Background Simulation: Progress

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Outline

Hall D Photo-Production Generator

- Hall D generator uses fits to various experimental data and SAID partial-wave analysis fits to generate photo-production cross sections for photon energies below $3\ \mathrm{GeV}$
- It uses modified version of PYTHIA 6.225 (2004) for photon energies above $3\ \mathrm{GeV}$
  - Hall D generator support from Eugene Chudekov and Mark Ito

Following $\gamma + p^+$ reactions considered for photon energies below $11\ \mathrm{GeV}$

Process	Fraction of Events	Energy Range
PYTHIA	13	$3.00 < E < 10.00$ *GeV*
$p^+ + \pi^0$	25	$0.15 < E < 3.00$ *GeV*
$n + \pi^+$	33	
$p^+ + \pi^+ + \pi^-(non - res.)$	4	
$p^+ + \rho^0$	3	
$\Delta^{++} + \pi^-$	7	
$p^+ + \pi^0 + \pi^0$	2	
$n + \pi^+ + \pi^0$	9	
$p^+ + \eta^0$	1	
$p^+ + \pi^+ + \pi^- + \pi^0$	3	
$n + \pi^+ + \pi^+ + \pi^-$	1	

Issues to Resolve

- Hall D code assumes Equivalent Photon Approximation (EPA) for electro-production
  - Cross check with data
  - $\pi 0$ cross sections for 11 GeV electron production from DVCS calorimeter
- Geant4 predicts excess π^0 compared to Hall D generator
  - Still Geant4 and Hall D generators agrees within factor of 2

Issues to Resolve : Geant4 Excess π^0

Table: Electron-Production Cross Sections Using Geant4 from Deuterium Target

	π^0		π^-		π^+	
Mom. Range (GeV)	xs (μb)	Rate (MHz)	xs (μb)	Rate (MHz)	xs (μb)	Rate (MHz)
0 - 1	79.40	50501.13	35.40	22514.30	36.15	22994.82
1 - 2	6.87	4371.82	5.81	3694.67	5.20	3304.61
2 - 3	2.25	1429.19	1.67	1064.09	1.31	833.17
3 - 4	1.21	770.76	0.77	489.92	0.53	333.89
4 - 5	0.65	411.91	0.34	218.44	0.28	174.75
5 - 10	0.97	614.74	0.34	215.31	0.25	159.15
Total	91.34	58099.55	44.33	28196.73	43.71	27800.39

Table: Electron-Production Cross Sections Using Hall D Generator from Deuterium Target

	π^0		π^-		π^+	
Mom. Range (GeV)	xs (μb)	Rate (MHz)	xs (μb)	Rate (MHz)	xs (μb)	Rate (MHz)
0 - 1	46.90	29830.49	44.97	28605.28	44.97	28605.28
1 - 2	4.36	2771.83	5.45	3467.62	5.45	3467.62
2 - 3	1.28	812.56	1.68	1069.88	1.68	1069.88
3 - 4	0.48	302.29	0.71	450.94	0.71	450.94
4 - 5	0.20	129.91	0.34	217.04	0.34	217.04
5 - 10	0.14	88.69	0.30	192.68	0.30	192.68
Total	53.35	33936.44	53.46	34003.77	53.46	34003.77

Issues to Resolve : Geant4 Excess π^0

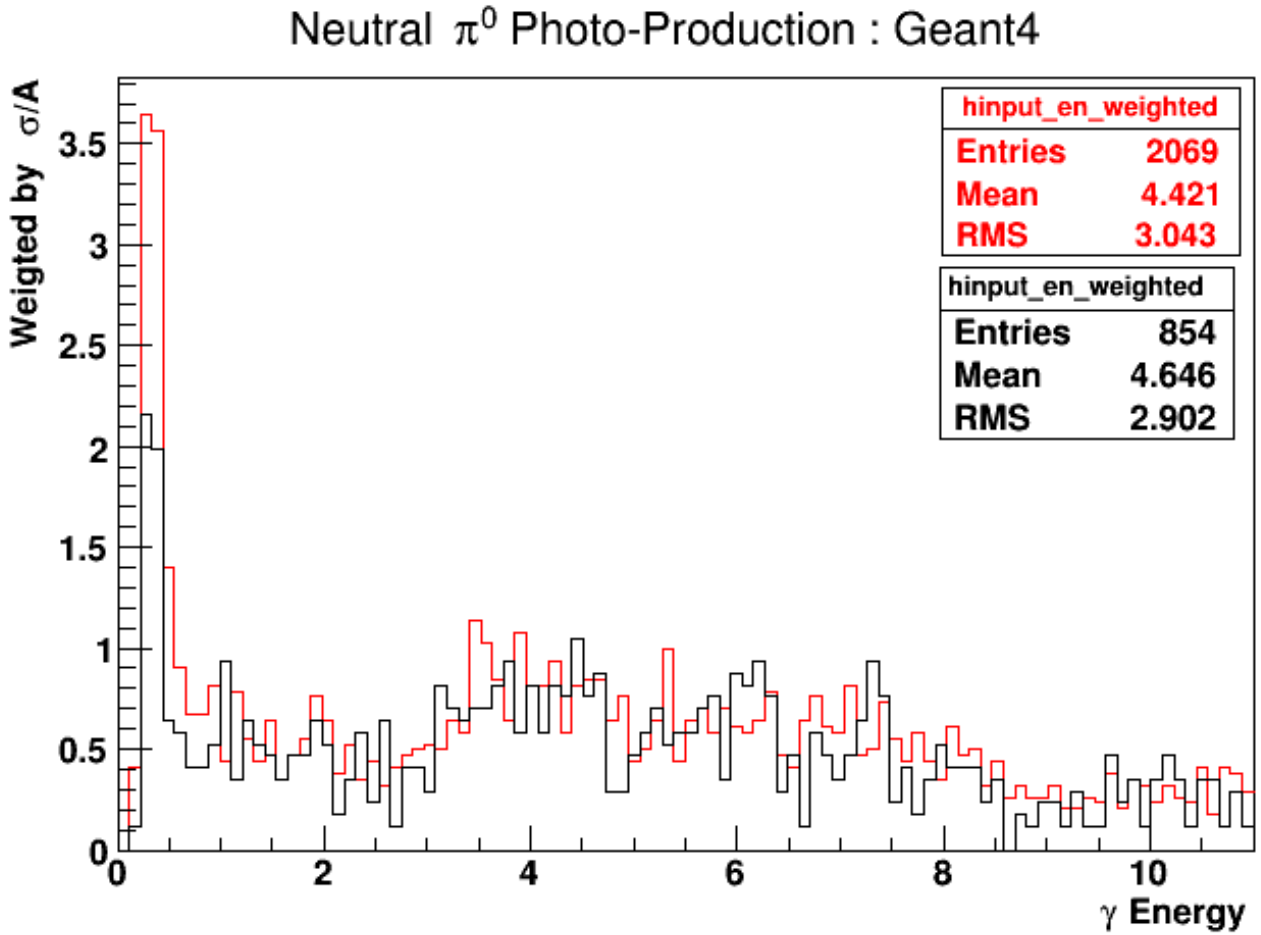
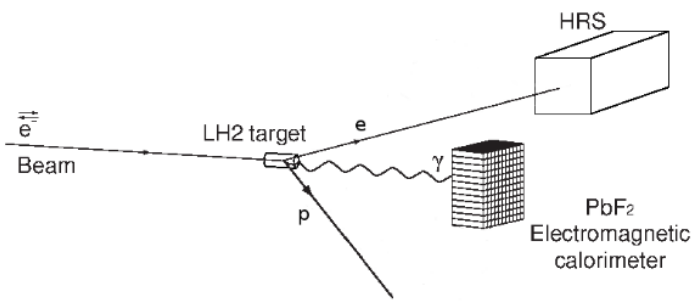


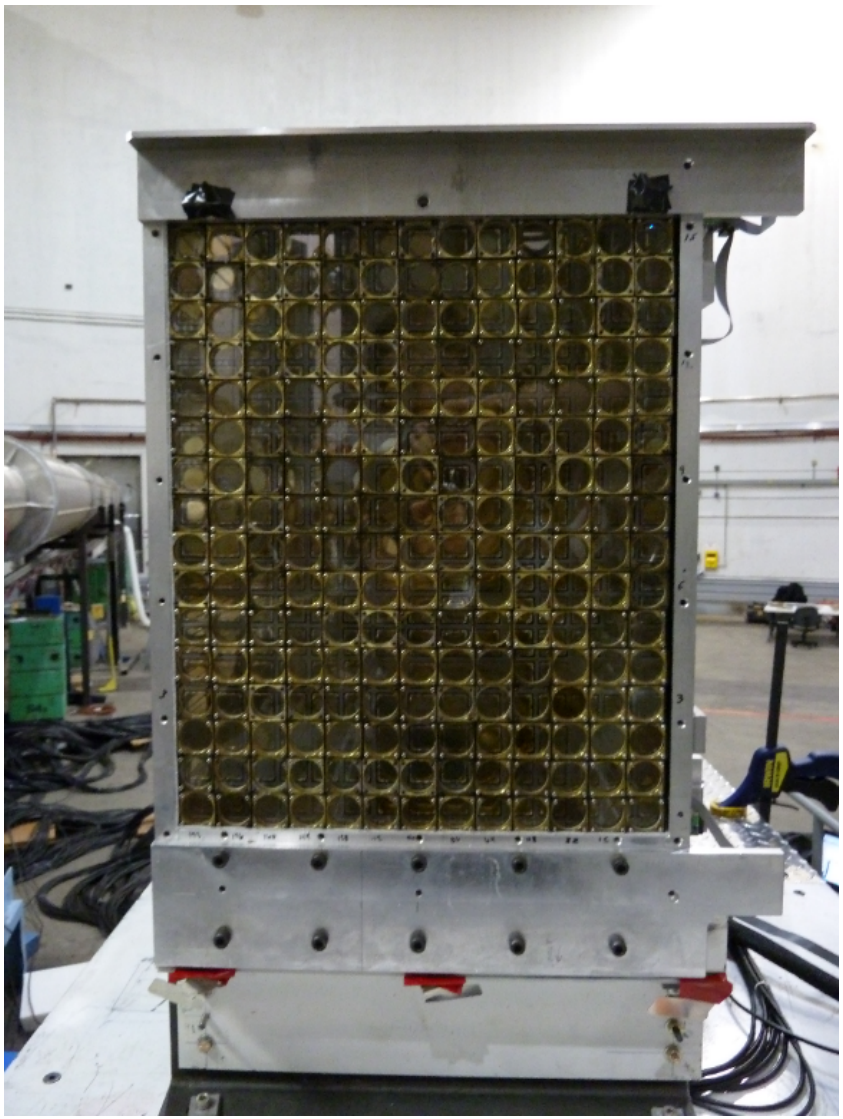
Figure: Proton $\sigma^{\gamma}(\pi^0)/A$ and Deuterium $\sigma^{\gamma}(\pi^0)/A$

DVCS π^0 Analysis by Ye Tian

Slides provided by Ye Tian

Goal : Utilizing updated $12\ \mathrm{GeV}$ beam, to detect two photon events in DVCS calorimeter to reconstruct π^0





DVCS π^0 Analysis by Ye Tian

Slides provided by Ye Tian

- Using accidental events to get inclusive π^0 cross section for momentums below $1\ \mathrm{GeV}$
- Beam energies available: $6.6\ \mathrm{GeV},\ 8.8\ \mathrm{GeV}$ and $11\ \mathrm{GeV}$
- Acceptance range 10^{o} to 20^{o}

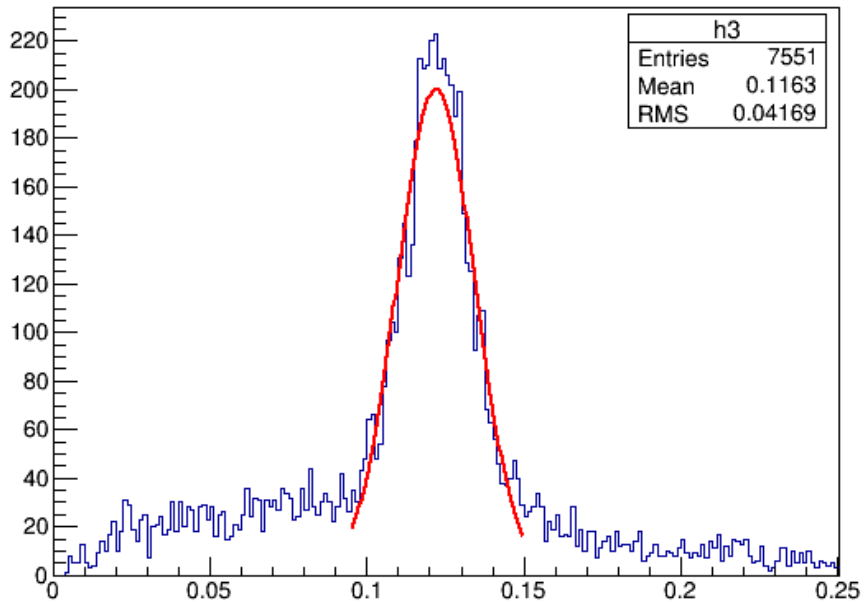


Figure: Preliminary : Invariant mass of two photon events

PVDIS Trigger Efficiency with Backgrounds : Electrons

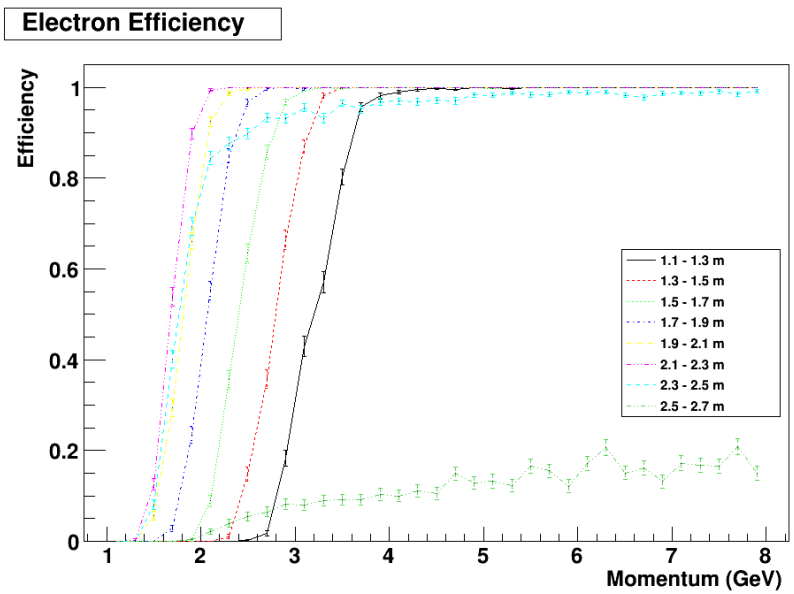


Figure: e^- Efficiency with no backgrounds

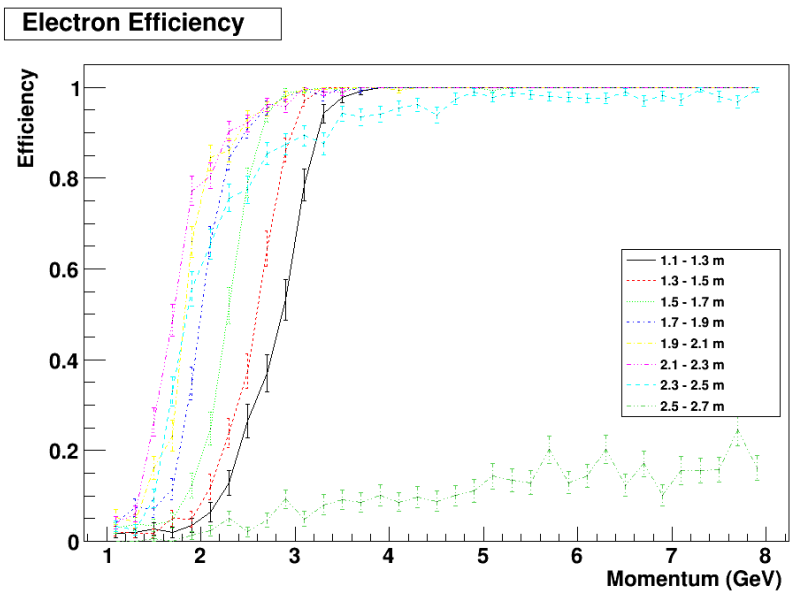


Figure: e^- Efficiency with all backgrounds

PVDIS Trigger Efficiency with Backgrounds : Pions

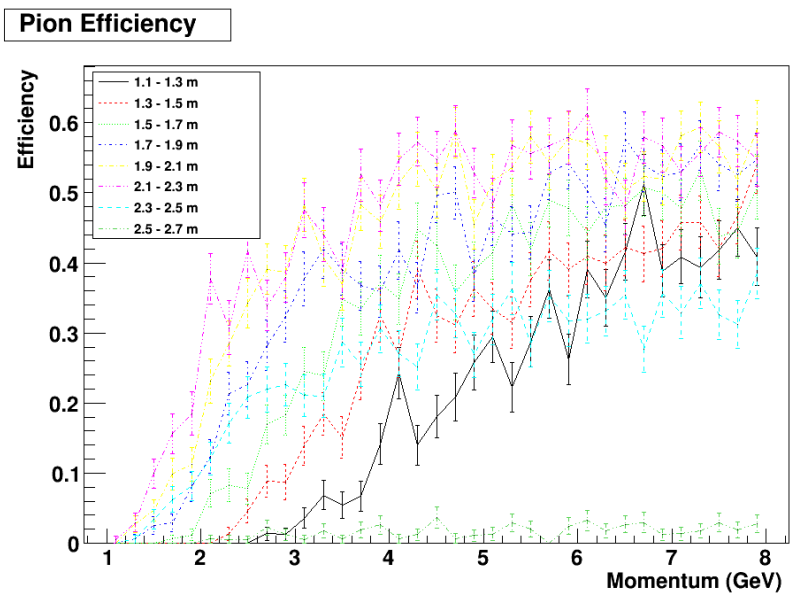


Figure: π^- Efficiency with no backgrounds

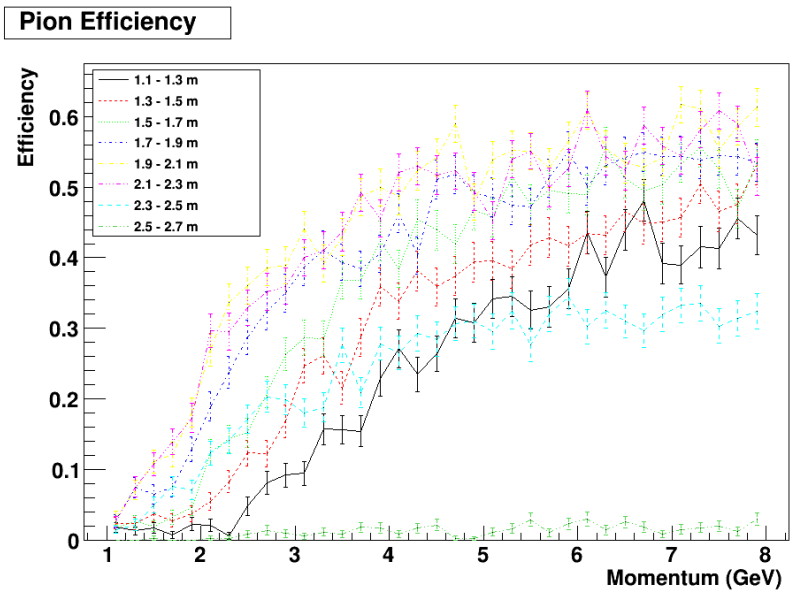


Figure: π^- Efficiency with all backgrounds

PVDIS ECAL Trigger Rates

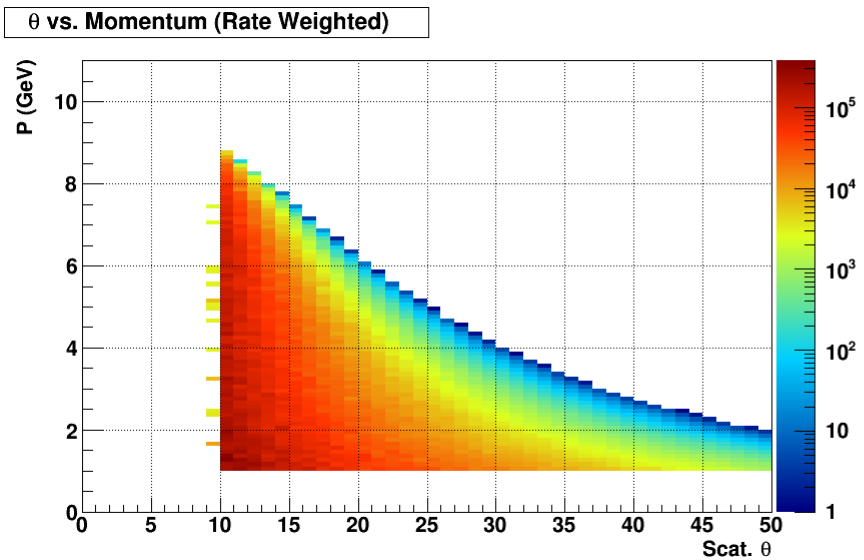
- Only 1 GeV or larger momentum tracks can initiate a trigger
- Low energy (less than 1 GeV) tracks contribute to trigger as pile up to high momentum tracks by increasing energy deposit in trigger windows
  - When only background tracks < 1 *GeV* incident on ECAL the total trigger rate is about 0.06 MHz (or 0.002 MHz per sector)
  - Only 2 out of 35070 windows triggered by low momentum pile up at higher radii (very low statistics)
  - Low momentum pions at higher radii are very rare
- Total (background+DIS) trigger rate is 5.1 MHz (or 0.17 MHz per sector)
- From Wiser based backgrounds : Total (background+DIS) trigger rate is 8.7 MHz (or 0.29 MHz per sector)
  - This includes 3.1 MHz background trigger due to pileups from tracks < 1 *GeV*

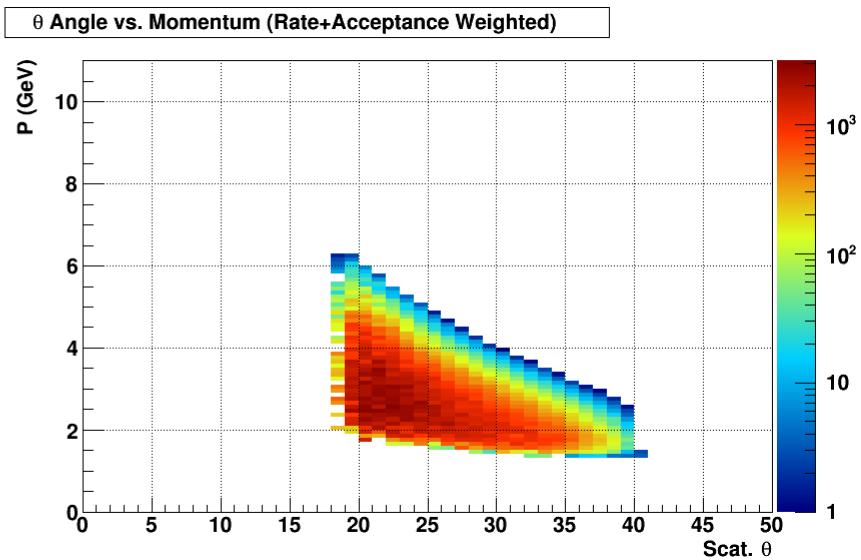
PID	Total Rate (MHz)	Trigger Rate (MHz)
π^-	280	4.5
π^+	150	0.3
DIS	0.44	0.26
Total ECAL Trigger		5.127

PVDIS FOM with Backgrounds

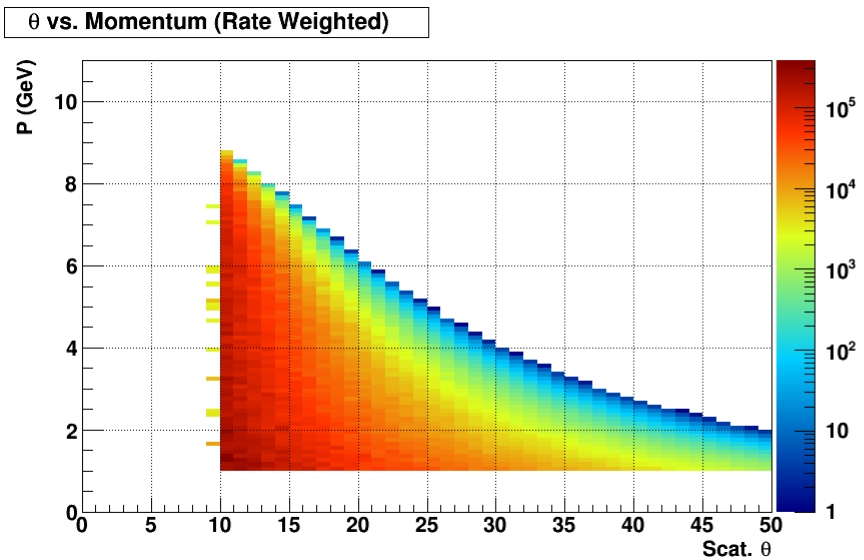
- PVDIS FOM revisited with new ECAL trigger response function
- Assumed Cerenkov will pass all DIS electrons
- Compared PVDIS FOM before and after the ECAL trigger

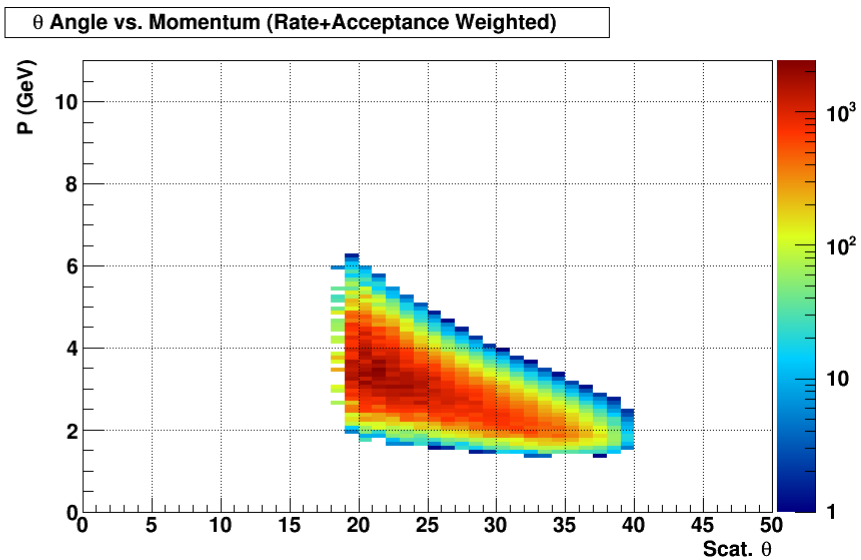
DIS Acceptance before Trigger



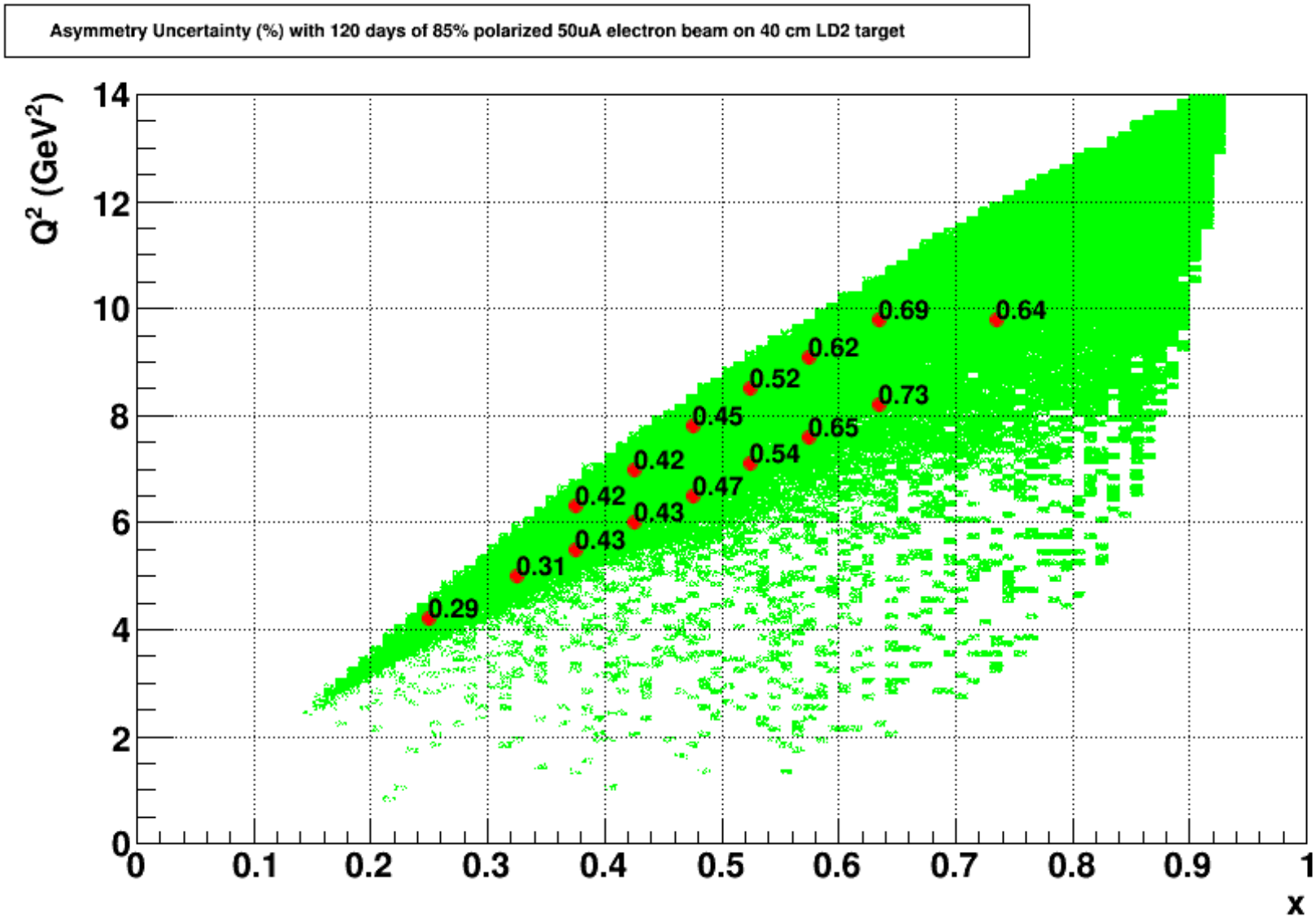


DIS Acceptance after Trigger

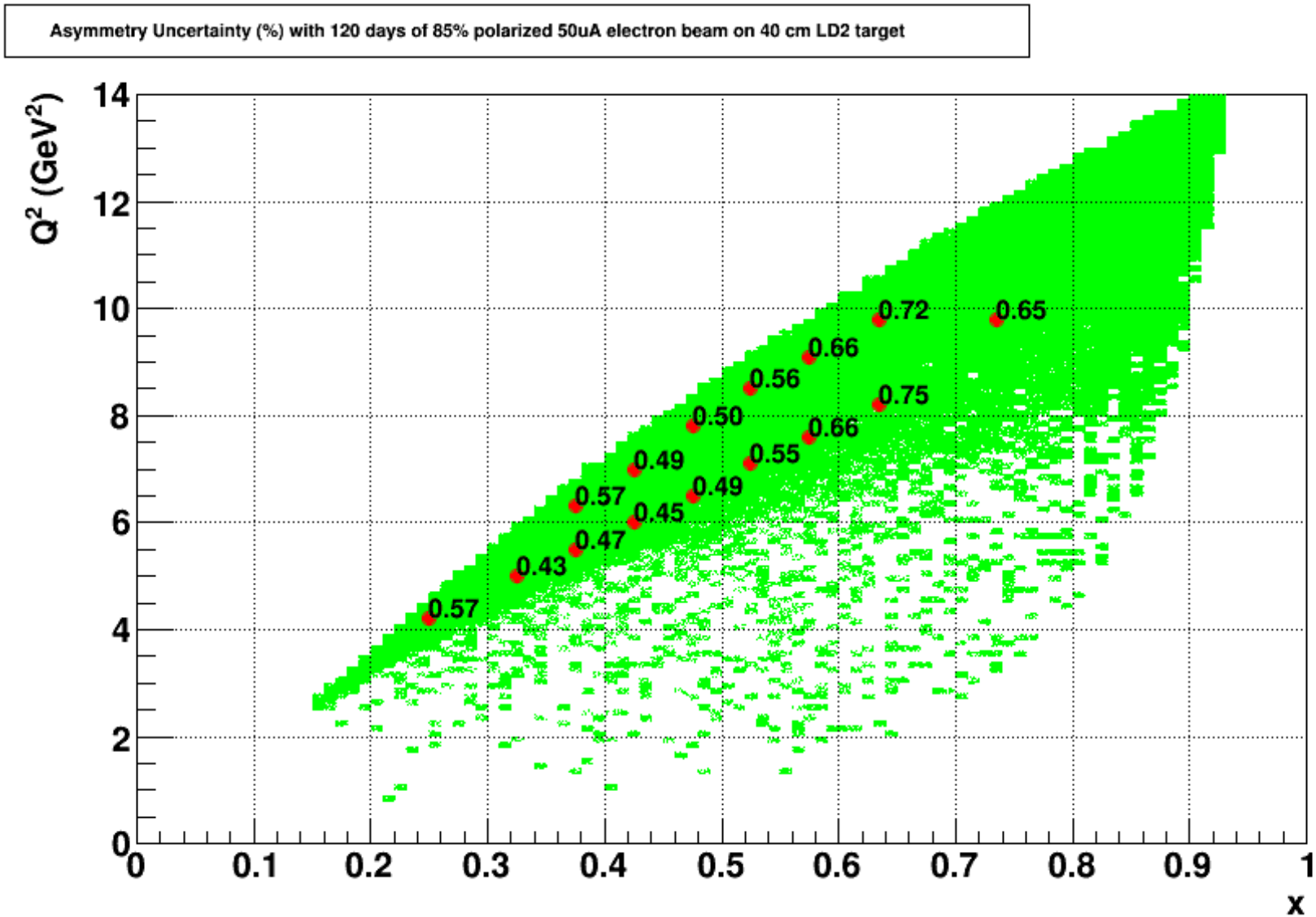




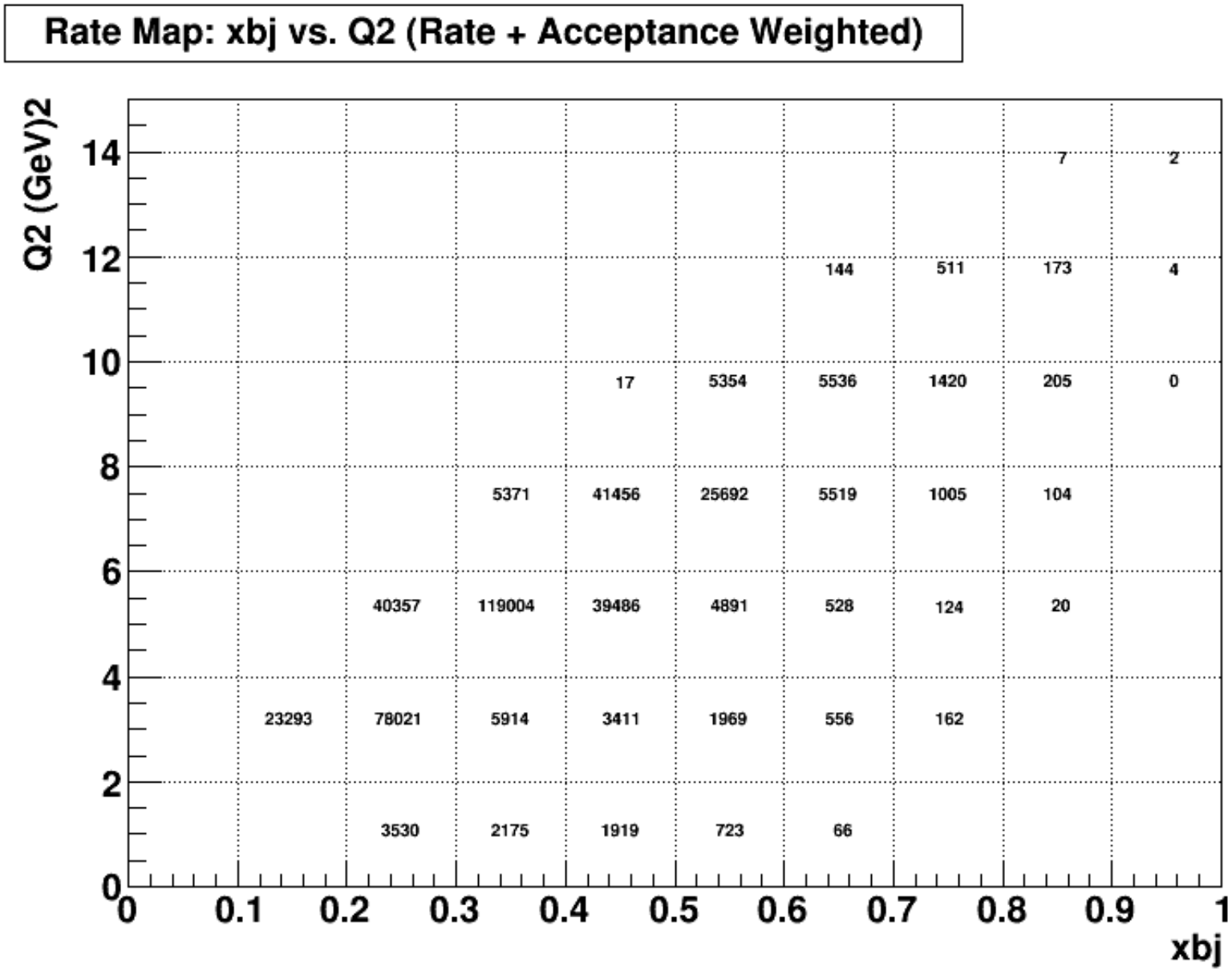
PVDIS FOM before Trigger



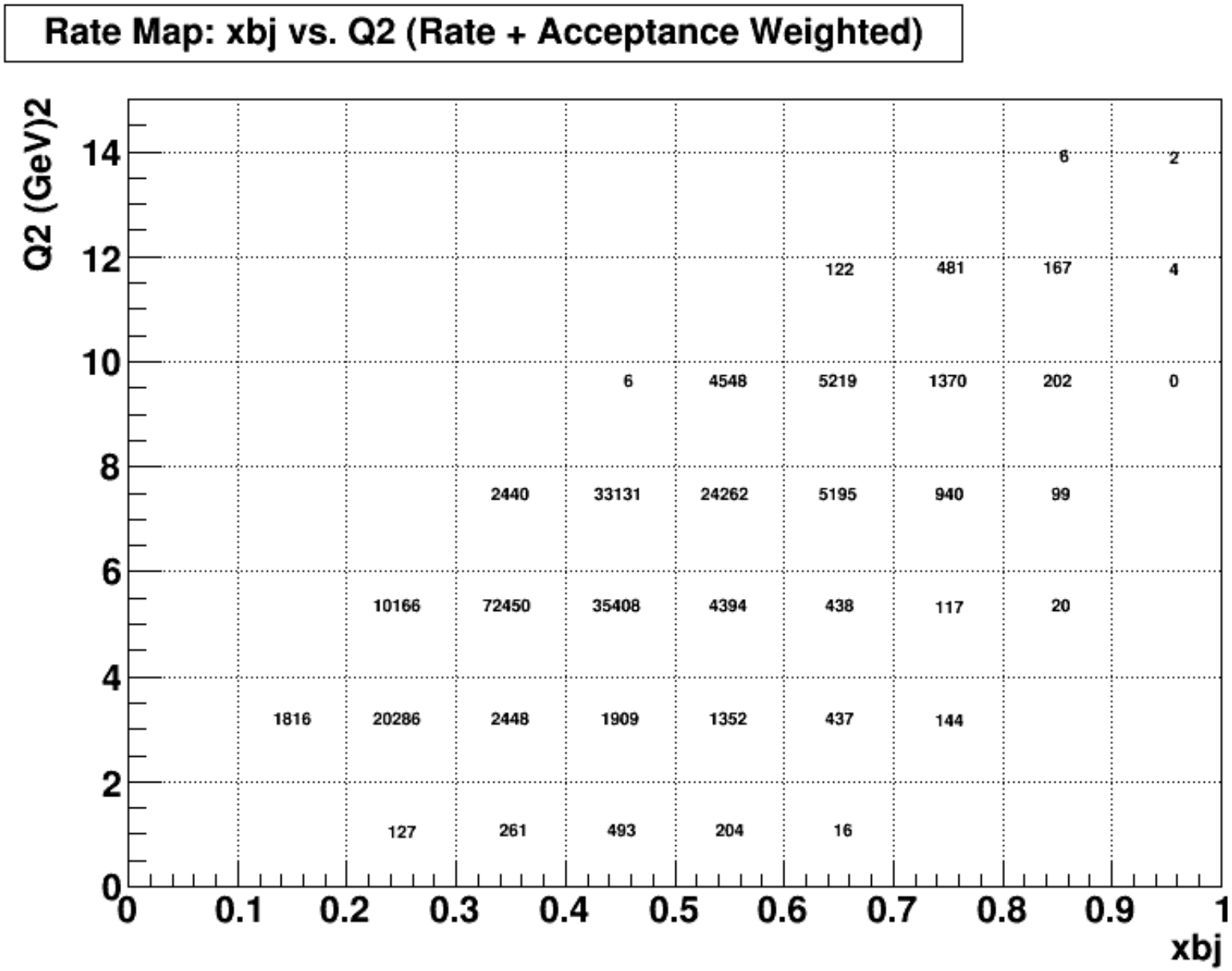
PVDIS FOM after Trigger



PVDIS Rate Map before Trigger



PVDIS Rate Map after Trigger



My Simulation To-Dos List

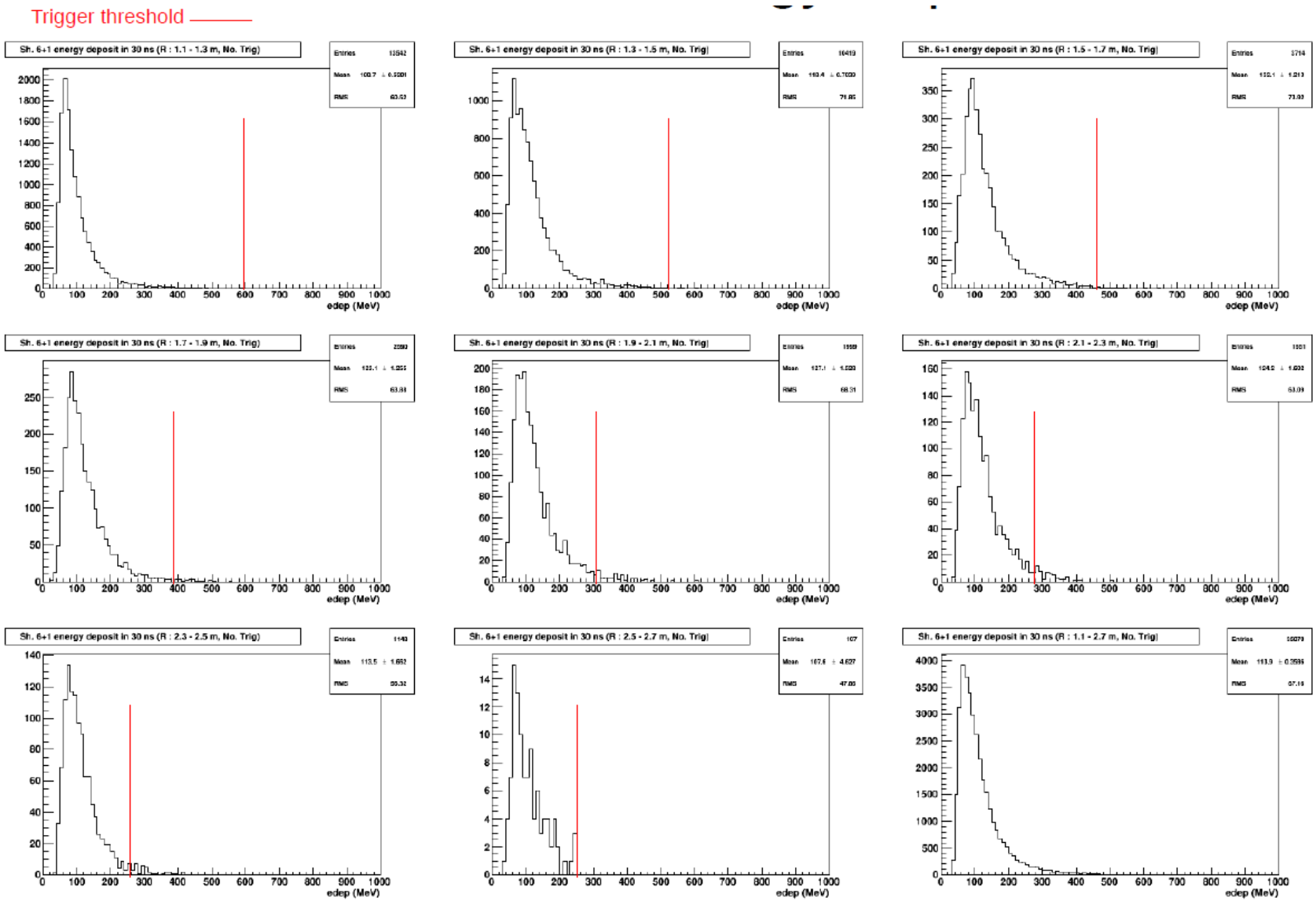
- SIDIS ECAL trigger responses (large and forward angle) : close to finish
- Simulate ECAL support structure :
  - Currently implementing Fibers
  - Add front and back plates
  - Add support rods and side plates
- Optimize the ECAL trigger : For instance optimize thresholds based on FOM (see rate map 17), including Pre-Shower?
- Background generator :
  - estimate hyperon contribution to pion background : Pion asymmetry estimation
  - Cross check with data: DVCS data
  - Adding electron vertex information (for SIDIS and J/ψ)

Supplementary

PVDIS FOM

Q^2 GeV^2	$A_{beam_{ave}}$ (ppb)	$\delta A_{beam_{ave}}$ (%)	Rate (Hz)
4.20	365214.25	0.57	30579
5.00	436394.23	0.43	37127
5.50	466107.21	0.47	27375
6.30	555876.32	0.57	13098
6.00	509720.15	0.45	25223
7.00	615986.47	0.49	14717
6.50	535749.88	0.49	19432
7.80	677128.99	0.50	11575
7.10	579095.91	0.55	13213
8.50	736003.66	0.56	7863
7.60	594356.10	0.66	8759
9.10	791141.17	0.66	4925
8.20	645045.42	0.75	5709
9.80	853324.71	0.72	3584
9.80	776222.89	0.65	5188

ECAL Triggers with All Backgrounds



ECAL Triggers with All Backgrounds