The Status of JUNO

Zhimin Wang
On behalf of the JUNO Collaboration

Institute of High Energy Physics, Beijing, 100049, China
wangzhm@ihep.ac.cn

Abstract. The Jiangmen Underground Neutrino Observatory (JUNO) is a multi-purpose underground experiment and the largest liquid scintillator (LS) detector going for neutrino mass hierarchy, precise measurement of neutrino oscillation parameters and other rare processes which include but not limited to solar neutrino, geo-neutrino, supernova neutrinos and the diffuse supernova neutrinos background. The 20” PMT system with ~18000 high quantum efficiency phototubes, including Hamamatsu 20” and newly developed NNVT MCP 20” tubes, is the key component of JUNO experiment for better energy resolution, good detector response etc. This article reports the status of the JUNO experiment.

1. Introduction
The Jiangmen Underground Neutrino Observatory (JUNO) is a multipurpose underground neutrino experiment. It will be constructed in an underground laboratory (700 m vertical rock overburden) under excavation in Jinji town, Kaiping City, Jiangmen City, Guangdong province, China. The main scientific goal is to measure the neutrino mass hierarchy by detecting reactor antineutrinos from nuclear power plants.

Figure 1. JUNO detector layout and simulated event display.

JUNO consists of a central detector, a water Cherenkov detector and a top muon tracker. The central detector is designed with 20 kton liquid scintillator (LS) and 18000 (20”) PMTs with ±3%/√E (MeV) energy resolution, also including a ~25,000 (3”) PMT array as a standalone calorimetry. An acrylic sphere with a diameter of 35.4 m is designed as the LS vessel, which is supported by a stainless steel struss (SSS) with a diameter of 40 m. All the PMTs for the central detector will be installed in the inner surface of SSS, while the out surface of the SSS will be used to install the PMTs for muon veto detector. The central detector will be submerged in a water pool, which is used to shield the central detector from natural radio-activities of the surrounding rock and air, and as an active muon...
Cherenkov detector.
To July 2017, the JUNO collaboration includes total ~71 institutes or universities, totally ~571 collaborators from all over the world.

2. Main recent progress

2.1. Central detector
The acrylic sphere vessel with 35.4 m diameter is the key design of central detector. It is bonded by ~260 acrylic panels with a thickness of 120 mm and supported by a stainless steel strut (SSS). The mechanical design is going on for optimization. While following the production R&D with several companies, the production bidding was signed to DONCHAMP finally, the production line and prototype are under preparing and in good shape.

![Figure 2. JUNO central detector design and acrylic prototyping.](image1)

2.2. Muon Veto detector
The JUNO Muon veto detector is made up with two separate detectors: a water Cherenkov detector filled with ~30 kton ultra-pure water and equipped with ~2000 20" PMTs, and a top tracker using OPERA plastic scintillator which already delivered to China and stored at the PMT characterization & potting station for JUNO located at Zhongshan Pan-Asia LTD. The optimization of the muon veto detector and the earth magnetic shielding system still are going on.

![Figure 3. JUNO Muon Cherenkov (left) and top tracker detector (right).](image2)

2.3. Electronics
2.4. Civil construction

Figure 5. JUNO site design overview and the slope tunnel
The civil construction is going on well with some delay. On Jan 10, 2015, the Civil construction kicked off, and on May 26, 2015, the vertical shaft digging started. On June 22, 2017, the slope tunnel digging accomplished, on July 1st, 2017, the vertical shaft accomplished.

3. 20” PMT receiving and test

3.1. 20” PMTs and receiving
The PMT instrument of JUNO includes PMT test, HV divider, water proof potting, implosion protection and installation. Any of them is playing a key job for the JUNO detector.

JUNO decided to use 5,000 Hamamatsu R12860-HQE and 15,000 NNVT MCP PMT for photon detection.
Figure 6. JUNO selected 20” PMTs: Hamamatsu R12860 (Left), NNVT 20” MCP-PMT (middle). JUNO PMT characterization & potting station at Zhongshan Pan-Asia received the 1st batch tubes (right).

To July 27th, JUNO already received total 2784 tubes, including NNVT MCP 1344 tubes and Hamamatsu 1440 tubes.

3.2. 20” PMT testing system

The PMTs will take a long time before its installation to the detector for characterization and potting: delivery from factory, open box check, acceptance tests, storage, integration with HV divider and check, characterization after water proof potting, storage, transfer/deliver to onsite for assembly, and installation (in-situ tests). Most steps on the list will be done at JUNO PMT characterization & potting station at Zhongshan Pan-Asia.

In order to realize both the acceptance and characterization tests before and after potting, the PMT test system is designed with two separate subsystems: the container system which is made up from a standard container to test 36 tubes each cycle to cover most of the parameters, and a scan station system to detail check the tubes for detection efficiency and the uniformity of the photo cathode. The two systems all are using 1 GHz waveform sampling electronics to record the PMT waveform for further analysis as JUNO designed.

Figure 7. JUNO PMT test system: bench test scheme (Left), the designed container system (right).

Figure 8. JUNO PMT test system: the scan station for photo cathode uniformity (hardware on left), sampling waveform (top right), charge spectrum (right bottom left), scanning process and points (right bottom right)
4. Schedule

JUNO planned to take data in 2020. And all the sub-systems are going well.

Reference:
1. JUNO-DocDB1892: Precision Oscillation Measurements with Next 2 Generation Reactor Neutrinos
2. JUNO-DocDB1983: JUNO Central Detector and its Calibration System
3. JUNO-DocDB2313: Double Calorimetry System in JUNO
4. JUNO-DocDB2474: Status and perspectives of JUNO experiment