Status and Prospects of China JinPing Deep Underground Laboratory (CJPL) and China Dark Matter EXperiment (CDEX)

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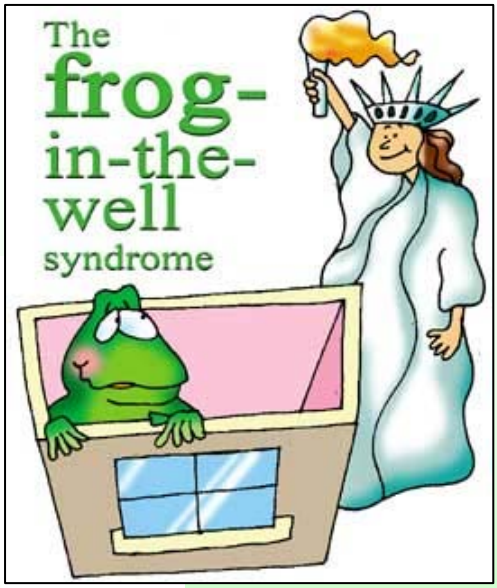
Outline：

- Survey of Low background Experiments in China
- The site of the new deep UL in China
- The condition of CJPL
- Plan for the construction of CJPL
- CDEX collaboration and plan

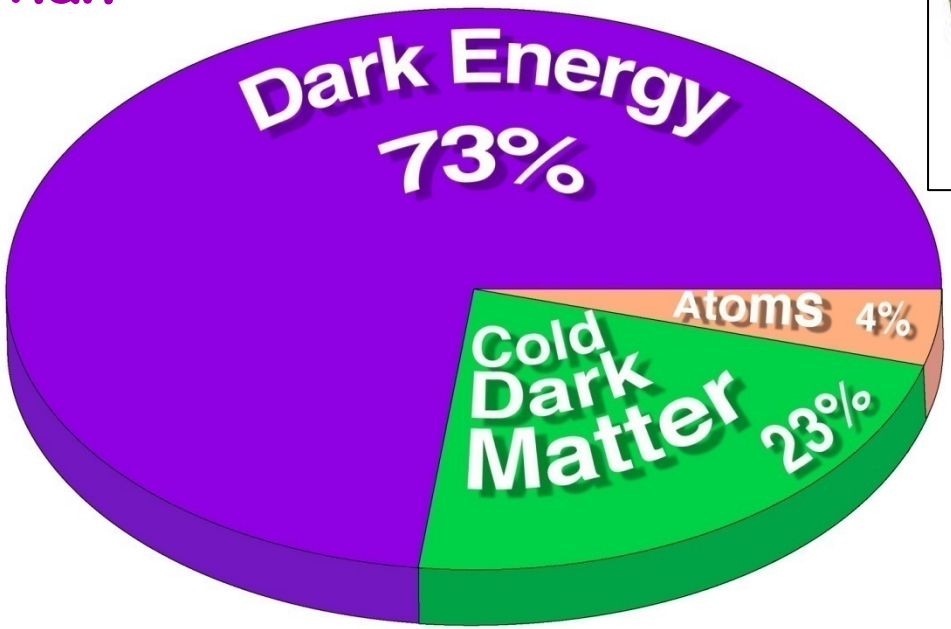
Brief Survey of Low Background Experiment in China

- 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
- CJPL and CDEX, 2009

Compositions of the Universe : We only Understand ~4% !!!????



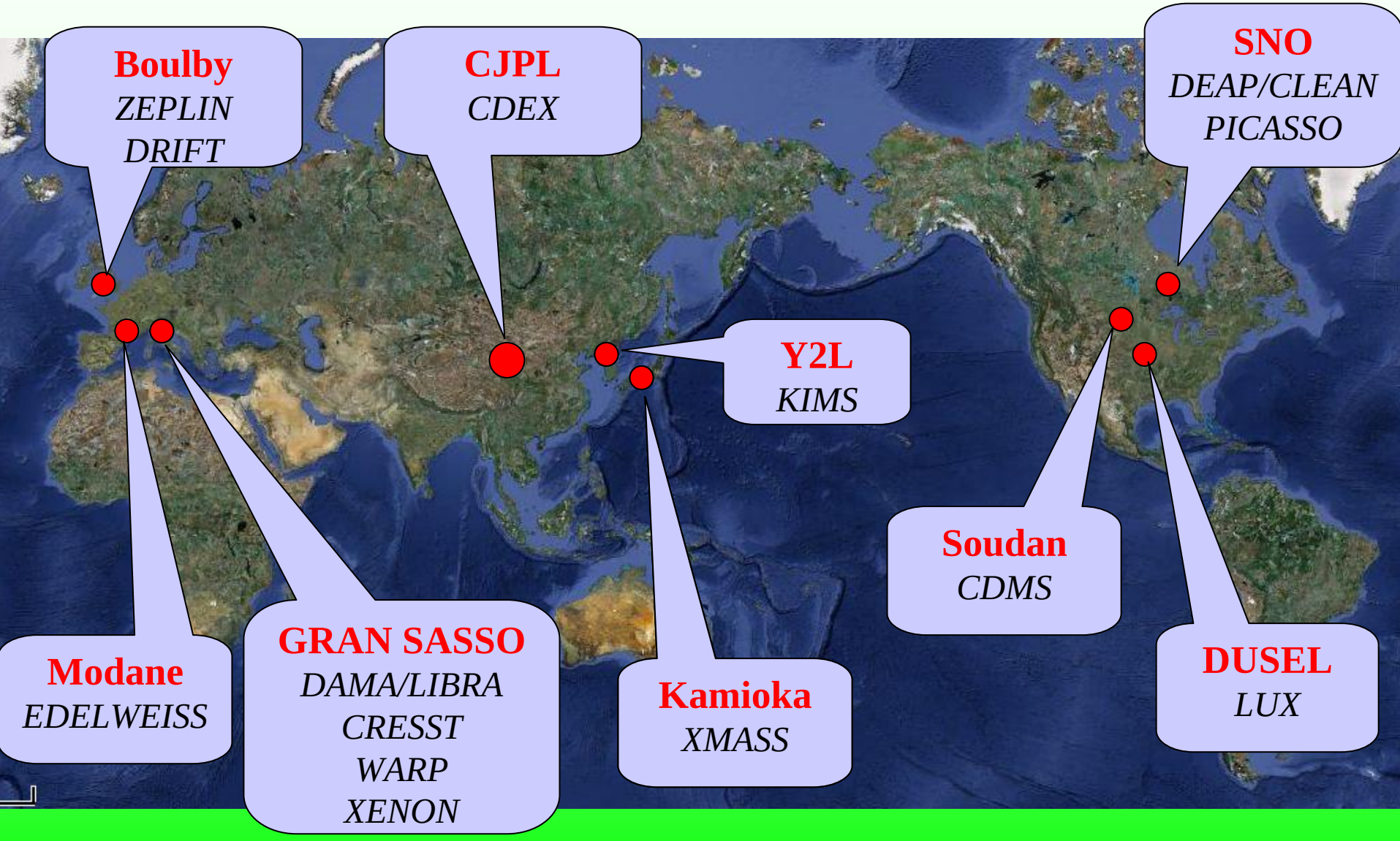
Dark Energy : "We know less than Nothing !"



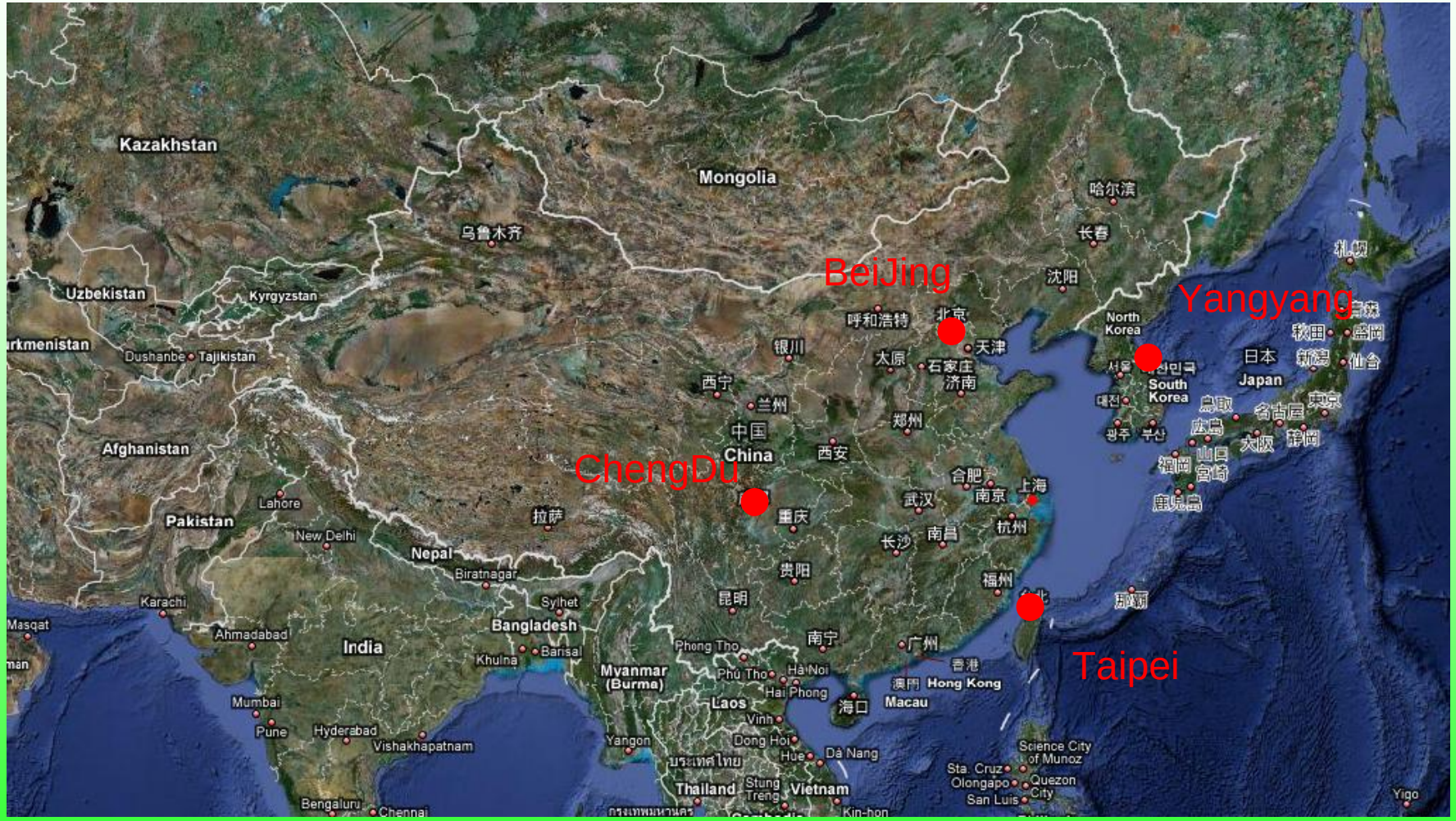
← Standard Model Matter : Understood

Dark Matter : "We know Nothing !" (but perhaps have reasonable guesses)

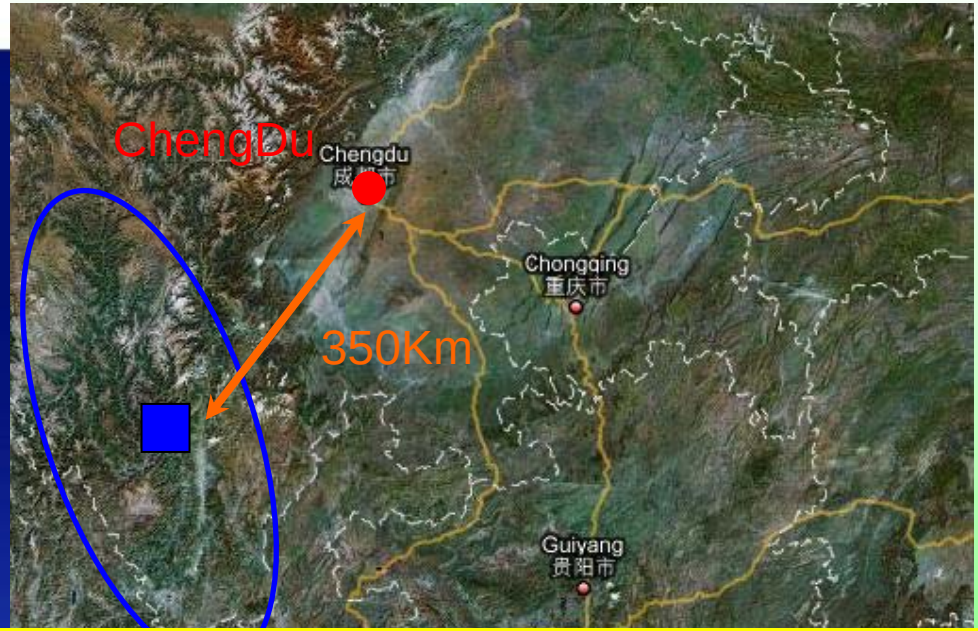
International Undergound Laboratories



The site of a new UL in China

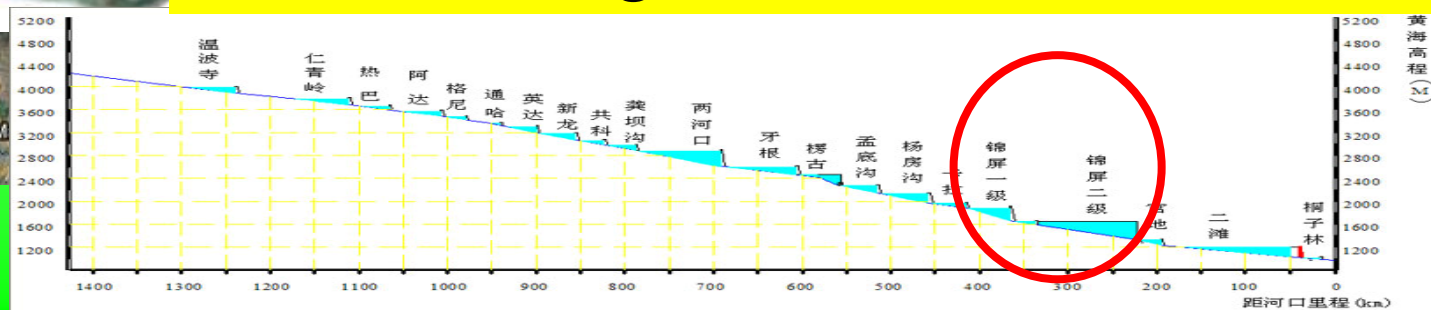


The site of a new UL in China

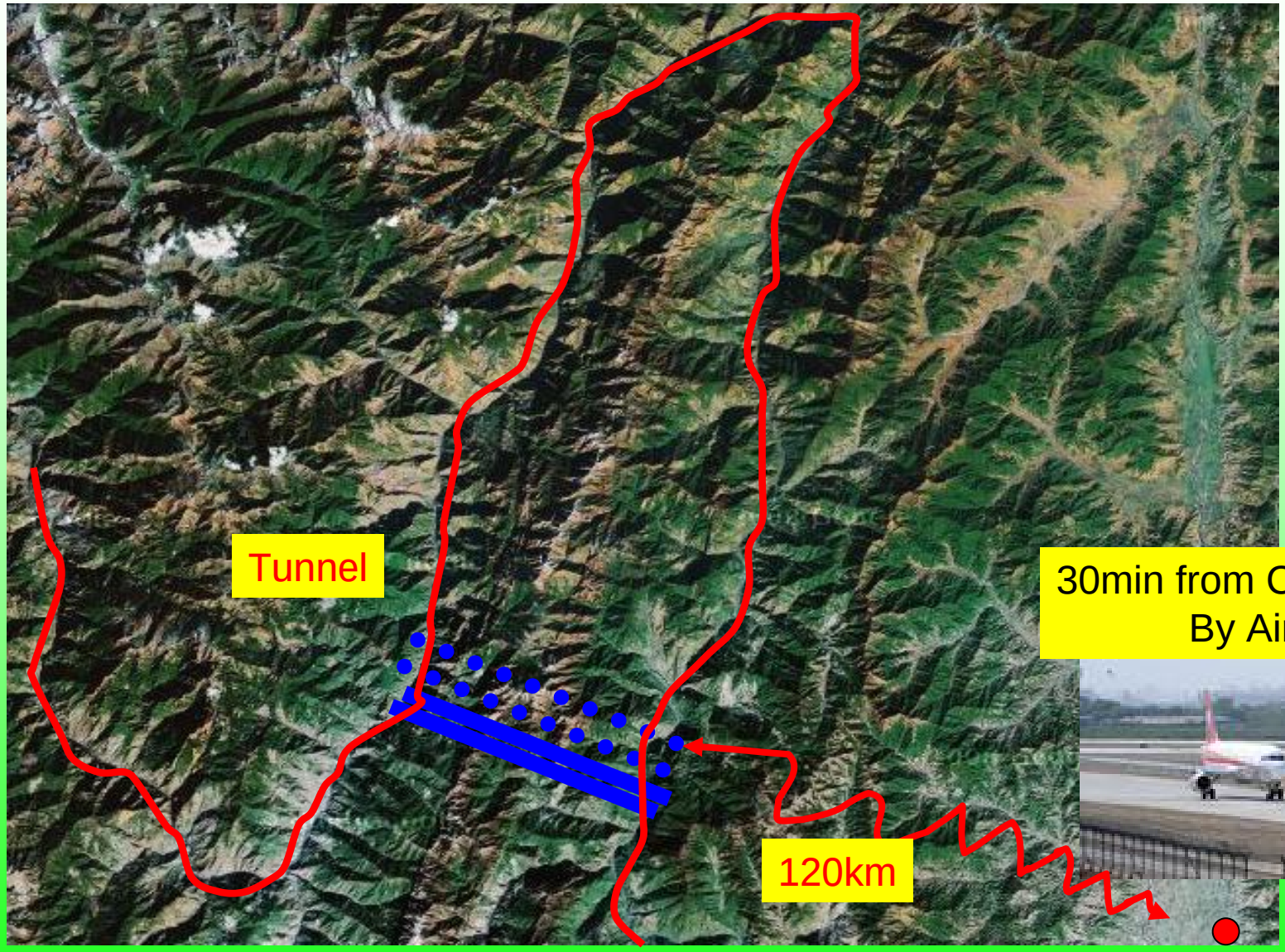


Ertan Hydropower Development Company
(EHDC)

JinPing Tunnel



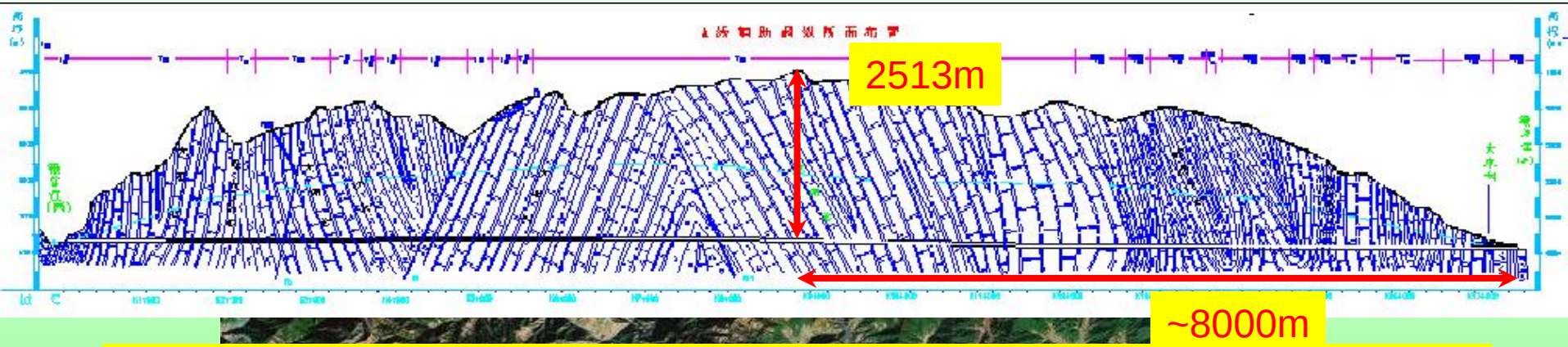
Yalong River and Jinping Mountain



Road and Tunnel

Logistic Condition of this UL

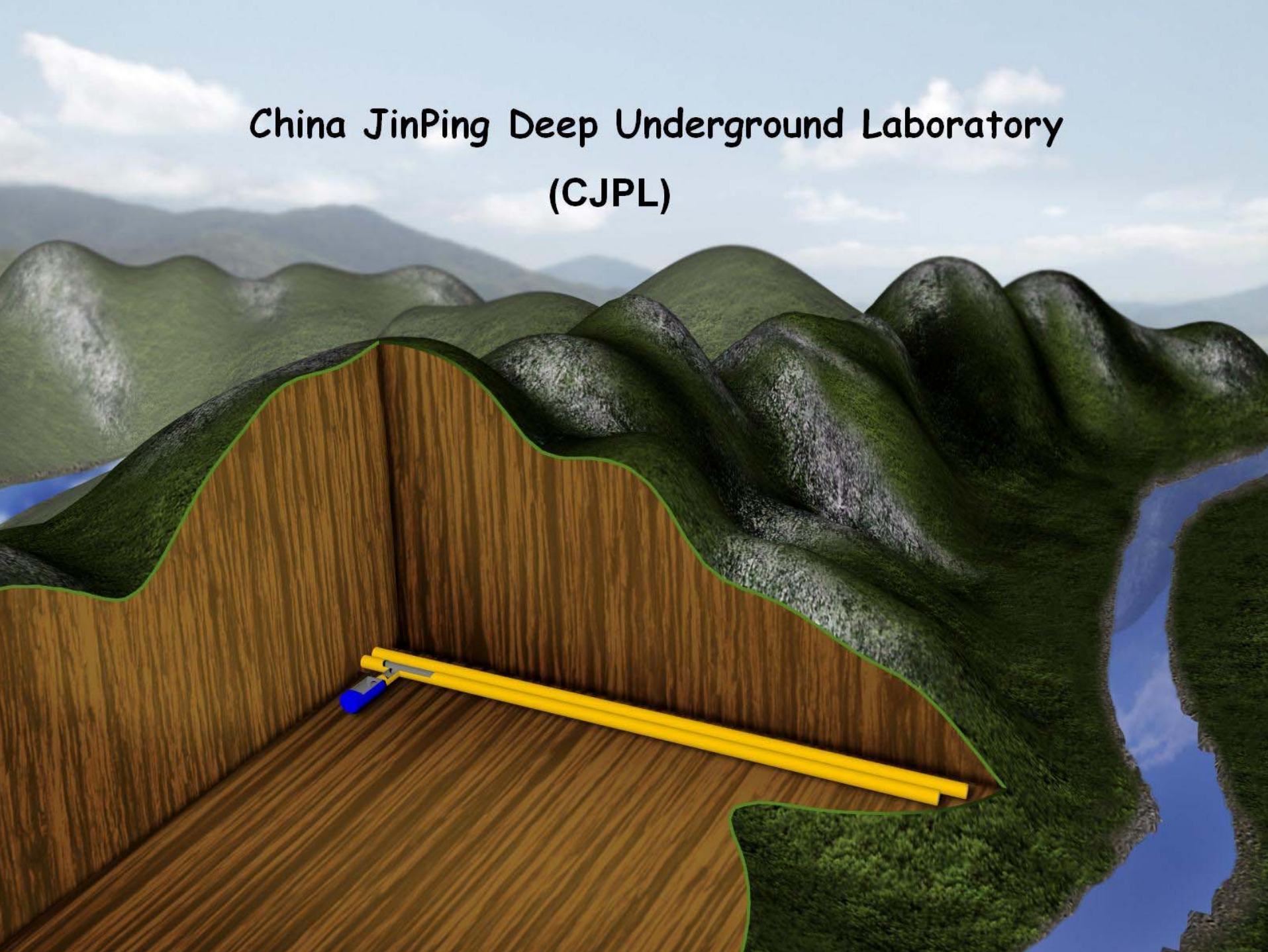
The basic conditions of CJPL



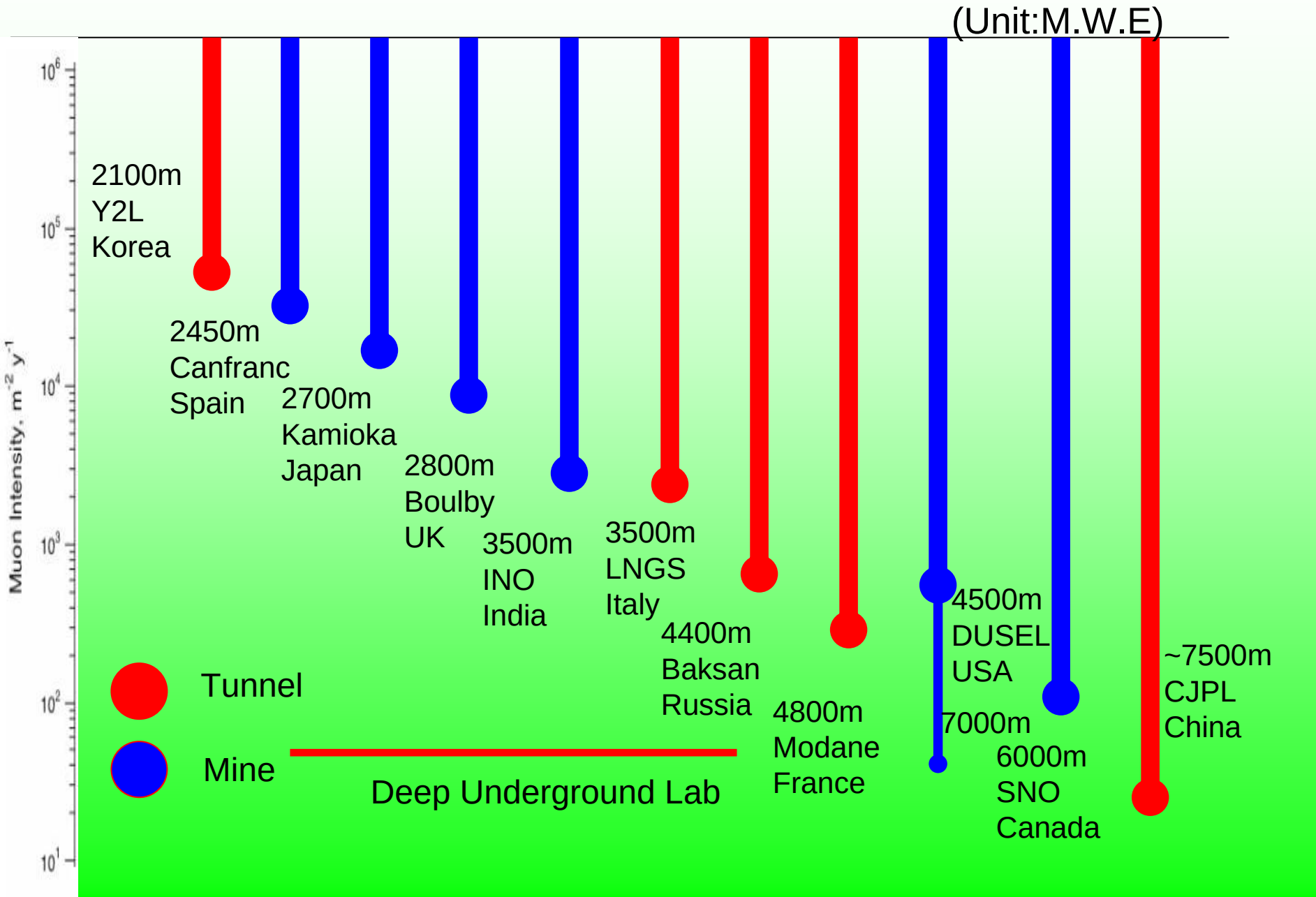
- Peak：4193m
- Maximum rock overburden: ~2500m
- Length of Tunnel: 17.5km
- Rock cover larger than 1500m:>70%
- Two tunnels for transportation

China JinPing Deep Underground Laboratory

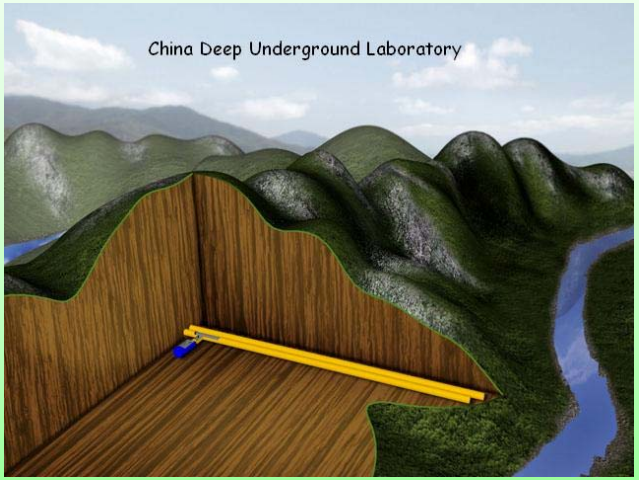
(CJPL)



Comparison of main ULs in the world



Cosmic-ray Flux



Y2L
(~6×10^{4} $m^{-2}\cdot y^{-1}$)

LNGS
(~ 2×10^{3} $m^{-2}\cdot y^{-1}$)

CJPL
(~2×10^{1} $m^{-2}\cdot y^{-1}$)

Muon flux:
--LNGS 100 times more than CJPL
--Y2L 3000 times more than CJPL

Agreement between EHDC and THU Signed

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

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

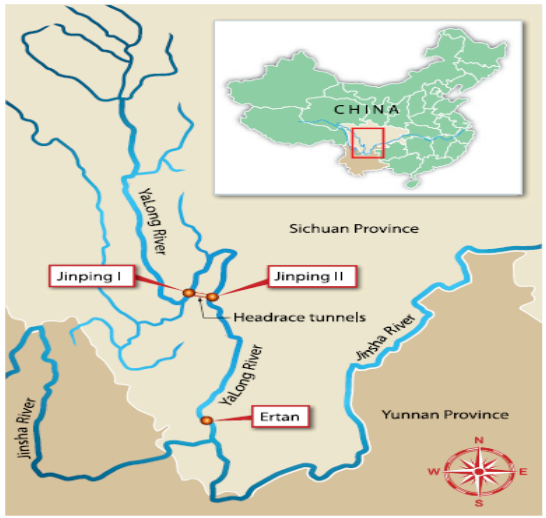
PARTICLE PHYSICS

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 candidate sites, including an underground aviation museum near Beijing and coal and gold mines around the country, all were judged too shallow or impractical.



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

Jinping, on the other hand, "looks ideal," Wang says. The lab would have approximately 2500 meters of marble and sandstone above it: more shielding than any similar site in the world. Researchers will be able to make a 1-hour drive from a regional airport to the lab's front door. And the tunnels are sized for construction equipment, promising smooth delivery of instruments and supplies.

Wang cautions that the lab is not a done deal. "It's really at a very early stage," he says. To start with, Yue's group must verify that the rock overburden really does screen out unwanted cosmic rays and that there is no unexpected radiation emanating from nearby rock or groundwater. To provide space for instruments, by the end of the year the team plans to have hollowed out a 5-meter-high, 5-meter-wide, 30-meter-long chamber. They will then measure cosmic ray flux and background radiation for about 6 months. And they will begin at least one experiment. Yue is forming a collaboration to install a germanium detector to search for a postulated component of dark matter known as WIMPs, or weakly interacting massive particles. Chinese physicists are also talking about observations of atmospheric and solar neutrinos as well as experiments to watch for neutrinoless double-beta decay, an extremely rare phenomenon that might help refine estimates of neutrino mass.

Yue doesn't yet know what the first phase will cost, as design efforts are just starting. "But [Tsinghua] university has promised strong support," he says, and they are seeking funds from the science ministry. If the project develops as hoped, says Yue, "we would want to get more universities and institutions from China and around the world to join us and push this project ahead."

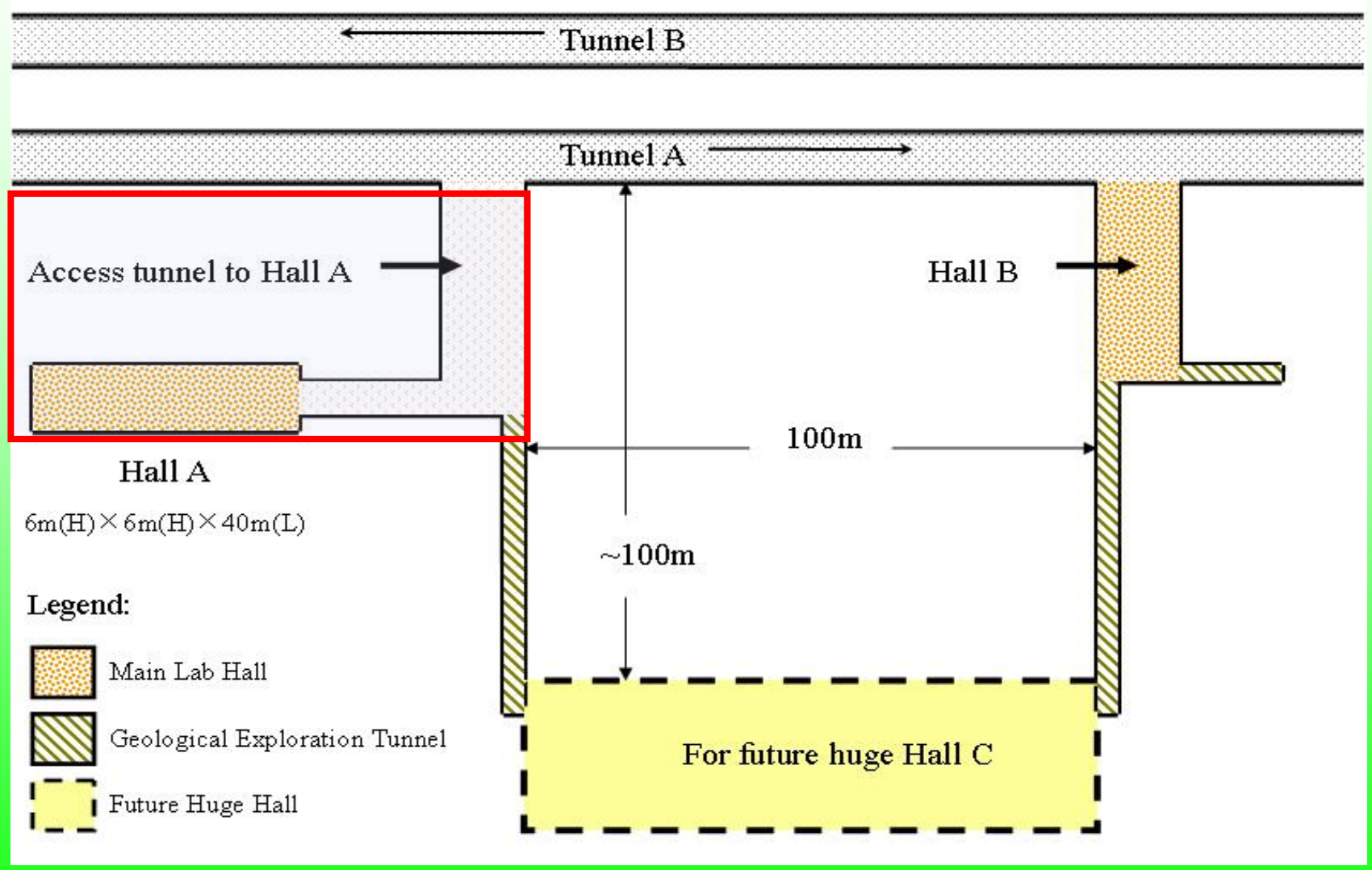
The good fortune befell physicists thanks to a mammoth hydroelectric project about 350 kilometers southwest of Chengdu, the capital of Sichuan Province, where the Yalong River makes a 150-kilometer-long U-turn around Jinping Mountain. Ertan Hydropower is building two dams: Jinping 1 at the start of the U-turn and Jinping 2 at the end. To move workers and materials between the construction sites, Ertan blasted a pair of 17-kilometer-

CREDITS (TOP TO BOTTOM): YUE QIAN; INTERNATIONAL WATER POWER & DAM CONSTRUCTION

Published by AAAS

The plan of CJPL construction

Phase-I: 6*6*40m Lab（RED Square）




2010/04/24


2010/04/24


2010/04/27


2010/04/28

China Darkmatter EXperiment (CDEX)

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(National Tsinghua University, NTHU)
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(TEXONO Collaboration)
S.K. Kim
(KIMS Collaboration)

PI

CDEX schedule

Phase-I (2010.9-2011.3)

-- 20g ULE-HPGe detector @ CDUL
-- Shielding system construction
-- HPGe detector for radioactive measurement
-- Radon monitor system

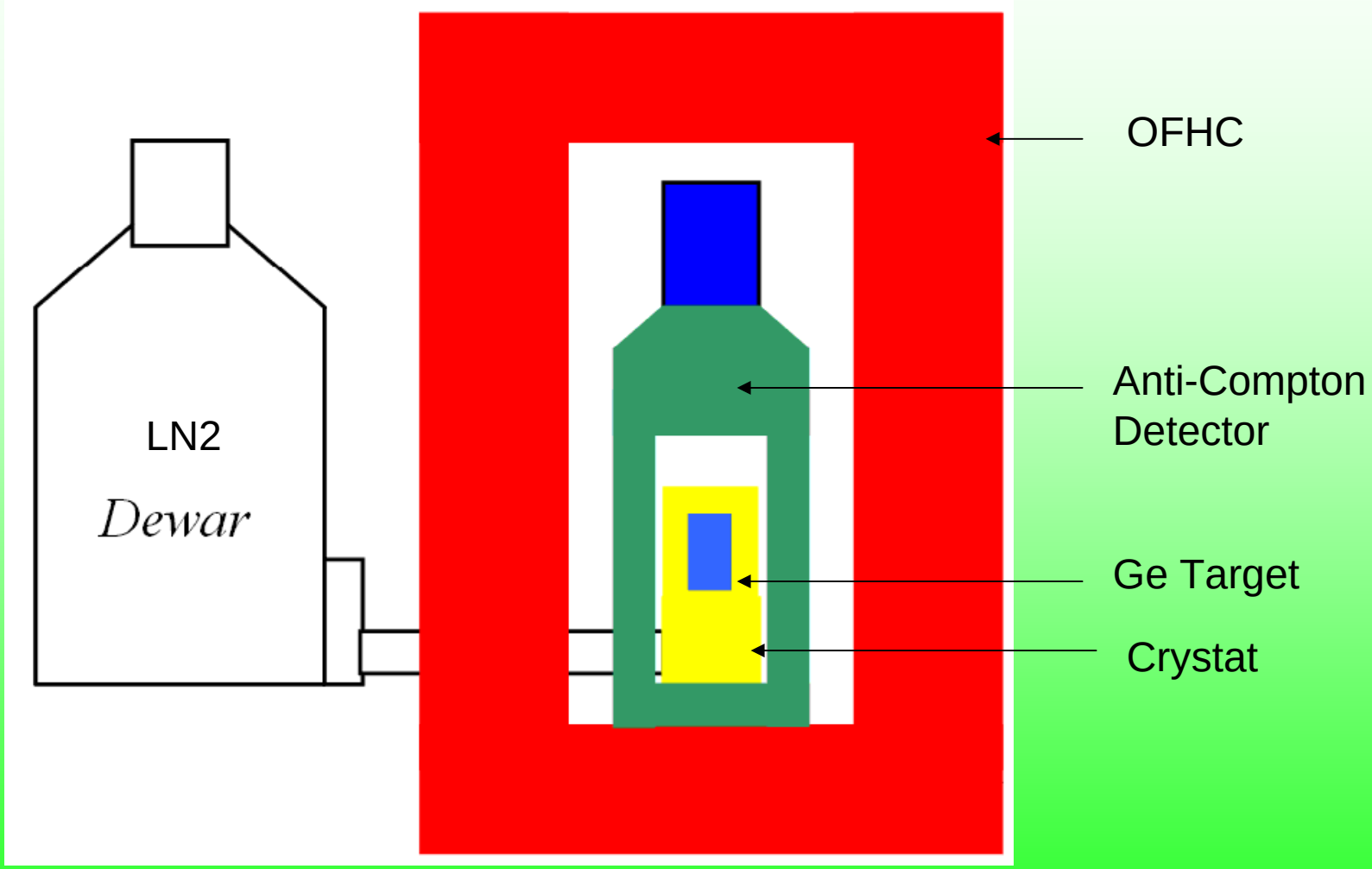
Phase-II (2010.12-2011.12)

-- ULE-HPGe detector(~1500g)

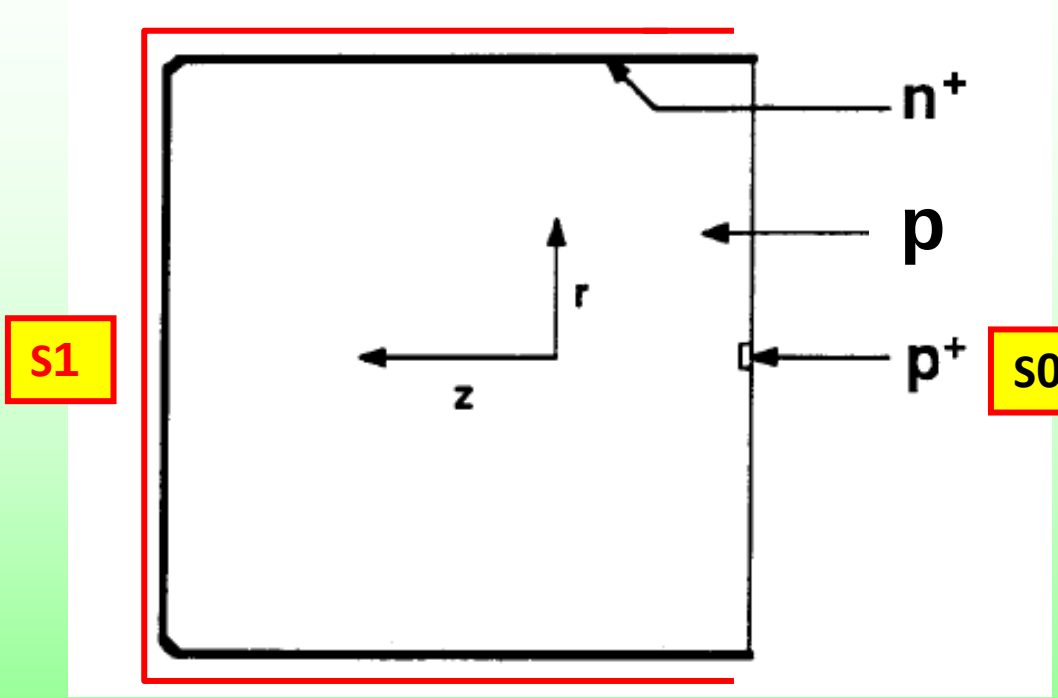
Phase-III (2012-)

-- ULE-HPGe detector(~10kg scale)

Detector and Shielding



Detector Scale-up Plans: Point Contact Ge Detector



- Large Mass & Low Threshold -- Proposed *[Luke 80's]* ; successful demonstration *[CoGeNT 2007]*
- Position-sensitive from drift-profile pulse shape
- 500-g built ; KS data taking Nov 2008 at KS lab
- 1000-g detector delivered Dec 2010

Start point:

20g ULE-HPGe

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]

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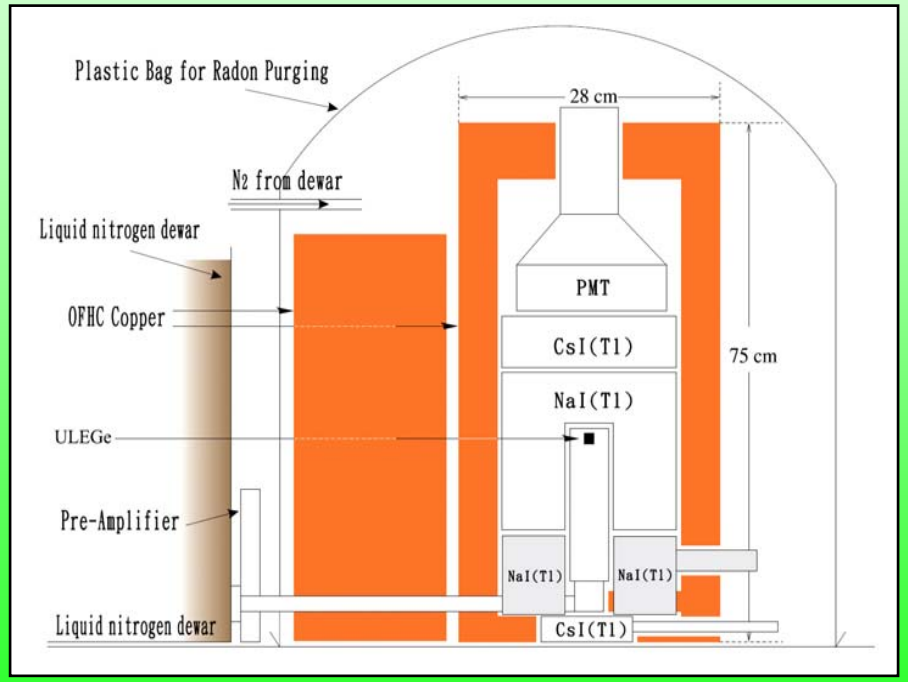
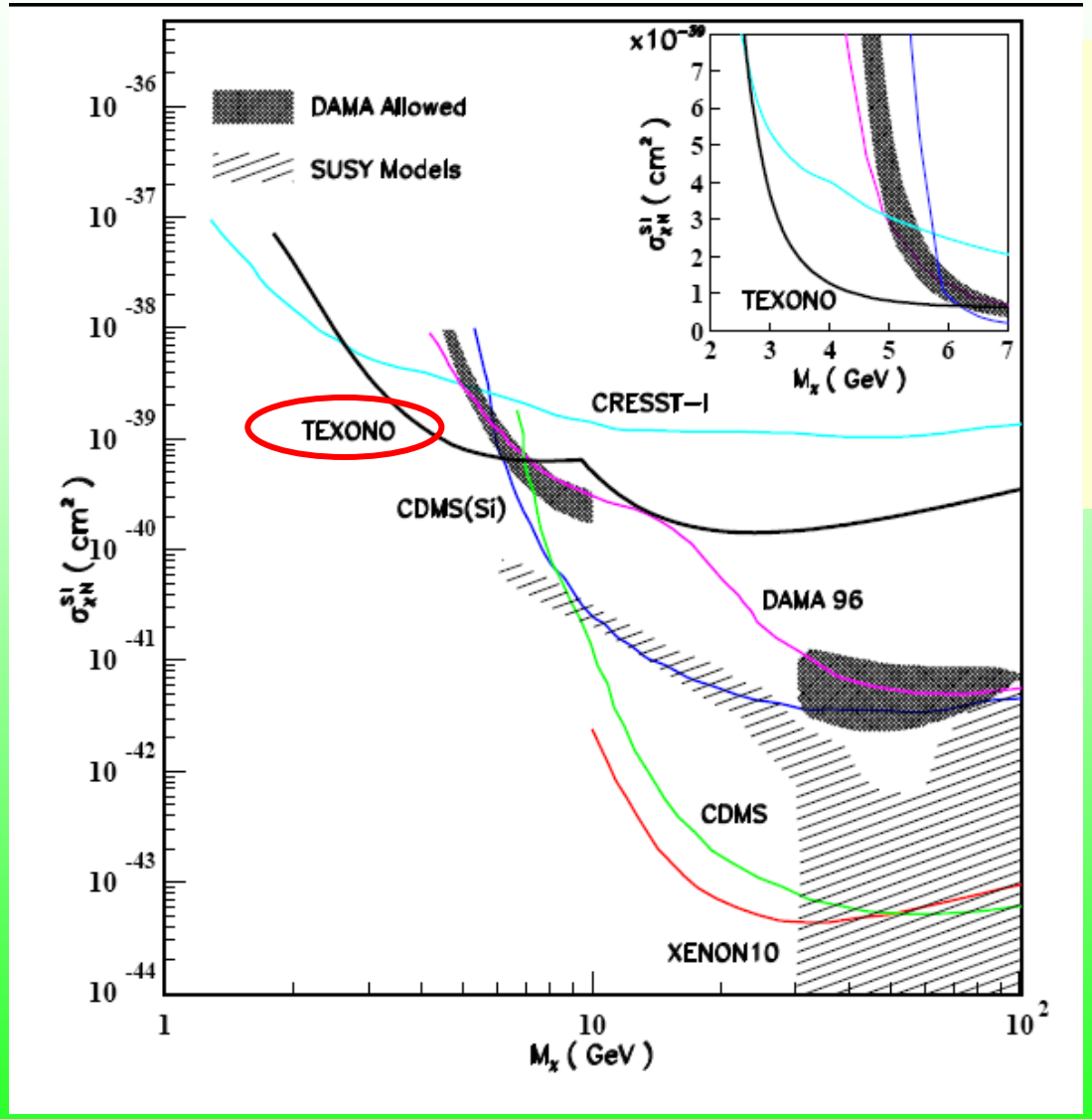


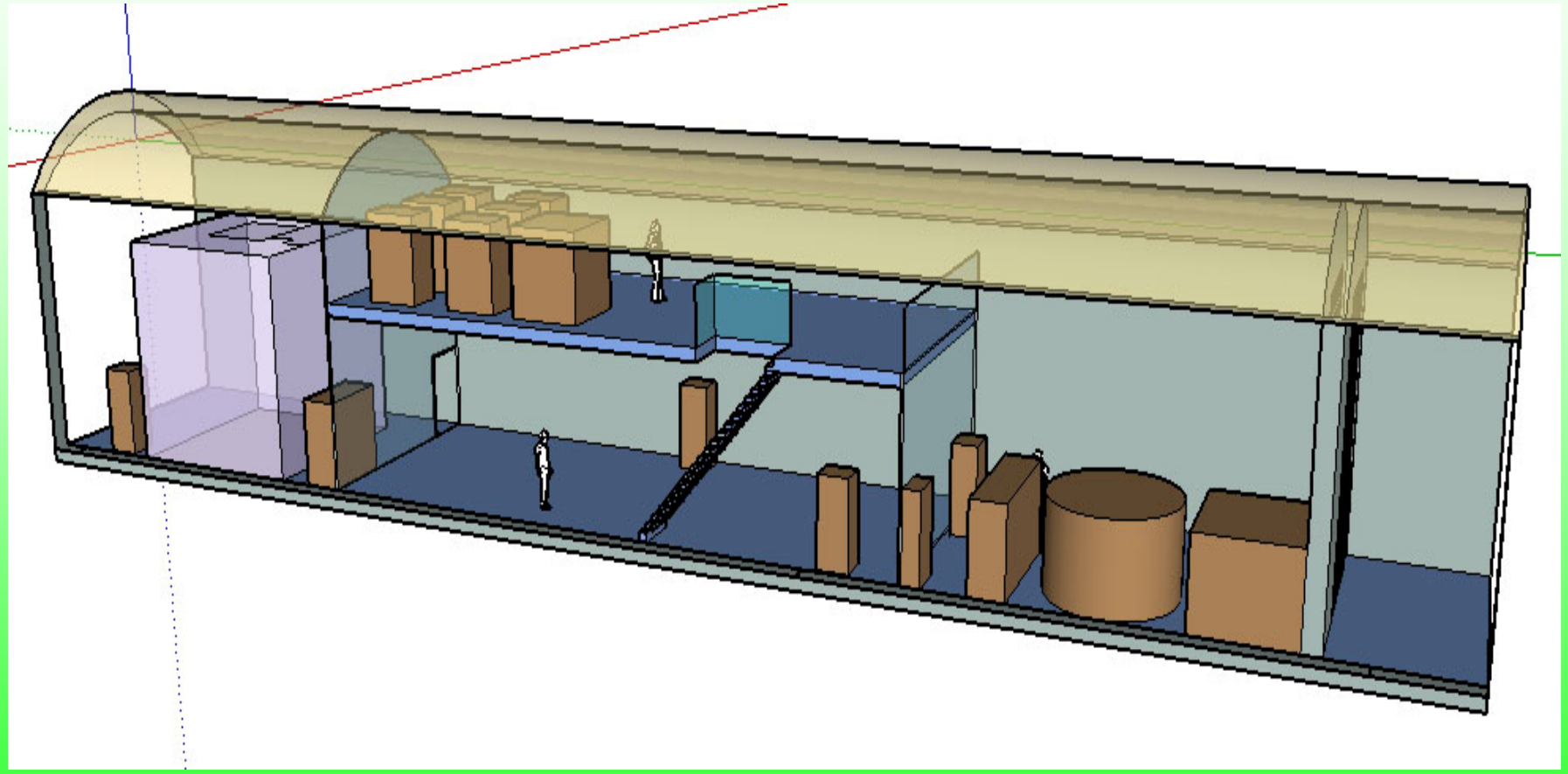
暗物质排除线



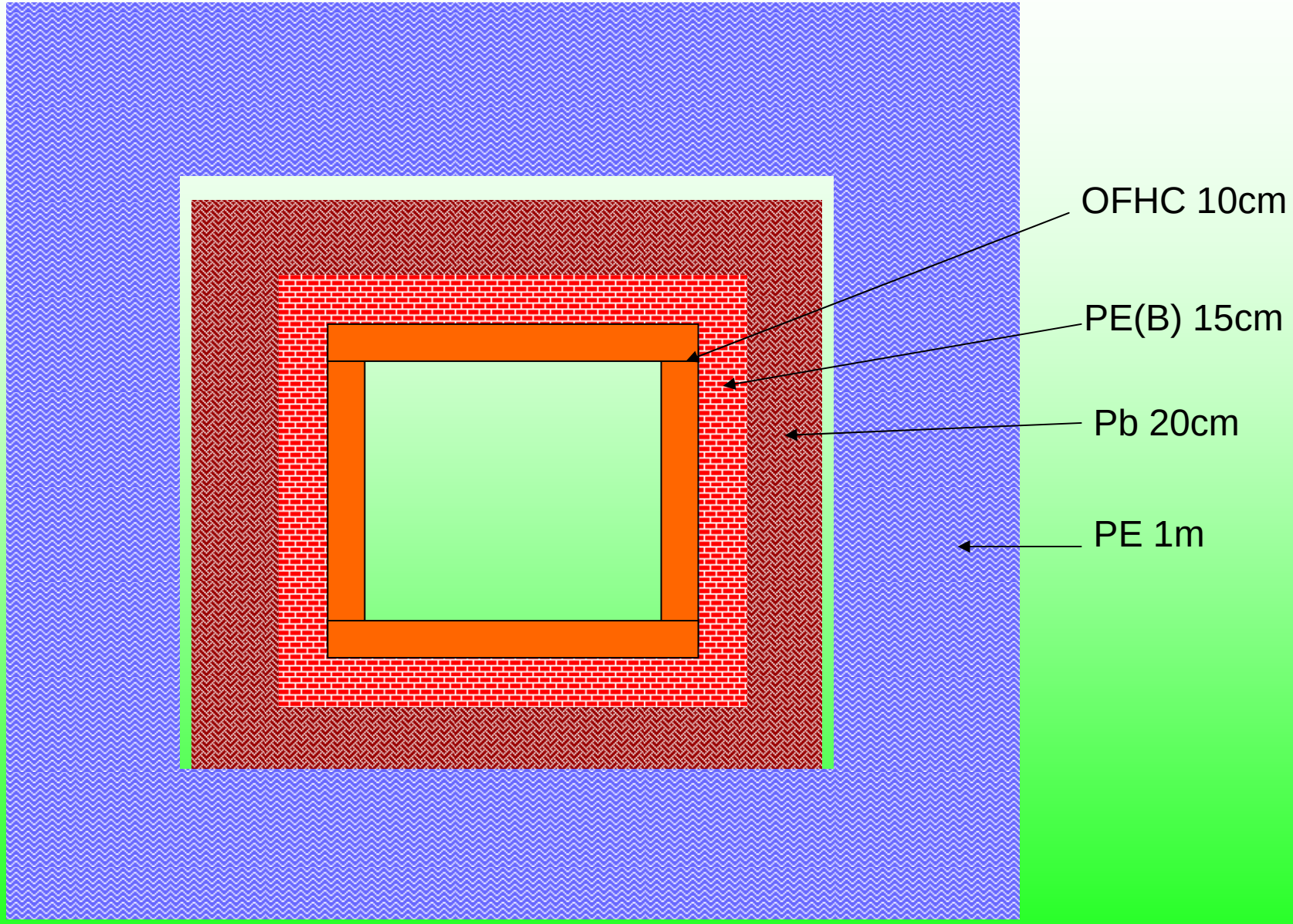
TEXONO : 20 g ULEGe at 220 eV threshold ⇒ low WIMP masses *[PRD 2009]*

Data Taking at KS with 500g Point-Contact Ge Underway

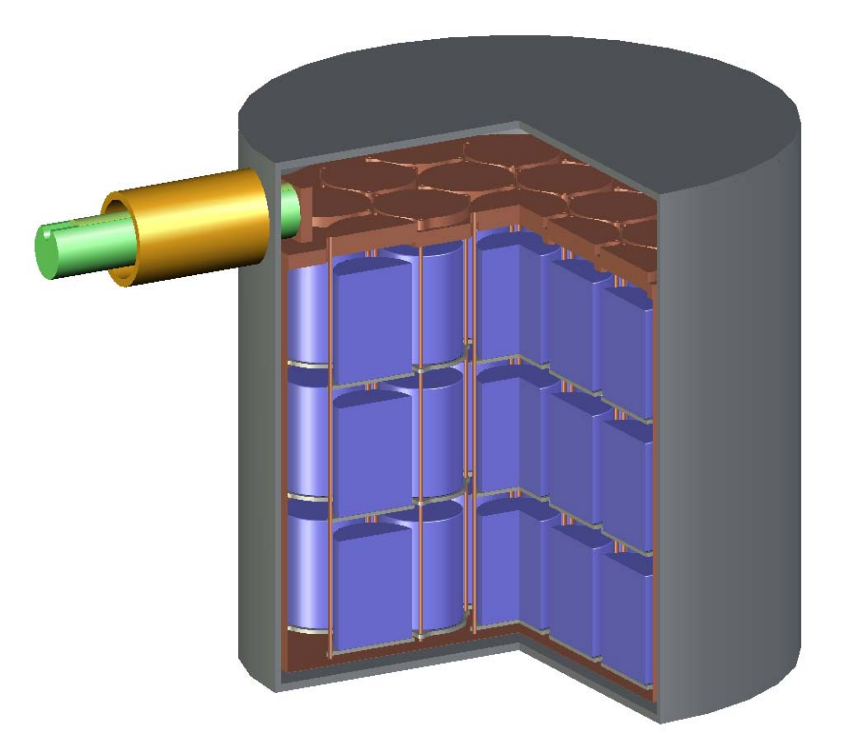
CJPL Main Hall Layout

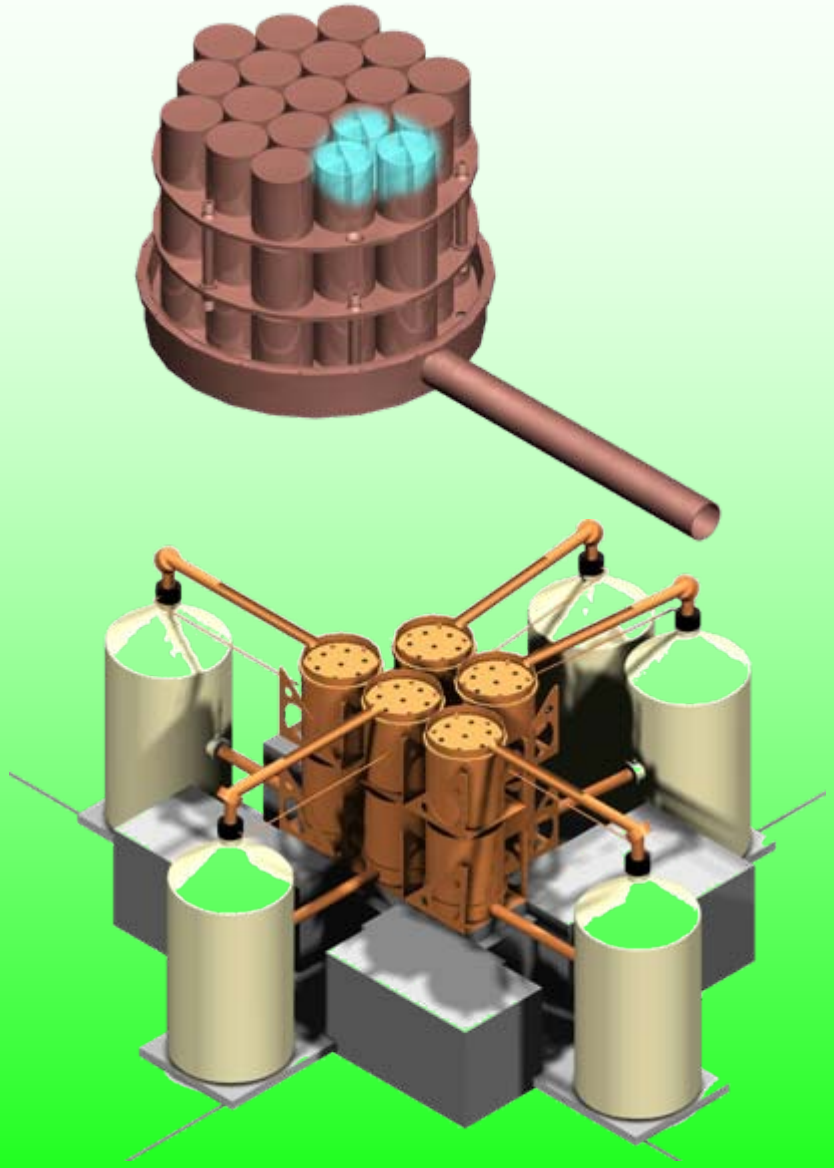


Shielding System@CJPL

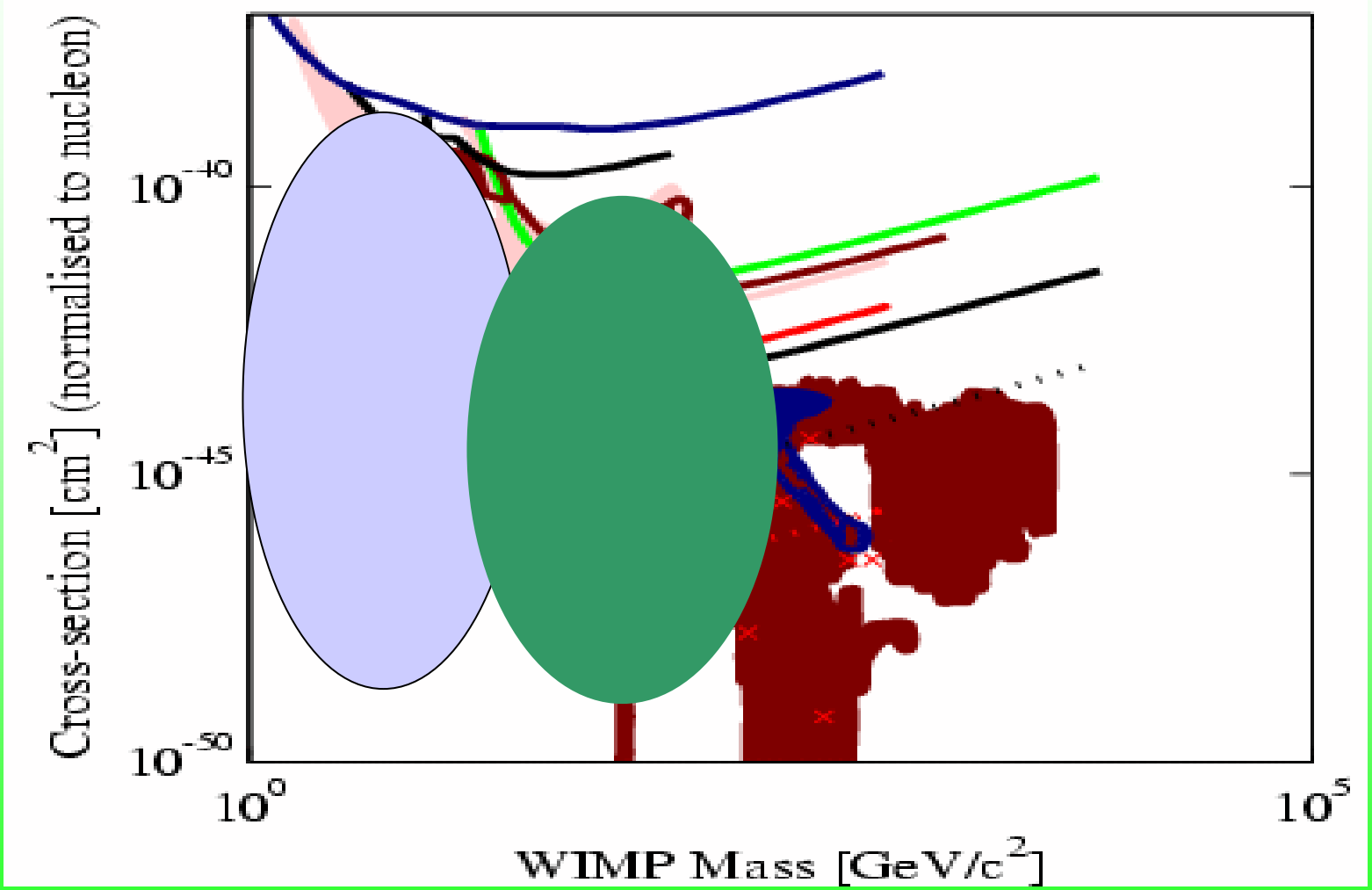


1ton Ge Array Detector system





CDEX target


Cross-section [cm^2] (normalised to nucleon)
10^{-40}
10^{-45}
10^{-50}
10^0
10^5
WIMP Mass [GeV/c^2]

Summary

- ✓ CJPL with 2500 rock overburden has been constructed and internal setup is under installation. In Sept. 2010, CJPL will be run formally.
- ✓ CJPL with dimensions: 6.5m(W)*8m(H)*40m(L)
- ✓ A new Collaboration CDEX has been setup for DM search with ULE-HPGe detector. CDEX will start to run its first prototype detector system from September 2010 on.
- ✓ The neutron flux, muon flux, gamma background, Radon concentration will be measured elaborately.
- ✓ Ultra-Low background measurement system based HPGe detector will be setup for material selection for dark matter experiment and another application.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