DIRC commissioning and data analysis

GlueX collaboration meeting

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INDIANA UNIVERSITY

Jefferson Lab

GSI

THE CATHOLIC UNIVERSITY of AMERICA

WILLIAM & MARY
CHARTERED 1693

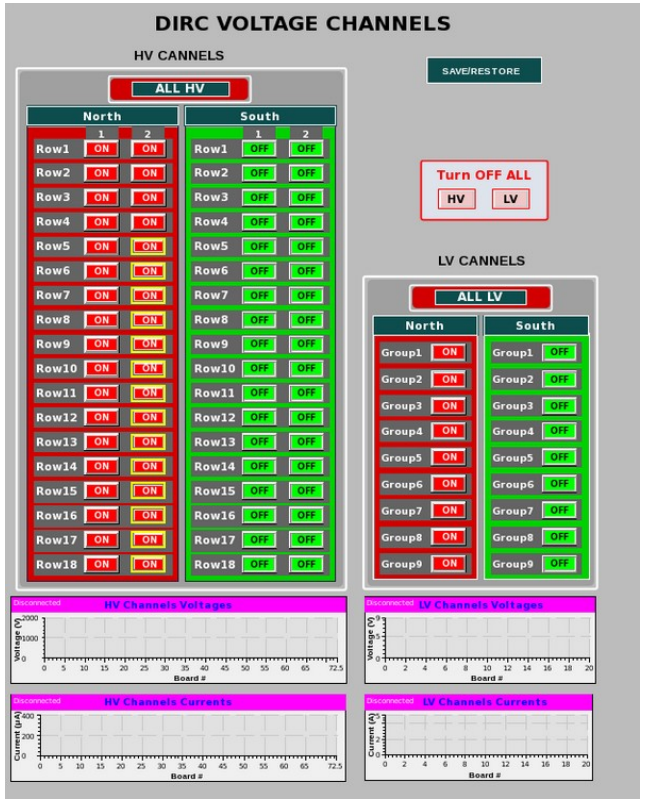
Commissioning Goals

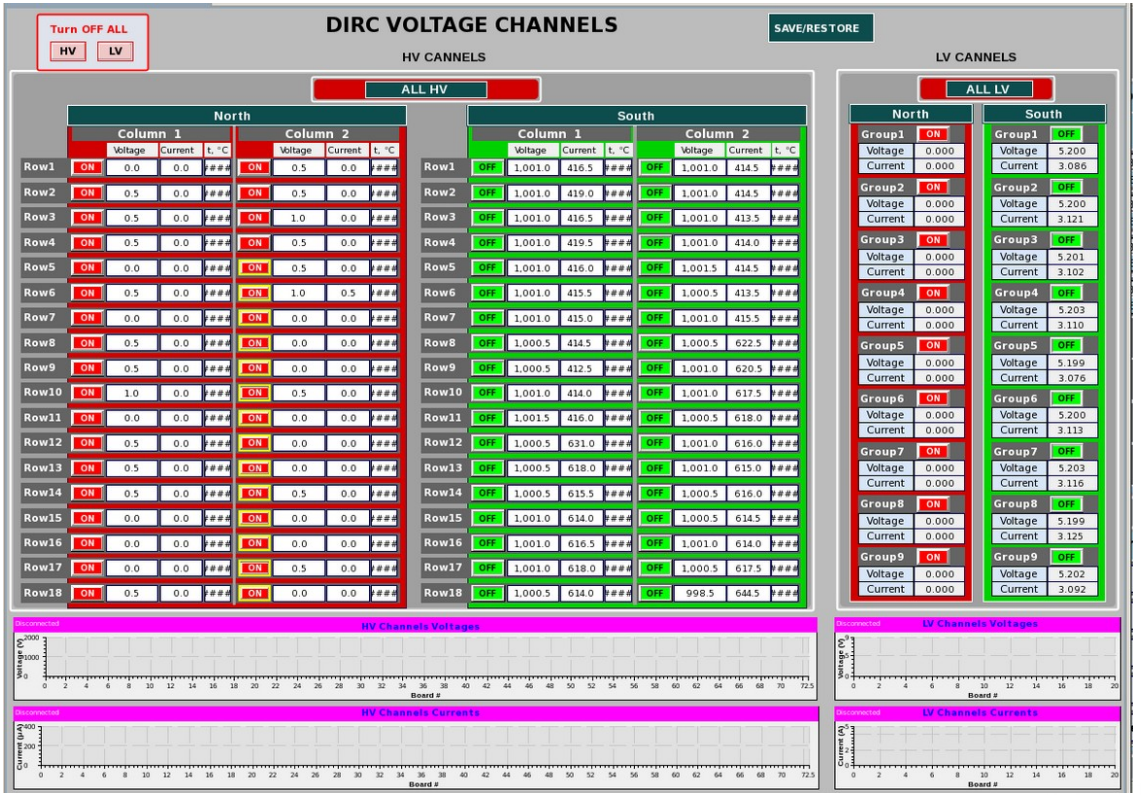
- Integrate DIRC readout with general Hall D DAQ and online/offline monitoring
- Confirm cabling through HV/mask checks with LED system
- Calibrate per-pixel timing offset of MAPMTs using LED system
- Implement reconstruction algorithm and compare data/MC:
  - photon multiplicity
  - Cherenkov angle resolution
- Determine geometric alignment parameters (position and angle offsets) for optical components

EPICS Integration

Low/high voltage control:

by Hovanes, Vanik, Nick

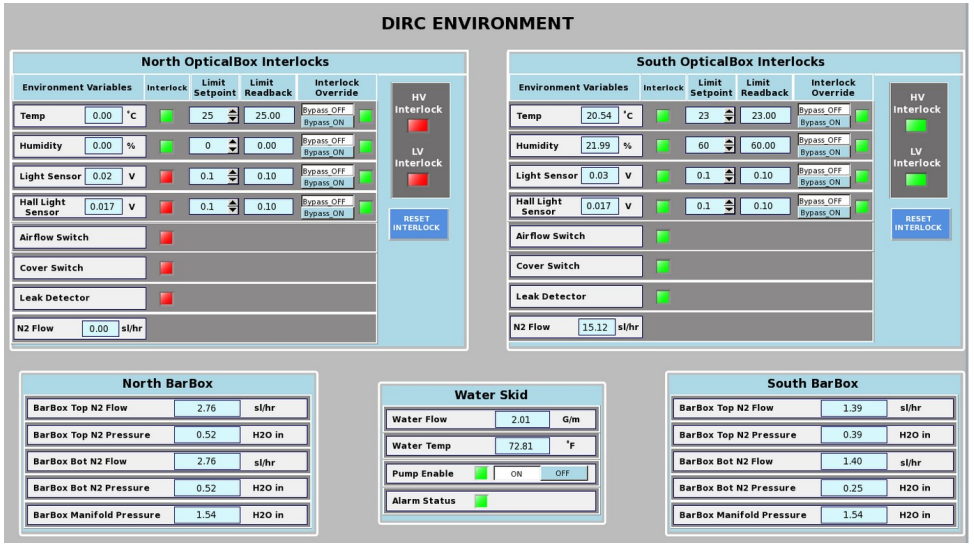




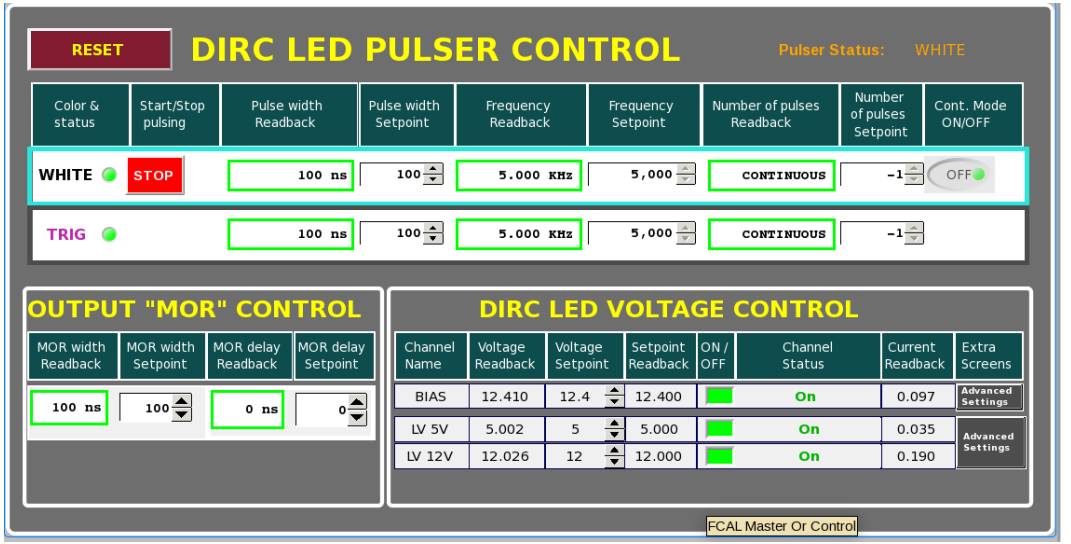
EPICS Integration

by Hovanes, Vanik, Nick

DIRC environment control:



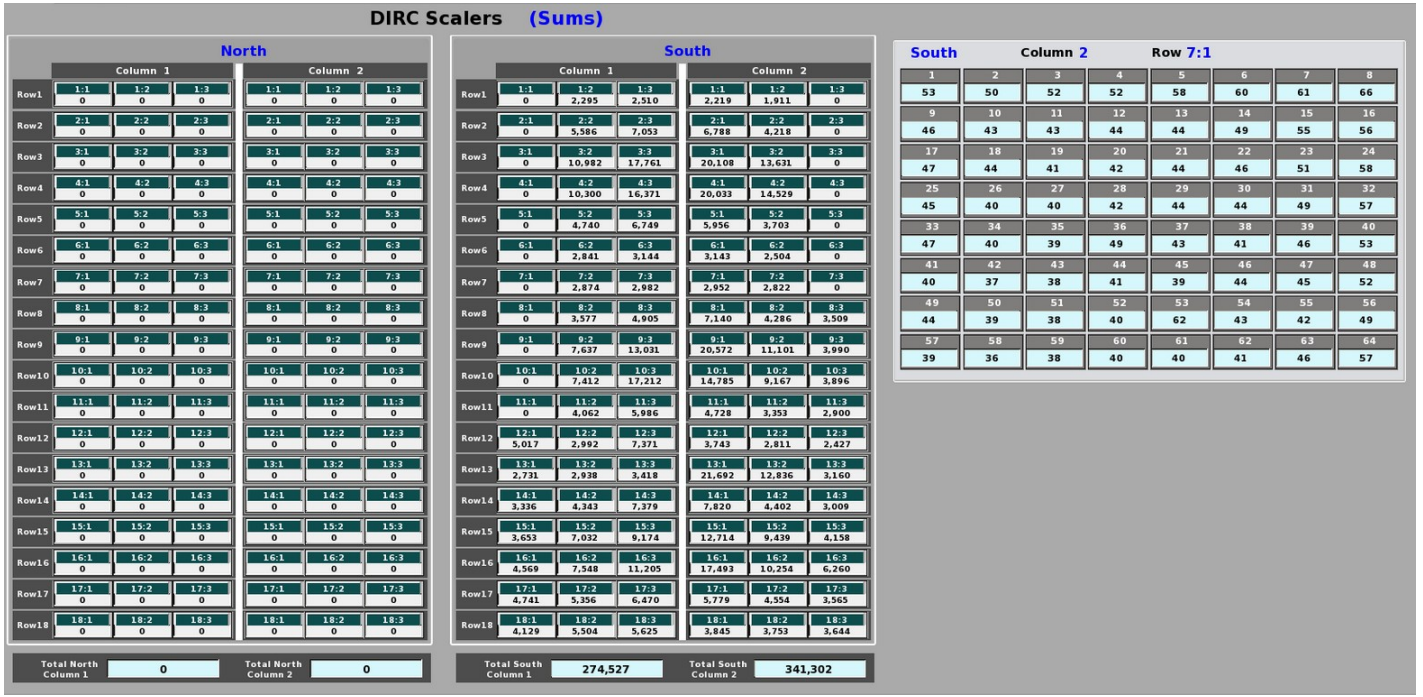
LED pulser control:



EPICS Integration

by Hovanes, Vanik, Nick

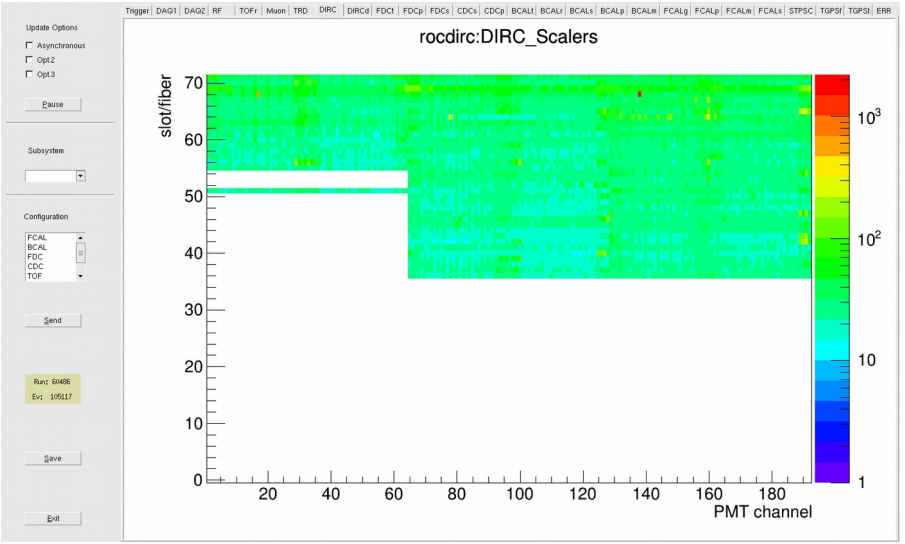
DIRC scalers per pmt/channel:



Monitoring Tools

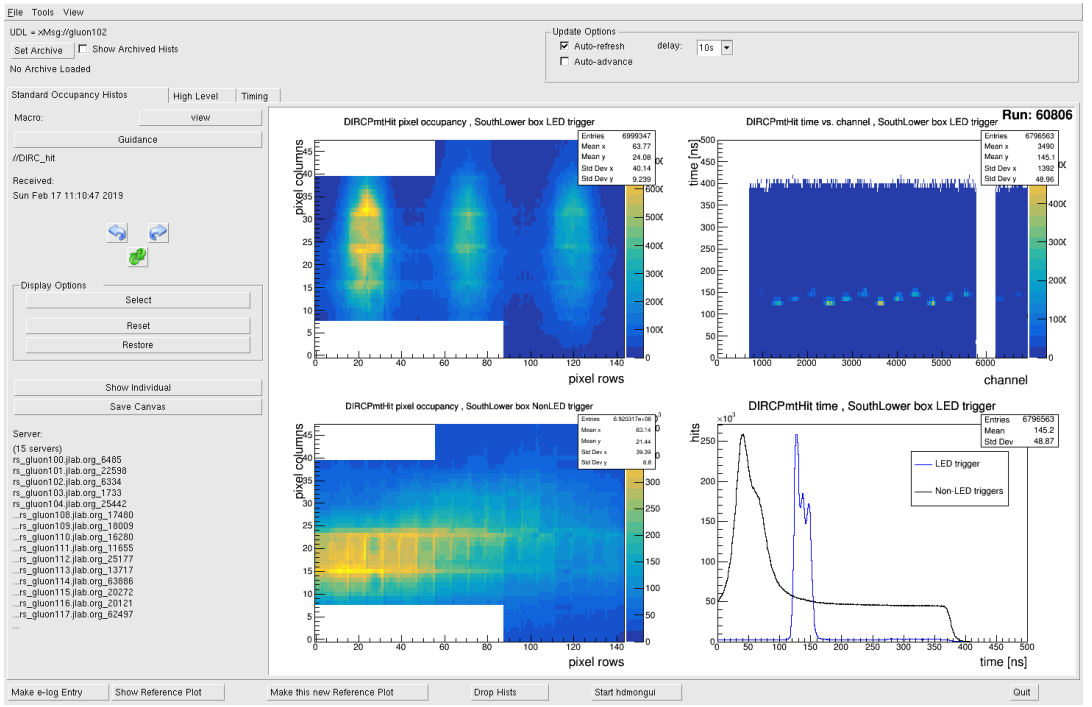
by Sergey

DIRC scaleres:



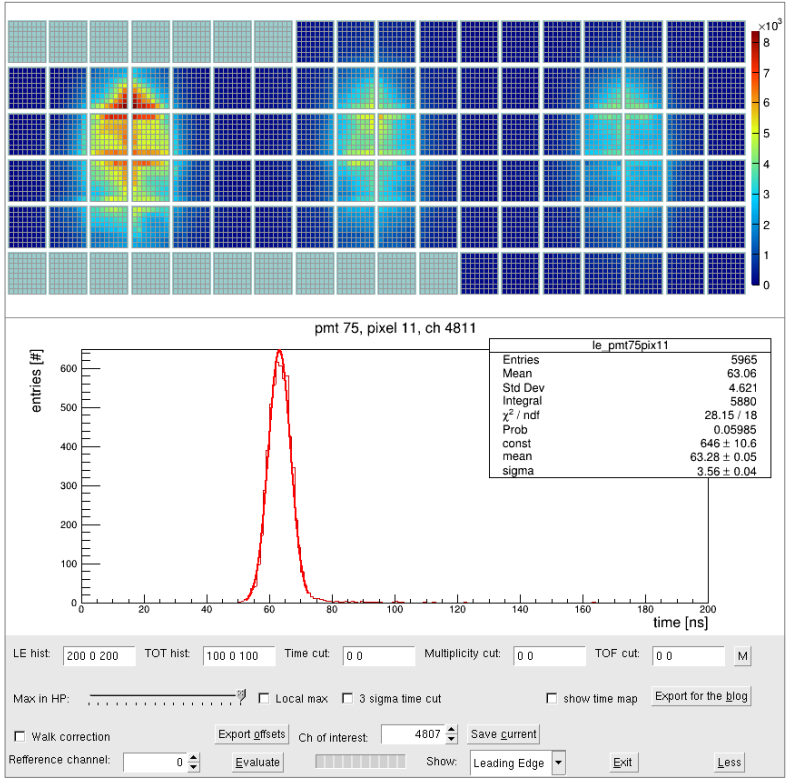
RootSpy:

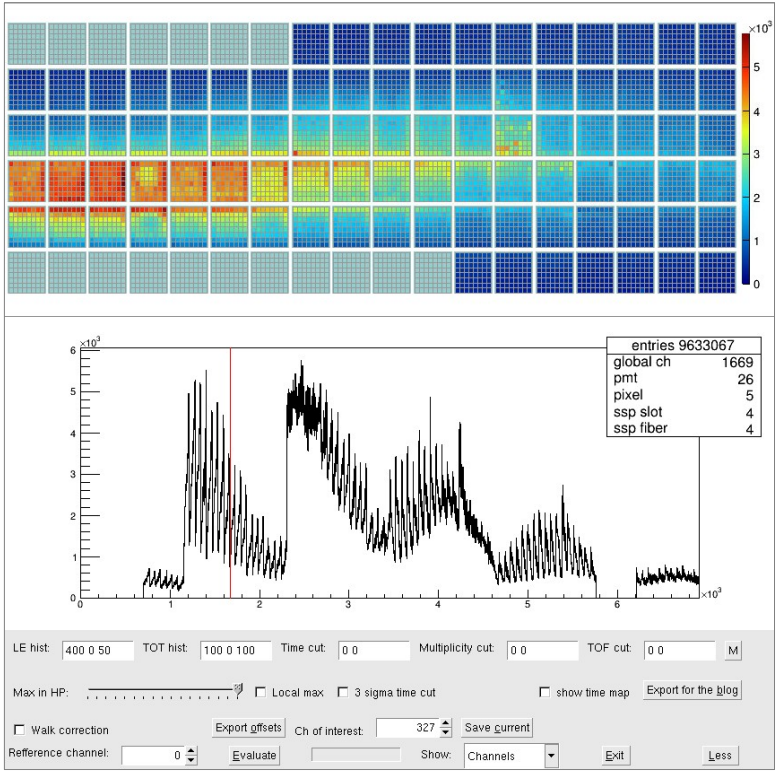
by David



Monitoring Tools

gdisplay:

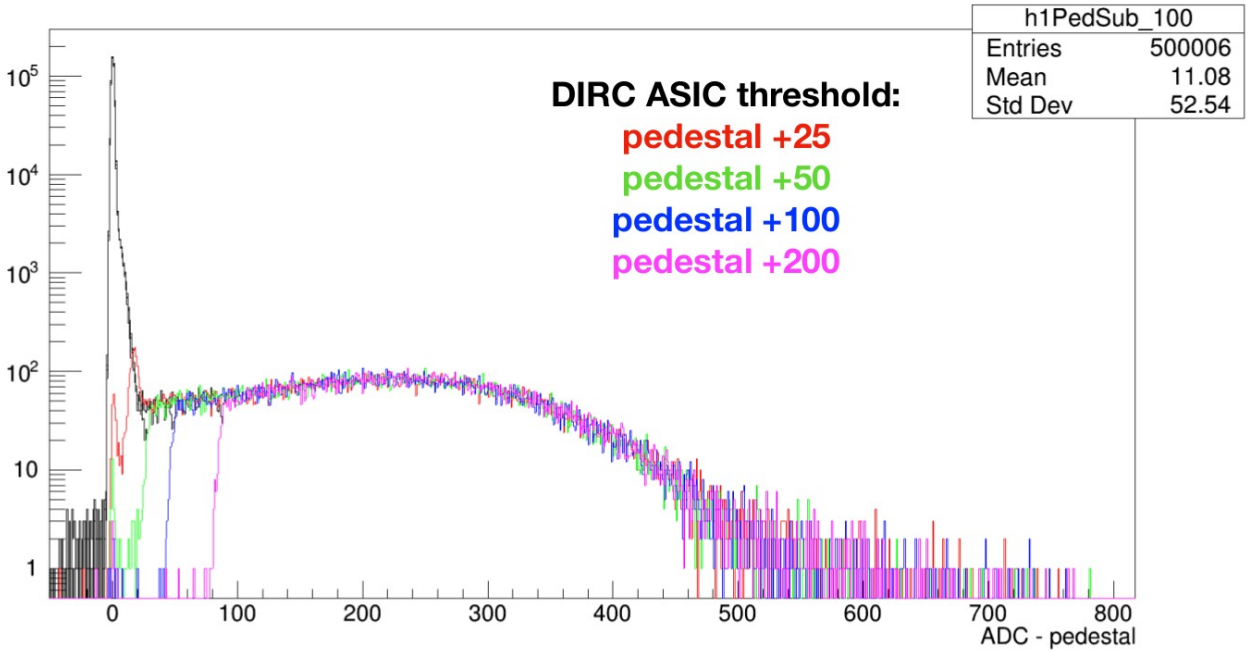




Laser calibration data

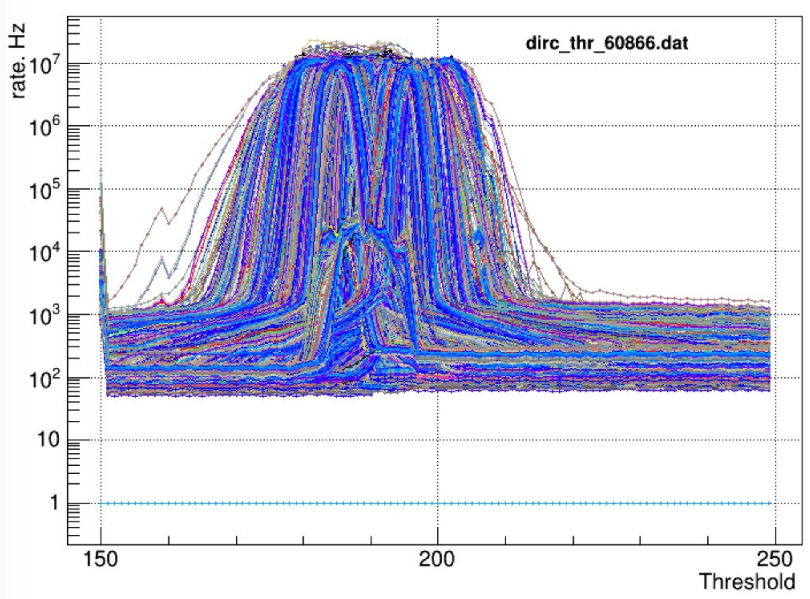
- Per-pixel gains determined from single PE peak fits
- Studying efficiency dependence on threshold in both laser test data and beam data to optimize for production running

Andrew Hurley, W&M

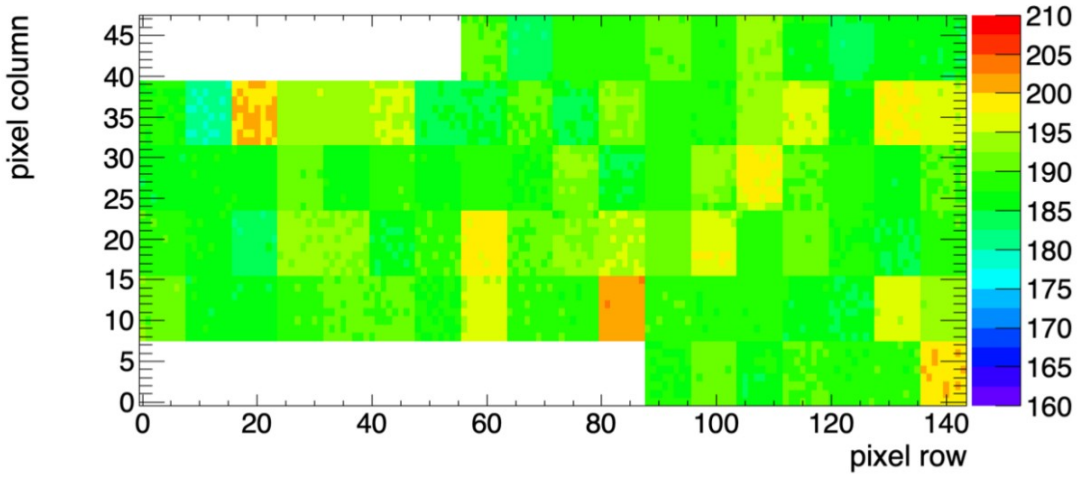


Threshold scans & Pedestal Map

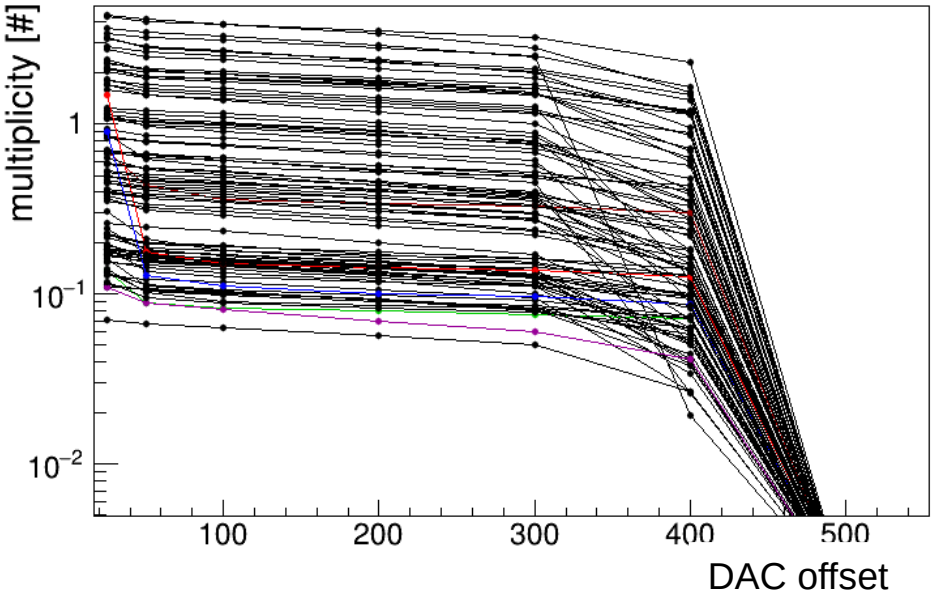
- Sergey wrote program to scan DAC thresholds and save scaler rate for every pixel (part of “daily” DIRC tasks)
- Take centroid of this scan to set pedestal and threshold for each PMT/ASIC

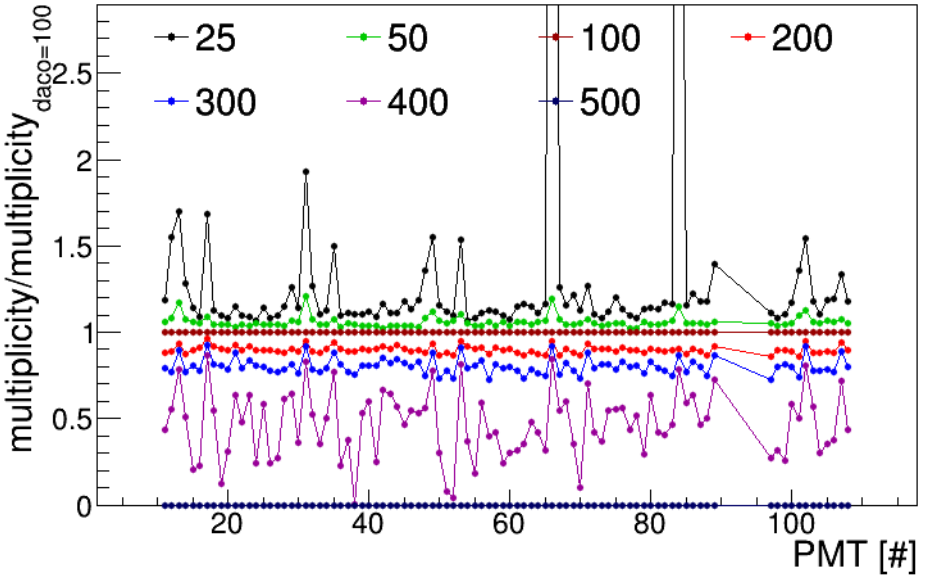


- Pedestals mostly driven by ASIC, so they are common across pixels in a given PMT as seen in threshold scan data
- Single threshold set for each PMT/ASIC is sufficient



Detected LED multiplicity per PMT

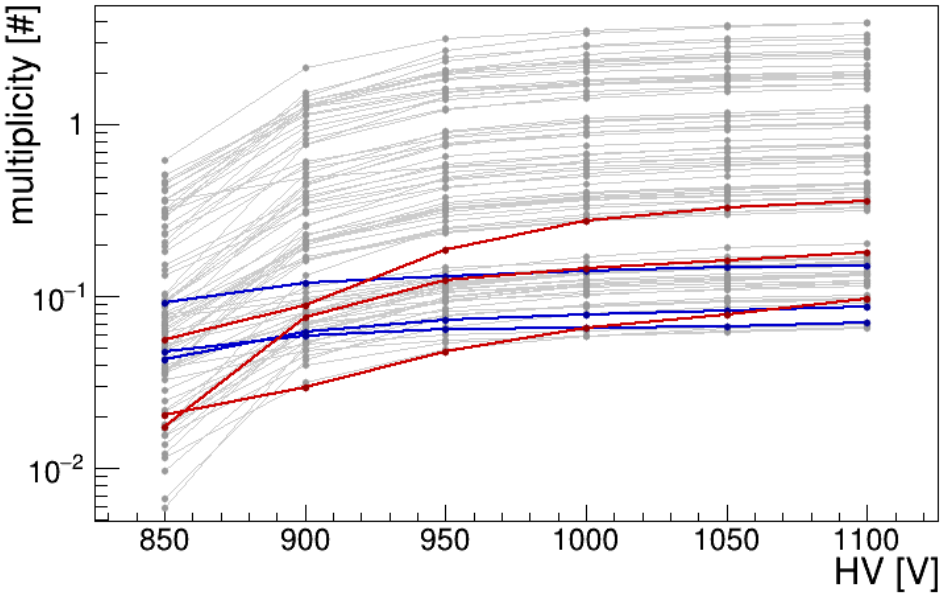


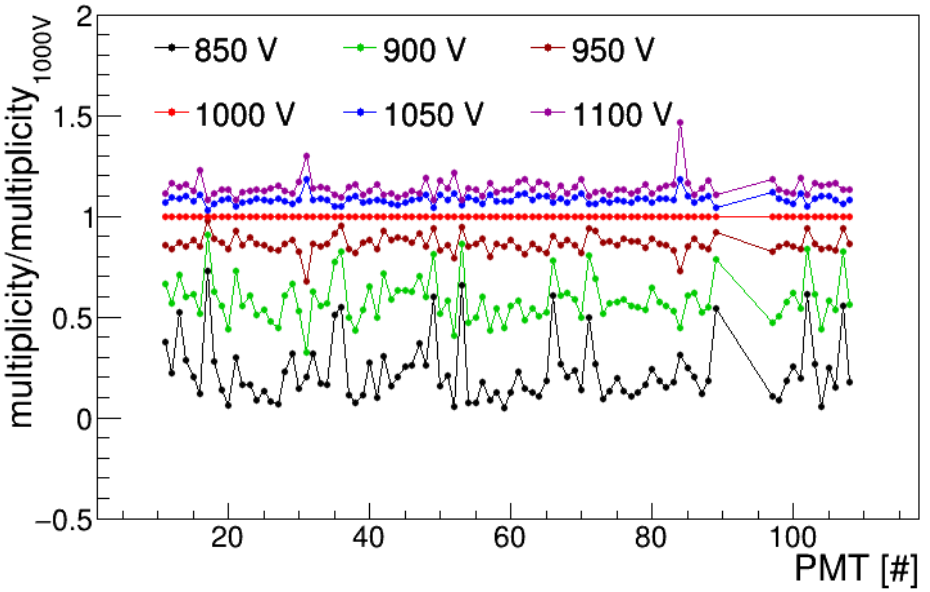


➡ offset 100 was used for most of the data; 1B triggers were collected @ 50, 200

HV scan

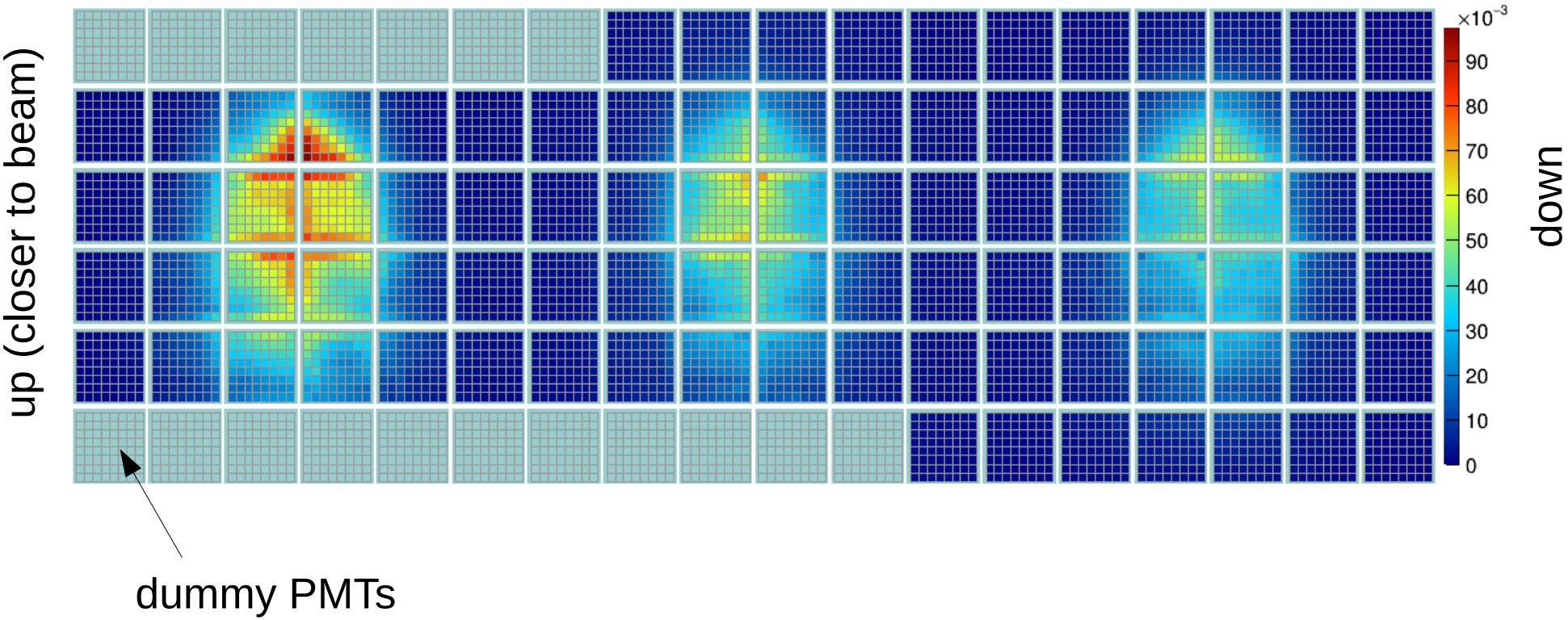
Relative multiplicity as a function of the PMT number and HV value:





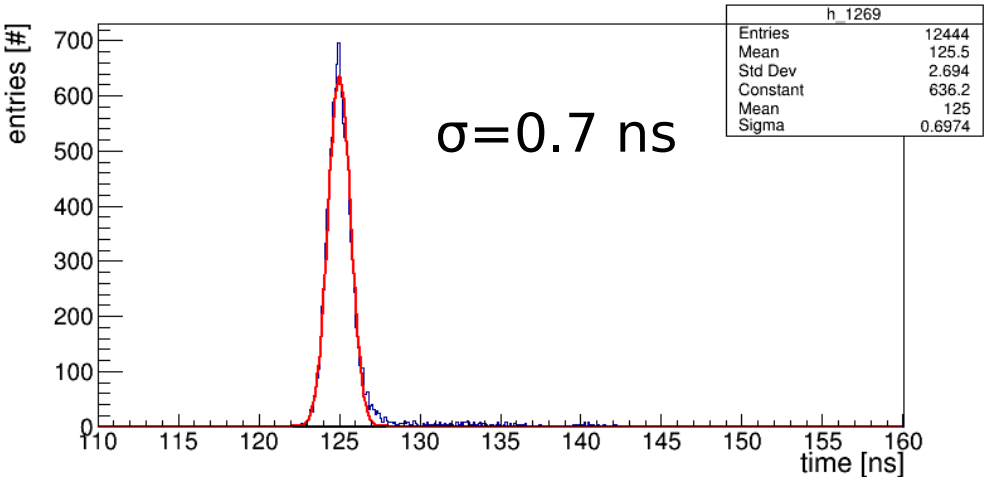
➡ 1000 V was used for most of the data

LED Hit Pattern

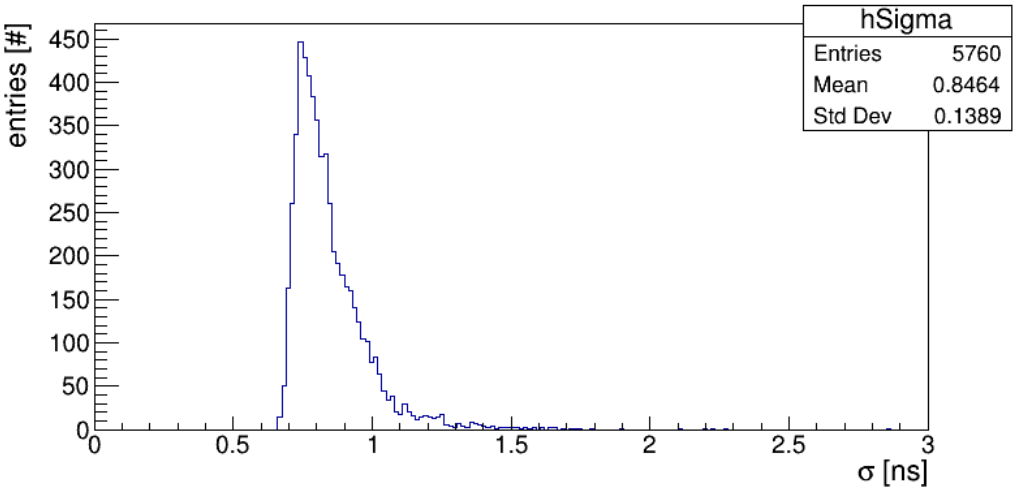


Time resolution from LED data

Example of time distribution for ch 1269:

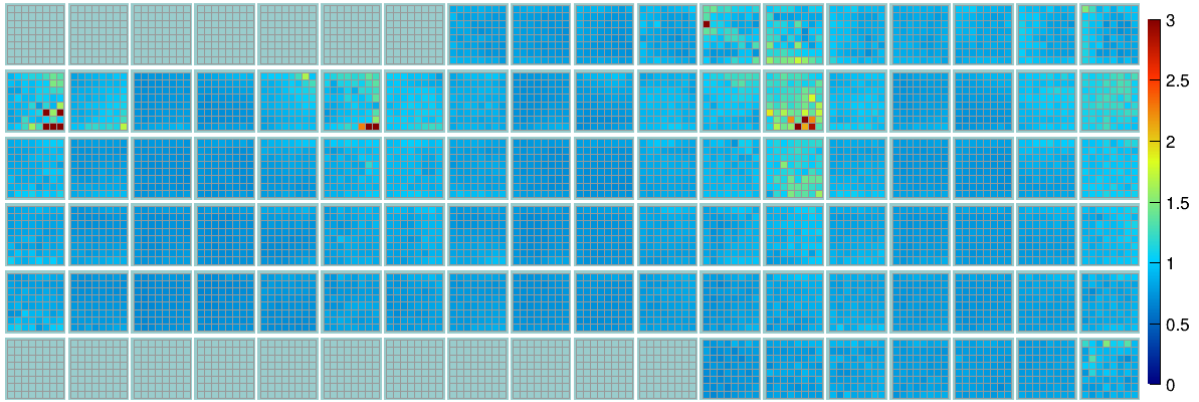


Resolution per channel after walk correction:

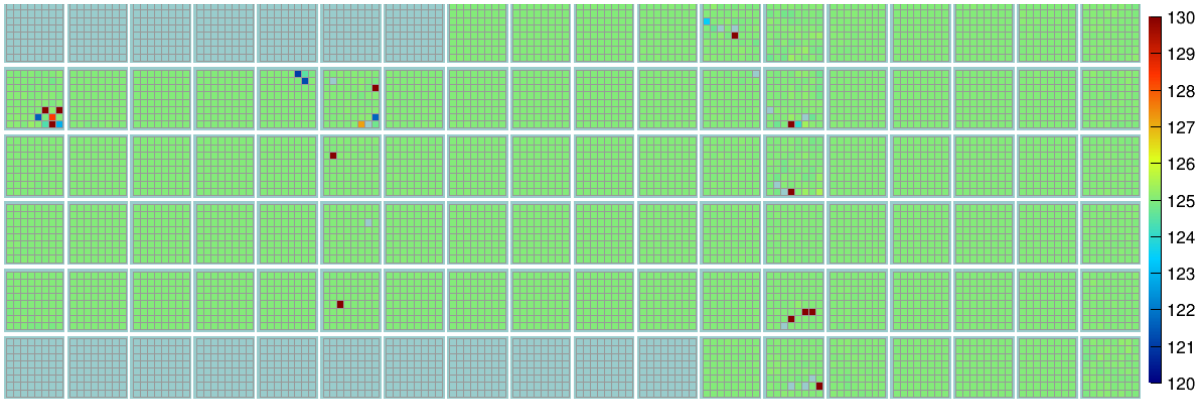


➡ mean resolution 0.8 ns

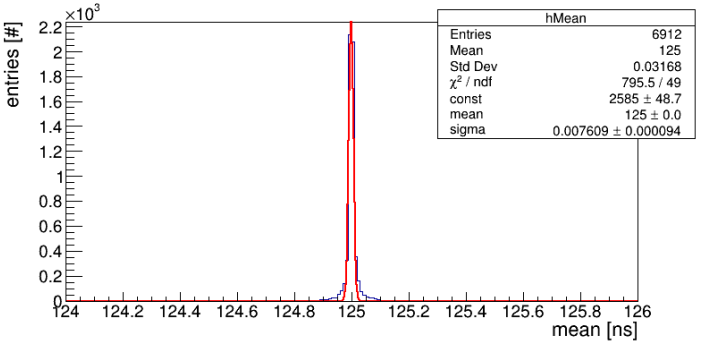
Time resolution from LED data



Time resolution [ns]

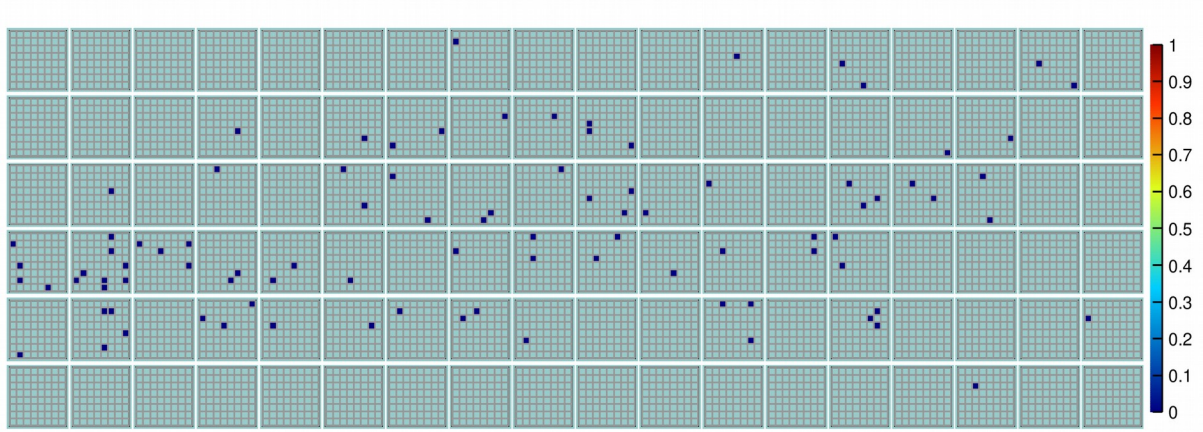


Time offsets [ns]



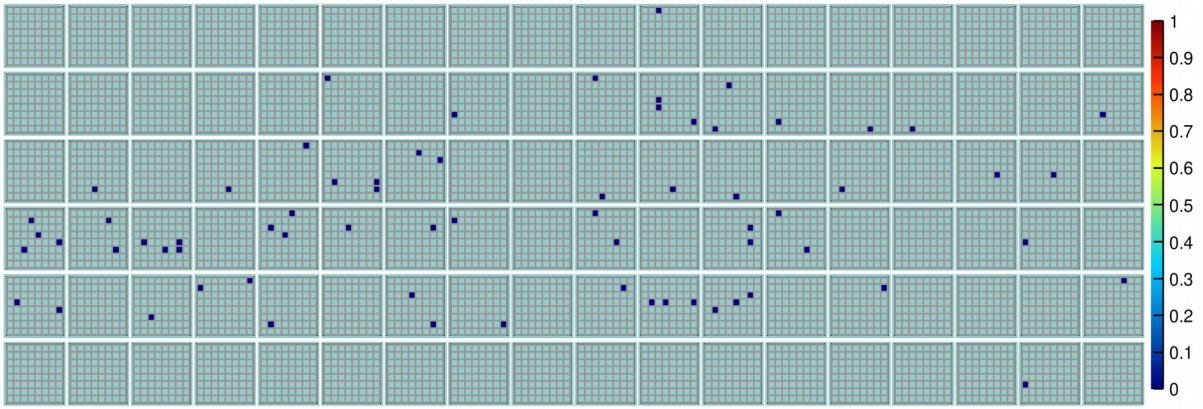
Good start time alignment

Single Event Hit Pattens



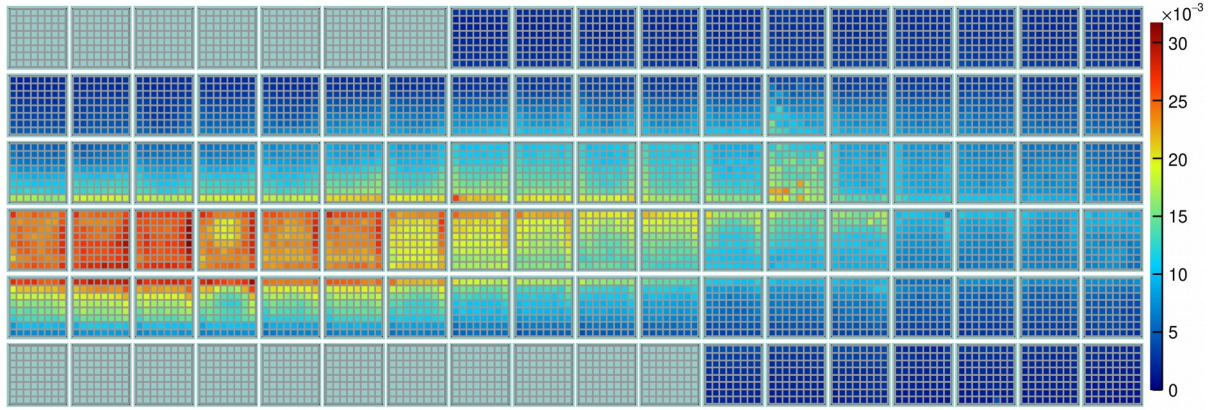
beam data, PID based on reconstructed ρ,φ events

pion

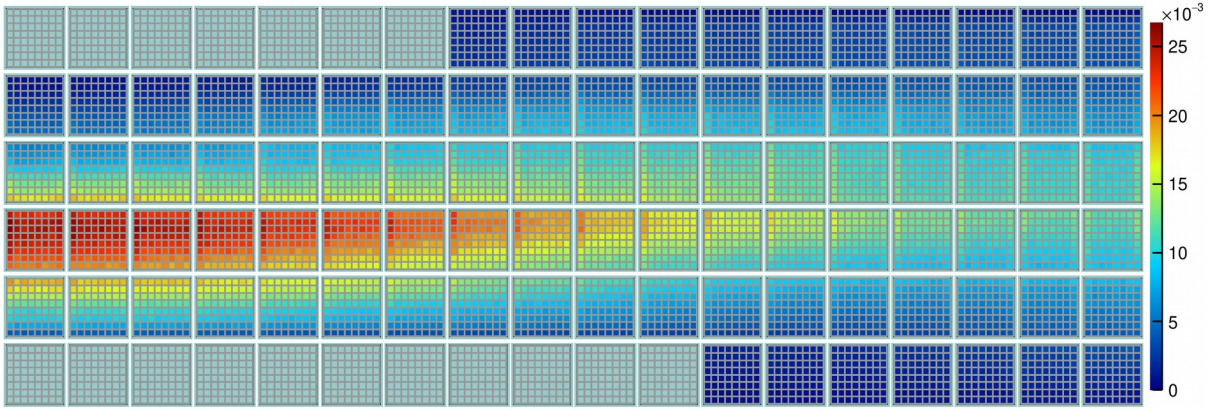


kaon

Hit Pattern Accumulated for All Angles



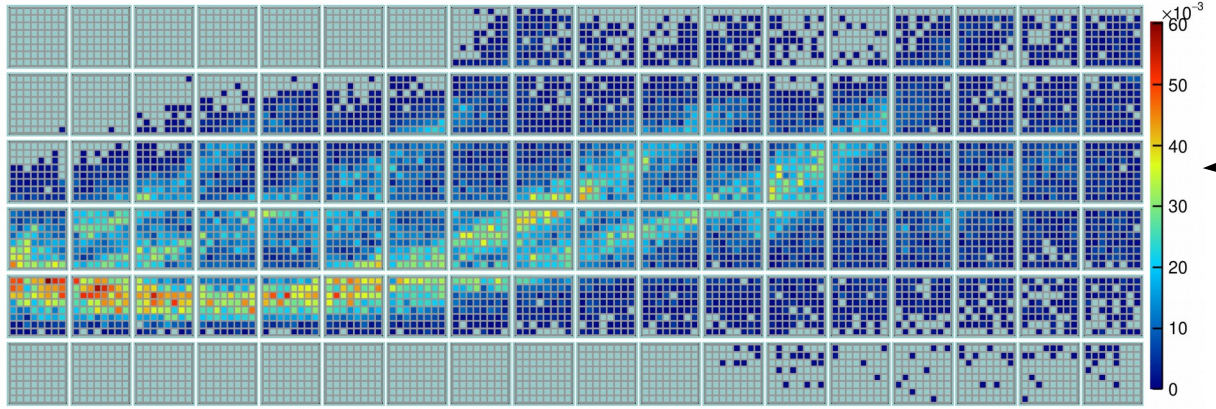
beam data



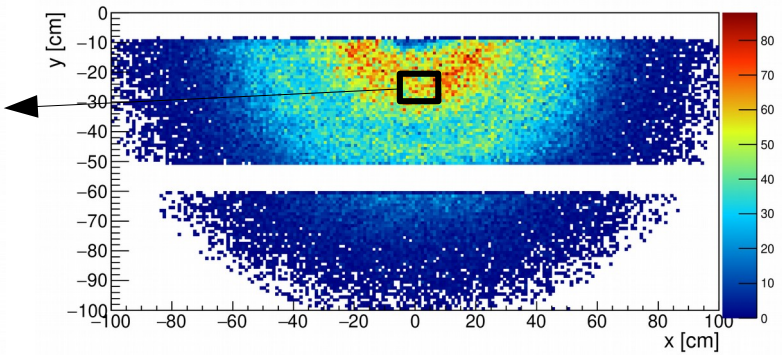
geant4

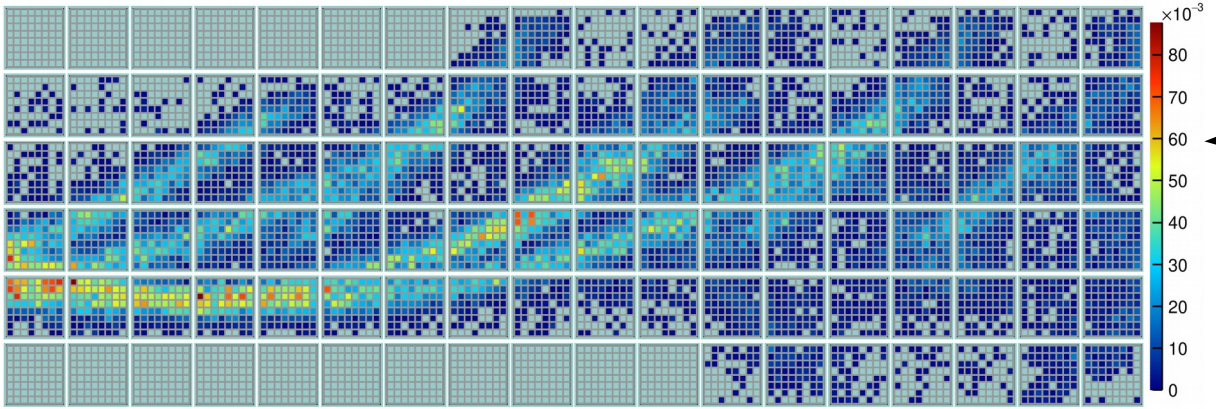
Hit Pattern

[3.8,4.2] GeV/c pions from beam

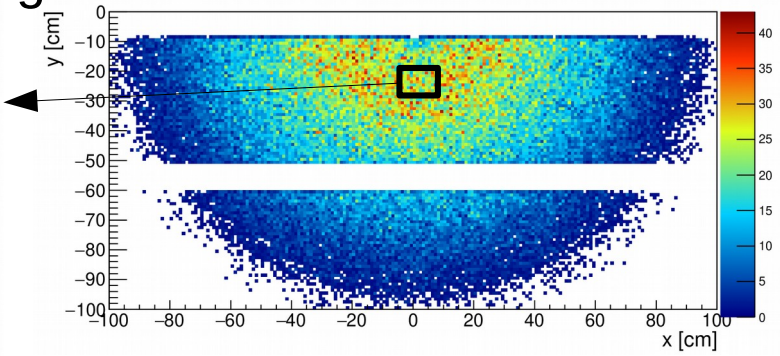


Hit positions on the radiator wall:

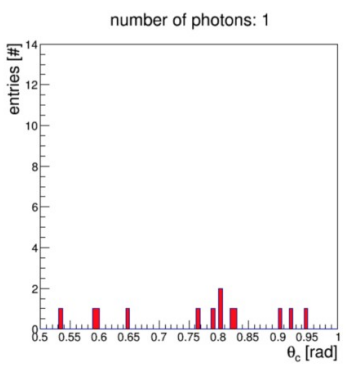


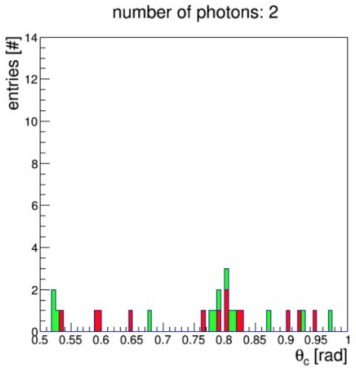


geant4

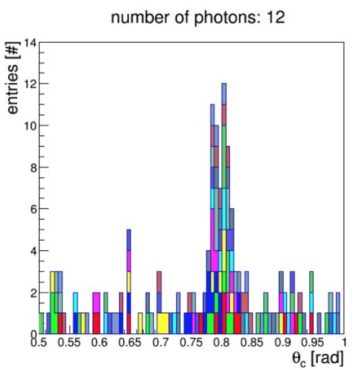


Geometrical Reconstruction





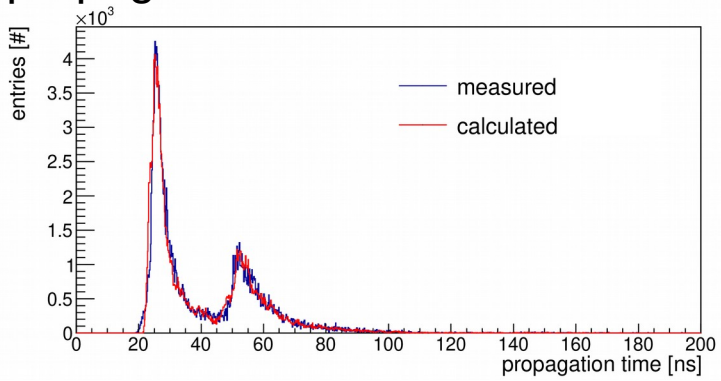
...



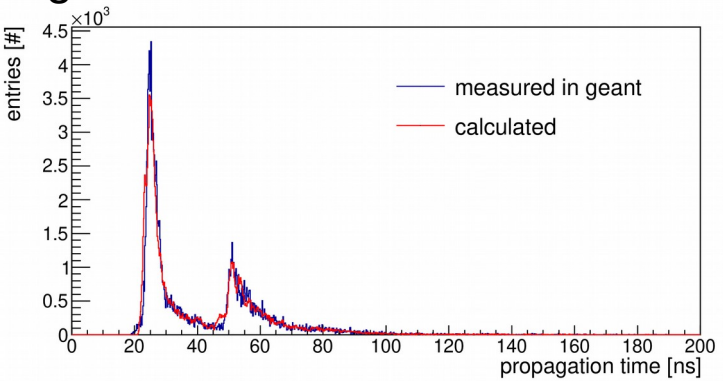
- Geometrical algorithm determine θ_c using Look Up Tables
- PID performed by unbind likelihood fit of the determined θ_c to different mass hypothesis

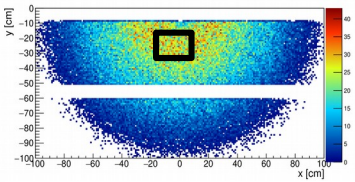
Geometrical Reconstruction

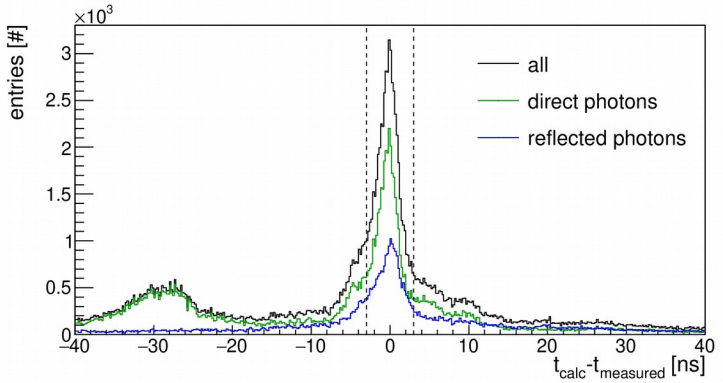
propagation time: beam data

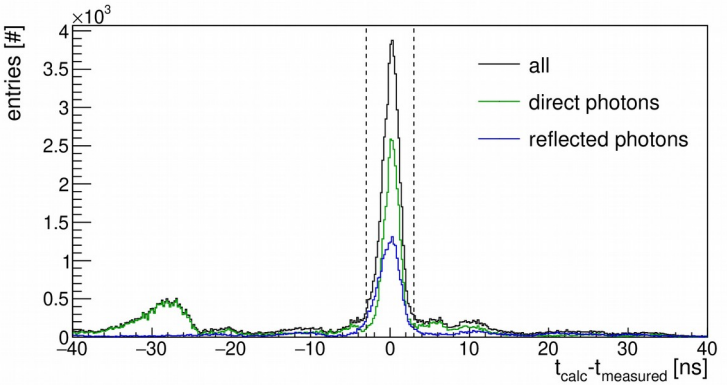


geant4 simulation:



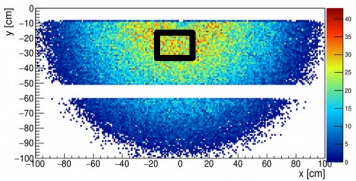




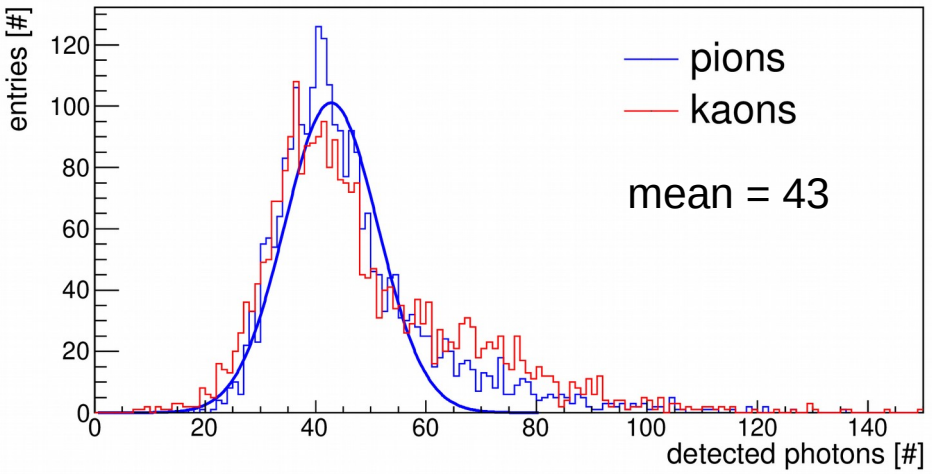


Reconstructed Photon Yield

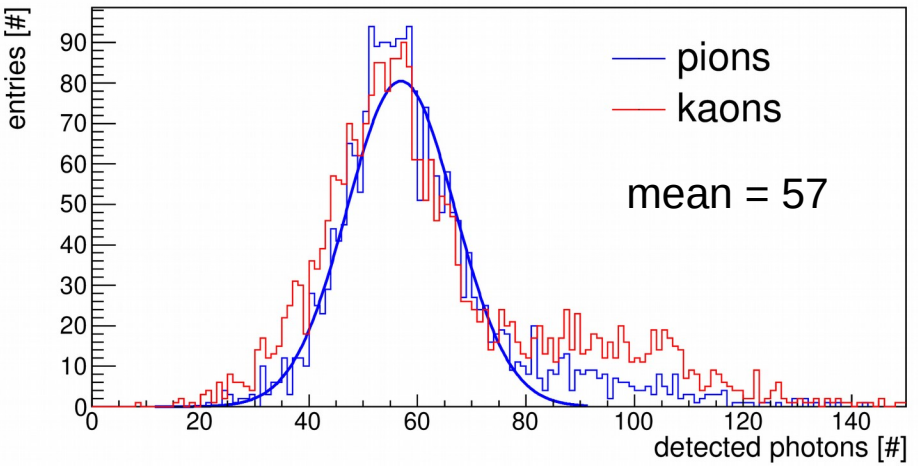
pions and kaons @ [3.8,4.2] GeV/c:



beam data



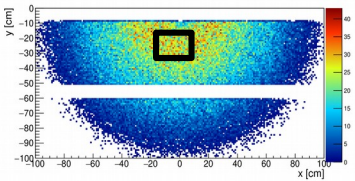
geant4 simulation:

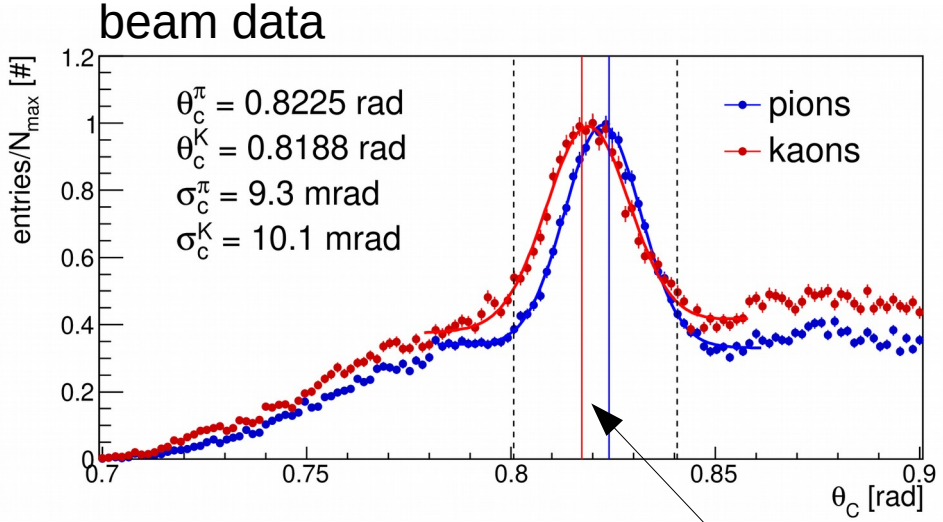


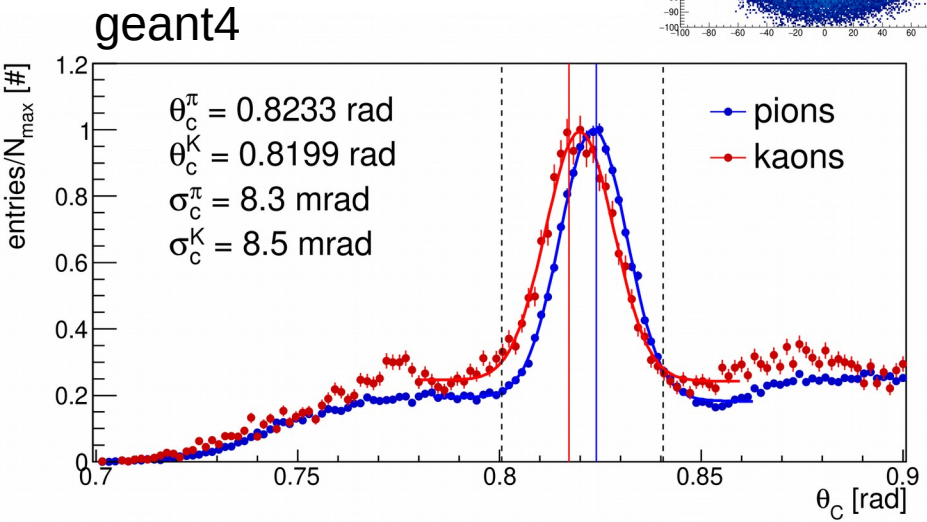
➡ high photon yield but still some discrepancy with simulations

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

- 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

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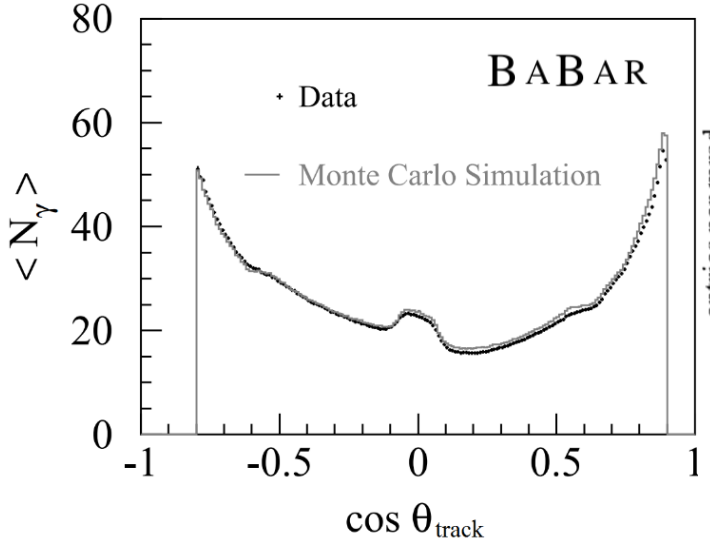
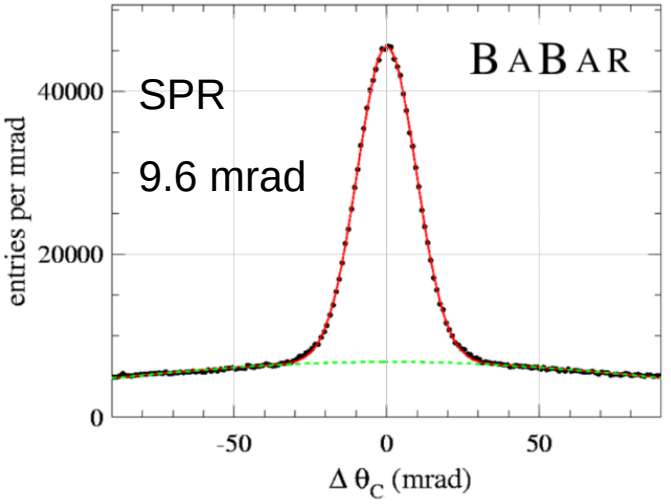
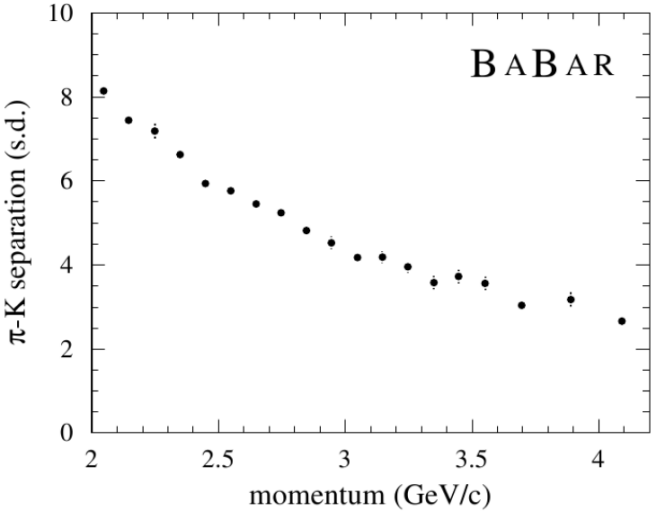
Thank you for the attention

Expected Performance

Based on BaBar results:







=> 3 s.d. π/K separation up to 4 GeV/c (2.4 mrad Cherenkov track resolution)