The taus, what about the taus?

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Belle Starr: Recap

- Coincidence hit selection
- Clusterize hits
- Perform first single shower M-estimator prefit
- Residual based hit selection $-40\,\text{ns} > h.t > 40\,\text{ns}$
- Clusterize hits
- Perform second single shower M-estimator prefit
- Perform a two shower PDF based likelihood fit on all hits in event, with likelihood:

$$\mathcal{L} = \sum_i P(\text{hit}_i|\text{vertex}_1) + P(\text{hit}_i|\text{vertex}_2) + P(\text{hit}_i|\text{bkg})$$

Robustness of prefits

In double bang events, give MC nu vertex or tau vertex to first prefit as start point and check for differences

dst between fit with start at nu and fit with start at tau pos

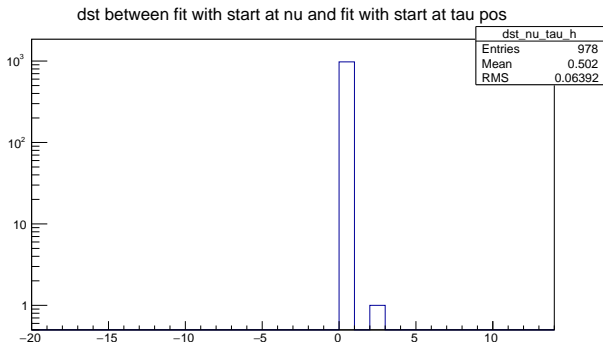| dst_nu_tau_h	
Entries	978
Mean	0.502
RMS	0.06392

Figure : Distance between the first prefit position for nu interaction vertex and tau decay vertex as start parameter

Prefit vertex preference

Observed preference for hadronic shower, caused by merging hits on the same PMT within 300 ns ("eats up" later tau hits)
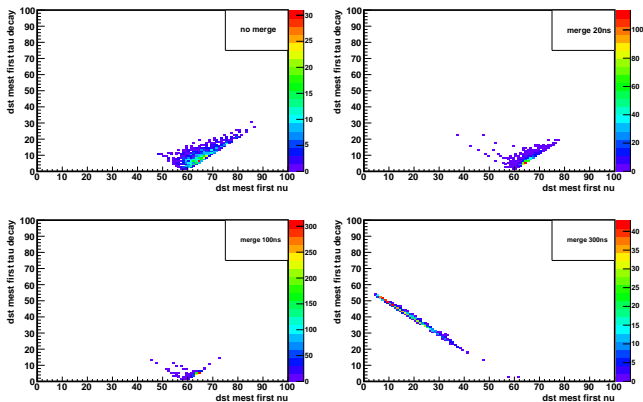

Figure : Distance between the first prefit position and nu interaction vertex and tau decay vertex

Change the score function of the minimizer to pull more towards one of the two showers
normal score function:

$$m = \sum_i \text{hit}_i.a \times \sqrt{\left(0.5 + \text{hit}_{i;\text{residual}}^2\right)}$$

weighted score function:

$$m = \sum_i \text{hit}_i.a \times \left(\sqrt{\left(0.5 + \text{hit}_{i;\text{residual}}^2\right)} \pm \text{scale} \times \text{hit}_{i;\text{residual}} \right)$$

Currently using scale factor 0.8

Idea to improve the prefits for two shower scenario

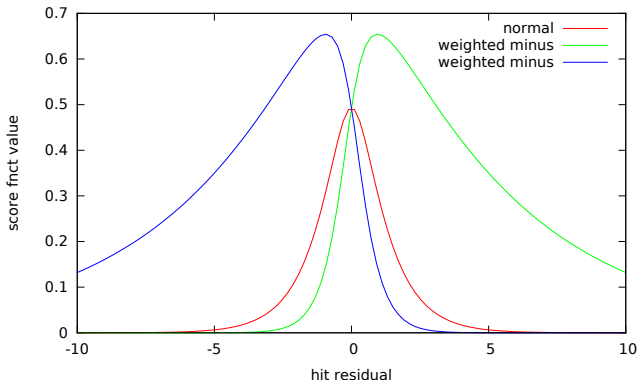Change the score function of the minimizer to pull more towards one of the two showers

Figure : $exp(-\text{score})$

Belle Starr performance for different bjorken y

Found in faulty MC that Belle Starr seems to perform badly for different bjorken y values, test on toy:
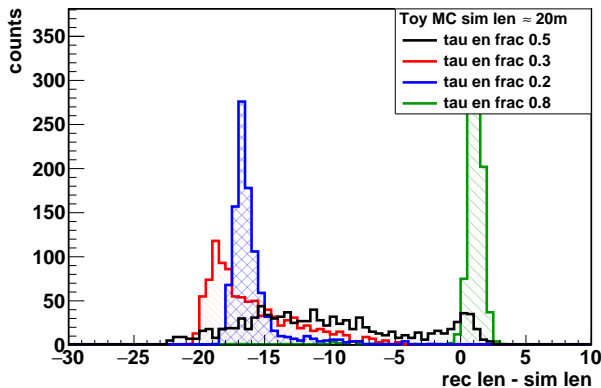

Figure : Reconstructed dst resolution for different bjorken y values at approx same flight length (between 19 meter to 23 meter)

Belle Starr performance for different bjorken y

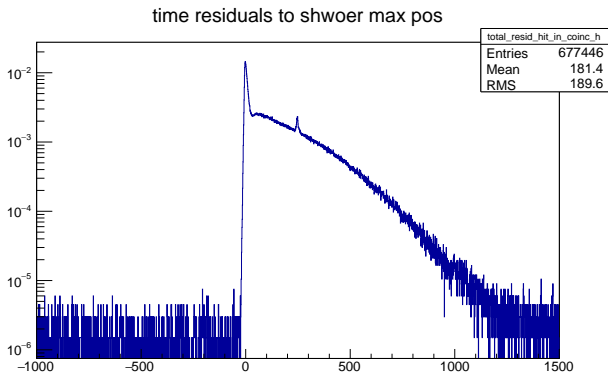Suggestion by Maarten: caused by long tail in used pdf for fit

Figure : PDF for all hits that form an L1

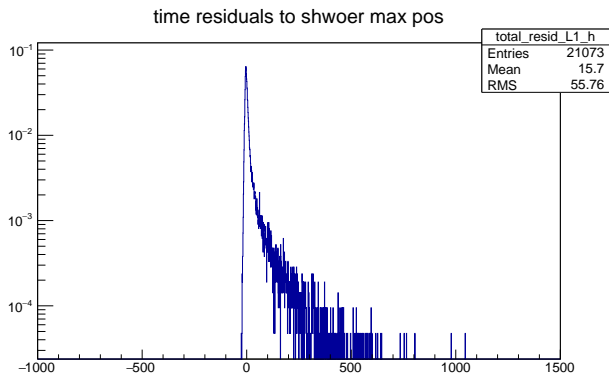Instead, use much tighter hit selection with less tails: first L1 on each DOM only

Figure : PDF for first L1 per DOM

Belle Starr performance for different bjorken y

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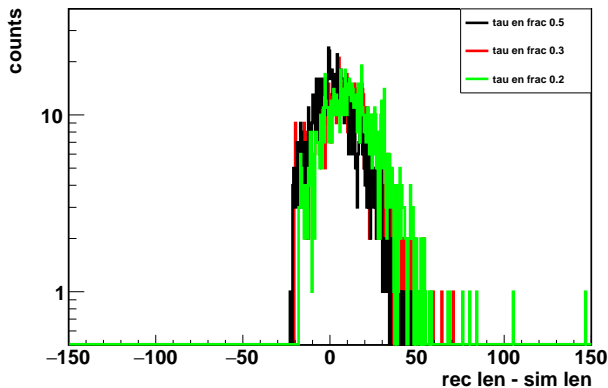

Figure : Reconstructed dst resolution for different bjorken y values with first L1 hit one each DOM