KaonLT Meeting

October 3rd, 2025

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The Fit-Finder Algorithm for L/T Separation Analysis

Abstract Keywords L/T separation · fitting algorithm · simulated annealing · cross-section analysis

1 Introduction

2 Physics Motivation and L/T Separation Background

* Add section explaining complexity of space and why this algorithm is needed vs previous methods.

3 The Fit-Finder Algorithm

In L/T (longitudinal/transverse) separation analyses, one must determine several independent cross-section components (σ_L, σ_T, σ_{LT}, σ_{TT}) from experimental data. The *Fit-Finder* algorithm is a procedure to fit parametric models for these components to measured data, optimising the parameters such that the model curves reproduce the data across the momentum transfer (t) spectrum. The algorithm combines conventional χ^2 minimisation with simulated annealing and other global optimisation techniques to robustly navigate a high-dimensional parameter space.

- Looking at different datasets for a validation of this algorithm
  - Testing performance vs traditional methods
  - Fpi-1 & 2 (pion/kaon), KaonLT (pion/kaon), etc.

Fpi-2 Fits

$$\sigma_L = \frac{p_1 Q^2}{\left(1 + p_2 Q^2 + 0.05 Q^4\right)^2} \exp\Big[\left(p_3 - p_4 \ln Q^2\right)(-|t|)\Big] ,$$

$$\sigma_T = \frac{p_5}{Q^2} + \frac{p_6}{Q^4} ,$$

$$\sigma_{LT} = \left(\exp\left[p_9 + \frac{p_{10}}{\sqrt{Q^2}}(-|t|)\right] + p_{11} - \frac{p_{12}}{Q^4}\right)\sin\theta_{\rm cm} ,$$

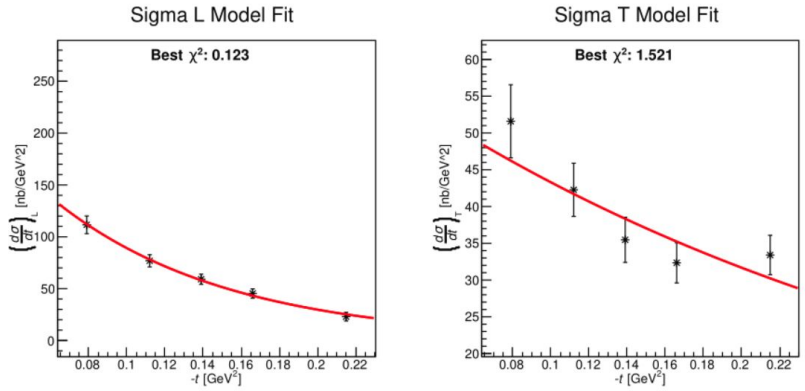
$$\sigma_{TT} = \frac{p_{13}}{Q^4}\left(\frac{-|t|}{\left(-|t| + m_\pi^2\right)^2}\right)\sin^2\theta_{\rm cm} ,$$

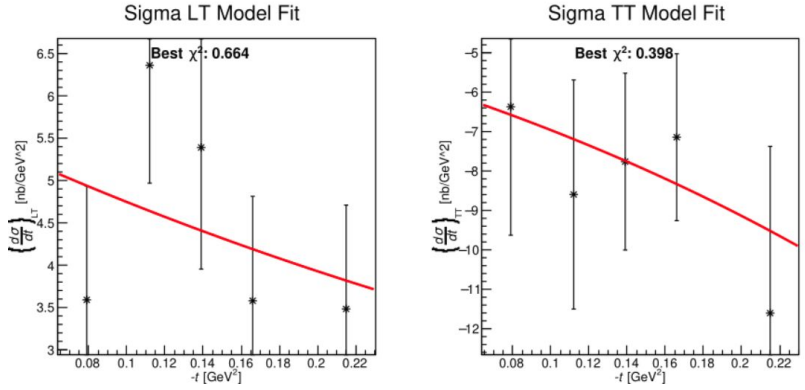
$$w_{\rm factor} = \frac{1}{\left(W^2 - m_{\rm tar}^2\right)^2} ,$$

3.50000e+02	1
1.77000e+00	2
1.60000e+01	3
7.50000e+00	4
4.50000e+00	5
2.00000e+00	6
0.00000e+00	7
0.00000e+00	8
7.90000e-01	9
3.40000e+00	10
1.10000e+00	11
3.60000e+00	12
-5.00000e+00	13
0.00000e+00	14
0.00000e+00	15
0.00000e+00	16

Fpi-2 Fits from Fit-SA-Minuit (FitSAMin, FiSAMi)

Q^2=1.6, W=2.22

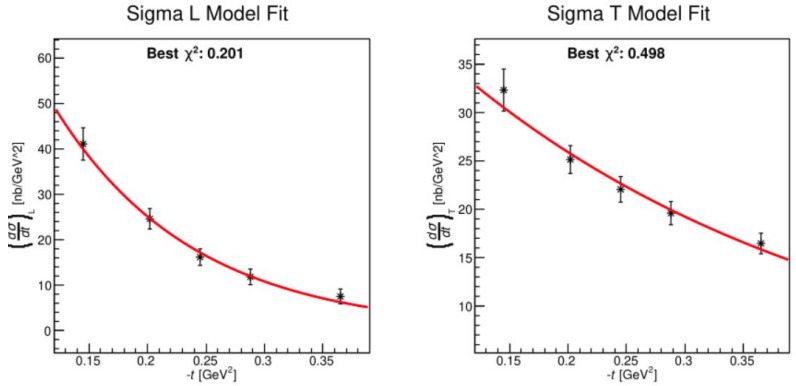


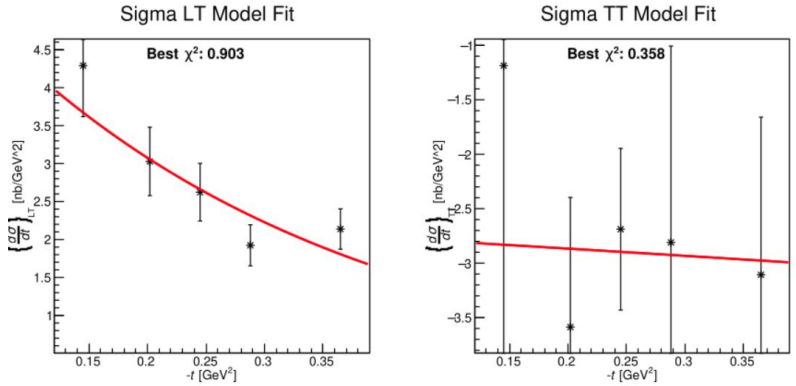


1.37071e-01	1
-7.57967e-01	2
1.81091e+00	3
-2.63329e+01	4
4.65396e+01	5
-3.17041e-02	6
0.00000e+00	7
0.00000e+00	8
8.26808e-02	9
-8.77926e-01	10
9.45717e-01	11
-2.71873e+00	12
-1.09191e+03	13
0.00000e+00	14
0.00000e+00	15
0.00000e+00	16

Fpi-2 Fits from Fit-SA-Minuit (FitSAMin, FiSAMi)

Q^2=2.45, W=2.22





2.17587e-01	1
-5.35344e-01	2
4.22219e+00	3
-5.30895e+00	4
1.56879e-03	5
-5.58336e-01	6
0.00000e+00	7
0.00000e+00	8
2.98436e-03	9
-5.47055e-01	10
1.61240e+00	11
-2.02712e+00	12
-8.68275e-06	13
0.00000e+00	14
0.00000e+00	15
0.00000e+00	16

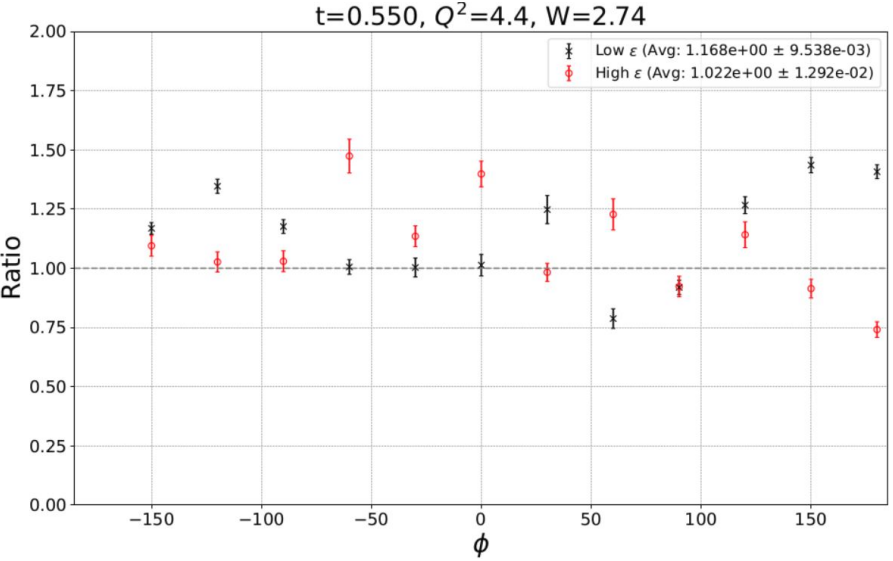
CSV formatted information

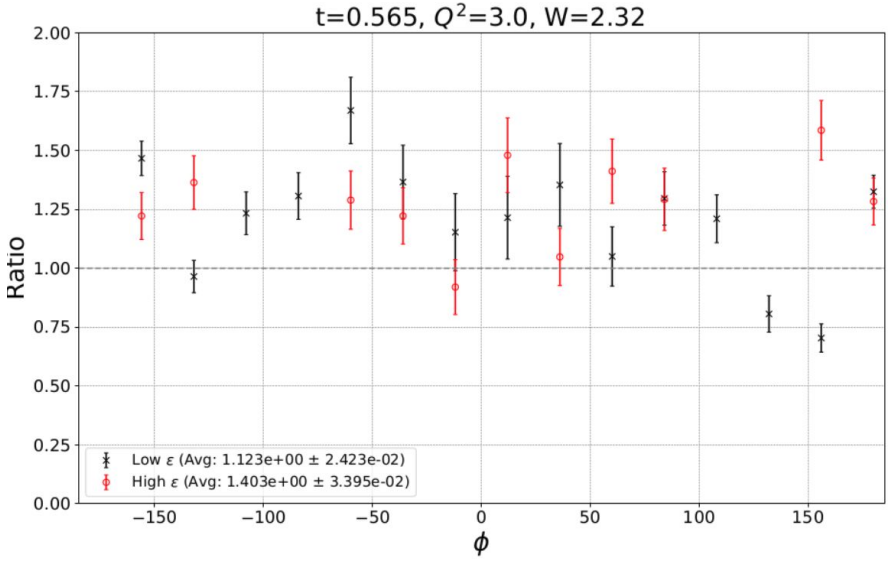
If I could get a csv file with the following information from Nacer and Vijay…

Q2_token ,W_token ,Q2,dQ2,W,dW,t,dt,sigL,dsigL,sigT,dsigT,sigLT,dsigLT,sigTT,dsigTT,chi2,tbin
16,222,1.416,0.001416,2.274,0.002274,0.079,0.000079,6.06,0.464,2.802,0.27,0.195,0.073,-0.346,0.177,3,1
16,222,1.513,0.001513,2.242,0.002242,0.112,0.000112,4.47,0.342,2.459,0.21,0.37,0.081,-0.5,0.169,3,2
16,222,1.593,0.001593,2.213,0.002213,0.139,0.000139,3.661,0.303,2.198,0.19,0.334,0.089,-0.481,0.139,3,3
16,222,1.667,0.001667,2.187,0.002187,0.166,0.000166,2.975,0.294,2.124,0.18,0.235,0.081,-0.469,0.139,3,4
16,222,1.763,0.001763,2.153,0.002153,0.215,0.000215,1.63,0.292,2.369,0.19,0.247,0.087,-0.823,0.3,3,5

Next Steps for Analysis

- Reanalyze…
  - Q^2=3.0/W=2.32
  - Q^2=4.4/W=2.74
  - Q^2=5.5/W=3.02
- Refine model, last fit optimizations **(Mid-October)**
- Preliminary systematics study **(Start of November)**
- Final full replay and finalize systematics study **(Before Thanksgiving)**





EXTRA