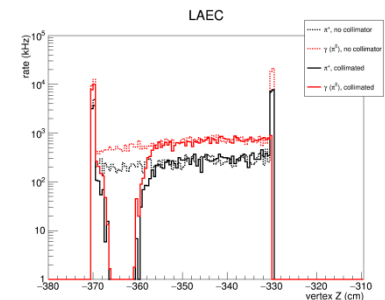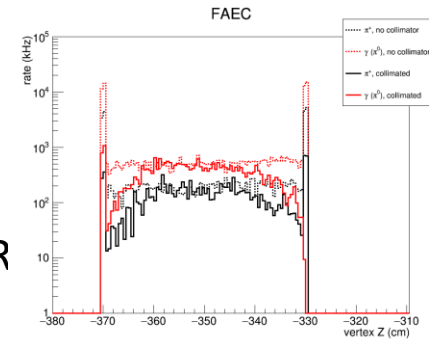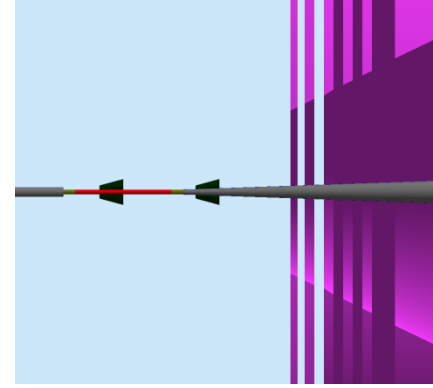# HGC and LGC cut study

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 CO_2 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 Npe>=1 where background particle rejection is lowest.

- All plots has signal and background events in 1:1 ratio
- Both LHC and HGC Npe 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 (Npe>=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	0.95	0.97
HGC (pim) Target full, w collimators	0.82	0.86
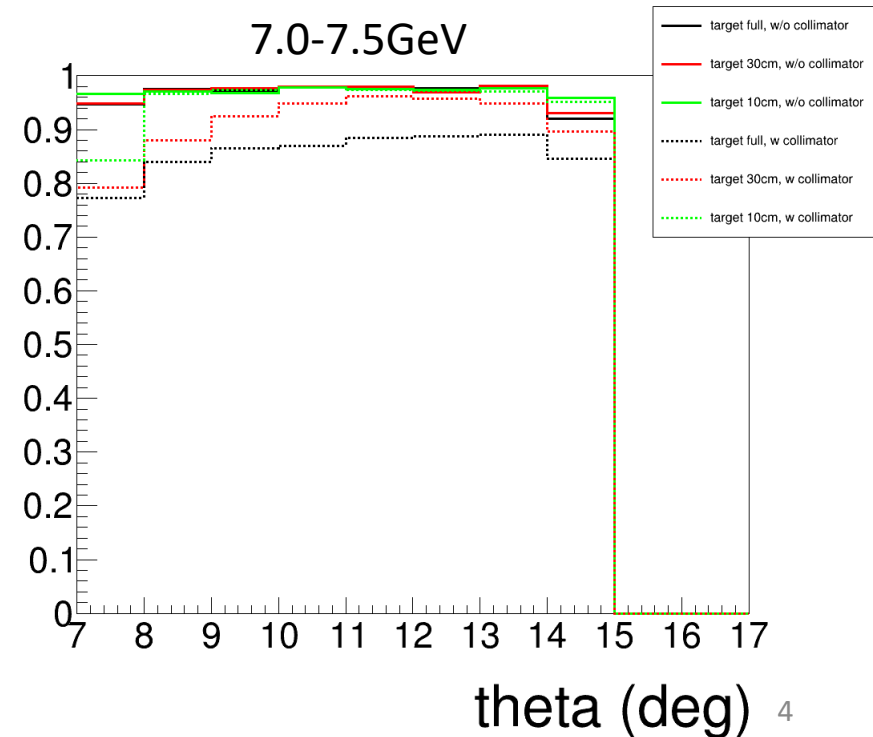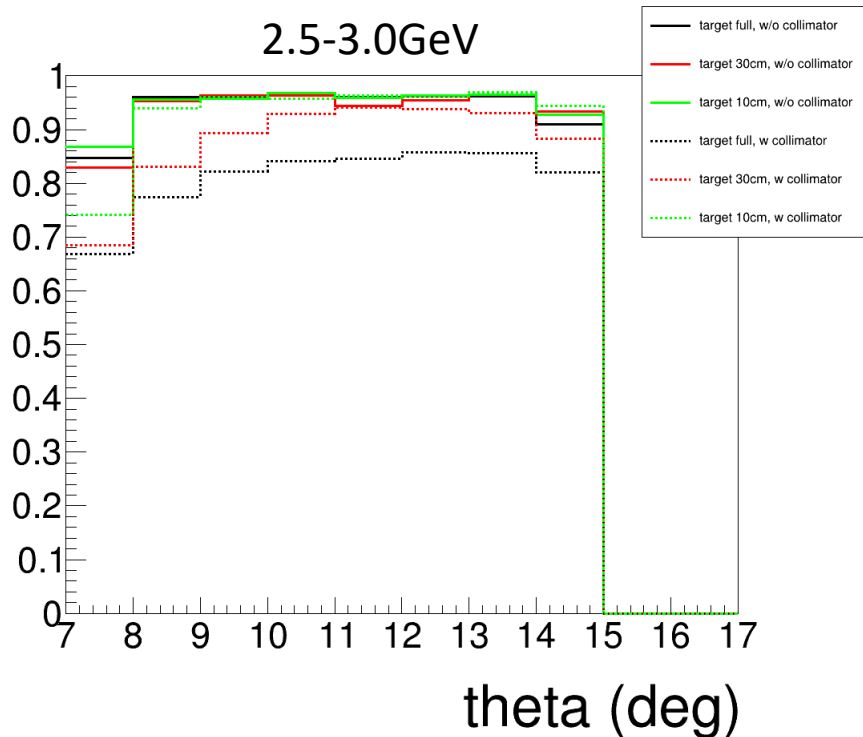
Max signal particle efficiency at target for LGC with full setup

LGC standalone setup with only decay effect has …… ?
LGC full setup pion rejection ~100 without much dependence on momentum, angle, collimator
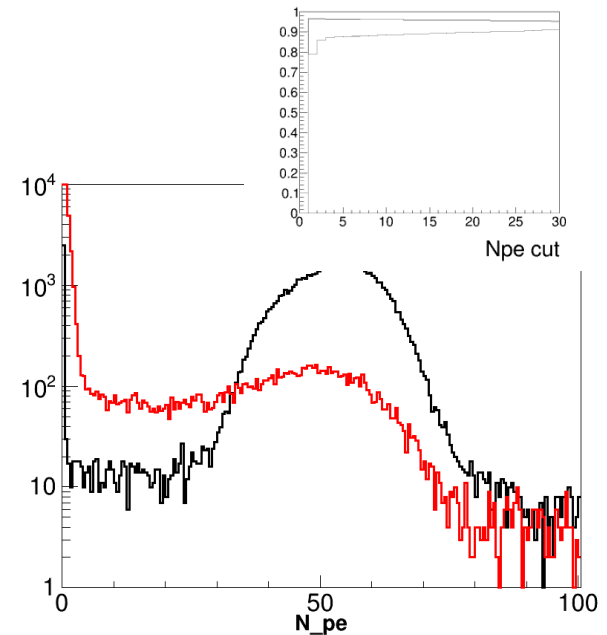
Signal particle Max efficiency (Npe>=1)	Low mom (1.0-1.5GeV) Full angle (8-15 deg)	high mom (4.0-4.5GeV) Full angle (8-15 deg)
LGC (e) Target full, w/o collimators	0.85	0.97
LGC (e) Target full, w collimators	0.58	0.68
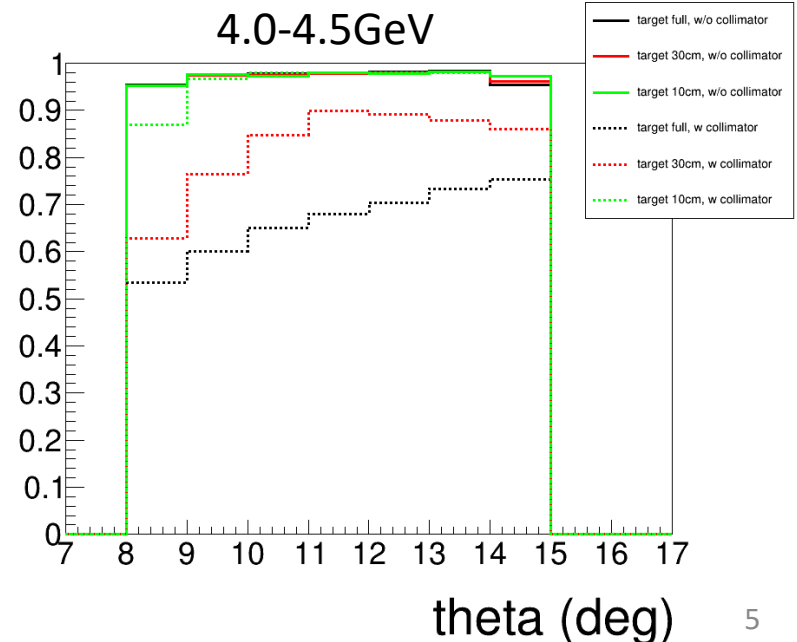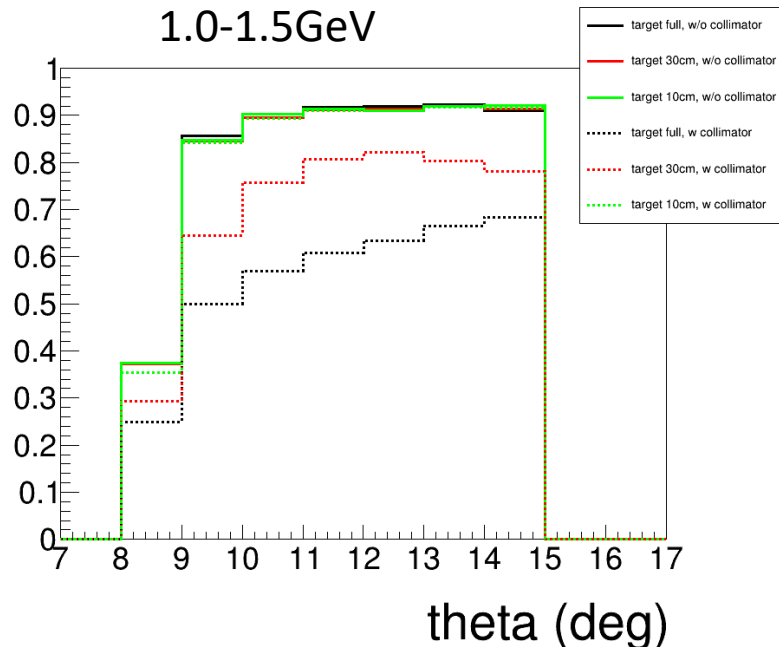
HGC_moved (7-15deg)

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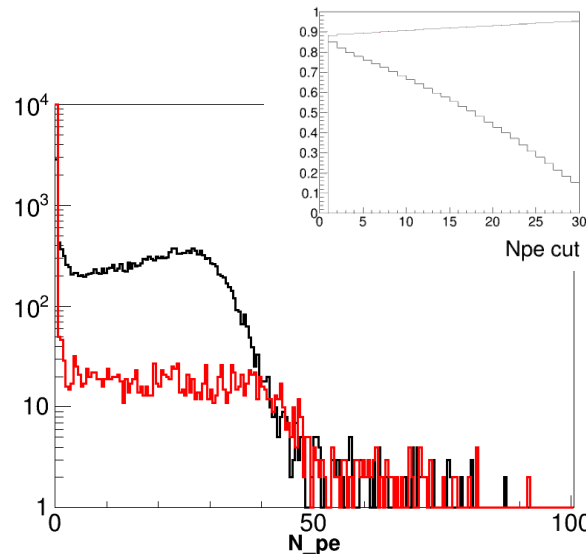- **without** collimator
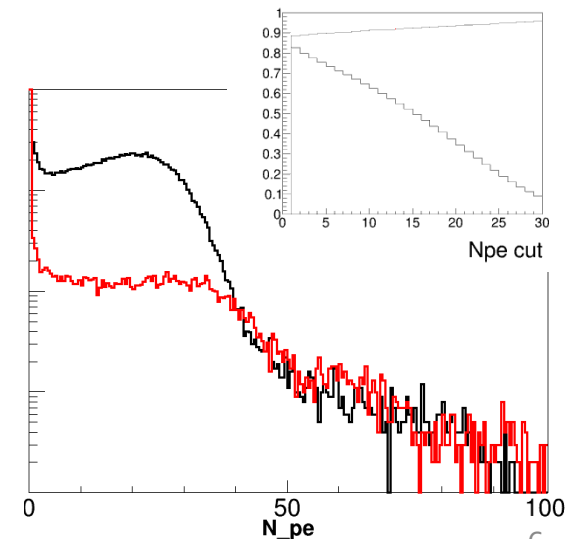

7.0-7.5GeV, 7-15deg

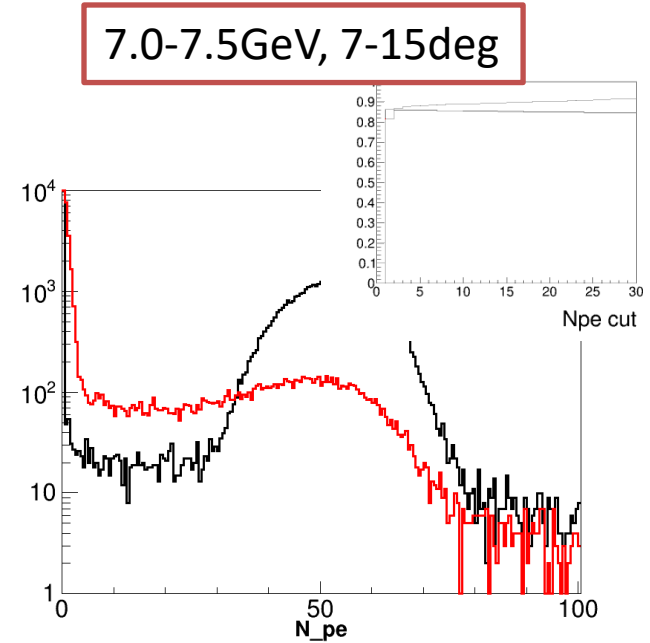2.5-3.0GeV, 7-8deg
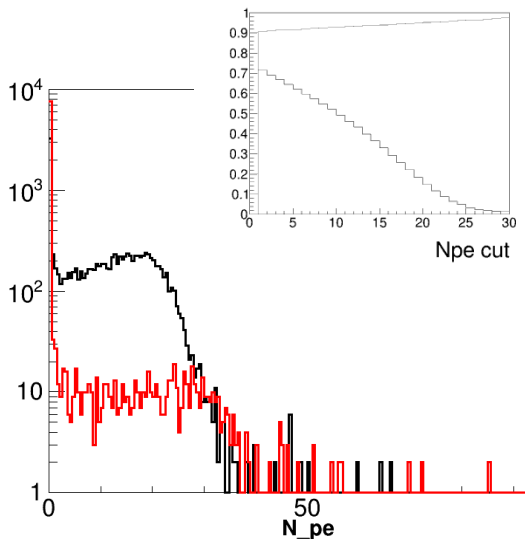
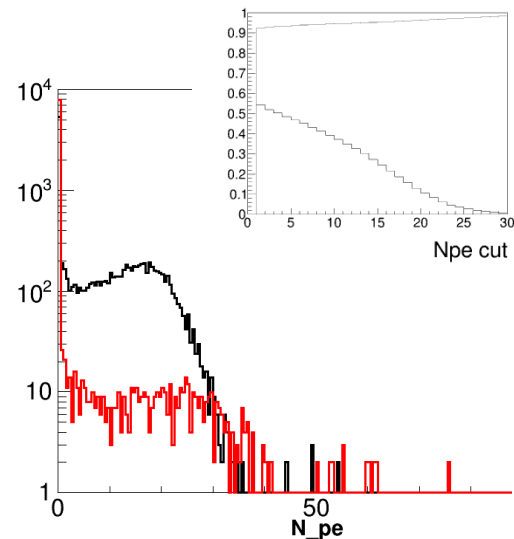2.5-3.0GeV, 13-14deg

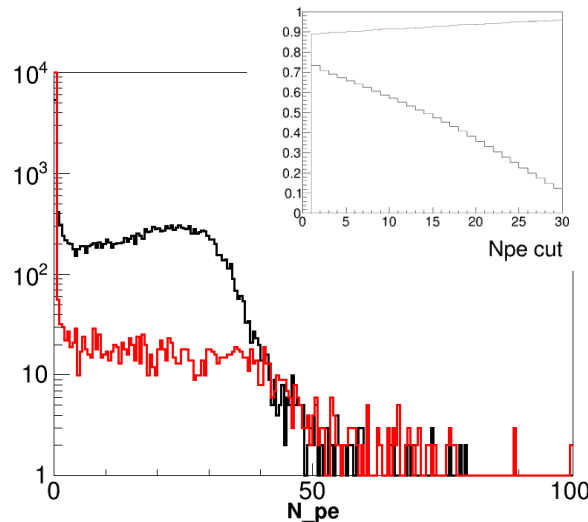2.5-3.0GeV, 7-15deg

HGC_moved (7-15deg)

- Signal in black shows eff, background in red shows 1-eff
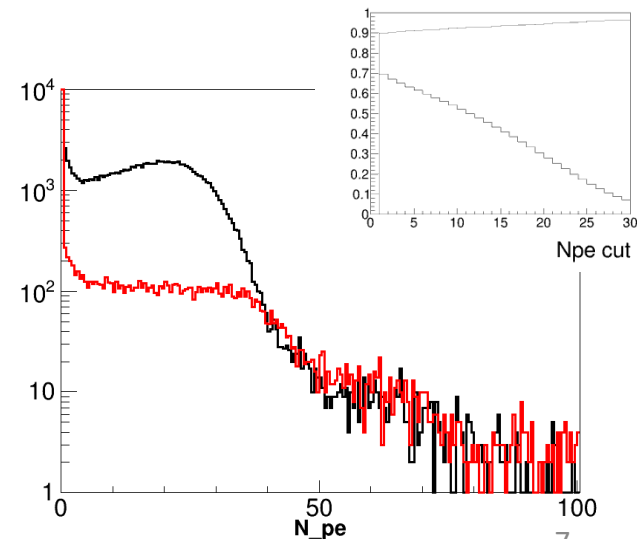- Full target
- with collimator
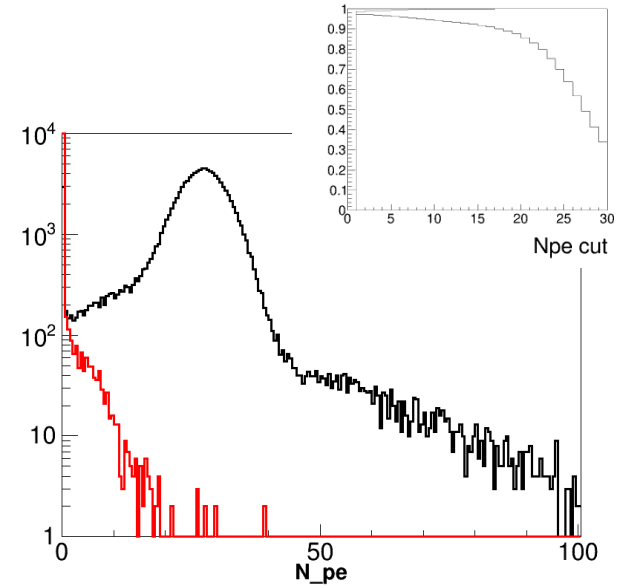
2.5-3.0GeV, 7-8deg

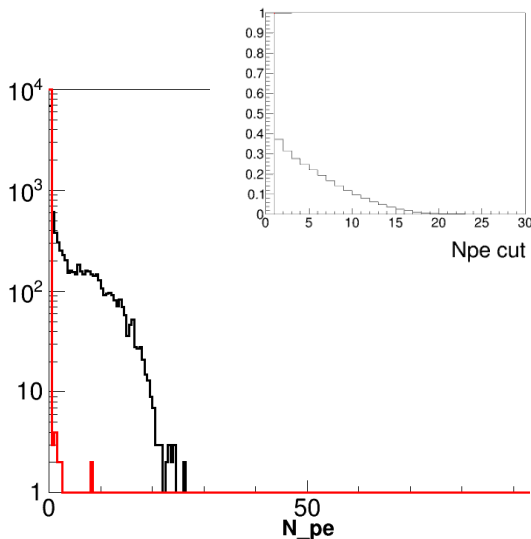2.5-3.0GeV, 13-14deg

2.5-3.0GeV, 7-15deg

LGC (8-15deg)

- Signal in black shows eff, background in red shows 1-eff
- Full target
- without collimator
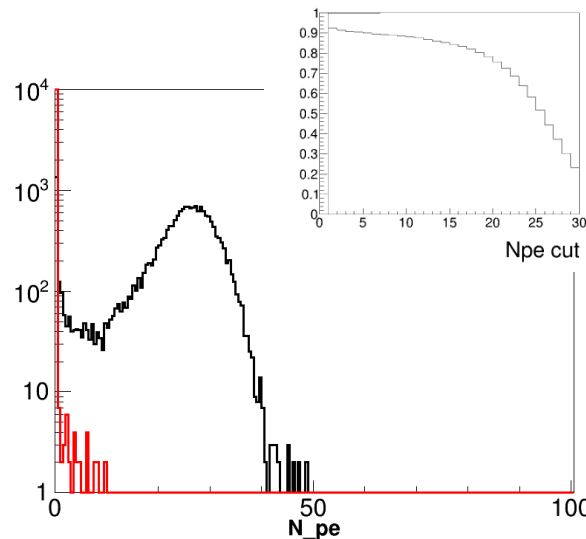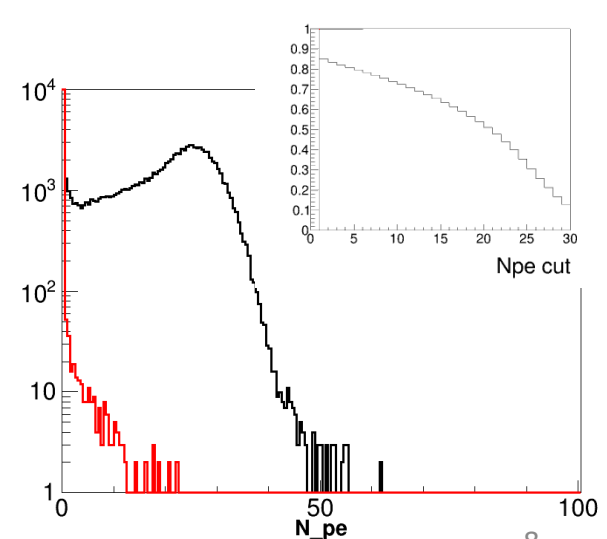
4.0-4.5GeV, 8-15deg

1.0-1.5GeV, 8-9deg

1.0-1.5GeV, 13-14deg

1.0-1.5GeV, 8-15deg

8

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
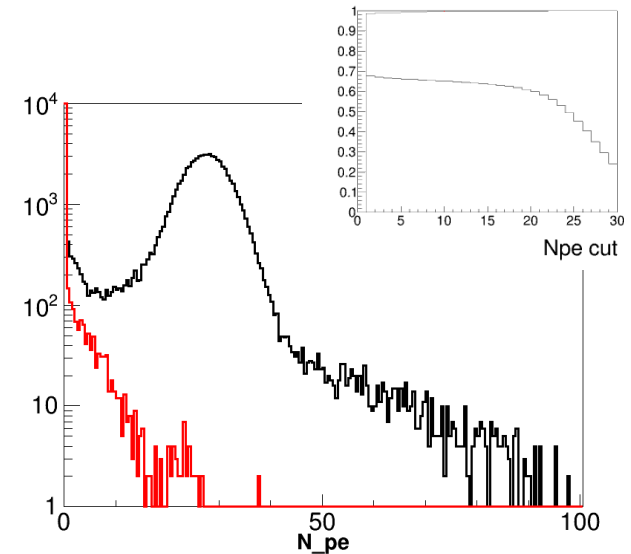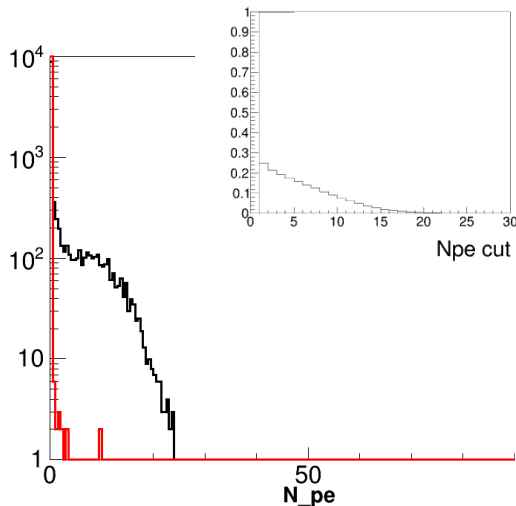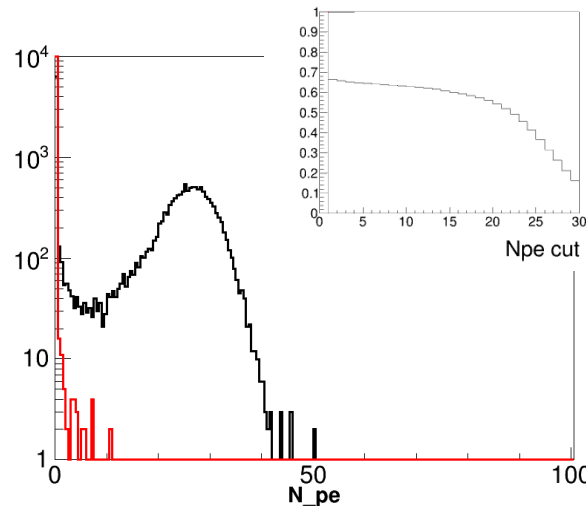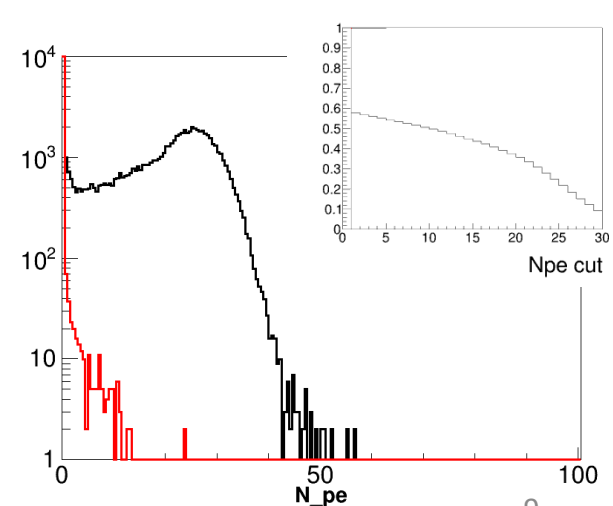

1.0-1.5GeV, 8-15deg

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

SIDIS_He3 full setup with longer endcap and 2D soleniodv9 field

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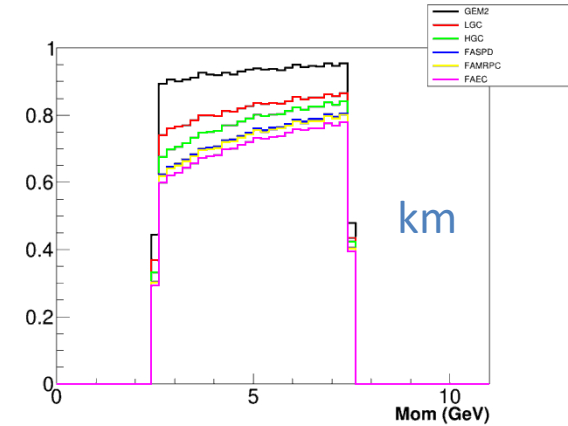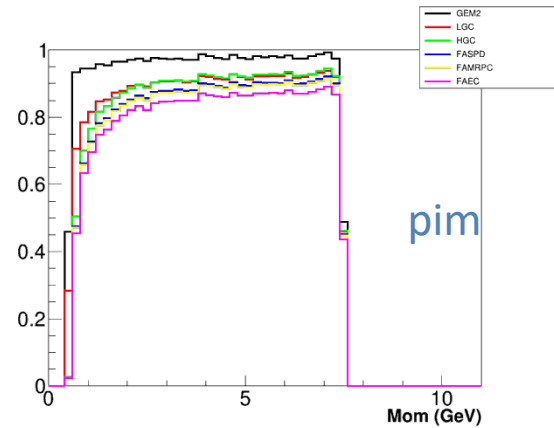
w Collimator
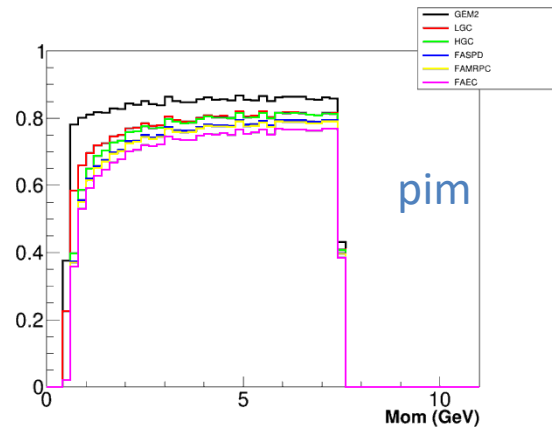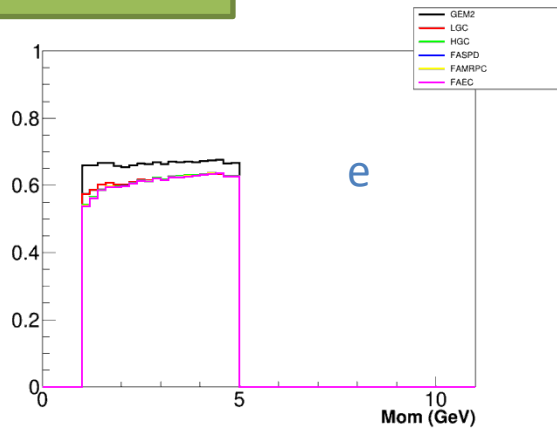
change between GEM2 and LGC mainly due to acceptance loss near 7 deg because it has not been optimized

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

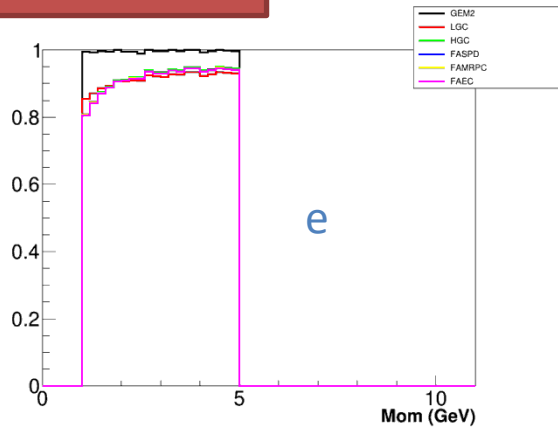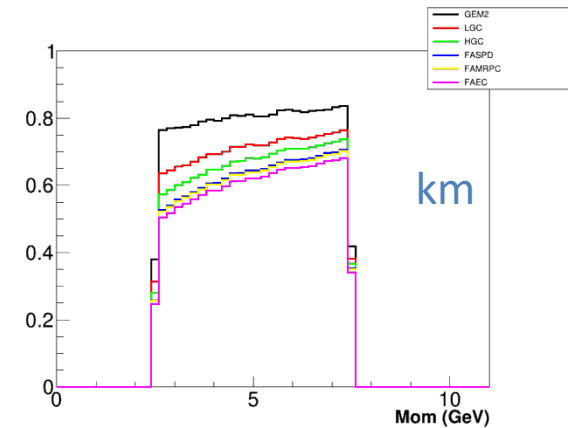| Mom (Gev)	1	2	3	4	5	6	7	8	9	10
pim	0.113	0.058	0.039	0.030	0.024	0.020	0.017	0.015	0.013	0.012
km	0.589	0.359	0.257	0.200	0.163	0.138	0.119	0.105	0.094	0.085

charged pion/kaon from 1 to 10 GeV

Decay_rate=1-exp(-x/(beta*gamma*lifetime*c))

decay rate

flight path (m)

pi- life time 2.60e-8s 99% muon

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

eff at target

Full Vz

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

2.5-3.0 GeV, Npe>10

HGCwinNO	0.988
original	0.985
Al_0.5	0.989
Al_1	0.985
Al_2	0.985
Al_5	0.979
Al_10	0.969
Al_20	0.951
Al_50	0.903
Al_100	0.830
CF_0.5	0.988
CF_1	0.985
CF_2	0.981
CF_5	0.967
CF_10	0.948
CF_20	0.909
CF_50	0.817
CF_100	0.696
HGCwinNO	0.904
original	0.905
Al_0.5	0.903
Al_1	0.903
Al_2	0.902
Al_5	0.900
Al_10	0.893
Al_20	0.887
Al_50	0.865
Al_100	0.837
CF_0.5	0.903
CF_1	0.904
CF_2	0.901
CF_5	0.896
CF_10	0.894
CF_20	0.884
CF_50	0.858
CF_100	0.826

Pion eff and kaon 1-eff

winNO
original
Al 0.5 -------------100   CF 0.5 --------------- 100

7.0-7.5 GeV , Npe>30

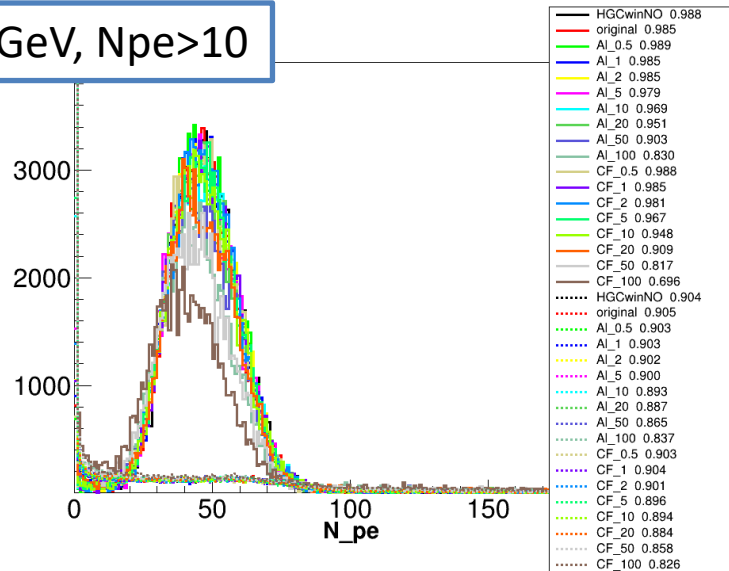|	
HGCwinNO	0.998
original	0.997
Al_0.5	0.997
Al_1	0.996
Al_2	0.994
Al_5	0.990
Al_10	0.983
Al_20	0.972
Al_50	0.933
Al_100	0.900
CF_0.5	0.996
CF_1	0.995
CF_2	0.990
CF_5	0.982
CF_10	0.968
CF_20	0.943
CF_50	0.873
CF_100	0.796
HGCwinNO	0.903
original	0.902
Al_0.5	0.902
Al_1	0.901
Al_2	0.902
Al_5	0.897
Al_10	0.893
Al_20	0.886
Al_50	0.862
Al_100	0.830
CF_0.5	0.902
CF_1	0.901
CF_2	0.899
CF_5	0.893
CF_10	0.886
CF_20	0.873
CF_50	0.840
CF_100	0.785

"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, Npe>10

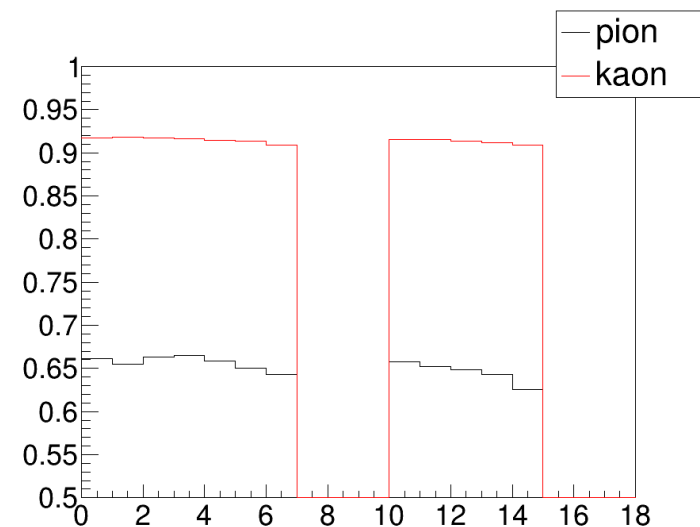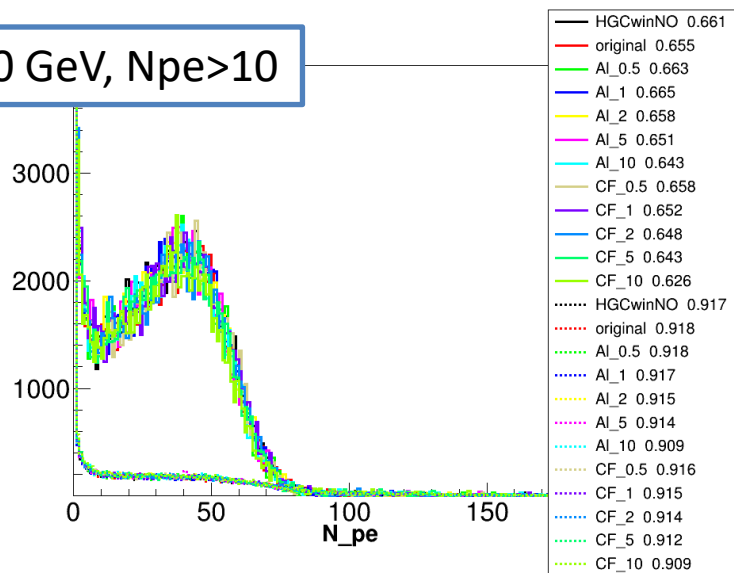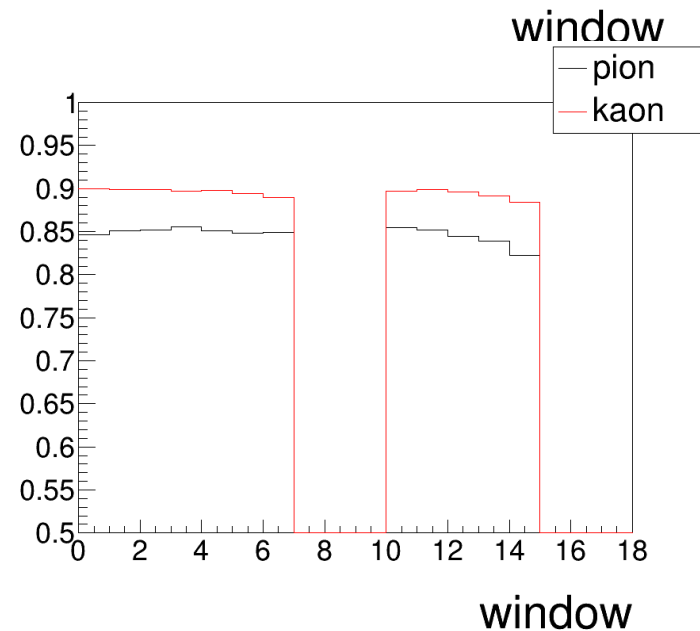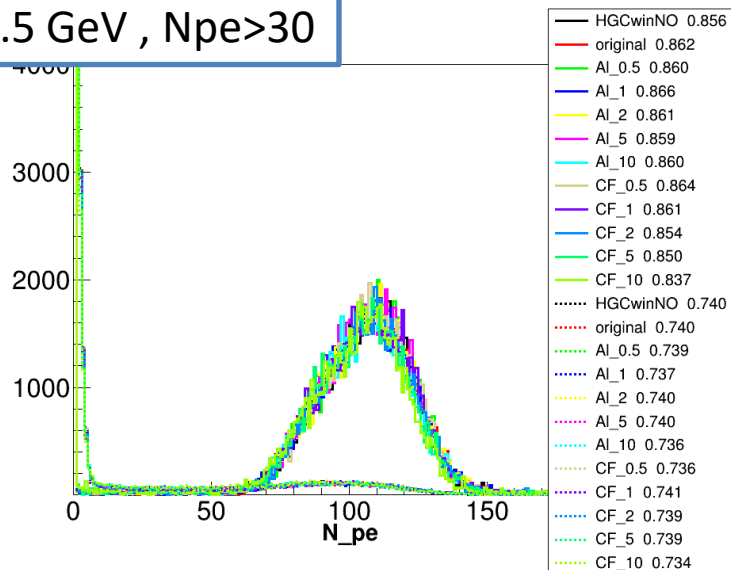|	
HGCwinNO	0.661
original	0.655
Al_0.5	0.663
Al_1	0.665
Al_2	0.658
Al_5	0.651
Al_10	0.643
CF_0.5	0.658
CF_1	0.652
CF_2	0.648
CF_5	0.643
CF_10	0.626
HGCwinNO	0.917
original	0.918
Al_0.5	0.918
Al_1	0.917
Al_2	0.915
Al_5	0.914
Al_10	0.909
CF_0.5	0.916
CF_1	0.915
CF_2	0.914
CF_5	0.912
CF_10	0.909

7.0-7.5 GeV , Npe>30

HGCwinNO	0.856
original	0.862
Al_0.5	0.860
Al_1	0.866
Al_2	0.861
Al_5	0.859
Al_10	0.860
CF_0.5	0.864
CF_1	0.861
CF_2	0.854
CF_5	0.850
CF_10	0.837
HGCwinNO	0.740
original	0.740
Al_0.5	0.739
Al_1	0.737
Al_2	0.740
Al_5	0.740
Al_10	0.736
CF_0.5	0.736
CF_1	0.741
CF_2	0.739
CF_5	0.739
CF_10	0.734

pion
kaon

window

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>=8deg cut

- Apply overall 0.85 eff for sidis event

SIDIS_He3 full setup acceptance (201701)
Primary particle detected by EC and GEM
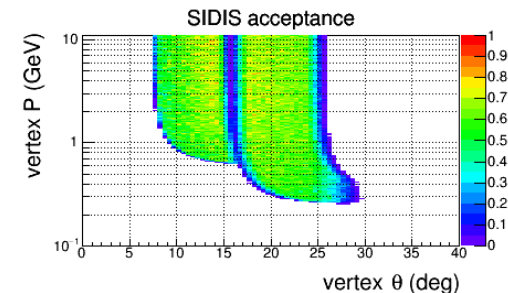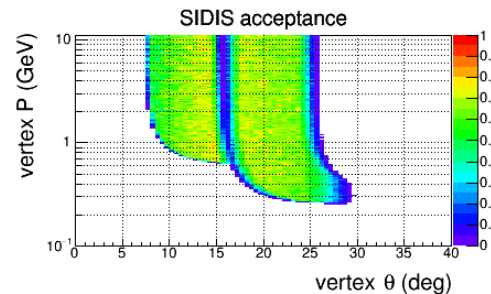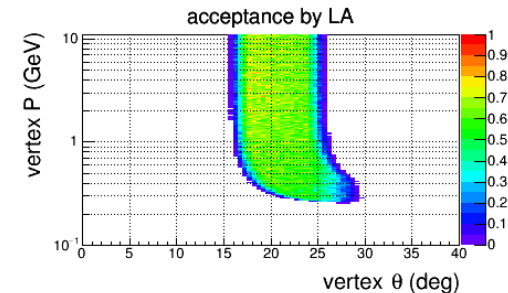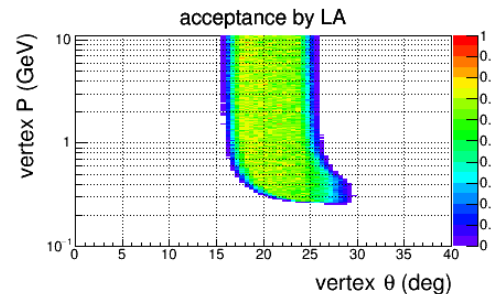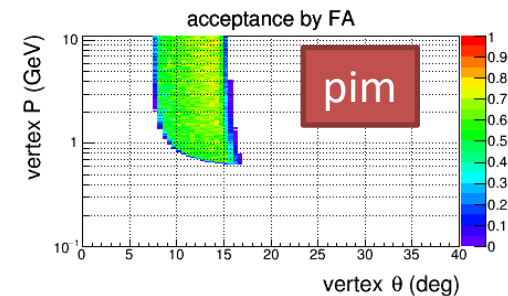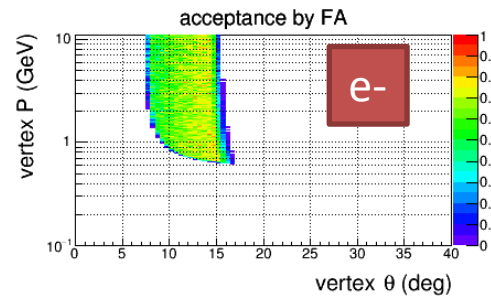
HGC pim eff at target
(Npe>=1, target full, full setup with collimator)

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

2.5-3.0GeV	0.544,0.647,0.689,0.712,0.724,0.733,0.735,0.704
2.5-3.0GeV	0.685,0.788,0.832,0.852,0.860,0.871,0.860,0.818,
2.5-3.0GeV	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,
7.0-7.5GeV	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,
4.0-4.5GeV	0.00,0.534,0.600,0.651,0.679,0.703,0.733,0.753,

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

19
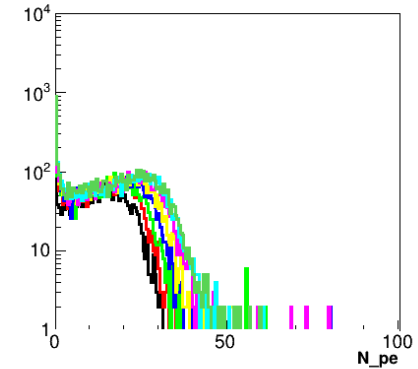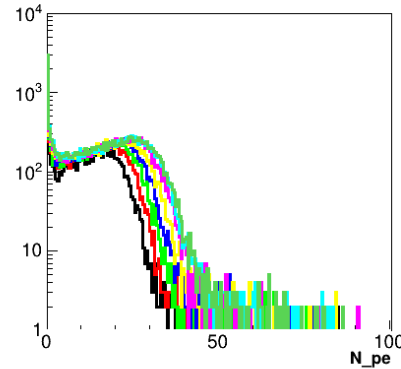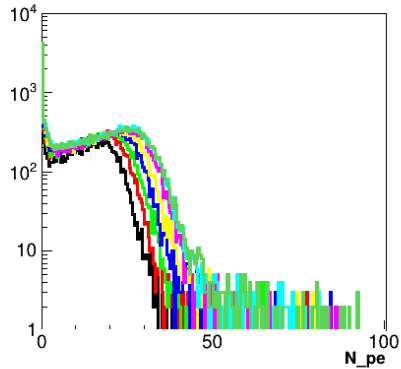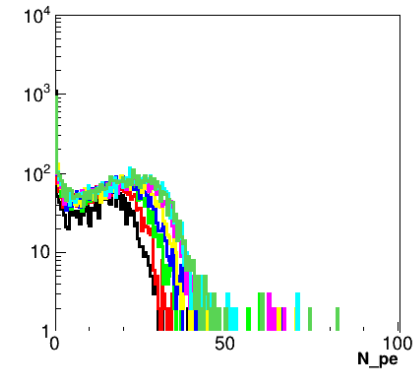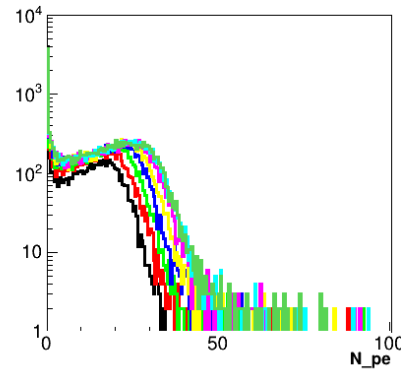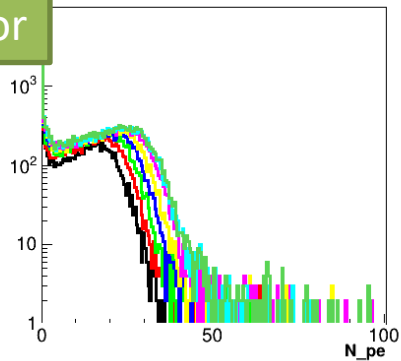
HGC signal Npe at various angle (mom 7.0-7.5GeV)
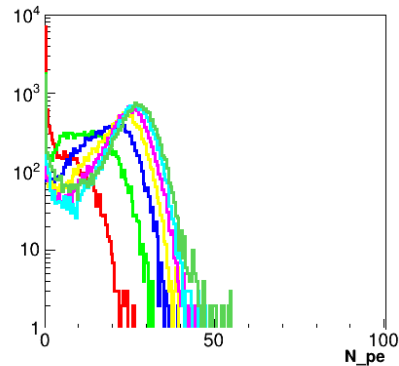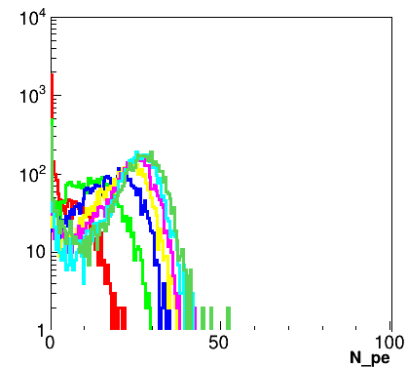
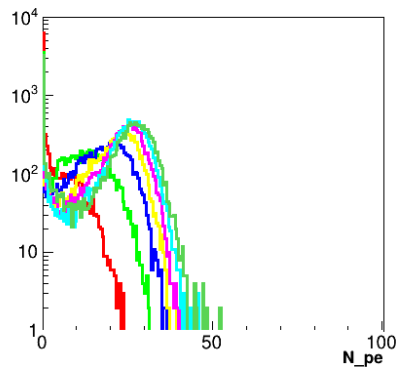w/o Collimator
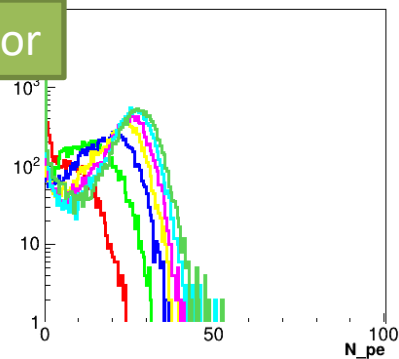
w Collimator

Target full

Target 30cm

Target 10cm

20

LGC signal Npe at various angle (mom 1.0-1.5GeV)
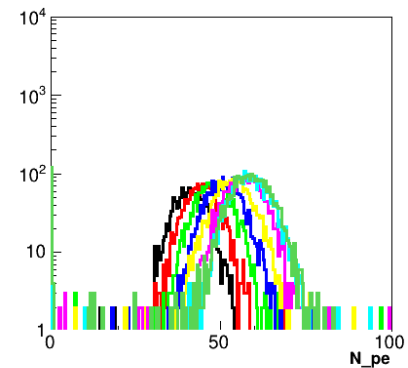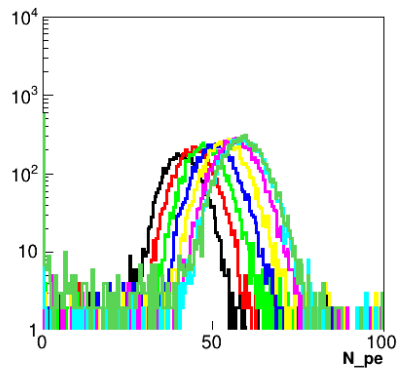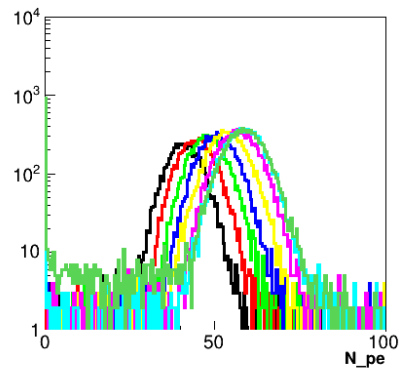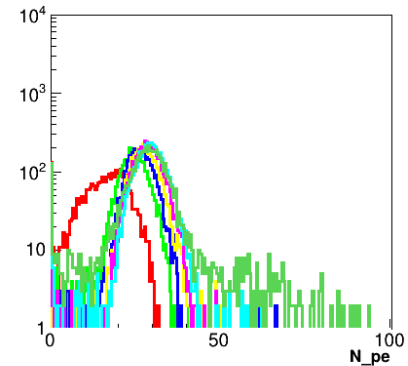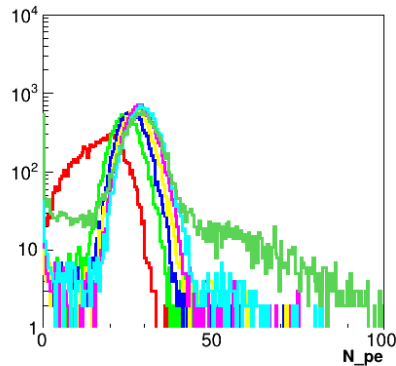
w/o Collimator
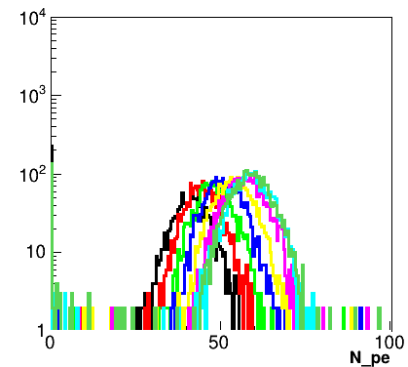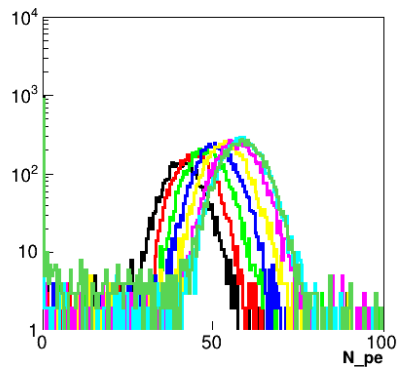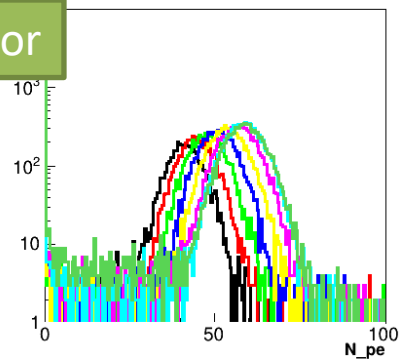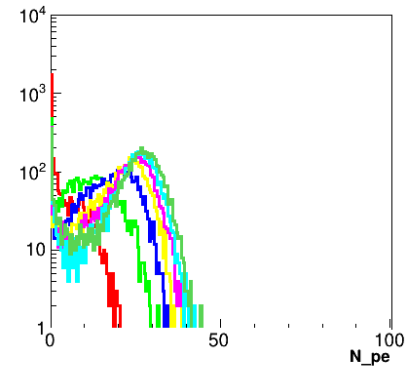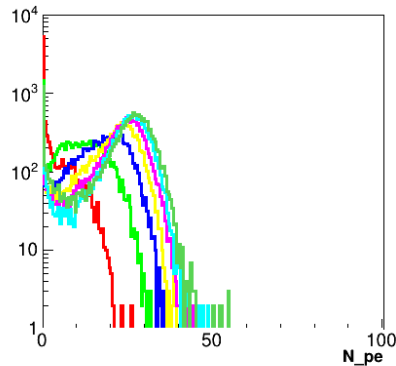
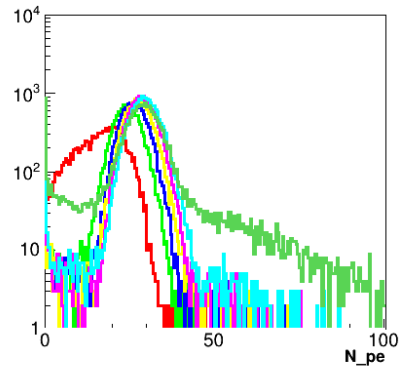w Collimator

Target full   Target 30cm   Target 10cm

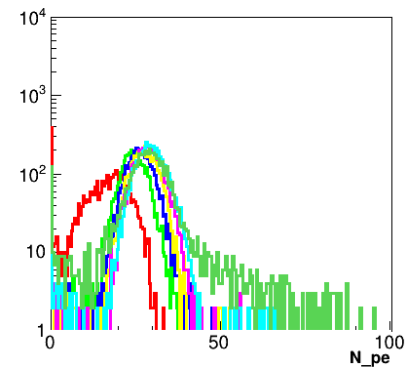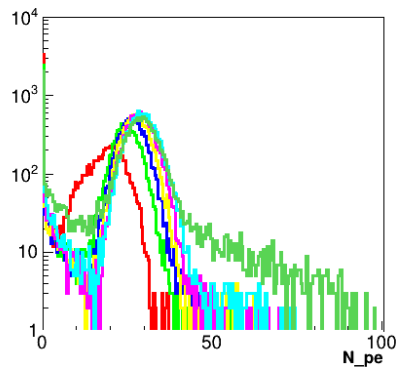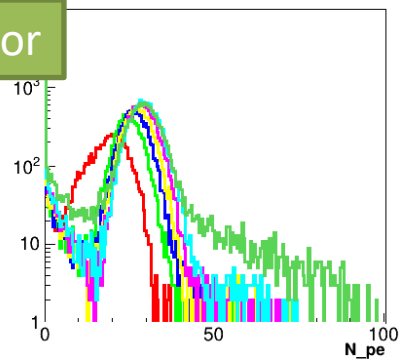# LGC signal Npe at various angle (mom 4.0-4.5GeV)

w/o Collimator

w Collimator

Target full

Target 30cm

Target 10cm