

CDEX dark matter experiment: Status and prospects

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

Outline

1. Introduction to CDEX
2. Status and prospects of CDEX
3. Summary and outlook

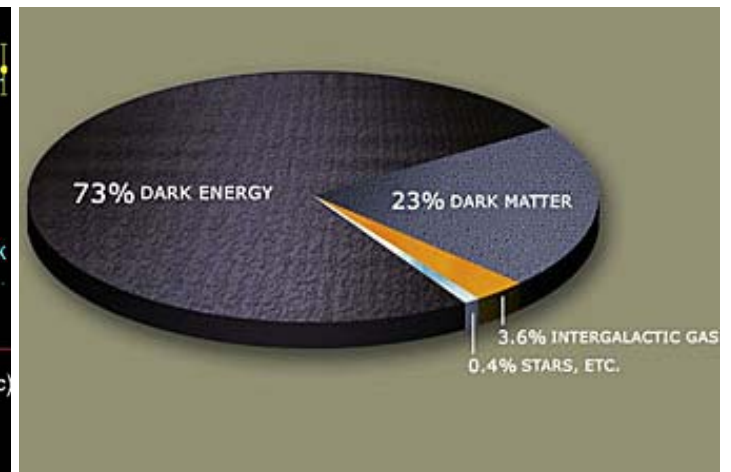
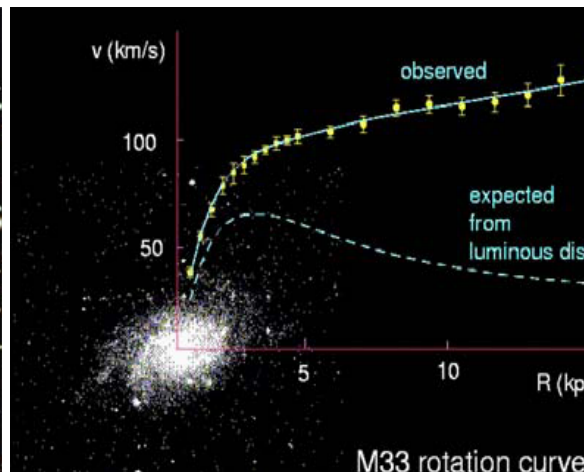
1. Introduction to CDEX

CJPL 

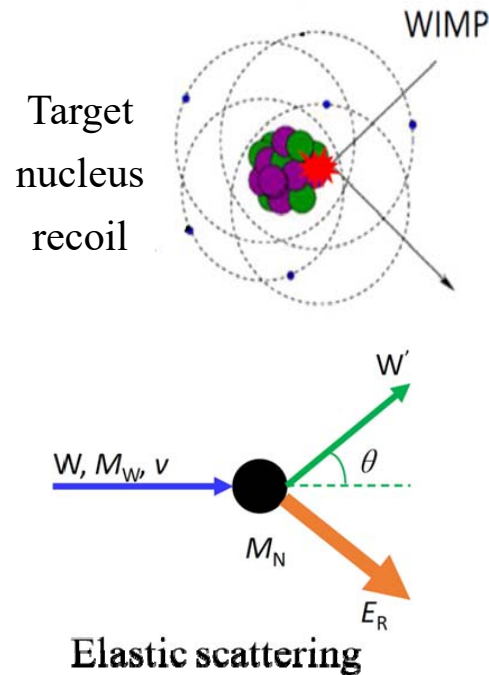
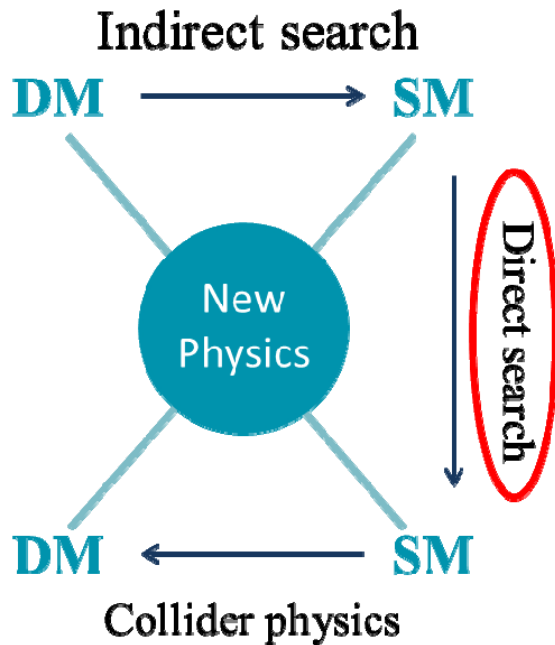
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Dark Matter

- Astronomical evidences of DM's existence.
- DM not observed and nature unknown.
- Weakly Interacting Massive Particles(WIMPs) well motivated candidate.



CDEX: China Dark matter EXperiment



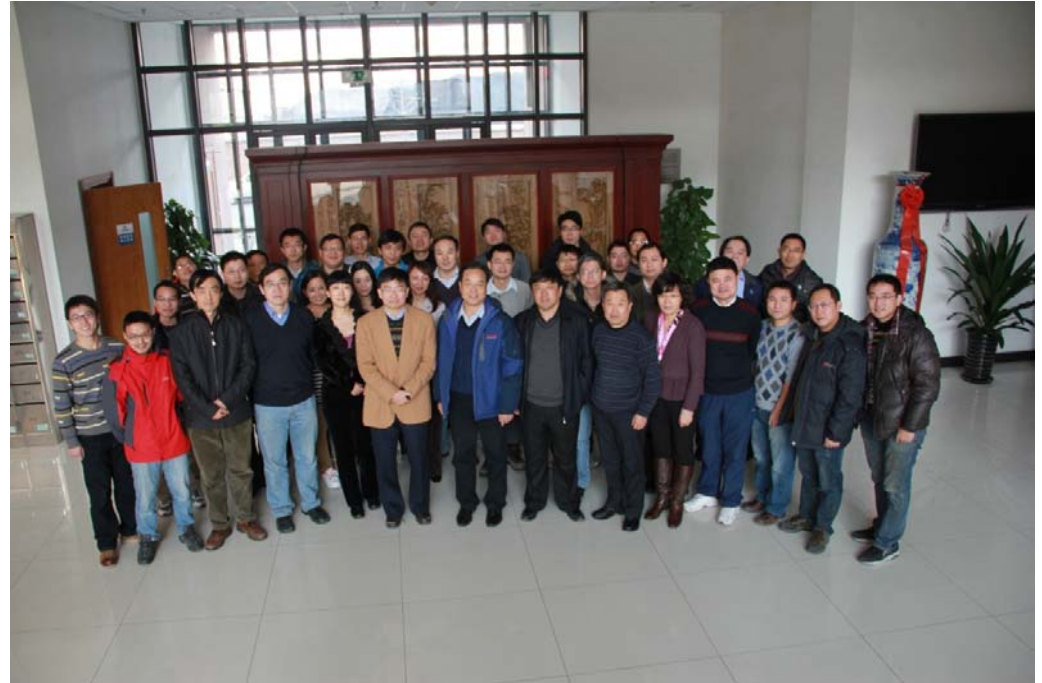
- Point-contact HPGe detector (PCGe):
 - ✓ Low energy threshold ($\sim 100\text{eVee}$)
 - ✓ Very good energy resolution
 - ✓ Easy to scale up



CDEX: direct detection of low mass dark matter with PCGe at China JinPing underground Laboratory(CJPL).

CDEX collaboration

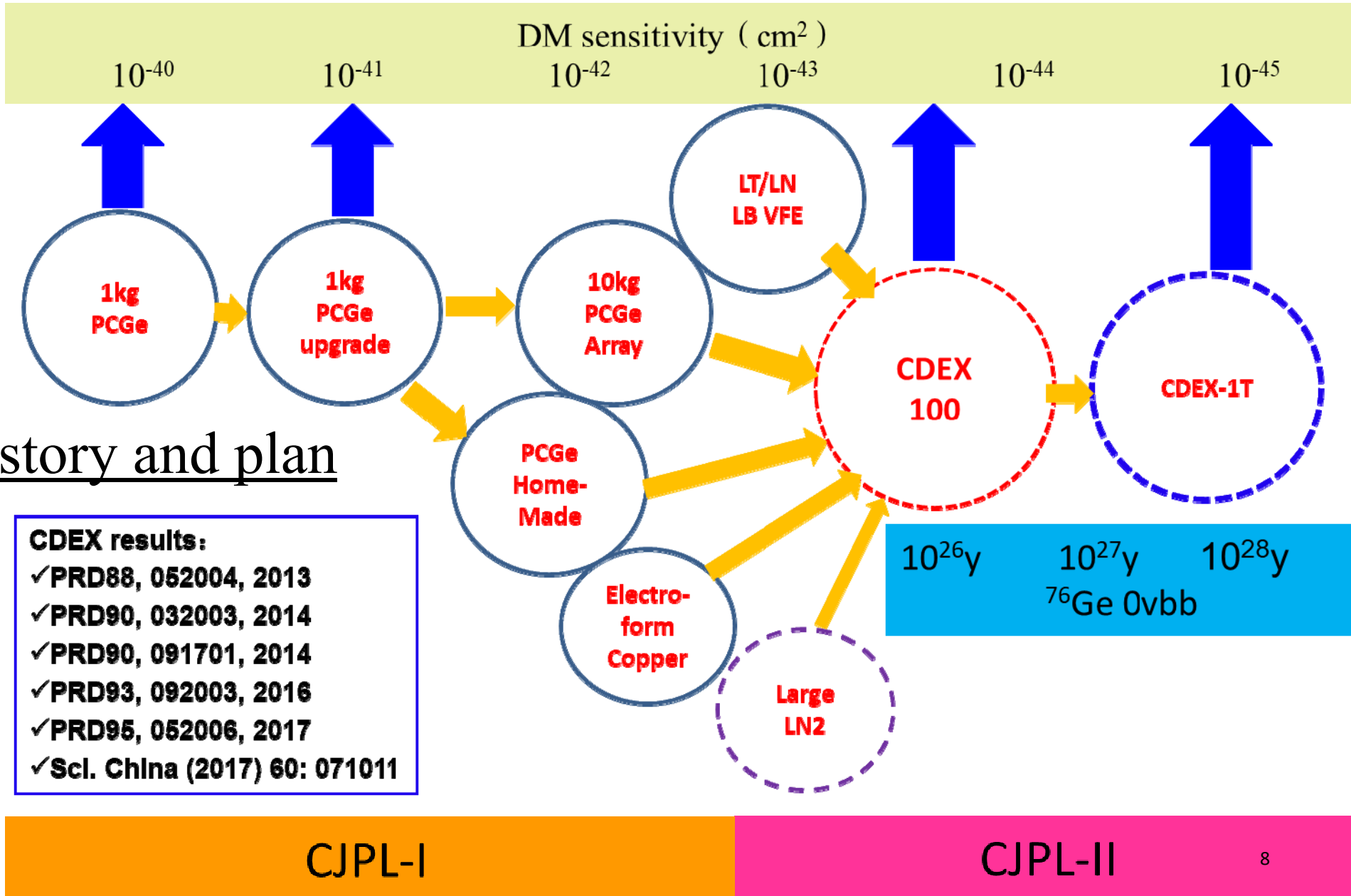
- Formed in 2009.
 - Tsinghua University, THU;
 - Sichuan University, SCU;
 - Nankai University, NKU;
 - China Institute of Atomic Energy, CIAE;
 - Yalong River Hydropower Company;
- Collaborating with TEXONO and KIMS group.



2. Status and prospects of CDEX

CJPL 

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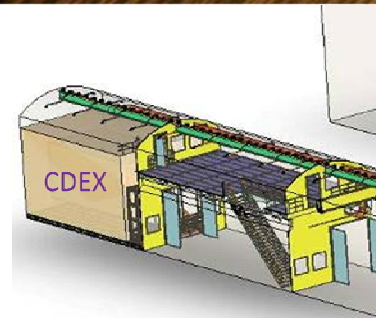
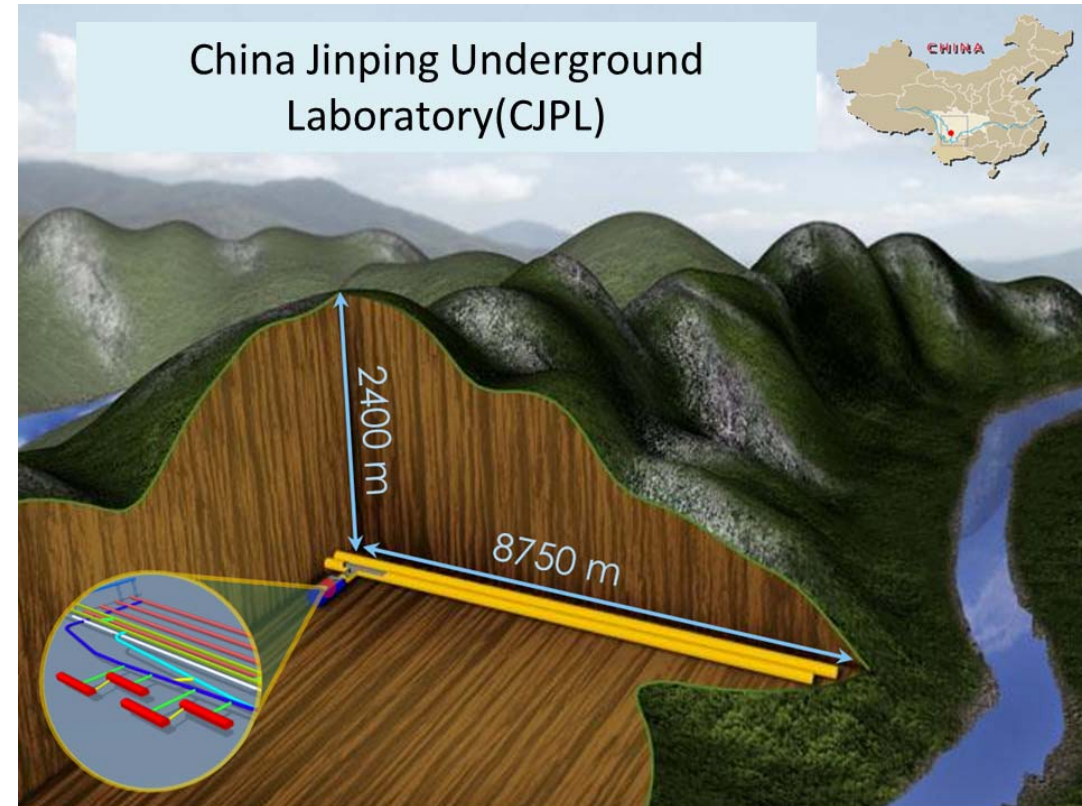


CDEX history and plan

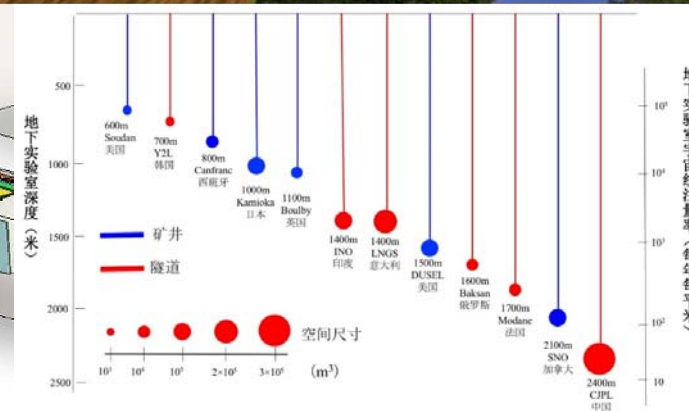
- CDEX results:**
- ✓PRD88, 052004, 2013
 - ✓PRD90, 032003, 2014
 - ✓PRD90, 091701, 2014
 - ✓PRD93, 092003, 2016
 - ✓PRD95, 052006, 2017
 - ✓Sci. China (2017) 60: 071011

CDEX stages

- CDEX-1: Development of HPGe detector, its background understanding and the studies of its performances based on 1kg-scale-mass HPGe detector.
- CDEX-10: Performances of HPGe array detector system and its passive/active shielding systems.
- CDEX-10X: Fabrication of HPGe detector and Germanium crystal growth by CDEX.

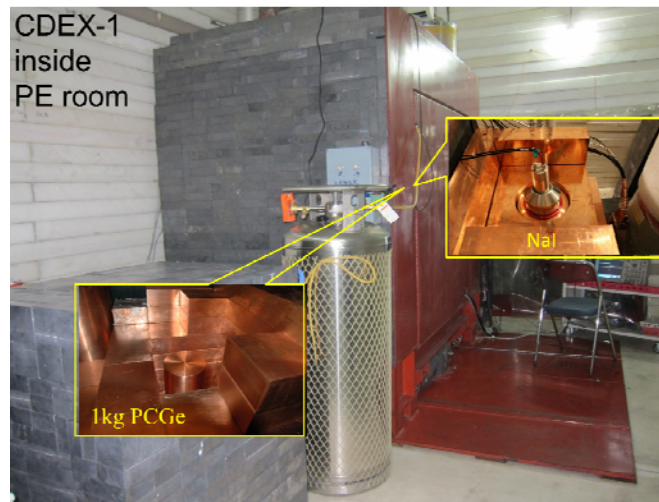


Layout of CJPL-I

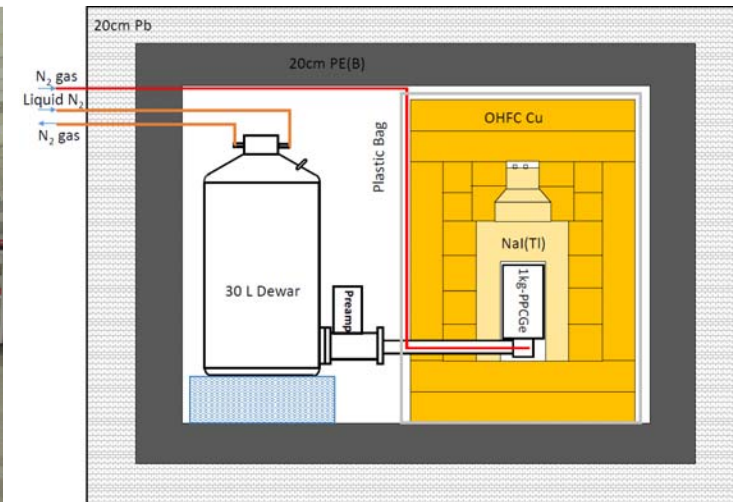


CDEX1 experiment

- CDEX1A
 - Designed and studied the first 1kg-PPCGe since 2010.
 - NaI(Tl) used as anti-Compton detector
- CDEX1B
 - Upgraded from CDEX1A: lower E threshold

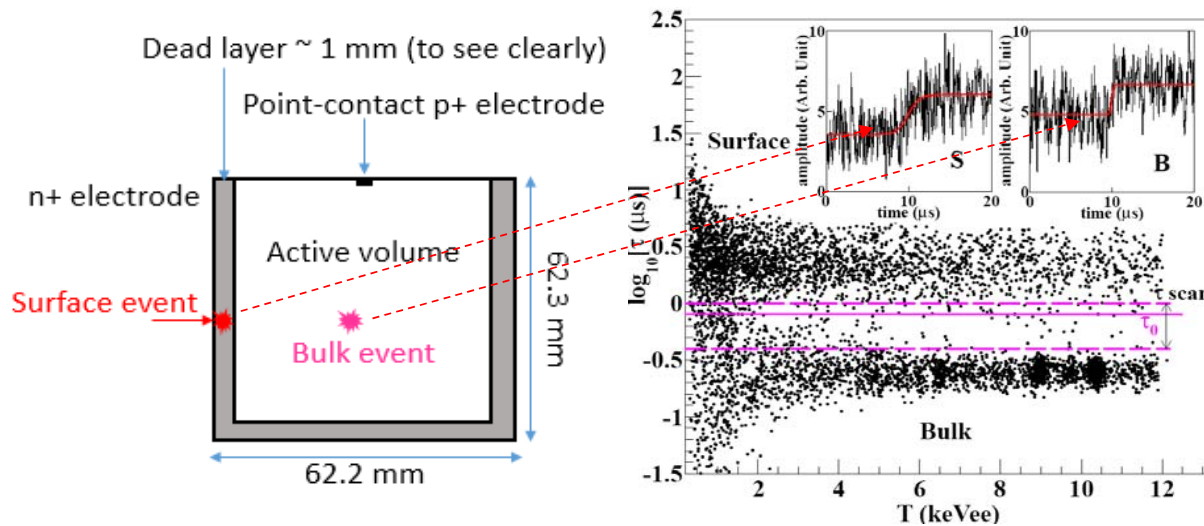


1kgPCGe+NaI(Tl)

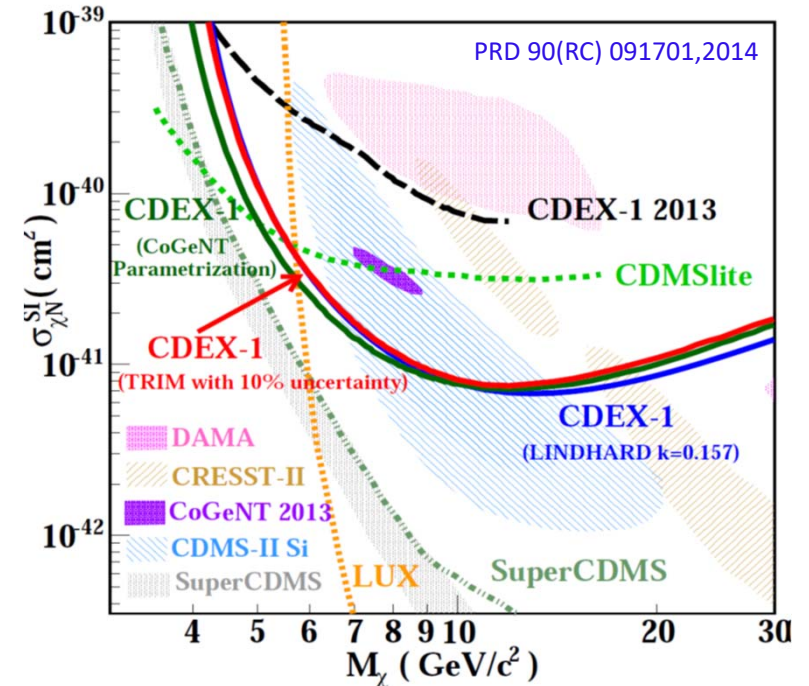


CDEX1A 2014 results

- B/S disc. to get rid of the Surface events with slow rise-time and partial charge collection;
- 1/3 background lower with AC detector;
- The best sensitivity by PCGe and Exclude the regions favored by CoGeNT.



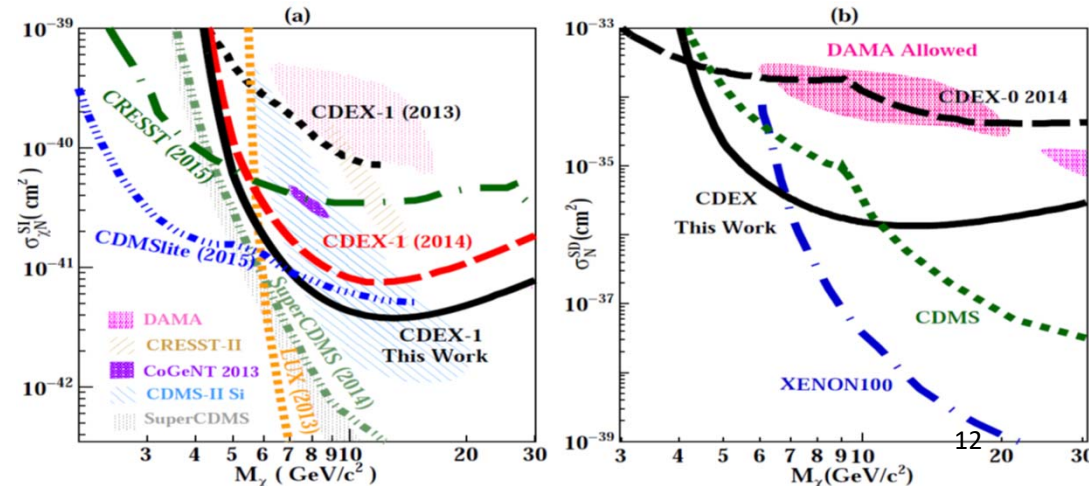
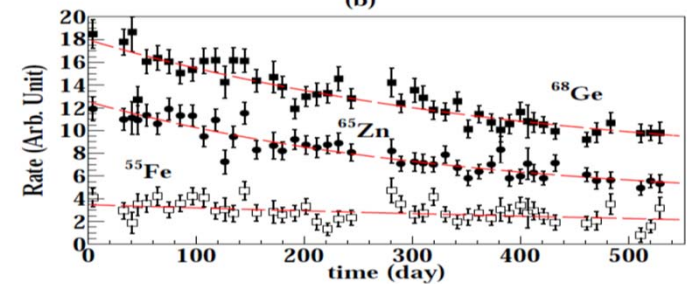
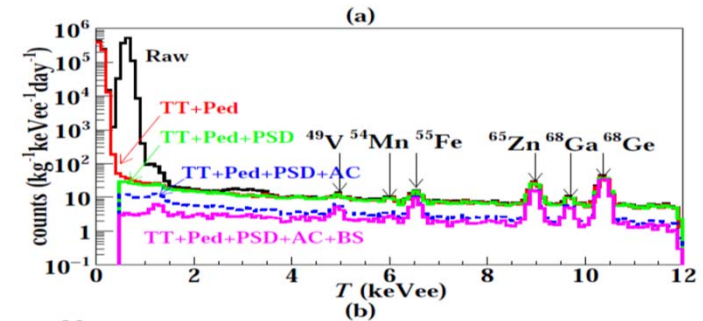
Bulk/Surface Discrimination



CDEX-1A 2016 results

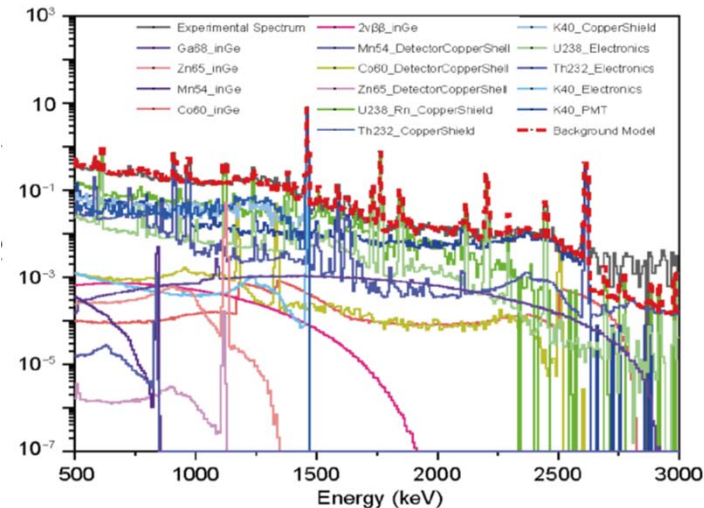
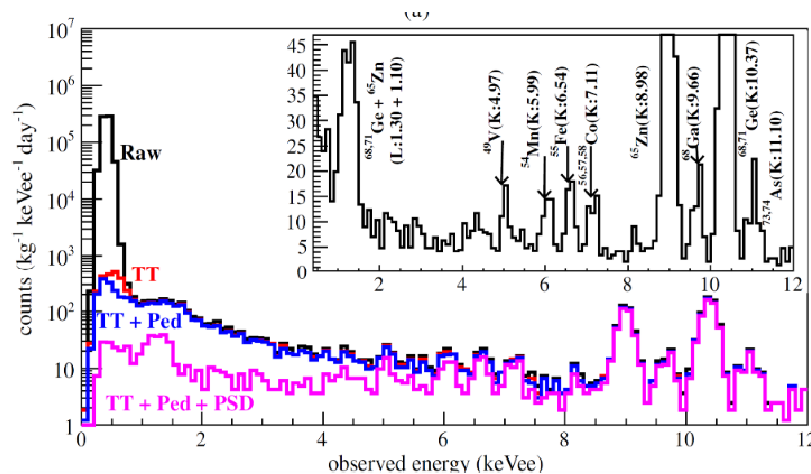
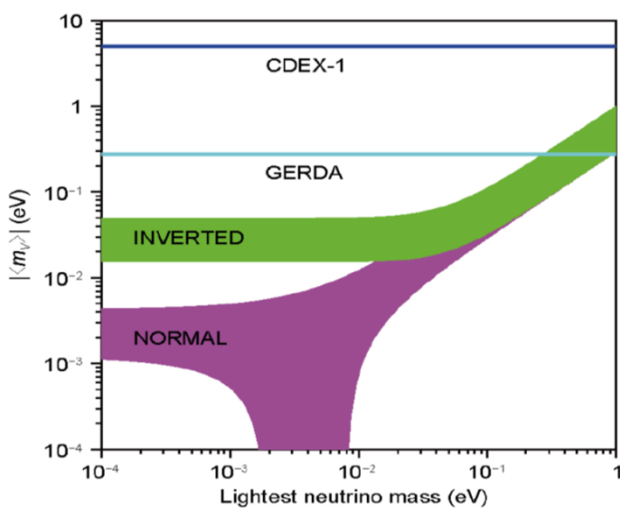
PRD93, 092003, 2016

- CDEX-1A run > 500 day, totally ~336 d·kg dataset;
- Flat background level decay from ~10 to ~3 cpkkd;
- Based on the decay of K/L x-ray peaks from the cosmogenic nuclei, the crystal history may be traced;
- ~2 times more sensitive than 2014 SI result and best sensitivity at 4-7 GeV region for SD;
- Annual Modulation analysis with >1 year data in prep.



CDEX-1 0νββ result

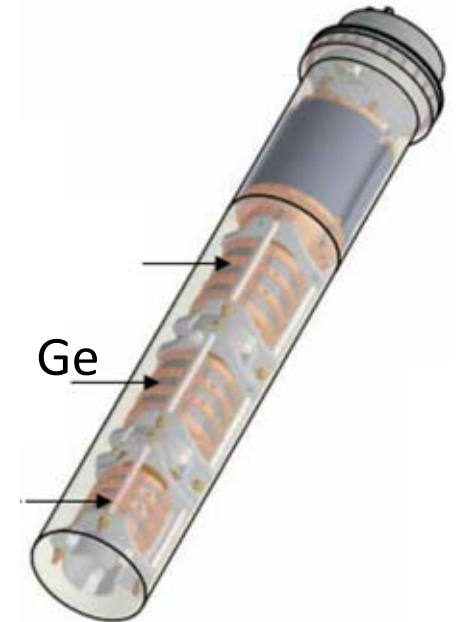
- First (preliminary) ^{76}Ge 0νββ result from CDEX-1 data;
- Method developed to estimate the level of cosmogenic events @ 2MeV based on cosmogenic characteristic X-ray peaks <10keV;



$$T_{1/2}^{0\nu} \geq 6.43 \times 10^{22} \text{ yr}, 90\% \text{ C.L.}$$

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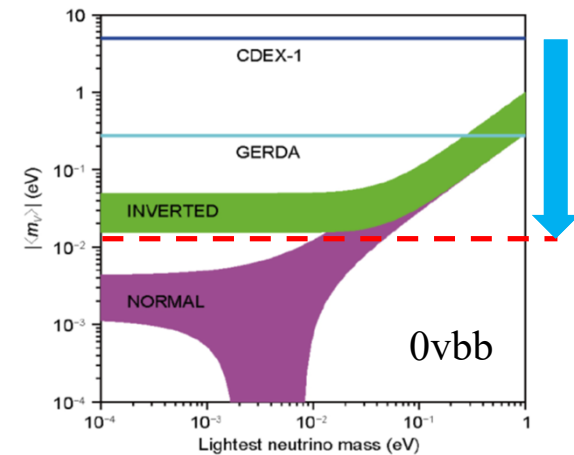
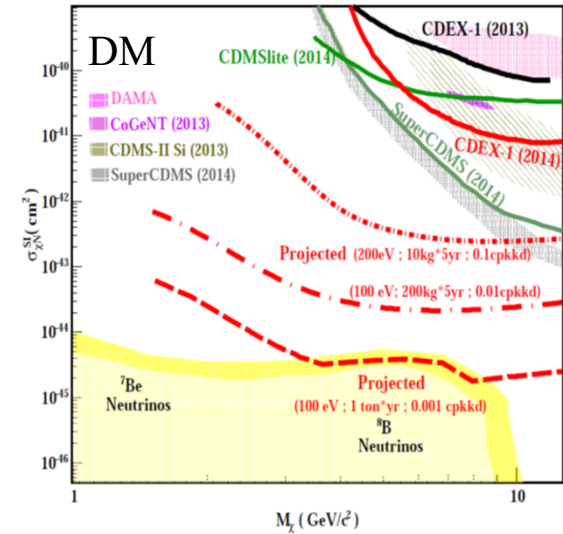
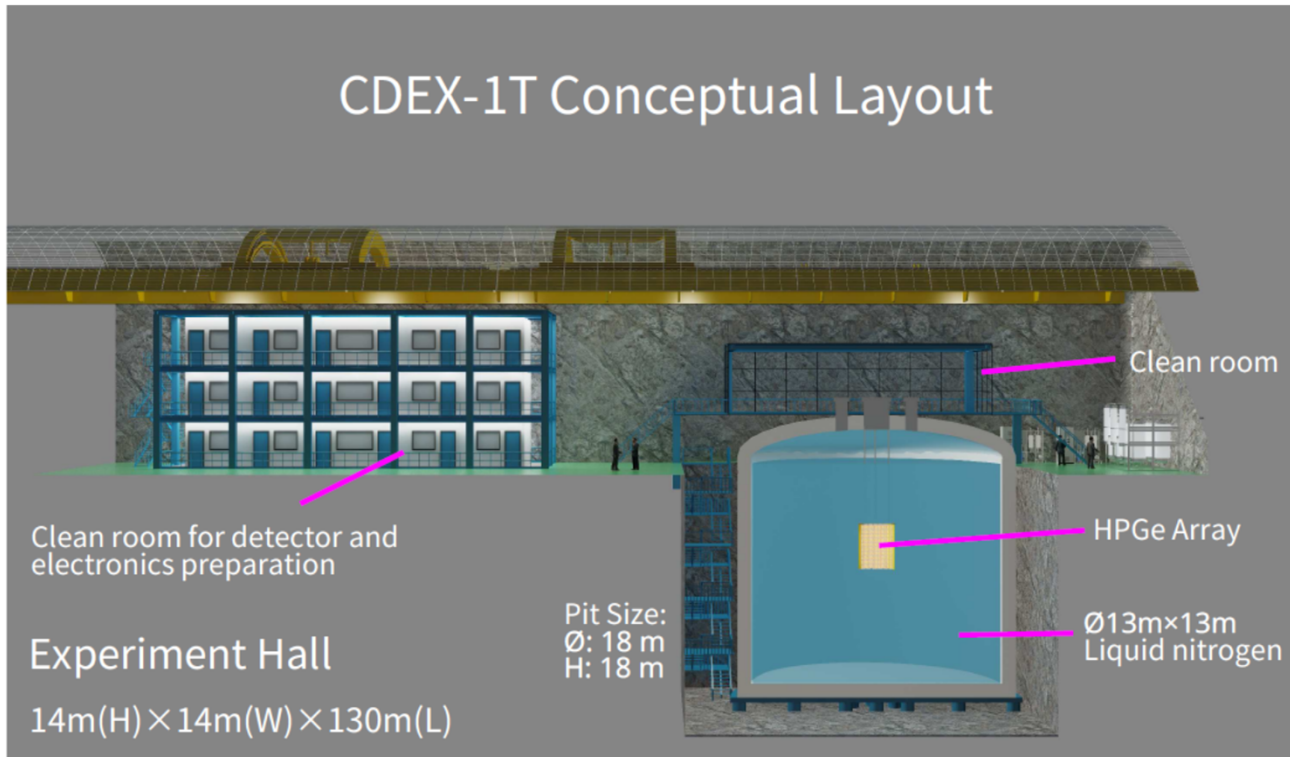
CDEX-10



- PCGe array with lower energy threshold:
CDEX-1: 400eV \rightarrow CDEX-10: <300eV;
- Totally 10kg PCGe under testing and run at CJPL.

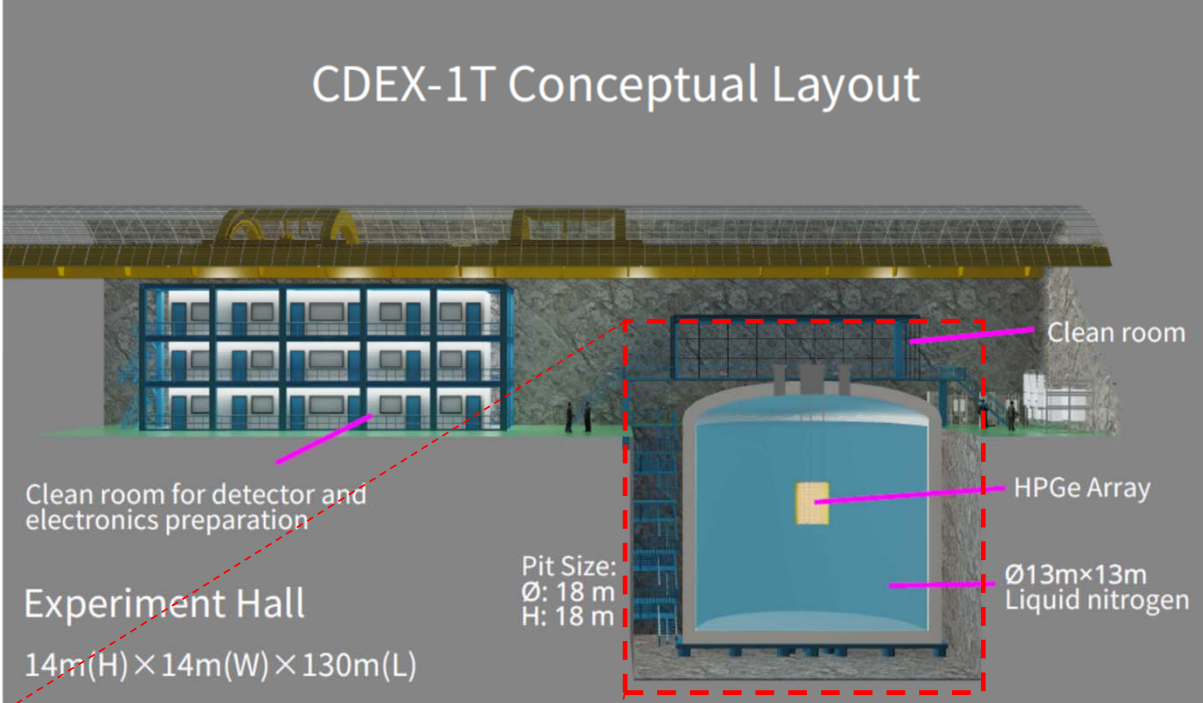
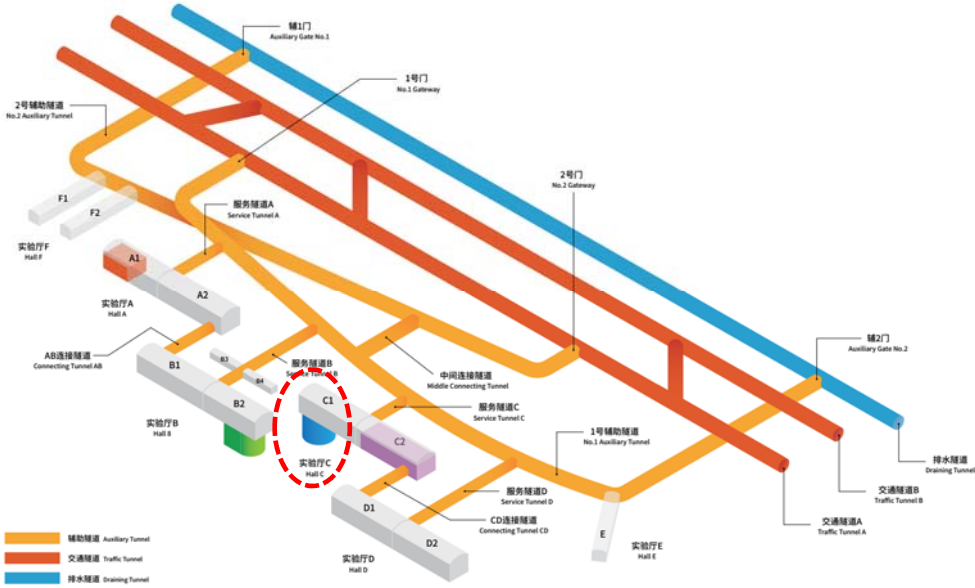
CDEX-1T experiment

Physical goals



CDEX-1T in CJPL2

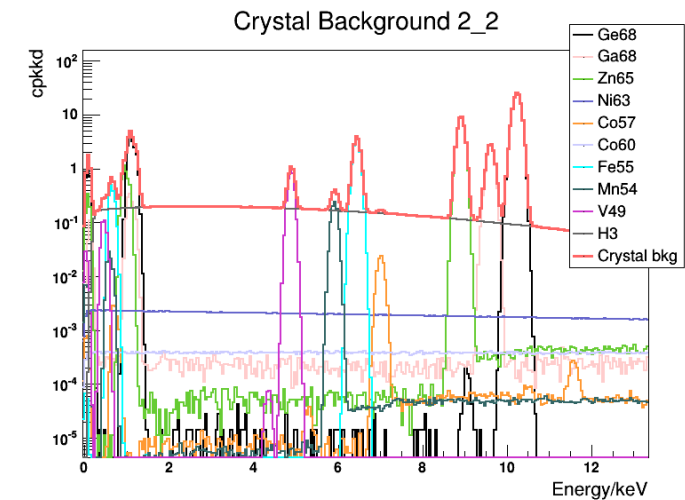
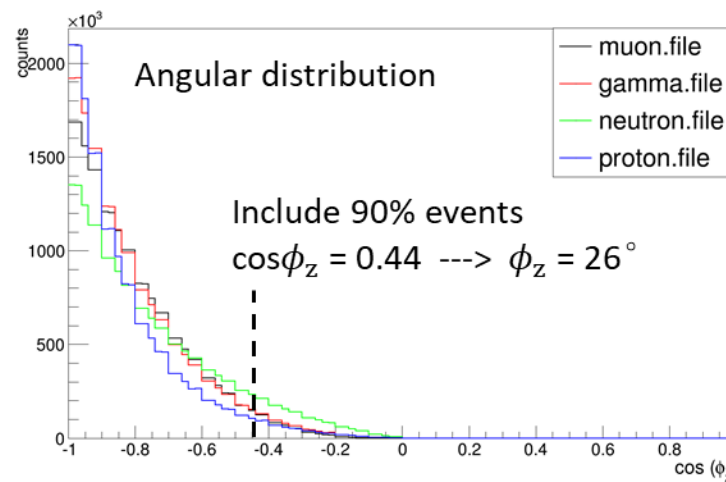
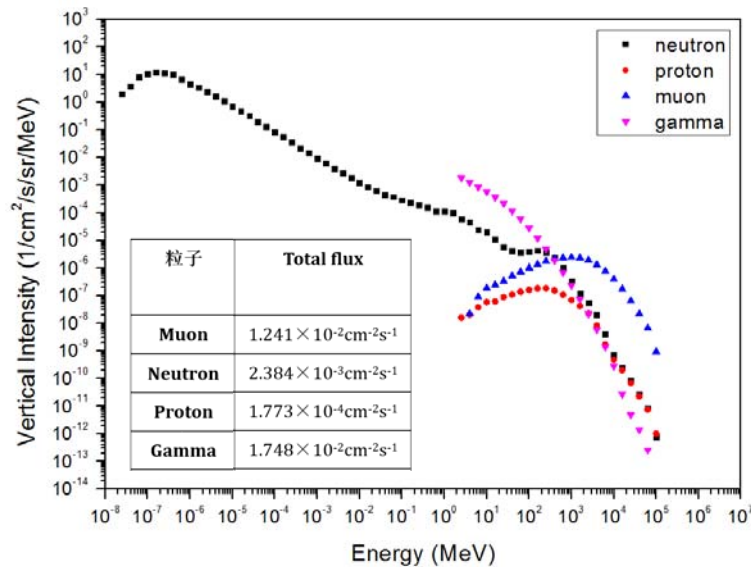
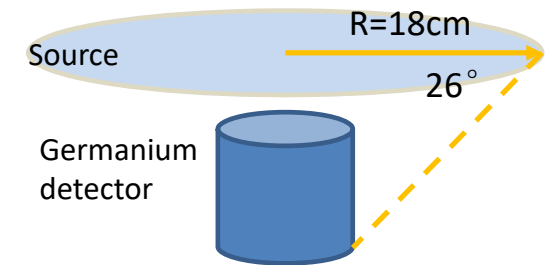
- Planned site at CJPL2
- Pit finished



Cosmogenic nuclides inside Ge

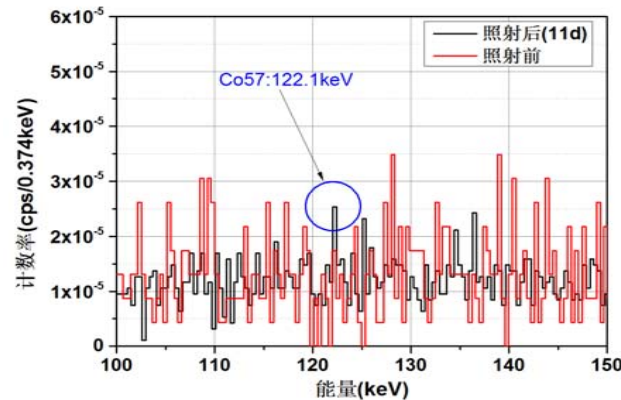
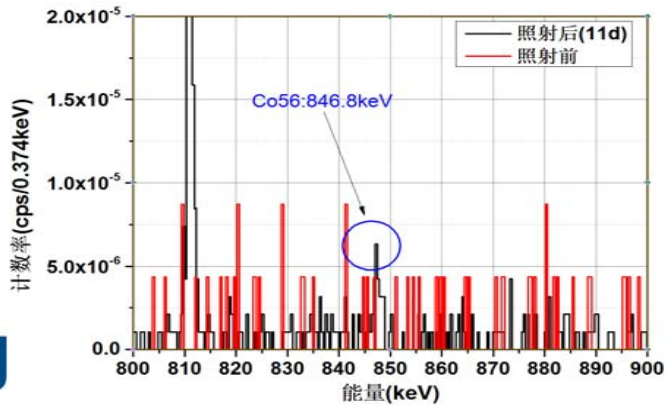
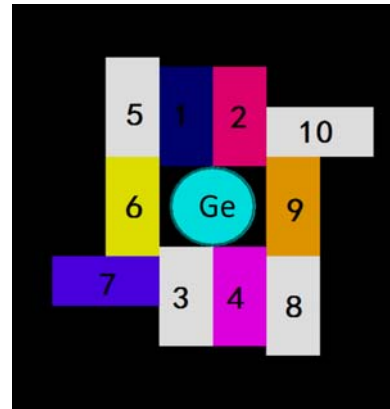
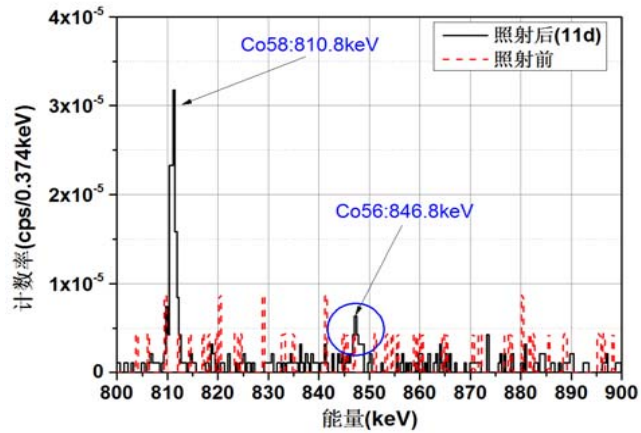
- Yield of cosmogenic nuclides

- 1kg Ge crystal
- CRY → muon/gamma/neutron/proton flux and spectrum
- Geant4 → yield of nuclides → background spectrum



Cosmogenic nuclides inside Cu

- Exposure at ~2400m from sea level for 41 days
- Measured by GeTHU1 gamma-ray spectrometer for 11 days



Nuclide	results (mBq/kg)
Co58	1.10 ± 0.12
Co57	0.47 ± 0.21
Co56	0.19 ± 0.06

4. Summary and outlook



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Summary & outlook

- CDEX 1A&B data taking and analysis.
- CDEX10 run and will move to CJPL2, toward 100kg scale.
- Cosmogenic nuclides in Ge and Cu studied by experiment and MC simulation.
- A ton-scale Ge DM/ $0\nu\beta\beta$ experiment is planned.

Thanks for your attention
Welcome to CJPL



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