HTCC update

CLAS12 software workshop

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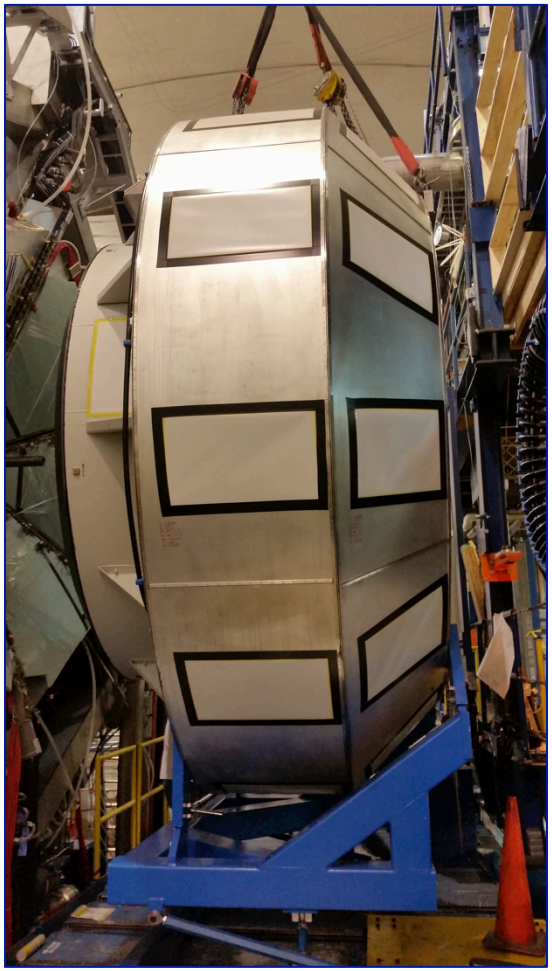
Outline

- HTCC overview
- KPP run
- Simulation
- Calibration
- Reconstruction
- Data analysis
- Current results
- Future steps

HTCC

In transit

In the Hall

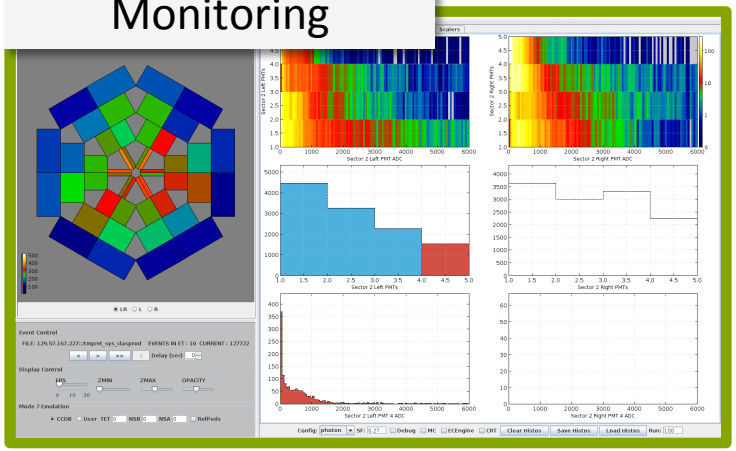


<u>High Threshold Cherenkov Counter</u>

Purpose:	e/π sep.
Radiator Gas (18.8m^3):	CO_2 (1atm)
Mirror thickness	135mg/cm^2
Pion threshold:	4.9 GeV/c
Number of Channels:	48
Light readout:	5”PMTs (Quartz)
Coverage in θ & ϕ	5^o – 35^o, 360^o

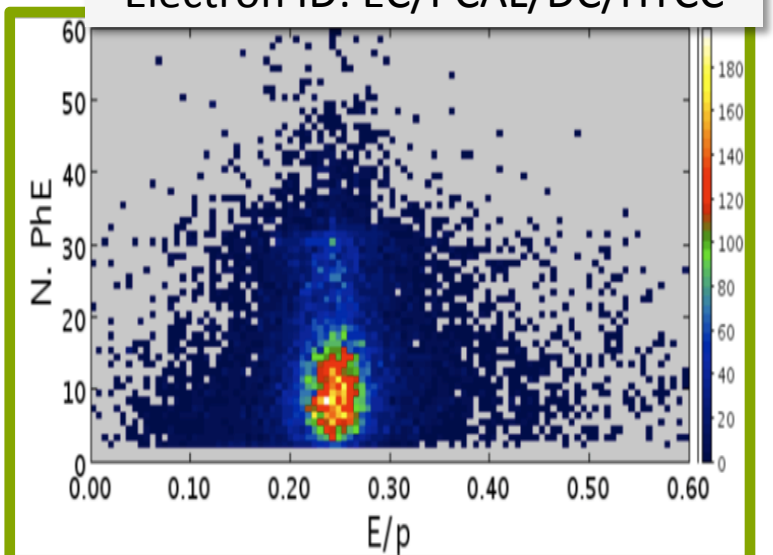
KPP run

Monitoring

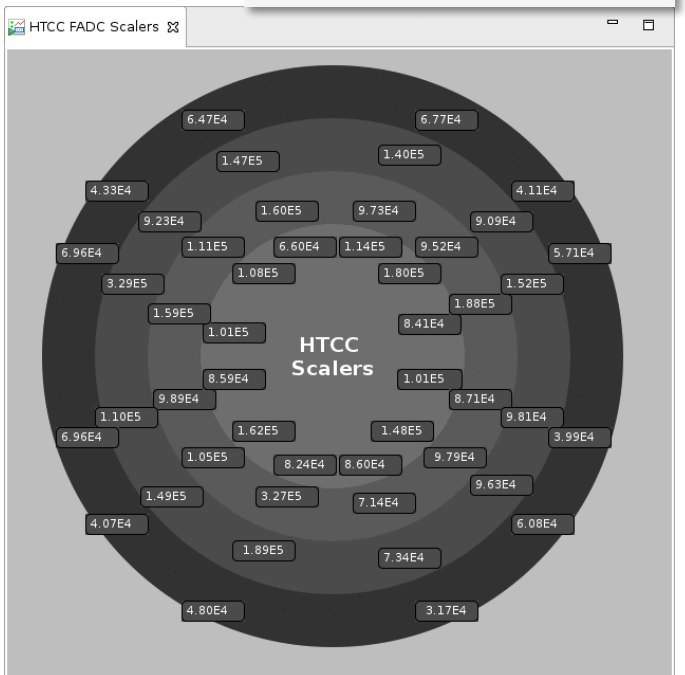


- HTCC was functioning during the whole KPP run period;
- All the systems (HV, readout, gas, monitoring) were working properly

Electron ID: EC/PCAL/DC/HTCC

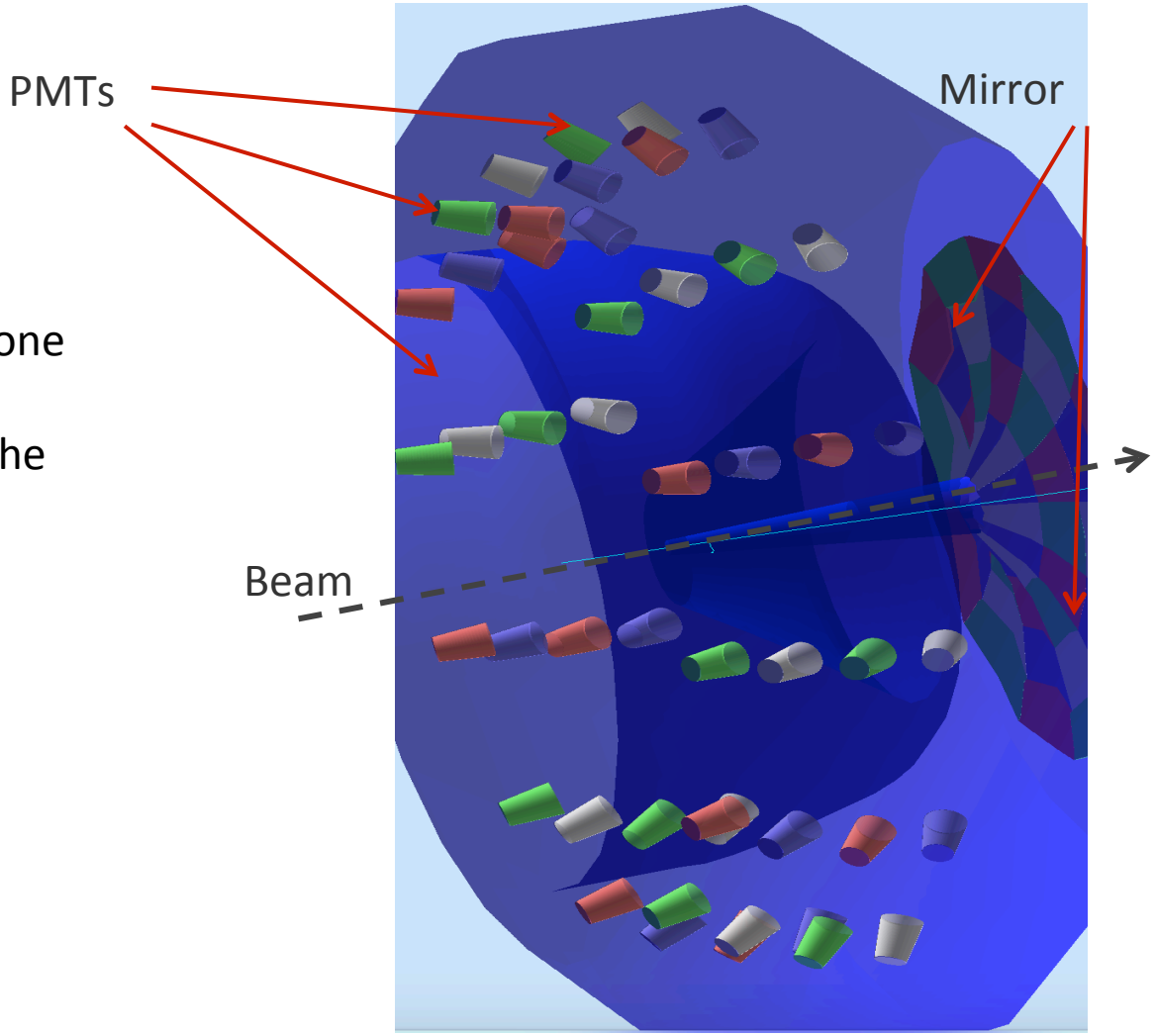


HTCC scalers

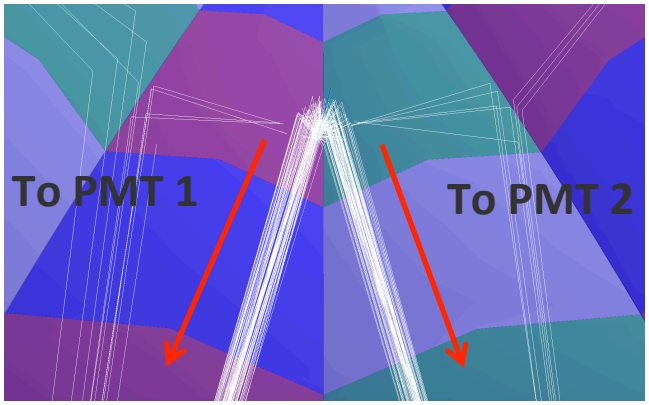


GEMC

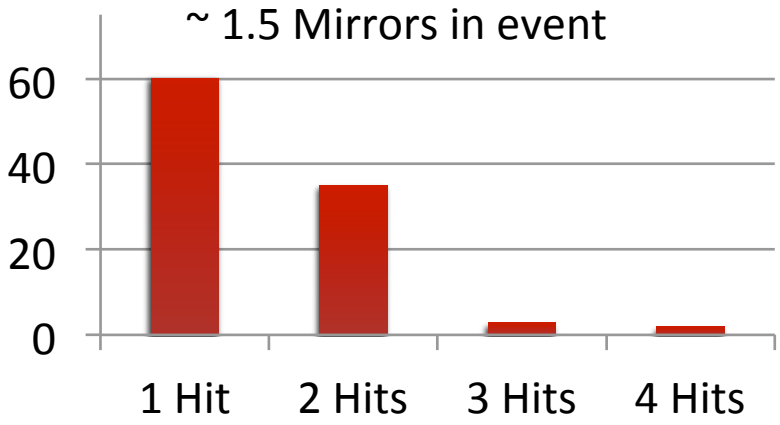
- Full HTCC geometry
- Measured mirror and Winston cone reflectance
- Realistic Quantum Efficiency of the PMT with Quartz Entry Window
- Realistic $C0_2$ gas transparency
- Realistic $C0_2$ gas refraction index



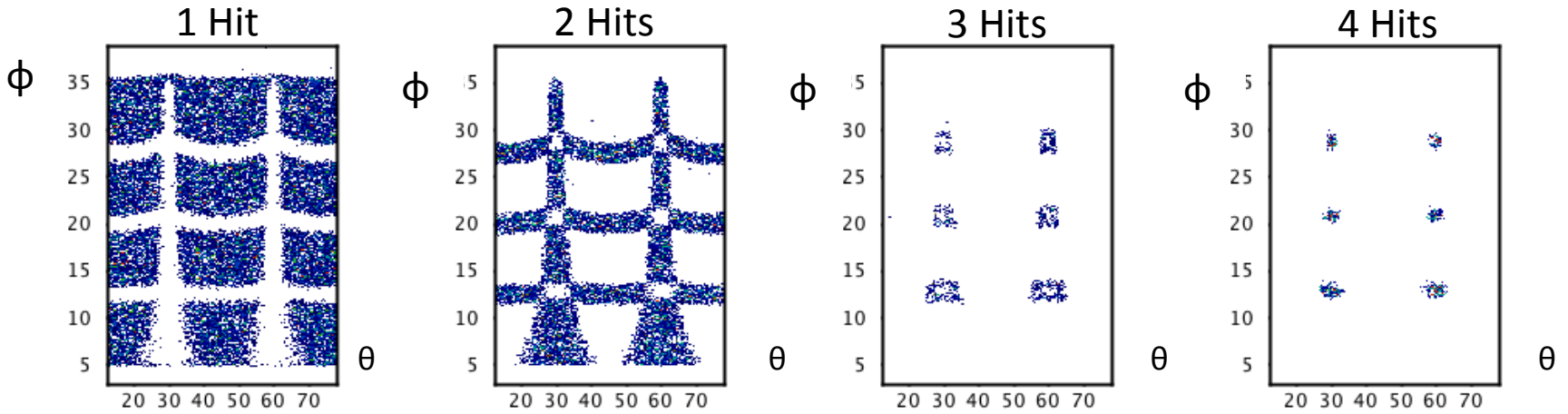
Reconstruction: clusters



Cerenkov radiation from single electron may split between mirrors and is collected by different PMTs



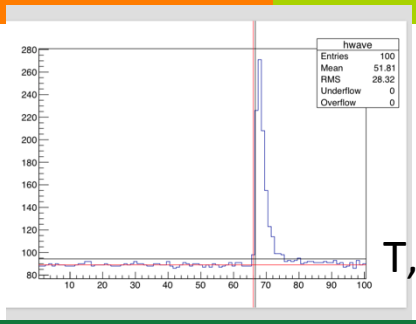
Geometrical pattern of single- and multiple hit events:



Data processing

FADC channel

Decoding



FADC spectrum in time, Mode1

Sector, halfsector, ring

sector	BYTE	4
layer	BYTE	2
component	SHORT	4
order	BYTE	0
ADC	INT	3060
time	FLOAT	136.000
ped	SHORT	103

Calculating pulse size and time based on threshold value

Reconstruction

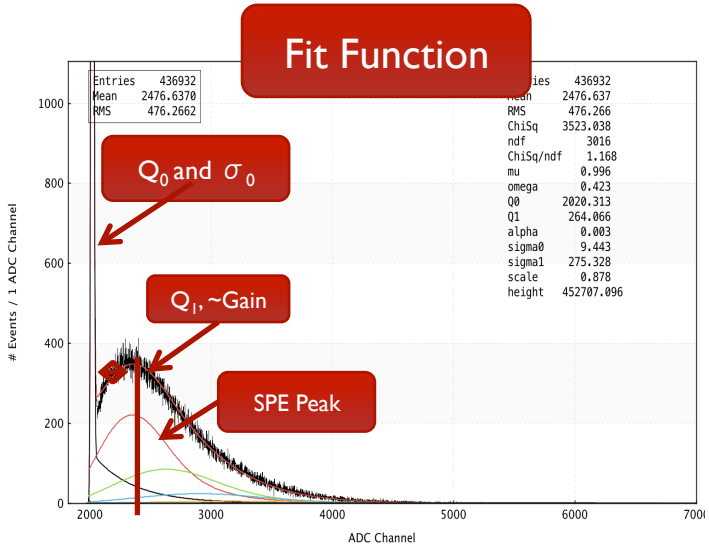
id	SHORT	0
nhits	SHORT	3
nphe	SHORT	44
time	FLOAT	136.632
theta	FLOAT	0.196
dtheta	FLOAT	0.038
phi	FLOAT	1.136
dphi	FLOAT	0.151
x	FLOAT	13.473
y	FLOAT	29.031
z	FLOAT	164.051

Calculating absolute signal strength and coordinate based on the PMT calibration

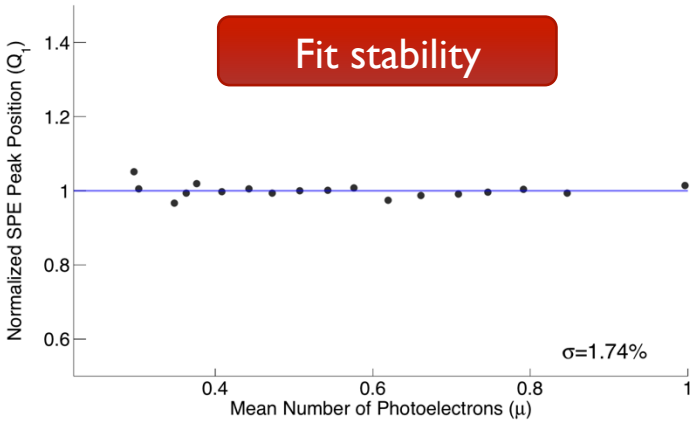
θ, ϕ

(x, y, z)

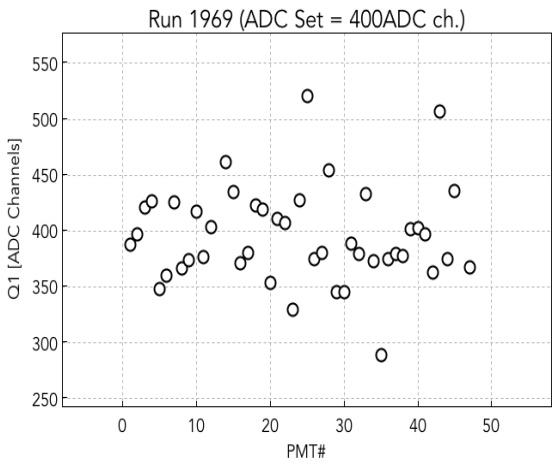
Calibration

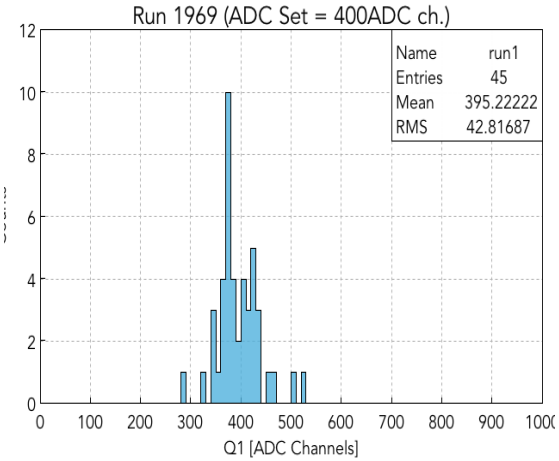


- Gain match with a SPE peak fit function with LED light pulser runs
- Successful HV Gain Match at two gain settings (225 and 400 channels per s.p.e)
- Most Channels matched within ±10%.



Gain Match





Data analysis

No solenoid magnet in front of the HTCC

Two approaches for electron ID:

- DC and EC/PCAL
  - Have tracks, better possibilities to select good electrons
  - Limited to sector 2 (8 PMTS)
- EC/PCAL
  - Based on geometrical match between hits in EC/PCAL and HTCC
  - No tracks
  - Can access all 48 PMTs

Run subperiods

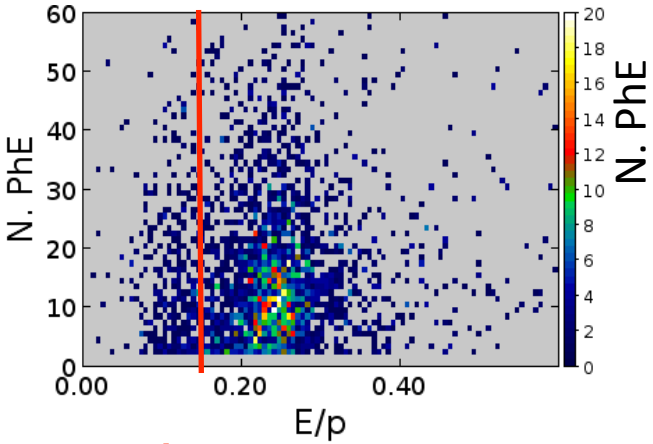
- Low lumi: nphe@ 225, inbending, runs 805 806
  - full set used
- Inbending400: nphe@400, runs 753-769
  - ~ 61 files, runs 75*, 76*
- Outbending400: nphe@400, runs 790-797
  - 11 files, runs 792, 795, 796, 797&798
- Zero field: nphe@400, run 798
  - one file exists, used
- Inbending225: nphe@225, regular lumi, runs 806-810
  - run 809 used

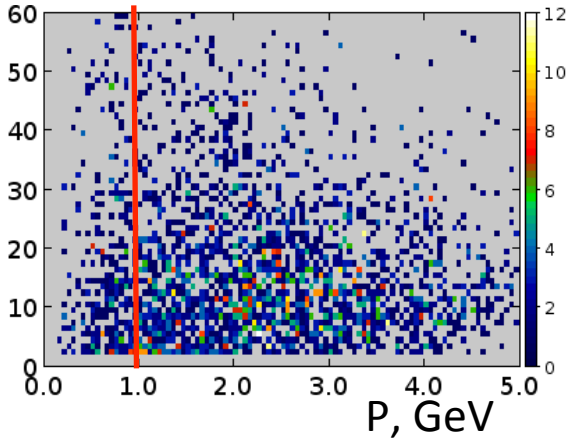
Procedure

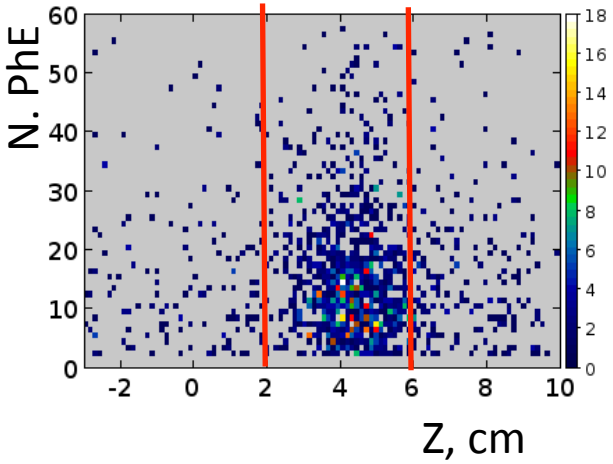
- Electron ID, we select good electrons based on DC and EC information;
- Overall HTCC signal for single hit events: we select good electrons and for them looks at the NPE spectrum for the single hit events;
- HTCC signal by individual mirrors for single hit events: look at the same signal within individual mirrors up to ring 3 (not enough statistics beyond that);
- Geometry and signal strength considerations: is there any dependence of the signal strength on the angular distributions of the electron events;

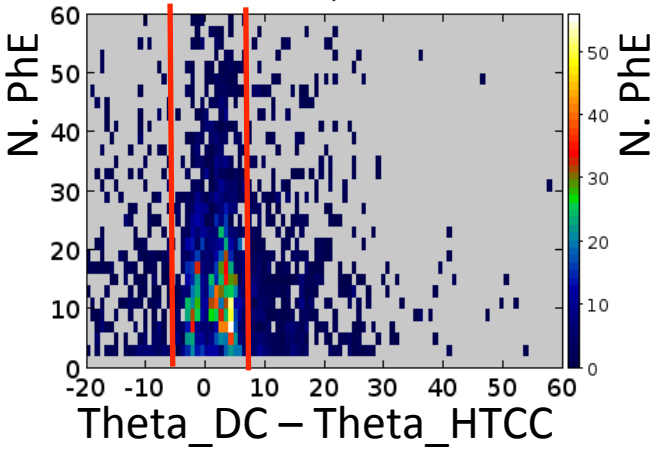
DC and EC/PCAL: electron id

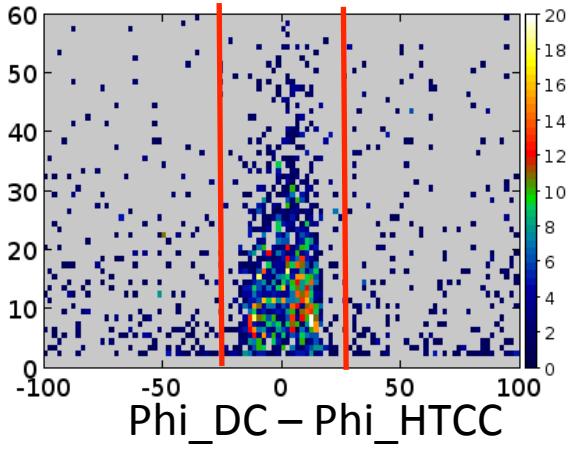
- E/p > 0.14
- P > 1
- |Phi_DC – Phi_HTCC|< 20
- 8> (Theta_DC – Theta_HTCC) >-4
- Theta_DC > 10
- 6 > Z >2







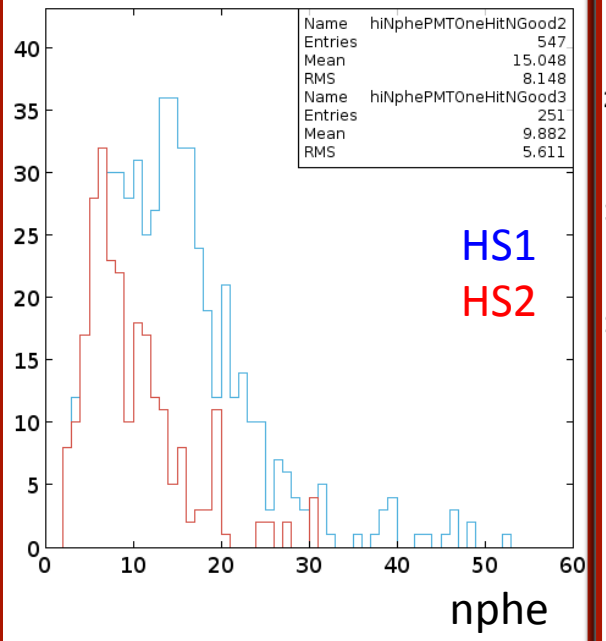




Set of cuts on sampling fraction, particle momentum, vertex position, and angular match between the DC and HTCC are developed.

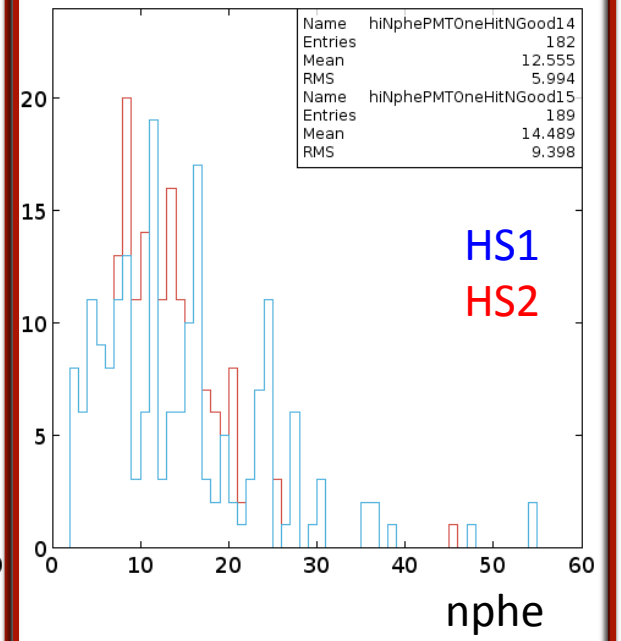
DC and EC/PCAL: NPE spectrum

Ring 1



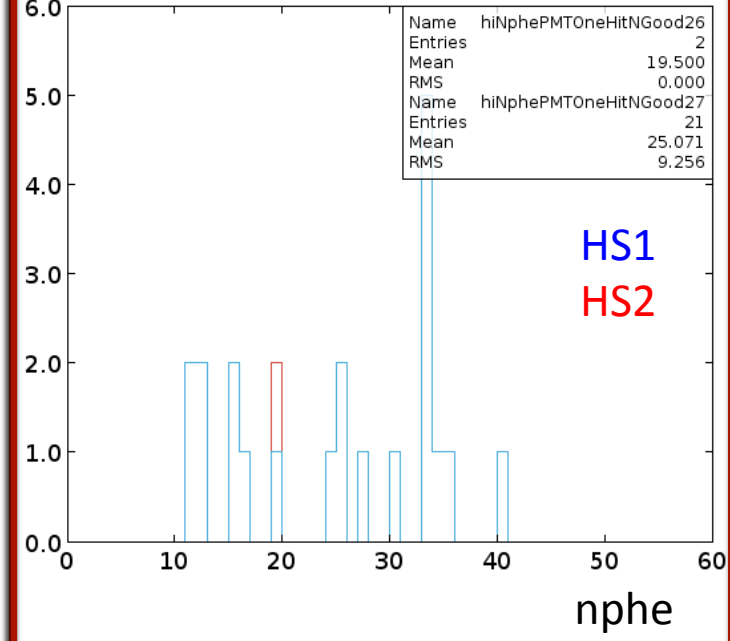
HS 2 is shifted to the lower side, number of events is different

Ring 2



Rather symmetric in both number of events and signal value

Ring 3



Low statistics

Ring 4 has just a few events, omitted.

DC and EC/PCAL: Summary

Position of a 1 hit peak

Configuration	Overall	R1HS1	R1HS2	Ratio	R2HS1	R2HS2	Ratio
Low lumi (inbending 225)	13.7	15.0	9.9	1.52	12.6	14.5	0.87
Outbending400	17.65	19.9	10.6	1.83	14.1	20.7	0.68
Inbending400	15.9	17.8	12.4	1.43	12.6	16.6	0.76
Inbending225	15.7	17.0	9.7	1.75	12.7	17.0	0.75

Different gain, same polarity
Rather consistent

Number of 1 hit events

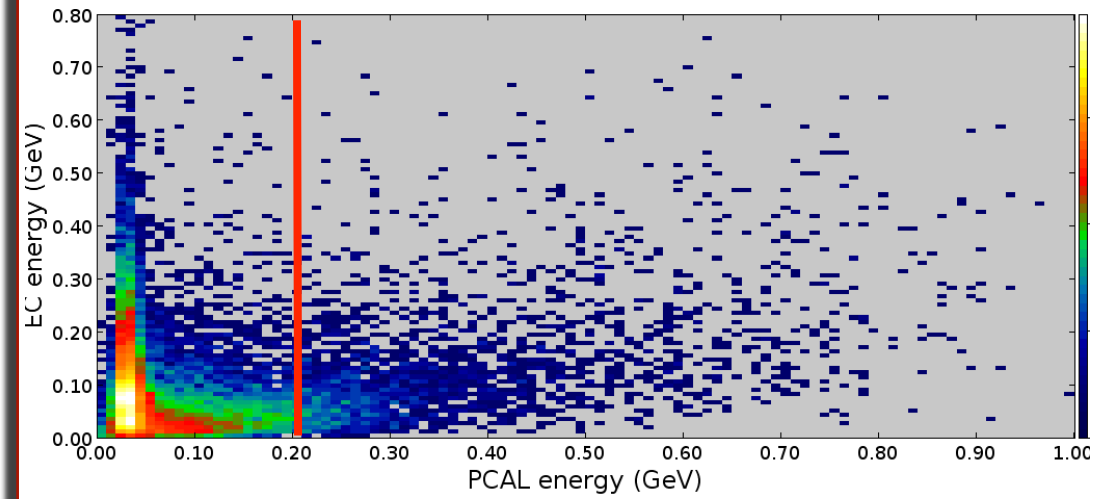
Configuration	Overall	R1HS1	R1HS2	R2HS1	R2HS2
Low lumi	1194	547	251	182	189
Outbending400	14632	6468	3199	1942	2357
Inbending400	777	259	132	173	161
Inbending225	862	389	145	118	142

HS1/HS2 asymmetry in number of events in R1

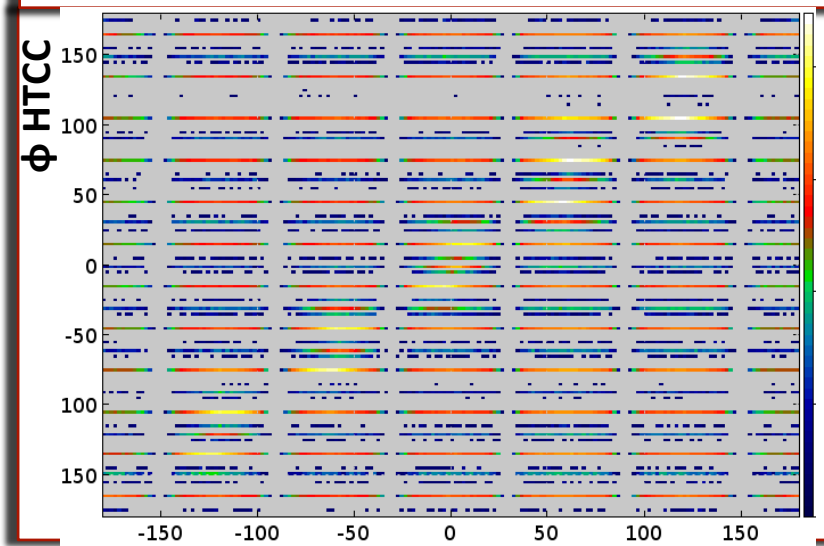
Full HTCC

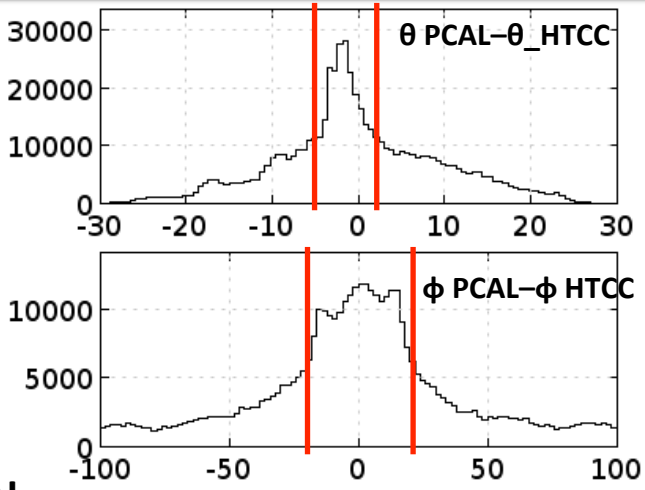
- remove DC track requirement
  - not able to use event builder;
- Select runs with 6 sector trigger (runs 753 – 767, inbending field)
- Require EC/PCAL hit & HTCC hit
  - Remove MIP by using PCAL;
  - Plot all HTCC hits vs PCAL hits;
  - find geometrical matches;
  - cut events based on geometry;
- Plot NPHE spectrum for each PMT

Electron ID in PCAL



Cut to remove MIPs in PCAL

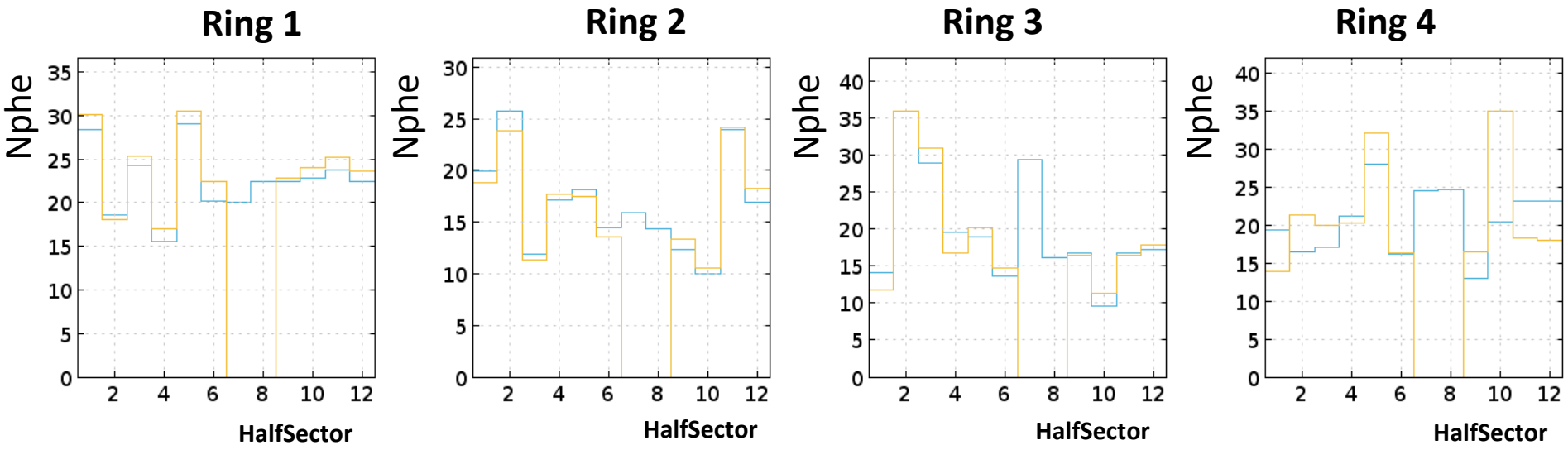




Geometrical match between HTCC and PCAL

Nphe by PMT

1 hit events



Cluster in EC/PCAL + geom match with PCAL + MIP cut in PCAL

Ccluster in EC/PCAL + geom match with PCAL + geom match with EC_IN+ MIP cut in PCAL

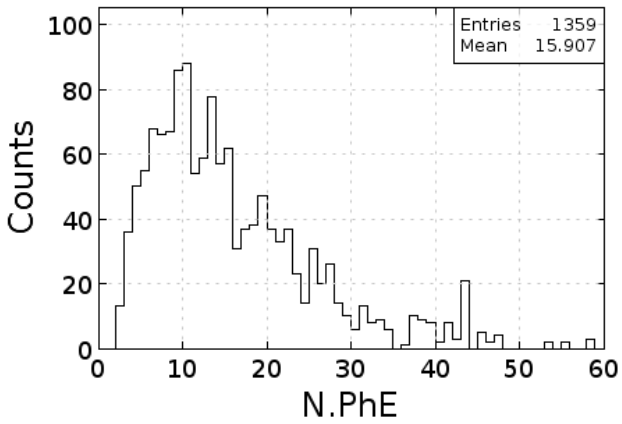
~ 20 Nphe on average

Consistent between different methods of electron ID

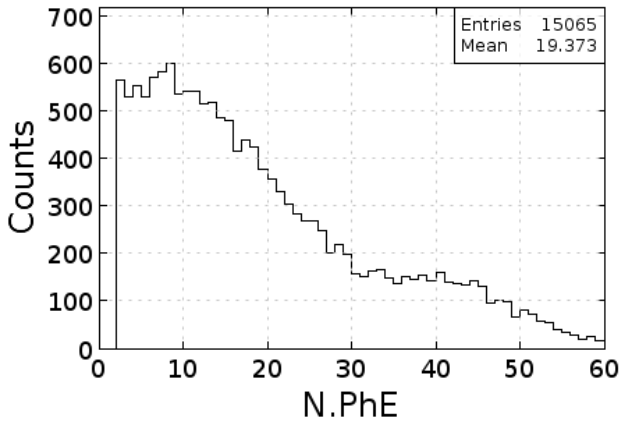
Sector 4 of EC was off during this part of the run.

Integral Nphe spectrum

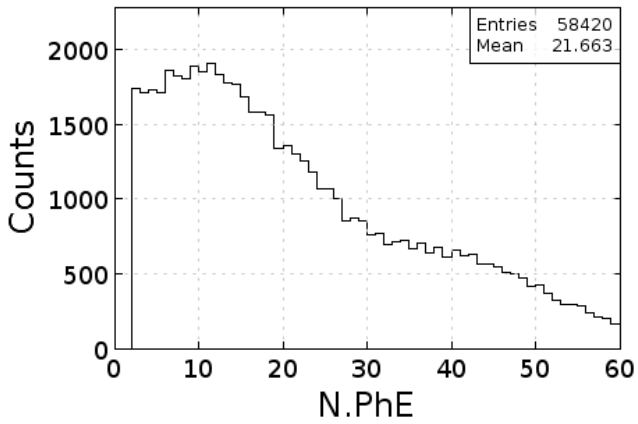
DC sector 2



PCAL sector 2



PCAL all sectors



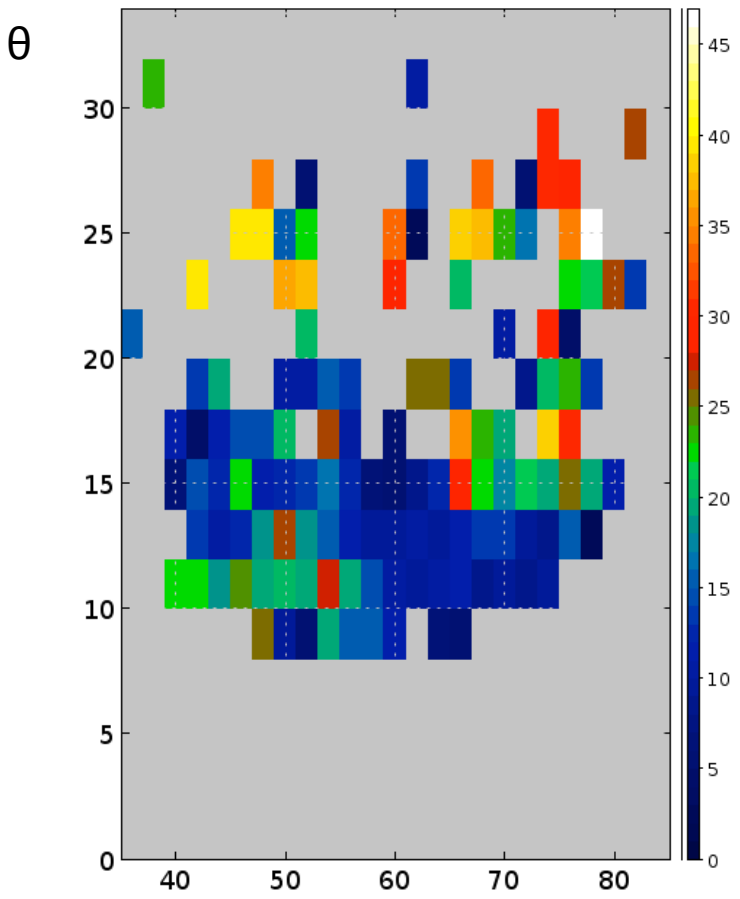
1 hit events

Electron ID performed with PCAL provides systematically higher Nphe
Second hump in case of PCAL electron ID needs more investigation

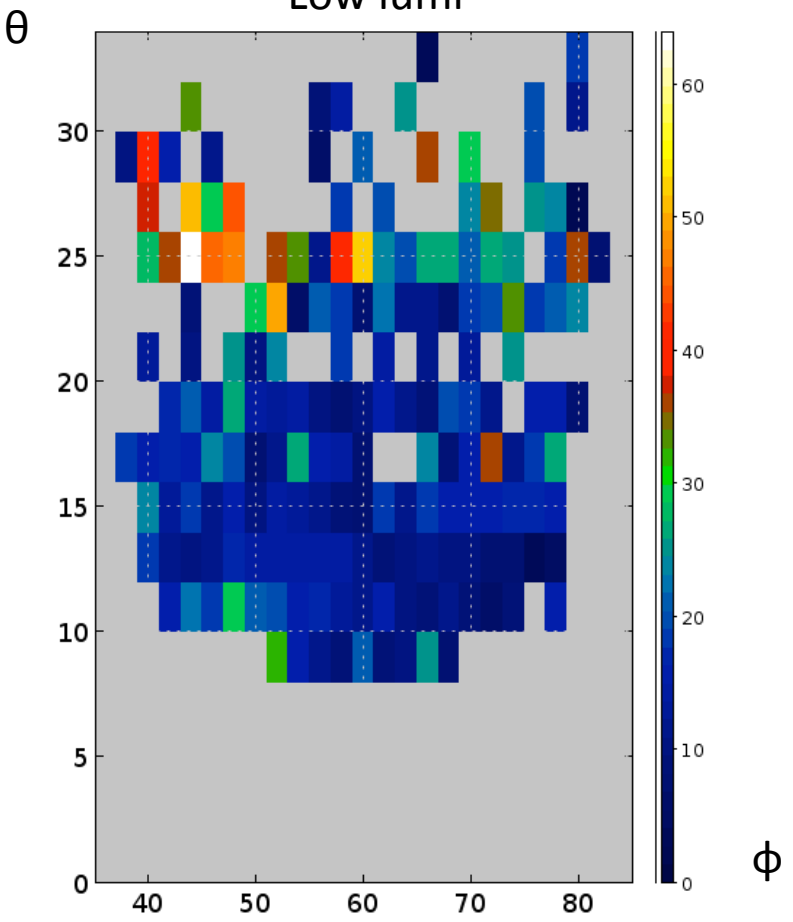
HTCC occupancy

Average number of Nphe per event as a function of angle as measured by DC when DC and EC are used to select events

inbending400

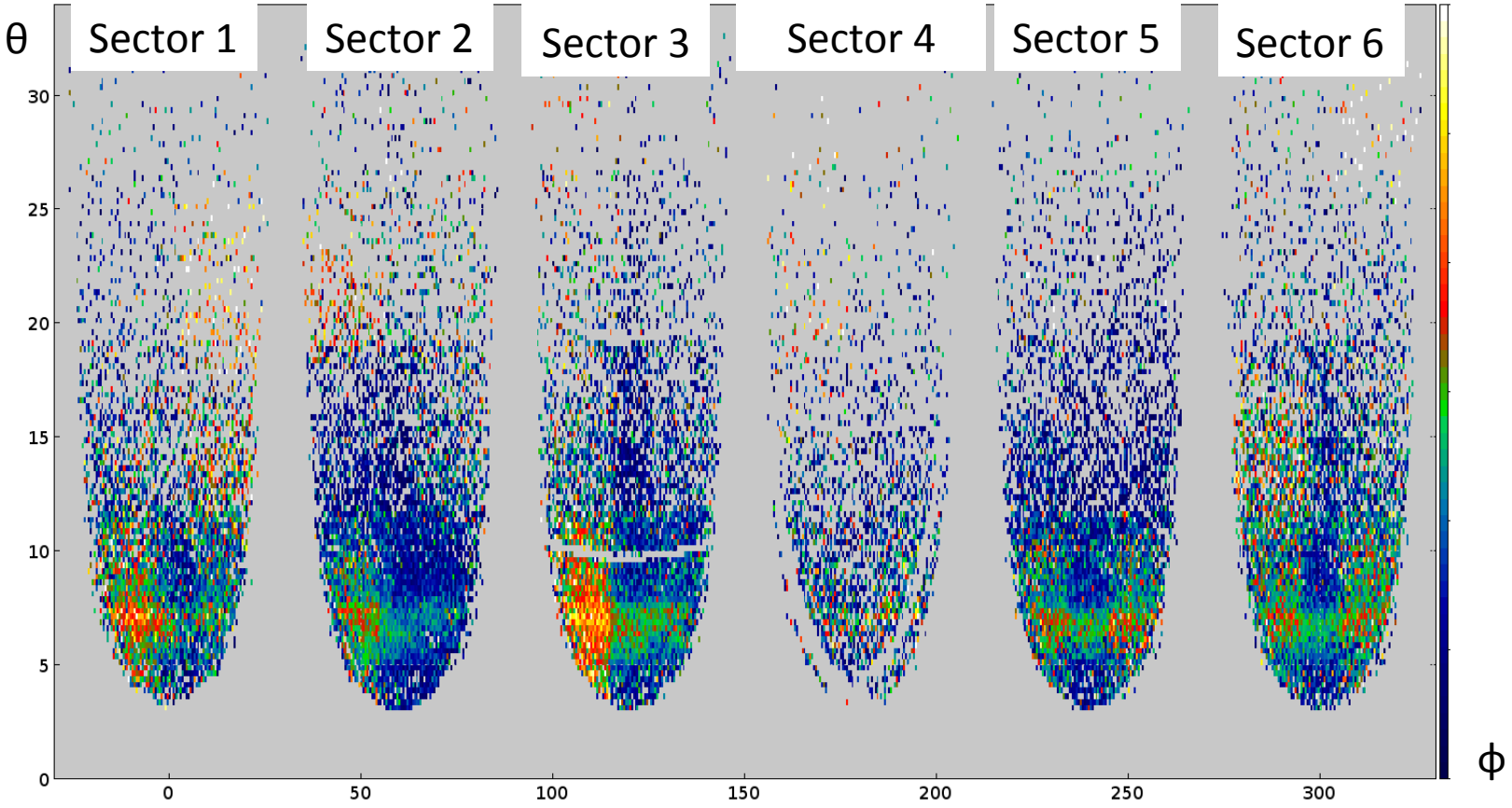


Low lumi



HTCC occupancy

Average number of Nphe per event as a function of angle as measured by PCAL when PCAL is used to select events



Some PMTs (mirrors) higher average

Conclusion

- HTCC worked properly during the whole KPP run;
- Data were cooked and analyzed immediately;
- As a part of the KPP run it met the DOE requirements;
- Signals from all 48 PMTs were extracted;
- Average number of Nphe is 19.4 for a single hit events (expected to grow when account for multiple hit events);
- Signals from 8 PMTs of sector 2 were extracted using different ways of electron ID;
- Average number of Nphe is compatible with estimations;
- There are discrepancies between different PMTs in the same ring to understand.