Magnificent CEvNS 2021

Wednesday 6 October 2021 - Thursday 7 October 2021

Book of Abstracts

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Metastable Water: Breakthrough Technology for Neutrinos & Dark Matter

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We will present a discussion of a new detector technology, the "Snowball Chamber,"which is based on the phase transition (of liquid to solid) for metastable fluids. A water-based supercooled detector has great potential for dark matter, but here we will focus on neutrino physics, utilizing the CEvNS interaction on Oxygen. It is likely possible to reach operational conditions wherein such a detector will respond to Oxygen nucleus recoils. The detector would thus be sensitive to the CEvNS interaction, but with a low-mass even-even nucleus. Precision tests of the Standard Model cross-section (e.g., Non-standard Interactions) would then be possible, devoid of the complicating uncertainties due to the nuclear form factor, and the less-well-predicted axial current contributions to neutrino cross-section. For homeland security applications, a (compact) water CEvNS detector could detect reactor neutrinos. Lastly, a detector using deuterated water could be a viable technology for normalizing low-energy neutrino fluxes from stopped-pion beams. Unfortunately, as it is only a threshold detector, each supercooled liquid module provides no spectral information on the nuclear recoils. This deficiency could be mitigated, however, through the use of a large modular array, with modules at slightly different thresholds, or with doping, in future work.

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CEvNS application to spent nuclear fuel verification

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The majority of spent nuclear fuel is kept in dry storage casks and no method to verify their contents currently exists short of opening the cask under water. Neutrino emissions from strontium-90 persist for many decades but due to the low endpoint energy these neutrinos are exceedingly difficult to detect via inverse beta decay. We present first results indicating that CEvNS detectors with a mass of the order 10kg could provide a meaningful verification of cask contents.

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Low-energy CEvNS probes of neutrino electromagnetic properties

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The effective Majorana neutrino magnetic moment detectable at a scattering experiment involves in reality a combination of fundamental transition magnetic moments (TMMs), CP violating phases and neutrino mixing parameters. Beyond the three neutrino picture, sterile neutrinos with keV-MeV masses and non-zero TMMs can also be probed through low-energy nuclear or electron recoil measurements. We will show how coherent elastic neutrino-nucleus scattering (CEvNS) experiments can probe this kind of physics with unprecedented sensitivity. Besides the current sensitivities, we show that future experiments with an artificial neutrino source can test the region of interest reported in the recent XENON1T result.

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First results from the BULLKID R&D

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BULLKID (Bulky and low-threshold kinetic inductance detectors) is an R&D project on an innovative cryogenic particle detector to search for low-energy nuclear recoils induced by neutrino coherent scattering or Dark Matter interactions. The detector unit consists of an array of 60 silicon absorbers of 0.3 g each sensed by phonon-mediated, microwave-multiplexed Kinetic Inductance Detectors. The arrays built up to now feature a total active mass of 20 g and the technology is engineered to ensure an easy scalability to a future kg-scale experiment. In this talk we will describe the BULLKID idea and we will show the recent and encouraging results obtained from the operation of the first prototypes.

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First results of the nuGeN experiment

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The νGeN project is aimed to study neutrino scattering at the close vicinity of the reactor core of Kalinin Nuclear Power Plant (KNPP). Its main interests are connected with the detection of coherent elastic neutrino-nucleus scattering (CEvNS) and the search for the magnetic moment of neutrino. The experimental setup is constructed under reactor unit #3 of KNPP at a distance of about 10 m from the center of the 3.1 GWth core. In this way, we obtain an enormous antineutrino flux of more than 5x10^13 ν/cm2/s. Materials of the reactor surrounding provide about 50 m w.e. overburden, that serves as a good shielding against cosmic radiation. In combination with low ambient background, it gives us a unique opportunity to investigate antineutrino properties at the best location in the world. A special lifting mechanism allows moving the spectrometer towards the reactor core changing the neutrino flux and thus suppressing main systematic errors caused by possible long-term instability and insufficient knowledge of neutrino flux. To detect signals from the neutrino scattering we use high-purity low-threshold germanium detectors surrounded by passive and active shieldings. A specially developed acquisition system allows suppressing noisy events. A detailed description of the experimental setup will be presented. In 2021 we finished optimization of the experimental setup and performed the first dedicated search of the CEvNS in the framework of our project by comparing the experimental spectra taken with regimes of reactor ON and OFF.

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Recent results of the CONUS experiment

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The CONUS reactor neutrino experiment aims to measure coherent elastic neutrino nucleus scattering (CEvNS) on germanium nuclei. The experiment is located at about 17 m distance from the 3.9 GWth core of the commercial nuclear power plant in Brokdorf, Germany. Four 1 kg point contact germanium detectors equipped with electric cryocooling allow to measure at the sub keV range with background rates in the order of 10 events per kg, day and keV. Constraints on the CEvNS rate with the first analyzed dataset including 248.7 kg d with the reactor turned on and background data of 58.8 kg d with the reactor off are reported. To improve the systematic uncertainty, a precise measurement of the ionization quenching factor of nuclear recoils in germanium was performed and the latest results will be shown. Moreover, the most recent CONUS limits on several parameters related to physics beyond the standard model such as non-standard neutrino interactions are presented.

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CEvNS and Dark Matter Signal in the LZ experiment

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LUX-ZEPLIN (LZ) is the largest noble liquid dark matter detector 1 mile underground at the Sanford Underground Research Facility (SURF) in Lead, SD. Using 7-ton liquid xenon as a target, LZ is projected to reach unprecedented sensitivities for WIMP in the mass range from 1 GeV/c2 to 10 TeV/c2. Aside from traditional WIMP searches, LZ will also be sensitive to Coherent Elastic neutrino-nucleus scattering (CEvNS) for neutrino of energy at the MeV-GeV scale. Since the CEvNS produces nuclear recoil signatures similar to WIMPs, its presence presents both challenges and opportunities for noble liquid experiments. In this talk, I will present an overview of the LZ experiment, and its potential in observing natural neutrinos via CEvNS. Then I will discuss the challenge it presents for LZ and its future generation experiment.

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Probing the Neutrino-Nucleus Elastic Scattering with Point Contact Germanium detectors and its Quantum-Mechanical Coherency Effects

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Neutrino Nucleus Elastic scattering (νA_{el}) is a well understood Standard Model process. Experimental cross-sections are enhanced and yet complicated by quantum-mechanical coherency effects with their q^2 dependence. Positive measurements of νA_{el} so far were achieved by the COHERENT experiment with stopped pion neutrinos (E_ν<53 MeV). The TEXONO experiment is pursuing measurement of the νA_{el} interactions with the reactor neutrinos (E_ν<10 MeV) at the Kuo-Sheng Reactor Neutrino Laboratory (KSNL) 1, in a kinematic regime where the QM coherency is complete,

and hence uncertainties of the nuclear many-body effects are decoupled. Point-contact germanium detectors at sub-keV sensitivities 2 are adopted to detect the low-energy nuclear recoils in νA_{el} . We will report our latest status and plan of this program. A complementing line of research is on the formulation of a universal scheme to quantify the QM coherency effects in νA_{el}, and study their dependence on experimental configurations 3. Constraints from existing and projected measurements 4 are presented.

1 "Research program towards observation of neutrino-nucleus coherent scattering.", H. T. Wong et al., J. Conf. Ser. 39, 266 (2006).
2 "Characterization and performance of germanium detectors with sub- keV sensitivities for neutrino and dark matter experiments.", A. K. Soma et al., Nucl. Inst. and Meth. in Phys. Res. A 836, 67-82 (2016).
3 "Coherency in neutrino-nucleus elastic scattering.", S. Kerman et al., Phys. Rev. D93, 113006 (2016).
4 "Studies of quantum-mechanical coherency effects in neutrino-nucleus elastic scattering.", V. Sharma et al., Phys. Rev. D 103, 092002 (2021).

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Status of the RED-100 experiment

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The RED-100 is a two-phase emission liquid xenon detector. It was deployed at the Kalinin Nuclear Power Plant (KNPP) to detect and study the process of Coherent Elastic Neutrino-Nucleus Scattering (CEvNS) on Xe nuclei in a close vicinity to a reactor core. CEvNS was predicted more than 40 years ago and was observed only recently by the COHERENT experiment with CsI and LAr targets deployed at the SNS (Oak Ridge, USA). Further study of this process with different targets and with different neutrino sources is ongoing all over the world. RED-100 is the first LXe detector operating near the reactor core of the nuclear power plant for the CEvNS study. One of the heaviest target material, the source of single neutrino type along with lowest neutrino energies provide the possibility to study CEvNS within unique parametric space of this process.
In this talk the status of the RED-100 experiment is presented, and the preliminary results of the first engineering run are discussed.

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The nuBDX-DRIFT Detector for CEvNS Physics at Fermilab

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I will discuss the prospects for using a nuclear-recoil TPC detector with directional sensitivity to study CEvNS at Fermilab. Even relatively small detectors would be able to make a significant detection of CEvNS on a year time scale in the NuMI beam with minimal background. A larger detector in the Near Detector Hall of the DUNE beam would be able to measure the weak mixing angle and neutron nuclear densities using CEvNS physics. Backgrounds are expected to small and multiple target nuclei, not previously studied, are possible with this technology.

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NEST: the powerful tool for simulating low-energy processes in noble elements

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Low-energy neutrino processes are of great interest for modern physics. It is an inseparable part for understanding the Standard Model (for example, studying coherent elastic neutrino-nucleus scattering (CEvNS) on different nuclei) and the possible processes beyond it (like non-standard neutrino interactions or dark matter).
The main problem of simulating such processes is inconsistency of various theoretical predictions with each other and experimental data, especially in low-energy (sub-keV) region.
The Noble Element Simulation Technique (NEST) provides a semi-empirical solution for the most common noble elements (xenon and argon) which combines theoretical models (such as Lindhard and its variations) and actual experimental data. NEST is capable of simulating the median scintillation and ionization yields for various interaction types, fields (including zero field) and energies (from sub-keV to MeV). On top of these, NEST also takes into account detector-specific effects.
In this talk NEST capabilities, including NR low-energy simulations, will be presented.

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SBC: The Scintillating Bubble Chamber Experiment

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The SBC Collaboration is constructing 10-kg liquid argon bubble chambers with scintillation readout for nuclear-recoil detection. The first device will be commissioned at Fermilab to measure sensitivity to sub-keV nuclear recoils. A second, roughly identical, device will be deployed underground at SNOLAB for a GeV-scale dark matter search. At the same time, the collaboration is exploring sites for a reactor CEνNS experiment. The technology is expected to provide extreme insensitivity to electron recoils for nuclear-recoil detection thresholds as low as 100 eV, allowing for detection of CEνNS from reactor neutrinos with a signal-to-background much better than one-to-one, and a possible future program of precision measurements.

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Improved study of the ionization efficiency for nuclear recoils in Si and Ge at low energies

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The nuclear recoil ionization efficiency or "quenching factor" (QF) plays a crucial role in low-threshold ionization type detectors aimed at detecting CEνNS and studying new physics through this channel. We present an improved model based on the integro-differential equation that describes the cascade process initiated by a nuclear recoil, which takes into account a more detailed modeling of nuclear and electronic stopping power at low energies, as well as the effect of electronic straggling. We incorporate the Coulomb repulsion effects for the electronic stopping using a semi-classical model proposed by Tilinin and other similar approaches. Our model also incorporates an energy-dependent binding energy up to the energy required to produce a Frenkel pair in a pure crystal. These effects describe the QF data available in silicon and give a rough description of recent data in germanium, up to recoil energies of about 40 eV.

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Long-lived Scalars at the Neutrino Frontier

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In light of the MiniBooNE anomaly, which exhibits a puzzling asymmetry in its excess events across the neutrino and antineutrino modes, and across the beam-target and beam-dump modes, I will motivate the searches for long-lived scalar particles and their associated gauge sector. These searches may be undertaken at the neutrino frontier experiments in order to test this solution to the MiniBooNE puzzle. For example, one search strategy may exist at GeV-scale proton beam facilities, such as COHERENT, CCM, and JSNS2, and complimentary strategies exist at higher energy environments such as the DUNE near detector complex.

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Inelastic neutrino-nucleus and dark matter-nucleus scattering

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We study inelastic neutrino-nucleus and dark matter(DM)-nucleus scattering using argon, cesium, and iodine target nuclei. We use Bigstick, a nuclear shell model code, to obtain the form factors of the nuclei. For the experiment setup (COHERENT and CCM) we estimate event rates for neutrino and dark matter scattering processes. Lastly we estimate cross-section and event rates of the inclusive photon final state from the decay of the excited states.

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Detecting Non-Standard Neutrino Interactions from Solar Neutrinos in Low Threshold Dark Matter detectors

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As low-threshold dark matter detectors advance in development, they will become sensitive to recoils from solar neutrinos which opens up the possibility to explore neutrino properties. We predict the enhancement of the event rate of solar neutrino scattering due to Non-Standard interactions (NSIs) in low-threshold DM detectors, particularly Skipper-CCDs. We consider five categories of interactions: the neutrino magnetic moment as well as interactions mediated by four types of mediators (scalar, pseudoscalar, vector, and axial-vector), and consider coupling these mediators to either quarks or electrons. Using these predictions, we place constraints on the mass and couplings of each mediator and the neutrino magnetic moment from current low-threshold detectors like SENSEI, Edelweiss, and Super CDMS, as well as projections from future experiments such as DAMIC-M and Oscura.

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Passive Crystal Neutrino Detectors for CEvNS Science and Security Applications

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Experimental efforts in CEvNS have gained significant momentum over the last few years, since the first observation of the CEvNS reaction at the SNS. Observing reactor CEvNS remains a milestone of interest with implications for basic science and nonproliferation reactor monitoring regimes. In this talk, we discuss a concept for an entirely passive, small, solid CEvNS detector that uses color center defects induced by CEvNS reactions in a crystal and light-sheet microscopy to obtain a signal. This concept, inspired by so-called "paleo-detectors"for astrophysical neutrinos and dark matter candidates, presents intriguing possibilities for a simpler low-threshold CEvNS detector. We will also review how this might be used for doing basic science physics with CEvNS at reactors and how it might be used to monitor nuclear reactors as part of international and multi-lateral security agreements.

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The CONNIE experiment: latest results and upgrade

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Located at a distance of 30 m from the core of the Angra II 3.8 GW nuclear reactor in Brazil, the Coherent Neutrino-Nucleus Interaction Experiment (CONNIE) uses fully depleted high-resistivity CCDs (Charge Coupled Devices) with the goal of measuring CEvNS of reactor antineutrinos with silicon nuclei. It has been taking data since 2016 with a noise level of less than 2 e- RMS and an active mass of ˜50 g. CONNIE has demonstrated to be competitive in probing physics beyond the Standard Model by placing stringent constraints on simplified extensions with light mediators.
The experiment has recently been upgraded to host 2 skipper CCD sensors. It has been operating for ˜2 months with these new generation detectors, achieving a noise of ˜0.2 e- RMS.
Here, we report on the latest CONNIE results before the upgrade, we present the current status of the experiment and we give a future overview of the upcoming year operations.

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A DM interpretation of the MB excess and its implications in CEvNS experiments

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The MiniBooNE excess has been considered as a potential new physics signal, and various approaches including dark matter interpretations and neutrino-sector physics have been investigated to explain the excess. We revisit the dark matter interpretation, imagining the situation where dark matter emerges from the decays of charged mesons, and discuss a few plausible scenarios that are not in conflict with the existing constraints. We then discuss how these scenarios can be tested in beam-based CEνNS experiments including CCM and JSNS^2.

Reactor neutrino spectrum and low energy excess talk / 39

Reactor flux predictions for CEvNS experiments

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Coherent elastic neutrino-nucleus scattering (CEvNS) offers a unique way to study neutrino properties and to search for new physics beyond the Standard Model. As neutrino sources, nuclear reactors deliver very intense fluxes which, combined to the high CEvNS cross-section, could potentially allow to perform precision physics with drastically smaller detectors.

For high statistics measurements, typically reachable after few years of data taking with kg-scale detectors, the sensitivity of CEvNS experiments at reactors is expected to be limited by the knowledge of the reactor antineutrinos flux. Over the last decades, Inverse Beta Decay (IBD) experiments conducted at short and long baselines from nuclear reactors have revealed significant discrepancies on both the rate and shape of the measured spectra compared to state-of-the-art predictions, thus questioning their reliability. Thanks to their small uncertainties, both resulting from high statistics and an excellent control of systematics, reactor antineutrino spectra measured by IBD experiments can be used as the main ingredient to a prediction for CEvNS experiments.

In this talk, I will present an overview of recent results obtained by IBD experiments and report about the status of these anomalies. The construction of a reactor flux predictions based on IBD measurements to estimate the expected CEvNS rate and recoil spectrum at nuclear reactors will be explained. A particular focus will be given on the expected uncertainties. Prediction of the low energy part of the neutrino spectrum that cannot be derived from IBD measurements will also be addressed.

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Status of the CHILLAX detector development

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Noble element detectors have an event-rate advantage in detecting low-energy CEvNS interactions. Existing argon and xenon detector technologies, however, have drawbacks that limit their applications in this field. CHILLAX is an effort to combine the advantages of a liquid argon target and a xenon-like performance in a single detector. In this talk, I will discuss the motivation for this unique detector design, the anticipated performance and the current status of the project.
This work was performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

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Overview cryogenic experiments; MINER/ RICOCHET/ NUCLEUS

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Excess workshop

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Supernova neutrino detection with RES-NOVA

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Neutrinos are key particles in many astrophysical sources. They influence the stellar evolution, drive the formation of heavy elements, and are also messengers of the most energetic and unexplored events in Universe, like Supernovae (SNe).
Neutrinos are key particles in many astrophysical sources. They influence the stellar evolution, drive the formation of heavy elements, and are also messengers of the most energetic and unexplored events in Universe, like Supernovae (SNe).
A timely and high-resolution detection of the neutrino signal produced by the next Galactic or extra-Galactic SN will provide the only empirical evidence of the dynamics and interaction processes intervening during a SN. The RES-NOVA experiment will hunt for neutrinos from SNe via CEvNS using an array of archaeological Pb-based cryogenic detectors. RES-NOVA will be as sensitive as super-size SN neutrino observatories while running a detector with a total active volume of only (60 cm)^3. RES-NOVA will be sensitive to SN bursts from the entire Milky Way Galaxy with >3σ statistical significance. During this workshop, the performance of the first small-scale proof of principle will be presented as well as sensitivity projections.

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NUCLEUS outer veto prototype for the CEυNS detection at nuclear reactors

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The detection of Coherent Elastic Neutrino-Nucleus Scattering (CEυNS) represents an experimental challenge because of its unique signature: a nuclear recoil with low energy in range of 10 to 100 eV on average.
This process, largely unexplored until today, could probe physics beyond the Standard Model such as non-standard neutrino interactions and electromagnetic form factors.
NUCLEUS is a nuclear reactor neutrino experiment conceived for CEυNS detection using a new type of ultra-low energy threshold (below 20 eV) cryogenic calorimeters based on the CRESST technology.
Thanks to the greatly enhanced CEvNS cross-section (10 to 1000 times greater than the standard neutrino detection channels), NUCLEUS is aiming for its first phase to develop a miniaturized detector of only 10 g target mass.
The detector will be installed at the Very Near Site (VNS), a shallow depth experimental hall located in between of the 2 nuclear reactors of the Chooz B power plant in France, with reactor baselines of 72 m and 102 m.
At this location with shallow-overburden, a highly efficient background suppression system will be fundamental.
It will include an active cryogenic outer veto designed to work in anti-coincidence with the target detector in order to identify and reject gammas due to the environmental radioactivity and neutron interactions, events that can mimic the CEυNS signal.
In this poster I will present the preliminary promising results obtained with our cryogenic outer veto prototype.

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Ricochet

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Development of an Organic Plastic Scintillator based Muon Veto Operating at Sub-Kelvin Temperatures for the NUCLEUS Experiment

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The NUCLEUS experiment aims to measure coherent elastic neutrino nucleus scattering of reactor anti-neutrinos using cryogenic calorimeters. Operating at an overburden of 3m.w.e., muon-induced backgrounds are expected to be dominant. For this reason, an efficient muon veto with a muon detection efficiency of more than 99% is indispensable and shall be achieved in NUCLEUS with a compact cube assembly of plastic scintillator panels. In order to prevent a large unshielded area where the cryostat enters the shielding arrangement without unnecessarily increasing the induced detector dead time, a novel concept has been investigated, consisting of a plastic scintillator based disc-shape active muon veto operating inside the NUCLEUS cryostat at sub-Kelvin temperatures. The required verification of the key physical aspects of the intended cryogenic muon veto detector concept by investigating its low temperature behavior led to the first reported measurements of organic plastic scintillators at sub-Kelvin temperatures. The functionality of the principal scintillation process of organic plastic scintillators at sub-Kelvin temperatures has been confirmed. On the basis of these findings, a disc-shape plastic scintillator based muon veto equipped with wavelength shifting fibers and a silicon photomultiplier to guide and detect the scintillation light has been developed. The NUCLEUS cryogenic muon veto will be the first of its kind to be operated at sub-Kelvin temperatures.

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Coherent Captain Mills Dark Matter Search

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Coherent Captain Mills (CCM) is a 10-ton liquid argon scintillation detector located at the Lujan Neutron Science Center at Los Alamos. CCM searches for sterile neutrinos and dark matter generated from an 800 MeV proton beam. In this talk I will discuss CCM's search for sub-GeV dark matter candidates including both vector portal and leptophobic dark matter as well as other dark sector particles like axion-like-particles(ALPS). I will present the results of an analysis performed on data collected from a 2019 engineering run as well as plans for an upcoming 2021 physics run with a significantly upgraded detector.

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CEvNS detection in XENONnT

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Dual-phase liquid xenon time projection chambers, like XENONnT, have leading sensitivities to rare particle interactions such as those expected from WIMP dark matter. With various detector upgrades, XENONnT will have improved sensitivity to low-energy interactions with signals as low as a single detected electron. This will allow XENONnT to detect Boron-8 solar neutrinos and neutrinos from potential galactic supernovae via coherent elastic neutrino nuclear scattering. In this talk, I will give an overview of the capability of XENONnT to detect astrophysical neutrinos via CEvNS.

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First operation of the BULLKID array of Kinetic Inductance Detectors.

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BULLKID is an R&D project which investigates a way of increasing the active volume of cryogenic detectors.
Several cubic silicon absorbers are carved in a 5 mm thick 3-inch diameter wafer. An array of multiplexed Kinetic Inductance Detectors (KIDs) senses the cubes with one KID per cube. When a particle interacts in the silicon it produces phonons which are then detected by the KID. The advantage of using KIDs lies in their natural multiplexing capability which is crucial to scale the technology up to hundreds or thousands of sensors.
The first prototype built consists of 60 cubes, with a measured energy resolution of around 100 eV_nr.
The response across the array is however not uniform and further refinements of the technology are ongoing.
Further improving the energy resolution is being evaluated as the next step in the R&D and might prove crucial in detecting Coherent elastic neutrino-nucleus scattering (CEvNS) or sub-GeV Dark Matter. If successful several wafers will be produced and stacked to reach the target mass.
In this poster we will describe the BULLKID project and the results from the operation of the first prototype.

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Welcome

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Closing remarks

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Installing a Skipper-CCD sensor in Atucha 2 power reactor: current status

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In this talk, we will show the current status of the effort to install a Skipper Charge Coupled Device (Skipper-CCD) with single-electron resolution in the Atucha 2 power reactor (in Argentina) at approximately 12 meters from the center of the core. We will revisit the main components of the system and its performance at Fermilab before commissioning. The installation is taking place in the fall of 2021, so some details of its progress will be discussed.

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Poster NUCLEUS Experiment

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Exploring coherent neutrino-nucleus scattering with NUCLEUS

Coherent elastic neutrino nucleus scattering (CEνNS) offers a unique way to study neutrino properties and to search for new physics beyond the Standard Model. The NUCLEUS experiment aims to measure CEνNS with reactor anti-neutrinos down to unprecedented low nuclear recoil energies. NUCLEUS will make use of $CaWO_4$ and Al_2O_3 based cryogenic detectors to perform precision measurements of CEνNS in order to reach a 20eV detection threshold and a rise time of a few 100μs which allows the operation above ground. After commissioning at TUM in late 2021, the experiment will be assembled at the Very Near Site, a new shallow experimental room in CHOOZ B nuclear power plant in France, in between two 4.25GW reactor cores with an average neutrino flux of $1.7 \cdot 10^{12} \frac{\overline{\nu}_e}{\mathrm{s\ cm^2}}$ at the detector's location. NUCLEUS plans to start its first phase in early 2023 and to obtain a measurement of the process with 10g target in few months of data taking, thanks to the high CEνNS cross-section.

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CRAB : Calibration by Recoils for Accurate Bolometry at the 100 eV scale using neutron capture

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The development of low-threshold detectors for the study of coherent elastic neutrino-nucleus scattering and for the search for light dark matter necessitates methods of low-energy calibration. We suggest this can be provided by the nuclear recoils resulting from the gamma emission following

thermal neutron capture 1. In particular, several MeV-scale single-gamma transitions induce well-defined nuclear recoil peaks in the 100 eV range. Using the FIFRELIN code 2, complete schemes of gamma-cascades for various isotopes can be predicted with high accuracy to determine the continuous background of nuclear recoils below the calibration peaks. We present a comprehensive experimental concept for the calibration of CaWO4 3 and Ge cryogenic detectors at a research reactor. For CaWO4 the simulations show that two nuclear recoil peaks at 112.5 eV and 160.3 eV should be visible above background simply in the spectrum of the cryogenic detector. Then we discuss how the additional tagging for the associated gamma increases the sensitivity of the method and extends its application to a wider energy range and to Ge cryogenic detectors.

1 L. Thulliez, D. Lhuillier et al., Calibration of nuclear recoils at the 100 eV scale using neutron capture, Journal of Instrumentation, 16, 7 (2021)
2 O. Litaize et al., Fission modelling with FIFRELIN, European Physical Journal A, 51, 12 (2015)
3 G. Angloher et al. Results on MeV-scale dark matter from a gram-scale cryogenic calorimeter operated above ground: CRESST Collaboration, European Physical Journal C, 77:637, 9 2017

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The COHERENT experiment at Oak Ridge National Lab

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The COHERENT collaboration operates an array of detectors in the ORNL Spallation Neutron Source (SNS) "Neutrino Alley" to search for coherent elastic neutrino nucleus scattering (CEvNS) and other low-energy rare scattering processes. Our goal is to precisely measure CEvNS (and other channels) to further understanding on a wide variety of questions in astro-, particle, and nuclear physics. We observed the world's-first events from CEvNS in 2017 with a cesium-iodide scintillation detector and have new results from an expanded data set. We followed up with a measurement on an much lighter argon nucleus, thus confirming the CEvNS hypothesis, that we published in 2020. Those measurements will be presented along with plans for further extending our physics reach with new detectors and our ongoing efforts to reduce systematic errors.

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COHERENT: A future tonne-scale LAr detector for CEvNS

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Coherent elastic neutrino-nucleus scattering (CEvNS) has been detected in a 24 kg single-phase liquid argon (LAr) scintillator detector. To obtain an event rate 20 times that of the 24 kg detector with a low threshold, the 750 kg LAr scintillator detector COH-Ar-750 has been designed by the COHERENT collaboration to be deployed at the Spallation Neutron Source at Oak Ridge National Laboratory. Work on the cryogenics system and light collection is ongoing. The 750 kg detector will be sensitive to non-standard neutrino interactions, nuclear form factors, inelastic charged-current and neutral-current events, and to light accelerator-produced dark matter. This poster will be an update on the work done towards the tonne-scale LAr detector.

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First Measurement of CEvNS on a Liquid Argon Target from the COHERENT Collaboration

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As part of the effort to observe and measure the cross-section of the CEvNS interaction, a single-phase liquid argon detector, COH-Ar-10, was deployed to the SNS in Fall 2016 by the COHERENT Collaboration. The 24kg fiducial volume target recently made the first low-N measurement of CEvNS in Spring 2020. The data used to make this measurement encompassed a year and a half of operation between mid-2017 and early 2019, a total of 6.12GWhr total integrated beam power. This poster will detail the recent COH-Ar-10 result as well as ongoing and future work.