Final Symposium of the Sino-German GDT Cooperation,Ringberg

Plans on Ge-76 double beta decay in China: A perspective in future

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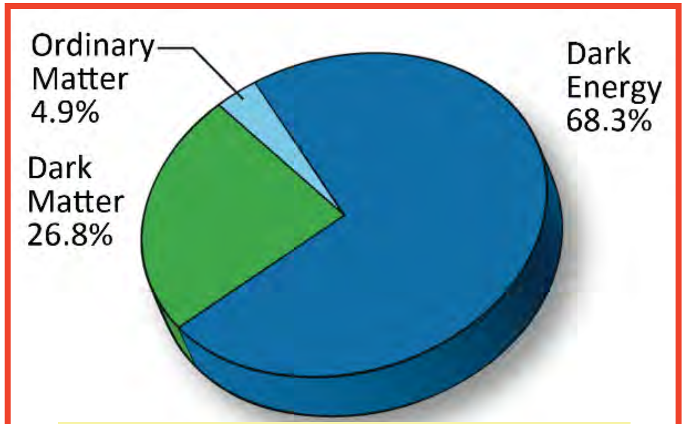
Outline

- CDEX-1T for DBD
- R&D in Tsinghua University
- International co-operation
- Summary

I. CDEX-1T for DBB

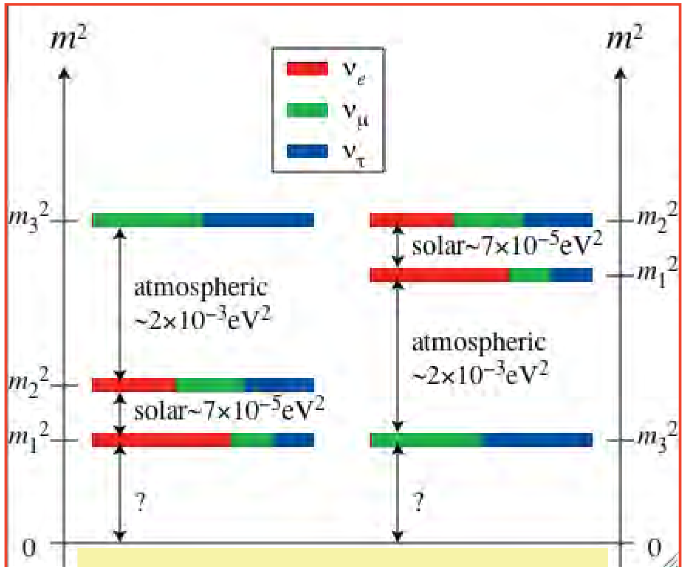
CDEX-1T for DBD



Universe mass components

Ge detector for dark matter:

- Ionization detector
  --- CDEX, CoGeNT
- Ionization and phonon detector
  --- Super(CDMS),
  EDELWEISS(EURECA)



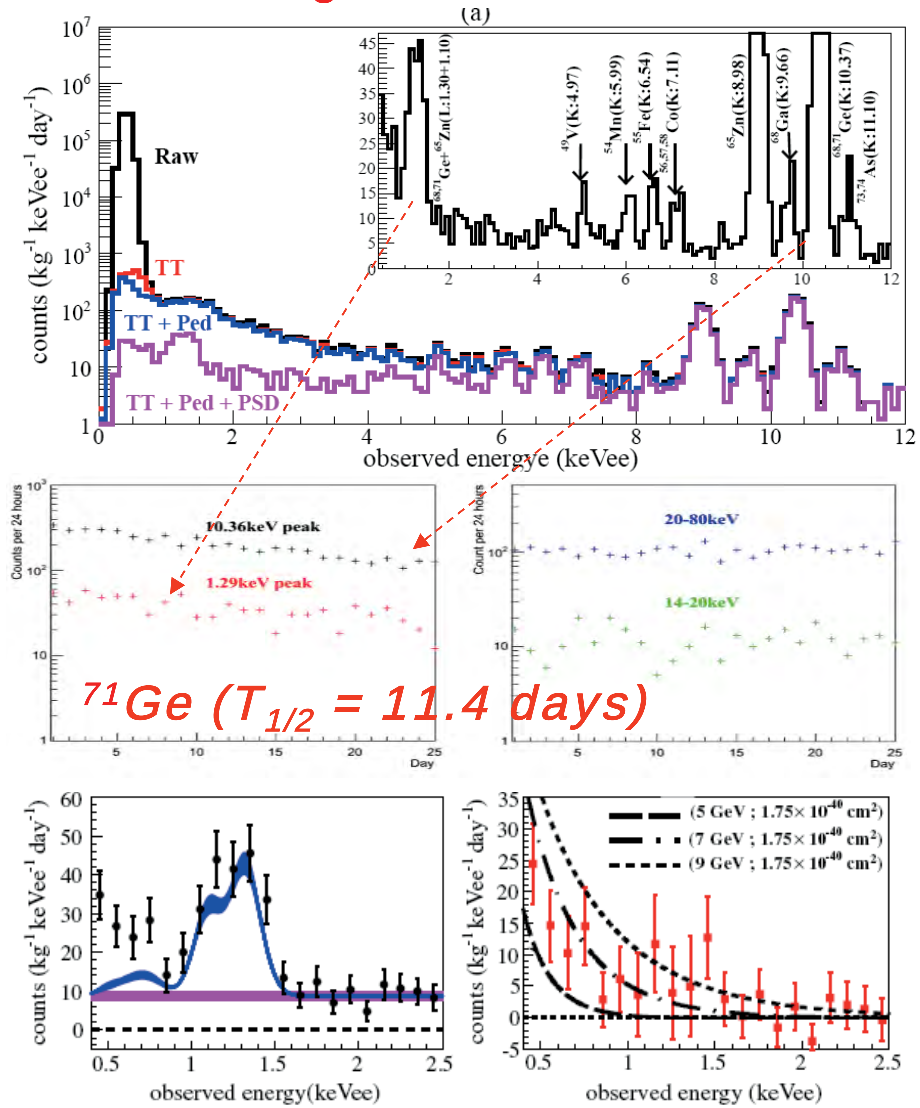
Neutrino mass hierarchy

Ge detector for DBD:

- Ge-76 DBD source and target
- Ionization detector
- H-M, GERDA and Majorana
- A new player: CDEX

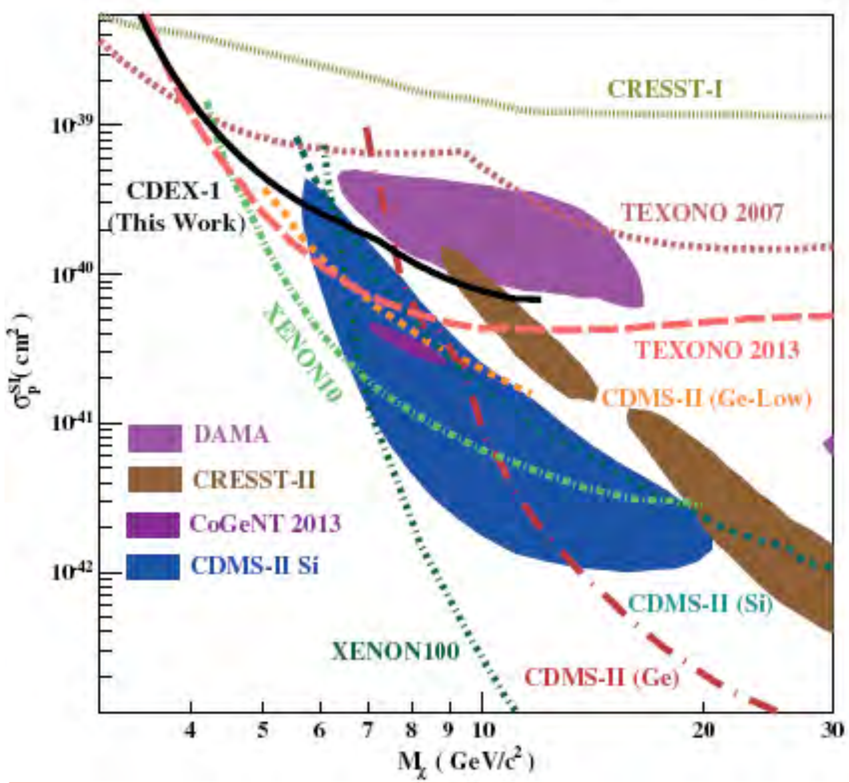
CDEX-1 experiment

C1A 1kg-PPCGe



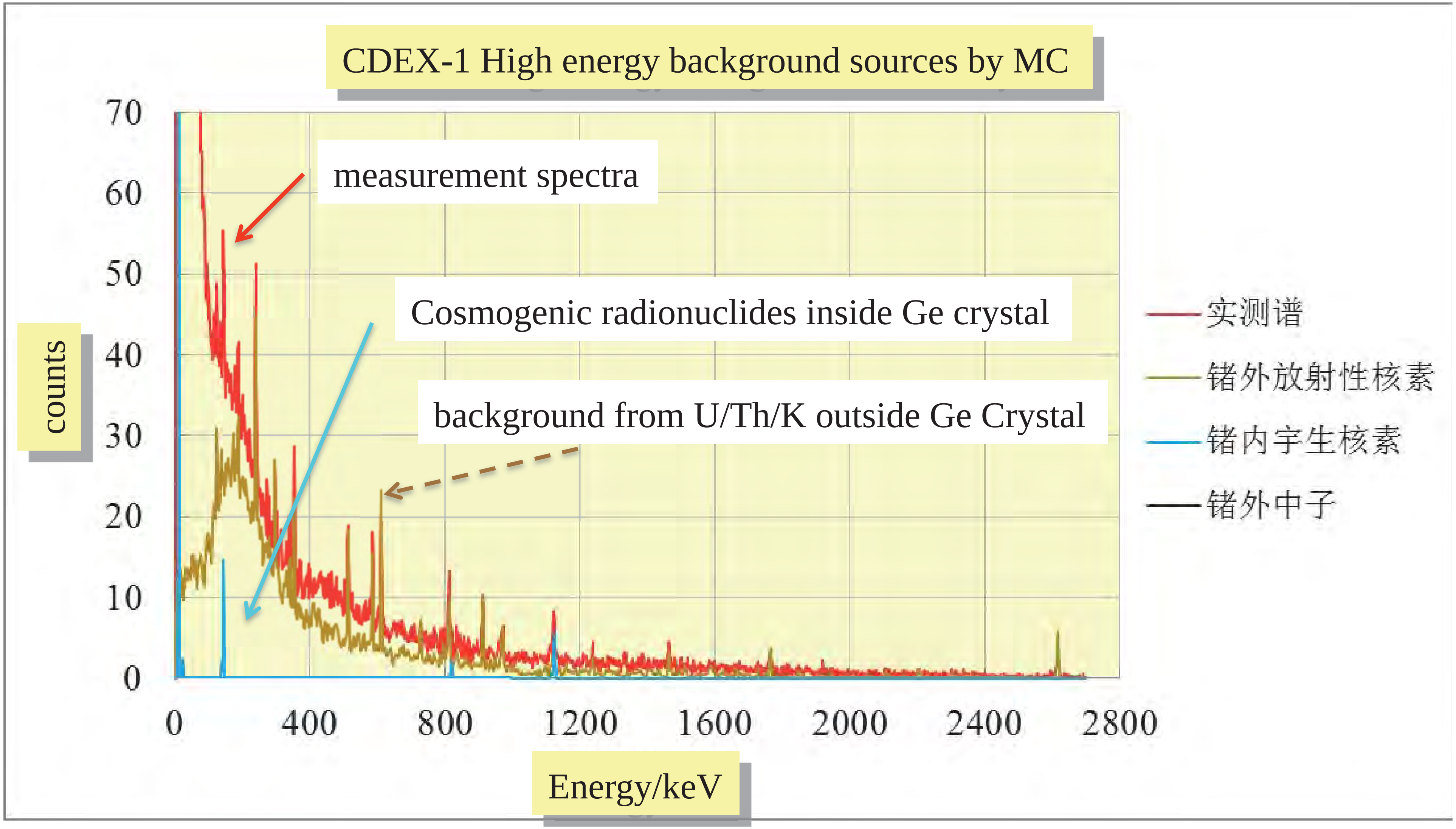
✓ Energy threshold ~400eV!

W. Zhao et al., Phys. Rev. D 88, 052004 (2013);



- The first dark matter physical result from mainland of China!
- The lowest energy threshold for PCGe detector in the world.

CDEX-1 High energy background



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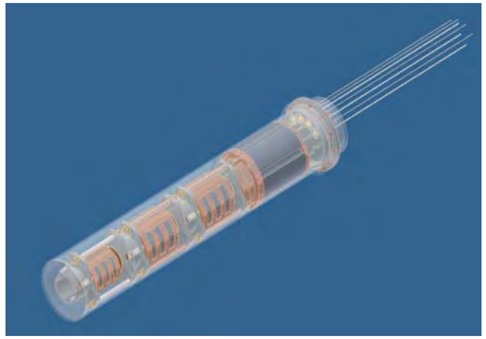
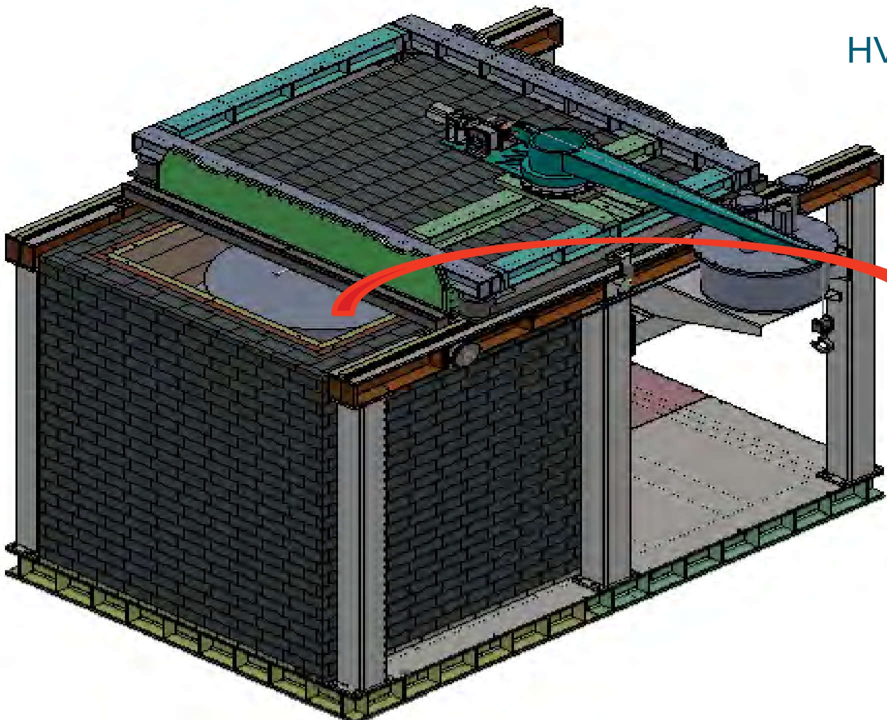
CDEX-10 Preliminary Test

features:

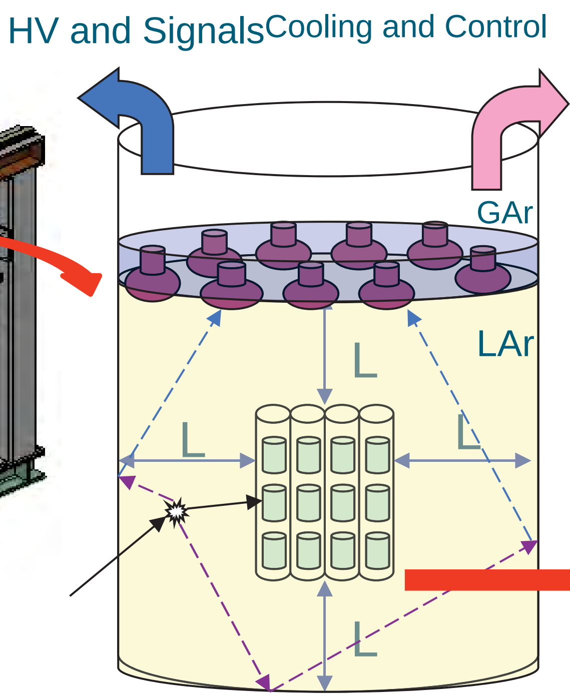
✓PCGe Array by module

✓LAr shielding&Veto System





CDEX-10 Render picture



10kg Ge + LAr

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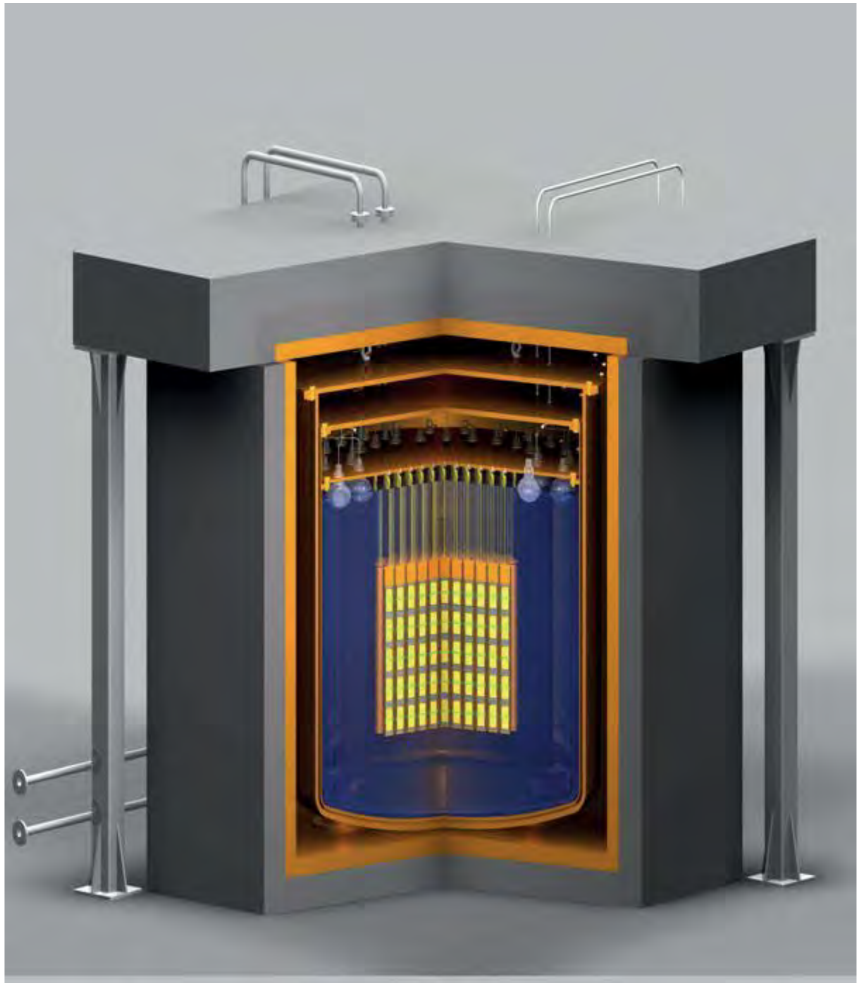
CDEX-1T
---Towards a multi-purpose experiment



●Goals：**Both Dark Matter & Double Beta Decay**

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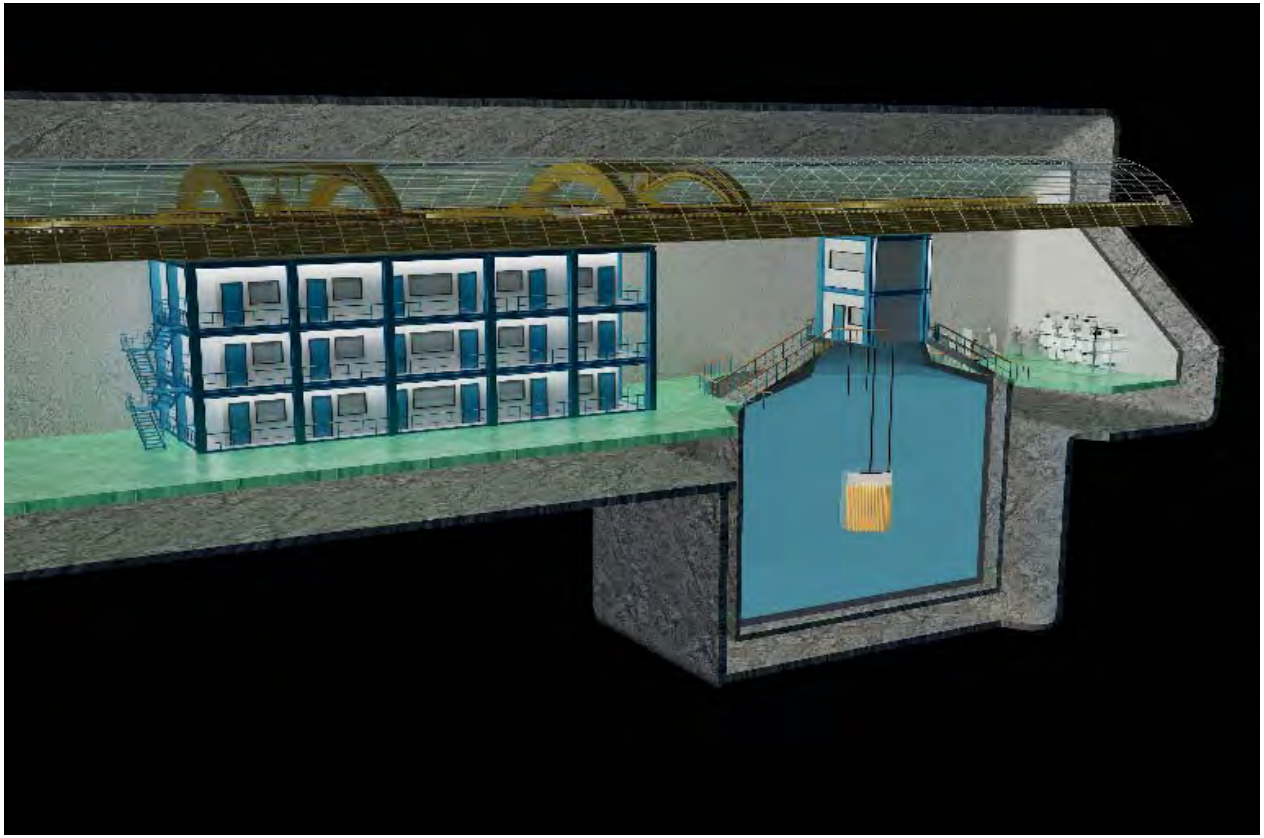
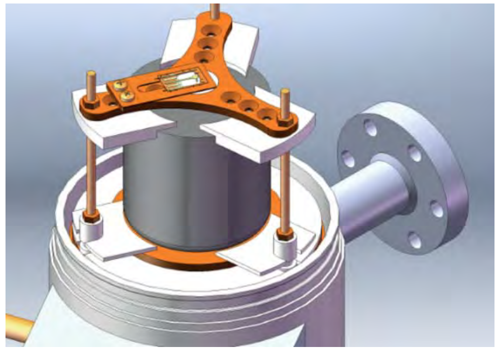
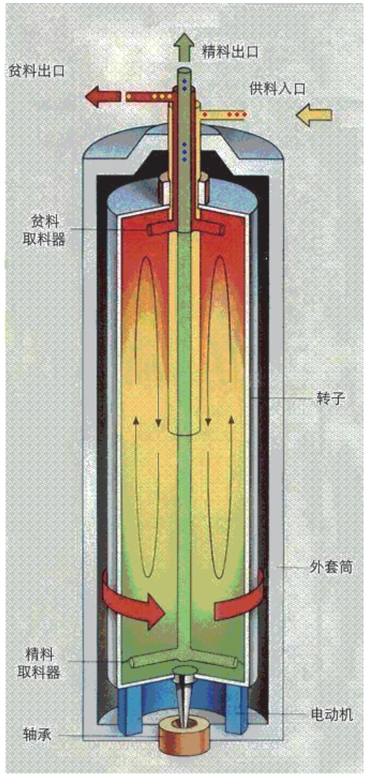
CDEX-1T proposal for CJPL-II

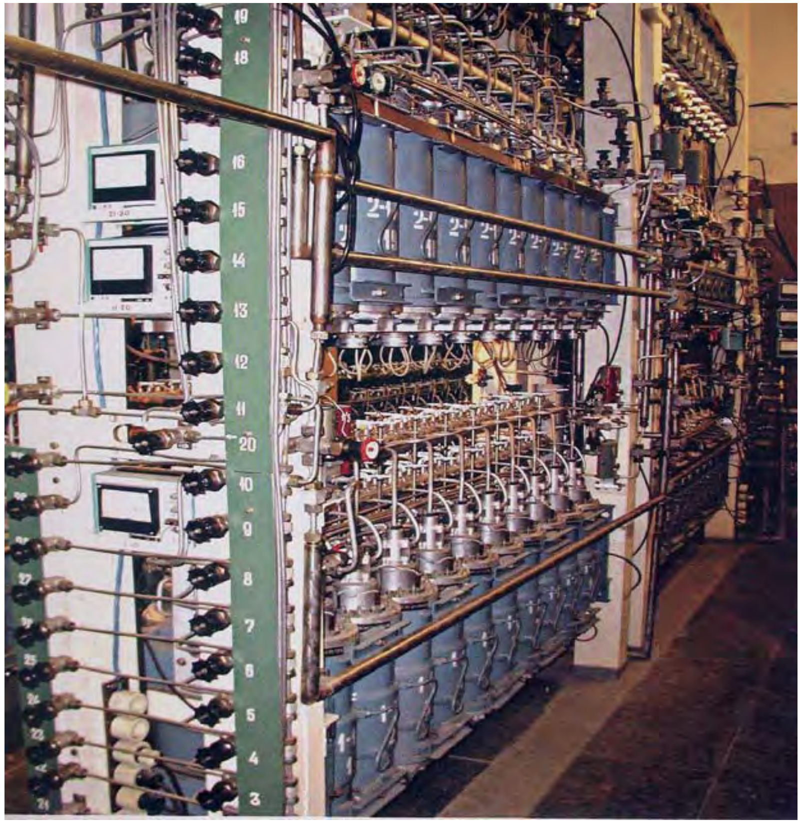




II. R&D in Tsinghua

1. ^{76}Ge Enrichment





^{76}Ge isotope can be enriched by centrifuges.

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currently conditions in Tsinghua

MAT-281 MS

MAT-253 MS

Once separation by single machine

Supply and control system of cascade

1. ^{76}Ge Enrichment

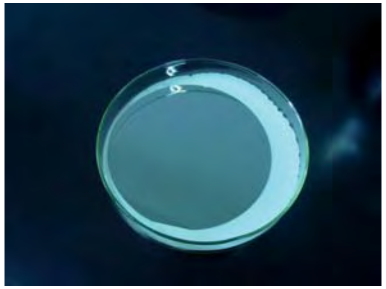
Element	isotopes	Abundance（%）
氙（Xe)	Xe-124	>99
氙（Xe)	Xe-129	>90
氙（Xe)	Xe-136	>99.5
钨（W）	W-186	>98
碲（Te）	Te-130	>99
锇（Os)	Os-192	>99
锇（Os)	Os-187	>15
硅（Si）	Si-28	>99

At the past years, some stable isotopes has been enriched by centrifuges in Tsinghua.

1. ^{76}Ge Enrichment

- Example for ^{28}Si enrichment:
  - $SiHCl_3$ as service substance
    - large scale production;
    - important raw material for Si crystal growth

molecular weight	molecular forma	% in $SiHCl_3$
134	$H^{28}Si^{35}Cl^{35}Cl^{35}Cl$	39.732
135	$H^{29}Si^{35}Cl^{35}Cl^{35}Cl$	2.025
136	$H^{30}Si^{35}Cl^{35}Cl^{35}Cl$	1.331
136	$H^{28}Si\ ^{35}Cl^{35}Cl^{37}Cl(3)$	38.616
137	$H^{29}Si^{35}Cl^{35}Cl^{37}Cl(3)$	1.968
138	$H^{30}Si^{35}Cl^{35}Cl^{37}Cl(3)$	1.294
138	$H^{28}Si\ ^{35}Cl^{37}Cl^{37}Cl(3)$	12.511
139	$H^{29}Si^{35}Cl^{37}Cl^{37}Cl(3)$	0.638
140	$H^{30}Si^{35}Cl^{37}Cl^{37}Cl(3)$	0.419
140	$H^{28}Si\ ^{37}Cl^{37}Cl^{37}Cl$	1.351
141	$H^{29}Si^{37}Cl^{37}Cl^{37}Cl$	0.069
142	$H^{30}Si^{37}Cl^{37}Cl^{37}Cl$	0.045



1. ^{76}Ge Enrichment

- Requirements of service substance for centrifugalization:
  - Heat stable while temperature ~570K
  - molecular weight > 70
  - Saturated Vapor pressures at normal atmospheric temperature > 665 Pa.
- ICP-MS analysis method of this service substance developing.

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1. ^{76}Ge Enrichment

- Germanium tetrafluoride(GeF_4) as service substance for ^{76}Ge for centrifugalization:
  - a noncombustible, strongly fuming gas with a garlic odor
  - Molecular weight 148.6
  - Saturated Vapor pressures 4 atm in -15 °C

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1. ^{76}Ge Enrichment

- Problems about GeF_4centrifugalization :
  - high pressure gas(~20atm) in 20 °C;
  - strong corrosiveness
- GeF_4 1-2-1 cascade once separation:

abundance	^{70}Ge（%）	^{72}Ge（%）	^{73}Ge（%）	^{74}Ge（%）	^{76}Ge（%）
light cut	34.11	35.31	7.26	21.83	1.50
raw material	20.54	27.73	7.74	36.25	7.75
heavy cut	4.99	18.59	8.01	53.40	15.02

- 86% ^{76}Ge production by a small scale cascade can be used in future

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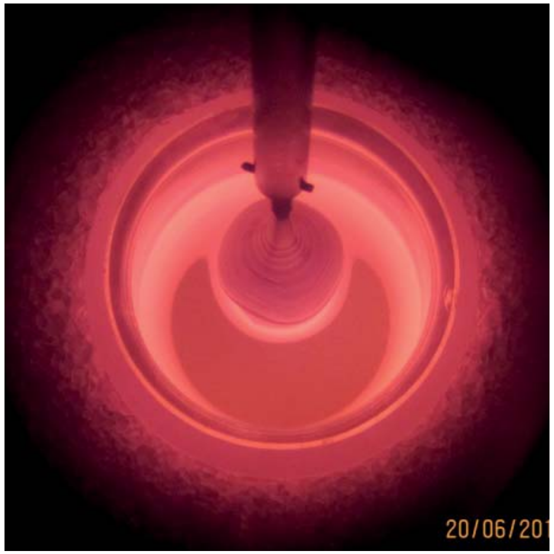
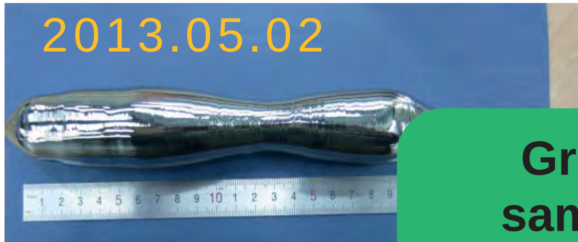
2. Germanium crystal growth for CDEX-1T

Zone refining machine

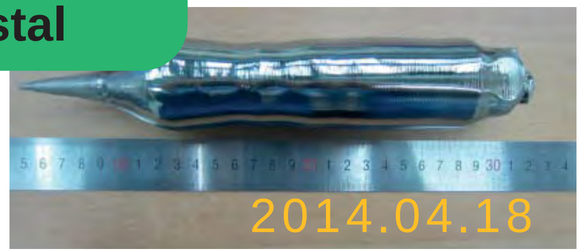
Czochralski machine

Cutting & Polishing





Grown samples Ge single crystal



3. PCGe detector for CDEX-1T

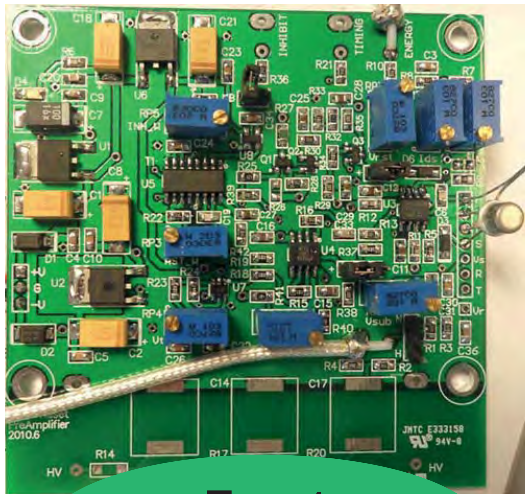
Vacuum Coating Machine

Magnetron Sputtering Device

Boron Implant Accelerator

10g Planar-Ge

500g PCGe (testing)



Front -electronics

4. low-background Electroform-Copper production

- Prototype device
  - Stainless steel mandrel
  - DC power supply

  Output: 5V, 500A, adjustable
  - T and pH monitor

Ref to Hao Ma's presentaiton.

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Ⅲ. International co-operation

- Continuous communication of CDEX、GERDA and Majorana after Symposium of Sino-German GDT Cooperation;
- Discuss a appropriate way to develop some common technics.

III. Summary

- In the future, CDEX would focus on DM detection experiment, and some R&D in CDEX would be carried on for DBB.
- R&D, like Ge-76 Enrichment, Ge crystal growth, Ge detector fabrication, low-background front-end electronics development, EF-Copper production in CJPL, large UL space and LN/LAr shielding system, are carrying on.
- Discuss with HPGe related scientists in the world to find whether and when a new DBD collaboration would be setup.

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Thanks!