

Muon Collider Full Simulation Studies

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Updates: Jet substructure to reduce fake jets

Signal process: $\mu^+\mu^- \rightarrow \nu\bar{\nu}H, H \rightarrow b\bar{b}$ at $\sqrt{s}=1.5$ TeV
with BIB overlaid at 1.5 TeV.

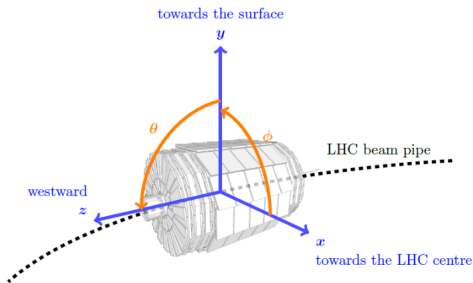
- Jets clustered with kt-algorithm with cone size of 0.7
- Jet daughter particles also stored

Coordinate system and variables in use

For jets and its daughter particles, (E, P_x, P_y, P_z) info stored as
TLorentzVector Jet

Then access its 'position' and 'time' (Jet.X(), Jet.Y(), Jet.Z(), Jet.T())

$$R = \sqrt{X^2 + Y^2} \quad \theta = \cos^{-1}\left(\frac{P_z}{P}\right) \quad \phi = \tan^{-1}\left(\frac{P_y}{P_x}\right)$$



Origin of fake jets

- hard scatter jets originating from IP
- bib (fake) jets are from particles coming from beam pipe, they enter calorimeter detector longitudinally

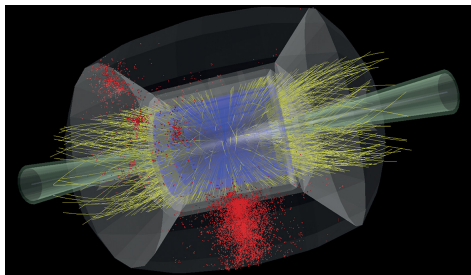


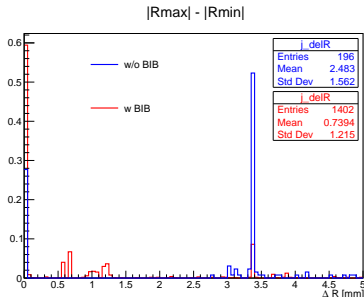
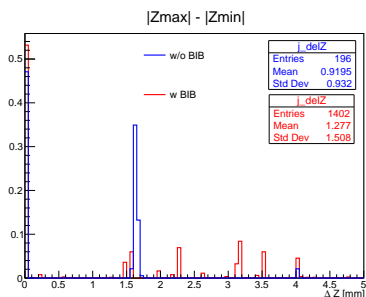
Figure: Simulation of $H \rightarrow b\bar{b}$ in presence of BIB. Credit: D Lucchesi et al

Jet substructure

Left: Longitudinal width ΔZ between jet daughter particles

Right: Depth into transverse plane ΔR where $R = \sqrt{X^2 + Y^2}$

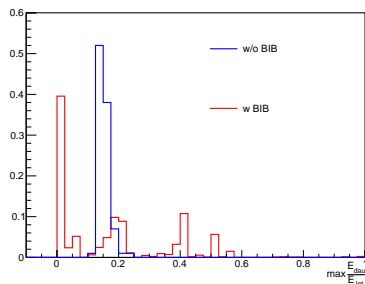
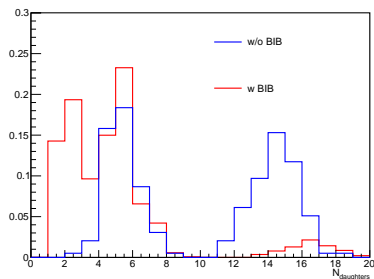
$$\Delta Z = |Z_{max}| - |Z_{min}| \text{ and } \Delta R = |R_{max}| - |R_{min}|$$



- fake jets have larger ΔZ since BIB particles more longitudinal
- and smaller ΔR

Jet substructure

Number of daughter particles within jet (left) and max E ratio (right)

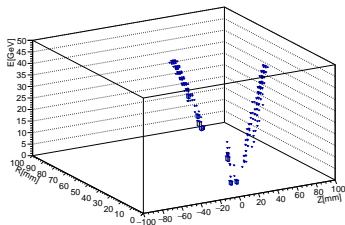
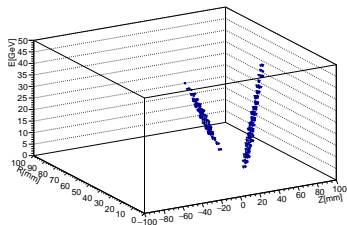
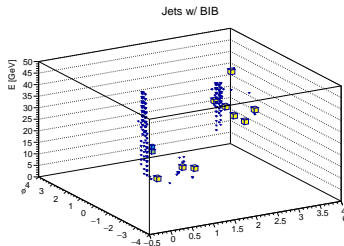
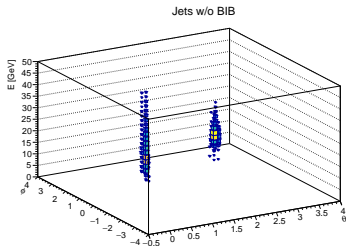


- fake jets have lower number of daughter particles
- fake jets have large energy fraction carried by single particle

Update

- Apply combination of ΔZ and ΔR cuts.
- Looking into jet daughter particles filling (Pandora PF Objects)
- Check acceptance of b-jets in presence of nozzle structure
 $0 < \theta < 10$ and $170 < \theta < 180$

Jet (θ, ϕ, E) and (Z, R, E)



Jet particles θ , ϕ , E

