Recent status and prospects of CJPL

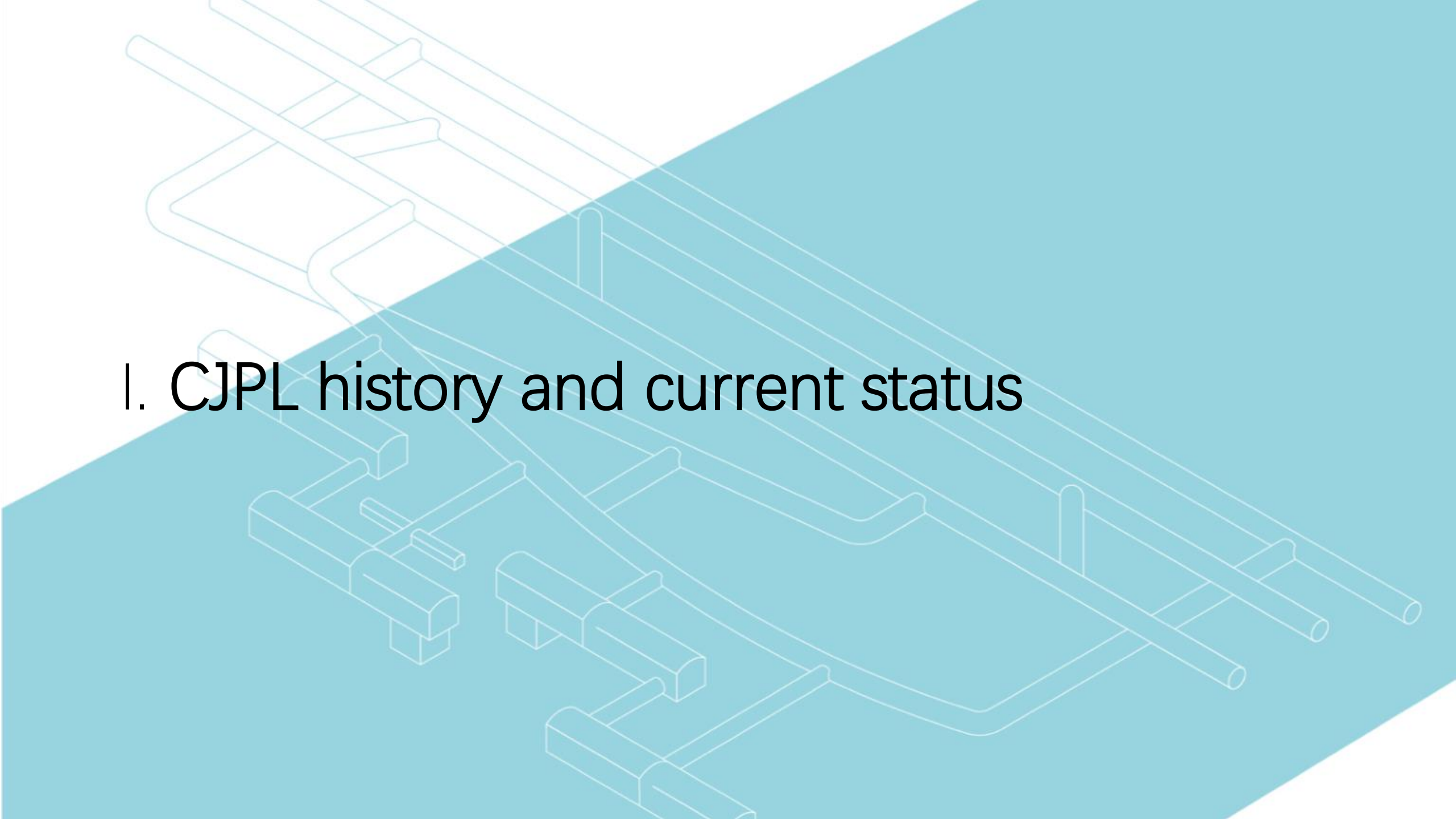
Zhi ZENG, Ming ZENG

Tsinghua University

2018-06-20

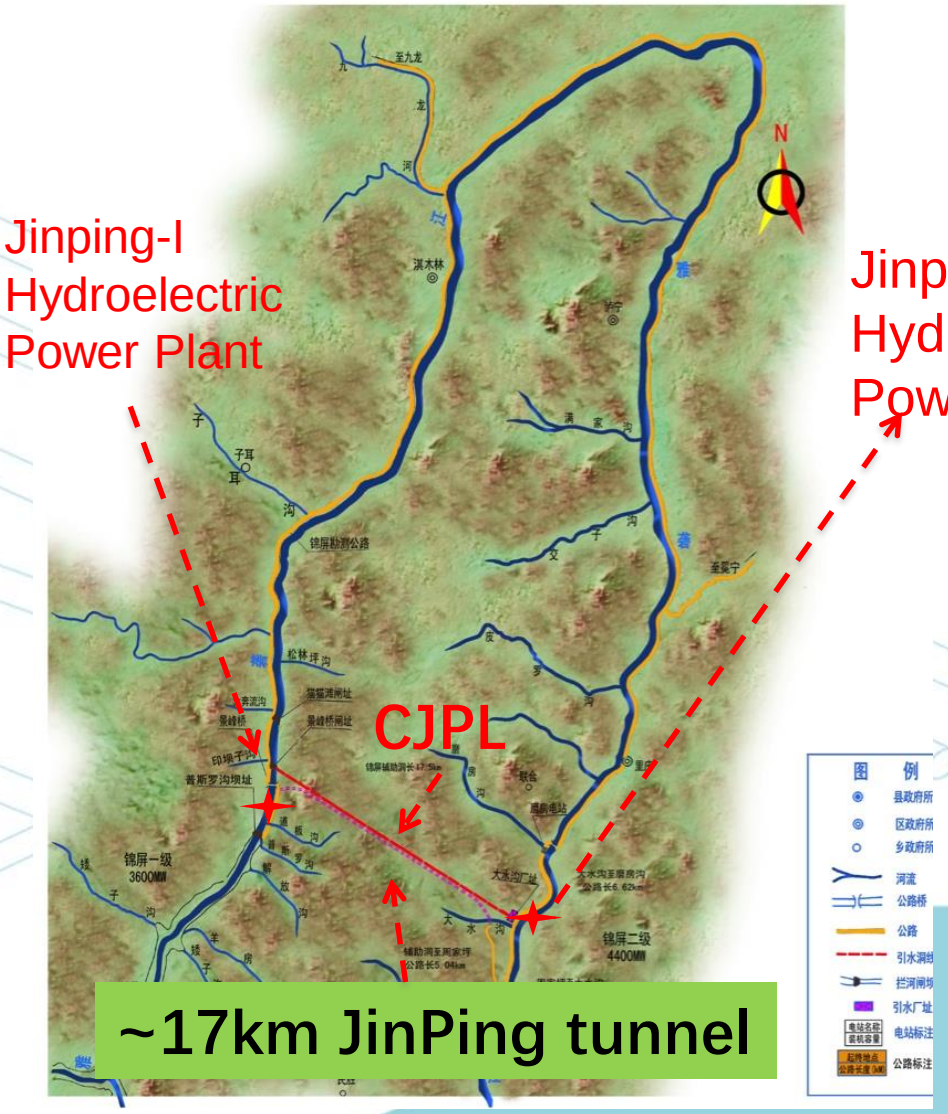
Outline

I. CJPL history and current status
II. CJPL-II Radiation Environment Measurement
III. The experiments in CJPL
IV. Summary

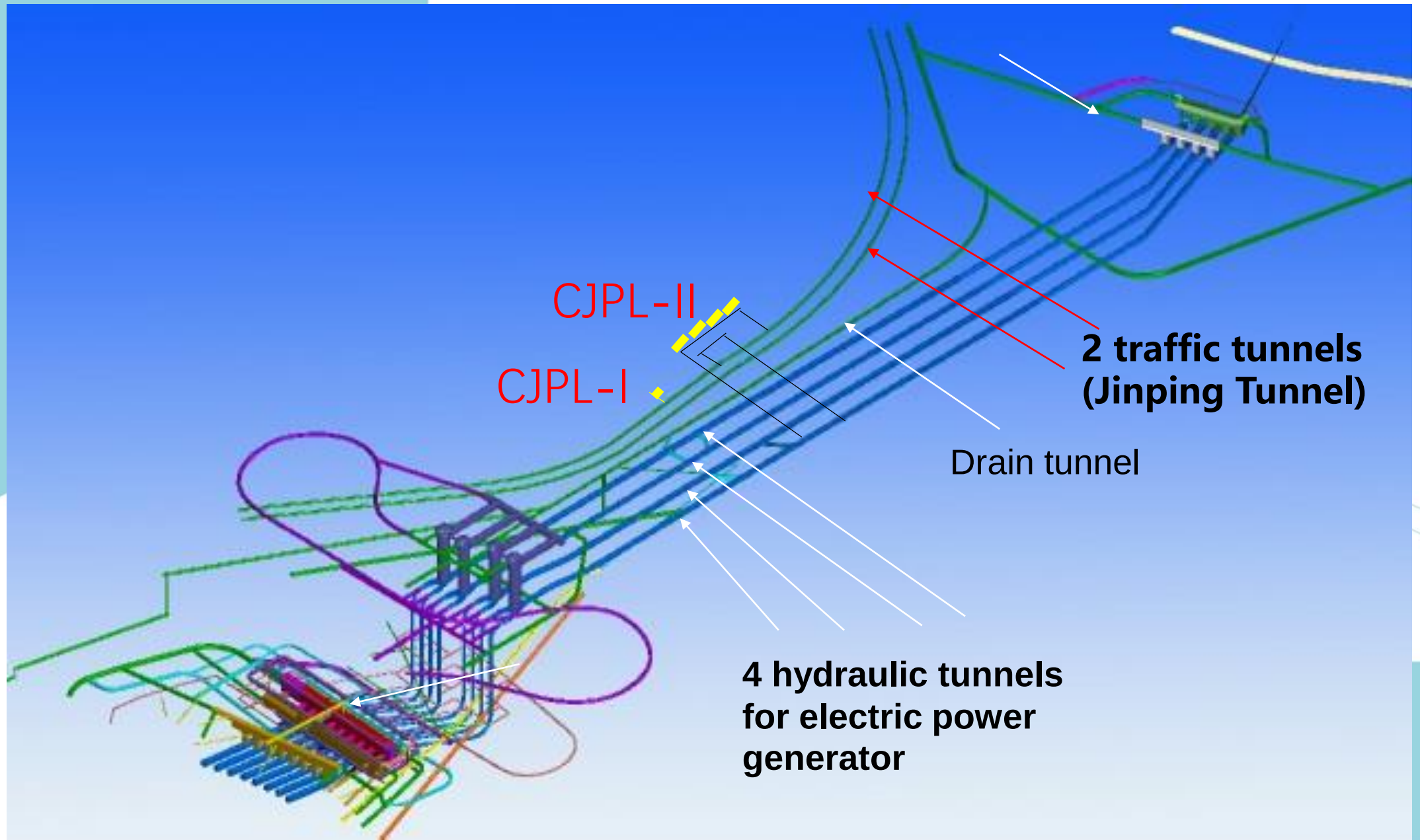


I. CJPL history and current status

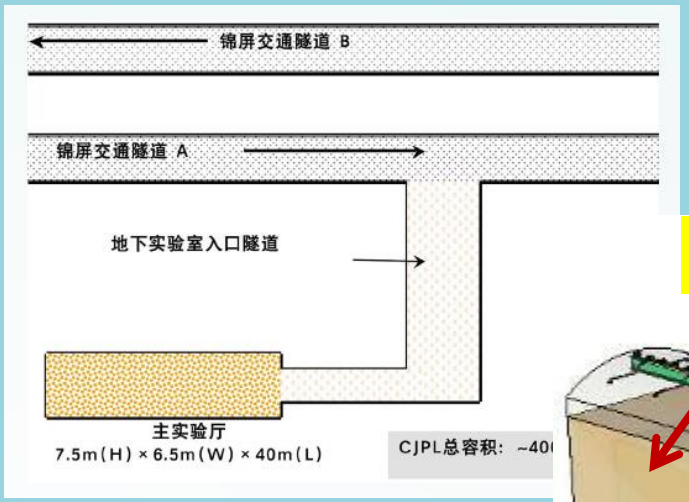
CJPL Location

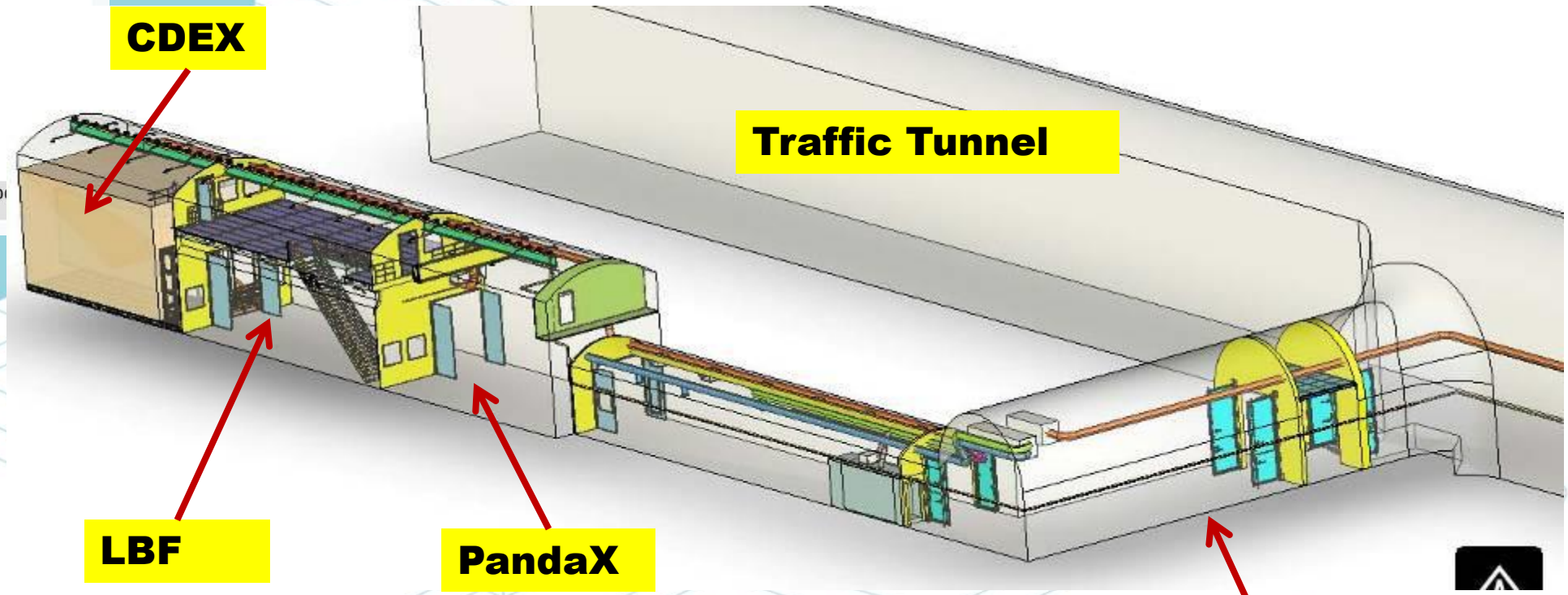


Tunnel Layout inside Jinping Mountain



Layout of CJPL-I

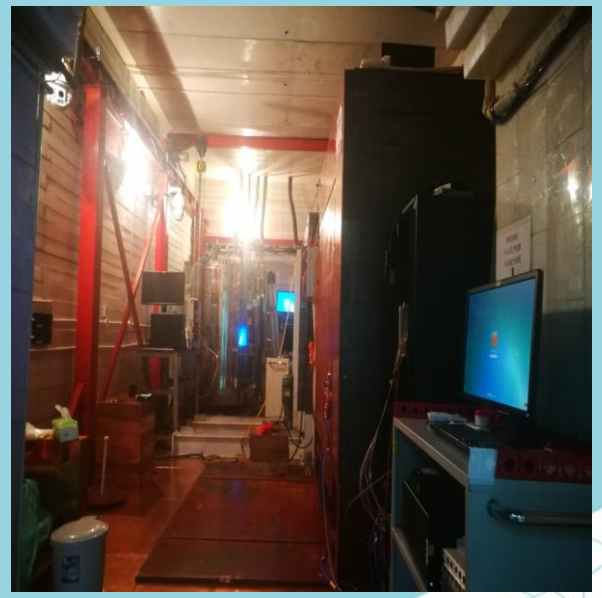




- Total space: 4000 m^3
- Main Lab Space: 6.5(W) x 6.5(H) x 42(L)

CJPL-I construction, 2009-2010

Current Status of CJPL-I



CDEX experiment

PandaX

Jinping neutrino

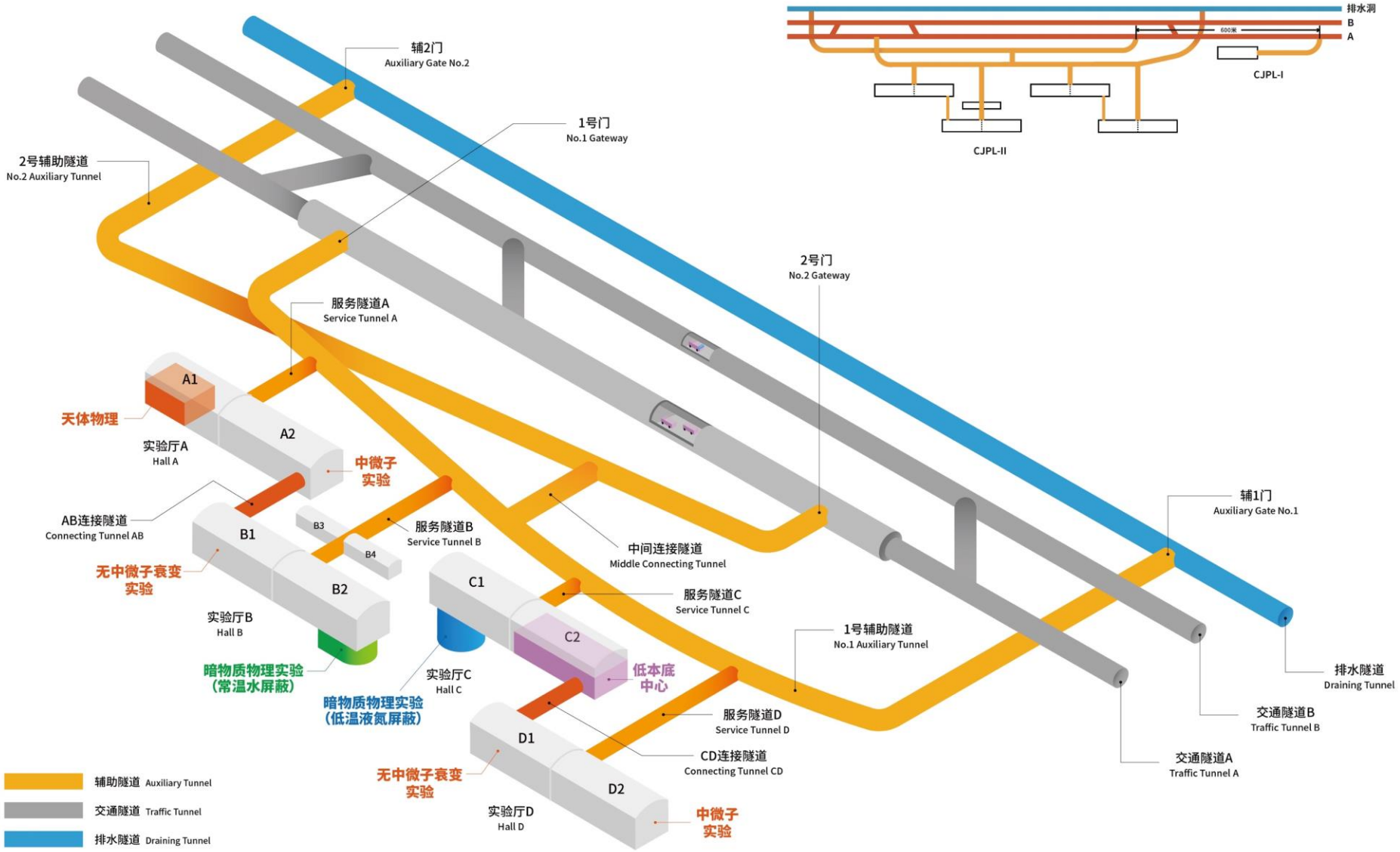
Low-background gamma spectrometer

- Physics experiments:
  - 2 dark matter experiments: CDEX, PandaX
  - 1 neutrino experiment: Jinping Neutrino experiment
- Low background counting facilities:
  - 2 low-background gamma spectrometers: GeTHU-I and GeTHU-II

Logistics of CJPL

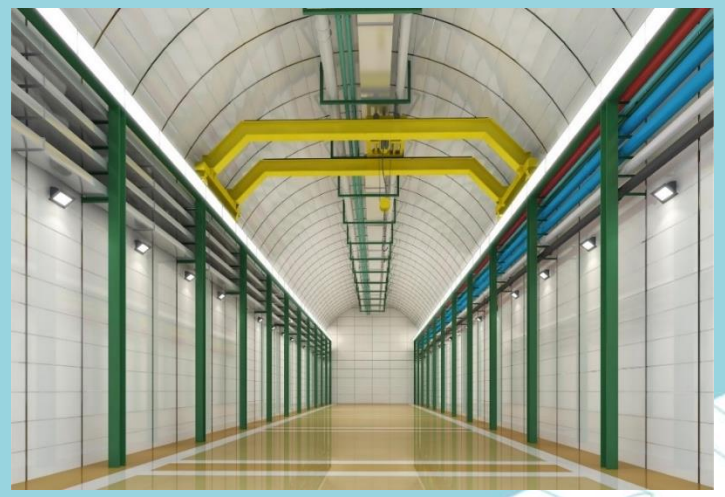
Convenient & Comfortable

Layout of CJPL-II



CJPL-II construction, since 2014

CJPL-II construction next plan



Hall

Service tunnel

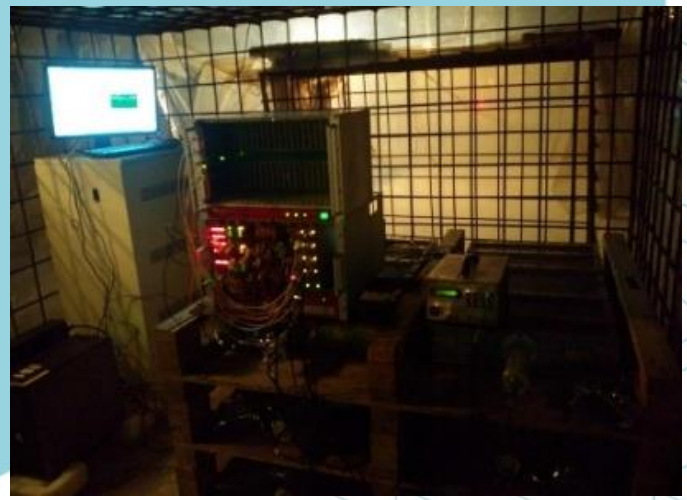
- CJPL was selected to be a candidate project of National Major S&T infrastructure of China in 2016.
- Proposal being prepared and possibly approved in the July of 2018.
- Possible users:
  - CDEX-1T(DM, 0νββ), PandaX-1T, LAr DM., CUPID-China.
  - Nuclear astroparticle physics
  - Solar neutrino experiment
  - Rock mechanics experiment
  - ……
- Service
  - Low background counting
  - Ultra pure copper
  - popularization of science

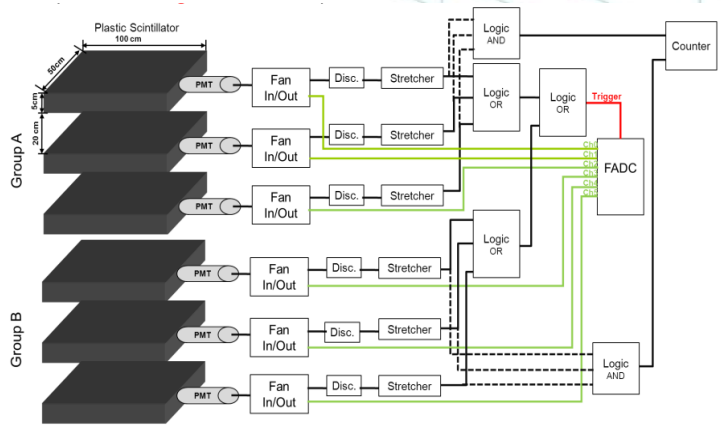
Ground campus

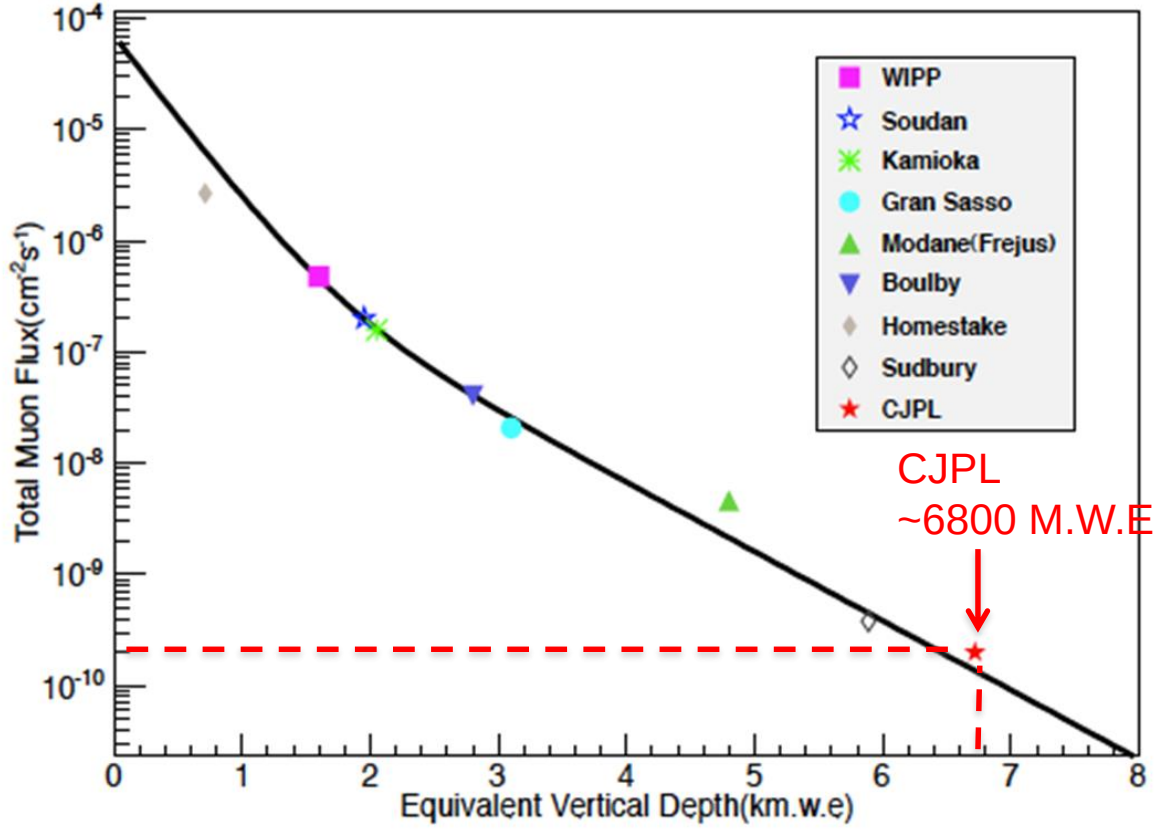
II. CJPL-II Radiation Environment measurement

Cosmic-ray Muon Flux measurement

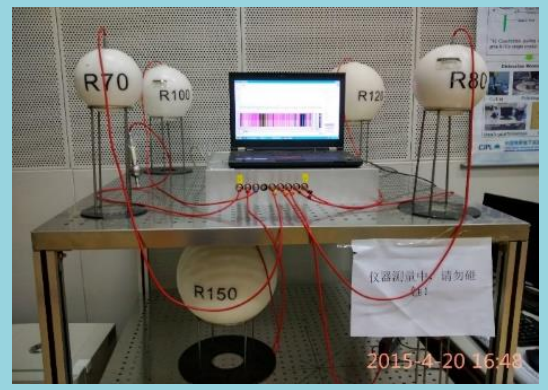
- **Muon flux in CJPL-I:** $(2.0 \pm 0.4) \times 10^{-10} cm^{-2} s^{-1}$
- **Muon flux in CJPL-II:** $(1.2 \pm 0.4) \times 10^{-10} cm^{-2} s^{-1}$



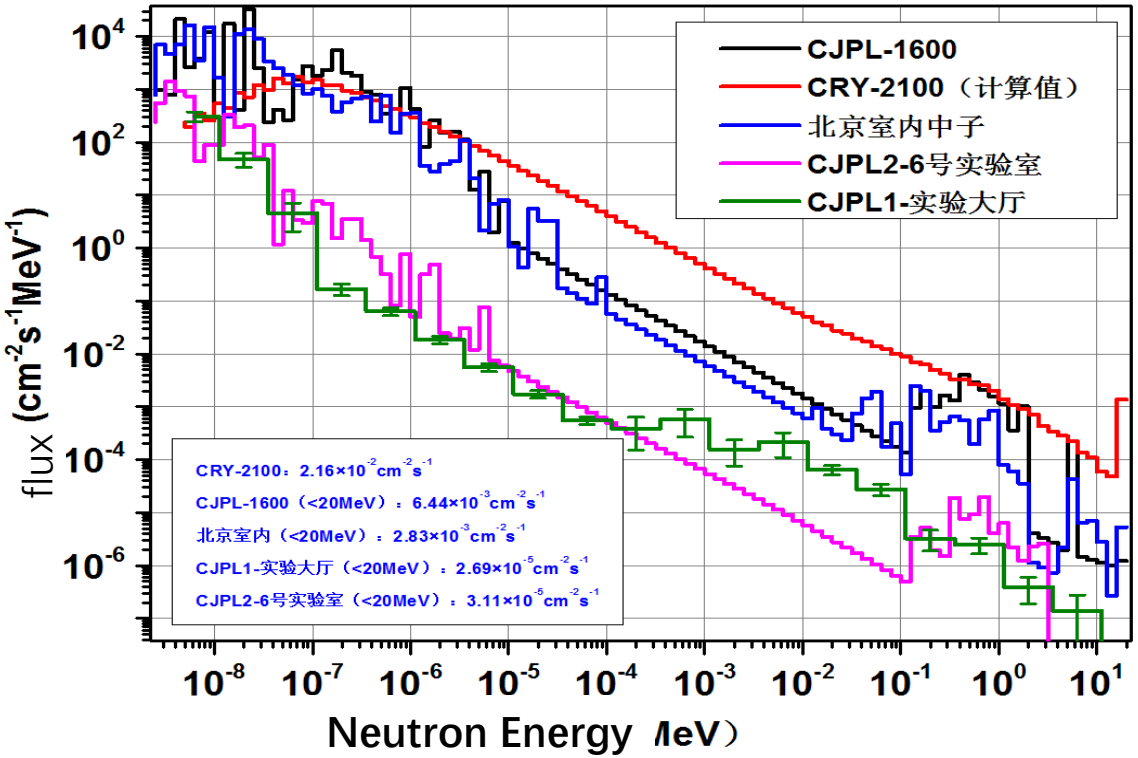




Neutron background

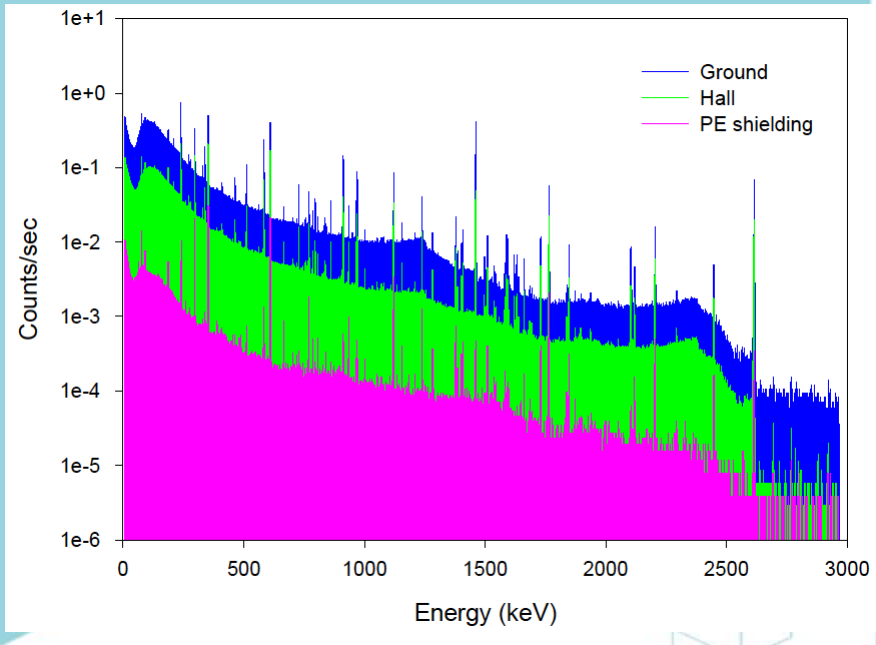


9 spheres neutron spectrometer



Lab	Depth (m.w.e)	Thermal neutron ($cm^{-2}s^{-1}$)	Fast neutron ($cm^{-2}s^{-1}$)
CPL	1000	No data	$(3.00\pm0.02)\times10^{-5}$
YangYang	2000	$(2.42\pm0.22)\times10^{-5}$	8×10^{-7}
Soudan	2090	$(0.7\pm0.08)\times10^{-6}$	No data
Canfranc	2450	$(1.13\pm0.02)\times10^{-6}$	$(0.66\pm0.01)\times10^{-6}$
Boulby	2800	No data	$(1.72\pm0.61)\times10^{-6}$
Gran Sasso	3600	$(1.08\pm0.02)\times10^{-6}$	$(0.23\pm0.07)\times10^{-6}$
Modane	4800	$(1.6\pm0.1)\times10^{-6}$	$(4.0\pm1.0)\times10^{-6}$
CJPL-II	6720	$(1.1\pm0.2)\times10^{-5}$	$(3.8\pm0.6)\times10^{-7}$

Radioactivity analysis by in-situ gamma

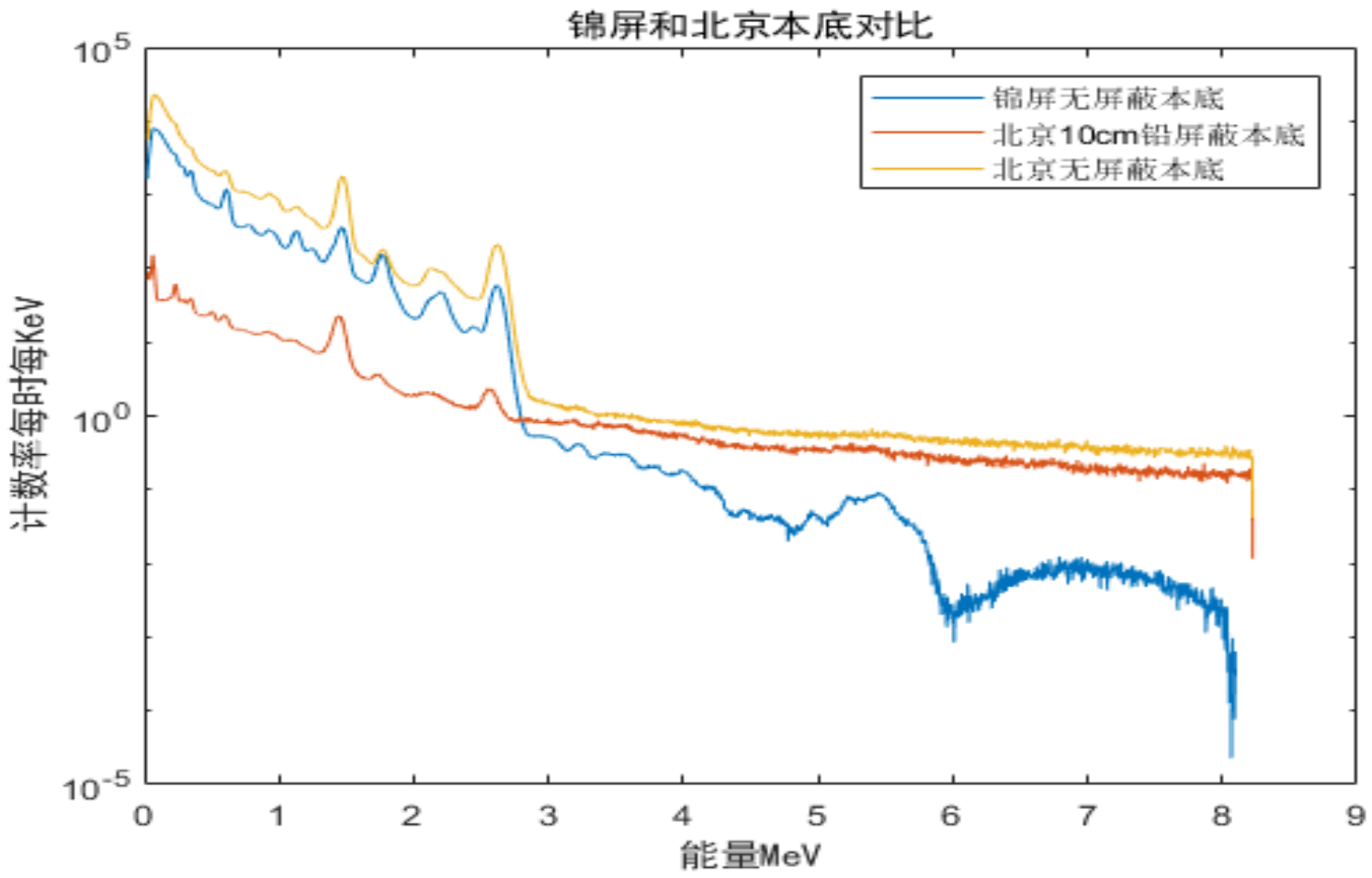


In-situ gamma spectrum in CJPL-I

Lab	^{238}U (Bq/kg)	^{232}Th (Bq/kg)	^{40}K (Bq/kg)
Gran Sasso	9.5	3.7	70
Modane	22.8	6.7	91
Boulby	7.1	3.9	120
CJPL-I	18.0±2.7	7.6±0.5	36.7
CJPL-II	8.2±4.9	2.9±1.1	47.2±9.1

Gamma Spectra by 5inch NaI(Tl)(< 8MeV)

CJPL-II C2, 740 hours



III. The experiments in CJPL

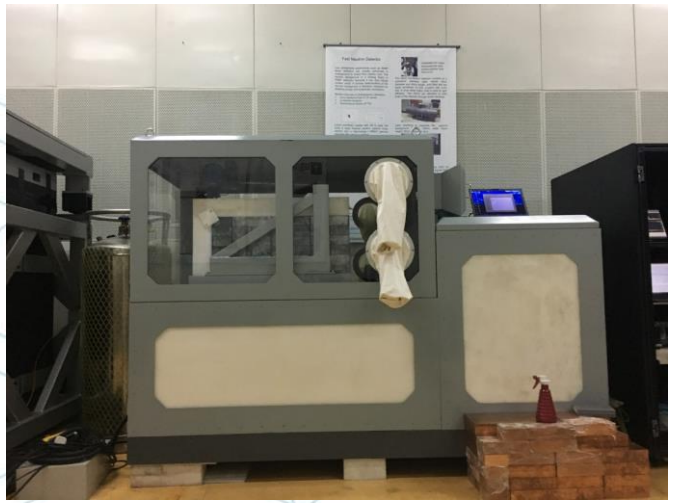
1. Low-background gamma spectrometer

GeTHU, low background gamma spectrometers in CJPL-I, designed for material screening for dark mater experiment. All the raw material used during construction of CJPL-II were investigated by GeTHU.

CJPL-I low background facility

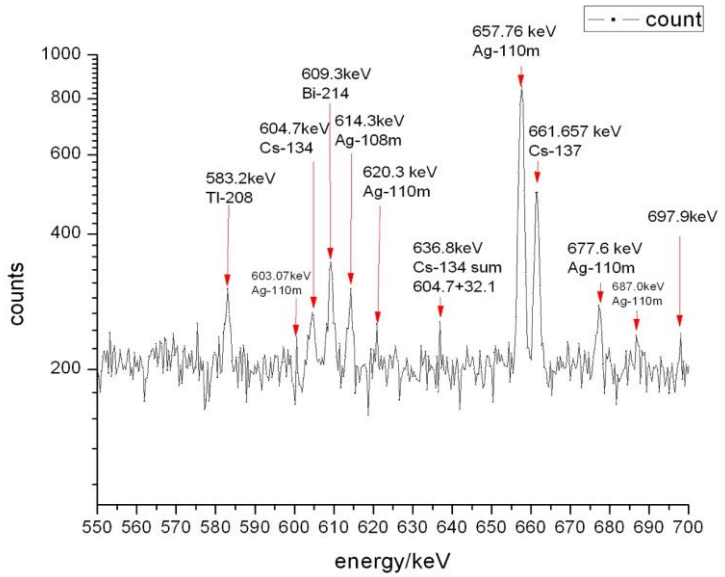
GeTHU-I

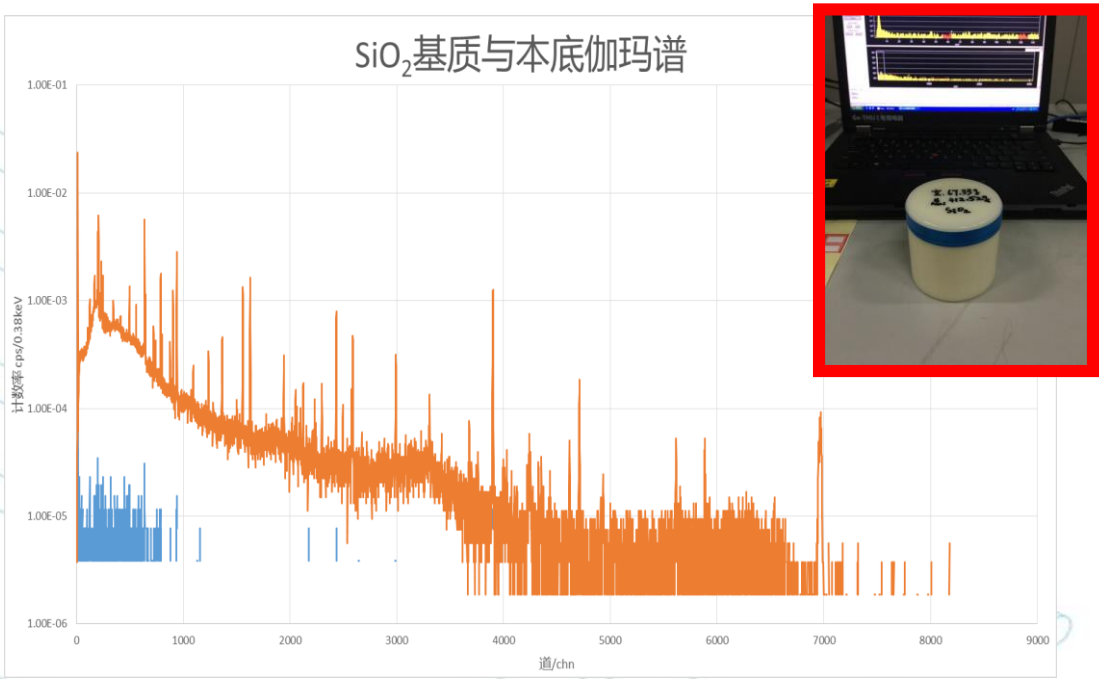
GeTHU-II



GeTHU-III

1. Low-background gamma spectrometer

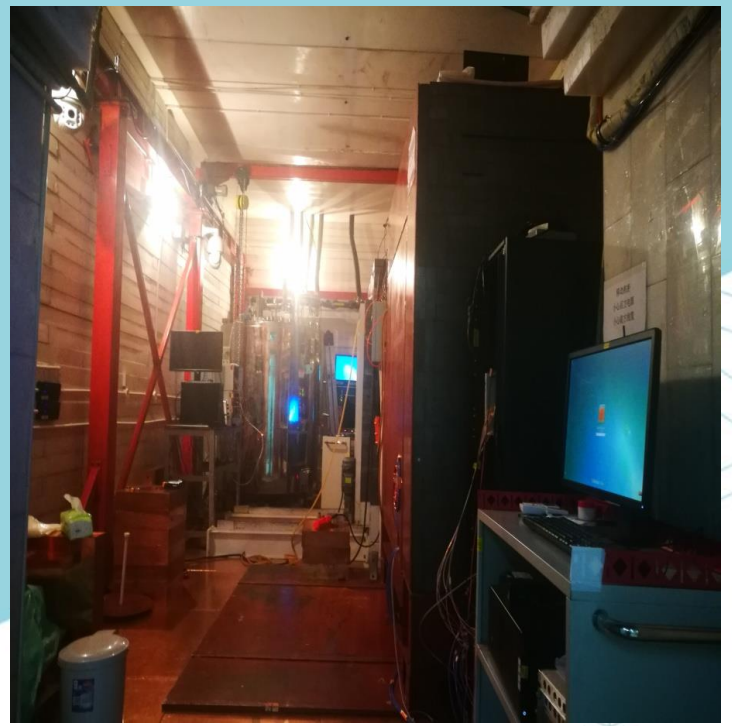




Squids from western Pacific Ocean measurement by GeTHU

The gamma spectrum of SiO_2 powder
used as basis material in a standard calibration sample.
Include:K-40: 27.3 Bq/kg； U/Th: < 10Bq/kg

2. Exepriments in CJPL-I

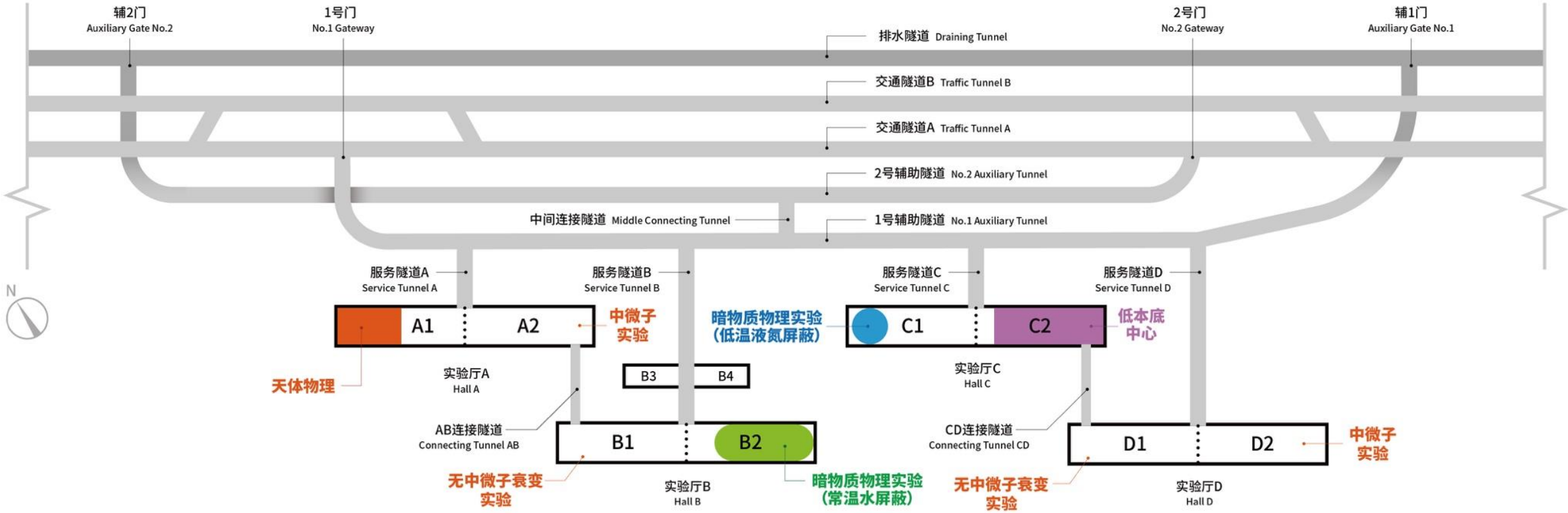


CDEX

PANDAX

Jinping Neutrino

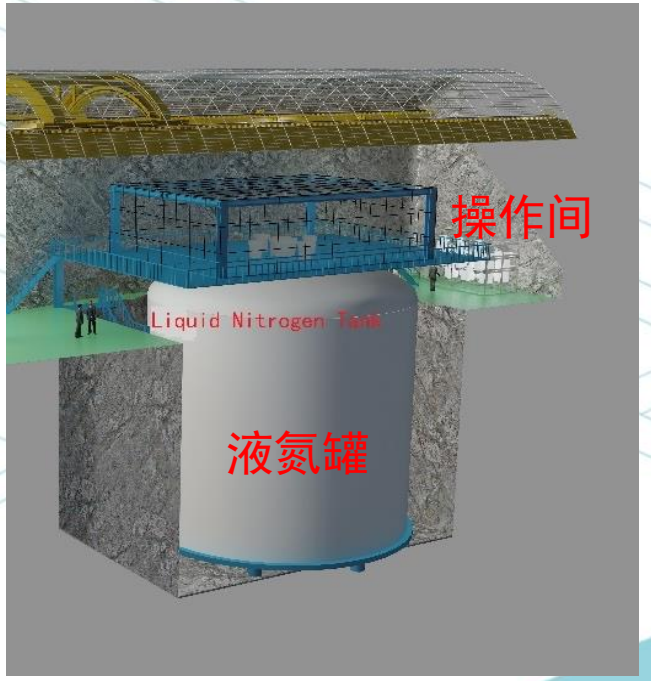
3. Experiments planning in CJPL-II



（1）大型液氮低温辐射屏蔽装置

- 液氮屏蔽，要求液氮中心区本底：10^{-6}cpkkd@2MeV。
- 需要大型液氮罐：液氮直径13m、高度13m，体积1725m^3；
- 需要安装空间：直径18m、可用高度32米的物理空间；
- 屏蔽装置操作间：要求洁净度主体万级、局部千级。

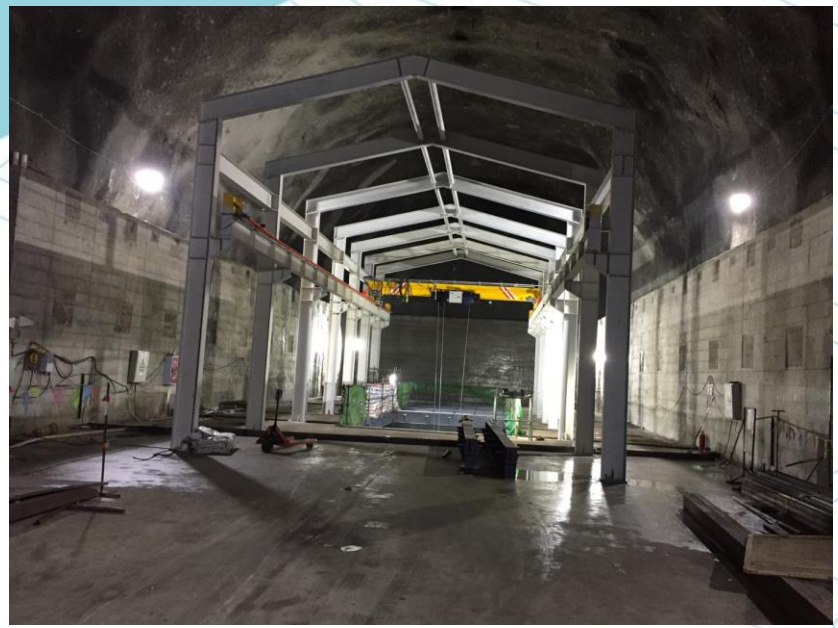
安装空间



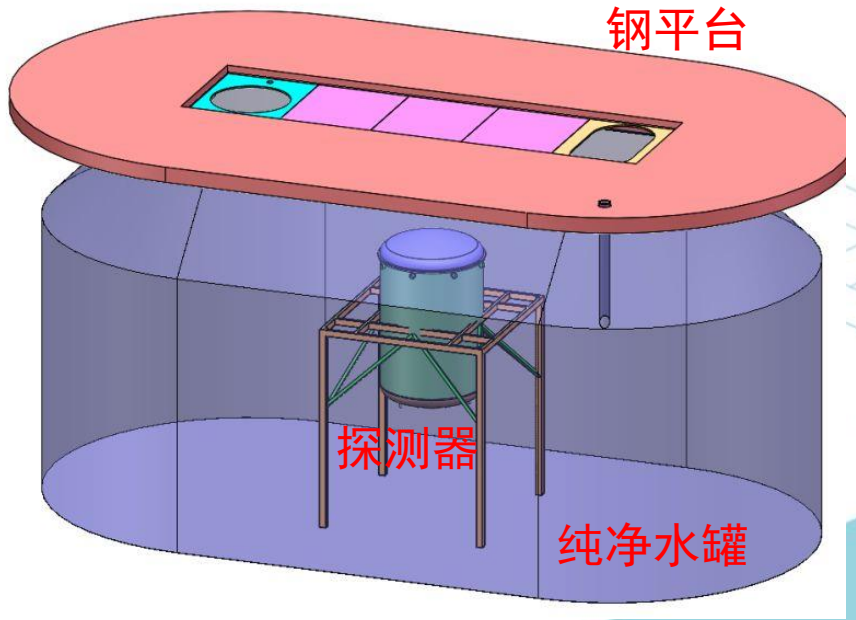
大型液氮罐效果图

(2) 大型常温纯净水辐射屏蔽装置

- 纯水屏蔽，要求纯水中心本底~10^{-5} cpkkd@2MeV
- 需要大型纯净水罐：4500m^3超纯去离子水
- 需要安装空间：长27米、宽15米、可用高度27米

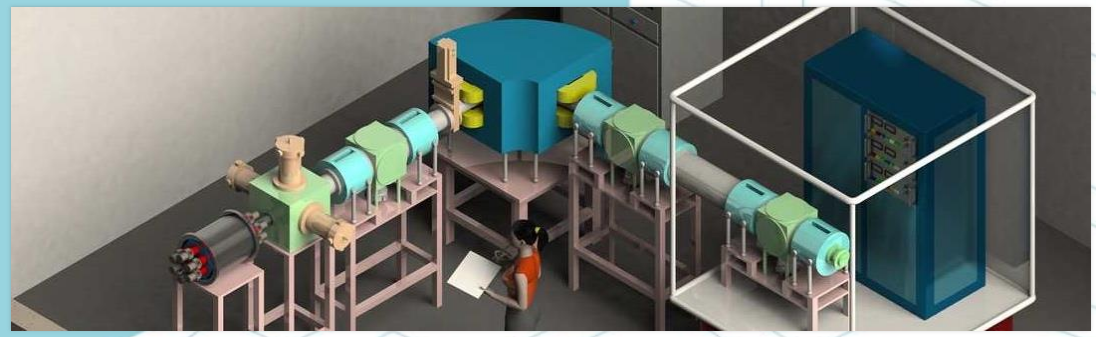


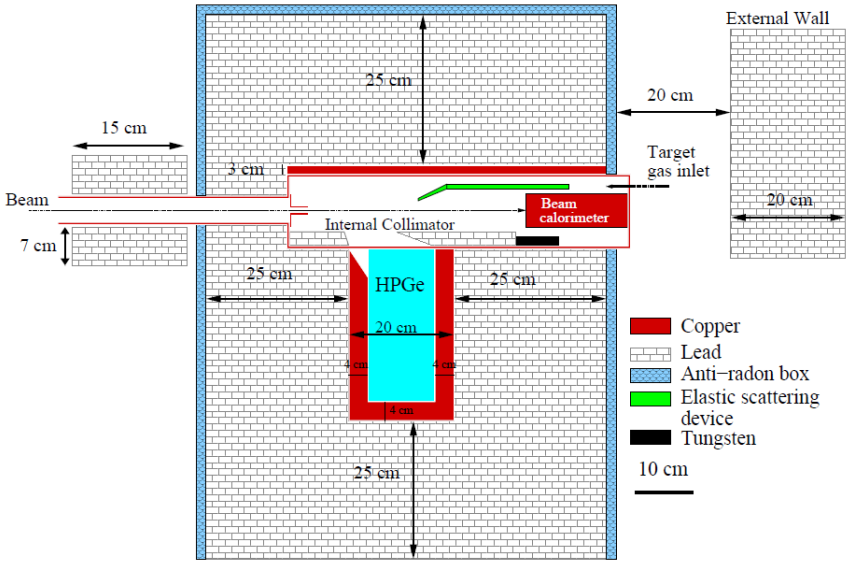
安装空间



大型纯净水罐效果图

(3)地下核天体物理实验




External Wall
25 cm
20 cm
15 cm
Target
gas inlet
3 cm
Beam
Beam
calorimeter
20 cm
Internal Collimator
7 cm
25 cm
HPGe
25 cm
20 cm
4 cm
4 cm
4 cm
25 cm
Copper
Lead
Anti−radon box
Elastic scattering
device
Tungsten
10 cm

(4)其他实验需求

■ 暗物质方面：
- CDEX高纯锗：10kg→吨级
- PandaX液氙：500kg→30吨级
- IHEP液氩：　1吨→20吨级
- 中法暗物质方向探测
- ……

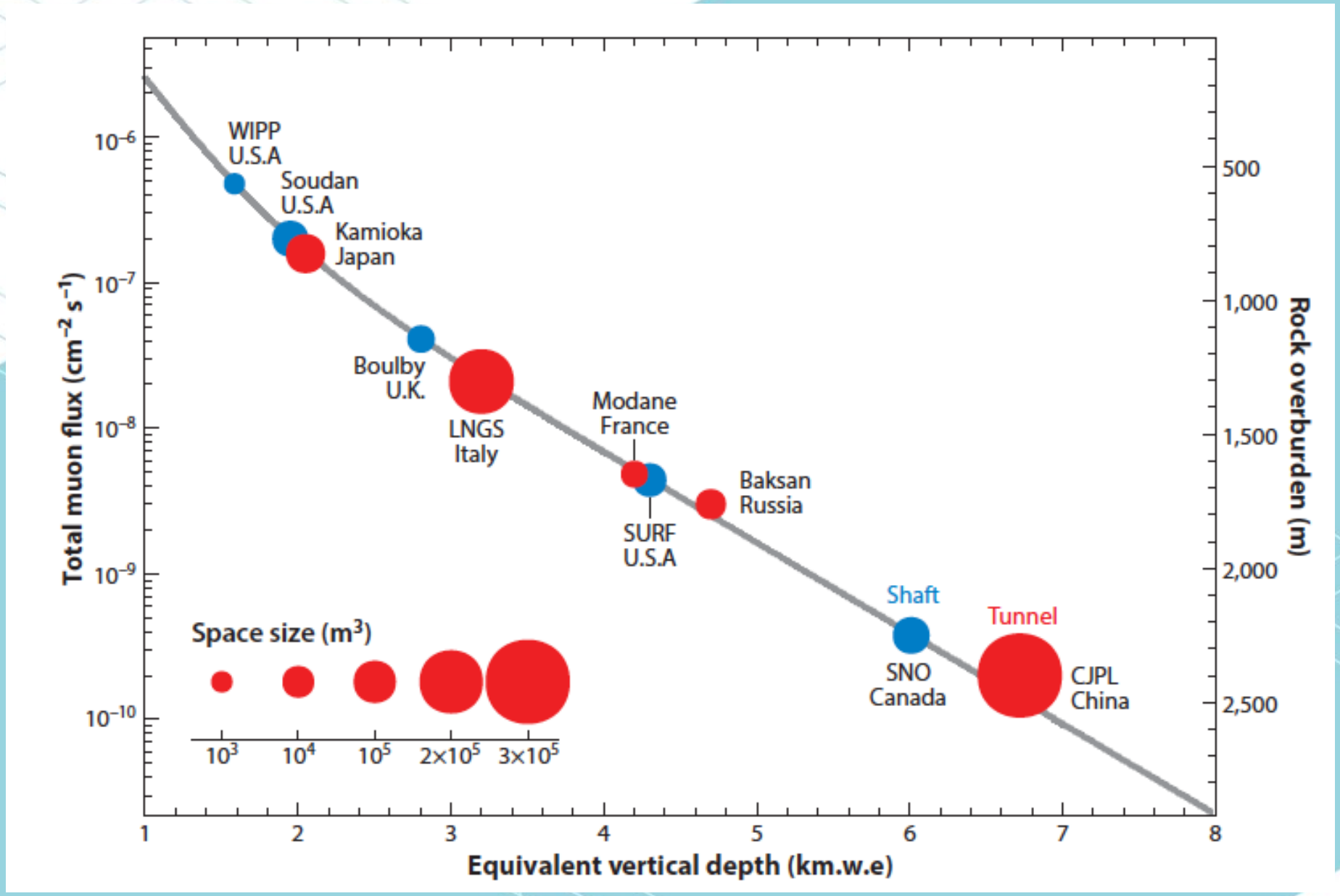
■双贝塔衰变实验：
- CDEX：　Ge-76　吨级
- PandaX：Xe-136　吨级
- 复旦：　Te-130　200kg
- 华师：　Se-82　吨级

■中微子实验：千吨级液闪

■深地岩土力学实验

中国锦屏地下实验室物理研讨会 2015.5.25-26

IV. Summary


WIPP
U.S.A
Soudan
U.S.A
Kamioka
Japan
Boulby
U.K.
LNGS
Italy
Modane
France
SURF
U.S.A
Baksan
Russia
Shaft
SNO
Canada
Tunnel
CJPL
China
Space size (m³)
10³
10⁴
10⁵
2×10⁵
3×10⁵
Total muon flux (cm⁻² s⁻¹)
10⁻⁶
10⁻⁷
10⁻⁸
10⁻⁹
10⁻¹⁰
Rock overburden (m)
500
1,000
1,500
2,000
2,500
1
2
3
4
5
6
7
8
Equivalent vertical depth (km.w.e)

Welcome to CJPL !