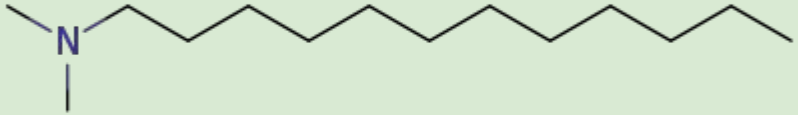
DDA Purification For 0νββ Search



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SNO+

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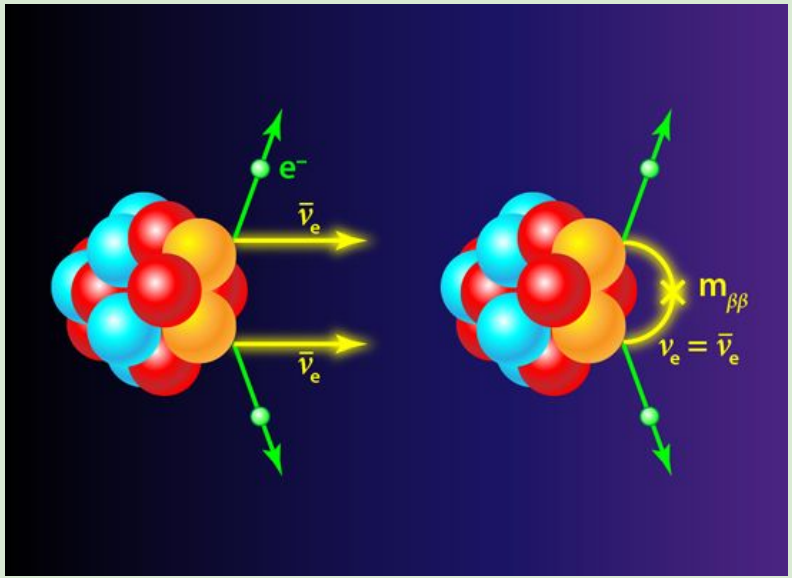
A brief introduction to SNO+

- 6m radius spherical neutrino detector
- Instrumented by ~9000 PMTs
- Filled with liquid scintillator, Linear Alkyl-Benzene (LAB)
- Submerged in ultra-pure water
- Ultimate goal of SNO+ is to search for neutrinoless double-beta decay (0νββ)

https://snoplus.phy.queensu.ca/about.html

Double beta decay

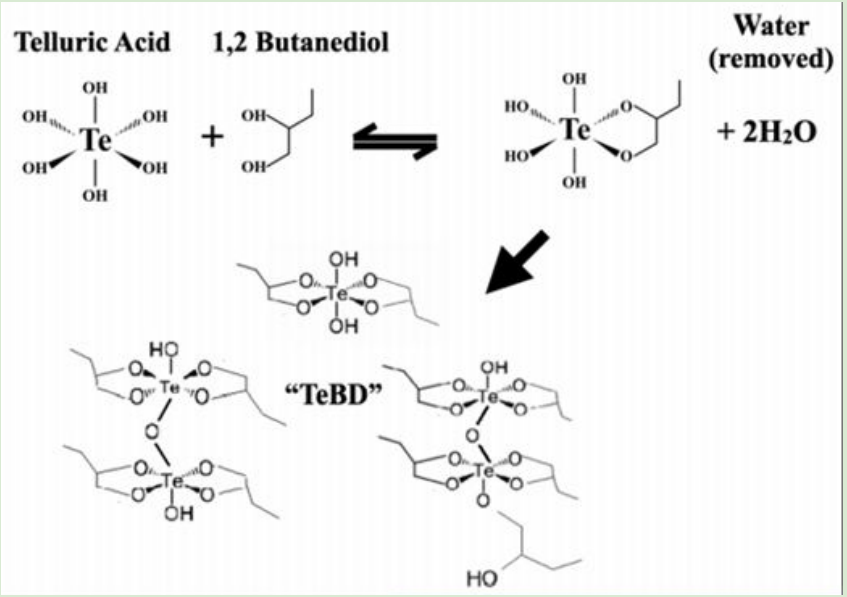


APS/Alan Stonebraker

- Two versions of double beta decay
- If neutrinos are majorana particles, 0vββ exists
- Would violate lepton-number conservation
- Since in liquid scintillator, looking for electron signature
- Tellurium-130 decay results in 2vββ and can result in 0vββ

Tellurium Cocktail

- Telluric acid (TeA) is insoluble with LAB
- Need to bond Telluric acid to Butane-Diol (BD) first, make TeBD
- This chemical reaction is a reverse hydration reaction, creates water - insoluble in mixture, bad for physics

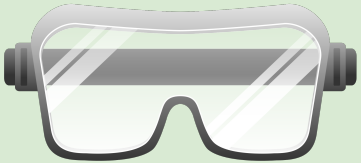


The role of DDA in the search for 0νββ

- TeBD - 3 parts TeA to 1 part BD
- DDA plays a crucial role as an amine neutralizer, stabilizes cocktail
- DDA neutralization and temperature + pressure controls prevent reverse hydration reaction, solution is then soluble in LAB

But what is DDA? PPE and Handling

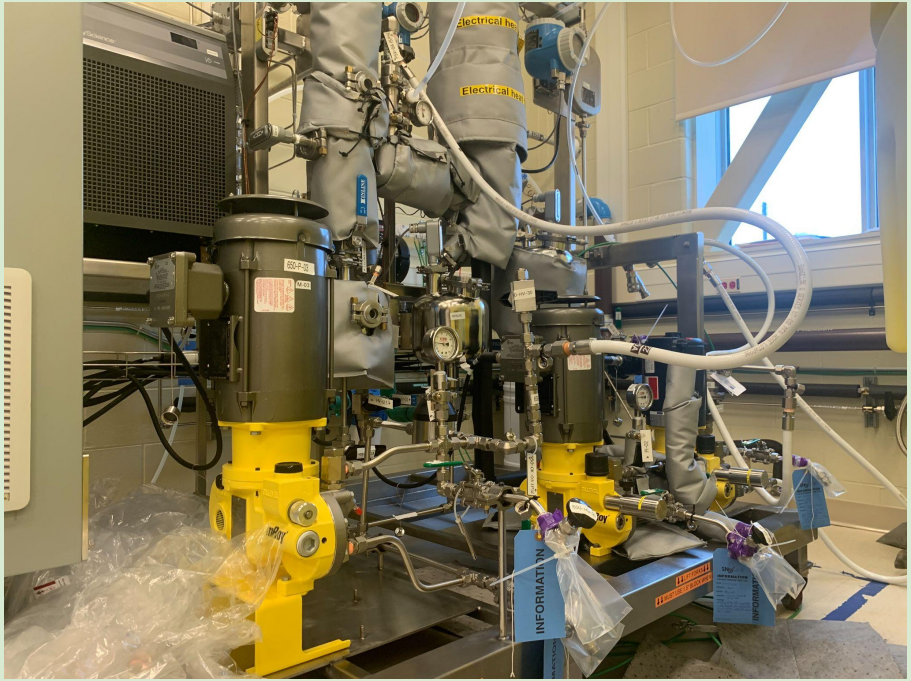
- N, N-DimethylDodecylAmine
- Clear liquid, irritant, smells like fish



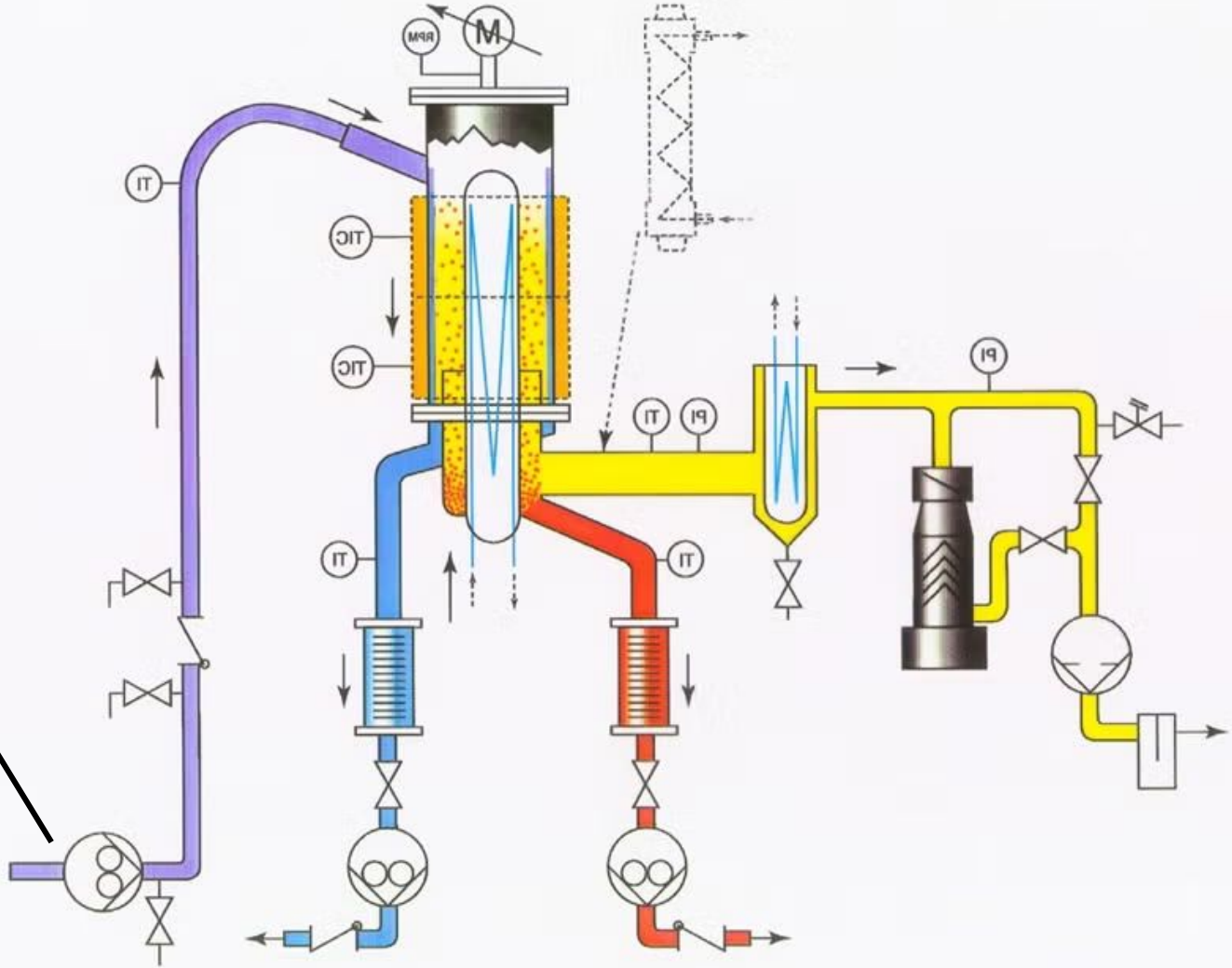
- Requires protection from contact and extended inhalation when handling
- PPE: Vest, goggles, thick nitrile gloves and face shield when transporting

https://openclipart.org/detail/196256/safety-goggles
https://www.vexels.com/png-svg/preview/318801/green-cleaning-gloves

DDA Distillation



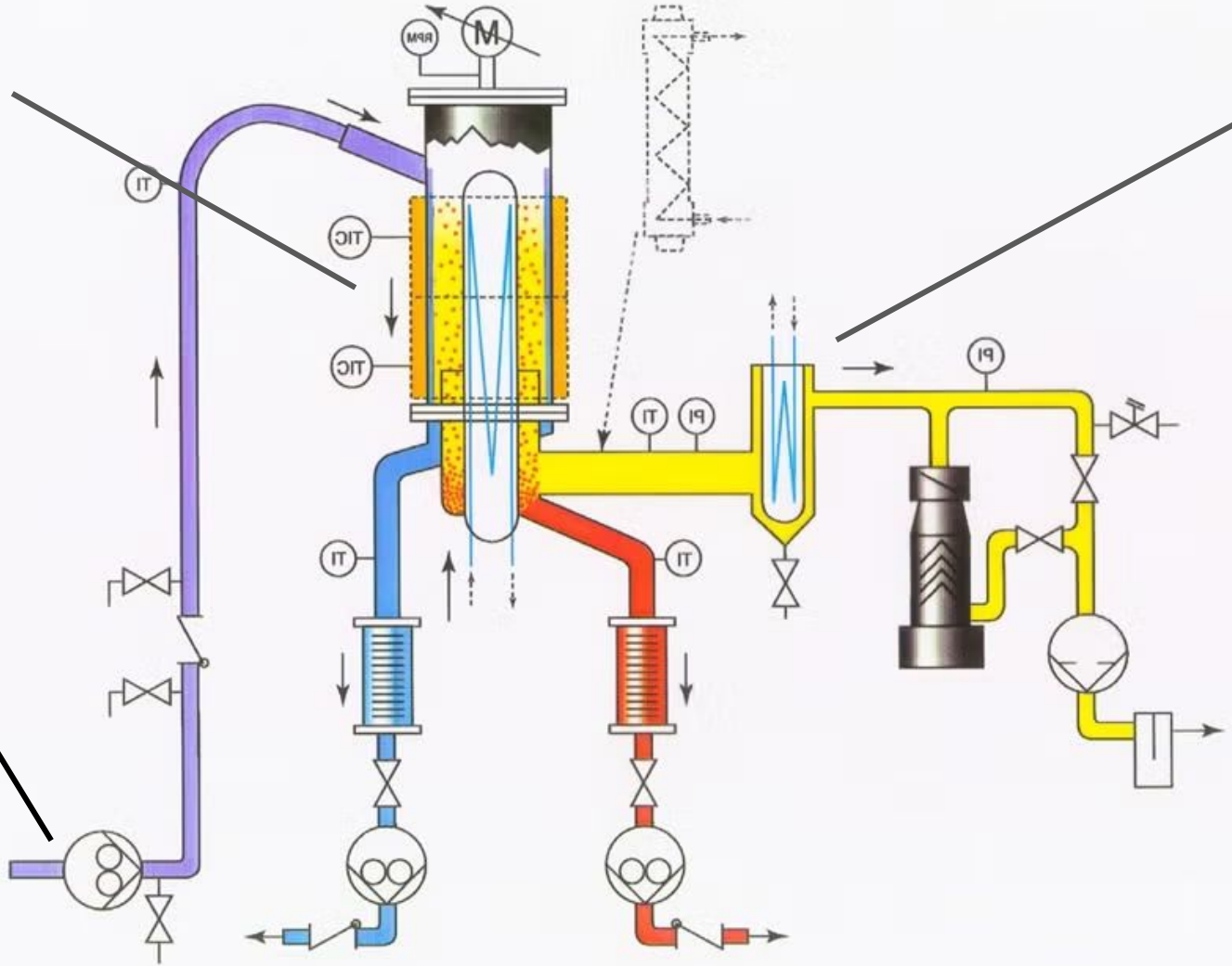
- DDA still intakes industrial DDA
- Removes water and radioactive isotopes with distillation, collects clean DDA
- Chemical cleanliness dependent on still parameters, needs Quality Assurance (QA)

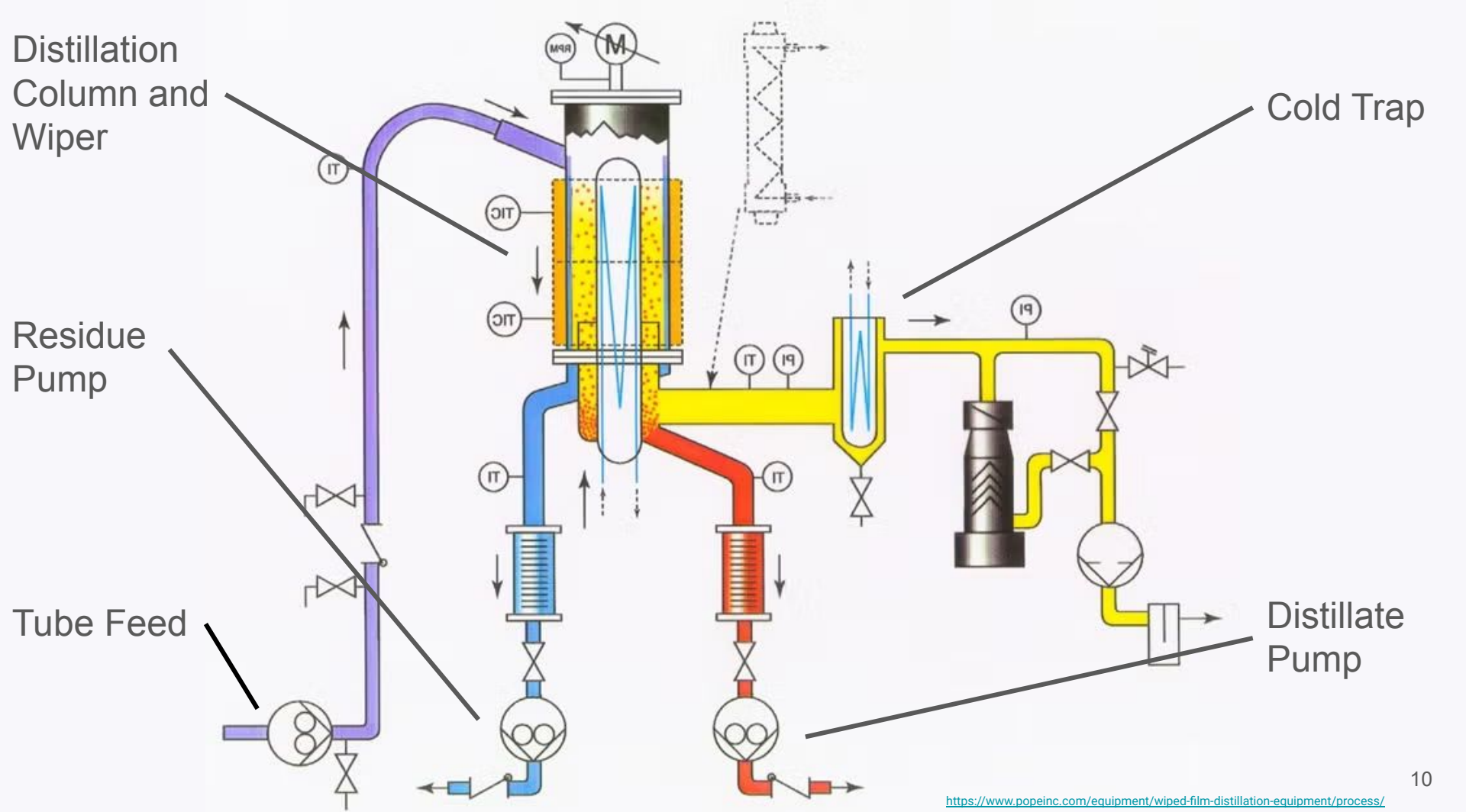

Tube Feed

Distillation Column and Wiper

Cold Trap

Tube Feed

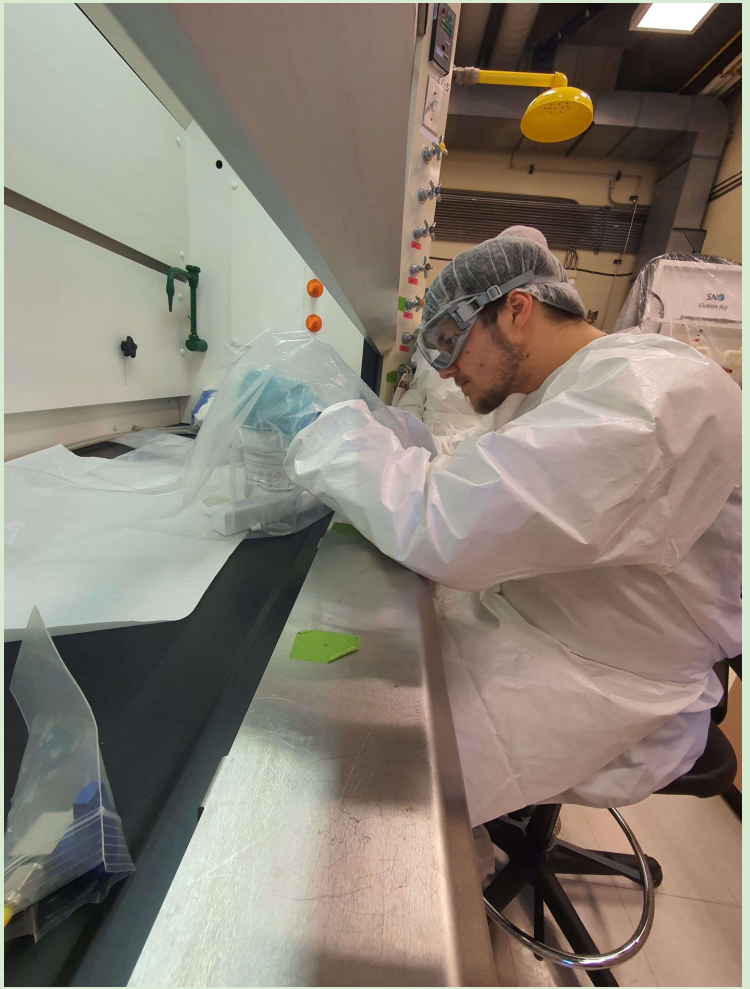




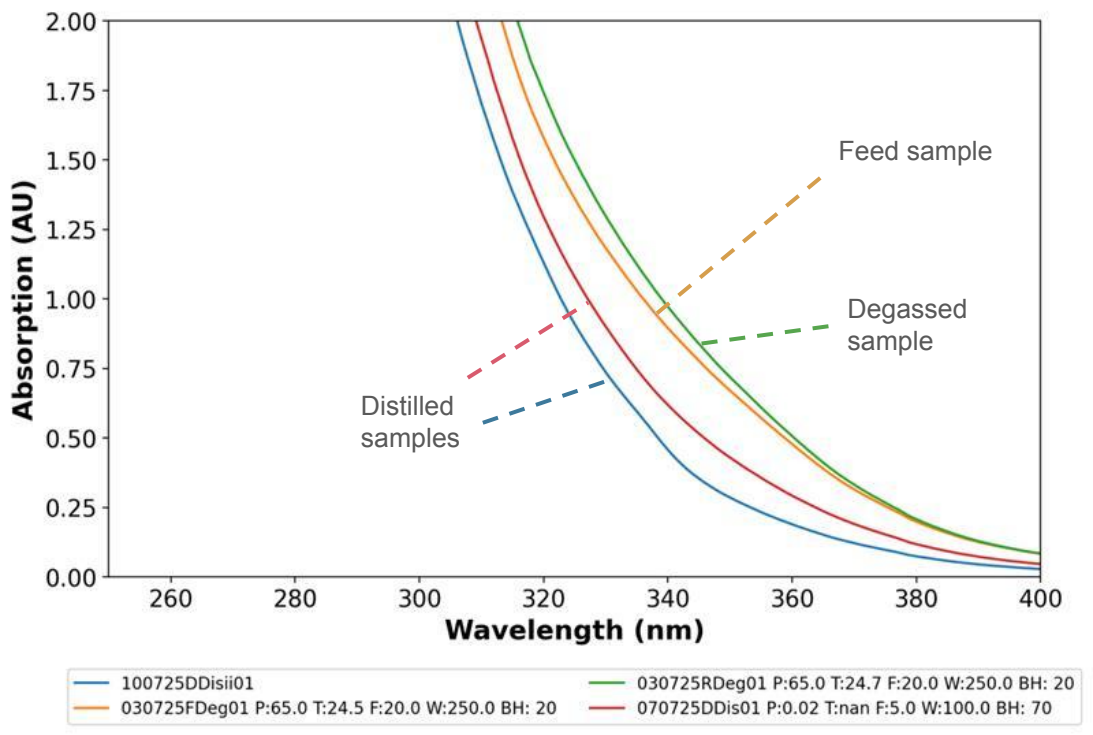
https://www.popeinc.com/equipment/wiped-film-distillation-equipment/process/

Quality Assurance (QA)

- Currently takes place in glove bag
- ultraviolet-visible spectroscopy (UV-VIS) and turbidity measurements taken from sample
- Results reflect how effective distillation parameters were
- Goal for distillation is effective AND efficient



DDA Test Batch



- Two week period running the DDA still in 12 hour shifts
- Frequent sampling
- A test run to make sure final batch passes QA and better assess still parameters
- Successful, with successive samples having lower absorption features

Glovebox Efforts

- Glovebag is incredibly unwieldy
- My project was to ship NEWS-G glovebox from underground to surface and repurpose for DDA QA
- Will reduce spills and allow for QA to be done more precisely and comfortably

Summary and Closing Remarks

- Analyzed DDA quality with QA work throughout summer
- Worked throughout test batch to get a better sense of still parameters for DDA loading phase. Successful full run with reasonable QA results
- Disassembled, shipped above ground and refurbished glovebox for improved QA in future, working to get new parts for chemical compatibility with DDA

Thank you! Questions?

Additional work for SNO+

- Assisted with assembly of AmBe calibration source in detector, prepared DCR for internal deployment
- Worked on analysis of high energy events in detector, data cutting to look for trends (currently incomplete!)
- Catalogued and prepared for SNO+ spare parts for purchase
- Worked at underground transfer station, neutralizing dilute acid

Resources

https://snoplus.phy.queensu.ca/about.html

APS/Alan Stonebraker - https://legend-exp.org/science/neutrinoless-bb-decay/neutrinos-vs-no-neutrinos

https://www.echemi.com/produce/pr22080127786-n-n-dimethyldodecylamine.html

https://openclipart.org/detail/196256/safety-goggles

https://www.vexels.com/png-svg/preview/318801/green-cleaning-gloves

https://www.popeinc.com/equipment/wiped-film-distillation-equipment/process/