K0s in PD-SP

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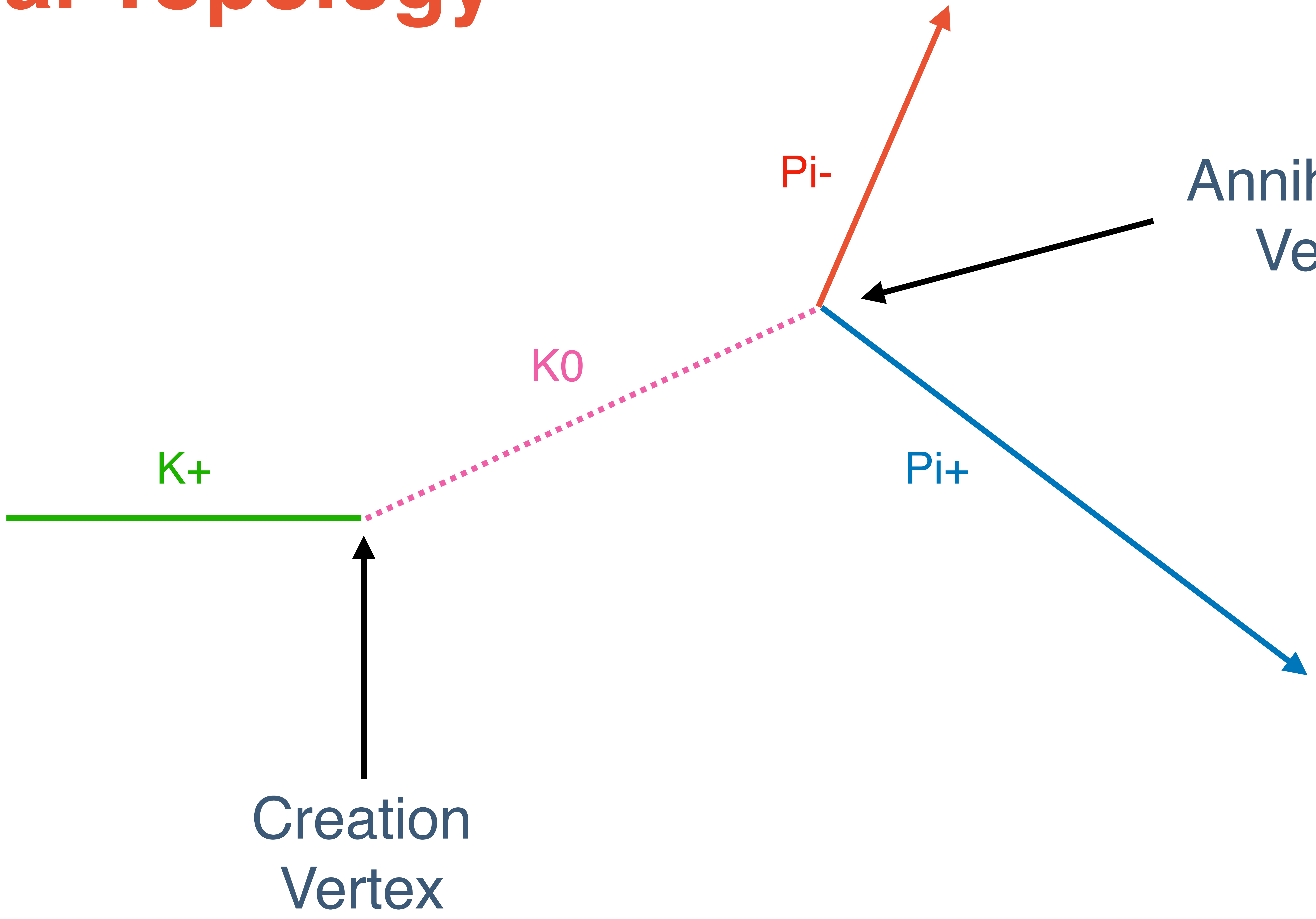
K0s Reconstruction Efficiency: K0->pi+ + pi-

	None	Pi-	pi+	Par	ParID	ParIsBeam	ParIsK+	vtxRad	PID
None	1158								
TrueParID	445	Is the reco parent of the Pi- the true parent of the K0?							
pi-	1017	392							
pi+	948		319						
Par	640			313					
ParID	928				287				
ParIsBeam	387					287(250)			
ParIsK+	1158						287(250)		
vtxRad10	395							214(182)	
PID	601								153(132)

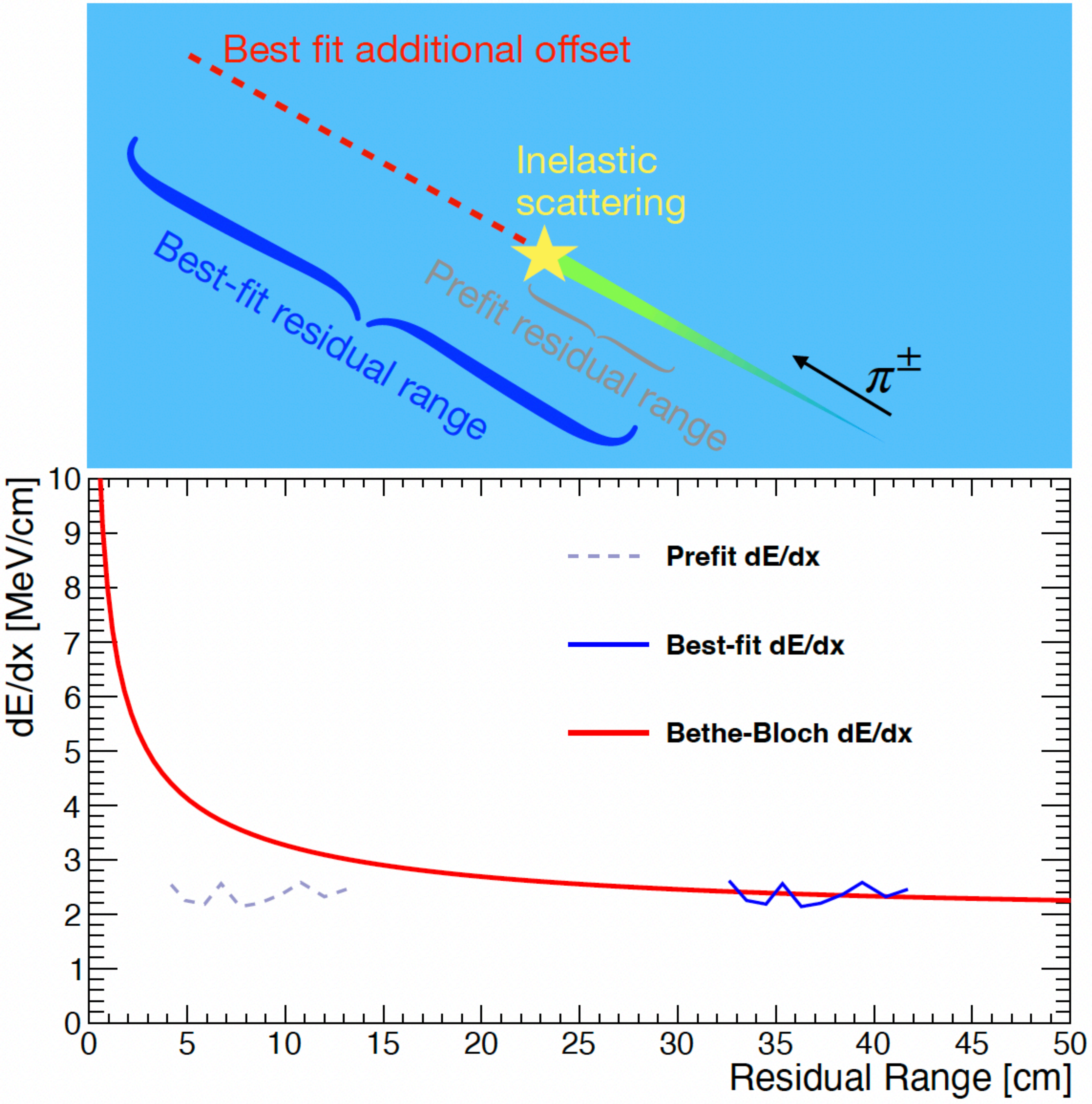
- 153(132) potentially reconstructable K0s -> Algorithm reconstructs 106(94) (~70% eff.)

Signal Topology

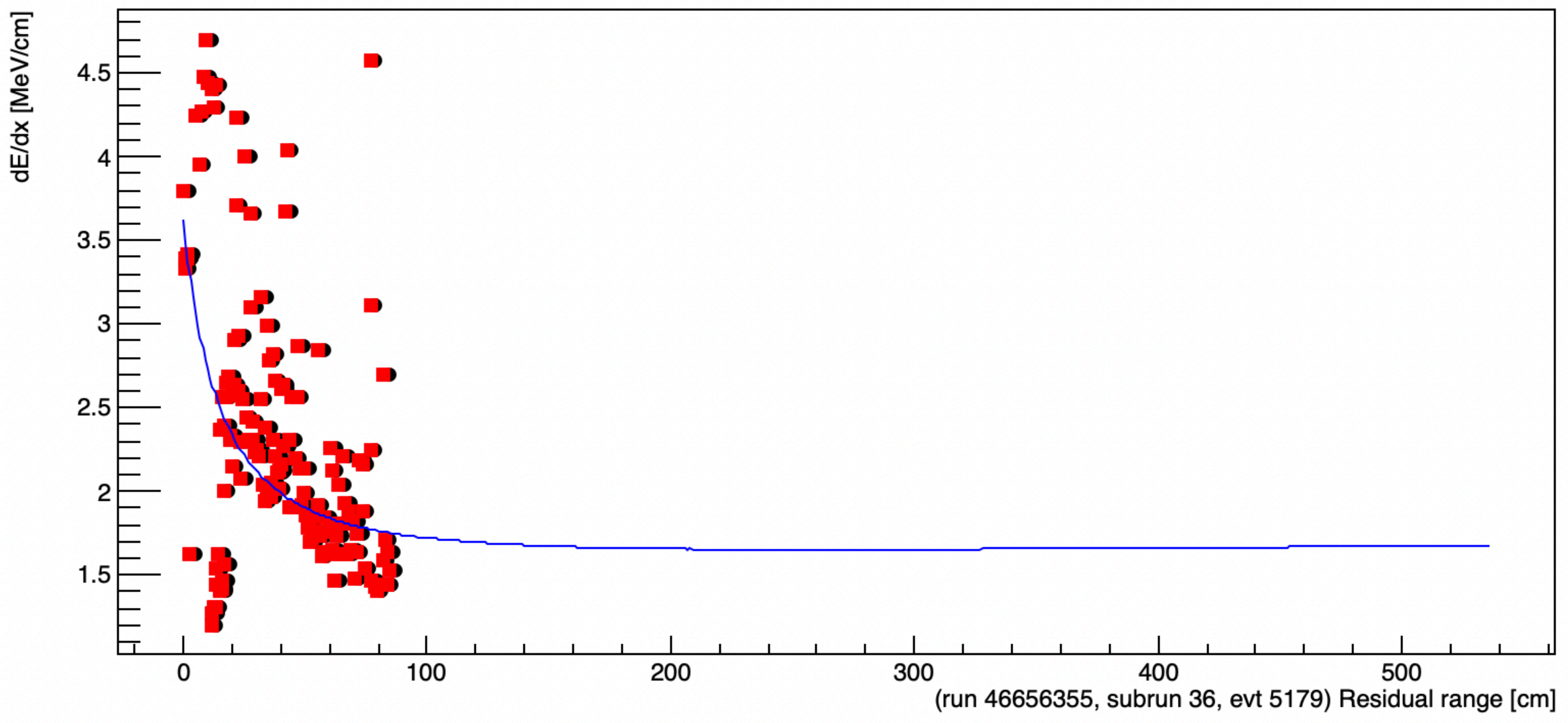


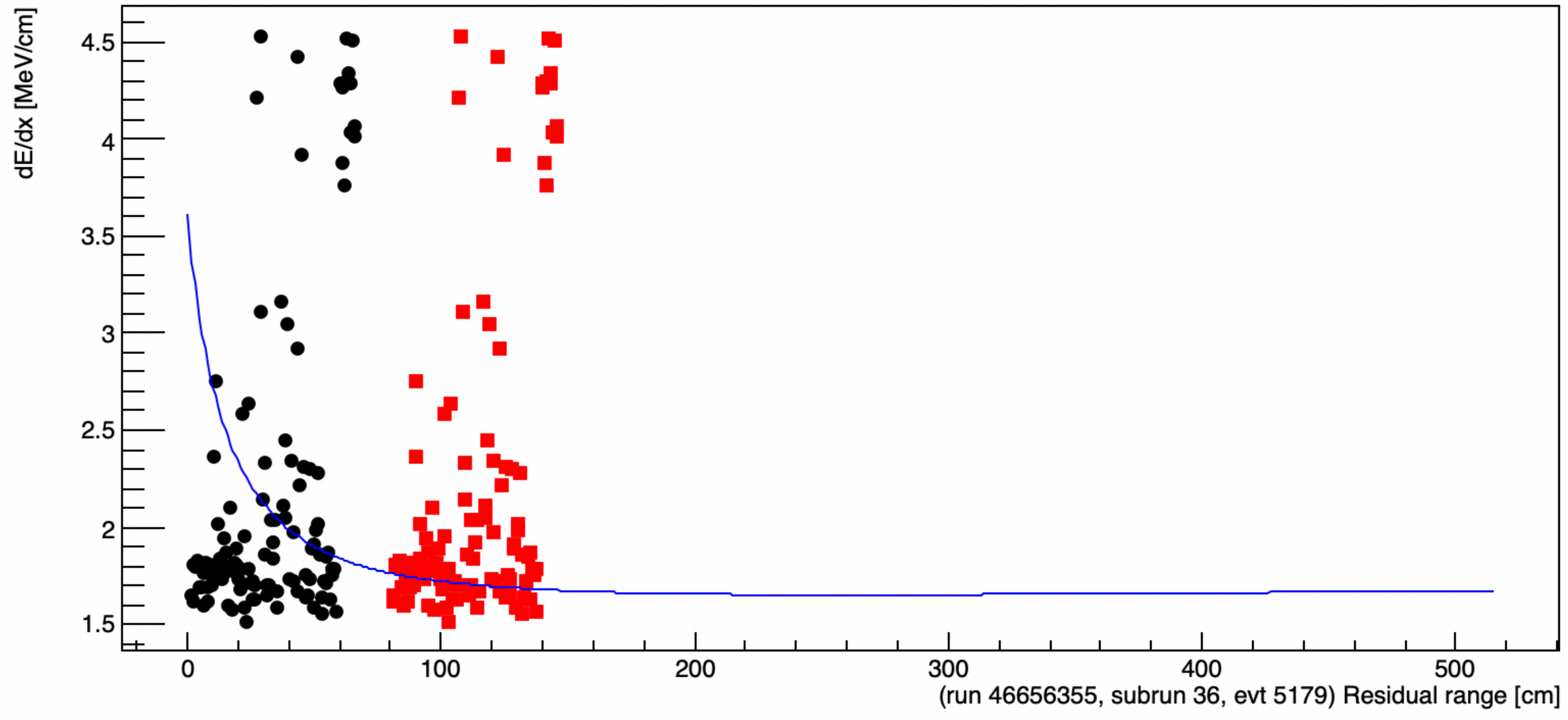
TLEFit: Current Implementation

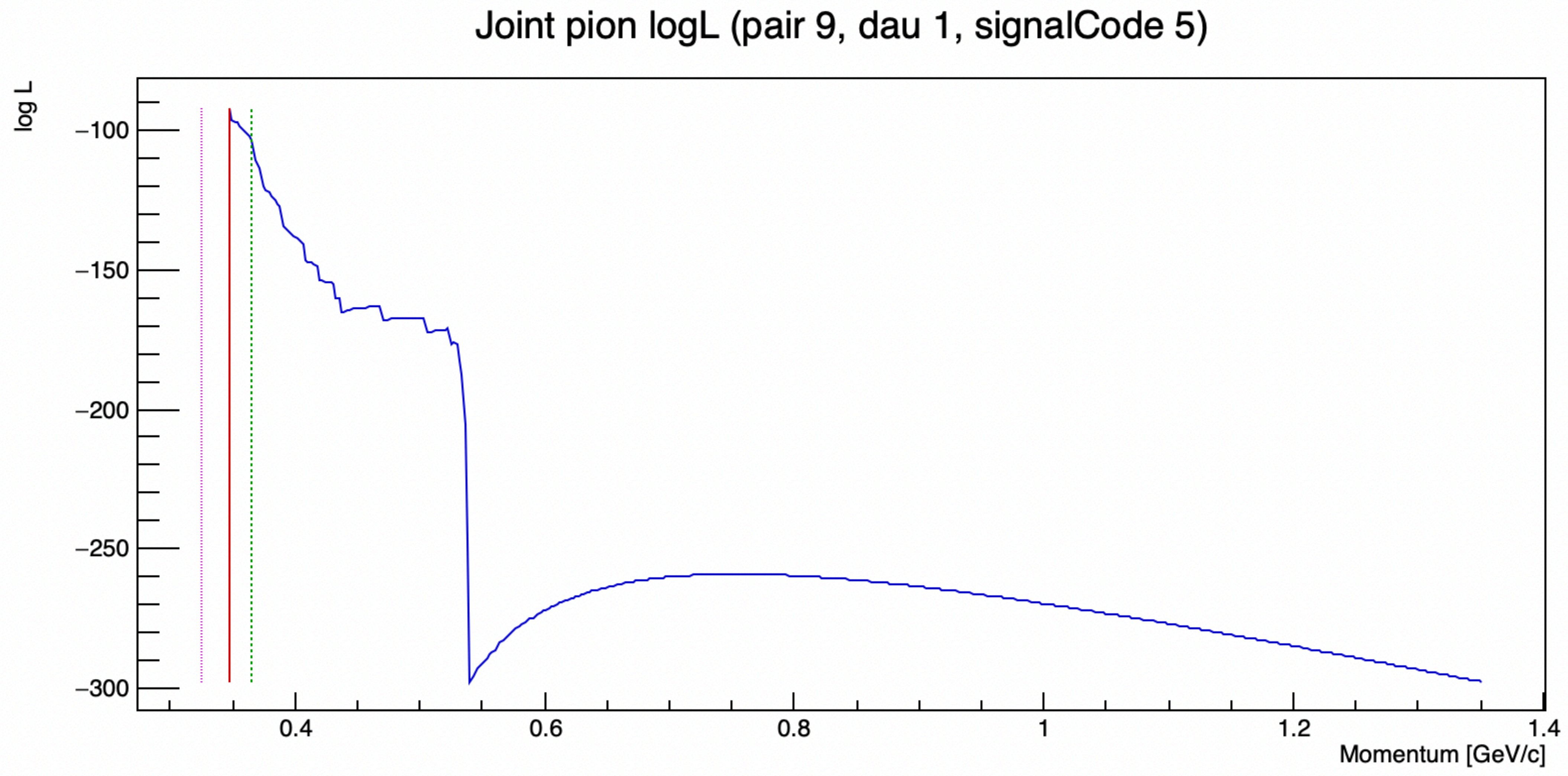
- Given an observed dEdx vs RR, it looks for the place where the observed dIdx matches better the prediction;
- Throws away 3 first/final hits;
- Clamps the dEdx to [0.5-5] MeV per hit;
- Scans within 450 cm of RR (~1.4 GeV momentum) in 1 cm steps;
- Uses template for RR<30cm and Landau-Vavilov for RR>30 cm;

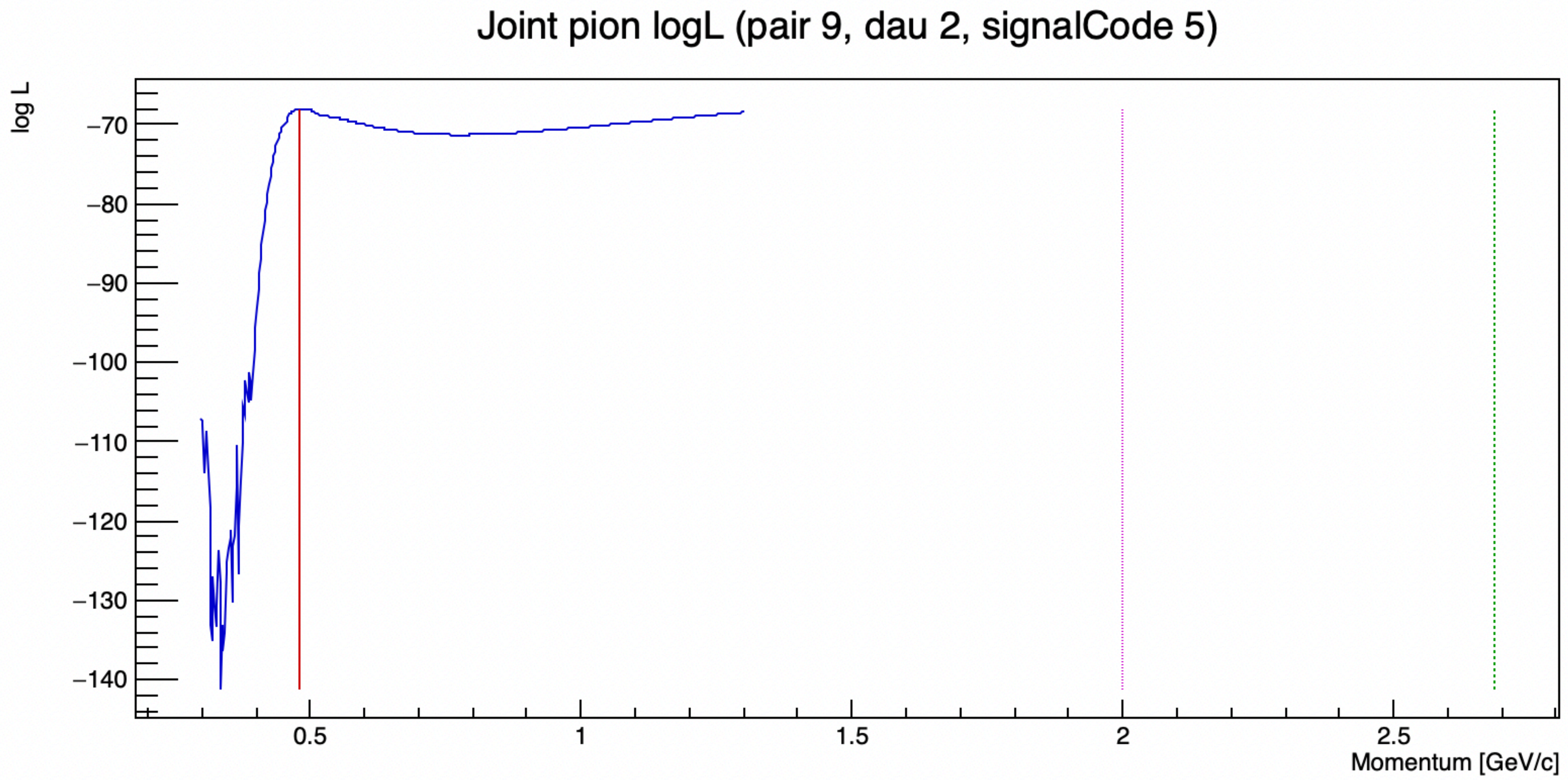


An example of TLEFit



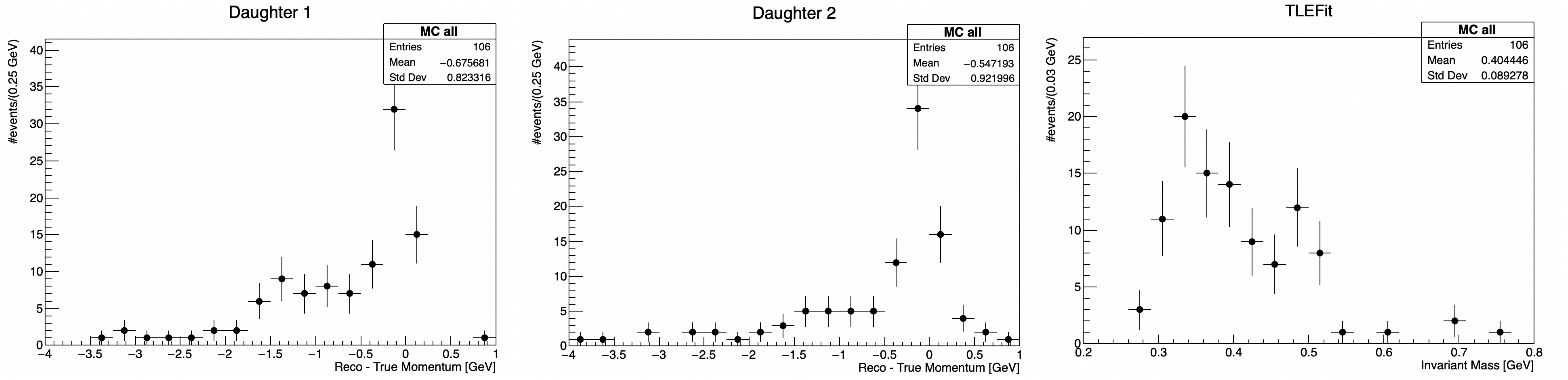






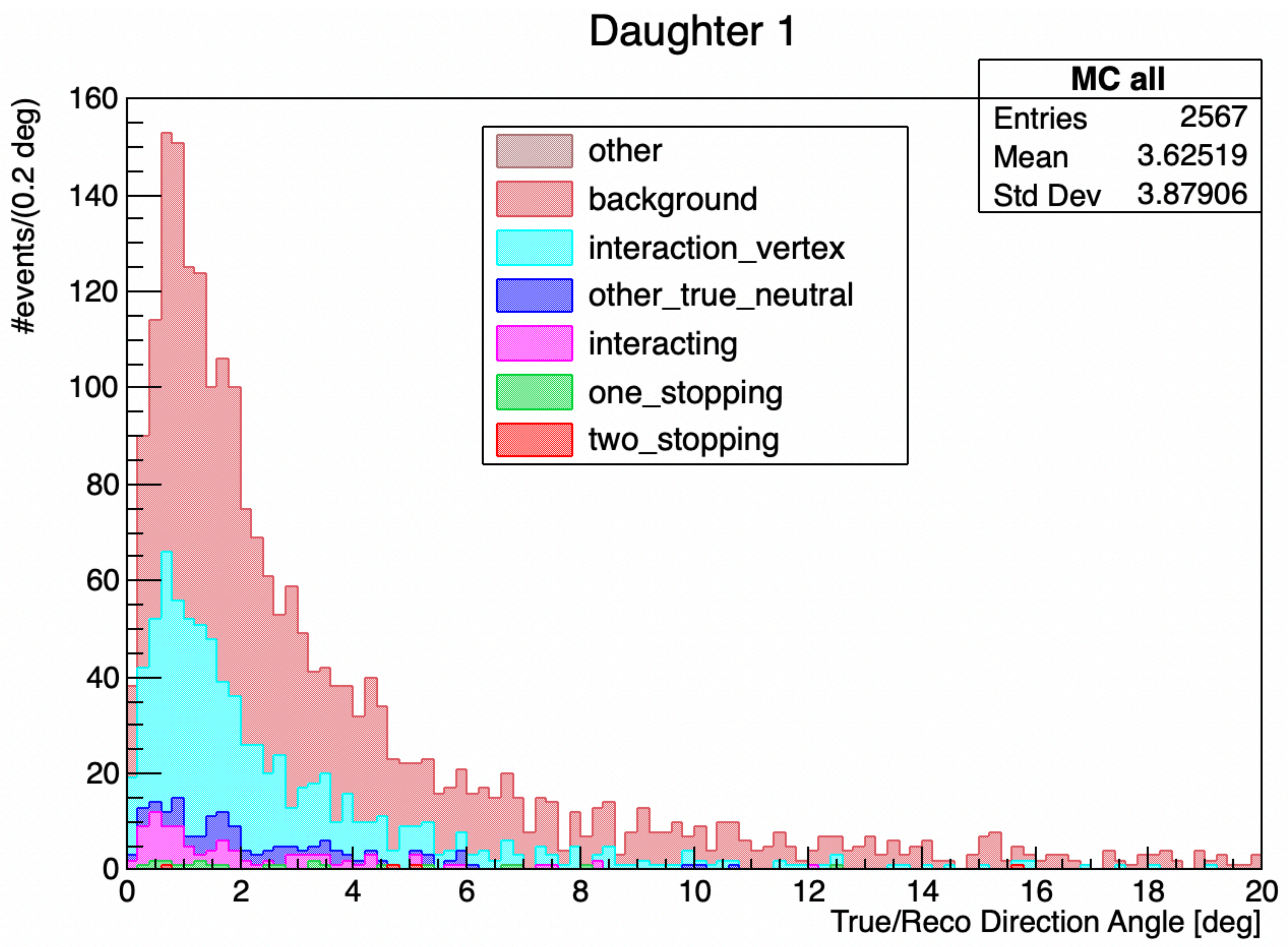
Performance of TLEFit

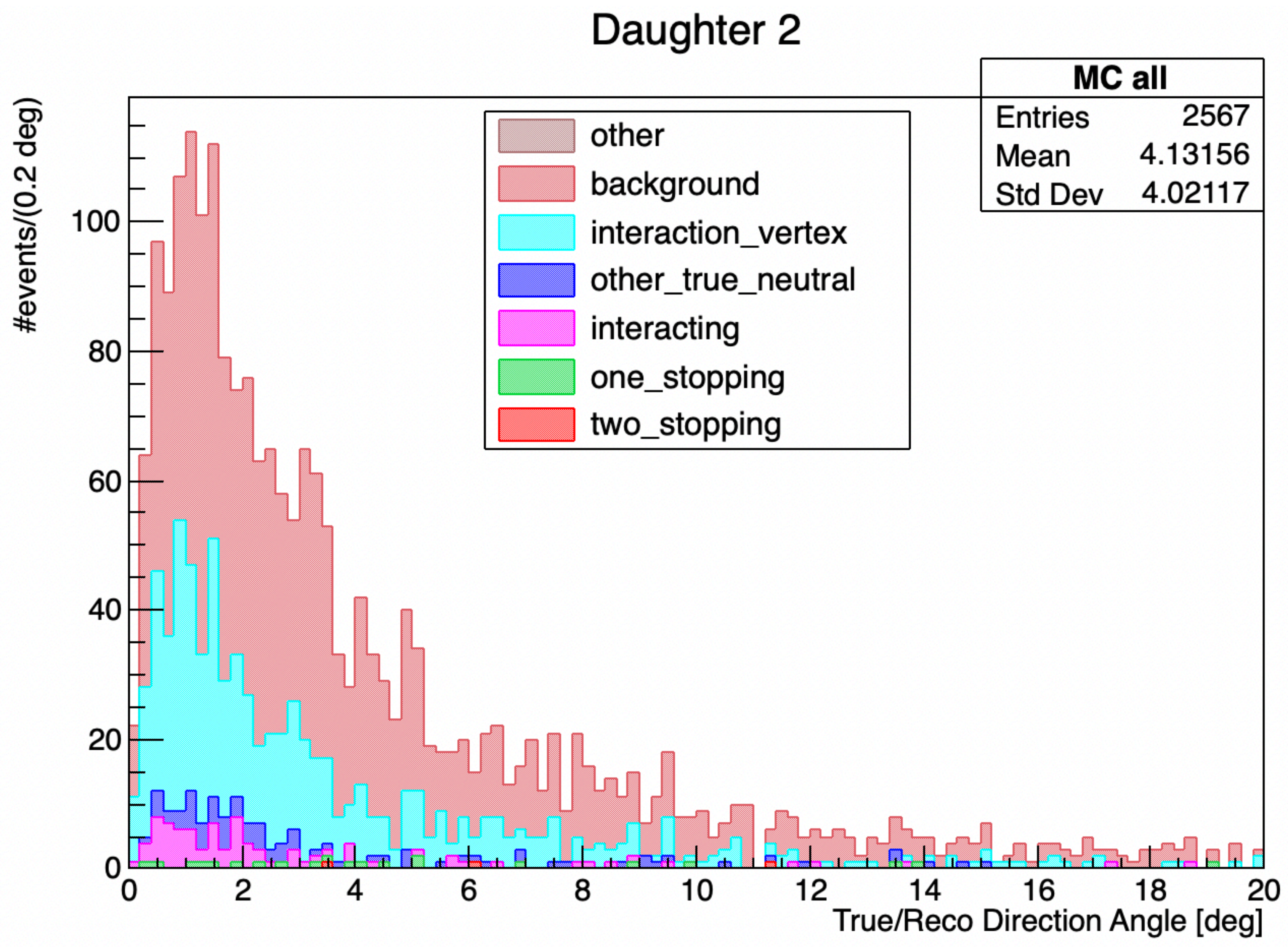
- TLEFit independently estimates the momenta of the two pions in a completely independent approach;
- These momenta are then used to compute the invariant mass given the measured directions of the two pions;



Pion Direction Reconstruction

- The angle between the true/reco directions of the pions, together with the uncertainty on the annihilation vertex position, has an effect on the reconstructed invariant mass;
- Daughter 1 is longer, so its angle is a bit better reconstructed than for Daughter 2
- The true/reco angle can be probably improved (algorithm not optimised yet);





TLEFit + Mass Penalty

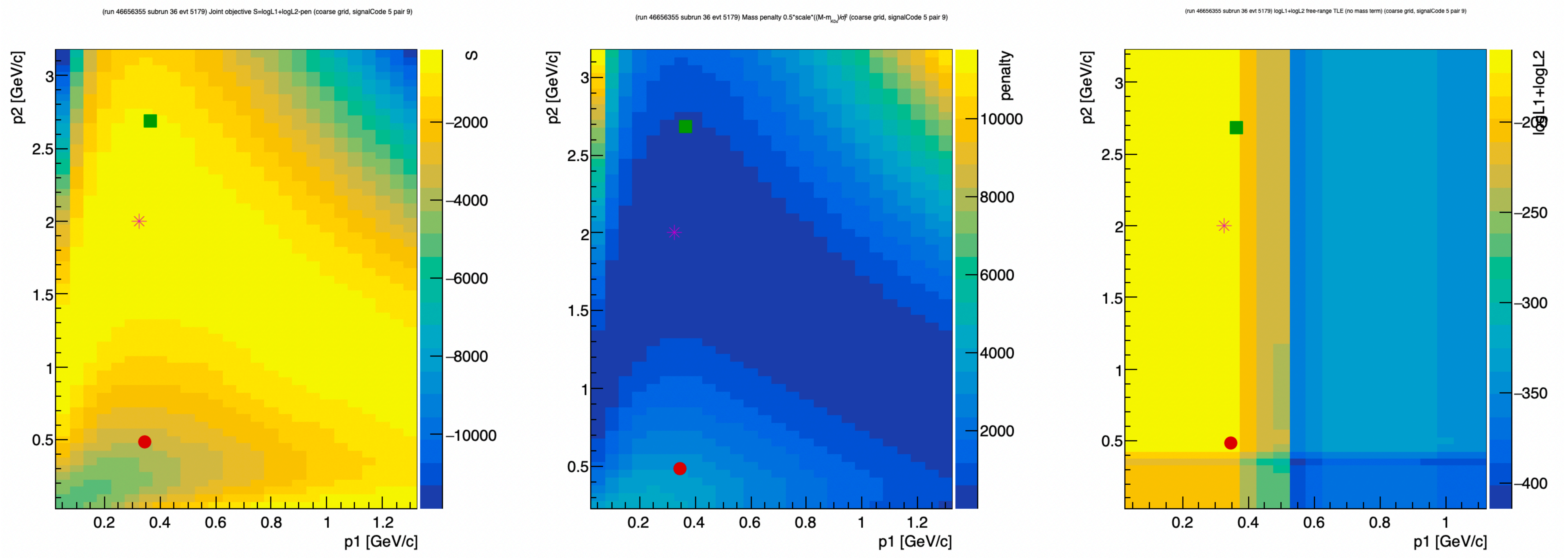
- We assume the two pions come from a two body K0 decay: this gives a constraint that we call “Mass Penalty”;
- We can define a new likelihood that is the sum of the two individual TLEFit likelihoods (L1, L2) and the mass penalty term that couples them;

$$\mathcal{L}(p_1, p_2) = \log L_1(p_1) + \log L_2(p_2) - \frac{\lambda}{2}\left(\frac{M(p_1, p_2) - m_{K_S^0}}{\sigma_M}\right)^2$$

- Here we are only estimating the magnitude of the momenta, the unit vectors of each particle is fixed and it comes from the reconstruction;
- Sigma_M is calculated event-by-event (~30 MeV) based on the curvature of the L1,L2 likelihoods around the maxima;

TLEFit + Mass Penalty

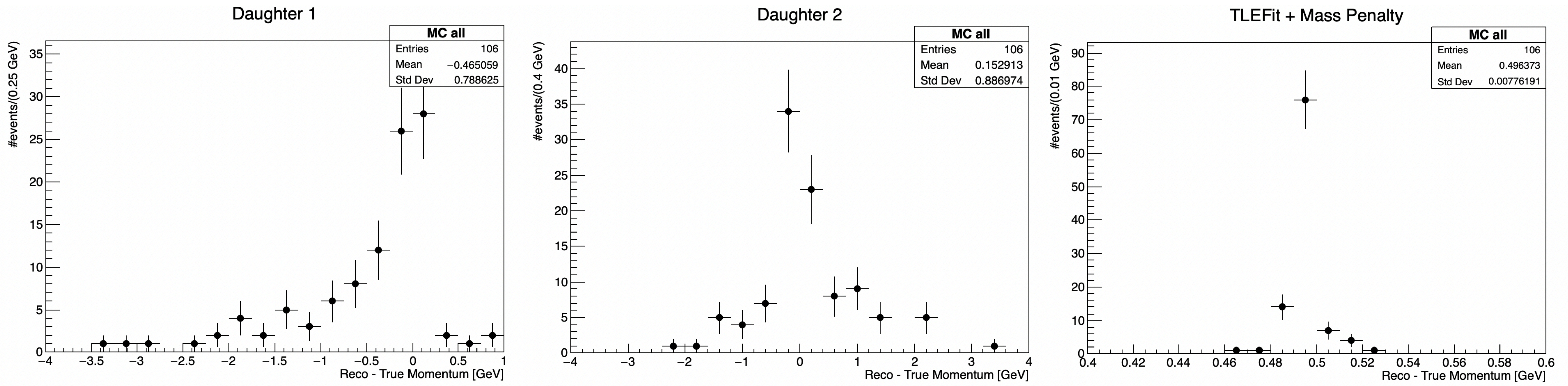
- The mass penalty term favours a region given the opening angle between the two pions;
- It’s contribution is determined by a scale parameter that is unable;



Performance of TLEFit + Mass Penalty

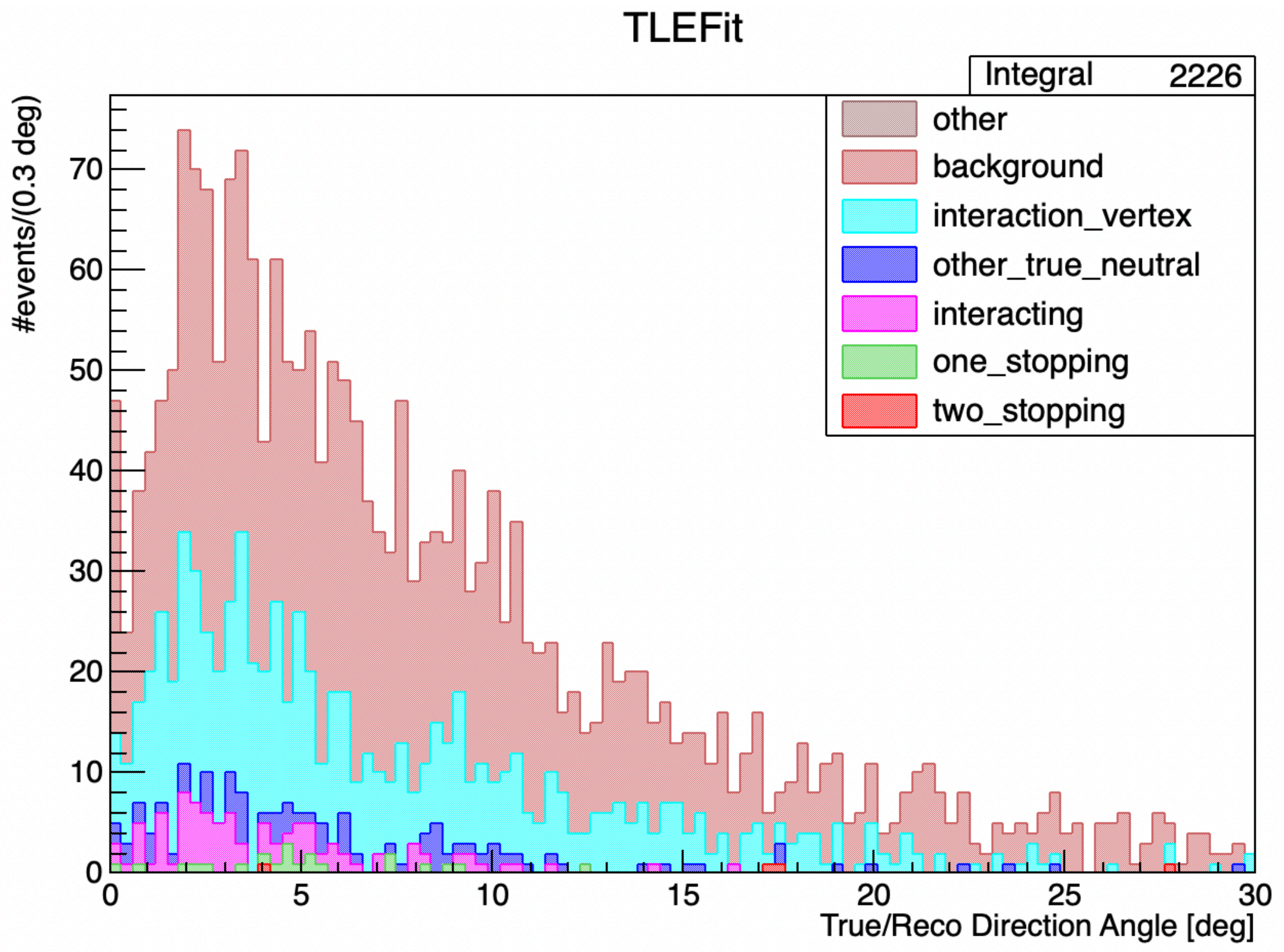
- Now, the two pion momenta are estimated simultaneously and they are forced to add up to the resultant momentum so that the invariant mass is the the K0 invariant mass (~497 MeV);

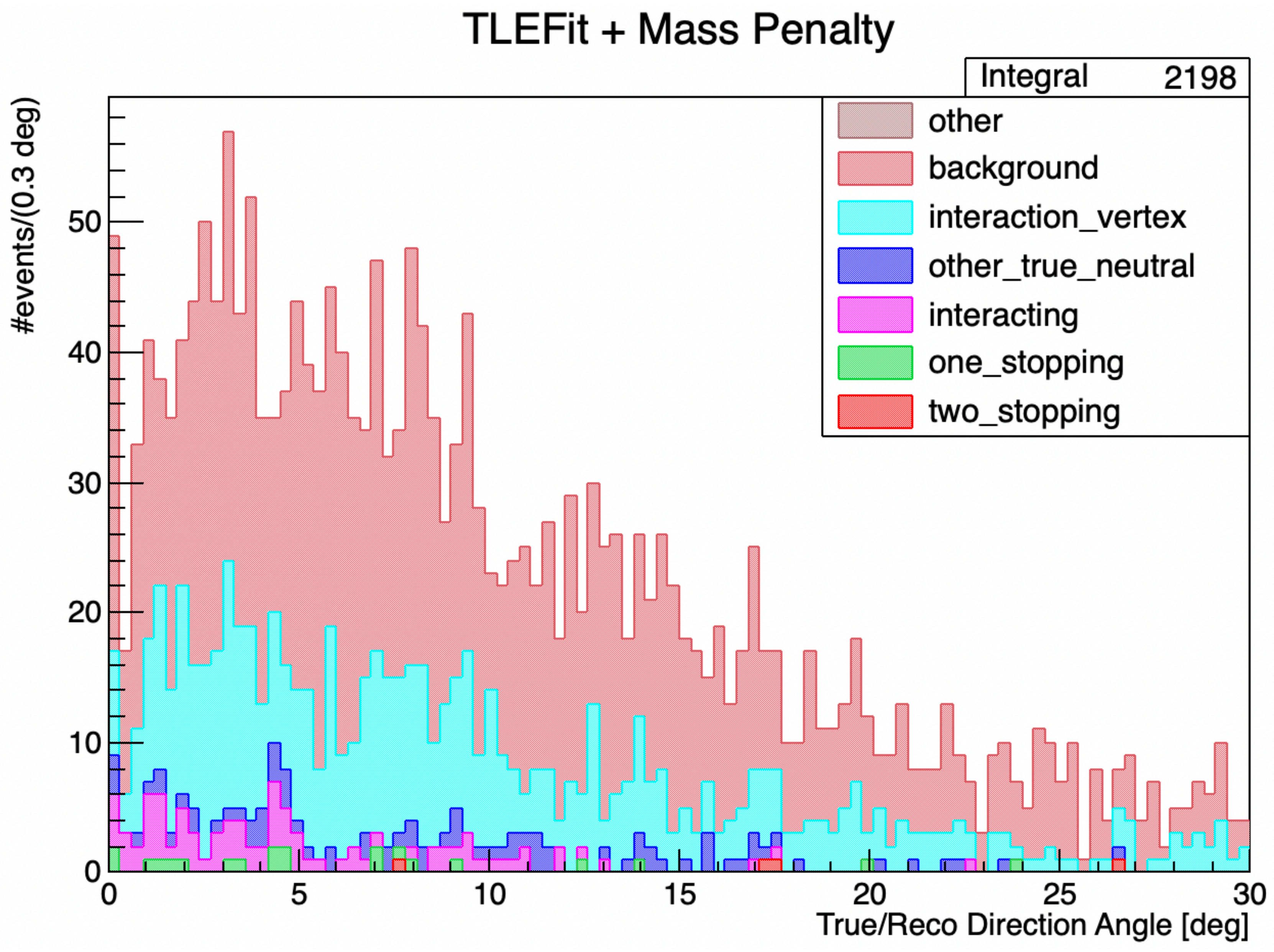
- Daughter1 (always longer) tends to move less than Daughter2 (always shorter): probably need a weight based on the length or other geometric properties;



Resultant Momentum Reconstruction

- The angle between the true/reco direction of the resultant momentum of the vertex;
- TLEFit + Mass Penalty brings more signal population closer to 0 while it widens the distribution for the non-matching candidates;





Next Steps

- It looks like the joint-fit technique goes towards the right direction;
- Ideally, I would like to constrain on the K0 momentum (from the creation vertex), but there are a lot of missing energy;
  - Although, there is a channel where this could be potentially done
  - K+ + n -> K0 + p
- Joint Fit could be done not only on the momentum magnitudes, but also on the pion directions;