Physics Beyond Colliders Kickoff Workshop

Report of Abstracts

Abstract ID : **3**

storage ring proton EDM measurement

Content

A measurement of the proton EDM to better than 10-29ecm, or better, allows us to probe physics in a new regime up to ˜3PeV mass scale. The use of the storage ring EDM technique permits 5 orders of magnitude improvement over current indirect measurements of dp (from Hg) and 3 orders magnitude more sensitivity on [U+F071]QCD inferred from neutron EDM measurements. Non-zero values of the pEDM would unambiguously point to the existence of NP. We describe the design of an electric- only ring that combines the frozen spin technique with counter-rotating proton beams that can deliver these physics objectives. The experimental and technological challenges have been addressed in detail over the last 5 years; developments in magnetic field shielding now make this a low risk and relatively low cost experiment. We present a summary of the major machine and detector components required to build this experiment.

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Status: ACCEPTED

Submitted by **BOWCOCK, Themis** on **Tuesday 10 May 2016**

Abstract ID : **4**

Search for millicharged particles in photon collisions

Content

Particles in a hidden sector can potentially acquire a small electric charge through their interaction with the Standard Model and consequently be observed as millicharged particles. We analyze the production of millicharged scalar, fermion and vector boson particles in collisions of polarized photons. The obtained results are model independent, being based purely on the assumptions of electromagnetic gauge invariance and unitarity. Polarization observables are evaluated and analyzed for each spin case. We show that the photon polarization asymmetries are a useful tool for discriminating between the spins of the produced millicharged particles. A prototype experiment to directly measure polarized cross sections of millicharged particles production in low energy photon-photon collisions is proposed.

Primary author(s) : Dr. GABRIELLI, Emidio (University of Trieste, Italy and NICPB, Tallinn, Estonia); Dr. MARZOLA, Luca (University Of Tartu, Estonia); Prof. MILOTTI, Edoardo (University of Trieste, Italy); Mr. VEERMAE, Hardi (NICPB, Tallinn, Estonia)

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Status: SUBMITTED

Submitted by **Dr. GABRIELLI, Emidio** on **Wednesday 11 May 2016**

Abstract ID : **5**

Two Pomeron loop topology in pp : the gap distribution in double diffraction, doubled multiplicity in multi particle production, string junctions and positive baryon asymmetry.

Content

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The topological presentation of pomeron exchange during the proton-proton collision of high energy is a cylinder that is covered with quark-gluon net [1]. I argue that, the process of double diffraction (DD) can be presented as pomeron exchange with the central loop of two uncut pomeron cylinders. Taking into account that the junction of three gluons has the positive baryon number, as well as the antijunction is of negative baryon charge, our pomeron cylinder loop can be covered by only a certain number of hexagons with 6 string junction (SJ) and antijunction vertices each [2]. It is reasonable to suggest that the dynamics of rapidity gaps in DD should be determined by the number of hexagons on the surface of the pomeron torus. Therefore, the gap distribution in DD events should have the discrete structure in the region of big gaps. There is another process with two pomeron loop configuration that is the particle production event with doubled multiplicity at the central rapidity , which corresponds to the cut along the pomeron loop. Moreover, the string junction torus can be released in the course of pp interaction as metastable "particle" and be suspected as Dark Matter candidate. The possibility of production of the states with many string junctions has been discussed recently by G.C. Rossi and G. Veneziano [3]. The positive hyperon production asymmetries that have been measured at LHC are more practical demonstration of string junction dynamics in proton-proton interactions [4]. These measurements have shown that the energy dependence of baryon excess in the central rapidity region depends on the parameter of the string junction. Therefore, the immediate goal of LHC experiments would be the measurements of asymmetry in heavy baryon production that let us estimate the important dynamical parameter of string junction – the intercept of SJ-antiSJ Regge trajectory. Furthermore, the detail study of the gap distributions in DD as well as the characteristics of events with doubled multiplicity, which both go on the level of 1.2% of total production cross section, would be also needed.

[1] G.C.Rossi and G. Veneziano, Phys.Lett. B {\bold 70}(1977)255. [2] O.I.Piskounova, the talk at ATLAS Diffraction Working Group meeting, 20 April 2015. [3] G.C.Rossi and G. Veneziano, JHEP 1606(2016)041.

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Status: SUBMITTED

Submitted by **PISKUNOVA, Olga** on **Tuesday 24 May 2016**

Abstract ID : **6**

The International Axion Observatory (IAXO)

Content

Axions are a natural consequence of the Peccei-Quinn mechanism, the most compelling solution to the strong-CP problem. Similar axion-like particles (ALPs) also appear in a number of possible extensions of the Standard Model, notably in string theories. Both axions and ALPs woudl be copiously produced at the sun's interior, and in addition they are very well motivated candidates for the Dark Matter. They are object of increasing interest by experimentalists. A relevant effort during the last decade has been the CAST experiment at CERN, the most sensitive axion helioscope to-date. Here I will present an initiative born as a large-scale ambitious follow-up of CAST: the International Axion Observatory (IAXO). As its primary physics goal, IAXO will look for solar axions or ALPs with a signal to background ratio of about 5 orders of magnitude higher than CAST. For this IAXO envisions a large superconducting toroidal magnet designed optimizing the axion helioscope figure of merit, extensive use of x-ray focusing optics and low background x-ray detectors. IAXO will venture deep into unexplored axion parameter space, thus having discovery potential. IAXO has also potential to host additional detection setups. Most interestingly, the large magnetic volume of IAXO could be used to detect relic axion or ALPs potentially composing the galactic halo of Dark Matter. IAXO has the potential to serve as a multi-purpose facility for generic axion and ALP research in the next decade, making use of technology and know-how from CERN.

Primary author(s) : GARCIA IRASTORZA, Igor (Universidad de Zaragoza (ES))

Presenter(s) : GARCIA IRASTORZA, Igor (Universidad de Zaragoza (ES))

Status: ACCEPTED

Submitted by **GARCIA IRASTORZA, Igor** on **Friday 27 May 2016**

Abstract ID : **7**

Tau-neutrino production study at CERN SPS: Novel approach by the DsTau experiment

Content

The tau-neutrino CC cross section has never been well measured. There has been only one measurement by the DONuT experiment with a systematic uncertainty larger than 50%, mainly due to uncertainties in the Ds differential production cross section in high energy proton interaction. The DsTau collaboration proposes to study tau-neutrino production and the energy distribution by analyzing Ds -> tau events in 400 GeV proton interactions. By employing the state-of-the-art emulsion particle detector technologies, we will analyze 10ˆ8 proton interactions and detect the double kink topology of Ds -> tau -> X decays. Accomplishing this new measurement, we will re-evaluate the tau-neutrino cross section with the data from DONuT and test lepton universality in neutrino CC interactions. Furthermore, it will provide data useful for future tau-neutrino experiments. In this talk, we report an overview of the experiment and the planned prototype test in 2016.

Primary author(s) : Dr. ARIGA, Tomoko (University of Bern); Dr. ARIGA, Akitaka (University of Bern)

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Presenter(s) : Dr. ARIGA, Tomoko (University of Bern)

Comments:

We will give an overview of the project for which LOI was submitted to the CERN-SPSC (CERN-SPSC-2016-013; SPSC-I-245).

Status: SUBMITTED

Submitted by **ARIGA, Tomoko** on **Wednesday 01 June 2016**

Abstract ID : **9**

Search for electric dipole moments using storage rings

Content

The Standard Model (SM) of Particle Physics is not capable to account for the apparent matter-antimatter asymmetry of our Universe. Physics beyond the SM is required and is searched for by (i) employing highest energies (e.g., at LHC), and (ii) striving for ultimate precision and sensitivity (e.g., in the search for electric dipole moments (EDMs)). Permanent EDMs of particles violate both time reversal (T) and parity (P) invariance, and are via the CPT-theorem also CP-violating. Finding an EDM would be a strong indication for physics beyond the SM, and pushing upper limits further provides crucial tests for any corresponding theo\-retical model, e.g., SUSY.
Direct searches of proton and deuteron EDMs bear the potential to reach sensitivities beyond 10^{-29} e·cm. As will be discussed in the presentation, this goal can be pursued either with an all-electric proton storage ring, or by an approach using a combined electric-magnetic lattice which shall allow access to the EDMs of proton, deuteron, and ^{3}He in one-and-the-same machine.
As a proof of principle experiment, the JEDI collaboration is currently preparing for a first direct measurements of the EDM of the proton and the deuteron using the conventional magnetic storage ring COSY. To open up the possibility for an EDM measurement, this experiment will employ a novel waveguide RF Wien filter, whereby the spins of protons or deuterons can be manipulated at frequencies of about 0.1 to 2 MHz.
The talk will highlight recent achievements from the JEDI R\&D program at COSY, and emphasize one of the most spectacular possibilities in modern science: Finding a signal for new physics beyond the Standard Model through the detection of a permanent electric dipole moment using a storage ring.

Primary author(s) : Dr. RATHMANN, Frank (Forschungszentrum Jülich)

Presenter(s) : Dr. RATHMANN, Frank (Forschungszentrum Jülich)

Status: SUBMITTED

Submitted by **RATHMANN, Frank** on **Saturday 04 June 2016**

Abstract ID : **10**

The Gamma Factory initiative

Content

This contribution discusses the possibility of broadening the present CERN research programme by a new component, making use of a novel concept of the light source. The proposed, partially stripped ion beam driven, light source is the backbone of the Gamma Factory initiative. It could be realized at CERN by using the infrastructure of the already existing accelerators. It could push the intensity limits of the presently operating light-sources by at least 7 orders of magnitude, reaching the flux of the order of 10^{17} photons/s, in the particularly interesting γ-ray energy domain of \mbox{ $1 \leq E_{photon} \leq 400$ MeV.} This domain is out of reach for the FEL-based light sources based on sub-TeV energy-range electron beams. The unprecedented-intensity, energy-tuned, quasi-monochromatic gamma beams, together with the gamma-beams-driven secondary beams of polarized positrons, polarized muons, neutrinos, neutrons and radioactive ions would constitute the basic research tools of the proposed Gamma Factory. A broad spectrum of new opportunities, in a vast domain of uncharted fundamental and applied physics territories, could be opened by the Gamma Factory research programme.

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Presenter(s) : KRASNY, Mieczyslaw Witold (LPNHE, IN2P3, CNRS, University Paris VI and VII)

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Status: ACCEPTED

Submitted by **KRASNY, Mieczyslaw** on **Thursday 09 June 2016**

Abstract ID : **11**

Search for dark sector physics in missing energy events at the CERN SPS

Content

The NA64 is a fixed-target experiment aiming to search for dark sector physics with a high-energy electron beam at the CERN SPS. The experiment uses a new approach combining the active beam dump and missing energy techniques. We present the future NA64 research program which is significantly extended %and has a certain advantages compared to the classical beam dump approach. by the inclusion of measurements with high-energy μ, π, K, and p beams. The program will deliver a rich and compelling physics opportunity by performing the sensitive searches for new symmetries, rare decays, and weakly-interacting particles from the dark sector and is based on the following motivations:
i) In addition to gravity, there might be another very weak interaction between the ordinary and dark matter transmitted by a new $U'(1)$ gauge boson (dark photon). NA64 plans to search for visible, e.g. into e^+e^-, $\mu^+\mu^-$, and invisible, e.g. into dark sector particles, decays of sub-GeV dark photons. The experiment has the exciting opportunity to probe a substantial fraction of the currently unexplored dark photon parameter space, probing kinetic-mixing parameter ϵ as low as $\epsilon^2 \simeq 10^{-6} - 10^{-10}$ and masses $M_{A'} \leq 500$ MeV by using $\simeq 100$ GeV electron beams from the CERN SPS. The search will also cover the region where the $(g-2)_\mu$ discrepancy between the measured and predicted anomalous magnetic moment of the muon can be explained by an additional $U'(1)$ gauge boson which decays mostly invisibly. %With an expected number of electron on target $10^{12}(10^{13})$ in 2016-2017 (2018 and beyond).
ii) A new sub-GeV gauge boson
zm (leptonic boson) from the $L_\mu - L_\tau$ flavor symmetry with couplings to μ and τ, but not electrons, could explain the $(g-2)_\mu$ discrepancy and the gap of high-energy neutrinos in IceCube, and is well motivated by neutrino mixing angles. The
zm could be observed in the reaction
$react$ of high-energy muon scattering off nuclei by looking for an excess of events with the large missing muon beam energy in a detector due to the prompt bremsstrahlung
zm decay
$zmnn$ into a couple of neutrino. \\ The availability of high energy ($\simeq 100$ GeV) and high intensity ($\simeq 10^6$/spill) muon beams at CERN SPS allows to search for the Z' with the sensitivity in coupling constant $\alpha_\mu \simeq 10^{-11}$, which is three orders of magnitude higher than the value required to explain the $(g-2)_\mu$ anomaly. This provides a unique opportunity either to discover or rule out the
zm in the proposed search in the near future. %The number of muons available at present is an order of 10^{15} μ/year, and it is anticipated to have more like $10^{18} - 10^{19}$ μ/year.
iii) In the standard model (SM) the rate of the neutral mesons (M^0) $\pi^0, \eta, \eta', K_S, K_L \to \nu\overline{\nu}$ decays is predicted to be extremely small. The decay $K^0_L(K^0_S) \to invisible$ has never been experimentally tested. In the SM its branching ratio for the decay into two neutrinos is helicity suppressed and predicted to be $\leq 10^{-10}$. In several popular extensions of the SM, e.g. the two-Higgs doublet model, the helicity suppression factor can be avoided resulting in the enhanced K^0_L rate e.g. into $\nu_\tau\overline{\nu}_\tau$ pair or pair of light scalars, and could be in the range $Br(K^0_L \to invisible) \simeq 10^{-8} - 10^{-6}$, still allowed by the most stringent constraints from the $K \to \pi\nu\nu$ decay. Another motivation to search for $K_S, K_L \to invisible$ decays is related to the still open question on how possible contributions from these decays influence the Bell- Steinberger unitarity relation - a powerful tool for testing CPT symmetry in the $K^0 - \overline{K}^0$ system. \\ The experiment utilizes the charge-exchange reactions of $\simeq (20-50)$

GeV π or K on nucleons of an active target, e.g. $\pi^-(K^-) + p \to M^0 + n$, as a source of the well-tagged M^0s emitted in the forward direction with the beam energy. If the decay $M^0 \to invisible$ exists, it could be observed by looking for an excess of events with a specific signature: the complete disappearance of the beam energy in the detector. This unique signal of $M^0 \to invisible$ decays allows for searches of the $K^0_L(K^0_S) \to invisible$ decays with a sensitivity in the branching ratio $\simeq 10^{-8}(10^{-6})$, and $\pi^0, \eta, \eta' \to invisible$ decays with a sensitivity of a few orders of magnitude beyond the present experimental limits by using the beams with intensity $I_{\pi,K} \simeq (10^5 - 10^6)$/spill. An experiment at such level of sensitivity would be a clean probe of new physics at and beyond the LHC mass scale. It is complementary to the search for rare $K \to \pi\nu\nu$ decay and thus %and provide a strong motivation for its sensitive search in a near future experiment. fits very well with the present kaon physics program at CERN. %With an expected $10^{15}(5.5x10^{16})$ muon decays in 2015-2016 (2018 and beyond).
iv) Searches for sub-GeV leptophobic dark sector bosons Z' coupled to quarks. The Z' could be produced in the high-energy proton collisions with nuclei of an active target, $pp \to Z' + X$, with the subsequent invisible decay $Z' \to \chi\overline{\chi}$ into lighter dark matter particles χ. The feasibility study shows that the NA64 can provide complementary coverage of the parameter space, which is intended to be probed by the planned experiment at the Main Injector at FNAL. In contrast to this project, the only assumption used in NA64 is that the $Z' \to \chi\overline{\chi}$ decay is predominant, but no assumptions are made on the value of the χ coupling strength to Z'. The experiment requires the use of the $\simeq (100-200)$ GeV proton beams with intensity $I_p \simeq (10^5 - 10^6)$/spill.
All these searches can be performed using a common experimental setup. Therefore, we regard all proposed measurements as a unified one NA64 experiment. Modifications to the existing NA64 setup are required. Some of the detector components have to be upgraded or newly made item-by-item to realize the final configurations.

Primary author(s) : GNINENKO, Sergei (Russian Academy of Sciences (RU))

Presenter(s) : GNINENKO, Sergei (Russian Academy of Sciences (RU))

Comments:

The abstract is submitted on behalf of the NA64 Collaboration

Status: ACCEPTED

Submitted by **GNINENKO, Sergei** on **Sunday 12 June 2016**

Abstract ID : **12**

AFTER@LHC : A fixed-target programme at the LHC for heavy-ion, hadron, spin and astroparticle physics

Content

In this talk, we review a number of recent ideas* put forward in favour of a fixed-target programme at the LHC - AFTER@LHC- dedicated to heavy-ion, hadron, spin and astroparticle physics. By extracting the beam with a bent crystal or by using an internal gas target, the multi-TeV LHC beams allow one to perform the most energetic fixed-target experiments ever with which one can access the essentially uncharted backward kinematics with detectors similar to LHCb or ALICE.
In particular we argue that this allows one to study pp, pd and pA collisions at $\sqrt{s_{NN}} \simeq$115 GeV and Pbp and PbA collisions at $\sqrt{s_{NN}} \simeq$72 GeV with extremely high precision with modern detection techniques. Such studies, including

- single transverse-spin asymmetries for hard and rare processes,
- suppression of heavy-flavours and quarkonia as well as azimuthal asymmetries down to the target rapidity in heavy-ion collisions,
- cold-nuclear matter effects,
- the physics involved in ultra-peripheral hadron and ion collisions,
- far backward gluon and heavy-quark sensitive processes,
- vector-boson production near threshold ...,

would greatly complement collider experiments, in particular those of the Electron-Ion Collider project or RHIC (with luminosities larger by 1 to 3 orders of magnitude).
Such a mode indeed allows for a broad physics programme, covering the large-x QCD frontier for particle and astroparticle physics, as well as spin and heavy-ion physics with respectively a polarised target and the LHC lead beam.
*: for a complete list of references see http://after.in2p3.fr/after/index.php/Recent_published_ideas_in_favour_of_

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Presenter(s) : LANSBERG, Jean-philippe (IPN Orsay, Paris Sud U. / IN2P3-CNRS)

Comments:

I intentionally left out simulation and performance studies by using LHCb or ALICE set-ups with a target system similar to SMOG or the HERMES gas target, as the subject of a possible dedicated talk for session 2 following our email exchanges.
I expect a few members of the AFTER@LHC study group to attend the workshop. As for now, I would be the speaker for this physics-oriented talk.

Status: ACCEPTED

Submitted by **LANSBERG, Jean-philippe** on **Tuesday 14 June 2016**

Abstract ID : **13**

Prospects for an experiment to measure BR($K_L \to \pi^0 \nu \bar{\nu}$) at the CERN SPS

Content

Precise measurements of the branching ratios (BRs) for the flavor-changing neutral current decays $K \to \pi\nu\bar{\nu}$ can provide unique constraints on CKM unitarity and, potentially, evidence for new physics. It is important to measure both decay modes, $K^+ \to \pi^+\nu\bar{\nu}$ and $K_L \to \pi^0\nu\bar{\nu}$, since different new physics models affect the rates for each channel differently. The NA62 experiment at the CERN SPS is currently collecting data and should measure BR($K^+ \to \pi^+\nu\bar{\nu}$) to within 10% by 2018; there are plans to measure BR($K_L \to \pi^0\nu\bar{\nu}$) with similar precision at a successor to the KOTO experiment at J-PARC using a low-energy secondary beam, but no official proposal has yet been made. We are investigating the feasibility of performing a measurement of BR($K_L \to \pi^0\nu\bar{\nu}$) using a high-energy secondary neutral beam at the CERN SPS in a successor experiment to NA62. The planned experiment would reuse some of the NA62 infrastructure, including possibly the NA48 liquid-krypton calorimeter; the measurement technique is complementary to that of KOTO Step 2 and would provide comparable sensitivity. The mean momentum of K_Ls decaying in the fiducial volume is 70 GeV. This causes decay products to be boosted forward, so that less demanding performance is required from the large-angle photon veto detectors. On the other hand, the layout poses particular challenges for the design of the small-angle vetoes, which must reject photons from K_L decays escaping through the beam pipe amidst an intense background from soft photons and neutrons in the beam. We present some preliminary conclusions from our feasibility studies, with an emphasis on the design challenges faced and the sensitivity obtainable for the measurement of BR($K_L \to \pi^0\nu\bar{\nu}$).

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Comments:

On behalf of the NA62-KLEVER project

Status: ACCEPTED

Submitted by **MOULSON, Matthew** on **Thursday 16 June 2016**

Abstract ID : **14**

A space-like measurement of the leading hadronic corrections to the muon g-2 with a muon beam

Content

The anomalous magnetic moment g-2 of the muon is a precision measurement which exhibits a 3.5σ deviation between theory and experiment, and in the next few years will be measured at Fermilab and J-PARC with even higher precision.
The hadronic contribution to the muon g-2 (a_μ^{HLO}) is the most important one after the pure QED contribution. It is however affected by a large uncertainty which dominates the error on the theoretical prediction in the Standard Model. Considering the present observed deviation of the experimental measurement, it is extremely important to get an independent measurement of the hadronic contribution to g-2 to reduce its uncertainty.
We propose a novel approach to determine the leading hadronic corrections to the muon g-2. It consists in a measurement of the effective electromagnetic coupling in the space-like region at low-momentum transfer. We discuss the possibility to perform this measurement by taking advantage of the high energy muon beam in the CERN North Area. We plan to realize a fixed target scattering experiment aiming at achieving a per mille accuracy on a_μ^{HLO}. Such an accuracy will allow an alternative determination of this fundamental quantity competitive with the present results obtained with the dispersive approach via time-like data.
Such precision would therefore allow a more stringent test of the Standard Model when compared with the g-2 measurements expected at Fermilab and J-PARC.

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Presenter(s) : VENANZONI, Graziano (Istituto Nazionale Fisica Nucleare Frascati (IT))

Status: ACCEPTED

Submitted by **VENANZONI, Graziano** on **Saturday 18 June 2016**

Abstract ID : **15**

Search for Hidden Particles with the SHiP experiment

Content

The experimental evidence for BSM physics such as the non-zero neutrino masses, the baryon asymmetry in the Universe, and the presence of non-baryonic dark matter may have their origin in new physics involving very weakly interacting particles as predicted by models with a secluded or hidden sector of particles. In general, these models contain mediators that couple very weakly with SM particles, acting as portals to the hidden sector, e.g. dark photon, Majorana neutrinos, dark scalars, etc… Relatively light warm dark matter is naturally accommodated in these models. Given the small coupling constants and typically long lifetimes, hidden particles have not been significantly constrained by previous experiments, and the reach at current experiments is limited by both luminosity and acceptance.
This talk will describe the recently proposed SHiP experiment at the SPS which is aiming at generically searching for hidden particles. The high power and unique operational mode of the SPS provide ideal conditions for accessing a wide variety of light long-lived very weakly interacting particles and light dark matter. With 2x1020 protons on target, SHiP is able to achieve sensitivities which are up to four orders of magnitude better than previous constraints, accessing a significant fraction of the unexplored parameter space. Such an experiment would be an essential complement to the LHC in the search for new physics at CERN.
The SHiP experiment is also ideally suited to study the interactions of tau neutrinos.

Primary author(s) : GOLUTVIN, Andrei (Imperial College London)

Presenter(s) : GOLUTVIN, Andrei (Imperial College London)

Comments:

There are two complementary documents, SHiP Technical Proposal (CERN-SPSC-2015-016) and SHiP Physics Proposal (CERN-SPSC-2015-017)

Status: ACCEPTED

Submitted by **GOLUTVIN, Andrei** on **Monday 20 June 2016**

Abstract ID : **16**

New Detectors to Explore the Lifetime Frontier

Content

Long-lived particles (LLPs) are a common feature in many beyond the Standard Model theories, including supersymmetry, and are generically produced in exotic Higgs decays. Unfortunately, no existing or proposed search strategy will be able to probe neutral LLPs with lifetimes near the limit set by Big Bang Nucleosynthesis (BBN), c tau < 10ˆ7 - 10ˆ8 m. We propose the MATHUSLA surface detector concept (MAssive Timing Hodoscope for Ultra Stable neutraL pArticles), which can be implemented cost-effectively and in time for the high luminosity LHC upgrade to find such ultra-long-lived particles (ULLPs), whether produced in exotic Higgs decays or more general production modes. We also advocate for a dedicated LLP detector at a future 100 TeV collider, where a modestly sized underground design can discover ULLPs with lifetimes at the BBN limit produced in sub-percent level exotic Higgs decays

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Presenter(s) : CURTIN, David (University of Maryland)

Comments:

We propose MATHUSLA, a dedicated detector for long-lived particles (LLPs) on the surface above CMS or ATLAS. The physics motivation is general, and it would allow for detection of LLPs with lifetimes near the BBN bound. The cost of the project is estimated to be in the O(20 million USD) range, which is very affordable, especially considering the resulting three orders of magnitude in reach improvement for particles with very long lifetimes, compared to searches with the LHC main detectors.
This workshop is the perfect venue to present our idea to CERN, and to gather feedback from the experimental community. We very much hope to present this proposal at this workshop.
(The paper was just uploaded to arxiv and will appear publicly in the coming days. I upload a pdf version of the paper with this abstract submission.)

Status: SUBMITTED

Submitted by **CURTIN, David** on **Monday 20 June 2016**

Abstract ID : **17**

Particle acceleration by strong interactions

Content

For accessing smallest structures the quest for high energies is mandatory. It is commonly believed that corresponding accelerator sites need to be large, and that even cosmic rays with up to 10**20 eV are accelerated by electromagnetic interactions in giant cosmic structures. If instead strong interactions of order 1GeV/fm could be exploited, acceleration sites could in principle fit the size of a laboratory experiment. Different aspects related to acceleration by strong interactions have been investigated before. For example in fixed target lepton-proton experiments, target protons were found to be accelerated up to GeV energies (e.g. M.Arneodo et al., ZPC 35(1987)433). The distance dependence of the attractive strong potential for quark-antiquark states has been studied in onium experiments (e.g. C.Ayala et al. arXiv:1509.01382), and investigated in deceleration processes of quarks and antiquarks in Z boson decays (e.g. M.Erdmann, PLB 510(2001)29).
For combinations of quark and (anti-)quarks in several color states a repulsive force is expected from fundamental calculations of Quantum Chromodynamics which could serve for acceleration purposes (see e.g. text books on QCD). Color octet contributions have been studied in heavy meson physics before (e.g. E.Braaten et al. Ann.Rev.Nucl.Part.Sci. 46(1996)197). A repulsive strong force, however, has not yet been directly measured.
Building an accelerator site based on strong interactions is obviously a major long term project. The challenges call for a decade of research, as preparation of quarks, gluons, or generally colored objects is required. Also ways to control the strong potential and to concatenate acceleration phases need to be found. It seems a good point in time to inquire the interest within the community, and to ask interested colleagues from theory and experiments to participate in setting up a suitable road map.
As a first step of an experimental program exploiting particle acceleration by strong interactions we suggest an experiment for direct observation of the repulsive force between two quarks.
Preparation of two quarks can be achieved by two deep inelastic scattering processes off a nucleus. Two electron beams are injected e.g. at 90 degree angle onto an iron target. The angles and energies of the scattered electrons determine the energies and flight directions of the two quarks. In this way, events with the two quarks having identical direction and energy can be selected such that the quark-quark center-of-mass energy is small.
If a repulsive force between the two quarks exists as predicted by QCD, the two quarks will acquire transverse momentum relative to their original flight direction. The quark transverse momenta will be measured as hadron transverse momenta in an appropriate detector system.
We present an experimental setup and challenges arising.

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Status: SUBMITTED

Submitted by **ERDMANN, Martin** on **Saturday 25 June 2016**

Abstract ID : **18**

advanced-KWISP: investigating short-range interactions at sub-micron scales.

Content

Sensitive measurements on the short range interactions between macroscopic bodies provide a window on possible physics beyond the standard model, including extra-dimensions, scalar dark matter and dilatons. The sub-micron scale distances is presently not accessible to experimental investigation, and may hold the key to understanding at least part of the dark matter puzzle. The *a*-KWISP (*advanced*-KWISP) proposal builds on the results obtained with the KWISP opto-mechanical force sensor, designed and constructed at INFN Trieste, and enters the short-distance interaction field with the novel "double-membrane" concept. Here interaction distances can be as short as 10 nm, much below the ≈10-30 micron distance which is the lower limit encountered by current experimental efforts. *a*-KWISP reaches the ultimate quantum-limited sensitivity by exploiting an array of technologies, and by achieving sub-Kelvin membrane temperatures with a combination of cryogenic and optical cooling. Access to CERN infrastructure will be key to the success of aKWISP, in order to build upon the experience being matured with KWISP at CERN, and to have direct access to advanced technologies readily available at CERN, such as patterned thin-layer coatings and cryogenic cooling.

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Presenter(s) : CANTATORE, Giovanni (Universita e INFN, Trieste (IT))

Status: ACCEPTED

Submitted by **CANTATORE, Giovanni** on **Monday 27 June 2016**

Abstract ID : **19**

Measurement of Short Living Baryon Magnetic Moment using Bent Crystals at SPS and LHC

Content

The magnetic moments of baryons containing u,d and s quarks have been extensively studied and measured. The experimental results are all obtained by a well-assessed method that consists in measuring the polarisation vector of the incoming particles and the precession angle when the particle is travelling through an intense magnetic field. The polarization is evaluated by analysing the angular distribution of the decay products. No measurement of magnetic moments of charm or beauty baryons (and τ leptons) has been performed so far. The main reason is the lifetimes of charm/beauty baryons, too short to measure the magnetic moment by standard techniques. One proposal to meet the challenge of measuring the magnetic moments of baryons with heavy flavoured quarks is to use the strong effective magnetic field inside the channels of a bent crystal instead of the conventional magnetic field to induce the precession of the polarization vector and measure the magnetic moment. The detailed precession theory has been developed in Ref. [1]. E761 Collaboration (1992) had demonstrated the feasibility of this idea by measuring the magnetic moment of the strange Σ+ baryon [2] using the decay into pπ0. In this talk we investigate scenarios and propose an experiment to measure the magnetic moment of the Λc and other charmed charged baryons at SPS and at LHC top energies. For the proposed experiments, the length and the crystal bending angle should be optimised at the different energies, to provide the maximal channelling efficiency. On the other hand, the crystal should be tightly packet with the target and tested to maximize the Λc yield taking into account the very short decay length of the charmed baryons. The detector should be very close to the crystal-target pack to maximize the yield. The unavoidable drawback would be the heavy background produced by the primary proton beam travelling close-by. The proposed experiment at SPS should be performed in the CERN North Area, whilst the LHC experiment should be kept in the LHC vacuum pipe and if possible use one of the existing LHC detectors.

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Presenter(s) : STOCCHI, Achille (LAL CNRS Universite Paris Sud)

Comments:

paper complemented by "Optical layout for the measurement of Short Living Baryon Magnetic Moment using Bended Crystals at LHC", Authors : D.Mirarchi1, S. Redaelli1, W. Scandale1,2, A. Stocchi2. 1CERN, 2LAL.

Status: ACCEPTED

Submitted by **SCANDALE, Walter** on **Tuesday 28 June 2016**

Abstract ID : **20**

Optical layout for the measurement of Short Living Baryon Magnetic Moment using Bended Crystals at LHC

Content

In this talk we investigate scenarios for an experiment to measure the magnetic moment of the Λc and other charmed charged baryons at LHC top energies. In the last decade, the UA9 Collaboration has developed the technology and more recently used it to demonstrate that bent silicon crystals can efficiently steer the diffusive halo surrounding the circulating beam in LHC, up to 6.5 TeV energy. A scenario is described here to deflect the halo particles in the vicinity of an interaction region of LHC. The deflected particles should be kept in the vacuum pipe and will follow trajectories well distinct from those of the circulating beam core. By approaching to the beam a target that intercepts the channelled beam, well separated from the beam core, the deflected halo can be efficiently used for fixed-target physics. In particular, by directing the deflected halo into another bent crystal tightly packed with a short and dense target, located in the LHC pipe just before an existing detector, living baryons should be produced and their polarization may be measured from the analysis of the decay products. An additional downstream collimation setup is also required to intercept halo particles non-interacting with the target and debris from the target itself, in order to ensure that losses remain safely below quench limits of superconducting magnets, thereby allowing the possibility of fixed-target operation in parasitic mode. As an example, a preliminary optical layout compatible with the existing installations in IR8 is presented.

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Comments:

Paper comlemente by "Measurement of Short Living Baryon Magnetic Moment using Bent Crystals at SPS and LHC", Authors: L. Burmistrov1, G. Calderini2, M. Garattini5, Yu. Ivanov3, L. Massacrier1,4, P. Robbe1,5, W. Scandale1,5, A. Stocchi1.
1 LAL, 2 LPNHE, 3 PNPI, 4 IPNO, 5 CERN

Status: SUBMITTED

Submitted by **SCANDALE, Walter** on **Tuesday 28 June 2016**

Abstract ID : **21**

Experimental checks of precise QCD predictions by studying the π+K−, K+π− and π+π− atoms

Content

The lifetime of the short-lived (τ_{th} about 3×10^{-15} s in the ground state) π^+K^-, $K^+\pi^-$, ($\pi^+\pi^-$) atoms($A_{\pi^+K^-}$, $A_{K^+\pi^-}$ and $A_{2\pi}$) is given within 1% (0.6%) precision by the S-wave πK ($\pi\pi$) scattering length combination $|a_{1/2} - a_{3/2}|$ ($|a_0 - a_2|$), where 1/2, 3/2 (0, 2) are the isospin values. Furthermore, the study of long-lived $A_{2\pi}$ states (states with non-zero orbital momentum, $\tau \geq 1 \times 10^{-11}$ s) allows to measure the Lamb shift depending on another $\pi\pi$ scattering length combination $2a_0 + a_2$. Therefore, the investigation of dimesonic atoms is the tool to measure model-independently πK and $\pi\pi$ scattering lengths, which have been calculated precisely in the framework of LQCD (Lattice QCD) and ChPT (Chiral Perturbation Theory). Up to now, dimesonic atoms have been investigated only in the experiment DIRAC, using the CERN PS 24 GeV/c proton beam.
The S-wave ππ scattering lengths described in QCD exploiting $SU(2)_L \times SU(2)_R$ symmetry breaking and confirmed experimentally with precision of about 4%. But these measurements - independently from their accuracy - cannot check the QCD predictions based on the chiral $SU(3)_L \times SU(3)_R$ symmetry breaking for strange sector. This check can be done by investigating the S-wave πK scattering lengths, where the s quark is involved.
LQCD and ChPT give $|a_{1/2} - a_{3/2}|$ with a precision of about 5% and 10%, respectively. The best direct measurement of this combination has an average precision of 35% (DIRAC experiment, to be published). It is obvious that for the time being LQCD and ChPT predictions, based on chiral $SU(3)_L \times SU(3)_R$ symmetry breaking, have not be checked experimentally with enough accuracy. A recent study has shown that the $\pi^+\pi^-$ π^+K^-, and$K^+\pi^-$ atom production per time will be 12 ± 2, 53 ± 11 and 24 ± 5 times higher than in the previous DIRAC experiment, if the incident proton momentum raise from 24 to 450 GeV/c ($\theta_{lab} = 4°$) and take in to account the SPS beam duty factor. This significant increase in $A_{\pi^+K^-}$ and $A_{K^+\pi^-}$ production makes it possible to measure $|a_{1/2} - a_{3/2}|$ at the 5% precision level with DIRAC in a comparable running time. For the first time, our thinking about chiral $SU(3)_L \times SU(3)_R$ symmetry breaking in QCD could be checked. The setup upgrading and geometry modification will enable a significant precision improvement.
The $\pi\pi$ scattering lengths a_0, a_2 and their difference have been calculated in ChPT with precision of 2.3% and 1.5%, respectively. The accuracy of these parameters can be improved. In some recent works, $\pi\pi$ scattering lengths were calculated using LQCD: with precision about 5% and less than 1.5%. Currently, only $|a_0 - a_2|$ has been measured in the NA48 and DIRAC experiments with a precision of about 4%, confirming the theoretical predictions. The scattering length a_2 has been determined by NA48 with a precision of 22% . The strong increase of the $A_{2\pi}$ yield allows to improve the $|a_0 - a_2|$ precision and to begin the study of the long-lived atom $A_{2\pi}$, which has been observed by DIRAC in 2015.
For all investigation of dimesonic atoms, the DIRAC experiment uses very thin targets without disturbing the proton beam and, hence, can be installed upstream of other experiments in the same beam.

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Status: ACCEPTED

Submitted by **AFANASYEV, Leonid** on **Tuesday 28 June 2016**

Abstract ID : **22**

PUMA : Pbar Unstable Matter Annihilation

Content

The study of the structure of unstable nuclei is an active area of nuclear physics research. New experimental probes are needed to investigate new emerging features in loosely bound nuclear systems and cope with difficulties resulting from the low-intensities of radioactive ion beams. One of the features emerging from the imbalance between protons and neutrons is that the neutron density distribution extends far outside with respect to proton one. This neutron skin, its thickness and its dependence with proton-to-neutron asymmetry contain unique information on low density neutron matter, the nuclear equation of state, and nuclear compressibility. Antiprotons as a probe for nuclear studies with unstable isotopes remain unexploited despite past pioneering work at CERN/LEAR and Brookhaven. Antiprotons are a unique probe sensitive to the ratio of neutron and proton densities at annihilation site, i.e. at the very surface of the nucleus at about $\rho=\rho0/1000$, typically at a radius r = rms + 2.5 fm. The PUMA project proposes a technical solution to pursue this goal in three steps : (i) the storage of a large number of antiprotons delivered by the AD/ELENA facility, (ii) the transportation of stored antiprotons to the ISOLDE facility (iii) the realization antiproton-unstable ion collisions. In this presentation, the PUMA concept and setup will be described, as well as the potentialities it offers for nuclear structure studies. The development phase and agenda will be briefly discussed.

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Presenter(s) : Dr. CORSI, Anna (CEA Saclay)

Status: SUBMITTED

Submitted by **CORSI, Anna** on **Tuesday 28 June 2016**

Abstract ID : **23**

Preliminary Study for a New Axion Dark-Matter Haloscope

Content

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A collaboration between CAPP/IBS KAIST in Korea, teams from CNRS/Université Grenoble Alpes and CERN is studying the possibility of developing a new haloscope for Axion dark-matter search. The superconducting coil under construction at LNCMI-Grenoble will provide a magnetic field of 9 T in a room temperature bore of 812 mm diameter and 1.4 meter high. This large bore superconducting magnet can host various types of microwave cavity detectors for the Axion to photon resonant conversion via the inverse Primakoff effect following the Sikivie's detection scheme. These cavities, possibly superconducting, are presently under study at CAPP/IBS and will have a high quality factor Q ˜ 10ˆ5-10ˆ6. Low-noise microwave amplification of the signal will be ensured by a DC superconducting quantum interference device (SQUID) or Josephson Parametric Amplifiers (JPA) cooled-down to 25 mK by a 3He/4He dilution refrigerator. This new haloscope will be designed to probe QCD dark-matter Axions in the mass range of 1-100 micro-eV with diphoton coupling constant reaching for the first time the theoretical prediction of the Dine-Fischler-Srednicki-Zhitnitsky (DFSZ) model.

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Status: SUBMITTED

Submitted by **PUGNAT, Pierre** on **Wednesday 29 June 2016**

Abstract ID : **24**

An electron beam for physics experiments based on AWAKE technology

Content

The AWAKE experiment [1] will be taking data over the next two years to establish the method of proton-driven plasma wakefield acceleration. An R&D programme is being formulated for post-LS2 in which the AWAKE experiment demonstrates [2] that bunches of about 10^9 electrons with an energy of 10 GeV accelerated in about 10 m of plasma are achievable and that the energy gain is scalable with length. Given a clean electron beam of O(50 GeV) and of a much higher rate than from the SPS secondary beam, new and improved fixed-target or beam-dump experiments are possible. An example is the NA64 experiment [3] which is searching for hidden sector physics such as dark photons using the secondary SPS electron beam at an intensity of $\sim 10^6$ e^-/s. With the expectation of being able to increase this rate by at least a factor of 100 using the AWAKE beam, sensitivity to new physics is correspondingly extended. An electron beam of O(50 GeV) is also planned for the LHeC which under the AWAKE scheme could be achieved in a plasma cell of ˜50 m in length, although with modest luminosities. This could open up the possibility of an LHeC-type project at relatively low cost and focusing on physics at low Bjorken-x such as saturation and QCD in general. An ultimate goal of the AWAKE technology is to use it to produce an electron beam of 3 TeV and collide with an LHC proton beam. This very high energy electron-proton collider [4] would probe a completely new regime in which QCD and the structure of matter is completely unknown. Again, this would be relatively low luminosity, but this is offset by the rapidly rising cross sections at low Bjorken x.

[1] AWAKE Coll., arXiv:1511.09032; arXiv:1512.05498
[2] E. Adli (AWAKE Coll.), IPAC2016 proceedings, p.2557-2560.
[3] https://na64.web.cern.ch
[4] A. Caldwell and M. Wing, arXiv:1606.00783

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Comments:

With input from AWAKE and NA64 collaborations

Status: ACCEPTED

Submitted by **WING, Matthew** on **Wednesday 29 June 2016**

Abstract ID : **25**

The AWAKE Facility at CERN and Its Unique Program Towards First Applications

Content

AWAKE at CERN is the first proton driven plasma wakefield acceleration experiment worldwide and will demonstrate the acceleration of externally injected electrons using a plasma wave excited by a CERN SPS proton bunch of 400GeV/c. With first applications of this plasma wakefield technology in mind, such as fixed target, beam-dump experiments and an electron beam for an LHeC-like experimental program (see M. Wing's abstract), the AWAKE collaboration aims to demonstrate in Run 2, after LS2, good emittance parameters for the accelerated electron beam. The electron bunches will have an intensity of ˜10E9 electrons/bunch and an energy gain of 10 GeV after ˜10m plasma. In addition it is intended to show the scalability of the AWAKE concept; this includes sustaining high gradients over significant distances, which will require controlled plasma wave characteristics and scalable length plasma sources. AWAKE is installed in the tunnel previously used for the CNGS experiments and offers a unique opportunity to exploit the experimental program of Run 2, with the possibility to extend the experimental area for scalability tests by 100 m in case the CNGS target area would be emptied. After successful Run 2 demonstrations, a scaled up version of the AWAKE experiment as a first application could be installed in a new location, geographically compatible with a first proton driven plasma wakefield accelerator. Here, an electron bunch of 50-100 GeV/electron driven by an SPS proton bunch could be sent through a (possibly new) tunnel from the SPS towards an existing LHC experiment such as ALICE or LHCb and collided with a LHC proton bunch. Other possible uses of such an electron beam are being explored. Key accelerator, technology and facility issues will be discussed in order to realize the AWAKE scheme for future particle physics experiments.

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Comments:

for the AWAKE Collaboration

Status: SUBMITTED

Submitted by **GSCHWENDTNER, Edda** on **Wednesday 29 June 2016**

Abstract ID : **26**

Exploring Confinement

Content

This note proposes an experimental programme to explore the QCD confinement phenomena at CERN with a new electron-proton and electron-nucleus collider using the existing SPS beams (optionally also the future SPL and PS proton and ions beams) and the polarised electron/positron beam in the range of 5 to 20 GeV from a newly built Energy Recovery Linac. On top of its inherent scientific merits, it could deliver the indispensable experimental input for the Precision Phase of the LHC research programme.

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Status: SUBMITTED

Submitted by **KRASNY, Mieczyslaw** on **Wednesday 29 June 2016**

Abstract ID : **27**

Investigating the QCD phase transitions with dileptons: new opportunities at the CERN SPS

Content

The theory of strong interactions, Quantum Chromodynamics (QCD), predicts a rich variety of different phases of strongly interacting matter. The QCD phase diagram is usually represented as a function of the temperature and baryon density. At sufficiently high temperatures, a transition from hadronic matter to a Quark-Gluon Plasma (QGP), a state where quarks and gluons are no more confined into hadrons, is predicted.
Experimentally, the conditions for the formation of the QGP can be reached in collisions of heavy nuclei at ultra-relativistic energies. The exploration of the QCD phase diagram is up to now mainly restricted to the region of low baryon density. In this regime, lattice QCD calculations predict a cross-over transition between hadronic matter and QGP, occurring at a temperature of 155 MeV [1]. On the other hand, the phase diagram for moderate temperatures and high baryon densities is largely unknown and the existence of a first order phase transition with coexistence of a mixed-phase was suggested. The first order transition line should end with a second order critical point [2]. The experimental test of this scenario is one of the outstanding questions in the field of non-perturbative QCD.
Furthermore, in vacuum, the light hadron masses are largely due to the spontaneous breaking of QCD chiral symmetry. At the phase boundary between hadronic matter and the QGP, chiral symmetry should be restored. This implies a change in the hadron mass spectrum, but how this is realized is not known.
In order to shed light on these fundamental phenomena, we propose to define a new experimental apparatus (here denoted NA60+) to measure the production of muon pairs with unprecedented precision in fixed-target nucleus-nucleus collisions in a low-energy scan at the CERN SPS [3]. The CERN SPS is unique for such systematic investigations, because it can deliver high-intensity beams to study, e.g., Pb-Pb collisions over the energy range from $\sqrt{s_{NN}}$ =5-6 up to 17 GeV in the centre-of-mass system.
In this energy regime, measurements of lepton pairs provide a rich set of observables. Dileptons are produced at all stages of the evolution of the created system, and offer the possibility to measure its temperature. The measurement for the first time of a caloric curve and the possible identification of a plateau can provide a direct and unambiguous evidence of a first-order phase phase transition. Chiral symmetry restoration can be also directly probed, by studying for the first time the mass modifications in a simultaneous measurement of the vector meson ρ and its axial vector partner a_1 close to the onset of deconfinement.
In addition, the study of J/ψ suppression and open-charm production are also expected to be sensitive to the onset of deconfinement.
High precision measurements of muon pairs were pioneered by the NA60 experiment, which coupled a traditional muon spectrometer to a silicon vertex tracker placed before the hadron absorber [4,5,6,7]. The NA60+ apparatus is meant as an evolution of NA60. It aims at an increase in statistics by a factor $\sim$ 100 over NA60 and even larger over RHIC and LHC experiments, while retaining a very good signal-to-background ratio even in central Pb-Pb collisions [3].
The CERN SPS appears to be the best facility for these measurements. Thanks to the new injection scheme it can deliver intense ion beams leading to interaction rates exceeding 1 MHz. An ion beam could be delivered to a fixed target experiment while the SPS is used as injector for LHC. Presently the NA61 experiment, with an experimental program on hadronic observables, is running at the CERN SPS and has a physics program complementary to the one proposed for NA60+.

In comparison, the other facilities operating in collider mode (RHIC and NICA) provide interaction rates 2-3 orders of magnitude smaller than the SPS, so that high-precision measurements are not possible. In addition, FAIR SIS/100 is designed to provide high interaction rates but the energy coverage is extremely limited. FAIR SIS/300 might provide a larger coverage but it is not approved at present and its operation would in any case only start well beyond 2030. Thus, no presently approved experiment is able to cover such a large energy interval and to collect at the same time the large statistics required for truly quantitative measurements. A high precision dilepton experiment at the CERN SPS as NA60+ would then represent a unique opportunity to investigate the QCD phase diagram in the next decade.

[1] Bazavov et al., HotQCD Coll., Phys. Rev. D90 (2014) 9
[2] M.A. Stephanov, K. Rajagopal, E.V. Shuryak, Phys. Rev. D60 114028 (1999)
[3] A. Dainese, E. Scomparin, G. Usai et al., White paper INFN What Next: Ultra-relativistic Heavy-Ion Collisions - Frascati Physics Series, Volume LXII, ISBN 978-88-86409-85-8; http://arxiv.org/abs/1602.04120
[4] R. Arnaldi et al., NA60 Coll., Phys. Rev. Lett. 96, 162302 (2006)
[5] R. Arnaldi et al., NA60 Coll., Phys. Rev. Lett. 99, 132302 (2007)
[6] R. Arnaldi et al., NA60 Coll., Phys. Rev. Lett. 100, 022302 (2008)
[7] R. Arnaldi et al., NA60 Coll., Eur. Phys. J. C 59 607 (2009)

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Comments:

Dear organizers, we have submitted an abstract for a proposal of new dilepton measurements in heavy ion collisions at the CERN SPS (session 4). We would like to draw the attention that this proposal is conceptually based on the previous NA60 experiment and would be complementary to the program of hadronic measurements presently performed by NA61-shine. For this reason it might fit in session 3 on the potential future of existing programmes as well.

Status: ACCEPTED

Submitted by **USAI, Gianluca** on **Thursday 30 June 2016**

Abstract ID : **28**

Searching for Axion-Like Particles with LHC magnets and Future VMB Measurements at CERN

Content

In recent years, several experiments have been proposed and conducted to find evidence of the existence of axion like particles (ALPs) in the laboratory. One possibility to search for axion-like signatures is based on so-called 'light shining through a wall'-type experiments. The leading limits from this approach come from the ALPS-I (DESY, Hamburg, Germany) and the OSQAR (CERN) collaborations. While OSQAR is using two LHC dipole magnets, but a single-pass laser beam, the ALPS-I experiment used a combination of a HERA dipole magnet and a high-finesse laser cavity.
As a first step, we propose to combine both approaches, i.e. implement a laser cavity within one LHC dipole magnet and conduct an ALPs search experiment by 2018. This would improve the sensitivity by a factor of 5-6 compared to previously published limits of model independent searches for axion masses below 10^{-3} eV. In the long term, we this experimental setup should serve as baseline for a first measurement of the magnetic vacuum magnetic birefringence (VMB) effects, i.e. a direct test of the predictions of QED.

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Status: SUBMITTED

Submitted by **SCHOTT, Matthias** on **Thursday 30 June 2016**

Abstract ID : **29**

Spectroscopy of strange and charmed mesons with COMPASS

Content

B. Ketzer for the COMPASS Collaboration
The excitation spectrum of hadrons is governed by strongly coupled quarks and gluons forming bound states. Its quantitative understanding is one of the great puzzles and goals of modern particle physics. Only recently, lattice QCD has begun to make predictions for the spectrum of mesons and baryons which have to be confronted with precise experimental data. Recent discoveries of new structures at e+e- colliders (Z_c^+, Z_b^+), LHCb (P_c) or COMPASS ($a_1(1420)$) have intensified hopes that states beyond the $q\bar{q}$ and qqq configurations of mesons and baryons have been observed both in the heavy-quark and the light-quark sector.
The strange sector has seen very little progress over the last decades, and consequently the spectrum of mesons containing strange quarks is much less known than the one of light quarks. The PDG lists only 13 kaon states in its summary tables, while another 13 are omitted, out of which 8 need confirmation. Very often, inconsistent and reaction-dependent results are reported for the masses and widths, which calls for clarification. Of particular interest are also the scalar states like the $K_0^*(800)$, related to the question of the groundstate scalar nonet. In addition, strange mesons play a vital role in final states of heavy mesons. An RF-separated kaon beam at CERN's M2 beamline would use the successful spectroscopy technology available at COMPASS to settle these questions. Last but not least, it would also permit to extend the study of chiral dynamics, explored in many aspects at COMPASS, to the strange sector.
An RF-separated beam also allows the use of low-energy antiprotons. At higher energies, antiprotons appear not to be advantageous to protons, as t-channel diffractive processes dominate. However, at beam energies around or below 20 GeV proton-antiproton annihilation plays a major role, which is to be exploited by the PANDA collaboration at FAIR in the longer-term future. We expect that several aspects of the physics program foreseen for PANDA could be realized earlier in COMPASS, e.g. the production of charmed hybrids and exotics. In addition, there is the possibility to reach higher masses than PANDA, touching the B threshold.

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Submitted by **KETZER, Bernhard** on **Thursday 30 June 2016**

Abstract ID : **30**

The DarkSide Dark Matter Program

Content

The DarkSide-50 dark matter detector at LNGS is a two-phase argon TPC, installed at the center of two nested veto detectors, a 30-tonne liquid scintillator neutron veto and a 1,000-tonne water Cherenkov muon veto. While operating in 2014 with a fill of argon extracted from the atmosphere, DarkSide-50 demonstrated its capability to operate in a background-free mode even in presence of the strong radioactive background due to the 39Ar isotope produced by cosmic rays. In 2015 DarkSide was filled with 150 kg of argon extracted from deep underground reservoirs, which was demonstrated to be highly depleted in 39Ar. Today DarkSide-50 is the only noble liquid dark matter detector operating in background-free mode. The combination of the DarkSide-50 results obtained with the atmospheric and underground argon fills allows to project that DarkSide-20k, a 20-tonne depleted argon detector proposed for construction at LNGS, will collect an exposure of 100 tonnes×year completely free of background. DarkSide-20k detector is set to start operating by 2020 and is projected to be the most sensitive dark matter experiment, with a sensitivity reaching well past the ultimate value possible for xenon-based detectors. DarkSide-20k will be followed after five years at LNGS by Argo, a 300-tonne dark matter detector capable to collect an exposure of 1,000 tonnes×year completely free of background, reaching the ultimate sensitivity before the onset of background due to nuclear recoils induced by neutrino coherent scattering. Argo will also be capable of performing a set of very high precision measurement of several solar neutrino sources. The future DarkSide programs are made possible by special technological programs for the procurement of underground argon (Urania project), in its additional isotopic rejection of 39Ar (Aria project), and in the development of special SiPM to replace cryogenic PMTs for operation as photosensors at 87K (DarkSide@Abruzzo project). We expressed our interest to assemble and operate at CERN the 1-tonne prototype of DarkSide-20k already under construction by the DarkSide Collaboration at this time. We anticipate that the prototype will be ready for assembly in the Summer 2017. Assembly and operation at CERN will enable to elicit strong participation in this activity from all DarkSide institution in a central location easily accessible to all of its groups. Operation of the 1-tonne prototype at CERN will help in quickly deploying the readout and the data acquisition systems of the novel SiPM-based photosensors equipping the 1-tonne prototype.

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Submitted by **GALBIATI, Cristiano** on **Thursday 30 June 2016**

Abstract ID : **31**

Future options for searching axion-like particles through light-shining-through-a-wall experiments

Content

Weakly interacting slim particles (WISPs) are searched for in purely laboratory based experiments with the so-called light-shining-through-a-wall (LSW) approach. Here the detection of axion and axion-like particles, which seem to be the best motivated WISPs from theoretical considerations, requires the presence of a long and strong magnetic field perpendicular to the light path. Current experimental activities are OSQAR at CERN and ALPS II presently under preparation at DESY. At ALPS II, dedicated complex optics, largely based on experiences gained in the context of LIGO, new detector technologies and modified dipoles from the HERA proton ring will be combined. In the future one could envisage a physics case strongly asking to increase the sensitivity of LSW experiments beyond the present scope. For example, direct dark matter experiments or solar observations might discover a light axion-like particle requiring to measure its properties unambiguously in a purely laboratory based experiment. In this contribution we will sketch scopes and limitations of "ultimate" LSW experiments based on advanced high field magnets presently under development in the frame of HL-LHC and FCC. It is evident that the corresponding high costs of such installations will require a very clear and convincing physics case.

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Status: ACCEPTED

Submitted by **LINDNER, Axel** on **Monday 04 July 2016**

Abstract ID : **32**

A New Search for Neutron-Anti-Neutron Oscillations

Content

Neutral particle oscillations have proven to be extremely valuable probes of fundamental physics. Kaon oscillations provided us with our first insight into CP-violation, fast B oscillations provided the first indication that the top quark is extremely heavy, B oscillations form the most fertile ground for the continued study of CP-violation, and neutrino oscillations suggest the existence of a new, important energy scale well below the GUT scale. An open question is whether neutrons oscillate to anti-neutrons, violating baryon number conservation. New high-power proton drivers serving spallation sources, together with modern neutron guiding techniques, should make it possible to build an experiment with approximately three orders of magnitude improvement in sensitivity to the neutron oscillation probability. This exciting possibility will be described.

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Status: SUBMITTED

Submitted by **BROOIJMANS, Gustaaf** on **Friday 08 July 2016**

Abstract ID : **33**

The CORE satellite project

Content

The CORE satellite project submitted to ESA is designed as the utimate instrument for measuring CMB polarisation. The data will bring potentially a lot of information on fundamental physics and on topics traditionally important at CERN. CORE would be sensitive enough for detecting the Gravitational Wave background predicted by many inflationary scenario, and connecting inflation to high-energy physics. In combination with large scale surveys such as those from the Euclid satellite, or from baryonic oscillation observations with spectrometric surveys from the ground, it would sharpen constraints on neutrino physics (absolute neutrino mass scale, tests of non-standard neutrino interactions, low-temperature reheating), dark matter physics (tests of DM annihilation, DM decay, DM feeble interactions or self-interactions). Finally it could test the presence of extra light relics in the universe (light sterile neutrinos, axion-like particles, etc.) and of many other extensions of the minimal cosmological model (primordial magnetic fields, topological defects, etc.) In this talk, we will present the main characteristics of the CORE satellite and discuss its connections with fundamental physics. We will give informations on the status of the project. We will show that if CERN is interested, it can play an interesting role in CORE, for instance by sharing its expertise on the handling and distribution of huge data sets and for joint analyses with other cosmological surveys such as Euclid and ground-based baryonic oscillation experiments. The CORE project is supported by a large international collaboration of observational cosmologists (Marco Bersanelli, François Bouchet, Paolo De Bernardis, Jacques Delabrouille, ...) and theoretical cosmologists (Antony Challinor, Jens Chluba, Martin Bucher, Fabio Finelli, Eiichiro Komatsu, Marin Kunz, Julien Lesgourgues, Alessandro Melchiorri, Rashid Sunyaev, Licia Verde, ...) It is recognised internationally as one of the potentially most promising experiments of precision cosmology in the next decades.

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Submitted by **LESGOURGUES, Julien** on **Saturday 09 July 2016**

Abstract ID : **34**

Precision Measurements of Kaon and Proton Structure with High Intensity RF-Separated Hadron Beams at the SPS.

Content

Using the high-intensity pion-dominated negative hadron beam at the SPS M2 beamline in combination with the world's largest polarized nucleon target and nuclear targets the COMPASS collaboration is in a unique position to study proton-structure through Drell-Yan production of di-muon pairs.
M2 upgrades resulting in high intensity RF-separated anti-proton and kaon beams would significantly expand the experimental reach of COMPASS and enable a worldwide unique and precise set of measurements including studies of transverse momentum dependent quark structure for protons and kaons, precise studies of nuclear effects and for the first time measurements of kaon quark-substructure. This presentation will describe the unique and broad Drell-Yan physics program with RF separated meson and anti-proton beams.
One example: measurements with a future anti-proton beam can be used to achieve a model independent extraction of the proton Sivers- and Boer-Mulders quark distributions with their interesting connections to intrinsic quark orbital angular momentum. Once the proton distributions will be known, the meson beams allow to experimentally determine Boer-Mulders quark distributions for Kaons and Pions, for the first time. Such results would make it possible to study the mass dependence of TMD effects in hadrons and to compare Boer-Mulders distributions for 2-quark and 3-quark bound states.

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Submitted by **GROSSE-PERDEKAMP, Matthias** on **Sunday 10 July 2016**

Abstract ID : **64**

Neutrinos from Stored Muons (nuSTORM)

Content

The Neutrinos from Stored Muons (nuSTORM) facility has been designed to deliver beams of nu_e and nu_mu from the decay of a stored beam. nuSTORM has the potential to:

- Serve the future long- and short-baseline neutrino-oscillation programmes by providing definitive measurements of ,nu_e N and nu_mu N scattering cross sections with percent-level precision; and
- Allow searches for sterile neutrinos of exquisite sensitivity.

nuSTORM is ideally matched to the development of the North Area at CERN where it could serve the experimental hall that will soon house the CERN Neutrino Platform.

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Comments:

The list of co-authors is contained in the file that has been uploaded. The abstract is submitted on behalf of the nuSTORM collaboration.

Status: ACCEPTED

Submitted by **LONG, Kenneth Richard** on **Tuesday 26 July 2016**