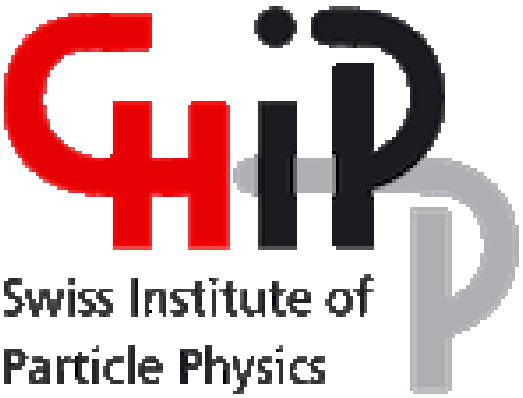
CHIPP/CHART Workshop on Sustainability in Particle Physics and CHIPP 2023 plenary

Wednesday, 14 June 2023 - Friday, 16 June 2023



Book of Abstracts

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Vertex Detectors for FCC-ee: Simulation and Sensor R&D

Author: Armin Ilg[1]

Co-authors: Anna Macchiolo [2]; Eduardo Ploerer [3]; Florencia Canelli [2]; Freya Blekman [4]; Kunal Gautam [5]

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The FCC-ee is a proposed future e^+e^- collider capable of producing all SM particles in large quantities and clean experimental conditions. Up to four experiments can detect the collision products, with IDEA being one of the proposed detector concepts at FCC-ee. IDEA needs to fulfil requirements similar to experiments at other proposed lepton colliders such as reliable particle identification, efficient flavour tagging and superior momentum resolution.

This contribution presents the progress of the implementation of the IDEA detector in full simulation using the key4hep and DD4hep framework used by many future collider communities.

An emphasis will be put on the design and full simulation implementation of the vertex detector which is crucial for many of the experimental goals of the FCC-ee program. The related R&D on DMAPS will be briefly discussed as well.

Limited flash talk slots:

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My contribution is about a project related to sustainability:

No

Field of contribution:

Particle physics

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Novel production method of a cold muonium beam

Author: Jesse Zhang[1]

Co-authors: Anna Soter [1]; Damian Goeldi ; Paul Wegmann [2]; Robert Waddy

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[2] *ETH Zurich*

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The LEMING experiment at the Paul Scherrer institute aims to measure the free fall of muonium (M $= \mu^+ + e^-$), an exotic atom consisting purely of leptons. Measuring the free fall of M would be the first test of the weak equivalence principle using elementary antimatter of the second generation and using a system without large hadronic contributions to its mass.
Such a direct measurement is performed by atom interferometry, which requires a high intensity, low emittance M beam. We are developing a novel M source based on stopping accelerator muons in a layer of superfluid helium at cryogenic temperatures.
In this contribution, results from the first observation of M emitted from superfluid helium are presented. An initial characterization of the M source shows a high vacuum M yield and sub-thermal beam dynamics. Prospects of this novel beam in the context of a free fall experiment will be discussed.

Limited flash talk slots:

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Field of contribution:

Particle physics

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Prospects to the PIONEER experiment

Author: Stefan Hochrein[None]

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Introduction to PIONEER, a next generation rare pion decay experiment located at PSI.

Limited flash talk slots:

My contribution is about a project related to sustainability:

No

Field of contribution:

Particle physics

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SoLAr

Author: Saba Parsa[1]

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The SoLAr detector concept, aims to extend the sensitivities of LArTPC detectors to the MeV energy range, and expands their physics reach to observe solar neutrinos and potentially supernovae neutrinos.
The core concept is centered around an integrated charge-light readout plane, consisting of pixel pads for charge collection and VUV SiPMs for direct de- tection of LAr scintillation light. The main challenges are to achieve low energy thresholds with an excellent energy resolution and successfully per- form background rejection using pulse shape discrimination.
A staged prototyping program is planned to demonstrate the technology viability of the detector concept step by step. In October 2022, a small scale SoLAr prototype was constructed and tested in LAr at Bern University. Here we present the results from the first prototype run with cosmics muons and discuss the roadmap to a ton scale demonstrator at Boulby Underground Laboratory.

Limited flash talk slots:

My contribution is about a project related to sustainability:

No

Field of contribution:

Particle physics

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HTS FCC-ee energy efficient beam optics

Author: Cristobal Garcia[1]

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The FCC-ee project takes a step forward towards the discovery of new physical phenomena beyond the frontier of the standard model, by aiming at unprecedented center of mass energies and luminosities in a double-ring lepton collider. In order to explore potential improvements to the current beam optics design, this work looks at the use of combined function magnets for the main dipoles and quadrupoles within the short straight sections of the arc cells to increase the bending radius, decreasing the synchrotron radiation (SR). The use of High Temperature Superconductors (HTS) and normal conducting technology for the combined function magnets is explored with comparisons to the current baseline aiming for potential savings above 10% of the SR power.

Limited flash talk slots:

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Yes

Field of contribution:

Accelerator physics

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Development of a cryogenic low threshold detector using perovskite nanocrystals

Author: Paul Wegmann[1]

Co-authors: Anna Soter [2]; Damian Goeldi ; Jesse Zhang [2]; Robert Waddy

[1] *ETH Zurich*

[2] *ETH Zürich*

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The LEMING (LEptons in Muonium INteracting with Gravity) experiment aims to measure the gravitational acceleration of Muonium (M = e^- + μ^+) in the gravitational field of the earth. An essential part of this experiment is the reliable detection of M's decay products, i.e. e^+ and e^-, at temperatures below 1 K. The electron, referred to as atomic electron, can be accelerated to energies of $\mathcal{O}$(keV), thus requiring a sensitive detector. This work considers perovskite nanocrystals for the detection of the atomic electron. Preliminary tests at room and cryogenic temperatures are presented.

Limited flash talk slots:

My contribution is about a project related to sustainability:

No

Field of contribution:

Particle physics

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Semi-visible dark photons at the NA64 experiment

Author: Martina Mongillo[1]

Co-authors: Benjamin Banto Oberhauser [1]; Paolo Crivelli [1]

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Beyond the minimal kinetically-mixed dark photon scenarios predicting fully visible and fully invisible mediator decays, next-to-minimal theories have been considered as compelling frameworks for thermal dark matter and some low-energy anomalies, as the muon g-2.
This talk will showcase the potential of the NA64 experiment in the exploration of rich dark sectors in which the dark photon is semi-visible. The NA64 invisible results have been re-interpreted in the context of two inelastic dark matter models to account for the different signal signature, entailing both missing energy and visible final states.

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No

Field of contribution:

Particle physics

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Latest results of NA64 searching for Dark Sectors at the CERN SPS

Author: Benjamin Banto Oberhauser[1]

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NA64 is a fixed-target frontier experiment running at the CERN SPS. NA64 searches for possible candidates of mediators between the dark sector and the standard model by looking for missing energy events in an active beam dump. After resuming data taking in 2021, NA64 has tripled its statistics, allowing us to set leading constraints to dark sector mediators in the light dark matter parameter space. This talk will focus on the latest results from the analysis of the 2021-2022 data as well as the current status of the experiment.

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No

Field of contribution:

Particle physics

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Search for the muon electric dipole moment using the frozen-spin technique

Author: Philipp Schmidt-Wellenburg[None]

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An electric dipole moment (EDM) of a fundamental particle would violate time (T) and parity (P) symmetry and by the virtue of the CPT theorem also the combined symmetry of charge conjugation and parity inversion (CP). Searches for EDM are generally considered highly sensitive probes for new physics and might shed light on still unresolved questions in particle physics and cosmology like the origins of matter, dark matter, and dark energy.
At the Paul Scherrer Institute in Switzerland, we are setting up an experiment searching for a muon EDM with a sensitivity of 3E-21 ecm using, for the first time, the frozen-spin technique in a compact

storage ring. This will lay the ground work for a second phase with a final precision of better than 6e-23 ecm.

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No

Field of contribution:

Particle physics

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Searching for Low-Mass Resonances Decaying into W Bosons

Author: Guglielmo Coloretti[1]

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In the light of the current hints for new scalars at the LHC at 95 GeV and 151 GeV, I present an analysis of low mass resonances decaying into W bosons. Recasting and combining the SM Higgs analyses of ATLAS and CMS, our results give further support to the existance of such new Higgs bosons.

The work is based on the paper: e-Print:2302.07276 [hep-ph]

Limited flash talk slots:

My contribution is about a project related to sustainability:

No

Field of contribution:

Particle physics

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Asymmetric Di-Higgs Signals of the N2HDM

Authors: Andreas Crivellin[1]; Sumit Banik[2]; Syuhei Iguro[3]; Teppei Kitahara[3]

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[3] *Nagoya University*

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I discuss the two-Higgs doublet model extended by a complex singlet and an additional U(1) gauge group (N2HDM-U(1)) and compare it to the standard two-Higgs doublet model with Z2 symmetries (N2HDM-Z2). We show that the N2HDM-U(1) is more predictive as it has one less free parameter, is CP conserving, and involves only spontaneous symmetry breaking. We then examine the phenomenological consequences for the Large Hadron Collider. In particular, we find that a sizable branching ratio of scalar decays to two different Higgses is possible in N2HDM-U(1), which is generally suppressed in N2HDM-Z2 for small scalar mixing. This is particularly relevant in light of the CMS excess in Higgs pair production at around 650 GeV decaying a Standard Model Higgs decaying to photons and a new scalar with a mass of ≈ 90 GeV decaying to bottom quarks.

Limited flash talk slots:

My contribution is about a project related to sustainability:

No

Field of contribution:

Particle physics

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Measurement of the tau g-2 in ultraperipheral PbPb collisions at the CMS experiment

Author: Arash Jofrehei[1]

[1] *University of Zurich (CH)*

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We present the first observation of τ lepton pair production in ultraperipheral nucleus-nucleus collisions. The measurement is based on a data sample collected by the CMS experiment at a per nucleon center-of-mass energy of 5.02 TeV, and corresponding to an integrated luminosity of $404\ \mu\mathrm{b}^{-1}$. The $\gamma\gamma \to \tau^+\tau^-$ production is observed with a statistical significance of at least five standard deviations for $\tau^+\tau^-$ events with a muon and three charged hadrons in the final state. The cross section is measured in a fiducial phase space region and is found to be $\sigma(\gamma\gamma \to \tau^+\tau^-) = 4.8 \pm 0.6\,(\mathrm{stat}) \pm 0.5\,(\mathrm{syst})\ \mu\mathrm{b}$, in agreement with leading-order QED predictions. The measurement, based on a small fraction of the expected integrated luminosity of the LHC nuclear program, establishes the potential for an ongoing analysis with substantially more precise determination of the anomalous magnetic moment of the τ lepton.

Limited flash talk slots:

My contribution is about a project related to sustainability:

No

Field of contribution:

Particle physics

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The high-speed optical- to-electrical conversion system for the readout of the ATLAS ITk Pixel detector

Author: Daniele Dal Santo[1]

Co-authors: Aaron Paul O'Neill [2]; Michele Weber [2]; Silke Mobius [2]

[1] *Universität Bern*

[2] *Universitaet Bern (CH)*

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For the High-Luminosity phase of the LHC (HL-LHC) the ATLAS detector will undergo a series of upgrades to cope with the increased number of proton interactions and harsher radiation environment. One of the key projects in this suite of upgrades is the ATLAS Inner Tracker (ITk) and its pixel detector, which will have unprecedented granularity and number of channels, that require extreme bandwidth of O(100 TB) for data readout. In this talk we present the so-called Optosystem, which performs the electrical-to-optical conversion of signals from the pixel modules. The key components, the Optoboards are housed in Optoboxes contained in 8 Optopanels located on the ITk endplates. The system is entirely designed and build in Bern. We show the design, testing and production of the system and recent results related to the performance tests of prototypes operating in a full data transmission chain.

Limited flash talk slots:

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My contribution is about a project related to sustainability:

No

Field of contribution:

Particle physics

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Outer Barrel services chain characterization for the ATLAS ITk Pixel Detector

Author: Silke Mobius[1]

Co-authors: Aaron Paul O'Neill [1]; Daniele Dal Santo [2]; Michele Weber [1]

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We present performance tests of the ATLAS Phase-II Outer Barrel Pixel detector services chains. The Phase-II pixel upgrade is part of the ITk HL-LHC upgrades to be installed later in this decade. After successful completion of the design phase, the final components are undergoing production and integration testing. A full data transmission chain is set up at the University of Bern for ITk that goes from the pixel sensors all the way to the FELIX backend data acquisition system. We present studies of data transmission involving different configurations and optimizations of data routes. Challenges and results of the services chain of the Outer Barrel will be highlighted.

Limited flash talk slots:

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My contribution is about a project related to sustainability:

No

Field of contribution:

Particle physics

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The rare decay of the Z⟶2τ2μ

Author: Fanqiang Meng[1]

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The first search for the Z boson decay to $\tau\tau\mu\mu$ is presented. The data analyzed were collected by the CMS experiment at the CERN LHC in proton-proton collisions at a center-of-mass energy of 13 TeV and correspond to an integrated luminosity of 138 fb^{-1}. Targeting tau lepton decays to muons and the corresponding
neutrinos, events with two pairs of oppositely charged muons are analyzed. The data are found to be compatible with the predicted background. An upper limit of 6.9 times the standard model expectation is placed on the ratio of event yields from the $\mathrm{Z} \to \tau\tau\mu\mu$ and $\mathrm{Z} \to \mu\mu\mu\mu$ decays, which corresponds to an upper limit on the ratio of branching fractions of these decay modes of 6.2.

Limited flash talk slots:

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My contribution is about a project related to sustainability:

Field of contribution:

Particle physics

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The NA62 experiment

Author: Alina Kleimenova[1]

[1] *EPFL - Ecole Polytechnique Federale Lausanne (CH)*

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NA62 is a fixed-target experiment at the CERN SPS dedicated to measurements of rare kaon decays. It is approved to take data until CERN long shutdown 3, with the primary goal to collect the order of 100 candidates $K^+ \to \pi^+\nu\bar{\nu}$ events and to measure the corresponding branching ratio with the precision of the order of 10%. The experiment resumed data taking in 2021 after CERN long shutdown 2, with an upgraded beamline, a new configuration of the beam tracker (GigaTracKer), new detectors installed upstream of the decay region to intercept early kaon decays, and a renovated small angle hadronic calorimeter (HASC). The 2021 run has been devoted to commissioning both the beamline and the new detectors. The present status of NA62 is discussed.

Limited flash talk slots:

My contribution is about a project related to sustainability:

Field of contribution:

Particle physics

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Searches for lepton flavour and lepton number violation in K+ decays

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Field of contribution:

My contribution is about a project related to sustainability:

Limited flash talk slots:

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Introduction to the workshop

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Introductory talk about sustainability

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Sustainability efforts in space research

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Sustainability in particle physics and industry / 34

Sustainability in particle physics research

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Sustainability in accelerator physics research

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Sustainability in particle physics and industry / 36

Short talk: HTS FCC-ee energy efficient beam optics

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Sustainability in particle physics research

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Role of science for a sustainable society

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Start-up: Transmutex

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Sustainability in industry

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CIPEA –CERN Innovation Programme on Environmental Applications

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Overview on future collider options

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Physics motivation for future colliders

Corresponding Author: rebeca.gonzalez.suarez@cern.ch

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Accelerator R&D for future colliders

Corresponding Author: tatiana.pieloni@cern.ch

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The CHEF proposal on experimental and theoretical foundations for FCC

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CMS/ATLAS physics highlights

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Low-energy physics at PSI/CERN

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Physics with forward and fixed target experiments at CERN

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Neutrino

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Theory: The Higgs boson and the top quark: precision theory for the LHC and beyond

Corresponding Author: massimiliano.grazzini@cern.ch

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Introduction

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Panel discussion

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Closing

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Closing remarks

Corresponding Author: armin.ilg@cern.ch

Field of contribution:

My contribution is about a project related to sustainability:

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