Progress Towards a 0νββ Lifetime Measurement at SNO+

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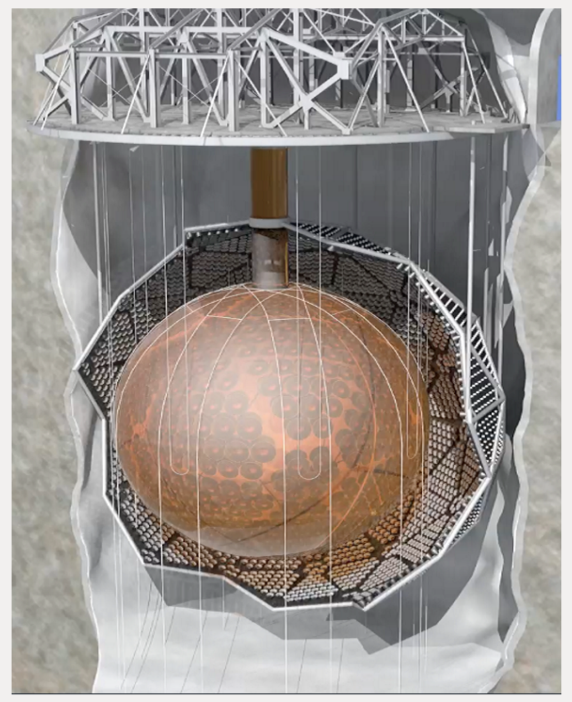
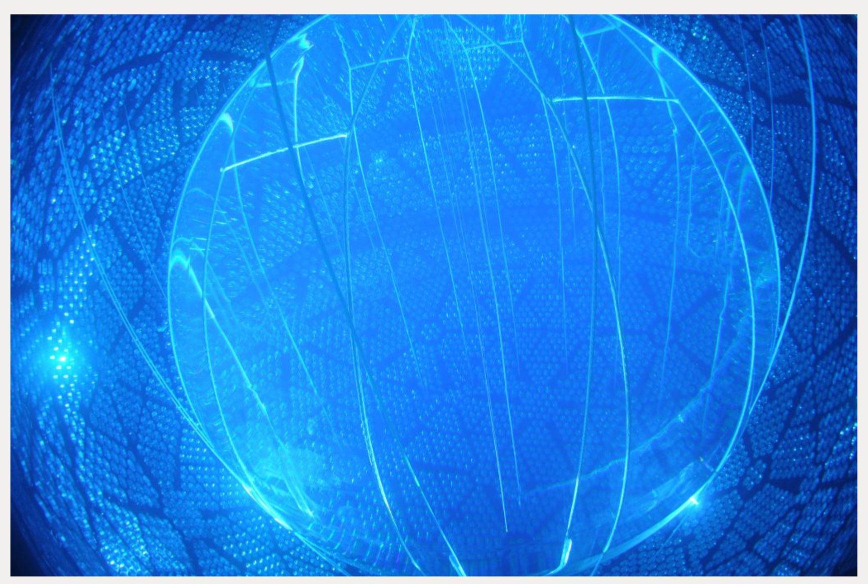
The SNO+ Experiment

The SNO+ experiment plans to make a measurement of the 0νββ half life to resolve the Dirac or Majorana nature of neutrinos

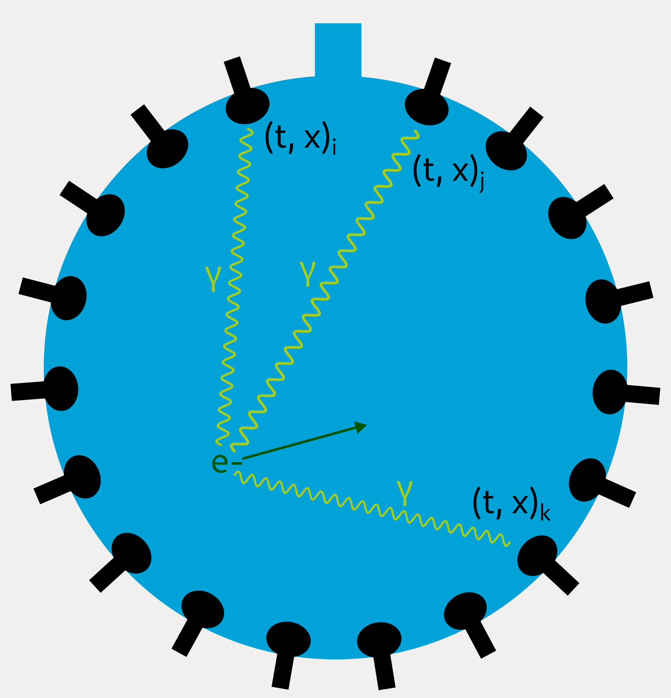
This will be accomplished by loading the SNO+ liquid scintillator with 3.9 tons of Tellurium (Te), **planned to begin in late 2027**





Sensitivity to the ^{130}Te 0νββ signal strongly depends on our ability to minimize and constrain backgrounds through the use of various reconstruction algorithms

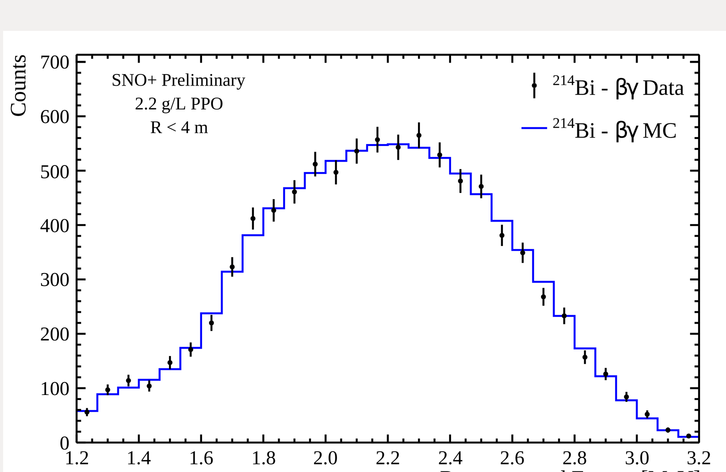
Event Reconstruction

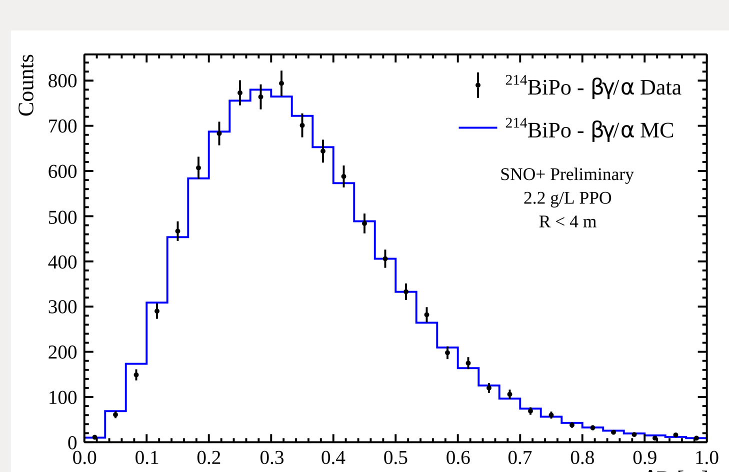


Using photon arrival times and positions from the ~9,500 PMTs in the SNO+ detector, likelihood based methods are used to reconstruct event positions, energies, and particle types

In the 2.2 g/L PPO phase, position resolution of ~12 cm has been demonstrated using tagged ^{214}Bi

Internal ^{214}Bi has also been used to demonstrate an energy resolution of ~6.5% / √E



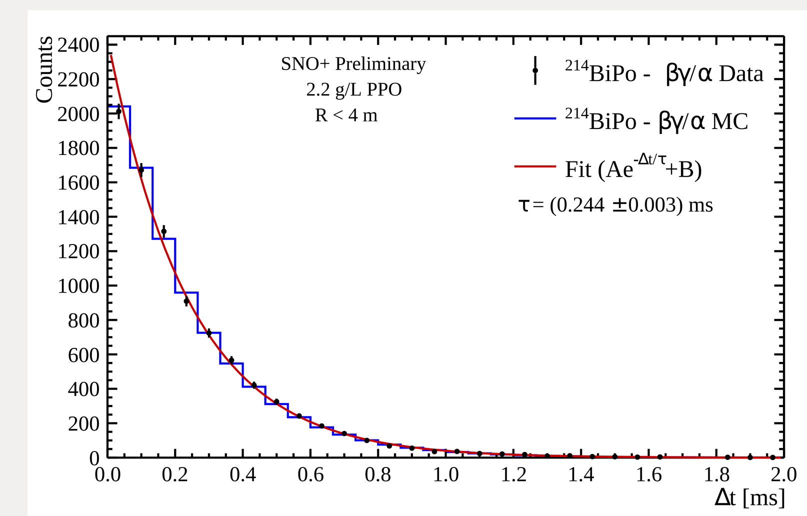


Backgrounds

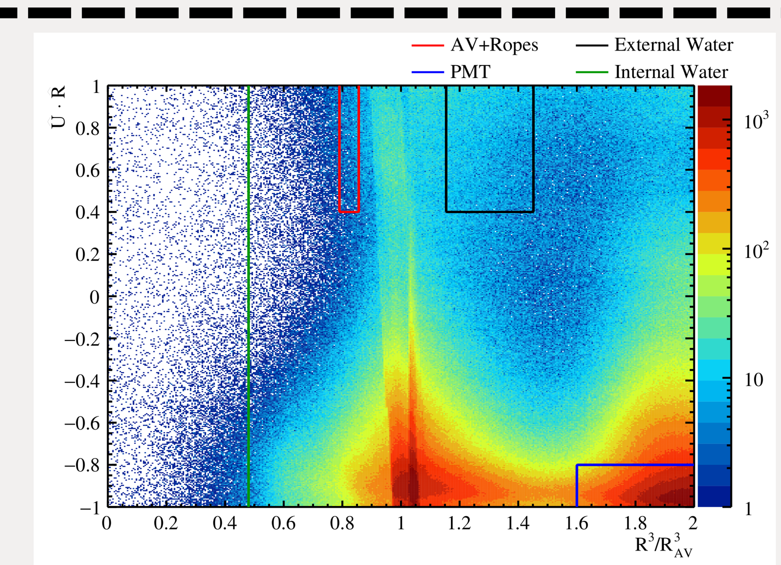
The ^{238}U chain, ^{232}Th chain, and external gammas are the most important backgrounds to characterize during the target out phase

The coincidence between ^{212}Bi^{212}Po and ^{214}Bi^{214}Po can be used to tag and remove a large majority of these backgrounds

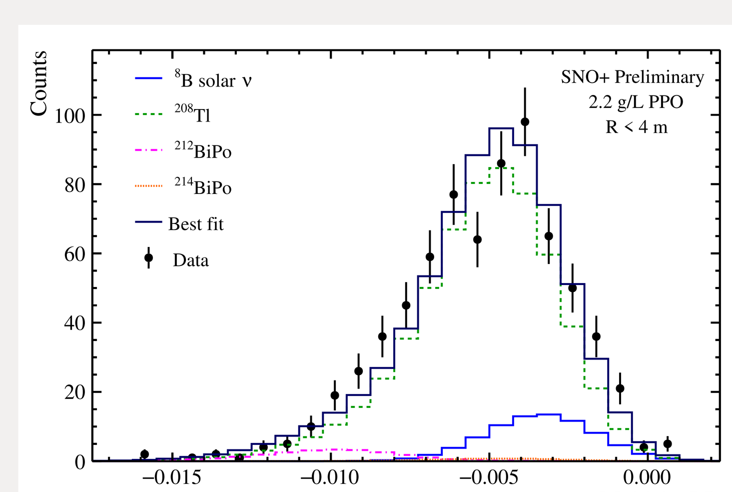
Coincidence tagging also allows us to measure the concentration of ^{238}U and ^{232}Th inside the scintillator



^{238}U = (6.2 ± 0.1) x 10^{-17} g/g$_{LAB}$ ^{232}Th = (7.5 ± 0.7) x 10^{-17} g/g$_{LAB}$

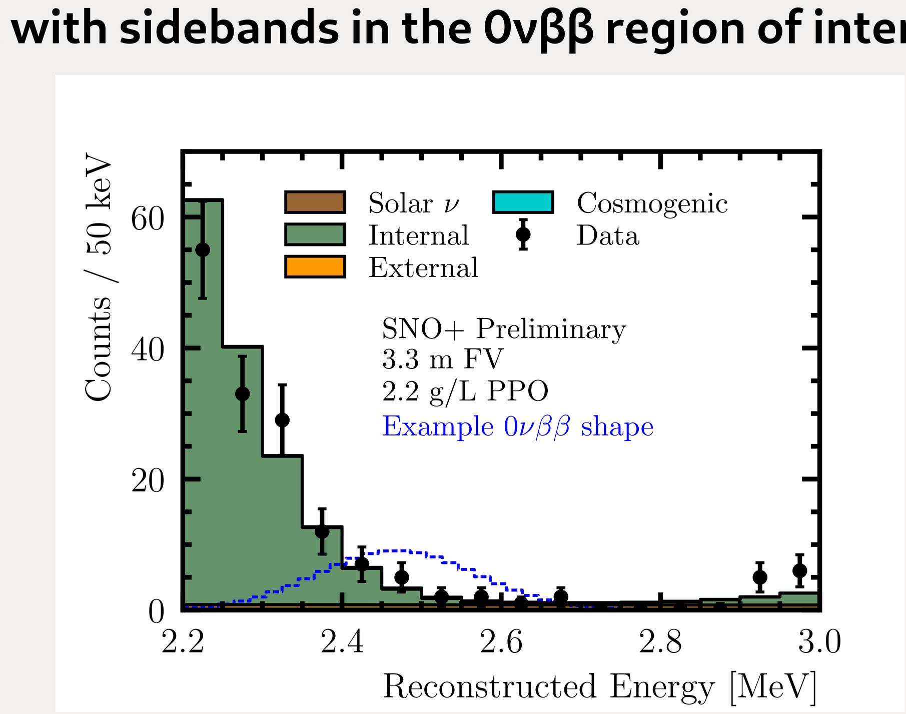


External rates from the acrylic vessel, external water, and PMTs can also be measured and constrained using their radial dependence, as was done during the water phase



Multisite classifiers also help differentiate electron-like events from externals, βγ, and βα events

After applying cuts to remove backgrounds, we observe **low counts consistent with sidebands in the 0νββ region of interest**

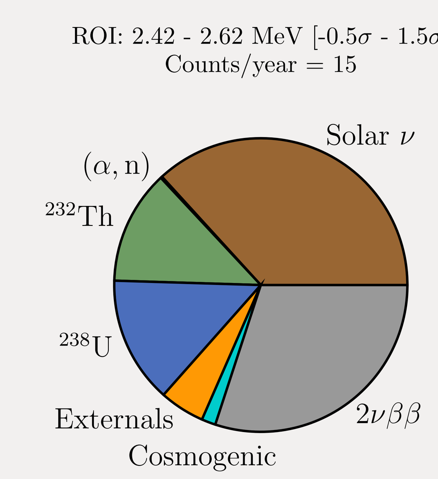


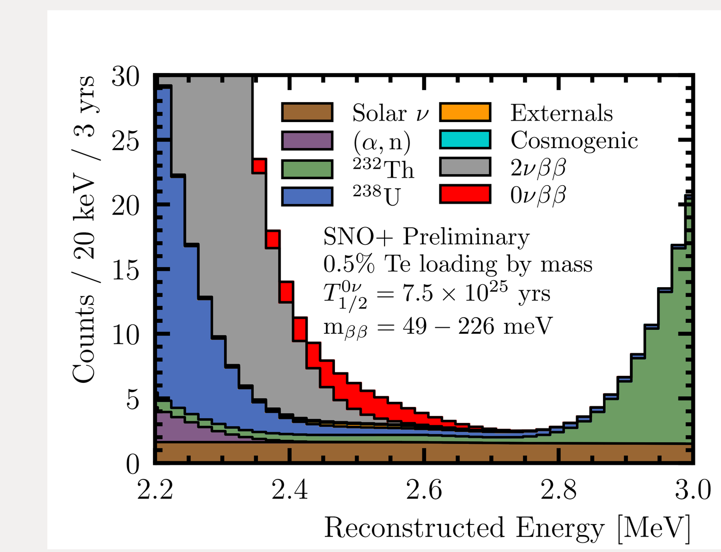
Tellurium Phase

We can provide robust estimates of our 0νββ lifetime limits by using the backgrounds and optics from the target out phase to inform our Tellurium phase expectations

For the 0.5% Te loading and 3 years of livetime we predict a limit of:

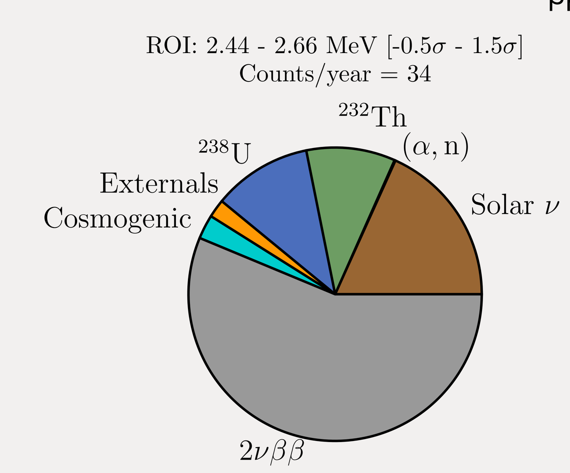
$T_{1/2}$ > 2x10^{26} years
$m_{\beta\beta}$ ~ 30 - 137 meV

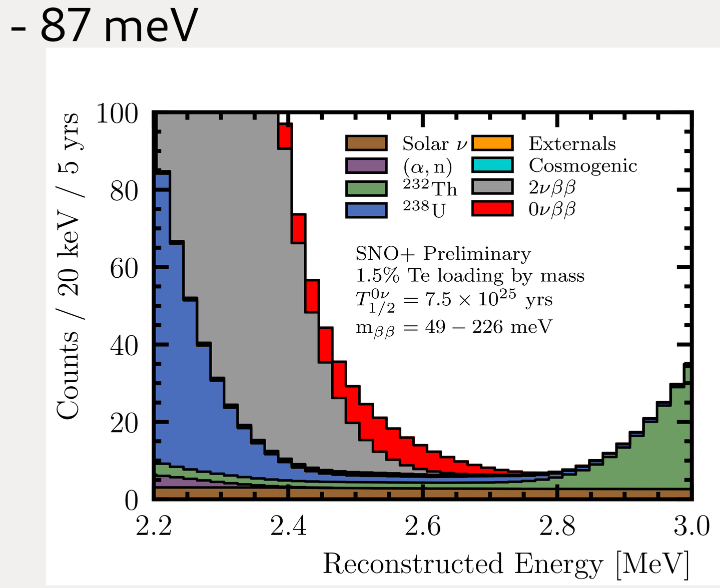




Following the 0.5% phase we intend to load up to 1.5% Te
For the 1.5% Te loading and 5 years of livetime we predict a limit of:

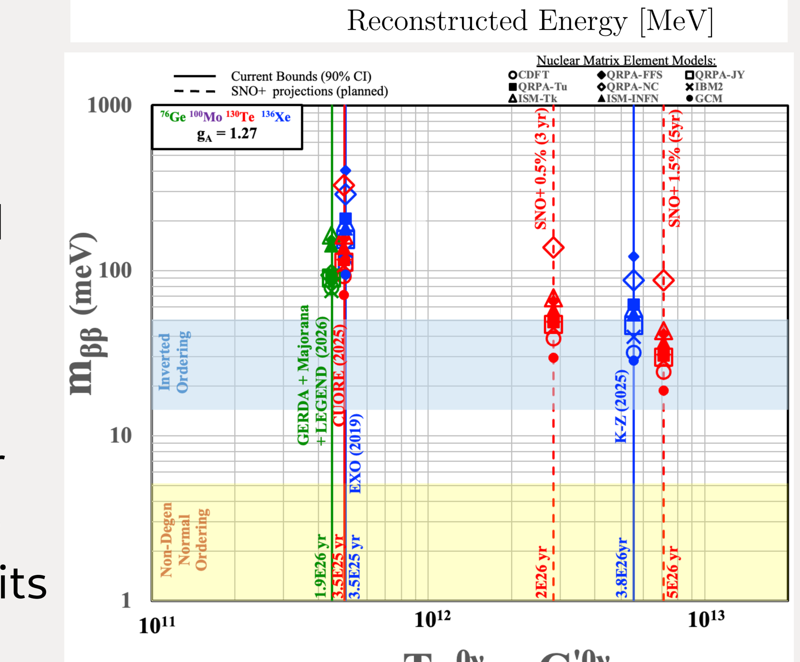
$T_{1/2}$ > 5x10^{26} years
$m_{\beta\beta}$ ~ 19 - 87 meV





At 1.5% loading we expect a world leading limit

Even at 0.5% loading, due to favorable phase space and nuclear matrix elements, $m_{\beta\beta}$ limits can be comparable to current leading limits



Acknowledgements

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