



Collaboration between JINR and China: The JUNO experiment

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October 13, 2022



Experiments with reactor electron antineutrinos

Daya Bay

- World's best measurement of $\sin^2 2\theta_{13}$ and Δm_{31}^2 at baseline 1.7 km
- Preparation: 2003–2011, operation: 2011–2020, data analysis: till ~ 2023
- Collaboration between JINR and China since 2004
- JINR contribution: fluor (PPO) production, data analysis
- Accolades: 1st JINR prize, 1st DLNP prize, Breakthrough in fundamental physics 2016
- Theses defended at JINR: 1 candidate, 2 doctors



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JUNO

- Determination of neutrino mass ordering: 3σ in 6 years (baseline 52.5 km)
- Precision measurement of Δm_{31}^2 , Δm_{21}^2 and $\sin^2 2\theta_{12}$
- Preparation: 2014–2023, planned operation: 2023–2043
- JINR participation: since 2014



Jiangmen Underground Neutrino Observatory

Reactor neutrino physics

- Determination of neutrino mass ordering: 3σ in 6 years
- Measurement of Δm_{31}^2 , Δm_{21}^2 and $\sin^2 2\theta_{12}$ with sub-percent precision
- Precision reactor antineutrino spectrum measurement
- Search for sterile neutrino oscillations at short baseline



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Other neutrino sources

- Low-, mid- and high- energy solar neutrino
- Geo-neutrino
- SuperNova and Diffuse SuperNova Neutrino Background
- Atmospheric neutrino: mass ordering and θ_{23}
- Proton decay



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Requirements

- Large (20 kt) ultra pure LS detector
- Outstanding energy resolution:
 - ▶ 3% at 1 MeV at 52.5 km
 - ▶ 2% at 1 MeV at 30 m
- High light collection: 18'000 PMTs



JINR contribution: detector

Current contributions

PMTs	<ul style="list-style-type: none"> • Silicon PMTs 		1	M\$
Power Supply	<ul style="list-style-type: none"> • High Voltage for PMTs, R&D, production costs 		2	M\$
	<ul style="list-style-type: none"> • Power Supply for silicon PMTs R&D 		0.5	M\$
Top Tracker muon veto	<ul style="list-style-type: none"> • previously, Opera Target Tracker 	(in-kind)	0.8	M\$
	<ul style="list-style-type: none"> • support structure R&D 		0.2	M\$
PMT studies	<ul style="list-style-type: none"> • Scanning stations R&D, production 	}	0.5	M\$
	<ul style="list-style-type: none"> • Large PMT characterization 			
	<ul style="list-style-type: none"> • Large PMT mass testing, long term testing 			
	<ul style="list-style-type: none"> • SiPM acceptance, mass testing 			
PMT protection	<ul style="list-style-type: none"> • against Earth Magnetic Field: R&D, prototypes 			
Computing	<ul style="list-style-type: none"> • Extended memory CPU servers (3000 cores) 		2	M\$
			7	M\$

- HV design, proposed by JINR has driven the design of electronics and DAQ.



JINR contribution: operation

Operation

- JUNO operation fee

3 k\$/FTE/year



JINR contribution: analysis

Operation

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3 k\$/FTE/year

Analysis

- Statistical analysis of reactor antineutrino oscillation data
- Reconstruction: primary vertex, energy, muon tracks. Classical approaches, machine learning.
- Event selection, background estimation
- Description of optical properties of PMTs
- Potential: atmospheric neutrinos, combination with accelerator experiments



JINR contribution: computing

Data centers

[See also a talk from LIT](#)

- Dubna is expected to be one of the data storage and data processing centers
- Data rate: 3 PB/year
- Memorandum of Understanding for computing is signed by JINR
- IHEP is able to facilitate construction of high speed channel on Chinese side



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Resources requirements, from MoU

JINR	Planned to be pledged*				
	2023	2024	2025	2026	2027
Tape (PB)	5	5	5	5	5
Disk (PB)	5	5	5	5	5
CPU (kHS06 [†])	36	36	30	20	10

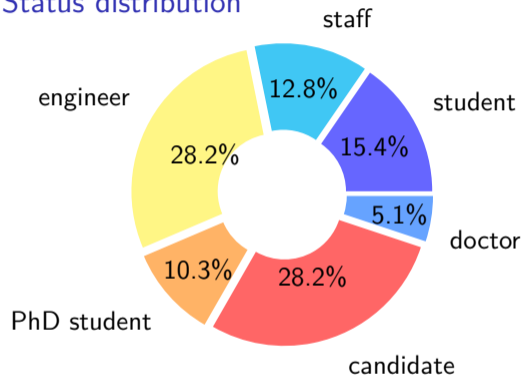
*numbers are *not* cumulative

[†]48 kHS06 \approx 2000 CPU



Staff summary: 2021–2023

Status distribution



Total FTE 19.87

Avg. people 38

FTE/person 0.52

Age distribution

