Comparison of different beam distance definitions for the VLC algorithm

Matthias Weber (CERN)

VLC algorithm introduced in "Jet reconstruction at high-energy electron-positron colliders" (EPJC 78 (2018) 144 by Boronat et al
https://arxiv.org/pdf/1607.05039.pdf

VLC uses recombination scheme similar to algorithms used at the LHC (k_T, anti-k_T etc) with a Durham like inter-particle distance

$$d_{ij} = 2\min(E_i^{2\beta}, E_j^{2\beta})(1 - \cos\theta_{ij})/R^2$$

and a beam distance measure.

VLC algorithm: beam distance measures

The paper suggests to use the following beam distance measure:

$$d_{i\mathrm{B}} = E_i^{2\beta} \sin^{2\gamma} \theta_{i\mathrm{B}}$$

paper

For all studies in the recent past we used the VLC algorithm as implemented in the contributions of FastJet (version 1.025):

$$d_{i\mathbf{B}} = E_i^{2\beta} (p_{\mathrm{T},i}/E_i)^{2\gamma}$$
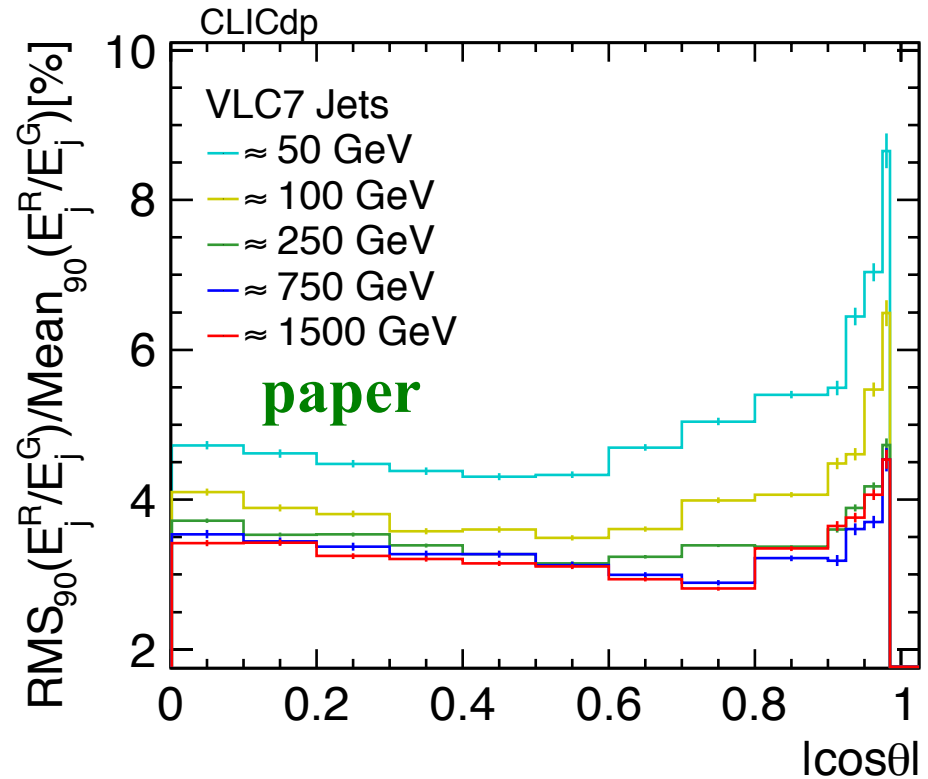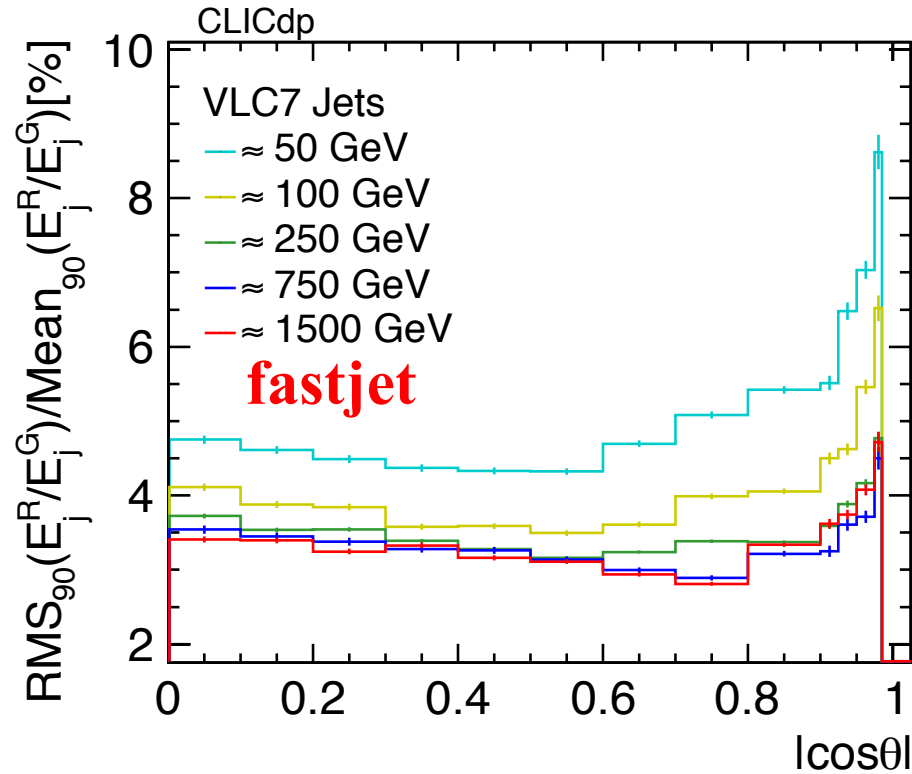
fastjet

Both beam distance measures are the same in case of massless particles/protojets.

Use E-scheme in recombination and massive particles/PandoraPFOs in jets → beam distance measures differ
→ValenciaPlugin file changed to use beam distance as proposed in the original paper, might be out in next version of contributions 1.040
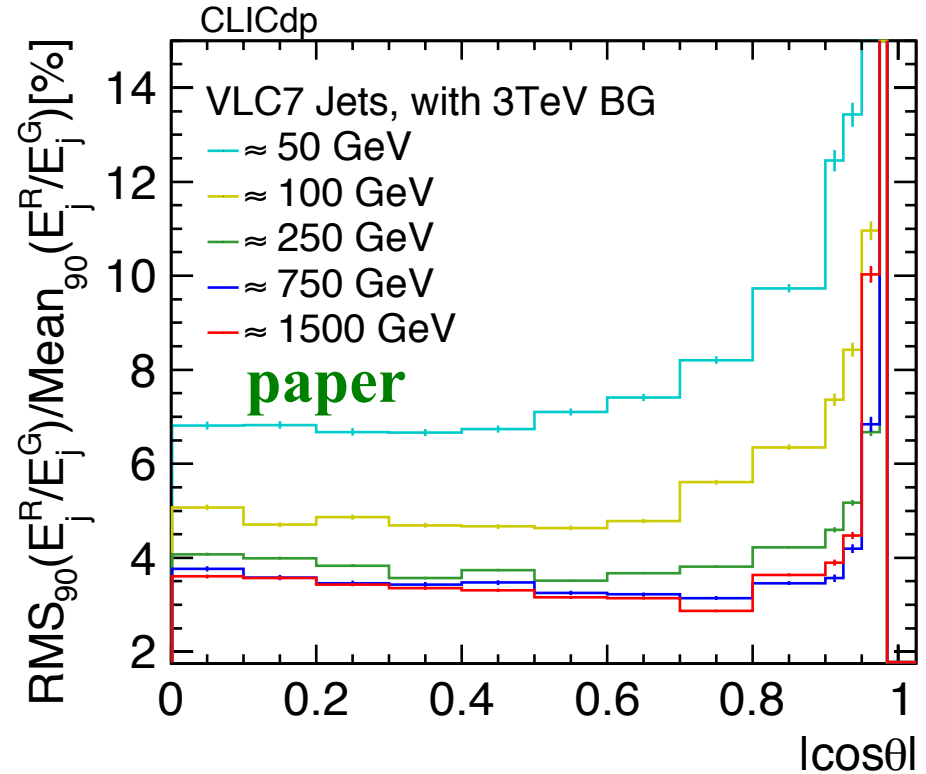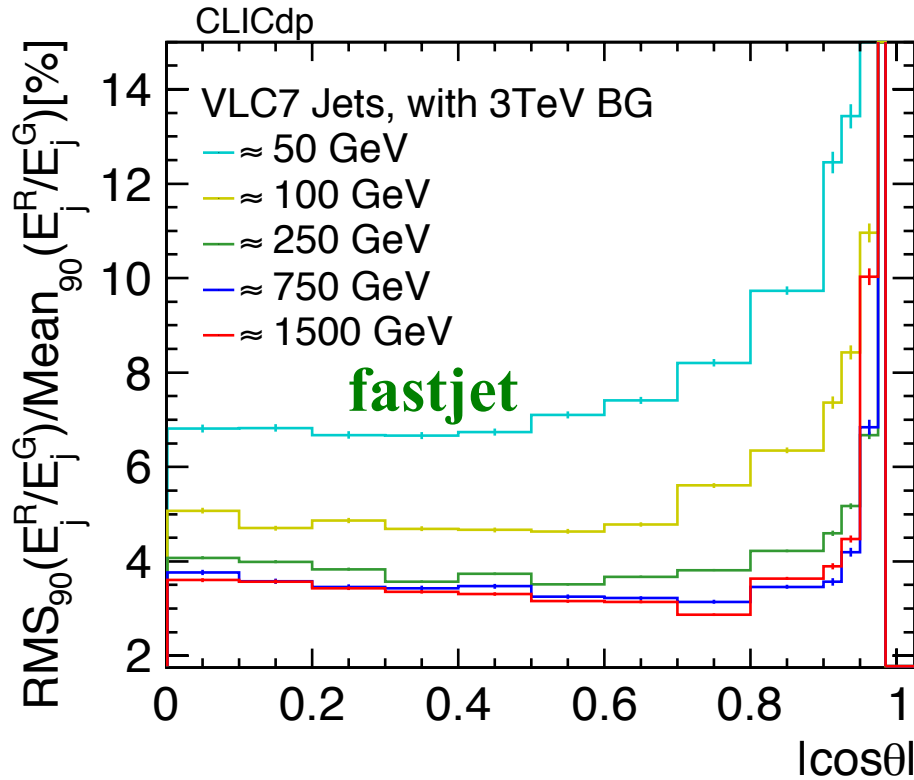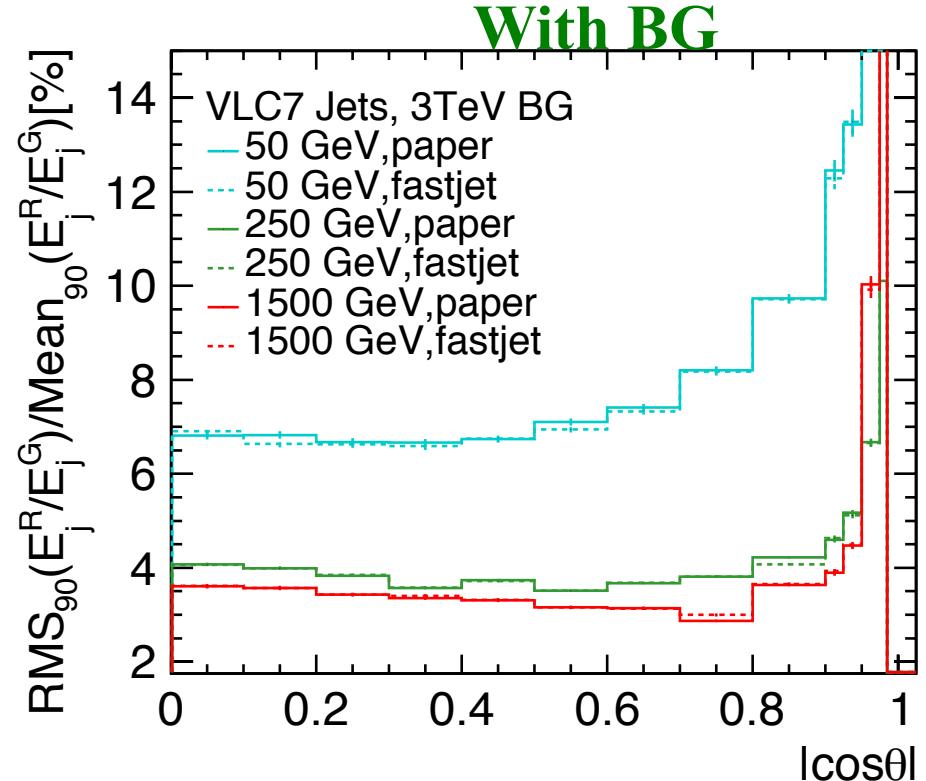
→ Check the impact of the different beam distance measures on final jets
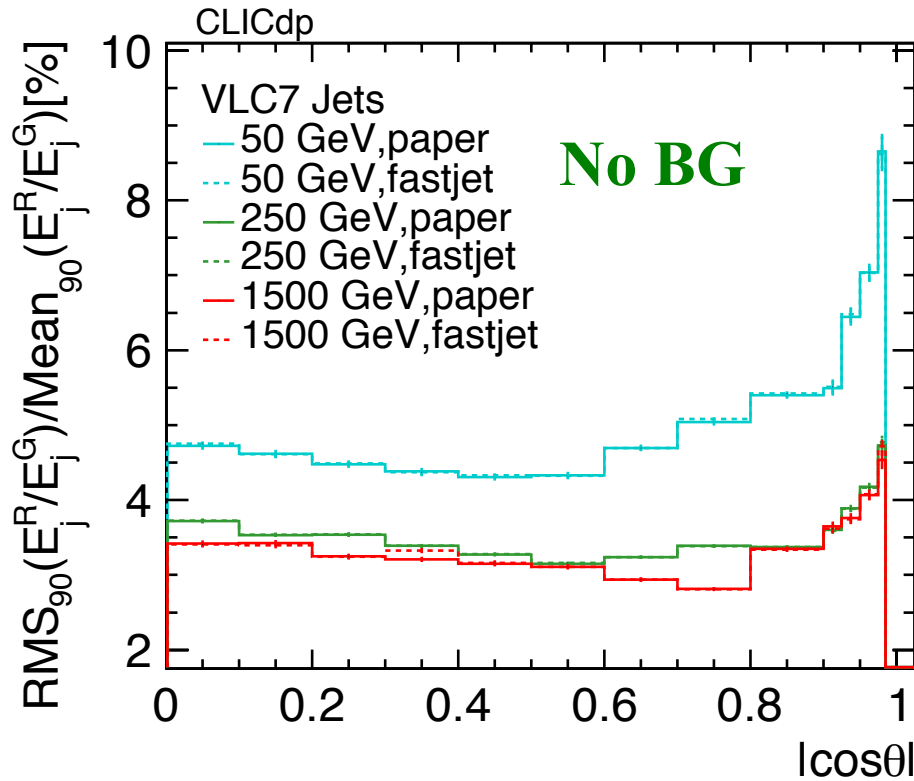
For all jet energies and all polar angles almost no changes visible

Also in presence of 3 TeV beam-induced backgrounds no sizeable changes observed

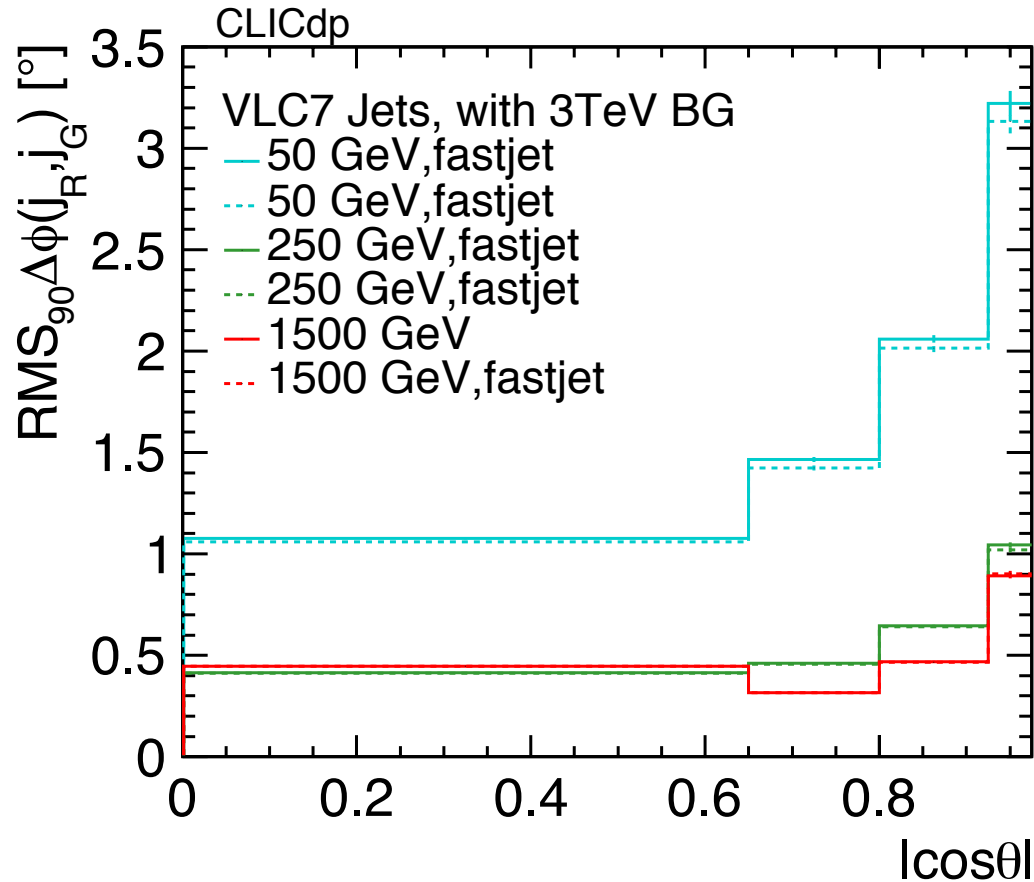Compare the paper beam distance and the fastjet distance of VLC on one plot, solid: fastjet version, dashed: paper version

→almost no differences, both beam distance measures lead to very similar results

Compare the paper beam distance and the fastjet distance of VLC on one plot, solid: fastjet version, dashed: paper version

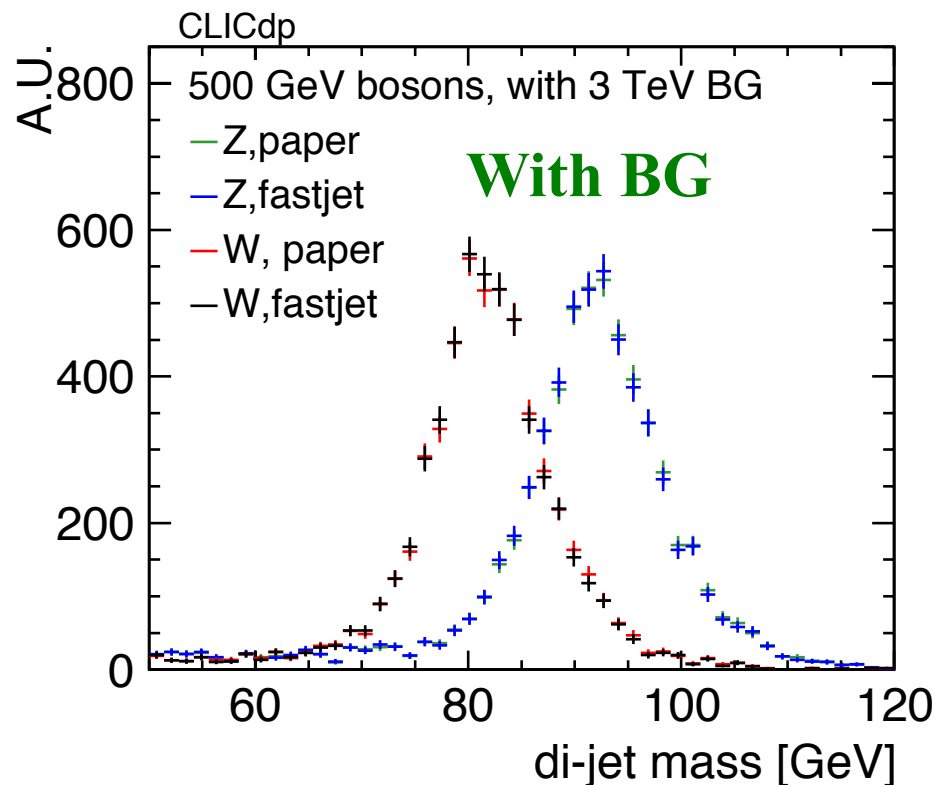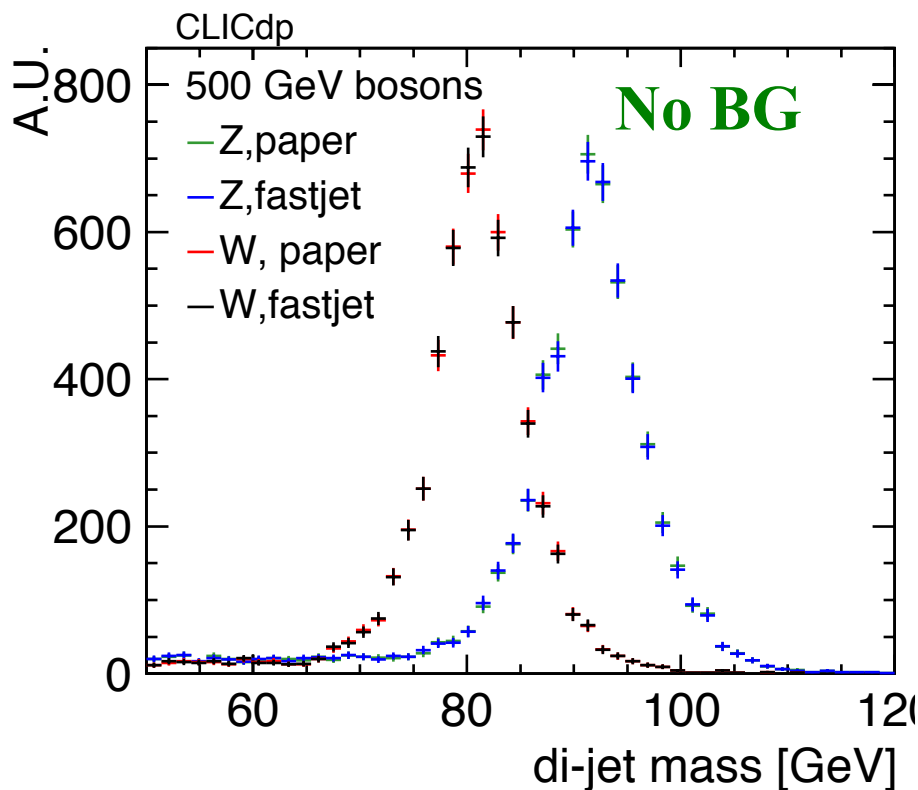→almost no differences, both beam distance measures lead to very similar results

DiJet Masses: use case W and Z mass separation

Compare the paper beam distance and the fastjet distance of VLC on one plot, checked for all bosons energies (same result for the other energies)
→almost no differences, both beam distance measures lead to very similar results

Conclusion

Checked two definition of beam distances for the VLC algorithm, in both cases the inter particle distance has been the same

No large differences can be found for jet energy resolution, jet phi and theta resolutions

DiJet mass distributions from W and Z bosons very similar
→ Mass separation remains largely unchanged