China JinPing Underground Laboratory (CJPL) and Dark Matter Experiments in China

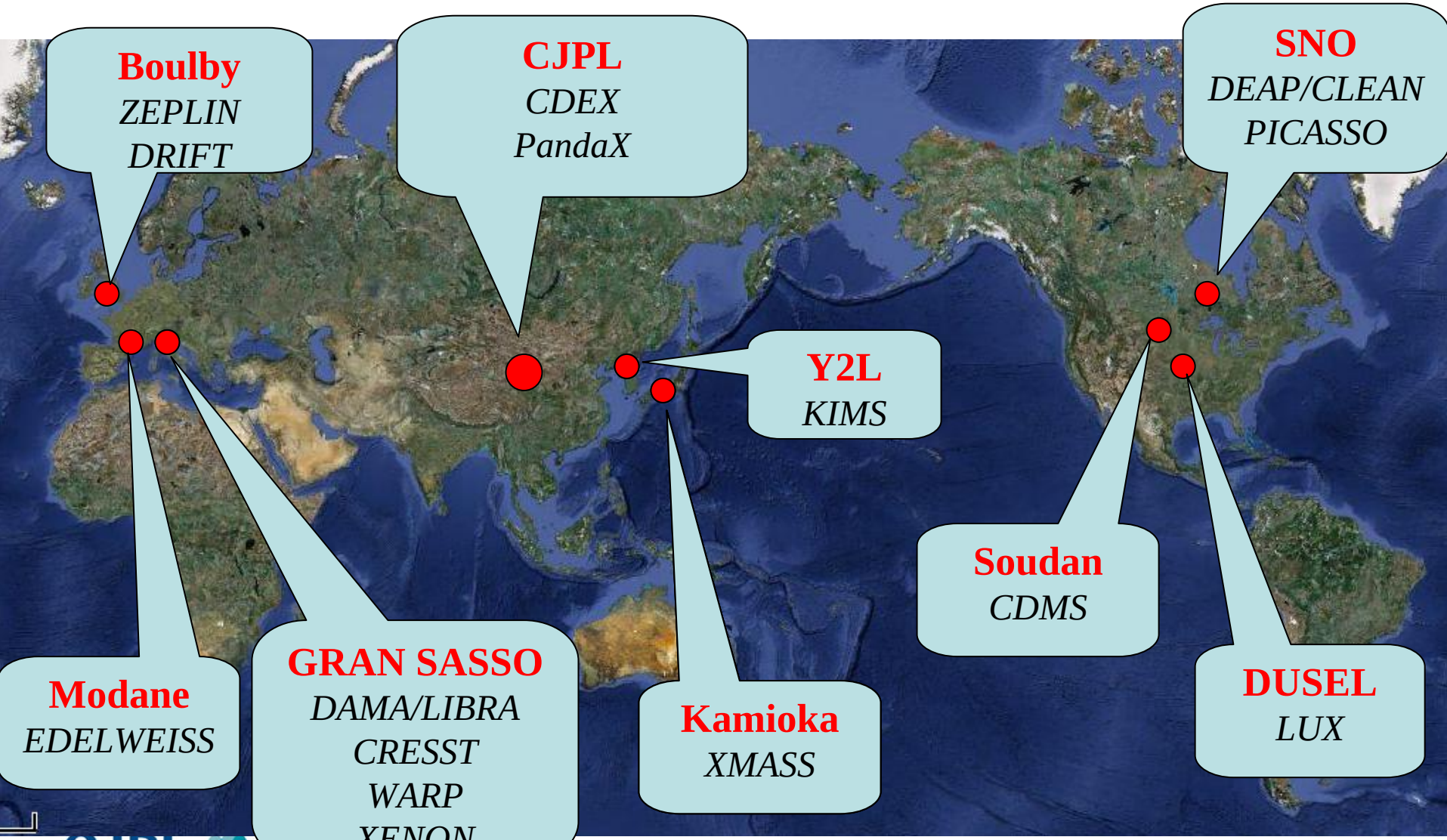
Qian Yue
Tsinghua University
April. 8, 2011

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

Outline：

- The recent status of CJPL
- Dark Matter Experiments in China
- CJPL and LSM Collaboration
- Summary

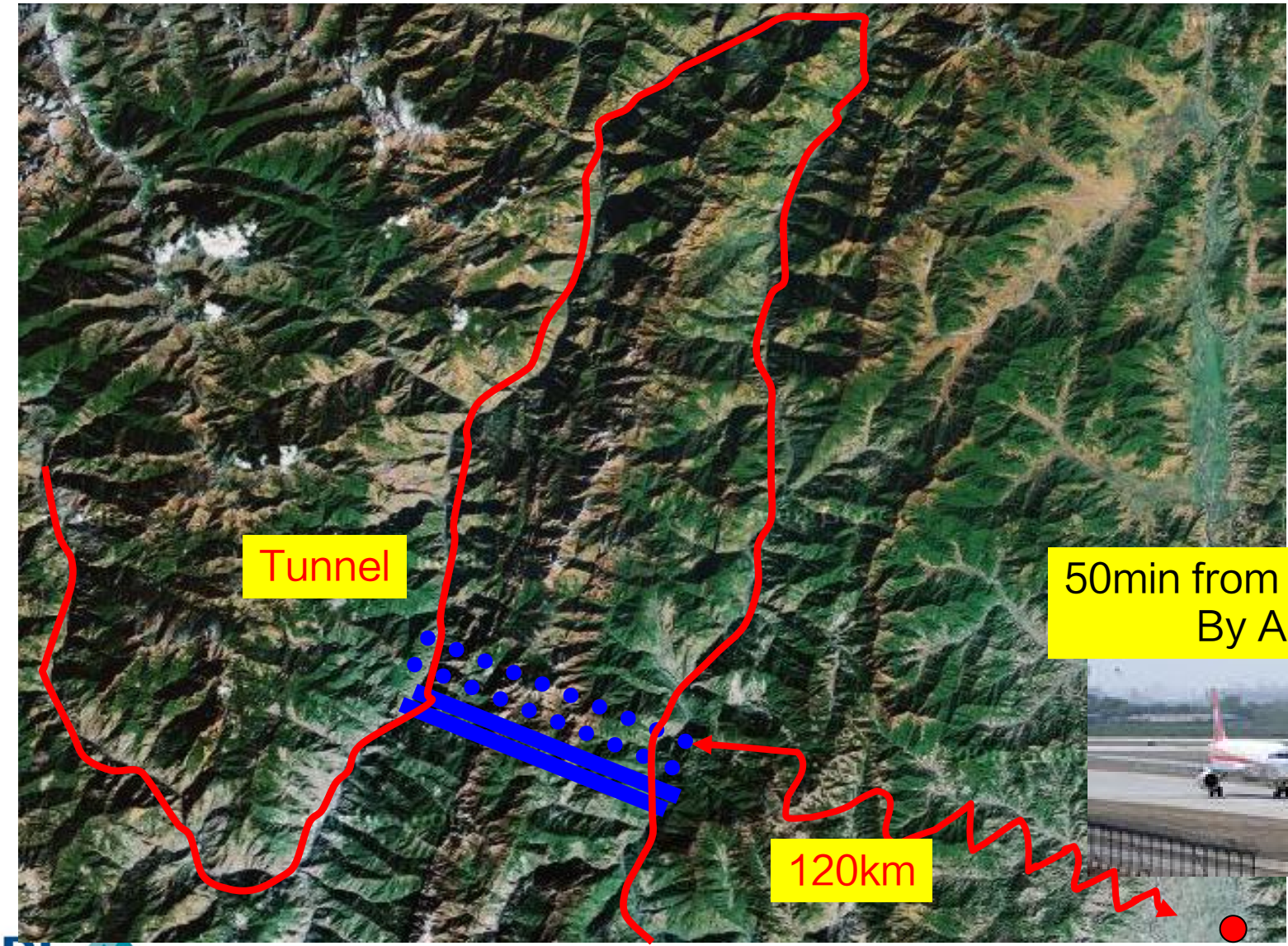
International Main UL



CJPL site

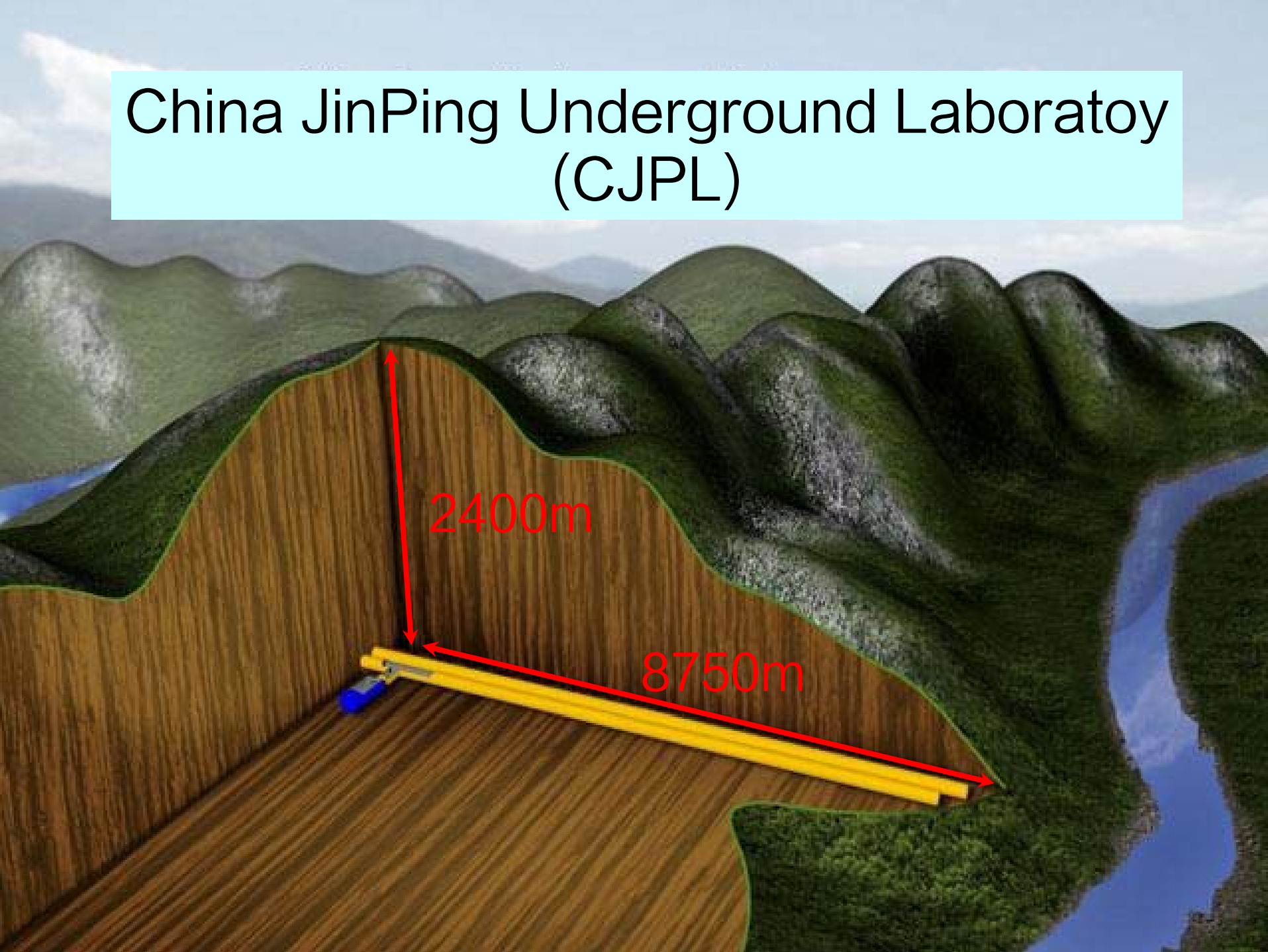
CJPL

Yalong River and Jinping Mountain

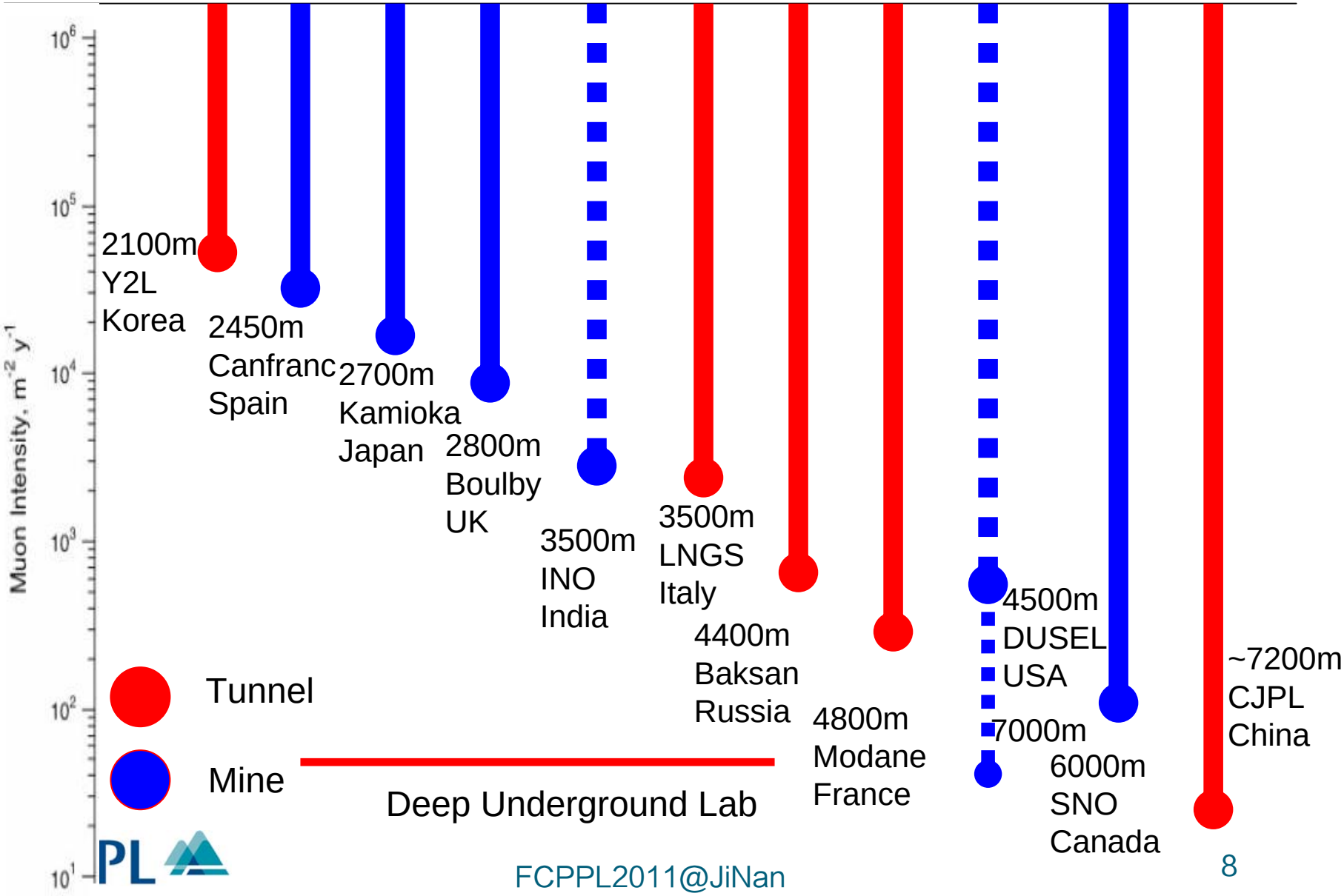


Road and Tunnel

China JinPing Underground Laboratoy (CJPL)



Comparison of main ULs in the world
(Unit:M.W.E)



MOU signed between EHDC and THU

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.

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China, others dig more and deeper underground labs

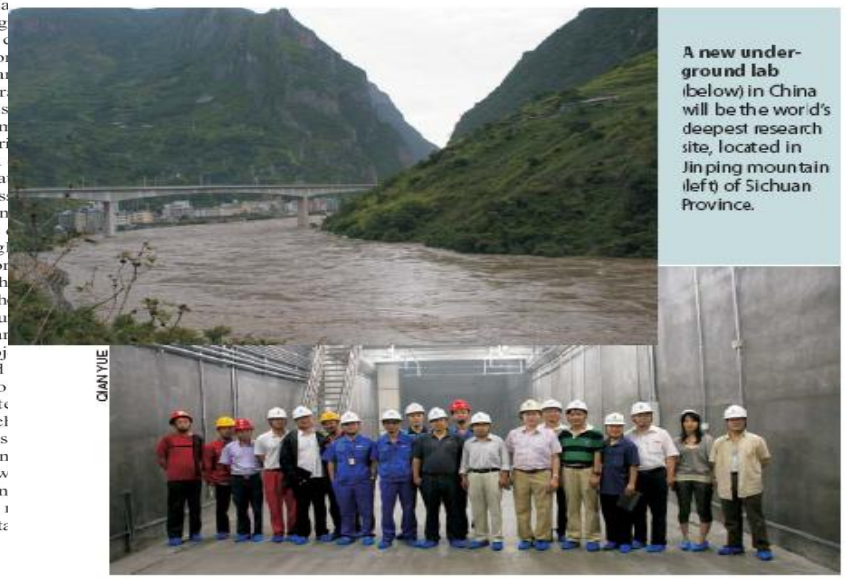
From tiny to gargantuan, experiments are in the works to exploit the shielding from cosmic rays that being deep underground offers.

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 start 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 finance, 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

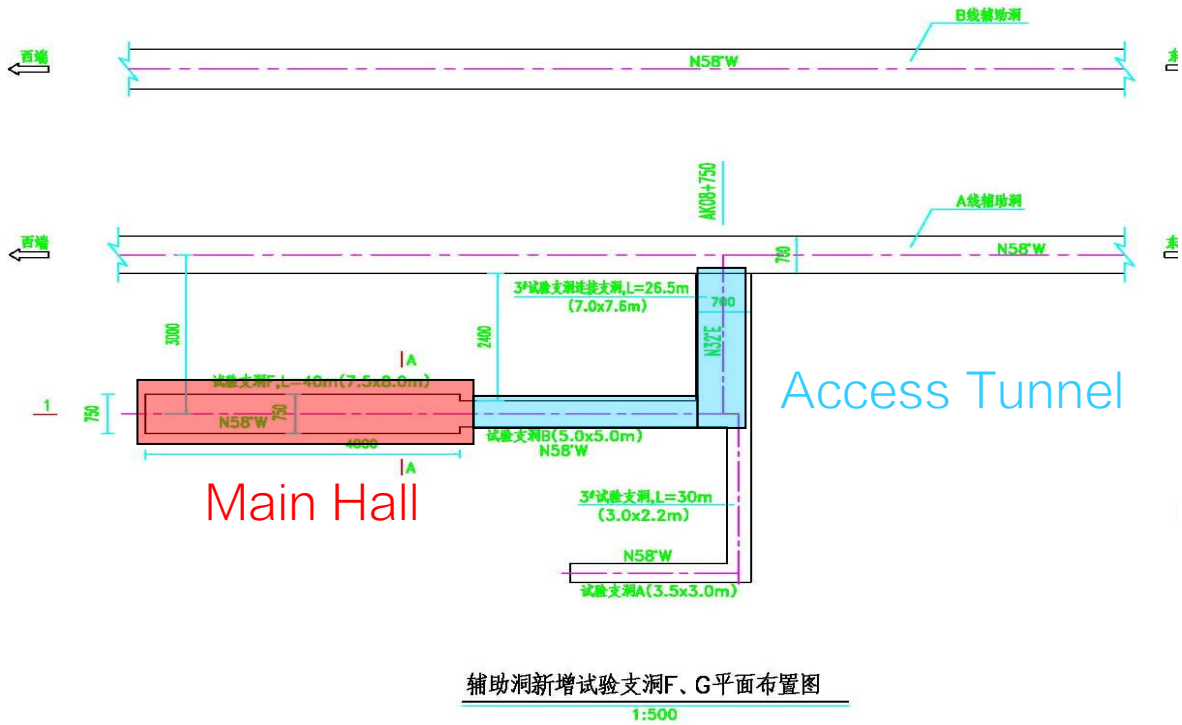
The CJPL grew rapidly from an idea to reality: In mid-2008 scientists got wind that the Ertan Hydropower Development Co



QIAN YUE

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

The Layout of CJPL-I



- Main hall: 6.5*6.5*40m
- Total Volume: ~4000m^3


2010/01/27


2010.03.1


2010.02.24


2010/04/24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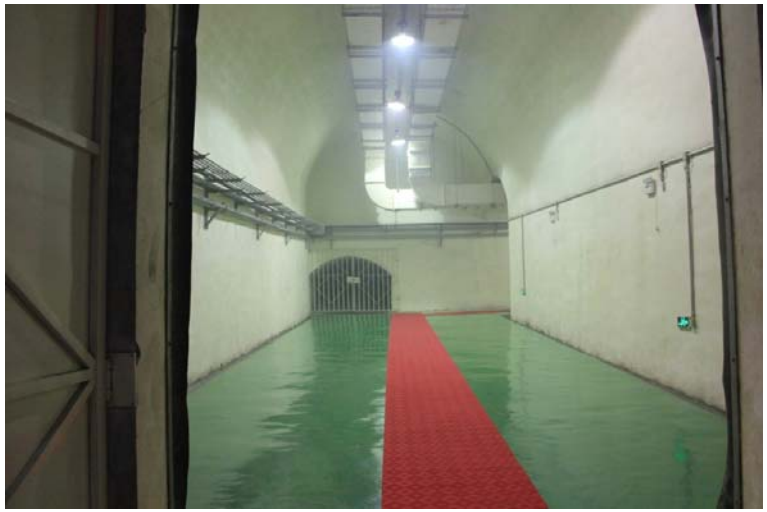
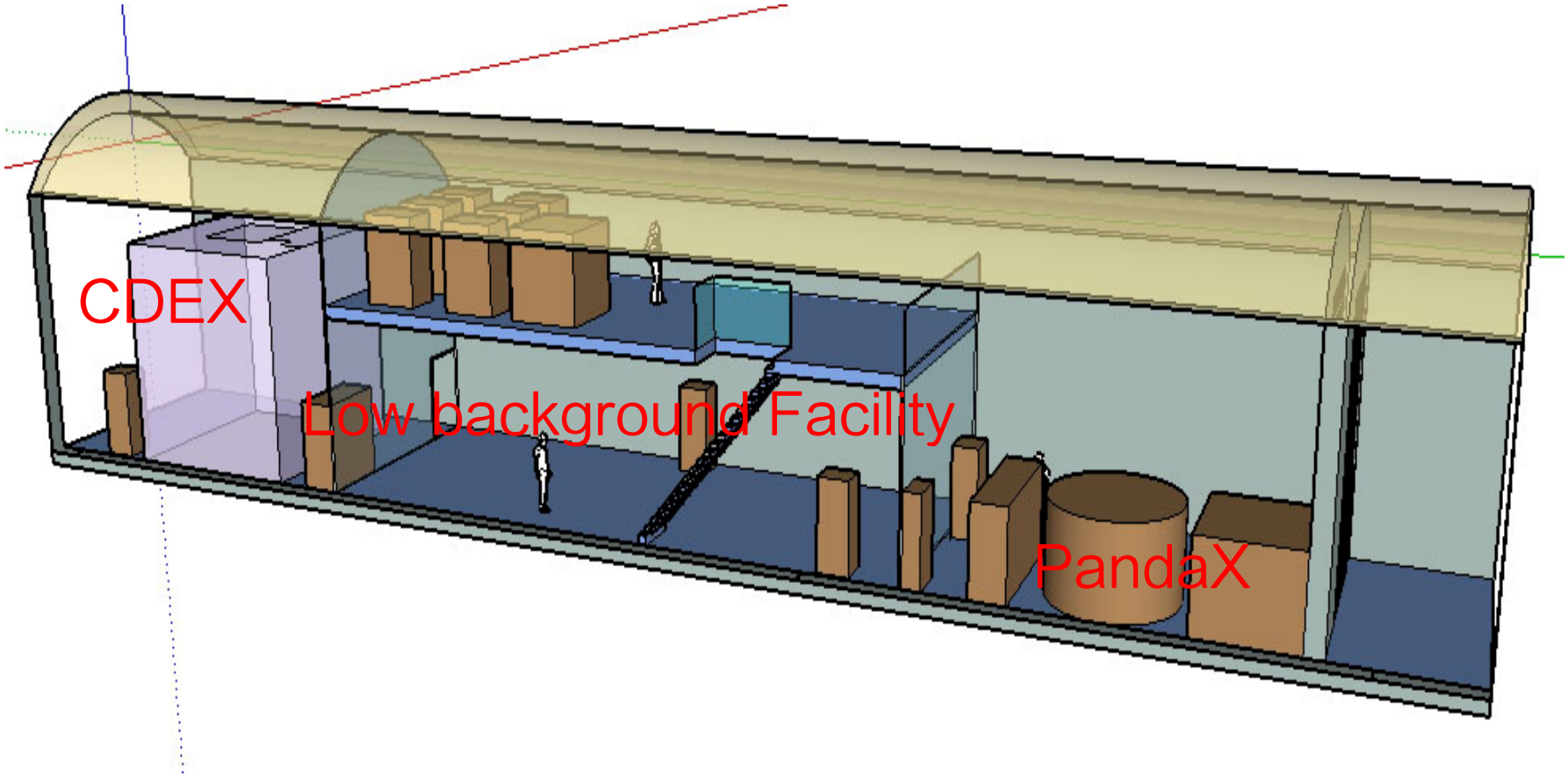
2010/04/28

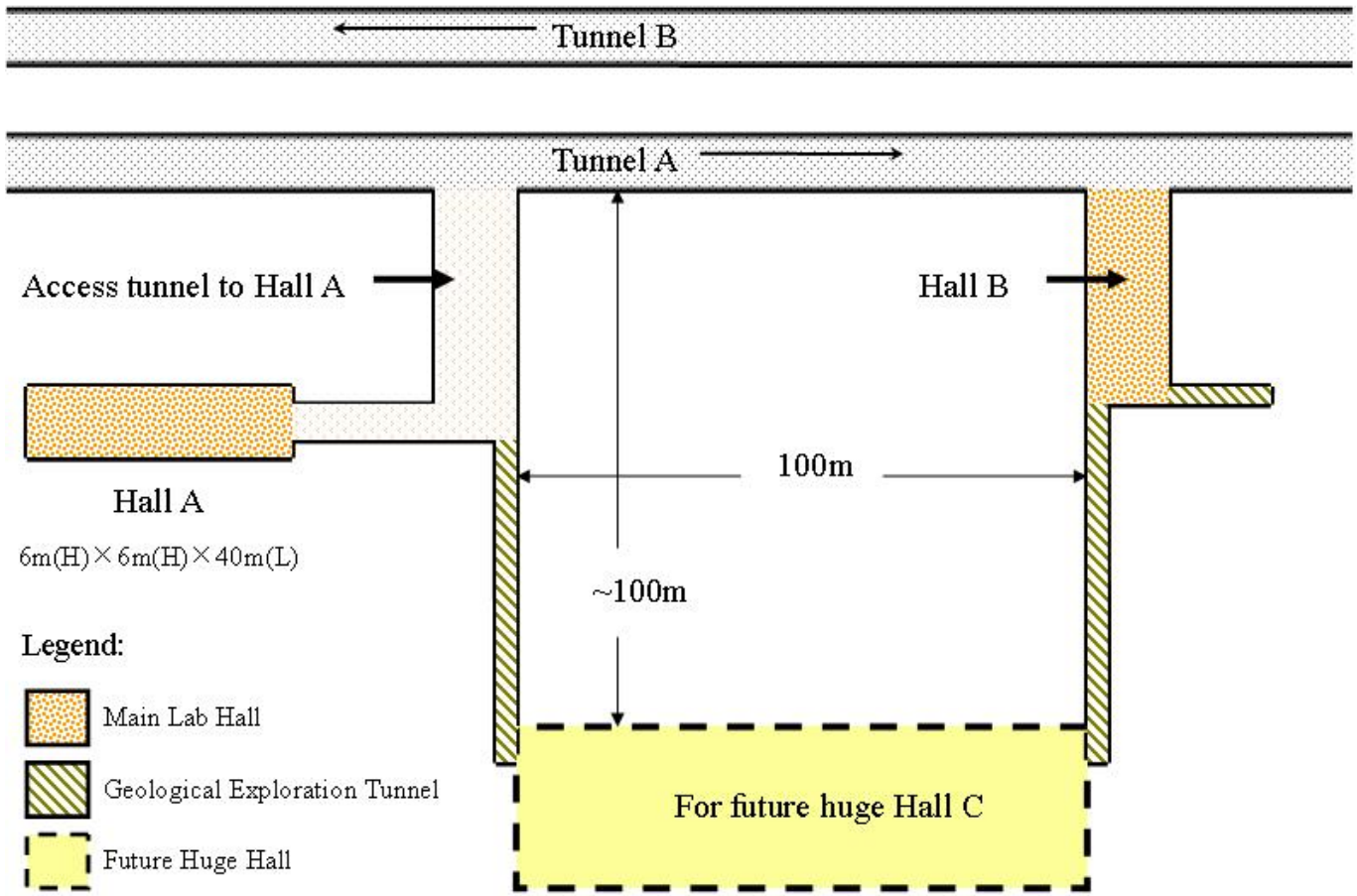
CJPL Openning Now!



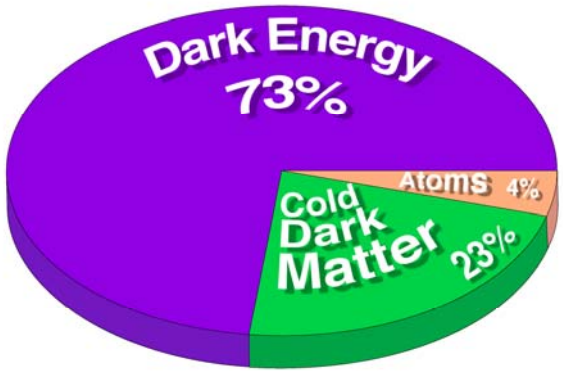
Internal space use

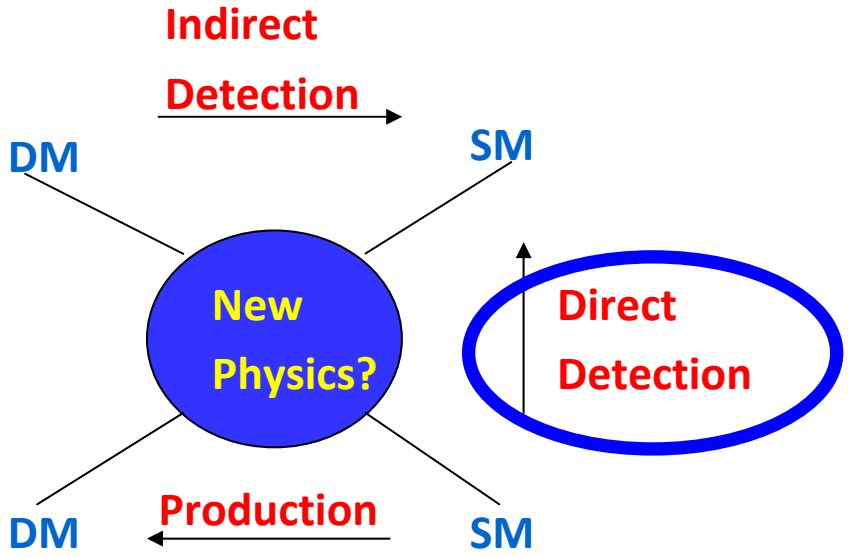


CJPL future development



Dark matter Experiments in China





Groups: CDEX(PCGe), PandaX(LXe), LAr,CsI(Na), CCD , …

China Darkmatter EXperiment (CDEX)

J. P. Cheng, K.J. Kang, J. Li, J.M. Li, Y.L. Li, Y.J. Li, H. Ma, N. Yi, Q. Yue, T. Xue, Z. Zeng

(Tsinghua University, THU)

K.X. Jing, C.J. Tang, Z.Y. Tang, H.Y. Xing, C. W. Yang, J.J. Zhu

(Sichuan University, SCU)

X.Q. Li, Y. Xu, C.X. Yu, M.G. Zhao

(Nankai Univeristy,NKU)

H. X. Huang, X. Li, J. Ren, X.C. Ruan, Z.Y. Zhou

(China Institute of Atomic Energy, CIAE)

Y.H. Chen, B.M. Shen, J.M. Wang, S.Y. Wu, X.H. Zeng

(Ertan Hydropower Development Company, EHDC)

H.T. Wang

(TEXONO Collaboration)

CDEX History

July，2003，Agreement between THU and SNU signed for DM search Experiment at Y2L, Korea

Agreement on Scientific collaboration

Following sincere and friendly discussion, Engineering Physic Department of Tsinghua University and Dark Matter Research Center o Seoul National University with a view to strengthening the friendshi bonds between the physicists of two institutions, to propelling th development of scientific research and teaching work, to promotin scientific and technological exchange and cooperation between the tw institutes, have arrived at following agreement.

1. The two parties think that dark matter search is impor basic research project in nuclear and particle physics. De g new detectors such as ultra low impurity crystal CsI(TI) or d tectors and measurement methods is main program in the project.

2. The two parties will provide each other with materials of science and technology, exchange relevant information, learn from each other, help raising each other's levels of scientific researches.

3. The two parties will point experts or professors, who will make up a joint meeting of scientific cooperation. The meeting will convene at least once each year to share experiences in the area of scientific research work and discuss questions of common interest.

4. Dark Matter Research Center will provide financial support for one or two students (either Master or Ph.D. course) from Tsinghua University to join the dark matter search project. The period of stay in Korea is one or two years.

5. Tsinghua University will invite professors or experts of Dark Matter Research Center to visit Tsinghua University and to give academic lectures about basic science of Dark Matter and to carry out cooperation.

6. The two parties should share scientific results and experience .

7. Neither parties shall break off the agreement without good reason or cause.

8. The present agreement will be valid for 5 years.

9. The present agreement is signed on July 30, 2003 by representatives of the two parties.

Professor Sun Kee Kim
Dark Matter Research Center
Seoul National University

Professor Kang, Kejun
Engineering Physics Department
Tsinghua University

1(Department of Engineering Physics, Tsinghua University, Beijing 100084, China)
2(Institute of High Energy Physics, Chinese Academy of Sciences, Beijing 100039, China)
3(Institute of Physics, AS, Taipei 11529, China)

Abstract An HPGe detector has been constructed for the direct detection of Weakly Interactive Massive Particles(WIMPs). The supersymmetric parameter space for WIMPs detection using this HPGe detector which has 100eV low-energy threshold and 5g mass has been explored based on the so-called Minimal Supersymmetric extension of the Standard Model(MSSM). The result shows that it will be possible to provide the most stringent upper bounds of WIMP-nucleus spin-independent cross-section at the lower WIMPs mass region.

PHYSICAL REVIEW D **79,** 061101(R) (2009)

New limits on spin-independent and spin-dependent couplings of low-mass WIMP dark matter with a germanium detector at a threshold of 220 eV

S.T. Lin,[1] H.B. Li,[1] X. Li,[2] S.K. Lin,[1] H.T. Wong,[1,*] M. Deniz,[1,3] B.B. Fang,[2] D. He,[2] J. Li,[2,4] C.W. Lin,[1] F.K. Lin,[1] X.C. Ruan,[5] V. Singh,[1,6] A.K. Soma,[1,6] J.J. Wang,[1] Y.R. Wang,[1] S.C. Wu,[1] Q. Yue,[2] and Z.Y. Zhou[5]

(TEXONO Collaboration)

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[2]*Department of Engineering Physics, Tsinghua University, Beijing 100084, China*
[3]*Department of Physics, Middle East Technical University, Ankara 06531, Turkey*
[4]*Institute of High Energy Physics, Chinese Academy of Science, Beijing 100039, China*
[5]*Department of Nuclear Physics, Institute of Atomic Energy, Beijing 102413, China*
[6]*Department of Physics, Banaras Hindu University, Varanasi 221005, India*
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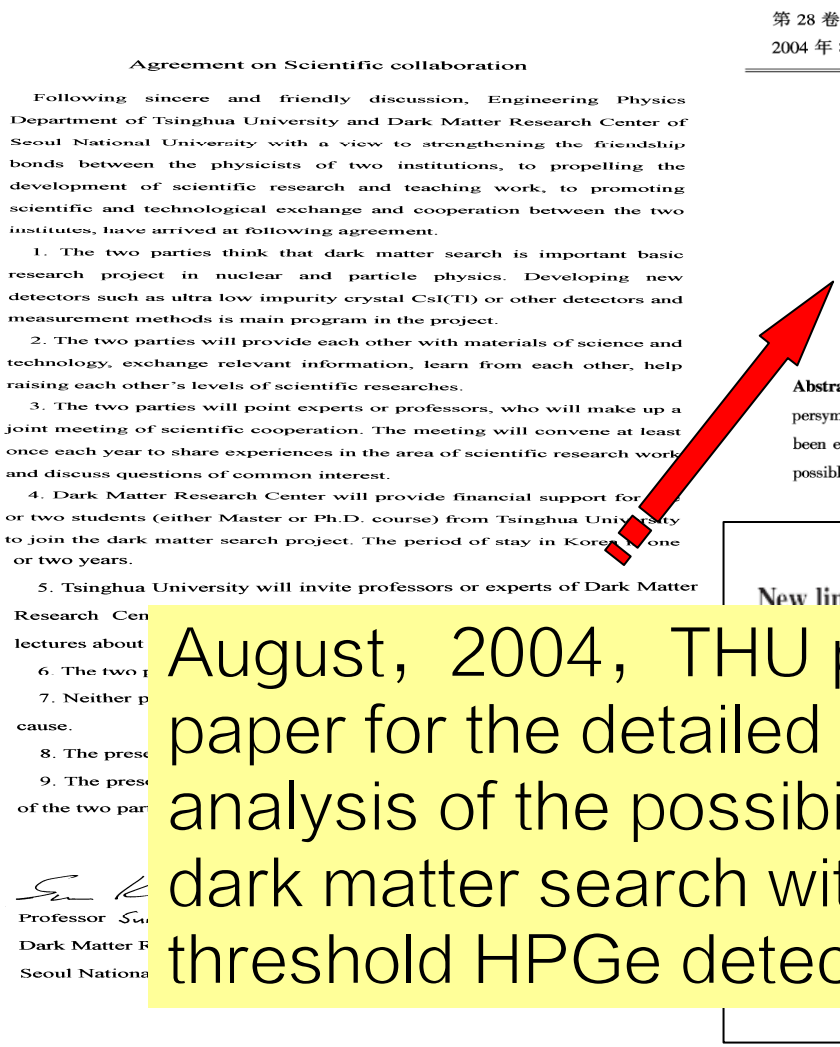
CDEX History



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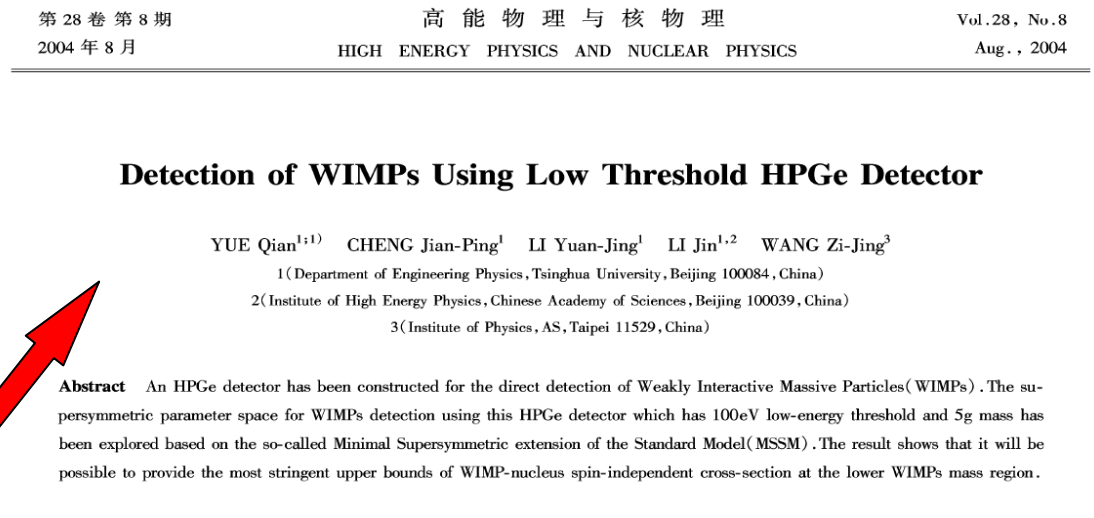

第 28 卷 第 8 期
2004 年 8 月

高 能 物 理 与 核 物 理
HIGH ENERGY PHYSICS AND NUCLEAR PHYSICS

Vol.28, No.8
Aug., 2004

Detection of WIMPs Using Low Threshold HPGe Detector

YUE Qian[1;1)] CHENG Jian-Ping[1] LI Yuan-Jing[1] LI Jin[1,2] WANG Zi-Jing[3]

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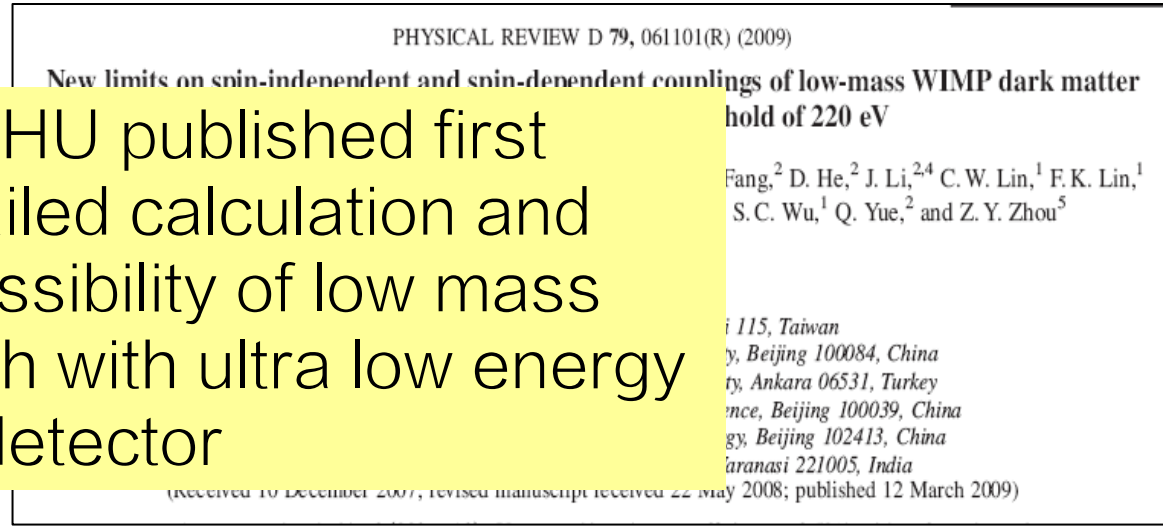

PHYSICAL REVIEW D 79, 061101(R) (2009)

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August，2004，THU published first paper for the detailed calculation and analysis of the possibility of low mass dark matter search with ultra low energy threshold HPGe detector

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Seoul National University

Professor Kang, Kejun
Engineering Physics Department
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ing 100084, China)
Beijing 100039, China)
a)

Interactive Massive Particles(WIMPs). The su-
s 100eV low-energy threshold and 5g mass has
Model(MSSM). The result shows that it will be
cross-section at the lower WIMPs mass region.

In 2009, TEXONO-CDEX published first dark matter experiment physical results With 20g ULE-HPGe detector.

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[6]*Department of Physics, Banaras Hindu University, Varanasi 221005, India*
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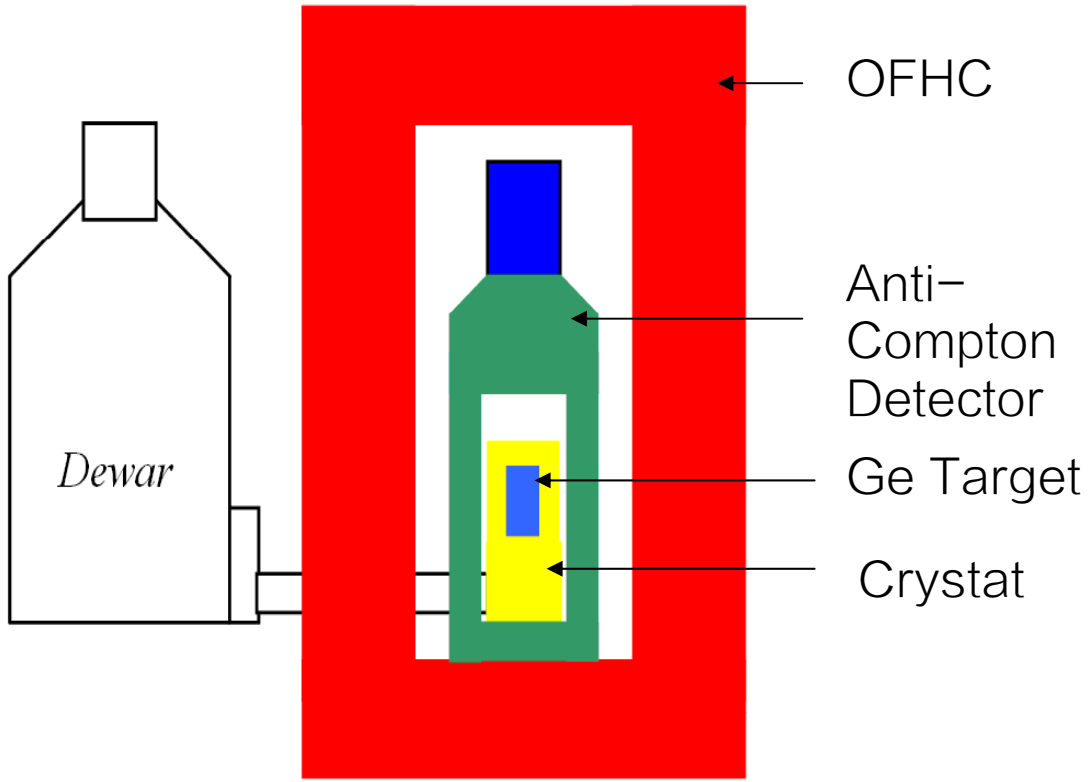
Detector System @ CJPL

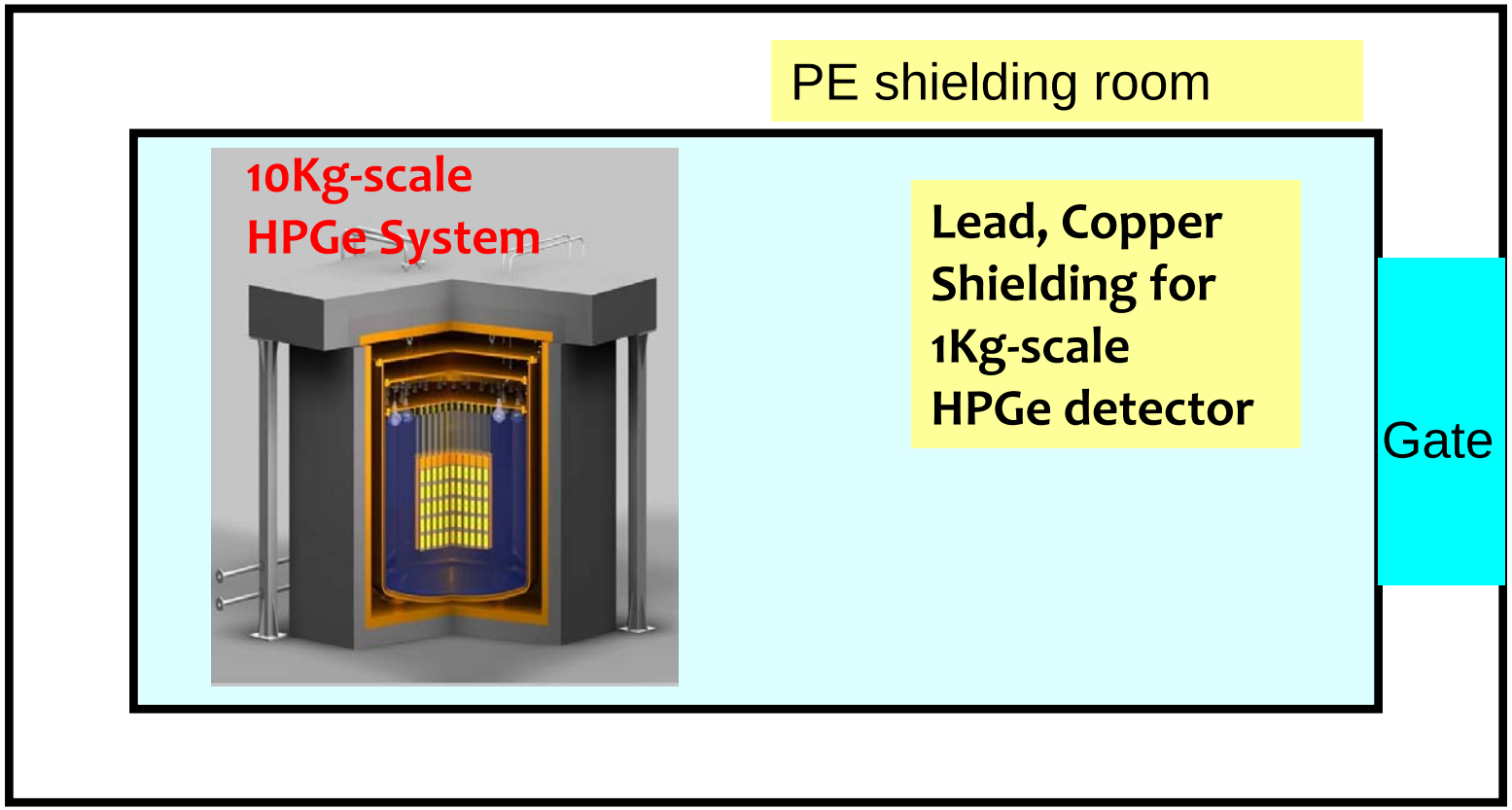
- ✓Point-contact Ge array detector with ultra-low energy threshold (~300eV or less)
- ●Mass of Ge target: 5g, 20g, 1000g



CDEX Shielding System

图 5 大门开启

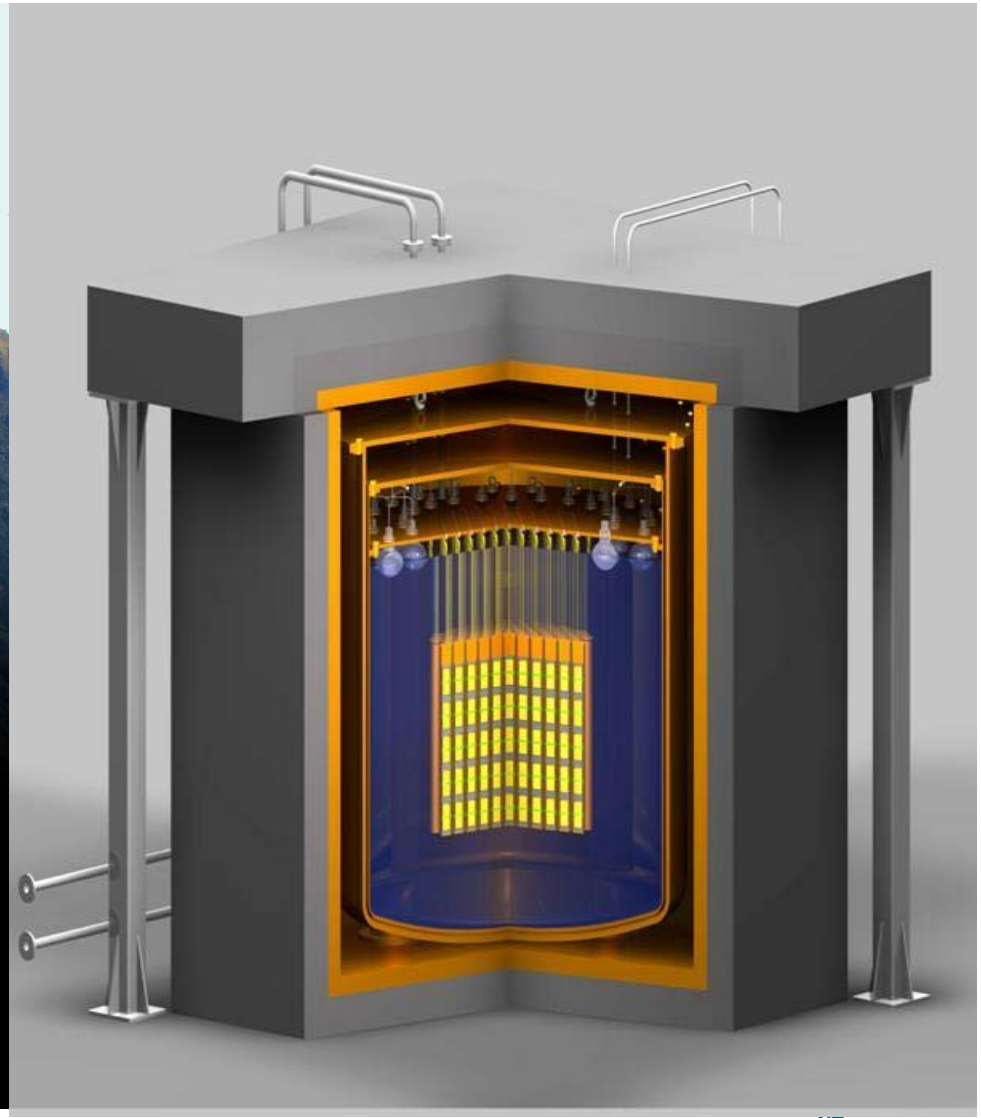
Shielding System and Layout



CDEX-TEXONO 1kg scale HPGe

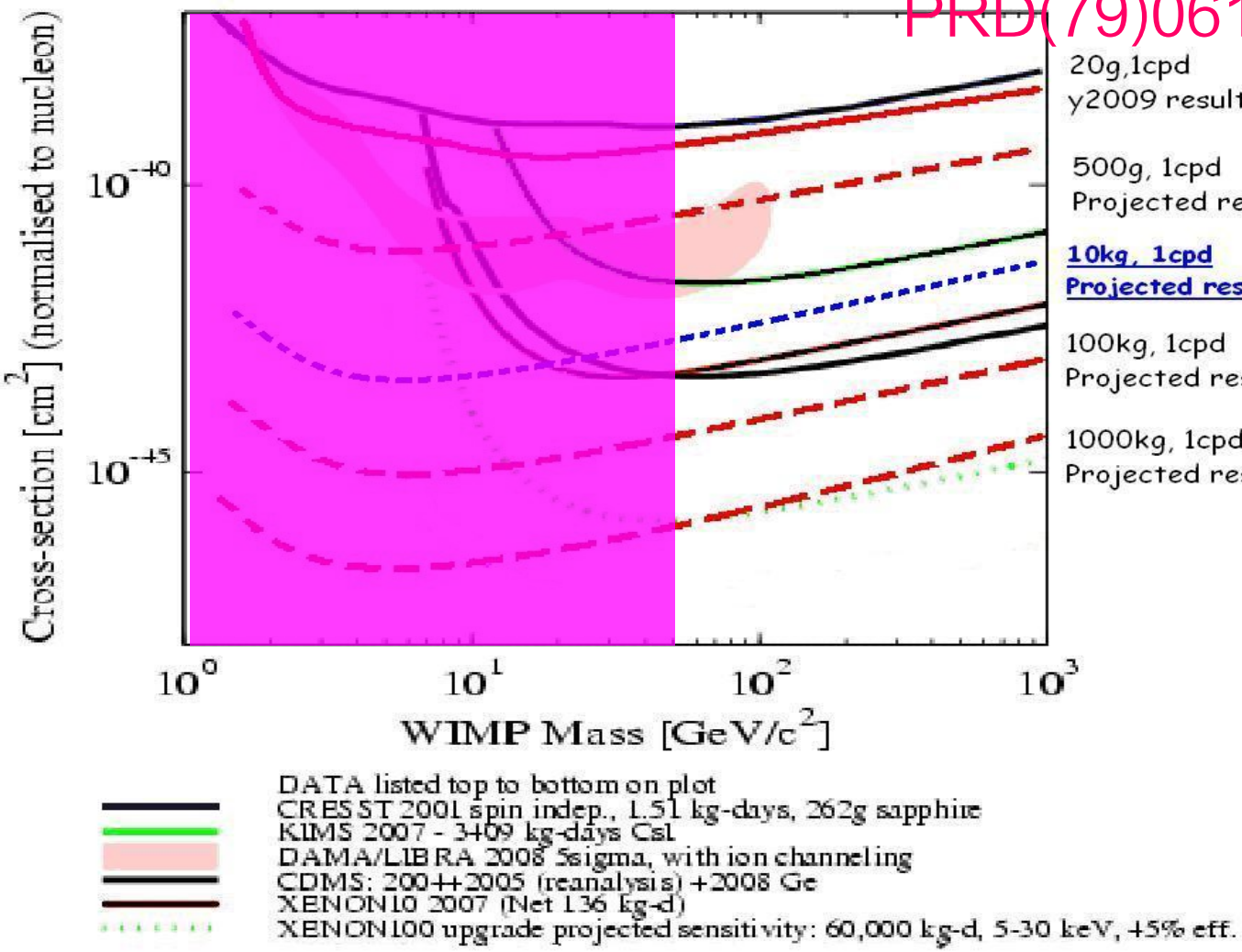
- 20g HPGe running now!
- 1kg PCGe detector testing!

CDEX-TEXONO 1T plan

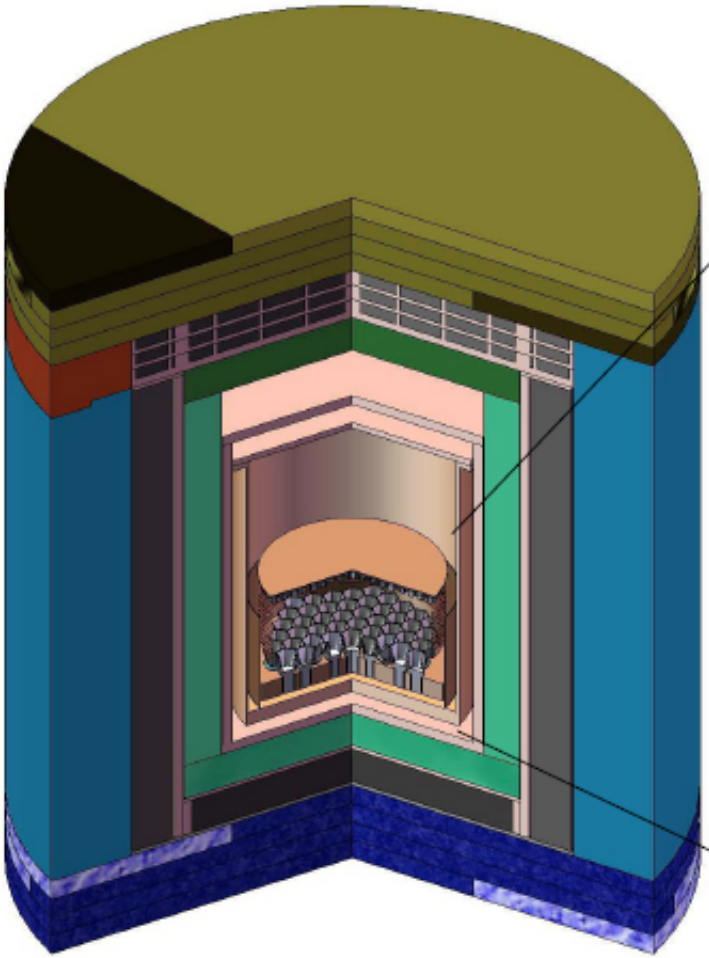


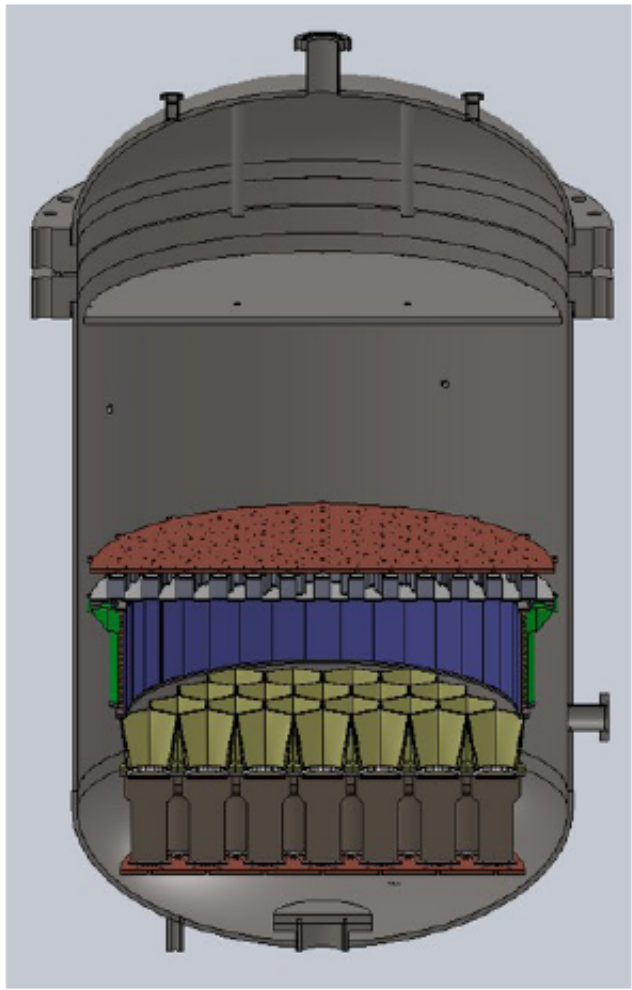
CDEX−TEXONO physics goal

PRD(79)061101,2009



PANDAX shield and inner vessel

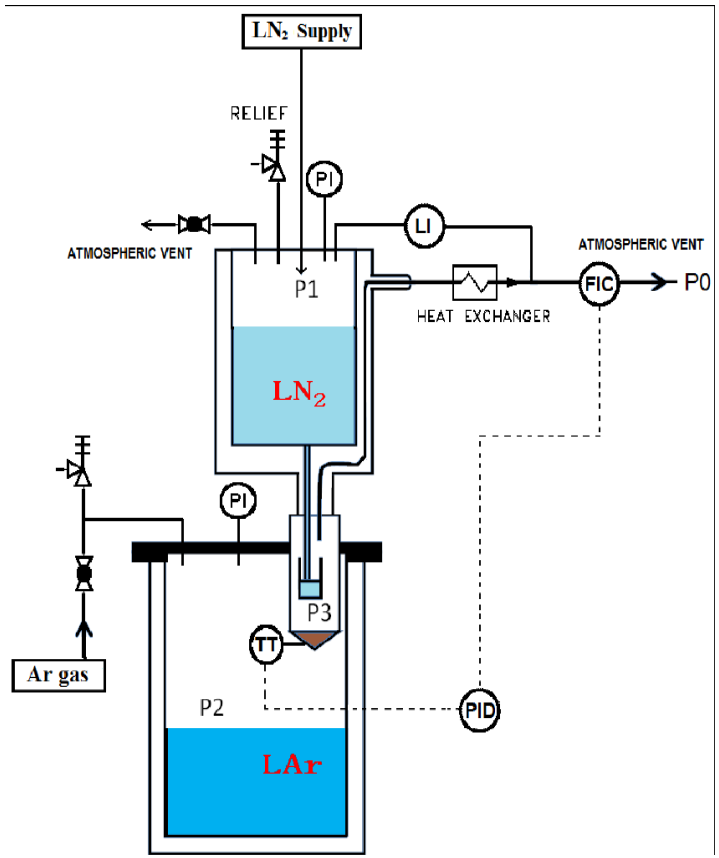




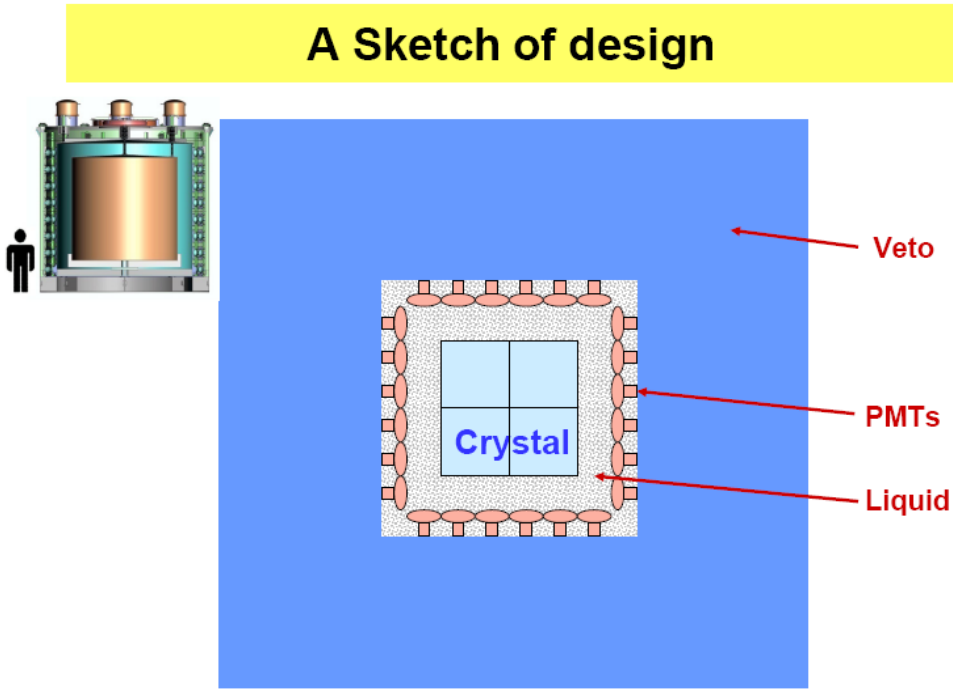
Passive shielding with Cu, Pb and PE

Kaixuan Ni's Talk!

New prototype detector development in IHEP of China



LAr detector



CsI(Na) detector

CJPL and LSM Collaboration

- LSM (France Modane Underground laboratory)
- CJPL and LSM has started to collaborate for sharing the UL construction experience.
- Three French scientists from LSM have visited CJPL last Nov. and two Chinese scientists visited LSM this March.
- CJPL and LSM will measure some samples for cross calibration of efficiency of low background facility detectors and methods.
- CJPL and LSM are discussing the possible project collaboration for neutron measurement with **Sphere Proportional Counter** from 2011.

More details in Ioannis GIOMATARIS's talk!

Summary

- CJPL is OK in 2010 with deepest rock overburden in the world. Low background facility has been planed to setup in CJPL. Muon flux, neutron flux are measuring now;
- CDEX Collaboration: 20g +1kg ULE-HPGe detector running now; Target: 1 ton PCGe array detector with LAr active shielding detector;
- PandaX 25kg → 1 ton LXe dark matter experiment;
- LAr/CsI(Na) prototype detectors are under design in IHEP;
- CJPL and LSM has collaborated to share UL construction experience, and are discussing the possible joint project in the future.

Thanks for the supports from FCPPL!

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