

# European Underground Rare Event Calorimeter Array



Hans Kraus

IDM2010, 30<sup>th</sup> July 2010



# The EURECA Collaboration

## France



CEA/IRFU Saclay  
CEA/IRAMIS Saclay  
CNRS/Neel Grenoble  
CNRS/CSNSM Orsay  
CNRS/IPNL Lyon  
CNRS/IAS Orsay  
CNRS/ICMCB Bordeaux

## United Kingdom



Oxford  
Sheffield

## Germany



MPI für Physik, Munich  
Technische Universität München  
Universität Tübingen  
Karlsruhe Institute of Technology

## Spain



Zaragoza

## Ukraine



Kiev

## International

JINR Dubna

Around 115 members (65 FTE) currently on Edelweiss, Cresst, Rosebud and others



**I:** Infrastructure

**C:** Cryogenics

**E:** Electronics

**D:** Detectors

**L:** Low-background

Balanced  
expertise  
through  
**~115 people**  
contributing  
**~65 FTE**

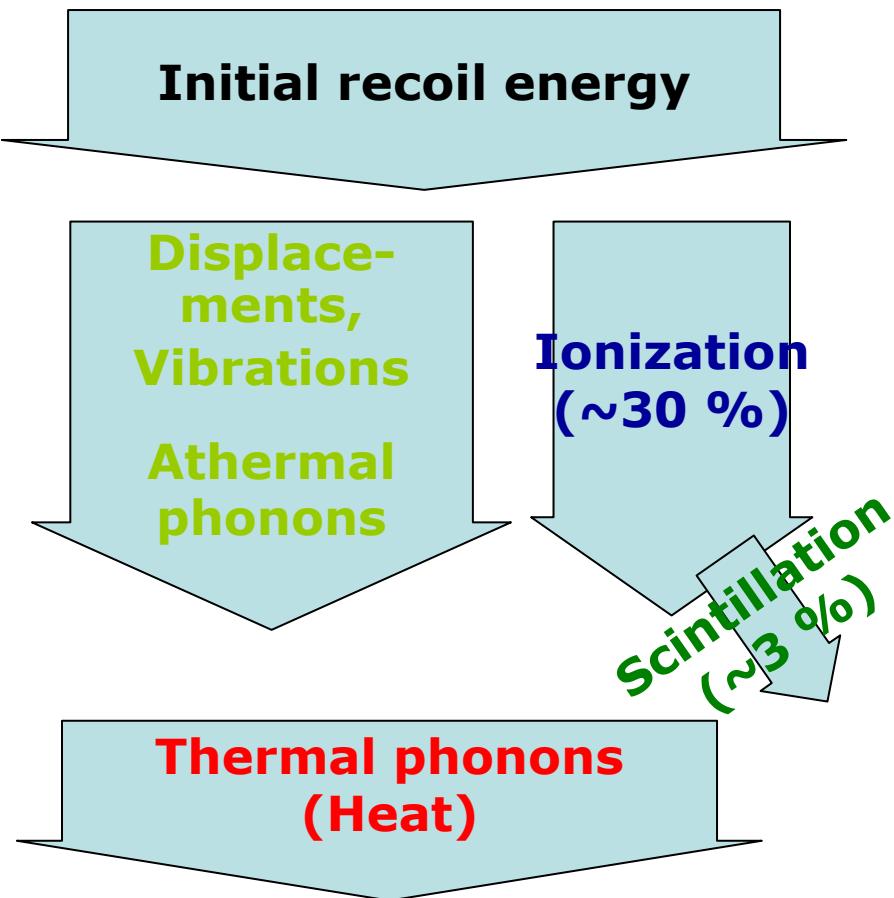
# Teams with Proven Expertise

Team	I	C	E	D	L
Max-Planck-Institut für Physik Munich		X		X	X
Technische Universität München	X			X	
Eberhard Karls Universität Tübingen	X		X		X
University of Oxford		X	X	X	
Karlsruhe Institute of Technology	X	X			
CEA/IRFU Saclay	X		X	X	
CEA/IRAMIS Saclay		X	X	X	
CNRS/IN2P3/CSNSM Orsay				X	X
CNRS/IN2P3/IPNL Lyon			X		X
CNRS/INSUE/IAS				X	X
CNRS/Neel Grenoble		X	X		
CNRS/CEA LSM	X				X
JINR/DLNP Dubna				X	X
Sheffield University	X				X
INR Kiev				X	X
CNRS/ICMcb	X	X			
CNRS/IAS Orsay				X	X
Universidad de Zaragoza	X				X



# Cryogenic Techniques

Combination of phonon measurement with measurement of ionization or scintillation



**Phonon:** most precise total energy measurement

**Ionization / Scintillation:** yield depends on recoiling particle

Nuclear / electron recoil discrimination.



# Work Packages and Global Fit

Memorandum of Understanding  
signed between EURECA,  
SuperCDMS, and GEODM:

On behalf of the  
EURECA collaboration

Hans Kraus  
EURECA Spokesperson

On behalf of the  
SuperCDMS collaboration

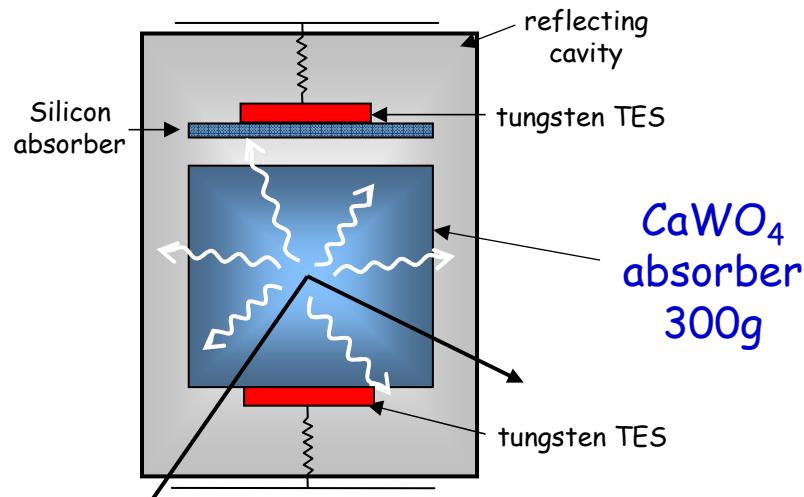
Blas Cabrera  
SuperCDMS Spokesperson

On behalf of the GEODM  
collaboration

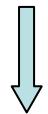
Sunil Golwala  
GEODM Spokesperson

Work package	EURECA	Super-CDMS	GEODM
Management	H Kraus	D Bauer	S Golwala
Infrastructure	G Gerbier	D Bauer	S Golwala
Cryogenics	A Benoit	D Bauer	S Golwala
Electronics	J Gascon	J Hall	B Sadoulet
Detectors	A Broniatowski / F v Feilitzsch	P Brink / N Mirabolfathi	P Brink / N Mirabolfathi
Low background	V Kudryavtsev / P Loaiza	P Cushman	P Cushman
Data Analysis	K Eitel	R Schnee	R Schnee

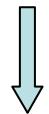
Maintain scientific independence, but collaborate  
where this is beneficial



## Phonon – Scintillation



**Energy scale:**  
**Excellent  
resolution**

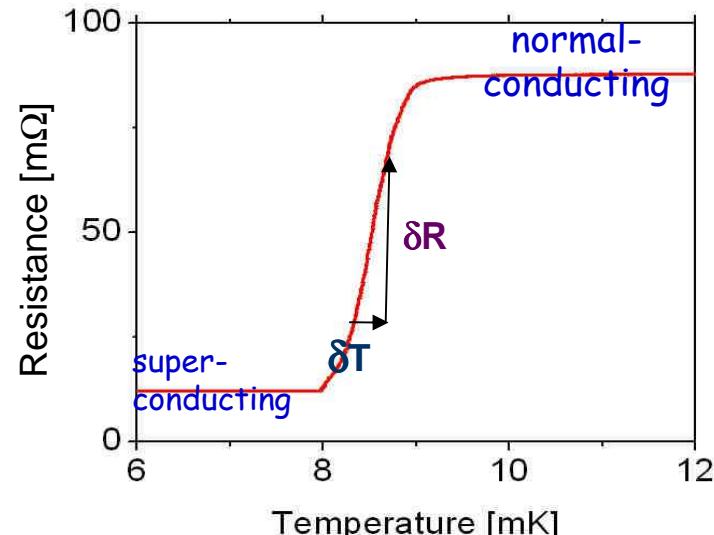


**Particle Identification:**  
**Background  
discrimination**

Range of Scintillator Targets

10 Detector Modules running

# CRESST Detectors



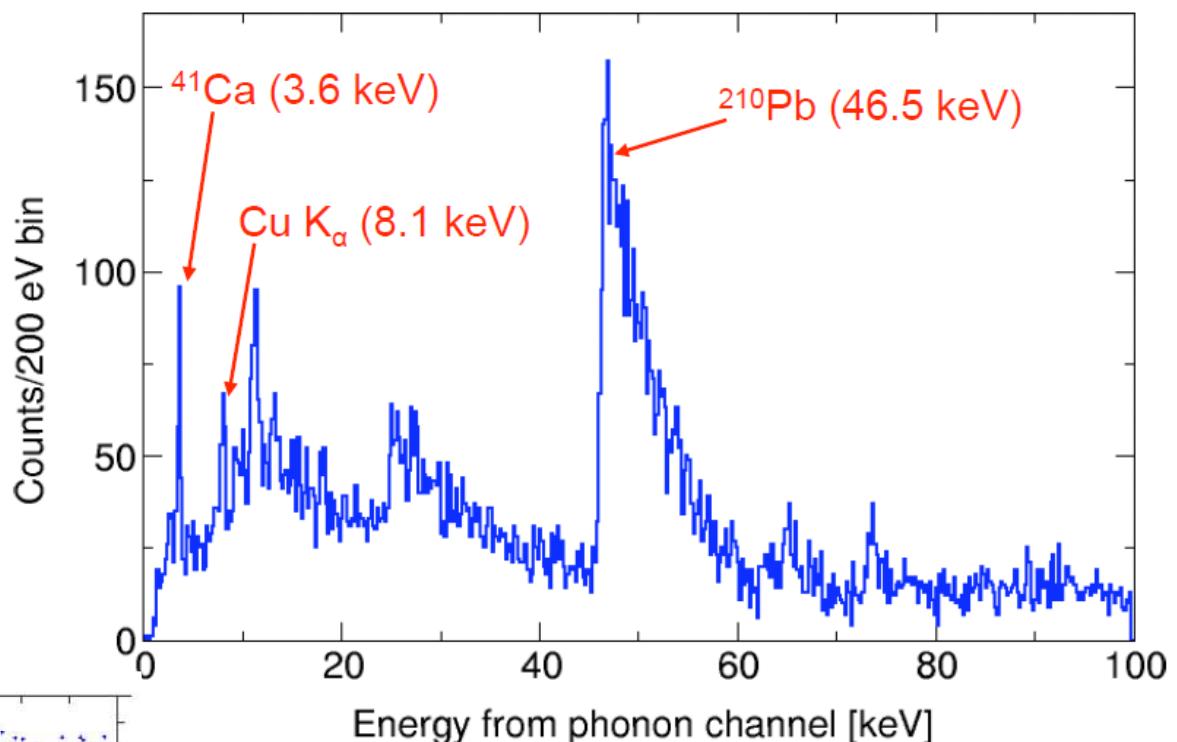
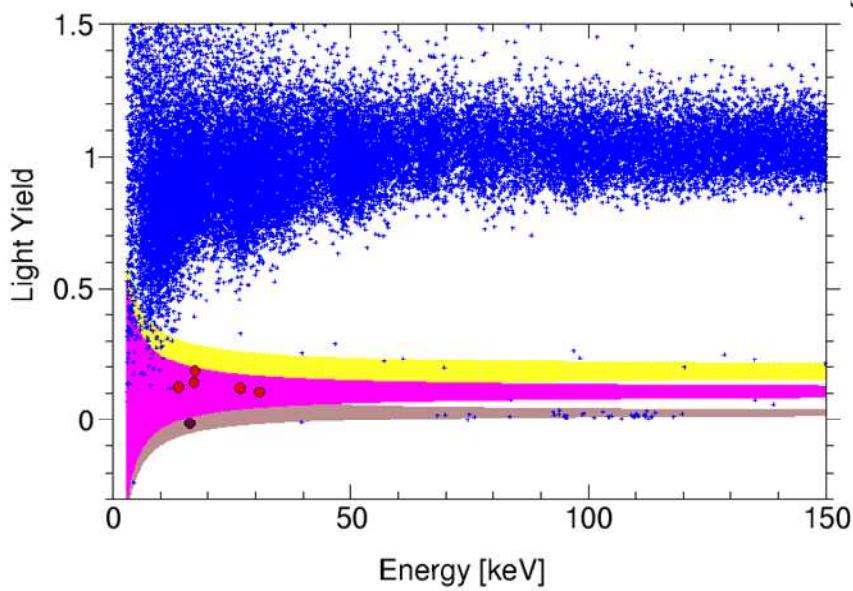


# CRESST Detector Capability

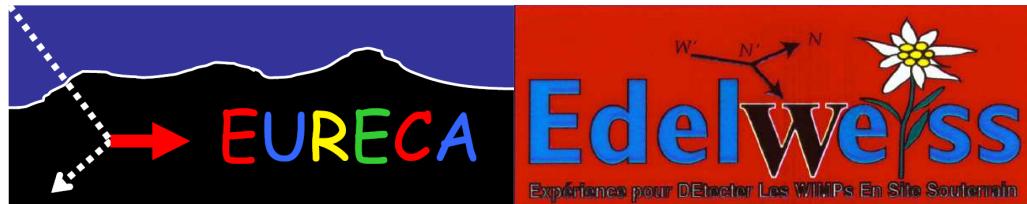
## Example of a Background Spectrum:

Resolution at low energy  
~ 300 eV (FWHM)

Threshold ~ 1 keV



Different target nuclei  
(in same environment)  
possible

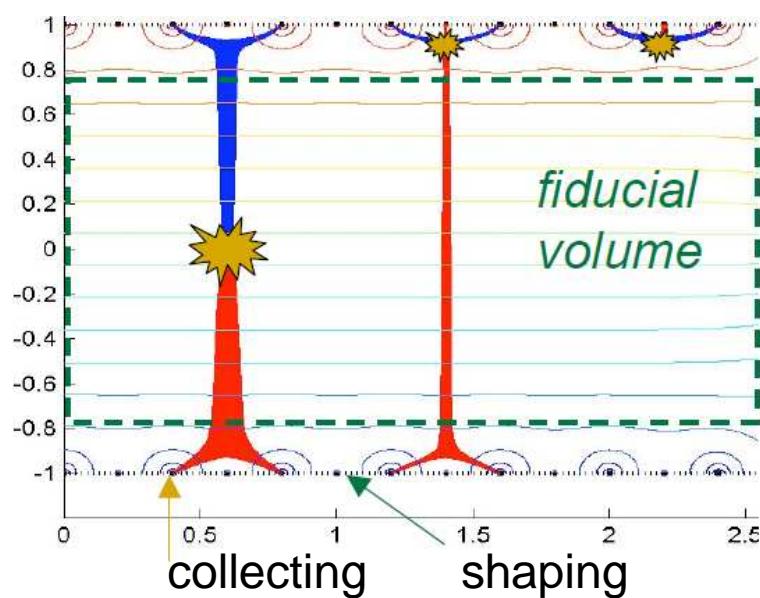


# Edelweiss Detectors

Phonon – Ionization

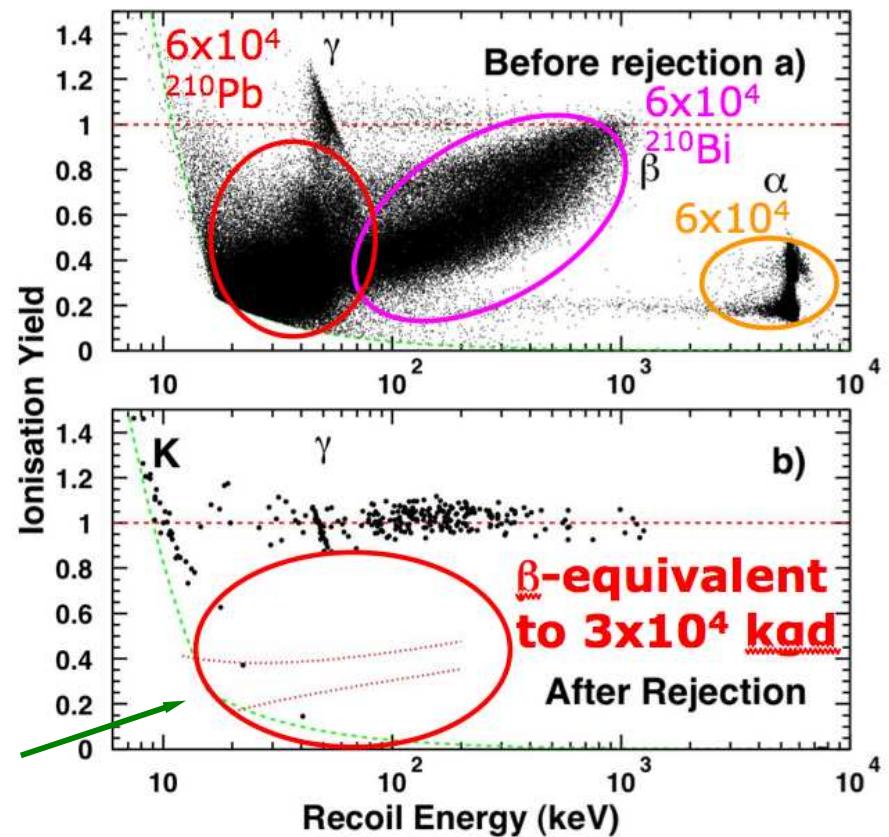
↓                    ↓

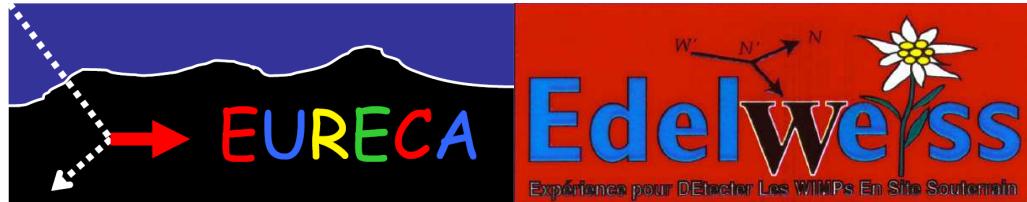
**Energy scale:**      **Particle Identification:**  
**Excellent**  
**resolution**              **Background**  
**discrimination**



1  $\beta$  event expected in 30,000 kg.d  
**equivalent to  $10^{-9}$  pb sensitivity**

From plain to  
concentric  
alternate V  
electrodes





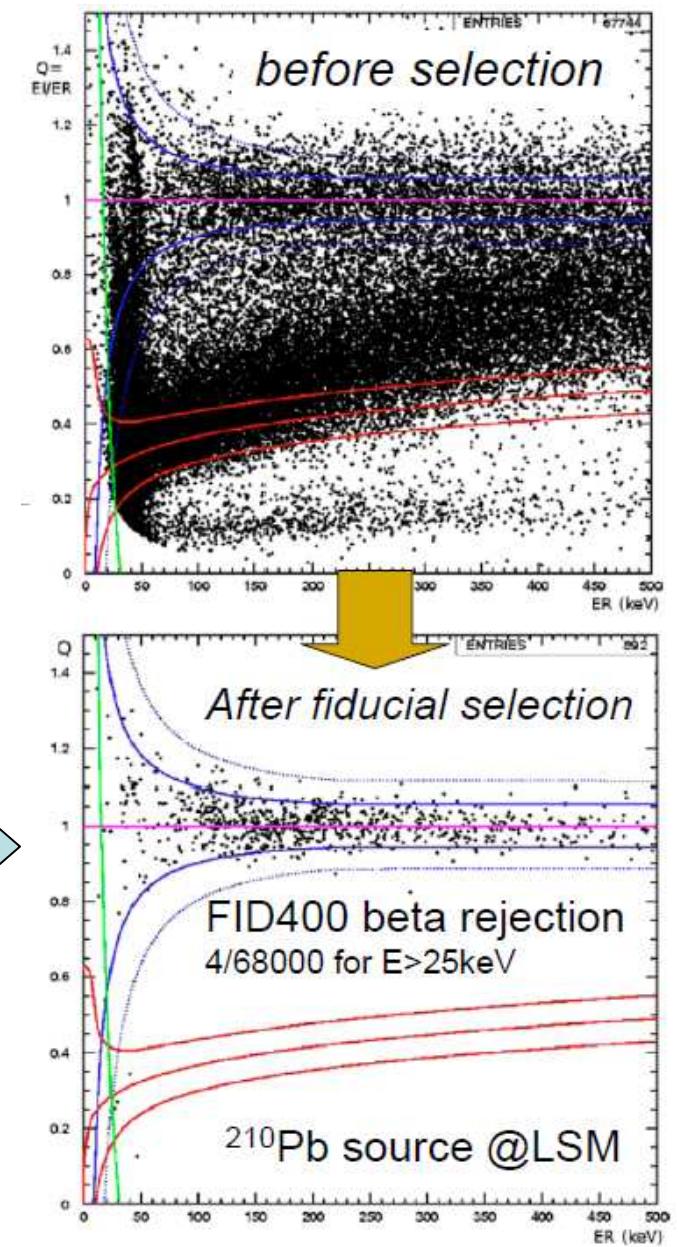
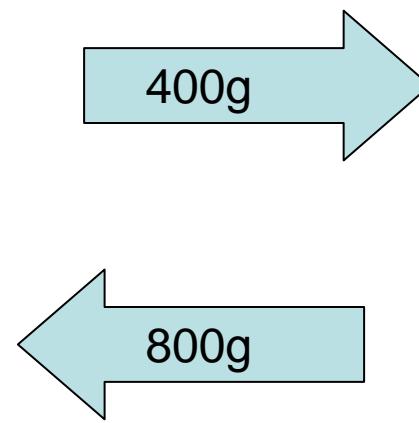
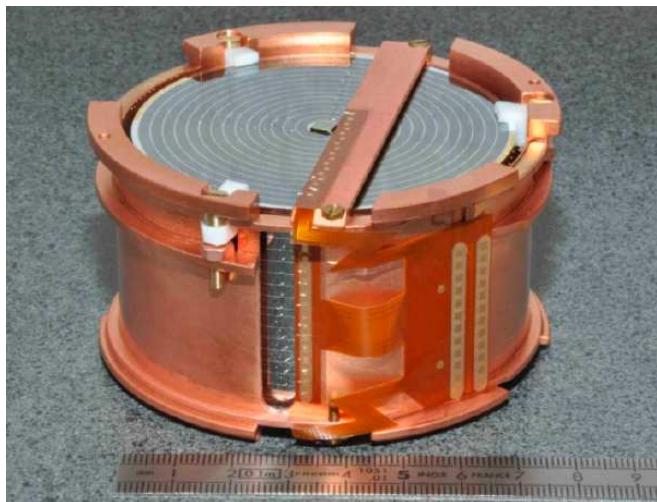
# Edelweiss Detectors

Interleaved Detectors:

PLB 681 (2009) 305 or [arXiv:0905.0753]

10x 400g Ge ID detectors running  
(Apr 2009 – May 2010).

July 2010: 2x FID400 and 4x FID800 installed (see EDELWEISS IDM2010 talk by E. Armengaud).





# EURECA in LSM

## Timeline:

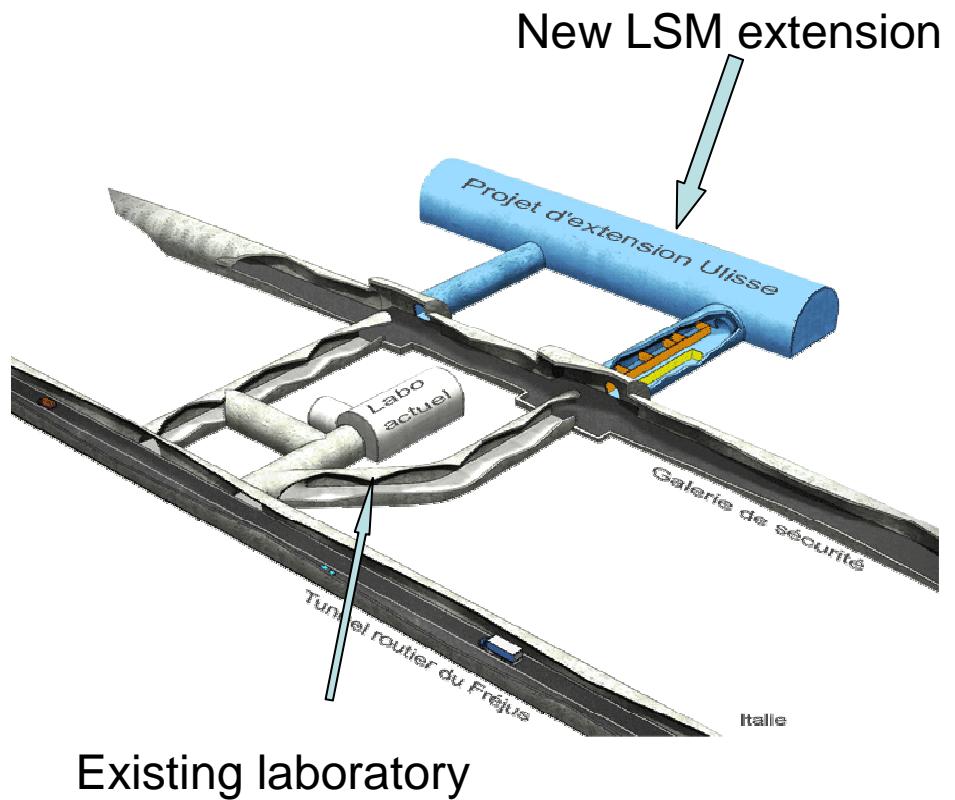
2009/12: Design Study → TDR

2012/13: In parallel to LSM excavation, 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.

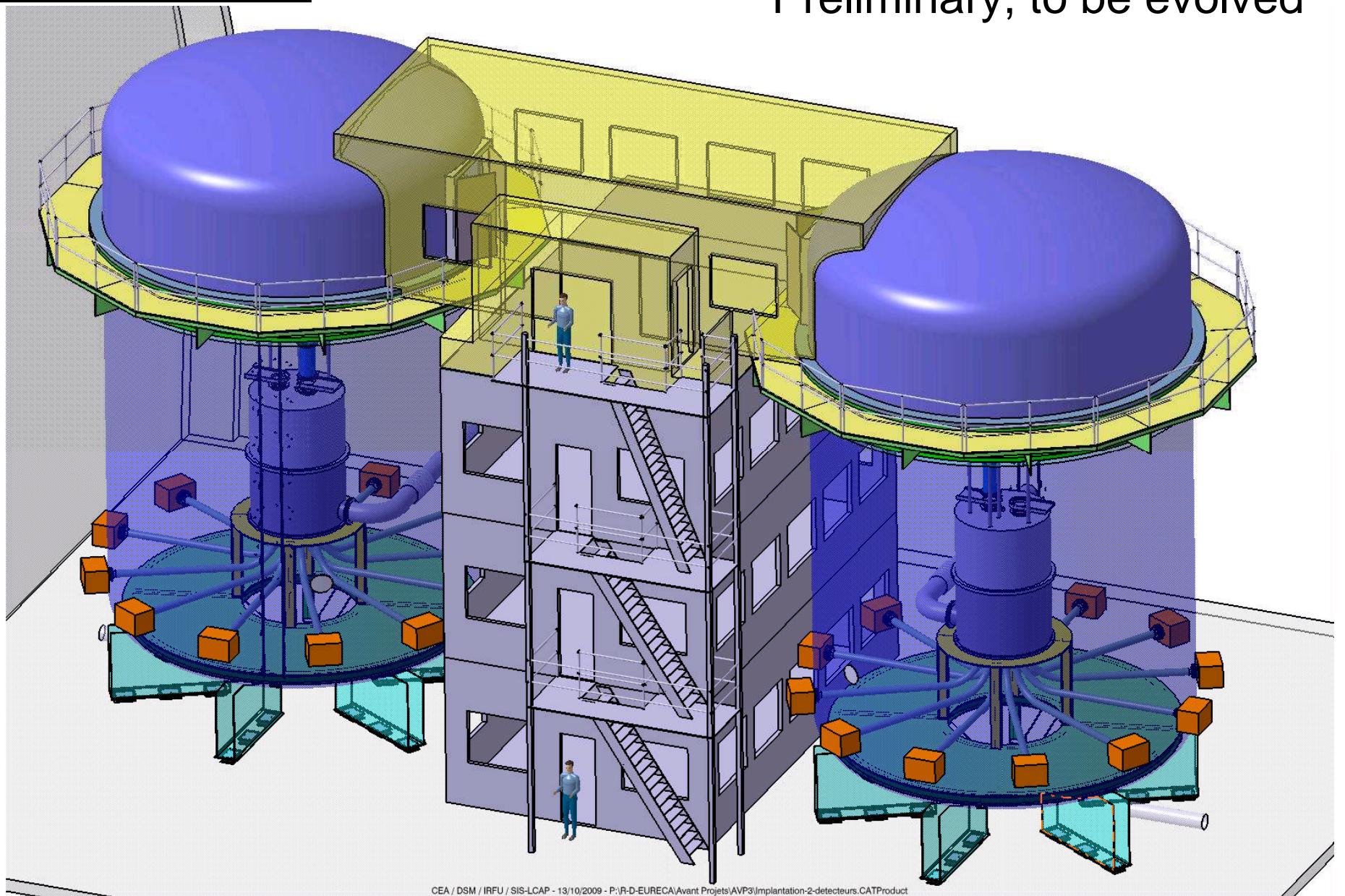
2018: One tonne target installed.

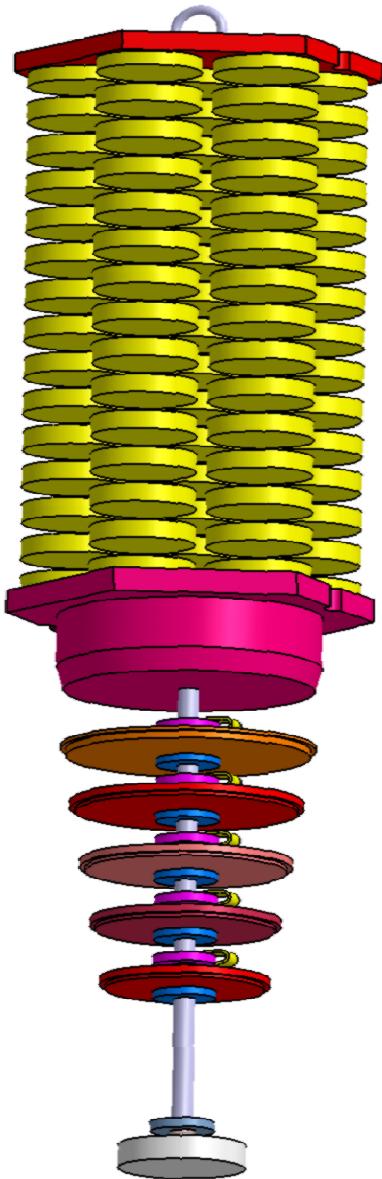




# Design Study View of EURECA

Preliminary, to be evolved



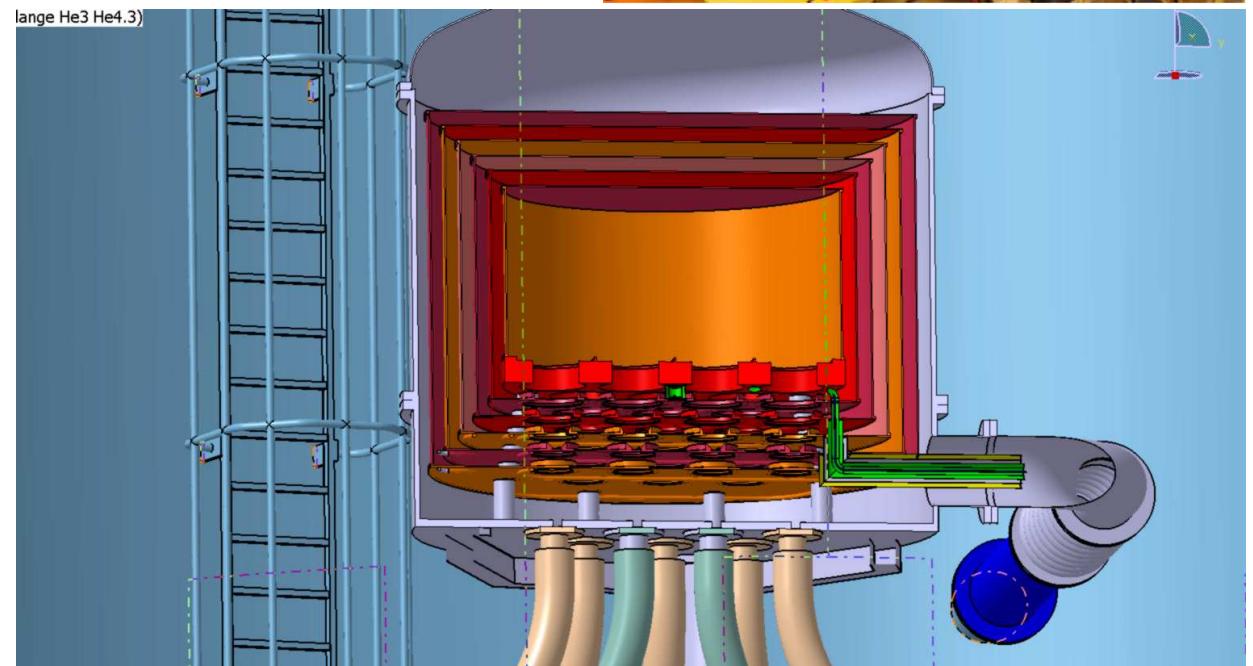


# Detector Accommodation

From 'local', on cryostat  
installation:



To tower structure with  
'remote' detector  
installation.

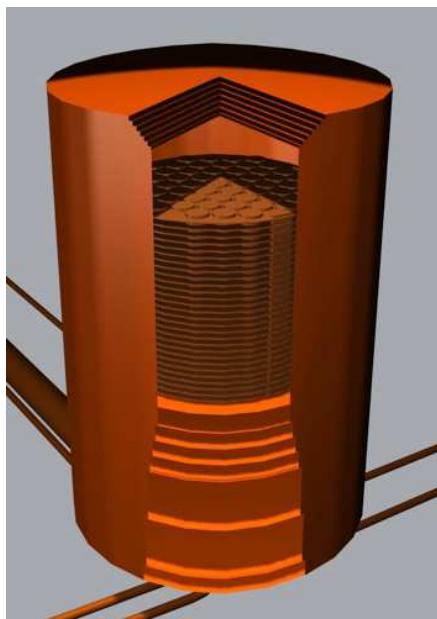




# Backgrounds

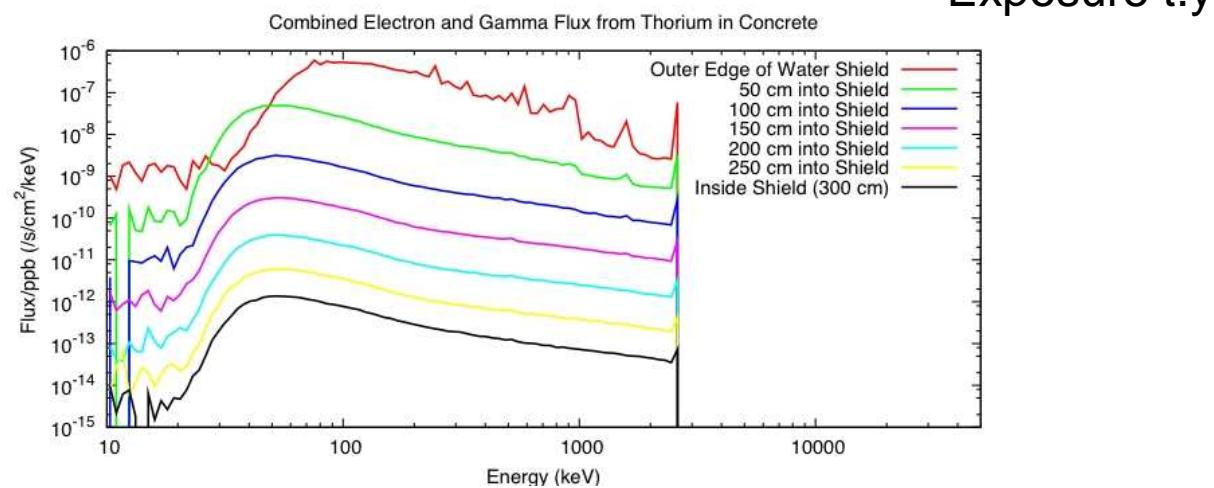
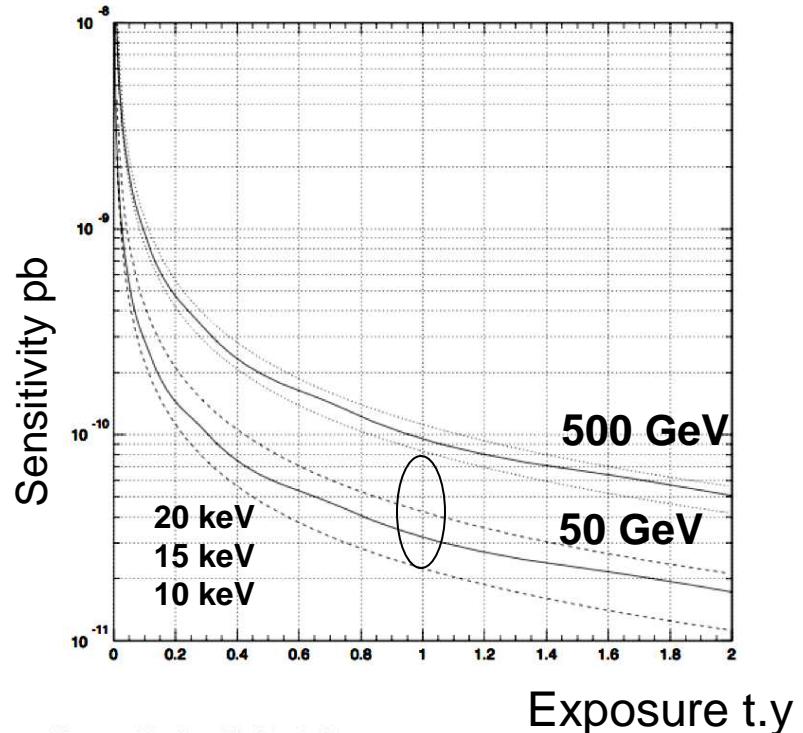
Reach background level  $\sim < 1 \text{ evt/t.y}$

- **Gamma:** with present level @ 0.16 evt/kg.d.keV: **ok**
- **Beta:** need factor 10 less on  $^{210}\text{Pb}$  surface contamination: **in hand**
- **Neutrons:** use of water shield: **ok**



Simulation of complete setup

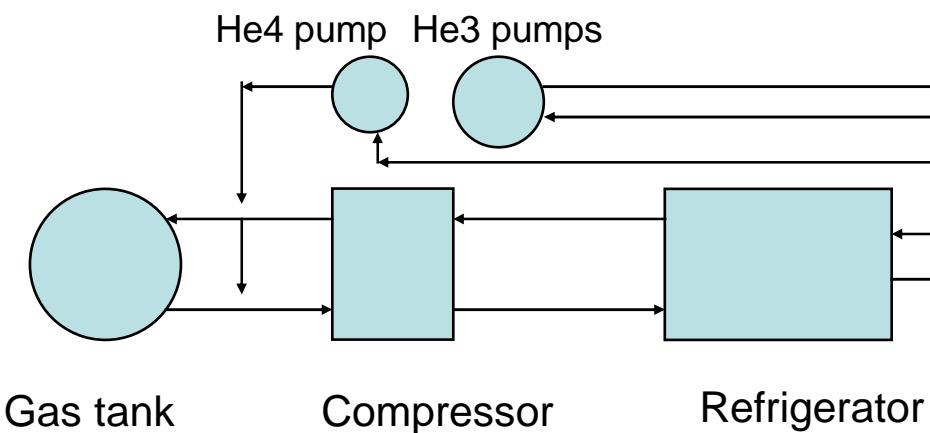
Limits from gamma background w present level & rejection factor



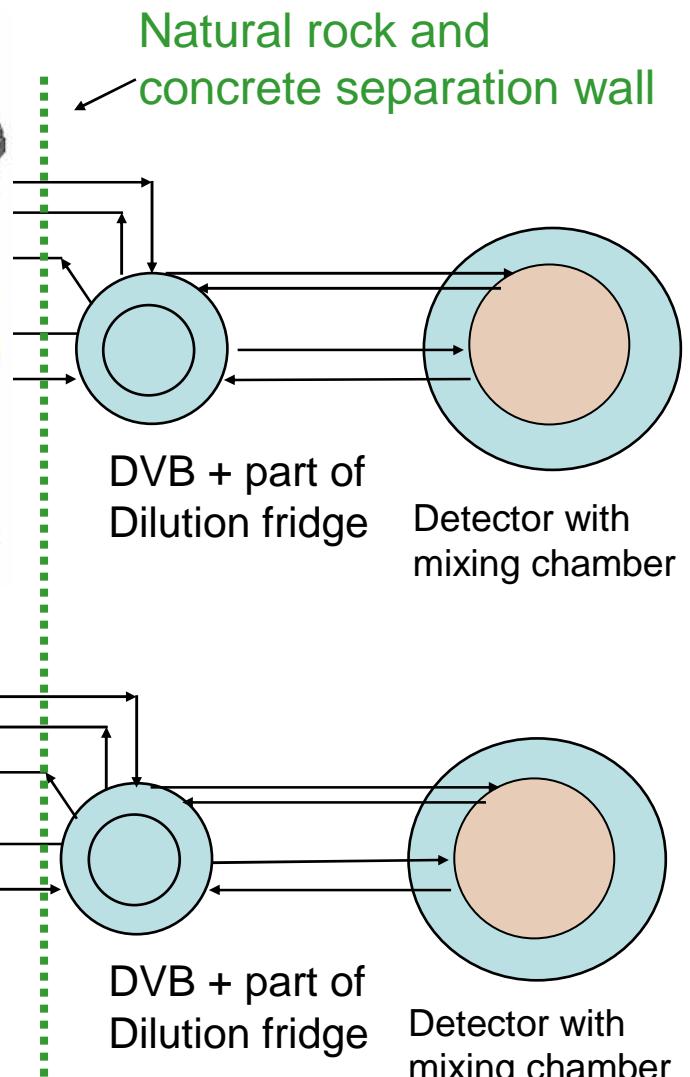
Optimisation of water shield thickness vs  $\gamma$  energy



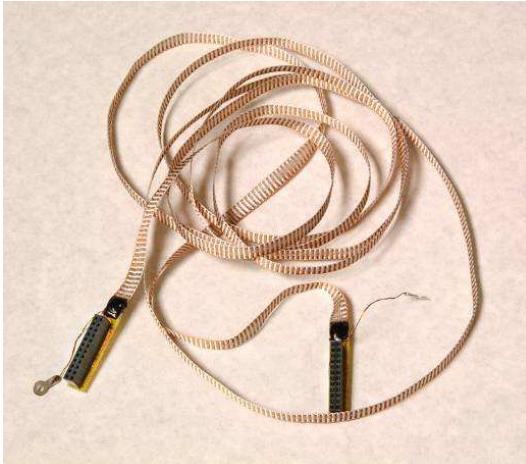
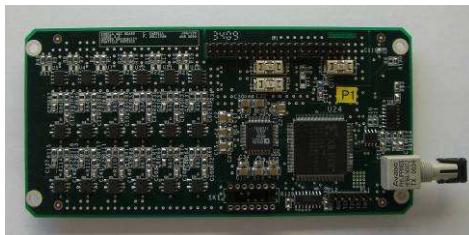
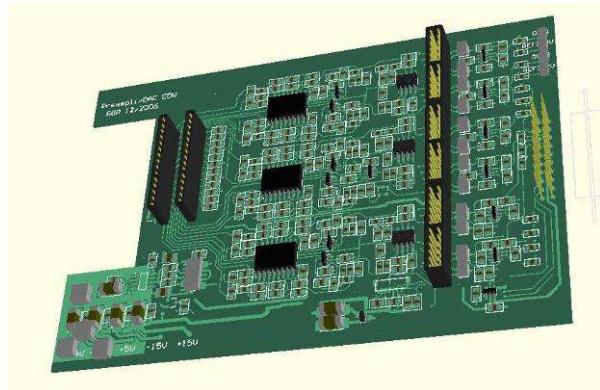
# Cryogenics: Equipment Location



Technical side cavern

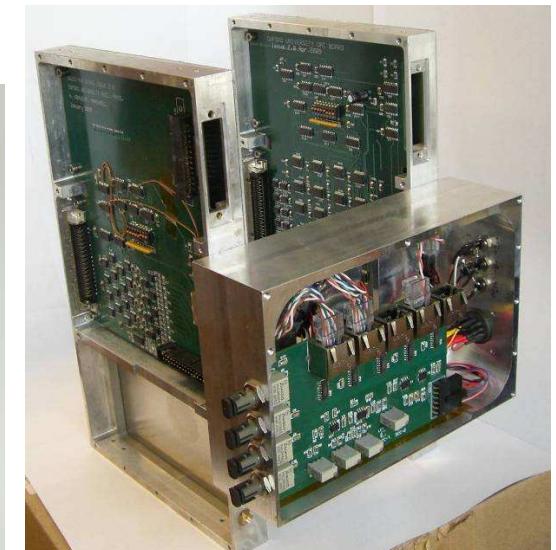


Detector hall



# Electronics, Cabling, Etc

- Reduce cost per channel
- Optimise number of channels needed
- Keep intellectual property in house
- Flexible, modular design
- Simplify
- Design, prototyping on track
- Test foreseen in EDW III set up





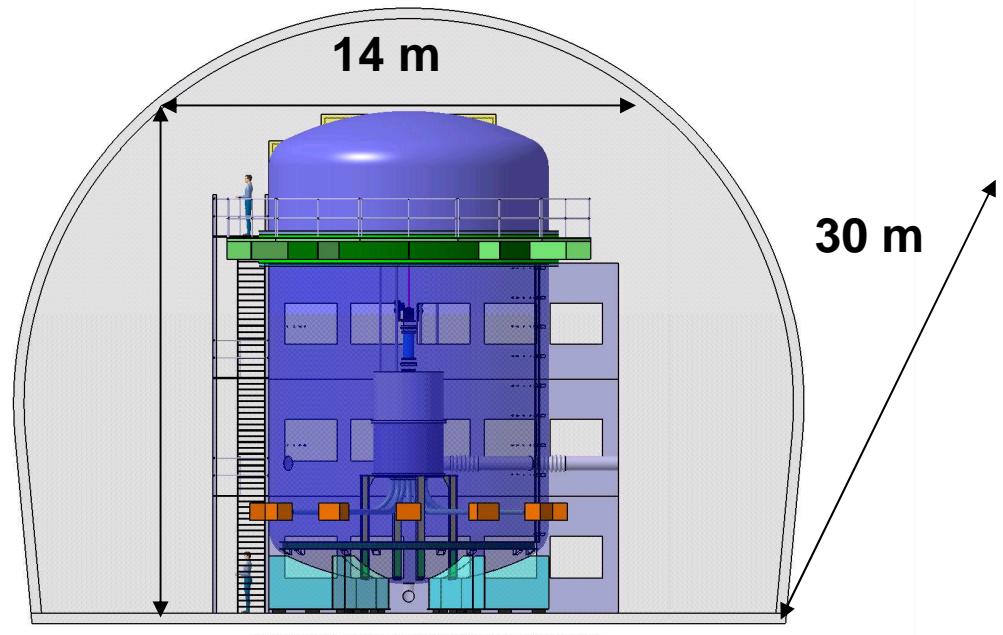
# Infrastructure for EURECA

Request to the host laboratory:

**Space:** a volume of  $30 \times 14 \times 14 \text{ m}^3$  to accommodate two water shields and the EURECA building in between.

**Services:** 190 kW electrical power; cooling facilities to remove 190 kW of heat; radon-free air ( $700 \text{ m}^3$  peak at  $<0.1 \text{ Bq/m}^3$ , safe for people to work in); purification of  $1,000 \text{ m}^3$  water; and  $\sim 160 \text{ m}^2$  clean room facilities (range of classes).

Away from the EURECA facility:  $500 \text{ m}^3$  for water storage and  $\sim 150 \text{ m}^3$  for compressors (liquid cryogen system) and gas storage.





# Timeline and Summary

Project	09	10	11	12	13	14	15	16	17	18	19
CDR/ASPERA D. Study											
TDR											
Decision											
Construction I (150 kg)											
Exploitation I											
Construction II (1 ton)											
Exploitation II											

EURECA is the European Cryogenic Dark Matter Search  
Well-aligned with other Tonne-scale Dark Matter Searches  
Complementarity absolutely crucial for Dark Matter Search  
EURECA Facility: Modular, flexible design