Exercises with Ntuples

With 2-Body Decay Example

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Ntuple Uses

- Make histograms on the fly
- Make correlations
  - Multiple dimensions of data
  - All related through some concept
    - Example: Two-Body decay variables
      - Parent 4-momentum, daughter 4-momenta, angular relationship between daughter momentum vectors, or between parent and daughter momenta.
  - Can make 2-D, 3-D, correlations between any of the variables
  - Can select on one, or multiple variables, and plot another variable.
    - Example: How does the opening angle behave as a function of the parent momentum?

Useful commands

- TNtuple::Print()
  - Spits out each branch of the Ntuple to the screen
    - Useful to see all the variable names as stored in the Ntuple
- TNtuple::Draw("x")
  - Draws a histogram of the variable x
- TNtuple::Draw("x","y>2")
  - Same as above, but only plots those cases where the variable y is greater than 2
  - 2-Body decay Example: draw the invariant mass of the parent for the cases where the daughter pT is greater than 3

Useful commands, part II

- Ntuple::Draw("log(x)")
  - You can plot functions of the variables, not just the variables themselves.
- Ntuple::Draw("y:x")
  - Plot y vs x (second variable is the abscissa, i.e. the x-axis), i.e. I interpret the colon as a "versus" to remember which one is which.
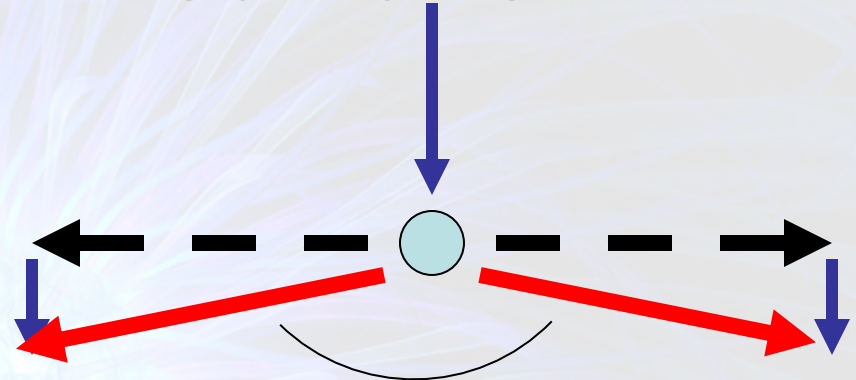
2 Body Decay: Minimum Opening Angle

- Lab Frame

- ϒ Rest Frame

$$p_\mu' = (M, \vec{0})$$

$$p_{\mu,1}' = (E', \vec{p}\,')$$

$$p_{\mu,2}' = (E', -\vec{p}\,')$$

$$p_\mu' = p_{\mu,1}' + p_{\mu,2}'$$

$$E' = \frac{M}{2} = \sqrt{\vec{p}\,'^2 + m^2}$$

$$\begin{pmatrix} E \\ p_\perp \\ p_L \end{pmatrix} = \begin{pmatrix} \gamma & 0 & \beta\gamma \\ 0 & 1 & 0 \\ \beta\gamma & 0 & \gamma \end{pmatrix} \begin{pmatrix} E' \\ p_\perp' \\ p_L' \end{pmatrix}$$

$$p_L = E'\beta\gamma = \frac{M}{2}\beta\gamma = \frac{p_\Upsilon}{2}$$

$$\cos\theta_{\min} = \frac{\vec{p}_1 \bullet \vec{p}_2}{|\vec{p}_1||\vec{p}_2|} = \frac{-p_\perp'^2 + p_\Upsilon^2/4}{p_\perp'^2 + p_\Upsilon^2/4}$$

$$p_\Upsilon = \sqrt{M^2 - 4m^2}\sqrt{\frac{1 + \cos\theta_{\min}}{1 - \cos\theta_{\min}}}$$

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Assignment

- Complete the steps of the derivation of the relationship between the parent momentum magnitude and the minimum opening angle of the daughters in the 2-Body decay

- Make a macro that plots these quantities from the 2-body decay Ntuple
  - It should make a 2-D histogram of upsP vs upsCosTheta
  - Make a TF1 that draws the minimum opening angle function on your plot, with the values of the corresponding parent and daughter masses

- Make one for the 2-Body decay code that throws upsilons uniform in pT and rapidity and one for Pythia. What are the differences you notice?

- Prepare a two slides explaining what you did and the plots you obtained for group meeting on Friday.