Scientific CCDs for DM and Neutrino detection

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Goal: lower the energy threshold in Si detectors

Look for coherent (DM/ν)-nucleus interactions by measuring the ionization produced by the nuclear recoils

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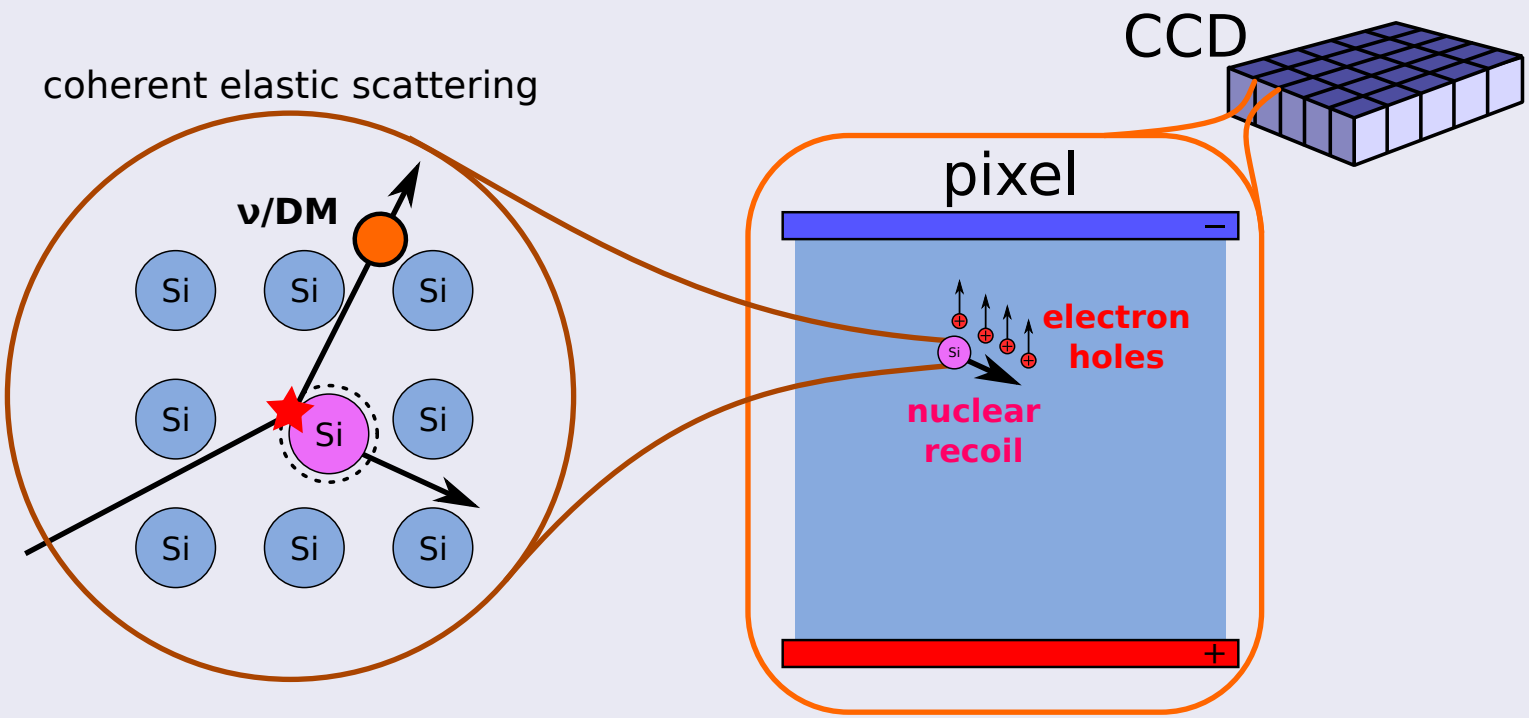
Look for coherent (DM/ν)-nucleus interactions by measuring the ionization produced by the nuclear recoils

Idea: use CCDs as target and record the ionization produced in Si



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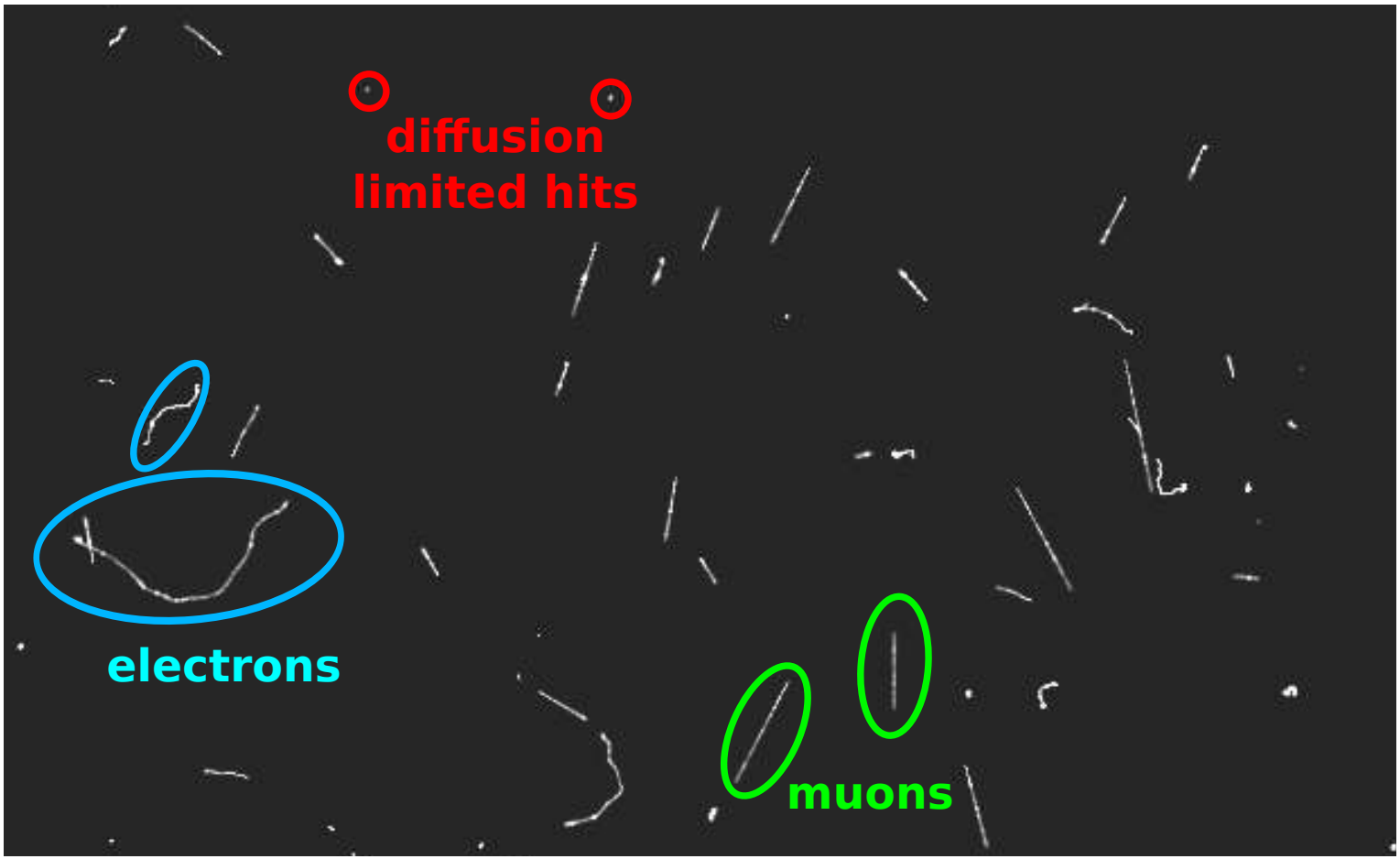

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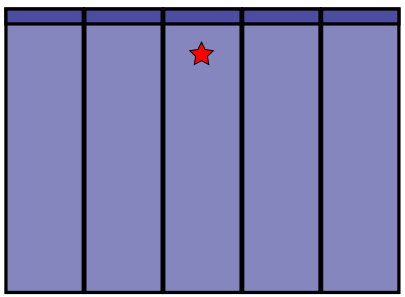

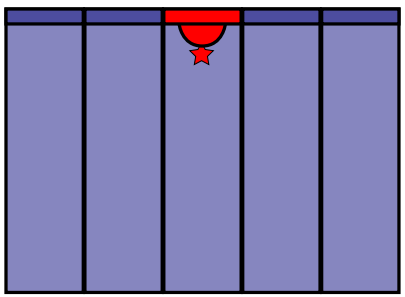

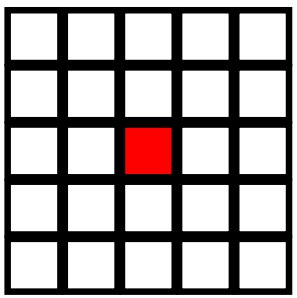

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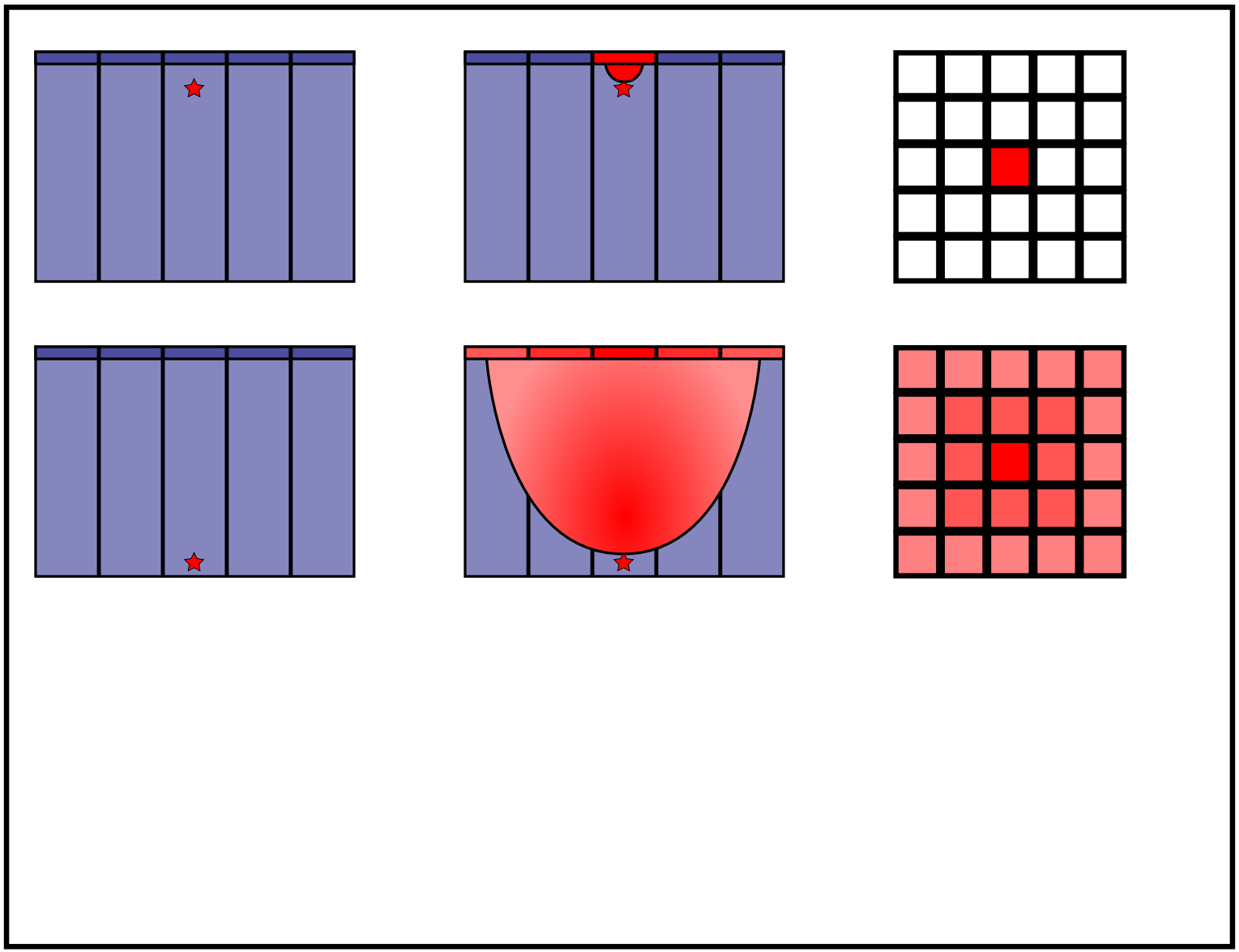

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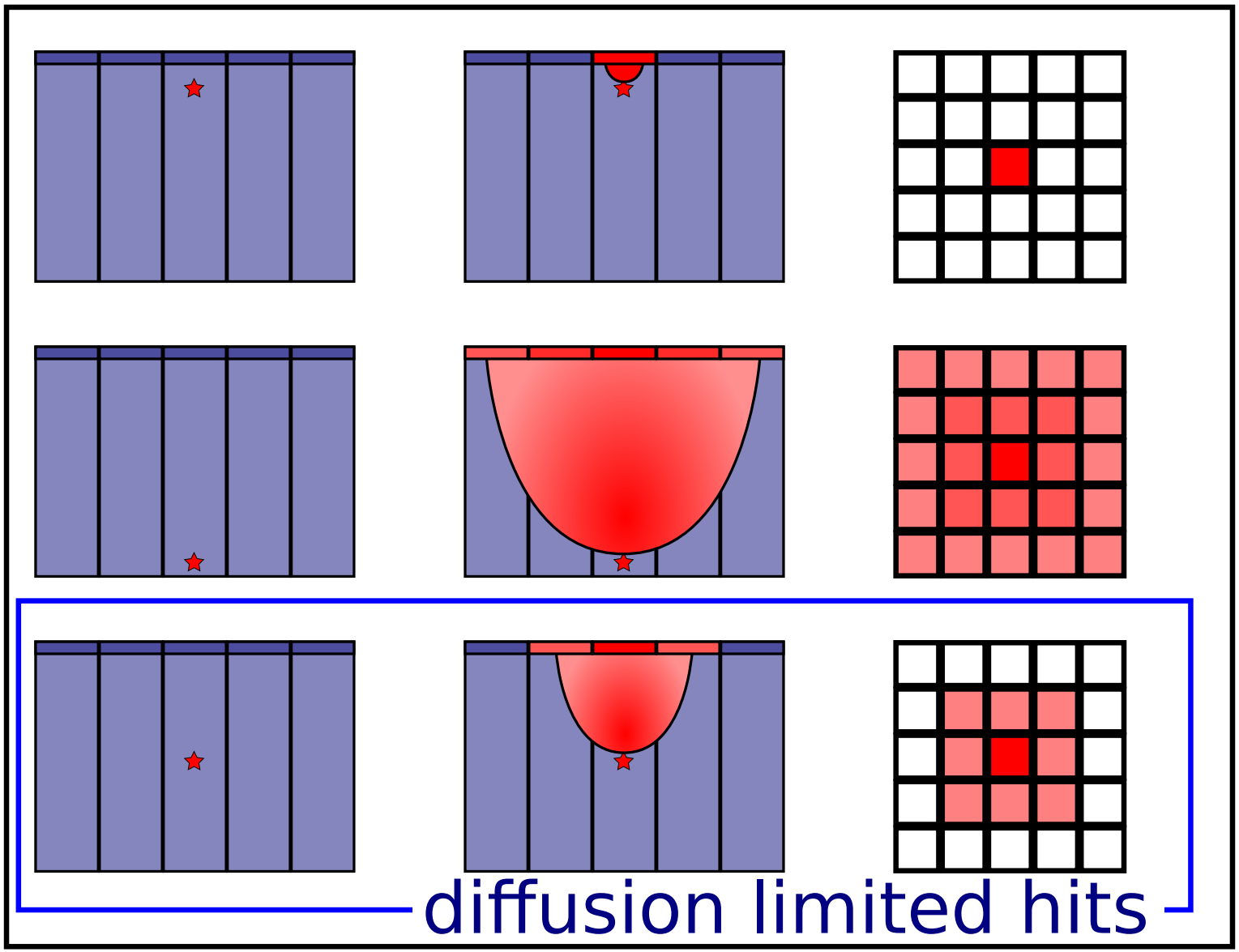
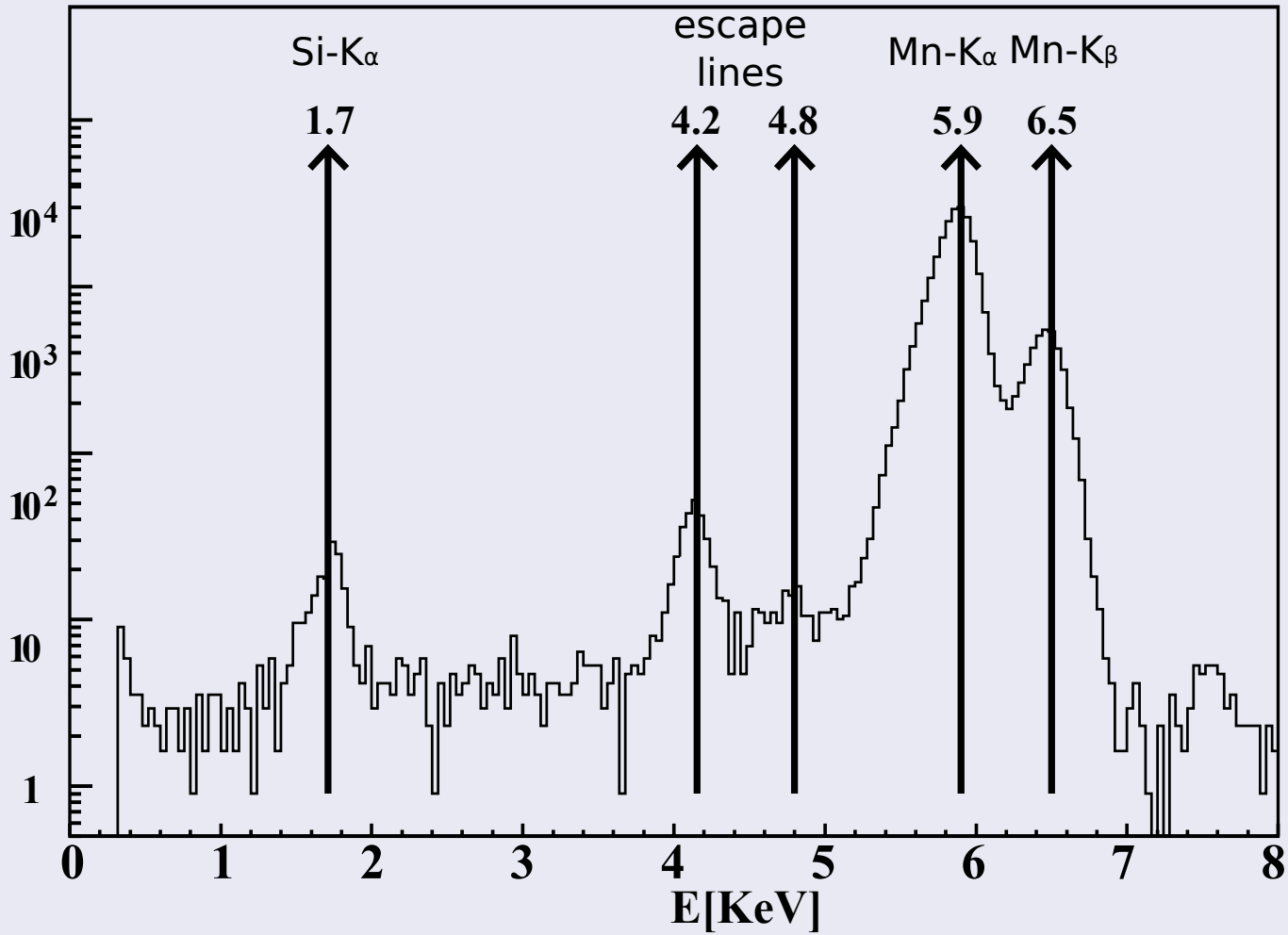
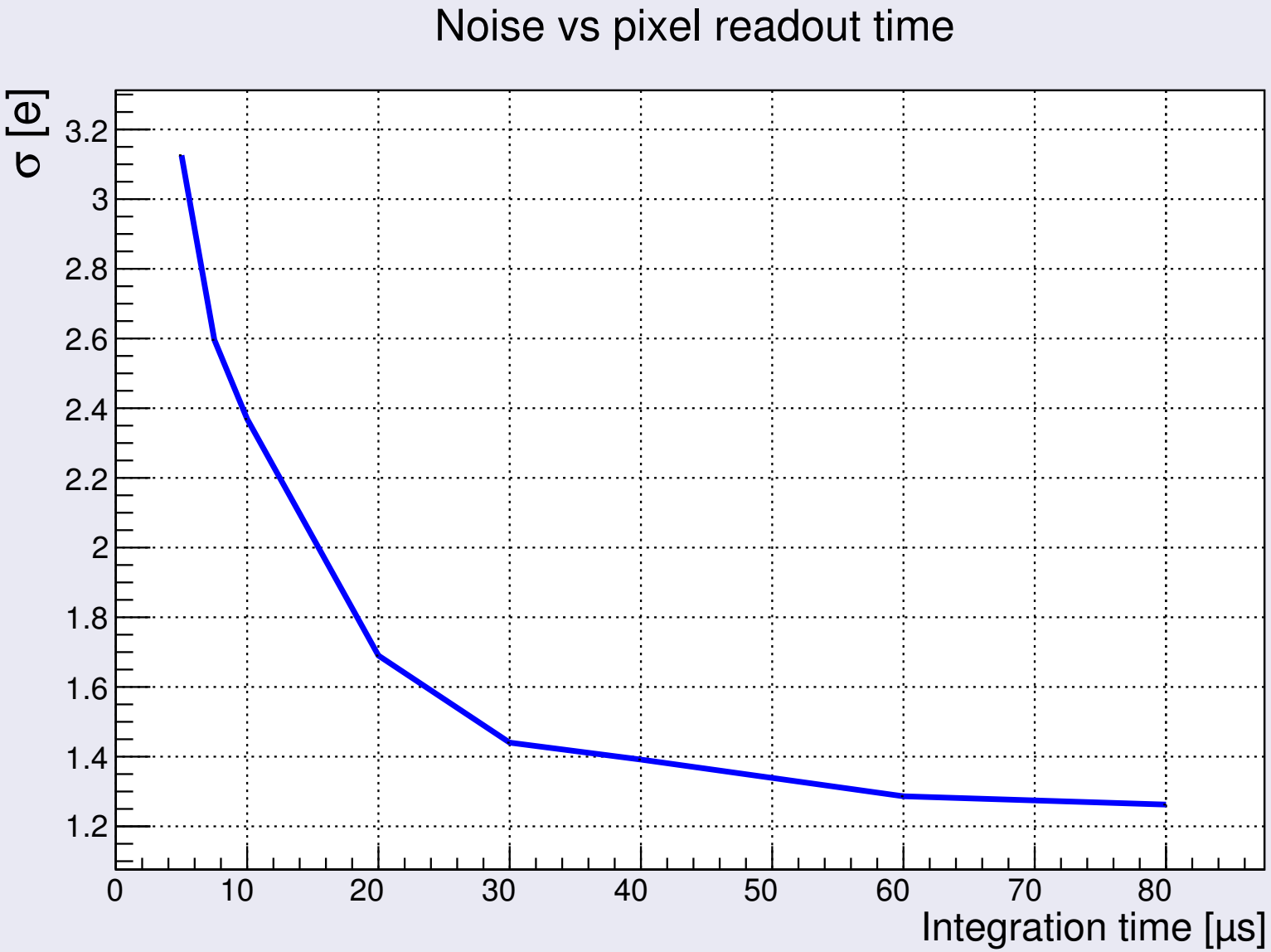


Energy calibration using a ^{55}Fe source



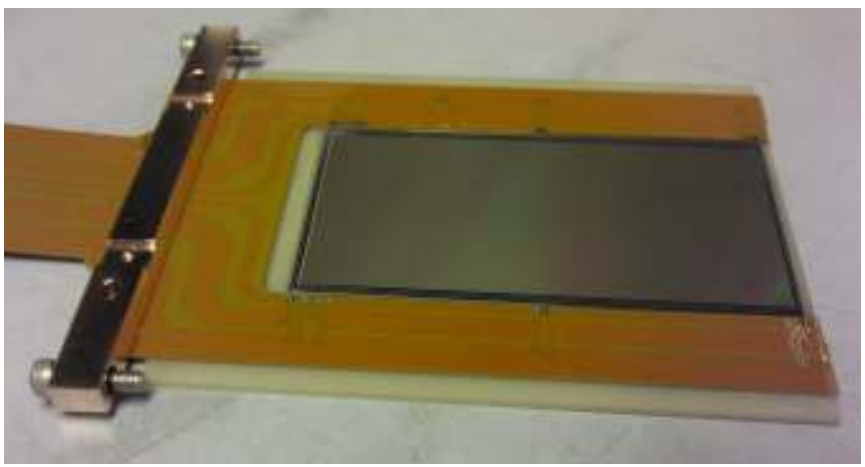
Low noise, almost 1 elctron!



Detector

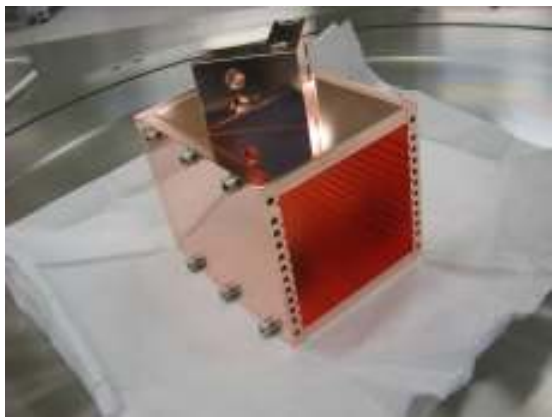
We use scientific CCDs from DECam

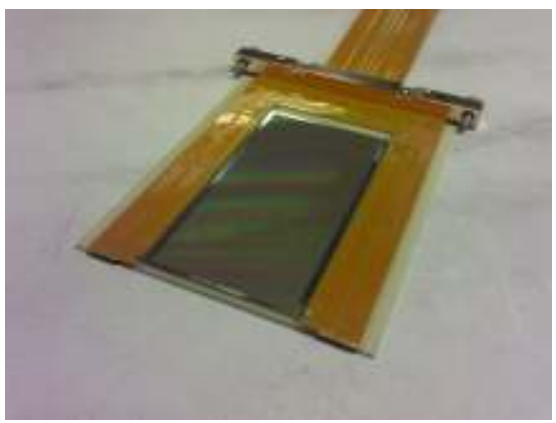
- 10x thicker than most CCDs (250 μm)
  - $\sim$1 gr per CCD
  - allows selection of limited diffusion events: *self-shielding*
- pixel size of 15 μm
- CCDs cooled to -150 C to achieve RMS of 2 e^-
- Threshold of 40 eVee

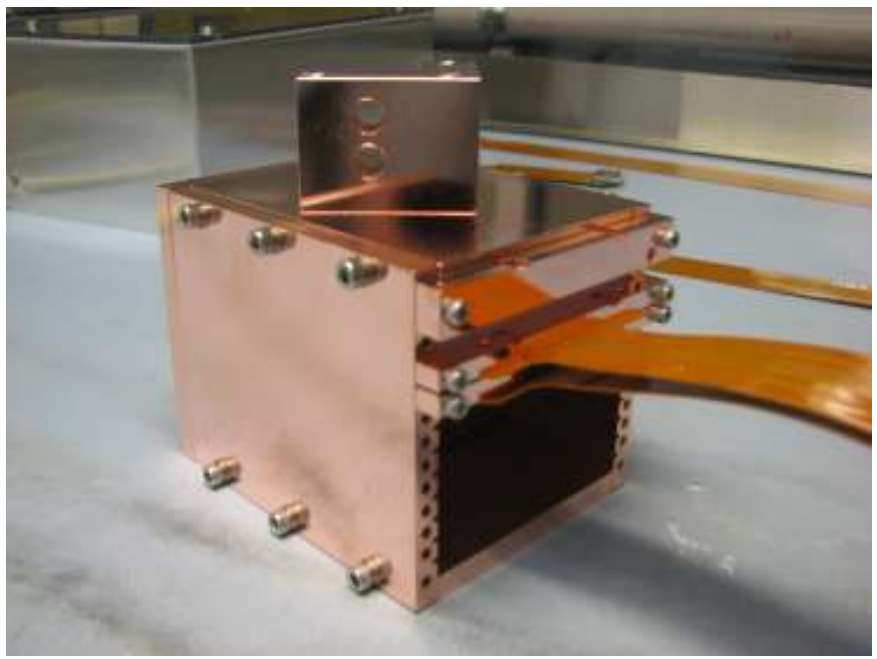


setup

10 scientific CCDs are installed in a low radiation package inside a copper box







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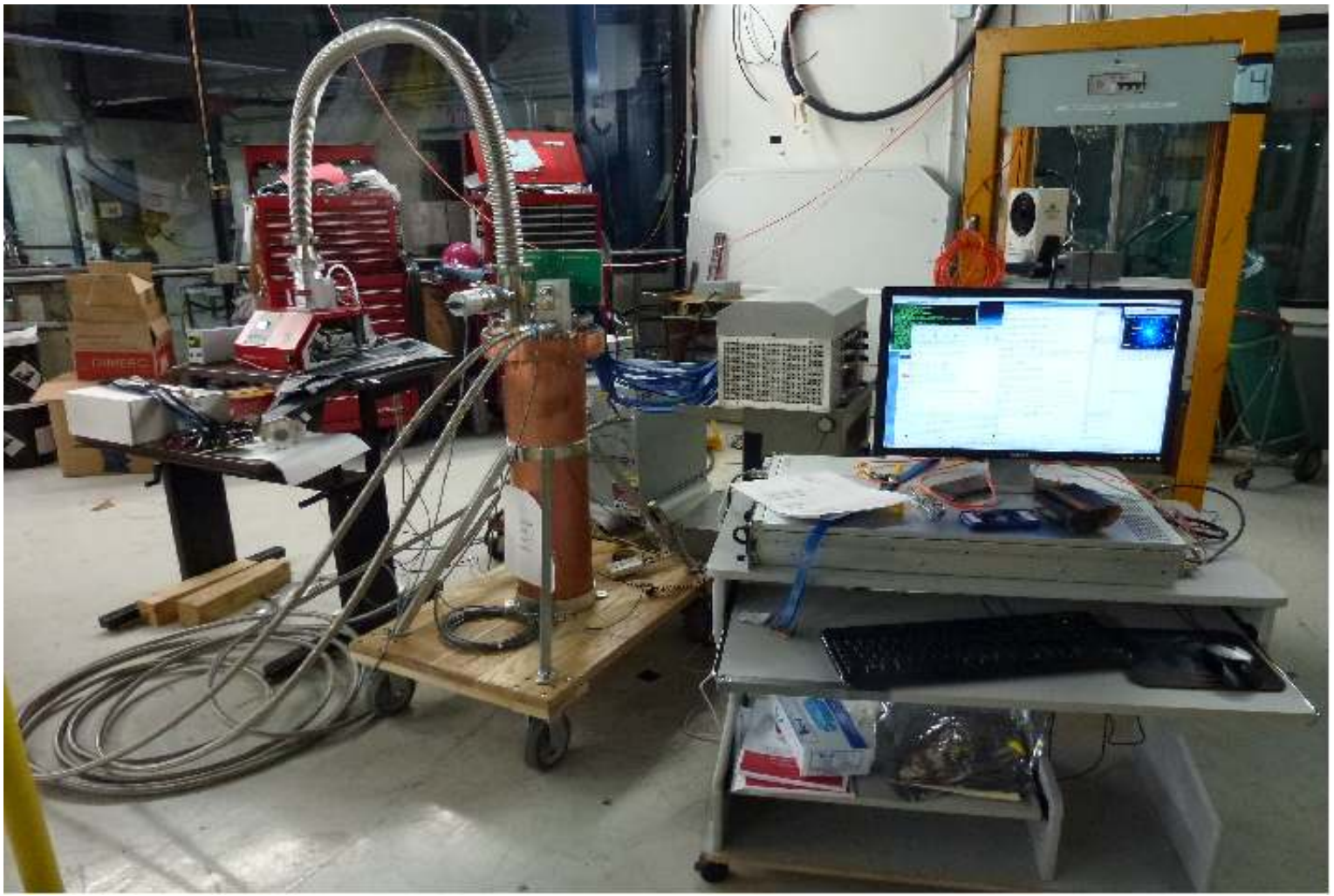

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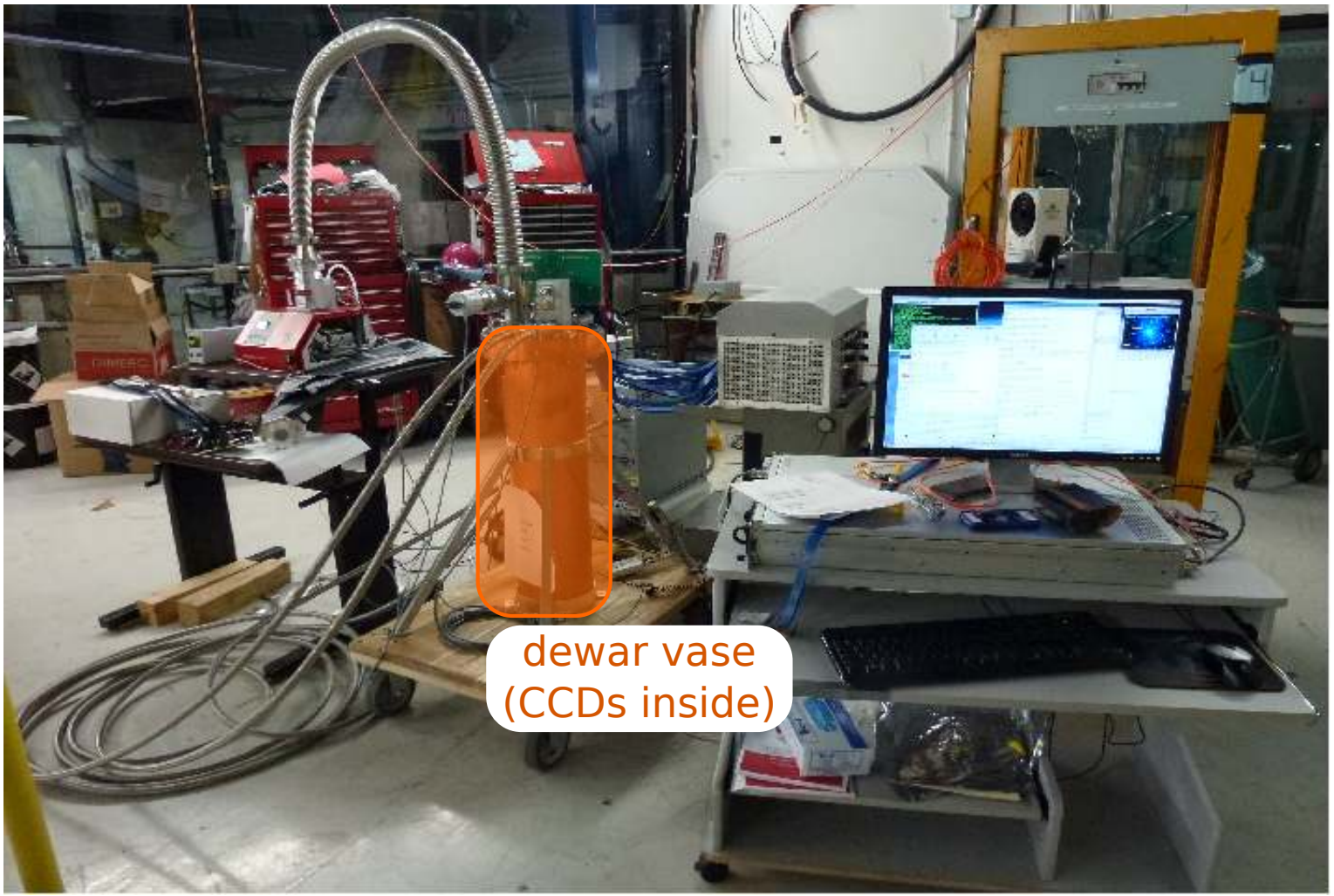

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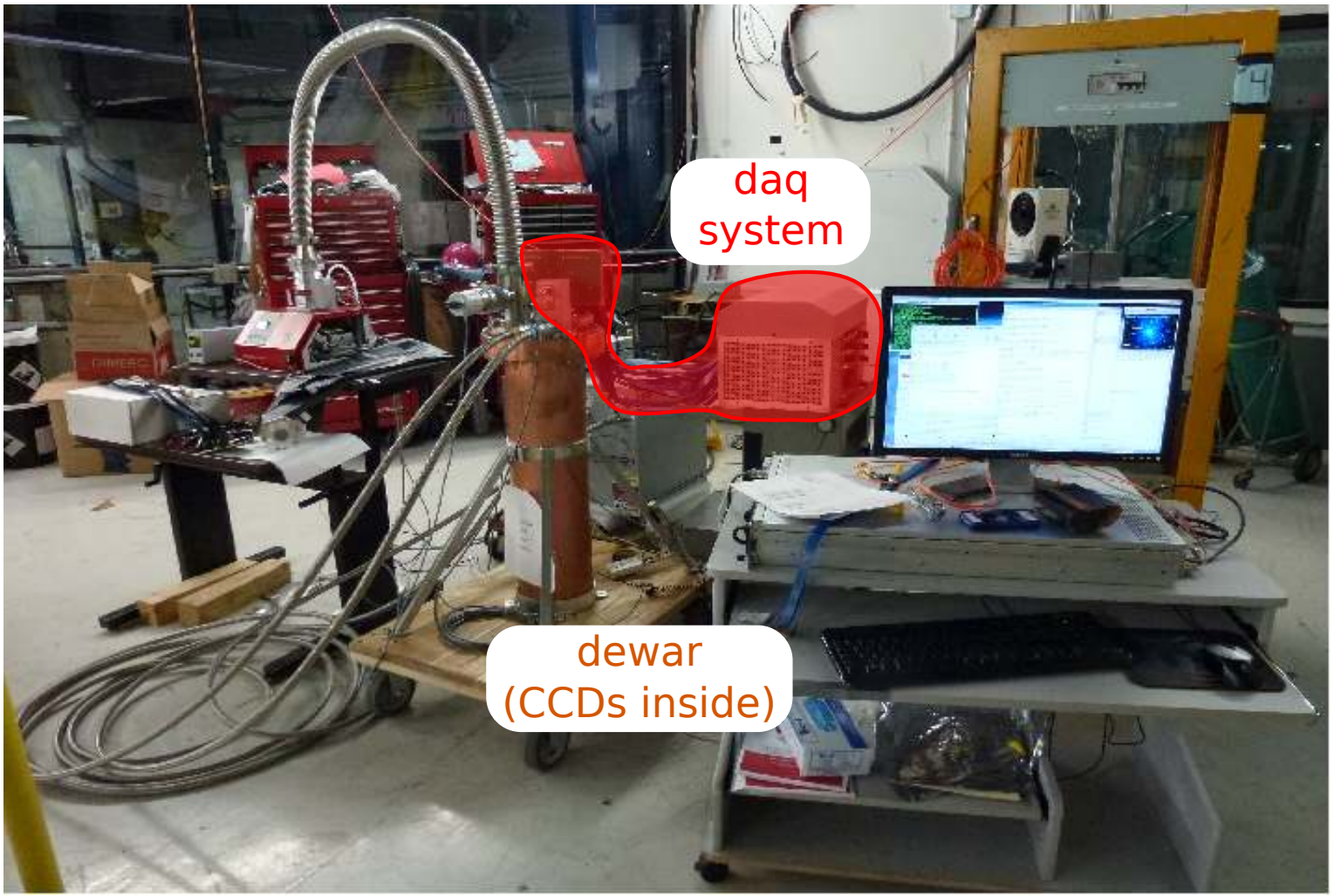

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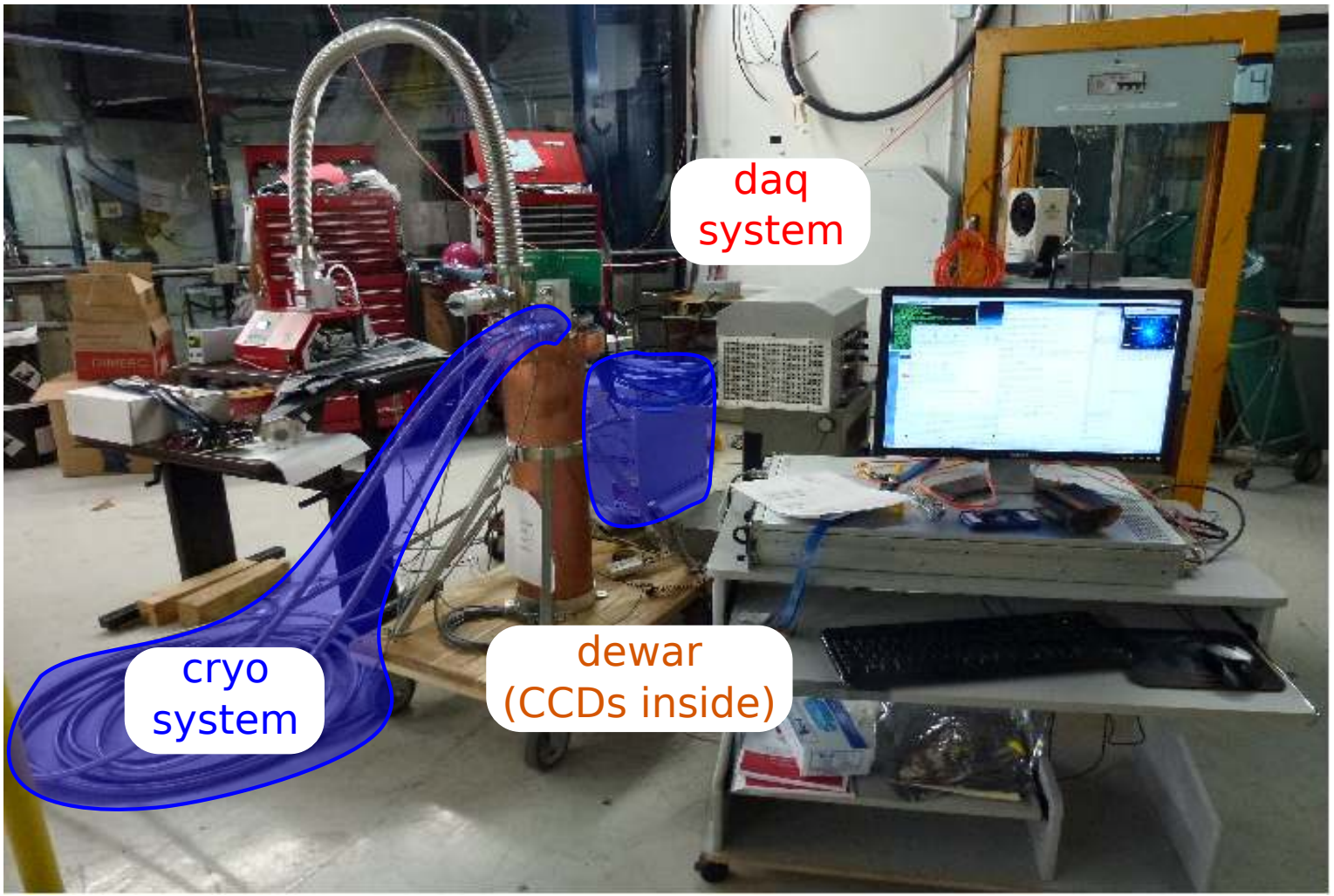

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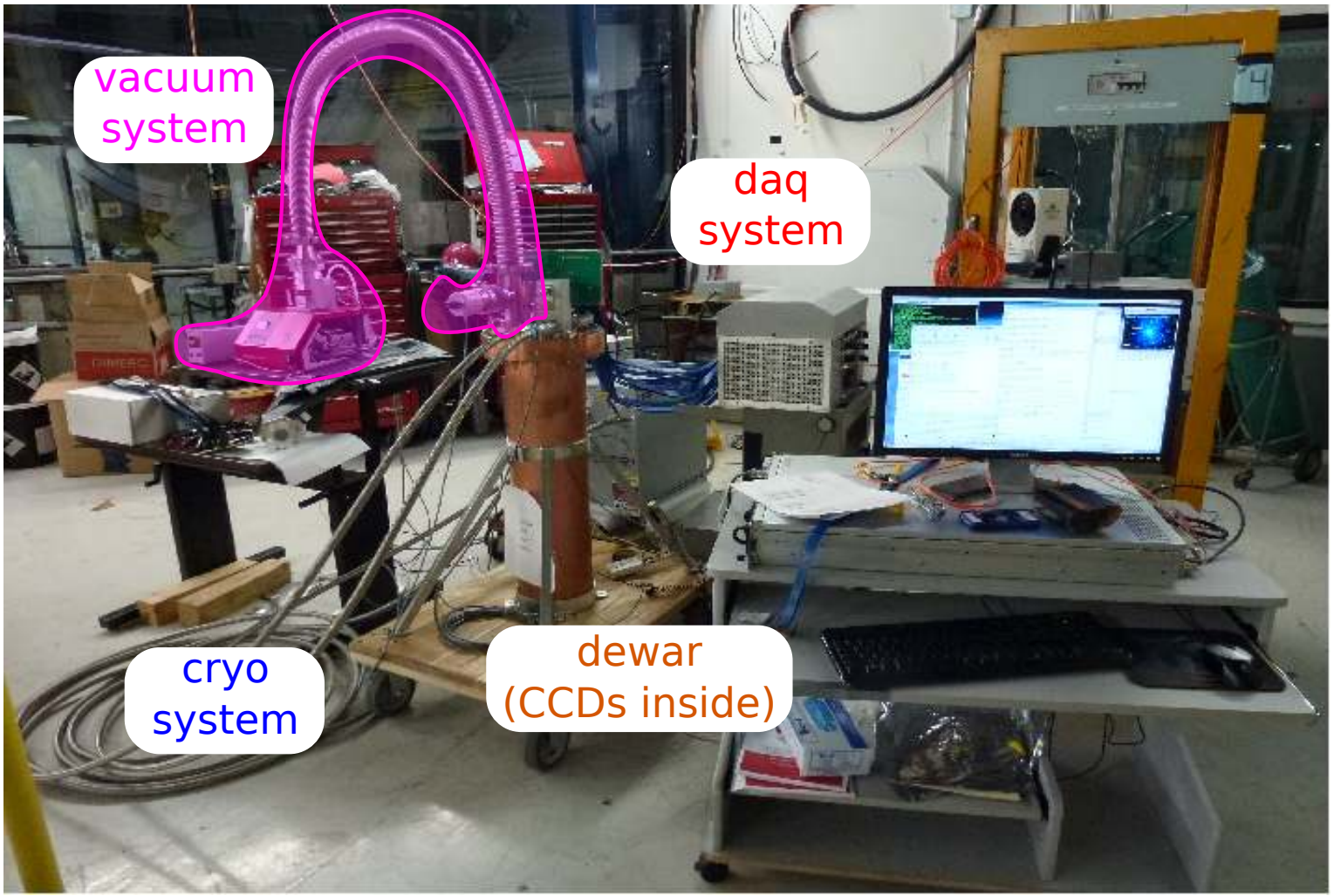
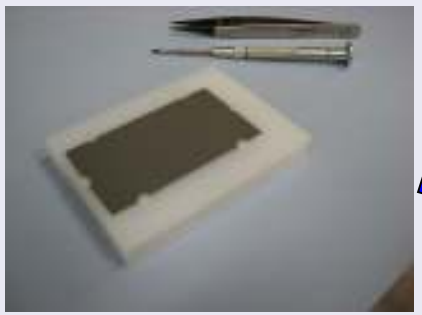


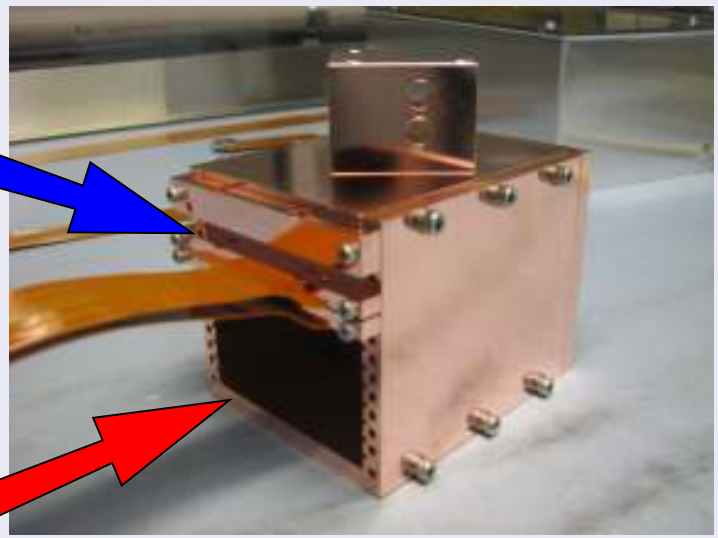
Background measurement capabilities.

The background can be measured inside the dewar using the CCDs

neutrons

polyethylen + boron layer
attached to the first CCD





gammas

crystal facing the last CCD

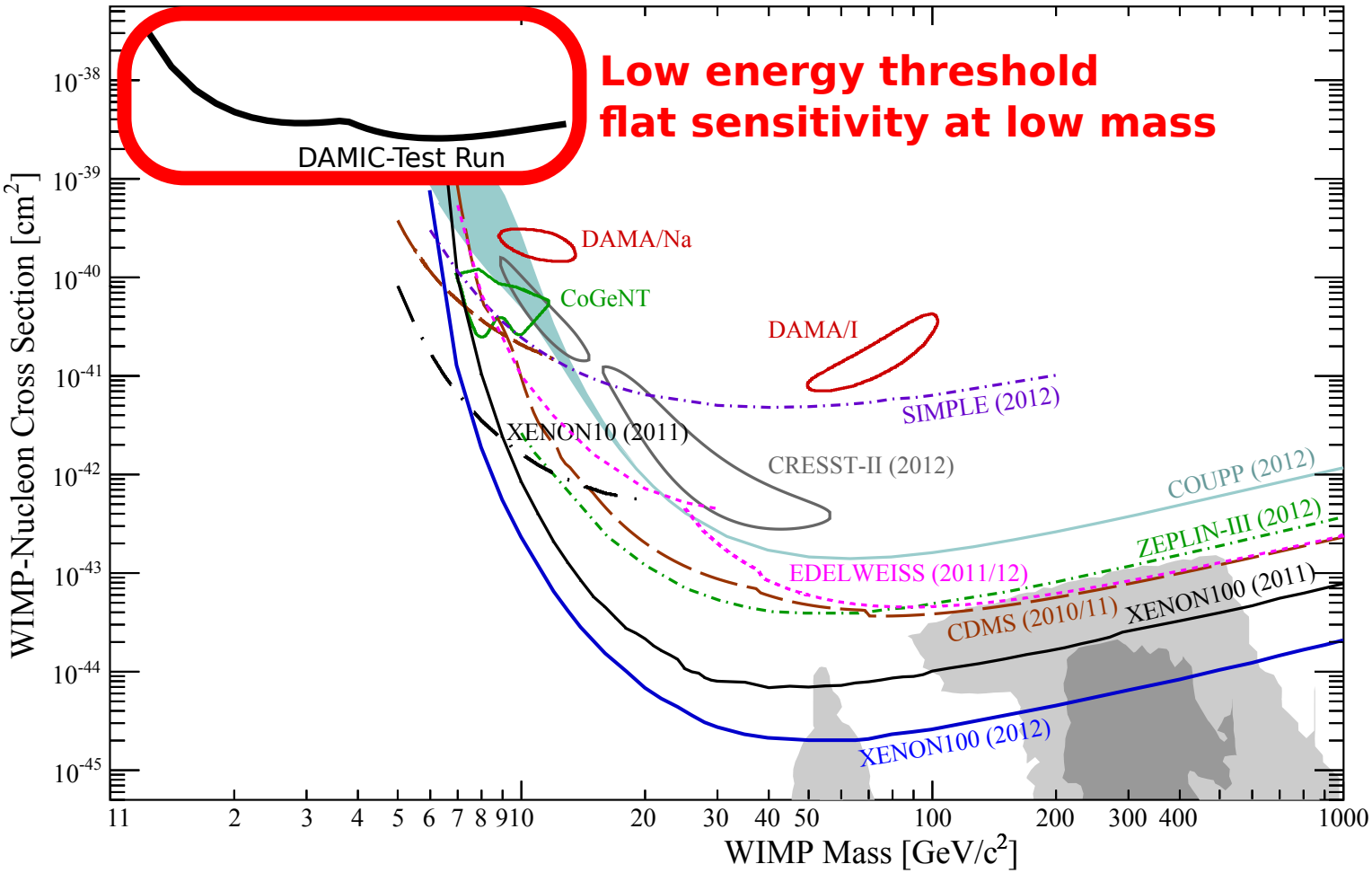
DAMIC:

DArk **M**ater **I**n **C**CDs

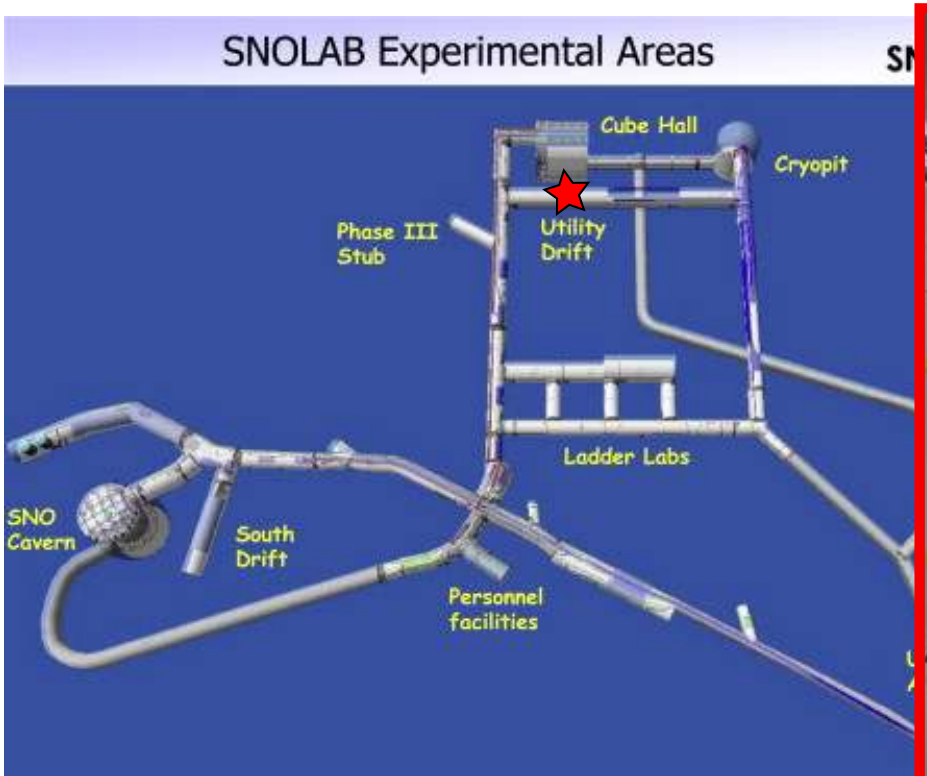
CONNIE:

COherent **N**eutrino-**N**ucleus **I**nteraction **E**xperiment

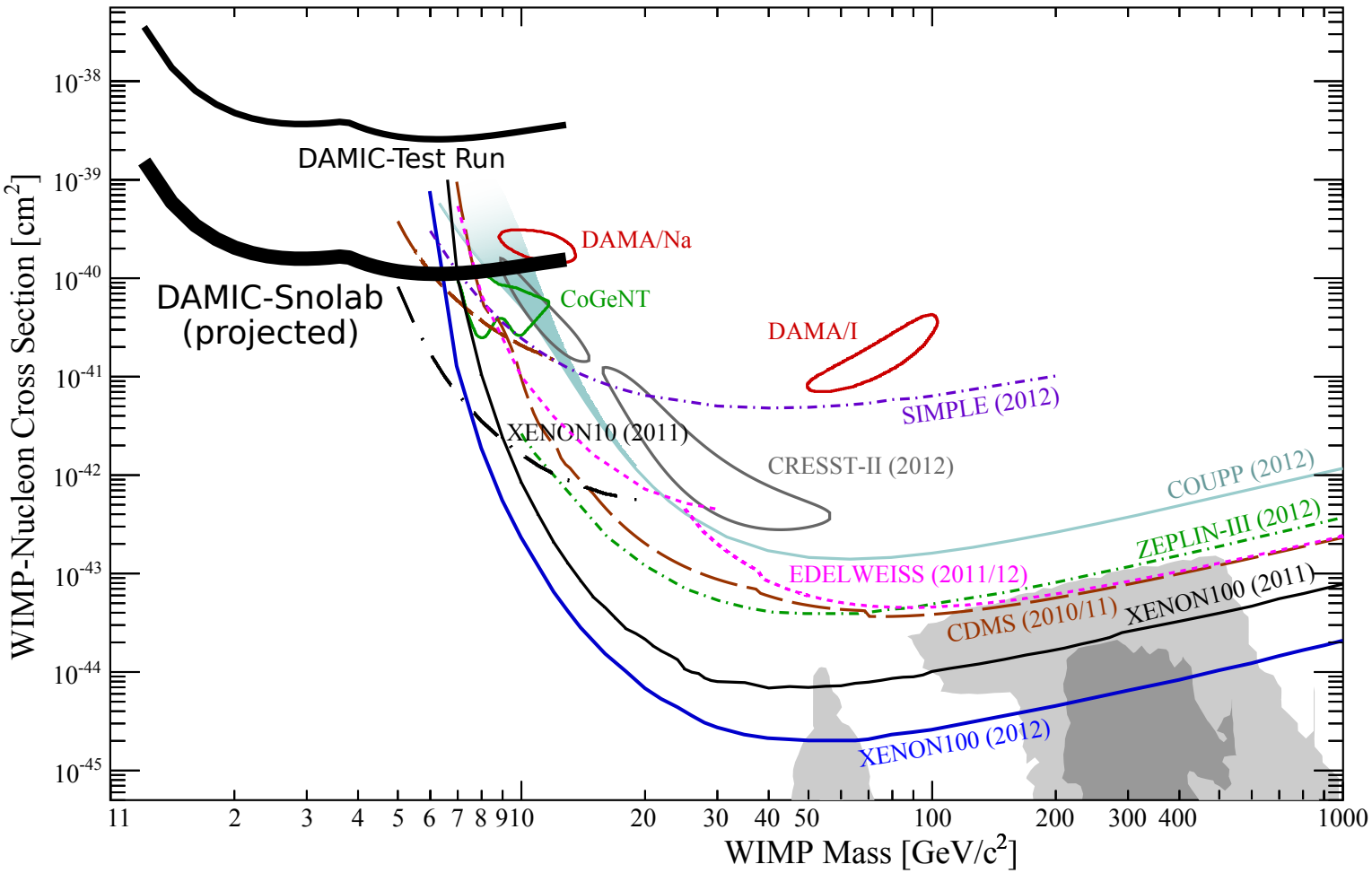
DAMIC: First run - technique demonstration @MINOS



DAMIC

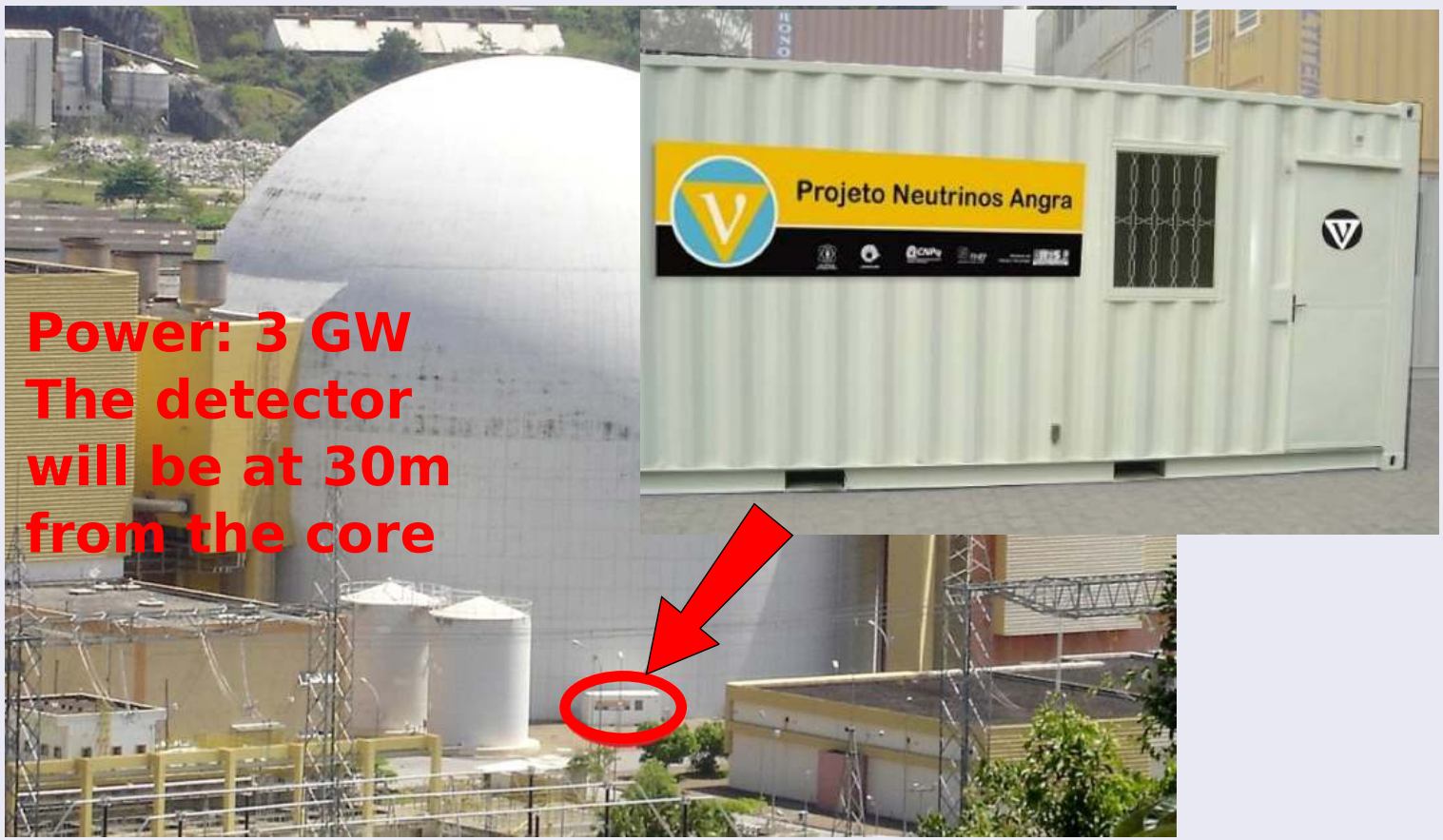

SNOLAB Experimental Areas
Cube Hall
Cryopit
Phase III Stub
Utility Drift
Ladder Labs
SNO Cavern
South Drift
Personnel facilities

DAMIC: Second Run - @Snolab



CONNIE

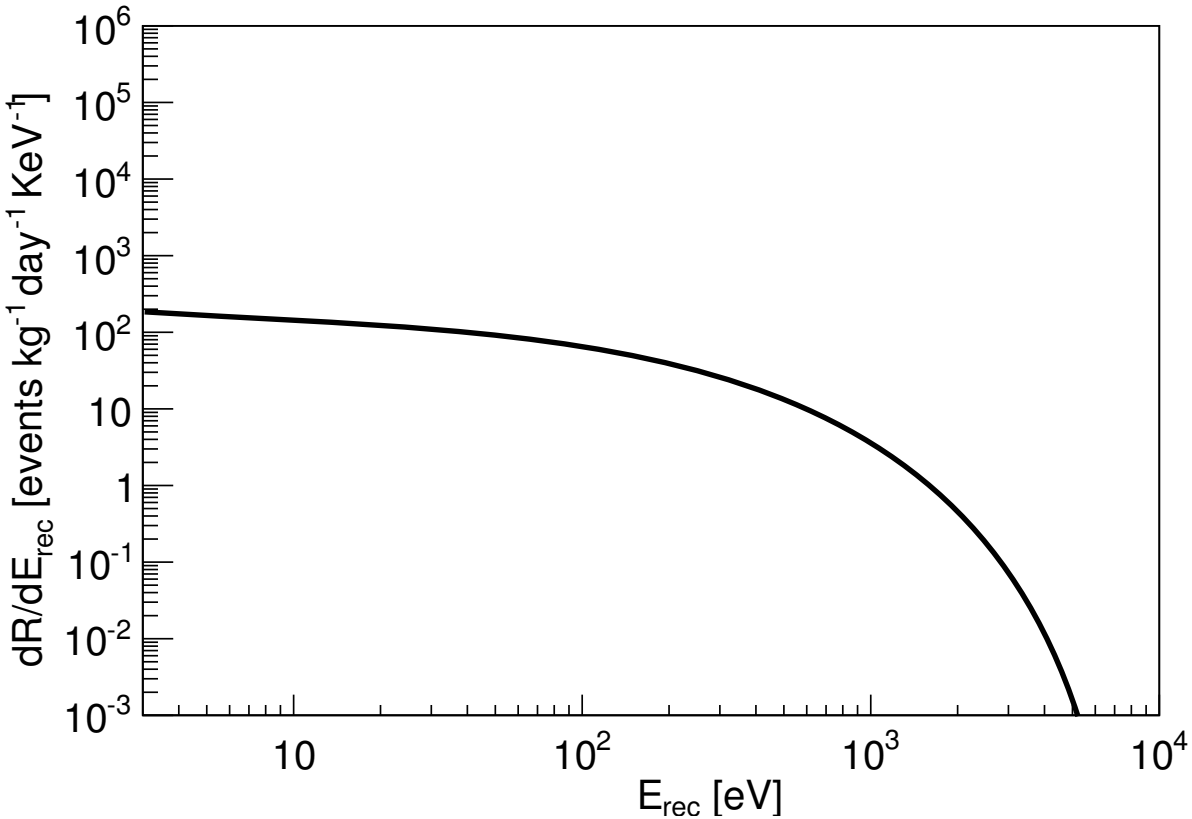
Location: Nuclear power plant in Angra, Brazil



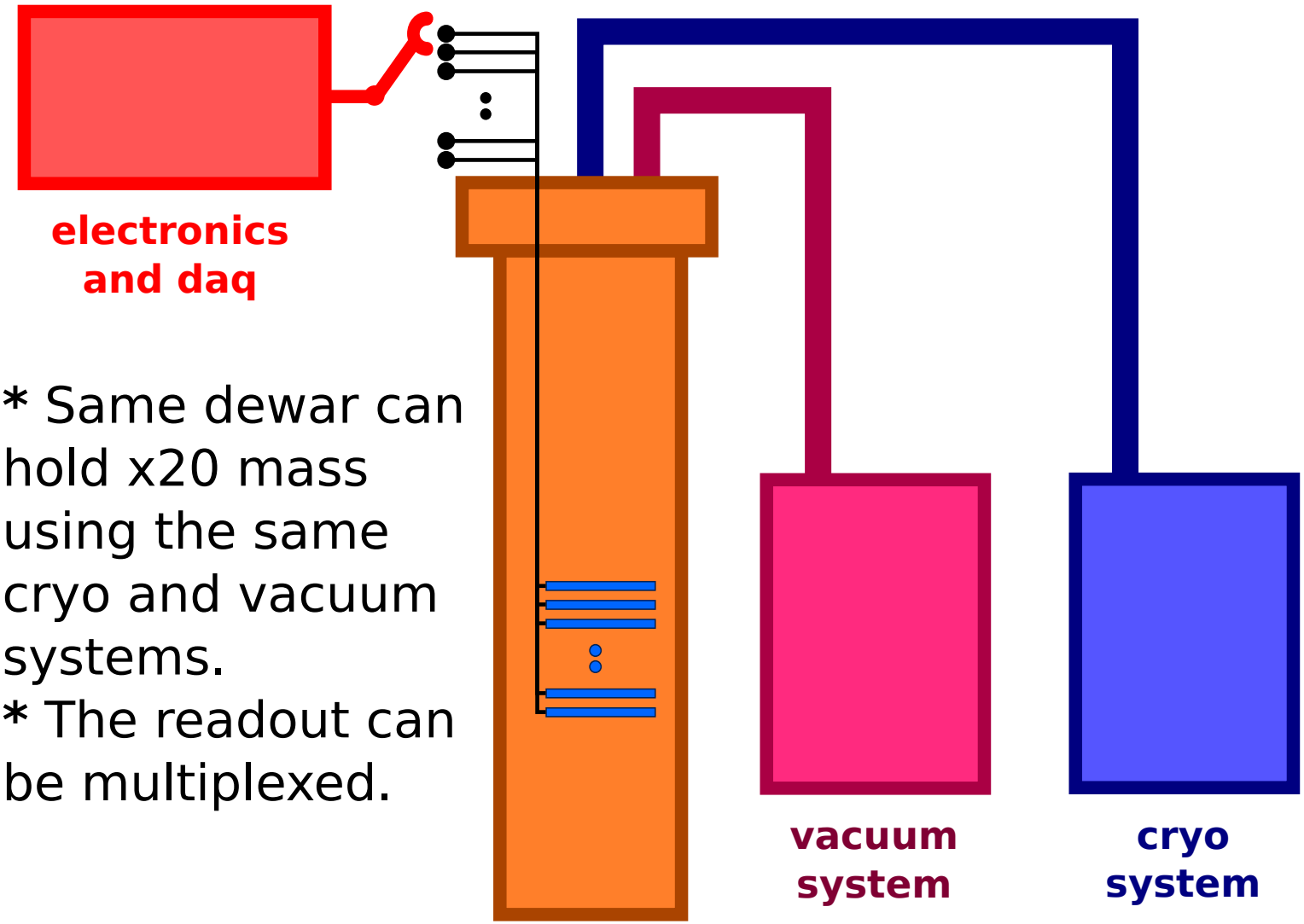
CONNIE

Event rate

For 10 grams: $\sim$ 0.3 ν elastic scattering events per day



Scalability

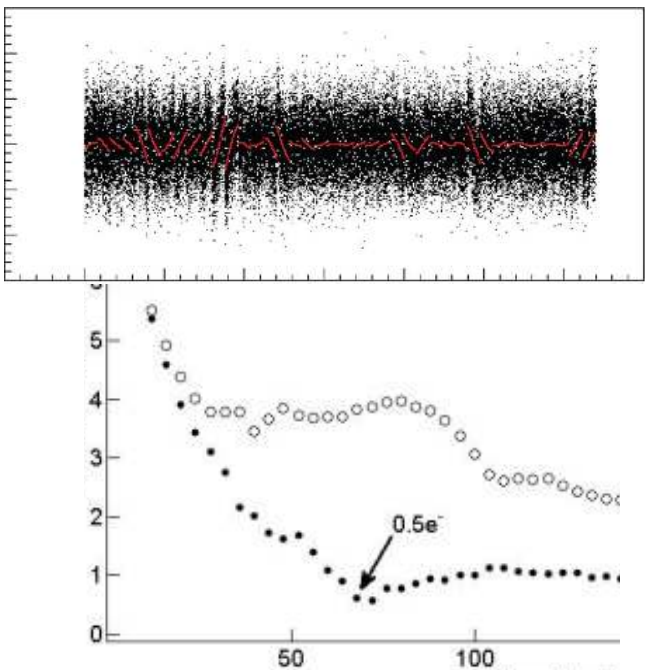


* Same dewar can hold x20 mass using the same cryo and vacuum systems.
* The readout can be multiplexed.

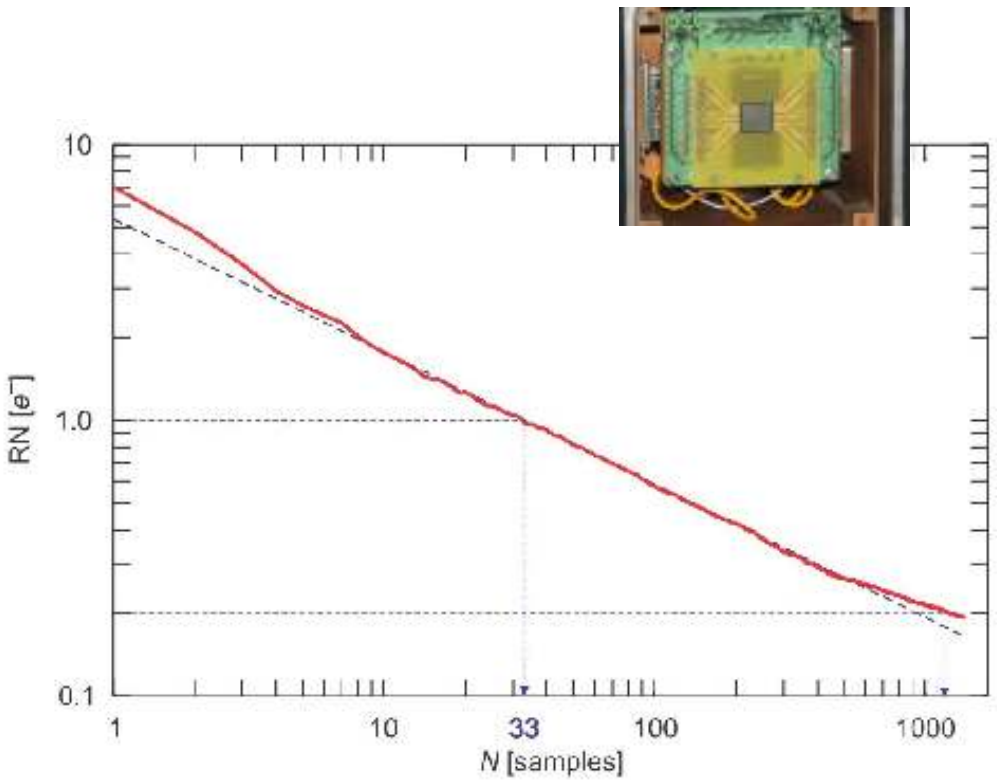
simple & cheap to scale up

Lowering the noise, reaching the sub-electron level.

Correlated noise reduction



SKIPPER CCD



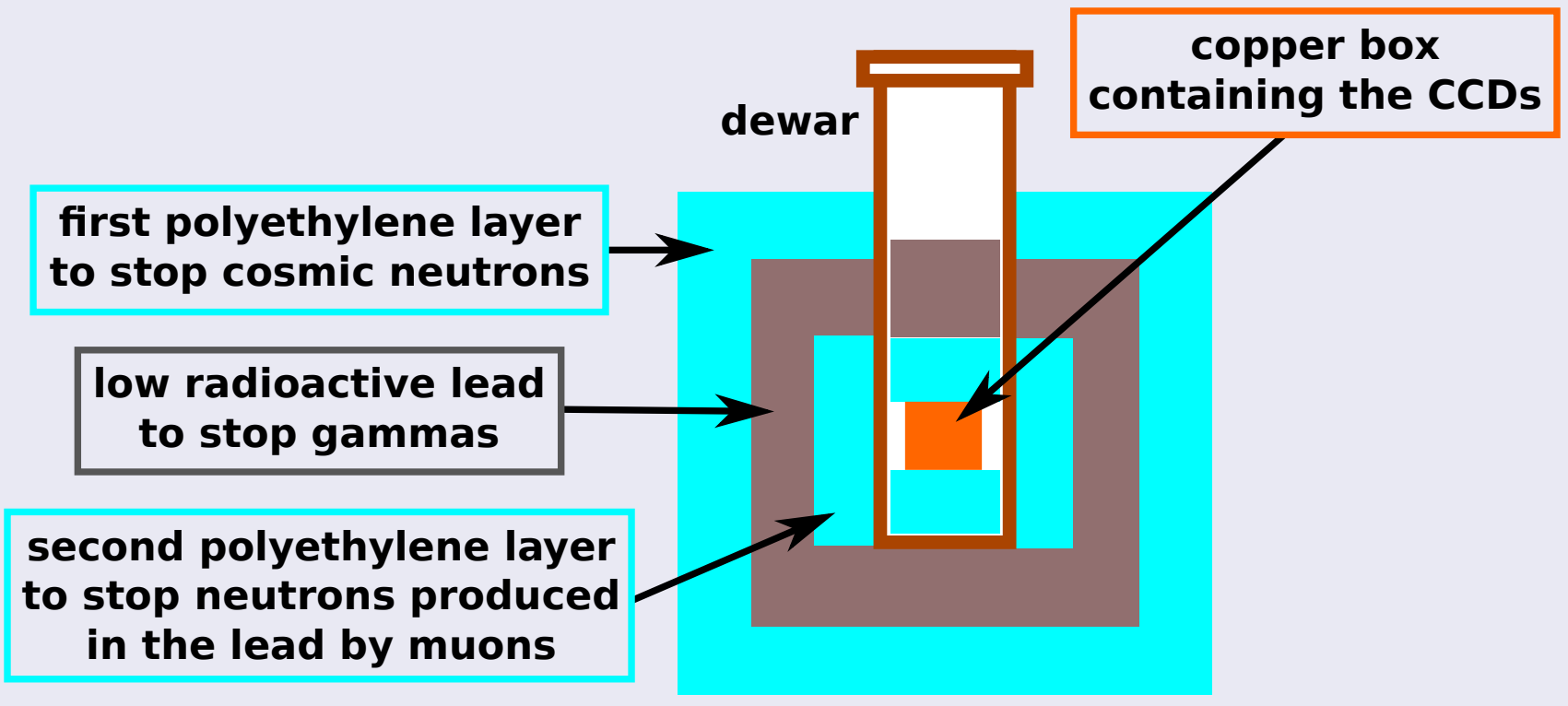
Summary

- CCDs are a good candidate for detecting low energy ν/DM events. The lack of mass is compensated by their low threshold.
- Scalable and compact.
- Neutron background is a big issue. Needs to develop shielding.
- Self-shielding capability for gammas by selecting limited diffusion events.
- Neutron and gamma detectors inside the dewar.
- Ongoing efforts by Fermilab and Chicago University to measure the quenching factor at low energies.
- DAMIC already installed and taking data @Snolab.
- CONNIE will be ready to ship in early 2013 and we expect to complete the installation at the Angra Nuclear Power Plant before June 2013.

BACK UP SLIDES

Shielding: preliminary design.

Three layers



Quenching factor.