

Neck Optics Tuning for the SNO+ Experiment

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2013 CUPC

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(with leadership from Dr. Jose Maneira)

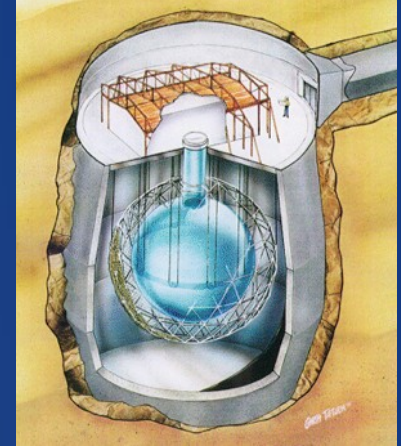


Outline

- SNO+ Experiment
- Neutrinos and Double-Beta Decay
- The SNO+ Detector
- Neck Optics Problem
- Analysis Results
- Conclusion



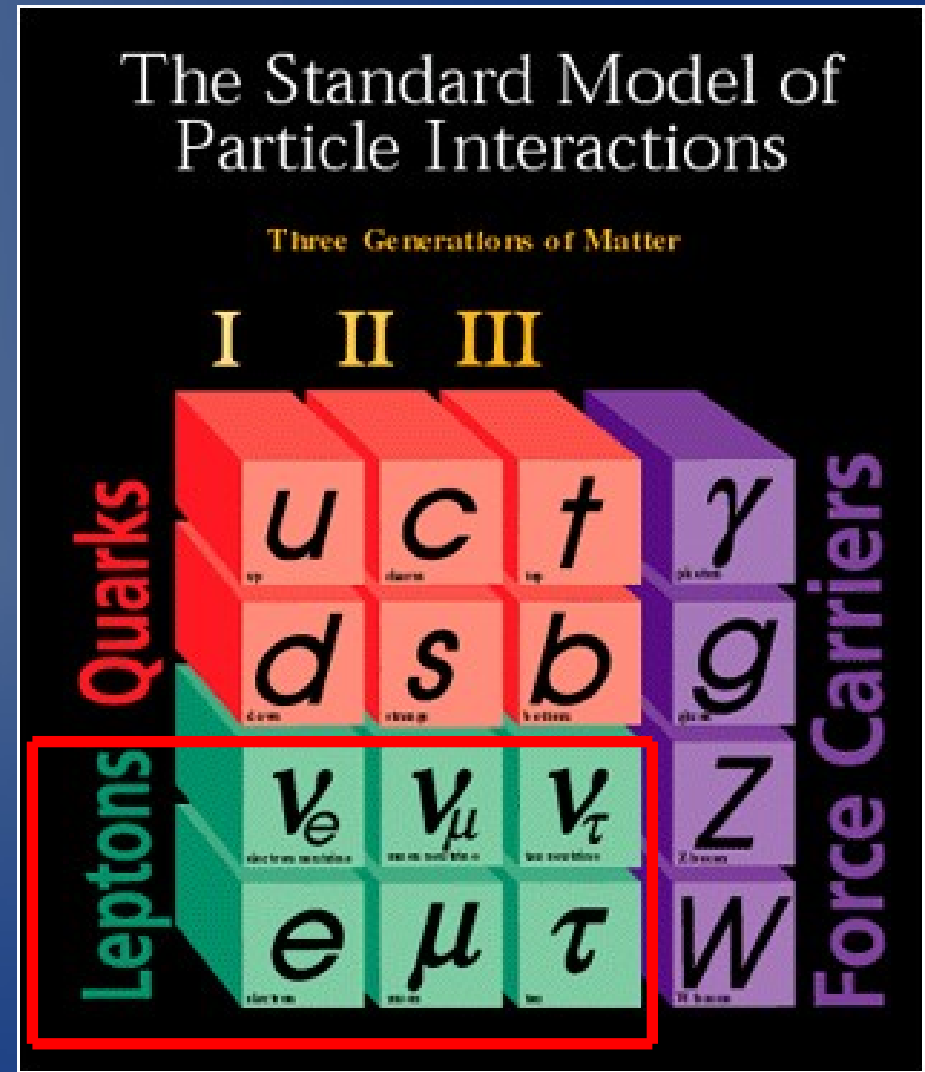
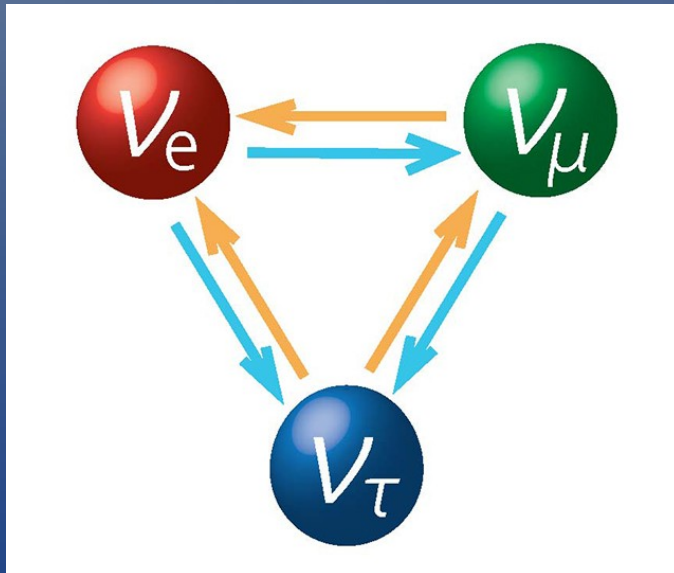
The SNO+ Experiment



- Large liquid scintillator detector-based neutrino experiment located ~2.1km underground at SNOLAB
- Follow up to the Sudbury Neutrino Observatory (SNO) experiment – solved the solar neutrino problem
- Scintillator – Linear Alkyl Benzene (LAB) – organic liquid, gives off light when charged particles pass through it

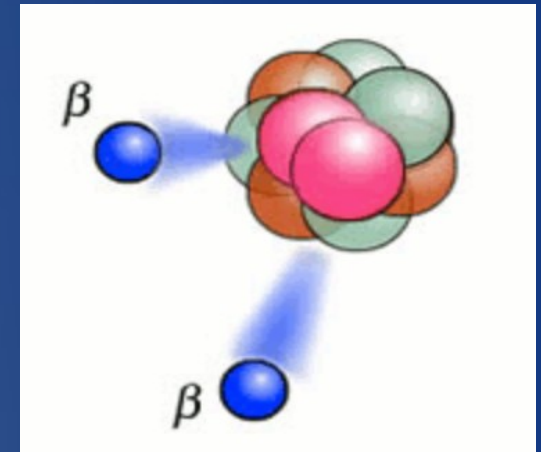
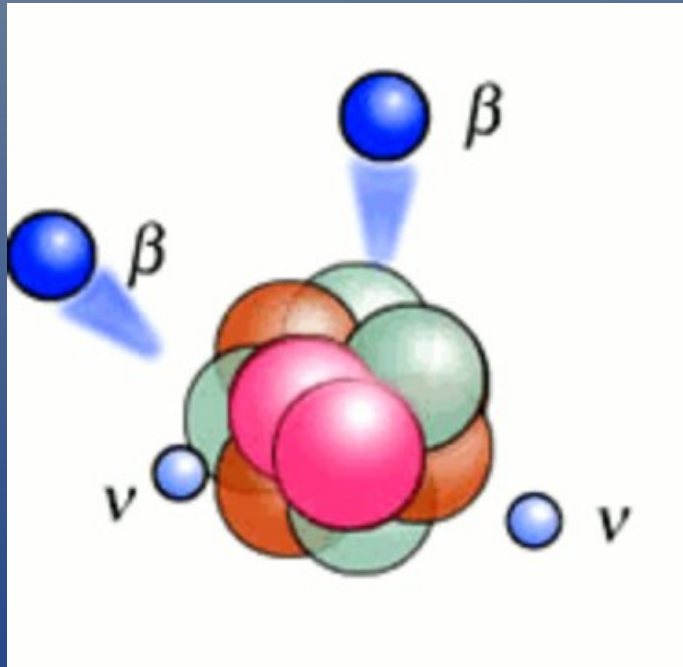
Neutrinos

- Neutrinos only interact with gravity and the weak nuclear force
- Very tiny, but **have mass**



Double-Beta Decay Physics

- 35 isotopes in nature for which beta decay is energetically forbidden, so double beta decay!
- Neutrinoless double-beta decay – proposed theoretically, yet to be seen in nature



- If found, neutrinos are Majorana particles i.e.

$$\nu = \bar{\nu}$$

The SNO+ Detector

AV Neck

- 7 m height
- 1.4 m diameter

Acrylic Vessel (AV)

- 12 m diameter

Liquid scintillator (LAB)

- 780 t

Phototube sphere (PSUP)

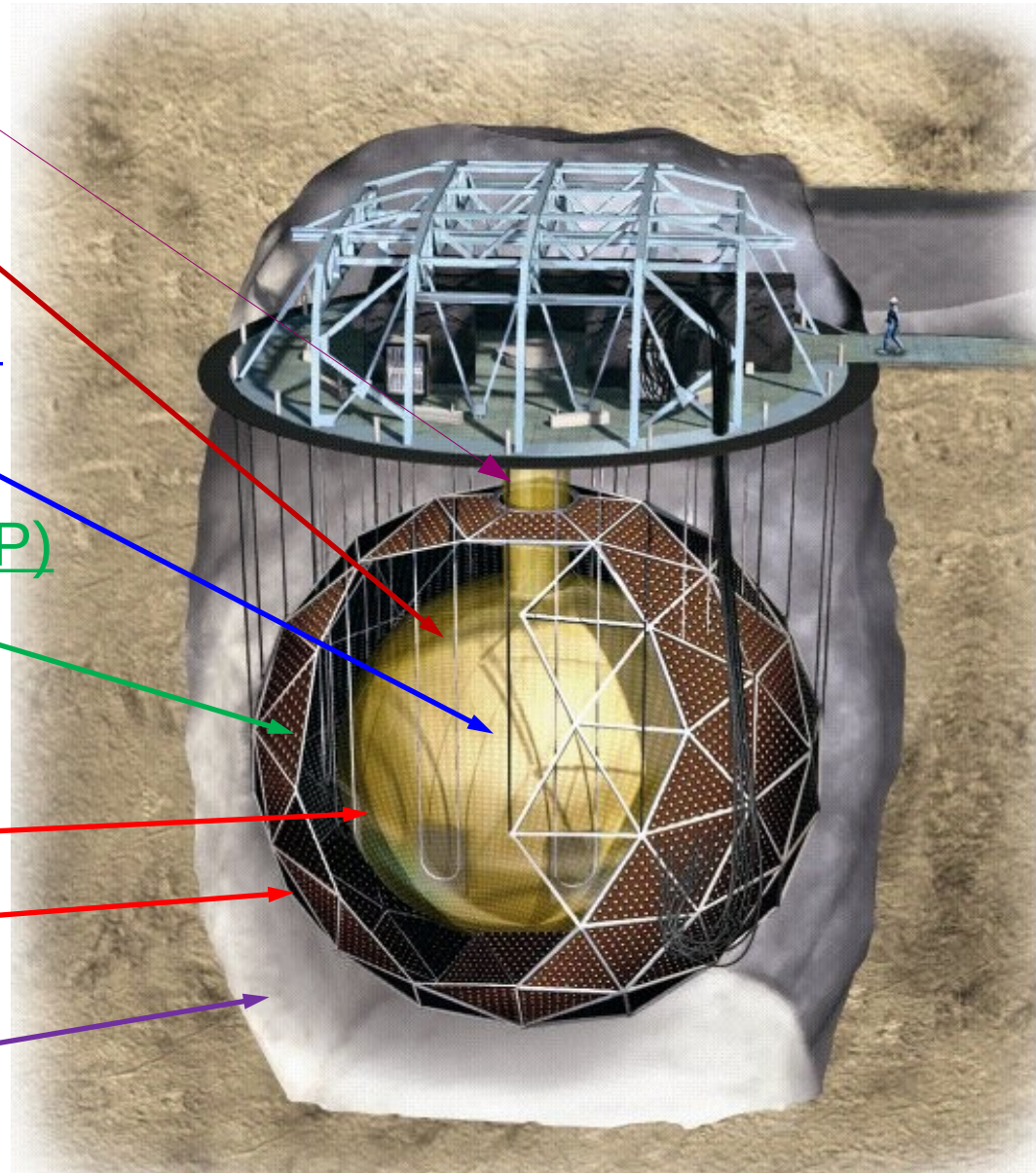
- 9000 active PMTs

Water shielding

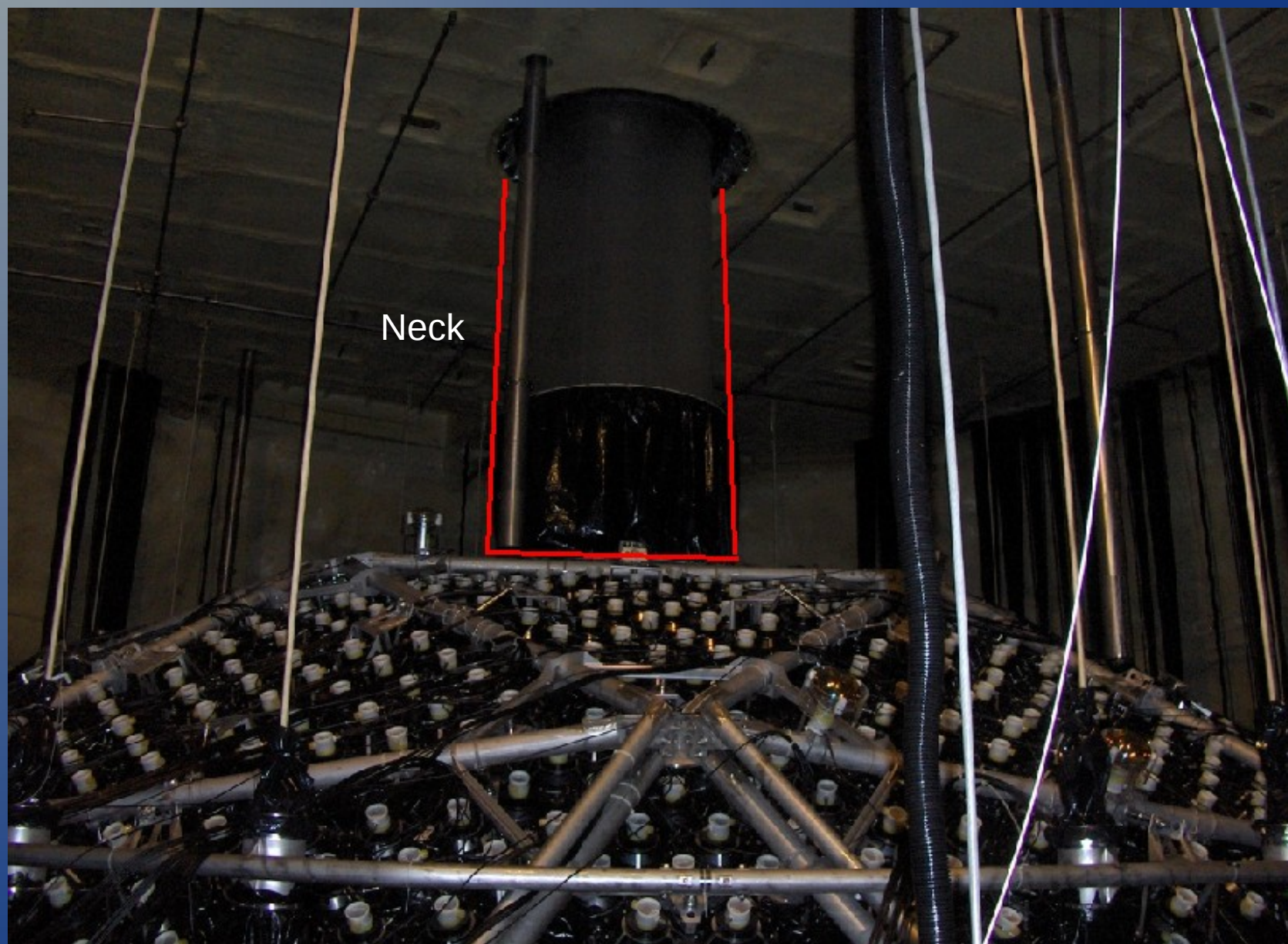
- 1700 t inner
- 5300 t outer

Urylon liner

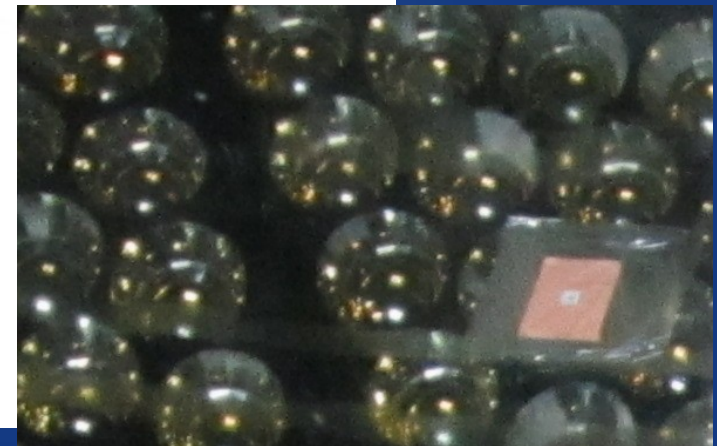
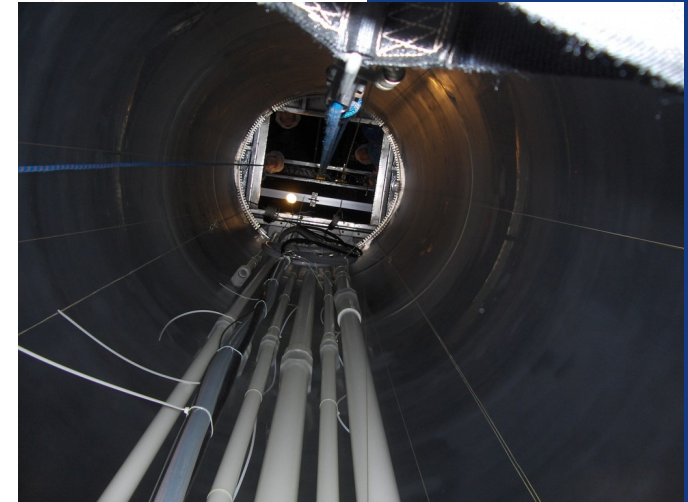
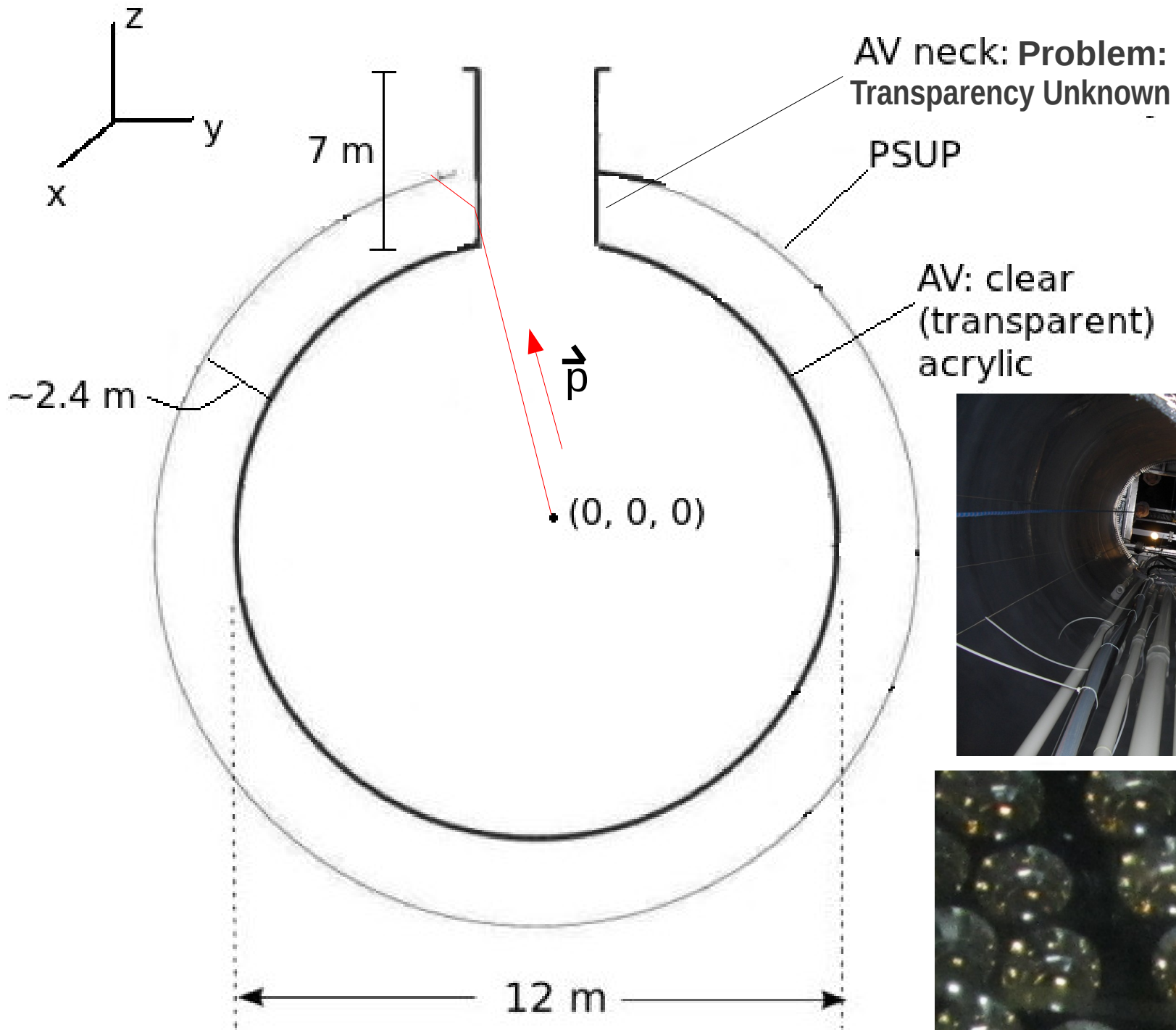
- radon seal



Neck Optics Tuning

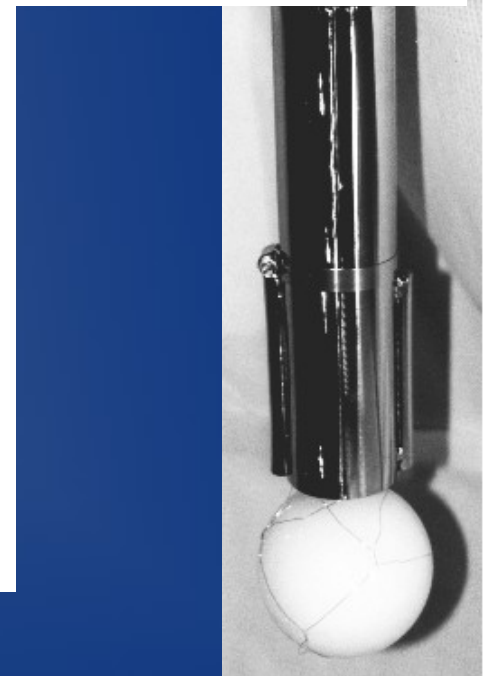
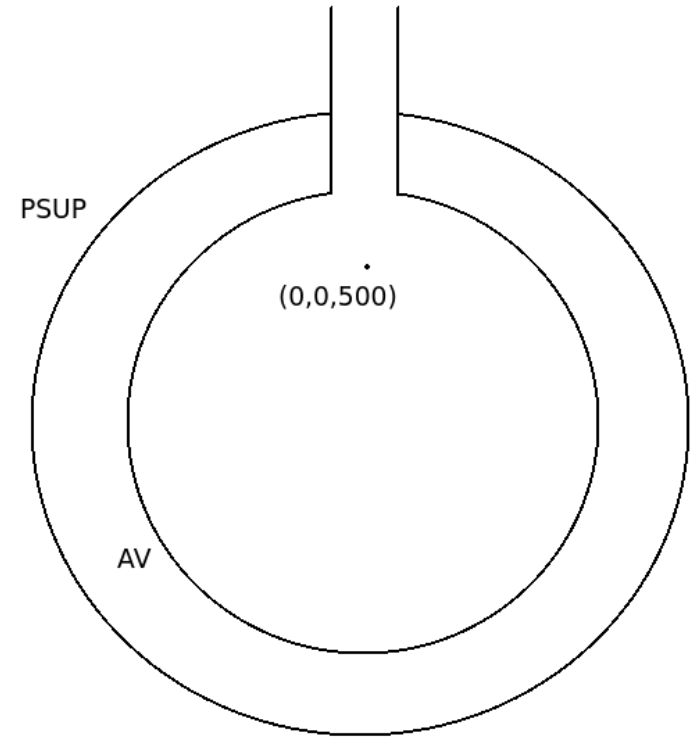
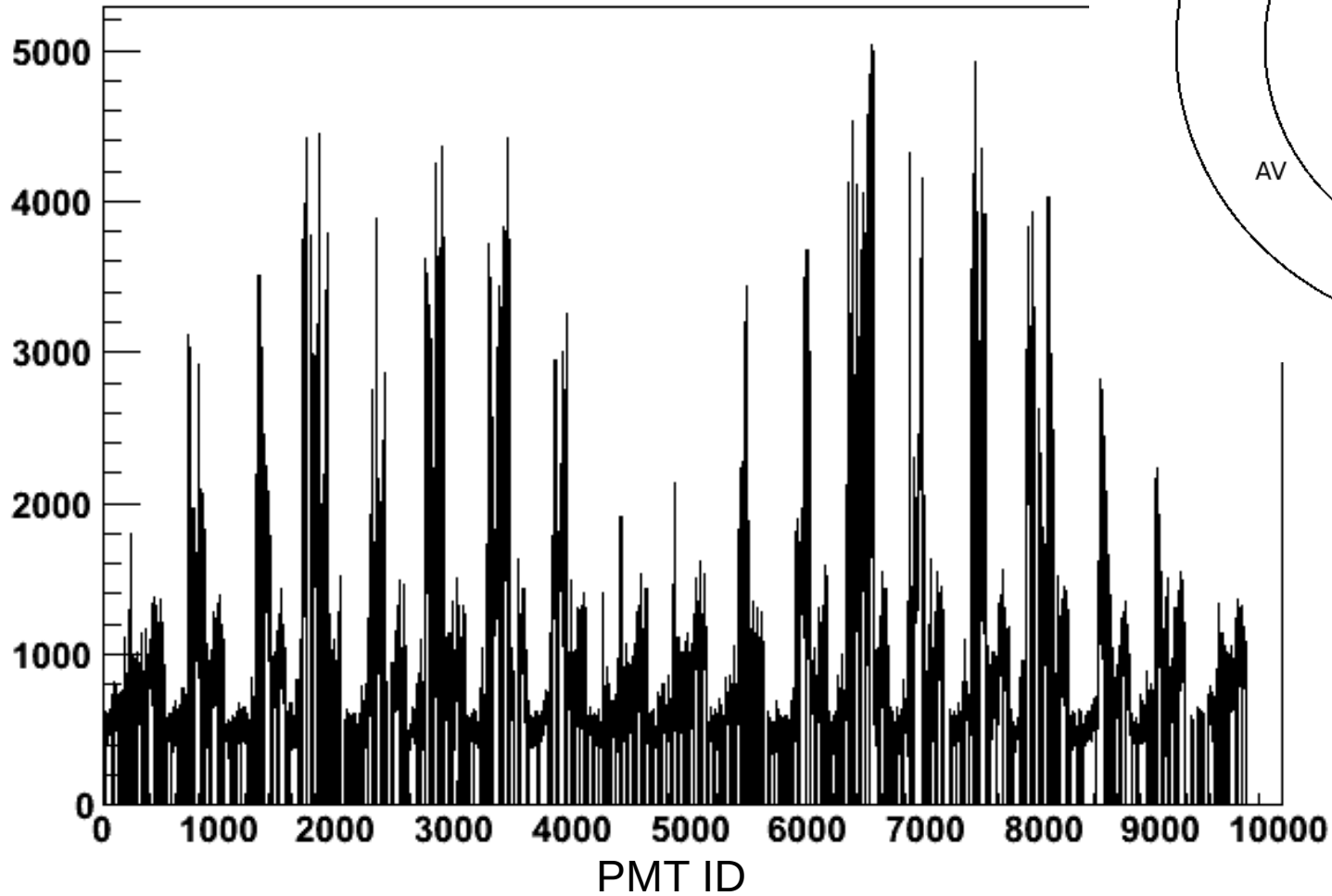


Neck

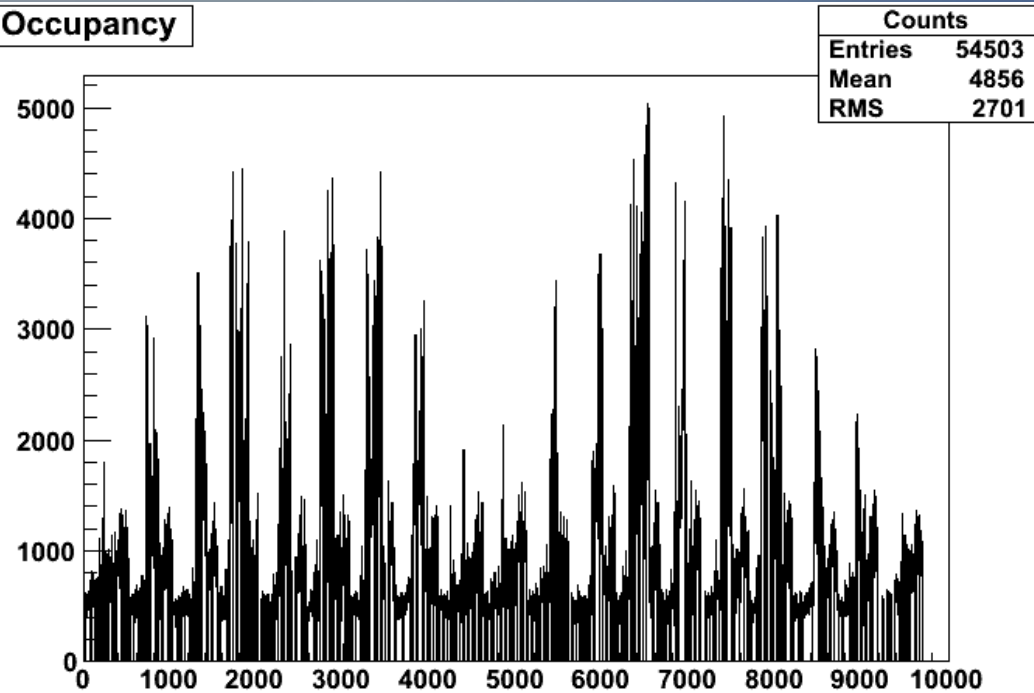


Analysis

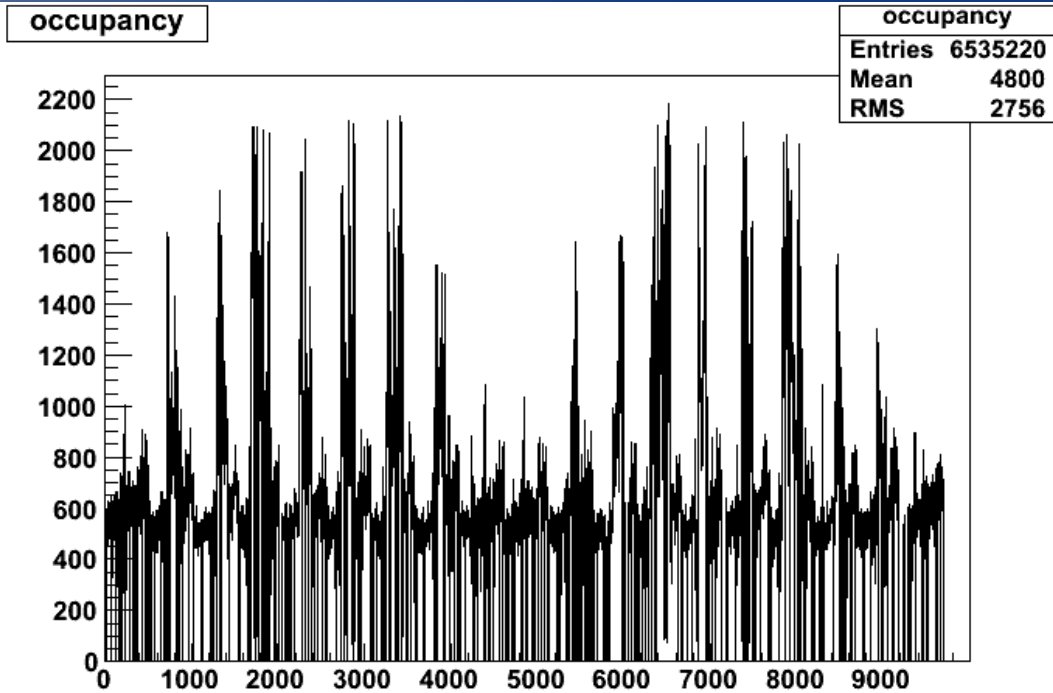
Occupancy



Data



MC Simulation

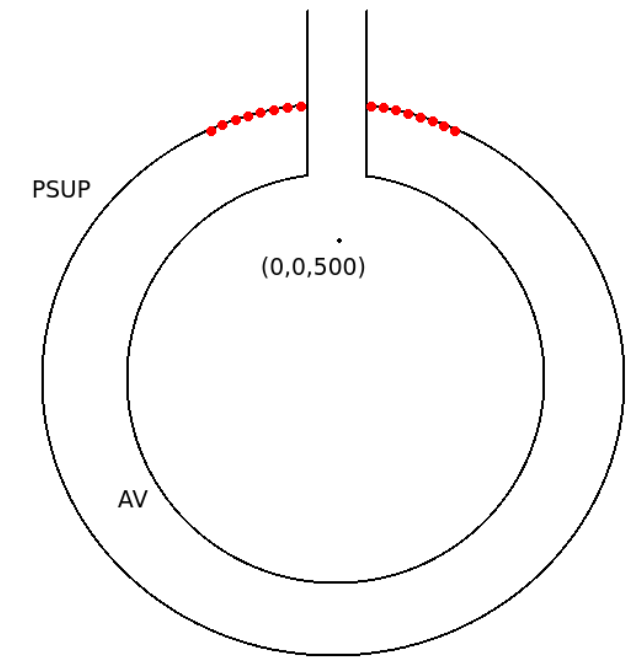
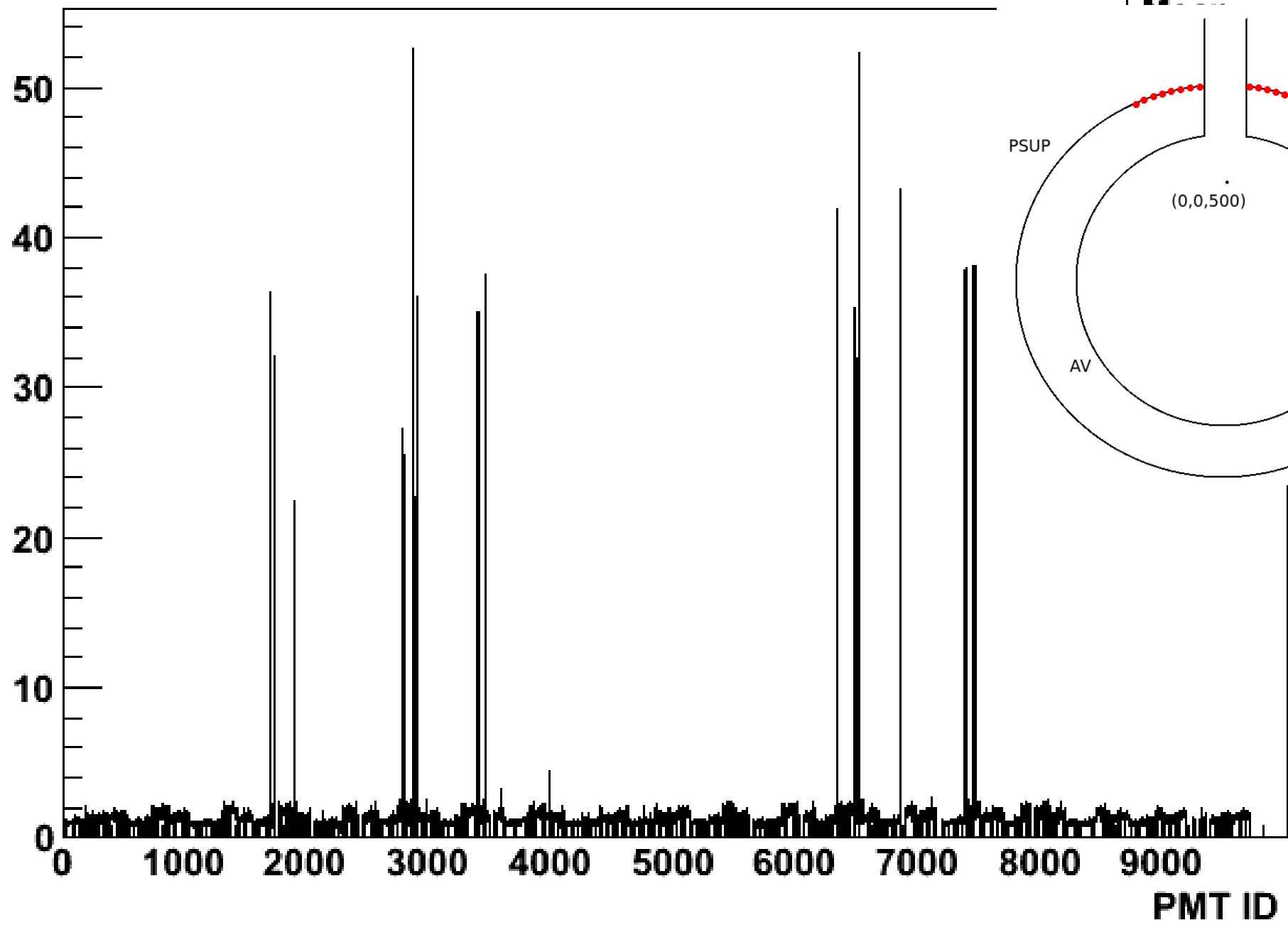


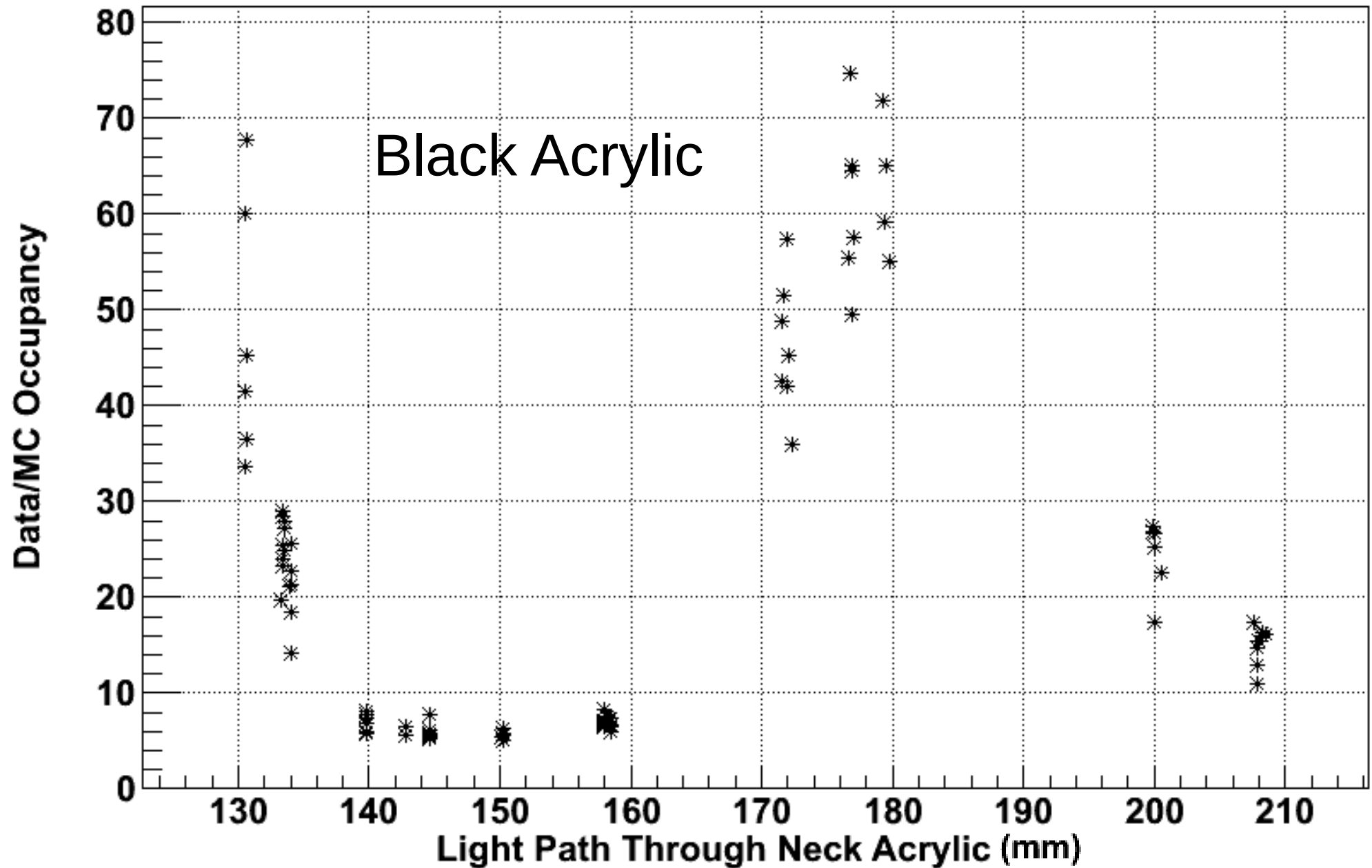
PMT ID

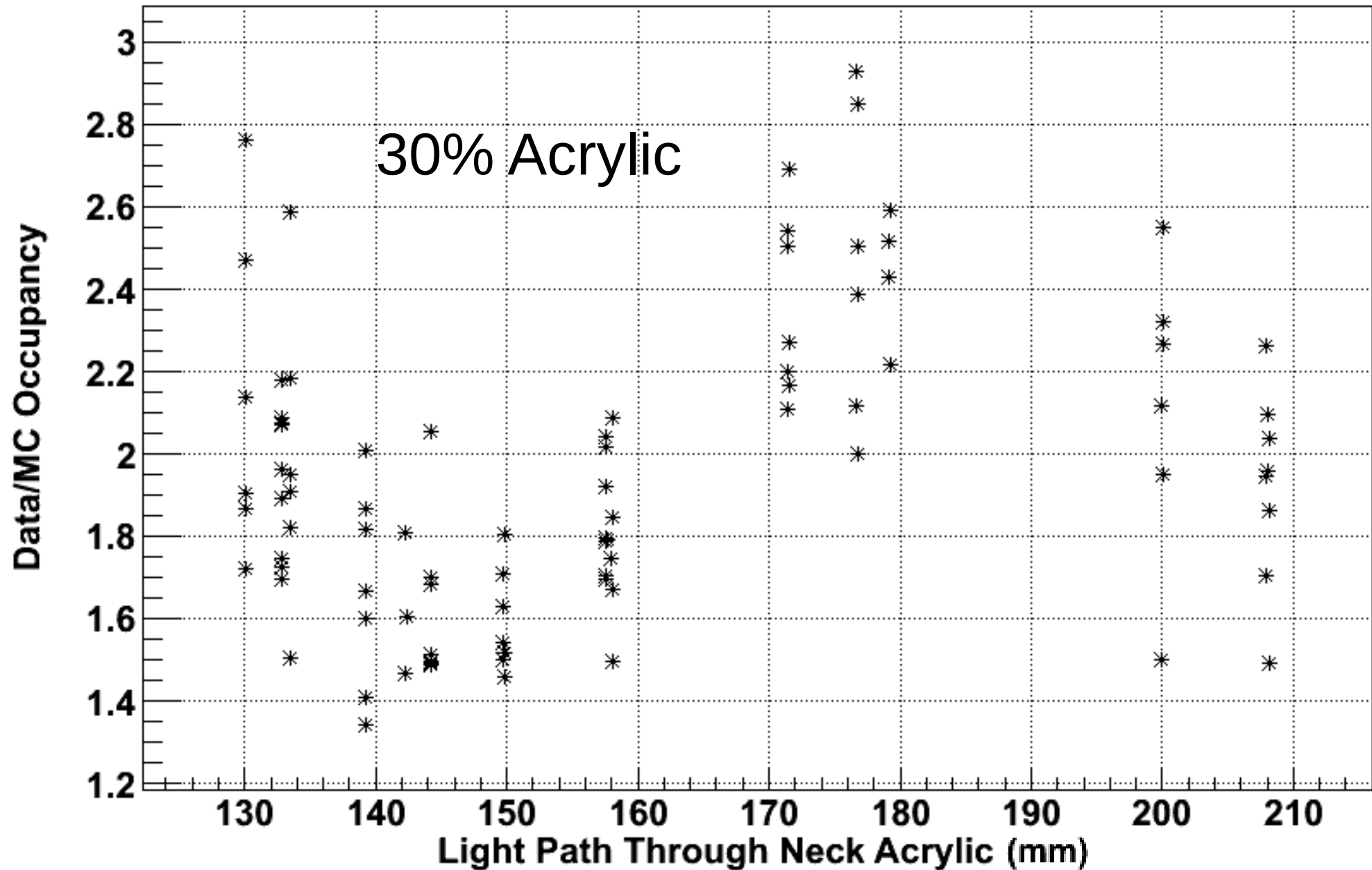
Relative Occupancy: SNO Laserball $\lambda=500\text{nm}$, $z=500\text{cm}$

Occupancy	
Entries	6535220
...	...

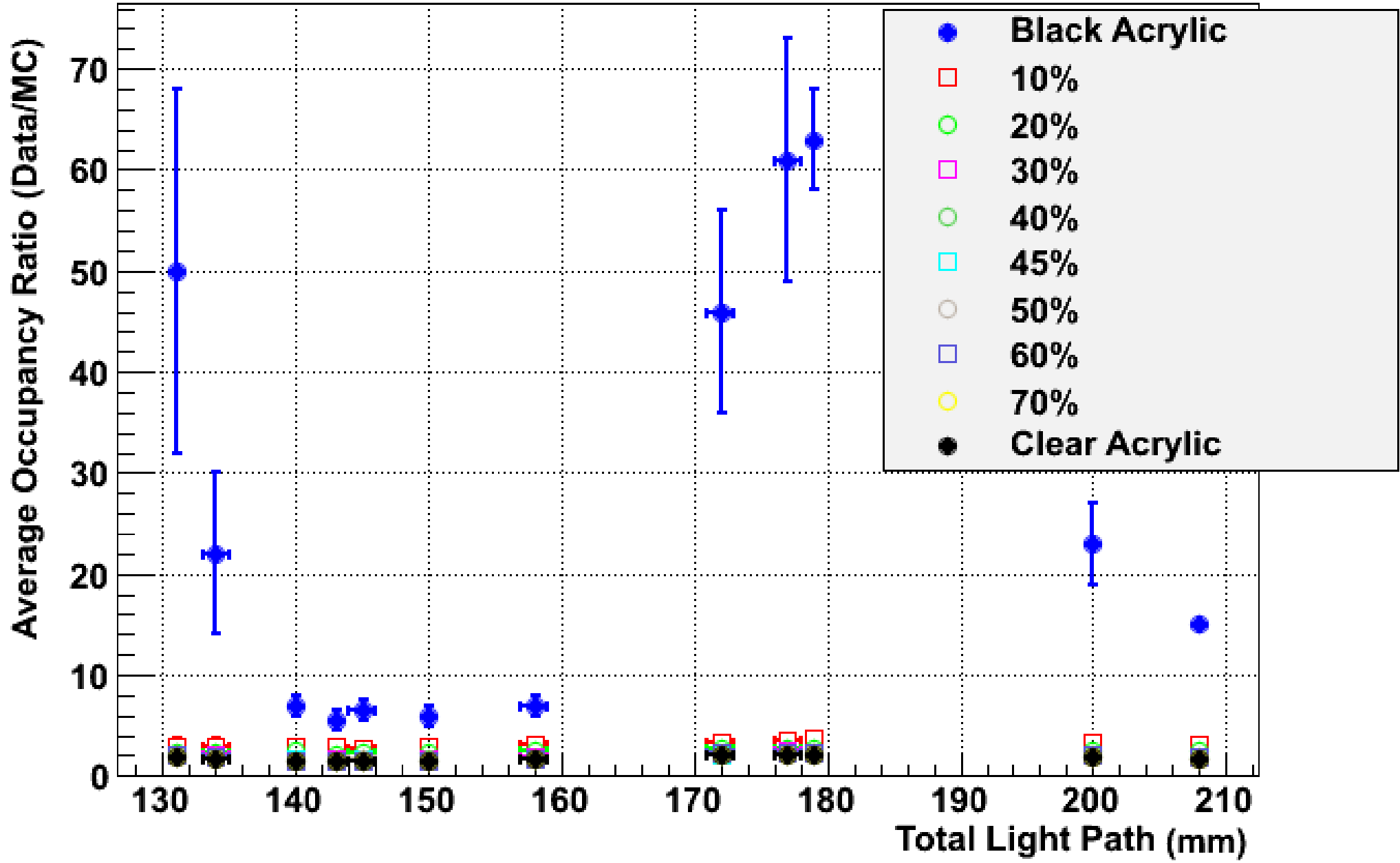
Data/MC Occupancy



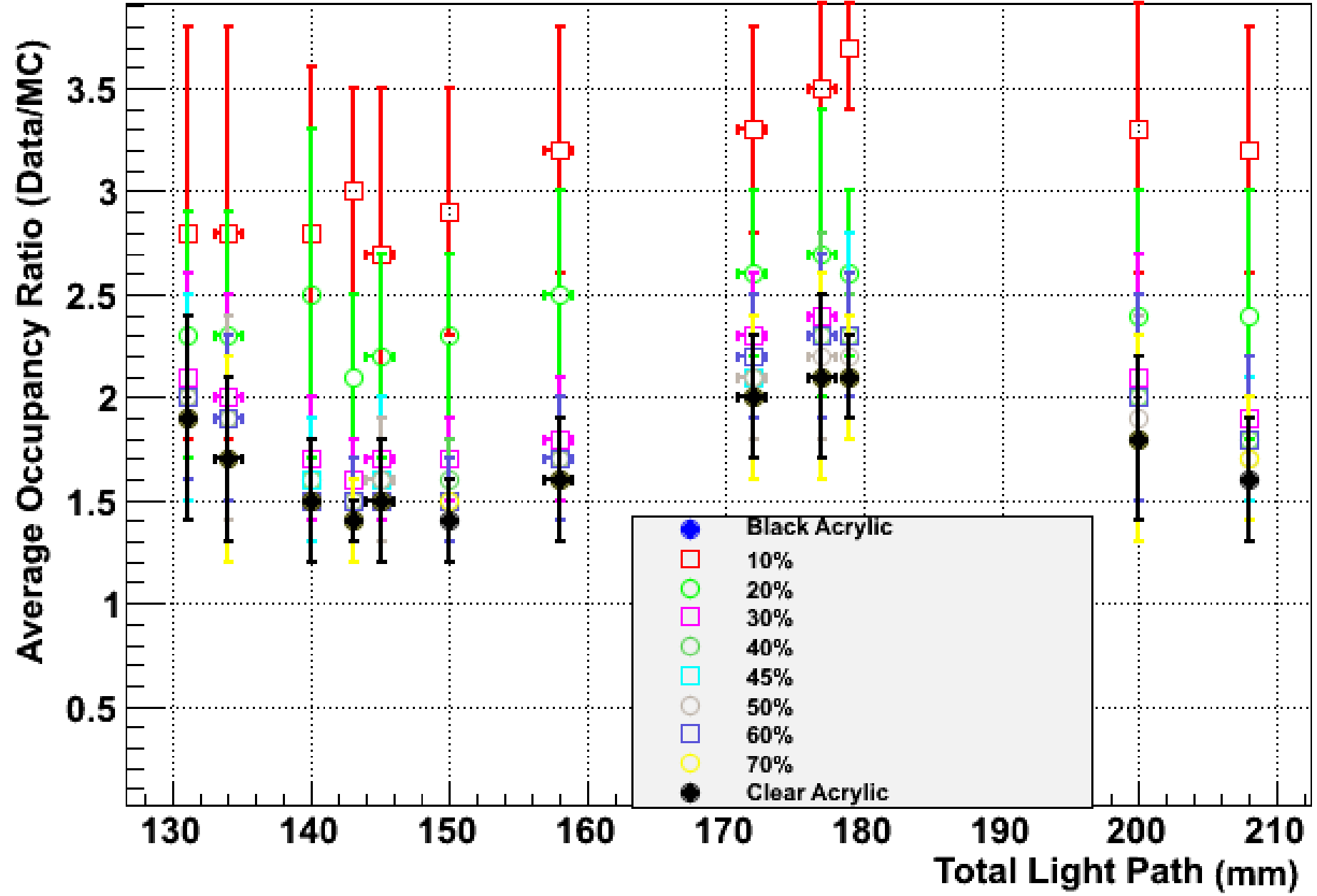
Occupancy Ratio vs Light Path, $\lambda = 500\text{nm}$, $z = 550\text{cm}$ 

Occupancy Ratio vs Light Path, $\lambda = 500\text{nm}$, $z = 550\text{cm}$ 

Occupancy Ratio vs Light Path for Increasing Absorption Lengths, $\lambda = 500\text{nm}, z = 550\text{cm}$



Occupancy Ratio vs Light Path for Increasing Absorption Lengths, $\lambda = 500\text{nm}, z = 550\text{cm}$



Conclusions

- SNO+ experiment will begin taking data soon
- First step to neck optics solution now complete with more accurate neck material implemented!
- Adding in correct neck optics to the database allows for a better understanding of events passing through the neck, thereby decreasing the experiment's systematic error

