University of Regina

Cross Section Checks
- t shift -

Abdennacer Hamdi

KaonLT Meeting
2026/04/30

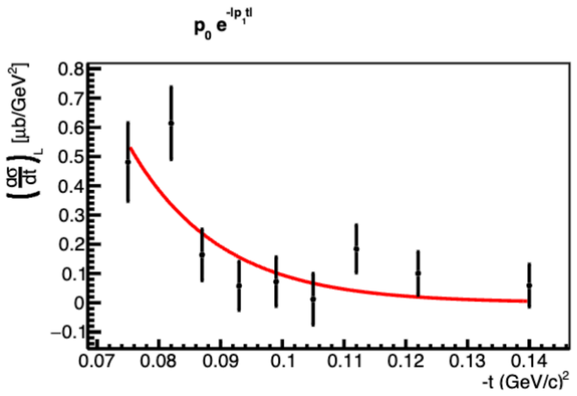
L, T, LT, TT Cross Sections

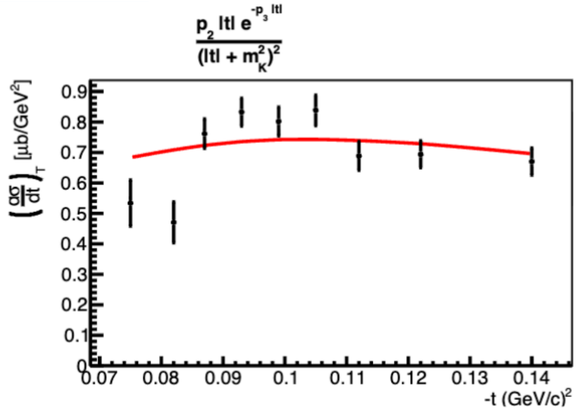
$p(e, e'K^+)\Lambda$

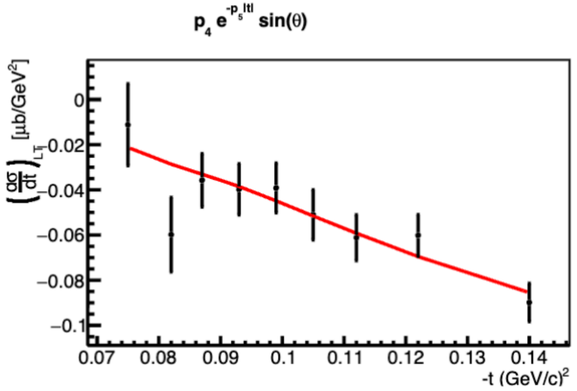
Before t-shift

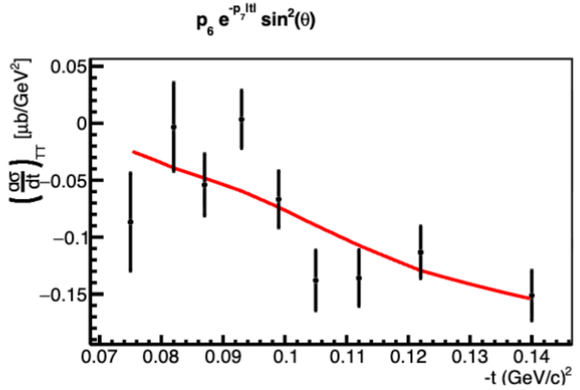
Negative σ_L

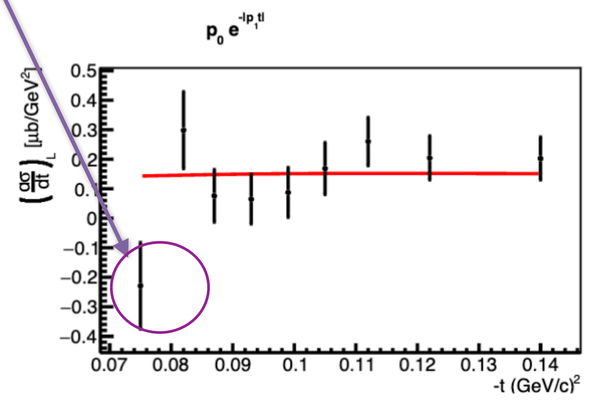
After t-shift

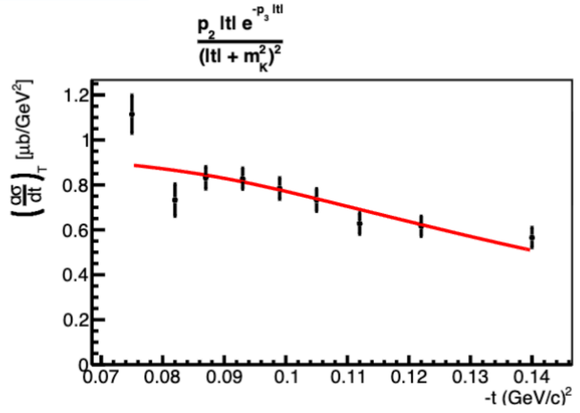


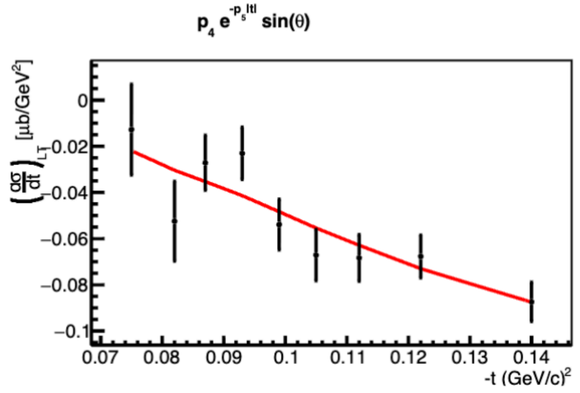


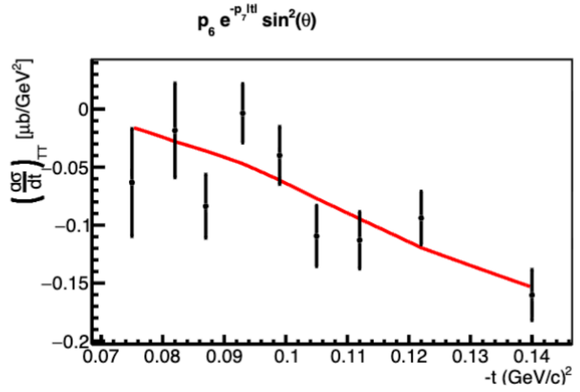












--- iteration 01 parameters -------	iteration 02 parameters ---
3359.768 6740.649 1	3359.742 6740.301 1
-73.994 24.387 2	-73.994 24.386 2
30.954 3.982 3	30.954 3.982 3
3.825 1.197 4	3.825 1.197 4
-7.762 3.580 5	-7.762 3.580 5
-0.258 3.773 6	-0.258 3.773 6
-265.990 156.560 7	-265.989 156.555 7
9.632 4.764 8	9.632 4.764 8

--- iteration 01 parameters -------	iteration 02 parameters ---
3359.768 6740.649 1	3.574 0.695 1
-73.994 24.387 2	0.000 0.007 2
30.954 3.982 3	81.521 11.859 3
3.825 1.197 4	13.311 1.424 4
-7.762 3.580 5	-8.722 3.575 5
-0.258 3.773 6	0.043 3.346 6
-265.990 156.560 7	-160.906 119.682 7
9.632 4.764 8	6.618 5.934 8

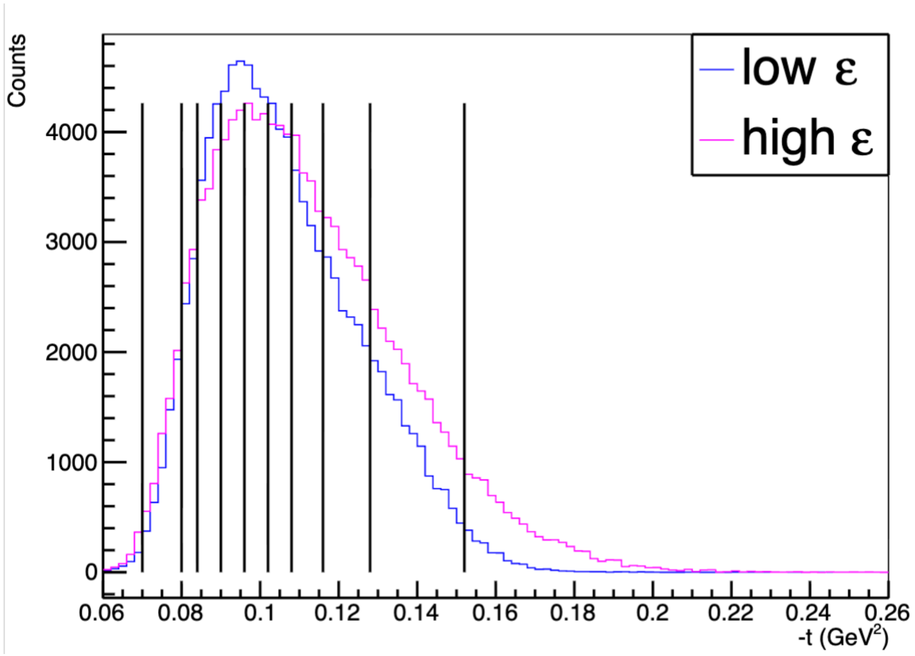
$$p(e, e'K^+)\Lambda$$

t-shift + new t-binning

t-shift + new t-binning

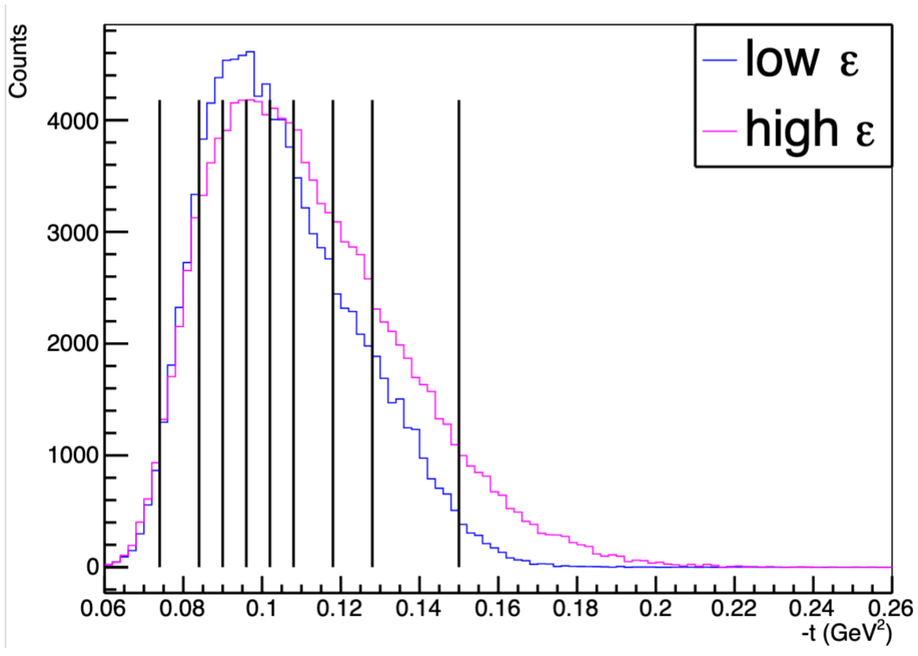
$p(e, e'K^+)\Lambda$

Before t-shift



t_min	t_max	t_center	Yield(lowe)	Error(lowe)	Yield(highe)	Error(highe)
0.07	0.08	0.075	5366.833	94.499	6213.5	99.789
0.08	0.084	0.082	5289.167	88.111	5560.0	89.303
0.084	0.09	0.087	11763.5	128.532	10703.833	124.308
0.09	0.096	0.093	13622.667	139.39	12239.0	134.485
0.096	0.102	0.099	13319.5	140.629	12538.5	138.018
0.102	0.108	0.105	12238.167	136.812	12109.167	137.066
0.108	0.116	0.112	13087.167	145.37	14430.333	152.257
0.116	0.128	0.122	14537.0	155.906	17588.333	170.715
0.128	0.152	0.14	14069.667	155.151	20359.0	187.915

After t-shift + new t-bins



t_min	t_max	t_center	Yield(lowe)	Error(lowe)	Yield(highe)	Error(highe)
0.074	0.084	0.079	11489.5	130.564	10962.0	127.157
0.084	0.09	0.087	12363.0	131.916	10780.833	124.93
0.09	0.096	0.093	13658.833	140.19	12240.167	134.606
0.096	0.102	0.099	13148.167	140.107	12395.0	137.623
0.102	0.108	0.105	11767.167	134.821	12095.667	136.895
0.108	0.118	0.113	15298.167	157.878	17420.0	167.932
0.118	0.128	0.123	11112.167	136.893	14241.167	153.691
0.128	0.15	0.139	12665.167	147.181	19075.667	181.804

L, T, LT, TT Models

$p(e, e'K^+)\Lambda$

$$\frac{d\sigma_L}{dt} = \frac{p_0 |t|}{(|t| + m_k^2)^2} e^{-p_1|t|}$$

$$\frac{d\sigma_T}{dt} = p_2 e^{-|p_3 t|}$$

$$\frac{d\sigma_{LT}}{dt} = p_4 e^{-p_5|t|} sin(\theta)$$

$$\frac{d\sigma_{TT}}{dt} = p_6 e^{-p_7|t|} sin^2(\theta)$$

$$w_{factor} = \frac{1}{(W^2 - m_p^2)^2}$$

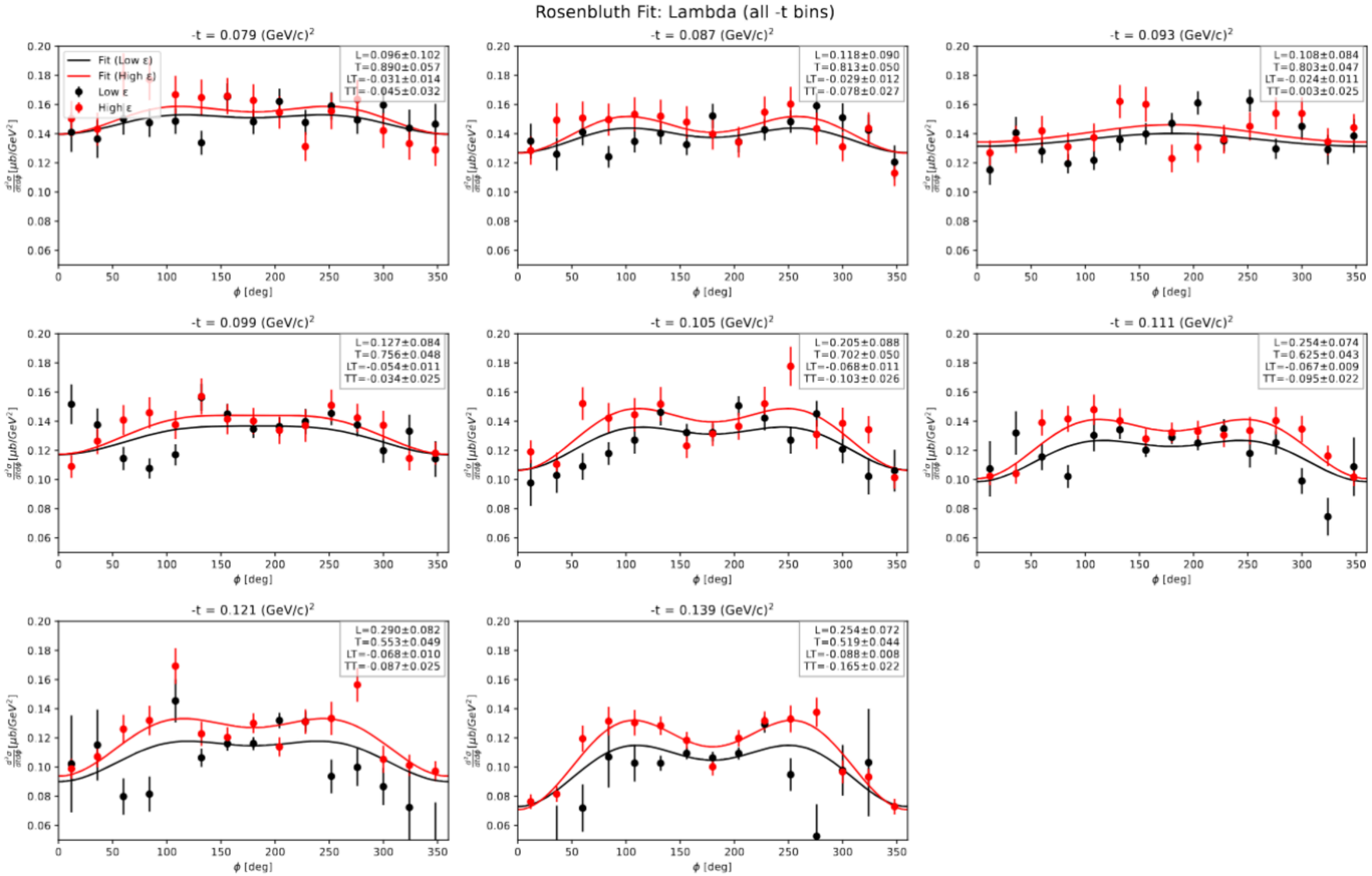
Negligible variation in the fit parameters

```
--- iteration 01 parameters ------- iteration 02 parameters ---
1.587      1.398  1              |   1.587      1.398  1
-10.960     7.386  2              |   -10.960     7.386  2
50.670     7.846  3              |   50.670     7.846  3
-10.721     1.525  4              |   -10.721     1.525  4
-8.531     3.485  5              |   -8.531     3.485  5
-0.284     3.357  6              |   -0.284     3.357  6
-96.041    77.005  7              |   -96.041    77.005  7
2.581      6.355  8              |   2.581      6.355  8
```

$$2\pi \frac{d^2\sigma}{dtd\phi} = \epsilon \frac{d\sigma_L}{dt} + \frac{d\sigma_T}{dt} + \sqrt{2\epsilon(\epsilon+1)} \frac{d\sigma_{LT}}{dt} cos\phi + \epsilon \frac{d\sigma_{TT}}{dt} cos2\phi$$

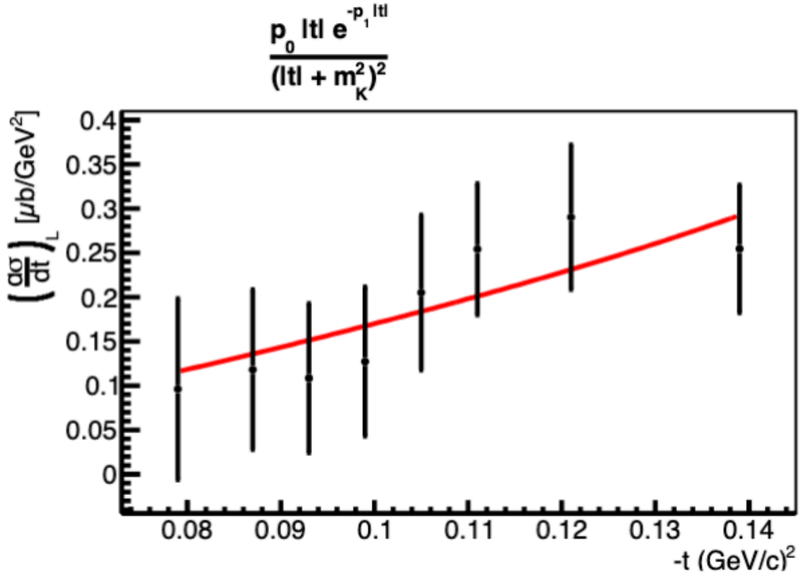
Low & High ε Simultaneous Fit (Rosenbluth)

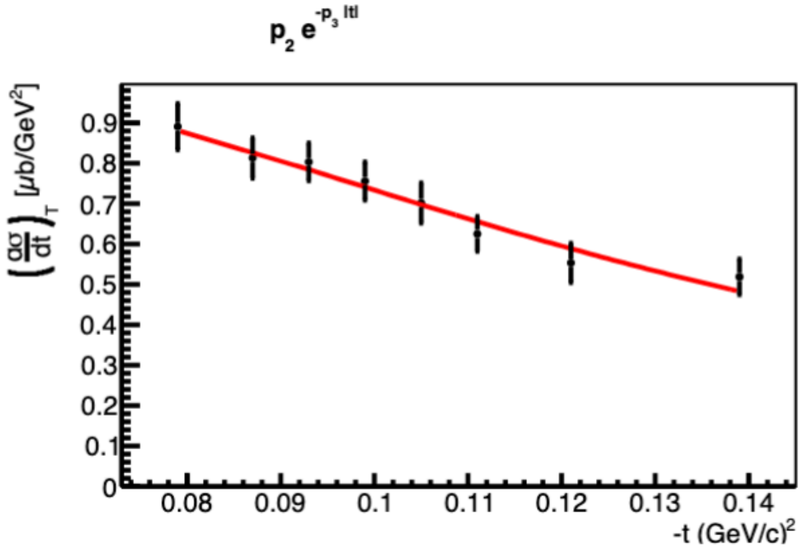
$p(e, e'K^+)\Lambda$

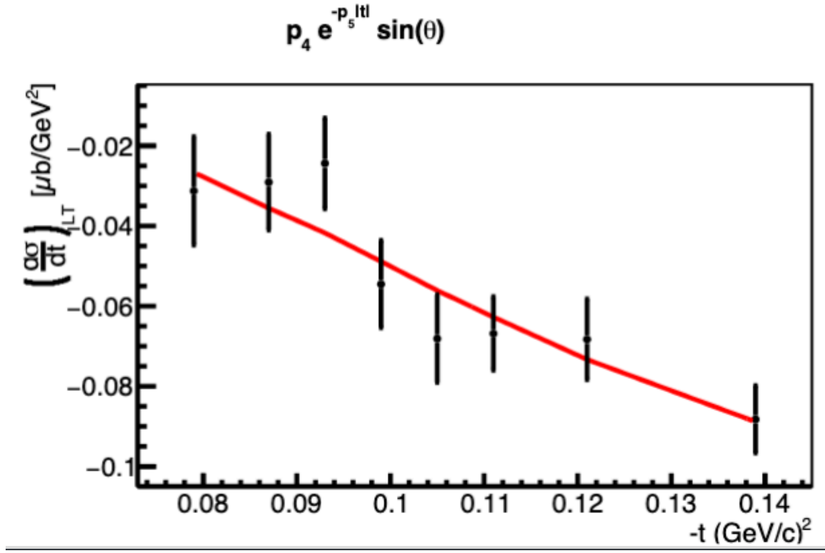


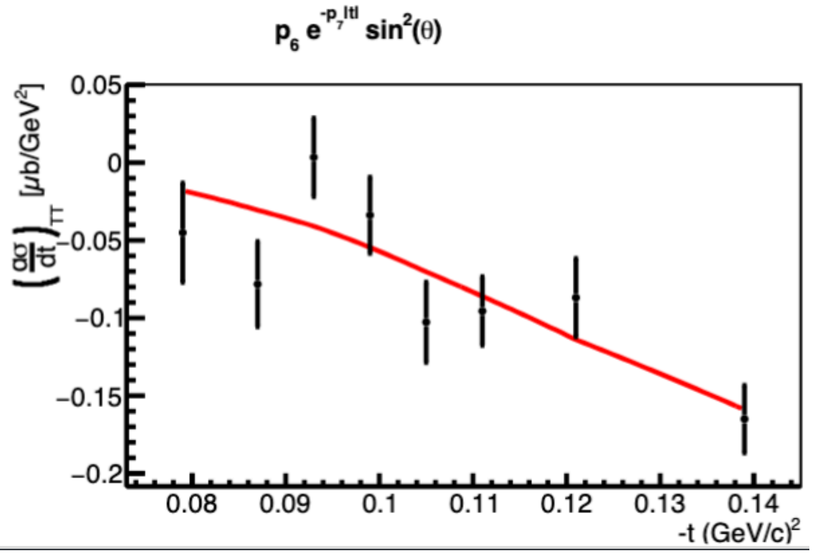
L, T, LT, TT Cross Sections

$p(e, e'K^+)\Lambda$





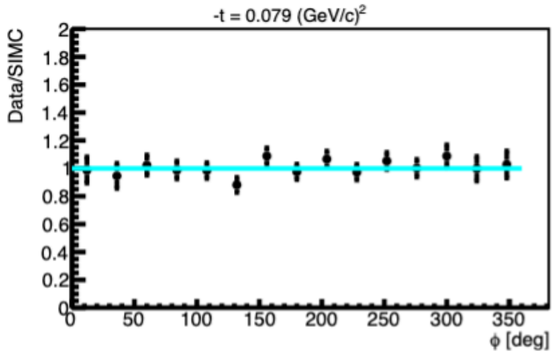


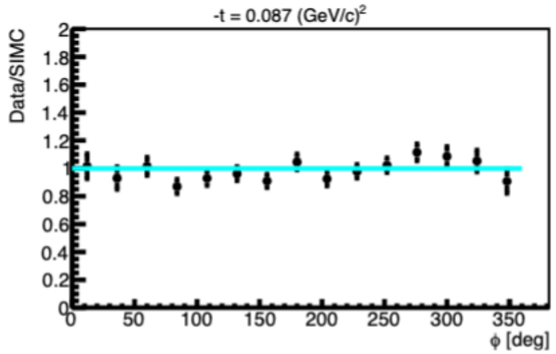


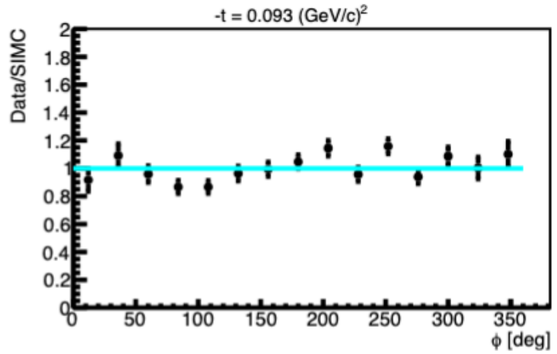
Data/SIMC Ratio

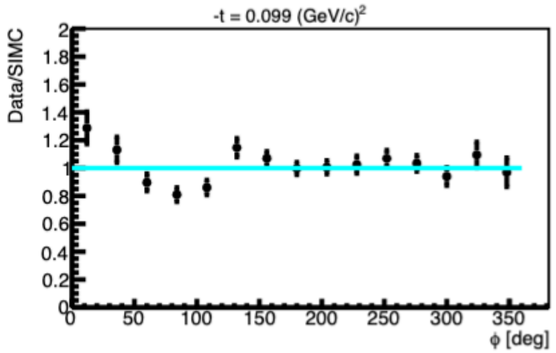
Low ε

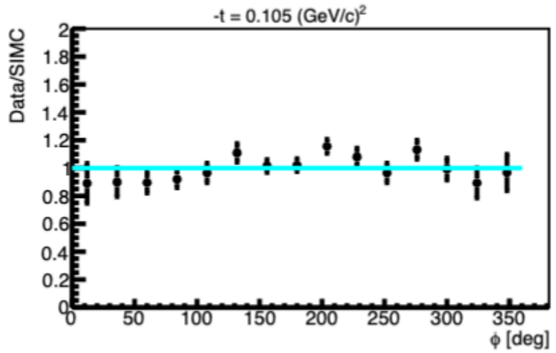
$p(e, e'K^+)\Lambda$

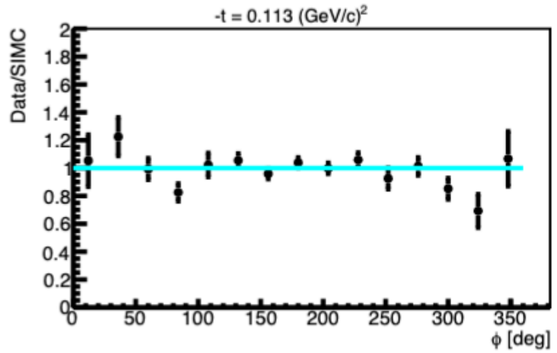


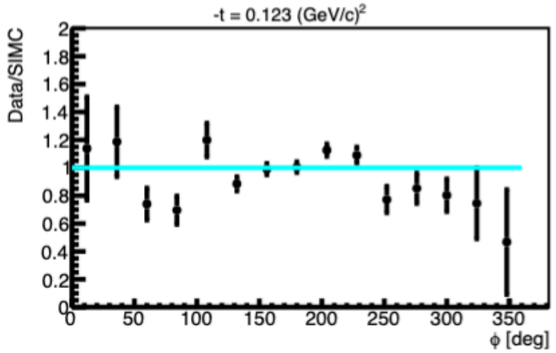


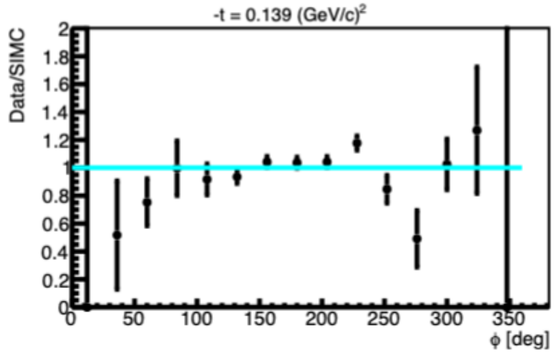








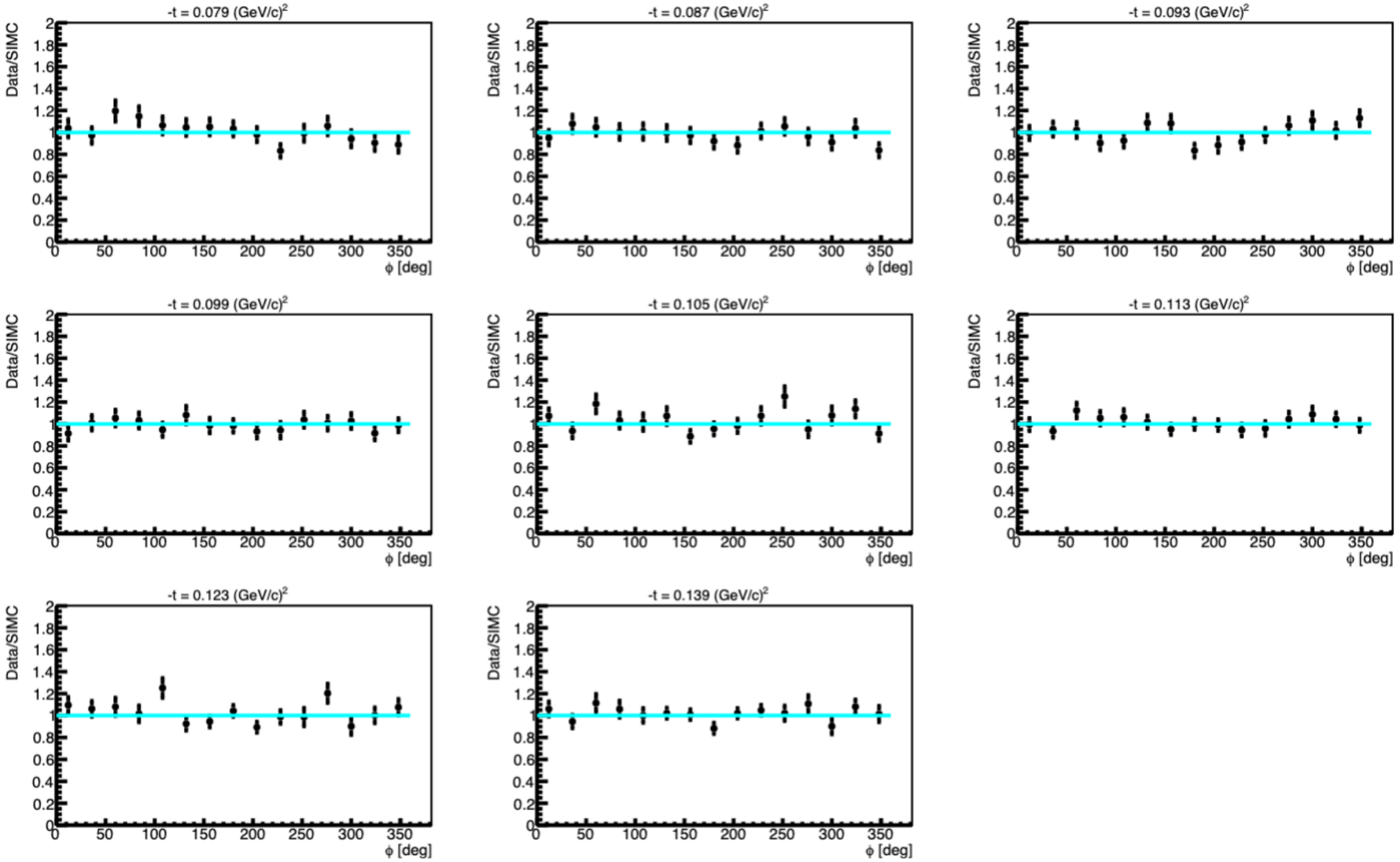




Data/SIMC Ratio

High ε

$p(e, e'K^+)\Lambda$



Data vs SIMC Kinematic

Centre Low ε

$p(e, e'K^+)\Lambda$

center_lowe

Λ^0(1116)

Beam Energy = 3.834 GeV

Q^2 = 0.499 GeV^2

P_{HMS} = 0.968 GeV/c

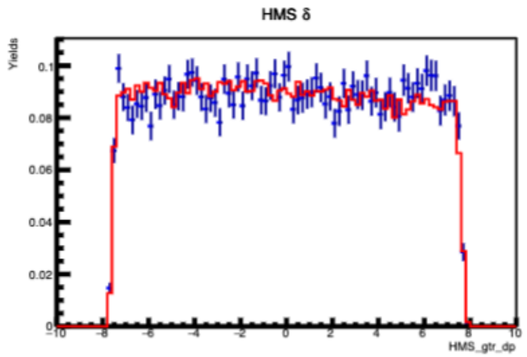
θ_{HMS} = 21.140°

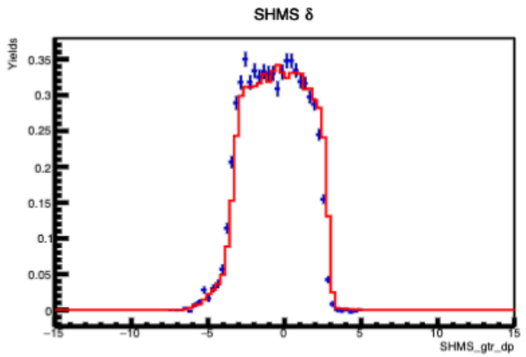
P_{SHMS} = 2.583 GeV/c

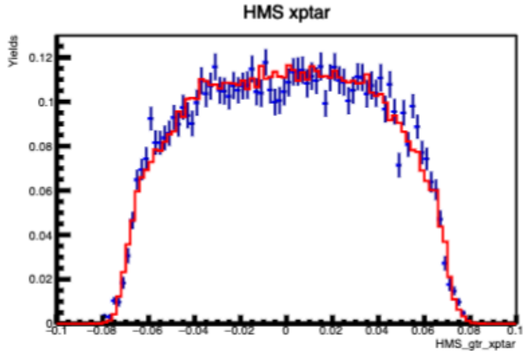
θ_{SHMS} = 6.790°

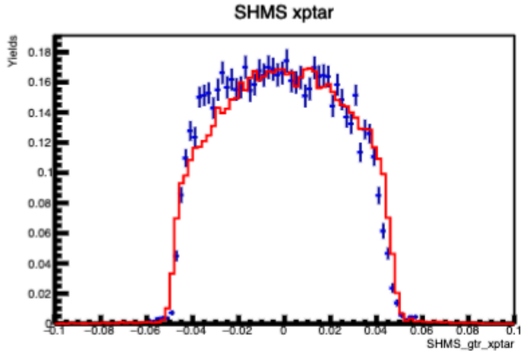
Red = SIMC

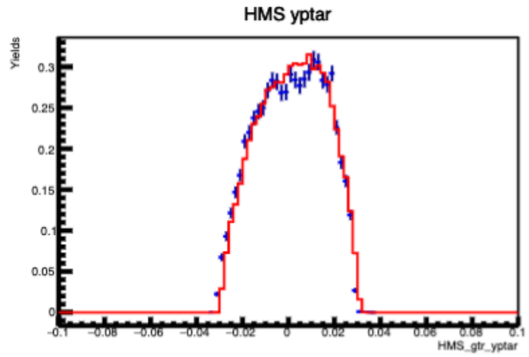
Blue = DATA

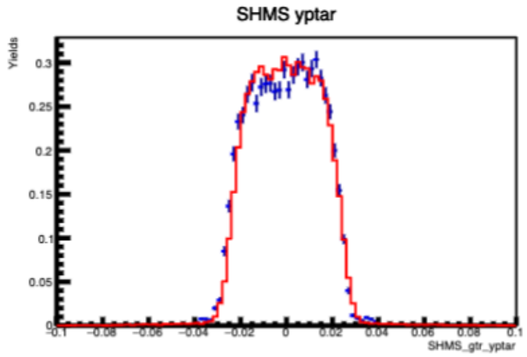


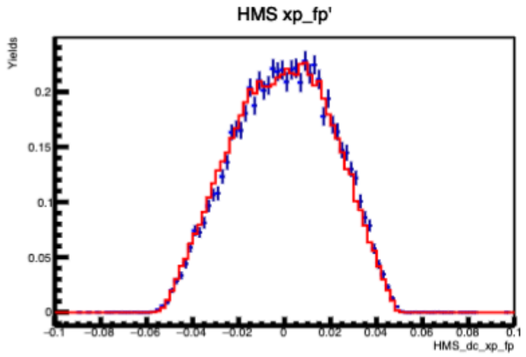








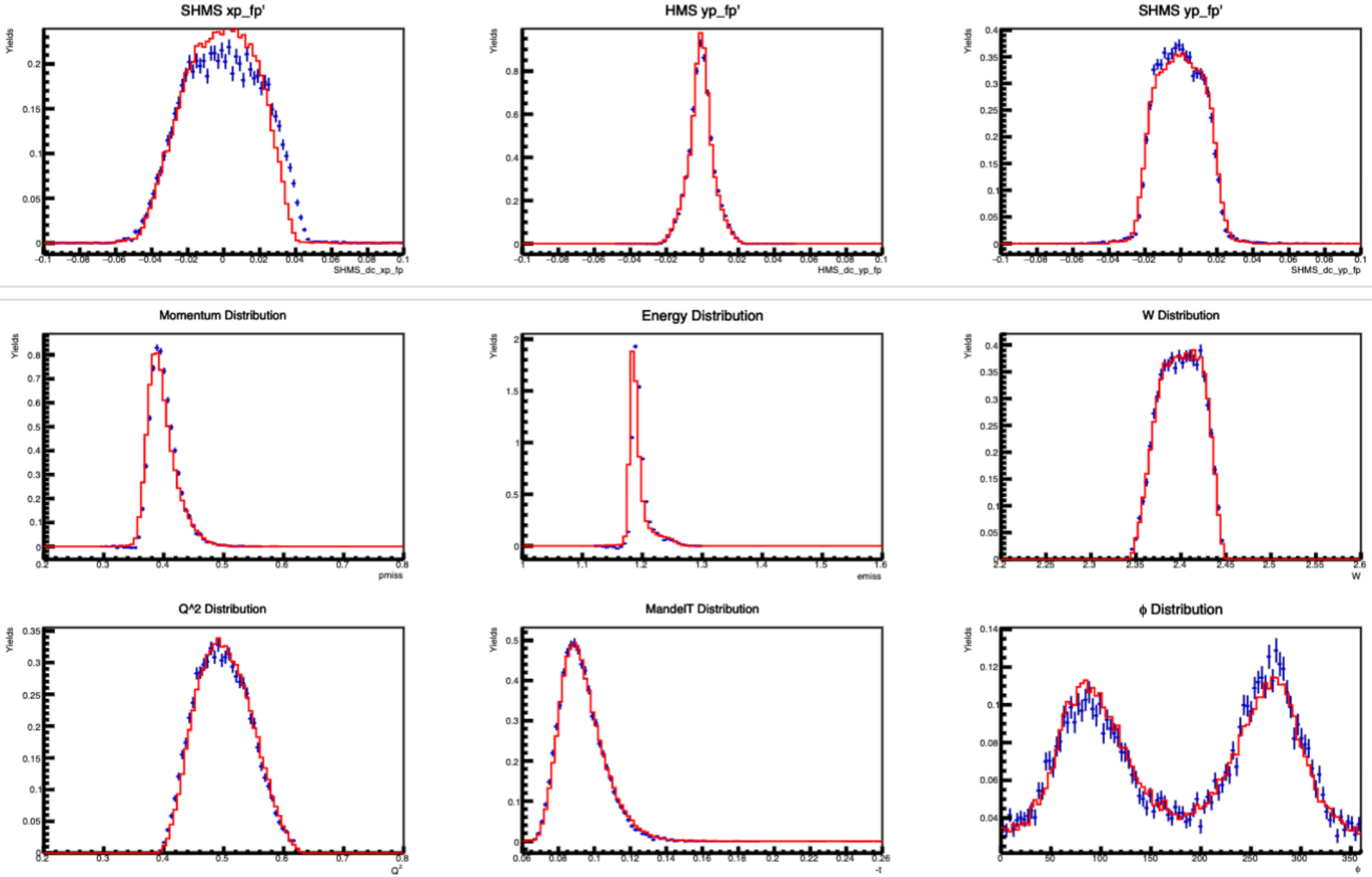




Data vs SIMC Kinematic

Centre Low ε

$p(e, e'K^+)\Lambda$



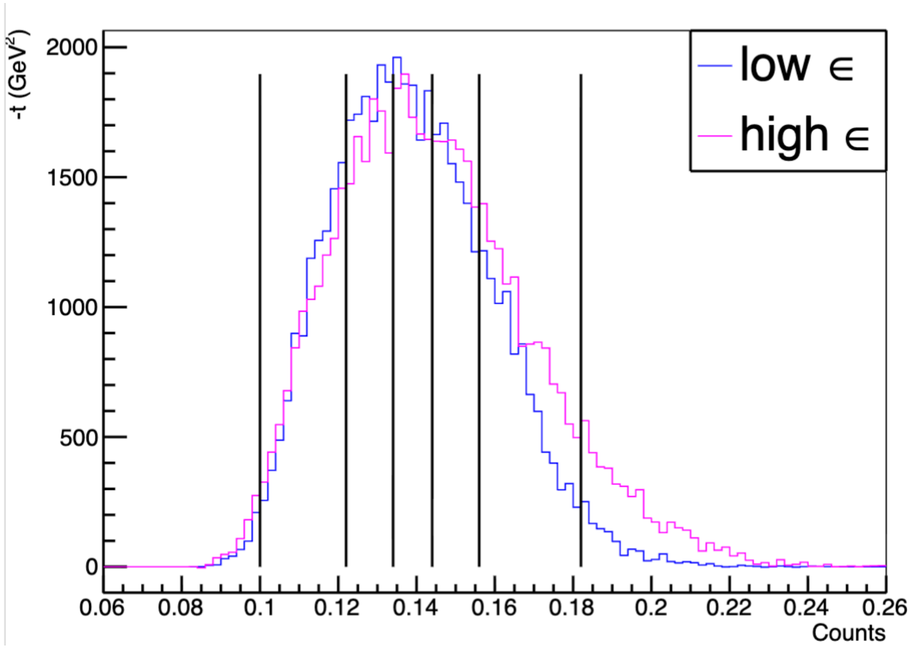
$$p(e, e'K^+)\Sigma^0$$

t-shift + new t-binning

t-shift + new t-binning

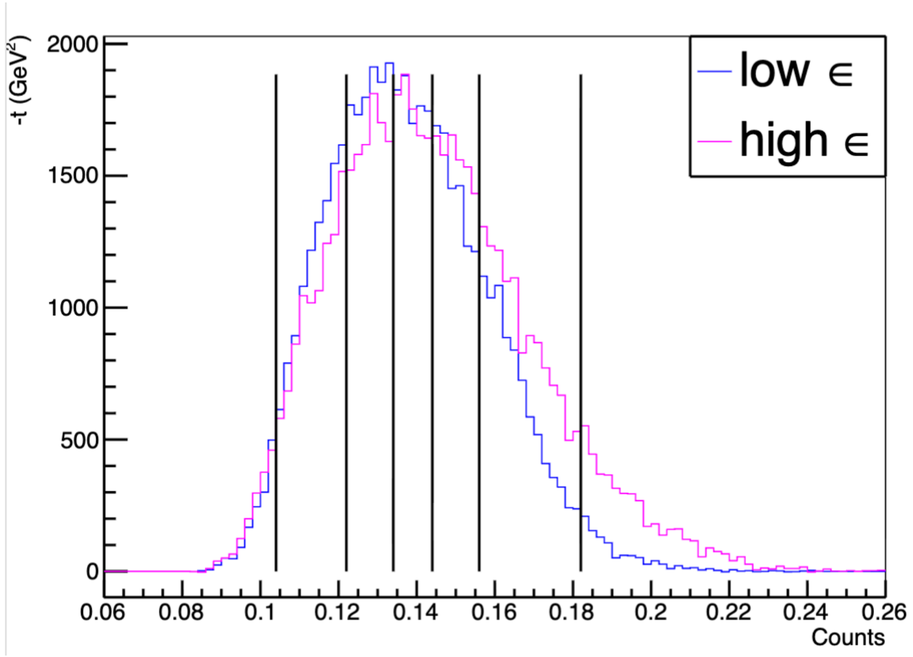
$p(e, e'K^+)\Lambda$

Before t-shift



t_min	t_max	t_center	Yield(lowe)	Error(lowe)	Yield(highe)	Error(highe)
0.1	0.122	0.111	10290.167	155.837	9851.833	153.448
0.122	0.134	0.128	10786.167	171.199	9840.0	162.016
0.134	0.144	0.139	9150.167	164.976	8781.833	157.962
0.144	0.156	0.15	9017.667	169.61	9473.167	168.519
0.156	0.182	0.169	9026.833	177.523	11915.333	198.363

After t-shift + new t-bins



t_min	t_max	t_center	Yield(lowe)	Error(lowe)	Yield(highe)	Error(highe)
0.104	0.122	0.113	10488.0	158.203	9290.5	149.49
0.122	0.134	0.128	10991.5	173.647	9863.5	162.507
0.134	0.144	0.139	8913.833	164.117	8739.167	157.744
0.144	0.156	0.15	8711.333	167.187	9410.833	167.988
0.156	0.182	0.169	8358.0	171.359	11733.167	197.145

L, T, LT, TT Models

$p(e, e'K^+)\Sigma^0$

$$\frac{d\sigma_L}{dt} = \frac{p_0 |t|}{(|t| + m_k^2)^2} e^{-p_1|t|}$$

$$\frac{d\sigma_T}{dt} = p_2 e^{-|p_3 t|}$$

$$\frac{d\sigma_{LT}}{dt} = p_4 e^{-p_5|t|} sin(\theta)$$

$$\frac{d\sigma_{TT}}{dt} = p_6 e^{-p_7|t|} sin^2(\theta)$$

$$w_{factor} = \frac{1}{(W^2 - m_p^2)^2}$$

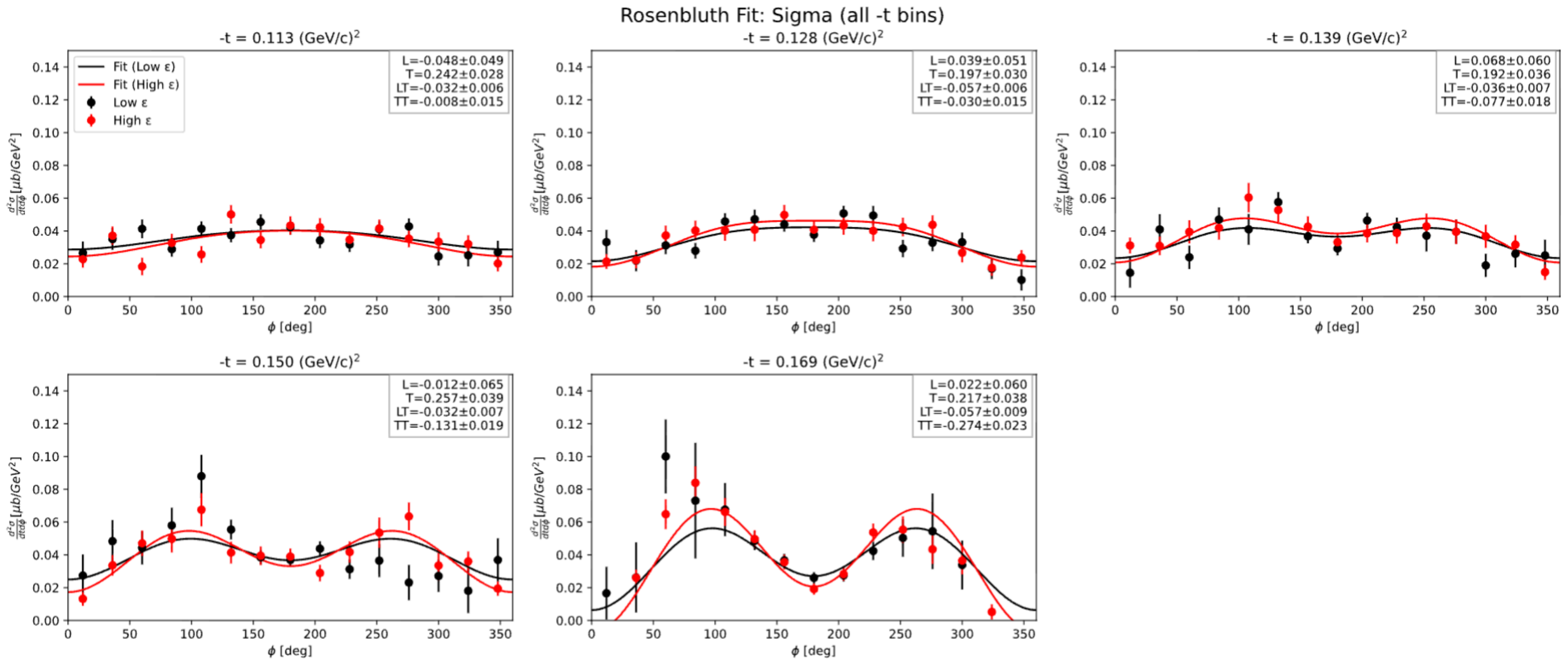
Negligible variation in the fit parameters

```
--- iteration 01 parameters ------- iteration 02 parameters ---
0.011      0.110  1            |   0.011      0.110  1
-24.074     63.543  2           |   -24.069     63.536  2
6.212      3.152  3             |   6.212      3.152  3
-1.234      3.727  4            |   -1.234      3.727  4
-54.418     35.436  5           |   -54.417     35.433  5
15.186      4.697  6            |   15.186      4.697  6
-4.421      4.003  7            |   -4.421      3.931  7
-19.341      5.591  8           |   -19.342      5.496  8
```

$$2\pi \frac{d^2\sigma}{dtd\phi} = \epsilon \frac{d\sigma_L}{dt} + \frac{d\sigma_T}{dt} + \sqrt{2\epsilon(\epsilon+1)} \frac{d\sigma_{LT}}{dt} cos\phi + \epsilon \frac{d\sigma_{TT}}{dt} cos2\phi$$

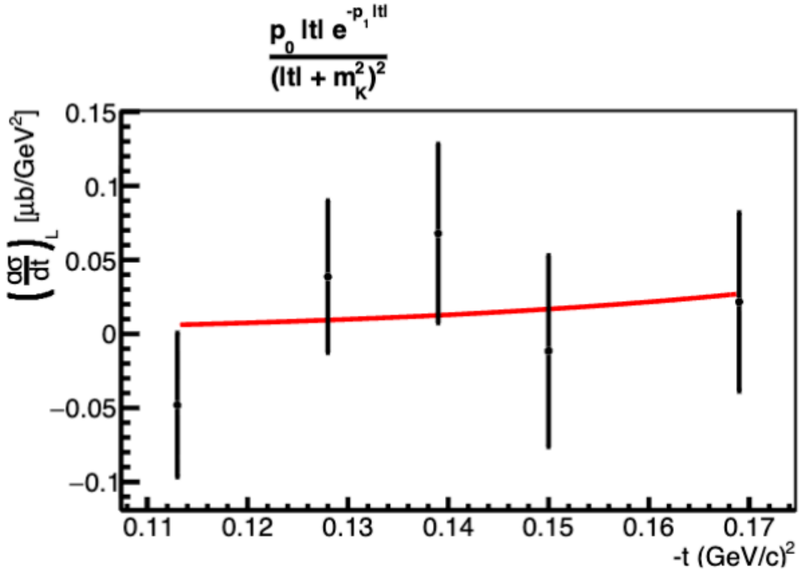
Low & High ε Simultaneous Fit (Rosenbluth)

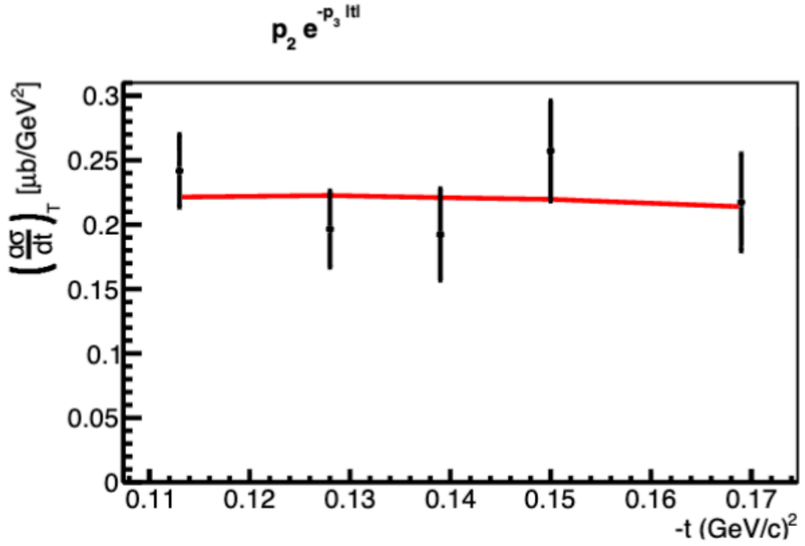
$p(e, e'K^+)\Sigma^0$

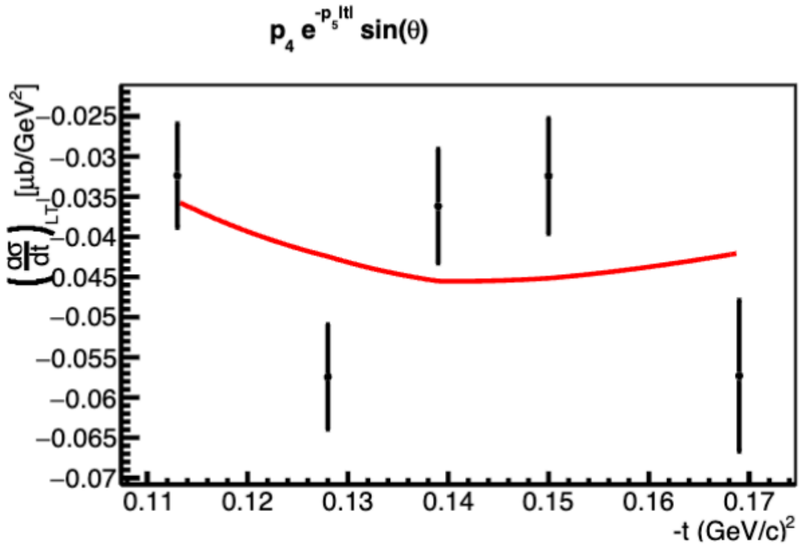


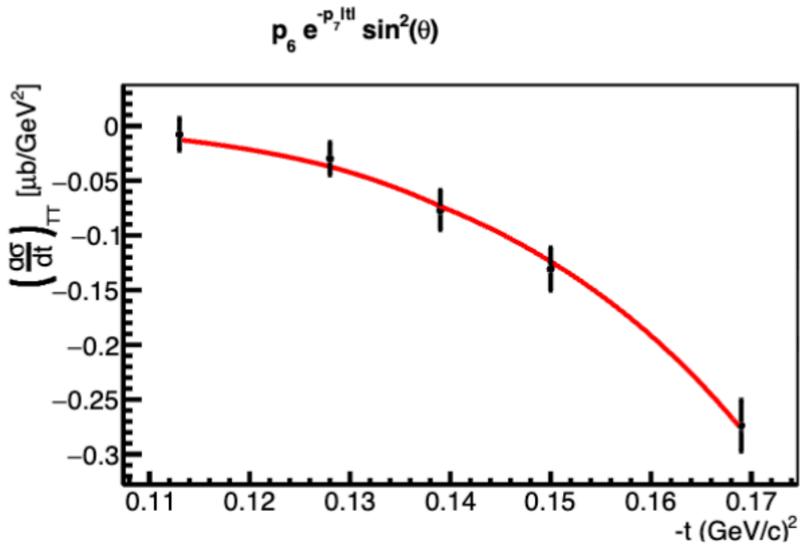
L, T, LT, TT Cross Sections

$p(e, e'K^+)\Sigma^0$





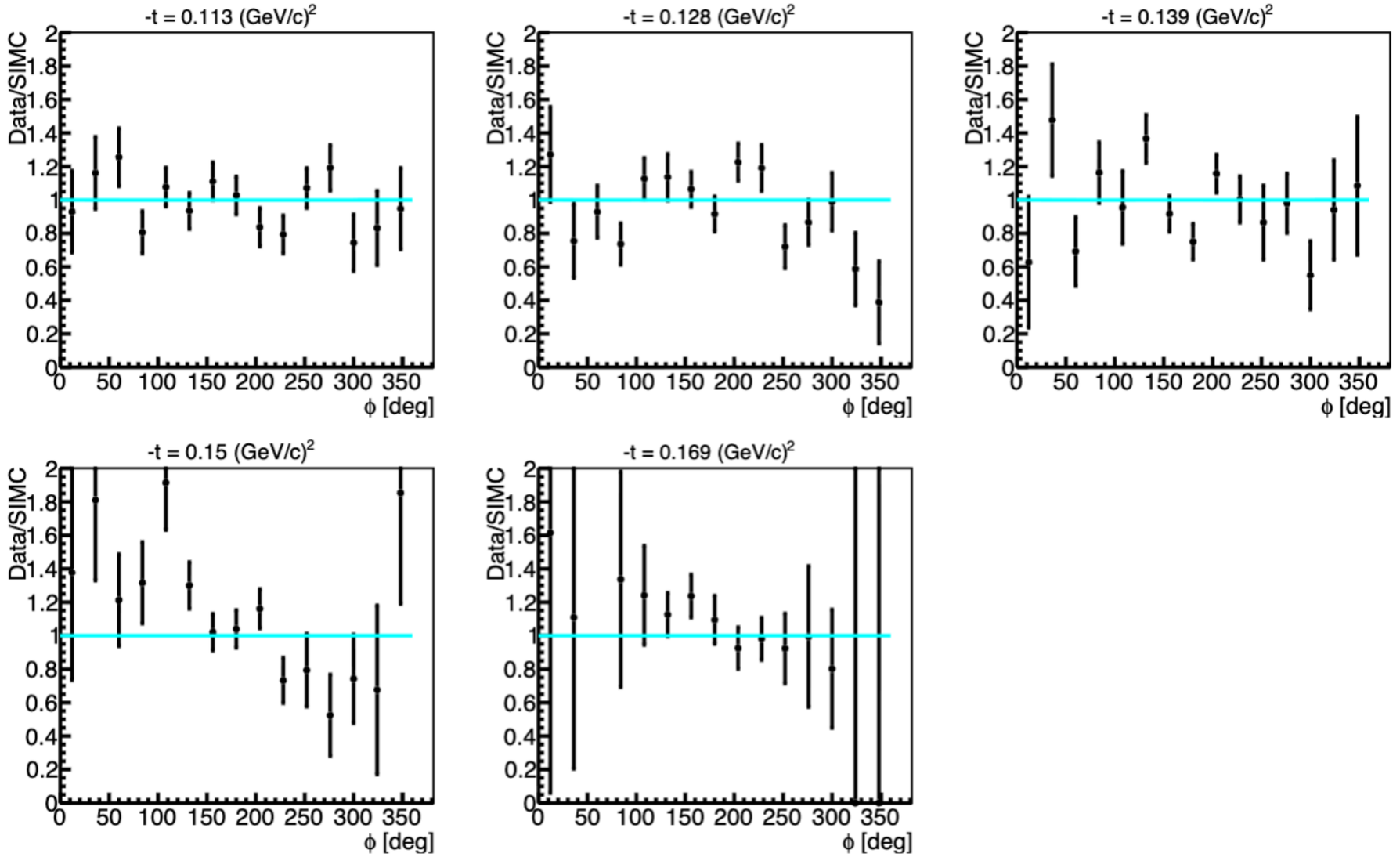




Data/SIMC Ratio

Low ε

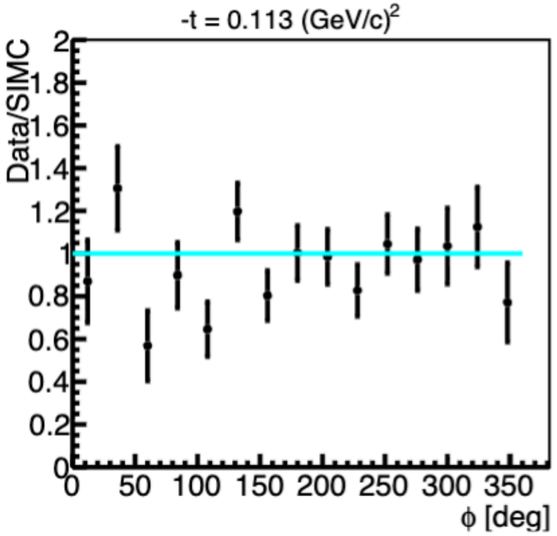
$p(e, e'K^+)\Sigma^0$

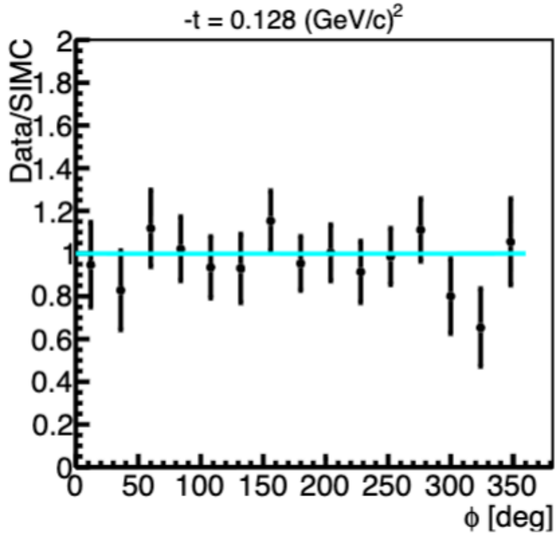


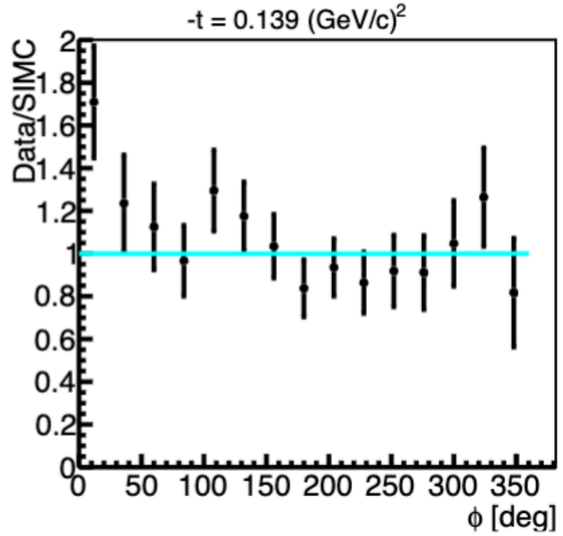
Data/SIMC Ratio

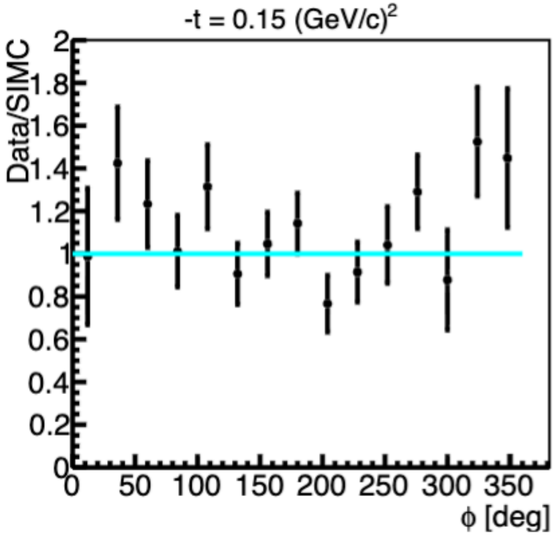
High ε

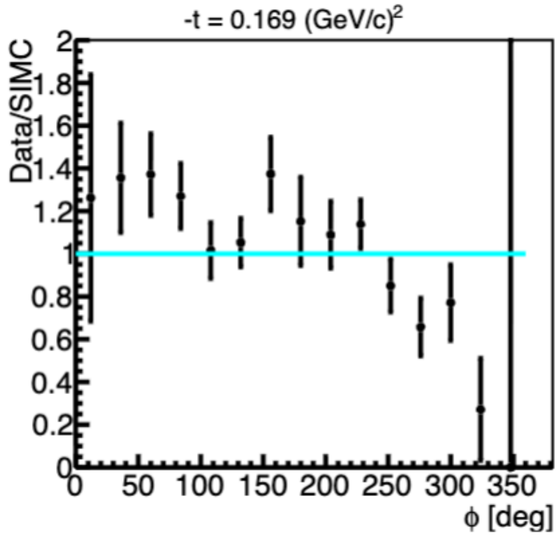
$p(e, e'K^+)\Sigma^0$











Data vs SIMC Kinematic

Centre Low ε

$p(e, e'K^+)\Sigma^0$

center_lowe

Σ^0(1193)

Beam Energy = 3.834 GeV

Q^2 = 0.500 GeV^2

P_{HMS} = 0.968 GeV/c

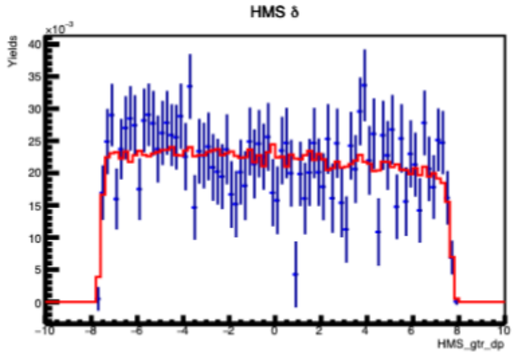
θ_{HMS} = 21.140°

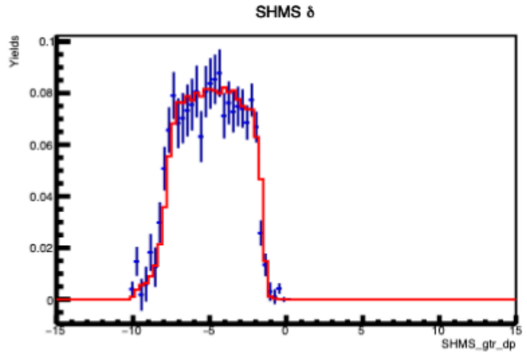
P_{SHMS} = 2.583 GeV/c

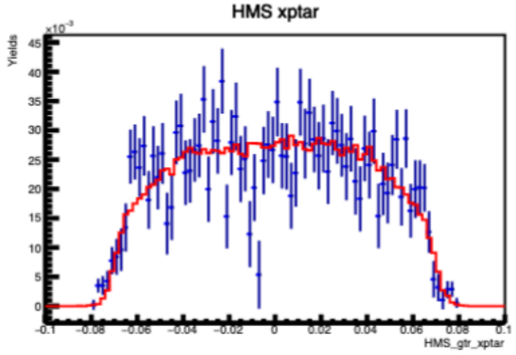
θ_{SHMS} = 6.790°

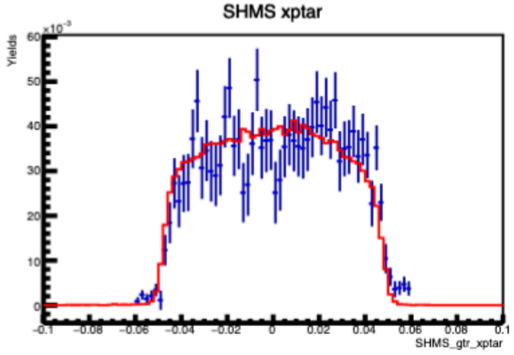
Red = SIMC

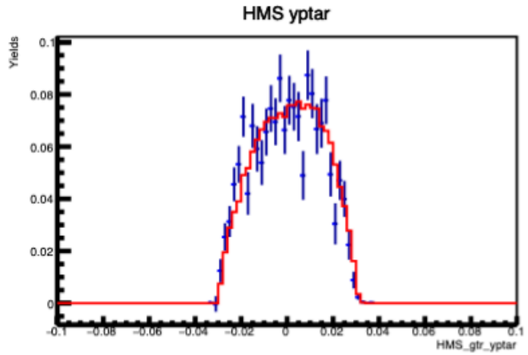
Blue = DATA

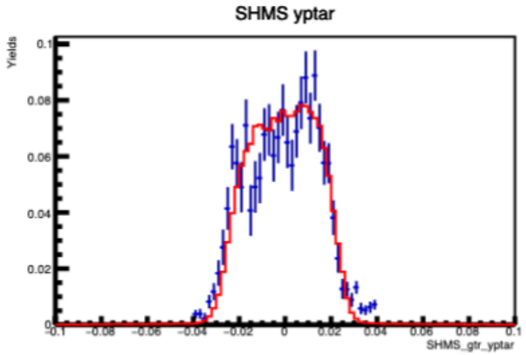


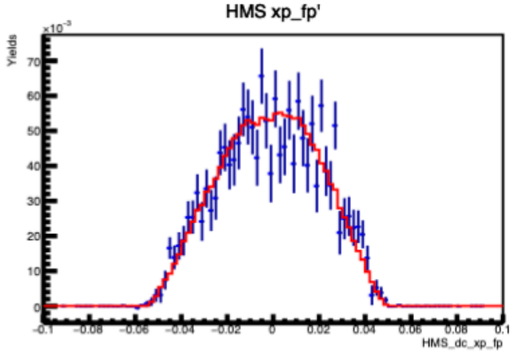












Data vs SIMC Kinematic

Centre Low ε

$p(e, e'K^+)\Sigma^0$