Hall C L/T Seperation Analysis

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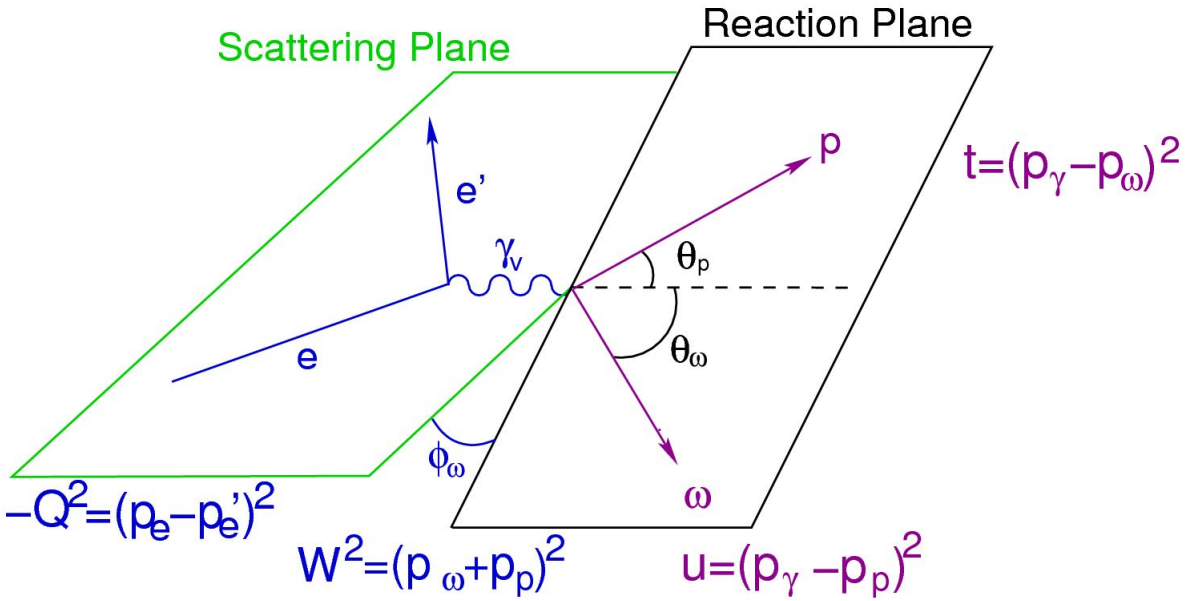
Rosenbluth（L/T）Separation



Virtual-photon polarization:

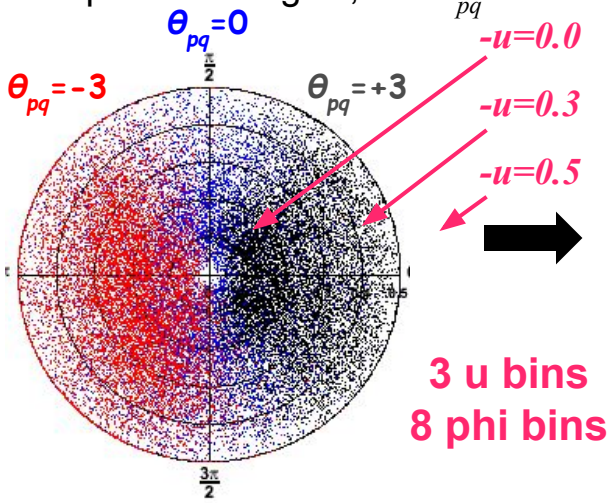
$$\varepsilon = \left(1 + 2\frac{(E_e - E_{e'})^2 + Q^2}{Q^2}\tan^2\frac{\theta_{e'}}{2}\right)^{-1}$$

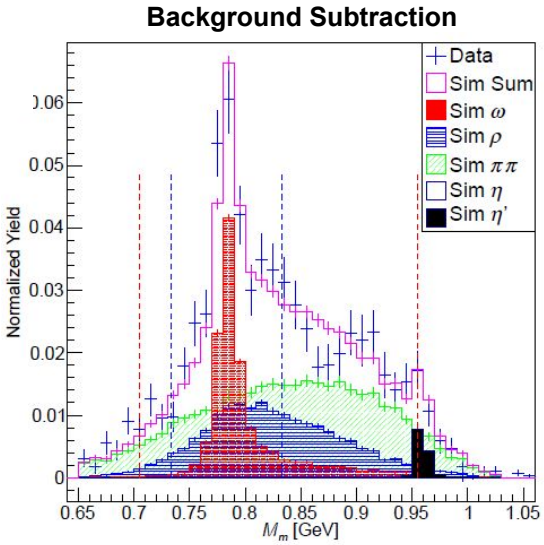
$$2\pi\frac{d\sigma}{dtd\phi} = \varepsilon\frac{d\sigma_L}{dt} + \frac{d\sigma_T}{dt} + \sqrt{2\varepsilon(\varepsilon+1)}\frac{d\sigma_{LT}}{dt}\cos\phi + \varepsilon\frac{d\sigma_{TT}}{dt}\cos 2\phi$$

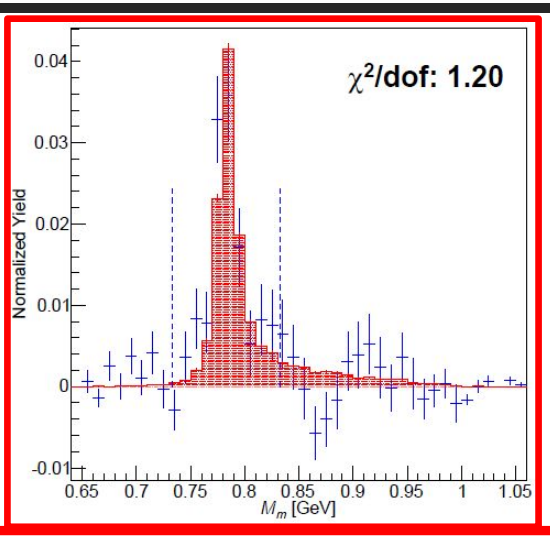
- Rosenbluth Separation requires
  - Separate measurements at different ε (virtual photon polarization)
  - All Lorentz invariant physics quantities: Q^2, W, t, u, remain constant
  - Beam energy, scattered e angle and virtual photon angle will change as the result, thus event rates are dramatically different

Iterative Procedure (Recipe) to A Full LT Separation

Improve φ coverage by taking data at multiple HMS angles, $-3^o<\theta_{pq}<+3^o$.





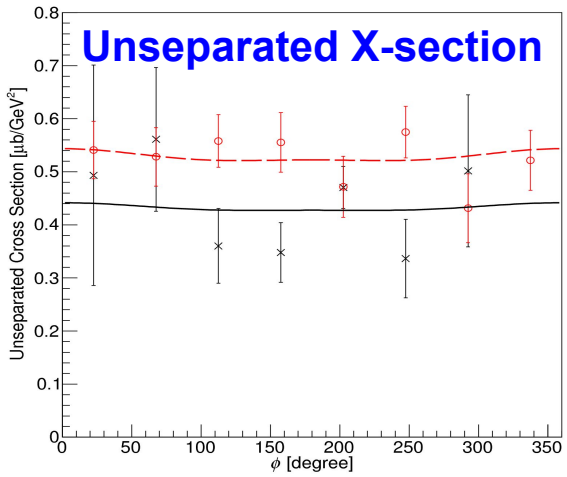


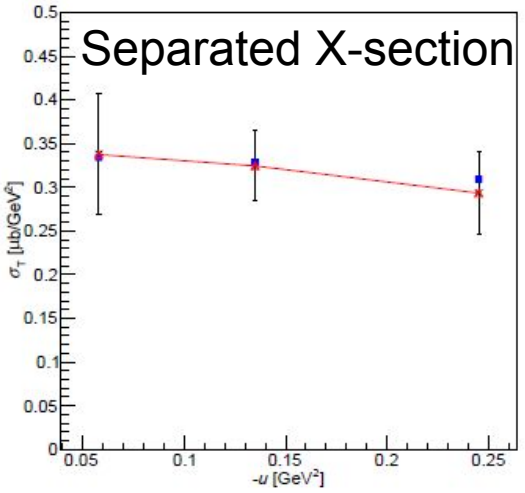
$$R = \frac{Y_{Exp} - Y_{\rho\ \mathrm{sim}} - Y_{Xspace\ \mathrm{sim}} - Y_{\eta\ \mathrm{sim}}}{Y_{\omega\ \mathrm{sim}}}$$

Combine ratios for settings together, propagating errors accordingly.

$$\frac{d^2\sigma}{dtd\varphi}_{EXP} = R\frac{d^2\sigma}{dtd\varphi}_{SIMC}$$

Empirical Model





Extract T, L, LT, TT via simultaneous fit

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

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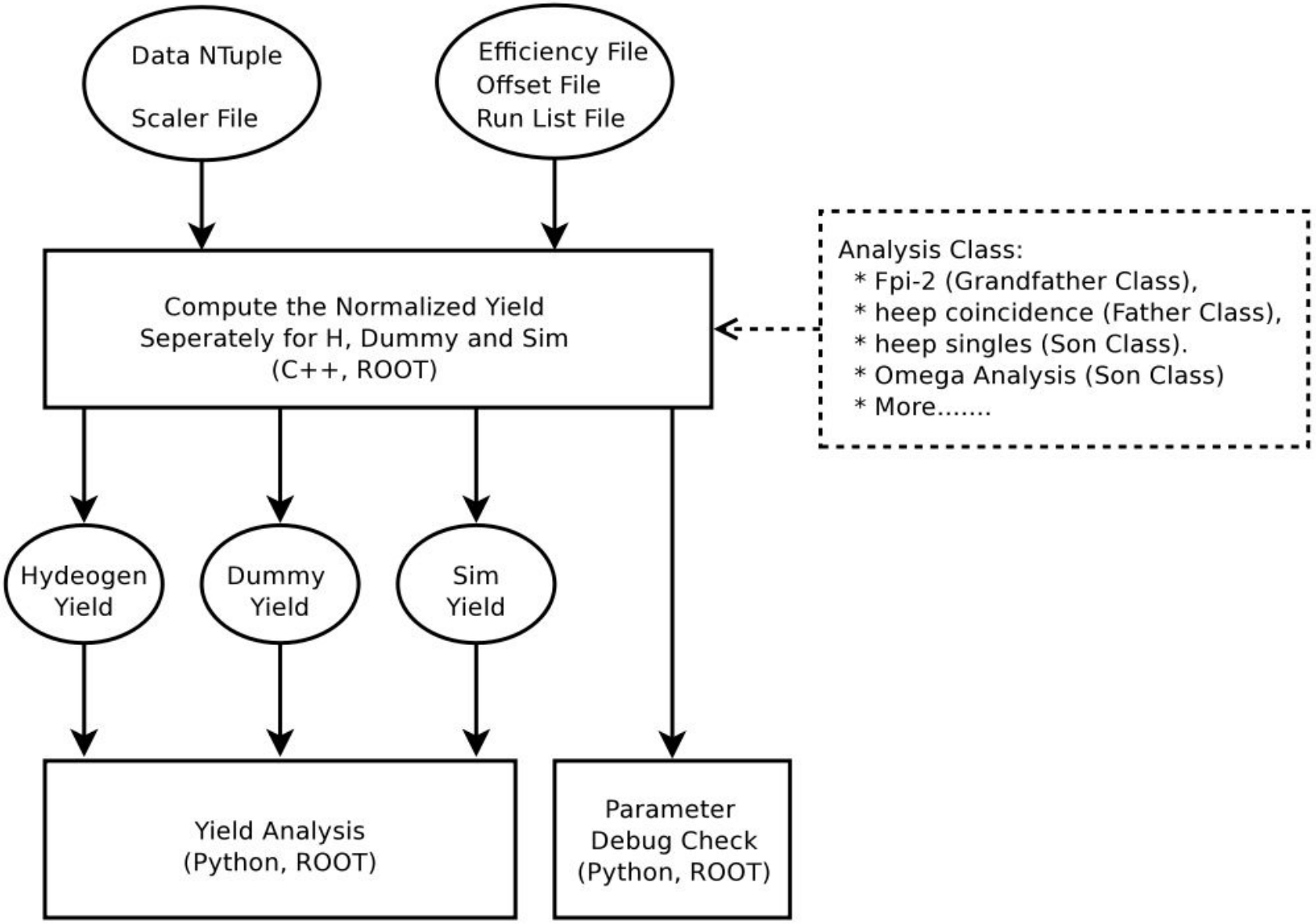
Overall flowchart

1. Efficiency (Run by run) [root, c++]
2. **Yield extraction (experiment and simulation) [root, c++]**
3. Combining plots (Root, python)
4. Background subtraction (subtracting sigma from Lambda events) [root, c++]
5. Summing the angle settings [root, c++]
6. Averaging the kinematics [Fortran]
7. Yield ratio [root, c++]
8. Generating SIM cross section [Fortran]
9. L/T seperation fitting [root, c++]
10. Suggested improved fitting/parameters [root, c++]

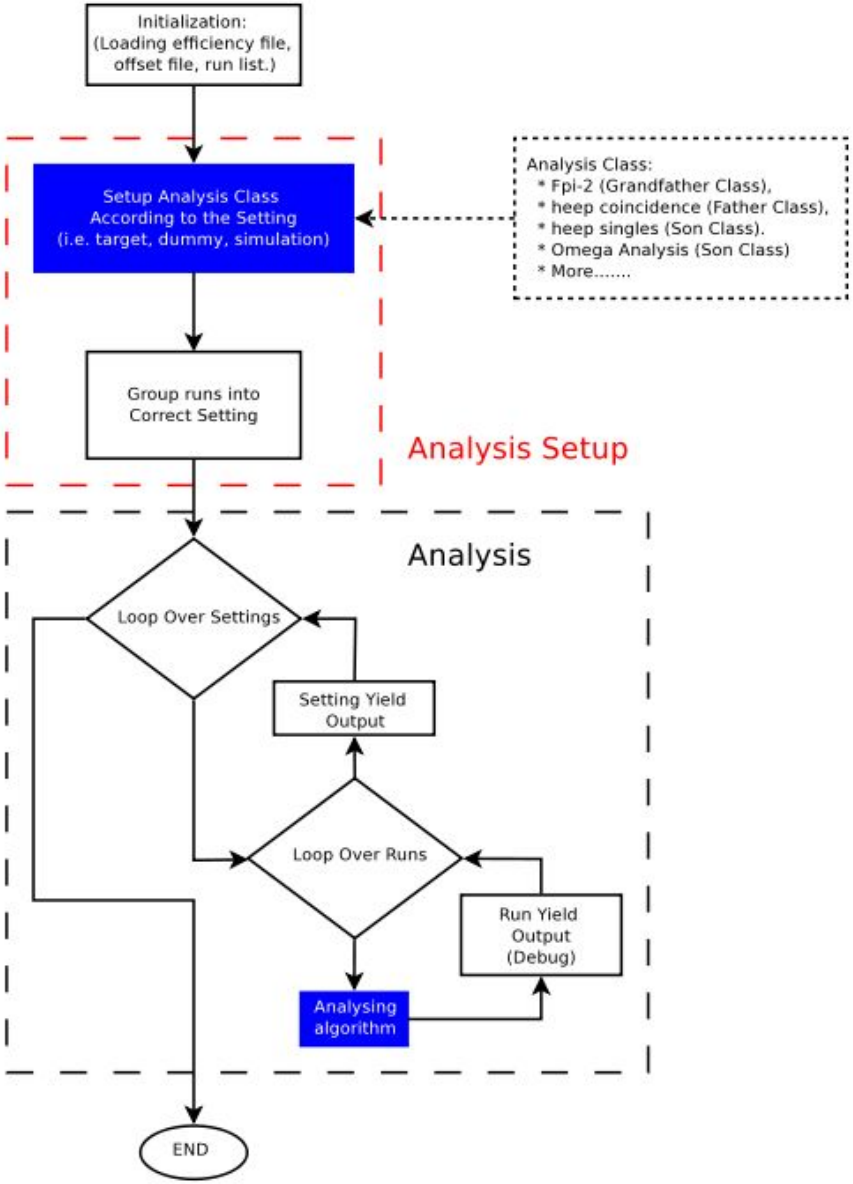
Kaon LT Kinematics Table

Q^2 (GeV^2)	x_B	ϵ	LH_2 hours	Dummy hours	Overhead (hours)	Total (hours)
0.40	0.072	0.411	94.1	6.4	4	104.5
0.40	0.072	0.692	62.1	4.3	4	70.4
Subtotal charge radius			156.2	10.7	8.0	174.9 (7.3 days)
1.25	0.122	0.477	13.6	1.0	4	18.6
1.25	0.122	0.696	10.6	0.7	4	15.3
2.00	0.182	0.396	44.2	3.0	4	51.2
2.00	0.182	0.584	24.7	1.7	4	30.4
2.00	0.182	0.751	24.5	1.7	4	30.2
3.00	0.250	0.393	77.2	5.4	4	86.6
3.00	0.250	0.689	54.0	3.8	4	61.8
Subtotal reaction mech.			248.8	17.3	28.0	294.1 (12.3 days)
1.70	0.249	0.587	20.4	1.4	4	25.8
1.70	0.249	0.858	11.9	1.0	4	16.9
3.50	0.250	0.357	46.4	0.4	4	50.8
3.50	0.250	0.555	38.8	0.3	4	43.1
Subtotal x_B=0.25			117.5	3.1	16.0	136.6 (5.7 days)
3.00	0.401	0.634	9.9	0.7	4	14.6
3.00	0.401	0.887	6.0	0.4	4	10.4
4.40	0.400	0.480	30.2	2.1	4	36.3
4.40	0.400	0.734	21.4	1.5	4	27.0
5.50	0.400	0.366	79.3	5.5	4	88.8
5.50	0.400	0.560	68.7	4.8	4	77.5
Subtotal x_B=0.40			215.5	15.0	24.0	254.5 (10.6 days)

Coding Coding Philosophy



Yield Analysis Code



Code

- Where the code is:
  https://github.com/billlee77/omega_analysis

- Thesis (Chap 4):
  - https://arxiv.org/pdf/1712.03214.pdf