China JinPing underground Laboratory (CJPL) and China Darkmatter Experiment (CDEX)

Qian Yue

Tsinghua University

Mar.24, 2011

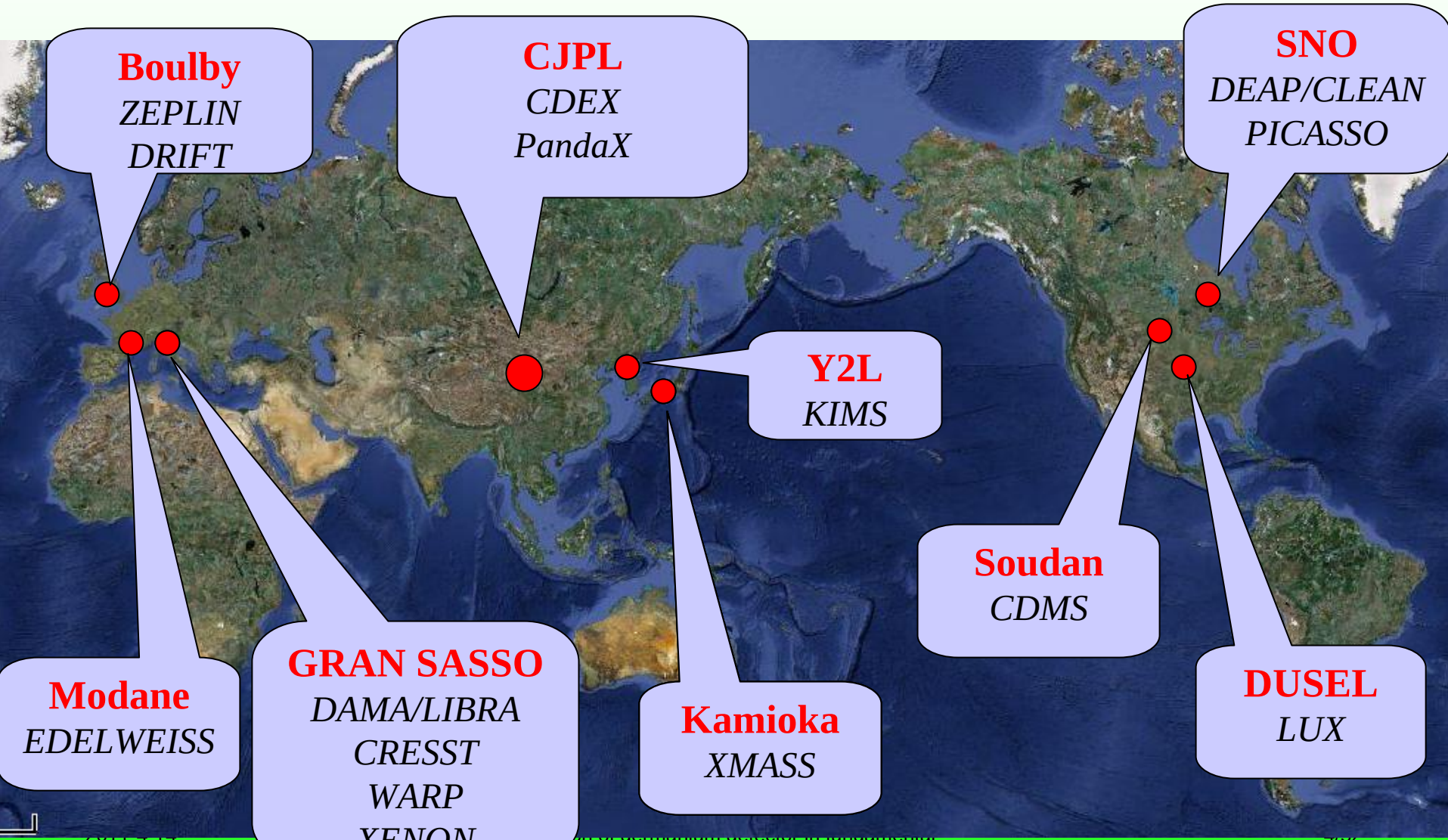
Outline

- Survey of Low background Experiment in China
- The recent status of CJPL
- The recent status and plan of CDEX
- Summary

Brief Survey of Low Background Experiment in China

- Double Beta Decay @ Coal Mine in Beijing 1980s
- Dark Matter Search as a member of DAMA 1990s
- Reactor neutrino experiment of TEXONO 1997
- Dark Matter Search of KIMS Collaboration 2000
- DayaBay neutrino experiment 2004
- DM search experiment with ULE-HPGe 2005
- DM search with ultra-low energy threshold PCGe array detector by CDEX-TEXONO 2009
- DM search with LXe detector by PandaX 2009
- DM search experiments in China with LAr, Bubble Chamber, CaF_2 Eu /BaF_2 ,CCD, …… 2009

International Main Undergound Laboratories



CJPL site

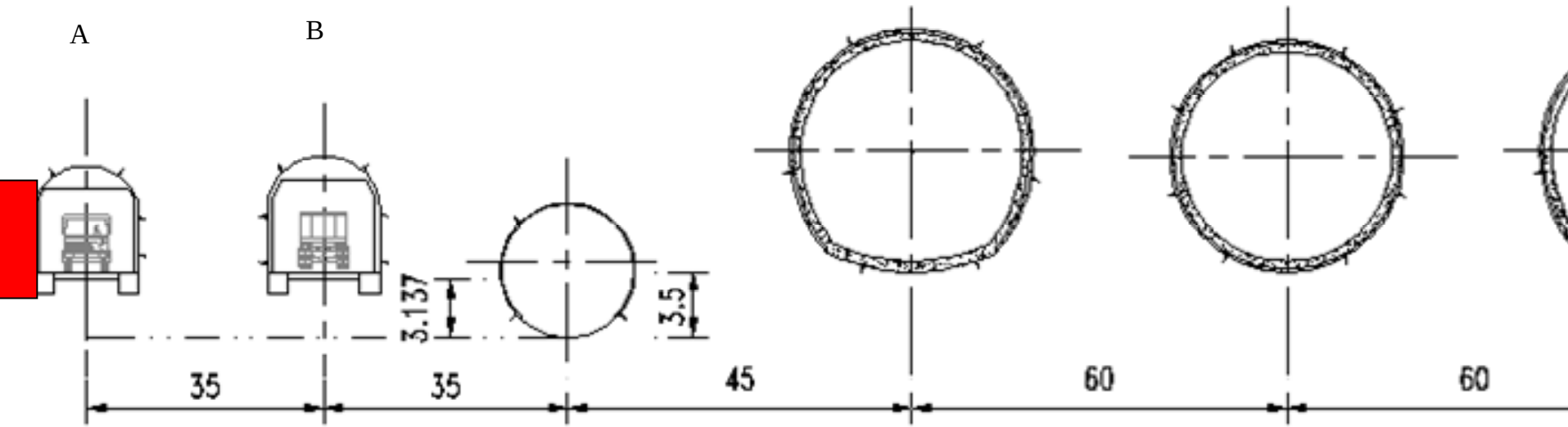

CHINA
Sichuan Province
YaLongRiver
Jinsha River
Jinping tunnels
YaLong River
Jinsha River
Jinsha River
N
Yunnan Province

Total seven tunnels:

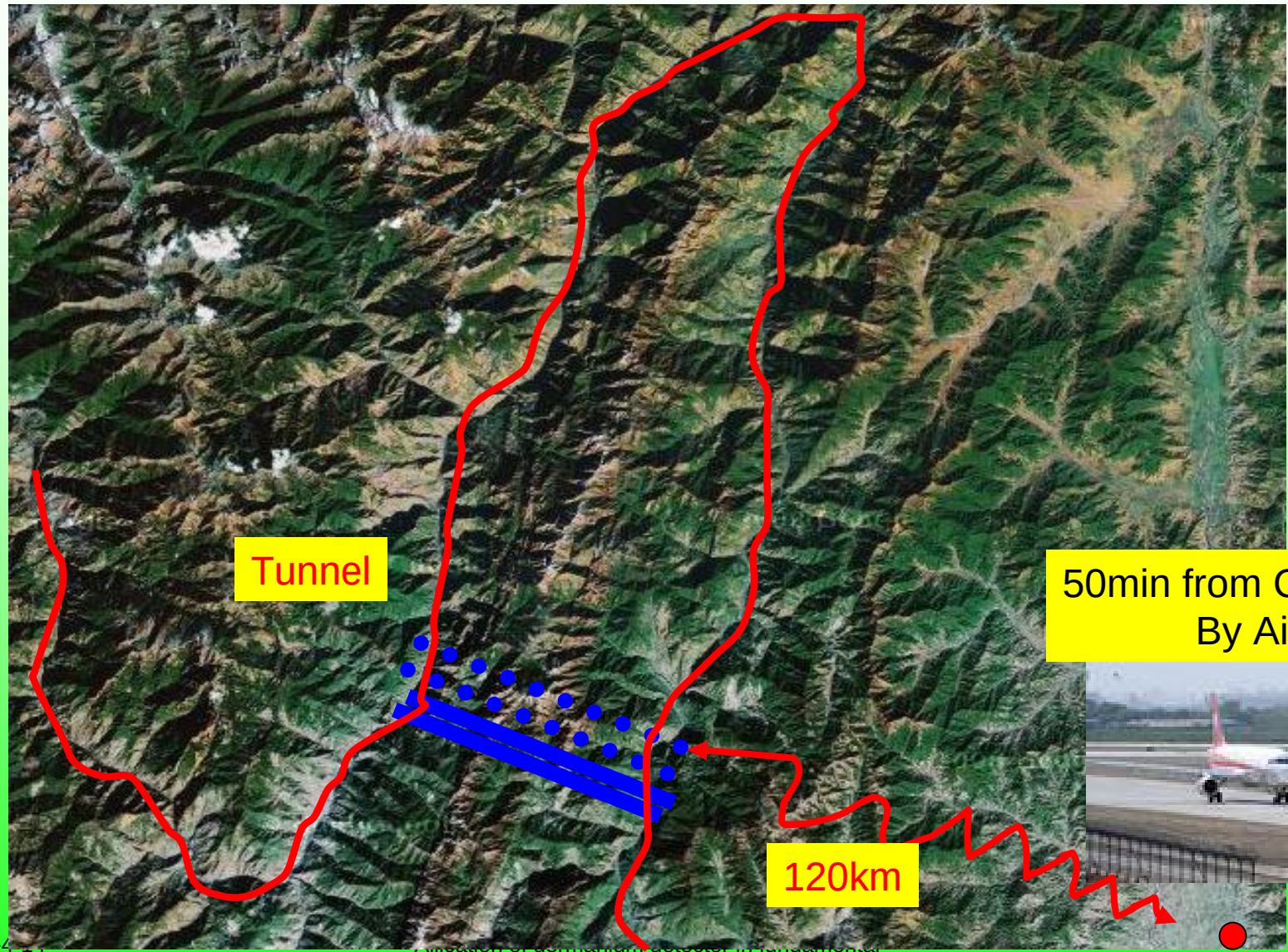
Transport Tannel (two)

Drainage Tunnel (One)

Headrace Tunnel (Four)



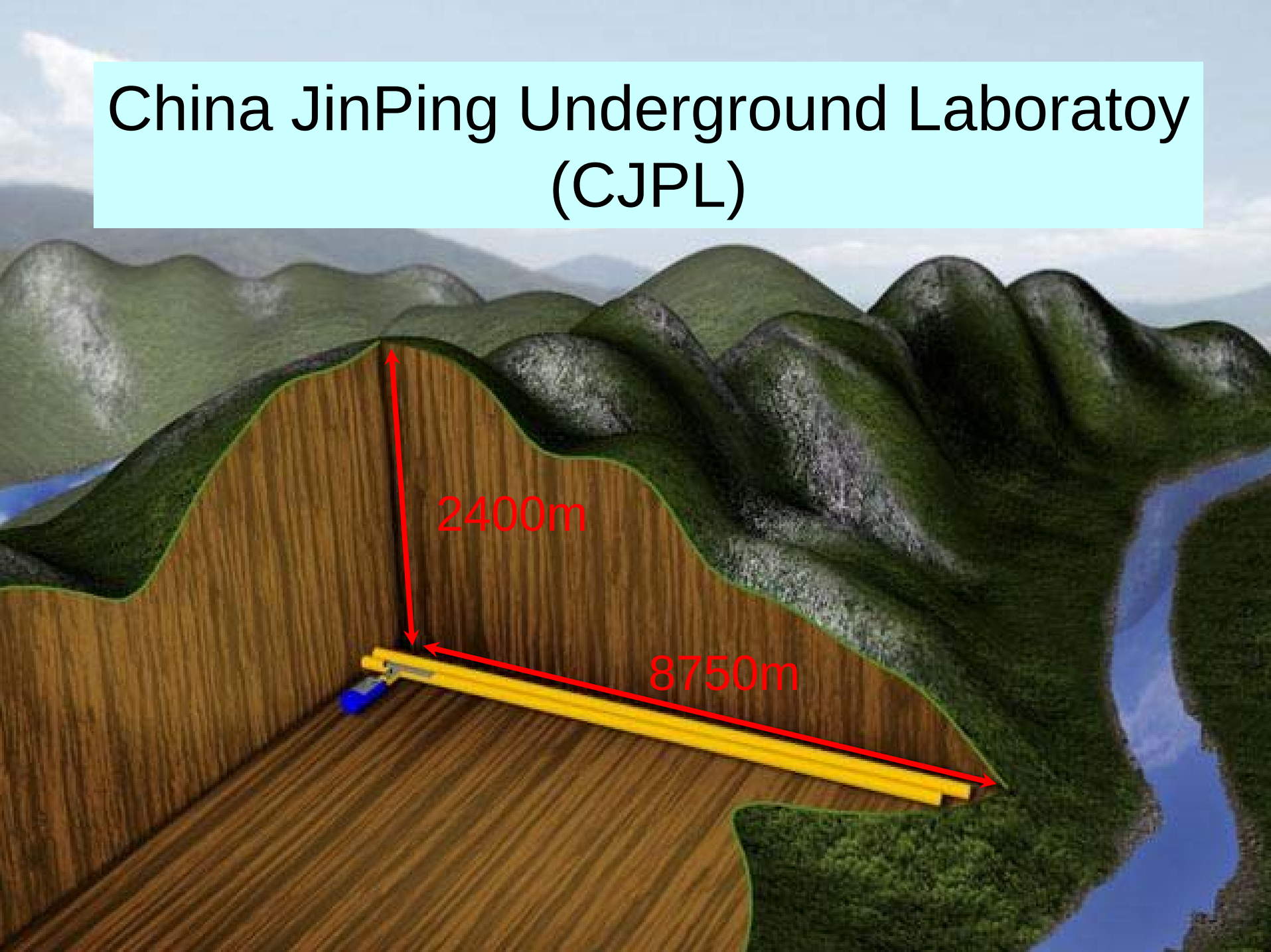
Yalong River and Jinping Mountain



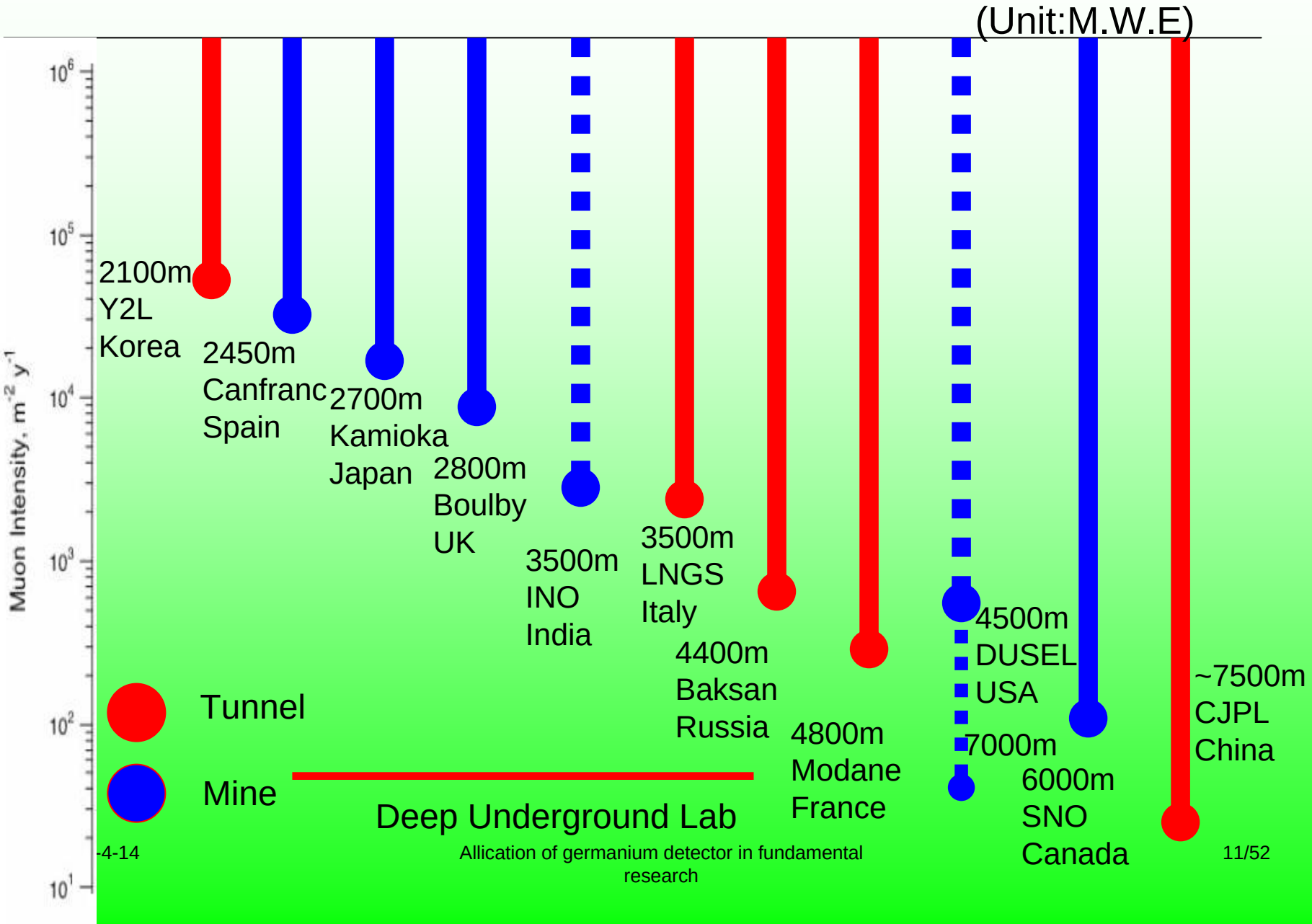
Road and Tunnel

Logistic Condition of this UL

China JinPing Underground Laboratoy (CJPL)



Comparison of main ULs in the world



MOU between EHDC and THU Signed

(MOE, SASAC, SDIC, NNFSC, THU, EHDC)

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.

Published by AAAS

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

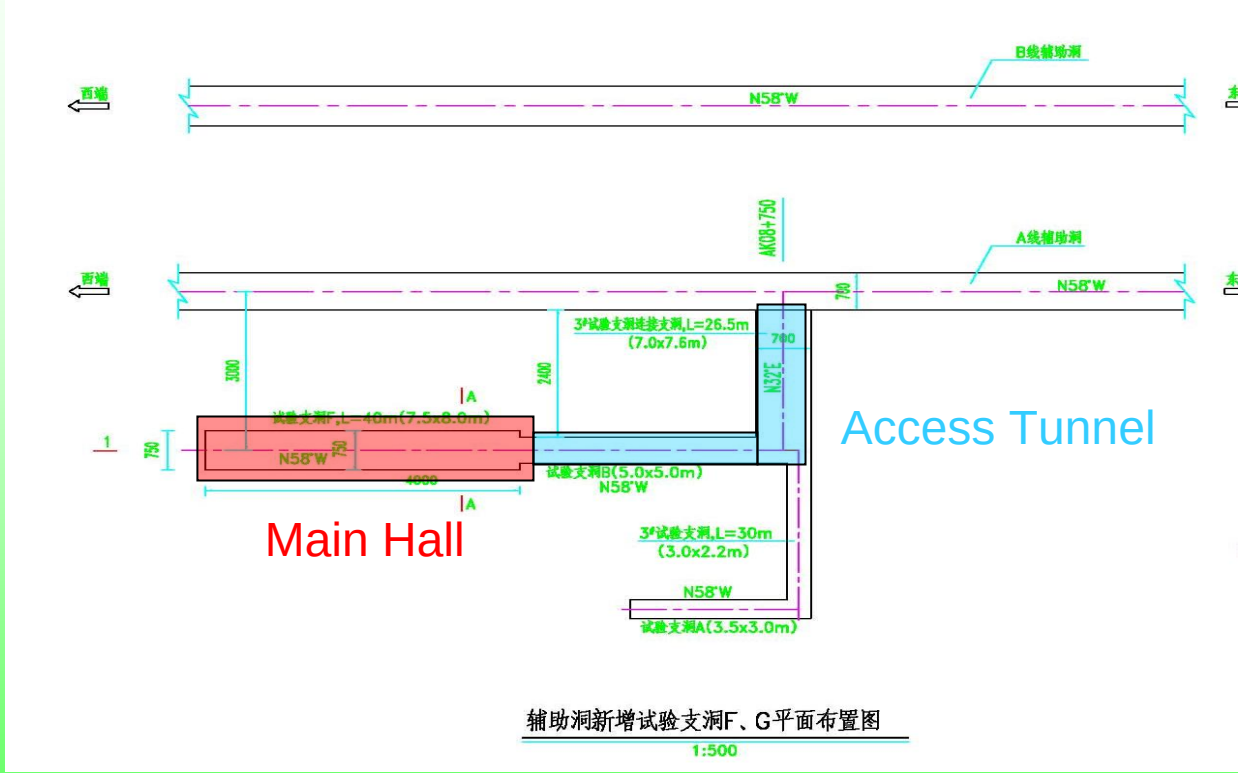
QIAN YUE

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

CJPL Rock Background

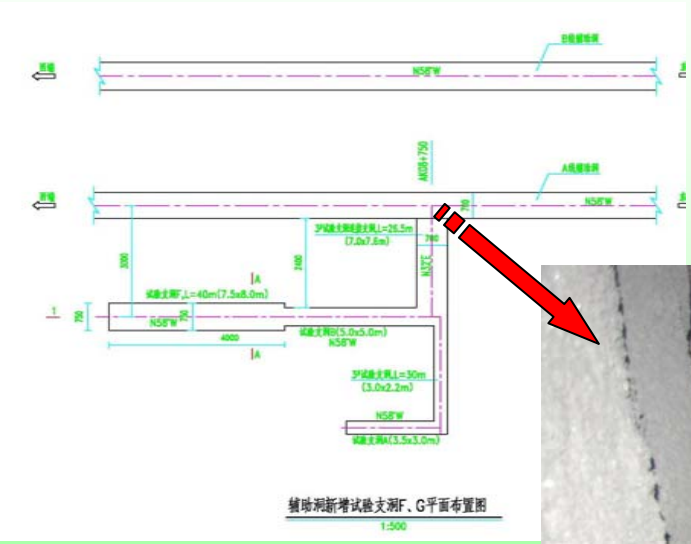
(Unit Bq/kg)	**K-40**	**Ra-226 (609keV)**	**Th-232 (911keV)**
JinPing Rock Sample	< 1.1	1.8±0.2	< 0.27
Beijing Normal Ground Level	~600	~25	~50

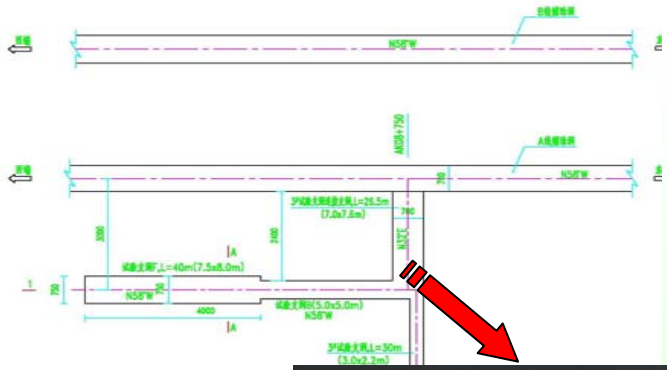
The Layout of CJPL-I



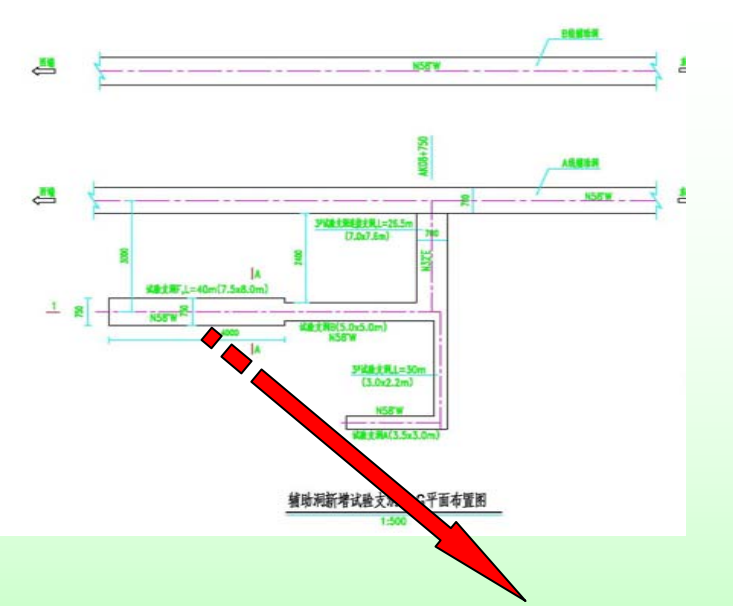
- **Main hall: 6.5*6.5*40m**
- **Total Volume: ~4000m^3**

Dig the tunnel for CJPL in July,2009





Aug., 2009



Jan., 2010


2010/01/27


2010.03.1


2010.02.24

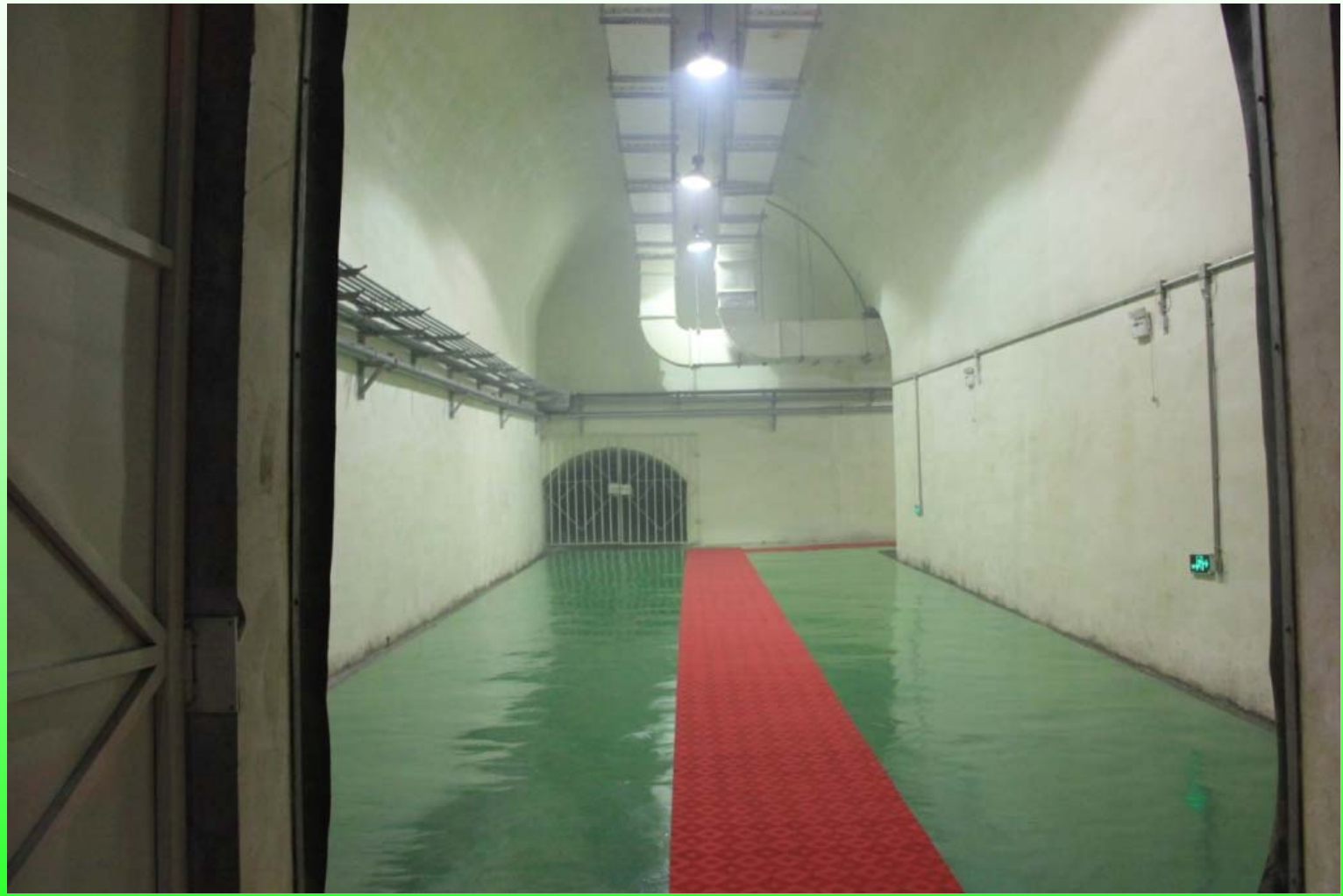

2010/04/24


2010/04/24


2010/04/27


2010/04/28

The Gate of CJPL in June 2010

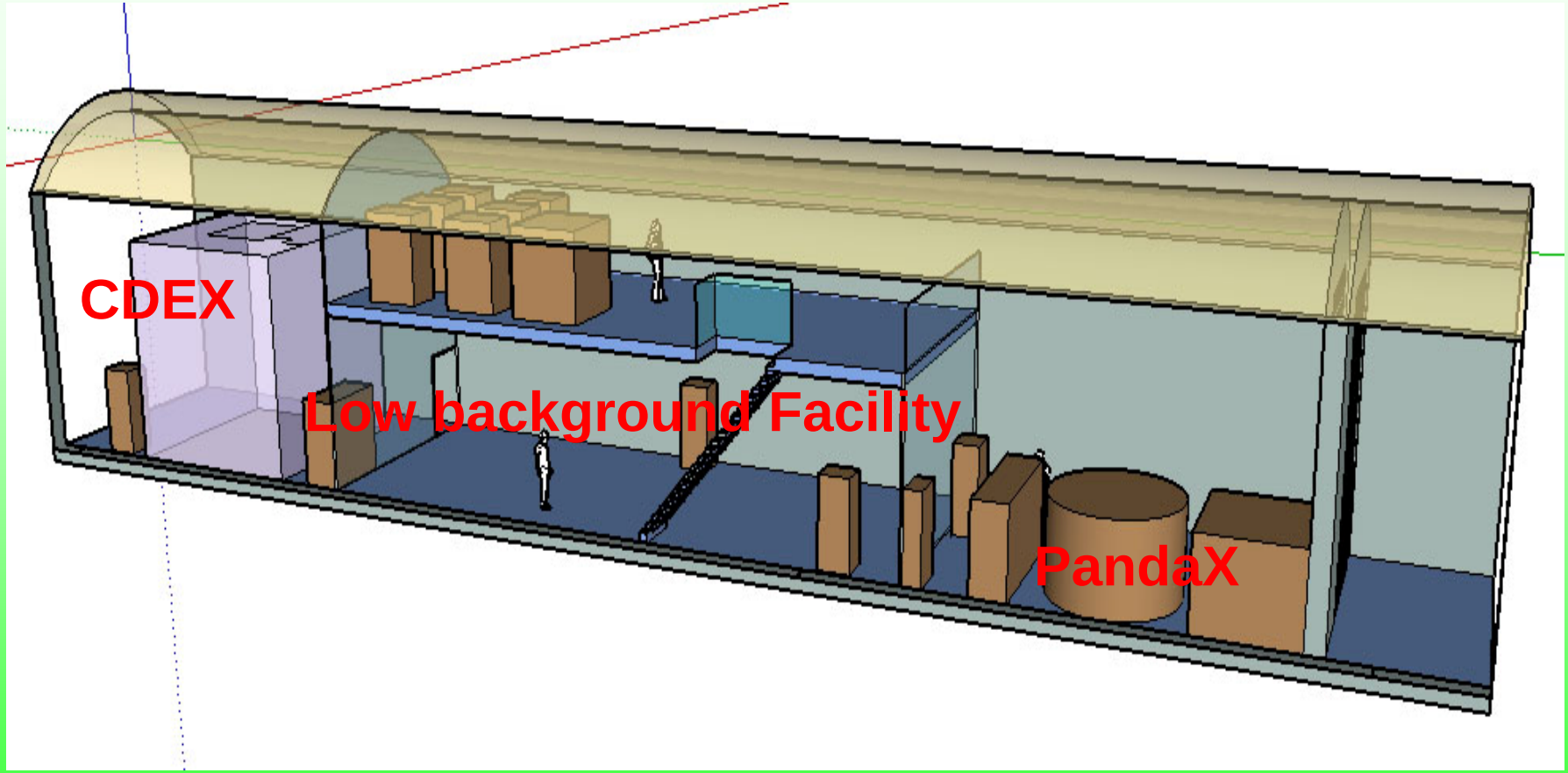


The main hall of CJPL in June 2010

Dec. 12,2010 Openning Ceremony

Inside the CJPL

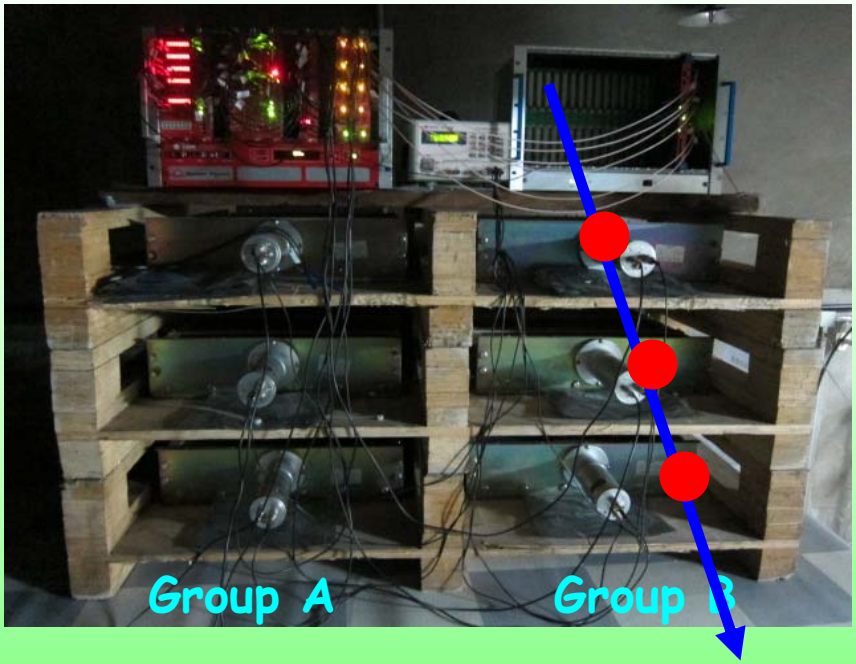
Internal space use

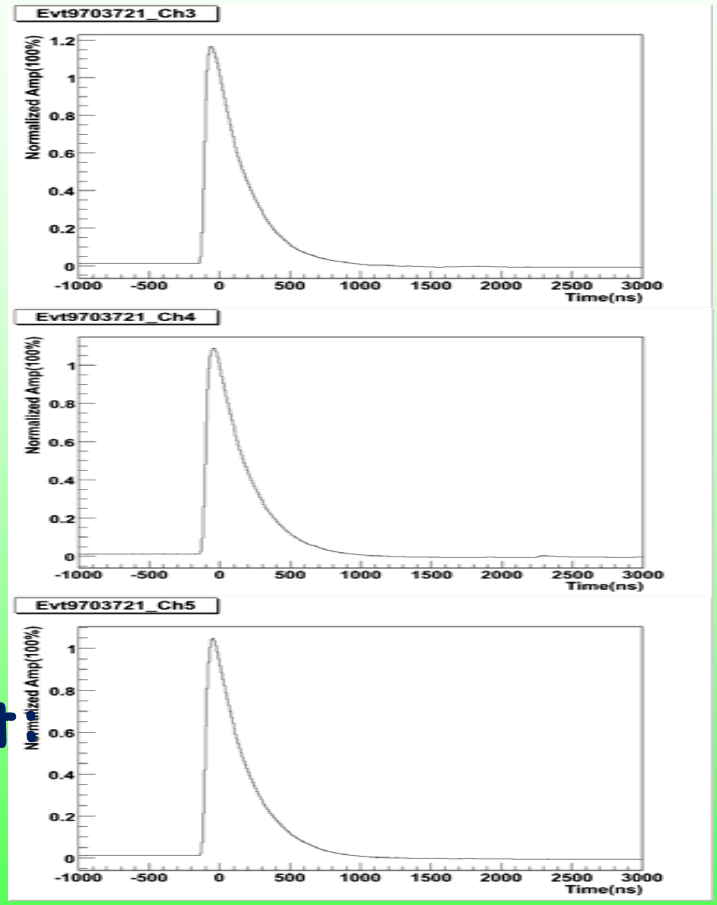


Measurements and studies of the performance of CJPL

- Muon flux measurement
- Gamma background measurement
- Neutron background measurement
- Radon level monitor
- Installation of Low background facility

Muon flux measurement



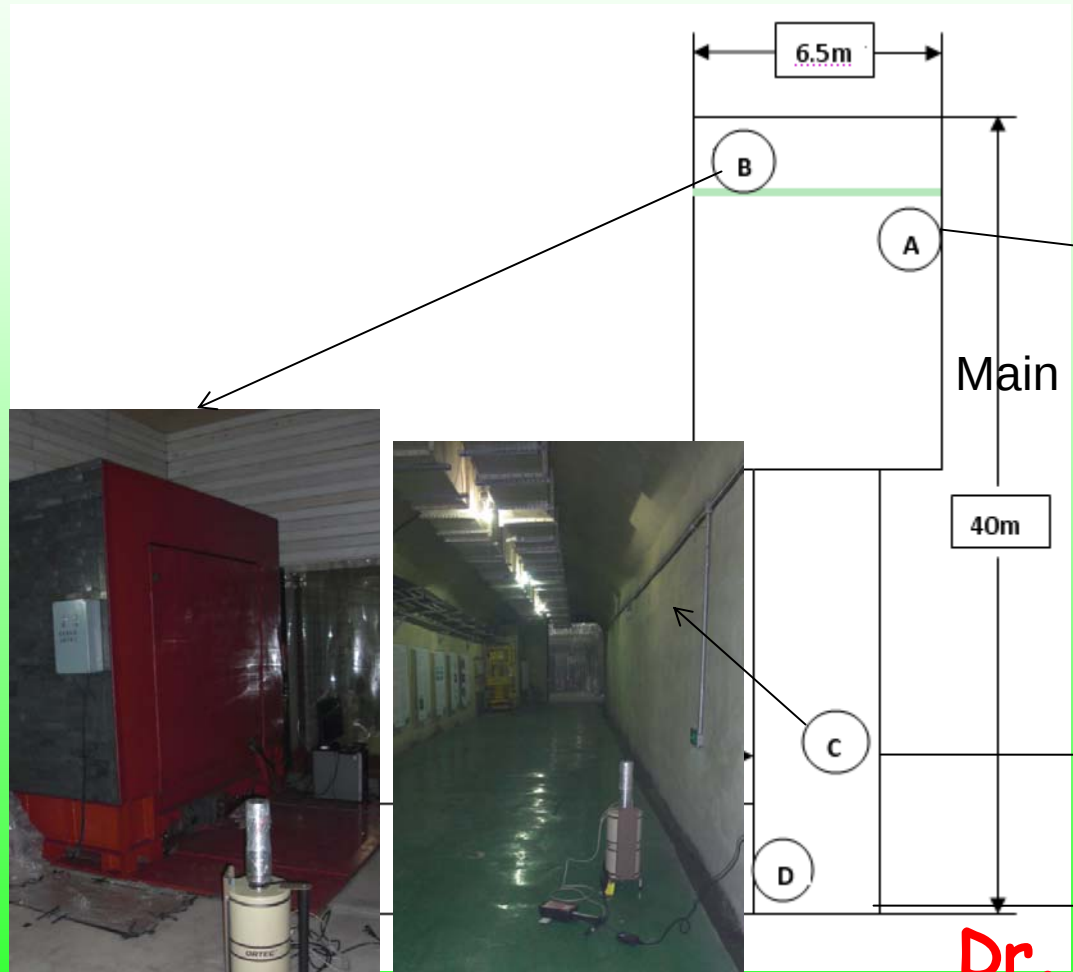


The first possible Muon event

- **Date:** 2010/12/02
- **Time:** 04:49:19
- **Group No.:** B

Yucheng Wu's Talk!

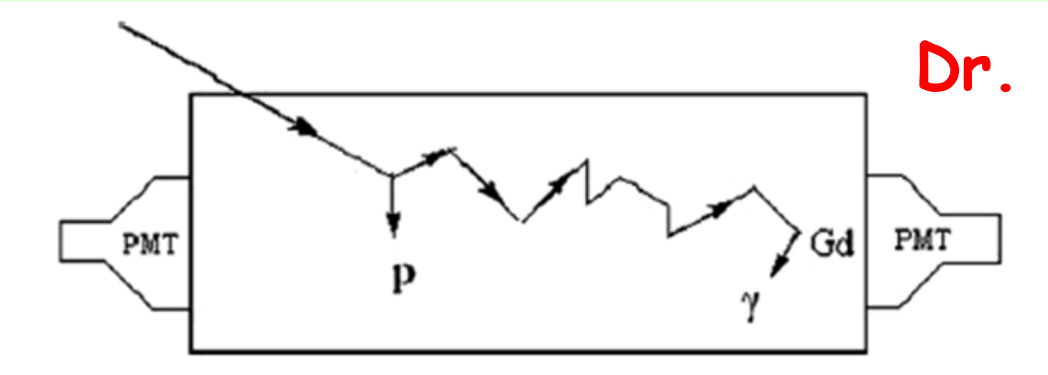
Gamma Background Measurement and Installation of Low Background Facility



Dr. Zhi Zeng's Talk!

Neutron background Measurement

- Fast neutron measurement with Gd-LS

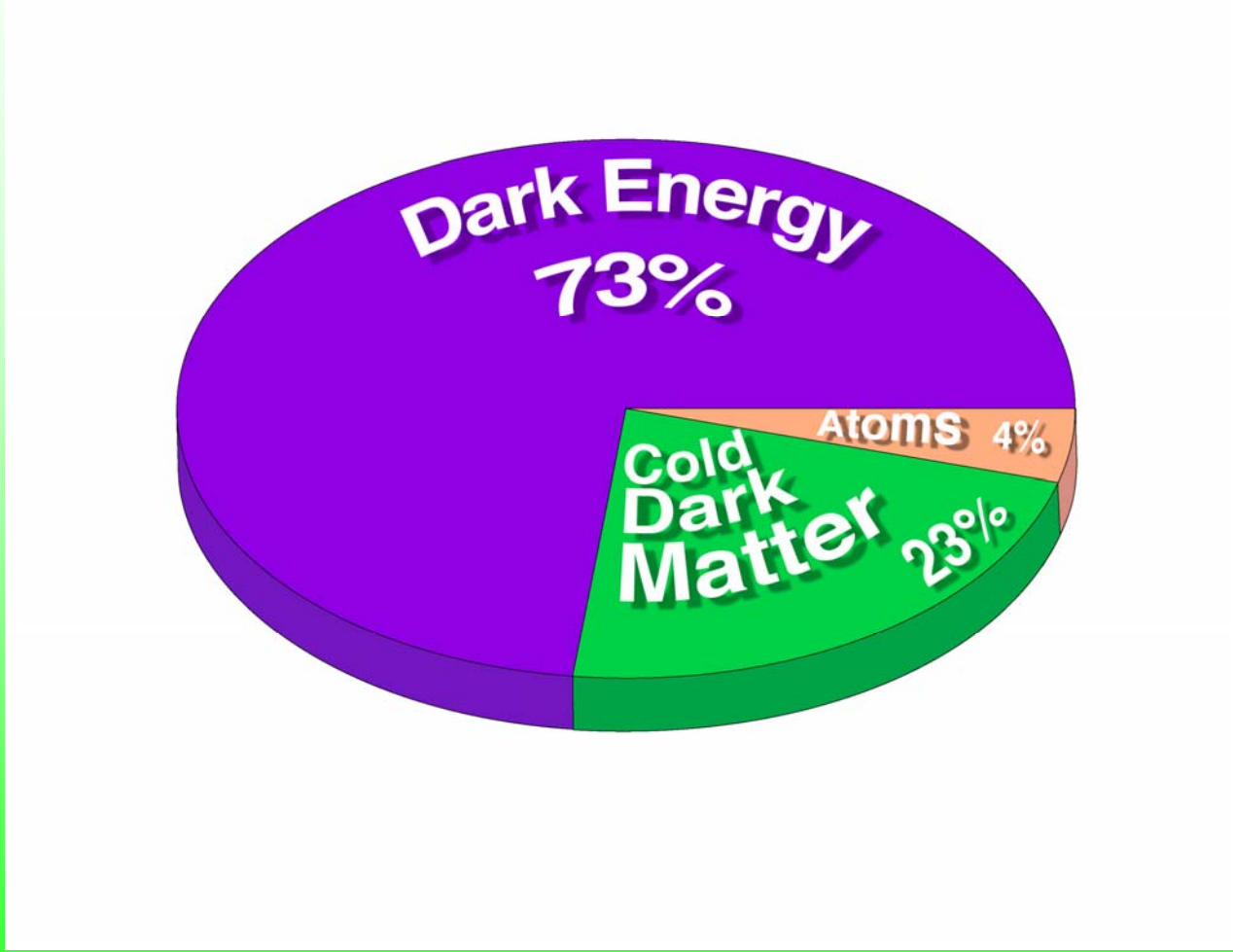


Dr. Jingjun Zhu's Talk!

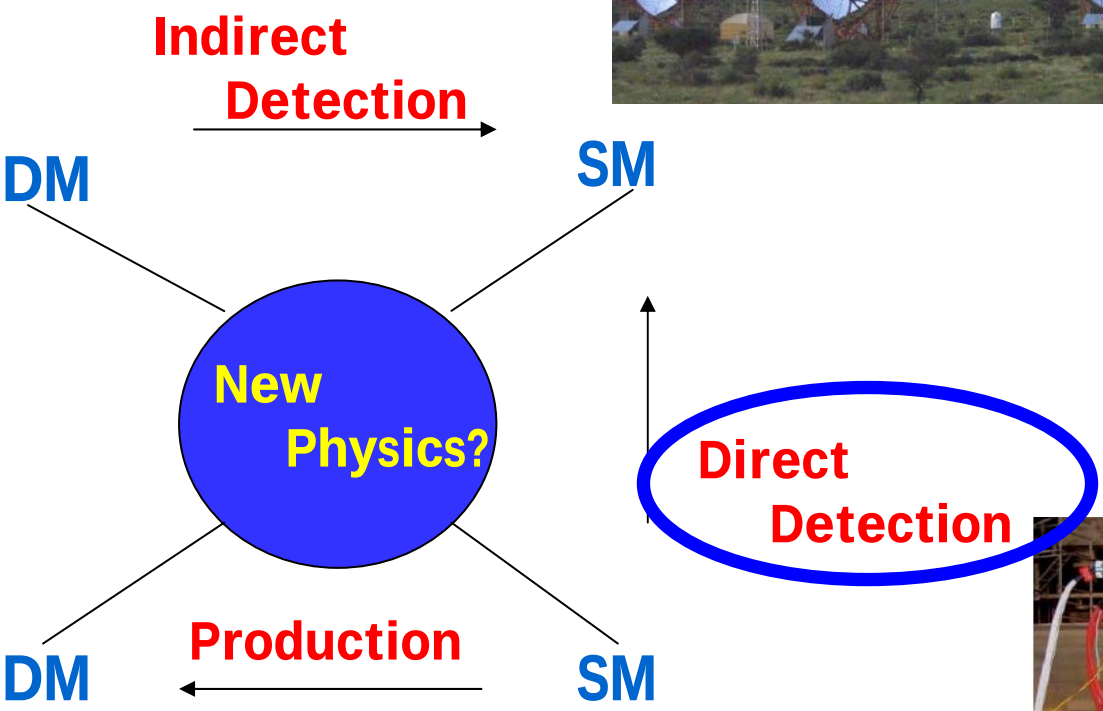
- Thermal neutron measurement with He-3 tube

Dr. Hui Gong's Talk!

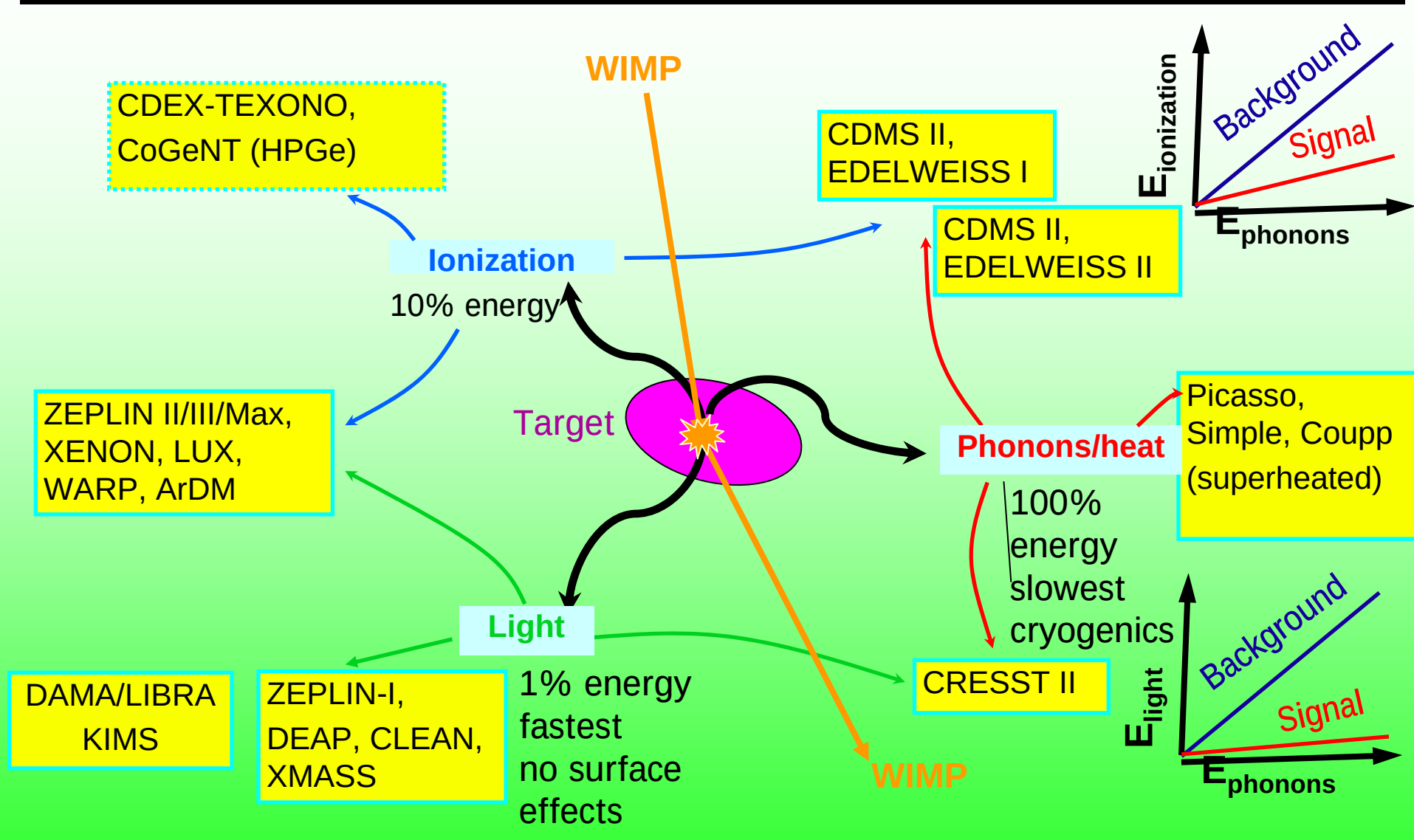
Dark matter Experiment in China



Dark matter detection



Detector Techniques - Present Focus : Nuclear Vs Electron recoils



◎ Future : Lower Threshold ; Direction Sensitive

Recent DM search results

CRESST Al_2O_3 262g
France Heat

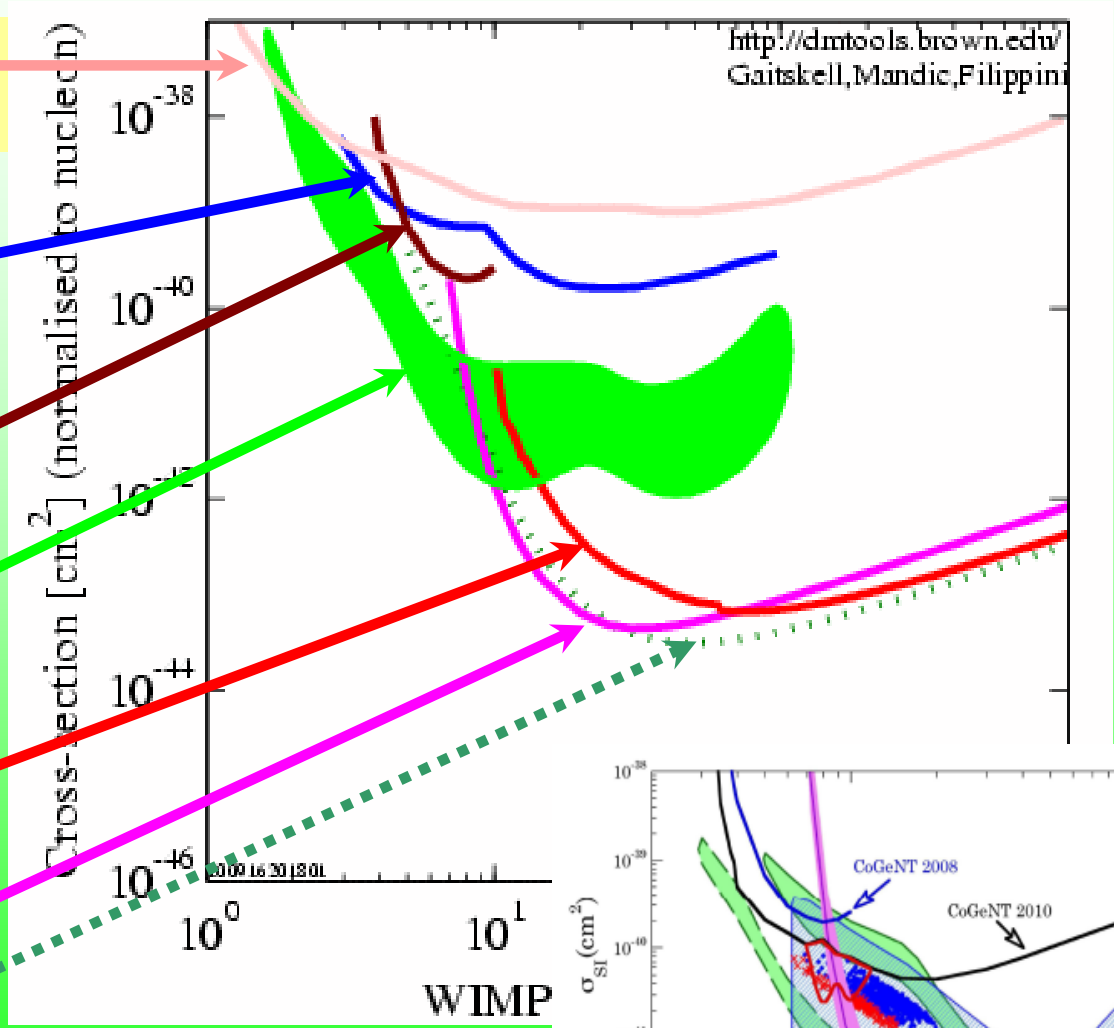
CDEX-TEXONO y2009
ULE-HPGe Detector Array
China Ionization

CoGeNT y2008
PCGe Detector
USA Ionization

DAMA NaI Crystal~200kg
Italy Light

CDMS Ge array
250g×7 y2009
USA Heat and Ionization

XENON10: 10kg LXe
USA Light and Ionization
XENON100:
100kg LXe y2010



CoGeNT y2010

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
(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-TEXONO 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 Physics Department of Tsinghua University and Dark Matter Research Center of Seoul National University with a view to strengthening the friendship bonds between the physicists of two institutions, to propelling the development of scientific research and teaching work, to promoting scientific and technological exchange and cooperation between the two institutes, have arrived at following agreement.

1. The two parties think that dark matter search is important basic research project in nuclear and particle physics. Develop new detectors such as ultra low impurity crystal CsI(TI) or other detectors 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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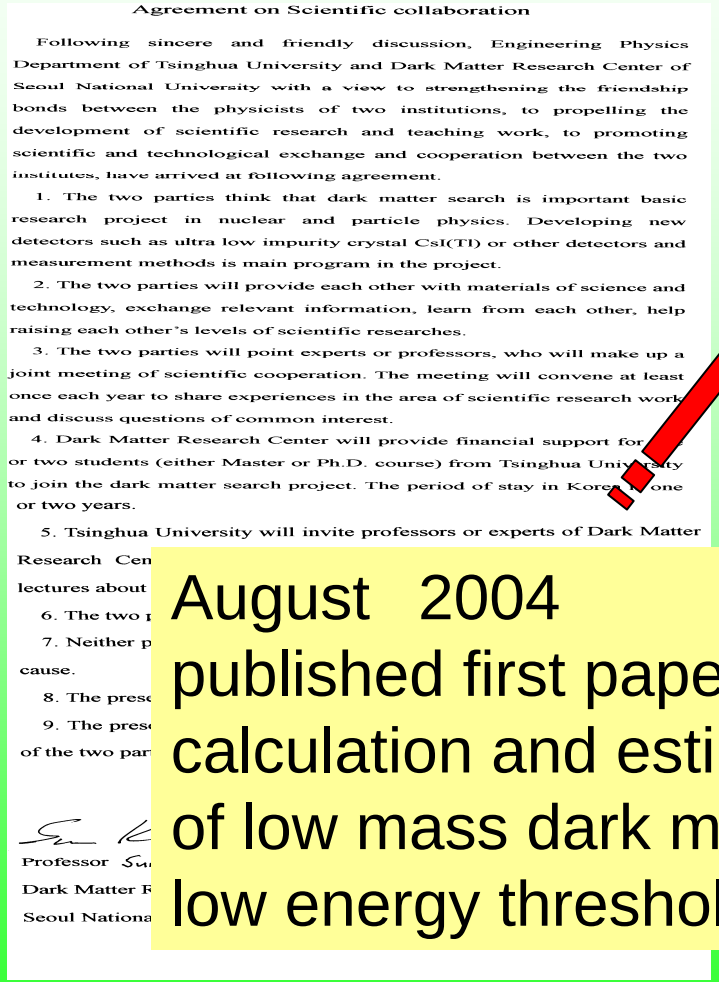
[2]*Department of Engineering Physics, Tsinghua University, Beijing 100084, China*
[3]*Department of Physics, Middle East Technical University, Ankara 06531, Turkey*
[4]*Institute of High Energy Physics, Chinese Academy of Science, Beijing 100039, China*
[5]*Department of Nuclear Physics, Institute of Atomic Energy, Beijing 102413, China*
[6]*Department of Physics, Banaras Hindu University, Varanasi 221005, India*
(Received 10 December 2007; revised manuscript received 22 May 2008; published 12 March 2009)

CDEX history



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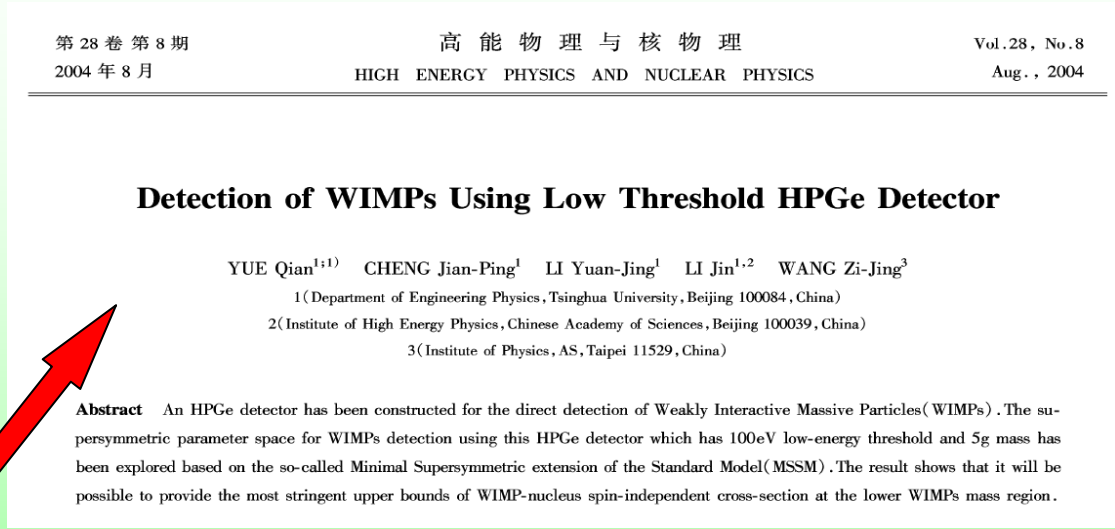
Dark Matter R...
Seoul Nationa...



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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2(Institute of High Energy Physics, Chinese Academy of Sciences, Beijing 100039, China)
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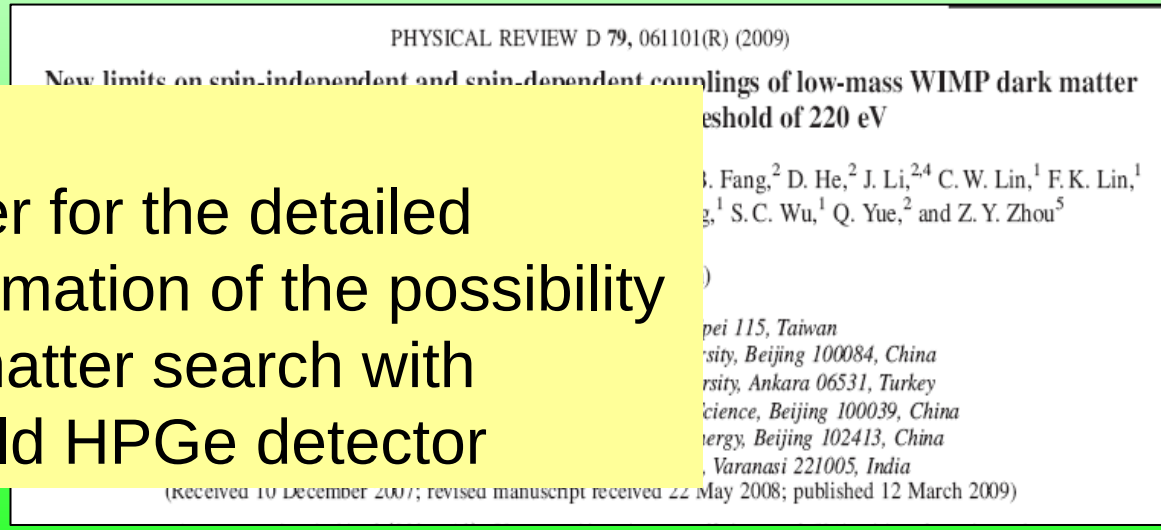

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August 2004
published first paper for the detailed calculation and estimation of the possibility of low mass dark matter search with low energy threshold HPGe detector

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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

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

第 28 卷 第 8 期
2004 年 8 月

高 能 物 理 与 核 物 理
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Vol.28, No.8
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Beijing 100039, China)
a)

Interactive Massive Particles(WIMPs). The su-
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(TEXONO Collaboration)

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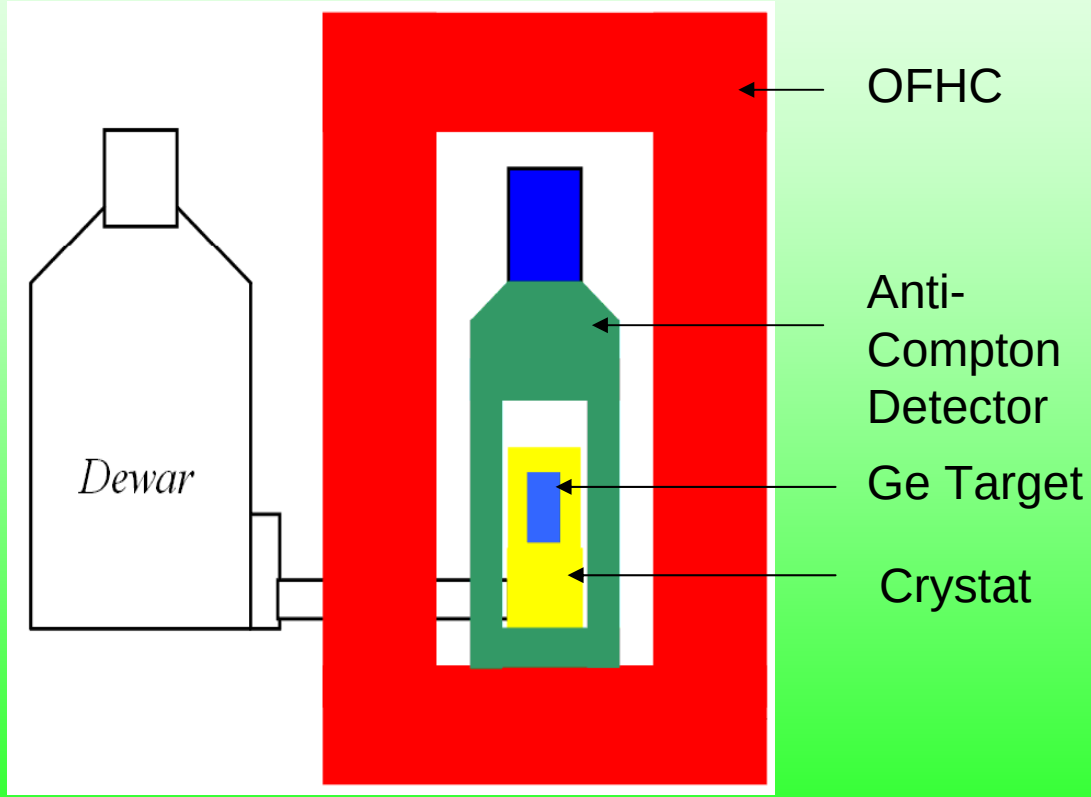
[6]*Department of Physics, Banaras Hindu University, Varanasi 221005, India*
(Received 10 December 2007; revised manuscript received 22 May 2008; published 12 March 2009)

Detector System @ CJPL

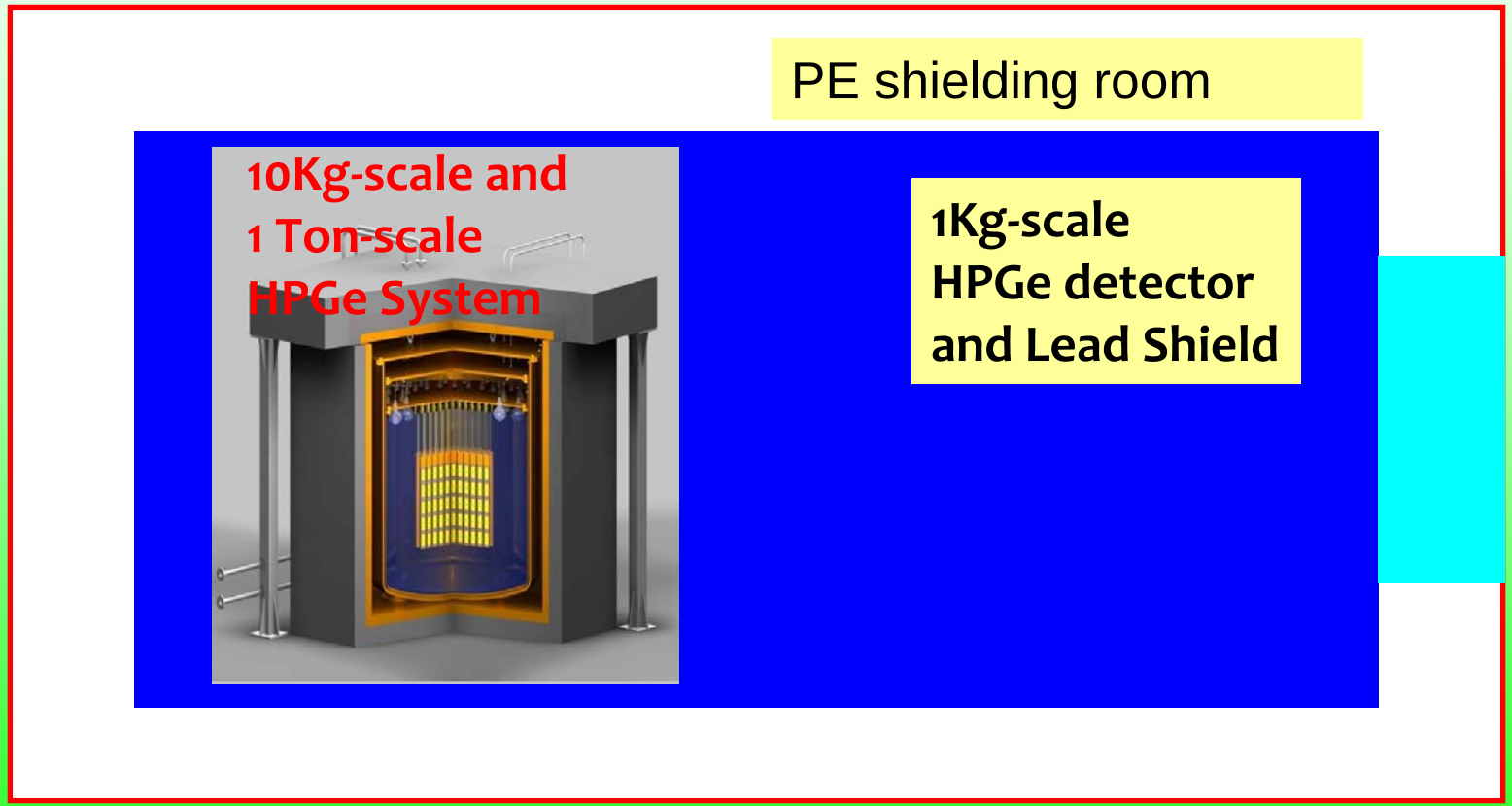
- ✓Point-contact Ge array detector with ultra-low energy threshold (~300eV or less)
- Mass of Ge target: 5g, 20g, 1000g



PE Shielding installation

Neutron Shielding and Layout

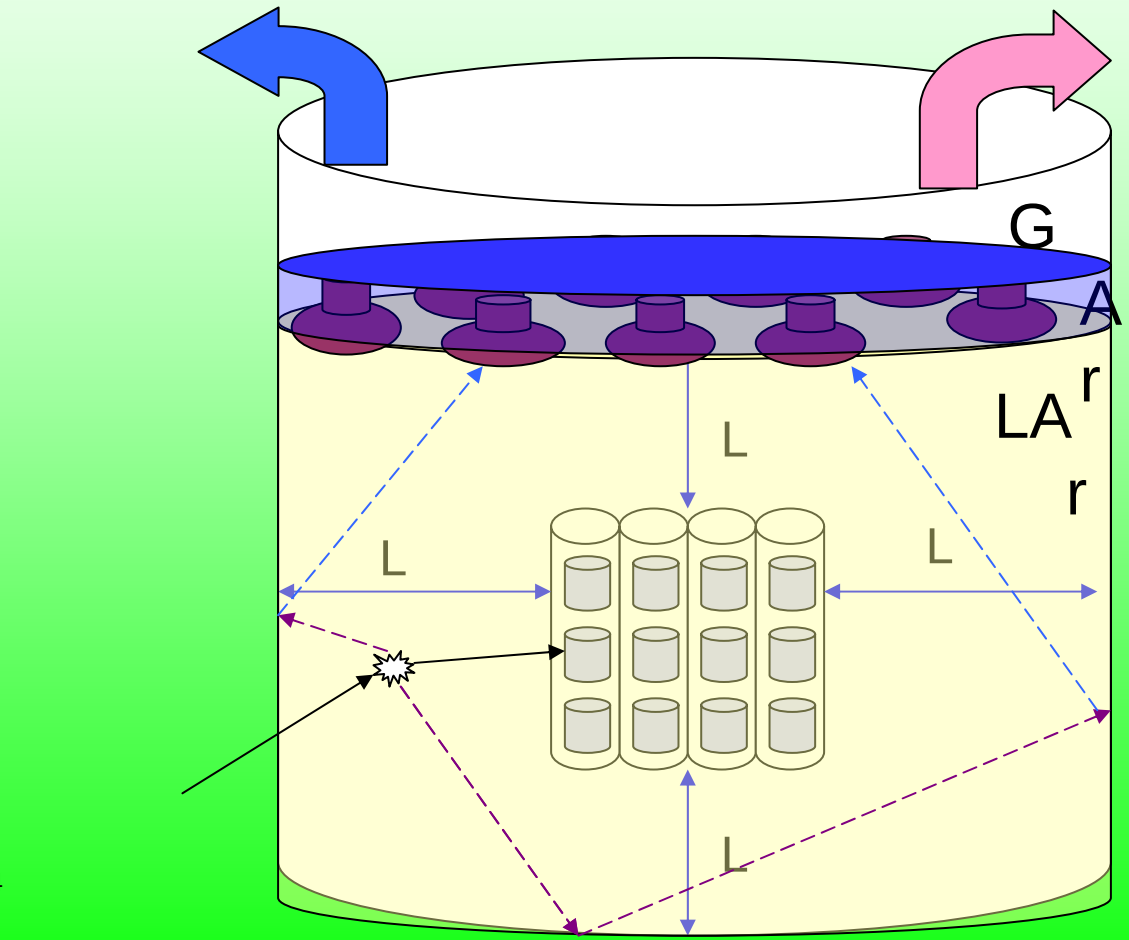
- 2010 9



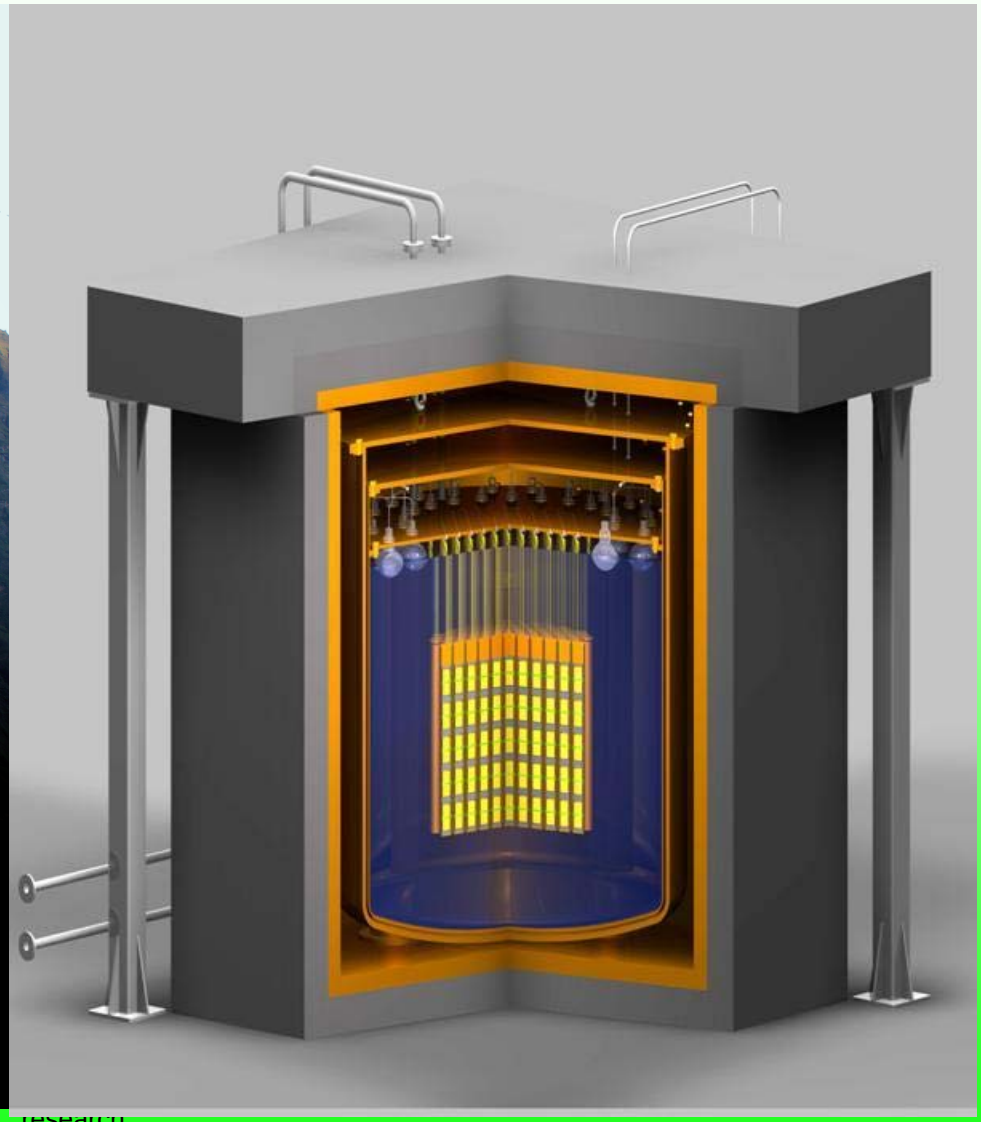
CDEX-TEXONO 1kg scale HPGe detector run!

- 20g HPGe test running now!
- 1000g PCGe detector in CJPL!
- Detectors produced by Canberra France!

10kg scale PCGe detector array with LAr active shielding



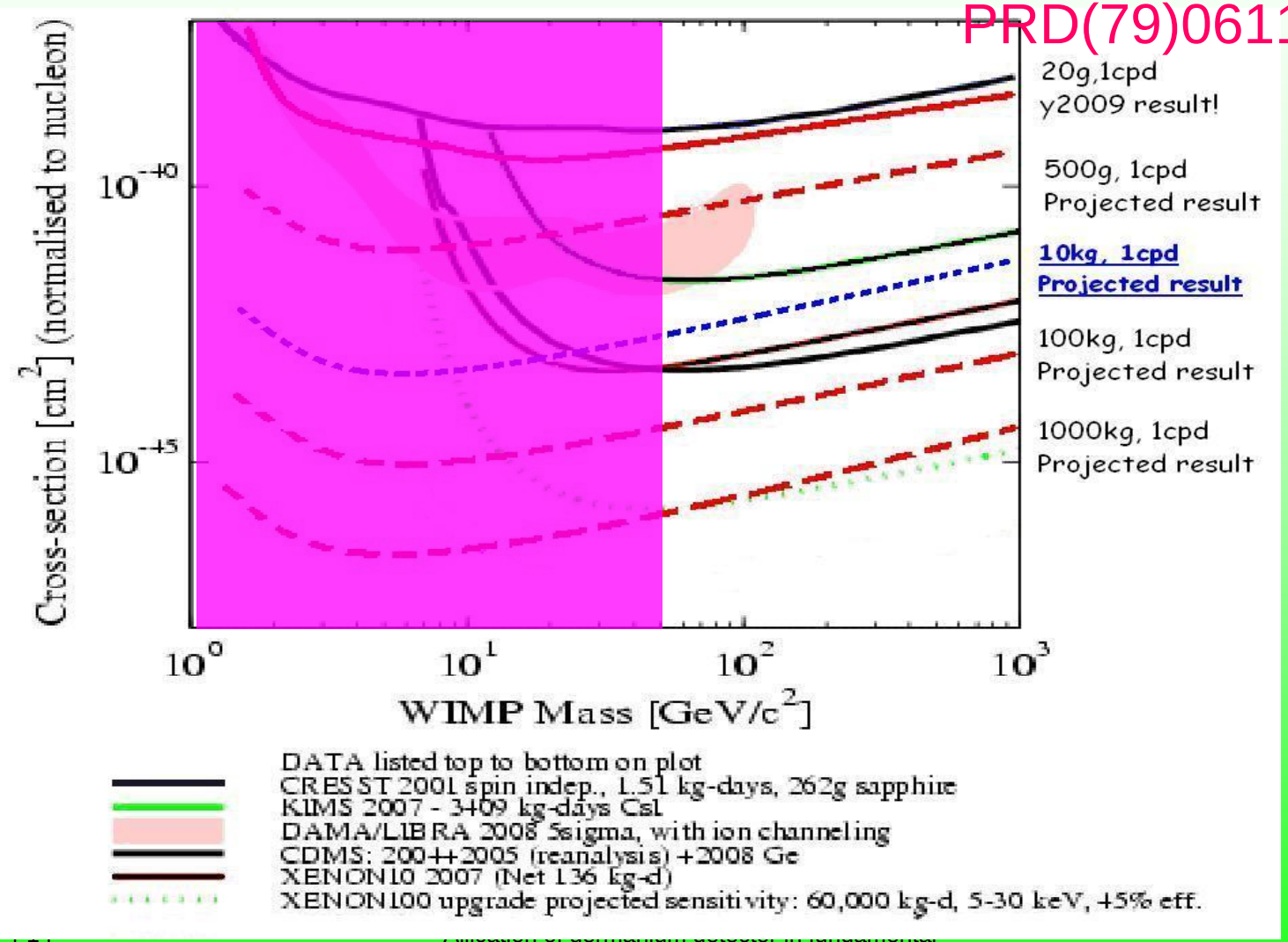
CDEX-TEXONO 1T plan



research

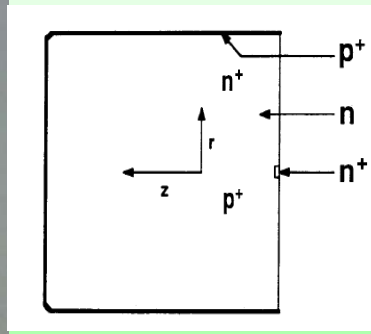
CDEX-TEXONO physics goal

PRD(79)061101,2009



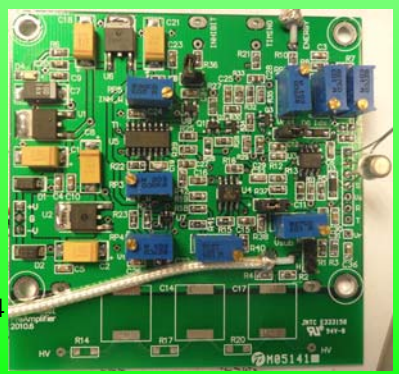
PCGe detector development

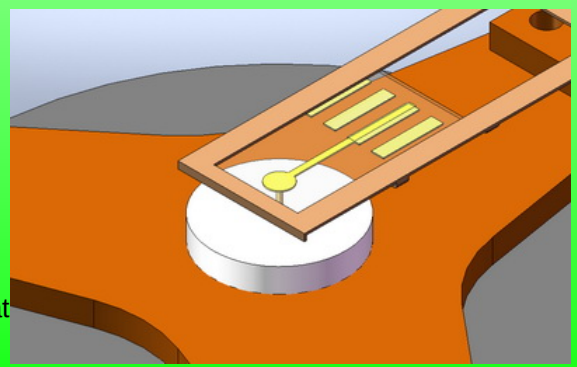
- Point-Contact detector development



Li Yulan's Talk

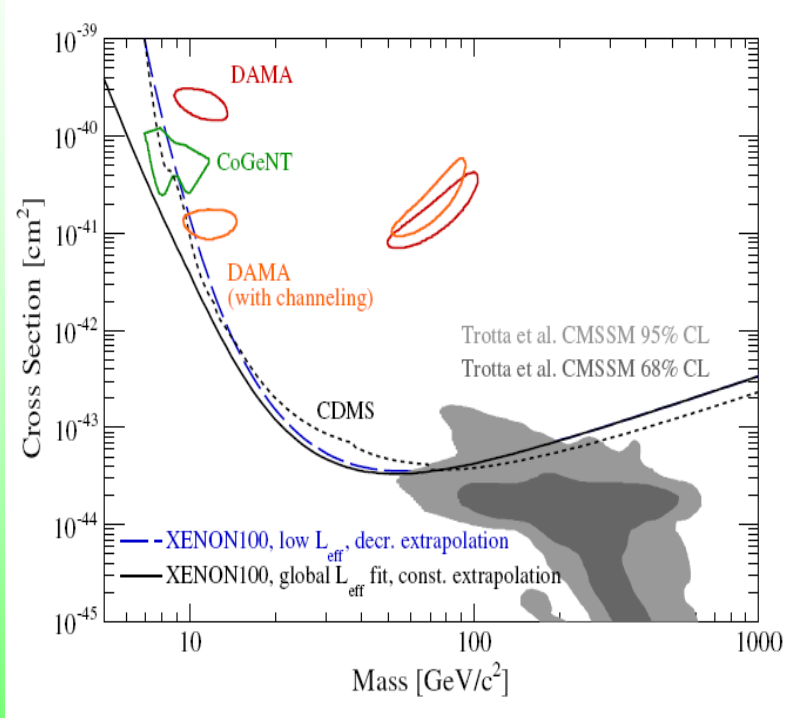
- Low Noise Pre-AMP electronics development

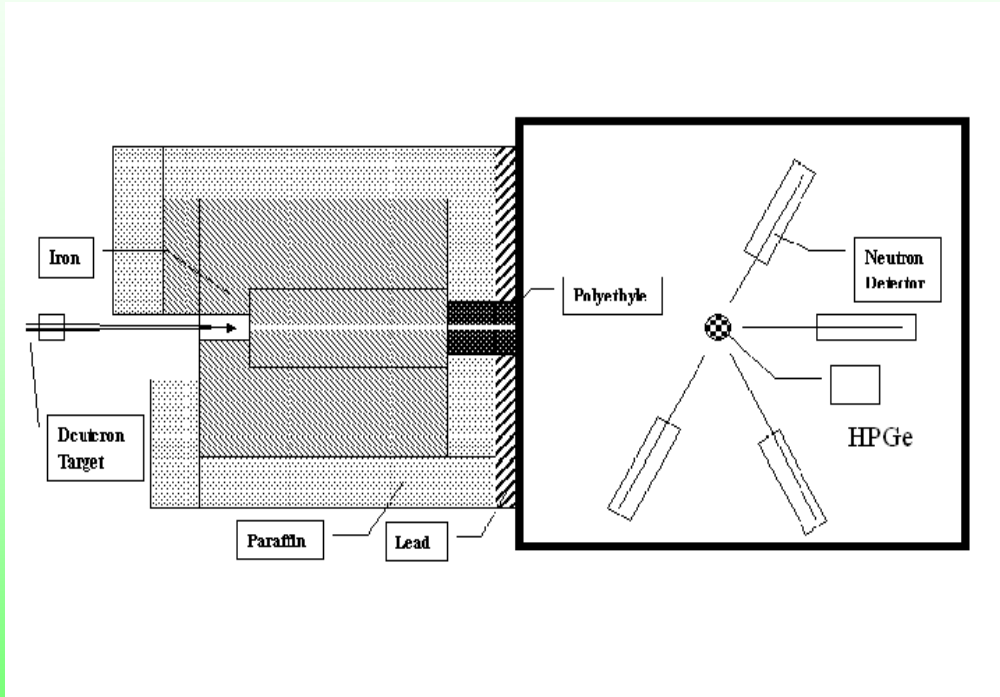




Deng Zhi's Talk
And
Zhu Weibin' Talk

Quenching Effect measurement of Ge





Ruan Xichao's Talk

Roadmap of CDEX-TEXONO

- From 2000, “learn” the DM related knowledge and the status of DM search experiment.
- 2003, Choose own physics goal: Low mass dark matter search with PCGe detector.
- 2005, Start 1kg-scale detector.
- 2011, 10kg-scale detector.
- 2015, 1T-scale PCGe array detector

Summary

- CJPL is OK in 2010 with deepest rock overburden. Low background facility has been planed to setup in CJPL. Muon flux, neutron flux, gamma background and radon concentration have been prepared to measure.
- CDEX-TEXONO Collaboration:

  PCGe detector: data taking from 2011 with 20g ULE-HPGe detector +1000g PCGe detector.

  Start to design 10kg-scale detector with Canberra France.
- CDEX-TEXONO Target: 1 ton PCGe array detector.
- PCGe also served as reactor neutrino detector for TEXONO-CDEX Collaboration at Taipei. Henry Wong's Talk

Summary

- We wish to exchange and share the updated Ge crystal growth and detector development experience with experts in Germany and in the World.
- Developing ton-scale Ge detector for DM and DBD is a long way to go. It will be benefit for us to collaborate in the future.
- CDEX-TEXONO wish to push the collaboration with GERDA and MPP.

Thank you!