Run 3 Electron Reconstruction Studies

Furkan Cetin

Heidelberg University

cetin@physi.uni-heidelberg.de

February, 2024

Motivation

- electrons heavily emit bremsstrahlung
- electron track-finding underperforms compared to other particles

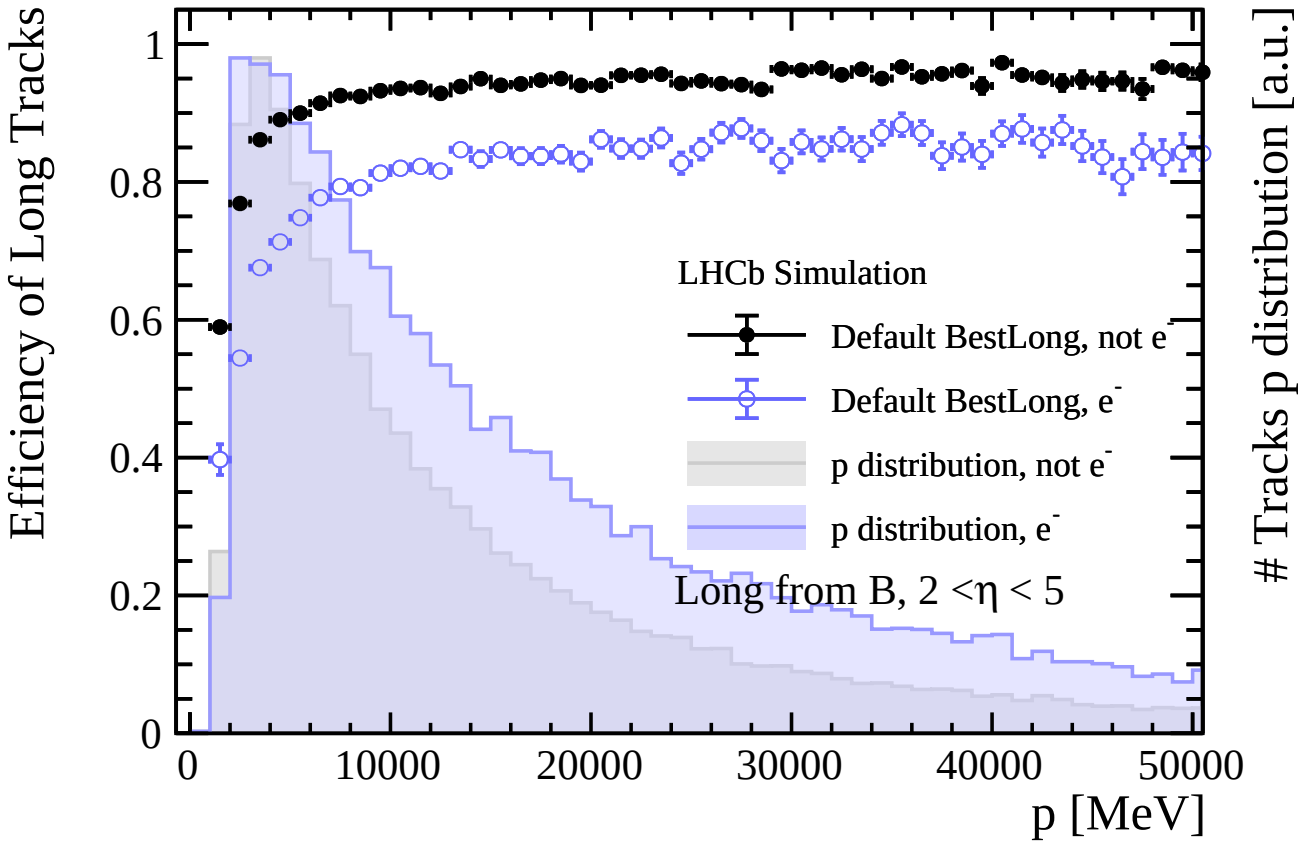

Figure: BestLong Efficiency of electrons and not-electrons. Electron bremsstrahlung in VELO considered in momentum distribution.

Reminder

Upper limit for electron Matching is determined by the Seeding efficiency.

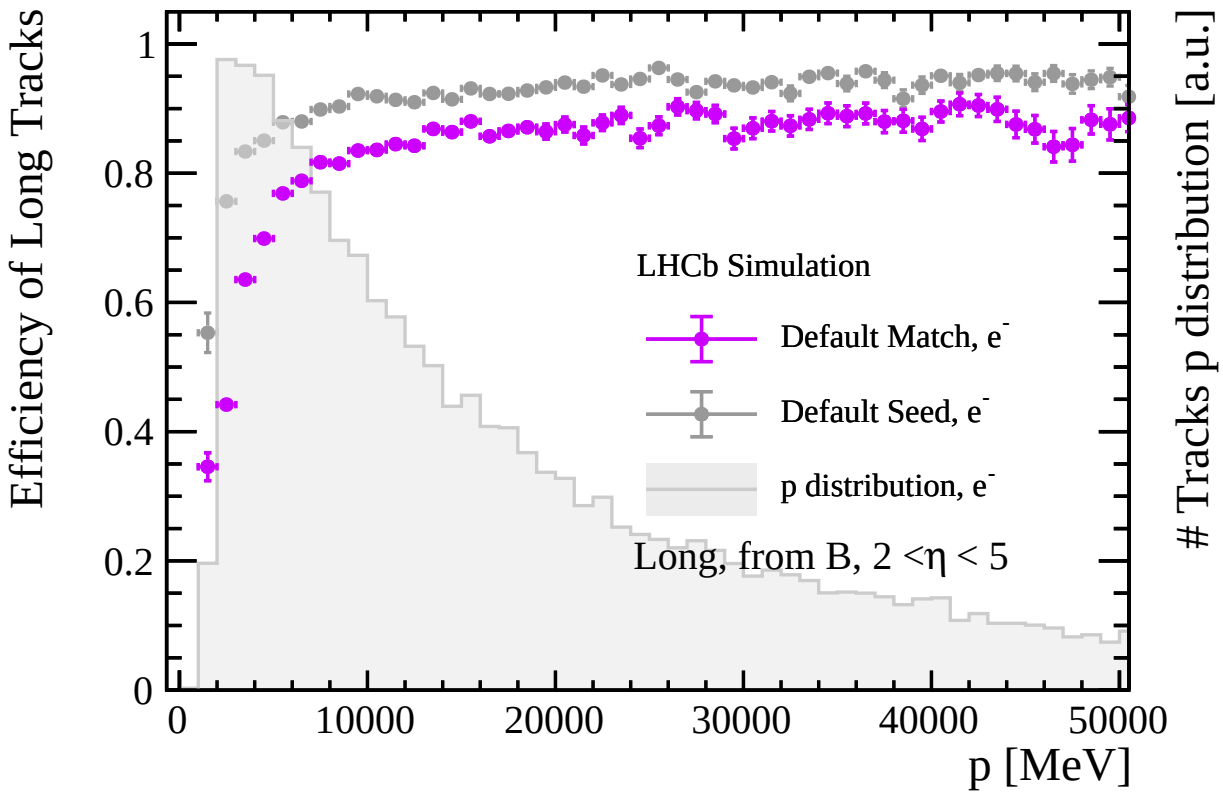

Figure: Efficiency for electron Match and Seed tracks. Electron bremsstrahlung in VELO considered in momentum distribution.

Efficiency Plot - Momentum Corrections

- redefined the momenta p and p_T of electrons that are used to illustrate efficiencies for MC particles

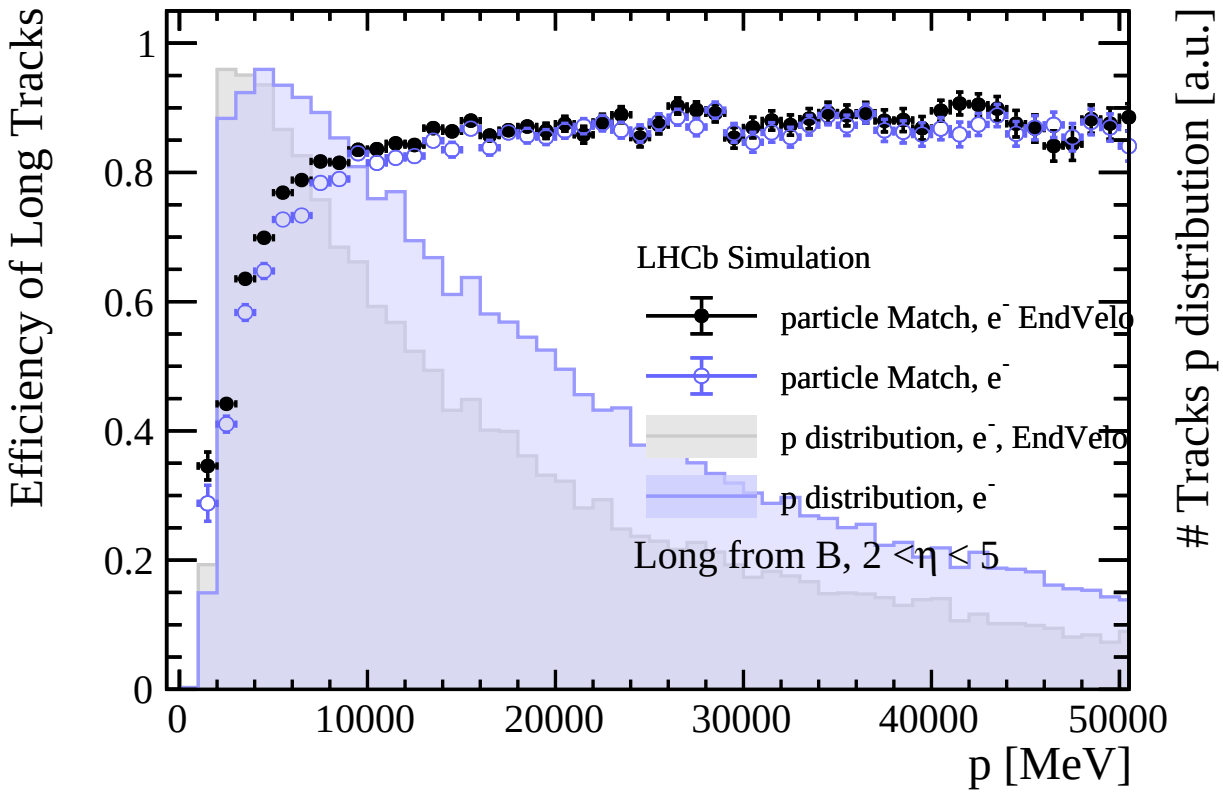

Figure: Efficiency for electron Match tracks using current and new momentum definition

Grunt Work

- new parameterisation of variables used in Matching (z_{mag} and $y_{\text{corr}}^{\text{match}}$)
- used only electrons, with some sanity cuts

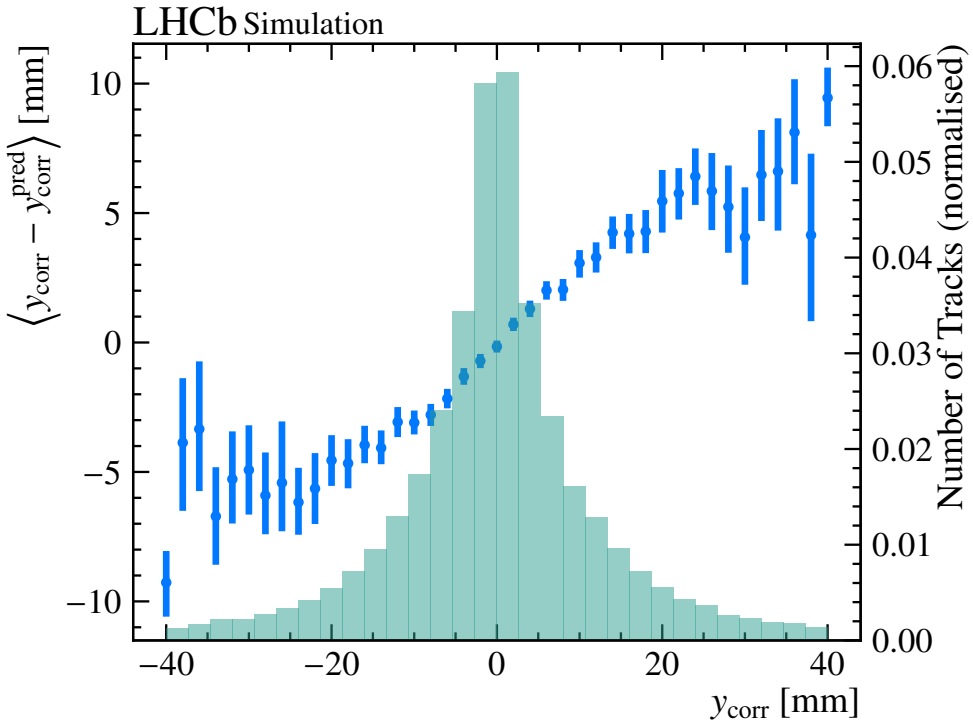

Figure: New parameterisation for $y_{\text{corr}}^{\text{match}}$.

z_{mag}

New parameterisation for the magnet kick position is not ideal but much better than what is currently used.

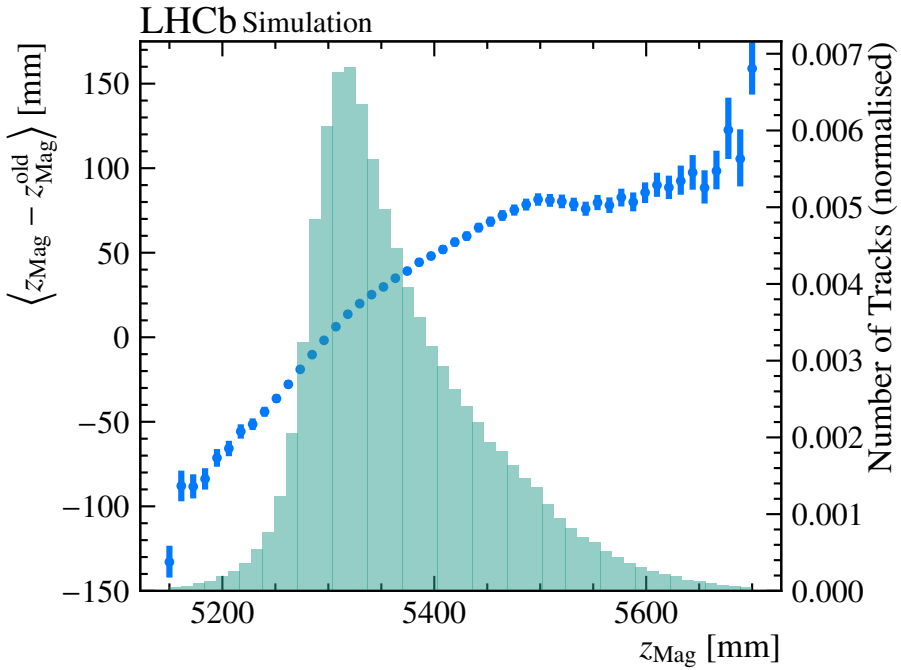

Figure: Old parameterisation for z_{mag}.

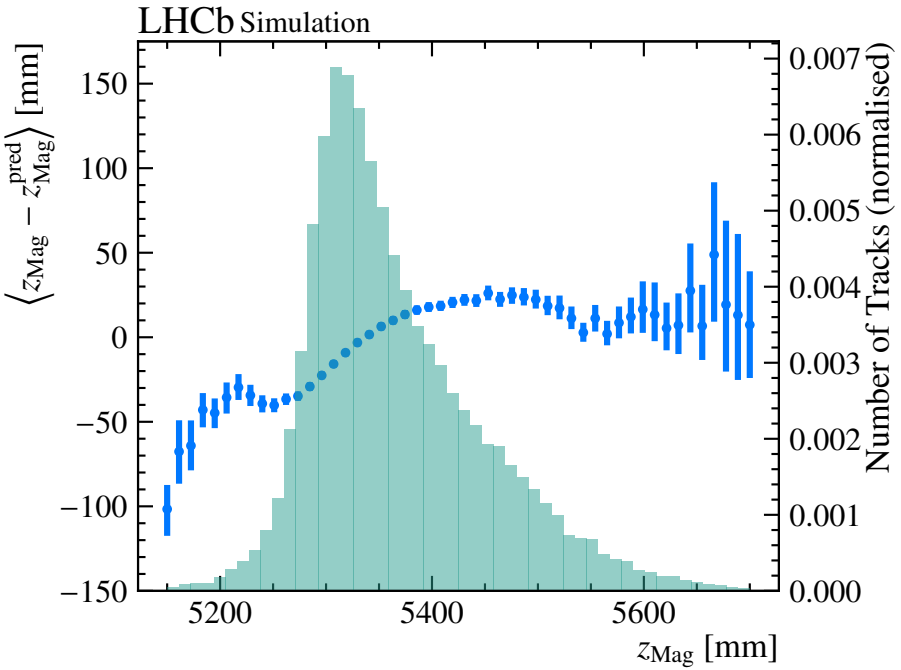

Figure: New parameterisation for z_{mag}.

Electron Matching using Calorimeter Information

- Matching trained with perfect T track selection

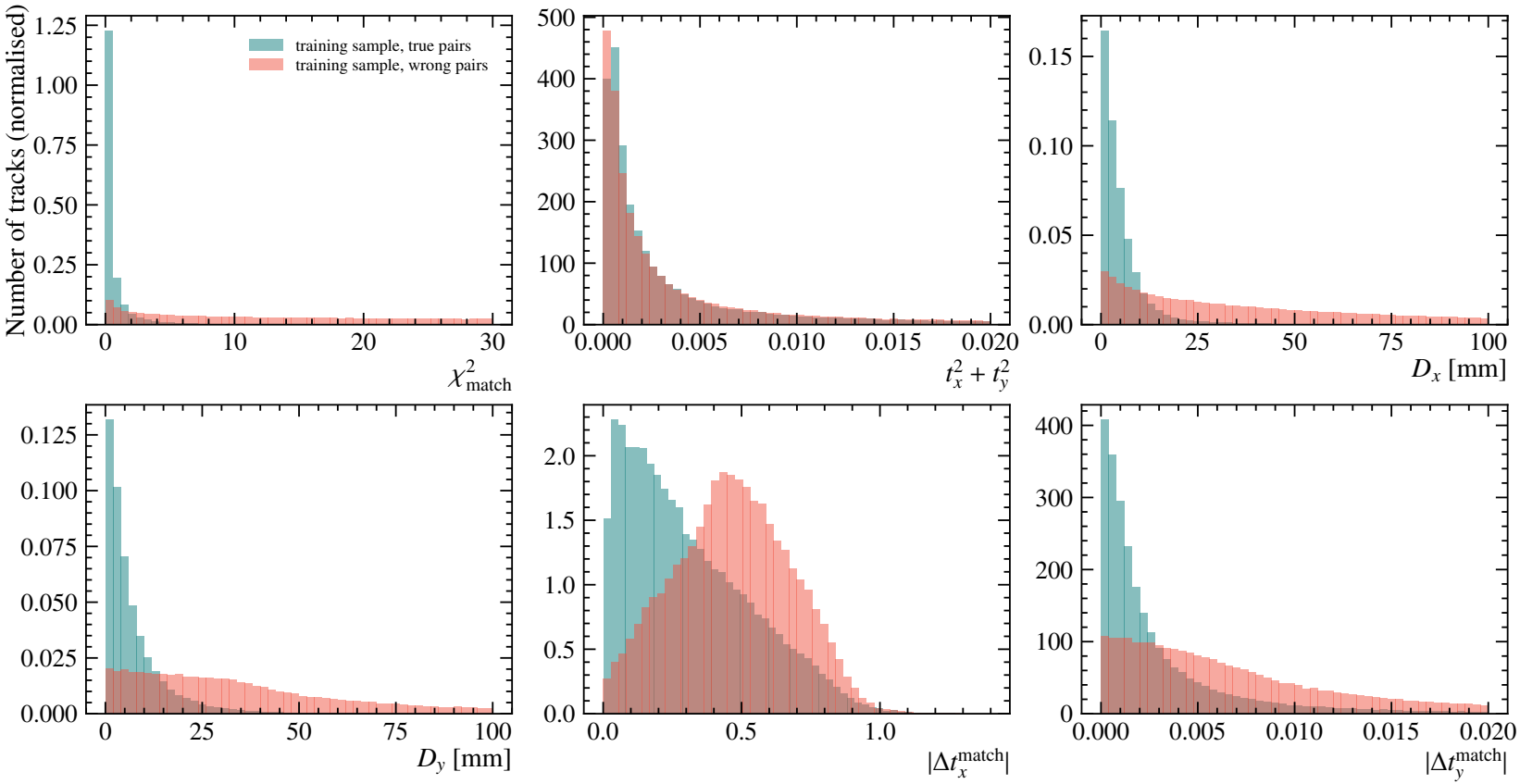

Figure: Electron Matching input variables' distributions

Efficiency

- Seed efficiency of about 92%
- Trained with T track selection

Table: Integrated efficiencies of different cuts. Obtained using MC sim of $B^0 \to K^*(J/\psi \to e^+e^-)$.

Cut	Default	No T Selection
`fromB`	83.46%	86.79%
`fromB_P>5GeV`	86.22%	89.19%
`fromB_P>3GeV_Pt>0.5GeV`	87.72%	90.68%
fake track fraction	17.44%	37.05%

Conclusion

- Electron Matching with perfect Seed track selection shows efficiency gains
- No variable currently shows significant enough improvements to warrant changing the Matching variables
- Adding z_{mag} could be a possibility

To do:

- study ECAL cluster filter to find ideal cut to control ghosts while maintaining efficiency gains

Momentum Corrections

- integrated efficiency remains constant
- electrons that lose more energy in the VELO have higher efficiency at lower momenta, on average

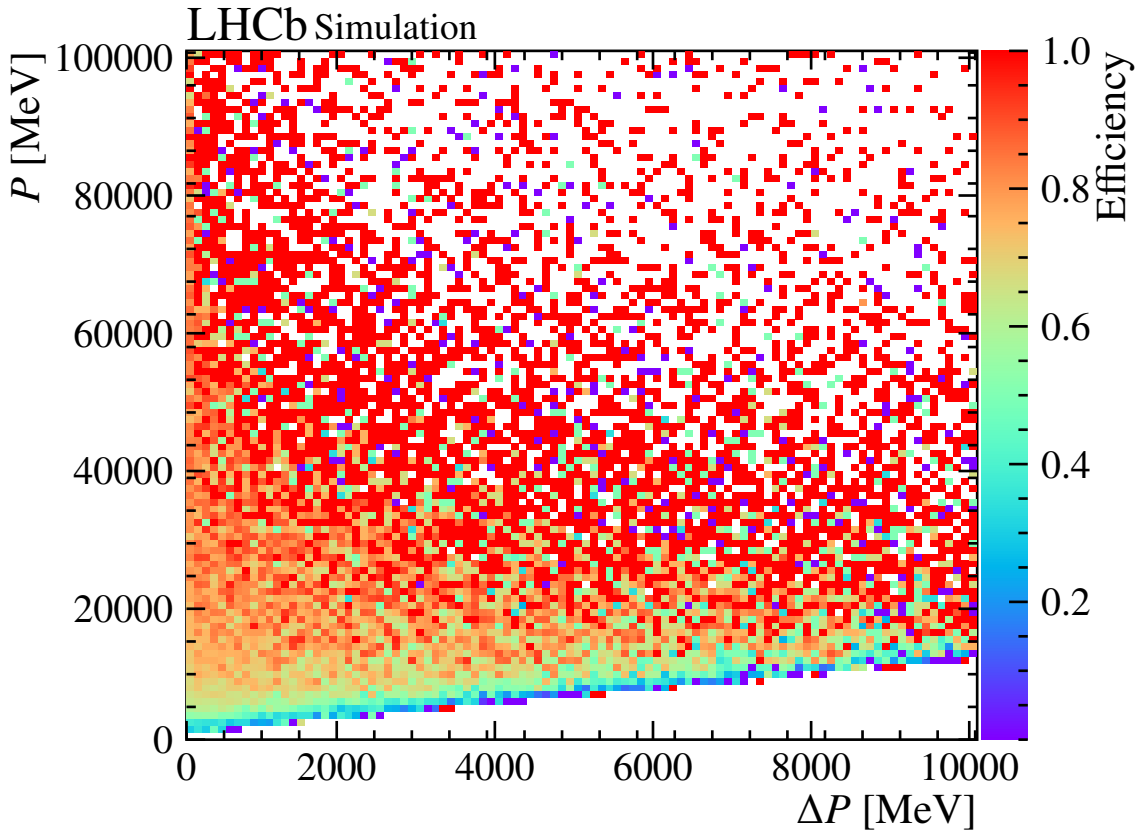

Figure: Efficiency for electron Long tracks as function of True$P$ and ΔP

Electron Matching using Calorimeter Information

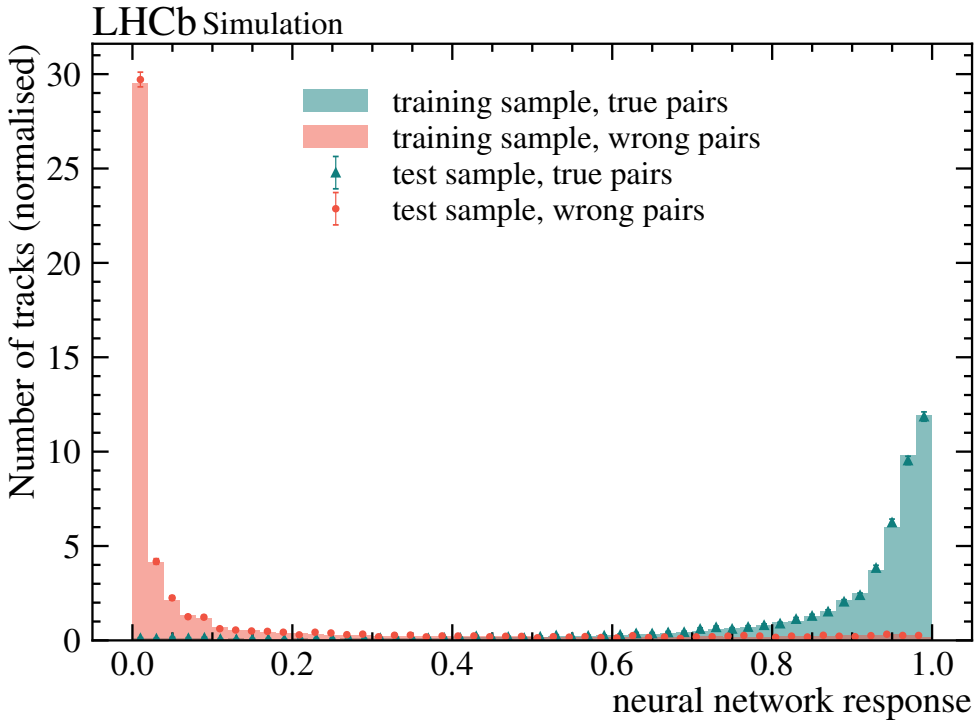

Figure: Electron Matching MLP response.

Raw Efficiency Before Parameterisation

- Efficiencies, without T track selection

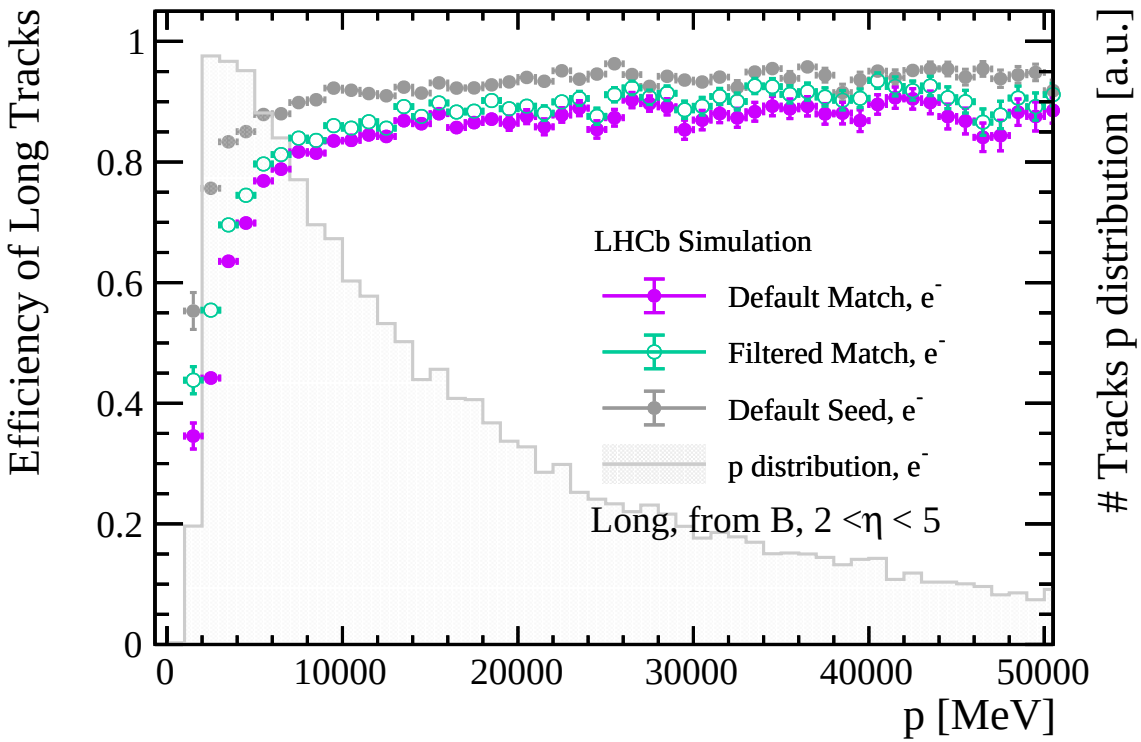

Figure: Electron Matching and baseline Matching Efficiency. Electron bremsstrahlung in VELO considered in momentum distribution.

Magnet Kick Position z_{mag}

$$z_{\text{mag}} = c_0 + c_2|x_{\text{EndT}}| + c_3 t_x^2 + |\Delta t_x^{\text{match}}|(c_1 + c_4|\Delta t_x^{\text{match}}|)$$

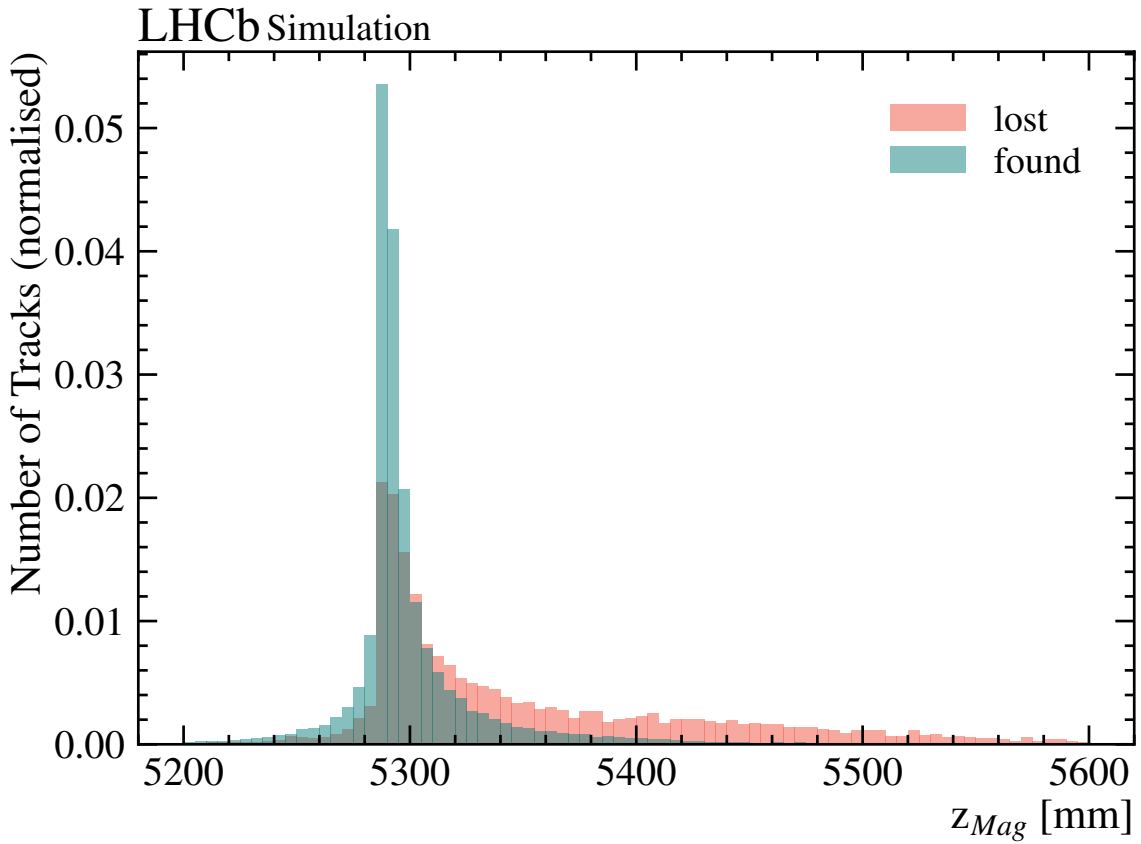

Figure: Pseudorapidity for lost and found electrons originating from a B meson.

Pseudorapidity η

- Matching already includes $t_x^2 + t_y^2$ but maybe η works better for electrons

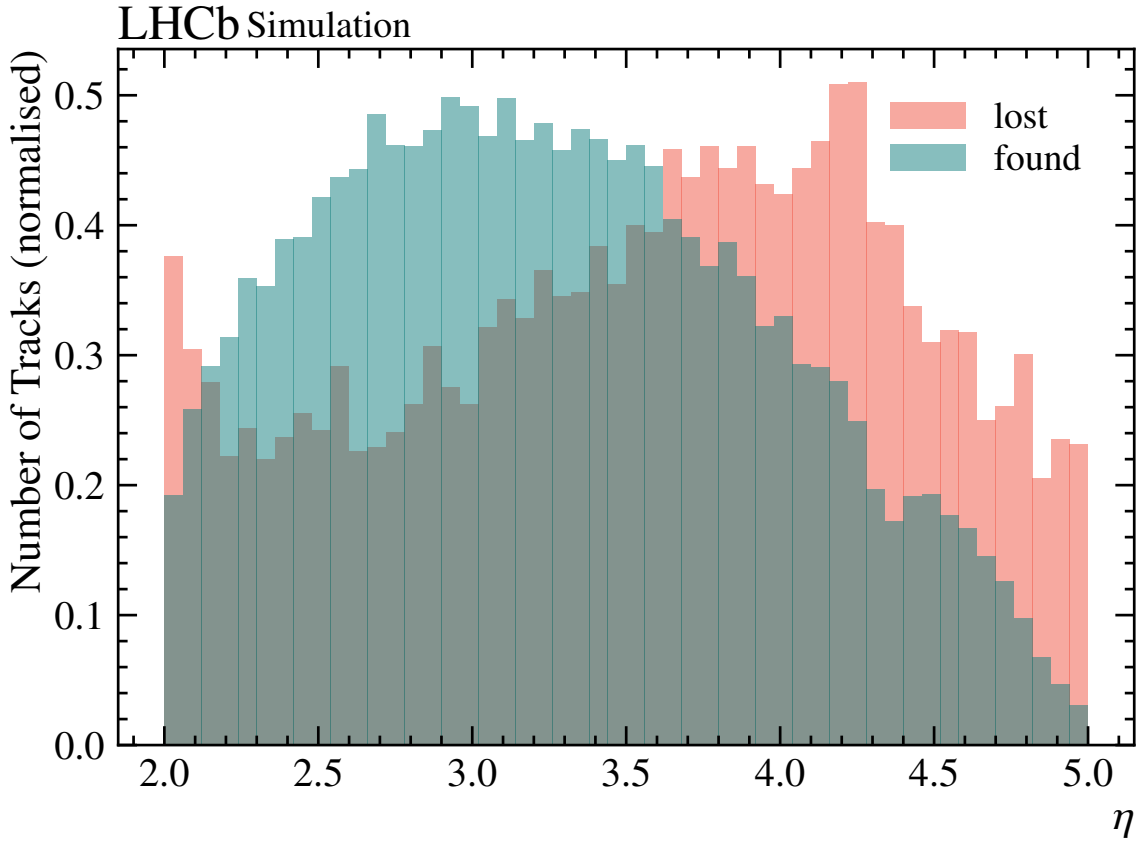

Figure: Pseudorapidity for lost and found electrons originating from a B meson.