SoLID Heavy Gas Cherenkov Update

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SoLID Collaboration Meeting. August 27, 2016.

NSERC CRSNG

FRN: SAPIN-2016-00031

SoLID HGC Prototyping

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Director's Review – March 2015:

"A heavy gas Cherenkov prototype will be built and tested in the near future."

Good News:

- Two equipment grants totaling C$99,960 (~US$77,300) have recently been awarded for HGC prototyping.

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CANADA FOUNDATION FOR INNOVATION | FONDATION CANADIENNE POUR L'INNOVATION

Government of Canada (50%)

Fedoruk Centre
SYLVIA FEDORUK CANADIAN CENTRE FOR NUCLEAR INNOVATION

Government of Saskatchewan (50%)

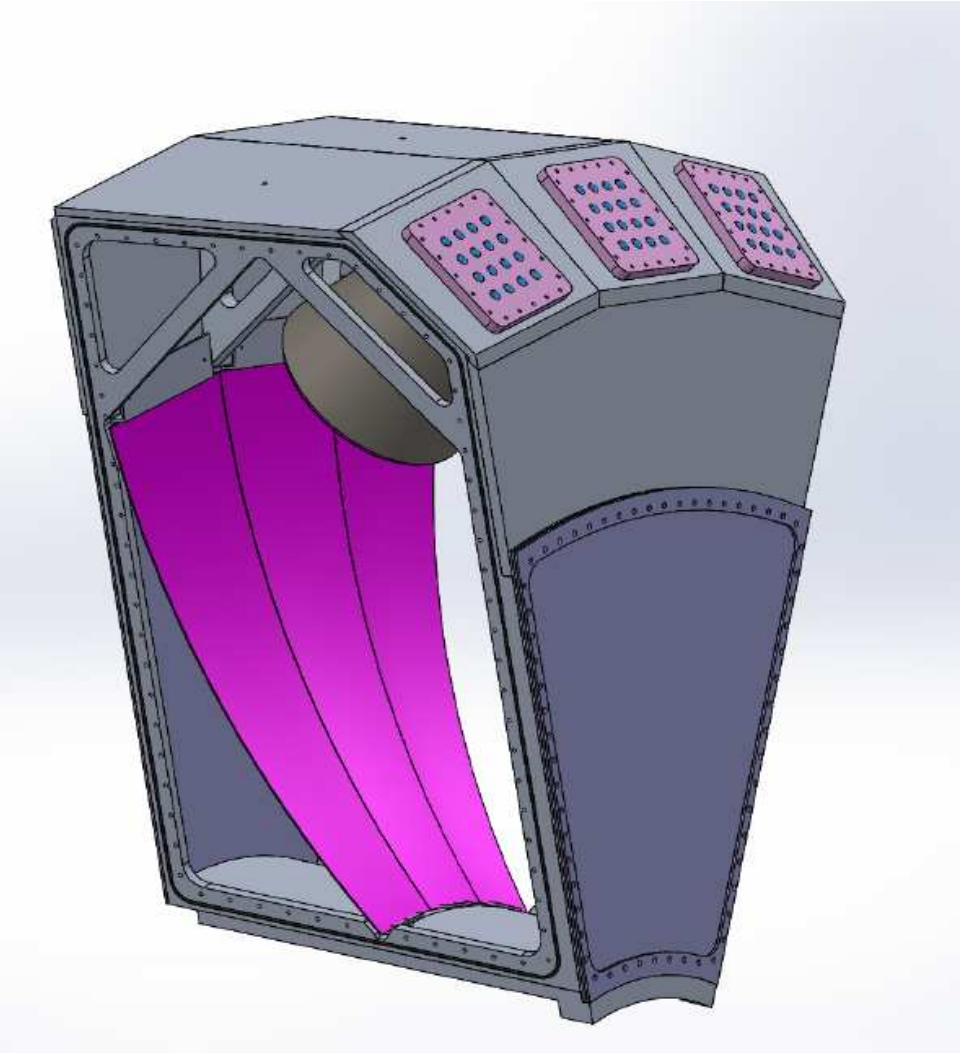
- The grants rely on an international partnership with our Duke University partners (MOU in progress).

Planned HGC Prototyping Studies

The grants will permit us to construct one SoLID HGC module for testing.

Questions to be addressed:

- Enclosure deformation at 1.5 atm operating pressure (investigate design and metal alloy options).
- Performance of the O-ring seals against adjacent units.
- Performance of thin entrance window in terms of light and gas tightness (test several options).
- Optical performance.



Conceptual design by Gary Swift, Duke U.

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Thin Entrance Window Options

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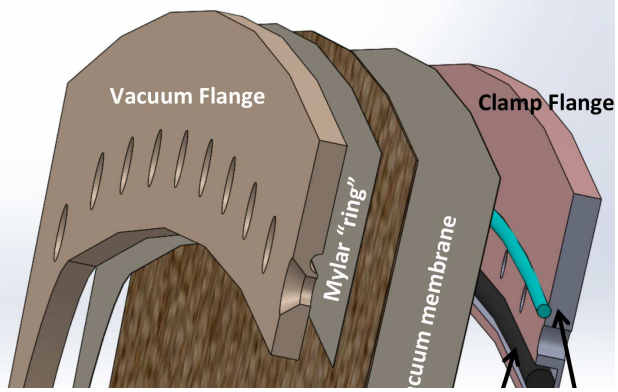
Madico Inc. (vendor for CLAS12–LTCC Low Threshold Cherenkov Counter)

- 3 layer construct:
  - 1st layer 1.5 mil white Tedlar (PVF)
  - 2nd layer 3.0 mil Mylar A (PET)
  - 3rd layer 1.5 mil white Tedlar (PVF)
- We have a sample of this material from Maurizio Ungaro.
- Madico projects it can hold up to 6 atm (LTCC is at 1 atm).

SoLID HGC is at 1.5 atm.

- **To reduce bulging, Madico recommends 5 mil PET instead of 3 mil for the middle layer.**
  - Making the window out of a thicker PET core will also allow us to draw it tighter when mounting on frame.
- Effort to make 10” test roll is nearly the same as a master roll as the 67” width requires commercial scale machines.
- They propose making 30 ft of material, 67” width of the above construction for US$4,000=C$5,194. The price includes all materials for assembly.
- One window is 67”x50”. Full detector requires 10 windows 500”=42’, 100’ should be enough.



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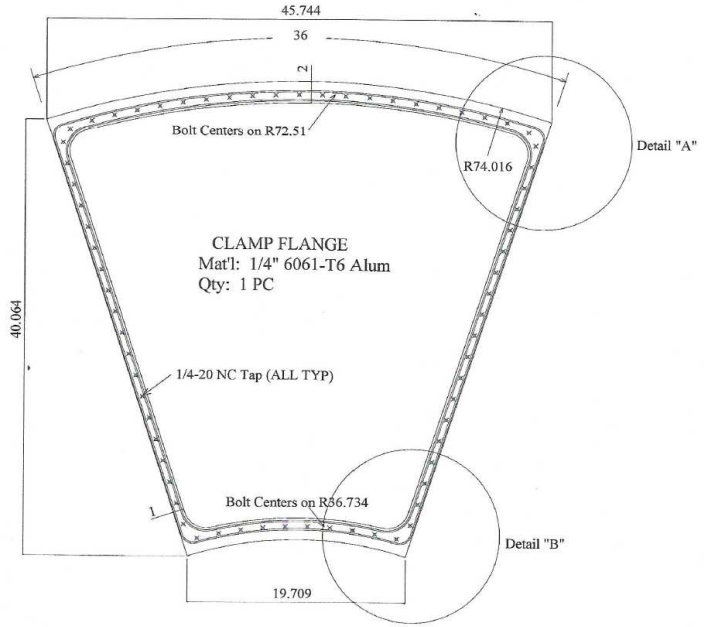
Thin Window Pressure Test Jig

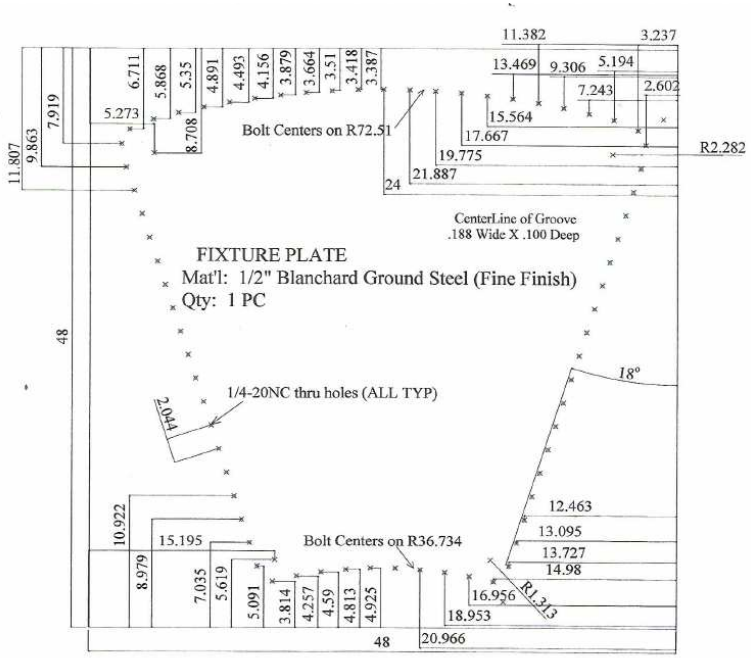
TWO BIDS SUBMITTED:

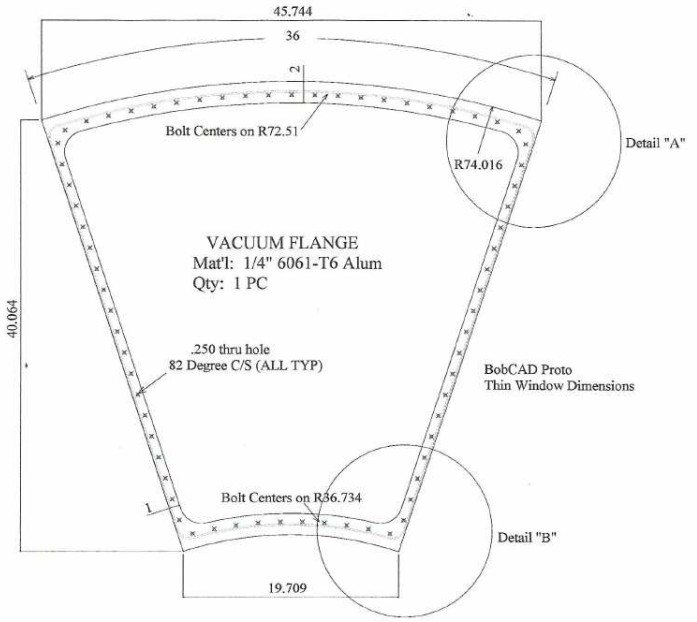
Ross Machine Shop **C$5,530**
(did GlueX BCAL machining)

Brandt Engineered Products **C$5,635**
(faster delivery)

Order placed with Brandt, expecting delivery in early October.







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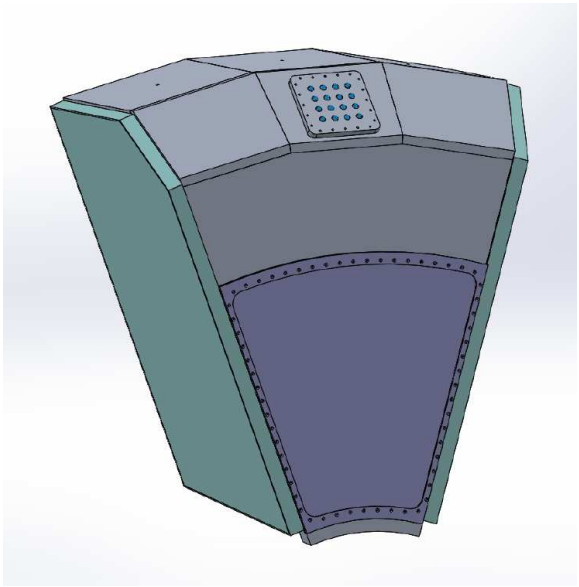
Gas Enclosure Test Plan

- **Need to test deformation at 1.5 atm. Since the spacing between the LGC, HGC and electromagnetic calorimeter is tight, there are strict requirements on the allowed deflection.**
- Back of the enclosure has conflicting requirements of thin (to avoid particle production affecting the downstream calorimeter) and strong (to reduce overall deflection). We anticipate needing to investigate several options, including different thicknesses of 6061 and 7075 alloy, or even carbon fiber epoxy to achieve necessary combination of thinness and strength.
- Left and right sides will be blanked off with 3/8" thick aluminum 6061 side covers and the enclosure pressurized above the 1.5 atm operating pressure to check for O–ring leaks.

C$58,422 is allocated for the gas enclosure.



Conceptual design by Gary Swift, Duke U.

- **Since we may have to make modifications to the design, the prototype enclosure frame will not be welded together. Instead, it will be bolted to allow easy disassembly, and sealed internally with RTV silicone adhesive.**
- **Once we are more confident in the design, we will try welding the prototype frame parts together to see whether this causes any undesirable warping.**

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Deep UV Mirror Reflectivity

- **Considering to purchase flat CFRP mirror samples (50.8 mm dia) from Composite Mirror Applications for coating at Stony Brook.**
  - Optical quality based on LHCb-type mirrors.
  - Cost 50xUS$132.45=US$6,623=C$8,560
- eRD6 RICH Prototype with deep UV sensitivity (~120 nm)
  (IEEE Trans. Nucl. Sci. 10.1109/TNS.2015.2487999)

- *Measure the reflectivity of VUV mirrors:* Stony Brook plans to produce high quality Al/MgF_2 coated mirrors for future RICH detectors. We plan to use our VUV spectrometer at BNL to measure the reflectivity of these mirrors. However, the spectrometer requires new hardware, commissioning, and possibly new software before these measurements can be performed.

- Big enough to make the mirror size we require.
- MUCH MUCH better vacuum
  - Big Mac 3×10^{-6} torr
  - INFN 7×10^{-8} torr

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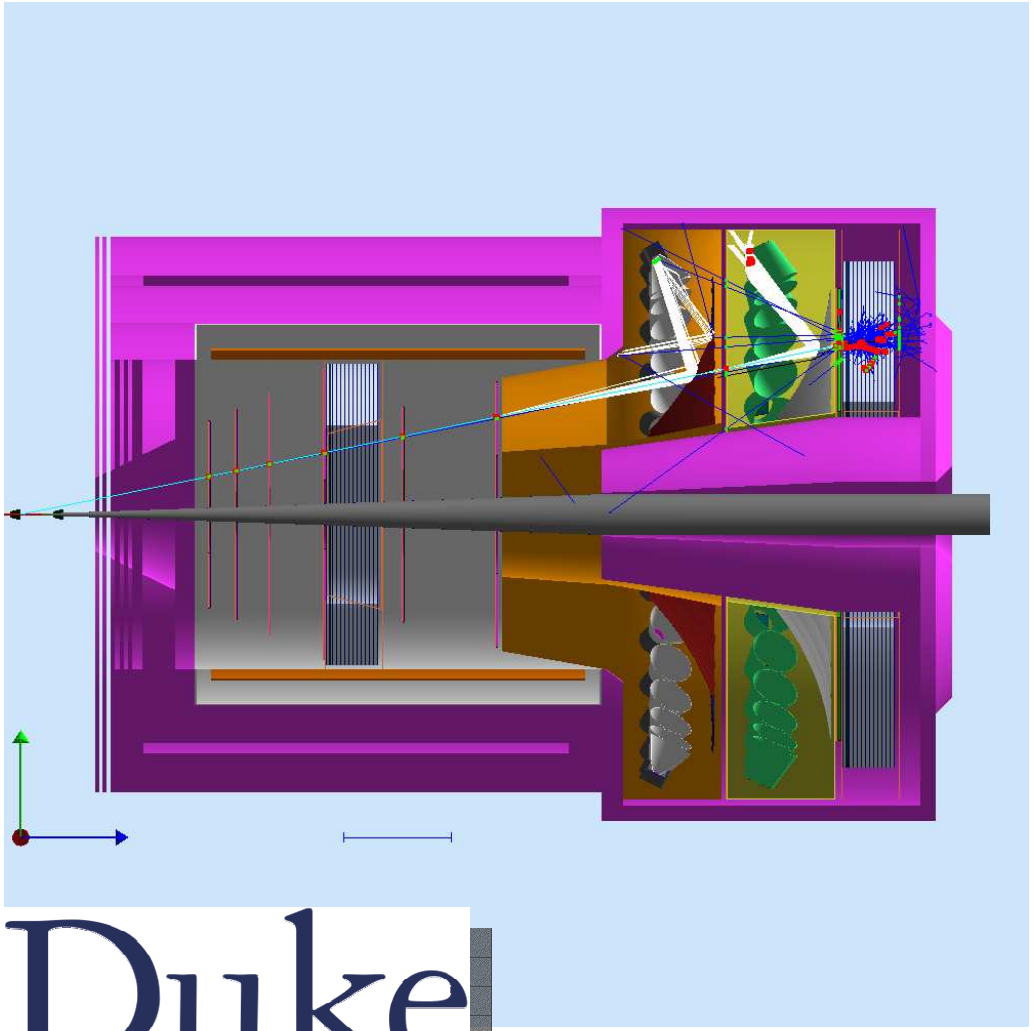
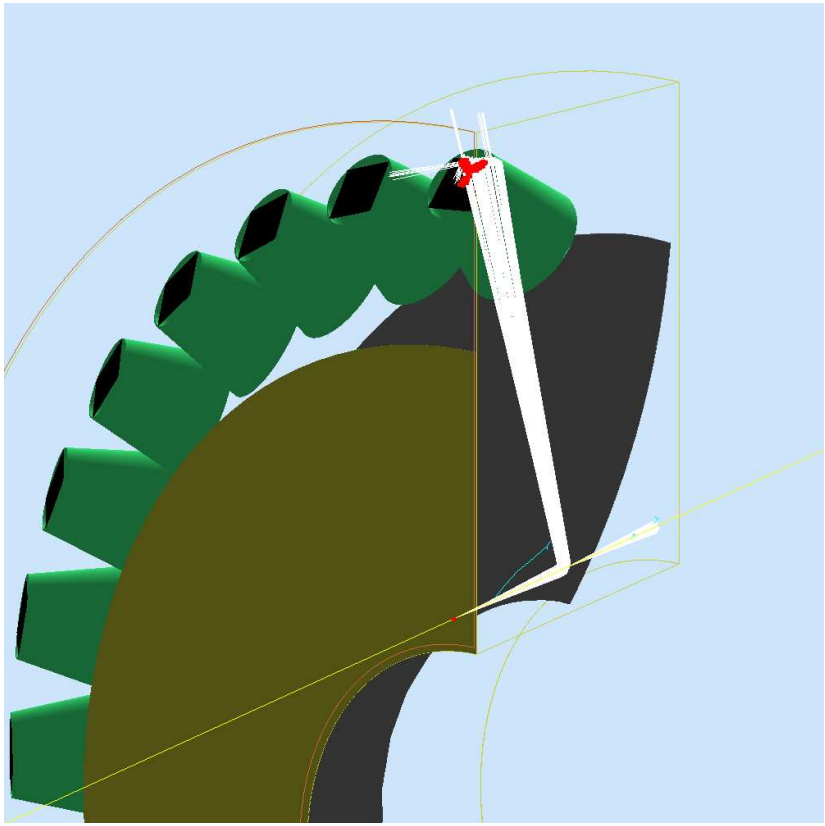
At the last meeting, Zhiwen presented an optimization for forward angle where more SIDIS physics and higher background are





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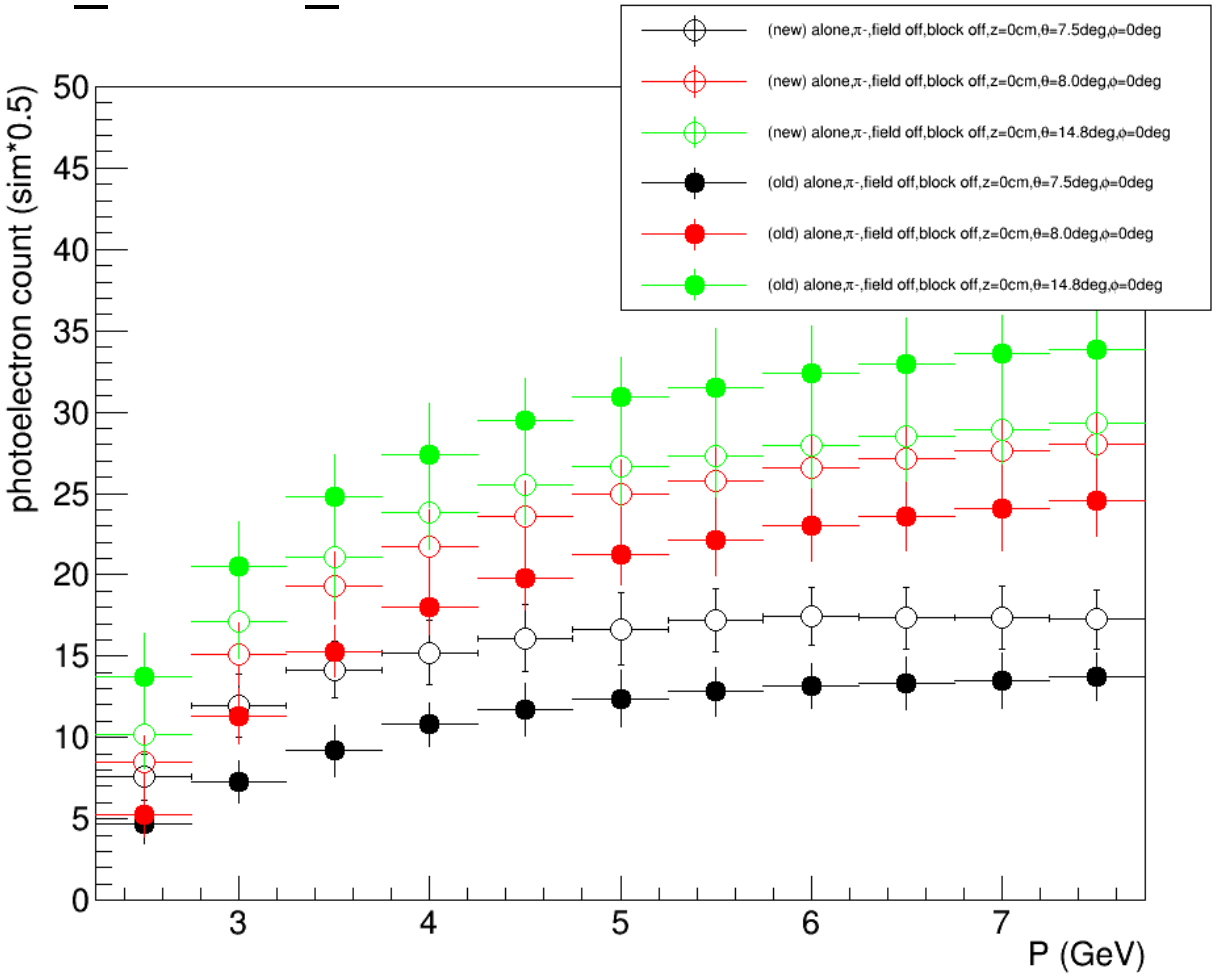
Comparison old and new (showed last time)

- Theta= 7.5deg and 8deg, increase by 20-30%
- Theta=14.8 deg, decrease by 20-30%
- QE use MAPMT_H12700_03



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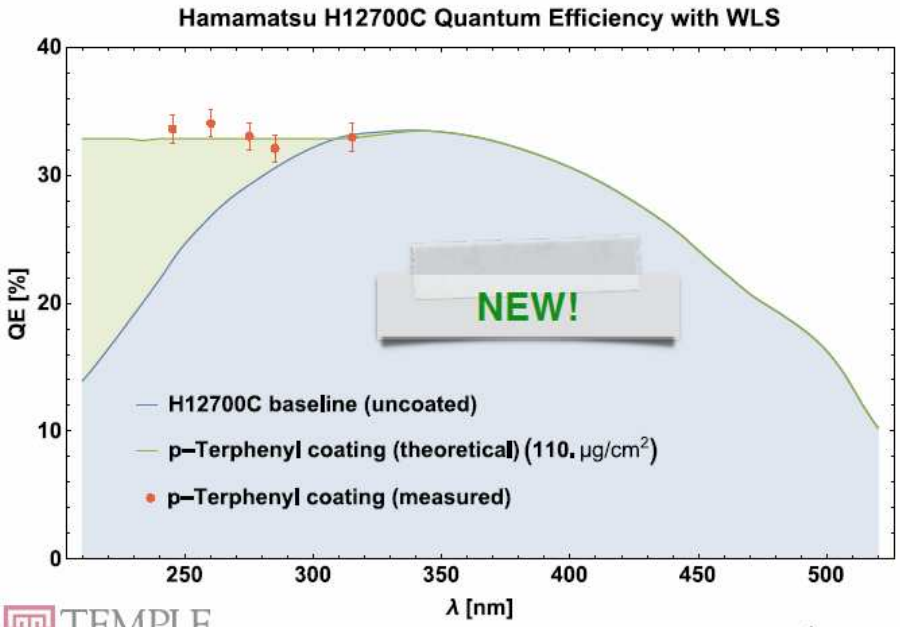
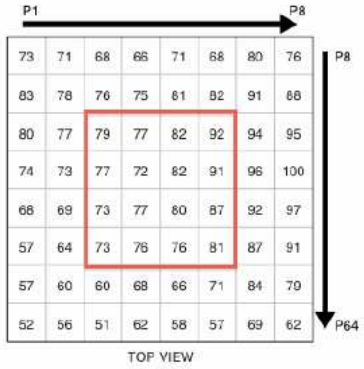
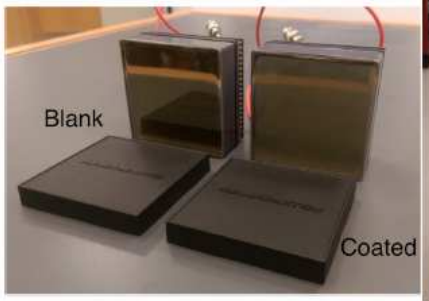
Considering Effect of Deep UV PMT

H12700C+WLS results

- Coating through **vacuum evaporation**
- Gain testing with 5 UV LEDs
- Results agree with expected gain, translates to **projected 30% gain** in Cherenkov efficiency!
- Ongoing: effects on resolution







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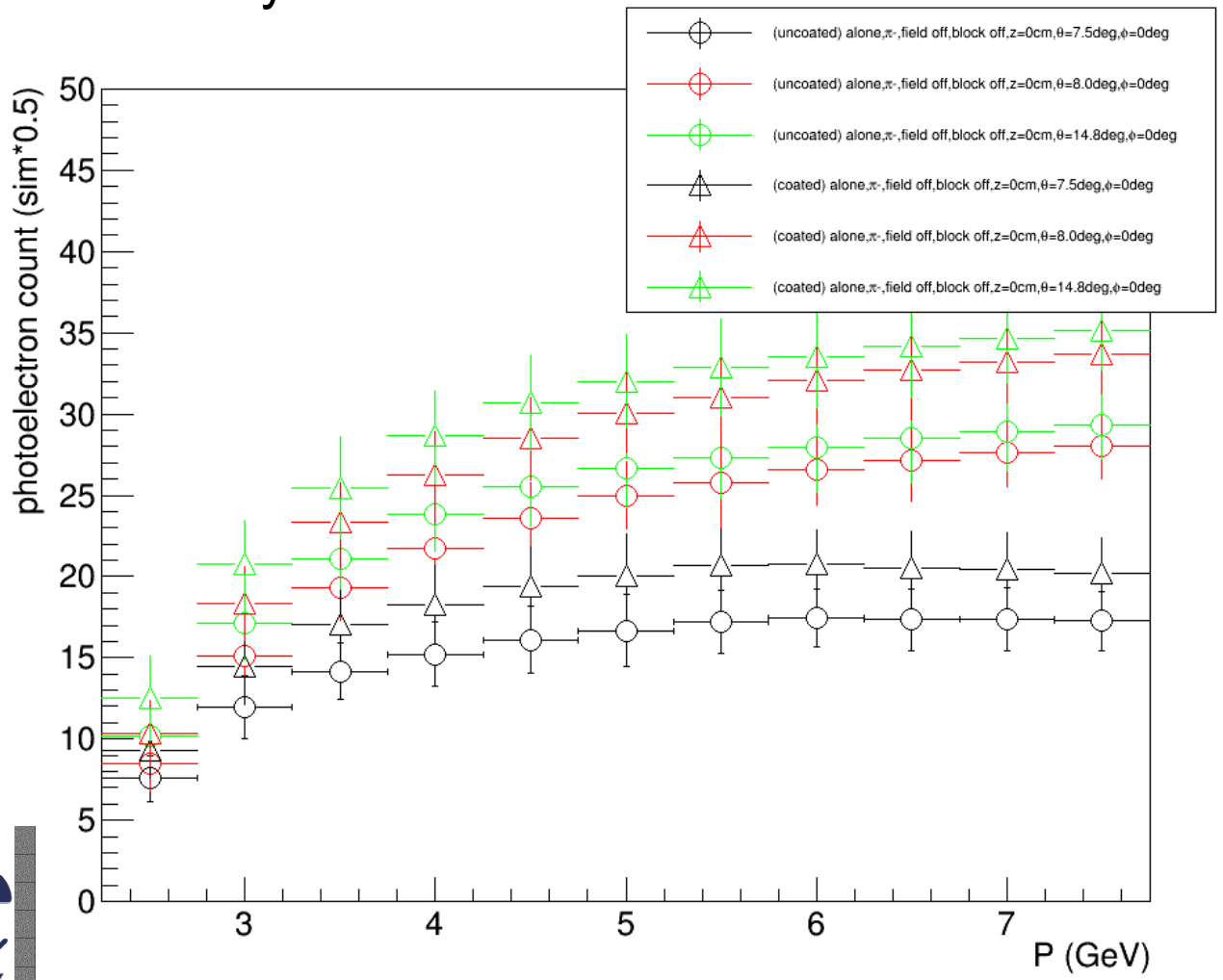
Comparison: WLS coating

- uncoated: QE use MAPMT H12700_03
- coated: QE use MAPMT H12700_03_WLS_meas
- Increase 20-30% everywhere



Outlook

- Gas window and enclosure prototyping starting in Regina.
- Duke group:
  - Performing further study the new configuration in simulation, especially on background
  - Making board with JLab electronic group and test them late Summer or early Fall
  - Collaborating on PMT shielding and PMT test with Wuhan University nuclear group.
- As raised by Rolf on Friday, we also need to optimize heavy gas operational costs.

Gas purity in Deep UV Region

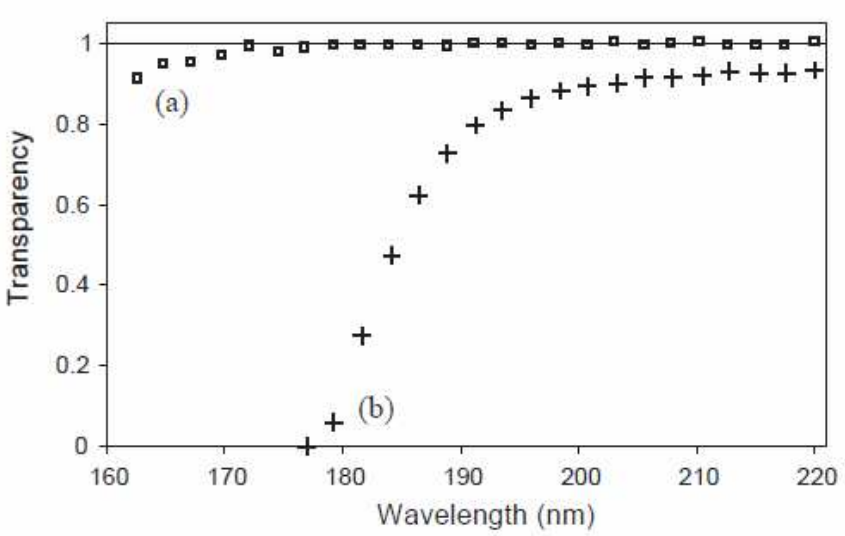
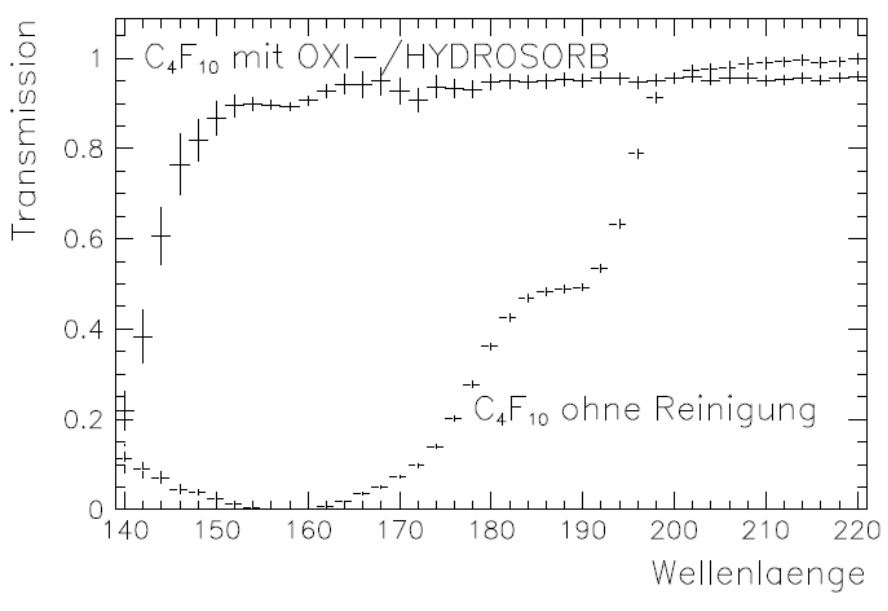


Fig. 1. Transparency as function of wavelength in two samples, [a] and [b], of C_4F_{10} for a 15 cm long photon path length at NTP. The oxygen and water contamination is, respectively, 4.3 and 5.0 ppm.



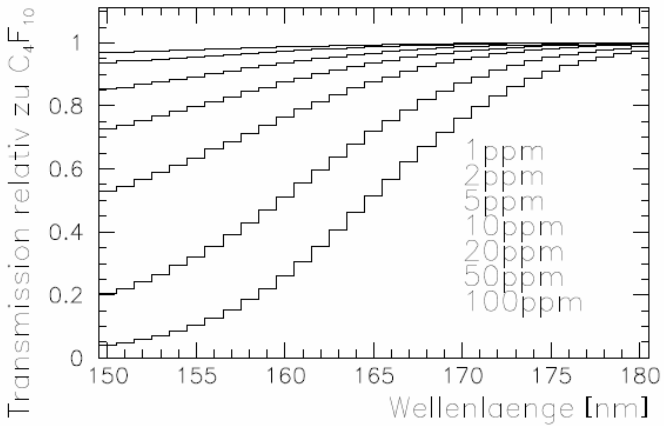


Figure 3: C_4F_{10} transmission for different O_2 concentrations in a 1m long test volume [6].

Hit pattern on 4x4 of 2”MAPMT (pionm, at phi=0deg)

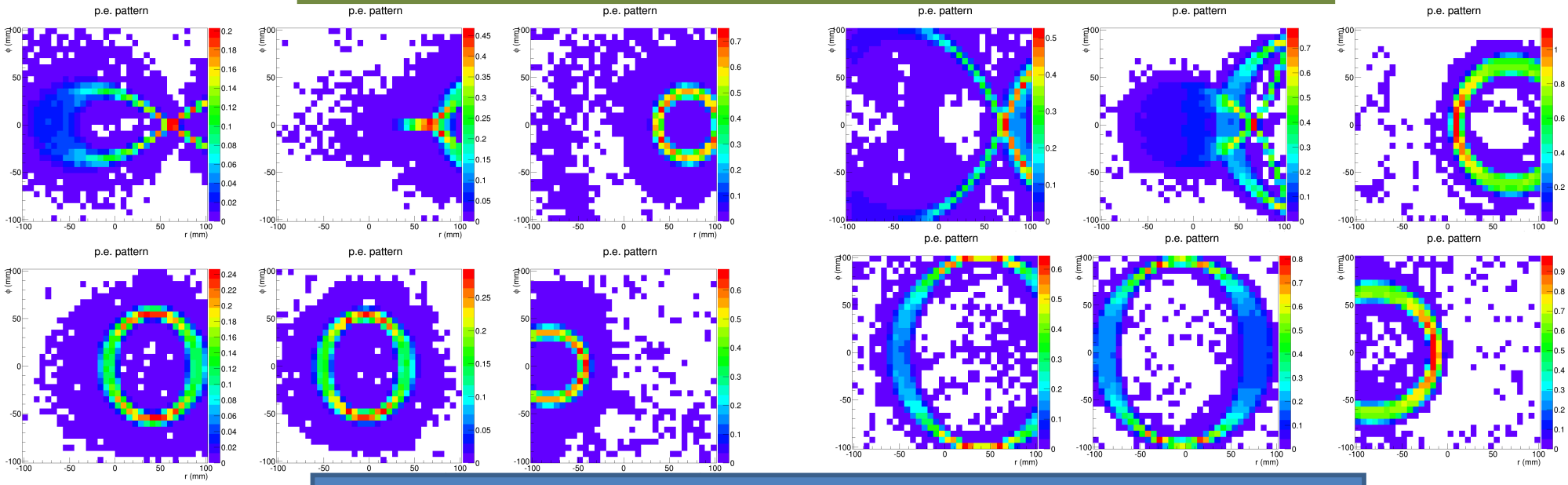
2.5GeV

7.5deg | 8.0deg | 14.8deg

7.5GeV

7.5deg | 8.0deg | 14.8deg

Old configuration, PMT at r=239.7cm, z=325cm, tilt 44 de



New configuration, PMT at r=249.7cm, z=335cm, tilt 65 de

- New configuration optimized for forward angle where higher rate, higher background
- New configuration relies more on one bounce photons from mirror, less on two bounce photons from cone

Result in pCDR