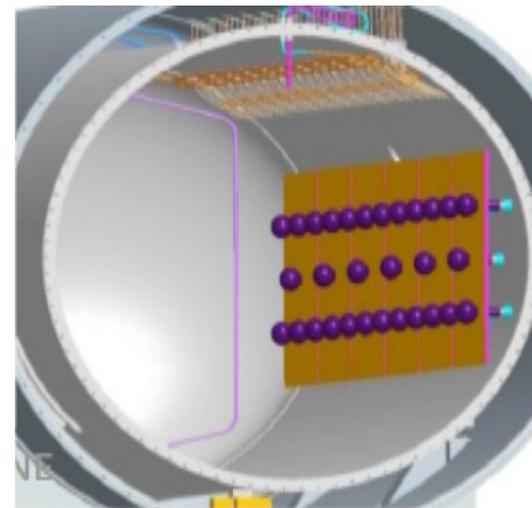
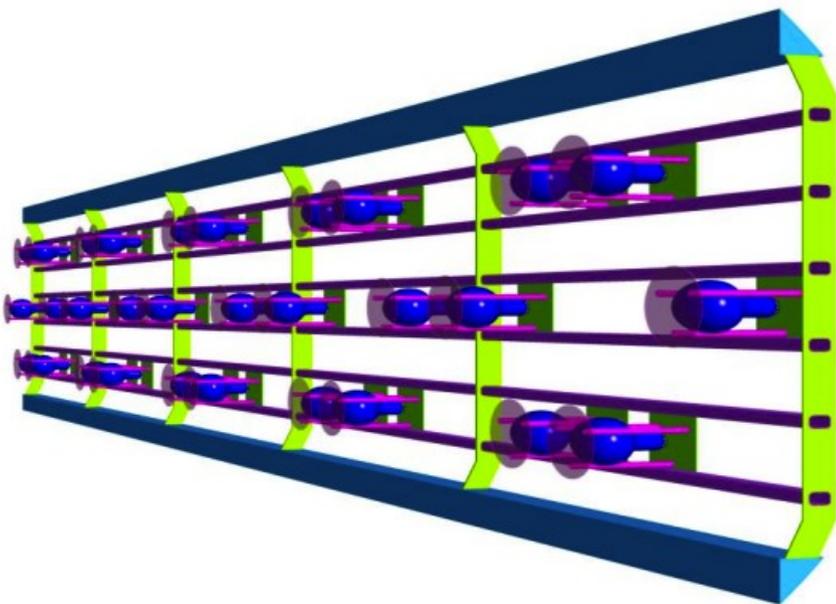
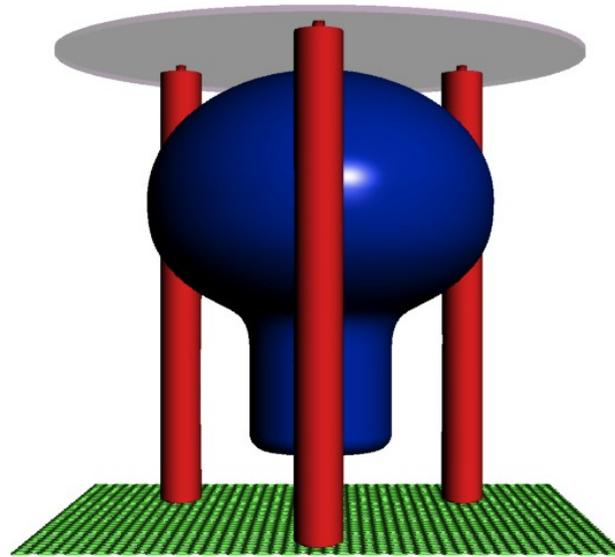


TPB Degradation Study

Christina Ignarra
December 9, 2011

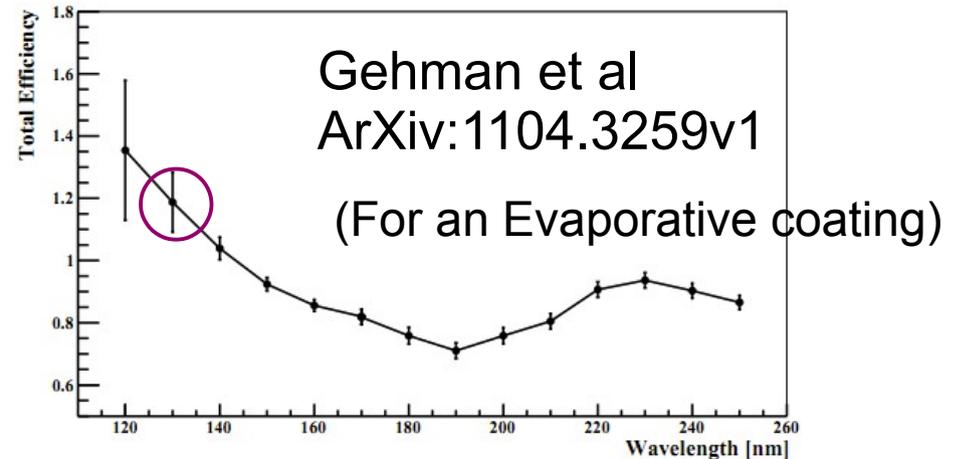
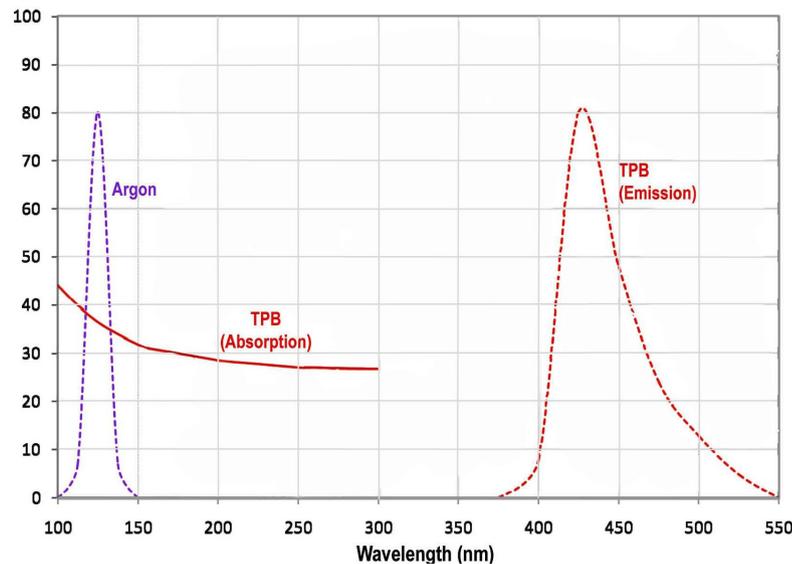
Light Collection System



30 PMTs facing TPC

Wavelength Shifting in MicroBooNE

We use a wavelength shifting material called Tetrphenyl Butadiene (TPB) to coat plates which will go in front of the PMTs



We use a mixture of 50% TPB and 50% polystyrene (PS) for our plate coating (yields about 50% of the light as an evaporative coating)

We find that mixing the TPB in PS makes the plates more durable and is much more cost effective

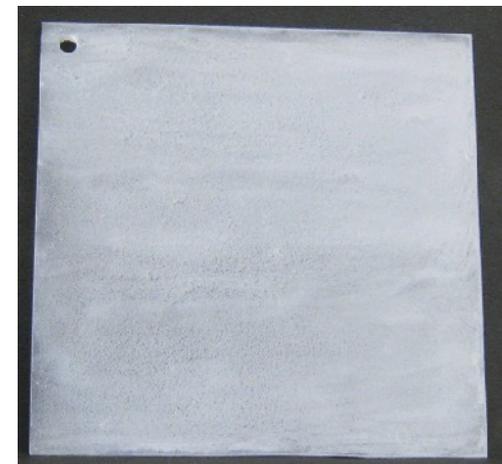
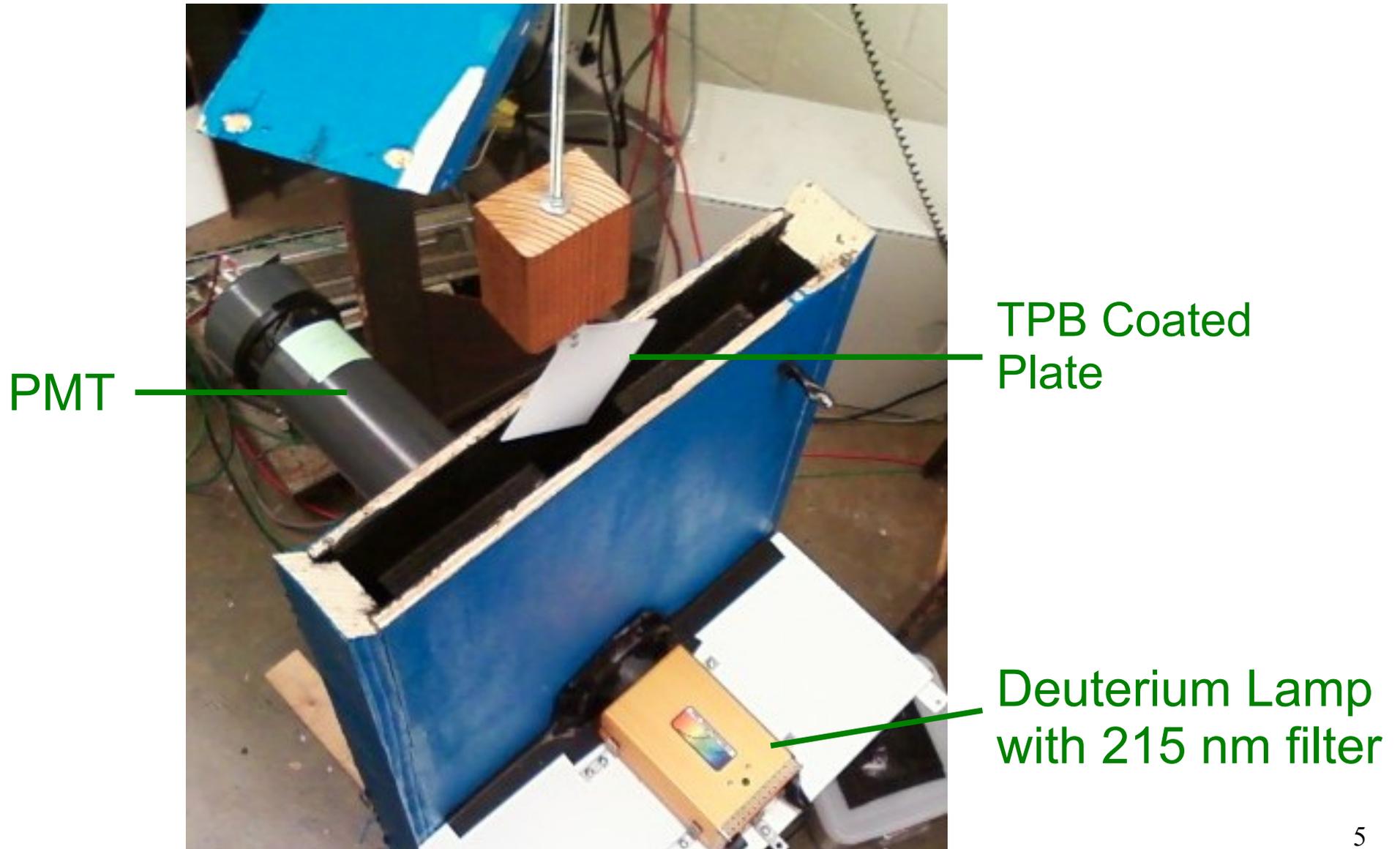


Plate sample with a 50% TPB-PS coating

TPB Degradation

- We have found that TPB degrades over time when left around in the lab.
- Initially suspected humidity
- This study shows that it is light that is the main culprit, and humidity is a smaller effect

Test Setup



Samples

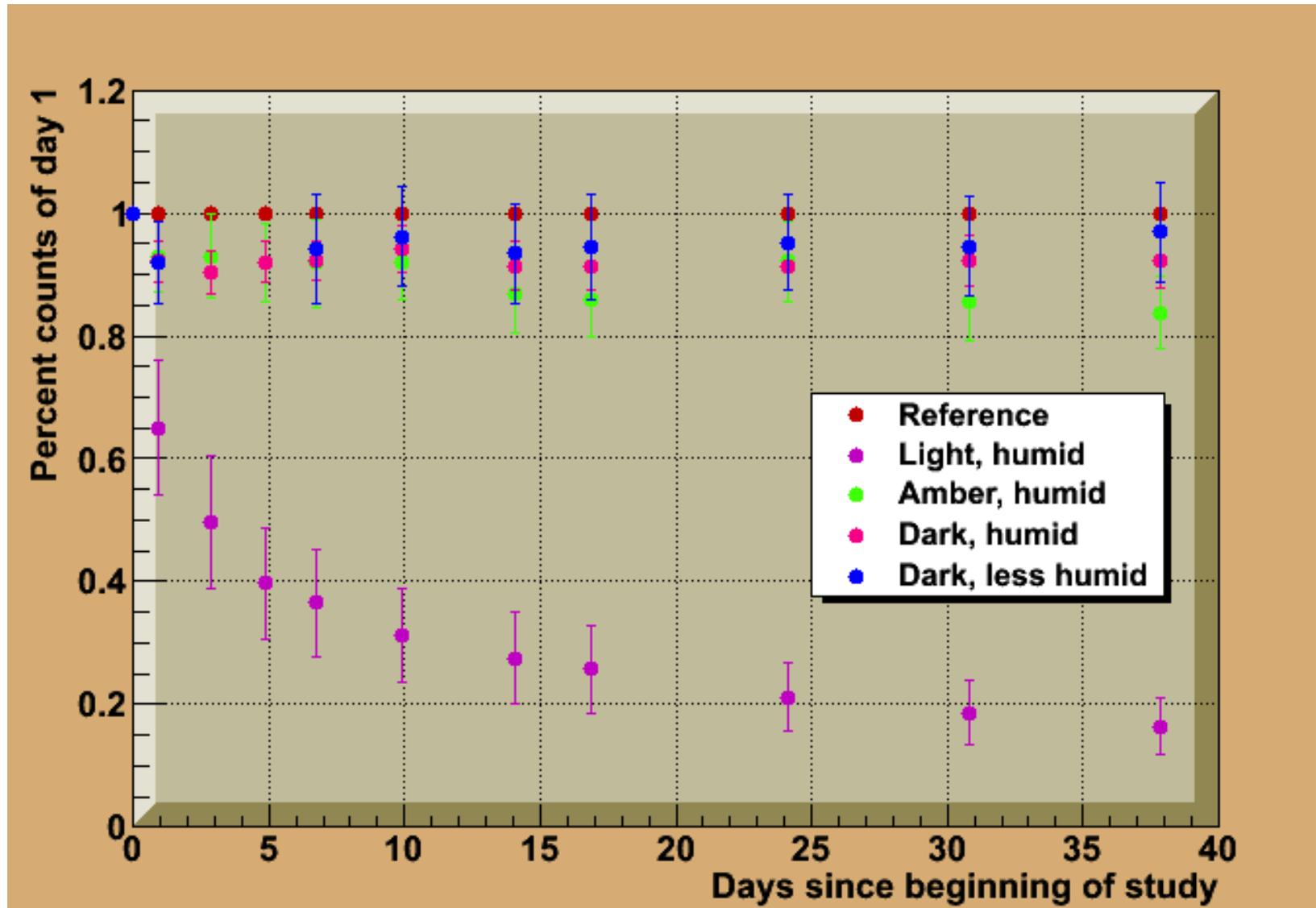
3 samples for each condition:

- Exposed to lab humidity and light
- Exposed to lab humidity and reduced wavelengths of light (amber filter)
- Exposed to lab humidity in the dark
- Exposed to reduced humidity ($\sim 20\%$) in the dark

Each plate measured in two different locations

Variations for a single plate similar to variations across plates

Results



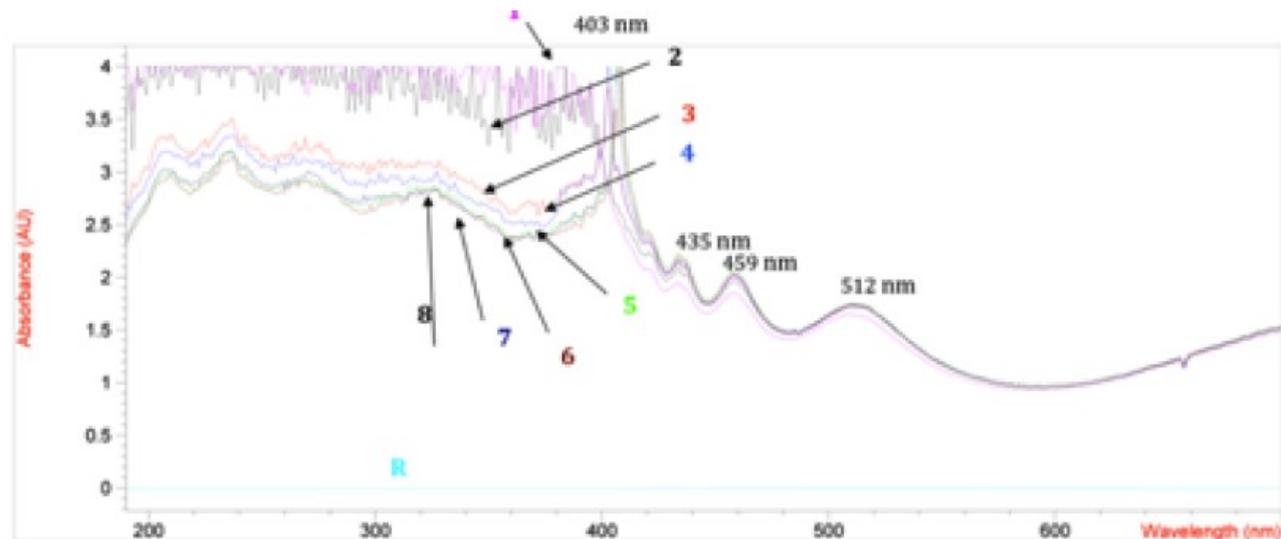
Each plate scaled by a reference plate and its preliminary measurement
Samples created on October 21, 2011

Results

- Amber filter helps significantly, but still see degradation
 - Does not block all lower wavelengths
- Study in progress to measure wavelength which degrades the TPB
 - Looking like it is UV light which is doing this
- During installation, may require filters on the lights and/or coverings for each PMT mount, but this should be pretty easy to accomplish

Humidity

- Delay of >1 hour between making plates and measuring them
- WArP saw degradation on the order of an hour
- Already degradation before our “before” measurement



TPB run 3

1	pos 1 (quartz/TPB)
2	pos 2 (TPB/quartz)
3	pos 2 after 30 minutes
4	pos 2 after 50 minutes
5	pos 2 after 100 minutes
6	pos 2 after 165 minutes
7	pos 2 after 225 minutes
8	pos 2 after 285 minutes
R	reference quartz cell

Figure 15: Absorbance of TPB as a function of wavelength. The efficiency decreases with time is due to water absorption. Vacuum pumping (or exposure to flow of dry atmosphere) ensures full recovery.

Humidity

Plan to measure humidity more carefully in the coming weeks

- Put plate in test setup immediately after creation
- Hook up to computer to measure every minute for 24 hours

So far looks like consistent with WArP, so hopefully we will be able to “dry out” our TPB too!

Restoring from Humidity

Next up is trying to restore plates

- WArP was able to do this with vacuum pumping
- We will try with Argon or Nitrogen gas
- Already have a desiccator box, but will try to run gas through test setup to watch restoration

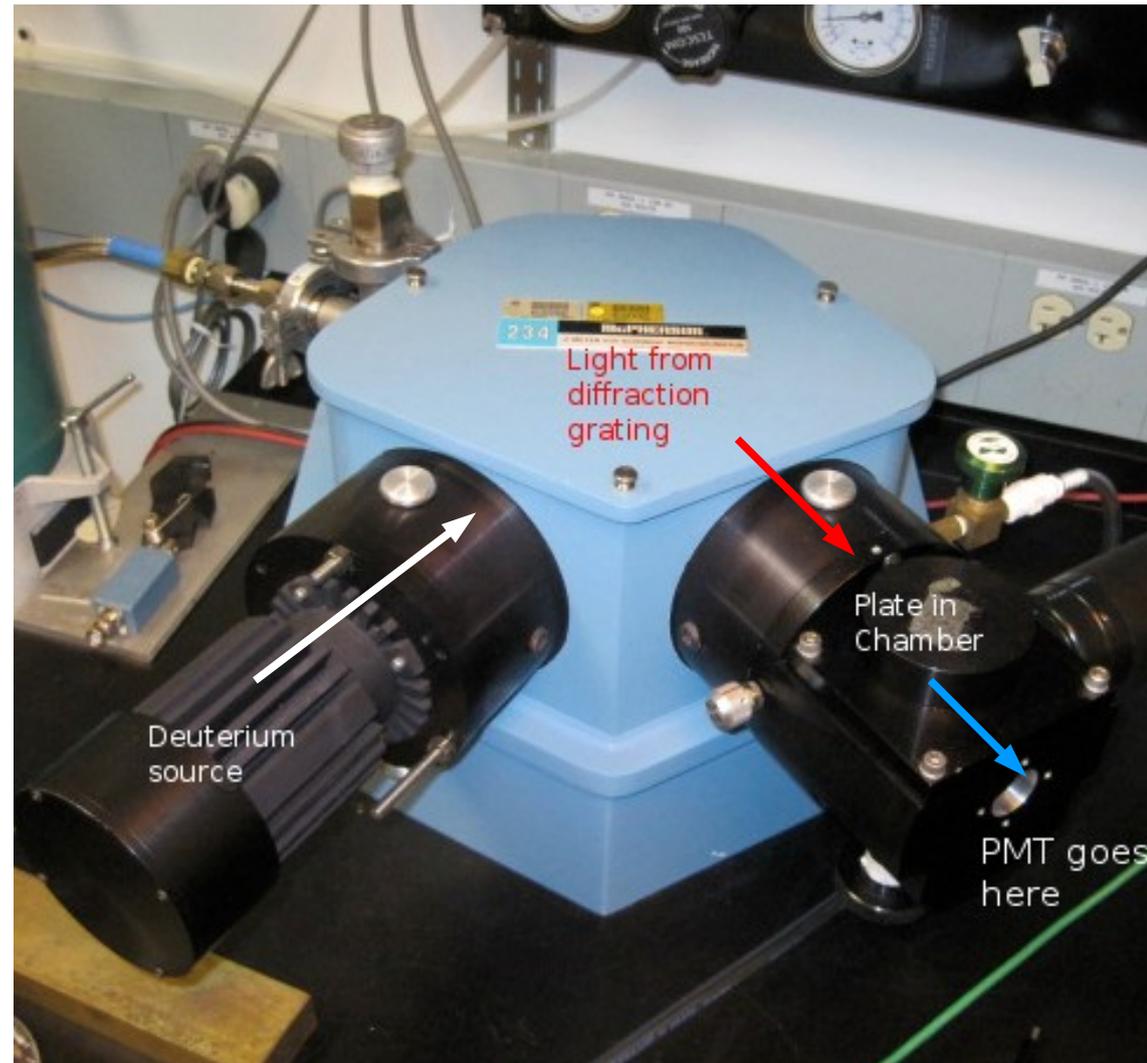
Why I am at Fermilab right now

- Vacuum monochrometer measurements in lab 6
- Repeat measurements made last year
 - Unknown exposure of previous samples to light and humidity
- New coating possibilities

Vacuum monochrometer setup

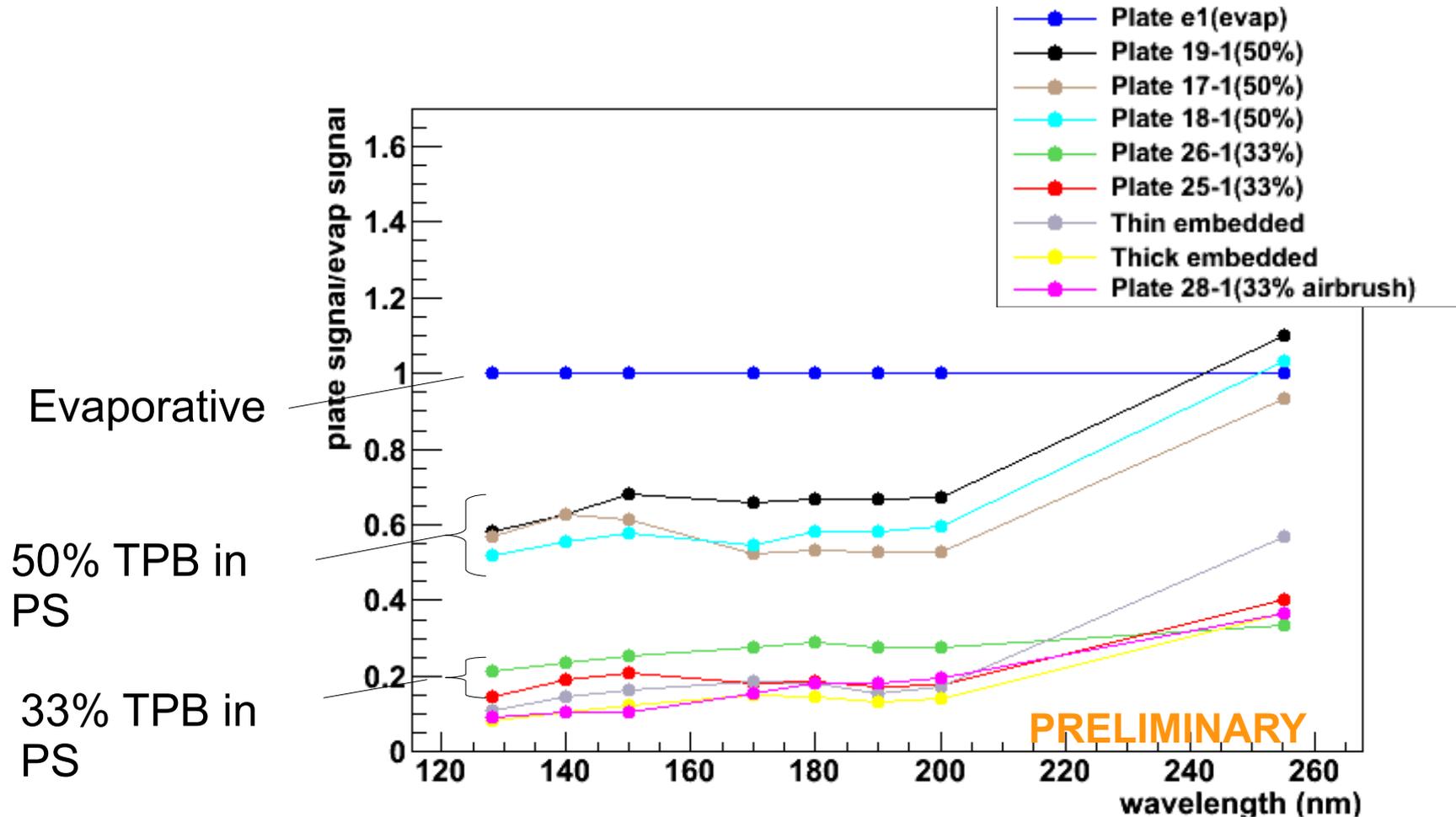
Vacuum setup at Fermilab

- McPherson 234 vacuum monochrometer
- McPherson model 632 UV Deuterium Lamp as light source
- Light from diffraction grating hits the plate and the output is measured by the PMT on the other side



Comparison of coating methods

Normalized to evaporatively coated plate



New Coatings to test

R&D for TPB coated light guides, which require clear, optically smooth coatings

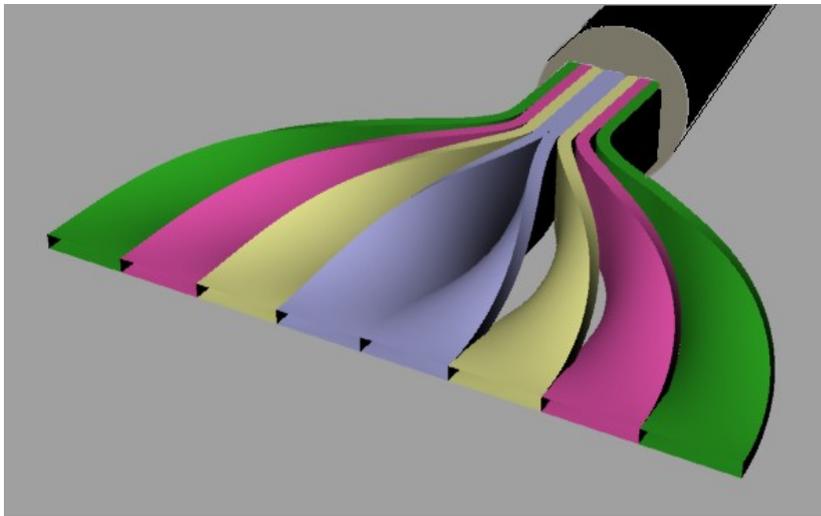


Illustration of paddle arrangement of lightguides



Adiabatic bending still allows light to be transmitted down the rod

This is R&D for future kton scale LAr detectors

- The lightguide system would allow for greater flexibility in PMT placement, more coverage, and take up far less space than a MicroBooNE-like system

New Coatings to test

- Lightguide testing in LAr suggests using UV transmitting acrylic instead of PS increases conversion efficiency for clear coatings
- Plan to test this new type of coating in the vacuum spectrometer, as well as 50% TPB-UVT plates
- Samples for this weekend:
 - 50% TPB-PS
 - 50% TPB-UVT acrylic
 - 33% TPB-UVT acrylic
 - 25% TPB-PS (max % before crystallization lower for PS than UVT acrylic)

Summary

- In 1 week, the fluorescent lights in our lab degrades our plates to <40% efficiency, <20% after a month
- Inconclusive results for humidity due to time delay from making to testing, follow-up coming in the next few weeks
 - Consistent with the WArP experiment so far
- Will try “drying out” plates shortly
- Vacuum monochrometer measurements to be made this weekend:
 - Redo older measurements which didn't take care to protect samples from light
 - Test UVT acrylic as TPB matrix