

Status of Jiangmen Underground Neutrino Observatory

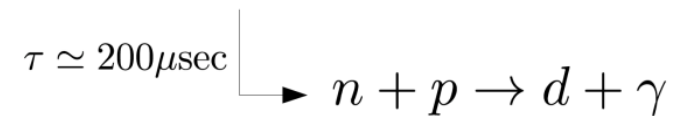
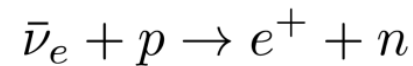
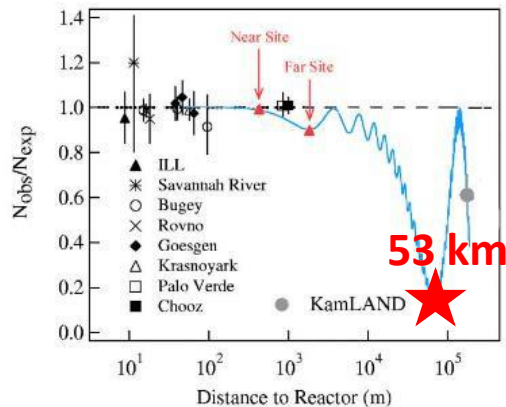


Yifan Yang - Université Libre de Bruxelles
on behalf of the JUNO Collaboration

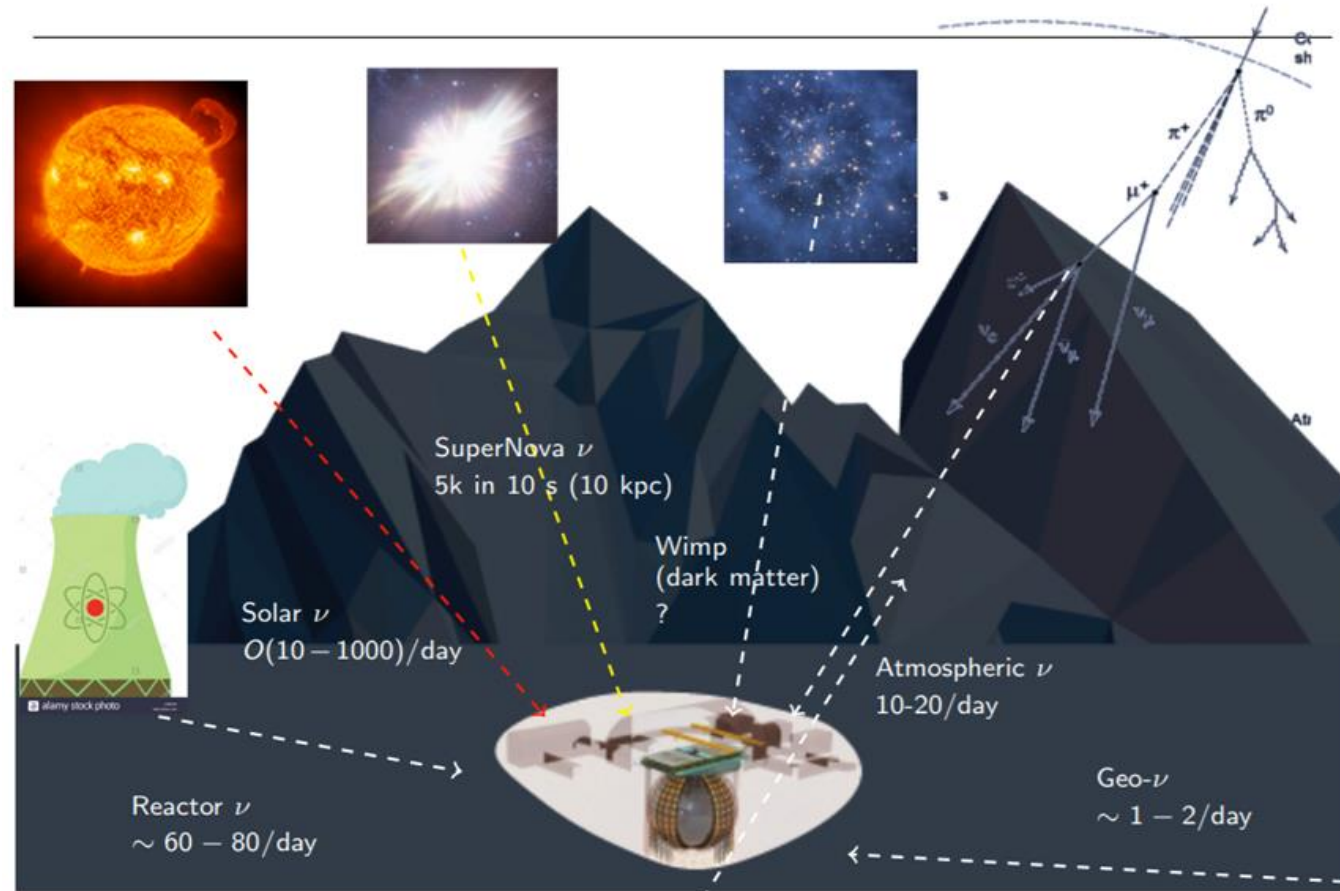
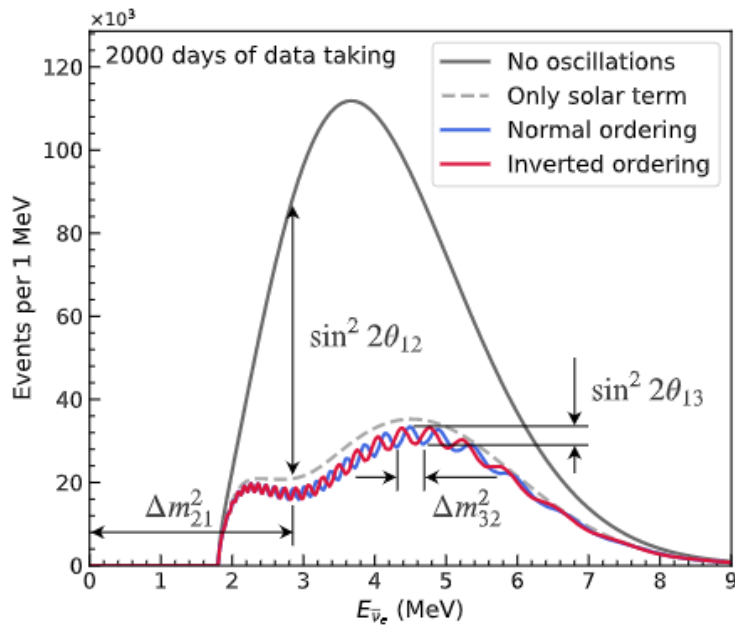


JUNO overview

- **Source:** Yangjiang and Taishan NPP
- **Baseline:** 53 km
- **Detection channel:** inverse β -decay
- **Target:** single volume 20-kt liquid Scintillator
- **Detection technique:** system of photomultiplier tubes (18k 20" PMTs + 25k 3" PMTs)
- **Overburden:** 700 m (1800 m.w.e)

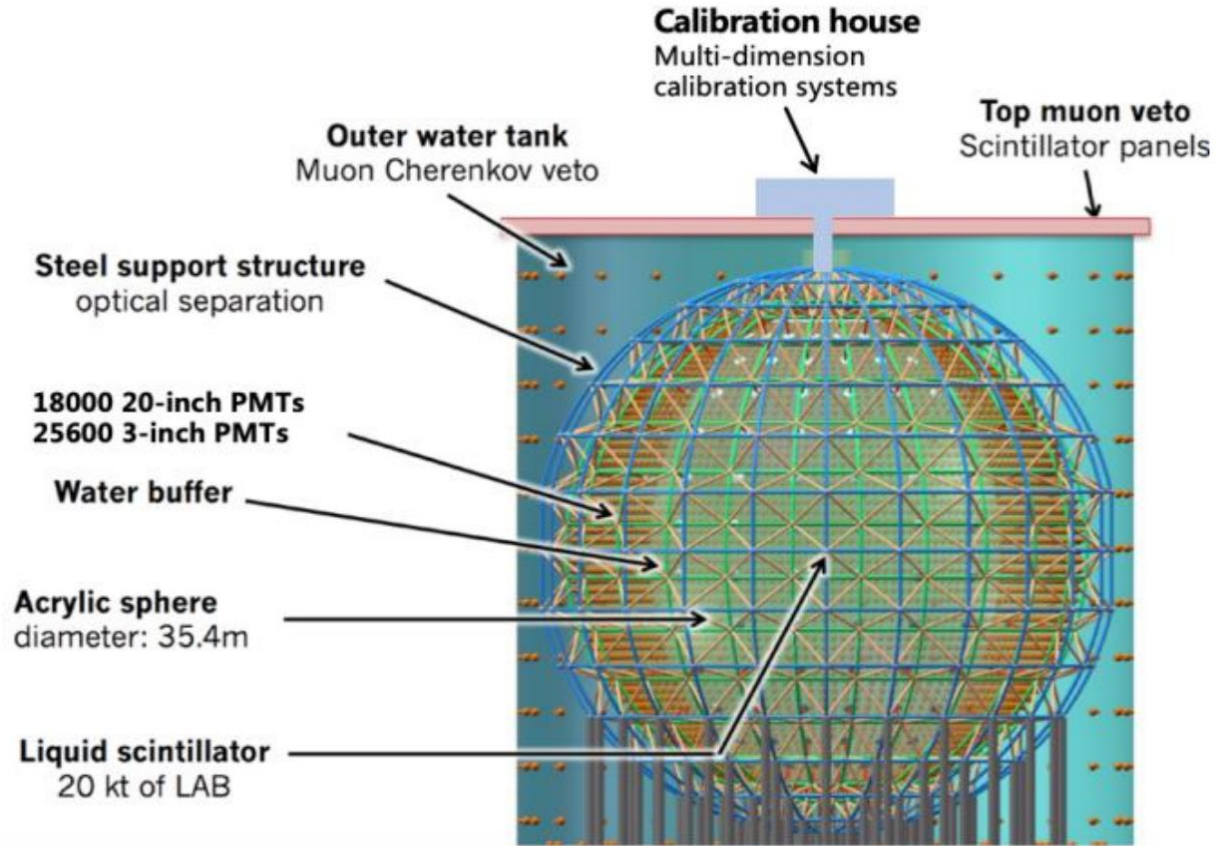


Rich physics program



A. Garfagnini PANIC 2021 Conference

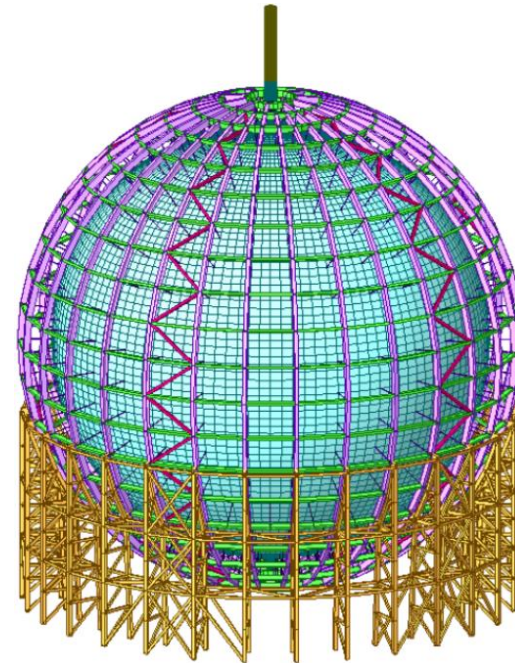
JUNO detector



Experiment	Daya Bay	BOREXINO	KamLAND	JUNO
LS mass	20 ton	~300 ton	~1 kton	20 kton
Coverage	~12%	~34%	~34%	~80%
Energy resolution	~7.5%/√E	~5%/√E	~6%/√E	~3%/√E
Light yield	~ 160 p.e. / MeV	~ 500 p.e. / MeV	~ 250 p.e. / MeV	~ 1200 p.e. / MeV

Center detector: Acrylic and Stainless steel

- Acrylic sphere
 - 35.4 meter diameter
 - 265 total panels
 - 590 connecting bars
- Stainless Steel structure
 - 40.1 meter diameter
 - 30 pairs of supporting columns
 - total weight: 600 t

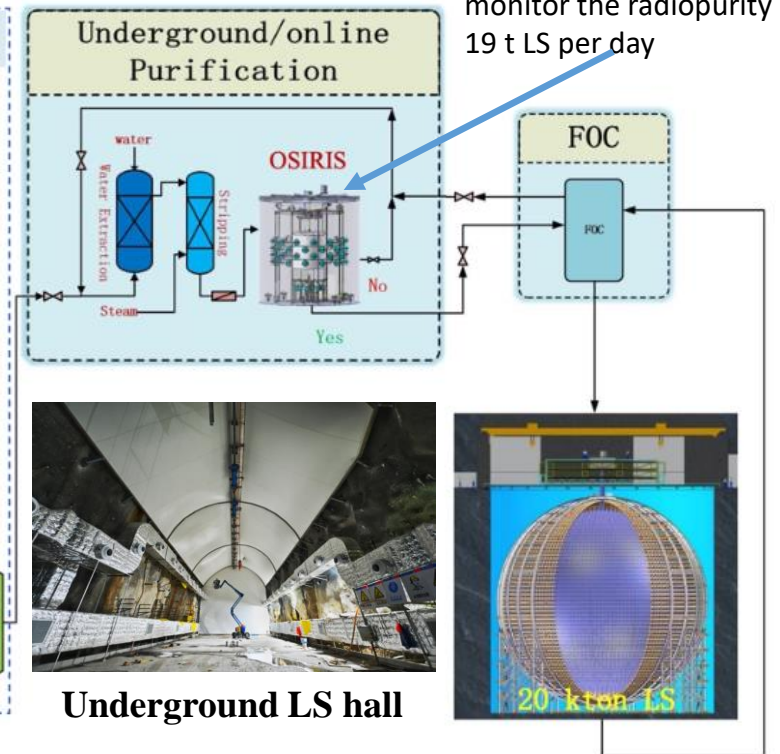
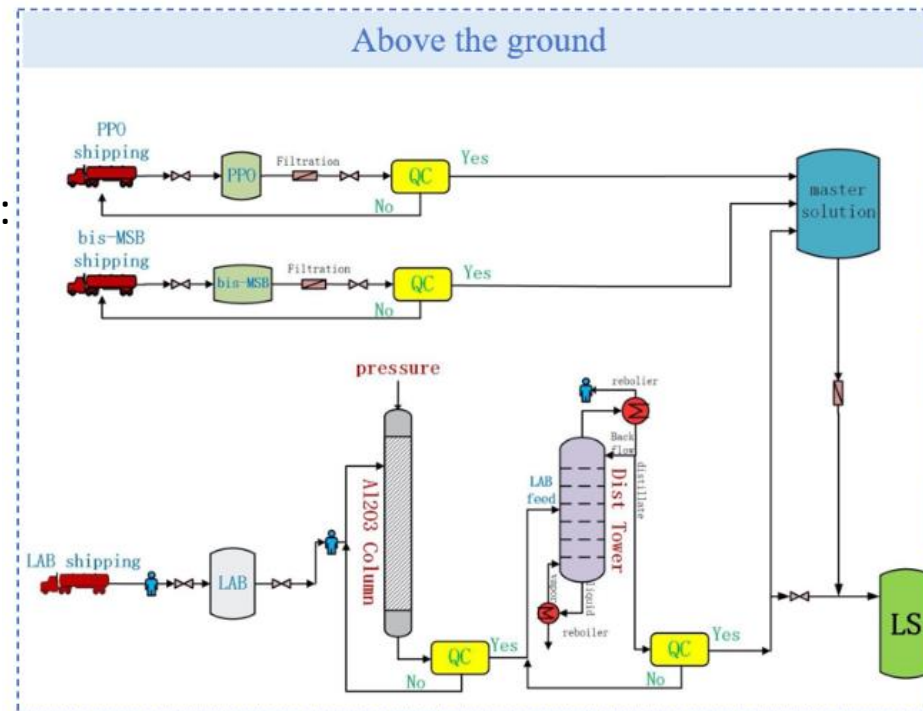


Liquid scintillator

long attenuation length
measured: > 20 m at 430 nm

high radiopurity requirements :
 10^{-15} g/g U/Th for reactor
antineutrinos to determine
NMO
 10^{-17} g/g U/Th for solar
neutrinos

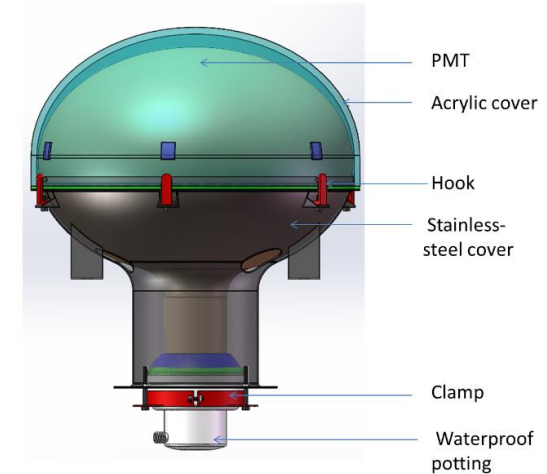
Multiple-level purification
systems



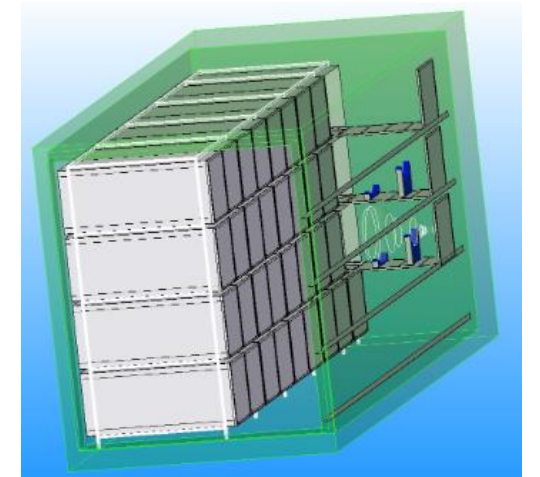
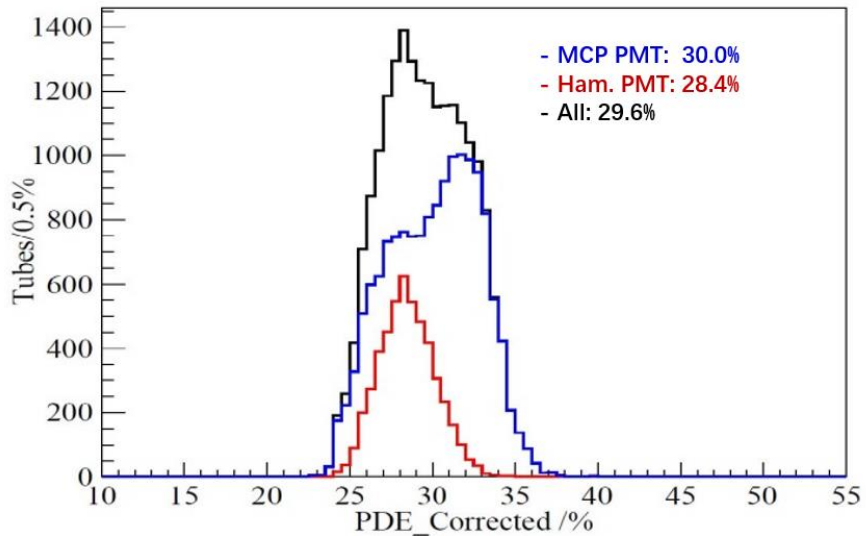
20 inch PMT

Two types of 20" PMTs will be deployed in JUNO:

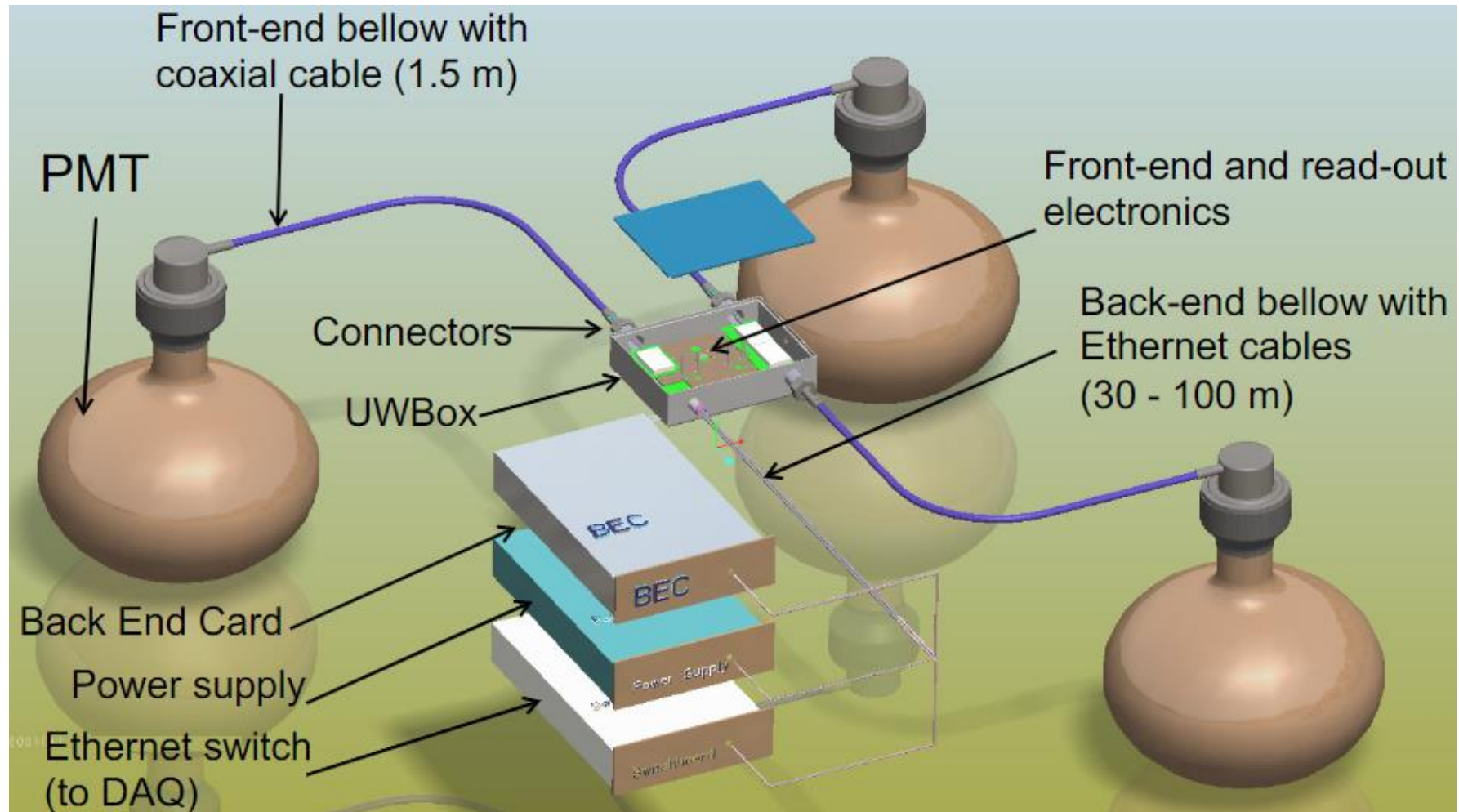
- 15 k NNVT MCP-PMT, (central detector and veto)
- 5 k Hamamatsu R12860 (central detector only)



Photon Detection Efficiency (PDE) :

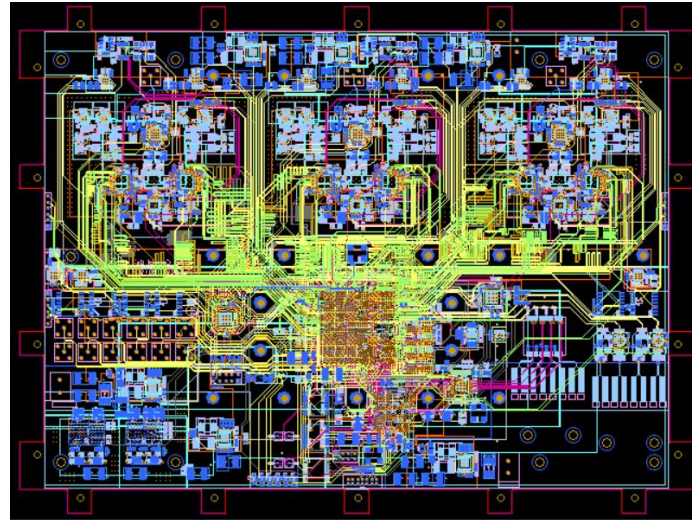


Readout scheme



Global Control Unit (GCU) and under water box

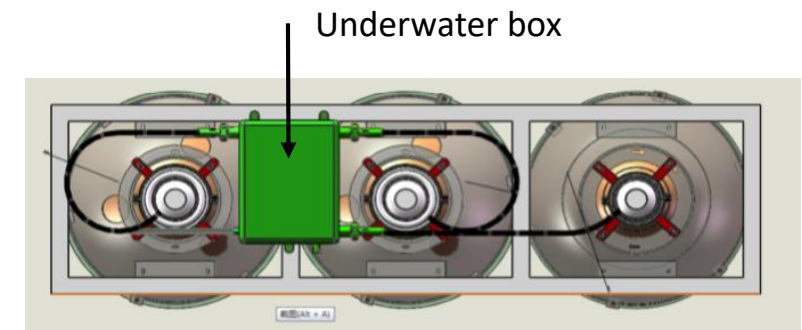
- Front-end electronics requirement
 - Dynamic range 1-1000pe
 - Amplitude dynamic range: 7.5mV – 7.5V(150uA – 150mA)
 - Resolution 0.1pe@1pe, 1%@>100pe
 - 3 channels 1Gsps 14 bits FADC
- Global trigger and self-trigger support
- Real-time charge and time calculation
- High voltage communication
- Ethernet readout support
- System synchronization, 8ns clock alignment
- Enough storage for trigger latency, Ethernet lag and supernova event
- Safe remote reprogramming support
- over-voltage protection, independent channel power control
- Power consumption: <10W/channel
- High reliability : 0.5%@6 years



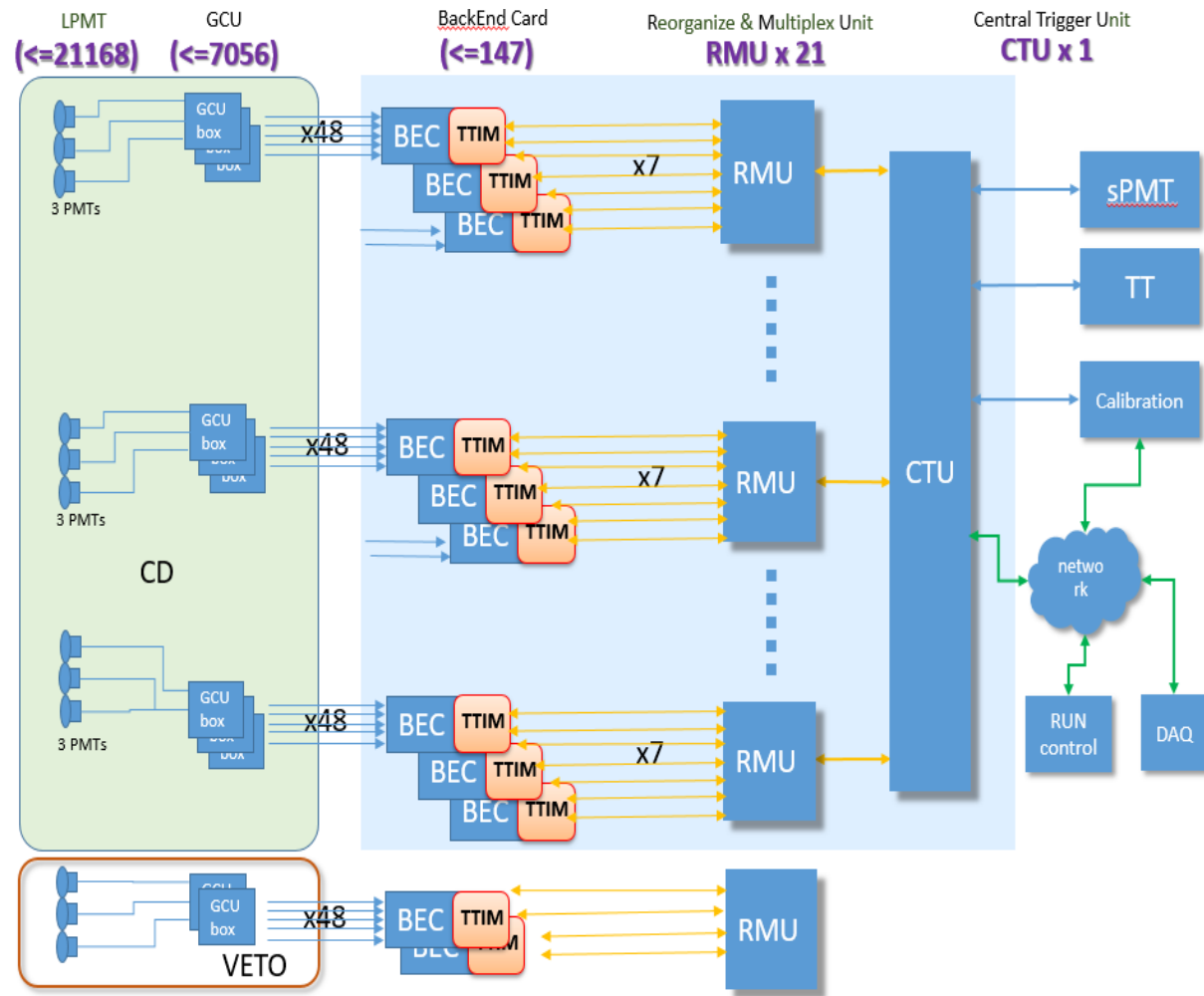
16 layers without buried/blind via
Size :262 X 192 mm
Thickness:2mm



Under water test in a swimming pool at -40m in Padova

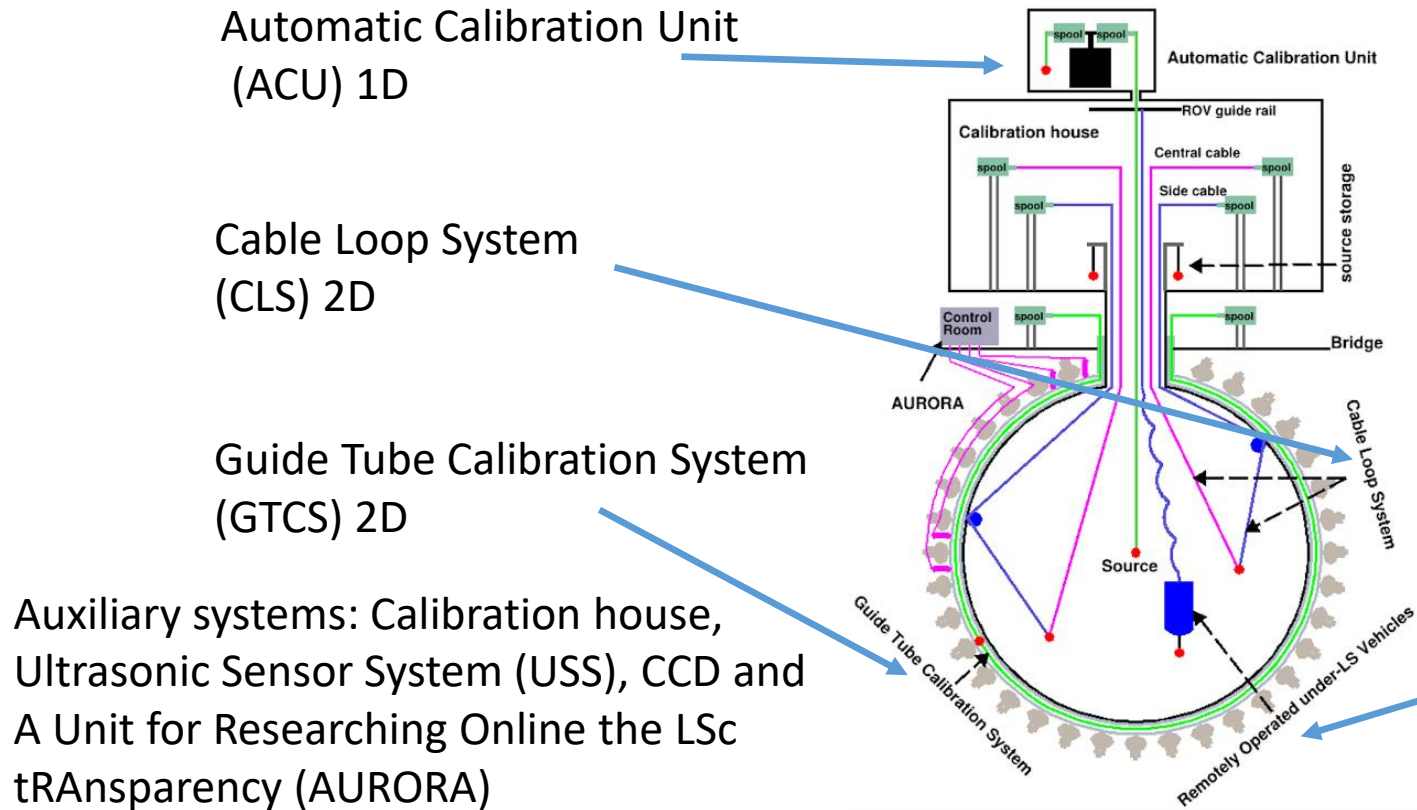


Readout electronics : Backend system



JUNO detector calibration system

requirements: <3% energy resolution at 1 MeV and 1% energy scale uncertainty



Calibration house and ACU

Remotely Operated Vehicle (ROV) 3D

The Taishan Antineutrino Observatory (TAO)

TAO is designed for a high precision measurement of the reactor antineutrino spectrum

- a model-independent reference spectrum for JUNO
- will provide a benchmark measurement for the nuclear database

30 m from one of the Taishan reactor cores

2.8 ton gadolinium-doped liquid scintillator

10 m² 95% coverage with SiPM

operate at -50°C (to reduce SiPM dark noise)

photon detection efficiency > 50%

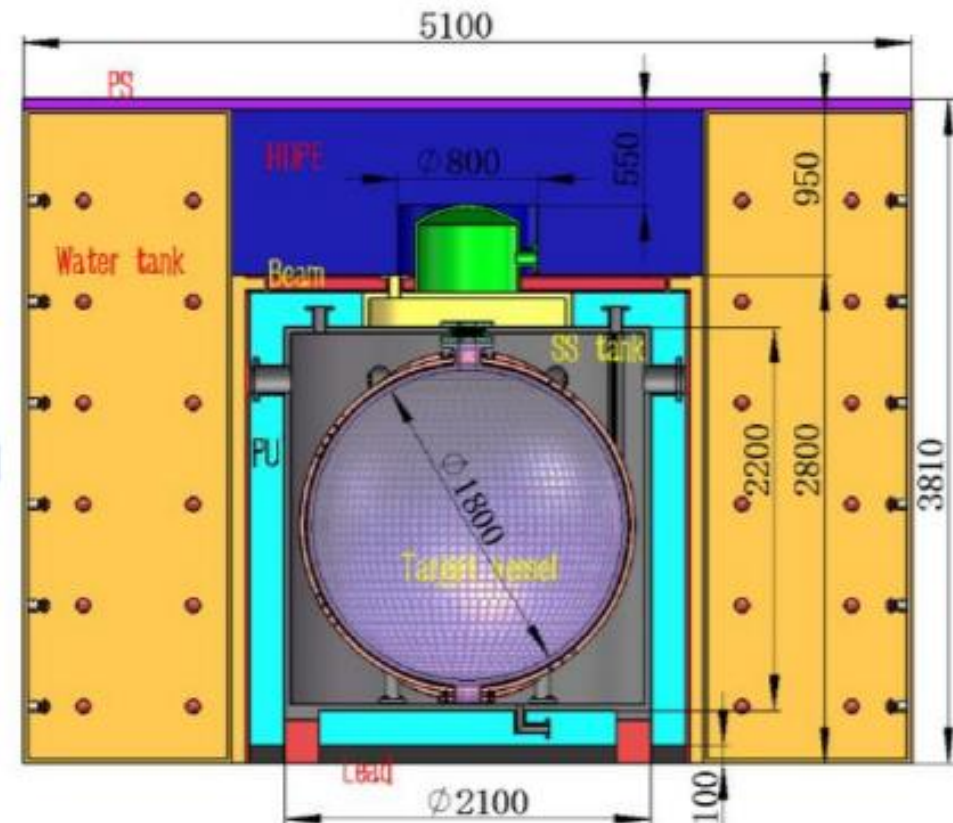
Light yield 4500 p.e./MeV

2000 reactor antineutrinos / day

excellent energy resolution: 1.5% at 1 MeV and

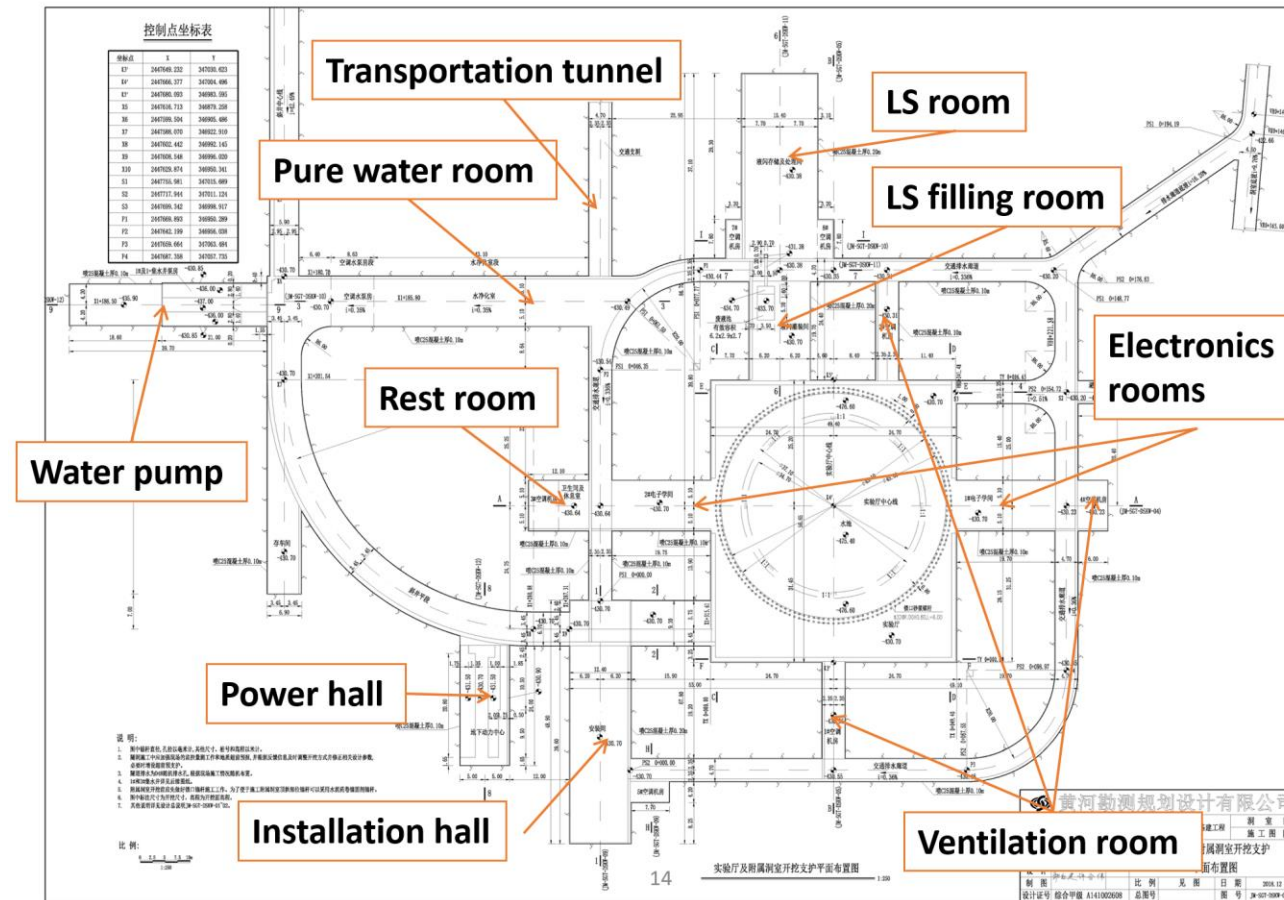
1.7% below 2 MeV

start operation in 2022



Conceptual Design Report: arXiv:2005.08745

Underground facility layout



Construction status



Above ground Campus

Transportation for slope tunnel



Conclusion

- JUNO will be the largest reactor neutrinos detector ever built (20 kton of LS) with unprecedented energy resolution (3% at 1 MeV)
- JUNO will measure mass hierarchy (3-4 σ with 6 years data taking) and 3 neutrino oscillation parameters to sub-percent level
- JUNO also has a rich physics potential with supernova neutrinos, geo-neutrinos, solar and atmospheric neutrinos, proton decay and other exotic searches such as searches for sterile neutrinos
- the production of the different parts and the civil engineering are well underway
- production and assembly of electronics components is going on
- installation of the main structure already started
- Data taking will start from 2023

Thanks!