronium reemission yield from mesostructured silica films, L. Liszkay et al., Appl. Phys. Lett. 92, 063114 (2008).

Summary :

We propose a measurement of the acceleration of antihydrogen atoms in the gravity field of the Earth using Hbar+ ions. Production involves a dense target made of positronium from the conversion of slow positrons. These positrons are themselves produced with a setup such as the one we are developing at Saclay, which comprises a small electron linac and a Penning trap. The antiprotons must be accumulated from the AD into a Penning trap such as in the ASACUSA collaboration. The high number of antiprotons needed would also benefit from an increased flux at low energies as envisaged in the ELENA project.

Primary authors : Dr. PEREZ, Patrice (IRFU, CEA-Saclay, France) ; Prof. DEBU, Pascal (IRFU, CEA-Saclay, France) ; Mr. DUPRE, Pierre (IRFU, CEA-Saclay, France) ; Dr. LISZKAY, Laszlo (IRFU, CEA-Saclay, France) ; Dr. MANSOULIE, Bruno (IRFU, CEA-Saclay, France) ; Dr. MURANAKA, Tomoko (IRFU, CEA-Saclay, France) ; Dr. REY, Jean-michel (IRFU, CEA-Saclay, France) ; Mr. RUIZ, Nicolas (IRFU, CEA-Saclay, France) ; Dr. SACQUIN, Yves (IRFU, CEA-Saclay, France) ; Prof. MOHRI, Akihiro (Atomic Physics Laboratory, RIKEN, Wako 351-01, Japan) ; Dr. KURODA, Naofumi (Institute of Physics, University of Tokyo, Komaba, 153-8902 Tokyo, Japan) ; Prof. YAMAZAKI, Yasunori (Atomic Physics Laboratory, RIKEN, Wako 351-01, Japan)

Co-authors :

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Track classification : Antiproton Decelerator (AD)

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Abstract ID : 52

Measurement of octupole collectivity in 220,222Rn and 222,224Ra using Coulomb excitation

Content :

The long range octupole-octupole part of the nuclear force is pronounced in nuclei for which the Fermi level is situated between close-lying subshells with a difference of total and orbital angular momentums of 3 [1]. Among others, such a configuration space is realised in the mass region near Z=88 (2f7/2; 1i13/2) and N=136 (2g9/2; 1j15/2), where 220,222Rn and 222,224Ra are situated. Especially, 224Ra is predicted in various models to be the most octupole soft nuclei. In some models even a static octupole deformation is predicted for this particular nucleus. The octupole softness/deformation is reflected in the low-lying level schemes of these nuclei, which were established in multi-nucleon transfer reactions [2,3]. Hereby, extremely low excitation energies for the octupole excitations (224Ra: E(3−)=290.4 keV) as well as the characteristic odd-even parity staggering for the Yrast states for levels with spin > 5 were observed. However, so far, no experimental information for the B(E3,0+ -> 3−) strength, directly related to the degree of octupole deformation beta_3, is available. Recent Coulomb excitation experiments on neutron-deficient Hg isotopes [4] demonstrated the unique capabilities of the ISOLDE facility to produce heavy nuclei in a sufficient amount and post-accelerate them using the REX Linac. Thus for the first time spectroscopic information about the crucial E3 transition strength, exploiting the well-established Coulomb excitation technique, can be obtained. Beyond the scope of nuclear structure this experiment is a first step towards the search for CP-violating effects inherent in the nuclear force. In octupole deformed odd-mass isotopes the pear-shaped octupole deformation of the intrinsic mean field results in close-lying parity doublets of particle-core coupled states [5]. In presence of parity violating forces the opposite parity partner will mix and the induced Schiff moment in the body-fixed frame is enhanced proportional to the octupole deformation. This makes the odd-mass Ra isotopes to a more favorable experimental laboratory for the search for flavorless CP-violation, than the classical case 199Hg [6]. [1] P. A. Butler and W. Nazarewicz, Rev. Mod. Phys. 68, 349 (1996). [2] J. F. C. Cocks et al., Phys. Rev. Lett. 78, 2920 (1997). [3] J. F. C. Cocks et al., Nucl. Phys. A645, 61 (1999). [4] P. A. Butler et al., ISOLDE proposal IS452. [5] N. Auerbach et al., Phys. of Atom. Nucl. Vol. 70, No. 9, 1654 (2007). [6] J. Dobaczewski and J. Engel, Phys. Rev. Lett. 94, 232502 (2005).

Summary :

An outlook for a proposed experiment utilizing the REX-ISOLDE facility to post- accelerate the, at this time then, heaviest post-accelerated radioactive beams is given. Applying the well established Coulomb excitation technique we will determine the degree of octupole collectivity in 220,222Rn and 222,224Ra. These nuclei are of particular interest, because in their odd-mass neighbors the theoretically predicted static octupole deformation would amplify possible parity violating effects inherent in the nuclear force.

Primary authors : Dr. SCHECK, Marcus (University of Liverpool)

Co-authors : Prof. BUTLER, Peter A. (University of Liverpool) ; GAFFNEY, Liam P. (University of Liverpool)

Presenter : Dr. SCHECK, Marcus (University of Liverpool)

Track classification : ISOLDE

Contribution type : --not specified--

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Abstract ID : 53

Into the Future with ISOLDE: Perspectives for Laser Spectroscopy Near the Doubly-Magic 100Sn and 132Sn

Content :

Collinear laser spectroscopy is a well-established experimental method for measuring spins, electromagnetic moments and root mean-square charge radii on nuclear ground and isomeric states. These are highly-sensitive probes of the nuclear intrinsic structure as well as of global nuclear properties like sizes and shapes. Collinear laser spectroscopy is, therefore, a key contributing factor for enriching our understanding of the atomic nuclei, in particular near closed shells, where experimental input is of critical importance for enhancing the predictability of nuclear theories. In the last few decades the achievements of collinear laser spectroscopy are inextricably bound to the successes of ISOLDE in isotope production and separation. Most recent highlights include the studies of 31Mg [1] and 33Mg [2] in the "island of inversion", a region where deformation drives properties of nearly-magic nuclei away from the valley of stability, the unraveling of the halo structures in the exotic nuclei 11Li [3], 11Be [4], and 17Ne [5], and the confirmation of monopole migration and inversion of states in 75Cu [6]. We aim to transfer the gathered knowledge and experience into the future with HIE-ISOLDE, where one of many exciting possibilities will be to probe the structure of the very-exotic nuclei near the doubly-magic 100Sn and 132Sn. These regions are of primary interest for studying the shell structure away from stability, which on the neutron-rich side is directly related to the duration of the r-process as it propagates over the waiting-point nuclei from zirconium to cadmium along N=82. Thus, the relevance of laser spectroscopy extends over to one of the fundamental questions in science, the synthesis of the matter constituting our world. The case of cadmium, with only two proton holes in the magic Z=50 shell, is of primary nuclear-structure interest. A number odd-mass isotopes possess two b-decaying states with very different intrinsic structure. These are poorly understood, as no spins and moments are measured away from the valley of stability. The scarcity of experimental data has to be overcome before building a coherent picture of this exotic region. The evolution of the nuclear shape along the cadmium chain and certainly the abrupt transition to sphericity at 130Cd, whose first 2+ state is considerably higher than in the lighter isotopes [7], would be detectable in the charge-radii changes from collinear laser spectroscopy. Approaching the nuclei near the doubly-magic 100Sn and 132Sn requires a new generation of technical solutions, such as higher production rates, improved beam dynamics, more efficient beam purification and higher-sensitivity detection methods. ISOLDE with its natural evolution into HIE-ISOLDE already provides considerable improvements for undertaking research in that direction. Laser spectroscopy on cadmium would certainly benefit from the recently-commissioned radio-frequency Paul trap for cooling and bunching the ion beam [8], which increases the sensitivity of the method by more than two orders of magnitude. [1] G. Neyens et al., Phys. Rev. Lett. 94, 022501 (2005). [2] D. T. Yordanov et al., Phys. Rev. Lett. 99, 212501 (2007). [3] R. Neugart et al., Phys. Rev. Lett. 101, 132502 (2008). [4] W. N⊠ortersh⊠auser et al., Phys. Rev. Lett. 102, 062503 (2009). [5] W. Geithner et al., Phys. Rev. Lett. 101, 252502 (2008). [6] K. T. Flanagan et al., in preparation. [7] A. Jungclaus and J. L. Egido, Phys. Scr. T125, 53 (2006). [8] H. Franberg et al., Nucl. Instr. and Meth. in Phys. Res. B 266, 4502 (2008).

Summary :

We aim to study the chain of cadmium with high-resolution laser spectroscopy for the first time. Our goal is to determine nuclear spins, moments and charge radii of ground and isomeric states between the neutron 50 and 82 shell closures and therefore to contribute decisively for a better understanding of the nuclear structure in the vicinity of the doubly-magic 100Sn and 132Sn. On the neutron-rich side in particular, this is expected to shed light on a shell-quenching hypothesis and consequently on the duration of the r-process along the waiting-point nuclei below 130Cd.

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Co-authors : FOR, The (COLLAPS collaboration)

Presenter : Dr. YORDANOV, Deyan (Max-Planck-Institut für Kernphysik)

Track classification : ISOLDE

Contribution type : --not specified--

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Abstract ID : 54

CMS Test Beams in the coming years

Content :
Current level of understanding of needs of CMS Collaboration for test beam and irradiation facilities in the coming years is presented. An outline of major areas of interest and planned activities is discussed.

Summary :
CMS experiment was a result of many years of minutious work on detector R, installation and commissioning. However, by the time the detector was built, the announced parameters of SLHC made a part of the applied techniques obsolete and opened the field for further detector and electronics developments. The collaboration is also aware that the operation of such a complex device in realistic conditions of high radiation environment and strong magnetic field may introduce a need for additional studies of the way the detector behaves. Both of these areas will require an access to reasonably realistic test facilities.

Primary authors : Dr. LAZIC, Dragoslav-laza (Boston University)

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Presenter : Dr. LAZIC, Dragoslav-laza (Boston University)

Track classification : Test Beams & Irradiation facilities

Contribution type : --not specified--

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Yes, I know it is a last minute...

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Abstract ID : 55

Future Irradiation Facilities at CERN

Content :
The CERN-wide working group on future irradiation facilities at CERN (http://www.cern.ch/irradiation-facilities) has recently conducted a broad user inquiry in order to get a clear picture of the needs for irradiation facilities at CERN. The inquiry was addressed to potential users from accelerator, experiment and radiation safety communities. As a result of the inquiry, the working concludes that 4 complementary facilities will be needed. For these 4 facilities the working group is currently preparing formal specification documents and proposals for implementation plans.

Summary :
The 4 complementary facilities are distinguished by the type of beam they shall provide: 1. Proton and ion irradiations at high energy and high density (fast extraction) (HiRadMat) 2. Proton irradiations at high intensity (slow extraction) 3. Mixed field irradiations, slow extraction 4. Gamma irradiations in the presence of a muon beam (GIF++)

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Track classification : Test Beams & Irradiation facilities

Contribution type : --not specified--

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Comments :

This abstract is submitted on behalf of the working group on future irradiation facilities at CERN

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Abstract ID : 56

DevDet: test beam infrastructures for SLHC, Linear Collider, Neutrino and B-physics communities

Content :
The DevDet project proposal, submitted to the European Commission in February 2008, describes detector development infrastructures for particle physics experiments. The DevDet project proposal is the result of a collective effort by the SLHC, Linear Collider, Neutrino and B-physics communities. In total 87 institutes from 21 countries joined DevDet. In particular, the proposal describes the testbeam requirements for the 4 different communities for the coming years. These test beam requirements provide valid input for the current workshop on new opportunities in the physics landscape at CERN.

Summary :
More details on DevDet can be found at its web site: http://project-fp7-detectors.web.cern.ch/project-FP7-detectors/Default.htm There are concrete plans to re-submit DevDet to the European Commission in 2009.

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Abstract ID : 57

Search for T violation in kaon decays using stopped positive kaons

Content :

One of the current topics in kaon decay physics is the search for violation of time reversal invariance (T violation). The most sensitive search is provided by the measurement of transverse muon polarization (PT) in the K^+-->pi^0 mu^+ nu decay, related to CP violation beyond the standard model. The physics potential in terms of discovery of new physics along with the power to constrain exotic models is competitive with other low energy experiments being planned or prepared, since the contribution to PT from the standard model is only in higher order and negligibly small and also the final interaction spurious effect is small. This channel is sensitive in particular to charged-Higgs dynamics and the accompanied CP violation. In order to perform such a symmetry test experiment with high precision, it is essential to suppress systematic errors in addition to obtain high statistical accuracy using a high intensity beam. For the suppression of systematics the use of stopped K^+ from a low momentum beam in conjunction with a symmetrical detector is most powerful. The most recent result of PT comes from the KEK-PS E246 experiment which gave |PT|<0.0050 (90% C.L.) [1]. A next generation experiment is now planned at J-PARC as the TREK experiment [2] aiming for a sensitivity of 10^-4. [1] M. Abe et al., Phys. Rev. D73, 072005 (2006) [2] TREK proposal; http://research.kek.jp/group/trek/proposal/index.html

Summary :

The importance of search for T violation in kaon decays is discussed. The muon transverse polarization PT in the K^+-->pi^0 mu^+ nu is sensitive to new physics beyond the standard model. Current experimental situation is introduced.

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Abstract ID : 58

Search for doubly charmed baryons

Content :

Hadron spectroscopy is an important tool in the understanding of strong interaction at large distances. Heavy quarks offer an important advantage as they constitute a static source of colour to all other quarks. Baryons with single charm or beauty quarks have been studied in recent times and in the case of charmed baryons many excited states have been identified, partially with surprising results (see heavy Lambda_c at a mass of about 2600 MeV/c**2). Baryons with two heavy quarks offer an interesting extension to this field of research, as the structure of the ground state looks meson like with a single light quark feeling a quasi static colour charge in the center similar to a B-meson . Excited states may show vibrational and rotational structures of the heavy pair in addition to the excitation of the light system, thus being quasi molecular. Experimental evidence for such states is still very weak as they only have been observed at a hyperon beam experiment at FNAL (SELEX), produced relatively copiously. Mass splittings and lifetimes observed deviate from expectations and are not really understood. We thus intend to continue this research. As such states have not been observed in photo- nor simple hadro-production we intend to repeat the experiment with high energy hyperons using the COMPASS spectrometer. COMPASS offers a modern high rate spectrometer, a prerequisite for such studies. The drawback of it is the maximal energy at the SPS of only 400 (450) GeV/c offering at most 350-400 GeV/c hyperons impinging on a target as compared to 600 GeV/c at SELEX. If the cross sections of FNAL can be confirmed, COMPASS should produce doubly charmed baryons copiously, allowing also to study the excitation spectrum of theses states.

Summary :

Spectroscopy of baryons with heavy quarks play a central role in understanding strong interactions. Heavy quark offer an important advantage as they constitute a static source of colour to all other quarks. Experimental evidence for doubly charmed baryons is still very weak as they only have been observed at a hyperon beam experiment at FNAL (SELEX), produced relatively copiously. COMPASS offers a modern high rate spectrometer, a prerequisite for such studies.

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Co-authors : COMPASS, Collaboration (CERN)

Presenter : Prof. PAUL, Stephan (Technical University Munich)

Track classification : SPS Hadrons and Ions

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Abstract ID : 59

Neutrino-oriented measurements at the ISOLTRAP/CERN

Content :
The neutrino emitted during the electron capture decay of a nucleus is monochromatic and has low energy. This remarkable fact opens a way for a comprehensive investigation of the electron neutrino: (1) The mass of the electron neutrino can be determined by microcalorimeters analyzing the atomic de-excitation spectrum following electron capture. (2) The neutrino oscillation length L32 can be measured in a relatively compact Time Projection Chamber (TPC). (3) The probability of neutrino-less double electron capture decay can be resonantly enhanced, if its decay energy is equal to the sum of the binding energies of the captured electrons. Its successful observation will mean that the neutrino is a Majorana particle. A prerequisite to this investigation is the knowledge of the decay energy, i.e. Q-value, of the electron capture decay with an accuracy on the level of 1 keV for the oscillation length L32 and down to a few eV for the neutrino mass. Such an accuracy for Q-values can be achieved nowadays only by Penning trap mass spectrometry by directly measuring the masses of the parent and daughter nuclides. The facility at which such high-precision mass measurements can be carried out has to provide (1) access to a variety of nuclides which decay by electron capture, (2) a monoisotopic beam of the nuclide of interest, and (3) highly charged ions of interest up to bare nuclei. ISOLDE can fulfill all these requirements and will be a unique facility suitable for the envisaged neutrino-oriented investigations because (1) a broad range of nuclides, which decay by electron capture, can be produced with high yields, (2) ISOLDE can deliver pure radioactive beams by application of the laser ion source, (3) highly charged ions can be charge-breeded by installation of an electron beam ion trap (EBIT), and (4) the ISOLTRAP Penning trap mass spectrometer, which is installed at ISOLDE and has been successfully applied to measure the masses of hundreds of nuclides, can be pushed to the required performance. A program to search suitable candidates for neutrino-oriented investigations has already been launched at ISOLTRAP and is successfully running. However, ISOLTRAP in its current state can only handle singly or doubly charged ions. That limits the accuracy of mass measurements to the level of keV or some hundred eV. Since the present cooling mechanism (buffer gas cooling) is excluded when investigating highly charged ions, evaporating cooling must be applied. In that case, the 'hottest' ions are forced to escape from the trap. This will result in large losses which must be compensated by higher yield as provided by the HIE-ISOLDE project.

Summary :
Monochromaticity of the neutrino emitted in electron capture decay of a nucleus opens a way for an investigation of the neutrino properties such as the neutrino mass, oscillation length L32 and its type (Majorana or Dirac). This requires the knowledge of Q-value of electron capture decay with an accuracy of 1eV to 1keV. Such an accuracy for Q-values is achievable only by Penning trap mass spectrometry by directly measuring the masses of the parent and daughter nuclides. Access to a variety of electron capture decay nuclides, highly selective RILIS ion sources and the Penning trap mass spectrometer ISOLTRAP makes the ISOLDE facility unique for measurements of required Q-values with an accuracy of of 1keV or some hundred eV. An upgrade of ISOLTRAP, as is foreseen in the HIE-ISOLDE project, will allow one to reach much higher accuracies, thus making possible the mentioned program on neutrino investigation.

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Abstract ID : 60

Crucial tests of chiral perturbation theory at COMPASS

Content :

Scattering high-relativistic charged pions in the Coulomb field of nuclei, denoted the Primakoff effect, accesses (quasi-real) photon-pion reactions with different final states. Apart the scattered charged pion, these have with increasing threshold, a real photon, or one or more neutral pions. The first process, effectively pion Compton scattering, is a clean way to determine the leading-order threshold deviation from the structureless QED cross section, parametrised in the pion polarisabilities. Those play a key role in understanding the standard model low-energy expansion of QCD (chiral perturbation theory, ChPT). This test of ChPT can be extended to kaons if an appropriate beam is available. A single neutral pion produced via the Primakoff effect violates natural parity in the process, parametrised in the chiral anomaly amplitude, for which ChPT also provides a firm prediction, to be tested experimentally. Equivalently, double neutral pion production, allowed in ChPT at tree level, constitutes a test of pion- pion scattering at low energy. At the adjacent region of higher center-of-momentum energies, resonances formed in pion-photon scattering, including exotic candidates, can be studied. The measurements require pion and kaon beams and a spectrometer with high rate capability and excellent electromagnetic calorimetry, which are available with the unique SPS-M2 beam line and the COMPASS spectrometer. Here the possibility to switch rapidly from a pion/kaon beam to a muon beam offers a unique possibility to directly compare point-like and extended particles.

Summary :

The SPS-M2 beam line offers a unique possibility for essential tests of chiral perturbation theory, particularly by measuring the pion (and kaon) polarisabilities and the chiral anomaly amplitude.

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Co-authors : COMPASS, Collaboration (CERN)

Presenter : Dr. FRIEDRICH, Jan (Technical University Munich)

Track classification : SPS Hadrons and Ions

Contribution type : --not specified--

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Abstract ID : 61

Production of high-energy secondary beam of ion fragments for experiments and instrument tests at CERN SPS

Content :
Following the request of the fixed target experiment, NA61/SHINE, the production of secondary multi-ion beams based on the fragmentation of a primary ion beam is proposed and studied. The fragmentation process of the impinging ions from SPS (typically fully stripped Pb82+ or In49+) provides secondary ions moving with a similar momentum per nucleon as the incident beam. Without major modifications to the existing secondary beam lines of the SPS North Area (like the H2, H4, or H8 beam lines), ion beams with a significantly enhanced yield of a wanted nuclei (a selected Z and A combination) can be produced. Additional instrumentation, partly along the beam line like CEDAR or threshold Cherenkov counters, and partly at the experiment side such as Cherenkov and scintillator detectors to measure the charge state of the ions, can be easily installed to allow tagging of the wanted ions with high precision. The application for a secondary P(Z=15,A=32) ion beam obtained from a 46 A-GeV/c Pb82+ primary beam as requested by the NA61/SHINE physics is presented. The intensity of the wanted ion beam is reduced by a factor of about 10^{-4} with respect to the intensity of the primary Pb beam. Secondary ion beams can be of use of future ion experiments or instrumentation tests.

Summary :
Secondary ion beams can be of use of future ion experiments or instrumentation tests.

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Abstract ID : 62

E0 transition strength measurements of shape-coexisting 0^+ states via conversion electron spectroscopy

Content :

Important insights to nuclear structure can be gained from studying deformed nuclei with coexisting shapes. Therefore a vital field of nuclear structure research at REX-ISOLDE is devoted to the investigation of shape coexistence in various regions of the nuclidic chart, drawing from the unique capabilities by REX-(in the future: HIE-)ISOLDE combined with high-resolution gamma spectroscopy with the MINIBALL spectrometer following Coulomb excitation and transfer reactions. These studies should be complemented by direct measurements of transition strengths of E0 ground state transitions from excited 0^+ states. Moreover, the interpretation of gamma spectroscopic data can be complemented by the measurement of converted low energy transitions especially in heavy nuclides. This can be achieved via conversion electron spectroscopy following beta decay. We recently developed a highly sensitive experimental setup based on a Mini Orange magnetic electron transport and filter system, which was successfully applied to the first identification of the E0 transition from the first excited (deformed) 0^+ state in 30Mg to the (spherical) ground state at the borderline of the 'Island of Inversion'. We propose to apply this technique complementary to gamma spectroscopy for the strong research program at ISOLDE aiming at shape coexistence studies, providing quantitative direct measurements of the electric monopole transition strength rho^2(E0). Isotopes of interest range from light nuclei like ^32Mg inside the island of inversion to heavy nuclei in the Hg and Pb mass region.

Summary :

It is proposed to complement gamma spectroscopic studies in nuclei with coexisting nuclear shapes by conversion electron measurements, aiming at direct measurements of E0 transitions (and thus of the electric monopole strength) . Gamma spectroscopic studies especially in heavy nuclei can be complemented by the measurement of converted low energy transitions.

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Abstract ID : 63

Future opportunities for emission channeling lattice location experiments using position-sensitive detectors and radioisotopes produced at HIE-ISOLDE

Content :

Emission channeling is a sensitive technique to measure the lattice location of radioactive impurities embedded in single crystals. It is based on the fact that charged particles from nuclear decay (alpha, beta-, beta+, conversion electrons, Auger electrons) experience channeling or blocking effects along major crystallographic axes and planes. The resulting anisotropic emission yield from the crystal surface characterizes the lattice site occupied by the probe atoms during decay and is measured using position-sensitive detectors. In particular we use - Si pad detectors (developed at CERN for the Compton camera project) and Si pixel detectors (under consideration are MediPix, TimePix) for the detection of electrons in the energy range > 40 keV up to several MeV (beta-, beta+, conversion electrons); - Charged Coupled Devices (CCDs) for the detection of very low-energy conversion electrons (< 40 keV) and Auger electrons; - Si detectors working with the principle of resistive charge division for the detection of alpha particles > 1 MeV. The main application of emission channeling is the lattice location of electrical, optical and magnetic dopants in semiconductors and oxides, e.g. electrical dopants in novel wide-band gap semiconductors such as ZnO, AlN, InN and diamond, transition metals and rare earths as magnetic impurities in spintronic materials, and rare earths as optical dopants in nitride semiconductors. In order to suppress dechanneling, the radioisotopes used for emission channeling experiments must be incorporated at a depth smaller than a few thousand Å below the surface of the sample, which is usually accomplished by means of low-energy ion implantation. The technique hence relies on the availability of a wide range of pure beams of radioisotopes at relatively high intensities (> 10E6 ions/s) but low energies (< 100 keV), for which ISOLDE is a unique facility. In particular, such beams have not been foreseen to be developed at SPIRAL or FAIR. Emission channeling experiments have successfully been demonstrated using ~65 different isotopes of a variety of elements including Li, Na, P, Ca, Fe, Cu, Ga, As, Se, Br, Rb, Sr, Ag, Cd, In, Sn, Sb, I, Xe, Ce, Pr, Nd, Pm, Sm, Eu, Gd, Tm, Yb, Lu, Hf, Au, Hg, Bi, Po, At, Rn, Fr and Ra. The beam intensity upgrade and the new target and ion source developments foreseen at HIE-ISOLDE, in particular the upgrade of the resonant laser ion source (RILIS) along with new ionization schemes and improved techniques for reducing surface-ionized radioisotopes, will make available pure radioactive beams for a number of elements which have been unavailable so far, or of insufficient purity or intensity. Among the radioactive probes which are feasible at HIE-ISOLDE in the near future are, e.g., 27Mg (9.5 min), 31Si (2.6 h), 35S (87.5 d), 65Ni (2.5 h), 75Ge (83 min), 124Sb (60 d), or 198Au (2.7 d). In the long run, we would like to encourage beam development of other promising emission channeling probes, in particular of the light elements, e.g., 8B (0.76 s), 15C (2.5 s), 16N (7.2 s), 19O (27 s), or 33P (25 d).

Summary :

Due to its ability to deliver high-intensity beams of a variety of radioisotopes at relatively low acceleration energy (< 60 keV), HIE-ISOLDE represents a unique facility to do lattice location experiments using the emission channeling technique. Future perspectives for such experiments in contemporary solid state physics are outlined.

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Abstract ID : 64

Towards Functional Spintronics Materials

Content :
The realization of semiconductors that are ferromagnetic above room temperature will potentially lead to a new generation of spintronic devices with revolutionary electrical and optical properties. Recently, ZnO and group-III-nitride based materials have been of growing interest following the theoretical prediction and first reports on experiments of room temperature ferromagnetism in these materials containing transition metals and rare earths as magnetic dopants. With a band gap in the ultraviolet region, devices based on these materials open up a variety of potential applications especially for spin-optoelectronic applications. Essential towards this goal is the thorough understanding of the electrical, optical and diffusive properties of magnetic dopants (Cr, Mn, Fe, Co, Ni) in these materials. ISOLDE with its unique wide range of pure radioactive ion beams, especially in combination with the resonant laser ion source (RILIS), allows the unambiguous characterization of potential magnetic dopants for these materials. Due to the beta-decay of radioactive transition metal and rare earth isotopes, optical transitions detected by photoluminescence spectroscopy (PL) and electronic states within the band-gap determined by deep level transient spectroscopy (DLTS) can be assigned unambigeously to a certain element. Using hyperfine interaction techniques in combination with radioactive probe atoms, like perturbed gamma-gamma angular correlation spectroscopy (PAC) or Mossbauer effect, the interactions amongst different dopants and/or intrinsic defects can be structurally identified on an atomic scale along with potential magnetic interactions. Last but not least, radioactive tracer diffusion allows the determination of the diffusion properties of dopants in compound semiconductors which can be strongly influenced by the stoichiometry, the charge of the involved defects, and the doping level of the material. This influence has been demonstrated recently for CdTe and ZnTe based II-VI semiconductors. This anormal diffusion may even open up the possibility of tailoring the position and width of magnetic layers within a semiconductor.

Summary :
Essential towards spintronics materials based on ZnO and group-III-nitrides is the thorough understanding of the electrical, optical and diffusive properties of magnetic dopants (Cr, Mn, Fe, Co, Ni) in these materials. ISOLDE with its unique wide range of pure radioactive ion beams allows the unambiguous characterization of potential magnetic dopants for these materials.

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Abstract ID : 65

Polarized beams at HIE-ISOLDE – from dreams to reality.

Content :

Radioactive beams of polarized nuclei can contribute substantially to the level of sensitivity of many experiments with exotic nuclei. Therefore obtaining an ion beam of few MeV/u of nuclei with polarized spins is a dream for many physicists. Polarized beams are a must for nuclear moment measurements and for studies of analyzing powers, which provide unique nuclear structure information that cannot be obtained by other means. There are several ways of obtaining an ensemble of nuclei with polarized spins. Among them one can mention the use of laser beams, reaction-induced polarization and by the application of the Tilted Foils (TF) technique. The Tilted Foils is one of the most appealing since it imposes the least requirements and is the easiest to use. In the TF method [1] the polarization is obtained for the atomic electrons via surface interaction of ions traversing a multifoil stack at an oblique angle. The atomic polarization thus produced is subsequently transferred to the nuclear spins. There are examples for the use of post-accelerated TF-polarized ions for Coulomb excitation studies [2] using stable isotopes. These experiments have been done using a LINAC very similar to the one of REX. REX-ISOLDE provides the first opportunity for post-acceleration of polarized radioactive beams. One of the key issues that needs deeper investigation before the TF-polarized beams can be routinely delivered by REX-ISOLDE is the velocity dependence of the polarization obtained. This will be done by the use of a beta-NMR setup, recently provided to ISOLDE by HMI, Berlin. [1] L. Baby et al., J. Phys. G 30, 519 (2004); and references therein. [2] J. Bendahan et al., Zeit. Phys. A331, 343 (1988)

Summary :

polarized beams, HIE-ISOLDE

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Abstract ID : 66

Search for heavy neutrinos in EC decay with the WITCH spectrometer.

Content :

[submitted by N. Severijns for the WITCH collaboration (Katholieke Universiteit Leuven, Westfälische Wilhems Universität Münster, CERN- ISOLDE, Academy of Sciences of the Czech Republic, GSI-Darmstadt, Karlsruher Institut für Technologie).] There is a continuous theoretical interest to introduce sterile neutrinos which could mix with ordinary neutrinos. Traditionally the presence of a high mass sterile neutrino admixture has been researched in beta decay by looking for distortions in the continuous beta spectrum [1]. Recent measurements have shown that full reconstruction of the neutrino momentum [2] provides an equally valid method for determining any heavy neutrino admixture. An overview of the status of this field is given in Ref. [2]. Of special interest for further progress are electron capture (EC) decays because of their simpler kinematics, caused by the fact that only two particles are present in the final state. If in case of the electron neutrino a heavy neutrino mass eigenstate would mix with the light mass eigenstate, the recoil energy of the daughter nucleus will be smaller than in the case with only the light neutrino mass eigenstate being present. The WITCH setup at ISOLDE, a worldwide unique combination of a Penning ion trap and a retardation spectrometer, allows producing isotopically pure samples and subsequently measuring the energy spectrum of the recoil ions from beta decays in the Penning trap. It could thus search for the presence of a heavy neutrino in EC decays by looking for a small EC contribution with a recoil energy that is lower than the one expected for emission of a massless neutrino. The interpretation of the limits that could then be set on the presence of a heavy neutrino mass eigenstate admixing in the ⊠e weak eigenstate would not depend on theoretical predictions. This type of experiment could thus provide model independent and direct limits on the admixture of a heavy neutrino. Two isotopes suited for such experiments with the WITCH setup are 144Eu and 140Pm [3], with EC branches of about 10%, respective half-lifes of 10 s and 9 s, and production yields of the order of 10^8 ions/microCoulomb. Measurements with these isotopes would be sensitive to heavy neutrinos with a mass between 0.5 MeV and 3.0 MeV. Simulations [3] have shown that for reasonable measuring conditions, a 0.5 % to 1 % admixture of a heavy neutrino would result in a relative change of about 5 x 10^-4, resp. 1 x 10^-3 in the relevant part of the recoil ion energy spectrum. Such measurements could be envisaged once the sensitivity of the WITCH setup is fully optimized. [1] J. Deutsch, M. Lebrun and R. Prieels, Nucl. Phys. A 518 (1990) 149. [2] M. Trinczek, et al., Phys. Rev. Lett. 90 (2003) 012501. [3] S. Coeck, Ph. D. thesis, Kath. Univ. Leuven (2007), unpublished.

Summary :

A possible experiment to search for the presence of a heavy neutrino in EC decays, using the WITCH Penning trap + retardation spectrometer setup at ISOLDE is presented.

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Co-authors :

Presenter : SEVERIJNS, Nathal (Instituut voor Kern- en Stralingsfysica - KU-University of Leuven)

Track classification : ISOLDE

Contribution type : --not specified--

Submitted by : NATHAL, Severijns

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Comments :

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Track judgments :

Track : ISOLDE

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Judged by :
Date :
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Abstract ID : 67

Test of the half-life oscillations observed at the ESR storage ring (GSI-Darmstadt) with the WITCH spectrometer at ISOLDE.

Content :

[submitted by N. Severijns for the CERN, Leuven, Aarhus, Chalmers, GSI-Darmstadt, Münster, Valencia, Bratislava2 collaboration.] Recently the studies on highly charged ions with ion storage rings [1] were extended to nuclear electron capture decays of hydrogenlike ions [2]. Careful experiments performed with only a few ions present in the storage ring at any given time have turned out to give a clear non-exponential distribution of the decay times [3]. There is as yet no consensus on the interpretation of this surprising finding, some theory papers have argued that this is a signature of neutrino-flavour mixing [4], whereas others have contested this suggestion [5]. To resolve this question more experimental data are needed. At present the non-exponential decay, an oscillation with period about 7 seconds on top of an exponential decay, has been observed for hydrogenlike 140Pr and 142Pm ions at the 99% confidence level [3]. We are currently exploring the possibility of testing for the effect in very different experimental circumstances, at ISOLDE. The electron capture decaying nuclei would be produced as usual in the ISOLDE targets, bunched in ISCOOL and/or REXTRAP, transferred to REXEBIS where they will be charge bred and finally let to an ion trap where the decay will be monitored. We propose to use the WITCH apparatus for the decay. With the WITCH spectrometer at ISOLDE, a worldwide unique combination of a Penning ion trap and a retardation spectrometer, the energy spectrum of the recoil ions is measured. The mono-energetic recoils from EC decays will show up as a peak that is, in the mass region we will focus on at ISOLDE (i.e. between about A = 20 and A = 40), typically about 80 eV more energetic than the endpoint energy of the recoils from beta+ decays. With the about 1% energy resolution of the spectrometer, these energies will be clearly separable. A random and flat beta particle background will be present under the recoil energy spectrum, the amplitude of which can be determined in the energy region above the EC recoil peak. If the oscillation period scales inversely with the mass of the decaying isotope (as suggested in [3]) it may turn out to be closer to one second for the lighter isotopes. Suitable candidates should therefore have half-lives in the range of one second to one minute. Combining this with the production yields at ISOLDE leaves 19Ne and 35Ar as clear candidates. The layout of the beamline connecting the REX mass separator with WITCH must be done and sufficient vacuum conditions established to allow the multiply charged ions to survive for several seconds. The ions must furthermore be cooled [6, 7] before being let into the decay trap (various choices for the cooling procedure are currently being discussed). This proposed experiment at REXEBIS and WITCH would give important independent information on the process of nuclear electron capture in few-electron systems. Measurements could start as soon as preparatory efforts will have created the required experimental conditions and the presently ongoing beta-neutrino correlation measurements with WITCH will have yielded the physics results. [1] F. Bosch, in The Euroschool Lectures on Physics with Exotic Beams, Vol. I, ed. J. Al-Khalili, E. Roeckl, Lect. Notes. Phys. 651 (Springer, Berlin Heidelberg, 2004) p. 137 [2] Yu.A. Litvinov et al., Phys. Rev. Lett. 99 (2007) 262501 [3] Yu.A. Litvinov et al., Phys. Lett. B 664 (2008) 162 [4] H.J. Lipkin, hep-ph/0801.1465; A.N. Ivanov et al., nucl-th/0801.2121, nucl-th/0803.1289, nucl-th/0804.1311; M. Faber, nucl-th/0801.3262; H. Kleinert and P. Kienle, nucl-th/0803.2938 [5] C. Giunti, Phys. Lett. B 665 (2008) 92; H. Burkhardt et al., hep- ph/0804.1099 [6] J. Bernard et al., Nucl. Instr. and Meth. A 532 (2004) 224. [7] Z. Ke et al., Hyperfine Interact. 173 (2006) 103.

Summary :

It is proposed to check for the recently observed non-exponential distribution of the decay times of several isotopes in the ESR storage ring at the GSI-Darmstadt, using the REX-EBIS charge breeder and the WITCH Penning trap setup at ISOLDE.

Primary authors : SEVERIJNS, Nathal (Instituut voor Kern- en Stralingsfysica - KU-University of Leuven)

Co-authors :

Presenter : SEVERIJNS, Nathal (Instituut voor Kern- en Stralingsfysica - KU-University of Leuven)

Track classification : ISOLDE

Contribution type : --not specified--

Submitted by : NATHAL, Severijns

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Last modified on : Wednesday 01 April 2009

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Track judgments :

Track : ISOLDE

Judgment :
Judged by :
Date :
Comments : ""

Abstract ID : 68

Prospects for tests of CPT using trapped antihydrogen in ALPHA

Content :
We will discuss the future prospects for antihydrogen physics in the ALPHA experiment at the Antiproton Decelerator (AD). The primary goal of this experiment is to spectroscopically compare hydrogen and antihydrogen as a test of CPT invariance. We will identify the physics and technical challenges that must be addressed in order to achieve this goal, and we will suggest a progression of increasingly precise microwave and laser measurements that could be performed on antihydrogen during the advertised operational lifetime of the AD. We will also discuss the impact that construction of the proposed ELENA ring would have on the viability of these measurements.

Summary :
Antihydrogen physics in ALPHA (AD-5) will be discussed.

Primary authors : Prof. HANGST, Jeffrey Scott (Institute of Physics and Astronomy)

Co-authors :

Presenter : Prof. HANGST, Jeffrey Scott (Institute of Physics and Astronomy)

Track classification : Antiproton Decelerator (AD)

Contribution type : --not specified--

Submitted by : HANGST, Jeffrey Scott

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Comments :

Status : SUBMITTED

Track judgments :

Track : Antiproton Decelerator (AD)

Judgment :
Judged by :
Date :
Comments : ""

Abstract ID : 69

Determination of the Vud quark mixing matrix element and searches for new physics in T = 1/2 mirror transitions.

Content :

Radioactive nuclei with well-known nuclear structure properties, and especially the ones at or close to the N = Z line, constitute excellent probes for low energy weak interaction studies. Of special interest in this respect are the determination of the Vud quark mixing matrix element and searches for new physics beyond the standard model. The precise determination of the Vud quark mixing matrix element allows for testing the Conserved Vector Current (CVC) as well as the unitarity of the quark mixing matrix. In addition, it permits to search for physics beyond the standard model (i.e. right-handed and/or scalar contributions to the weak interaction). A continued effort to determine the masses (Q-values), half-lifes and branching ratios for 0+ to 0+ superallowed Fermi transitions along the N = Z line will further improve the precision of Vud and will allow testing and optimizing the nuclear models that are used to calculate the nuclear structure dependent corrections. The HIE-ISOLDE upgrade will significantly extend the possibilities for these studies. Recently, the corrected Ft values for the T = 1/2 mirror transitions have been determined as well, including all relevant radiative and nuclear structure related corrections [1]. It has been shown that these, in combination with measurements of correlations between the spin and momentum vectors of the particles involved in the beta decay, provide a new and independent means to test CVC and to determine Vud [2]. The currently available dataset allowed the determination of Vud with a precision that is already comparable to the value obtained from free neutron decay. Moreover, for several mirror transitions the beta-neutrino correlation and/or the beta asymmetry parameter turn out to be especially sensitive to Vud [3]. E.g. a determination of the beta-nu correlation with a relative accuracy of 0.5% for any of the mirror transitions from 11C to 45V would yield a precision at least similar to the value quoted in ref. [2], with 17F and 19Ne being the most sensitive, provided the Ft value is known with an accuracy of 5 x 10^-4. Further, with this precision for the respective Ft-values, a determination of the beta asymmetry parameter A for the mirror transitions of 19Ne, 33Cl and 35Ar with an accuracy of 0.5 % allows determining the value of Vud with an absolute accuracy between 0.0005 and 0.0010, compared to the present accuracy of 0.00022 from the dataset for the 0+ to 0+ transitions [3]. In addition, such measurements will significantly add to our understanding of right- handed as well as scalar and tensor type contributions to the charged current weak interaction. Beams of several of these isotopes are readily available at ISOLDE, while the HIE- ISOLDE upgrade will provide even higher intensities and increased purity. [1] N. Severijns, M. Tandecki, T. Phalet and I.S. Towner, Phys. Rev. C 78 (2008) 055501. [2] O. Naviliat-Cuncic and N. Severijns, accepted for publication in Phys. Rev. Lett. [3] O. Naviliat-Cuncic and N. Severijns, accepted for publication in Eur. Phys. J. A.

Summary :

The superallowed beta transitions of the T = 1/2 mirror nuclei are presented as a new tool to determine the Vud quark mixing matrix element. This requires high precision determination of the quantities leading to the corrected Ft-values for such transitions, i.e. half-lifes, brancing ratios and masses (Q values), as well as high accuracy (i.e order of 0.5 % or better) measurements of correlations in the decay of these mirror transitions. The latter will also significantly extend our knowledge on possible sources of physics beyond the standard electroweak model (e.g. scalar, tensor and/or right-handed charged current contributions to the weak interaction).

Primary authors : SEVERIJNS, Nathal (Instituut voor Kern- en Stralingsfysica - KU-University of Leuven) ; NAVILIAT-CUNCIC, Oscar (LPC-Caen and Univ. Caen)

Co-authors :

Presenter : SEVERIJNS, Nathal (Instituut voor Kern- en Stralingsfysica - KU-University of Leuven)

Track classification : ISOLDE

Contribution type : --not specified--

Submitted by : NATHAL, Severijns

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Comments :

Status : SUBMITTED

Track judgments :

Track : ISOLDE

Judgment :
Judged by :
Date :
Comments : ""

Abstract ID : 70

Nuclear data at n_TOF for fundamental science and technological applications

Content :
The n_TOF facility at CERN offers unique conditions worldwide for the measurement of neutron capture and neutron induced fission cross sections. The high neutron intensity and optimized duty cycle of the n_TOF neutron beam allows measuring the properties of highly radioactive species. Such is the case, for example, of the heavy elements with Z≥90, which are difficult to investigate and handle due to their α and β-activity and, in some cases, spontaneous fission. The nuclear structure of such nuclei is of great relevance for the improvement of nuclear models and can be investigated efficiently by neutron bombardment. Indeed, the most reliable experimental data on nuclear level density parameters concerns the s-wave neutron resonance spacing D0 at the neutron separation energy Sn obtained in neutron capture experiments. Such experiments have also a great relevance for the sustainability of the nuclear energy production and, more particularly, for finding a satisfactory strategy for the final management of the nuclear waste. The n_TOF facility has also proven to be a unique place for investigating the nuclear fission process from thermal energies up to several hundred MeV in one single experiment. Properties like the fragment charges and mass distributions, the energy released, the fragment deformations, and excitation energies, which are among the questions not yet fully understood theoretically, can be addressed at n_TOF. Furthermore, n_TOF can contribute as well to the nuclear energy applications, where it remains of major importance in to be able to estimate accurately the probability that fission occurs when competing with other decay channels or the number of neutrons released during the fission process. Many measurements made at CERN in the previous campaign had become the best world wide data available and are opening new levels of detail in the structure of the neutron induced reactions. Those measurements are at the same time improving our evaluation of the feasibility and performance of transmutation reactors proposed for the nuclear waste minimization before final disposal. Several expert groups of international organizations (NEA/OCDE, IAEA) had prepared compilations of nuclear data needs to approach the required precision to grant the feasibility of the new applications providing enhanced sustainability on the use of resources and reduction of final waste and environmental impact. The n_TOF Facility in its present form can strongly contribute to reach several of this requirements in the best worldwide conditions, both for Z≥90 and for isotopes of lower Z with low capture cross sections or significant radioactivity. Furthermore, modifications of the present experimental area and the construction of a new short flight path and the associated experimental area, for which conceptual designs are available, would enable the utilization of samples of additional isotopes only available or manageable in very small amounts, thus opening the way to achieve a large fraction of the previously quoted nuclear data needs. It is remarkable the coincidence on the isotopes, reactions and precision requirements from the fundamental nuclear physics and astrophysics needs and the needs for industrial applications. This coincidence has been the base for the strong and close cooperation of the corresponding researchers within the n_TOF experiments in the past and the motivation to propose its continuation in future experiments

Summary :
The n_TOF facility at CERN offers unique conditions worldwide for the measurement of neutron capture and neutron induced fission cross sections. The high neutron intensity and optimized duty cycle of the n_TOF neutron beam allows measuring the properties of highly radioactive species. Such is the case, for example, of the heavy elements with Z≥90, which are difficult to investigate and handle due to their α and β-activity and, in some cases, spontaneous fission. The nuclear structure of such nuclei is of great relevance for the improvement of nuclear models and can be investigated efficiently by neutron bombardment. Indeed, the most reliable experimental data on nuclear level density parameters concerns the s-wave neutron resonance spacing D0 at the neutron separation energy Sn obtained in neutron capture experiments. Such experiments have also a great relevance for the sustainability of the nuclear energy production and, more particularly, for finding a satisfactory strategy for the final management of the nuclear waste. The talk will outline the possibilities of n_TOF to perform a campaign of high accuracy measurements covering some of the most relevant nuclear data needs in both fields.

Primary authors : GONZALEZ ROMERO, Enrique (Centro de Investigaciones Energ. Medioambientales y Tecn. - (CIE)

Co-authors :

Presenter : GONZALEZ ROMERO, Enrique (Centro de Investigaciones Energ. Medioambientales y Tecn. - (CIE)

Track classification : nTOF

Contribution type : --not specified--

Submitted by : GONZALEZ ROMERO, Enrique

Submitted on Wednesday 01 April 2009

Last modified on : Sunday 05 April 2009

Comments :
on behalf of the n_TOF_ph2 Collaboration

Status : PROPOSED TO ACCEPT

Track judgments :

Track : nTOF

Judgment : Proposed to accept
Judged by : GUNSING, Frank
Date : 05 April 2009 13:58
Comments : "The n_TOF collaboration has decided to submit two abstracts (id 70 and 77) for the allocated timeslot of one hour, which together with a short introduction of the convenor, will give an overview of the plans of n_TOF for the coming years. These two presentations allow to cover the two main fields of impact of the common n_TOF experiments: fundamental science and technological applications on one side and nuclear astrophysics on the other side."

Abstract ID : 71

USE AN LHC QUADRUPOLE MAGNET AS AXION ↔ PHOTON CONVERTER

Content :

Background information & motivation: We build upon our experience with CAST, OSQAR and solar observations asking whether out streaming axions convert to X-rays near the magnetized solar surface. In fact, solar X-rays correlate with areas of strong magnetic activity, and more specifically with areas with field gradients. State-of-the-art missions search also for axions in solar X-rays. However, own simulation with Geant4 revises their old concept, since hard X-rays, from converted axions with maxion > meV/c2, follow a random walk outwards. Interestingly, a new theoretical idea suggests that axions may interact even stronger with spatially varying magnetic fields. Simple examples show that the photon production out of a magnetic field that has a field gradient in a direction different to that of the incident axion beam is enhanced as opposed to the standard axion picture, where this possibility is not allowed. While this is subject to further theoretical calculations, taking this as a generic scenario, it matches solar X-ray observations and it favours this proposal. In short, we suggest for the first time to replace the dipole magnet widely used in axion experiments with a quadrupole (e.g. from LHC, ISR or LEP), inspired observationally and supported theoretically. This makes promising to do more Monte Carlo work aiming to mimick the Sun. Time schedule: (1) 2009- to operate OSQAR with an LHC 3.1 m long quadrupole with a maximum field of ~7 T and a gradient up to ~250 T/m implies no significant additional workload or funding requirements. Such a measurement should start in the near future, and with luck, it can become a “first”. (2) 2010- once the quadrupole is placed appropriately in SM18, it could get in its field-of-view the Sun for ~10 minutes during ~2-3 consecutive days. This will allow to perform an other “first” CAST-like measurement using a best performing quadrupole. To repeat this short solar exposure several times, a simple only horizontally operating turning table can be used at the beginning. Also, measurements with a strong X-ray source might be envisaged. (3) 2012- following measurements with the “new OSQAR”, the outcome of our theoretical calculations plus Monte Carlo simulation of solar processes will allow us to decide how to proceed in 1-3 years time. For example, whether we will replace the CAST dipole magnet with the quadrupole, or install in SM18 a new turning table (still less demanding than that in CAST due to less load). In either case, new low noise detectors of the Micromegas type or others along with new X-ray optics with larger focal length, and therefore better performance, can be implemented to optimise the performance of the new axion helioscope. Request from CERN: After approval, we will need the availability of one or even two LHC quadrupoles in SM18. For the first 2-3 years, at least, the needed equipment and support is estimated to be of the order of ~100kCHF per year. The estimated cost for a new turning table is about 150kCHF, but it could be constructed mainly in home institutes. Detectors and the use eventually of new X-ray optics can be provided only by collaborating institutes, which have experience in this matter.

Summary :

Conclusion: we suggest a novel search for axions using as catalyst a quadrupole magnet replacing the dipole magnets used in CAST and OSQAR. A spatially varying magnetic field renders a quadrupole magnet to eventually uncover physical processes occurring at the Sun. At this stage, the motivation is observationally driven and theoretically encouraged. The concept is new, it can easily, rapidly and at low cost be implemented in OSQAR experimental environment at CERN. Afterall, such a type of an experiment with a quadrupole field is new and there is room for surprises.

Primary authors : Dr. SIEMKO, Andrzej (CERN) ; Prof. ZIOUTAS, Konstantin (University of Patras)

Co-authors :

Presenter : Dr. SIEMKO, Andrzej (CERN) ; Prof. ZIOUTAS, Konstantin (University of Patras)

Track classification : PS and Non-accelerator Experiments

Contribution type : --not specified--

Submitted by : Prof. ZIOUTAS, Konstantin

Submitted on Wednesday 01 April 2009

Last modified on : Wednesday 01 April 2009

Comments :

This proposal was prepared with inputs from OSQAR & CAST and
1) Eduardo Guendelman and Idan Shil

Status : SUBMITTED

Track judgments :

Track : PS and Non-accelerator Experiments

Judgment :
Judged by :
Date :
Comments : ""

Abstract ID : 72

Dark Matter Searches with XENON and Neutrinoless Double Beta Decay Searches with GERDA

Content :

The XENON100 time projection chamber (TPC), with a total of 170 kg of liquid Xe mass (65 kg as WIMP target) viewed by 242 low-background, UV-sensitive PMTs, is currently under commissioning at the Gran Sasso Underground Laboratory (LNGS). The aim is to test the WIMP-nucleon cross section down to 2e-45 cm2. The next phase in the XENON program, XENON1t, foresees the operation of 3t of LXe (1t as target mass) with a 4-pi readout of new photosensors, Quartz Photon Intensifying Detectors (QUPIDs). There are many challenges connected with the operation of a 3t LXe-TPC: the HV-system for drifting electrons over 1m, the liquid purification system for obtaining < 1 ppb O2 equivalent purity, the ultra-low background Cu cryostat, the cryogenic system, the 85-Kr purification, the shield, etc, and CERN could take on a major system in such a future project. CERN proton and muon beams could be used to study radioisotope production in xenon by spallation reactions. GERDA is an experiment to search for the neutrinoless double beta decay in enriched 76-Ge detectors. The aim of GERDA Phase I and II is to reach a sensitivity for the effective Majorana neutrino mass of 270 meV and 110 meV, respectively. This is achieved by operating bare HPGe crystals in 70 m3 of liquid argon (LAr), which serves as a passive shield (in Phase I) against the external radioactivity and is in addition surrounded by a water Cerenkov shield. GERDA is under construction at LNGS; the detector commissioning is planned for summer 2009, after which the science run will start. Phase I will operate 17.9 kg of existing enriched 76-Ge detectors in LAr. For Phase II, two different detector schemes, as well as the possibility of instrumenting the LAr are under study. CERN proton and muon beams could be used to study the in-situ production of long-lived radioactive isotopes in Ge (and in LAr), in particular 68-Ge and 60-Co, which can provide dangerous backgrounds for this type of experiment.

Summary :
See abstract.

Primary authors : Prof. BAUDIS, Laura (University of Zurich)

Co-authors :

Presenter : Prof. BAUDIS, Laura (University of Zurich)

Track classification : PS and Non-accelerator Experiments

Contribution type : --not specified--

Submitted by : BAUDIS, Laura

Submitted on Wednesday 01 April 2009

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Comments :

Status : SUBMITTED

Track judgments :

Track : PS and Non-accelerator Experiments

Judgment :
Judged by :
Date :
Comments : ""

Abstract ID : 73

Towards a new generation of axion helioscopes

Content :
The CAST (CERN Axion Solar Telescope) experiment is searching for solar axions by their conversion into photons inside the magnet pipes of an LHC dipole. The analysis of data taken has shown no signal above the background, thus implying an upper limit to the axion-photon coupling of gaγγ < 0.9 × 10−10 GeV−1 at 95% CL for ma < 0.02 eV. Recent results and ongoing measurements, with the magnet bores filled with a buffer gas (Phase II), are improving the sensitivity of the experiment for higher axion masses up to 1 eV. Detectors have been continuously improving and background levels are reaching very low values. This would allow CAST to improve the present result easily and without major modifications in its infrastructure, by returning to Phase I after accomplishing the present program with a buffer gas. Simulations show that a sensitivity of 5 × 10-11 GeV−1 is under reach within a year's data taking, surpassing clearly for the first time the limits coming from astronomical observations. In parallel, low energy solar axion measurements in the new land of the sub-keV range down to visible will be performed. For this, various detectors are needed to cover each narrow range in the: visible (some first measurements have already been done during CAST Phase II), UV, EUV, soft X-rays. They will allow reaching better sensitivity to QCD-inspired solar axions, but also to other axion-like particles (ALPs). In addition, some more ideas on ALPs searches will be addressed, such as a resonant regeneration experiment performed in a CAST-like magnet. With presently available techniques on resonant Fabry-Perot optical cavities, there is the potential of covering a zone of the ALPs parameter space larger than the one currently reached by CAST. The sensitivity of helioscope axion searches depends strongly on the magnet's characteristics; CAST has been the leading helioscope because of its magnet strength. Ongoing R on dipoles will lead to stronger and bigger magnets in the coming years (2013-2015). Such a magnet could either be adopted to the existing infrastructure of CAST, thus eliminating the cost to the magnet itself, or be used with a new tracking and cryogenics system, improving thus many characteristics (like daily tracking time, safety etc) but increasing the cost. In parallel, effort will be devoted on the development of high efficiency focusing devices and new electronics for the detectors, aiming to achieve very low background levels. All this would allow pushing the sensitivity of the experiment to the level of 10-11 GeV−1, probing the QCD axion model region for masses higher than 10-2 eV. In order to exceed the limit of 10-11 GeV−1 with a helioscope, specially developed magnets are necessary. Taking advantage of the fact that the important parameter is the strength and not the homogeneity of the magnetic field, a stronger magnet with bigger aperture, could be designed and constructed especially for such an experiment. This is a more expensive and long term option, which would allow reaching the limits of the helioscope axion searches with an increased discovery potential.

Summary :
The CAST (CERN Axion Solar Telescope) experiment is searching for solar axions by their conversion into photons inside the magnet pipes of an LHC dipole. Several years of data taking have resulted to the strictest experimental limit in axion to photon coupling constant over a large mass range. We will report on the on the plans of CAST for the near future. Furthermore, we will present the prospects of helioscope axion searches, based on new developements on magnet and detector technologies.

Primary authors : Dr. PAPAEVANGELOU, Thomas (CEA-IRFU Saclay)

Co-authors :

Presenter : Dr. PAPAEVANGELOU, Thomas (CEA-IRFU Saclay)

Track classification : PS and Non-accelerator Experiments

Contribution type : --not specified--

Submitted by : PAPAEVANGELOU, Thomas

Submitted on Thursday 02 April 2009

Last modified on : Thursday 02 April 2009

Comments :

On behalf of the CAST Collabotation

Status : SUBMITTED

Track judgments :

Track : PS and Non-accelerator Experiments
Judgment :
Judged by :
Date :
Comments : ""

Abstract ID : 74

Testing nuclear models through shape changes in proton-rich heavy nuclei at ISOLDE

Content :

REX-ISOLDE has recently demonstrated a capability, unique worldwide, to post- accelerate mass 200 and heavier ions, albeit at ~3 MeV/u. A programme of Coulomb excitation measurements of the mid-neutron shell Hg, Pb, Po and Rn isotopes has been successfully initiated. Here, these neutron-deficient nuclei have been schematically described as oblate (β ~ -0.15) or spherical ground states coexisting with prolate (β ~ 0.25) structures, separated by energies less than 1 MeV. However, a detailed microscopic description of these nuclei is required, which can only be tested against precision measurements of the nuclear wavefunctions. Precision tests of nuclear models may be achieved in the next few years by extending the programme for the first time to odd-mass nuclei, in order to probe the single particle configurations of the low-lying states and the shape-polarising effect of the extra nucleon. Investigation of odd-mass light Pb, Po and Rn nuclei would be of particular interest since the two competing shape minima appear as a 3/2- ground state and close-lying 13/2+ isomer in e.g. 199Rn and 201Rn. Both these states are close to 100% alpha emitters and are produced with similar intensity as ISOLDE beams. This suggests the possibility of a simultaneous Coulomb excitation of ground state and isomer, disentangling the two through measurements of the respective alpha decay. HIE-ISOLDE would be essential to obtain a full and detailed understanding of the shape coexistence phenomenon in these heavy proton-rich nuclei. For sub-barrier Coulomb excitation, HIE-ISOLDE would provide the optimum energy of 5 MeV/u which would allow all nuclei of interest be studied, giving at least an order of magnitude more yield for states reached by two-step and higher order excitations. This would enable the rotational invariants to be constructed for the co-existing band structure in these nuclei, yielding in a model independent way their dynamic charge distribution. HIE-ISOLDE, supplying accelerated beams up to 10 MeV/u could also be used for transfer reactions, allowing the dominant single particle contributions to the wavefunction and two particle correlations to be measured directly. Transfer reactions would also give significant new information, for example (d,p) and (p,d) transfer reactions on e.g. 183Hg and 185m,gHg to probe the shape coexistence in the even-even Hg neighbours. A challenging extension would be to perform two-proton transfer e.g. 184Hg(3He,n) to probe the shape coexistence related to the excited 0+ states in 186Pb – the nucleus which has become the textbook case for nuclear shape coexistence.

Summary :

The prospects are excellent for carrying out detailed tests of nuclear models through investigation of the shape of heavy proton-rich nuclei at HIE-ISOLDE. The availability of the necessary accelerated radioactive beams is unique worldwide.

Primary authors : Dr. JENKINS, David (University of York)

Co-authors :

Presenter : Dr. JENKINS, David (University of York)

Track classification : ISOLDE

Contribution type : --not specified--

Submitted by : Dr. JENKINS, David

Submitted on Friday 03 April 2009

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Comments :

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Track judgments :

Track : ISOLDE

Judgment :
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Date :
Comments : ""

Abstract ID : 75

Exploring nuclei at the limit of REX-ISOLDE and HIE-ISOLDE using an active target detector

Content :

The beams of exotic nuclei produced at REX-ISOLDE presently, and at HIE-ISOLDE in the future, offer a unique possibility of applying direct reaction methods for the study of the nuclear structure very far from stability. In light-ion transfer reactions, which are performed in inverse kinematics, the energy resolution degrades rapidly with the target thickness when a solid target is used, thus preventing measurements with the most exotic and weak ion beams. The active target concept allows to overcome this problem. It is a gaseous detector, where the nuclei of the detection gas are at the same time the target nuclei. The tracks of ionizing particles are recorded, allowing a precise reconstruction of the reaction kinematics in the whole gas volume. It ensures a high efficiency coupled with a low detection threshold. Typically, the target thickness is one to two orders of magnitude larger than a conventional solid target. Direct reactions can thus be studied using the weakest post-accelerated beams. At REX-ISOLDE these studied can be performed in the neutron-rich Ni region, and with HIE-ISOLDE they will be extended to the Pb region. Information on masses (from reaction Q-values) and single-particle structure of states (from reaction cross sections) can be combined with that obtained by other techniques (decay and laser spectroscopy, Coulomb excitation), fully exploiting the unique opportunities present at ISOLDE.

Summary :

The active target detector is a high-luminosity detection setup that will allow studying the structure of the most exotic ion beams produced at REX-ISOLDE and HIE- ISOLDE applying direct reaction methods.

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Co-authors :

Presenter : Dr. RAABE, Riccardo (GANIL)

Track classification : ISOLDE

Contribution type : --not specified--

Submitted by : RAABE, Riccardo

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Comments :

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Track judgments :

Track : ISOLDE

Judgment :
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Date :
Comments : ""

Abstract ID : 76

Scientific plans of the DIRAC experiment beyond 2010

Content :

The main task of the DIRAC experiment is to check precise predictions of low-energy QCD using ππ and πK atoms. At present, theory predicts the ππ s-wave scattering lengths with a precision of 1.5% for |a0-a2| and about 2.5% for a0 and a2. The theoretical uncertainty is mainly determined by uncertainties on two constants of ChPT. In 2006, these constants were obtained from Lattice calculation and one can expect that in a few years this calculation will give an even higher precision of ππ scattering lengths. Experimentally, the scattering lengths were obtained from K-meson decays (K3π, Ke4) and from the ππ-atom lifetime. At present, the precision of ππ scattering lengths measurements is a few percents worse than the theoretical precision. For this reason, improving the experimental accuracy is an important task. The experimental data collected by DIRAC in 2008 and 2009 will allow to reach the precision of about 2.5% for |a0-a2|. The low-energy QCD predicts πK scattering lengths with a precision of about 10%. In a near future, this accuracy will be significantly improved. The experimental estimations of πK scattering lengths were obtained from πK scattering phases at high energy using Roy-Steiner equations. Direct measurements of the πK phases at low energy or of the πK scattering lengths do not exist. The DIRAC experiment plans to observe πK atoms using data collected in 2007-2009 and to measure the lifetime of these atoms and, hence, to obtain the first evaluation the s-wave scattering length combination |a1/2-a3/2|. The measurement of the s-wave πK scattering lengths will test our understanding of the chiral SU(3)L⊗SU(3)R symmetry breaking of QCD (u, d and s quarks), while the measurement of ππ scattering lengths checks only the SU(2)L⊗SU(2)R symmetry breaking (u, d quarks). In 2009, we are planning to present a request for a data-taking run in 2010 with the aim of observing the long-lived states of ππ atoms. This experiment can be performed with the existing setup without modifications, neither of detectors nor of electronics. Further data taking will allow us to obtain experimentally a value of the Lamb shift ΔE(2s-2p) in this atom. The measurement of ΔE(2s-2p) allows determining the combination of ππ scattering lengths 2a0+a2 in a model-independent way. Together with the ππ atom lifetime measurement, this permits to determine a0 and a2 separately. The method of the Lamb shift measurement uses only the well-known theory of the Stark effect. From the data to be collected in 2008 and 2009, it will be possible to observe the Coulomb enhancement in the production of K+K− pairs, and thus to determine, in a model independent way, the number of K+K− atoms produced at the same time. This analysis will allow us to estimate the feasibility to observe these atoms and to measure their lifetime. The 2008-2009 data will also allow us to search for the Coulomb enhancement in the production of πμ pairs and thus to determine, in a model-independent way, the number of πμ atoms produced. This analysis will allow to decide if it is possible with this experiment to observe this atom. The final aim is to measure the Lamb shift in the πμ atom, which is strictly related to the electromagnetic radius of the charged pion. New possibilities to check the predictions of the low-energy QCD would be available after the installation of the DIRAC setup on the 450 GeV SPS proton beam. Simulations based on FRITIOF6, which gives correct π and K meson spectra in the dynamic range of the DIRAC spectrometer, show that at the same intensity of the secondary particles across the forward detectors the number of detected ππ atoms will be 15 times higher than the one at 24 GeV, the number of K+π− atoms 25 times higher and the number of K−π+ atoms 32 times higher. This enhancement in atom yields allows to obtain simultaneously |a0-a2| with a precision of about 1.5% and about 5% for |a1/2-a3/2| within 12 months of data taking. The measurement of the Lamb shift in ππ and πK atoms would take another run. These results would provide the crucial check of low-energy QCD predictions. Migration from PS to PS2 with the 50 GeV beam would also provide a significant gain in the mesonic atom production. The required statistics and achievable accuracy are under investigation.

Summary :

see above

Primary authors : NEMENOV, Leonid (Joint Institute for Nuclear Research (JINR))

Co-authors :

Presenter : NEMENOV, Leonid (Joint Institute for Nuclear Research (JINR))

Track classification : SPS Hadrons and Ions ; PS and Non-accelerator Experiments

Contribution type : --not specified--

Submitted by : NEMENOV, Leonid

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Track judgments :

Track : SPS Hadrons and Ions

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Comments : ""

Track : PS and Non-accelerator Experiments

Judgment :
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Date :
Comments : ""

Abstract ID : 77

Neutron studies at n_TOF – a window to stellar evolution and nucleosynthesis

Content :

Only the first three chemical elements have been produced immediately after the Big Bang. All the other elements (Z>3) were synthesized in stars and in stellar explosions. The quest for the origin of the elements is, therefore, strongly connected to the mechanisms governing the life and evolution of stars and to the nuclear reaction processes taking place in their interiors. By far, most of the isotopes found in Nature are the result of neutron induced reactions in stars. Initiated by Carlo Rubbia and his colleagues and supported as a European project, the construction of the CERN spallation neutron source n_TOF took place in 2000. In parallel, the n_TOF Collaboration was established with about 120 participants from more than 30 institutes, mostly from the EU, but also from the USA and Russia, to perform the first measurement campaign starting in 2002. The facility is characterized by the combination of high neutron flux, excellent time resolution, and very low backgrounds. What is unique, however, is the outstanding duty cycle of only one intense proton pulse every 2.4 seconds, which makes n_TOF the most luminous neutron source world-wide. These features are providing the ideal environment for neutron time-of-flight experiments covering the full energy range of astrophysical interest. The excellent performance of the facility is complemented by the use of the most advanced detection and data acquisition techniques for neutron cross section studies. In the present paradigm for the origin of the elements there are two neutron capture processes, each contributing about half of the abundances beyond Fe, which are named according to their characteristic time scales. The rapid neutron capture process (r process) is commonly associated with supernova explosions. In this case, neutron capture times are in the range of milliseconds, much faster than beta decays. Accordingly, the r-process path runs close to the neutron drip line and comprises a complex reaction network among exotic and extremely neutron-rich nuclei. In contrast, the slow neutron capture process (s process) takes place during the He burning stages of stellar evolution. In the s process, neutron capture times are much longer than typical half-lives for beta decay. The relevant nuclear physics input for quantitative studies of the s and r process is determined by the time scales: in the s process the resulting abundances are directly correlated with the neutron capture cross sections of the stable nuclei in the stability valley, whereas the r abundances depend mostly on the unknown beta decay rates on the r-process path as well as on the decay chains back to stability. Obviously, the nuclear input for the s process can be accurately determined in laboratory experiments. Under stellar conditions, neutrons are quickly thermalized in the hot and dense stellar plasma and effective reaction rates need to be derived from energy dependent neutron capture cross sections in the range from 100 eV to well above 500 keV, where n_TOF offers outstanding opportunities. Such measurements are also important for unstable isotopes, which are crucial for the analysis of branchings in the reaction path of the s process, as will be illustrated at the example of Sm-151. An extensive experimental plan for continuation of neutron capture cross section measurements for s-process studies and related nuclear astrophysics phenomena (e.g. cosmic clocks) will be presented. This plan is partly based on the present installation but also envisaging the enormous improvement, which could be obtained with a second experimental area at a shorter flight-path. A hundred times higher flux, a factor of ten improvement in the duty factor and strongly reduced backgrounds will allow for investigation of important cases, which are inaccessible so far. This includes studies on unstable samples in the nanogram range, which could be produced by future radioactive ion beams at CERN.

Summary :

The characteristics of the n_TOF facility are illustrated with emphasis on applications in nuclear astrophysics. An extensive experimental plan for continuation of neutron capture cross section measurements for s-process studies and related nuclear astrophysics phenomena (e.g. cosmic clocks) will be presented. This plan is partly based on the present installation but also envisaging the enormous improvement, which could be obtained with a second experimental area at a shorter flight-path.

Primary authors : Dr. MENGONI, Alberto (IAEA, Vienna) ; Dr. KAEPPELER, Franz (FZK, Karlsruhe)

Co-authors : N_TOF, Collaboration (CERN)

Presenter : Dr. MENGONI, Alberto (IAEA, Vienna)

Track classification : nTOF

Contribution type : --not specified--

Submitted by : Dr. MENGONI, Alberto

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Status : PROPOSED TO ACCEPT

Track judgments :

Track : nTOF

Judgment : Proposed to accept
Judged by : GUNSING, Frank
Date : 05 April 2009 13:59
Comments : "The n_TOF collaboration has decided to submit two abstracts (id 70 and 77) for the allocated timeslot of one hour, which together with a short introduction of the convenor, will give an overview of the plans of n_TOF for the coming years. These two presentations allow to cover the two main fields of impact of the common n_TOF experiments: fundamental science and technological applications on one side and nuclear astrophysics on the other side."

Abstract ID : 78

AEGIS: measurement of the gravitational interaction of antihydrogen

Content :
The experimental program of AD-6 has been described as part of the documents submitted to the SPSC [1]. In those documents, this program extends at least to 2013, which should allow us to achieve the main physics goal of the experiment - a measurement to 1% of the gravitational interaction of antimatter. Our program however is broader and longer-term than that. The attached timeline of the experiment covers the activities we intend to carry out over the next decade.

Summary :
The measurement of the gravitational interaction of antimatter profits greatly from the use of cold antihydrogen; in our set-up, this temperature is defined by the temperature of the antiprotons at the moment of formation. After making and characterizing a beam of antihydrogen, we will carry out the first measurement of its gravitational interaction using a moiré deflectometer (a set of gratings that introduces a periodic structure into the antihydrogen beam, and allows precisely measuring the velocity-dependent downward shift induced by gravity during the flight through the deflectometer). In a second stage, we intend to work on trapping the antihydrogen atoms from the beam, using a scheme that follows that developed by our collaborators working with hydrogen atoms [2]. Work on implementing this in the AEGIS set-up will start in 2012, tests of deceleration will take place in 2013, and first attempts to trap antihydrogen at the end of the flight tube normally housing the moiré deflectometer could take place at the end of 2014. In parallel, we will install a pulsed Lyman-alpha laser, initially to cool the produced beam radially, and also to be in a position to laser-cool the trapped antihydrogen atoms down to the recoil limit (2015). This technical development also entails a first spectroscopic measurement of the 1s-2s transition, and will naturally also lead to precise CPT tests involving spectroscopy of (e.g.) 1S-2S transitions of antihydrogen. If trapping and cooling are successful, we will repeat the gravitational measurement with the (mK) antihydrogen atoms from the trap, which will lead to a significantly improved measurement of the gravitational interaction of antimatter. We are also exploring the possibility of a true interferometric gravitational measurement at that point. Assuming the technical success of the involved steps, the sensitivity of the measurement can then be increased even further. Furthermore, trapping of antihydrogen atoms will undoubtedly be an enormous step, potentially leading to a wide range of measurements that have been demonstrated with normal matter: Bose-Einstein condensation or molecular formation of antimatter through precise spectroscopic measurement are obviously appealing possibilities, which could lead to comparison with molecular clocks and to tests of fundamental physics such as CPT violation or variation of fundamental constants. The feasibility of such measurements rests on overcoming numerous technical obstacles. This physics program, which extends beyond the end of the foreseen availability of antiprotons at the AD, would benefit significantly from an increased intensity in the number of antiprotons (such as would be provided by the ELENA upgrade to the AD), and will require long-term availability of antiprotons at CERN or at FLAIR. [1] http://documents.cern.ch/cgi-bin/setlink?base=spsc=public=spsc-2007-017 [2] S. Hogan et al., Phys. Rev. Lett. 101, 143001 (2008)

Primary authors : DOSER, Michael (CERN)

Co-authors : AEGIS, Collaboration ((collaborating institutes))

Presenter : DOSER, Michael (CERN)

Track classification : Antiproton Decelerator (AD)

Contribution type : --not specified--

Submitted by : DOSER, Michael

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Track judgments :

Track : Antiproton Decelerator (AD)

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Date :
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Abstract ID : 79

An additional Extra Low ENergy Antiproton ring "ELENA" at AD

Content :

Research on fundamental symmetries is a very important part of modern physics programs. The CPT theorem demands that for each particle (or element) the equivalent antiparticle (or antielement) has the same mass, lifetime, spin, and isospin but an opposite value for all of the additive quantum numbers. The proof (or disproof) of the validity of this basic symmetry may be the key to such fundamental aspects as the matter--antimatter asymmetry in the universe. Physics is still in a phase where it is important to accumulate high precision experimental data from different leptonic and/or hadronic systems. The role of matter--antimatter comparisons is significant and powerful. There is in fact growing interest in CPT and Lorentz violation on the theoretical side, based e.g. on extensions of the Standard Model [1] and involving Quantum Gravity [2] which is important to be accompanied by experimental developments. A comparison of the well known hydrogen spectral lines (especially the 1S -- 2S transition) with those of its antihydrogen counterpart is a unique opportunity for a direct test of CPT symmetry in a combined particle system. Equally, a direct verification of the validity of the weak equivalence principle - by measuring the gravitational force between matter and antimatter - allows a unique and new test of our understanding of gravity. The Antiproton Decelerator (AD) at CERN has led to significant production rates of cold antihydrogen, which has received great acknowledgements in the scientific community, as well as in the public media. Thus, CERN is unique in the world, and provides experimental opportunities which allow to explore fundamental and new physics, and which are very productive. The formation of antihydrogen typically requires a large number of antiprotons at high densities which cannot be achieved at the present antihydrogen experiments with a single AD bunch. Stacking techniques are used to increase the number of trapped antiprotons. The efficiency of the experiments would be hugely improved and the productivity and the availability of the unique user facility AD at CERN with its great scientific potential would be greatly enhanced if a further deceleration and cooling storage ring would be installed between the AD and the experiments. Such a ring could be the suggested ELENA ring as proposed and described elsewhere [3] [1] see e.g. talks of K. Jungmann, N.E. Mavromatos, N. Russell and others, presented at LEAP05, AIP Conference Proceedings, Volume 796) 373. [2] see e.g. J. Ellis, J. Lopez, N.E. Mavromatos and D.V. Nanopoulos, Phys.Rev. D 53 (1996) 3846 [3] see: http://cdsweb.cern.ch/record/1072485/files/ab-2007-079.pdf

Summary :

It is envisaged that ELENA will increase the phase space density at 100 keV by one to two orders of magnitude, depending whether the experiments are using the RFQD already or not, respectively. This would raise the efficiency of the antiproton/antihydrogen program at CERN by a very large factor. The construction of a rather small machine for this purpose is feasible. The main challenges for such a project of deceleration to very low energies, such as ultra low vacuum and effective electron cooling, can be managed. The proposed ELENA ring can be located inside the AD hall without large modifications. All installation work for ELENA can be done without significant influence on the AD operation for physics, but for commissioning some extra time has to be scheduled. The experience gained at existing low-energy storage rings such as AD (CERN), ASTRID (Aarhus), TSR (Heidelberg), and CRYRING (Stockholm) can be exploited in the design and construction of ELENA.

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Co-authors : THE AD-USER COMMUNITY, Experiments At Ad (worldwide)

Presenter : OELERT, Walter (Institut fuer Kernphysik)

Track classification : Antiproton Decelerator (AD)

Contribution type : --not specified--

Submitted by : OELERT, Walter

Submitted on Sunday 05 April 2009

Last modified on : Sunday 05 April 2009

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Track judgments :

Track : Antiproton Decelerator (AD)

Judgment :
Judged by :
Date :
Comments : ""

Abstract ID : 80

Antihydrogen Potential and Challenges for CERN'S Unique Low Energy Antiprotons

Content :

CERN not only leads the world in "high energy" physics. It has long also distinguished itself by pursuing fundamental particle physics at lower energy scales when the laboratory possesses the unique capability to do so. CERN introduced the world's lowest energy antiprotons at 5 MeV. Experimenters at LEAR and then the AD introduced particle traps to lower the energy by up to an additional ten orders of magnitude in energy, making it possible to compare q/m for the antiproton and proton at the 9 parts in 10^{10} level. Now, antihydrogen is being formed by two different methods at the AD. The expectation is that antihydrogen spectroscopy will provide comparisons of antihydrogen and hydrogen at much higher precisions. The lowest-ever (1.2 K) electron and positron temperatures recently realized bode well for making colder antihydrogen atoms,. These are needed to realize the goal of trapping antihydrogen atoms in magnetic traps that have been demonstrated at the AD. The future is challenging and exciting. The long term goal, for which the AD was constructed, is extremely accurate laser spectroscopy of antihydrogen atoms. Steady progress continues on the needed laser systems needed for cooling and spectroscopy, and a second generation of magnetic trap is under construction. Even lower plasma temperatures seem possible. On the side, it seems feasible to use a single antiproton to measure the antiproton magnetic moment a million times more accurately. An upgraded AD, able to deliver many more antiprotons at lower energies to traps, would speed the progress.

Summary :

CERN not only leads the world in "high energy" physics. It has long also distinguished itself by pursuing fundamental particle physics at lower energy scales when the laboratory possesses the unique capability to do so. CERN introduced the world's lowest energy antiprotons at 5 MeV. Experimenters at LEAR and then the AD introduced particle traps to lower the energy by up to an additional ten orders of magnitude in energy, making it possible to compare q/m for the antiproton and proton at the 9 parts in 10^{10} level. Now, antihydrogen is being formed by two different methods at the AD. The expectation is that antihydrogen spectroscopy will provide comparisons of antihydrogen and hydrogen at much higher precisions. The lowest-ever (1.2 K) electron and positron temperatures recently realized bode well for making colder antihydrogen atoms,. These are needed to realize the goal of trapping antihydrogen atoms in magnetic traps that have been demonstrated at the AD. The future is challenging and exciting. The long term goal, for which the AD was constructed, is extremely accurate laser spectroscopy of antihydrogen atoms. Steady progress continues on the needed laser systems needed for cooling and spectroscopy, and a second generation of magnetic trap is under construction. Even lower plasma temperatures seem possible. On the side, it seems feasible to use a single antiproton to measure the antiproton magnetic moment a million times more accurately. An upgraded AD, able to deliver many more antiprotons at lower energies to traps, would speed the progress.

Primary authors : Prof. GABRIELSE, Gerald (Harvard University)

Co-authors :

Presenter : Prof. GABRIELSE, Gerald (Harvard University)

Track classification : Antiproton Decelerator (AD)

Contribution type : --not specified--

Submitted by : GABRIELSE, Gerald

Submitted on Sunday 05 April 2009

Last modified on : Sunday 05 April 2009

Comments :

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Status : SUBMITTED

Track judgments :

Track : Antiproton Decelerator (AD)

Judgment :
Judged by :
Date :
Comments : ""

Abstract ID : 81

Opportunities for European neutrino oscillation physics building on the T2K experience

Content :

The current focus of the CERN program is the Large Hadron Collider (LHC), however, CERN is engaged in long baseline neutrino physics with the CNGS project and supports T2K as recognized CERN RE13, and for good reasons: a number of observed phenomena in high-energy physics and cosmology lack their resolution within the Standard Model of particle physics; these puzzles include the origin of neutrino masses, CP-violation in the leptonic sector, and baryon asymmetry of the Universe. They will only partially be addressed at LHC. T2K is optimized for searching for electron appearance with a sensitivity sin^2(2theta_{13}) < 0.01 (90%C.L.). A large fraction of the European neutrino community is visibly engaged in T2K, with participants from France, Germany, Italy, Poland, Spain, Switzerland and United Kingdom. The T2K beam will start commissioning in April 2009 and the first physics results are expected by summer 2010. The baseline intensity of the T2K beam is 750 kW. A plan to upgrade the Main Ring to 1.6 MW has been presented in the KEK roadmap. Possible scenarios for beam upgrade and new far detectors have been discussed at the 4th International Workshop on Nuclear and Particle Physics at J-PARC (NP08) in March 2008. A positive measurement of sin^22theta_{13}>0.01 in T2K would certainly give a tremendous boost to neutrino physics by opening the possibility to search for, and study, CP violation in the lepton sector and the determination of the neutrino mass hierarchy with upgraded conventional super-beams. These experiments (so called « Phase II ») require, in addition to an upgraded beam power, next generation very massive neutrino detectors with excellent energy resolution and high detection efficiency in a wide neutrino energy range, to cover 1st and 2nd oscillation maxima to help lift the degeneracy among the parameters governing neutrino oscillations, and excellent particle identification and pi0 background suppression. Two generations of large water Cherenkov detectors at Kamioka (Kamiokande and Super- Kamiokande) have been extremely successful. And there are good reasons to consider a third generation water Cherenkov detector with an order of magnitude larger mass than Super-Kamiokande for both non-accelerator (proton decay, supernovae, ...) and accelerator-based physics. In parallel, the pioneering developments of the ICARUS liquid Argon TPC with immersed readout wires, already the fruit of several decades of R, has not been able, although offering better physics performance, to deliver detectors competitive with Super-Kamiokande, nor envisage an ultimate detector challenging the planned third generation water Cerenkov detectors. Only a very massive underground liquid Argon detector of about 100 kton could represent a credible alternative for the precision measurements of « Phase-II » and aim at significantly new results in neutrino astroparticle and non-accelerator-based particle physics (e.g. proton decay). The new concept « GLACIER », scalable to a single detector unit of mass 100 kton, was proposed in 2003: it relies on a cryogenic storage tank developed by the petrochemical industry (LNG technology) and on a novel method of operation called the LAr LEM-TPC. LAr LEM-TPCs operate in double phase with charge extraction and amplification in the vapor phase. The concept has been very successfully demonstrated on small prototypes: ionization electrons, after drifting in the LAr volume, are extracted by a set of grids into the gas phase and driven into the holes of a double stage Large Electron Multiplier (LEM), where charge amplification occurs. Each LEM is a thick macroscopic hole multiplier, which can be manufactured with standard PCB techniques. The electrons signal is readout via two orthogonal coordinates, one using the induced signal on the segmented upper electrode of the LEM itself and the other by collecting the electrons on a segmented anode. The images obtained with the LAr LEM-TPC are of very high -- « bubble-chamber-like » -- quality, owing to the charge amplification in the LEM and have good measured dE/dx resolution. Compared to LAr TPCs with immersed wires, whose scaling is at least limited by mechanical and capacitance issues of the long thin wires and by signal attenuation along the drift direction, the LAr LEM-TPC is an elegant solution for very large liquid Argon TPCs with long drift paths and mm-sized readout pitch segmentation. A ton-scale LAr LEM-TPC detector is being operated at CERN in Blg 182 within the CERN RE18 experiment (ArDM). The proposed next step beyond that is the construction of device dedicated for the precise calibration, the study of the calorimetric response and for the particle recognition capability of such detectors. The proposed test beam will be located in the CERN North Area (see ePiLAr in test beam submission). The current CNGS optimization provides limited sensitivity to sin^2(2theta_{13}), CP- violation in the leptonic sector and mass hierarchy determination. Ideas to improve the sin^2(2theta_{13}) sensitivity at the CNGS have already been discussed in JHEP 0209 (2002) 004. More recently, the physics potential of an intensity upgraded and energy re-optimized CNGS neutrino beam coupled to a 100 kton liquid Argon TPC located at an appropriately chosen off-axis position was published in JHEP 0611, 032 (2006). The discussion relied on the observation that whereas J-PARC provides a rapid cycle with high intensity proton bunches at approx. 40 GeV/c, the CERN proton complex has fewer protons and a slower cycle but can accelerate to 400 GeV/c. Hence, the SPS higher energy can – on paper – compensate for the lower proton intensity. In addition, the intensity in SPS could profit from future upgrades of the LHC injection chain. In practice, calculations show that the sin^2(2theta_{13}) reach and the searches for CP-violation and mass hierarchy are competitive with future options at J-PARC if the CNGS beam intensity can be increased compared to its design value 4.5x10^{19} pot/yr by a factor x3-x10. Yet CNGS intensity limitations do not only come from the performance of the accelerator complex. An upgraded CNGS -- competitive with JPARC -- will require a re- classification and/or partial reconstruction of the neutrino beam-line infrastructure, raising questions of feasibility, timescale and costs. In the context of the EC FP7 design study LAGUNA, the possibility to rely on an alternative source of medium-energy high-intensity protons from CERN (e.g. from a newly built PS) is under discussion. The LAGUNA community is studying the feasibility of a new large underground infrastructure in Europe able to host next generation neutrino physics and astro-particle physics and proton decay experiments. Seven sites are presently being considered. Given the intensity limitation of the CNGS design, the option of a completely new high-intensity neutrino beam line from CERN towards one of the LAGUNA sites should be left open. For the longer term and in absence of a positive result from T2K, large underground detectors in the LAGUNA sites could be operated as well in connection with other, more advanced neutrino beams like for instance beta-beams or neutrino factories. Such beams are currently being studied within the FP7 design study EuroNU.

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Co-authors :

Presenter : Prof. RUBBIA, Andre (ETH Zurich)

Track classification : SPS Rare K-decays and CNGS ; New Proton drivers at CERN

Contribution type : --not specified--

Submitted by : RUBBIA, Andre

Submitted on Sunday 05 April 2009

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Judged by : TOURAMANIS DOURAMANIS, Christofas
Date : 08 April 2009 06:26
Comments : "I propose to accept this abstract for which I am one of the proposers."

Track : New Proton drivers at CERN

Judgment :
Judged by :
Date :
Comments : ""

Abstract ID : 82

Test Beam exposure of a Liquid Argon TPC Detector at the CERN SPS North Area (ePiLAr)

Content :
There have been several ideas over the past years on how to construct very massive neutrino detectors. Two generations of large water Cherenkov detectors at Kamioka (Kamiokande and Super-Kamiokande) have been extremely successful. There are good reasons to consider a third generation water Cherenkov detector with an order of magnitude larger mass than Super-Kamiokande. In parallel, the pioneering developments of the ICARUS liquid Argon TPC with immersed readout wires, already the fruit of several decades of R, have not yet led to detectors competing with Super-Kamiokande, in spite of significant advances and better intrinsic physics performance. At this point in time the realization of the ultimate LAr TPC that will compete with the planned third generation water Cerenkov detectors offers great promise and many challenges. Only a very massive underground liquid Argon detector of about 100 kton could represent a credible alternative for the precision measurements of « Phase-II » long baseline experiments and aim at significantly new results in neutrino astroparticle and non-accelerator-based particle physics (e.g. proton decay). The new concept « GLACIER », scalable to a single detector unit of mass 100 kton, was proposed in 2003: it relies on a cryogenic storage tank developed by the petrochemical industry (LNG technology) and on a novel method of operation called the LAr LEM-TPC. LAr LEM-TPCs operate in double phase with charge extraction and amplification in the vapor phase. The concept has been very successfully demonstrated on small prototypes: ionization electrons, after drifting in the LAr volume, are extracted by a set of grids into the gas phase and driven into the holes of a double stage Large Electron Multiplier (LEM), where charge amplification occurs. Each LEM is a thick macroscopic hole multiplier, which can be manufactured with standard PCB techniques. The electrons signal is readout via two orthogonal coordinates, one using the induced signal on the segmented upper electrode of the LEM itself and the other by collecting the electrons on a segmented anode. The images obtained with the LAr LEM-TPC are of very high -- « bubble-chamber-like » -- quality, owing to the charge amplification in the LEM and have good measured dE/dx resolution. Compared to LAr TPCs with immersed wires, whose scaling is at least limited by mechanical and capacitance issues of the long thin wires and by signal attenuation along the drift direction, the LAr LEM-TPC is an elegant solution for very large liquid Argon TPCs with long drift paths and mm-sized readout pitch segmentation. A ton-scale LAr LEM-TPC detector is being designed, constructed and operated at CERN in Blg 182 within the CERN RE18 experiment (ArDM). The next step beyond that is the construction of device, ePiLAr, dedicated for the precise calibration, the study of the calorimetric response and for the particle recognition capability of such detectors. The proposed test beam, to be located in the CERN North Area, will in particular be targeted at studying the following points:
a) Liquid Argon Purity: A crucial design feature of multi-kiloton mass liquid argon detectors for neutrino experiments (and other physics such as proton decay) is that the main cryogenic vessel is not evacuable. An automatized gas purging and GAr/LAr purification system necessary to achieving adequate argon purity in a large tank without evacuation will be developed and its performance demonstrated on a ton-scale device. This prototype will form the base for future up-scaling of purification systems for larger systems. b) Electron, neutral pion, charged pion, muon reconstruction: A crucial feature of the LAr TPC is the possibility for a very fine sampling, which should deliver unmatched performances in particle identification and reconstruction. The reconstruction of electrons, neutral and charged pions and muons will be demonstrated in a dedicated test beam, instrumenting the cryogenic infrastructure (dewar, purification, etc.) developed under (a) into a complete TPC detector. The obtained results will allow to further optimize the readout parameters for future large detectors. c) Electron/pi0 separation: A crucial feature of the LAr TPC is the possibility to precisely measure and identify electrons from neutral pion backgrounds. The experimentally achievable separation will be demonstrated by inserting a hydrogenate target inside the detector in order to collect a significant sample of charge exchange events pi^-p->n+pi^0. The obtained results will allow to further optimize the readout parameters for future large detectors. d) Calorimetry: A specific feature of the LAr TPC is its 100% homogeneity and full sampling capabilities. As an extension of the measurements performed in above, more refined measurements with low energy particles (0.5-5 GeV/c e/mu/pi) will yield actual calorimetric performance and determine the ability to reconstruct full neutrino events in the GeV-range. These results will play a fundamental role in future projects involving low energy neutrino beams or sensitive searches for proton decay and complement direct measurements in a low energy neutrino beam. e) Hadronic secondary interactions: If sufficient statistics is collected, an exclusive final state study of pion secondary interactions will be attempted. Comparison

of the data obtained with MC (e.g. GEANT4) will allow to cross-check and eventually tune these models. These results could be relevant for running experiments (e.g. T2K). f) LAr TPC readout systems: An important issue for the realization of large LAr detectors will be the availability of low cost large scale readout solutions matched to a LEM readout method. The measurements will allow to tests and optimize with real physics signals (hadronic and electromagnetic showers) the schemes currently under development: (1) an already existing industrial solution developed in 2008 in Collaboration with CAEN (Italy), and (2) a novel development of analog readout based on a low noise ASIC chip allowing for the low cost integration of a large number of channels and compatible with application at cryogenic temperatures. In addition, a data acquisition system will be developed based on a distributed system of asynchronous smart sensors, reading large groups of channels, with local processors dealing with zero suppression and transmitting data through a Gigabit Ethernet network up to PC cluster for event building, reconstruction and storage. A precise clock distribution system used for the time-stamping of the collected charges, and integrated in the data network by exploiting the IEEE1588 standard, will be used.

Summary :
In order to perform a test beam campaign with a novel LAr LEM-TPC detector, we would like CERN to envisage: • the availability of 0.5-5 GeV/c e/mu/pi with well defined momenta at the CERN SPS North Area. The possibility to reach lower momenta (200, 400 MeV/c) should be considered; • a low intensity of particles during spills (< kHz); • the availability of liquid Argon cryogenic infrastructure in the NA, in particular partial reuse of equipment prepared for ATLAS liquid Ar test beams; • a duration of the test of about 2 to 3 years.

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Abstract ID : 83

Exciting exotic isotopes : the possibilities of Multiple Step Coulomb excitation

Content :

REX-ISOLDE has been the world leading facility in the field of low energy (< 3 MeV.A) Coulomb excitation with post-accelerated Radioactive Ion Beams since its first commissioning back in 2001. The successfull program of low energy Coulomb excitation has yielded over 10 reviewed articles in acclaimed scientific literature. This success is partly due to the expertise present at ISOLDE to produce a whole wealth of unique beams of short lived radioactive isotopes. Single step excitations are the dominant excitation process at the currently available beam energies at REX-ISOLDE, yielding crucial structural information (i.e. transitions rates) between the nuclear ground state and excited states up to around 1.5 MeV. With a beam energy of up to 5 MeV.A, the probability for multiple step excitation increases drastically. With more nuclear states being populated in the same nucleus, more experimental observables, such as transition strength ratios, quadrupole moments and mixing ratios become available. This information is crucial input to theoretical models which describe the low energy structure of the nucleus in terms of its shape. One specific physics case which benefits directly from a higher beam energy in Coulomb excitation is the possibility to identify mixed symmetry states in collective nuclei. These peculiar states are predicted within the IBM-2 model of the nucleus and are extremely sensitive to the residual proton-neutron interaction betweeen valence protons and neutrons. The higher beam energy increases the probability to populate this state drastically, making it possible to systematically search for these states.

Summary :

The possible availability of post accelerated beams up to 5 MeV.A at REX-ISOLDE increases drastically the probability for multiple step Coulomb excitation studies. This yields much more detailed and complete information on the electromagnetic transition probabilities in short lived isotopes at low excitation energies. This information is crucial to validate the various theoretical models of the atomic nucleus.

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Exciting exotic isotopes : the possibilities of Multiple Step Coulomb excitation

Content :

REX-ISOLDE has been the world leading facility in the field of low energy (< 3 MeV.A) Coulomb excitation with post-accelerated Radioactive Ion Beams since its first commissioning back in 2001. The successfull program of low energy Coulomb excitation has yielded over 10 reviewed articles in acclaimed scientific literature. This success is partly due to the expertise present at ISOLDE to produce a whole wealth of unique beams of short lived radioactive isotopes. Single step excitations are the dominant excitation process at the currently available beam energies at REX-ISOLDE, yielding crucial structural information (i.e. transitions rates) between the nuclear ground state and excited states up to around 1.5 MeV. With a beam energy of up to 5 MeV.A, the probability for multiple step excitation increases drastically. With more nuclear states being populated in the same nucleus, more experimental observables, such as transition strength ratios, quadrupole moments and mixing ratios become available. This information is crucial input to theoretical models which describe the low energy structure of the nucleus in terms of its shape. One specific physics case which benefits directly from a higher beam energy in Coulomb excitation is the possibility to identify mixed symmetry states in collective nuclei. These peculiar states are predicted within the IBM-2 model of the nucleus and are extremely sensitive to the residual proton-neutron interaction betweeen valence protons and neutrons. The higher beam energy increases the probability to populate this state drastically, making it possible to systematically search for these states.

Summary :

The possible availability of post accelerated beams up to 5 MeV.A at REX-ISOLDE increases drastically the probability for multiple step Coulomb excitation studies. This yields much more detailed and complete information on the electromagnetic transition probabilities in short lived isotopes at low excitation energies. This information is crucial to validate the various theoretical models of the atomic nucleus.

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Abstract ID : 85

High-precision studies on pure species using Penning traps

Content :

In recent years, atomic physics techniques have provided major input in answering fundamentally important questions not only in atomic, but also in nuclear physics and astrophysics, for example concerning the structure of nuclides, the stellar processes powering the universe, and the processes responsible for heavy-element formation. Penning traps lead the way in such applications, as proved by the pioneering ISOLTRAP setup located at ISOLDE and devoted to high-precision mass measurements by cyclotron frequency determination. Because of many advantages of a three-dimensional ion confinement in well controlled fields the traps are currently used in many other online applications, from beam cooling and bunching (e.g. REXTRAP at ISOLDE) to studies of beta-neutrino correlations for weak-interaction studies (e.g. WITCH at ISOLDE). In addition, due to its high-resolving power the Penning-trap mass spectrometers have recently found a novel application, that of isobaric and isomeric beam purification for decay-spectroscopy studies. Currently, Penning traps allow reaching mass uncertainty better than 10-8 (e.g. Mg-22), a resolving power approaching 10 million (Hg isotopes), for singly or maximum doubly ionized species with production rates as low as 1 ion/s (No-252) and half- lives down to 10 ms (Li-11). However, these impressive performances in precision, resolving power, sensitivity and applicability could not be achieved simultaneously for one specific species. This contribution aims at pushing the present limits of online mass spectrometry even further, thus allowing studies of nuclides and physics questions inaccessible before. One of the planned developments is closely connected to the HIE-ISOLDE project, and is devoted to production and the use of highly-charge ions at ISOLTRAP. Since highly charged ions have higher cyclotron frequencies the resolving power and the precision are increased; or vice versa, a high-precision mass measurement can be performed in a much shorter time compared to the case of singly charged ions. This development will allow accessing very neutron-rich nuclides relevant for the nucleosynthesis rapid neutron capture (r process) which have too short half-lives to be studied efficiently with the required relative precision below 10-7 (especially those in transitional regions, e.g. around Te-140 at N=88). Also, new ways of checking the unitarity of the CKM quark mixing matrix will be possible by deriving with high-precision the Ft values of the T = 1/2 mirror beta transitions, which allow determining the Vud matrix element. For this application, the masses of a dozen of nuclides, e.g. O-15, Na-21, Mg-23, Ca-39, have to be known with the relative precision better than 10-8. When coupled to the newly developed decay-spectroscopy station at ISOLTRAP, also their half-lives and branching ratios (necessary to obtain precise Ft-values) will be accessible with no systematic uncertainties due to beam contamination.

Summary :

The contribution is devoted to the use of highly-charged ions to increase the precision, resolving power, and sensitivity of Penning-trap mass spectrometry. This will allow addressing nuclides and physics topics inaccessible before, such as very neutron-rich nuclides important for the nucleosynthesis or nuclides relevant for determining precisely the Vud element in the CKM quark mixing matrix.

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Abstract ID : 86

Future perspectives in multifunctional oxide materials and the impact of ISOLDE activities using radioactive isotopes: local probes for global challenges

Content :

Strongly correlated electron oxide materials present a vast variety of physical behaviours. Magnetic, electronic and lattice interactions lead to cooperative phenomena like High-Tc superconductivity, colossal magnetoresistance or ferroelectricity, which are topics of advanced research in Physics and Materials Science. The coupling of magnetic and dielectric degrees of freedom has aroused a further interest on multiferroics oxides, on the quest to implement new device design architectures with magnetoelectric control of spintronic devices, such as new generation memory elements, high-frequency magnetic devices, and micro-electro- mechanical systems. These modern functional materials stimulate much scientific interest as the fascinating fundamental physics of colossal magnetoresistance and multiferroism challenge the scientific community understanding. The use of radioactive isotopes as local probes to study these materials is of particular interest, since hyperfine techniques, allowing combined interaction studies (e.g. PAC spectroscopy), provide magnetic field, structural order and electrical polarization information from specific lattice locations using different radioactive ions. As an example, these are particularly suited for local probing of the ubiquitous nanophase separation on these materials, with spontaneous inhomogeneities at nanometer scale. Another aspect with far reaching consequences, related to the grand challenges that foster modern research on materials, is the need for adequate tools to "see and feel" at the nanoscale, to determine the positions and function of all the elements (atoms, electrons, electric and magnetic fields) in a nanoscale solid/structure. The understanding of the properties modification and control at the nanoscale, in nanoparticles/tubes/rods/dots and interfaces prepared with a large variety of techniques calls for the development and availability of complementary radioactive ion techniques with site or element specificity.

Summary :

The ability to probe the nanoscale world using radioactive ions greatly enhances our understanding of modern, complex, strongly correlated electron oxide materials.

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Fixed-Target Experiments in the PS2 era

Content :

For the phase-II upgrade programme of LHC, a new synchrotron is proposed – called PS2 – to replace the existing PS machine. The PS2 machine is expected to operate with an injection energy of 4 GeV and maximum extraction energy of 50 GeV, and to be operational by 2018/2019. The cases for physics experiments attached to the PS2 machine are discussed in view of the expected world-wide competition at the time of its startup, as well as the operation of FT experiments and test beams in the SPS North Area using PS2 as the injector to the SPS. In particular, we discuss the intensity requirements for compelling rare kaon and muon experiments and anticipated requests for intensities beyond those foreseen for LHC operation, which could impact the PS2 machine design and SPS upgrade programme.

Summary :

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Track classification : Possible future developments

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Functionalized nanoparticles studies at ISOLDE

Content :
A new line of application of local probing using radioactive isotopes was started with the research on the coordination mechanisms of heavy metal ions to functionalized nanoparticles. As an example, we mention nano-sized (50 nm) magnetite particles used for removal of heavy metals from water (or other fluids) in magnetically assisted chemical separation methods. The particle surface is modified by attaching inorganic or organic molecules providing them a specific functionality. Using radioactive heavy metal ions for PAC spectroscopy (191Hg, 111Cd and others) one can probe the local coordination at the metal sites on the nanoparticles surface. These studies will make possible not only an increase of the efficiency of the particles but also development of new functionalized nanodispersed systems for environmental, therapeutic and toxicological processes. Synergistic effects are expected in this project, due to the complementary competences of the involved research groups providing expertise in 1) design and control of functionalised nanoparticles and 2) biological effects and toxicity of heavy metal ions. Future perspectives for metal-specific hyperfine local probing techniques using radioactive ions have a bright future, on themes ranging from development of functionalized nanoparticles for tumour targeting, chemical process studies, up to sensor development for single (or few)-molecule detection. A possible trend is the extension of the concept of drug-delivery nanoparticles to developing radioactive ion /molecule-delivery mechanisms, to provide ways of placing the probes at specific locations for site or surface specific studies (including the guidance with magnetic fields or enclosure in pits). The possibility of using the techniques not only in solids but also in liquid (and in vivo) environments is also an advantage. The combination of such nuclear techniques with materials and molecular experimental advances, and with the state-of-the art of computational methods, will provide insight into many fields of science where powerful nanoscale specific tools are a must.

Summary :
Functionalized nanoparticles such as those which are currently being developed for the removal of heavy metals from water (and other fluids) can be better understood - and consequently optimized - by the applied study of radioactive probes to understand the local coordination of heavy metals on the nanoparticle's surface.

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Abstract ID : 89

Studies of rare decay channels of exotic nuclei by using implantation technique at REX-ISOLDE and HIE-ISOLDE

Content :

Studies of nuclei far from stability have in recent years produced a few surprises when the generally accepted paradigms on e.g. the size of the atomic nucleus and the occurrence of magic numbers needed to be adapted [1]. During all 40 years of its operation, by using low-energy (up to 60 keV) radioactive beams, ISOLDE provided many interesting cases of decay studies, which were important both for the fundamental research and for the applications and life sciences. Recently, with the advent of the post-accelerated radioactive beams (presently, up to 3 AMeV) at REX-ISOLDE, a completely new series of experiments, which involve few- nucleon transfer and Coulex excitation reactions, became possible at ISOLDE. The REX-ISOLDE facility together with the planned HIE-ISOLDE upgrade will allow yet another type of the experiments: studies of rare decay channels by using an implantation technique. In this novel technique [2,3], the post-accelerated short-lived nuclei are implanted in a highly-segmented Si detector, in which all possible particle decays are measured and parent-daughter decay correlations can be investigated. By using this technique in a recent study of a two neutron-halo nucleus 11Li(T1/2~8.5 ms), a detailed investigation of very rare decay channels, including the beta-delayed deuteron and triton emission, was performed [4]. This technique will further be extensively used in the future experiments at REX-ISOLDE and HIE-ISOLDE. For example, due to unique beam purity and high beam intensities of heavy (A>170) radioactive beams, the use of the implantation technique will be very important in the studies of the electron-capture delayed fission in the Pb region or for the accurate measurements of alpha decay branching ratios in the Pb-U region. [1] R.F. Casten and B. M. Sherill, Progress in Particle and Nuclear Phyiscs 45, p.171 (2000). [2] D. Smirnov et al., Nucl. Instr. & Meth., A547, 480 (2005). [3] J. Büscher et al., Nucl. Instrum. Methods Phys. Res. B 266, 4652 (2008) [4] R. Raabe et al., "b-delayed Deutron Emission from 11Li: Decay of the halo", PRL, 101, 212501(2008).

Summary :

Future Studies of rare decay channels of exotic nuclei by using implantation technique at REX-ISOLDE and HIE-ISOLDE

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Abstract ID : 90

Beta-NMR as a novel technique using radioactive beams for biophysical studies

Content :
Beta-NMR, which is a part of the future plans for HIE-ISOLDE project, online perturbed angular correlation (PAC) and distribution (PAD) of gamma rays are nuclear techniques which have not been applied in biochemistry yet. Therefore, within the next couple of years we would like to focus on applying beta-NMR method for studies on biological systems. The use of a combination of the radioactive ion beam facility, such as ISOLDE, with tilted-foil technique opens up the wide spectrum of isotopes which are interesting from the biological point of view and allows for measurements of spectroscopic properties (e.g. the electric field gradient) in proteins containing probe atoms or ions that are spectroscopically silent in most other techniques, due to their closed shells. Cu(I) would be an attractive starting point, as it is such a closed shell ion which is present in many proteins involved in for example electron transport and catalysis of redox reactions. With the use of this techinque the detection efficiencies are as much as 10 orders of magnitiude greater than with conventional NMR spectroscopy and therefore it would have a considerable impact in biological chemistry.

Summary :
Beta-NMR has not previously been applied in biology, and this application would break new ground

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Abstract ID : 91

Search of the QCD critical point: study of dimuon pair production at the SPS in the energy range 40-160 GeV/nucleon

Content :

The study of strongly interacting matter at high temperature and/or baryon density in ultra-relativistic heavy ion collisions is a field of research which has reached today a considerable maturity. Fixed- target experiments have been carried out at the AGS and SPS with heavy-ion beams at $\sqrt{s}\le$20 GeV/nucleon, and have been followed by an experimental program at the RHIC ion collider, up to $\sqrt{s}=$200 GeV/nucleon. The detection of lepton pairs played a very important role since the very beginning. Fundamental achievements, as the discovery of anomalous J/ψ suppression (NA50, NA60 at SPS, PHENIX at RHIC) and the study of the low and intermediate mass continuum (CERES, HELIOS-3, NA50 and NA60 at SPS, PHENIX at RHIC), connected with chiral symmetry restoration, required in fact a very precise measurement of lepton pairs. In particular, the third generation NA60 experiment at the CERN SPS, coupling the use of a high granularity silicon tracker to a traditional magnetic spectrometer with a selective dimuon trigger, has pushed to unprecedented levels the statistical accuracy, the mass resolution and the background rejection capabilities. This permitted to perform for the first time a quantitative characterization of the ρ spectral function and of the emission of thermal lepton pairs in nuclear collisions. As of today (beginning of 2009), the field is expected to evolve in two different directions. At the LHC, baryon-free deconfined matter with still higher initial temperature, extending over larger regions and with a longer lifetime, will be created. The produced medium will be a reasonable approximation in the lab of the state of the early universe a few micro-seconds after the Big-Bang. On the other hand, the study of the QCD phase diagram remains almost unexplored in the region of moderate temperature and high baryon density. In this regime, lattice QCD studies foresee the occurrence of a critical point, separating a region of a first-order phase transition from hadronic matter to the QGP from a region where the transition is a simple fast cross-over. The search for such a critical point largely motivated the fixed-target CBM experiment at the forthcoming FAIR facility, with a maximum beam energy of about 40 GeV/nucleon ($\sqrt{s}\sim$10 GeV/nucleon). This physics domain also attracted considerable interest inside the RHIC community, leading to the approval of a "low-energy" program, with beams down to a few GeV/nucleon. Finally, at the CERN SPS, the recently approved NA61 experiment aims at studying collisions again with emphasis on the low-energy side (a few tens GeV/nucleon), with a physics program similar to the one proposed at the other two facilities. Both the RHIC program and the NA61 experiment will essentially address the study of hadronic observables, due to the intrinsic low luminosity of the RHIC collider at low energy and to the TPC-based experimental set-up of NA61, resp. For this reason, it would be extremely interesting to extend the lepton measurements made by the NA60 experiment at the CERN SPS by performing an energy scan from the SPS topmost energy down to 40-50 GeV/nucleon, close to the maximum FAIR energy. This would permit the study of leptonic observables in a region of increasing baryon density, close to the possible position of the QCD critical point. The theoretical description of this region, in terms of phenomenology of leptonic probes, is still at a rather preliminary stage. However, there are effects seen at higher energy, as the enhancement of the dilepton yield in the region around the ρ meson, that are expected to be proportional to the baryochemical potential, and that should therefore be considerably enhanced at lower energies. A pioneering measurement performed by CERES at 40 GeV/nucleon indeed seems to suggest this trend. Another key observable, J/ψ suppression, exhibits a threshold- like behaviour at top SPS energy, when studied as a function of the centrality of the collision. The extension of its systematic study towards lower energy could reveal detailed information on the nature of the observed threshold behaviour, and allow a more direct connection with the underlying physics mechanism.

Summary :

In this talk first ideas on a new NA60-like experiment will be presented, focusing on the required detector changes. After completion of its physics program in 2004, the apparatus and in particular the large muon spectrometer, based on a toroidal magnet and various sets of MWPCs, is still standing in the high-luminosity ECN3 hall. The possibility to re-use some of the still in-place detectors will be discussed together with the possibility to use a new beam line in a different location.

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More intense and energetic muon and hadron beams for nucleon structure and spectroscopy

Content :

Fundamental QCD questions could be answered at COMPASS if a substantial increase of luminosity of the muon beam, and of the energy of both the muon and hadron beams can be achieved. 1/ MUON BEAM. The high energy polarized muon beam of the CERN SPS is presently offering the unique place in the world where to perform polarized deep inelastic scattering experiments. The highest available energy with a high polarization is of the order of 200 GeV, and the maximum luminosity reached in the M2 beam line ~10^32. COMPASS has exploited this facility during the past years to provide important results on the spin of the nucleon. To go further and study in detail the transverse spin structure, the role of gluons in the spin structure, and the spatial distribution of gluons and quarks in the nucleon, it is essential to enlarge the kinematic range. This can be achieved only by increasing both the luminosity and the energy of the beams available at the COMPASS experiment which can handle polarized as well as unpolarized targets. Very precise measurements of inclusive and exclusive deep inelastic polarized processes at low x and high Q2 values are still needed, as well as new observables like the generalized parton distributions (GPDs) and the Transverse Momentum Dependent distributions (TMDs) which can be studied via both DIS or Drell-Yan processes and require high luminosity. The muon flux arriving at COMPASS has been carefully optimized over the last decade. The main limiting factor to reach higher intensities results from the maximum number of protons which can be extrated from SPS quoted as ~3.2*10^13 (~2*10^13) protons/spill for the long (short) SPS flat tops. Several other limiting factors have been identified: radio protection issues at several places along the beam line, resistance of the T6 primary production target, quadrupoles and other elements of the beam and transfer lines, and finally beam halo level in the experiment. As a consequence, a major upgrade of the beam line including eventually underground installation is unavoidable to reach higher luminosity. Projects for future facilities, like an electron ion collider, to resume studies in this field of physics are already under discussion in other labs. However, such a machine will not be available before 10 or 15 years, and CERN can be a major competitor in this physics domain meanwhile. 2/ HADRON BEAMS. Some of the important physics channels using hadron beams within COMPASS require highest possible energies from the SPS. These comprise central production of hadron resonances, where central production and diffractive production can only be separated kinematically. The central production process is governed by double region exchange and Pomeron-Pomeron scattering, the fraction of which is strongly energy dependent, where the latter one raises with energy. The second topic is connected with the installation of a hyperon beam inside the north area to study doubly charmed baryons. High energy boosts the decay length and thus yield of hyperons extracted from a double bent channel. In addition, charm production cross sections are strongly energy dependent at low center of mass energies, thus the gain in yield of doubly charmed baryon seems substantial. At present, the COMPASS beam line can only transport 270 GeV/c beams, mostly connected with power supplies of the magnets installed. It is desireable to increase the energy up to 450 GeV/c, the highest one available from SPS.

Summary :

Fundamental QCD questions could be answered only at COMPASS with a substantial increase of luminosity of the muon beam, and of the energy of both the muon and hadron beams. Higher energy polarized ep collider will not be built before 10 or 15 years, and CERN has a major role to play meanwhile.

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Exotic atomic physics at ISOLDE

Content :

Today Isolde/CERN is and will be expected to stay the world leading facility for the investigation of nuclides far-off the valley of stability regarding the range of accessible elements, the individual isotopic yields and the overall experimental conditions. The wide range of existing routine investigations concerns nuclear physics investigations, studying i.e. mass, size, shape and isomerism of nuclei as well as nuclear excitation schemes througout the accessible ~3000 radionuclides known to form the chart of nuclides. Life times and decay characteristics are of particular relevance for astrophysics investigations regarding the different nucleosynthesis processes, while selected isotopes constitute ideal probes in solid state analysis or bio-medical research. For the wide majority of investigations nowadays ion beam purity in respect to isobaric radiocontamination is the major concern, often even surpassing the importance of highest isotopic yield. Correspondingly selective ionization using the Resonance Ionization Laser Ion Source (RILIS) has developed to become the most prominent ionization method, to be routinely used for the majority of ISOLDE experiments by now. In addition to existentially supporting attached experiments the ISOLDE RILIS has emerged into an independent research unit for laser spectrocopic research and isomer selection. Presently 27 elements are accessible at the ISOLDE RILIS, constituting just about 40% of the so far ~70 elements produced at ISOLDE and still limiting the access to a variety of elements and isotopes of substantial relevance for fundamental questions. Developments on the laser side, in particular involving reliable and low maintenance state-of-the-art solid state laser systems(SSLs), significantly enhance the performance and enlarge the elemental range for any RILIS. Within the last ten years ionization schemes of 34 elements have been successfully developed for SSL-RILISs and ionization efficiencies well above 30% have been demonstrated. Another 50 elements are in reach, to cover almost the full periodic table except for the lower right hand corner. Utilizing the advantages of SSLs, we thus propose as a so-far unusual and somewhat novel research direction at ISOLDE the field of Exotic Atomic Physics (EAP). In support to standard investigations EAP studies the atomic structure and nuclear influences on it within exotic species, which are not accessible off-line. The technology so be used is medium- to high-resolution laser spectroscopy applied either directly within the SSLs-RILIS or in combination with the existing or up-coming on- line laser experiments, i.e. Collaps and CRIS. We have developed high repetition rate lasers with highest continuous wavelength tuning range above 300 nm and/or high resolution narrow band-width of ~20 MHz to be used e.g. for Doppler-free two-photon spectroscopy in-source. Prominent candidates for EAP are At, where the fundamental quantity of the ionization potential (IP) as well as any quotable spectroscopic information are unknown, and Po. Even though nuclear ground and isomeric states have been investigated in Po at the ISOLDE RILIS, atomic spectroscopic data of only 27 levels in this element is extremely scarce and the IP is uncertain to about 45 cm^-1. Future investigations are foreseen also for Fr to verify the IP, which has been determined at ISOLDE II in a collaboration including the author on the basis of few low lying lelves, this time using high lying Rydberg level convergences instead. The upgrade of the ISOLDE RILIS also includes the introduction of the laser ion source trap LIST within the Hie-ISOLDE project, which will enable unrivaled suppression of any isobaric contamination already within the ion source and permit for a complete control of temporal and spatial ion beam structure to adapt to the individual on-line experiment.

Summary :

Exotic atomic physics investigations, i.e. laser spectroscopy on exotic species, as produced solely at ISOLDE, is proposed, giving access to fundamental quantities of relevance like the ionization potential, for cahracterization and understanding of atomic structures and influences of nuclear structure within.

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Abstract ID : 94

Electronic Structure of Isolated Guest Atoms on Surfaces

Content :
The ISOLDE facility offers the unique possibility to investigate the electronic structure of isolated guest atoms on surfaces by applying nuclear techniques. In recent times, an almost comprehensive study of the magnetic hyperfine fields and the electric field gradients of cadmium atoms on nickel surfaces has been presented by the ASPIC group (Helmholtz-Zentrum Berlin für Materialien und Energie). The results of these measurements promoted the development of a unified model which is expected to allow for the interpretation of electronic effects in the great variety of nanometer-scaled or even smaller devices. In particular, the magnetic hyperfine field of the current experiments could be understood from the spin-dependent s-wave scattering of conduction electrons on the impurity potential, while specific populations in the p-sublevels have been made responsible for the field gradients in the different environments. The current experiments have demonstrated the feasibility of investigations which demand ultra-clean preparation techniques on-site and online at the ISOLDE facility. This topic has also been extremely important in contemporary research (e.g. 2007 Nobel prizes) and the way has been paved for commencing experiments on the behaviour of d-electrons (transition elements) and f-electrons (rare earth elements) utilising the radioactive isotopes which are uniquely offered by the ISOLDE mass separator.

Summary :
The ASPIC experiment at CERN performs surface physics with the radioactive probes available from the ISOLDE facility. It continues to further our understanding of fundamental magnetic interactions in materials which also underpins many important modern technologies such as the magnetic coupling responsible for giant magnetoresistance.

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Continuing surprises from isotopically pure materials: the continuing re-evaluation of “known” impurities in semiconductors

Content :

The randomness present in semiconductors grown using source materials with the natural isotopic abundances affects intrinsic vibrational properties and this becomes manifest in phonon dispersion curves and lifetimes [1]. There are also strong isotopic effects on the thermal conductivity [2]. Isotopic effects on electronic properties of semiconductors were not expected to be all that important especially since the relevant electron and hole wavefunctions typically sample many unit cells of the crystal. However, results for isotopically enriched Si clearly show effects due to isotopic randomness, and that observed spectroscopic limits are a consequence of the randomness in the distribution of its isotopic constituents. In addition, detailed information on impurities has also been obtained for enriched silicon, including data for radioactive isotopes provided by ISOLDE. The range of techniques and isotopes (e.g. clean intense beams of many of the most important impurities in Si) available at ISOLDE has helped to address questions and provide chemical information which is not readily answered using conventional methods. The expansion of these early studies on Si to isotopically enriched semiconductors in general is likely to provide significant new information for a broad range of semiconductor devices.

References: [1] E.E. Haller, Isotopically engineered semiconductors, J. Appl. Phys. 77 (1995) 2857. [2] M. Cardona, Isotopic effects in the phonon and electron dispersion relations of crystals, Phys. Status Solidi B 220 (2000) 5.

Summary :

By using isotopically pure materials (e.g. 99.999% 28Si) rather than those blessed with the natural distribution of isotopes (e.g. 28Si, 29Si 30Si) to study some of the most common impurities in Si, it has been found that a feast of information which is normally "hidden" is revealed, pertaining to the structural and electronic properties of these impurities. Indeed many of the most studied systems in Si have been found to be incorrect and important new data have been obtained which is vital not just from a spectroscopic viewpoint, but also has implications for technological applications and in particular processing of the material.

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Nuclear Charge Radii of Beryllium Halo Isotopes at ISOLDE

Content :

Recently we have measured the nuclear charge radii of Be-7,9,10,11 at ISOLDE using collinear laser spectroscopy with accuracy better than 1% [Nör09]. Particularly the charge radius of the one-neutron halo nucleus Be-11 provides important input data for nuclear structure theories. It was the first time that the charge radius of a one- neutron halo has been measured and the combination with matter radii and B(E1) strength distribution will allow us to disentangle the charge radius increase caused by the center-of-mass motion of the core and the nuclear core deformation [Tan09]. Measuring nuclear charge radii of halo isotopes with laser spectroscopy is a challenge for several reasons: Halo isotopes are only produced with low yields and have usually lifetimes of only a few ms. Hence, preparation and spectroscopy of the ions must be fast. Moreover, halo isotopes are only known in the very light region of the nuclear chart, where the field shift – which contains the nuclear charge radius information - contributes only on the order of 1E-4-1E-5 to the total isotope shift. To extract the nuclear structure information, experimental isotope shift measurements with a relative accuracy of a few times 1E-6 must be combined with atomic structure calculations of similar accuracy. These are so far only available for one-, two-, and three-electron systems [Yan08, Puc08]. We have performed these measurements at the collinear laser spectroscopy setup at ISOLDE using for the first time a frequency comb for very precise measurements of the absolute transition frequency with relative accuracy better than 10-9. Only in this way it was possible to overcome the systematic uncertainties caused by insufficient knowledge of the acceleration voltage of the ions. With this technique, it will be possible to study also the isotopes Be-12 and Be-14. Both are extremely interesting since their nuclear structure is not completely understood yet. For instance, in Be-12 it is not clear at all whether the 0+ ground state is based on p states or on intruder states from the sd shell. Also it has been recently found in proton scattering that also Be-12 exhibits a long tail of neutron matter, which supports a halo picture also for this nucleus. For Be-14 it is still debated whether it is a two-neutron or a four-neutron halo nucleus. Inverse proton scattering indicates that the core of Be-14 is substantially different from the free Be-12 nucleus. Information about the nuclear charge radii of these isotopes will significantly contribute to the understanding of these systems. The yields provided by the current ISOLDE facility are sufficient for charge radii measurements of Be-12 if we combine our technique with the recently installed cooler and buncher ISCOOL. An accuracy comparable to that reached for Be-11 is expected. However, for a measurement of Be-14 the yields are too low, but if they can be improved by one to two orders of magnitude with HIE-ISOLDE, such a measurement may become feasible. This would for the first time allow comparison of nuclear charge distributions in three different kinds of halo configurations within one element. References [Nör09] W. Nörtershäuser et al., PRL 102, 062503 (2009) [Tan09] I. Tanihata, in preparation [Yan08] Z.-C. Yan et al., PRL 100, 243002 (2008) [Puc08] M. Puchalski and K. Pachucki, PRA 78, 052511 (2008).

Summary :

We propose to measure the nuclear charge radii of the short-lived halo isotopes Be-12 and Be-14 using collinear laser spectroscopy. The combination of frequency-comb based collinear spectroscopy with high-precision atomic structure calculations allows the extraction of the tiny nuclear volume effect from the measured isotope shift.

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