Water Cherenkov detector of the JUNO Veto System

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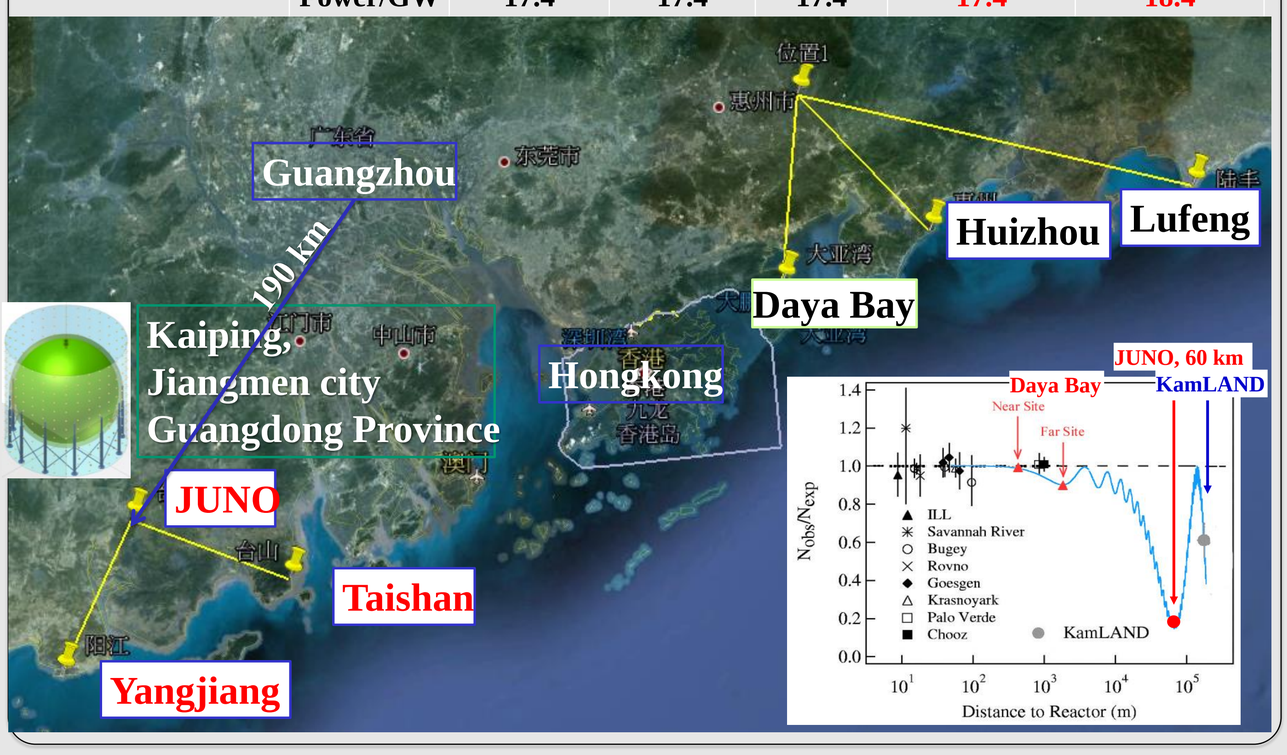
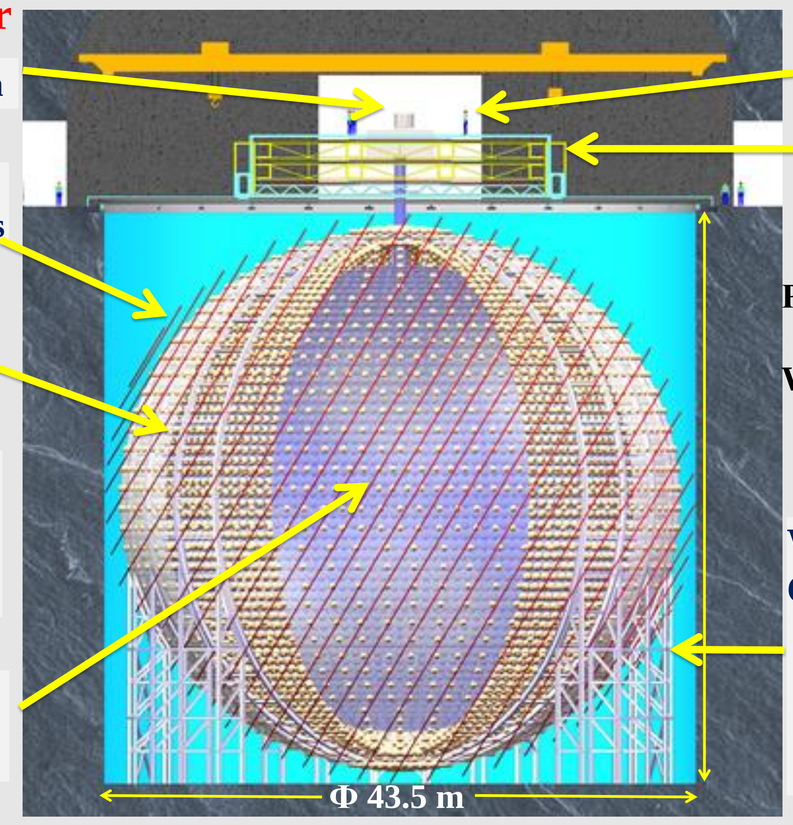
Abstract The Jiangmen Underground Neutrino Observatory (JUNO) is a 20 kton liquid scintillator detector with primary physics goal of neutrino mass hierarchy determination and other measurements, including precise neutrino oscillation parameters, solar neutrino, geo-neutrino, supernova neutrinos and the diffuse supernova neutrinos background. The detector will be built in 700m deep underground laboratory. A multi-veto system will be built for cosmic muon detection and background reduction. The outer of the central detector is filled with water and equipped with ~2000 MCP-PMTs (20 inches) to form a water Cherenkov detector for muon tagging. Both the water Cherenkov detector walls and the central detector external surface are coated with Tyvek reflector to increase the light collection efficiency. The muon detection efficiency is >95% for water Cherenkov detector. With this veto system, the cosmic muon induced fast neutron background can be reduced at the level of ~0.1/day.

Site location

NPP	Daya Bay	Huizhou	Lufeng	Yangjiang	Taishan
Status	Operation	Plan	Plan	Construction	Construction
Power/GW	17.4	17.4	17.4	17.4	18.4

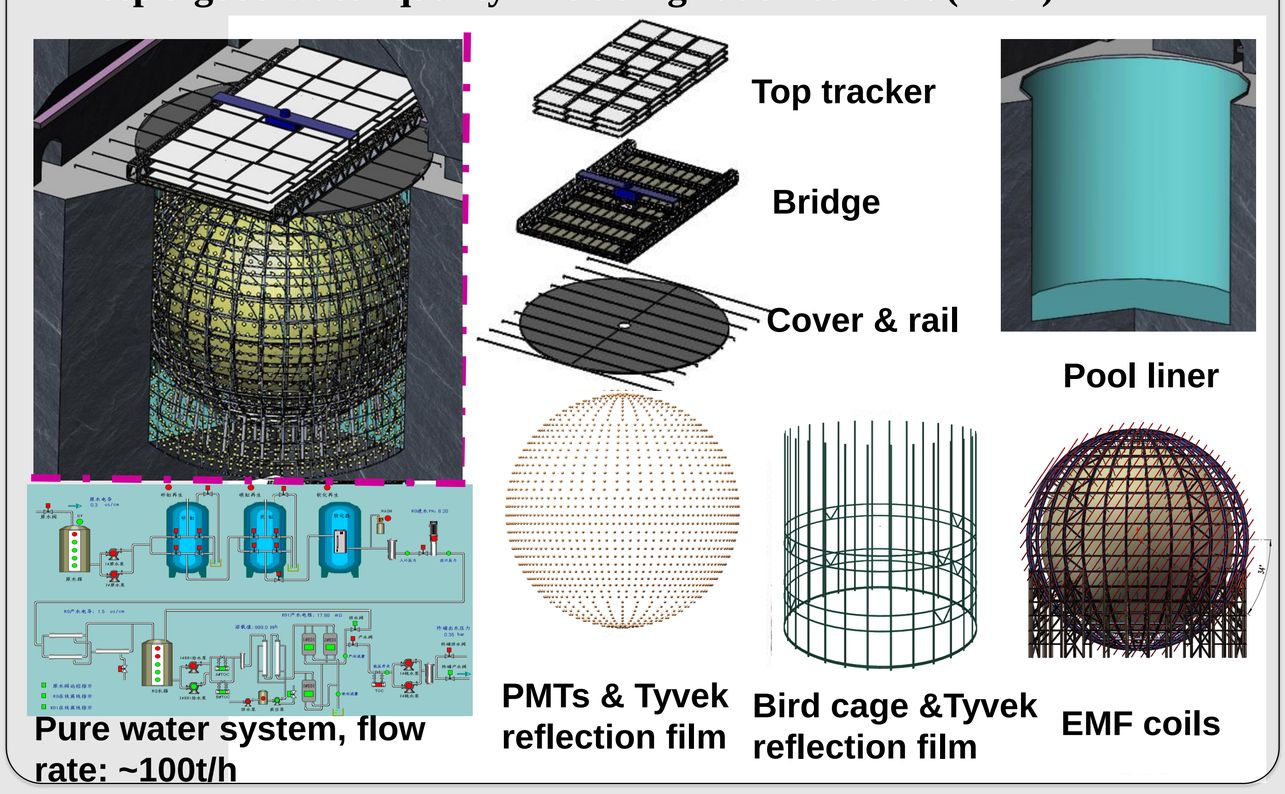


JUNO Detector



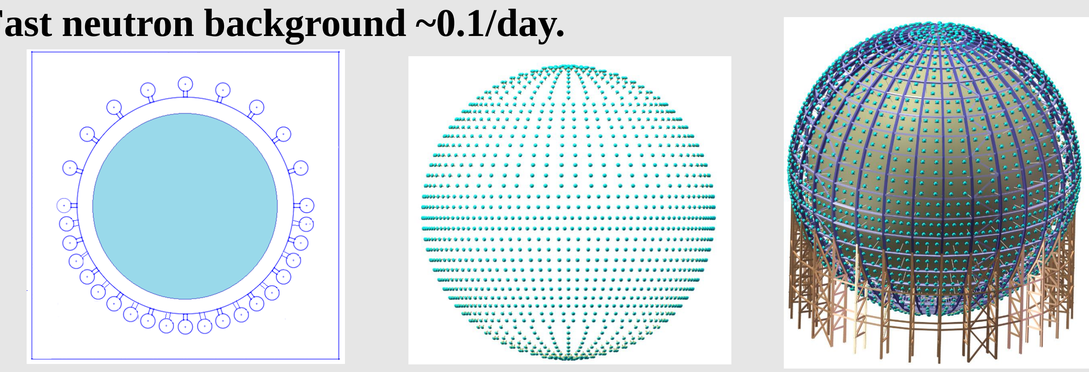
Veto system

- Top tracker (TT), Re-using OPERA plastic scintillator tracker (P183)
- Water Cherenkov detector
- Compensation coils system used for earth magnet field (EMF) shielding to keep PMT performance. (P175)
- Water system: Employ a circulation/polishing water system;, Keep a good water quality -including radon control. (P181)



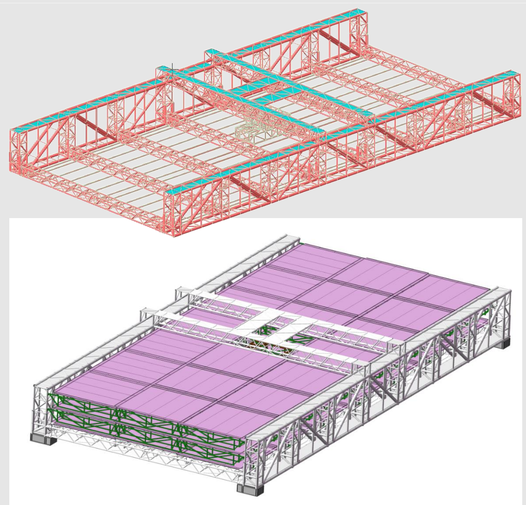
Specifications of water Cherenkov detector

- 20 inch MCP-PMT used for veto system with number~2400;
- Detector efficiency requirement is expect to be>95%;
- Fast neutron background ~0.1/day.



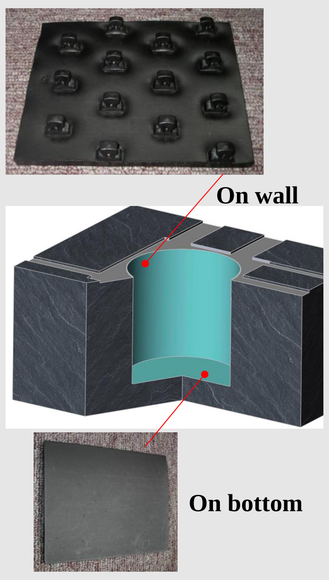
Bridge

- long ~48m and width ~25m,
- Carbon steel ~225T
- Support for
  - TT
  - Calibration room
  - Water and liquid scintillator pipes
  - Cover



Pool liner

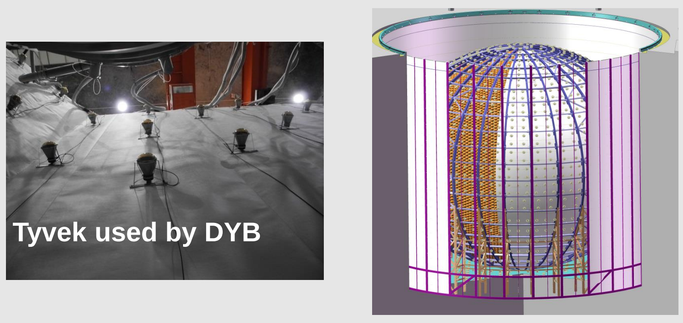
- To separate pure water from rock
- To prevent rock radon diffusing into the poo.
- Two kinds of HDPE plate, with and without nails.
- Thickness 5 mm.



Tyvek reflection film

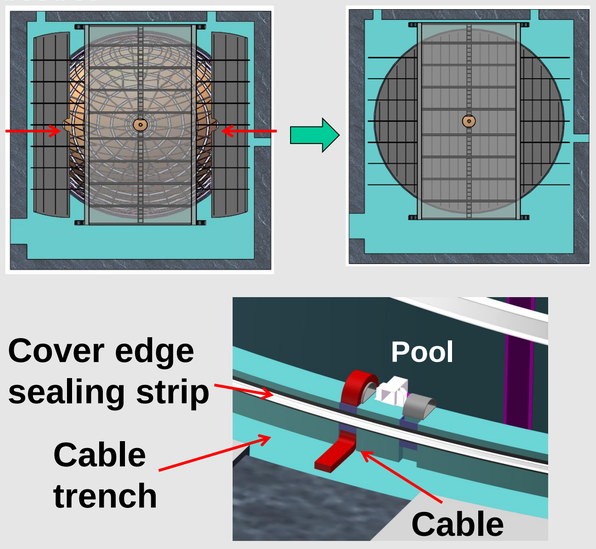
To be installed on

- Surface of the SS latticed shell
- Pool wall, bottom and top



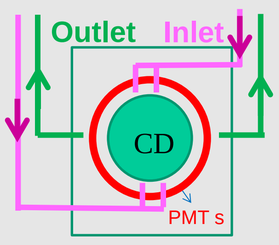
Cover and cable trench

- Two simi-circle covers are zipped in the middle, edges fixed on the pool
- Cable trench lining HDPE, filling water to seal cable and cover edge

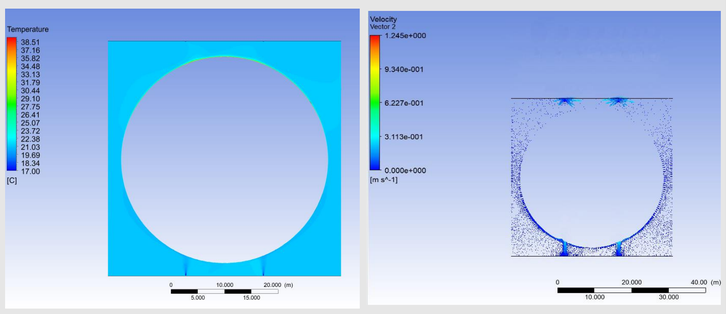


Water circulation

- Keep water highly tranparent
- Keep uniform water temperature (21±1℃)
- Prevent radon diffusing to CD



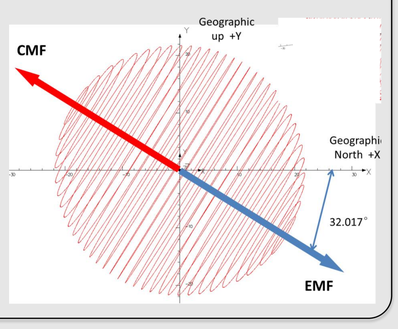
Waterway sketch



Temperature distr. Velocity distr.

Compensation coils of EMF

- One set coils generate the opposite direction of the geomagnetic field to compensate the total earth magnetic field
- 16 pairs shielding coils scheme
  - Give lower residual B-field for Veto PMT
  - More uniform current distribution for each pair of coils
  - Most of the space between coils are equal
- EMF on site ~0.45G



Related presentations/posters

[T1] B. Wonsak, Status and Prospects of the JUNO Experiment
[P183] J.P.A.M. de Andr´e, Y. Gornushkin, M. Dracos, the top tracker of the JUNO experiment
[P181] C. Guo, the water system and radon measurement system of JUNO veto detector
[P175] N. Suwonjandee and B. Asavapibhop, Earth Magnetic Field Compensation Coils System for JUNO

Reference:

[1] F. P. An et al. [JUNO Collaboration], J. Phys. G 43 (2016) no.3, 030401 [1507.05613].
[2] F. P. An et al. [JUNO Collaboration], JUNO Conceptual Design Report, 2015, [arXiv:submit/1361070]

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