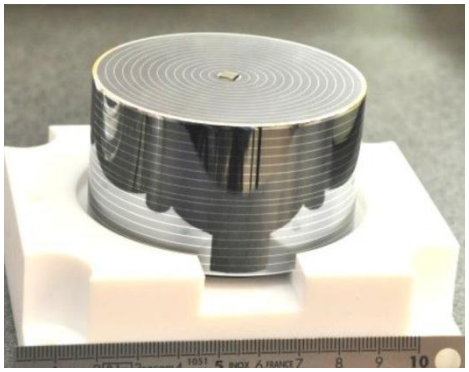
The EDELWEISS dark matter search: Latest results and future plans

- Direct dark matter search
- Cryogenic germanium detectors
- CDMS-EDELWEISS combined limit: 3.3×10^{-8}pb excluded at 90GeV
- EDELWEISS III
- EURECA



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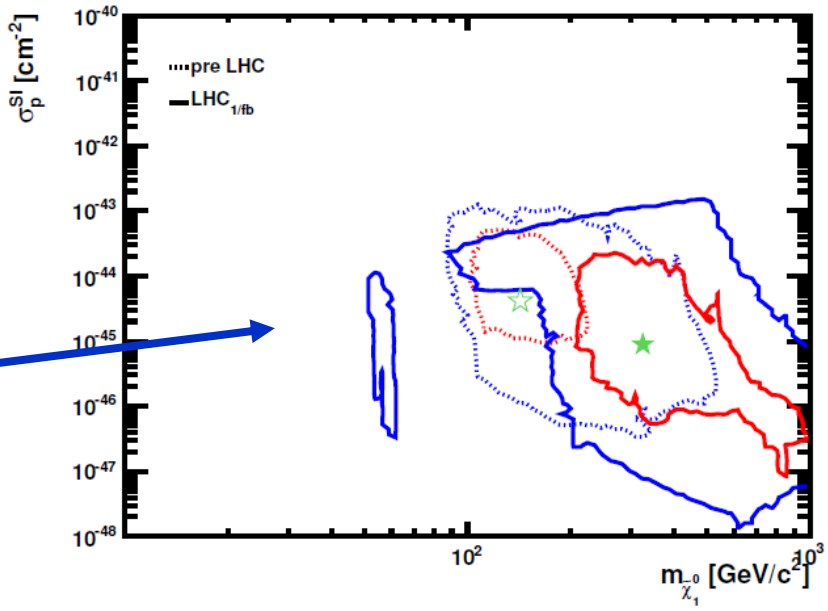
EDELWEISS collaboration: CEA Saclay (IRFU, IRAMIS), CNRS-CSNSM Orsay, KIT (IK, EKP, IPE) Karlsruhe, CNRS Institut Néel Grenoble, IPN Lyon, Laboratoire Souterrain de Modane, JINR Dubna, University of Oxford, University of Sheffield

Searching for dark matter

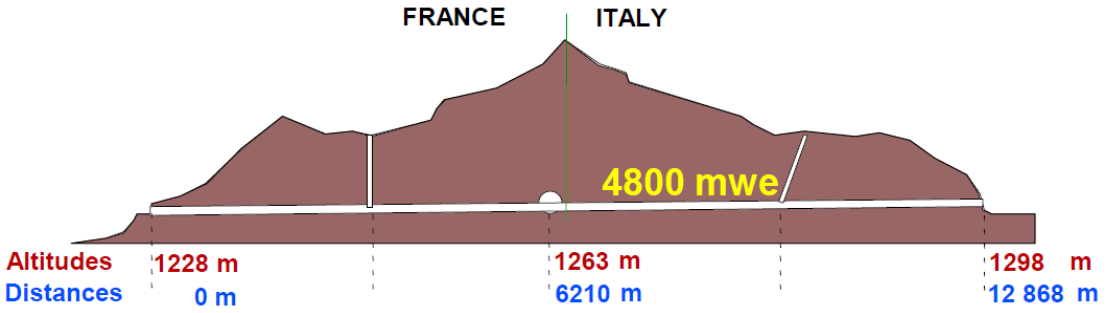
- Evidence for dark matter: galaxy rotation curves, clusters, CMBR, nucleosynthesis, bullet cluster…
- Candidates: WIMPs – supersymmetric neutralinos, KK particles, technibaryons…
- Search for elastic scattering
  - ~10keV nuclear recoil
  - <0.01 events/kg/day
- Need: Sensitive detectors with excellent discrimination. Low background



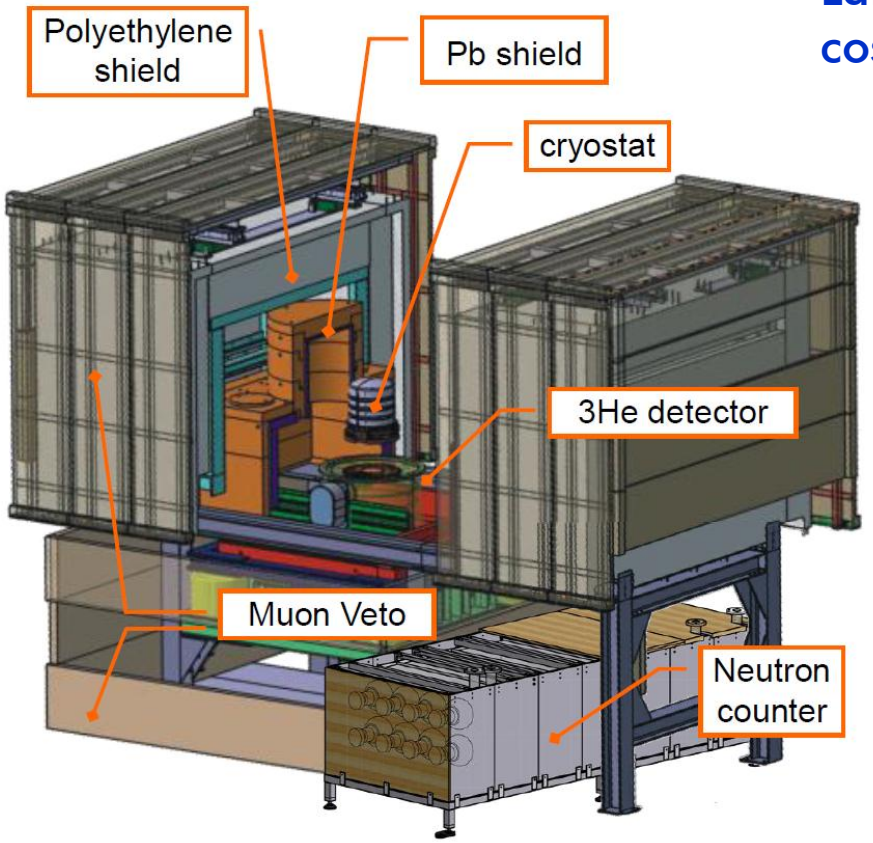
Buchmueller et. al. arXiv:1110.3568

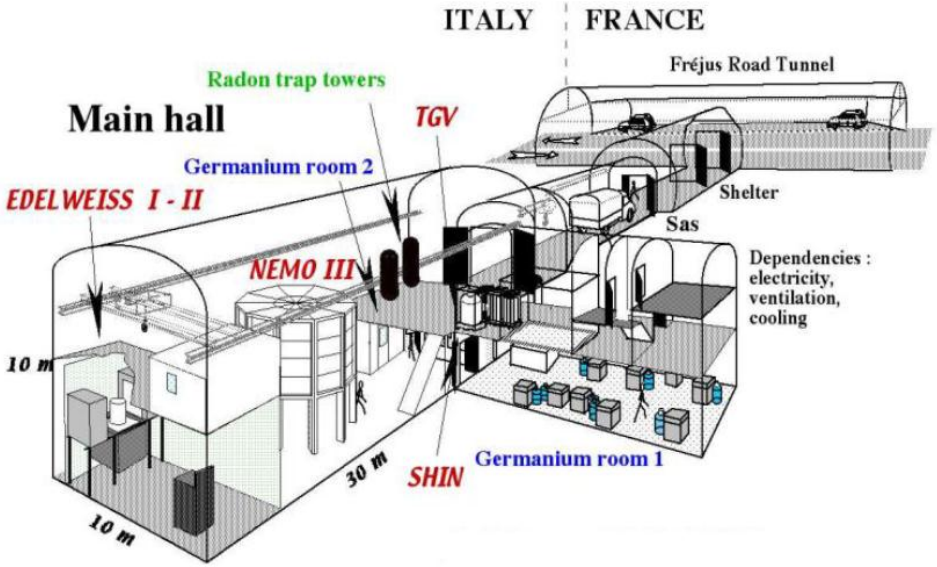
Edelweiss

- Cryogenic germanium phonon-ionization detectors
- Laboratoire Souterrain de Modane



Laboratoire Souterrain de Modane: cosmic muon flux 4 μ/m²/day

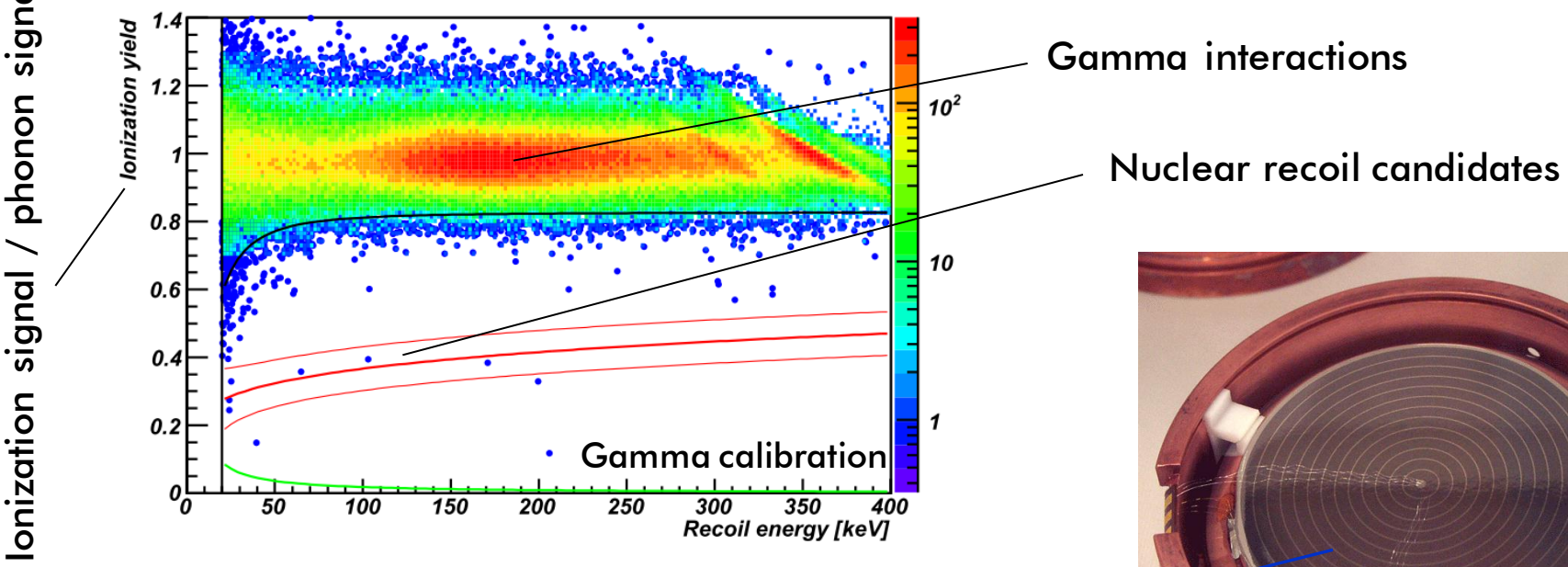




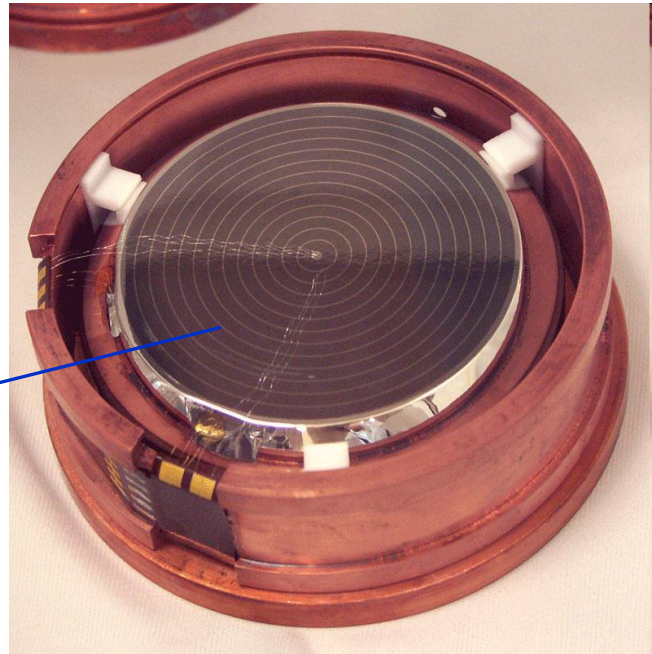
Shielding: 4800mwe rock; 20cm lead; 50cm polyethylene

InterDigit (ID) detectors

- Germanium crystal at 20mK
- Simultaneous phonon – ionization detection Discrimination of nuclear recoils (WIMPs, neutrons) from electron recoils (α, β, γ)



- Interleaved electrodes at different potentials allows rejection of surface events



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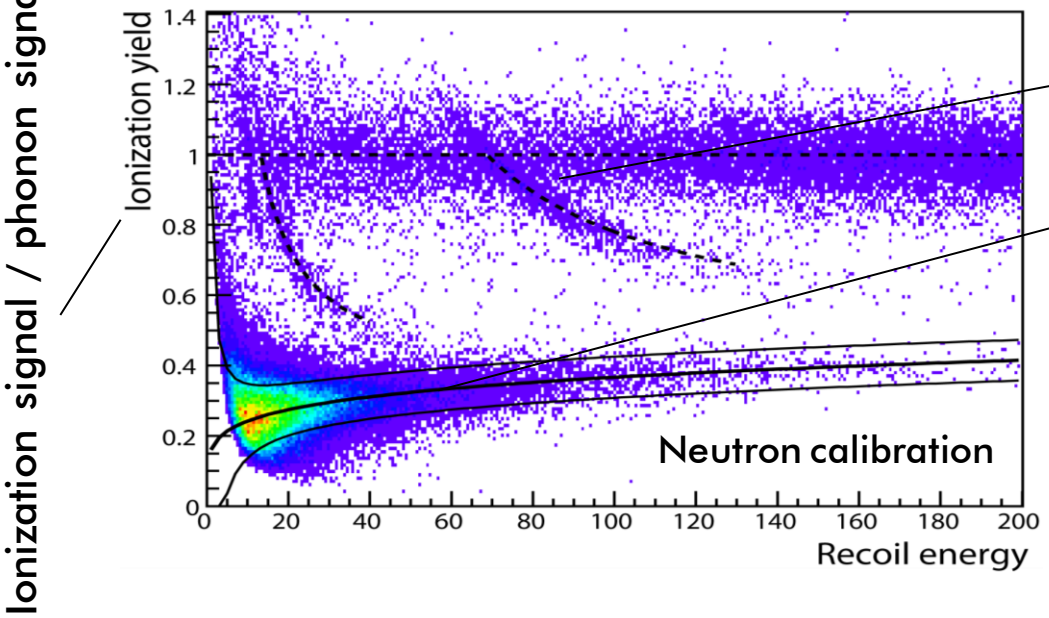

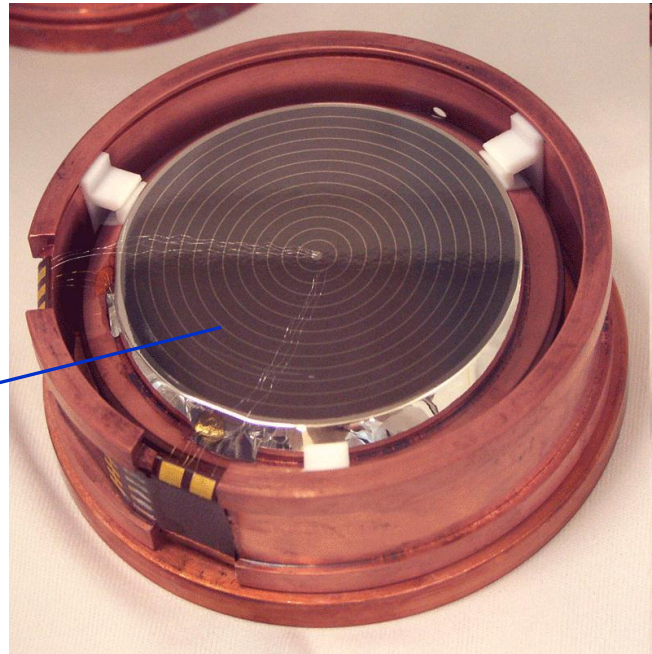

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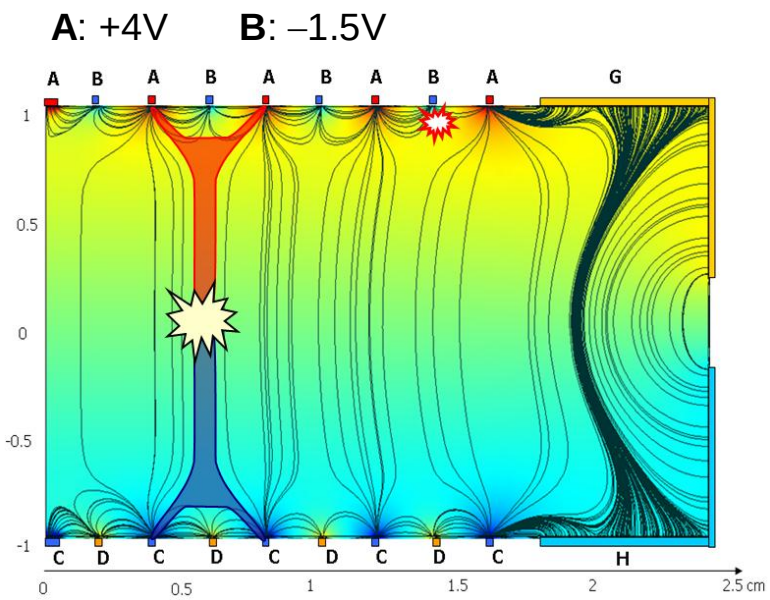
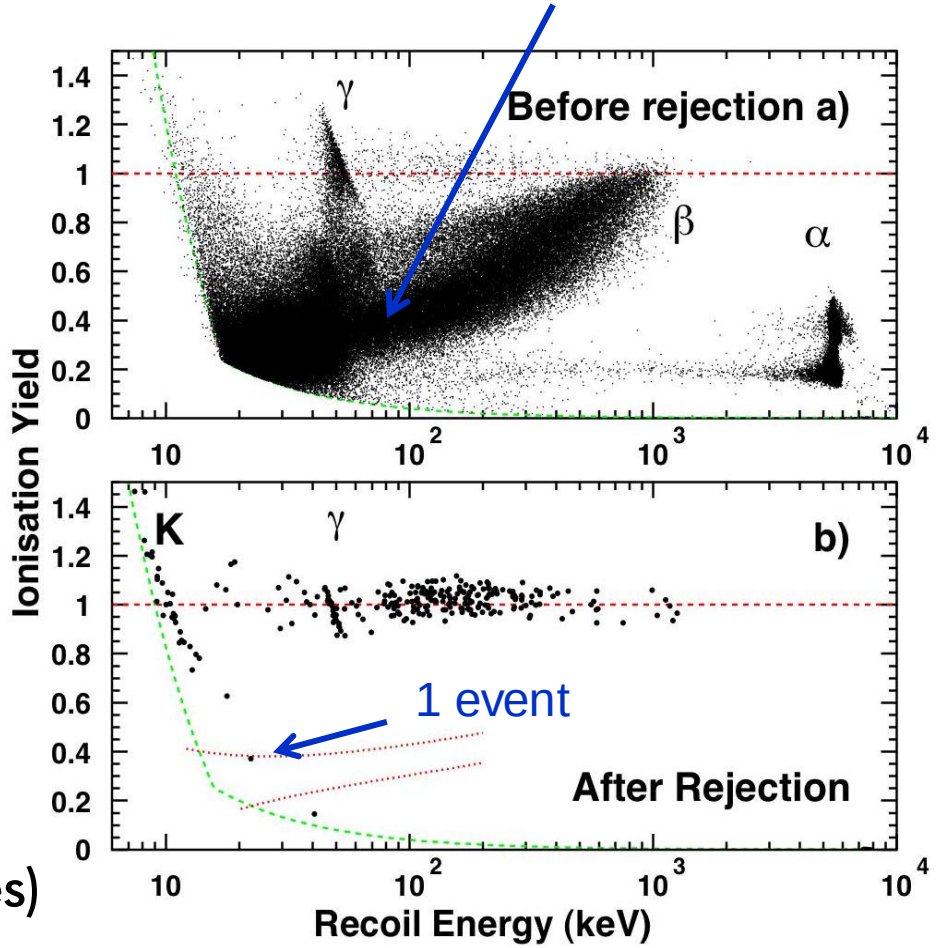
Surface event rejection



^{210}Pb Calibration
6×10^{4} β events



Bulk events:
charge → AC (Fiducial electrodes)

Surface events:
charge → AB or CD

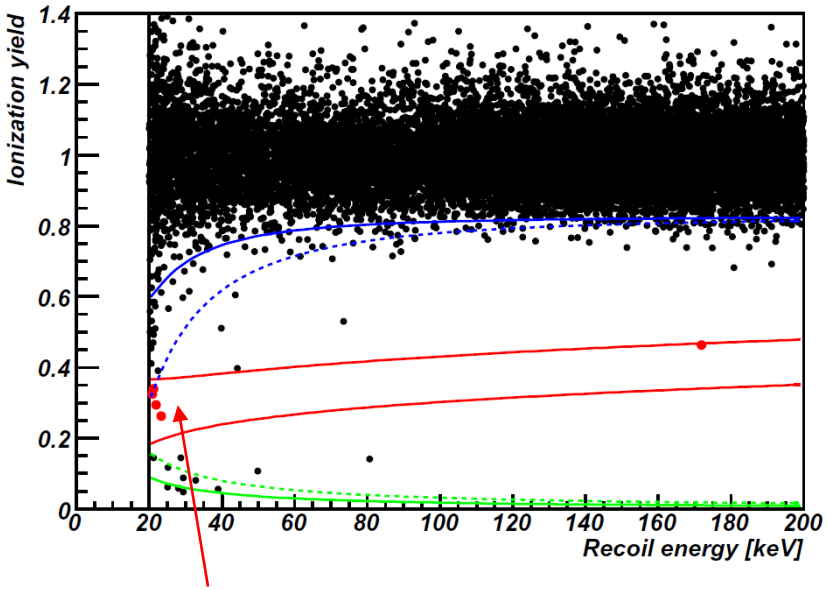
Surface event (β) rejection:
6×10^{-5} (90% CL)

A. Broniatowski et al Phys Lett B 681 (2009) 305 [arXiv:0905.0753]

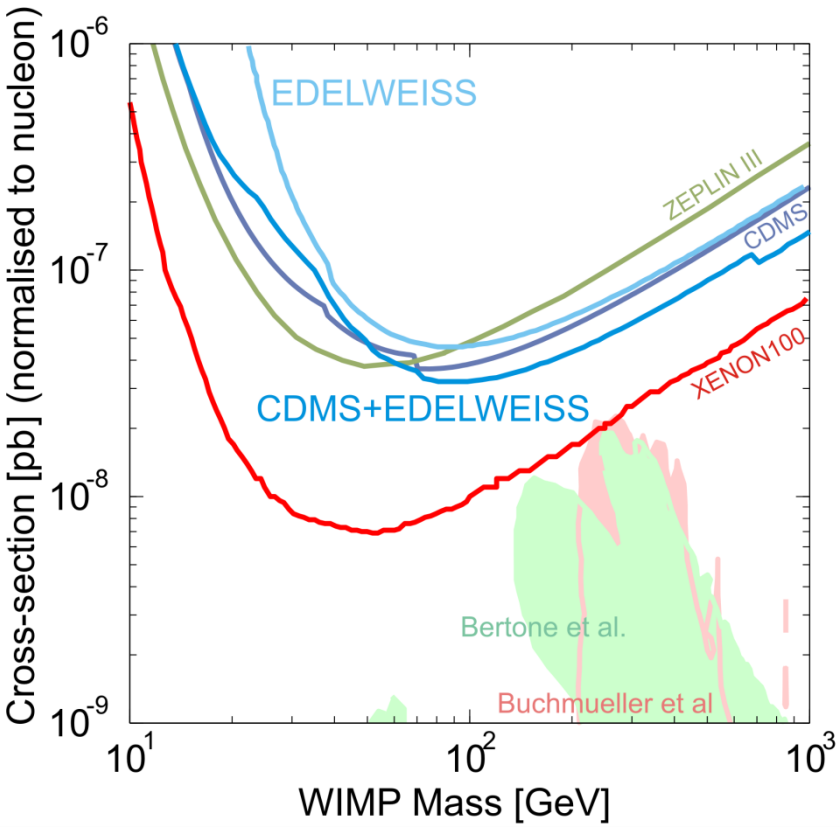
EDELWEISS-II final result

- Ten 400g ID Ge detectors, 384kg day

Final result: Physics Letters B. 702 (2011) 329-335 arXiv:1103.4070



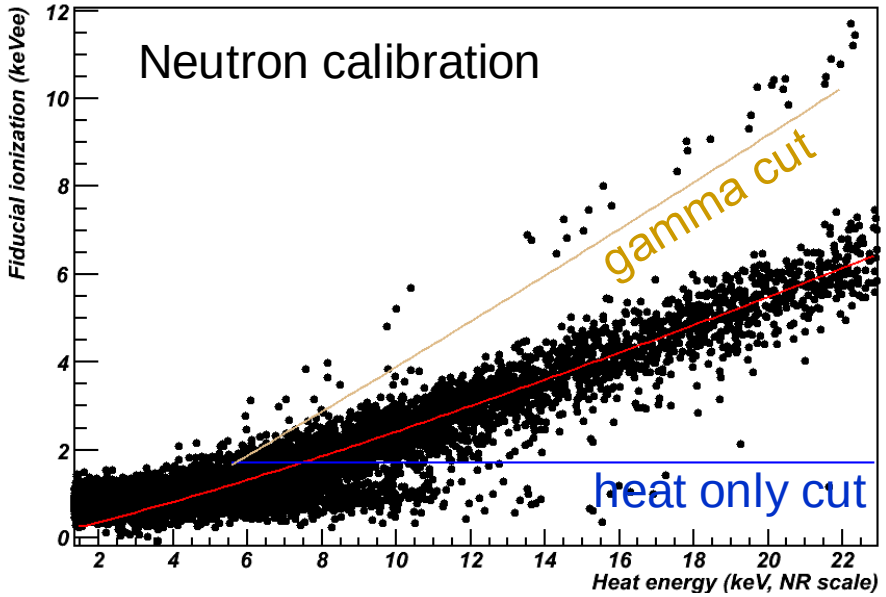
- Five nuclear recoil events (above 20keV)
- 4.4×10^{-8}pb excluded for 85GeV WIMP
- With CDMS data 3.3×10^{-8}pb excluded at 90GeV

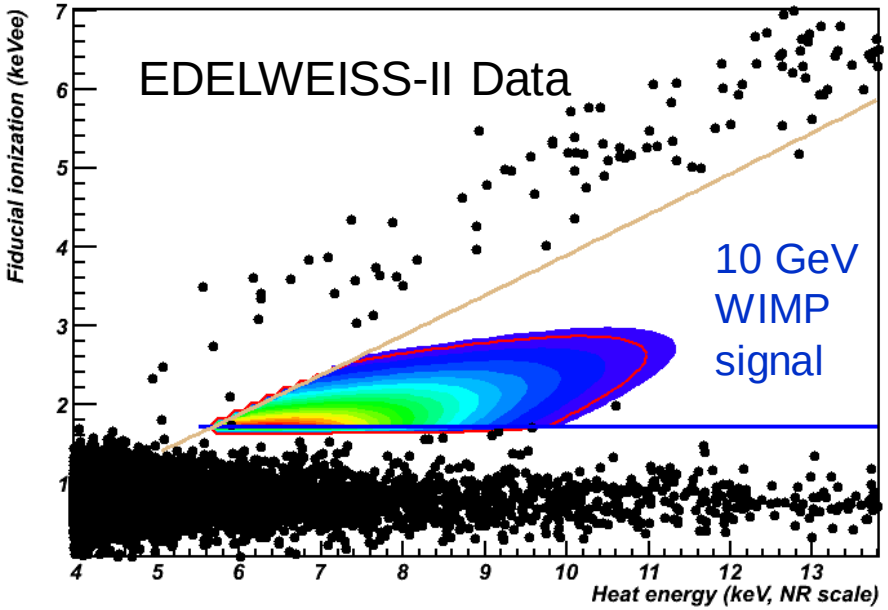


Phys, Rev. D 84 (2011) 011102(R), arXiv:1105.3377

EDELWEISS low energy analysis

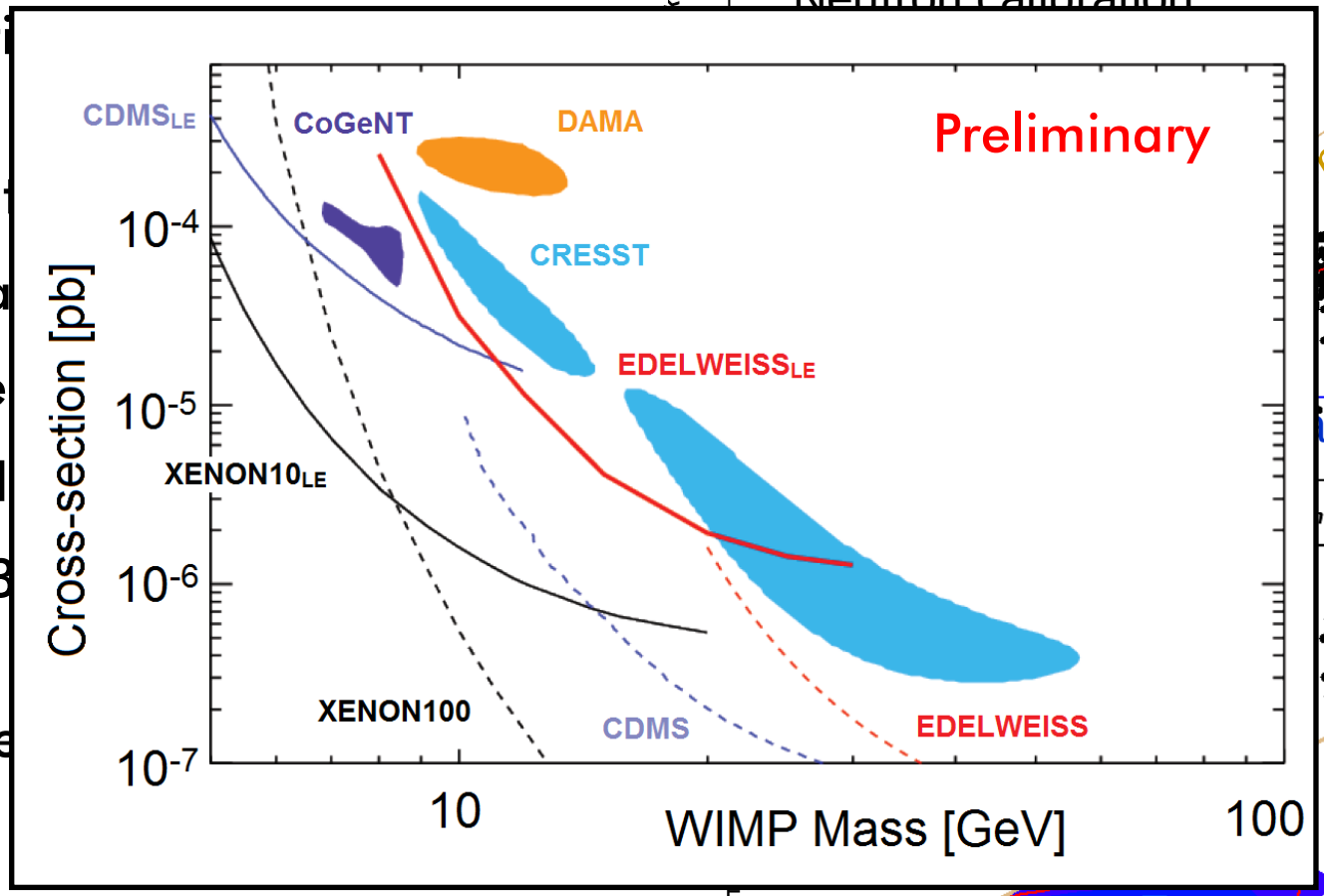
- ID3 detector – best heat and ionization resolution
- Define cuts in Fiducial ionization vs Heat energy plot
  - Gamma cut
  - Heat only pulse cut
- 31kg d
- For 8-30 GeV WIMP, we get 1-3 events in ROI
- Expected background ~1





EDELWEISS low energy analysis

- ID3 detector – best heat and ionizati
- Define vs Heat
  - Ga
  - He
- 31kg d
- For 8-3 events
- Expecte



EDELWEISS II Background estimate

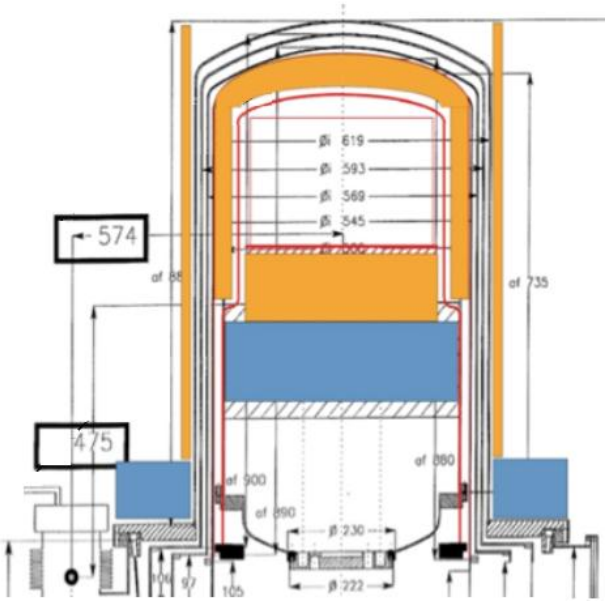
- Gamma background – 1.8×10^4 events (20-200keV)
  ^{133}Ba calibrations $\rightarrow$ 3×10^{-5} leakage into NR band
  $\rightarrow$ <0.9 events
- Surface events – 5000 events, rejection factor 6×10^{-5}
  $\rightarrow$ 0.3 events
- Muon induced events missed by veto $\rightarrow$ <0.4 events
- Neutrons from rock – GEANT4 simulations $\rightarrow$ 0.11 events
- Neutrons from contaminants in shield/cryostat $\rightarrow$ 0.21 events
- Neutrons from connectors / cabling in cryostat $\rightarrow$ 1.1 events

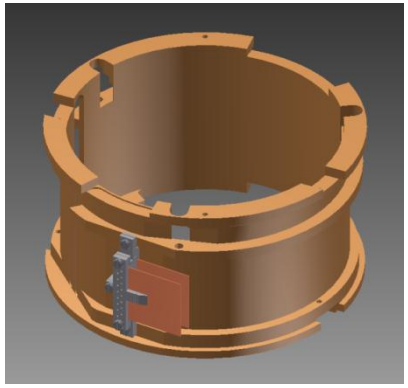
Total background estimate 3.0 events 90% CL

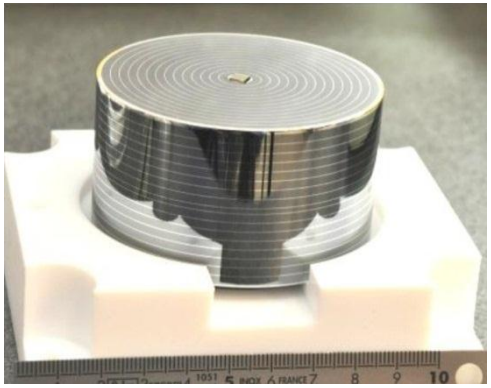
EDELWEISS III

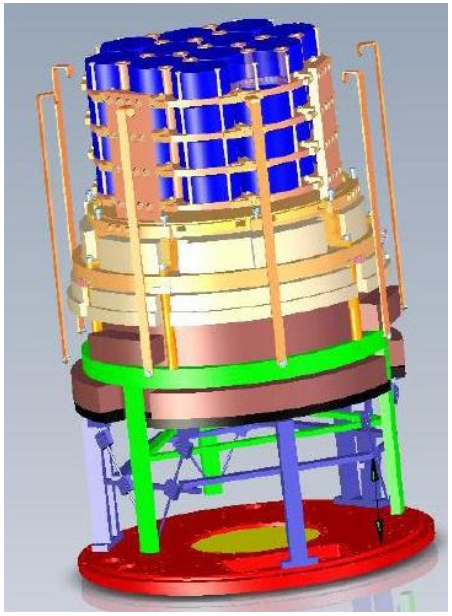
Increase detector mass
Decrease background

- Search for dark matter to 5×10^{-9}pb
- 40 FID-800 detectors installed 2012
- New Kapton cabling, connectors
- New cold electronics
- New cryostat design
- New internal PE shield
- New copper thermal shield



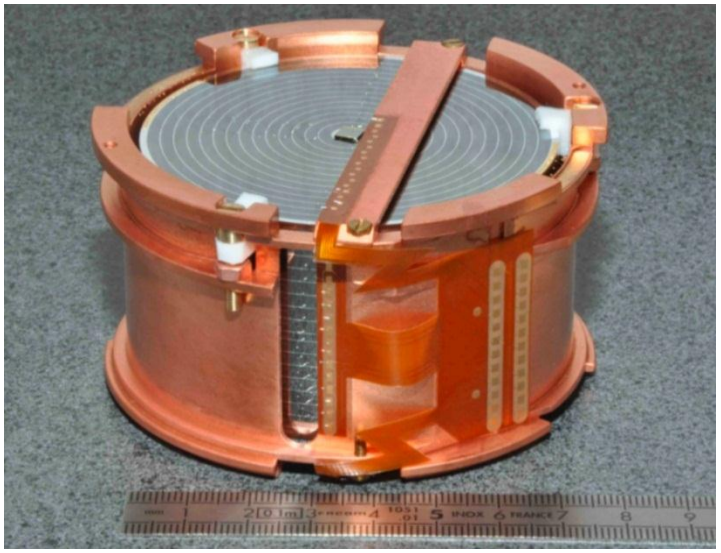


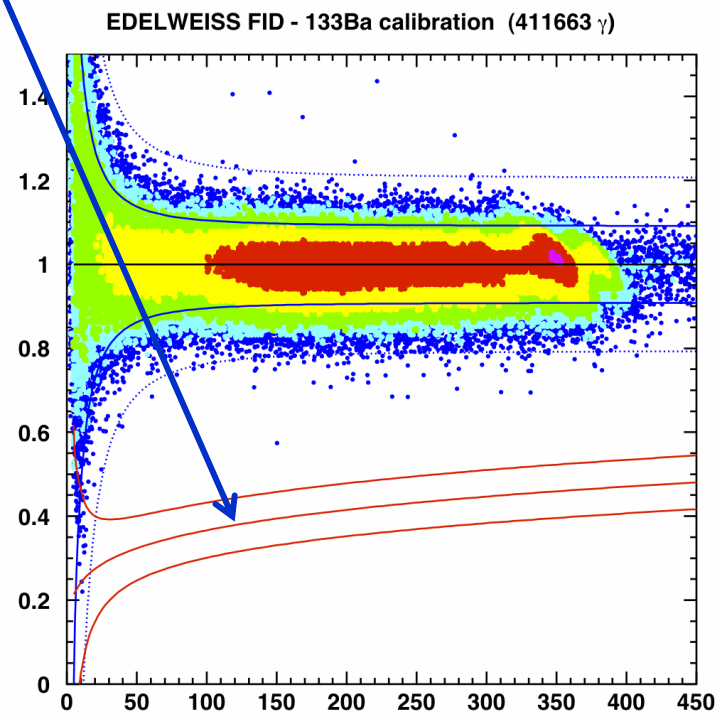


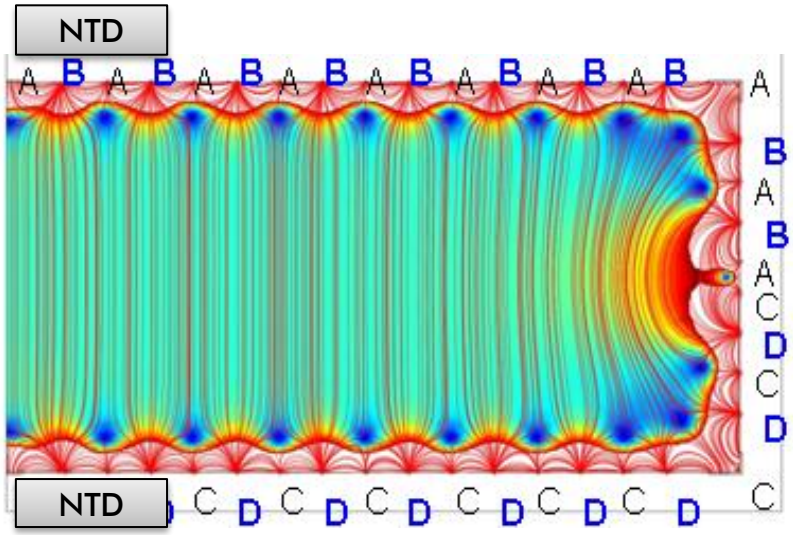


FID-800 detectors

- 800g crystals, fiducial mass >600g
- Improved background discrimination:
  0 NR events / 4×10^5 γ
  (ID detectors 6 NRs / 3×10^5 γ)







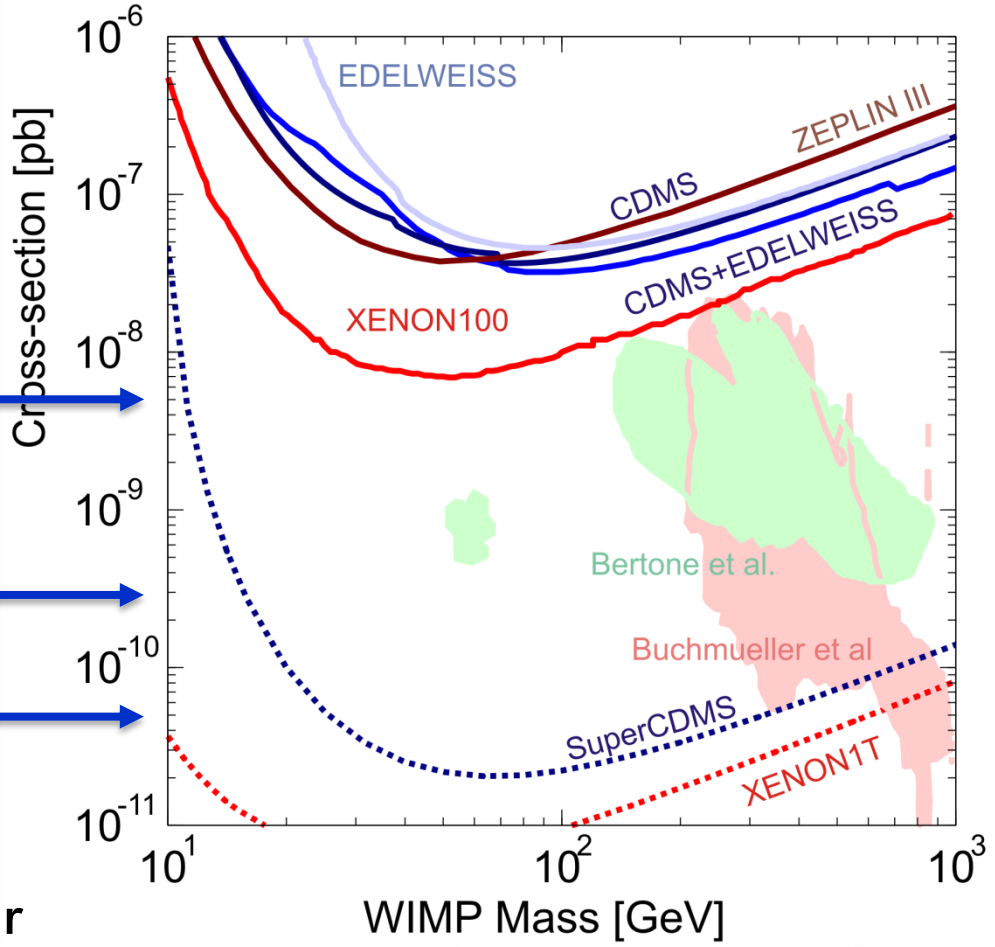
EURECA

European Underground Rare Event Calorimeter Array

EDELWEISS III →

EURECA phase I →

EURECA phase II →



- 10^{-10}pb - 1 event/tonne/year
- EURECA: 1-tonne dark matter search with cryogenic detectors
- EDELWEISS, CRESST, ROSEBUD collaborations + new members
- New LSM extension