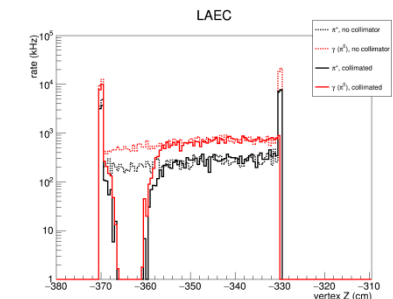
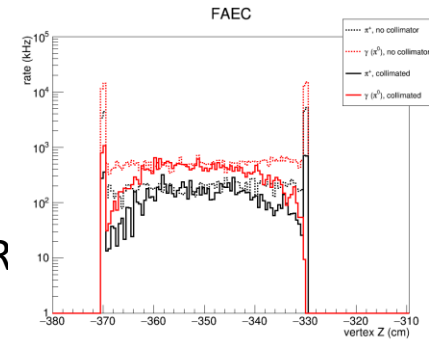
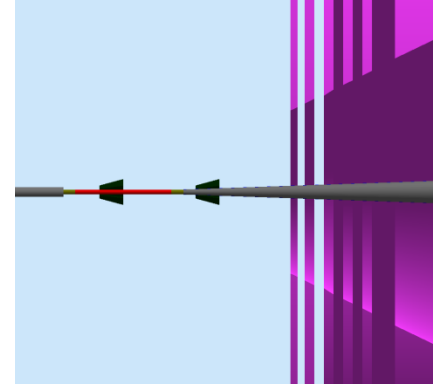


HGC and LGC cut study

Zhiwen Zhao

2019/03/26

Simulation note



- Simulation of SIDIS_He3 full setup with longer endcap and 2D solenoidv9 field
- The target front and back window collimators (made of tungsten) can block forward angle view for about 5cm in vertex Z
- HGC works from 2.5-7.5GeV
- LGC works from 1-4.5GeV
- “HGC_moved” detector description in simulation is newer than preCDR
 - at new location 20cm further downstream
 - has new optics with 40-50% more photons
 - Cover 7-15 deg instead of 8-15deg
- “LGC” detector description in simulation is the old
 - at current location, without 10cm downstream extension
 - Still cover 8-15deg
 - Use CO2 gas
- Pion decay into muon which won't have light in LGC
- Pion decay into muon which might have light in HGC, depending on mom and angle
- Kaon decay into muon and pion which might have light in HGC, depending on mom and angle

How to interpret result

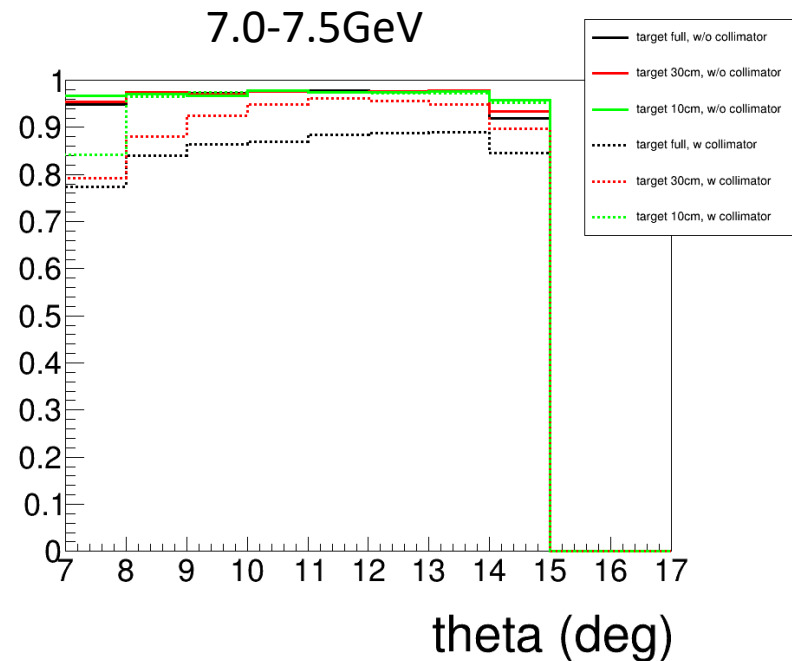
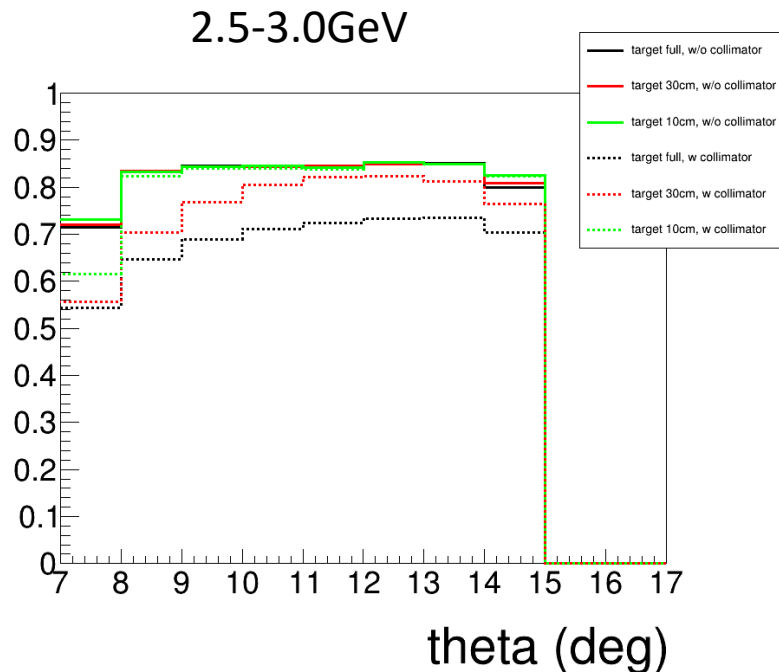
- “efficiency at target”:
 - The probability of a particle from target being detected by certain detector. It include
 - It includes the effect of geometry acceptance, material along flight path and “efficiency at detector”
- Cerenkov signal particle has max eff at $N_{pe} \geq 1$ where background particle rejection is lowest.
- All plots has signal and background events in 1:1 ratio
- Both LHC and HGC N_{pe} shown
 - has a factor 0.5 on top of simulation output for any possible loss
 - sum of all 30 sectors. (Later with tracking info, we could sum only a couple sectors for better rejection.)
- Shooting single particle evenly over target, mom, theta and phi angle.
Then checking HGC and LGC performance dependence over target vertex, mom, angle and collimator

Max signal particle efficiency at target for **HGC** with full setup

HGC standalone setup with only decay effect has pion eff ~ 0.99 and kaon rejection ~ 10

HGC full setup kaon rejection ~ 10 without much dependence on momentum, angle, collimator

Signal particle Max efficiency ($N_{pe} \geq 1$)	Low mom (2.5-3.0GeV) Full angle (7-15 deg)	high mom (7.0-7.5GeV) Full angle (7-15 deg)
HGC (pim) Target full, w/o collimators	0.83	0.98
HGC (pim) Target full, w collimators	0.70	0.86

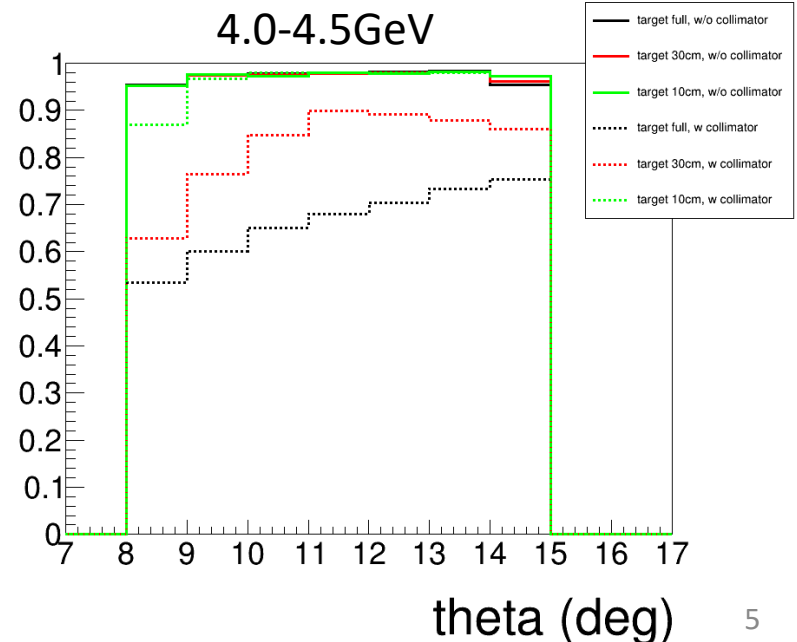
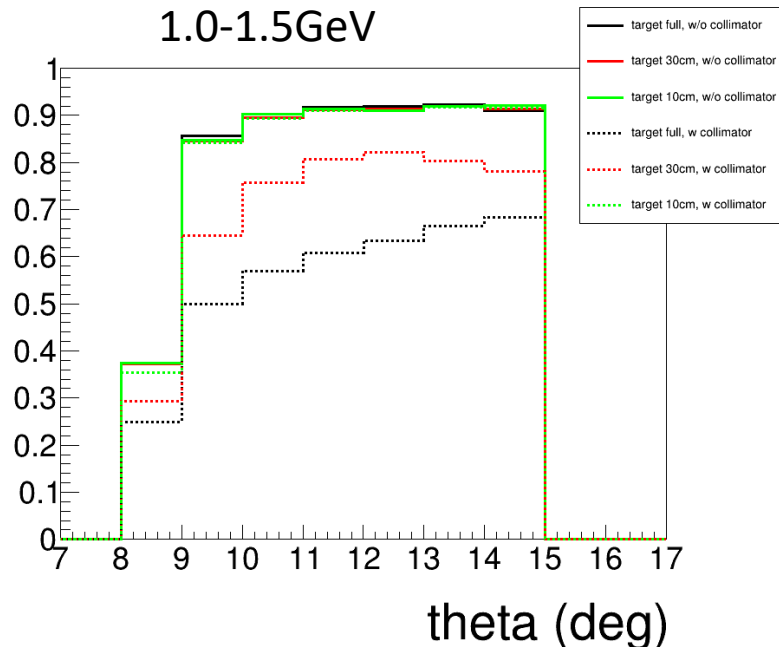


Max signal particle efficiency at target for LGC with full setup

LGC standalone setup with only decay effect has ?

LGC full setup pion rejection ~ 100 without much dependence on momentum, angle, collimator

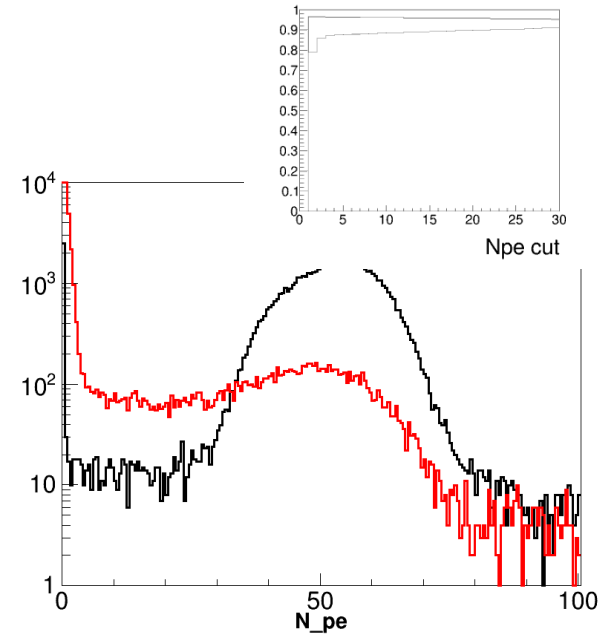
Signal particle Max efficiency ($N_{pe} \geq 1$)	Low mom (1.0-1.5GeV) Full angle (8-15 deg)	high mom (4.0-4.5GeV) Full angle (8-15 deg)
LGC (e) Target full, w/o collimators	0.85	0.97
LGC (e) Target full, w collimators	0.58	0.68



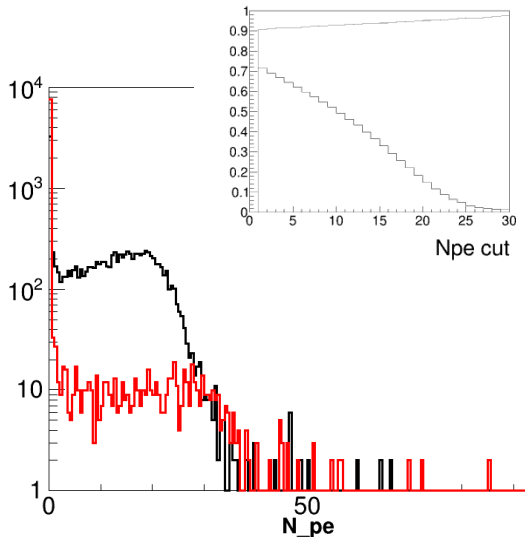
HGC_moved (7-15deg)

- Signal in black shows eff, background in red shows 1-eff
- Full target
- **without** collimator

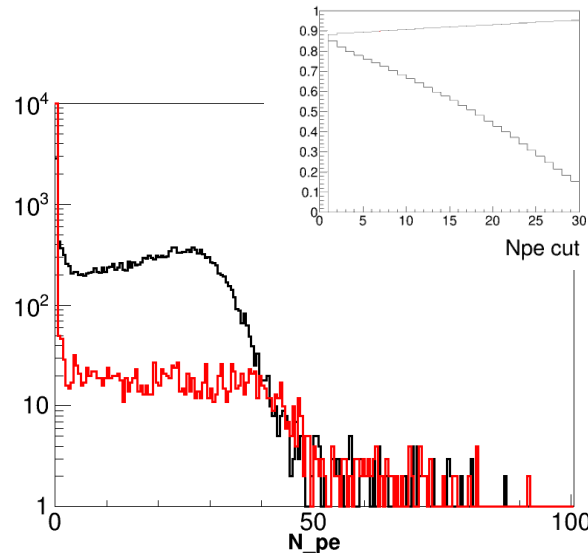
7.0-7.5GeV, 7-15deg



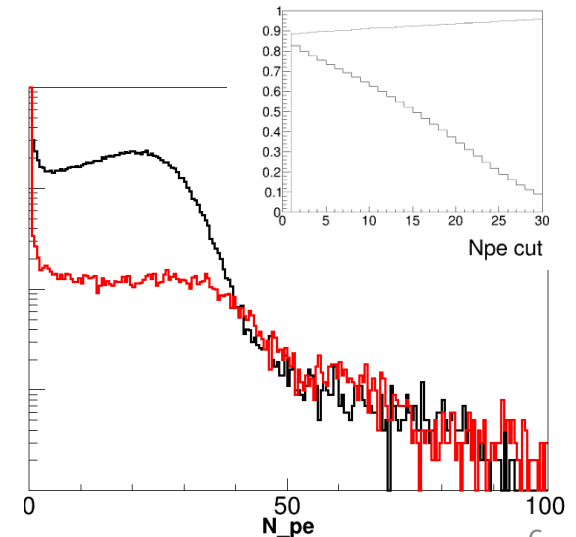
2.5-3.0GeV, 7-8deg



2.5-3.0GeV, 13-14deg

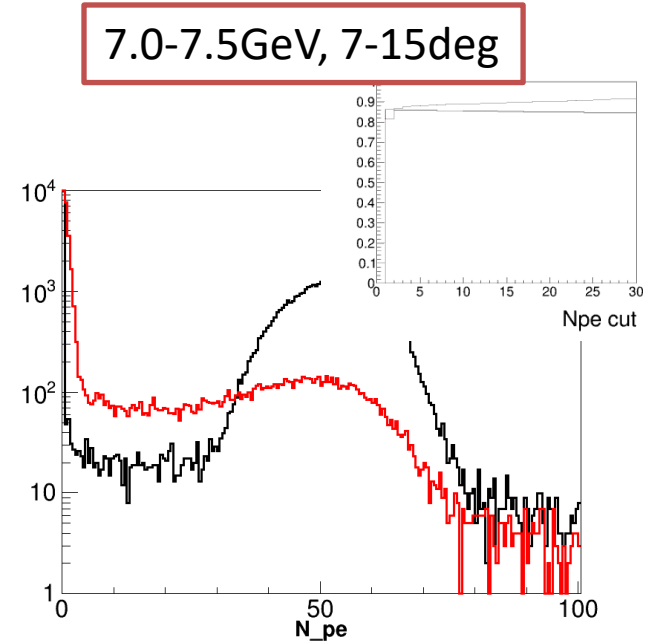


2.5-3.0GeV, 7-15deg

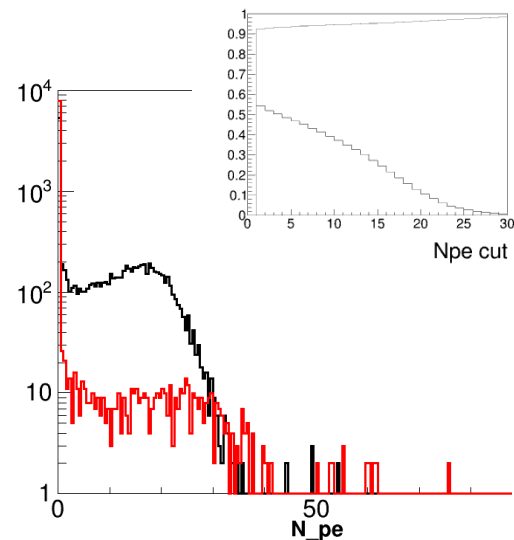


HGC_moved (7-15deg)

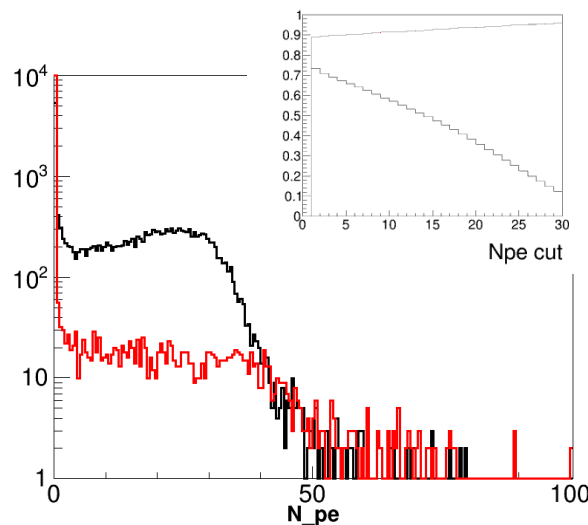
- Signal in black shows eff, background in red shows 1-eff
- Full target
- **with** collimator



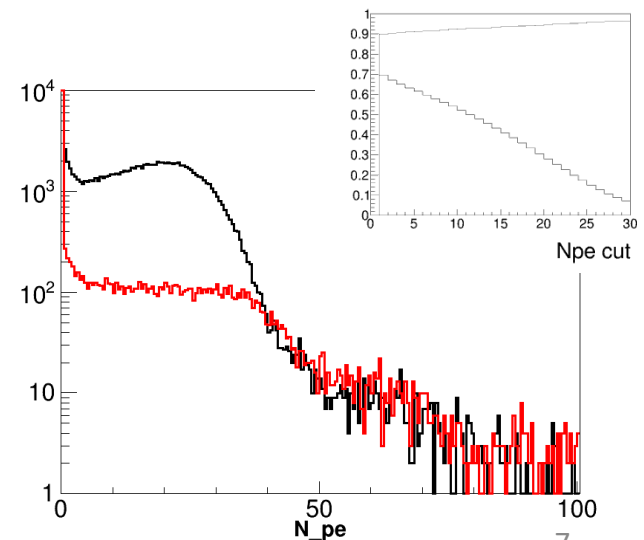
2.5-3.0GeV, 7-8deg



2.5-3.0GeV, 13-14deg



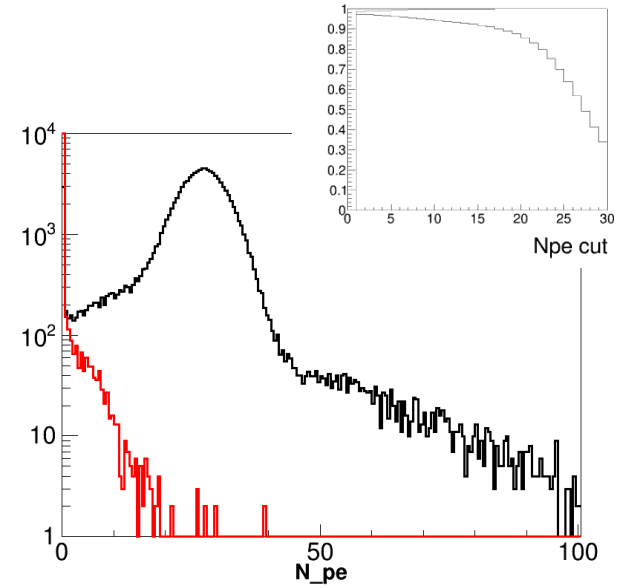
2.5-3.0GeV, 7-15deg



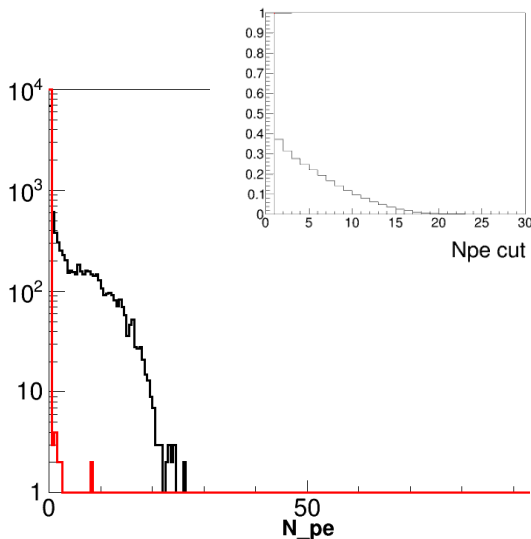
LGC (8-15deg)

- Signal in black shows eff, background in red shows 1-eff
- Full target
- **without** collimator

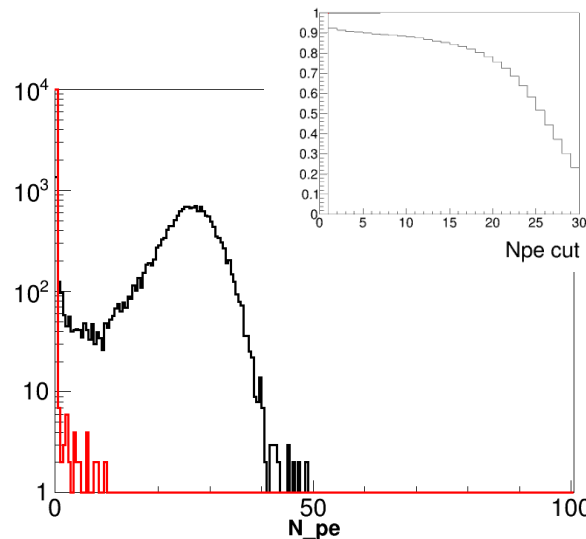
4.0-4.5GeV, 8-15deg



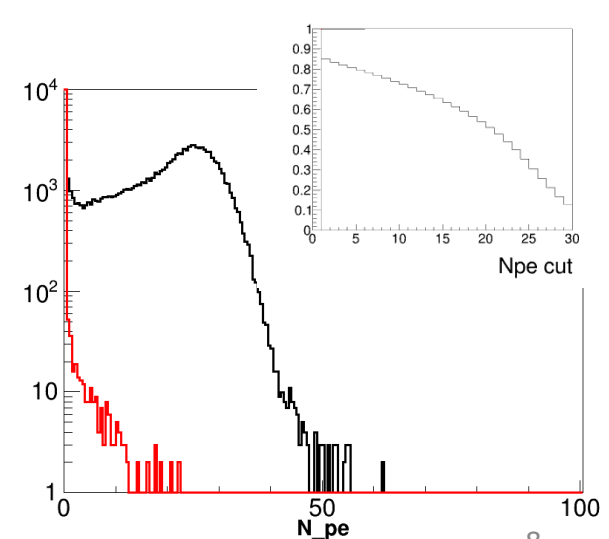
1.0-1.5GeV, 8-9deg



1.0-1.5GeV, 13-14deg



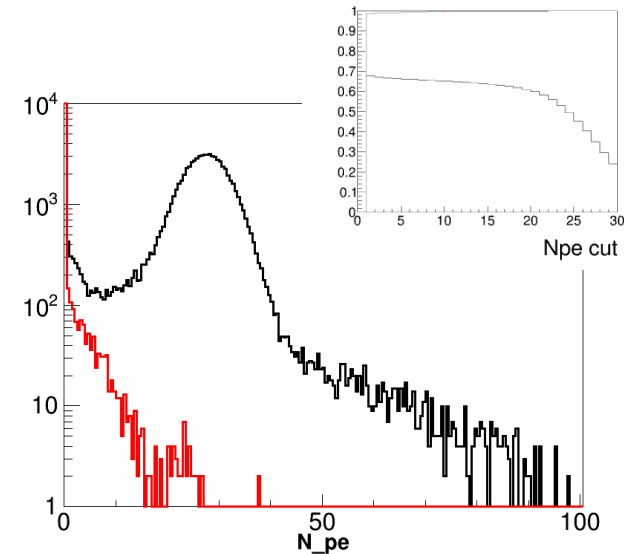
1.0-1.5GeV, 8-15deg



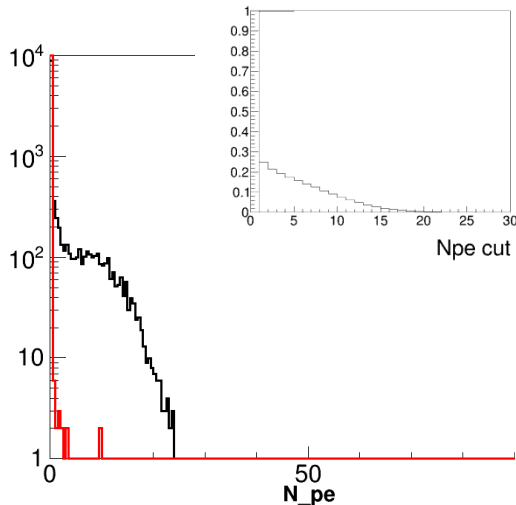
LGC (8-15deg)

- Signal in black shows eff, background in red shows 1-eff
- Full target
- with collimator

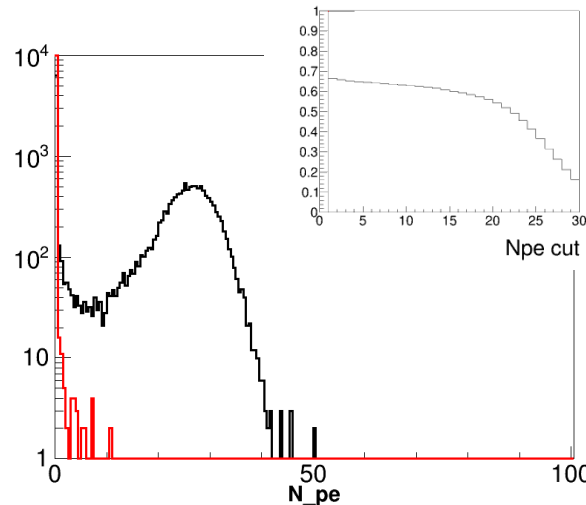
4.0-4.5GeV, 8-15deg



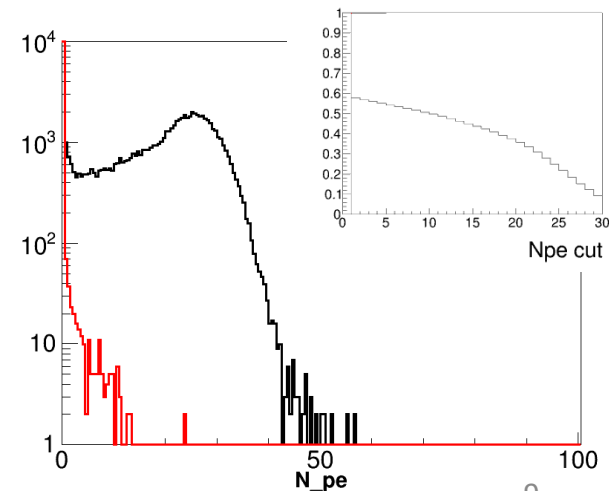
1.0-1.5GeV, 8-9deg



1.0-1.5GeV, 13-14deg



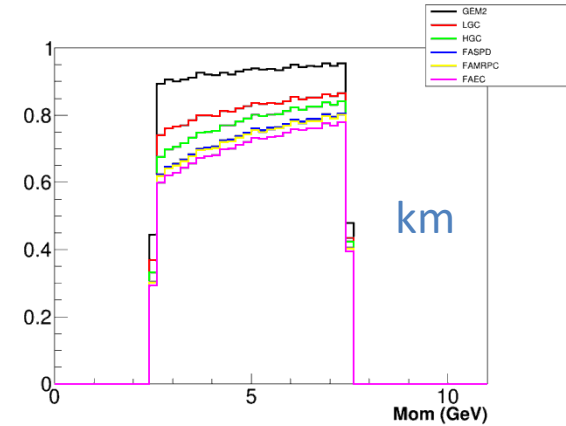
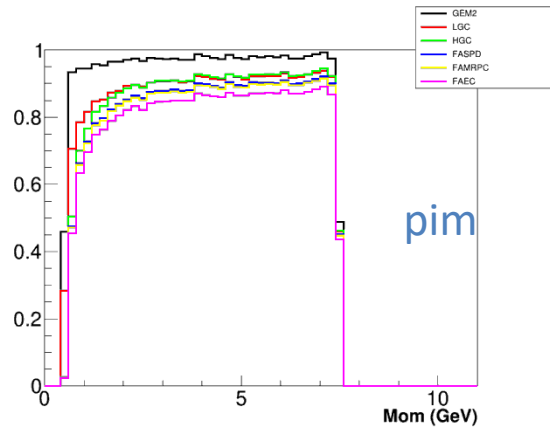
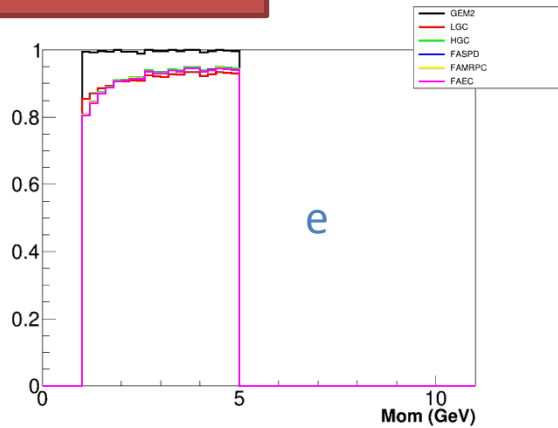
1.0-1.5GeV, 8-15deg



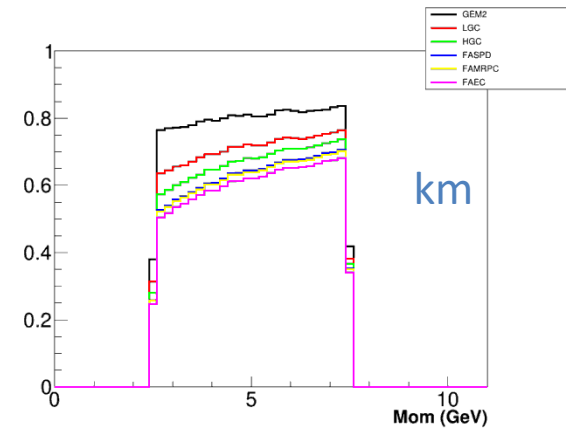
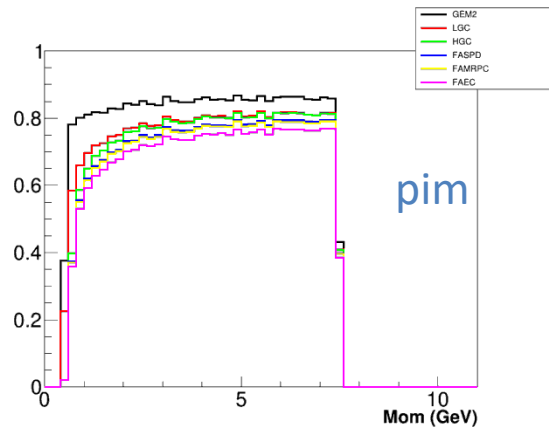
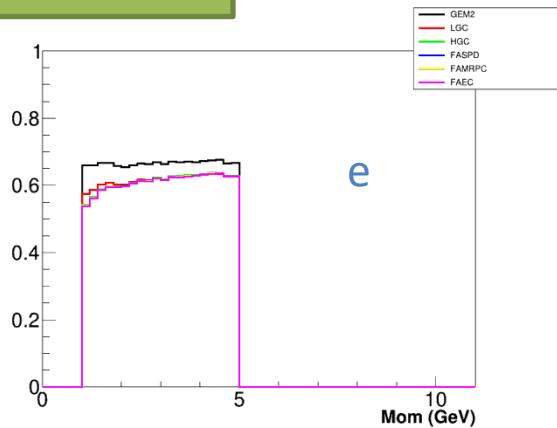
Particle surviving rate at various forward angle detector entrance (full target and 7-15deg)

SIDIS_He3 full setup with longer endcap and 2D solenoidv9 field

w/o Collimator



w Collimator

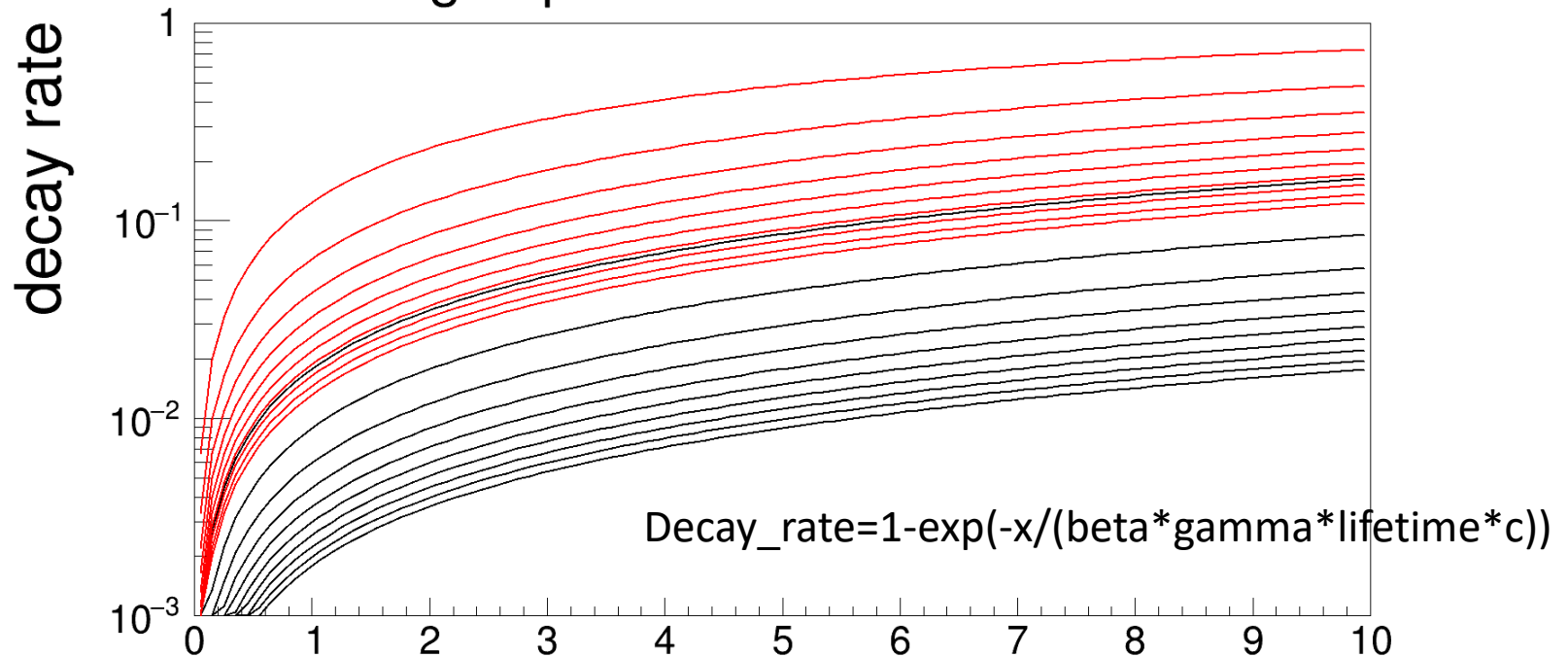


change between GEM2 and LGC mainly due to acceptance loss near 7 deg because it has not been optimized

Decay rate in vacuum with 6.7m flight path (from target to hgc window in current endcap)

Mom (Gev)	1	2	3	4	5	6	7	8	9	10
pim	0.113	0.058	0.039	0.030	0.024	0.020	0.017	0.015	0.013	0.012
km	0.589	0.359	0.257	0.200	0.163	0.138	0.119	0.105	0.094	0.085

charged pion/kaon from 1 to 10 GeV



pi- life time 2.60e-8s 99% muon
K- life time 1.24e-8s 63% muon, 30% pion

flight path (m)

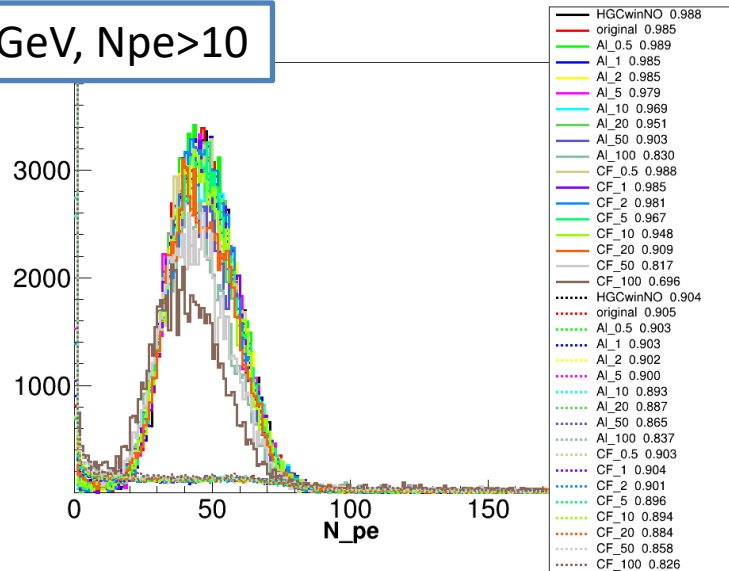
“single particle clean” with “hgc_moved”

eff at target

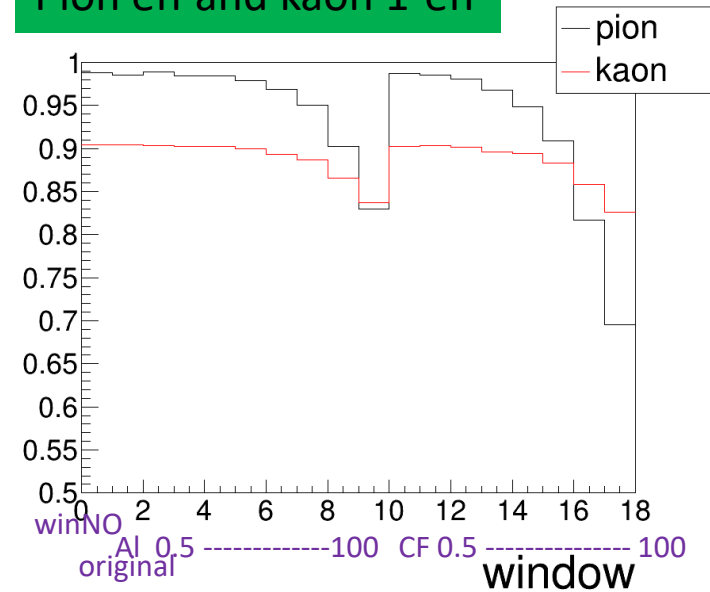
Full Vz

(The probability of a particle from target passing hgc cut)

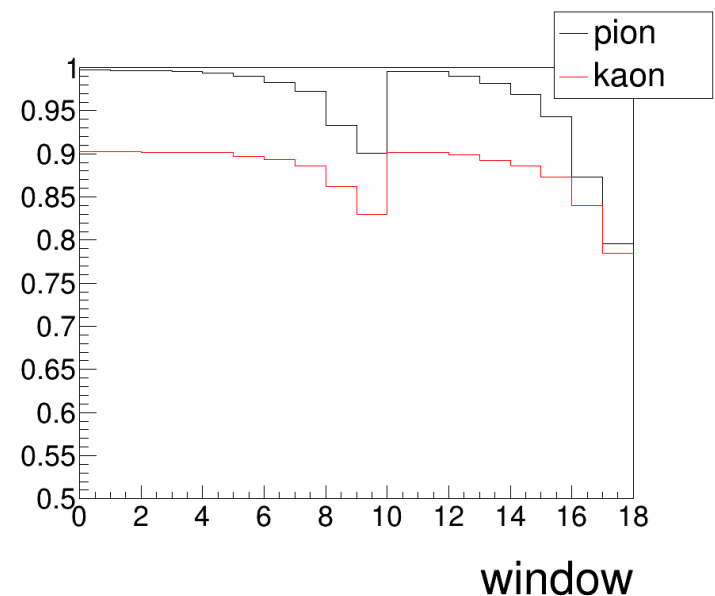
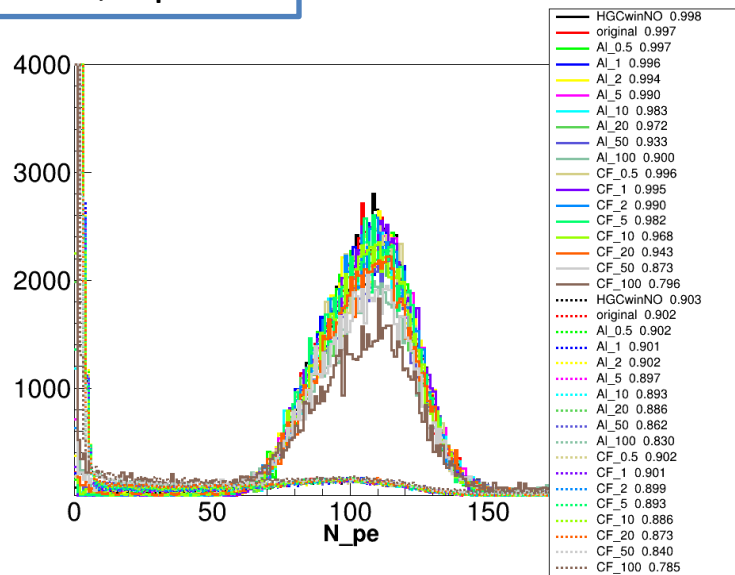
2.5-3.0 GeV, $N_{pe} > 10$



Pion eff and kaon 1-eff



7.0-7.5 GeV, $N_{pe} > 30$



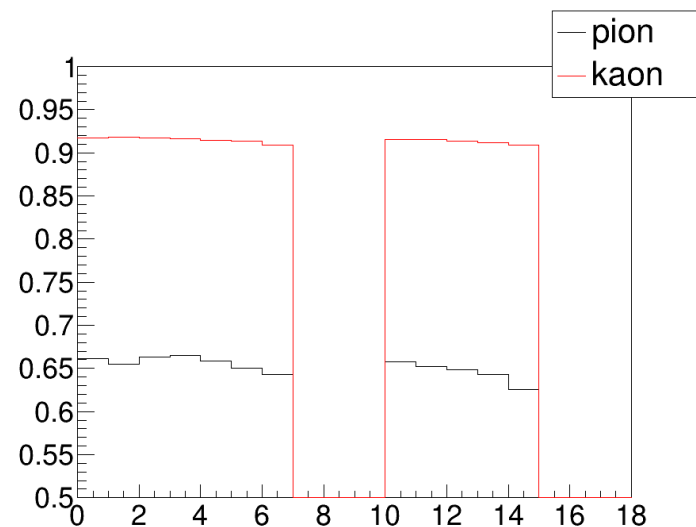
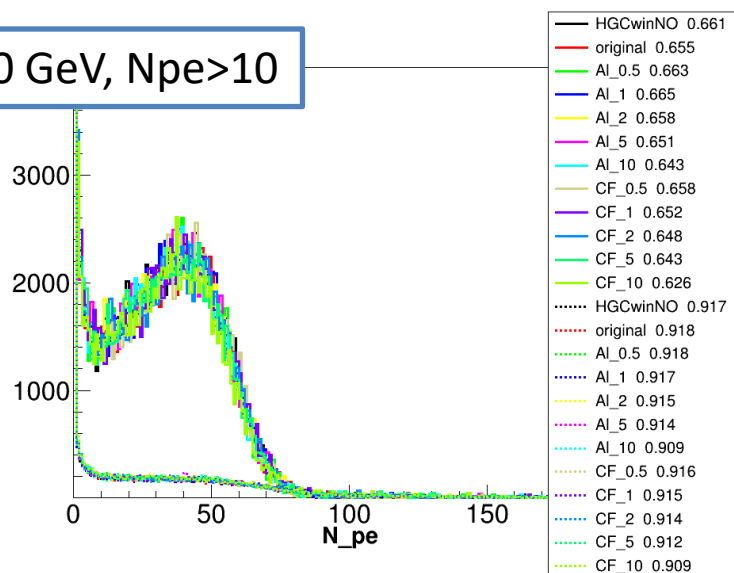
“single particle **dirty**” with “hgc_moved”

eff at target

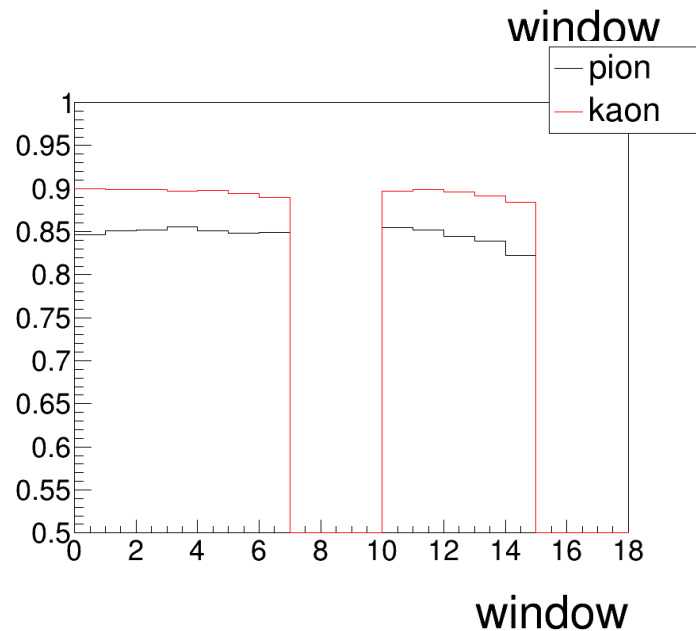
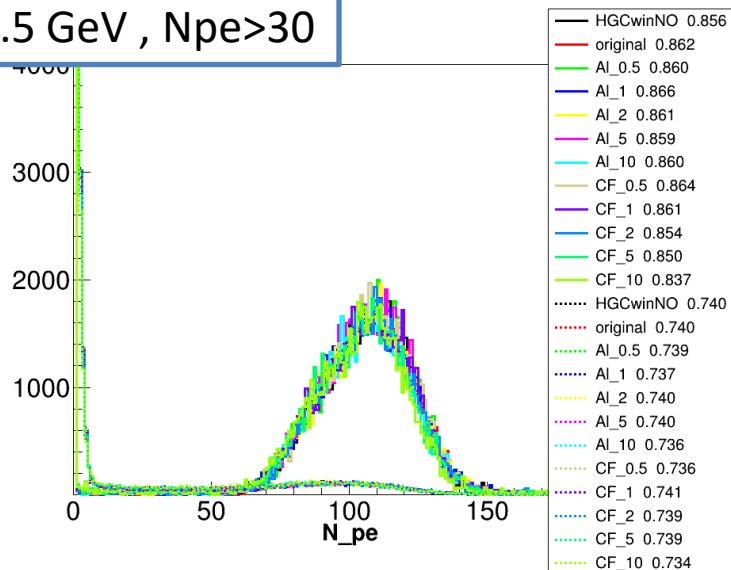
Full Vz

(The probability of a particle from target passing hgc cut)

2.5-3.0 GeV, $N_{pe} > 10$



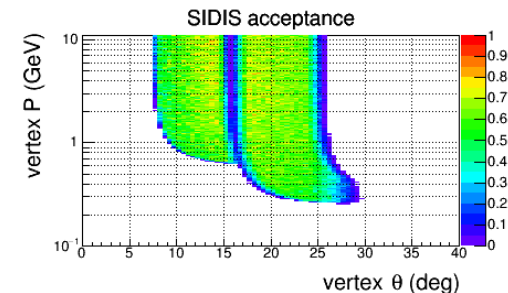
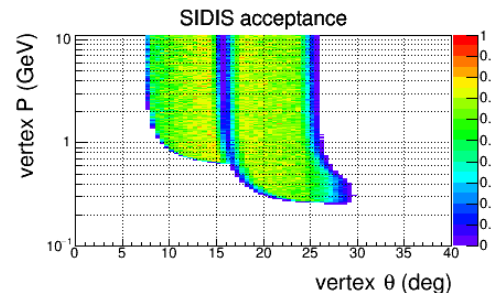
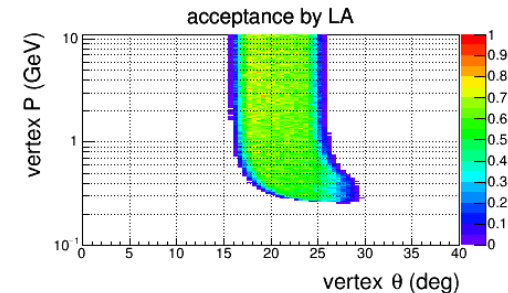
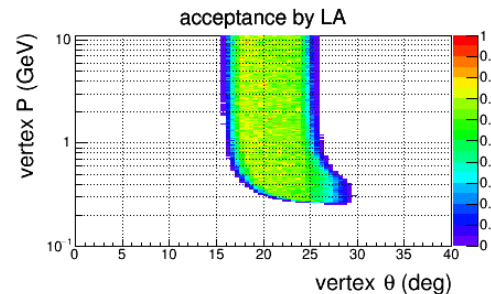
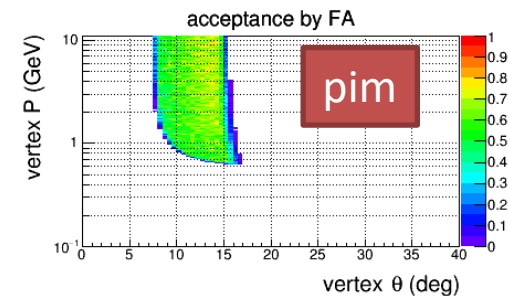
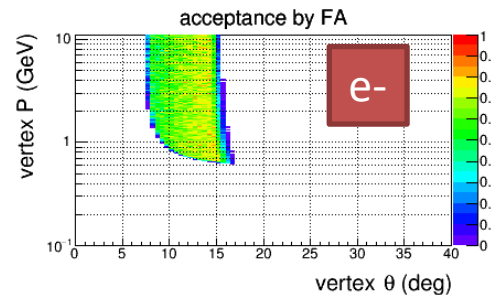
7.0-7.5 GeV, $N_{pe} > 30$



How acceptance and efficiency apply to SIDIS_He3 physics projection

- SIDIS generator with crosssection
- Apply acceptance from 2D plot for e and pion
- Apply $\theta \geq 8^\circ$ cut
- Apply overall 0.85 eff for sidis event

SIDIS_He3 full setup acceptance (201701)
Primary particle detected by EC and GEM



HGC pim eff at target

(Npe>=1, target full, full setup with collimator)

7-8,8-9,8-9,....., 14-15 deg

2.5-3.0GeV

2.5-3.0GeV

2.5-3.0GeV

.

.

.

.

.

.

7.0-7.5GeV

0.544,0.647,0.689,0.712,0.724,0.733,0.735,0.704

0.685,0.788,0.832,0.852,0.860,0.871,0.860,0.818,

0.711,0.801,0.839,0.845,0.859,0.870,0.870,0.826,

0.721,0.818,0.842,0.856,0.859,0.871,0.873,0.826,

0.718,0.821,0.845,0.863,0.866,0.880,0.876,0.839,

0.732,0.821,0.848,0.867,0.872,0.875,0.881,0.831,

0.748,0.827,0.847,0.856,0.871,0.885,0.888,0.839,

0.759,0.834,0.854,0.861,0.873,0.880,0.884,0.838,

0.761,0.842,0.855,0.871,0.871,0.885,0.884,0.848,

0.773,0.840,0.865,0.869,0.885,0.887,0.890,0.845,

HGC pim eff at target

(Npe>=5, target full, full setup with collimator)

7-8,8-9,8-9,....., 14-15 deg

2.5-3.0GeV	0.469,0.566,0.603,0.624,0.641,0.653,0.658,0.629,
2.5-3.0GeV	0.683,0.786,0.830,0.849,0.858,0.869,0.858,0.816,
2.5-3.0GeV	0.708,0.800,0.838,0.844,0.858,0.868,0.869,0.823,
.	0.717,0.815,0.840,0.854,0.857,0.869,0.871,0.822,
.	0.716,0.819,0.843,0.861,0.865,0.878,0.875,0.836,
.	0.729,0.819,0.846,0.864,0.870,0.873,0.880,0.827,
.	0.745,0.823,0.846,0.855,0.868,0.884,0.886,0.835,
.	0.755,0.831,0.852,0.859,0.871,0.878,0.882,0.834,
.	0.756,0.839,0.853,0.869,0.870,0.883,0.882,0.843,
7.0-7.5GeV	0.769,0.837,0.862,0.866,0.882,0.884,0.887,0.840,

LGC e- eff at target

(Npe>=1, target full, full setup with collimator)

7-8,8-9,8-9,....., 14-15 deg

1.0-1.5GeV	0.00,0.250,0.500,0.570,0.609,0.633,0.665,0.684,
1.5-2.0GeV	0.00,0.440,0.552,0.599,0.637,0.661,0.696,0.712,
2.0-2.5GeV	0.00,0.486,0.563,0.606,0.645,0.679,0.702,0.728,
.	0.00,0.514,0.577,0.620,0.658,0.691,0.716,0.733,
.	0.00,0.519,0.587,0.630,0.666,0.695,0.722,0.745,
.	0.00,0.532,0.593,0.642,0.669,0.704,0.726,0.749,
.	0.00,0.534,0.600,0.651,0.679,0.703,0.733,0.753,
4.0-4.5GeV	

LGC e- eff at target

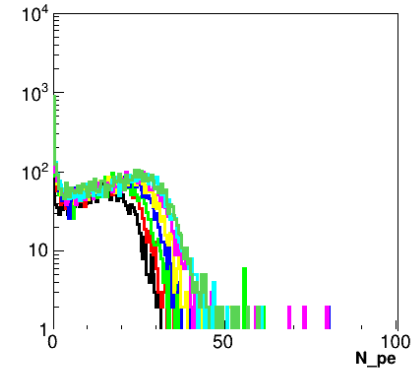
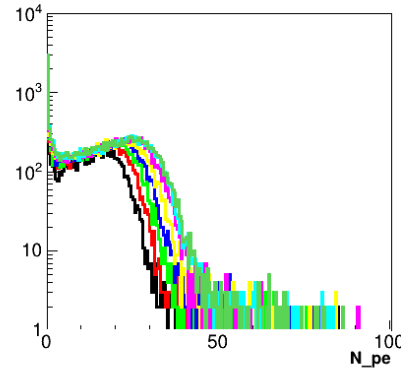
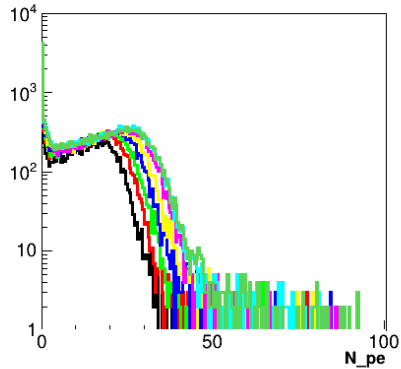
(Npe>=5, target full, full setup with collimator)

7-8,8-9,8-9,....., 14-15 deg

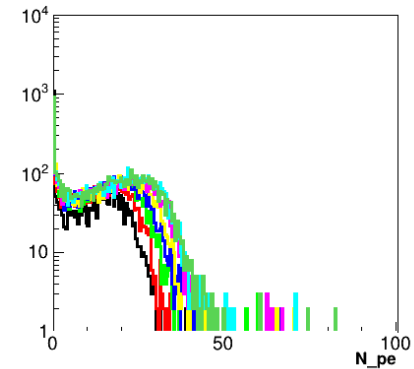
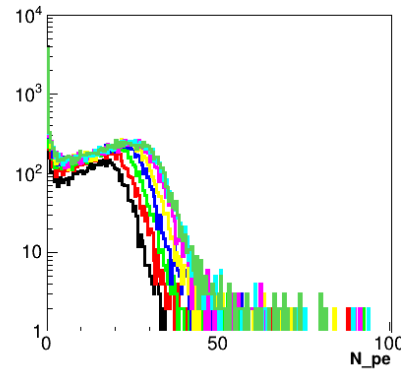
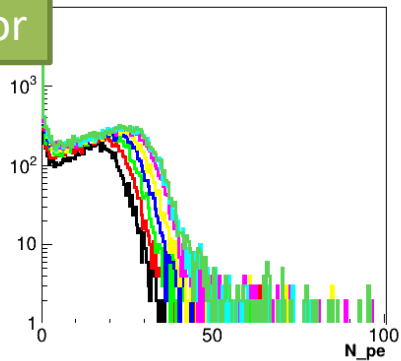
1.0-1.5GeV	0.00,0.158,0.443,0.537,0.584,0.610,0.645,0.655,
1.5-2.0GeV	0.00,0.385,0.537,0.585,0.623,0.649,0.682,0.688,
2.0-2.5GeV	0.00,0.454,0.550,0.595,0.634,0.667,0.689,0.704,
.	0.00,0.495,0.565,0.608,0.647,0.679,0.702,0.713,
.	0.00,0.504,0.574,0.617,0.654,0.683,0.708,0.724,
.	0.00,0.517,0.580,0.630,0.658,0.691,0.712,0.729,
.	0.00,0.518,0.588,0.637,0.667,0.689,0.720,0.732,
4.0-4.5GeV	

HGC signal Npe at various angle (mom 2.5-3.0GeV)

w/o Collimator



w Collimator



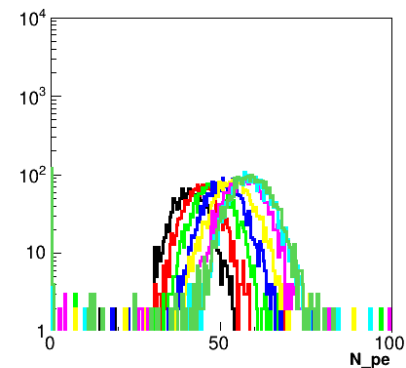
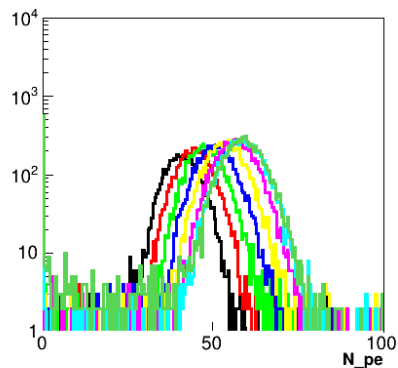
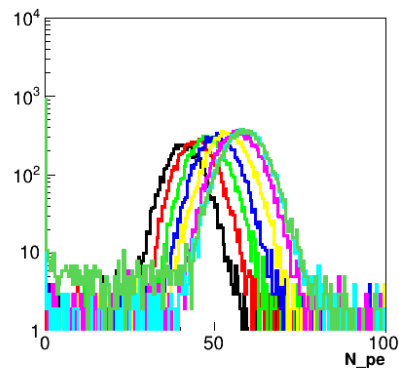
Target full

Target 30cm

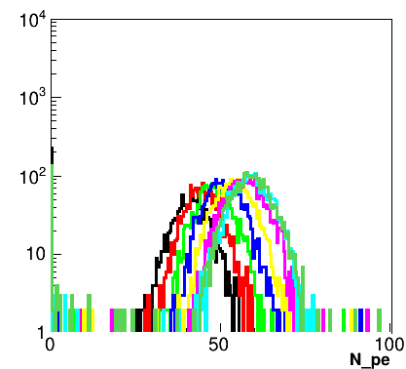
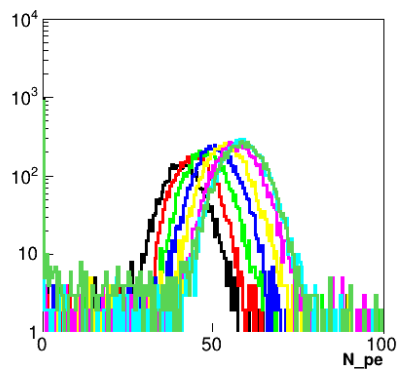
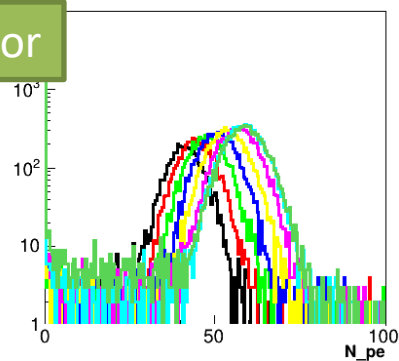
Target 10cm

HGC signal N_{pe} at various angle (mom 7.0-7.5GeV)

w/o Collimator



w Collimator



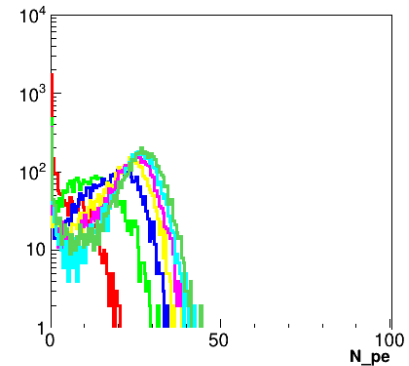
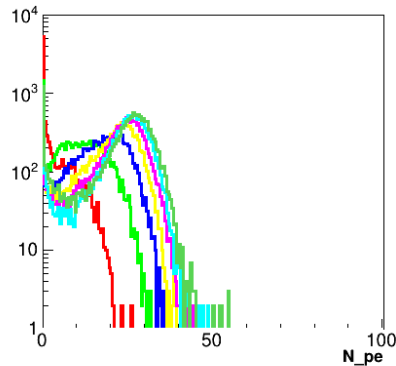
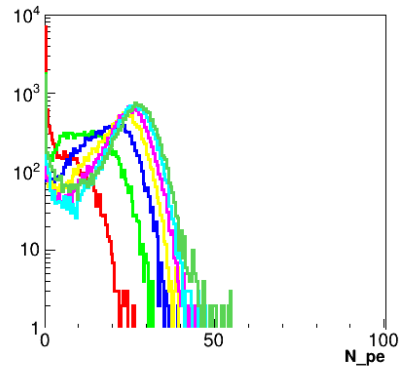
Target full

Target 30cm

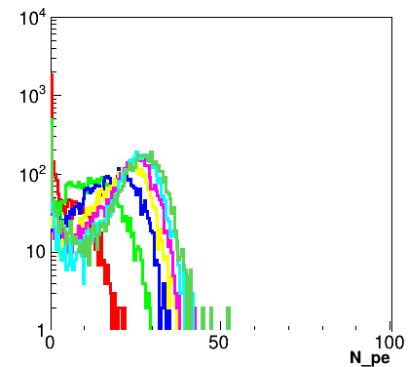
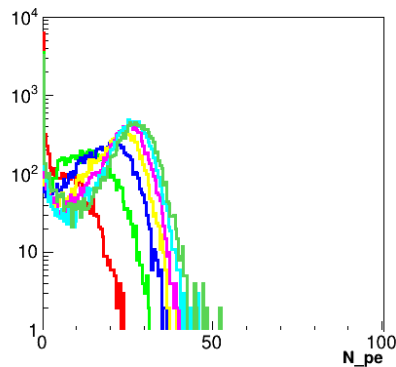
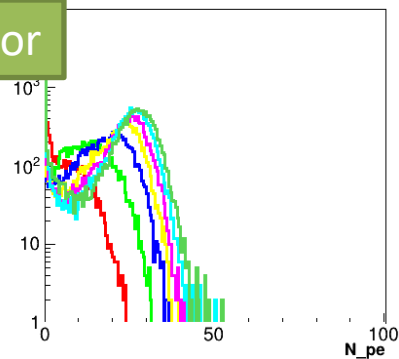
Target 10cm

LGC signal Npe at various angle (mom 1.0-1.5GeV)

w/o Collimator



w Collimator



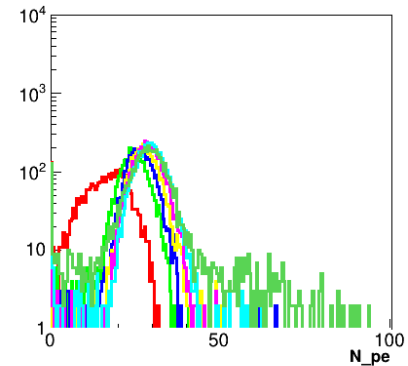
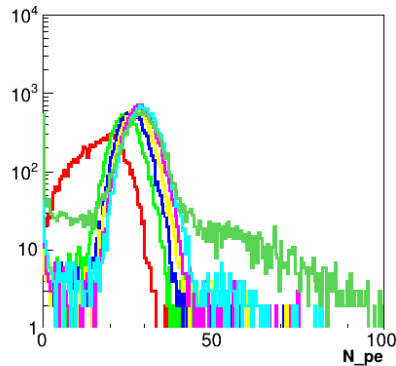
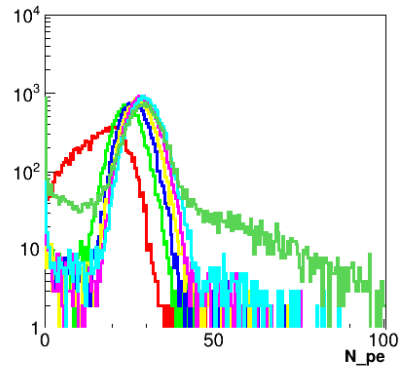
Target full

Target 30cm

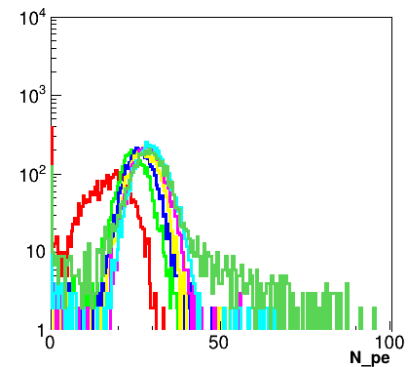
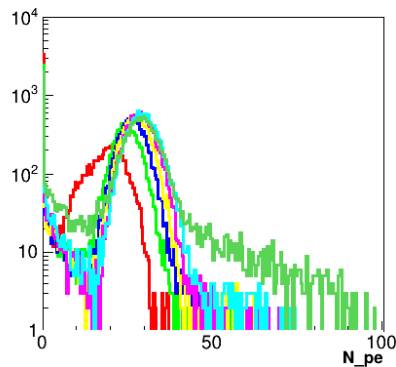
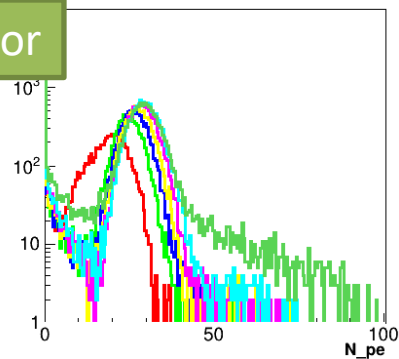
Target 10cm

LGC signal Npe at various angle (mom 4.0-4.5GeV)

w/o Collimator



w Collimator



Target full

Target 30cm

Target 10cm