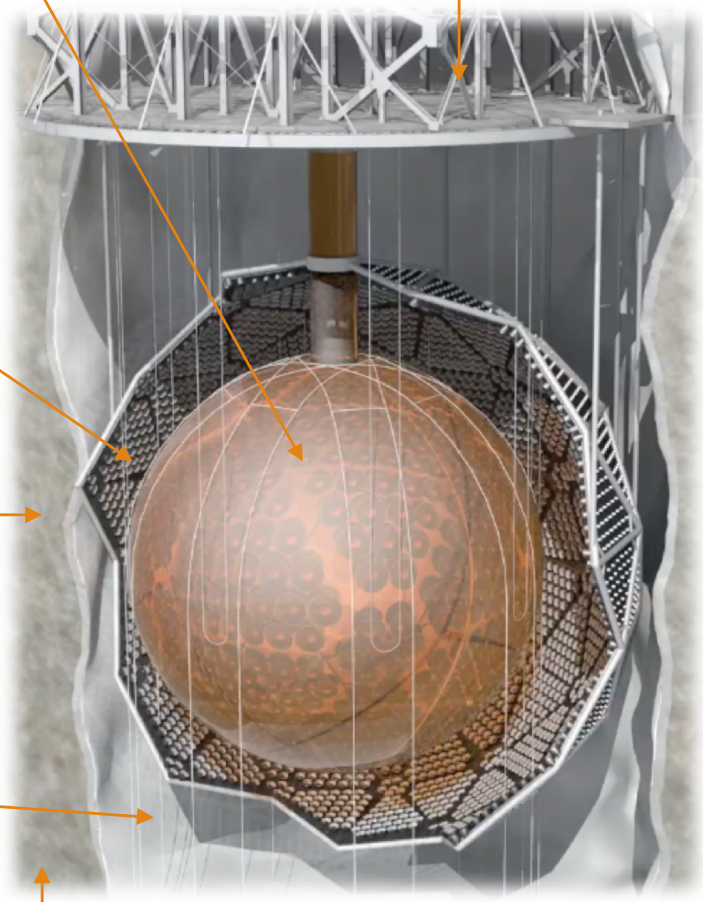
Current status of the SNO+ experiment

IOP JOINT APP AND HEPP MEETING

What is SNO+?



- Low background neutrino experiment
- Primary physics goal is to search for Neutrinoless Double Beta Decay.
- Phased experiment:
  - Water phase
  - Pure scintillator phase
  - Loaded scintillator phase

Loaded scintillator ($0\nu\beta\beta$) phase:

- Loaded with 0.5% Natural Te
- ~400 PMT Hits / MeV
- $T_{1/2}^{0\nu} > 1.9 \times 10^{26}$ years, counting analysis

What's the timeline?

2016 November:
- Water fill completed

2016 December:
- Detector commissioning data

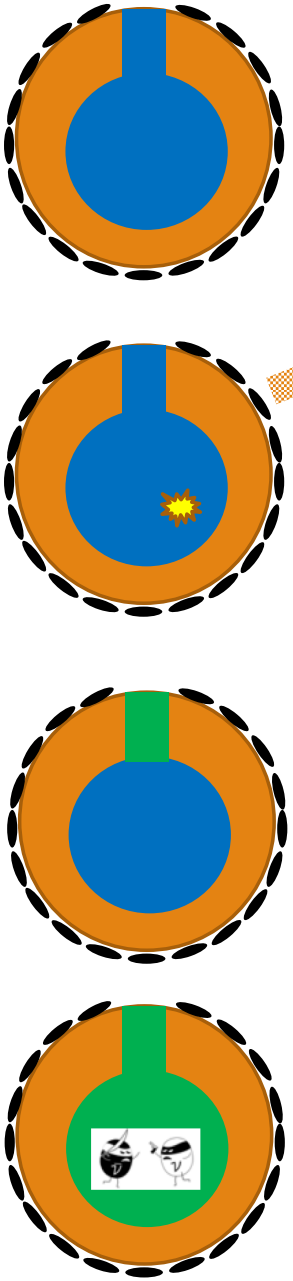
2017 May:
- Physics data taking begins

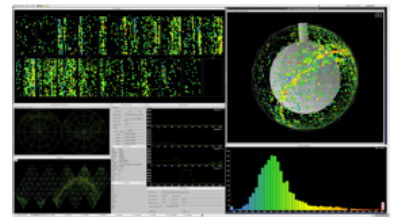
NOW

2018 Summer:
- Begin scintillator fill
- ***Water phase physics results***

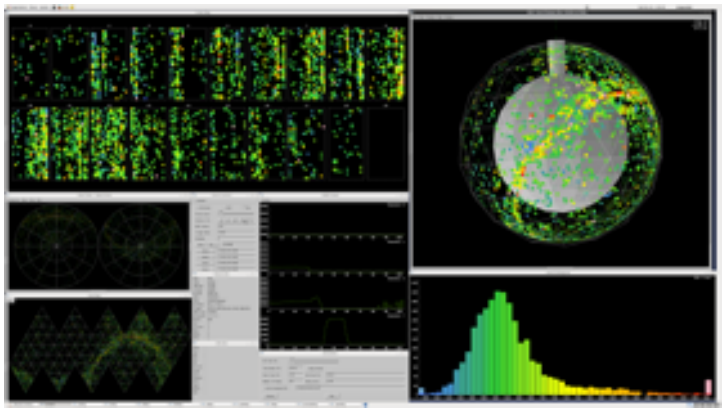
2018 Winter:
- Scintillator backgrounds phase

2019 Spring:
- **Isotope deployment**



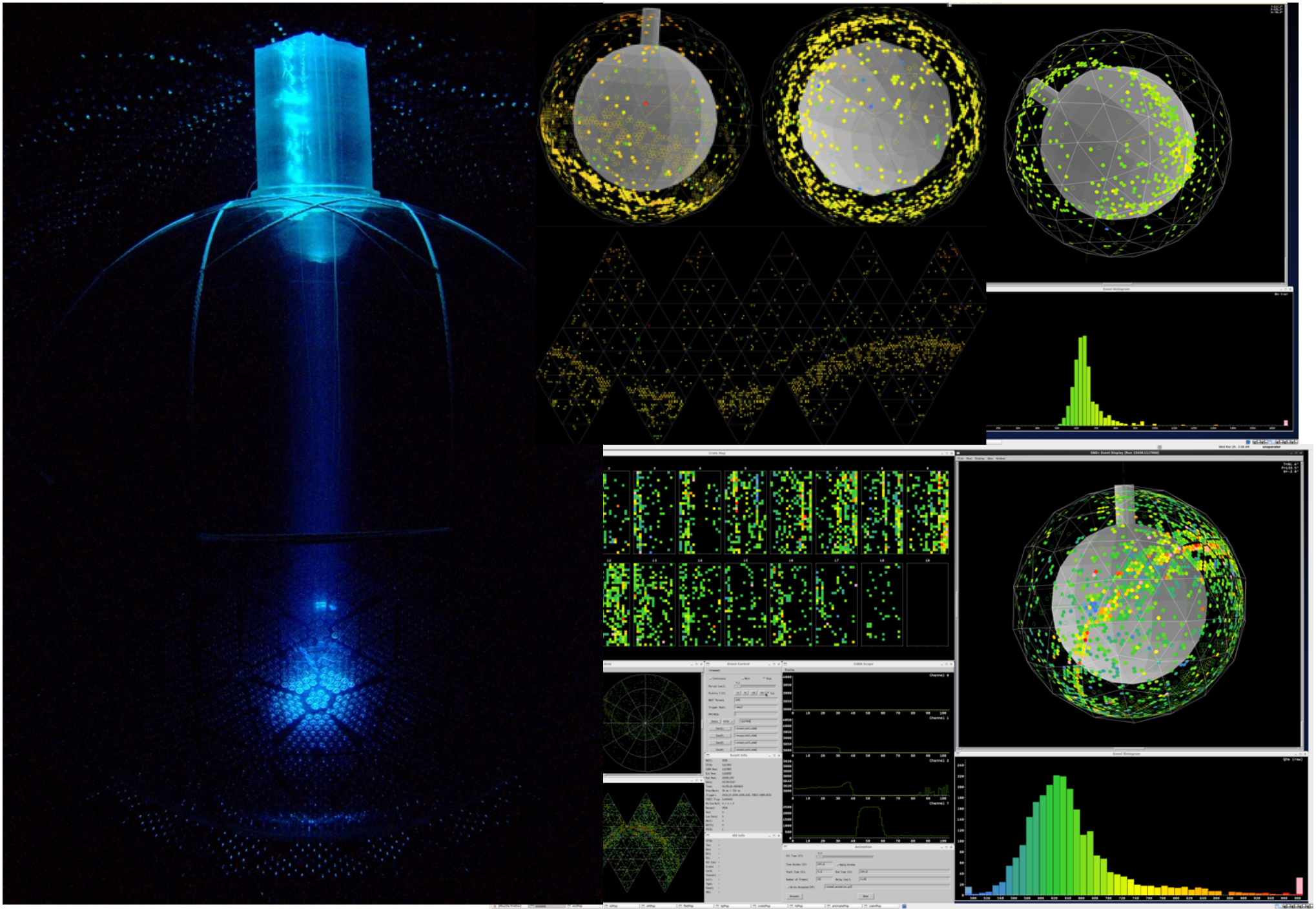


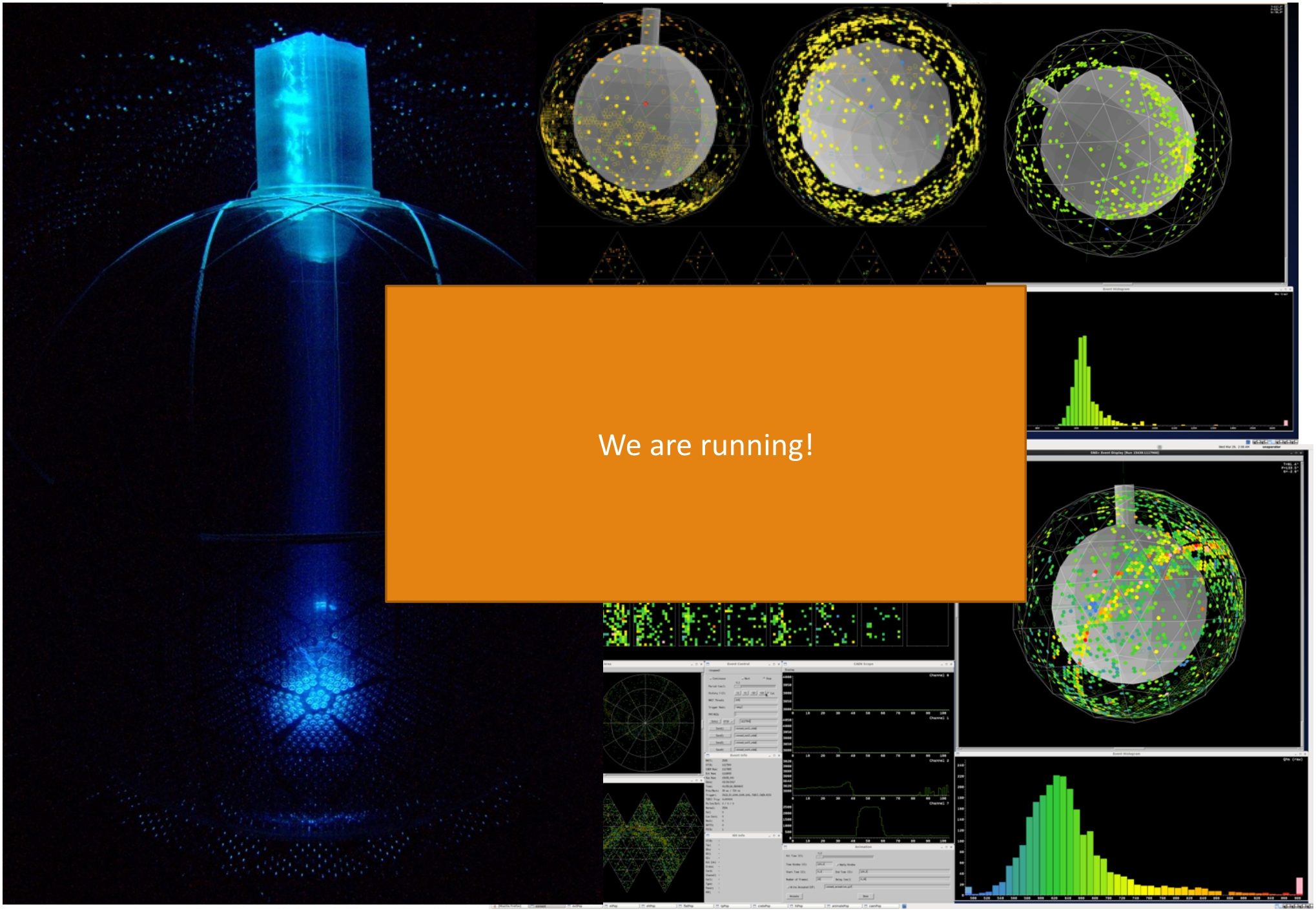
First results coming soon!



What does the data look like?

WATER PHASE DATA BEING ACQUIRED NOW





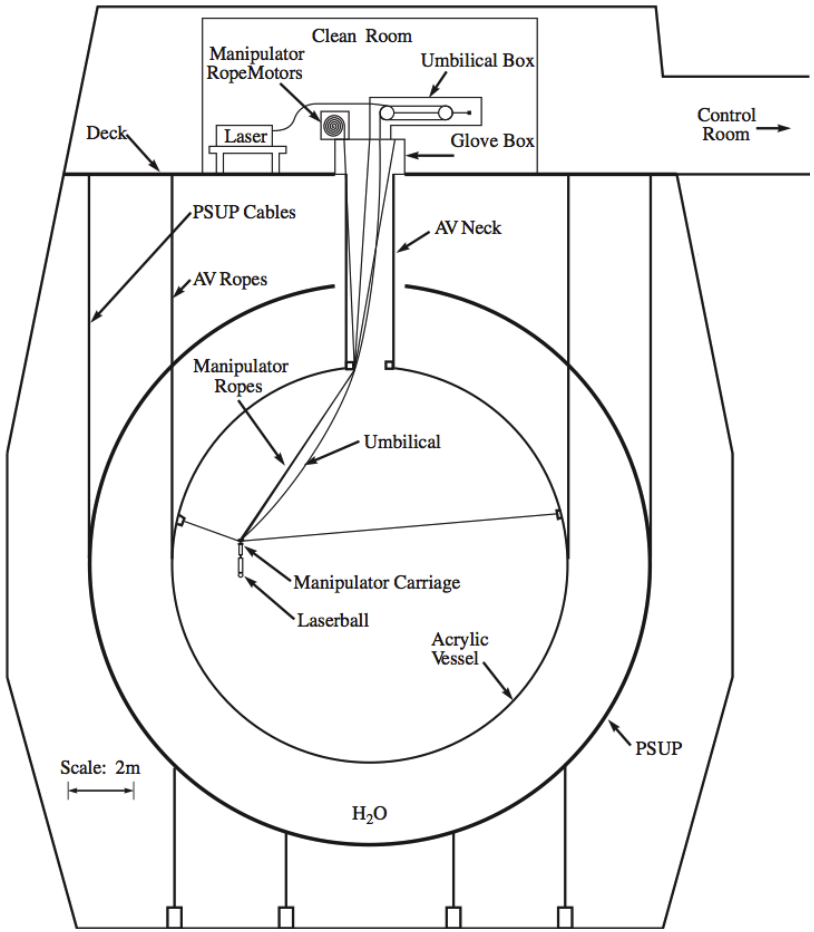
We are running!

What are we doing with water phase data?

FIRST RESULTS EXPECTED THIS SUMMER!

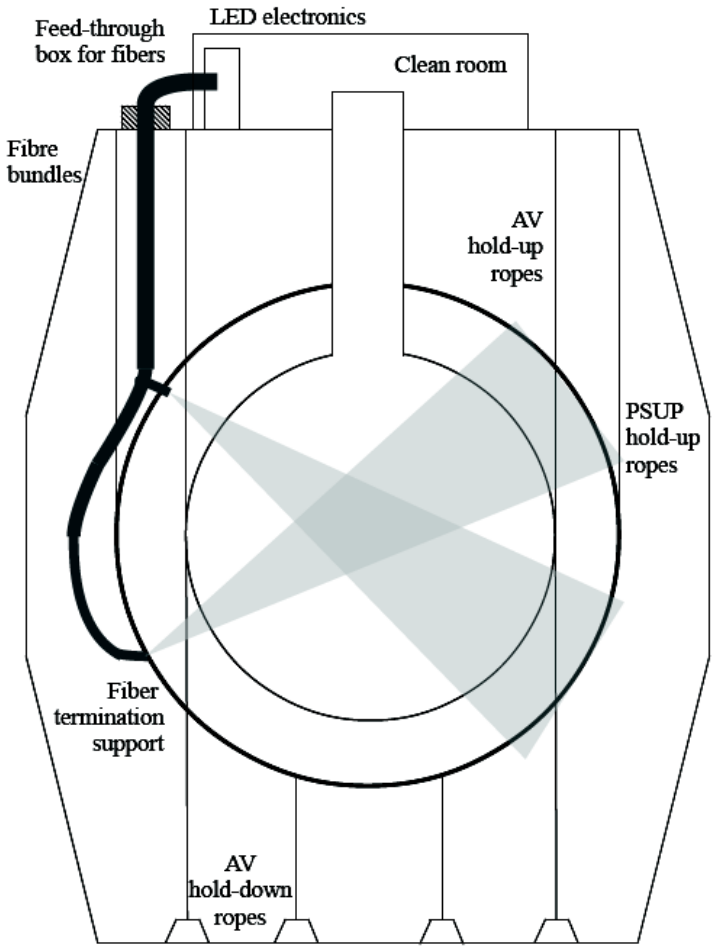
How do we get to the physics?

Deployed sources



External sources

Embedded LED/Laser Light Injection Entity (ELLIE)



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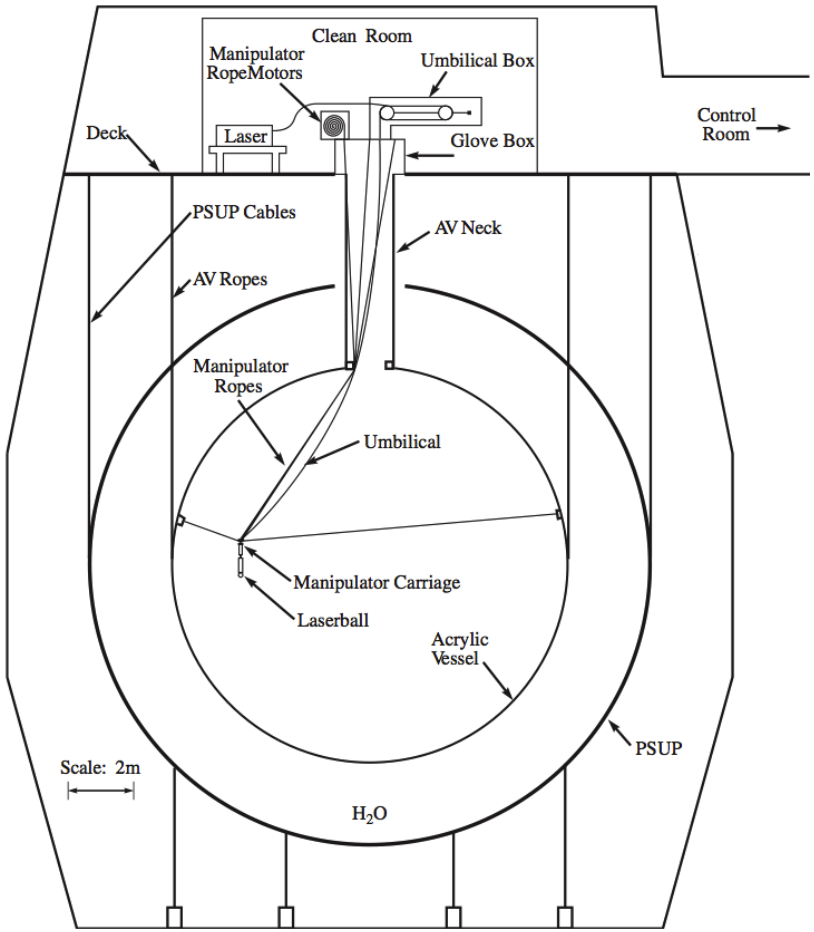

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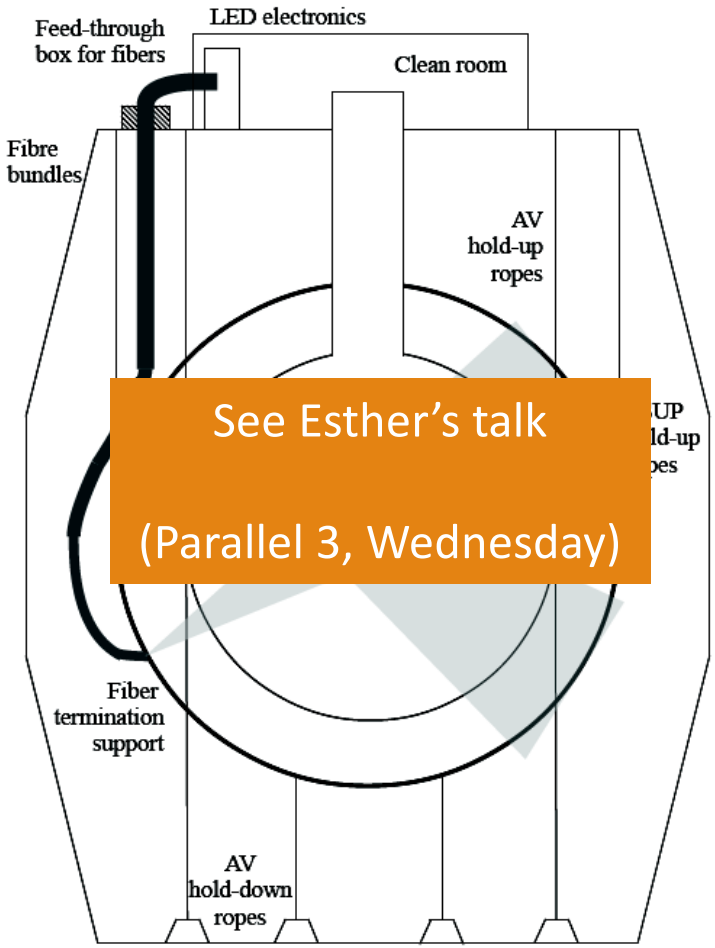
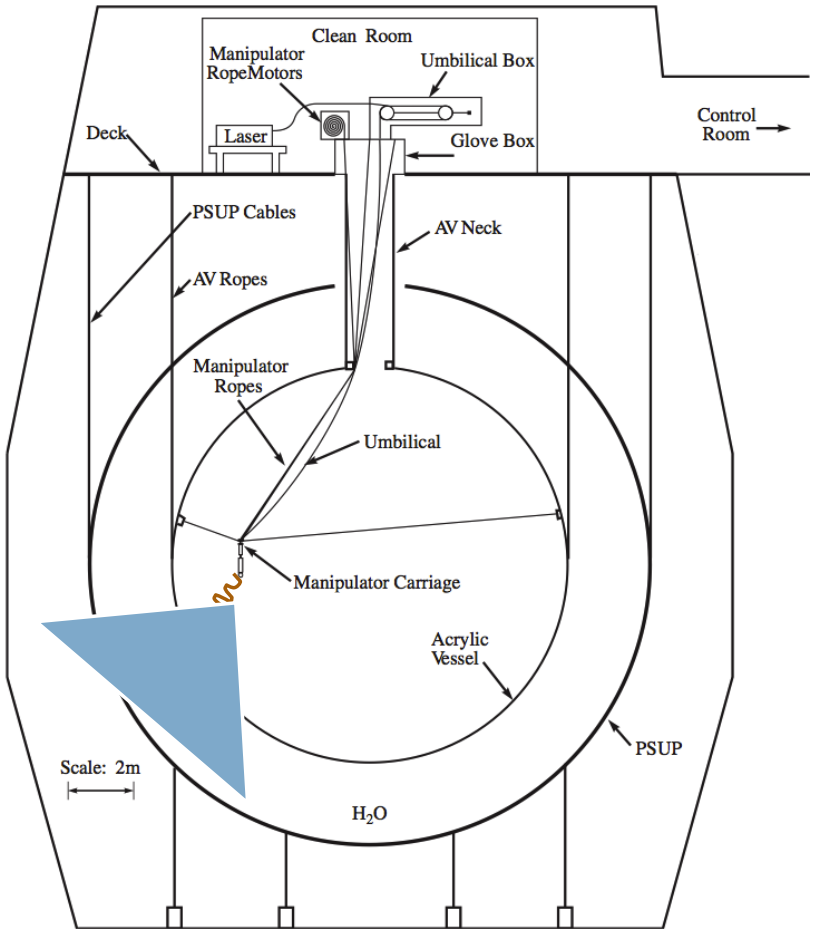


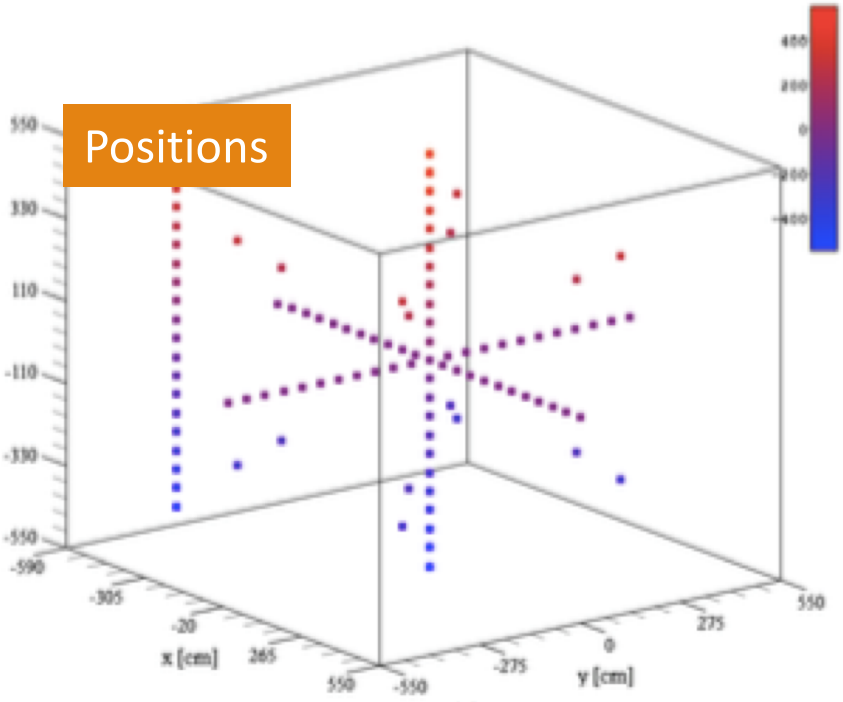
See Esther's talk

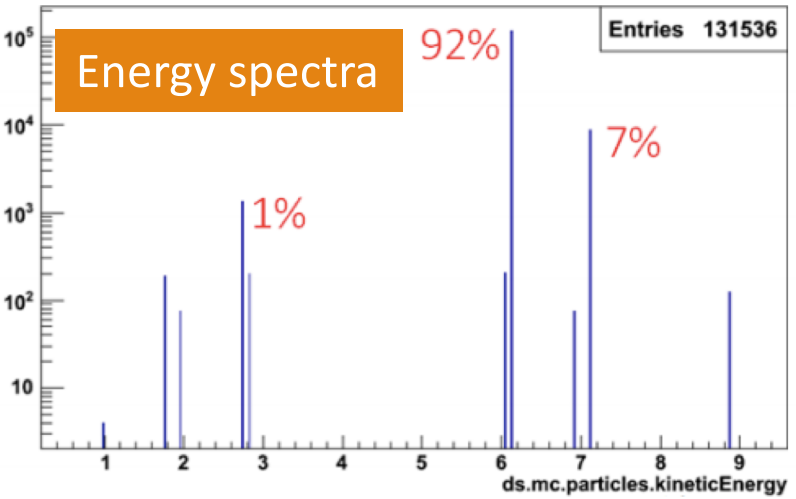
(Parallel 3, Wednesday)

How do we get to the physics?

N16 source

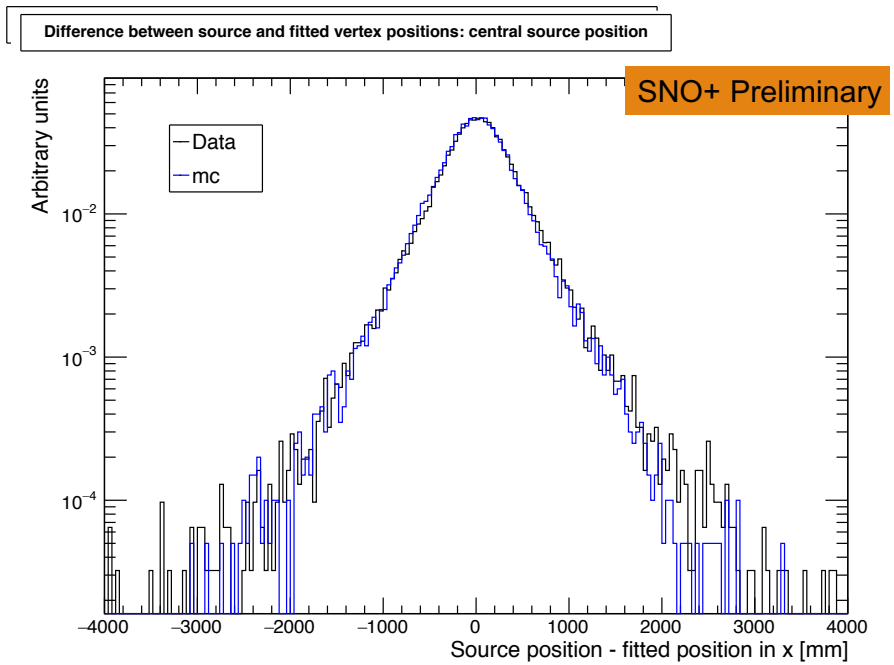




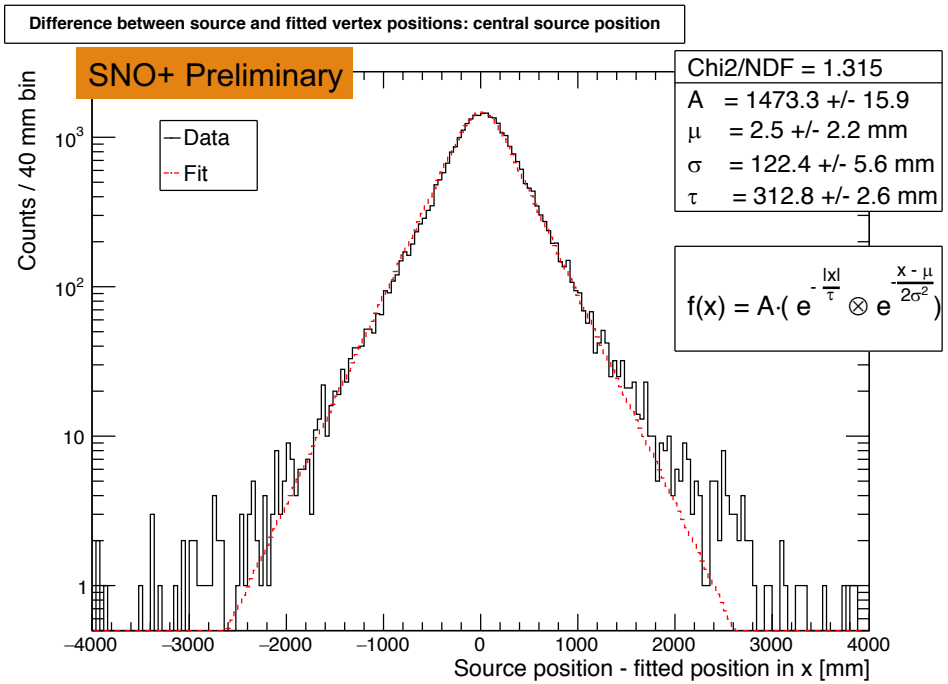


N16 Source: Position systematic

Data vs mc comparisons



Quantify reconstruction performance

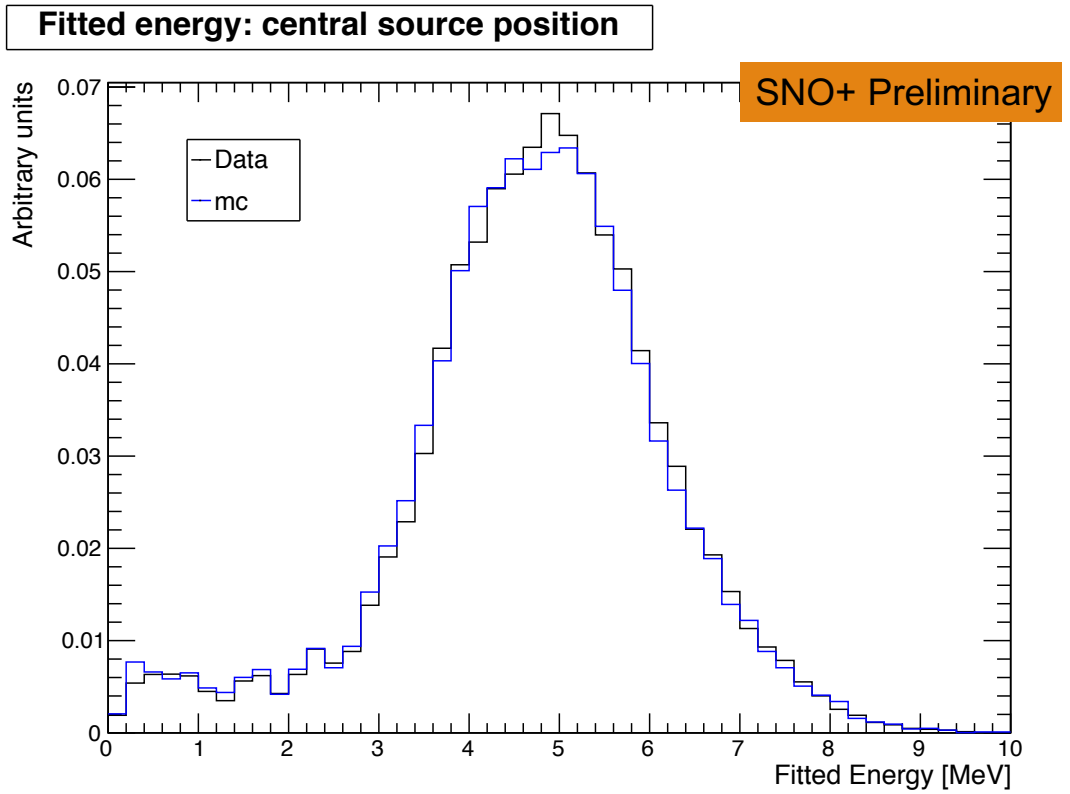


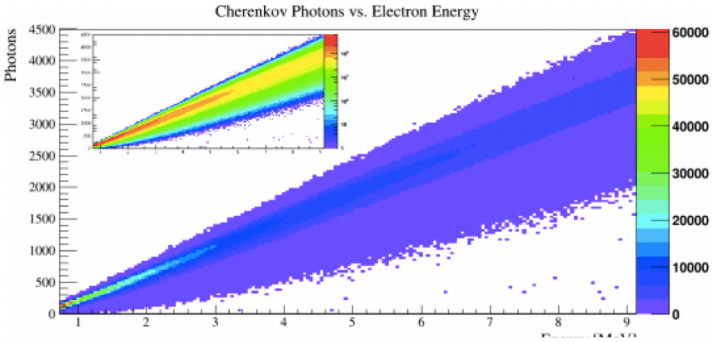
	Data	MC	Data – MC
μ	2.5 +/- 2.2	-17.4 +/- 2.7	**19.9 +/- 3.5 mm**
σ	122.4 +/- 5.6	138.1 +/- 6.7	**-15.7 +/- 8.7 mm**
τ	312.8 +/- 2.6	297.7 +/- 3.4	**15.1 +/- 4.3 mm**

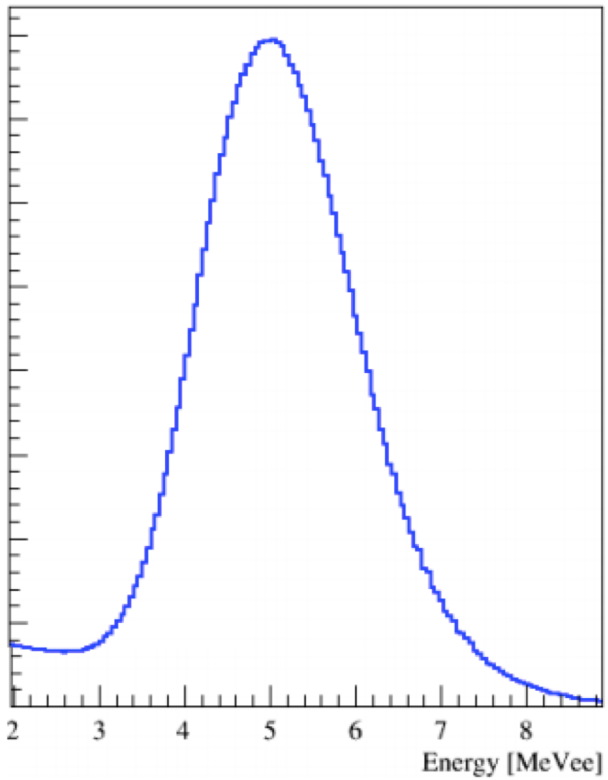
$$f(x) = A \cdot (e^{-\frac{|x|}{\tau}} * e^{-\frac{(x-\mu)^2}{2\sigma^2}})$$

μ: Bias in reconstructed position
σ: Resolution of reconstructed position
τ: Exponential due to gamma interaction length

N16 Source: Energy Systematic



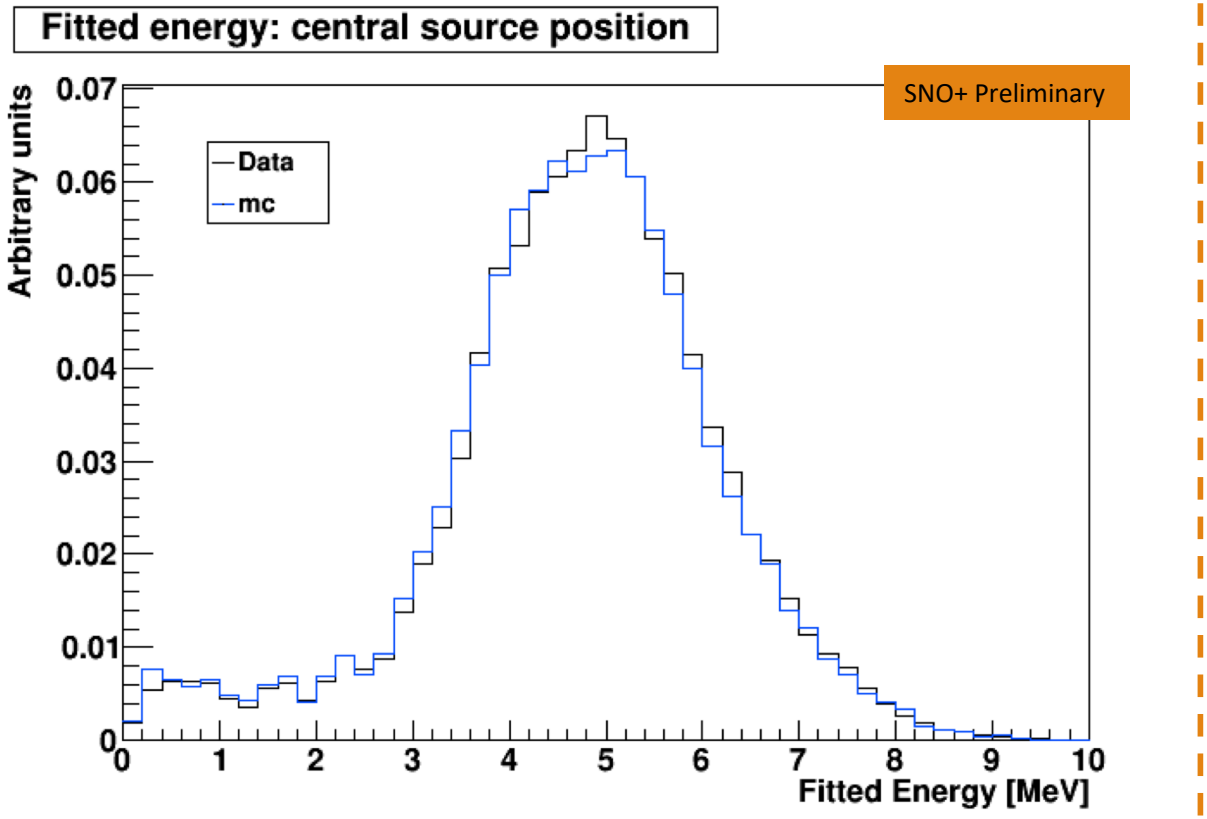


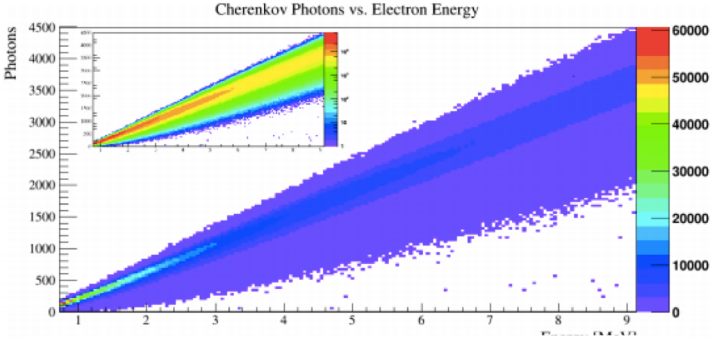


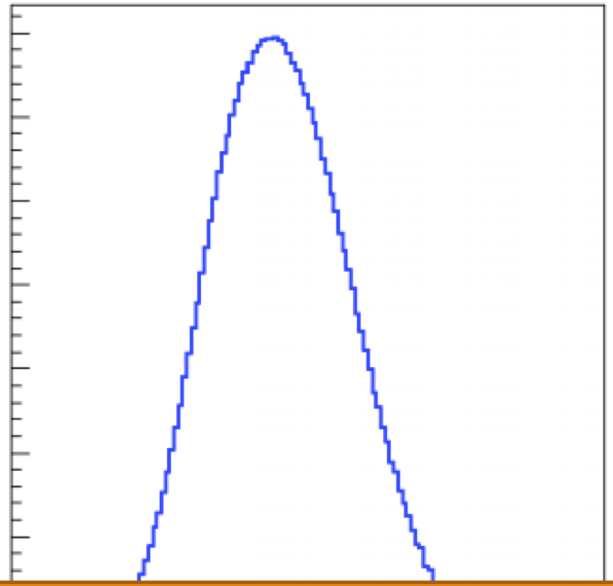
- Simulate number of Cerenkov photons in N16 event
- From simulation of electrons, relate the number of photons to an energy distribution
- Fit convolution of energy distribution with Gaussian

$$P(T_{eff}) = N \int P_{source}(E_e) \frac{1}{\sqrt{2\pi\sigma}} e^{-\frac{((1+\delta_E)T_{eff} - E_e)^2}{2\sigma^2}} dE_e$$

N16 Source: Energy Systematic

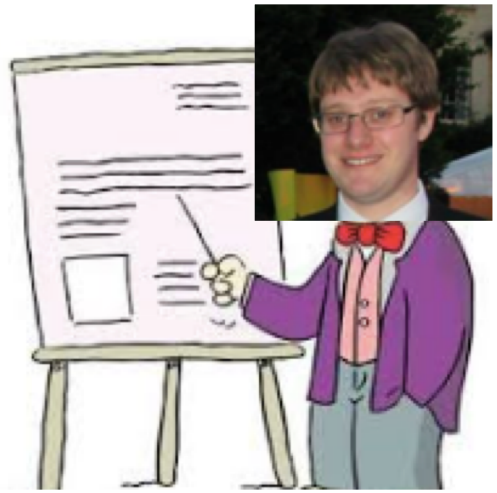






Many more higher order considerations!

What can we measure in water phase?



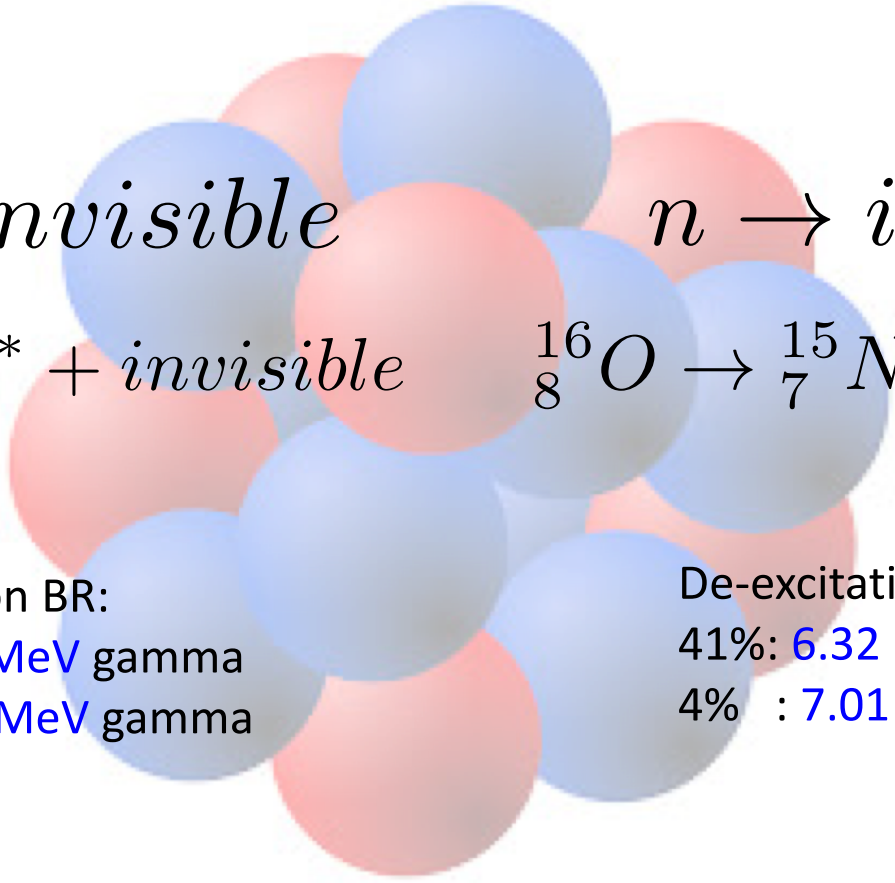
NUCLEON DECAY LIMITS EXPECTED THIS SUMMER

Invisible nucleon decay

Search for nucleons decaying to ‘invisible’ particles (i.e. those which give no signal in a water Cerenkov detector) signaling a violation of Baryon number conservation.

$$p \rightarrow invisible \qquad n \rightarrow invisible$$

$$^{16}_{8}O \rightarrow ^{15}_{8}O^{*} + invisible \qquad ^{16}_{8}O \rightarrow ^{15}_{7}N^{*} + invisible$$



De-excitation BR:
44% : 6.18 MeV gamma
2% : 7.03 MeV gamma

De-excitation BR:
41%: 6.32 MeV gamma
4% : 7.01 MeV gamma

http://dx.doi.org/10.1103/PhysRevC.48.1442

Invisible nucleon decay

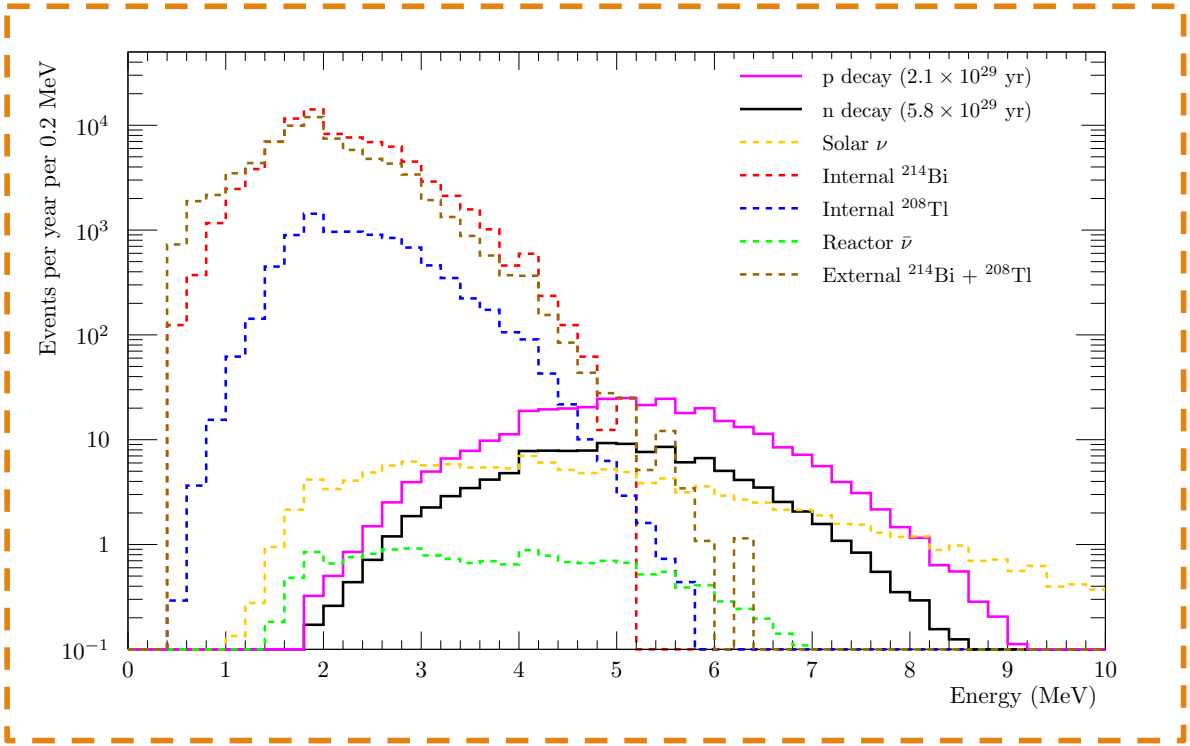
$$\tau > \frac{N_{nucleons} \times \epsilon \times f_T}{S_{90\%}}$$

$N_{nucleons}$ = 2.4 x 10^{32}

ε is the efficiency of detecting the decay in the signal window

f_T = 0.25; the livetime in years.

S_{90} is the expected signal events at 90% confidence limit



Projected Sensitivities:

$\tau_n > 1.25 \times 10^{30}$ [years]

KamLAND: $\tau_n > 5.8 \times 10^{29}$ years

http://arxiv.org/abs/hep-ex/0512059

$\tau_p > 1.38 \times 10^{30}$ [years]

SNO: $\tau_p > 3.9 \times 10^{29}$ years

https://arxiv.org/abs/hep-ex/0310030

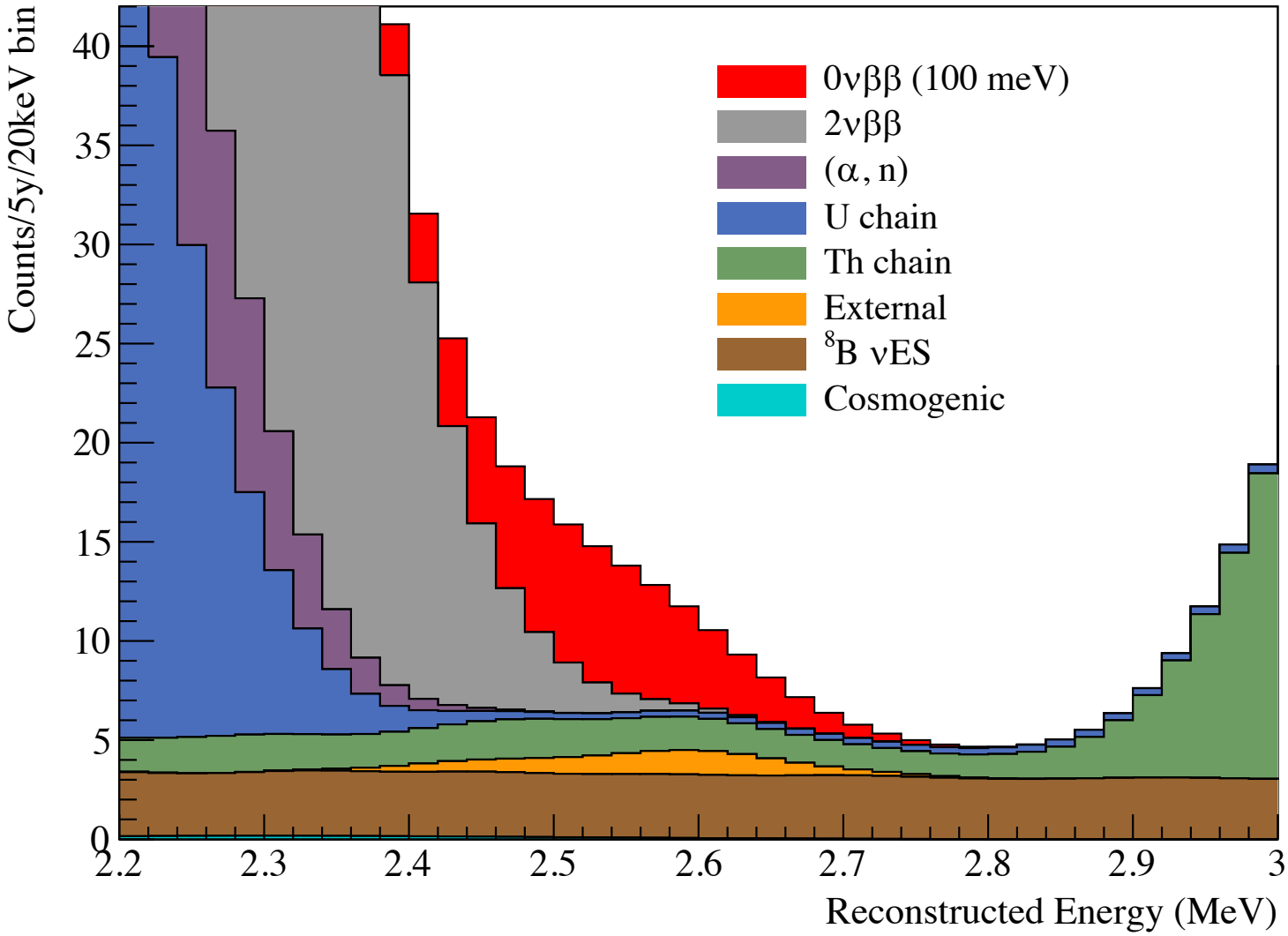
Thanks!

SNO+ IS NOW AN ACTIVE, RUNNING EXPERIMENT

PHYSICS RESULTS THIS SUMMER

TELLURIUM LOADING: SPRING 2019

FV = 3300;


Counts/5y/20keV bin
0
5
10
15
20
25
30
35
40
2.2
2.3
2.4
2.5
2.6
2.7
2.8
2.9
3
Reconstructed Energy (MeV)
0νββ (100 meV)
2νββ
(α, n)
U chain
Th chain
External
^{8}B νES
Cosmogenic

How does SNO+ compare?