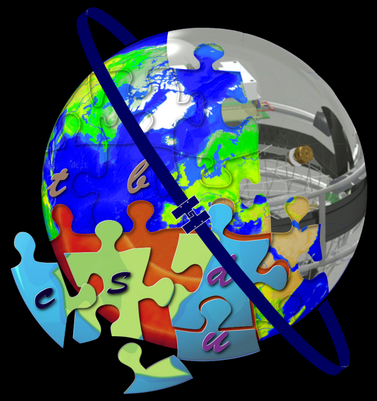


Dmitry V.Naumov



JINR
Neutrino Program

Major research directions

Major Research

Fundamental properties

- ★ Masses, mixing, CP
- ★ Mass ordering
- ★ Dirac or Majorana
- ★ Sterile neutrinos

Neutrinos as messengers

- ★ Astrophysical UHE neutrinos
- ★ Solar and geo-neutrinos
- ★ Dark matter

Neutrino interactions

- ★ ν–nucleus cross sections
- ★ Coherent scattering,
- ★ ν_τ

Neutrinos as instruments

- ★ NPP spectra guards

Foundations & Technologies

We build the tools & standards

03-2-1100-1-2024/2028

Radiochemistry and spectroscopy for astrophysics and nuclear medicine

@JINR

PI: D.V. Filosofov

Deputies: Yu.B.Gurov, A.Kh.Inoyatov, D.V. Karaivanov

Team: 29.5 FTE/57

Aim & motivation:

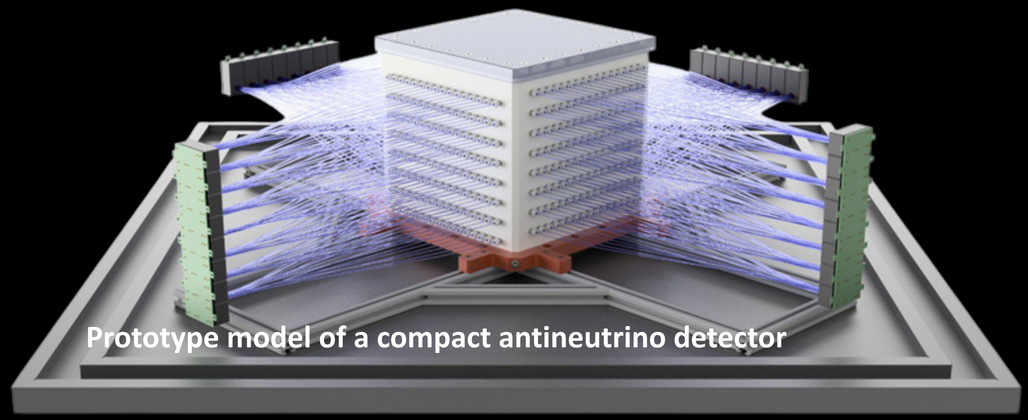
Development of methods for nuclear spectroscopy and radiochemistry to use in nuclear medicine, astrophysics, and neutrino physics.

Major results

— COFE detector technology developed for compact, well-localized antineutrino detection via inverse β-decay.

— R&D of Te-loaded plastic scintillators for neutrinoless double β-decay searches.

— SUPEC-7000 ICP-MS commissioned, enabling ultra-low radioactivity assays for low-background experiments.



A 20×20×20 cm^3 COFE detector prototype:
— inorganic scintillator powder, wavelength-shifting fibers;
— matched refractive indices (BaF_2 and $C_3O_3H_8$) ensure efficient light collection.
— Neutron detection by 0.6% GdF_3.
— Tests with a 137Cs source show gamma detection up to 500–600 keV.

Nuclear Spectrometry for the Search and Investigation of Rare Phenomena

@JINR

PI: D. Zinatulina

Deputies: K. Gusev (LEGEND), D. Ponomarev (Zr-BNO), S. Rozov (Se-LSM)

Team: 22 FTE/59

Experiments:

LEGEND, TGV, SuperNEMO, Se-LSM, Zr-BNO, MONUMENT

Science case

$2\nu\beta\beta$:

- **low-threshold detectors: Ge (vGEN), cryogenic (Richochet)**

$0\nu\beta\beta$:

- vGEN, Richochet

Major methodological results in 2025

LEGEND :

— after background reduction LEGEND-200 was successfully resumed operation with 60 enriched germanium detectors (~140 kg of ^{76}Ge)

Zr-BNO :

— the first measurement campaign of ^{96}Zr samples at BNO is completed; data analysis is in progress

Se-LSM :

— data taking for $2\nu2\beta$ decay of ^{82}Se to excited states of ^{82}Kr are ongoing, with > 29,550 hours accumulated

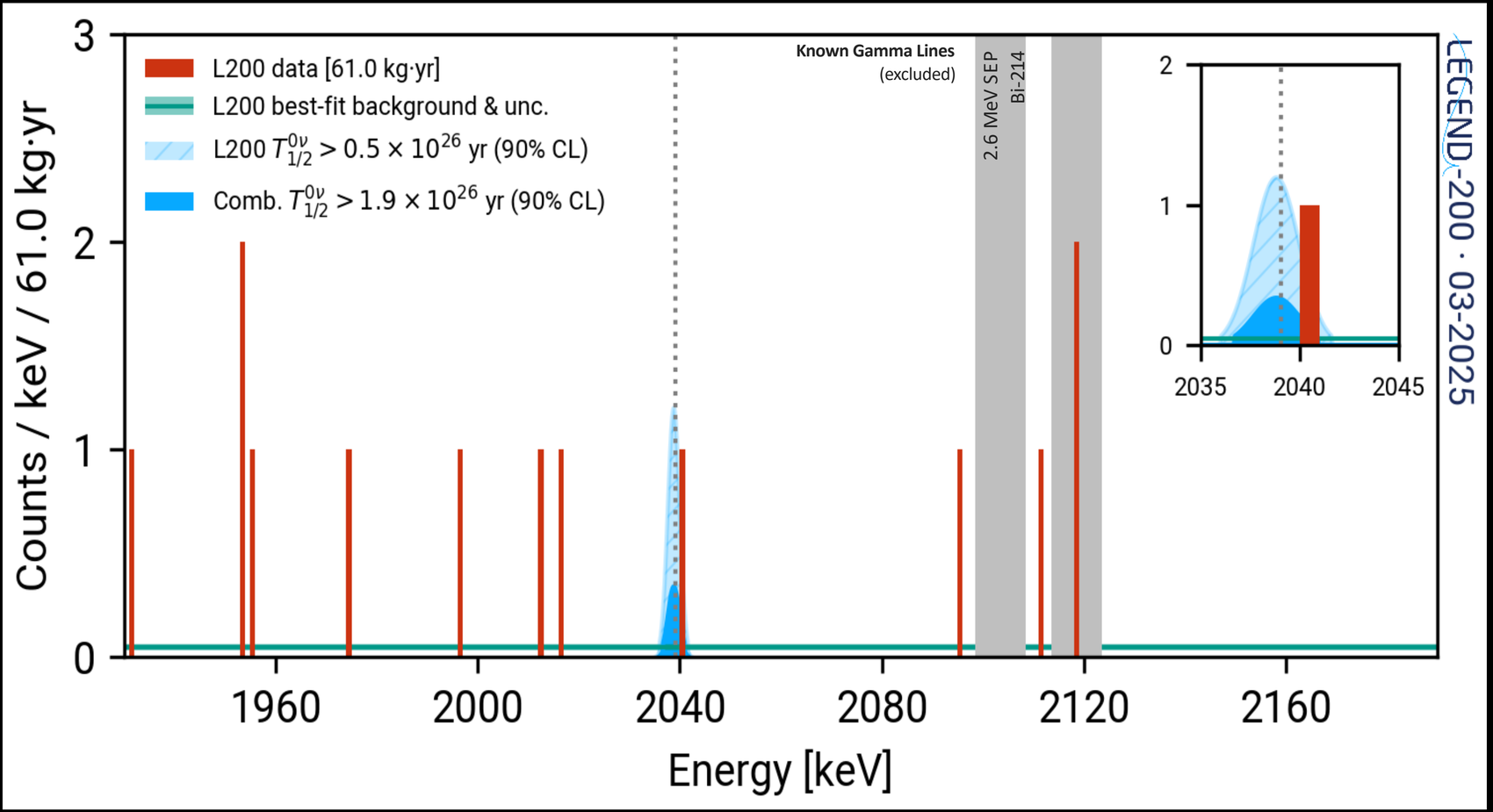
SuperNEMO :

— according to the IN2P3 Directive (of March 2025), data taking will end by December 2026, with dismantling by December 2027

MONUMENT :

— Analysis of **2021 and 2023** data is ongoing; **R&D for 2026 measurements** has started, including a **silicon-strip muon trigger**.

Major results@LEGEND



- ★ Extensive background reduction achieved
- ★ Both frequentist and Bayesian analyses show no evidence for $0\nu2\beta$, setting best limit on lifetime 2.8×10^{26} yr

PRL (Accepted) https://doi.org/10.1103/25tk-nctn

Major results

Se-LSM:

— Observed $2\nu2\beta$ decay $^{82}\mathrm{Se} \rightarrow {}^{82}\mathrm{Kr}$ with half-life time ~ 6×10^{22} years

MONUMENT:

— Measured total rate of the muon capture in $^{76}\mathrm{Se}$.

1. MONUMENT: https://doi.org/10.48550/arXiv.2510.23401
2. LEGEND: PRL (Accepted) https://doi.org/10.1103/25tk-nctn
3. Se-LSM: Physics of Particles and Nuclei, 2025, Vol. 56, No. 3, pp. 831–834.
4. SuperNEMO: 2025 JINST 20 T11003
5. SuperNEMO: 2025 JINST 20 P06018
6. SuperNEMO : arXiv:2509.08931

Reactor neutrinos: precision & applications

From applications → world-leading precision

03-2-1100-2-2024/2028

Investigations of reactor neutrinos on a short baseline

@JINR

PI: I. Zhitnikov

Deputies: **A. Lubashevskiy** (vGeN), **S. Rozov** (Ricochet), **M. Shirchenko** (DANSS)

Team: 20.6 FTE/57.

Science case

CEvNS:

— **low-threshold detectors: Ge (vGEN), cryogenic (Richochet)**

μ_ν:

— vGEN, Richochet

Sterile neutrino:

— DANSS/DANSS-2

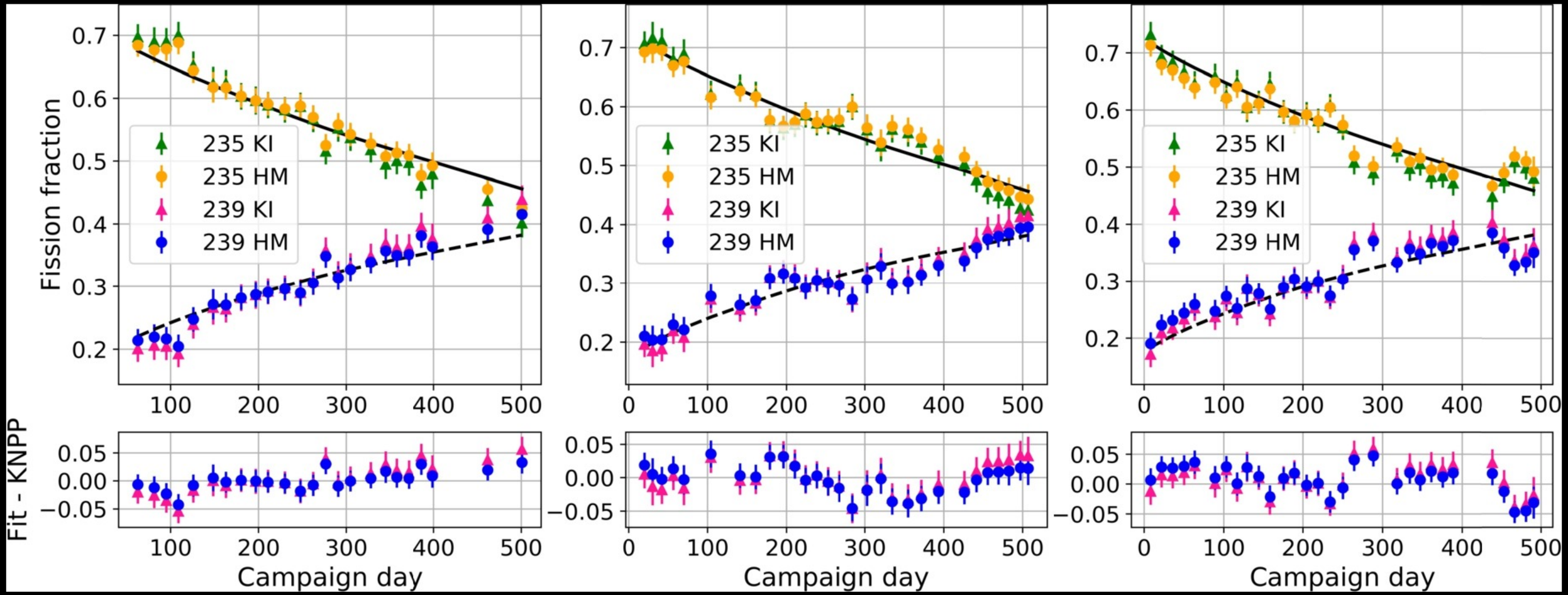
Remote reactor core monitoring:

— DANSS/DANSS-2

Major methodological & technical results (2025)

- **vGeN**
  New HPGe calibration method using a *volume uranium source* developed.
- ***DANSS***
  Long-term reactor thermal power monitoring with antineutrinos demonstrated, achieving ~1% accuracy for weekly averages.
- **DANSS**
  Technology for optical adapters coupling fiber systems to photodetectors developed.
- **DANSS-II**
  Shielding design optimized to suppress detector background.
- **Ricochet (ILL, Grenoble)**
  Detector installation and commissioning completed in H1 2025;
  first physics run with 18 detectors started July 2025 (runs until Feb 2026).

Major results@DANSS

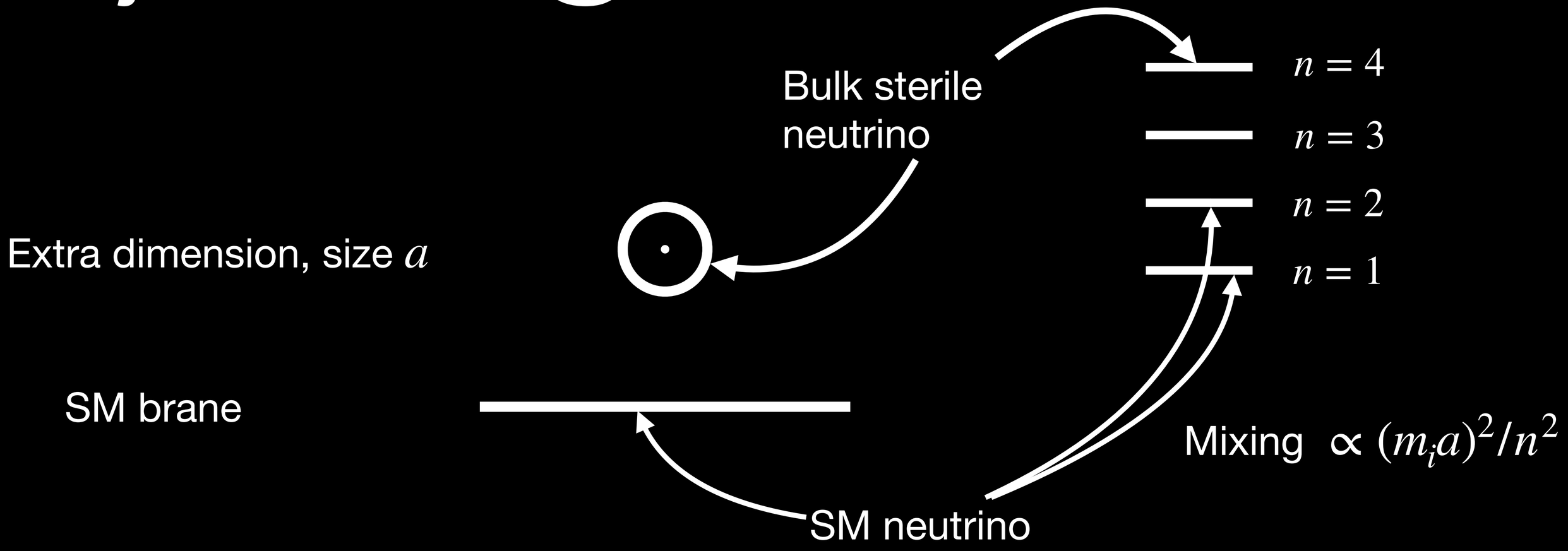


— Method and measurement of fission fractions of 235U and 239Pu isotopes @ NPP

Physics Letters B, 866, 2025, 139575

Phys. Rev. D 112, 112005, 2025

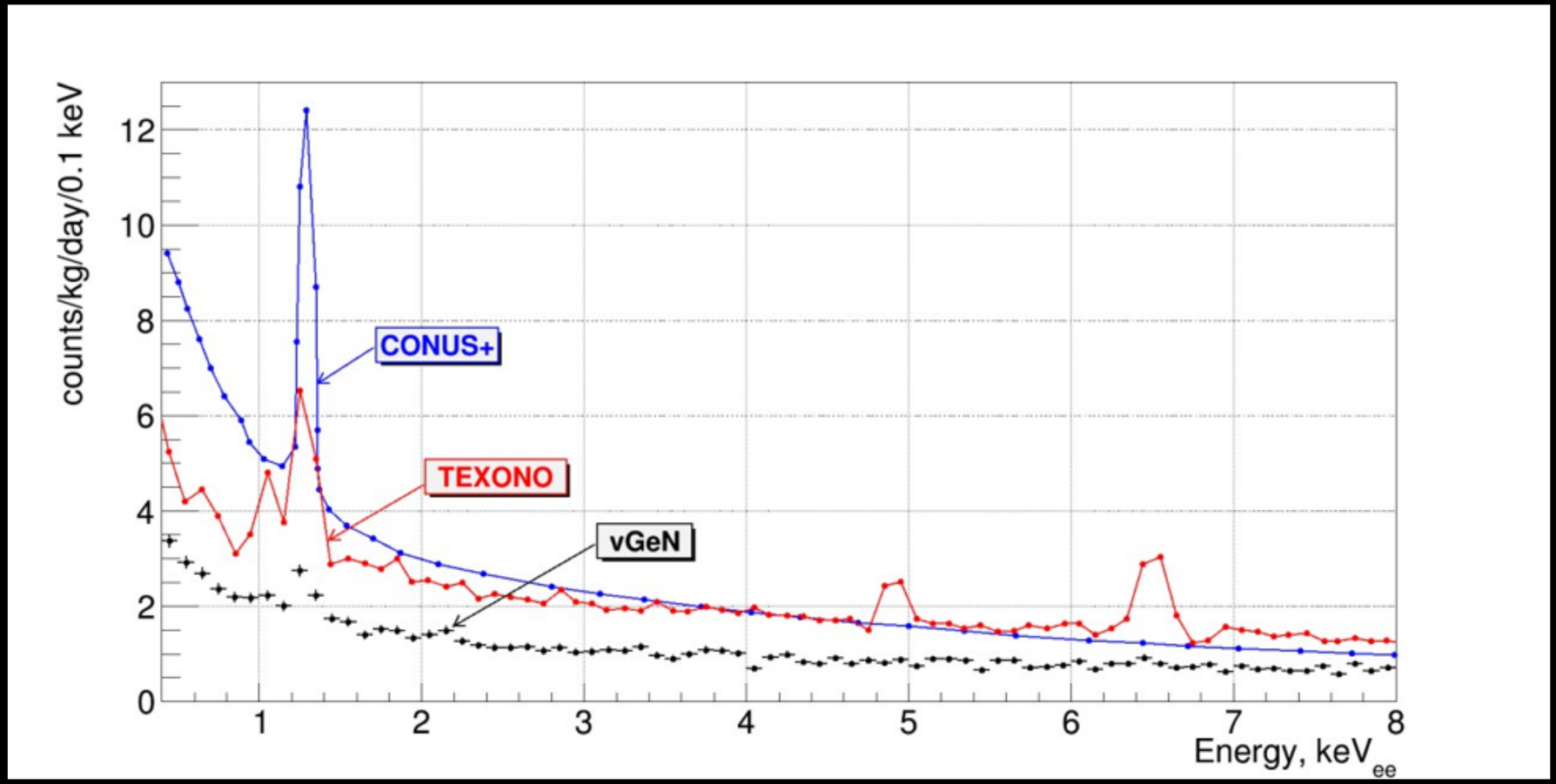
Major results@DANSS



No evidence for Large Extra Dimensions is observed, excluding most LED explanations of the gallium and reactor anomalies.

JETP Lett. 122, 1–7, 2025

Major results@vGEN



— the lowest background among HPGe reactor experiments

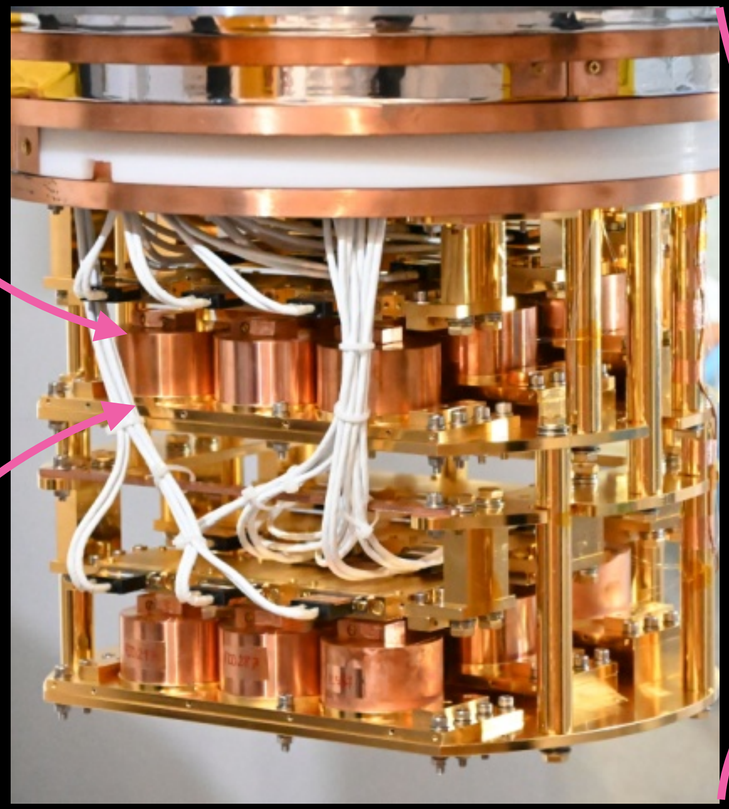
— exclude at 2.5σ Dresden-II CEvNS claim

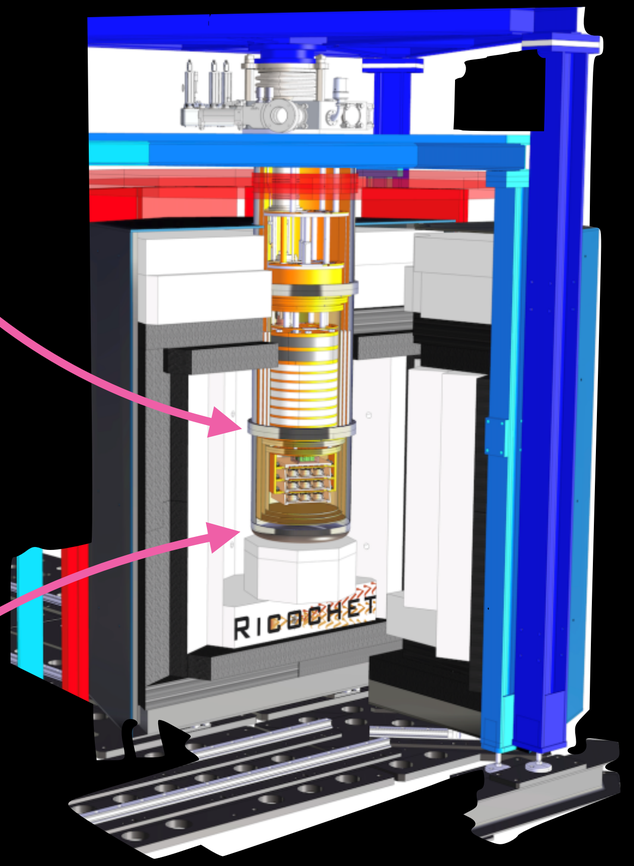
Chinese Physics C 49 (5), 053004, 2025

Bulletin of the Lebedev Physics Institute № 11, 46-62, 2025

RICOCHET

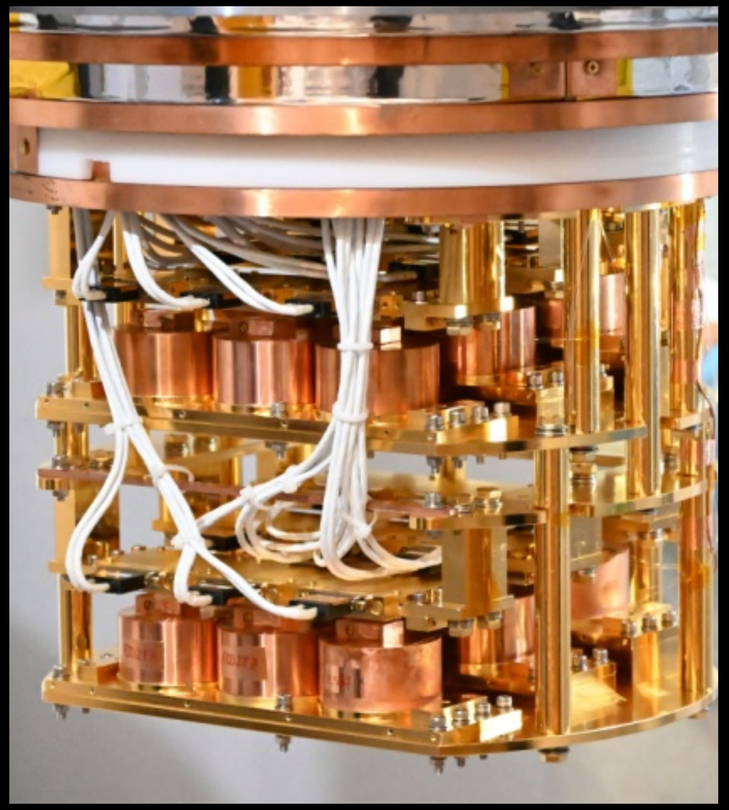


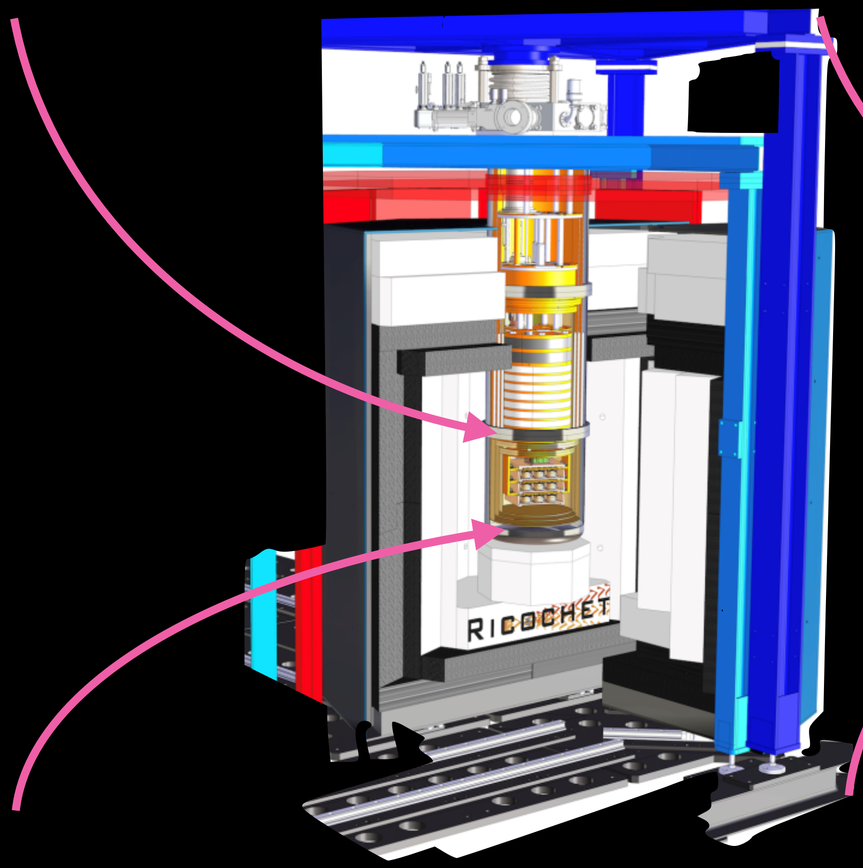




Ge bolometers: ~20 mK working temperature,
discrimination nuclear/electron recoils

RICOCHET







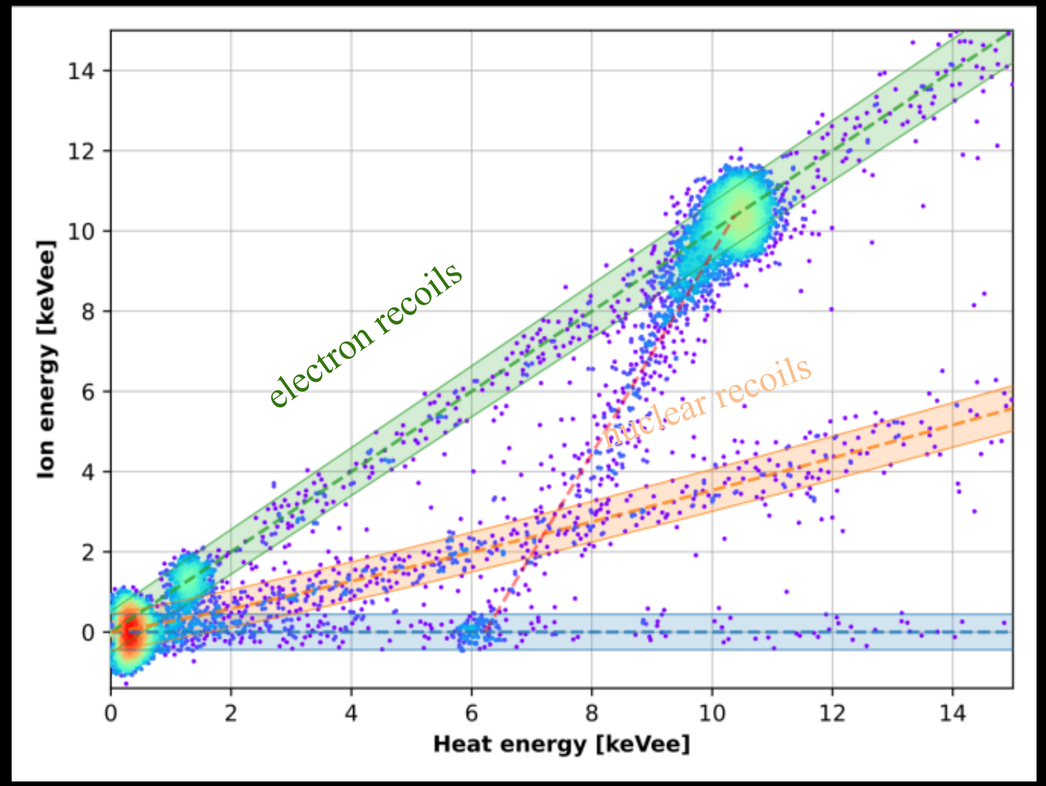
@ILL (France):

8.8 m from the core. 58 MW

RICOCHET

Threshold: 50 eV
Events/day/kg: 11





JINR contribution:

low background cryosystem, veto system, supplementary detectors, background studies.

First results expected in 2026!

arXiv:2507.22751, 2304.14926v2, 2306.00166, 2208.01760

02-2-1099-4-2026/2028

JUNO

@JINR

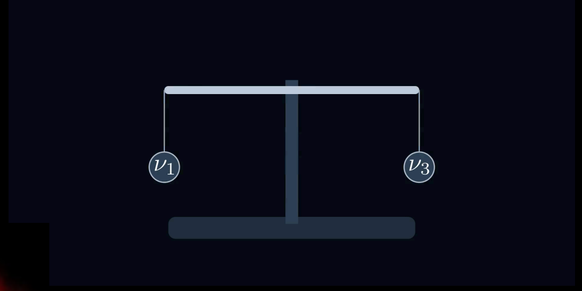
PI: **D.V. Naumov**, Deputies: **M.O. Gonchar, N.V. Anphimov**

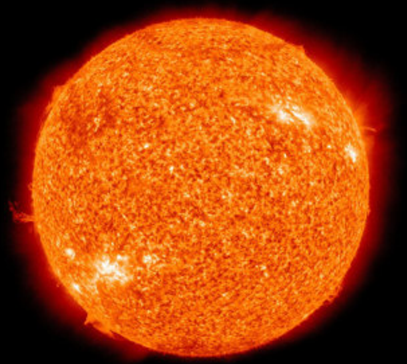
Team:19.3 FTE/33. Young scientists:18

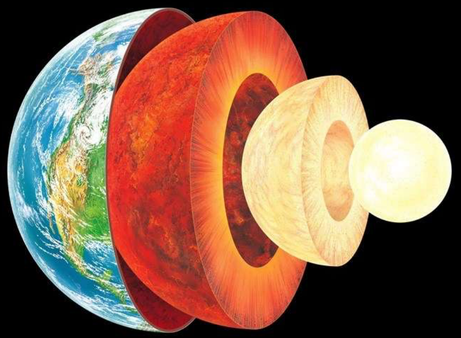
@JUNO

Institutional Board, Executive Board, Publication Committee
L2: PMT Instrumentation
Analysis Coordination Committee, Speaker’s Committee

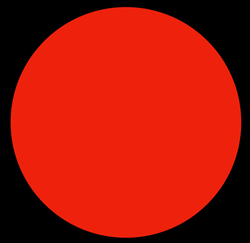
- ★ Neutrino Mass Ordering
- ★ Solar
- ★ Geo
- ★ SuperNOVA
- ★ Atmospheric
- ★ Proton decay

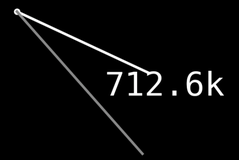












Achievements

10 years after: successful filling and commissioning of 20 kton liquid scintillator detector

JINR contribution:

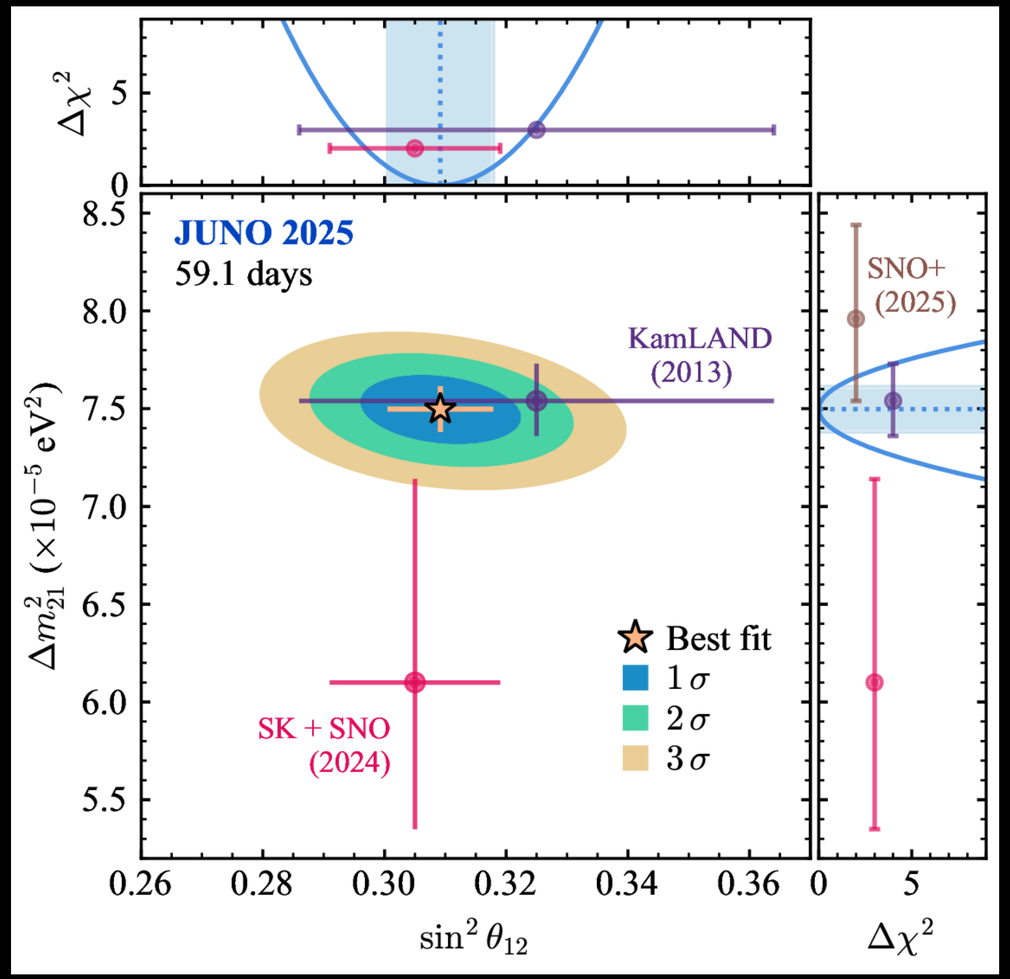
- ⋆ HV power units for 20000 large photomultipliers (LPMT) and 25000 small photomultipliers.
- ⋆ LPMT characterisation, mass testing.
- ⋆ μ-veto detector Top Tracker (TT): design of the structure, plastic scintillator (in-kind), assembly, DAQ implementation, monitoring.
- ⋆ Design of protection against Earth Magnetic Field for PMTs.
- ⋆ Detector installation, shifts.
- ⋆ TAO detector installation, SiPM testing, SiPM power supply.
- ⋆ Contribution to the Distributed Computing Infrastructure.

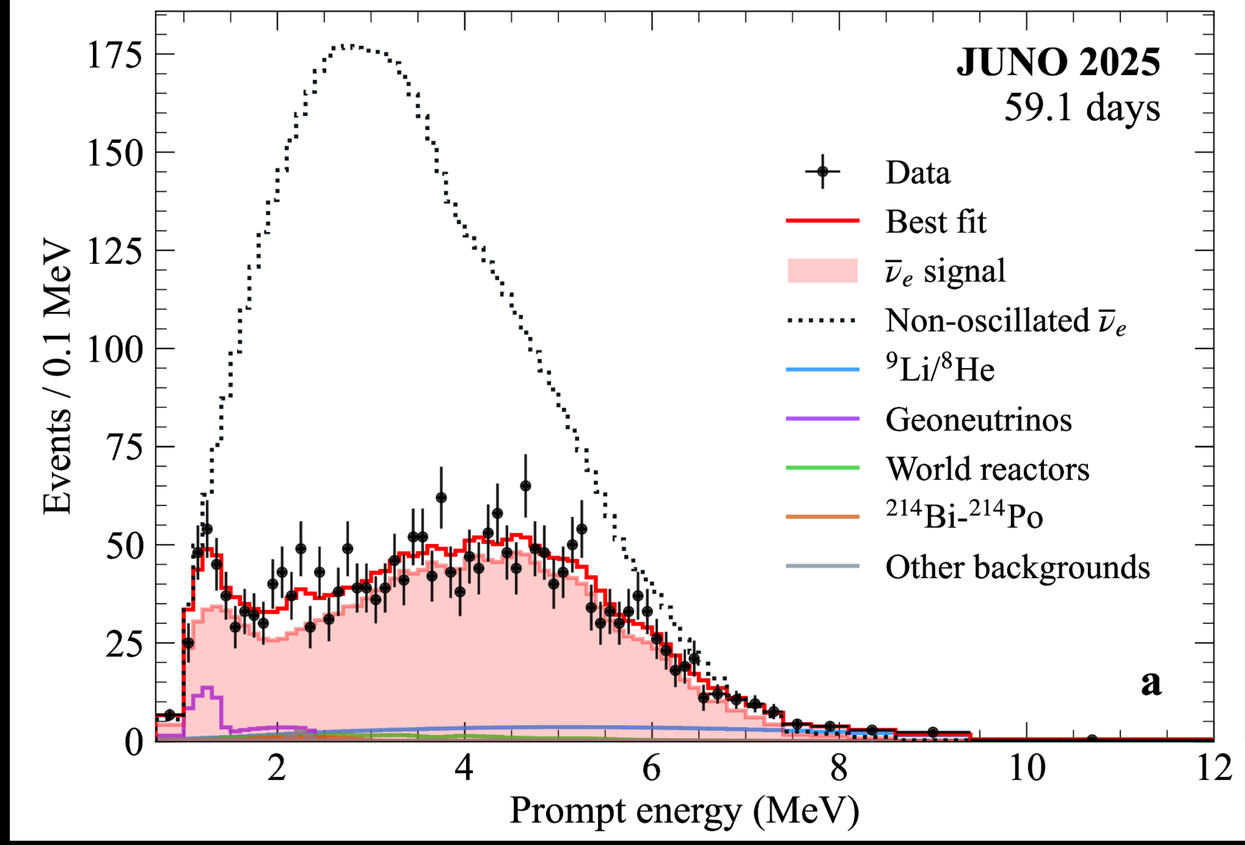
Major results

- World's best measurement with 59.1 days of data:

$$\sin^2\theta_{12} = 0.3092 \pm 0.0087 \quad (2.8\%)$$

$$\Delta m^2_{21} = (7.50 \pm 0.12) \times 10^{-5}\text{eV}^2 \quad (1.6\%)$$





- Stable operation.
- Outstanding detector performance:
  - energy non-uniformity within 1% (<16 m)
  - energy non-linearity uncertainty within 1%
  - energy resolution σ=3.4% at ~1 MeV
- Low background: 15% with ~40 anti-ν/day.
- Consistent analysis results by 3 independent groups.
- Daya Bay near detector data (Zenodo) → constraint for the reactor antineutrino spectrum.

JINR contribution to analysis and operation:

- Muon track reconstruction.
- IBD candidates event selection. Efficiency calculation, background estimation.
- Study of the uniformity of detector response.
- Development of the fitters for combined JUNO + Daya Bay (near) measurement:
  - Open fitter for Daya Bay data: https://pypi.org/project/dayabay-model/
  - Fitter for JUNO.
- Sensitivity estimation and oscillation analysis.
- Data Quality monitoring web-site.
- Shifts.

PhD theses to-be-defended (2026):

- Dmitry Dolzhikov: “Study of the stability of the Daya Bay detectors and measurement of neutrino oscillation parameters in JUNO”.
- Vitalii Zavadskyi: “Search for sterile neutrino in the Daya Bay experiment and Full Daya Bay data release.”

Papers:

- First measurement of reactor neutrino oscillations at JUNO e-Print: 2511.14593 [hep-ex]. Accepted to journal.
- Initial performance results of the JUNO detector e-Print: 2511.14590 [hep-ex]. Accepted to Chin.Phys.C.
- Simulation of the background from $^{13}C(\alpha,n)^{16}O$ reaction in the JUNO scintillator. Eur.Phys.J.C 85 (2025).
- Potential to identify neutrino mass ordering with reactor antineutrinos at JUNO. Chin.Phys.C 49 (2025).

Accelerated neutrinos: Energy frontier & flavor physics

World-leading precision with accelerators

02-2-1099-4-2026/2028

Study of neutrino properties in accelerator experiments

@JINR

PI: **L.D. Kolupaeva**, **A.G. Olshevski**,

Deputies: **Yu. A. Gornushkin, O.B. Samoylov**

Team: 23.7 FTE/46.

@NOvA

three-flavor analysis convener, exotics convener

@DsTau

collaboration board chair

Science case

NOvA and T2K:
— MO and precision measurement of lepton mixing in neutrino oscillations

DsTau:
— ν_τ production

FASER:
— measurement of ν-nucleus cross-sections for neutrino energies in $(350\,\mathrm{GeV} - 7\,\mathrm{TeV})$

PhD Theses

— **4** defended
— **5** soon to-be-defended

JINR contribution:

— Methodological detector contributions
— Computing resources
— Data analyses

NOvA:

- Three-flavor oscillation analysis
  - NOvA-T2K joint analysis
- supernova neutrino trigger and analysis
- magnetic monopole search
- high-energy muon spectra
- atmospheric neutrino oscillations
- theory of neutrino interactions

T2K:

- Search for axion-like particles,
- systematic uncertainties evaluation,
- Event reconstruction with Machine Learning,
- theory of neutrino interactions.

DsTau, Faser:

- Data analysis
- High track density processing

Major results@NOvA

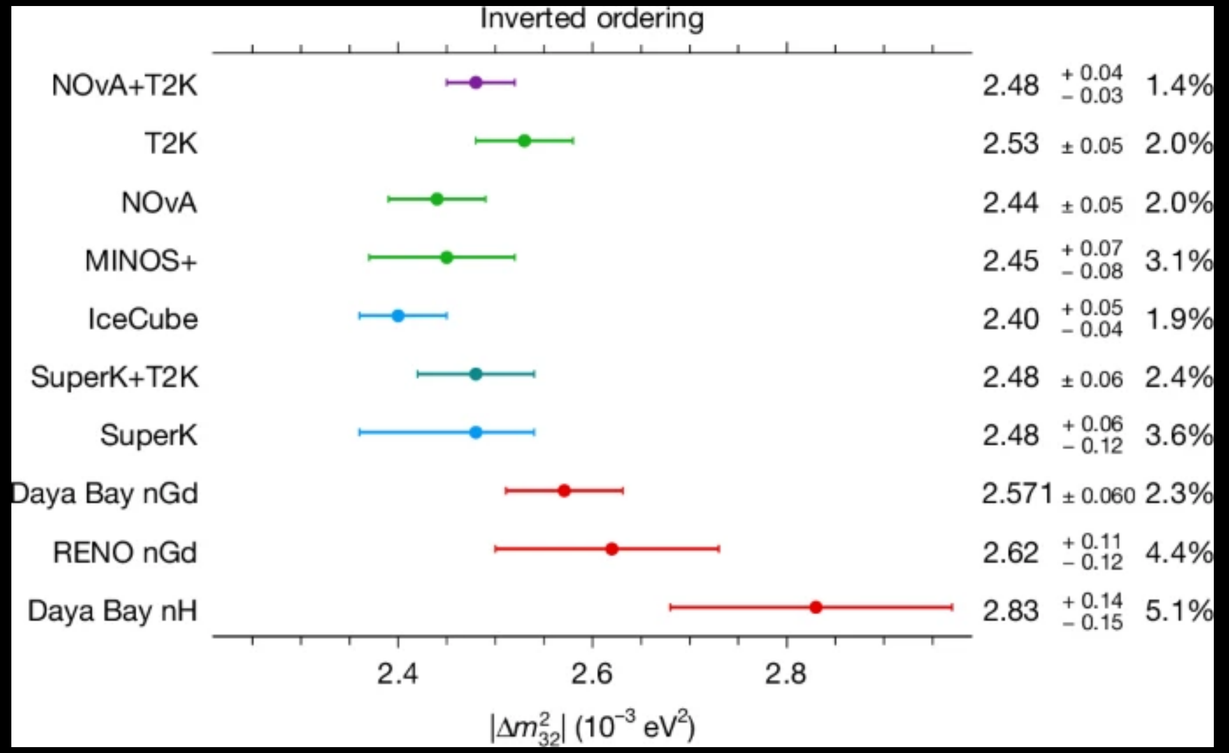
- The first joint analysis of datasets from NOvA and T2K:

$$\Delta m^2_{32} = \quad 2.43^{+0.04}_{-0.03} \times 10^{-3}\text{eV}^2 \quad \text{(NO)}$$

$$\Delta m^2_{32} = -2.48^{+0.03}_{-0.04} \times 10^{-3}\text{eV}^2 \quad \text{(IO)}$$

- No preference for mass ordering (MO)

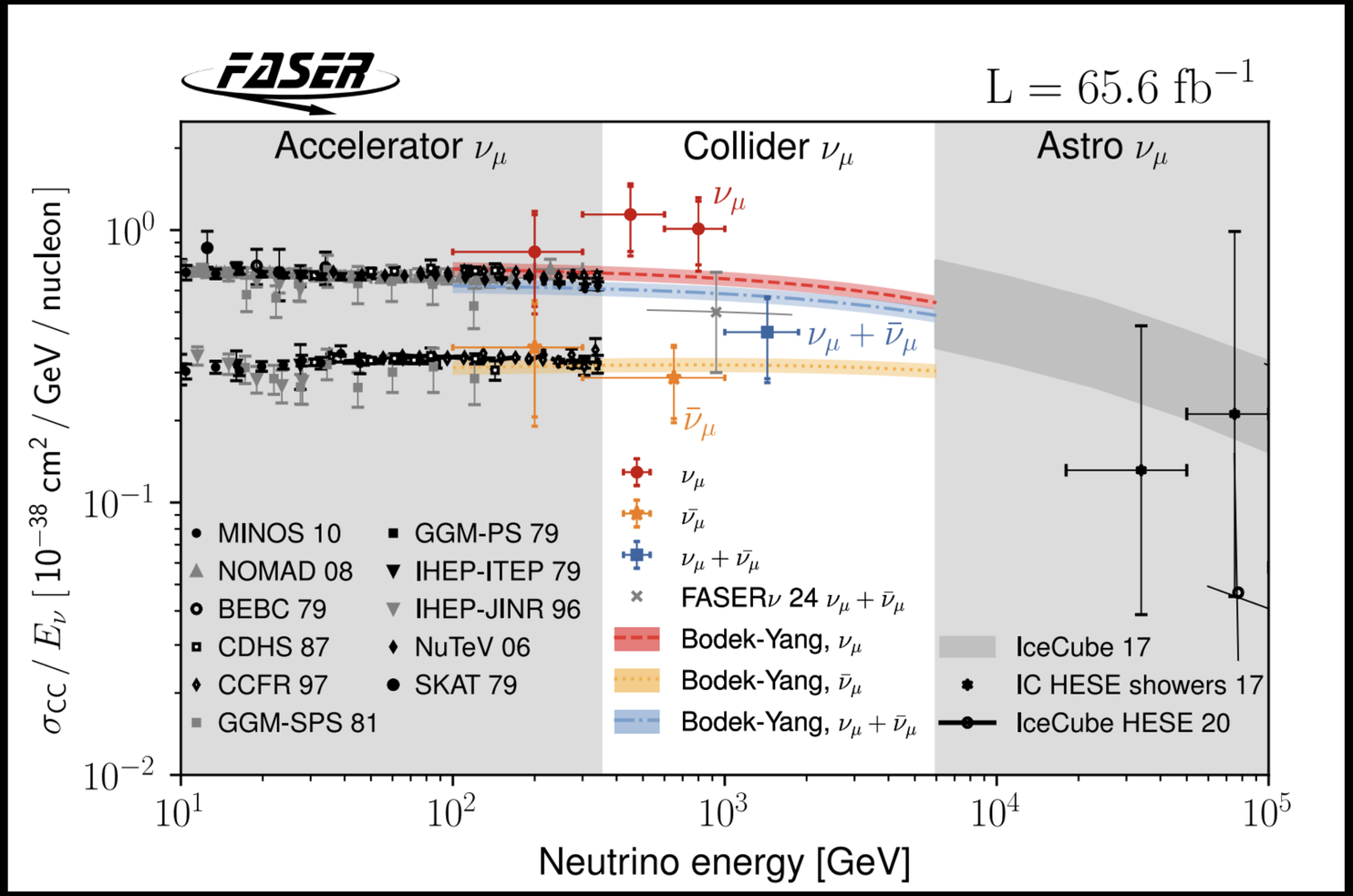
- Assuming inverted MO, evidence for CP violation (significance $> 3\sigma$)



Nature 646, 818–824 (2025)

Major results@FASER

- First measurement of ν_μ cross-section and flux in neutrino energy interval $(350\,\mathrm{GeV} - 7\,\mathrm{TeV})$
- New limits on the production of axion-like and other exotic particles that decay into photons.



Phys.Rev.Lett. 134 (2025) 21, 211801
JHEP 01 (2025) 199

Astrophysics:
Scale & discovery potential

Multi-messenger astronomy

02-2-1099-3-2015/2026

TAIGA Experiment

@JINR

PI: A. Borodin

Deputy

Team: XX FTE/11

Science case

Study γ & CR in $\left(10^{13} - 10^{18}\right)$ eV

— search for PeVtrons,

— CR mass composition,

anisotropy in $(100 - 3000)$ TeV

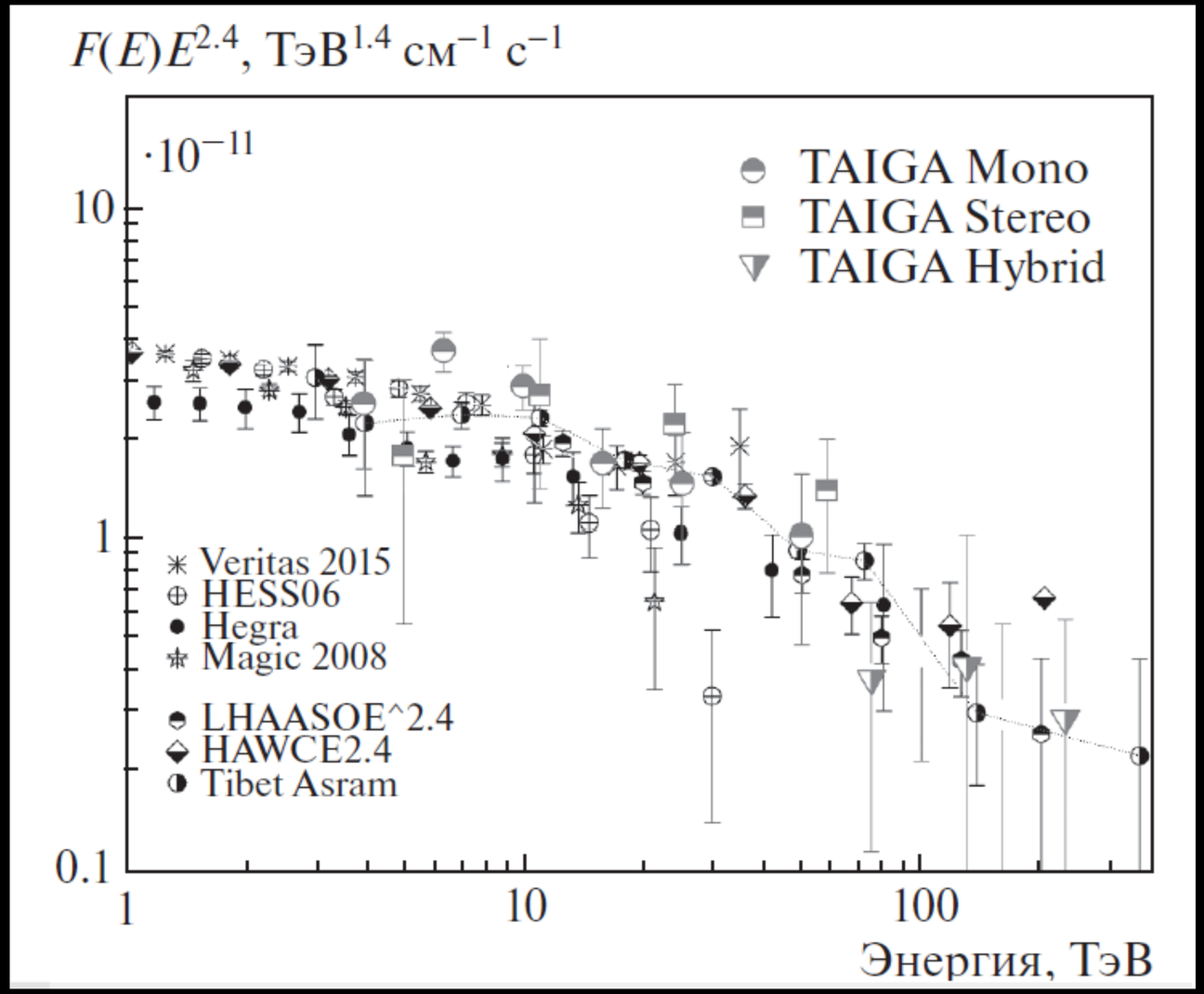


JINR contribution:

- ★ Production of atmospheric Cherenkov gamma telescopes (IACT).
- ★ Serial production and upgrade of IACT mirrors; development of lightweight composite mirror technology.
- ★ MC simulation of the TAIGA IACT performance and optimization of gamma/hadron separation.

Major results

- ⋆ TAIGA Observatory operates **four** 4.5-m IACTs; the **fifth** is installed and will be commissioned in **2026**.
- ⋆ Muon detector prototype launched; full **TAIGA-100 prototype** deployment expected in **2026** (4 muon detectors + 49 wide-angle Cherenkov stations).
- ⋆ Key publications: spectrum of the **light cosmic-ray component**, **Crab gamma-ray spectrum**, and the **TAIGA-100 project** description



02-2-1148-3-2010/2028

Baikal-GVD

@JINR

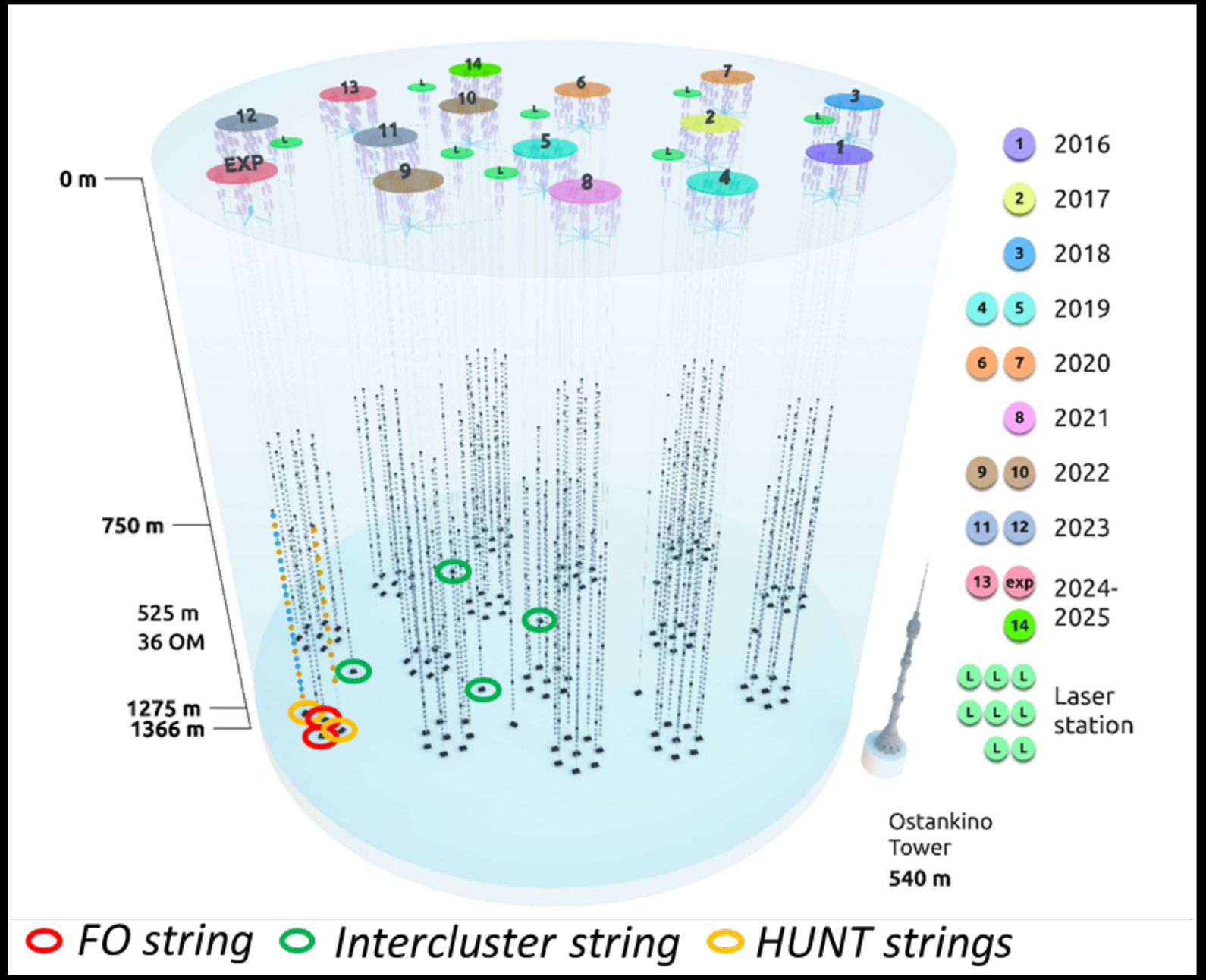
PI: I. A. Belolaptikov

Deputy S. V. Rozov

Team: 35 FTE/45

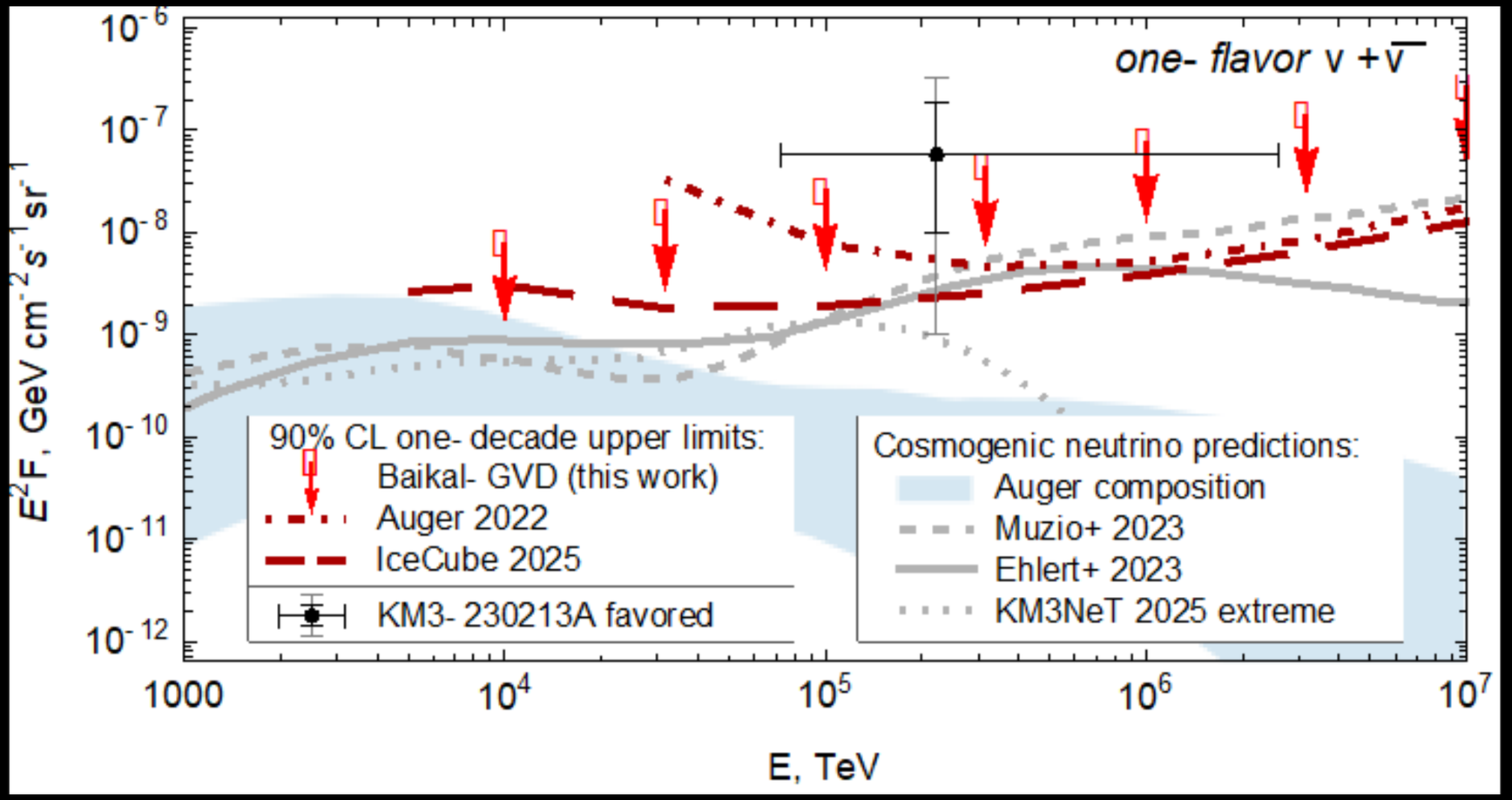
By 2025:

- ★ Installed:14 full clusters.
- ★ About 4,300 photodetectors.



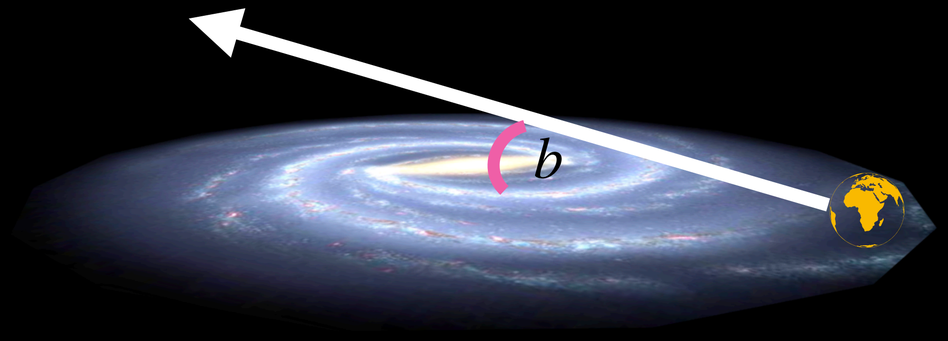
Total: 4284 OM + 8 laser stations

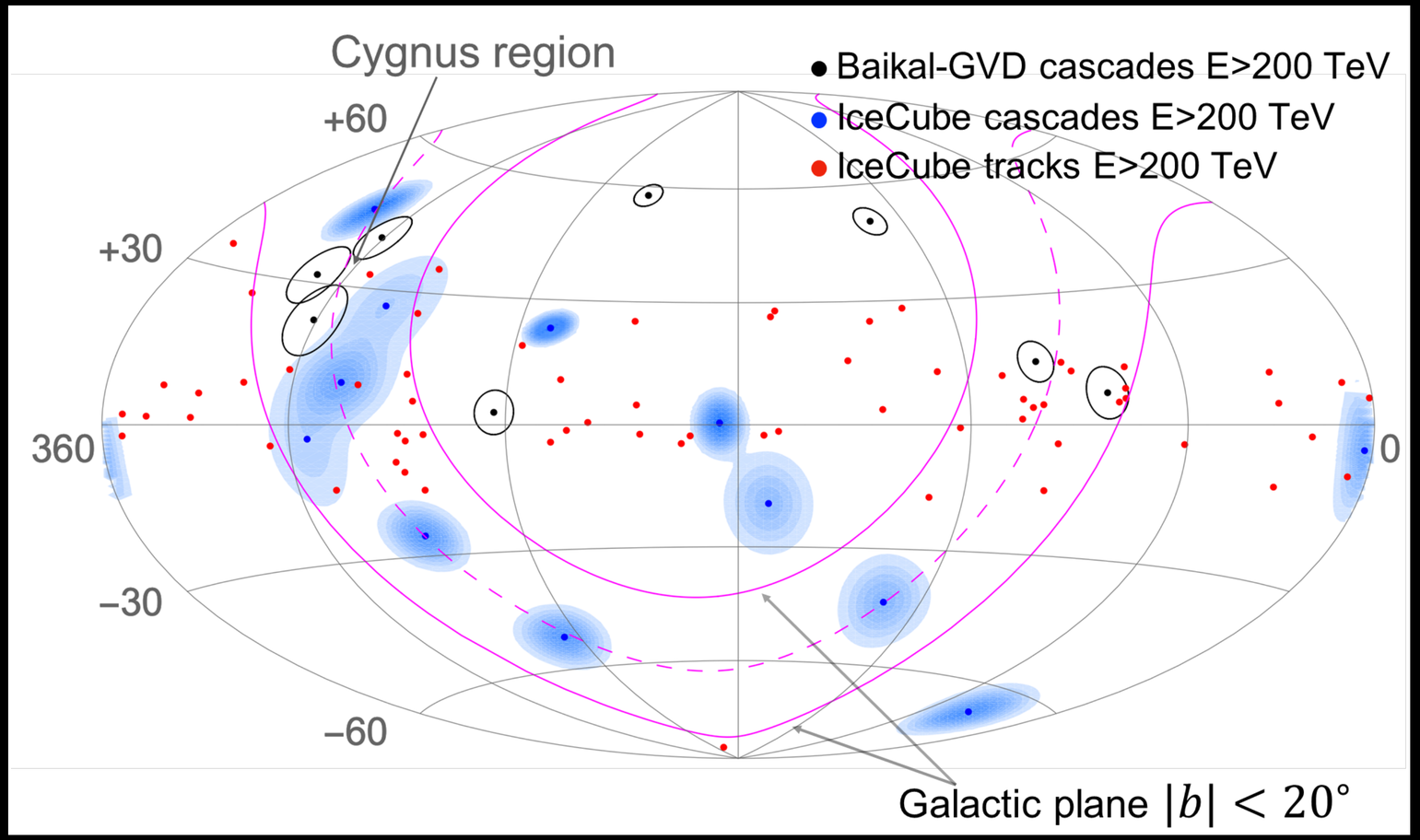
Major results



- Six years of Baikal-GVD data, a 90% C.L. upper limit on the cosmogenic neutrino flux was set.
- A joint IceCube–PAO–Baikal-GVD–KM3NeT analysis constrains the UHE neutrino flux, consistent with a flavour-balanced composition in the 72 PeV–2.6 EeV range.

Major results





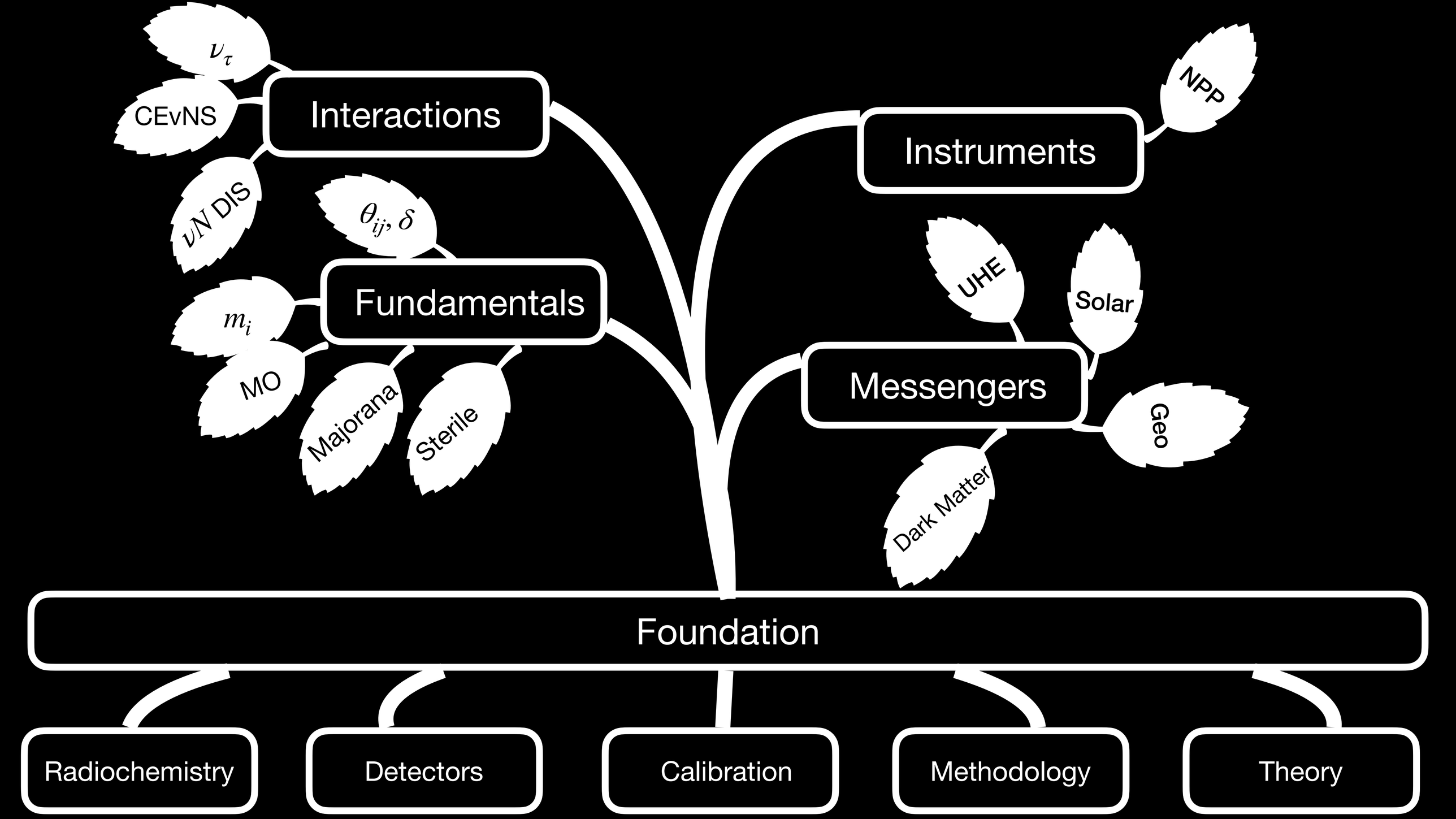
- ★ Baikal-GVD cascade data (2018–2023) indicate a Galactic neutrino component above 200 TeV at 2.5 σ;
- ★ a joint Baikal-GVD + IceCube analysis increases the significance to 3.6 σ.

2026 Expedition

- Ready for deployment 900 optical modules
- Install
  - 2 new clusters,
  - 2 additional inter-cluster strings
  - 1 prototype string for the next generation detector

Publications

1. Probing the Galactic neutrino flux at neutrino energies above 200 TeV with the Baikal Gigaton Volume Detector // V.A. Allakhverdyan [et al.] (Baikal-GVD Collaboration) and Y. Y. Kovalev, A. V. Plavin, D. V. Semikoz, S. V. Troitsky // Astrophys.J. - 2025. -V.982. -Is. 2. -P. 73// DOI: 10.3847/1538-4357/adb630.
2. Constraints on the diffuse flux of multi-PeV astrophysical neutrinos obtained with the Baikal Gigaton Volume Detector// V.A. Allakhverdyan [et al.] (Baikal-GVD Collaboration) and A.V. Plavin, D. V. Semikoz, S. V. Troitsky // Phys. Rev. D – 2025. –V.112. –P. 083025 //DOI: https://doi.org/10.1103/jlz3-26lw.
3. Приборы и методы долговременного мониторинга гидрооптических характеристик глубинных вод оз. Байкал// А.В. Аврорин, А.Д. Аврорин, В.М. Айнутдинов [и др.] (Baikal-GVD Collaboration) // Оптика атмосферы и океана. – 2025. — Т.38. –Вып.5. -УДК 551.463.3 //DOI: 10.15372/AOO20250506
4. Применение инерциальной системы позиционирования для оценки координат и ориентации оптических модулей глубоководного телескопа BAIKAL-GVD // А.В. Аврорин, А.Д. Аврорин, В.М. Айнутдинов [и др.] (Baikal-GVD Collaboration) // Приборы и техника эксперимента. – 2025. — Вып.3. –С.12 -УДК 539.123.
5. // DOI:http://iet.ras.ru/2025/3/pub/12.pdf
6. Design and Implementation of the Fast Data Processing System for the Baikal-GVD Neutrino Telescope// V.A. Allakhverdyan [et al.] (Baikal-GVD Collaboration) // e-Print: 2511.03438 [astro-ph]. –2025. //DOI: https://doi.org/10.48550/arXiv.2511.038438 In publication JINST


ν_τ
CEvNS
Interactions
νN DIS
θ_{ij}, δ
Fundamentals
m_i
MO
Majorana
Sterile
NPP
Instruments
UHE
Solar
Messengers
Geo
Dark Matter
Foundation
Radiochemistry
Detectors
Calibration
Methodology
Theory