SoLID Simulation and Trigger Update

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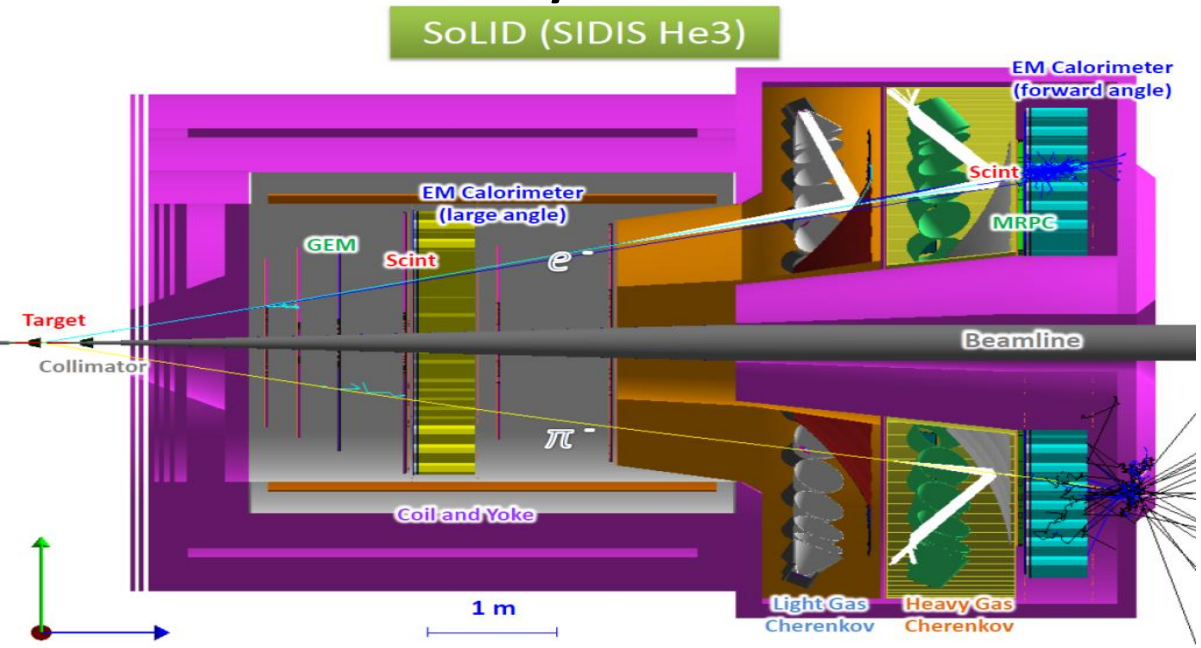
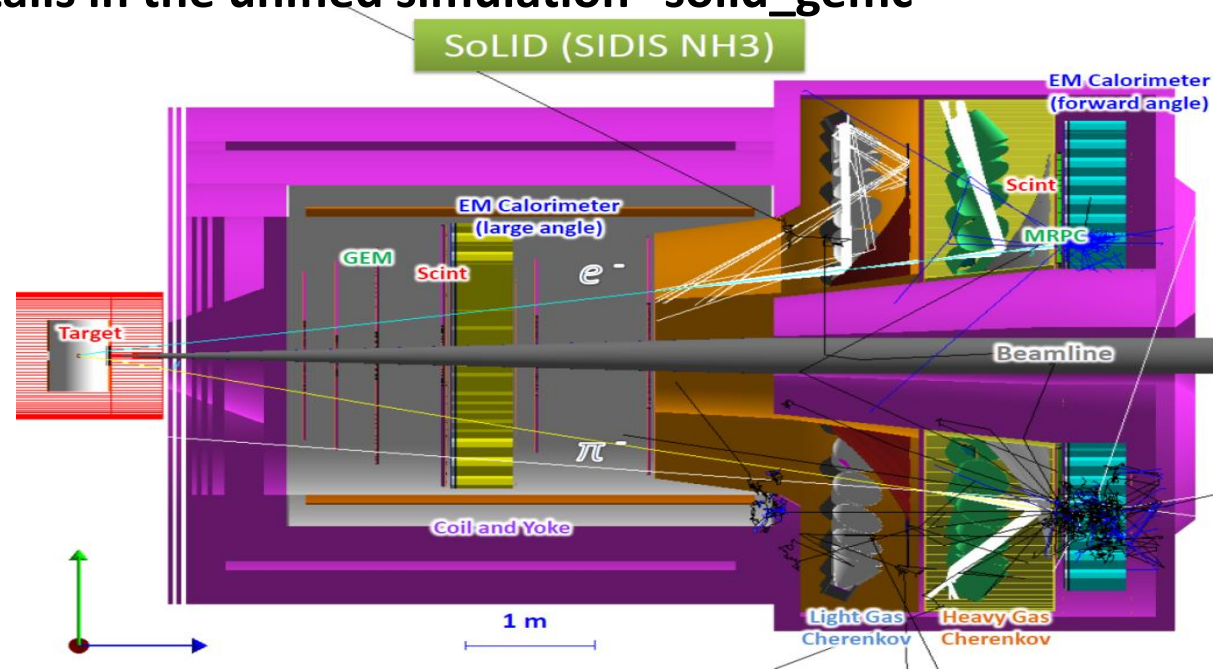
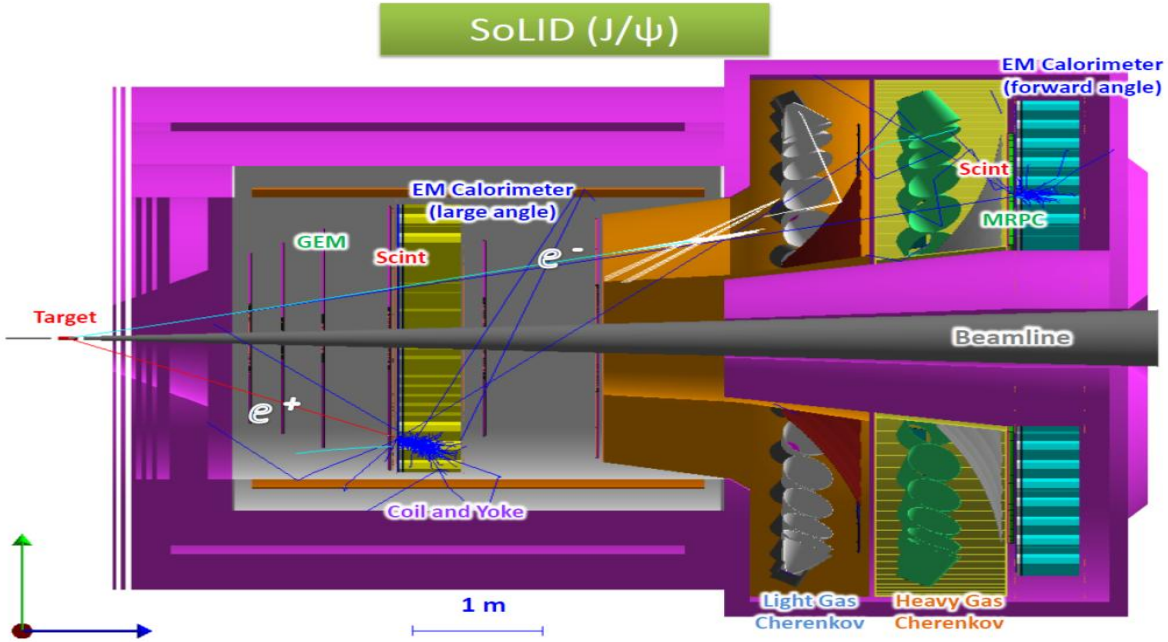
Review Comment (general simulation)

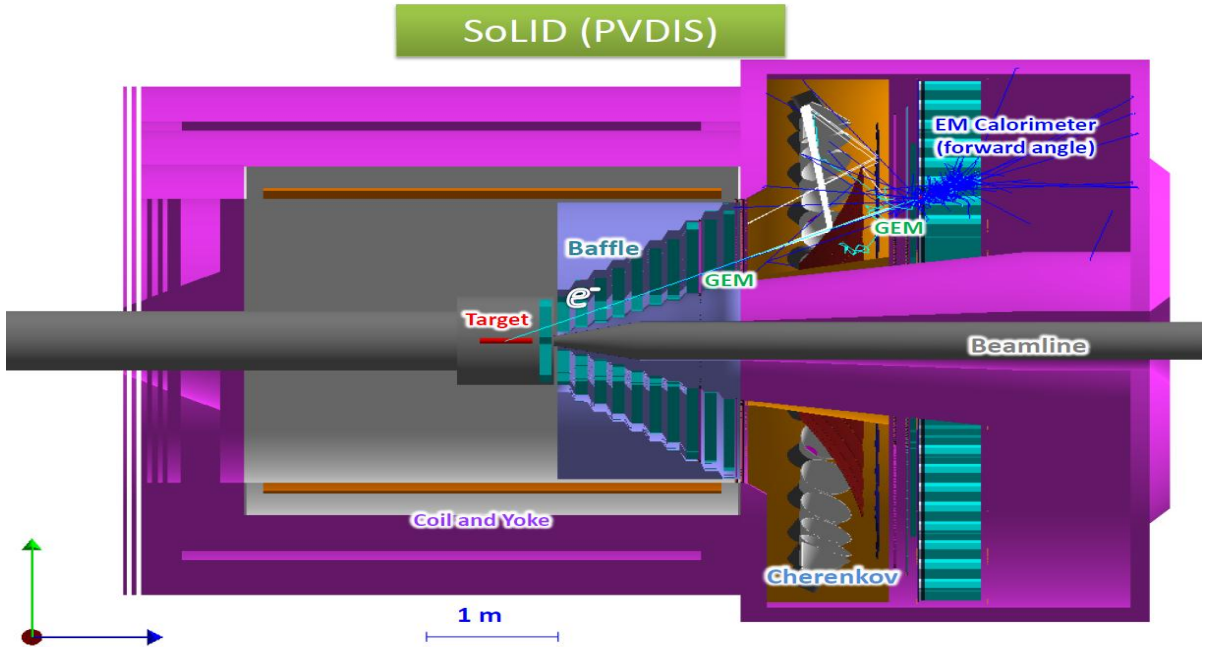
- End-to-end simulations with realistic subsystem responses and material budgets
- The development of a simulation framework with realistic reconstruction and analysis should be pursued with high priority and increased resources.
- Having a functional simulation and reconstruction routines as soon as possible should be a high priority in the software effort. Such software will pay off many times over in experimental design and avoiding pitfalls.
- Acceptances, efficiencies, and systematic uncertainties should be simulated for each of the core measurements.

all subsystems with various level of details in the unified simulation “solid_gemc”









PVDIS LD2 Rate

PID	Only EC fired	Rate with EC and lgc both fired for the same e or pion event	Efficiency of LGC
Electron	0.24 MHz	0.23 MHz	95.7%
Pim	4.43 MHz	0.64 KHz	0.01%
Pip	0.43 MHz	0 (limit: 0.04kHz)	0.01%
Pi0	0.015 MHz	8.5 KHz	55%

Well defined particles with EC&LGC = (230 + 0.64 + 0.04 + 8.5) KHz = 239 KHz = 8 KHz/sector

Random coincidence per sector = 170 KHz * 803 KHz * 30ns = 4.1 KHz/sector

Total: (8+4.1) KHz = 12.1 KHz/sector

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SIDIS_He3 trigger

hit matching

Trigger condition

- e_FAEC: R(105-235)cm, Q2>=1, Jin's wiser trigger curve
- e_LAEC: R(80-140)cm,P>3, Jin's wiser trigger curve
- h_FAEC: R(105-235)cm, cut below MIP, Jin's wiser trigger curve
- e_LGC: at least 2 PMT and each has at least 2 photons, similar to PVDIS
- e_FASPD and h_FASPD: Edep>0.5MeV
- e_LASPD: Edep>1.5MeV
- e_MRPC and h_MRPC are not working yet, so not used

Trigger logic

e_FA: e_FAEC & e_LGC & e_FASPD
e_LA: e_LAEC & e_LASPD
h_FA: h_FAEC & h_FASPD

1. Starting from EC and record all hits pass trigger
2. Then check matching LGC sectors and two neighboring sectors, if any sector passes, then LHC pass
3. Then check matching SPD sector
4. Finally we have individual triggers, we can count single trigger rate without double counting

1. Then check coincidence trigger with all hits from single trigger
2. Check e_LA & h_FA
3. Check e_FA & h_FA and choose to cut on hit distance on FAEC

single (gas(hallD),win up(wiser),win down(wiser))

Jin's EC Wiser trigger **hit matching**

e_FA(kHz)	EC	EC+LGC	EC+LGC+SPD
Electron	68 (57)	63(56)	58(52)+1+2
Pip	694(643)	4.2(3.3)	3.8(3.1)+2.5/2+1.6/2
Pim	537(492)	4.0(3.2)	3.6(3.0) +2.3/2+2.1/2
Pi0	1024(120)	43(31)	32(30) +1.1/2+5.8/2
P	202(185)	0(0)	0(0) +0/2+0/2
all hadrons, no electron	2692	62	47 +?+?
Total:			105+4+7=116

electron trigger self coin prescaled by 10

61/10=6kHz

Only primary particle in parenthesis,
In case of pi0, only e+ or e-

Pi0 before LGC 26(26)
Pi0 before GEM 13(12)

e_LA(kHz)	EC	EC+SPD
electron	4.5(4.3)	4.1(4)+3.6+2.6
Pip	8.6(8.5)	7.9(8.1)+8.4/2+5.6/2
Pim	6.4(6.0)	5.9(5.7) +6.1/2+3.7/2
Pi0	15.3(0.2)	0.6(0.2) +0.4/2+0.3/2
P	2.9(3.2)	2.8(3.0) +7.6/2+4.8/2
all hadrons, no electron	38	18 +?+?
Total:		22 +14+10=46

h_FA(kHz)	EC	EC+SPD
electron	140(94)	100(87) +4+4
Pip	5855(4898)	5151(4447) +3405/2+4570/2
Pim	4925(3787)	3971(3435) +3300/2+4590/2
Pi0	4607(811)	548(468) +33/2+171/2
P	3510(3103)	3164(2831) +2243/2+2563/2
all hadrons, no electron	17392	12805 +?+?
Total:		12913 +4500+6000=23413

Random coin (116+46-10.3-7.06-6.96)*23413*1e3*30e-9=97KHz

Coin

Direct estimation: using SIDIS generator, EC&GEM acceptance histogram and 8deg cut with or without vertex angle>2.5deg

hit matching

Coin trigger rate (kHz) (EC distance cut for e_FA & h_FA)		e_FA	h_FA	e_LA	e_FA & h_FA	e_LA & h_FA	(e_FA & h_FA) + (e_LA & h_FA)	Direct estimation
e+pip	>= 0cm	36(32)	127(74)	4.5(3.5)	[80]36(6.3)	[1.3]1.2(0.71)	[81.3]37.2(7.0)	(7.54)
	>= 0.1cm	same	same	same	[18]13(6.3)	Same	[19.3]14.2(7.0)	(7.54)
	>= 32.5cm	same	same	same	[11]9.1(6.3)	same	[12.2]10.3(7.0)	(7.45)
e+pim	>= 0cm	27(25)	99(58)	3.3(2.8)	[58]27(4.7)	[1]0.76(0.53)	[59]27.76(5.2)	(5.51)
	>= 0.1cm	same	same	same	[13]9(4.7)	same	[14]9.76(5.2)	(5.51)
	>= 32.5cm	same	same	same	[7.5]6.3(4.7)	Same	[8.4]7.06(5.2)	(5.44)
e+pi0	>= 0cm	27	42	2.6	27	0.05	27.05	
	>= 0.1cm	same	same	same	3.8	same	3.85	
	>= 32.5cm	same	same	same	0.6	same	0.65	
e+p	>= 0cm	22	94	2.5	22	0.76	22.76	
	>= 0.1cm	same	same	same	7.9	same	8.66	
	>= 32.5cm	same	same	same	6.2	same	6.96	

only primary particle in parenthesis,
double counting NOT removed in square bracket

SIDIS coin (9.1+6.3+0.6+6.2)+(36+27+27+22)/10+(1.2+0.76+0.05+0.76)=36kHz

Coin

Direct estimation: using SIDIS generator, EC&GEM acceptance histogram and 8deg cut with or without vertex angle>2.5deg

hit matching

Coin trigger rate (kHz) (EC distance cut for e_FA & h_FA)		e_FA	h_FA	e_LA	e_FA & h_FA	e_LA & h_FA	(e_FA & h_FA) + (e_LA & h_FA)	Direct estimation
e+kp	>= 0cm	10	19	1	10	0.06	10.06	
	>= 0.1cm	same	same	same	1.7	same	1.76	
	>= 32.5cm	same	same	same	0.6	same	0.66	
e+km	>= 0cm	1.3	6.8	0	1.3	0.002	1.302	
	>= 0.1cm	same	same	same	0.23	same	0.232	
	>= 32.5cm	same	same	same	0.11	same	0.112	
e+k0	>= 0cm	5.4	23	0.5	5.4	0.12	5.52	
	>= 0.1cm	same	same	same	1.9	same	2.02	
	>= 32.5cm	same	same	same	1.6	same	1.72	
all hadrons, no electron	>= 0cm	47	18	12805	47	5.9	53	
	>= 0.1cm	same	same	same	22	same	28	
	>= 32.5cm	same	same	same	17	same	23	

only primary particle in parenthesis,
double counting NOT removed in square bracket

hadron coin (17)+(47)/10+(5.9)=28kHz

SIDIS_He3 trigger rate summary

- Single e 116+46=162kHz

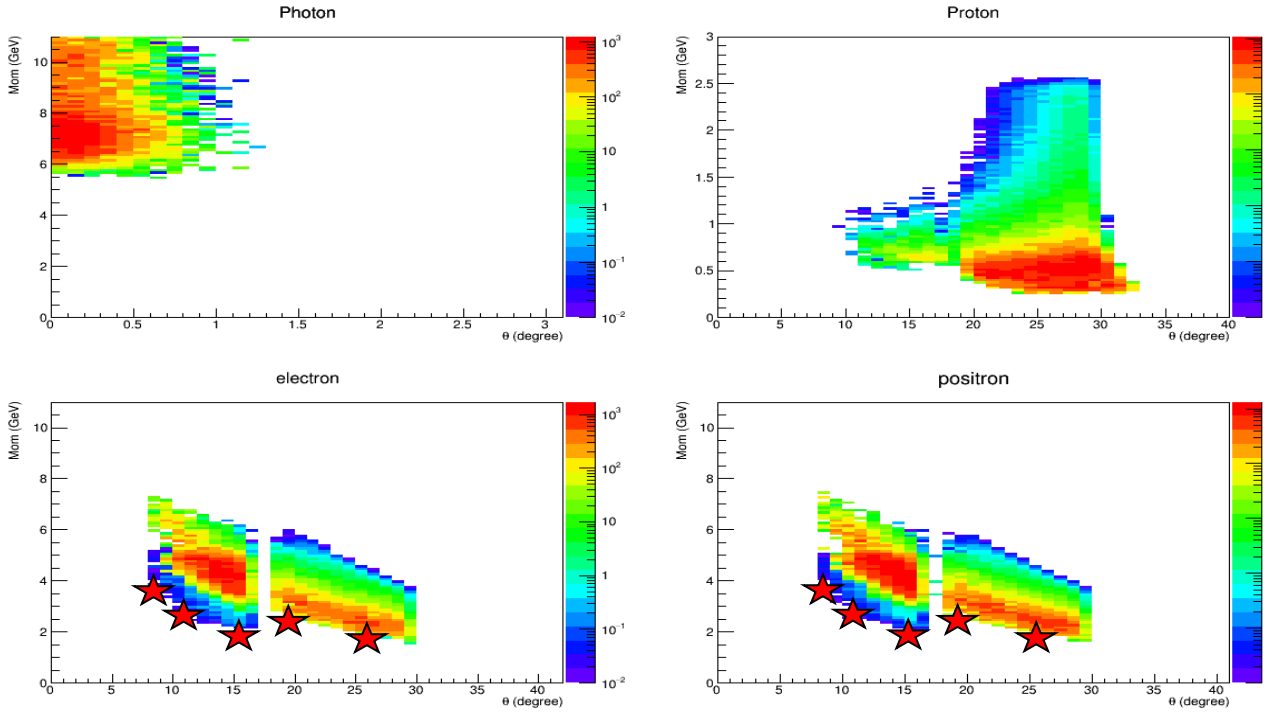
- Random coin 97kHz
- True coin rate <70kHz
  - electron trigger self coin 6kHz
  - coin from SIDIS 36kHz
  - coin from hadrons 28kHz (still missing window)

Total coin rate 167kHz + from hadrons of windows

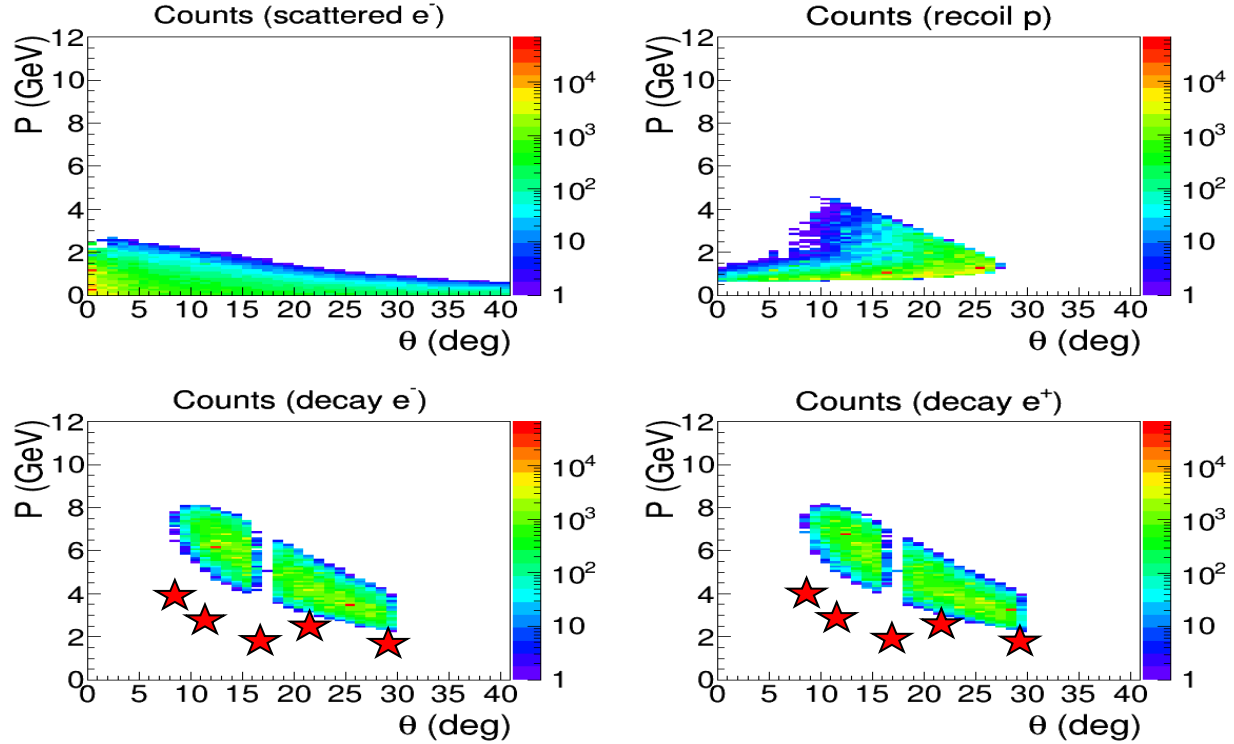
All three true coin rate has overlaps but can't know how much without a complete generator!

JPsi_LH2 trigger

TCS/BH (photo + quasi-photoproduction)
Require proton and decay pair



Jpsi (Electroproduction)
Require decay pair only



Possible Trigger 2 (radial): electron trigger by FAEC with 4GeV (r=105-115cm), 3GeV (r=115-145cm) and 2GeV (r=145-235cm), by LAEC with 3GeV (r=80-100cm) and 2GeV (r=100-140cm) (stars shows trigger energy)

This allows both TCS and JPsi electroproduction and photoproduction in data collection

JPsi_LH2 trigger

hit matching

Trigger condition

- e_FAEC: radial, Jin's wiser trigger curve
- e_LAEC: radial, Jin's wiser trigger curve
- e_LGC: at least 2 PMT and each has at least 2 photons, similar to PVDIS
- e_FASPD and h_FASPD: Edep>0.5MeV
- e_LASPD: Edep>1.5MeV
- e_MRPC and h_MRPC are not working yet, so not used

Trigger logic

e_FA: e_FAEC & e_LGC & e_FASPD
e_LA: e_LAEC & e_LASPD

1. Starting from EC and record all hits pass trigger
2. Then check matching LGC sectors and two neighboring sectors, if any sector passes, then LHC pass
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4. Finally we have individual triggers, we can count single trigger rate without double counting

1. Then check coincidence trigger with all hits from single trigger

JPsi_LH2

hallD generator, SIDIS generator & Jin's EC Wiser trigger

hit matching

e_FA(kHz)	EC	EC+LGC	EC+LGC+SPD
electron	355	321	300
Pim	588	10.2	9.4
Pip	674	8.5	7.5
P	207	0	0
Pi0	1762	48	26.4
all hadrons, no electron	3690	81	56
Total:			356

Coincidence trigger searches through all possible candidates (N) and find pairs N*(N-1)/2

Self Coin prescaled by 100

(356+433)/100=8kHz

e_LA(kHz)	EC	EC+SPD
electron	21	19
Pim	117	106
Pip	179	164
P	123	114
Pi0	306	11
all hadrons, no electron	814	414
Total:		433

Coin trigger rate (kHz)	e_FA	e_LA	(e_FA + e_LA) & (e_FA + e_LA)
e+pip	250	24	5
e+pim	185	18	3.5
e+pi0	217	19.5	3.6
e+p	120	13	1.8
all hadrons, no electron	56	414	0.3
Total			14.2

Random coin (356+433)*(356+433)*1e3*30e-9=19KHz

True coin 14.2kHz

Total 52kHz

Todo

- Use halld generator for He3 window
- Update EC trigger curve and work on EC simulation in general
- Modify halld generator including e and hadrons
- Add low energy EM better
- Add elastic, quasi-elastic?
- Add radiative correction?

Need manpower urgently!