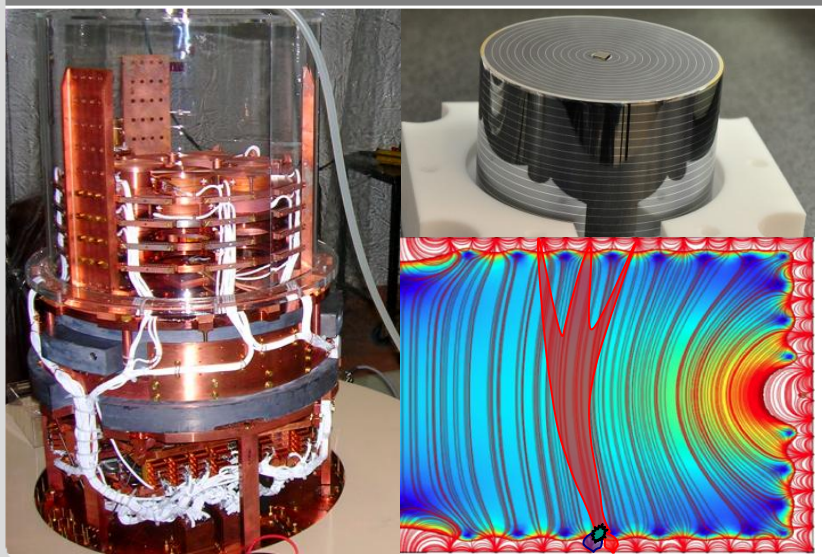
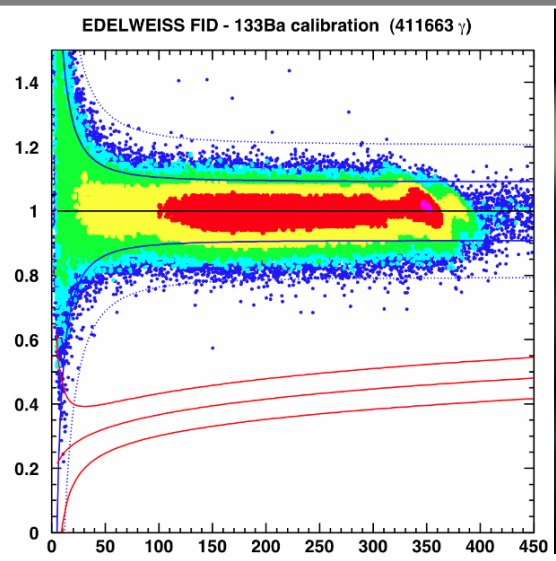
The EDELWEISS DM search: Recent results and outlook for 2013

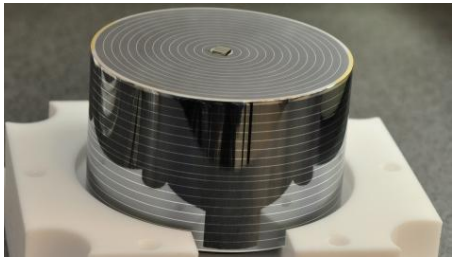
Benjamin Schmidt, KIT Campus North, EDELWEISS experiment,
Rencontres de Physique de la Vallée d'Aoste, Feb 2013



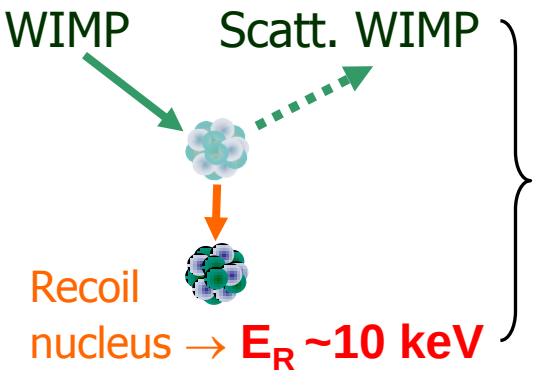


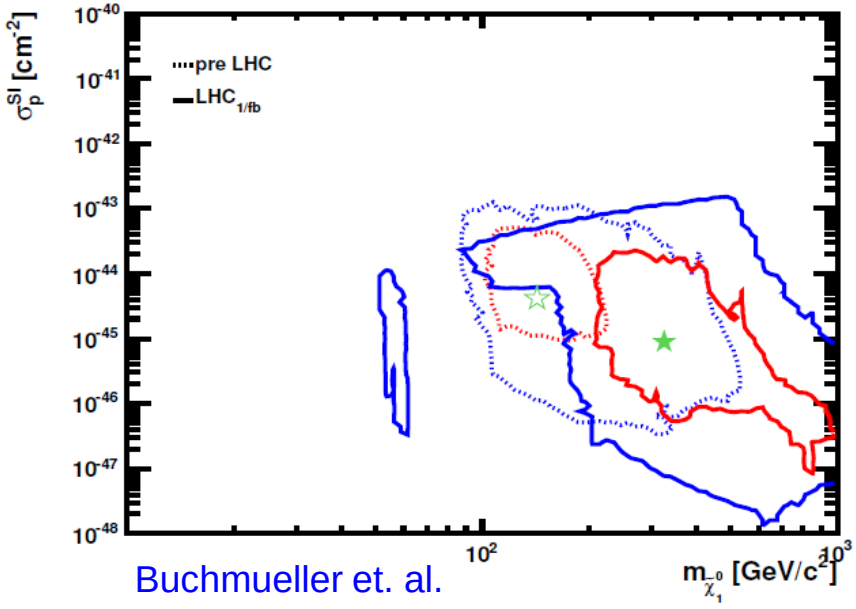
Direct Dark Matter search

- Evidence for dark matter: galaxy rotation curves, clusters, CMB, nucleosynthesis, bullet cluster
- Candidates: WIMPs – supersymmetric neutralinos, KK particles, technibaryons…
- Search for elastic scattering
  - **~10 keV nuclear recoil**
  - **< 1 event/kg/year**
  - **Need excellent background suppression**



- Cryogenic germanium phonon-ionization detectors

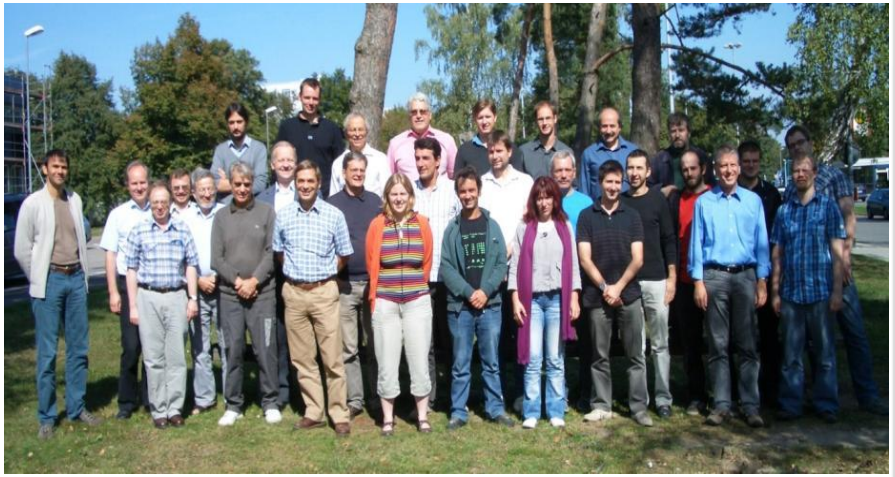


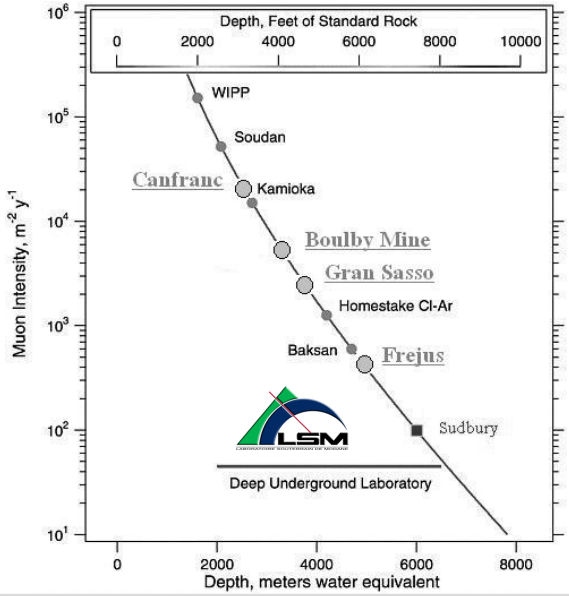


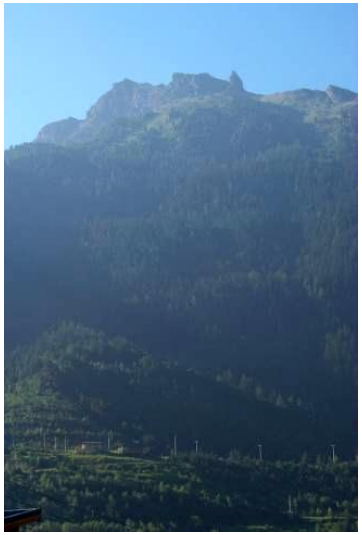
Buchmueller et. al.
Eur. Phys. J. C (2012) 72:1878

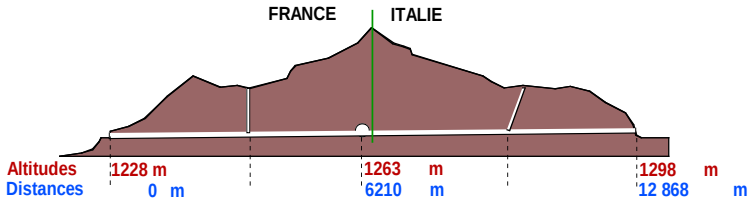
The EDELWEISS Collaboration

- CEA Saclay (IRFU and IRAMIS)
- CSNSM Orsay (CNRS/IN2P3 + Paris Sud)
- IPNLyon (CNRS/IN2P3 + Univ. Lyon 1)
- Néel Grenoble (CNRS/INP)
- Karlsruhe Inst. of Technology (IK, EKP, IPE)
- JINR Dubna
- Oxford University
- University of Sheffield



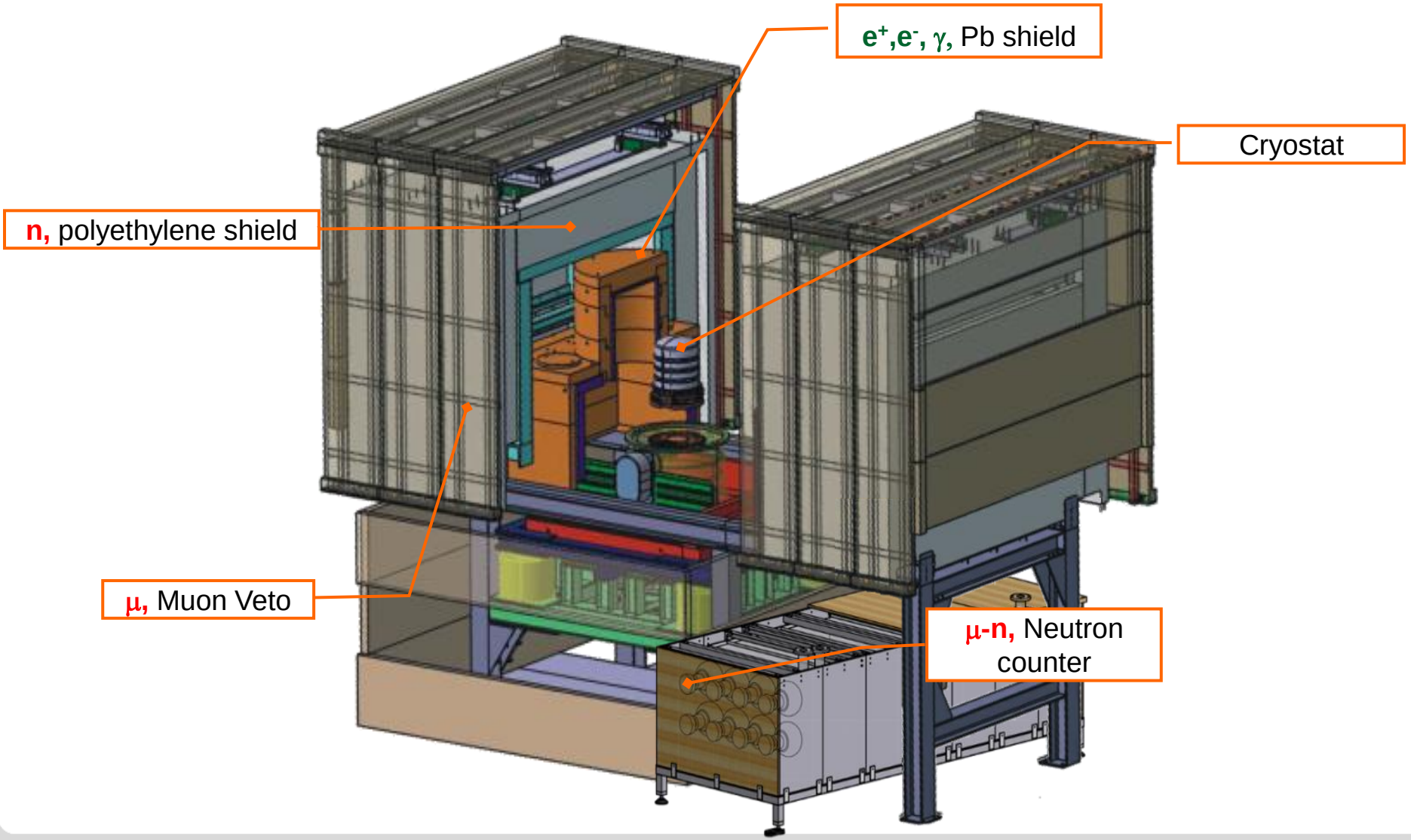






- Experimental site: *Laboratoire Souterrain de Modane (LSM)* in Fréjus Tunnel
- 4800 mwe depth: ~5 muon/day/m^2
- 10^{-6} neutrons/cm^2/s (>1MeV)
- Deradonized air supply
  (~10 Bq -> ~30 mBq)

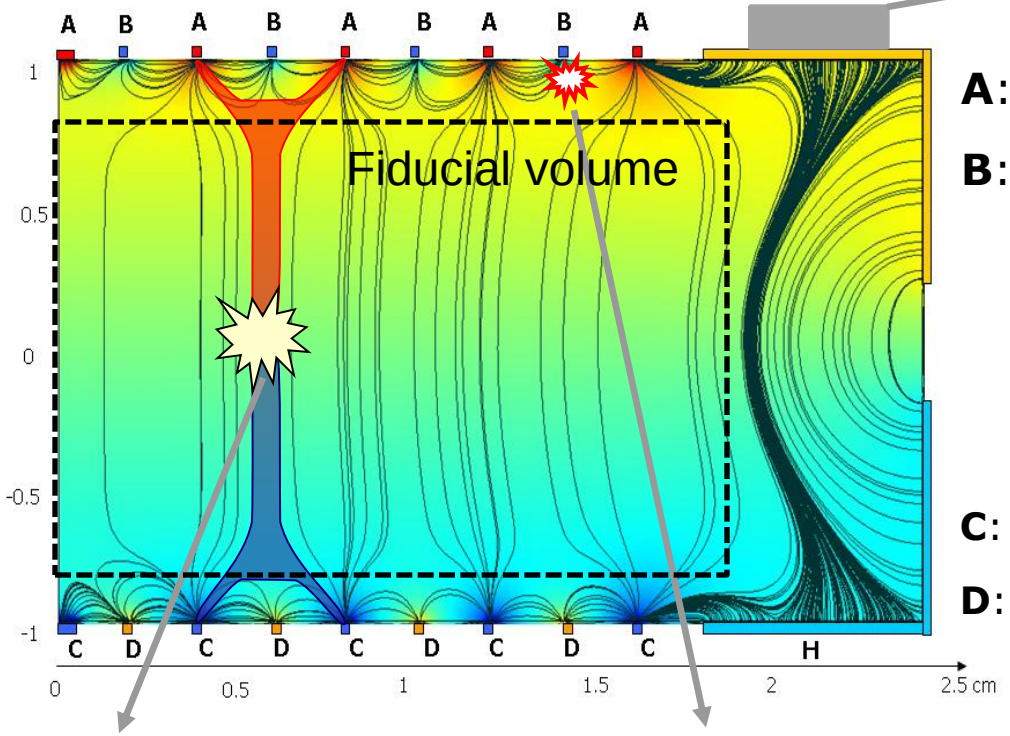
Background suppression in EDELWEISS



Nuclear recoil event discrimination & Surface event rejection- principle

Event discrimination via simultaneous charge and phonon measurement

Al electrodes ~100 nm



A: +4 V

B: –1.5V

C: –4 V

D: +1.5V

Bulk/Fiducial event
Charge collected on electrodes A&C

Surface event
Charge collected on electrodes A&B

NTD Phonon/Heat sensor
= calorimetric measurement of total energy (T=18 mK, $\Delta T \sim 0.1\ \mu K/keV$)

Al electrodes
Ionization measurement
(sub-keV resolution)

Ionization yield
$Q = E_I/E_{Rec}$ nuclear recoils have ~1/3 Q of e-recoils

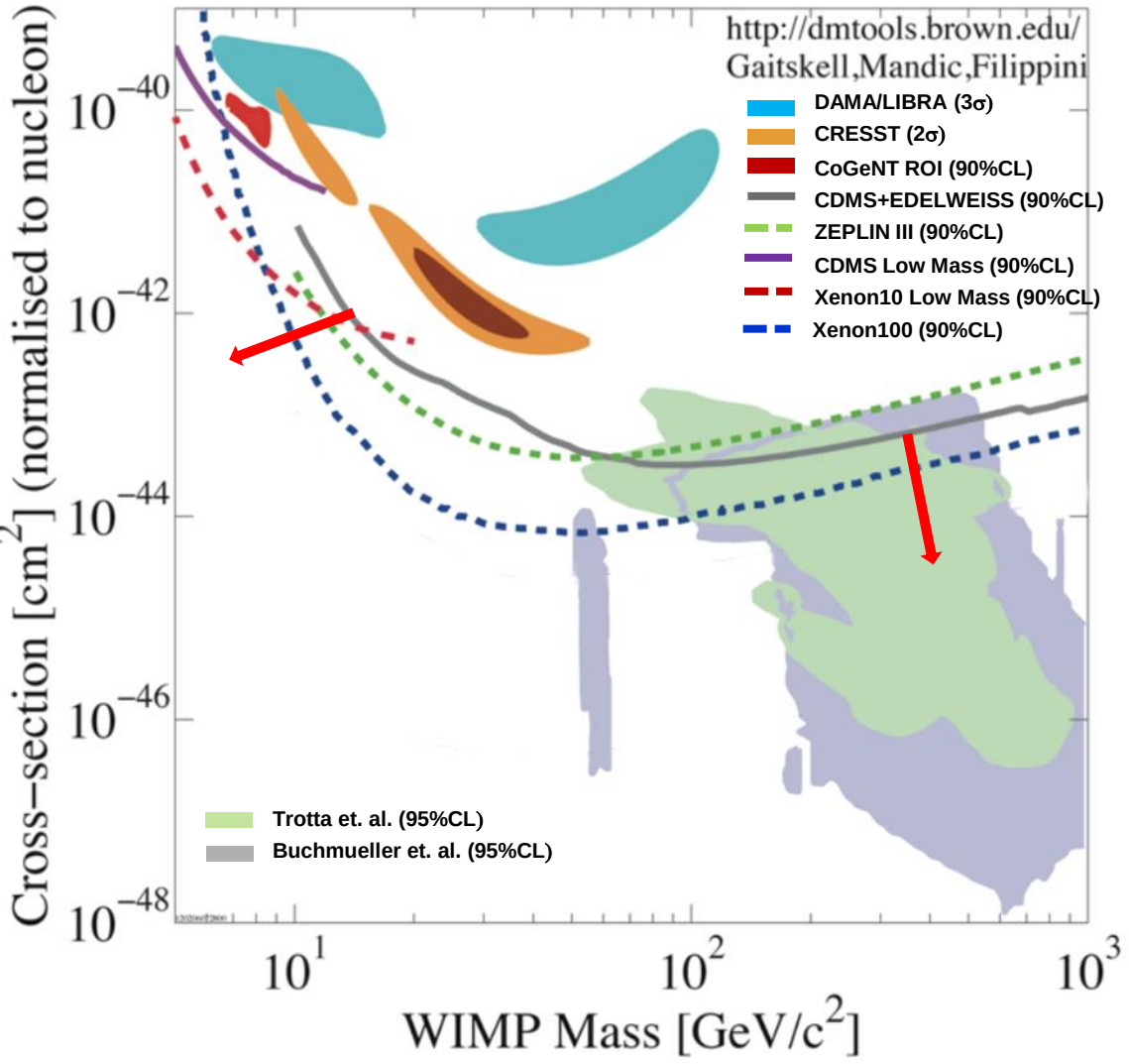
Results EDELWEISS-II

EDELWEISS-II: important progress with cryogenic Ge detectors

- One year of WIMP search
- 4.4x10^{-8} pb (90%CL) sensitivity achieved at 85 GeV/c^2
- Data combined with CDMS
- Backgrounds start to appear

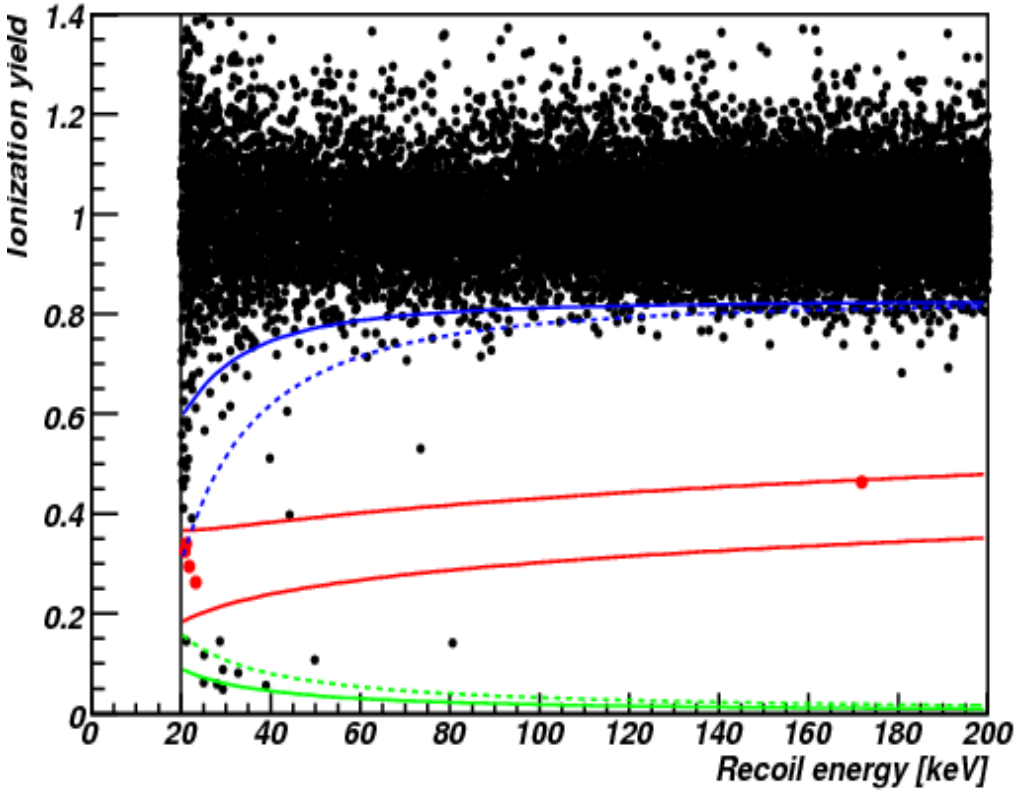
EDELWEISS 2011:
PLB, 702(5), 329-335

CDMS & EDELWEISS 2011:
PRD, 84(1), 1-5

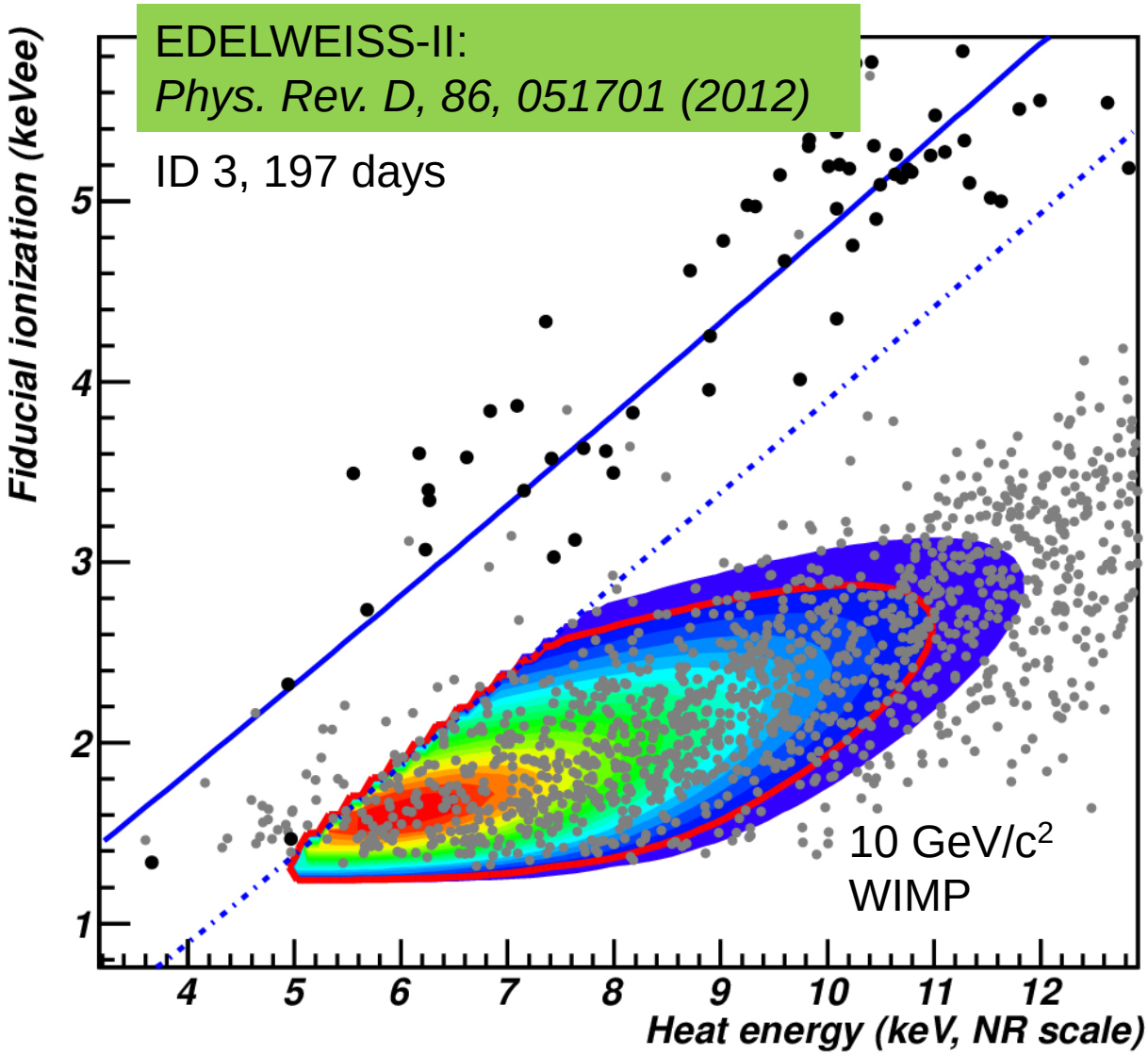


Lessons learned from EDELWEISS-II (384 kgd)

- Further remove background (3 events in Edw-II)
  - ≤ 1.2 γ rejection
  - ≤ 1.8 neutrons
- Lower analysis threshold
  - Edw-II: semi-blind CDM analysis for O(100 GeV/c^2) WIMP mass
- Increase total and fiducial mass



EDELWEISS-II
Low WIMPmass analysis results

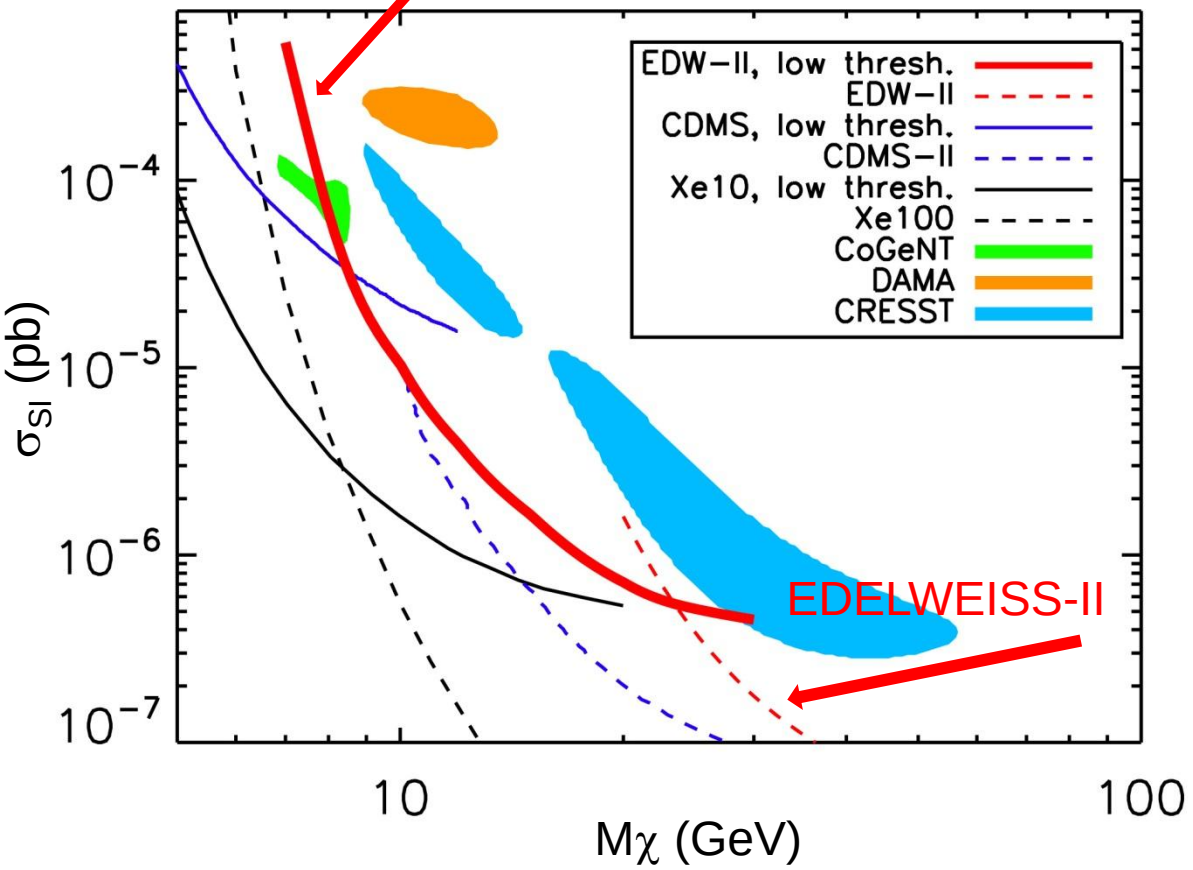


EDELWEISS-II
Low WIMPmass analysis results

- Low energy analysis of 2009-2010 data (4 ID detectors)

- 4/10 ID detectors (~113 kg d)
- 1.4 – 1.9 keV Ionization threshold
- 95% C.L. gamma cut
- Background expect.: γ + ion. threshold + n: 2.9 evts / 1 observed

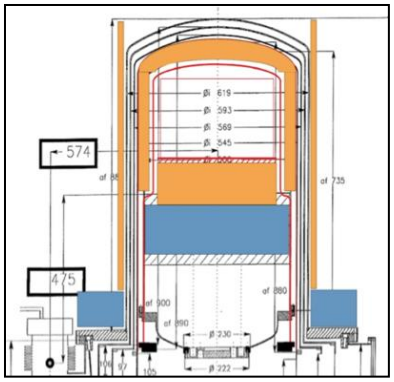
EDELWEISS-II: *Phys. Rev. D, 86, 051701,* (2012)

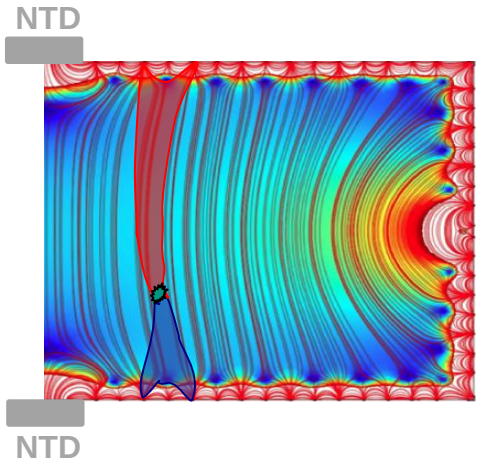


Potential for significant progress in EDELWEISS-3

Upgrades in EDELWEISS-3

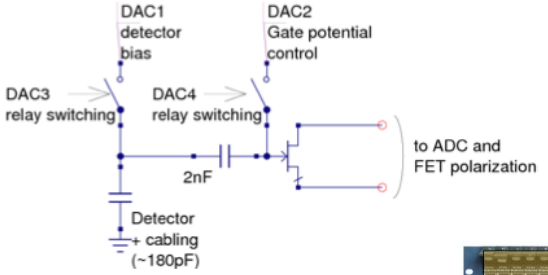
1. Suppression of n-background





2. Improvement of γ discrimination

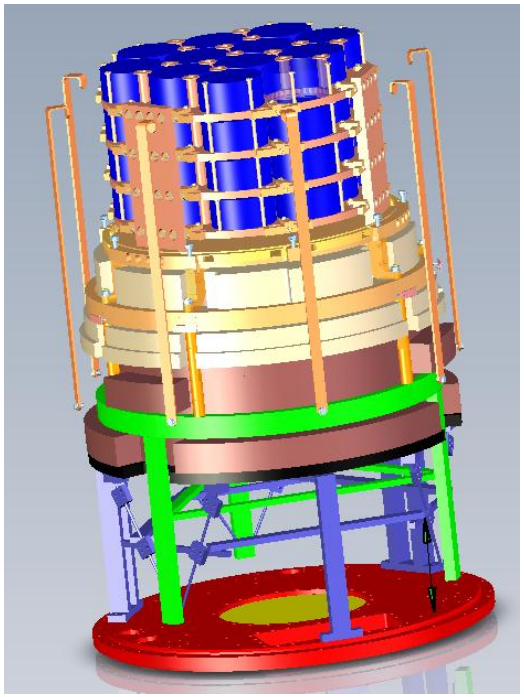
3. Lowering resolutions and thresholds

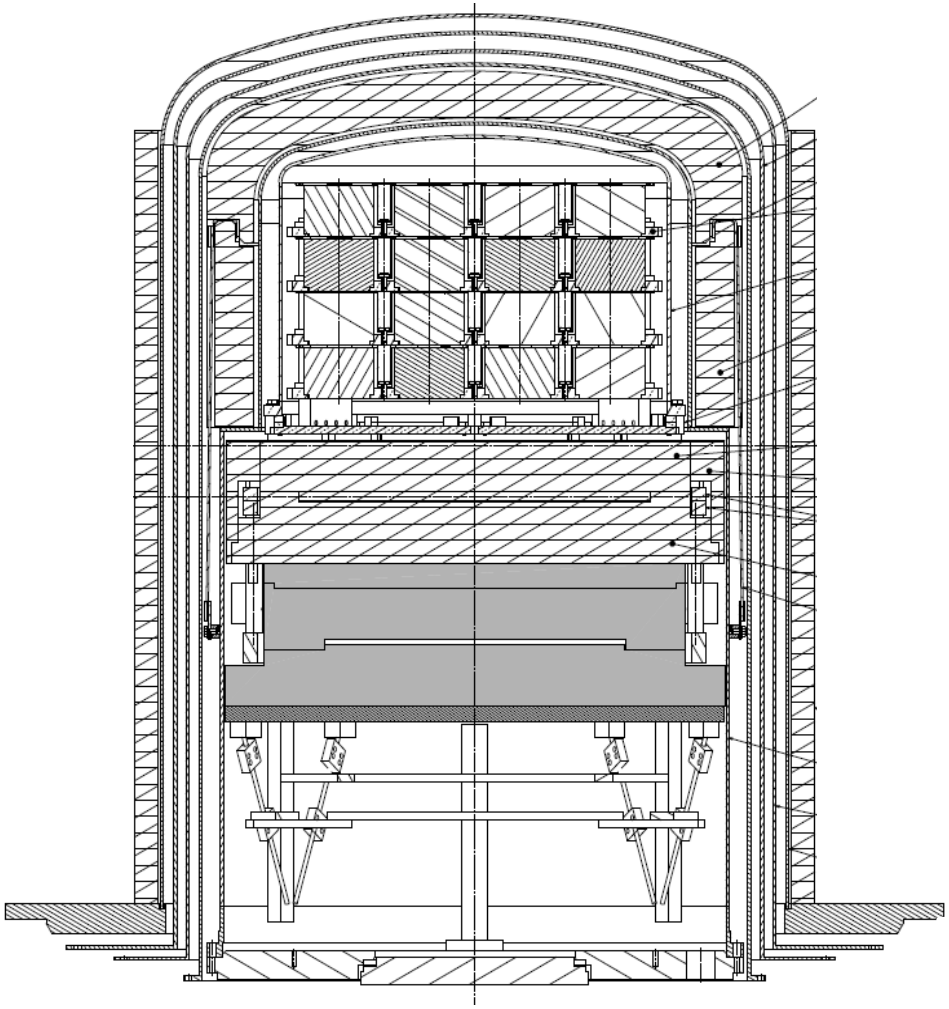


4. Enable upscaling towards 1ton-scale exp.

Upgrades towards EDELWEISS-3
1. Suppression of n background

- Additional cold PE shield
- New Kapton cabling
- Better radiopure connectors
- Redesign of copper shields

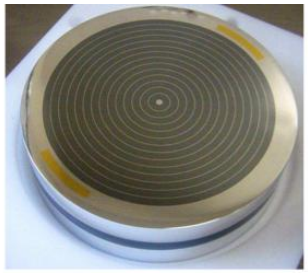


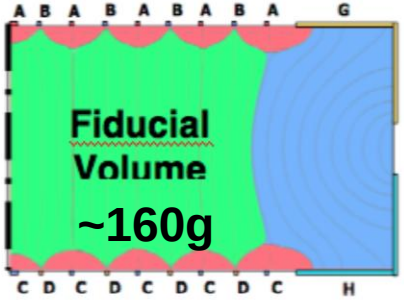


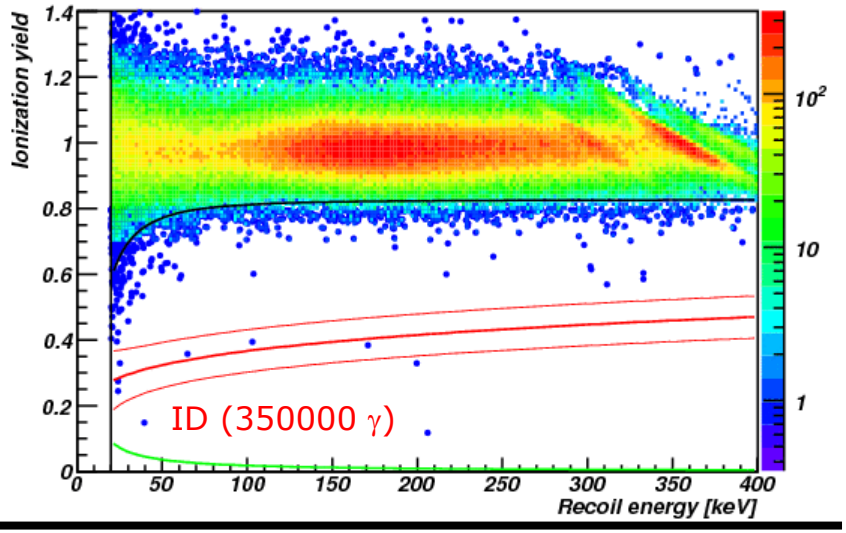
x10 better neutron suppression

2. Improvement of γ discrimination

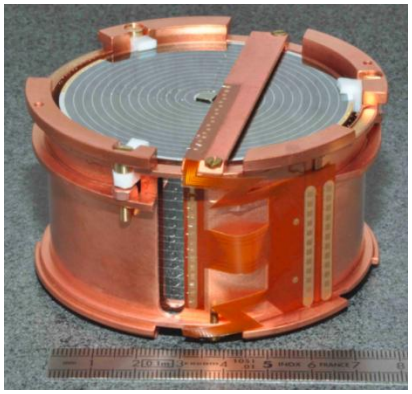
EDELWEISS-II
ID 400g with ~**160g** fiducial mass

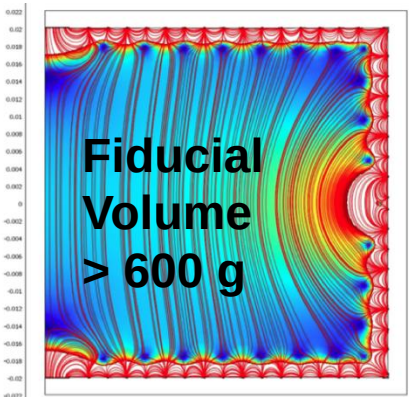


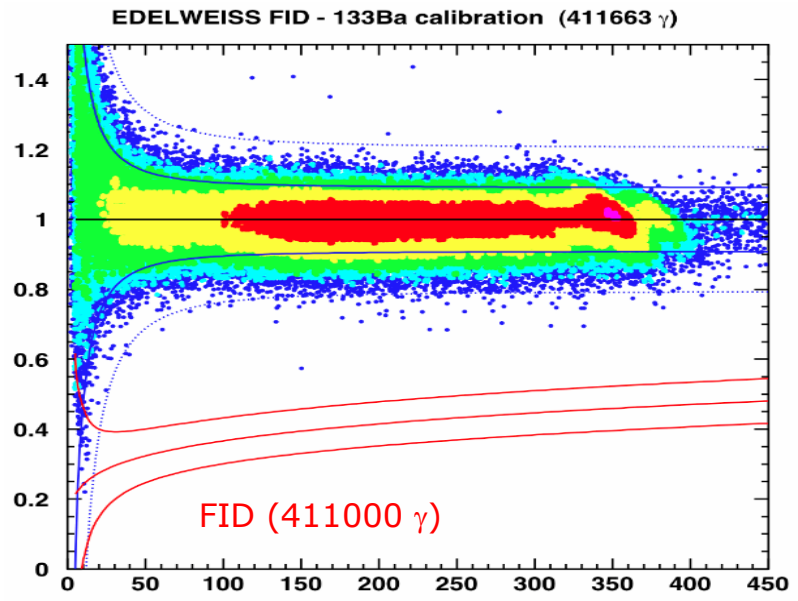




EDELWEISS-III
FID 800g with ~**600g** fiducial mass



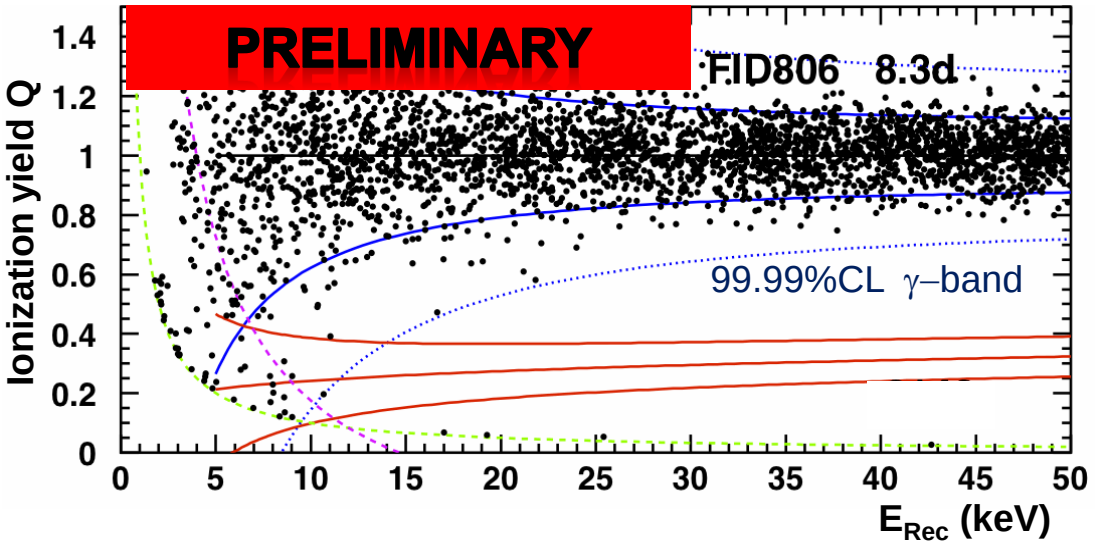




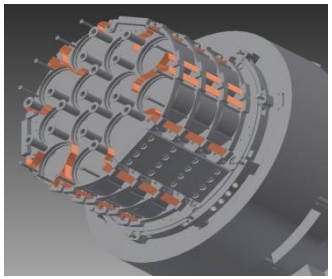
3./4. Improvement of resolutions and thresholds

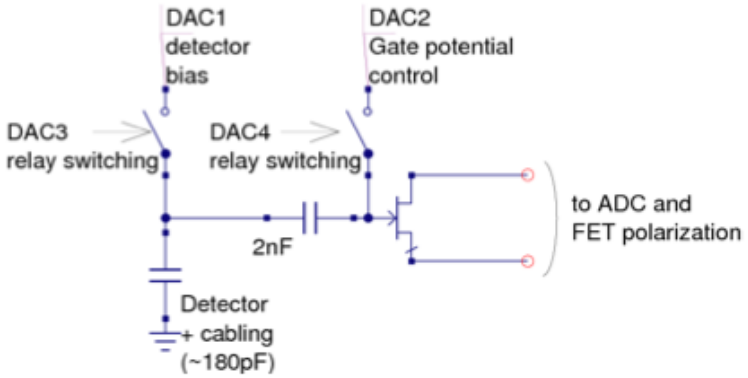
- Resolution improvement aimed at > 30%

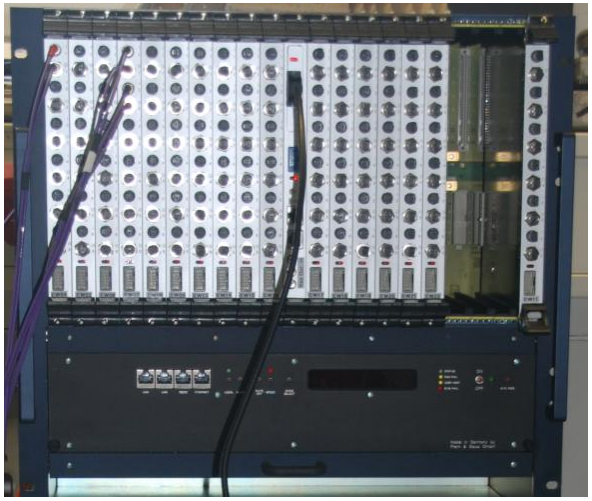
  yields sensitivity < 5 keV, full sensitivity at ~ 10 keV



- New cables, electronics and integrated DAQ system







Timeline/Projection EDELWEISS-III

- End of February (now)
  - **First EDELWEISS-III commissioning run**
  - Upgraded cryogenics
  - ~15 FID 800 g detectors largest cryogenic mass of heat+ion Ge detectors
  - Upgraded readout electronics + Kapton cables
  - Inner PE shield (partially) + new Cu screens
- Summer 2013
  - Fully equipped cryostat ~40 FID 800g detectors
  - Time resolved ionization readout (40 MS/s)