SIDIS Trigger Rate and PID Update

- SIDIS trigger rate summary
- SIDIS trigger rate updates for HGC window thickness
- PID summary (need to be updated)

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SIDIS Trigger Rates Updates with 3GeV trigger threshold for LAECAL

Rate (kHz) Ecal+LGC(2,2)+SPD(>0.425MeV)	7 modules **3 GeV** trigger threshold for LAEC +Up window+ down widow
FA e^-	60+1.1+1.8
FA hadron no e^-	29+3.6+5.3
LA e^-	4.1+3.6+2.6
LA hadron no e^-	7.7+6.5+3.8
hadron trigger	8013+2591+3887
SIDIS coin	31.2
Hadron coin	14.7+2.52+2.61=19.83
Total rate	**<85 kHz** (30ns time window)

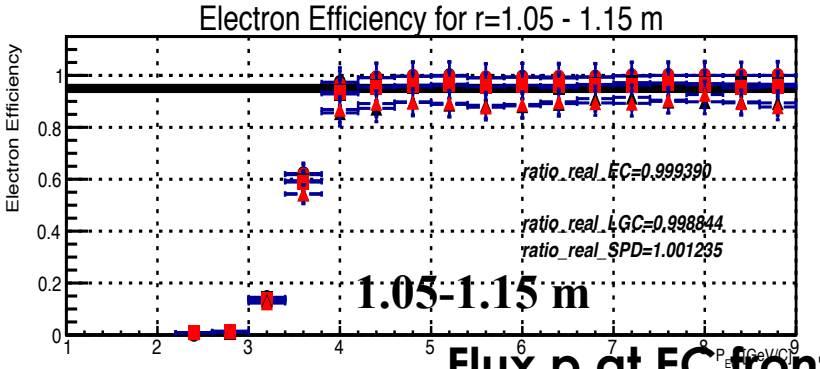
SIDIS HGC Window Thickness

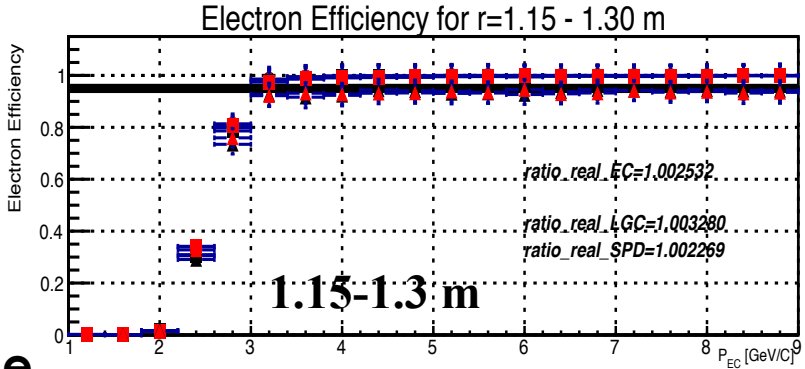
window thickness all in cm

	front	back
original	0.04(Kevlar)	0.10(Al)
real	0.24(CF)	0.64(Al)

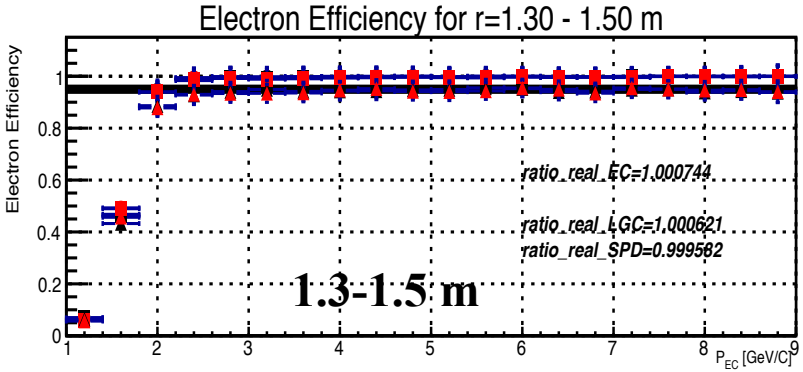
- What's the influence of the changing on the SIDIS trigger rate?
- What's the influence of the changing on the PID performance (π rejection)?

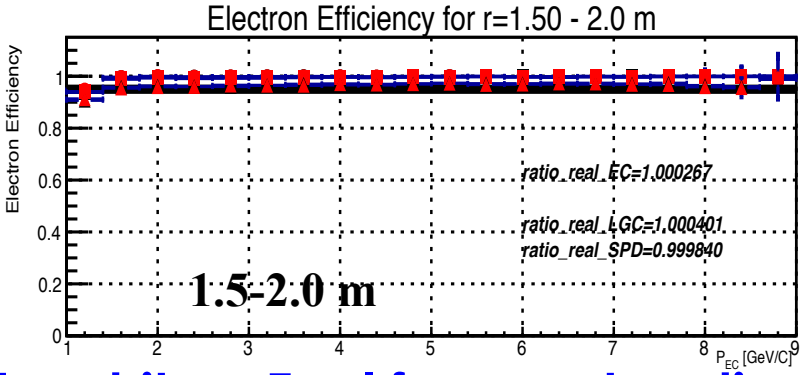
Electron Ecal Response



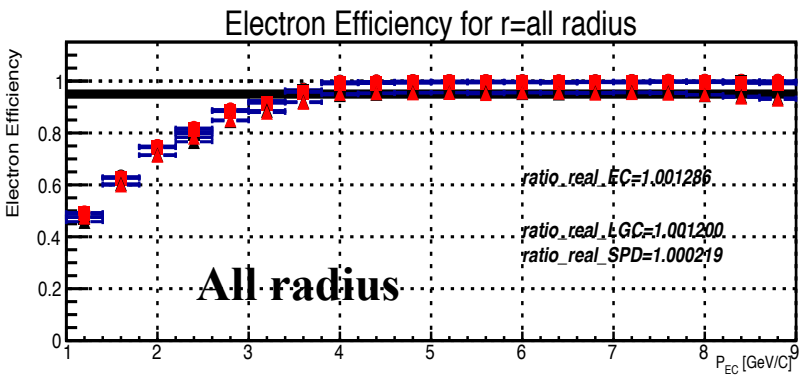


Flux p at EC front plane





Electron hit on Ecal from vertex directly



orignal HGC, EC

HGCreal, EC

orignal HGC, EC+LGC

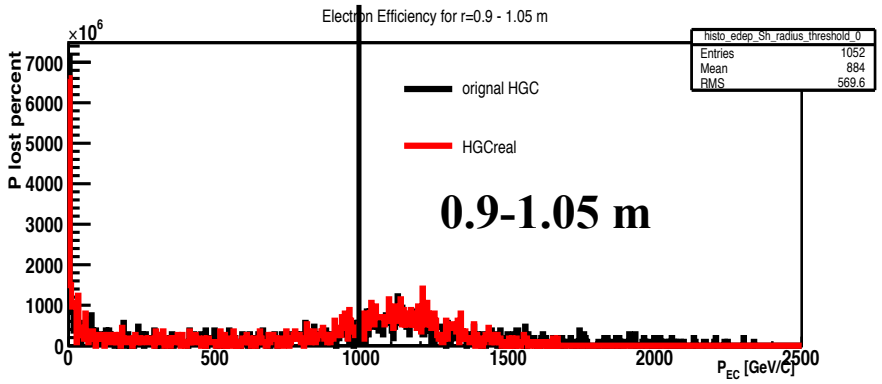
HGCreal, EC+LGC

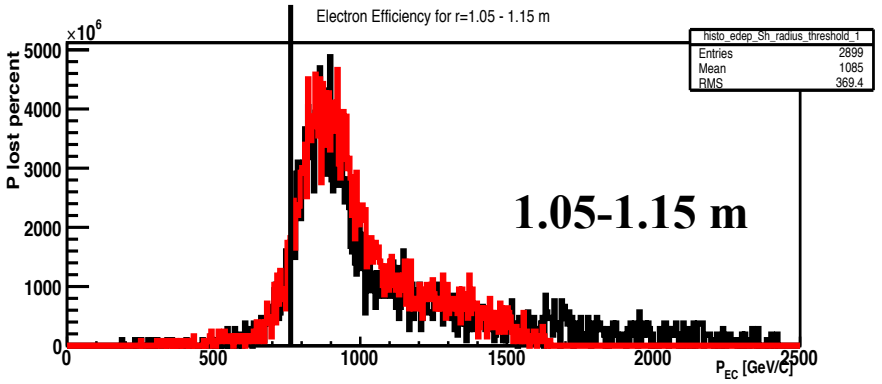
orignal HGC, EC+LGC+SPD

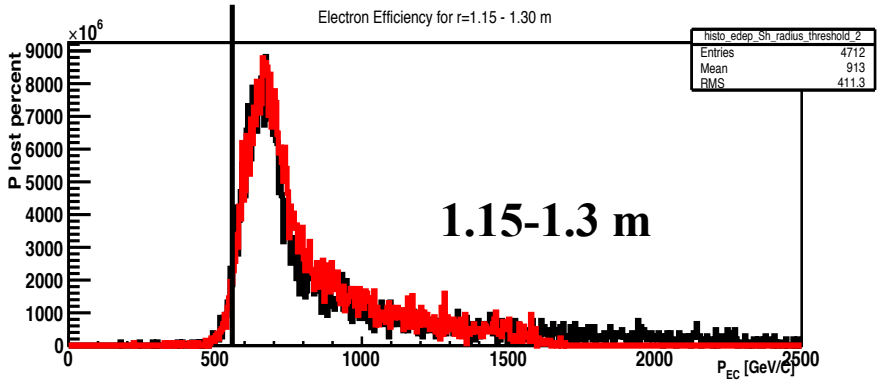
HGCreal, EC+LGC+SPD

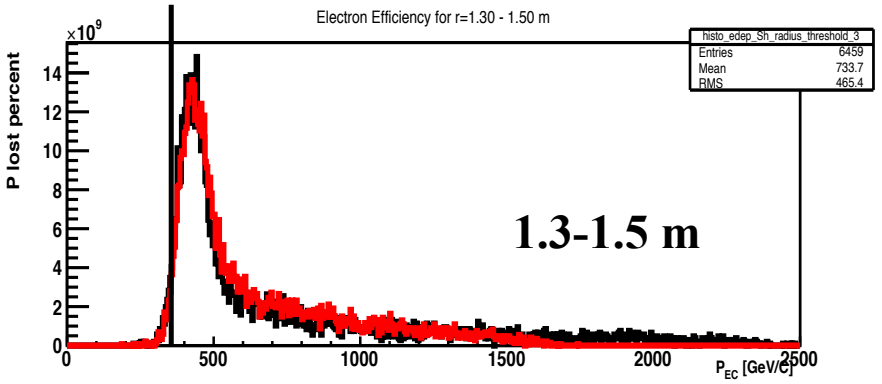
eDIS all detectors

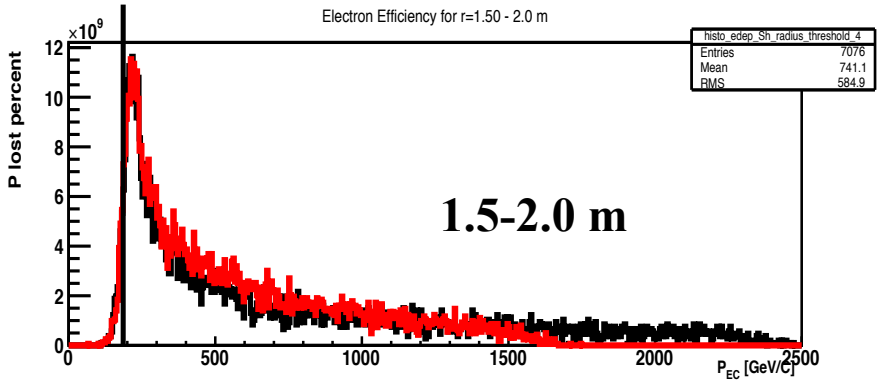
Evenly distributed Electron 6p1 Ecal Deposit E











Single e^- Trigger Rates

Rate (kHz)	FAEC	FAEC+LGC	FAEC+LGC+SPD
Original e^-	70.4(58.4)	65.0(57.9)	60.0(54.4)
Real e^-	68.1(54.6) 70.4(56.4) 71.92(57.57)	62.7(54.2) 64.98 (56.0) 66.12(57.10)	57.9(50.8) [-3.3(6.5)%] 59.97(52.5) 61.03(53.50) [-1.6%]
Original π^0	519.7(59.27)	22.13(15.98)	16.6(15.08)
Real π^0	508.65(67.25)	20.122(14.1)	14.93(13.38)
Original π^-	656(584.5)	3.97(3.4)	3.56(3.13)
Original p	250(226.8)	0(0)	0(0)

( ) means that count particle from vertex, for π^0 ( ) means e- or e+ hit on Ecal

Lower Ecal threshold by 3.3%, Lower Ecal threshold by 6.5%

Single e^- Trigger Rates

Rate (kHz)	FAEC	FAEC+LGC	FAEC+LGC+SPD
Original all hadrons no e	1934.47	34.74	26.58
Real all hadrons no e	1904.2 2080.86 2157.5	32.1 35.84 37.13	24.4 27.49 28.60 (+6.5%)
Original total FAECAL	2004.9	99.3	86.58
Real total FAECAL	2229.4	103.3	89.6 (+3.6%)

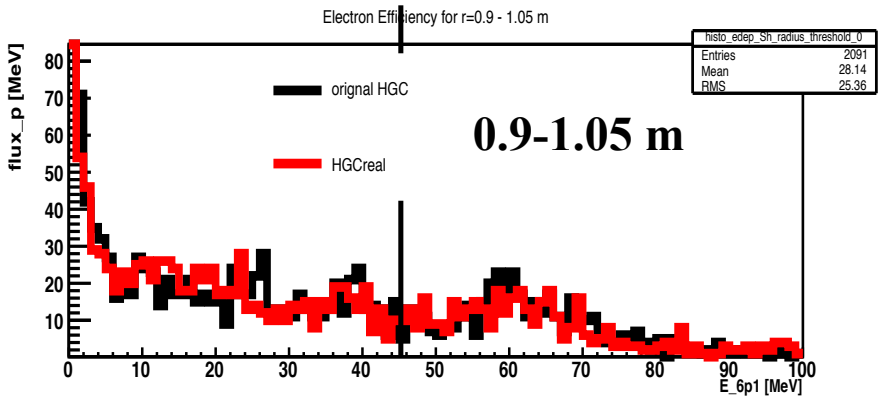
Lower Ecal threshold by 3.3%, Lower Ecal threshold by 6.5%

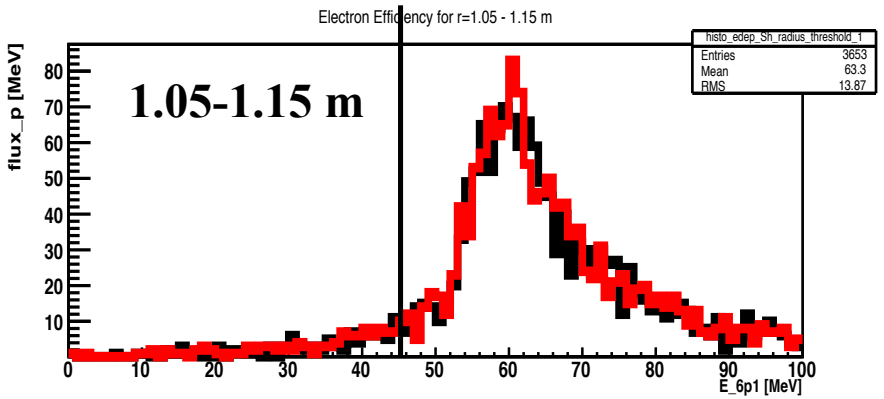
Hadron Trigger Rates

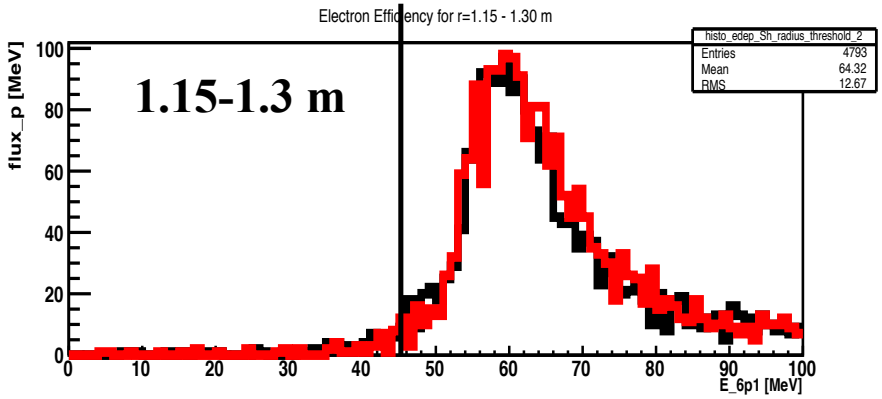
h_FA (kHz)	EC	EC+SPD
Original e^-	135.8(92)	96.7(85)
Real e^-	130.5(90.5)	96.7(83.3)
Original π^0	2269.61(376.0)	259.25(216.0)
Real π^0	2251.2 (430.97)	328.891(278.96)
Original all hadrons no e-	10066.7	7511.69
Real all hadrons no e-	9970.9 (-0.09%)	7518.66(+0.09%)

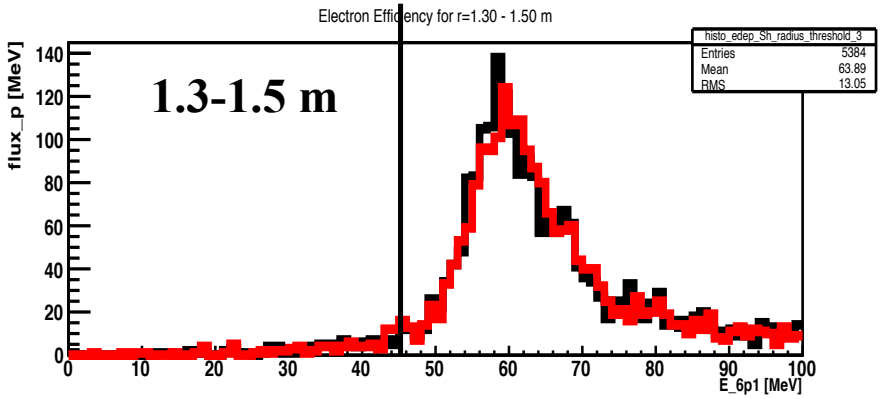
We can keep the hadron trigger as 4s of the MIP cut !

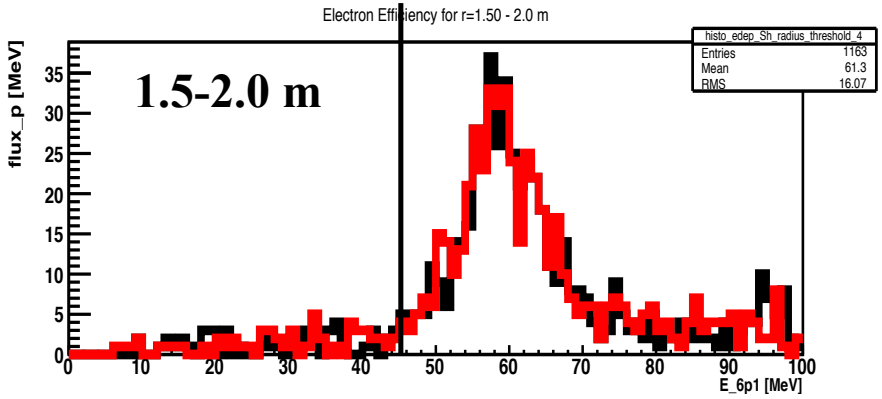
MIP 6p1 Ecal Deposit E











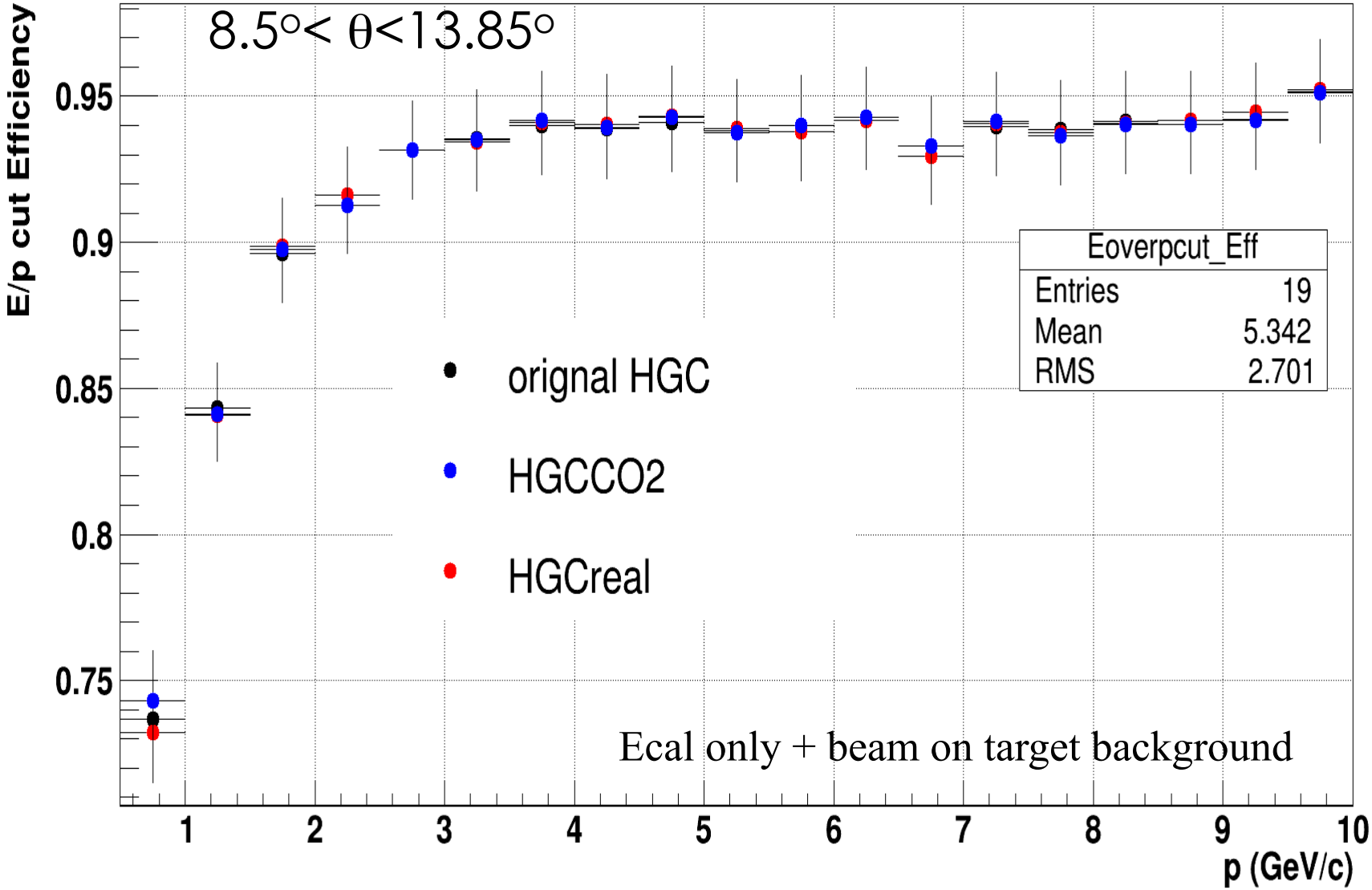
4 σ of MIP peak cut

SIDIS Total Trigger Rates Updates
(3GeV trigger threshold for LAECAL)

Rate (kHz) Ecal+LGC(2,2)+SPD(>0.425MeV)	Original +Up window+ down widow	HGC real
FA e^-	60+1.1+1.8	61.03+2.95
FA hadron no e^-	26.58+3.6+5.3	28.60+9.48
LA e^-	4.1+3.6+2.6	same
LA hadron no e^-	7.7+6.5+3.8	same
hadron trigger	7611.69+2591+3887	7618.66+6483.8
SIDIS coin	31.2	same
Hadron coin	14.7+2.52+2.61=19.83	same
Total rate	**<83 kHz**	**<84.7kHz [+2%]**

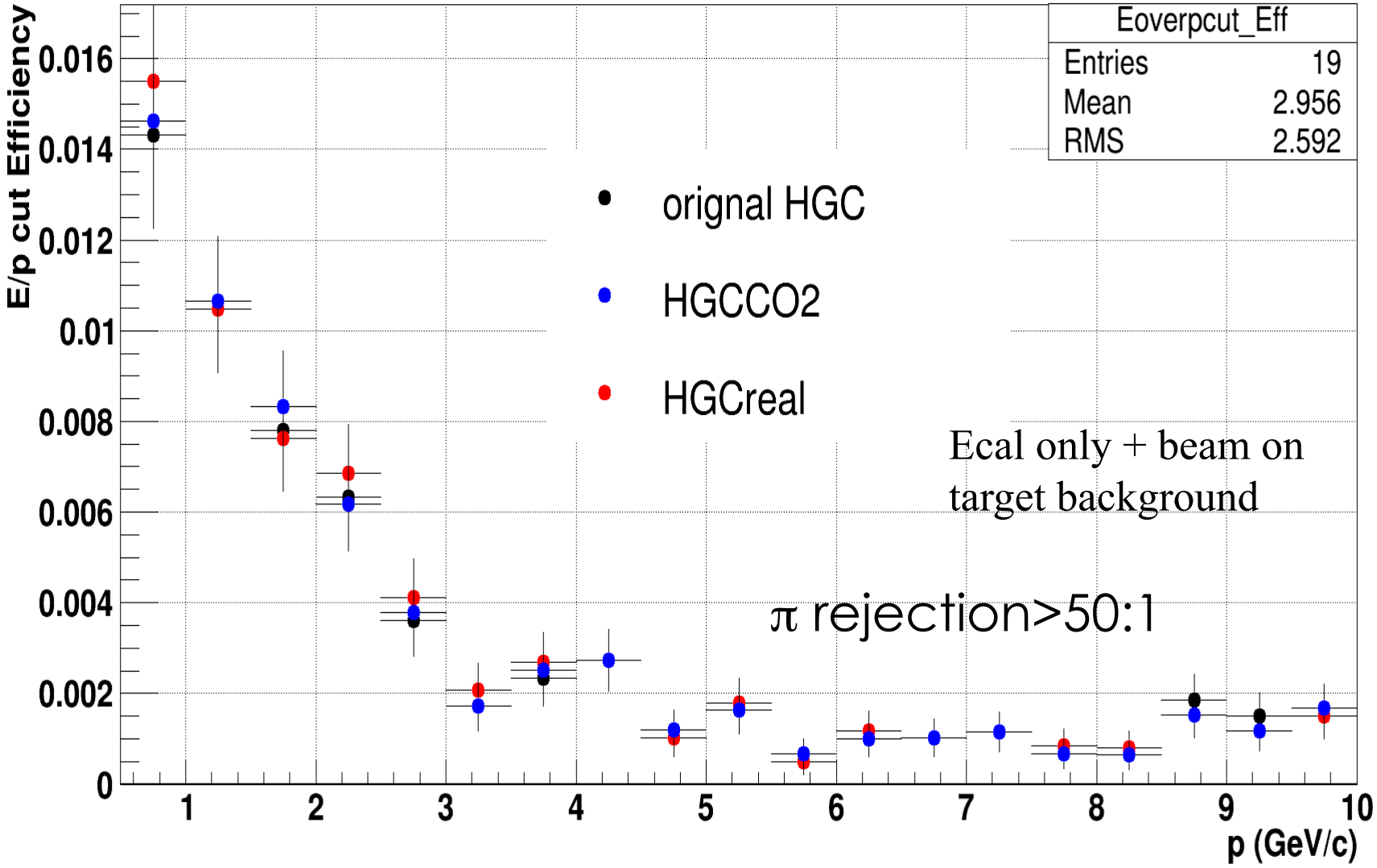
Based on the current simulation files and bggen event generator !

Offline PID performance FAECAL



We need new simulation files to updated the results !

Offline PID performance FAECAL



We need new simulation files to updated the results !

Summary and To-do

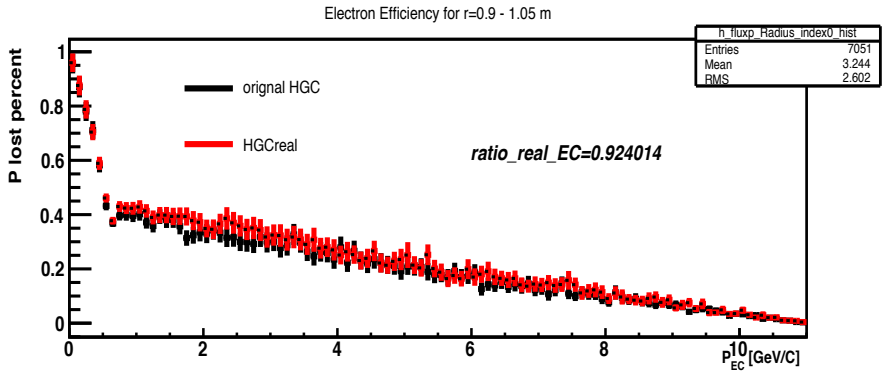
- The HGC window thicker thickness will increase the total trigger rate by 2% (<100kHz), when we keep the vertex electron efficiency > 93.4%. If need, we could further lower the threshold to achieve electron efficiency > 95%.

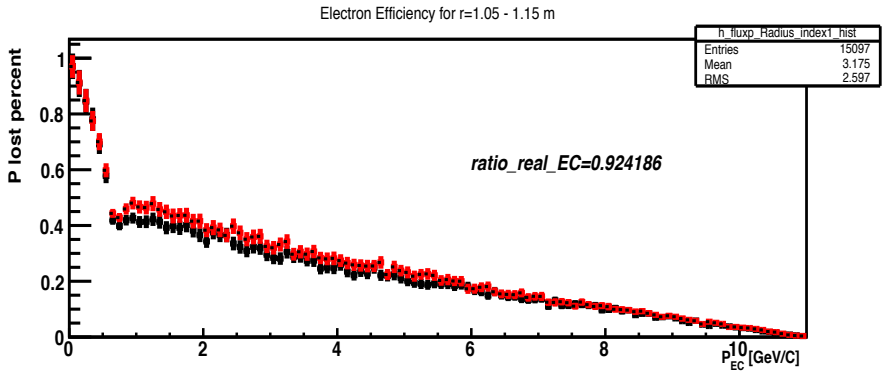
- The influence of the HGC window thickness need to be finalized with the right simulation files, the current study shows that the pion rejection is better than 50:1 without the edge effect. With the edge effect, the electron efficiency will be ~10% lower.

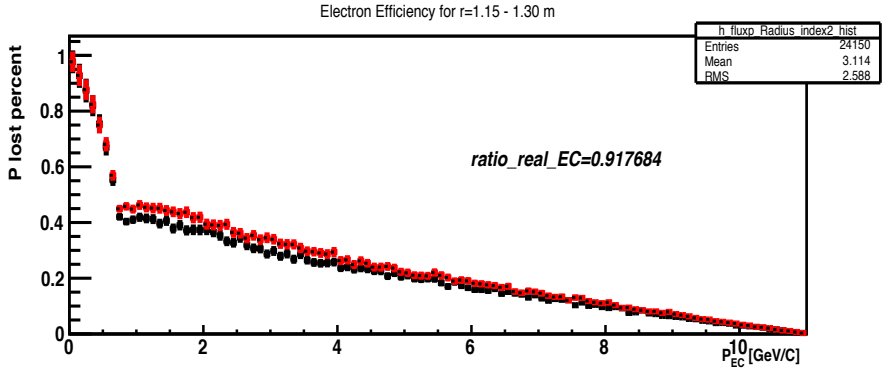
From the preliminary estimation, changing the HGC window to a thicker material (real) doesn't bring any potential trouble to the SIDIS total rate.

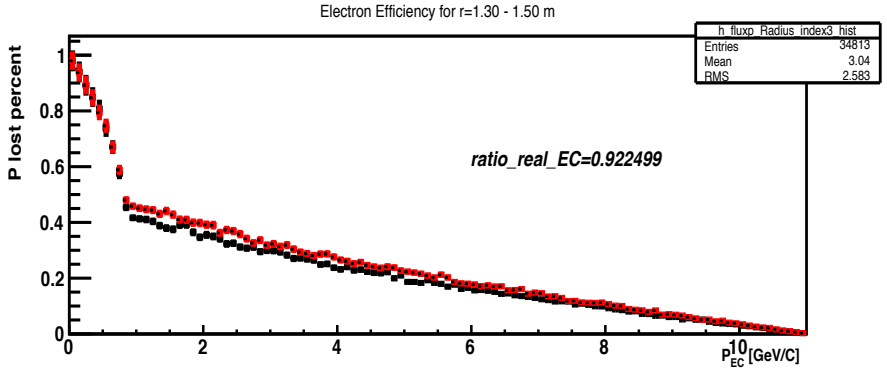
Backup

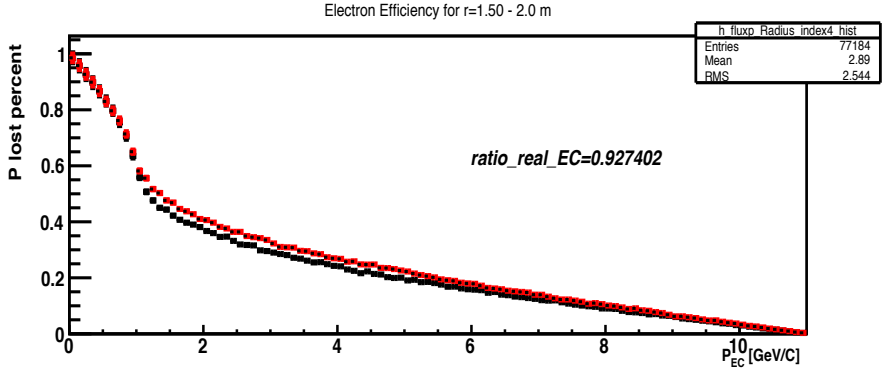
Momentum Lost

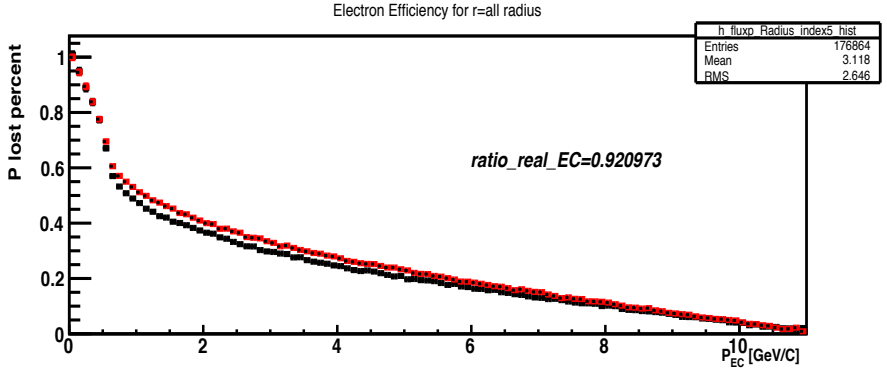




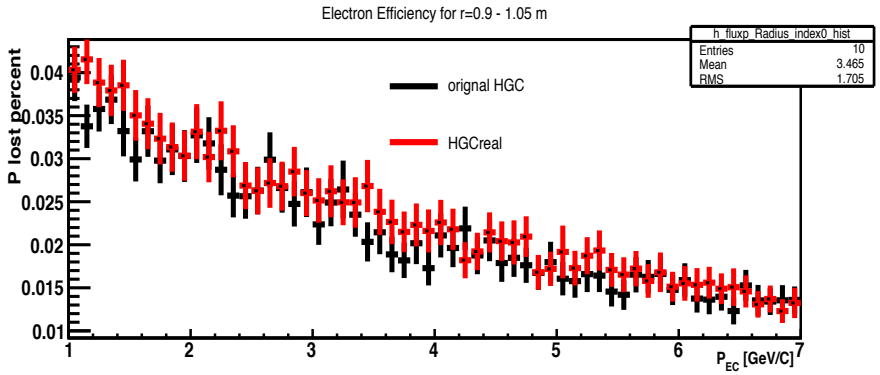


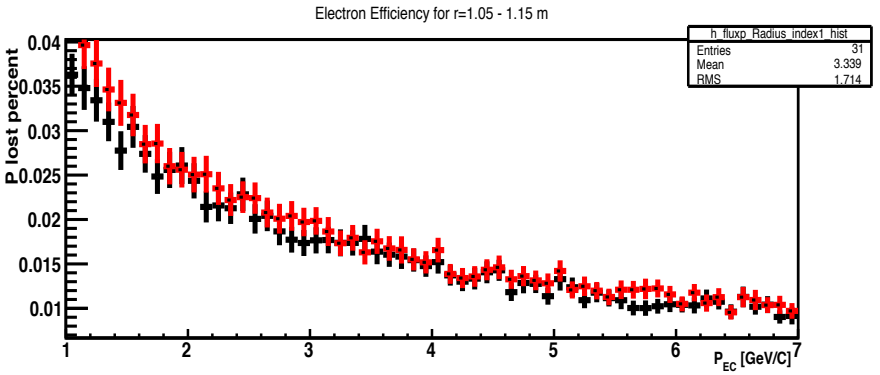


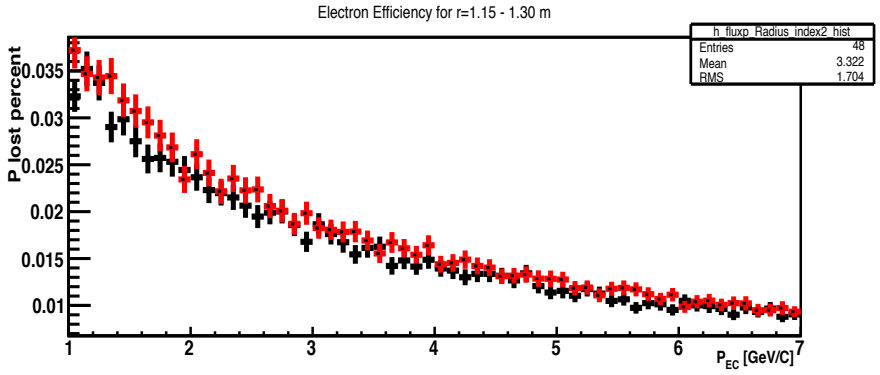


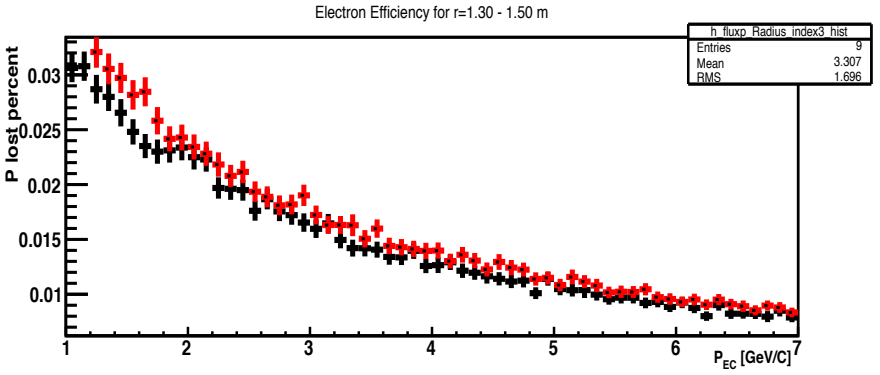


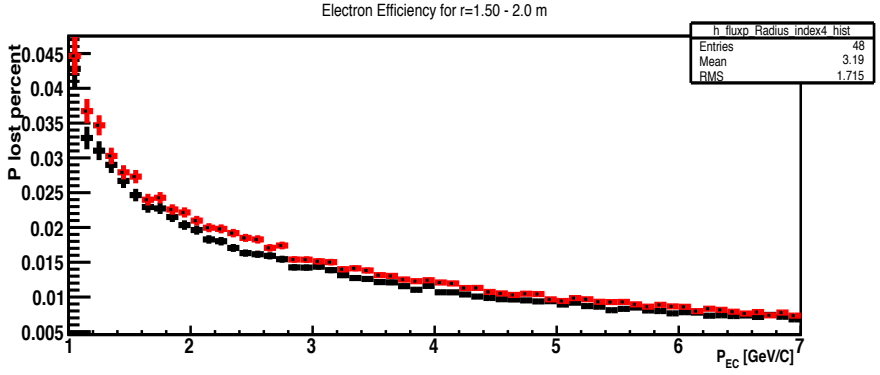
Momentum Lost

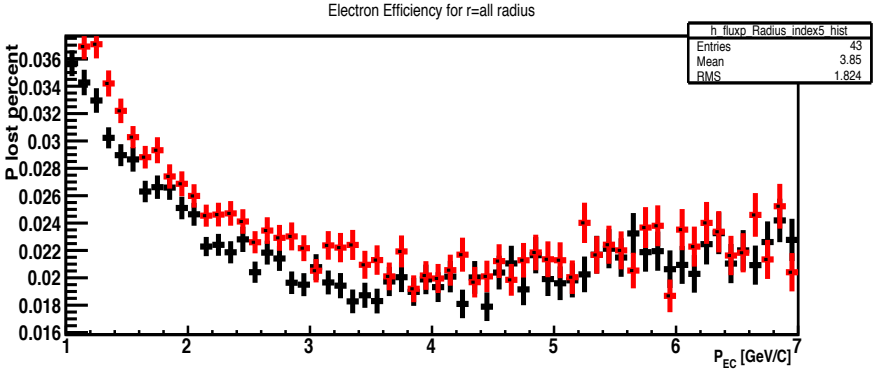












SIDIS trigger rates Update

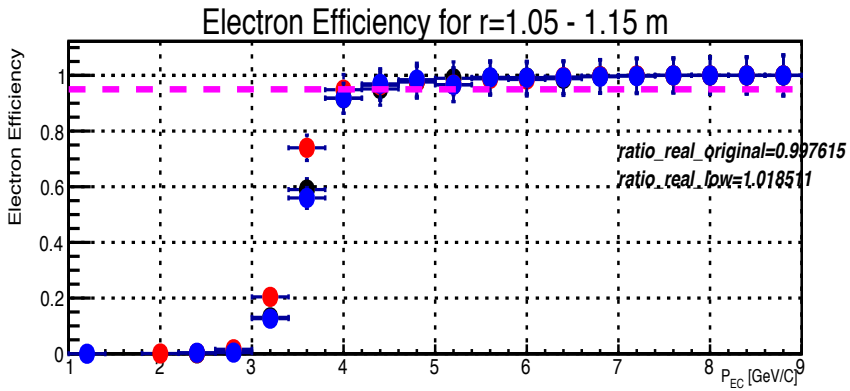
- **Single e (e_FAEC[e,h]+e_LAEC[e,h]):** 128.1kHz>100kHz
- **Hadron (h_FAEC[e,h]):** 14491kHz
- **Random coin**: assuming no correlation between electron and hadron trigger:

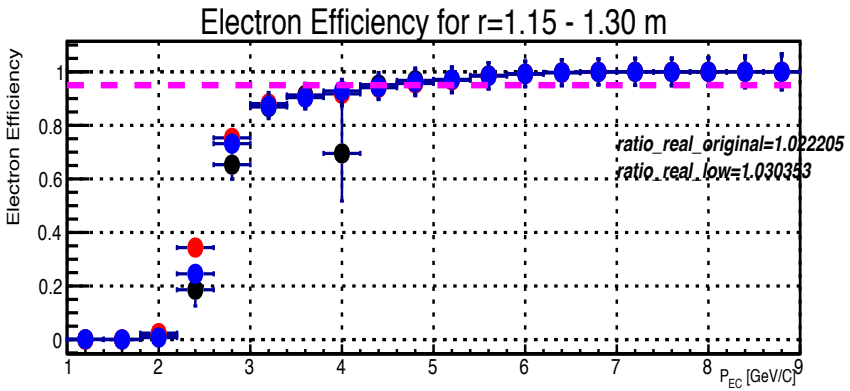
(e_FAEC[e,h]+e_LAEC[e,h])*(h_FAEC[e,h])*time window (30ns)

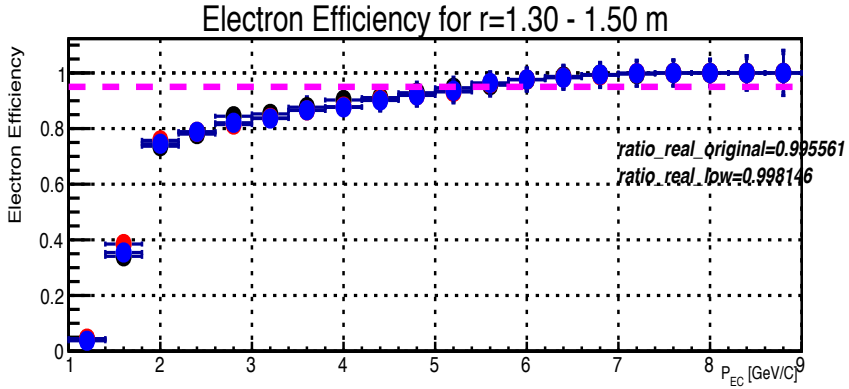
- ❖ **SIDIS coin (Duke e⁻ hadron generator)** **Has overlap, and how much?**
- ❖ **Hadron coin (Bggen genertor)**

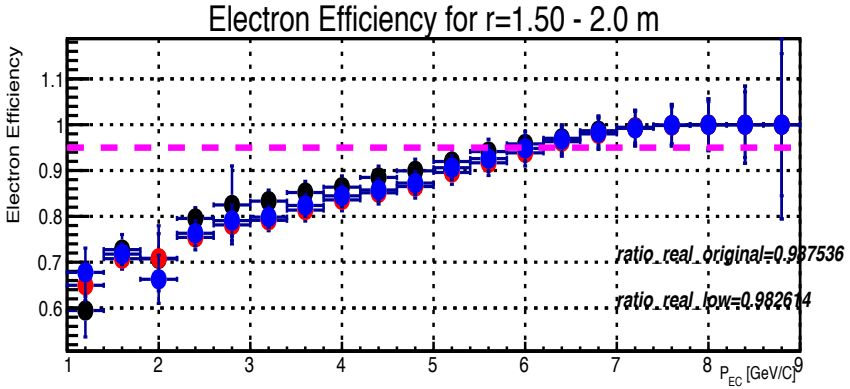
$$Trigger\ rate_{total} = \left(e^{-}_{TR} - Coin^{SIDIS}_{TR} - Coin^{bggenhadron}_{TR}\right) * h_{TR} * TW + Coin^{SIDIS}_{TR} + Coin^{bggenhadron}_{TR}$$

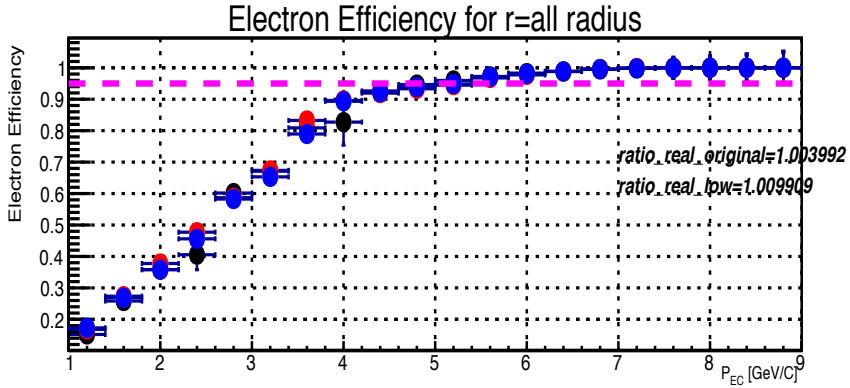
Electron Trigger Efficiency











Reduce 185.87 MeV to 165.87 MeV

- orignal HGC
- HGCreal original
- HGCreal lower EC threshold

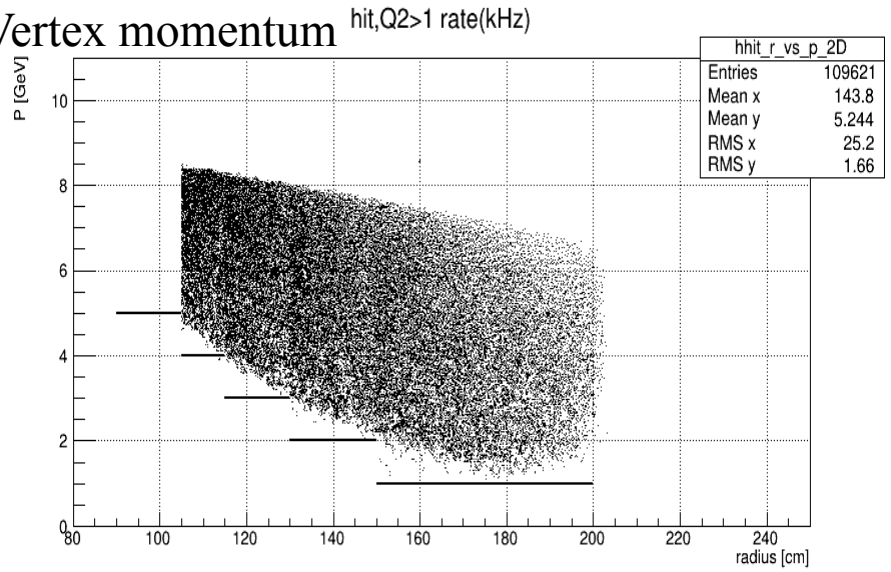
SIDIS electron trigger even e^-

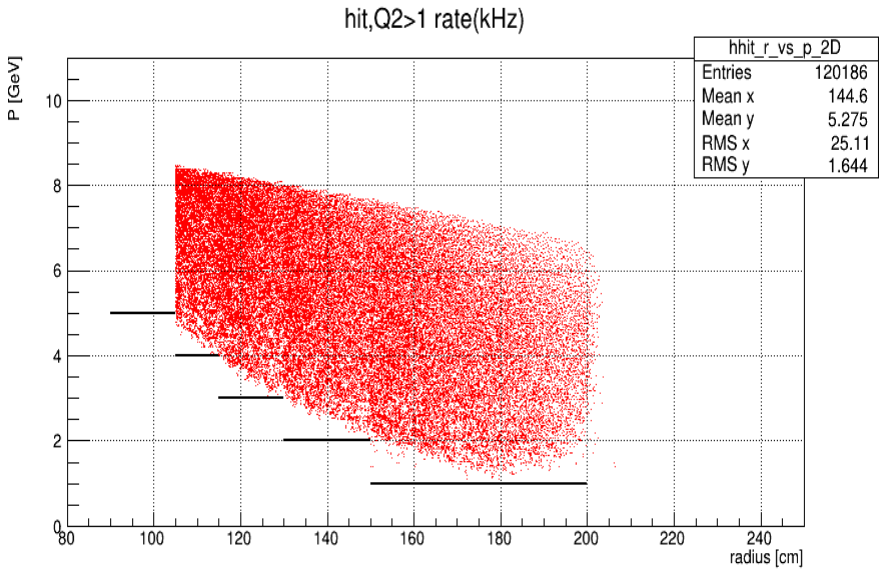
FAEC electron trigger

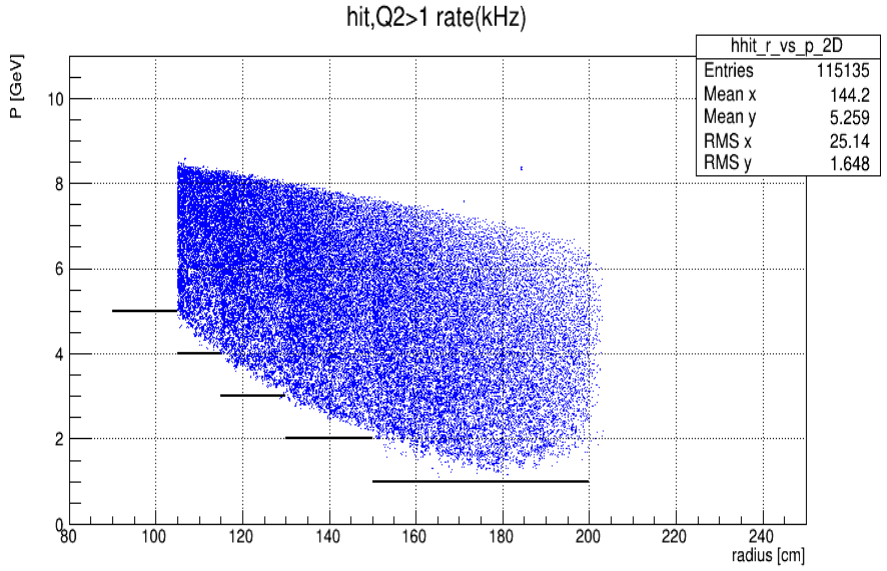
Radius (cm)	6+1 Cluster Threshold (MeV)		
	original	3.3%	6.5%
90-105	990.09	956.5	925.5
105-115	762.6	736.7	712.9
115-130	557.97	539.1	521.64
130-150	355.25	343.2	332.12
150-200	185.8	179.6	173.77

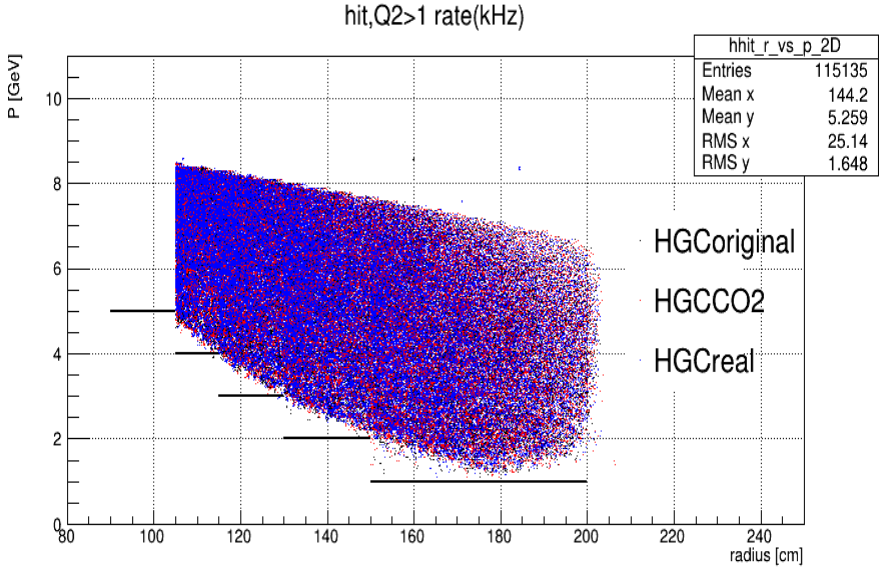
$Q^2>1GeV^2$, and W>2 eDIS

Vertex momentum

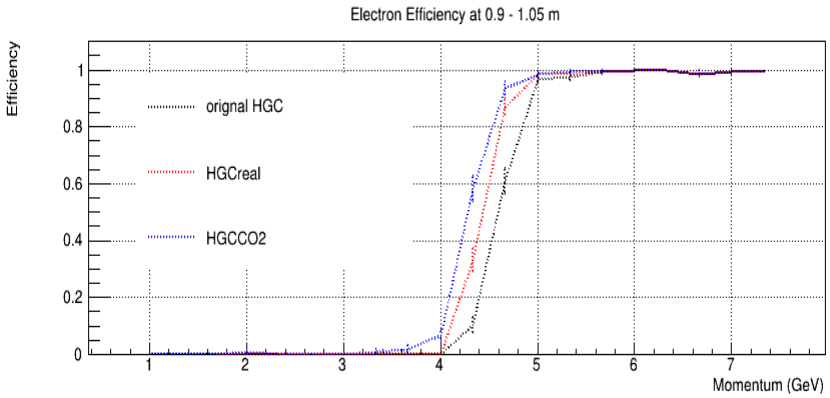


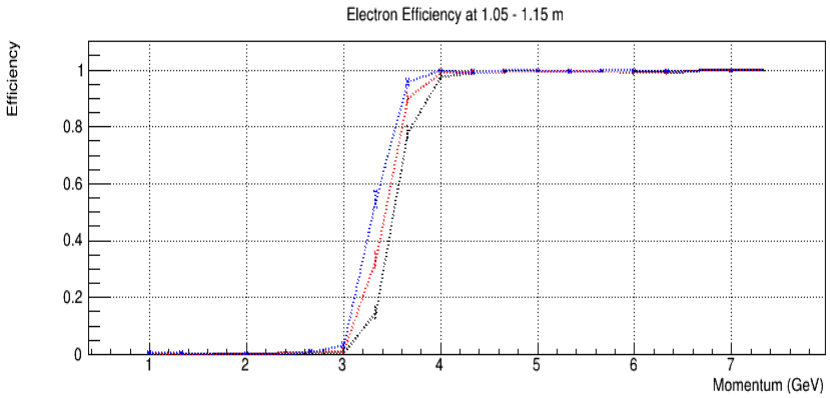


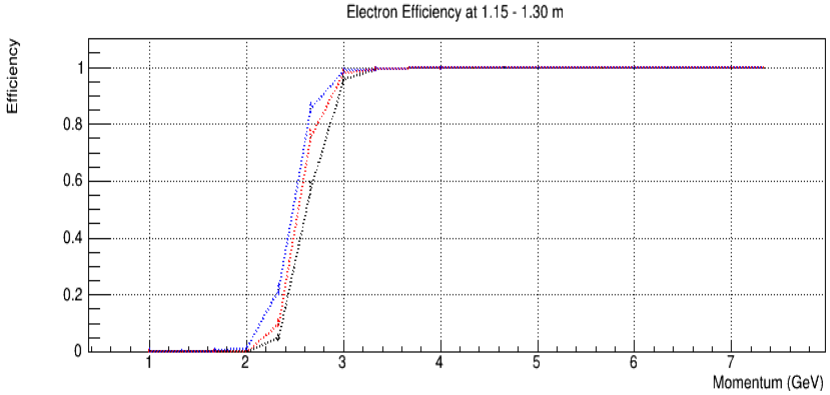


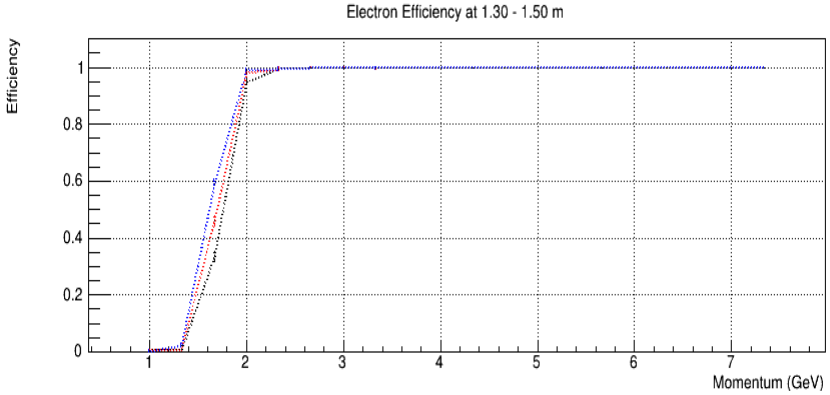


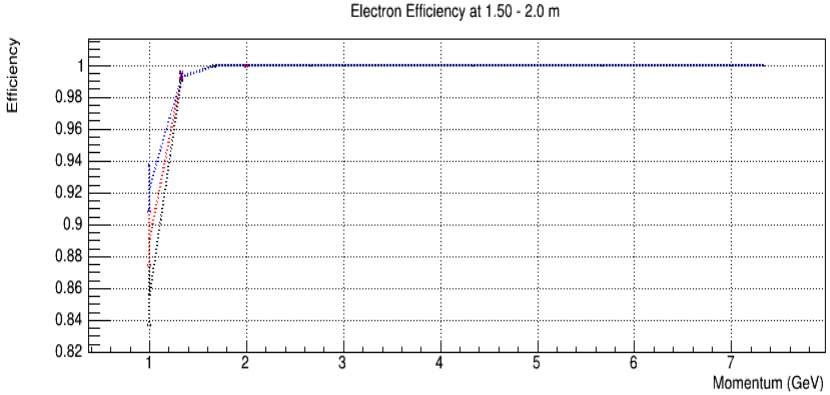
Electron Trigger Efficiency



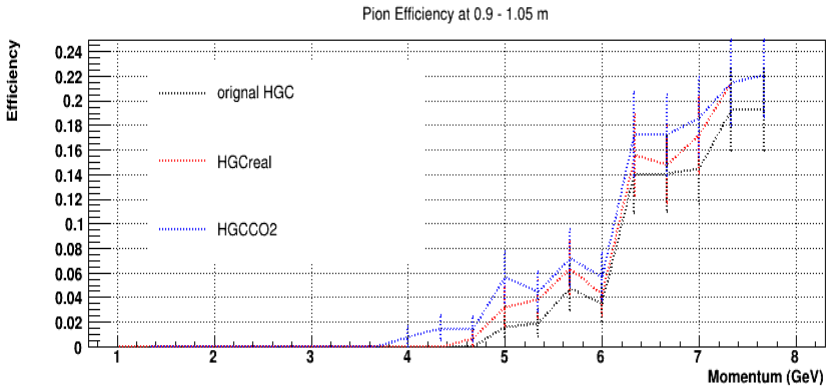


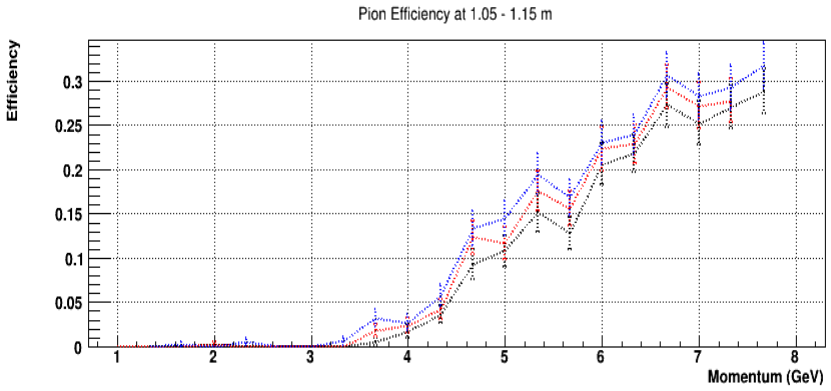


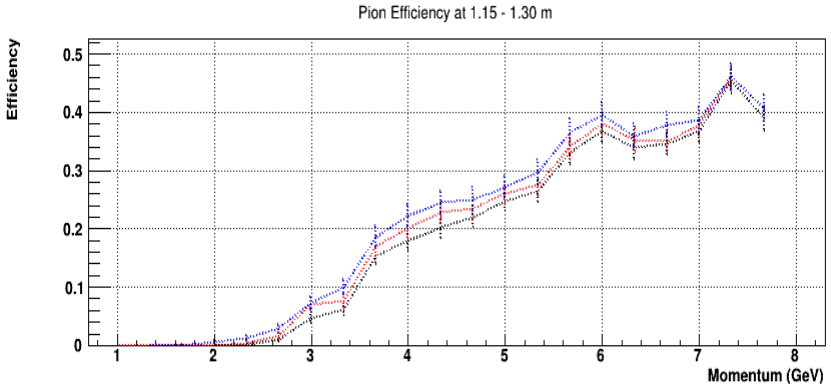


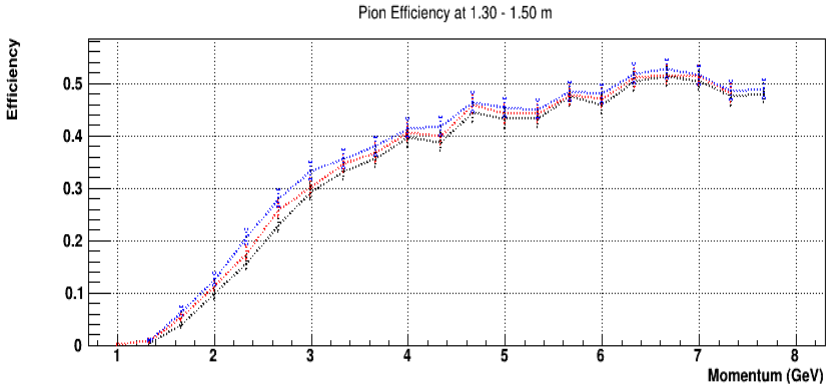


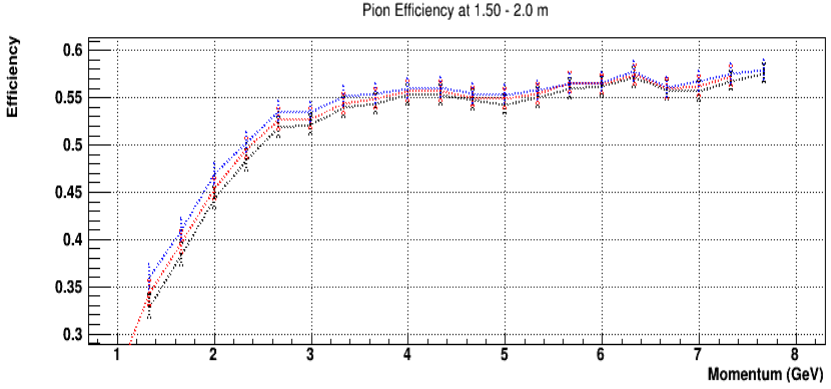
Pion Trigger Efficiency







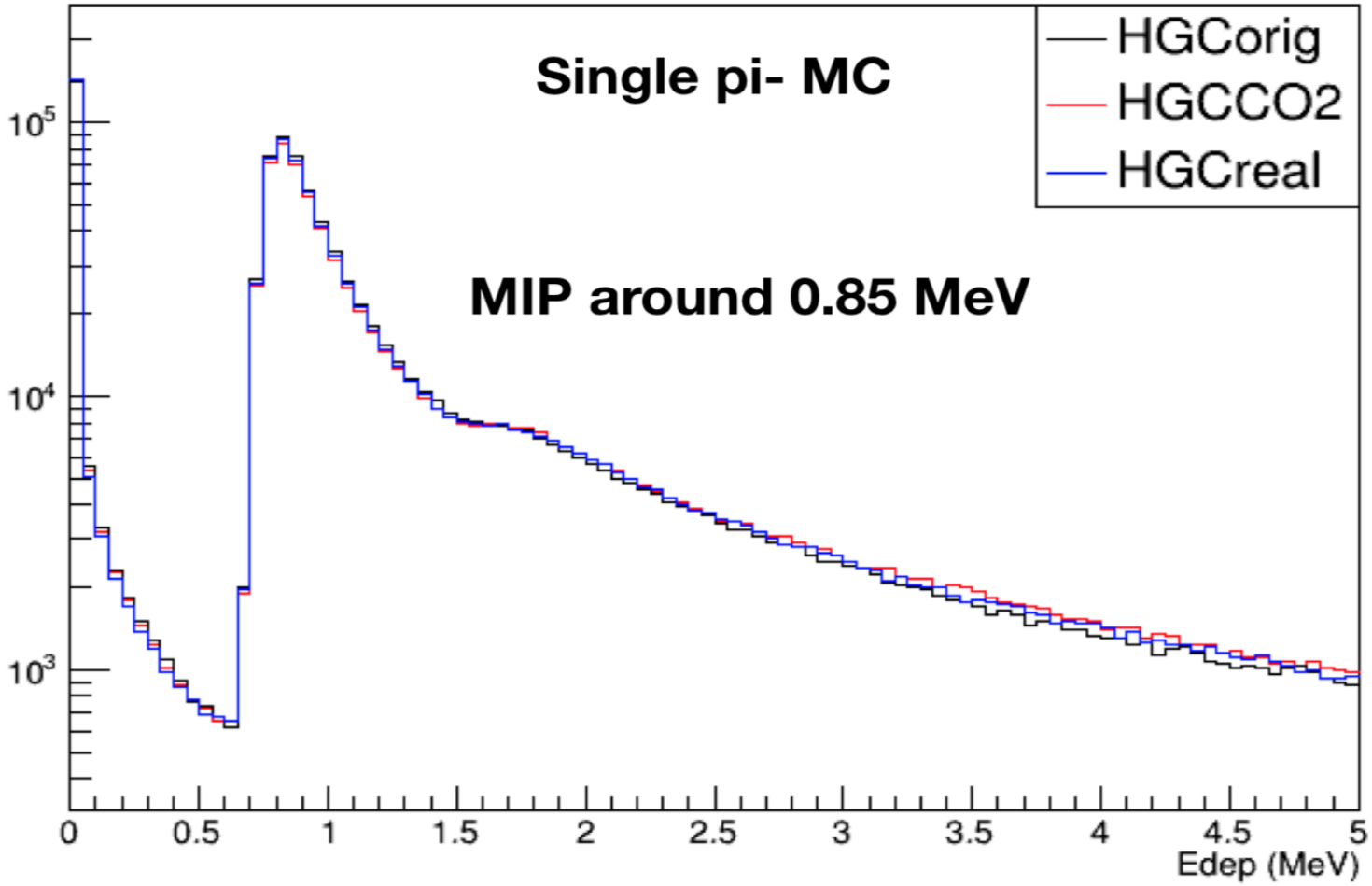




Single e^- Trigger Rates

Rate (kHz)	FAEC	FAEC+LGC	FAEC+LGC+SPD
Original e^-	70.4(58.4)	65.0(57.9)	60.0(54.4)
Real e^-	68.1(54.6)	62.7(54.2)	57.9(50.8) (-3.3(2)%)
CO_2 e^-	65.5(50.1) 69.36	60.5(49.7) 64.0	56.2(46.8) (6.5%) 59.2
Original π^0	519.8	22.0	16.53 16.58
Real π^0	507.8 559.9	20.4 22.5	15.0 15.1 16.8
CO_2 π^0	484.1 546.3	18.5 21.2	13.2 13.3 15.3

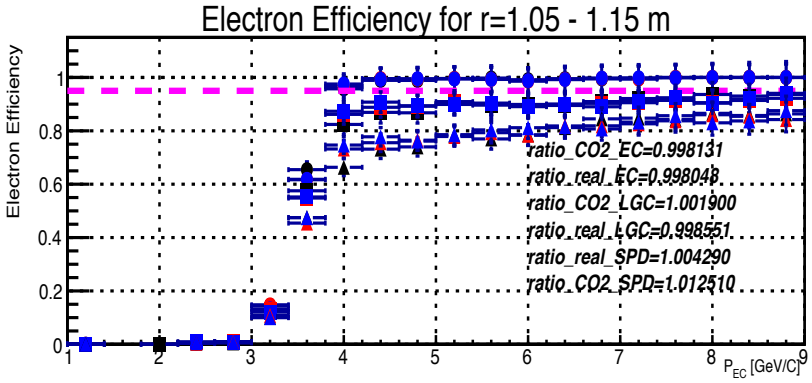
SPD Threshold Cut on Trigger Rate

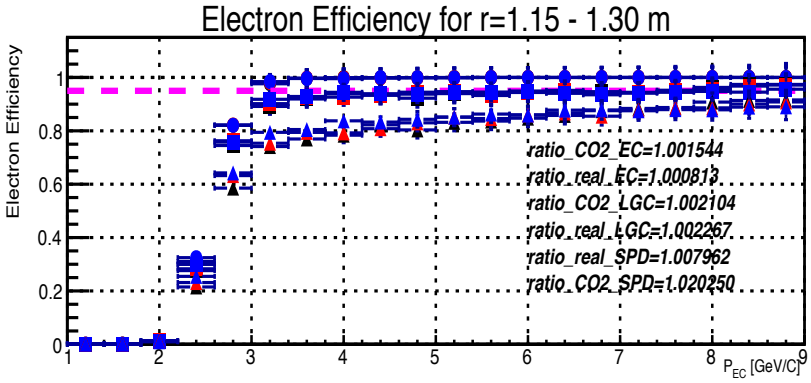


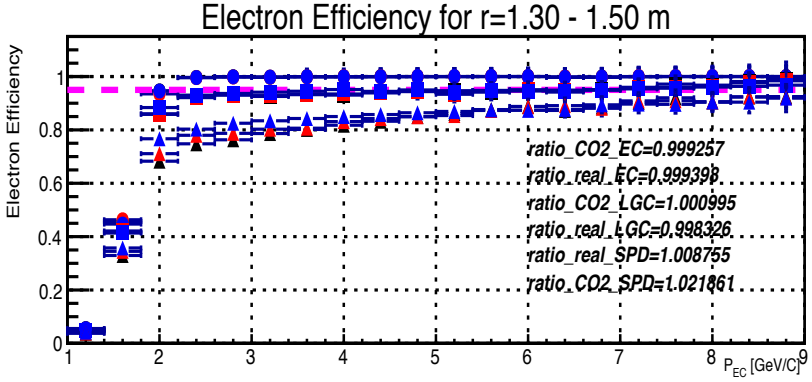
From: Sanghwa

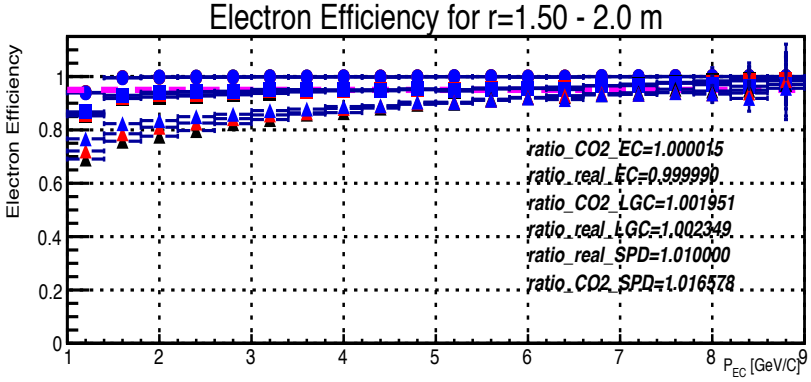
0.5 MeV cut was used for Zhiwen's previous rate estimation

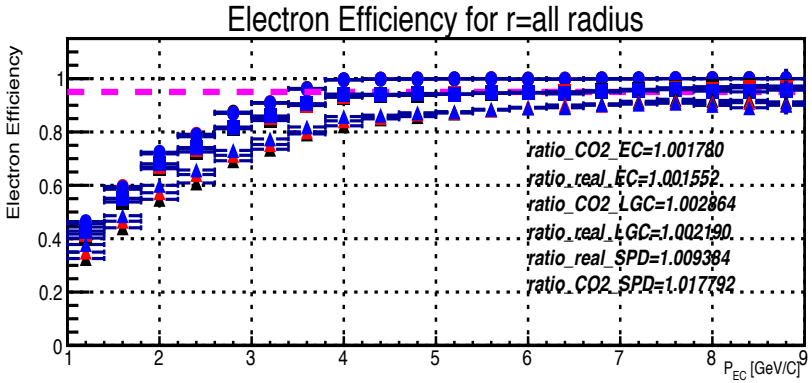
Electron Trigger Efficiency E_SPD>0.5MeV





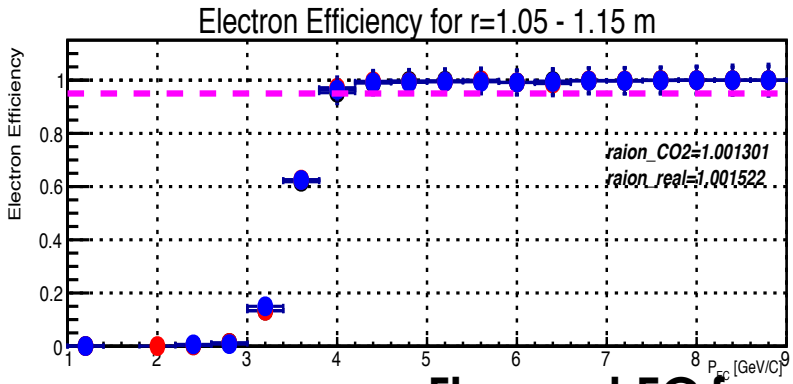


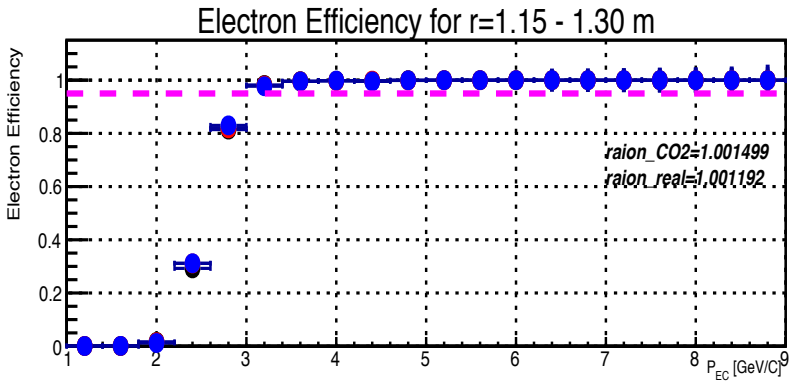




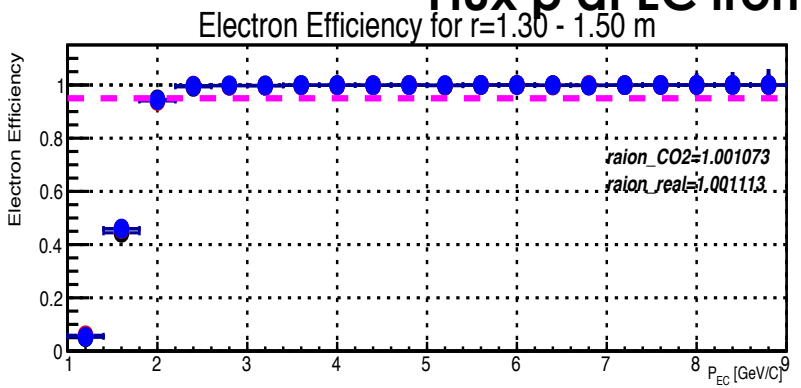
- orignal HGC, EC
- HGCCO2, EC
- HGCreal, EC
- orignal HGC, EC+LGC
- HGCCO2, EC+LGC
- HGCreal, EC+LGC
- orignal HGC, EC+LGC+SPD
- HGCCO2, EC+LGC+SPD
- HGCreal, EC+LGC+SPD

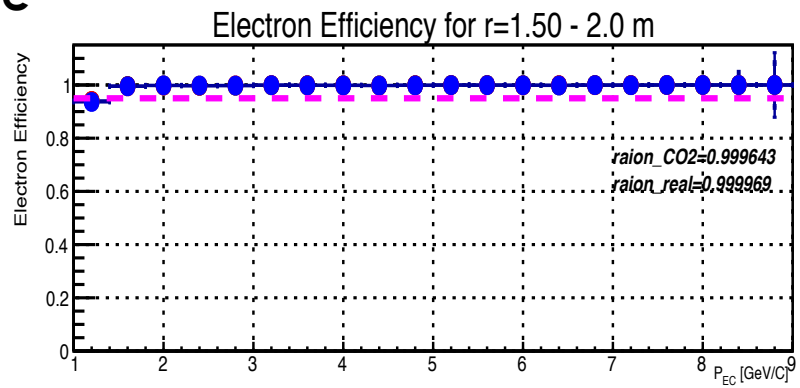
Ecal Electron Trigger Response

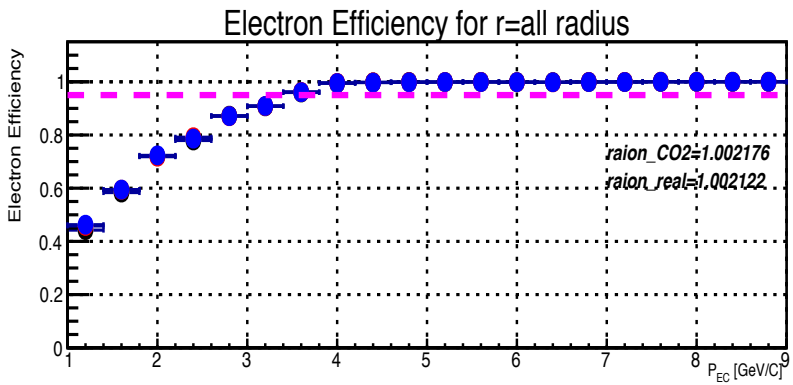




Flux p at EC front plane







- orignal HGC
- HGCCO2
- HGCreal

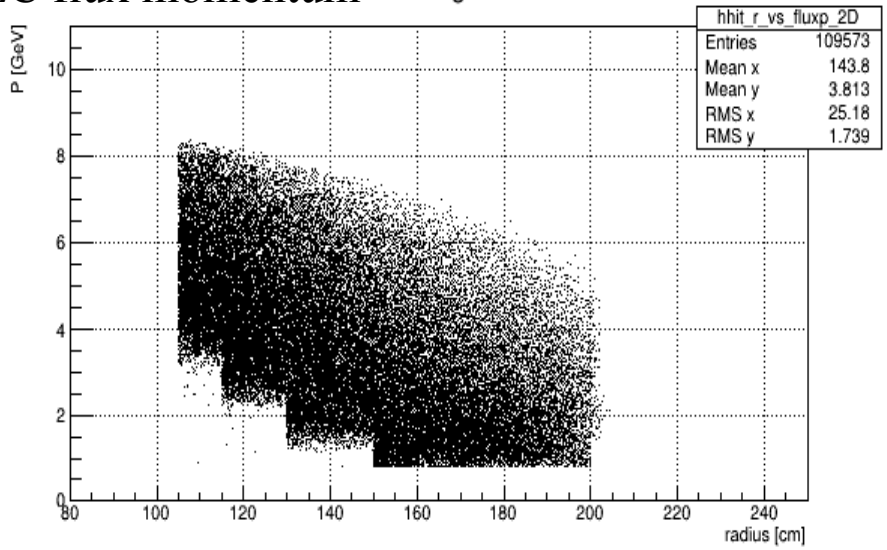
eDIS all detectors

Single e^- Trigger Rates

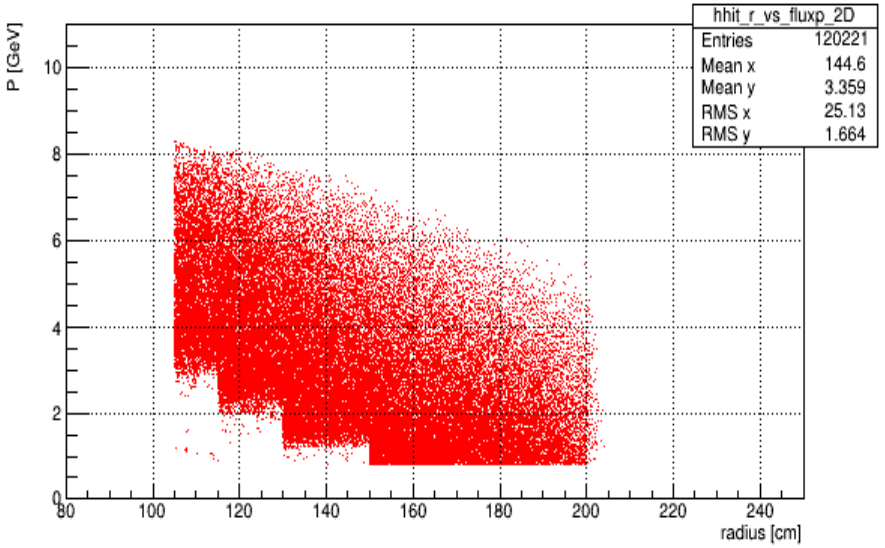
Rate (kHz)	FAEC	FAEC+LGC	FAEC+LGC+SPD
Original e^-	70.4(58.4)	65.0(57.9)	60.0(54.4)
Real e^-	68.1(54.6) 70.4(56.4) 71.92(57.57)	62.7(54.2) 64.98 (56.0) 66.12(57.10)	57.9(50.8) [-3.3(6.5)%] 59.97(52.5) 61.03(53.50)
Original π^0	519.8	22.0	16.53
Real π^0	508.65(67.25) 572.76(77.59)	20.122(14.1) 23.14(16.5)	14.9339(13.38) 17.33(15.56) [+16%]
Original π^-	656(584.5)	3.97(3.4)	3.56(3.13)
Original p	250(226.8)	0(0)	0(0)

$Q^2>1GeV^2$, and W>2 eDIS

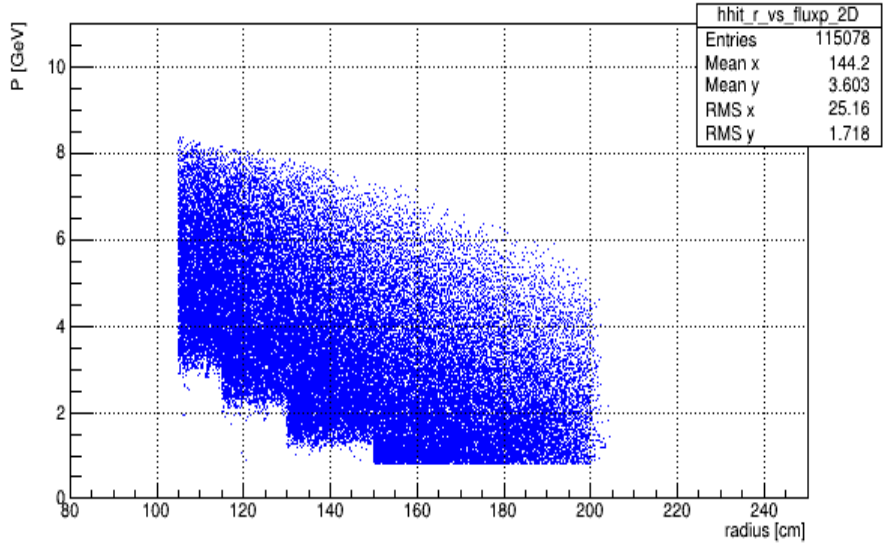
EC flux momentum HGCoriginal



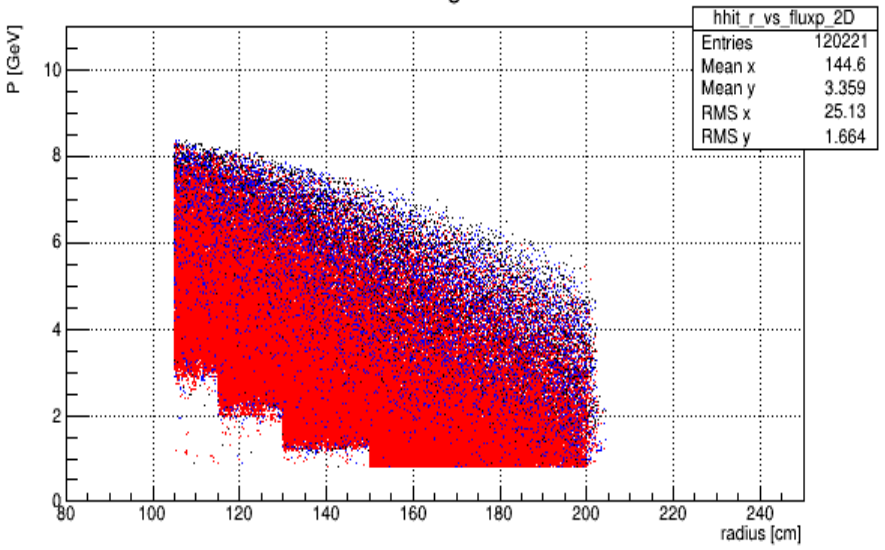
HGCCO2



HGCreal



HGCoriginal



PID Performance Summary

- Without background contribution, PID performance (e/p-separation) from both FAEC and LAEC are little better than the PrecDR results (by ignoring the edge effect)

- By including the edge effect, the PID performance will be 10%-15% worse than that without the edge effect.

- With background contribution, PID performance from both FAEC and LAEC are worse than PrecDR results.

  >50:1 π- rejection at 95% e efficiency for p>2GeV/C (FAEC)

  22:1 π- rejection at 70% e efficiency for 1<p<2 GeV/C (FAEC)

  >50:1 π- rejection at 96% e efficiency for p>4GeV/C and 85%-90% for 2GeV<p<4GeV (LAEC $\theta[18^o,22^o]$)