From SNO $\rightarrow$ SNO+
Updating Calibration Hardware

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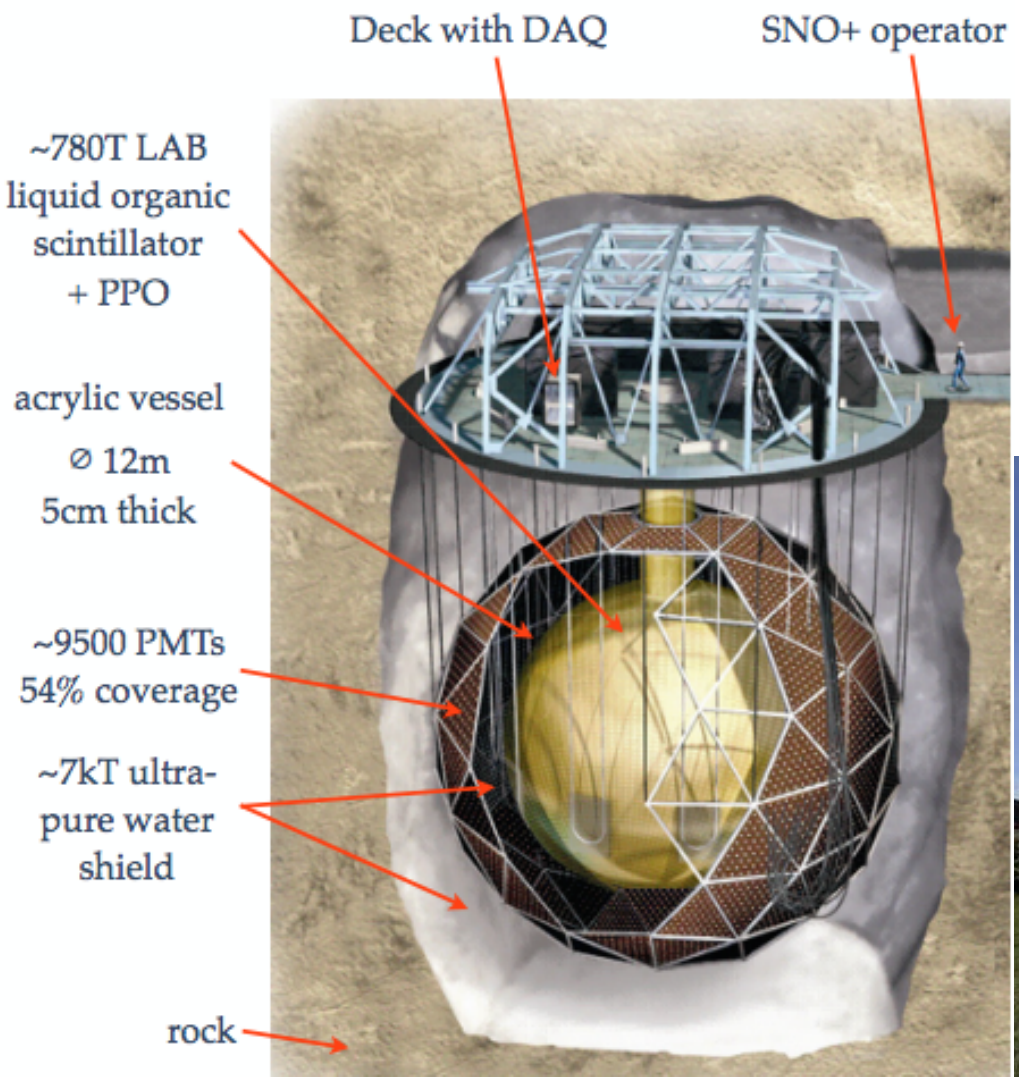
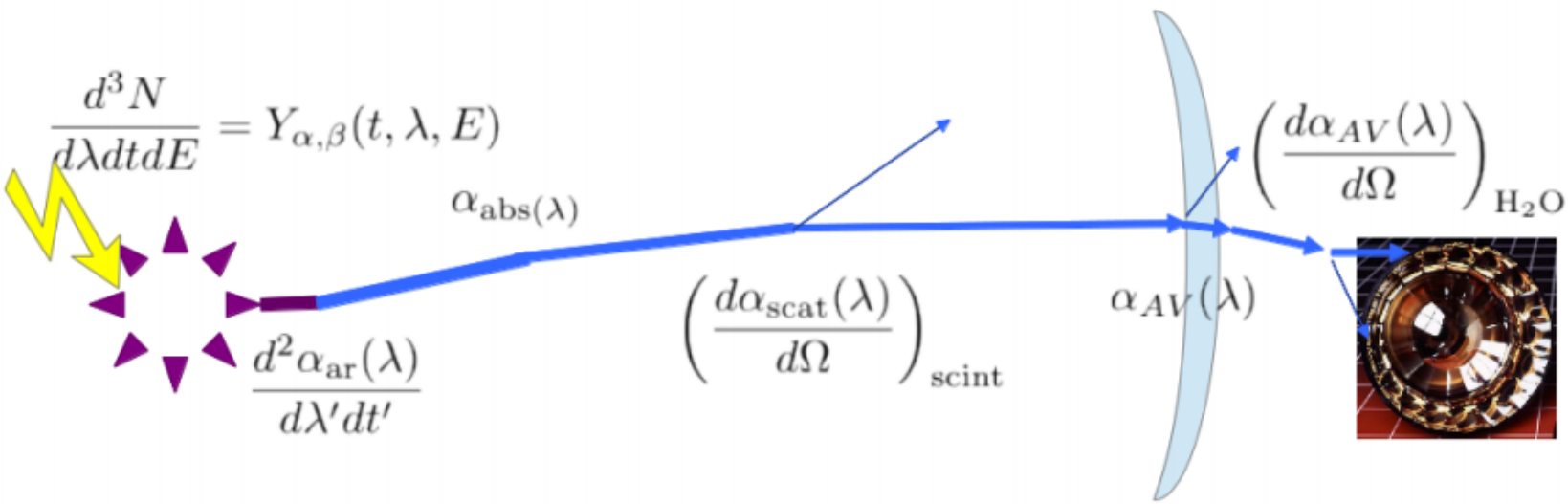
SNO+ Detector at SNOLAB

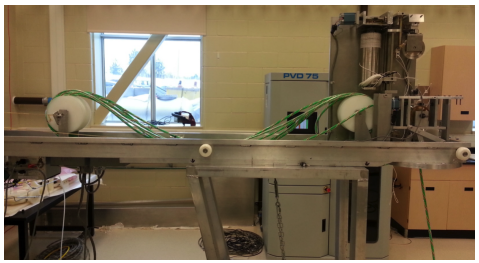


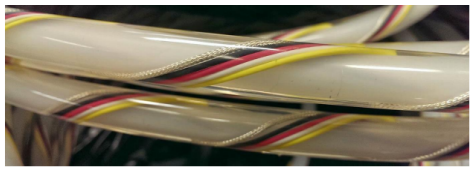
Calibration Source Selection

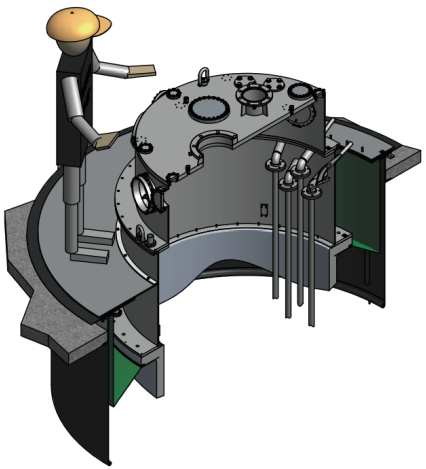
- The goals of SNO+'s calibration campaign strategy are to characterize the detector's response to different particles: γ, n, β.
- Some radioactive sources will only be deployed in either the water or scintillator phase, others in both phases.
- We will use the data to measure input parameters for our Monte Carlo and verify our simulation of energy resolution.

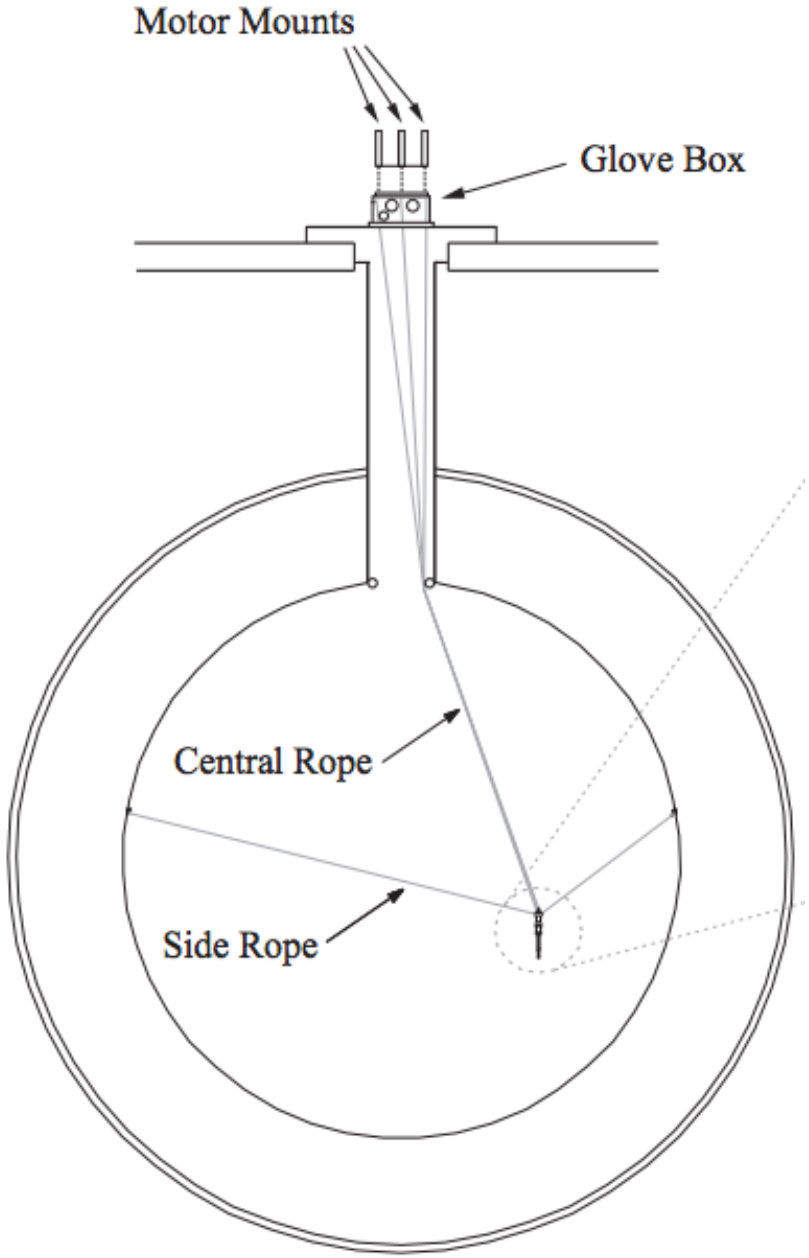


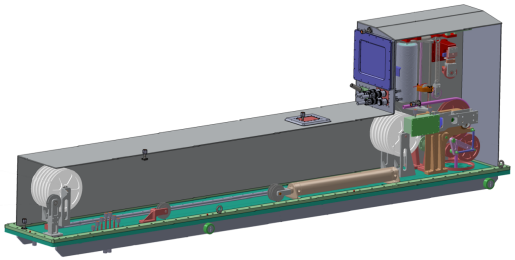
Upgrades to Original SNO Calibration System

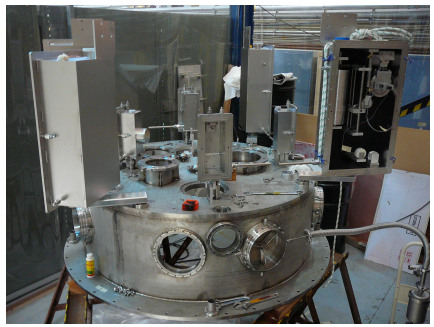




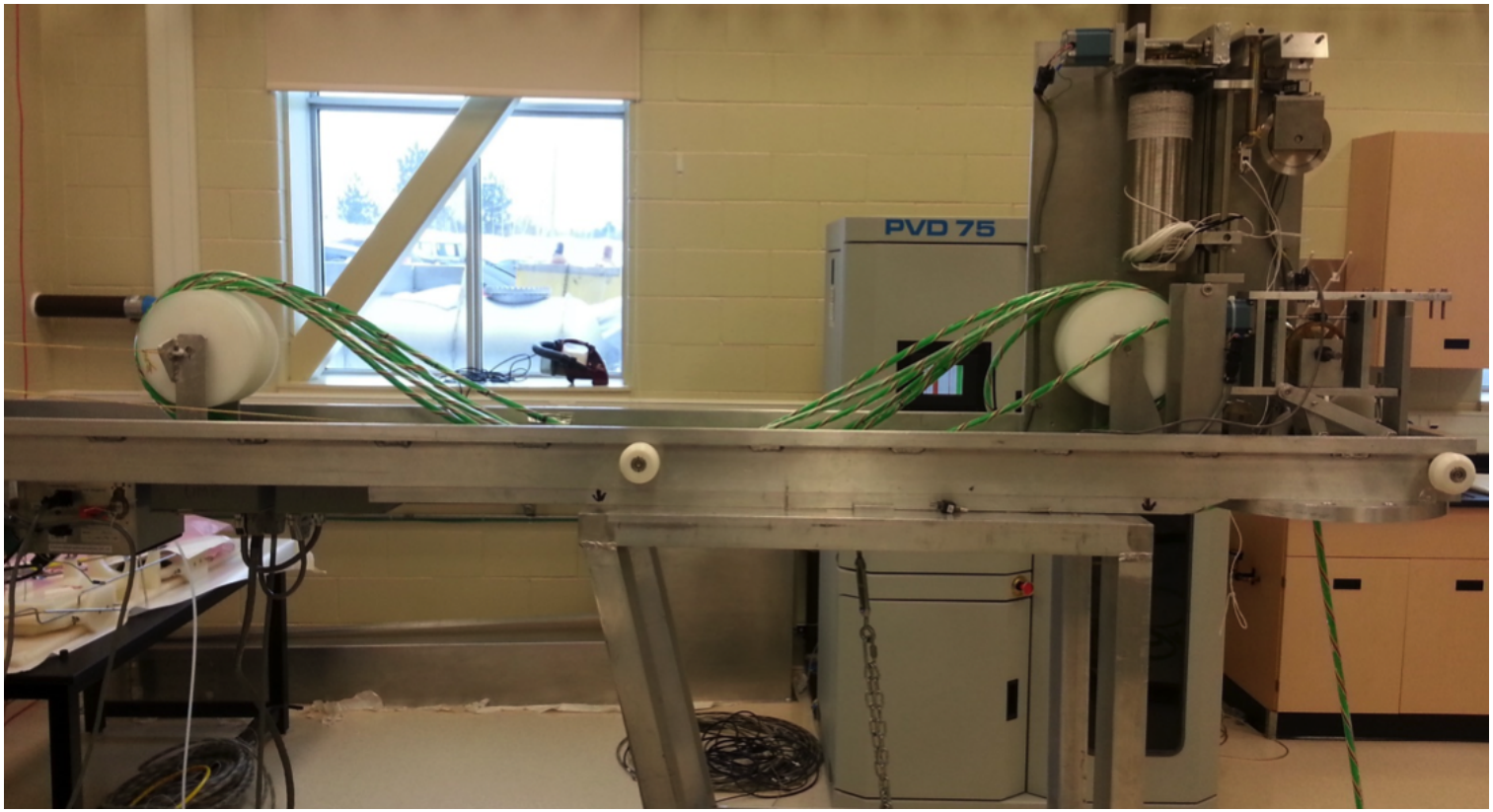








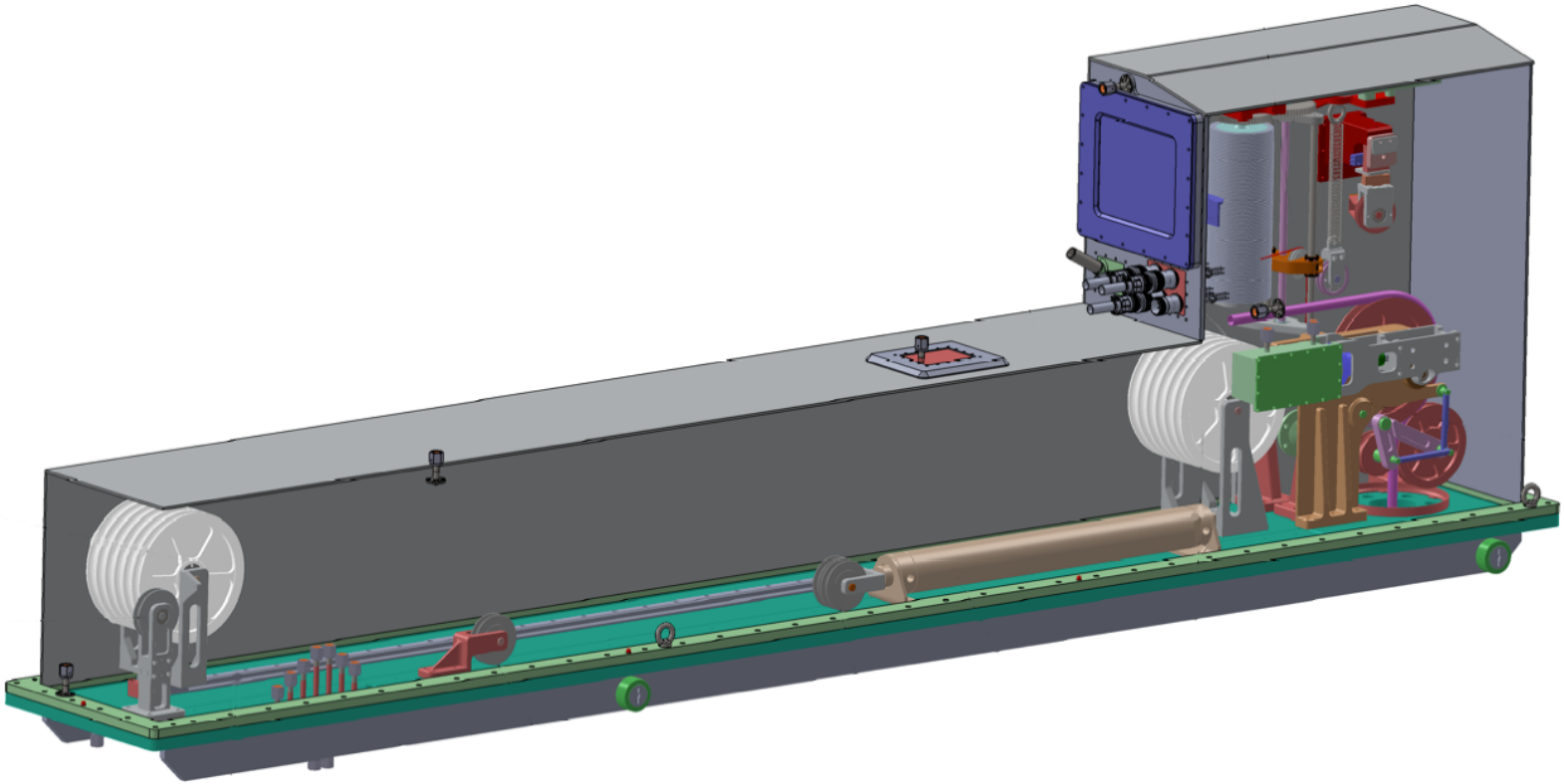
Umbilical Retrieval Mechanism - Water Fill



The Umbilical Retrieval Mechanism (URM) allows us to deploy the calibration sources to specific locations in the detector. Two original SNO URMs will be used in the water-fill phase.

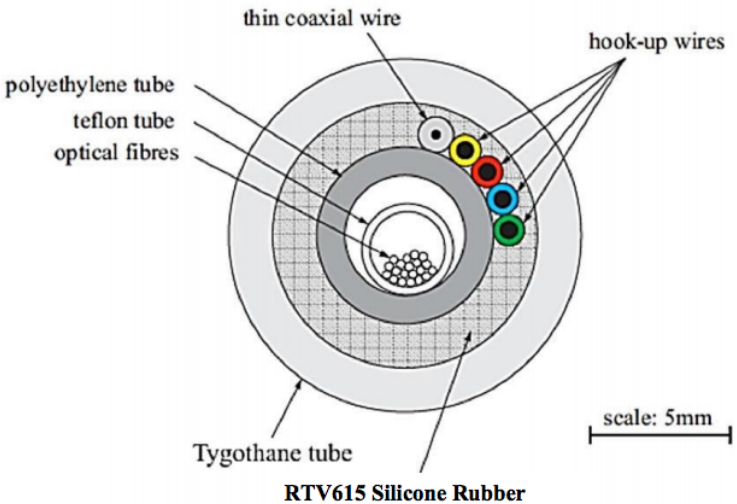
Umbilical Retrieval Mechanism - LAB Fill

After the detector is filled with LAB-based scintillator, we will use new URMs that are currently being designed at LIP-Coimbra with changes that are prototyped and tested at SNOLAB.



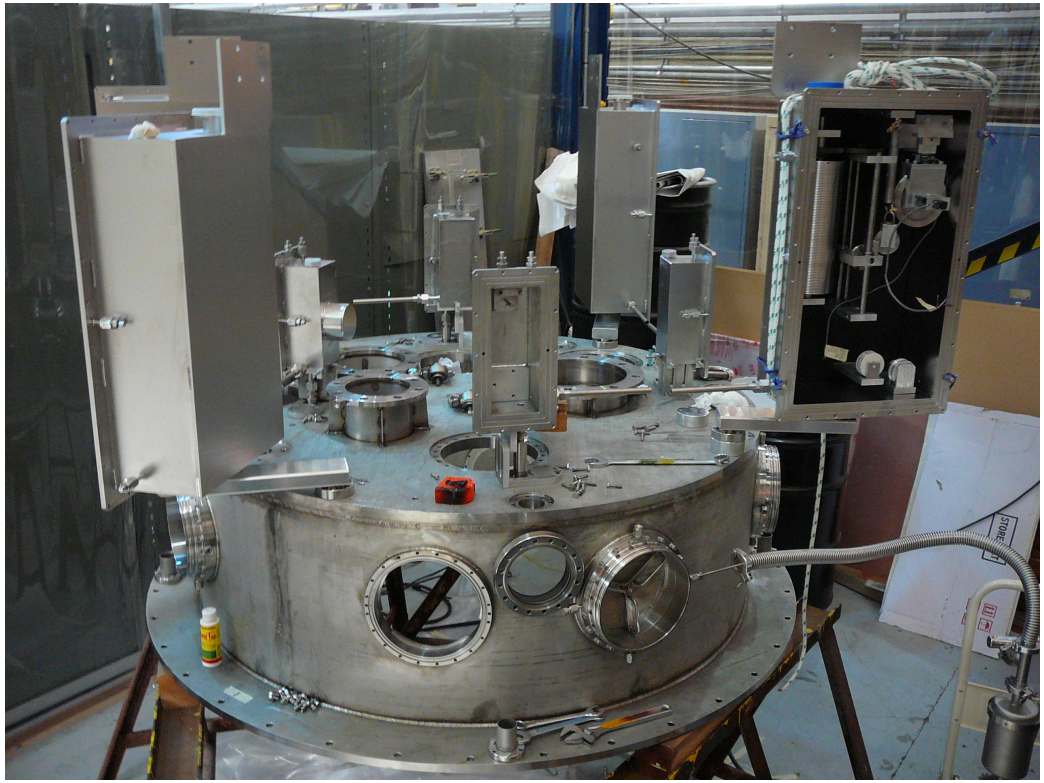
SNOLAB co-op students have been working on modifying the drive pulley system to increase the friction and tension needed to deploy a source precisely.

Source Umbilicals



The umbilical contains a co-axial cable for a PMT and wires for positioning LEDs, which surround a central tube for the deployment of gaseous sources and contains quartz fibres for the Cherenkov source.
This effort is from Queen's University.

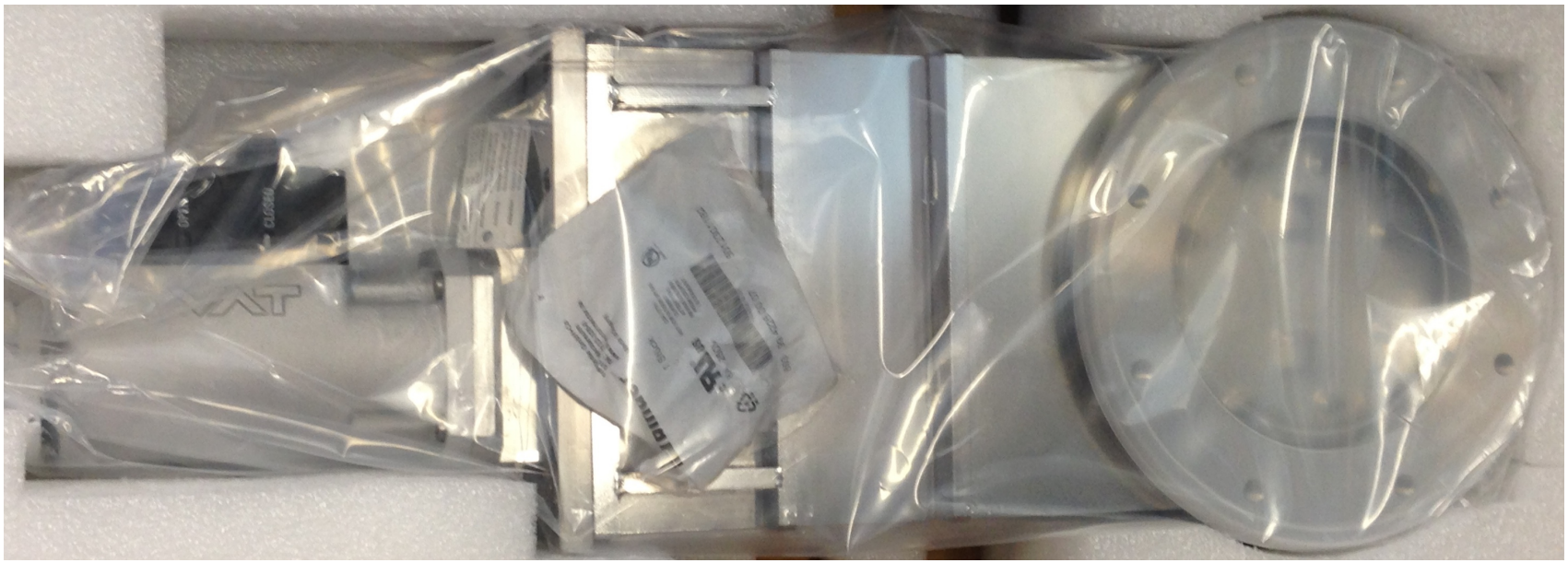
Universal Interface



The Universal Interface (UI) connects the URM and the detector. It contains many sensors providing information about liquid levels and nitrogen cover gas quality, motor boxes for the side ropes that let us deploy sources off-centre, and glove ports for attaching sources. This effort is from TRIUMF.

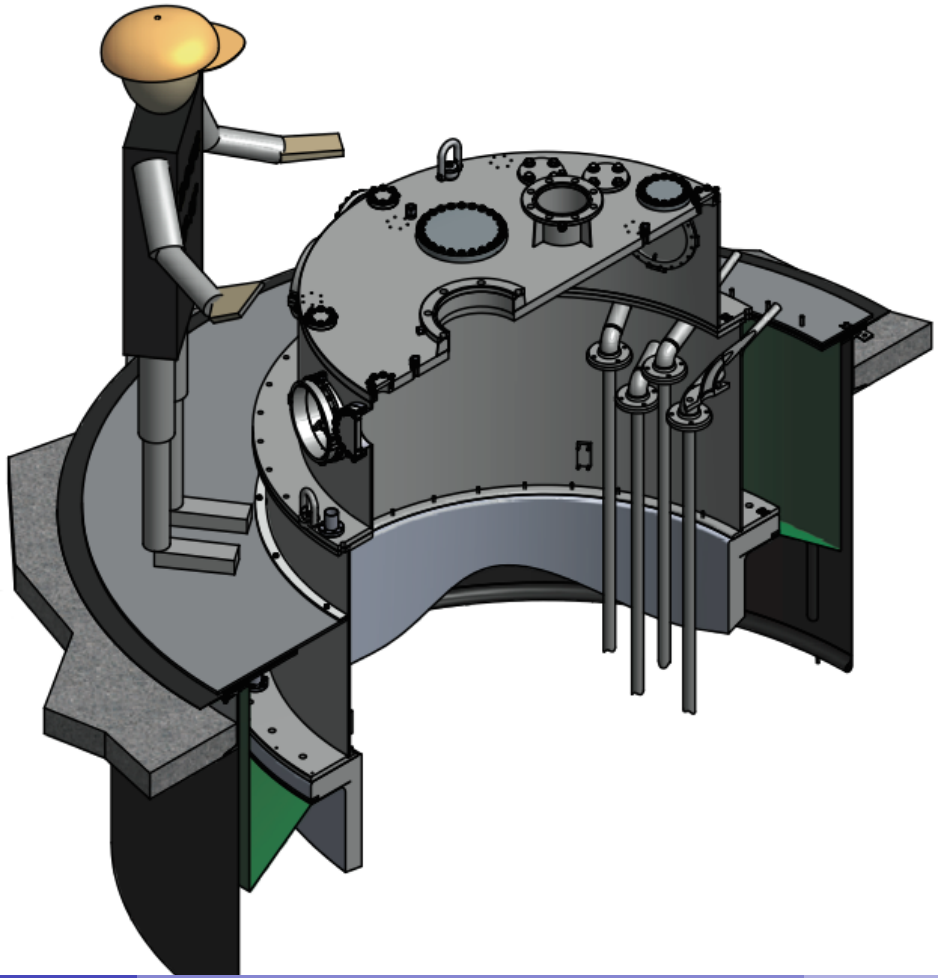
Universal Interface & Gate Valves

To avoid mine air getting into the detector, the URMs and UI are sealed and filled with nitrogen gas.
Ports where sources enter the UI will be sealed with gate valves. These gate valves will be instrumented with sensors to know with certainty when the valve is open and a source is being deployed.



Sliding Floor

Surrounding the UI is a Sliding Floor. This must be a light tight barrier between the deck and the cavity volumes surrounding the detector's neck while protecting neck and the filling pipes while providing a stable surface to work from during calibrations.

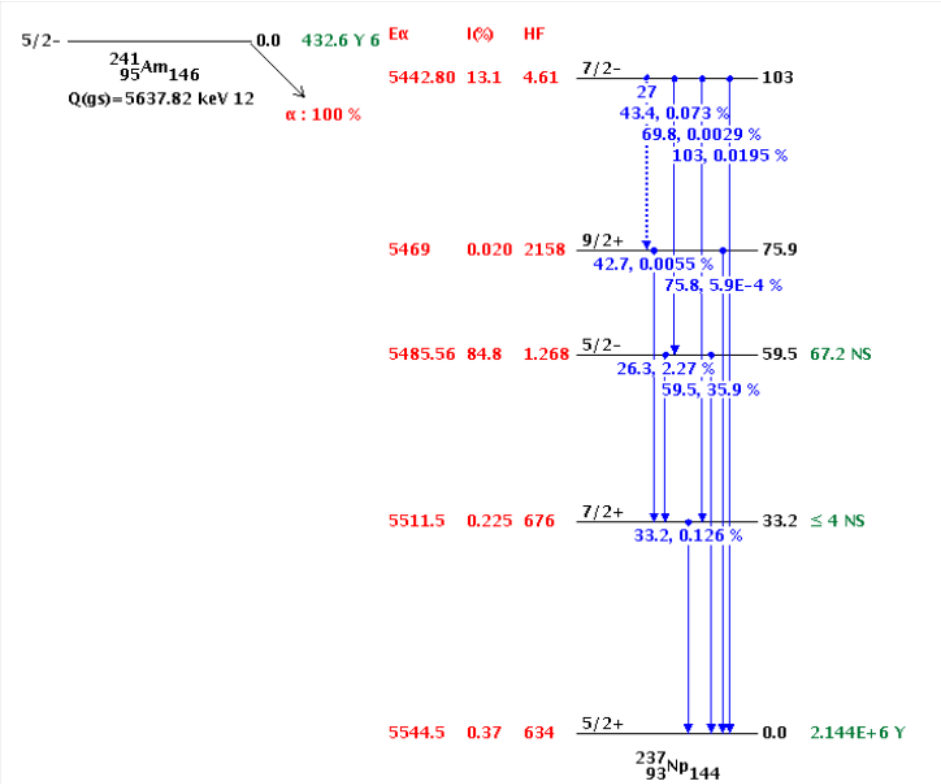


Americium-Beryllium

^{241}Am exclusively α decays. When mixed in a foil or powder with ^{9}Be, this induces

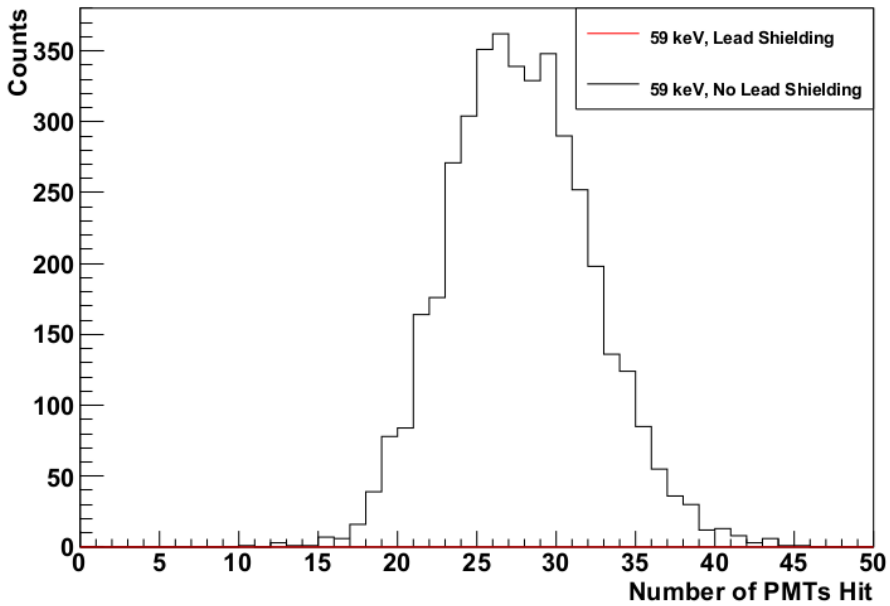
$$^{9}\mathrm{Be}(\alpha, n)^{12}\mathrm{C}.$$

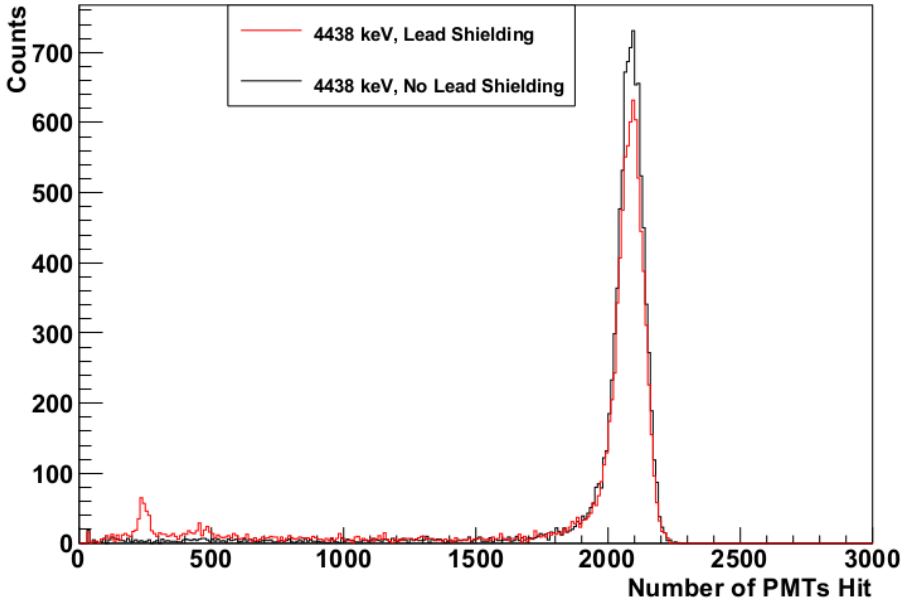
Depending on the energy of the neutron released, ^{12}C may be in an excited state and releases a 4.438 MeV γ. We will use this source to measure the detector's energy scale, energy resolution, and our vertex reconstruction.



Americium-Beryllium

To block the x-rays associated with α-decay, we will shield the source with a few millimetres of lead to avoid blinding our detector. I am also working on improving the simulation of this source.





Current Status and Future Steps

- SNO+ is currently filling with water, should finish this summer.
- Installation of Sliding Floor and Universal Interface will happen this summer.
- We will take data during water fill to study our backgrounds, commission the optical calibration systems, and start physics analysis.
- Scintillator process plant commissioning and start of scintillator fill in 2015.