GlueX DIRC commissioning

EIC PID Consortium meeting

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GlueX DIRC team

Massachusetts Institute of Technology

INDIANA UNIVERSITY

Jefferson Lab

GSI

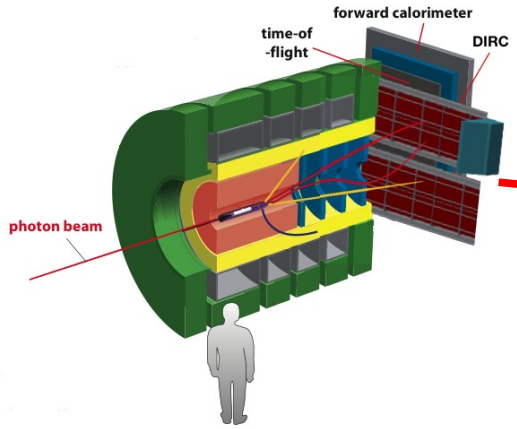
THE CATHOLIC UNIVERSITY of AMERICA

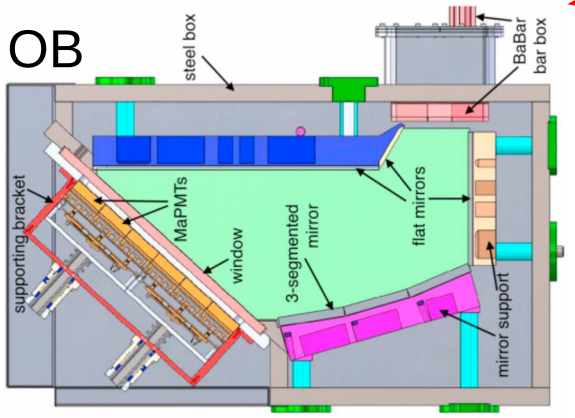
WILLIAM & MARY
CHARTERED 1693

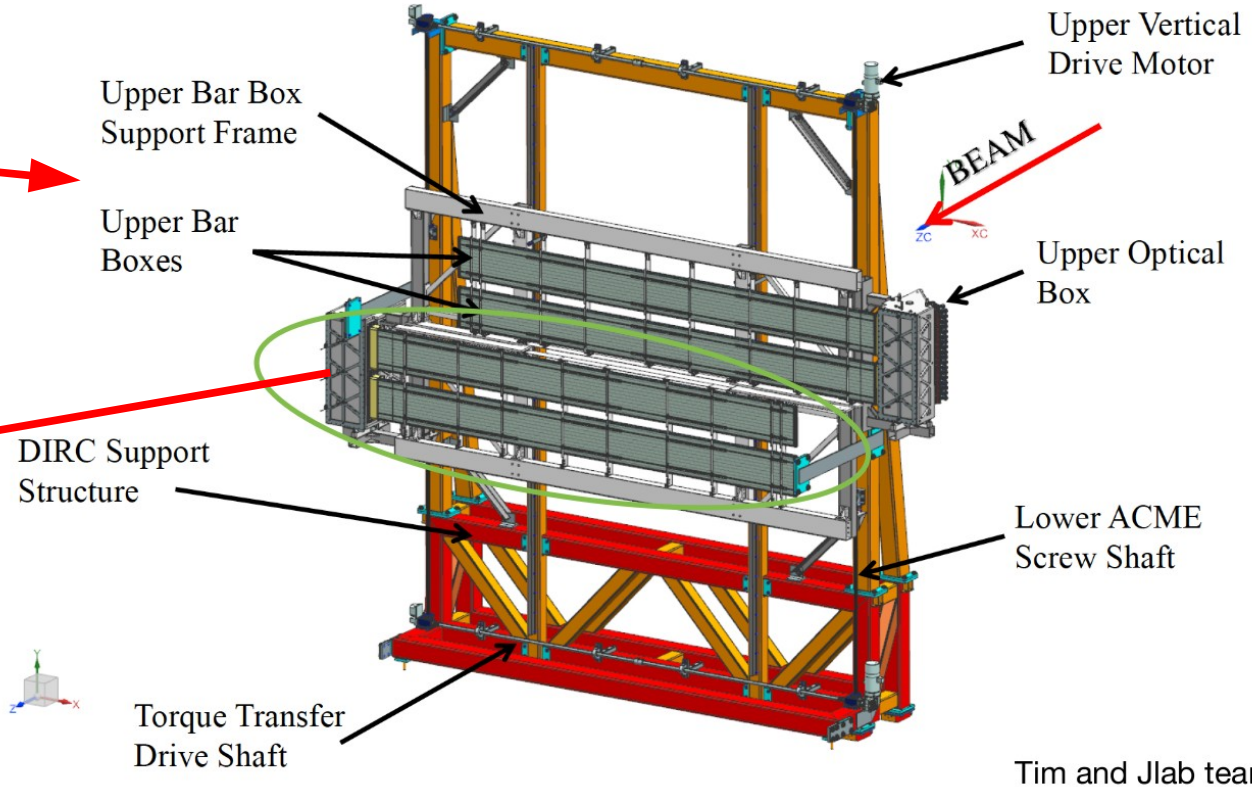
Commissioning Goals

- Assemble and install lower half of the GlueX DIRC
- Test airflow, water and light leaks
- Integrate DIRC readout with general Hall D DAQ and online/offline monitoring
- Calibrate per-pixel timing offset of MAPMTs using LED system
- Implement reconstruction algorithm and compare data/MC:
  - photon multiplicity
  - Cherenkov angle resolution
- Determine geometric alignment parameters (position and angle offsets) for optical components

The lower half of the DIRC and OB





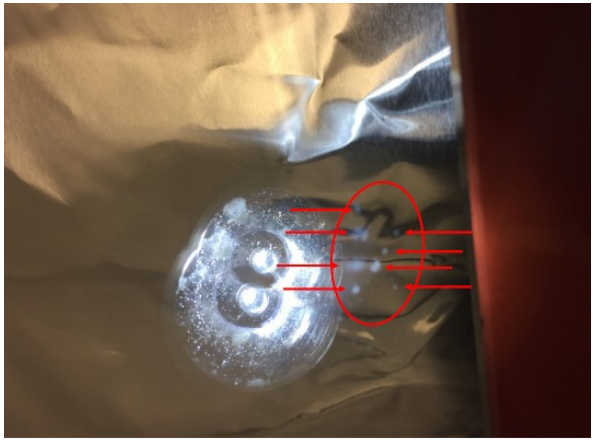


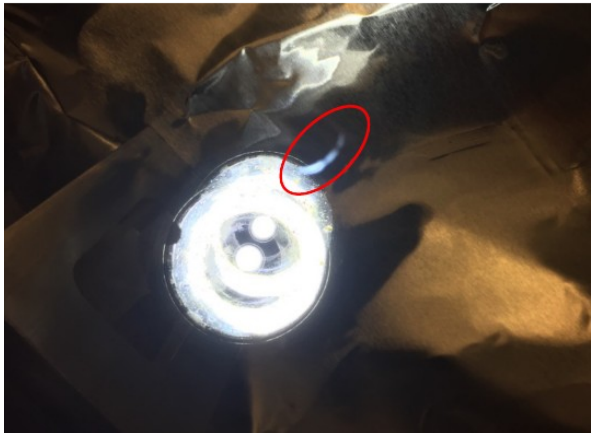
Tim and Jlab team

Window and mirror cleaning

by Greg Kalicy

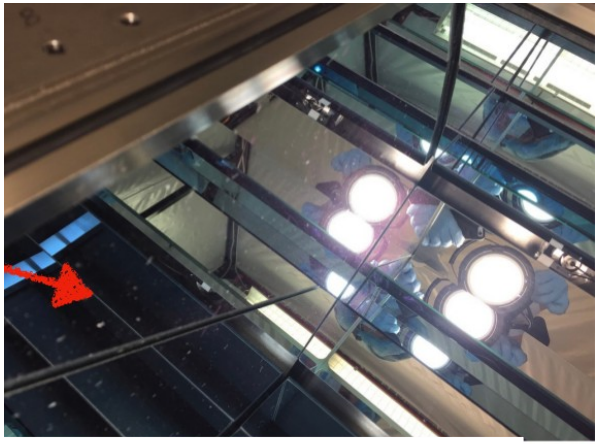
optical window





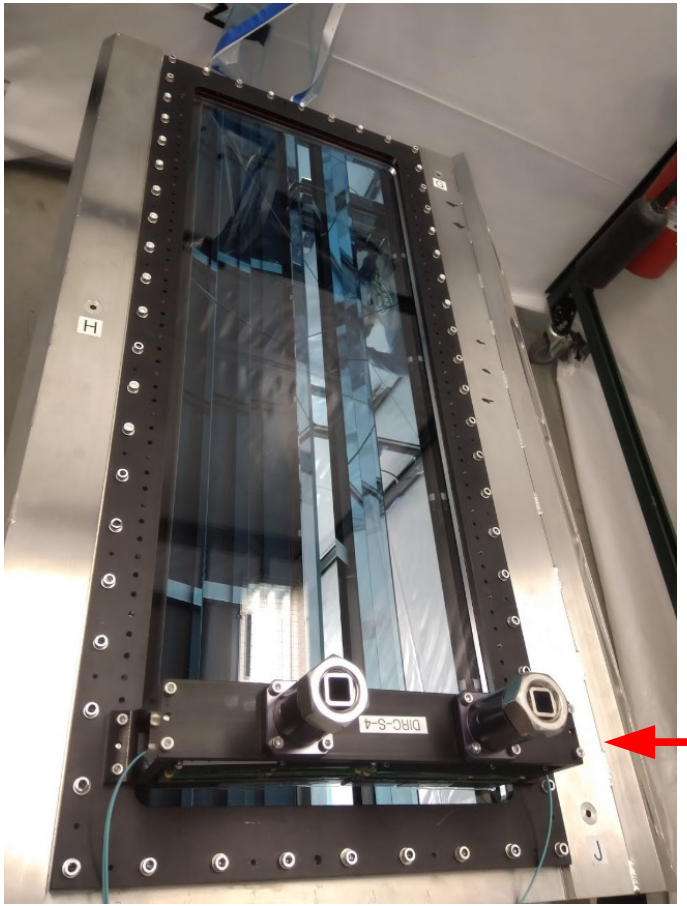
side mirror

before



after

Water leak test



Water leak test with fused silica window after the OB was modified

OK

Test application of one module. New technology for optical coupling

Air flow test and monitoring

DAQ monitoring GUI from Sergey

35.743
- 37.689
35.436
38.512
39.519
39.819
42.672
43.456
39.373
39.396
41.626
- 42.664
45.679
45.41
47.294
48.463
45.11
45.064
47.655
48.286
48.77
- 49.824
51.516
52.677
48.709
50.193
51.662
54.576
52.3
53.084
52.115
- 47.063
54.738
53.646
51.062
47.332

Temperature is below 60 C!

OK

Optical coupling technique

Inspired by Belle II experience

Custom made 2 mm thick 2 inch x 6 inch cookies (single cookie fo 3 PMTs)

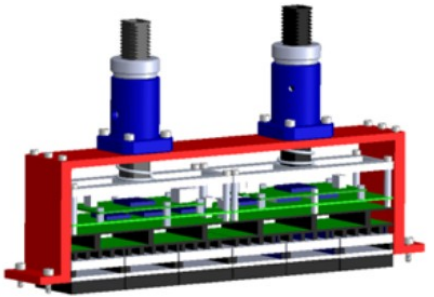
Softest mixture of RTV615 silicone

Flat surfaces

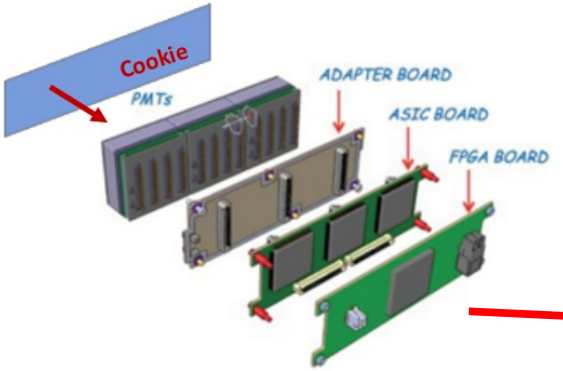
Stored between kitchen foil - handy

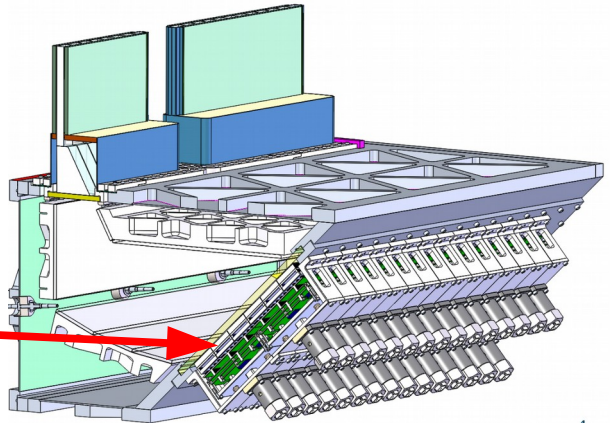
One OB needs 36 cookies, we had about 80, but we discarding about 10-15 of them

Application requires greasing the cookie on both sides

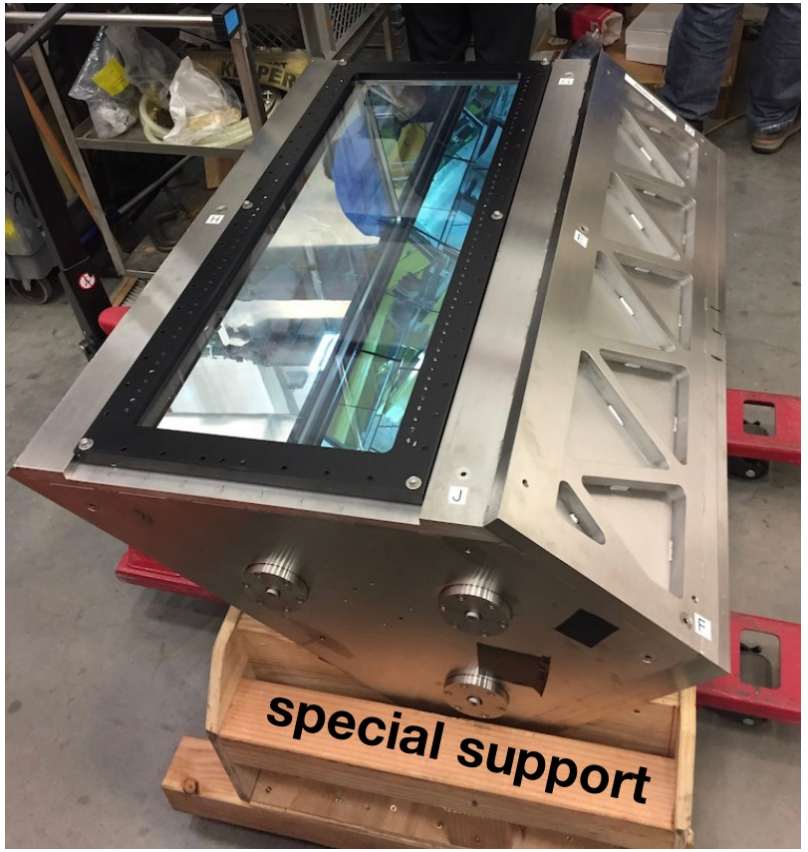


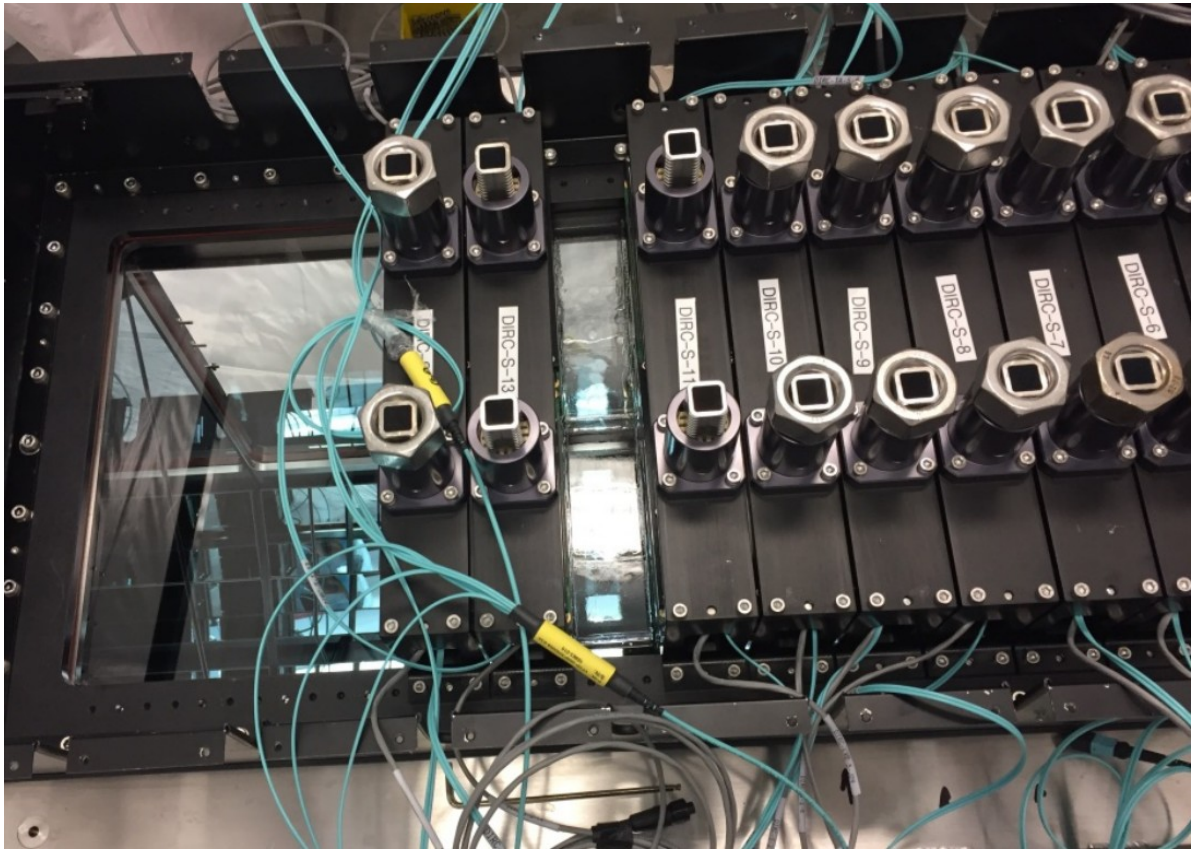
PMT/electronics support bracket developed at MIT-Bates





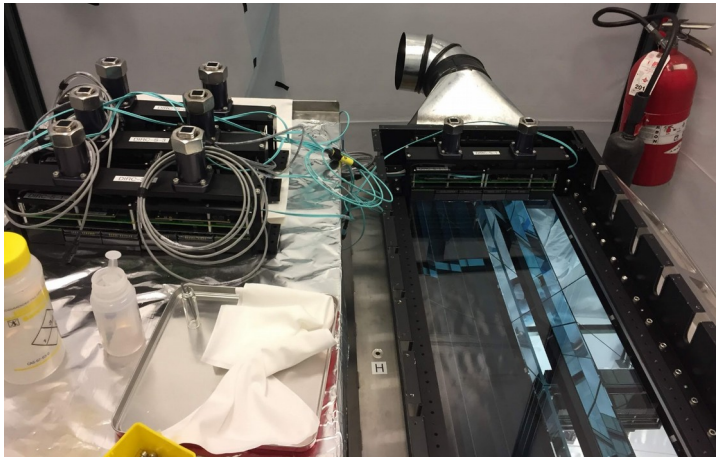
Readout assembling

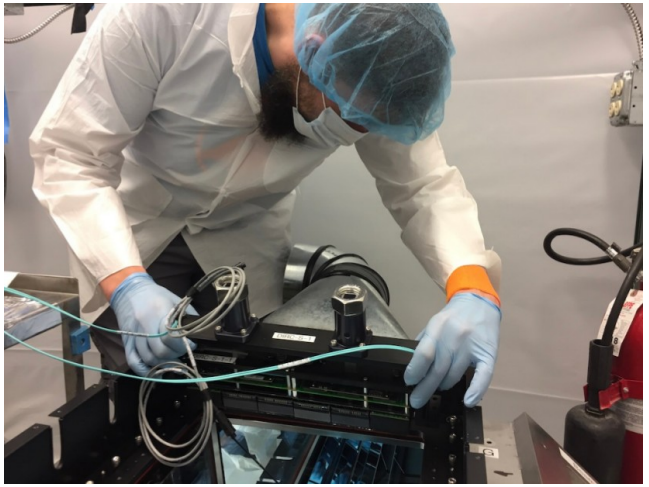


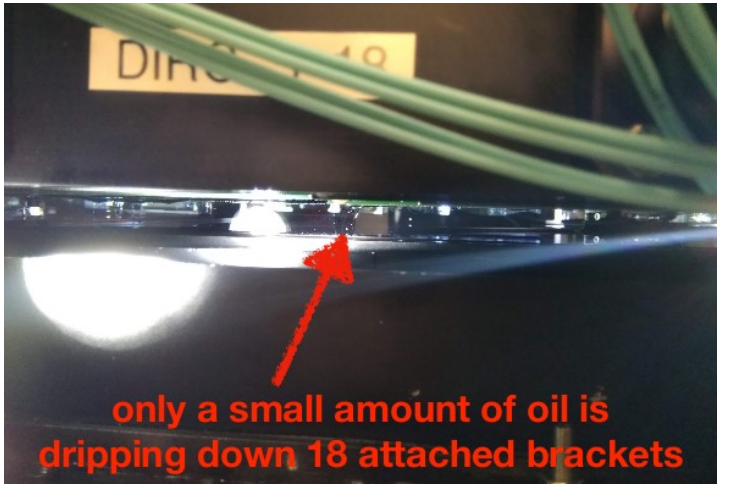


Readout assembling

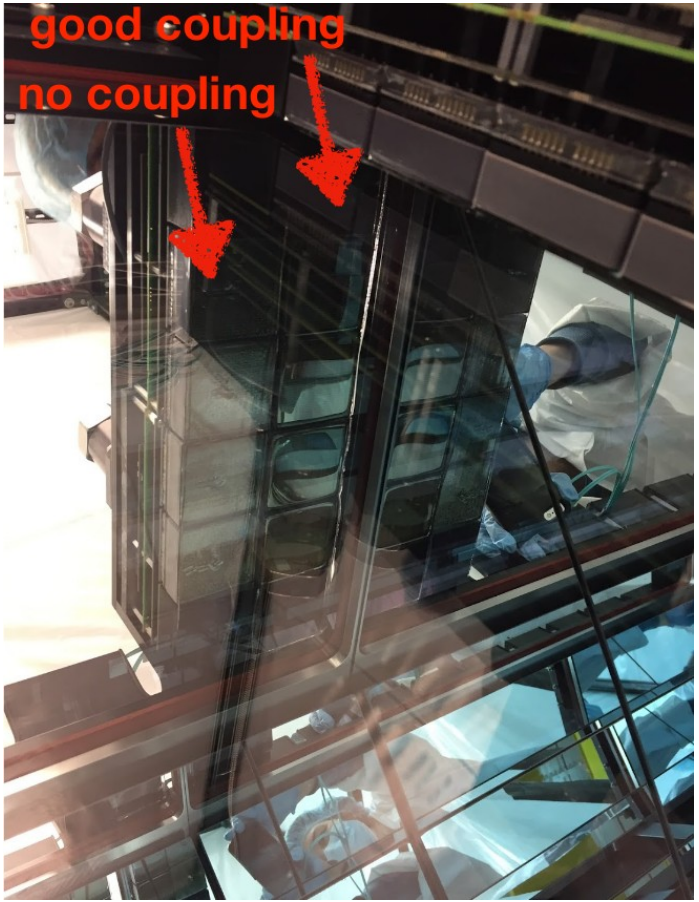
- all PMTs were installed in about 2 days
- exchange of an individual module is possible
- greasing oil is quite viscose and does not drip out
- good optical coupling on >99% of the surface (one “control bubble” of the size of about 4 pixels)







Optical coupling check



OB is installed and attached to the bar boxes. All/near all modules installed.

Light leak test

Bar box is not very light tight

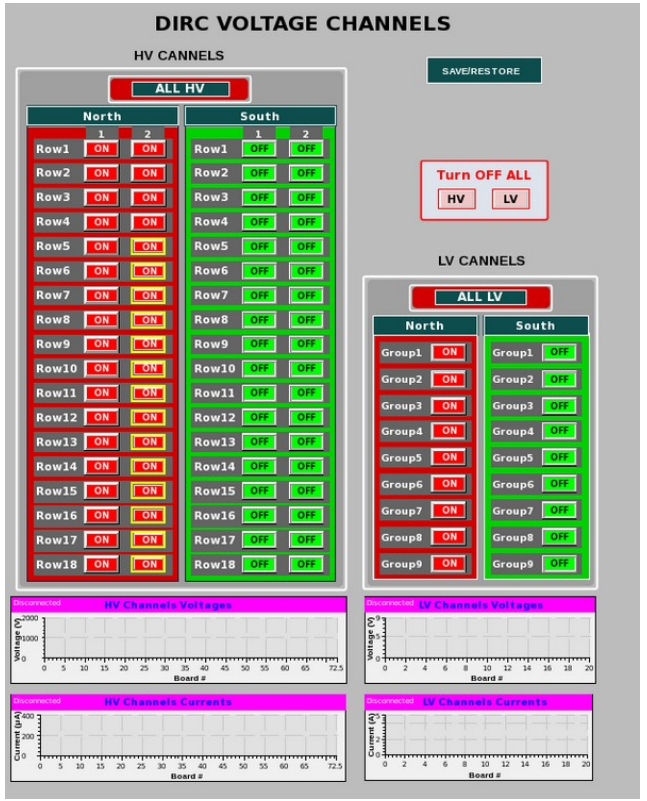
Sealing it with tapes and cloth helped, but still small light leaks remains

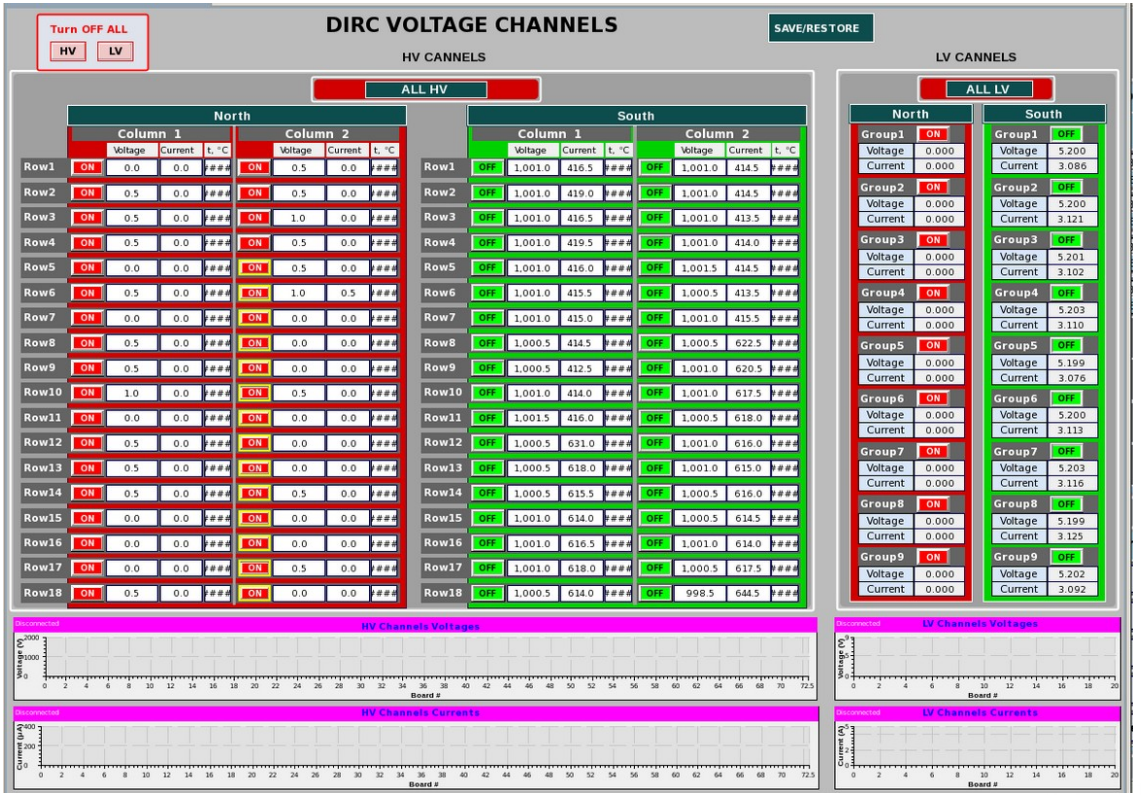
=> data taking with hall's lights off during the commissioning

EPICS Integration

Low/high voltage control:

by Hovanes, Vanik, Nick

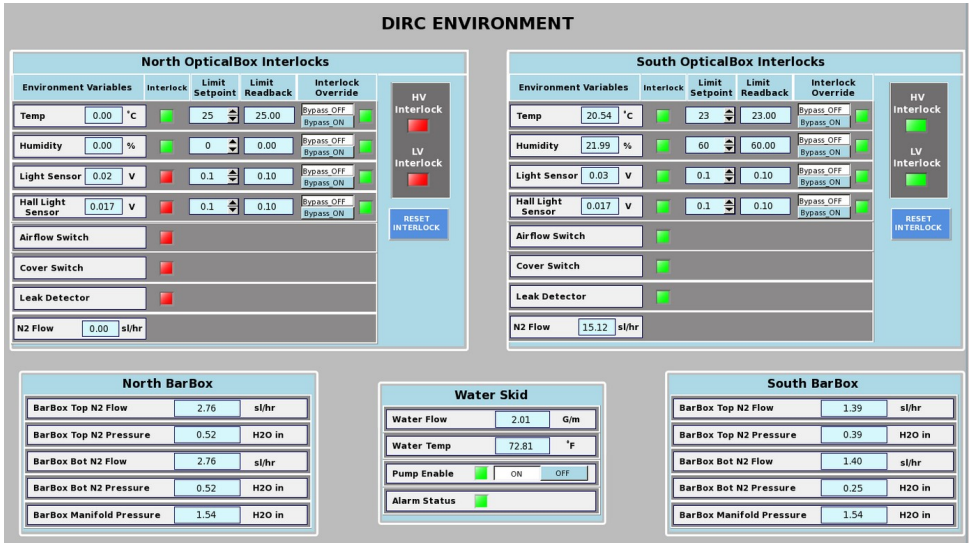




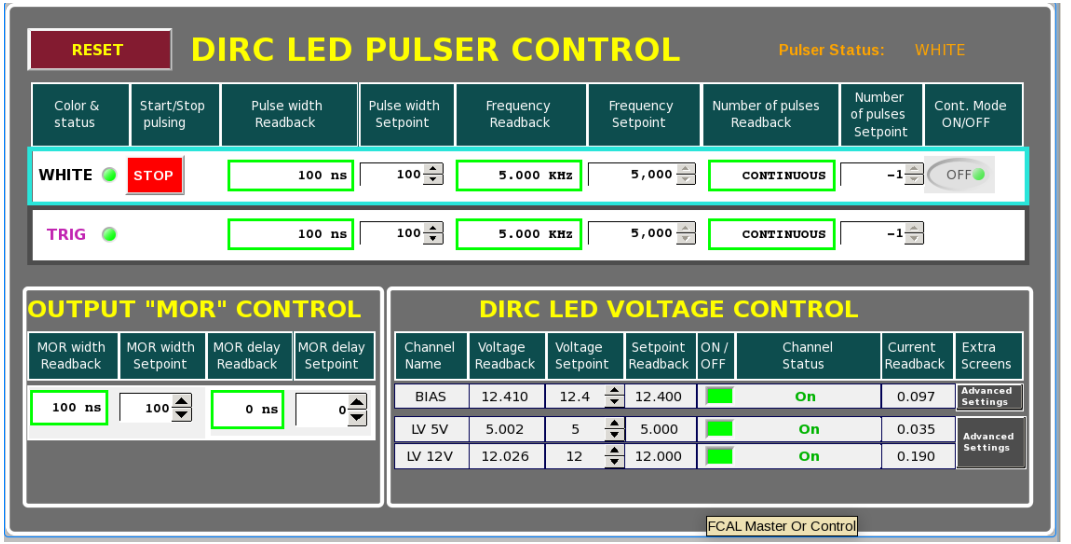
EPICS Integration

by Hovanes, Vanik, Nick

DIRC environment control:



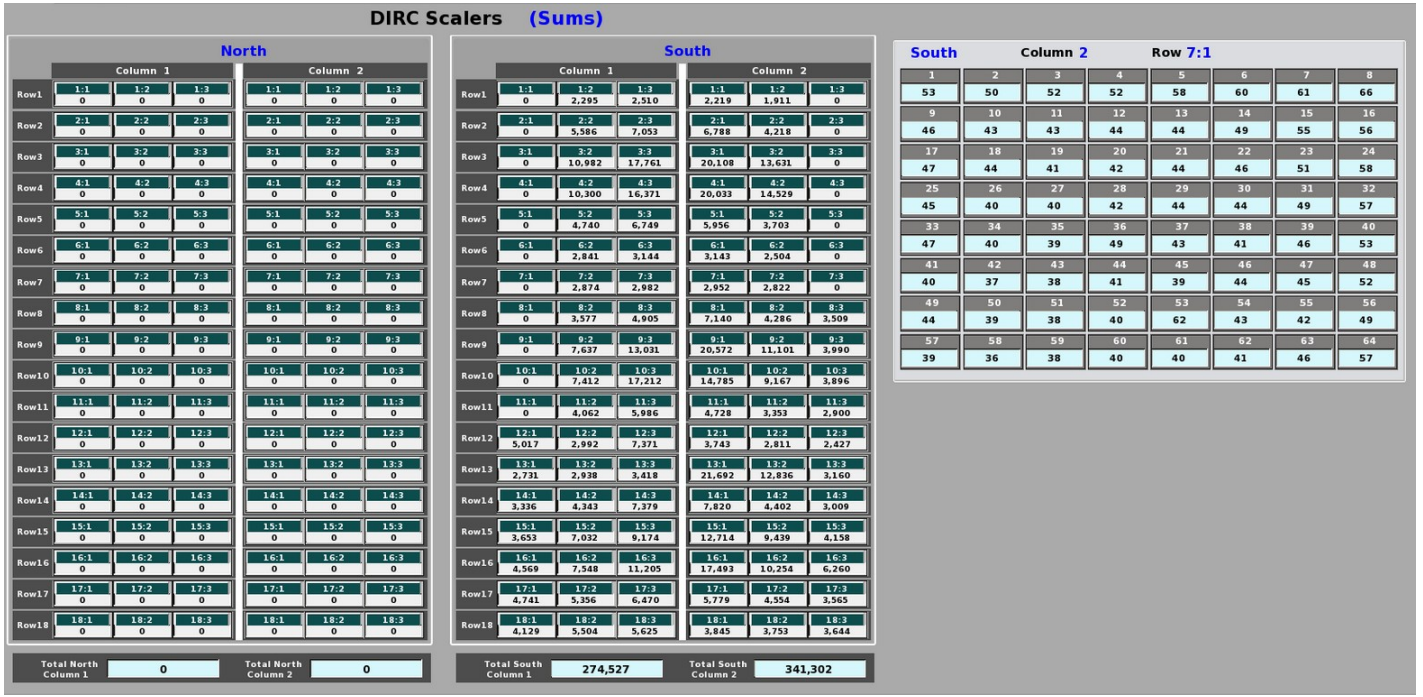
LED pulser control:



EPICS Integration

by Hovanes, Vanik, Nick

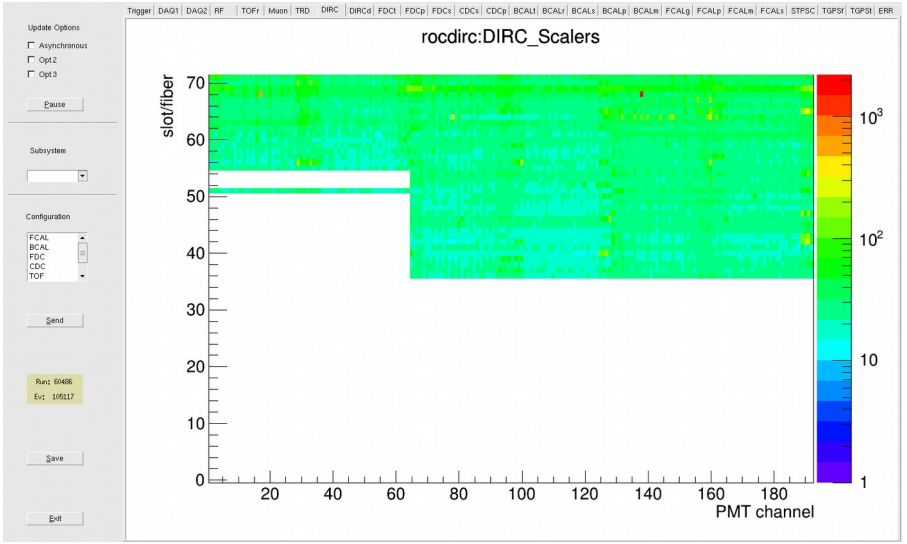
DIRC scalers per pmt/channel:



Monitoring Tools

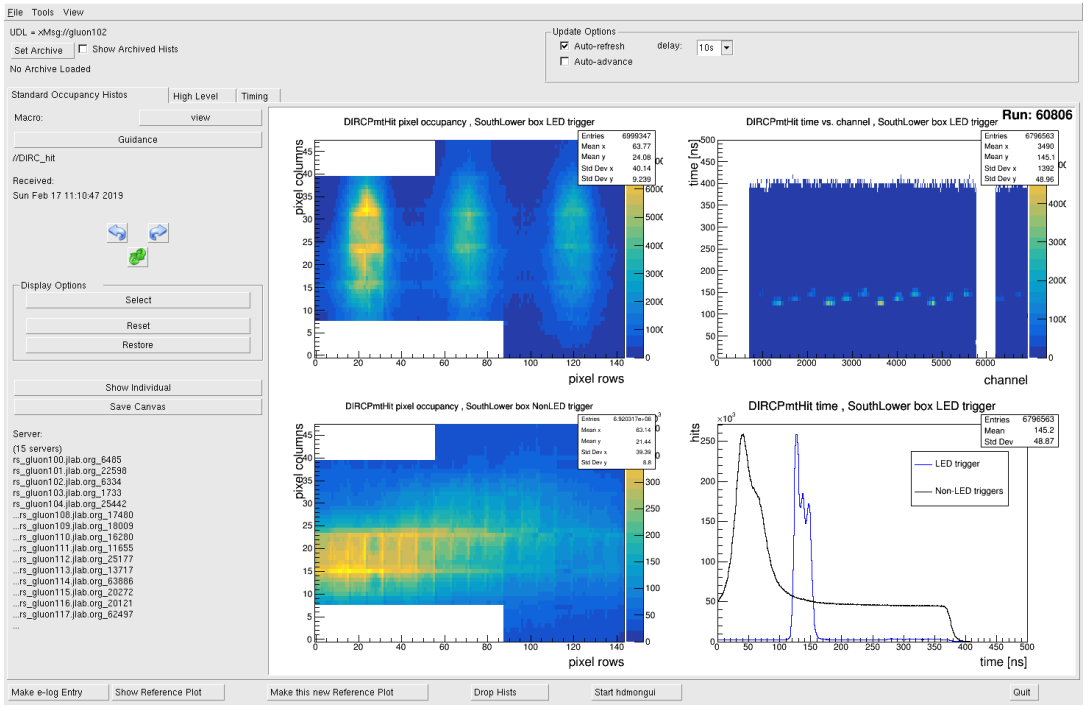
by Sergey

DIRC scaleres:



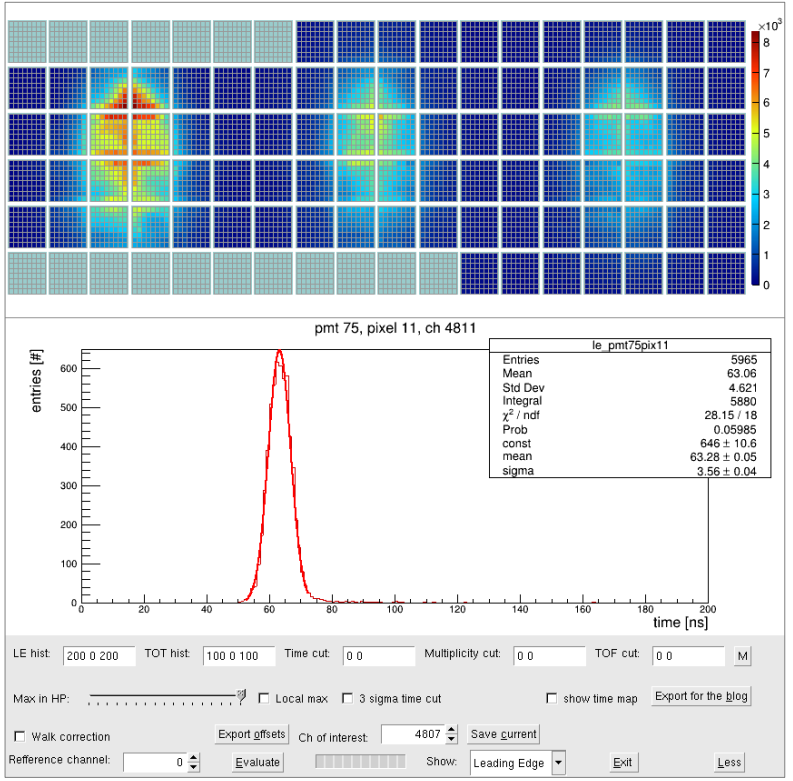
RootSpy:

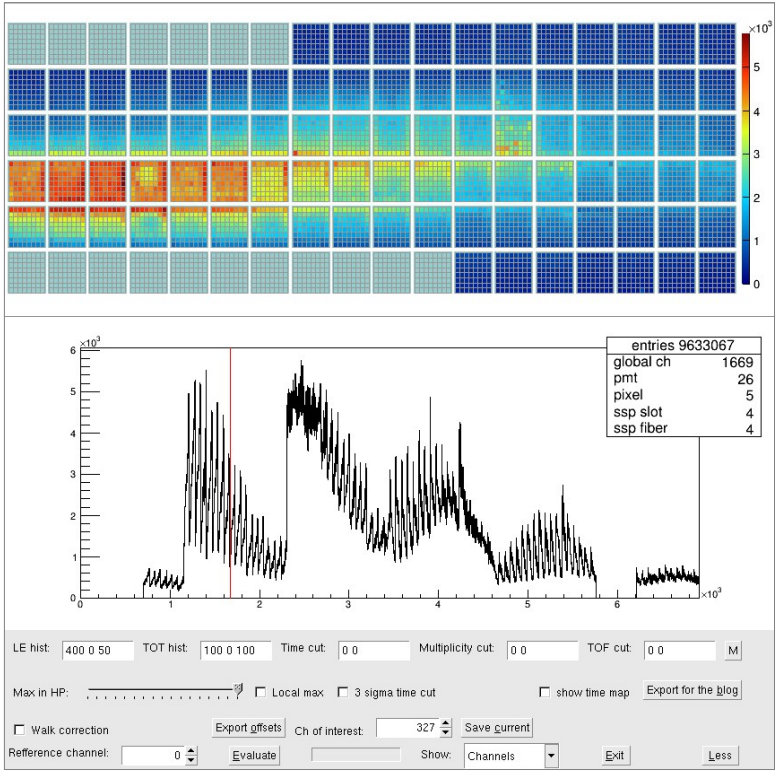
by David



Monitoring Tools

gdisplay:

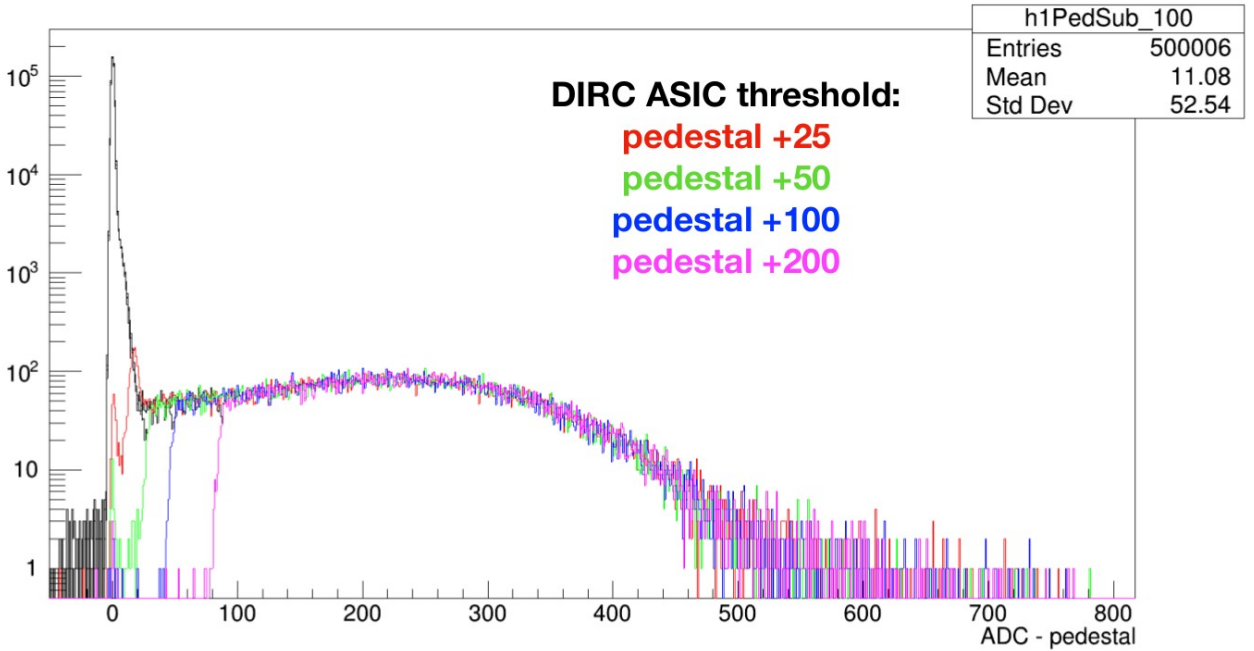




Laser calibration data

- Per-pixel gains determined from single PE peak fits
- Studying efficiency dependence on threshold in both laser test data and beam data to optimize for production running

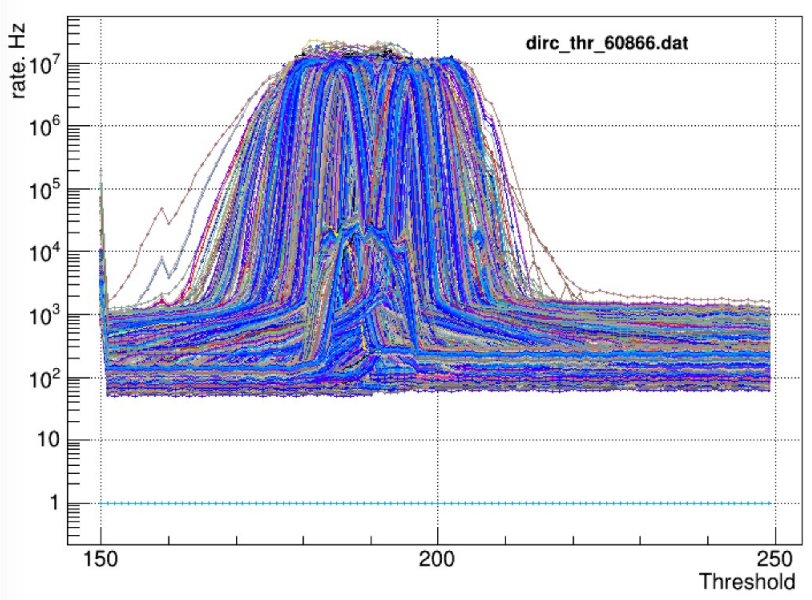
Andrew Hurley, W&M

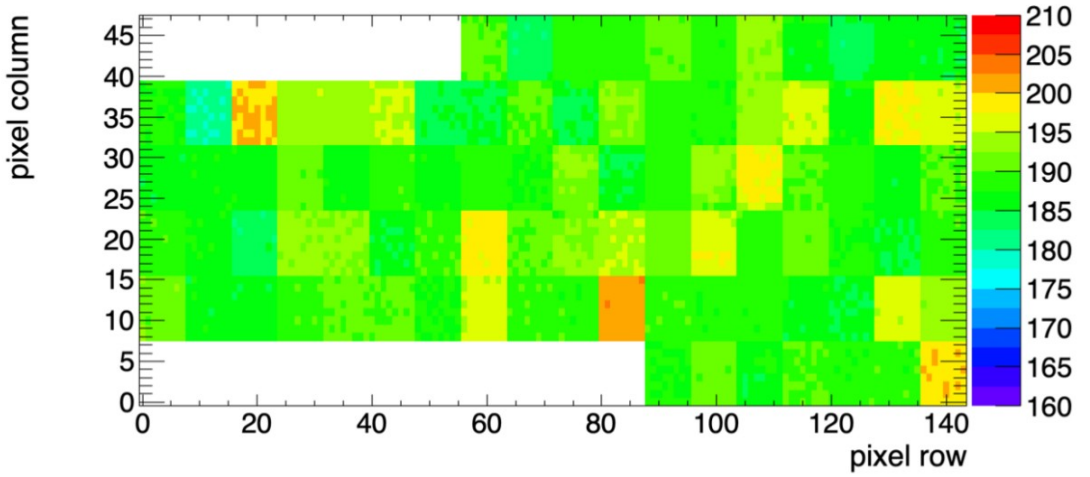


Threshold scans & Pedestal Map

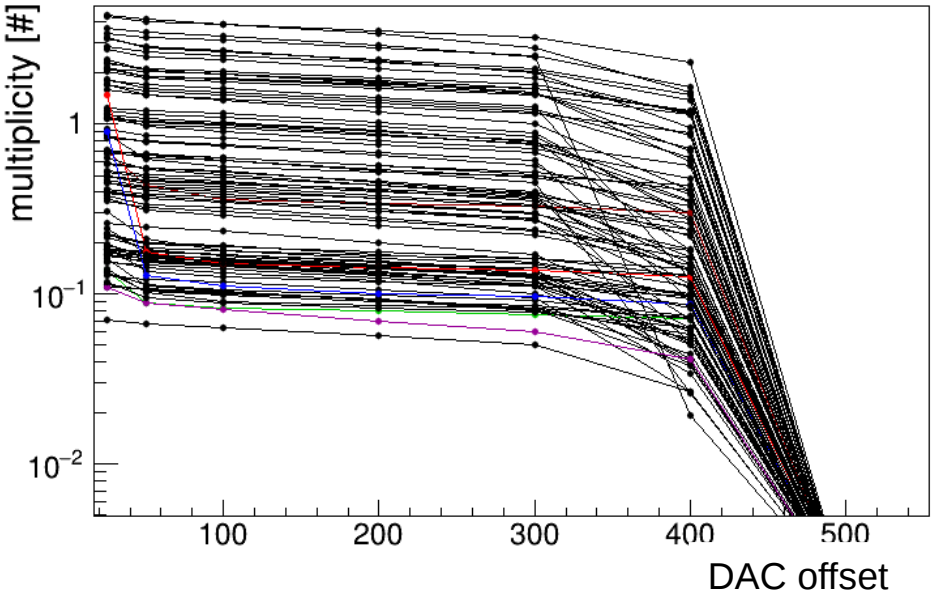
- Sergey wrote program to scan DAC thresholds and save scaler rate for every pixel (part of “daily” DIRC tasks)
- Take centroid of this scan to set pedestal and threshold for each PMT/ASIC

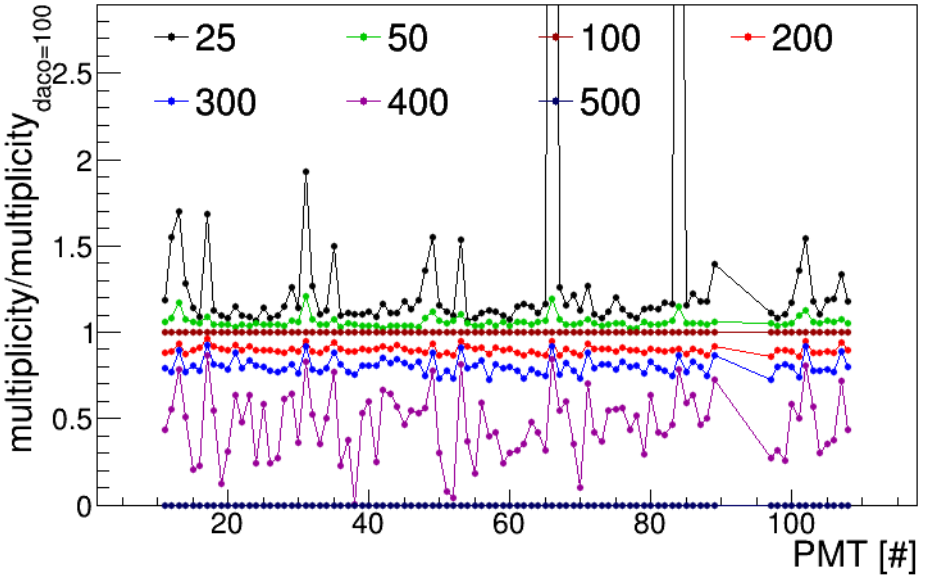
- Pedestals mostly driven by ASIC, so they are common across pixels in a given PMT as seen in threshold scan data
- Single threshold set for each PMT/ASIC is sufficient





Detected LED multiplicity per PMT

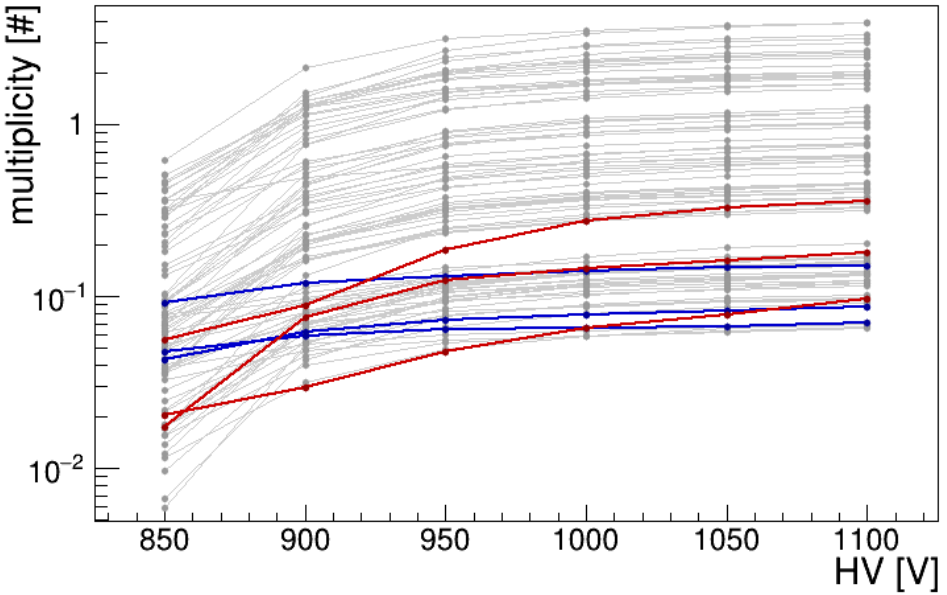


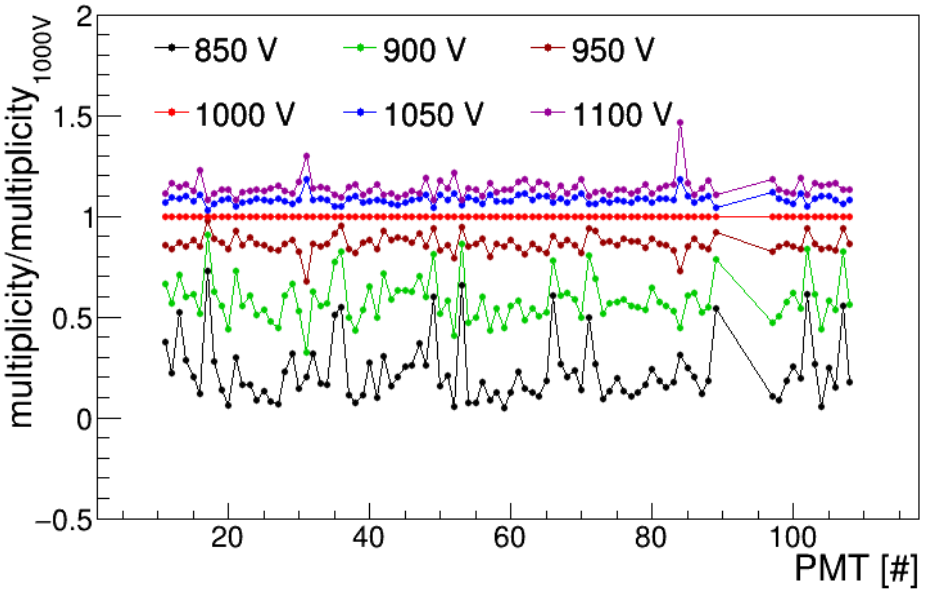


➡ offset 100 was used for most of the data; 1B triggers were collected @ 50, 200

HV scan

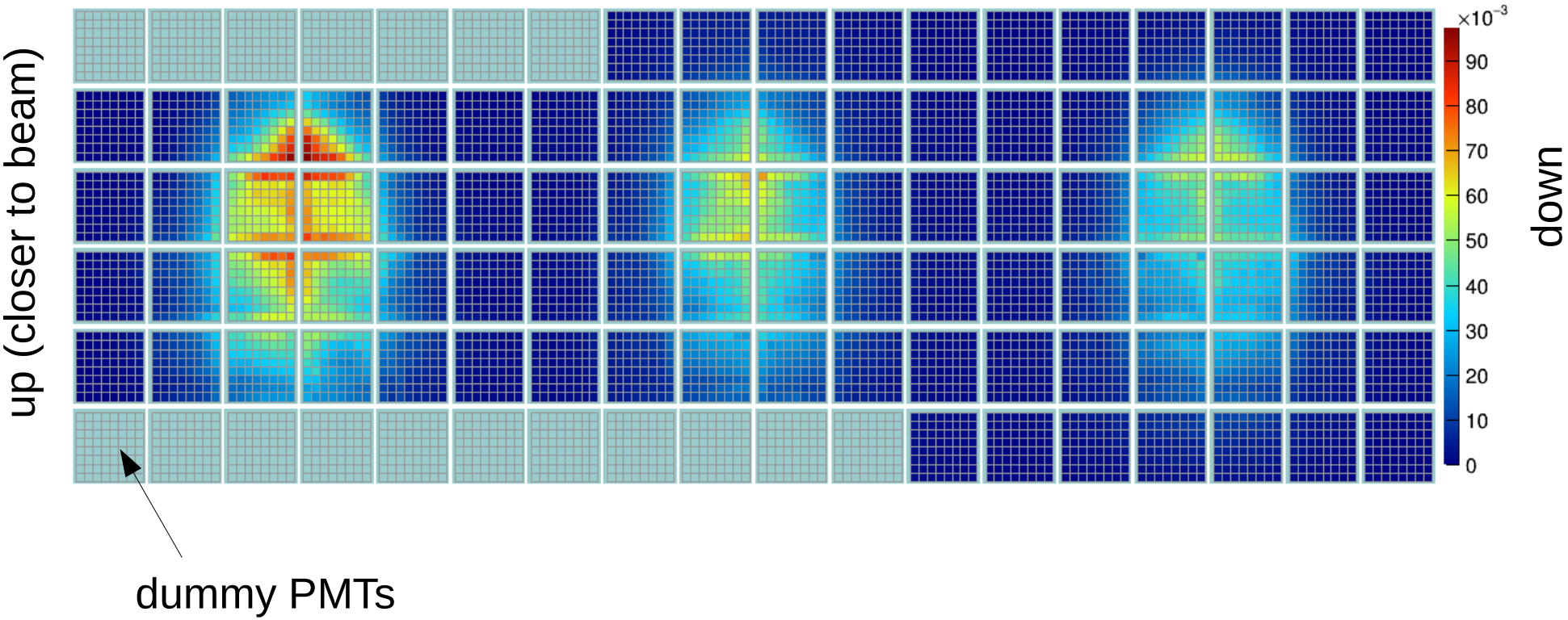
Relative multiplicity as a function of the PMT number and HV value:





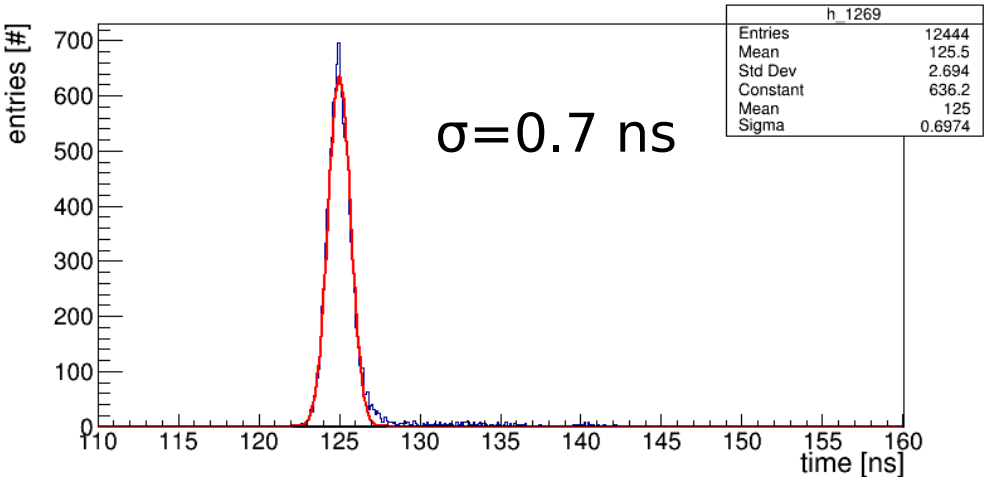
➡ 1000 V was used for most of the data

LED Hit Pattern

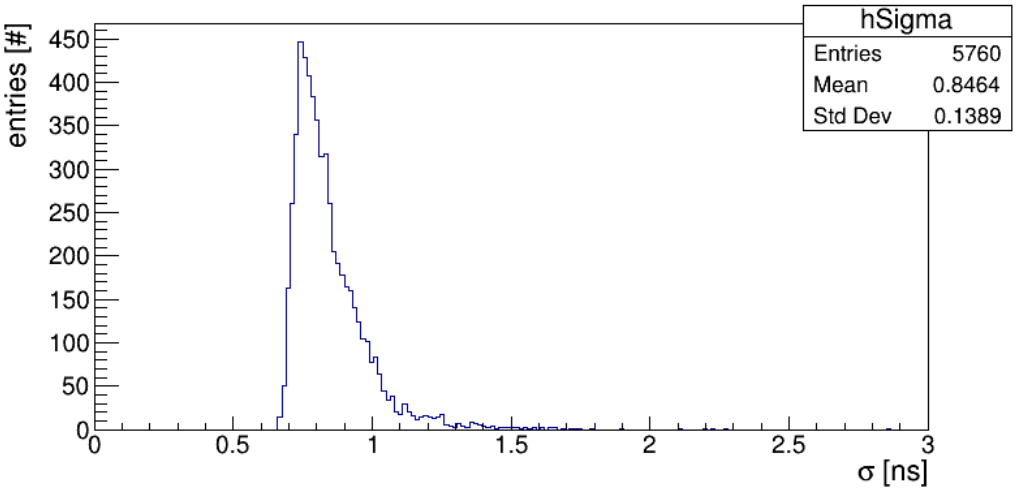


Time resolution from LED data

Example of time distribution for ch 1269:

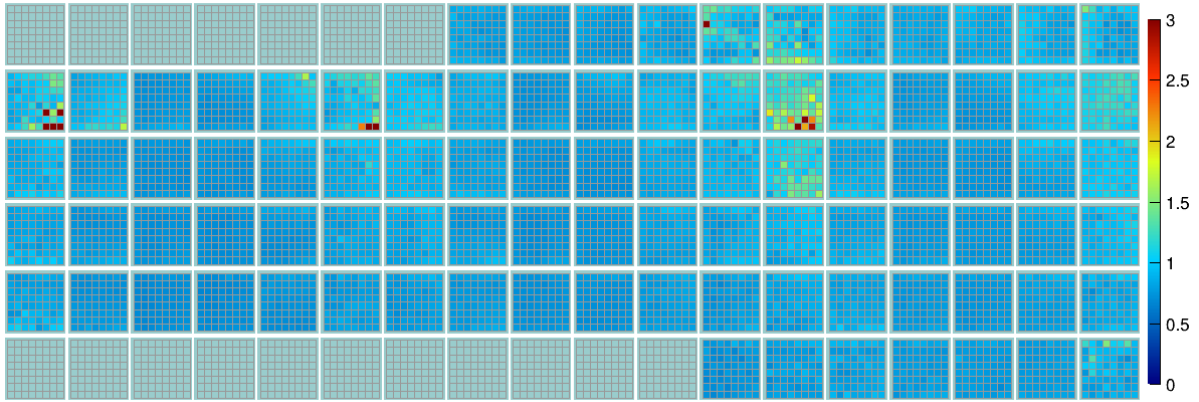


Resolution per channel after walk correction:

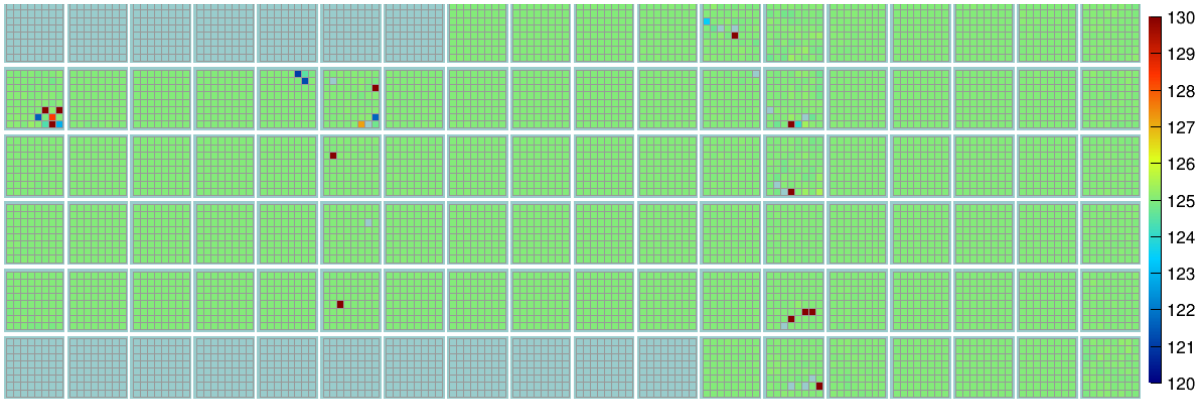


➡ mean resolution 0.8 ns

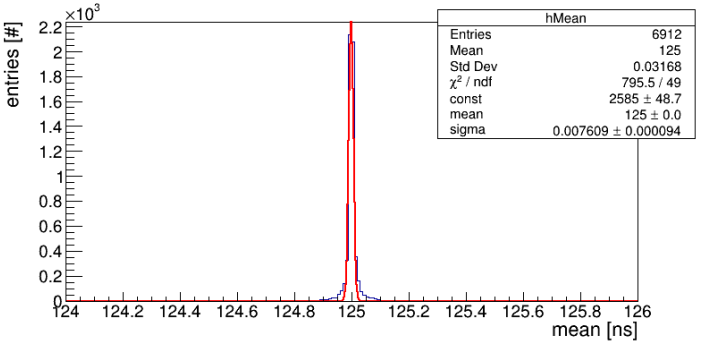
Time resolution from LED data



Time resolution [ns]

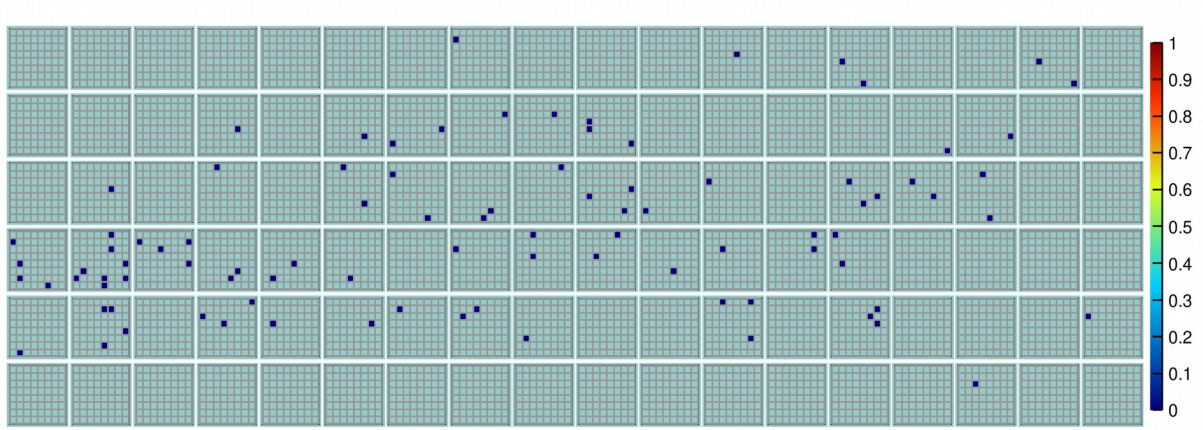


Time offsets [ns]



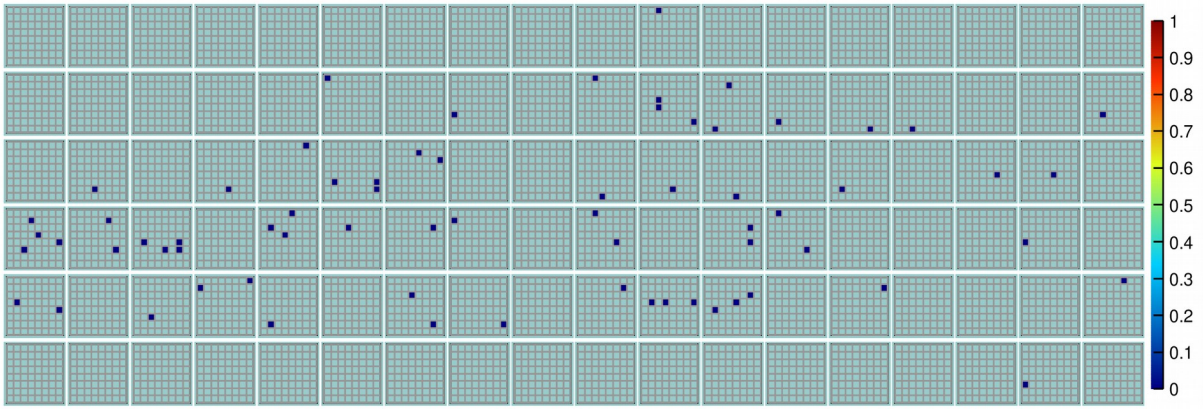
Good start time alignment

Single Event Hit Pattens



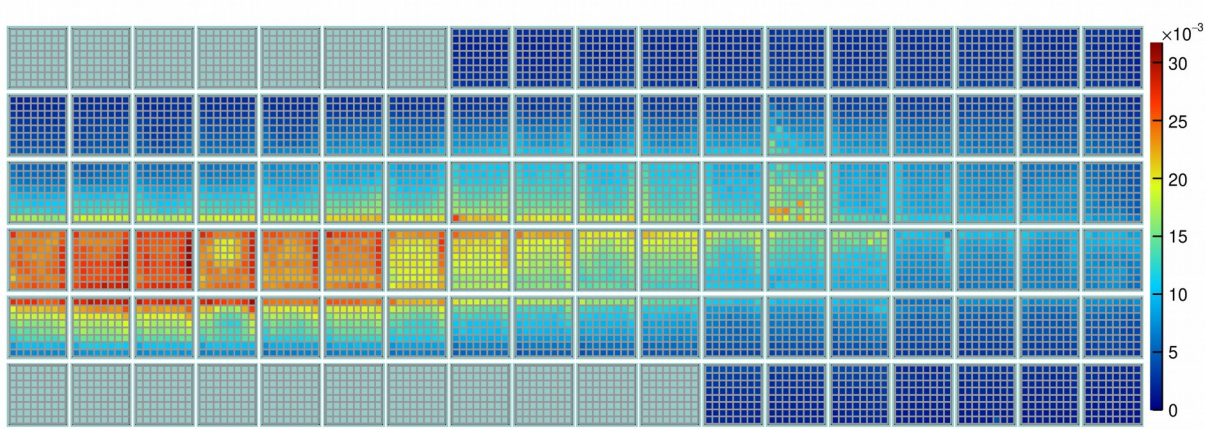
beam data, PID based on reconstructed ρ,φ events

pion

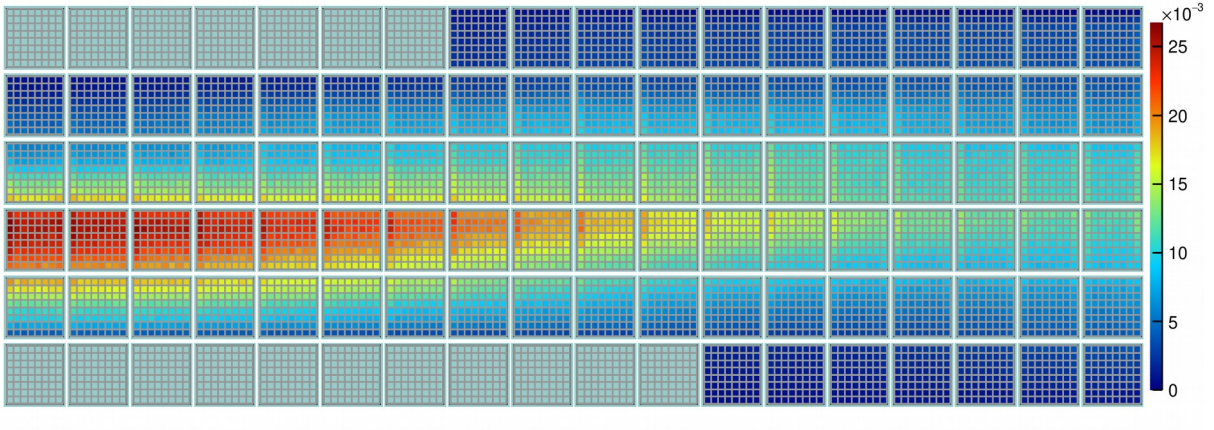


kaon

Hit Pattern Accumulated for All Angles



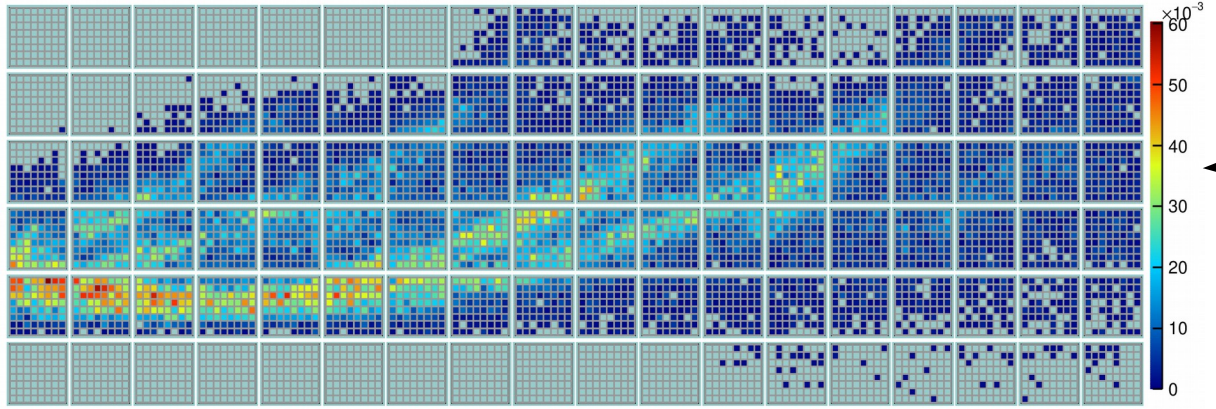
beam data



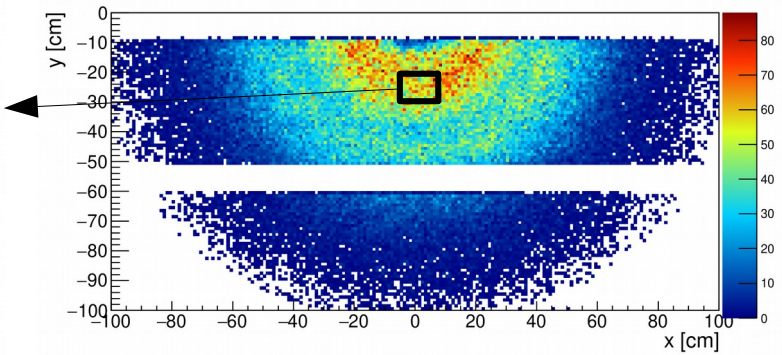
geant4

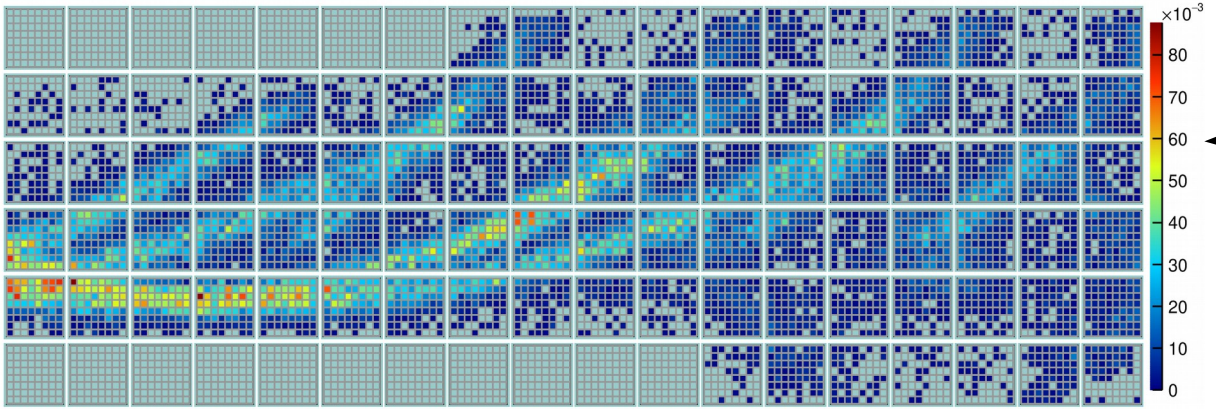
Hit Pattern

[3.8,4.2] GeV/c pions from beam

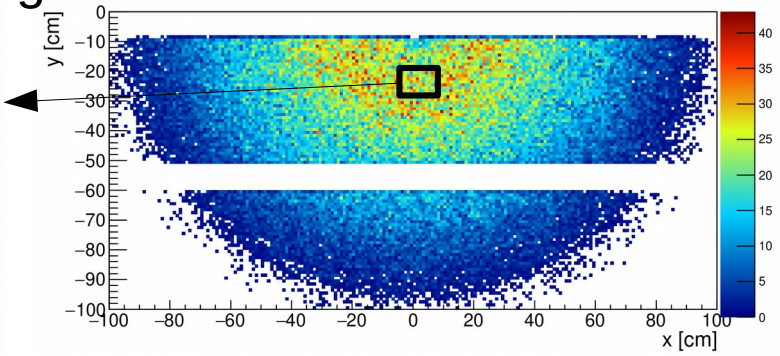


Hit positions on the radiator wall:

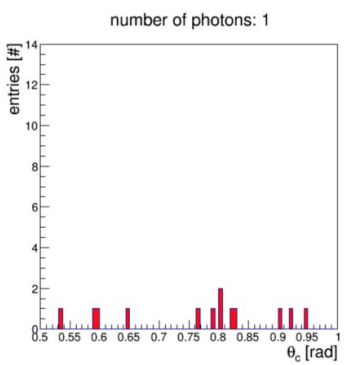


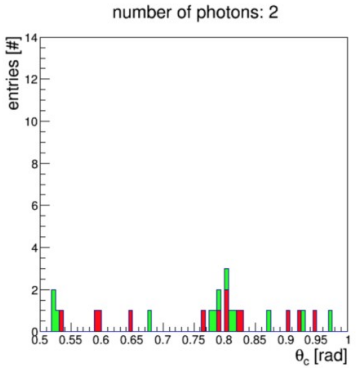


geant4



Geometrical Reconstruction





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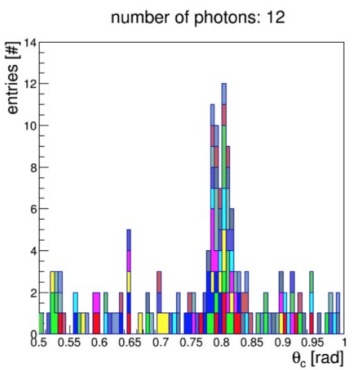
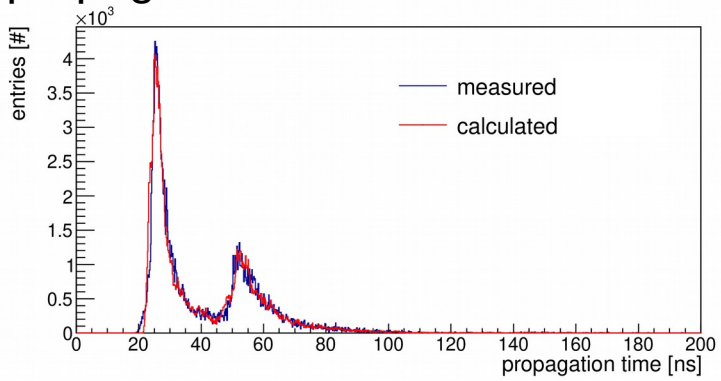


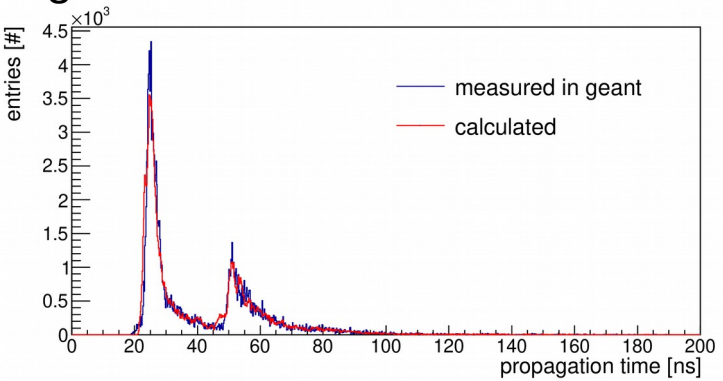
- Geometrical algorithm determine θ_c using Look Up Tables
- PID performed by unbind likelihood fit of the determined θ_c to different mass hypothesis

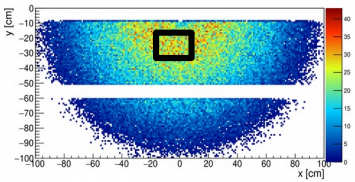
Geometrical Reconstruction

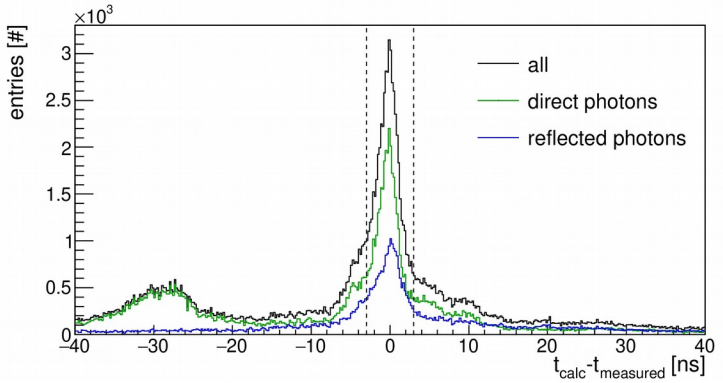
propagation time: beam data

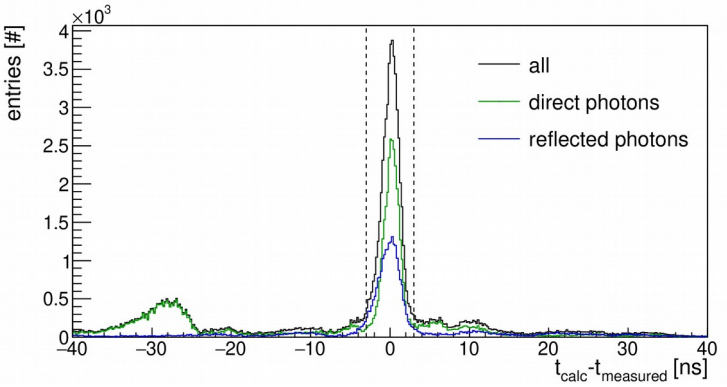


geant4 simulation:



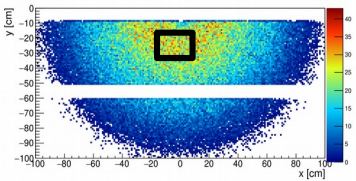




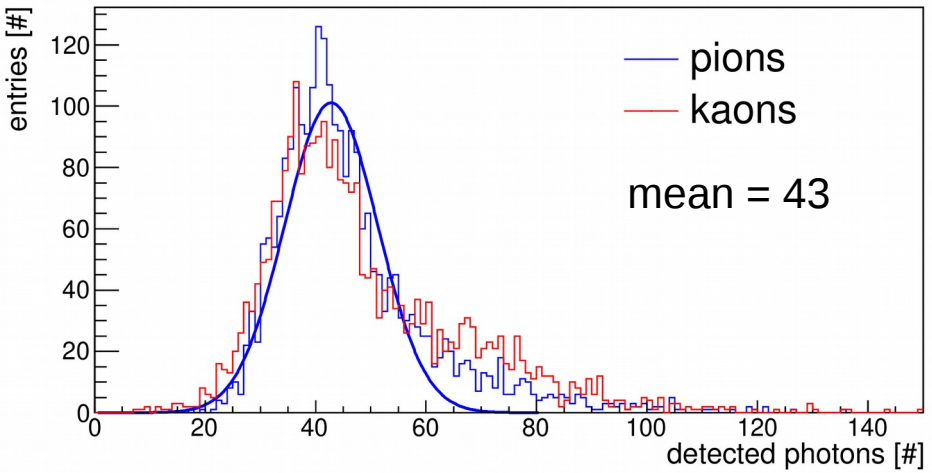


Reconstructed Photon Yield

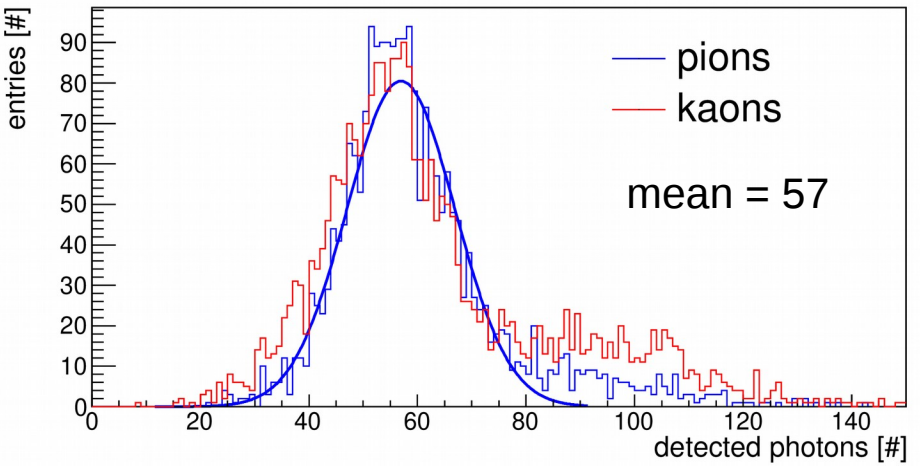
pions and kaons @ [3.8,4.2] GeV/c:



beam data



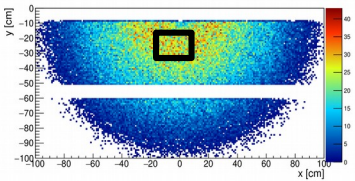
geant4 simulation:

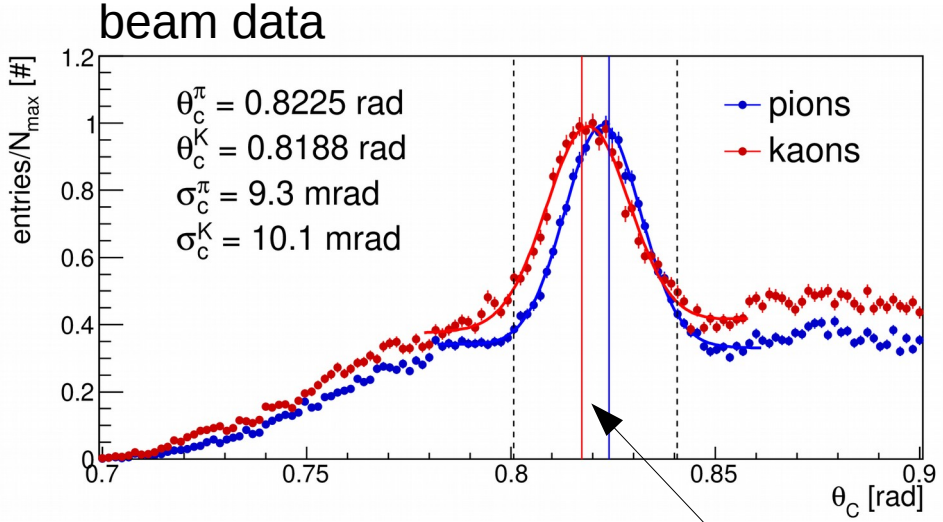


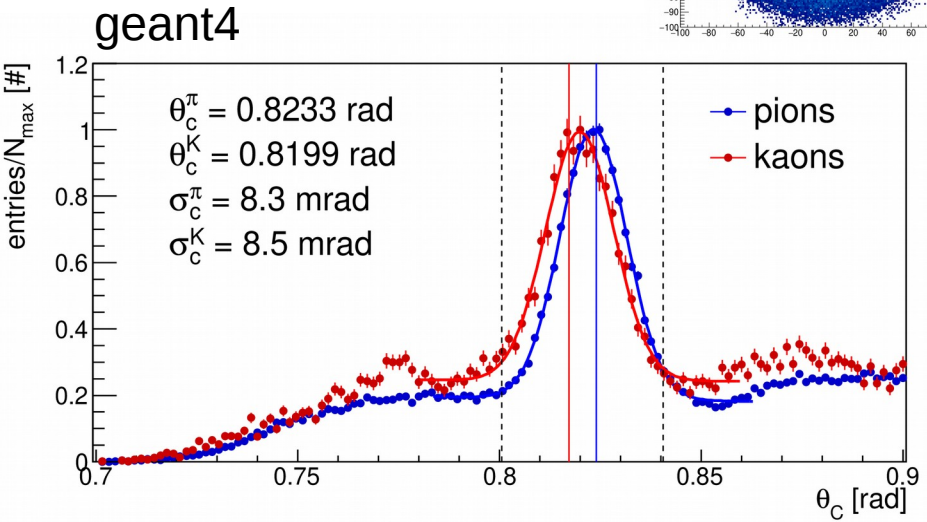
➡ high photon yield but still some discrepancy with simulations

Geometrical Reconstruction

Reconstructed Cherenkov angle for pions and kaons @ [3.8,4.2] GeV/c:







expected θ_c for pions and kaons

➡ obtained SPR 9-10 mrad

Summary

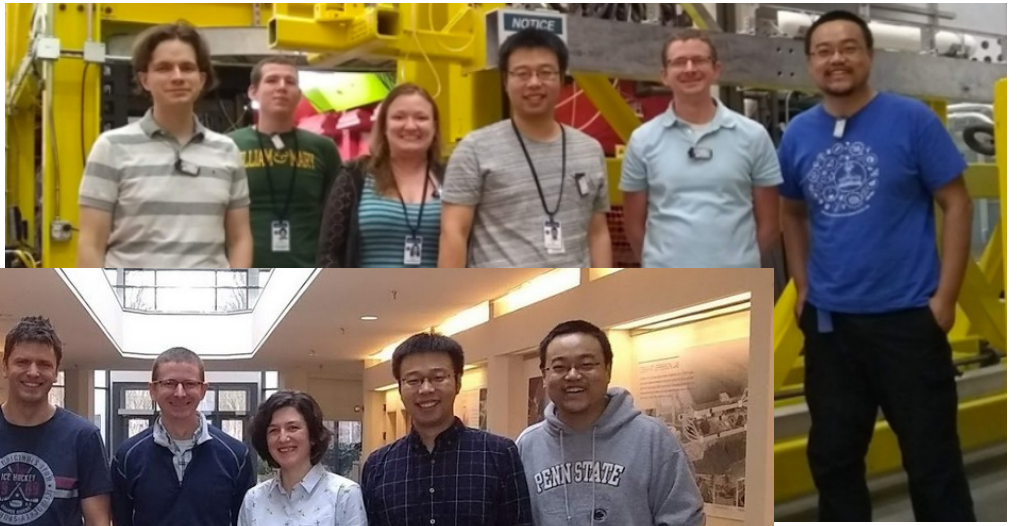
- The lower half of the DIRC was assembled and installed
- Air flow test, water/light leaks tests are OK
- DIRC readout was implemented into Hall D DAQ and online/offline monitoring
- Optimal gain and threshold for PMT's pixels were determined and used to collect ~10B triggers at various beam and detector conditions
- Sub nanosecond timing resolution was obtained
- Geometrical reconstruction algorithm (Look Up Table) was implemented into GlueX software and successfully used to reconstruct first data
- Demonstrated initial performance of the DIRC in terms of the photon yield and SPR
- Good agreement between beam data and geant4 simulations

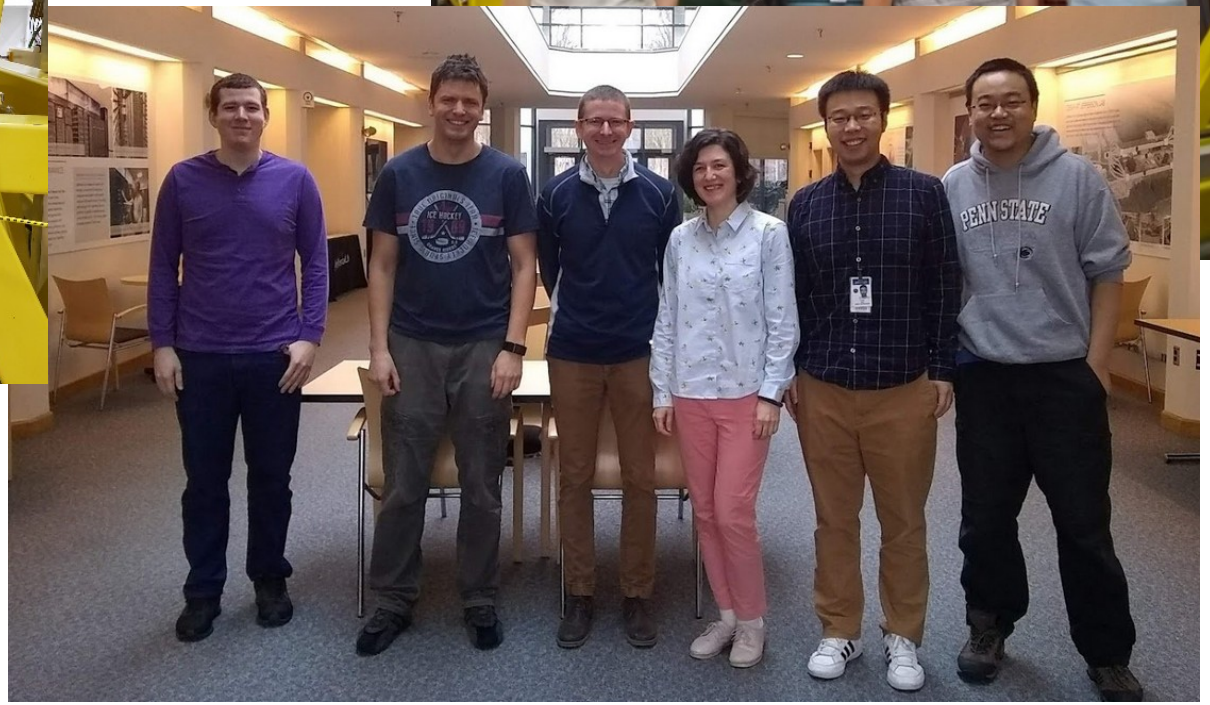
➡ Successful commissioning of the DIRC

Outlook

- Evaluation of the performance over all available phace space
- Geometric alignment using FastDIRC
- Per PMT/pixel θ_c correction
- Comparisons of beam intensity dependence and threshold dependence of the reconstruction

- Assembling and installation of the second half of the detector





Thank you for the attention