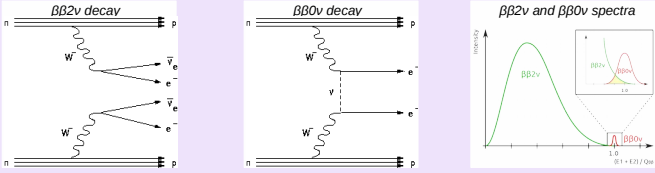


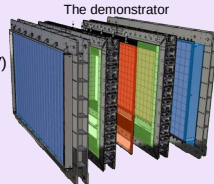
## The SuperNEMO demonstrator

The SuperNEMO experiment aims to study the neutrinoless double beta decay ( $\beta\beta 0\nu$ ) and reach a sensitivity on this decay of  $10^{26}$  years, i.e a Majorana neutrino mass of 50-100 meV.



It is composed of:

- A **source foil** containing the  $\beta\beta$  emitters: 7kg of  $^{82}\text{Se}$  ( $Q_{\beta\beta 0\nu} = 2.99$  MeV)
- A **tracker** to identify the particles and reconstruct their trajectory: 2034 Geiger cells (14970 wires)
- A **calorimeter** to measure the energy and the time of flight (TOF) of particles: 712 optical modules (OMs)



The demonstrator is currently being installed at the Laboratoire Souterrain de Modane (LSM).

## The main wall calorimeter

The SuperNEMO main wall calorimeter: 520 Optical Modules (OMs).

Each OM is composed of [1] :

- 10 L NUVIA plastic scintillator
- R5912-03 mod HAMAMATSU 8 " photomultiplier tube
- Teflon and Mylar wrapping
- RTV615 optical coupling
- Individual pure iron magnetic shield



$$\text{Measured Resolution} = \frac{8.3\%FWHM}{\sqrt{E}} \text{MeV} [2]$$

Other expected performances:

- Time resolution of 400 ps( $\sigma$ ) @ 1 MeV
- No ageing in 5 years
- Gain survey with an accuracy < 1 %
- Low background PMT
- Low backscattering
- 50 %  $\gamma$  tagging @ 1 MeV

## Energy corrections with optical simulations

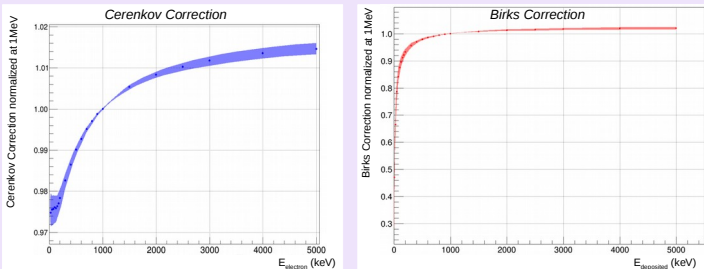
**Goal:** understand every effect in the calorimeter which can affect the true deposited energy and modify the measured energy [3] .

### Non-linear effects : Birks and Cerenkov

Depends on the energy and the type of the particle  $\rightarrow$  non-linearity of light production

**2 main effects:**

- **Birks:** local saturation of the scintillation light yield. Stronger at low energies and for  $\gamma$ -rays.
- **Cerenkov:** production of additional light for  $E_{\text{electrons}} > 150$  keV in the SuperNEMO scintillators.

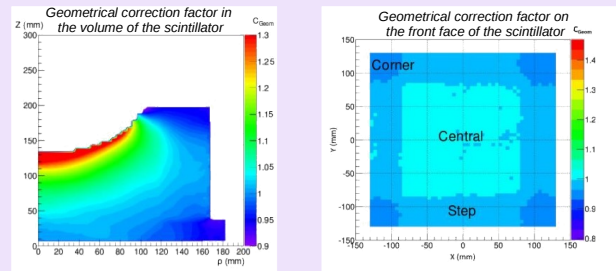


### Non-uniformity effect : Geometrical

Depends on the interaction position of the particle  $\rightarrow$  non-uniformity of light collection

**2 main origins:**

- **Geometry** of the scintillator (Step, corners).
- **Inhomogeneity** of the photocathode of the photomultiplier tube.



## Improvement of the energy resolution of the SuperNEMO experiment

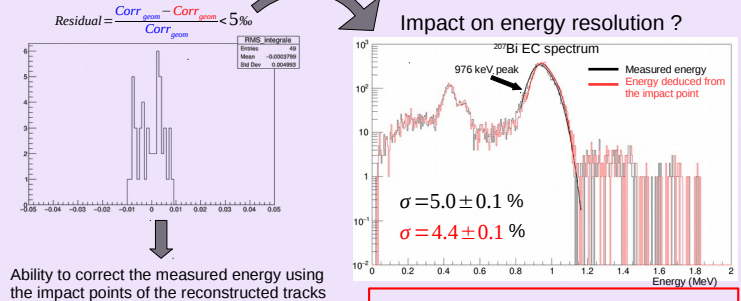
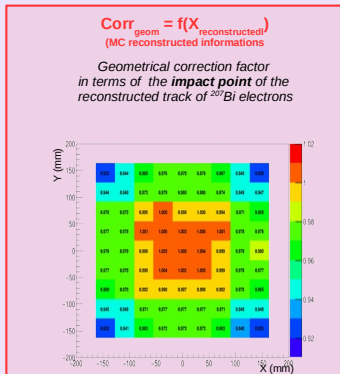
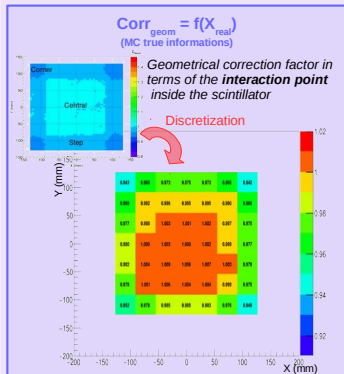
**Goals:** Demonstrate the capability to correct the non-uniformity effect of each electron energy deposit using the impact point on the calorimeter.

Optical simulation (previously described)



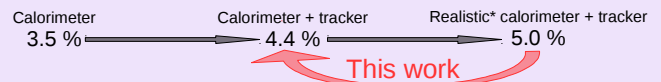
Use the SuperNEMO simulation software (FALAISE):

- Simulation of 100M  $^{207}\text{Bi}$  events (calibration source of the experiment)
- 1 electron event = 1 track + 1 calorimeter hit



Energy resolution improvement :  $\sim 12\%$

Resolution  $\sigma$  @ 976 keV



\*Realistic\* calorimeter model = Birks + Cerenkov + Geometrical

## References

- [1] E. Chauveau. PhD Thesis, Université de Bordeaux, 2010.
- [2] Calorimeter development for the SuperNEMO double beta decay experiment, Nucl. Inst. Meth. A, 868 : 98-108 (2017).
- [3] A. Huber. PhD Thesis, Université de Bordeaux, 2017.

