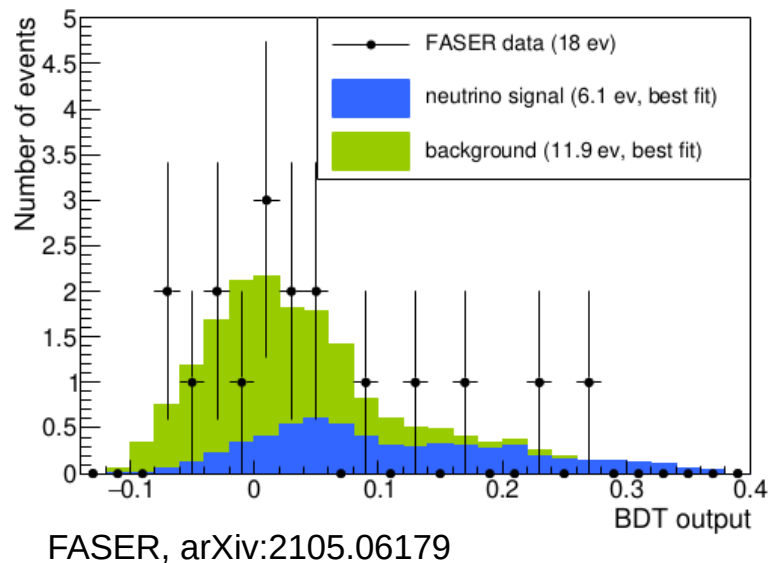
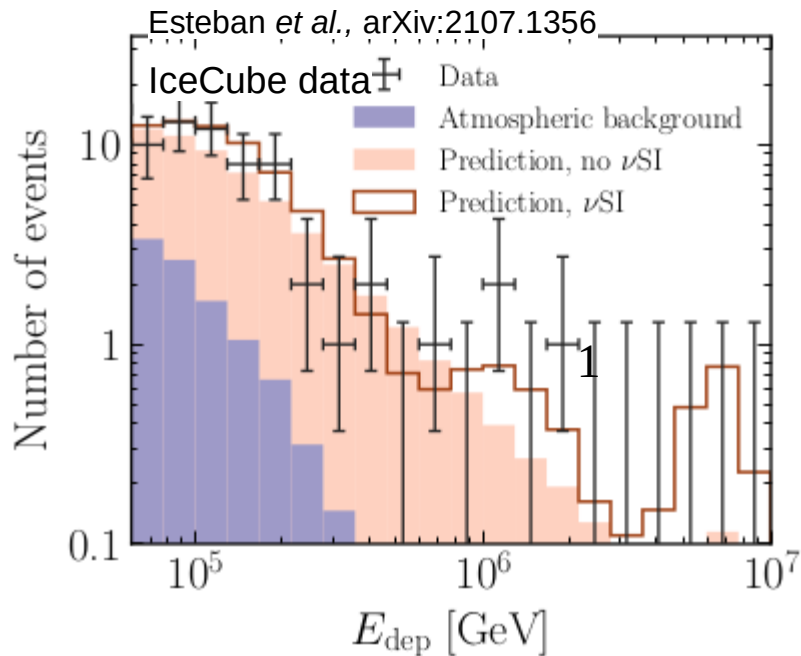
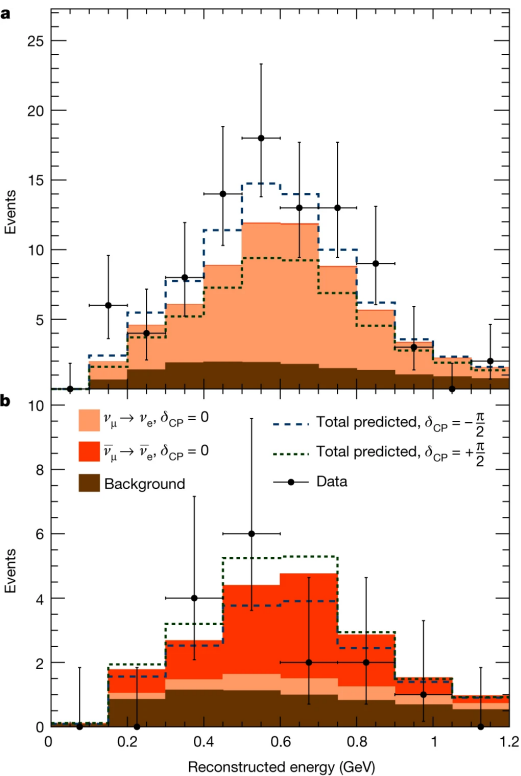


Updates from the Neutrino Frontier



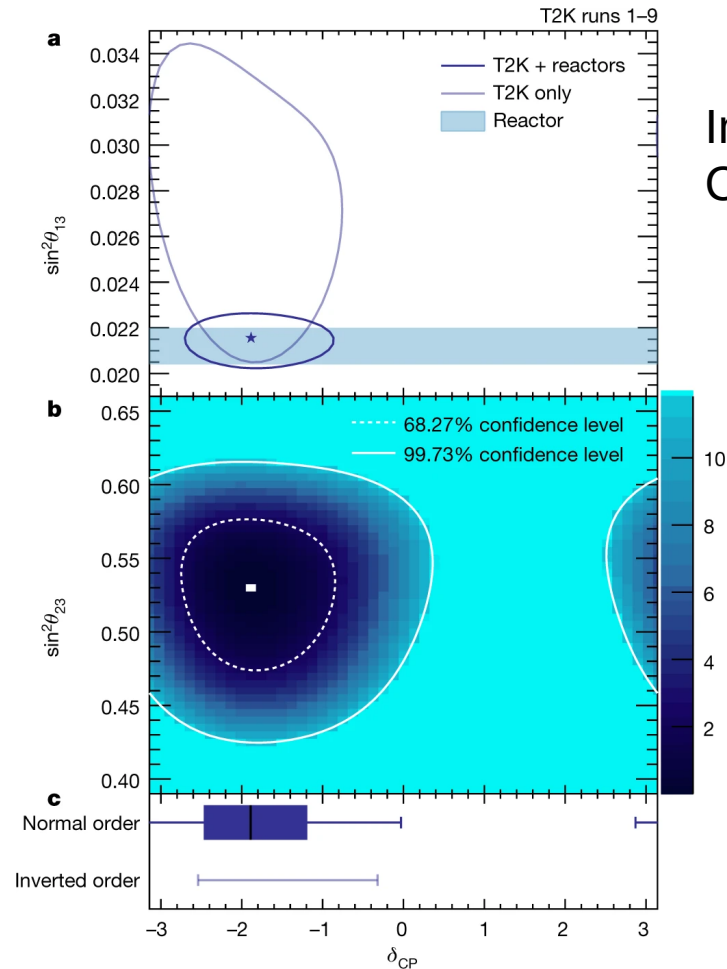
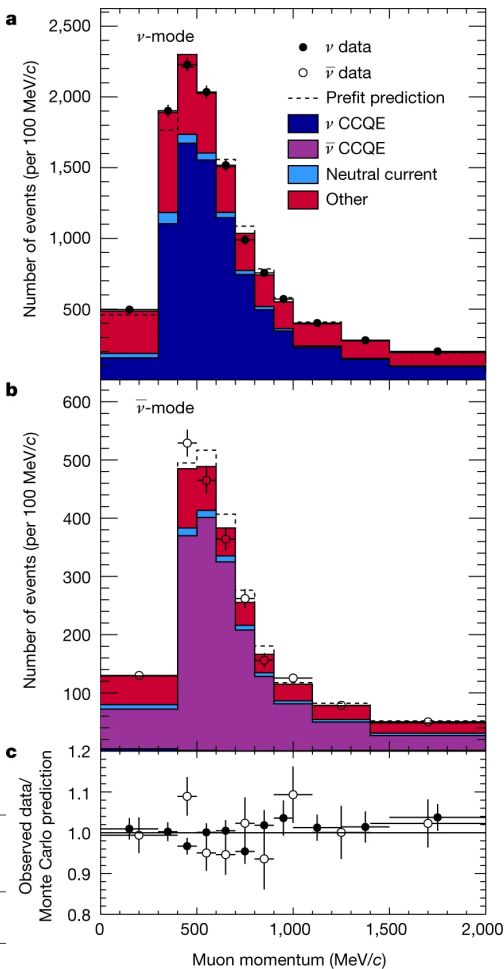
T2K

Nature 580, (2020) 339–344.

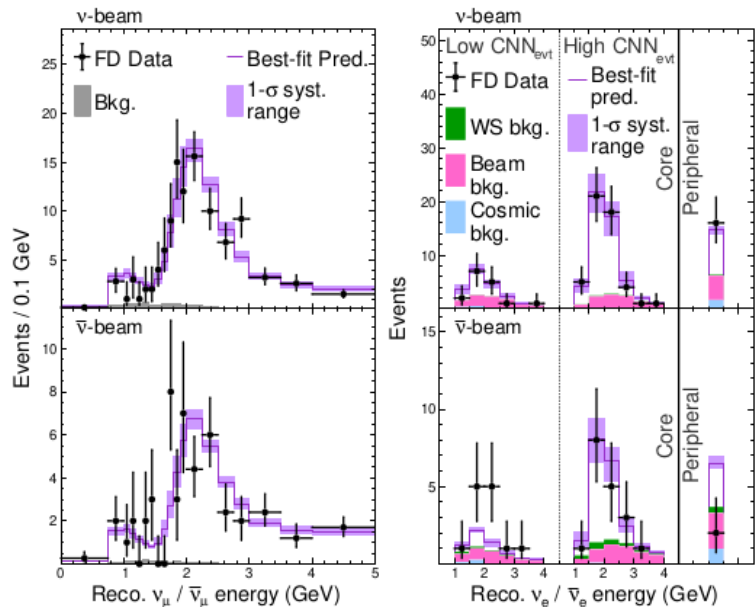


c

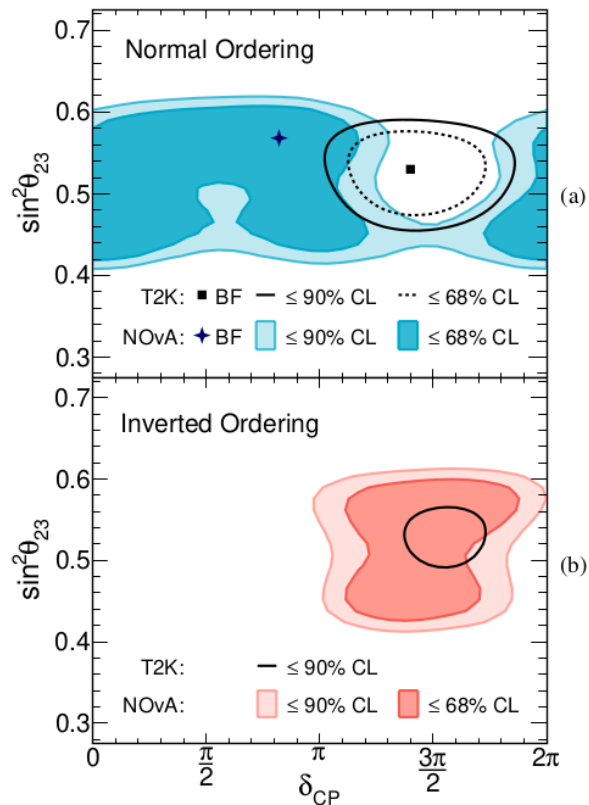
	1e0de ν -mode	1e0de $\bar{\nu}$ -mode	1e1de ν -mode
$\nu_\mu \rightarrow \nu_e$	59.0	3.0	5.4
$\bar{\nu}_\mu \rightarrow \bar{\nu}_e$	0.4	7.5	0.0
Background	13.8	6.4	1.5
Total predicted	73.2	16.9	6.9
Systematic uncertainty	8.8%	7.1%	18.4%
Data	75	15	15



Indication for CP violation?

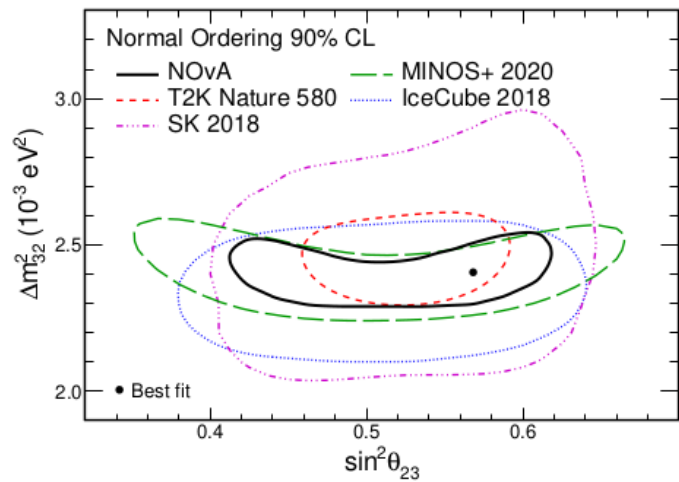


NOvA

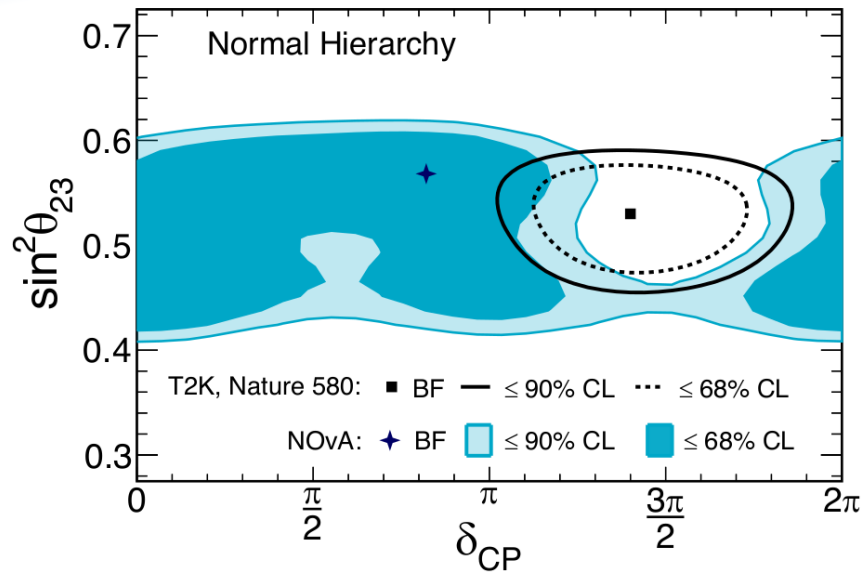


CP and mass hierarchy not independent.

Good agreement on the atmospheric data



T2K and NOvA



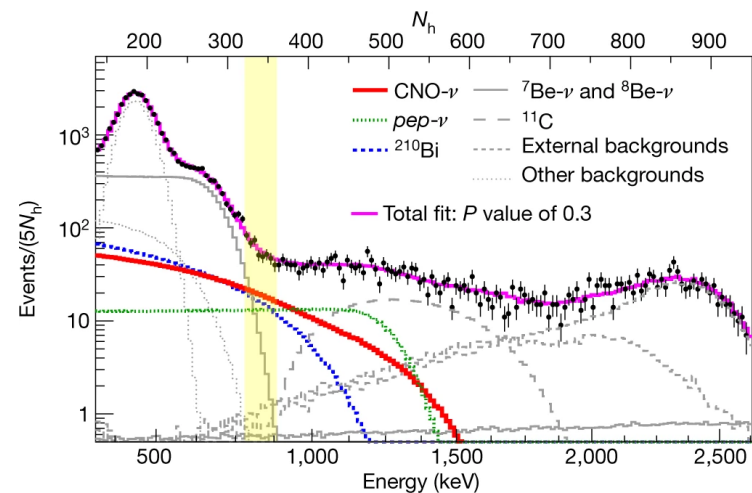
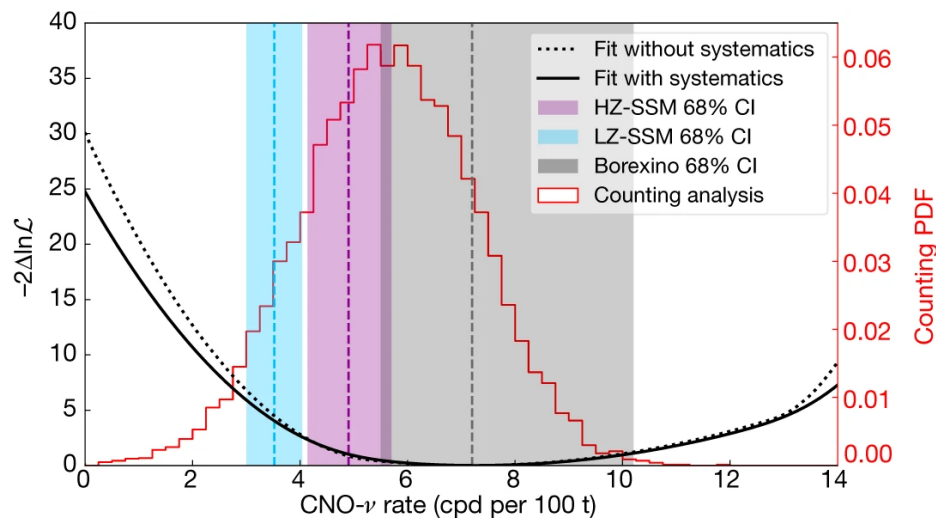
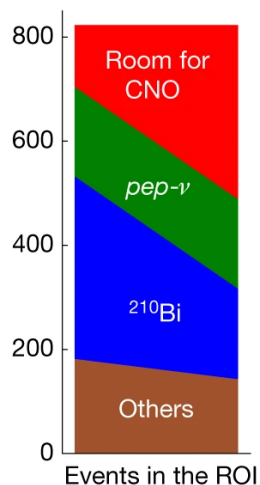
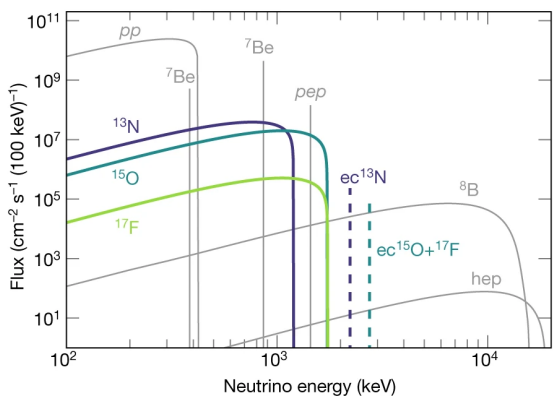
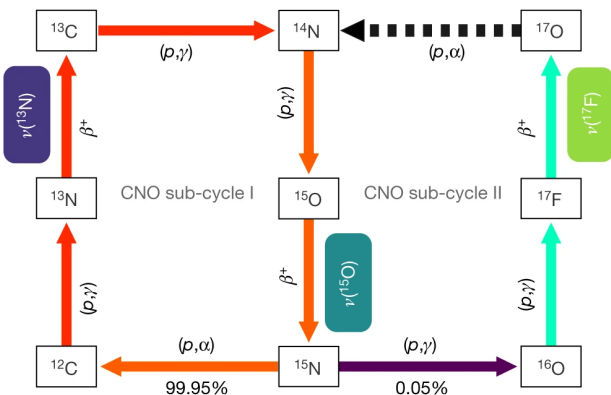
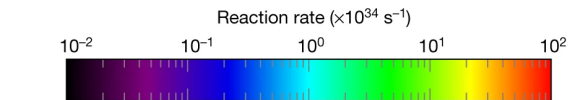
Maybe a statistical fluctuation

Could be exciting BSM (new matter effects etc.)

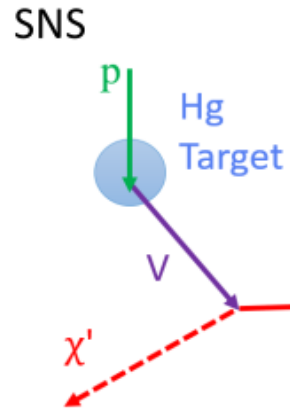
Also could be neutrino nucleus interaction systematic

Borexino

Understanding fusion in stars was the original motivation for Davis and Bahcall to look at solar neutrinos.

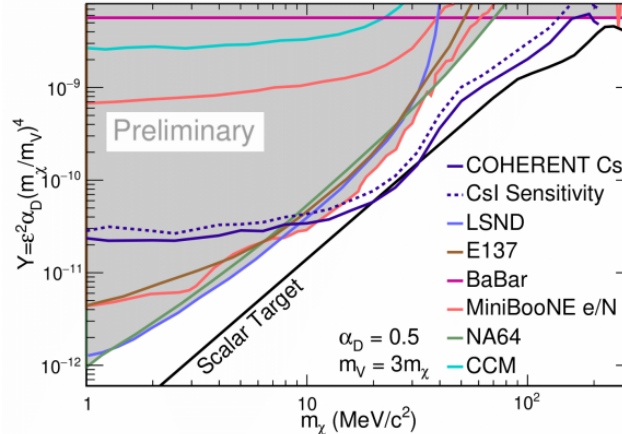
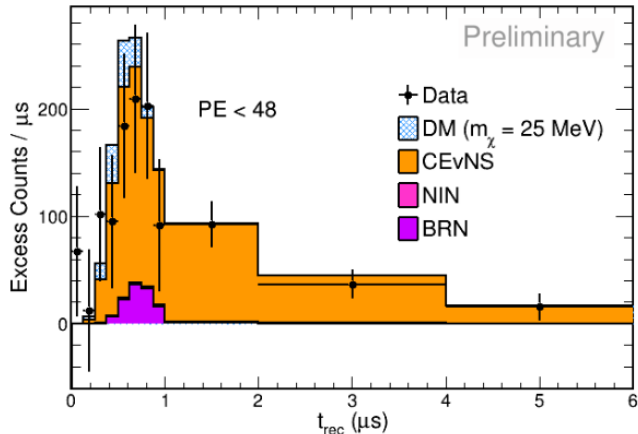
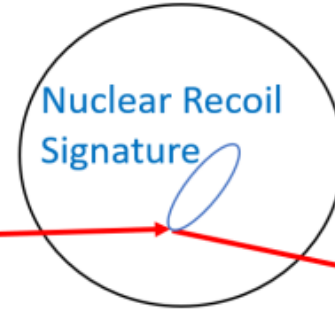


BSM at neutrino experiments



Recent COHERENT example at the SNS
Lots of theory activity

COHERENT detector



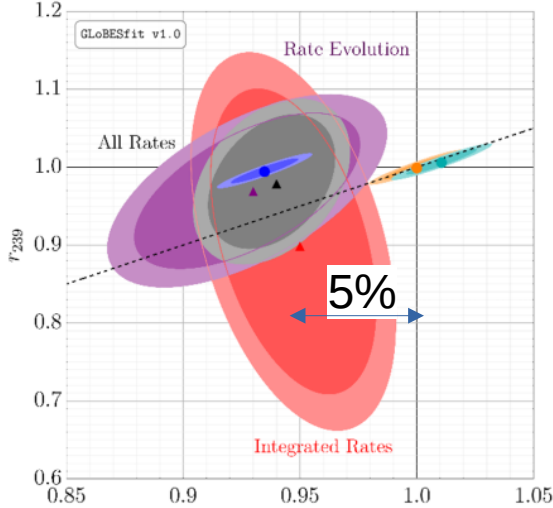
Intense flux of mesons/photons at neutrino beam target
→ light BSM states can be produced

Neutrino detectors ideal for detection (sub)weakly interacting particles.

SBN at FNAL very good at this and in the future DUNE

Reactor anomaly

Berryman, PH, JHEP 01 (2021) 167



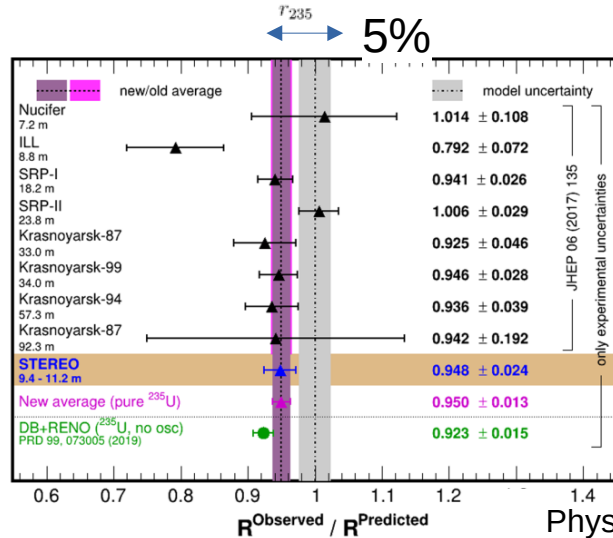
Overall RAA is about 6%

5% shift in U235 would nearly accommodate the RAA

Kopeikin *et al.* beta measurement moves 5% in the right way

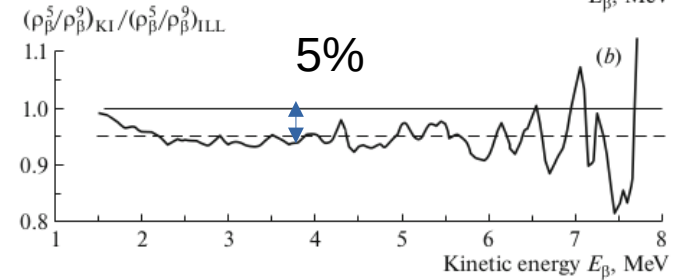
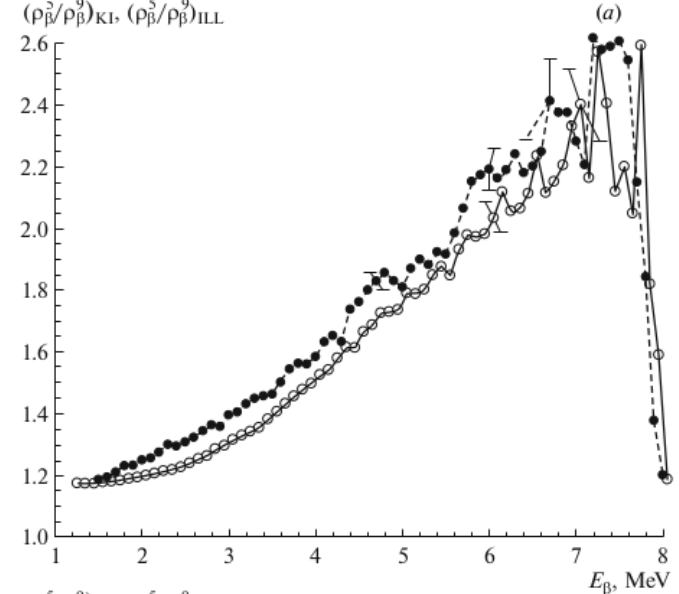
Which in turn would make HM flux prediction and neutrino flux measurement agree.

NB: 5 MeV bump remains...

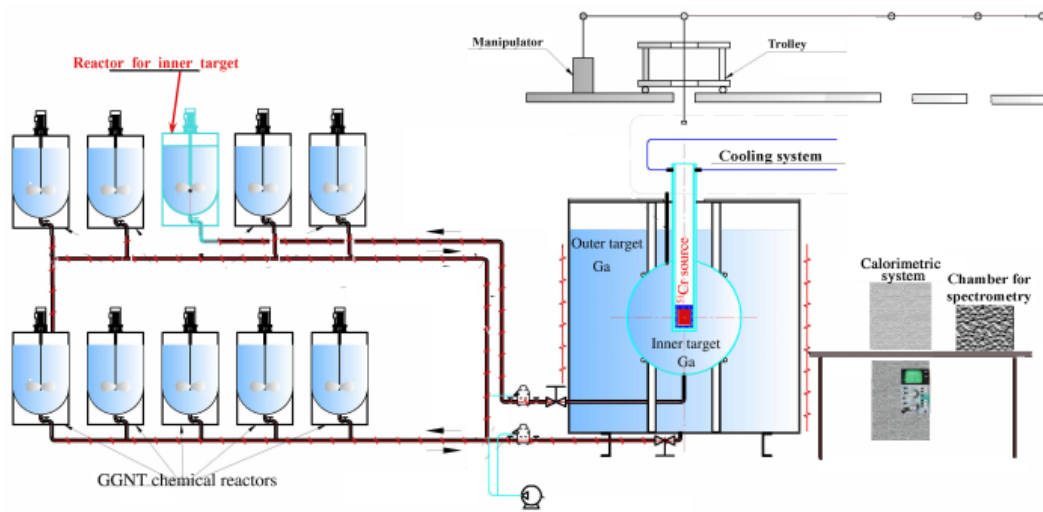


Phys.Rev.Lett. 125 (2020) 20, 201801

Kopeikin *et al.* Phys.Atom.Nucl. 84 (2021) 1

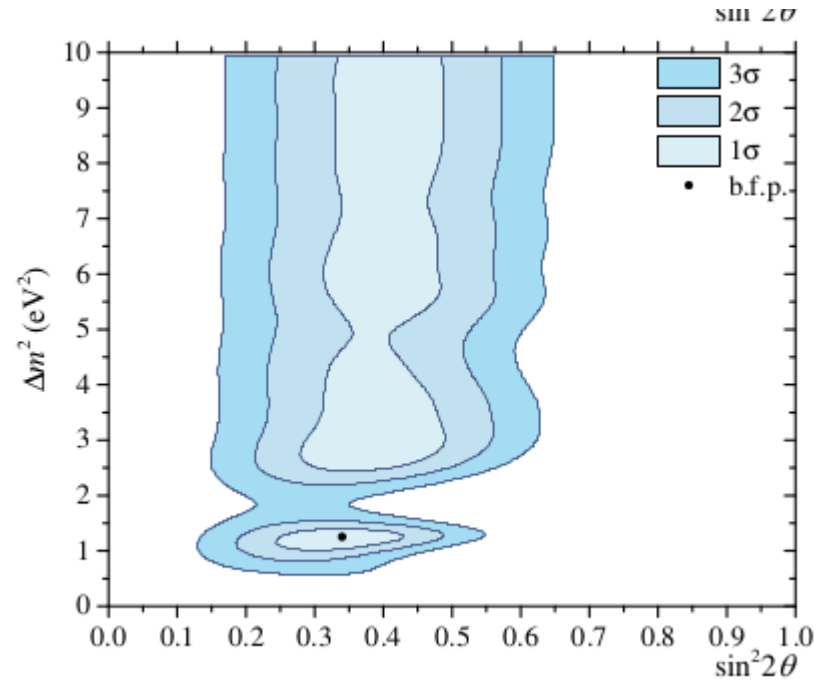


Gallium anomaly update



BEST collaboration, arXiv:2109.11482

$$R_{in} = 0.791 \pm 0.05 \text{ and } R_{out} = 0.766 \pm 0.05.$$



Consistent with previous gallium results, close to 4 sigma effect!

White paper coordination

Neutrino frontier is holding a series of short (~2 hour) workshops for coordination/discussion of particular Snowmass white paper topics

See NF calendar for dates/times <https://snowmass21.org/neutrino/start>

Date, Time (US Eastern)	Slot 1 Topic (contact)	Slot 2 Topic (contact)
July 28, 10 am	Kickoff	CEvNS (Louis Strigari, Phil Barbeau, Raimund Strauss)
August 27, 9 am	Tau neutrinos (Andre de Gouvea, Peter Denton, Irina Mocioiu)	Sterile neutrinos (Georgia Karagiorgi, Bryce Littlejohn, et al.)
Sept 7, 6 pm	Early career meeting (Jacob Zettlemoyer)	Early career meeting
September 22, 10 am	Neutrino Self-Interactions (Kevin Kelly, Nikita Blinov, Mauricio Bustamante, and Yue Zhang)	Open
October 7, 6 pm	STS Neutrinos (Kate Scholberg, Jason Newby)	Neutrino Cross Sections (Kendall Mahn) TBC
October 22, 9 am	Theory of Neutrinoless Double Beta Decay (TF11/NF09, Saori Pastore)	Reactor neutrinos (Nathaniel Bowden, Bryce Littlejohn, Pedro Ochoa)
November 2, 10 am [note: rescheduled from 6 pm]	Forward Physics Facility for the HL-LHC era (Jonathan Feng, Maria Vittoria Garzelli, Felix Kling, Milind Diwan)	Open
November 17, 10 am	Low Energy Physics in Liquid Argon (LEPLAr organizers)	NF Community Engagement (Claire Lee)
December 9, 6 pm	Neutrinos at ORNL (Kate Scholberg, Louis Strigari, Rex Tayloe, Jason Newby) TBC	Open

Contact NF conveners or topical group conveners if you'd like to organize in one of the open slots

NF report timeline

- Extended outline due (NF): Dec 18
- Report draft due (NF): Feb 28
- Contributed papers due: March 15
- NF Workshop: March 16-18
- Preliminary Report due (NF): May 10
- Preliminary Report due (Snowmass): May 31
- Final Report due (NF): Sept 9
- Final Report due (Snowmass): Sept 30, 2022

Neutrinos beyond HEP

- Panel discussion today at 2:30-4:30pm (ET) Zoom link
- Panelists:
- Laura Cadonati (gravitational waves)
- Rachel Carr (NuTools)
- Mark Kamionkowski (Astro 2020)
- Josh Klein (0NuBB NP panel)
- Manfred Lindner (IUPAP neutrino panel)

NF01 Neutrino Oscillations

Peter B. Denton (BNL)

Megan Friend (KEK)

Mark Messier (Indiana U.)

Hiro Tanaka (SLAC)

NF01 Three flavor oscillation news in the past year

- ▶ New oscillation results from:
 - ▶ T2K: [2101.03779](#)
 - ▶ NO_vA: [2108.08219](#)

Follow ups to their presentations at Neutrino 2020

- ▶ New sensitivity analysis from DUNE: [2109.01304](#)
- ▶ Community is evaluating JUNO's sensitivity
- ▶ Long-baseline in China? (FCC to CJPL/JUNO) [2108.11107](#)
- ▶ FNAL director Nigel Lockyer to step down, search ongoing
- ▶ NO_vA beam record 843 kW
- ▶ J-PARC upgrade ongoing to 1.32s repetition rate, 700+ kW in 2022 (targeting 1.3 MW)
- ▶ HK tunnel/DUNE cavern evacuations in progress
- ▶ CERN to provide two DUNE cryostats
- ▶ DeepCore atmospheric analysis ongoing (3yr → 8yr)

NF02 Understanding experimental neutrino anomalies

Bryce Littlejohn (IIT)

Georgia Karagiorgi (Columbia)

Pedro Machado (FNAL)

Alex Sousa (Cincinnati)

NF02 - New Results (2020-21)

Atmospheric

● IceCube

- eV-Scale Sterile Neutrino Search Using Eight Years of Atmospheric Muon Neutrino Data from the IceCube Neutrino Observatory PRL 125 (2020) 14, 141801
- Searching for eV-scale sterile neutrinos with eight years of atmospheric neutrinos at the IceCube Neutrino Telescope, Phys.Rev.D 102 (2020) 5, 052009

Accelerator

● MiniBooNE

- Updated MiniBooNE neutrino oscillation results with increased data and new background studies PRD 103 (2021) 5, 052002

● MINOS + Daya Bay

- Improved Constraints on Sterile Neutrino Mixing from Disappearance Searches in the MINOS, MINOS+, Daya Bay, and Bugey-3 Experiments PRL 125 (2020) 7, 071801

LBL Reactor

● RENO

- Search for Sub-eV Sterile Neutrinos at RENO PRL 125 (2020) 19, 191801

● Double Chooz

- Search for signatures of sterile neutrinos with Double Chooz Eur. Phys. J. C 81 (2021) 8, 775

SBL Reactor

● STEREO

- Improved sterile neutrino constraints from the STEREO experiment with 179 days of reactor-on data PRD 102 (2020) 5, 052002

● PROSPECT

- Improved short-baseline neutrino oscillation search and energy spectrum measurement with the PROSPECT experiment at HFIR PRD 103 (2021) 3, 032001

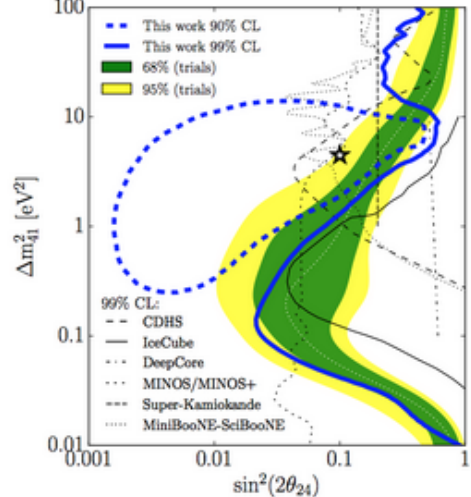
● Neutrino-4,

- Search for sterile neutrinos with the Neutrino-4 experiment and measurement results, Phys.Rev.D 104 (2021) 3, 032003
- **PROSPECT** and **STEREO**, Note on arXiv:2005.05301 (Comment)
Neutrino-4, A Comment on the note arXiv:2006.13147 on arXiv:2005.05301, (Comment on comment)

Beta Decay

● KATRIN

- Bound on 3+1 Active-Sterile Neutrino Mixing from the First Four-Week Science Run of KATRIN PRL 126 (2021) 9, 091803



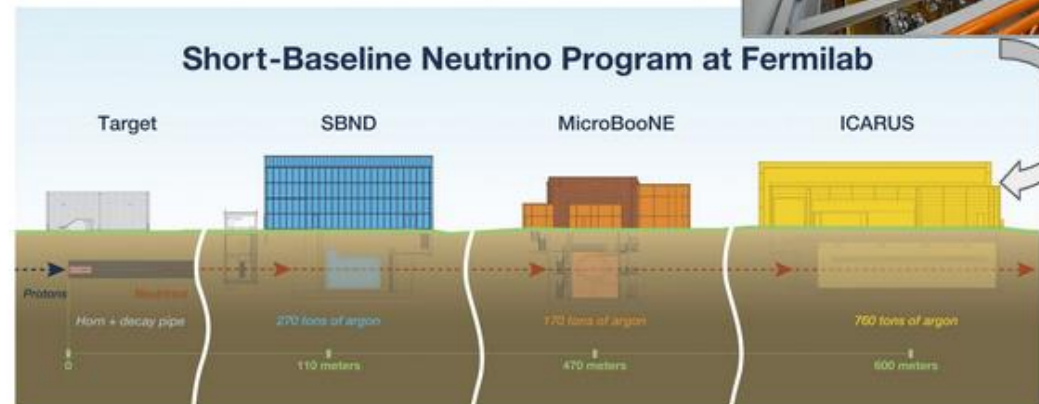
NF02 - Theory/Phenomenology Developments (2019-21)

- Non-Standard Interactions, e.g.:
 - P. Denton et al., Activating the 4th Neutrino of the 3+1 Scheme., PRD 99 035003, (2019)
- Sterile neutrino + decay:
 - M. Moulai, et al., Combining Sterile Neutrino Fits to Short Baseline Data..., PRD 101 5, 055020, (2020).
 - DeGouvea et al., On the Decaying-Sterile Solution... JHEP 07 141 (2020).
 - Dentler, et al., Decaying Sterile Neutrinos and the Short-Baseline... PRD 101 115013 (2020).
- Emphasis on Z' models, e.g.:
 - Ballet, et al., Dark neutrinos and a three portal connection ... PRD 101, 115025 (2020).
 - Arguelles, et al., Testing New Physics Explanations of the MiniBooNE..., PRL 123 26, 261801 (2019).
- Extended Higgs with Sterile Neutrinos
 - B. Dutta et al., Explaining $(g-2)_{\mu,e}$, the KOTO anomaly and the MiniBooNE..., PRD 102 5, 055017 (2020).
- Emphasis on alternative searches, e.g.:
 - O.G. Miranda et al., Future CEvNS experiments as probes of lepton unitarity..., PRD 102 113014 (2020).



NF02 - On the horizon

- Results from **MicroBooNE** on mB low-energy excess
- **SBL reactor** data-taking / analysis push towards fully addressing suggested reactor anomaly phase space
- **KATRIN**: larger datasets in the can for sterile analyses
- **JSNS2** data-taking underway to directly test LSND
- Start of beam operations for ICARUS, commissioning and operations for SBND (**SBN program at FNAL**)
- Much, much more!



NF03 BSM

Pilar Coloma (IFT, Madrid)

Lisa Koerner (U. of Houston)

Ian Shoemaker (Virginia Tech)

Jae Yu (UT Arlington)

Current status regarding white papers

Based on the LOIs submitted to our group, we have organized ourselves into six sub-topical groups:

- Heavy neutral leptons
- Coherent Elastic Neutrino-Nucleus Scattering
- BSM effects on neutrino flavor (neutrino oscillations and UHE neutrinos)
- Baryon number violation
- Cosmogenic dark matter and exotic particle searches
- Beam-originating dark matter candidate searches

We have already identified coordinators/editors for each of them. The status of each white paper varies but they are all more or less on track.

We have also requested explicit feedback from the community regarding this initiative.

New results related to BSM (~last year or so)

- Nov 2020: KATRIN bound on light sterile neutrinos: <https://arxiv.org/abs/2011.05087>
- May 2021: NA62 bounds on Heavy Neutral Leptons (HNL): <https://doi.org/10.1016/j.physletb.2021.136259>
- June 2021: MicroBooNE search for a Higgs portal: <http://arxiv.org/abs/2106.00568>
- June 2021: Reinterpretation of MicroBooNE search as a bound on HNL (Kelly and Machado) <http://arxiv.org/abs/2106.06548>
- June 2021: New bounds on HNL from ArgoNeut data, <https://arxiv.org/pdf/2106.13684.pdf>
- July 2021: New results from DANSS on light sterile neutrinos: [talk at EPS-HEP](https://arxiv.org/pdf/2012.10255.pdf), see also <https://arxiv.org/pdf/2012.10255.pdf>
- July 2021: New bounds on HNL using old CHARM data (Boiarska, Boyarsky, Mikulenko, Ovchynnikov) <https://arxiv.org/abs/2107.14685>
- Sep 2021: New bounds on HNL from hodoscopic detectors (Argüelles, Foppiani, Hostert) <https://arxiv.org/abs/2109.03831>

NF04 Neutrinos from natural sources

Yusuke Koshio (Okayama U.)

Gabriel D. Orebi Gann (UC
Berkeley/LBNL)

Erin O'Sullivan (Uppsala)

Irene Tamborra (NBIA)

NF04 Recent progress

- Solar: Borexino's first detection of CNO neutrinos [Nature 587 577-582 (2020)]
- Geo:
- Supernova and early universe: Progress on the phenomenology and understanding of neutrino mixing
- Detection methods: Directionality observed in pure LS detectors [arxiv.org/abs/2109.04770]
- Atmospheric: First result from KM3NeT (see ICRC2021)
- Extra galactic: Possible association of a neutrino with a TDE [Nature Astron. 5 510-518 (2021)] and NGC 1068 [Phys. Rev. Lett. 124, 051103 (2020)], deployment of radio array in Greenland (RNO-G)

NF04 White Paper plans

- Solar: recent review article summarises the field [arxiv.org/abs/2107.08613]
- Supernova: recent theory review articles [arxiv.org/abs/2011.01948, arxiv.org/abs/2009.14157, arxiv.org/abs/2010.09013]
- Atmospheric: based on <https://www.mdpi.com/2218-1997/6/6/80>,
- Extra galactic: Plans for a high energy neutrino whitepaper together with the cosmic frontier
- Early universe: Looking into the possibility of coordinating a white paper

Reminder of NF04 Topics

This topical group covers neutrino detection from all natural sources, including the Earth and astrophysical sources, as well as modeling of neutrino physics in these sources. Specific topics include (LOIs received):

- Solar: 26
- Geo: 9
- Supernova: 28
- Atmospheric: 16
- Extragalactic/high energy: 23
- Early universe: 3

https://snowmass21.org/neutrino/natural_sources/start

NF05 Neutrino Properties

Carlo Giunti (Torino)

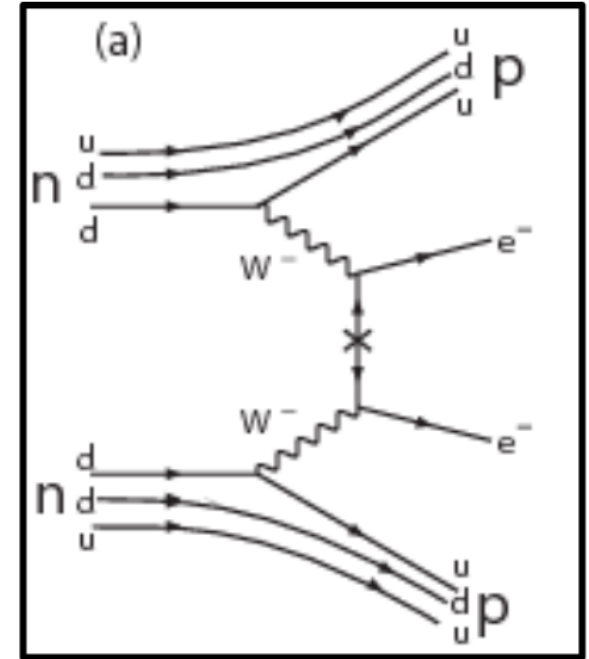
Ben Jones (UT Arlington)

Lisa Kaufman (SLAC)

Diana Parno (Carnegie Mellon U.)

Summary from NF05 - neutrino properties

- Main focus is on
 - **direct neutrino mass measurements** and
 - **neutrinoless double beta decay**
- **Nu electromagnetic properties** also within purview
 - But limited activity in the US...
 - Except within the context of coherent neutrino scattering (that group is stewarding in that context)
- We hosted a six-part program of mini workshops Summer 2020
- And a two-day workshop on the future of neutrinoless double beta decay beyond the ton-scale in Dec 2020
- These activities nucleated white papers in both areas which are being led by proponents in those areas.



Links to NF05 Snowmass workshops:

<https://indico.fnal.gov/event/43812/>
<https://indico.fnal.gov/event/43814/>
<https://indico.fnal.gov/event/43811/>
<https://indico.fnal.gov/event/43806/>
<https://indico.fnal.gov/event/43789/>
<https://indico.fnal.gov/event/43813/>
<https://indico.fnal.gov/event/46424/>

Summary from NF05 neutrino properties

White paper status:

- Community wide white paper on **direct neutrino mass measurements** in preparation
- White paper on **xenon procurement strategies for future kiloton scale TPCs** nucleated by ACFI workshop is nearing completion (and probably also going to be submitted for publication)
- Due to ongoing DOE NP "downselect" process which we do not want Snowmass to interfere with we are **not coordinating white papers from ton-scale programs in Onubb**, but expect that some collaborations may produce them, at their own discretion.
- We welcome contributed white papers from any others - please warn us if you have one in the works that we do not know about.

Kilotonne-scale xenon detectors for new physics searches

D.S. Akerib,^{1,2} A. Avasthi,³ T. Bowyer,⁴ C. Bray,⁵ E. Church,⁴ A. Fan,^{1,2} R. Guenette,⁶ S.J. Haselschwardt,⁷ J. Hayes,⁴ M. Heffner,^{8,*} A. Jamil,⁹ B.J.P. Jones,¹⁰ L.J. Kaufman,¹ R.F. Lang,¹¹ K.G. Leach,⁵ B.G. Lenardo,¹² W.H. Lippincott,¹³ A. Marino,⁵ D.N. McKinsey,^{14,7} E.H. Miller,^{1,2} D.C. Moore,^{9,†} B. Mong,¹ B. Monreal,³ M.E. Monzani,^{1,2} I. Olcina,^{14,7} J.L. Orrell,⁴ A. Pocar,¹⁵ P.C. Rowson,¹ R. Saldanha,⁴ S. Sangiorgio,⁸ T.A. Shutt,^{1,2} and C. Stanford⁶

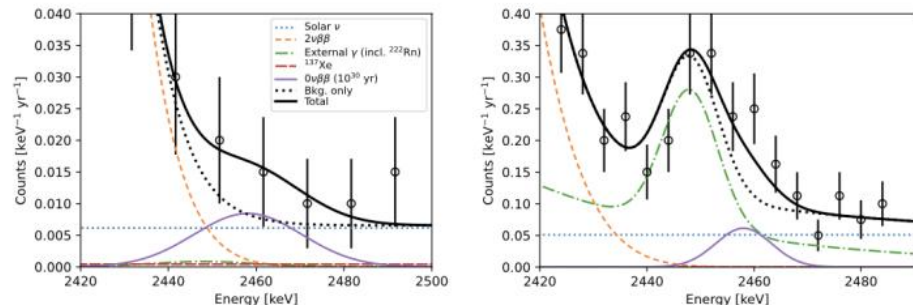
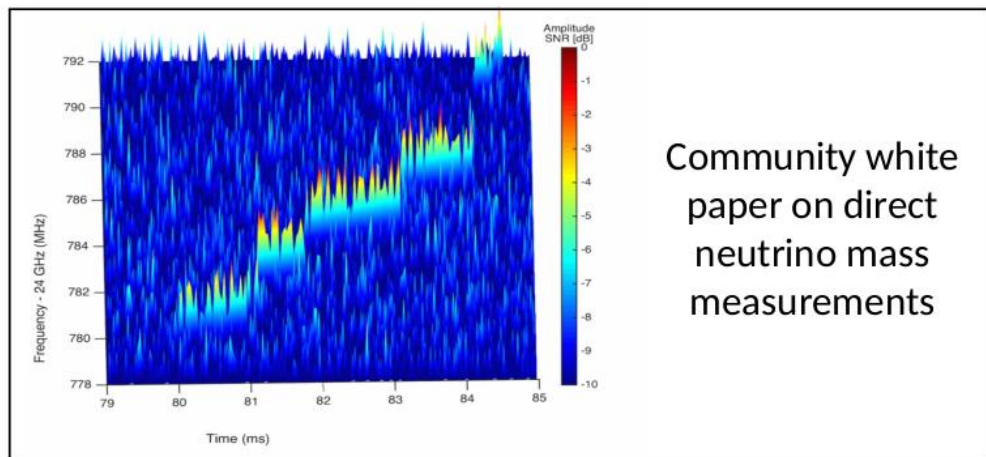


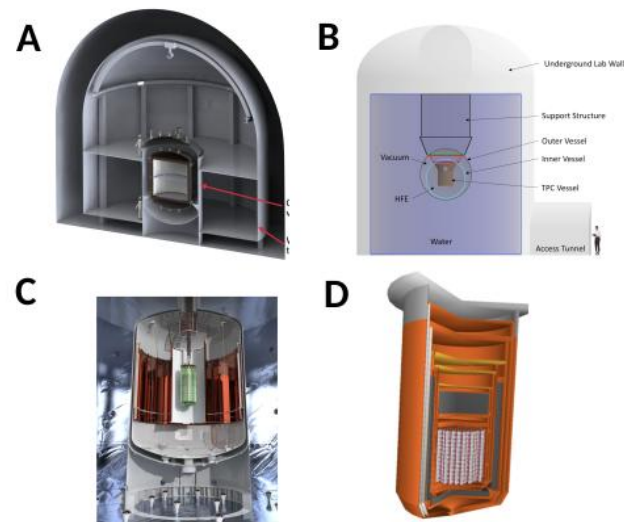
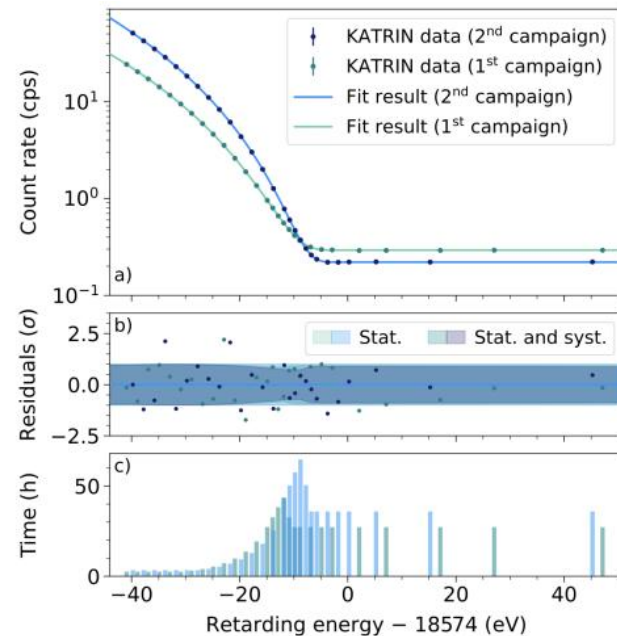
FIG. 9. Example background model for a LXe concept (left) and GXe concept (right). For the LXe concept (left), the estimated spectrum is shown for an enriched detector in the fiducial region > 42 cm from the vessel walls assuming $m_{det} = 300$ t, $\eta = 0.9$, $\sigma/Q = 0.5\%$, and Cherenkov-based single β rejection with the efficiencies specified in the text. The GXe concept (right) assumes a ^{136}Xe detector with $m_{det} = 3$ kt, $\eta = 0.089$, $\sigma/Q = 0.2\%$. In addition to the expected backgrounds, a potential $0\nu\beta\beta$ signal with a half-life of 10^{30} yr is shown. The error bars show an example toy dataset near the median discovery potential for a livetime of 20 yr.



Community white paper on direct neutrino mass measurements

NF05 Physics news:

- KATRIN now below 1 eV on neutrino mass sensitivity ✉
- Neutrinoless double beta decay at ton-scale proceeding through ongoing NP portfolio review process, Gran Sasso workshop happening at the end of September to coordinate international efforts.
 - <https://agenda.infn.it/e/double-beta-2021>
- New sensitivity papers from some ton-scale proposed experiments have come out recently:
 - A) *NEXT*: <https://arxiv.org/abs/2005.06467>
 - B) *nEXO*: <https://arxiv.org/pdf/2106.16243>
 - C) *LEGEND*: <https://arxiv.org/abs/2107.11462>
 - D) *CUPID*: <https://arxiv.org/abs/1907.09376>
- Snowmass group is *not* getting involved in the ton-scale programs
- White papers in progress on direct neutrino mass and on procurement of xenon for beyond-normal-ordering scale detectors



NF06 Neutrino Interaction Cross Sections

Jonathan Asaadi (UT Arlington)
Baha Balantekin (U. Wisconsin)
Kendall Mahn (Michigan State U.)
Jason Newby (ORNL)

NF06: Neutrino Interaction Cross-Sections Topical Group

Jonathan Asaadi(jonathan.asaadi@gmail.com), Baha Balantekin (baha@physics.wisc.edu),
Kendall Mahn (mahn@msu.edu), Jason Newby (newbyrj@ornl.gov)

And Much thanks to our Early Career members:

Steve Gardiner (gardiner@fnal.gov), Tanaz Mohayai (mtanaz@fnal.gov)
Vishvas Pandey (vishvaspandey@gmail.com), Jacob Zetlemoyer (jzettle@fnal.gov)

Reaching out to experimental collaborations, nuclear and astrophysicists and other stakeholders regarding:

- Relevant measurements for neutrino interactions at all energy regimes and all probes (electrons, pions, etc welcome)
- Open "operational" concerns including theory and software
- Users of neutrinos as a source for what their needs are.

Workshops & White Papers

Electron Scattering Workshop (Dec 2020) <https://indico.fnal.gov/event/46620/>

- Define the role of electron scattering data and collate the run plans of various efforts for users to compare/contrast. Included perspectives from nuclear and astro physics of broad interest.
- Whitepaper Outlined based on the workshop - contact us to join!
<https://www.overleaf.com/4212219177vsnmhzhfkmtfg>

Low Energy Neutrino Workshop (Planned for Nov 2021)

- Explore connections between Low Energy Neutrino Nucleus scattering physics and corresponding electron-nucleus scattering
 - CEvNS, 10s of MeV inelastic nu scattering, kaon-decay at rest, ...
 - Parity Violating Electron Scattering, low energy electron scattering
 - Needs for DUNE LE/SN program
- Workshop will define scope of Whitepaper

Workshops & White Papers (cont.)

NF06 Contribution to Theory Workshop in August 2021

- Theory white paper near completion

Generator Workshop (planning for November 2021)

- Discussion-based, will be survey driven
- Invitations coming out soon to complete survey!

Soliciting other possible white papers - contact us with your ideas!

- In contact with community groups such as NuSTEC; presenting status on Oct 7th at the NF white paper coordination meetings

NF07 Applications

Nathaniel Bowden (LLNL)

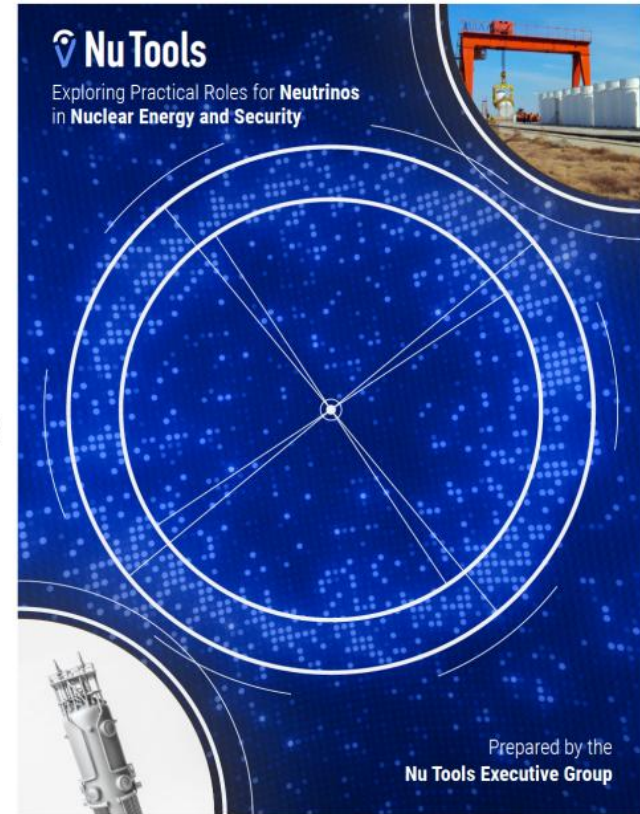
Jon Link (Virginia Tech)

Wei Wang (Sun-Yat Sen U.)

Developments in Neutrino Applications

Nu Tools Study was recently released

- Supported by NNSA Nonproliferation R&D Office to evaluate the utility of neutrino technology with ***a focus on end-user input***
- The report Findings examine:
 - **Cross-cutting topics** like *End-user Engagement* and *Technical Readiness* for adoption
 - **Potential use cases for neutrinos**, e.g.:
 - Most promising: *Advanced reactors and Future Nuclear Deals*
 - Potential utility, but challenging: *Spent Fuel, Post-incident Instrumentation*
 - Not Promising: *Existing reactors under safeguards, Reactor Instrumentation, Non-cooperative Monitoring*
- The report also describes a framework for evaluating utility that might be useful for novel technologies beyond neutrinos



<https://nutools.ornl.gov/>

NF08/TF11 Neutrino Theory

André de Gouvêa (Northwestern U.)

Irina Mocioiu (Penn State U.)

Saori Pastore (Washington U.)

Louis Strigari (TAMU)

Neutrino Theory: List of topics

Theory of Neutrino Physics

1. What is the **origin of nonzero neutrino** masses. Open questions, models, and how can we learn more? How does this connect with other open questions in particle physics and cosmology (dark matter puzzle, baryogenesis, stability of the Higgs boson mass)?
2. Is there a **theory of flavor**? What is it? How do we learn more? How well do we need to know the elements of the mixing matrix (including CP), and why? How are leptons and quarks connected?
3. Solving current (and future!) **neutrino puzzles**, including the short-baseline anomalies.

These include connections to experiments that will help piece the neutrino mass puzzle, including searches for kinematical effects of nonzero neutrino masses and understanding the neutrino mass ordering, searches for new neutrino states and new neutrino properties and interactions, searches for charged-lepton flavor-violation, searches for lepton number violation (e.g. neutrinoless double-beta decay), searches for baryon number violation (proton decay, neutron-antineutron oscillations), high energy collider experiments, low-energy observables, including searches for permanent EDMs, other experiments that will help shine light on the flavor puzzle (e.g., rare meson decays and other flavor observables in the quark sector).

Theory for Neutrino Physics

1. **Simulating astrophysics sources** of neutrinos and computing neutrino transport in these environments (supernova neutrinos sources of ultra-high energy neutrinos and cosmic rays);
2. **BSM neutrino physics in early universe cosmology** (neutrino properties from cosmology and solve “puzzles” in cosmological data);
3. Computing **neutrino-nucleon and neutrino-nucleus scattering**, from low-energy scattering — including CEvNS — solar and supernova neutrinos up to DIS, including implementation (and validation against electromagnetic data);
4. **Neutrino phenomenology** for neutrino experiments. Understanding how well different neutrino properties including BSM effects can be measured and constrained by future neutrino experiments of all stripes (oscillations, both long- and short-baselines, CEvNS, solar, atmospheric, SN, and UHE neutrinos, direct detection experiments);
5. **Non-neutrino phenomenology** for neutrino experiments (e.g., searches for DM in neutrino experiments, searches for hidden sectors, etc);
6. Computing **matrix elements for neutrinoless double-beta decays**.

White papers:

1. [Theoretical tools for neutrino scattering: interplay between lattice QCD, EFTs, nuclear physics, phenomenology, and neutrino event generators](#) (commissioned by TF11/NF08, NF06, TF05, RF04)
2. [Theory of neutrinoless double beta decay](#) (commissioned by TF11/NF08, TF05, RF04)
3. [Muon colliders for neutrinos](#) (new topic with TF, EF, under debate)

Workshops:

1. [Mini-workshop](#) on Neutrino Theory. 21-23 September, 2020
2. Snowmass [mini-workshop](#) in preparation for the white paper “Theoretical tools for neutrino scattering: the interplay between lattice QCD, EFTs, nuclear physics, phenomenology, and neutrino event generators.” August 23-25, 2021
3. Theory of neutrinoless double beta decay WP will be presented on [Oct 22nd @ 9 am ET](#)

NF09 Artificial Neutrino Sources

Laura Fields (FNAL)

Alysia Marino (U. of Colorado Boulder)

Pedro Ochoa (UCI)

Josh Spitz (U. of Michigan)

News during the pause

- nuSTORM/ENUBET complementarity and plans to possibly merge
 - See, e.g.,
 - https://enubet.pd.infn.it/presentations/ENUBET_MuonColl_20210604_v2.pdf
 - <https://indico.cern.ch/event/1018506/contributions/4274452/attachments/2215485/3750562/01-2021-03-25-Long-intro.pdf>
- First measurement from EMPHATIC hadron production experiment at FNAL (2106.15723).
- Forward Physics Facility at LHC initiative is coming together.
 - See workshop (11/9/2020): <https://indico.cern.ch/event/955956/>
- Beam Physics with a Booster Accumulator Ring initiative is coming together
 - See workshop (12/15/2020): <https://indico.fnal.gov/event/46607/>

Reminder

- Tau Neutrino Physics with Artificial and Natural Sources Workshop (9/28-10/1). <https://www.bnl.gov/nutau2021/>
- Possible nuSTORM white paper workshop in the future.



NF10 Neutrino Detectors

Josh Klein (Pennsylvania)

Anna Machado (UNICAMP)

David Schmitz (Chicago)

Raimund Strauss (TUM)

NF10

Neutrino detectors

Josh Klein, Ana Machado, Dave Schmitz,
Raimund Strauss

Neutrino Detectors come in many flavors:

- Liquid Argon TPCs (wires/pixels/phases) and other TPCs
- Water/Ice Cherenkov detectors
- Liquid scintillation detectors: Water-based or hybrid scintillation/Cherenkov
- Solid-state detectors
- Segmented detectors
- Plastic and Inorganic scintillator detectors
- Cryogenic (mK) detectors
- Bolometric detectors
- ...



WS1: Water/scintillator/photon detectors

WS2: Noble element TPCs

WS3: Low-threshold detectors

The Neutrino Physics Frontier group NF10 will cover the application of enabling technologies in the context of physics capabilities.

- We focus on enabling technology for future neutrino experiments!
- We group neutrino detectors into 3 categories:

- We work on the interface with the Instrumentation Frontier
- We want to advertise technical advances driven by neutrino physics
- We organize dedicated workshops and panel discussions
- We plan for a white paper on neutrino detectors

WS1:

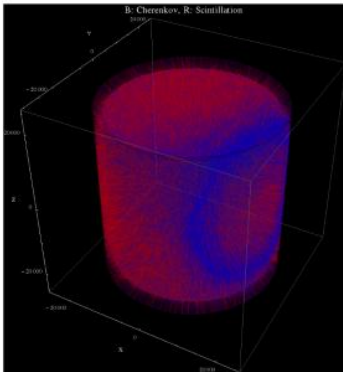
Water/scintillator/photon

Broad Physics Program from MeV---TeV using new enabling technologies:

- Advanced scintillators
- New photon sensors
- Fast timing
- Photon sorting technologies
- New loading techniques
- New large-scale detector ideas

Workshop in December 2020; white paper planned

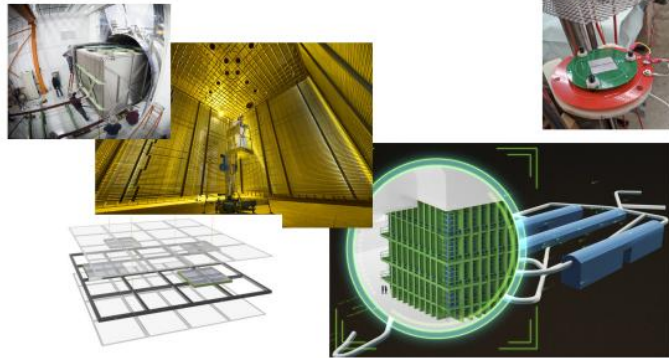
General interest in hybrid (Cherenkov/scintillation) detectors



WS2:

Noble element TPCs

Liquid argon TPCs have been successfully operated at 10^2 - 10^3 ton scales on the way to the 10^4 ton scales of DUNE.



R&D efforts continue to optimize physics capabilities in future detectors:

- liquid and HP gas TPCs
- charge readout technologies
 - vertical/horizontal drifts
 - wires/CRP/pixel readouts
 - readout electronics
- scintillation detection technologies
 - photon collectors/sensors
 - dopants

WS3:

Low-threshold detectors



Exploring **sub-keV energies** with multiple technologies:

- Cryogenic (mK) detectors
- Bubble chambers
- Scintillation detectors
- Ionization detectors /CCDs
- Gaseous detectors
- *New ideas:* Paleo, Color centers, Snowball

Exploiting **CEvNS** for reactor, solar and supernova neutrinos

Workshops: The Magnificent 7s '20&'21
White paper on CEvNS

Updates from CEF

Claire Lee (FNAL) is our liaison to CEF.

CEF has a working group 7:
Environmental and Societal Impacts

Conveners:

Michael Headley (SURF)

Véronique Boisvert (Royal Holloway, University of London)

Ken Bloom (University of Nebraska)

There is a planned white paper:

Impacts of Particle Physics laboratories on local communities
headed by Mike Headley

Summary

- NF is still in a collecting-input mode
- So focus is on white papers and the many excellent topical workshops. Please, do engage with those!
- Synthesis will start with the New Year
- First draft reports prior to March NF-wide meeting
- March NF-wide meeting is essential to define the major themes for NF.