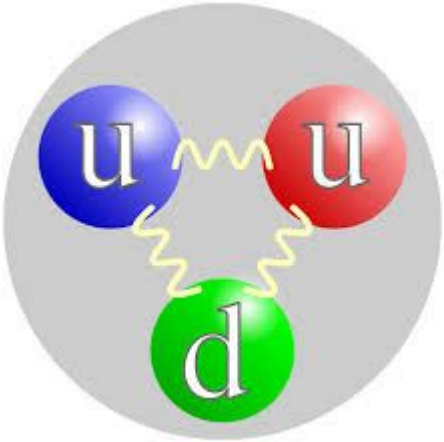
Lambda b polarization

Λ_b^0

- Particles similar to proton in structure with one u quark replaced with a beauty (b) quark (udb)
- B quarks come from Z decay
- Decays via weak force to lambda 0 (uds) and dilepton:

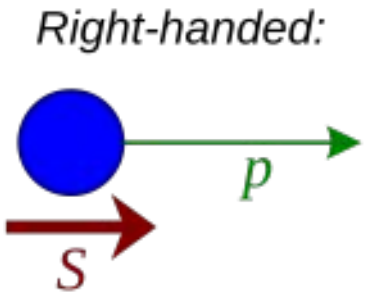
$$\Lambda_b^0 \rightarrow \Lambda^0 + \mu^+ \mu^-$$

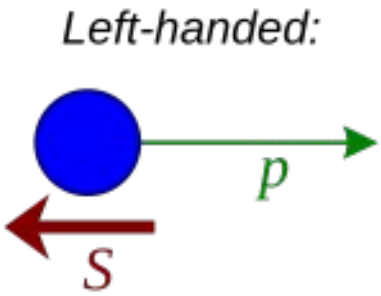
$$\Lambda^0 \rightarrow p^+ + \pi^-$$

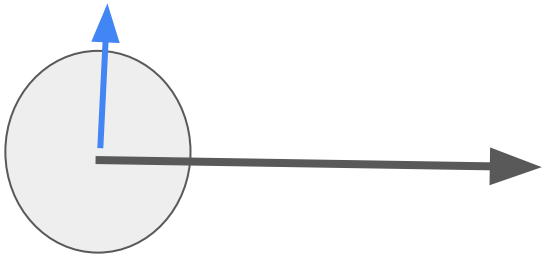


Proton structure

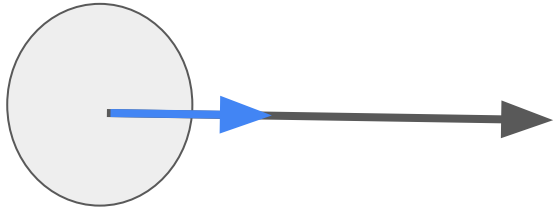
- Since this is a weak force interaction, the spin of the lambda b matters
- Helicity = component of spin in direction of momentum
- Polarization of Lb comes from polarization of Z boson







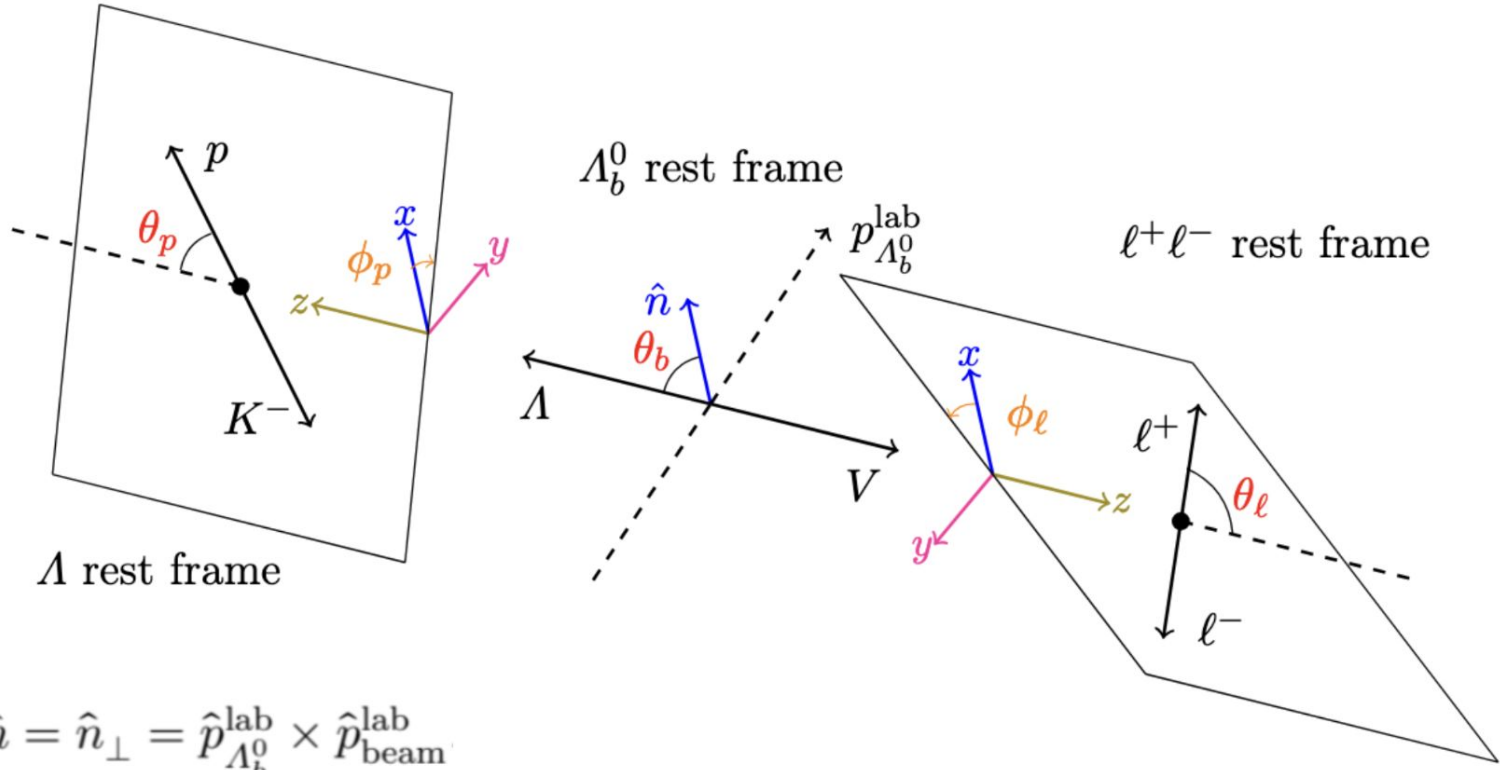
H = 0
(longitudinal)



H = 1
(transverse)

θ: angle between $\vec{p}$ and z-axis

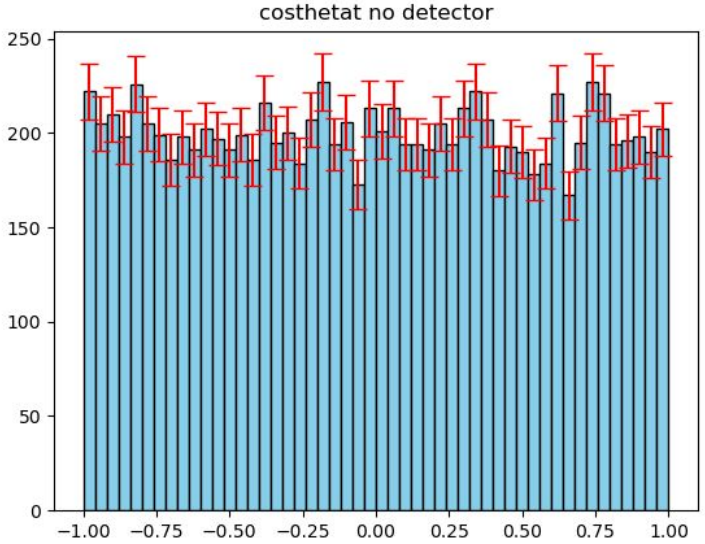
ϕ : polar angle

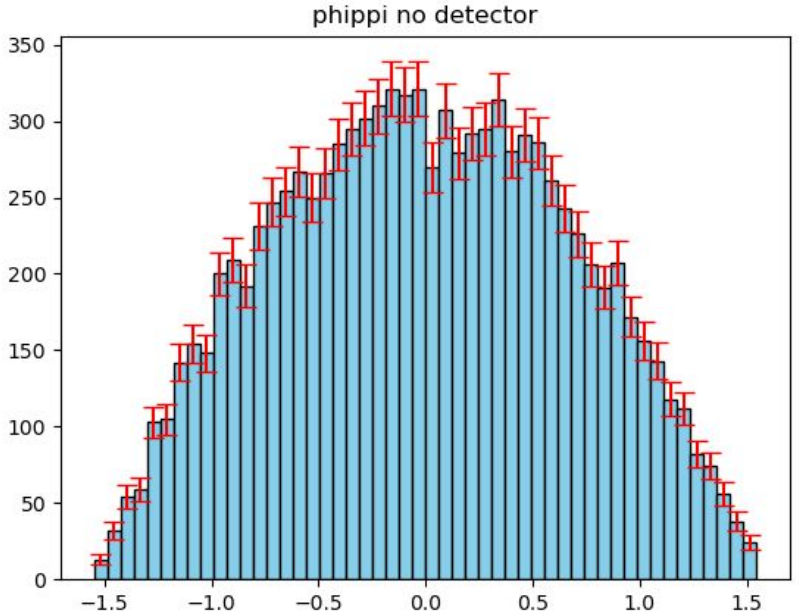


$$\hat{n} = \hat{n}_\perp = \hat{p}_{\Lambda_b^0}^{\rm lab} \times \hat{p}_{\rm beam}^{\rm lab}$$

$$\hat{n}_\parallel = \hat{p}_{\Lambda_b^0}^{\rm lab}$$

Example plots:



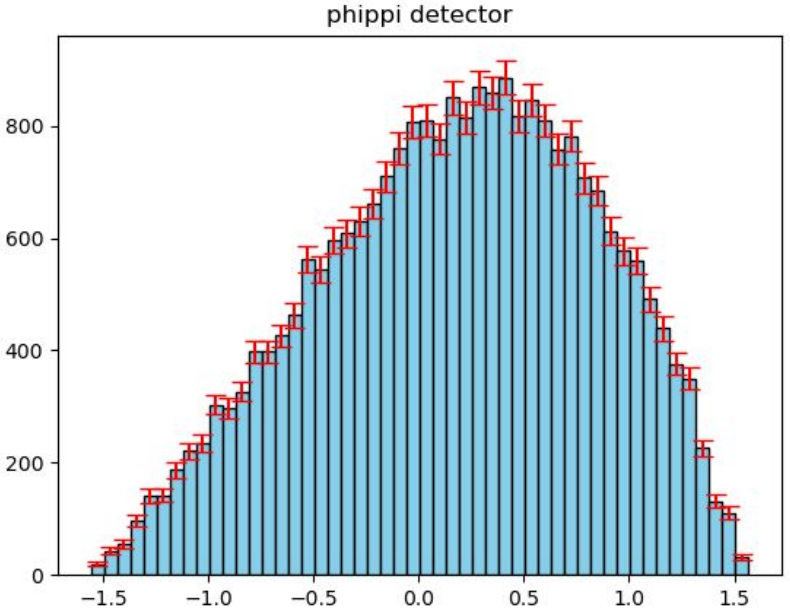


Detector effects

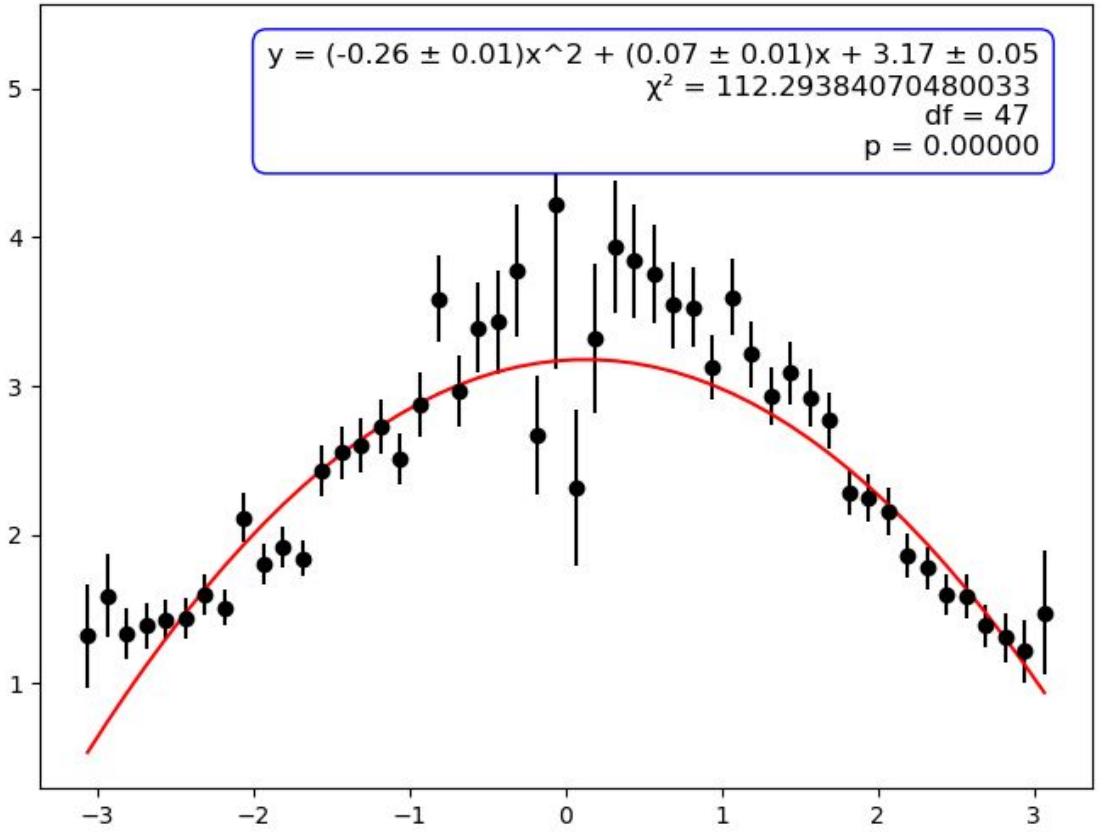
Need to fit the angles to a pdf:

$$\frac{\mathrm{d}^6\Gamma}{\mathrm{d}q^2\,\mathrm{d}\vec{\Omega}} = \frac{3}{32\pi^2}\Big(\sum_{i=0}^{34} K_i(q^2) f_i(\vec{\Omega})\Big)$$

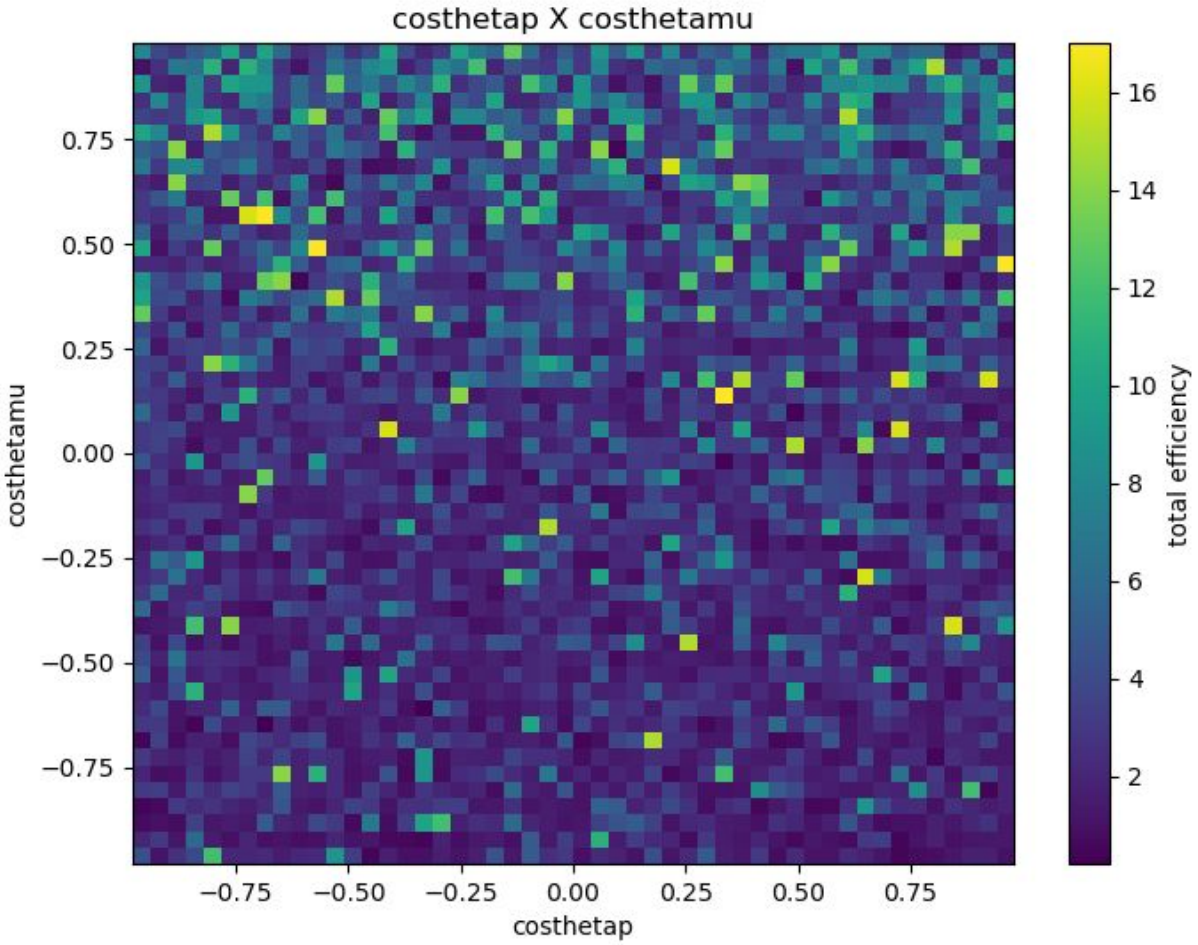
$$\begin{aligned}
\frac{\mathrm{d}^6\Gamma}{\mathrm{d}q^2\,\mathrm{d}\vec{\Omega}} = \frac{3}{32\pi^2}\Big(& \left(K_1 \sin^2\theta_l + K_2 \cos^2\theta_l + K_3 \cos\theta_l\right) + \\
& \left(K_4 \sin^2\theta_l + K_5 \cos^2\theta_l + K_6 \cos\theta_l\right) \cos\theta_b + \\
& \left(K_7 \sin\theta_l \cos\theta_l + K_8 \sin\theta_l\right) \sin\theta_b \cos\left(\phi_b + \phi_l\right) + \\
& \left(K_9 \sin\theta_l \cos\theta_l + K_{10} \sin\theta_l\right) \sin\theta_b \sin\left(\phi_b + \phi_l\right) + \\
& \left(K_{11} \sin^2\theta_l + K_{12} \cos^2\theta_l + K_{13} \cos\theta_l\right) \cos\theta + \\
& \left(K_{14} \sin^2\theta_l + K_{15} \cos^2\theta_l + K_{16} \cos\theta_l\right) \cos\theta_b \cos\theta + \\
& \left(K_{17} \sin\theta_l \cos\theta_l + K_{18} \sin\theta_l\right) \sin\theta_b \cos\left(\phi_b + \phi_l\right) \cos\theta + \\
& \left(K_{19} \sin\theta_l \cos\theta_l + K_{20} \sin\theta_l\right) \sin\theta_b \sin\left(\phi_b + \phi_l\right) \cos\theta + \\
& \left(K_{21} \cos\theta_l \sin\theta_l + K_{22} \sin\theta_l\right) \sin\phi_l \sin\theta + \\
& \left(K_{23} \cos\theta_l \sin\theta_l + K_{24} \sin\theta_l\right) \cos\phi_l \sin\theta + \\
& \left(K_{25} \cos\theta_l \sin\theta_l + K_{26} \sin\theta_l\right) \sin\phi_l \cos\theta_b \sin\theta + \\
& \left(K_{27} \cos\theta_l \sin\theta_l + K_{28} \sin\theta_l\right) \cos\phi_l \cos\theta_b \sin\theta + \\
& \left(K_{29} \cos^2\theta_l + K_{30} \sin^2\theta_l\right) \sin\theta_b \sin\phi_b \sin\theta + \\
& \left(K_{31} \cos^2\theta_l + K_{32} \sin^2\theta_l\right) \sin\theta_b \cos\phi_b \sin\theta + \\
& \left(K_{33} \sin^2\theta_l\right) \sin\theta_b \cos\left(2\phi_l + \phi_b\right) \sin\theta + \\
& \left(K_{34} \sin^2\theta_l\right) \sin\theta_b \sin\left(2\phi_l + \phi_b\right) \sin\theta\Big) \ .
\end{aligned}$$



Efficiencies



2D plots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0.00
0.25
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0.75
costhetap
total efficiency
16
14
12
10
8
6
4
2