

$0\nu\beta\beta$ sensitivity with the SuperNEMO demonstrator

Rencontres de Moriond, YSF 2017

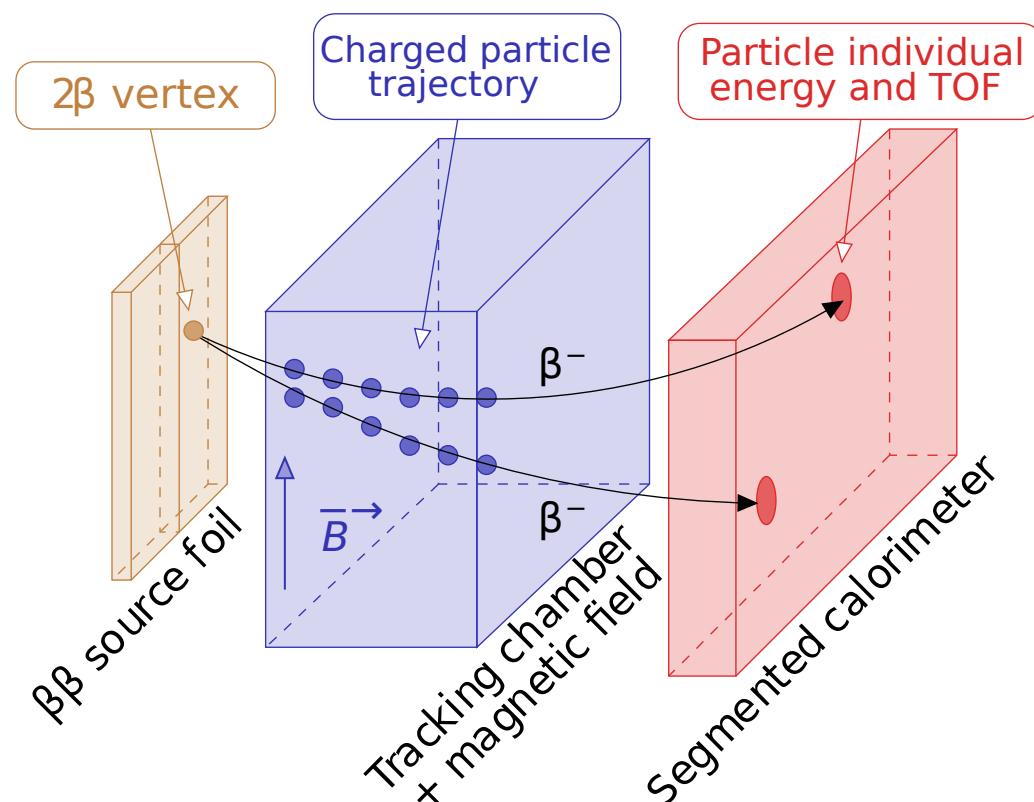
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The SuperNEMO experiment

- Looking for the **nature of the neutrino** via the **neutrinoless double beta decay $0\nu\beta\beta$**
- Unique experimental approach combining **tracking** and **calorimetry** techniques :



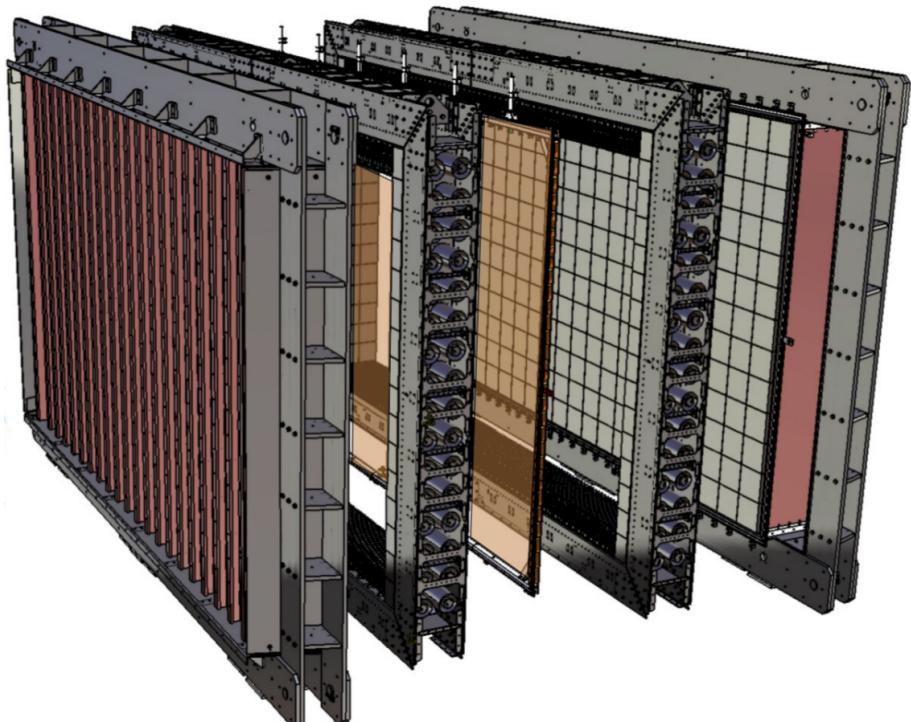
The SuperNEMO demonstrator

Source :

7 kg of ^{82}Se

$$T_{1/2}(2\nu\beta\beta) = 10.3 \pm 0.3 \text{ (stat)} \pm 0.7 \text{ (syst)} \text{ } 10^{19} \text{ y}^*$$

$$Q_{\beta\beta} = 2.996 \text{ MeV}$$



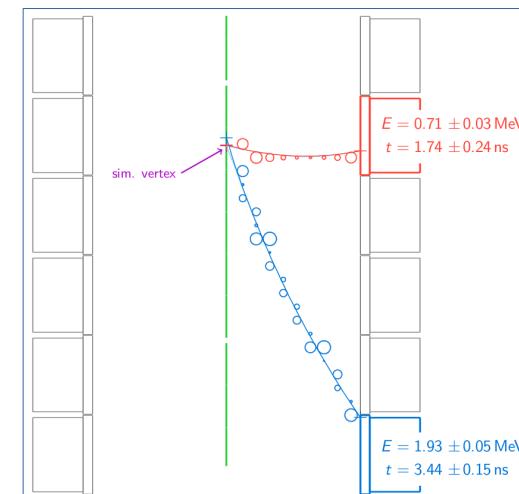
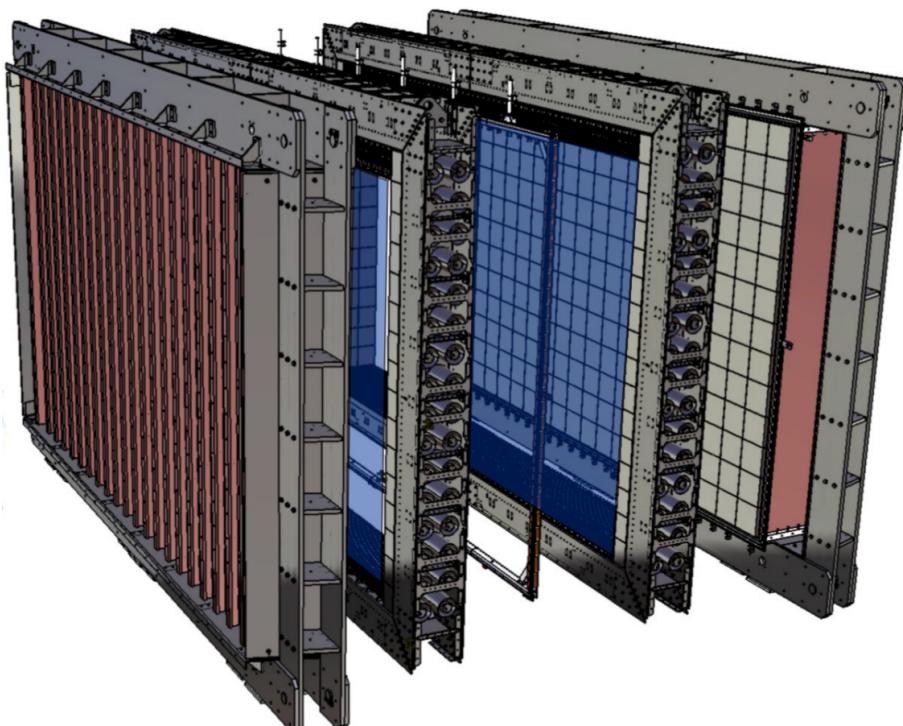
*JETPLett.80:377-381,2004

The SuperNEMO demonstrator

Tracker :

Wire chamber (2034 wires)

3D track reconstruction



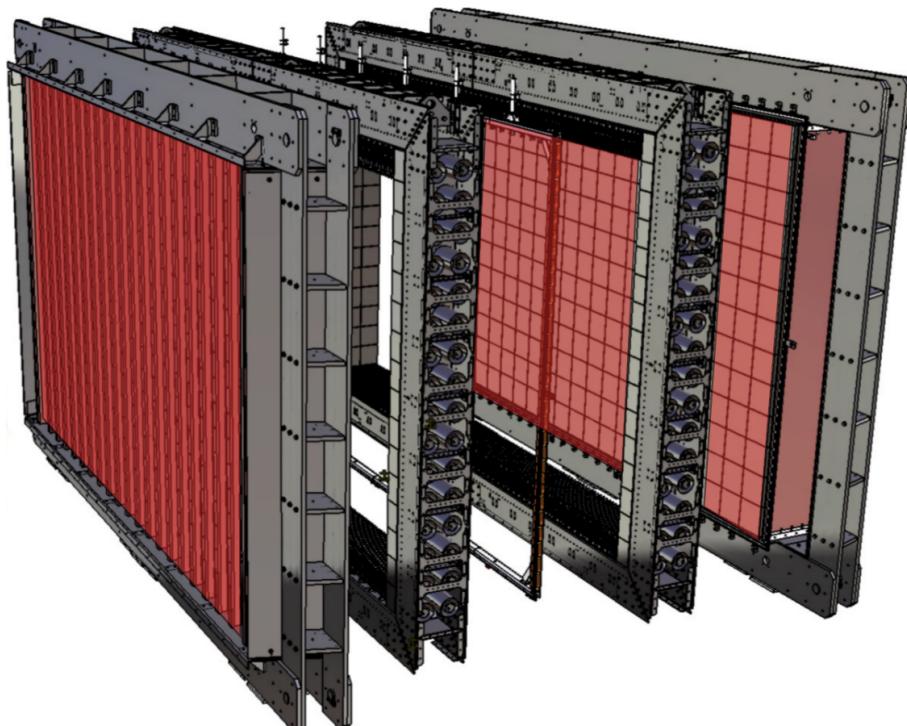
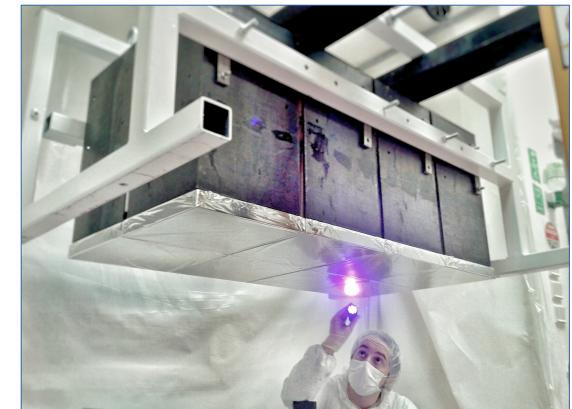
The SuperNEMO demonstrator

Calorimeter :

520 x 8" PM + 192 x 5"PM coupled to polystyrene scintillators

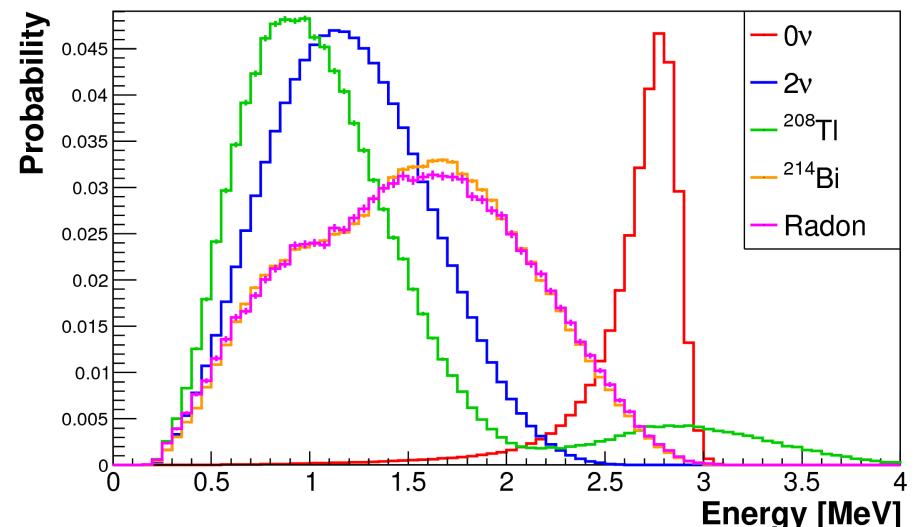
Energy resolution : 8 % FWHM @ 1 MeV

Time resolution : $\sigma = 400$ ps @ 1 MeV



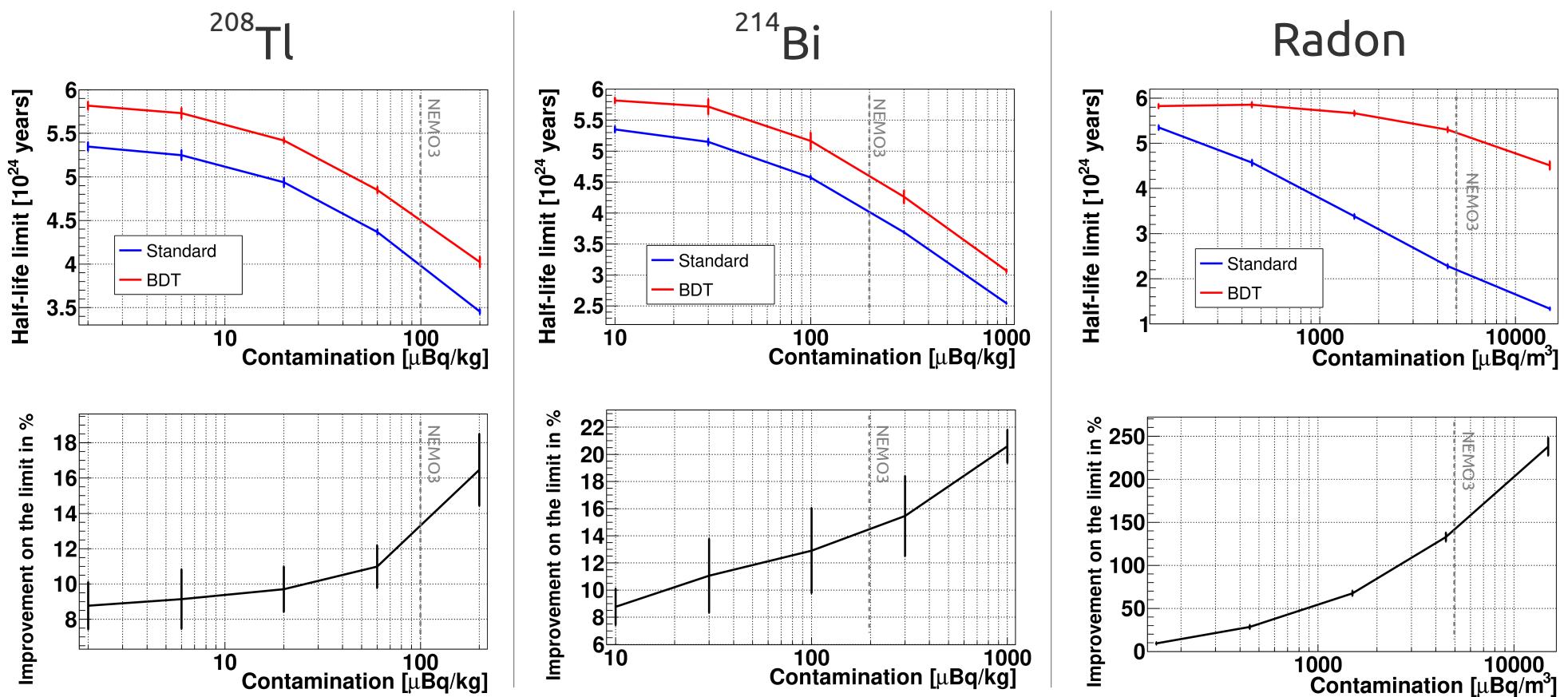
Analysis strategy

- $0\nu\beta\beta$ signature : **2 electrons**
- Main **backgrounds** :
 - $2\nu\beta\beta$
 - source contamination (^{208}Tl , ^{214}Bi)
 - Radon emanation ($^{222}\text{Rn} \rightarrow \dots \rightarrow ^{214}\text{Bi}$)
- Use **dedicated channels** to measure the backgrounds :
 $1eN\gamma$ for ^{208}Tl and ^{214}Bi , $1e1\alpha$ for ^{214}Bi ...
- Use **topological informations** to discriminate between $0\nu\beta\beta$ mechanisms and to improve the background rejection : individual electrons energy, angle, TOF, vertices distance...



SuperNEMO demonstrator sensitivity

- Train **BDTs** to discriminate signal events from background events
- Radiopurity requirements : $A(^{208}\text{Tl}) = 2 \mu\text{Bq/kg}$, $A(^{214}\text{Bi}) = 10 \mu\text{Bq/kg}$ and $A(\text{Radon}) = 150 \mu\text{Bq/m}^3$
- **Half-life limit** as a function of the background contamination levels :



Conclusions

- The SuperNEMO demonstrator should reach a sensitivity of $T_{1/2}(\nu\beta\beta) > 5.9 \cdot 10^{24} \text{ y}$ 90 % CL with the background requirements for a 17.5 kg.y exposure.
- The use of topological informations in **multivariate analysis** guarantees a **10 % minimal improvement** on the sensitivity depending on the background contamination (90 % increase considering the NEMO3 background levels).
- The **commissioning** of the demonstrator started in LSM and it should start **taking data in Summer 2017**.

BACKUP

Full scale SuperNEMO

- Preliminary

Extrapolating to the full scale SuperNEMO *i.e.* 500 kg.y :

$$\tau_{1/2}(0\nu\beta\beta) > 6.8 \cdot 10^{25} \text{ y } 90\% \text{ CL}$$

corresponding to a limit on the effective neutrino mass

$$\langle m_{\beta\beta} \rangle < 60 - 150 \text{ meV}$$