Construction and commissioning of the SuperNEMO detector tracker

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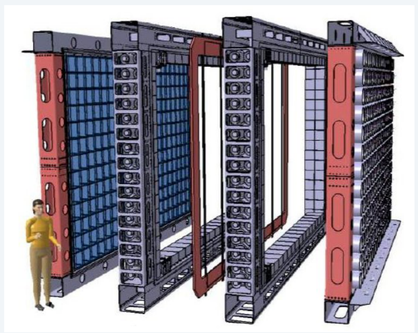
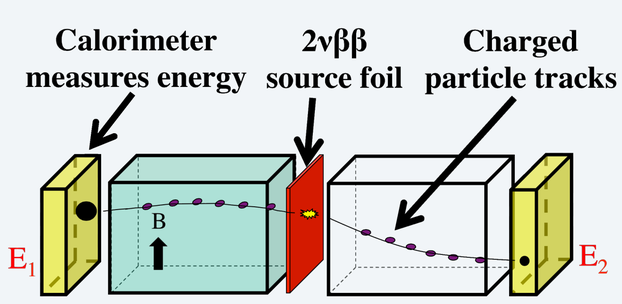
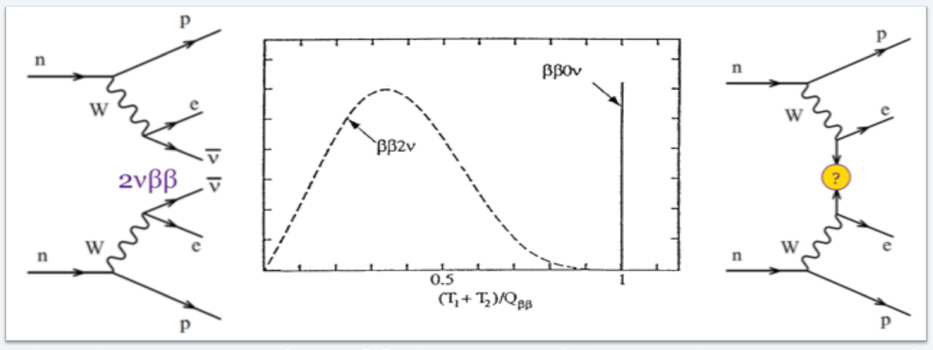
The SuperNEMO detector will search for 0νββ decay at the Modane Underground Laboratory. The detector design allows complete topological reconstruction of the decay event enabling excellent levels of background rejection and, in the event of a discovery, the ability to determine the nature of the lepton number violating process. In order to demonstrate the feasibility of the full experiment, we are building a Demonstrator Module containing 7 kg of ^{82}Se, with an expected sensitivity of $T_{1/2}^{0\nu} > 6.6 \times 10^{24}$ y after 2.5 y. The Demonstrator tracker is currently being assembled in the UK. The main challenge in the tracker design is the strict radiopurity requirements necessary to limit the background. The cell wiring is semi automated and every step of the tracker assembly happens in a clean environment. All components are carefully screened for radiopurity and each section of the tracker, once assembled, is sealed and checked for radon emanation. We present the detector design, the current status of the construction and present the first results from the surface commissioning of one section of the Demonstrator Module tracker.

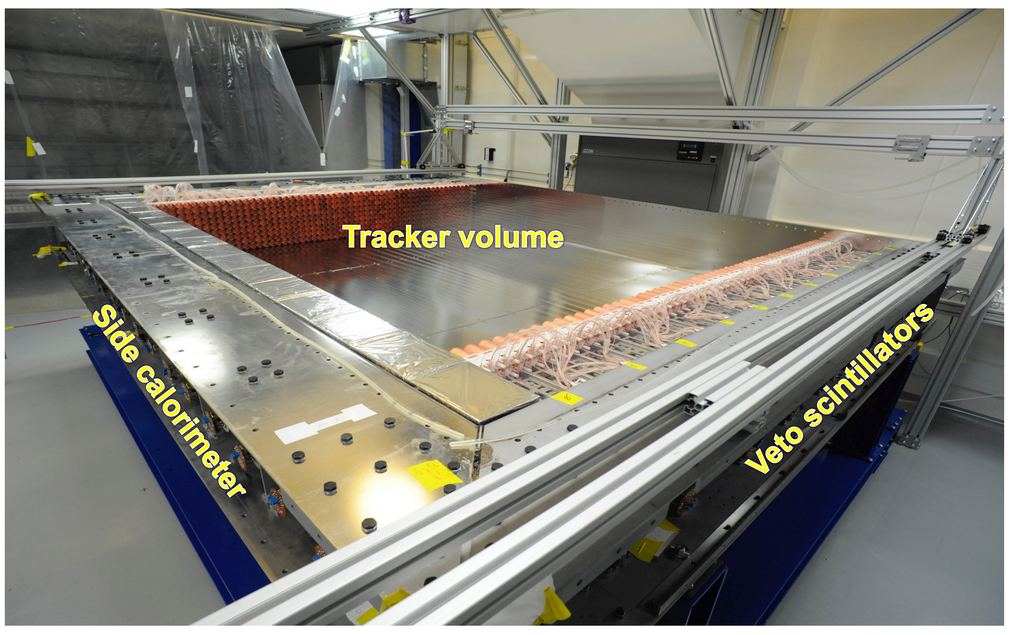




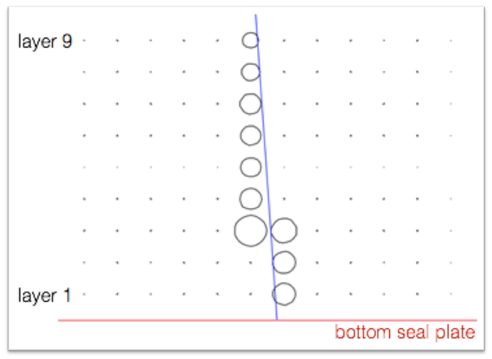
A single module can host a 15m² source foil surrounded by a tracker and a calorimeter, allowing the full reconstruction of a ββ decay [1]. This results in unprecedented background rejection (bg index 10^{-4} events/keV/kg/yr).

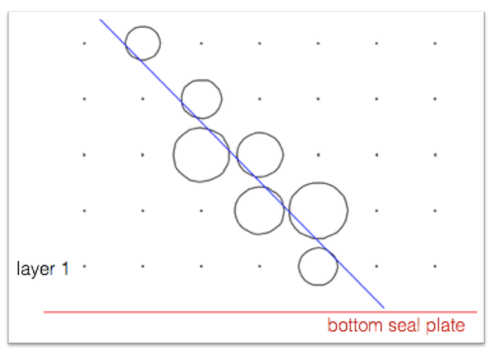


The observation of a 0νββ decay would prove the existence of Majorana ν and provide the fist evidence for lepton number violation. Majorana neutrinos hold the promise of explaining the origin of ν mass and probing GUT scale physics.

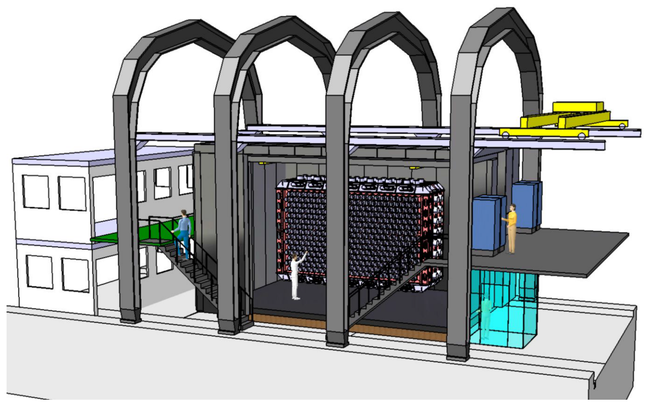


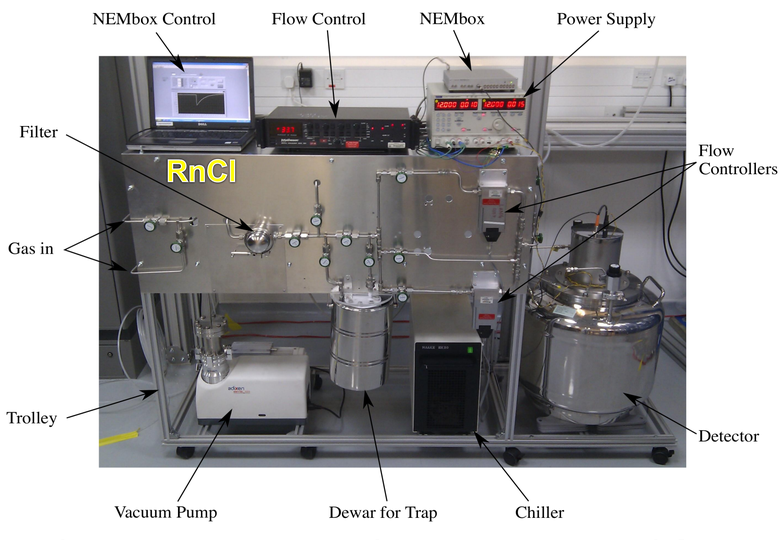
The first quarter of the Demonstrator Module has been completed and is currently undergoing commissioning.





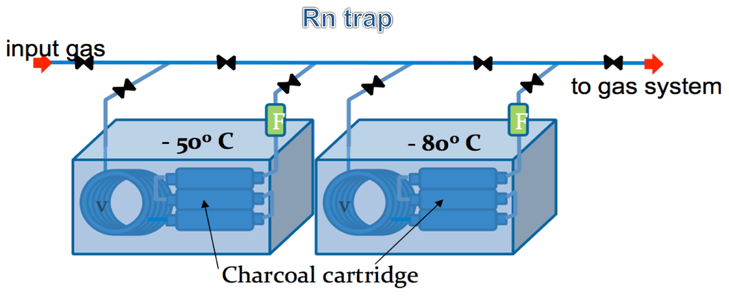
252 cell have been tested so far; anode signals have been observed on all channels and the first cosmic events have been reconstructed; cathode signals are currently under study.
The tracker construction will be completed by the end of 2015 and the Demonstrator commissioning will begin in 2016 in Modane.



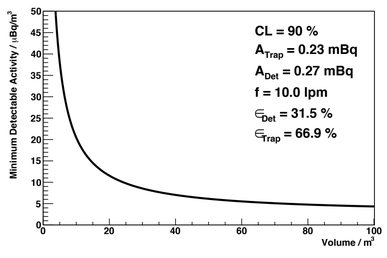


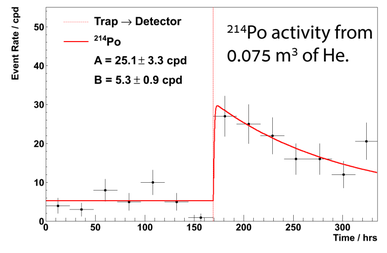
In the Rn concentration line gas is pumped from the sample through a cold carbon trap that adsorbs Rn which is later released and transferred to a detector.

Every component of detector is screened for radiopurity, first with an HPGe detector then specifically for Rn emanation. The radon level must be kept < 0.15 mBq/m³.

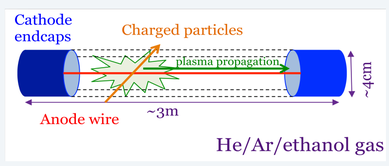


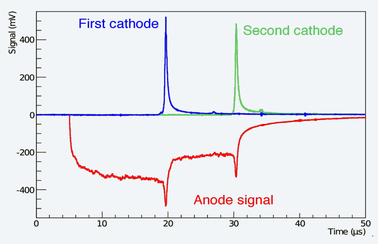
The Rn of the gas source is significant, thus a Rn trap has been designed, capable of achieving a suppression factor of 20 in N_2; the suppression factor for He is expected to be > 10^{10}.

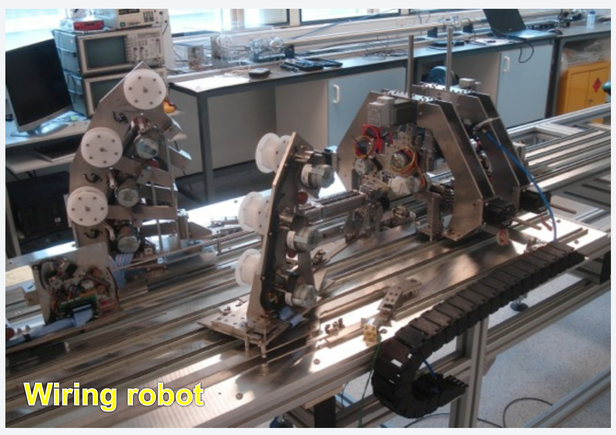




Gas	Source	Radon Level (μBq/m³)
He	***Cylinder***	***70 – 100***
N_2	Cylinder	400 – 1000
N_2	***Boil-off***	***90 – 140***
N_2	Rn-Trap	20 ± 12
He	***Rn-Trap***	***< 5***







The Demonstrator Module has 2034 drift cells operating in Geiger mode; the anode time provides the track distance from the wire and the cathode information is used to measure the longitudinal coordinate. Delrin, copper and steel are the only materials used in the construction to ensure excellent radiopurity. For the same reason a wiring robot is used to automate cell assembly. Two rows of 9 cells are mounted in a "cassette" in Manchester; cassettes are then shipped to MSSL where they are tested, inspected, cleaned and installed on the tracker frame.

References
[1] Probing New Physics Models of Neutrinoless Double Beta Decay with SuperNEMO, R. Arnold et al., Eur. Phys. J. CDOI 10.1140/epjc/s10052-010-1481-5 (2010)