



Optical Calibration Update

Victor Goicoechea Casanueva, Kevin Thieme, Jelena Maricic

University of Hawaii

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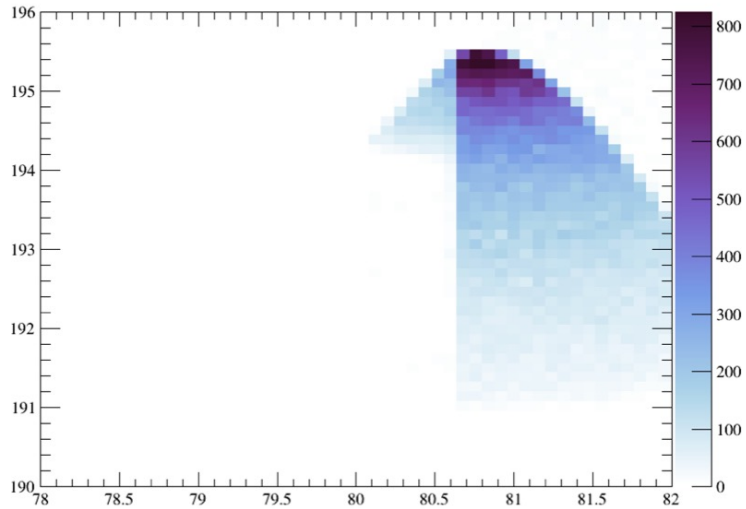


Optical Simulation Results



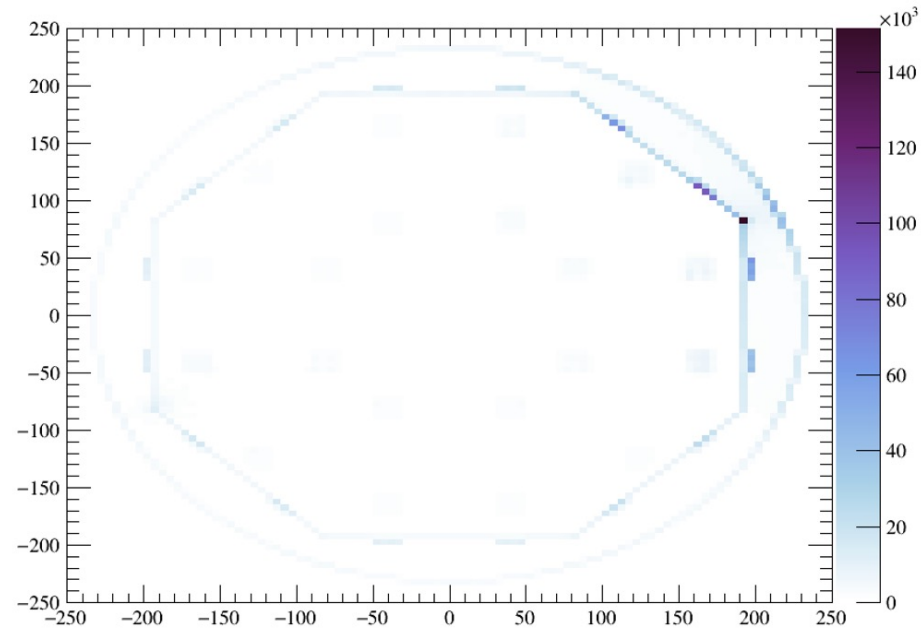
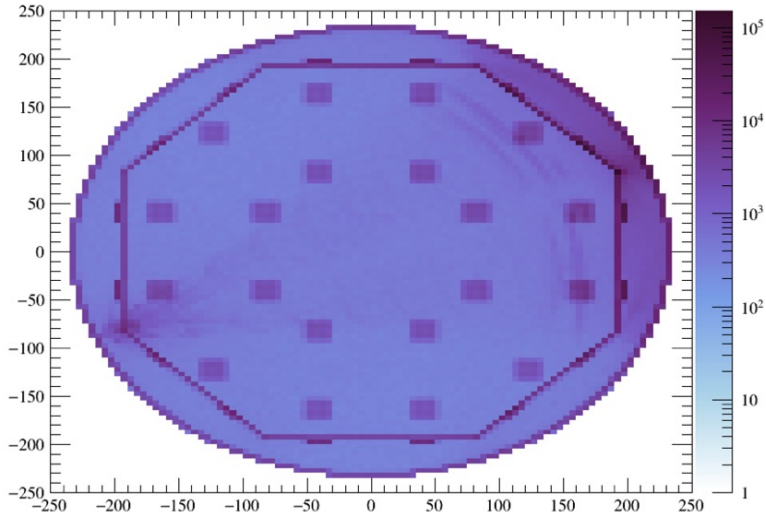
- Geant4 DarkSide simulations used to study illumination of the detector from the fixed points in veto and TPC.
- Results compared for illumination with different options:
 - Veto fiber in the corner
 - Single edge fiber location in TPC for a single fiber
 - Single fiber corner location for the TPC
 - 4 fibers in corner locations for the TPC
 - 8 fibers in corner locations for the TPC

Veto: 1 fiber in the corner



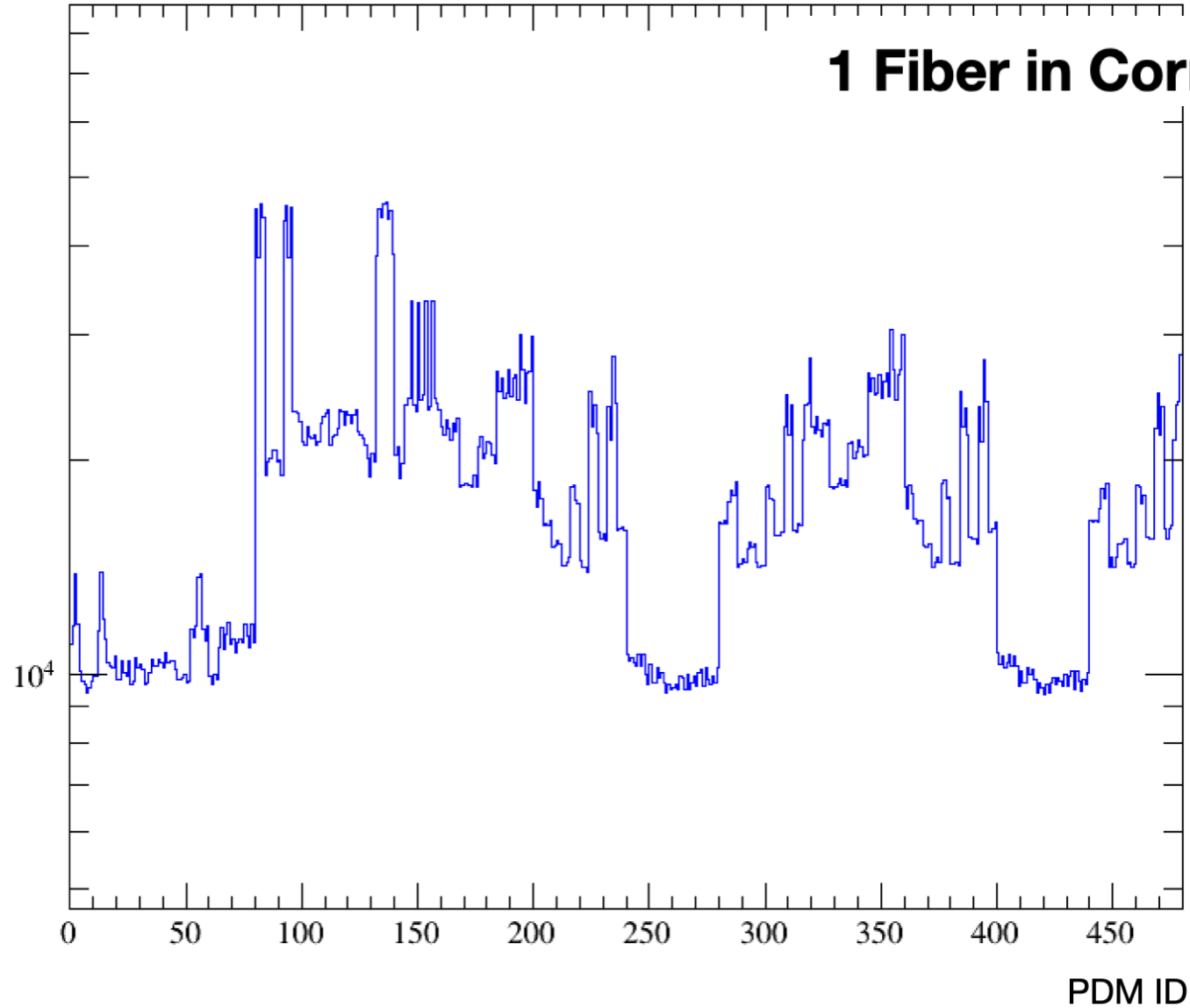
1e7 photons with NA = 0.22

Illuminates 2 sides of the veto octagon.





Veto PDM hit map



1 Fiber in Corner, $1e7$ photons with NA = 0.22

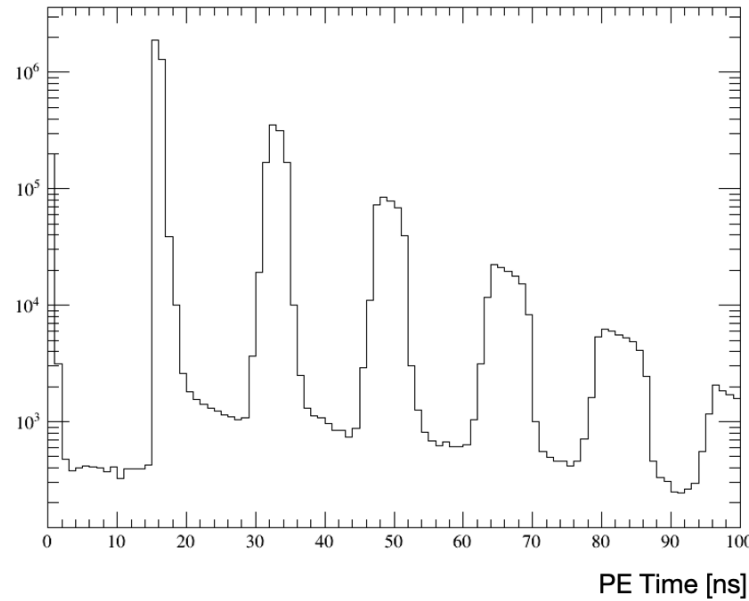
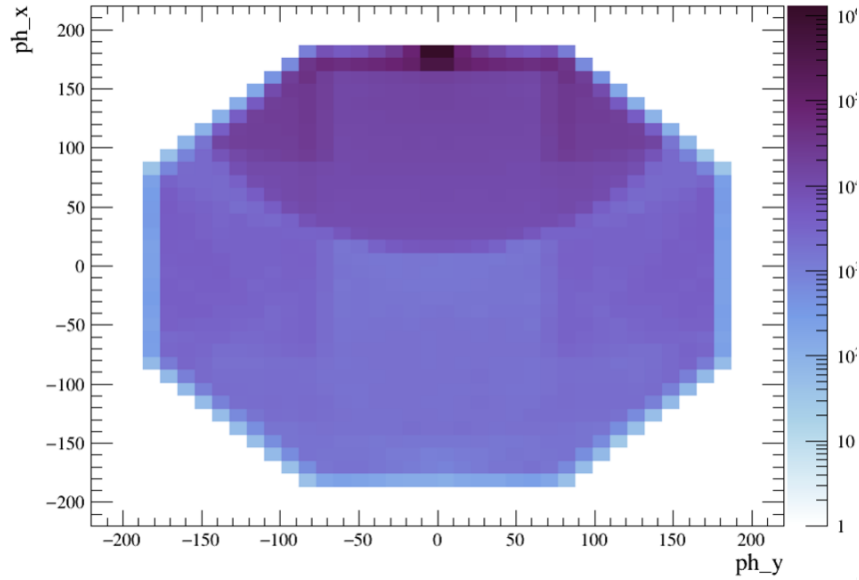
Illumination varies significantly among PDMs
But, there are no blind stops.



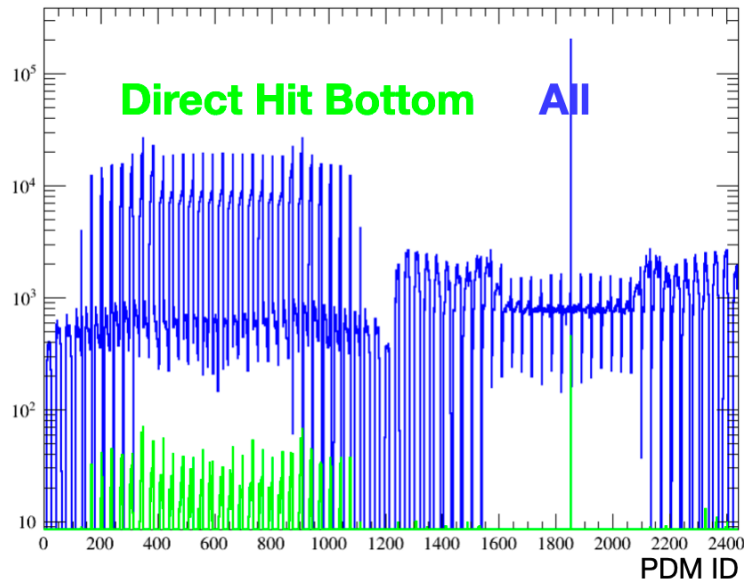
TPC: Edge fiber



1e7 photons with NA = 0.22



PDM Hit Map



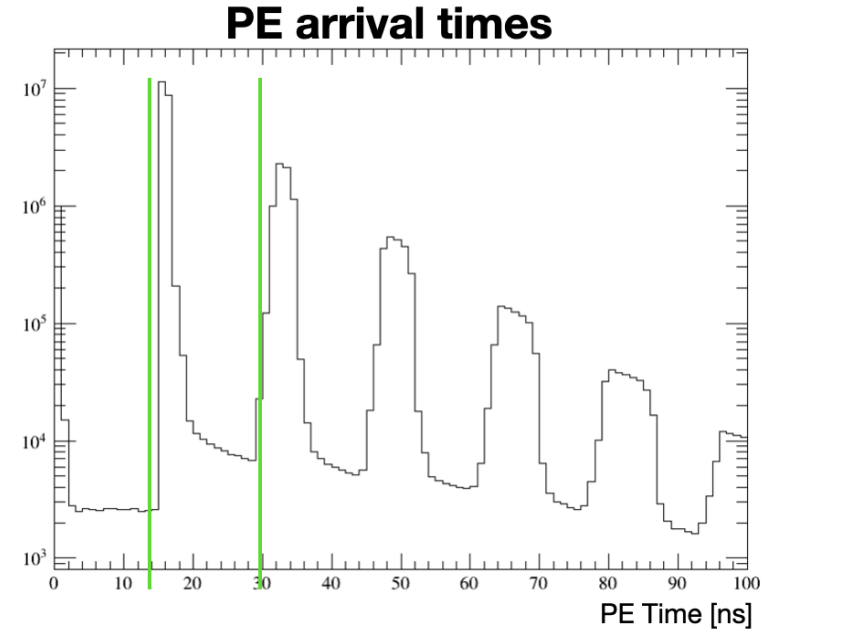
We can distinguish direct from reflected photons
By timing.



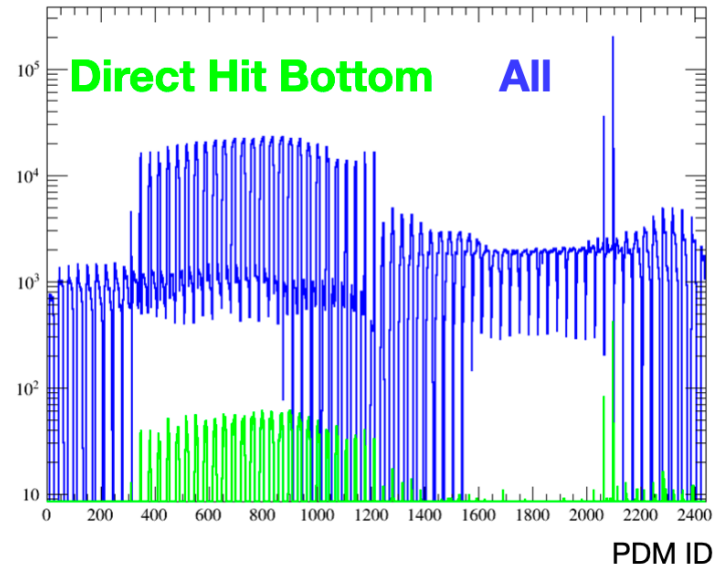
TPC: single corner fiber 1e7 photons with NA = 0.22



Better spread of direct hits
From corner fiber, compared to
Edge location.



PDM Hit Map



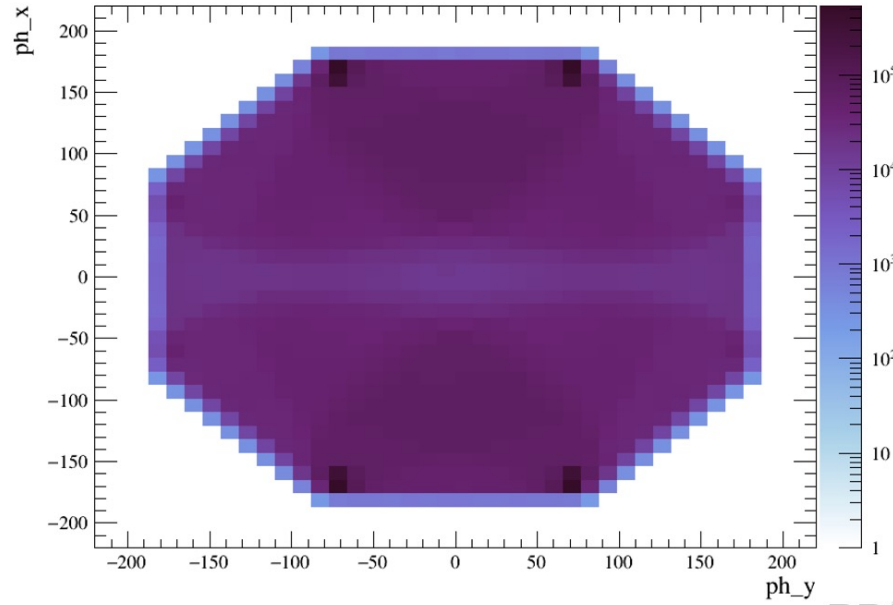


TPC: 4 corner fibers

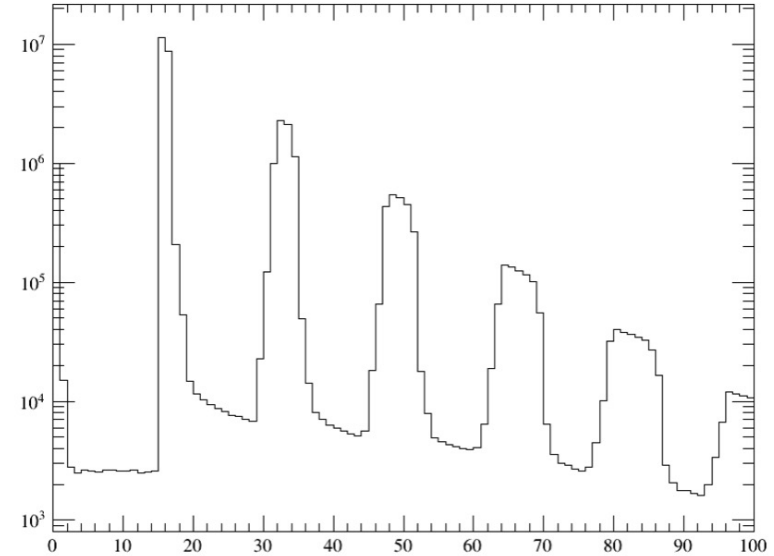
1e7 photons with NA = 0.22



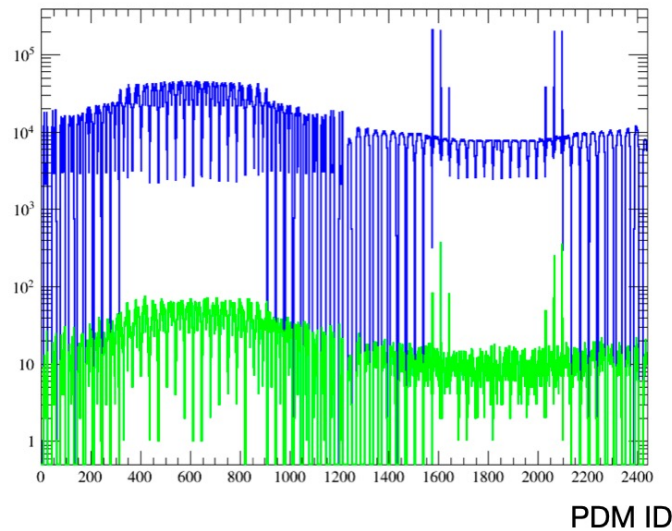
All Photons



PE arrival times



PDM Hit Map



Better spread of direct hits
From a single corner fiber.



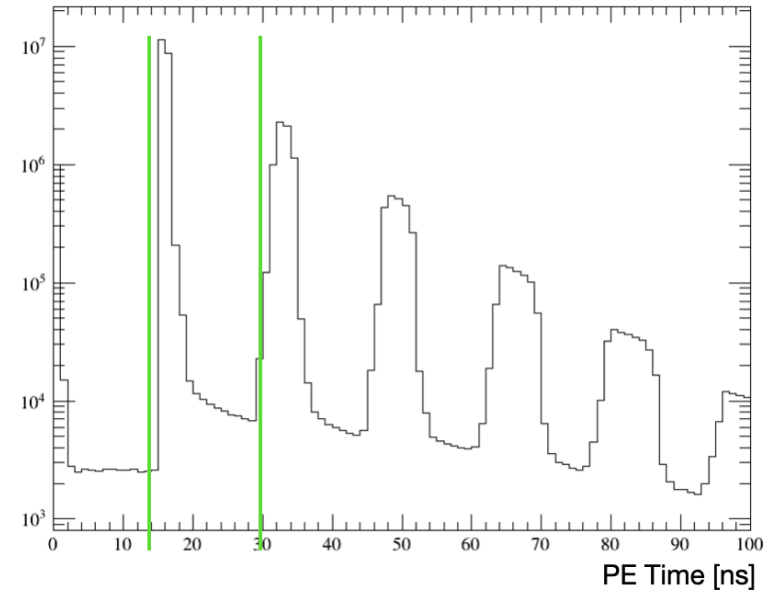
TPC: 8 corner fibers

1e7 photons with NA = 0.22

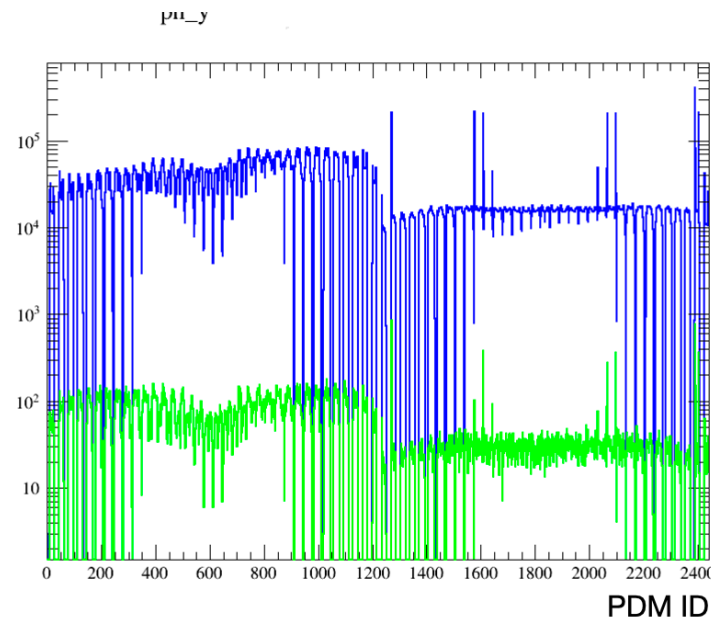


Good coverage of the PDMs with Direct photons.

PE arrival times



PDM Hit Map





Optical Simulation Outcomes



- Veto

- Place 8 fibers at the top and 8 fibers at the bottom of the veto
- Attach the fibers across from each of the eight corners of the octagon
- Will insure excellent coverage with each PDM being visible from at least two locations

- TPC

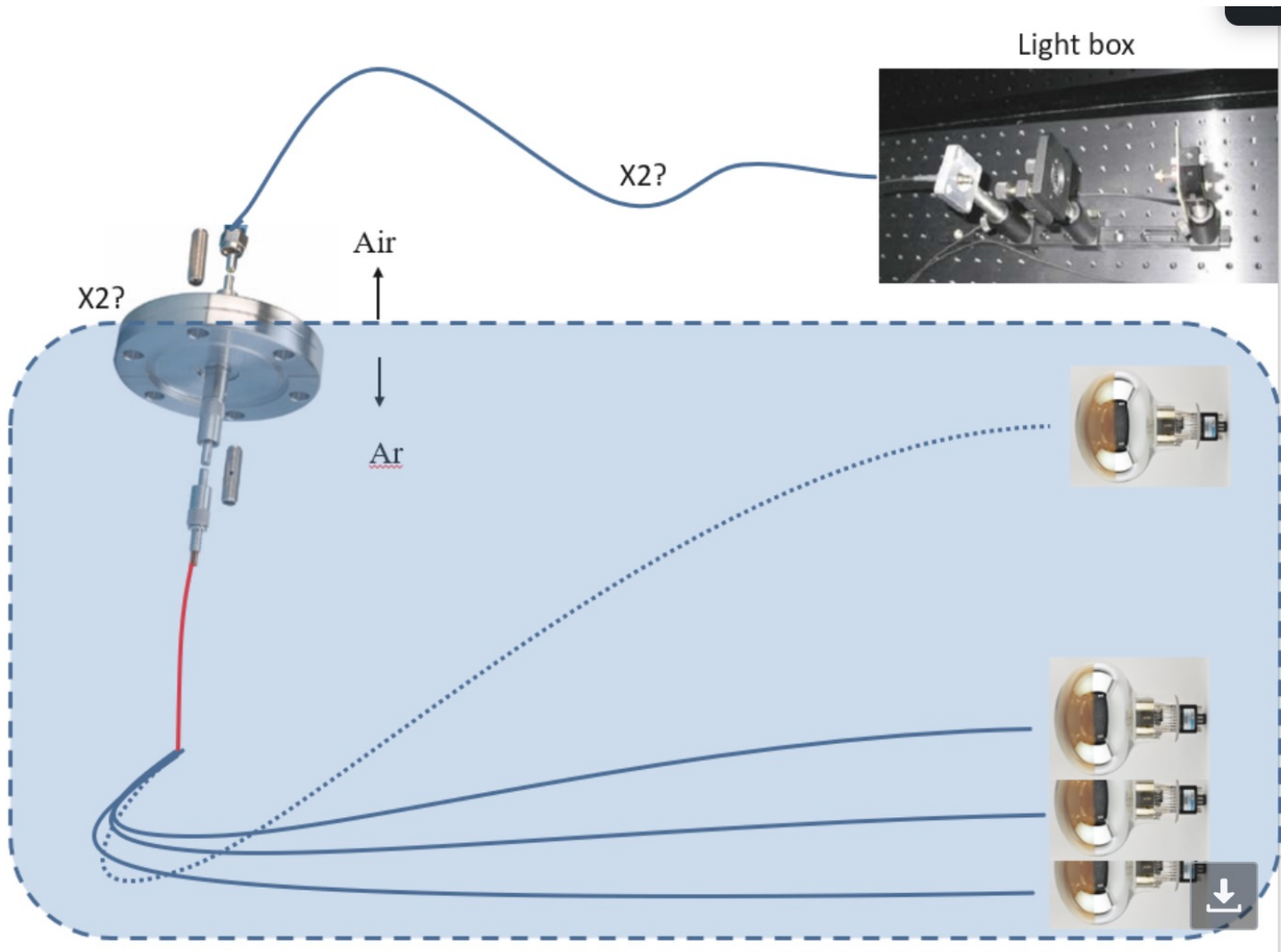
- Place fibers at 8 top and 8 bottom corners for best direct light illumination
- Good redundancy as each PDM illuminated from at least two locations
- Good collection efficiency
- Simulation utilized 10^7 photons, but the single light pulse contains more than this



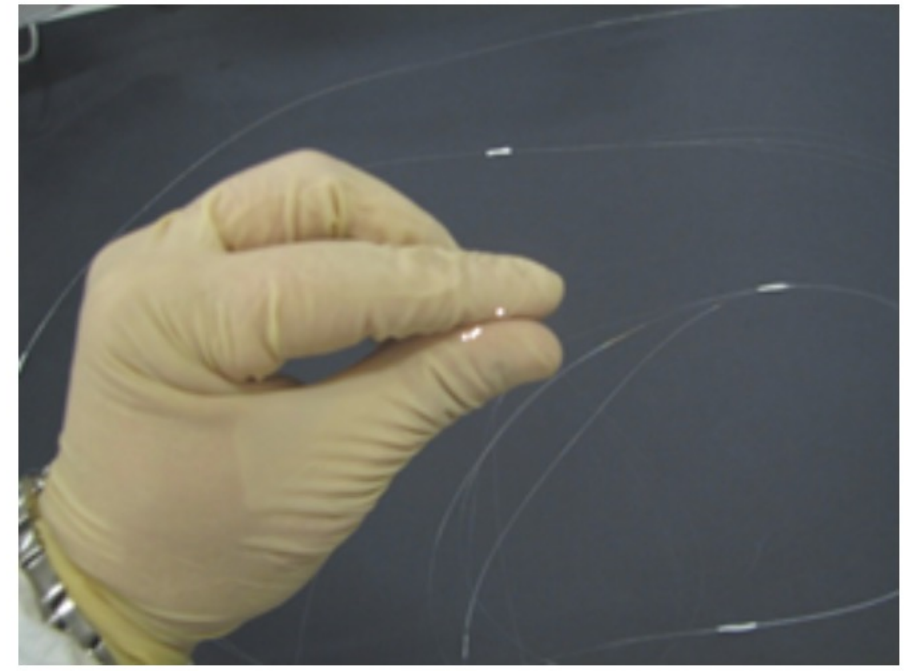
Practical Considerations



- We can use PMMA fibers that are cheaper than quartz fibers and less fragile (based on advice from Roberto Santorelli in his ArDM setup).
- We have ordered PMMA fibers from Thorlabs
- Need to decide on the core diameter based on the tests.
- Their NA is up to 0.5, which ensures excellent light spread
- If routing is not an issue, will consider diffusers at the fiber tips.
- Each location will be equipped with two fibers for redundancy.
- Fibers will have their own protective casing will routed toward the stainless steel vessel.
- Model taken from SNO+ and Double Chooz



- Excellent bending radius
- 100 um acrylic (PMMA)

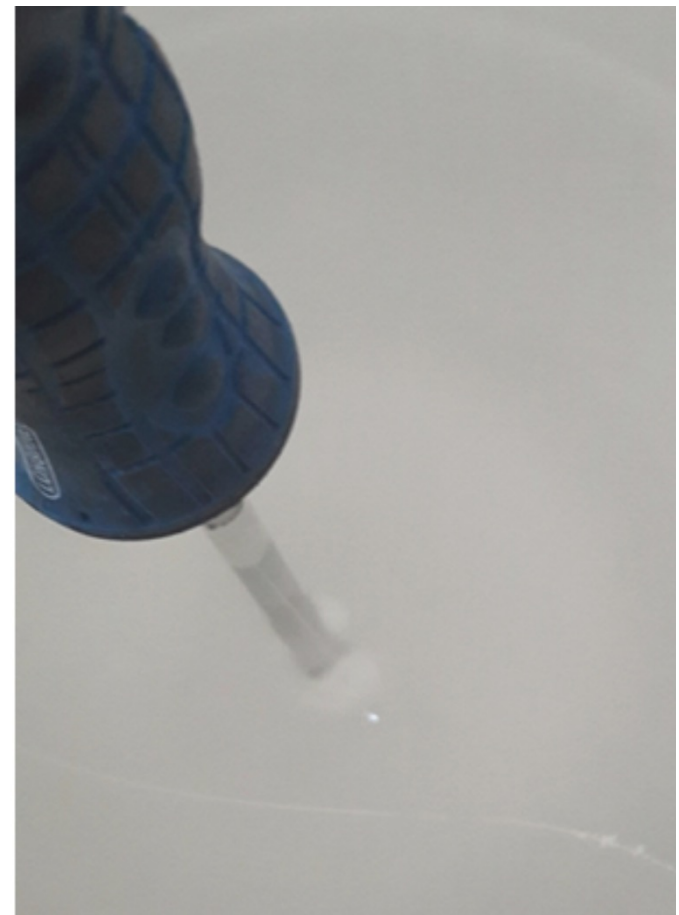
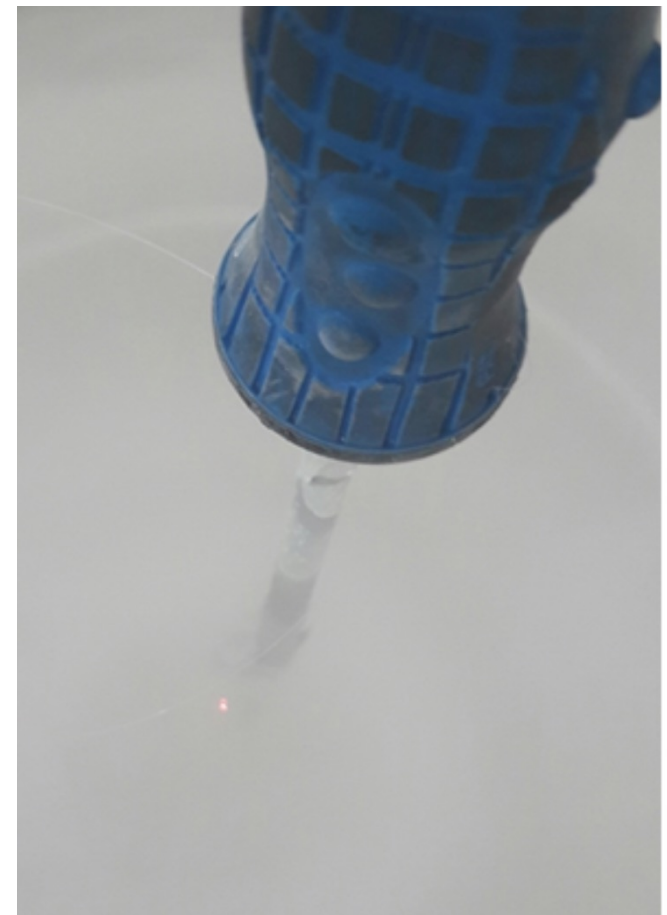


PMMA Fibers appear to be very strong

- LN2 tests with blue and red LED in ArDM and XENON100

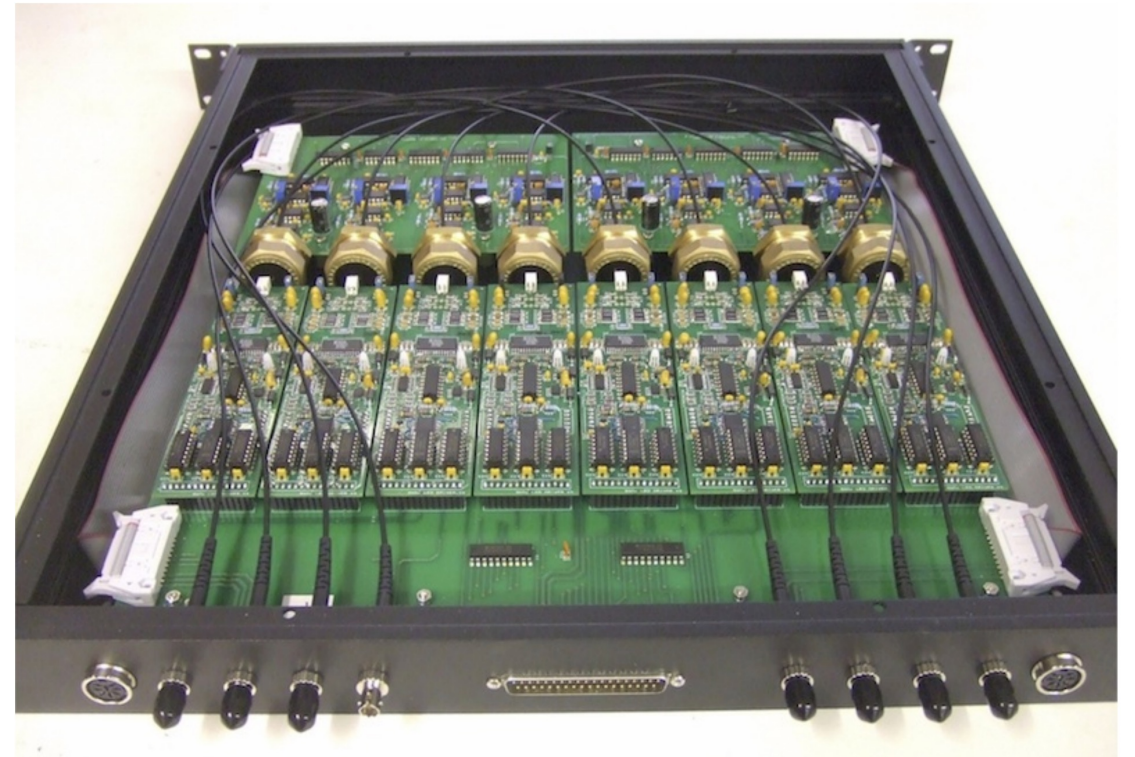


- C40 flange hanging on PMMA fiber
- Strong fibers



Light source

- TPC timeline allows for use of LEDs for light injection from the LED pulser box.
- LED pulser boxes allow use of different wavelengths while providing pulses that are 5-10 ns long.
- Elaborate pulser box from SNO+





Conclusion and next steps



- It is best to put fibers at the top and bottom corners in TPC and Veto --> 16 locations in TPC and 16 locations in Veto.
- Each locations served with 2 fibers
- Total of 64 fibers needed to instrument the TPC and veto.
- Finalize flanges for the TPC and veto fibers.
- Finalize the routing of the fibers to their respective locations
- Design the fiber protection during routing
- Mounting locations in the TPC and Veto.
- Test the PMMA fiber in LN2.
- Test acceptance and light throughput with a laser and LEDs.
- It is easier to couple laser first followed by LEDs.