



WEEKLY GROUP MEETING

Status Reports

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FRIDAY 8TH MAY 2026.

FCC Studies

B_c Fragmentation

Objectives

- The channel to be used for this study is:
 - $B_c^+ \rightarrow \tau^+ \nu$
 - $\mathcal{B}(B_c^+ \rightarrow \tau^+ \nu)_{SM} = \tau_{B_c^+} \frac{G_F^2 |V_{cb}|^2 f_{B_c}^2 m_{B_c} m_\tau}{8\pi} \left(1 - \frac{m_\tau^2}{m_{B_c}^2}\right)^2$ which is quite large
- The primary objectives are:
 - extracting the CKM element $|V_{cb}|$ from this decay channel
 - determination of the fragmentation fraction (hadronization factor) f_{cb} better than 5% precision, say at the 1% level
- It's noteworthy to point out that there's no existing work/studies on this though coupled with the fact that our group is new to FCC.....it might proceed a bit slowly
 - found a relevant thesis titled “**Feasibility study of the branching fraction measurements of $(B_c^+ \rightarrow \tau^+ \nu)$ and $(B_u^+ \rightarrow \tau^+ \nu)$ at LHCb**” [here](#)
- Eluned has put us in contact with the EPFL group working on this same leptonic decay channel, whom we could benefit from their wealth of experiences.

Samples

- The samples used for this quick checks are located within:
 - /eos/experiment/fcc/ee/generation/DelphesEvents/winter2023/IDEA/p8_ee_Zbb_ecm91
 - REC/SIM not specified.....believe to be a combination of both though
 - numerous file ~ 4389 files with millions of events ~ 438738637
 - CLD: /eos/experiment/fcc/ee/generation/FullSimulation/CLD/p8_ee_Zbb_ecm91
 - REC & SIM samples in different folder
 - SIM samples used for this checks
 - few file ~ 100 files
- Interested in generator-level analysis at this point.....so using the simulated and not the reconstructed samples for these few checks
- The first reasonable step would be to check the branches within the root files and get the exact branches needed for the analysis.

Flight Distance & Flight Time

- Flight distance otherwise decay distance is computed as the distance between the vertex coordinates and the endpoint coordinates.
 - The branches used are;
 - MCParticle.PDG
 - MCParticle.vertex.x
 - MCParticle.vertex.y
 - MCParticle.vertex.z
 - MCParticle.endpoint.x
 - MCParticle.endpoint.y
 - MCParticle.endpoint.z
 - MCParticles.momentum.x
 - MCParticles.momentum.y
 - MCParticles.momentum.z
 - MCParticle.daughters_begin
 - MCParticle.daughters_end
-

- Mathematically:

- $L = \sqrt{dx^2 + dy^2 + dz^2}$

- $c.t = \frac{L.m}{\beta}$

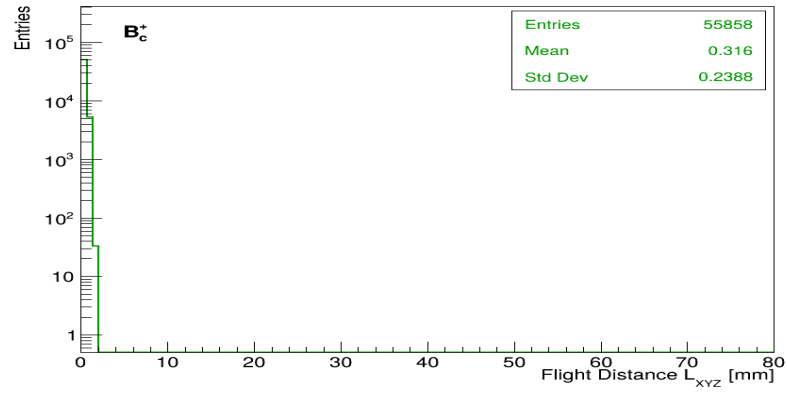
B-Hadron Production Fractions: IDEA

class_code	class_name	scientific_label	count	fraction_of_all_selected_B_hadrons
1	Bd_B0	B^0_{d}	63839176	0.432987579
2	Bu_Bplus	B^+_{u}	63871939	0.433209793
3	Bs_Bs0	B^0_{s}	14201896	0.096323997
4	Bc_Bcplus	B^+_{c}	55858	0.000378855
5	Lb_LambdaB0	$\# \Lambda^0_{b}$	3228775	0.021899084
6	Xi_b	$\# \Xi_{b}$	872176	0.005915511
7	Omega_b	$\# \Omega_{b}$	10868	7.37E-05
8	Other_b_baryon	Other b baryons	1358128	0.009211468

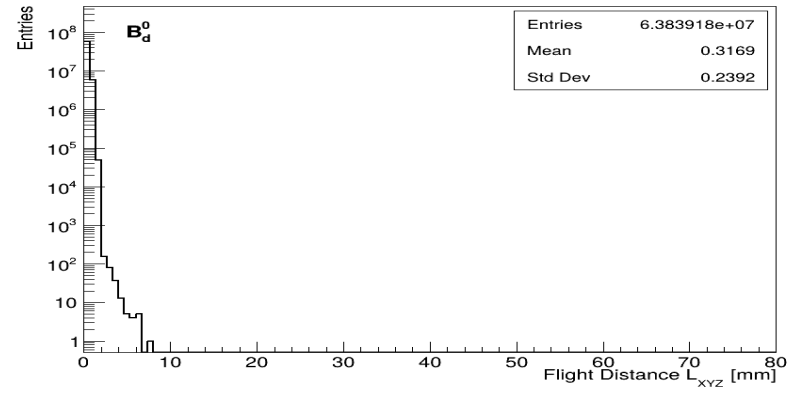
branch	description	count
n_Bc_541	B_{c}^{+} / B_{c}^{-} 541	33040
n_BcStar_543	B_{c}^{*} 543	22818
n_BcExc_10541	B_{c} excited 10541	0
n_BcExc_10543	B_{c} excited 10543	0
n_BcExc_20543	B_{c} excited 20543	0

Flight Distance: IDEA

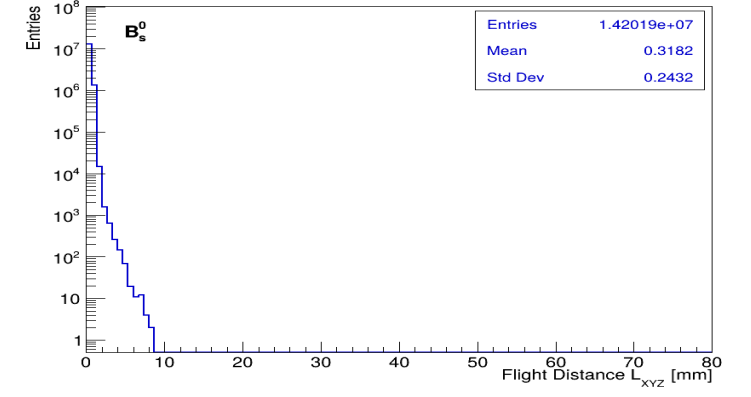
B_c^+ truth flightDistance_mm



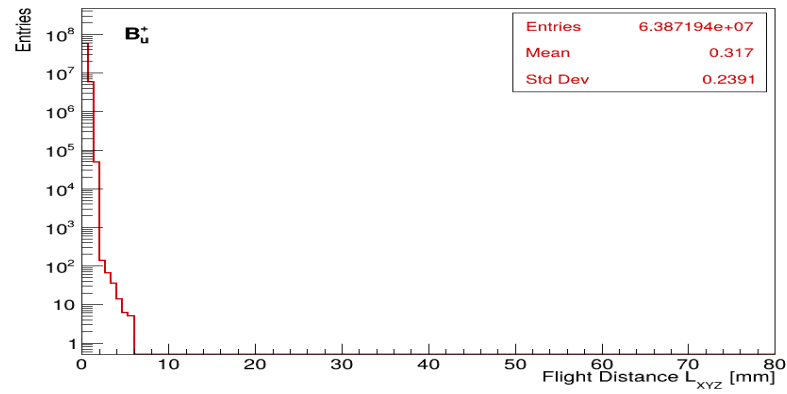
B_d^0 truth flightDistance_mm



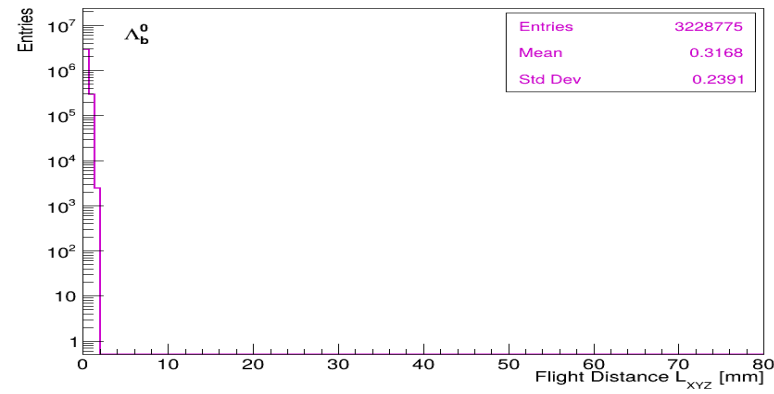
B_s^0 truth flightDistance_mm



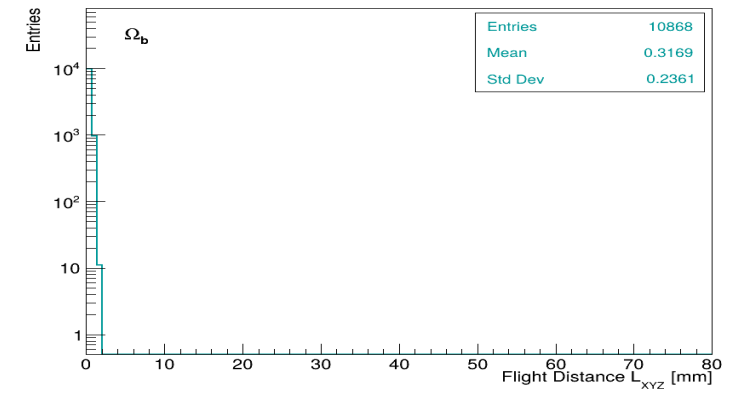
B_u^+ truth flightDistance_mm



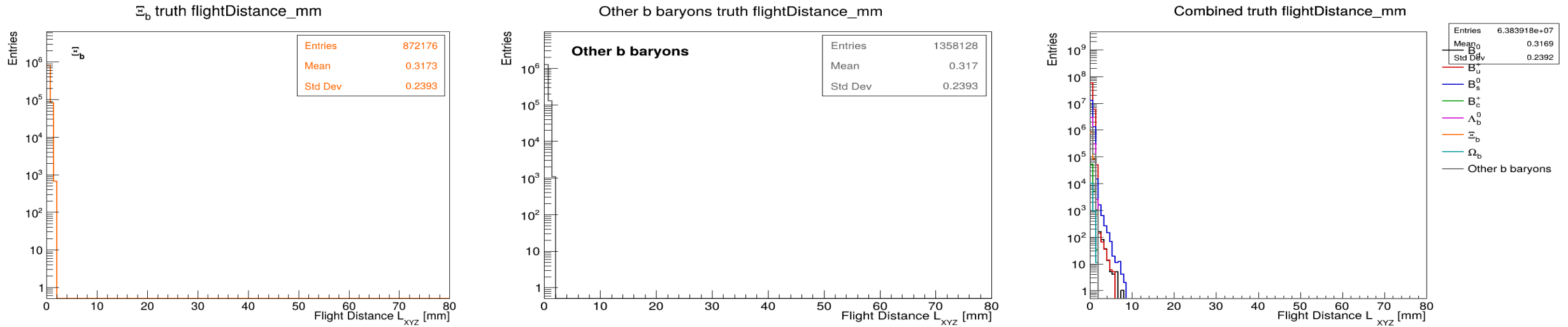
Λ_b^0 truth flightDistance_mm



Ω_b truth flightDistance_mm

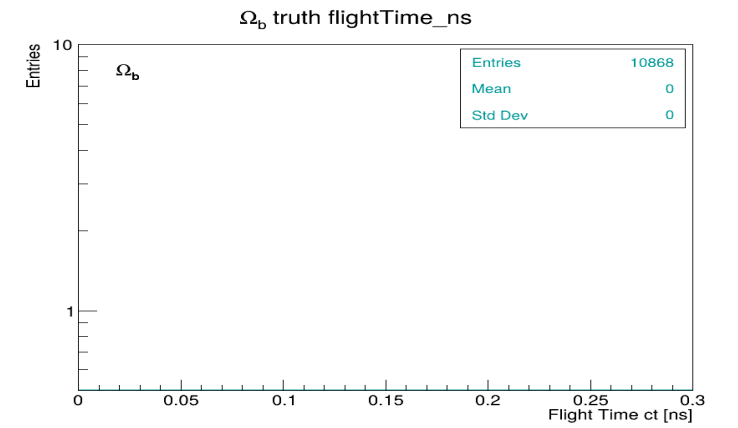
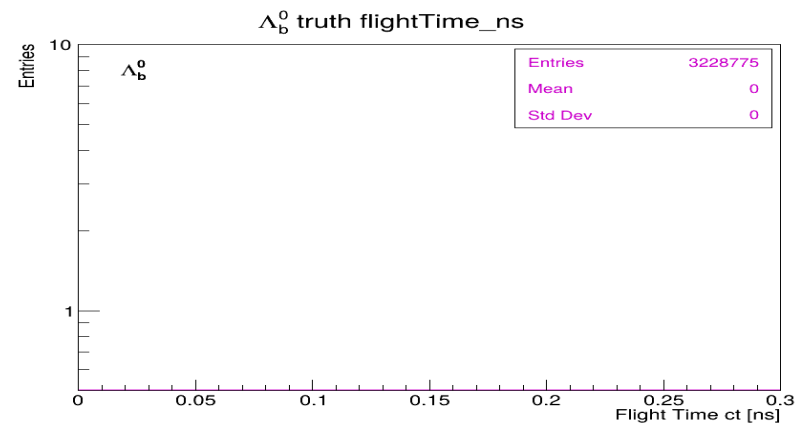
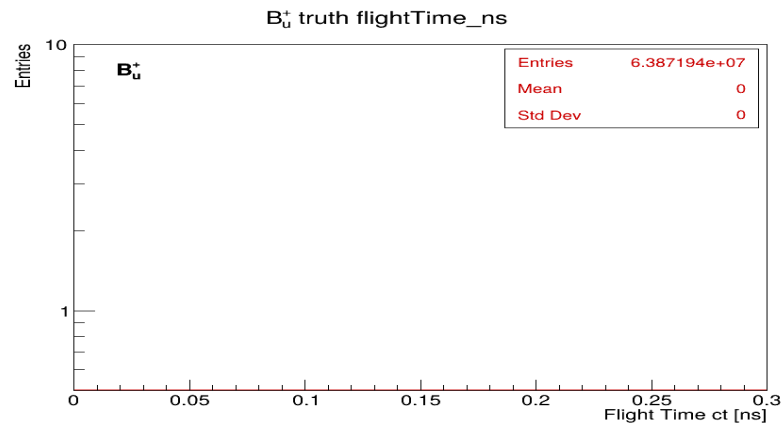
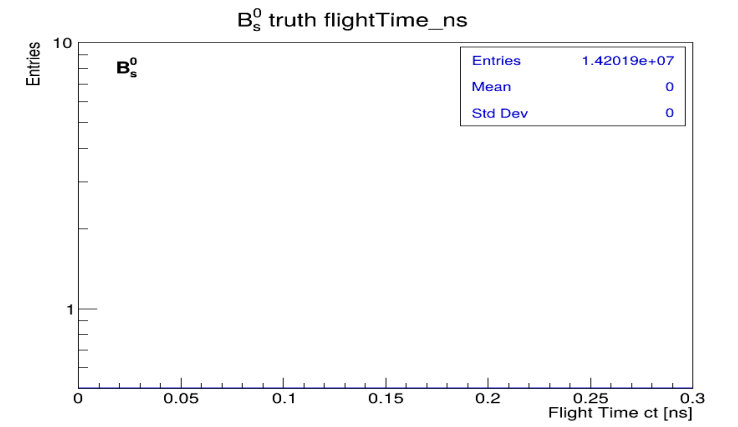
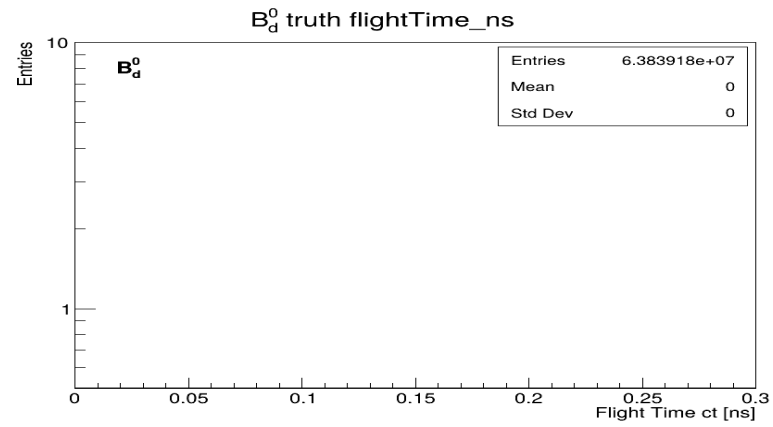
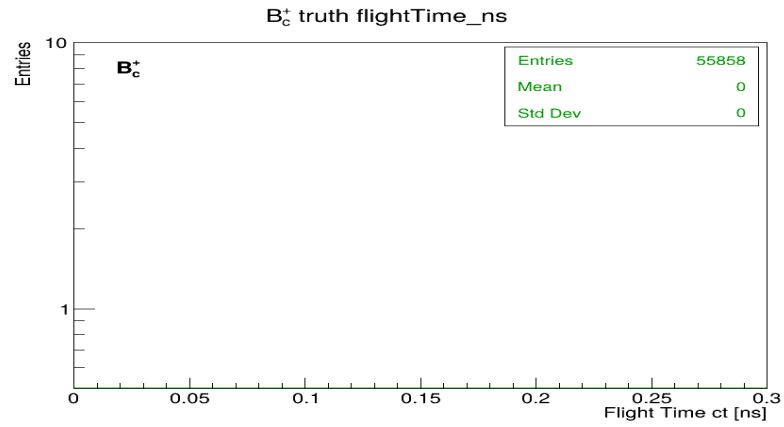


Flight Distance: IDEA

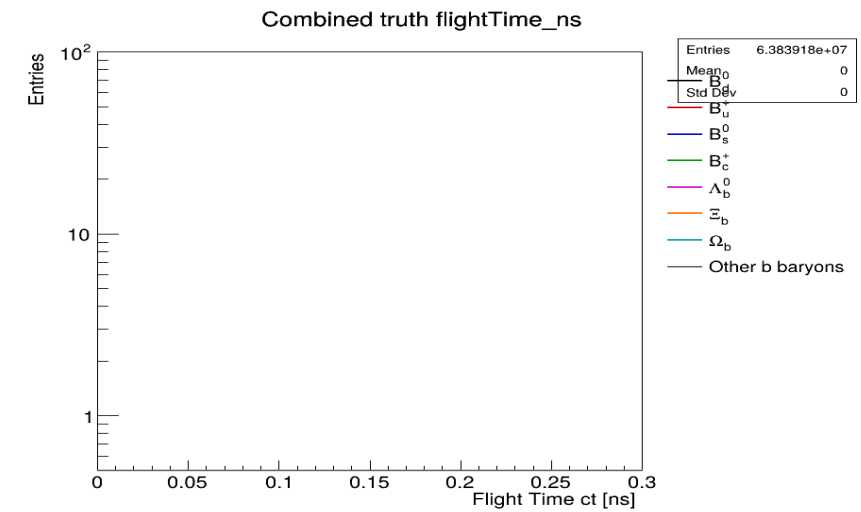
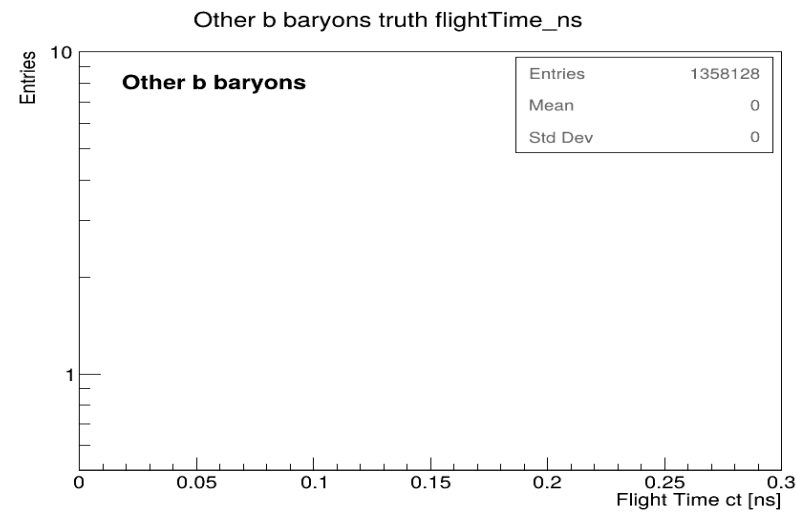
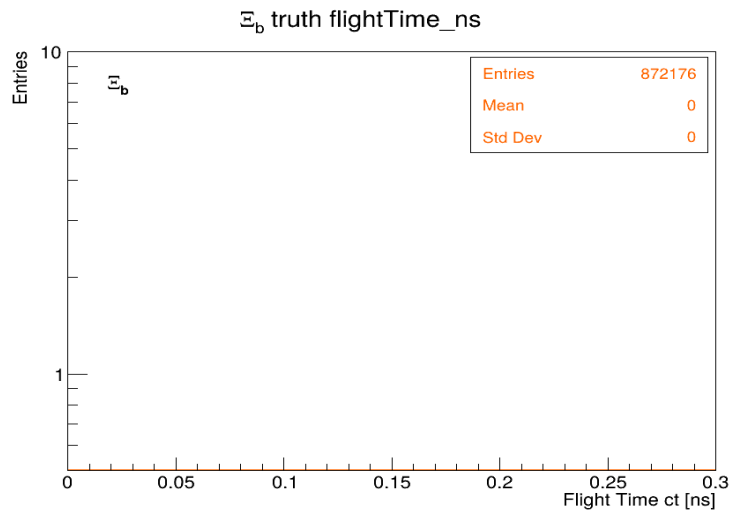


- NB: Other B-Baryons class includes any baryons with PDG values 5000–5999, after removing B_c first

Flight Time: IDEA



Flight Time: IDEA



- NB: Other B-Baryons class includes any baryons with PDG values 5000–5999, after removing B_c first
- The flight times are extremely too small.....maybe due to the division by c or the usage of the `MCParticle.endpoint."variable"` instead of `MCParticle.daughters_end`

Conclusions

- Just setting out with the truth analysis.....will take it up from here
- We shall be running this analysis in parallel with the EPFL group
- We shall be employing the traditional method: selection cuts while the EPFL will employ ML method.
- More updates loading.....

Backups

B-Hadron Production Fractions: CLD

CLD

B0 : 0.255129

B+ : 0.258198

Bs : 0.0570743

Bc : 0.000208572

Lb : 0.0217064

Other : 0.407684

IDEA

B0 : 3.77688e+08 (0.256728)

B+ : 3.77744e+08 (0.256766)

Bs : 8.40074e+07 (0.0571028)

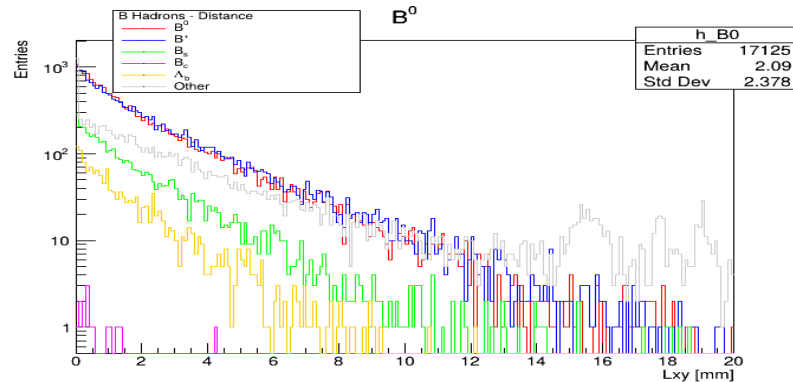
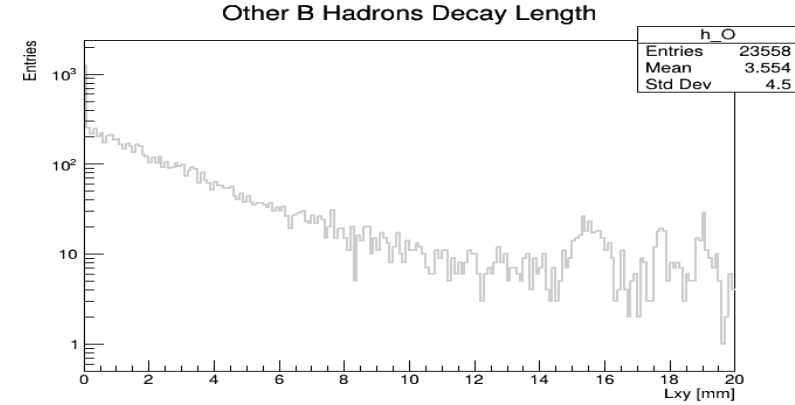
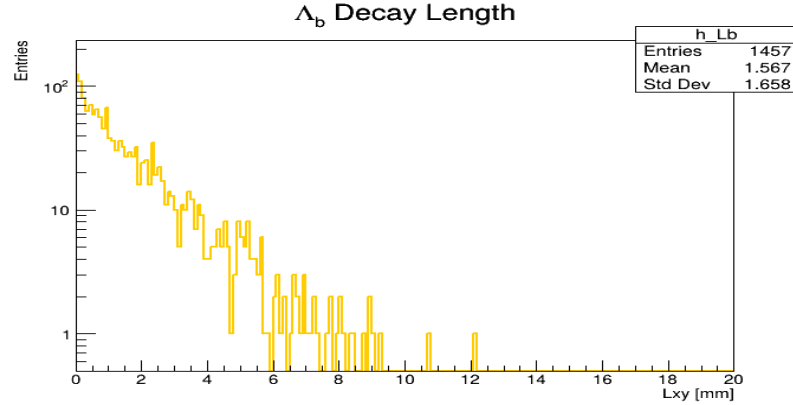
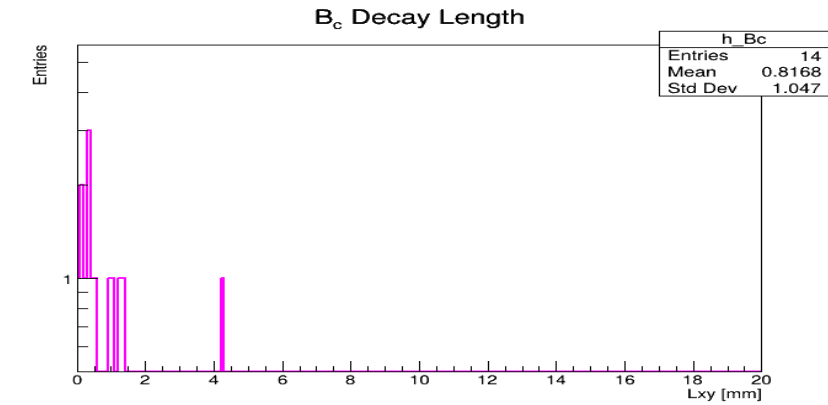
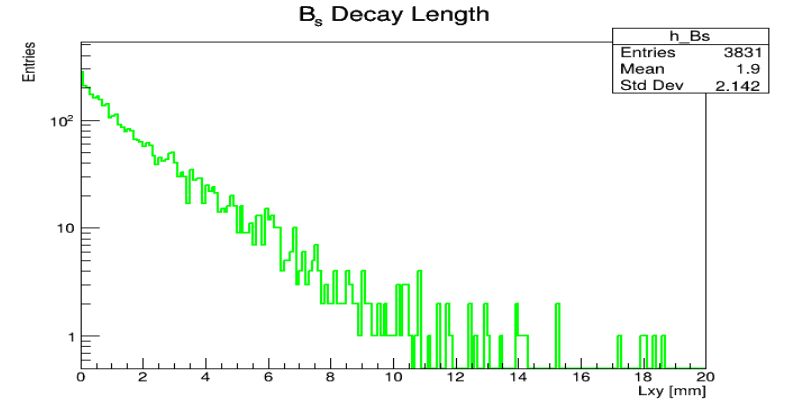
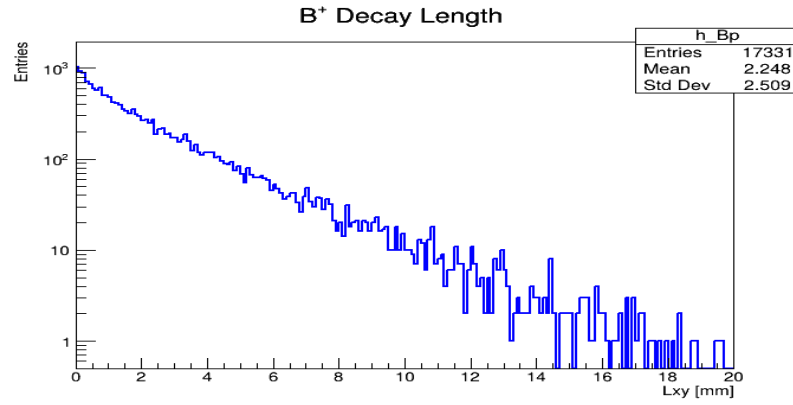
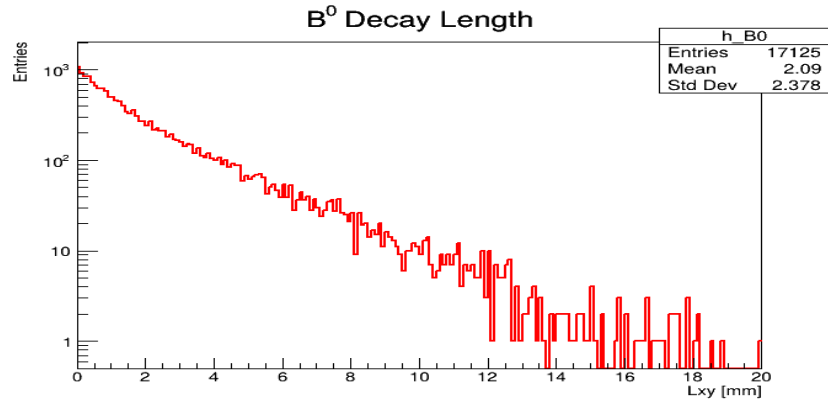
Bc : 330159 (0.000224421)

Lb : 3.22435e+07 (0.0219171)

Other : 5.99148e+08
(0.407262)

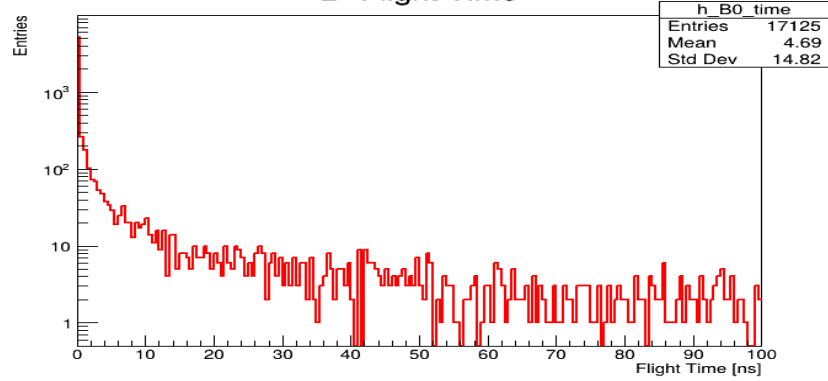
Total B hadrons: 1.47116e+09

Flight Distance: CLD

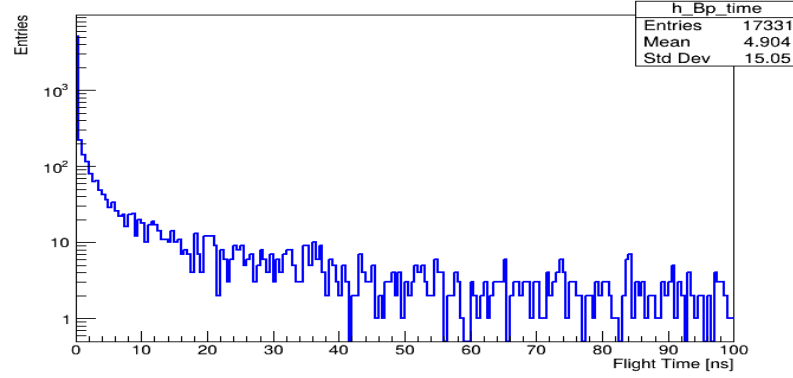


Flight Time: CLD

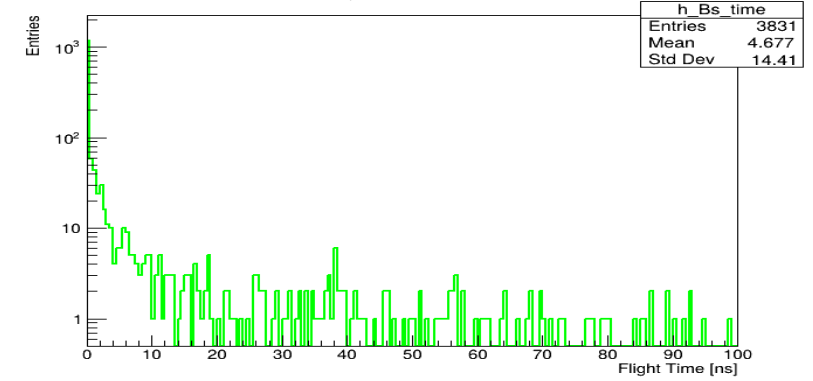
B⁰ Flight Time



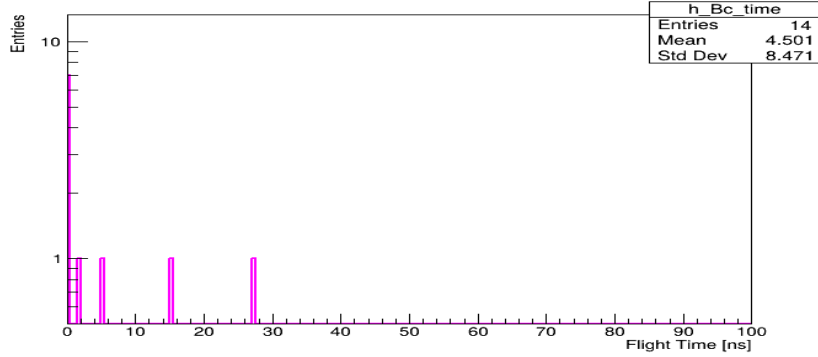
B⁺ Flight Time



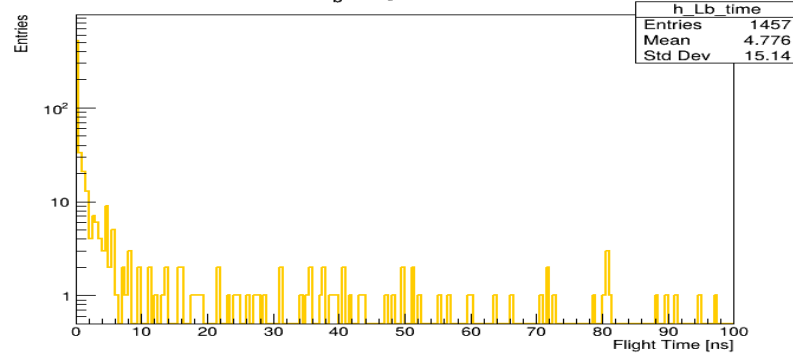
B_s Flight Time



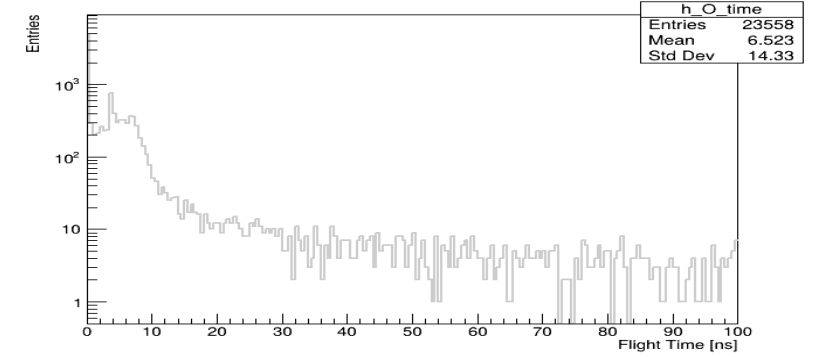
B_c Flight Time



Λ_b Flight Time



Other B Hadrons Flight Time



B⁰

