LBNE

Colorado State University

WLS FIBER-BASED PHOTON DETECTOR PROTOTYPE AND A CRYOGENIC DETECTOR DEVELOPMENT FACILITY

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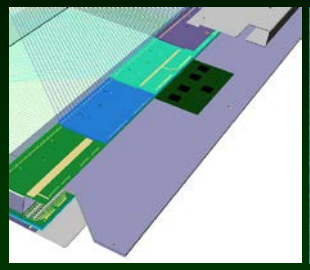
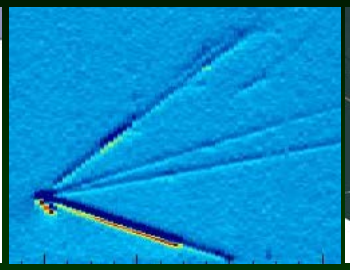
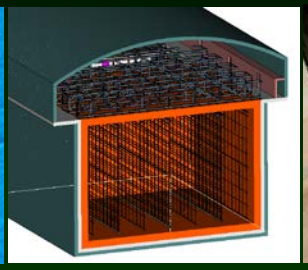
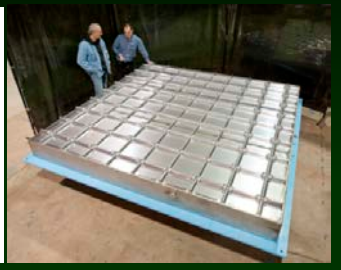
LAr TPC Workshop
Fermilab - Batavia, IL
March 21, 2013

WLS Fiber-Based Prototype

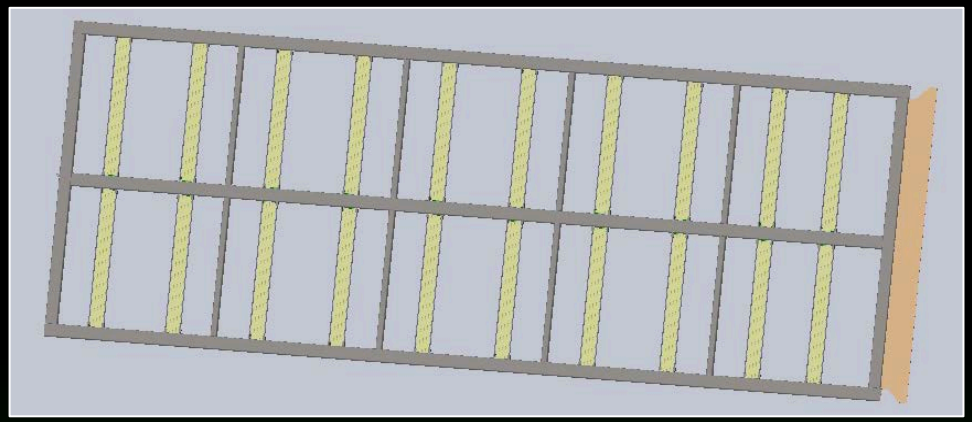
- Why investigate fibers?
  - Potentially lead to cost savings – gang several channels to single photo-sensor
  - Could be used in a hybrid system with bars or some other "bulk" design
  - ~~Crazy~~ More exotic ideas like instrumenting the CPA with fibers and have sensors located some distance away
- How do you do this? One of three ways…
  - Coat the fibers with WLS (TPB or Bis-MSB)
  - Dope cladding with WLS (or an inner cladding perhaps)
  - Dope fiber core and use very thin cladding

We are starting with the last option – have a sample of Bis-MSB doped fiber from Saint-Gobain (BCF-12 1 mm dia.)

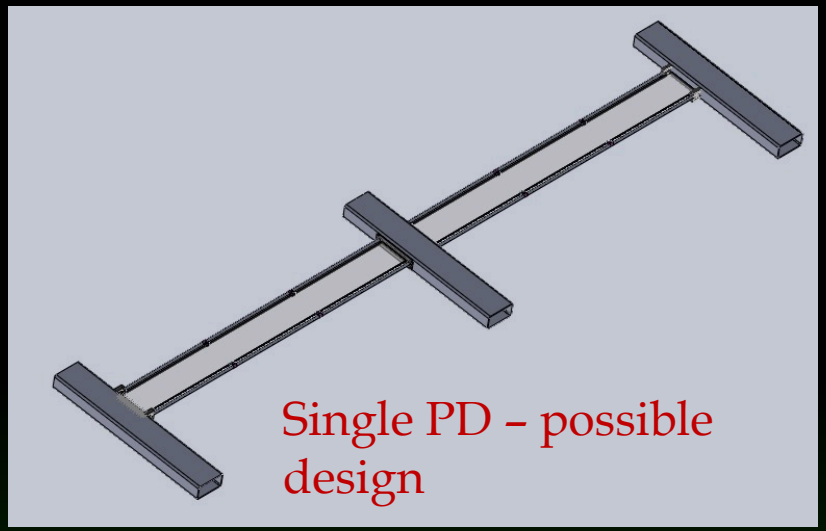
Sent sample to LBNL for Vic to look at with his VUV system (next talk).

WLS Fiber-Based Prototype

- Design considerations
  - To keep PD design and engineering effort in check it is critical that the fiber-based design fit into the same package as the IU paddles



Fibers assemblies could be used in place of the paddles in this design – or perhaps to fill the empty regions

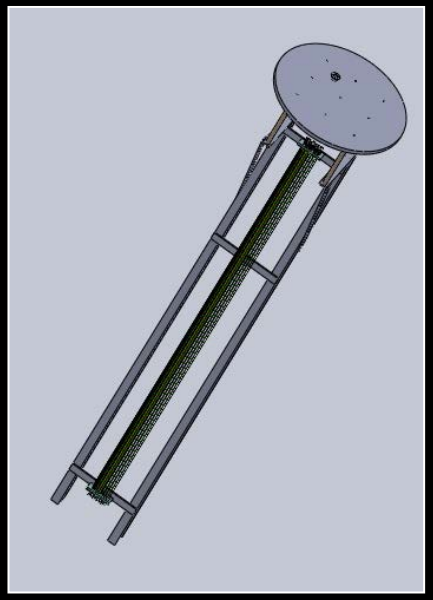


Courtesy Dave Warner

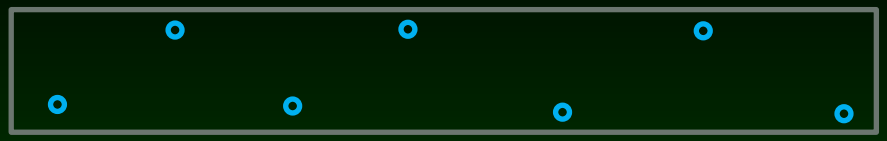
Fiber-Based Prototype

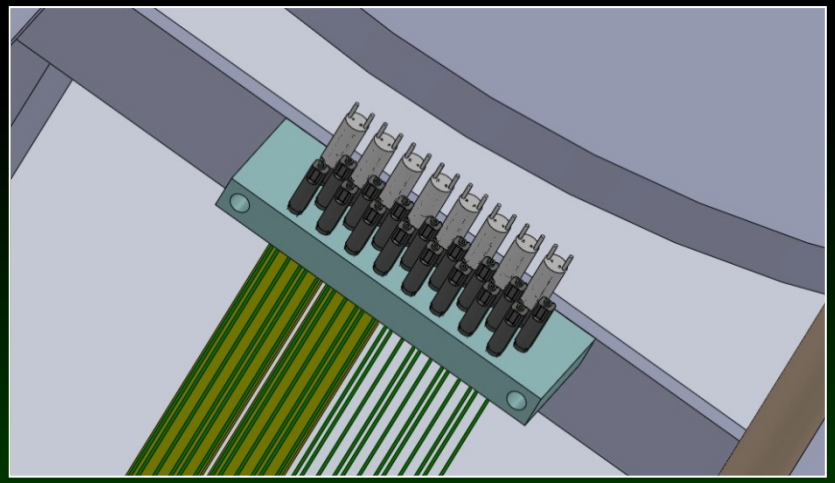
Preparing for tests this fall and next summer

- Test this fall proof of principle
- Would like to compare prototype operation with simulated events (triggered cosmics) in LAPD
- Assuming successful first test we would proceed to integrated test in 35 t cryostat next year
- Plan to test pure fiber-based system and some form of hybrid system if possible



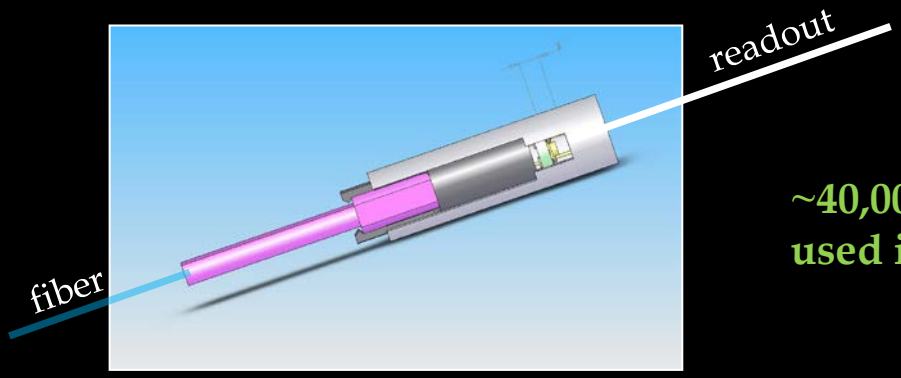
Fiber Layout for Prototype Test





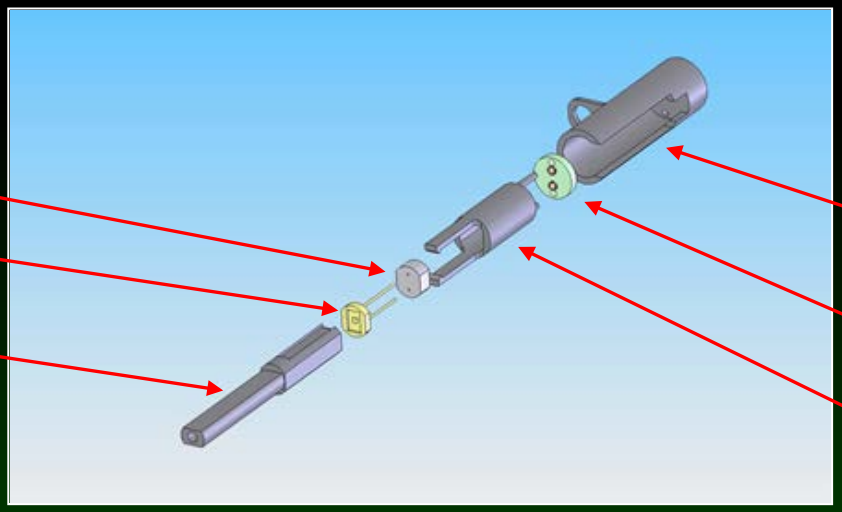
Optical Mounting of Fiber to MPPC

Starting with design for optical connectors used in T2K (single fiber mount)



~40,000 of these systems used in T2K near detector

MPPC housing and ferrule design by Dave Warner



Exploded view showing all components

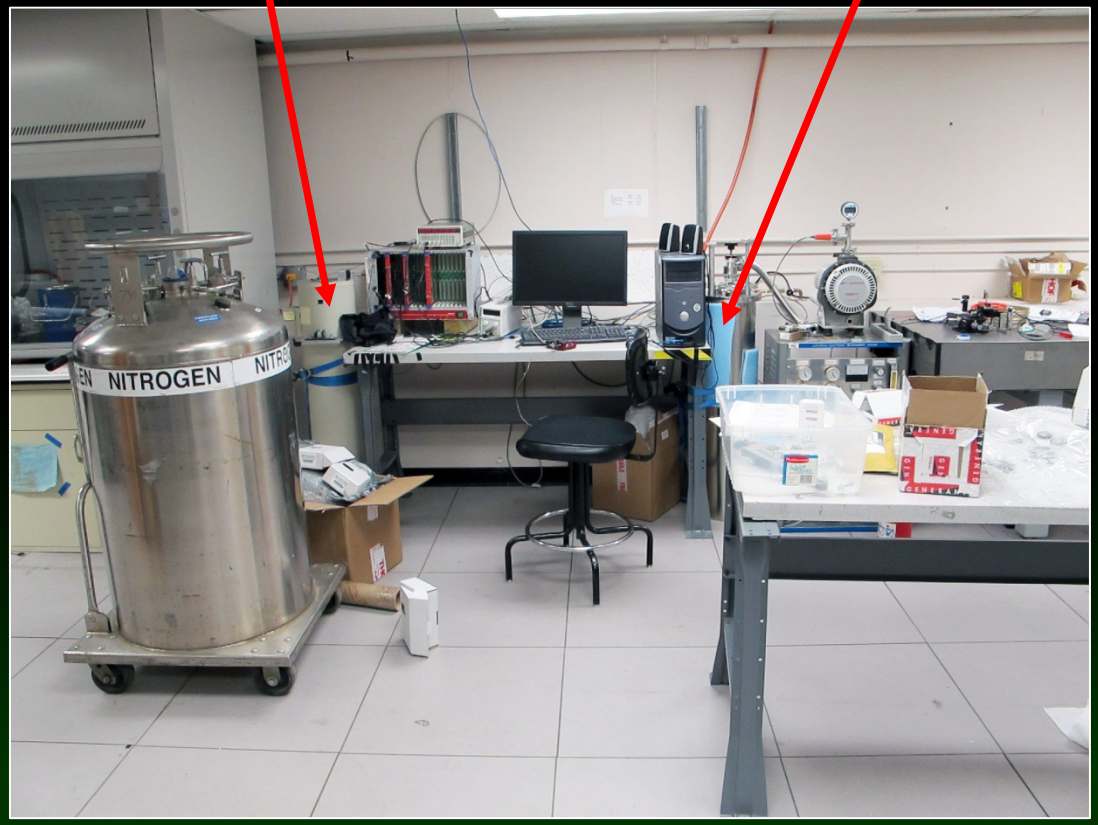
Cryogenic Detector Development Facility

20 l and 40 l Vessels

20 liter (open) dewar – for quick optical and mechanical tests in LN2

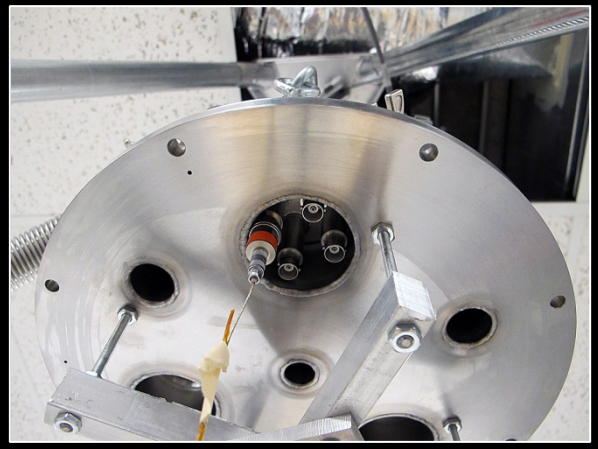
40 liter (evacuated) dewar – prototype of 500 liter system – small scale testing

Successfully completed evacuate, GAr purge, LAr fill cycle.



Cryogenic Detector Development Facility

40 l vessel



Underside of lid showing feed-throughs and mounting infrastructure.

SiPM housings/ferrules mounted on cold frame

Opening the 40 liter system following a test

Cryogenic Detector Development Facility

500 l vessel

Designed to accommodate full scale (length) photon detector components

- Starting with a simple system – (no circulation, filters, or condenser)
- 1-ton crane allows us to quickly and easily add/remove components

Cryogenic Detector Development Facility

500 l vessel

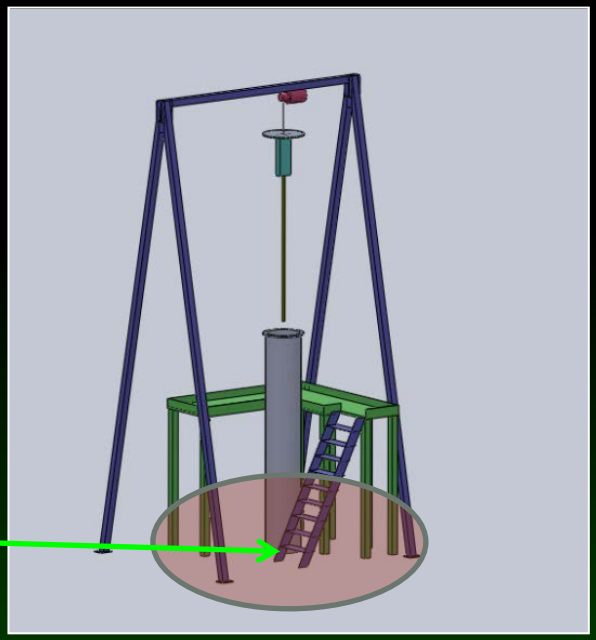
Crane, platform, and dewar in place. Safety, plumbing and vacuum system are next.

Cryogenic Detector Development Facility

Safety

Working with university EH&S to ensure safe operation of facility

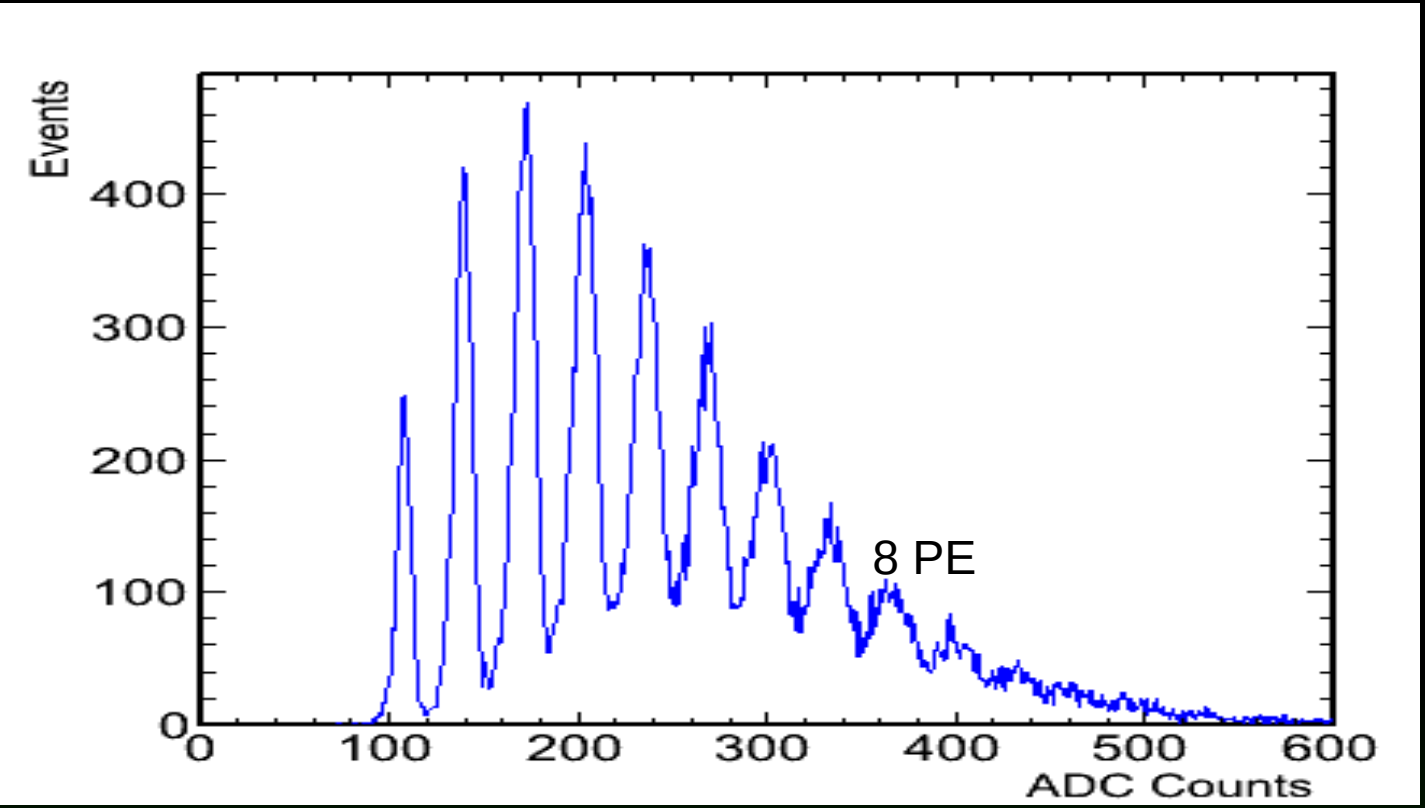
- ODH monitors
- Strict access control
- Real-time video surveillance
- Large catch basin under 500 l vessel
- Venting system to push GAr outside



Catch-basin to contain liquid in case of catastrophic failure of 500 liter vessel

Supplemental Material

Test of SiPM at LN2 temp

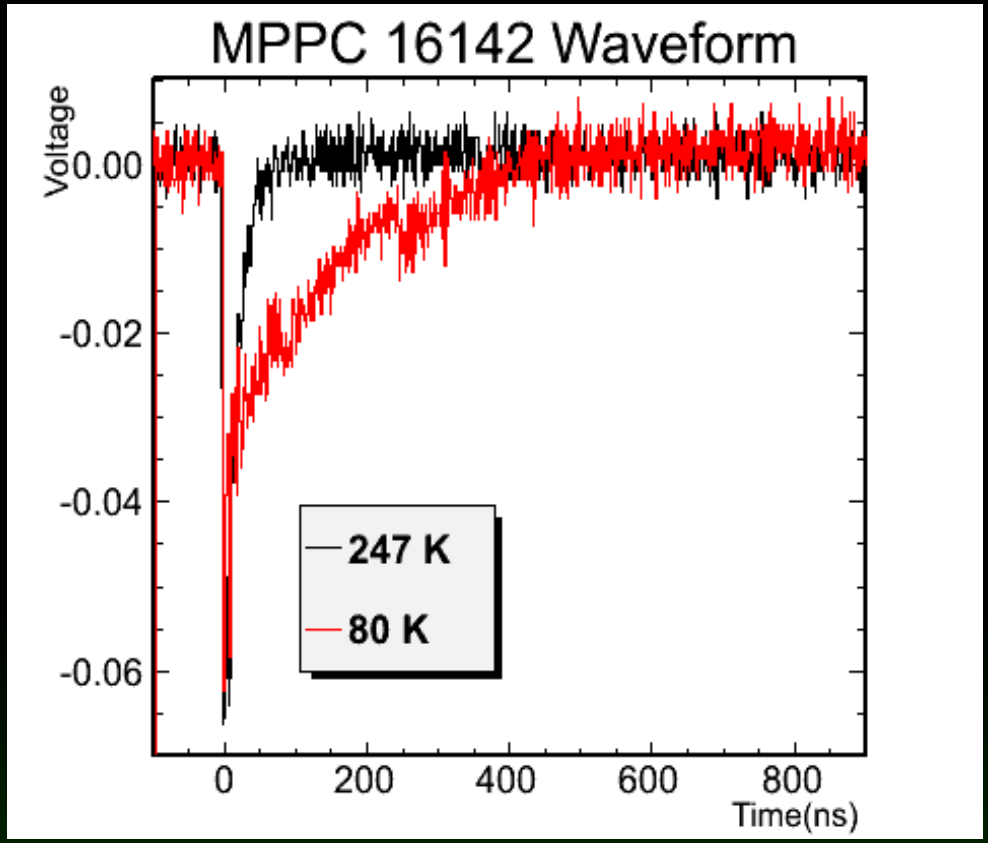


Able to easily distinguish events of up to 8 PE from LED light with MPPC submerged in liquid nitrogen

Ryan Wasserman (CSU)

Cold SiPM tests

Observed widening of signals from SiPMs in the cold.



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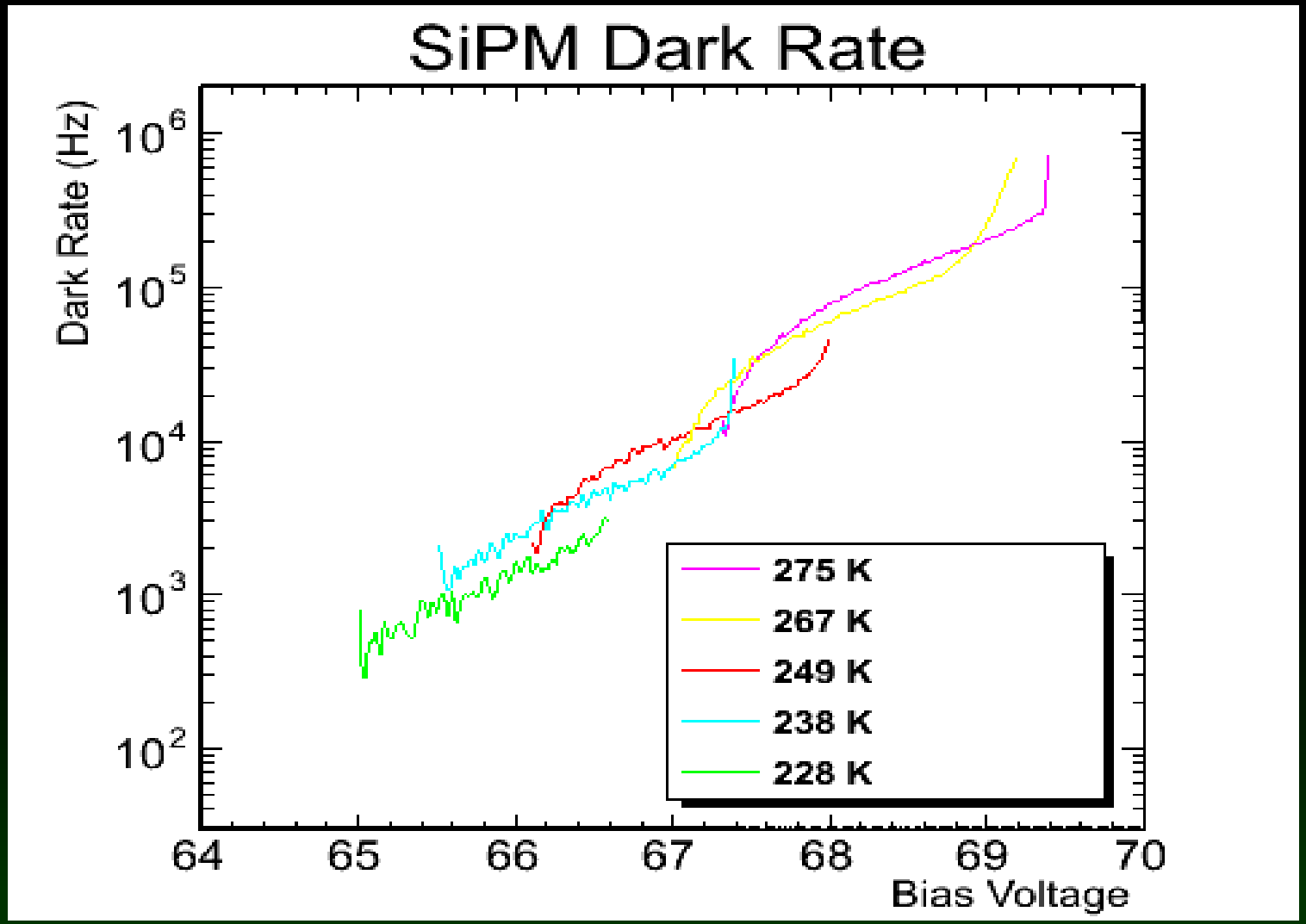

Courtesy Ryan Wasserman (CSU)

Basic Simulation – Sanity Check

- Very simple simulation using G4
  - 4x4x4 m liquid argon volume with absorbing walls (only singlet photon from LAr scintillation)
  - One wall covered by layer of clear core 1 mm fibers with a WLS (Bis-MSB) cladding 0.25 mm thick - fiber spacing is 1″
  - Each fiber has 50 micron pixel SiPM (Hamamatsu devices described earlier) on one end with realistic photon detection efficiency.