Latest results and future plans for the Edelweiss dark matter search

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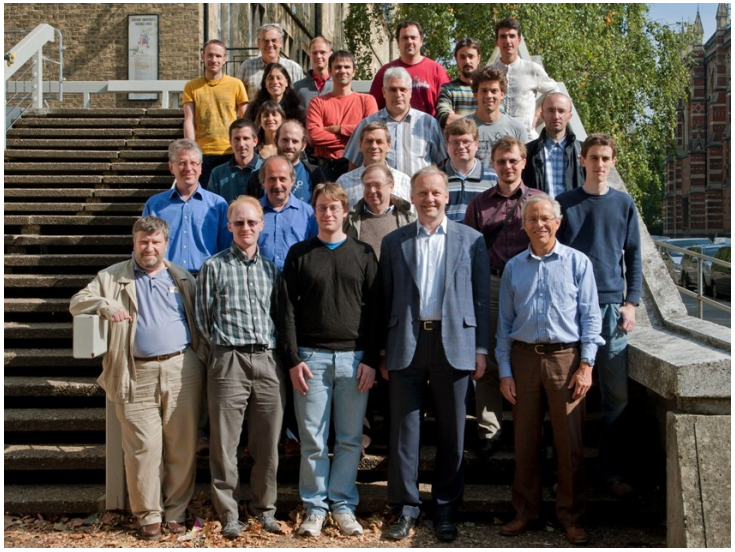
On the behalf of the EDELWEISS collaboration

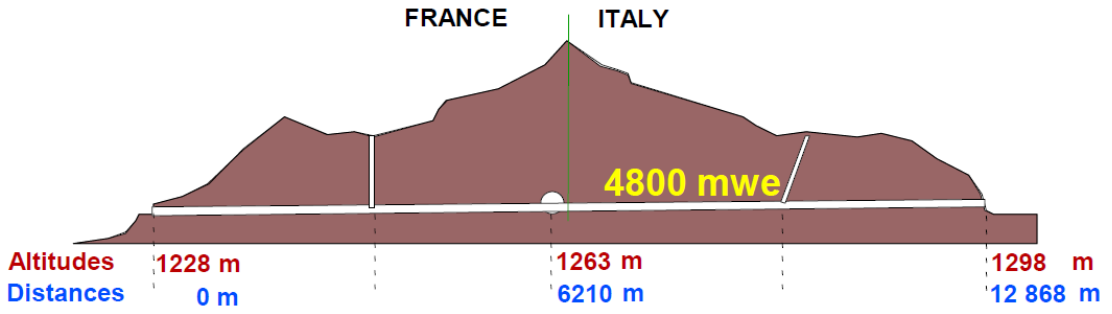


Edelweiss collaboration: CEA Saclay (IRFU, IRAMIS), CNRS-CSNSM Orsay, KIT (IK, EKP, IPE) Karlsruhe, CNRS Institut Néel Grenoble, IPN Lyon, Laboratoire Souterrain de Modane, JINR Dubna, University of Oxford, University of Sheffield

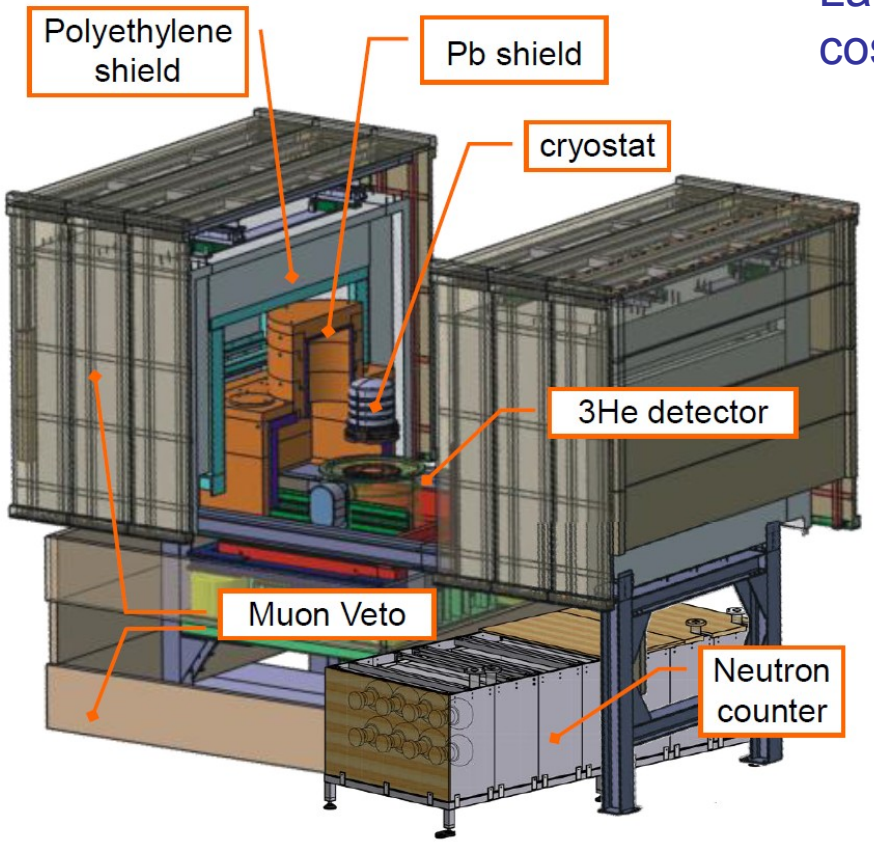
Expérience pour **DE**tecter
Les **W**imps **E**n **SI**te
Souterrain

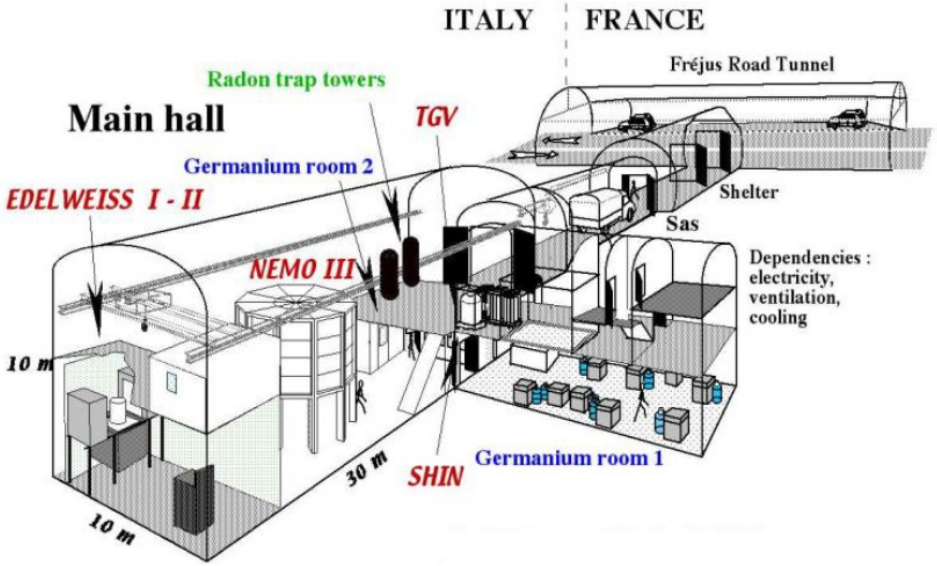
EDELWEISS-II Dark matter search

- Search for scattering of WIMP dark matter
  ~10keV nuclear recoil
  <0.01 events/kg/day
- Needs:
  - Sensitive detectors
  (cryogenic germanium phonon & ionization detectors)
  - Low background
  (passive shielding & ultra-low radioactivity materials)
  - Excellent background discrimination
  (active rejection by vetoing muons & surface events)
  - Long term runs & stability
  (calibrations & cryogenics concerns)
- Laboratoire Souterrain de Modane
(4800m water equivalent, 4μ/m^2/day)



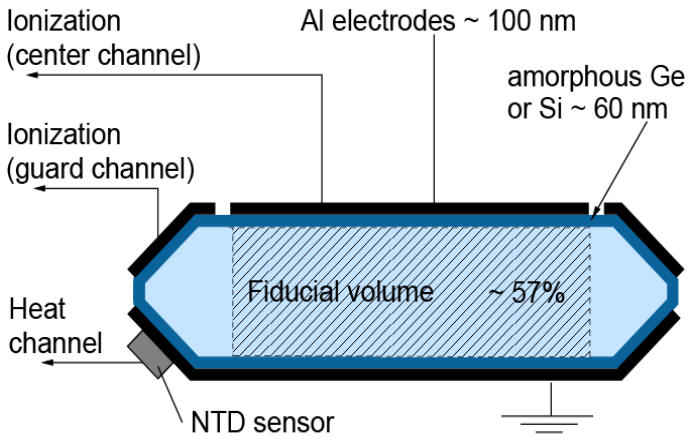
Laboratoire Souterrain de Modane:
cosmic muon flux 4 μ/m^2/day

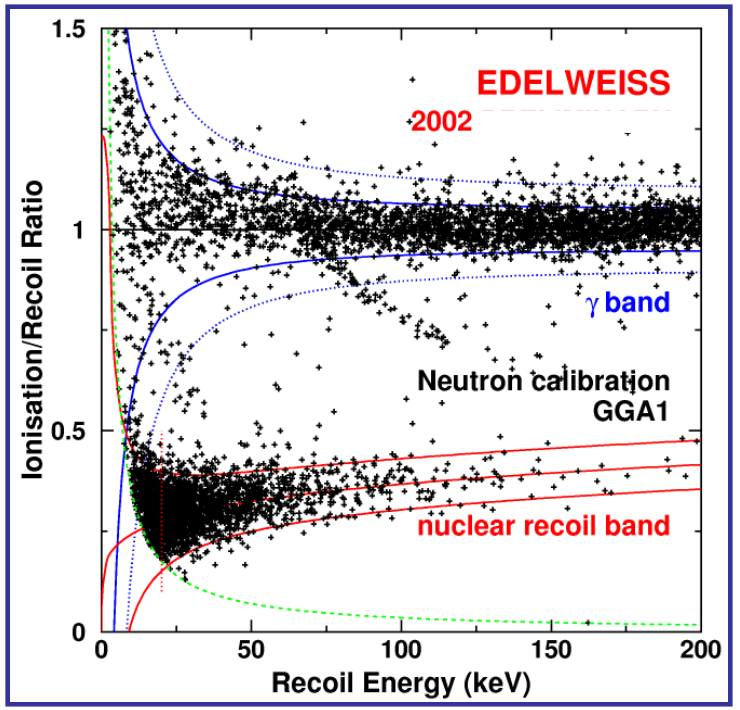




Shielding: 4800mwe rock; 20cm lead; 50cm polyethylene

Edelweiss I – Detectors





Target:

Ge crystal

Phonon - signal:

NTD-Ge (~ 20 mK)

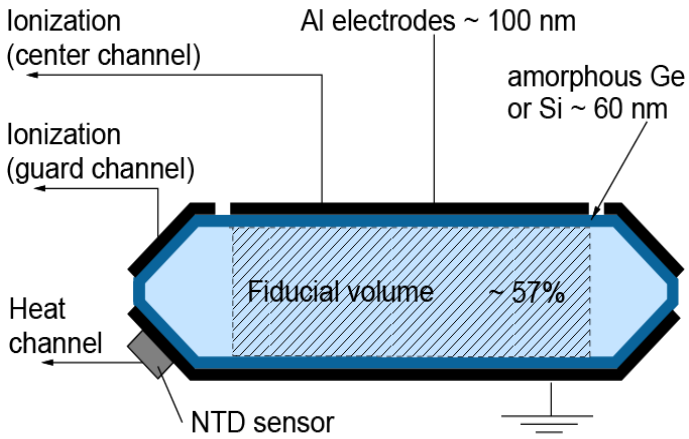
Ionisation - signal:

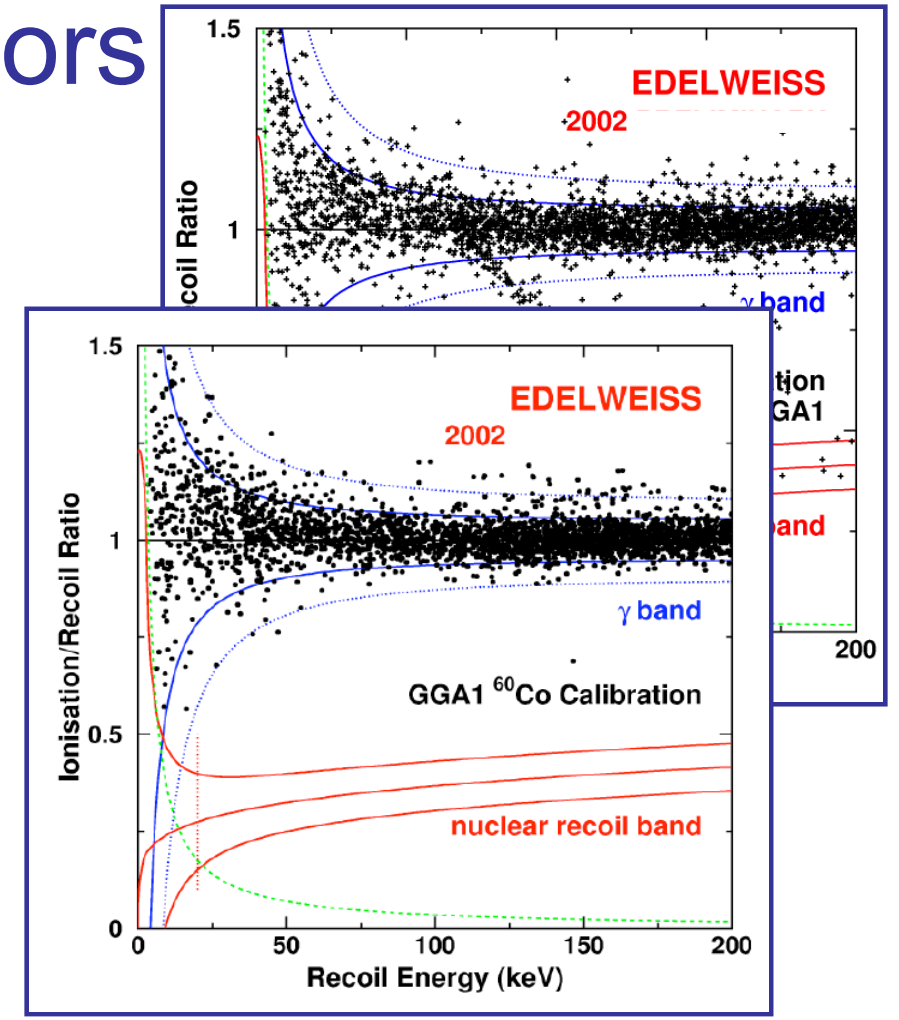
Inner disc / outer guard ring

few V/cm

- Event by event background discrimination
- Limitation: surface events

Edelweiss I – Detectors





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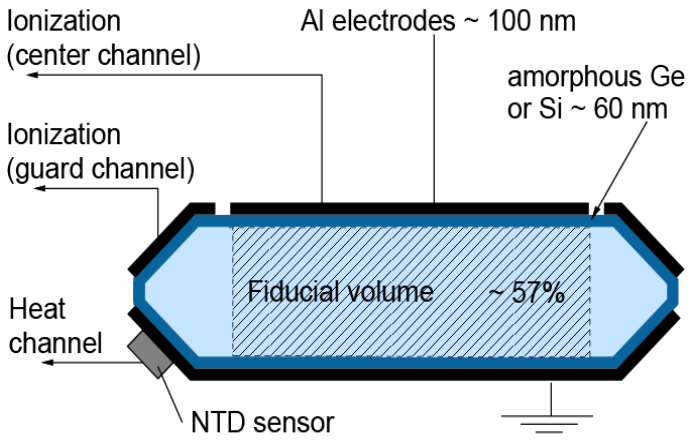

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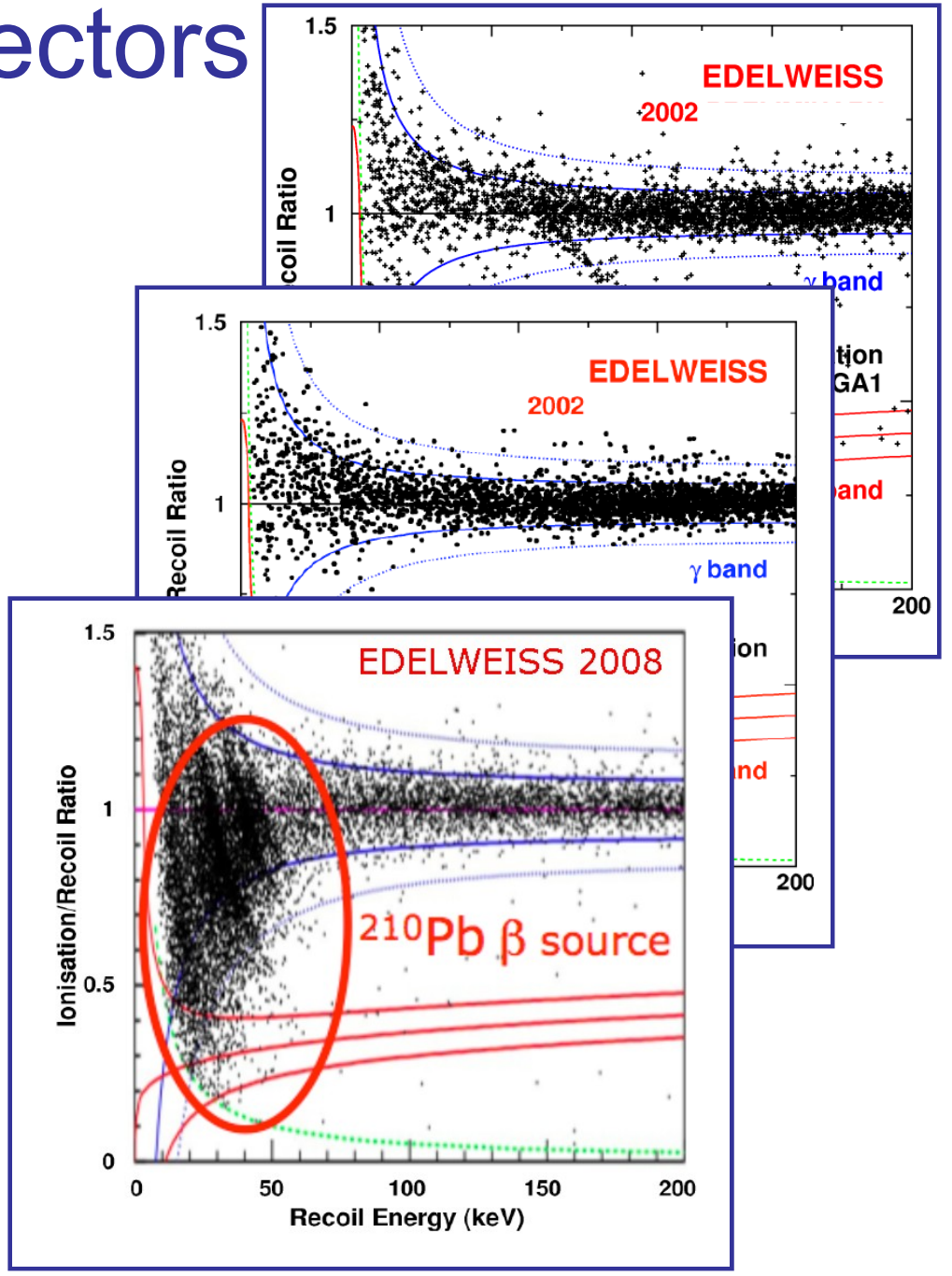
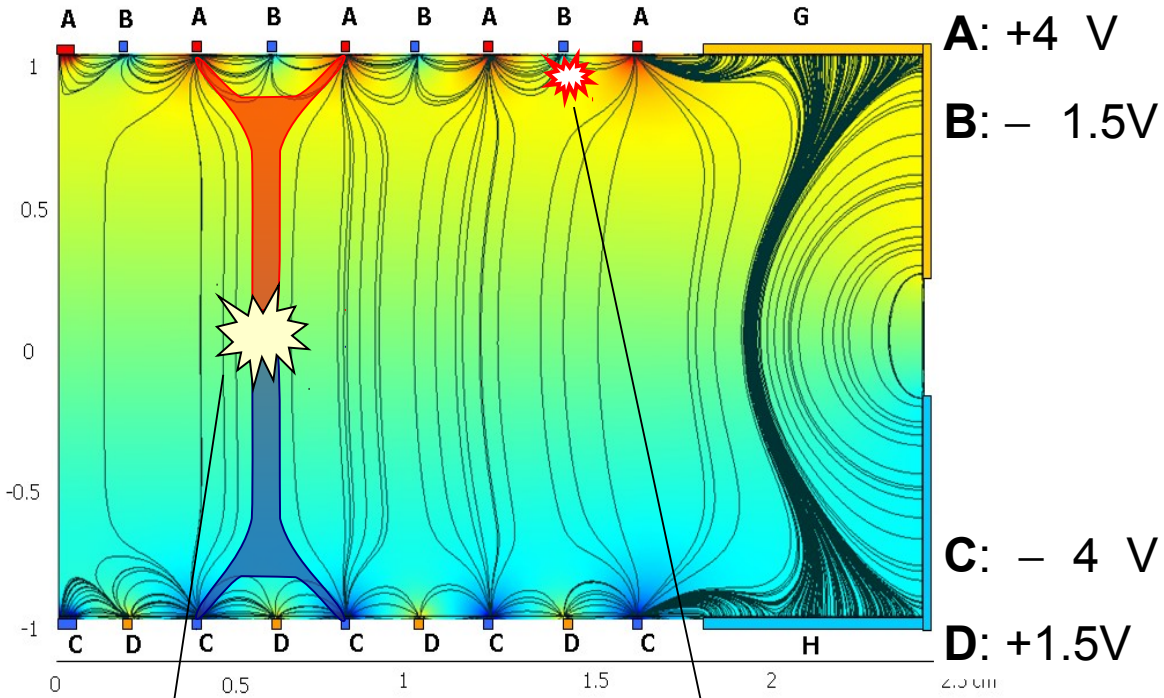


Edelweiss II InterDigit (ID) detectors

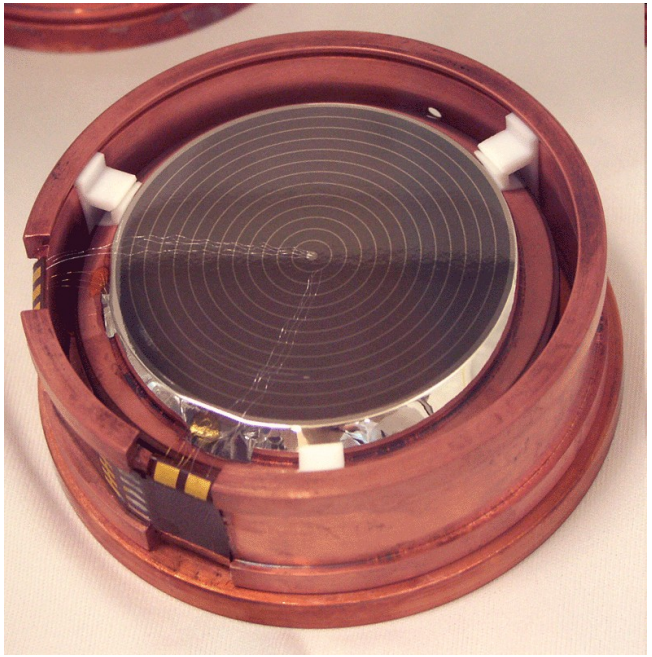


A: +4 V

B: – 1.5V

C: – 4 V

D: +1.5V



Surface event (β) rejection: 10^5

Surface events:
charge on veto electrodes
(A & C + guard rings)

Bulk events:
charge only on fiducial electrodes (B&D)

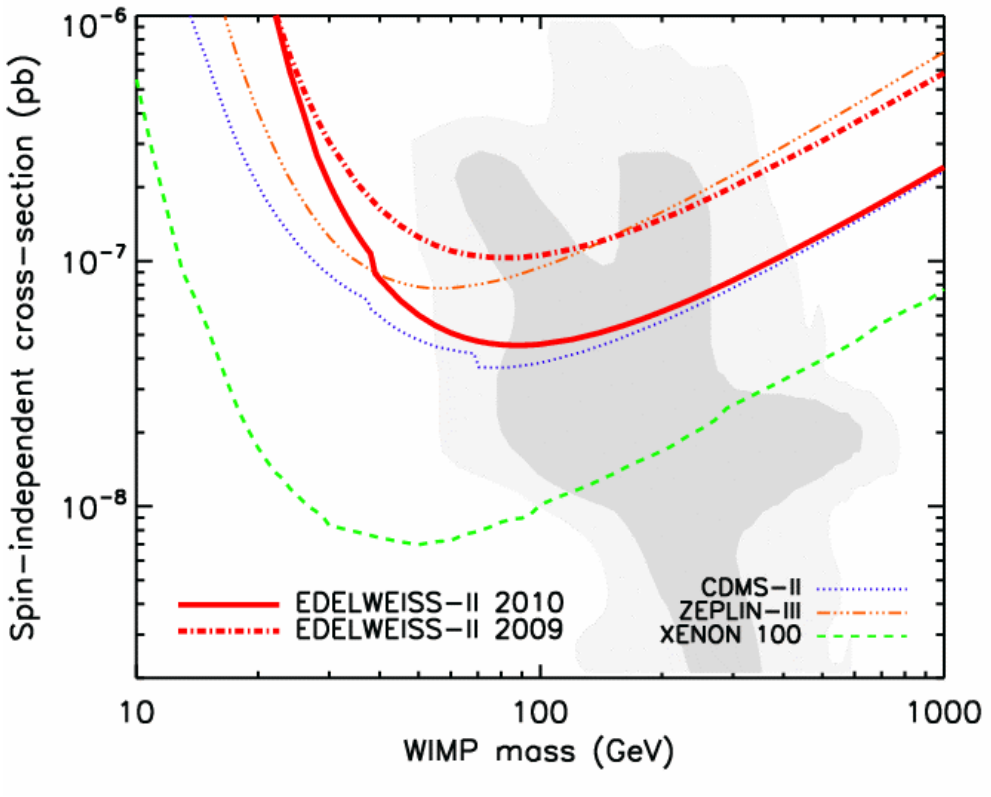
A. Broniatowski et al ***Phys Lett B 681 (2009) 305*** *[arXiv:0905.0753]*

Edelweiss II Results

Preliminary result: Physics Letters B 687 (2010) 294-298

Final result: Submitted to Physics Letters B. **arXiv:1103.4070v2**

- Run April 2009 - May 2010
  14 months of continuous operation@20mK
  85% duty cycle
- Ten 400g ID Ge detectors, 384kg day
- 4.4× 10^{-8}pb excluded for 85GeV WIMP
- Five nuclear recoil events (above 20keV analysis threshold)
- Background estimate: 3.0 events



[CDMS December 2009 result: 3.8× 10^{-8}pb, 2 nuclear recoil events]

Edelweiss II Background estimate

- Gamma background:
  - Total $1.8\times\ 10^4$ events in electron recoil band (20-200keV)
  - Assuming gaussian statistics, no nuclear recoil candidate due to statistical fluctuation expected
  - Non gaussianities ? Systematics ? => estimation by calibration data

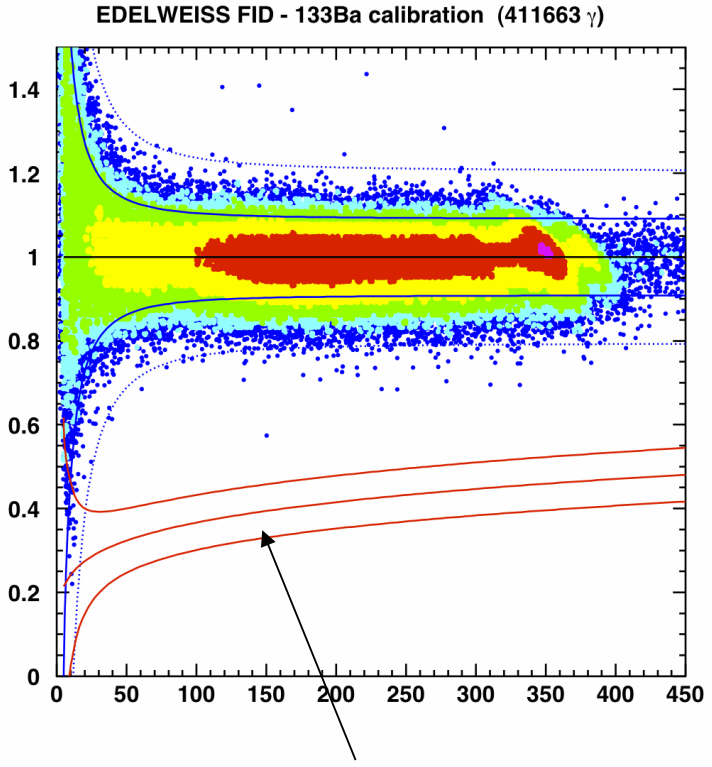
  ^{133}Ba gamma calibrations $\rightarrow$ $3\times\ 10^{-5}$ leakage into nuclear recoil band

  $\rightarrow$ **<0.9 events**
- Surface events – 5000 events, rejection factor $6\times\ 10^{-5}$
  $\rightarrow$ **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 cabling inside cryostat $\rightarrow$ **1.1 events**

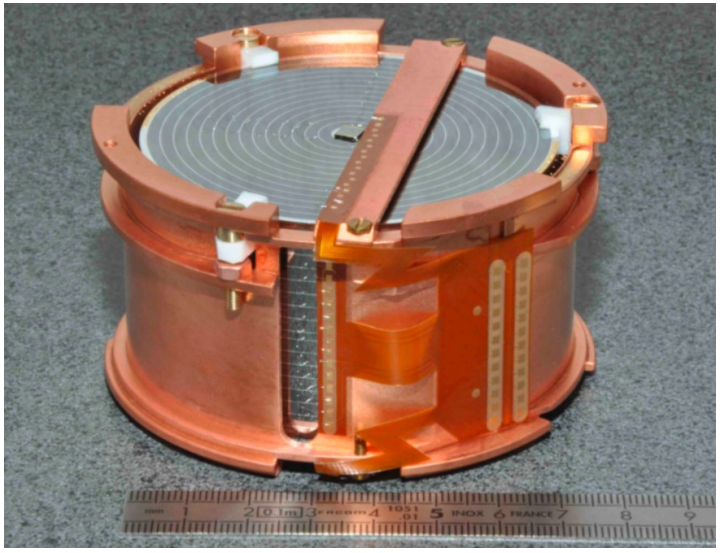
Total background estimate < 3.0 events 90% CL

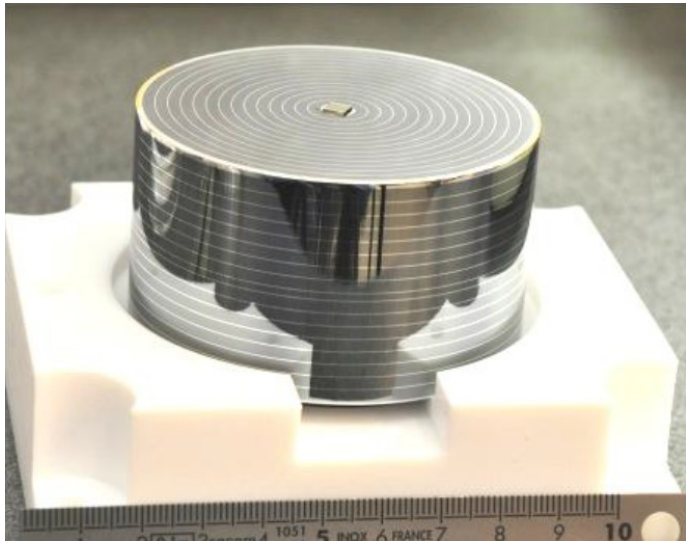
Edelweiss future plans

- FID800 detectors
  800g crystals,
  fiducial mass >600g
- 4 FID800, 2 FID400 installed for commissioning run July 2010 – January 2011
- Next goal: Edelweiss-III: Array of 40 FID800 $\rightarrow$ 5$\times$ 10^{-9}pb



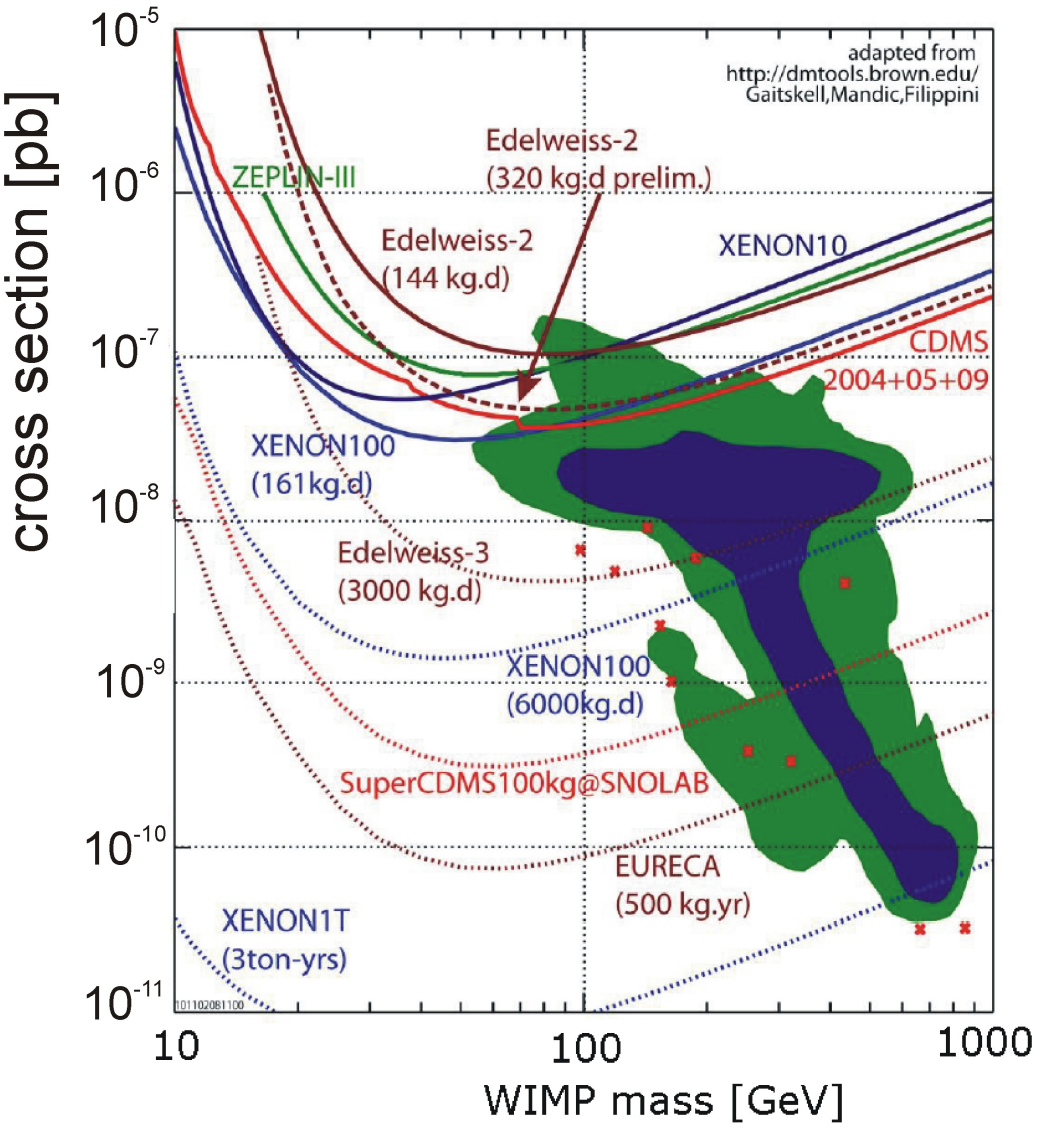
No events in nuclear recoil band





European Underground Rare Event Calorimeter Array

- Dark matter experiment, to search for WIMP interactions to $\sigma \sim 10^{-10}$pb (~1 event/tonne/year)
- CRESST and EDELWEISS, and additional groups
- Cryogenic (<100mK) calorimeters
- Multiple target materials: Ge, $CaWO_4$, $ZnWO_4$….
- Mass: above 100 kg towards 1 tonne



Timeline:

2010/2011: Design Study → TDR

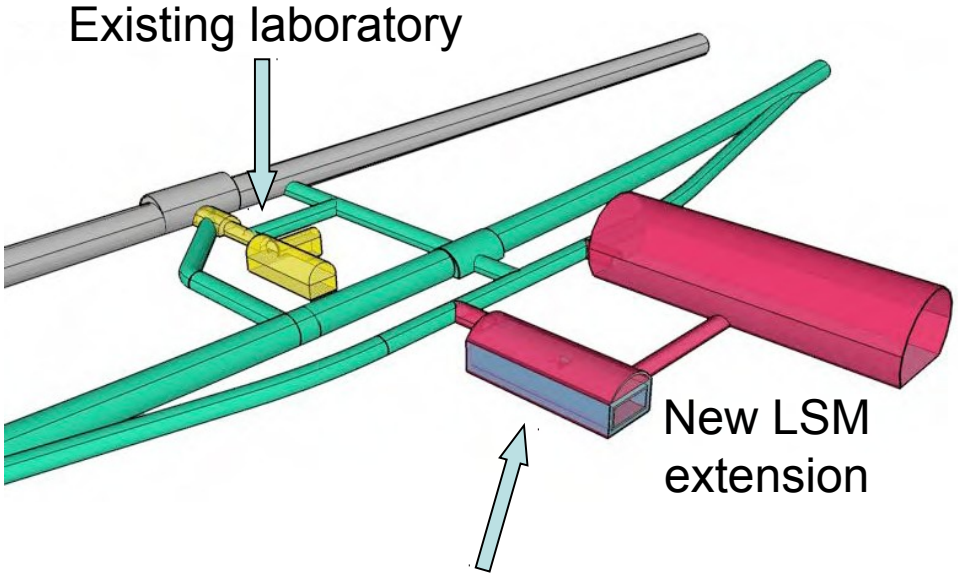
2011/12: Digging out of LSM extension begins. In parallel, begin construction of EURECA components away from LSM. Aim for ~100kg stage (10^{-9} pb).

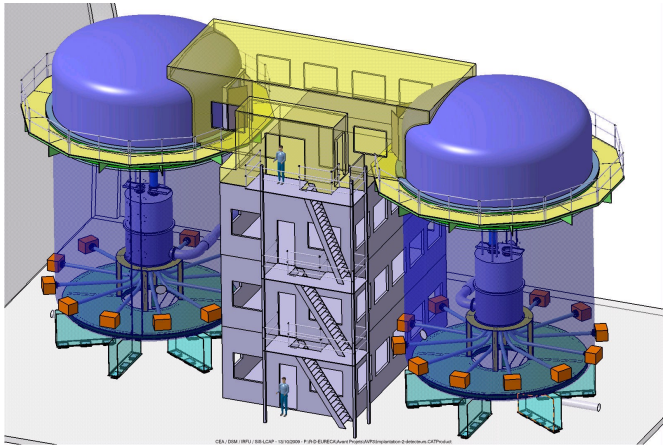
2014: LSM extension ready to receive EURECA.

2015: Begin data taking and in parallel improve and upgrade.

2018: One tonne target installed.

Spokesman: Hans Kraus (2005-2010), since January 2011: Gilles Gerbier





Possible EURECA Facility Layout

Summary

- Edelweiss-II: Direct WIMP search with cryogenic germanium detectors
- Interleaved electrodes allow surface event rejection
- Ten 400g Ge-ID detectors – 384 kg day
- $4.4\times\ 10^{-8}$pb excluded for 85GeV WIMP
- Nuclear recoils: 5.
- Expected background: 3. (gamma, beta leakage, neutrons from cosmic muons, radioactivity)
- …Edelweiss-III ($5\times\ 10^{-9}$pb)….EURECA (10^{-10}pb)