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# Detector identifier and geometry management system in JUNO experiment

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In offline software of JUNO experiment, detector identifier (ID) and geometry management are indispensable parts. Detector identifier provides a unique ID number for every detector unit with readout, which is used by different applications in offline software. An ID mapping service is under development to provide associations between different sets of ID systems, including offline software, data acquisition, online event classification, electronics, detector testing and commissioning, etc. The geometry management system is developed based on Geant4 and GDML to precisely describe the detector details, such as geometrical structure, detector shapes, and positions. In offline software, the geometry management system provides consistent detector description information for different applications through interfaces between them.

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## 1. Introduction of the JUNO Experiment

The Jiangmen Underground Neutrino Observatory (JUNO) is located in Jiangmen, Guangdong province, China, approximately 53 kilometers away from both the Yangjiang and Taishan Nuclear Power Plants [1]. The scientific objectives of JUNO encompass a variety of goals, including but not limited to the following:

- Determination of the neutrino mass ordering (NMO).
- Precise measurements of the oscillation parameters $\Delta m^2_{21}$, $\Delta m^2_{31}$, $\sin^2\theta_{12}$.

Currently, the JUNO detector is under construction. As shown in Fig. 1, it comprises three sub-detectors: Central Detector (CD), Water Cherenkov detector (WP), and Top Tracker (TT) [1]. The CD is an acrylic sphere with diameter of 35.4 meters, comprising 20 kton liquid scintillator (LS). The surface of CD is equipped with 17,612 20-inch PMTs and 25,600 3-inch PMTs. In the WP, a total of 2,400 20-inch veto PMTs are positioned on the outer surface of the CD, which is used to detect the Cherenkov light emitted by cosmic muons and to distinguish backgrounds from atmosphere and surrounding rocks. The TT is positioned above the WP with three horizontal layers of plastic scintillator detectors, which are used to determine the direction of atmospheric muons.

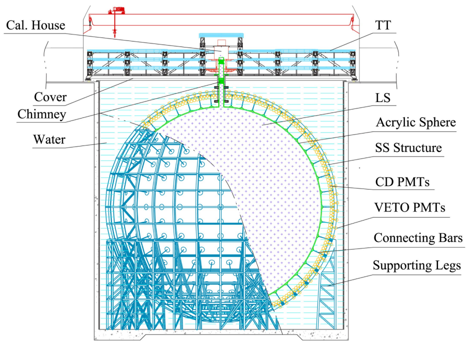


**Figure 1:** Sketch of the JUNO Detector [1].

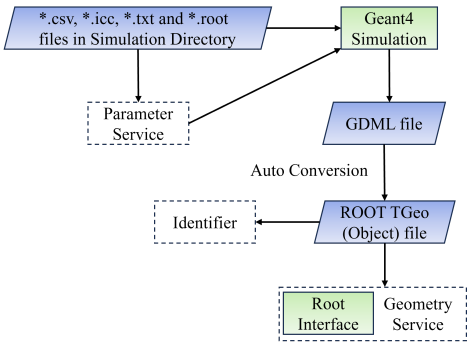


**Figure 2:** The workflow of geometry service.

## 2. Identifier in JUNO

In the JUNO experiment, an identifier system has been designed to effectively control the correlations among different detector units, which can be used in simulation [3], reconstruction [4–6], event display [2, 7, 8] and detector performance evalution [9]. Different defintions of identifiers are specifically designed for different sub-detectors, including CD, WP, and TT.

Every identifier is a 32-bit unsigned integer to represent a detctor unit like PMT in CD or WP. They are designed to have different hierarchy and segments to match the different structure and arrangements of PMTs in WP and CD.

## 3. ID Mapping Service

The ID mapping service (IDService) revolves around Identifiers, facilitating seamless conversion between several ID systems defined in different applications, including PMT testing, PMT potting, detector installation, data acquisition, and offline software, to ensure interoperability across various applications and user groups. During the initialization, IDService will generate an Identifier for every detector unit, and then construct the bi-directional correlations between the Identifier and its corresponding definitions in different ID systems. The users can make use of the IDService to quickly match the event data between different applications with the Identifier.

## 4. Geometry in JUNO

The geometry service is meticulously crafted to accurately depict detector and offer consistent detector information for various applications [10]. In response to diverse requirements within offline software, we have realized the workflow of detector geoemtry description, as shown in Fig. 2. An upgraded version comprises two geometry systems: a light-weight system tailored for basic PMT position and direction information retrieval, resulting in reduced memory consumption; while the other is a comprehensive system designed to provide in-depth details, such as the PMT shape, materials and boundary, enabling users to access full detector information. These two geometry management systems have been seamlessly integrated into the offline system, offering the flexibility to choose and utilize for different applications based on their specific requirements and preferences.

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## References

[1] Abusleme, *et al.*, [JUNO Collaboration], Prog. Part. Nucl. Phys. **123**, 103927 (2022)

[2] Z.Y. You, K.J. Li, *et al.*, JINST. **13**, T02002 (2018)

[3] T. Lin, Z. Deng, *et al.*, Chin. Phys. C. **40**, 086201 (2016)

[4] Z.Y. Li, Y.M. Zhang,*et al.*, Nucl. Sci. Tech. **32**, 49 (2021)

[5] Z. Qian, V. Belavin, *et al.*, Nucl. Instrum. Meth. A. **1010**, 165527 (2021)

[6] Z.Y. Li, Z. Qian, *et al.*, Nucl. Sci. Tech. **33**, 93 (2022)

[7] J. Zhu, Z.Y. You, *et al.*, JINST. **14**, T01007 (2019)

[8] M.H. Liao, K.X. Huang, *et al.*, arXiv:2406.16431 [physics.ins-det]

[9] S. Zhang, J.S. Li, *et al.*, Nucl. Sci. Tech. **32**, 21 (2021)

[10] K.J. Li, Z.Y. You, *et al.*, Nucl. Instrum. Meth. A. **908**, 43-48 (2018)