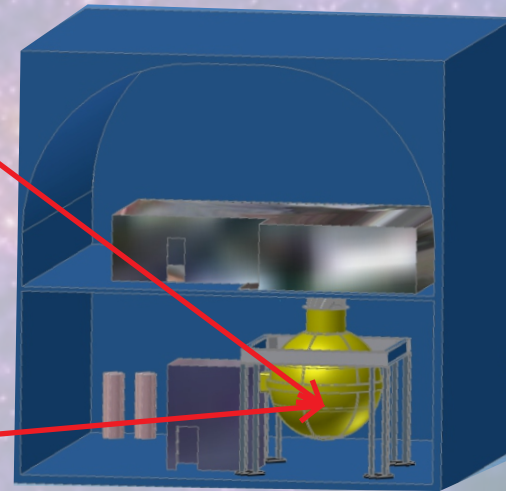
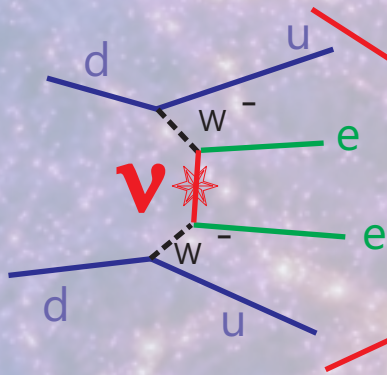


Germanium Detector Development GeDet



Project Review 2015

**I. Abt, L. Garbini, Ch. Gooch, H. Liao, X. Liu, B. Majorovits,
M. Palermo, O. Schulz, M. Schuster, H. Seitz**
guests: J. Langford



Germanium, what for?

Neutrinos and Dark Matter

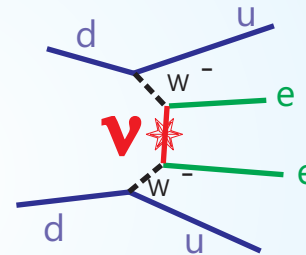
not with Ge
at MPI (yet?)



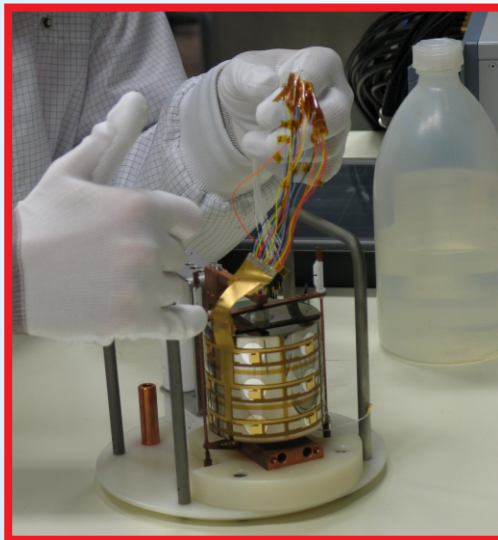
1-ton



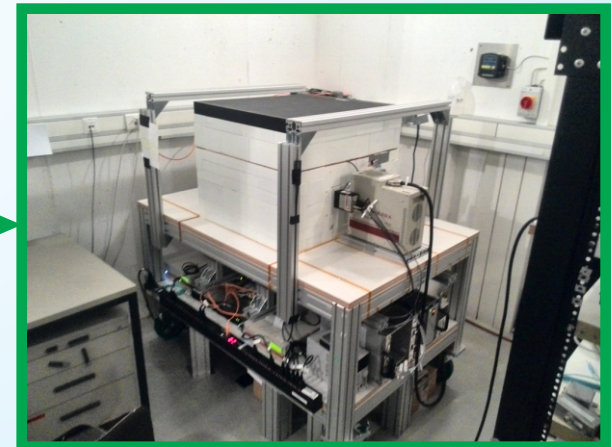
future projects ?



Majorana mass



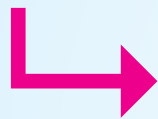
- Goals
- Detector Technology
- Minidex →
- Future Eol



Expectations and Goals

Neutrinoless Double Beta Decay

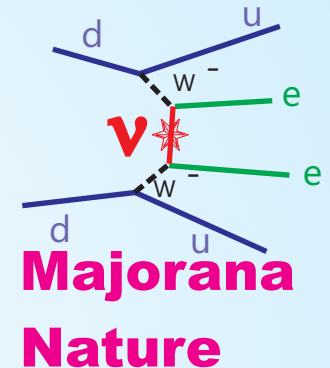
should be studied down to 10 meV
to exclude inverted hierarchy



1t for 5 years with

1 background event in 5 years

background at 10^{-5} /kg /keV /y



Dark Matter

should be studied until neutrinos are seen



1t for 5 years with

a few background events

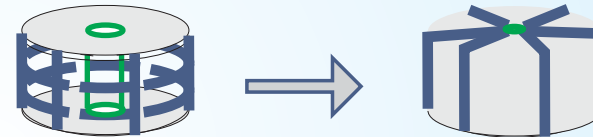
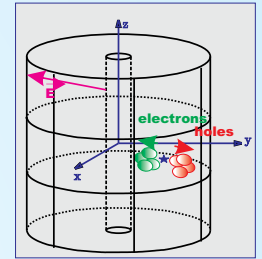
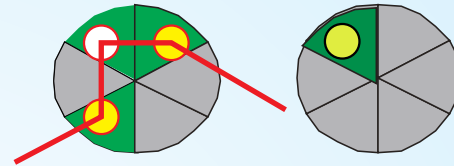
at very low threshold



Background and Technology

Photons

**Segmentation can
gain a factor 10
in background suppression**



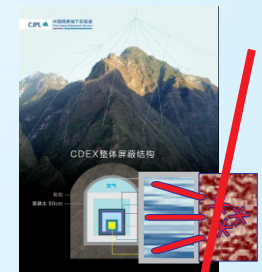
low threshold => point contact

Alphas

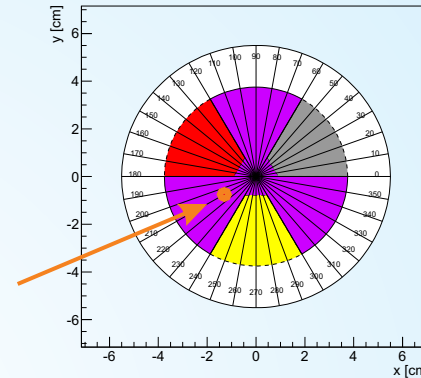
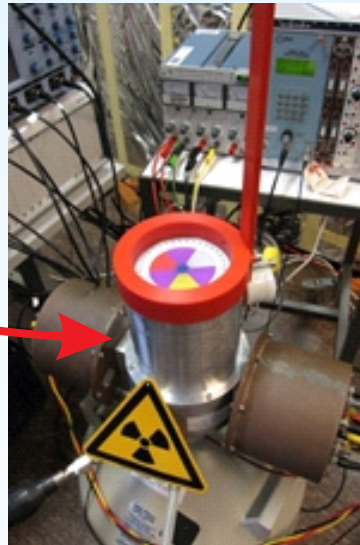
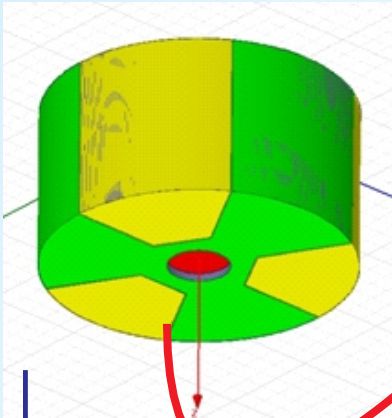
typical surface contamination

Neutrons from muons

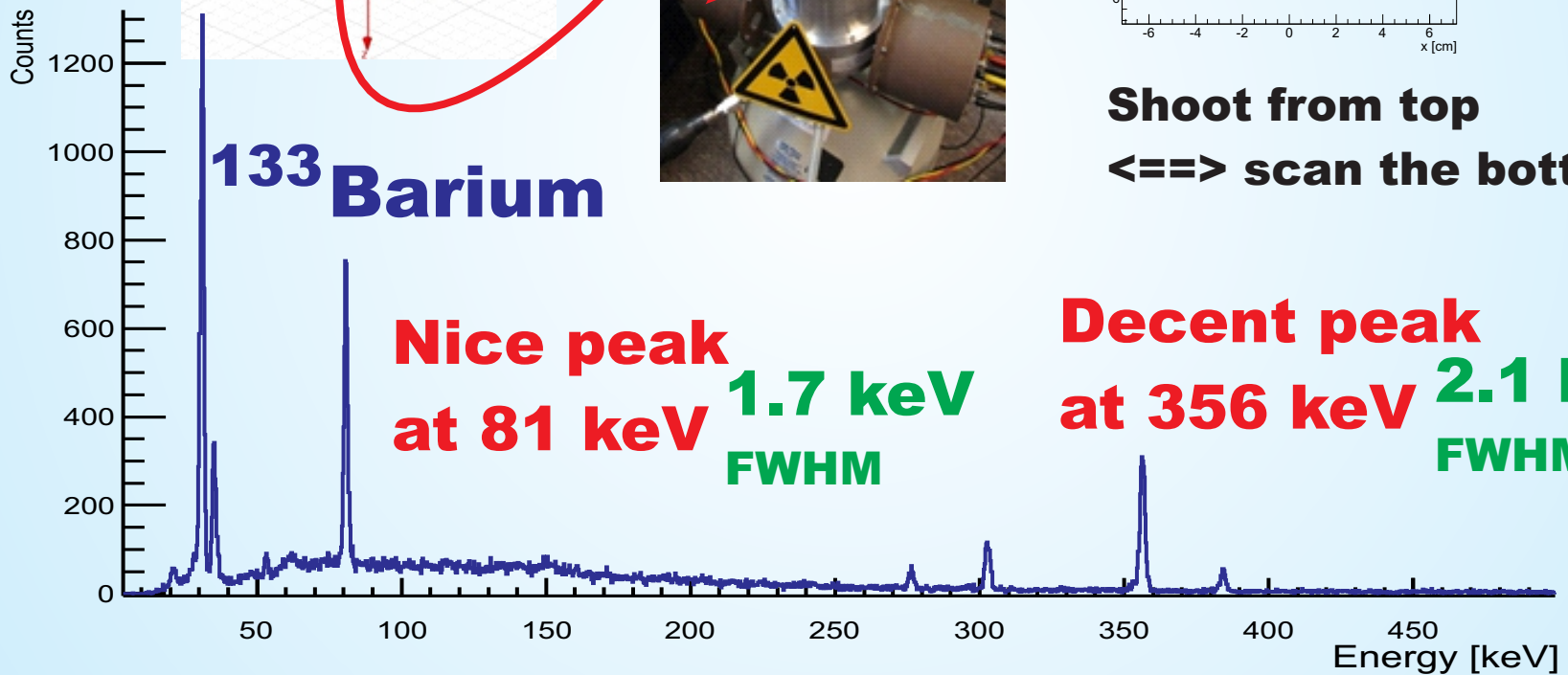
how to measure, how to shield



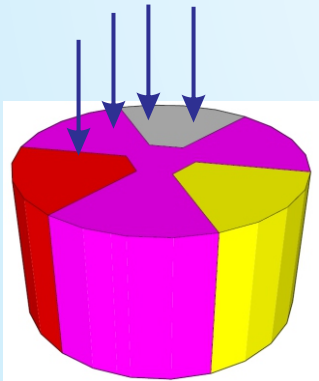
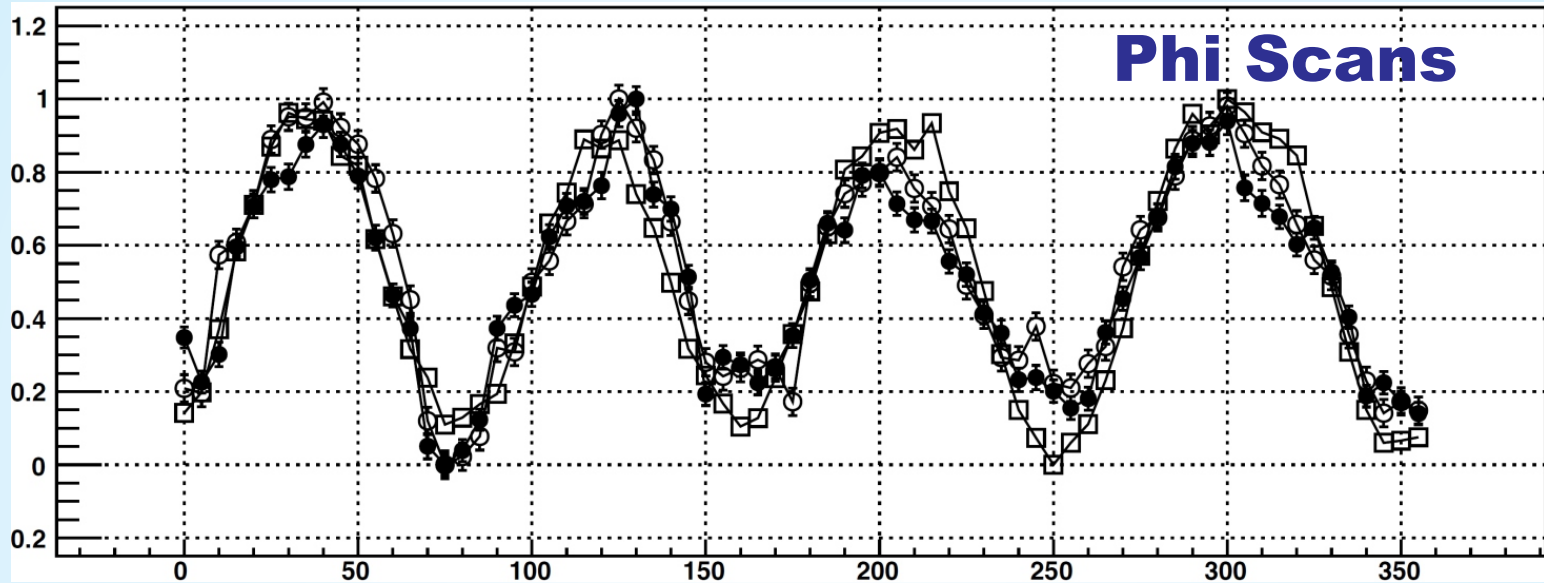
Segmented Point Contact Detector



Shoot from top
<==> scan the bottom



Segmented Point Contact Detector

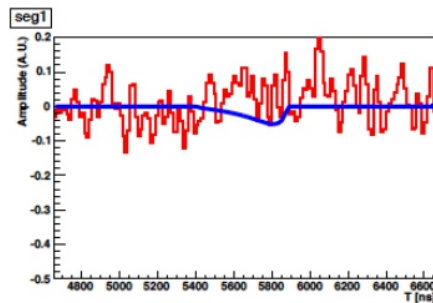
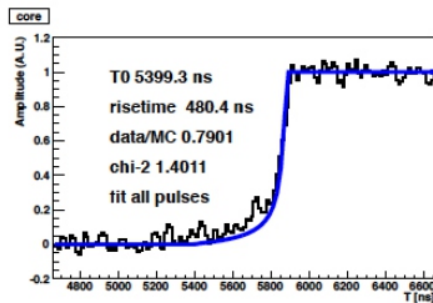


Clearly see the crystal axes

The axes are needed as input for the Monte Carlo to simulate pulses.



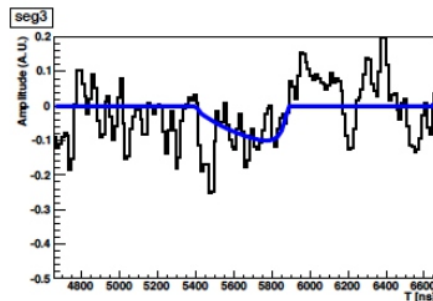
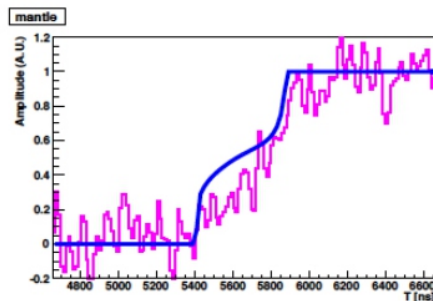
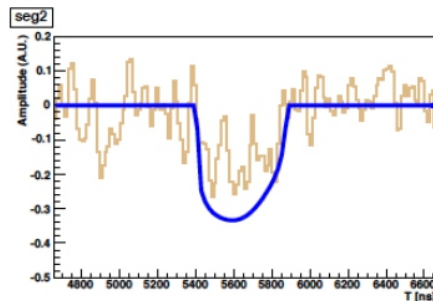
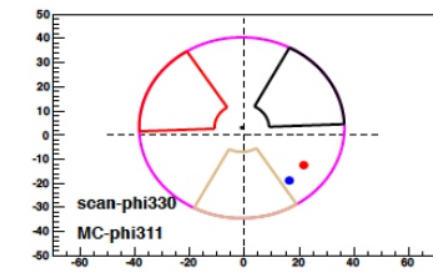
Segmented Point Contact Detector



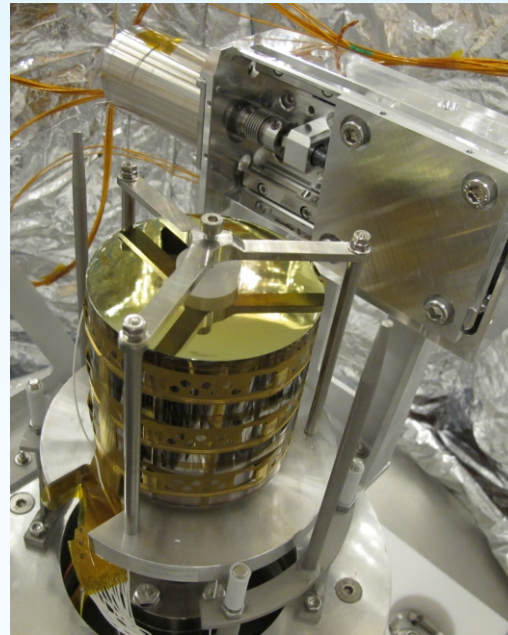
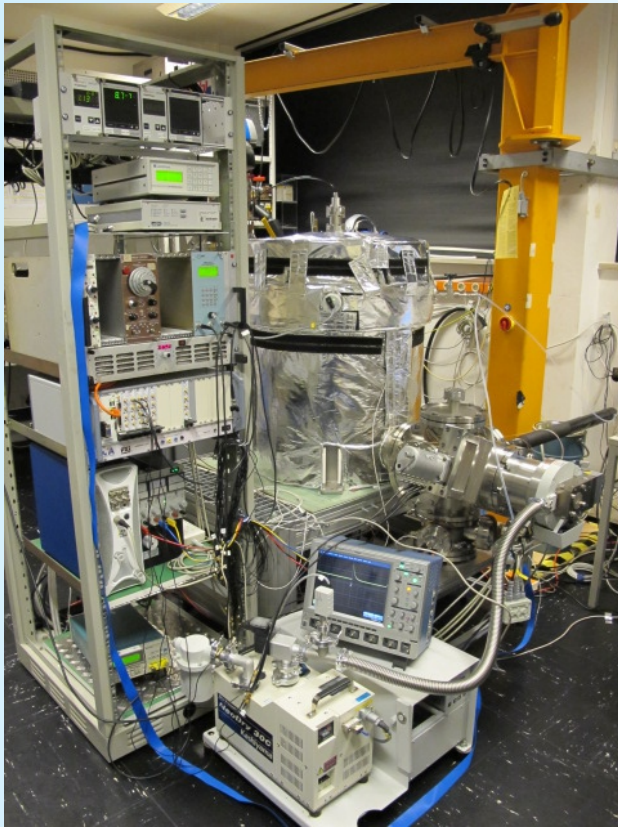
Reconstruct phi of individual events to some degrees.

Simulated pulses do not quite match, underestimate unisotropies.

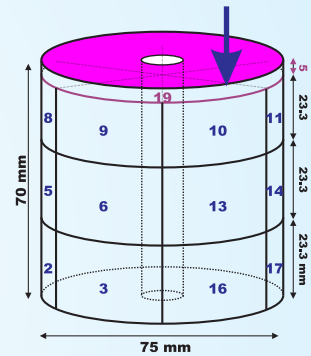
Detector was turned. Cryostat problems. New cryostat ordered.



Alphas and GALATEA

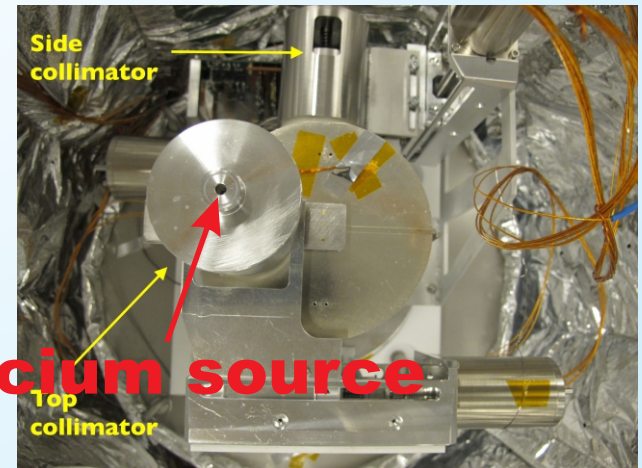


Special 18+1 segmented detector



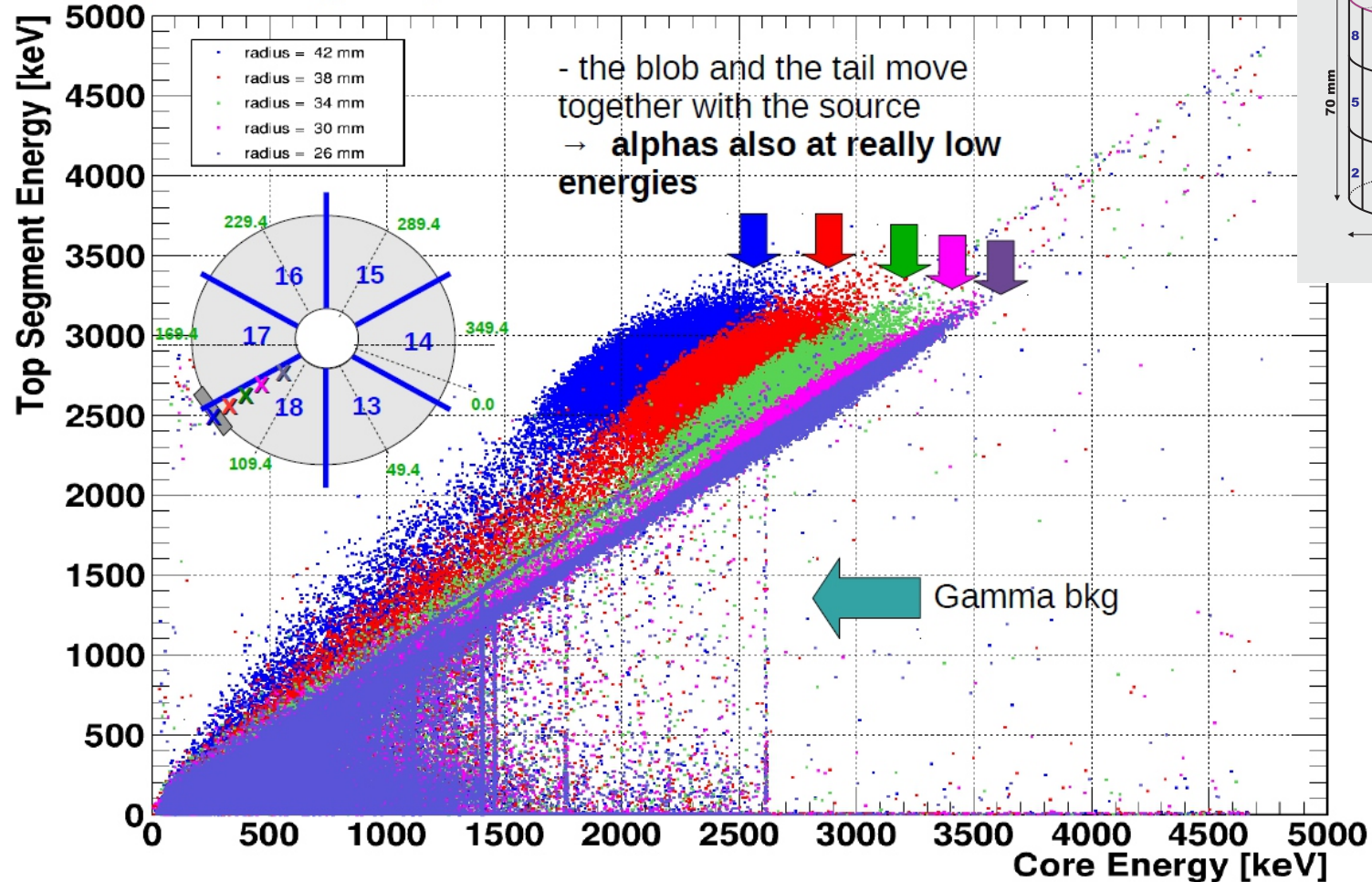
No material between source and detector

Characterize alpha events on passivated surface with Americium source



Alphas

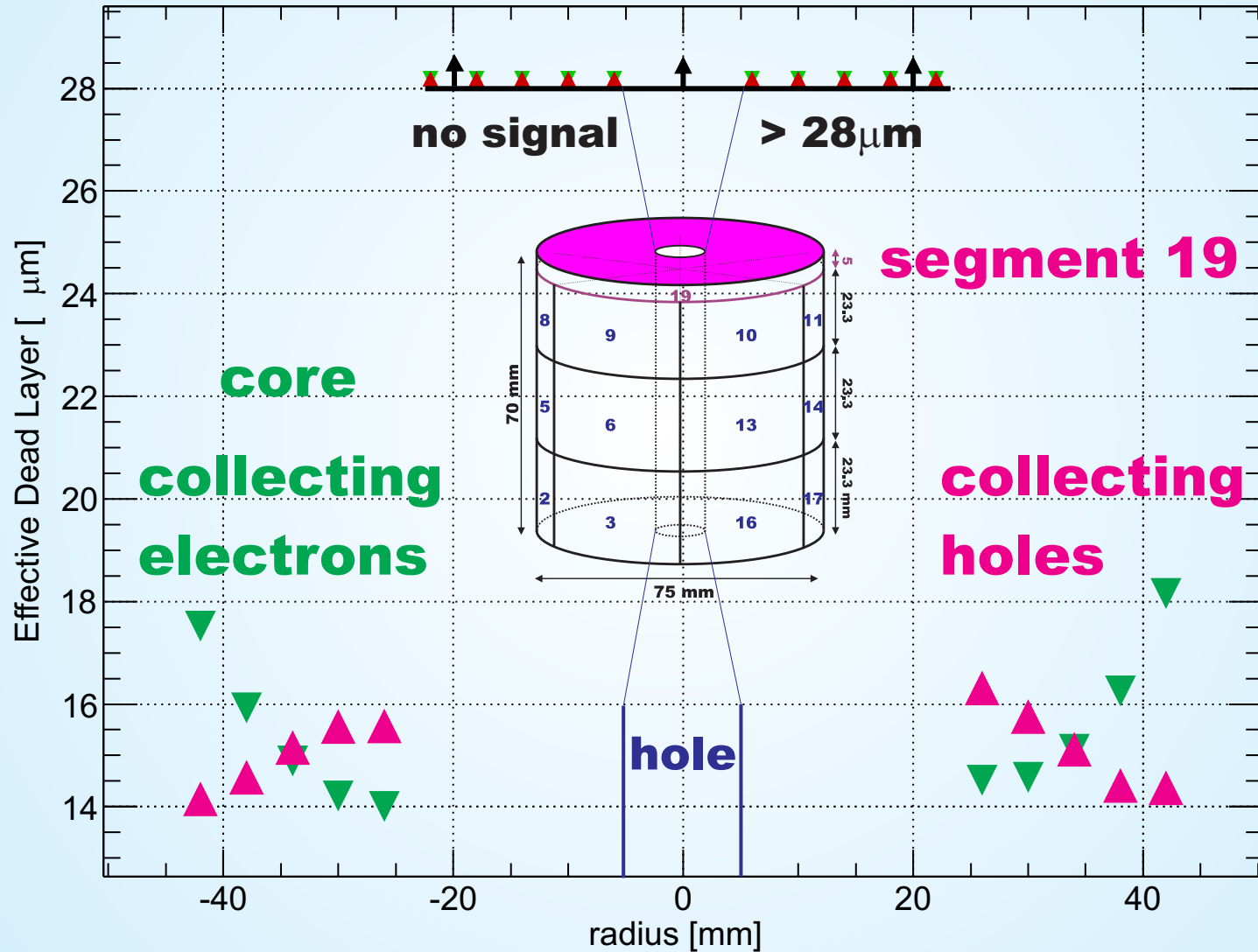
- fixed phi scanning along the radius



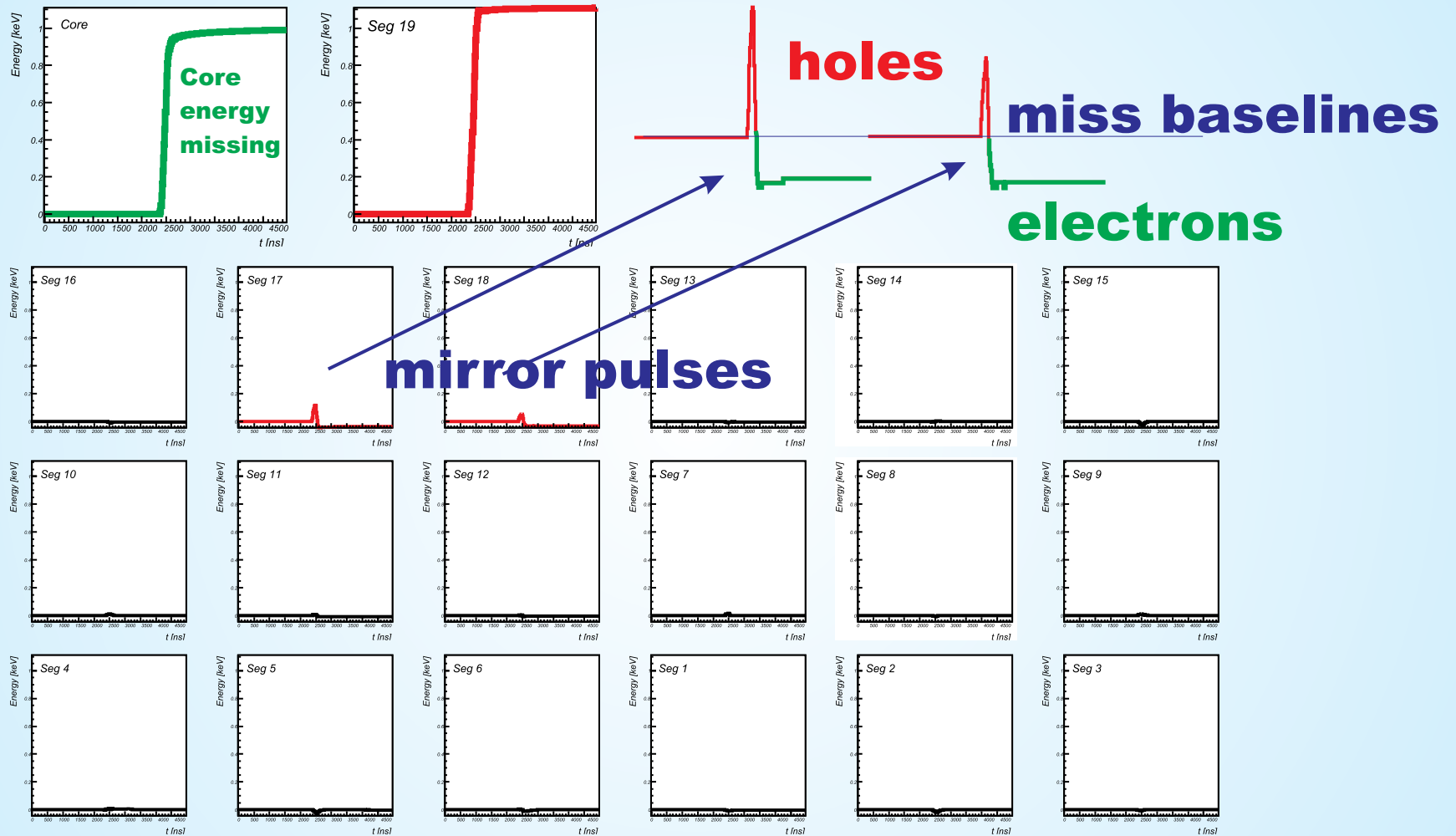
5 MeV alphas from Americium



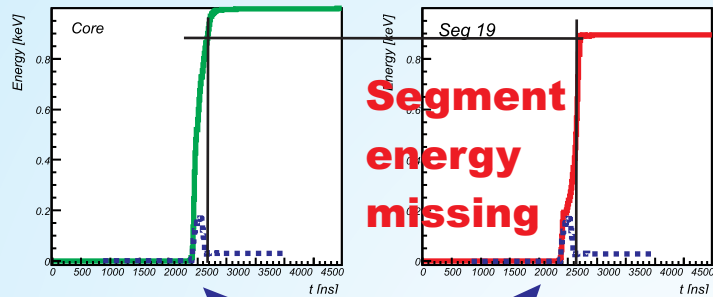
Dead Layers



Electron Trapping



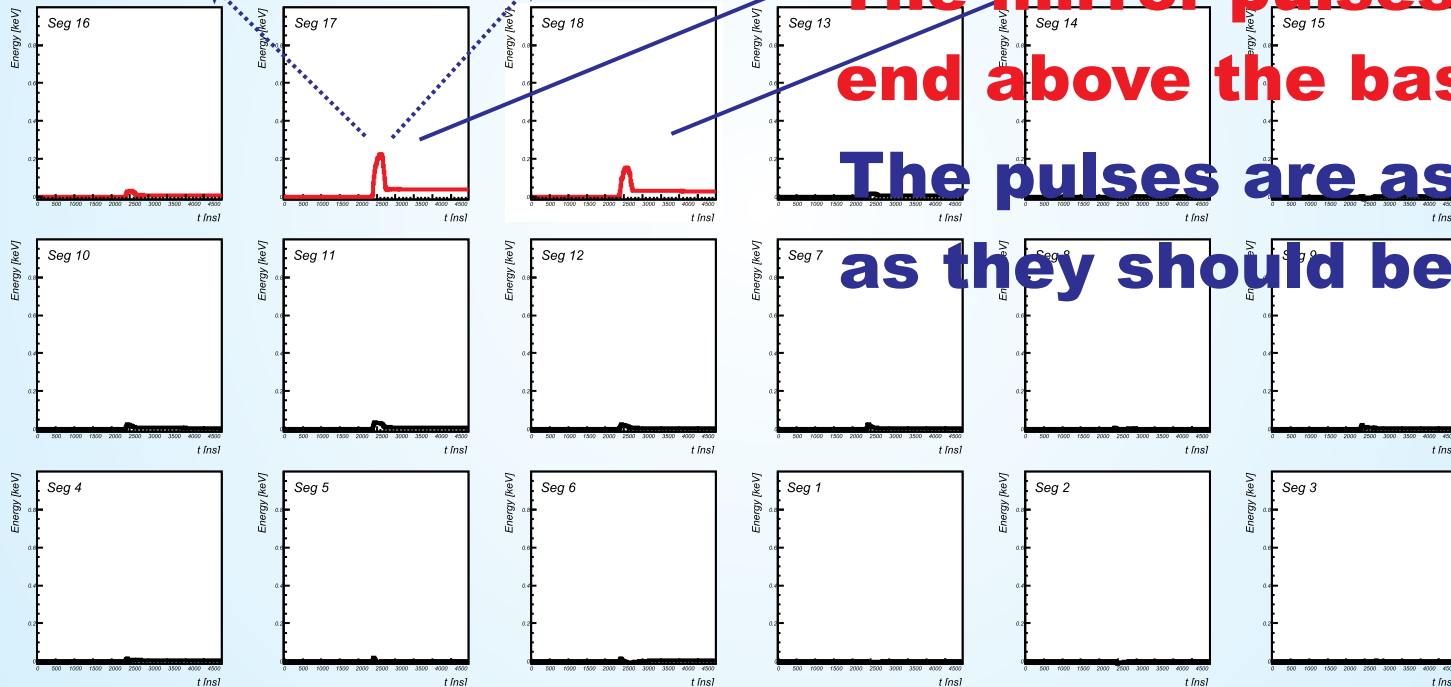
Hole Trapping



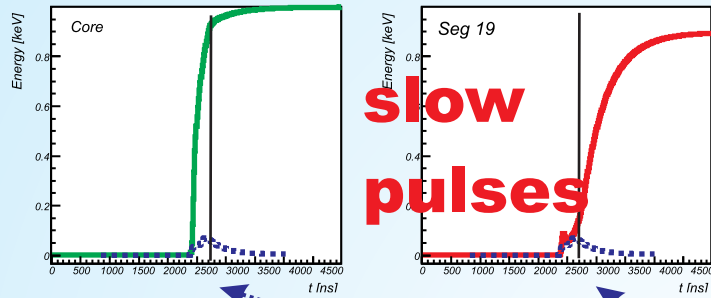
see hole drift

The mirror pulses end above the baseline

The pulses are as fast as they should be

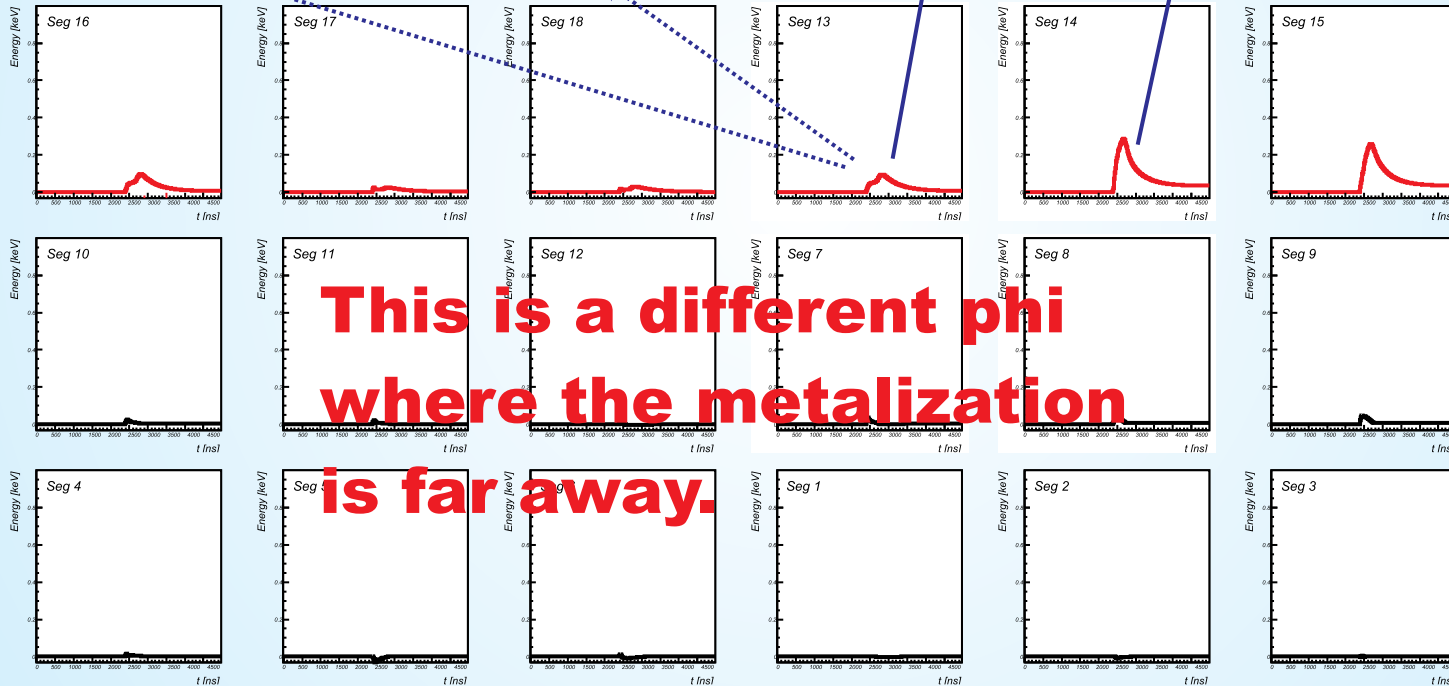


Hole Trapping

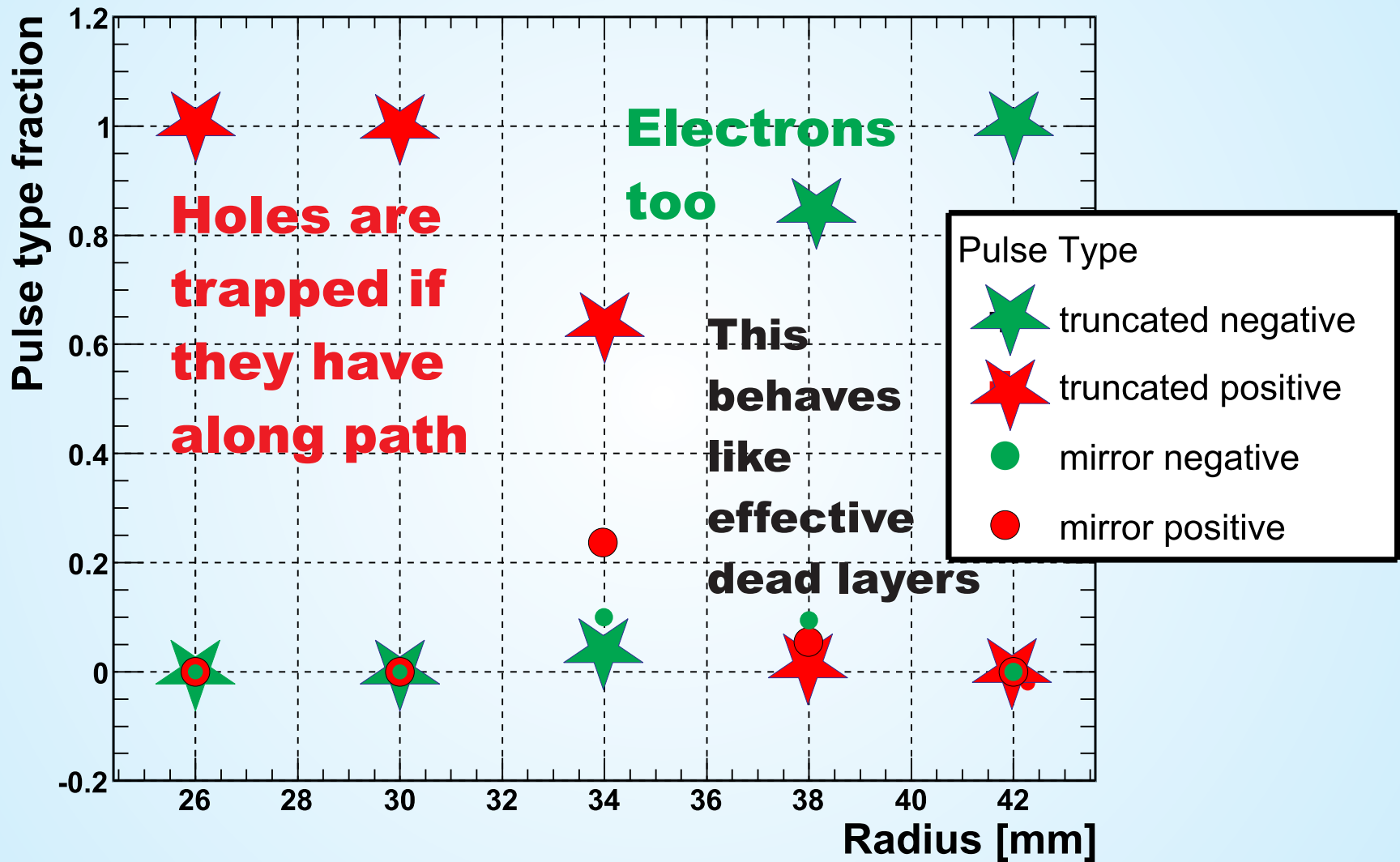


The kink
is real.

Is charge
trapped and
released ?

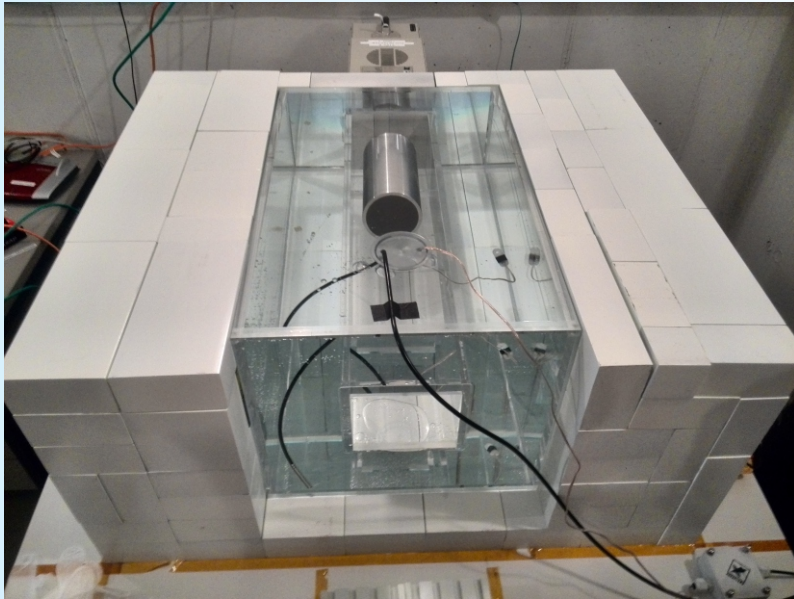


Hole Trapping

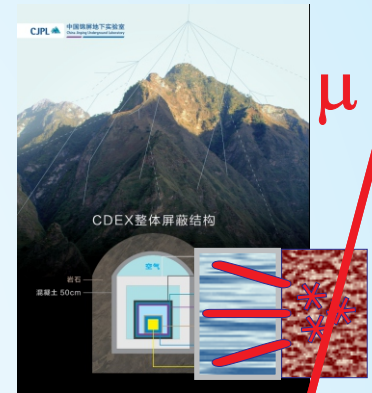


Muon Induced Neutrons

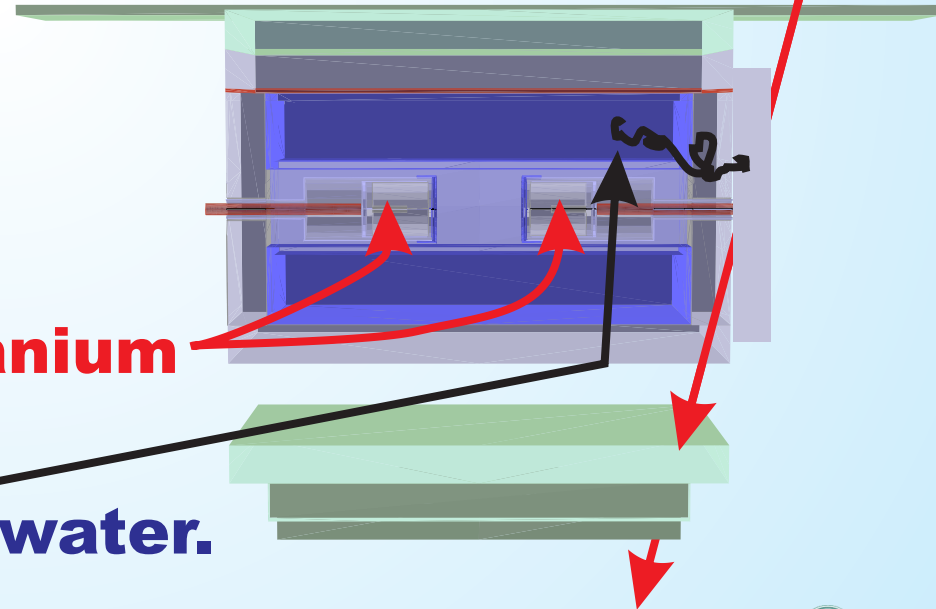
Irreducible and nasty background, especially when meta-stable states are created.



**Worth
measuring**



**Use two standard germanium
detector to see signal
from neutron capture in water.**



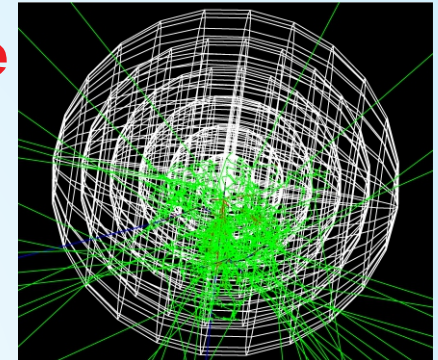
Muon Induced Neutrons

Too much background on the surface

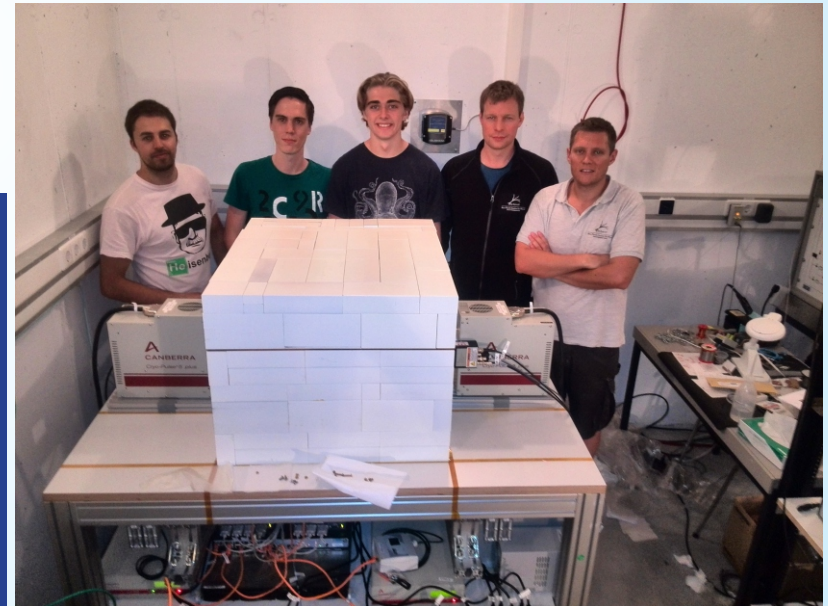
Go to shallow lab in Tübingen:

MC: expect S/B of 5 ~ 6

Cooperation



EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN



Deutsch-Chinesische-Kooperationsgruppe

Development of High Purity Germanium Detector Techniques
for Applications in Fundamental Research

Finanziell unterstützt durch: Chinesisch-Deutsches Zentrum für Wissenschaftsförderung Peking, China

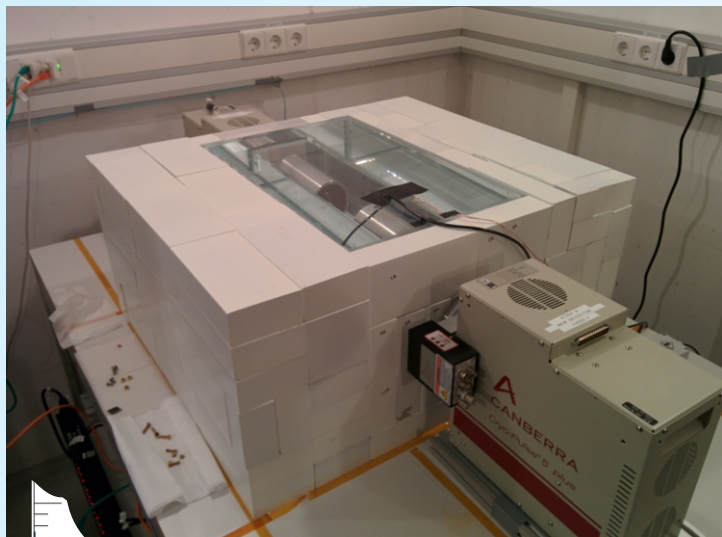
中德合作研究小组

应用于基础研究的高纯锗探测器技术研发

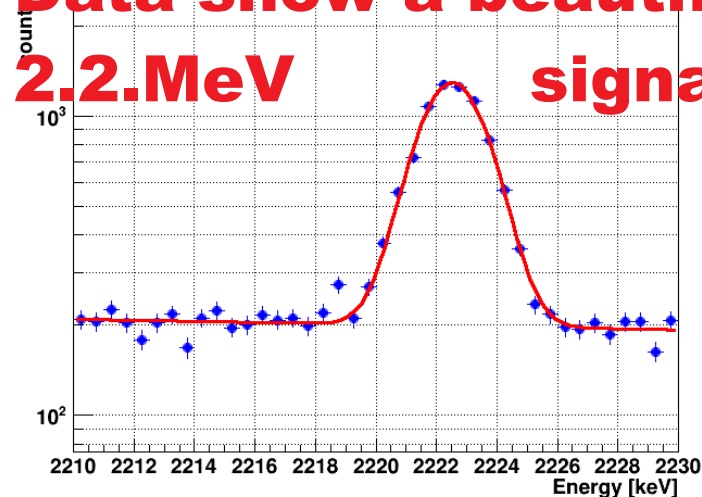
资助者: 中德科学中心 / 中国 北京



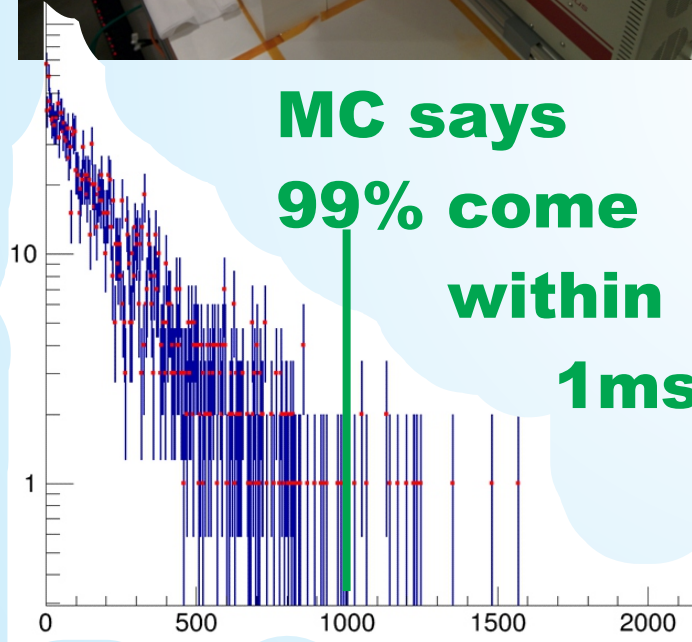
Muon Induced Neutrons



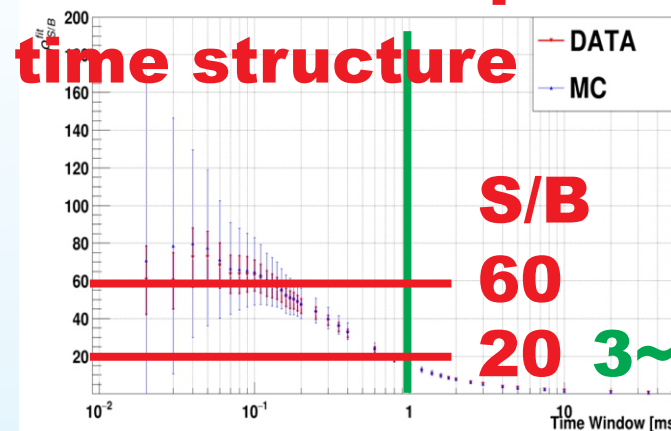
Data show a beautiful 2.2-MeV signal



MC says
99% come
within
1ms



Data confirm predicted time structure

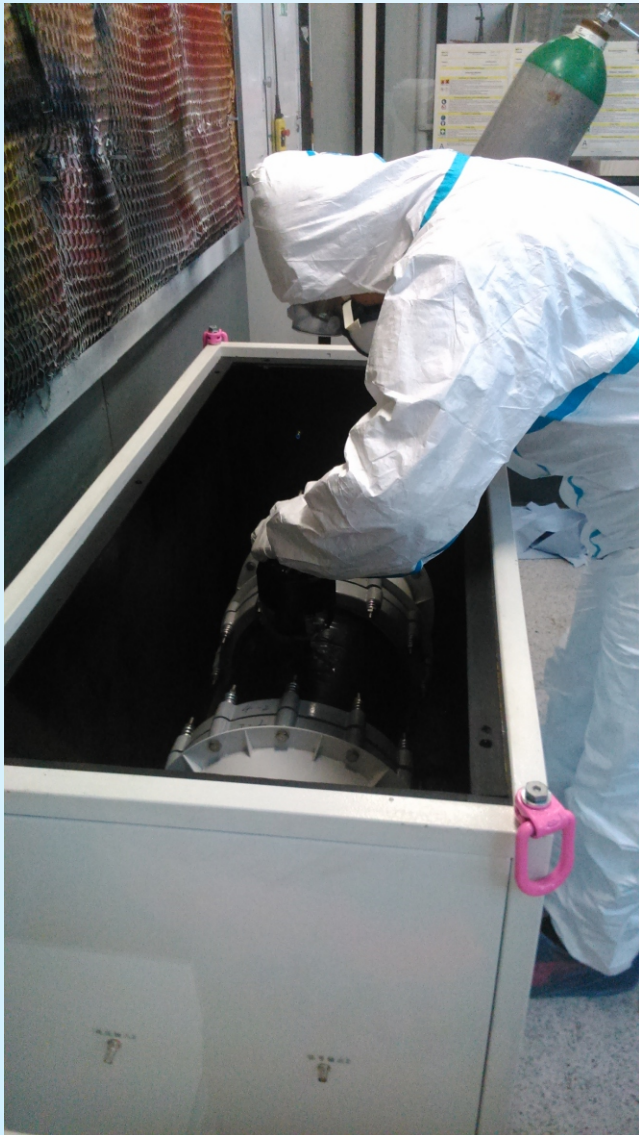


S/B
60
20 3~4 x MC



Muon Induced Neutrons

Upgrade the setup



**Get a fast
neutron
detector**



EBERHARD KARLS
UNIVERSITÄT
TÜBINGEN



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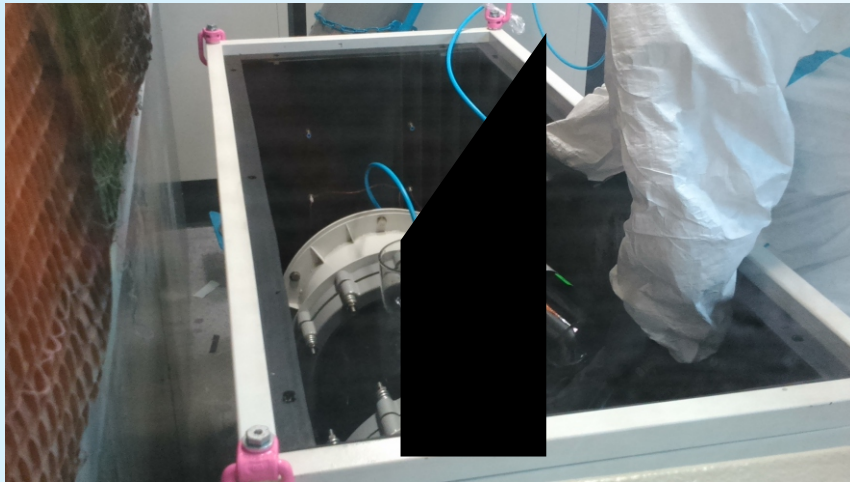
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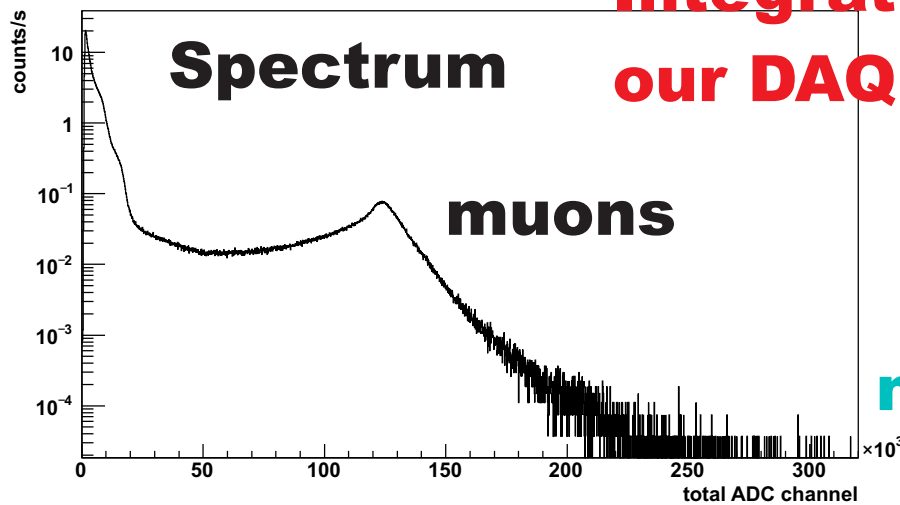
资助者: 中德科学中心 / 中国 北京



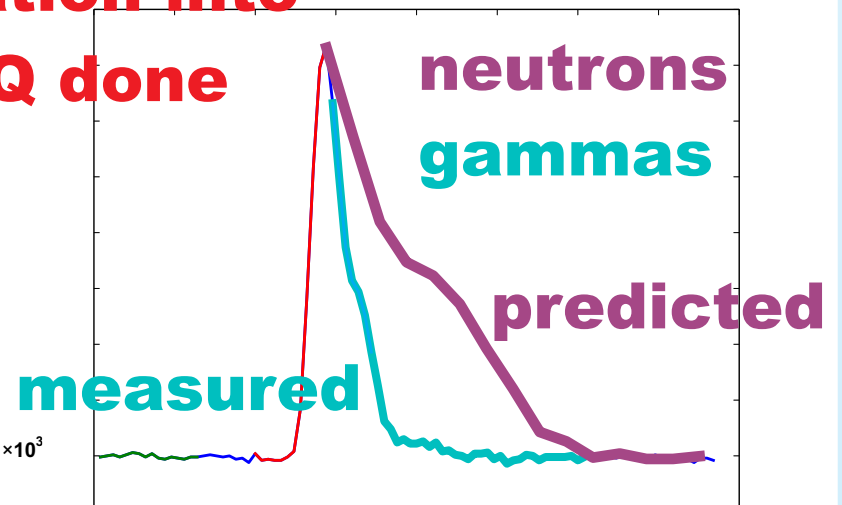
Muon Induced Neutrons



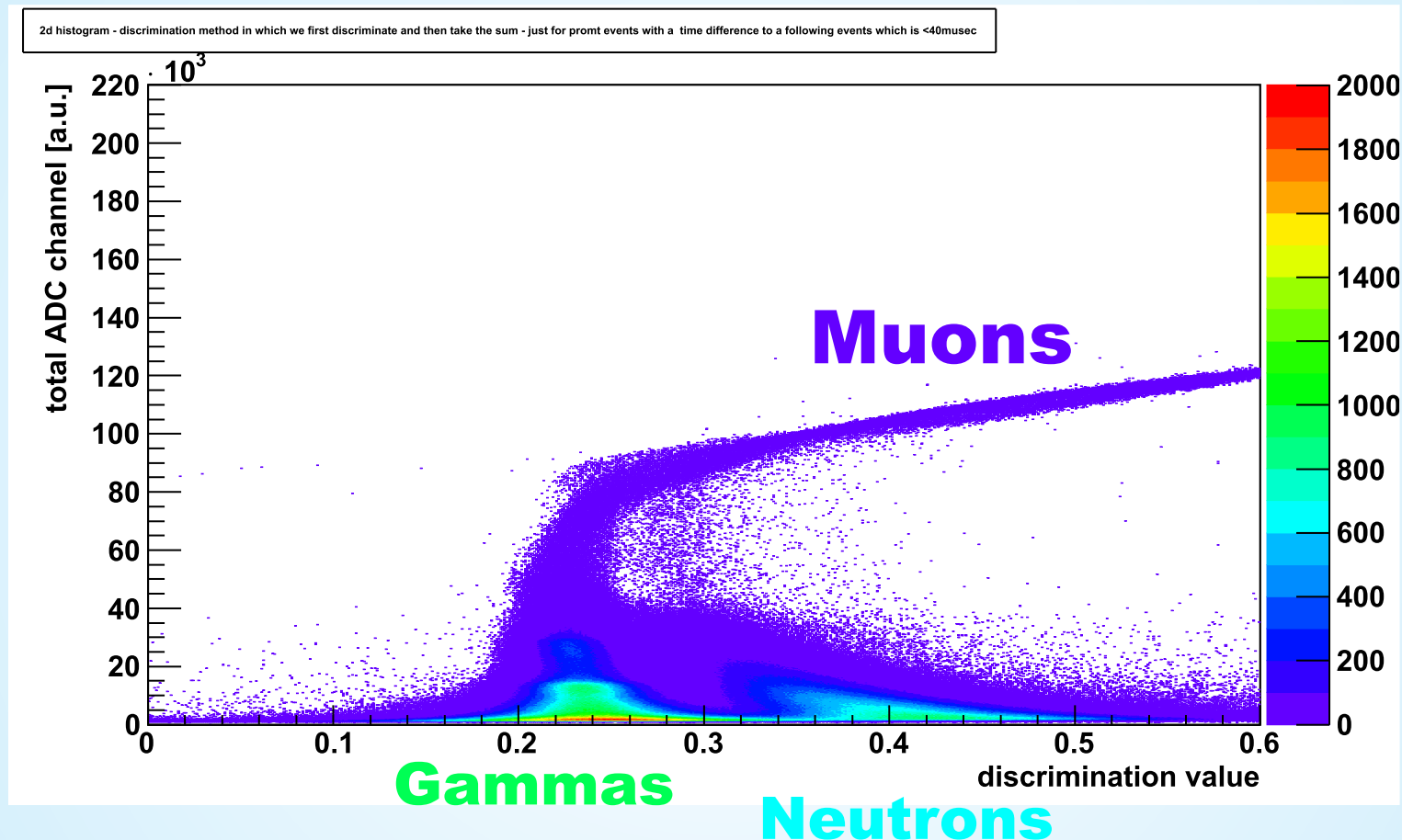
total energy spectrum of PMT1+PMT2



**Integration into
our DAQ done**



Muon Induced Neutrons



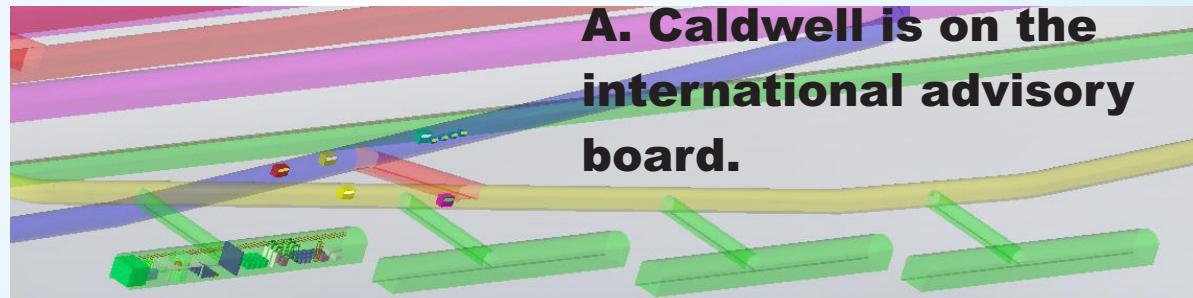
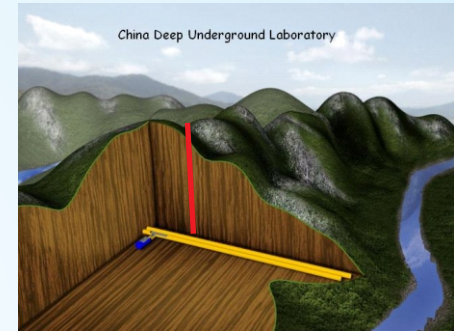
Test with Neutron Source

China Jinping Laboratory



It would be nice to open the deepest underground lab to the international community.

↳ **Expression of Interest**



2400m of rock

7500 mwe

60 muons /m²/y

4 x 2 labs each lab: 63.5m x 14m x 14m

This is under construction - plus end-cavities.

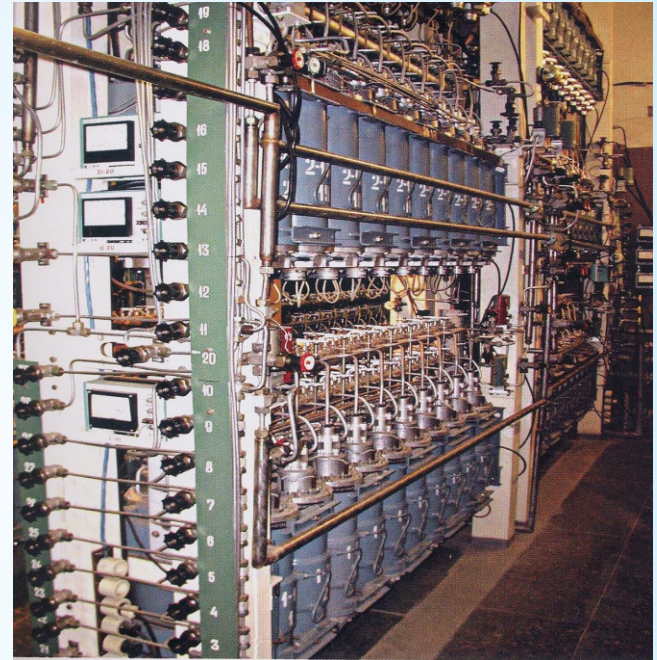
Rock work volume of 8 x labs	130591 m ³
Concrete work volume	26427 m ³
Steel structure	912 T

Construction under way

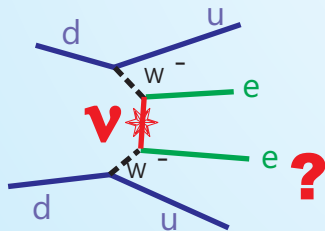


Symposium at Ringberg

Excavation started 1.11.14



How about



Supply and control system of cascade

Tsinghua is starting an effort to enrich ^{76}Ge to $\sim 85\%$



Symposium at Ringberg

Dark Matter

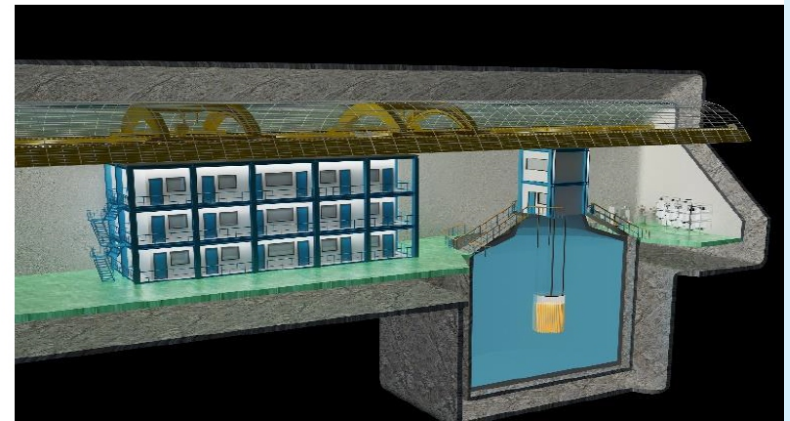
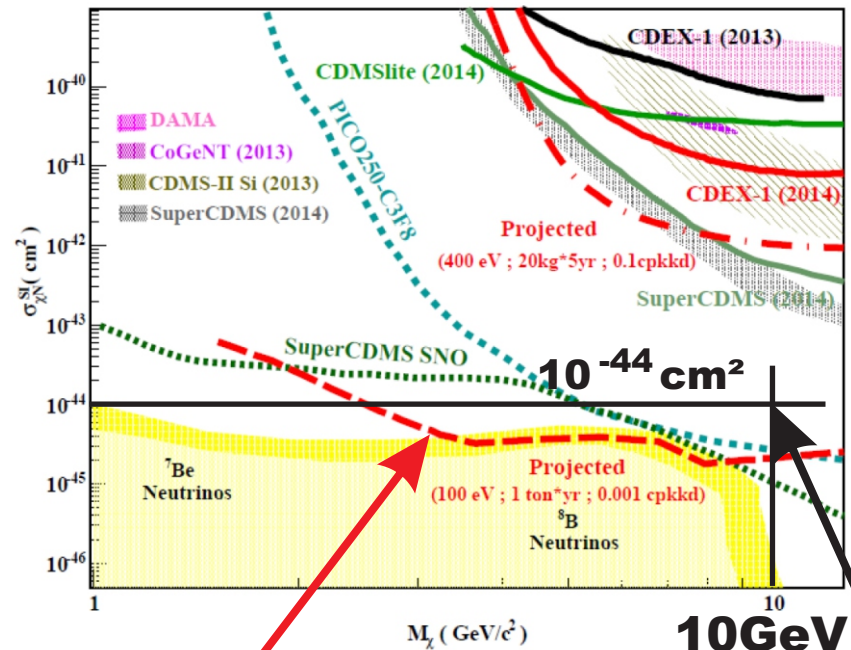
Germanium detectors target low mass wimps.

Neutrino coherent scattering

Look at reactor and beyond

CDEX 200 at CJPL

Projected sensitivities of CDEX

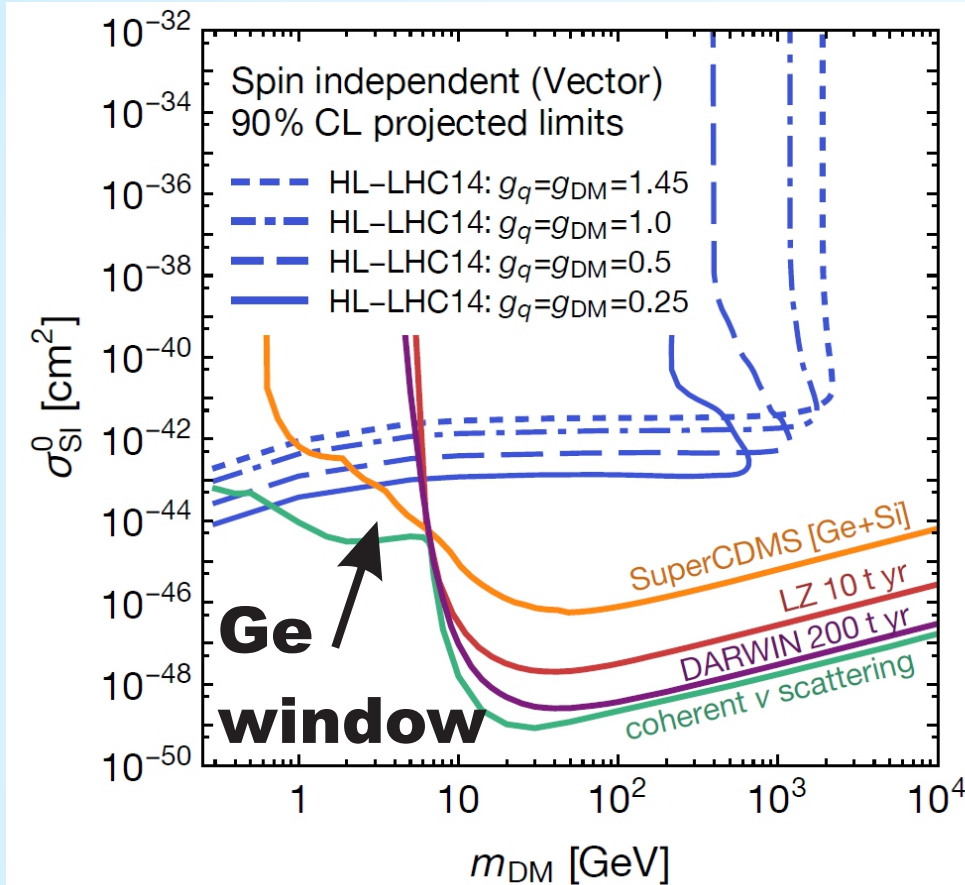


100eV 1ty 0.001c/kg/keV/d

but how? \longrightarrow R&D



Symposium at Ringberg



**Simplified model
currently used by
DM community:**

- vector boson**
- DM is spin 1/2 fermion**
- pure s wave**
- point like nucleon**
- LHC does best
at low masses.**

1409.4075v3 [ref 28]

**The age of models
has come.**



Symposium at Ringberg



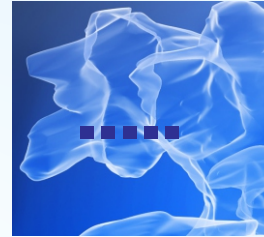
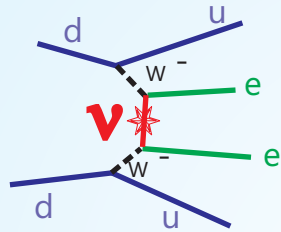
We are looking for ways to intensify international cooperation and share information and work more effectively.

**Support for an Eol is growing.
US groups are interested.**



[In]Famous Last Words

Germanium detectors might give us the chance to address some very fundamental questions.



We need new detector technologies to get to the next level.

We work on detector development.

We try to evaluate future options.

After the final symposium of our cooperation at Ringberg, we are working on future network for R & D .

