Study for SoLID
Baffle, Background and Trigger Rate

Zhiwen Zhao

JLab&ODU, UVa

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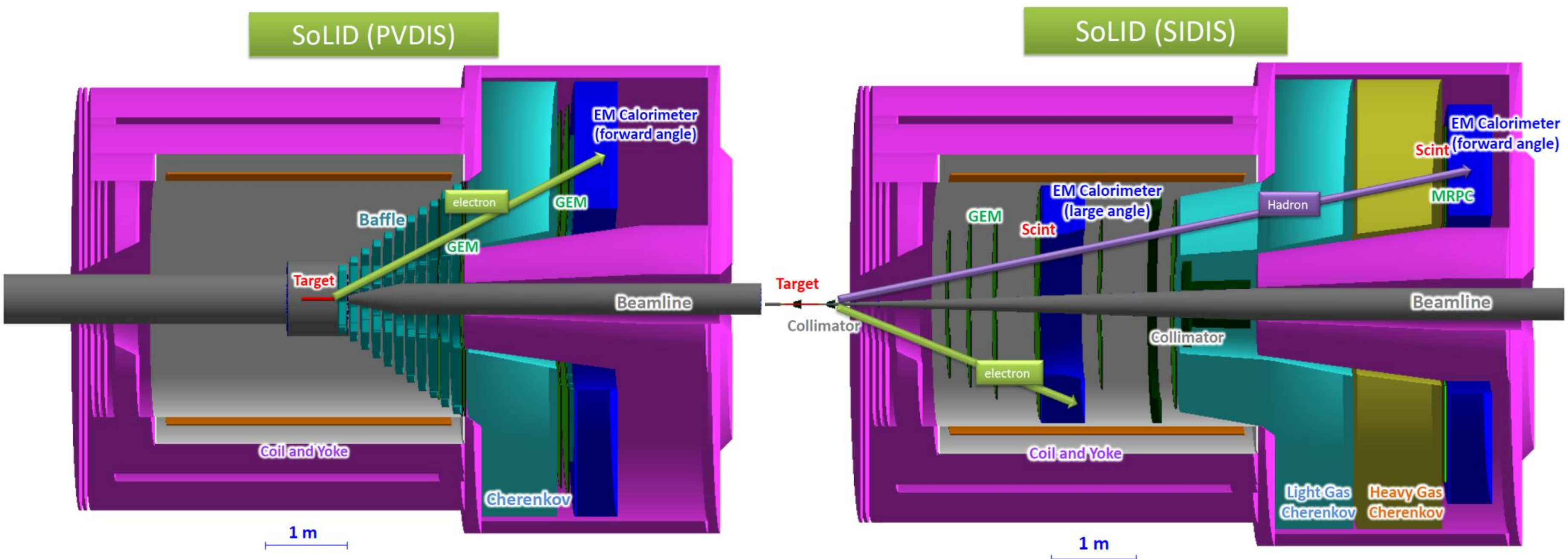
SoLID (Solenoidal Large Intensity Device)

- Unique device combines large acceptance and high intensity
- Optimize the design accordingly

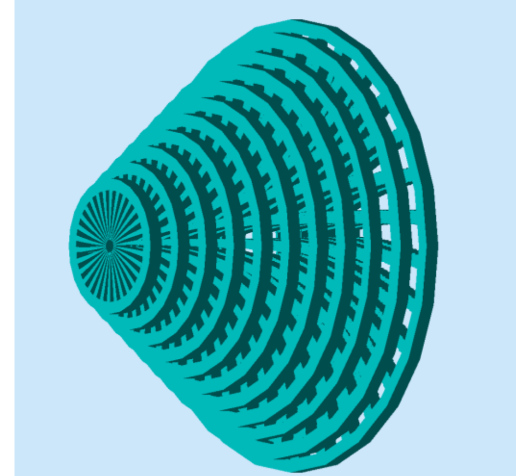


Estimation of Radiation and Luminosity

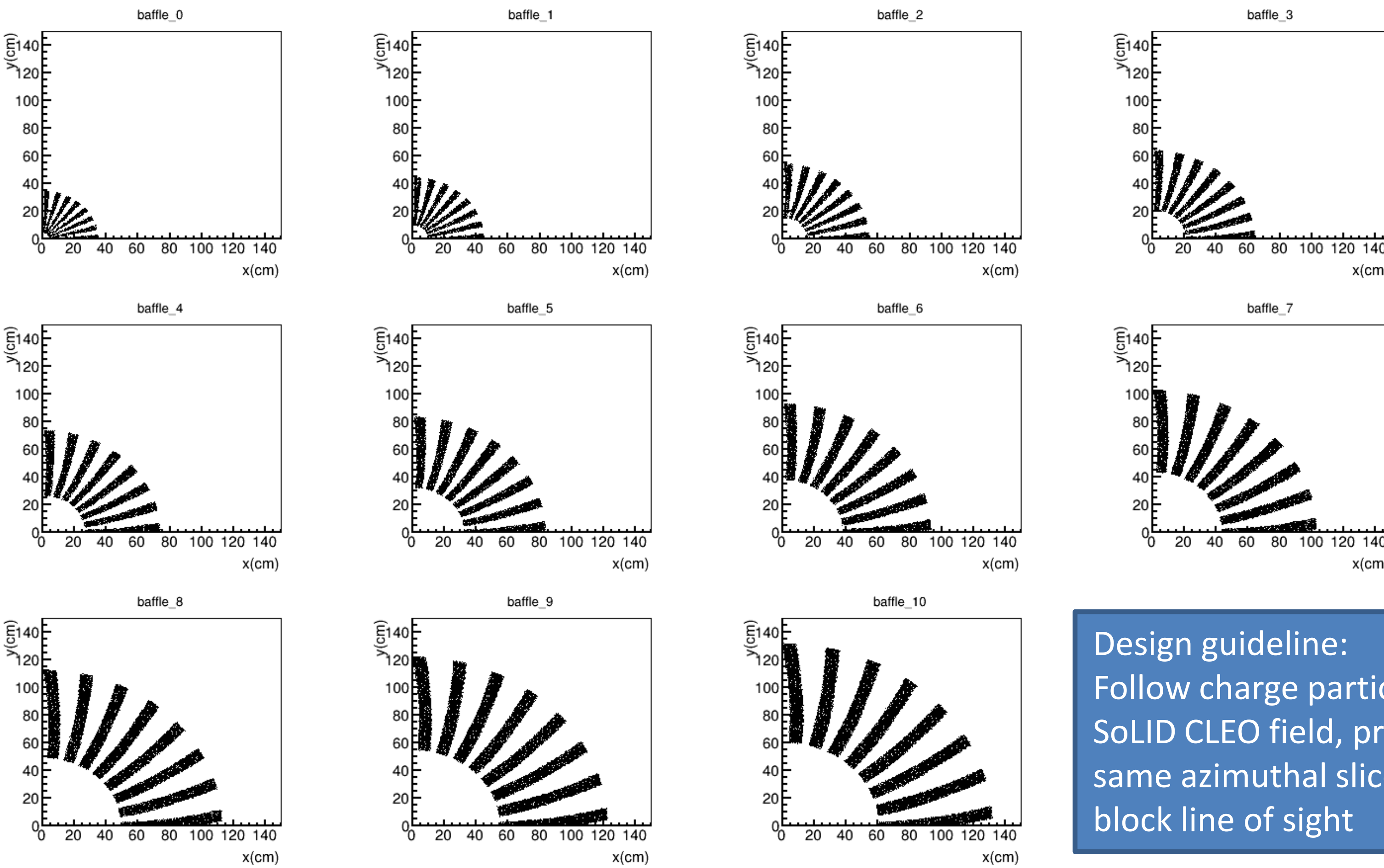
	PVDIS	SIDIS ^3He
Beam	50uA	15uA
Target	LD2 40cm	10amg He3 40cm
Window	Al 2*100um	Glass 2*120um
Radiation length (target)	5.4e-2	0.8e-3
Radiation length (window)	2.25e-3	3.4e-3
Radiation length (total)	5.6e-2	4.2e-3
Luminosity (target)	1.27e39	3e36
Luminosity (window)	1e37	3.7e36
Luminosity (total)	1.27e39	6.7e36
Design	baffle	target window collimator

PVDIS Baffle

1^{st} to 11^{th}, 9cm thick lead plane each



Placed right after the target, enough material to block photons, pions and secondary particles.

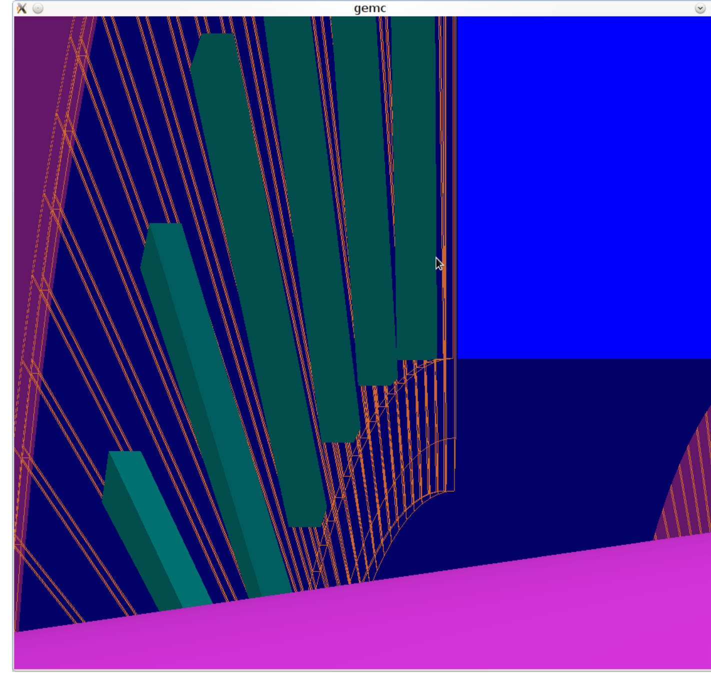


Design guideline:
Follow charge particle bending in SoLID CLEO field, preserve the same azimuthal slice and block line of sight

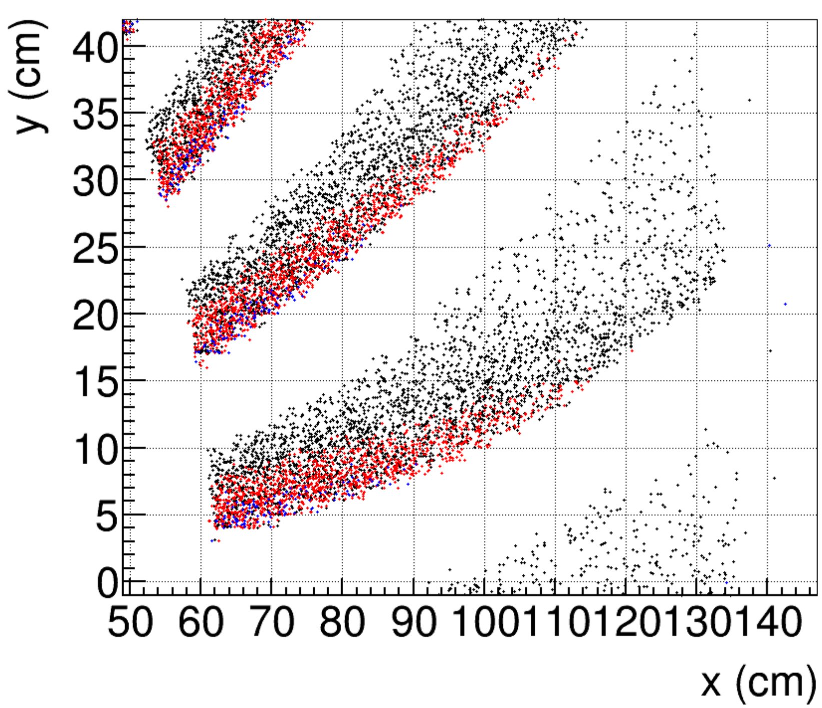
PVDIS Baffle

12^{th} , 5cm lead plane (EC photon block)

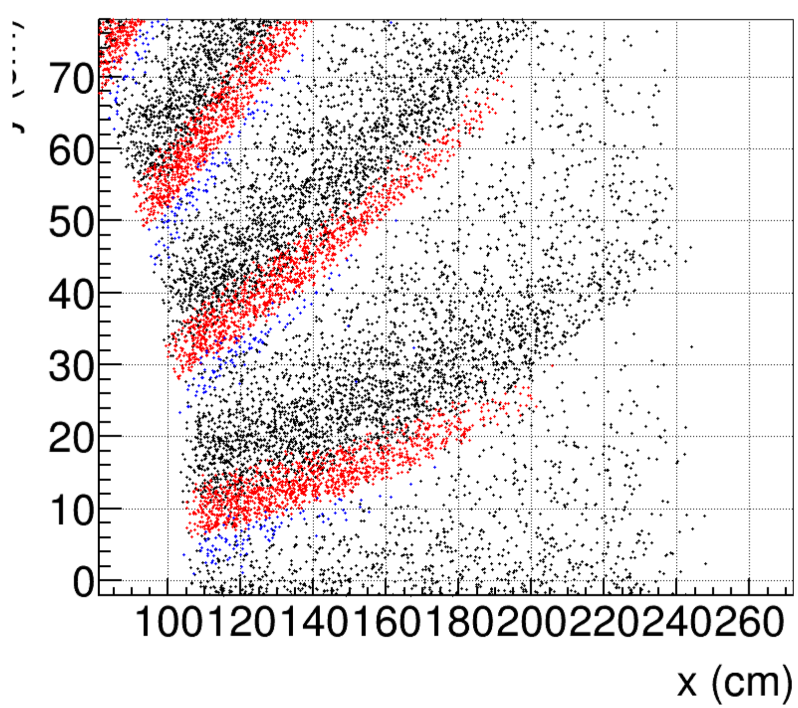
High energy electrons have least bending, only separate from photons before EC



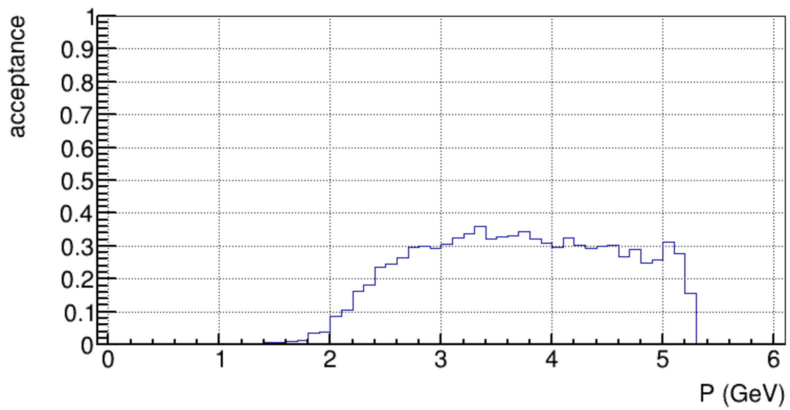
hits behind 11th baffle (black(-),red(0),blue(+))

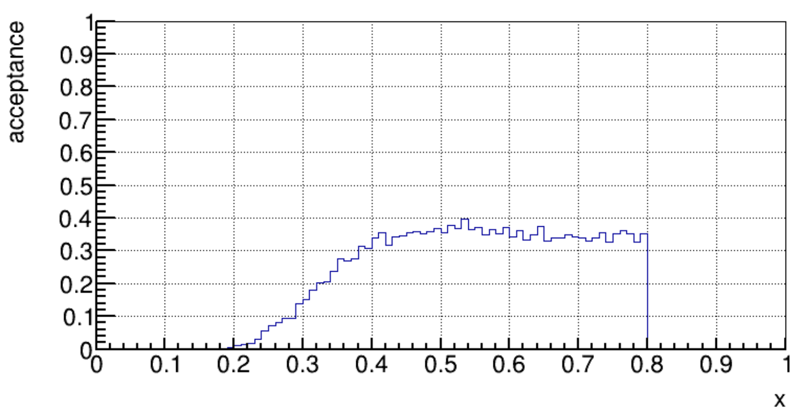


hits before FAEC (black(-),red(0),blue(+))

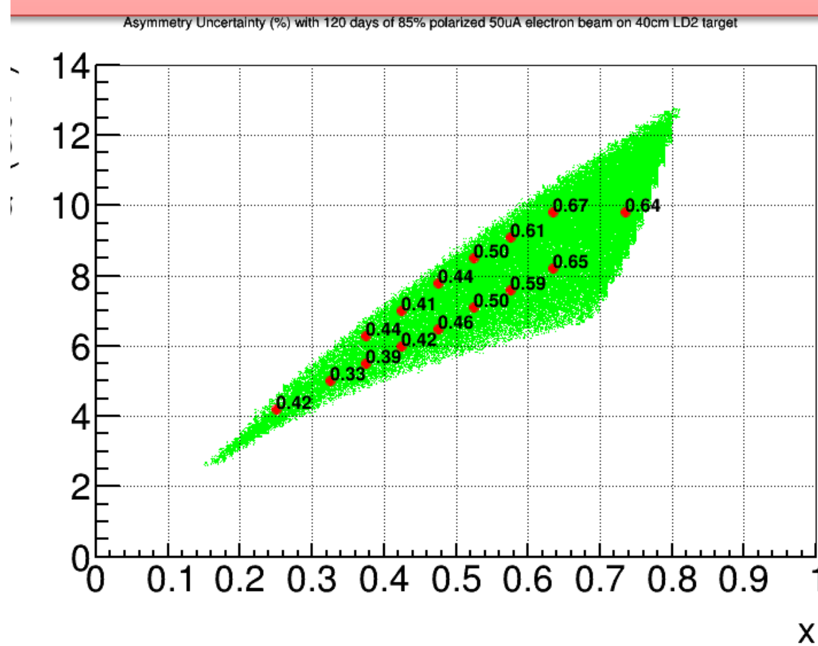


PVDIS Baffle: Impact on e(DIS)



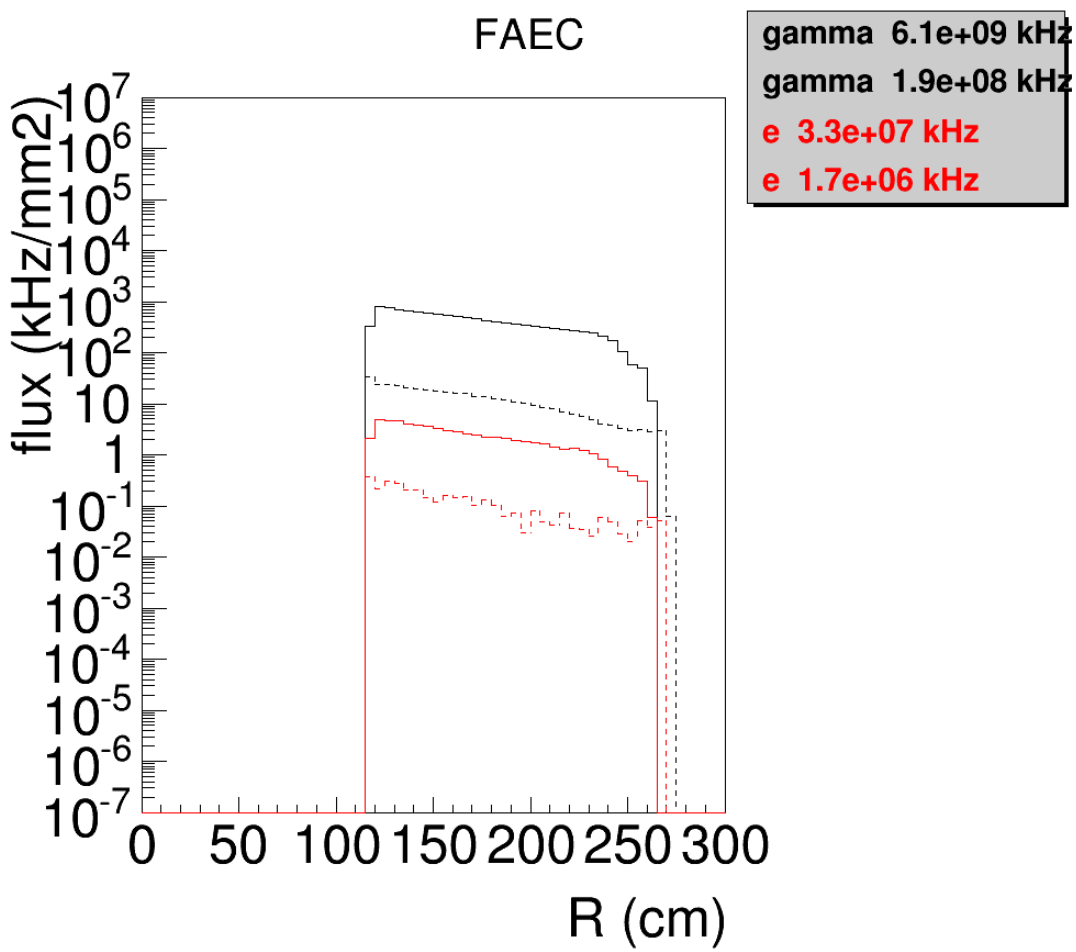


- e(DIS) flat ~30% acceptance at high P and high x
- Ensure good FOM



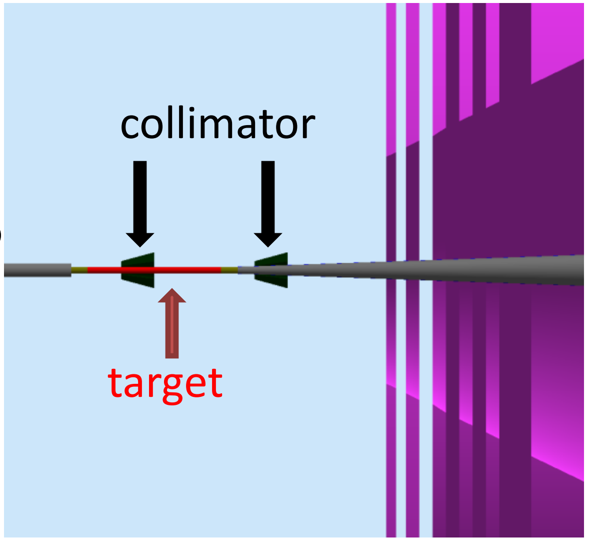
PVDIS Baffle: Impact on Background

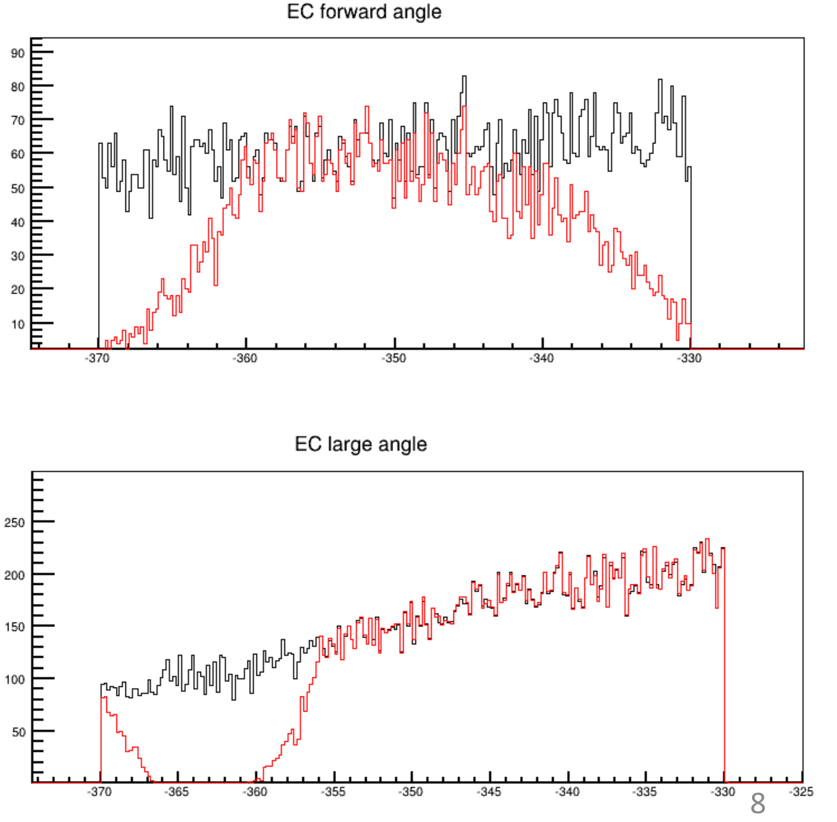
EM background on FAEC reduce by factor 20 - 30



SIDIS ^{3}He
Target window Collimators

- A pair of Tungsten collimators are optimized to block both low energy EM particles and hadrons from target windows into forward angle detectors
- The accepted particles at forward angle and large angle EC are shown with (red) and without (**black**) the collimators





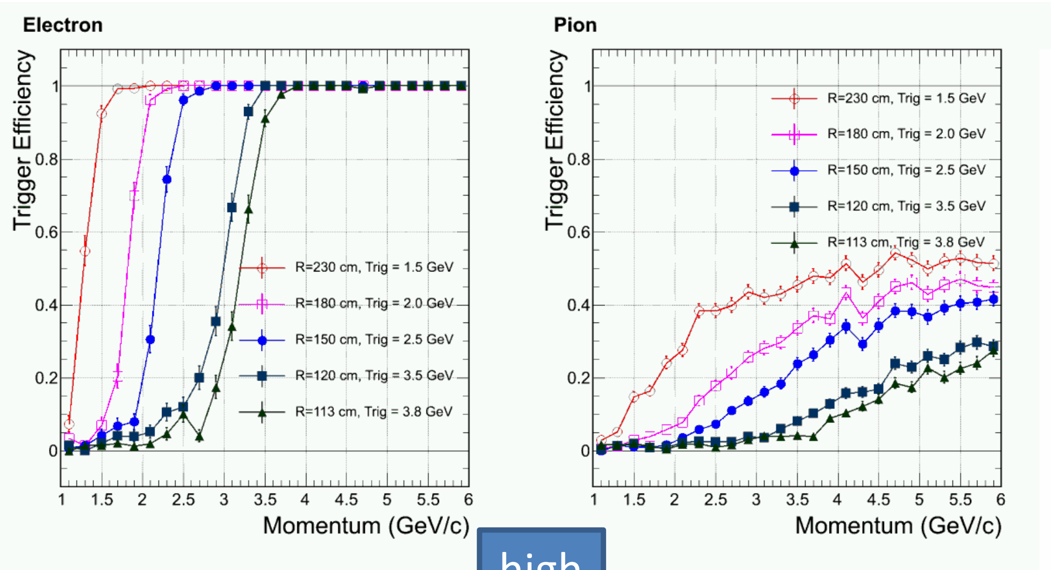
Background Study Procedure

- SoLID full setup in GEMC (Geant4) with realistic materials
- EM background produced from 11GeV e- on different targets, according to the physics models in Geant4
- Hadron background, generated from event generators (Wiser fit) on both target and target windows, then passed into GEMC to produce secondary particles according to the physics models in Geant4

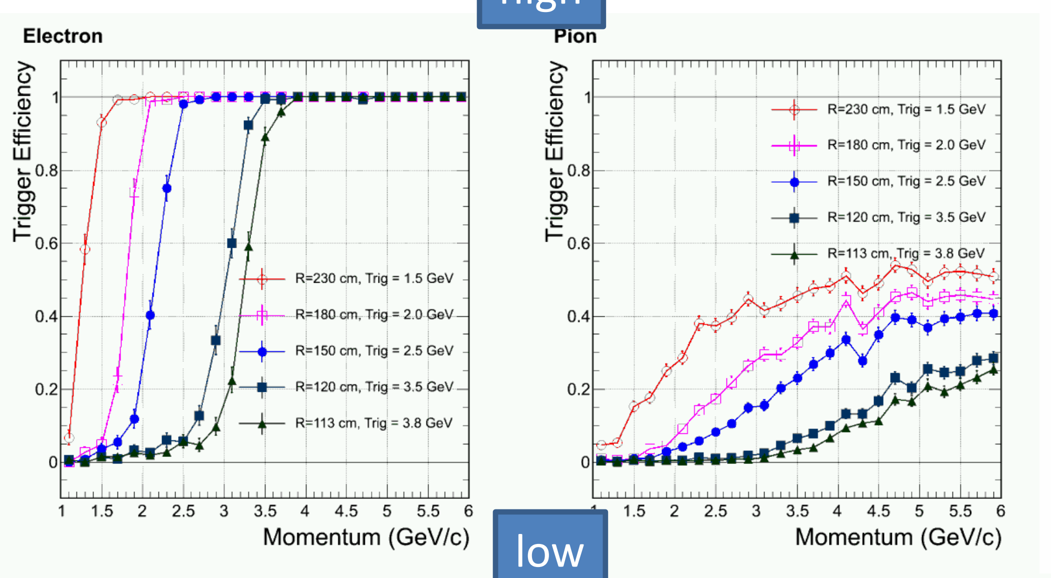
Trigger Rate Study Procedure

- Use simulation results from the background study
- Different detectors with trigger conditions
- Estimate trigger rate from individual detectors
- Estimate random coincidence trigger rate from a set of detectors

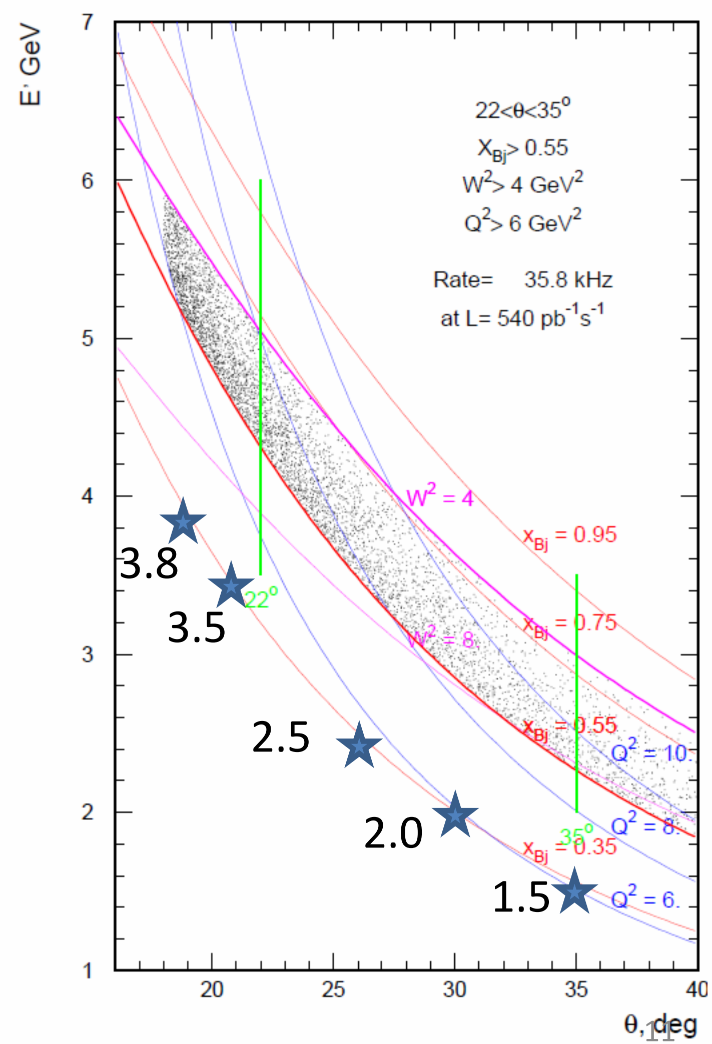
PVDIS FAEC Radius-dependent Trigger



high



low

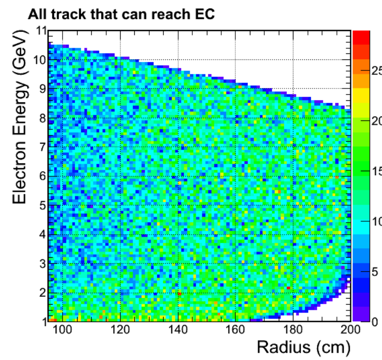


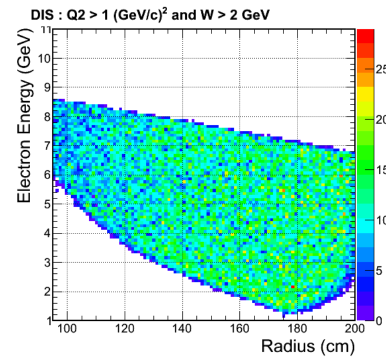
SIDIS ^{3}He FAEC Radius-dependent Electron Trigger

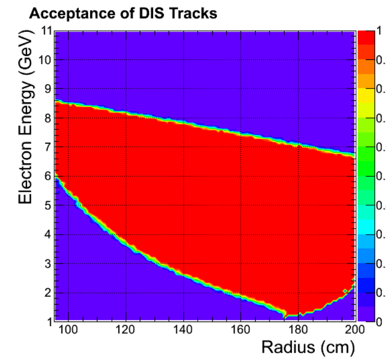
Radius(cm)	P Threshold (GeV)
90 - 105	5.0
105 - 115	4.0
115 - 130	3.0
130 - 150	2.0
150 - 200	1.0
200 - 230	2.0

6 point cut, right on Q2=1 line and field bend line

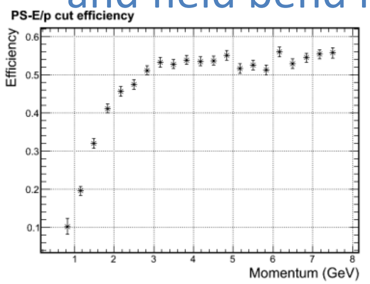
e(DIS) acceptance for SoLID CLEO and 40 long target

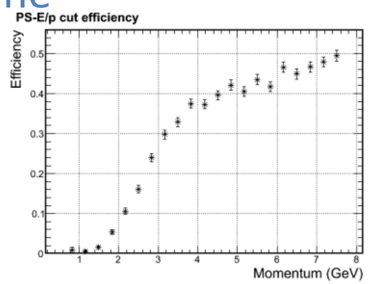


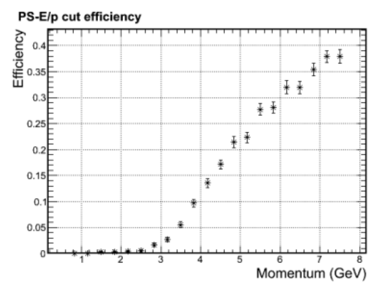


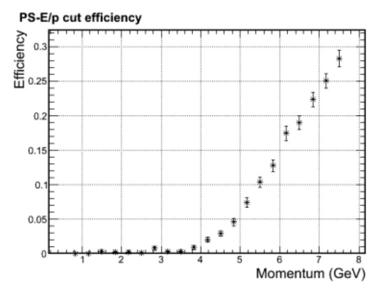


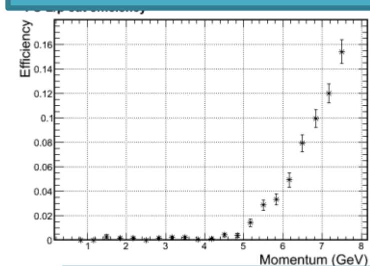
pion eff. VS Mom











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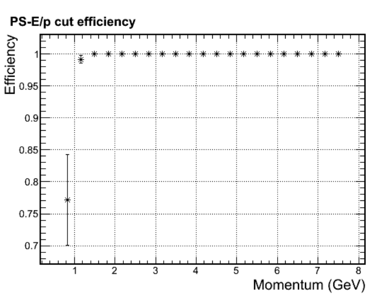

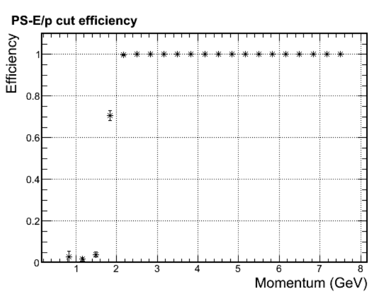

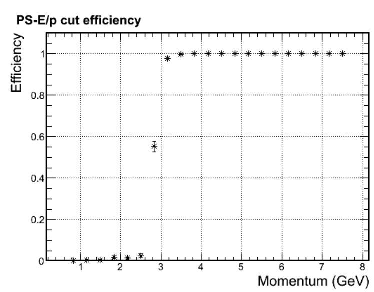

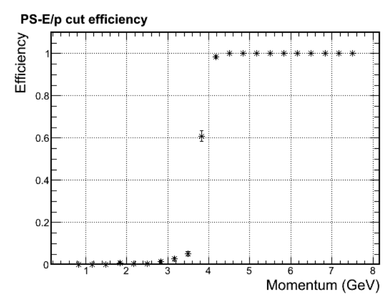

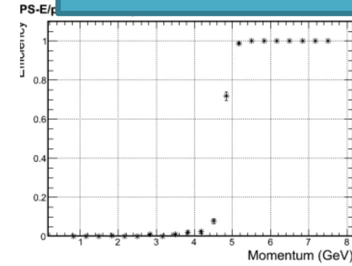

PVDIS FAEC Trigger Rate

region	full	high	low
rate entering the EC (kHz)			
e^-	413	148	265
π^-	5.1×10^5	2.7×10^5	2.4×10^5
π^+	2.1×10^5	1.0×10^5	1.2×10^5
$\gamma(\pi^0)$	8.4×10^7	4.2×10^7	4.3×10^7
p	5.5×10^4	2.4×10^4	3.1×10^4
sum	8.5×10^7	4.2×10^7	4.3×10^7
trigger rate for $p > 1$ GeV (kHz)			
e^-	321	80	231
π^-	4.8×10^3	3.4×10^3	1.4×10^3
π^+	0.28×10^3	0.11×10^3	0.17×10^3
$\gamma(\pi^0)$	4	4	0
p	0.18×10^3	0.10×10^3	0.08×10^3
sum	5.6×10^3	3.7×10^3	1.9×10^3
trigger rate for $p < 1$ GeV (kHz)			
sum	$(3.1 \pm 0.7) \times 10^3$	$(1.6 \pm 0.4) \times 10^3$	$(1.5 \pm 0.4) \times 10^3$
Total trigger rate (kHz)			
total	$(8.7 \pm 0.7) \times 10^3$	$(5.3 \pm 0.4) \times 10^3$	$(3.4 \pm 0.4) \times 10^3$

PVDIS Trigger Rate

- PVDIS setup has 30 sectors, rates below are for one sector
- 0.276MHz EC trigger rate
- 2MHz Cherenkov trigger rate
- Radom coincidence trigger rate combining EC and LGCC within a 30ns window

  16.6 kHz = 0.28MHz*2Mhz*30e-9ns
- PVDIS physics rate is about 10.4kHz
- Total rate 27kHz

SIDIS ^{3}He FAEC and LAEC Trigger Rate

region	FAEC	LAEC
rate entering the EC (kHz)		
e^-	93.4	18.7
π^-	5.36×10^3	1.55×10^4
π^+	5.96×10^3	1.66×10^4
$\gamma(\pi^0)$	1.52×10^5	2.43×10^5
$e(\pi^0)$	6.52×10^3	2.04×10^3
p	1.86×10^3	6.16×10^3
electron trigger rate (kHz)		
e^-	74.2	11.68
π^-	500	5.16
π^+	548	5.12
$\gamma(\pi^0)$	896	12.5
$e(\pi^0)$	43	0.14
p	109	2.15
sum	2170	36.75
MIP trigger rate (kHz)		
e^-	93.4	
π^-	5240	
π^+	5800	
$\gamma(\pi^0)$	6760	
$e(\pi^0)$	772	
p	1732	
sum	2×10^4	

SIDIS ^{3}He Trigger Rate

Within a 30ns widow, reduction factors are

LGCC	~50 (pion,proton)
MRPC+FASPD	~20 (gamma)
LASPD	~10 (gamma)

- FAEC electron trigger rate

  2170 kHz -> 129.7 kHz (LGCC and MRPC+FASPD)
- LAEC electron trigger rate

  37 kHz -> 25.5 kHz (LASPD)
- FAEC charged particle (MIP) trigger rate

  20 MHz -> 14 MHz (MRPC+FASPD)
- Radom coincidence trigger rate combining electron and charged particle trigger within a 30ns window

  65.2kHz = (129.7+25.5)kHz*14MHz*30ns
- SIDIS physics rate is 6kHz
- Total rate 72kHz

Summary

- Both SoLID SIDIS and PVDIS setups are designed to handle the required luminosity
- It could be extended to other physics which needs such luminosity