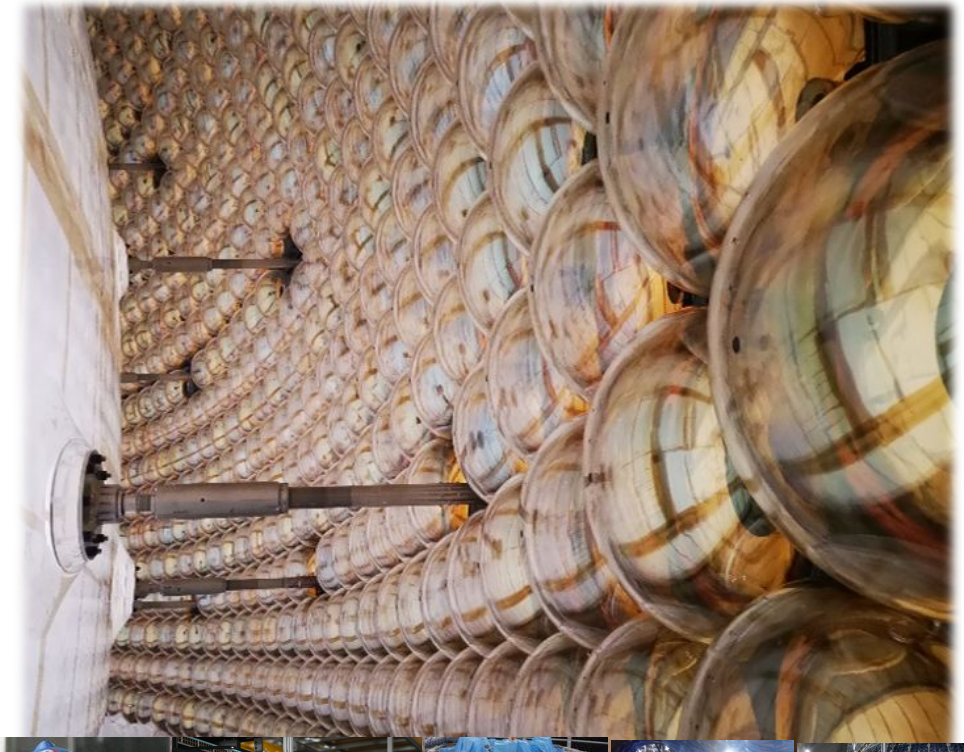
IIHE annual meeting, 5 November, 2026

JUNO Neutrino Experiment @IIHE

Barbara Clerbaux, Marta Colomer,
Amina Khatun, Alfonso Lazo, Yifan Yang
MA2: Diel Chedjou, Nafiz Ahmed,
Lucas Mangez, Emma Desomberg







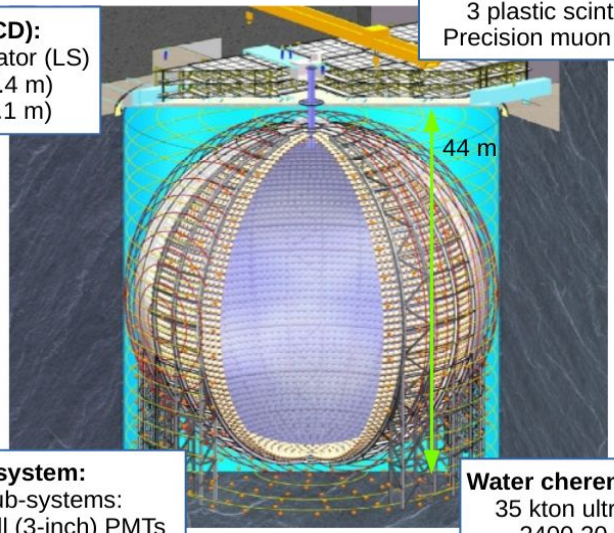
JUNO at a glance

Main goals :

- determining the neutrino mass ordering
- precision measurement of the oscillation parameters (Δm^2_{12}, $\sin^2\theta_{21}$ and Δm^2_{31})

Central detector (CD):
20 kton of Liquid Scintillator (LS)
Accrylic vessel (ϕ 35.4 m)
Steel structure (ϕ 40.1 m)

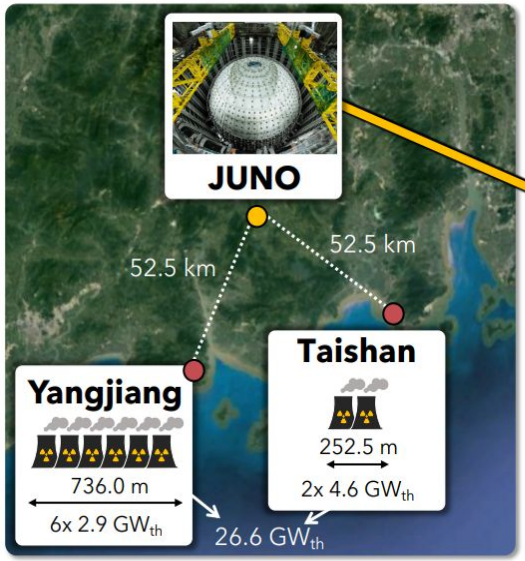
Top Tracker:
3 plastic scintillator layers
Precision muon tagging (veto)

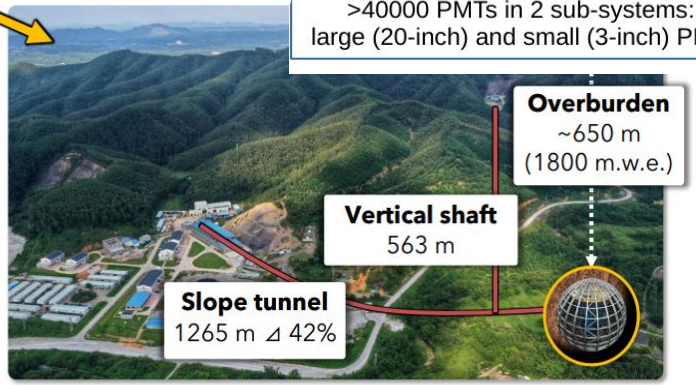




Light detection system:
>40000 PMTs in 2 sub-systems:
large (20-inch) and small (3-inch) PMTs

Water cherenkov detector:
35 kton ultra-pure water
2400 20-inch PMTs





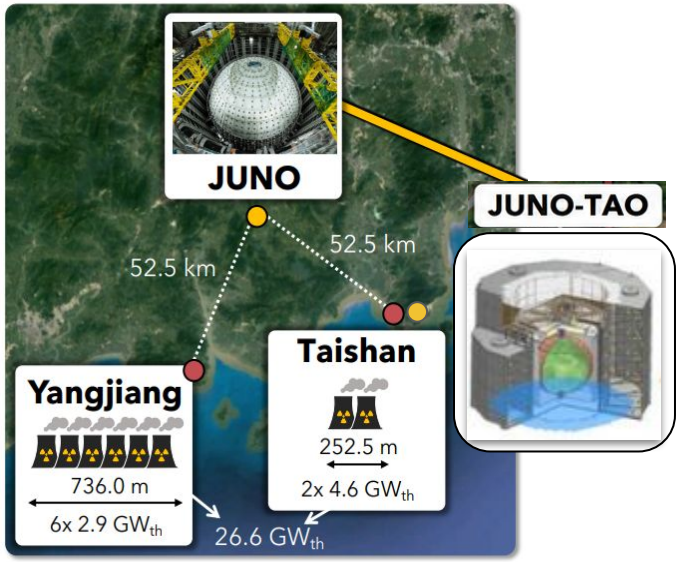
Started data taking in August 2025



The JUNO satellite detector (TAO)

Main goals :

- Constrain the unoscillated reactor neutrino flux for JUNO
- U/Pu neutrino spectrum measurement with improved precision
- 5 MeV “Bump” investigation and Fine Structure observation
- Sterile neutrinos and other BSM physics



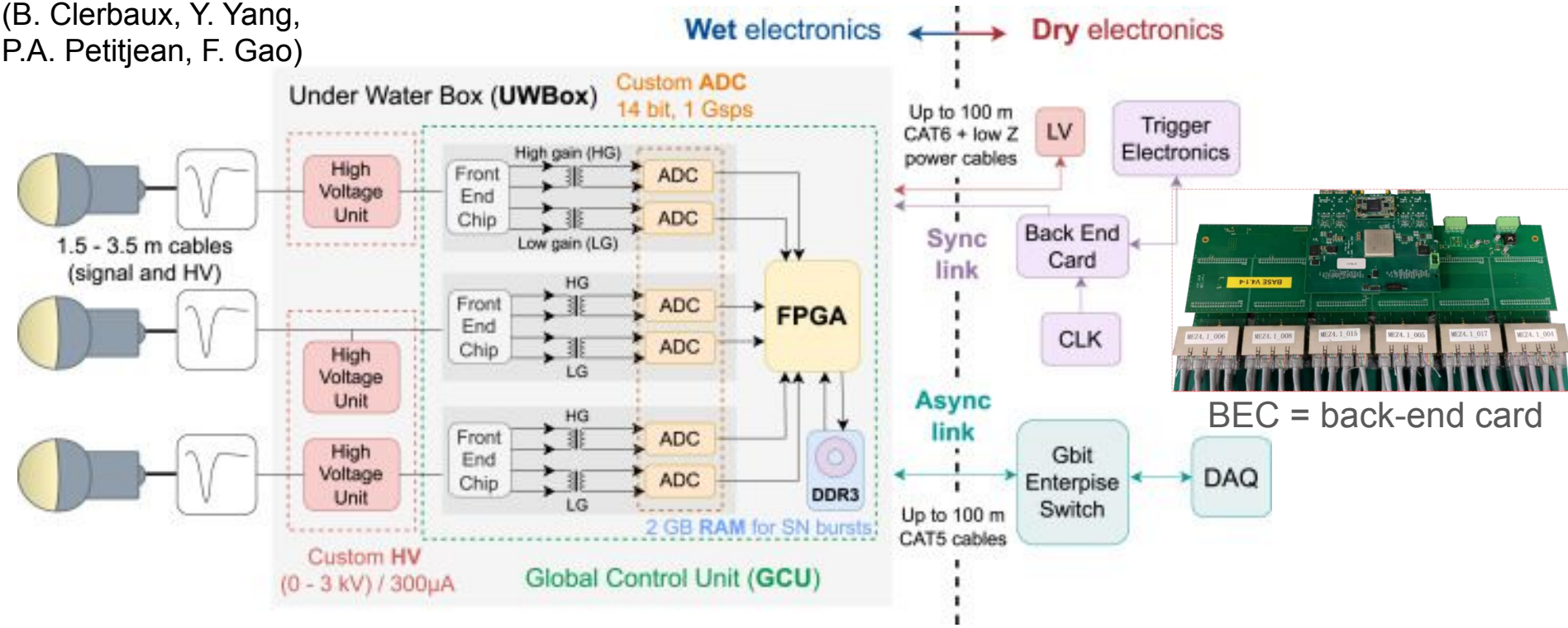
JUNO-TAO
Satellite experiment of JUNO
Short Baseline (43.2 m)
Small-scale (⌀= 1.8m):
2.8 ton LS - dopped with Gd
New technology:
Low temperature LS - SiPMs

Started data taking in February 2026



JUNO electronics readout: IIHE involvement

(B. Clerbaux, Y. Yang,
P.A. Petitjean, F. Gao)



- IIHE responsible for the design, testing and production of the JUNO BECs
- BECs provide direct links between underwater electronics and the trigger system
- N. Ahmed (MA2-2027): streaming raw waveforms from GCU to BEC →optimize trigger



JUNO electronics & AI research

Y. Yang



Diagnostics Agent
N. Mahri (MA2–2026)

Automated fault-finding on GCU–BEC–RMU and data transmission links between them

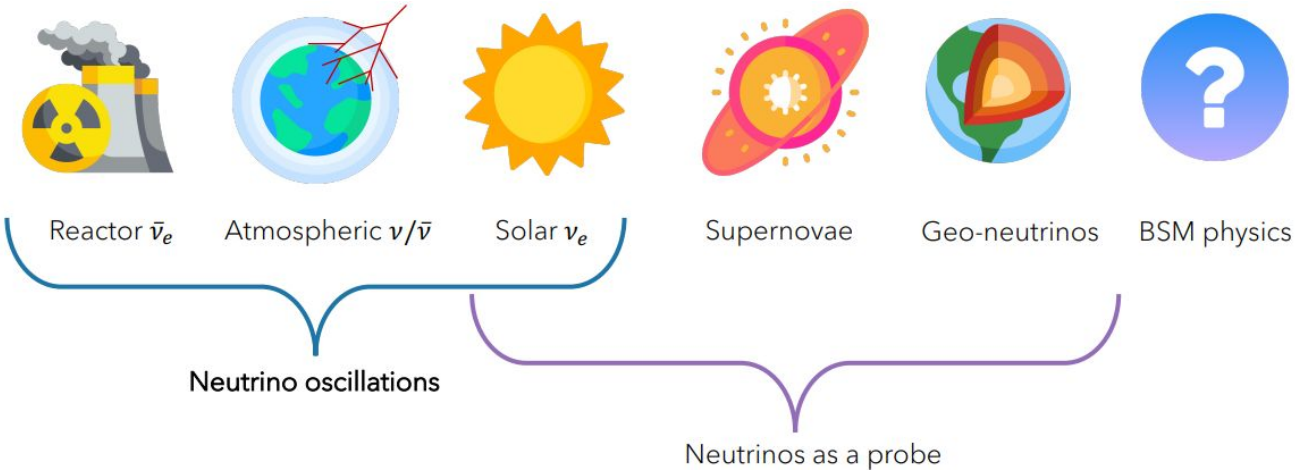


Generative AI for fast JUNO simulation
D. Chedjou (MA2–2027)

- ~1800 photon per MeV deposit
- 17612 PMTs reading photon hits

Model mapping particle input to trigger output (to PMT photon hits): End-to-end bypass GEANT+elecsim

JUNO physics program: IIHE involvement





- TAO data analysis: used for JUNO reactor analysis flux constraints (A. Lazo)
- Background evaluation: BiPo, fast-neutrons, double neutrons, atmospheric NC (A. Khatun, M. Colomer)
- Calibration: direct input for the detector response model in the JUNO reactor analysis (A. Khatun, A. Lazo, E. Descomberg, M. Colomer)



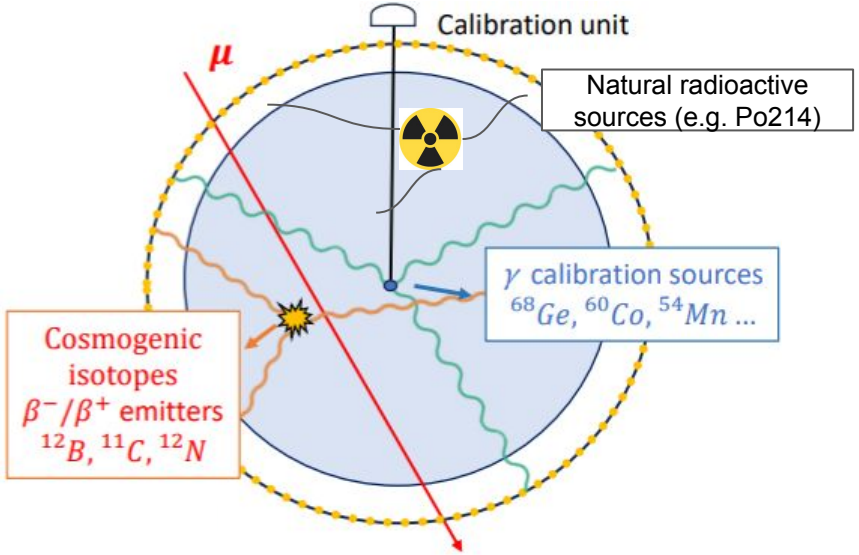
- Working group coordination (M. Colomer)
- Data analysis, fitter, reconstruction, calibration (A. Khatun, L. Mangez, M. Colomer)

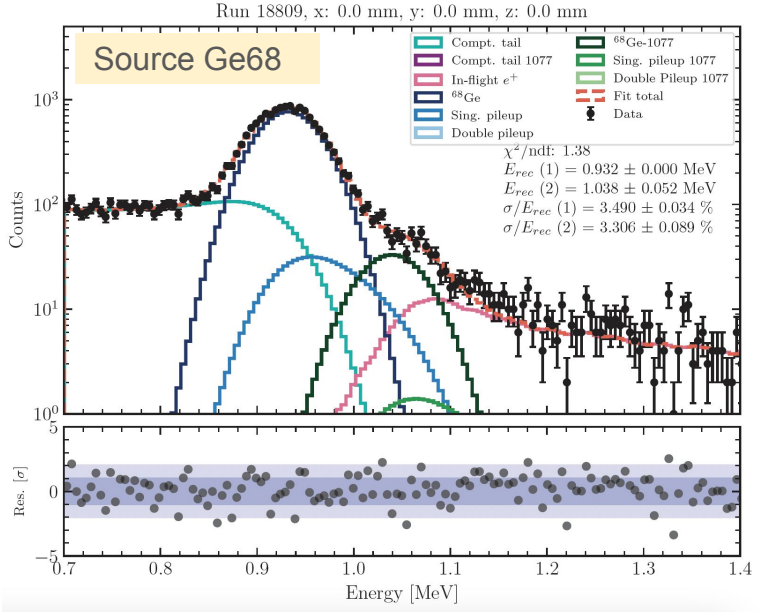


- Involved in review committees of DSNB and CCSN online monitor (M. Colomer)
- Expertise in the topic and contact with SNEWS network (M. Colomer - convener within SNEWS)



JUNO detector response: energy calibration





- Energy calibration in JUNO is key to achieve the physics goals (Eres ~3% @1MeV)
- Both artificial and natural sources are used to have the best detector response understanding

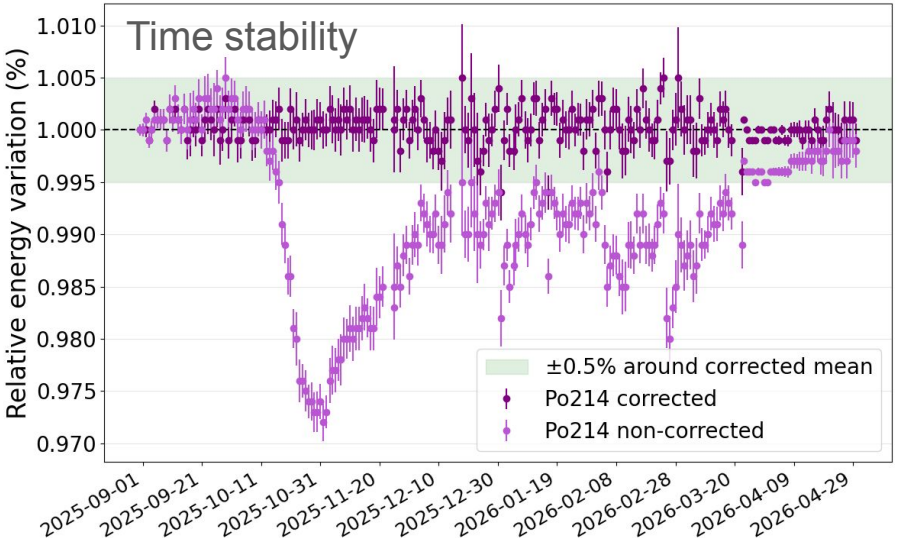
- Gamma calibration sources at known positions help understand light yield and resolution (Eres ~3.5% @1 MeV at detector center)
- Natural sources (β and α) provide continuous monitoring and isotropic standard candle



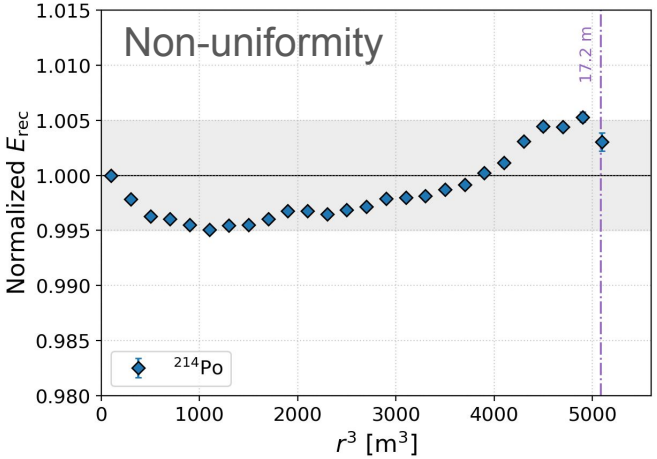
JUNO detector response: energy calibration

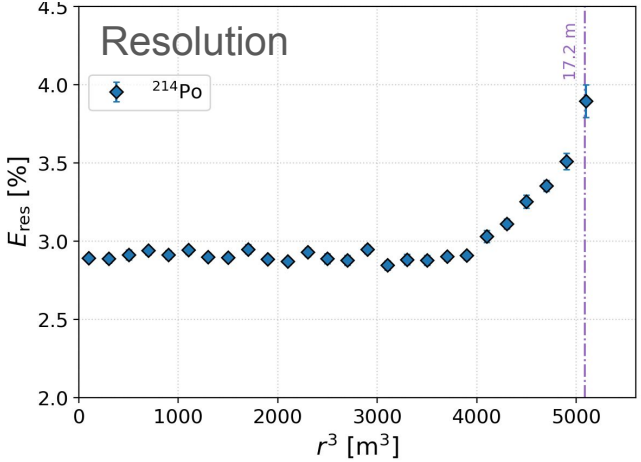
Calibration using Po214 (natural radioactivity):

- ***α*** particle with Evis~0.93 MeV



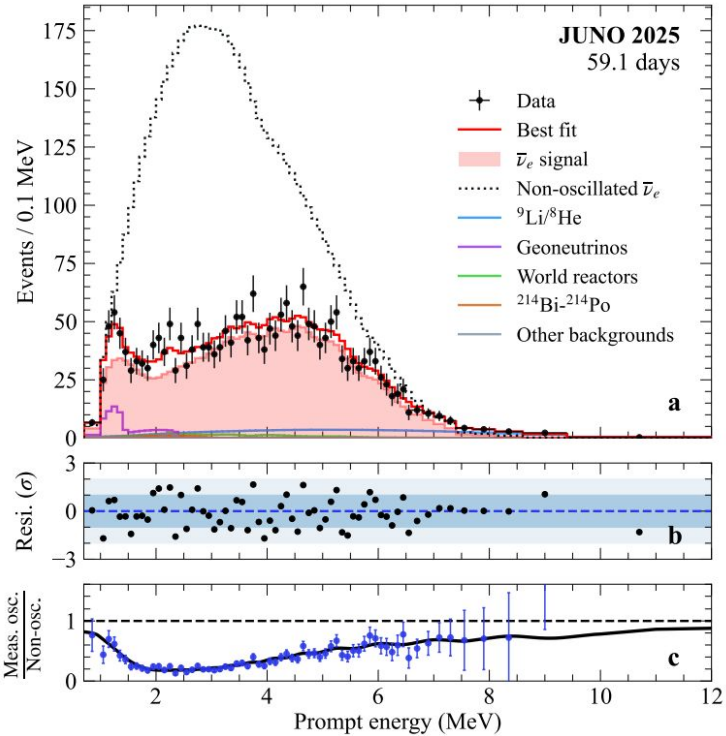
- Time variations: < +-0.5%
- Non-uniformity: < +-0.5%
- Resolution: ~2.9% (<3.5% at the borders)

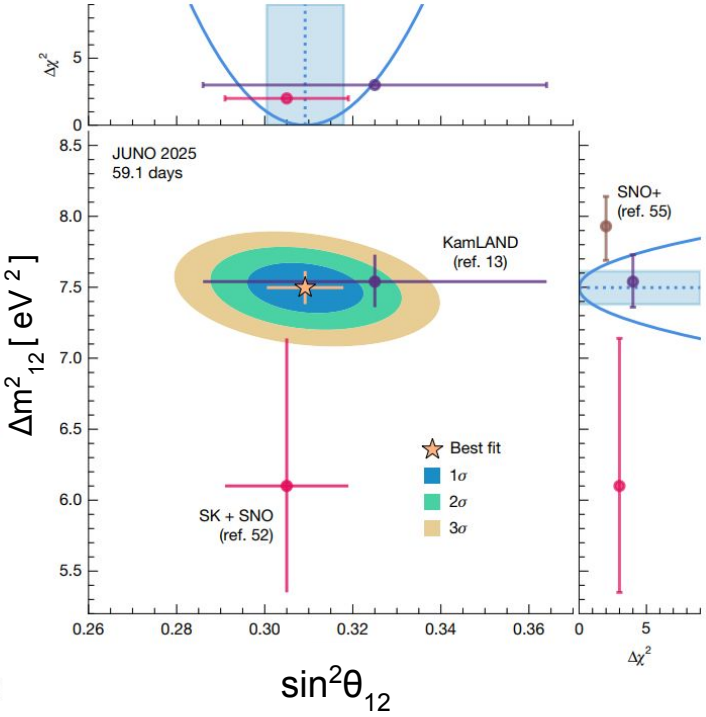




Highlights : reactor neutrino results (59 days)

- First results published in Nature 654, 343–348 (2026) with ~59 days of data
- World-leading measurement of two oscillation parameters:
  - Δm^2_{12} (2.5 -> 1.6%) and $\sin^2\theta_{12}$ (3.9 -> 2.8%)

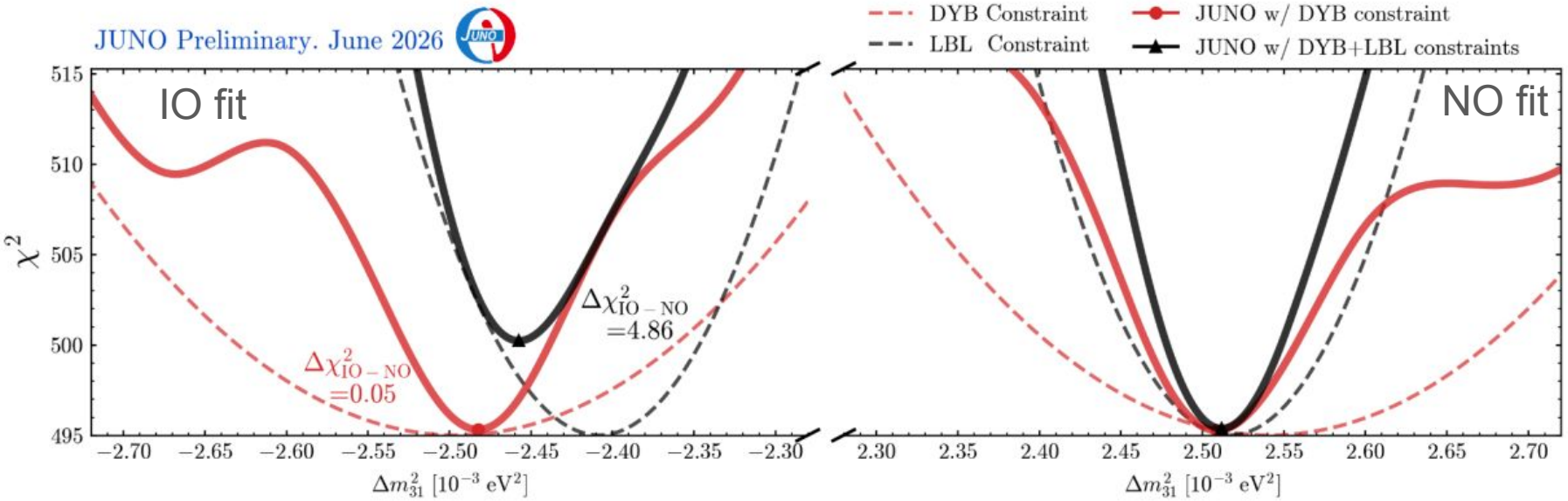






Highlights : reactor neutrino results (207 days)

- Updated results presented in Neutrino2026 and submitted for publication: https://arxiv.org/abs/2609.37895
- World-leading measurement of three oscillation parameters:
  - Δm^2_{12} (1.6 -> 1.1%), $\sin^2\theta_{21}$ (2.8 -> 2.1%) and Δm^2_{31} (~1.4 -> ~1%)
- First evidences of the neutrino mass ordering:
  - Normal ordering favored at 2.1 σ with NuFit LBL (NovA+T2K) + DayaBay constraints

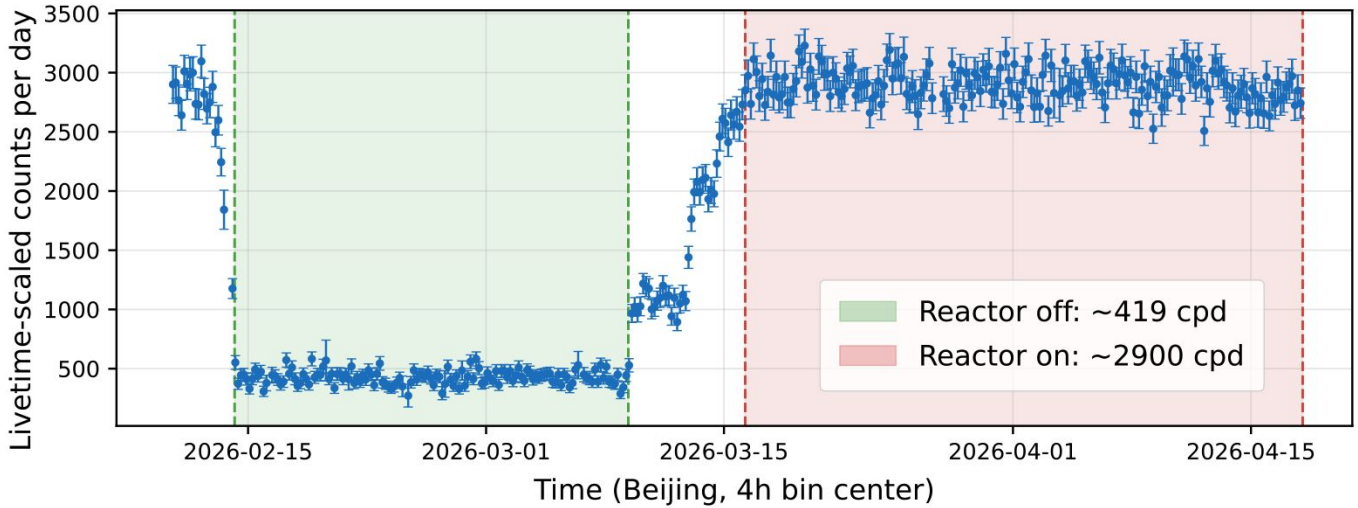


Highlights : TAO reactor neutrino spectra

A. Lazo

First JUNO-TAO results with ~30 days of reactor-on data

https://arxiv.org/abs/2610.23331

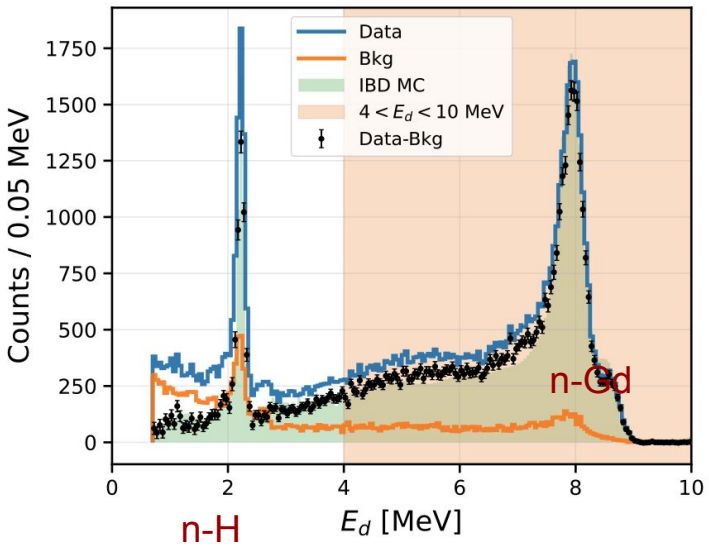


- Reactor-off data : data-driven background
- Reactor-on data : IBDs reactor analysis (physics)
- All : detector response

Highlights : TAO reactor neutrino spectra

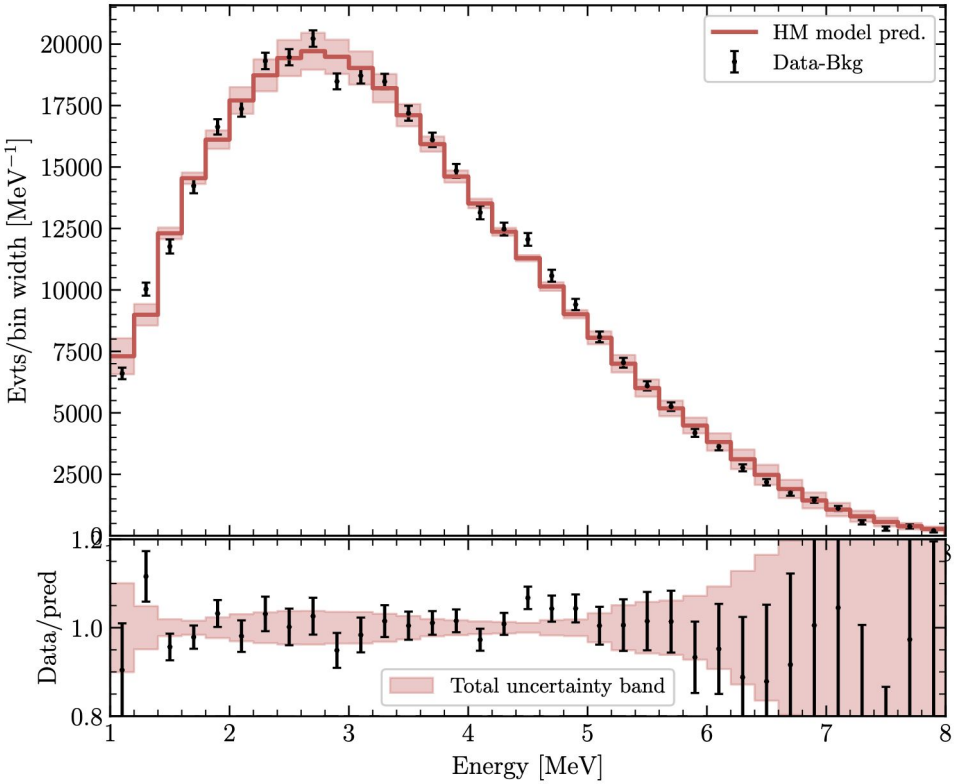
A. Lazo

Reconstructed energy of delayed signal:



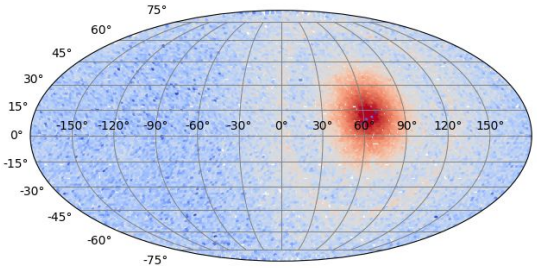
Small detector →energy leakage

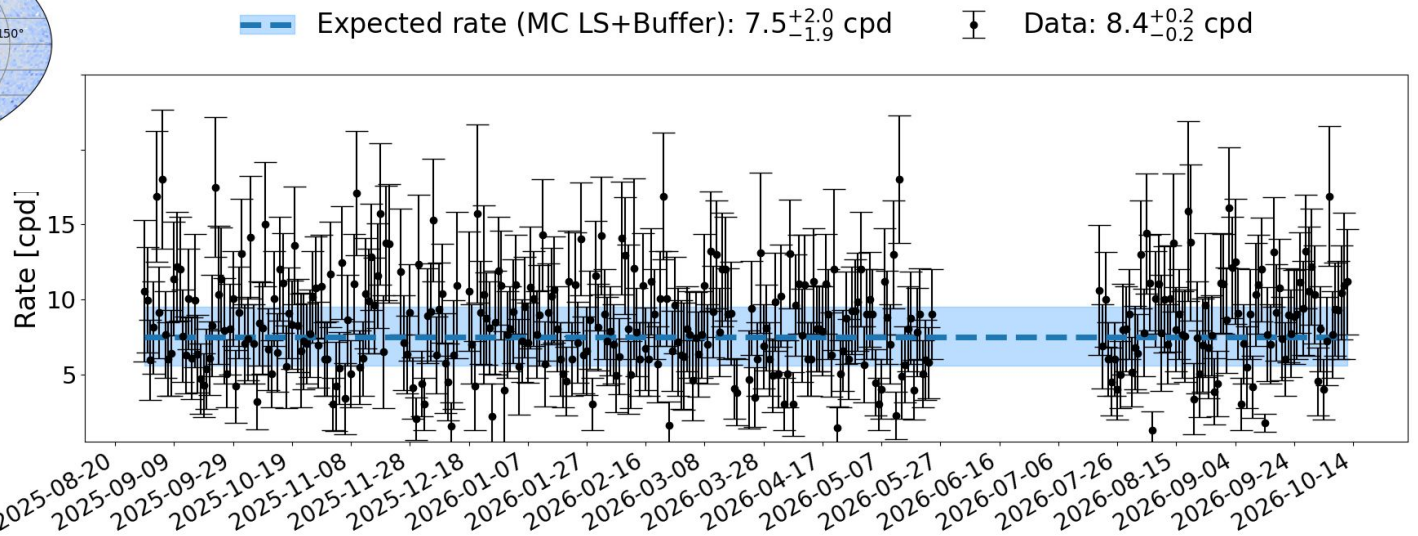
Reconstructed IBD prompt signal spectrum:



Highlights : atmospheric neutrino results

A. Khatun
M. colomer

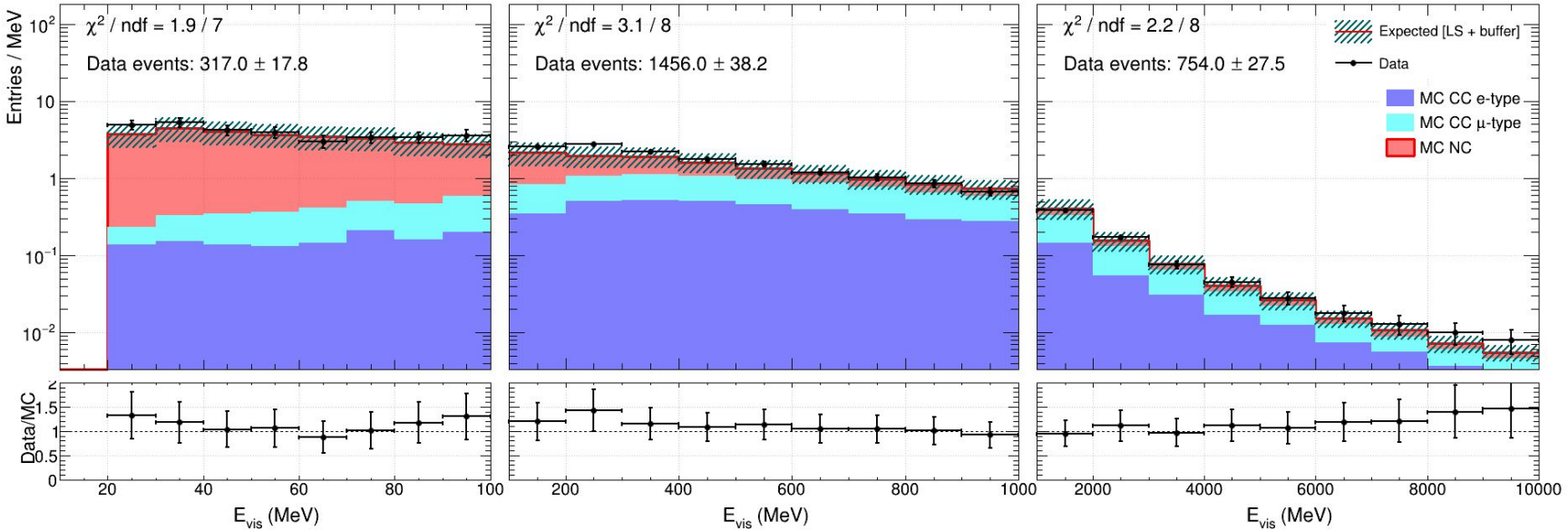




- First atmospheric neutrino sample in LS experiment:
  - ~2500 events in ~300 days with Evisible [20 MeV;10 GeV]
- Consistent rate with expectation, stable over data taking (daily basis)

Highlights : atmospheric neutrino results

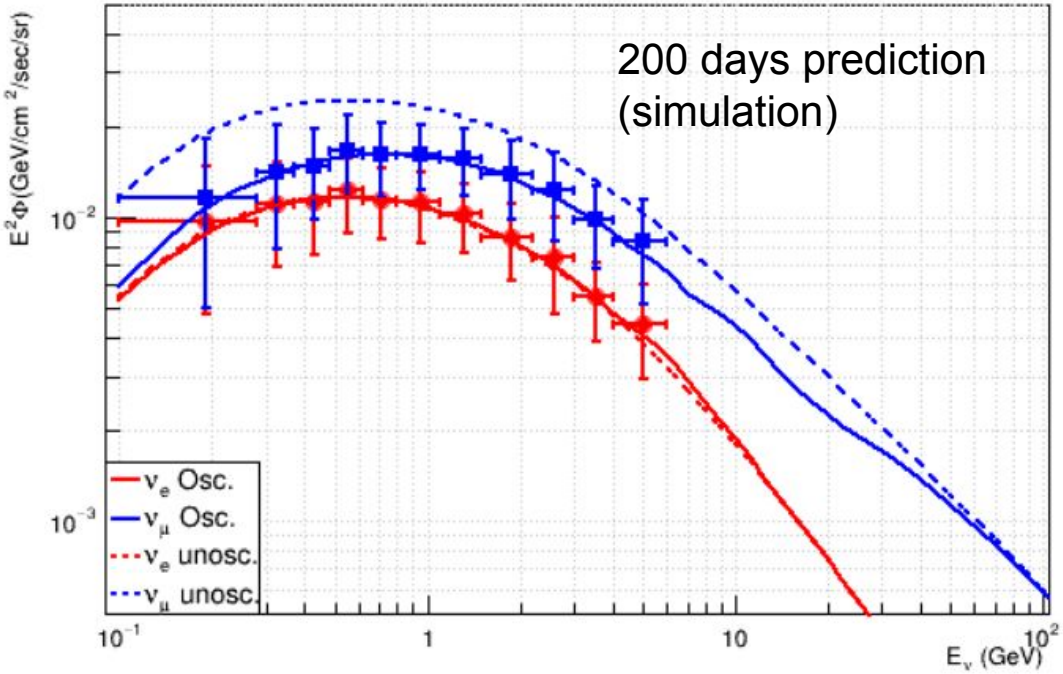
A. Khatun
M. colomer



- First atmospheric neutrino spectra measurement:
  - ~2500 events in ~300 days with Evisible [20 MeV;10 GeV]
- Consistent with model prediction within uncertainties
  - Ongoing work: complete detector response related systematics

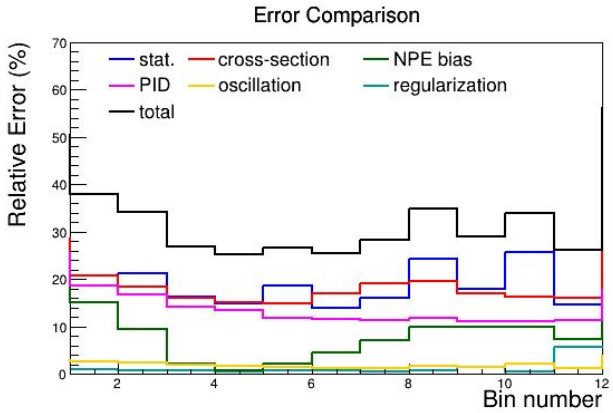
Towards first atmospheric neutrino physics

From measured spectra to unfolded physical flux:



Soon: analysis on data → flux measurement

- Asimov monte-carlo study finalized : promising capabilities (A. Khatun)
- Working on reconstruction and flavor separation: T. Bruffaerts (MA2-2026), L. Mangez (MA2-2027), M. Colomer
- Systematics budget (A. Khatun):
  - Stats and cross-section dominate, PID follows



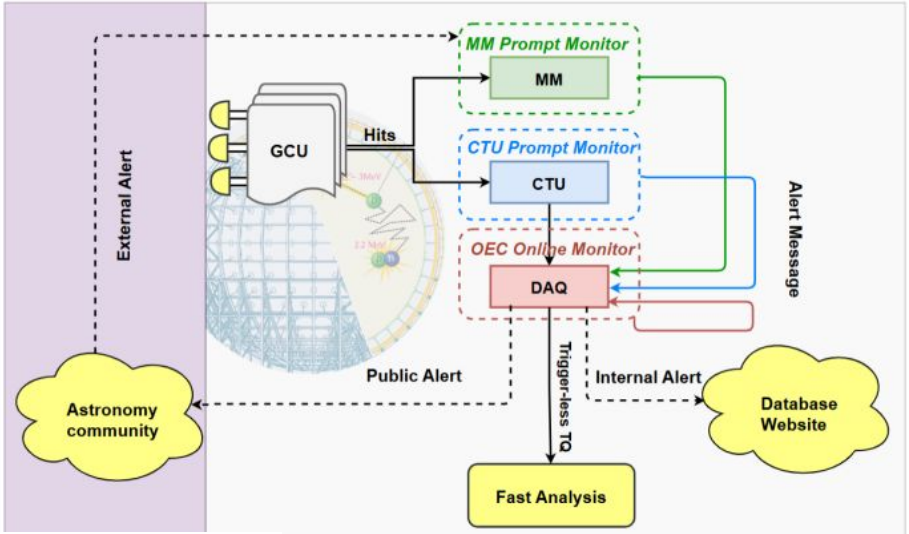
Highlights : Supernova burst monitoring status

Three monitors in place in JUNO:

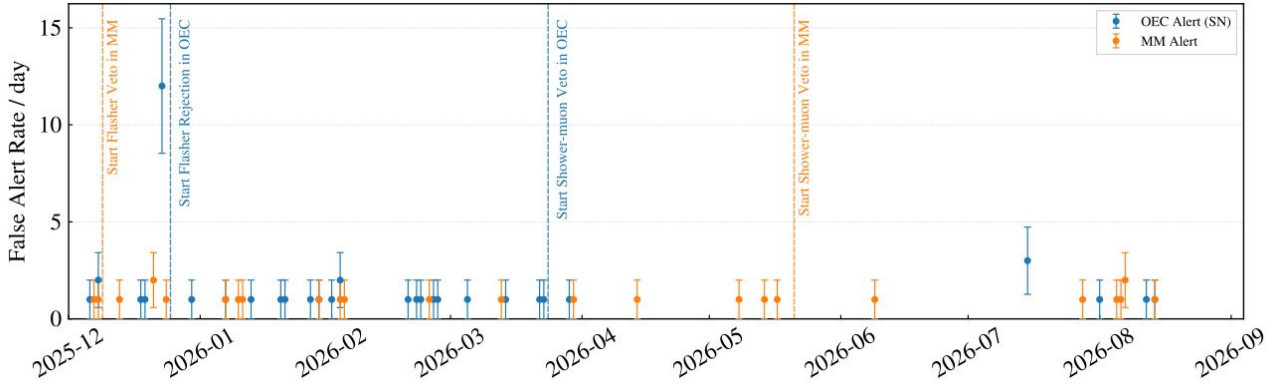
- Online Monitor (OEC) at DAQ stage:
  - Uses fast reconstruction information
- Multi-messenger (MM) monitor at CPU level
  - Uses raw PMT hit information
- Prompt Monitor at the Central Trigger Unit (CTU) stage
  - Under commissioning, too many false alerts

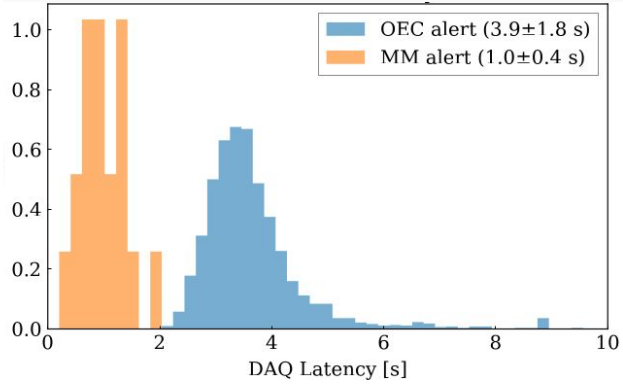
OEC and MM triggers running and sending alerts to SNEWS since Nov. 2025:

- False Alert Rate: ~1/ 3 months
- Livetime coverage: >99%

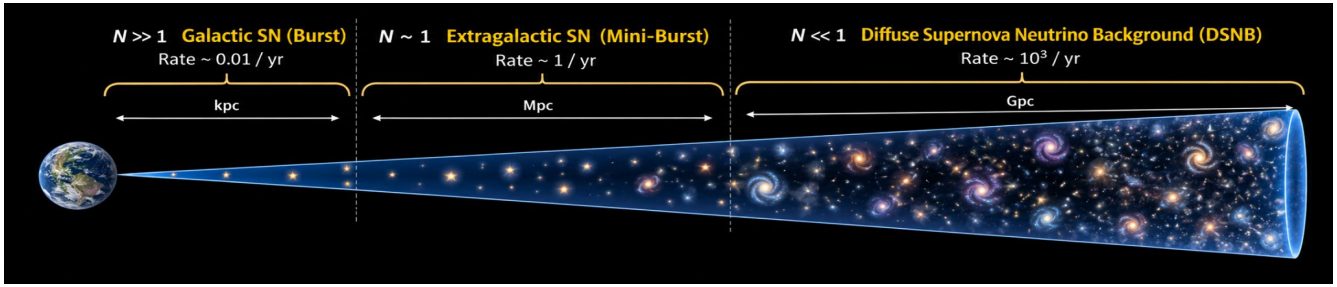


F. Rosso (MA2-2025), M. Colomer





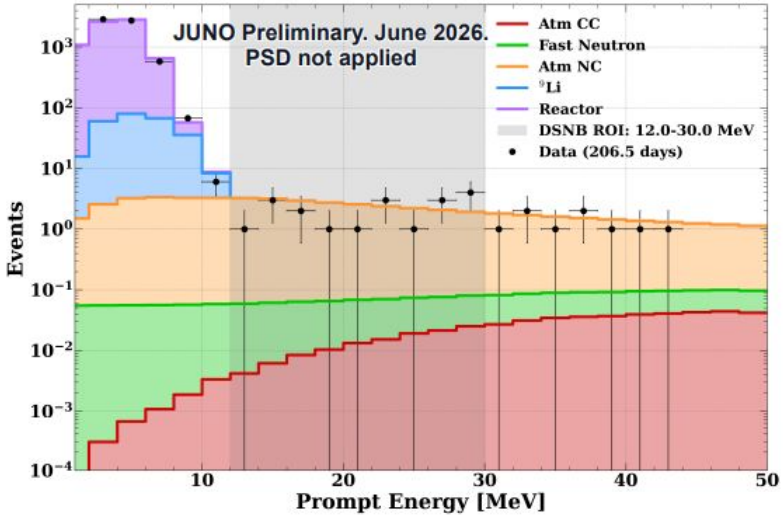
Highlights : First DSNB search results

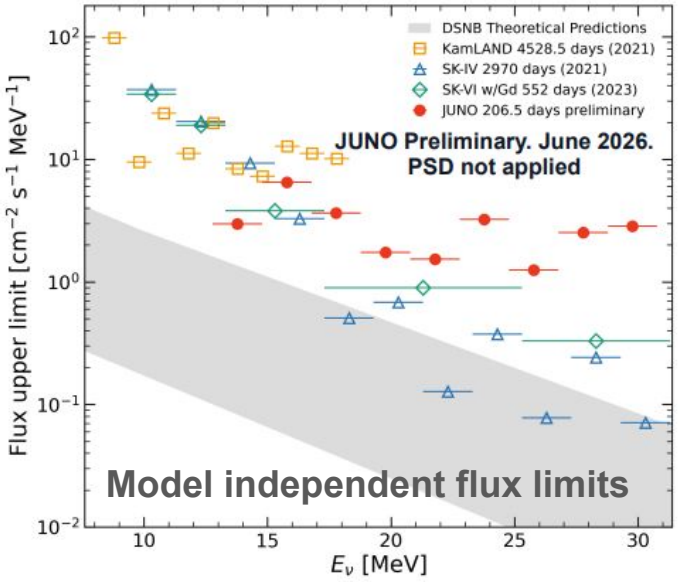


DSNB: signal from all supernova explosions in the Universe story

TO BE DISCOVERED

- 19 events observed:
- expected background: 21±10



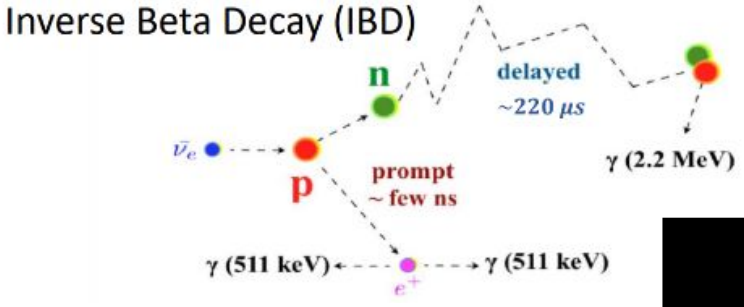




Conclusions

- JUNO has now collected ~300 days of data
- First results with 60 and 207 days datasets have been released in different physics topics:
  - reactor , atmospherics, DSNB…
  - IIHE JUNO group is involved in different tasks - contributing actively to first JUNO results
- JUNO is ready to send and receive multi-messenger alerts
- We are working towards a better understanding and improvement of the detector response
- New results with larger dataset coming soon, stay tuned

How do we detect reactor neutrinos in JUNO?

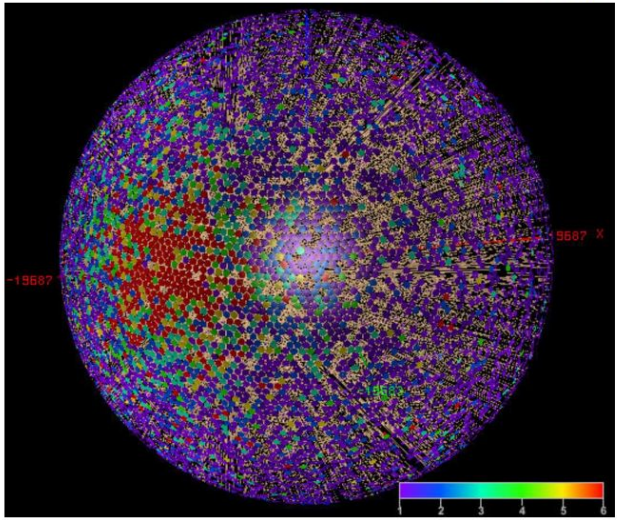


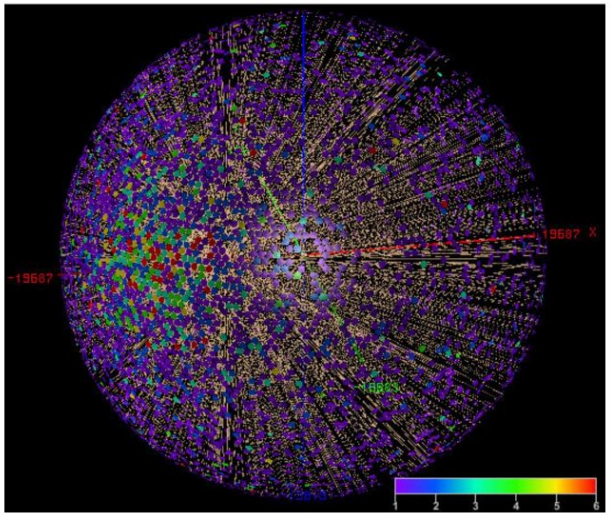
Prompt signal: e+



Delayed signal:
neutron capture





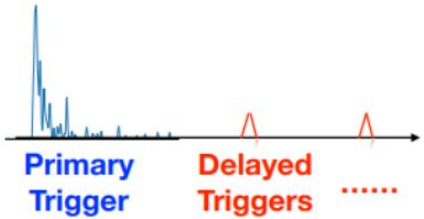


Time and space coincidence and mono-energetic delayed photons:

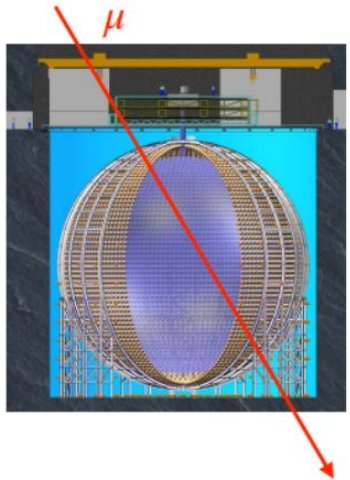
clean signature = less background

Selecting atmospheric neutrinos in JUNO

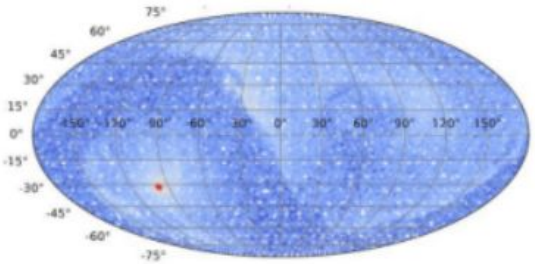
CD primary selection → **CD-only selection (fully contained)** → **PMT flasher rejection** → **Untagged muon removal**



Identify the primary signal triggers (reject afterpulses, secondary particles)



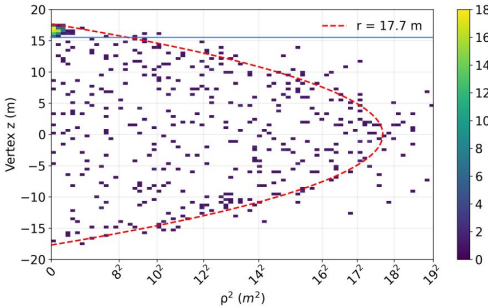
Cosmic muons and partially contained events are removed by the veto detectors (WP/TT trigger)



Flashing PMTs with sudden and high count rate increases

↓

Removed using event topology: npe cluster around hottest PMT



Muons going through the “chimney” cannot easily be removed/seen by the WP/TT

↓

Vertex reconstruction allows to remove them