

CDEX and CJPL

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Tsinghua University
On behalf of CDEX Collaboration
May. 8, 2012

CJPL 

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

内容:

- CDEX前世今生与海峡两岸粒子物理实验合作
- CDEX 研究计划
- 中国锦屏地下实验室(CJPL)
- CDEX研究现状
- 总结

CDEX前世今生与海峡两岸粒子物理实验合作

- 2002年，在台湾中研院合作开展CsI探测中微子实验研究；
- 2003年，开展低阈值HPGe测量暗物质的实验可行性研究；

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-Ping¹ LI Yuan-Jing¹ LI Jin^{1,2} WANG Zi-Jing³

CDEX前世今生与海峡两岸粒子物理实验合作

- 2002年，在台湾中研院合作开展CsI探测DM实验研究；
- 2003年，开展低阈值HPGe测量暗物质的实验可行性研究；
- 2004年，北京-台北-首尔三方讨论合作开展高纯锗探测暗物质研究，由清华大学牵头，利用5g探测器在韩国Y2L地下实验室开展研究；2005年，实验正式开始。

➔ 高纯锗暗物质实验，清华大学牵头，中研院物理所和韩国首尔大学

➔ 碘化铯中微子实验，中研院牵头，清华大学和韩国首尔大学参加

➔ 碘化铯暗物质实验，韩国首尔大学牵头，清华大学和中研院参加

CDEX前世今生与海峡两岸粒子物理实验合作

- 2005年,2006年, 发表相关研究文章, ;

第 30 卷 第 6 期
2006 年 6 月

高能物理与核物理
HIGH ENERGY PHYSICS AND NUCLEAR PHYSICS

Vol. 30, No. 6
Jun., 2006

**Experimental Study on the CsI(Tl) Crystal Anti-Compton
Detector for Dark Matter Search***

HE Dao¹ LI Yu-Lan¹ YUE Qian^{1;1)} LI Yuan-Jing¹ LI Jin¹ CHENG Jian-Ping¹
KWAK J W² KIM S K² LI Xin¹ WANG H T³

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第 31 卷 第 6 期
2007 年 6 月

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HIGH ENERGY PHYSICS AND NUCLEAR PHYSICS

Vol. 31, No.
Jun., 200

**Status of ULE-HPGe Detector Experiment for
Dark Matter Search***

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KIM S. K.² KWAK J. W.² WANG H. T.³

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2 (School of Physics, Seoul National University, Seoul 151-742, Korea)
3 (Institute of Physics, AS, Taipei 11529, China)

CDEX前世今生与海峡两岸粒子物理实验合作

- 2006年，20g高纯锗探测器在台湾核二厂开展暗物质研究；
- 2007年，递交文章；2009年发表首个暗物质物理结果；

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. Zhou⁵

(TEXONO Collaboration)

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⁵*Department of Nuclear Physics, Institute of Atomic Energy, Beijing 102413, China*

⁶*Department of Physics, Banaras Hindu University, Varanasi 221005, India*

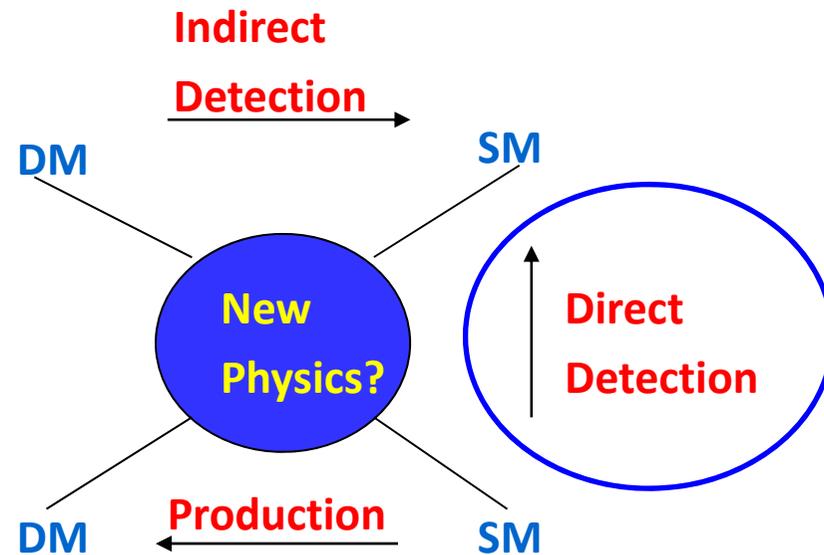
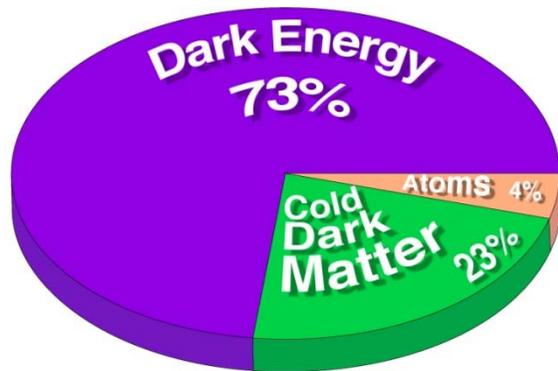
(Received 10 December 2007; revised manuscript received 22 May 2008; published 12 March 2009)

CDEX前世今生与海峡两岸粒子物理实验合作

- 2009年3月，CDEX合作组成立。
- 2009年5月，清华大学与二滩公司联合建设CJPL；
- 2010年2月CJPL正式启用；



China Dark matter Experiment (CDEX)

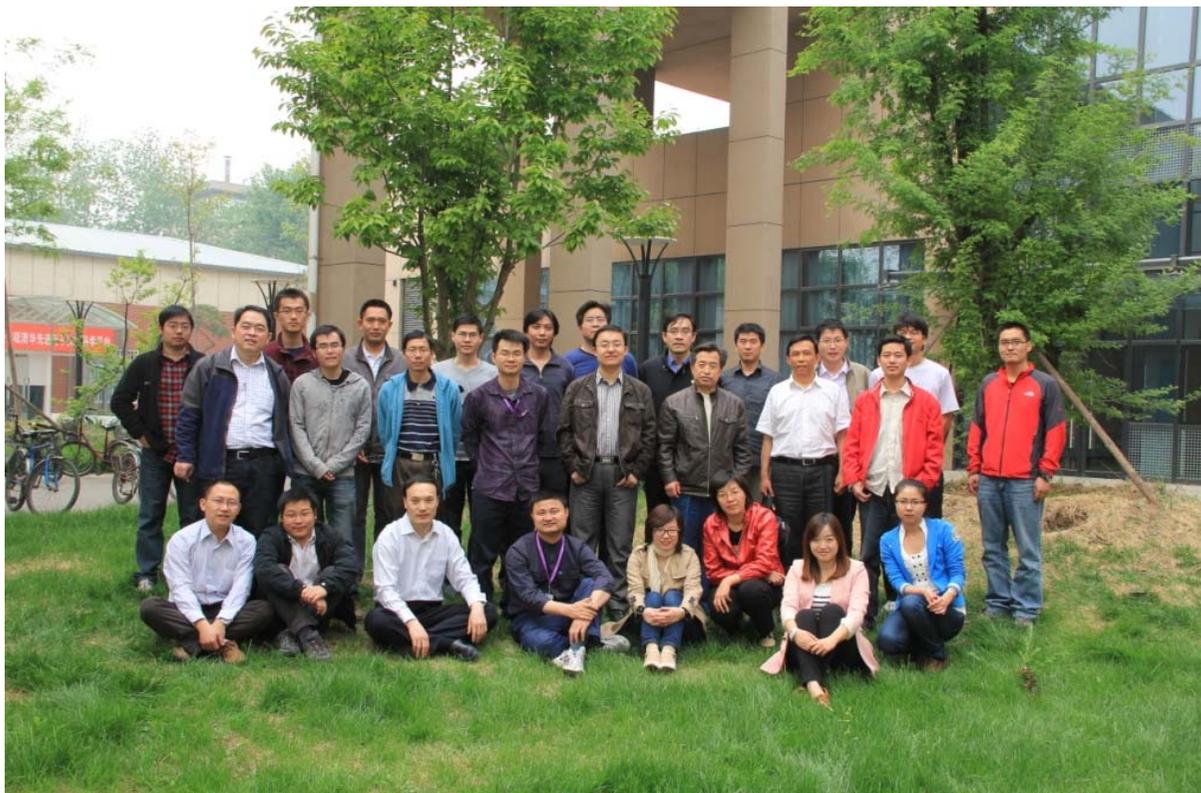


CDEX Target:

Direct detection of cold dark matter with Ton-scale Point-Contact Germanium (PCGe) array detectors with ultra-low energy threshold($<300\text{eV}$).

China Darkmatter EXperiment (CDEX)

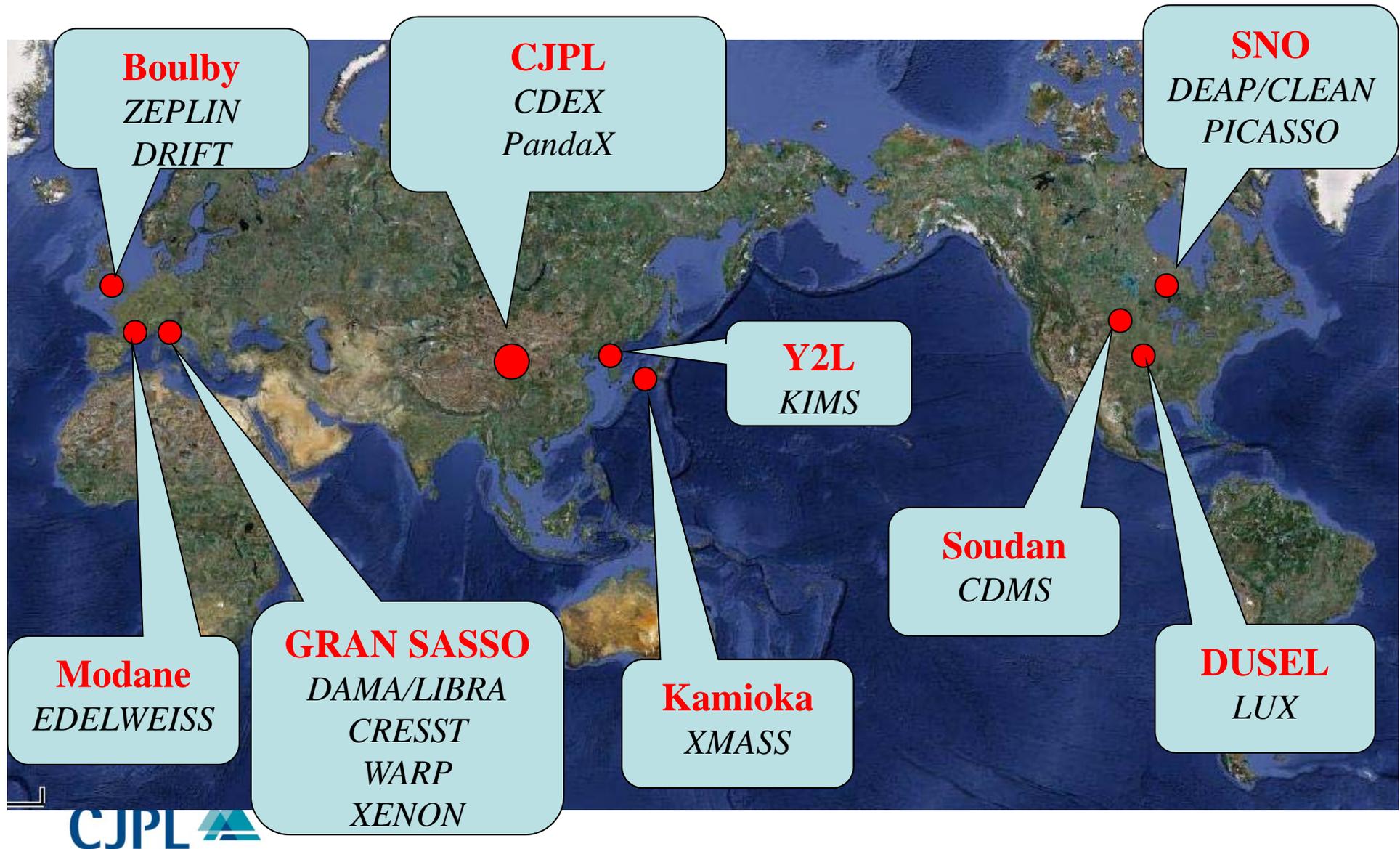
- 清华大学
- 四川大学
- 南开大学
- 中国原子能科学研究院
- 二滩水电开发有限公司
- 与TEXONO合作组紧密合作：CDEX-TEXONO



CJPL 



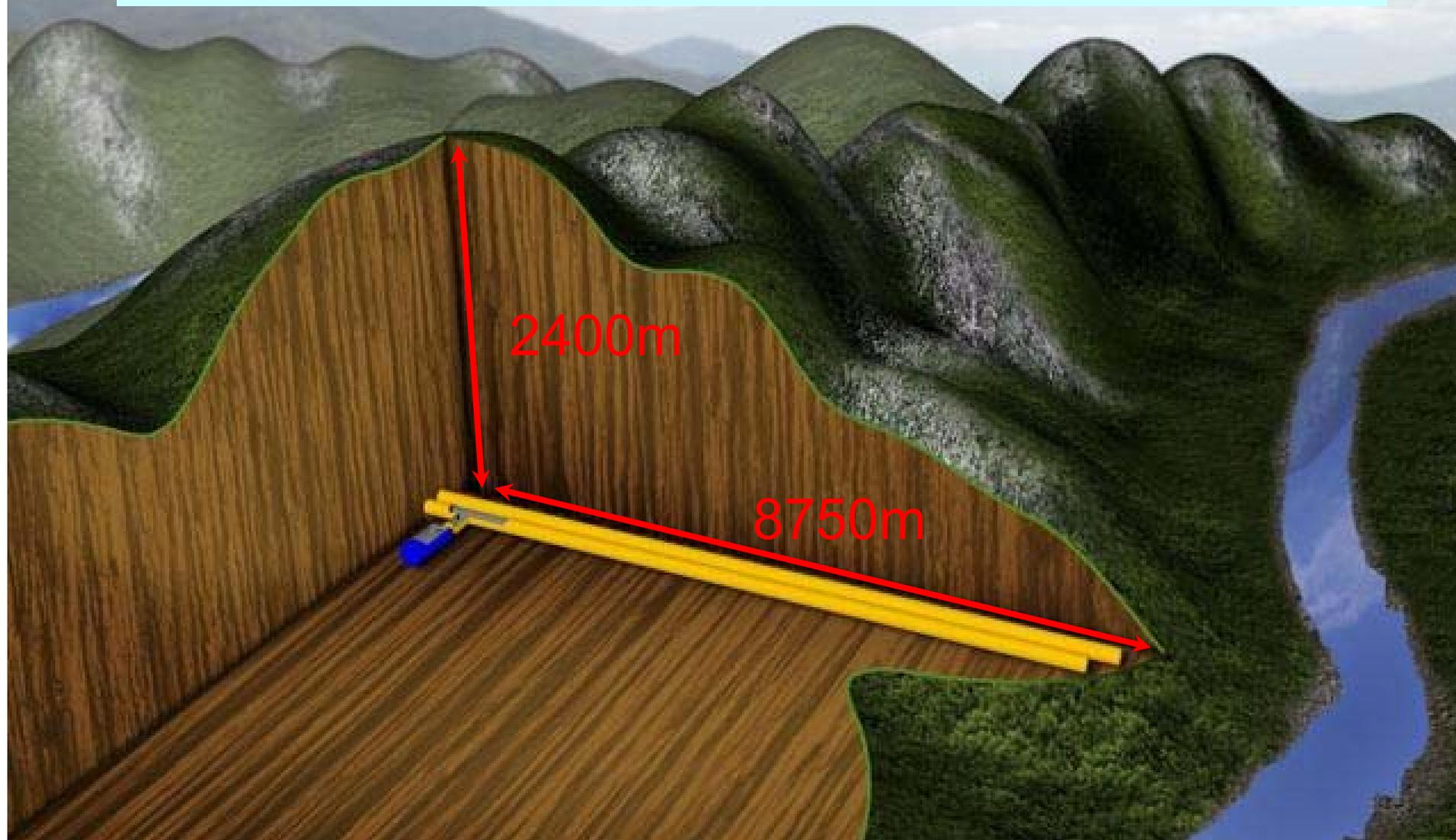
International Main Underground Laboratories



CJPL site



China JinPing Underground Laboratory (CJPL)



CJPL Rock Background

(Unit: Bq/kg)	K-40	Ra-226 (609keV)	Th-232 (911keV)
JinPing Rock Sample	< 1. 1	$1.8 \pm 0. 2$	< 0. 27
Beijing Normal Ground Level	~600	~25	~50

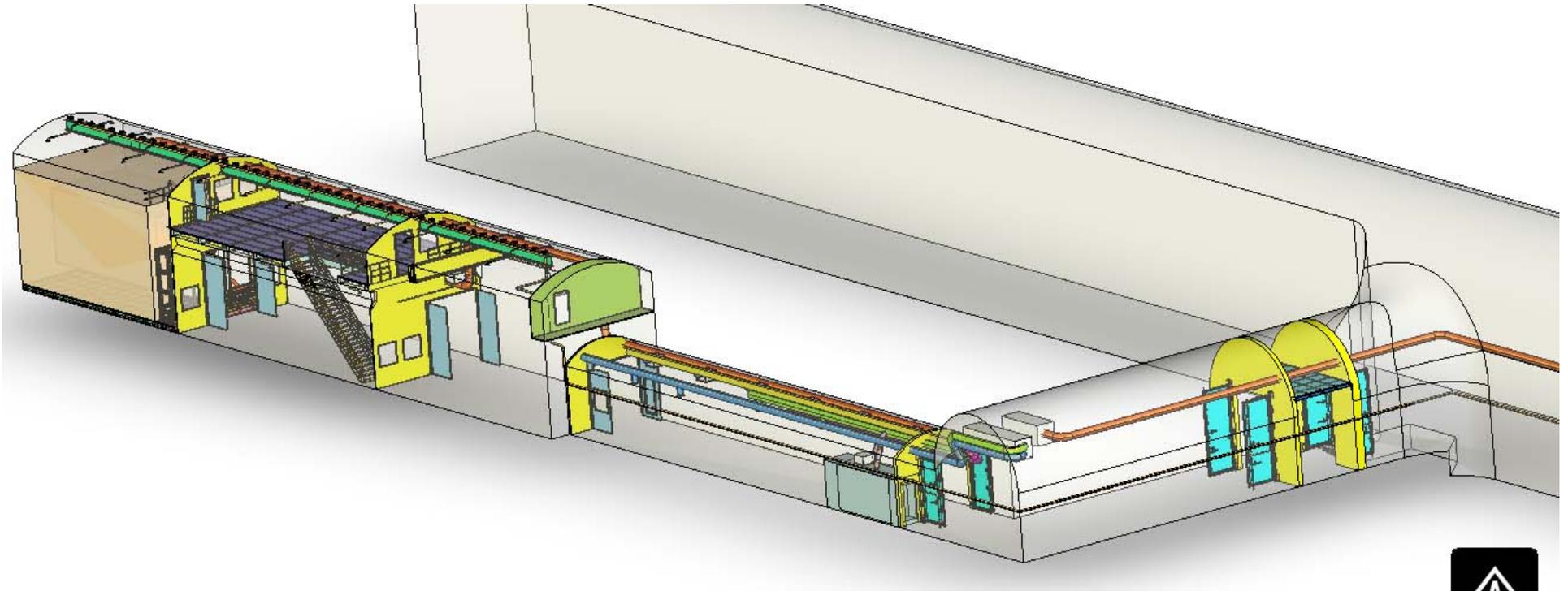
Inside of CJPL



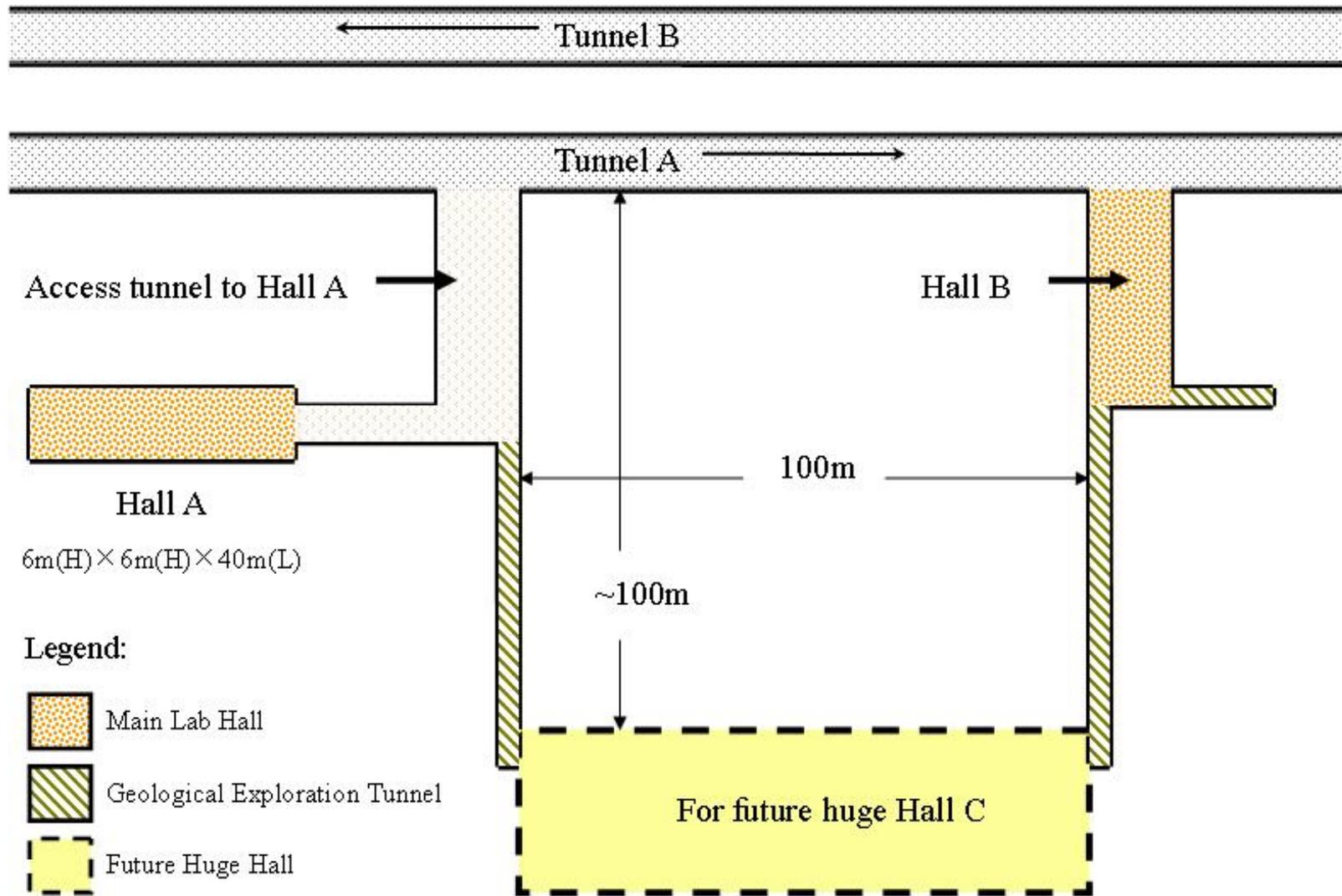
2011年重要建设工作——通风系统



CJPL内部布局



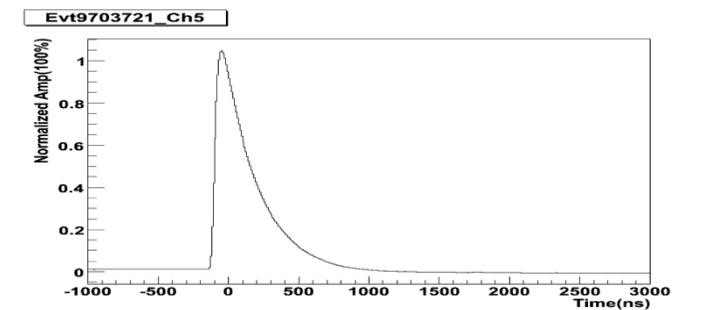
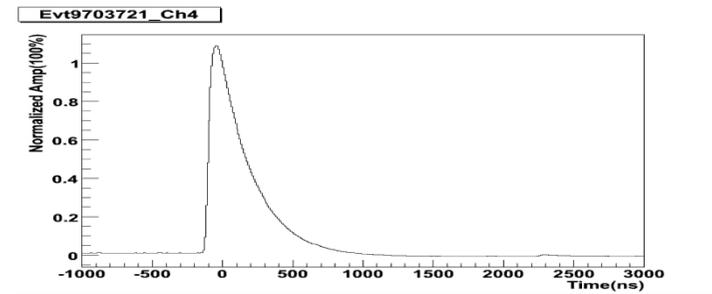
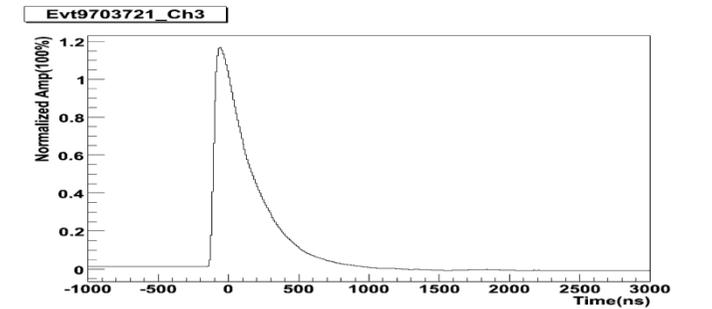
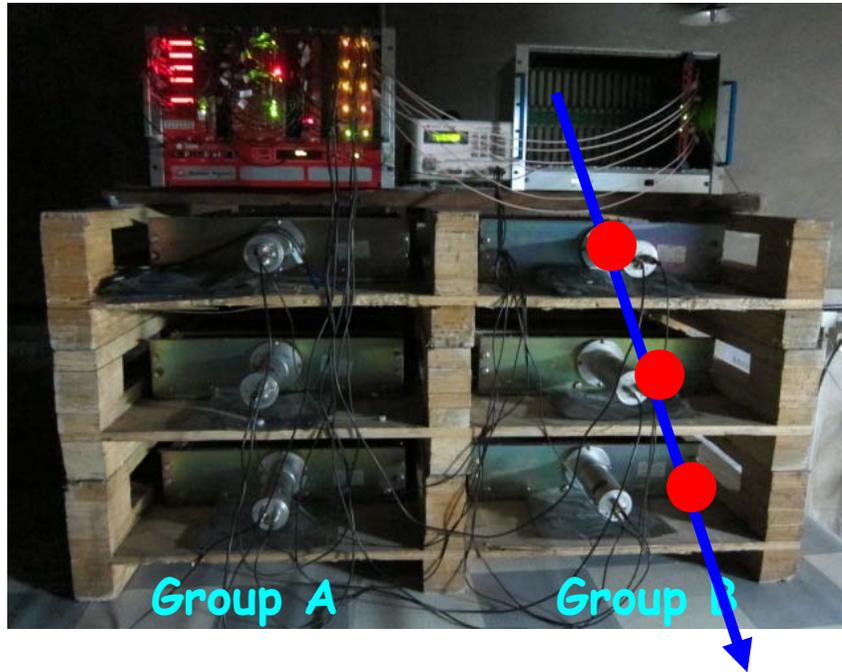
CJPL Future Plan



CJPL重要实验性能参数研究

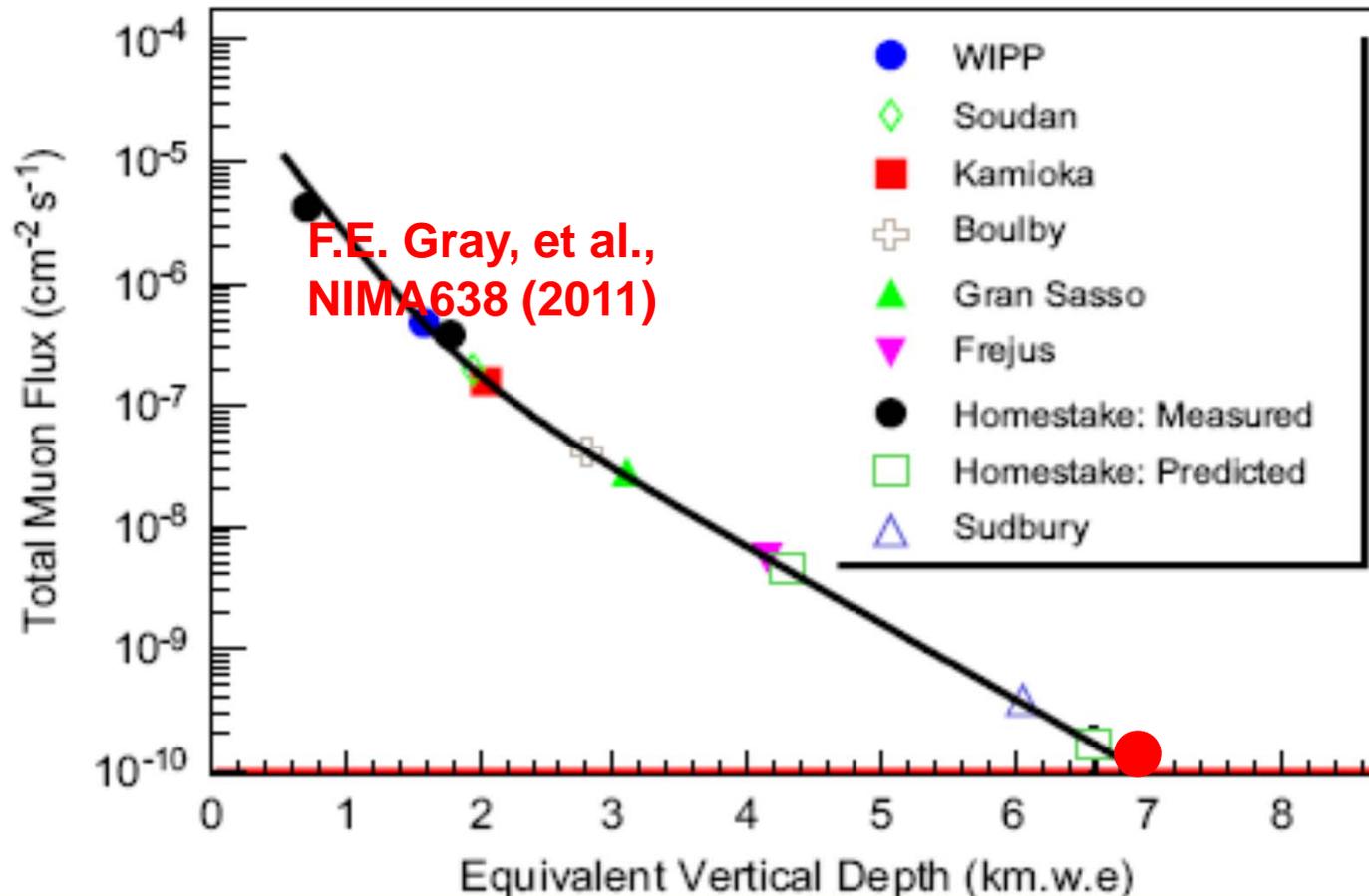
- 宇宙线通量测量；
- 本底伽马通量测量；
- 氦气含量测量；
- 热中子测量；
- 快中子测量；
- 低本底测量装置。

宇宙线通量测量



- 171天测量得到28个事例！
- 文章正在准备中！

CJPL 宇宙线通量初步结果

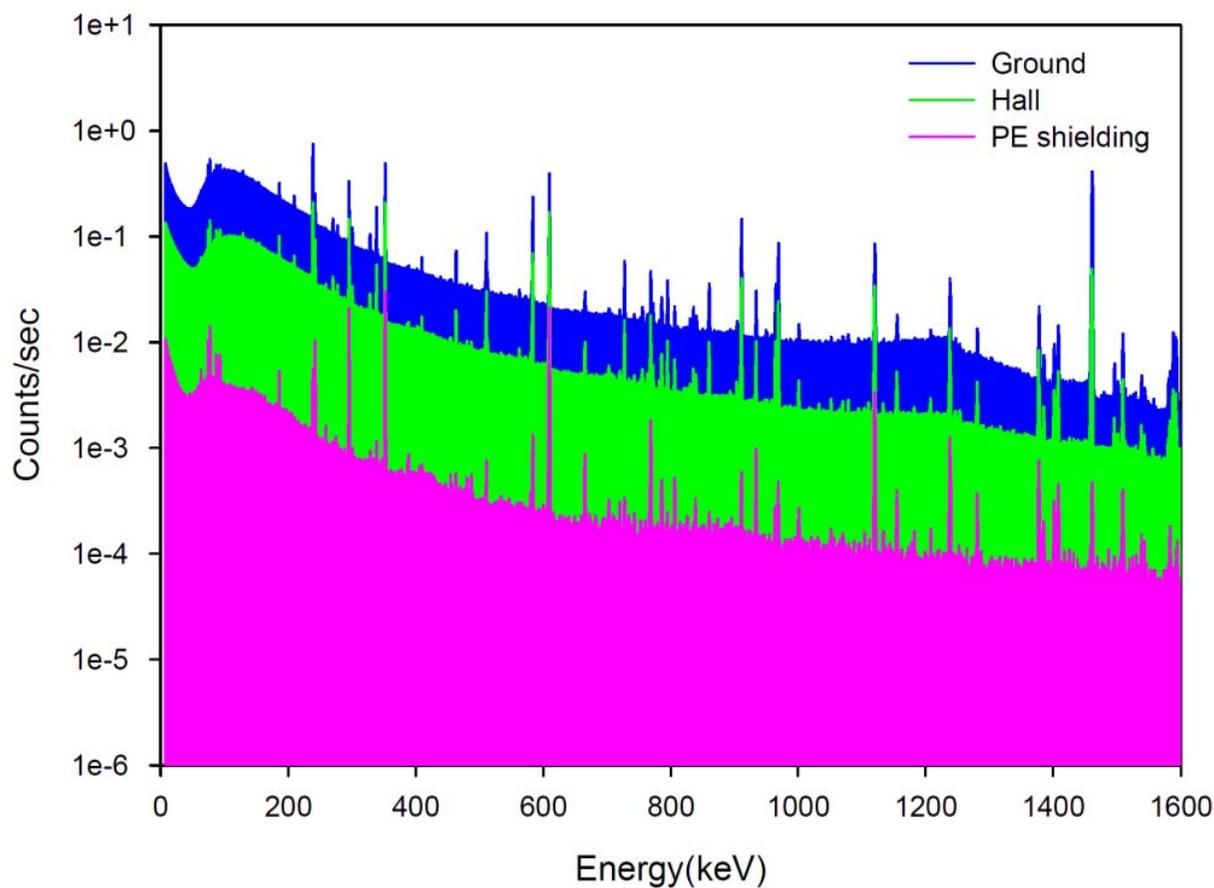


CJPL初步宇宙线测量结果:

$\sim 2 \times 10^{-10} \text{ cm}^{-2} \text{ s}^{-1}$, 是地面通量的约亿分之一。

实验室环境伽马本底测量

- 环境伽马来自周围岩石，混凝土，钢材等实验室建设和屏蔽材料。

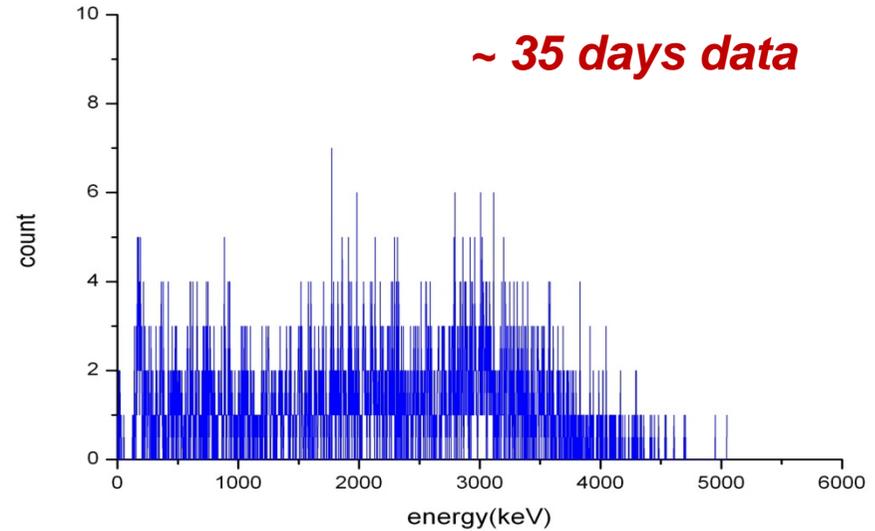
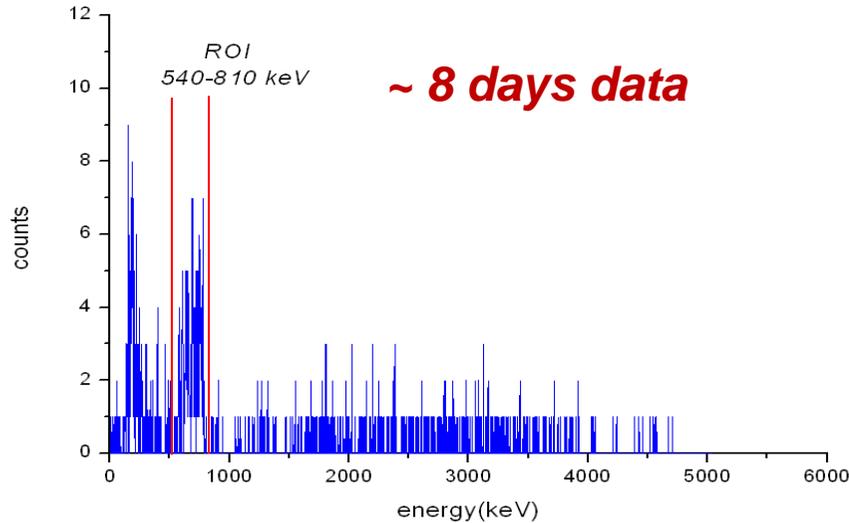


CJPL热中子通量测量

- 自行研制低本底He-3管测量热中子通量，需要定制：
 - 高纯无氧铜管壁减小本底；
 - 双端读出定位入射粒子位置；
 - 直径25.4mm*1m有效长度。



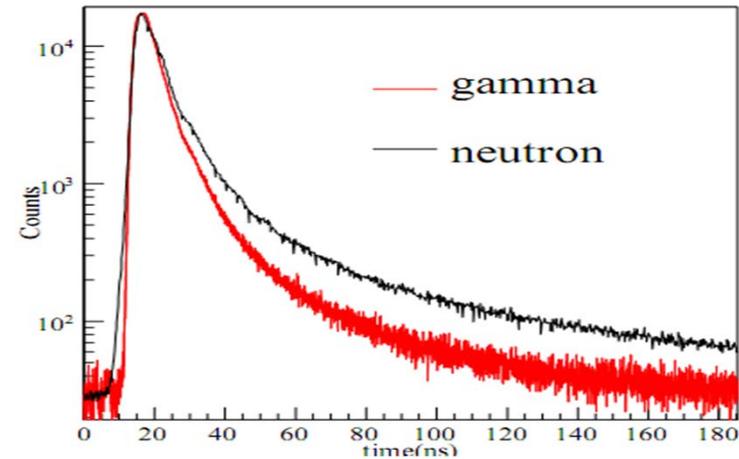
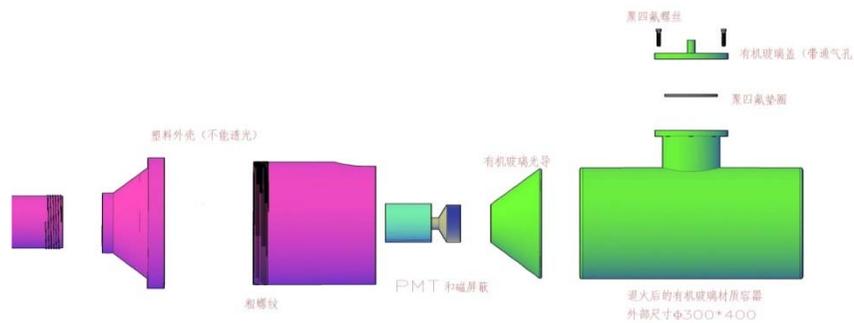
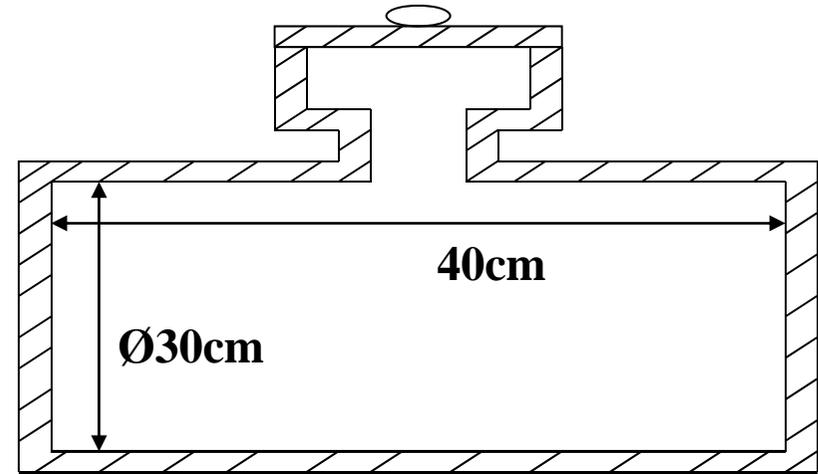
CJPL热中子通量测量初步结果



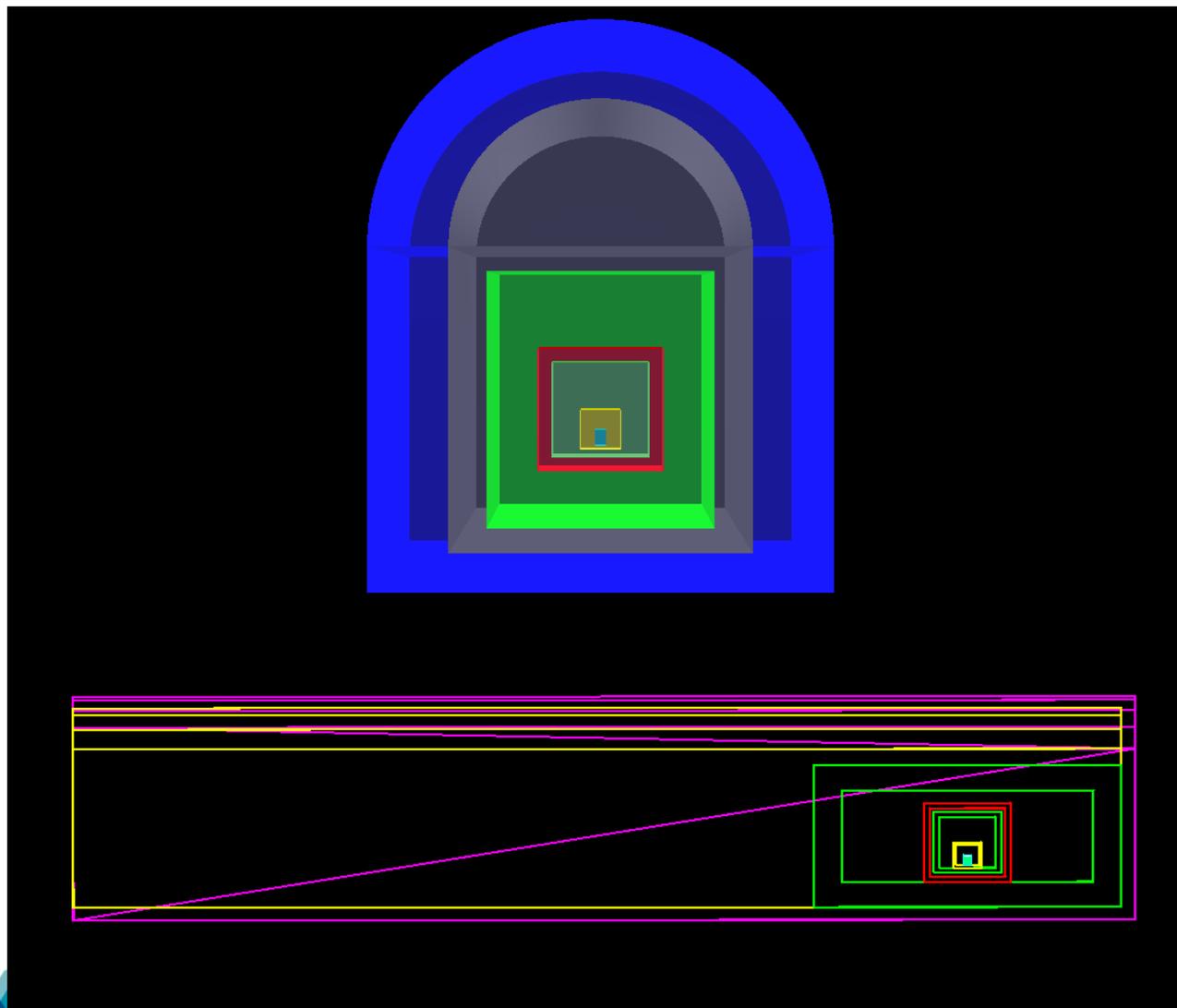
	大厅	屏蔽体内
ROI内计数率	34.11 cpd	3.71 cpd
α 在ROI内的计数率	4 cpd	4.4 cpd
热中子的计数率	~30 cpd	< 1 cpd
热中子通量	$4.34 \times 10^{-6} \text{ n/cm}^2/\text{s}$	$< 1.45 \times 10^{-7} \text{ n/cm}^2/\text{s}$

CJPL快中子通量测量

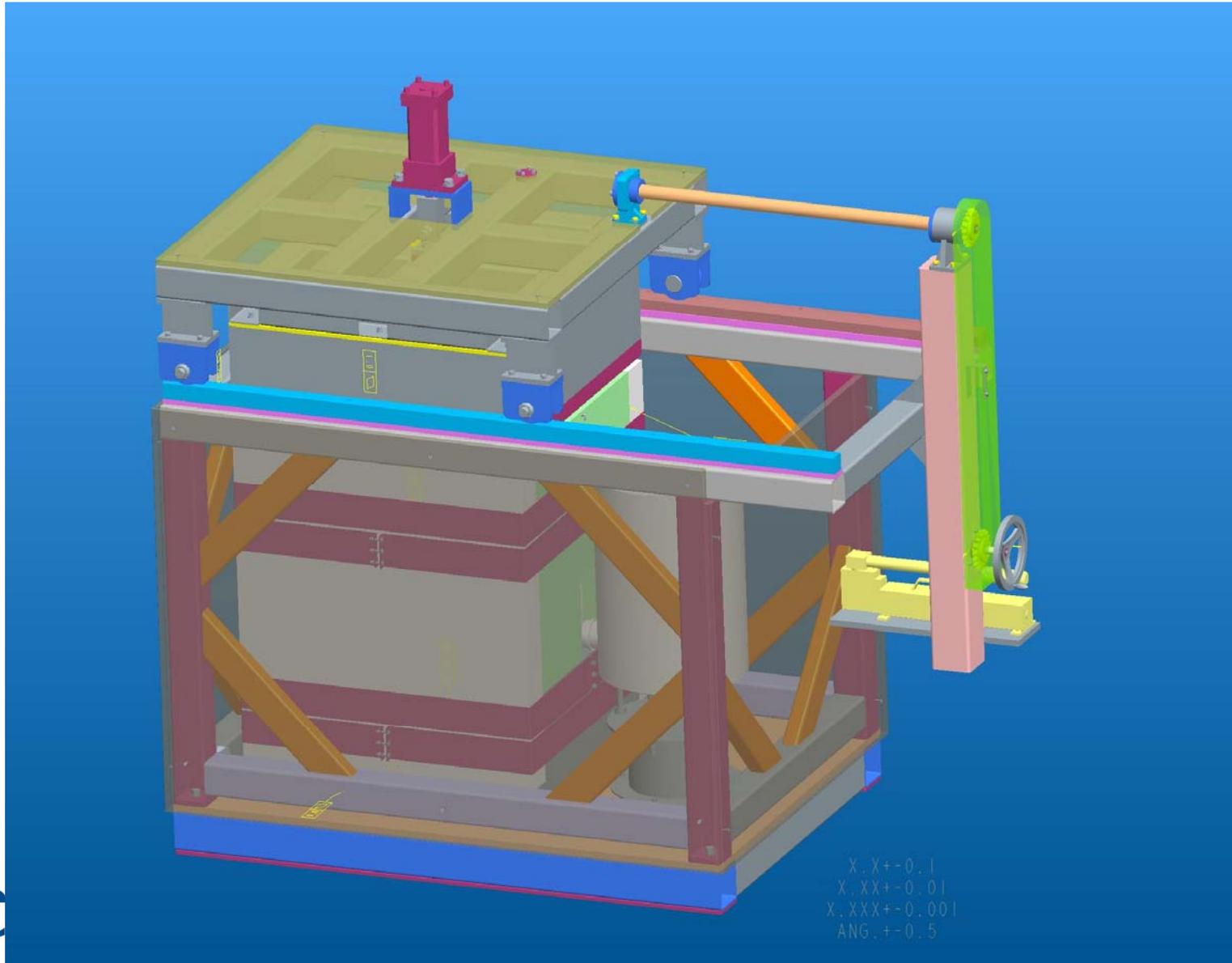
载钷液闪探测器，正在川大和原子能院开展地面实验室研究和刻度，2012上半年在CJPL开展研究工作。



CJPL快中子模拟研究



低本底测量装置的建立



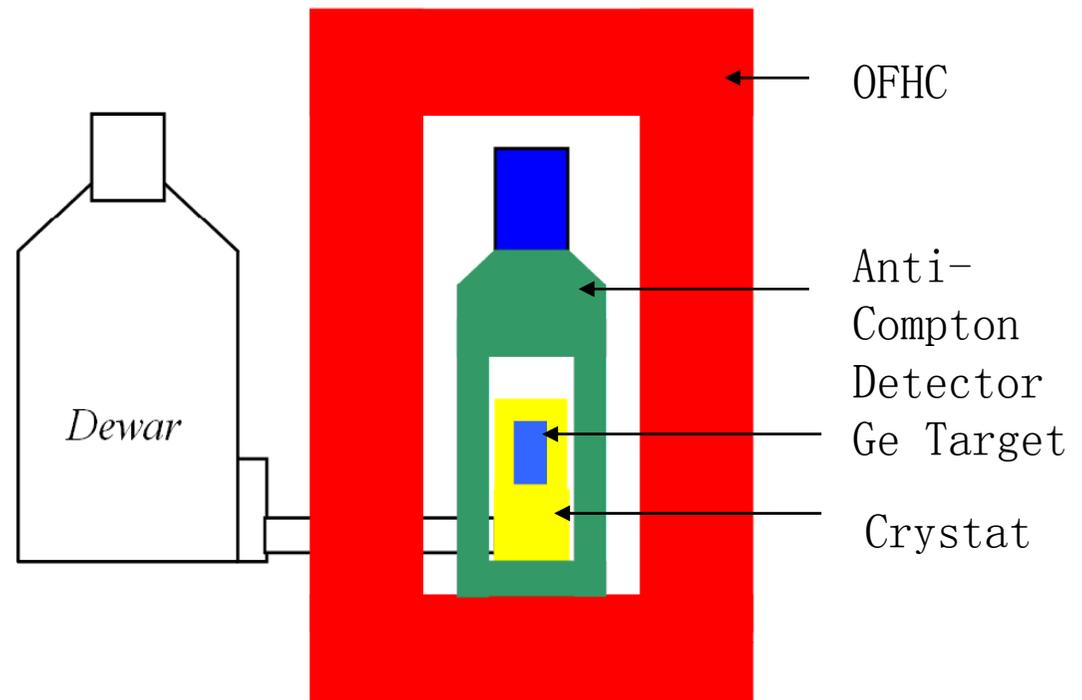


CDEX实验进展

- CDEX-1实验： 5g、20g、1000g
- CDEX-10实验： LAr+HPGe
(质量为10+X公斤， 自主研发部分HPGe)
- CDEX-1T

CDEX-1 @ CJPL

- ✓ Point-contact Ge array detector with ultra-low energy threshold ($\sim 300\text{eV}$ or less).
- ✓ Mass of Ge target: 5g, 20g, 1000g.
- ✓ Ultra-pure CsI(Tl) crystal serve as active shielding and anti-compton detector.



CDEX Shielding System

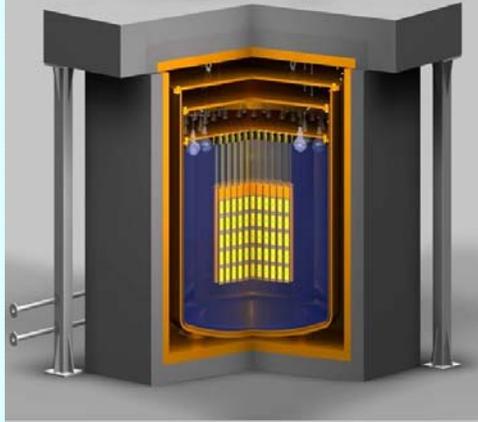


图 5 大门开启

CDEX-1kg & 10kg Shielding system

PE shielding room

10Kg-scale
HPGe System



Lead, Copper
Shielding for
1Kg-scale
HPGe detector

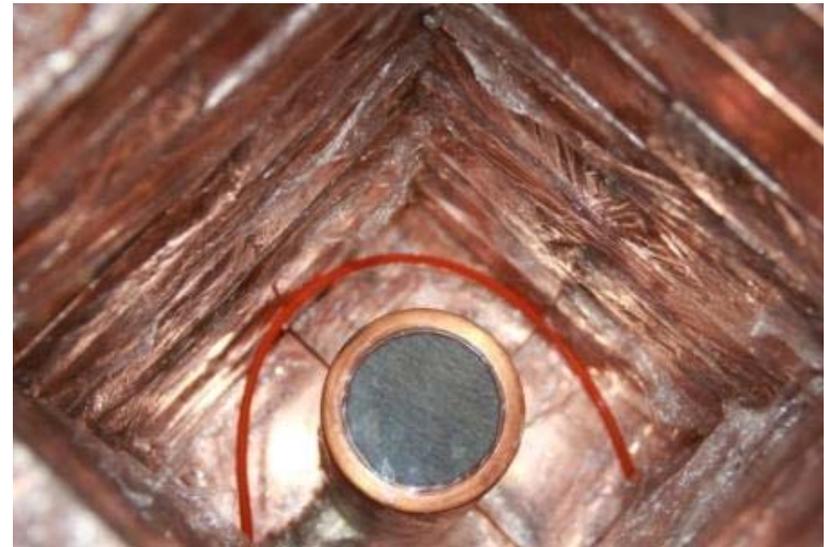
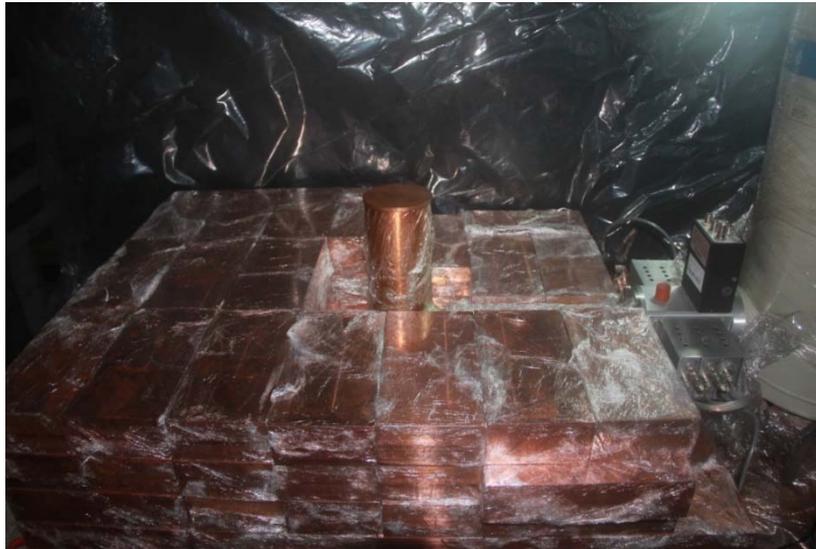
Gate



CDEX-1 in CJPL



CDEX-1kg scale HPGe detector



- 20g HPGe running and data analysis now!
- 1kg PCGe detector data taking!

CDEX-10kg

LAr: Passive shielding + Active shielding.

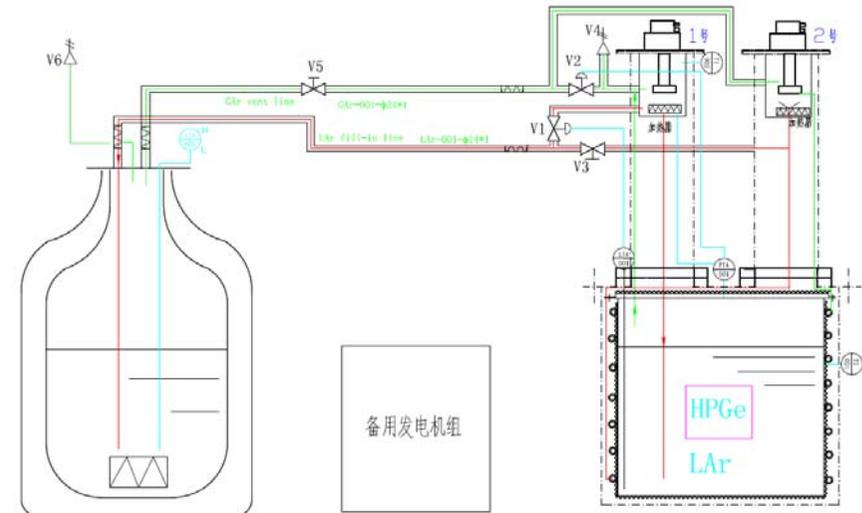
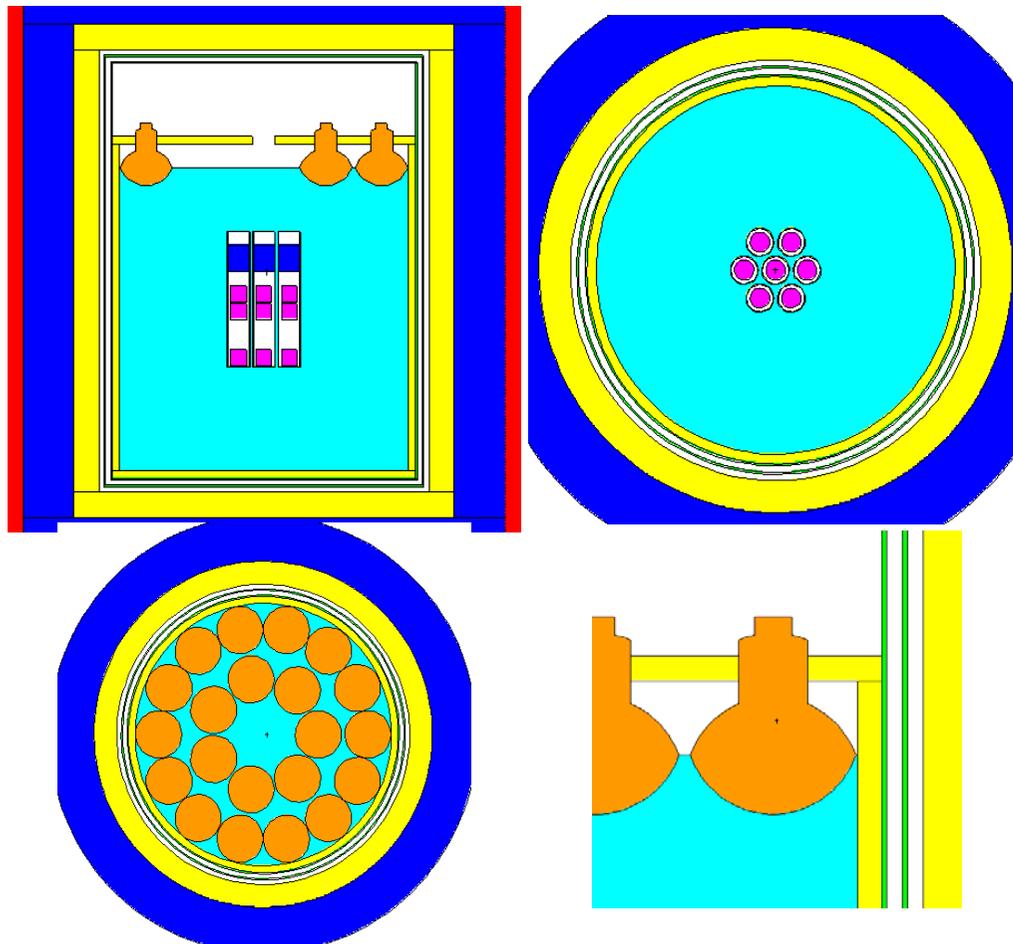
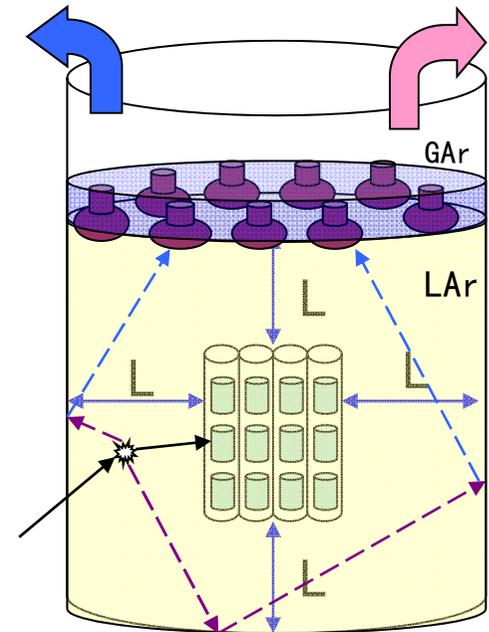
Ge: Encapsulated into Al vacuum tube for cooling.

Ge: Three PCGe in one tube.

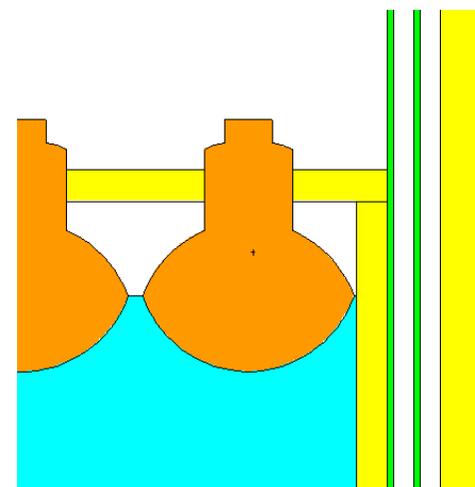
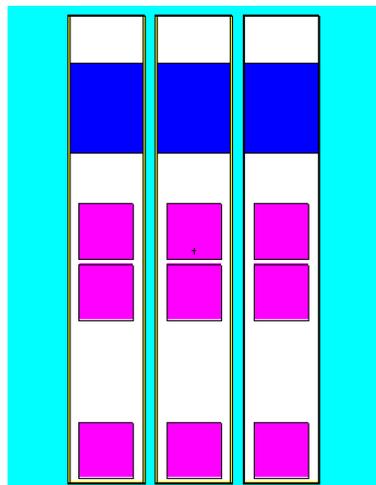
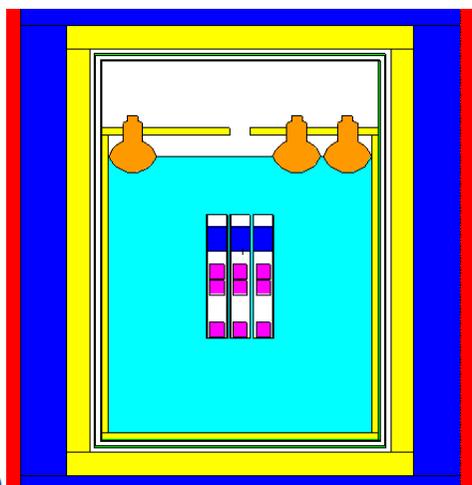
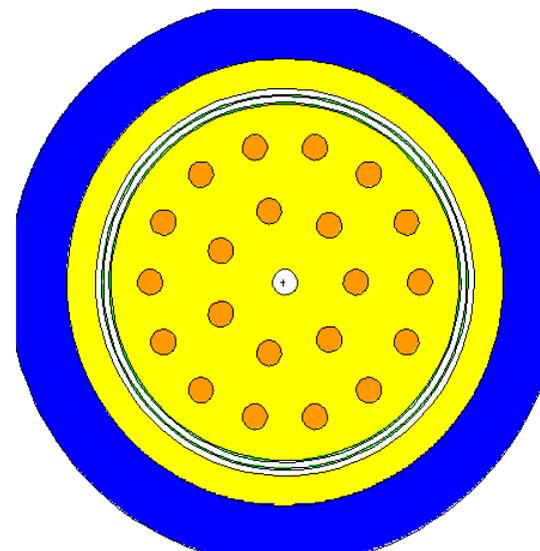
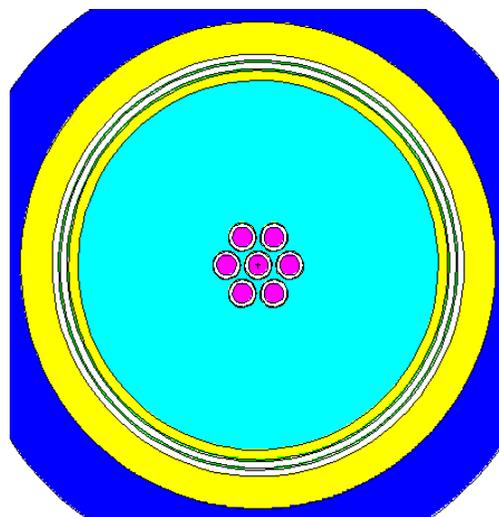
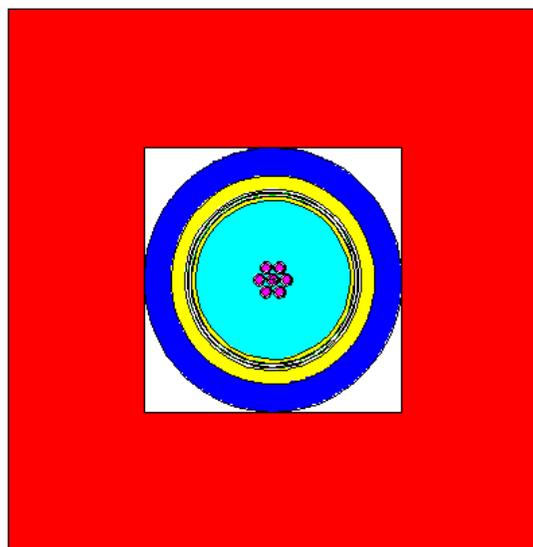
WLS: Transferring 128nm light to ~420nm light.

HV and Signals

Cooling and Control

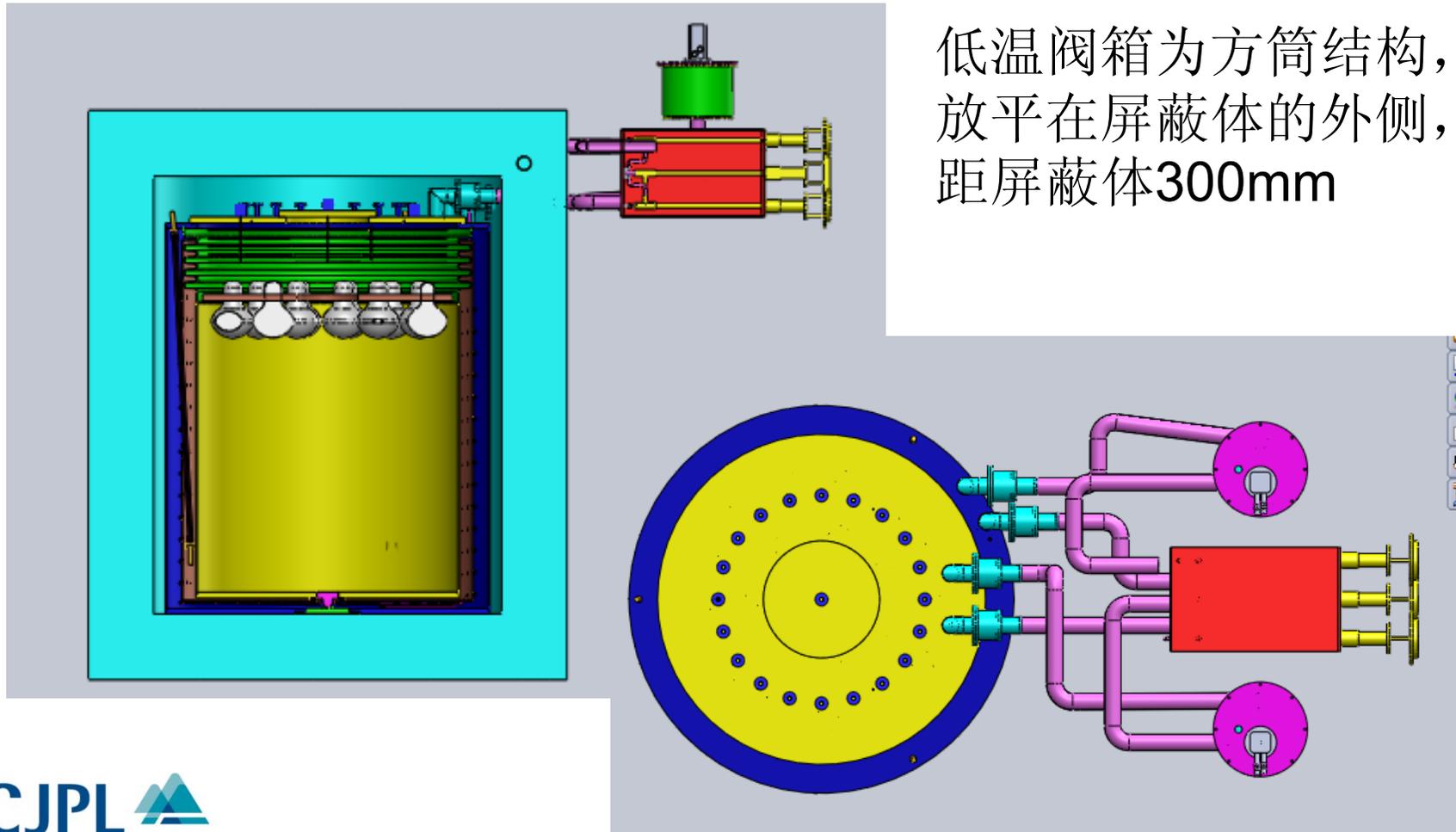


CDEX-10 探测系统模拟

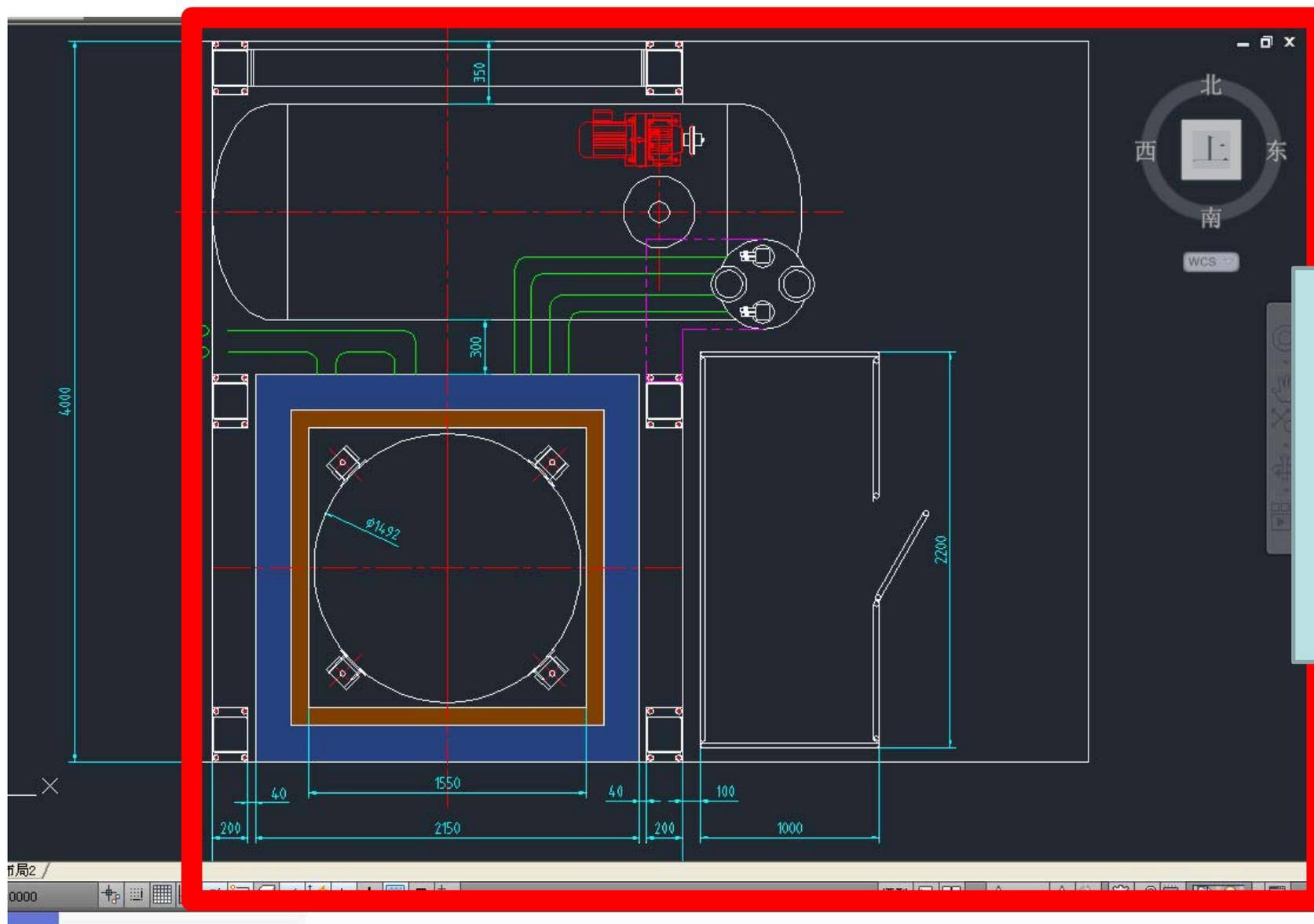


CDEX-10 低温反符合系统设计

恒温杜瓦结构示意图



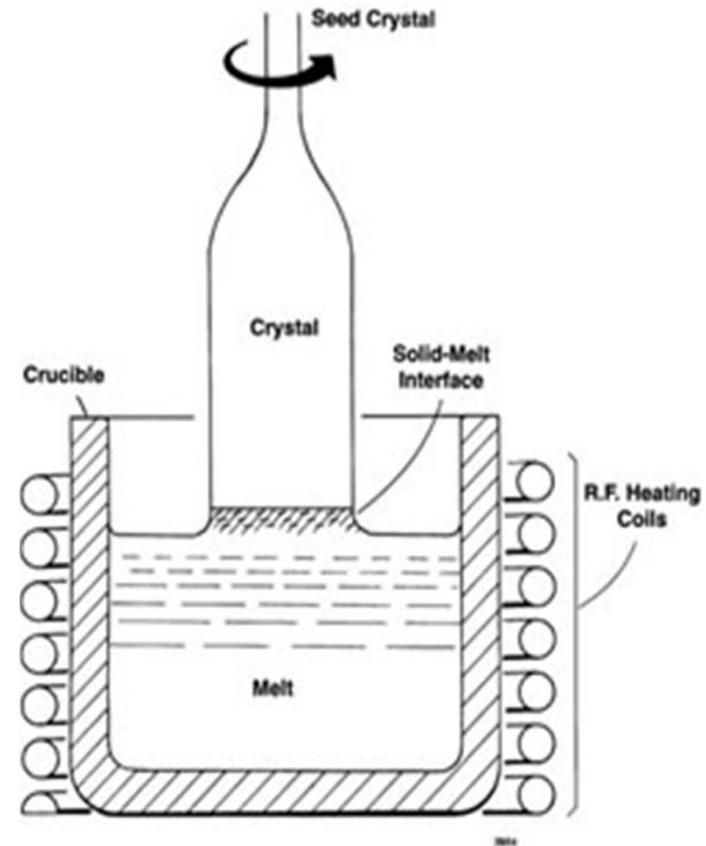
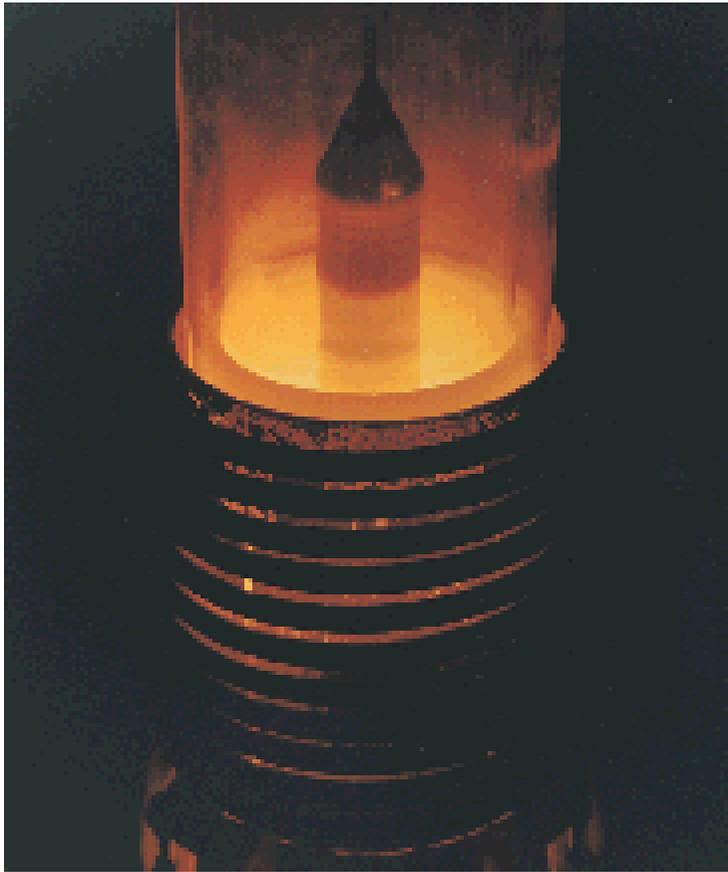
CDEX-10布局示意图



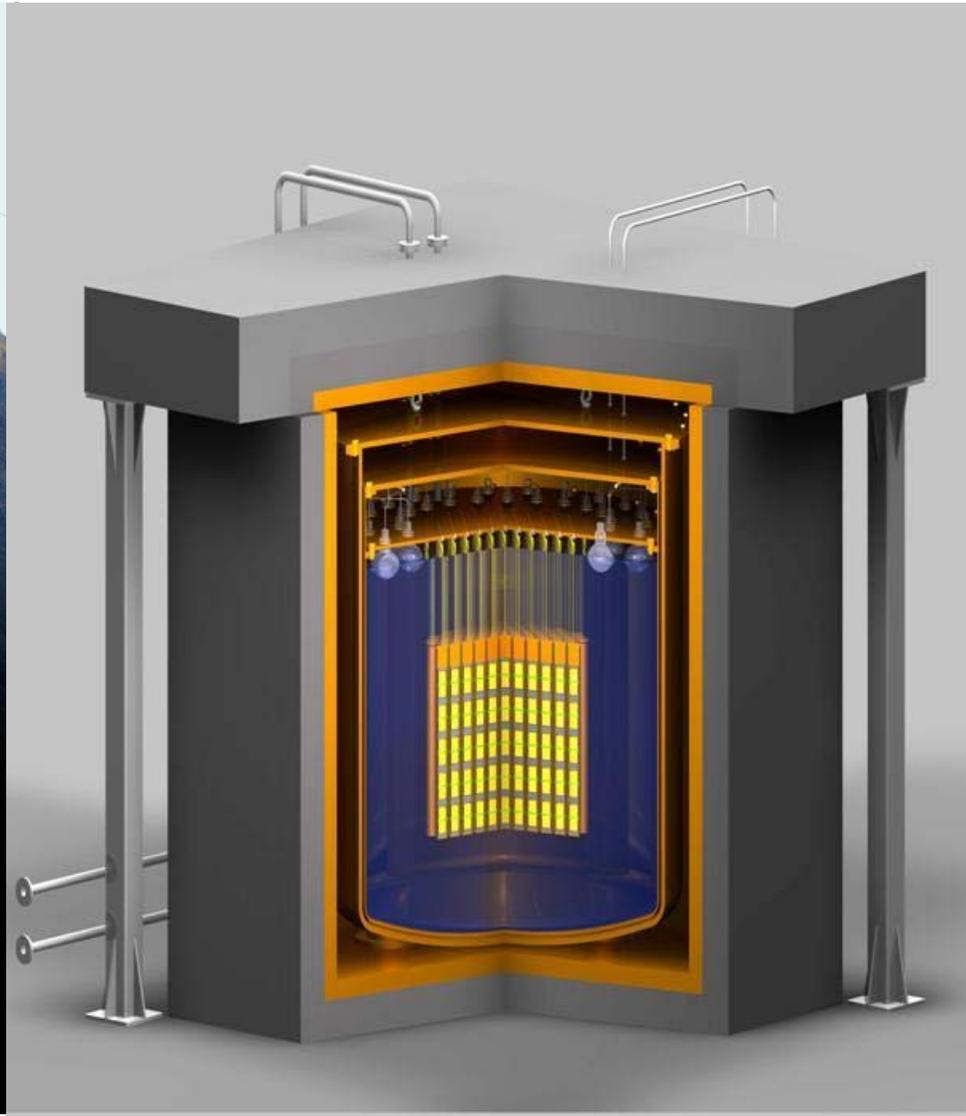
聚乙烯
屏蔽体
大门



高纯锗晶体生长



CDEX-1T plan



Summary

- CJPL with deepest rock overburden in the world run now. Muon and Neutron flux measuring and first LBF OK!
- New ventilation system has been installed and started run now. The fresh air supplement is fine now.
- CDEX Experiment:
 - CDEX-1: 20g +1kg ULE-HPGe detector running now;
 - CDEX-10+X: under engineering design;
- HPGe detector manufacture and HPGe crystal growth started by Tsinghua university.
- 希望两岸的合作在未来能够进一步深化，取得更多更好的研究成果！



CJPL 

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

谢谢!