China Jinping Underground Laboratory and Jinping Neutrino Experiment

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(for the research group)

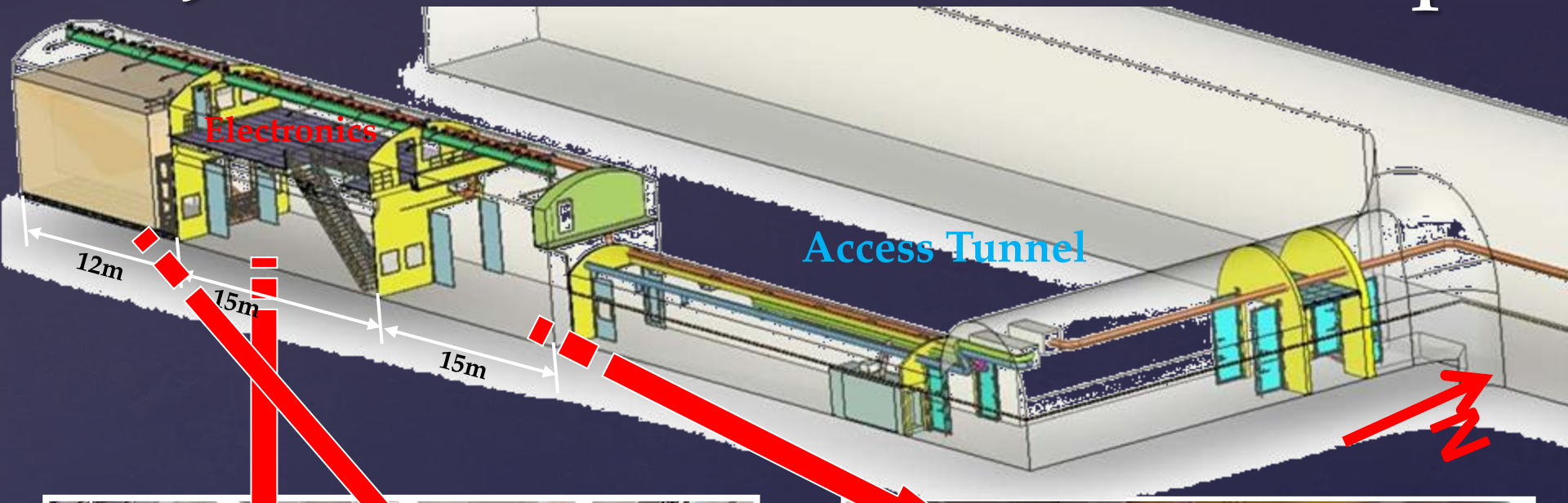
Nov. 5, 2016 at NNN'16, IHEP, China

Location of CJPL

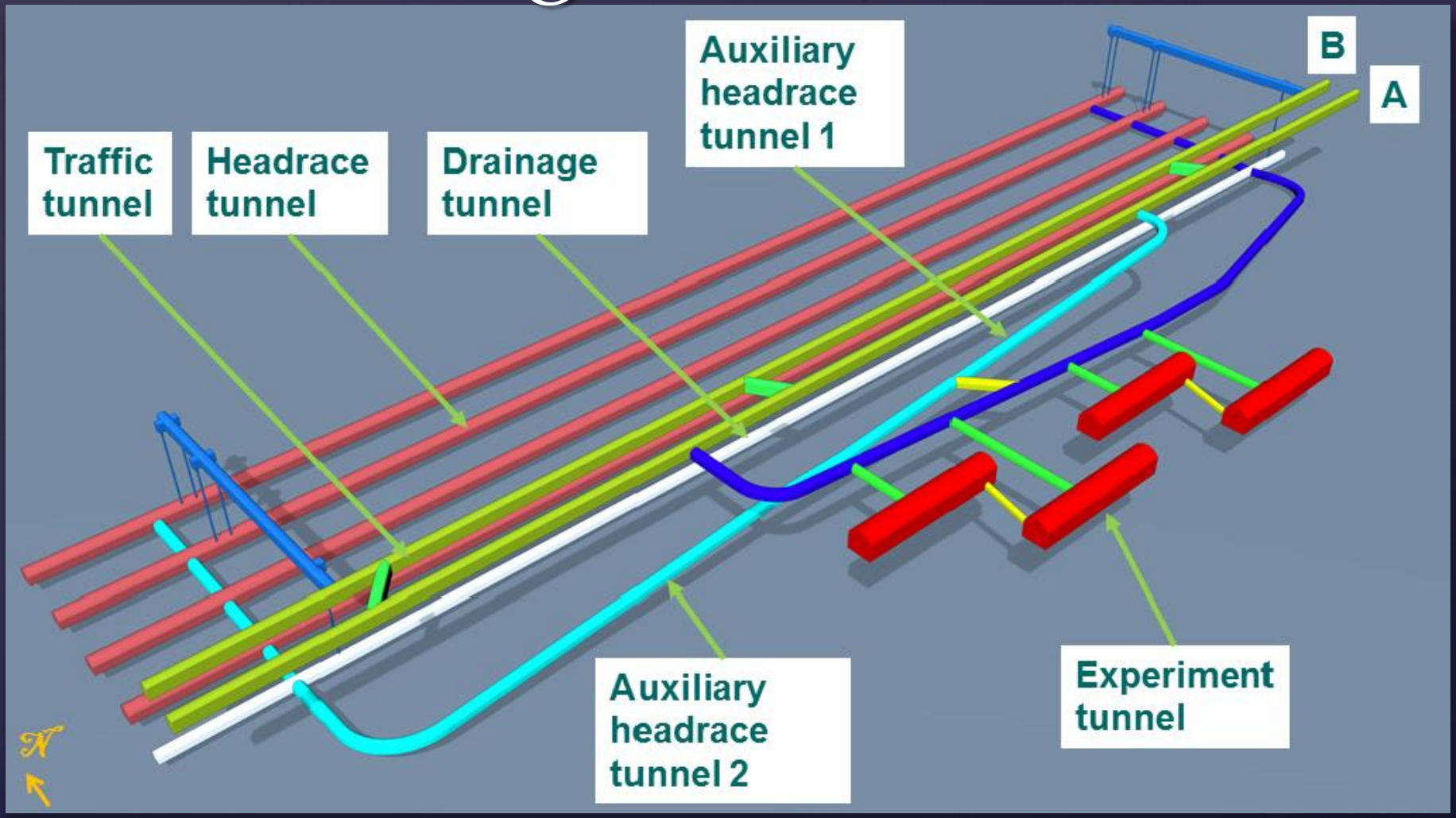
Travel:

1. To Xichang airport by air (from Beijing, Shanghai, etc.)
2. To Jinping laboratory by car (2 hours)

CJPL-I and Dark Matter Exp.



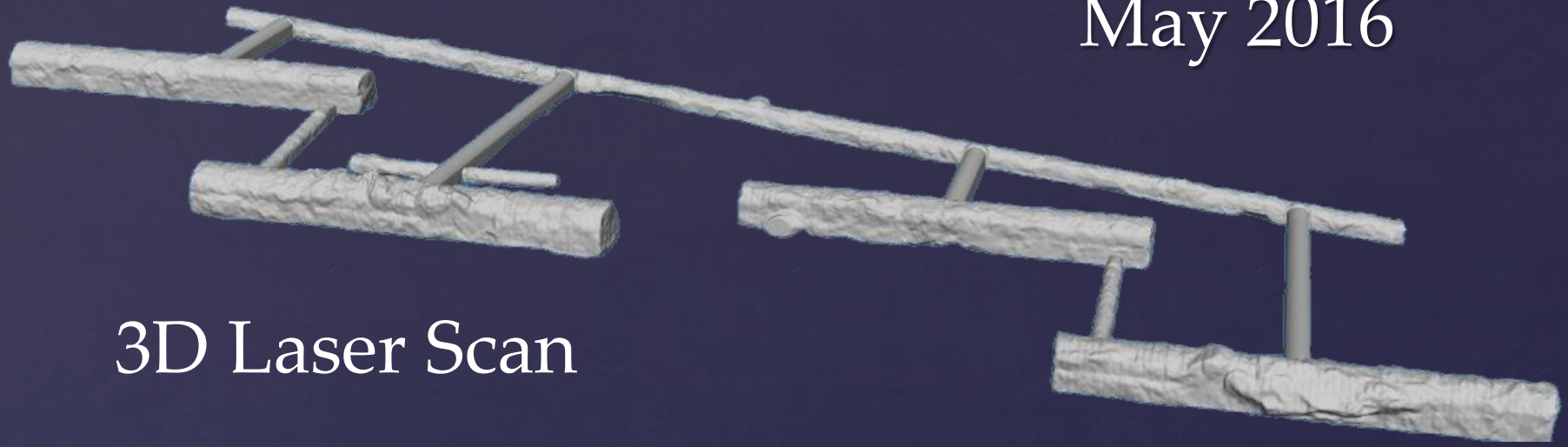
Design of CJPL-II



	CJPL-I	CjPL-II
Rock Work	4000 m^3	131000m^3

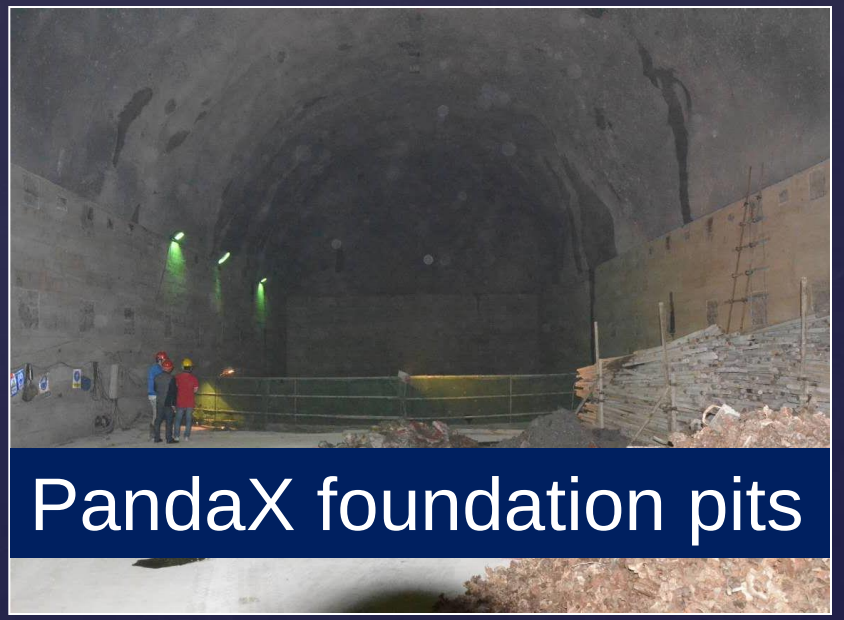
CJPL Current status

May 2016



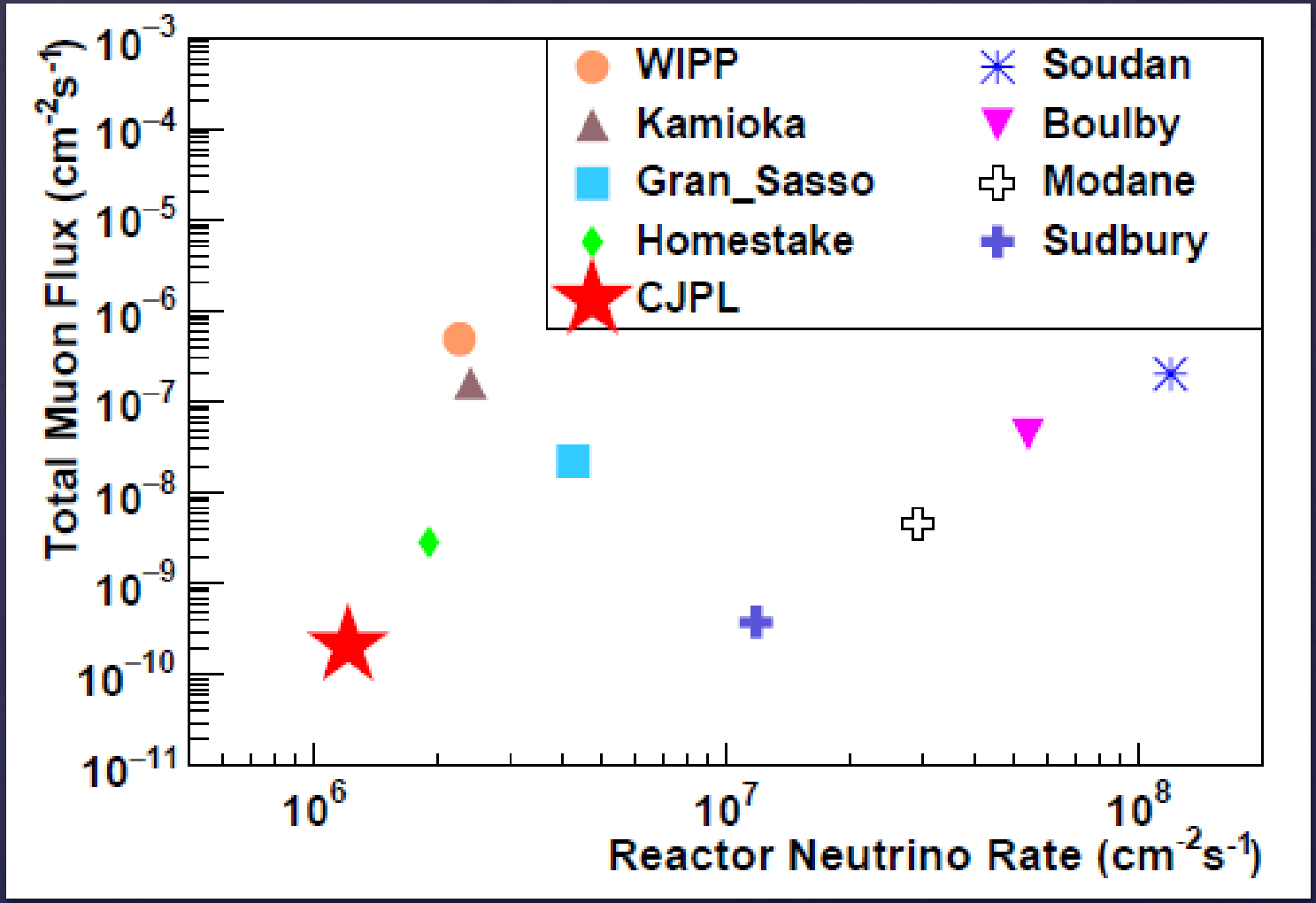
3D Laser Scan

CDEX foundation pit



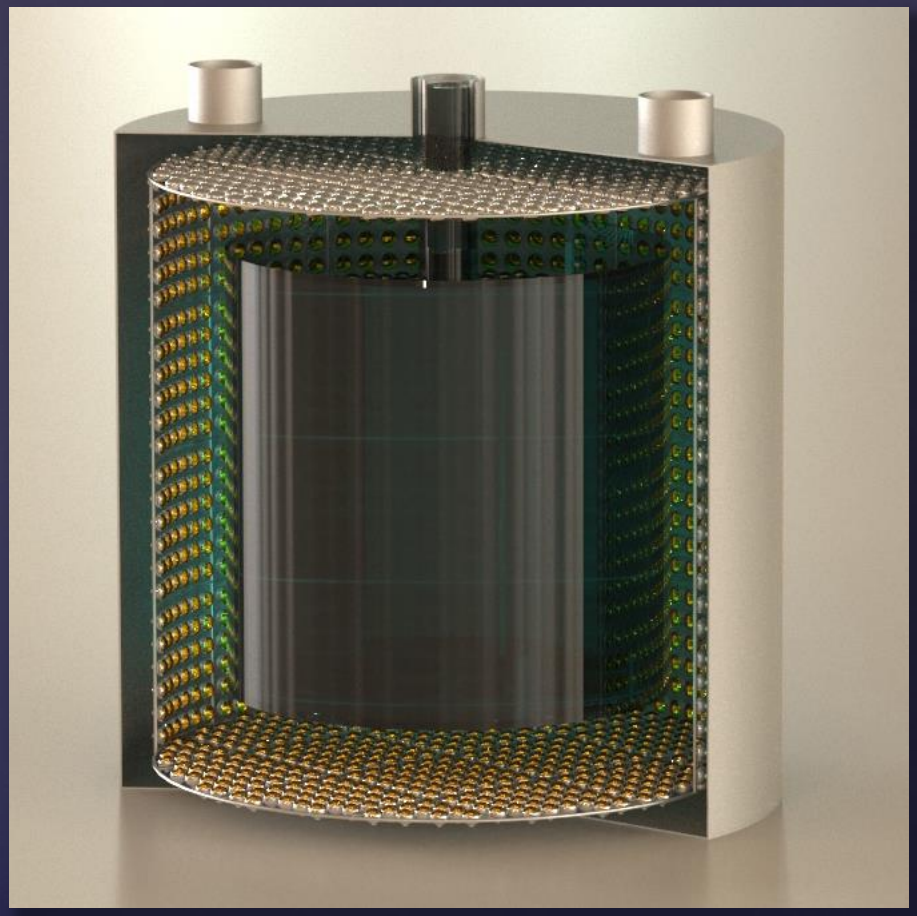
PandaX foundation pits

Ideal Low Bkg. Laboratory



→Overburden 2400 m←

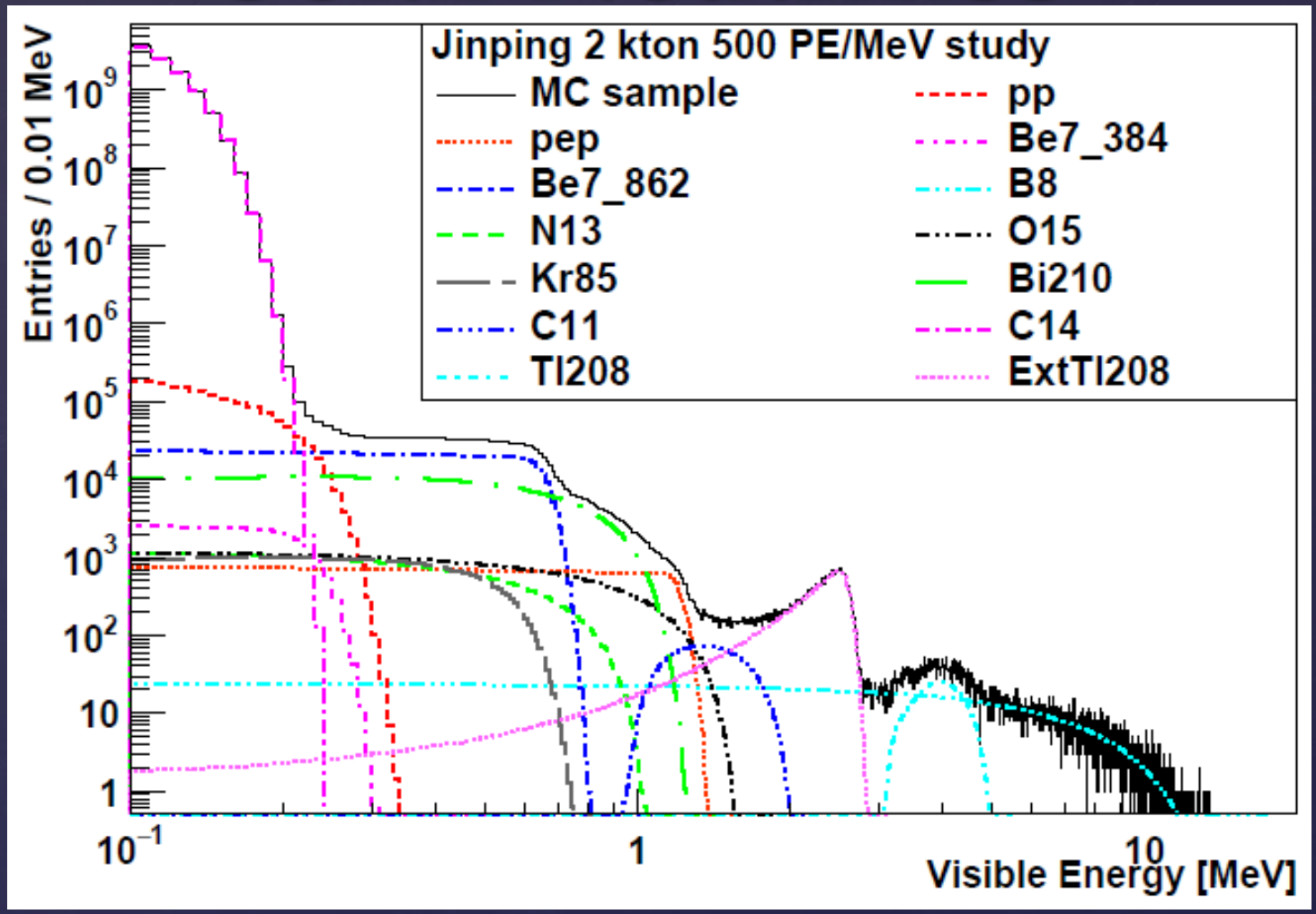
Jinping Neutrino Experiment



Or spherical detector

- TWO detectors
- Total fiducial mass 2000 tons (solar), 3000 tons (geo, supernova)
- Liquid scintillator or slow liquid scintillator
- ~20 m for height and diameter for each
- Light Yield>500 PE/MeV

Solar Neutrinos

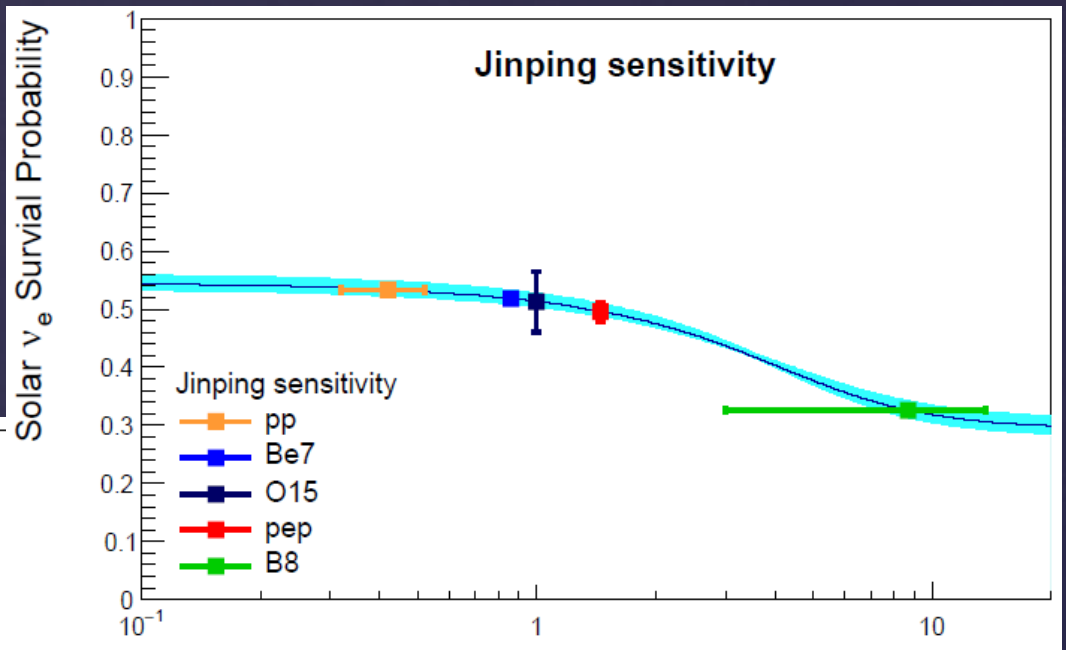


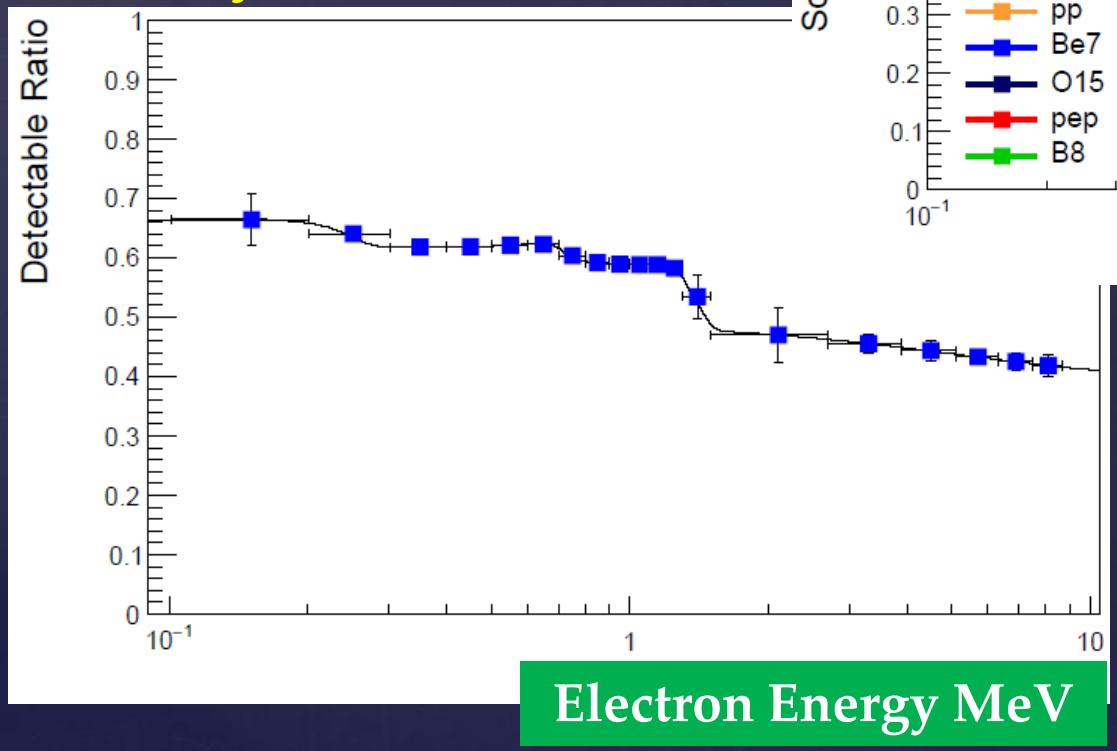
Simulation study with Borexino and Jinping assumptions.

Various target mass and resolutions studied.

Solar Neutrinos Oscillation

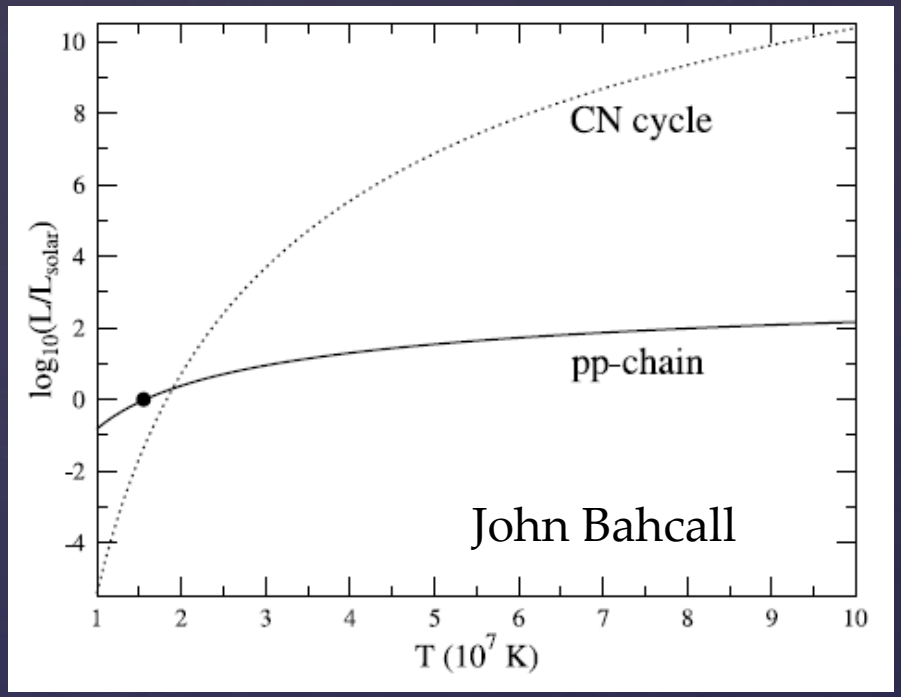
Tightly constrain neutrino oscillation upturn in Solar density

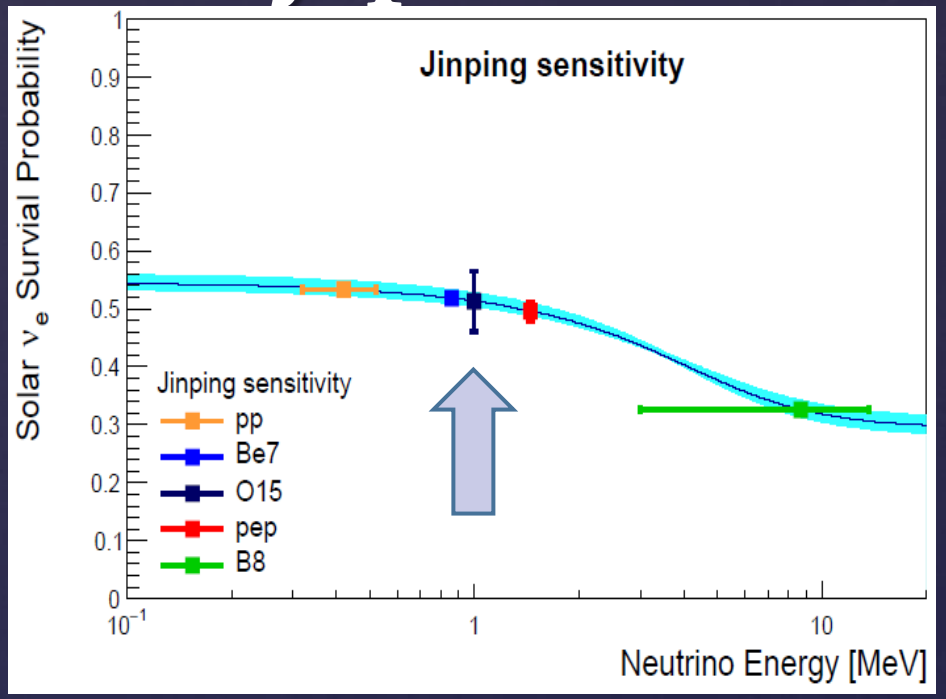




Reject or discover new physics (sterile, NSI, CPT)

Discover CNO neutrino
Address metallicity problem

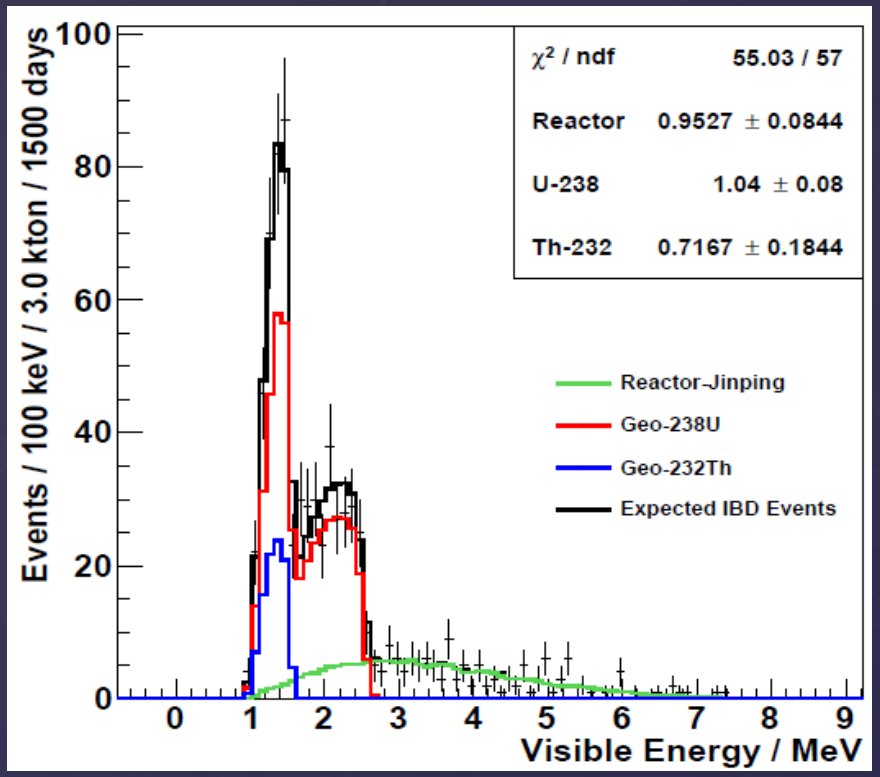


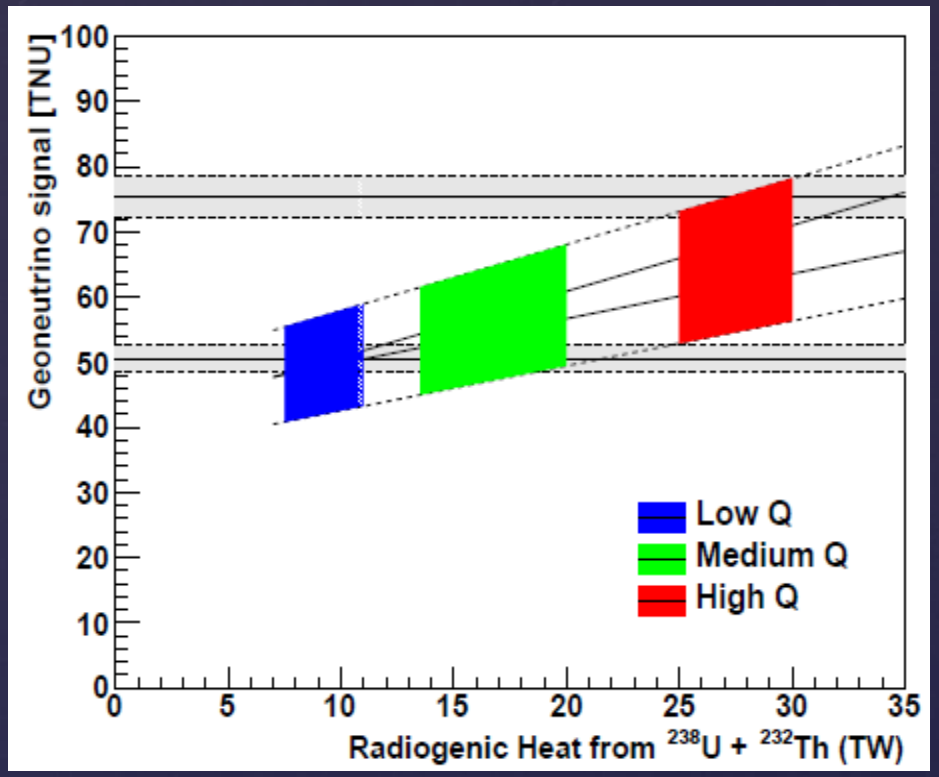


Above 15 MK CN fuel the stars

- Precise measure of all components
- Expected to discover CN ν
- O-15 precision 10%
- Direct proof for metallicity problem

Geoneutrinos





- U geoneutrino spectrum
- Th geoneutrino spectrum
- Th/U ratio ~ 10%
- Geo-reactor

- Address mantel contribution
- Geoneutrino flux prediction at Jinping

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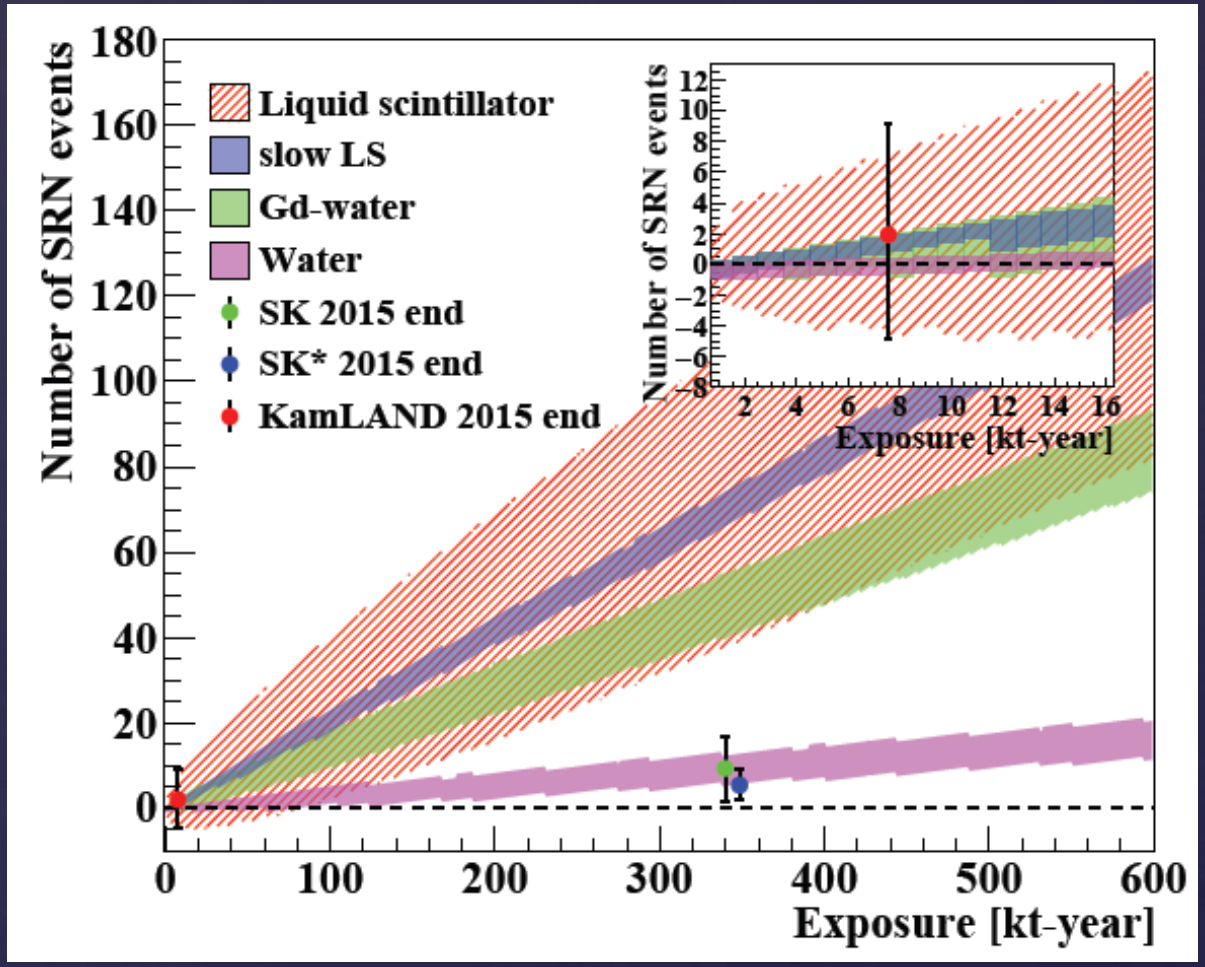
Supernova Relic Neutrinos

1. Liquid scintillator is fine with solar and geo-neutrino detection
2. Slow LS will strengthen solar nu detection
3. Slow LS is fantastic for SRN

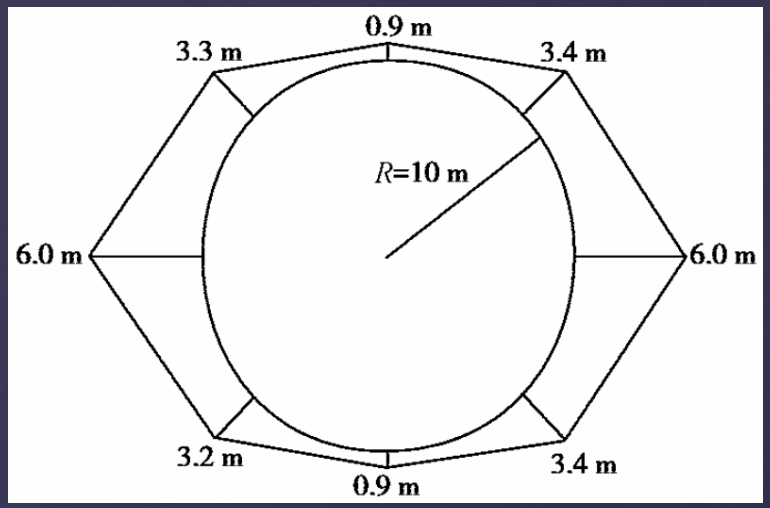


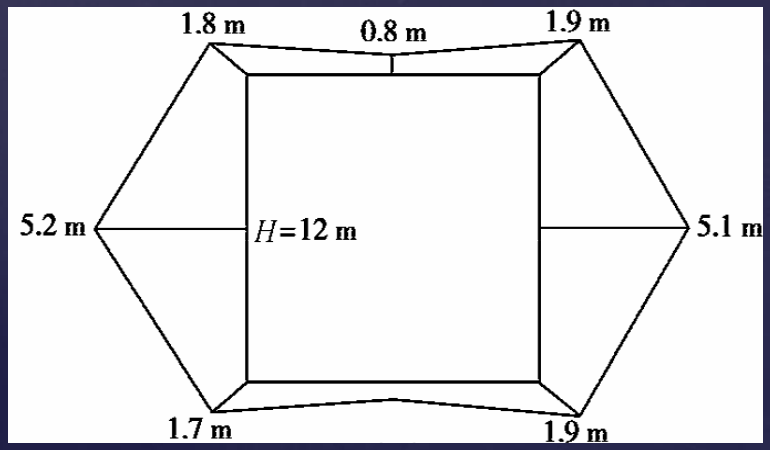
A 20-kton exposure with LAB may find the first golden SRN candidate.

ArXiv:1607.01671

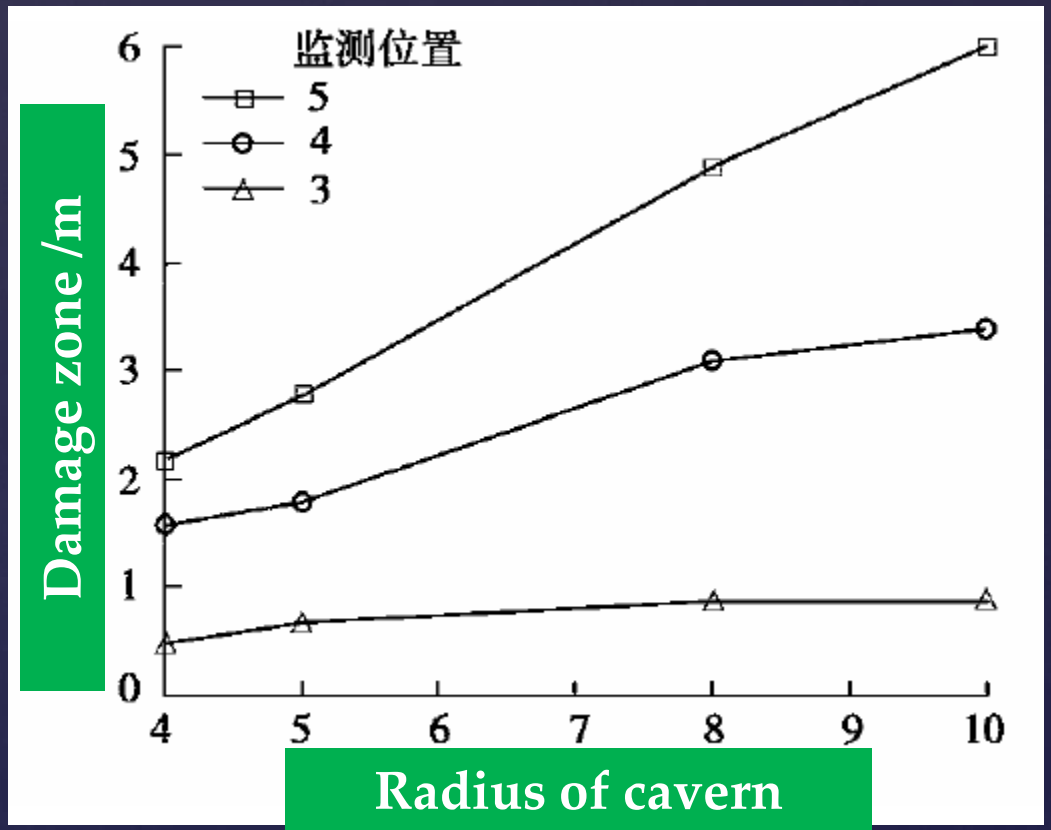
Rock Damage Zone

Damage zone shape



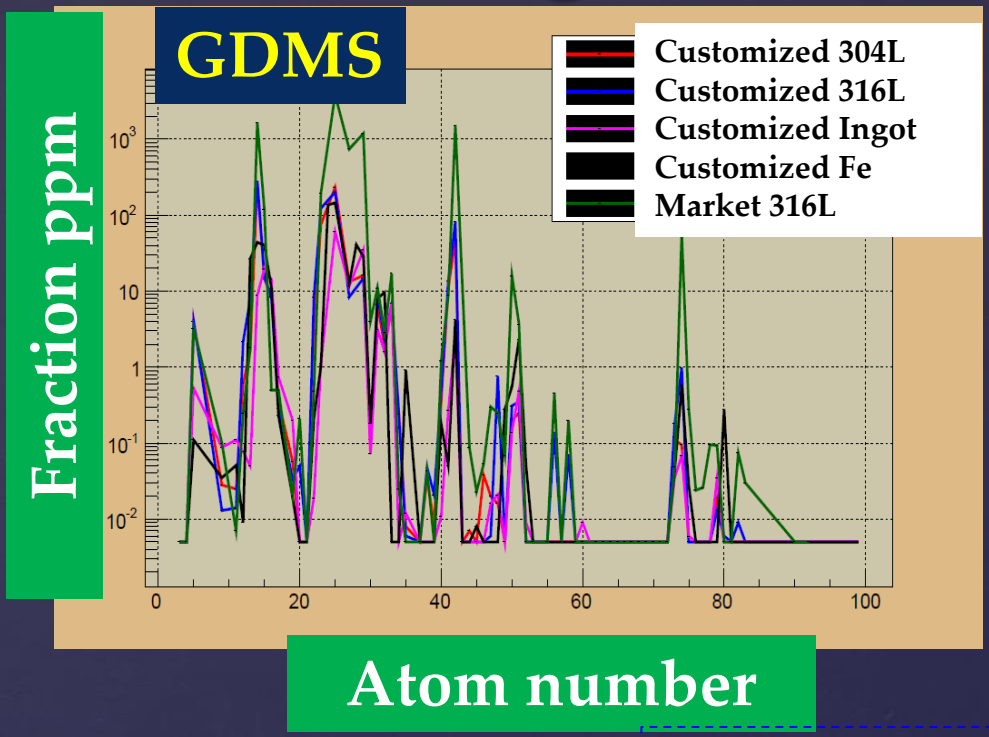


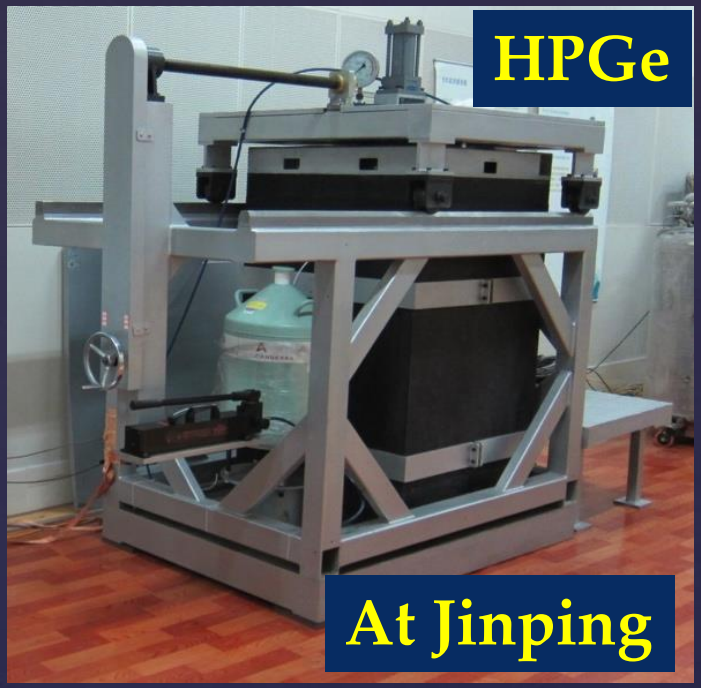
Rock simulation study under Jinping situation. Agree with Exp.



Chinese Journal of Geotechnical Engineering, Vol.38 Supp.2, 67 (2016)

Low background stainless steel





Results

1. Co60 ~1/10 of market sample
2. Tl208 ~1/10
3. almost all impurity ~1/10
4. K40 lowest
5. U, Th need more measurement

Mechanical Property of Acrylic

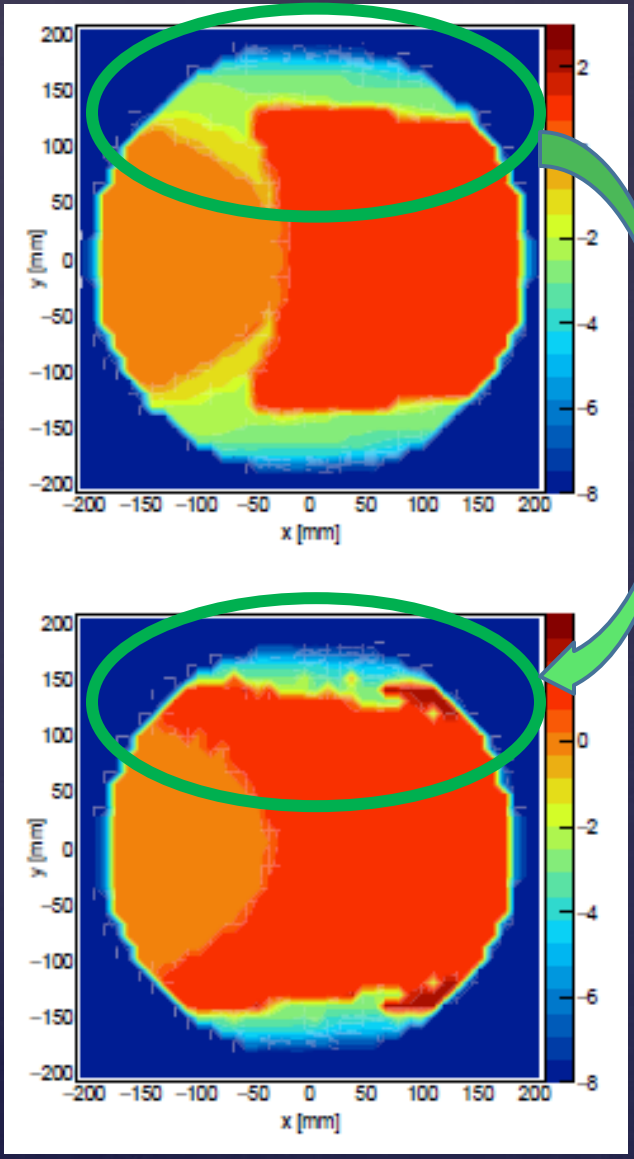
tensile-strength

impact ductility

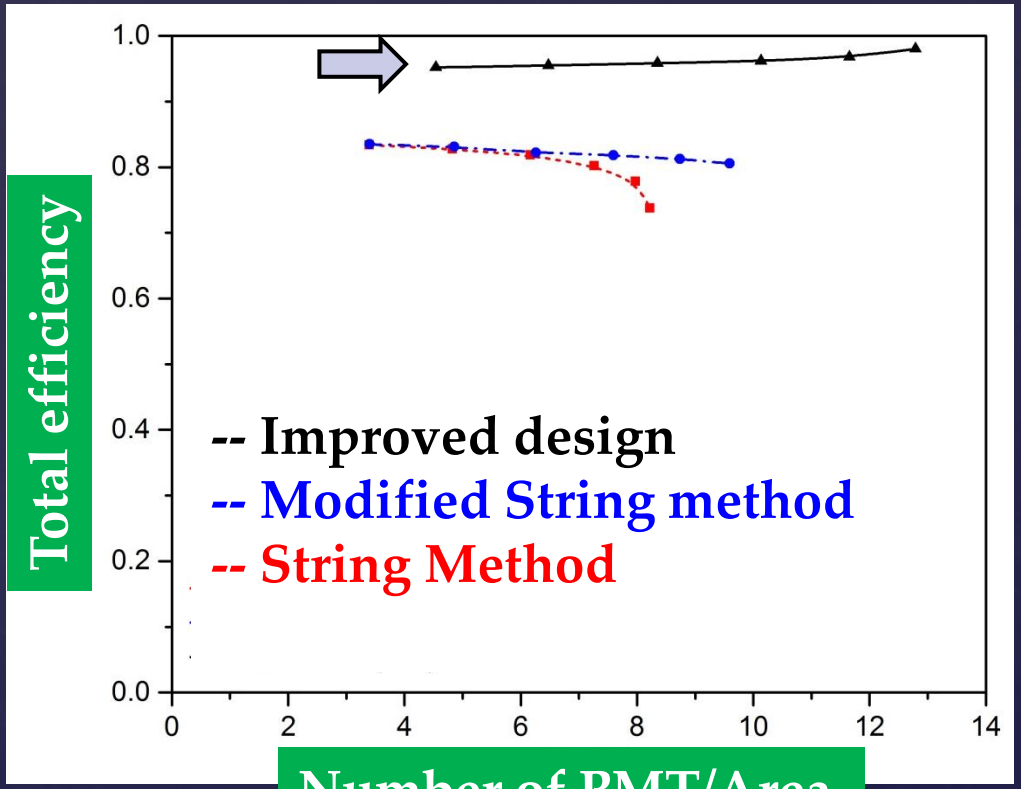
fracture toughness

These measurements played a key role in the 1-ton prototype design.

Improved Reflector (Winston Cone)

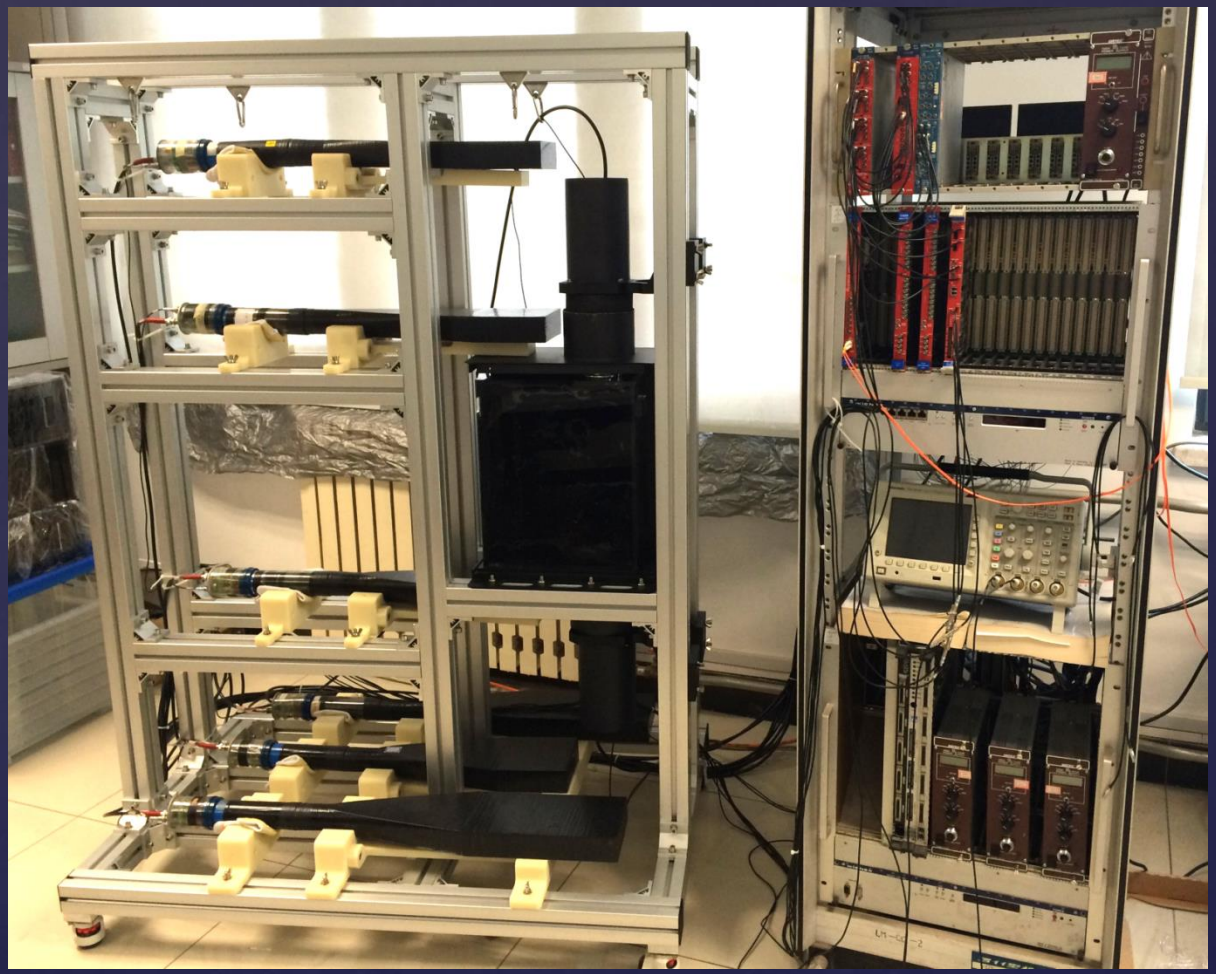


Improved design
Pro: 98% acceptance (20% more)
Con: 30% more PMTs

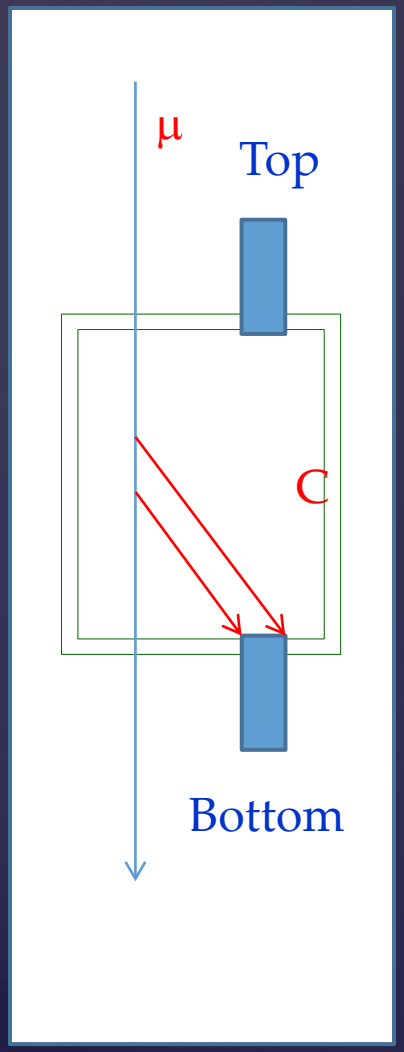


20 L Experiment

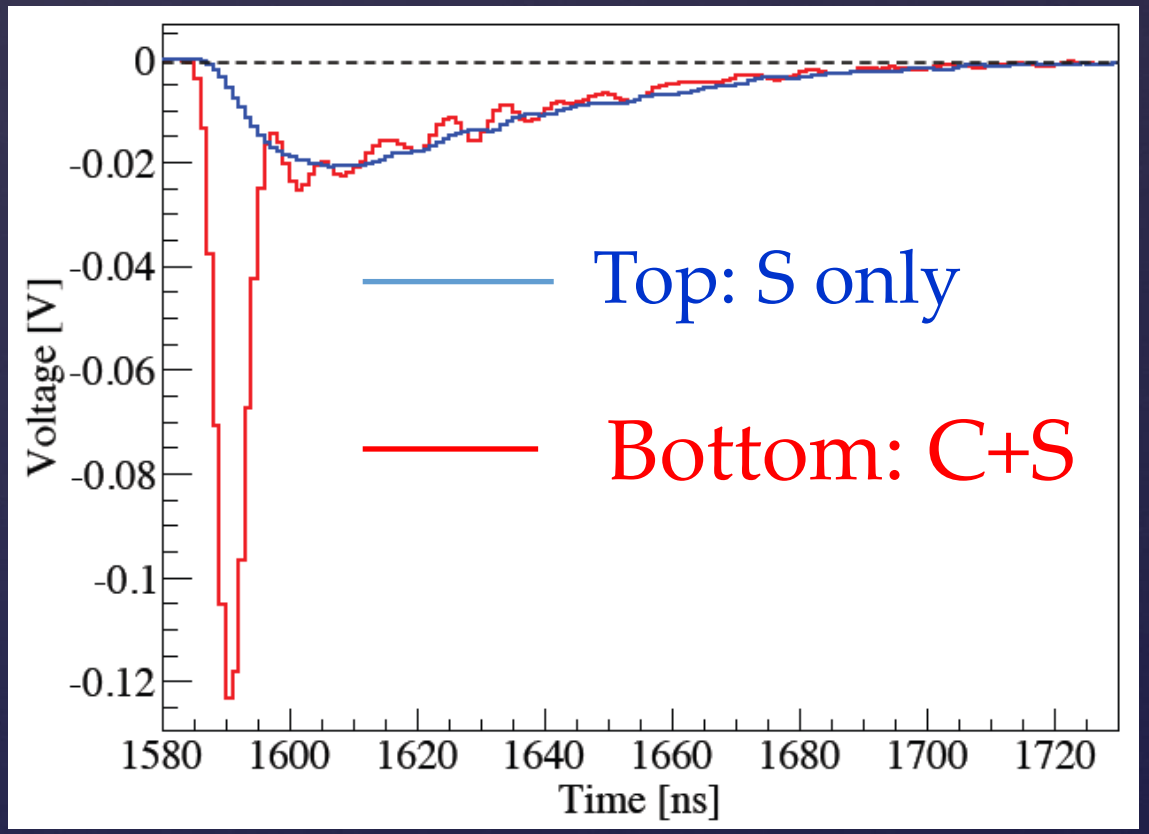
Measure Cherenkov and scintillation light time structure and light yield



LAB test and other liquid



Waveforms of top and bottom PMTs in LAB



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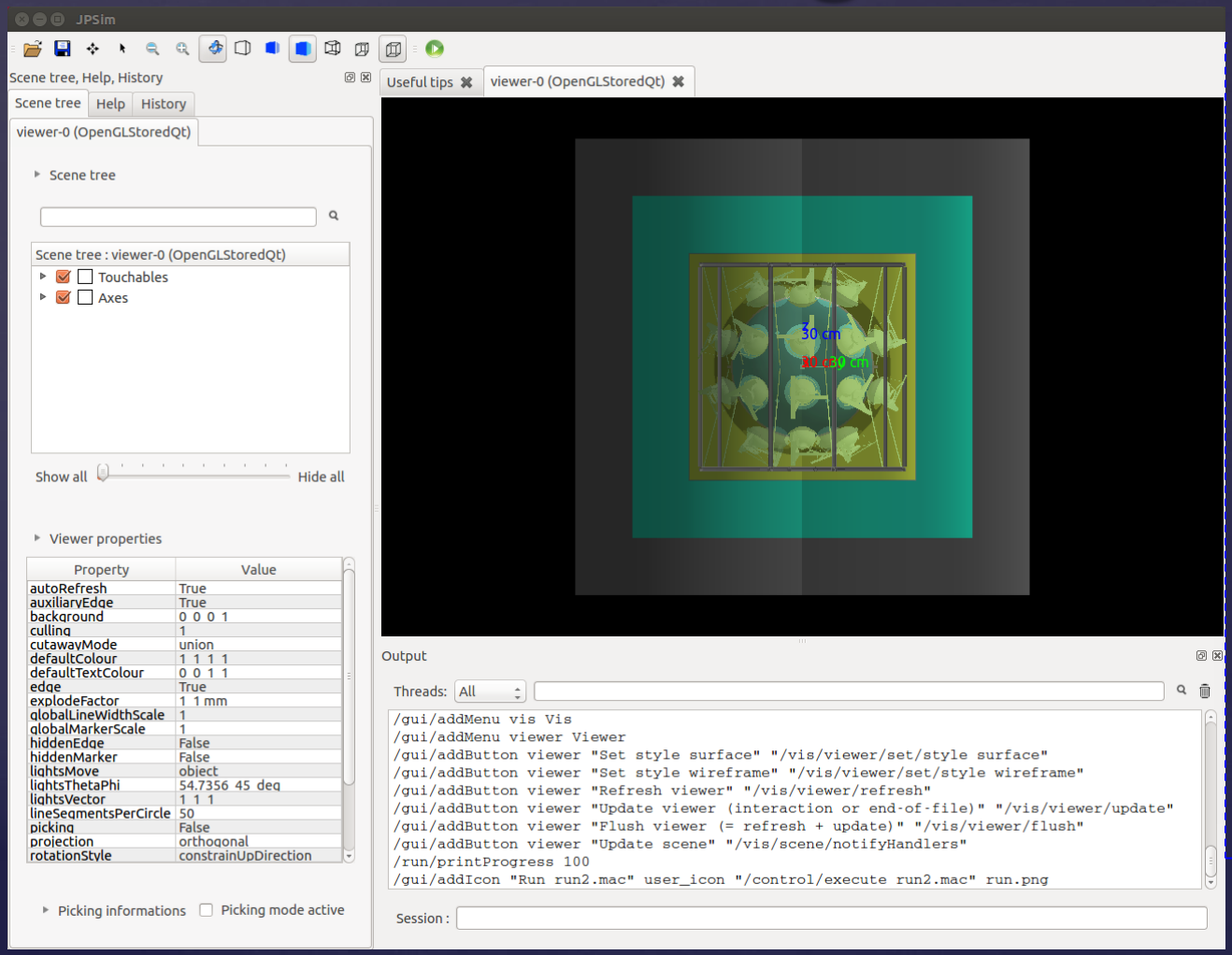
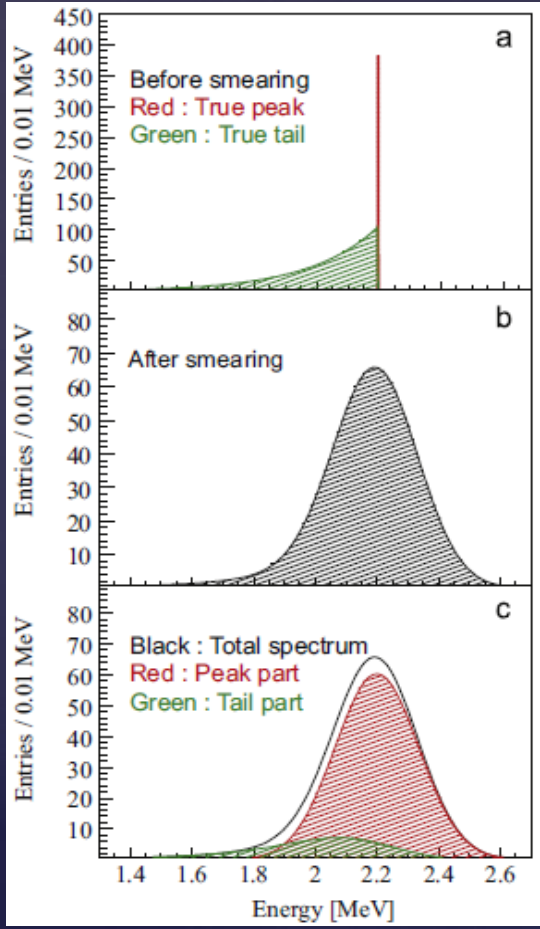
Jinping Simulation & Analysis Package (JSAP)



JSAP

1. **Comprehensive & Simple & Efficient**
2. Handle different geometry setup
3. **Waveform simulation**
4. Free flow style simulation
5. ...

Calorimeter Function, more physical Replacing Crystal Ball



Fit range	Calorimeter Best fit	Crystal ball Same range	Crystal ball Best fit
Liquid scintillator			
Peak accu.	−0.042%	−0.80%	−0.53%
Resolution accu.	0.044%	4.8%	1.9%
Peak area accu.	−0.59%	22%	19%
χ^2/NDF	119/118	9027/120	115/47
Calibration source			
Peak accu.	0.0054%	−0.40%	−0.25%
Resolution accu.	0.22%	5.8%	2.6%
Peak area accu.	−0.095%	18%	14%
χ^2/NDF	59/35	5197/35	81/15
CsI crystal array			
Peak accu.	−0.18%	−1.2%	−1.1%
Resolution accu.	0.15%	7.3%	5.5%
Peak area accu.	17%	128%	124%
χ^2/NDF	378/395	8383/395	1411/176

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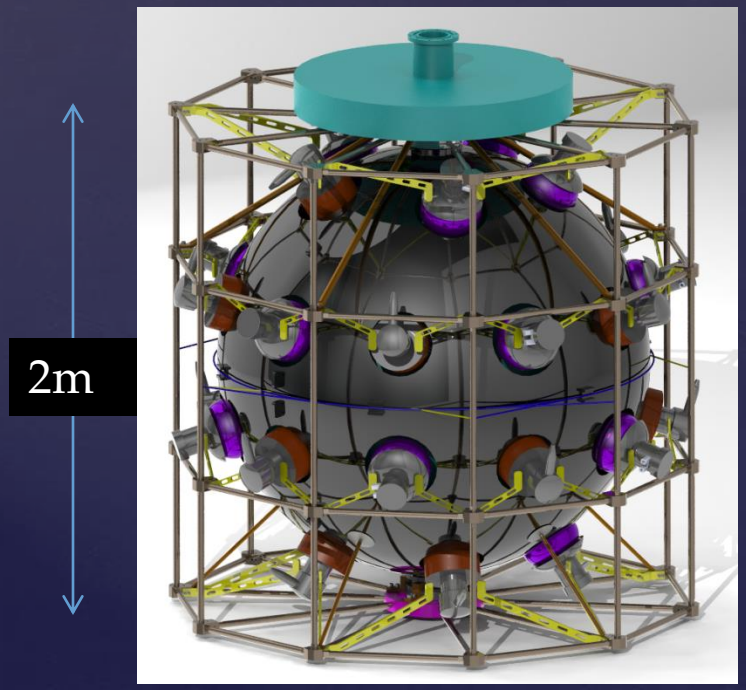
1-ton Prototype

1. Detector design and fabrication
2. Measure fast neutron background
3. Test detection material: water, LS, and slow LS
4. A low bkg. facility

Schedule:

1. Deliver the main body in 2016/12
2. Full assembly by 2017/03
3. Take data in 2017-2018



Design

Fabrication

A 10~100 ton Prototype

a）Verify detector design, fabrication, and operation
b）Test neutrino detection target material
c）Low background target material
d) Ready for a kilo-ton detector

Conclusion

- Jinping Neutrino Experiment is the next step to explore the nature
  - solar neutrino upturn constrained
  - discover CNO which fuels the stars
  - O-15 at 10%, direct evidence for metallcity
  - Th/U ratio, Th, U geo-nu spectra
  - slow LS -> golden SRN candidate
- Rock, SST, Acrylic, target material (Yalong river water) are under investigation
- Jinping simulation is in progress. Replace Crystal Ball function.
- 20-L test stand is in use
- 1-ton prototype is in progress
- 10~100 ton prototype is in plan

Thank you

Especially thanks the information given by CJPL (Zhi Zeng)

More detail of the Jinping Neutrino Experiment can be found at
http://jinping.hep.tsinghua.edu.cn