

SoLID J/Psi Optimization

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Goal

- Obtain most events (FOM) by adjusting
 - Target position
 - Additional change to SIDIS configuration

Previous Estimation

- Based on an old version of MC
- Geant3 BaBar acceptance
- Used 4 fold events with t –channel model

Target center(cm)	-350	-360	-368
FOM(relative crossection)	0.722	0.969	0.809

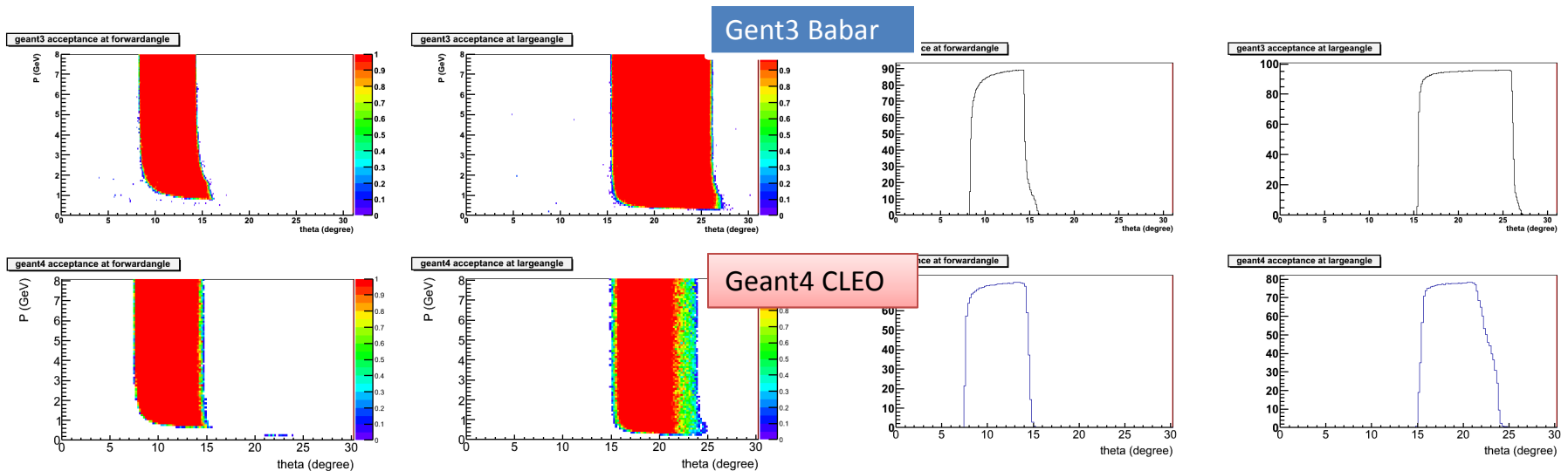
- We shall update the result with
 - latest MC(better way to treat phase space, fix a Q2 sign bug etc)
 - geant4 CLEO acceptance
 - 2g model

Acceptance: General Consideration

- Assume we can adjust GEM size, then only limitation of polar angle acceptance is from EC, thus EC determines the acceptance.
- EC needs to contain enough EM shower to do pid.
- Assume minimum requirement is tracks staying in EC at least 30cm in Z. (this is not as good as shower length, but easier to implement)
- Refer to large angle EC (LAEC) layout in backup

Acceptance comparison

- Both with target at -360cm.
- Was Geant3 BaBar using smaller target?
- Geant3 Babar acceptance has SIDIS LAEC move 12cm upstream, Geant4 CLEO acceptance has no change to SIDIS LAEC
- Geant3 Babar field about 1.5T and Genat4 CLEO field about 1.4T, thus Genat4 CLEO gains at forward angle and low P
- With conservative EC detection requirement, Genat4 CLEO loses at large angle

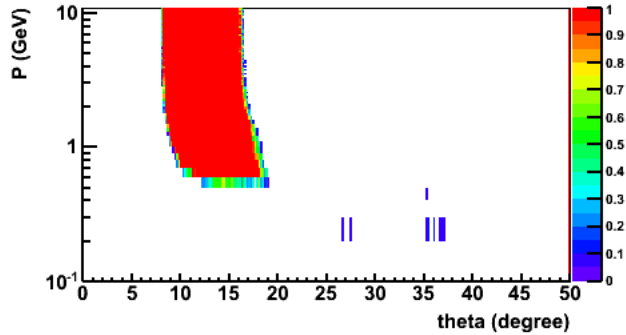


acceptance of P VS theta

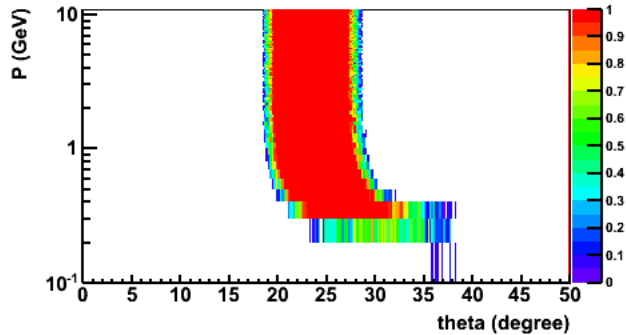
acceptance of theta, unnormlized

acceptance and target position

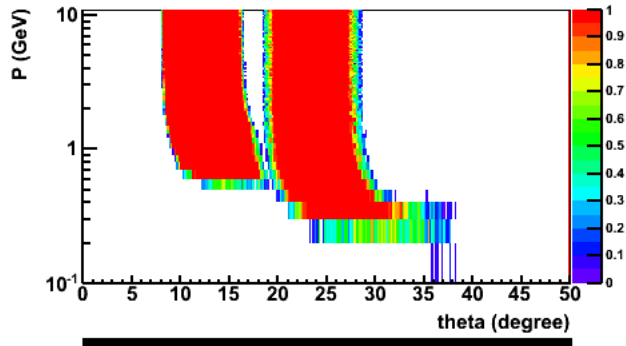
acceptance at forwardangle



acceptance at largeangle



acceptance



- SIDIS is optimized with target centered at -350cm
- SoLID polar angles shift to larger values when long target moves downstream along beamline

Target center (cm)	-360	-350	-330	-310	-305	-300	-295	-290	-270	-250
Max polar angle (deg)	23.3	23.9	25.3	26.9	27.3	27.8	28.3	28.7	30.7	33.0
Min Polar angle (deg)	7.4	7.5	7.7	7.9	7.95	8.0	8.1	8.2	8.4	8.7

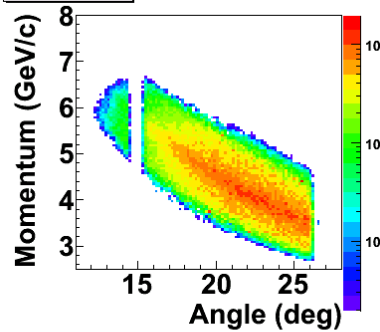
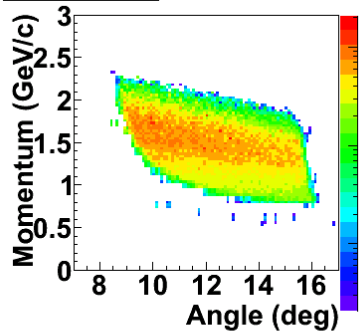
Target at -300cm

How acceptance affect FOM (based on 2g model and 4 fold)

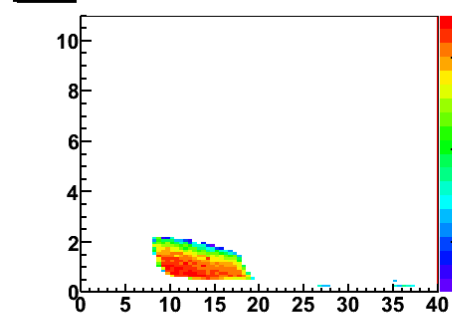
Target -360cm,
Geant3 BaBar,
From proposal

Target -300cm,
Geant4 CLEO,
current

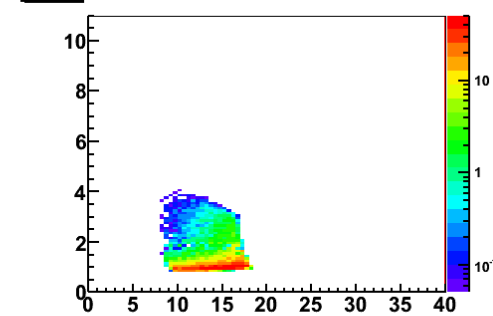
Scattered Electron



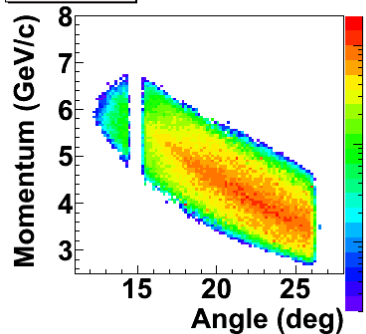
htemp



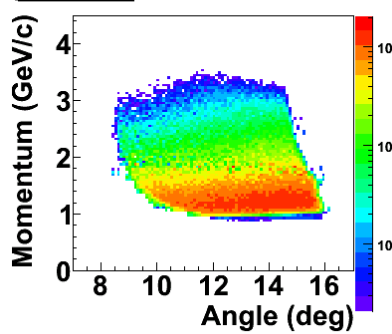
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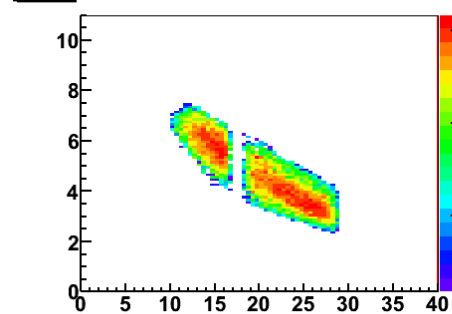
Decay Positron



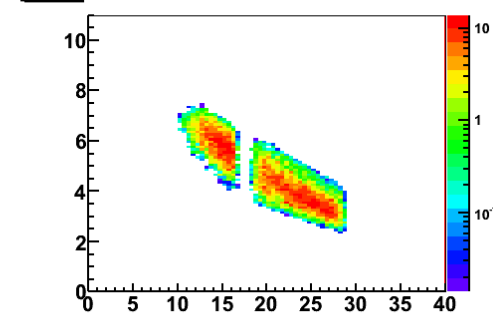
Recoil Proton



htemp



htemp



Increase mainly comes from

- for scattering electrons and recoil proton, better coverage at lower energy and forward angle
- for decay pair, better coverage at forward angle

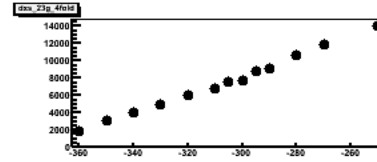
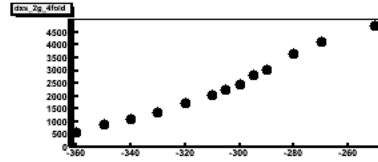
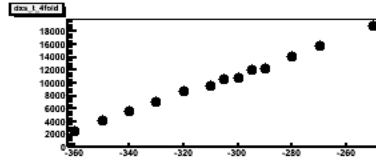
Number of events at different target position with geant4 CLEO

W range
(4.1, 4.5) GeV

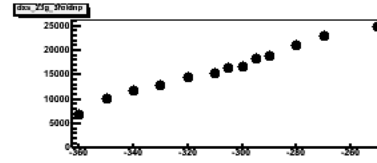
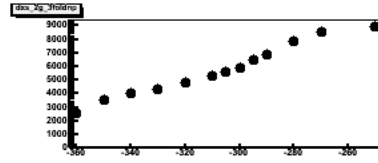
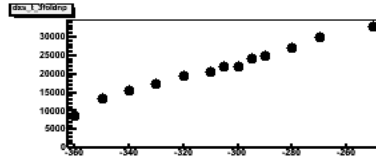
t model

2g model

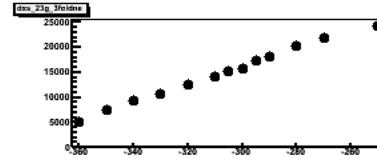
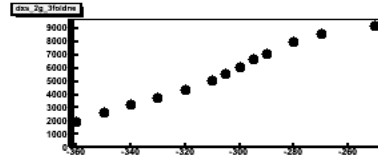
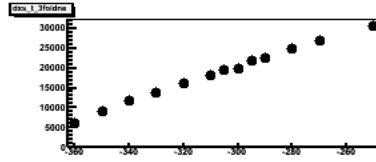
2+3g model



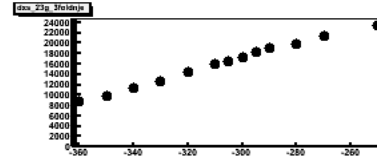
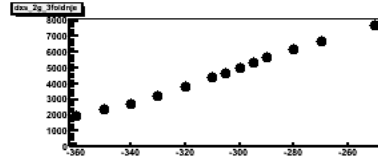
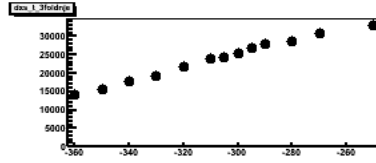
4 fold



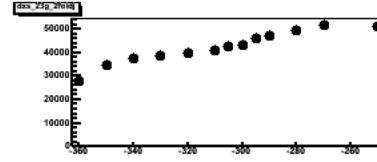
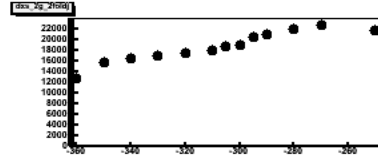
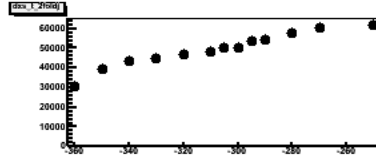
3 fold no p



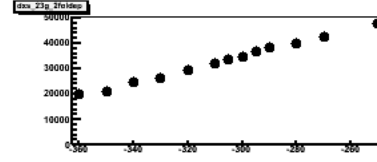
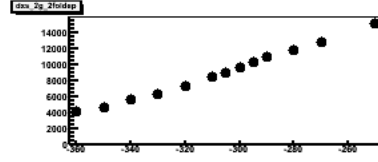
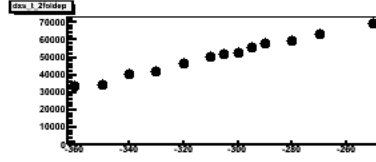
3 fold no e



3 fold no je



2 fold j



2 fold ep

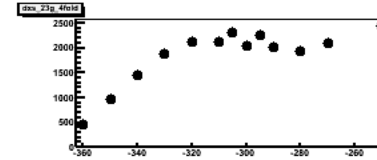
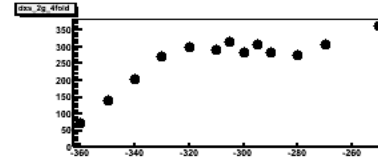
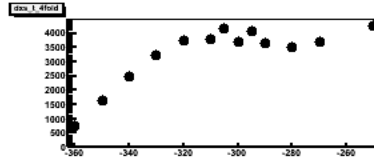
Number of events at different target position with geant4 CLEO

$W < 4.25$ GeV

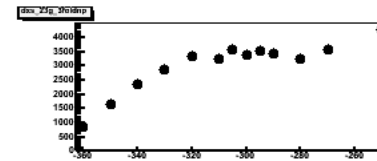
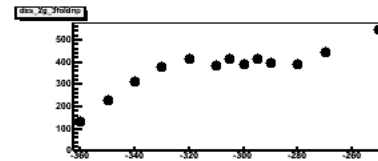
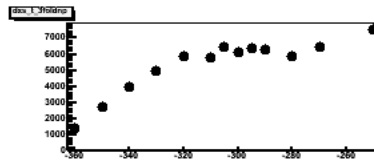
t model

2g model

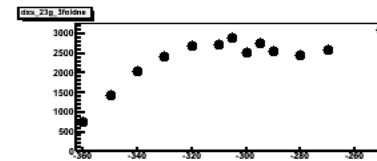
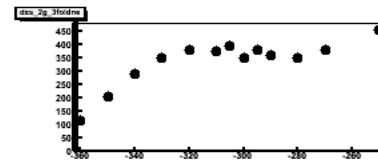
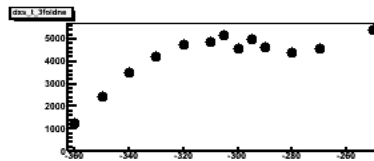
2+3g model



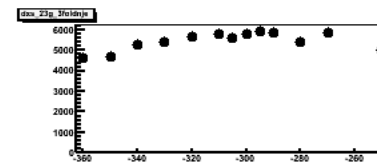
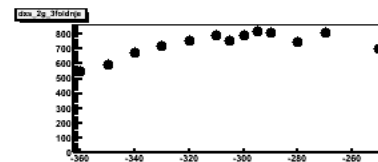
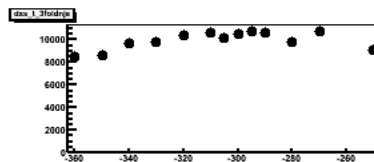
4 fold



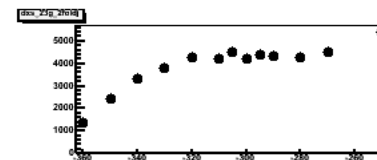
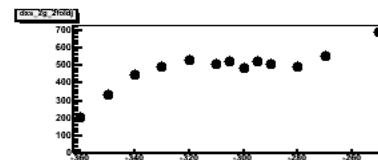
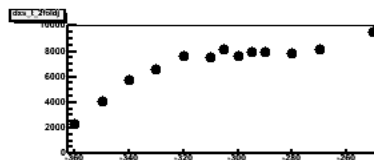
3 fold no p



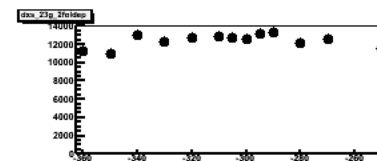
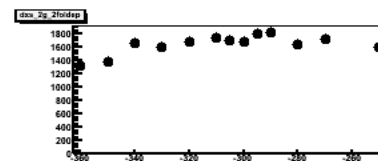
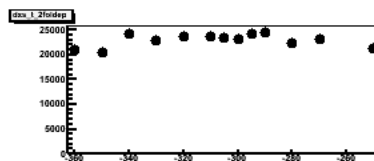
3 fold no e



3 fold no je



2 fold j



2 fold ep

Target position

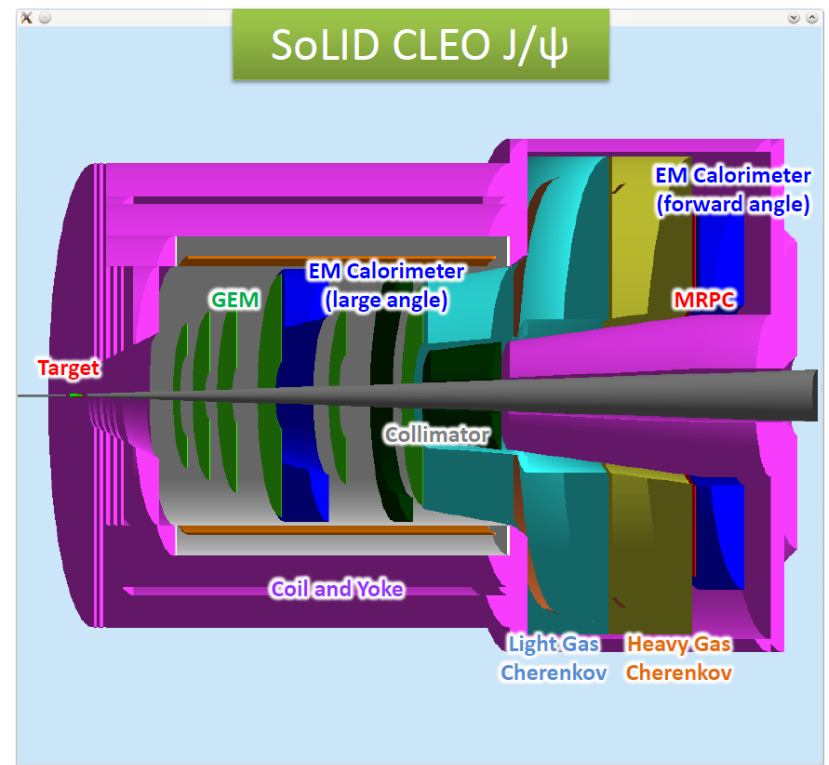
- Generally moving downstream gains rate
- At about between -310 and -300 cm, stop gaining for lower W
- Choose -300cm as target position, now the 2g model and 4 fold has 2.5k events comparing to 0.7k in proposal

number of events (FOM) with target at -300cm

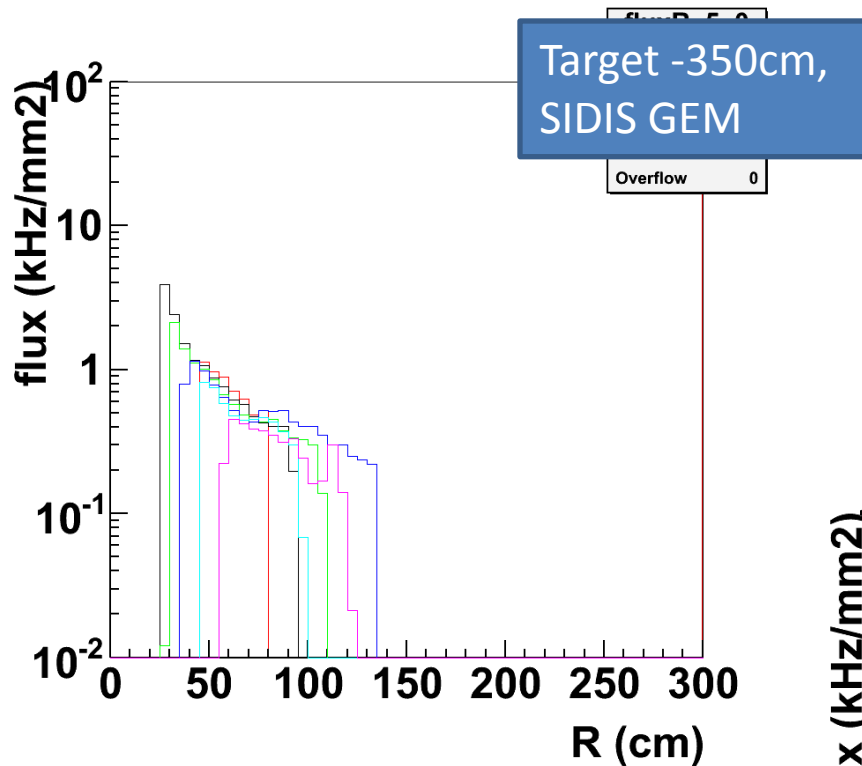
	4 fold	3 fold (no p)	3 fold (no e)	3 fold (no je)	2 fold (j/psi)	2 fold (ep)
t model	10.7k	22.2k	19.9k	25.5k	50.3K	53.0k
2g model	2.5k	5.9k	6.0k	5.0k	19.1k	9.6k
2+3g model	7.7k	16.7k	15.8k	17.3k	43.2k	34.7k

Impact

- Moving 15cm long target downstream by 60cm, from -360cm to -300cm
- No need to change solenoid opening or LAEC position
- GEM area increases by less than 2% comparing to SIDIS requirement, but PVDIS requires much more. Therefore there is no need for additional GEM for SIDIS or Jpsi if the rearrangement from PVDIS to SIDIS/JPsi works (see backup slides)
- rate on GEM and MRPC (see slides later)
- Radiation level on EC (see slides later)

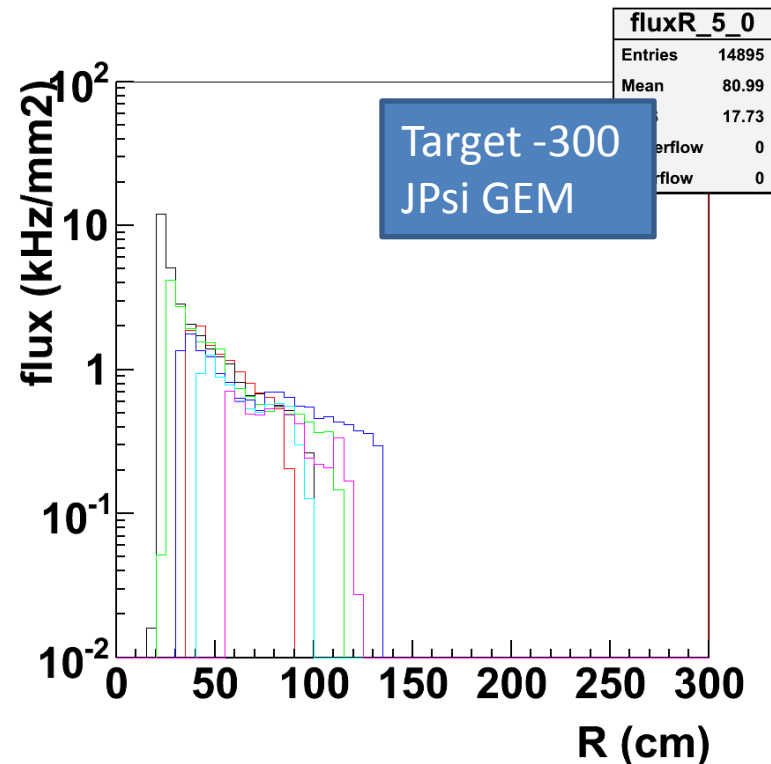


GEM rate from EM background

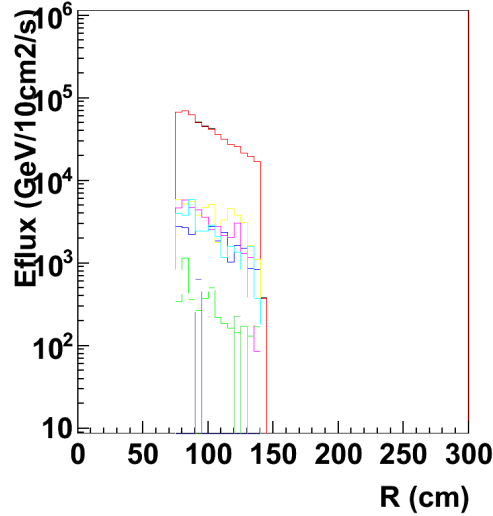
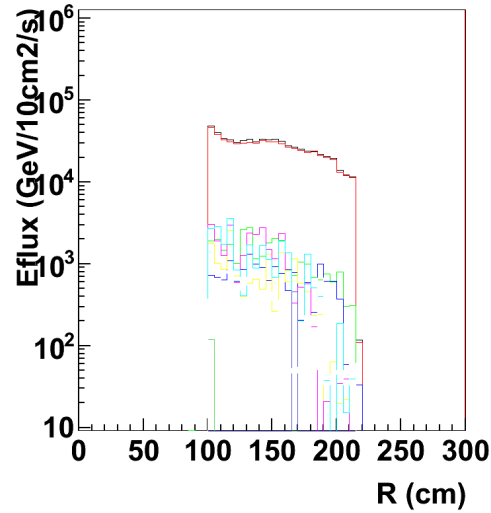


COMPASS GEM works at
30kHz/mm²

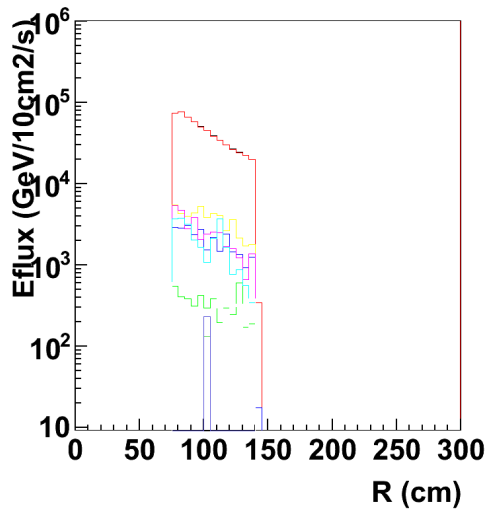
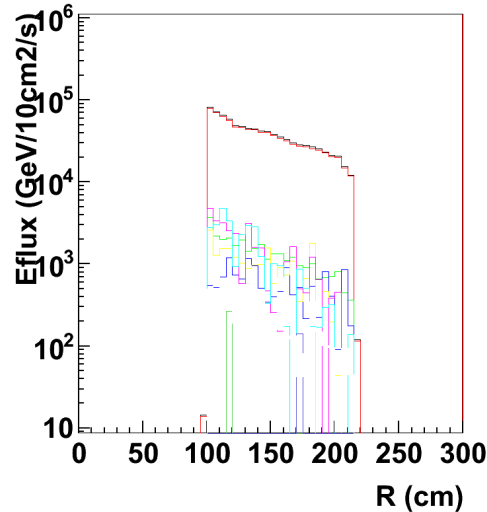
For most forward angle, we
can reduce tracking from 5
planes to 4 planes to reduce
rate



Eflux of EM background on EC



Target -350cm



Target -300cm

Other thoughts

- Lower field might help with acceptance rate, but it can harm momentum resolution
- How different JPsi decay model will change things?
- Current forward angle GEM distance is limited by light gas Cherenkov length. If it can be made smaller, scattering electron momentum resolution can be improved somewhat?
- If it can run two particle trigger, can other physics (e.g. TCS) be extracted from the data?

backup

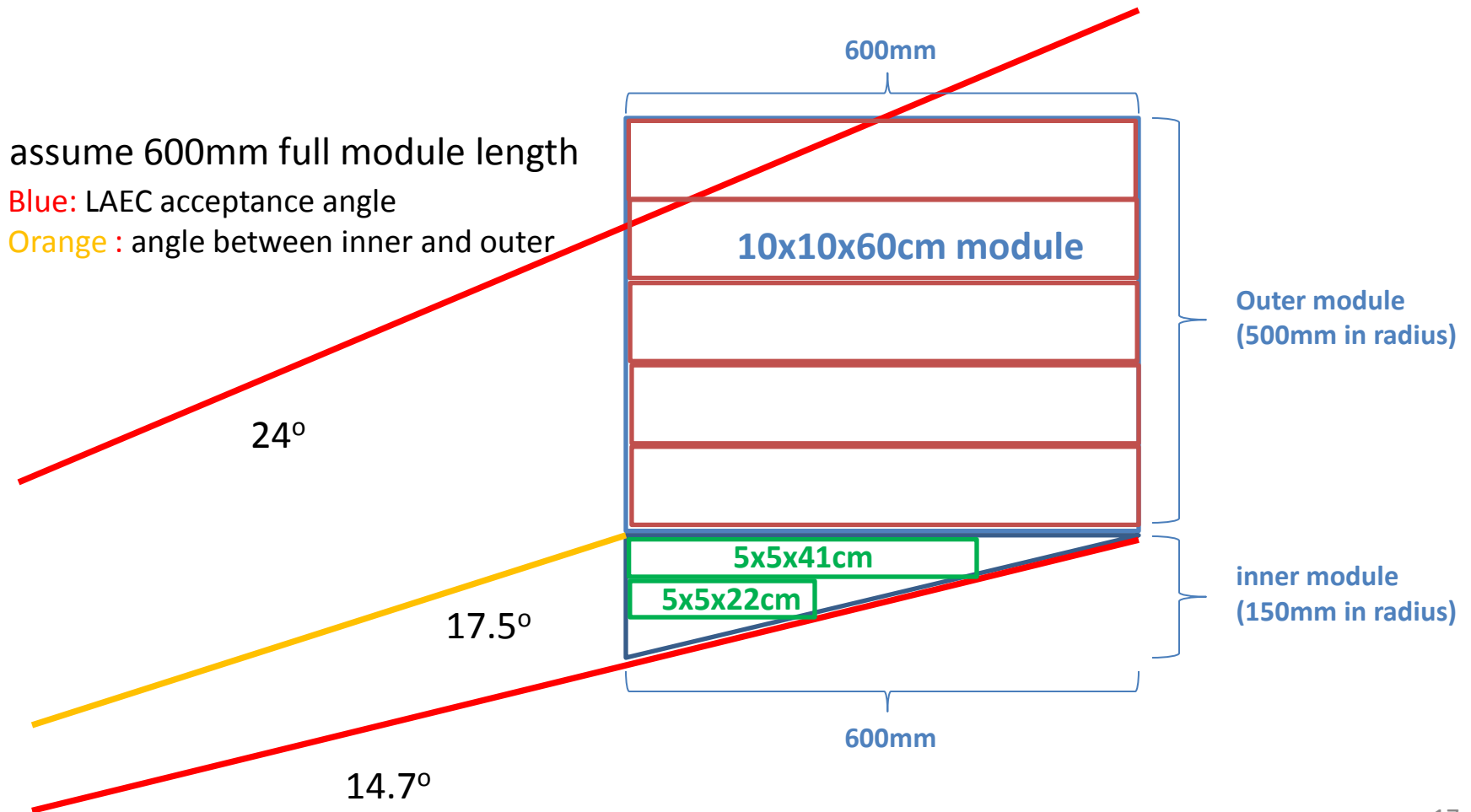
Confirm previous rate result

- Try to rerun Xin's latest MC code with Geant3 BaBar acceptance
- Condition: 15cm long target, $1e37\text{cm}^2/\text{s}$, 50 days, 0.85 eff

	4 fold 2g	4 fold 2+3g	3 fold(no p) 2g	3 fold(no p) 2+3g
In proposal	0.7k	2.9k	2.1k	8.1k
Now	0.7k	2.9k	1.9k	6.8k

- No sure why 3 fold (no p) doesn't match exact?

Large Angle EC (LAEC) sideview



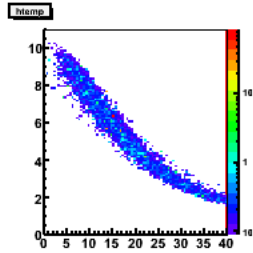
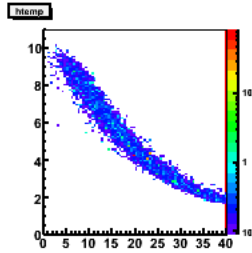
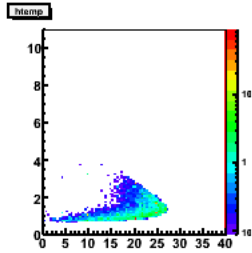
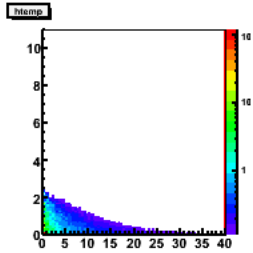
P VS Theta (target at -300cm with genat4 CLEO acceptance)

Scattered electron

proton

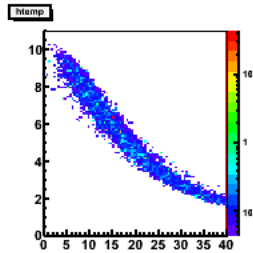
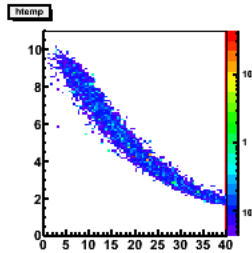
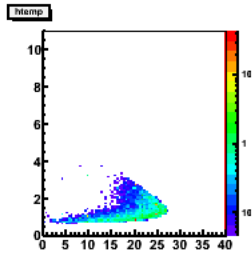
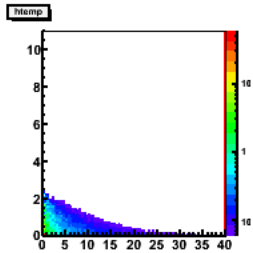
decay electron

Decay positron



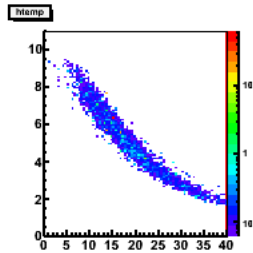
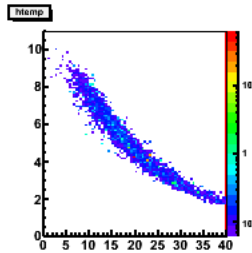
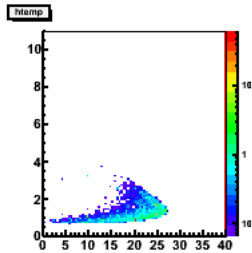
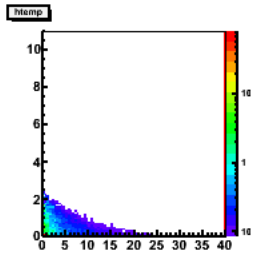
dxs_2g

2g model crosssection



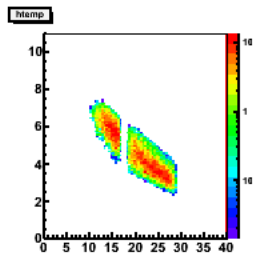
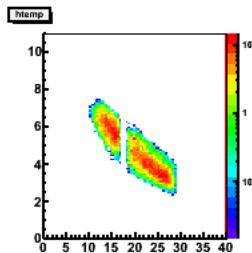
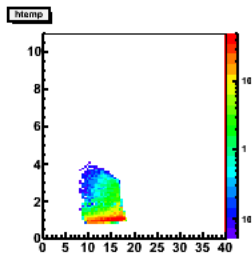
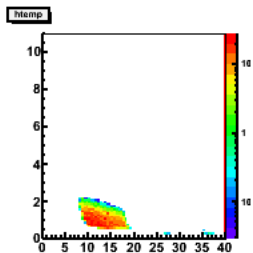
*weight

Additional weight by kinematics



*weight_decay

Additional weight by decay distribution

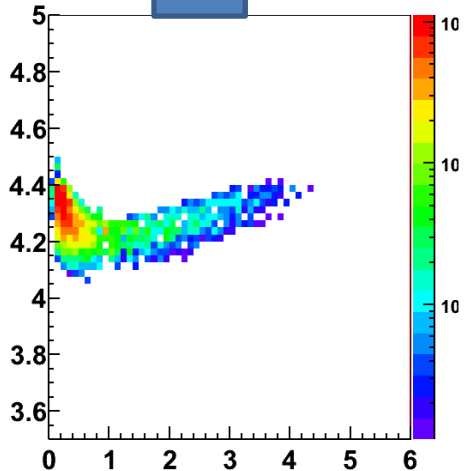


*acceptance

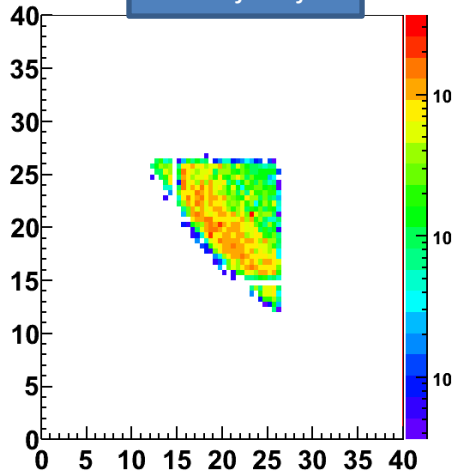
Additional weight by 4-fold acceptance

How acceptance affect FOM (based on 2g model and 4 fold)

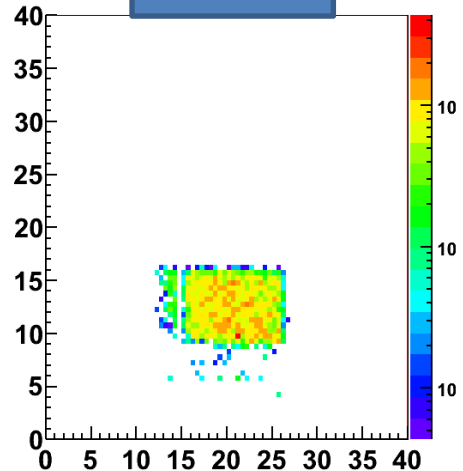
W:t
je2'accep_e)



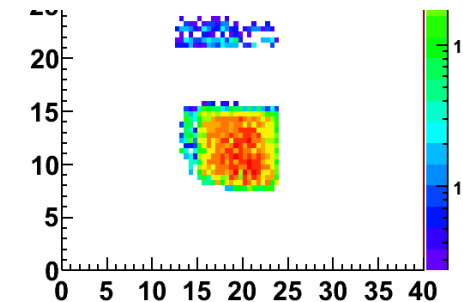
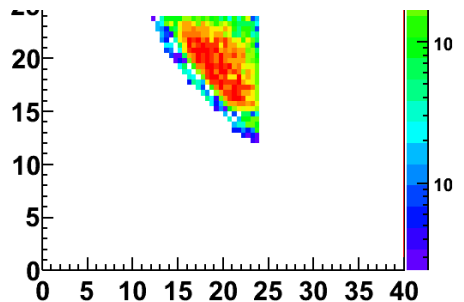
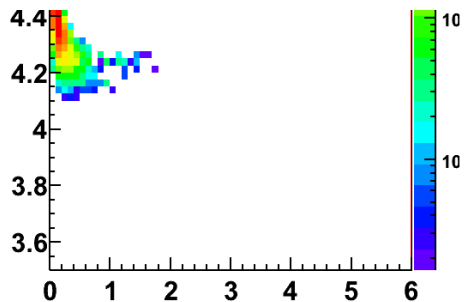
Theta je1: je2



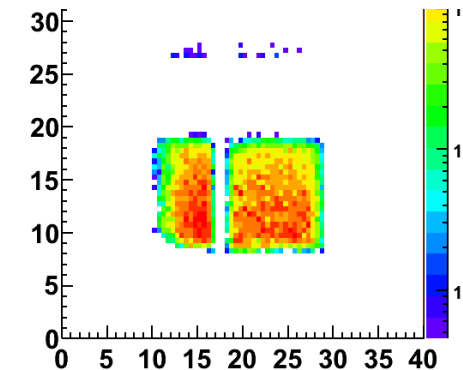
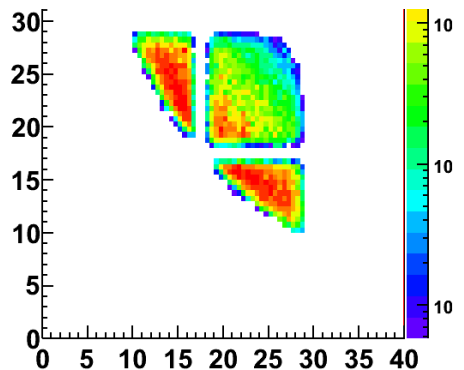
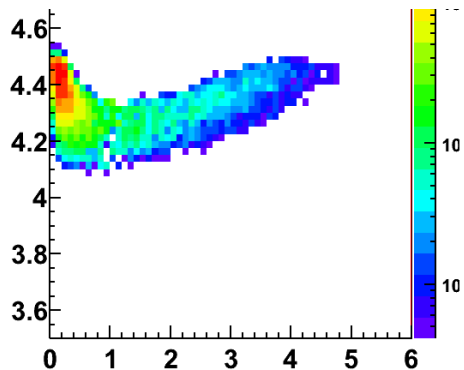
Theta e:Je1



Geant3 BaBar
Target -360cm



Geant3 CLEO
Target -360cm



Geant3 CLEO
Target -300cm

PVDIS GEM

id	Z (cm)	PVDIS target center		PVDIS target full	
		R range (cm)	Area (m2)	R range (cm)	Area (m2)
1	157.5	56-107	2.6116	48-122	3.9521
2	185.5	67-128	3.7369	59-143	5.3307
3	306	113-215	10.5105	105-230	13.1554
4	315	117-222	11.1824	109-237	13.9135
total			28.0414		36.3517

- CLEO coil center at 0.
- PVDIS 40cm long target with center at 10cm
- PVDIS angle 21-36 degree
- Considering the CLEO baffle, plane 1 and 2 are directly behind baffle and only need partial coverage (70-80%?), plane 3 and 4 are between Cherenkov and EC and need full coverage
- To cover full target, GEM needs to increase by 30%

SIDIS/JPsi GEM

id	z (cm)	SIDIS target center		SIDIS target full		JPsi target center			
		R range (cm)	Area (m2)	R range (cm)	Area (m2)	R range needed (cm)	Area needed (m2)	Area addition to "SIDIS target center" (m2)	Area addition to "SIDIS target full" (m2)
1	-175	46-78	1.2466	41-87	1.8498	36-67	1.0031	0.2576	0.1210
2	-150	26-91	2.3892	23-98	2.8510	21-80	1.8720	0.0738	0.0276
3	-119	30-103	3.0502	27-112	3.7118	25-97	2.7595	0.0864	0.0327
4	-68	37-126	4.5575	34-135	5.3624	32-123	4.4312	0.1084	0.0415
5	5	46-95	2.1705	44-100	2.5334	42-90	1.9905	0.1106	0.0540
6	92	58-118	3.3175	55-123	3.8026	55-115	3.2044	0.1065	0.0000
total			16.7315		20.1110		15.2607	0.7433 (4.5%)	0.2768 (1.4%)

- CLEO coil center at 0.
- Plane (1,2,3,4) cover large angle and plane (2,3,4,5,6) cover forward angle
- SIDIS 40cm long target with center at -350cm
- SIDIS angle 7.5-14.85-24 degree
- JPsi 15cm long target with center at -300cm tentatively
- JPsi angle 8- 16.28-28 degree
- PVDIS has more than enough GEM for SIDIS/JPsi to cover full target

Xin's old slides

PID and Acceptance

Scattered Electron:

GC + Calorimeter @
forward angle

Decay Electron/Positron:

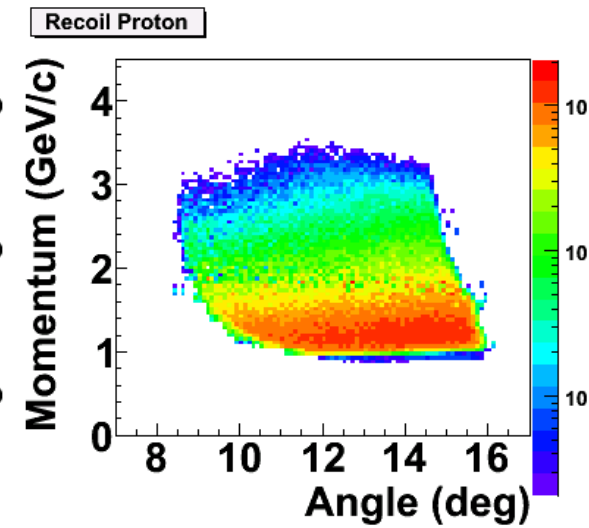
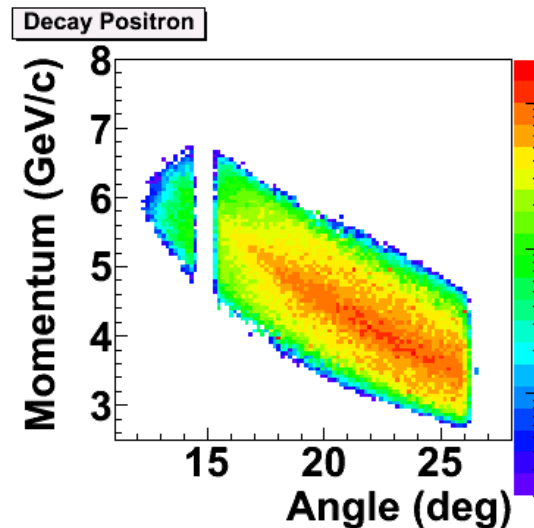
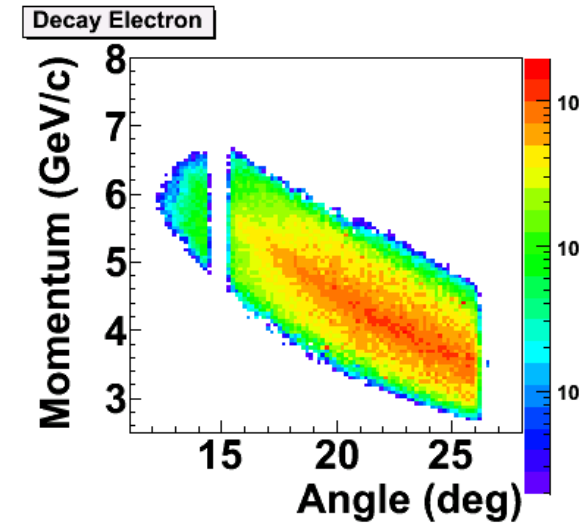
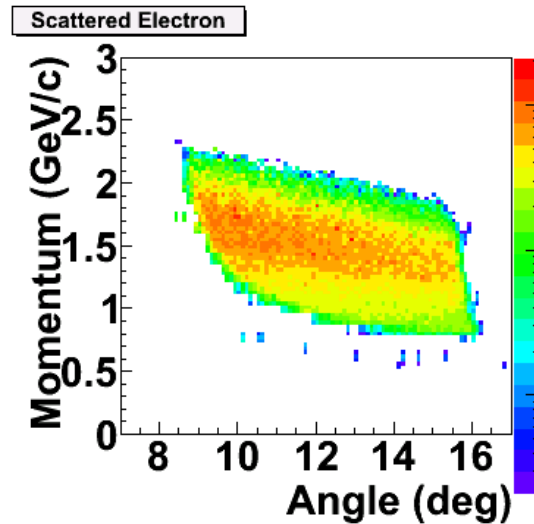
Calorimeter only @ large
angle

GC+Calorimeter at
forward angle

Recoil Proton:

100 ps TOF: 2 ns
separation between p/K
@ 2 GeV/c + 8 m

Exclusivity will further
strengthen PID with
kinematics fitting.

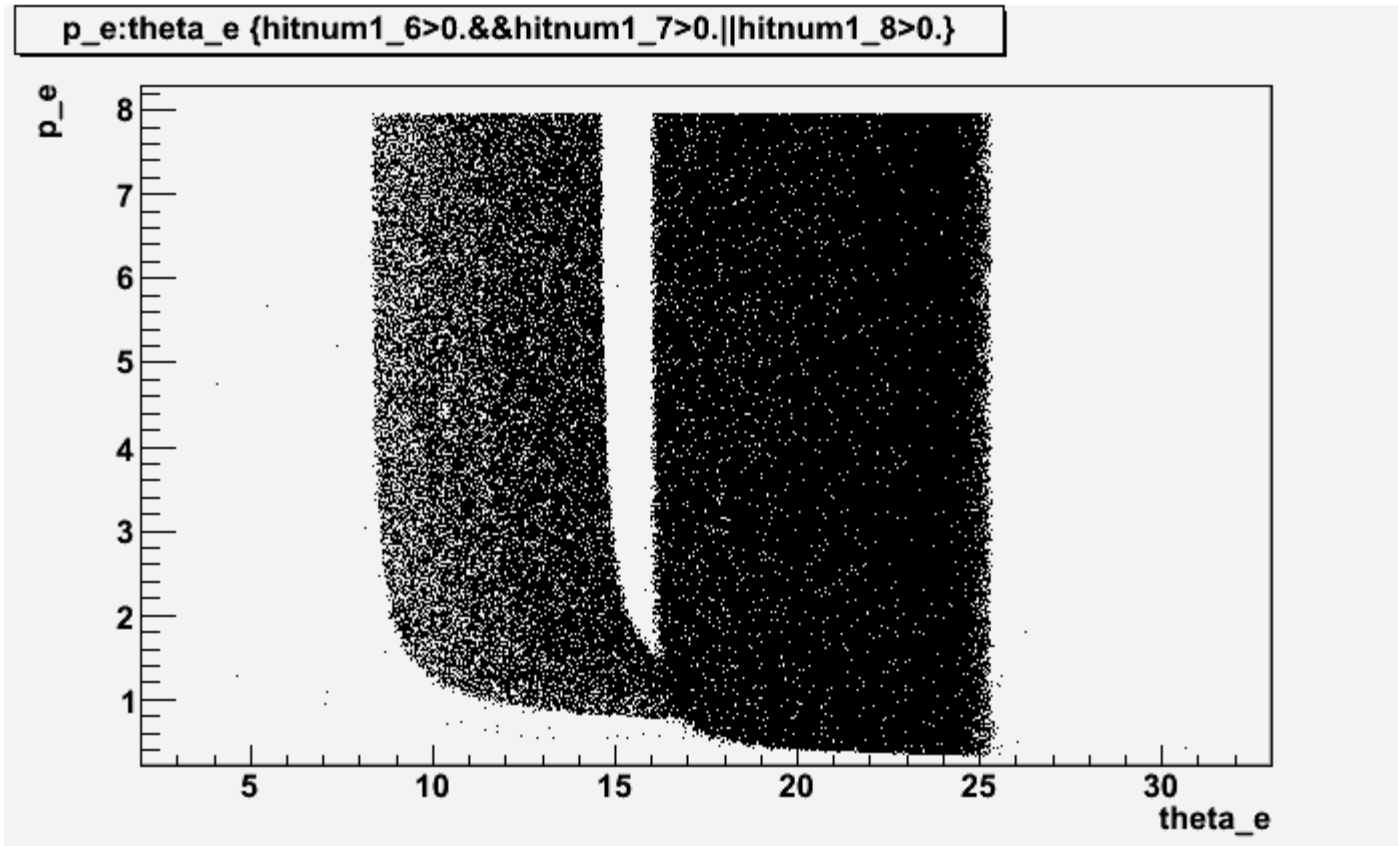


Main trigger rate is below **1 kHz** with 50 ns coincidence window. Comparing to **~50 kHz** design trigger rate for SIDIS.

Comparison (cross section weighted)

- Nominal Case: 0.722
- -10 cm Case: 0.969
- -18 cm Case: 0.809
- We will just go with -10 cm as nominal design.
 - We need to comparing to the old toy MC calculation:
 - Toy MC: 0.33
 - Now: 0.969
 - (we have higher acceptance than previously estimated)

Get an idea of the acceptance (theta vs. p)



Forward acceptance:

Minimum angle: 8.3 degrees

Maximum angle: 17 degrees vs. 15 degrees etc

Large angle acceptance: Minimum 16 degrees

Maximum: 25.3 degrees

