



Jian Tang

Sun Yat-Sen University, Guangzhou, China

On behalf of the Jinping neutrino working group

NNN2018, TRIUMF, Canada
November 3rd, 2018

Email: tangjian5@mail.sysu.edu.cn



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- **Motivations of such a neutrino experiment**
- **Physics prospects**
- **Status of the 1-ton prototype**
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Motivations

Physics prospects:

- **Missing data support in the transition from vacuum to matter in solar neutrino oscillations. New physics there?**
- **U/Th/K ratios inside the Earth with geoneutrinos?**
- **Valuable information in Diffusive Supernova Neutrino Backgrounds/Supernova relic neutrinos to be decoded?**

Technological readiness:

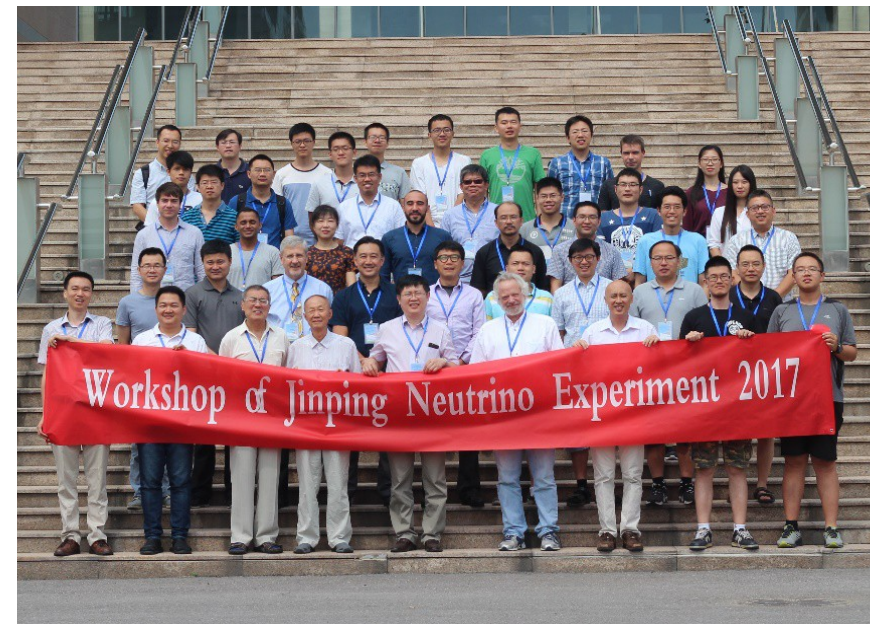
- **Water Cerenkov detector: low light yield but directionality.**
- **Liquid scintillator detector: high light yield without directionality.**
- **Slow liquid scintillator: Cerenkov + Scintillator signals to improve particle identifications!**
- **China Jinping underground laboratory offers the opportunity.**

Meetings and Pre-collaboration

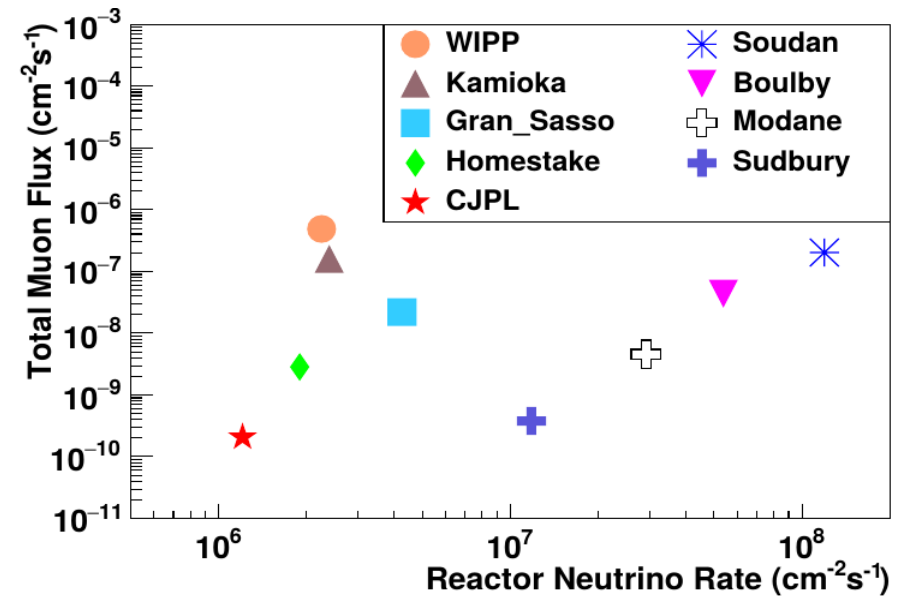
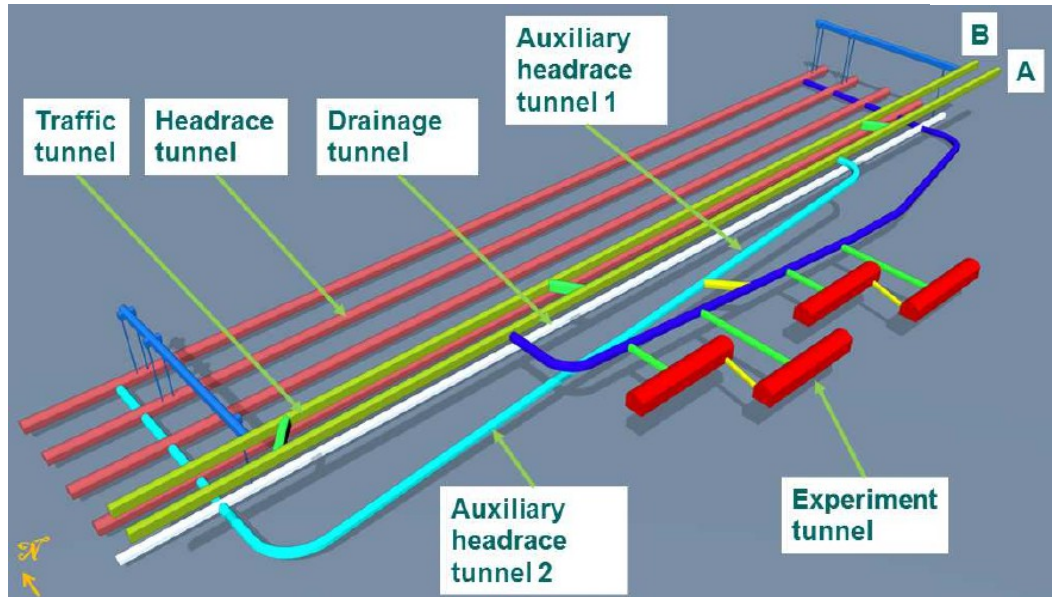
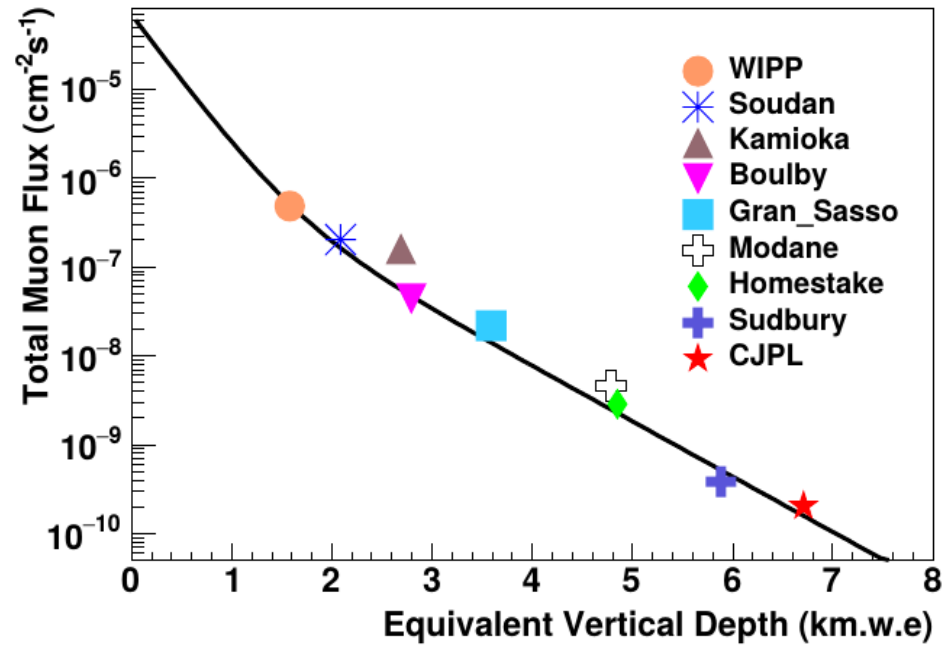
1. 2015, 2017 two international workshops

2. Pre-collaboration:

Tsinghua, SYSU, Queen's University, UCAS, Guangxi University, Shandong University, BNL, University of Maryland, Technische University of Dresden, University of Mainz, Charles University, University of Michigan, Nanjing University, Wuhan University

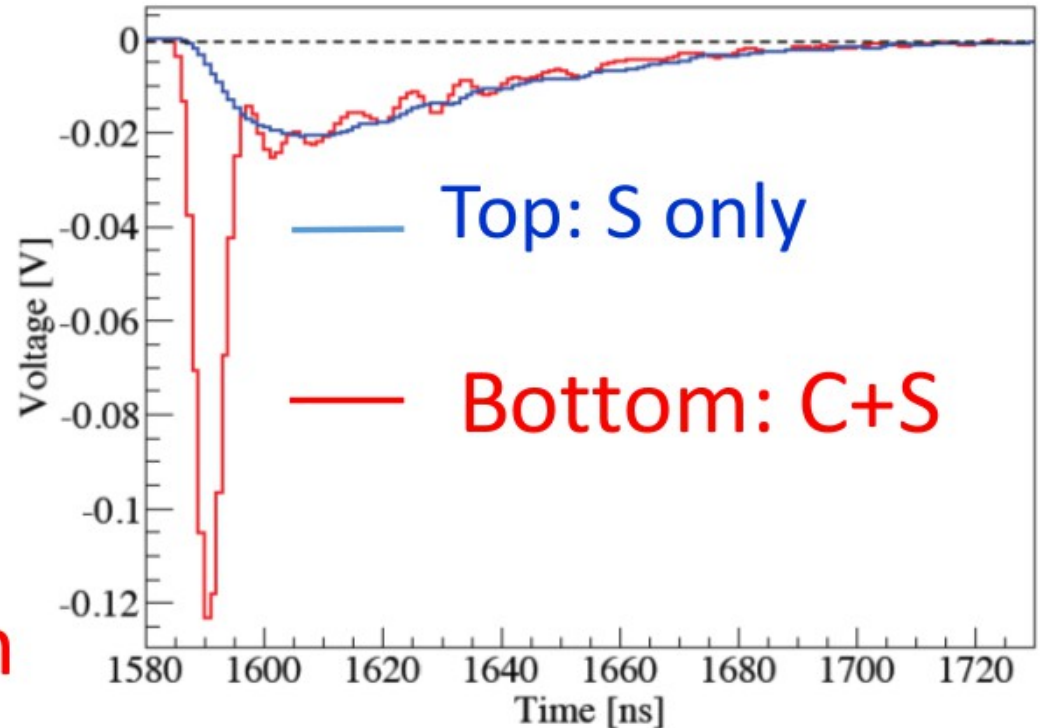
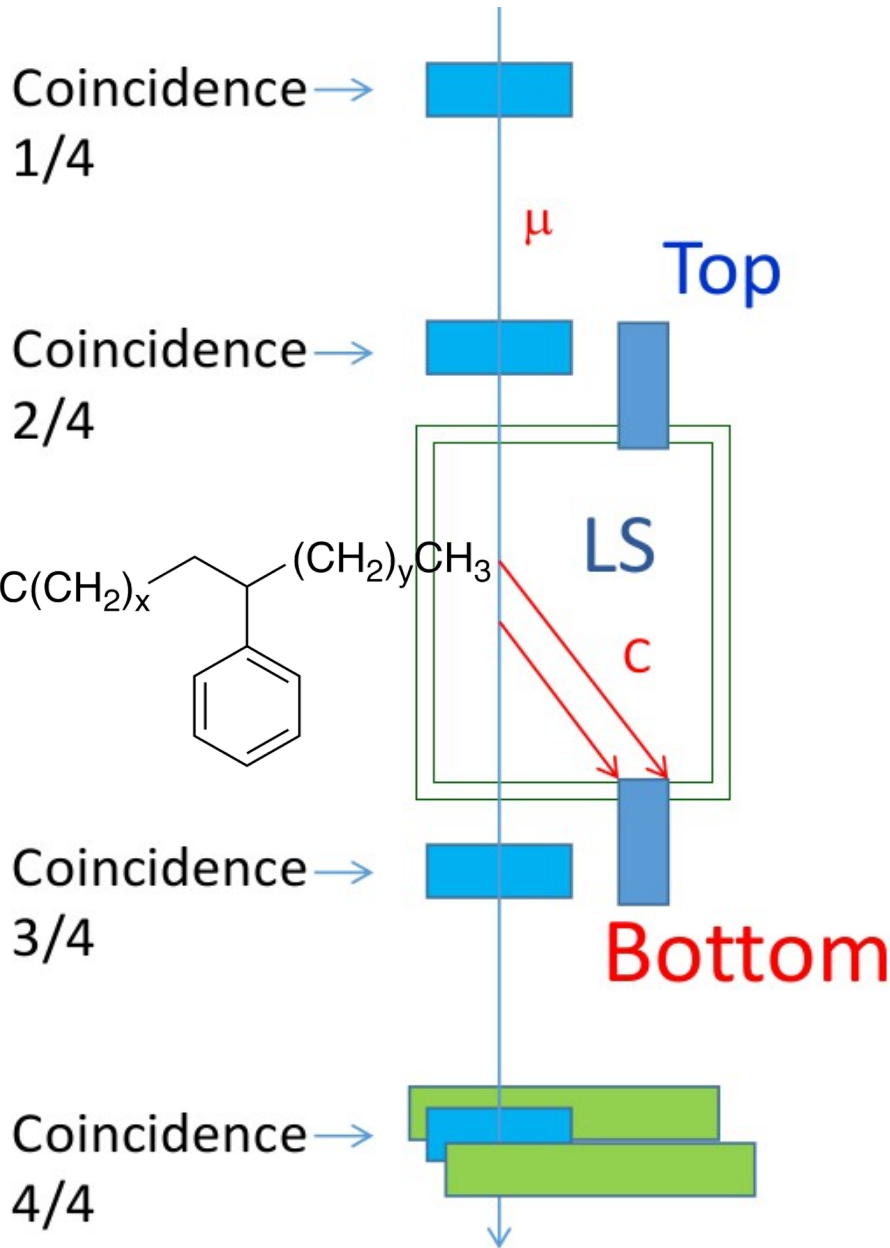


A chance to conduct neutrino experiments in CJPL



A slow liquid scintillator recipe realized in THU

Waveforms of top and bottom PMTs in LAB



Nucl. Instrum. Methods Phys. Res. A 830 (2016) 303

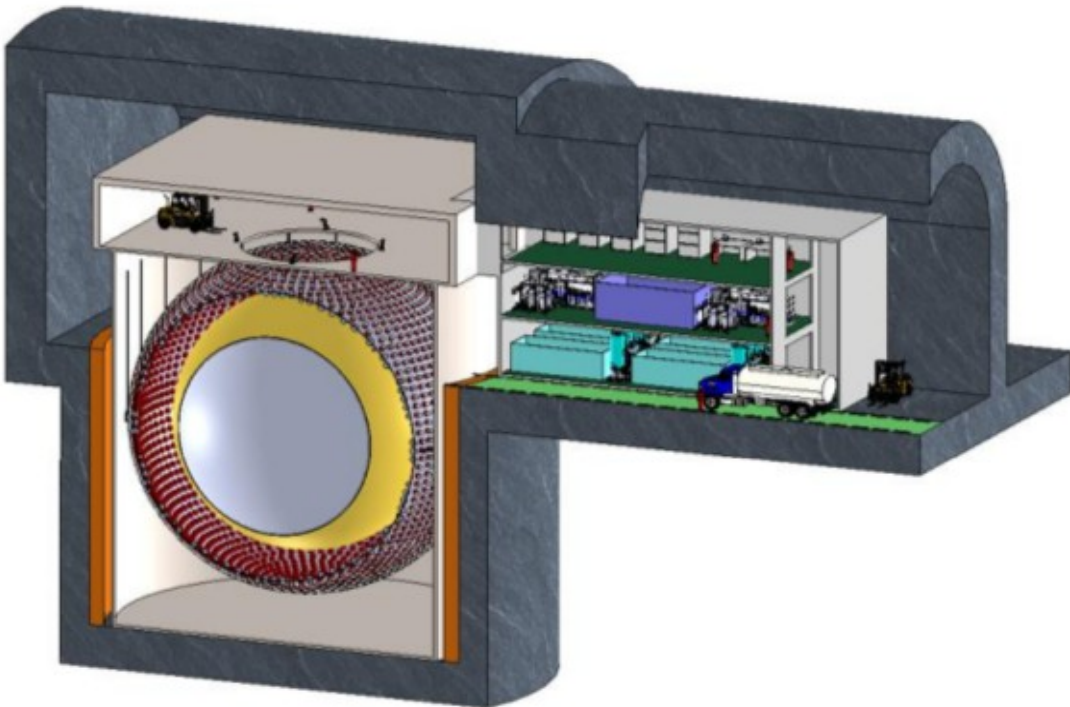
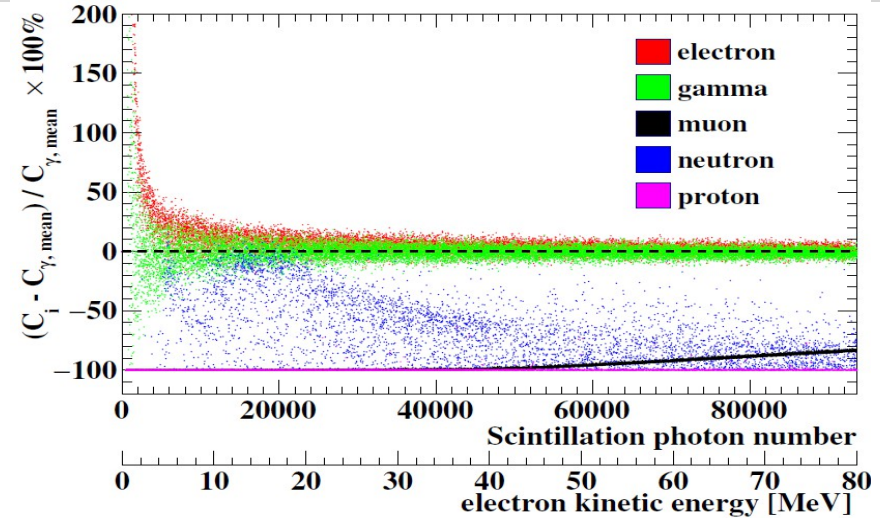


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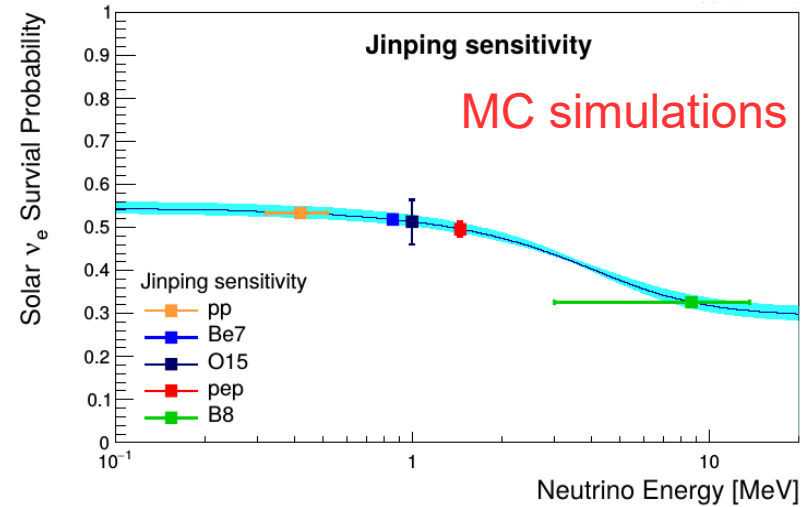
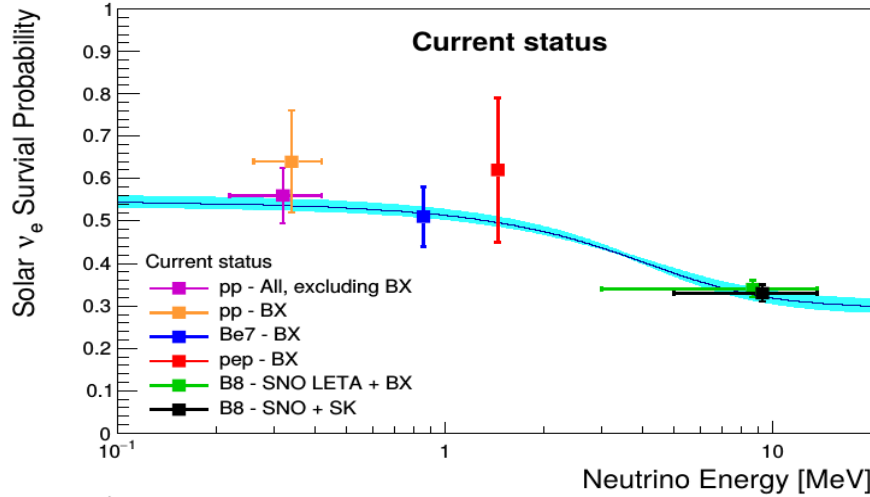
Preliminary proposal for such a neutrino experiment

- **2 kton fiducial mass**
- **5 year data taking**
- **Slow liquid scintillator**
- **500 PE/MeV light yield**
- **1.5% systematic uncertainties for flux measurements**

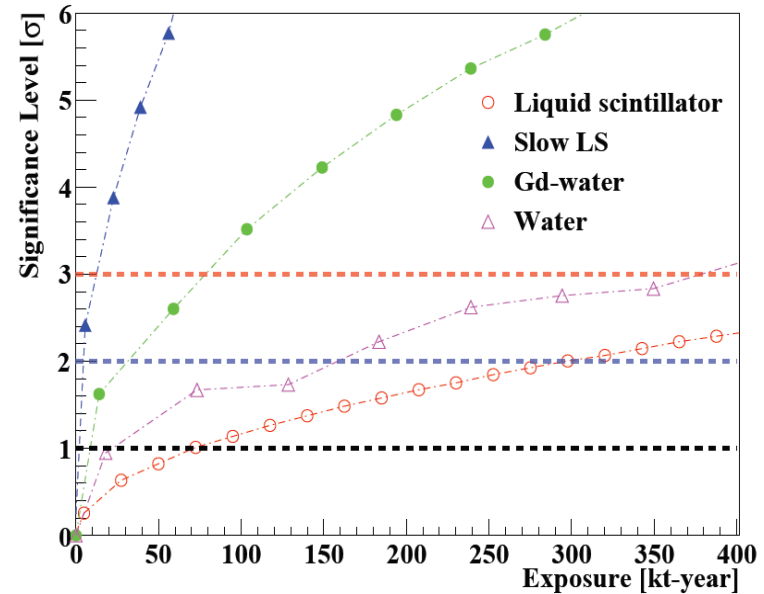
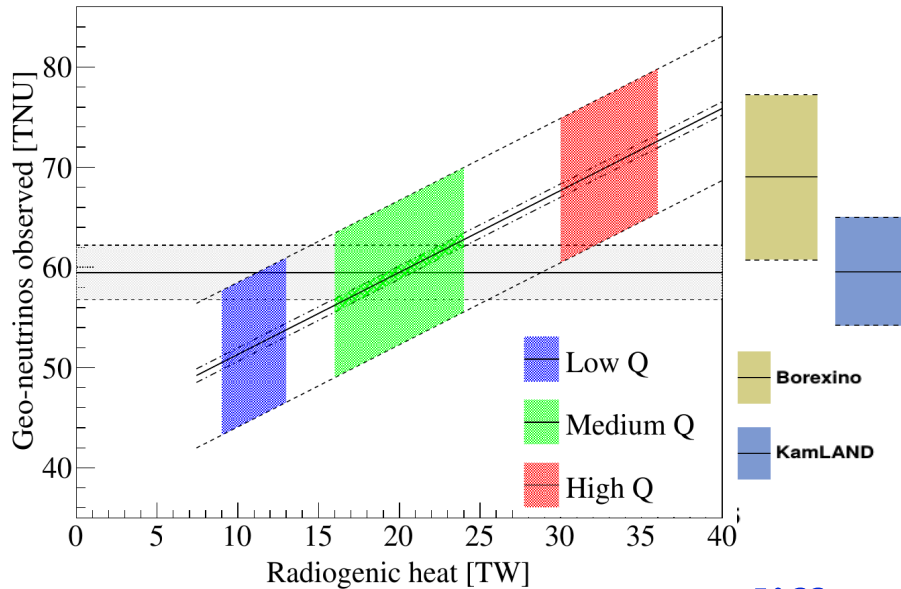


Physics prospects

- Solar neutrino oscillations+MSW matter effects in the transition region.**



- Detection of geoneutrinos to probe the geochemical contents inside the Earth.**



- DSNB neutrino detections with different recipes.**



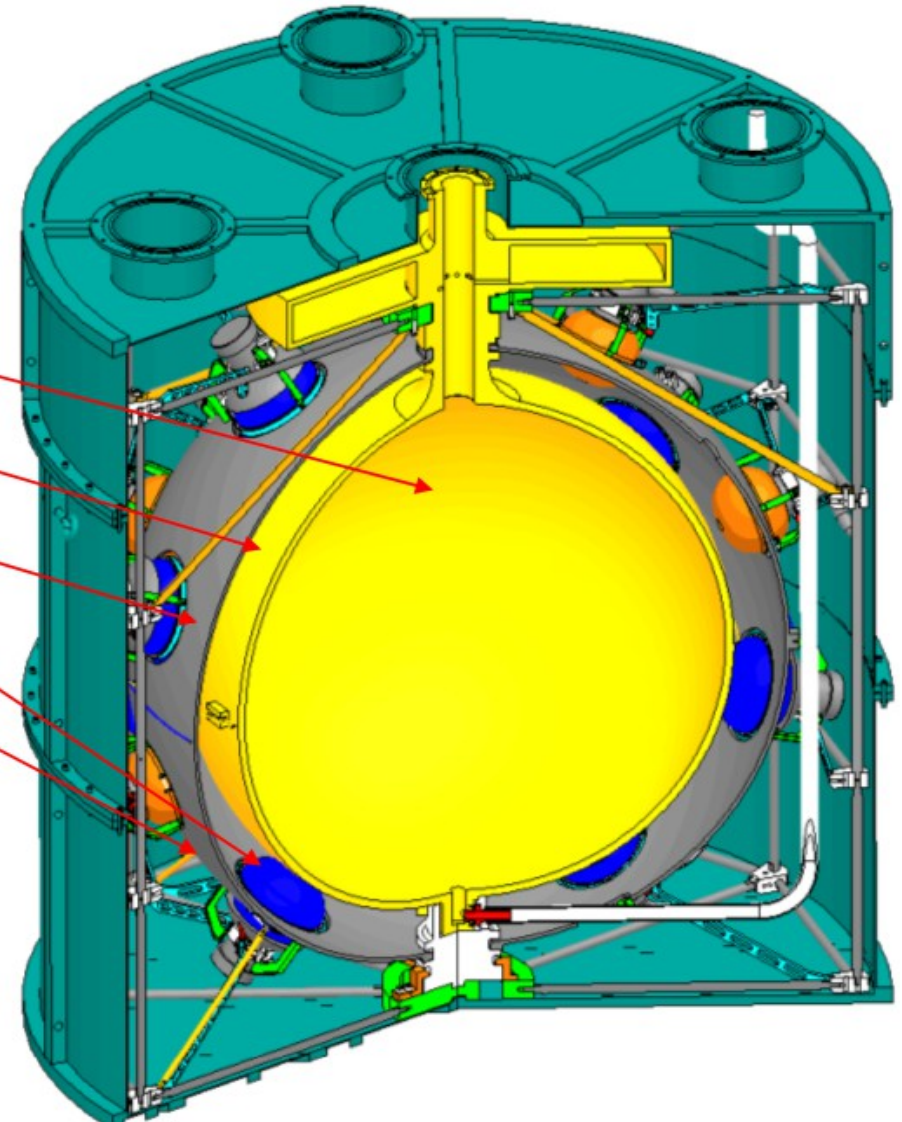
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Accumulate experience with 1-ton prototype detector

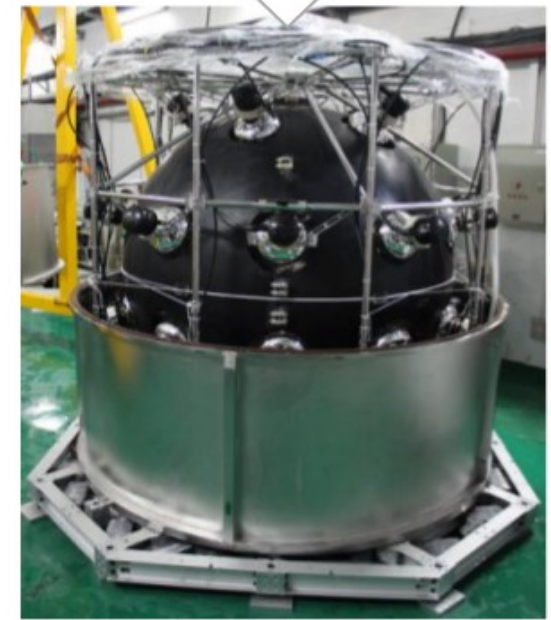
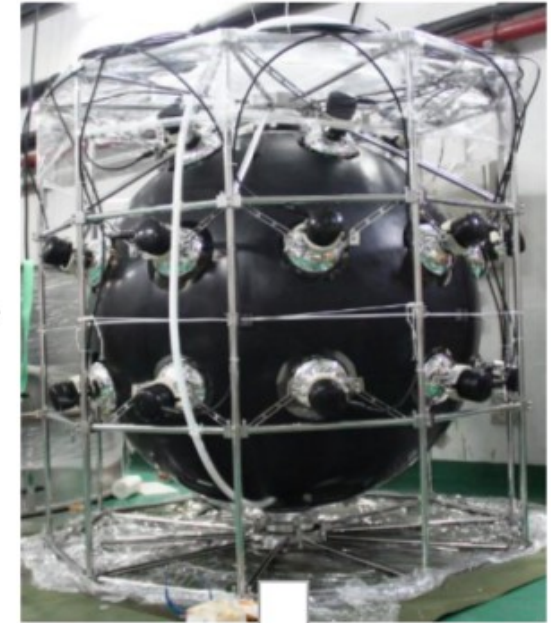
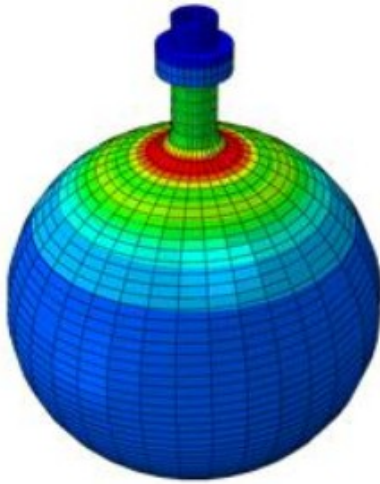
1. Measure fast neutron background
2. Test detection material: water, LS, and slow LS
3. A low bkg. facility
4. Reconstruction

1 ton liquid scintillator
Transparent acrylic vessel
Water
30 8" PMTs
Black non-reflective shielding
FADC 10 bit 1GS/s
Lead shielding



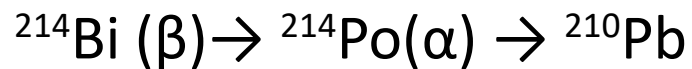
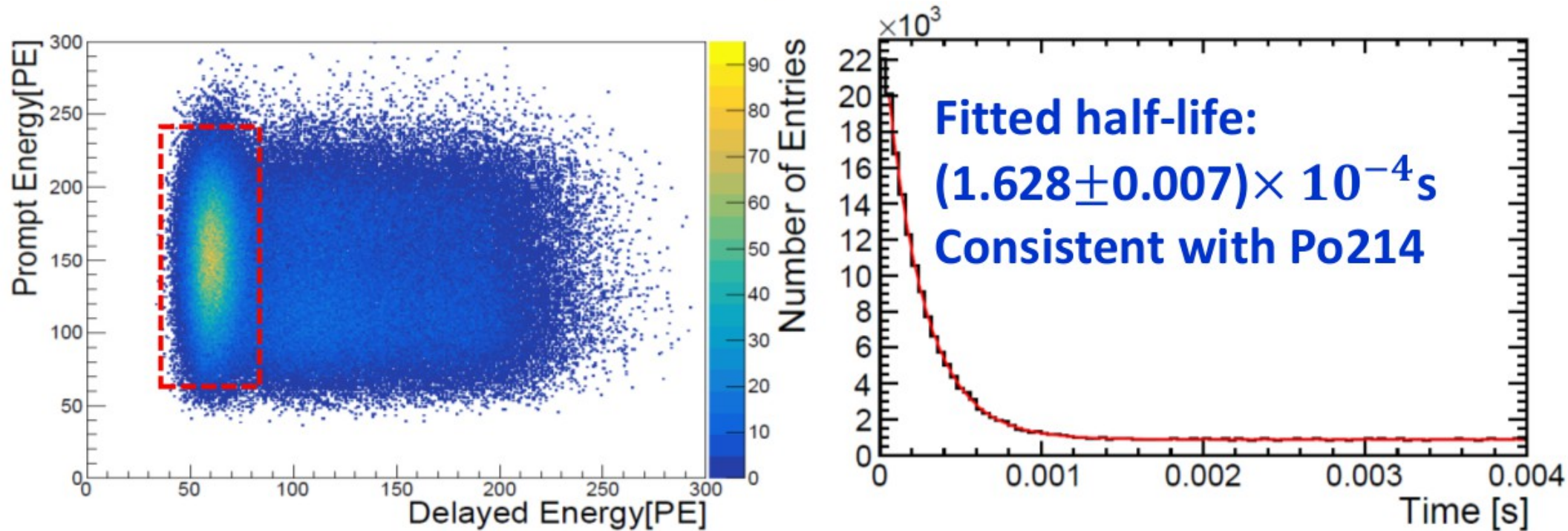
Building a 1-ton prototype detector

S, Mises
(Avg: 75%)
2.102
1.927
1.752
1.577
1.403
1.228
1.053
0.878
0.703
0.528
0.353
0.178
0.004



^{214}Bi events in the prototype

1. Prompt-delayed distance cut
2. Prompt and delayed energy cut

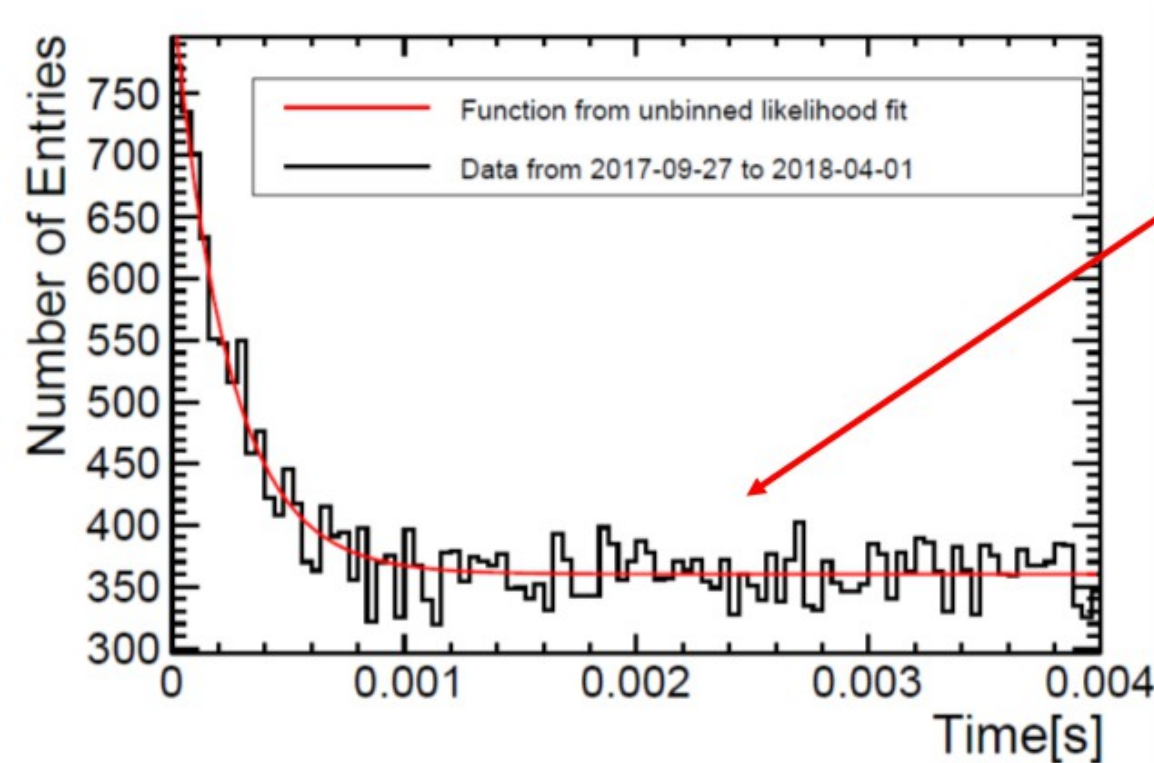


$$\tau(^{214}\text{Po}) = 236.6 \mu\text{s}$$

Background levels in the prototype detector

Assuming all later Bi214 from U238 (90 days after beginning)

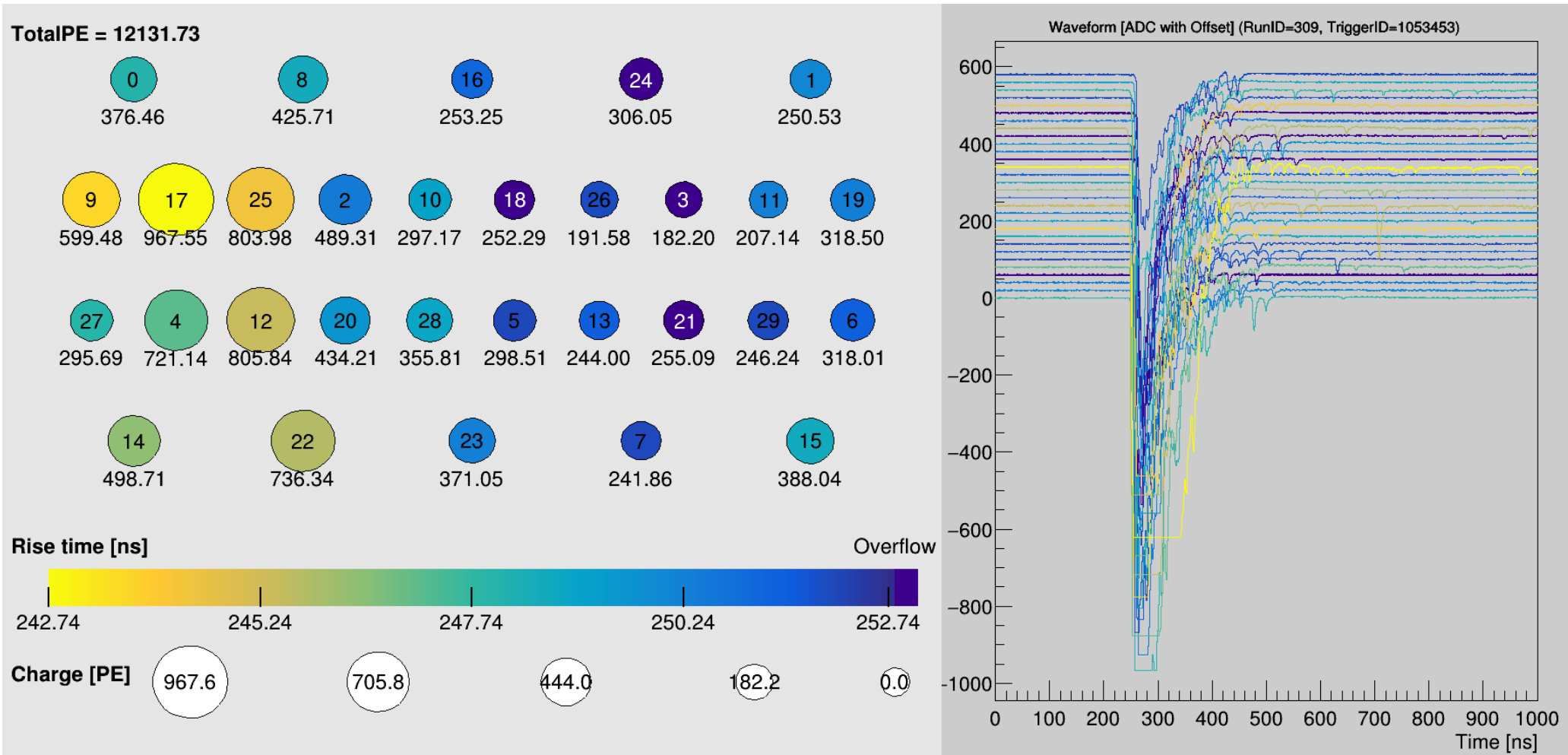
$$\begin{aligned}R_{U-238} &= (2.457 \pm 0.088) \times 10^{-9} \text{Bq/g} \\ &= (1.99 \pm 0.07) \times 10^{-13} \text{g/g}\end{aligned}$$



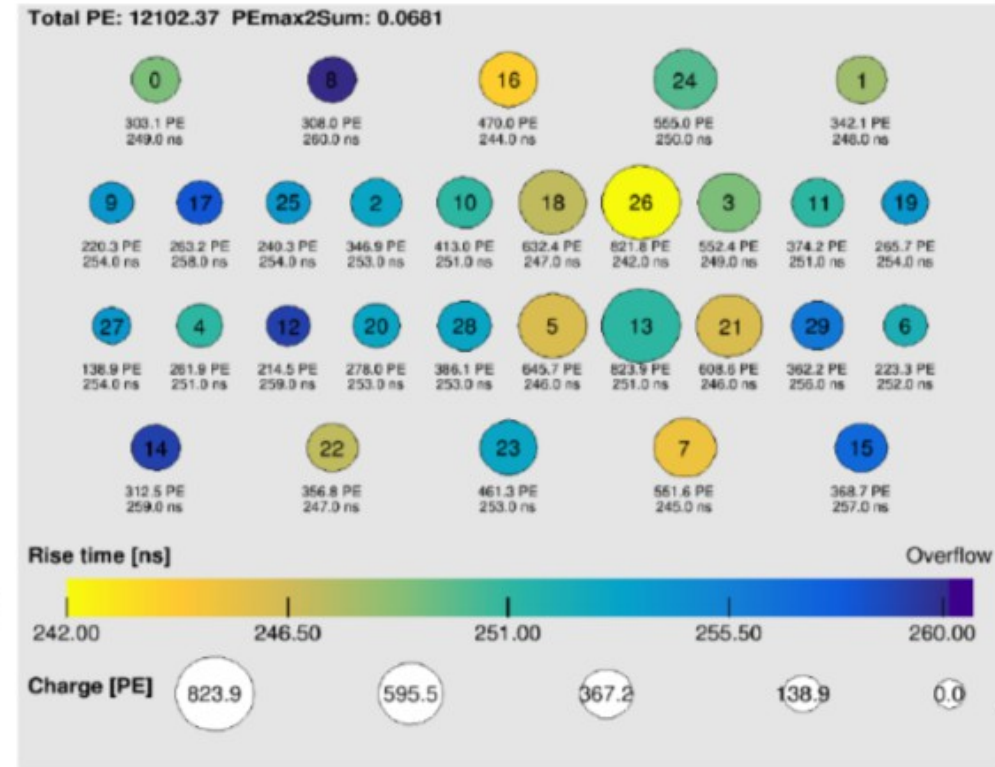
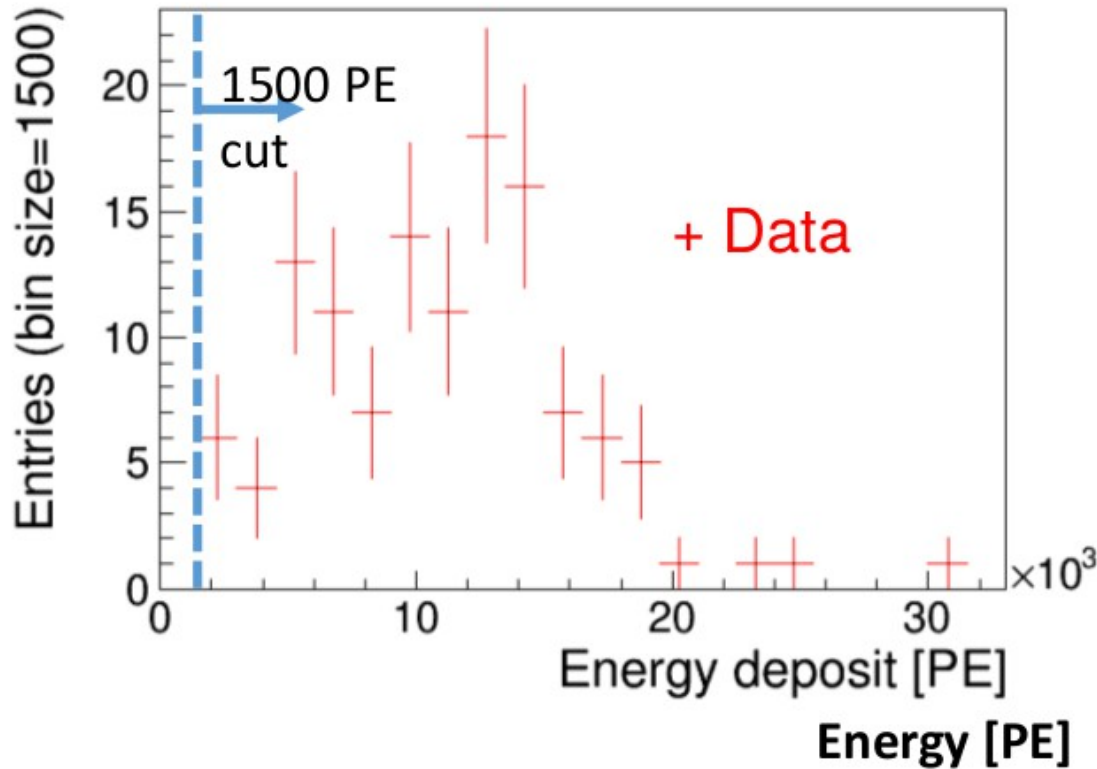
Considering the current background level,
the U238 detection limit:
reach 10^{-15} g/g in a month

Planning LS purification and equipment upgrade
Good for efficiency study

Cosmic muons hit the detector



Cosmic muons hit the detector



High energy event detected
100 – 300 MeV (saturated)
Energy scale ~60 PE/MeV
Shape understood

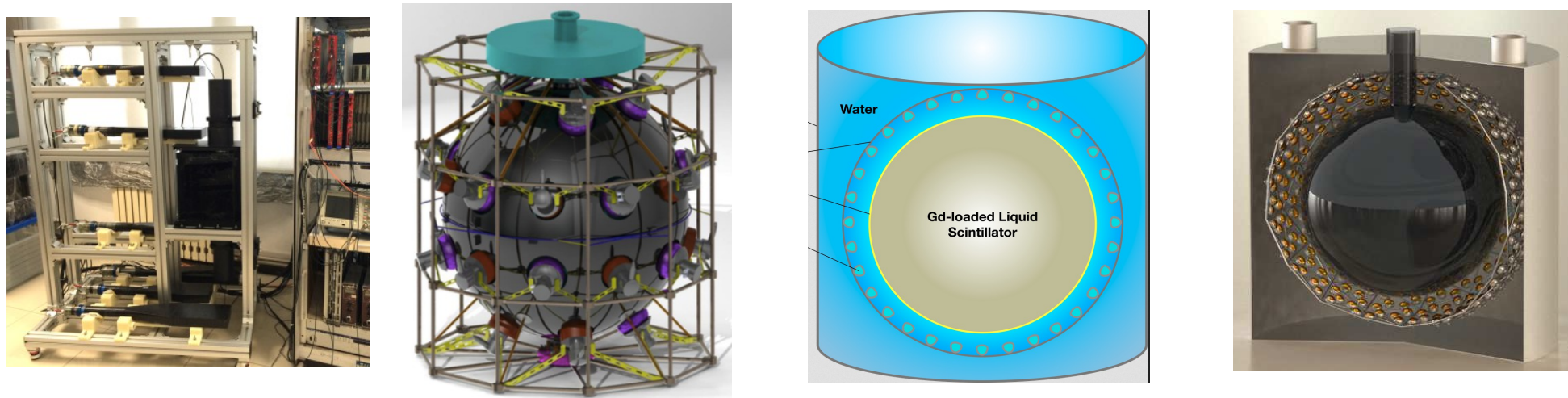
Event display
Color -> PMT hit time
Size -> Charge
Consistent with muon pattern



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A road map for Jinping neutrino experiment



- A 200-ton prototype will be built next year to measure geoneutrinos first.
- The 200-ton prototype can test all parts for PMT, scintillator, mechanical structure etc.
- A kiloton detector is in schedule.



Summary

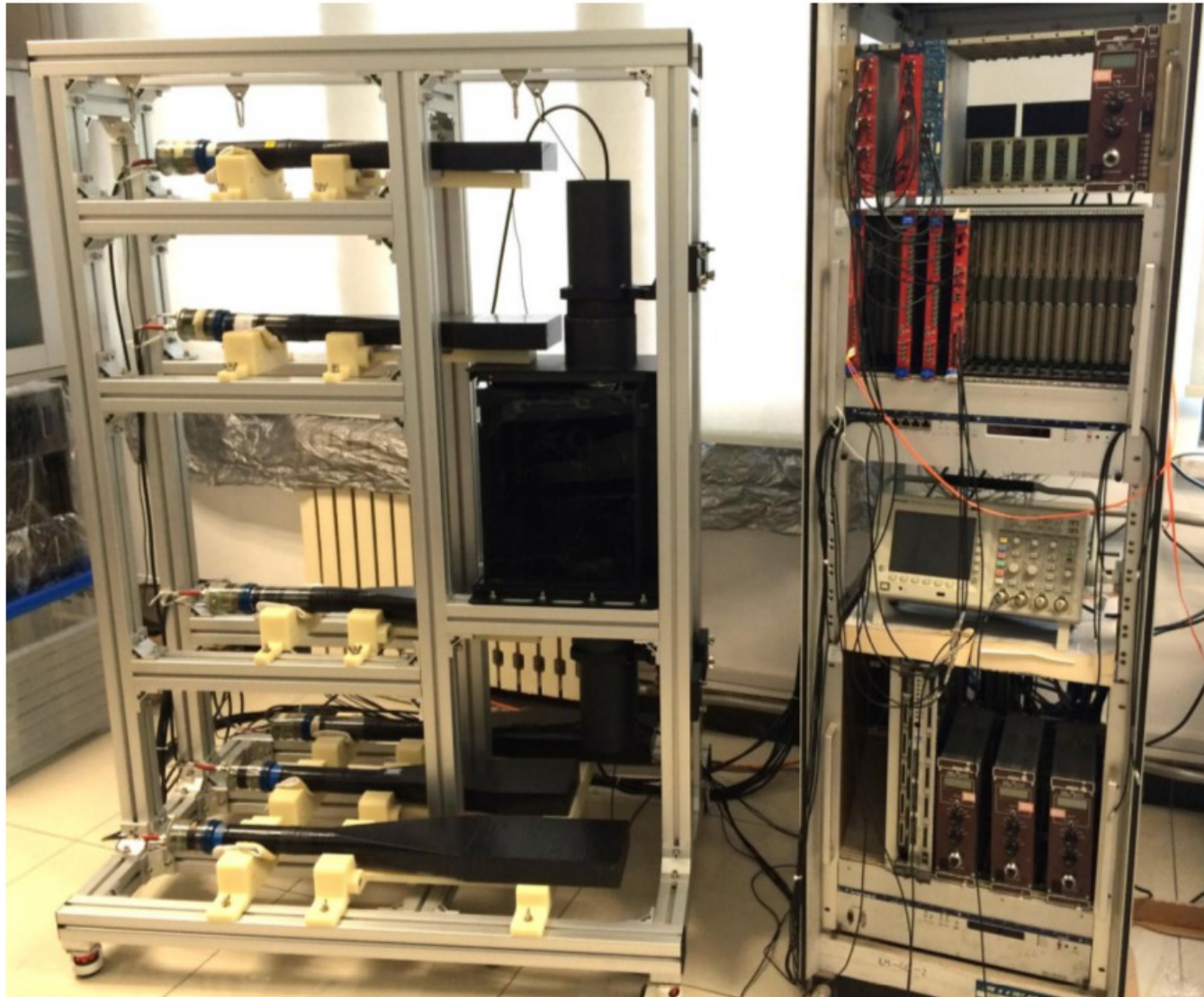
- **Good to push forward the Jinping neutrino experiment to study solar neutrinos, geoneutrinos and DSNB neutrino.**
- **Adopt the slow liquid scintillator to read Cerenkov + Scintillator signals for particle identifications.**
- **1-ton prototype detector has been running since May in 2017. Preliminary analysis of background levels done.**
- **Welcome to work together on the neutrino experiment in Jinping underground laboratory.**

More information in the poster session:

- Preliminary design study for Jinping neutrino experiment by Wentai Luo.
- Detection of electron anti-neutrino at Jinping by Jinjing Li.

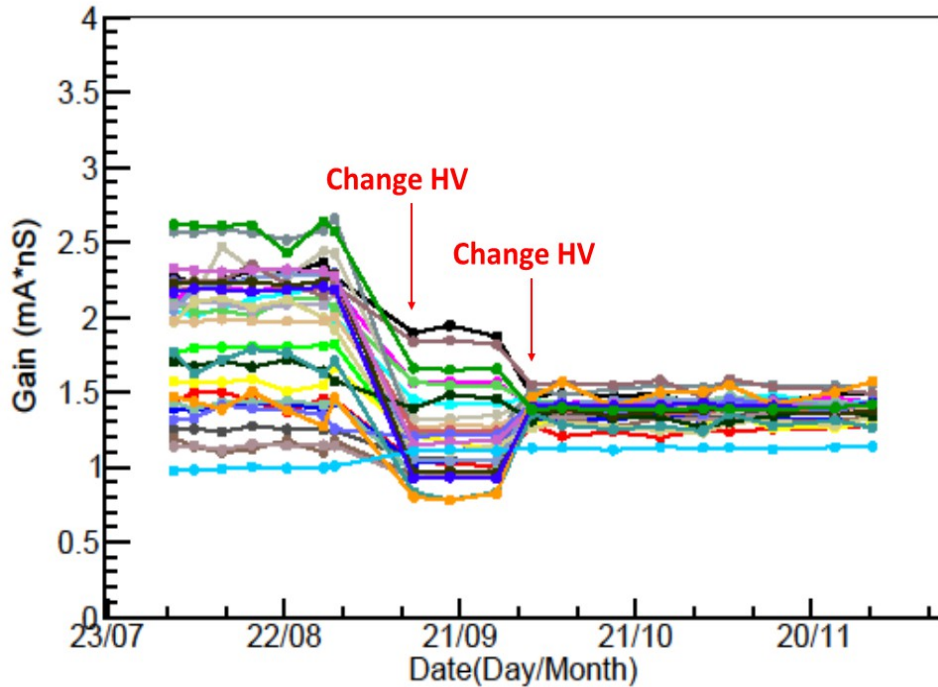
Thanks for your attention!

20 L prototype running in Tsinghua University



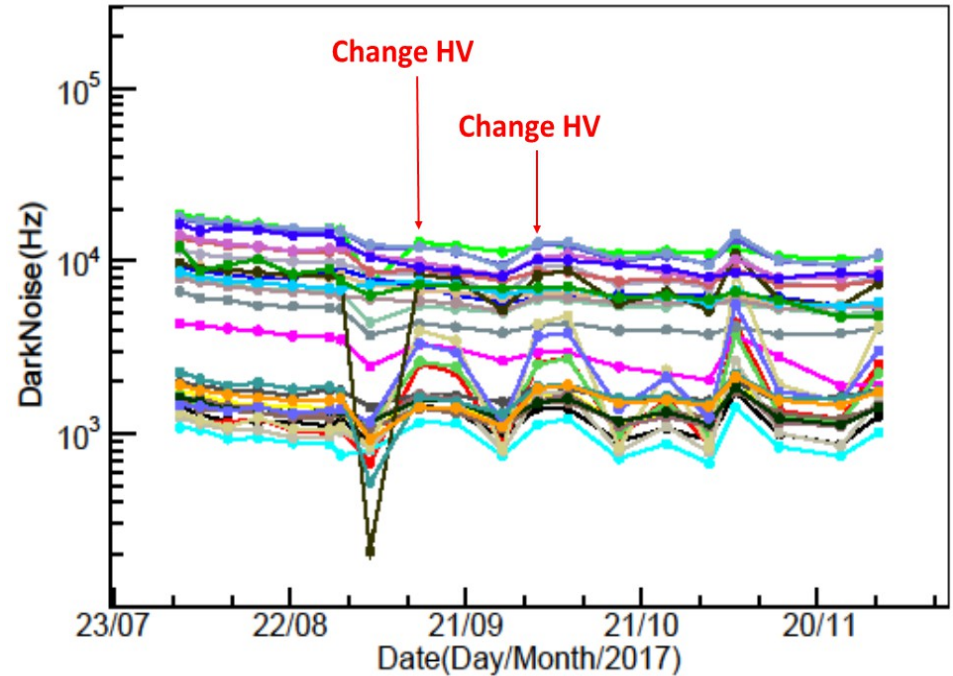
Monitor of light sensors in the prototype detector

Gain VS Time



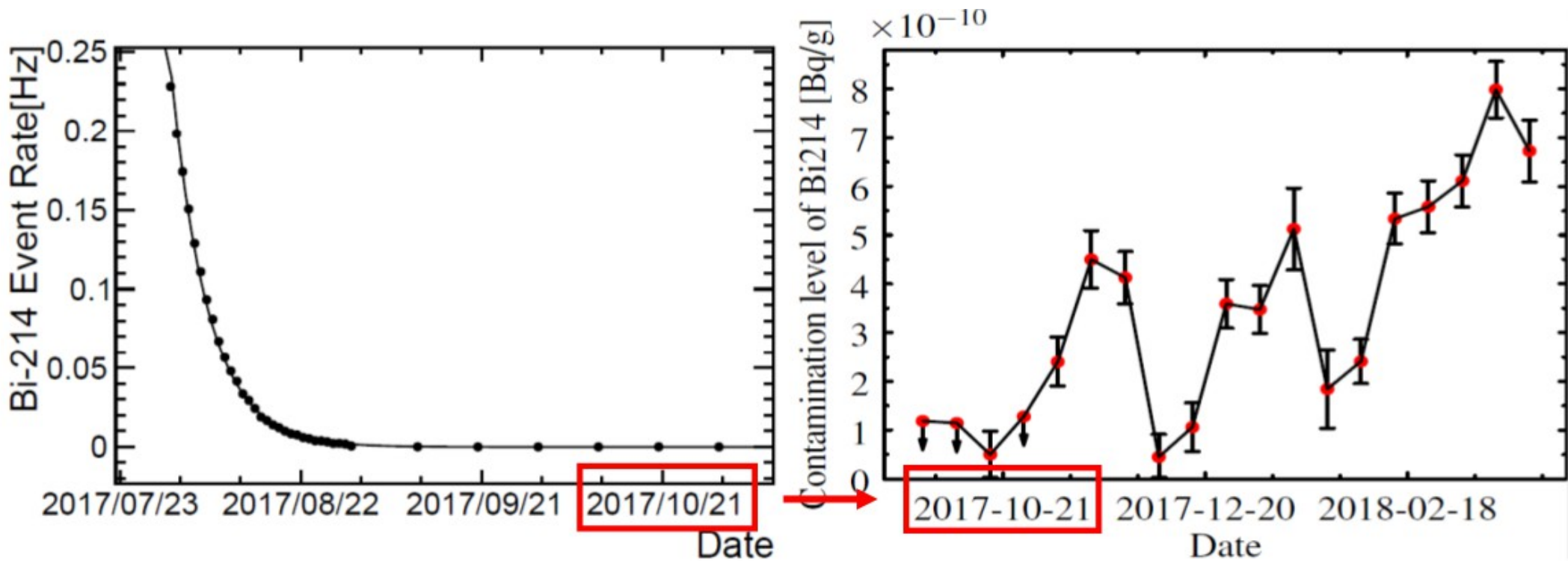
PMT gains are set uniformly

DarkNoise Rate VS Time



PMT dark noise has settled down to 5k-10k

^{214}Bi events in the prototype



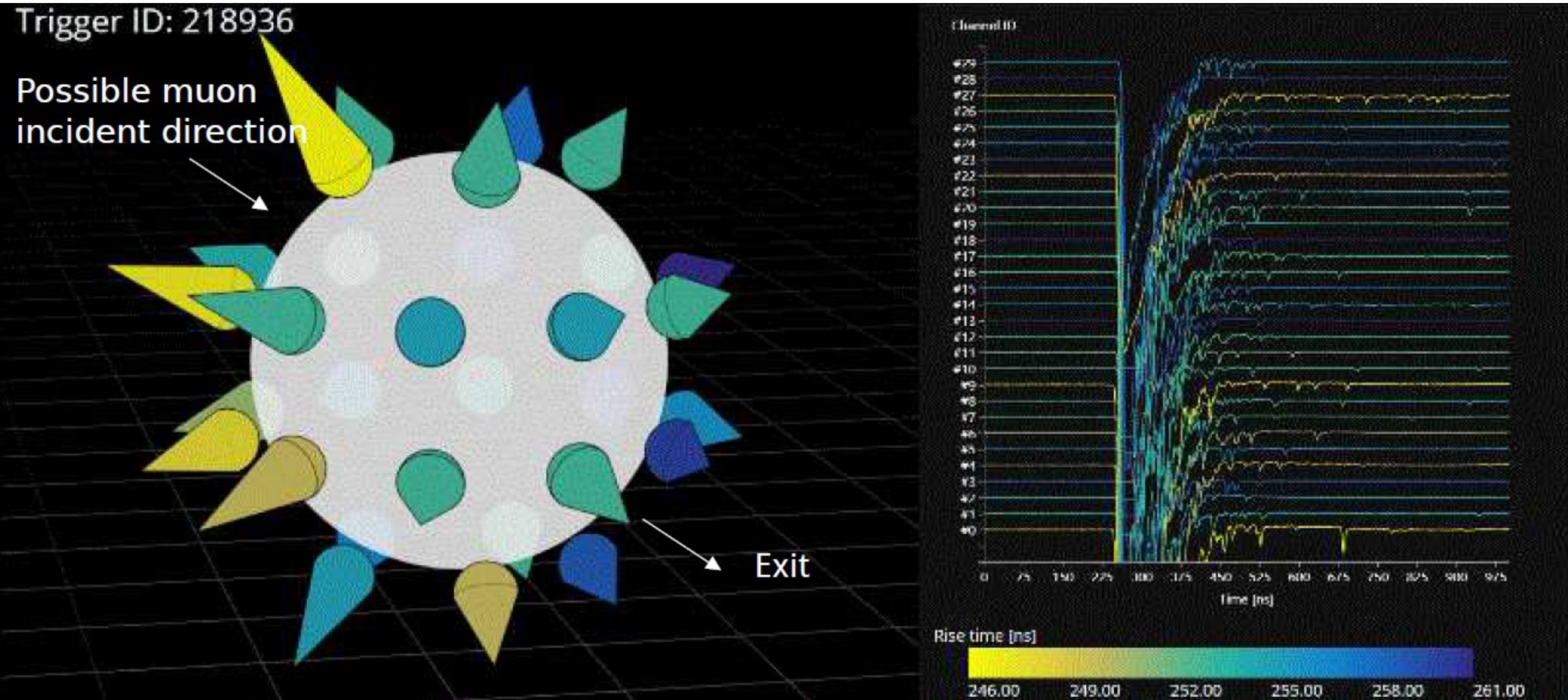
Initially decay away
with half-life (4.219 ± 0.014) day

Slightly longer than
Rn222 (3.82 day)

Later fluctuate at a low level
out of statistical uncertainty

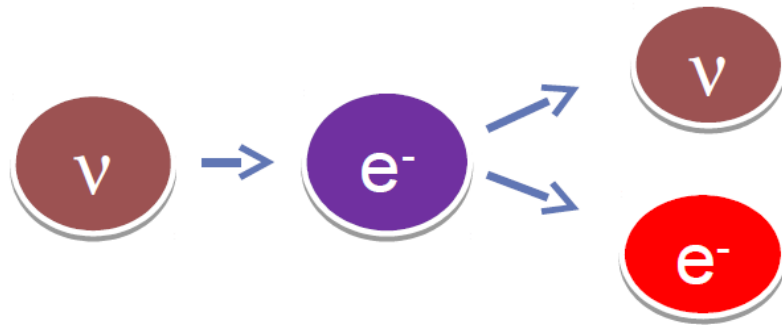
=> Air ($\text{Rn}222$) leaks in

Cosmic muons hit the detector



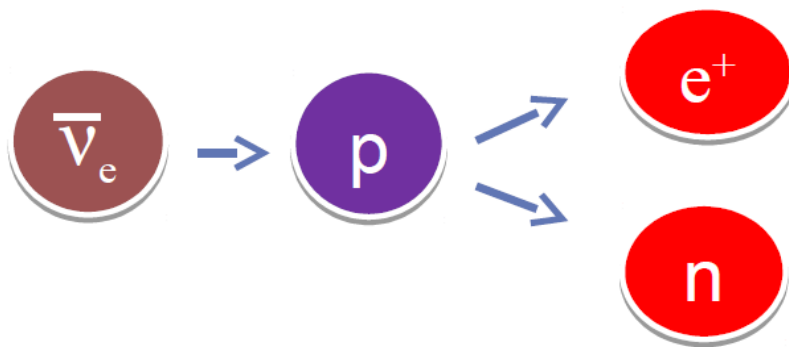
Neutrino detections

Solar neutrino detection



The electron is selected and its energy is measured with liquid scintillator and is related to original neutrino

Geo and SNe neutrino detection



The positron and neutron are selected and positron energy is measured with liquid scintillator.