

DVCS rate estimation for HallC experimental settings

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- ★ Motivation/Proposed settings
- ★ Generator
- ★ Experimental setup
- ★ Estimated rates for few kinematic settings

Proposed Settings by Charles

Complement to Hall A: kinematics at the same Q^2 , x_B as E12-06-114, but at higher energies, to allow separation of $|DVCS|^2$ and $\text{Re}[DVCS^*BH]$
Not accessible in Hall A and have larger cross sections and larger calor angles than their Hall A counterparts e.g. $Q^2 = 3$ $x_B = 0.36$

Low x_B extension ($x_B = 0.2$): Requires small calorimeter angles, but has large cross sections. Can be run with low luminosity.
e.g. $Q^2 = 2$ $x_B = 0.2$

High Q^2 Extension at three $x_B = 0.36, 0.5, 0.6$: Requires small calorimeter angles, and the cross section is small. e.g. $Q^2 = 8.1$ $x_B = 0.5$

Table of all proposed kinematic settings is in the backup slides

Generation of events

Generator: Used the $ep \rightarrow ep\gamma$, developed by Carlos.

Flat over $Q^2, x_B, t, \phi, \phi_e$ within their accesable (detectable) range for corresponding kinematic setting

$$psf = \Delta Q^2 \times \Delta x_B \times \Delta t \times \Delta \phi \times \Delta \phi_e$$

$$\sigma_{ep \rightarrow ep\gamma} = \sigma_{BH} + \sigma_{DVCS} + \sigma_{Int}$$
 C++ code by H. MOUTARDE

- Double Distribution model fitted to meson production data
- reproducing well DVCS data
- Fast performance

arXiv:1210.6975

Experimental setup

Geant4 code for HallA adjusted for HallC settings

Hall A calorimeter

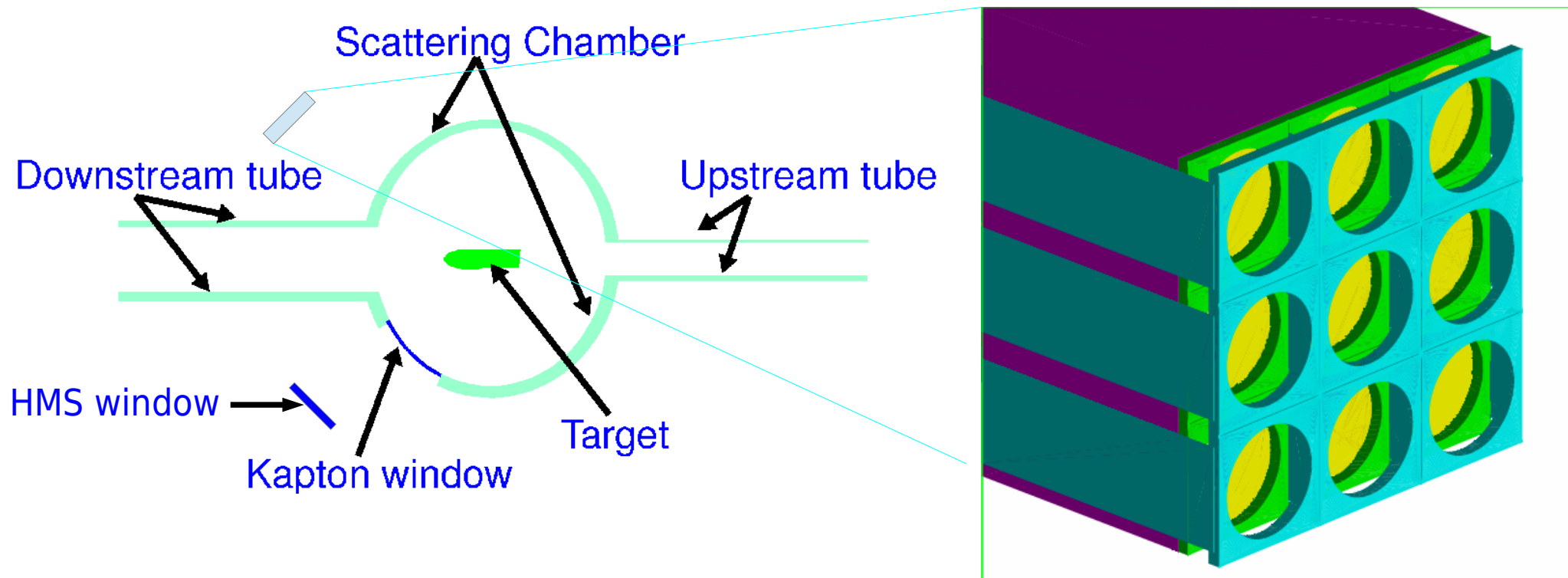
16×13 PbF2 blocks

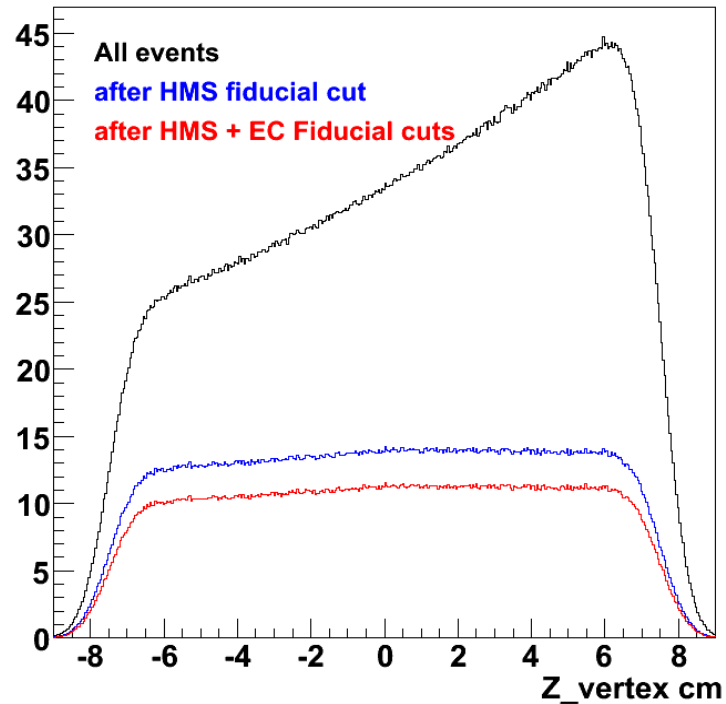
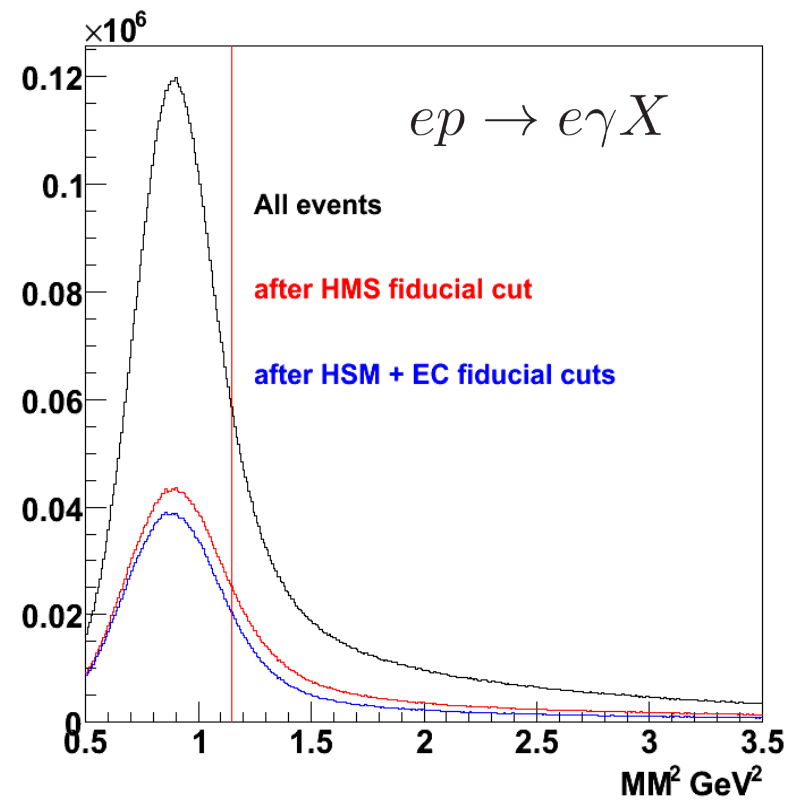
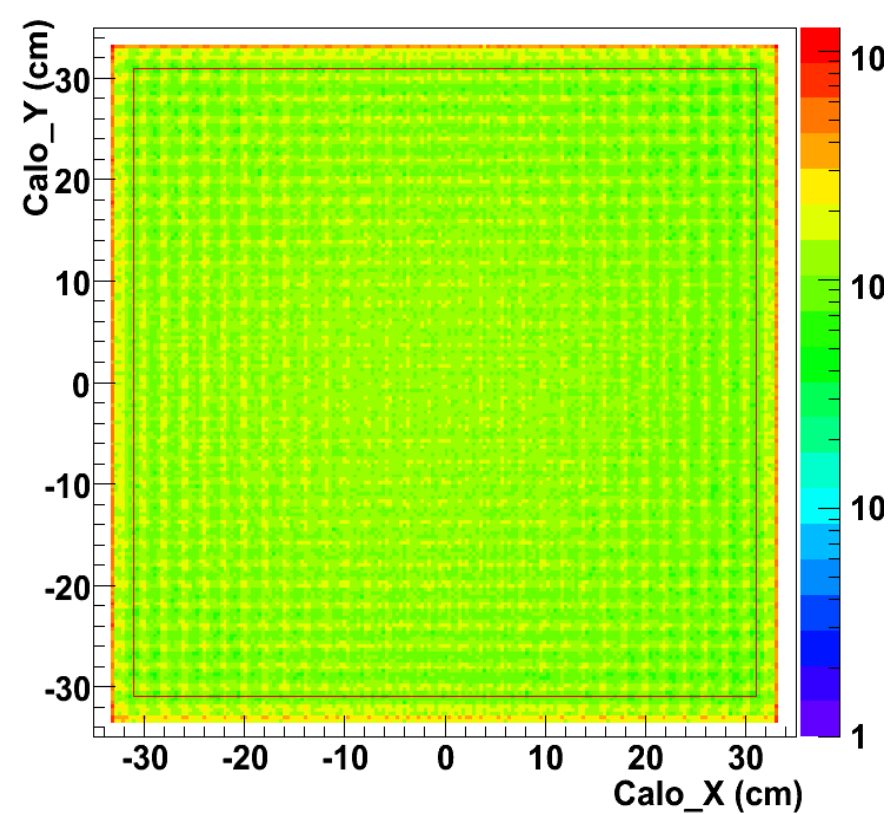
block size: $3 \times 3 \times 18.6$ cm

Designed in HallC

34×34 PbF2/(PbWO₄) blocks

block size: $2 \times 2 \times 18.6$ cm

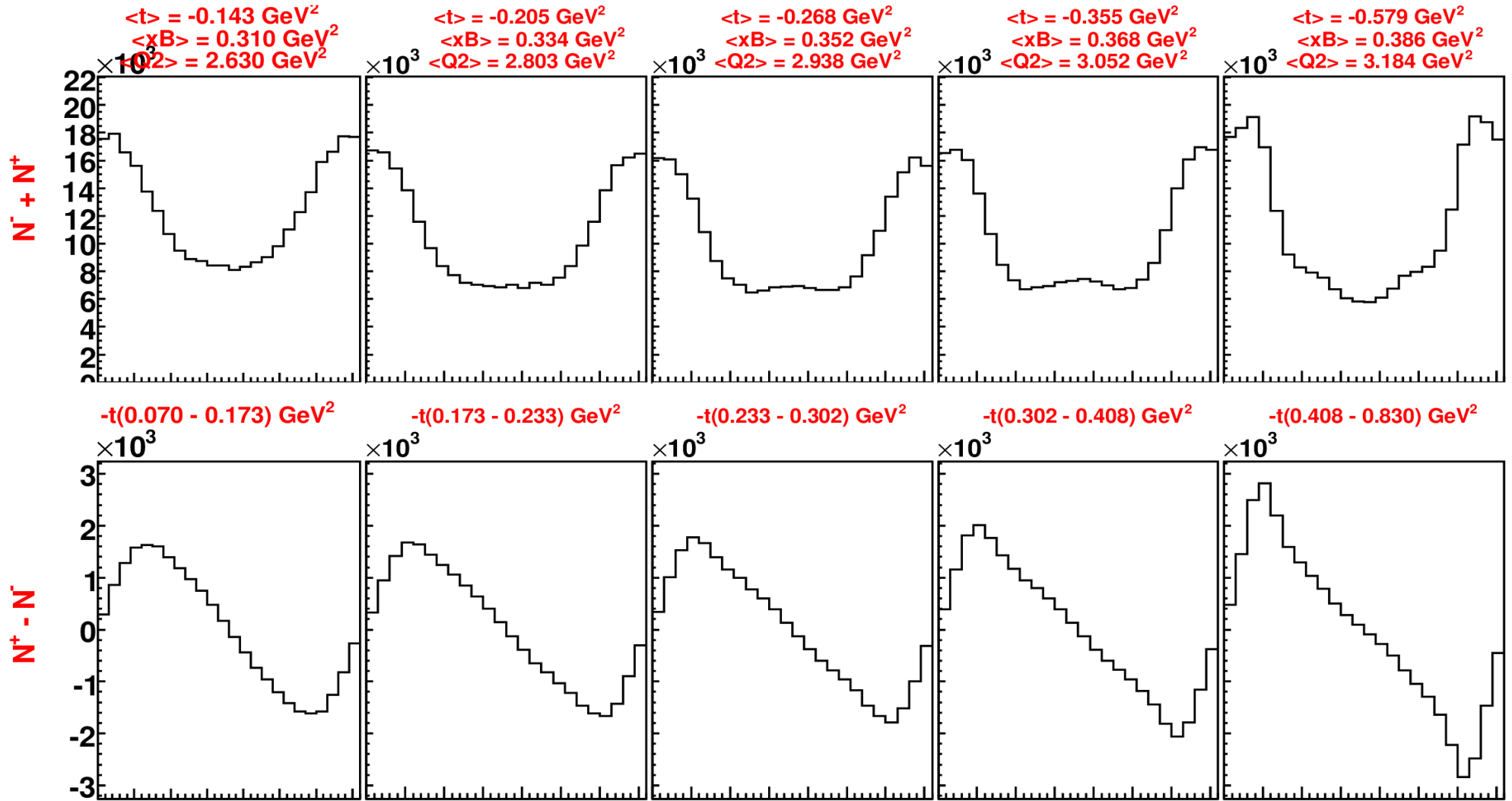




Energy in blocks was smeared to resolution measured in Hall A

- $-31 < X < 31 \text{ cm}, -31 < y < 31 \text{ cm}$
- $0.9 \cdot P_0 < P_e < 1.1 \cdot P_0$
- $\phi_{HMS} - 27.5 < \phi_e < \phi_{HMS} + 27.5 \text{ mrad}$
- $-70 < \theta_e < 70 \text{ mrad}$
- $-6.5 < vz < 6.5 \text{ cm}$
- $mm^2 < 1.15 \text{ GeV}^2$

Rates



$$P_e = 6.56 \text{ GeV}/c$$

$$\text{Calo distance} = 3 \text{ m}$$

$$L = 7.44 \times 10^{37} \text{ cm}^{-2} \text{ s}^{-1}$$

$$Q^2 = 3 \quad x_B = 0.36 \quad E_b = 11 \text{ GeV}$$

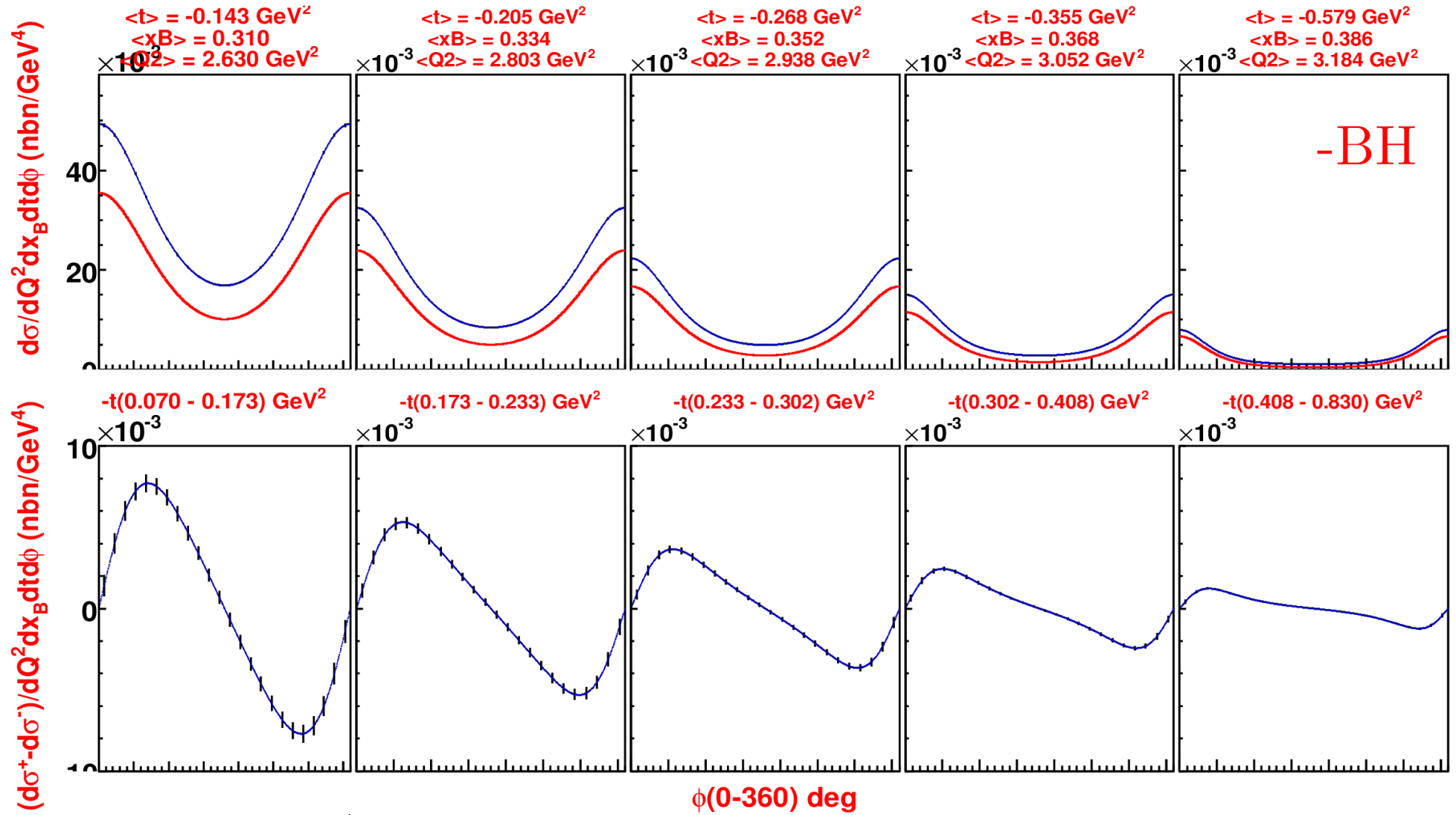
$$\phi(0-360) \text{ deg}$$

$$\theta_{HMS} = 11.70^\circ$$

$$\theta_{Calo} = 16.2^\circ$$

1 Day of running

Rates



$$P_e = 6.56 \text{ GeV}/c$$

$$\theta_{HMS} = 11.70^\circ$$

1 Day of running

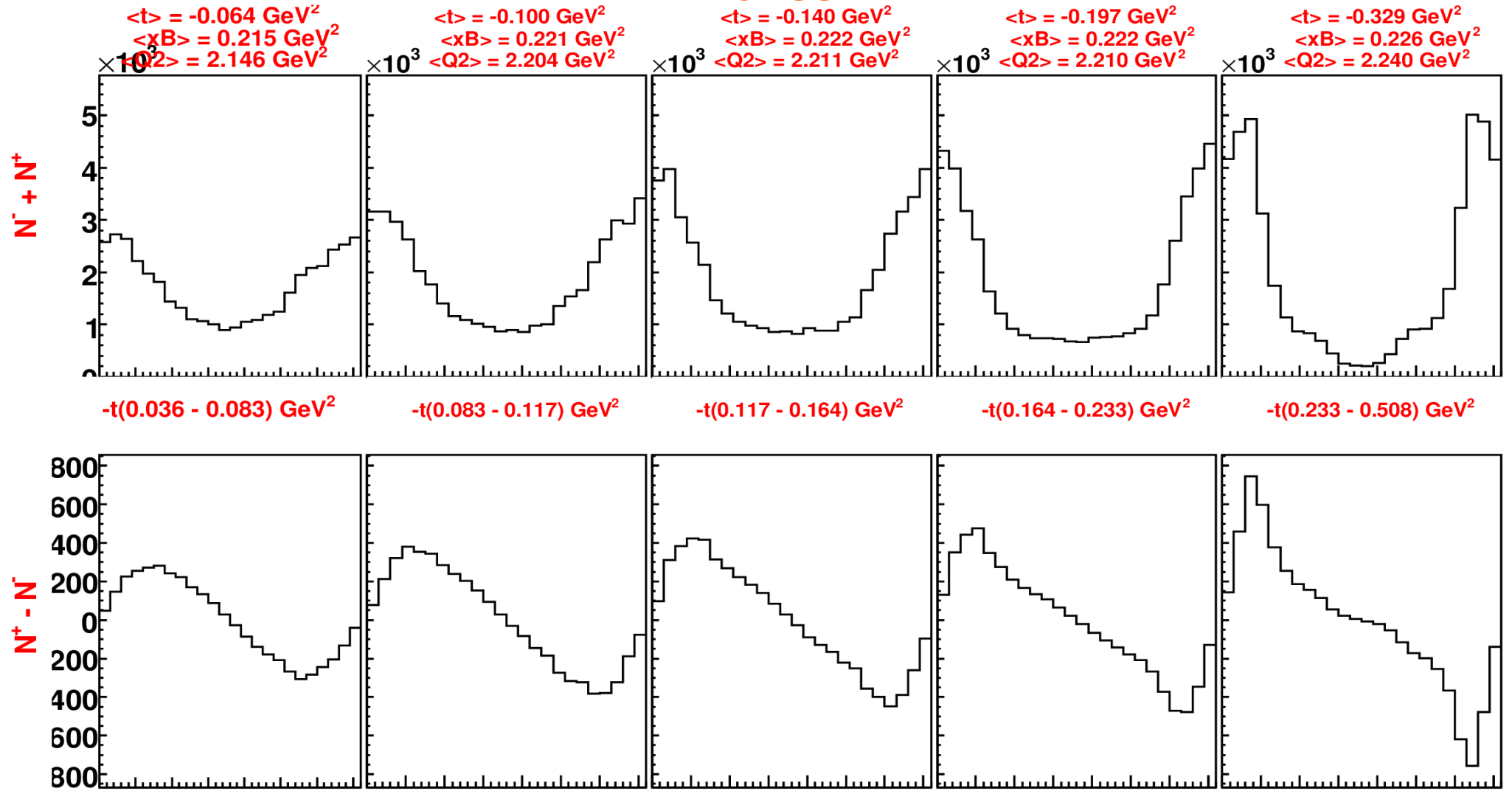
$$\text{Calo distance} = 3 \text{ m}$$

$$\theta_{Calo} = 16.2^\circ$$

$$L = 7.44 \times 10^{37} \text{ cm}^{-2} \text{ s}^{-1}$$

$$Q^2 = 3 \quad x_B = 0.36 \quad E_b = 11 \text{ GeV}$$

Rates



$\phi(0-360)$ deg

$$P_e = 3.47 \text{ GeV}/c$$

$$\theta_{HMS} = 14.70^\circ$$

1 Day of running

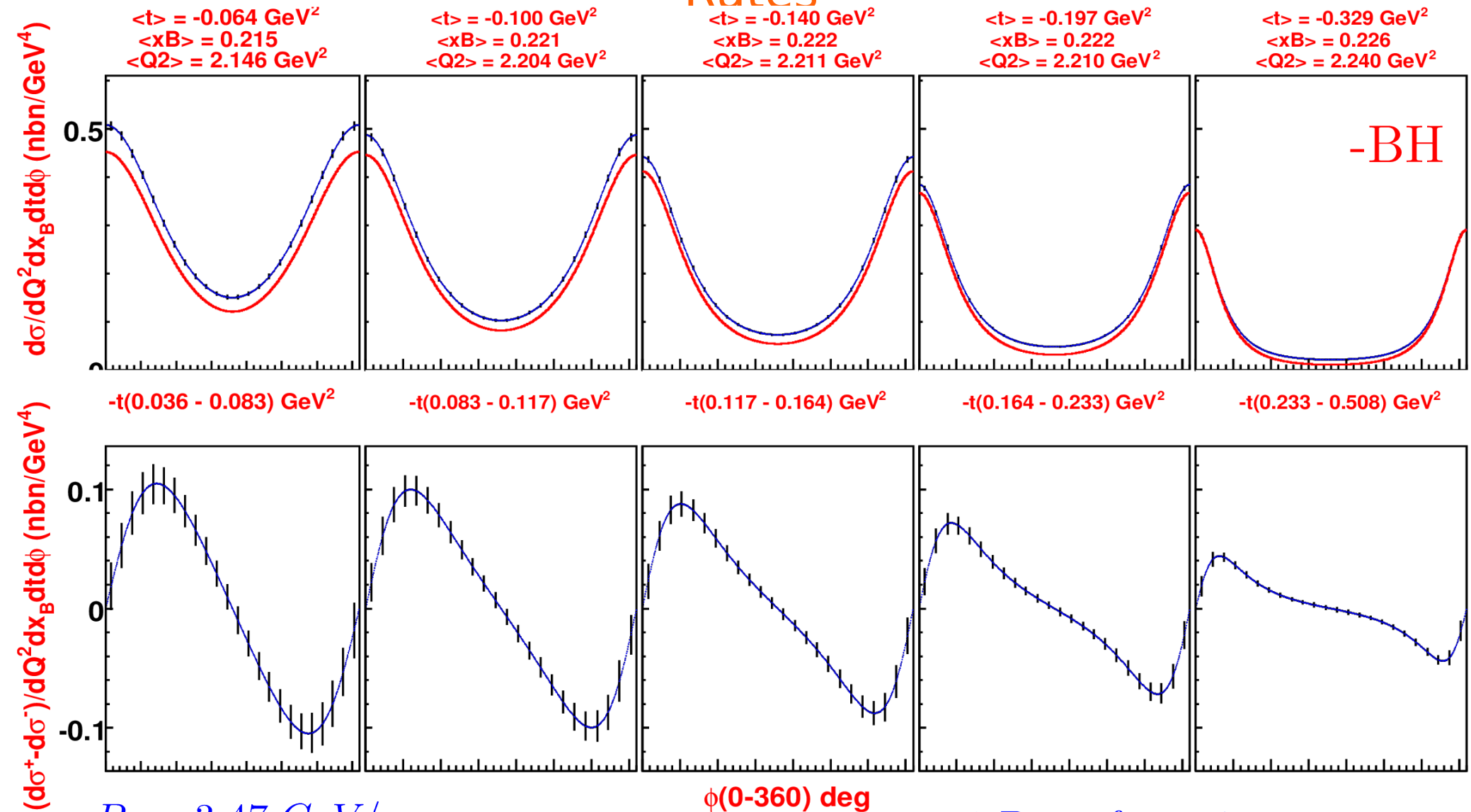
$$\text{Calo distance} = 4 \text{ m}$$

$$\theta_{Calo} = 9.19^\circ$$

$$L = 1.32 \times 10^{37} \text{ cm}^{-2} \text{ s}^{-1}$$

$$Q^2 = 2 x_B = 0.2 \quad E_b = 8.8 \text{ GeV}$$

Rates



$$P_e = 3.47 \text{ GeV}/c$$

$$\text{Calo distance} = 4 \text{ m}$$

$$\phi(0-360) \text{ deg}$$

$$\theta_{HMS} = 14.70^\circ$$

$$\theta_{Calo} = 9.19^\circ$$

1 Day of running

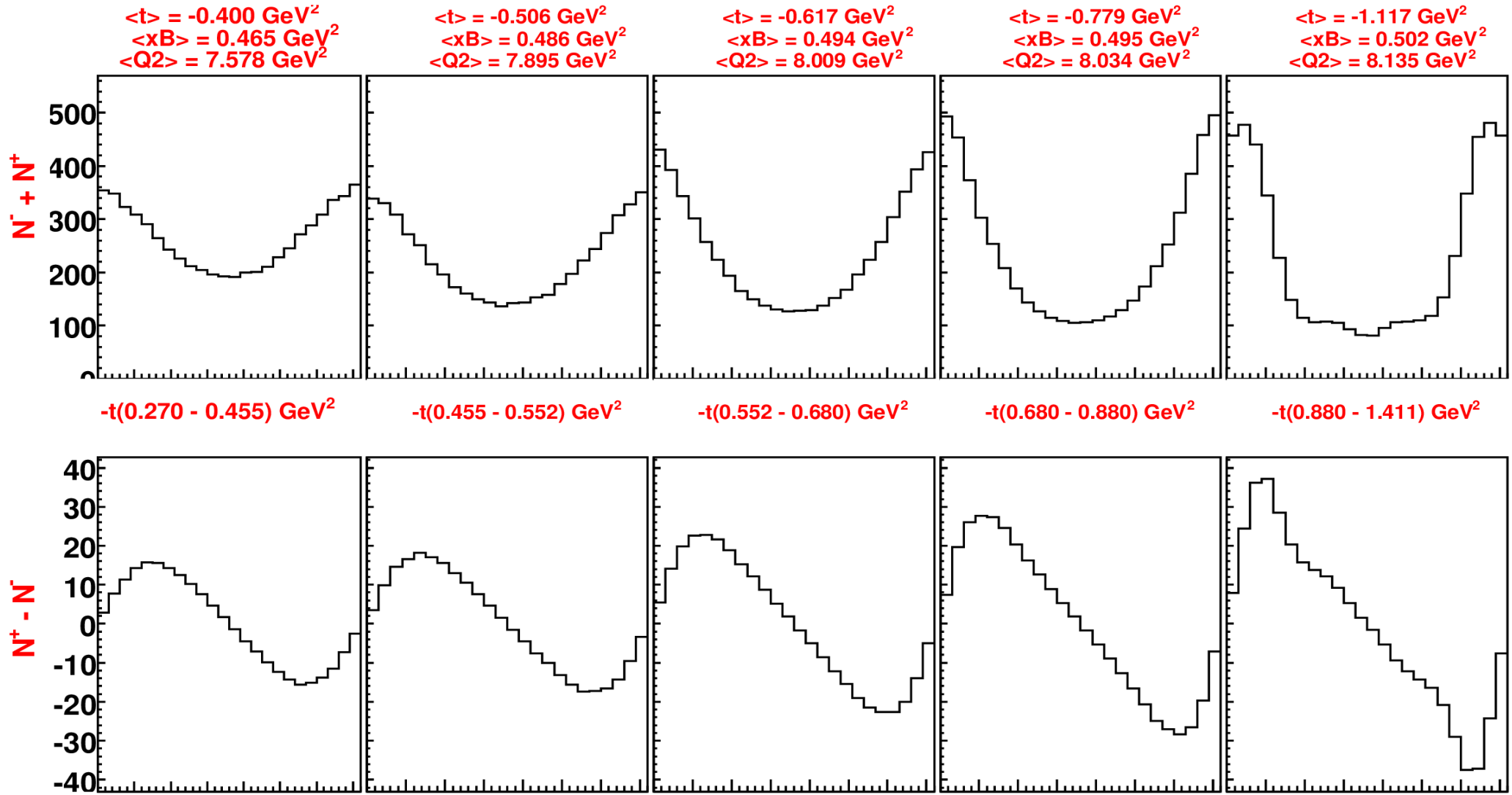
$$L = 1.32 \times 10^{37} \text{ cm}^{-2} \text{ s}^{-1}$$

$$Q^2 = 2 \ x_B = 0.2 \ E_b = 8.8 \text{ GeV}$$

DVCS is small according to the model

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Rates



$$P_e = 2.36 \text{ GeV}/c$$

$\phi(0-360) \text{ deg}$

$$\theta_{HMS} = 32.40^\circ$$

5 Day of running

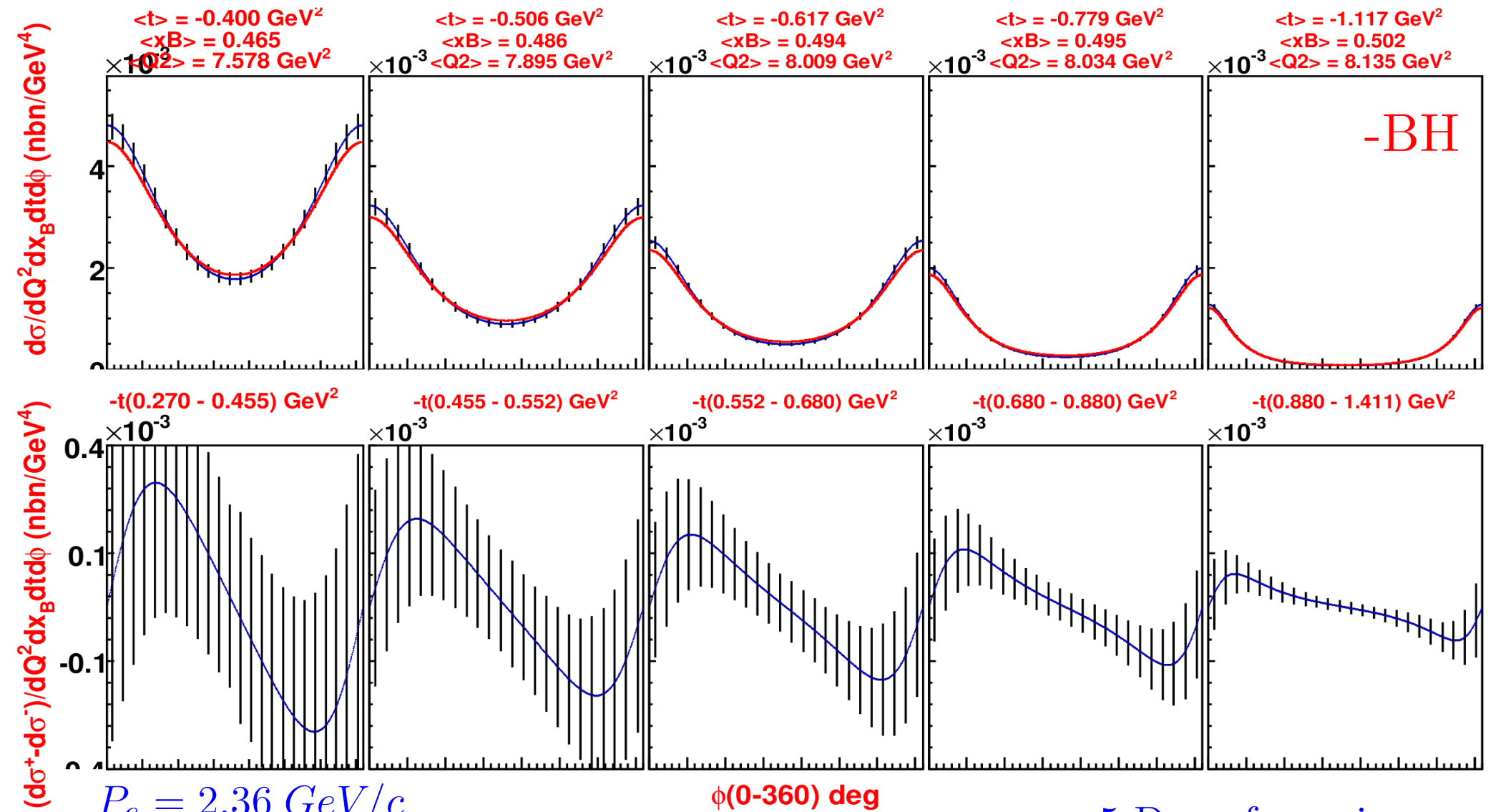
$$\text{Calo distance} = 4 \text{ m}$$

$$\theta_{Calo} = 8.01^\circ$$

$$L = 1.32 \times 10^{37} \text{ cm}^{-2} \text{ s}^{-1}$$

$$Q^2 = 8.1 \text{ } x_B = 0.5 \text{ } E_b = 11 \text{ GeV}$$

Rates



$$P_e = 2.36 \text{ GeV}/c$$

$$\text{Calo distance} = 4 \text{ m}$$

$$L = 1.32 \times 10^{37} \text{ cm}^{-2} \text{ s}^{-1}$$

$$Q^2 = 8.1 \quad x_B = 0.5 \quad E_b = 11 \text{ GeV}$$

$$\theta_{HMS} = 32.40^\circ$$

$$\theta_{Calo} = 8.01^\circ$$

5 Day of running

DVCS is small according to the model.

More luminosity is needed

Luminosity at $d = 110 \text{ cm}$, was $10^{37} \text{ cm}^{-2} \text{ s}^{-1}$

Proposed luminosities are obtained, by keeping the same amount of rates in a same solid angle

		Hall A											
kBeam	(GeV)	6.60	8.80	11.00	6.60	8.80	11.00	11.00	8.80	8.80	11.00	11.00	
Q2	(GeV^2)	3.00	4.00	4.55	3.10	4.80	6.30	7.20	5.10	6.00	7.70	9.00	
xBj		0.36	0.36	0.36	0.50	0.50	0.50	0.50	0.60	0.60	0.60	0.60	
MProton	(GeV)	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	
nu	(GeV)	4.44	5.92	6.74	3.30	5.12	6.72	7.68	4.53	5.33	6.84	8.00	
kScatt	(GeV)	2.16	2.88	4.26	3.30	3.68	4.28	3.32	4.27	3.47	4.16	3.00	
csThe		0.89	0.92	0.95	0.93	0.93	0.93	0.90	0.93	0.90	0.92	0.86	
epsilon		0.54	0.55	0.65	0.75	0.67	0.64	0.51	0.74	0.63	0.62	0.46	
the	(deg)	26.53	22.93	17.92	21.76	22.19	21.07	25.64	21.23	25.61	23.67	30.25	
snThq		0.20	0.18	0.19	0.33	0.25	0.21	0.18	0.31	0.26	0.23	0.18	
Thq	(deg)	11.66	10.33	10.70	19.04	14.47	12.40	10.19	17.78	14.81	13.07	10.21	
pMin	(GeV/c)	0.42	0.42	0.42	0.66	0.66	0.66	0.66	0.89	0.89	0.89	0.89	
1./(1.-eps)		2.19	2.24	2.83	3.99	3.01	2.77	2.05	3.83	2.69	2.61	1.84	
qvec	(GeV/c)	4.77	6.25	7.07	3.74	5.57	7.17	8.13	5.06	5.87	7.38	8.54	
q'	(GeV)	4.36	5.83	6.65	3.11	4.91	6.50	7.46	4.18	4.97	6.47	7.62	
tmin	(GeV^2)	-0.16	-0.17	-0.17	-0.36	-0.39	-0.40	-0.40	-0.65	-0.67	-0.69	-0.71	
sqrt(tmin)	(GeV)	0.40	0.41	0.41	0.60	0.62	0.63	0.64	0.81	0.82	0.83	0.84	
CaloDist		1.50	2.00	2.50	1.50	2.00	2.50	2.50	1.50	2.00	2.50	3.00	
DOmega		6.16E-02	3.47E-02	2.22E-02	6.16E-02	3.47E-02	2.22E-02	2.22E-02	6.16E-02	3.47E-02	2.22E-02	1.54E-02	
Th_gg_max		1.24E-01	9.31E-02	7.45E-02	1.24E-01	9.31E-02	7.45E-02	7.45E-02	1.24E-01	9.31E-02	7.45E-02	6.20E-02	
q'_min		4.11	5.59	6.44	2.94	4.68	6.25	7.13	3.82	4.68	6.15	7.31	
tmax		-0.62	-0.63	-0.56	-0.68	-0.82	-0.88	-1.03	-1.34	-1.22	-1.29	-1.28	
tmin-tmax		0.46	0.47	0.39	0.32	0.43	0.48	0.62	0.69	0.55	0.60	0.57	
Th_calog_edgedeg		5.93	6.03	7.26	13.31	10.17	8.96	6.75	12.05	10.52	9.64	7.34	
Lumi		1.86E+37	3.31E+37	5.17E+37	1.86E+37	3.31E+37	5.17E+37	5.17E+37	1.86E+37	3.31E+37	5.17E+37	7.44E+37	
d4sig(0deg)	nb/GeV^4	8.21E-02	3.64E-02	1.92E-02	1.24E-03	4.47E-03	2.33E-03	2.38E-03	1.22E-03	9.95E-04	5.06E-04	5.12E-04	
d4sig(180)	nb/GeV^4	1.44E-02	7.80E-03	4.69E-03	4.07E-03	1.73E-03	1.01E-03	1.06E-03	5.60E-04	4.68E-04	2.78E-04	2.95E-04	
Days		3.00	2	1	5	4	4	7	13	16	13	20	
Jacob_e	GeV	2.31	3.08	5.01	6.58	6.33	7.02	4.76	9.95	6.87	8.03	4.96	
counts in DeltaT bin		5.55E+04	5.36E+04	5.46E+04	2.22E+04	3.96E+04	4.30E+04	4.07E+04	3.80E+04	3.82E+04	3.65E+04	3.71E+04	
Total Beam Time		Hall A Total = 88 PAC Days											

		Hall C Complement to Hall A Kinematics							
kBeam	(GeV)	8.80	11.00	11.00	8.80	11.00	11.00	11	11.00
Q2	(GeV^2)	3.00	3.00	4.00	3.10	3.1	4.80	5.10	6.00
xBj		0.36	0.36	0.36	0.50	0.50	0.50	0.60	0.60
MProton	(GeV)	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
nu	(GeV)	4.44	4.44	5.92	3.30	3.30	5.12	4.53	5.33
kScatt	(GeV)	4.36	6.56	5.08	5.50	7.70	5.88	6.47	5.67
csThe		0.96	0.98	0.96	0.97	0.98	0.96	0.96	0.95
epsilon		0.77	0.86	0.74	0.87	0.92	0.80	0.85	0.78
the	(deg)	16.08	11.70	15.38	14.55	10.98	15.65	15.38	17.84
snThq		0.25	0.28	0.22	0.37	0.39	0.29	0.34	0.30
Thq	(deg)	14.66	16.20	12.44	21.63	23.05	16.57	19.82	17.23
pMin	(GeV/c)	0.42	0.42	0.42	0.66	0.66	0.66	0.89	0.89
1./(1.-eps)		4.31	7.28	3.81	7.79	12.96	5.10	6.45	4.54
qvec	(GeV/c)	4.77	4.77	6.25	3.74	3.74	5.57	5.06	5.87
q'	(GeV)	4.36	4.36	5.83	3.11	3.11	4.91	4.18	4.97
tmin	(GeV^2)	-0.16	-0.16	-0.17	-0.36	-0.36	-0.39	-0.65	-0.67
sqrt(tmin)	(GeV)	0.40	0.40	0.41	0.60	0.60	0.62	0.81	0.82
CaloDist		3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
DOmega		4.55E-02	4.55E-02	4.55E-02	4.55E-02	4.55E-02	4.55E-02	4.55E-02	4.55E-02
Th_gg_max		1.07E-01	1.07E-01	1.07E-01	1.07E-01	1.07E-01	1.07E-01	1.07E-01	1.07E-01
q'_min		4.17	4.17	5.51	2.98	2.98	4.61	3.91	4.59
tmax		-0.51	-0.51	-0.77	-0.60	-0.60	-0.95	-1.17	-1.38
tmin-tmax		0.35	0.35	0.60	0.24	0.24	0.56	0.52	0.71
Th_calog_edgedeg		8.55	10.09	6.33	15.52	16.93	10.46	13.71	11.11
Lumi		7.44E+37	7.44E+37	7.44E+37	7.44E+37	7.44E+37	7.44E+37	7.44E+37	7.44E+37
d4sig(0deg)	nb/GeV^4	3.88E-02	2.70E-02	1.99E-02	8.64E-03	7.19E-03	3.07E-03	9.48E-04	6.92E-04
d4sig(180)	nb/GeV^4	8.97E-03	7.63E-03	4.94E-03	3.48E-03	3.30E-03	1.33E-03	4.83E-04	3.60E-04
Days		2	1	3	3	2	5	5	10
Jacob_e	GeV	6.22	11.69	6.79	14.63	25.61	12.65	18.85	14.04
counts in DeltaT bin		7.98E+05	8.19E+05	7.92E+05	9.01E+05	1.28E+06	5.04E+05	2.69E+05	2.58E+05
		504	505	506	507	508	509	510	511
Total Beam Time		Hall C Complement Total = 31 PAC Days							

Hall C — Low-x				Hall C — High-Q2			
6.60	8.80	11.00	11.00	11.00	11.00	11.00	kBeam
2	2	2	3	5.5	8.1	10	Q2
0.20	0.20	0.20	0.20	0.36	0.50	0.60	xBj
0.94	0.94	0.94	0.94	0.94	0.94	0.94	MProton
5.33	5.33	5.33	8.00	8.14	8.64	8.88	nu
1.27	3.47	5.67	3.00	2.86	2.36	2.12	kScatt
0.88	0.97	0.98	0.95	0.91	0.84	0.79	csThe
0.34	0.66	0.80	0.49	0.46	0.37	0.32	epsilon
28.28	14.70	10.27	17.33	24.15	32.40	38.26	the
0.11	0.16	0.18	0.11	0.14	0.14	0.14	snThq
6.26	9.19	10.57	6.28	7.93	8.01	7.99	Thq
0.21	0.21	0.21	0.21	0.42	0.66	0.89	pMin
1.52	2.97	5.07	1.97	1.84	1.58	1.47	1./(1.-eps)
5.51	5.51	5.51	8.18	8.47	9.09	9.43	qvec
5.31	5.31	5.31	7.97	8.05	8.42	8.50	q'
-0.04	-0.04	-0.04	-0.04	-0.17	-0.41	-0.71	tmin
0.21	0.21	0.21	0.21	0.41	0.64	0.84	sqrt(tmin)
4.00	4.00	4.00	4.00	4.00	4.00	4.00	CaloDist
2.56E-02	2.56E-02	2.56E-02	2.56E-02	2.56E-02	2.56E-02	2.56E-02	DOmega
8.00E-02	8.00E-02	8.00E-02	8.00E-02	8.00E-02	8.00E-02	8.00E-02	Th_gg_max
5.19	5.19	5.19	7.70	7.71	7.94	7.90	q'_min
-0.27	-0.27	-0.27	-0.55	-0.82	-1.31	-1.85	tmax
0.23	0.23	0.23	0.50	0.65	0.90	1.14	tmin-tmax
1.68	4.61	5.98	1.70	3.34	3.43	3.40	Th_calog_edge
1.32E+37	1.32E+37	1.32E+38	1.32E+37	1.32E+37	1.32E+37	1.32E+37	Lumi
3.29E+00	7.19E-01	3.92E-01	4.87E-01	2.26E-02	2.88E-03	6.29E-04	d4sig(0deg)
2.45E-01	9.80E-02	4.62E-02	7.55E-02	5.60E-03	1.29E-03	3.70E-04	d4sig(180)
1	1	1	1	5	5	12	Days
0.63	2.29	4.68	1.65	2.78	3.01	3.14	Jacob_e
1.55E+05	3.56E+05	6.37E+06	1.53E+05	6.14E+04	8.15E+03	4.37E+03	counts in DeltaT bin
512	513	514	515	516	517	518	