Status of DAMIC

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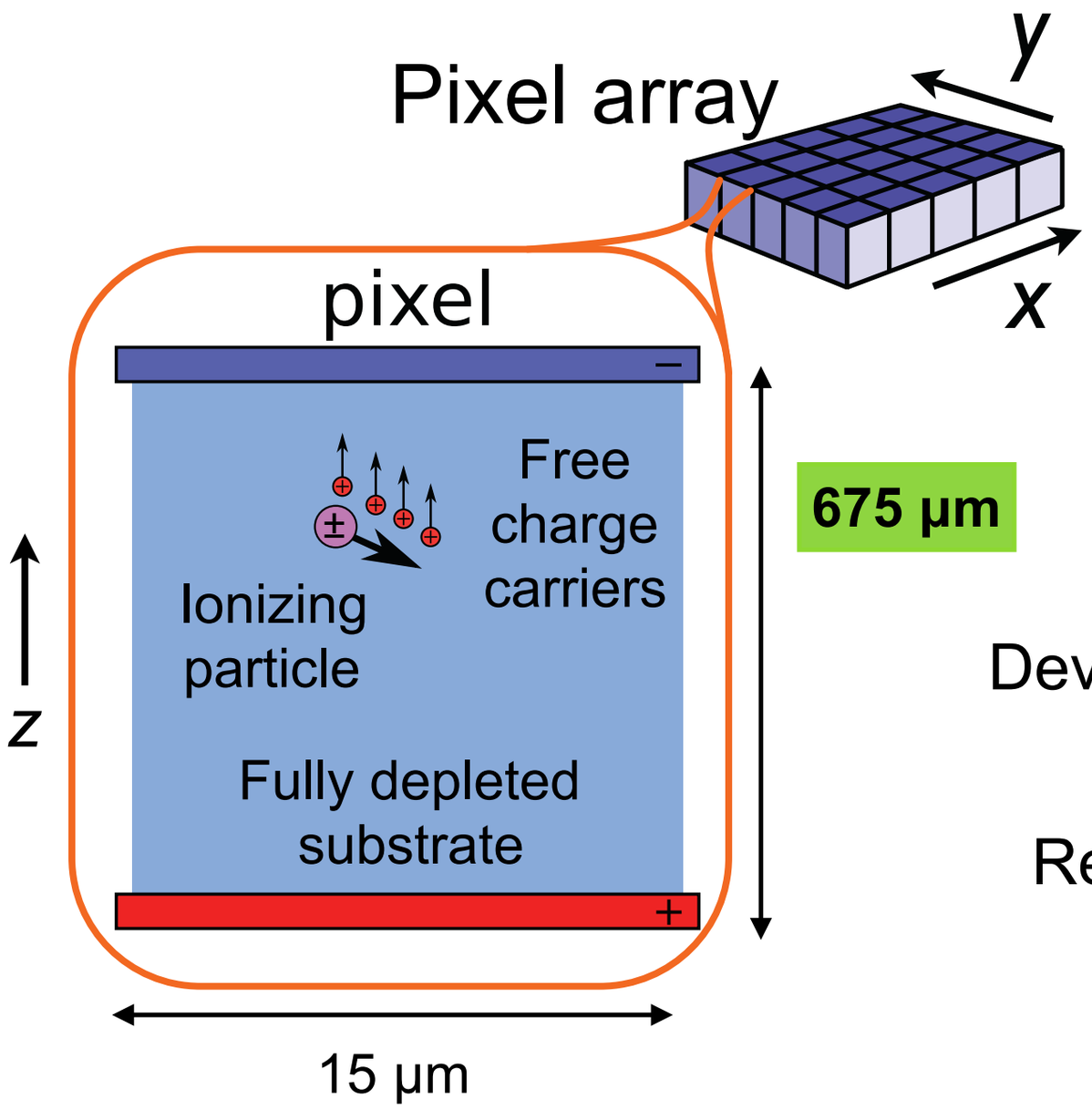
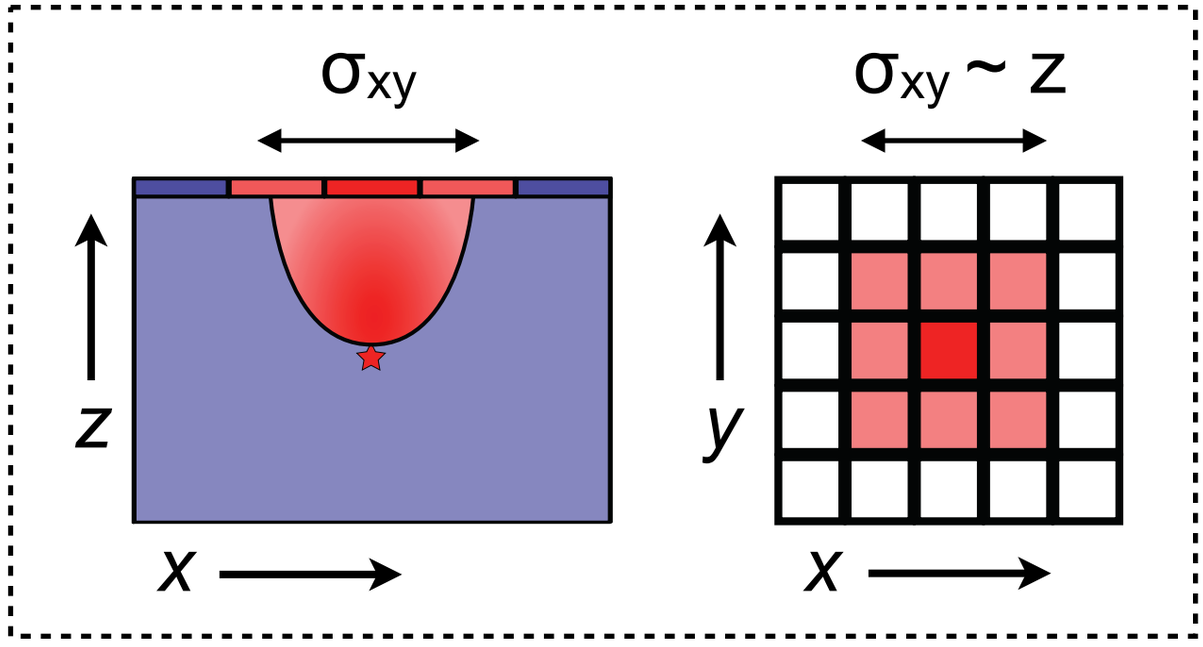
Charge coupled device



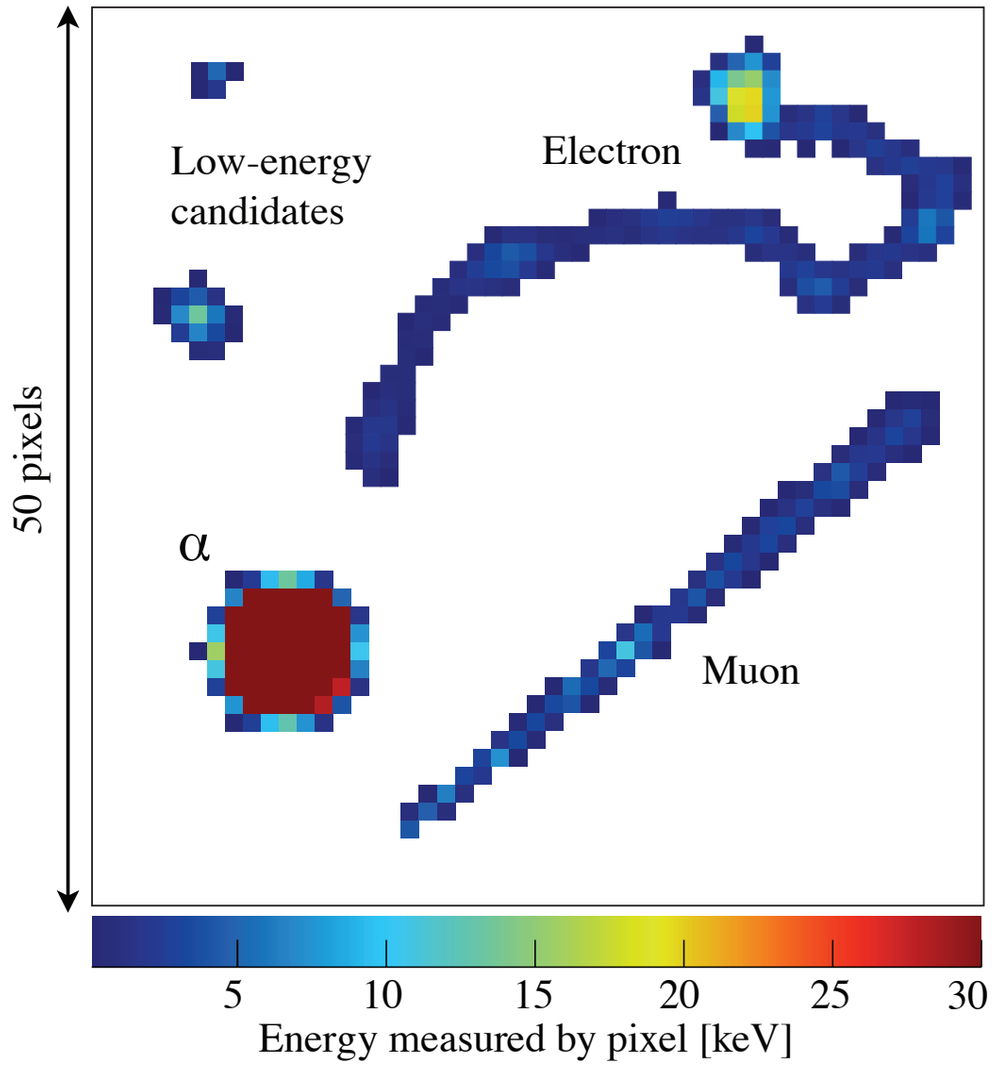


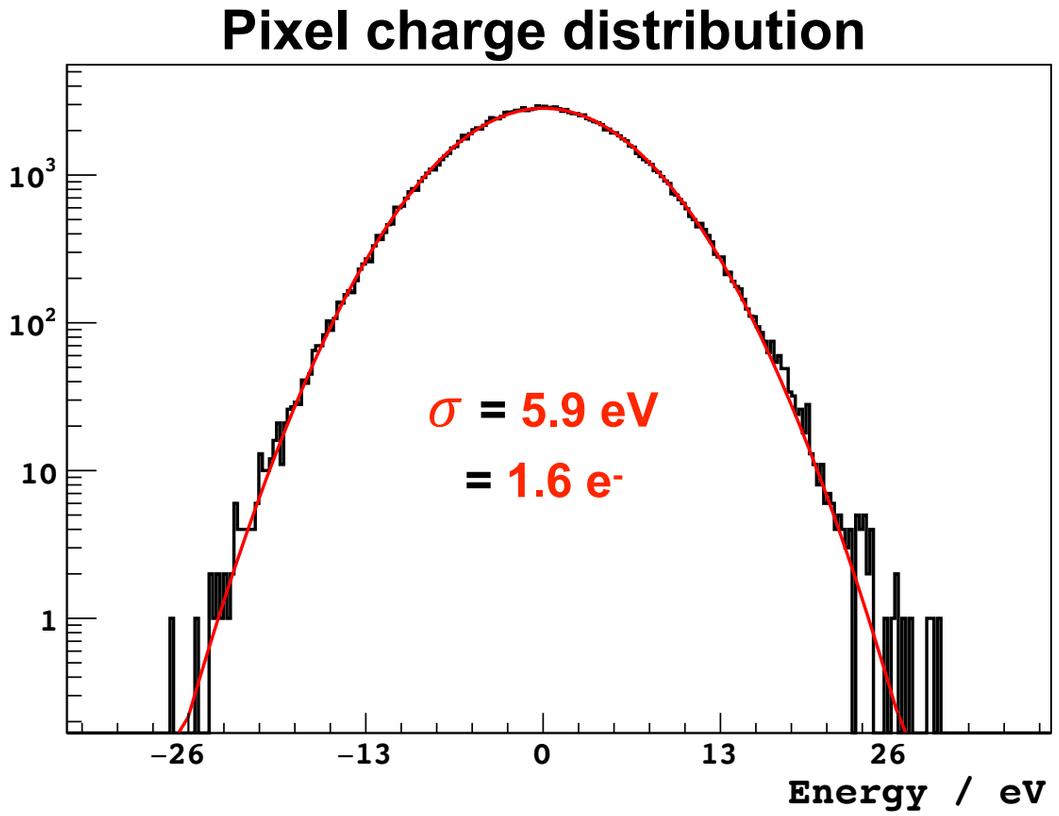
Device is “exposed,” collecting charge until user commands readout.

Readout can be slow / non-destructive : **very low noise (~1 e^-).**

Silicon band-gap: 1.2 eV.
Mean energy for 1 e-h pair: 3.8 eV.

Perfomance





particle identification and background characterization

$\sigma_{xy} \approx z$: fiducial volume definition

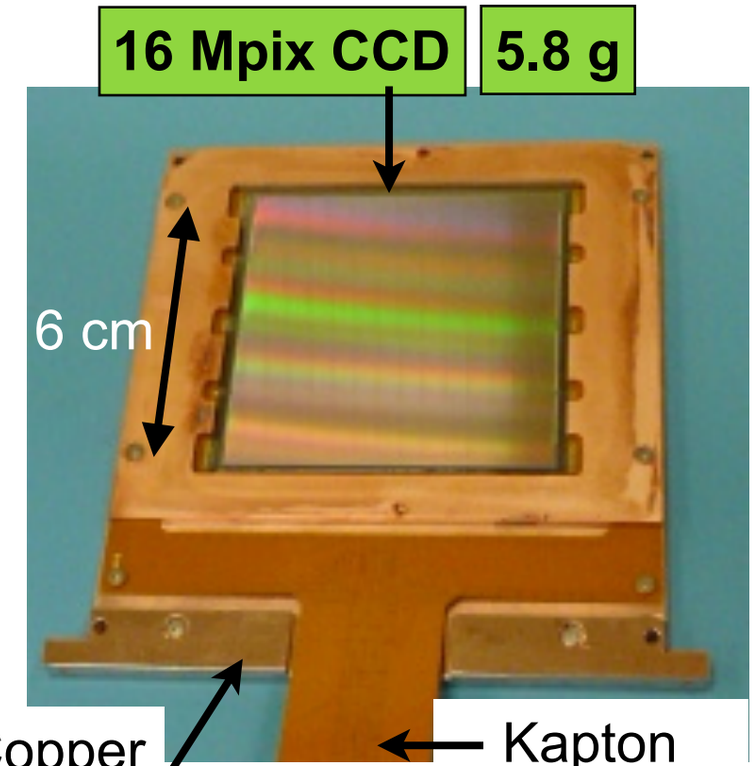
Very low noise and dark current

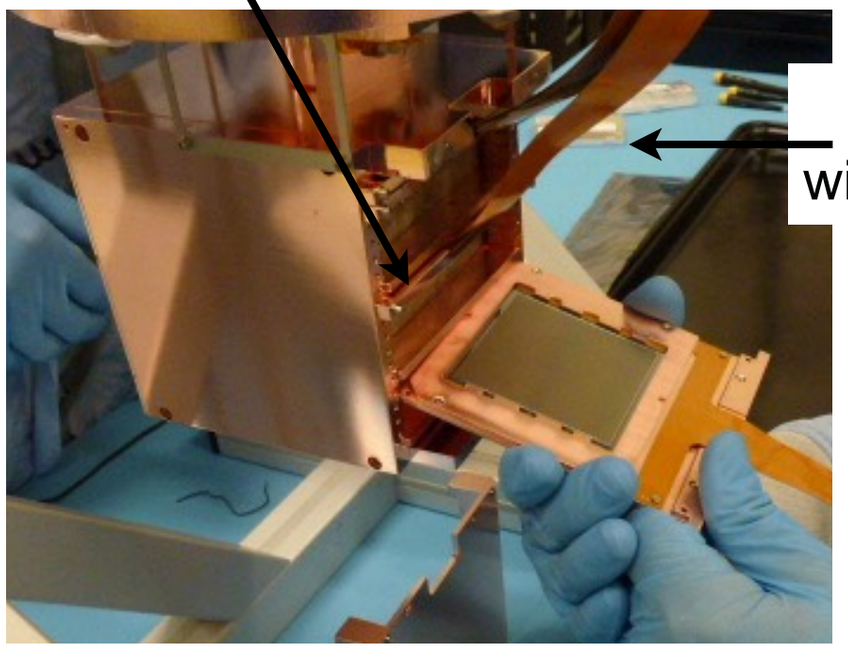
lowest dark current ever measured in a silicon detector:

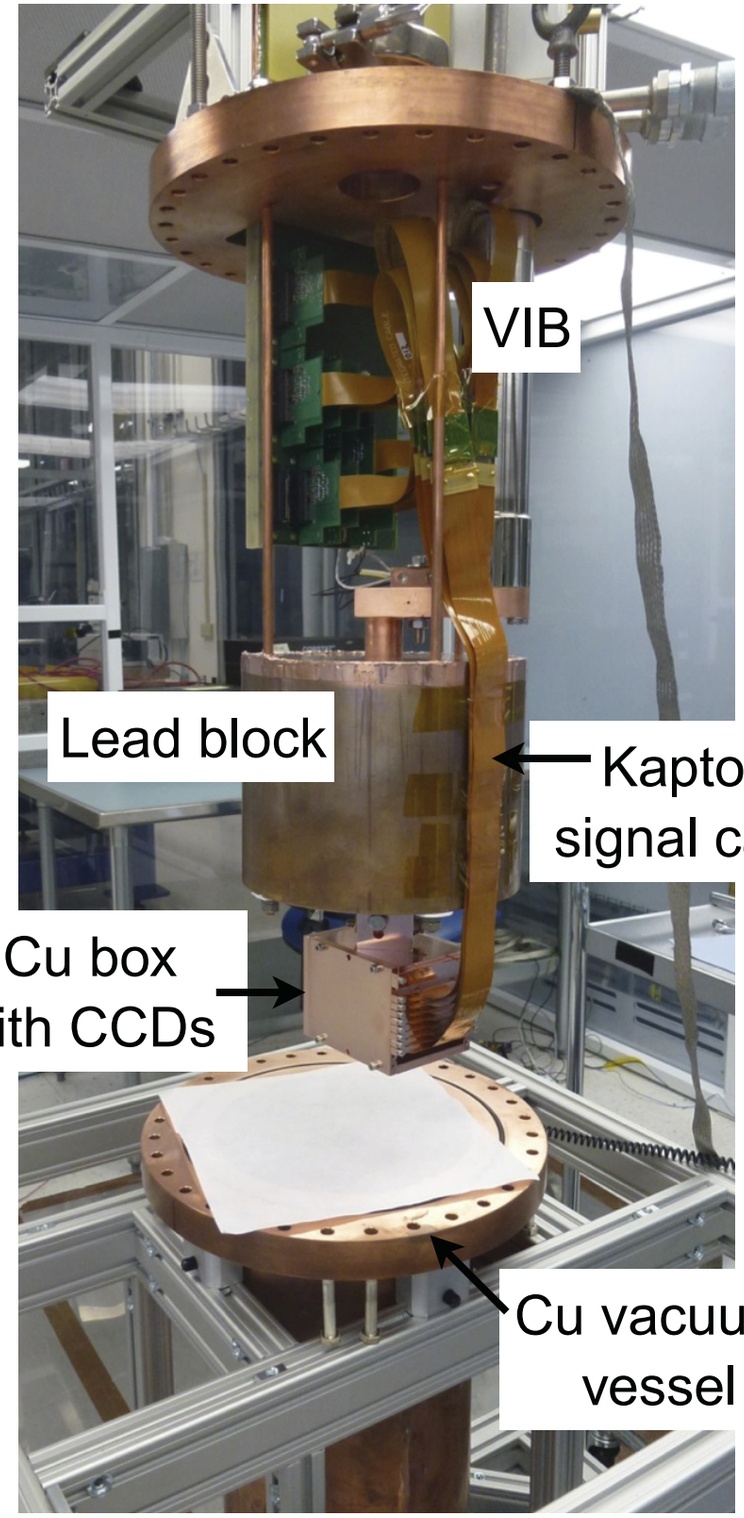
5×10^{-22} A/cm^2 (at 140 K)

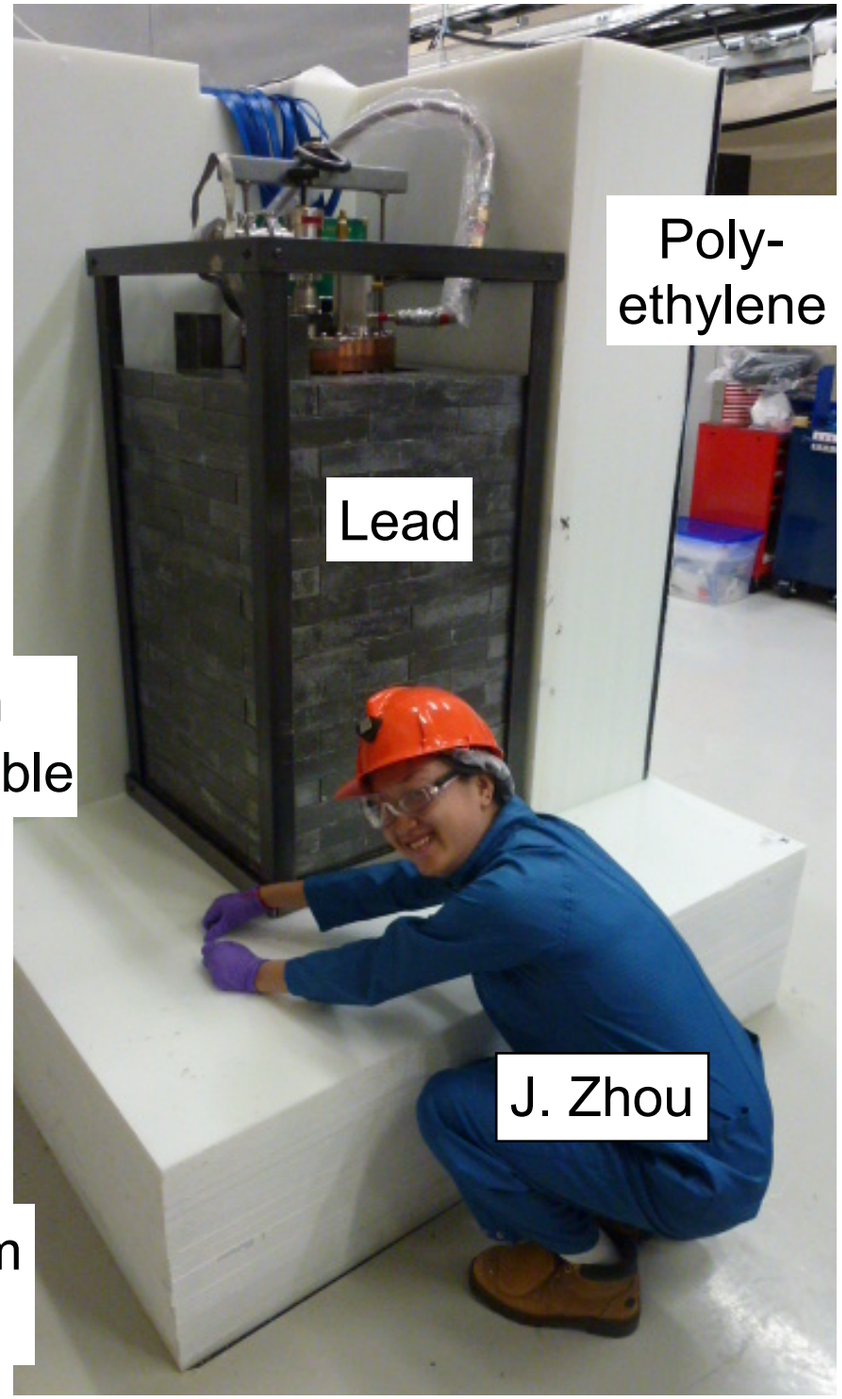
(improved wrt R&D phase where σ = 2 e$^-$ and current = 10^{-21} A/cm^2 at 100 K)

SNOLAB Installation

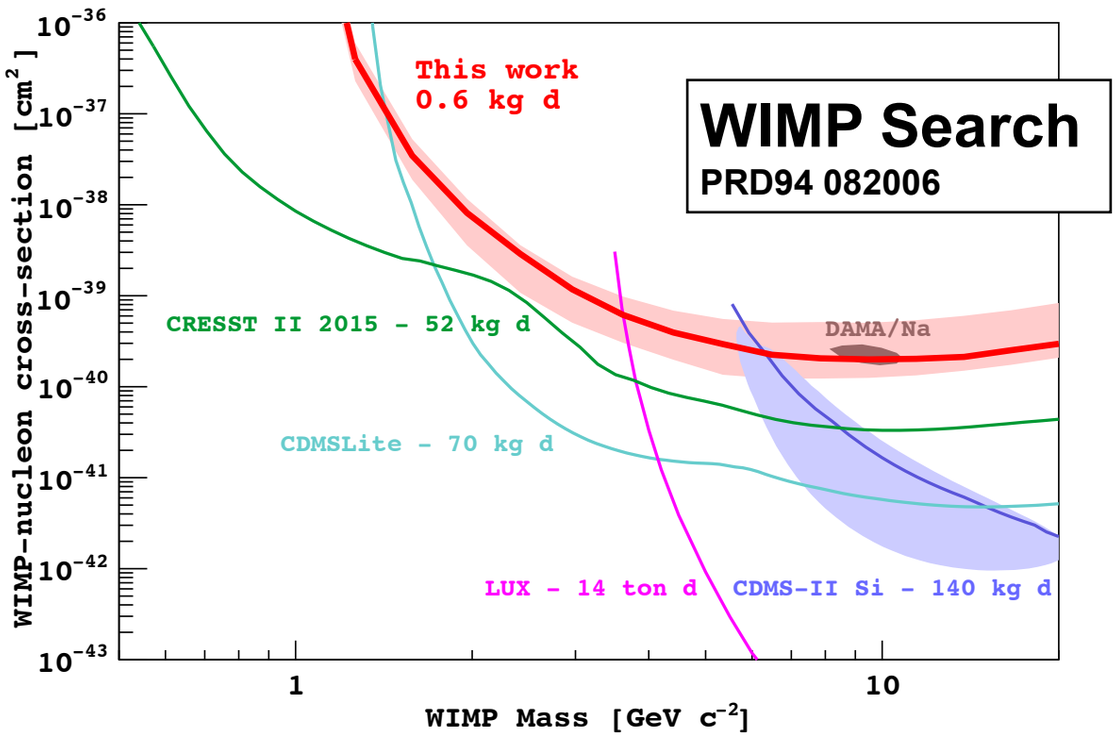


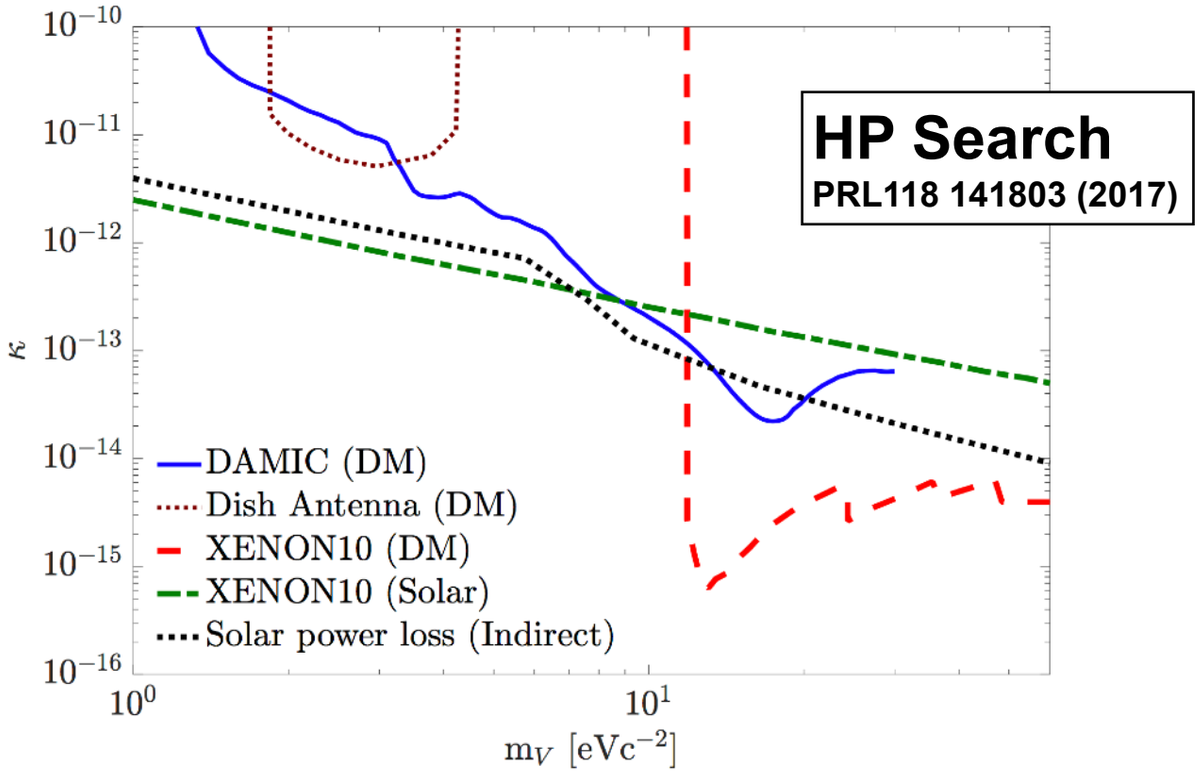


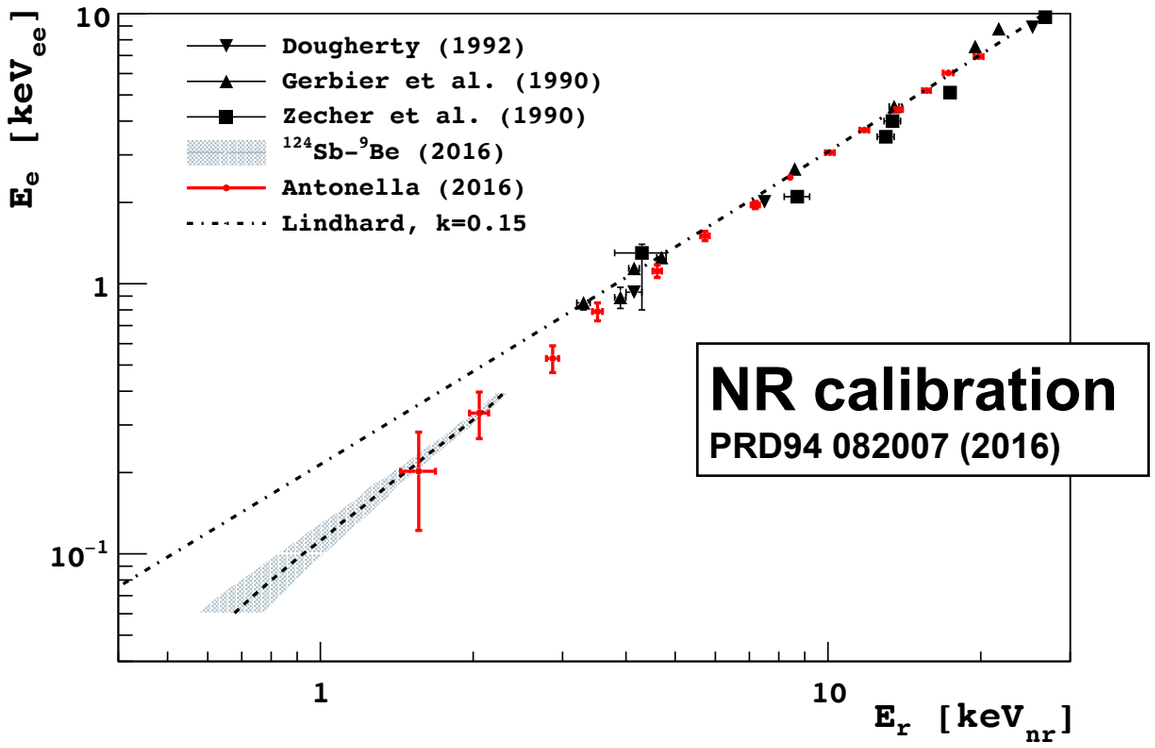


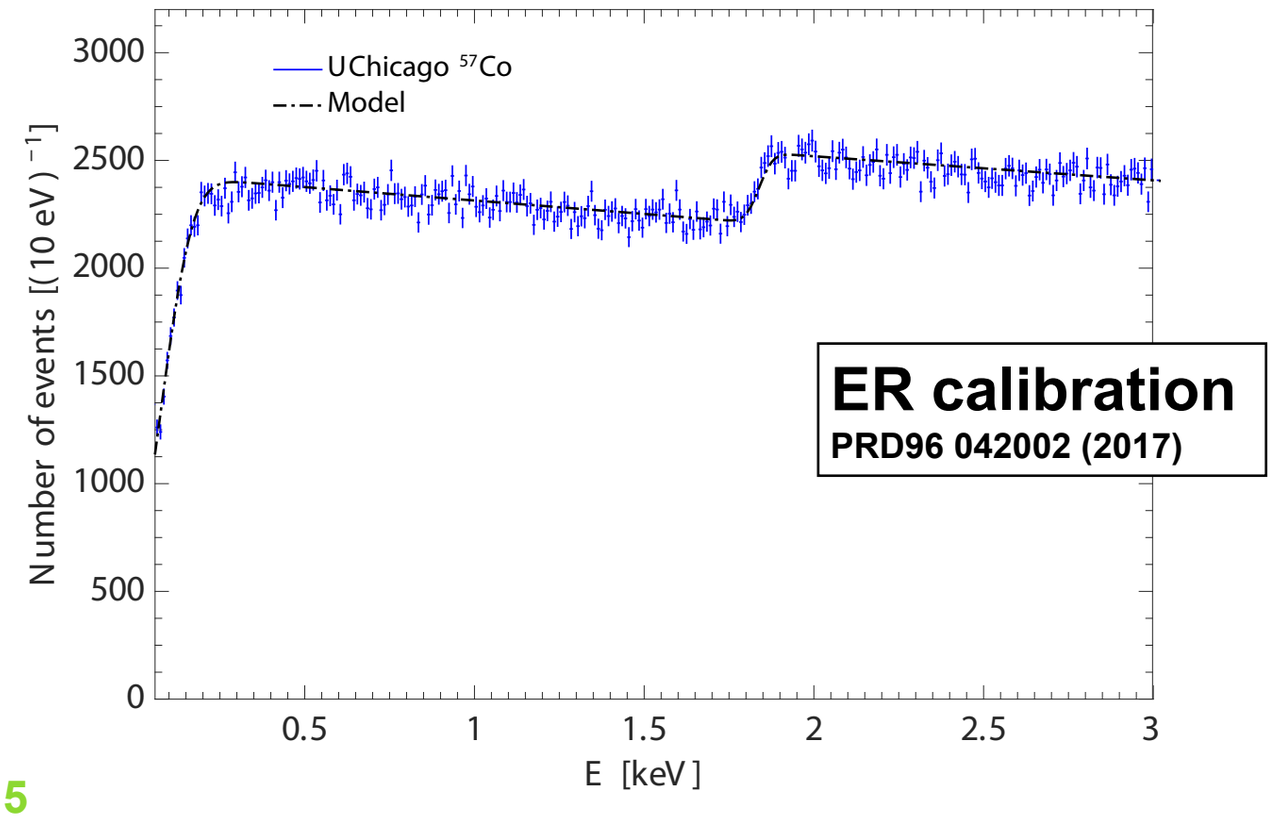


Selected results



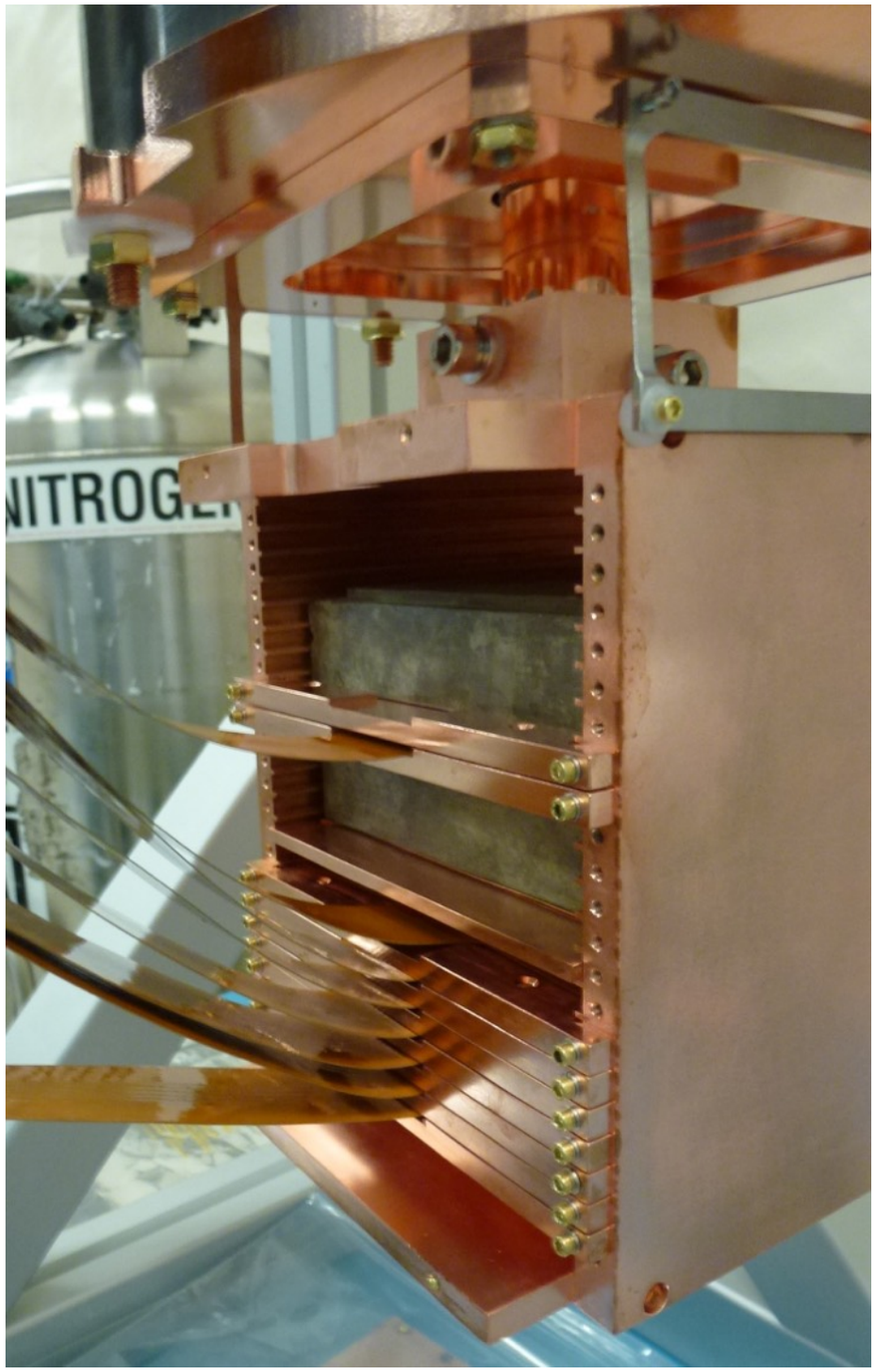






Current status

- **7 CCDs** in stable data taking since 2017 (1 CCD sandwiched in ancient lead).
- **40 g detector mass .**
- **Operating temperature of 140K.**
- **Exposure for image : 8h and 24h** (each image acquisition is followed by a “blank” exposure).
- **7.6 kg day of data for background characterization.**
- So far, **4.6 kg day of data collected for DM search in 1x100 format.**

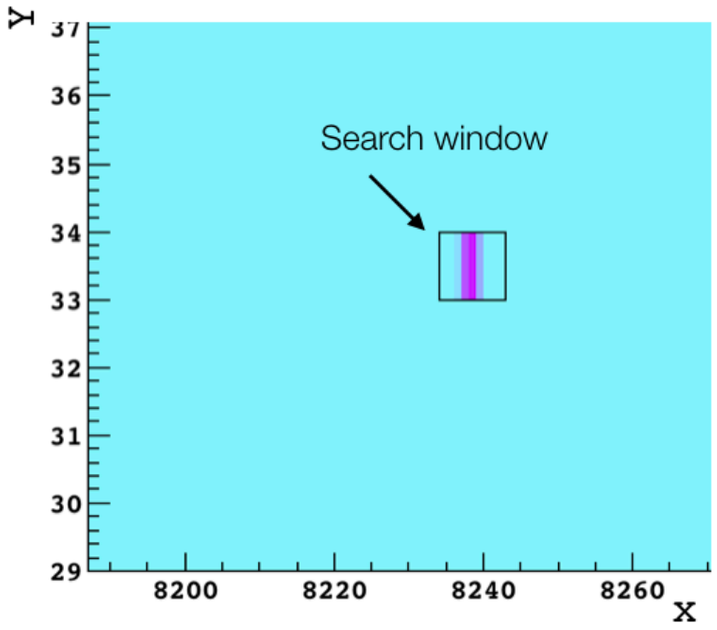


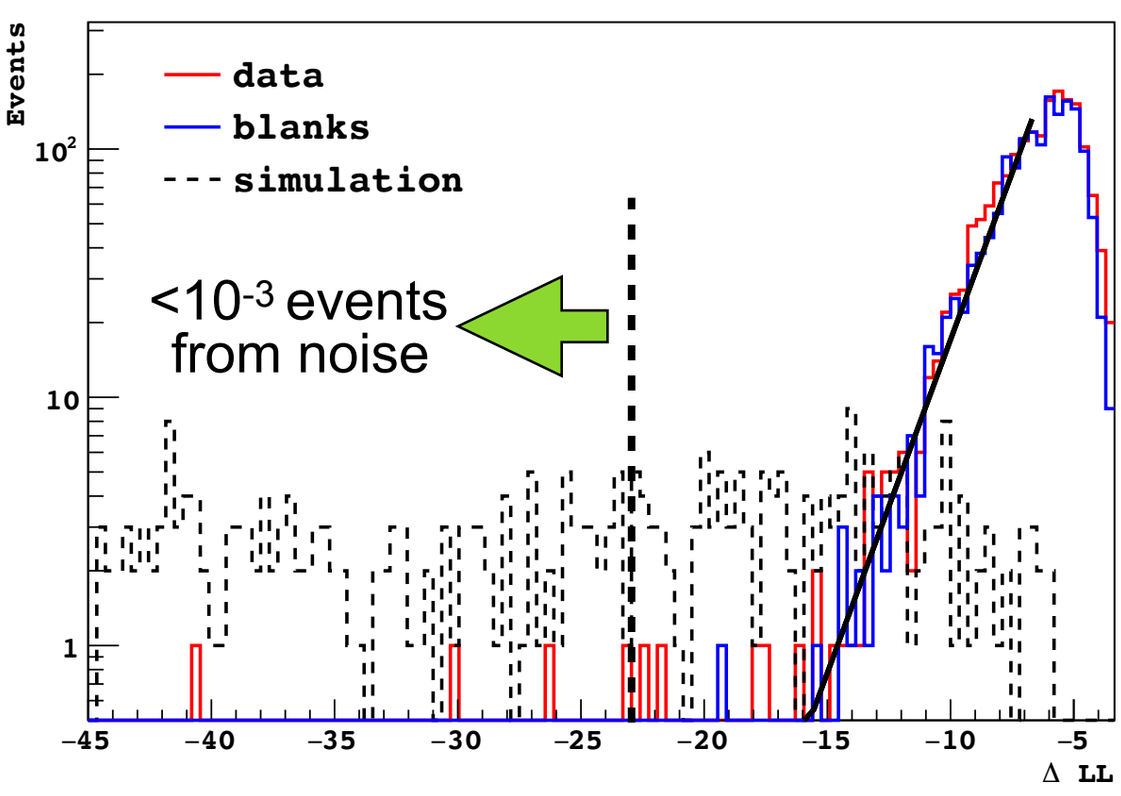
Event selection

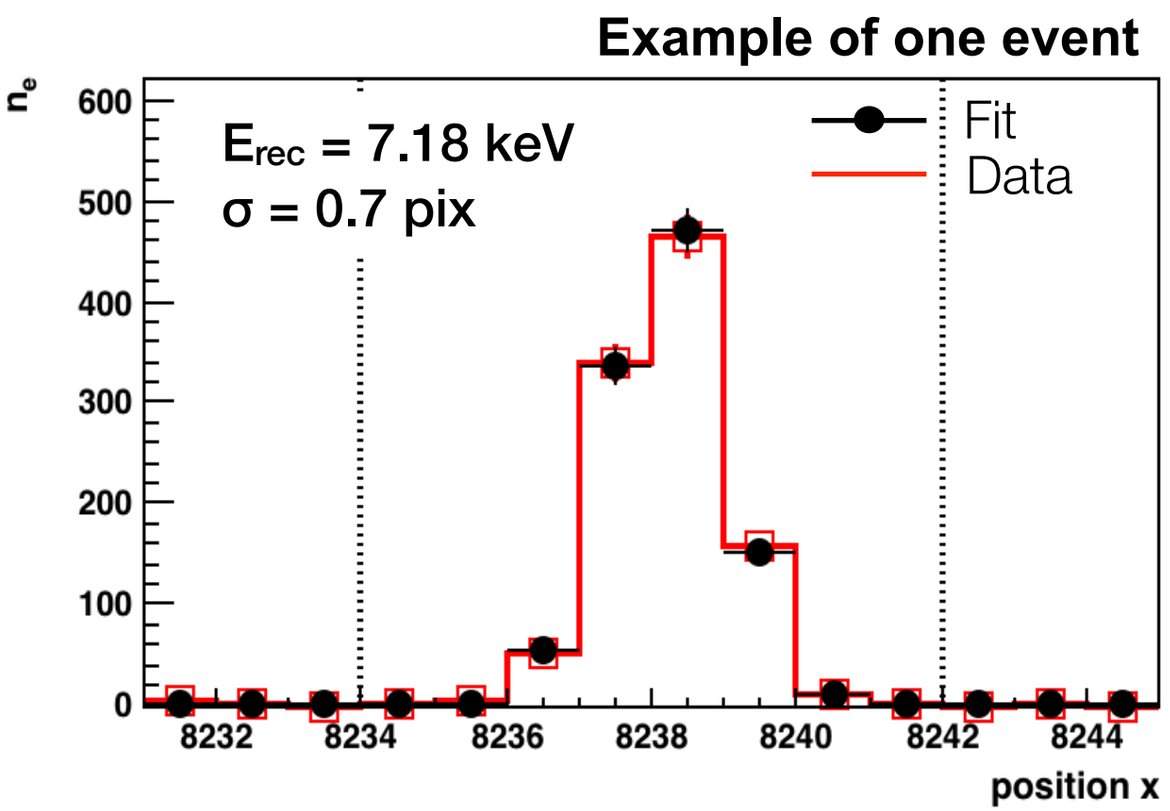
- Pedestal and correlated noise subtraction (hot pixels among several images masked)
- LL fit of the signal in a moving window across the image

$$\Delta LL = \mathscr{L}_n - \mathscr{L}_s$$

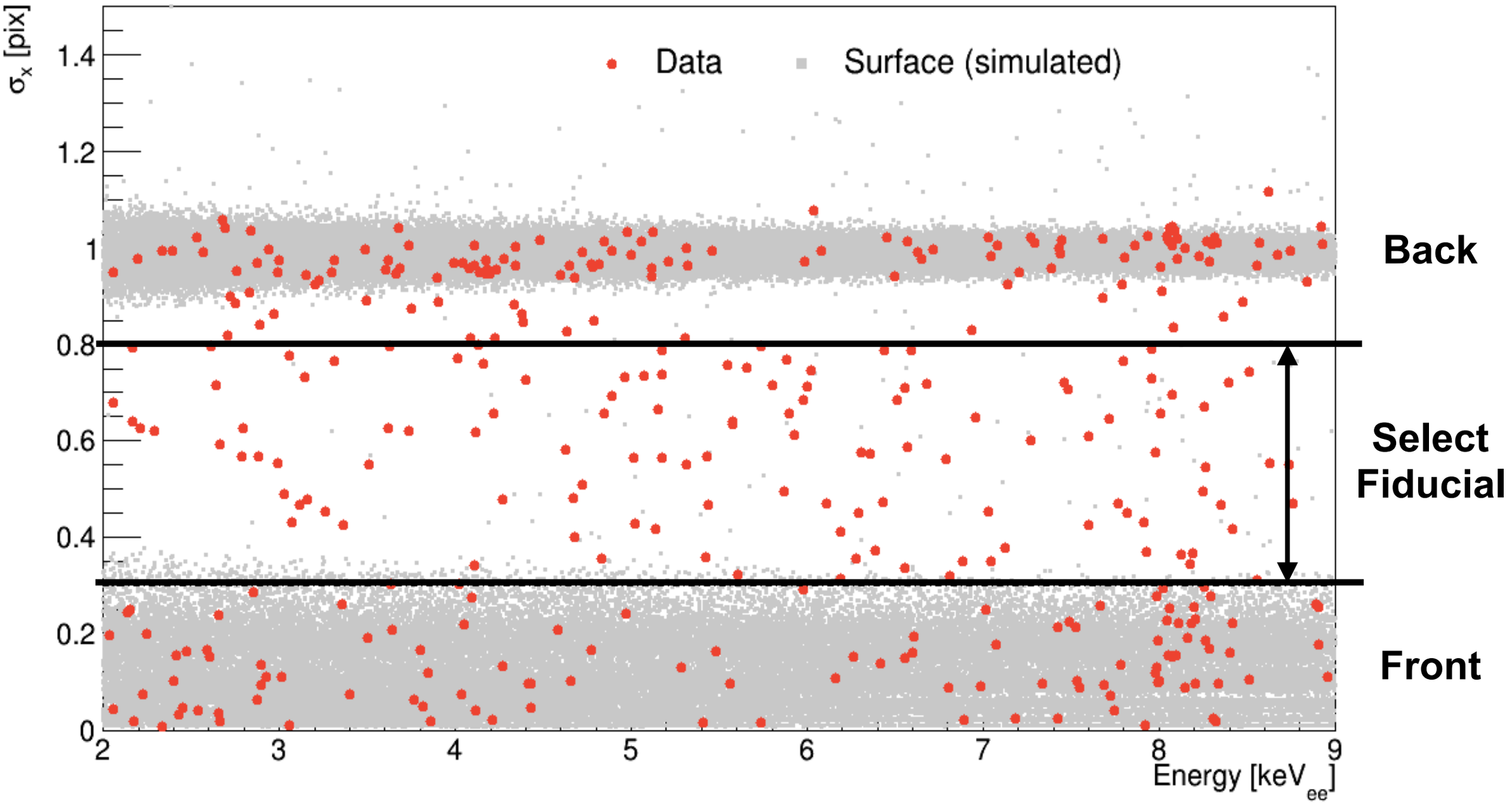
flat noise — Gauss signal + flat noise



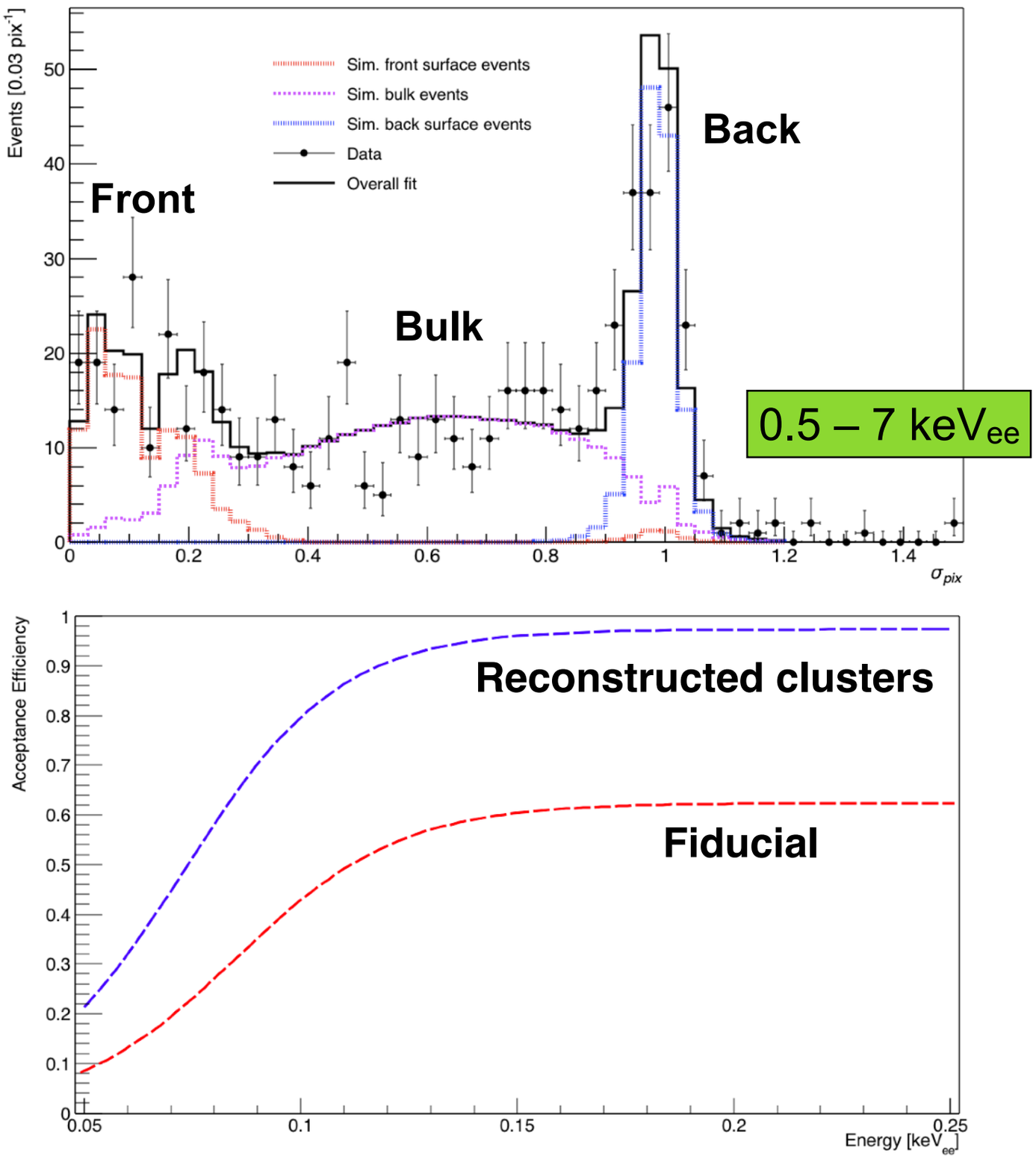




Surface background



Acceptance

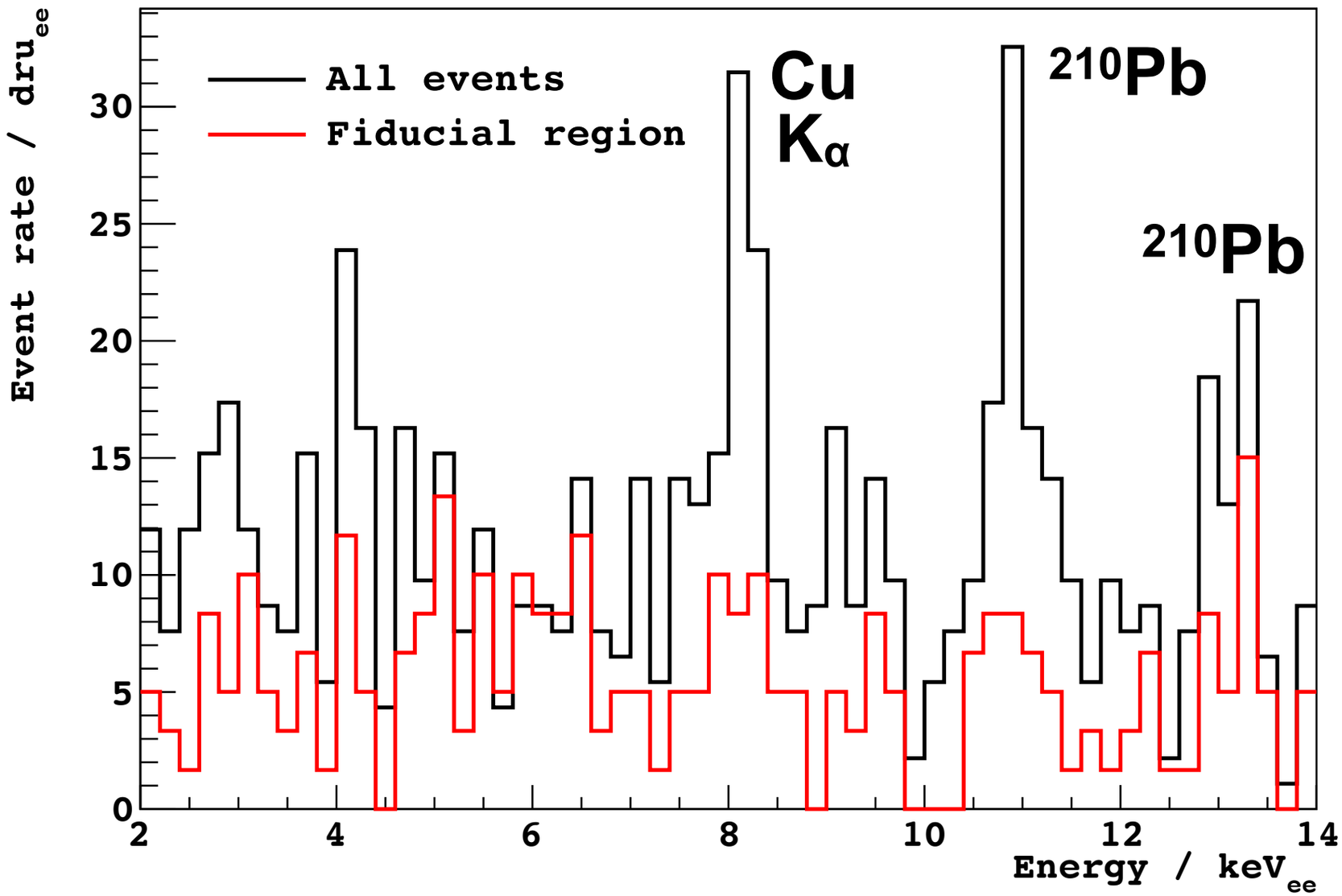


Background + signal model from simulations.

Acceptance for bulk events.

Energy threshold : 50 eV$_{ee}$

Energy spectrum



≃**5 dru** in fiducial region, consistent between CCDs

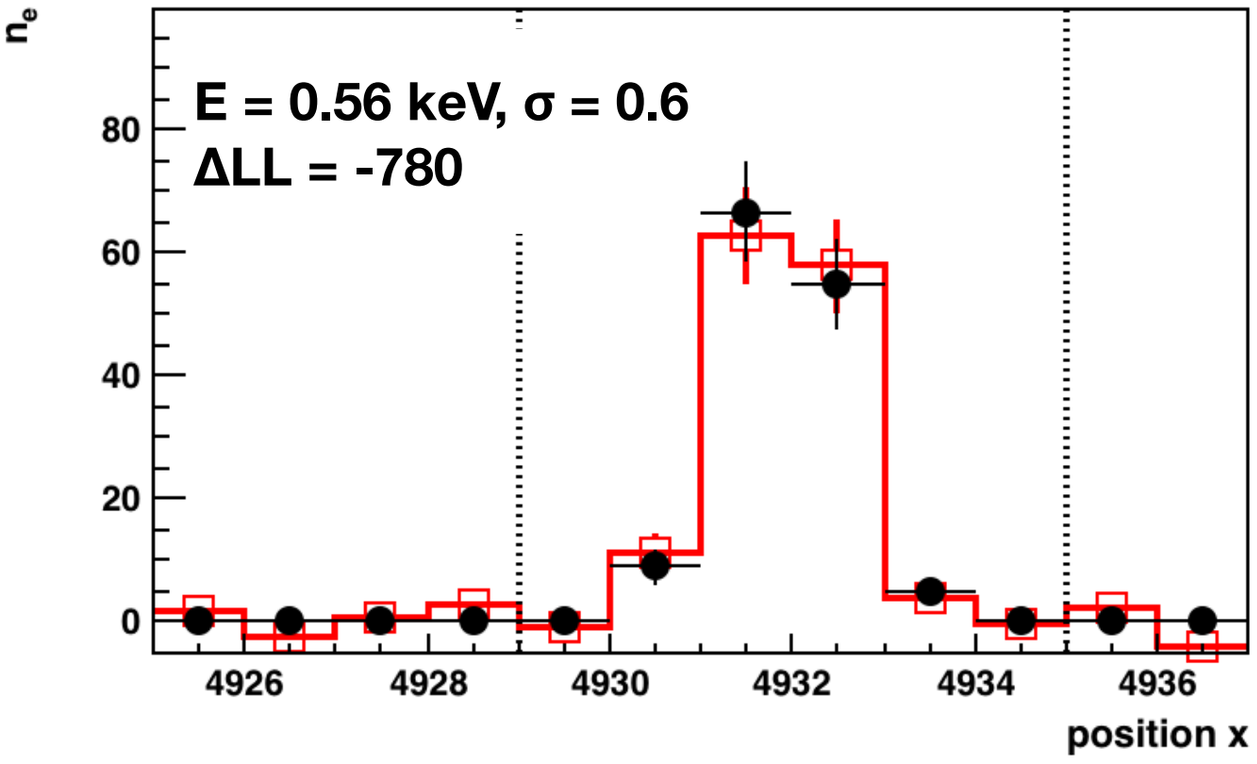
a factor of ≃ 3-4 lower than our previous background level

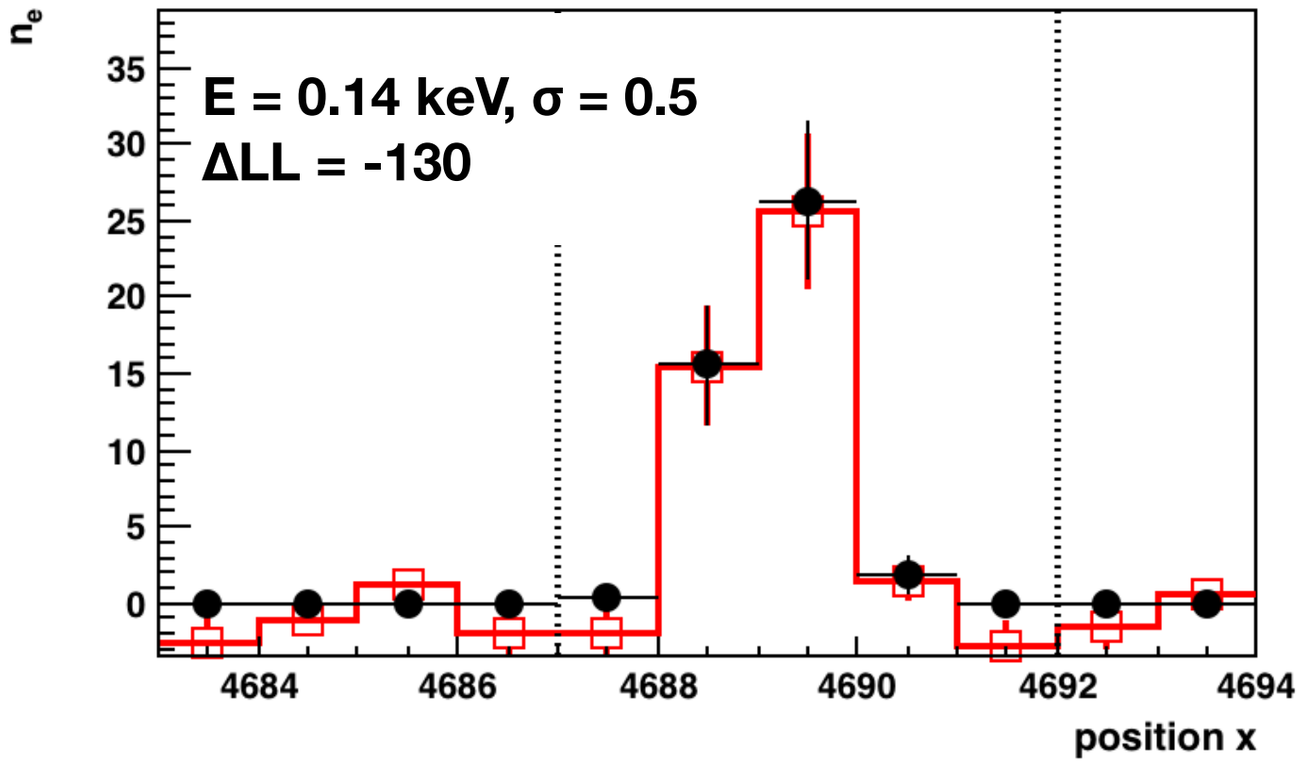
≃**2 dru** for lead sandwiched CCD

Low energy data

- We are analyzing the data from 50 eV to 2 keV, which provide most sensitivity to low mass WIMPs. Some examples of candidates.

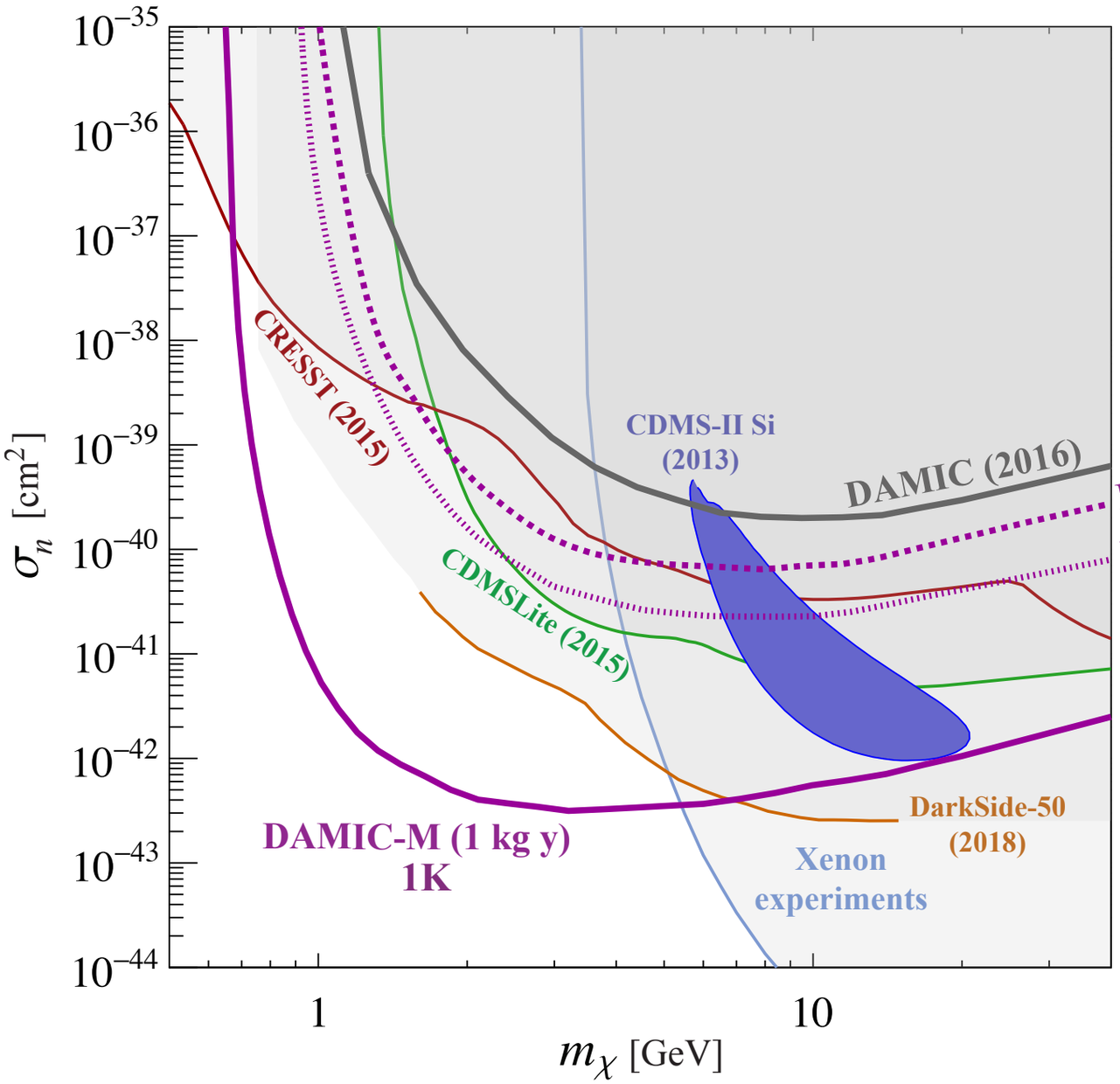
Two example events (data + fit)





- **<u>NOTE</u>**: CDMS II silicon potential signal obtained with a 7 keV_{nr} threshold (≈2 keV_{ee}).
  We are exploring for the first time the silicon target with a much lower threshold of 0.6 keV_{nr} (≈ 0.05 keV_{ee})
  Our results will be relevant for SuperCDMS Si and DAMIC-M.

Sensitivity



Current exposure (03/2018) and bkg (5 keV$_{ee}$/kg/d)

Exposure by end 2018

Background studies

- **Cosmogenic ^{32}Si**

Search for spatially correlated beta decays.
Sensitivity with current data is few Bq/kg.

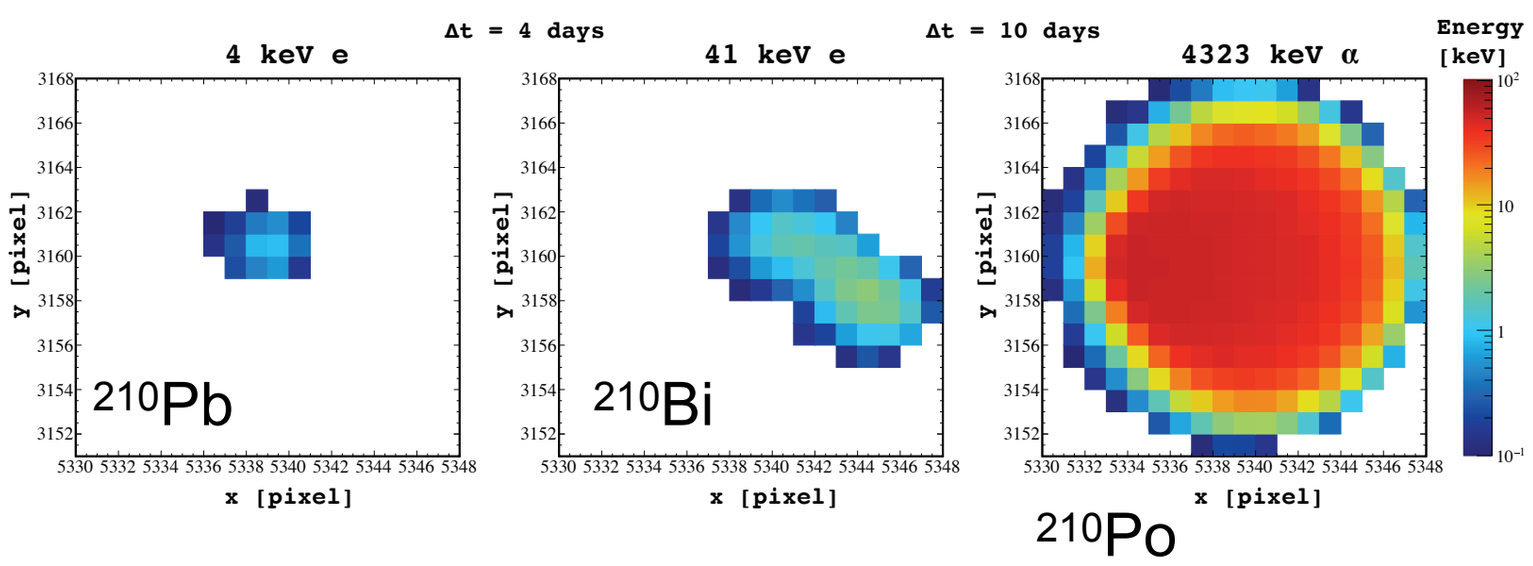
Previous results: **JINST 10 P08014 (2015)**

^{32}Si ($T_{1/2}$= 150 y, β) ➔ ^{32}P ($T_{1/2}$= 14 days, β)

candidate ^{32}Si – ^{32}P in new data

- **Bulk and surface bckd.**

ppt levels sensitivity to bulk contamination

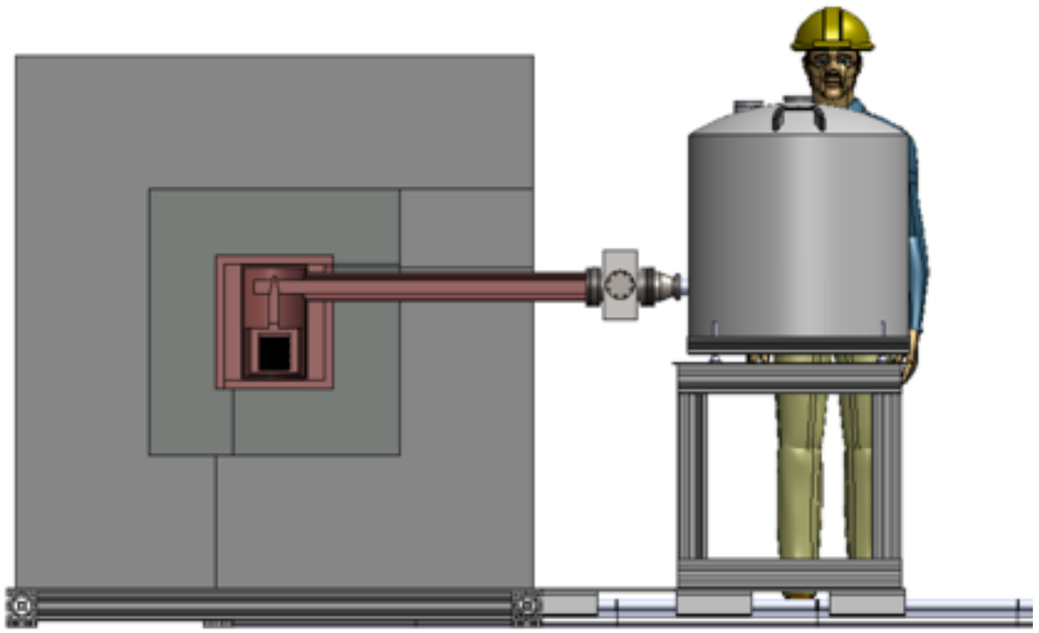


- **Cosmogenic tritium sensitivity**

Sensitivity to activation rate down to few tens of tritium atoms/kg/day.

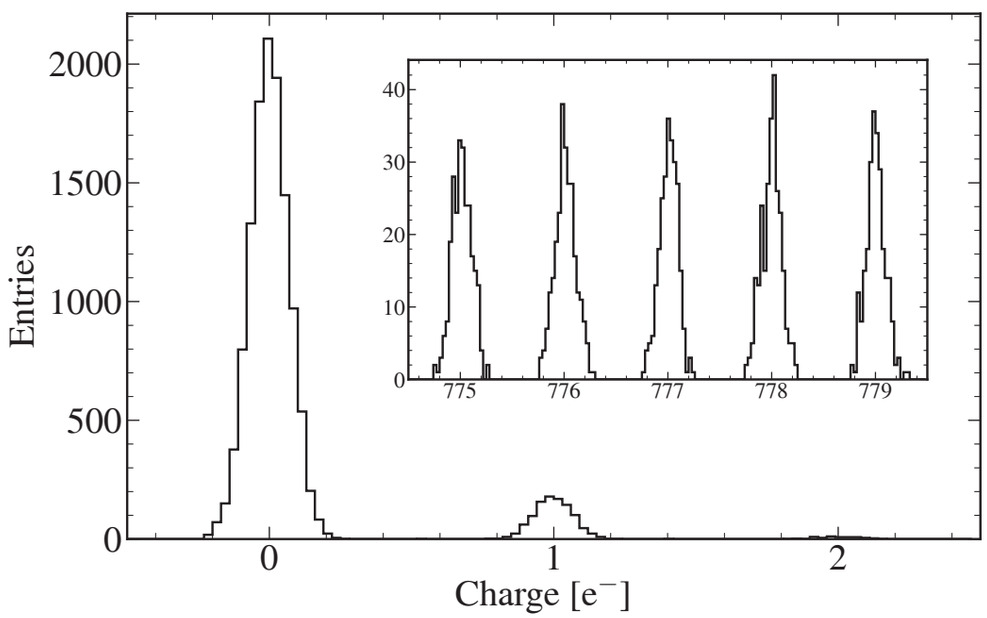
Also direct measurement at LANSCE.

DAMIC-M (1K)

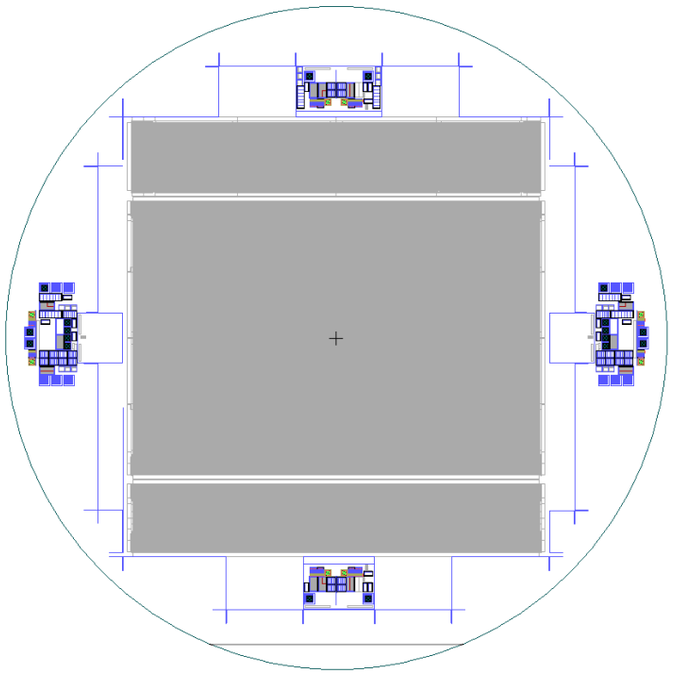


- Most massive CCDs ever built **(6k x 6k x 1mm, mass 20 g).**
- Skipper readout for **sub-eV noise.**
- **Bkg reduction to a fraction of dru** (improved design, materials, procedures).

SENSEI R&D at FNAL (1 g)
PRL119 131802 (2017)



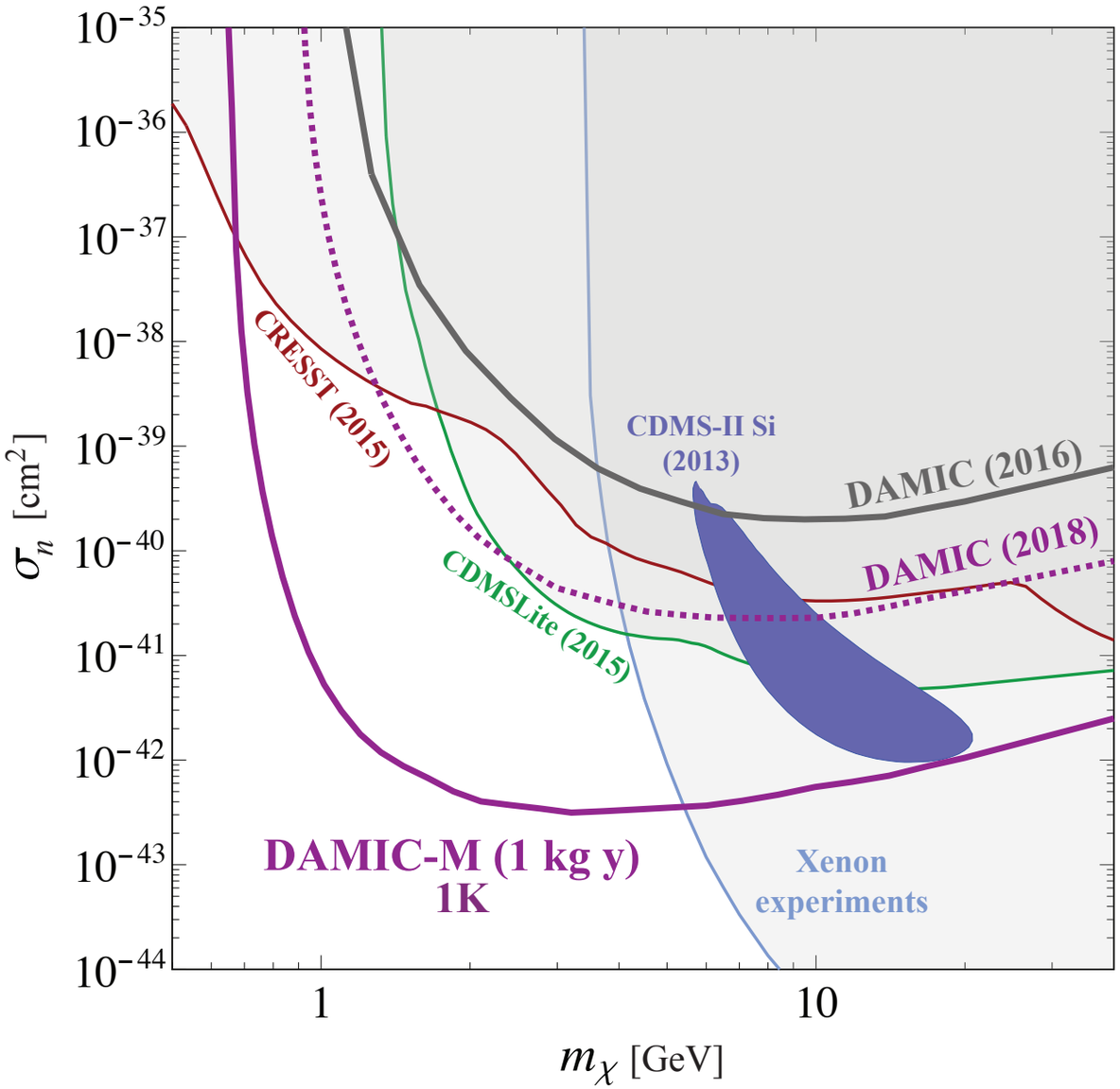
Large size Skipper CCDs (6k x 4k) for DAMIC-M development (**10 g**!) will arrive at UW in Summer 2018.



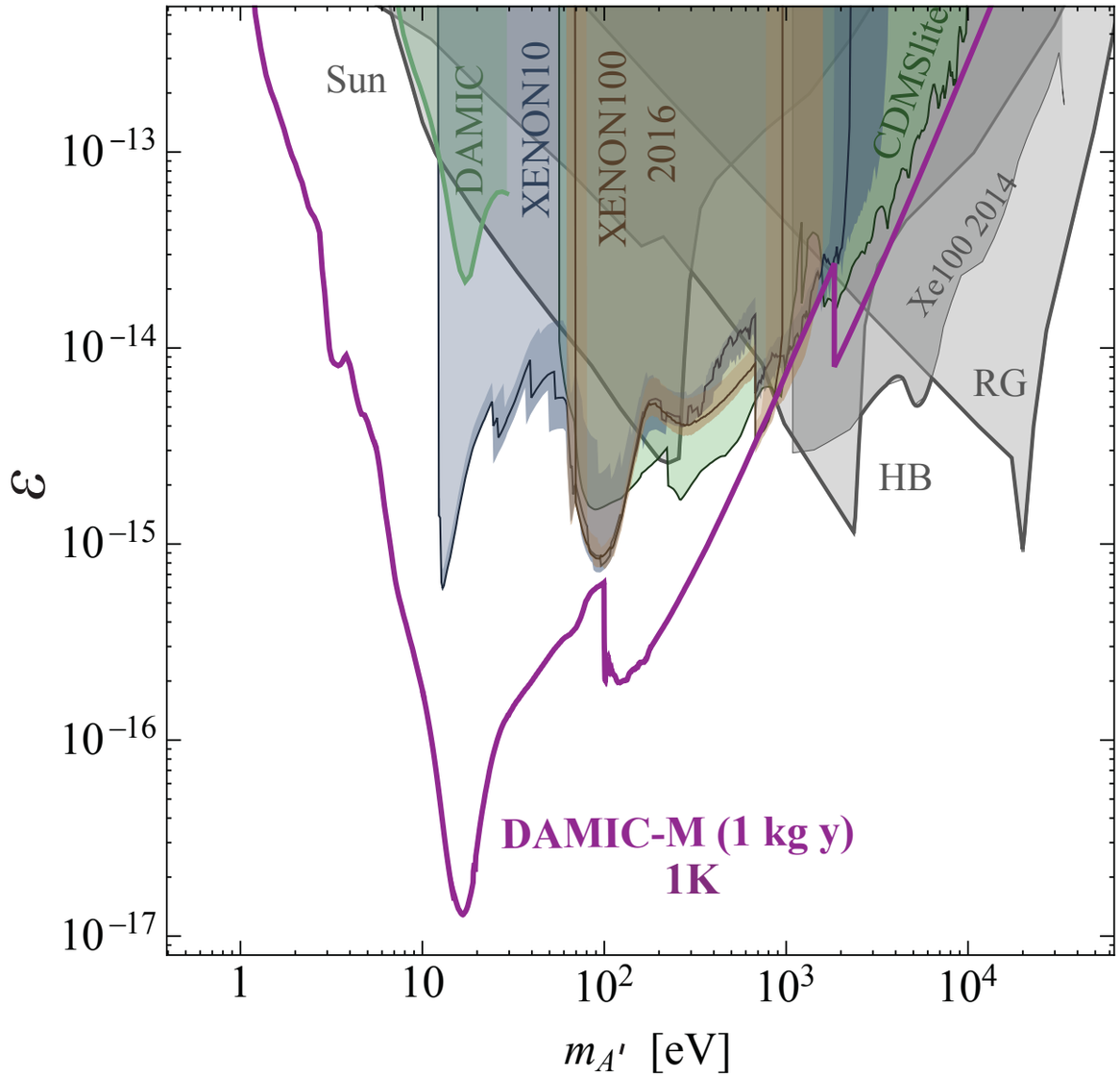
Wafer-layout by S. Holland (LNBL)

Forecast I

WIMP nuclear recoil search



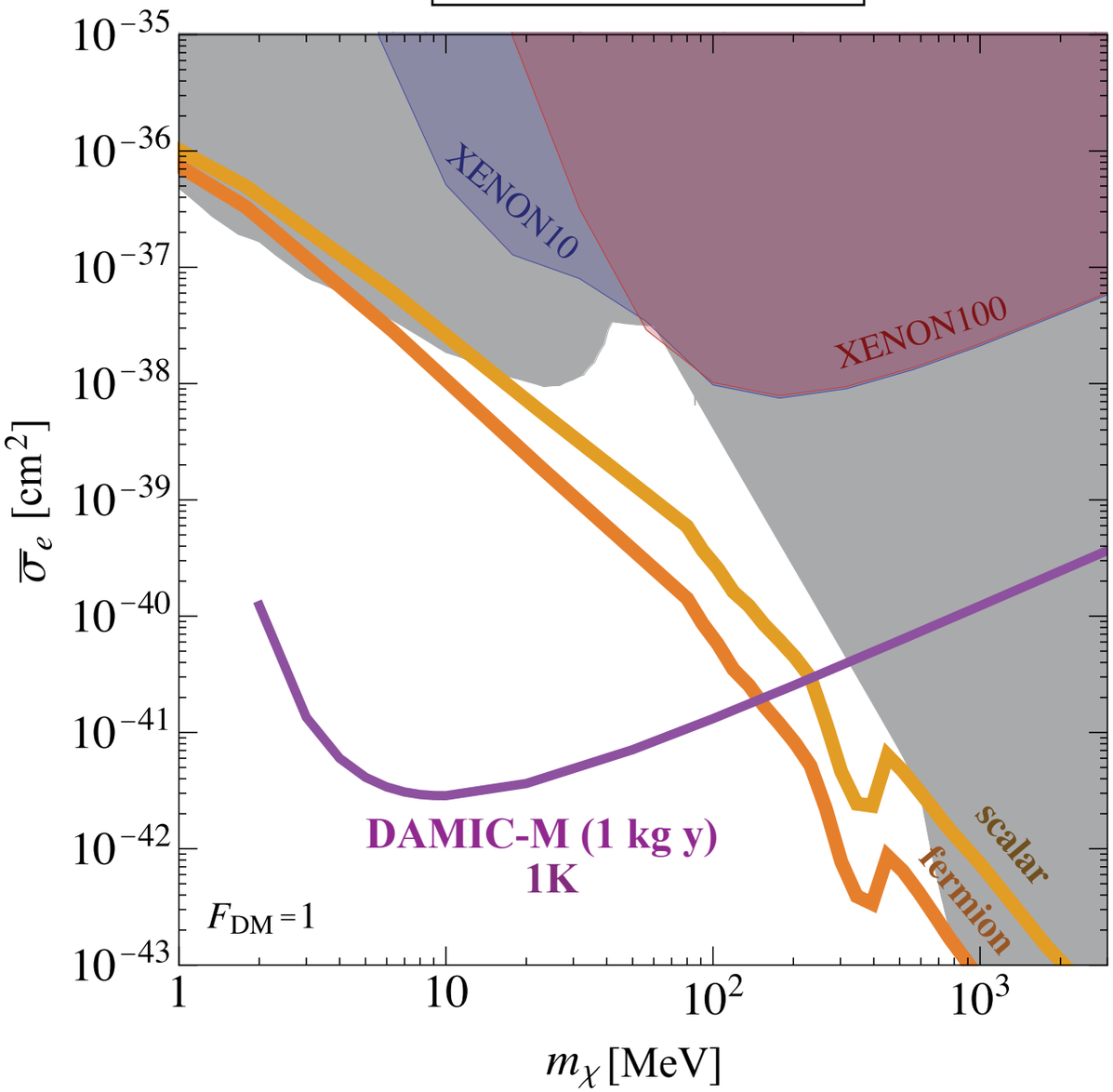
Hidden photon search



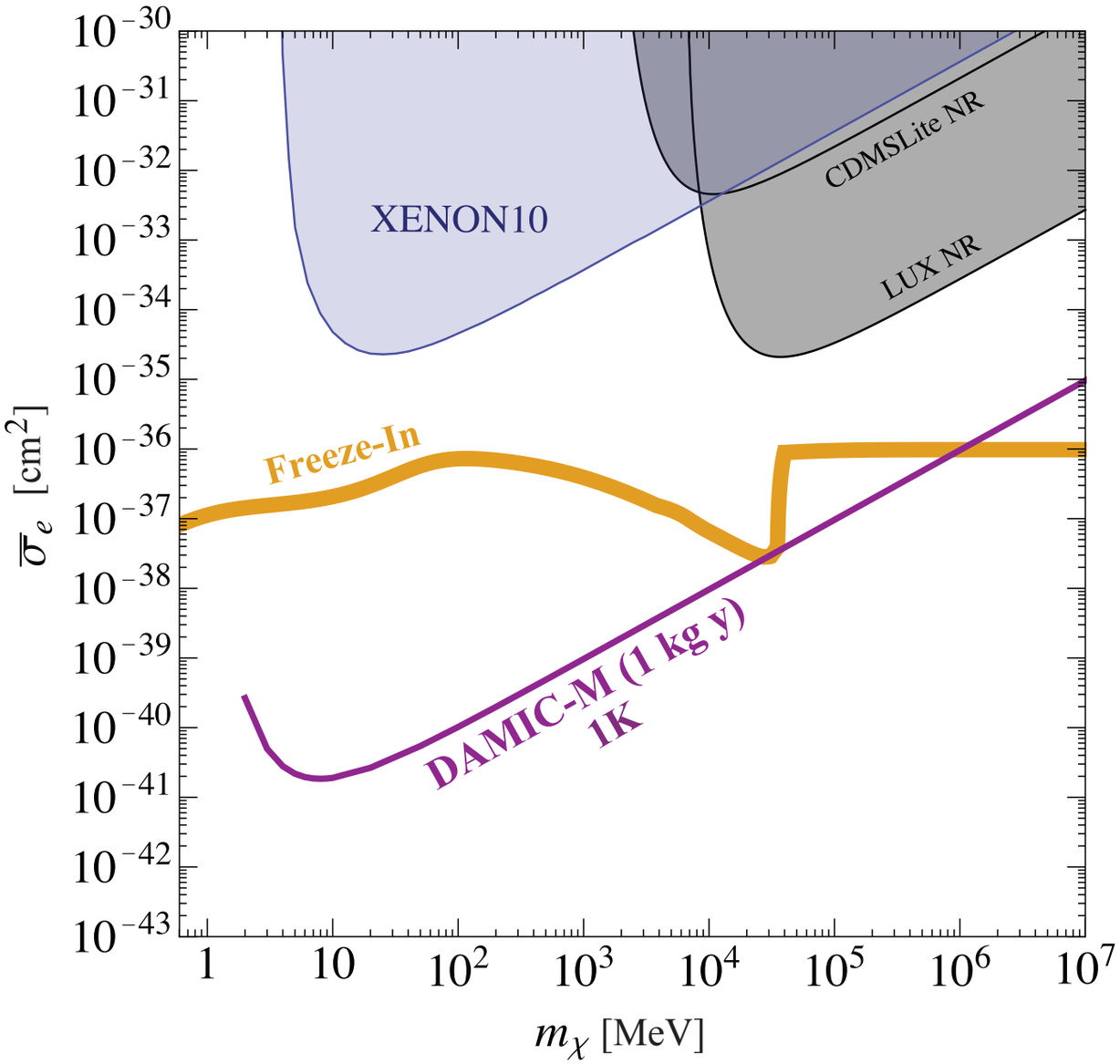
Forecast II

Light dark matter - electron scattering

Heavy mediator



Light mediator



Outlook

DAMIC operating with 40g detector since 2017.
Collected exposure:
– 4.6 kg d so far, ~ 13kg day by the end of 2018

High quality data:
- 50 eV threshold
- Low noise (dominated by readout)
- Few dru background

These data will provide essential information for the next generation of silicon detectors (DAMIC-M, SuperCDMS):
- spectrum below 2 keV
- Cosmogenic and radiogenic background in silicon
- CCD dark current at lowest temperature

Next stage: a kg size DAMIC detector at LSM, in France.
A large skipper CCD will be characterized this year (SNOLAB setup continuing running).

Thank you!