Proposal to add laser Calibration/Monitoring part to the GlueX FDIRC

GlueX PID upgrade meeting Februar 2016

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Outlook

- What type of Calibration/Monitoring systems are around
- Our experience with PANDA DISC DIRC prototypes
- Our suggestions for GlueX FDIRC
- What we can do here in Giessen
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Calibration/Monitoring systems

Probably the most complete one of such a system was built for ATLAS Tile-Calorimeter. The three types were used:

- Charge injection to check FEE
- Laser pulse injection, to check photon detector response
- Radioactive source for a long term gain control

For a Laser pulse system they report 0.5% precision in PMT gain control

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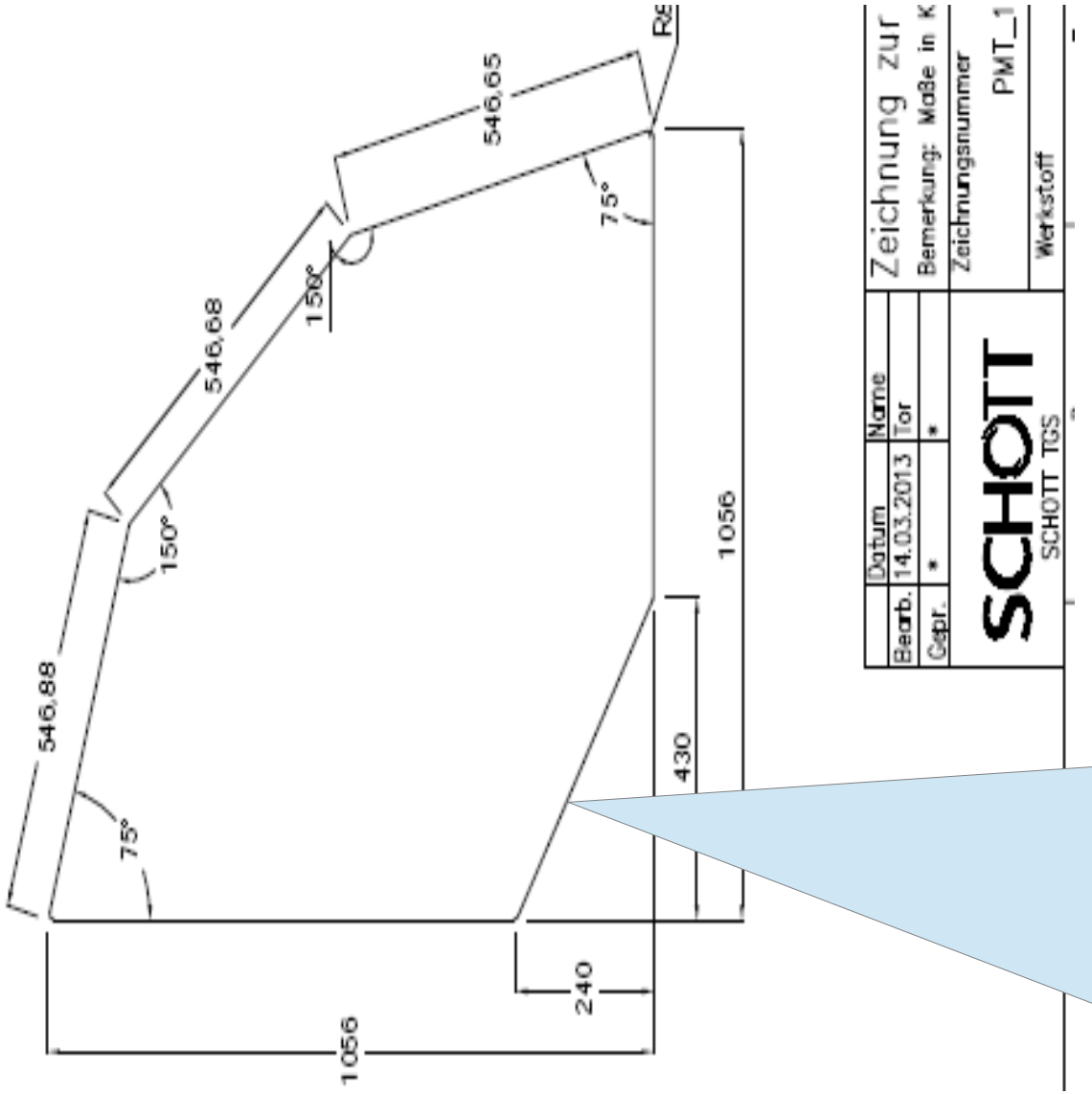
Laser calibration/monitoring systems are foreseen for PANDA DISC and Barrel DIRC's

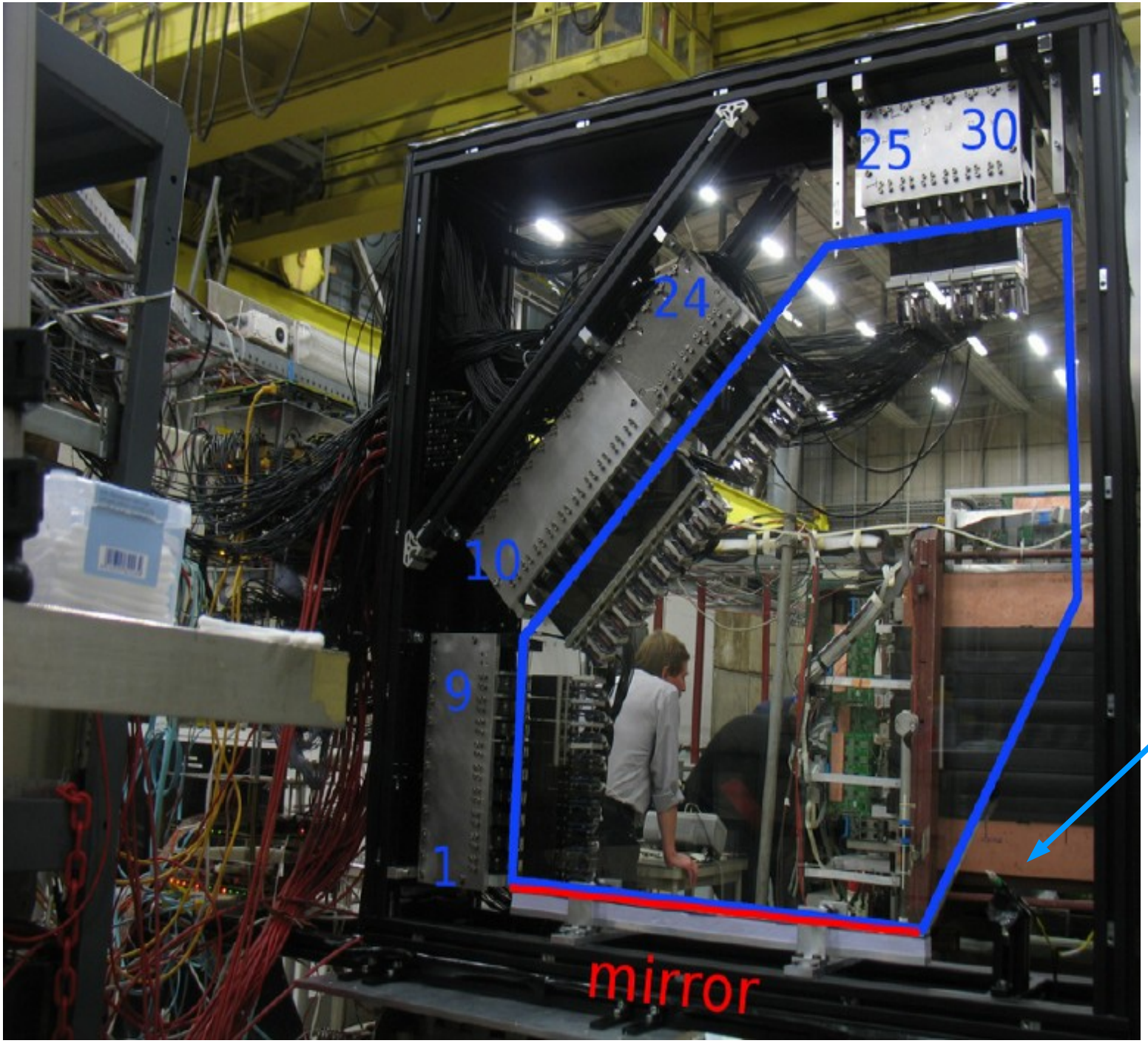
For the BELLE2 iTOP is also similar system is under construction/built

Our experience, full size(PANDA DISC DIRC) fiber shinning inside Disc



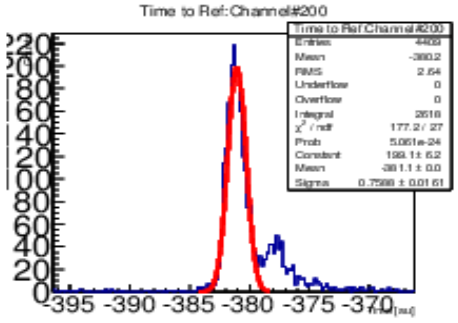
An “multi-mode” fiber coming from Laser shinning in a “diffuse” way inside Disc should hit every channel of photon detector producing
A signal that is sensitive to the Disc and photon detector characteristics

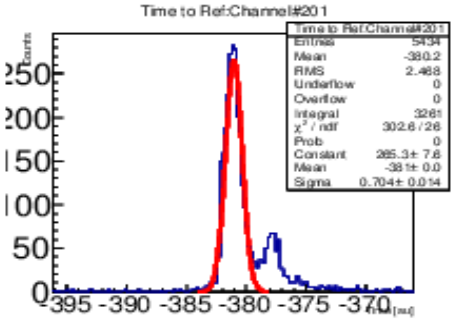
Exercising on Prototypes

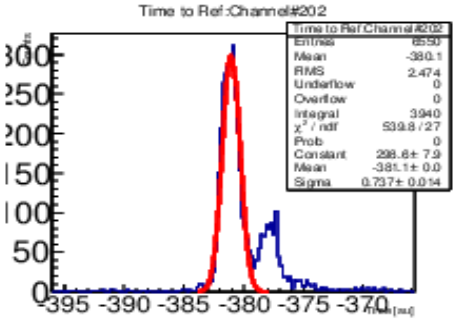


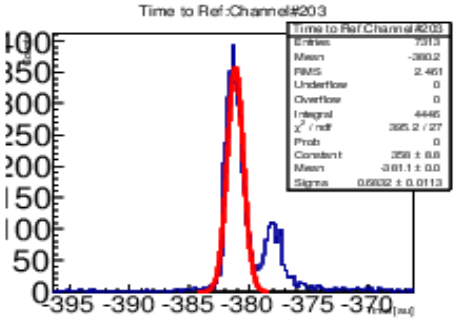
PiLas Laser fiber

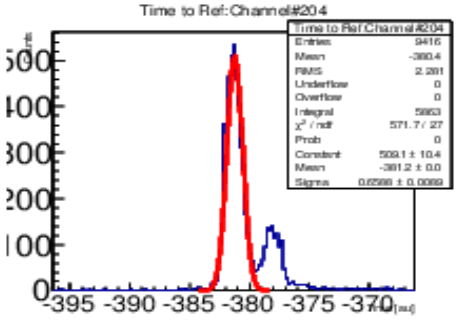
Time spectra pro PMT

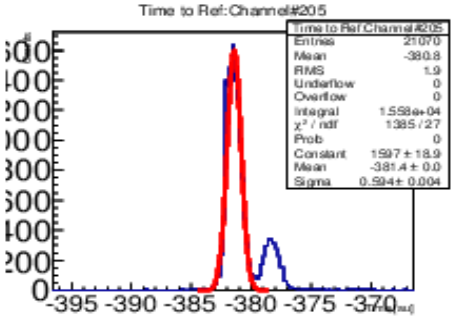


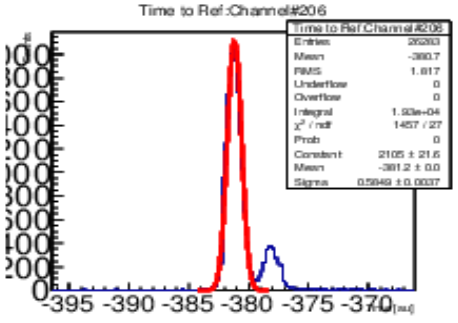


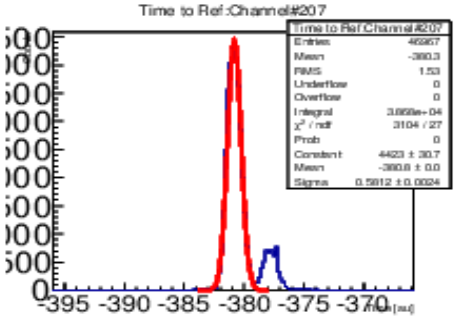


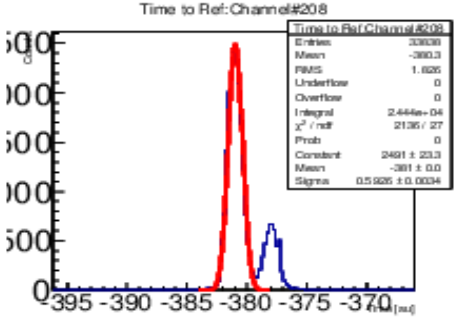


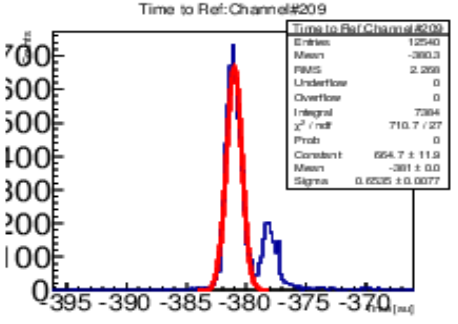


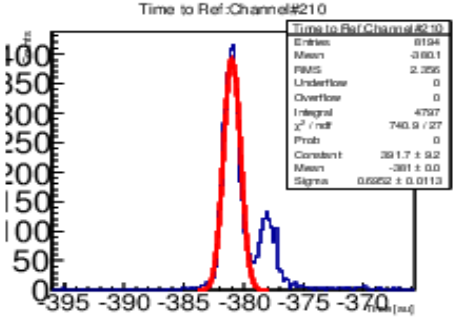


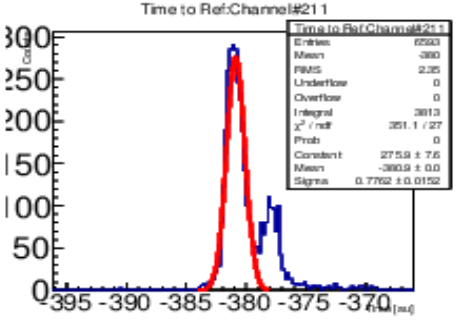


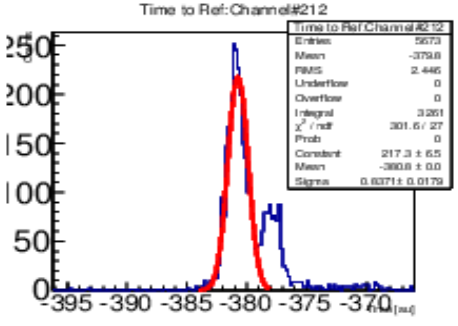


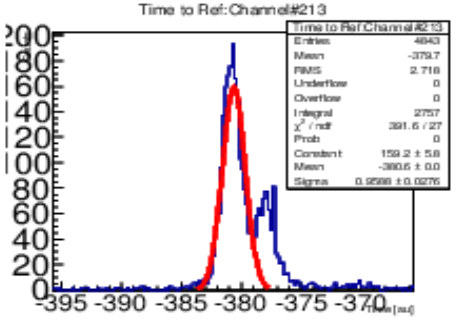


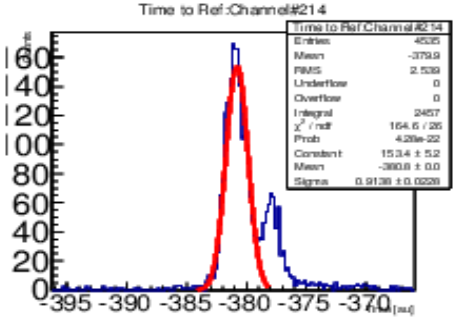


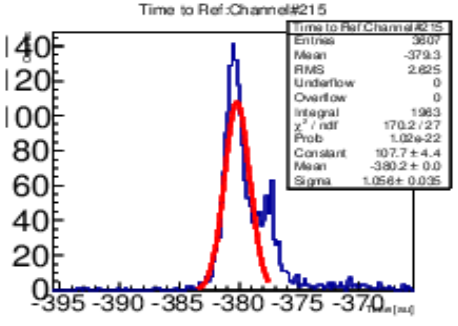




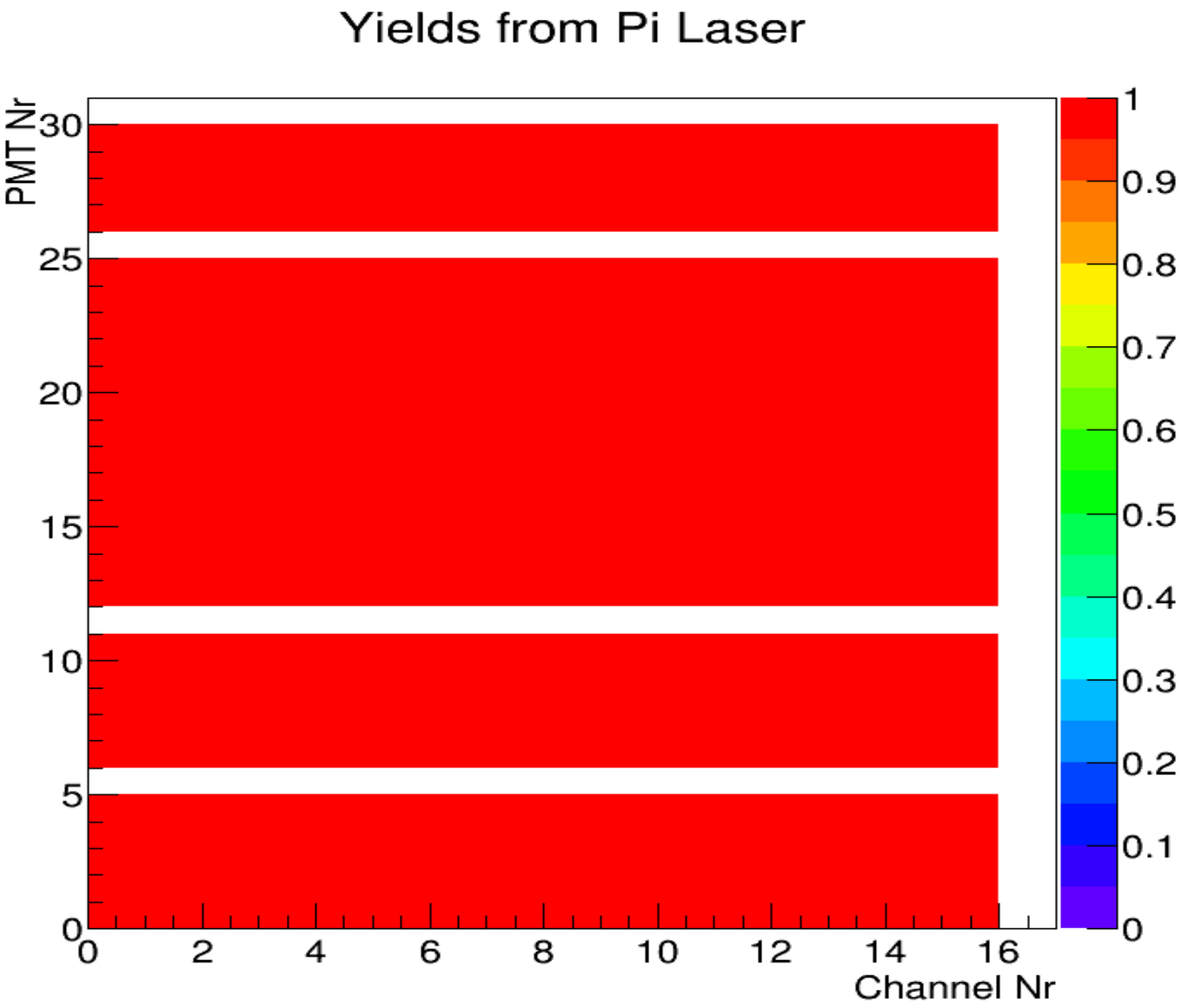








Functionality of DISC CERN Prototype checked by LMS



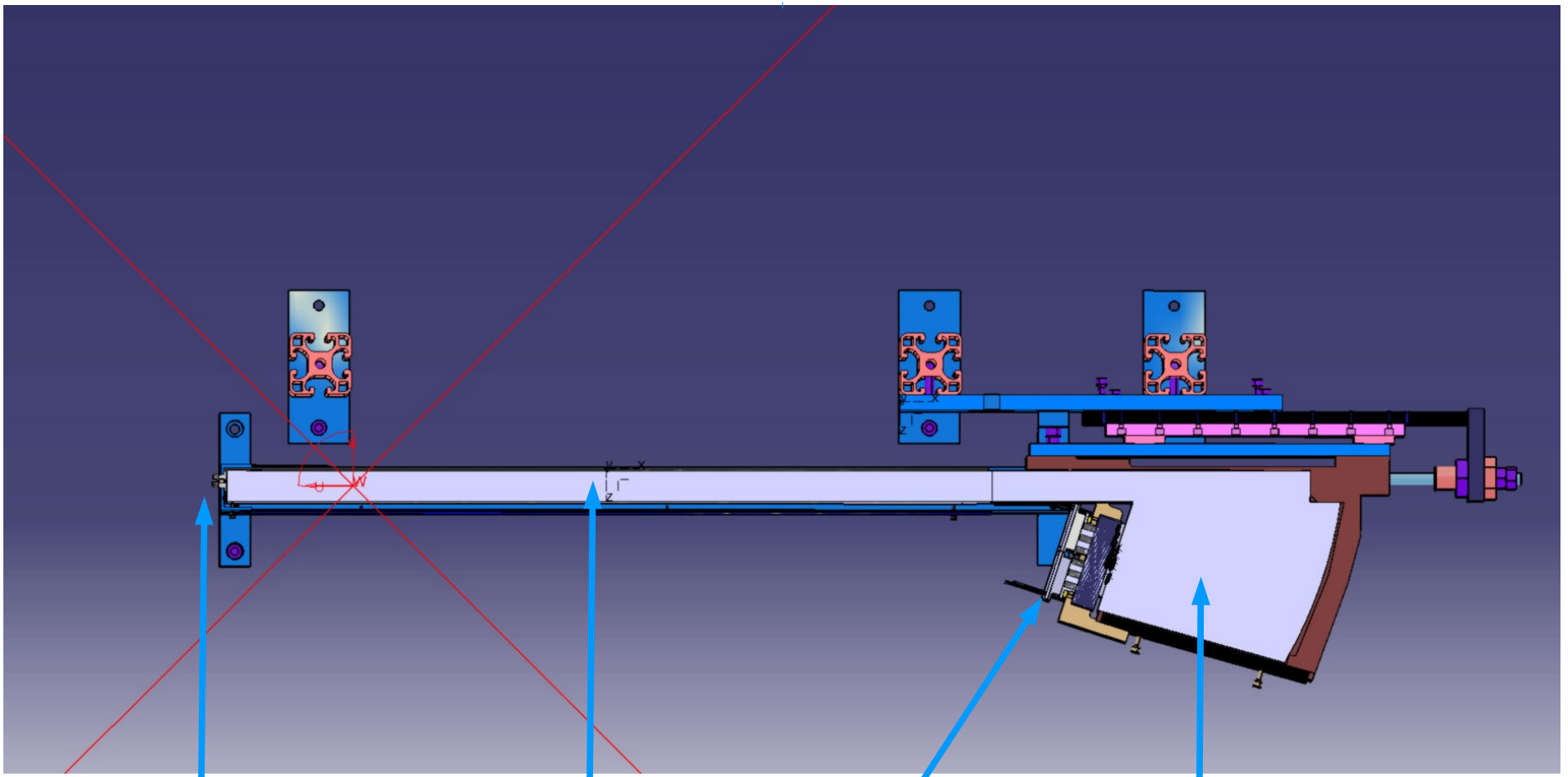
-If Chn. Contains >1k Events === 1

-one can monitor the Peak position. i.e. Calibration

-Peak width, i.e. Chn. Quality

-Peak Integral, i.e. Radiator+Photon Detector stability

Laser system on DISC DIRC upcoming prototype



Fiber connector Quartz radiator MCP-PMT Focusing element

Our suggestion for FDIRC

- Build similar Laser Monitoring System(LMS) as we have for our prototypes, but adjusted for HallD with goals:

- Check the stability of the time for every readout channel
-
- Check the stability of the gain for each readout channel
-
- It should be possible to measure the detector surface acceptance and create weights in PID ML estimation

Our suggestions for GlueX FDIRC

- With hardware PiL040, single mode(SM) multi mode(MM) fiber('s), water tight feedthrough('s) diffuser('s)(optional)

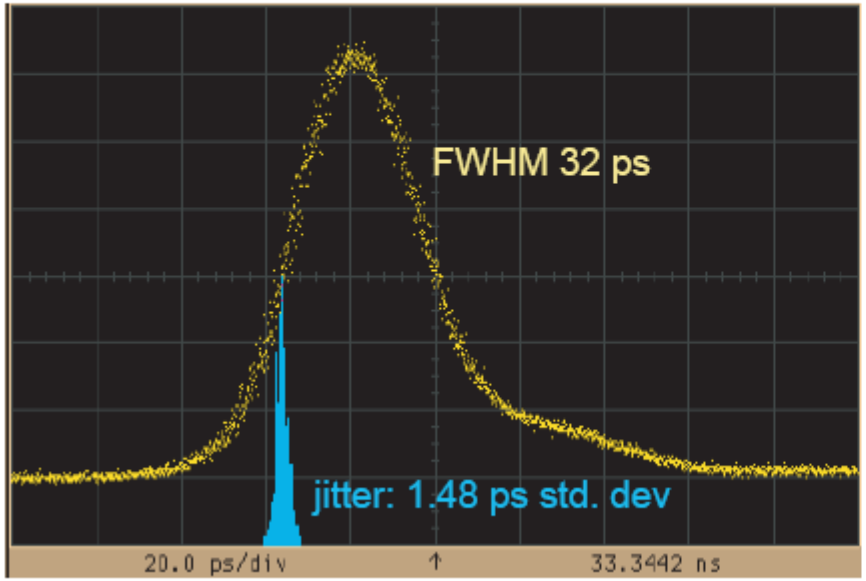
Hardware needed for

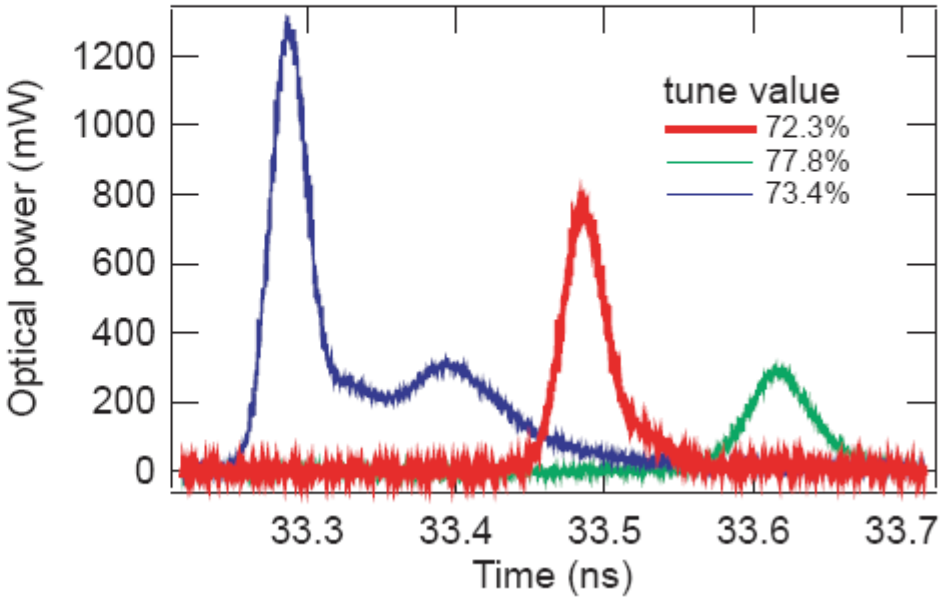
1) - Picosecond pulsed laser (λ~405nm considering the Cherenkov light properties and PMT QE);
2) single mode (SM) fiber ~ 10 m length(depending where we allowed to install the Laser
3) at the end of the SM fiber one multi mode (MM) fiber bundle
   ~ 1 m length(depending where we can install the Reference counter)
4) Reference counter in location where external influences(mag. Field, temperature change, etc) are minimal

PiLas Laser

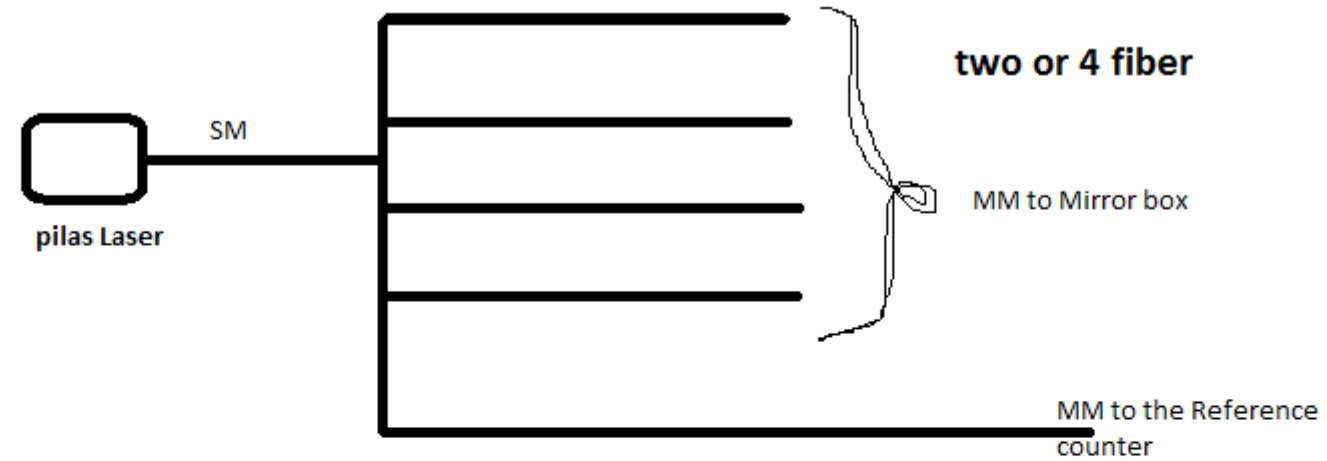
Sample data of a PiLas with center wavelength of 405 nm (PiL040)

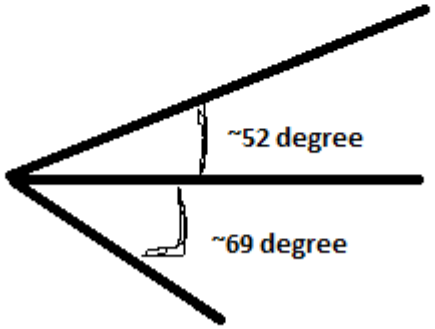
Sampling oscilloscope data





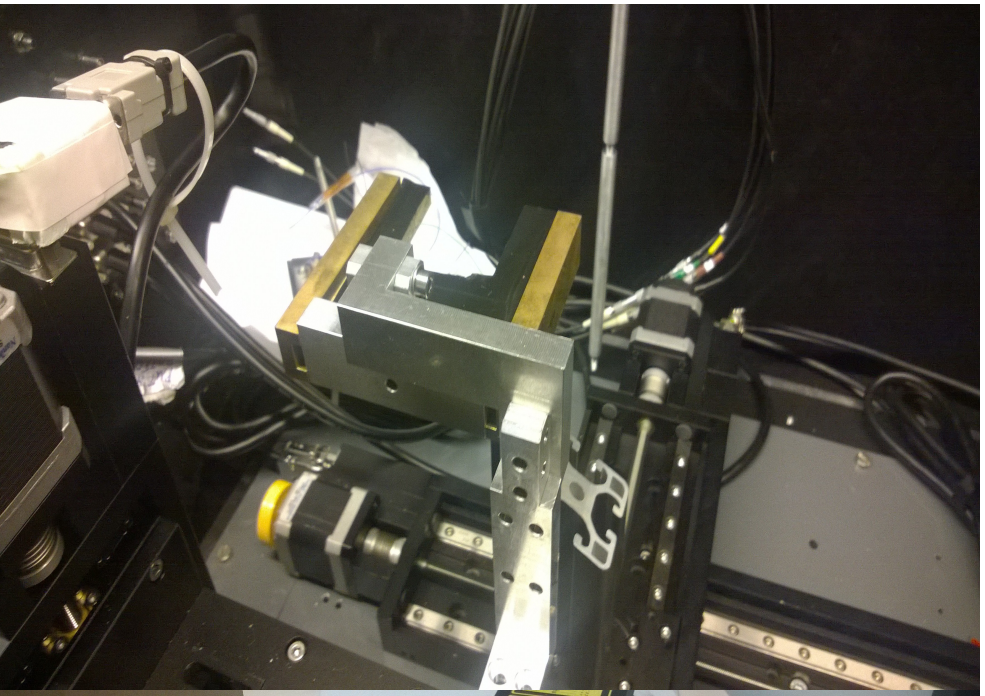
Possible schemes of Laser splitting

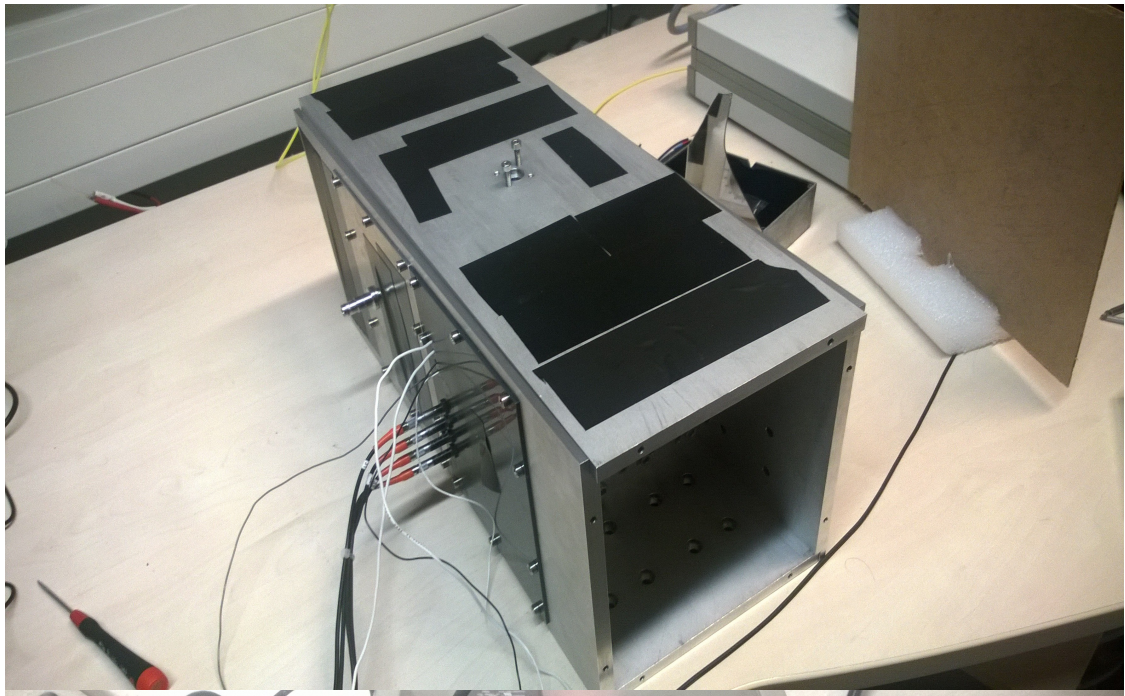




In case of twoo light source for each Mirror box those angles will be ~38 and ~52 degree enabling to buy standard fiber and avoid diffuser

What we can do here in Giessen





What we can do here in Giessen

- We have(top left) dark box with step motors, where laser profile one can measure after fiber(CCD), currently we focus the laser light(less than a few um) the spot to check resolution of Photonis(0.5mm)/Hamamatsu(0.35mm) MCP
- Black box(top right) where we have permanent magnets installed to check its effect on photon detectors
- Our PiLas laser(bottom left) , similar one we want to have for FDIRC
- Waveform digitizer(SAMPIC) for 16 channels, to save and analyze response of Photon detectors, currently it is accumulating data from our Cosmic station(scintillating telescope allowing to define muon track) as a “testbeam”

Backup goes from here

If we are lucky maybe in 2018 we will see the “Cherenkov” smile(like in next two slides) from FDIRC and multiplicity and better occupancy(another two slides at the end) from FDIRC LMS

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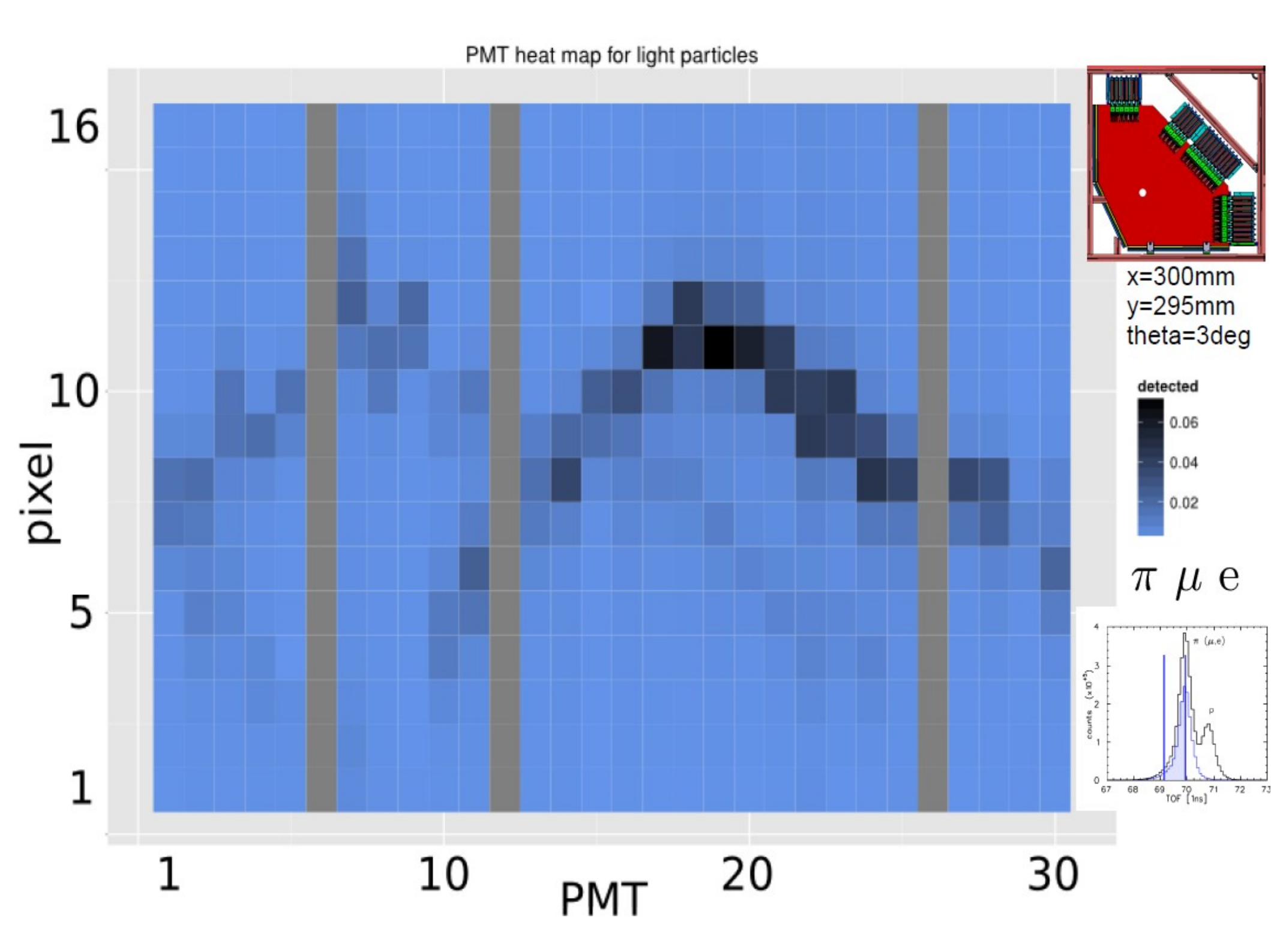
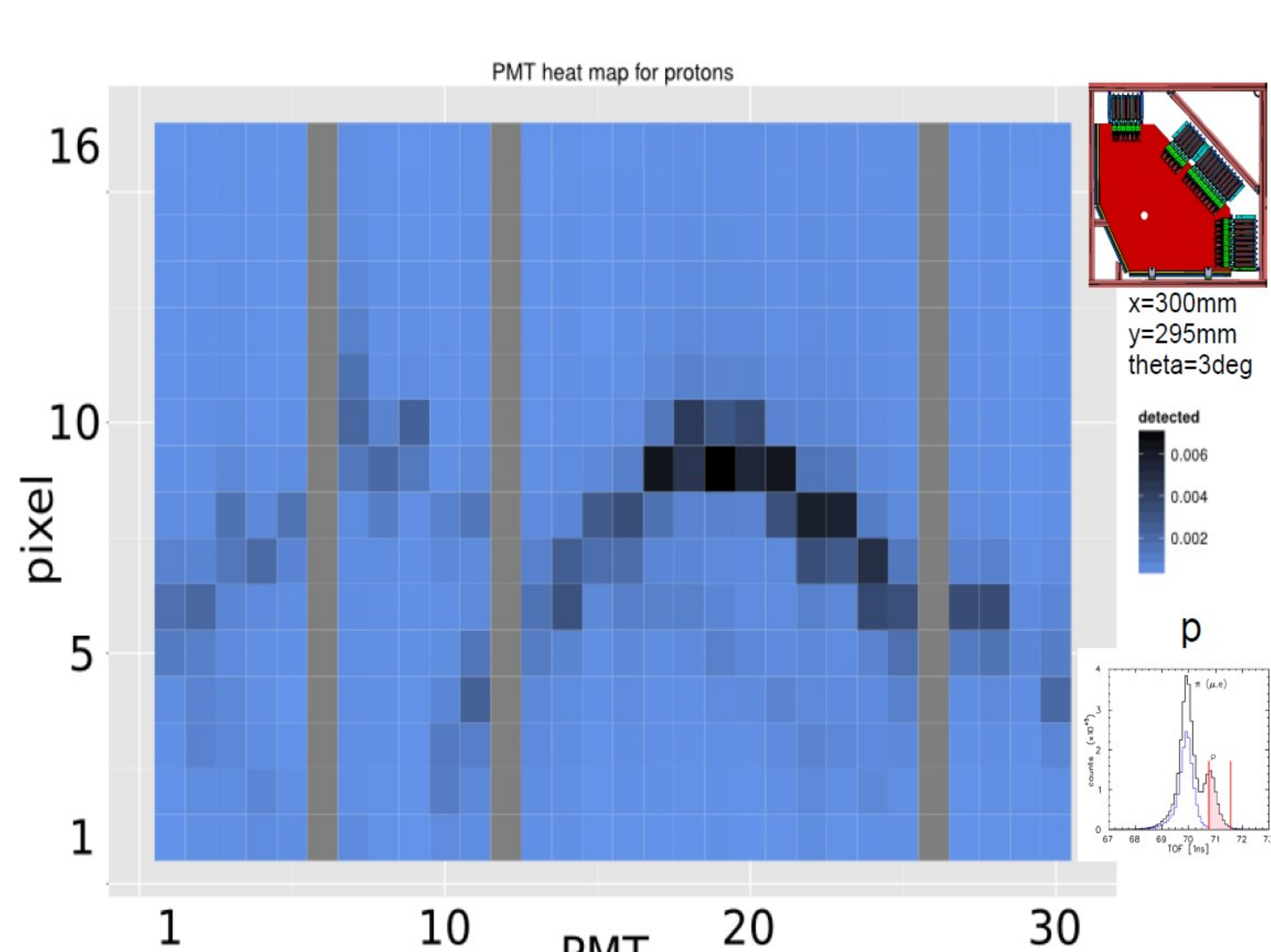
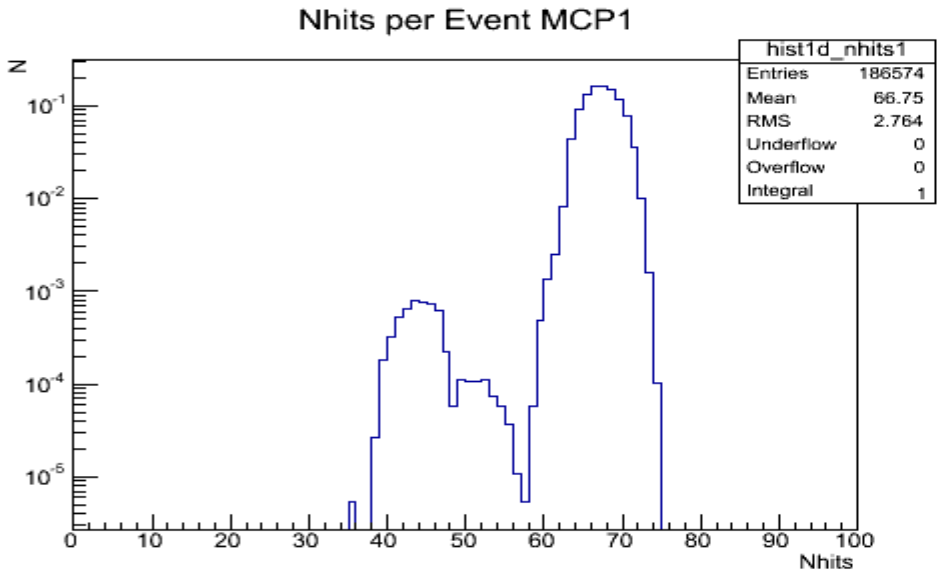
to GlueX being «open source» Project

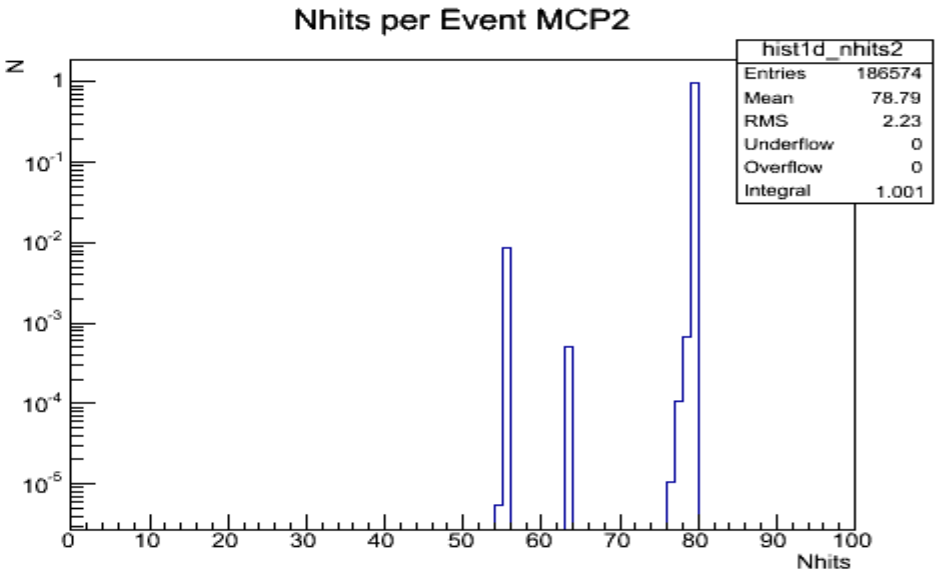

PMT heat map for light particles
16
10
5
1
pixel
1
10
20
30
PMT
x=300mm
y=295mm
theta=3deg
detected
0.06
0.04
0.02
π μ e
counts (x10^3)
π (μ,e)
p
TOF [1ns]

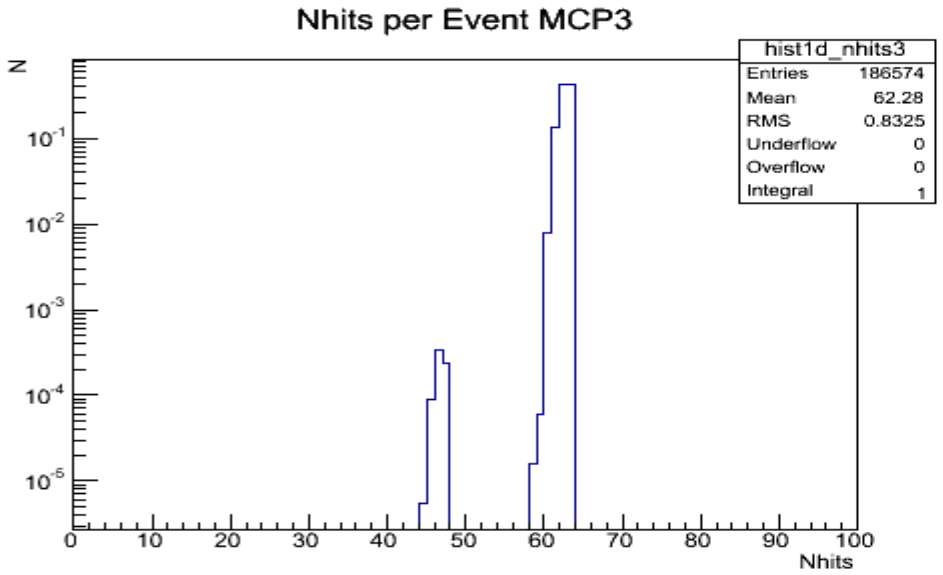

PMT heat map for protons
16
10
5
1
pixel
1
10
20
30
PMT
x=300mm
y=295mm
theta=3deg
detected
0.006
0.004
0.002
p
counts (x10^3)
TOF [1ns]
67
68
69
70
71
72

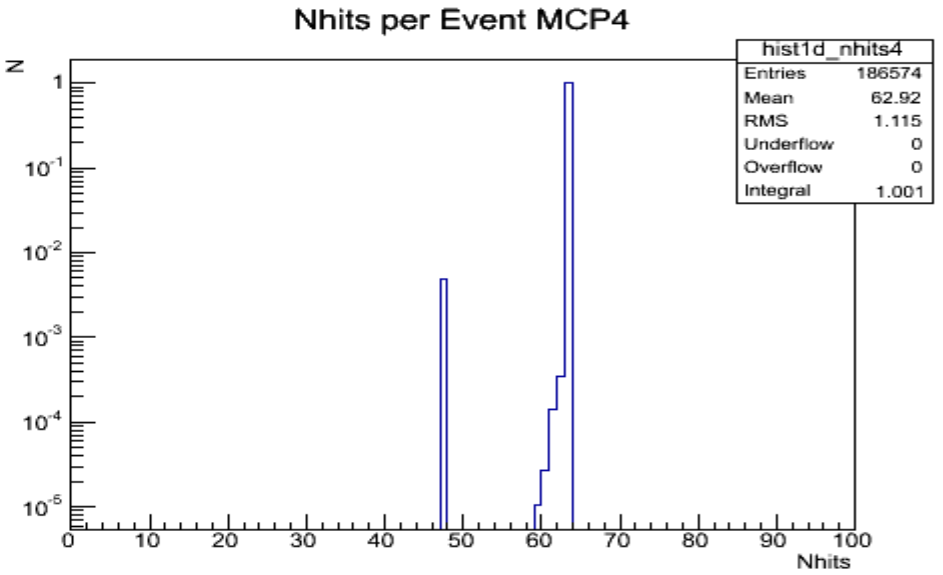
nice hit occupancy from Laser

we are missing only 10 channel from Photonis









Almost all channels response equally