APS April Meeting, Annaheim CA 4.30.2011

LIGHT COLLECTION IN MICROBOONE

ARATI PRAKASH

Outline

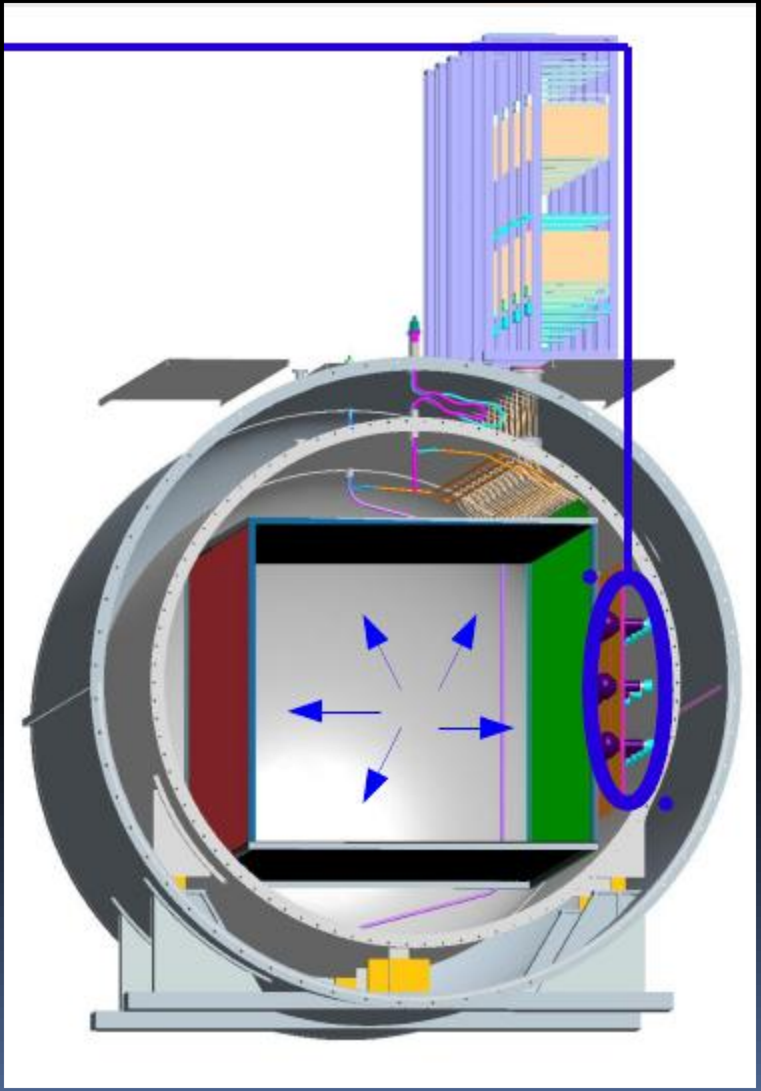
- What is MicroBooNE
- Light in Liquid Argon
- MicroBooNE PMT System Design

MicroBooNE Experiment

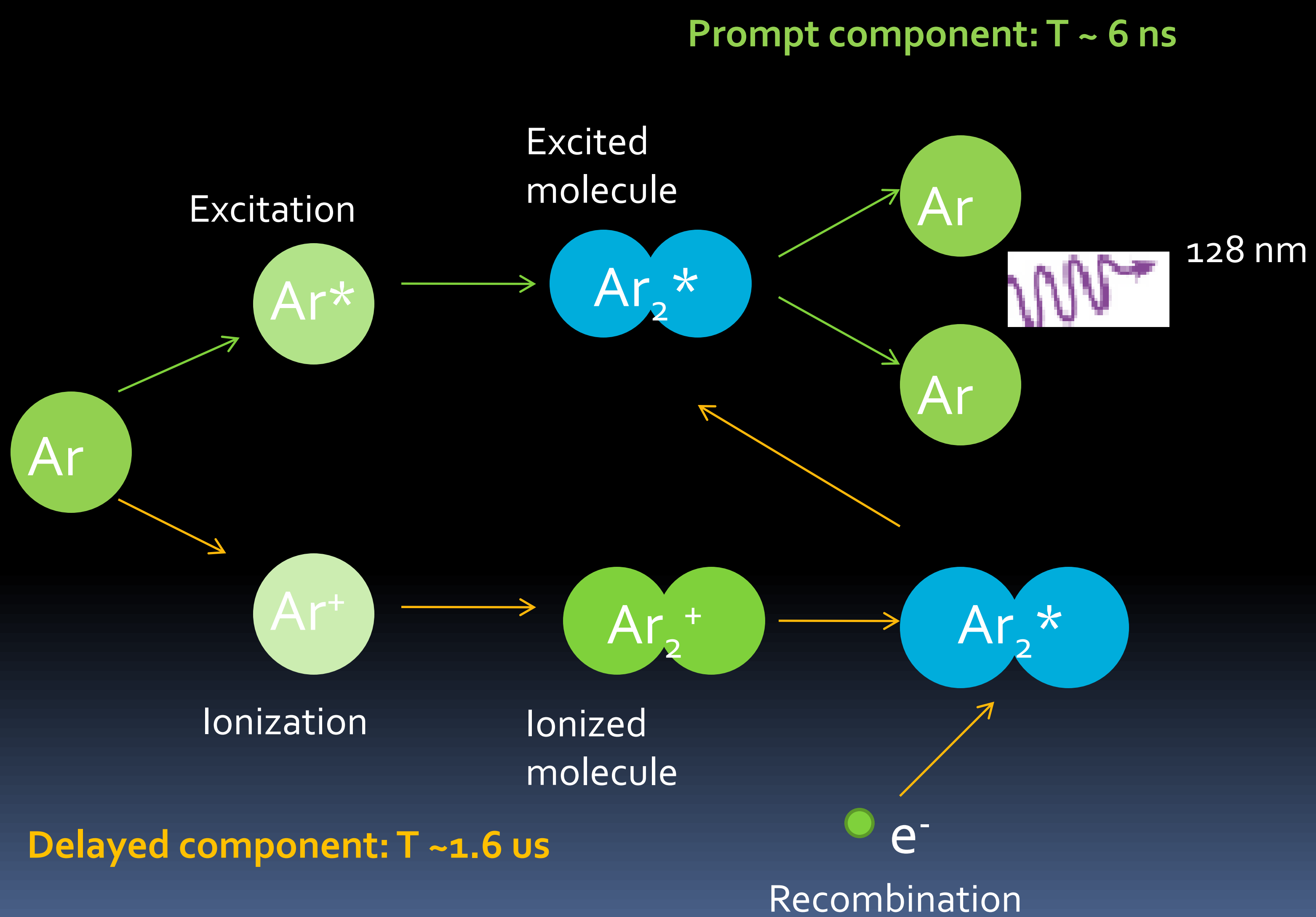
- Liquid Argon Time Projection Chamber (LArTPC) to examine low energy neutrino cross sections and investigate the low energy excess events observed in the MiniBooNE experiment.
- Expected to start running in 2013
- Located on axis to the 700MeV Booster Neutrino Beamline at Fermilab

MicroBooNE Detector Design

- LArTPC: 3 wire planes with 2.5m drift in 170 tons of LAr (73 tons fiducial volume)
- Located in a cylindrical cryostat vessel: 4m radius x 12 m length
- PMT system sits along the wall behind the TPC
  - Charge drifts to the TPC planes T~ms
  - PMT scintillation light detected T ~ns
  - So, the PMT system in principal can trigger the TPC



Scintillation Light

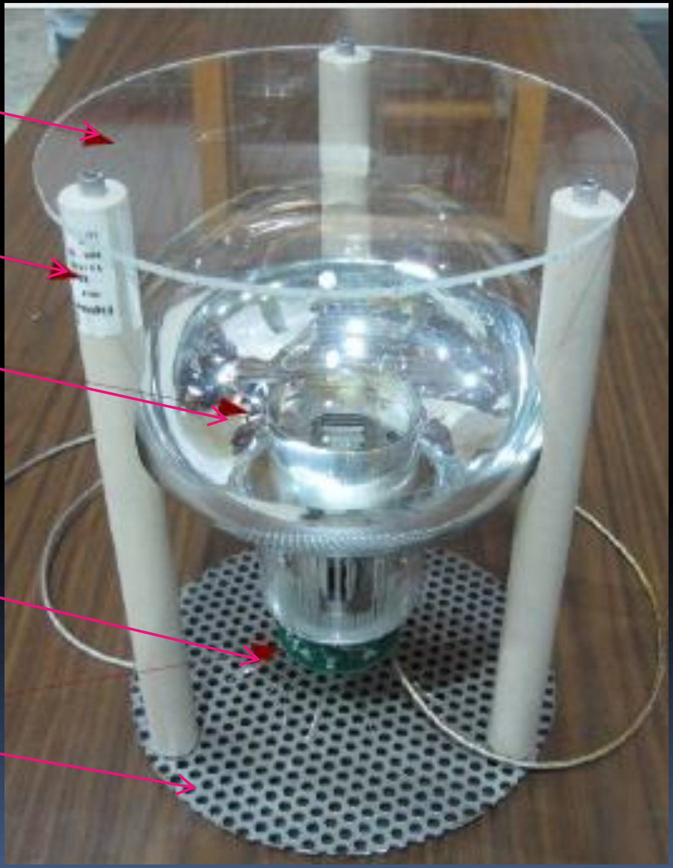


Design Constraints

- PMTs must work efficiently at cryogenic temp (87K)
- Scintillation light (128nm) must be made visible to PMTs
- Optimize Cost vs. coverage
- Maintain LAr purity
- Space constraints for TPC
- Longevity of the System

PMT Units

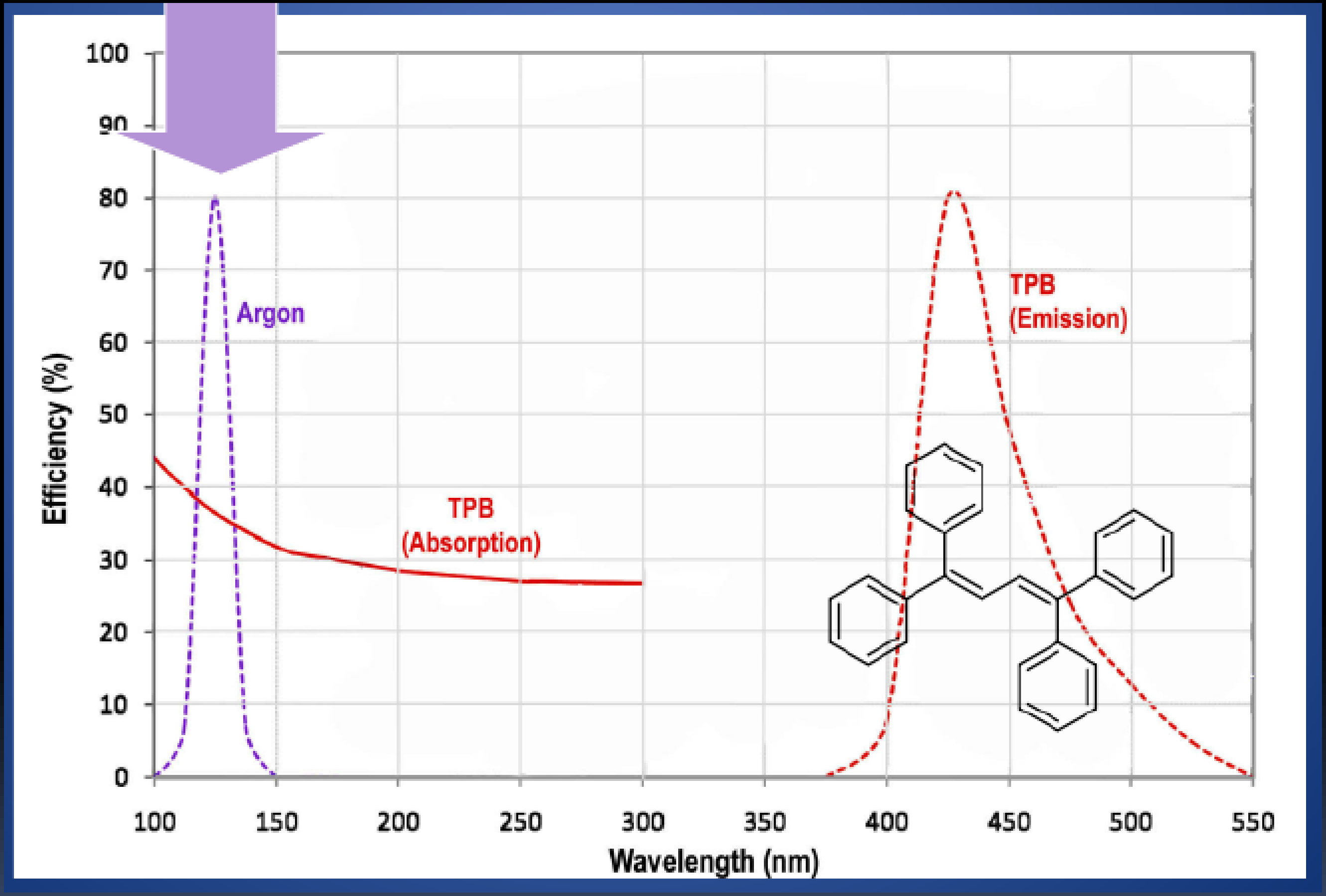
- 30 8-inch cryogenic PMTs
- Each unit has 5 components:
  - WLS plate
  - PEEK posts
  - PMT
  - Base + cable
  - Backplate



Wavelength shifting

- Scintillation light is produced in the UV ~128nm.
- We use Tetraphenyl butadeine (TPB) coated acrylic plates to shift the light into the visible.

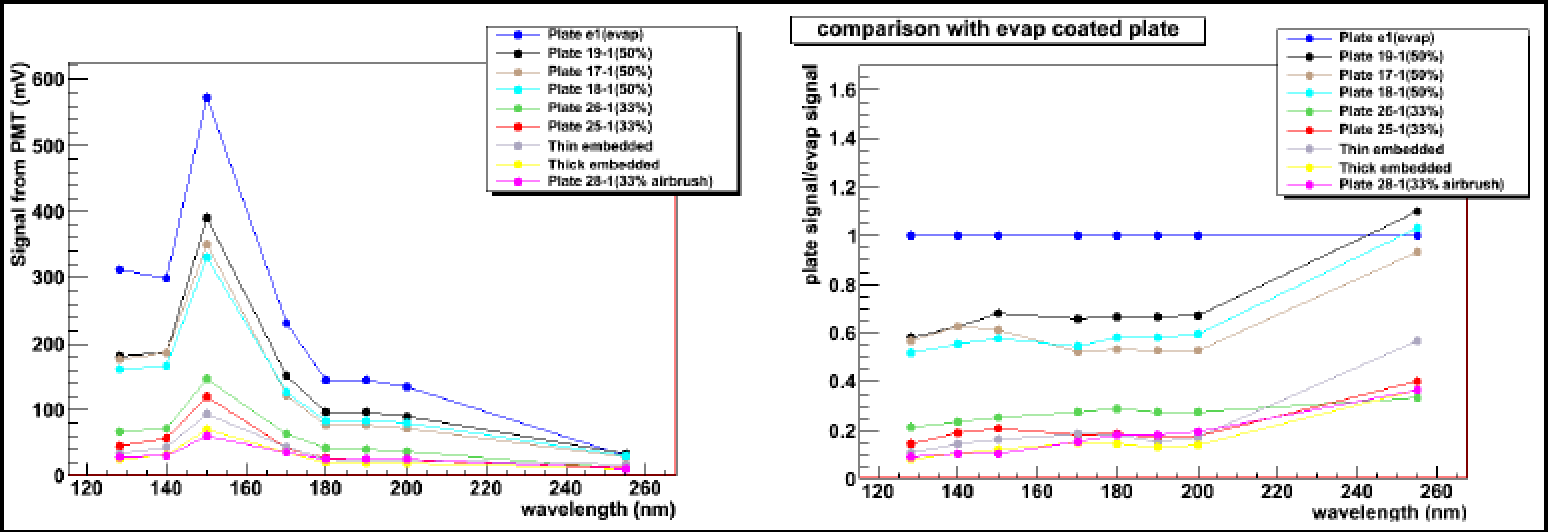
Wavelength Shifting



Wavelength Shifting

- Plates are 1/8” thick, 12” diameter
- Coated side faces into the detector
- TPB is mixed with Polystyrene and brushed onto plates.
- It is important to keep these plates dry to preserve their function.

Wavelength Shifting



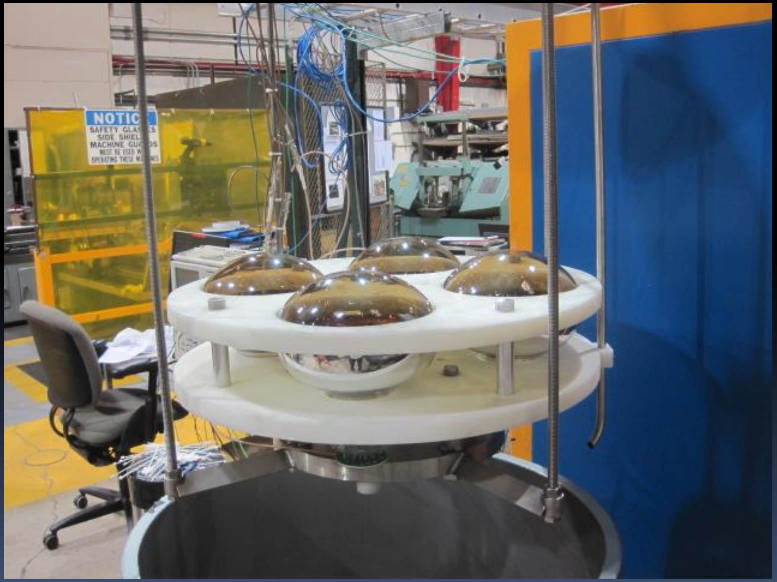
- Vacuum spectrometer data taken at Fermilab shows that evaporative coating is the most efficient, but paint brushing the plates with TPB is a cost effective solutions that meets our needs.

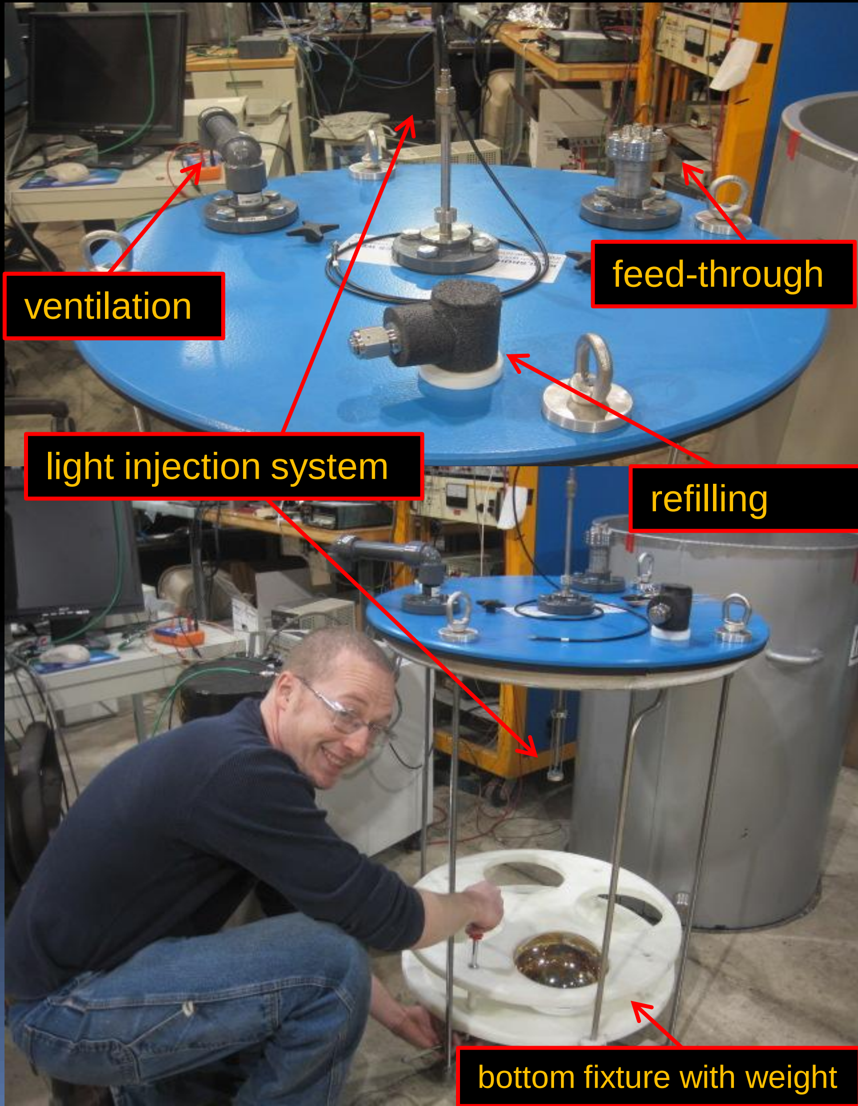
(Christina Ignarra, MIT)

Testing the PMT Units

- Late design/early construction phase
- Testing the PMTs

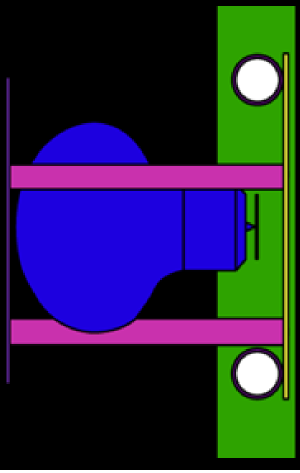
  in a dewar at Fermilab

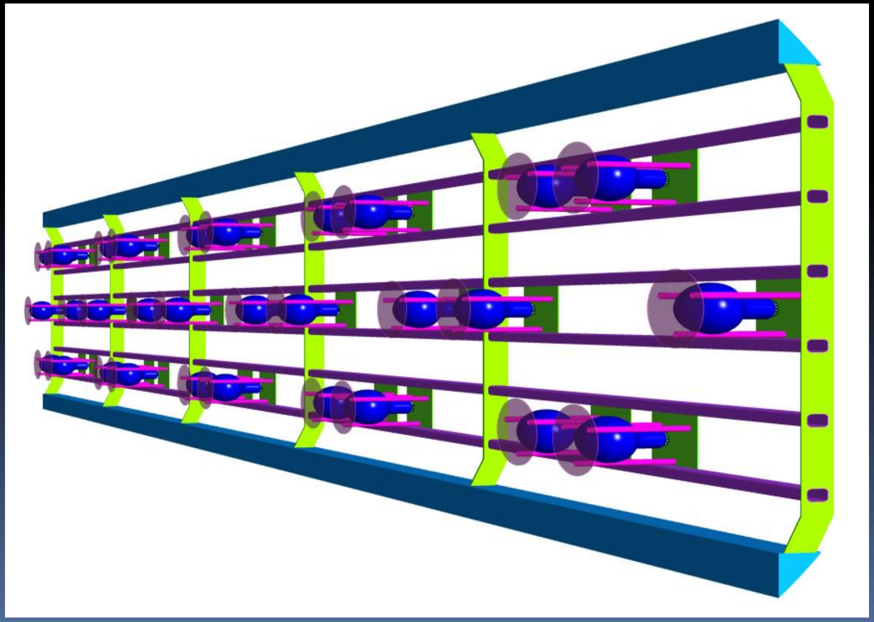


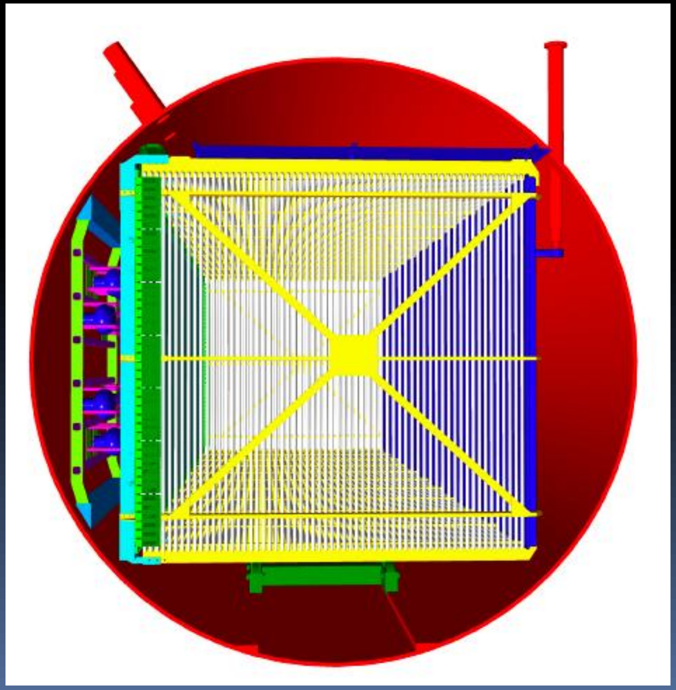


Configuration in the detector

- Fit to length of cryostat, behind TPC
- Flexible positioning of PMTs
- Stainless steel

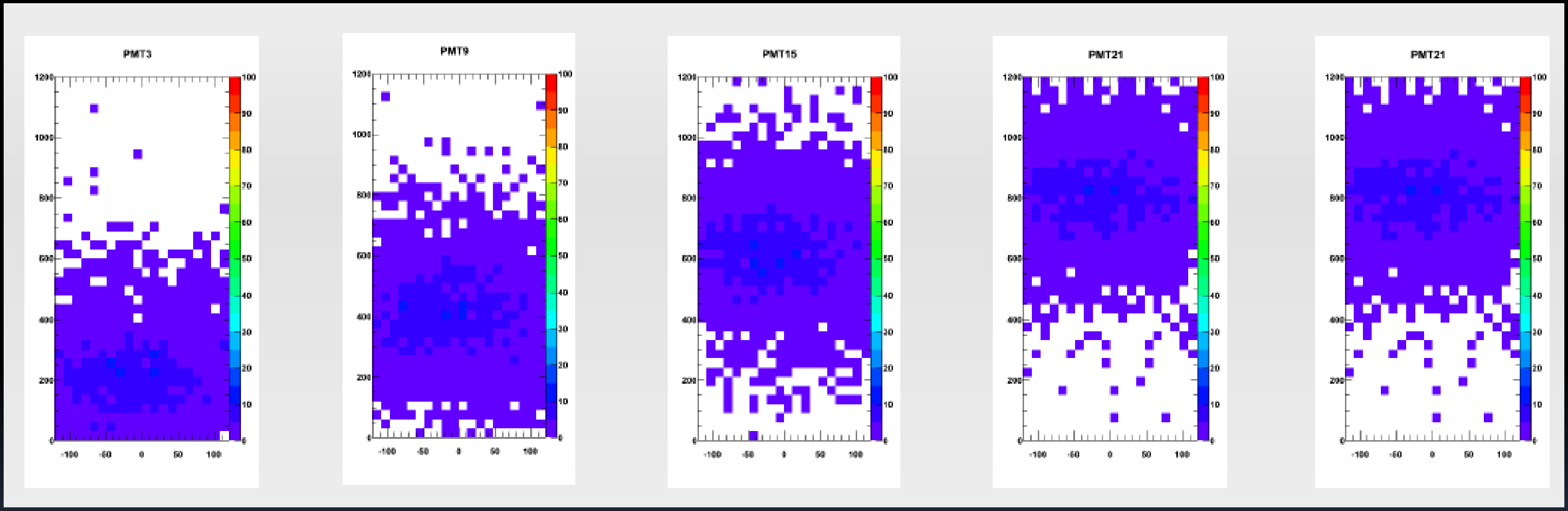






Configuration in the detector

- Coverage of a line of PMTs in Z



Work in Progress

- Humidity tests of the WLS plates (MIT)
- Developing full optical MC simulation in LArSoft (MicroBooNE collaboration at Fermilab, MIT and elsewhere)
- Use of waveguides to increase coverage (MIT)

The PMT system and the results of ongoing R&D will be useful for LAr experiments to come.

People

MIT

- Prof. Janet Conrad
- Len Bugel
- Christina Ignarra
- Ben Jones
- Teppei Katori
- Arati Prakash
- Kelly Swanson
- Tess Smidt

St. Mary's University

- Prof. Paul Neinaber
- Tom Briese
- Tim McDonald

NMSU

- Prof. Vassili Papavassiliou

Princeton

- Bill Sands