

The Status and Plan of China JinPing underground Laboratory (CJPL)

13th International Conference on Topics in
Astroparticle and Underground Physics (TAUP)

Sept, 2013

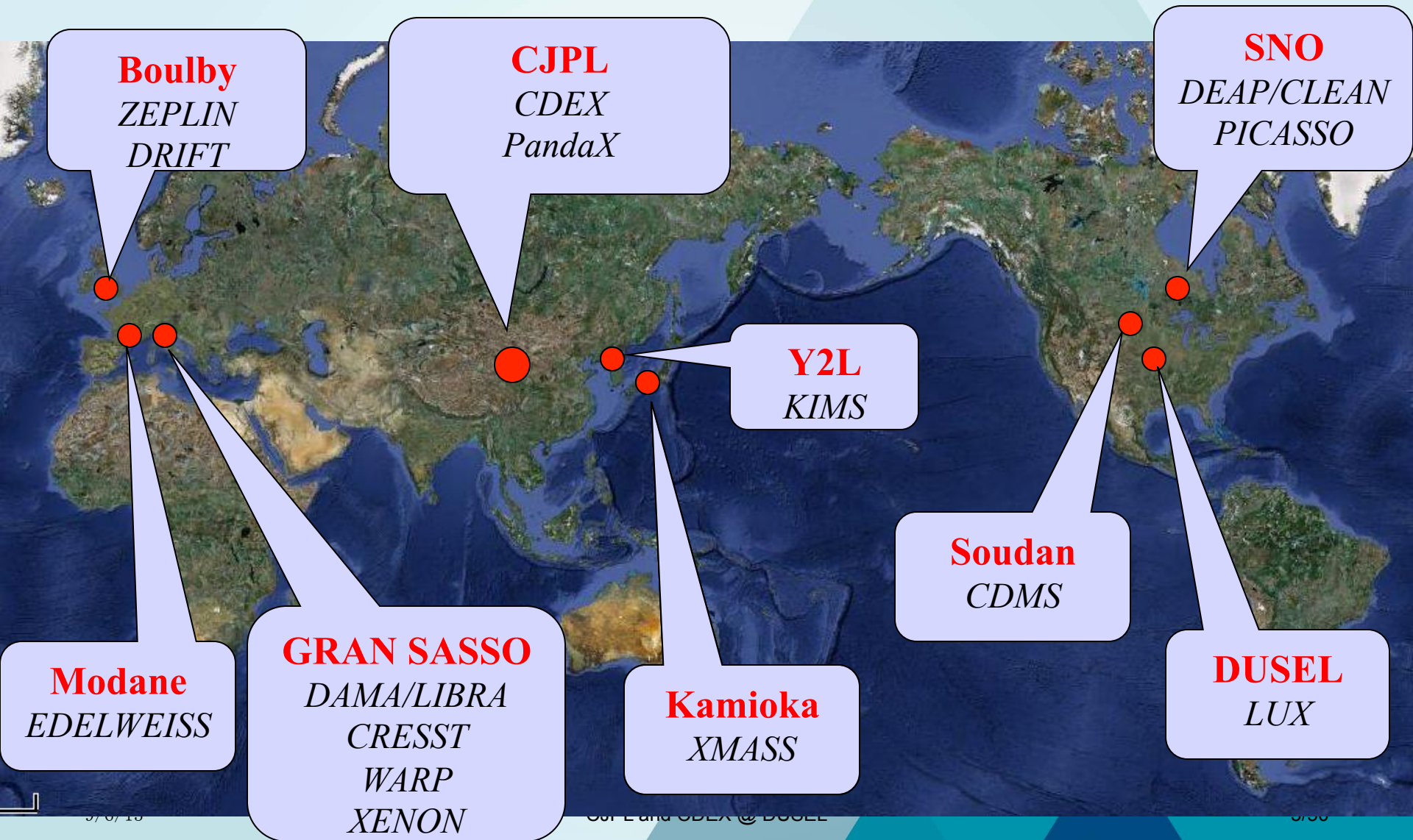


中国锦屏地下实验室
China Jinping Underground Laboratory

Outline:

- The site information of CJPL-I
- The rock work of CJPL-I
- The infrastructure of CJPL-I
- CDEX, PandaX and LBF inside CJPL-I
- Concept design of CJPL-II
- Summary

International Main Underground Laboratories



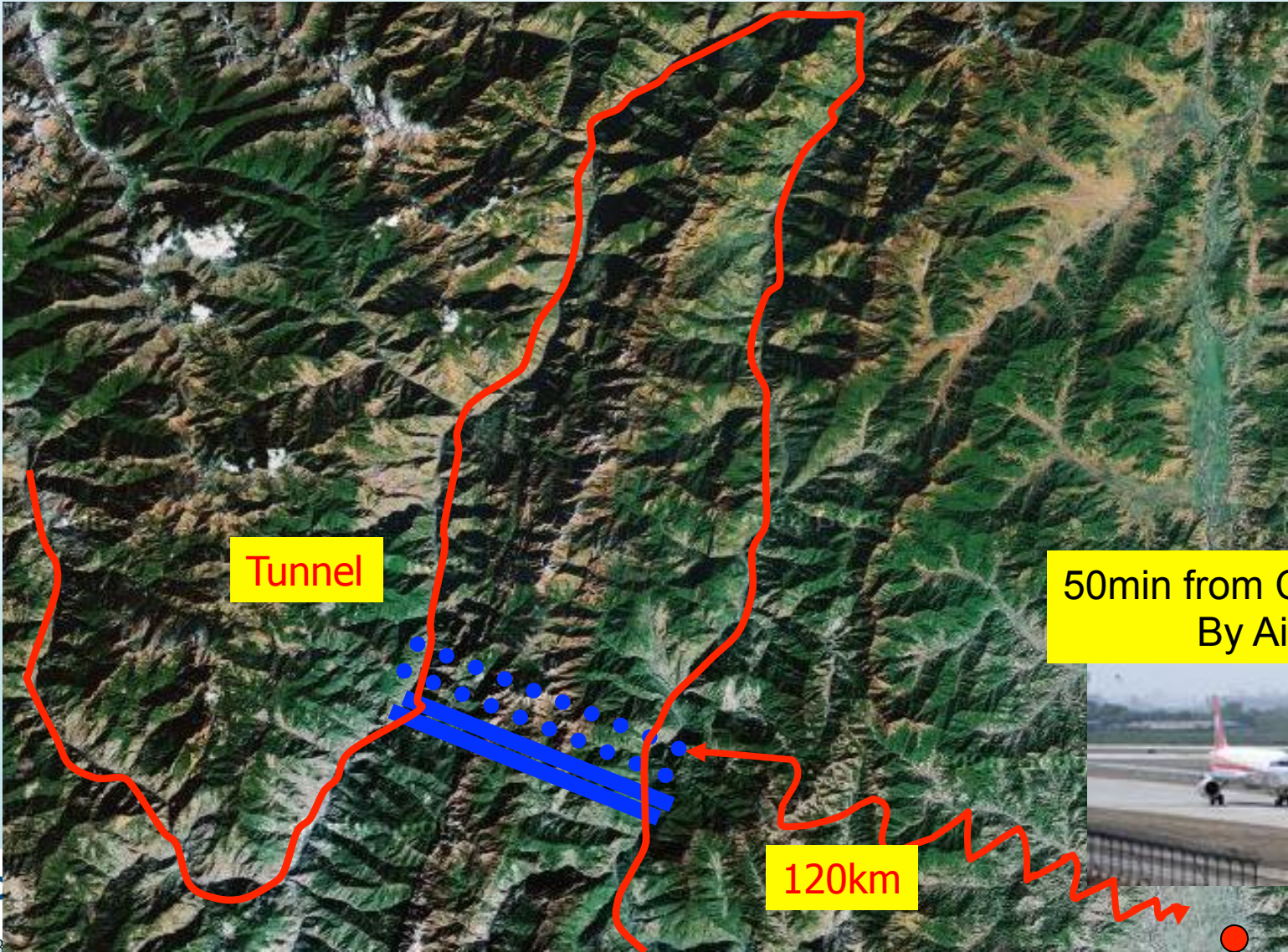
CJPL site



中国锦屏地下
China Jinping Undergro

9/6/13

Yalong River and Jinping Mountain



Tunnel

50min from Chengdu
By Air

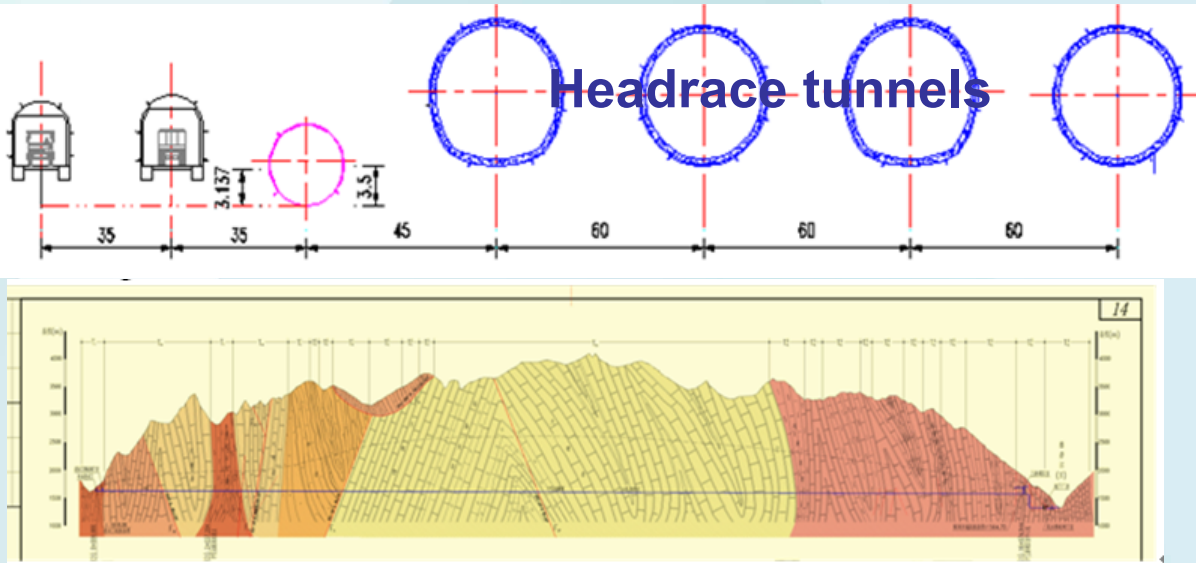
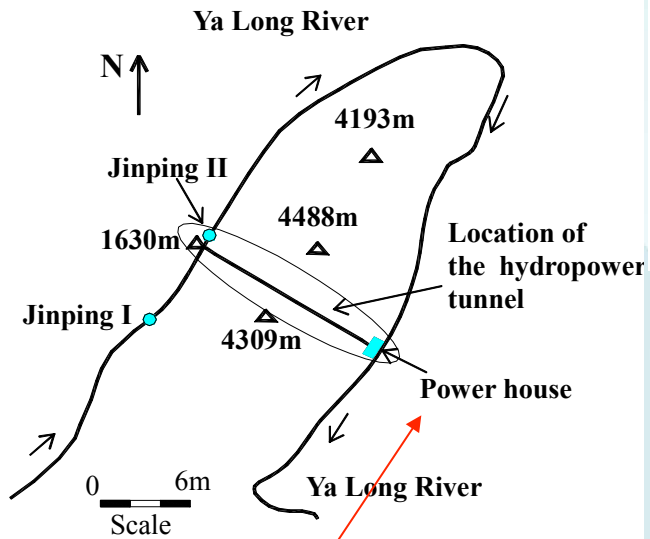


120km



XiChang

Jining II, China



- Seven high pressure tunnels: two auxiliary tunnels, one water drainage tunnel and four headrace tunnels
- Maximum overburden of 2525 m and principal stress of 70MPa by back analysis
- Average length of 17.7km
- Excavated mainly in marble by TBM and D&B



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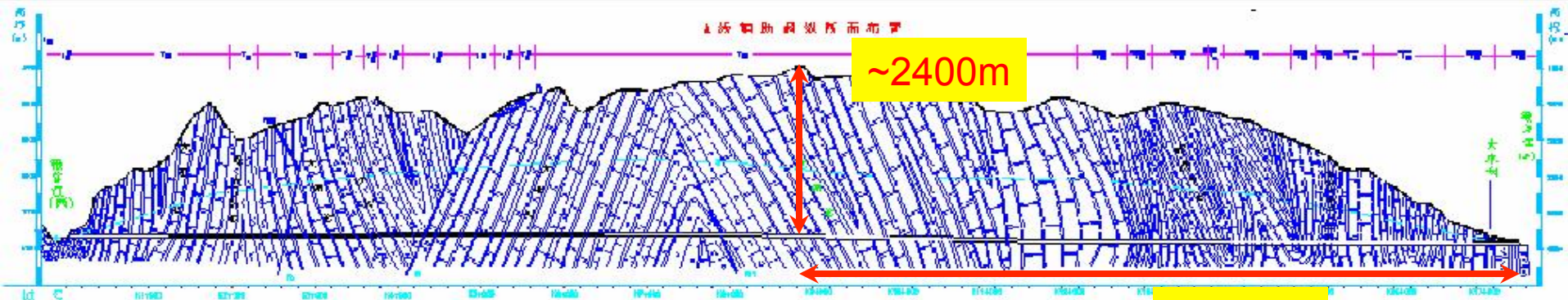
Road and Tunnel

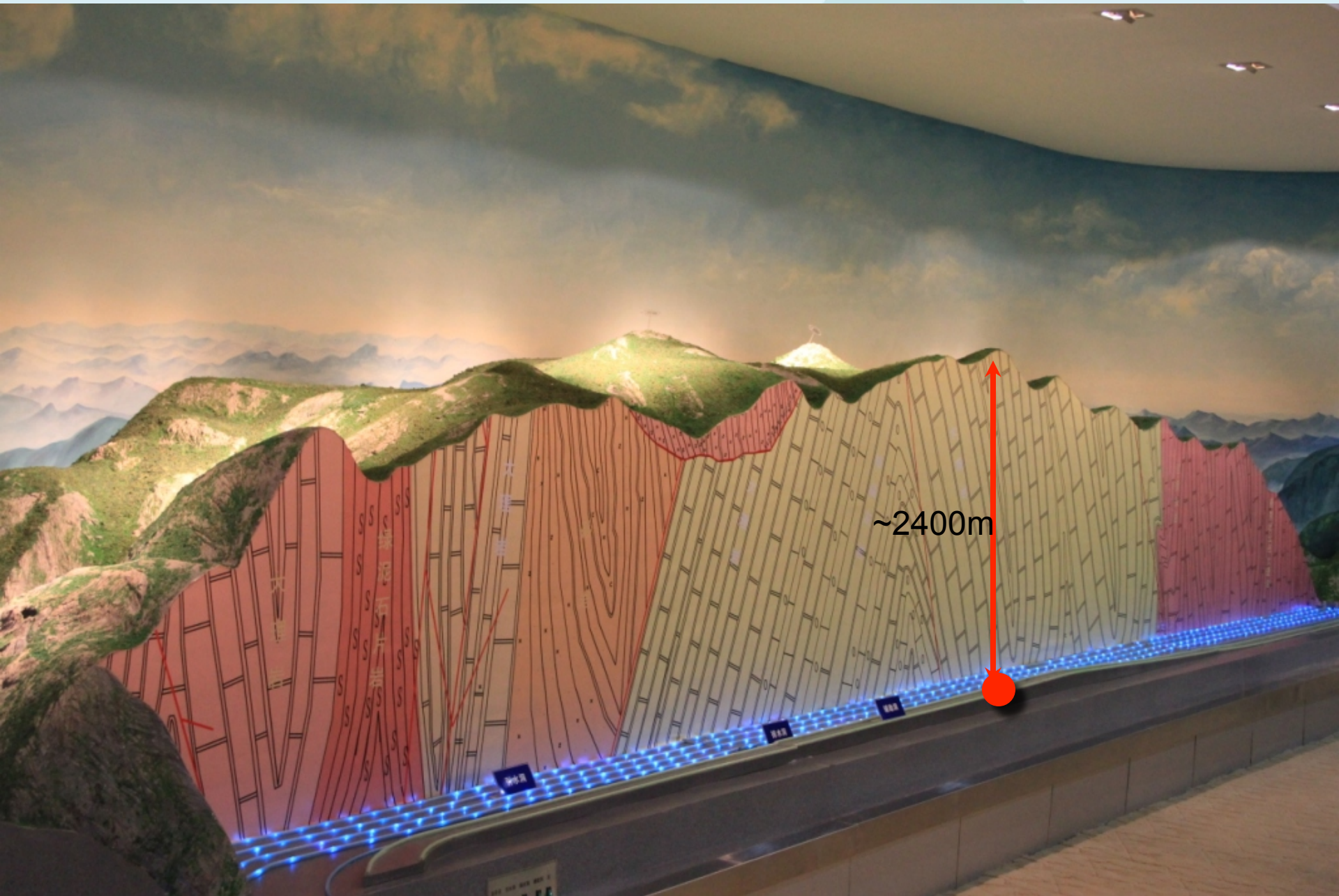


Logistic Condition of this UL



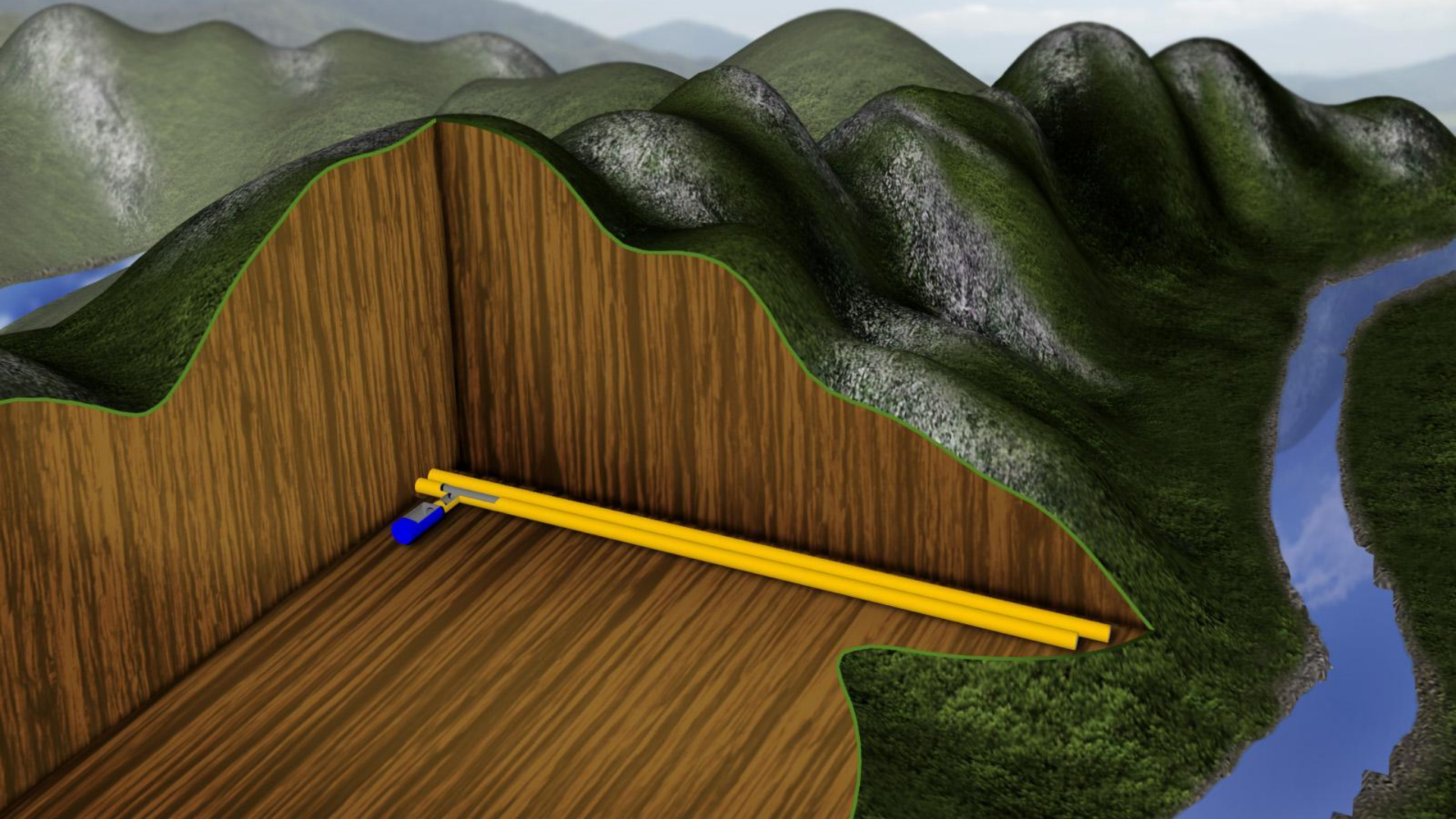
The basic conditions of CJPL





~2400m

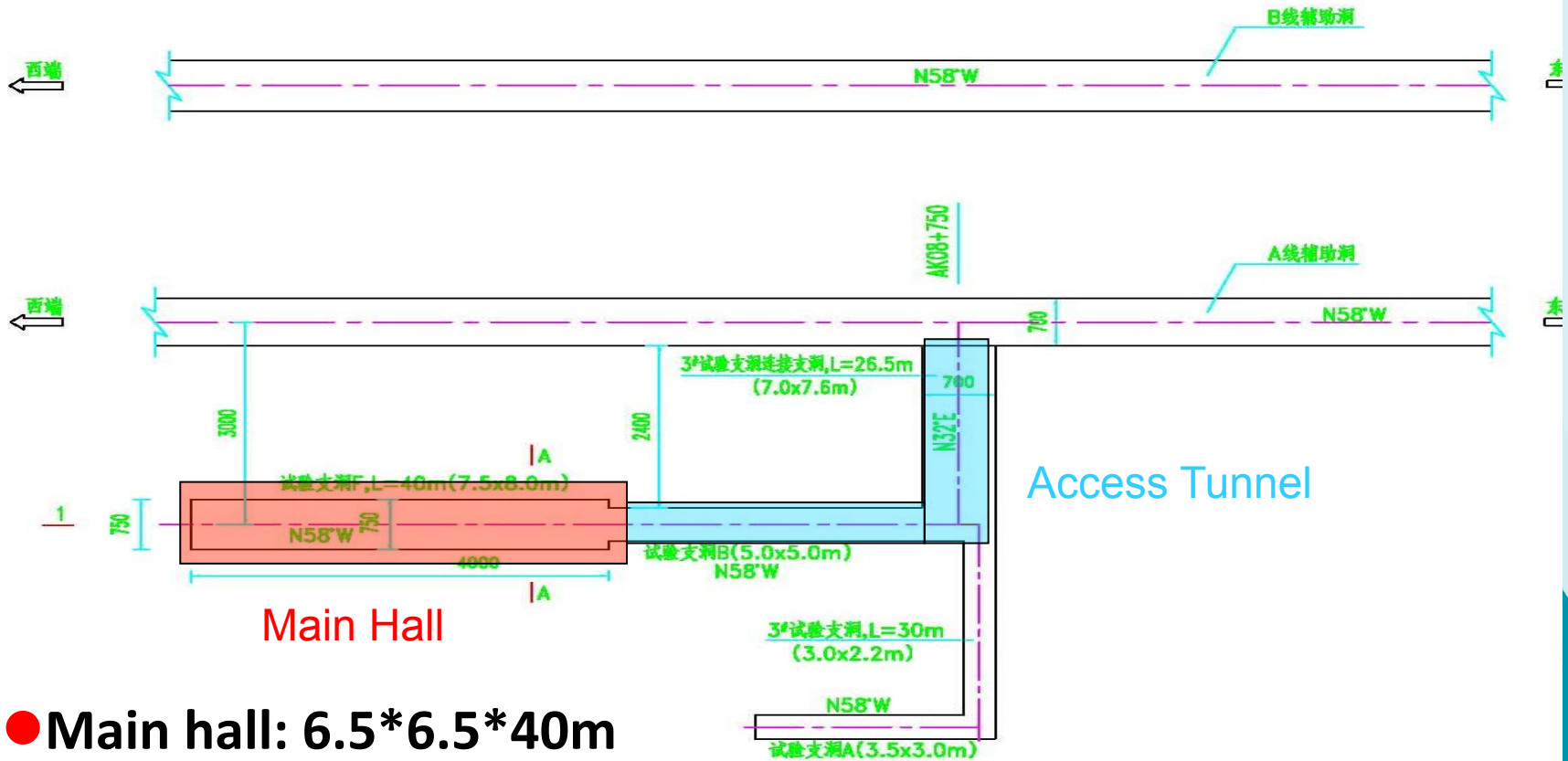
China JinPing Deep Underground Laboratory (CJPL)



MOU between EHDC and THU Signed



The Layout of CJPL-I



- Main hall: 6.5*6.5*40m
- Total Volume: ~4000m³

辅助洞新增试验支洞F、G平面布置图

1:500

● Evolution of surrounding rock

(Institute of Rock and Soil Mechanics, Chinese Academy of Sciences)



Acoustic wave (single or cross-hole method)



Sliding Micrometer



Digital borehole camera



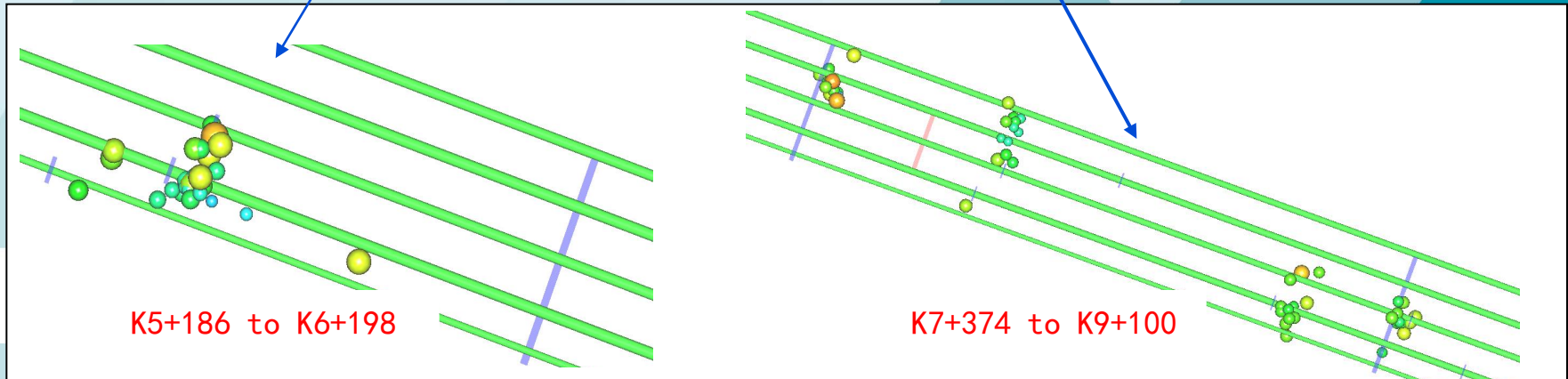
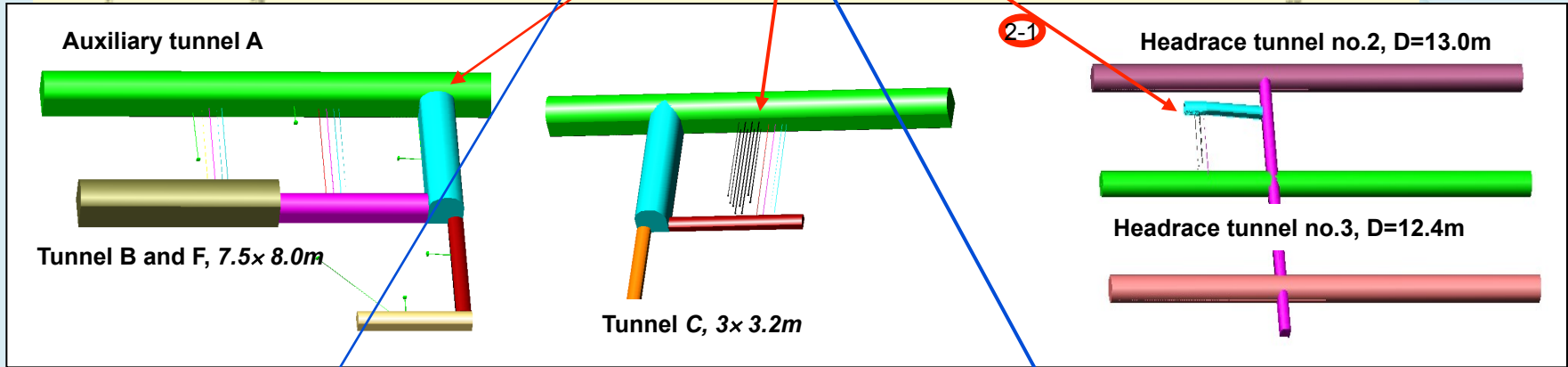
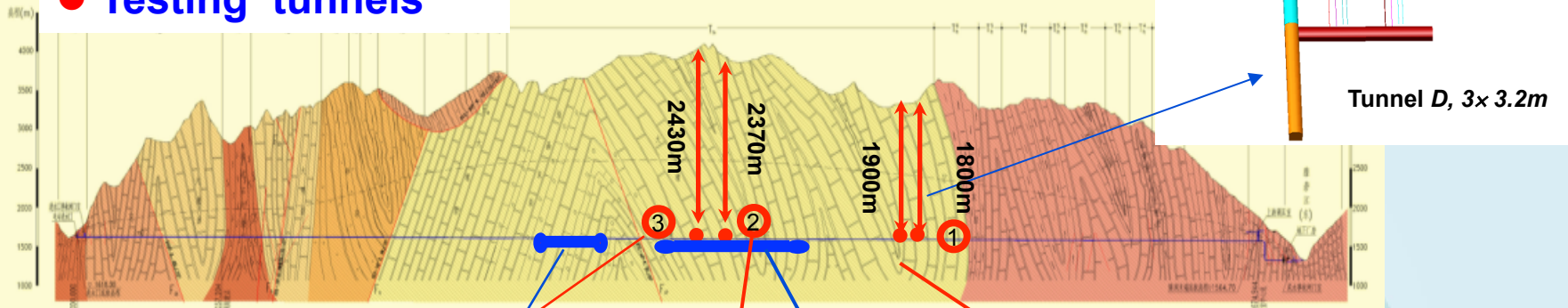
Microseismic



Acoustic emission

- Structure
- Elastic wave
- Deformation
- Fractures
- Rockburst/Rock spalling

● Testing tunnels



Evolution of excavation damaged zone

zone

- **Excavation Damaged Zone (EDZ):** new fractures observed by digital borehole camera, $>0.2\text{mm}$
- **Excavation disturbed Zone (EdZ):** deformation obviously and micro fractures concentrated, measured by acoustic emission and sliding micrometer

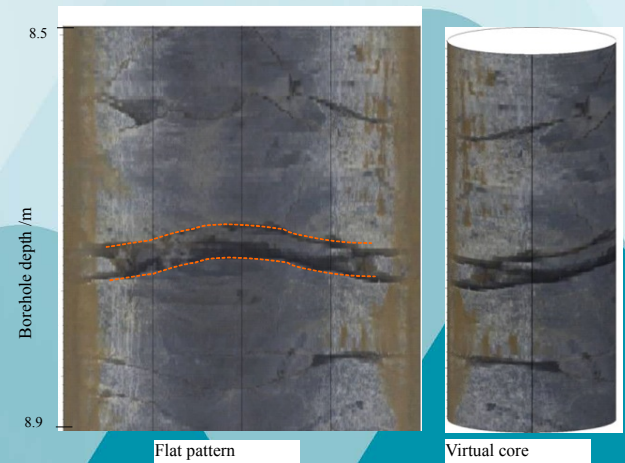
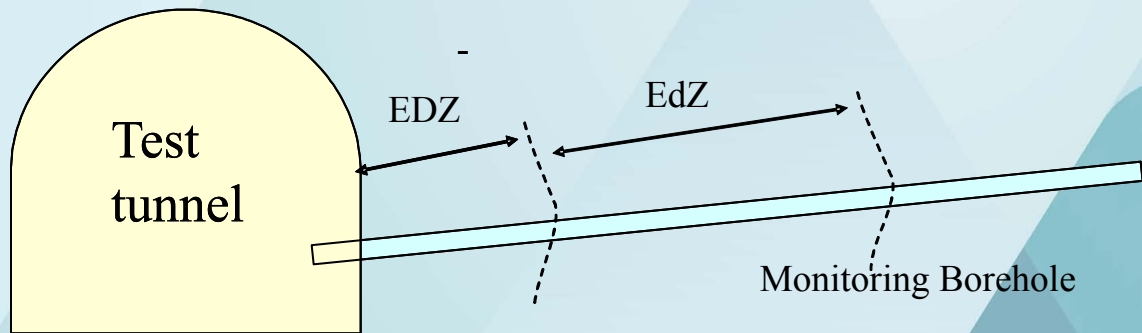
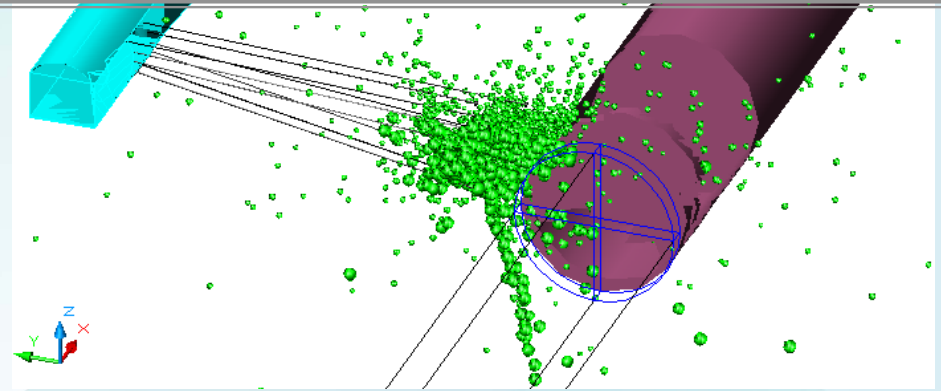
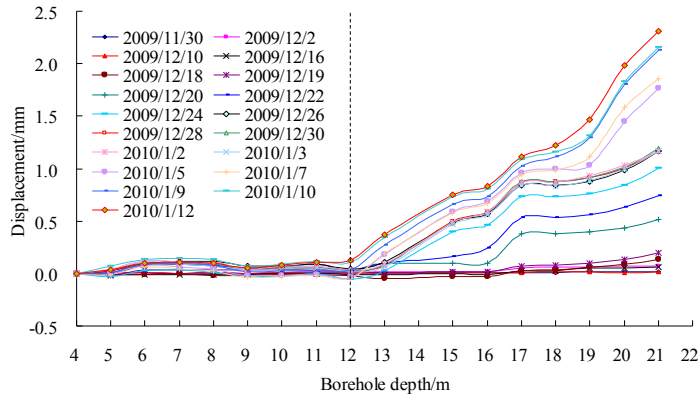


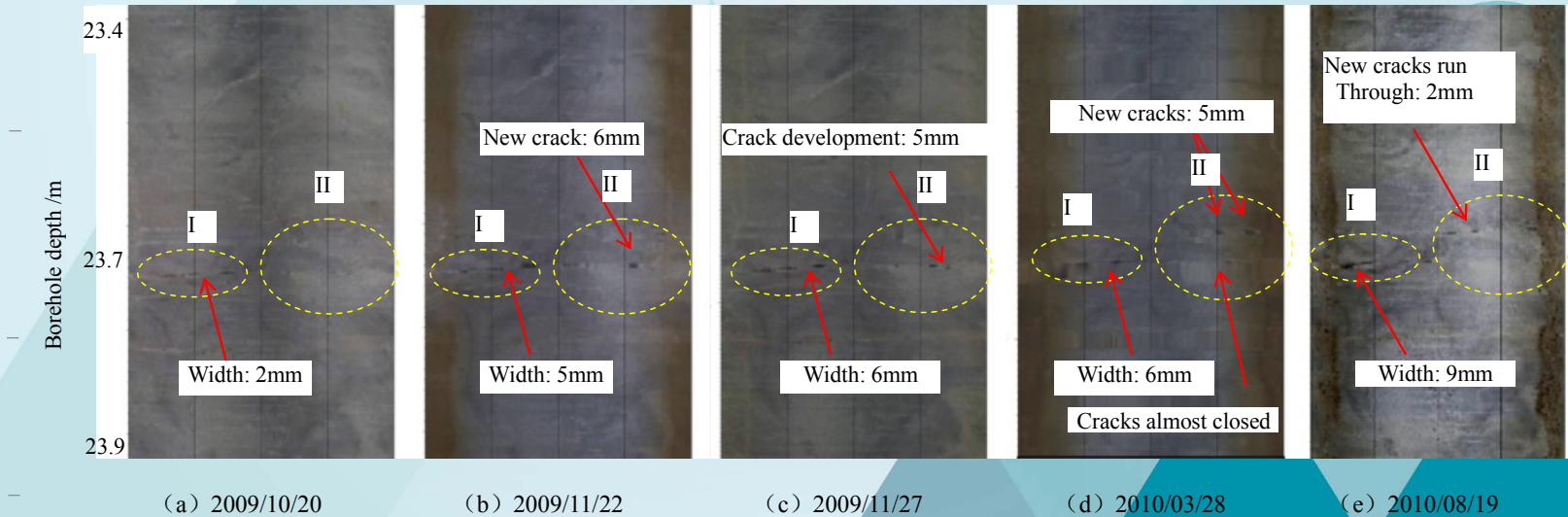
Image of borehole wall and fractures

● Typical testing results



Deformation of surrounding rockmass in test tunnel F

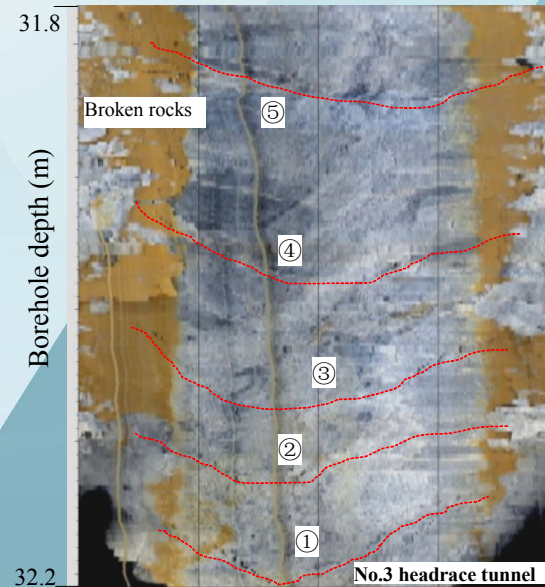
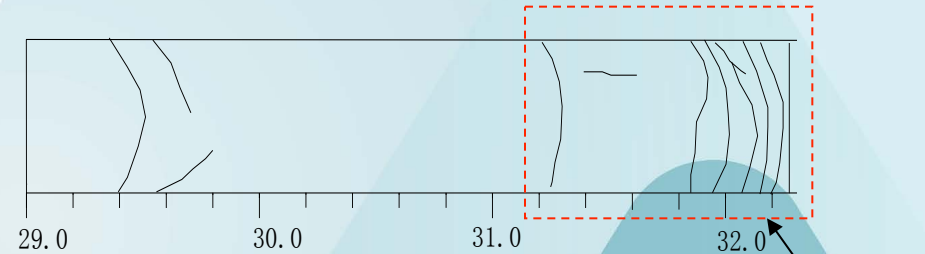
Acoustic emission of headrace tunnel of No.3



EDZ formation and evolution observed by digital borehole camera in a borehole wall of test tunnel C

Rock spalling process

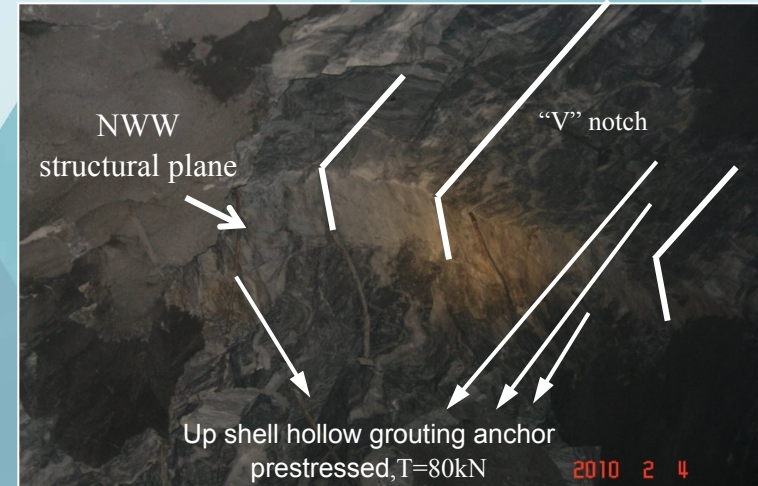
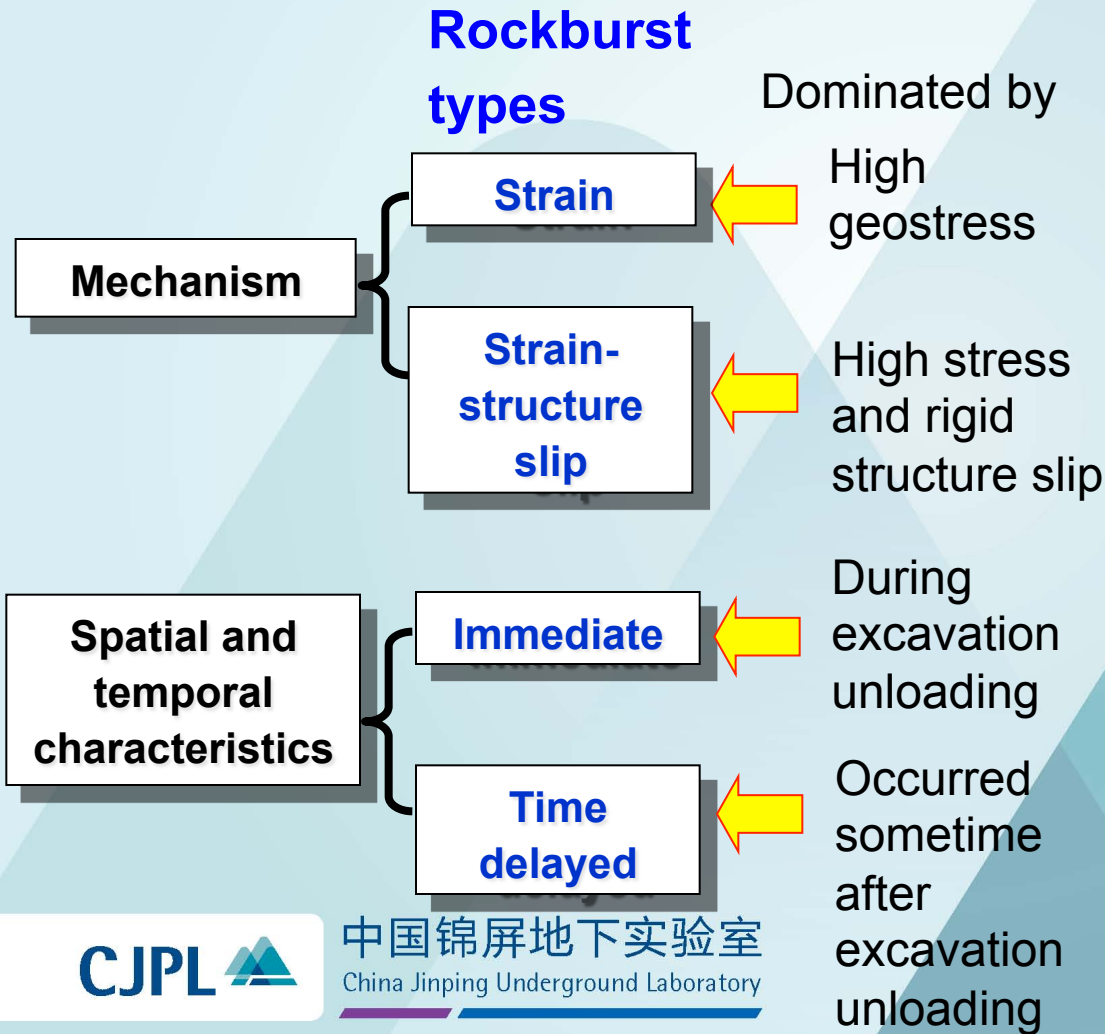
- *In situ* observation on tunnel sidewall
- Digital borehole camera for rock mass fractures



Flattered
image of
borehole
wall

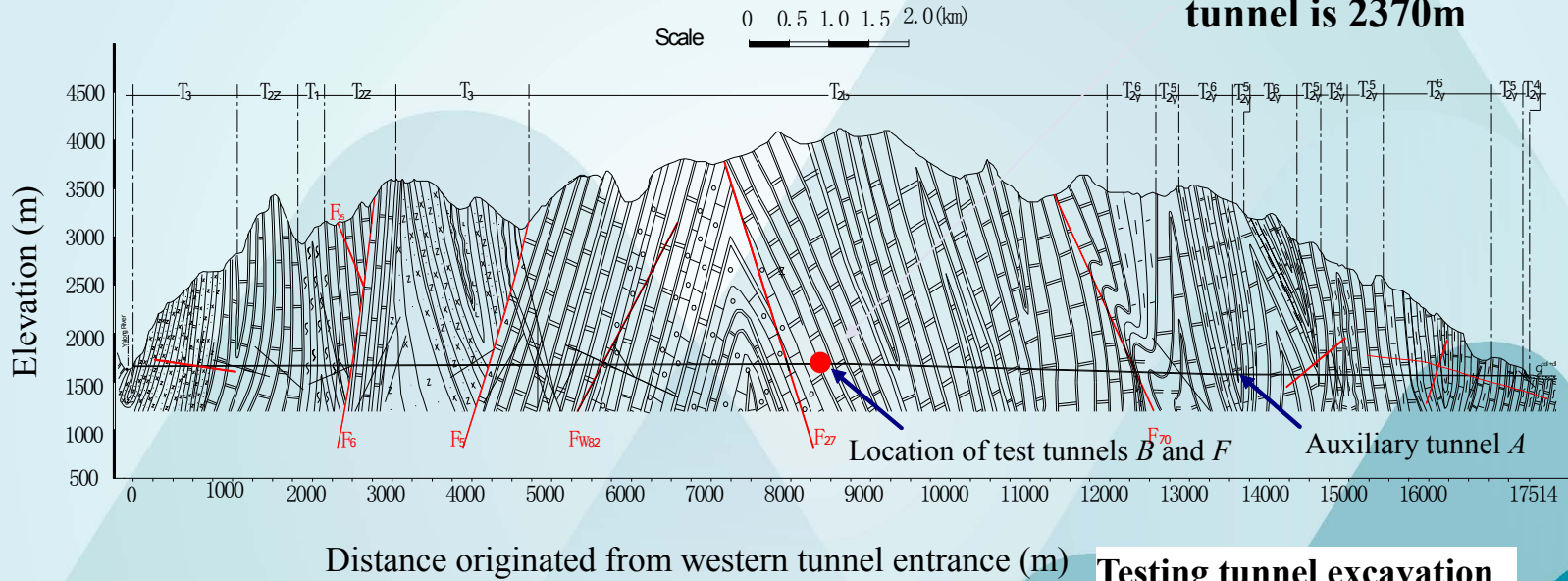
Fractures

In situ observation of rockburst evolution process

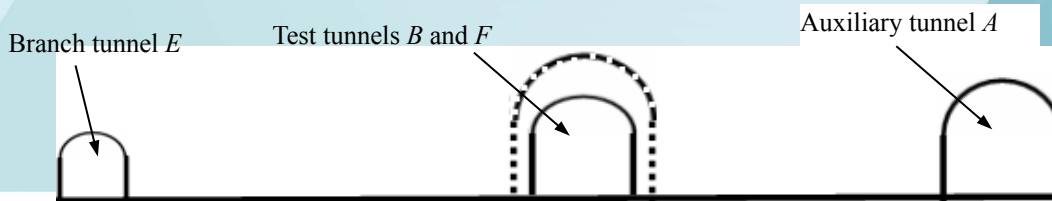


● Immediate rockburst-Testing site

Overburden of test tunnel is 2370m



Testing tunnel excavation

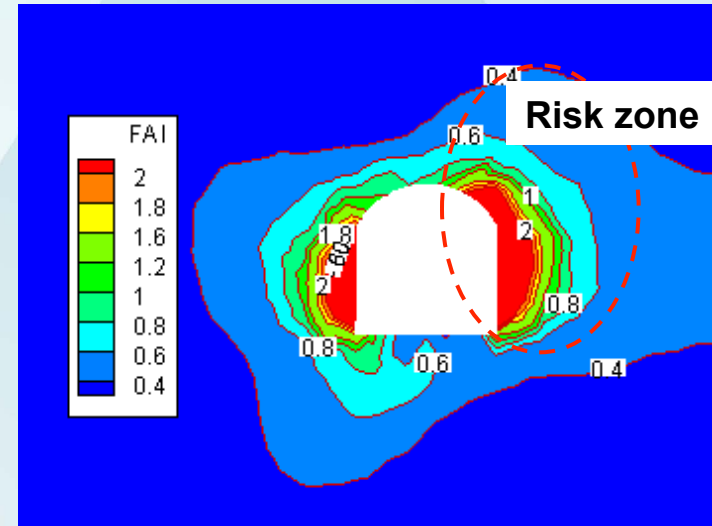
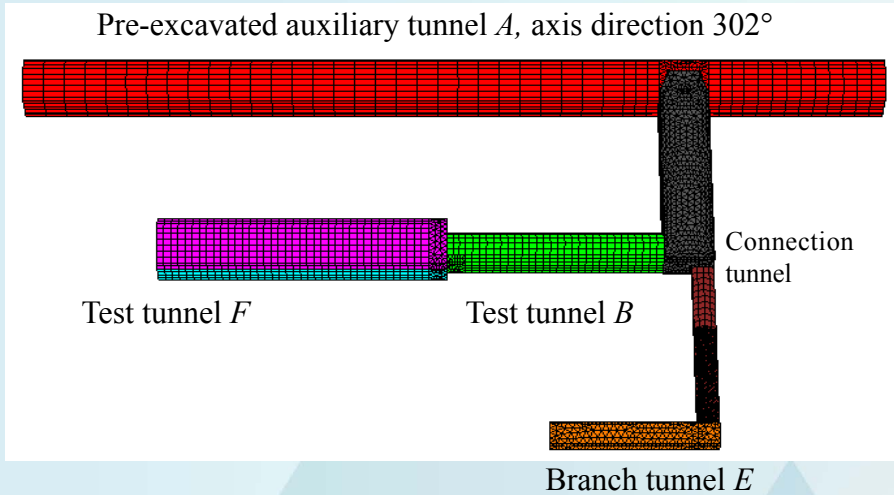


CJPL

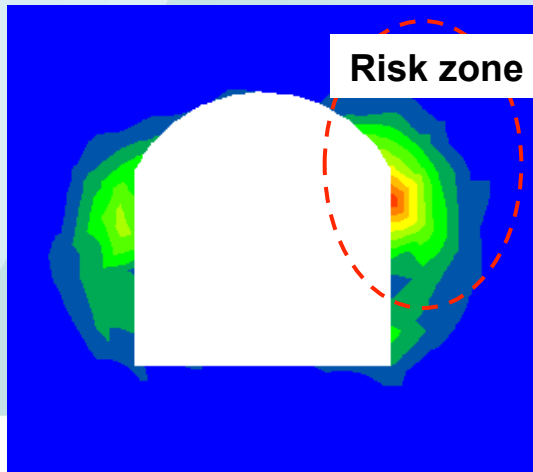
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Profile of tunnels

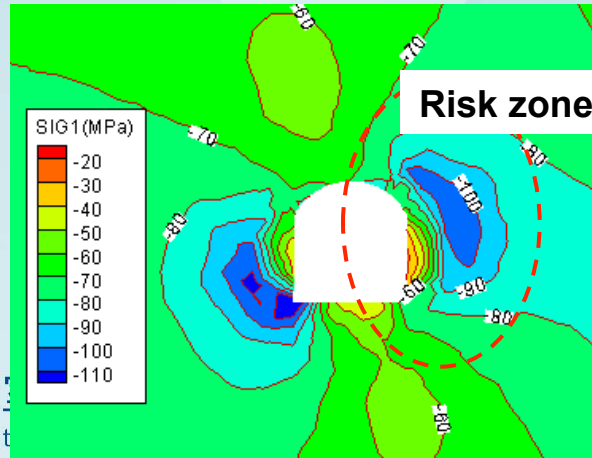
● Immediate rockburst-Numerical analysis



Distribution of failure approach index(FAI)



Distribution of local energy released rate (LERR)

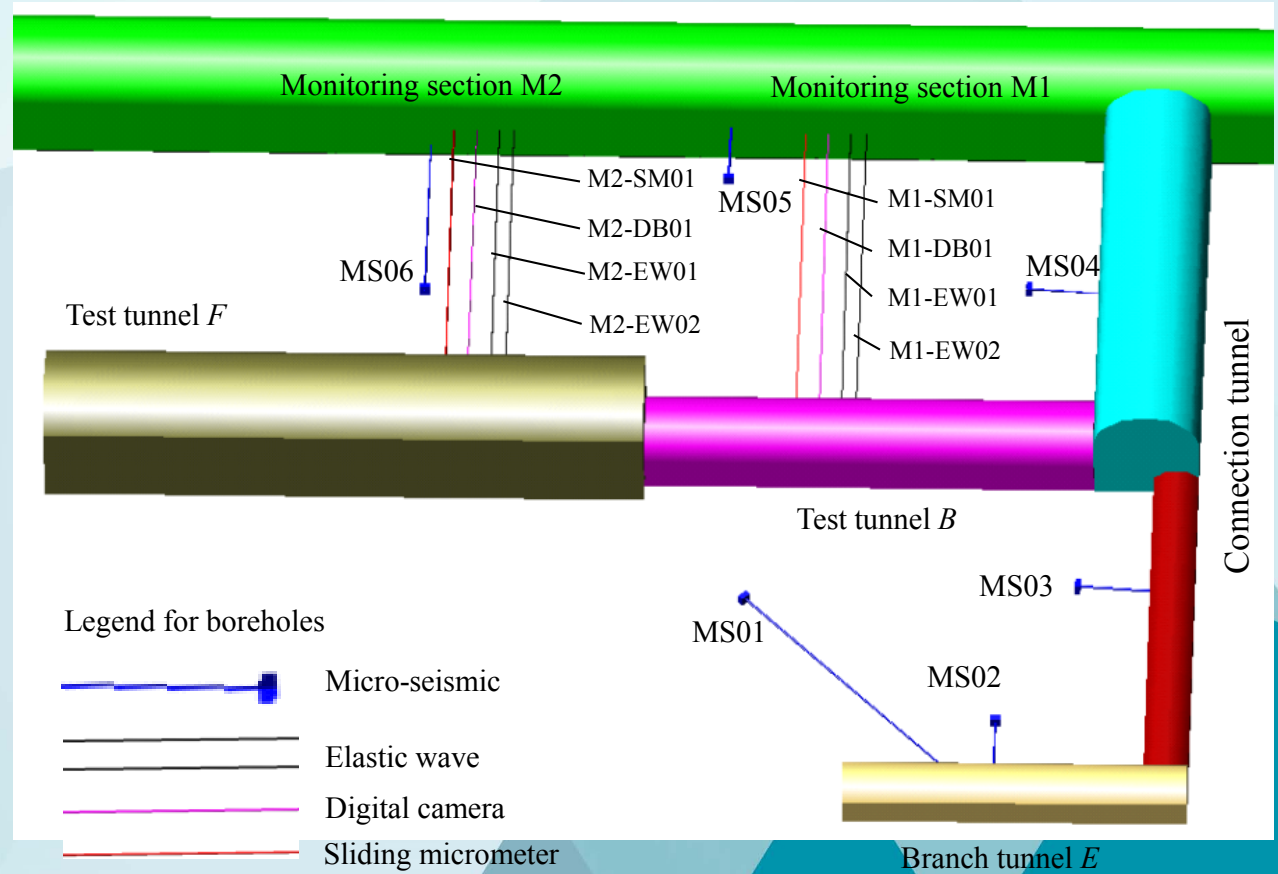


Distribution of the maximum principal stress

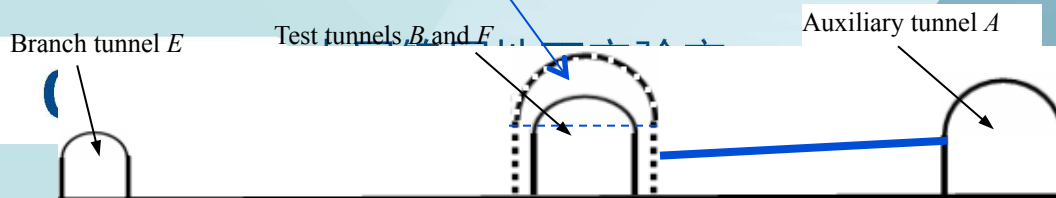
Tunnel northern sidewall has the maximum risk of rockburst

● Immediate rockburst-Configuration of monitoring facilities

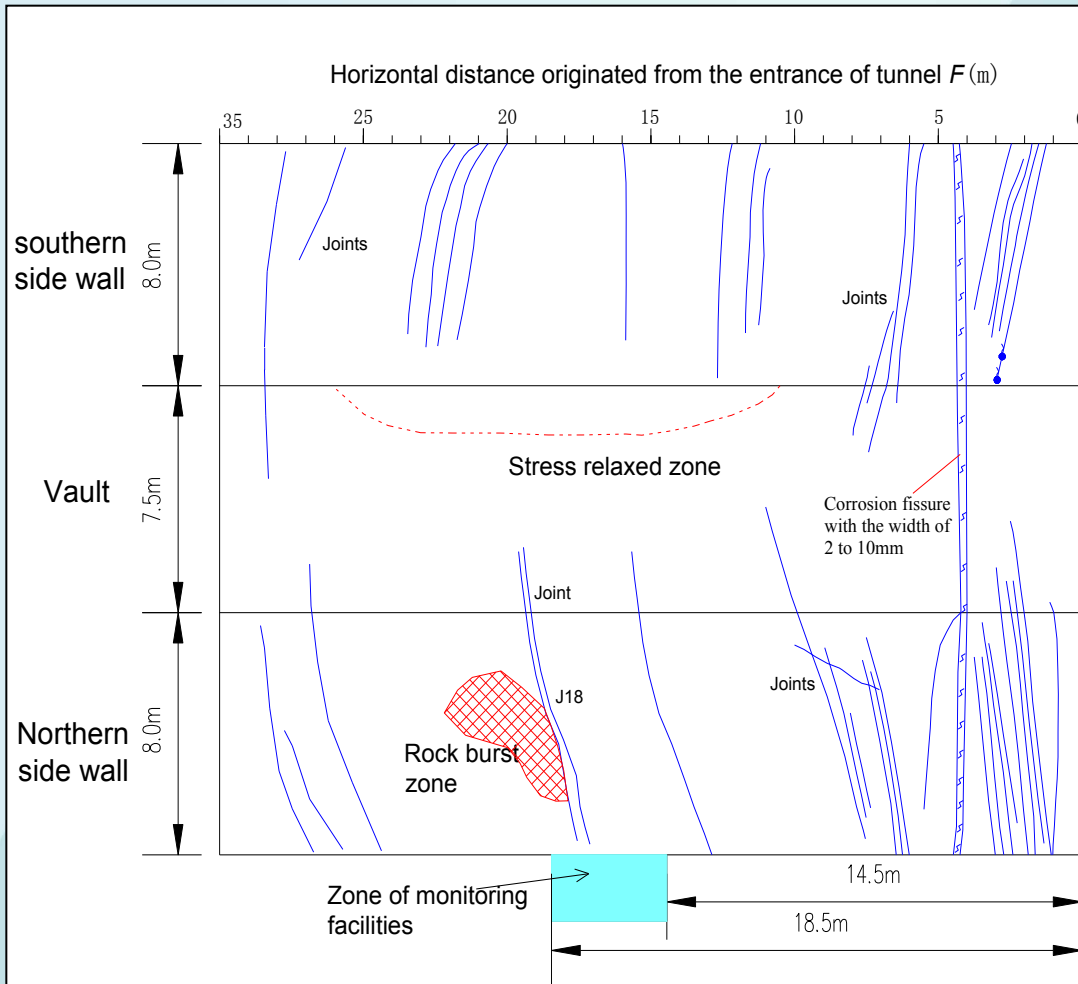
Pre-excavated auxiliary tunnel *A*, axis direction 302°



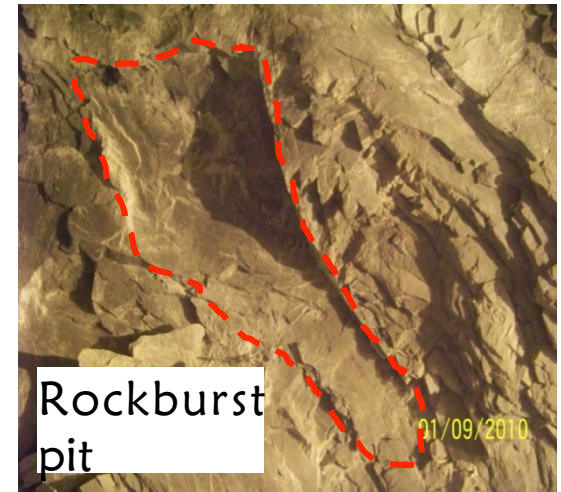
Excavation at two benches



● Description of immediate rockburst



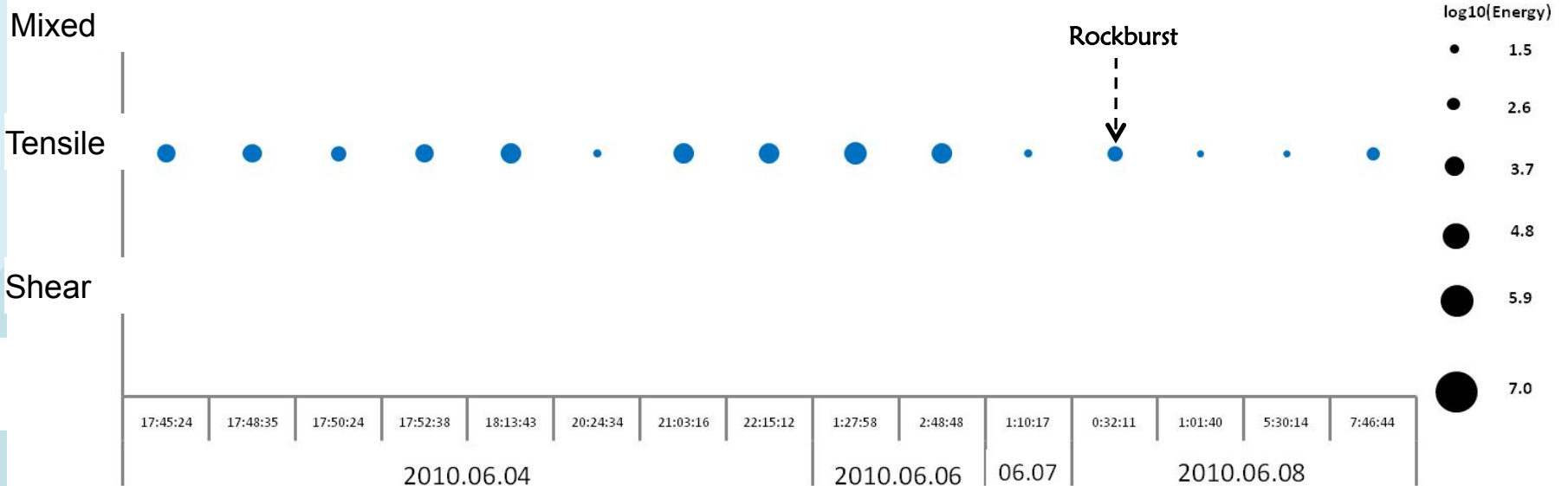
Unfolded geological sketching



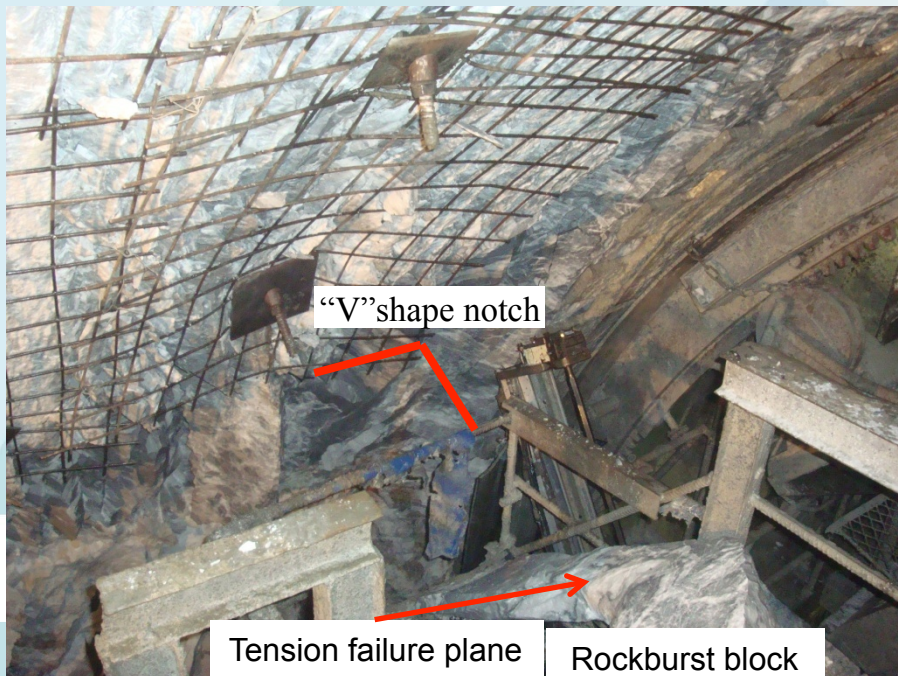
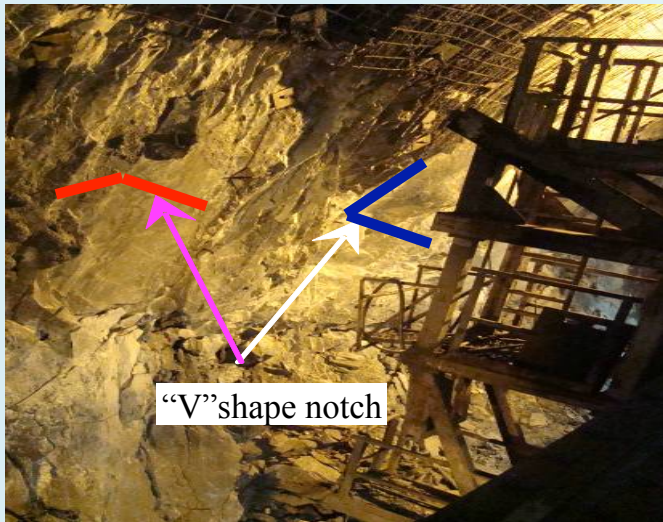
Rockburst occurred on January 09, 2010, with the volume about 6.3 m^3

Evolution mechanism of immediate strain rockburst: tensile failure mainly

Slight rockburst occurred at northern sidewall to spandrel of 3# TBM headrace tunnel at K11+080-090, June 08, 2010, notch depth: 20-35cm



Intensive rockburst occurred at southern sidewall to spandrel of 3# TBM headrace tunnel at K11+045-054, June 11, 2010, notch depth: 1-1.2m



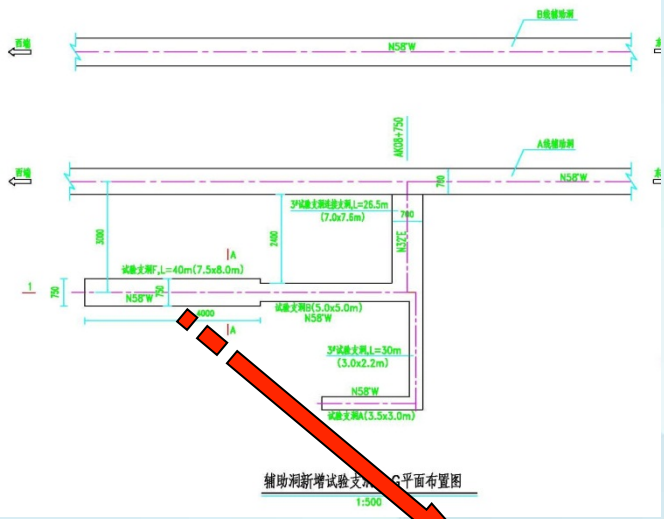
Civil Work of CJPL-I



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China Jinping Underground Laboratory

28/52



Jan., 2010

参建各方积极协调解决现场问题



开挖过程中遇到强岩爆



加强混凝土施工过程质量控制



混凝土衬砌单元工程优良率达到85%以上





2010/01/27



2010.03.17



2010.02.24



The Gate of CJPL in June 2010



The main hall of CJPL in June 2010

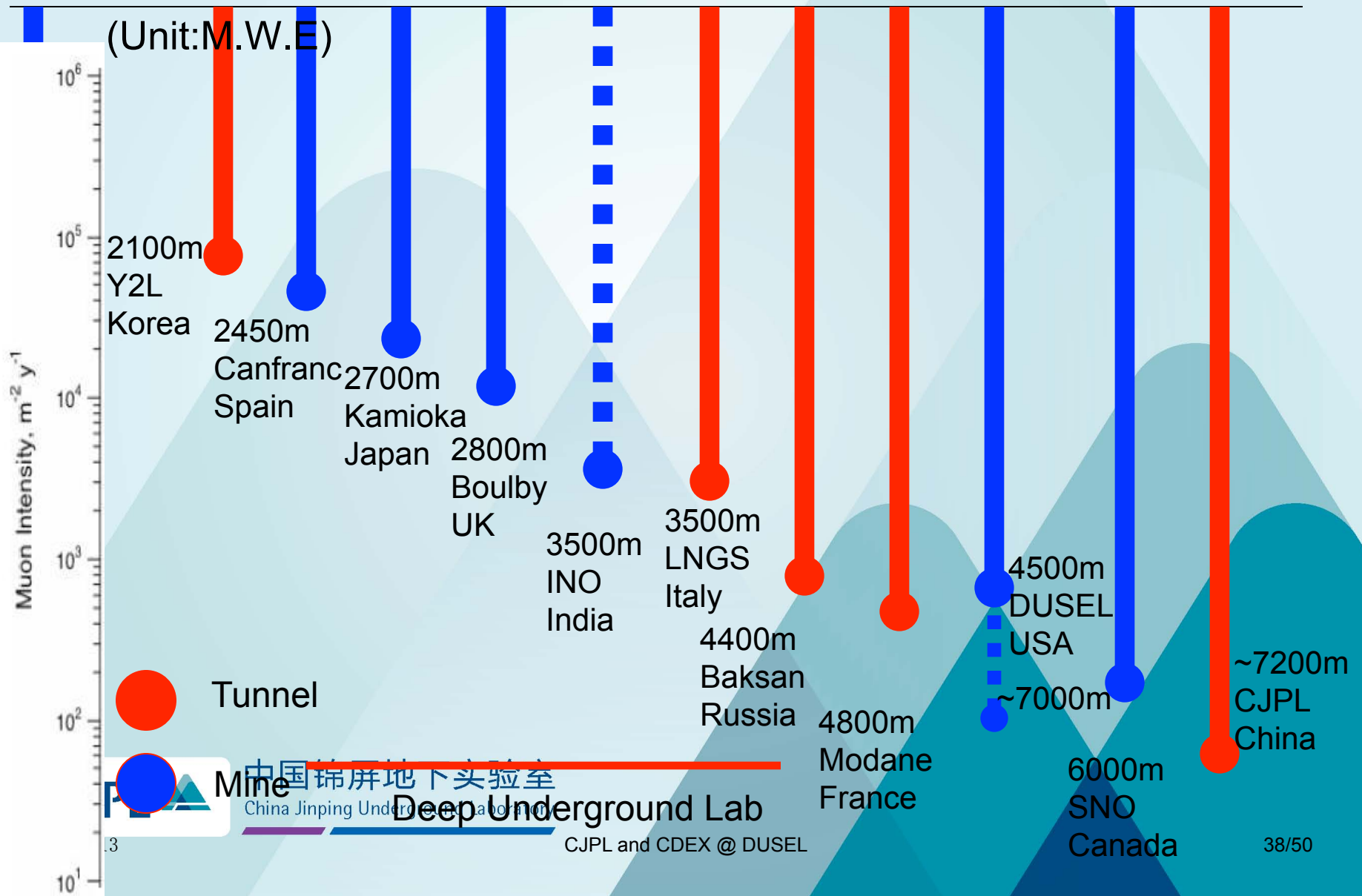


Dec. 12, 2010 Opening Ceremony



国资委副主任邵宁、基金委副主任沈文庆院士、清华大学党委书记胡和平、二滩公司总经理陈云华为实验室揭牌

Comparison of main ULs in the world



International Highlight: 《Science》, 《Physics Today》



Going deep. Chinese scientists hope this tunnel will soon host a premier underground lab.

PARTICLE PHYSICS

Chinese Scientists Hope to Make Deepest, Darkest Dreams Come True

Particle physicist Yue Qian had his eureka moment in front of the TV set. For over a decade, Chinese scientists have longed for an underground laboratory that would enable them to join efforts across the globe to detect dark matter, observe neutrinos, and watch for exotic particle physics phenomena. Searches for suitable sites repeatedly came up empty-handed. But last August, after Yue caught a news report on the completion of two tunnels piercing Jinping Mountain in Sichuan Province, he felt that the long quest for such a lab might finally be over.

After months of negotiations, on 8 May Tsinghua University in Beijing, where Yue is an associate professor, signed an agreement with the tunnels' owner, Ertan Hydropower Development Co., to hollow out an experimental chamber. The Jinping lab would be the deepest underground science facility in the world, edging out—by 100 meters or so—the Deep Underground Science and Engineering Laboratory that the U.S. National Science Foundation may build in an abandoned mine in Lead, South Dakota. By placing sensors deep in the earth, physicists hope to reduce spurious signals from cosmic rays. China's subterranean aspirations have been circulating in Asia for months; the international community will get its first glimpse of the project at a dark-matter workshop in Shanghai on 15 June and

at an astroparticle and underground physics conference in Rome next month.

An underground lab has been a dream for several generations of Chinese scientists, says Wang Yifang, a particle physicist at the Institute of High Energy Physics of the Chinese Academy of Sciences in Beijing. Past candi-



Short cut. Tunnels between the Jinping dams on the Yalong River offer a serendipitous lab site.

China, others dig more and deeper underground labs

From tiny to gargantuan, experiments are in the works to exploit the shielding from cosmic rays that being deep underground offers.

Initial experimental plans are modest, but with its drive-in access and extreme depth, the new China Jinping Deep Underground Laboratory (CJPL) has the potential to become a major international player. China is plunging into the vibrant global scene of underground labs with a small dark-matter experiment set to star: collecting data this fall.

"Underground science is really booming," says André Rubbia, the ETH Zürich physicist who chairs LAGUNA, a study of European underground sites for a megaton long-baseline neutrino experiment. "With bigger and bigger accelerators more difficult to build and fi-

nance, physicists realize that there is a huge amount of science to be done underground—in a low-background environment—that is complementary to the high-energy frontier," he says. Physicists go underground to block cosmic rays from experiments that look for neutrinos, dark matter, proton decay, double beta decay, and the like. Underground sites are also attracting projects in other areas, including geology, electronics, gravity waves, biology, and engineering.

Small but fast

The CJPL grew rapidly from an idea to reality: In mid-2008 scientists got wind that the Ertan Hydropower Development Co



A new underground lab (below) in China will be the world's deepest research site, located in Jinping Mountain (left) of Sichuan Province.



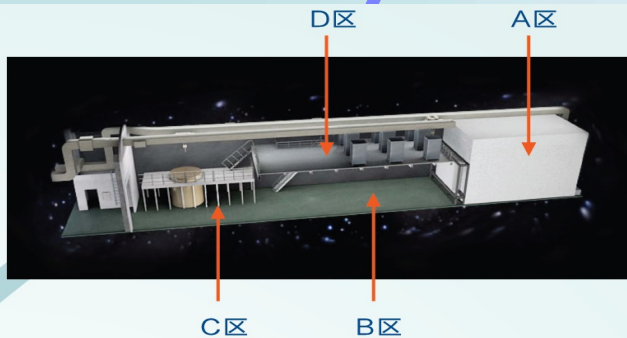
QIAN YUE

CJPL-Infrastructure

- Underground Laboratory (Inside Tunnel)
- Ground Laboratory (Monitor Building)
- Remote Data Center (Tsinghua Univ.)



Internet



室
tory

Date Center and Network Workshop



锦屏洞口实验室方案效果图——通讯室

Ground Office



锦屏洞口实验室方案效果图——办公室

Storage Room for Experiment



CJPL

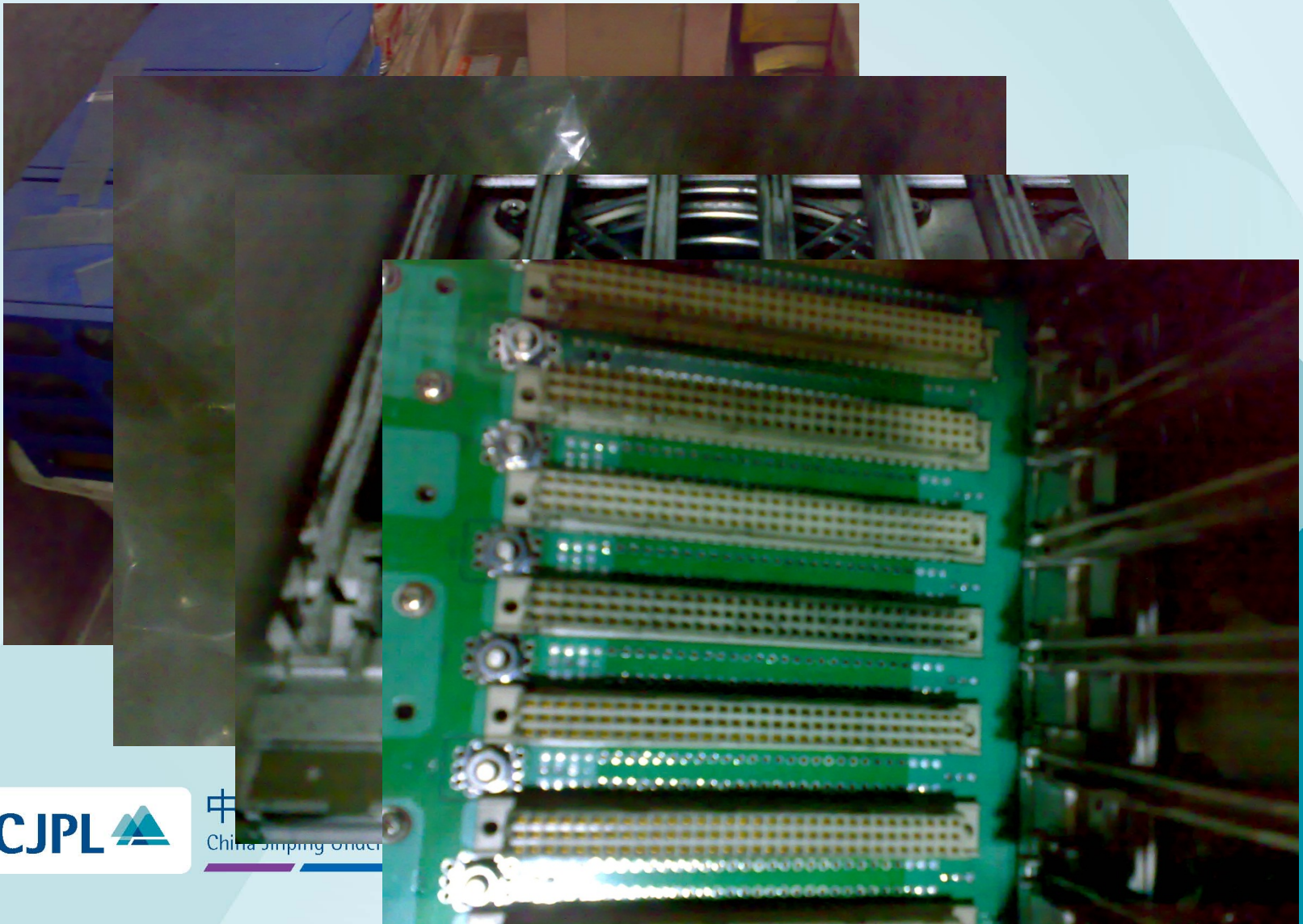
Remote Data Center in Tsinghua University



Fresh Air System

- To reduce dust
- To reduce Radon
- To make a comfortable working space

Instrument destroyed by Dust



Clean Air System for CDEX



Flesh Air tube work



Flesh air tube work



Fresh Air System

15nights (90hours) for 9000m tube installation



Vent-pipe of Fresh Air System

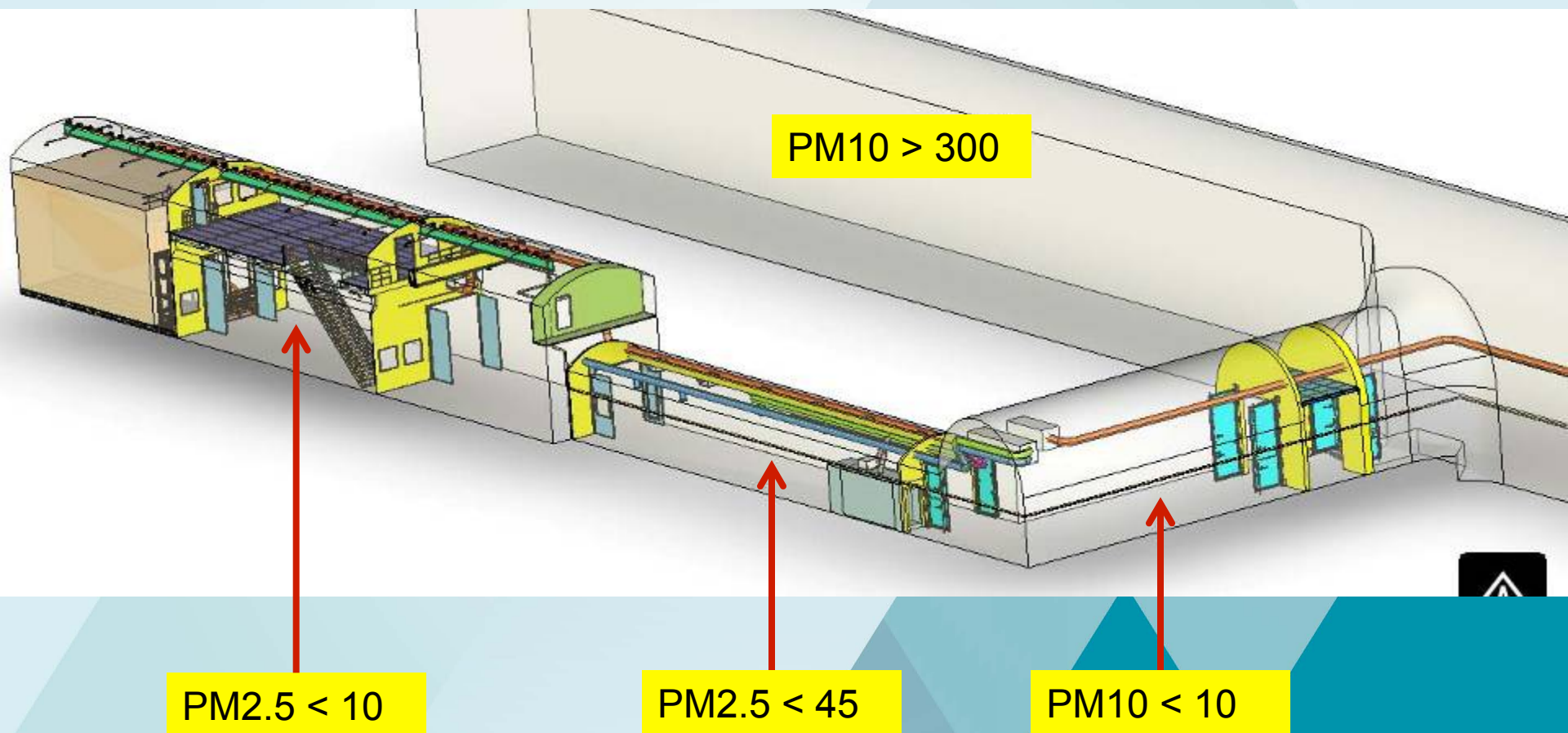


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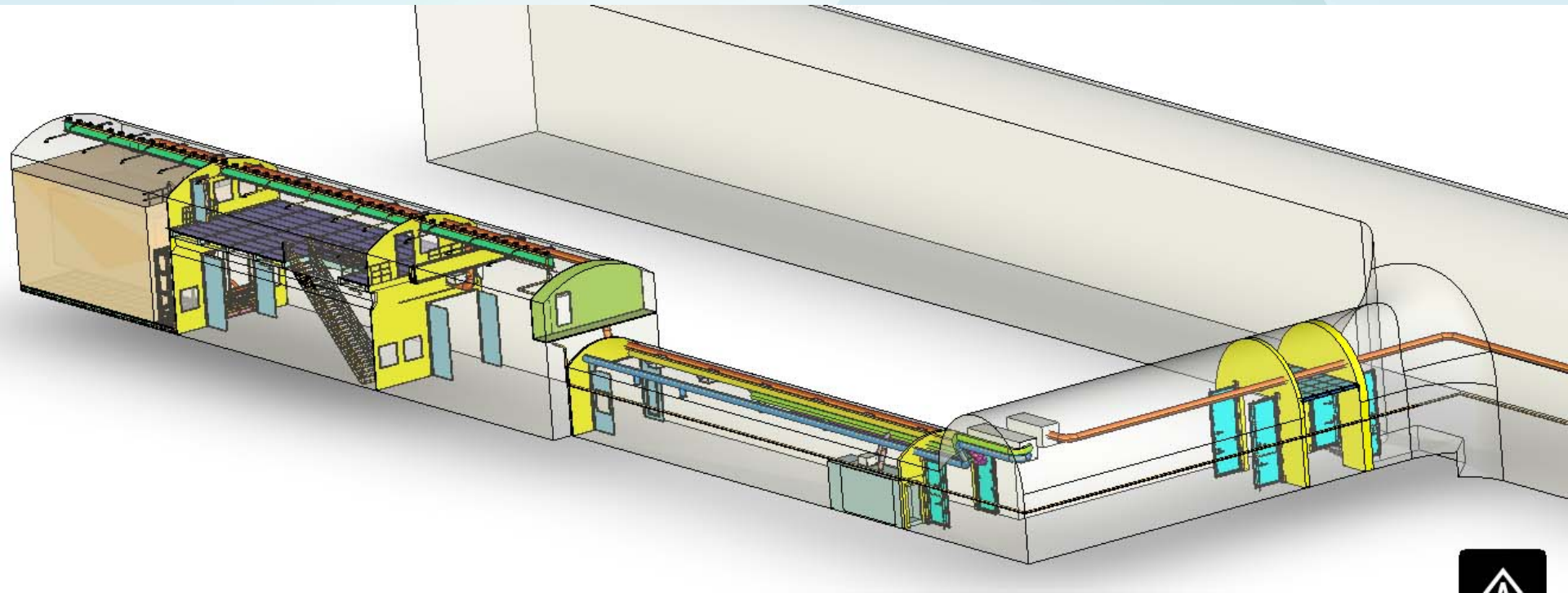
Air-tight Door and Air shower



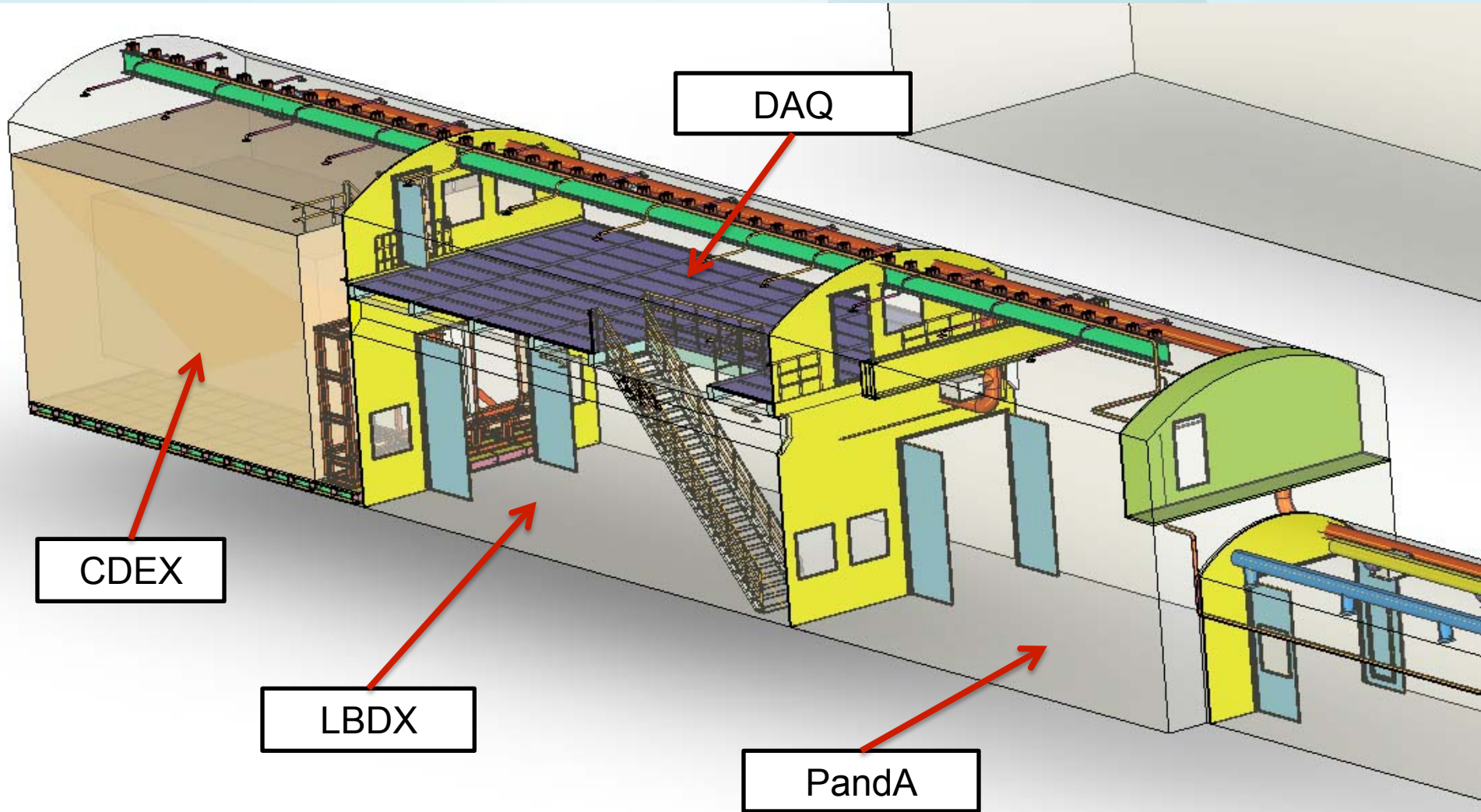
Layout of CJPL-I



CJPL Infrastructure



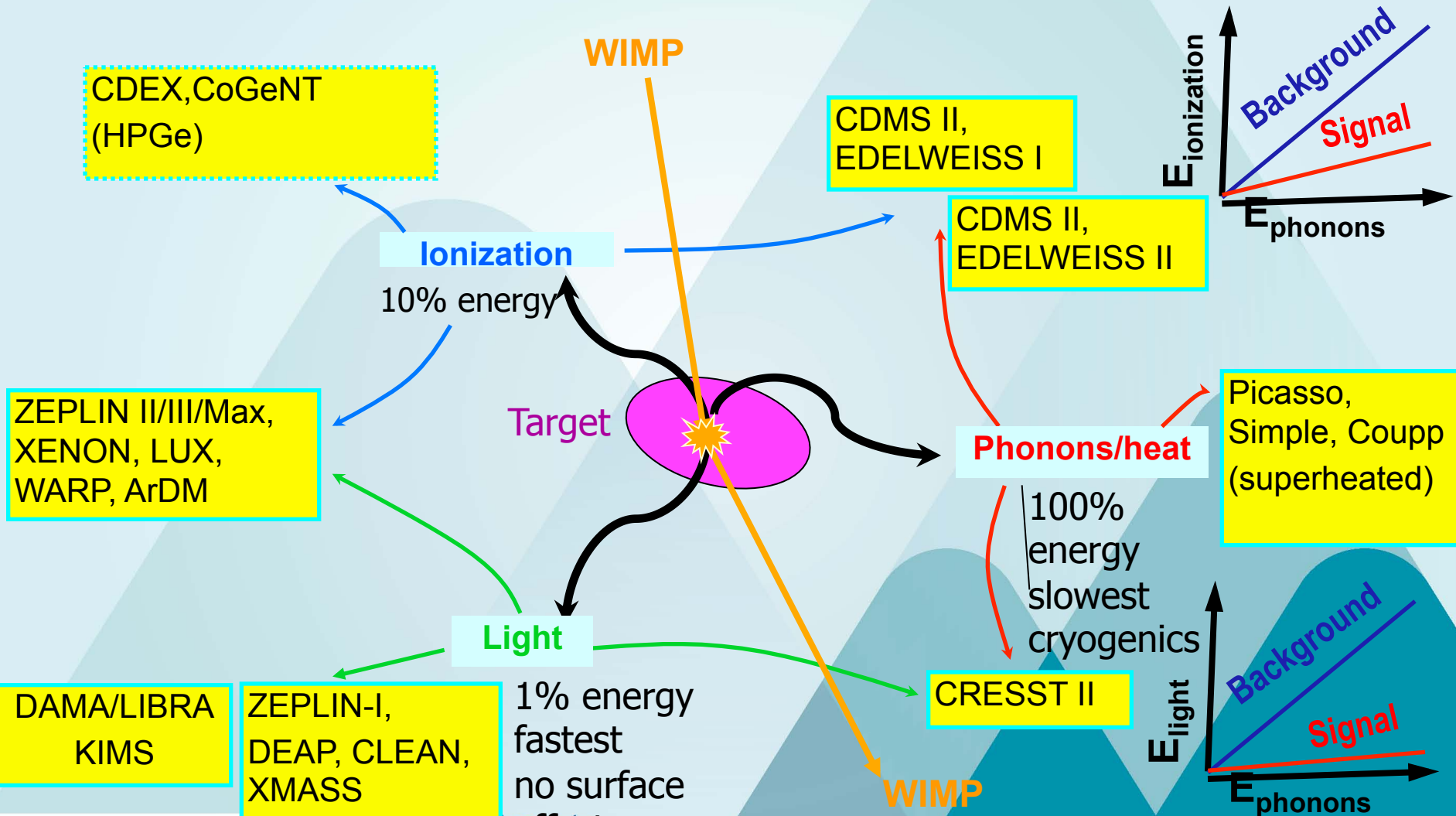
CJPL Internal Layout





CDEX, PandaX and LBF inside CJPL-I

Detector Techniques - Present Focus : Nuclear Vs Electron recoils

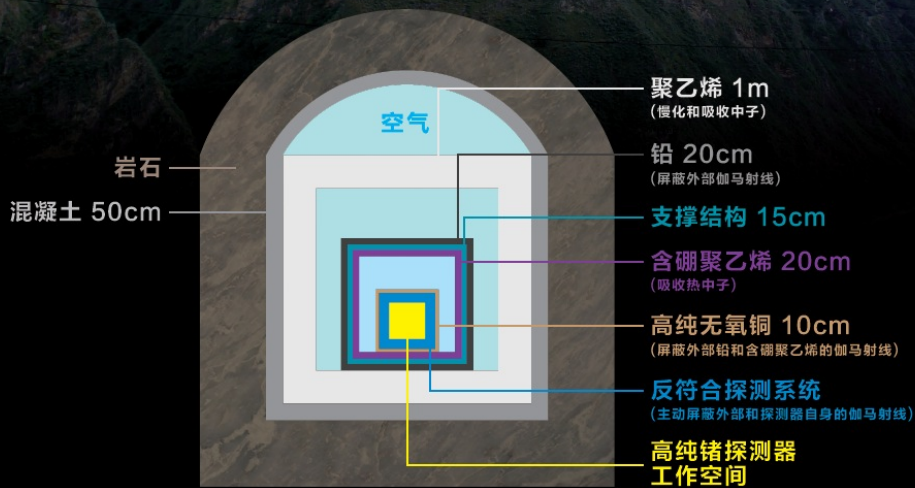


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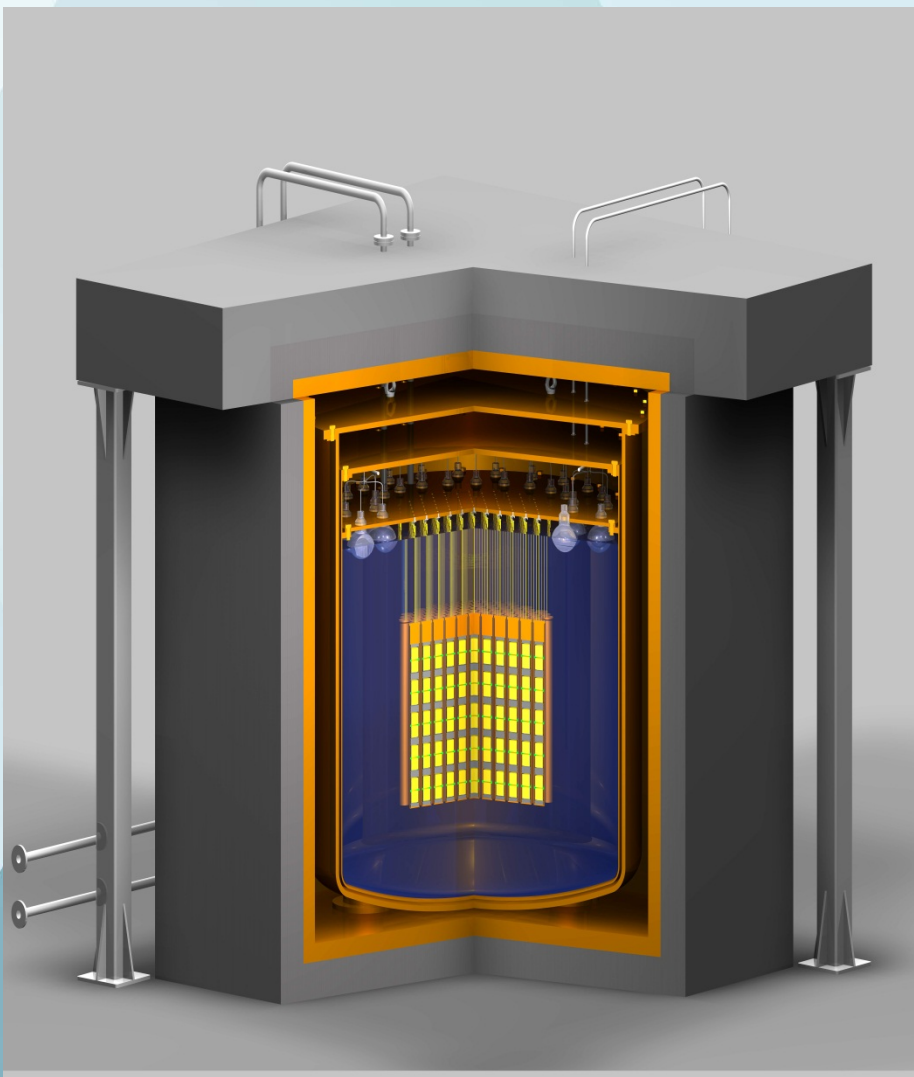
© Future : Lower Threshold ; Direction Sensitive



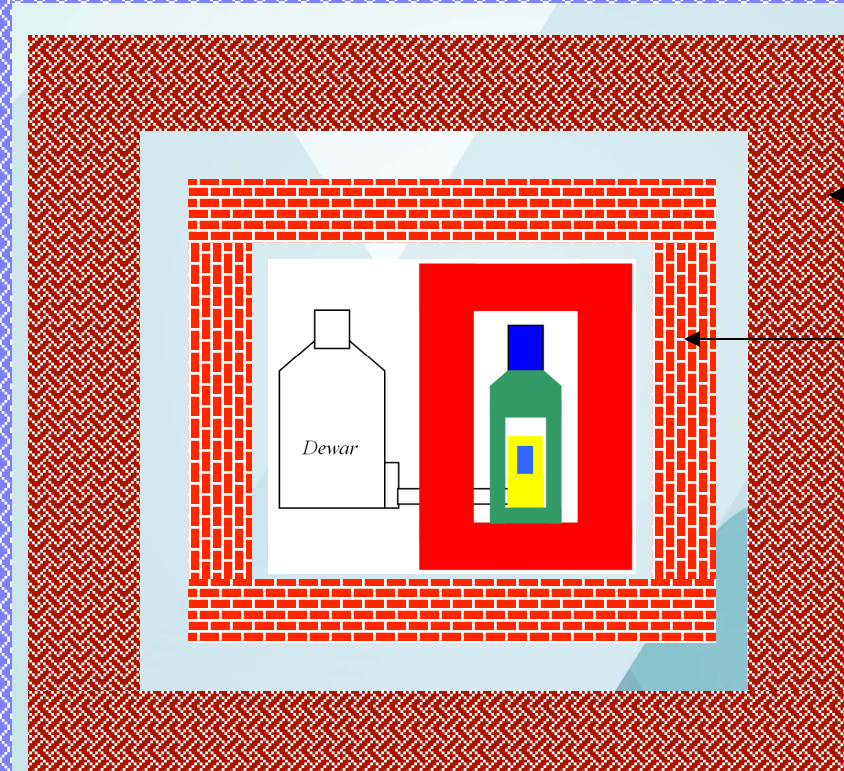
CDEX整体屏蔽结构



China Dark-matter Experiment (CDEX)



Detector and Shielding



← Polyethylene

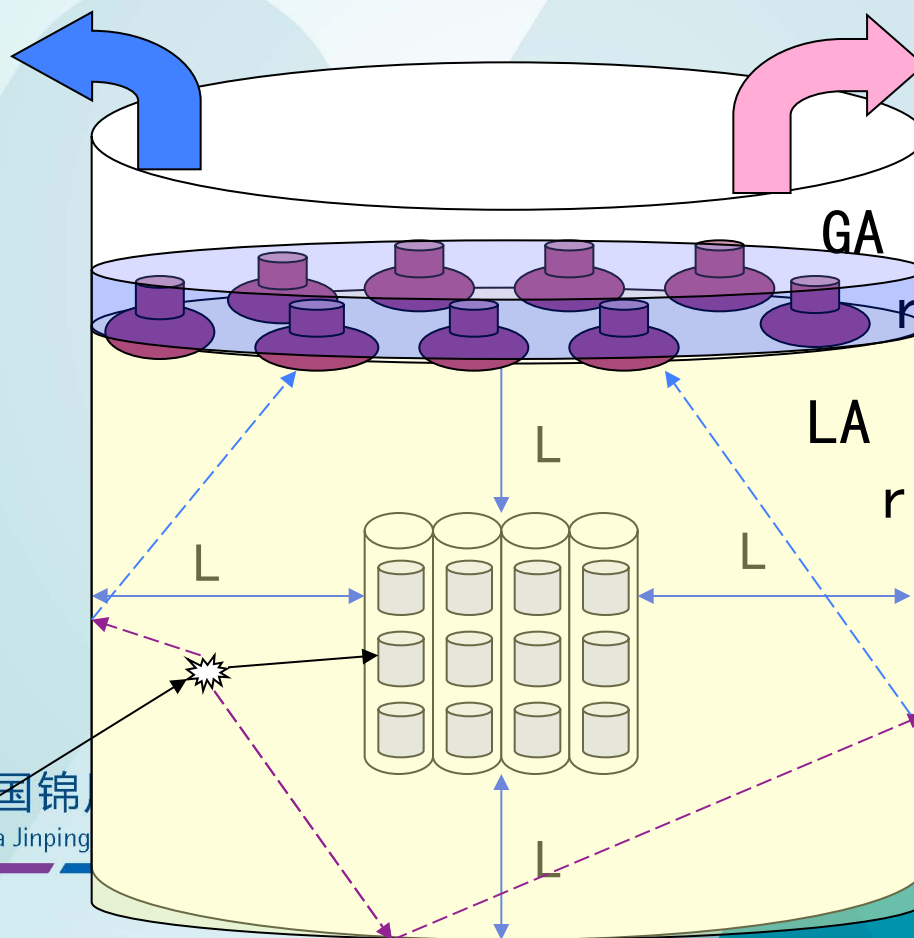
← Lead

← Copper

10kg scale PCGe detector array with LAr active shielding

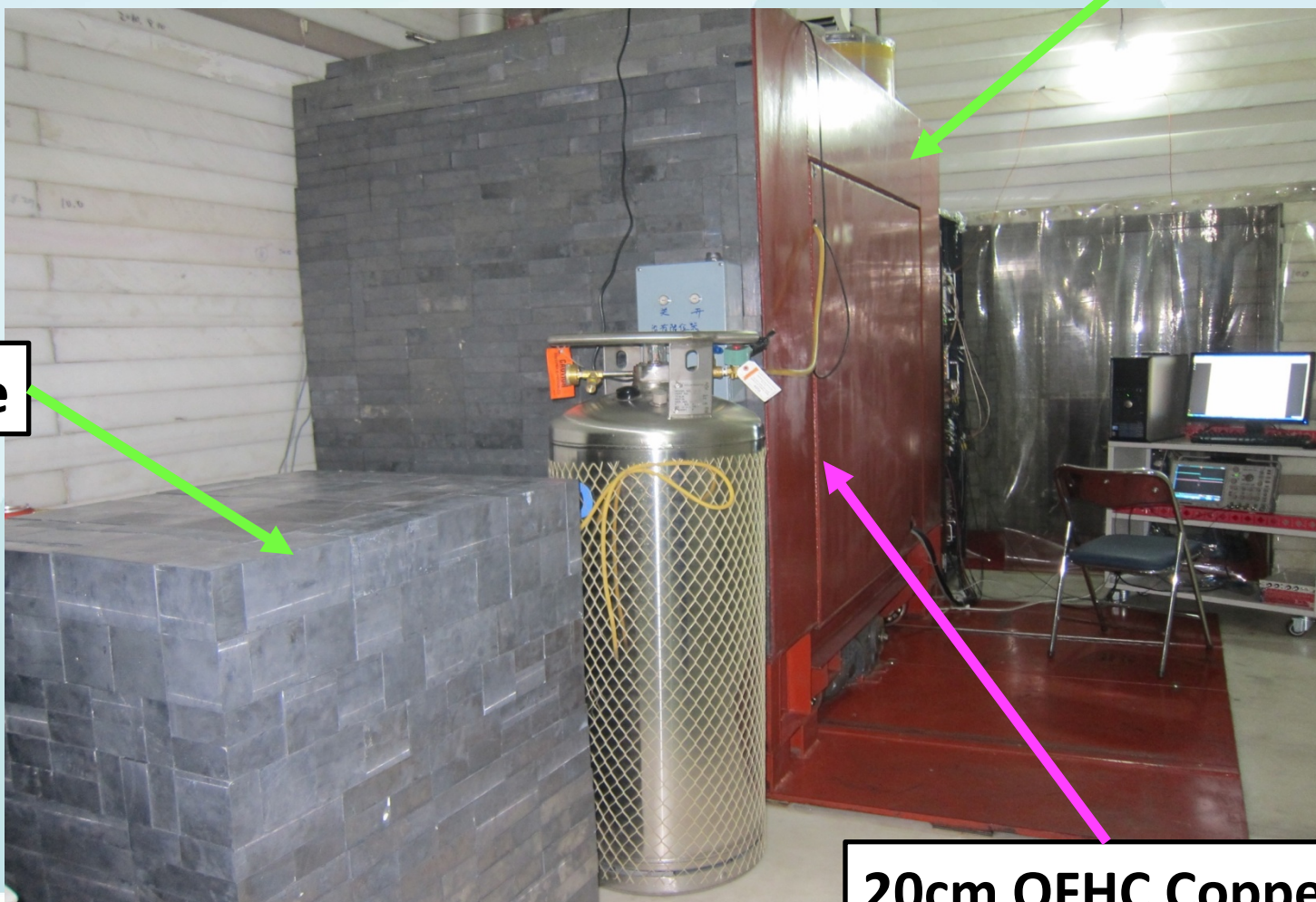
HV and Signals

Cooling and Control





4x5g ULEGe



1kg PCGe

**20cm OFHC Copper
+20cm Lead**

PandaX



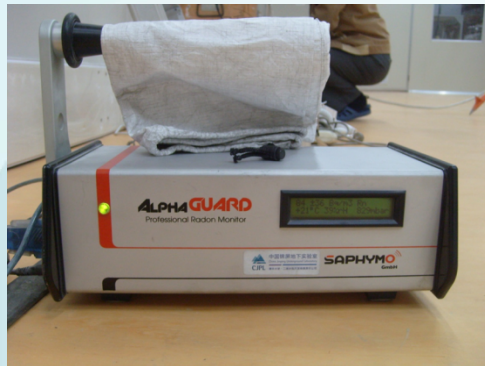
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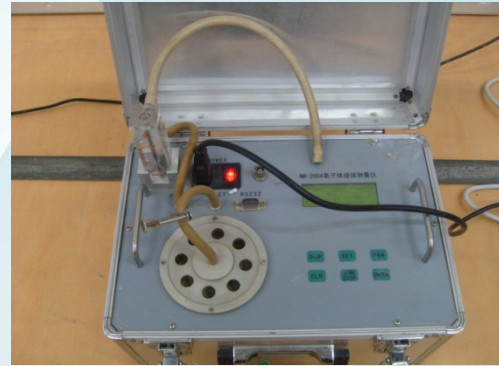
Low Background Radiation Measure



GMX365B
(HPGe)



NR200A
($100 \sim 1.5 \times 10^{-3} \text{uJ/}$
 m^3)



AlphaGuard
(5cpm)



Leica Disto A5
(0.002m)

Focus: ^{214}Pb 、 ^{214}Bi 、 ^{228}Ac 、 ^{212}Pb 、 ^{208}Tl and ^{40}K
Based the characteristic peak of ^{214}Pb and ^{214}Bi

In the Cave



CJPL Rock Background

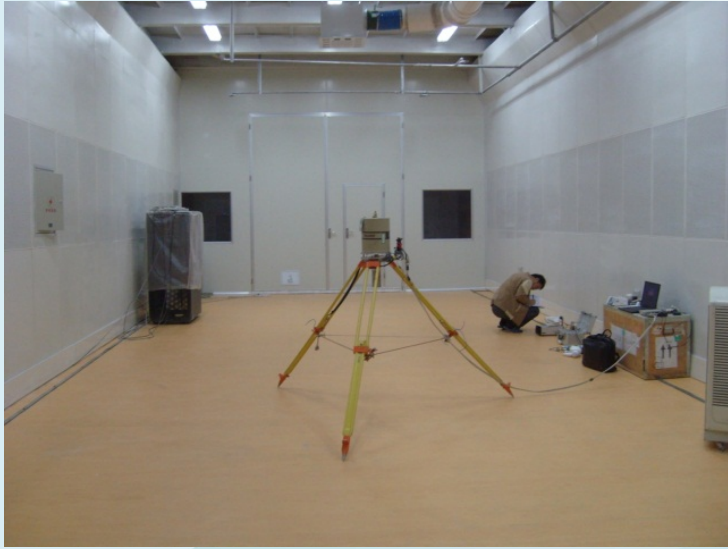
(Unit: Bq/kg)	K-40	Ra-226 (609keV)	Th-232 (911keV)
JinPing Rock Sample	< 1.1	1.8 ± 0.2	< 0.27
Beijing Normal Ground Level	~600	~25	~50

In the tunnel



C.

In side CJPL (LBF)

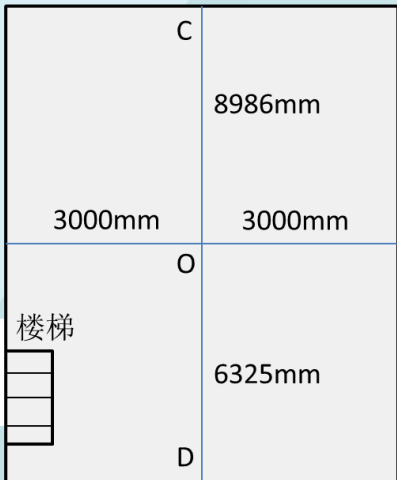


聚乙烯室门

Humidity: 42%; Temperature: 23°C。
Average dose rate of Radon:

$133 \pm 24 \text{ Bq/m}^3 (8.1 \times 10^{-1} \mu\text{J/m}^3)$

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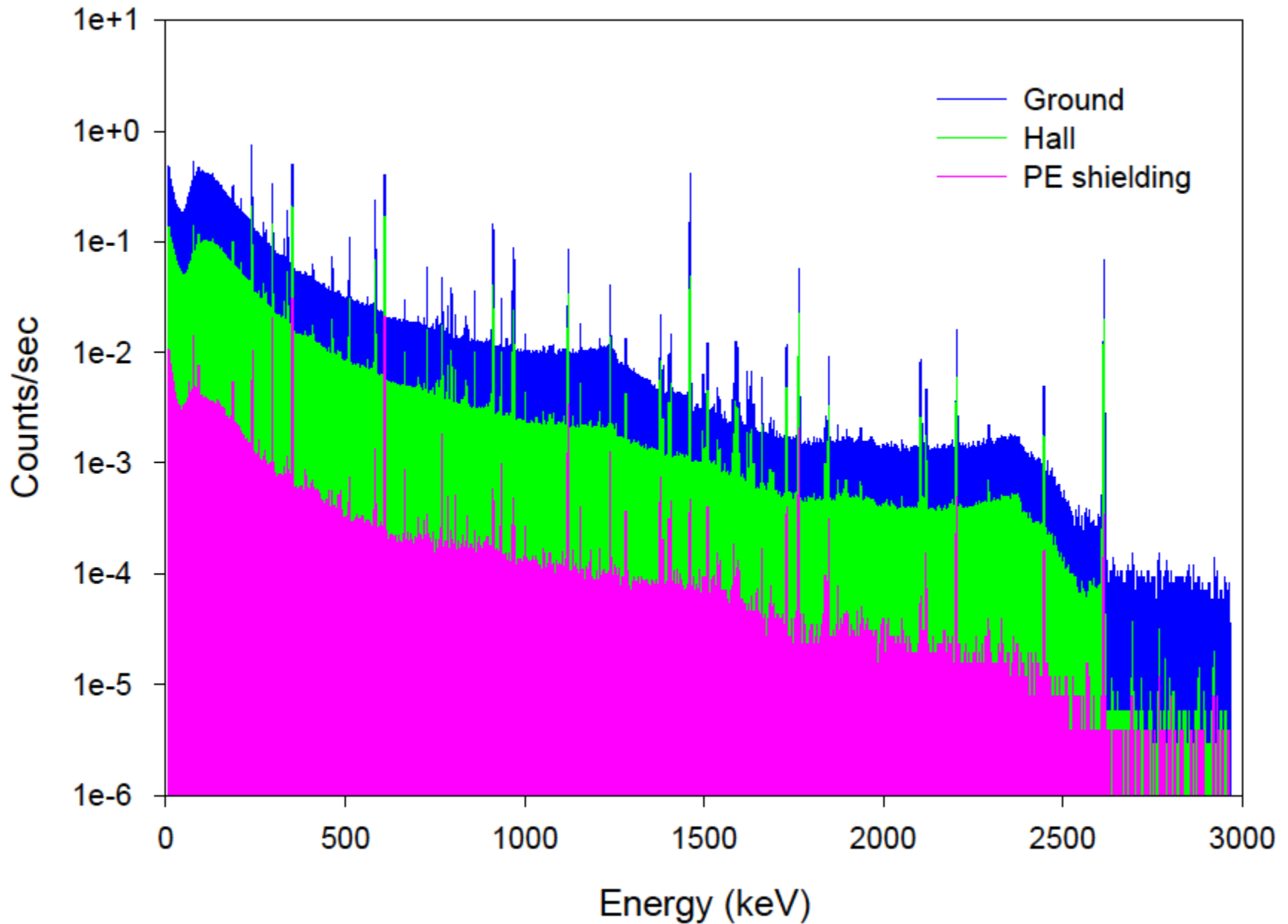
交大实验室门

Inside CJPL (CDEX)



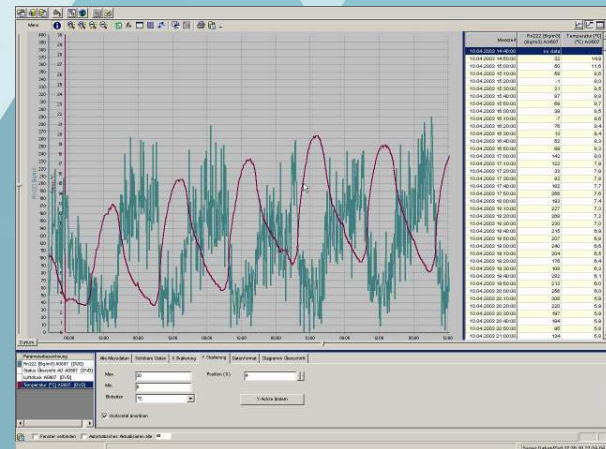
Humidity: 37%; Temperature: 21℃。
Average dose rate of Radon: $34 \pm 7 \text{ Bq/m}^3$ ($2.6 \times 10^{-1} \mu\text{J/m}^3$)

Radiation Measure of CJPL

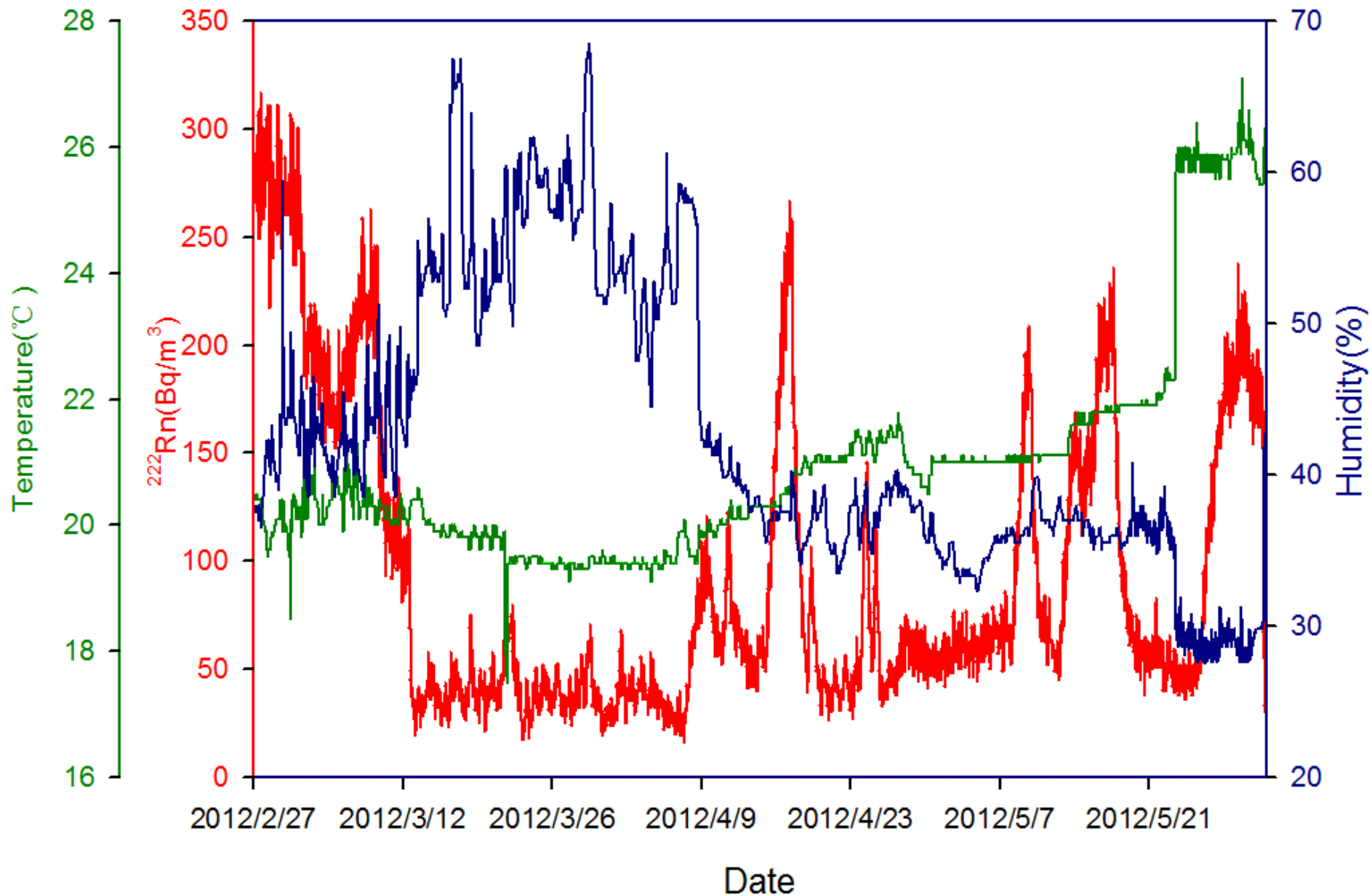


Unexpected Result of Radon Measure

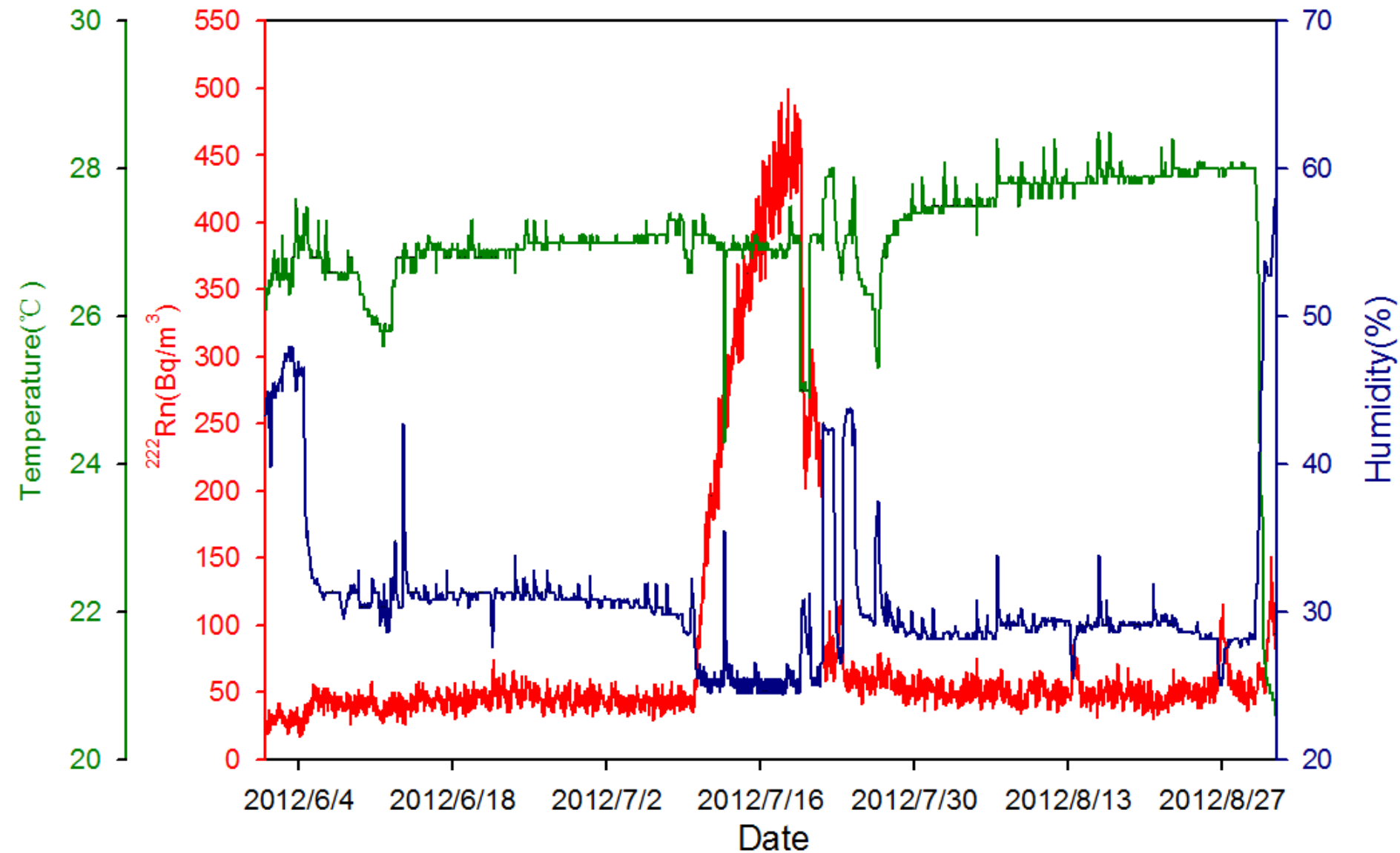
- Syphymo AlphaGuard PQ2000
 - Measuring range: 2- 2000000 Bq/m³;
 - Sensitivity: 1 cpm per 20 Bq/m³;
 - Detector filling system: Design optimized for fast passive diffusion :10/60 min and flow mode : 1/10 min (PQ2000 PRO only)



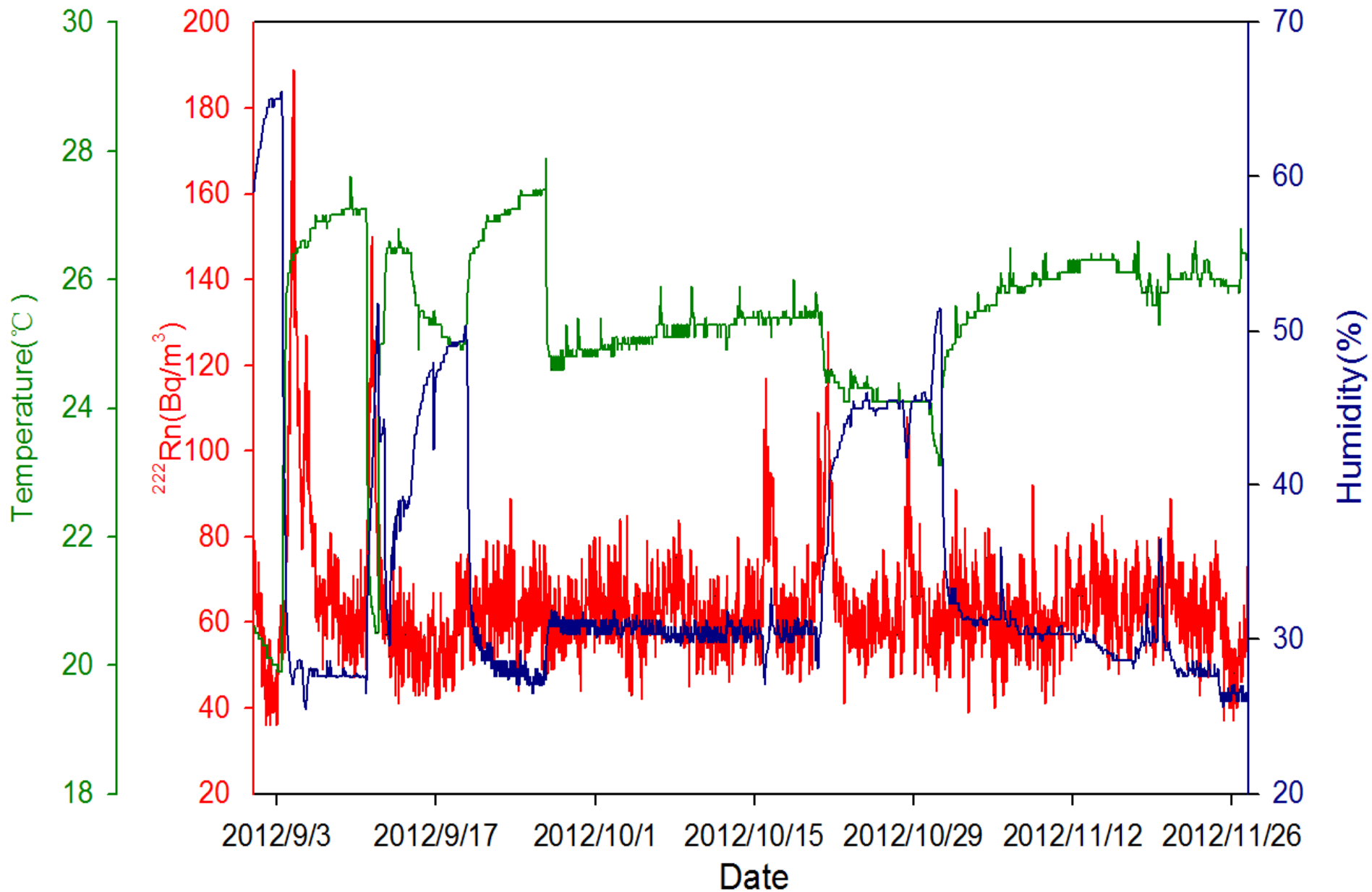
The measurement of Radon in CJPL



The measurement of Radon in CJPL



The measurement of Radon in CJPL



据四川地震台网测定，2012年7月18日04时18分42.0秒，在四川冕宁与石棉交界处（北纬：29.0度，东经102.2度）发生M3.7级地震

2012年6月19日上午10时02分09秒，在凉山州冕宁县与盐源县交界处王家村子（北纬28度14分，东经102度43分）发生M2.8级地震

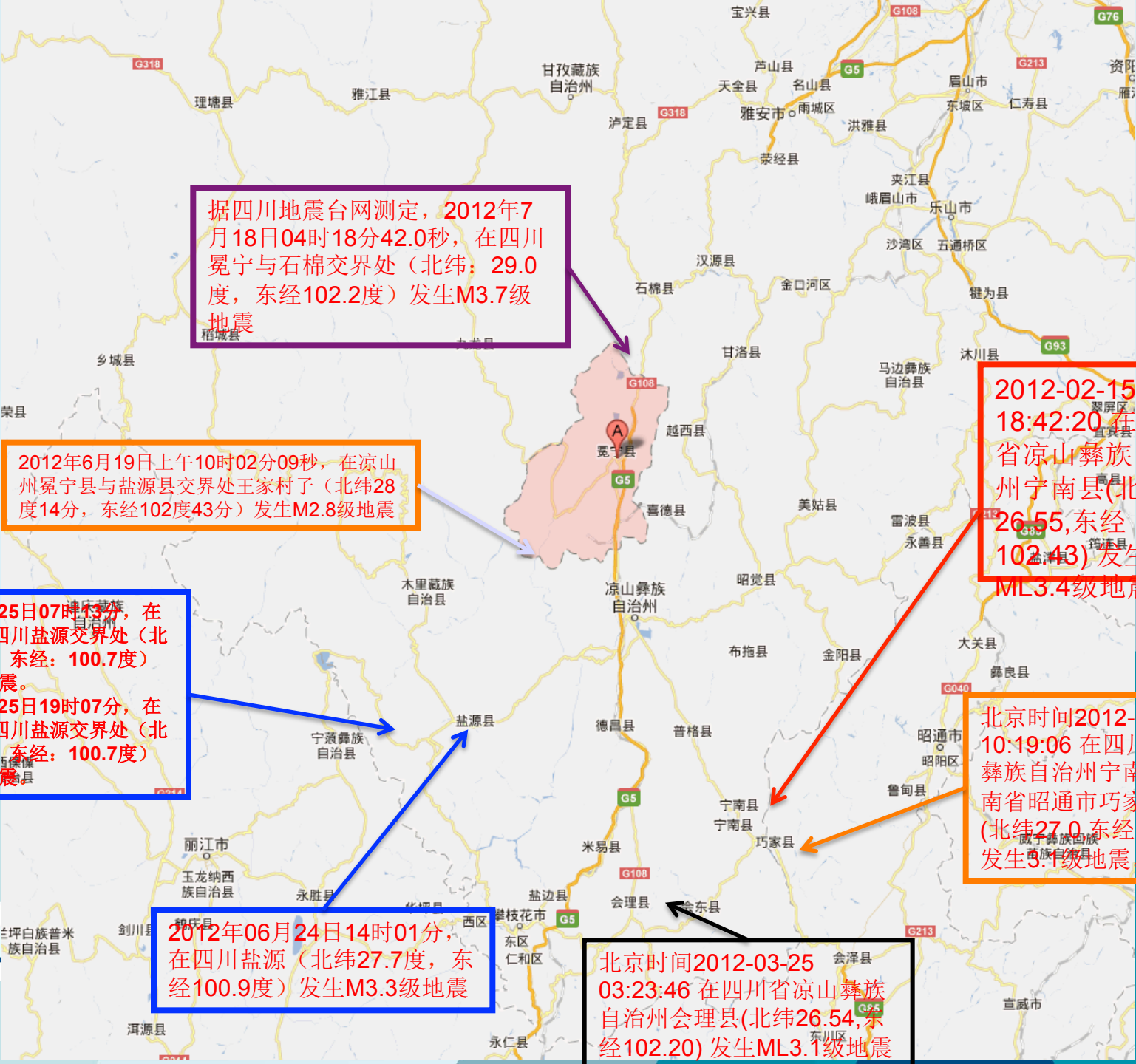
2012-02-15 18:42:20 在四川省凉山彝族自治州宁南县(北纬26.55,东经102.43)发生ML3.4级地震

2012年06月25日07时13分，在云南宁蒗、四川盐源交界处（北纬：27.8度，东经：100.7度）发生3.2级地震。
2012年06月25日19时07分，在云南宁蒗、四川盐源交界处（北纬：27.8度，东经：100.7度）发生3.0级地震。

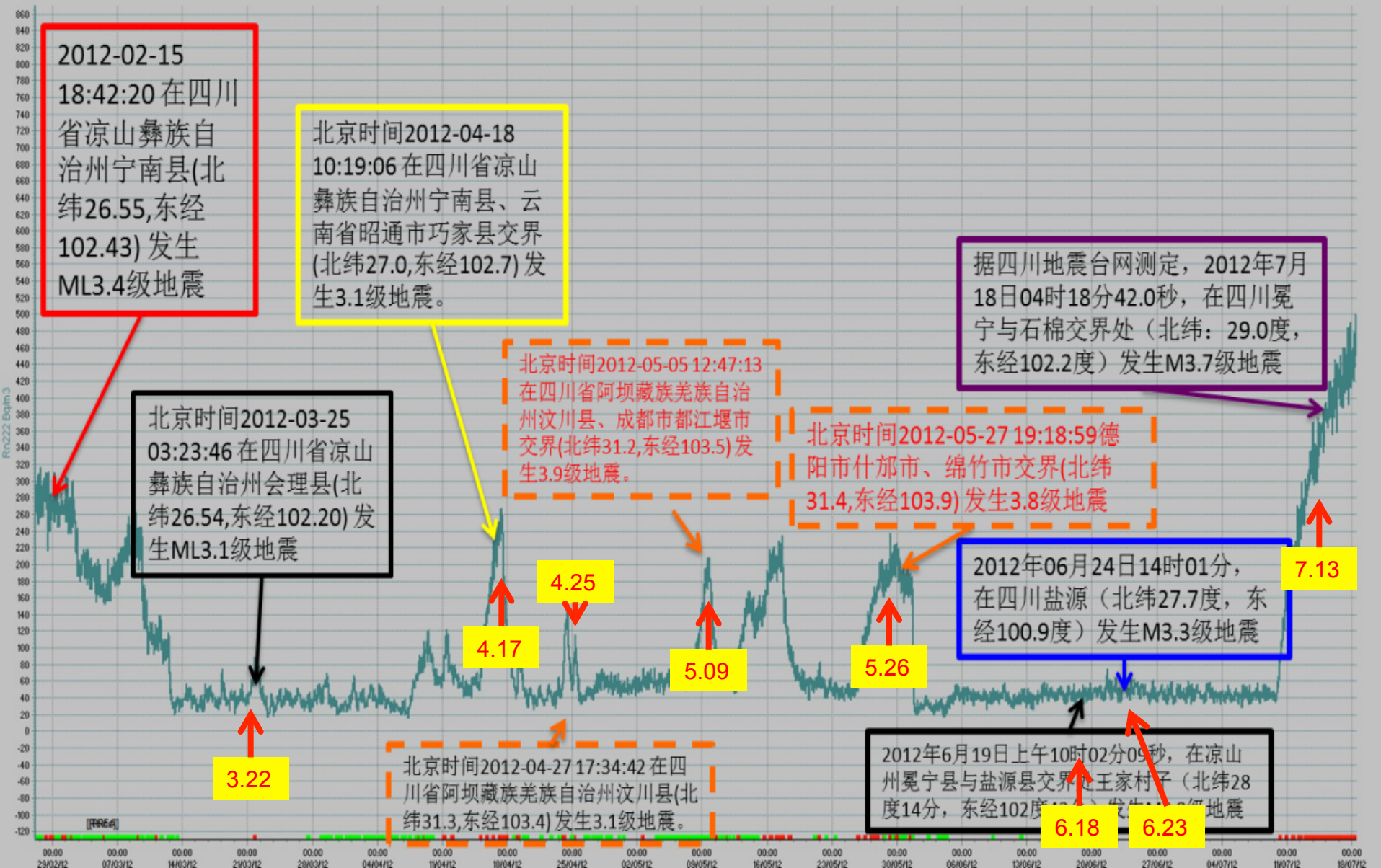
北京时间2012-04-18 10:19:06 在四川省凉山彝族自治州宁南县、云南省昭通市巧家县交界(北纬27.0,东经102.7)发生3.1级地震。

2012年06月24日14时01分，在四川盐源（北纬27.7度，东经100.9度）发生M3.3级地震

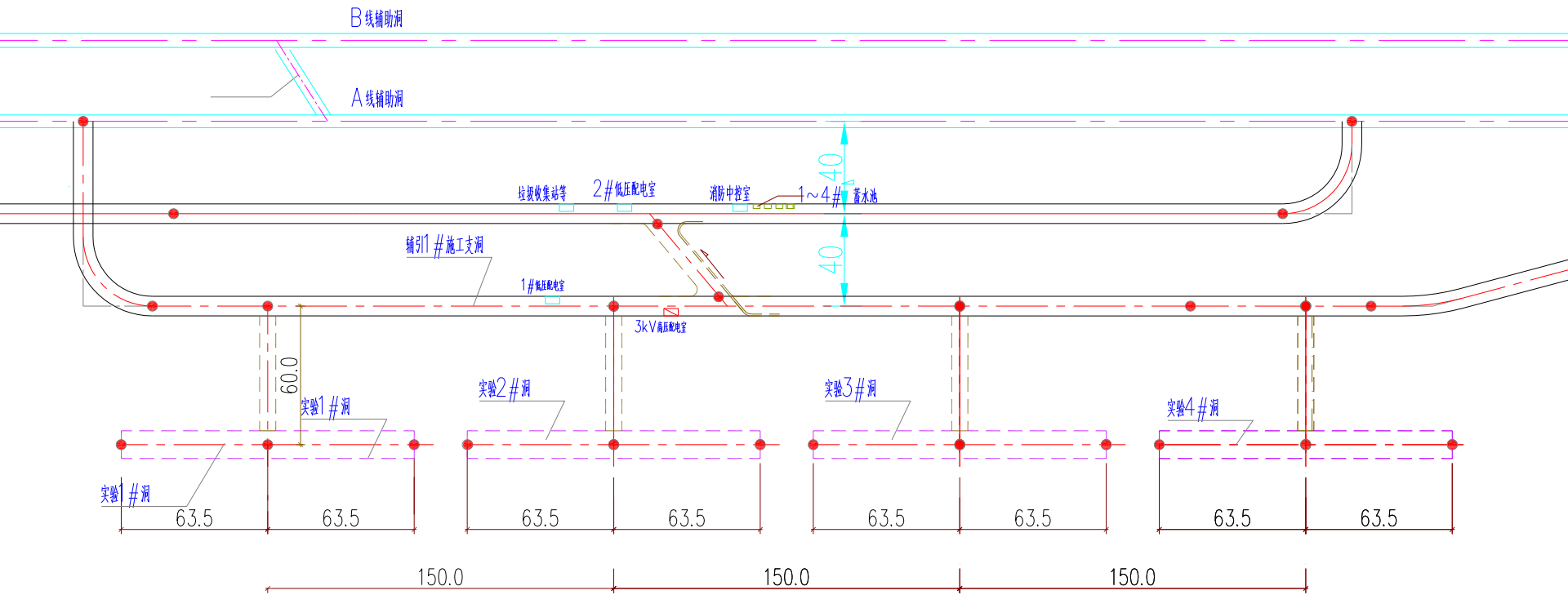
北京时间2012-03-25 03:23:46 在四川省凉山彝族自治州会理县(北纬26.54,东经102.20)发生ML3.1级地震



The relation between radon and earthquake nearby CJPL



CJPL II



• More Space

- $4000\text{m}^3 \rightarrow 96,000\text{m}^3$
- $60\text{kVA} \rightarrow 600\text{kVA}$
- $40\text{m}^3/\text{h} \rightarrow 5000\text{m}^3/\text{h}$

• More Project

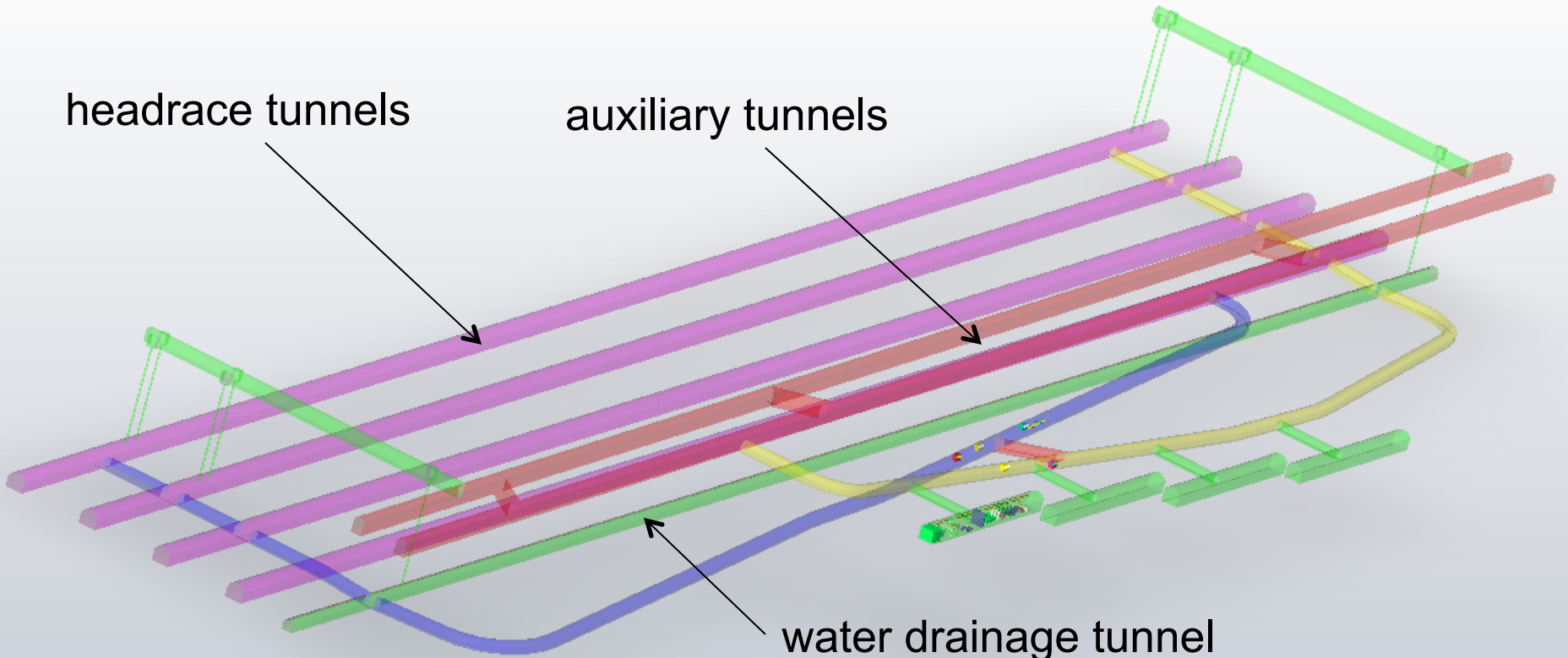
- CDEX-1T
- PandaX-1T
-

CJPL-II

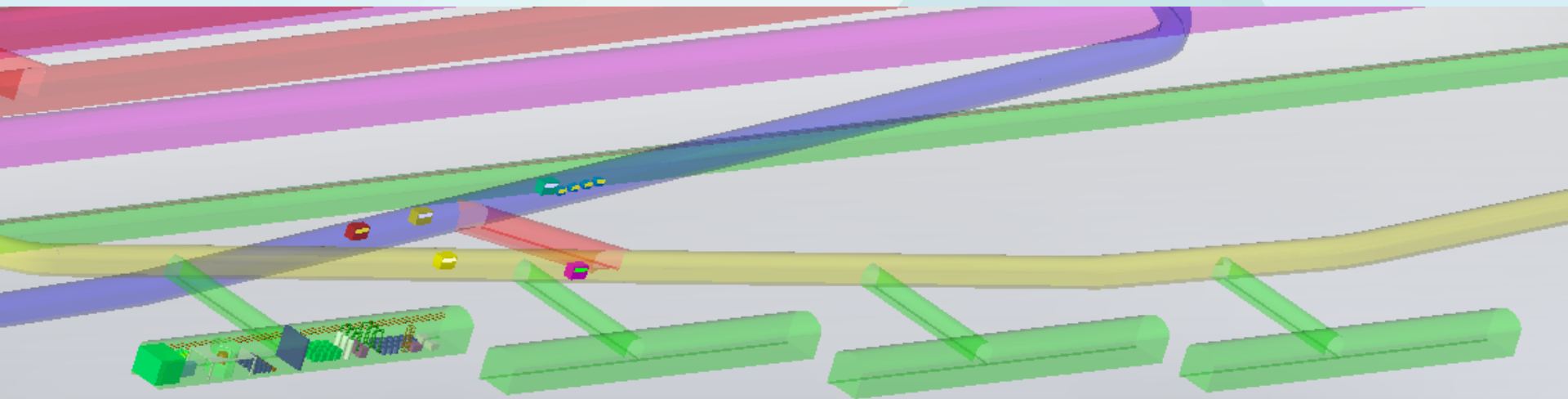
headrace tunnels

auxiliary tunnels

water drainage tunnel



8 rooms of CJPL-II



Rock work volume of 8 x labs

130591 m³

Concrete work volume

26427 m³

Steel structure

912 T

Civil work of CJPL-II

	项目及名称	单位	数量	备注
1	实验洞石方洞挖	m ³	112445	14.0×14.0
2	交通洞石方洞挖	m ³	18146	9.0×8.0
3	涨壳式预应力中空注浆锚杆Φ32, L=6m	根	26574	
4	带垫板砂浆锚杆Φ32, L=6m	根	5562	
5	普通砂浆锚杆Φ32, L=3m	根	7210	
6	喷C30纳米钢纤维混凝土, h=15~20cm	m ³	4306	
7	喷C25混凝土, h=10cm	m ³	1373	
8	C25W8底板混凝土(二)	m ³	7706	
9	C25W8衬砌混凝土(二)	m ³	13042	
10	钢筋制安	t	912	
11	通风系统	项	1	



Plan of Civil Work

- Jun. 2013 ~ Dec. 2013 : Concept Design
- Jan. 2014 ~ May. 2014 : Detail Design
- Jun. 2014 ~ Oct. 2014 : Tender Process
- Nov. 2014 ~ Dec. 2014 : Contract and approval
- Jan. 2015 ~ May. 2015 : Dig and Support
- Jun. 2015 ~ Sep. 2015 : Concrete work
- Apr. 2015 ~ Jun. 2015 : Flesh air tube work
- Oct. 2015 : Civil work Accept Test
- Nov. 2015 ~ Jun. 2016 : Infrastructure work

Question about CJPL-II

- New Request from Physicist
- New Idea for Engineer
- Useful Advice for planning and design
- New Think for Future

Thank

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