Strategy of HPGe screening measurements in the SuperNEMO experiment

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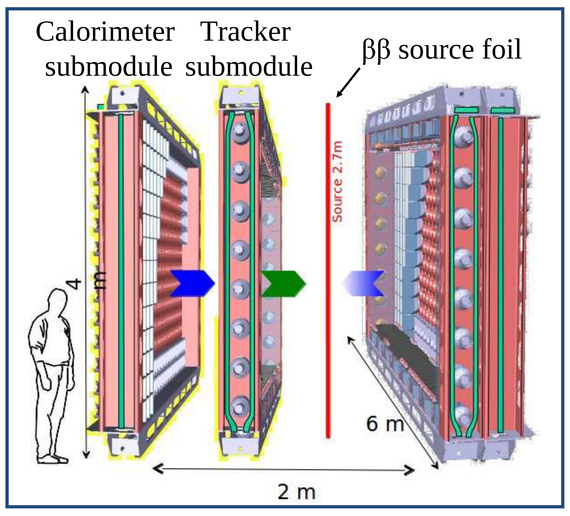
on behalf of the SuperNEMO collaboration

Full SuperNEMO experiment

(22 modules)

- Tracko-calo technique
- Source : 100 kg of ^{82}Se
- $T_{1/2}(\beta\beta0\nu) > 10^{26}$ y
- $\langle m_\nu \rangle$ < 40-110 meV



SuperNEMO Demonstrator (1st module)

Radiopurity requirements :

- Source foil : A(^{214}Bi)< 10µBq/kg, A(^{208}Tl)< 2µBq/kg **(BiPo3 detector)**
- Radiopurity of the gas : A(^{222}Rn)< 0.15 mBq/m^3 **(Rn strategy)**
- **Radiopurity of the materials : low-backgound gamma spectrometry screening (High Purity Germanium, HPGe)**

PRISNA platform (Bordeaux) : a facility dedicated to a γ radiopurity pre-screening of the materials

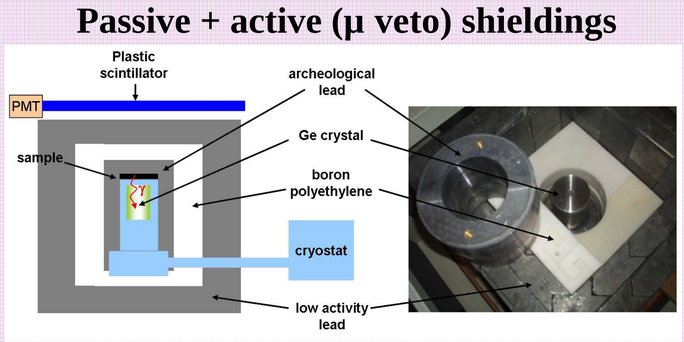
Building constructed in 2009

3m soil+ 0,5m concrete = 6 mwe

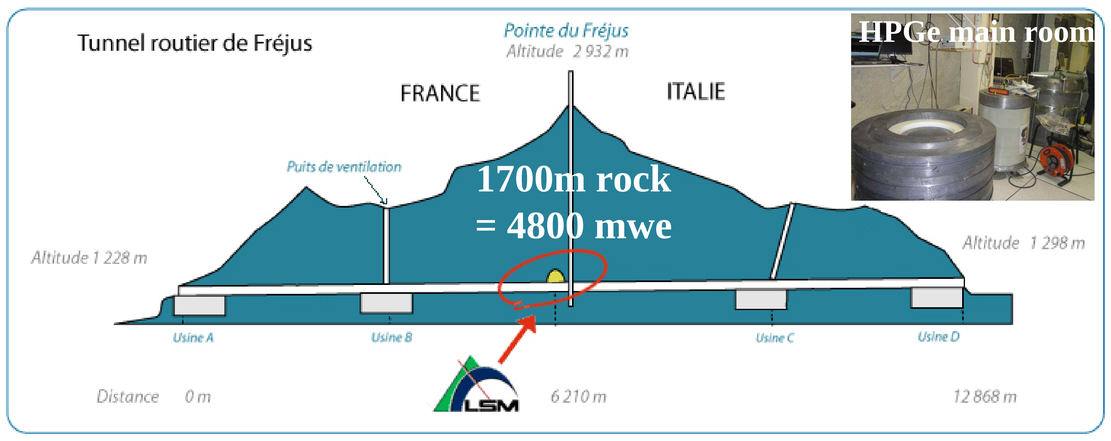
Pool of HPGe detectors :

- 2 coaxial-type for big samples (few 100cm^3) and Eγ>100 keV
- 2 well-type for small samples (few cm^3) and Eγ >40 keV

Passive + active (µ veto) shieldings



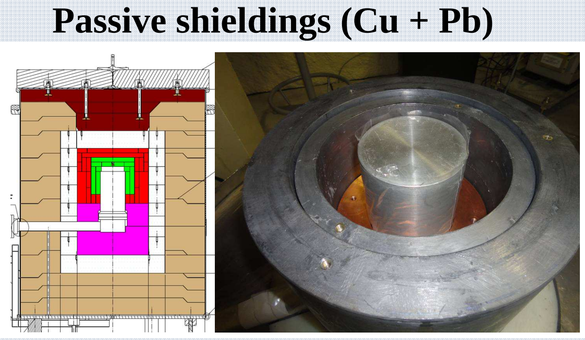
LSM platform (Modane) : a facility dedicated to an ultra-low γ radiopurity screening of the materials



Pool of HPGe detectors :

- 3 coaxial-type for big samples (few 1000cm^3) and Eγ>100 keV
- 1 planar-type for thin samples (few mm) and Eγ>20 keV

Passive shieldings (Cu + Pb)



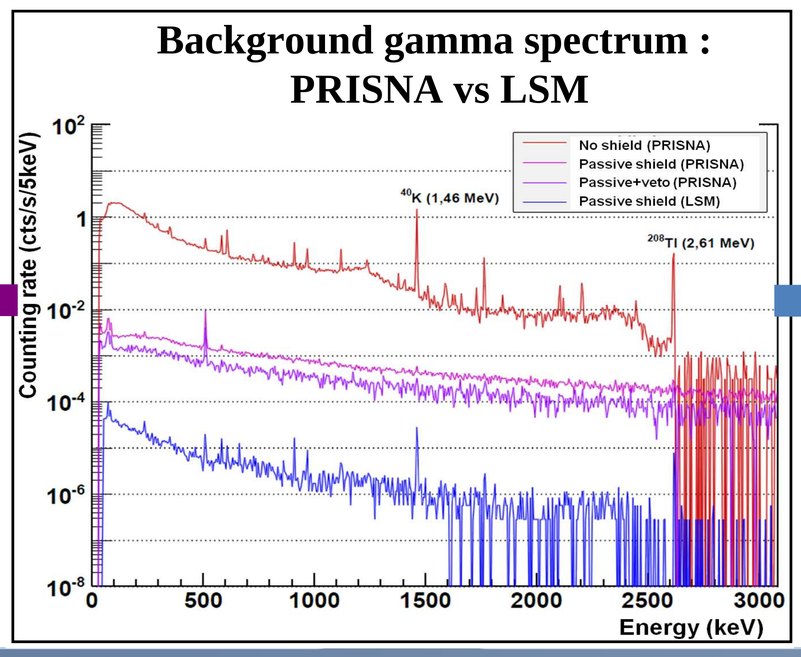
Typical sensitivity

Type	Background (counts/mn)	Detection limit (mBq/kg)		
	[30-3000 keV]	^{214}Bi (352 keV)	^{208}Tl (238 keV)	^{210}Pb (46 keV)
Coaxial	4	< 25[a]	< 10[a]	-
Well	10	<60[b]	<20[b]	<200[b]

[a] = 100g of sample and 7 days of measurement
[b] = 6g of sample and 7 days of measurement

Best sensitivity achieved : 10 mBq/kg

Background gamma spectrum : PRISNA vs LSM



Typical sensitivity

Type	Background (counts/mn)	Detection limit (mBq/kg)		
	[30-3000 keV]	^{214}Bi (352 keV)	^{208}Tl (238 keV)	^{210}Pb (46 keV)
Coaxial	0.16	< 0.2[a]	< 0.07[a]	-
Planar	0.11*	<0.7[a]	<0.25[a]	<7[a]

[a] = 1kg of sample and 30 days of measurement
** = for [20-1500 keV]*

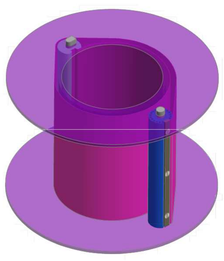
Best sensitivity achieved : 0.07 mBq/kg

Radiopurity strategy for the SuperNEMO demonstrator module

Ultra-critical materials

^{82}Se source foils

- HPGe screening of the **^{82}Se foils after their production** at a level of 0.1-1 mBq/kg → **LSM**



Delrin spool for ^{82}Se foil transportation and HPGe measurements

- Final sensitivity achieved with the BiPo3 detector at the level of 2-10 µBq/kg for ^{214}Bi and ^{208}Tl

Critical materials

Tracker + source frame

- HPGe screening of the **materials in direct contact with the tracker gas** at a level of 0.1-1 mBq/kg → **LSM**
- Cross-check of possible surface contamination with a Rn emanation chamber dedicated to large samples
- Final Rn emanation measurement will be performed for all the tracker module with the Rn concentration line (Goal : A(^{222}Rn) < 0.15 mBq/m^3)

Rn barrier

« Less* » critical materials

Calorimeter + surroundings

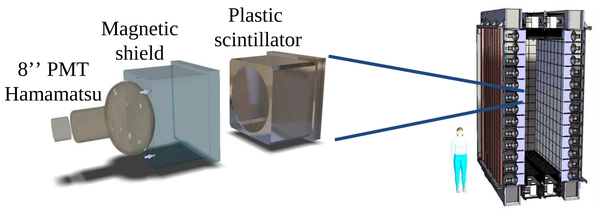
- HPGe pre-screening of the materials at a level of 10-100 mBq/kg → **PRISNA** → **enough for materials with low mass or far from the tracker** (resistances for HV divider, connectors for cables…)
- HPGe screening of the materials at a level of 1-10 mBq/kg → **LSM**
→ required for materials with high mass (plastic scintillors, PMT, iron frame…)

***Other possible background : alpha-induced neutrons in low Z materials**

Example : glass of PMT as a « reference » material

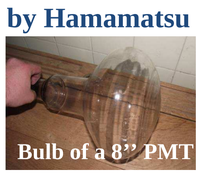
- SuperNEMO demonstrator : two main calorimeter walls
- Total : 520 plastic scintillators coupled to 8'' PMT

→ Glass of PMT : main issue for radiopurity concern



Radiopurity budget of the best glass provided by Hamamatsu

Number of 8'' PMT	Mass of glass (kg)	^{40}K (Bq)	^{214}Bi (Bq)	^{208}Tl (Bq)
1 PMT	0.96	0.580	0.096	0.019
520 PMT	500	302	50	10



→ need to improve the radiopurity of the glass by a factor 2 to fullfil the SuperNEMO requirements

Radiopurity requirement for the other materials : their total activity does not exceed 10% of the glass activity of the 520 x 8'' Hamamatsu PMT