LAr R&D Progress Updates

Yichen, Vyara

8/5/25

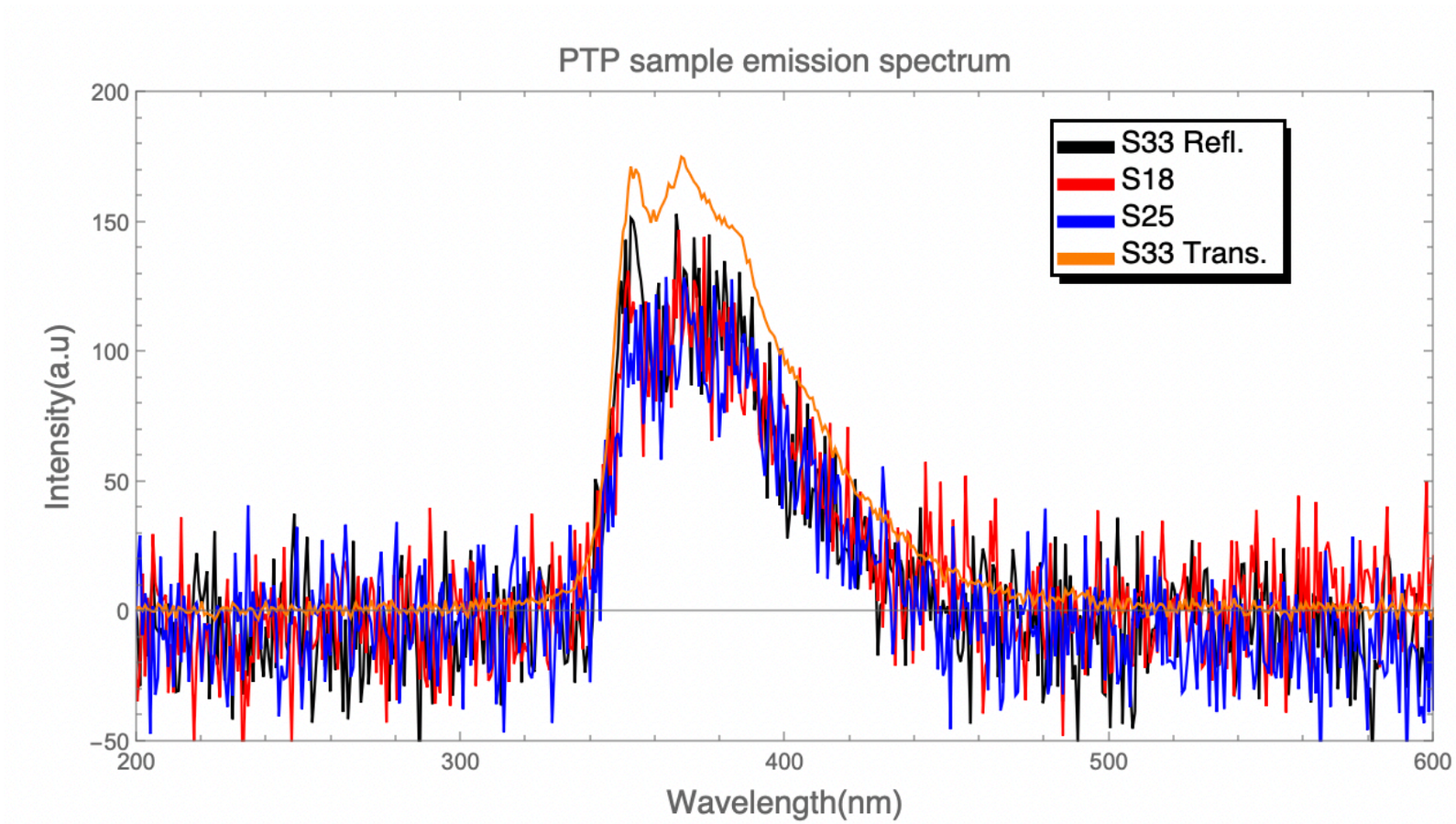
BROOKHAVEN
NATIONAL LABORATORY

Lab Safety and Space Management

- **Two EEI inspection requested**
  - HV cable test in GAr by Volodya
  - Power supply unit by Guang
  - Previous EEI document provided as a reference
  - I visited the equipment in the lab
- **6000-gallon LN2 refill**
  - The LN2 level runs low below 30” inch
  - Ordering another refill for next week
  - Will evacuate the parking lot with a notice to the department

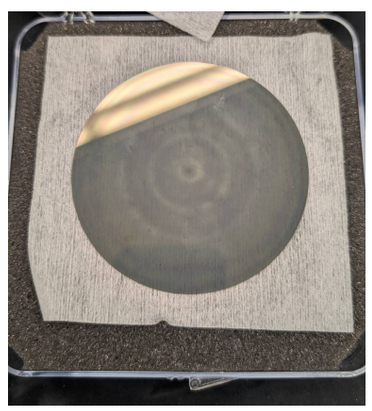
LFO new sample measurement

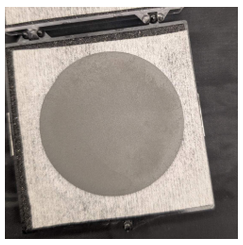
- **Spectrum measured in reflective mode**
  - Conduction confirmation measurement with only 3 samples
  - The signal amplitude is pretty low and more noisy, but still agrees with the transmission mode measurement

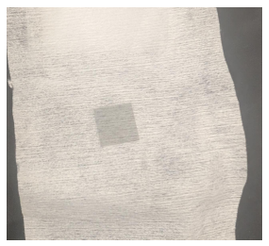


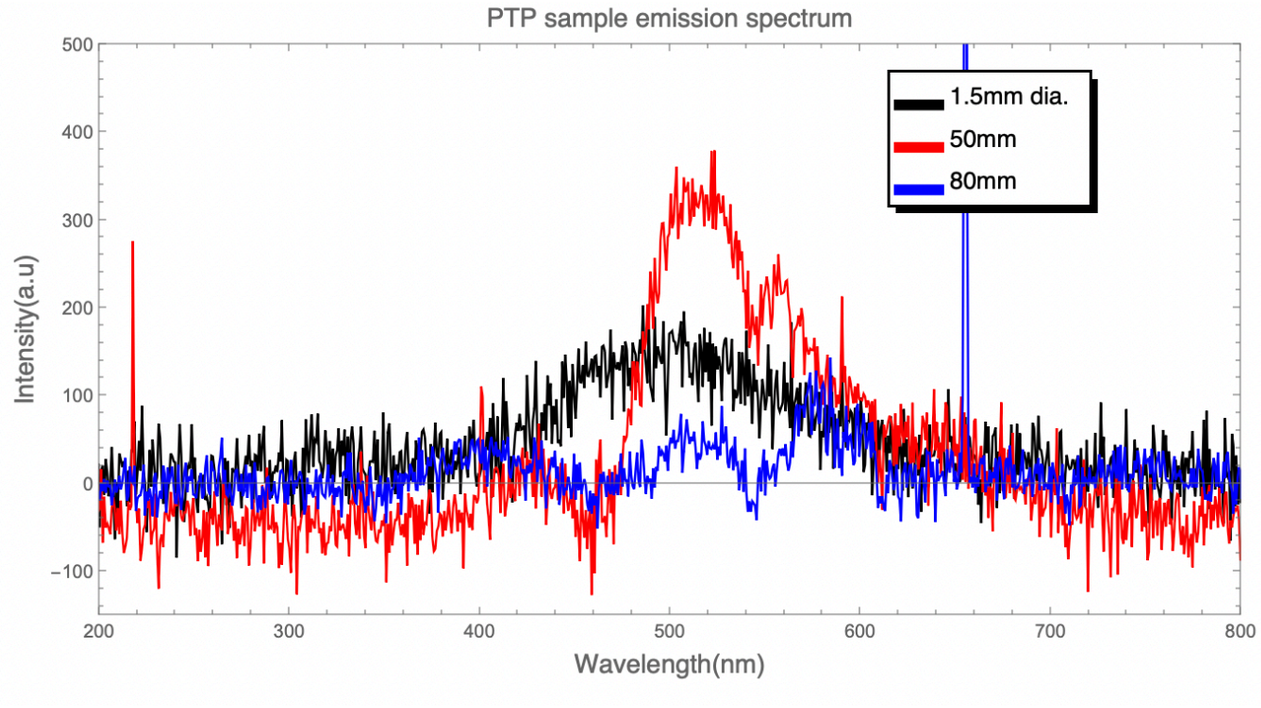
Diamond sample measurements

- **Conducted measurement with diamond samples from Aleksey**
  - 2 samples with diamond powder coating, 1 sample as a doped diamond substrate
  - No observed signal under 266nm, similar to the previous diamond samples
  - Weak emission with 200nm excitation



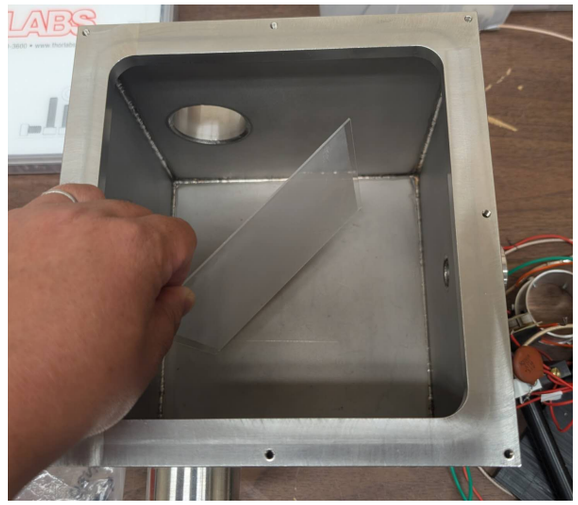






Plan for the Test Chamber

- **Test chamber design and machining**
  - One problem I found during the preliminary design is the sample size
    - The current sample is pretty big: 143.5mm x 143.5mm
    - The test chamber as a dimension of 7” x 7.5” x 8”
    - No much room to move the filter
  - Solution 1: Using the existing chamber with a size trimmed down filter
    - Pros: More efficient with existing portal; less machining time, less cost
    - Cons: Not a full size test; need to figure out the way to cut the substrate
  - Solution 2: Making a new chamber to accommodate the filter
    - Pros: More flexibility; full size test;
    - Cons: Longer lead time; higher cost;
  - I think the solution 1 is better and I can have the design complete by the end of next week
    - Modification to the chamber with an additional portal
    - Adapter tube between the monochromator and the test chamber with pending length(I had discussion with KHV)
  - Plan to send out to KHV for machining, they just returned from seasonal vacation, the estimated machine time is 3-4 weeks



Plan for the thermal stress measurement

- **Thermal stress test with LN2 bath**
  - Talked to Shanshan about using the LN2 bath in cold electronics lab
  - Plan to conduct the measurement next week once the LN2 being delivered to the 6000-gallon tank
  - Plan to the use the new batch of filter with bad coating quality
  - Testing plan
    - 1. Vertical test, setting up the sample vertically with an existing frame in the basket
      - Dropping the basket down to the LN2 bath, keeping it above the LN2 with ~ 1” for ~10 mins
      - Slowing immerse the filter into the LN2 in ~3 mins
      - Leaving the sample in the bath overnight
      - Move it out from LN2, keep it above the LN2 for 1 hour, and then lift it up closer to the top of the dewar for another 1 hour to reduce water condensation
    - 2. Horizontal test, with similar setup as the vertical test, only difference is the keep the sample horiontally on top of the LN2 for 1 hour before immersion

- Should be able to finish in 3 days

Plan for the light yield measurement

- **Light yield measurement**
  - For both relative and absolute light yield/efficiency measurement, we need to have a full collection of the converted light
  - We could either use thermal power meter or PMTs to measure the energy of the input excitation from the monochromator
  - Need to have an improved light collection scheme than current setup to measure the light yield after the wavelength shifting
    - Not easy with current setup inside the collimator box
    - More practical to do the measurement in the test chamber
    - Another option is using Minfang's setup, reaching out for a tour for the lab to check the setup
  - Still need more careful thoughts on this measurement

Additional Updates

- **NSLS-II beam test**
  - 3x LFO samples sent to Thomas for the XFP beamline test with >15.6eV X-ray, i.e. < ~0.1nm lights
  - Thomas is setting up the equipment in the beamline
  - I will go over to the take a look at the setup today
- **Poster session for Vyara**
  - Vyara is going to present her work on this Thursday at Berker Hall around noon
  - Please attend the session if you have time

CPAD 2025 abstract

- The deadline for abstract submission is 08/08, I'm submitting an abstract on the filter work

  - The Deep Underground Neutrino Experiment (DUNE) is the next-generation long-baseline neutrino oscillation experiment that seeks to address fundamental questions in particle physics, including neutrino mass ordering and the matter–antimatter asymmetry of the universe. A critical challenge in DUNE is the detection of scintillation light from neutrino interactions in LAr with emissions at 127 nm, outside the sensitivity range of conventional photodetectors. To enable detection, this vacuum ultraviolet (VUV) light must be wavelength-shifted to the visible range (~420 nm) using materials such as para-Terphenyl (pTP). The proposed photon detection System (PDS) of DUNE Phase-II Far Detector (FD3) requires a large area of ~2000 m² coverage of wavelength shift filters with a mean light yield of 180 PE/MeV, that leads to a production requirement of ~ 100k pieces of filter plates with the current PDS unit with a dimension of 143.5mm x 143.5mm. We aim to develop and confirm a scalable, cost-effective wavelength shifter coating technology in collaboration with industry. This study investigates the use of industrial vacuum vapor deposition to produce high-quality, uniform pTP coatings with improved process control. The samples produced have been characterized using a UV monochromator and synchrotron light source at NSLS-II with measurement on emission spectra and light yield, while the coating thickness was measured by profilometer. Preliminary results show promising consistency and performance improvements over lab scale coatings. Furthermore, these filters coated with pTP are planned to be cold-tested in the 260-L LAr test stand at BNL to demonstrate the reliable performance under cryogenic conditions and offering a solution for scalable coating for the FD3. This work advances the development of robust photon detection systems for all noble element detectors and contributes to detector R&D aligned with DOE scientific missions.