






# Low mass WIMP searches with EDELWEISS III: first results

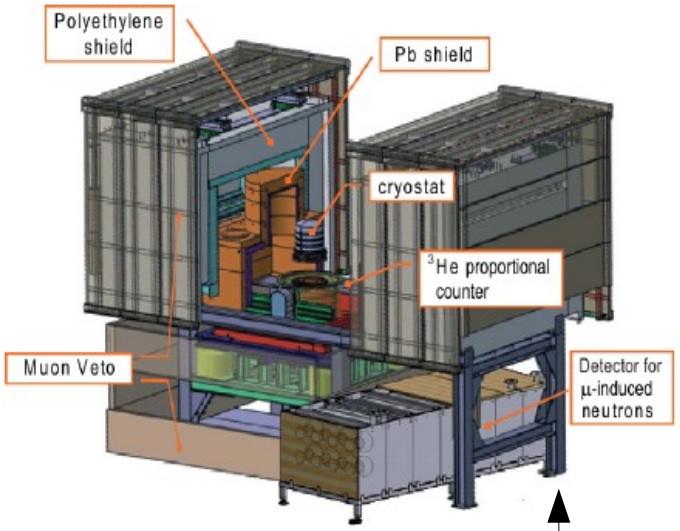
Thibault de Boissière


# Part I

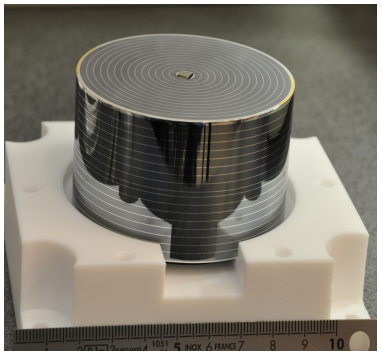
# The EDELWEISS-III experiment

# The EDELWEISS-III experiment

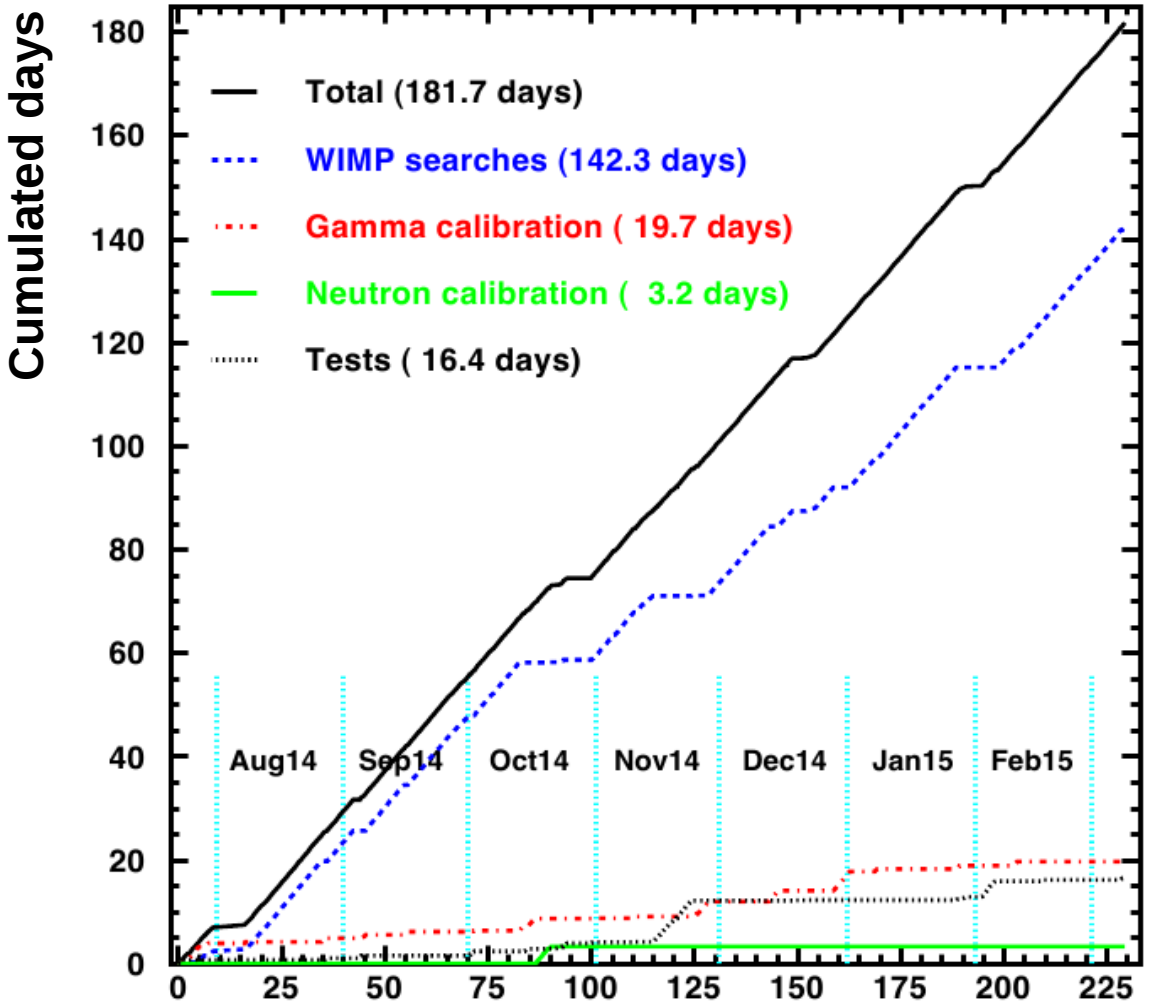
## Setup and status




Setup

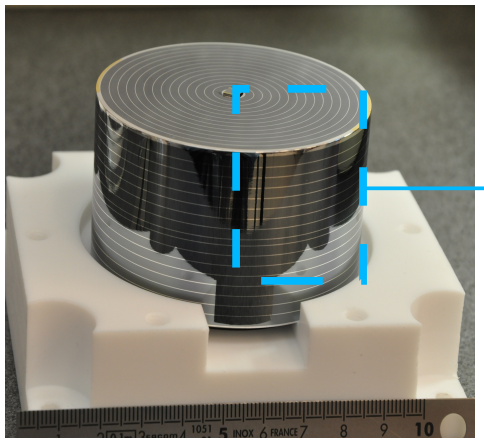


Germanium bolometer

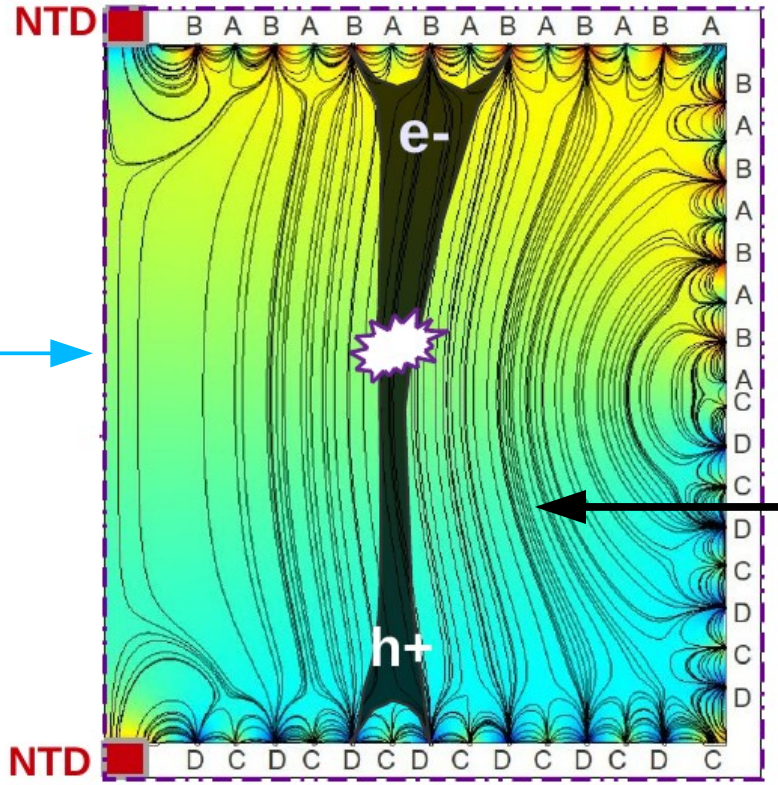



**24 detectors running**
**Physics data since summer 2014**
**Expect 3000 kg.d for Summer 2015**

# The EDELWEISS-III experiment:
## Detector scheme



800 g detector
600 g fiducial mass



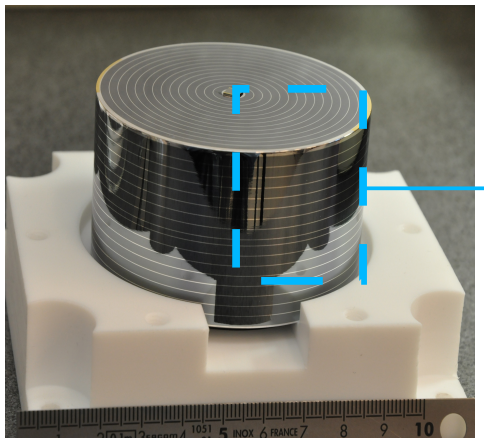

**4 ionisation channels:**
A,B,C,D (interleaved electrodes)

**2 heat channels:**
Thermal photon measurement with NTD

**Electric field lines**

**Bulk (fiducial) event:** charge is collected in B and D

# The EDELWEISS-III experiment:
## Detector scheme



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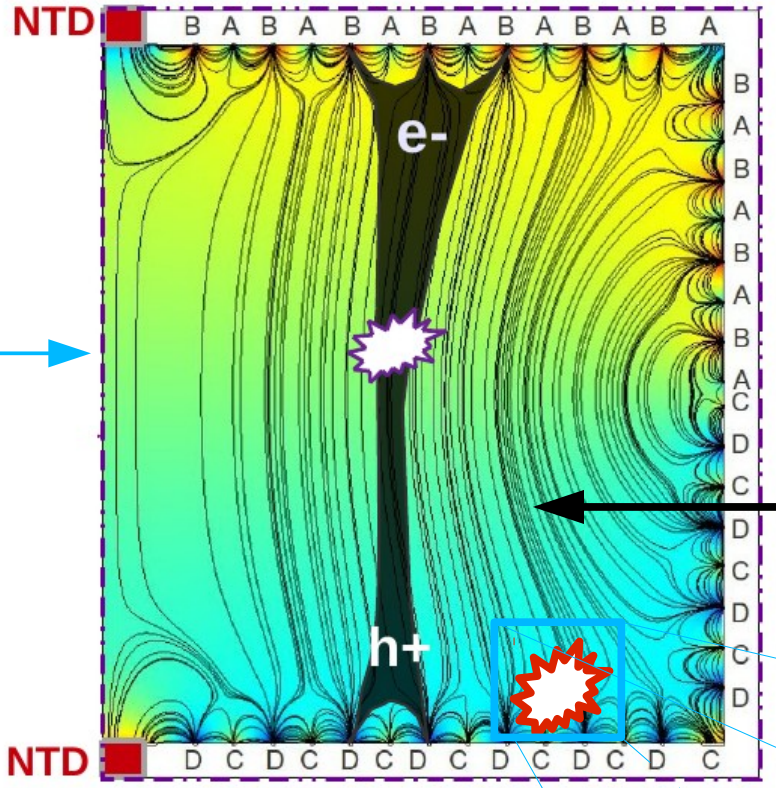
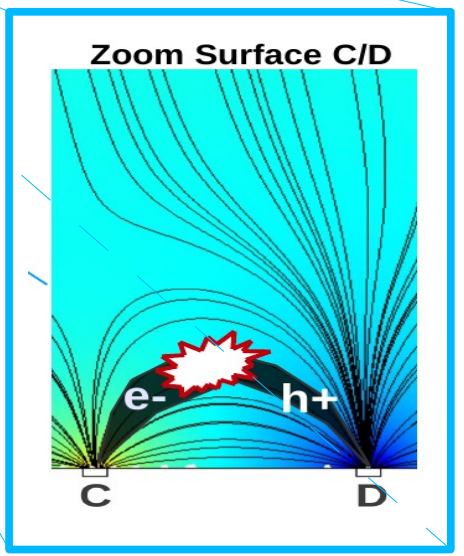



**4 ionisation channels:**
A,B,C,D (interleaved electrodes)

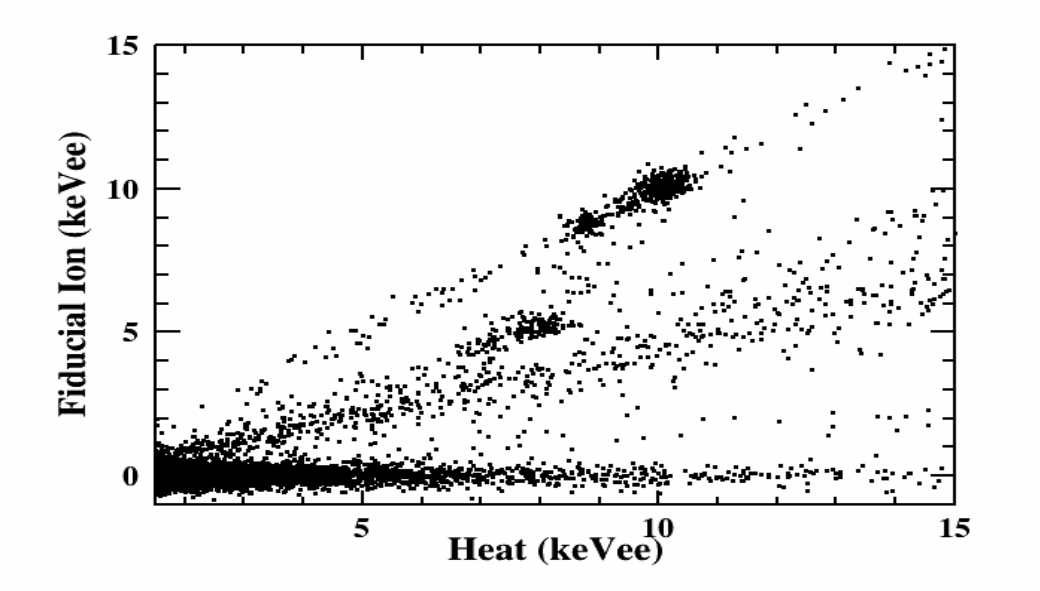
**2 heat channels:**
Thermal photon measurement with NTD

**Electric field lines**

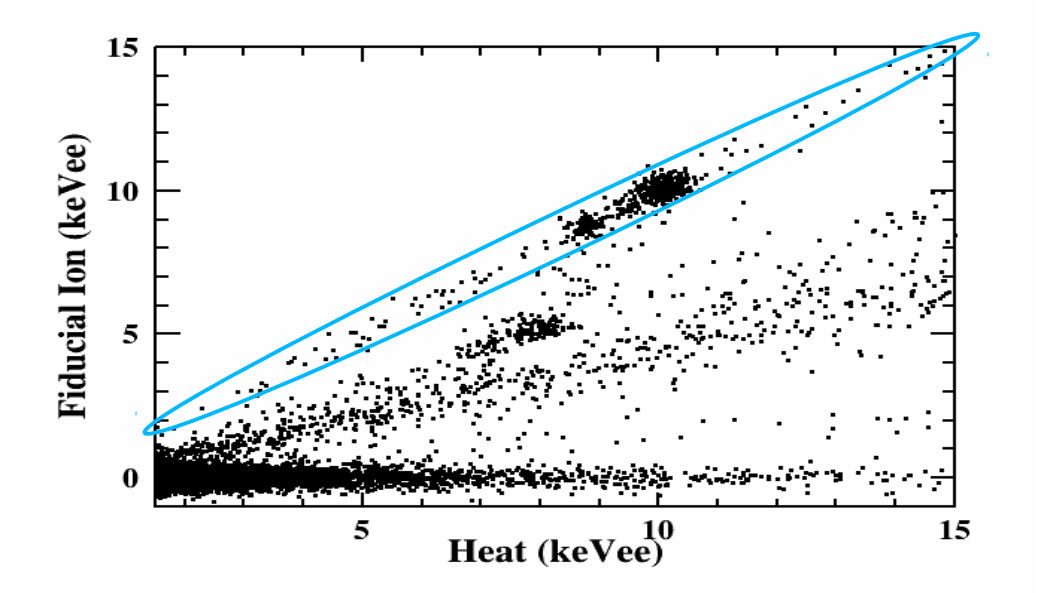



**Bulk (fiducial) event:** charge is collected in B and D
**Surface event:** charge is collected in A and B or C and D

# The EDELWEISS-III experiment:
## Background rejection

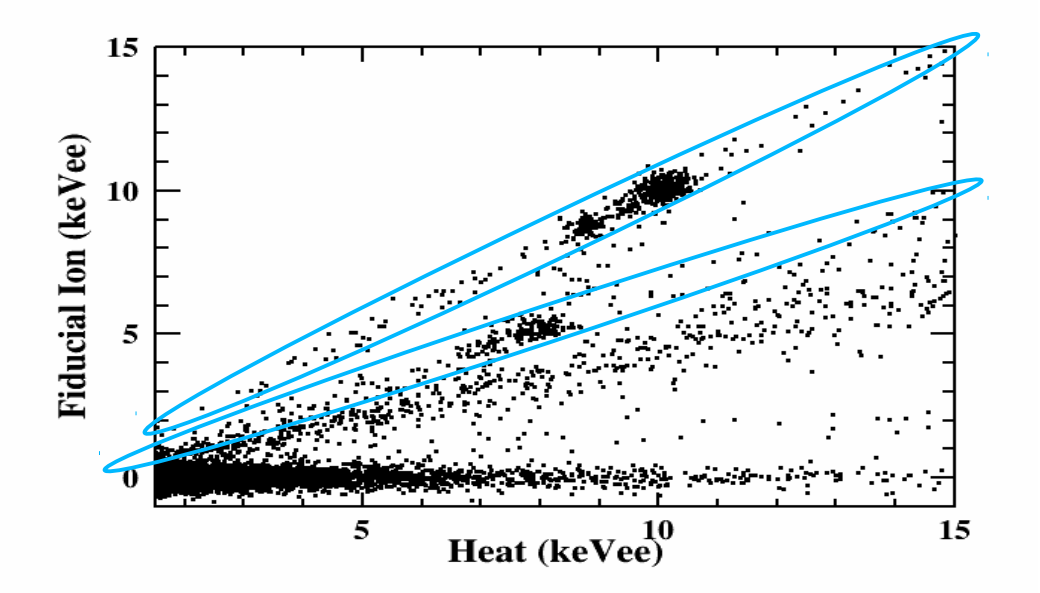


# The EDELWEISS-III experiment:
## Background rejection




**Fiducial gamma**

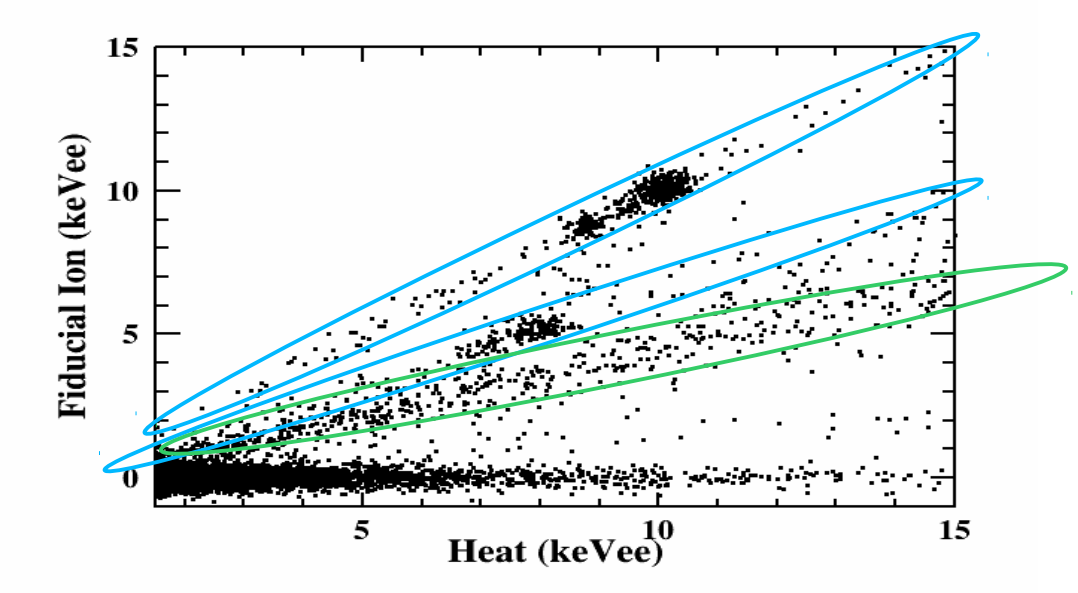
# The EDELWEISS-III experiment:
## Background rejection




**Fiducial gamma**

**Surface Gamma**

# The EDELWEISS-III experiment:
## Background rejection

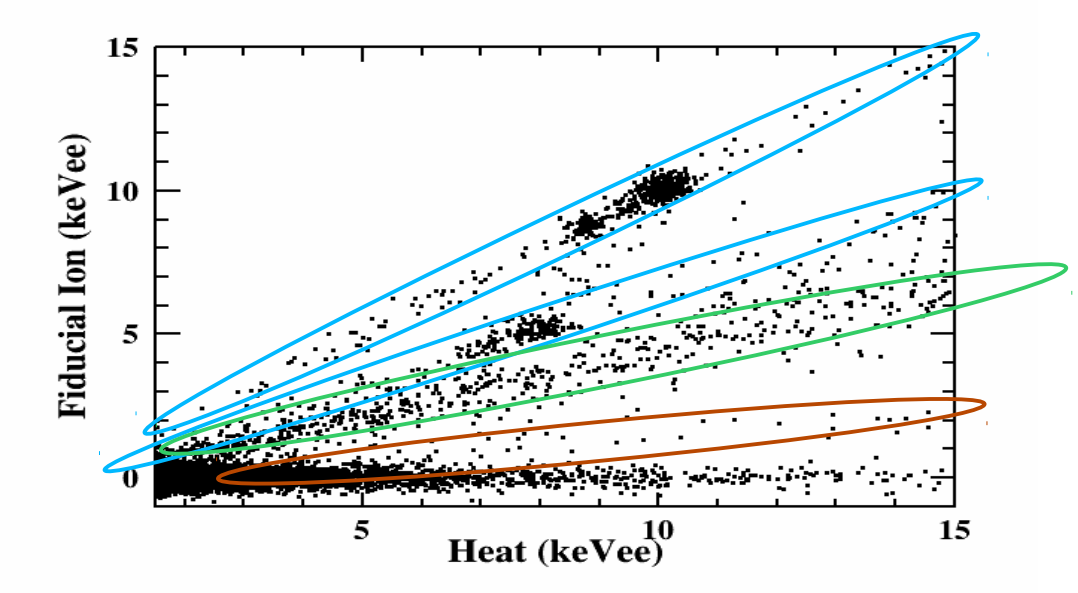



**Fiducial gamma**

**Surface Gamma**

**Surface Beta**

# The EDELWEISS-III experiment:
## Background rejection



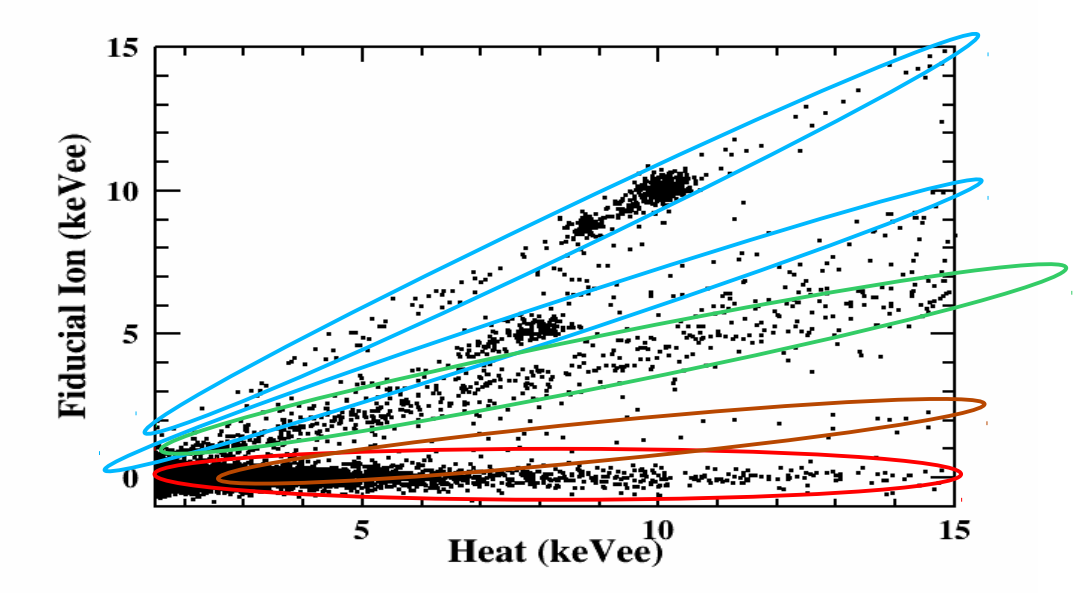

**Fiducial gamma**

**Surface Gamma**

**Surface Beta**

**Surface Lead**

# The EDELWEISS-III experiment:
## Background rejection




**Fiducial gamma**

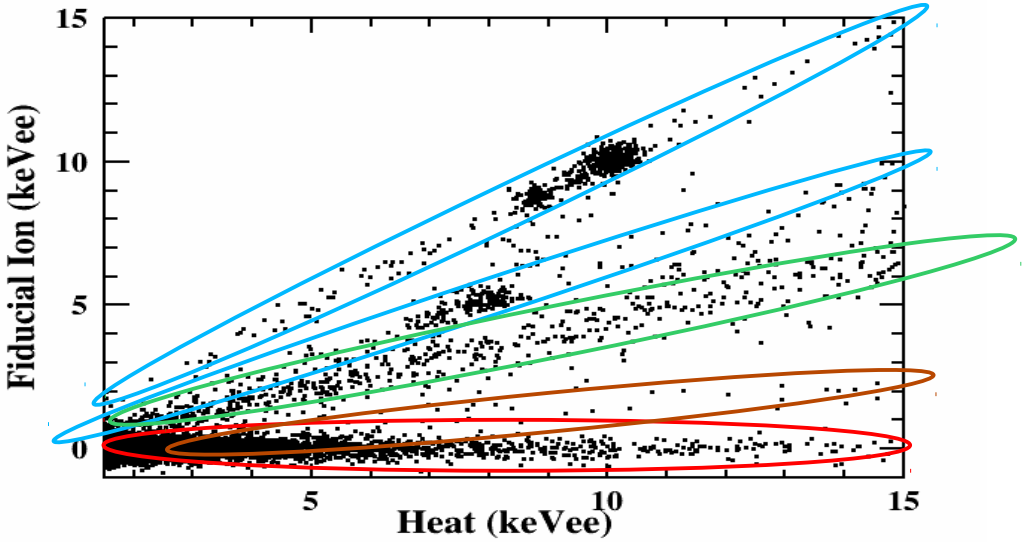
**Surface Gamma**

**Surface Beta**

**Surface Lead**

**Heat only**

# The EDELWEISS-III experiment:
## Background rejection



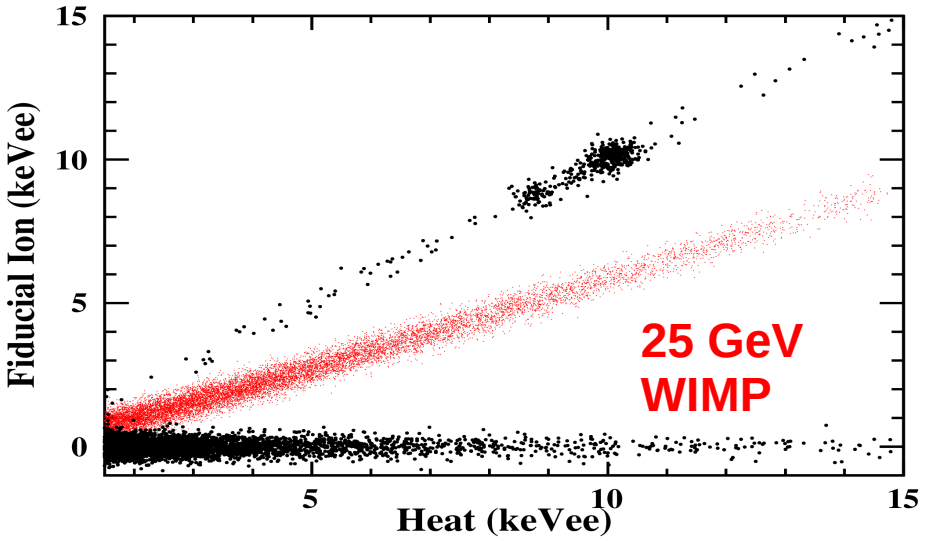

**Fiducial gamma**

**Surface Gamma**

**Surface Beta**

**Surface Lead**

**Heat only**




-We remove surface events using the ionisation channels

-We combine ionisation and heat to discriminate fiducial gamma and heat only versus WIMPs


# Part II
# First EDWELWEISS-III search for low mass WIMPs

# First EDWELWEISS-III search for low mass WIMPs:
Foreword

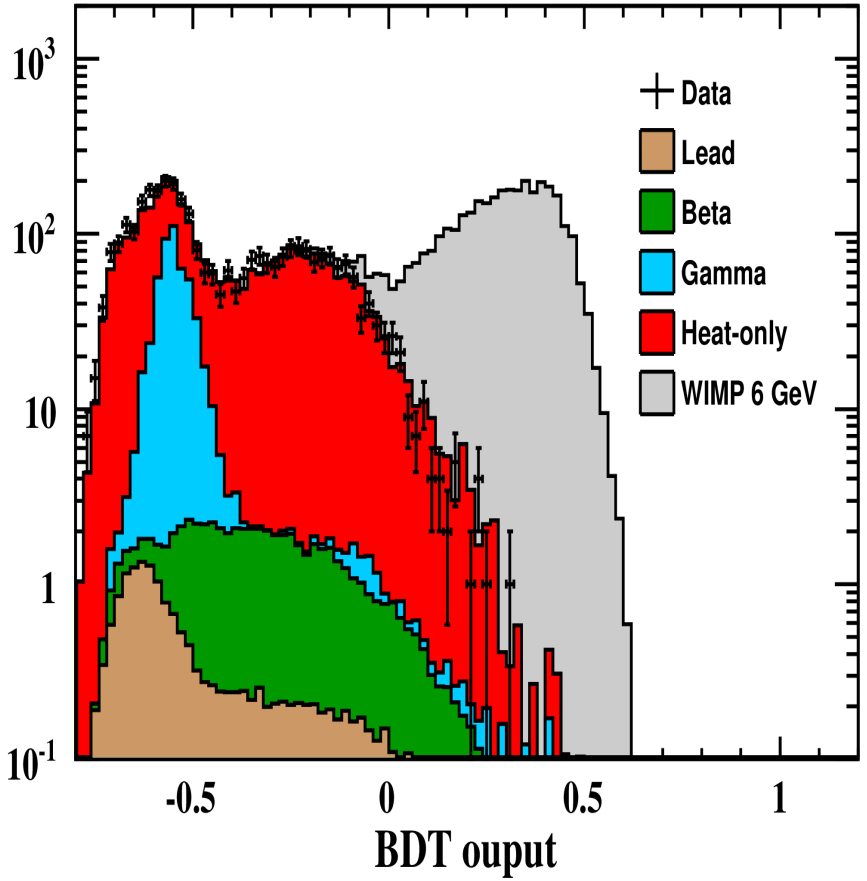
**We picked one standard detector:**
- Unblinded a small fraction of the data set, Aug – Dec 2014.
- Allows us to prepare the analysis
- Exposure 35 kg.d after cuts.

**We define a simple region of interest (ROI):**
- In particular Heat >1.5 keVee (3.6 keVNR)

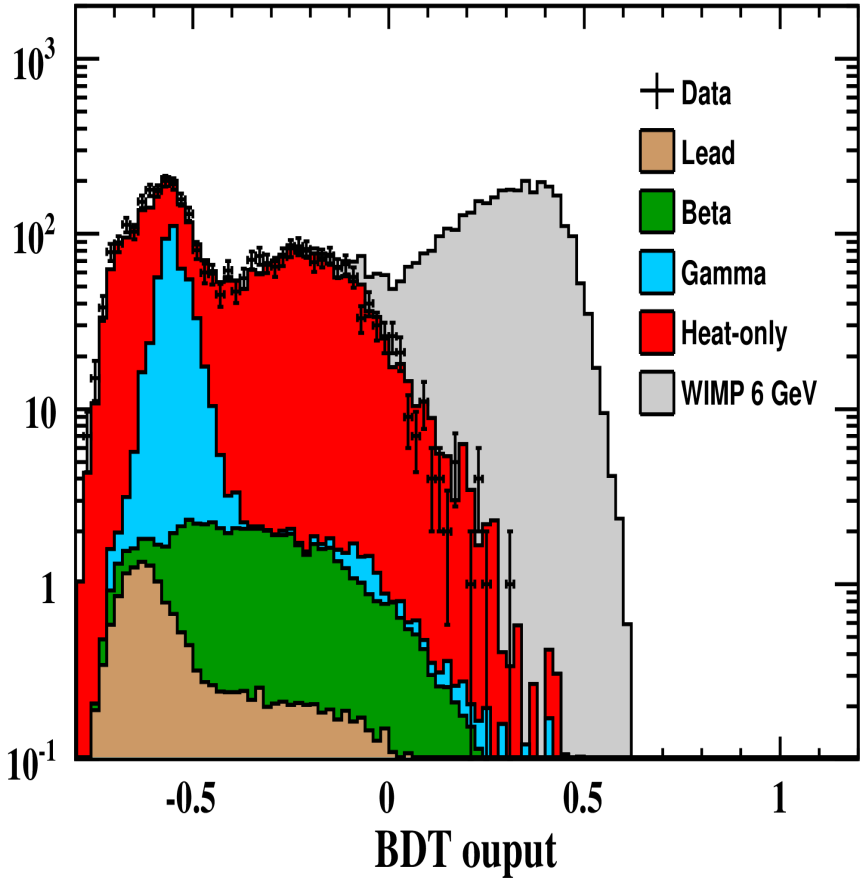
**We use Boosted Decision Trees within this ROI :**
- Combine the 6 variables (4 ionisation and 2 heat) for Signal/Background discrimination

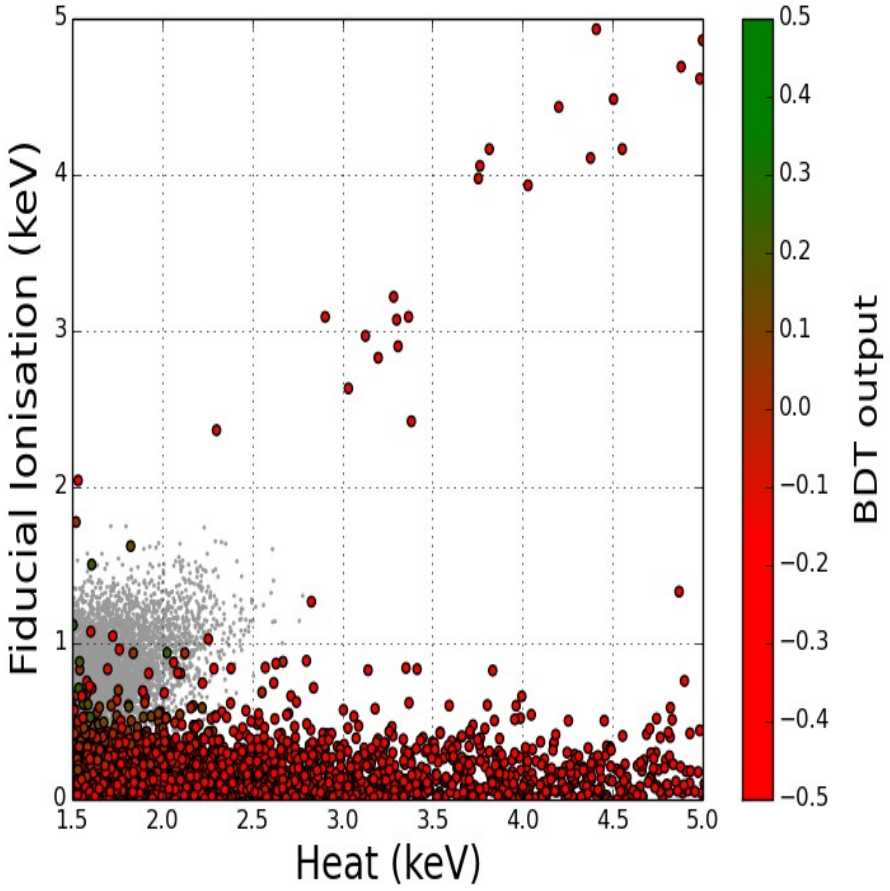
**Background models are data driven:**
- Use regions without signal (sideband) to build the model
- Use calibrations as crosscheck.

# WIMP search data:
## Boosted Decision Trees

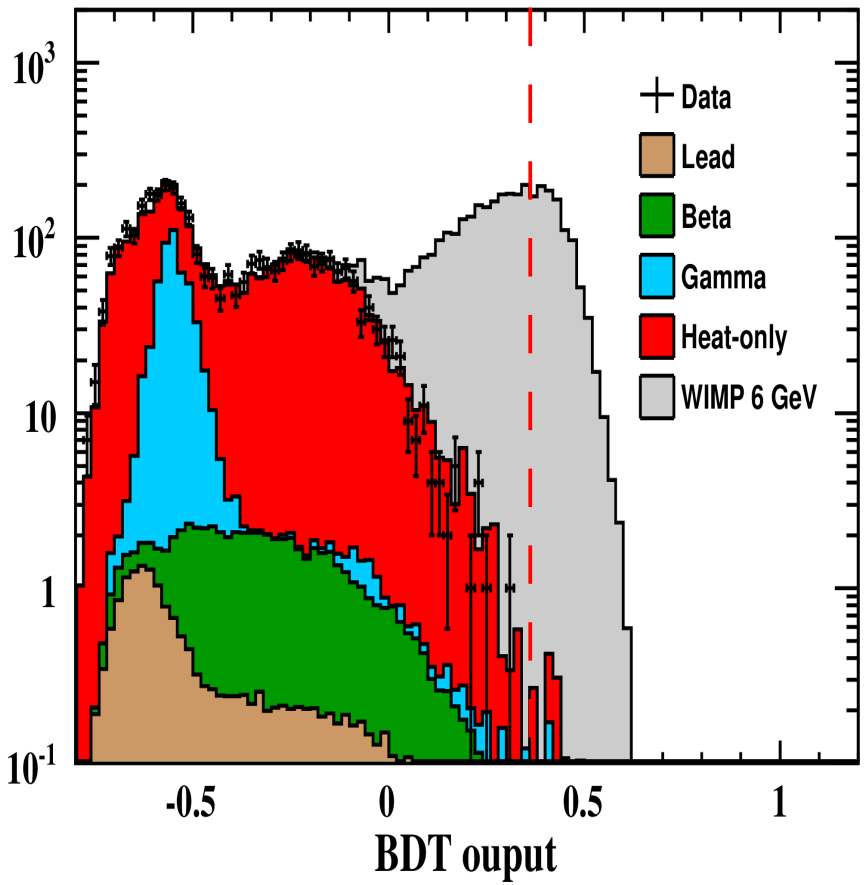


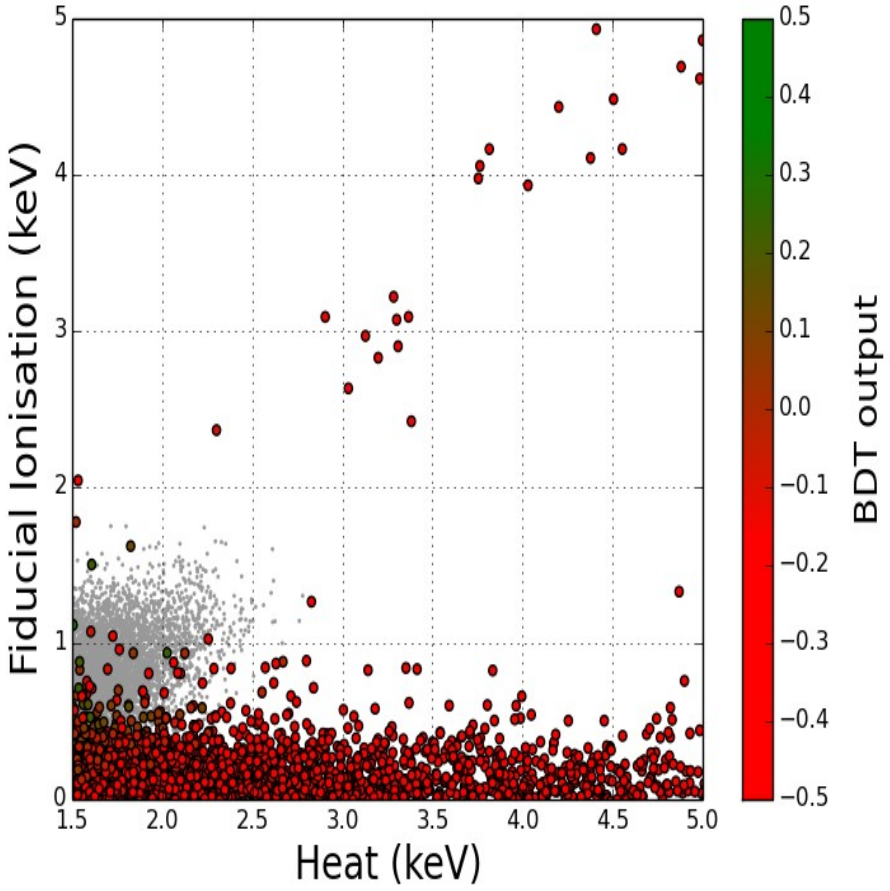
# WIMP search data:
Boosted Decision Trees



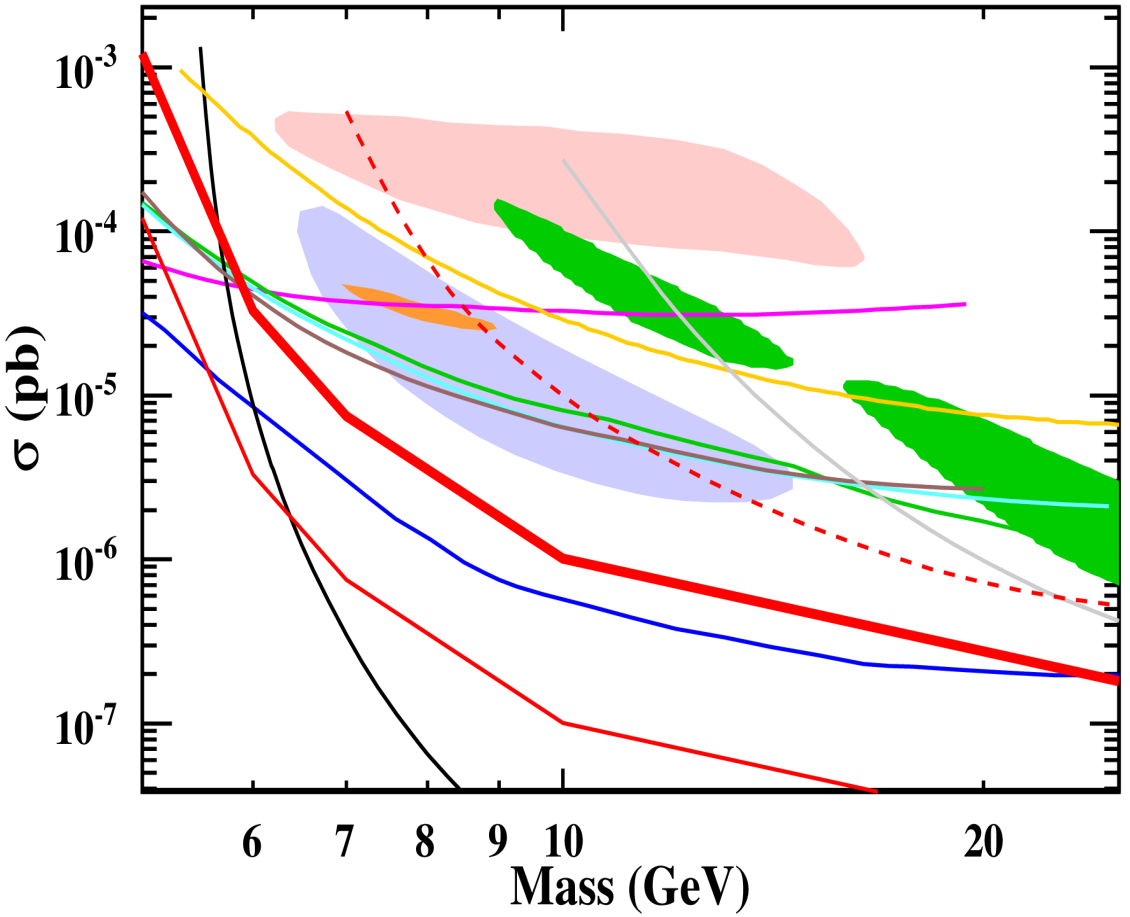



# WIMP search data:
## Boosted Decision Trees



# First EDELWEISS-III result:
low mass exclusion limit

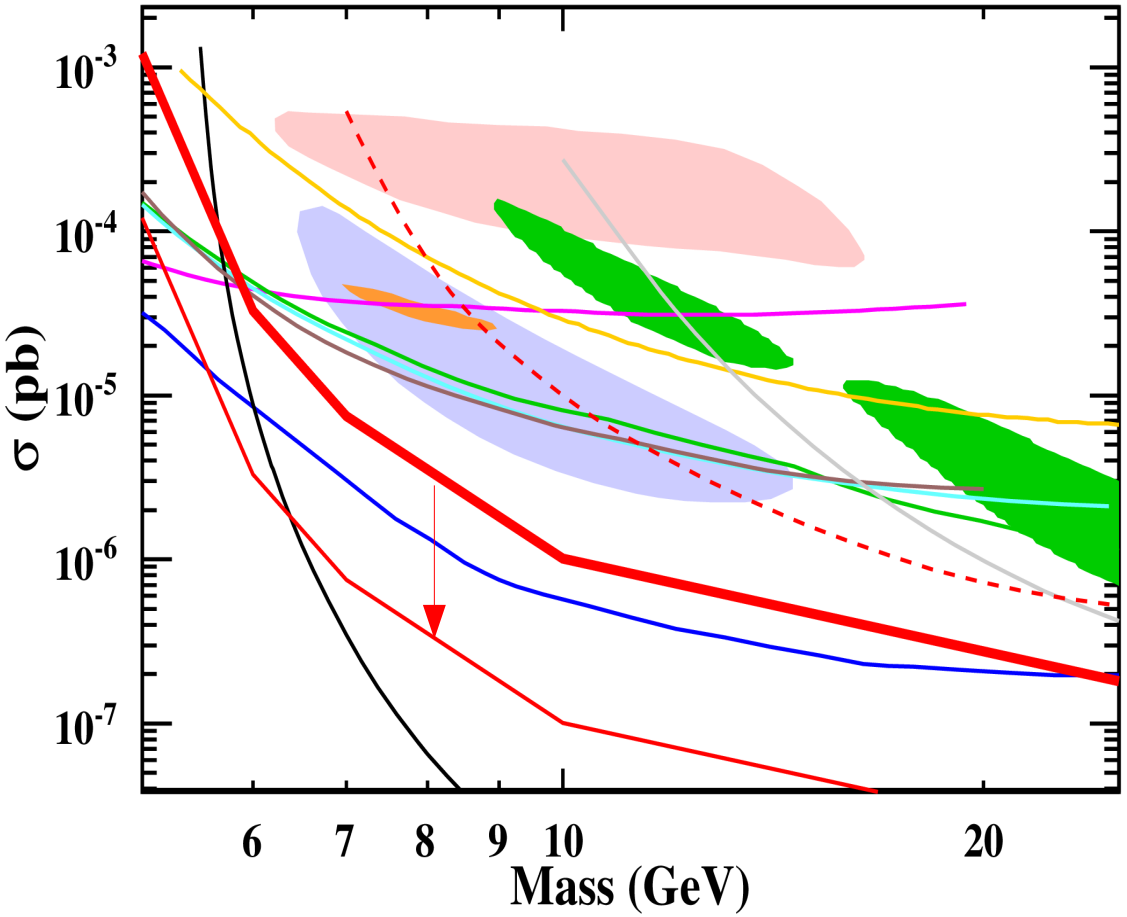



DAMA
SCDMS
CDMSLite
CDMS Si
CoGeNT
LUX
XENON 10 S2 only
SIMPLE
COUPP
CRESST
PICO 2L
EDW II
EDW III FID837

**Limit obtained with a single detector**

- Poisson limit after BDT cut
- Analysis threshold: 1.5 keVee (3.6 keVNR)
- 35 kgd exposure after cuts

# First EDELWEISS-III result:
low mass exclusion limit




DAMA
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EDW II
EDW III FID837

**Expect fast improvements in sensitivity:**

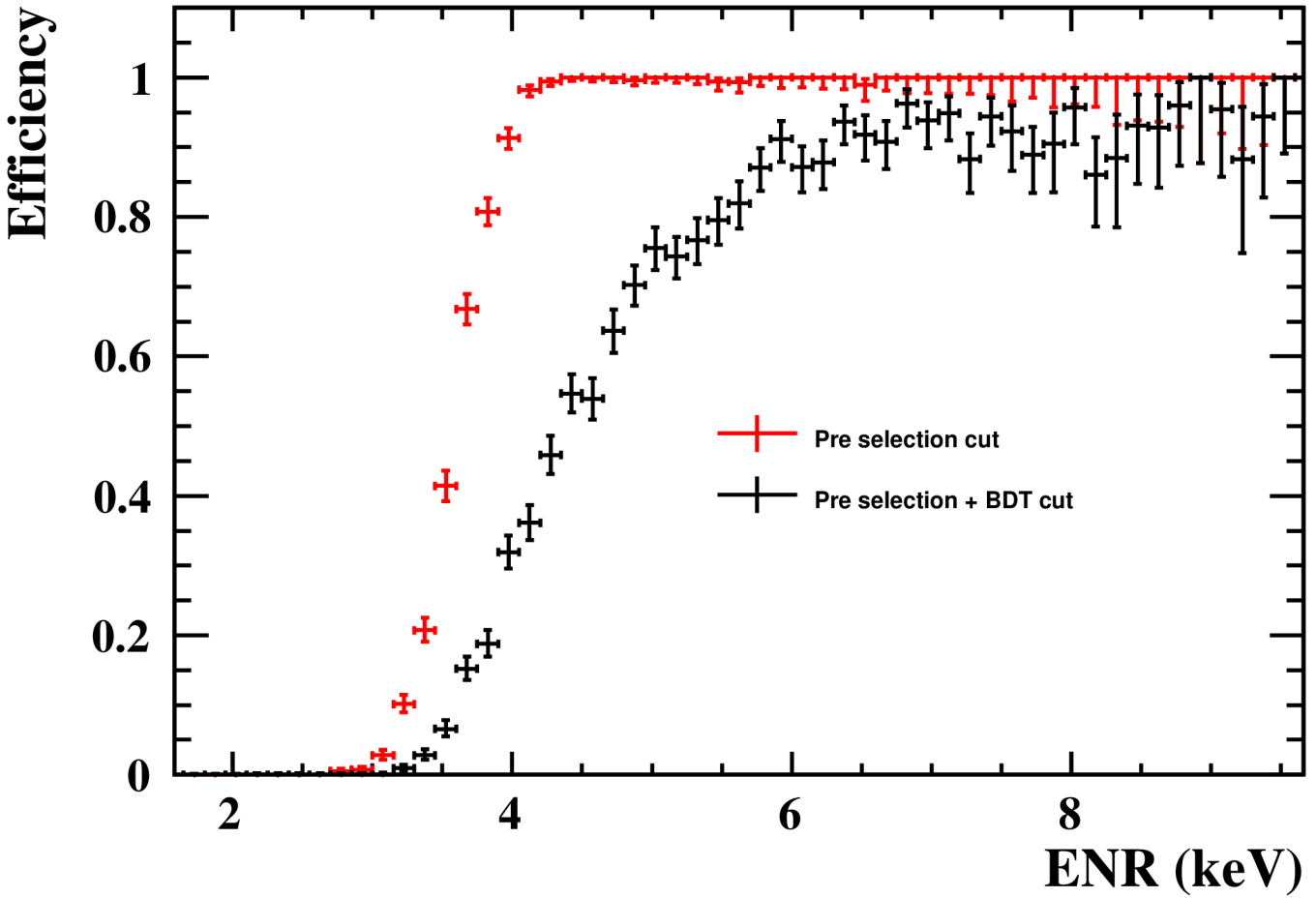
- We already have x10 more data of similar quality

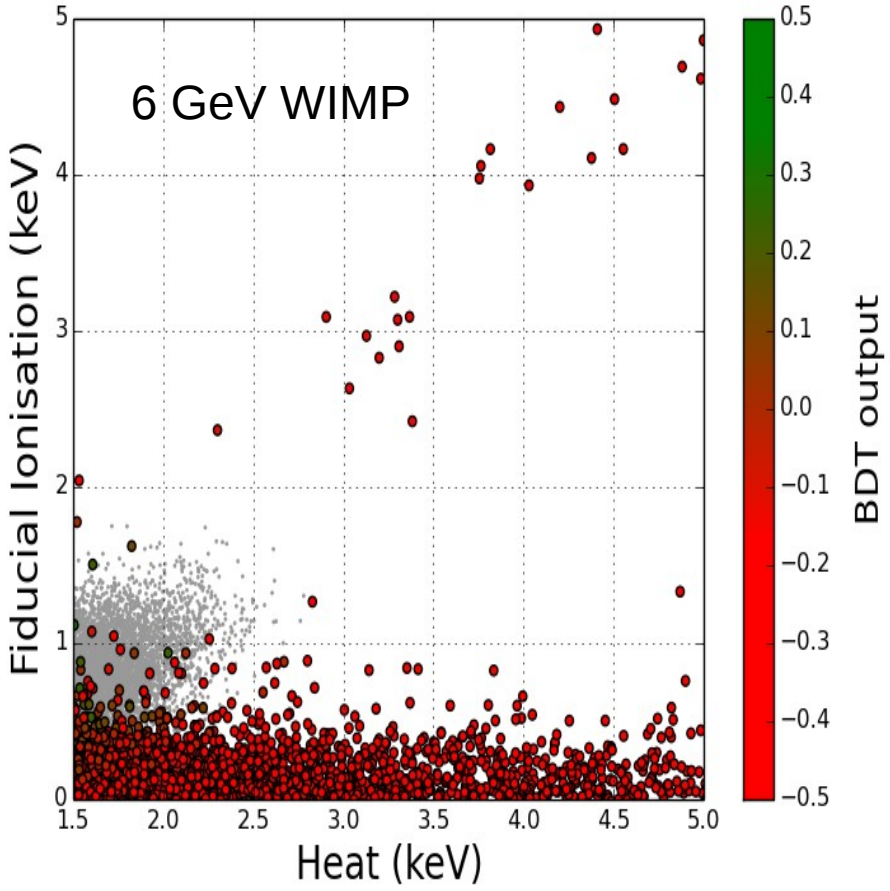
- Run ongoing

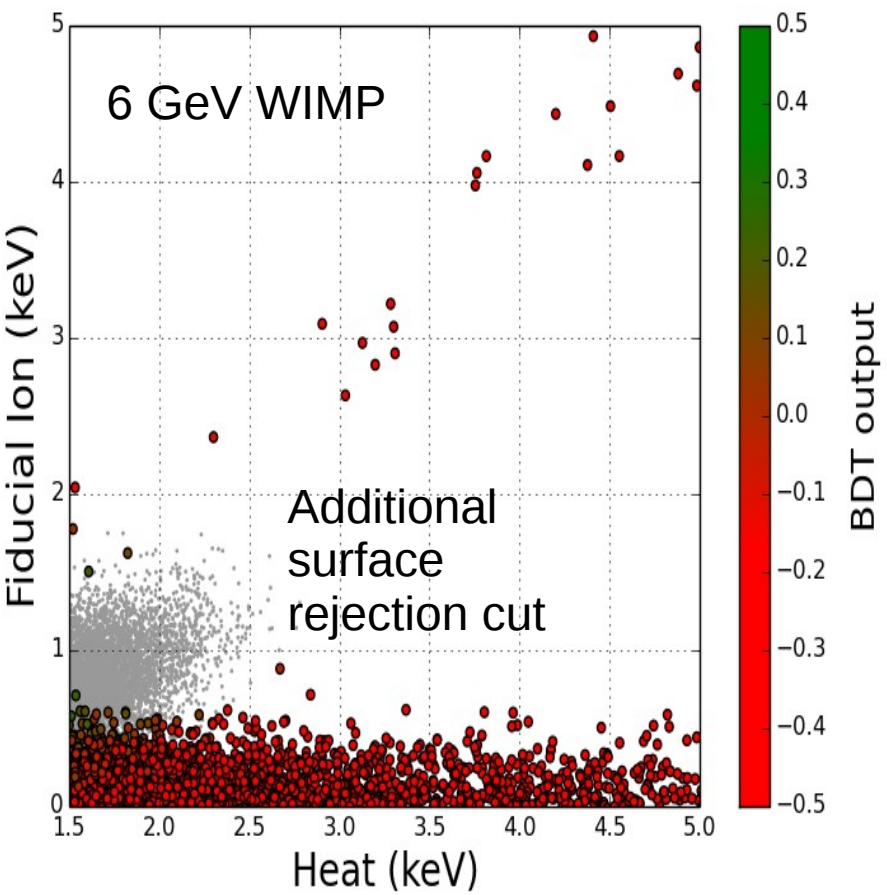
- Will decrease the analysis threshold


# Backup

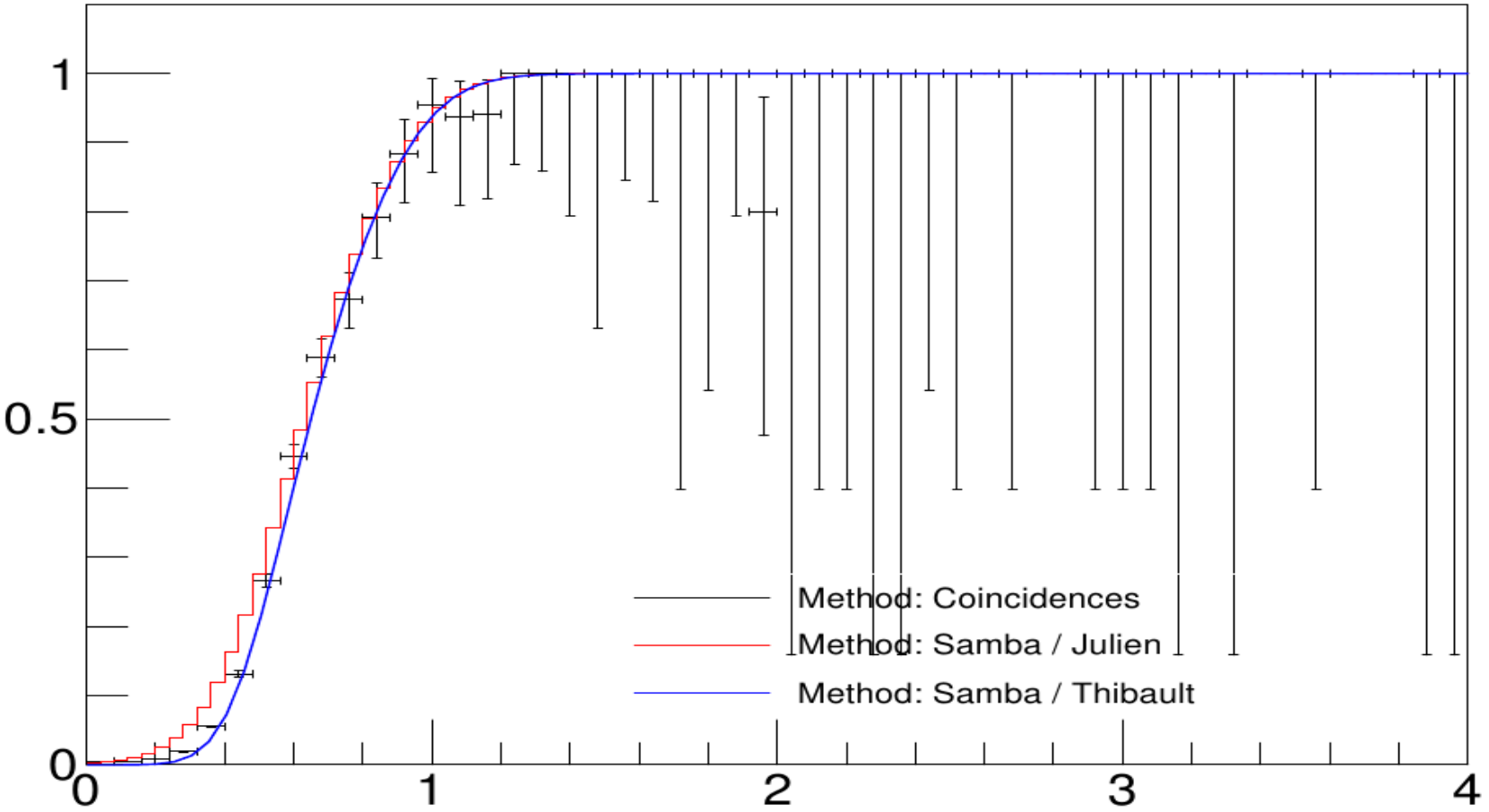
For 10 GeV WIMP

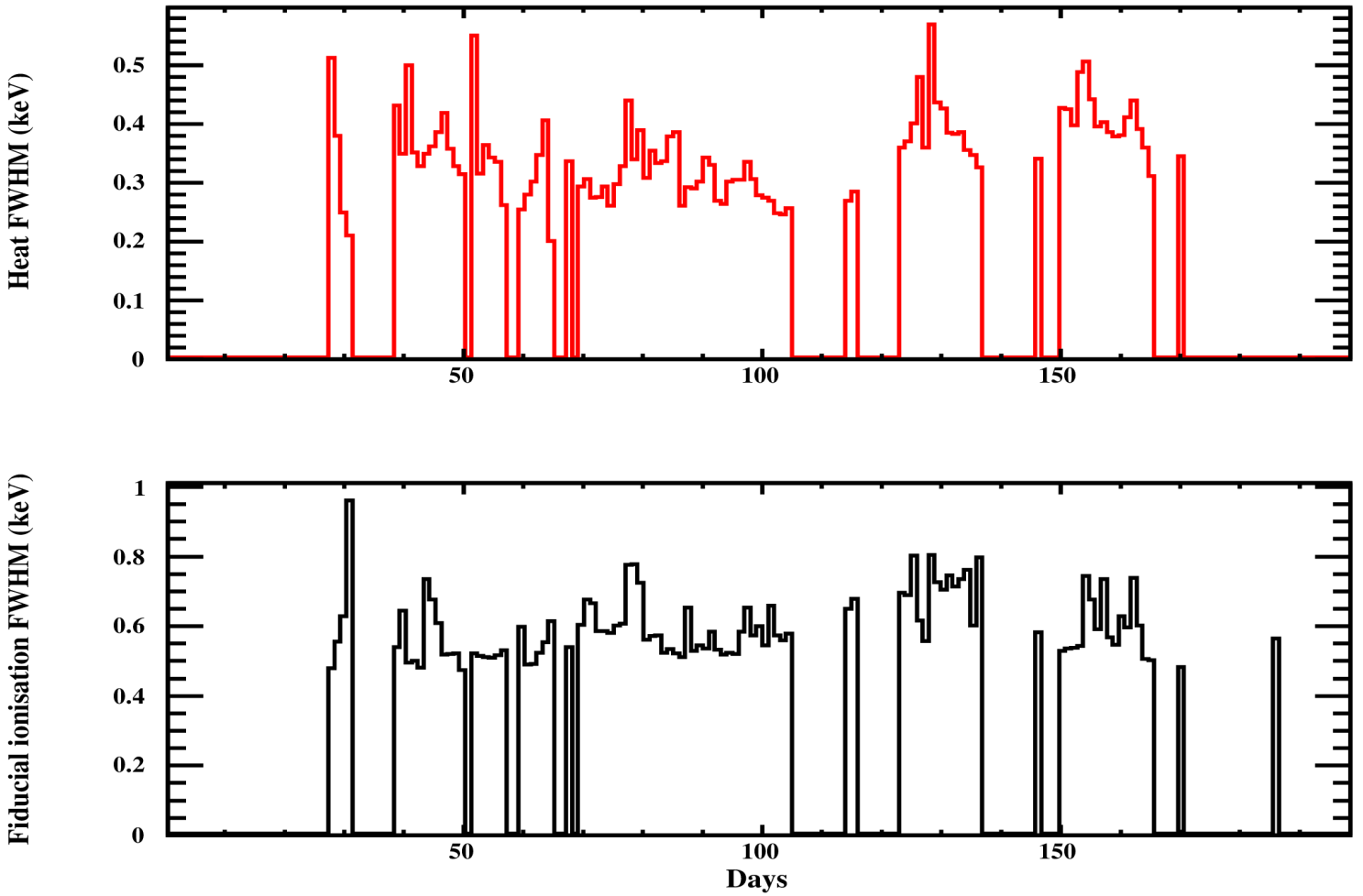


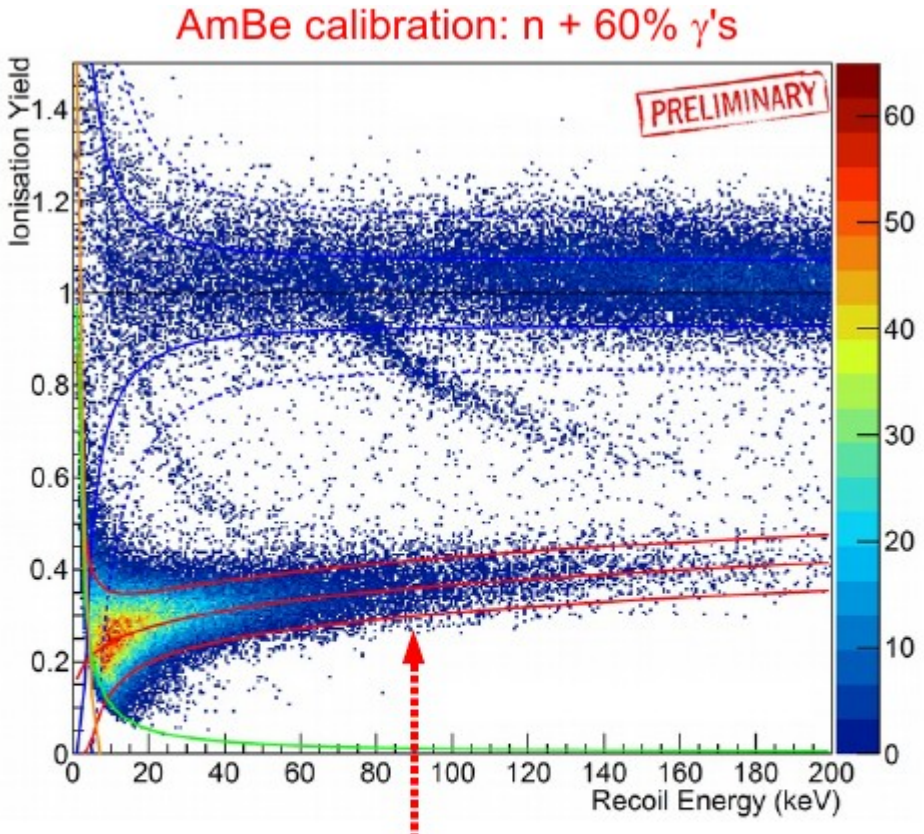

6 GeV WIMP
Fiducial Ionisation (keV)
Heat (keV)
BDT output

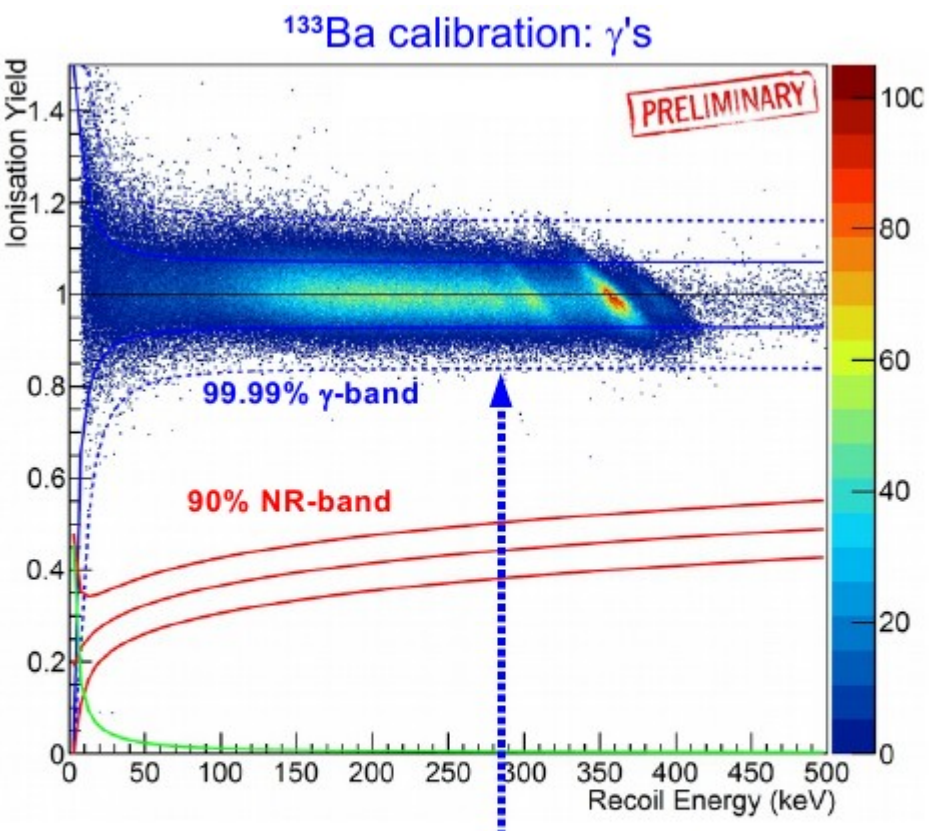

6 GeV WIMP
Additional surface rejection cut
Fiducial Ion (keV)
Heat (keV)
BDT output

Online trigger efficiency




Heat FWHM (keV)
0
0.1
0.2
0.3
0.4
0.5
50
100
150
Fiducial ionisation FWHM (keV)
0
0.2
0.4
0.6
0.8
1
50
100
150
Days




Nuclear Recoils
Q ≈ 1/3
*("quenching")*

Ionization yield
$Q = E_{ion} / E_{recoil}$

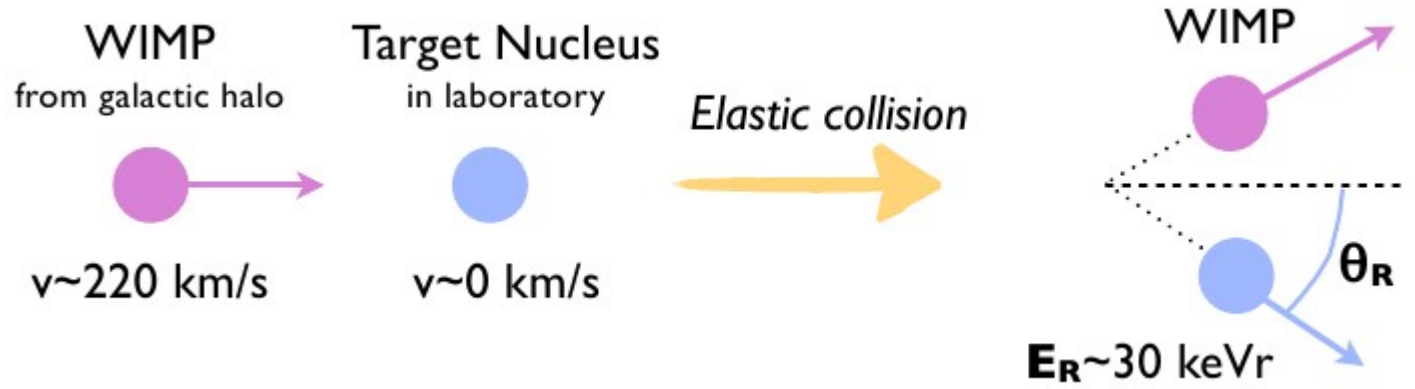
Electron Recoils
Q = 1
(by normalization)

# WIMP direct detection
## Brief review

-We have **evidence** for Dark Matter: CMB, Lensing, Galaxy Rotation curves...

-Well motivated **candidate**: WIMP (massive, stable, charge neutral, weakly interacting)
→ It provides the missing matter density in a natural way

-**Detection** scheme:




### Challenges:

- Many backgrounds
- Low energy scale for the recoil (~ keV)
- Low event rate (< evt/kg/year)