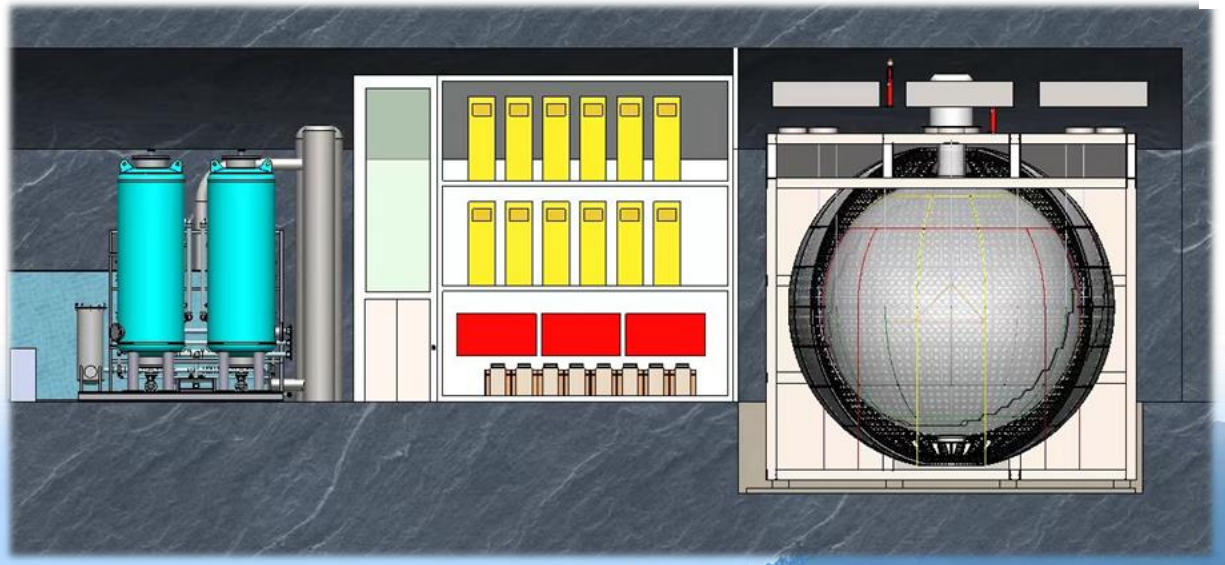
JINPING NEUTRINO EXPERIMENT



Construction progress of Jinping Neutrino Experiment

Wentai Luo

For Jinping Neutrino Experiment Research Group

Nov. 10, 2023 @ FCPPL2023, Zhuhai

Outline

- Near term goal of the project
- Detector and technology development
- Liquid scintillator development
- Summary

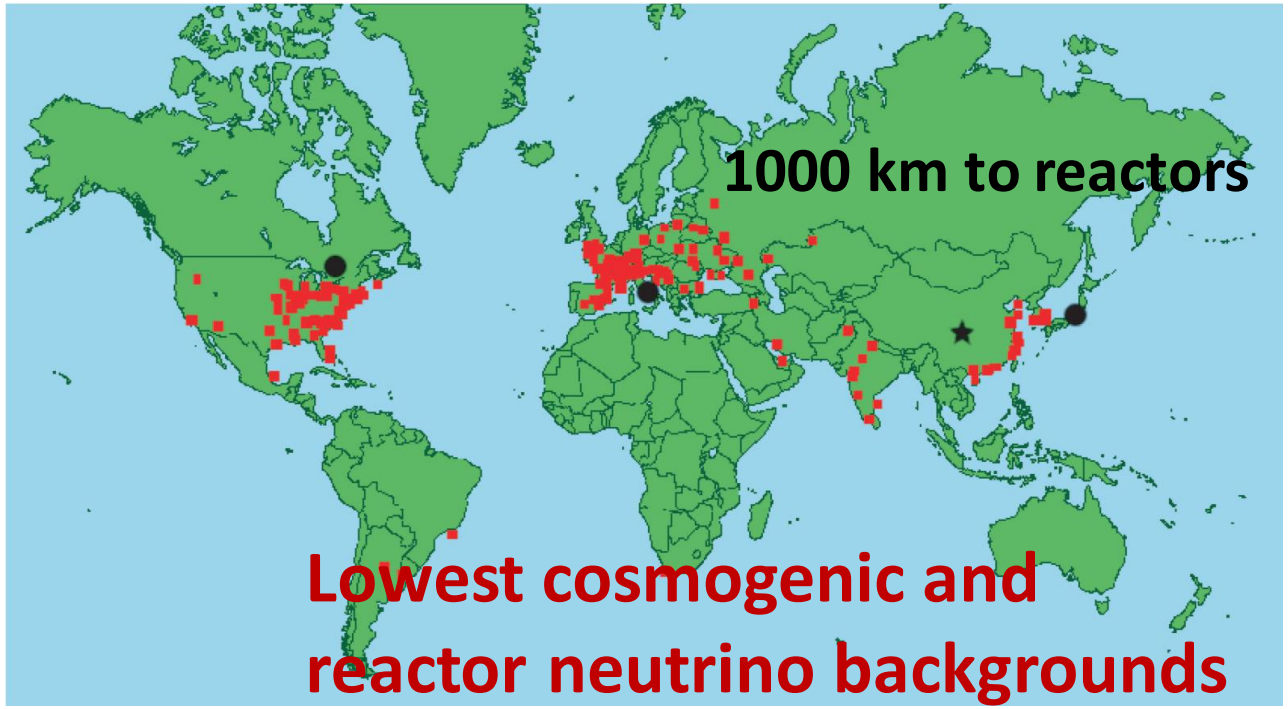
Outline

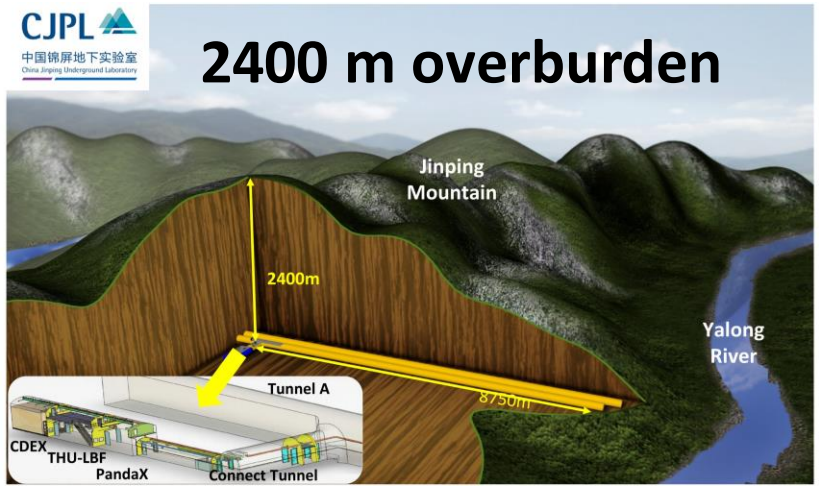
- **Near term goal of the project**

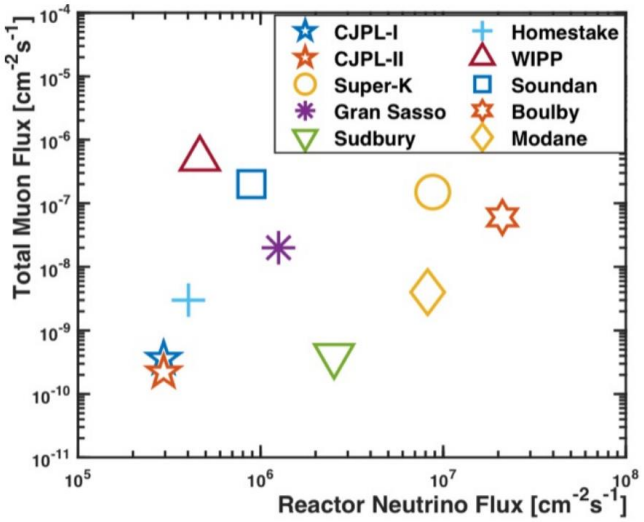
- **Detector and technology development**
- **Liquid scintillator development**
- **Summary**

Experimental site at CJPL

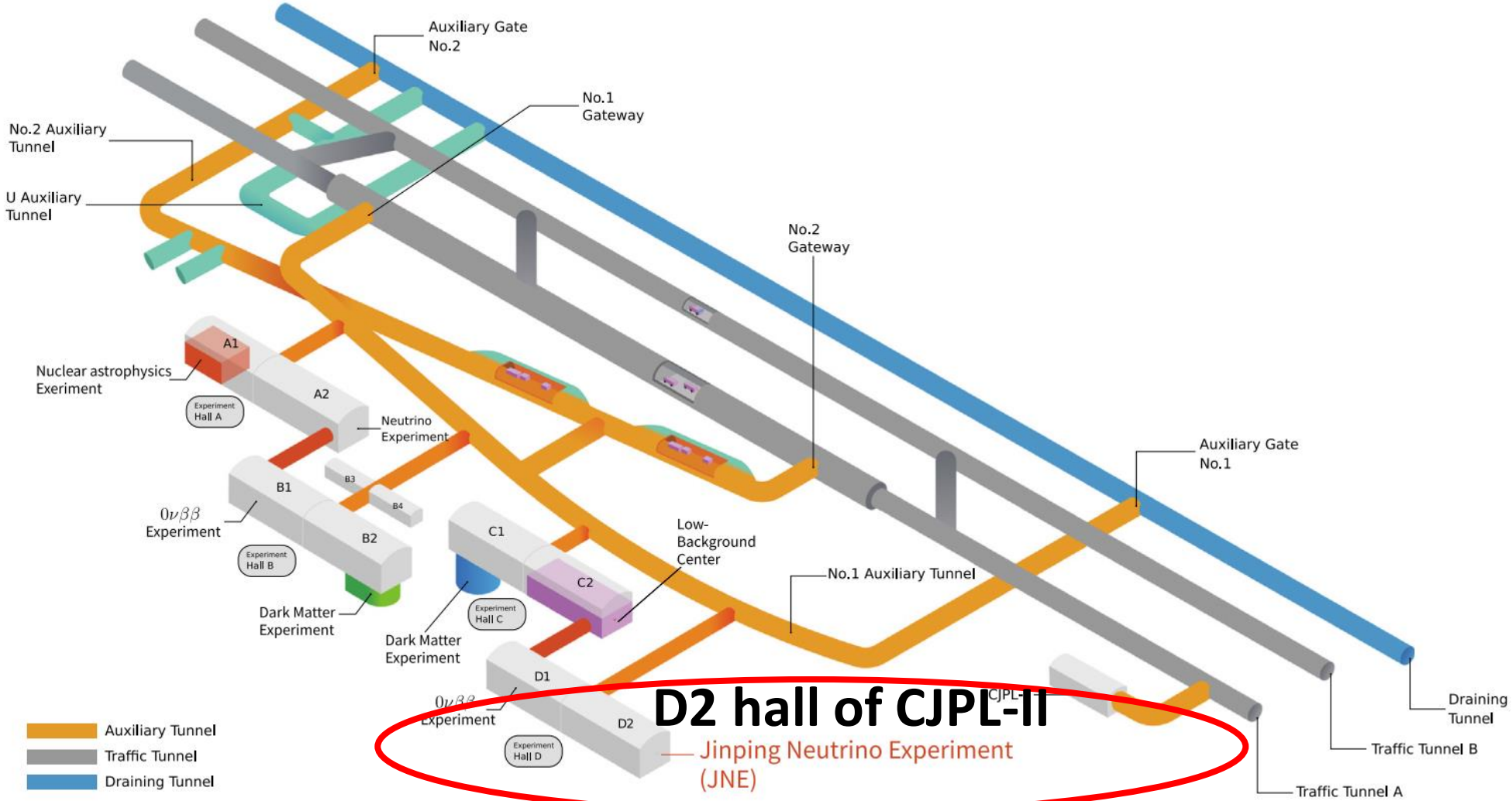
Solar neutrino observatory at China Jinping underground laboratory



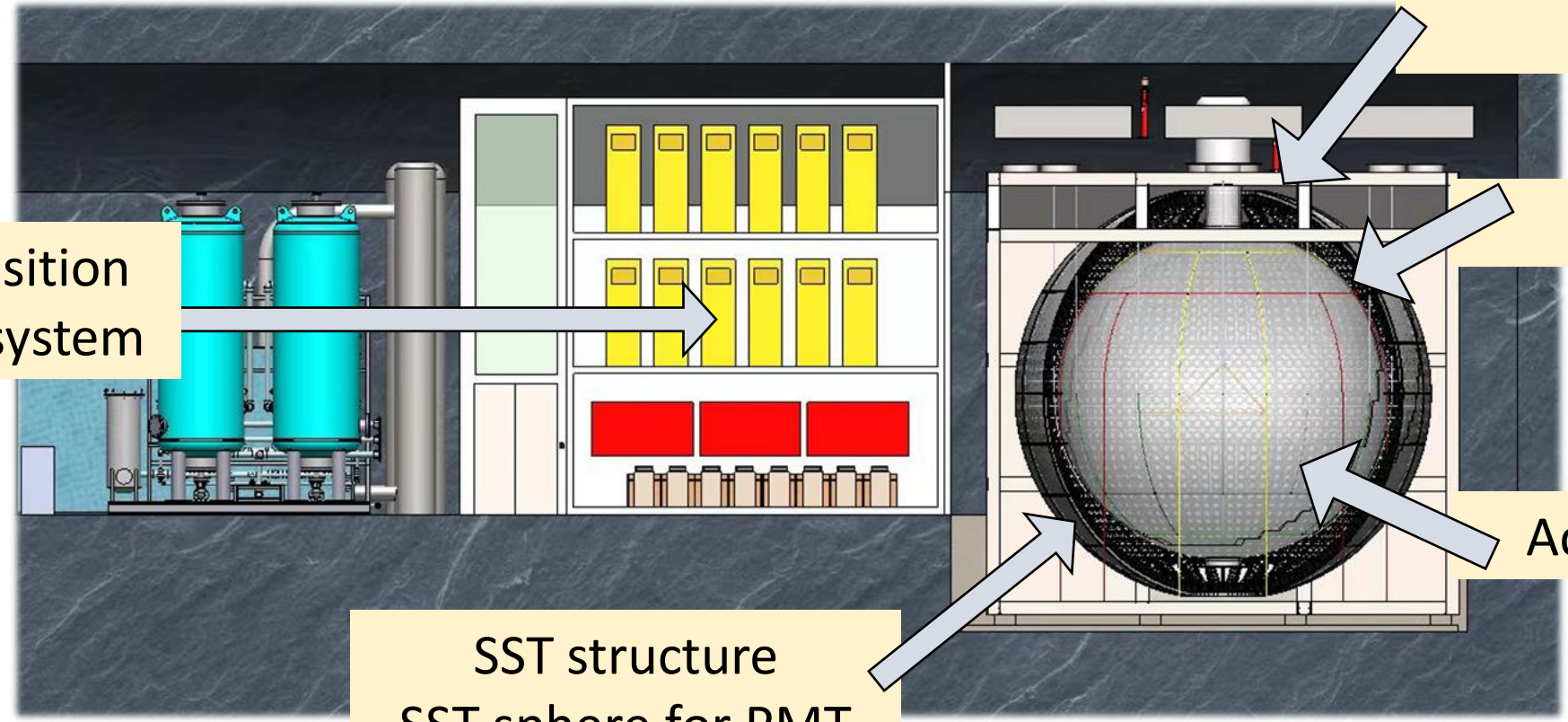




D2 hall of CJPL phase II



Concept of the detector



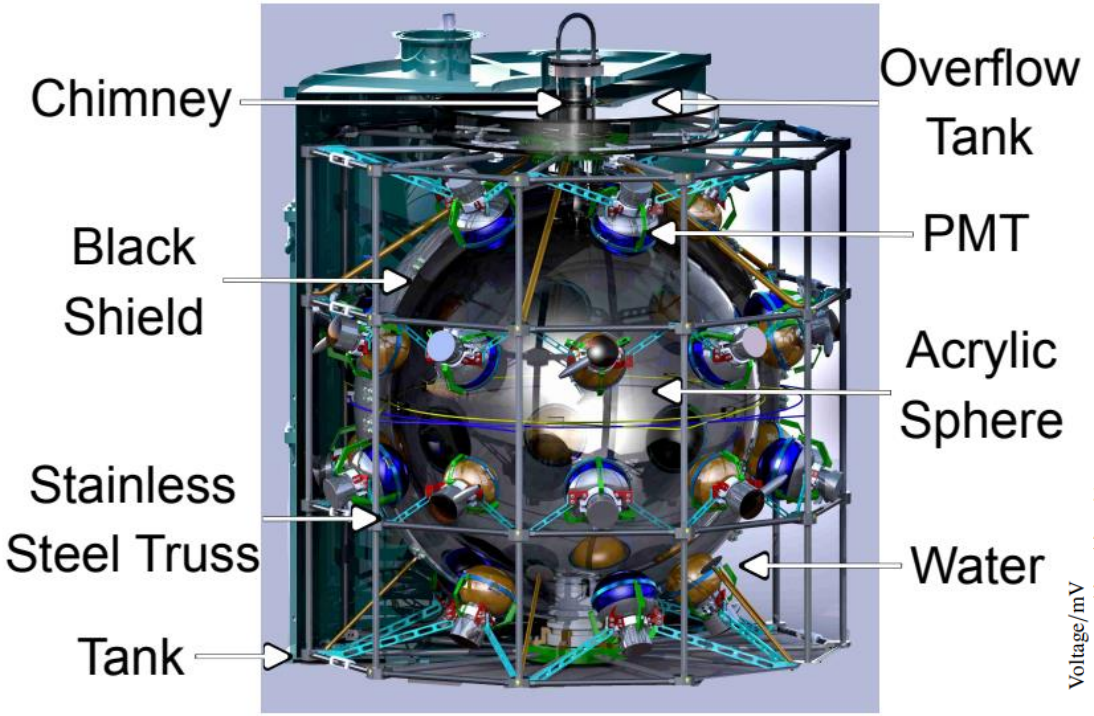
Short term goal

1. Hundred-ton solar neutrino observatory
   a. Detector construction
   b. Replaceable detection media, allowed density range ± 20% wrt water, oil- or water- based liquid scintillator
2. Low background PMT, U, Th<1 Bq/kg, K<2.4 Bq/kg
3. ADC chips and waveform readout electronics
   a. AD chips, 12 bit, 1 GSPS, 350 mW
   b. waveform readout, 400 MHz, 40 Gbps
4. Solar B-8 neutrino detection with water

Outline

- Near term goal of the project
- **Detector and technology development**
- **Liquid scintillator development**
- **Summary**

One-ton prototype

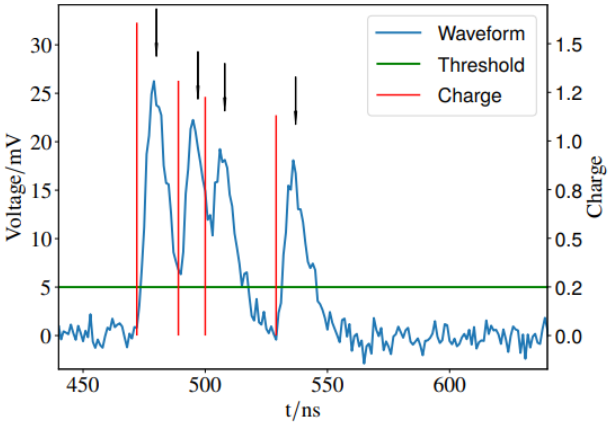


1-ton prototype at CJPL-I

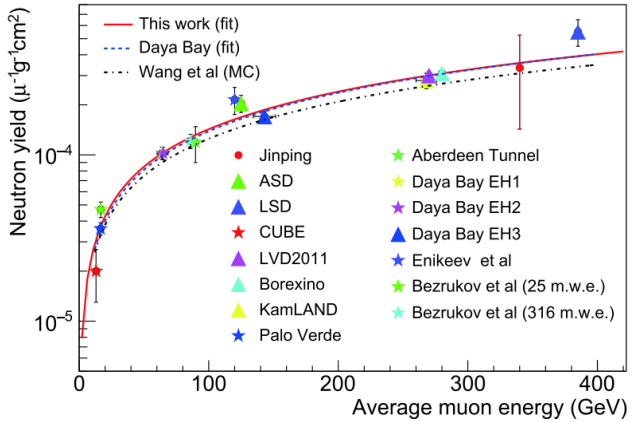
Running for ~5 years

Background measurement

		PMT	LS
Decay rate [Bq/g]	^{214}Bi	-	$(1.59 \pm 0.20) \times 10^{-8}$
	^{208}Tl	$(1.64 \pm 0.47) \times 10^{-3}$	-
	^{212}Bi	-	$<(1.01 \pm 0.20) \times 10^{-9}$
	^{40}K	$(1.24 \pm 0.35) \times 10^{-2}$	-
Contamination level [g/g]	^{238}U	-	$(1.28 \pm 0.16) \times 10^{-12}$
	^{232}Th	$(1.12 \pm 0.32) \times 10^{-6}$	$<(2.49 \pm 0.50) \times 10^{-13}$
	^{40}K	$(4.67 \pm 1.35) \times 10^{-8}$	-



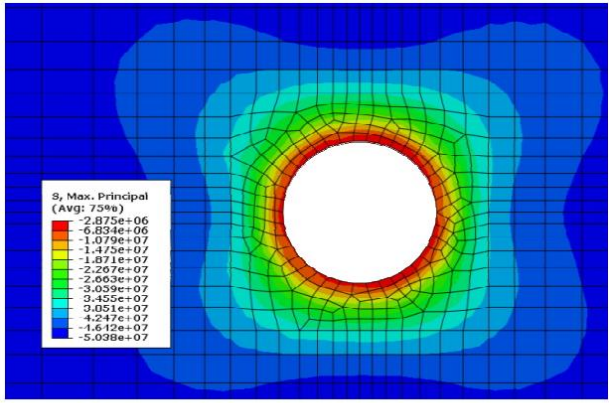
Waveform analysis, total reflection reconstruction



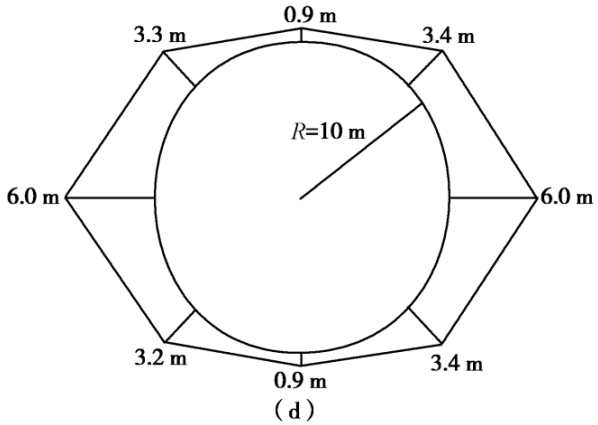
Muon flux and muon-induced neutron yield

One-ton prototype

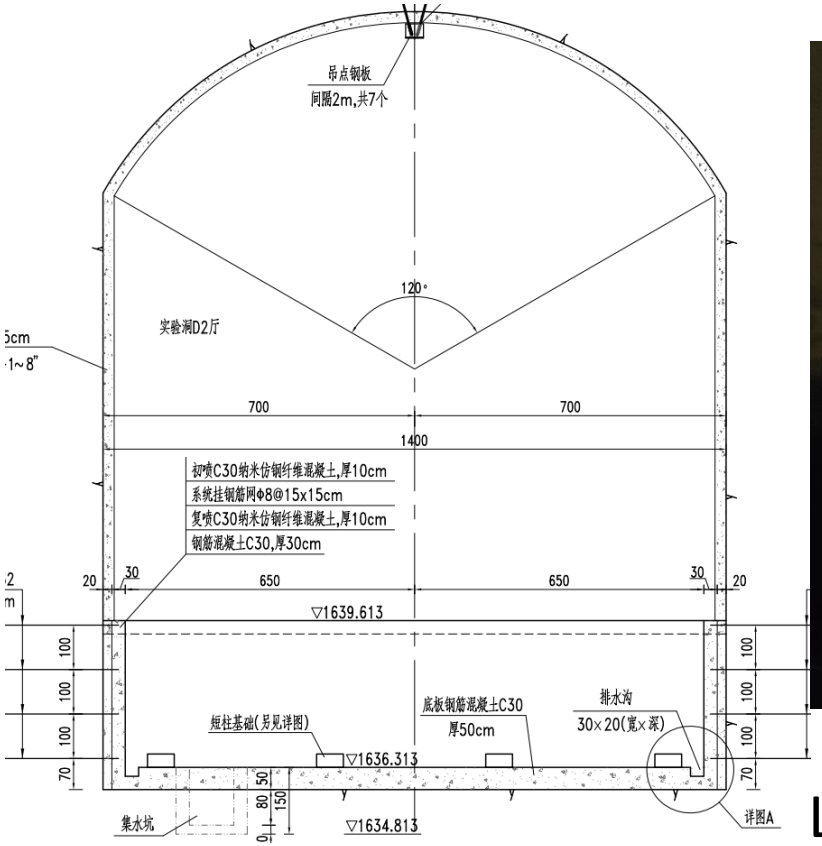
500-ton detector foundation pit



（a）最大主应力



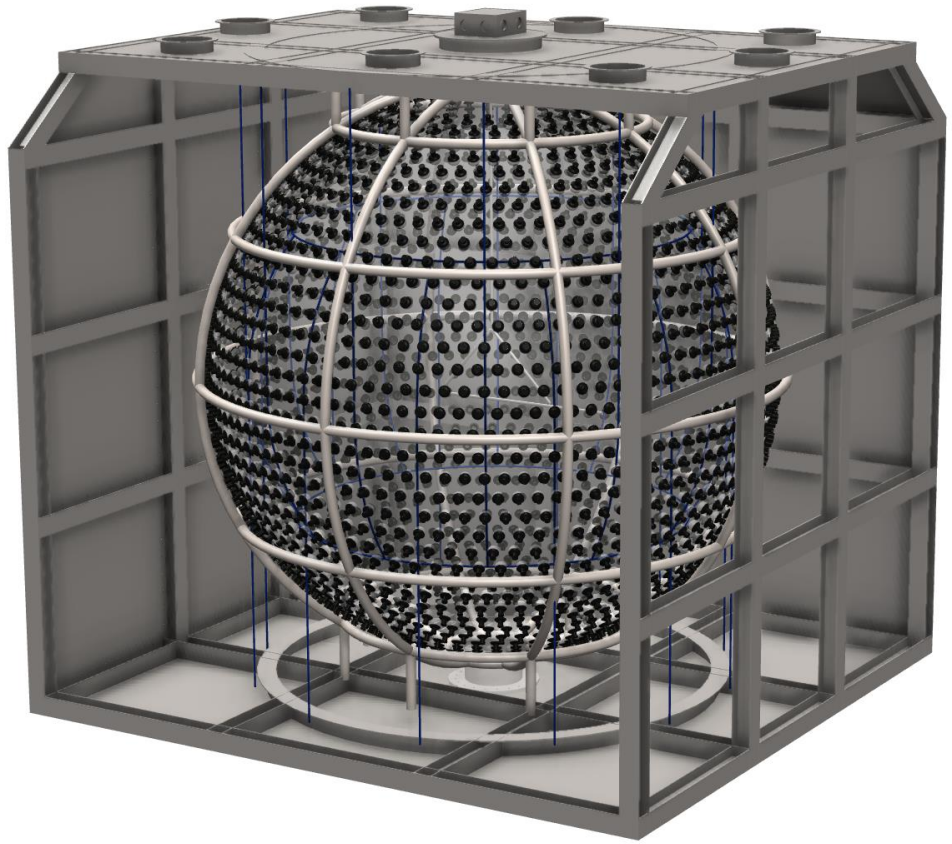
Damage zone study



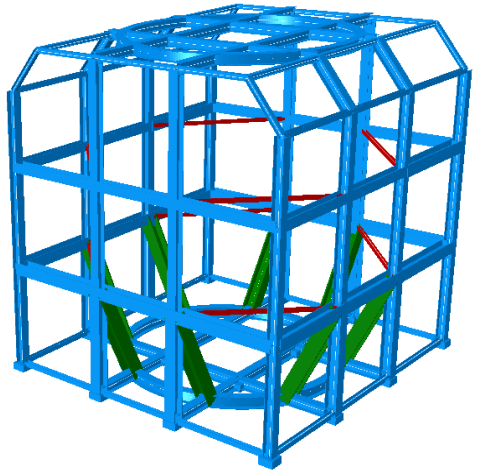
Detector foundation pit design

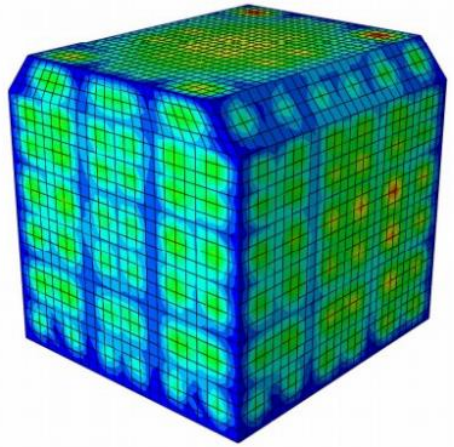
Last 2 month: Pit acceptance completed, 15.3m*13m*13m
Include water- and radon- proofed

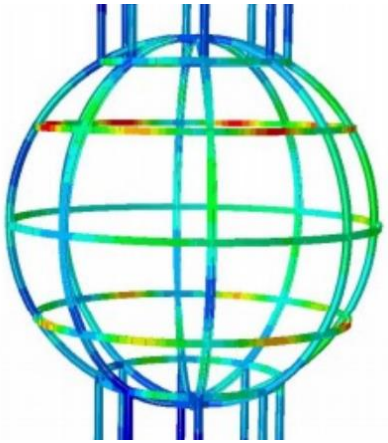
Detector tank and main structure



1. Contain veto water
2. Hold PMTs’ SST sphere
3. Hold central **gravity-buoyancy tolerant acrylic vessel**
4. Support instruments on top

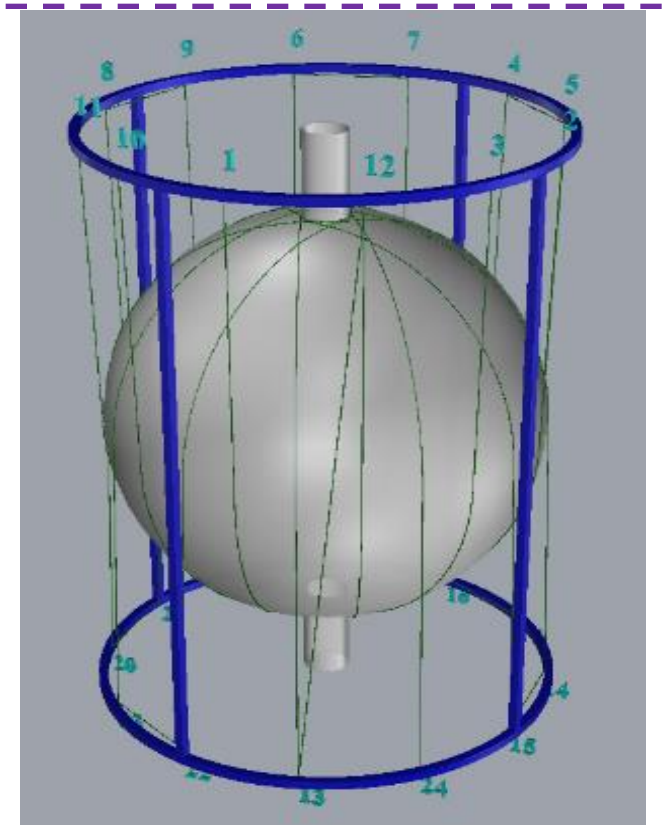




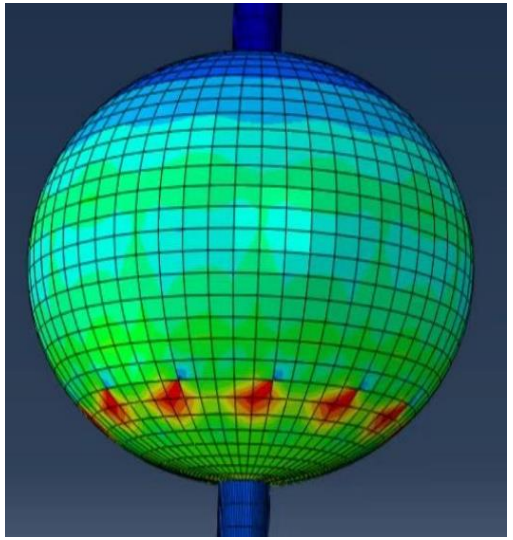


Rope to hold the central acrylic vessel

1. Acrylic vessel and rope
   a. 500 cubic meter
   b. Rope for low background
2. Rope net
   a. Gravity
   b. Buoyancy
3. Rope tension test
4. Creeping test
   a. in water
   b. in white oil



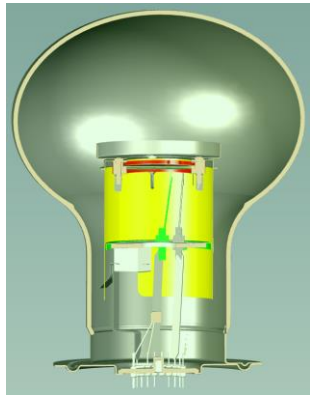
Replaceable detection media, allowed density range ± 20% wrt water, oil- or water- based liquid scintillator



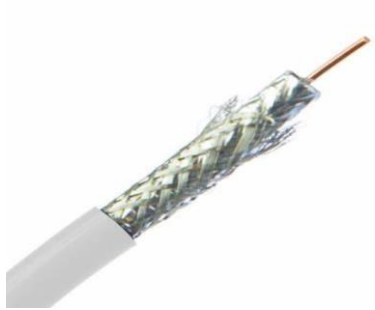
Joint PMT study with NNVT, IHEP

- 8-inch, MCP-based PMT, Low U、Th、K background, Fast, 30% DE
- See Performance evaluation of 20cm MCP-PMTs by Jun Weng

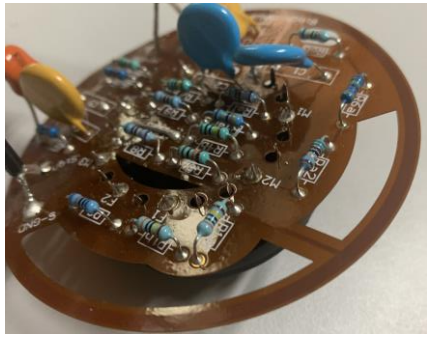
Raw material and production environment



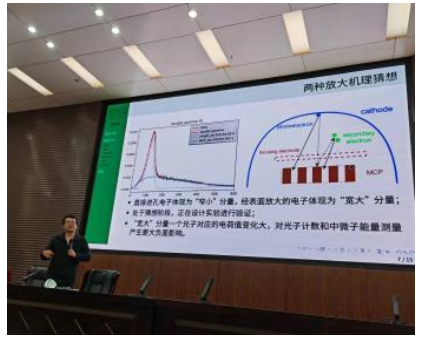
Structure improvement and part selection



Cable



HV divider



MCP magnifying

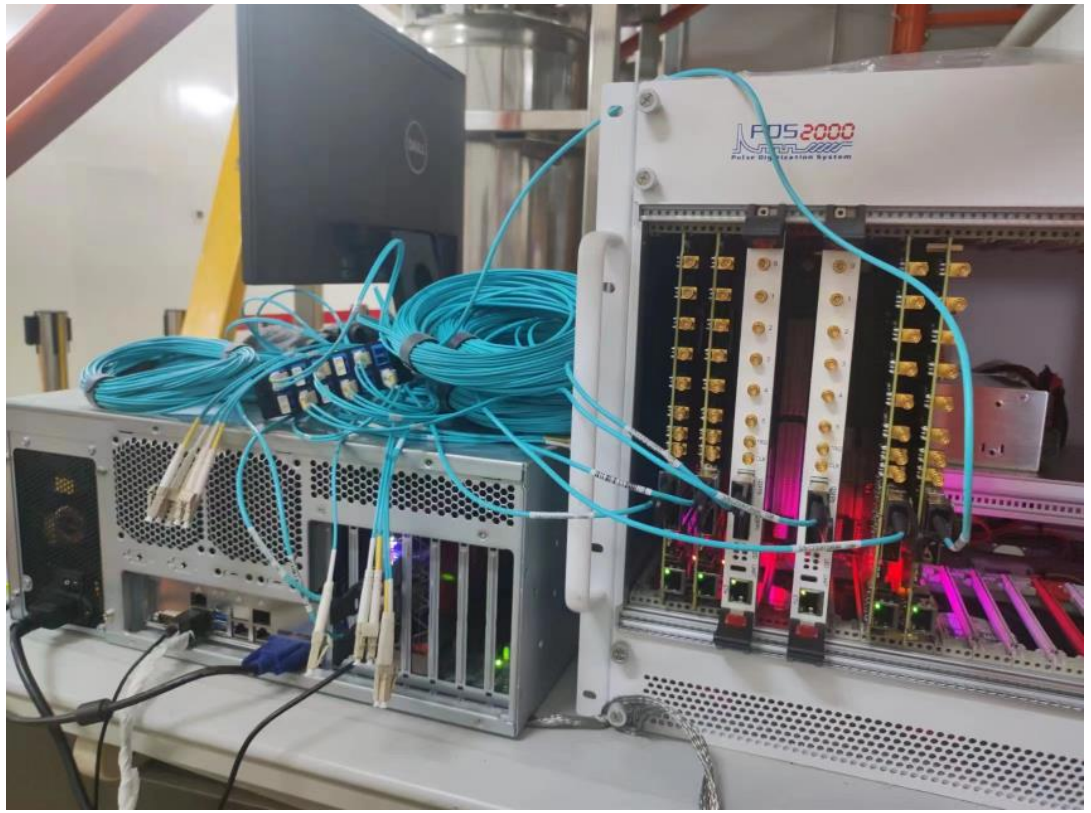
FADC and readout design and testing

Goal：

A、AD chip，Dual-channel，12-bit，1 GSPS，350 mW/ch；

B、waveform readout，4000 chs，40 Gbps readout bandwidth；

ADC chip Testing

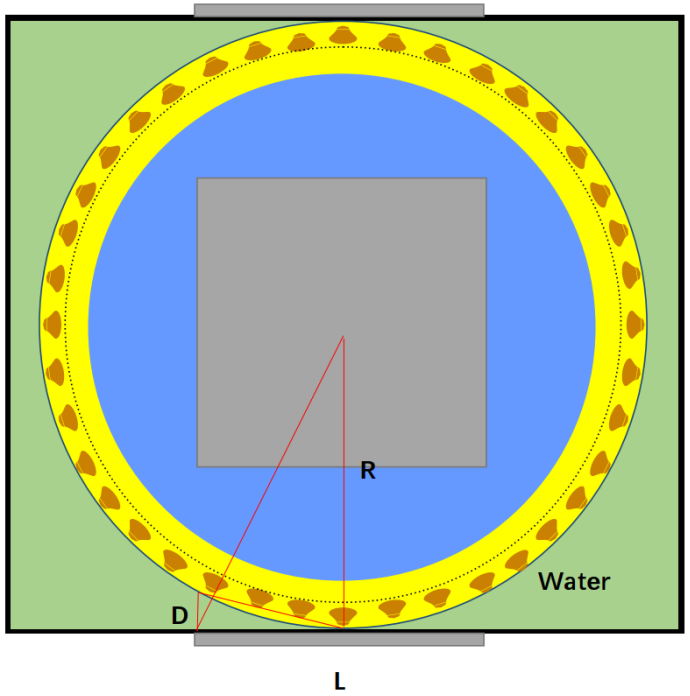


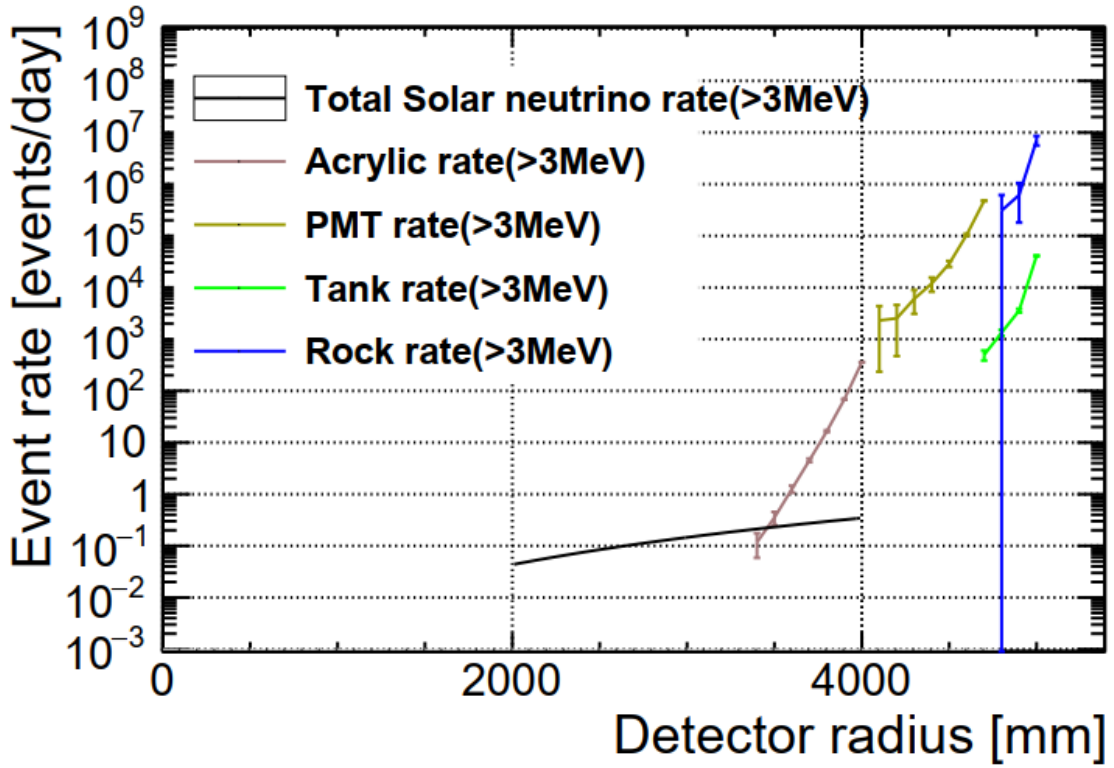
30 Ch Readout board testing

Solar B8 neutrino and background simulation

In the central zone of the detector, B8 neutrinos have a good signal-to-background ratio

a. Gamma, beta, neutron background simulation for PMT, steel structure, rock, water
b. Solar neutrino simulation





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- **Liquid scintillator development**
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Slow liquid scintillator

Slow Time Spectrum

Slow liquid scintillator

✓Good angular resolution

✓Good energy resolution

Water

✓ Good angular resolution

× Bad energy resolution

?

Oil (LAB)

× Bad angular resolution

✓Good energy resolution

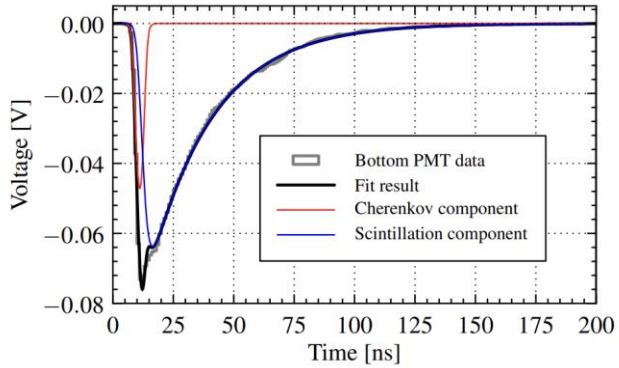
Fast Time Spectrum

Low light yield

High light yield

Slow LS Candidate:

- Oil-based Slow LS
  - LAB+PPO+bisMSB



- Water-based Slow LS
  - LiCL-water
  - See Development of metal-doped liquid scintillator by Ye Liang

Outline

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Summary

- Hundred-ton solar neutrino observatory at CJPL II
  - Detector construction
  - Replaceable detection media, allowed density range ± 20% wrt water, oil- or water-based liquid scintillator
- **New MCP-PMT**, Low background, fast, high QE (See Performance evaluation of 20cm MCP-PMTs)
- ADC chips and waveform readout electronics under design and testing
  - AD chips, 12 bit, 1 GSPS, 350 mW
  - waveform readout, 400 MHz, 40 Gbps
- Solar B-8 neutrino detection with water
- Explored the option with **LiCl aqueous solution** (See Development of metal-doped liquid scintillator)

JINPING NEUTRINO EXPERIMENT

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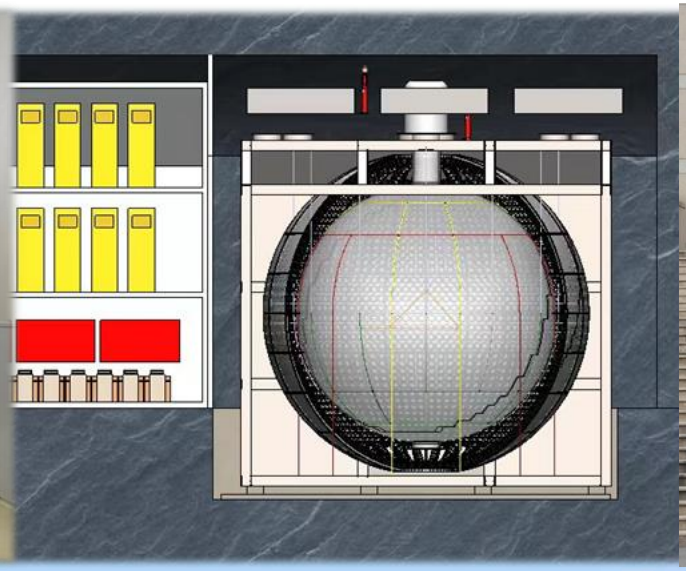

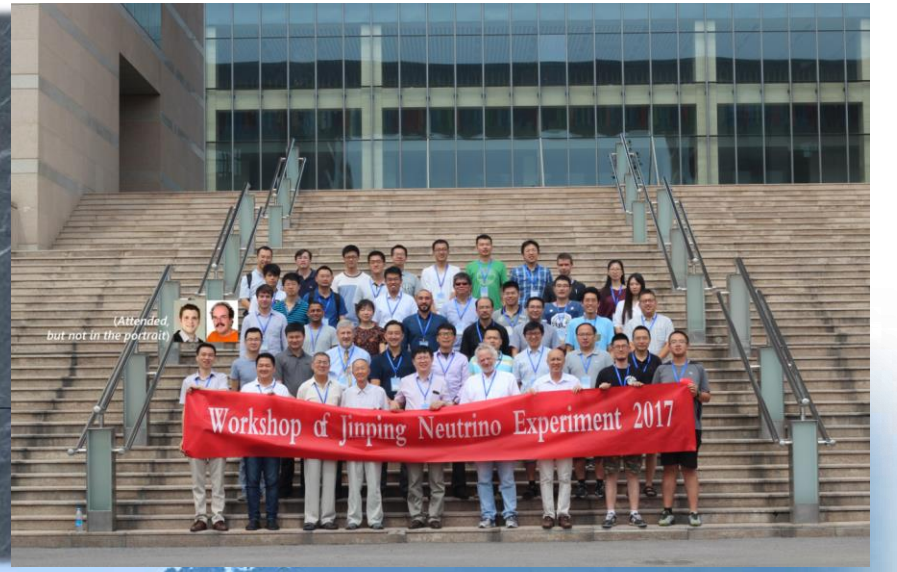

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Thank You!