# P5 Town Hall Meeting


# Report of Contributions

https://indico.bnl.gov/e/p5meeting2023

Contribution ID: **1** Type: **not specified**

# Introduction and Reports from International Partners

Contribution ID: **2** Type: **not specified**

# ENERGY FRONTIER - Overview (Session Chair: T. Bose)

*Wednesday, 12 April 2023 09:00 (25 minutes)*

**Presenter:** REINA, Laura (Florida State University)

Contribution ID: **3** Type: **not specified**

# Energy Frontier

Contribution ID: **4** Type: **not specified**

# Energy Frontier and Dark Matter Searches with Beams

Contribution ID: **5** Type: **not specified**

# Future Colliders

Contribution ID: **6** Type: **not specified**

# Reports

Contribution ID: **7** Type: **not specified**

# Instrumentation and Computing Frontiers

Contribution ID: **8** Type: **not specified**

# New Opportunities

Contribution ID: **9** Type: **not specified**

# BNL Program

Contribution ID: **10** Type: **not specified**

# Short Remarks & Open-mike Session

Contribution ID: **11** Type: **not specified**

# Closed Session

Contribution ID: **12** Type: **not specified**

# Gravitational Waves

Contribution ID: **13** Type: **not specified**

# Gravitational Waves

Contribution ID: **14** Type: **not specified**

# National Initiatives

Contribution ID: **15** Type: **not specified**

# Brookhaven HEP Program, Short Remarks Session

Contribution ID: **16** Type: **not specified**

# Adjourn

Contribution ID: **17** Type: **not specified**

# Adjourn

Contribution ID: **20** Type: **not specified**

# Precision theory for energy and intensity frontiers

Precision theoretical calculations have guided experimental discoveries, such as the Higgs boson, top quark, and neutrino masses. They are essential for distinguishing signals of New Physics from the Standard Model background, designing new experiments, and providing insight into the fundamental nature of the universe. Investing in theoretical support for experiments is critical for the future of high-energy physics. Experimental results can only be interpreted with sufficiently precise theoretical calculations, and we otherwise risk missing opportunities for discovery. Modern precision theory is highly challenging and needs focused effort. It requires developing new techniques and tools, significant computing resources, and large research collaborations.
As the United States continues to lead the way in high-energy physics, I will highlight how we must prioritize investment in precision theoretical predictions.

**Primary author:** SZAFRON, Robert (Brookhaven National Laboratory)

Contribution ID: **24** Type: **not specified**

# A Liquid Argon Detector for the Far Forward Neutrinos at the LHC

The FASER experiment detected, for the first time, neutrinos from pp collisions in the LHC. These neutrinos have energies between the most energetic neutrinos ever produced by human-made sources until now and high-energy cosmic neutrinos. This discovery opens a new window for studying TeV-energy neutrinos of all three flavors, as well as BSM and QCD physics. A liquid argon detector with high spatial and energy resolution in a wide energy range would allow for looking into the details of neutrino interactions and dark matter searches in the far forward direction of the LHC. However, designing such a detector presents many challenges, including muon backgrounds, requirements on the readout and trigger, and identification of tau neutrinos. A Preliminary examination of event rates and backgrounds suggests that a liquid argon detector is feasible and groundbreaking, with fruitful unexplored physics waiting to be discovered.

**Primary author:** WU, Wenjie (member@uci.edu;employee@uci.edu;staff@uci.edu)

Contribution ID: **27** Type: **not specified**

# Data Preservation in High Energy Physics

Data Preservation (DP) is a mandatory specification for any present and future experimental facility and it is a cost-effective way of doing fundamental research by exploiting unique data sets in the light of the ever increasing theoretical understanding. When properly taken into account, DP leads to a significant increase in the scientific output (10% typically) for a minimal investment overhead (0.1%). DP relies on and stimulates cutting-edge technology developments and is strongly linked to Open Science and FAIR data paradigms. The recently released DPHEP report (attached) summarizes the status of data preservation in high energy physics from a perspective of more than **ten years of experience** with a structured effort at international level (DPHEP).

**Primary authors:** DPHEP, Collaboration; DIACONU, Cristinel (CPPM, Aix-Marseille Université, CNRS/IN2P3 (FR))

Contribution ID: **28** Type: **not specified**

# How to Accelerate Future Innovation in the Instrumentation and Computational Frontiers, and Everywhere

In this brief presentation, I will discuss ideas on how to improve the review process for new ideas including new projects, including: (1) double-blind review for concepts being proposed by individual PIs or small consortia instead of large collaborations, which will help with DEI enormously according to published studies, (2) institution of a new rebuttal round, along with answers to reviewers from the previous cycle permitted and encouraged as well, (3) clear budget guidance in tight fiscal times especially for R&D consortia, (4) better support for truly interdisciplinary endeavors, including going outside of physics, (5) more direct encouragement of community engagement, (6) less multiplication of regulations and appendices, and (7) a miscellaneous/other or blue-sky category for R&D which does not fit within an established category. The two examples used in this talk will be the snowball chamber (Instrumentation) and the Noble Element Simulation Technique or NEST (Computation).

**Primary author:** SZYDAGIS, Matthew (The University at Albany, SUNY)

Contribution ID: **29** Type: **not specified**

# Strong and Robust Searches for Millicharged Particles at the Energy Frontier with LHC FPF and FORMOSA

We identify potentially the world's most sensitive location to search for millicharged particles in the 10 MeV to 100 GeV mass range: the forward region at the LHC. In this location, we propose constructing a scintillator-based experiment, FORward MicrOcharge SeArch (FORMOSA) [1], and estimate the corresponding sensitivity projection. We show that FORMOSA can discover millicharged particles in ample and unexplored parameter space and study strongly interacting dark matter that ground-based direct-detection experiments cannot detect. The newly proposed LHC Forward Physics Facility (FPF) [2] provides an ideal structure to host the FORMOSA experiment; however, alternative locations may be possible.

The FORMOSA detector is proposed to be constructed of plastic scintillators; however, the exciting possibility of using alternative scintillator material with significantly higher light yield will be studied in the coming years. One such material is a CeBr3 scintillator (available from Berkeley Nucleonics). This provides a light yield approximately factor 30 times higher than the same length of plastic scintillator with excellent timing resolution. This would allow much lower charges to be probed with the FORMOSA detector. Further updates to the detector design can be studied with a FORMOSA demonstrator in the forward region of the LHC.

[1] PRD (2021), https://arxiv.org/abs/2010.07941
[2] Phys. Rept. (2022), https://arxiv.org/abs/2109.10905
[3] milliQan, PLB (2015), https://arxiv.org/abs/1410.6816
[4] FerMINI, PRD (2019), https://arxiv.org/abs/1812.03998

**Primary authors:** Dr TSAI, Yu-Dai (member@uci.edu;employee@uci.edu;staff@uci.edu); Prof. CITRON, Matthew (University of California, Davis)

Contribution ID: **31** Type: **Early Career Scientist**

# DarkQuest: A dark sector upgrade to SpinQuest at the 120 GeV Fermilab Main Injector

Expanding the mass range and diversifying the techniques used in the search for dark matter is an important part of the worldwide particle physics program. Accelerator-based searches for dark matter and dark sector particles are a uniquely compelling part of this program as a way to both create and detect dark matter in the laboratory and to explore the dark sector by searching for mediators and excited dark matter particles. In this proposal, we present the upgrade of the SpinQuest nuclear physics detector at Fermilab with a refurbished electromagnetic calorimeter creating the DarkQuest Experiment. Once upgraded, the DarkQuest experiment will be a proton fixed-target experiment that will have the leading sensitivity to an array of visible dark sector signatures in the MeV-GeV mass range. By building on the existing accelerator and detector infrastructure, DarkQuest offers a powerful upgrade for a modest cost that can be realized on a short timescale.

**Primary authors:** APYAN, Aram (Brandeis University); HARRIS, Philip (MIT); MCCORMACK, William (MIT); BATELL, Brian (Chicago); MANTILLA SUAREZ, Cristina Ana (FNAL); Prof. SPERKA, David (Boston University); Dr KELLER, Dustin (UVA); Prof. PETAR, Maksimovic (Johns Hopkins); Prof. LIU, Miaoyuan (Purdue University); TRAN, Nhan (Fermilab); GORI, Stefania (University of Chicago); Dr FENG, Yongbin (Fermilab); DEMIRAGLI, Zeynep (Boston University)

Contribution ID: **32** Type: **not specified**

# Introduction

*Wednesday, 12 April 2023 08:30 (5 minutes)*

**Presenter:** GIBBS, Doon (Brookhaven National Laboratory)

Contribution ID: **33** Type: **not specified**

# Logistics

*Wednesday, 12 April 2023 08:35 (10 minutes)*

**Presenter:** JUNK, Suzanne (Brookhaven National Laboratory)

Contribution ID: **34** Type: **not specified**

# P5 Introduction

*Wednesday, 12 April 2023 08:45 (15 minutes)*

**Presenter:** MURAYAMA, Hitoshi (faculty@berkeley.edu;employee@berkeley.edu;member@berkeley.edu)

Contribution ID: **35** Type: **not specified**

# (1) Tribute to Meenakshi

*Wednesday, 12 April 2023 09:25 (5 minutes)*

**Presenter:** TRICOLI, Alessandro (Brookhaven National Lab)

Contribution ID: **36** Type: **not specified**

# (2) HL-LHC Physics

*Wednesday, 12 April 2023 09:30 (20 minutes)*

**Presenter:** BROOIJMANS, Gustaaf (Columbia University)

Contribution ID: **37** Type: **not specified**

# (3) HL-LHC Detectors

*Wednesday, 12 April 2023 09:50 (20 minutes)*

**Presenter:** CANEPA, Anadi (Fermilab)

Contribution ID: **38** Type: **not specified**

# OTHER EXPERIMENTS (1) MATHUSLA (Session Chair: Y. Gershtein)

*Wednesday, 12 April 2023 10:40 (15 minutes)*

**Presenter:** LUBATTI, Henry (University of Washington, Seattle)

Contribution ID: **39** Type: **not specified**

# (2) FPF

*Wednesday, 12 April 2023 10:55 (15 minutes)*

**Presenter:** FENG, Jonathan (UC Irvine)

Contribution ID: **40** Type: **not specified**

# (3) LDMX

*Wednesday, 12 April 2023 11:10 (15 minutes)*

**Presenter:** NELSON, Timothy (SLAC)

Contribution ID: **41** Type: **not specified**

# (4) Other accelerator-based BSM experiments (CODEX-b, CCM, DarkQuest, etc.)

*Wednesday, 12 April 2023 11:25 (20 minutes)*

**Presenter:** GORI, Stefania (University of California, Santa Cruz)

Contribution ID: **42** Type: **not specified**

# GRAVITATIONAL WAVE – Overview (Session Chair: P. Merkel)

*Wednesday, 12 April 2023 12:45 (20 minutes)*

**Presenter:** BARYAKHTAR, Masha (University of Washington)

Contribution ID: **43** Type: **not specified**

# (1) MAGIS (remote)

*Wednesday, 12 April 2023 13:05 (20 minutes)*

**Presenter:** HOGAN, Jason (Stanford University)

Contribution ID: **44** Type: **not specified**

# DEI

*Wednesday, 12 April 2023 13:25 (20 minutes)*

**Presenter:** ASSAMAGAN, Ketevi Adikle (BNL)

Contribution ID: **45** Type: **not specified**

# INSTRUMENTATION FRONTIER - Overview

*Wednesday, 12 April 2023 13:45 (20 minutes)*

**Presenter:** ZHANG, Jinlong (Argonne National Laboratory)

Contribution ID: **46** Type: **not specified**

# (1) CPAD (remote)

*Wednesday, 12 April 2023 14:05 (15 minutes)*

**Presenter:** ARTUSO, Marina (member@syr.edu;employee@syr.edu;faculty@syr.edu)

Contribution ID: **47** Type: **not specified**

# (2) Workforce Development

*Wednesday, 12 April 2023 14:20 (15 minutes)*

**Presenter:** CARINI, Gabriella

Contribution ID: **48** Type: **not specified**

# (3) Industry Connections & Technology Transfer (remote)

*Wednesday, 12 April 2023 14:35 (20 minutes)*

**Presenter:** FAHIM, Farah (Fermilab)

Contribution ID: **49** Type: **not specified**

# COMPUTING FRONTIER The future of HEP Software and Computing - from Snowmass to P5 (Session Chair: K. Cranmer)

*Wednesday, 12 April 2023 15:25 (30 minutes)*

**Presenter:** ELVIRA, Daniel (Fermilab)

Contribution ID: **50** Type: **not specified**

# (1) Workforce Development (connection to industry & Impact Beyond HEP)

*Wednesday, 12 April 2023 15:55 (20 minutes)*

**Presenter:** ELMER, Peter (Princeton University)

Contribution ID: **51** Type: **not specified**

# (2) Connection to Industry & Impact Beyond HEP

*Wednesday, 12 April 2023 16:15 (15 minutes)*

**Presenter:** HSU, Shih-Chieh (University of Washington)

Contribution ID: **52** Type: **not specified**

# NATIONAL INITIATIVES - (1) QIS (remote)

*Wednesday, 12 April 2023 16:30 (15 minutes)*

**Presenter:** MISEWICH, Jim

Contribution ID: **53** Type: **not specified**

# (2) Microelectronics

*Wednesday, 12 April 2023 16:45 (15 minutes)*

**Presenter:** PARSONS, John (Columbia University)

Contribution ID: **54** Type: **not specified**

# (3) AI/ML

*Wednesday, 12 April 2023 17:00 (15 minutes)*

**Presenter:** SHANAHAN, Phiala (MIT)

Contribution ID: **55** Type: **not specified**

# DEPARTURE TO WECOME RECEPTION

*Wednesday, 12 April 2023 17:15 (45 minutes)*

Contribution ID: **57** Type: **not specified**

# INTERNATIONAL - (1) View from KEK (remote) (Session Chair: H. Murayama)

*Thursday, 13 April 2023 08:30 (20 minutes)*

**Presenter:** YAMAUCHI, Masa (KEK)

Contribution ID: **58** Type: **not specified**

# (2) View from IHEP (remote)

*Thursday, 13 April 2023 08:50 (20 minutes)*

**Presenter:** WANG, Yifang (IHEP)

Contribution ID: **59** Type: **not specified**

# (3) View from CERN

*Thursday, 13 April 2023 09:10 (30 minutes)*

**Presenter:** GIANOTTI, Fabiola (CERN)

Contribution ID: **60** Type: **not specified**

# FUTURE COLLIDERS – (1) Implementation Task Force (Session Chair: B. Heinemann)

*Thursday, 13 April 2023 10:10 (30 minutes)*

**Presenter:** ROSER, Thomas (BNL)

Contribution ID: **61** Type: **not specified**

# (2) Physics at Higgs Factories (circular & linear)

*Thursday, 13 April 2023 10:40 (30 minutes)*

**Presenter:** WANG, Lian Tao (University of Chicago)

Contribution ID: **62** Type: **not specified**

# (3) Detector Circular Colliders

*Thursday, 13 April 2023 11:10 (25 minutes)*

**Presenter:** RAJAGOPALAN, Srini (BNL)

Contribution ID: **63** Type: **not specified**

# (4) Detector Linear Colliders

*Thursday, 13 April 2023 11:35 (25 minutes)*

**Presenter:** WHITE, Andrew (University of Texas, Arlington)

Contribution ID: **64** Type: **not specified**

# (5) Physics at 10 TeV parton scale (Session Chair: S. Asai)

*Thursday, 13 April 2023 13:00 (30 minutes)*

**Presenter:** MEADE, Patrick (SBU)

Contribution ID: **65** Type: **not specified**

# (6) Detector at Muon Collider

*Thursday, 13 April 2023 13:30 (25 minutes)*

**Presenter:** JINDARIANI, Sergo (Fermilab)

Contribution ID: **66** Type: **not specified**

# (7) Detector at 100 TeV pp Collider

*Thursday, 13 April 2023 13:55 (25 minutes)*

**Presenter:** ENO, Sarah (member@cern.ch)

Contribution ID: **67** Type: **not specified**

# GRAVITATIONAL WAVE – (2) Cosmic Explorer

*Thursday, 13 April 2023 14:20 (20 minutes)*

**Presenter:** BARISH, Barry (Faculty@ucr.edu)

Contribution ID: **68** Type: **not specified**

# BROOKHAVEN PROGRAM

*Thursday, 13 April 2023 14:40 (20 minutes)*

**Presenter:** DENISOV, Dmitri (Brookhaven National Laboratory)

Contribution ID: **69** Type: **not specified**

# SHORT REMARKS (Session Chair: P. Onyisi)

*Thursday, 13 April 2023 15:30 (2 hours)*

**Presenters:** APRESYAN, Artur (Fermilab); CESAROTTI, Cari (MIT); VERNIERI, Caterina (SLAC); WEBER, Christian (Brookhaven National Laboratory); DIACONU, Cristinel (CPPM, Aix-Marseille Université, CNRS/IN2P3 (FR)); PINNA, DEBORAH (MEMBER@wisc.edu;EMPLOYEE@wisc.edu); CUMMINGS, Grace (Fermilab); OJALVO, Isabel (Princeton University); DICKINSON, Jennet (Fermilab); GENSER, Krzysztof (Fermilab); SZYDAGIS, Matthew (The University at Albany, SUNY); WILKINSON, Michael K. (University of Cincinnati); PESKIN, Michael (SLAC); TRIBEDY, Prithwish (BNL); SUFIAN, Raza (Brookhaven National Laboratory); SZAFRON, Robert (Brookhaven National Laboratory); SHIVELY, Savannah (member@uci.edu;staff@uci.edu;employee@uci.edu;student@uci.edu;alum@uci.edu); MAZZA, Simone (University of California - Santa Cruz); KUMAR, Soubhik (UC Berkeley); DU, Tianjia (student@uchicago.edu;staff@uchicago.edu;member@uchicago.edu); NEUMANN, Tobias (Brookhaven National Laboratory); SARICA, Ulascan (UCSB); WU, Wenjie (member@uci.edu;employee@uci.edu;staff@uci.edu); MCCORMACK, William (MIT); TSAI, Yu-Dai (University of California, Irvine)

Contribution ID: **70** Type: **not specified**

# OPEN MIC SESSION

*Thursday, 13 April 2023 17:30 (30 minutes)*

Contribution ID: **71** Type: **not specified**

# Adjourn

*Thursday, 13 April 2023 18:00 (5 minutes)*

Contribution ID: **72** Type: **not specified**

# P5 Committee – Closed Session

*Friday, 14 April 2023 08:30 (3h 30m)*

Contribution ID: **75** Type: **Early Career Scientist**

# Physics On the way to 10 TeV

An immediate result of Snowmass 2021 is the community's clear intention to reach the multi-TeV scale with colliders, in particular with large support behind a 10 TeV muon collider. While the timescale to 10 TeV center-of-mass collisions is most quickly realized with a muon collider, the projection for construction is still upwards of 25+ years. In this remark, I will illustrate physics possibilities along the way to 10 TeV with the various staging of demonstrator facilities in the development and construction of the necessary and novel muon collider technology.

**Primary author:** CESAROTTI, Cari (MIT)

Contribution ID: **76** Type: **Not Early Career Scientist**

# On Sustaining Geant4

Abstract

The talk offers a perspective on the most widely used HEP simulation tool, i.e., Geant4, and related challenges faced by US HEP community and Geant4 Collaboration, especially the ones related to the Geant4 physics models and the lack of personnel.
It centers on a quote from (the Snowmass2021 Book) Rare Processes and Precision Measurements Frontier (RPF) p538-539:
• The RPF wants to send a strong and emphatic message, also discussed in the Computing Frontier report: **GEANT4 is not sufficiently supported in the U.S.** The physics models of some crucial processes, including but not limited to their cross-sections, rates, and spectra, are in disrepair […] Many experiments in RPF rely on low-energy phenomena whose simulations are not kept up to date; when bugs and errors are found, they are **not fixed because there is no one to fix them**. GEANT is infrastructure akin to "roads and bridges"; ***the current trajectory endangers progress across particle physics.***

**Primary author:** GENSER, Krzysztof (Fermilab)

Contribution ID: **79** Type: **Not Early Career Scientist**

# Importance of the particle physics information services

Particle physics has a uniquely effective information infrastructure, based on the services INSPIRE, Particle Data Group, arXiv, and HepData. Of these, the first two rely on funding from the US DOE. As these services aid you in preparing the P5 report, please remember to recommend their continued support.

**Primary author:** PESKIN, Michael (SLAC)

Contribution ID: **83** Type: **Early Career Scientist**

# The importance of shielded transverse detectors for BSM physics with long-lived particles

The observation of the decay in flight of exotic long-lived particles with $c\tau > \mathcal{O}(1\ \mathrm{m})$ would be a compelling signature for many Beyond Standard Model (BSM) scenarios. The sensitivity to such particles of existing LHC experiments, however, is limited by complicated trigger environments, high backgrounds, and/or geometric restrictions to the forward region, leaving a significant region of phase-space unexplored. A dedicated, shielded, transverse experiment is therefore essential to search for many BSM scenarios above the electroweak scale at the high-luminosity LHC (HL-LHC).

We here briefly present the physics case for a dedicated, transverse, zero-background long-lived particle detector at the HL-LHC.

**Primary author:** WILKINSON, Michael (University of Cincinnati)

Contribution ID: **86** Type: **Early Career Scientist**

# Long-term development of 4/5D detectors for future colliders and blue-sky R&D

In the past few years, the Low Gain Avalanche Detector (LGAD, thin silicon detectors with modest internal gain and extremely good time resolution) technology have been significantly advanced. The first application of this kind of device will be in the ATLAS and CMS timing layers at the HL-LHC. The first prototypes of LGADs produced few years ago within the collaborations did not show sufficient radiation hardness. However, LGADs with radiation hardness up to a fluence of 2.5E15 Neq/cm2 were developed in the last 5 years thanks to a focused R&D effort.
This successful development paves the path for next generation machines (e.g., FCC-hh) that will require radiation tolerance an order (or more) of magnitude greater and at the same time require a better timing and position resolution. The cited requirements are in a high pile-up environment that is not suitable for AC-LGADs which is the most advanced high granularity LGAD prototype. There are several new LGAD prototypes that are geared towards satisfying all of these requirements as well as radiation hardness, this contribution will give a brief overview on them and the path forward in their development. In the same scope, electronics and integration development is necessary to reduce the power dissipation requirement and increase the channel density. Finally, the need of blue-sky (not tied to experimental application) R&D for timing detectors will be highlighted. For each of the cited developments a tentative funding profile will be presented.

**Primary author:** MAZZA, Simone (University of California - Santa Cruz)

**Co-authors:** SEIDEN, Abraham (SCIPP); SADROZINSKI, Hartmut (SCIPP- UC Santa Cruz); OTT, Jennifer (University of California, Santa Cruz (US)); SCHUMM, Bruce (UC Santa Cruz)

Contribution ID: **88** Type: **Early Career Scientist**

# Beyond the Energy Frontier: Advancing Precision Measurements and Exploring the Unknown

The Energy Frontier's Snowmass report carefully laid out the plans of the US EF community to reach the next level of precision measurements and explore beyond the current known energy scales. This plan is a guideline for what we should be aiming to achieve. It also will inspire the next generation of particle physics experimentalists and revitalize the US community. In this 5 minute talk I will outline some of the physics we hope to be able to do at the next generation of colliders, why the US community needs to continue proposing exciting projects on US soil and what systemic changes need to be implemented to the current planning process in order to achieve these goals in a reasonable amount of time.

**Primary author:** OJALVO, Isabel (Princeton University)

Contribution ID: **89** Type: **Early Career Scientist**

# A Framework for Interdisciplinary Research in High-Energy and Nuclear Physics

The intersection between high-energy and nuclear physics has been growing in recent times. As an early career nuclear physicist, I am excited by the prospect of employing detector technologies and analysis techniques established in high-energy physics at future mega-nuclear physics facilities such as the electron-ion collider (EIC). Fast-time pixel or strip AC-LGAD sensors, as well as the associated front-end electronics and the FELIX read-out board, have the potential to be used in nuclear physics investigations. Furthermore, tools developed for jet substructure analysis and techniques based on machine learning can be used to improve the precision of measurements in nuclear physics. In exchange, the community of nuclear physics can help improve the precision of the parton distribution functions (PDFs), which are crucial in both high-energy and nuclear physics. With the timeframe in mind, the next big nuclear physics facility, EIC can also provide a platform to efficaciously demonstrate several technologies aimed at high-energy physics experiments for the first time. While there is no official structure in place to facilitate collaboration between the two fields, it is critical to establish a framework for interdisciplinary research in order to capitalize on the strengths of each field and make significant progress in our understanding of the fundamental particles and forces. This can be accomplished by organizing joint conferences and workshops, funding interdisciplinary research, developing joint training programs, and encouraging more dialogue and collaboration on projects of mutual interest between the "office of nuclear physics" and the "office of high energy physics" within an official framework.

**Primary author:** TRIBEDY, Prithwish (BNL)

Contribution ID: **90** Type: **Early Career Scientist**

# Broad impact of the Energy Frontier towards BSM searches in synergy with the other frontiers: Axion and ALP example

Energy frontier searches have a broad impact on and synergy with the other frontiers. In this talk, I will focus on how terrestrial probes, especially the energy frontier experiments, can play an important role in this regard, in combination with cosmic and intensity frontier probes. I will give an example involving heavy axions that solve the strong CP and axion quality problem, and how the high-luminosity LHC can discover them.

**Primary author:** KUMAR, Soubhik (UC Berkeley)

Contribution ID: **91** Type: **not specified**

# Group Photo

Contribution ID: **100** Type: **Early Career Scientist**

# Elucidating the quark and gluon distributions in the nucleon, pion, and kaon from lattice QCD

Understanding the internal structure and dynamics of protons and neutrons - the complex many-body systems consisting of strongly interacting quarks and gluons - is at the core of exploring the visible matter universe. However, precise knowledge of the gluon distributions and their roles in hadron structures remains one of the most challenging but fundamental issues in nuclear and particle physics. In this short remark, I will discuss the particular case of gluons and the potential impact that first-principles lattice QCD can have on our understanding of their distributions inside hadrons. With the prospects for determining high-precision quark-gluon distributions, lattice QCD has the potential to complement the theoretical predictions of physics outcomes from present and next-generation hadron colliders.

**Primary author:** SUFIAN, Raza (Brookhaven National Laboratory)

Contribution ID: **107** Type: **Early Career Scientist**

# Can future colliders be the light to see dark matter?

Despite different astrophysical measurements indicate the existence of dark matter, no evidence for its non-gravitational interactions with standard model particles is yet available. If these interactions are present, dark matter could be produced at colliders, and many searches are performed in this direction at LHC. A very interesting opportunity to further shed light on the dark matter mystery is provided by future high-energy hadron and lepton colliders.
In fact, as I will mention in this remark, scenarios where the dark matter particle is the lightest member of an electroweak multiplet can be investigated in the multi-TeV regime at muon colliders as well as through precision measurements at electron and hadron colliders.

**Primary author:** PINNA, DEBORAH (MEMBER@wisc.edu;EMPLOYEE@wisc.edu)

Contribution ID: **109** Type: **Early Career Scientist**

# milliQan and future ancillary experiments

During LHC Run3, the milliQan experiment will search for millicharged particles as an indicator of a dark sector, expecting to exclude much of the previously unexplored parameter space in the 1GeV to 100GeV mass range. Besides the advantage of exploring a large phase space at relatively low cost, small ancillary experiments like milliQan are very student friendly: there are many opportunities to learn and contribute, from building the detector to powering it and taking data, and developing simulation and analysis code. I wanted to share my positive student experience with milliQan so far, in hopes of promoting it and similar ancillary experiments in the future. Particularly, I hope that future large facilities will be designed with the consideration of leaving space and access for ancillary experiments in mind.

**Primary author:** DU, Tianjia (student@uchicago.edu;staff@uchicago.edu;member@uchicago.edu)

Contribution ID: **112** Type: **Early Career Scientist**

# Maximizing the Return on US Investment in the LHC: Time to Take Action

Despite investing a massive $500,000,000 in the construction of the Large Hadron Collider (LHC) and committing a significant portion of our high-energy experimental community to the LHC, there is a risk that we may struggle to comprehend the results due to the limitations of our current precision theory modeling. This is particularly concerning given the LHC's future role as a precision machine that will probe even the rarest of processes with high accuracy. As we move beyond the Higgs discovery phase, the LHC's potential to further advance our understanding of fundamental physics is immense, and accurate interpretation of the results is crucial to harnessing the full scientific potential of our investment.

Therefore, I urge measures to protect the value of the US investment in the LHC program and allocate sufficient resources to improve our precision theory modeling, keeping pace with the LHC's advancements. This will help maximize the return on our investment and advance our understanding of the universe.

**Primary author:** NEUMANN, Tobias (Brookhaven National Laboratory)

Contribution ID: **114** Type: **Early Career Scientist**

# Large Language Models for Particle Physics Experiments

Particle Physics experiments rely on large code bases. These include proprietary code for common programming languages, as well as code and instructions for specialized programs and languages. Working with these, as well as developing, maintaining, and creating such code is part of the work of particle physicists.
AI driven Large Language Models like Chat GPT-4 have recently made great leaps in not only processing and generating natural language, but they have also shown themselves adept at handling code. They can provide solutions to common coding problems, generate working code snippets, explain parts of given code, and can introduce users interactively to new programming languages.
We propose here to establish a service that provides particle physics experiments with the ability to train and use Large Language Models on their code bases to aid in the development and use of the relevant code. Additionally, this service should maintain Large Language Models that are explicitly trained on commonly used particle physics specific software like Monte Carlo Event generators and pertinent specialized domain knowledge to service as an interactive knowledge repository.
This service would allow to operate experiments using such services at greater efficiency, would speed up R&D and data analysis efforts, while also lowering the learning curve new members of experiments.

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# Detector R&D for future colliders

Detector R&D for future colliders requires large collaborative efforts, years of development, and shared resources are key for successful outcomes. I would like to provide remarks on the needs for the community to develop and maintain a common framework for detector R&D for future experiments, in concert with accelerator R&D such that they can be develop together and support each other. Such coordinated efforts would provide a focused R&D environment for development of the ambitious technologies required for future machines.

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# A US-based future collider initiative for physics prospects and detector R&D

The community, as emerged from the Energy Frontier report, supports the possibility of a Higgs factory and the R&D for a future muon collider in the US. Indeed, given global uncertainties, consideration should also be given to the timely realization of a possible domestic Higgs factory, in case none of the currently proposed options are realized.
In general, the investment in detector and collider R&D for lepton facilities in the US should start now, and run in parallel with the LHC to enable a future e+e− precision electroweak program and a high-energy machine.
The opportunity to work on fundamental problems while using state-of-the-art technologies, and develop them as necessary, is the leading motivator for the students. A US-based future collider program can provide the much needed impetus to make particle physics programs attractive to the young and future generations in the US.

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# Dual readout crystal calorimetry for precision measurements at future colliders

While adequately supporting the construction, operation, and physics mission of the High Luminosity LHC (HL-LHC) begins to build the foundation for the HEP calorimetric techniques of the future, increased investment in calorimetry R&D is needed to meet the demands of future colliders. The calorimeters of the collider experiments beyond the HL-LHC, for both lepton machines and future hadron machines, demand top-of-the-line energy resolution, precision timing information, and sufficient granularity. In the precision arena, dual readout (DR) techniques serve to increase the hadronic energy resolution of calorimeter systems by accessing more information available in an event: both the Cerenkov and scintillation light that result from the particle interactions with the material. I am advocating for DR crystal calorimetry that targets increased hadronic energy resolution in precision electromagnetic calorimeters, thereby improving the overall system performance at Higgs factories and beyond. DR crystal calorimeters can further exploit longitudinal segmentation for particle ID and timing information to recover high-occupancy performance. By supporting DR calorimeter R&D now, we can build the optimal calorimeter for future machines.

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# On-chip intelligence and real-time data-processing

Highly granular pixel detectors allow for increasingly precise measurements of charged particle tracks, both in space and time. A reduction in pixel size by a factor of four in next-generation detectors will lead to unprecedented data rates, exceeding those foreseen at the High Luminosity Large Hadron Collider. Despite this increase in data volume, smart data reduction within the pixelated region of the detector will enable physics information to be extracted from the pixel detector with high efficiency and low latency, and has the potential to enable the use of precise vertex information at the LHC bunch crossing frequency of 40 MHz (Level-1 trigger) for the first time. Using the shape of charge clusters deposited in arrays of small pixels, the physical properties of the traversing particle can be extracted by locally customized neural networks. Data from the sensor will be processed with a custom readout integrated circuit designed on 28 nm CMOS technology capable of operating at 40MHz and in extreme radiation environments. This talk will present several promising methods of on-chip data reduction including the application of a momentum selection, as well as reconstruction of particle hit position and incident angle.

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# Shifting trends in the research involvement of a younger and more global generation of scientists

Our high energy physics community is experiencing a transition period, and a different set of challenges in manpower than those from a couple decades ago. In terms of research participation, I find from discussions among young experimental researchers in my community that there is increasing willingness to get involved in multiple frontiers and for them to utilize their expertise in broader contexts. It is important to consider the potential, synergistic benefits for researchers to be able to exercise their skills in multiple frontiers, and this could alleviate some of the manpower issues in our field. We will also need to allow greater flexibility for the international community to participate in the US research programs, and the existing infrastructure to support international researchers needs to adapt to accommodate the increasing levels of global participation.

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