PVDIS
baffle,trigger and rate

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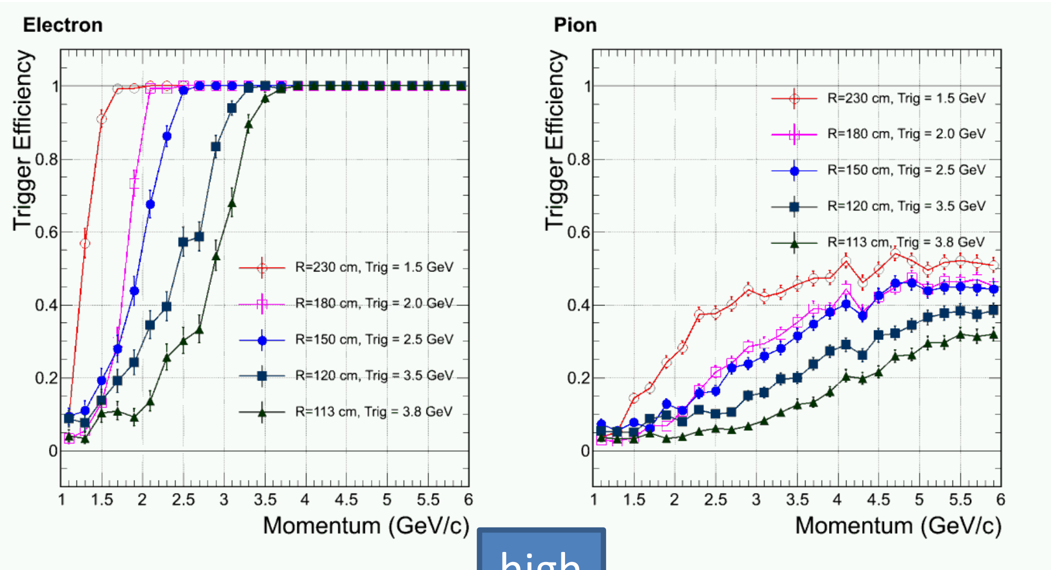
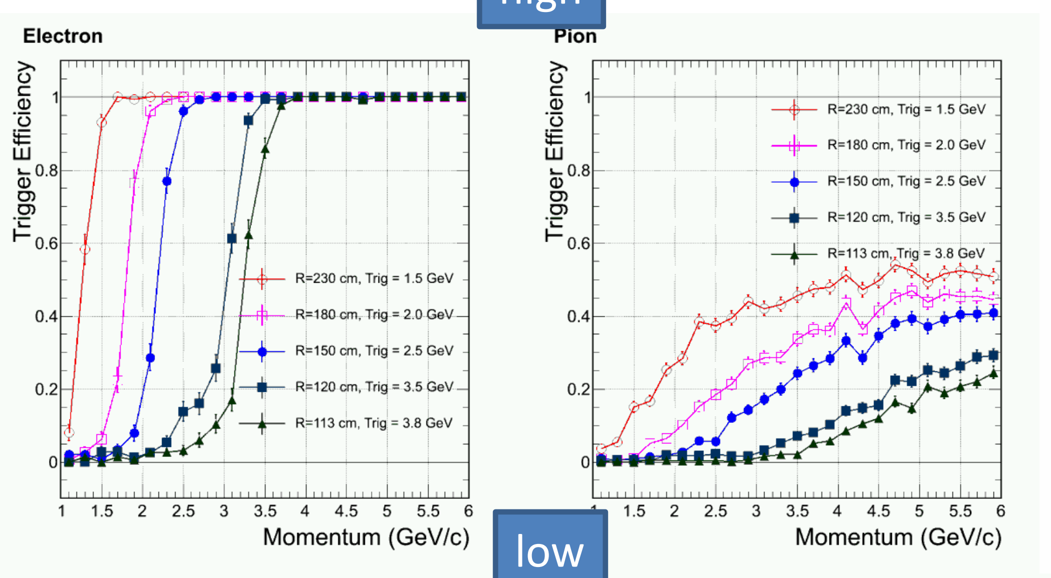
More1 trig

Assumption

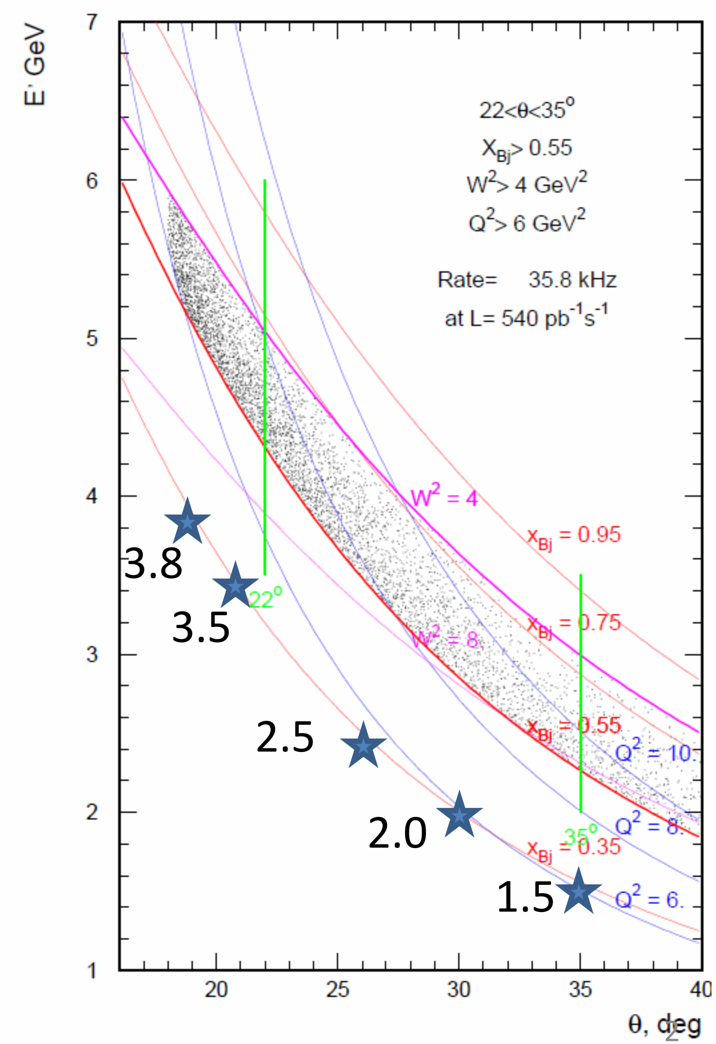
- trig_eff(P>6GeV) = trig_eff(P=6GeV)
- trig_eff_Proton = 0.5*trig_eff_pion
- P<1GeV, there are two methods



high



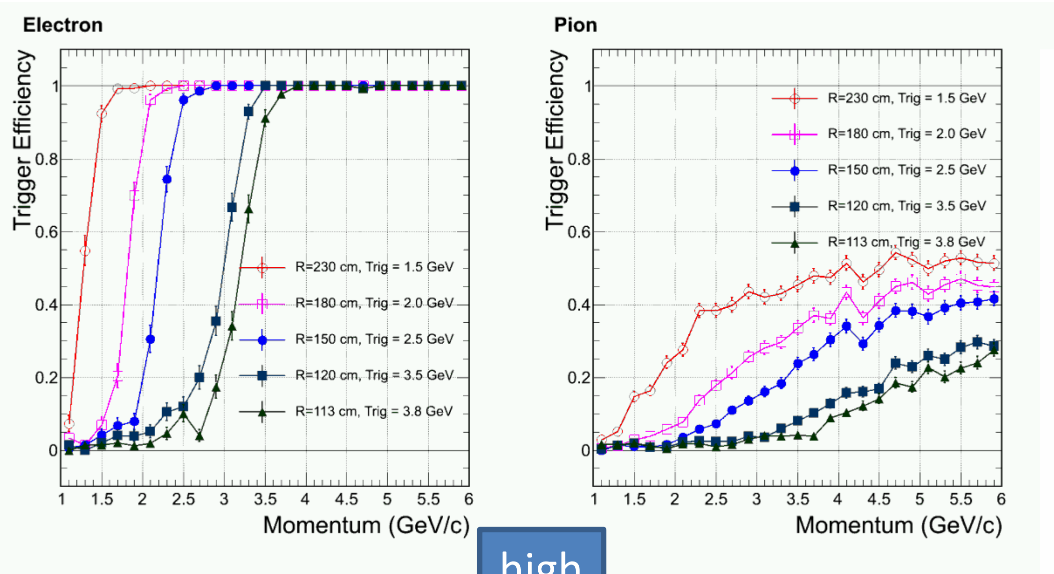
low



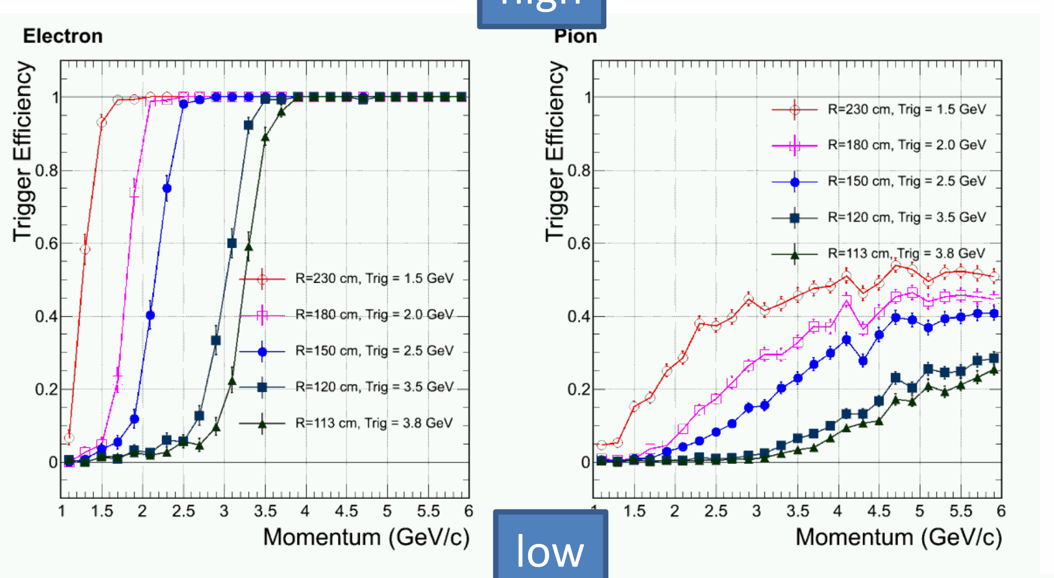
More1 block trig

- trig_eff(P>6GeV) = trig_eff(P=6GeV)
- trig_eff_Proton = 0.5*trig_eff_pion
- P<1GeV, there are two methods

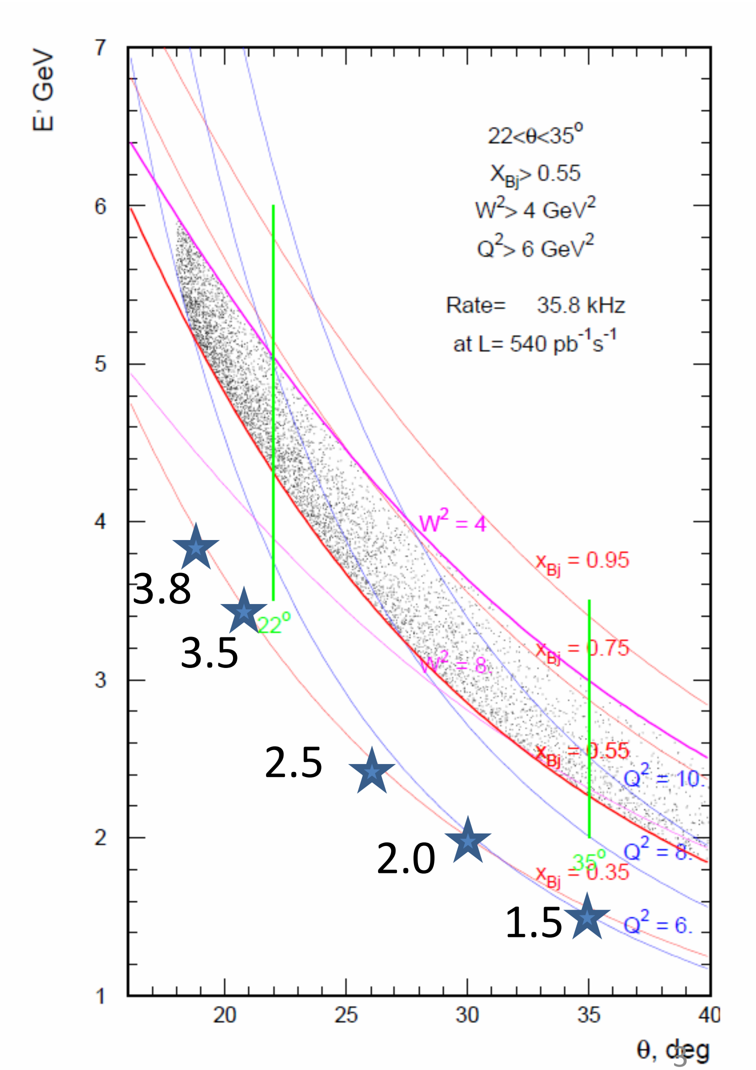
Assumption



high



low



How to read
the rate table on next slide

- All rate are in kHz
- All rate on whole EC plane, divide by 30 to get sector rate
- Top section is without trig cut, bottom section is with trig cut
- Rate has distribution over phi angle every 12 degree, we take 0-6 degree as high rate area and 6-12 degree as low rate area. The full rate area includes both

Rate (kHz)		More1 block(more1 block trig) full	More1 block(more1 block trig) High	More1 block(more1 block trig) Low	More1 (more1 trig) full	More1 (more1 trig) High	More1 (more1 trig) Low
e (W>2)	kry	413	149	265	469	205	264
π-	Kry				5.29e4	4.11e4	1.19e4
	lead	5.08e5	2.72e5	2.36e5	5.45e5	3.15e5	2.30e5
π^+	Kry				2.27e4	1.00e4	1.27e4
	lead	2.13e5	0.98e5	1.15e5	2.13e5	1.04e5	1.08e5
$\gamma(\pi^0)$	kry	5.06e3	5.06e3	0	1.20e6	1.20e6	0
	lead	8.44e7	4.16e7	4.28e7	7.51e7	3.37e7	4.14e7
p	Kry				3.65e3	1.80e3	1.85e3
	lead	5.50e4	2.38e4	3.12e4	5.49e4	2.65e4	2.84e4
Total (lead)							
e (W>2)	kry	311	80	231	359	128	231
π-	Kry						
	lead	5.88e3	3.80e3	2.08e3	1.37e4	1.17e4	1.93e3
π^+	Kry						
	lead	0.57e3	0.19e3	0.38e3	1.54e3	1.18e3	0.36e3
$\gamma(\pi^0)$	kry	2.1	2.1	0	1.23e4	1.23e4	0
	lead	26	26	0	1.31e4	1.31e4	0
p	Kry						
	lead	0.24e3	0.12e3	0.12e3	0.61e3	0.45e3	0.16e3
Total (lead)		7.03e3	4.22e3	2.81e3	2.93e4	2.66e4	0.27e4

Method 1

trig_eff(P<0.5GeV) = 0
trig_eff(0.5<P<1GeV) = 0.5*trig_eff(P=1GeV)

Rate (kHz)		More1 block(more1 block trig)			More1 (more1 trig)		
		full	High	Low	full	High	Low
e (W>2)	kry	413	149	265	469	205	264
π-	Kry				5.29e4	4.11e4	1.19e4
	lead	5.08e5	2.72e5	2.36e5	5.45e5	3.15e5	2.30e5
π^+	Kry				2.27e4	1.00e4	1.27e4
	lead	2.13e5	0.98e5	1.15e5	2.13e5	1.04e5	1.08e5
$\gamma(\pi^0)$	kry	5.06e3	5.06e3	0	1.20e6	1.20e6	0
	lead	8.44e7	4.16e7	4.28e7	7.51e7	3.37e7	4.14e7
p	Kry				3.65e3	1.80e3	1.85e3
	lead	5.50e4	2.38e4	3.12e4	5.49e4	2.65e4	2.84e4
Total (lead)							
e (W>2)	kry	311	80	231	359	128	231
π-	Kry						
	lead	4.83e3	3.43e3	1.40e3	1.08e4	9.34e3	1.41e3
π^+	Kry						
	lead	0.28e3	0.11e3	0.17e3	0.62e3	0.44e3	0.18e3
$\gamma(\pi^0)$	kry						
	lead	4	4	0	4.72e3	4.72e3	0
p	Kry						
	lead	0.18e3	0.10e3	0.08e3	0.44e3	0.32e3	0.12e3
Total (lead)		5.61e3	3.72e3	1.88e3	1.69e4	1.50e4	0.19e4

Method 2

trig_eff(P<1GeV) = 0
The trig rate in this low energy region is estimated separately.

Trigger Rate Summary

- Max sector DAQ rate 65kHz, if it's 30kHz then, it cost 2.1M$ less, 20kHz for 3.7M$ less according to Alex's DAQ talk in May 2013 Collaboration meeting.
- Cherenkov will help to reject trigger from hadrons background (random trigger) with 30ns window, but it has no effect on true electron
- Trigger rate per sector
  - Radom trigger per sector (method 2)

    ((4.83e3+0.28e3+4+0.18e3)+0.1e3*30)*2e6*30e-9/30=16.6kHz
  - True electron trigger per sector

    311/30= 10.4 kHz
  - Total 16.6+10.4=27kHz

Assume 50uA, 40cm LD2
Pol_beam 85%, 120 days

Assume 21-36 degree,
EC R(110,250)cm nominal acceptance

Err_Apv(%)

x	0.20-0.30	0.30-0.35	0.35-0.40	0.40-0.45	0.45-0.50	0.50-0.55	0.55-0.60	0.60-0.67	0.67-0.80
More1 Before trig cut	0.262	0.284	0.275	0.286	0.314	0.354	0.427	0.468	0.641
More1 after trig cut	0.364	0.315	0.283	0.288	0.314	0.354	0.427	0.468	0.641
More1 block before trig cut	0.290	0.304	0.287	0.294	0.319	0.356	0.427	0.468	0.641
More1 block after trig cut	0.422	0.333	0.294	0.296	0.32	0.356	0.428	0.468	0.641

New trigger strategy

- Embedding bgd stochastically according to its 3D distribution
- Look for percentage of 30ns trigger window that pass trigger threshold
- Good for low energy background pile ups
- Can not handle rare events due to stat. limit
- Handle p<1GeV background particle trigger

From background embedding

- Embedding bgd stochastically according to its 3D distribution
- Produce trigger turn on curve for high energy particle
- Good for rare events, e.g. DIS
- Can not handle low energy particle dominated trigger, which is non-linear
- Handle p>1GeV particle dominated trigger

From trigger turn on curve

Low energy (P<1GeV) particle trigger

- Place a calorimeter 6+1 cluster at given reference radius location
- Assume a 30ns trigger integration window, stochastically simulate which bgd particle would fly into calorimeter
  - including e/gamma/pi+/-/0/proton, 1keV – 1GeV
  - Particle with P>1GeV is ignored in this case, since their trigger rate should be counted in high energy trigger curve x rate study
- Simulate scintillator energy deposition in the shower part for all these particle and sum to give a trigger signal
- Repeat for 60k times, check the probability to produce a trigger. Trigger threshold set according to the radius
- Multiply by number of trigger channels and get the total low energy trigger rate

Inspect on few triggered case

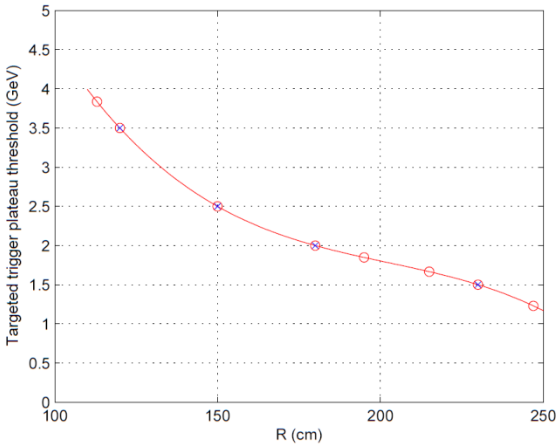
- For low radiation slice at R=230 cm, trigger threshold is
  - scintillator energy > 283 MeV
  - targeted high trigger efficiency for electron with E>1.5 GeV
- 9 out of 60k simulations produced a trigger

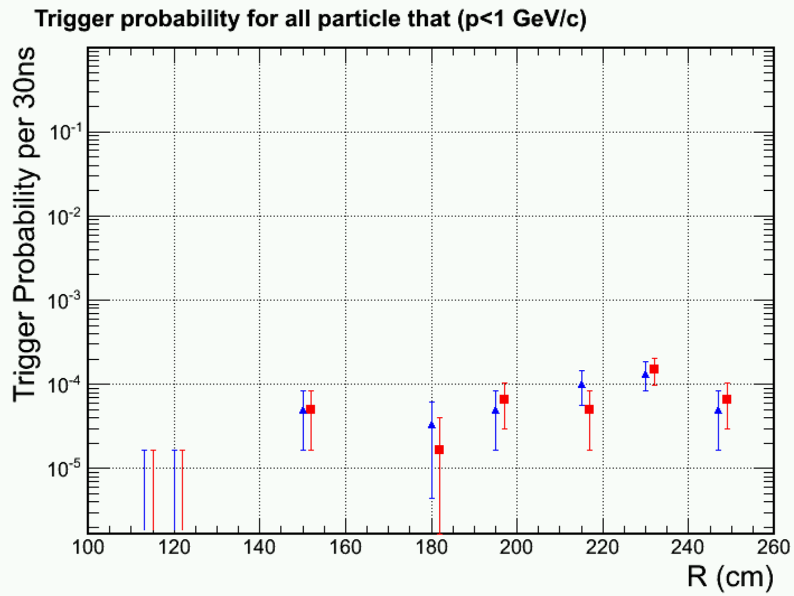
n_*: number of that particle for 30ns window
sh_*: shower scintillator energy deposition for that particle species

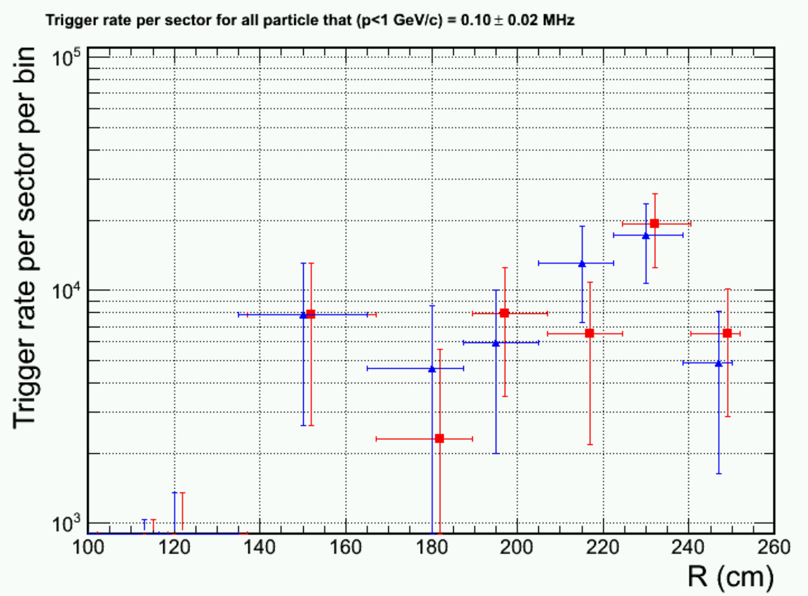
Row	n_elec	sh_elec	n_gamma	sh_gamma	n_gamma_p	sh_gamma_	n_pip	sh_pip	n_pim	sh_pim	
5116	0	0	11	1.4133610	4	0.8096210	0	0	1	287.67065	<- Pi- dominated
10508	0	0	13	0	10	17.858110	0	0	1	272.90136	
12082	0	0	13	1.1497589	5	3.1542911	1	328.03814	0	0	<- Pi+ dominated
26961	0	0	15	0	9	13.370458	0	0	1	277.56695	
31170	0	0	18	3.771492	4	3.6389594	0	0	1	301.99948	
37962	0	0	12	0	2	0	0	0	2	315.43313	
40813	0	0	20	10.953822	6	12.016947	0	0	1	266.20440	
42284	1	0	13	1.1786102	5	1.1385887	1	82.557189	1	216.75323	<- two pion pile up
42872	0	0	16	0.9754827	4	0	0	0	1	285.33731	

Total rate from P<1GeV particle

- Sum = 0.10 ± 0.2 MHz per sector
  - Statistical precision can be improved with more simulation
  - Ignored correlation between neighboring trigger channels -> over estimate
- Dominated by radius region R~230cm, where trigger threshold is low (E_{target}=1.5GeV)



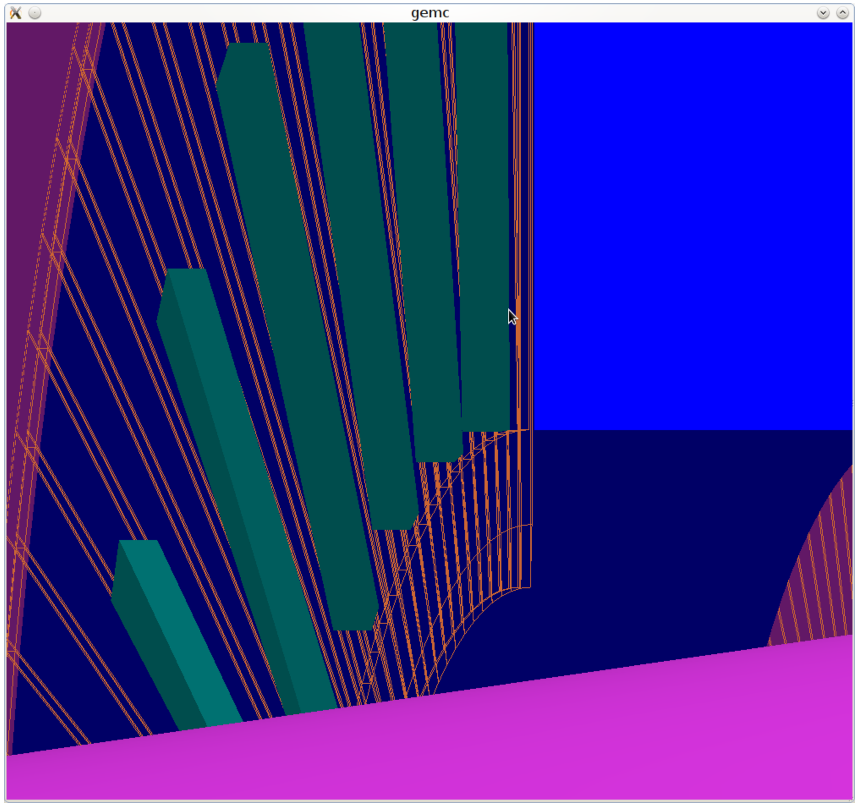




- High radiation phi slice
- Low radiation phi slice

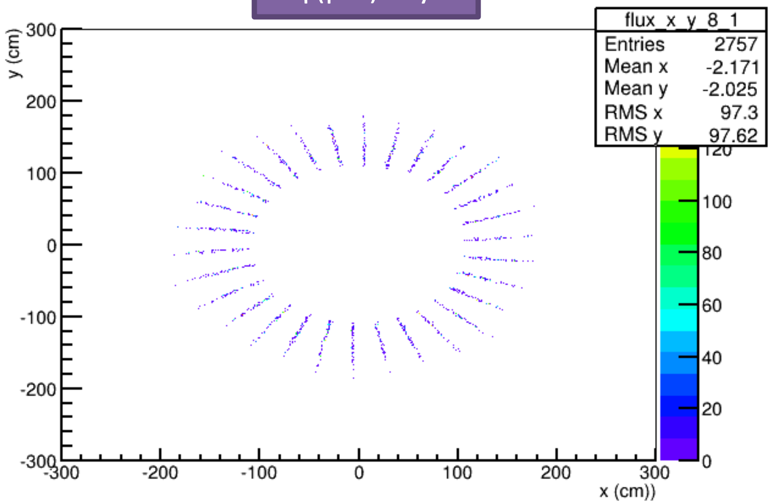
EC photon block

- EC module R(110,265)cm
- EC photon block ("more1 block")
  - 30 of them
  - R(110-200)cm
  - Start from 2.2 degree and width 2.5 degree. (They can be further optimized)
  - 5cm($8*X_0$) thick lead, hope to reduce photon energy by 1 order
- EC module reduction about 180, 10% of total

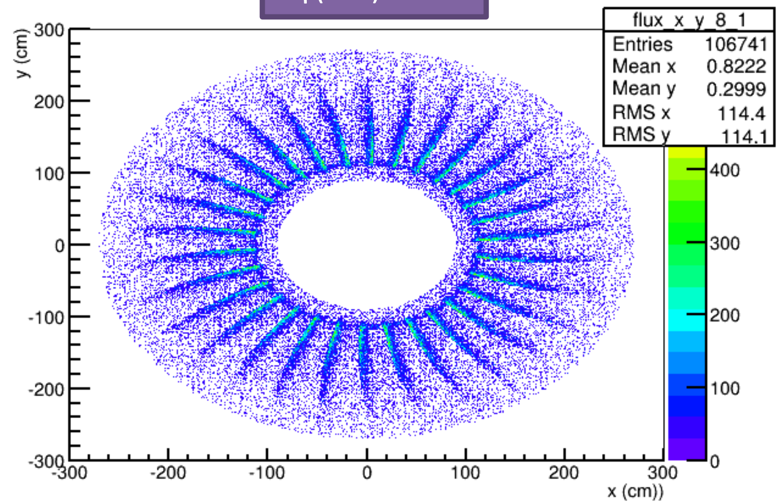


Rate of More1

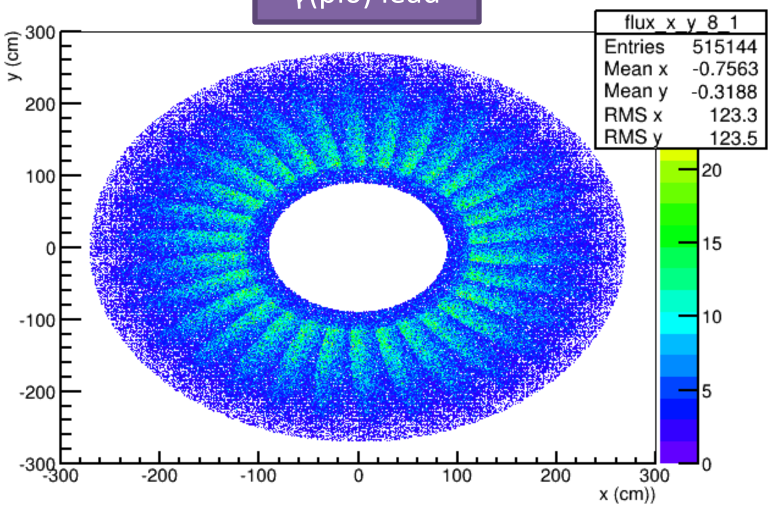
γ(pi0) Kry



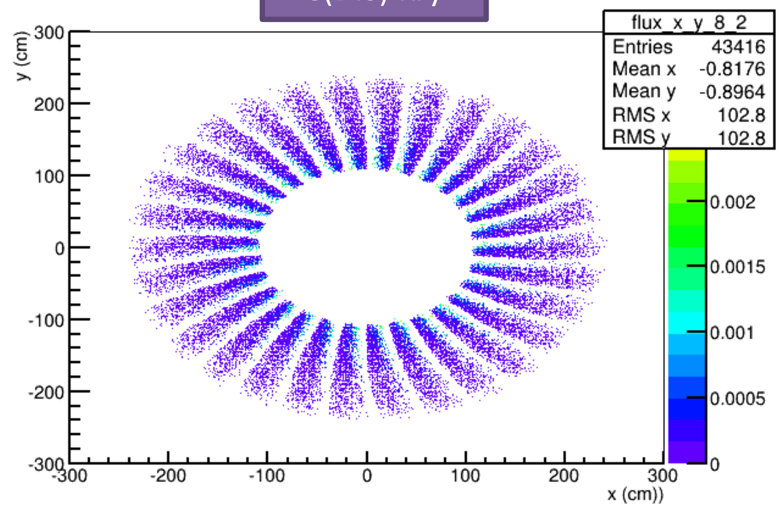
γ(EM) lead



γ(pi0) lead

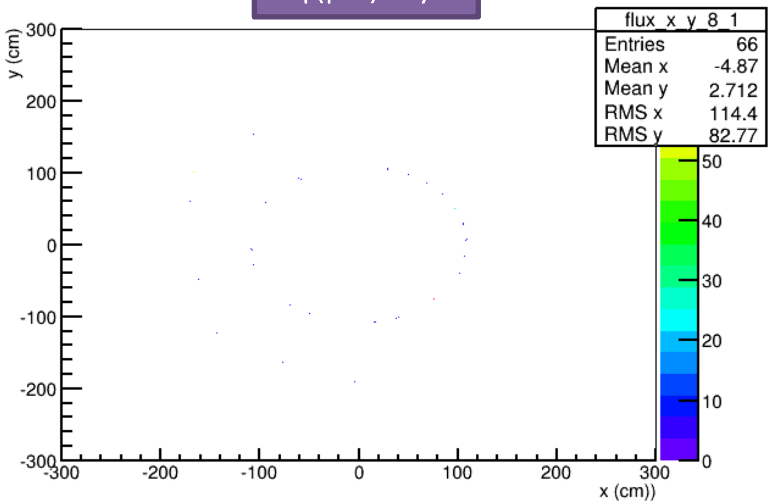


e(DIS) Kry

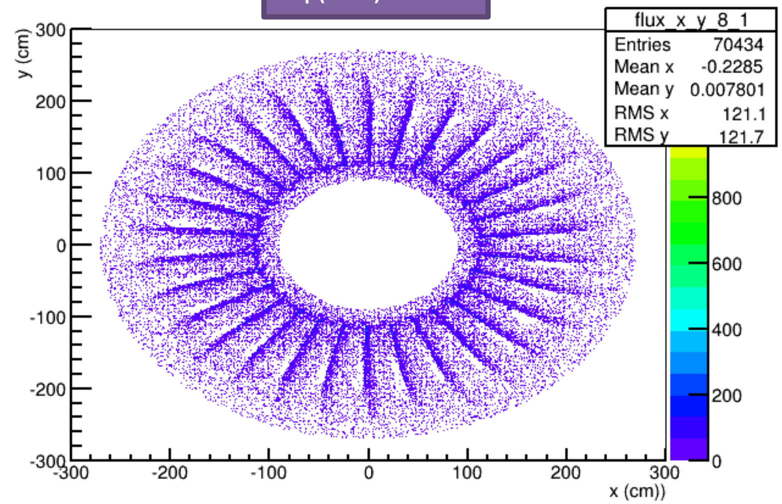


Rate of More1 block

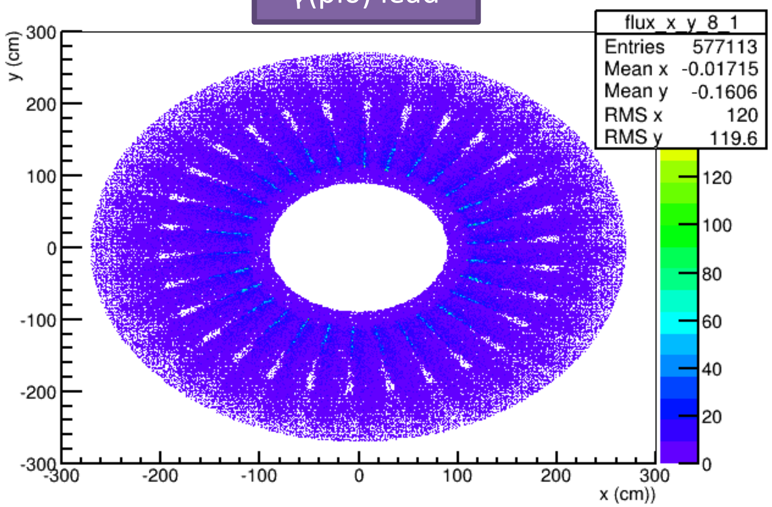
γ(pi0) Kry



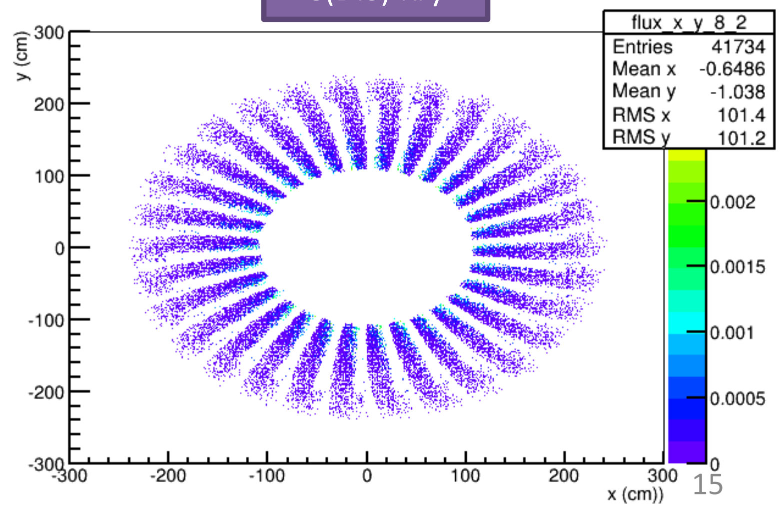
γ(EM) lead



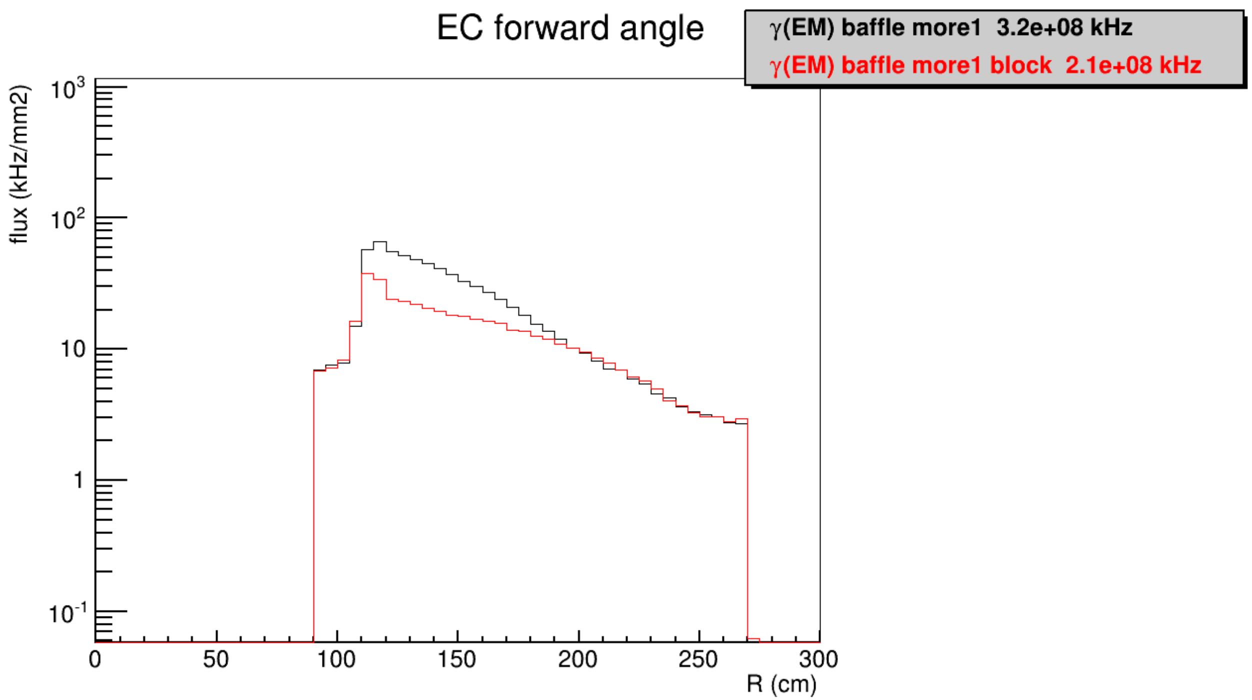
γ(pi0) lead



e(DIS) Kry



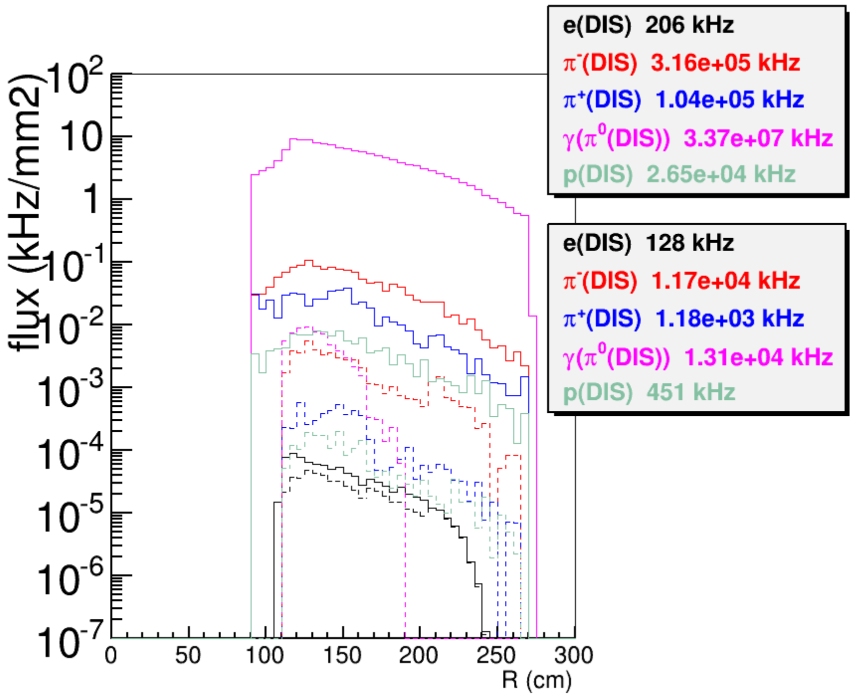
γ(EM) lead
rate of more1 and more1 block



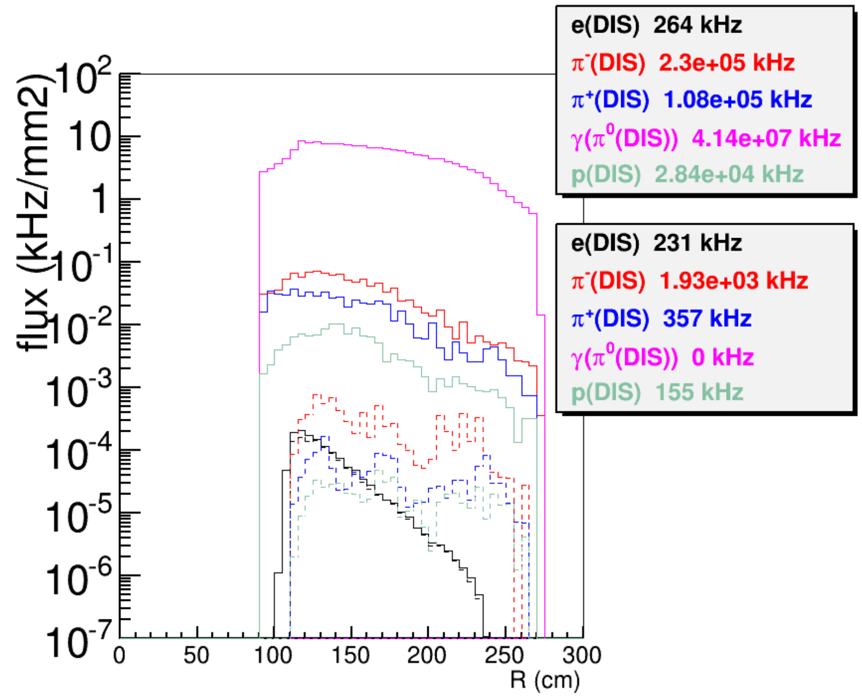
Method 1

Rate before and after trig cut (More1 with more1 trig)

high



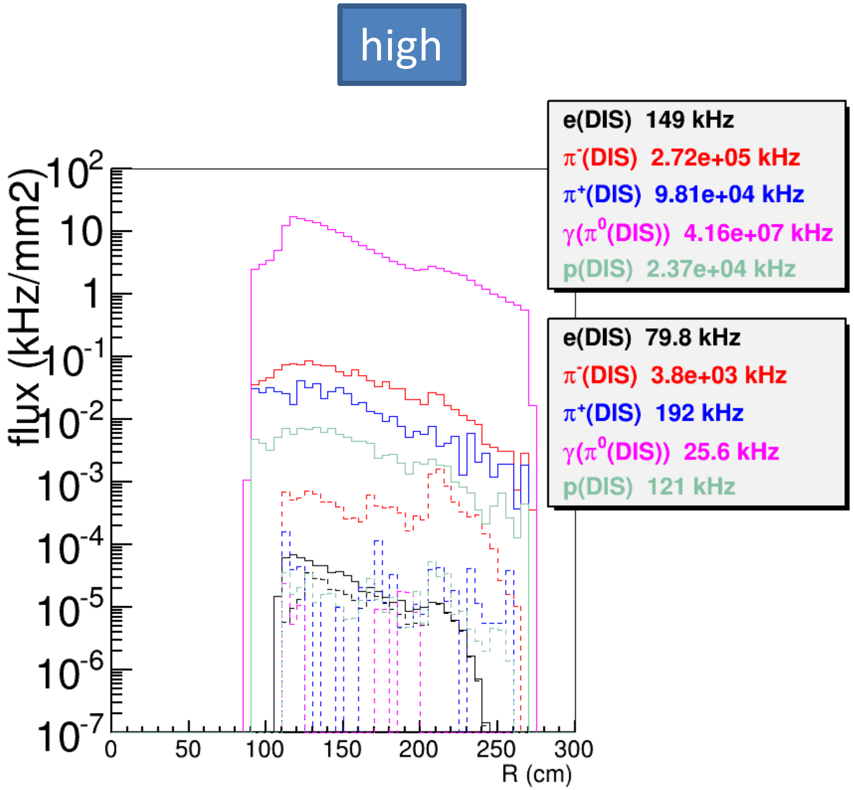
low

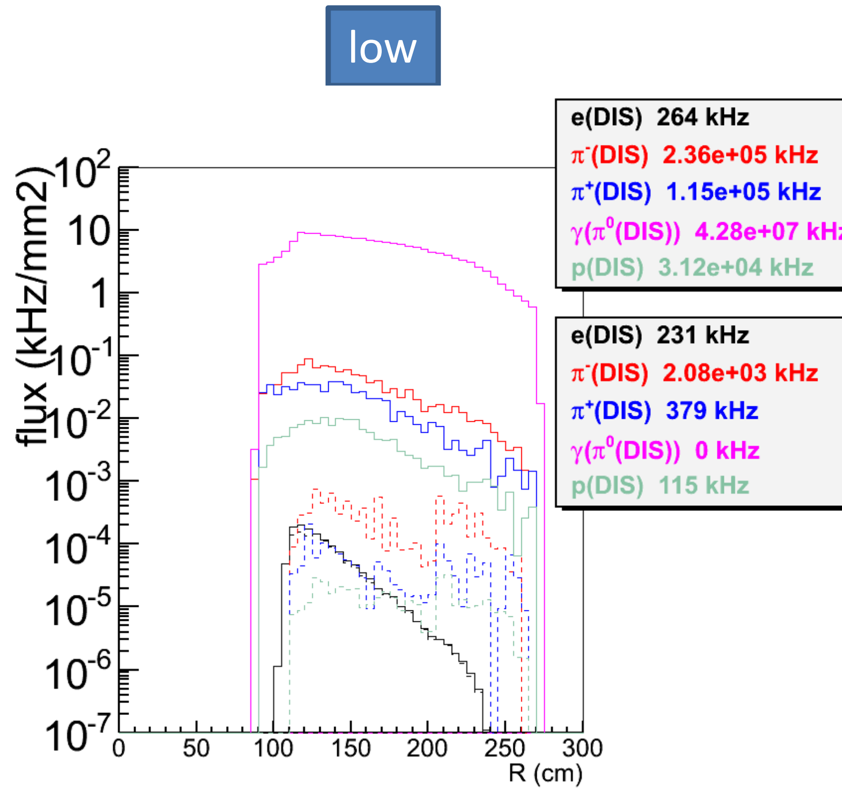


- Next slide shows the cut effect in “log(Ek) vs R”

Method 1

Rate before and after trig cut (More1 block with more1 trig)

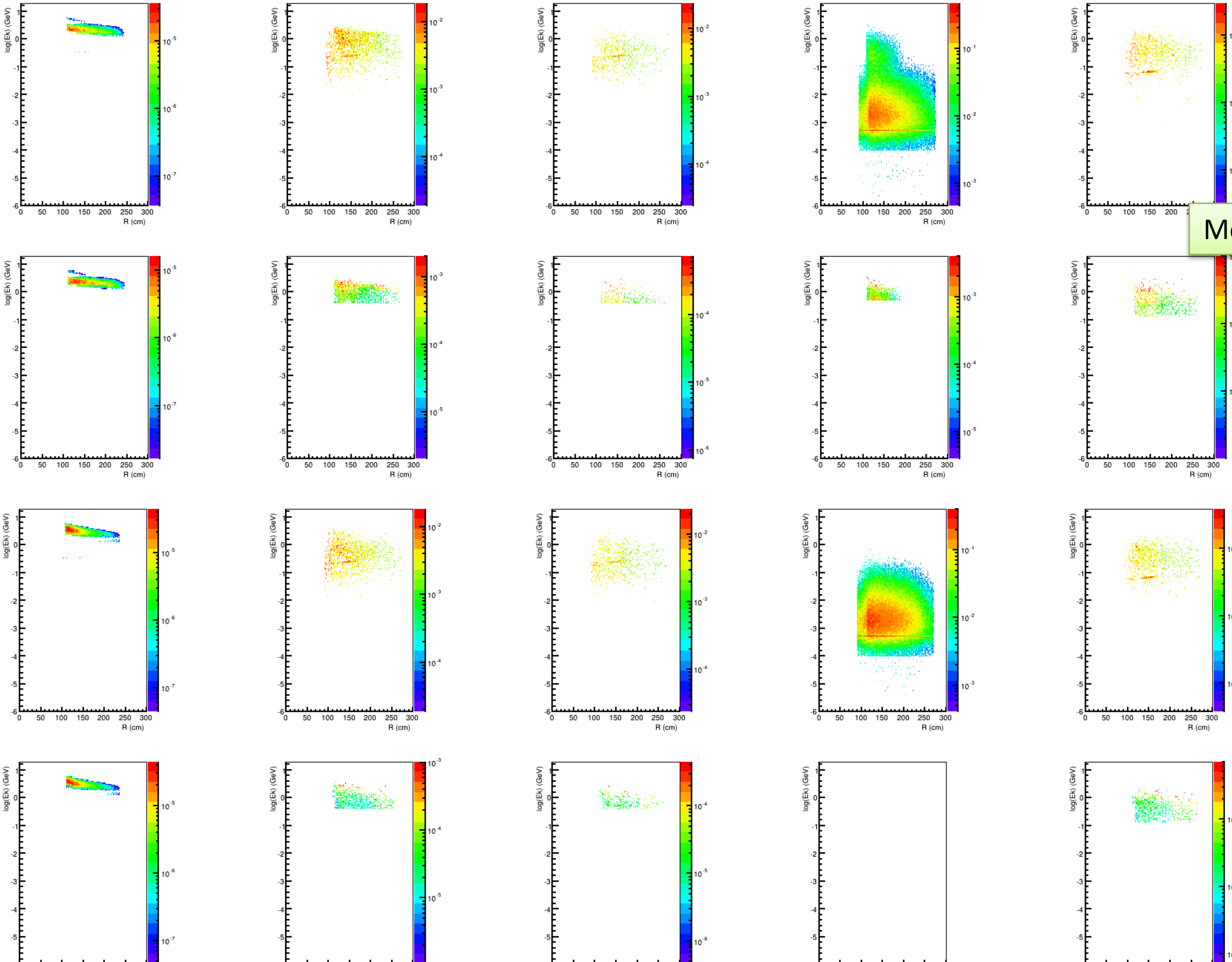




- Next slide shows the cut effect in “log(Ek) vs R” e DIS | pi- | pi+ | γ(pi0) | p

More1 with More1 trig

Method 1



high, Before cut

High, After cut

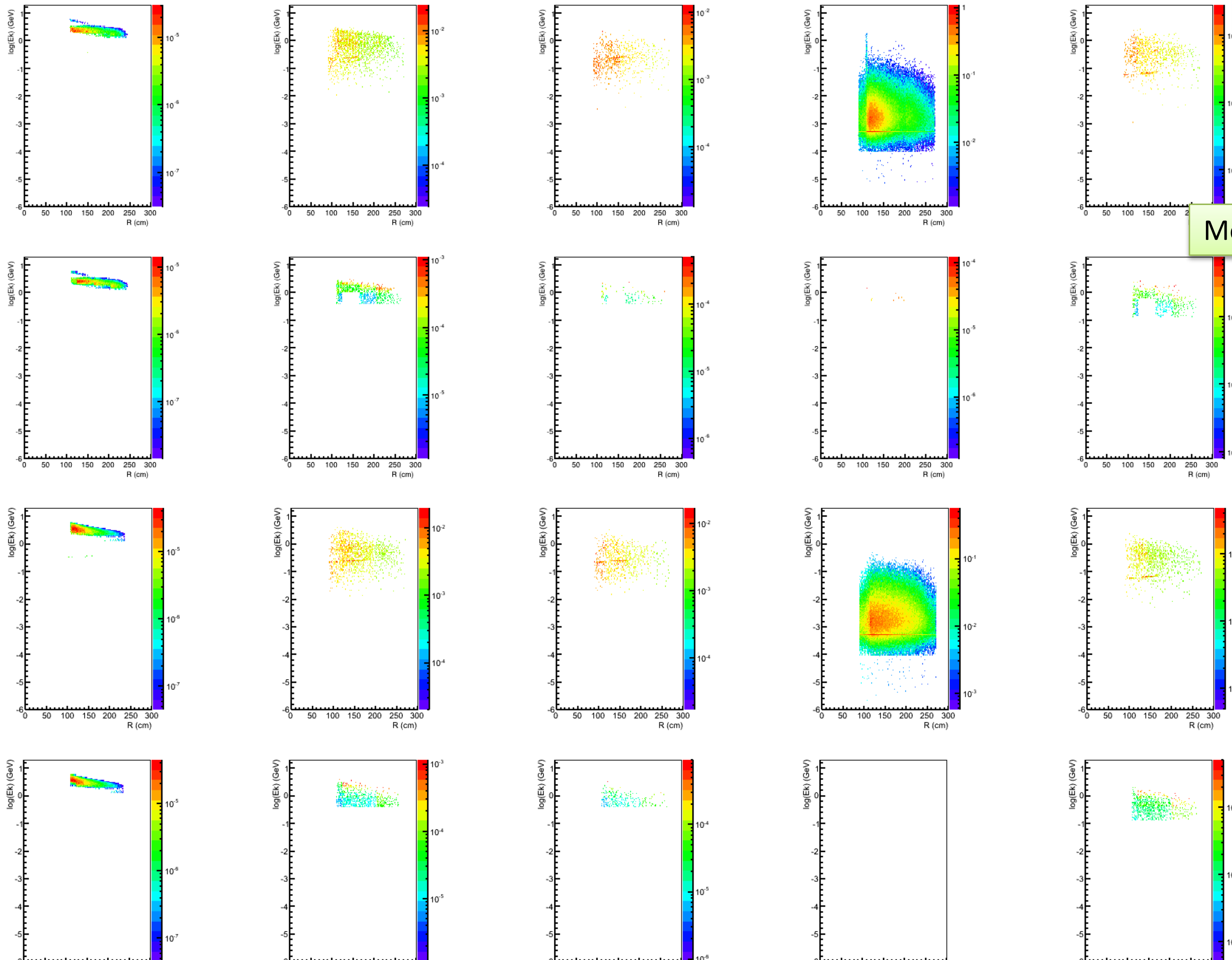
Low, Before cut

Low, After cut

e DIS	pi-	pi+	γ(pi0)	p

More1 block with More1 block trig

Method 1



high, Before cut

High, After cut

Low, Before cut

Low, After cut

Rate vs R
(more1 with more1 trig, lead)

Method 1

R(cm)	high					low				
	100-116	116-124	124-165	165-205	205-265	100-116	116-124	124-165	165-205	205-265
eDIS	1.38E+01	3.16E+01	8.90E+01	5.58E+01	1.53E+01	3.38E+01	7.18E+01	1.31E+02	2.35E+01	3.50E+00
π-	1.24E+04	3.27E+04	1.42E+05	8.42E+04	4.47E+04	1.16E+04	2.42E+04	1.04E+05	6.17E+04	2.87E+04
π+	5.26E+03	1.19E+04	5.15E+04	2.29E+04	1.26E+04	6.52E+03	1.19E+04	4.63E+04	3.04E+04	1.32E+04
$\gamma(\pi^0)$	1.08E+06	3.38E+06	1.29E+07	9.51E+06	6.91E+06	1.08E+06	3.14E+06	1.37E+07	1.31E+07	1.04E+07
p	7.53E+02	2.64E+03	1.22E+04	6.91E+03	3.92E+03	1.13E+03	2.62E+03	1.49E+04	6.03E+03	3.75E+03
total	1.10E+06	3.43E+06	1.31E+07	9.62E+06	6.97E+06	1.10E+06	3.18E+06	1.39E+07	1.32E+07	1.04E+07
eDIS	3.77E+00	1.39E+01	5.93E+01	3.64E+01	1.48E+01	2.45E+01	5.61E+01	1.24E+02	2.28E+01	3.34E+00
π-	3.12E+02	1.43E+03	6.09E+03	1.91E+03	2.01E+03	1.52E+01	1.29E+02	7.73E+02	3.99E+02	6.13E+02
π+	4.07E+01	1.55E+02	7.13E+02	1.66E+02	1.08E+02	2.47E+00	2.09E+01	1.08E+02	9.51E+01	1.30E+02
$\gamma(\pi^0)$	9.83E+02	3.14E+03	8.69E+03	2.97E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
p	9.09E+00	4.24E+01	2.66E+02	7.99E+01	5.36E+01	3.54E-01	5.25E+00	4.27E+01	4.51E+01	6.15E+01
total	1.35E+03	4.78E+03	1.58E+04	2.49E+03	2.19E+03	4.25E+01	2.11E+02	1.05E+03	5.62E+02	8.08E+02

Rate vs R
(more1 block with more 1 block trig, lead)

Method 1

R(cm)	high					low				
	100-116	116-124	124-165	165-205	205-265	100-116	116-124	124-165	165-205	205-265
eDIS	1.10E+01	2.49E+01	6.69E+01	3.04E+01	1.53E+01	3.39E+01	7.19E+01	1.32E+02	2.35E+01	3.49E+00
π-	1.30E+04	2.90E+04	1.18E+05	6.73E+04	4.43E+04	9.58E+03	3.14E+04	1.02E+05	5.61E+04	3.66E+04
π+	4.65E+03	1.13E+04	4.79E+04	2.06E+04	1.37E+04	5.11E+03	1.38E+04	5.61E+04	2.74E+04	1.27E+04
$\gamma(\pi^0)$	2.23E+06	6.26E+06	1.84E+07	7.83E+06	6.90E+06	1.20E+06	3.48E+06	1.44E+07	1.32E+07	1.04E+07
p	1.30E+03	2.46E+03	1.07E+04	5.59E+03	3.70E+03	1.30E+03	3.35E+03	1.58E+04	7.18E+03	3.62E+03
total	2.25E+06	6.30E+06	1.86E+07	7.92E+06	6.96E+06	1.22E+06	3.53E+06	1.46E+07	1.33E+07	1.05E+07
eDIS	1.01E+00	4.39E+00	3.75E+01	2.20E+01	1.49E+01	2.48E+01	5.55E+01	1.25E+02	2.29E+01	3.33E+00
π-	1.21E+02	2.03E+02	7.77E+02	8.18E+02	1.89E+03	1.63E+01	1.16E+02	7.53E+02	3.52E+02	8.43E+02
π+	2.87E+01	1.59E+01	1.02E+01	5.67E+01	8.07E+01	5.94E+00	4.96E+01	1.03E+02	5.38E+01	1.67E+02
$\gamma(\pi^0)$	4.36E+00	3.10E+00	0.00E+00	1.81E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
p	6.38E+00	6.97E+00	2.58E+01	2.81E+01	5.34E+01	1.37E+00	3.83E+00	3.37E+01	2.45E+01	5.19E+01
total	1.61E+02	2.33E+02	8.51E+02	9.43E+02	2.04E+03	4.84E+01	2.25E+02	1.01E+03	4.53E+02	1.07E+03

Rate (kHz)		More1 block (more1 trig)			More1 (CLEO trig)			More1 (more1 trig)		
		full	High	Low	full	High	Low	full	High	Low
e DIS	kry	413	148	265	469	205	264	same	same	same
π-	Kry				5.29e4	4.11e4	1.19e4	same	same	same
	lead	5.08e5	2.72e5	2.36e5	5.45e5	3.15e5	2.30e5	same	same	same
π^+	Kry				2.27e4	1.00e4	1.27e4	same	same	same
	lead	2.13e5	0.98e5	1.15e5	2.13e5	1.04e5	1.08e5	same	same	same
$\gamma(\pi^0)$	kry	5.06e3	5.06e3	0	1.20e6	1.20e6	0	same	same	same
	lead	8.44e7	4.16e7	4.28e7	7.51e7	3.37e7	4.14e7	same	same	same
p	Kry				3.65e3	1.80e3	1.85e3	same	same	same
	lead	5.50e4	2.38e4	3.12e4	5.49e4	2.65e4	2.84e4	same	same	same
Total (lead)										
e DIS	kry	335	104	231	403	145	258	359	128	231
π-	Kry				5.22e3	4.00e3	1.22e3			
	lead	1.22e4	1.01e4	0.21e4	1.87e4	1.26e4	0.60e4	1.37e4	1.17e4	1.93e3
π^+	Kry				0	0	0			
	lead	1.35e3	970	381	2.48e3	1.09e3	1.43e3	1.54e3	1.18e3	0.36e3
$\gamma(\pi^0)$	kry	2.3	2.3	0	3.22e4	3.22e4	0	1.23e4	1.23e4	0
	lead	230	115	0				1.31e4	1.31e4	0
p	Kry				0	0	0			
	lead	927	404	120	957	475	481	0.61e3	0.45e3	0.16e3
Total (lead)		1.45e4	1.17e4	0.28e4	5.34e4	4.59e4	0.75e4	2.93e4	2.66e4	0.27e4

Method 1