PROCEEDINGS OF SCIENCE

The SuperNEMO $\beta\beta$ source production

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SuperNEMO takes advantage of the tracking calorimetry technique successfully used by NEMO3. This technique reduces the backgrounds and allows for excellent discrimination of different $0\nu\beta\beta$ mechanisms. SuperNEMO can simultaneously observe different double beta emitters, ^{48}Ca, ^{82}Se and ^{150}Nd are currently under consideration. The demonstrator will employ 7~kg of enriched ^{82}Se shaped in thin foil installed in the centre of the detector. The R&D for new techniques of foil fabrication will be described, focusing on materials choice and background reduction at the level of 2μBq/kg and 10μBq/kg for ^{208}Tl and ^{214}Bi respectively. New developments with innovative purification methods will also be discussed with the aim of comparing the radio-purities at a later stage.

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1. SuperNEMO

Since many years, the NEMO (Neutrino Ettore Majorana Observatory) experiments have explored the nature of neutrinos with ever increasing sensitivity [1]. The next generation experiment will be SuperNEMO. SuperNEMO is a neutrinoless double beta decay (0νββ) experiment combining tracking and calorimetry with a ββ source at the center. This technique reduces the backgrounds and allows for excellent discrimination of different 0νββ mechanisms. The source is comprised of 36 foils with the following geometry: 2700x135(125)x0,25mm^3. Figure 1 shows the installation of the source foils inside the source frame.

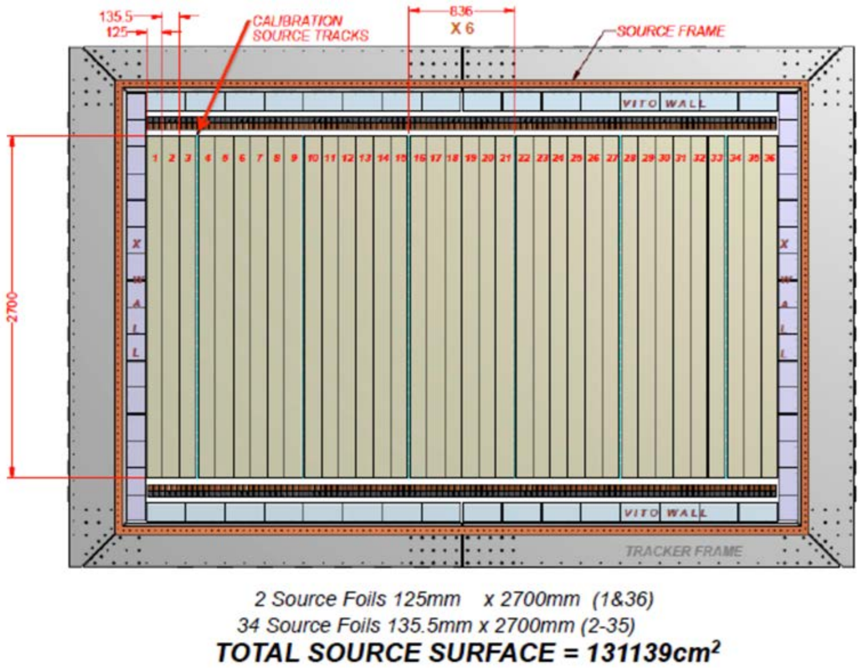

Figure 1: Source foils inside the Source frame.

A demonstrator module is currently under construction using 7kg of ^{82}Se. It is being installed under 1700m of mountain rock at LSM (Laboratoire Souterrain de Modane, France) for additional background shielding. Figure 2 shows the SuperNEMO demonstrator module integration in the LSM cavern. One can see the double beta source in yellow in the center, the calorimeter in red, green and blue, and the tracker in the space between the source and the calorimeter. A more complete description of the demonstrator module can be found elsewhere [2]. Other isotopes are also envisaged like ^{150}Nd or ^{48}Ca at a later stage.

2. Novel ^{82}Se foil production

The source foils using ^{82}Se are being prepared with a similar protocol as the one used for the composite type ^{100}Mo foils in NEMO-3, which have shown good performance in low level background achievement. 11 of the SuperNEMO source foils have been prepared with this method. However, in a constant search for more radiopure techniques, some innovations have been introduced for the remaining foils and a novel foil production has been developed.

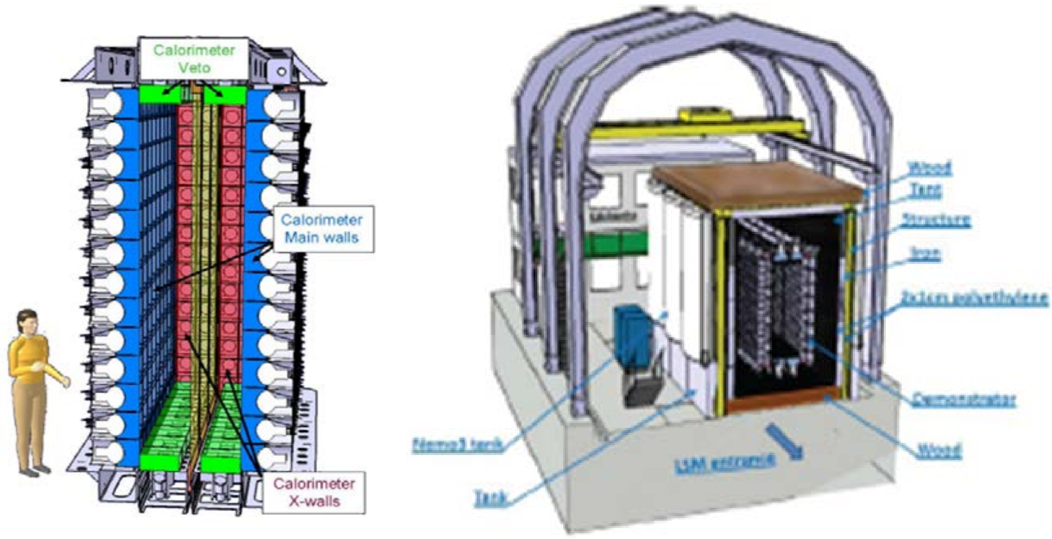

Figure 2: SuperNEMO detection module with the double beta source in yellow, the calorimeter in red, green and blue, and the tracker in the space between the source and the calorimeter. The structure is about 5m high. On the right, one sees how the demonstrator will be shielded in the LSM cavern.

For the foil preparation, one first mixes ^{82}Se powder with PVA (Poly-vinyl-alcohol) glue with a proportion Se/PVA =90%/10% weight and a thickness of 40-60mg/cm^2. Then the mixture is poured onto a special mold. Once dried, the long foil is cut into stand-alone pads that can be easily handled. The pads are then inserted into a Raw Mylar protection. The foil can then be installed in the dedicated frame and used in the detector as the source in the center. Figure 3 shows the different foil production steps. The foil preparation is done in an ISO 6 clean room. 25 out of 36 foils are being built with this design.

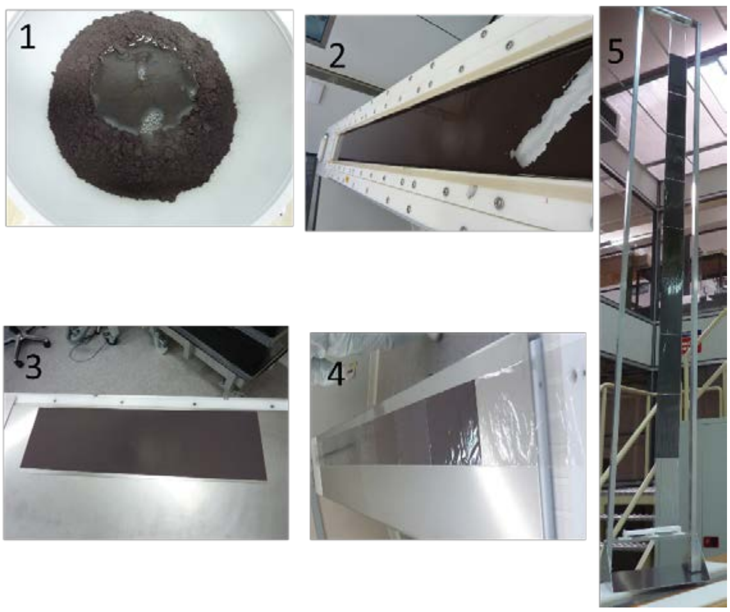

Figure 3: Foil production steps. 1: Mix ^{82}Se powder with PVA (Poly-vinyl-alcohol) glue; 2:Pour onto mould; 3: Cut into stand-alone pads; 4: Insert in Mylar protection; 5: Install in frame.

3. Choice of material

For the sensitivity needed, the required radiopurities for main background sources are $\mathcal{A}(^{208}Tl) < 2$ μBq/kg and $\mathcal{A}(^{214}Bi) < 10$ μBq/kg. Different ^{82}Se powder purification techniques will be compared for the best background reduction like distillation, chromatography or chemical precipitation. Radiopurity is measured in BiPo-3, a detector with sensitivity of 2-10 μBq/kg[3]. BiPo-3 is a dedicated detector for the measurement of ultra-low levels of contamination in ^{208}Tl and ^{214}Bi present in the SuperNEMO source foils, but also in other thin materials. Every ingredient entering the foil preparation is measured for radiopurity and validated before integration in the demonstrator (PVA, Se, Mylar etc…). Figure 4 shows some ^{82}Se pads before BiPo-3 measurement. Foil measurements and analysis are still ongoing in order to make a more precise evaluation of ^{82}Se radiopurity. The Raw Mylar used for the foil envelope has shown an activity of $\mathcal{A}(^{208}Tl) < 49$ μBq/kg and $\mathcal{A}(^{214}Bi) < 210$ μBq/kg but the total contribution to activity will be much lower since Mylar represents only 10% of total source mass. It has been chosen as the purest option we have found up to date. PVA showed activities of $\mathcal{A}(^{208}Tl) < 12$ μBq/kg and $\mathcal{A}(^{214}Bi) <$ 768 μBq/kg. However, to minimize impact, we have chosen to include only 10% of mass.

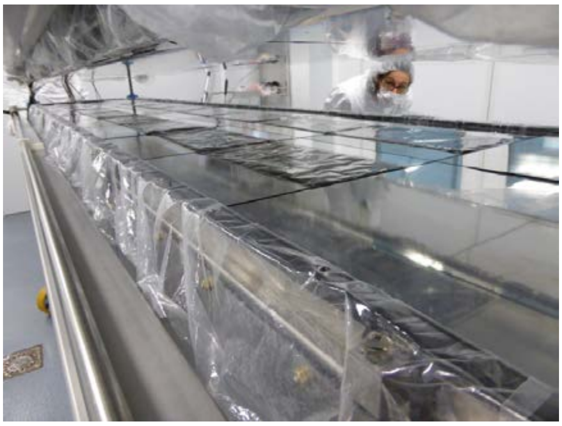

Figure 4: ^{82}Se pads inside the radiopurity detector BiPo-3.

4. Conclusion

The demonstrator installation is underway and well advanced. The ^{82}Se foils will be integrated after the tracker and calorimeter have been installed. This is planned for spring 2017. Final measurement of the foils to be installed in the demonstrator is ongoing. This work contributes to the study for reducing background. It is also a good opportunity to validate different purification techniques.

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References

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