

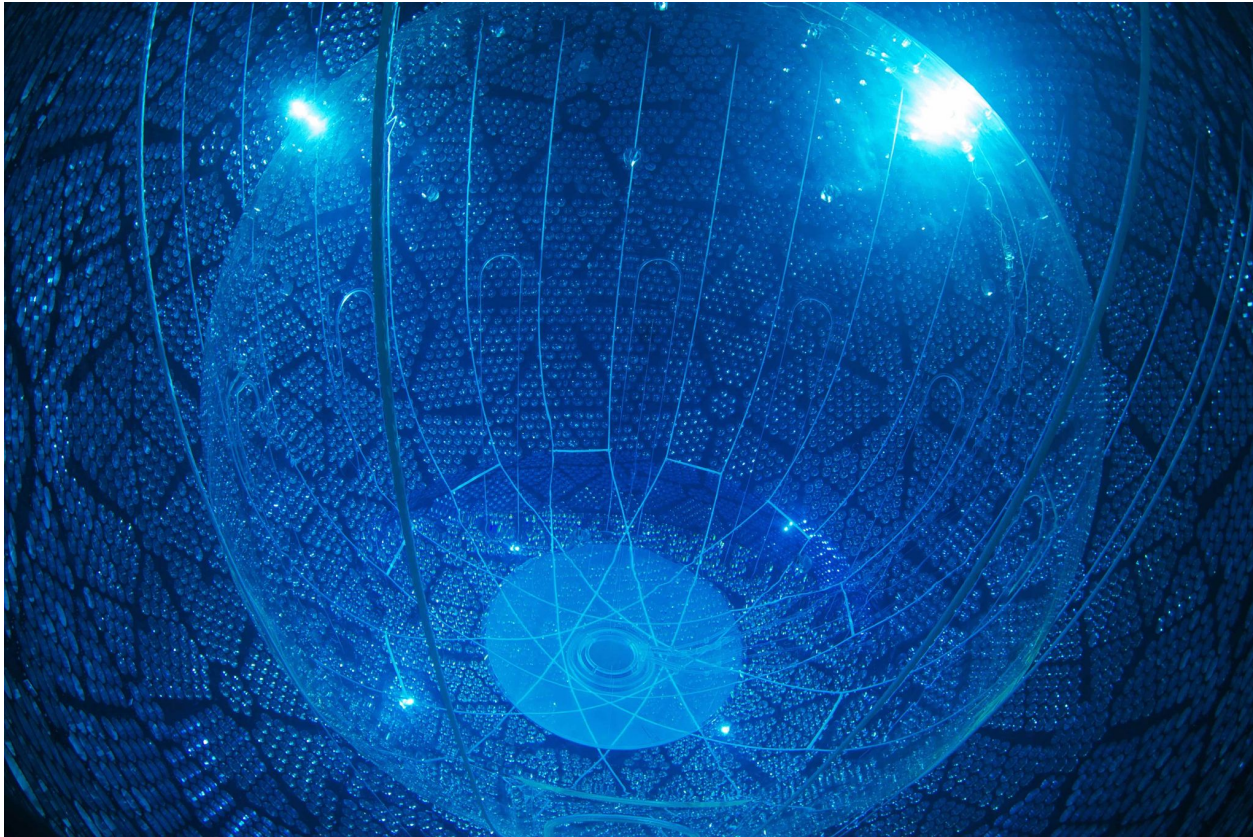
Studying Muon Events Within SNO+

Victoria Howard



LaurentianUniversity
Université**Laurentienne**

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- SNO+ is a liquid organic scintillator detector that is aiming to study neutrinos.
- The detector is located 2km (~1.2 mi) below ground.

Phases of the Experiment

Phase 1 "Water Phase"

Detector filled with light water.

Completed

Phase 2 "Scintillator Phase"

Light water replaced with scintillator.

In progress

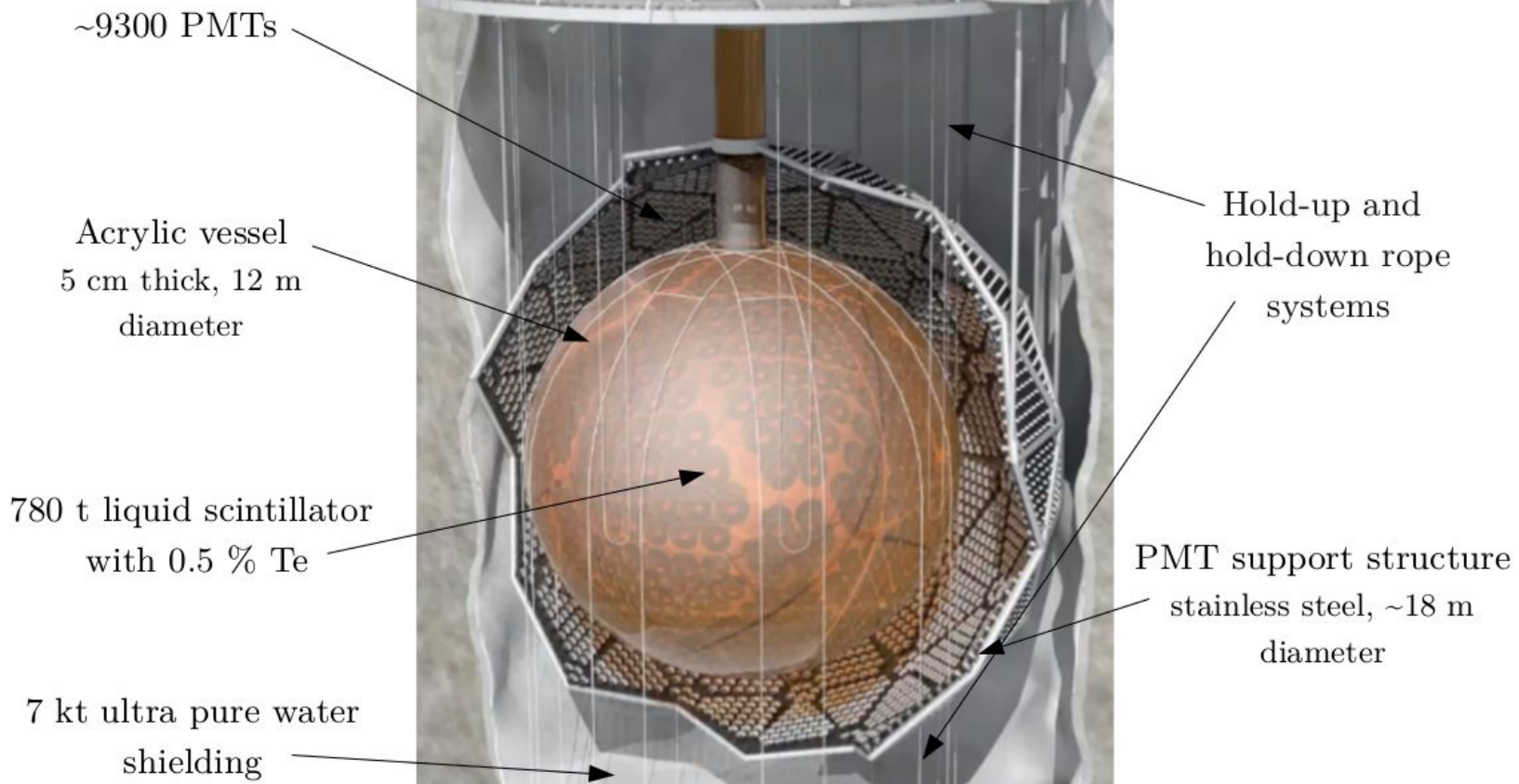
Phase 3 "Tellurium Phase"

3.9 tonnes of natural tellurium added into scintillator.

In preparation

Goals of the Experiment

- Search for the neutrinoless double beta decay.
- Measure the lifetime of the two-neutrino double beta decay.
- Measuring of geoneutrinos.
- Observation of reactor antineutrino oscillations.
- Supernova neutrino monitoring.
- Searching for exotic physics.



How Does SNO+ Detect Neutrinos?

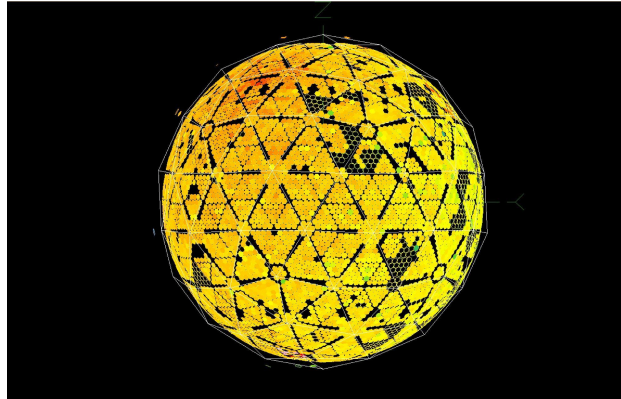
- For an observable neutrino to occur, it must first interact to produce a charged particle.
- Interactions can be with particles such as electrons and nuclei.
- Once the interaction has occurred, light is produced as the charged particle passes through the scintillator.
- This light is detected by the PMTs.



What I did this summer...

What is Tagged as a Muon?

- A muon is an elementary particle that is classified as a lepton.
- When a muon comes through the detector, a lot of hits will be seen due to energy.
- There are two main criteria for tagging muons.
 1. Large nHit values (number of hit PMTs per event)
 2. A high number of OWL (OutWard Looking PMT) hits

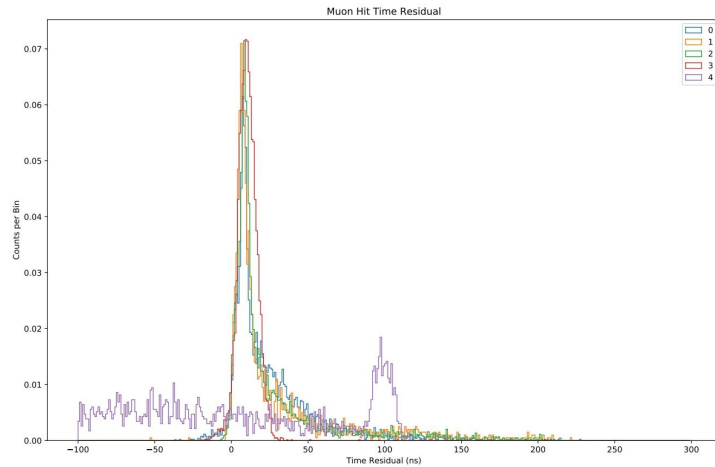


Interesting Muon Events

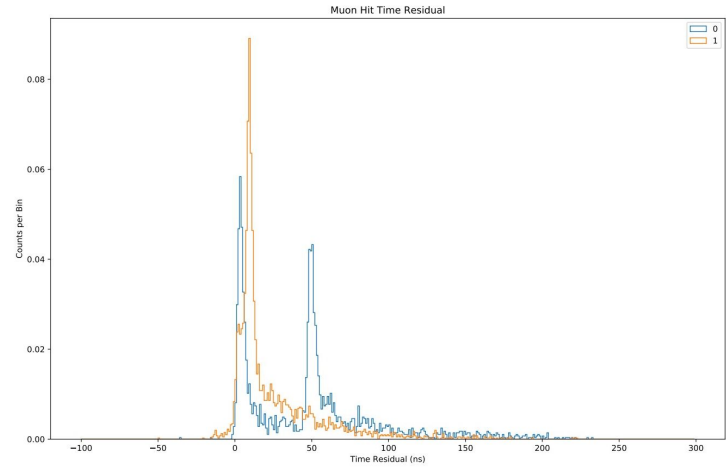
- 10 different runs were looked at.
- Each was tagged as having multiple muon events.
- The runs selected had the following criteria:
 1. Must be a physics run.
 2. Preferably during a time when no one was UG (easy confirmation no one was on deck).
 3. No weird events or breakdowns seemed to be going on.

Interesting Muon Events

- Hit time residual plots were made for all of the tagged muon events, and two different types of interesting plots were found.



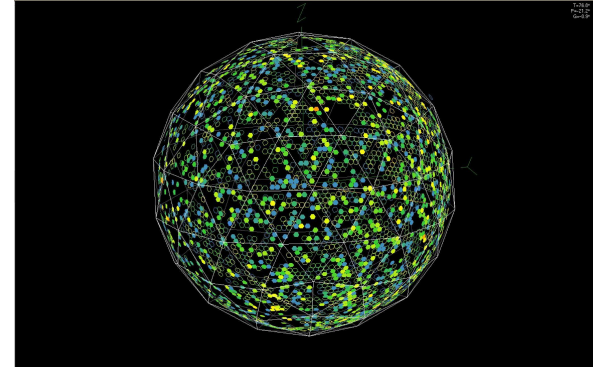
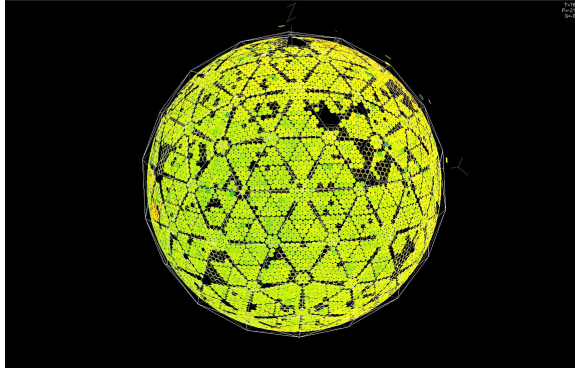
100ns bump



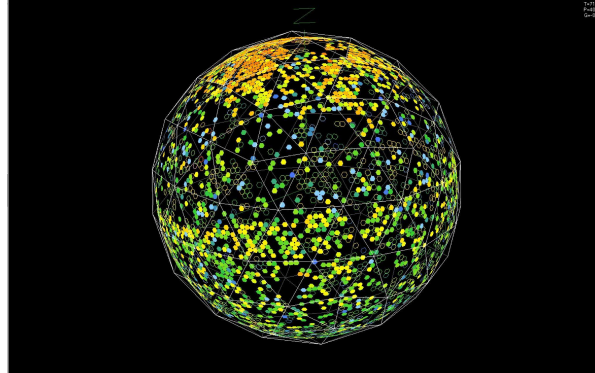
Double peak

Muons in xsnoed

- Since there were multiple instances of the two interesting hit time residual plots, the zdab files were downloaded and put into xsnoed to see what the events looked like in the detector.
- xsnoed is a graphical representation of the detector.
- zdab files are the raw data.



The tagged muon event followed by the 100ns bump.



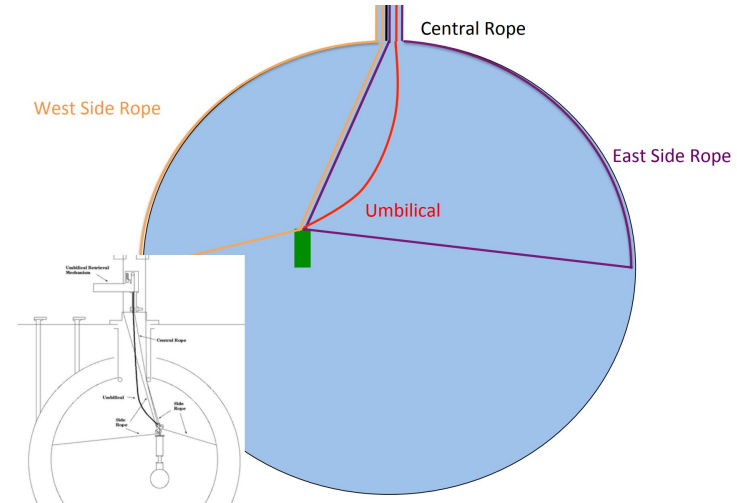
Double peak

Muons in xsnoed

- From what was seen in xsnoed the following can be concluded:
 1. The 100ns bumps are most likely caused by some type of reflection within the AV (the timing between muon and the next event seems to indicate this).
 2. The double peaks are the so-called “neck events” that have been observed since around February-March, there is still no conclusion as to what these events are.

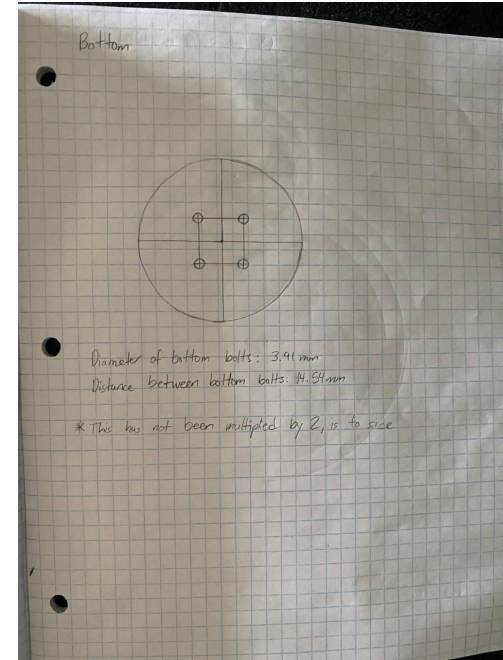
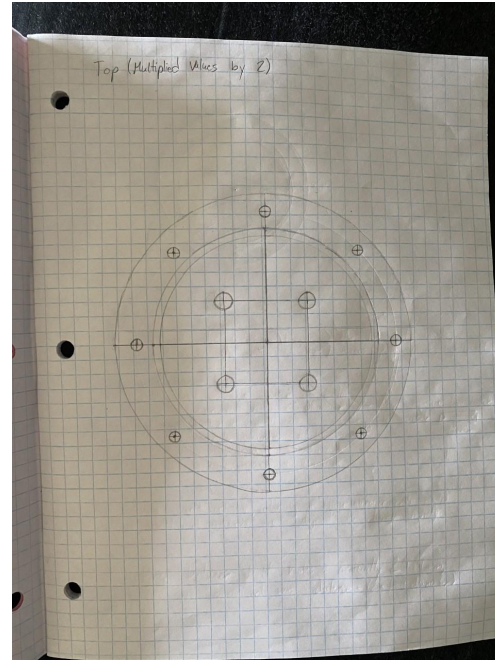
Calibration

- Materials need to be compatible with scintillator.
- Materials need to be of high radiopurity.
- The new calibration system must be clean enough to not add to the very stringent background requirements.



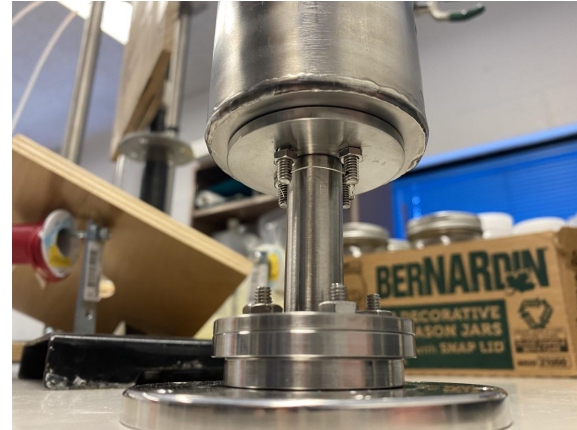
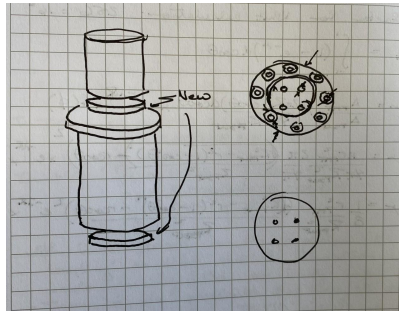
URM Dummy Source

- Design on the URM dummy source is completed
- The dummy source will be used to commission the manipulator system that allows sources to be moved inside the AV (acrylic vessel).
- This has not yet been done.
- Currently the dummy source is mostly assembled.
- Two pieces have been ordered that will allow for the assembly of the dummy source to continue.



URM Dummy Source

- The top piece is intended to connect the source connector to the weight (top two pictures).
- The bottom piece is intended to close off the bottom hole (bottom picture).



URM Commissioning

- The cover of URM4 was recently removed so the inside could be cleaned with UPW.
- It was moved from the temporary cart it was on to an adjustable one.



Umbilical Cleaning Vessel

- The umbilical needs to be soaked in LAB for ~1 month to get the optimal cleanliness before installation to URM4.
- A document was made with a rough plan for cleaning the umbilical.
- In addition to the soak, a nitrogen bath will be utilized to reduce radon exposure.
- This plan is subject to change depending on what is doable and pending the review by the SNO+ source committee.
- As of right now, vessels are being looked at, though the lid of the chosen vessel will need to be altered.



Thank you for listening!