Exploring Spin Effects in Lambda B Production and Decay

$p+p \rightarrow \Lambda_b + X \rightarrow J/\Psi(\mu\mu) + \Lambda_0(\pi p)$

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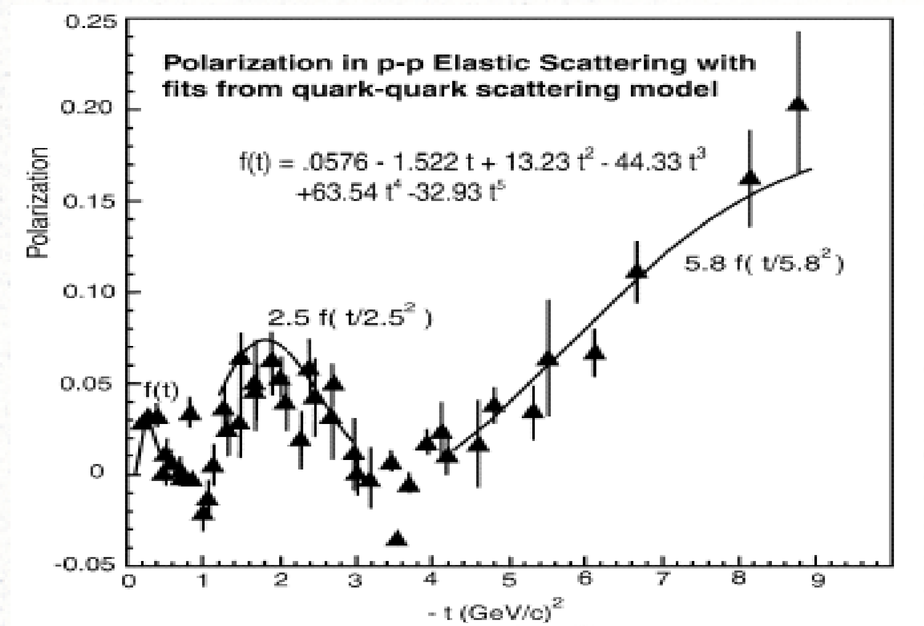
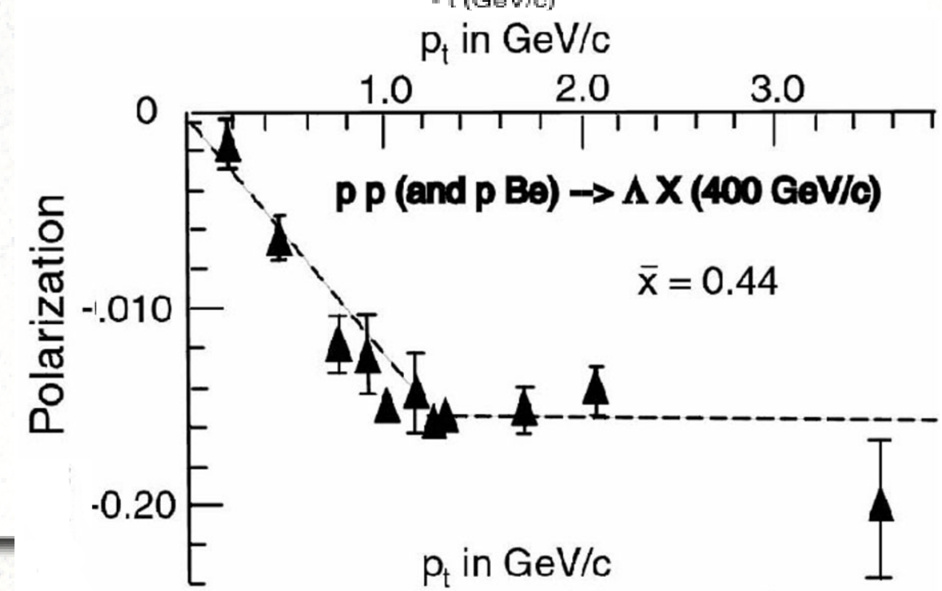
Polarized Surprises

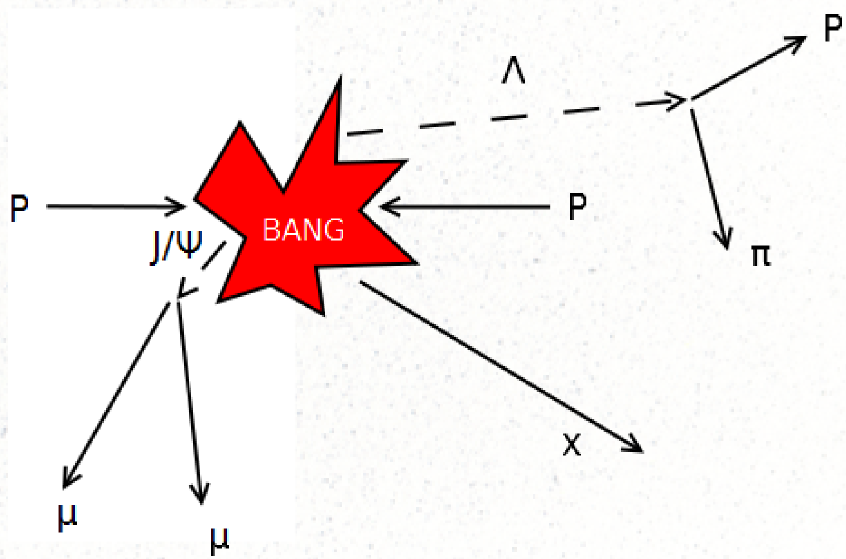
- Physicists expected spin effects to play no role at higher energy
- Big surprises came when looking
  - Proton Proton Scattering
  - Λ_0 decay



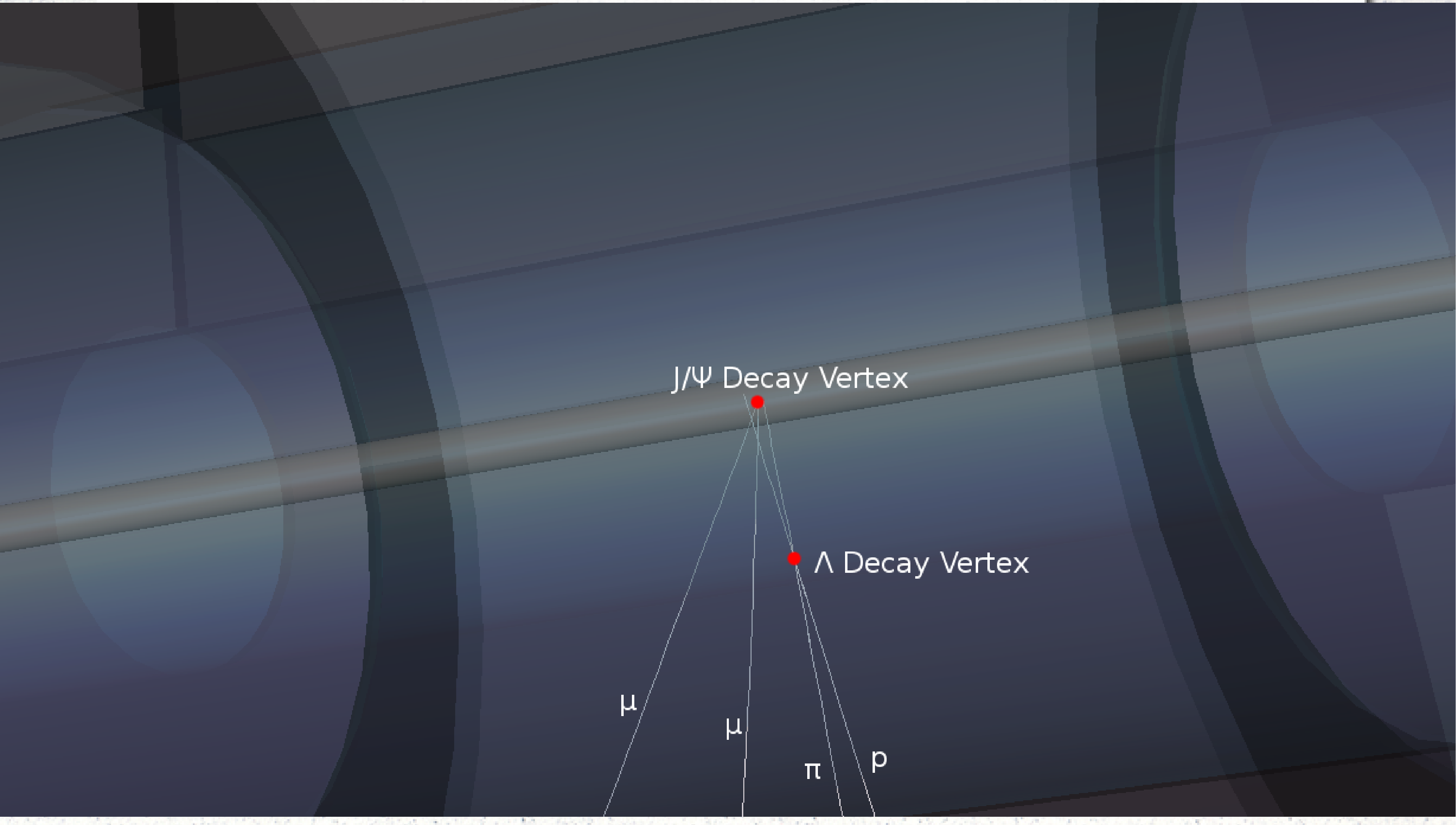


Why Study Λ_b?

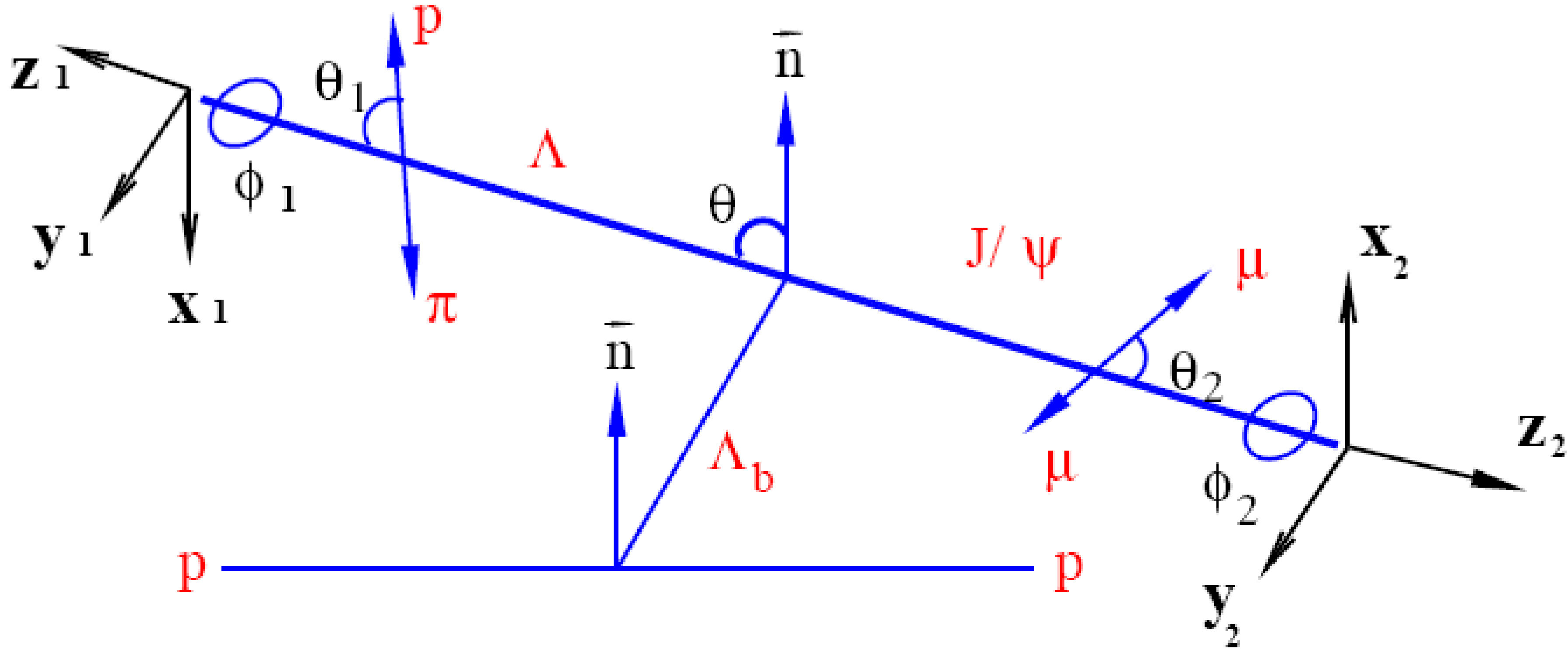
- To study particle production mechanisms through spin effects
- To test model predictions of parity violation
- To test dependence of polarization on quark mass
- To look for heavy quark Compositeness



Simulated Λ_b Decay (VP1)



Λ_b Decay Angles Convention



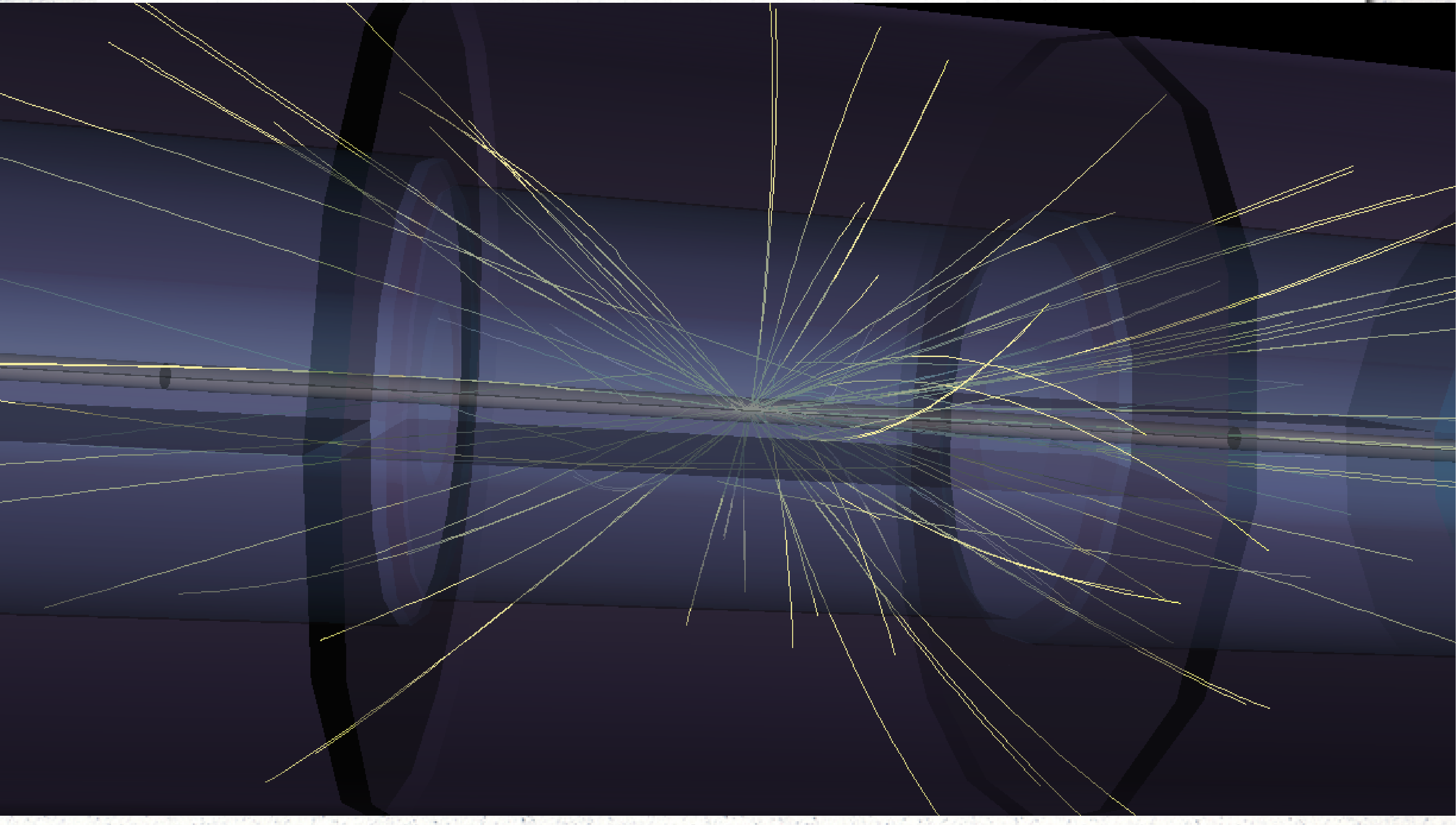
Λ_b Decay Probability Distribution Function

i	f_{1i}	f_{2i}	F_i
0	$a_+a_+^* + a_-a_-^* + b_+b_+^* + b_-b_-^*$	1	1
1	$a_+a_+^* - a_-a_-^* + b_+b_+^* - b_-b_-^*$	P_b	$\cos\theta$
2	$a_+a_+^* - a_-a_-^* - b_+b_+^* + b_-b_-^*$	α_Λ	$\cos\theta_1$
3	$a_+a_+^* + a_-a_-^* - b_+b_+^* - b_-b_-^*$	$P_b\,\alpha_\Lambda$	$\cos\theta\,\cos\theta_1$
4	$-a_+a_+^* - a_-a_-^* + \frac{1}{2}b_+b_+^* + \frac{1}{2}b_-b_-^*$	1	$1/2\,(3\cos^2\theta_2 - 1)$
5	$-a_+a_+^* + a_-a_-^* + \frac{1}{2}b_+b_+^* - \frac{1}{2}b_-b_-^*$	P_b	$1/2\,(3\cos^2\theta_2 - 1)\ \cos\theta$
6	$-a_+a_+^* + a_-a_-^* - \frac{1}{2}b_+b_+^* + \frac{1}{2}b_-b_-^*$	α_Λ	$1/2\,(3\cos^2\theta_2 - 1)\ \cos\theta_1$
7	$-a_+a_+^* - a_-a_-^* - \frac{1}{2}b_+b_+^* - \frac{1}{2}b_-b_-^*$	$P_b\,\alpha_\Lambda$	$1/2\,(3\cos^2\theta_2 - 1)\ \cos\theta\cos\theta_1$
8	$-3Re(a_+a_-^*)$	$P_b\,\alpha_\Lambda$	$\sin\theta\ \sin\theta_1\ \sin^2\theta_2\ \cos\varphi_1$
9	$3Im(a_+a_-^*)$	$P_b\,\alpha_\Lambda$	$\sin\theta\ \sin\theta_1\ \sin^2\theta_2\ \sin\varphi_1$
10	$-\frac{3}{2}Re(b_-b_+^*)$	$P_b\,\alpha_\Lambda$	$\sin\theta\ \sin\theta_1\ \sin^2\theta_2\ \cos(\varphi_1 + 2\,\varphi_2)$
11	$\frac{3}{2}Im(b_-b_+^*)$	$P_b\,\alpha_\Lambda$	$\sin\theta\ \sin\theta_1\ \sin^2\theta_2\ \sin(\varphi_1 + 2\,\varphi_2)$
12	$-\frac{3}{\sqrt{2}}Re(b_-a_+^* + a_-b_+^*)$	$P_b\,\alpha_\Lambda$	$\sin\theta\ \cos\theta_1\ \sin\theta_2\ \cos\theta_2\ \cos\varphi_2$
13	$\frac{3}{\sqrt{2}}Im(b_-a_+^* + a_-b_+^*)$	$P_b\,\alpha_\Lambda$	$\sin\theta\ \cos\theta_1\ \sin\theta_2\ \cos\theta_2\ \sin\varphi_2$
14	$-\frac{3}{\sqrt{2}}Re(b_-a_-^* + a_+b_+^*)$	$P_b\,\alpha_\Lambda$	$\cos\theta\ \sin\theta_1\ \sin\theta_2\ \cos\theta_2\ \cos(\varphi_1 + \varphi_2)$
15	$\frac{3}{\sqrt{2}}Im(b_-a_-^* + a_+b_+^*)$	$P_b\,\alpha_\Lambda$	$\cos\theta\ \sin\theta_1\ \sin\theta_2\ \cos\theta_2\ \sin(\varphi_1 + \varphi_2)$
16	$\frac{3}{\sqrt{2}}Re(a_-b_+^* - b_-a_+^*)$	P_b	$\sin\theta\ \sin\theta_2\ \cos\theta_2\ \cos\varphi_2$
17	$-\frac{3}{\sqrt{2}}Im(a_-b_+^* - b_-a_+^*)$	P_b	$\sin\theta\ \sin\theta_2\ \cos\theta_2\ \sin\varphi_2$
18	$\frac{3}{\sqrt{2}}Re(b_-a_-^* - a_+b_+^*)$	α_Λ	$\sin\theta_1\ \sin\theta_2\ \cos\theta_2\ \cos(\varphi_1 + \varphi_2)$
19	$-\frac{3}{\sqrt{2}}Im(b_-a_-^* - a_+b_+^*)$	α_Λ	$\sin\theta_1\ \sin\theta_2\ \cos\theta_2\ \sin(\varphi_1 + \varphi_2)$

Progress

- Toy Monte Carlo Event Generator was created
- An analysis program was written
  - 10'000 events were generated, and neglecting detector acceptance the analysis program was able to accurately extract polarization
  - Need to account for detector acceptance
- A plug-in for VP1 was created showing only relevant particles
  - Needs polishing and user friendliness

Without Plugin



With Plugin