Other things related to TCD (simulation,machine learning,maroc)

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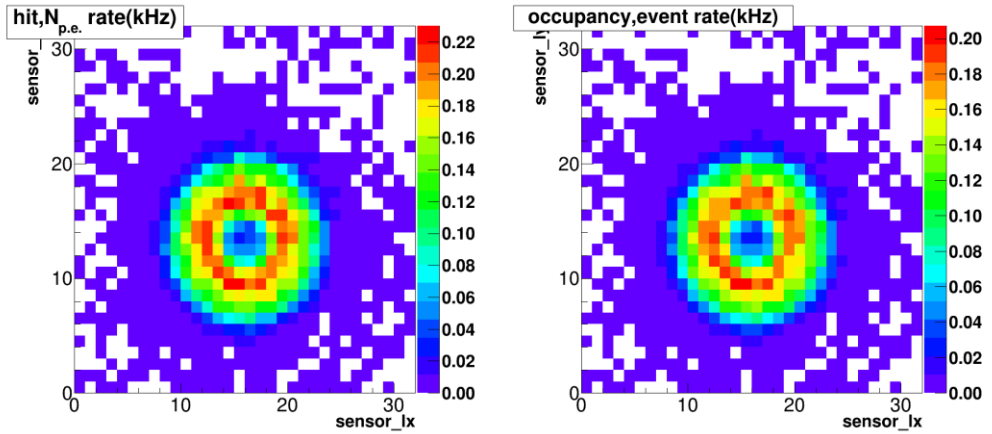
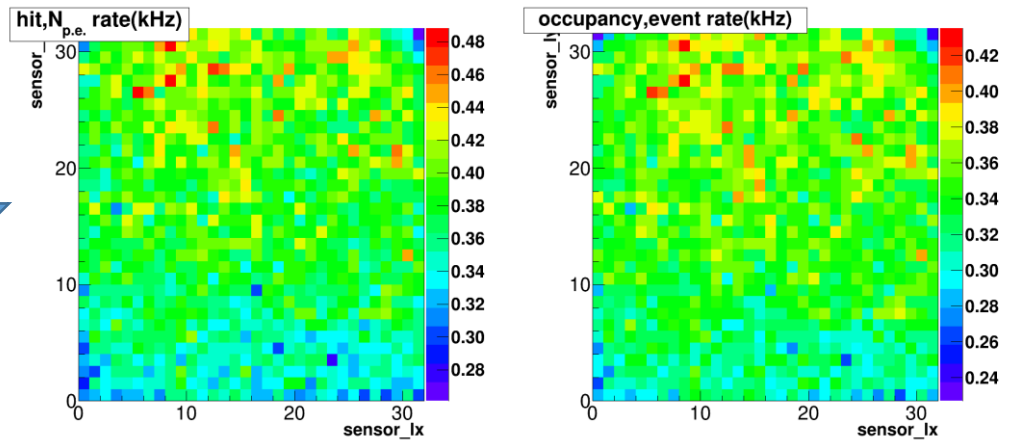
2020/06/08

Cherenkov response

- “e central” evenly shooting e- of 0<P<5GeV along Cherenkov tube axis from z=0
- “e broad” evenly shooting e- of 0<P<5GeV within angle of theta 5deg and phi 5deg from z=(-20,20)cm

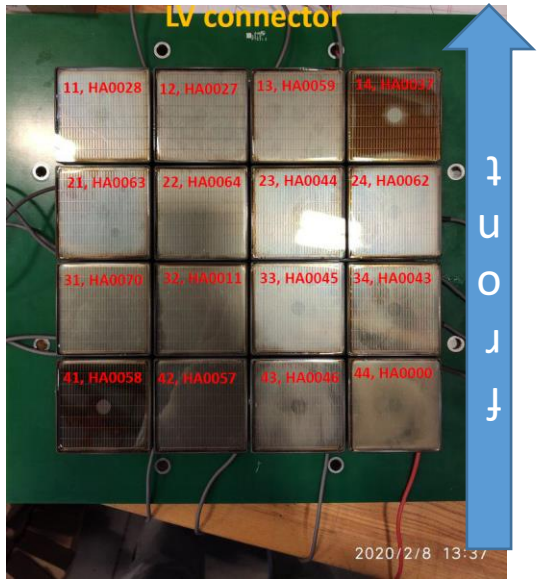


front

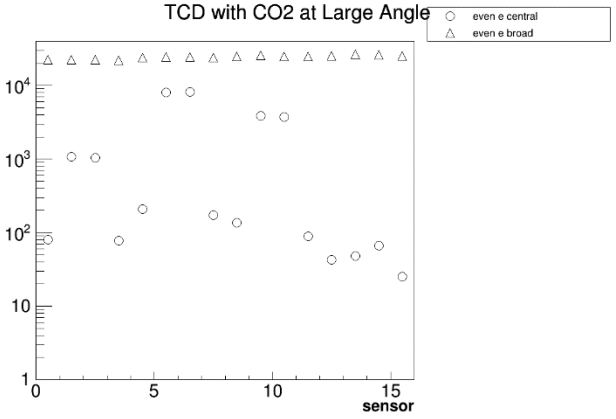


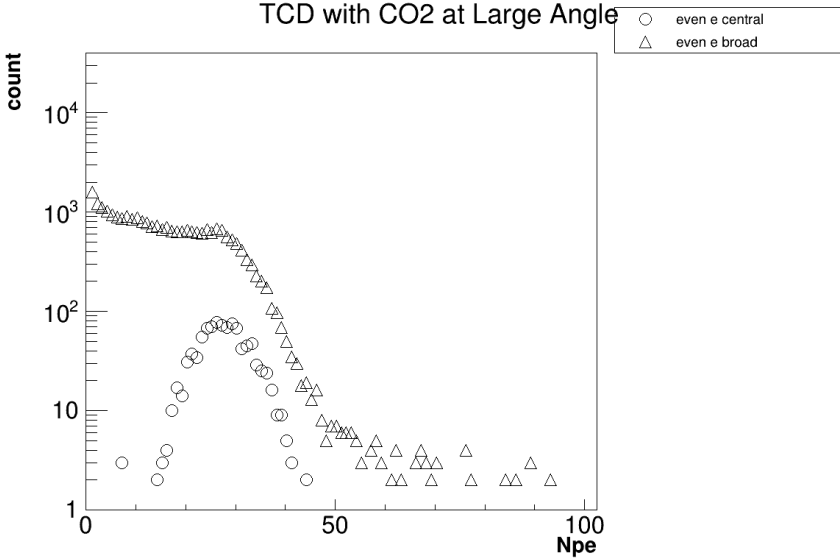
Cherenkov

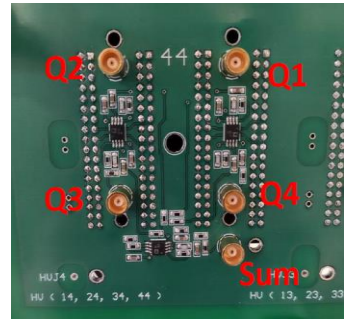
- 12.25’ inner diameter, 60” long
- 0.005” Al front window, 0.75 PVC back window
- Mirror at 40” from front window, 2cm thk PVC
- PMT 22.75” above mirror



front

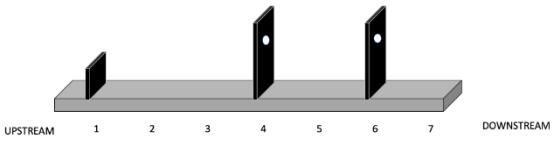






PMT back view, pmt_id=pmt_x+4*pmt_y
pmt_id=0 and pmt_x=0,pmt_y=0 is PMT11

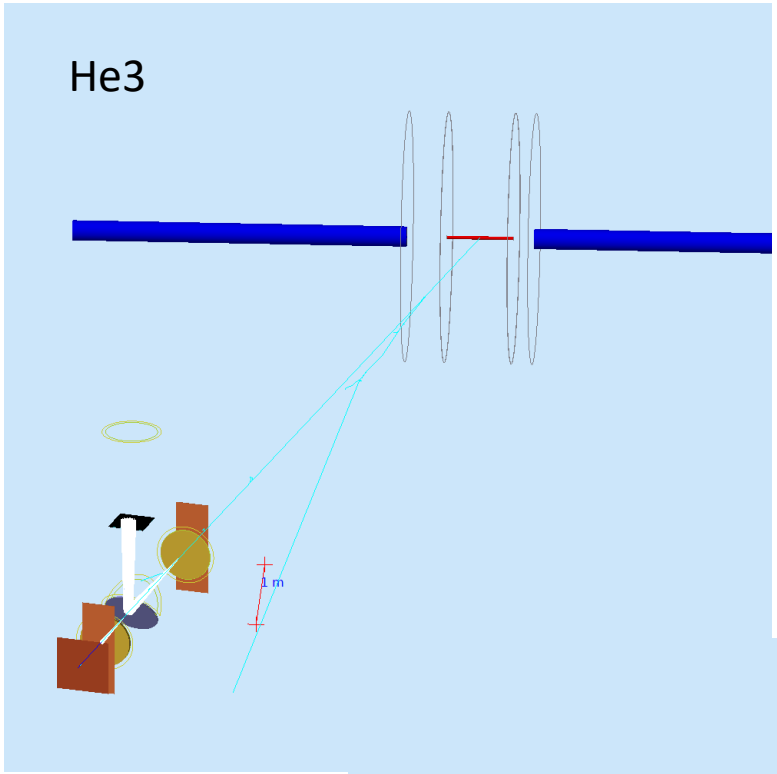
setup

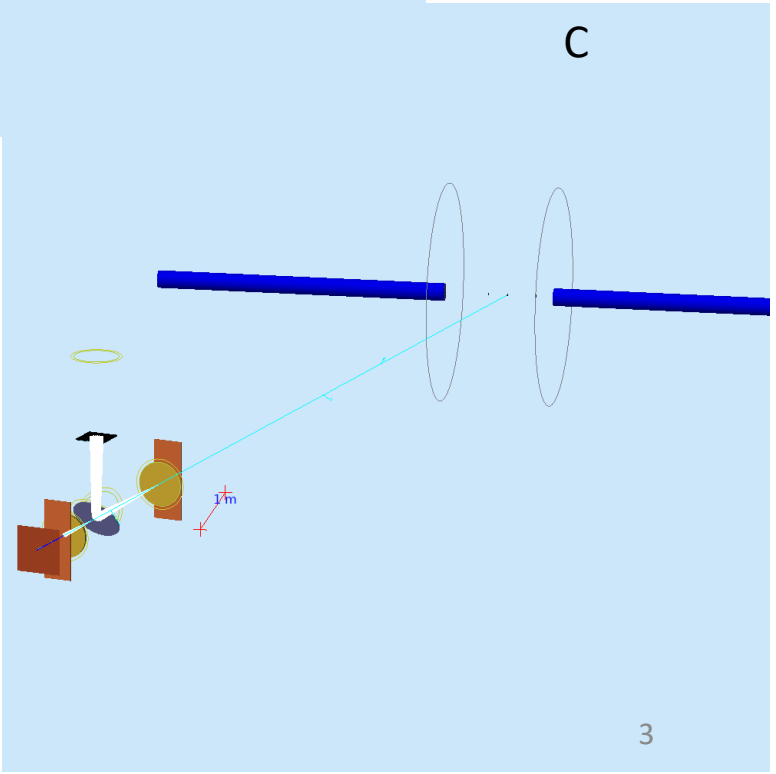


- Target
  - SIDIS_He3 40cm cell with center at pivot z=0
  - 3 Carbon foils 0.01” thk each at z=-200,0,133.35mm
    - https://logbooks.jlab.org/entry/3750828
  - N2 gas around target cell 75cm thk

- TCD at large angle
  - Same height as beamline, aiming at pivot
  - following beam direction, 74.55 deg at the left
  - SC front plane 17 feet 10 inch (543.6cm) from pivot

- Running condition
  - 30uA, 10.4GeV





Things along beam

He3	Be (up)	Al(up)	N2 (up)	Glass (down)	He3 gas	Glass (down)	N2 (down)	Al(down)	Be(down)
Z (cm)	-12.8*2.54	-12.8*2.54	-26.256	-20	0	20	31.9	17.25*2.54	17.25*2.54
L (cm)	0.01*2.54	0.0002*2.54	12.512	0.012	40	0.012	23.815	0.001*2.54	0.02*2.54
Rad L	0.7e-3	0.06e-3	0.37e-3	1.7e-3	0.8e-3	1.7e-3	0.73e-3	0.3e-3	1.4e-3
Lumi (/cm2/s)	5.30e36	0.155e36	1.6e36	3.74e36	6e36	3.74e36	3.2e36	0.774e36	10.6e36

How good is alignment?
It would be nice to have tracking!

Carbon	N2	C1	C2	C3
Z (cm)	5.6515	-20	0	13.335
L (cm)	76.33	0.01*2.54	0.01*2.54	0.01*2.54
Rad L	2.3e-3	1.3e-3	1.3e-3	1.3e-3
Lumi (/cm2/s)	10e36	5.7e36	5.7e36	5.7e36

- Lumi
  - from target cell 13.48e36 and from others 21.63e36
  - Beamline components are important
- Angle
  - Cerenkov Tube inner diameter 12.25”, front window to mirror 40”, 9 deg=tan(12.25/2/40)/3.1416*180
  - Beamline upstream window to TCD, 3.3deg=asin(sin(105.5/180*3.1416)/543.6*12.8*2.54)/3.1416*180
  - Beamline downstream window to TCD, 4.5deg=asin(sin(105.5/180*3.1416)/543.6*17.25*2.54)/3.1416*180
  - TCD can see both beamline windows

TCD at large angle, CO2, 30uA

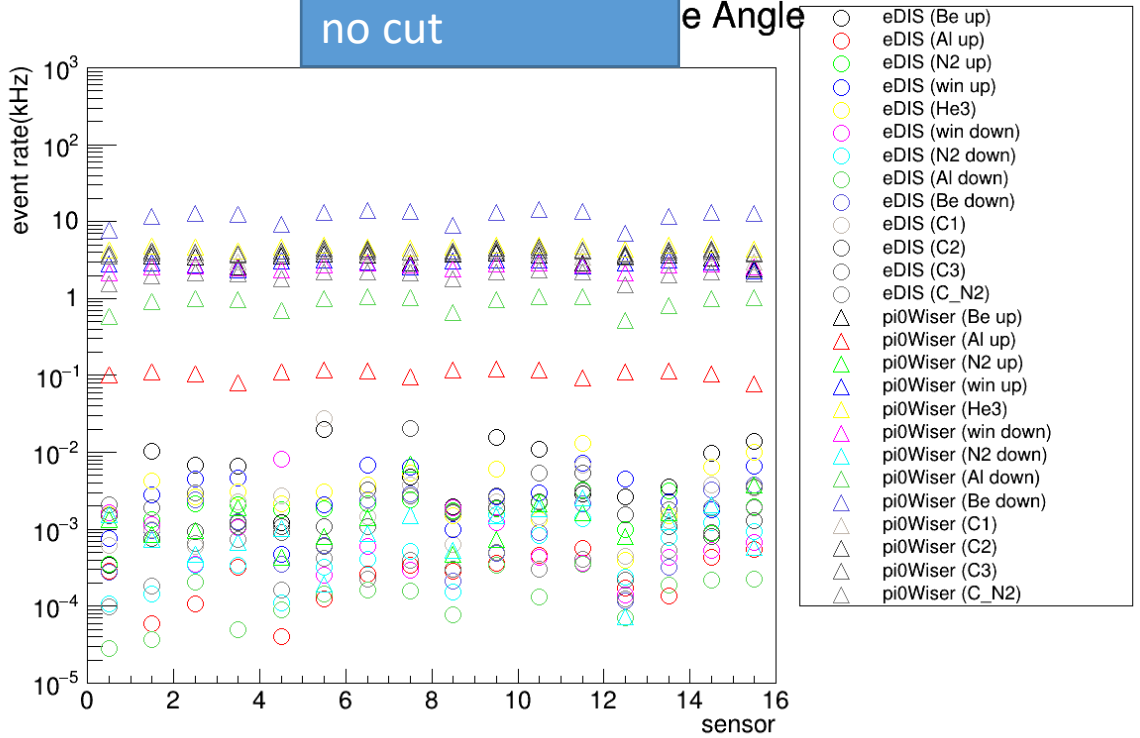
- preliminary rate of all things along beam from the generator of eDIS and pi0Wiser
- Be downstream and He3 show high rate, similar to lumi
- To do: other generators, “beam on target” more events

Avg rate/pmt

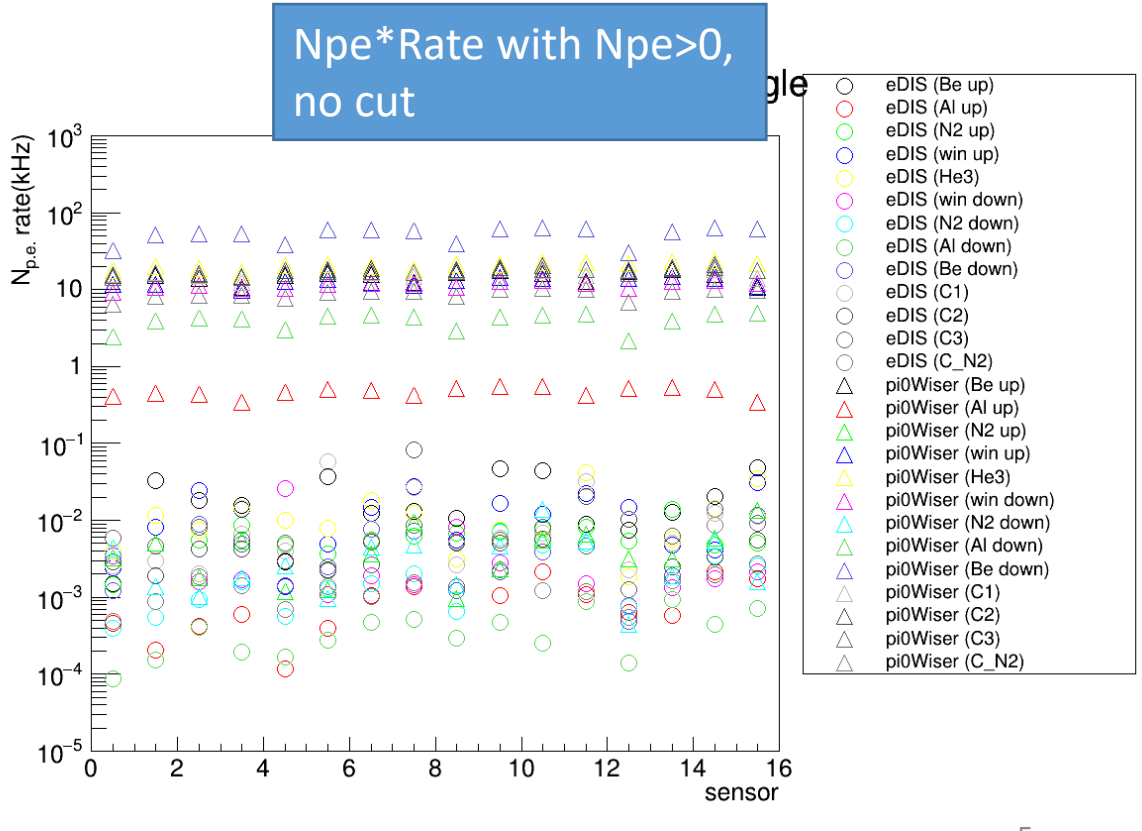
rate/Npe rate (kHz)	No cut	EdepSC2 >0.7MeV	Eec>0.1GeV	Both cut
He3	26/117	18.4/88	5.8/32.4	5.3/30
Carbon	30/133	21.0/100	6.6/36.6	6.0/34

Avg Npe ~4.5/pmt

Rate with Npe>0, no cut



Npe*Rate with Npe>0, no cut



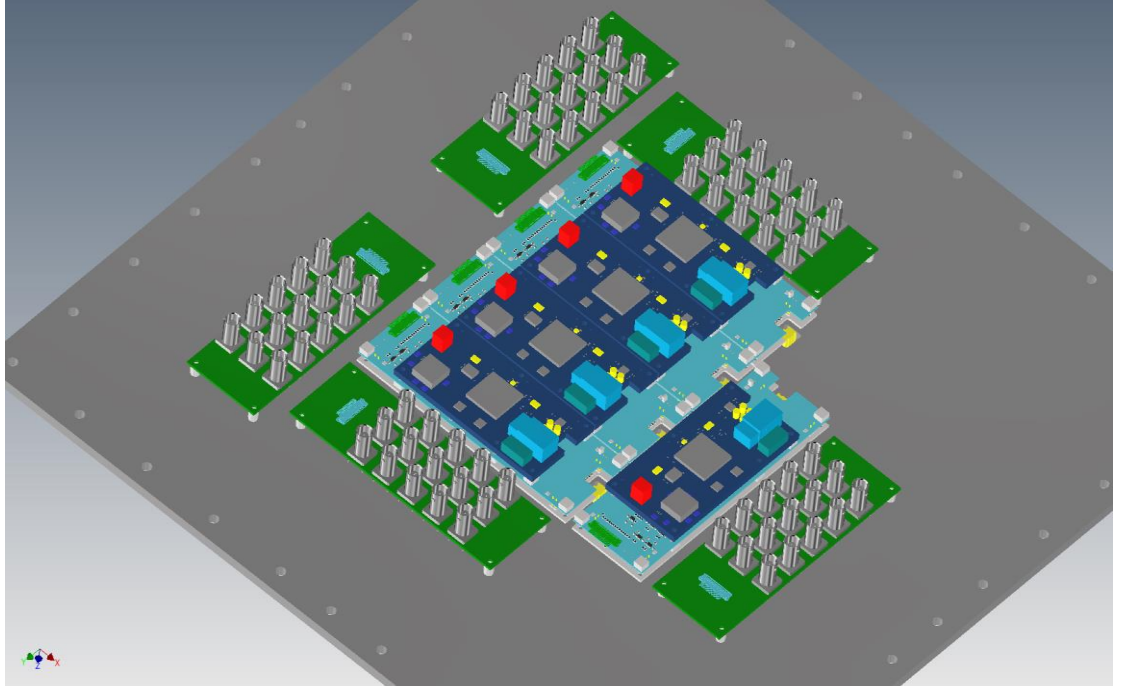
Use machine learning for MAPMT signal/background separation

ML algorithm	Train pion0	Train electron	Test pion0	Test electron
SVM	88.1%	85.0%	69.2%	75.2%
RND	73.4%	65.3%	72.1%	65.3%
MLP	71.0%	74.4%	70.3%	74.5%

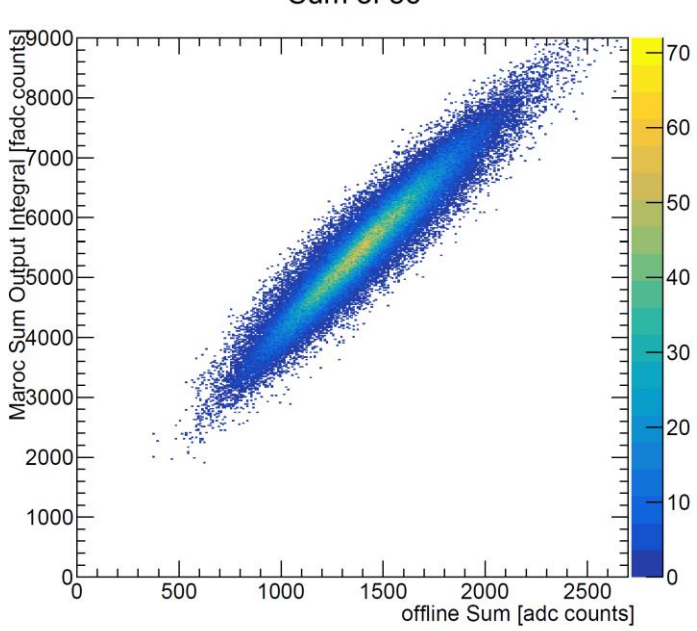
- First attempt, using simulated data from TCD
  - As signal, high energy electron from target
  - As background, high energy pi0 from target which has decay photons and electrons and knock-on electrons entering TCD in different angle and position
  - pixel information summarized into five statistical features as input: # photoelectrons, average pixel_x, average pixel_y, variance of pixel_x, variance of pixel_y
- Next steps
  - Using quad or total sum as input for comparison
  - Using simulation true info like hits on front window to understand results
  - Tune ML and test different algorithm like 2D image pattern recognition etc
  - Test it on beamtest data
  - Apply lessons learn to SoLID LGC and HGC

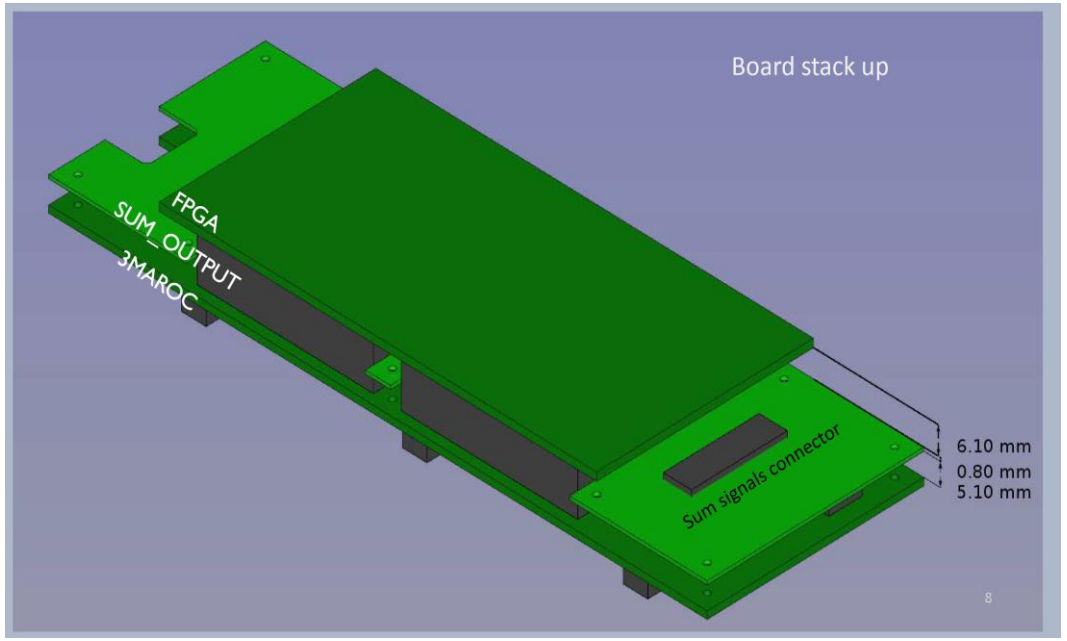
MAROC sum readout

- Collaboration with INFN Ferrara and JLab electronic group
- readout all 64 pixels, 4 of quad and 1 total sum for 1 MAPMT H12700 at the same time
- Test board tested with laser
- All boards were made and delivered at jlab when shutdown started. As jlab reopens, they will be tested and be ready for beamtest.



Linear relation between total sum signal and sum of individual pixel



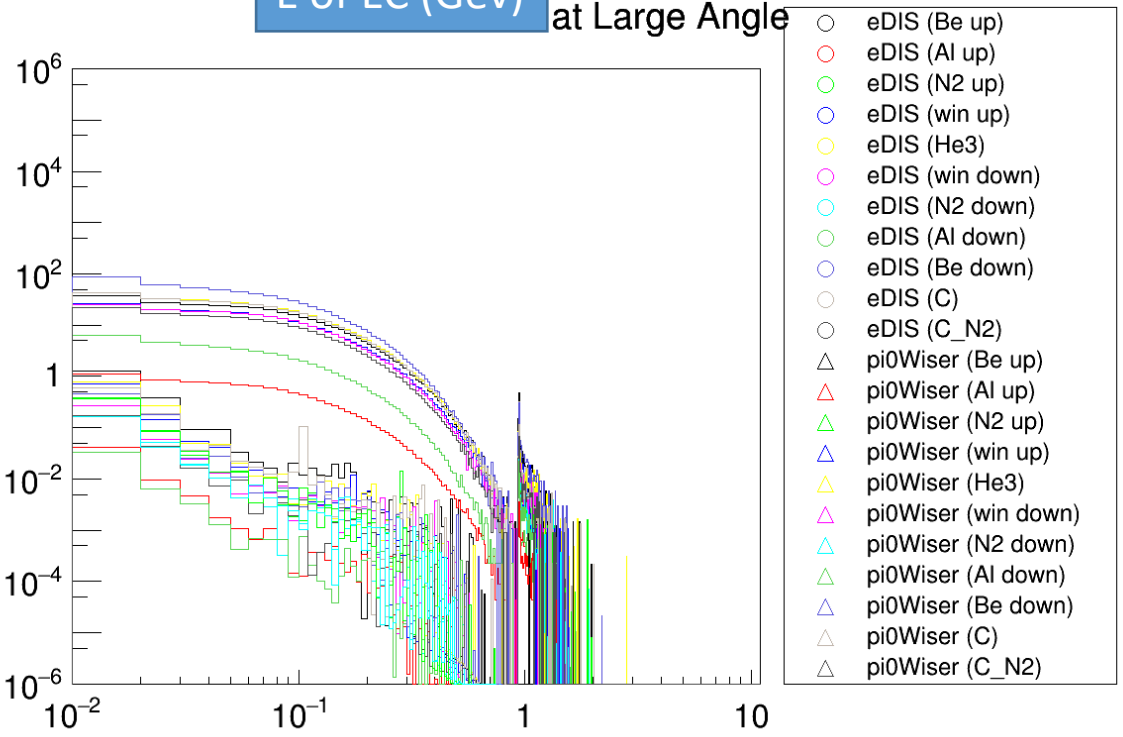


backup

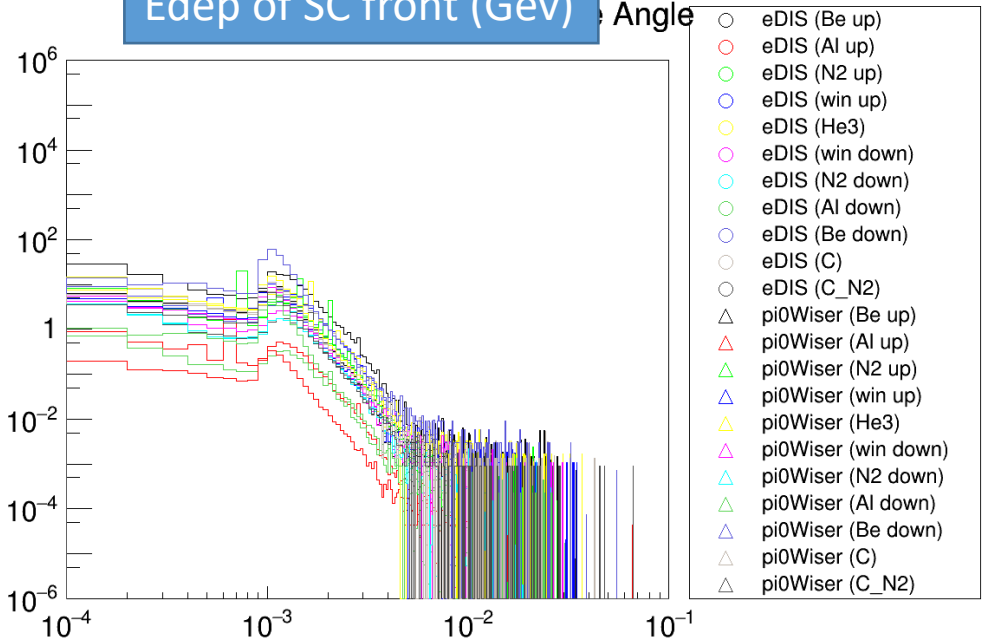
EC and SC

- EC
  - 9 of module in 3x3 array
  - Each module 4.25x4.25” square, 18in long
  - EC front 17” behind Cherenkov back window
  - only record particle entering EC front, no sim for energy deposition
- SC
  - size 8”x22”, 0.25” thk, material G4_PLASTIC_SC_VINYLTOLUENE
  - SC front is 5” before Cherenkov front window, SC back is 5” behind Cherenkov back window

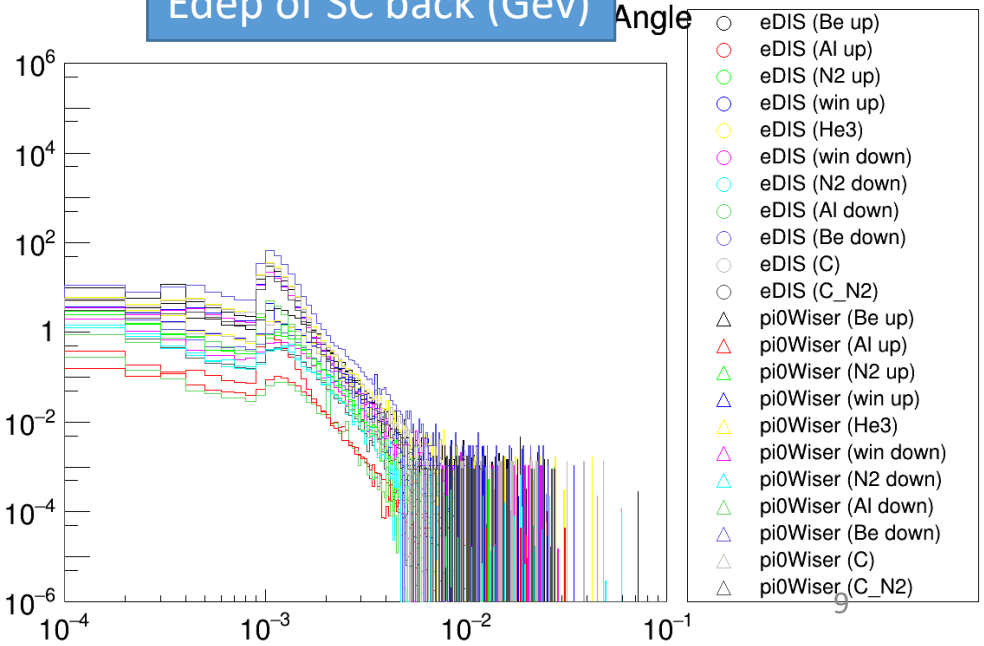
E of EC (Gev) at Large Angle



Edep of SC front (Gev) Angle

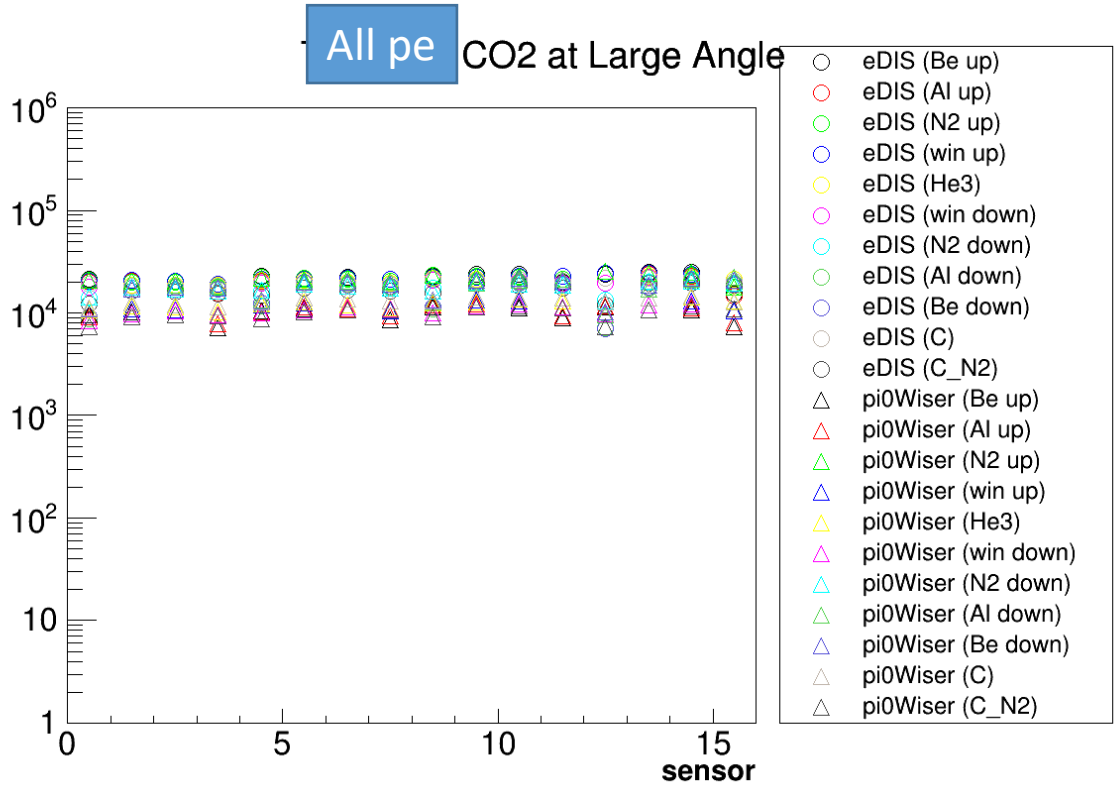


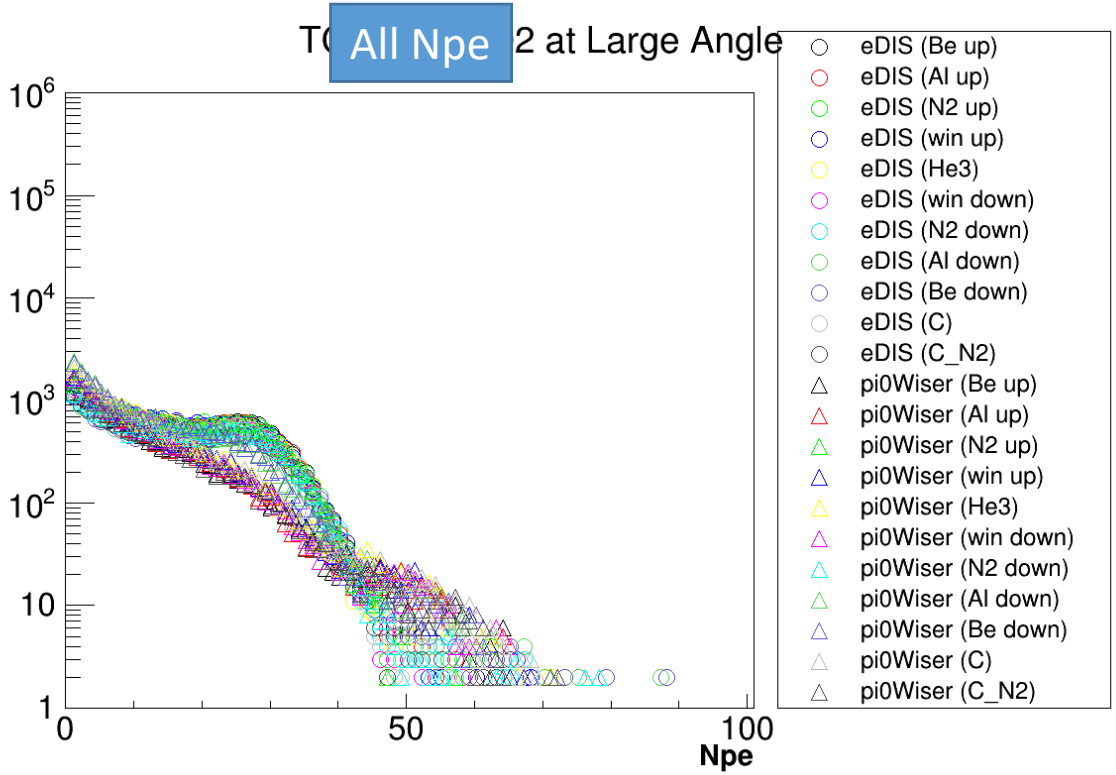
Edep of SC back (Gev) Angle



Cherenkov response

pe and Npe





Run 160: production run at 30uA with He3
fadc in mode 1 with 4ns sample for EC and SC2 behind Cherenkov
trigger threshold: EC 100/150,SC2 200,Cher 20