Muon Collider Full Simulation Studies

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Updates: Jet substructure to reduce fake jets

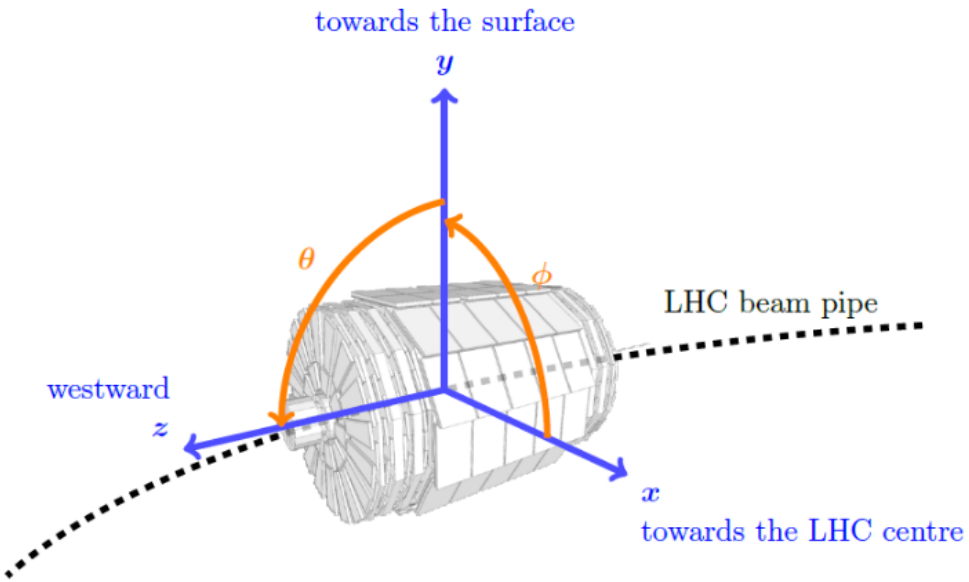
Signal process: $\mu^+\mu^- \rightarrow \nu\bar{\nu}H, H \rightarrow b\bar{b}$ at $\sqrt{s}$=1.5 TeV with BIB overlaid at 1.5 TeV.

-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, Px, Py, Pz) info stored as TLorentzVector Jet
Then access its 'position' and 'time' (Jet.X(), Jet.Y(), Jet.Z(), Jet.T())

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



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

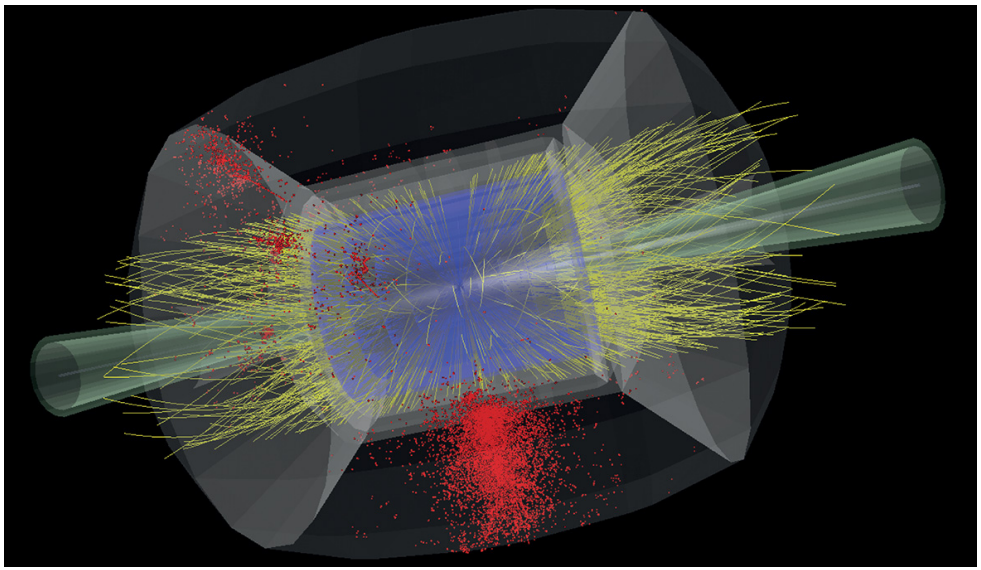
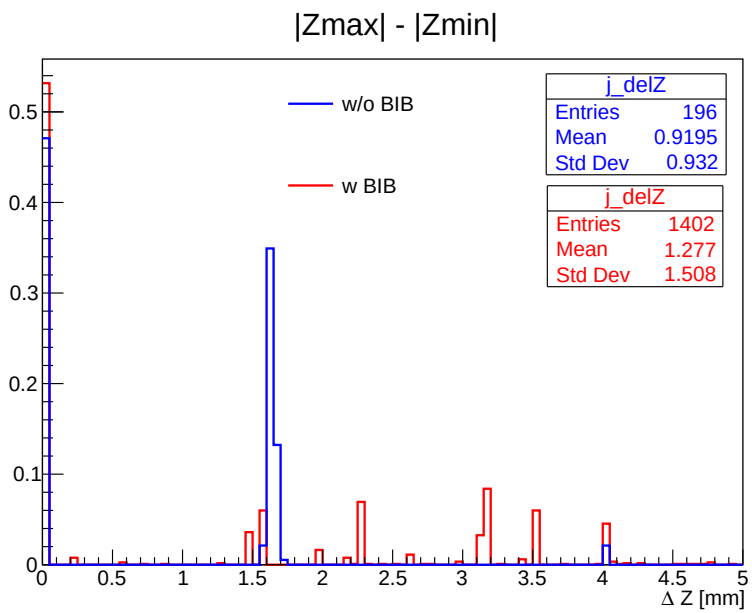
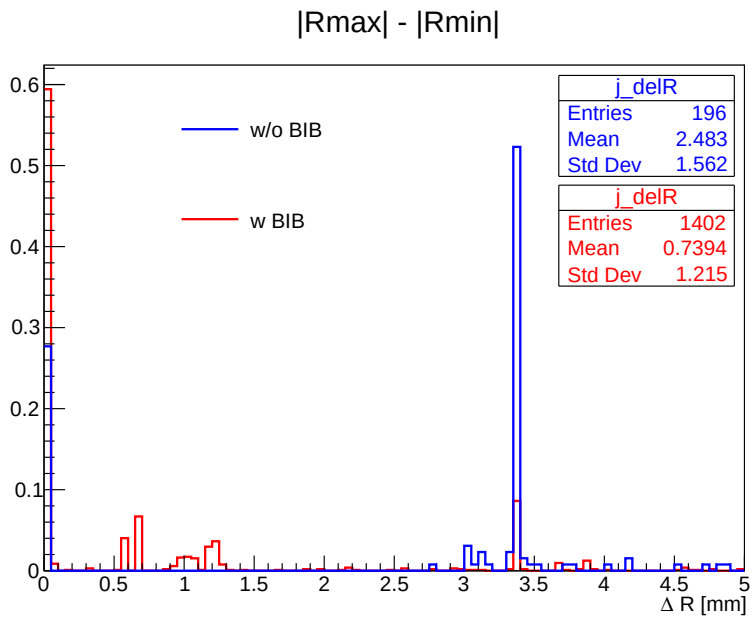


Figure: Simulation of $H \rightarrow b\bar{b}$ in presence of BIB. Credit: D Lucchesi et al

Jet substructure

Left: Longitudinal width ΔZ between jet daughter particles
Right: Depth into transverse plane ΔR where $R = \sqrt{X^2 + Y^2}$
$\Delta Z = |Z_{max}| - |Z_{min}|$ and $\Delta R = |R_{max}| - |R_{min}|$

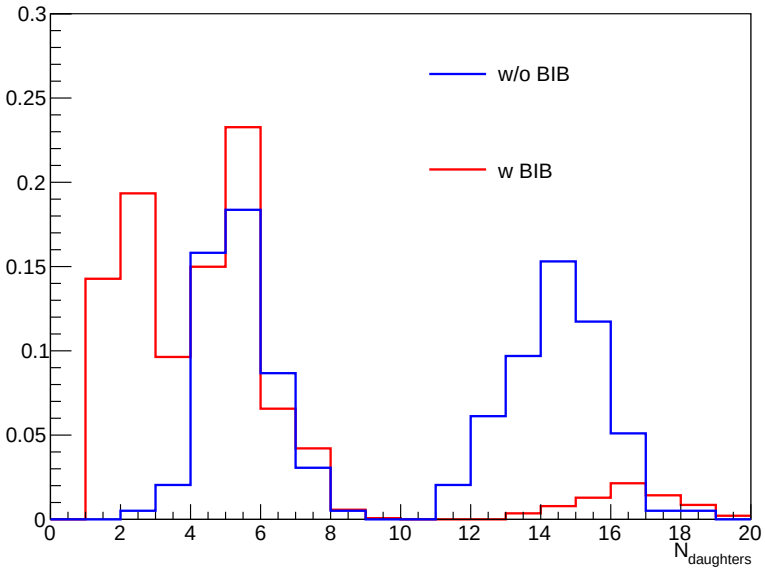


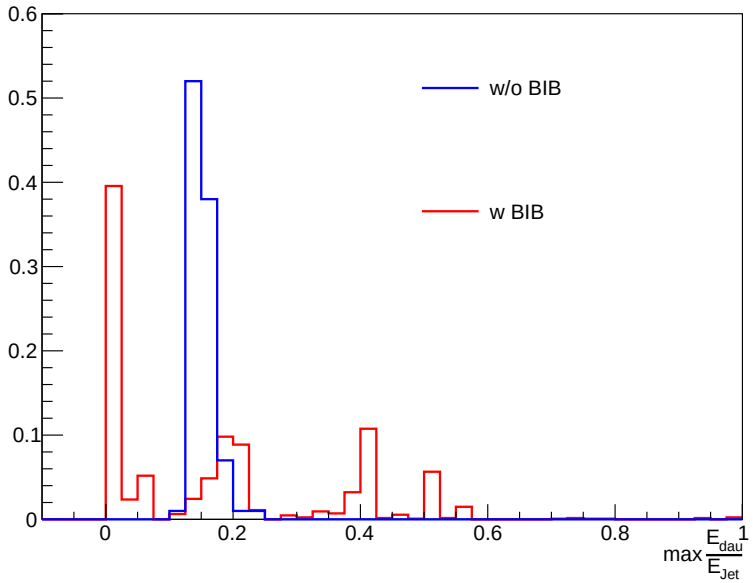


- fake jets have larger ΔZ since BIB particles more longitudinal
- and smaller ΔR

Jet substructure

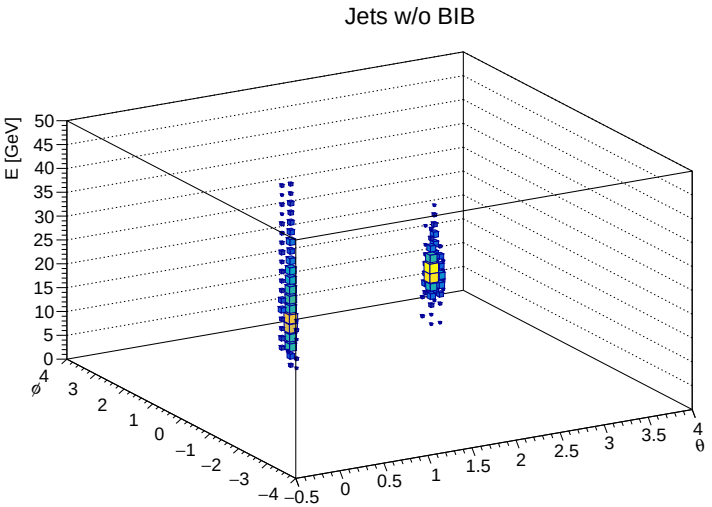
Number of daughter particles within jet (left) and max E ratio (right)

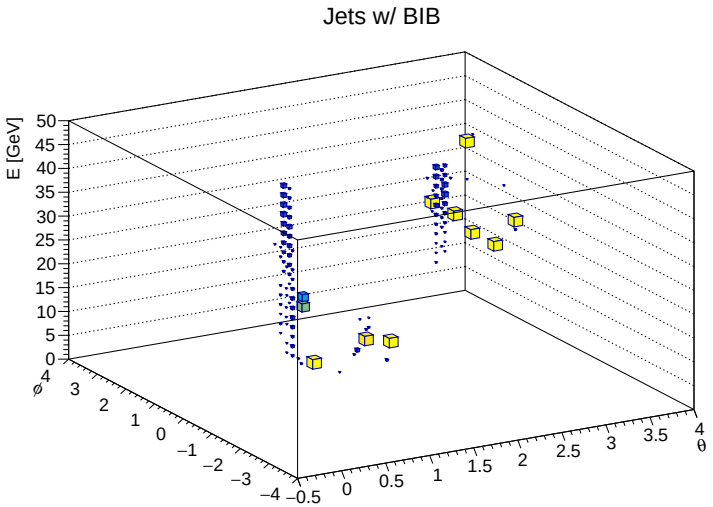


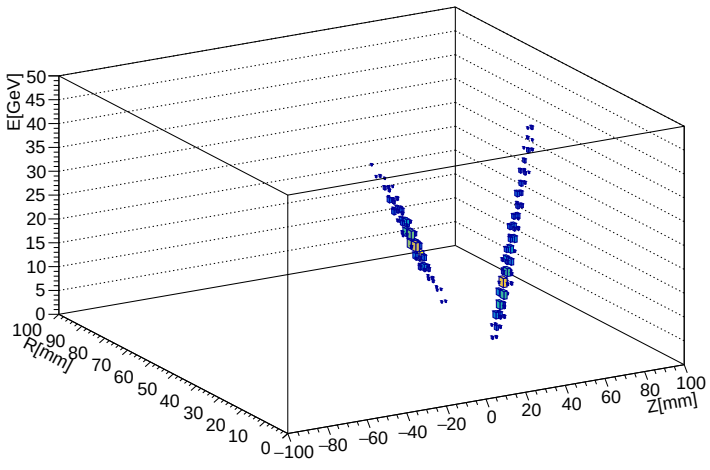


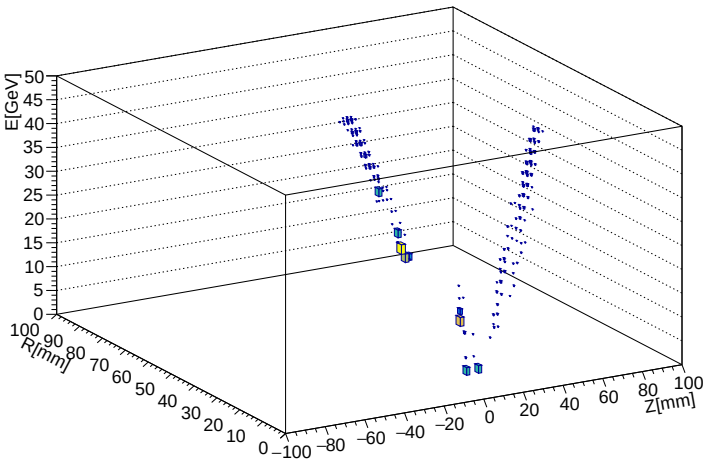
- fake jets have lower $N_{daughters}$
- fake jets have large energy fraction carried by single particle

Jet (θ, ϕ, E) and (Z, R, E)

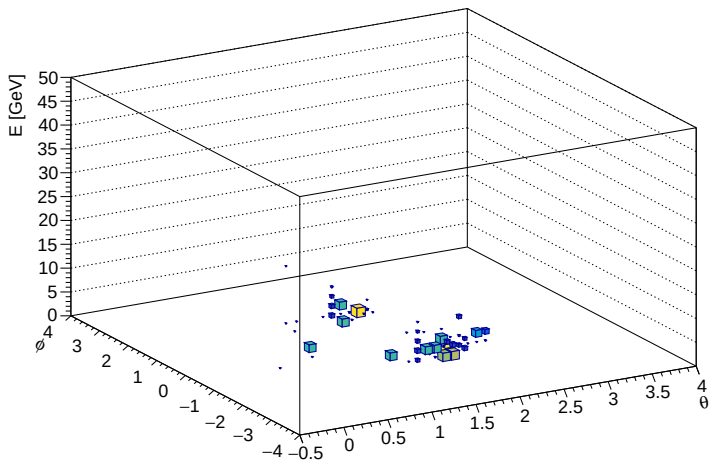


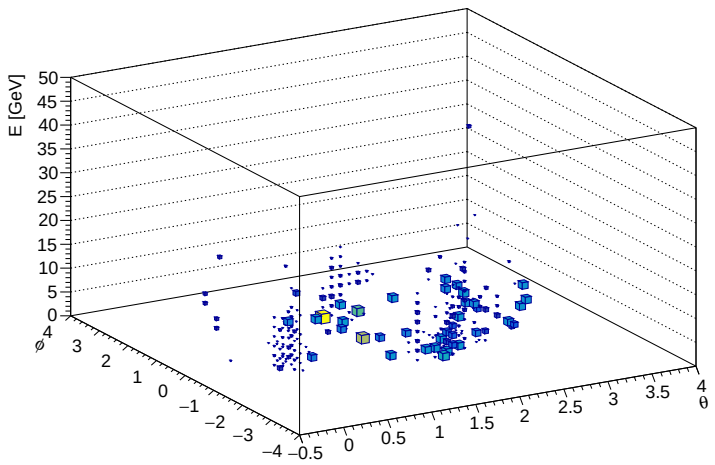






Jet particles θ, ϕ, E





Next steps

- Check di-jet mass peak after reducing fake jets