

# Recent status and future plan of China JinPing underground Laboratory

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May. 31, 2018



中国锦屏地下实验室  
China Jinping Underground Laboratory

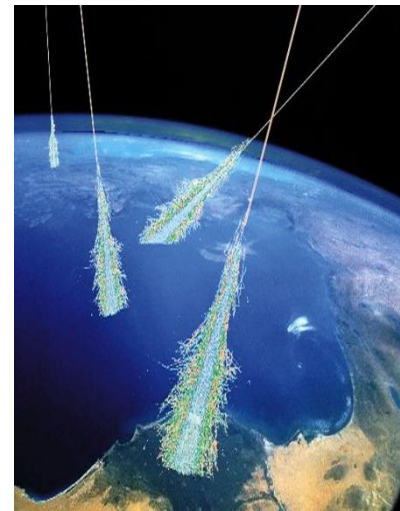
# Outline :

- Physics based on UL
- International UL introduction
- China Jinping Underground Laboratory (CJPL)
- Experiments in CJPL-I
- CJPL-II and planned experiments inside
- Summary

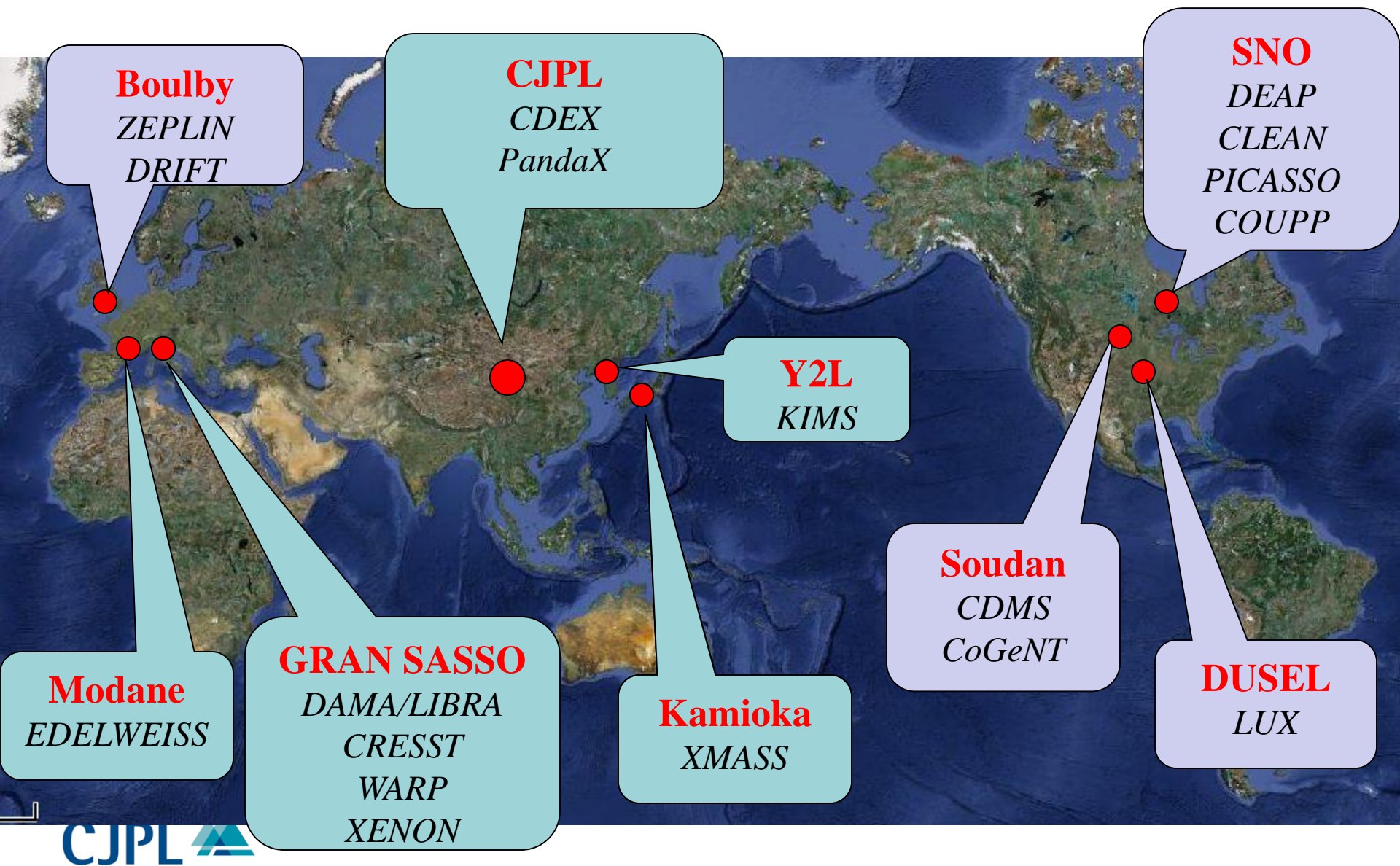
# Science based on UL

High energy cosmic-rays could contribute instantaneous and delayed backgrounds for some rare-event experiments and need to be stopped with deep rock overburden:

- Direct detections of Dark matter;
- Neutrino physics:  $0\nu\beta\beta$ ; solar, atmospheric, reactor, accelerator, and supernova neutrinos;
- Astrophysics: stellar reactions.....
- Proton decay;
- Rock mechanics, seismology, and geophysics;
- Biology.....



# International Main ULs



# ULs and several main parameters

Asia:

CJPL, Kamioka,  
Y2L, **INO**

Europe:

Baksan, Boulby,  
LNGS, LSC,  
Modane

North America:

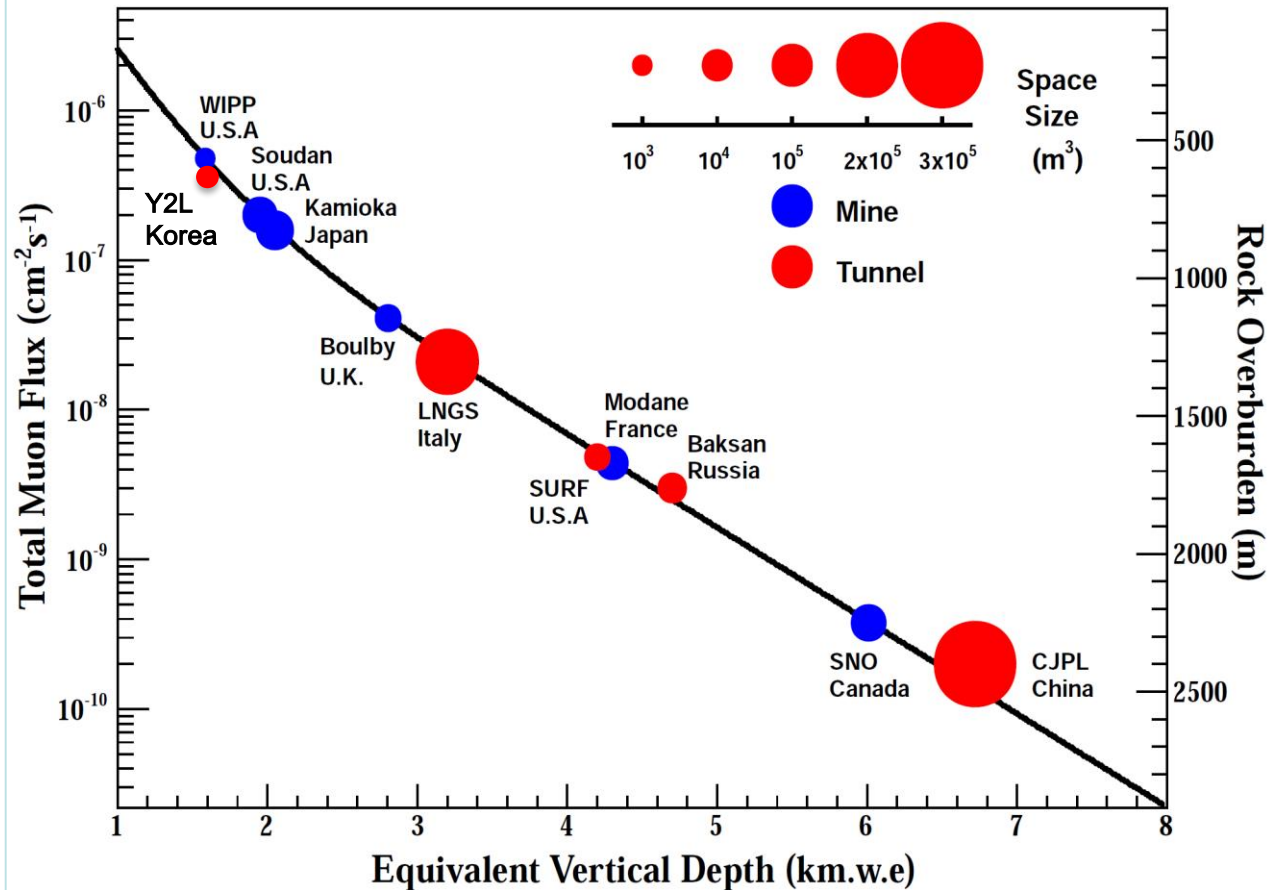
SNOLab, SURF,  
Soudan(\*), WIPP

South America:

**Andes**

Australia:

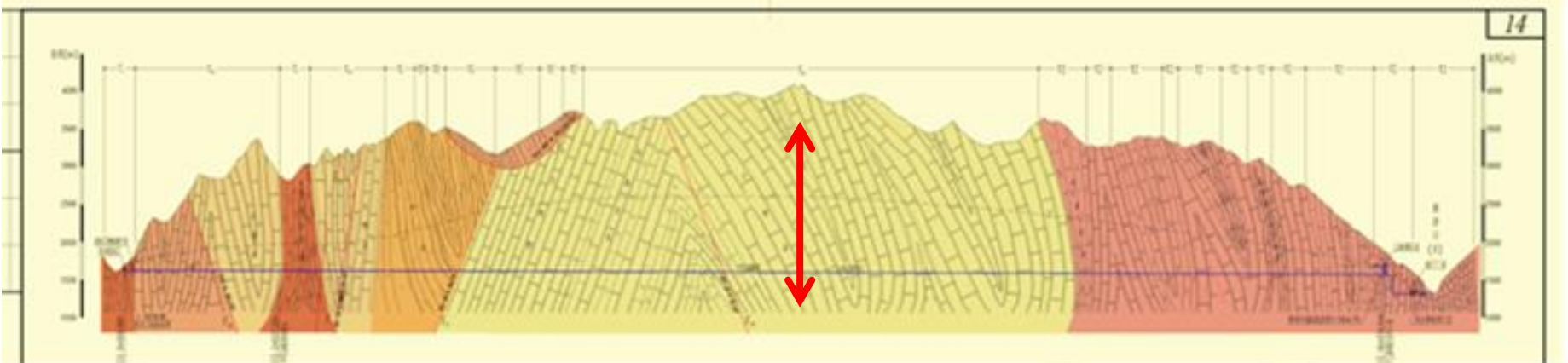
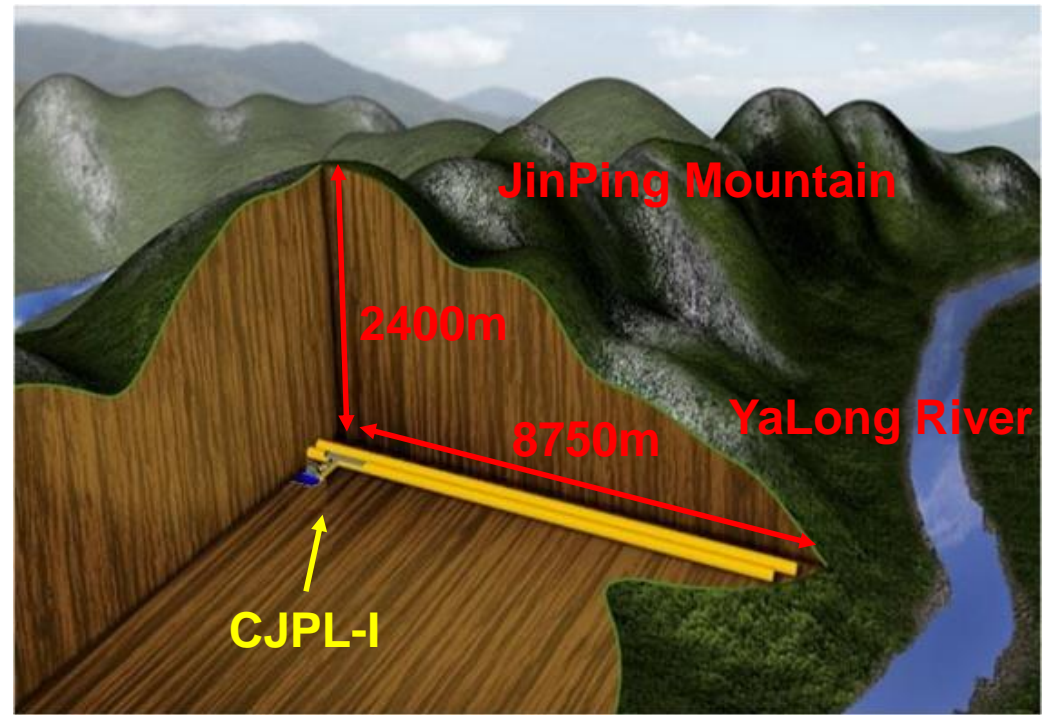
**Stawell**



\* Soudan UL being decommissioned in 2017!



# China Jinping Underground Laboratory



# Convenient transportation



Highway+Special road access by car from nearest Xichang airport, cost 2h.

Direct flight from many main city to Xichang.

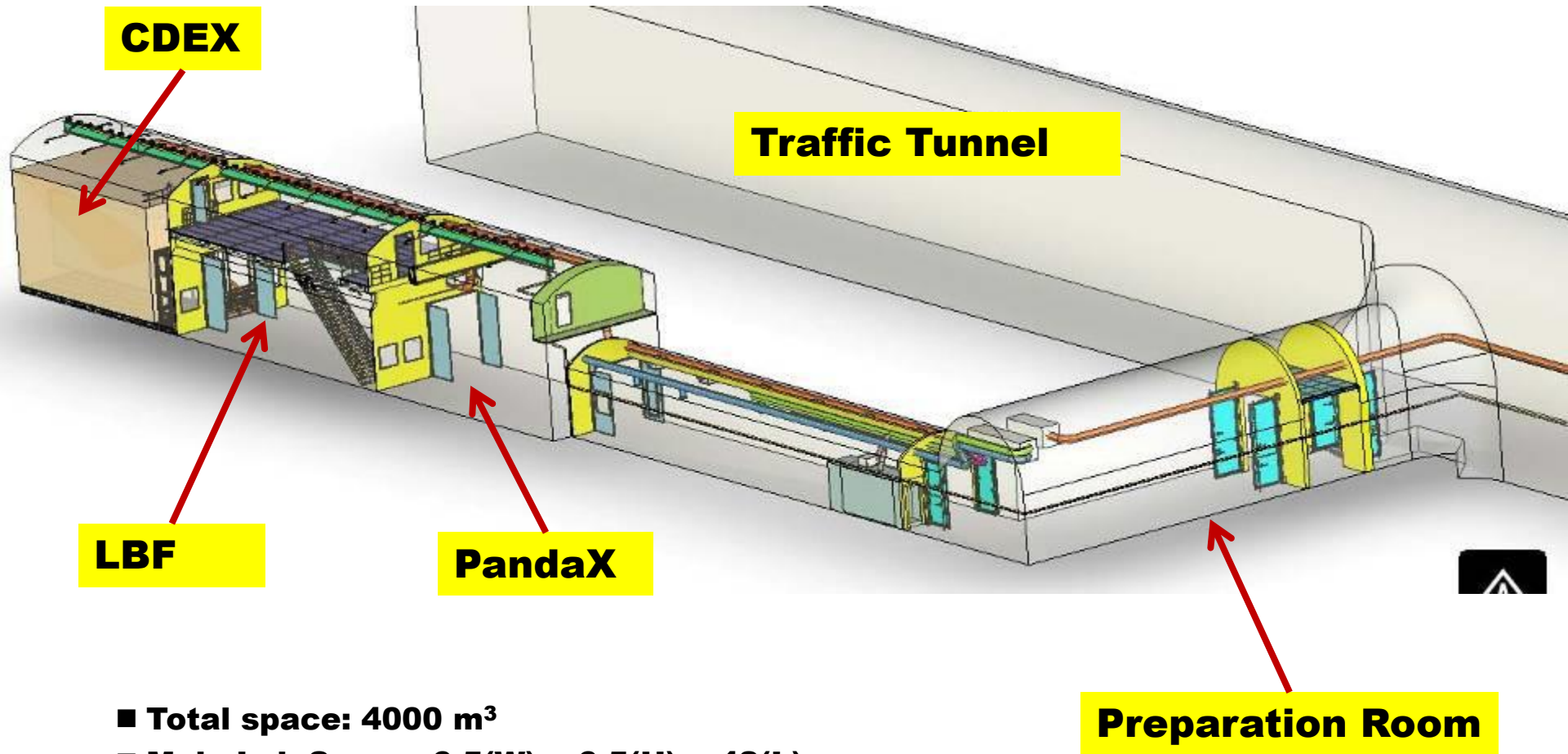


# Logistic Condition of CJPL





# Layout of CJPL-I



■ Total space: 4000 m<sup>3</sup>

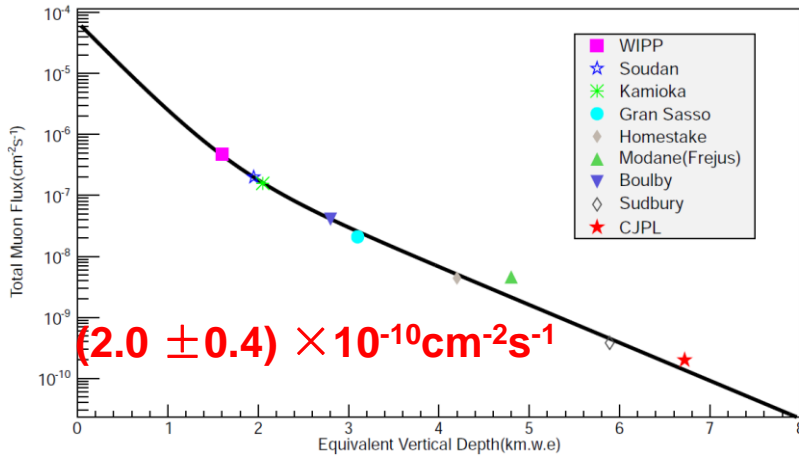
■ Main Lab Space: 6.5(W) x 6.5(H) x 42(L)



# Background Measurement of CJPL-I

*Chinese Physics C 37, 8 (2013) 086001*

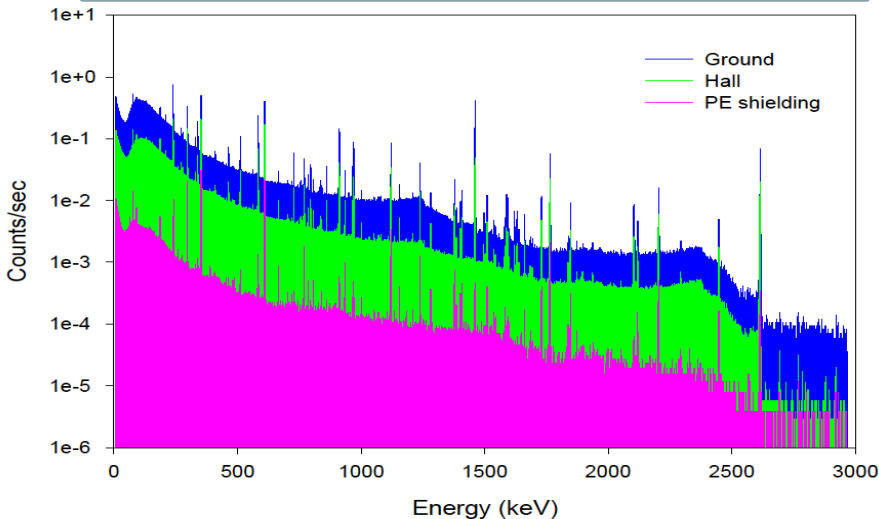
Muon flux  $\sim 60$  muons/year/m<sup>2</sup>



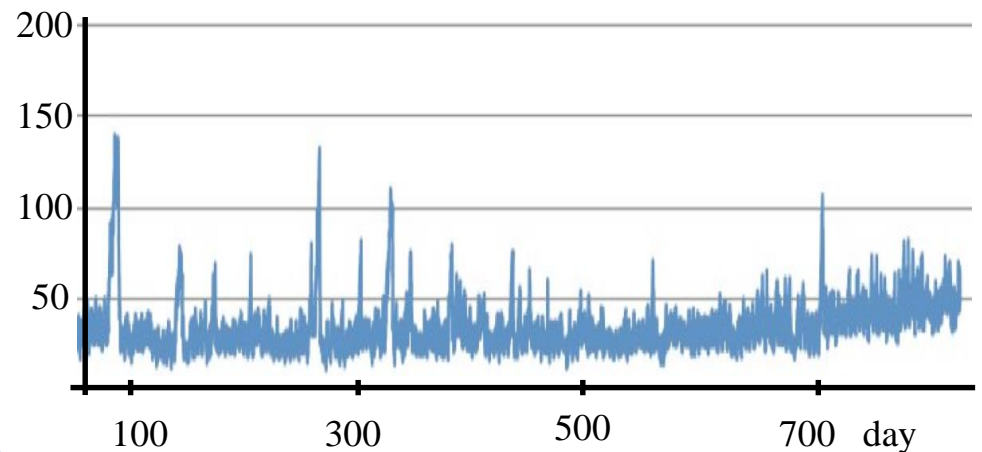
Rock background

(Unit : Bq/kg)	K-40	Ra-226 (609keV)	Th-232 (911keV)
Rock Sample	< 1.1	1.8±0.2	< 0.27
Ground Level(Beijing)	~600	~25	~50

Gamma ray flux in CJPL



Radon Monitoring (Bq/m<sup>3</sup>)





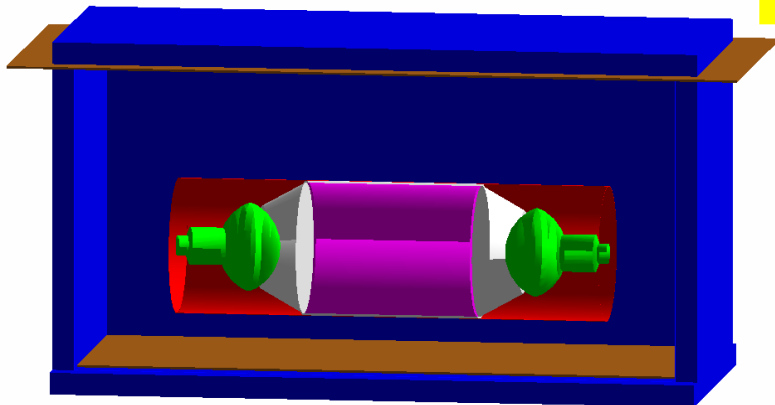
# Neutron flux Measurement of CJPL-I

## Fast neutron flux compare with other UL

Underground laboratory	Fast neutron flux n/cm <sup>2</sup> /s	Energy range	Depth (m)
YangYang	$4.17 \times 10^{-6}$	1-10MeV	700
Canfranc	$0.41 \times 10^{-6}$	1-10MeV	800
Gran Sasso	$0.42 \times 10^{-6}$	1-10MeV	1400
Boulby	$1.72 \times 10^{-6}$	>0.5MeV	1100
Modane	$0.40 \times 10^{-6}$	2-6MeV	1780
CJPL Hall	$0.15 \times 10^{-6}$	1-10MeV	2400
CJPL Poly-room	$4.27 \times 10^{-9}$	1-10MeV	2400



Fast neutron detector



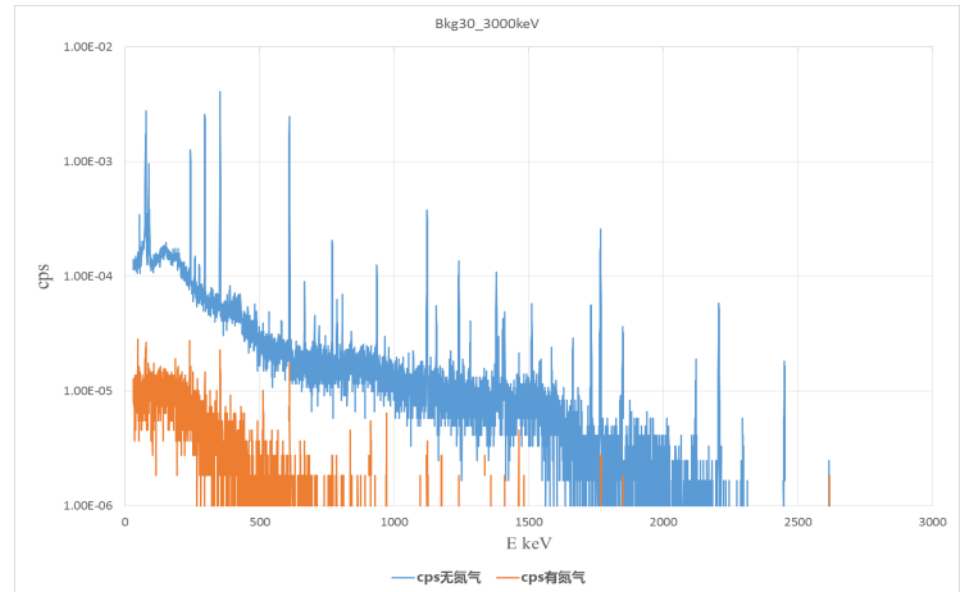
Fast neutron detector



Thermal neutron flux:  $< 4.4 \times 10^{-6}$  n/cm<sup>2</sup>/s

# LBF in CJPL

Low background Facility Sensitivity :  $< 1.0$  mBq/kg



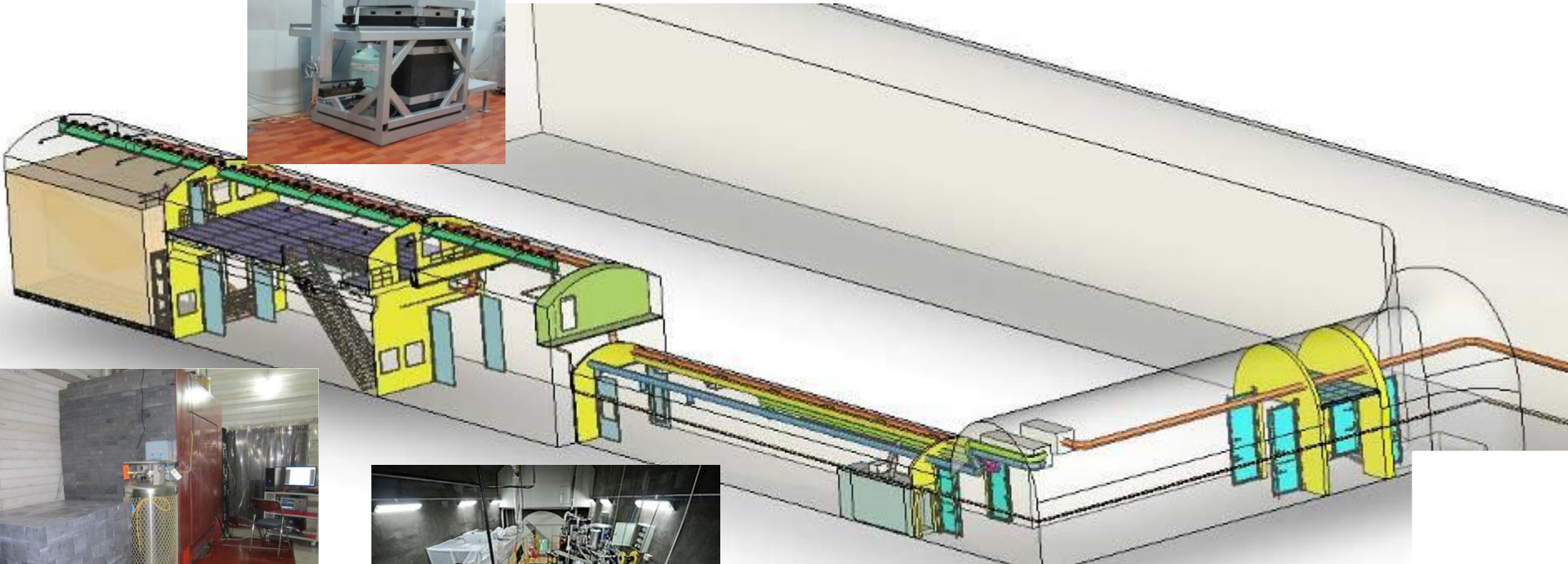
# Summary of CJPL conditions

- Setup and run by THU and EHDC
- Deepest laboratory in the world
  - ~2400m rock overburden (6720 m.w.e)
  - Muon-induced background is negligible (~60muons/yr/m<sup>2</sup>)
- Low natural radioactivity in the laboratory
  - Marble stone with the lowest natural radioactivity
- Horizontal access to the laboratory
  - Large facilities directly transported to CJPL by truck
  - Personnel access by car
  - 20min from ground site to underground lab
- Environmental T: <18°C, save much power



# Recent experiments in CJPL-I

**LBF**



**CDEX**



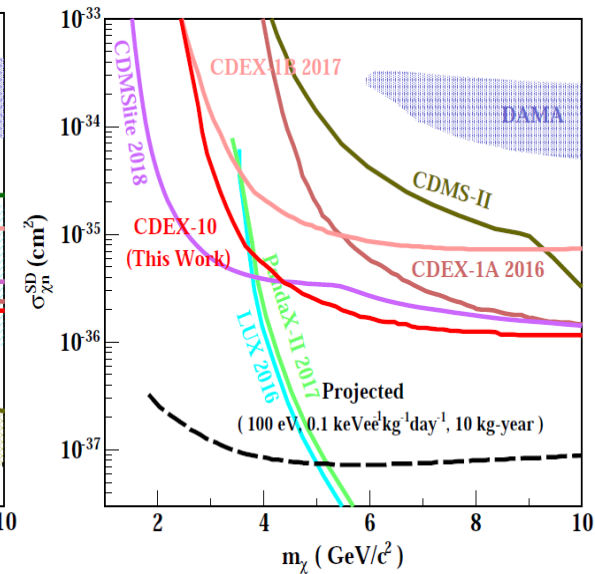
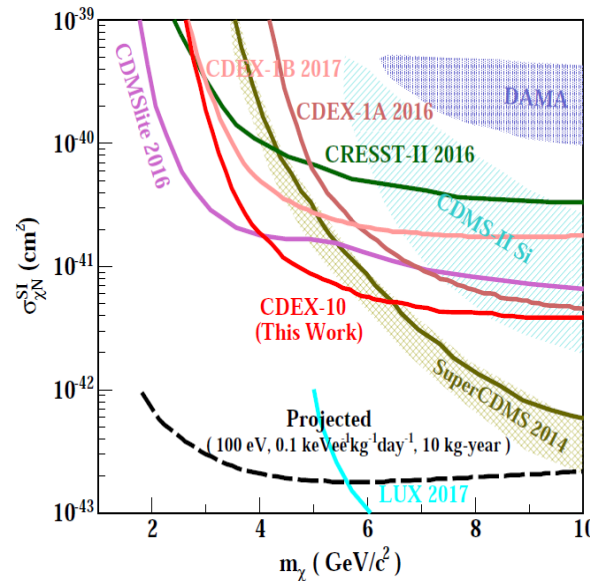
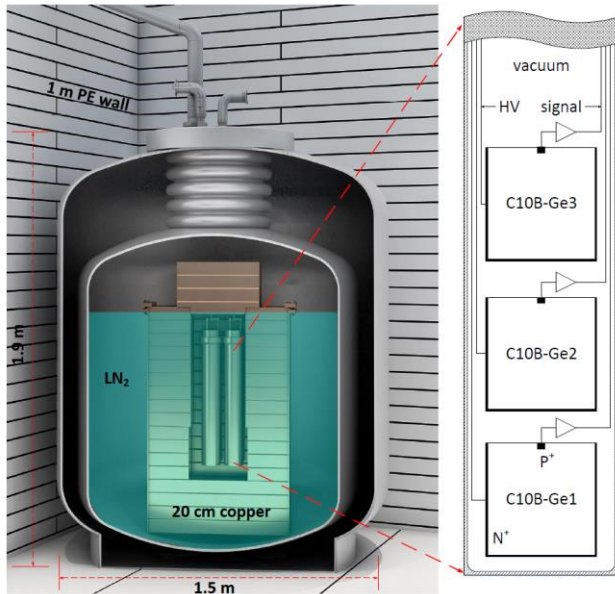
**PandaX**



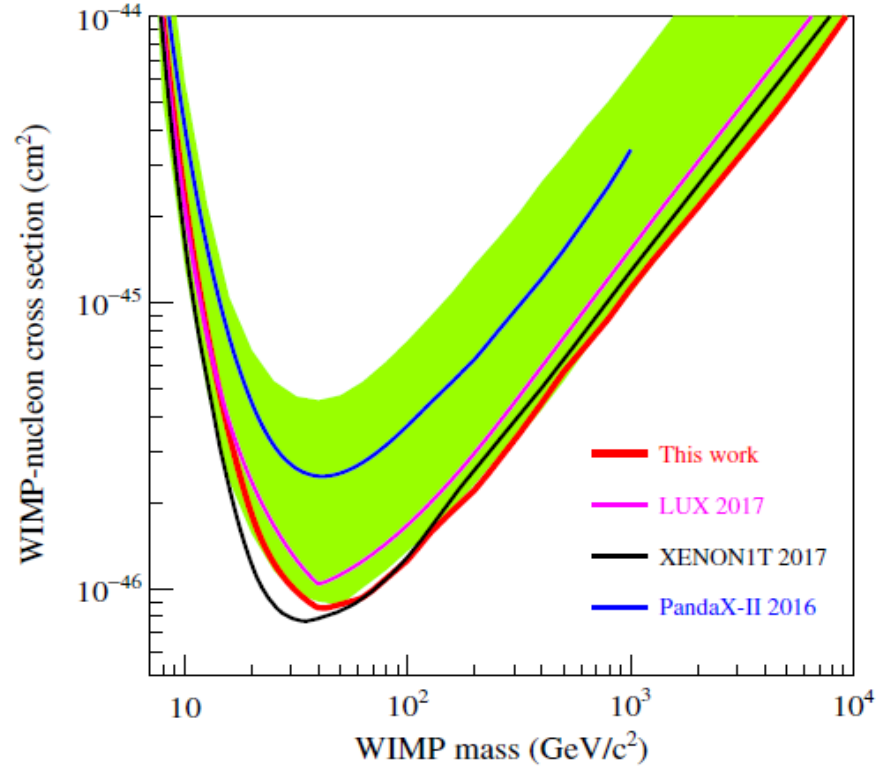
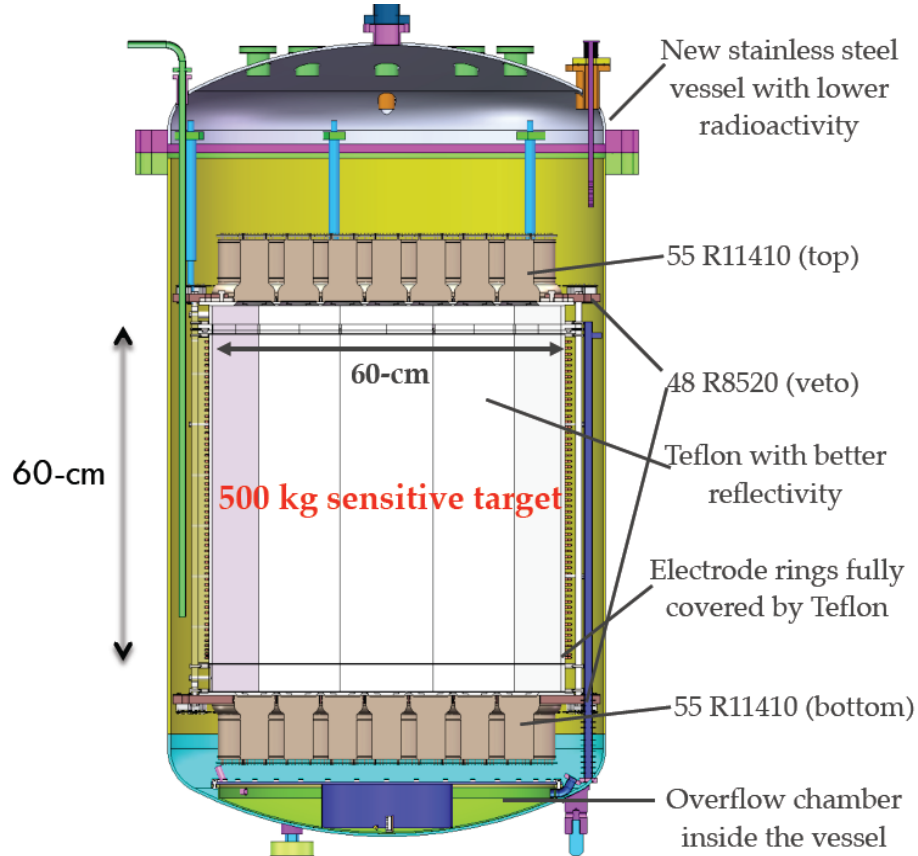
**Jinping  
neutrino  
Experiment**

# CDEX recent status

- Now 10kg-scale Ge detector array for light DM search;
- New results accepted by PRL(arXiv:1802.09016);
- The best sensitivities on 4-5 GeV mass region for SI;
- The best sensitivities below 4 GeV mass region for SD.



# PandaX recent results



PhysRevLett.119.181302



# Jinping Neutrino Experiment

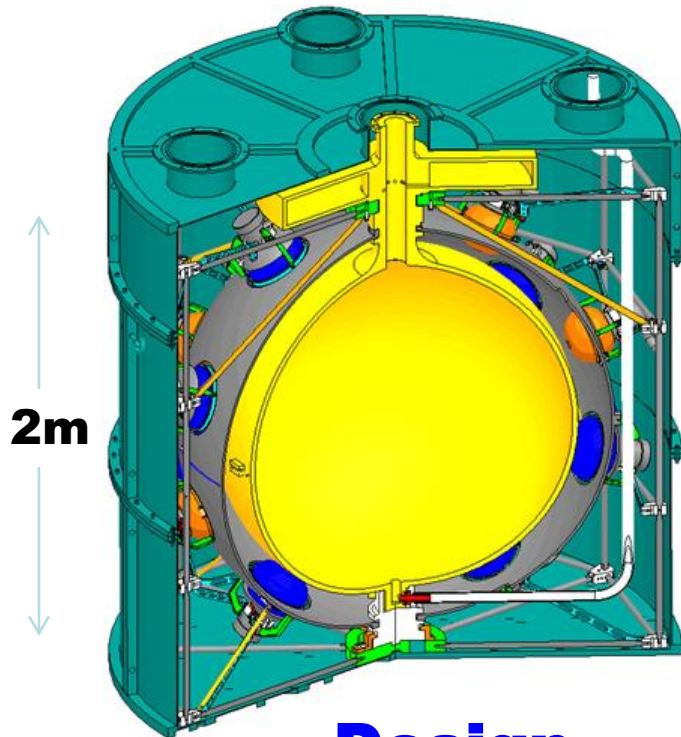
## 1-ton Prototype of Jinping Neutrino Experiment

### Physics goals:

1. Solar neutrino, geoneutrino, ...
2. Measure fast neutron background
3. Test detection material: water, LS, and slow LS

### Schedule:

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



2m

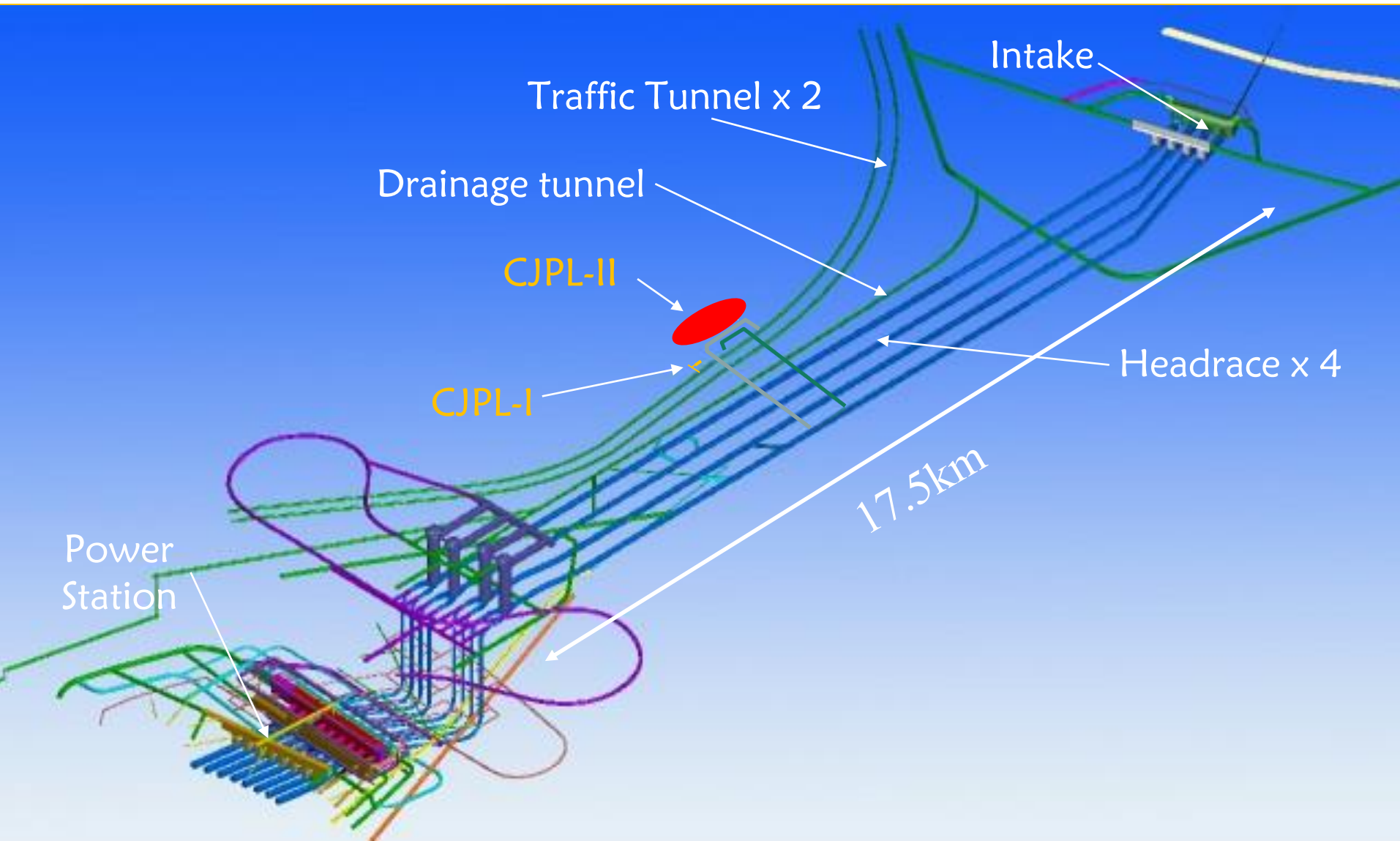
**Design**



**Assembly**  
03/11/2016

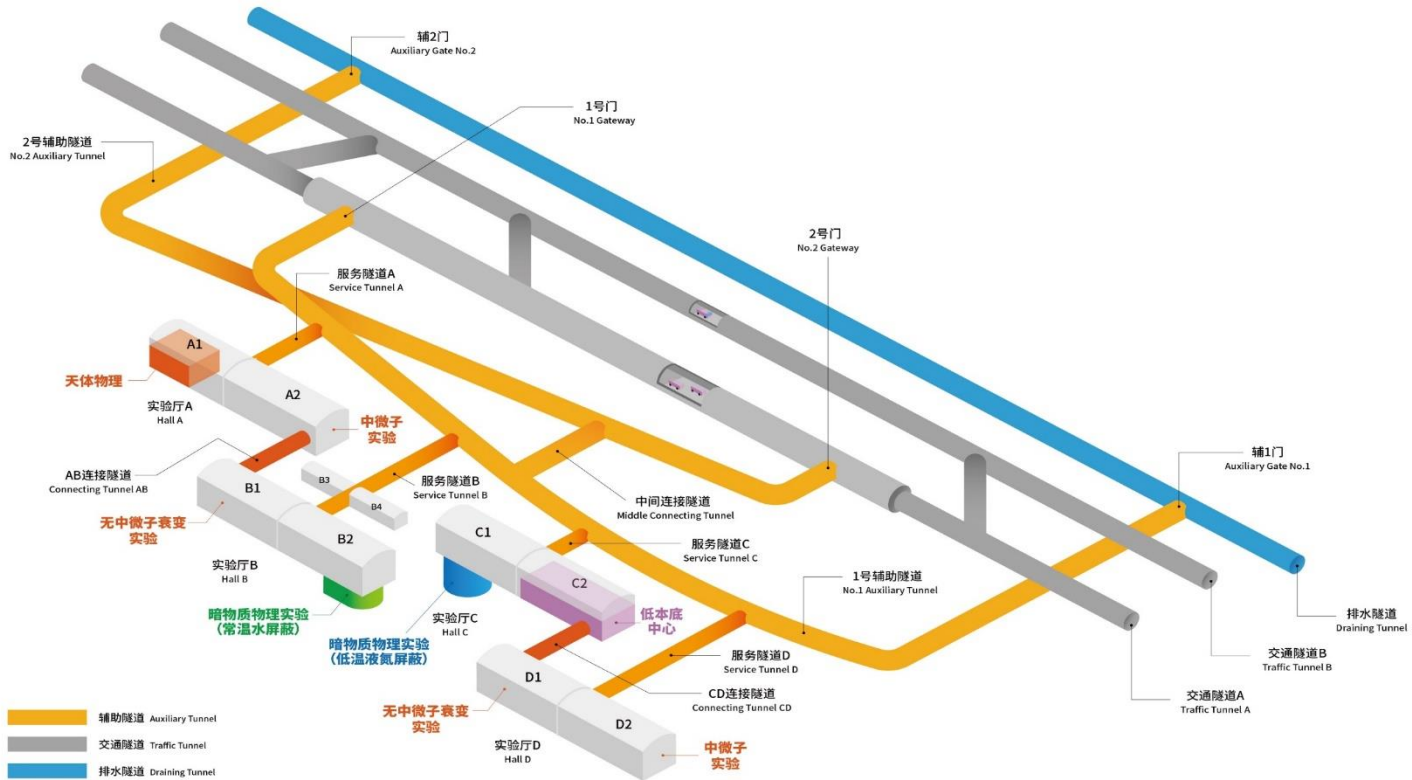
**Fabrication**

# CJPL in Jinping tunnels



# The layout of CJPL-II

- 4 main halls : 14m(H)×14m(W)×130m(L);
- Total Volume: 300K m<sup>3</sup>;
- Two expanded spaces:  
C1-- $\phi 18\text{m} \times 32\text{m(H)}$  and B2-- $27\text{m(L)} \times 14\text{m(W)} \times 30\text{m(H)}$





# Status of CJPL-II

- **2015:** The rock excavations completed;
- **2016:** Expansion of two sites finished;
- **2017:** Ventilation system installation finished.





# CJPL-II project

- ✓ CJPL been selected as a project of national major S&T infrastructure of China.
- ✓ Funding: \$200M.



Main Hall x 8



C1 LN2 Tank



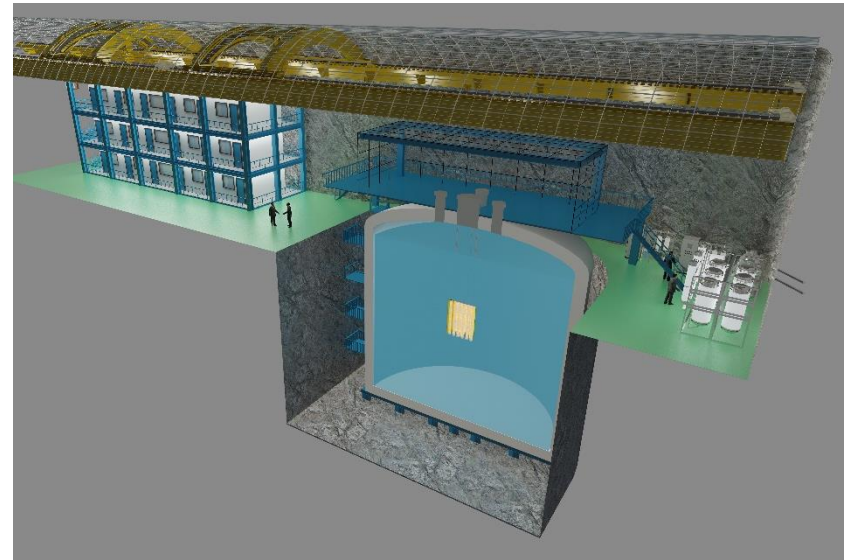
Internal traffic tunnel

# CJPL-II possible users

- CDEX-1T (Ge DM+DBD Exp.)
- PandaX-4T (Xe DM Exp.)
- LAr dark matter experiment
- Nuclear astroparticle physics
- Solar neutrino experiment
- Rock mechanics
- CUPID-China(DBD)
- .....

# CDEX-1T experiment

- Large underground space in CJPL-II ready now;
- Started to install the 1800m<sup>3</sup> liquid N<sub>2</sub> tank;
- Finished by the end of 2018!

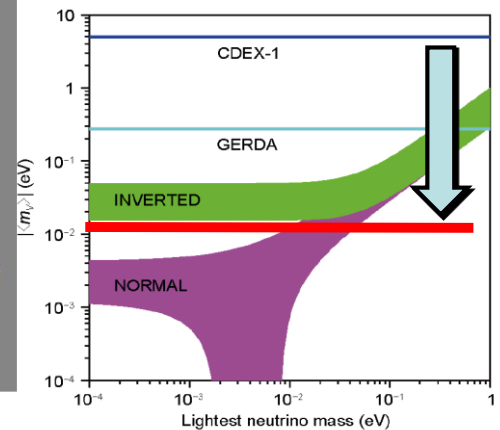
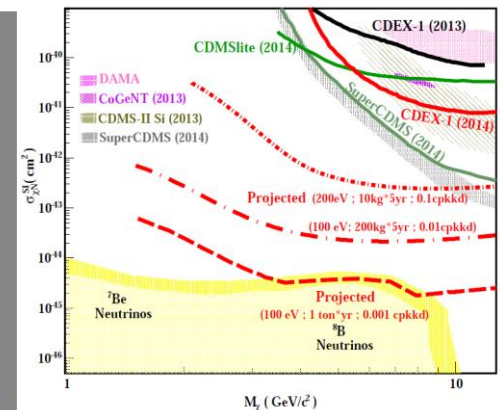
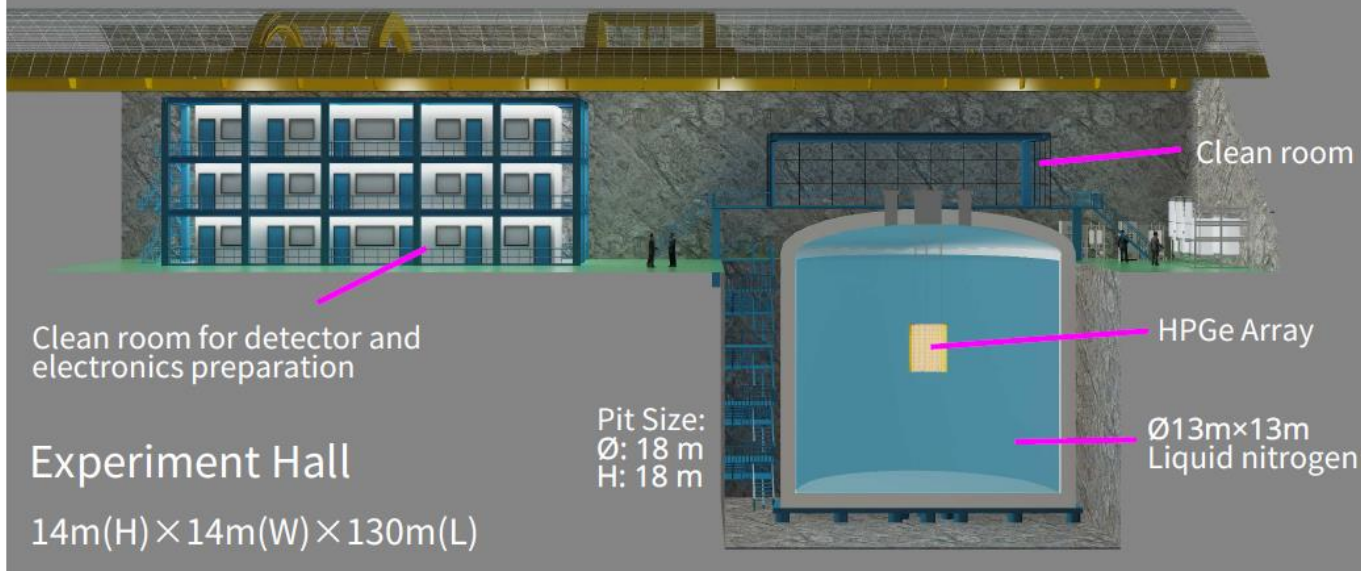




# CDEX-1T experiment

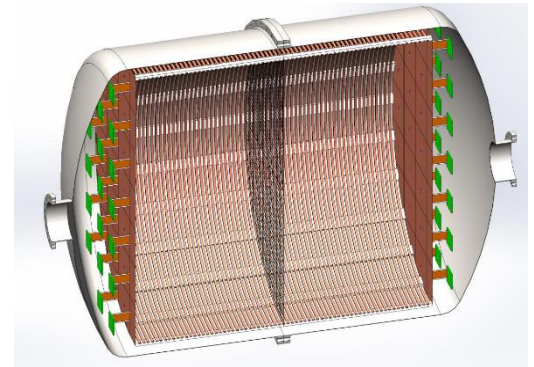
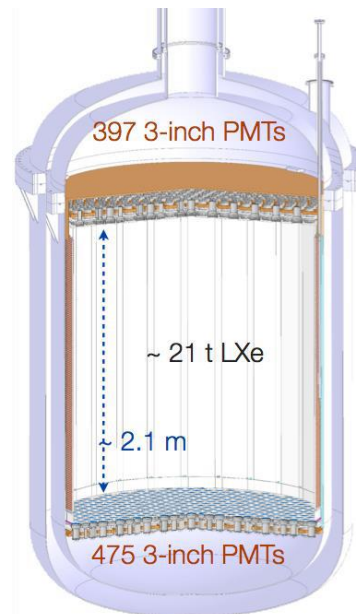
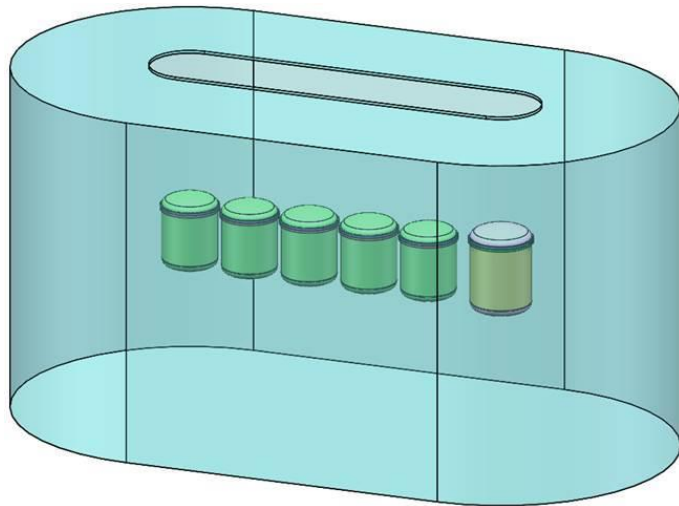
- A ton-scale Ge detector array and LN shielding+cooling system in the CJPL-II;
- Dark matter + ( $0\nu\beta\beta$  + Solar  $\nu$ ).

## CDEX-1T Conceptual Layout





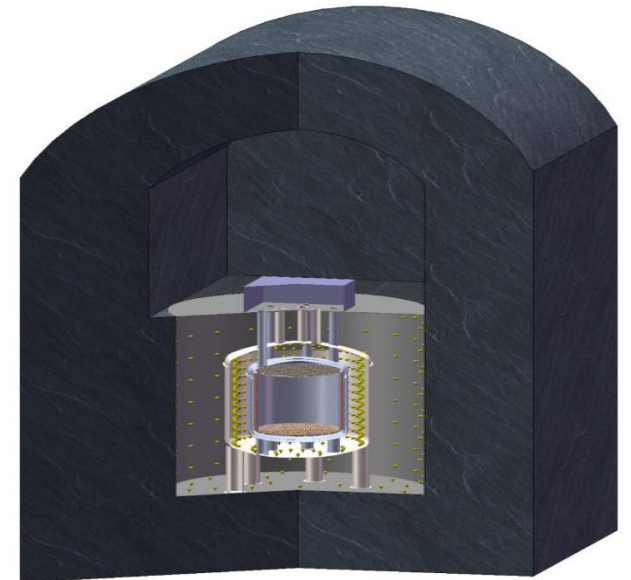
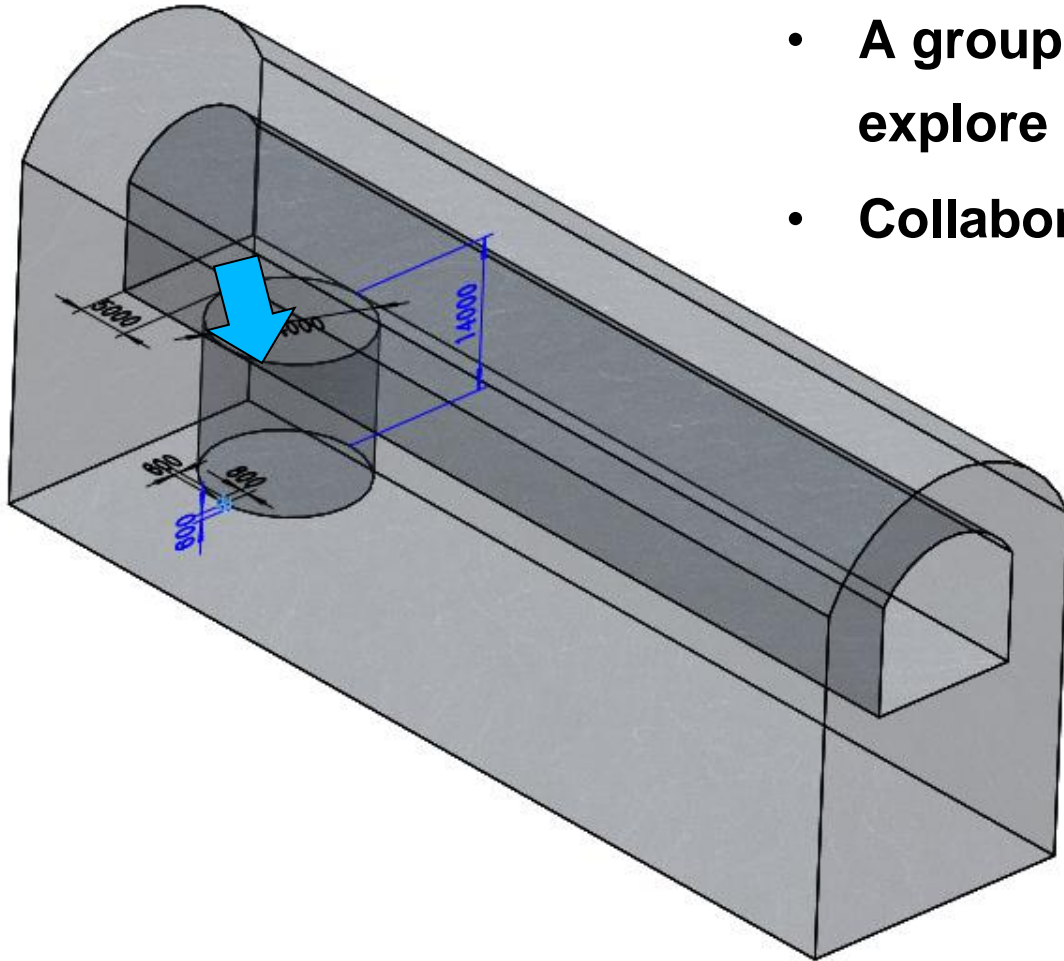
# PandaX in CJPL-II



- Now 4T LXe detector under construction;
- Future 30T LXe DM detector;
- $5 \times 200$ kg HP(10-15bar) Xe136 gas TPC

# Liquid Argon Dark Matter Experiment in CJPL-II

- A group from IHEP of China to explore LAr detector technique;
- Collaborate with DarkSide;



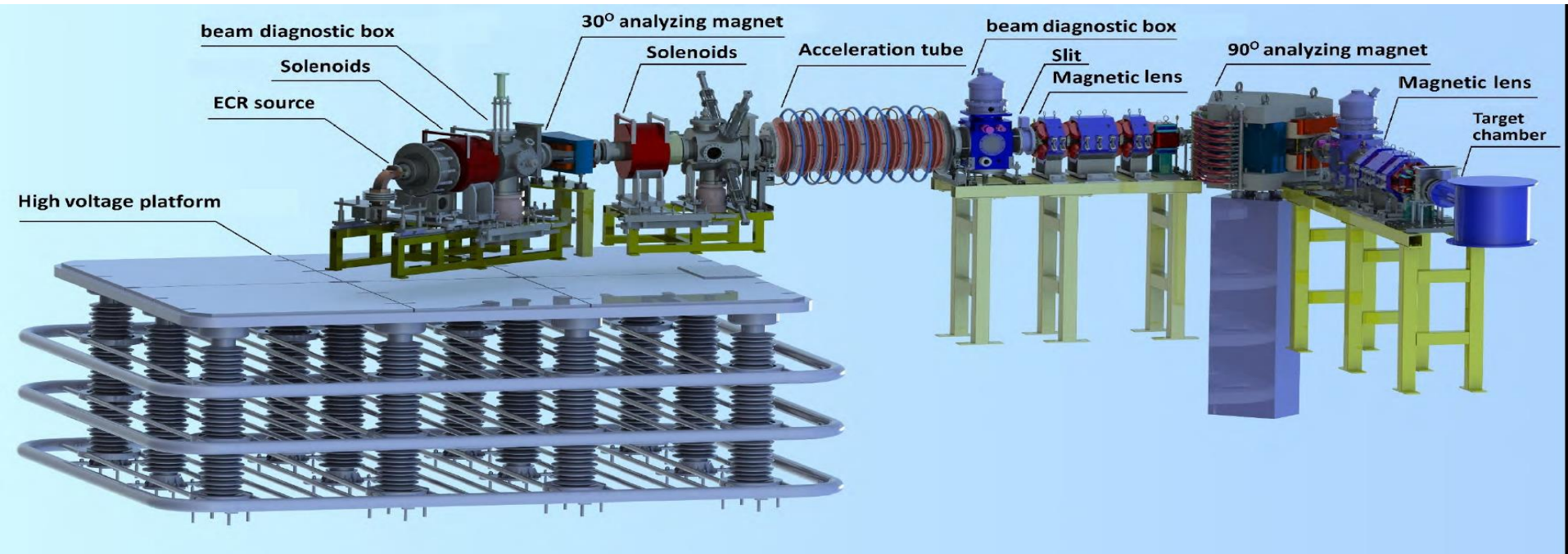
# JINPING Underground Nuclear Astrophysics (JUNA) Experiment



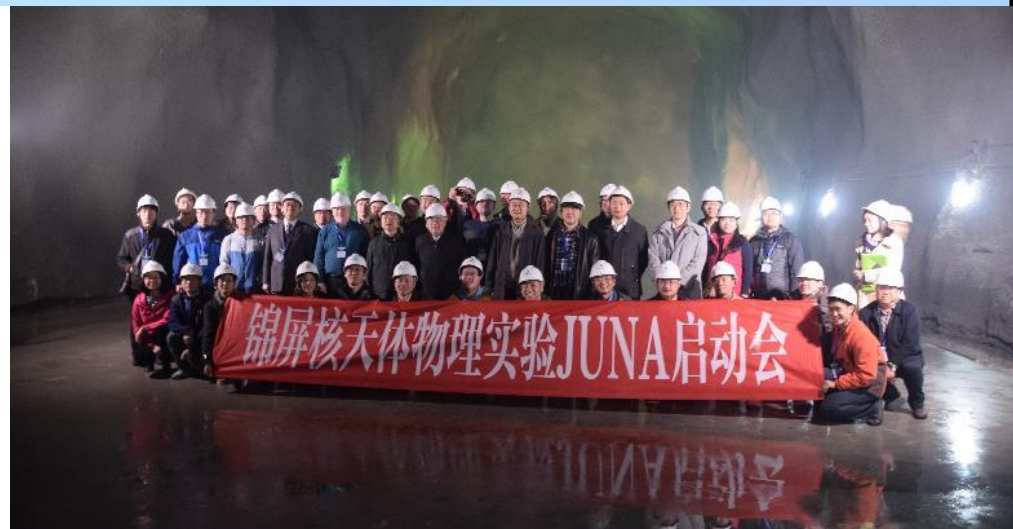
- JUNA aims at direct measurement of  $(\alpha, \gamma)$ ,  $(\alpha, n)$  reactions in hydrostatic helium burning and  $(p, \gamma)$ ,  $(p, \alpha)$  reactions in hydrostatic hydrogen burning;
- JUNA will provide key inputs of nuclear physics for understanding evolution of stars and origin of elements.

Physics	Reaction	Current	Desired
Massive star	$^{12}\text{C}(\alpha, \gamma)^{16}\text{O}$	60%, 890 keV	20%, 220-380 keV
s-process neutron source	$^{13}\text{C}(\alpha, n)^{16}\text{O}$	60%, 279 keV	10%, 140-230 keV
Galaxy $^{26}\text{Al}$ source	$^{25}\text{Mg}(p, \gamma)^{26}\text{Al}$	20%, 92 keV	5%, 50-300 keV
F abundace	$^{19}\text{F}(p, \alpha)^{16}\text{O}$	80 %, 189 keV	5 %, 50-250 keV

# JUNA Astroparticle experiment

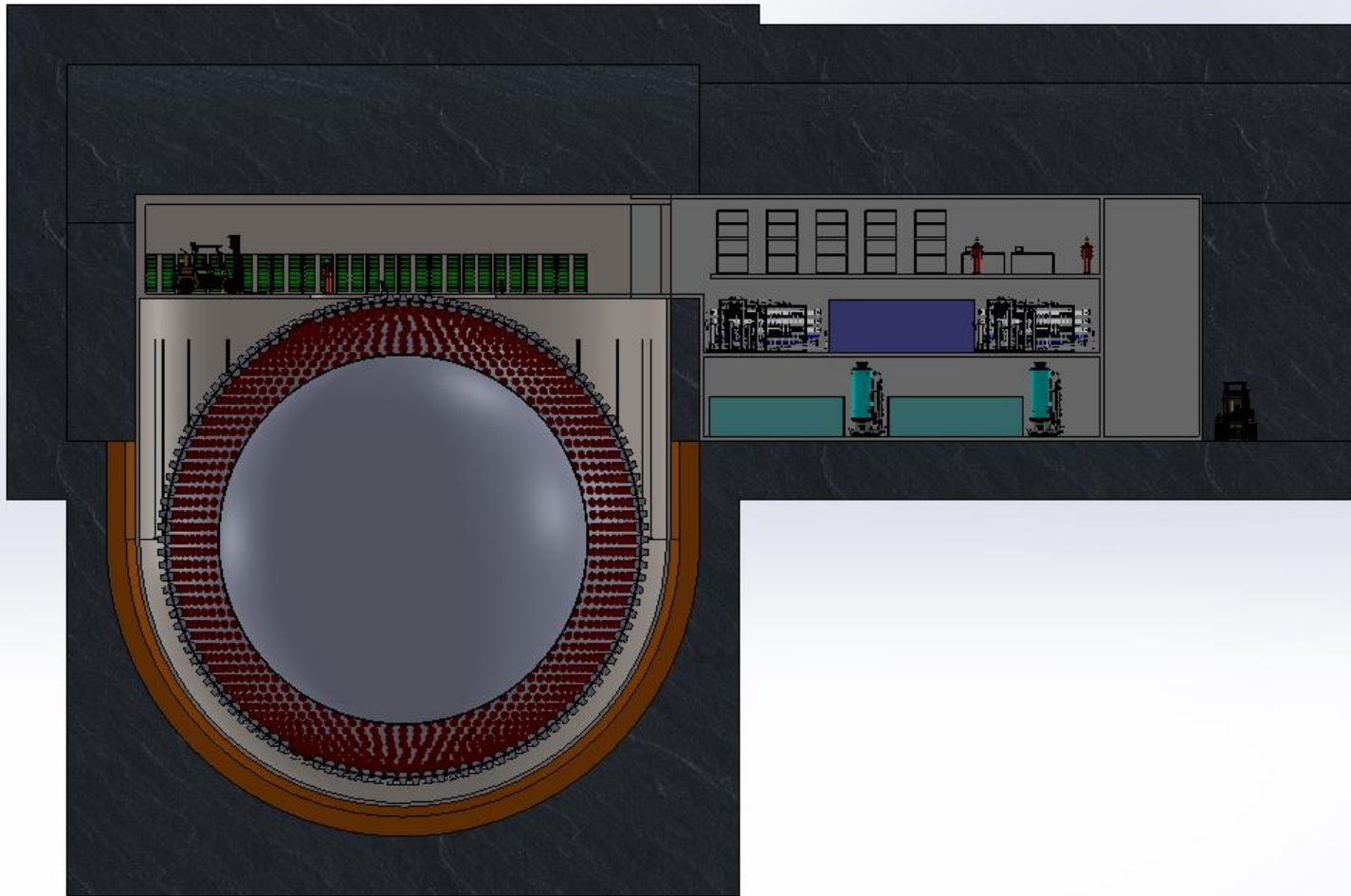


Now start to construct the infrastructure for accelerator and shielding system!





# Jinping Neutrino Experiment Kilo-Ton scale from 2020



# Summary

- CJPL-1 with deepest rock overburden in the world run now; Two DM experiments run in and published important physical results;
- CJPL-II with deepest rock overburden, largest space in the world under setup, funding from Chinese government approved;
- Experiments applying CJPL-II space including: DM, DBD, Neutrino, Astrophysics;
- The possible users of CJPL-II in the world are welcome.