First look at flavour tagging at CLIC using LCFIPlus including beam-induced backgrounds

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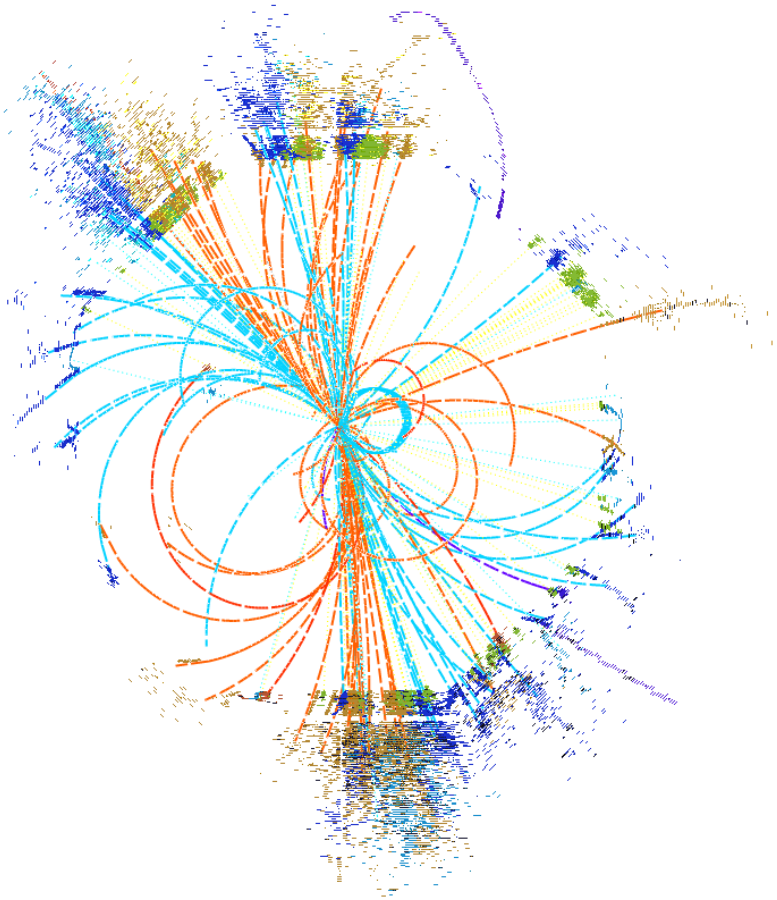
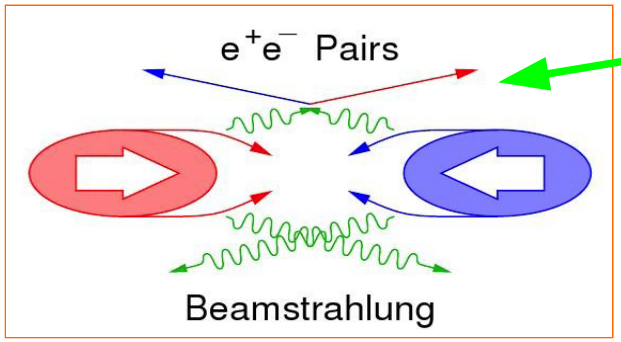
on behalf of the CLICdp collaboration

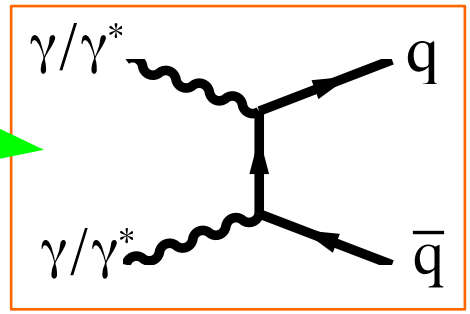


2014 International Workshop on Future Linear Colliders (LCWS14), Belgrade

Reminder: beam-induced backgrounds



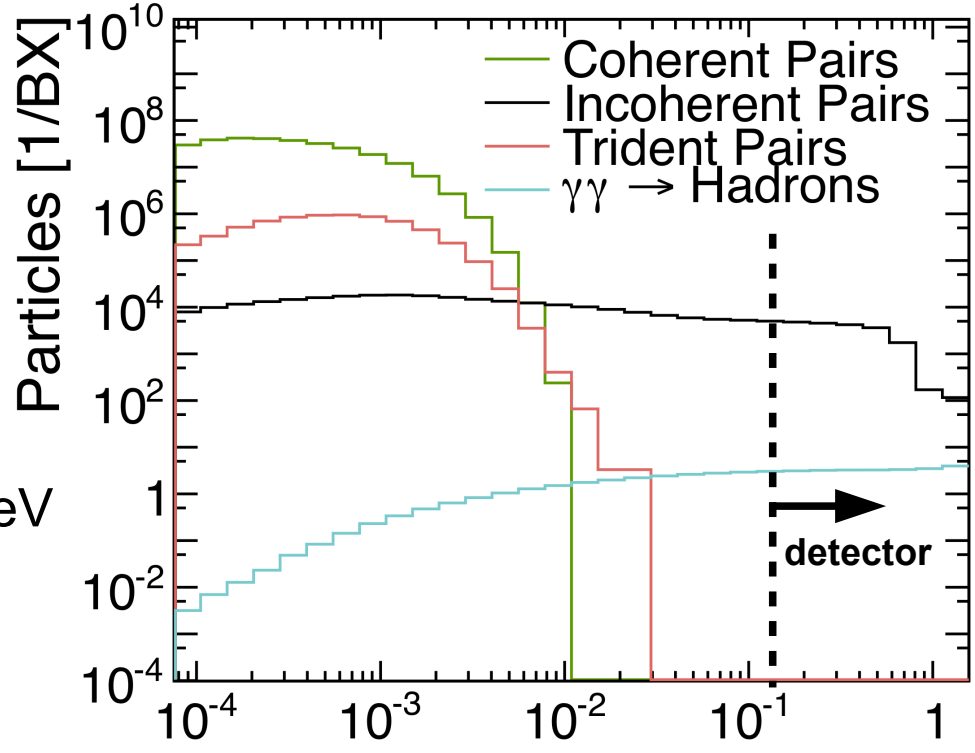
- e^+e^- pairs
- $\gamma\gamma \rightarrow$ hadrons



Coherent e^+e^- pairs:
$7 \cdot 10^8$ per BX, very forward
Incoherent e^+e^- pairs:
$3 \cdot 10^5$ per BX, rather forward
→ Detector design issue
(high occupancies)

$\gamma\gamma \rightarrow$ hadrons:
- "Only" 1.3(3.2) events per BX at 1.4(3) TeV
- Pileup is main background in calorimeters and trackers

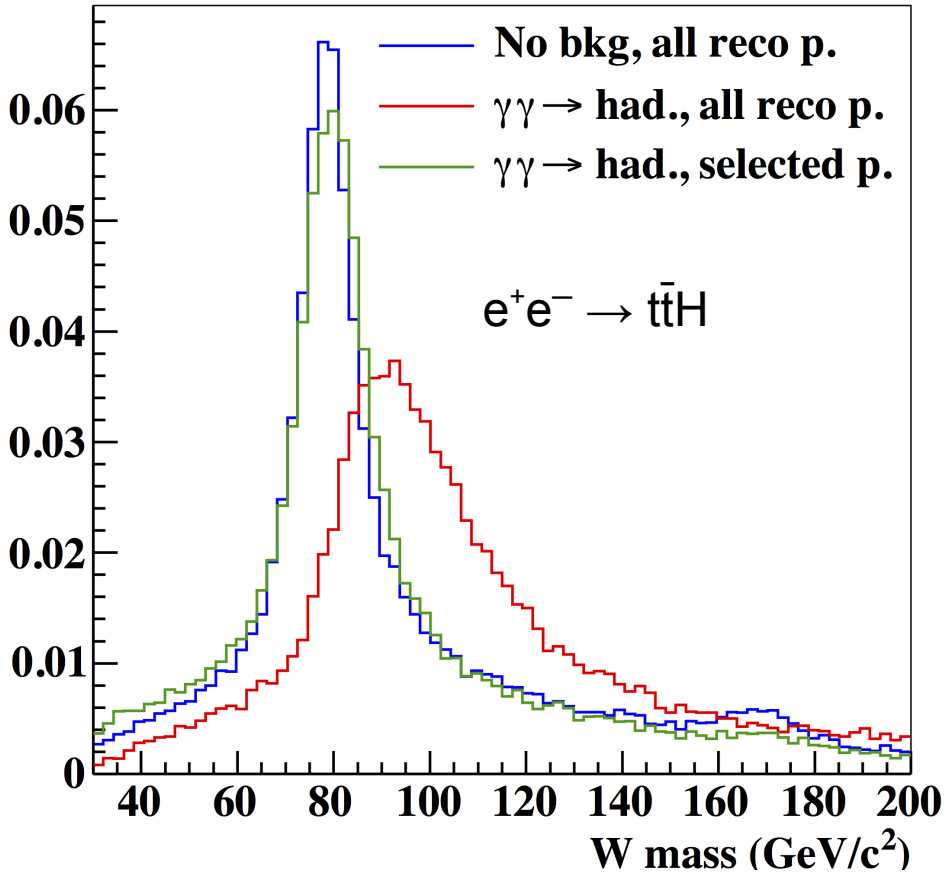
→ Impact on physics performance
→ Included in benchmark studies based on full detector simulations



BX = bunch crossing

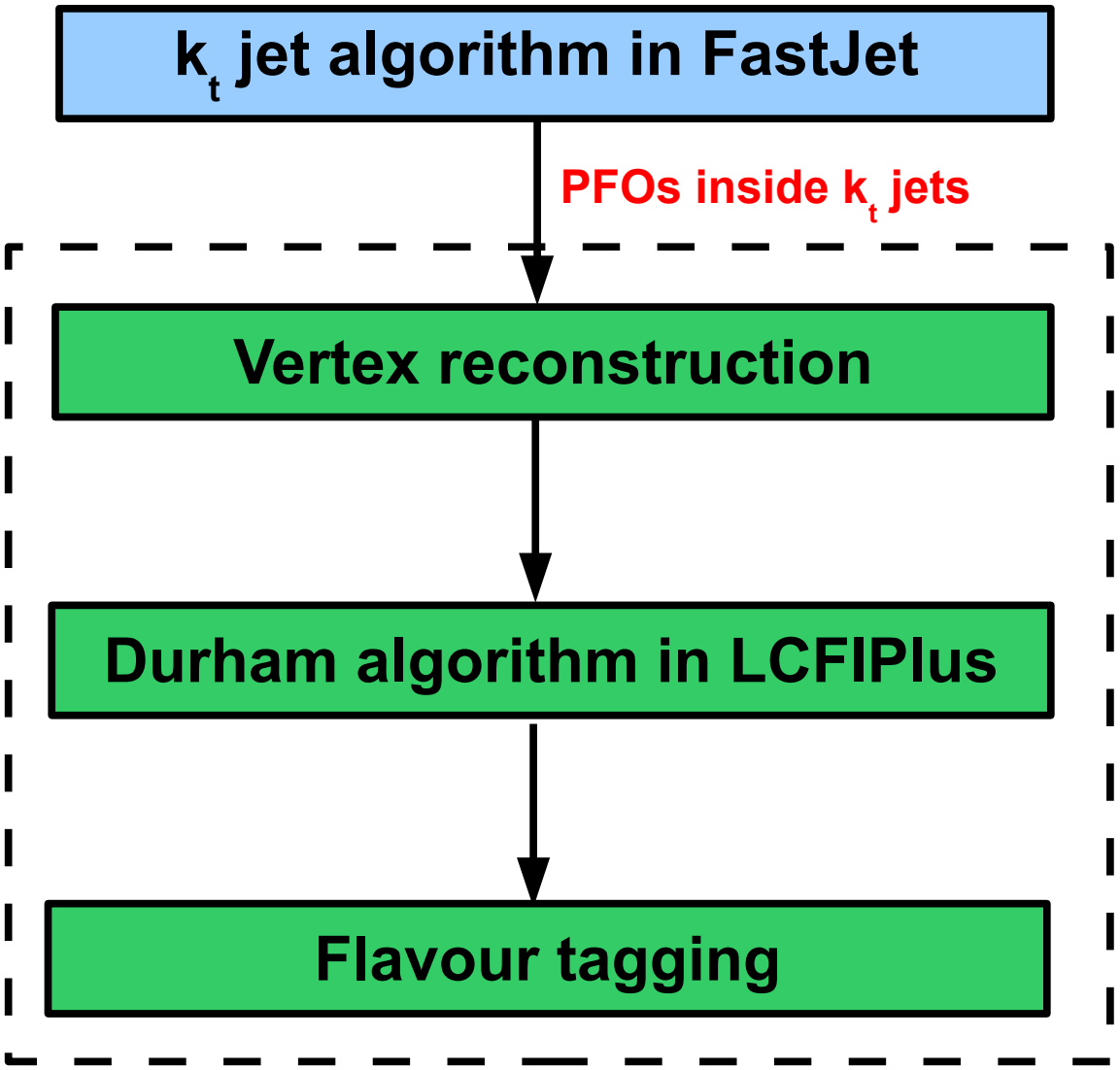
Suppression of γγ → hadrons

Two steps:
1.) Combined timing and p_T cuts to select reconstructed particles
2.) Hadron-collider type jet algorithms (with beam jets): require R paramter which needs to be tuned for each analysis



Flavour tagging:
- LCFIPlus performs jet reconstruction using vertex information
- LCFIPlus does not include a suitable jet algorithm to suppress pileup

First approach to use LCFIPlus for CLIC



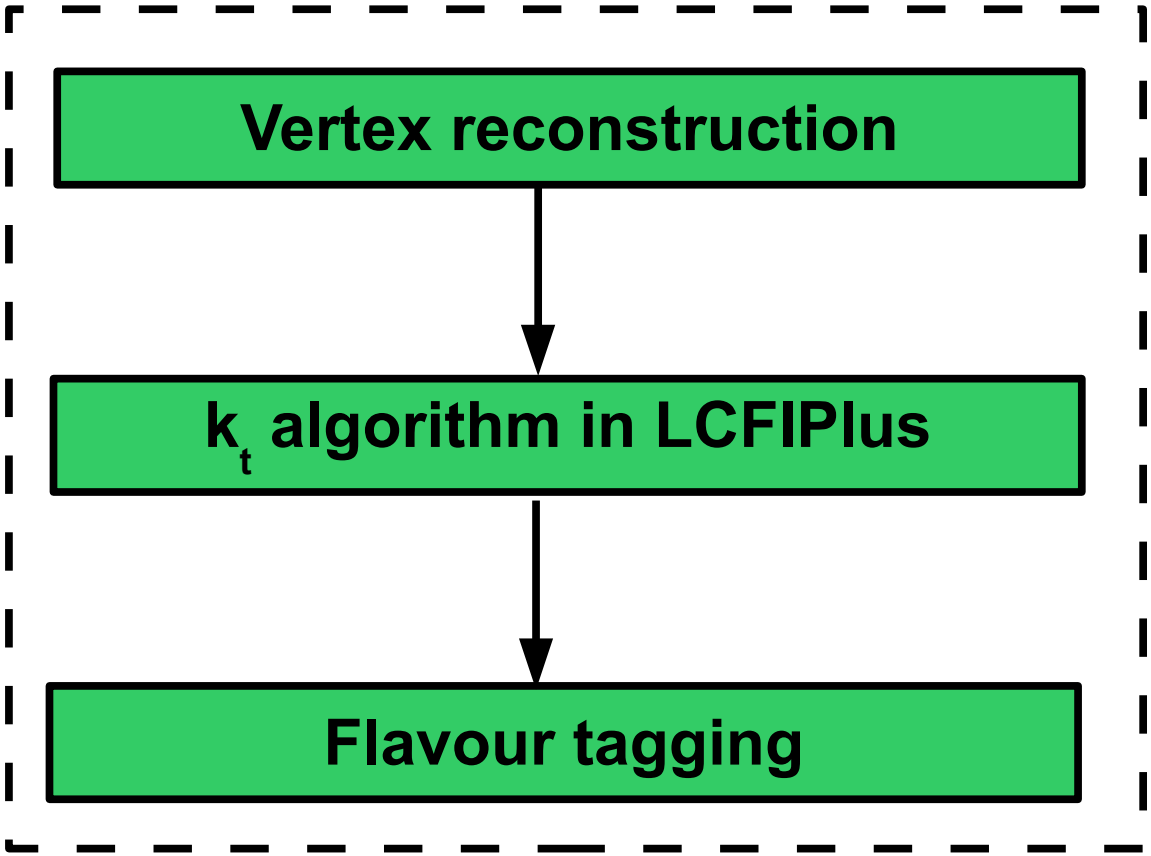
- Only the Durham algorithm is available in LCFIPlus (uses vertex information)

Issues:

- Need to rerun vertexing each time the R paramter is changed
  → very slow for busy events
- Not desirable to run many packages

New approach

Implemented the longitudinally invariant k_t algorithm(*) in LCFIPlus, uses vertex information in the same way was Durham



(*) for the experts:

- $d_{ij} = \min(p_{t,i}^2, p_{t,j}^2)\Delta R_{ij}^2/R^2$

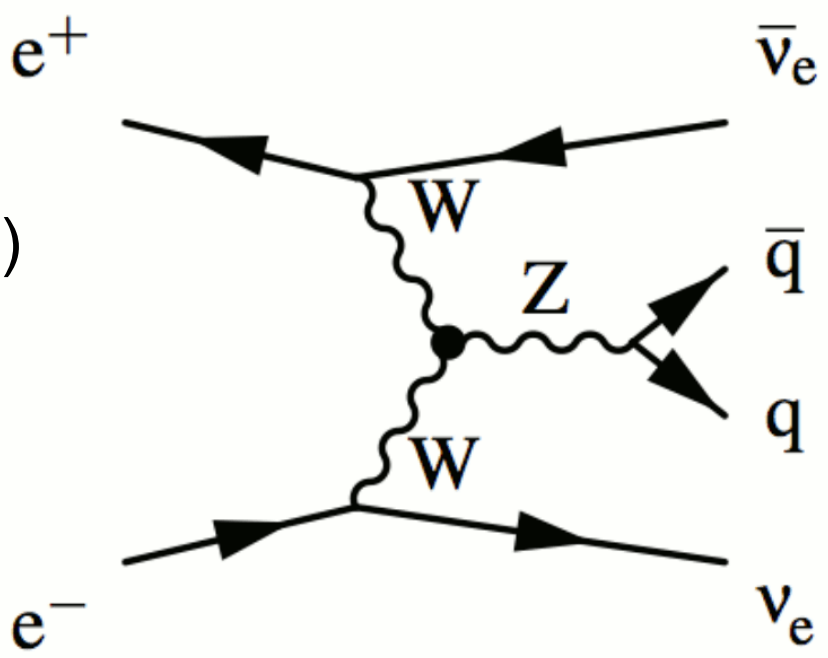
with $\Delta R_{ij}^2 = (y_i - y_j)^2 + (\Phi_i - \Phi_j)^2$

- Beam distance: $d_{iB} = p_{t,i}^2$
- E-scheme for recombination

Testing the new approach

$\sqrt{s}$ = 1.4 TeV

Event samples
(50% training, 50% testing):
$e^+e^- \rightarrow Z\nu\bar{\nu} \rightarrow b\bar{b}\nu\bar{\nu}$ (90000 events)
$e^+e^- \rightarrow Z\nu\bar{\nu} \rightarrow c\bar{c}\nu\bar{\nu}$ (90000 events)
$e^+e^- \rightarrow Z\nu\bar{\nu} \rightarrow u\bar{u}/d\bar{d}/s\bar{s}\nu\bar{\nu}$ (90000 events)

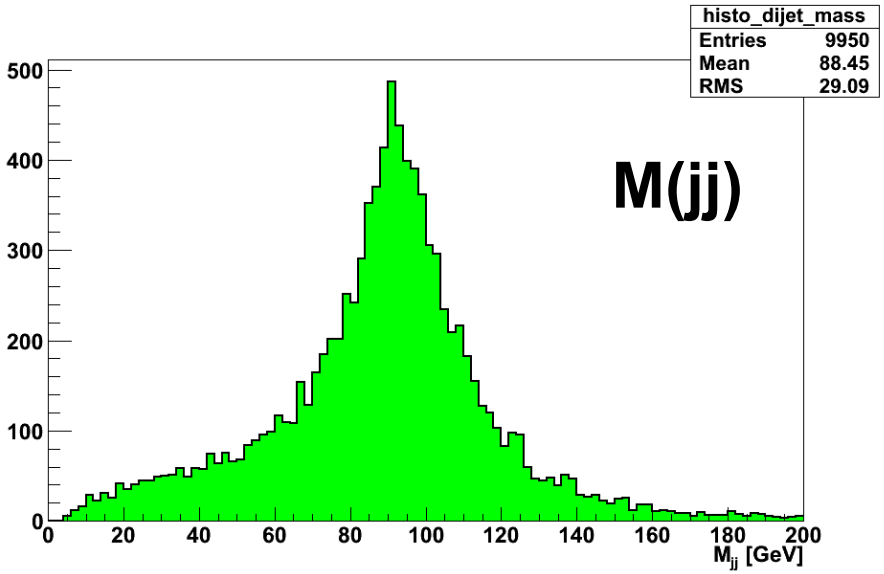


→ Jets not monoenergetic

→ Kinematic distributions of the jets similar to Higgs production in WW fusion

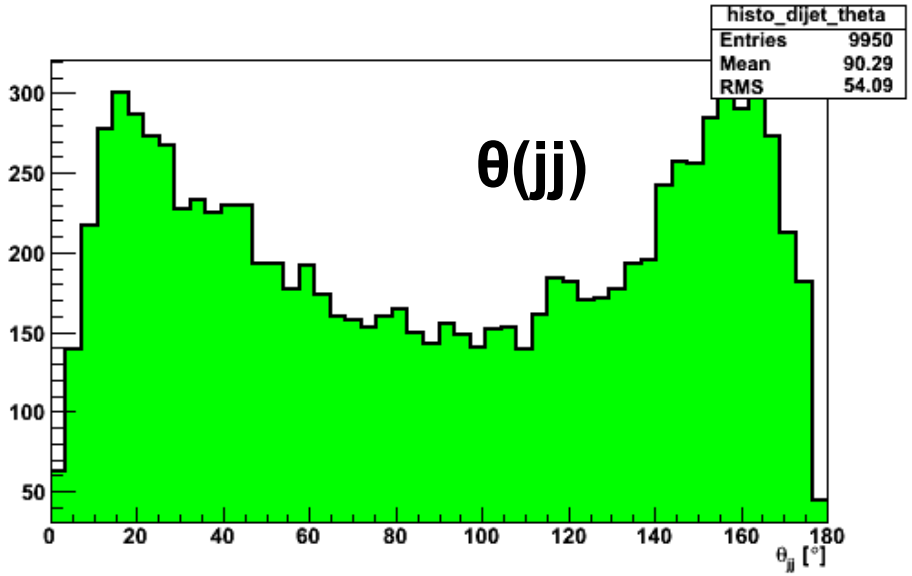
The events were reconstructed and simulated for CLIC_ILD

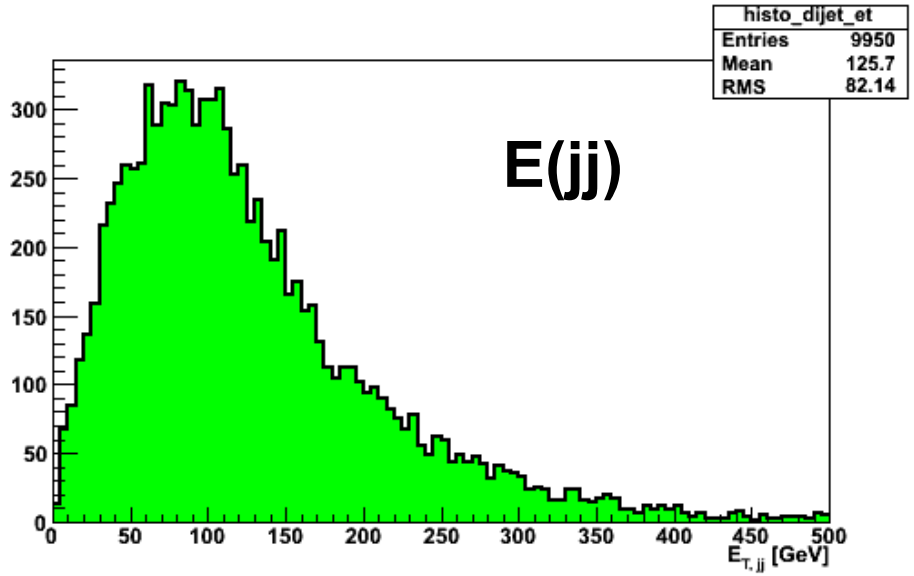
Event reconstruction using the new algorithm



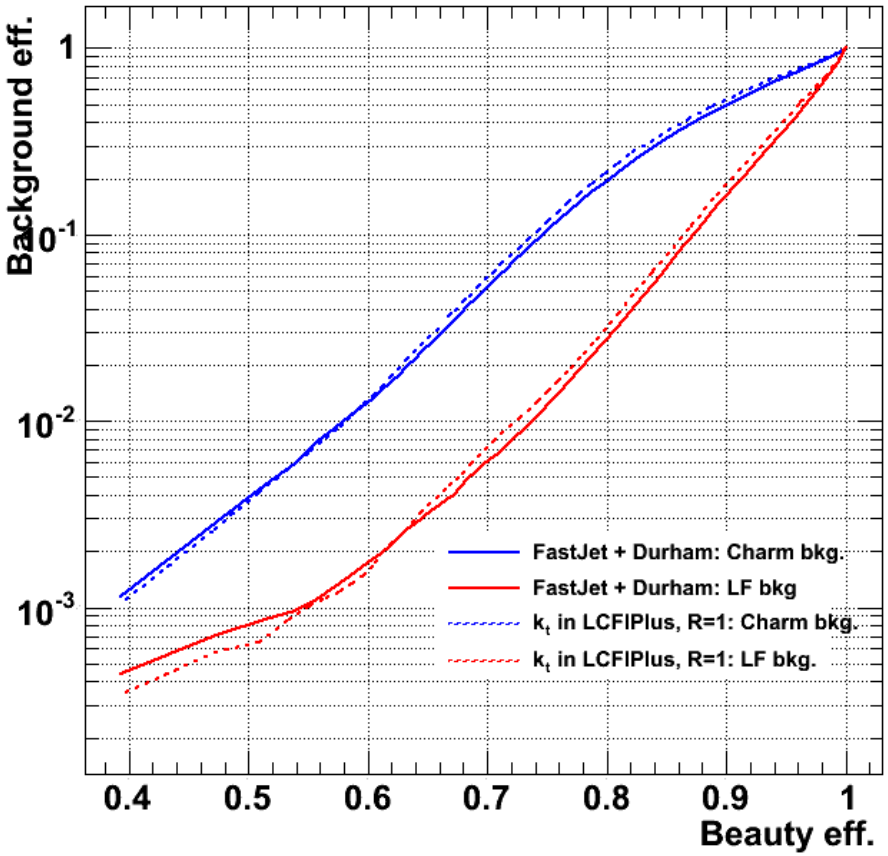
- R=0.7, selected PFOs
- 10000 events with $Z \rightarrow u\bar{u}/d\bar{d}/s\bar{s}$

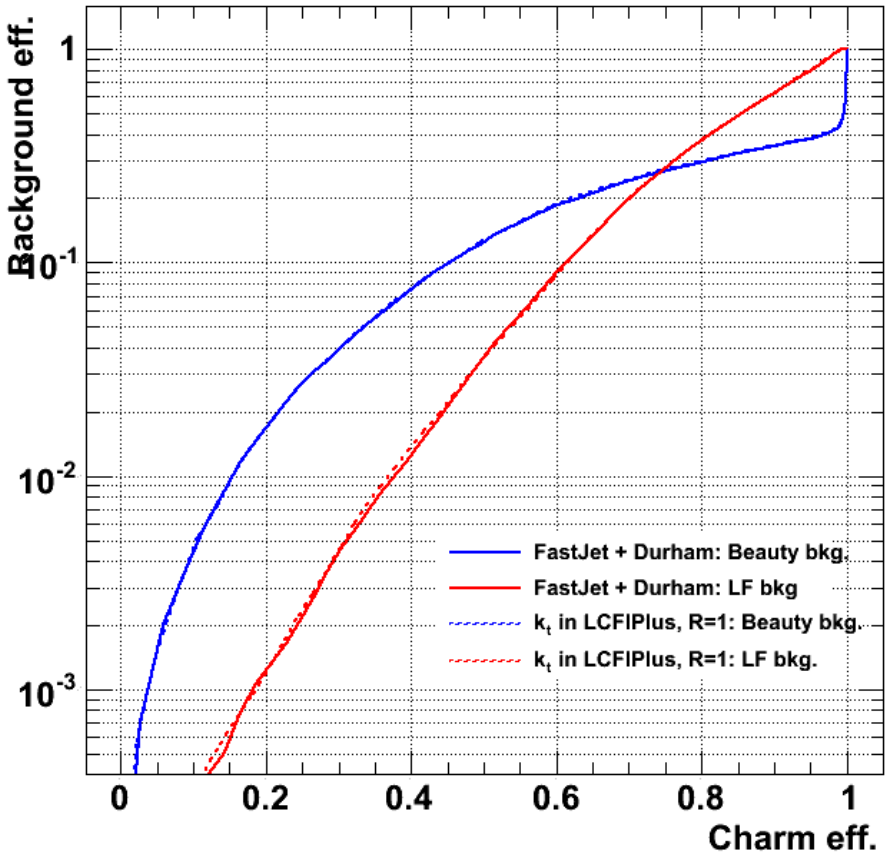
The settings for the new algorithm are not optimised!





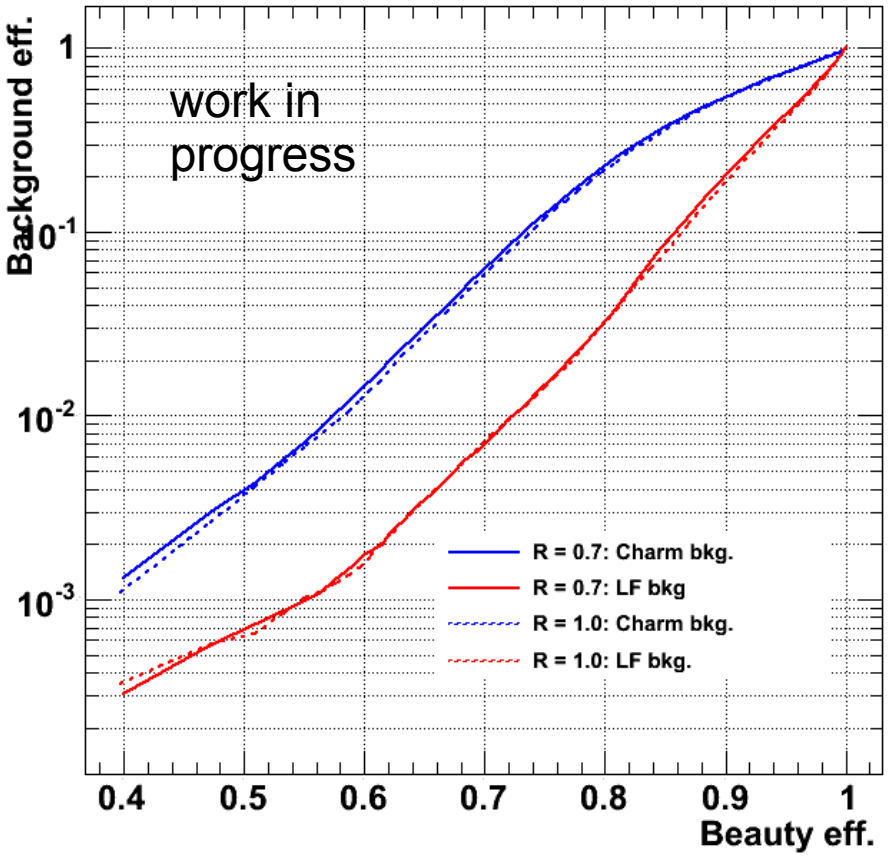
Comparison of both approaches

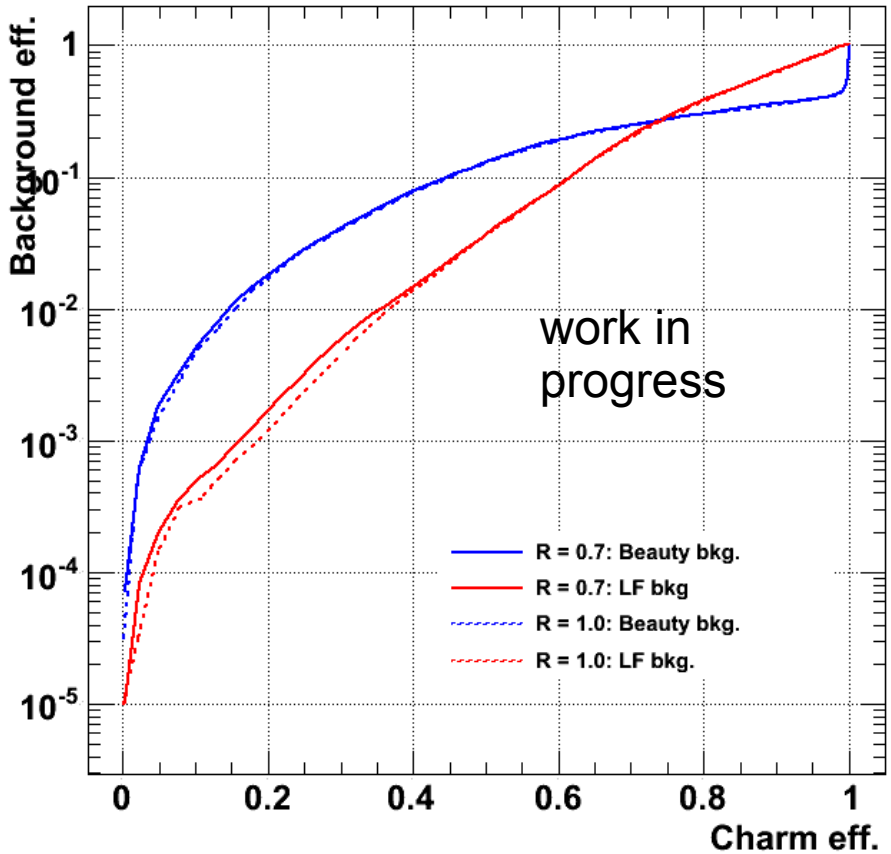




Very similar performance of both strategies

Impact of the R parameter





Only small dependence of the results on R

→ Tune R parameter for mass resolutions in analyses

Summary and conclusions

- A hadron-collider type k_t algorithm with beam jets was added to LCFIPlus

Advantages for the analysers:
- FastJet not needed when jet finding is done in LCFIPlus
- The value of R can be changed without repeating the vertexing

- The performance is very similar as for the previous approach

- No dependence of the flavour tagging performance on the R parameter observed