LCFIPlus
status and plan

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Direction of LCFIPlus development

LCFIVertex The first realistic flavor tagging in ILC

- Incorporating modern flavor tagging techniques to obtain reasonable performance
- No other algorithms to be compared…
- Mainly tuned with Z-pole qqbar samples

LCFIPlus Our second version

- Clear target: Higgs self-coupling to ~30%
  → high demand for performance
- Focused on >=4 jet environments
- Including jet clustering (performance driver for 6-jets)
- Trying many ideas for performance improvement

LCFIPlus
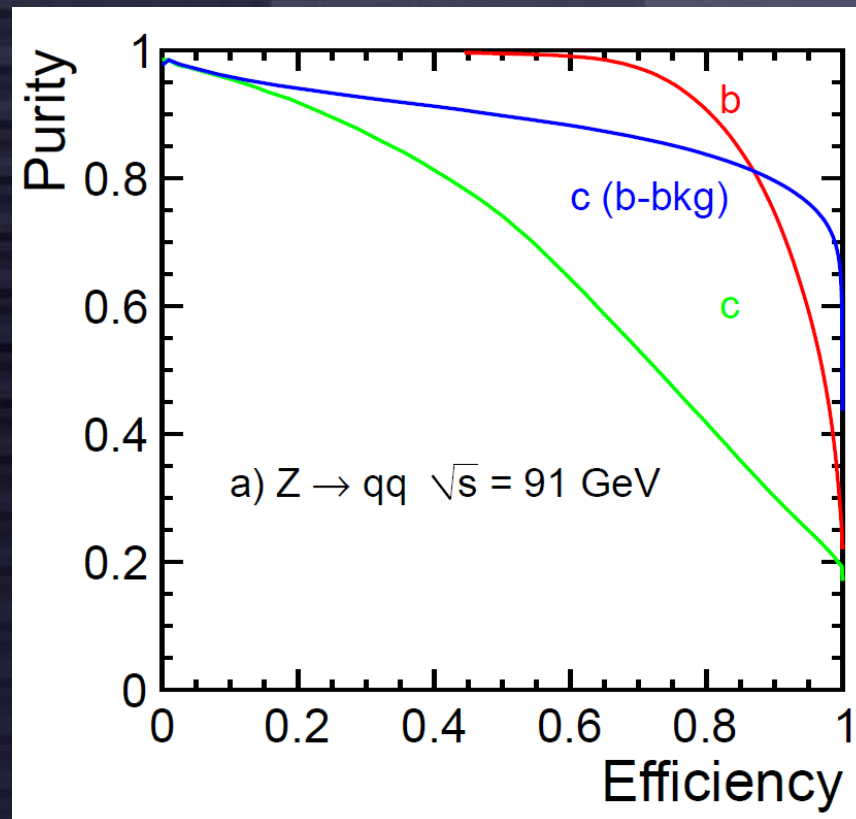
improvement

feedback

analysis
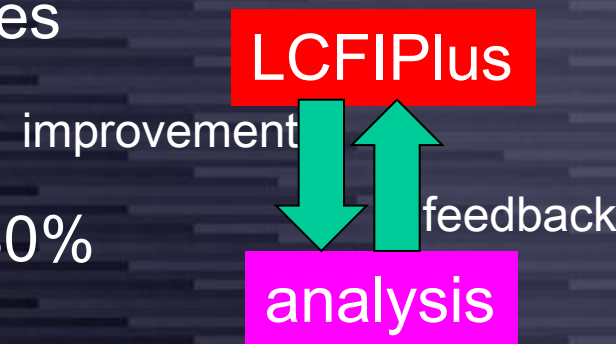
LCFIPlus is more performance-driven, mainly concentrated on many-jet processes

Performance: (old) LCFI vs LCFI+
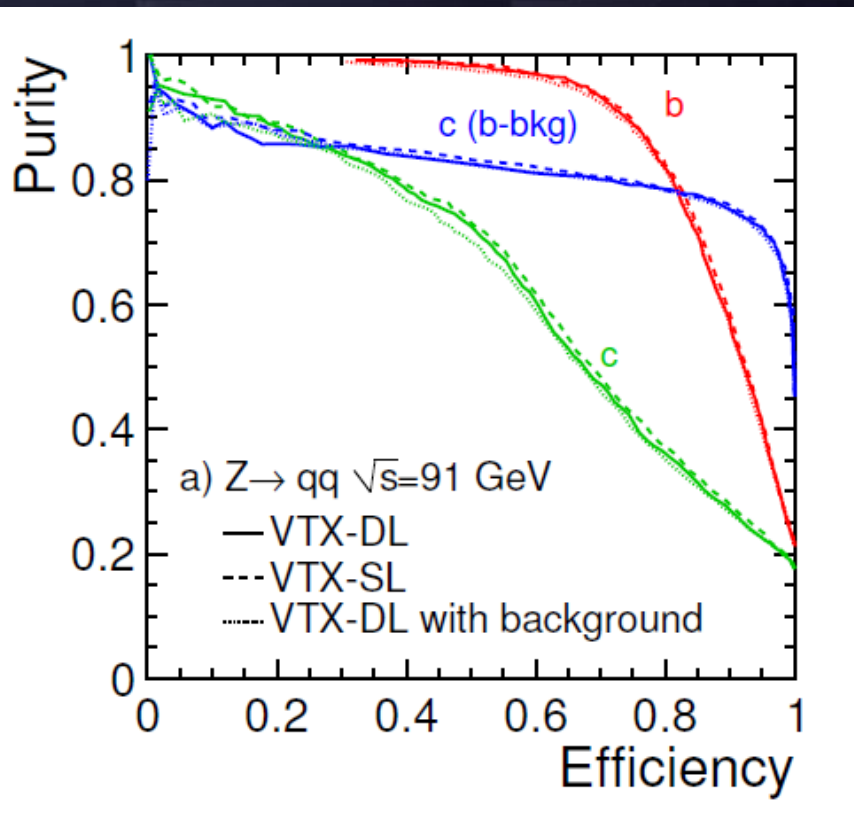
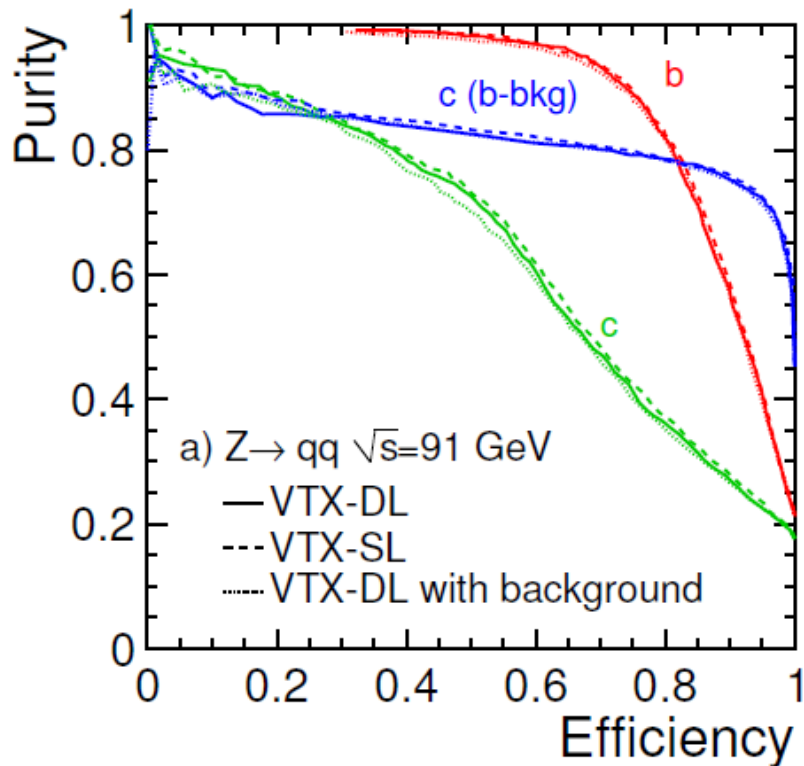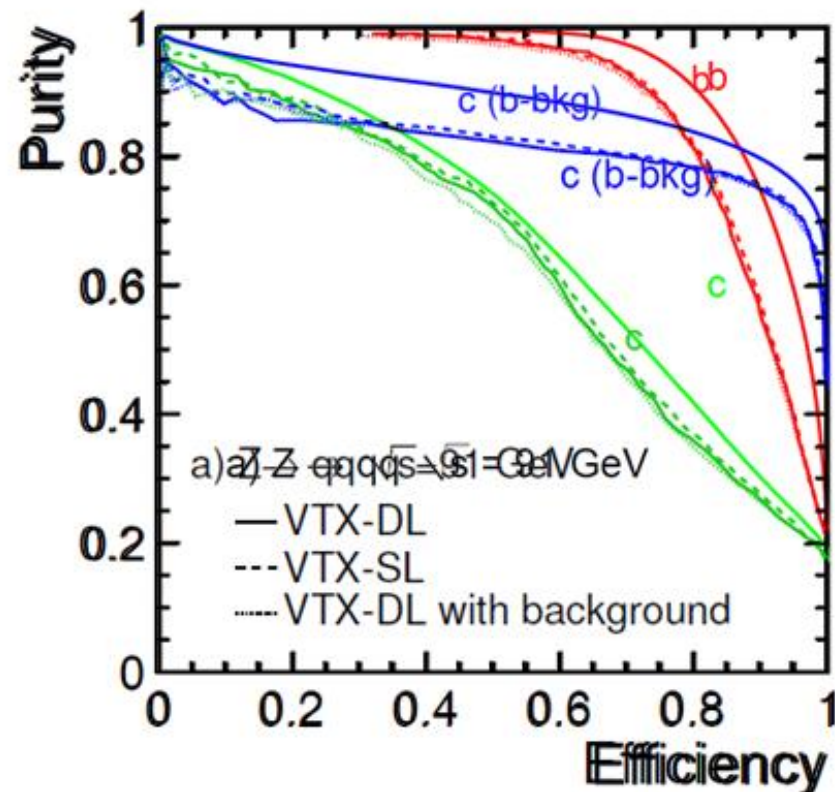LCFIVertex performance
in ILD LoI

ILD_o1_v5
LCFIPlus v02 variables

Performance: (old) LCFI vs LCFI+

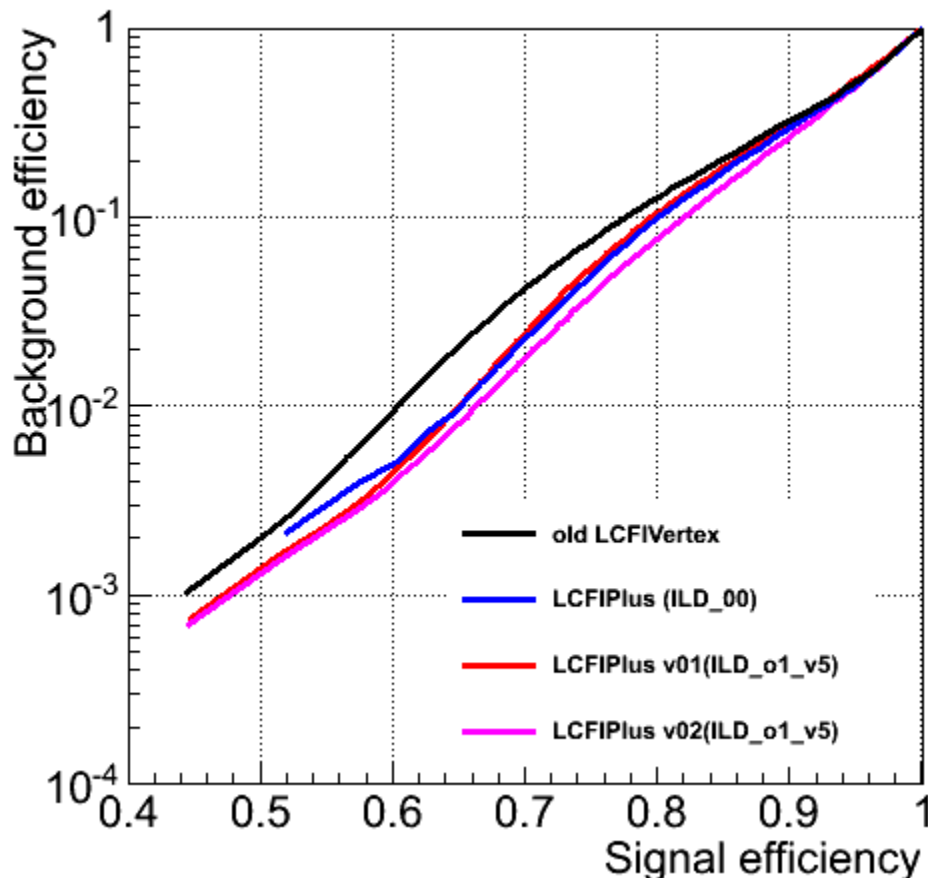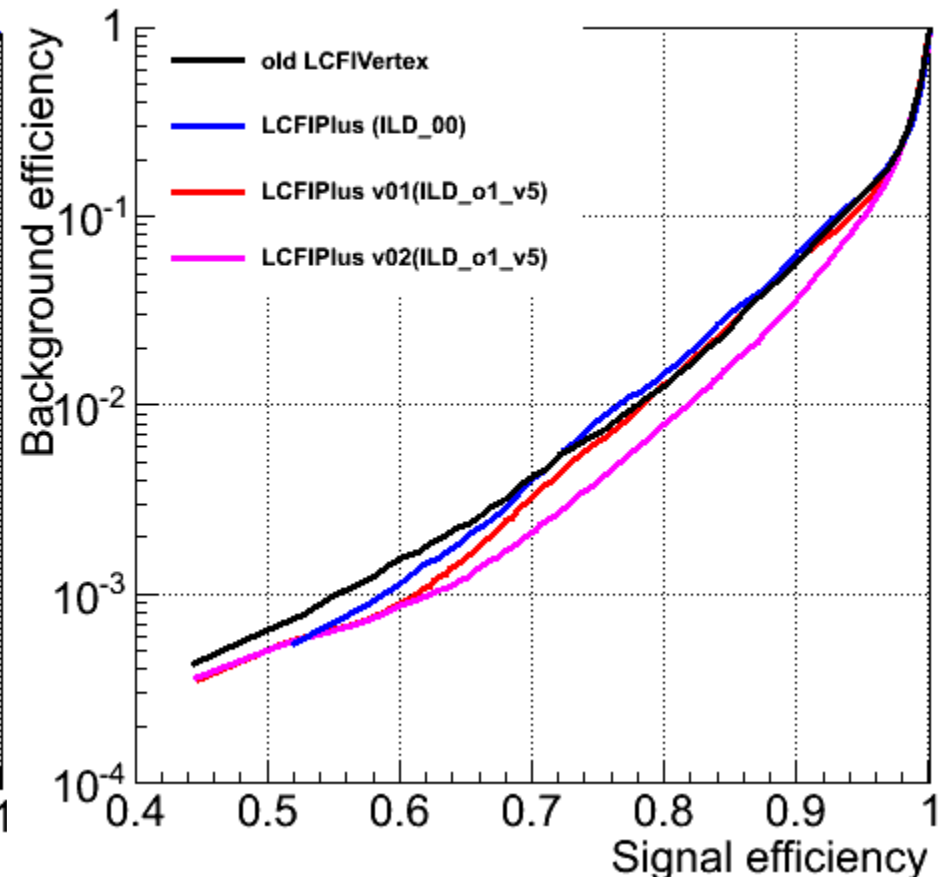LCFIVertex performance
in ILD LoI

ILD_o1_v5
LCFIPlus v02 variables

# b-tag performance: Z-pole qq

b-tag: Z->qq at 91.2 GeV, c bkg

b-tag: Z->qq at 91.2 GeV, uds bkg

old LCFIVertex -> LCFIPlus improvement seen in all region
ILD_00 & ILD_o1_v5 give similar performance
v02 is better than v01 in all region: use v02!

LCFIPlus achievements

1. Vertex finder (primary & secondary)
   – Do not use jet direction
   – Optimized! (critical)
2. Jet clustering
   – Using vertex information in some ways
3. Vertex Refiner
   – Single track vertices (critical)
   – Optimization again using jets
4. Flavor tagging
   – Imported to TMVA (more general)
   – Adding some variables

SecVtx
Single track vertex
IP
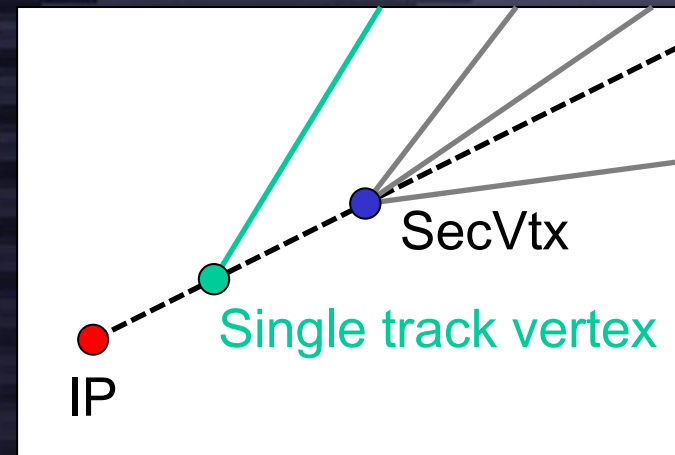
Current activity

LCFIPlus: A Framework for Jet Analysis in Linear Collider Studies

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Abstract

LCFIPlus is a modular software package for reconstruction and analysis which should been performed after particle reconstruction by particle flow or other techniques in linear collider studies. The current package includes vertex finders, jet clustering and quark flavor identification. Those algorithms are applied to the result of ILD full simulation and reconstruction. Improvements have been shown for the flavor tagging performance from the previous package LCFIVertex with the previous reconstruction software.

Key words: Linear Collider, Flavor Tagging, Vertex Finder, Jet Clustering

**To be submitted very soon!**

Issues / Plans

Issues / Vertex finder

- Not robust against background
  - $\gamma\gamma$ → hadrons (CLIC performance very bad)
  - pairs (ref. Mori-san's talk)
- b/c separation
  - More efficient finder ← → worse b/c separation
  - Should be treated with different vertex finder
  - Critical for vertex detector optimization
- Association of low-energy tracks
  - not important in flavor tagging
  - Important for the vertex charge measurement

IP   b   c
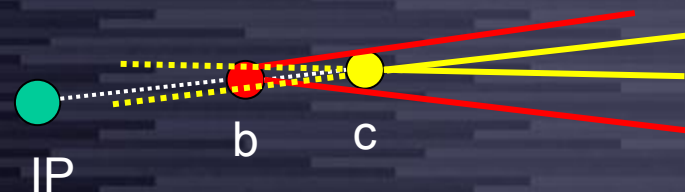
Performance ILD vs CLIC
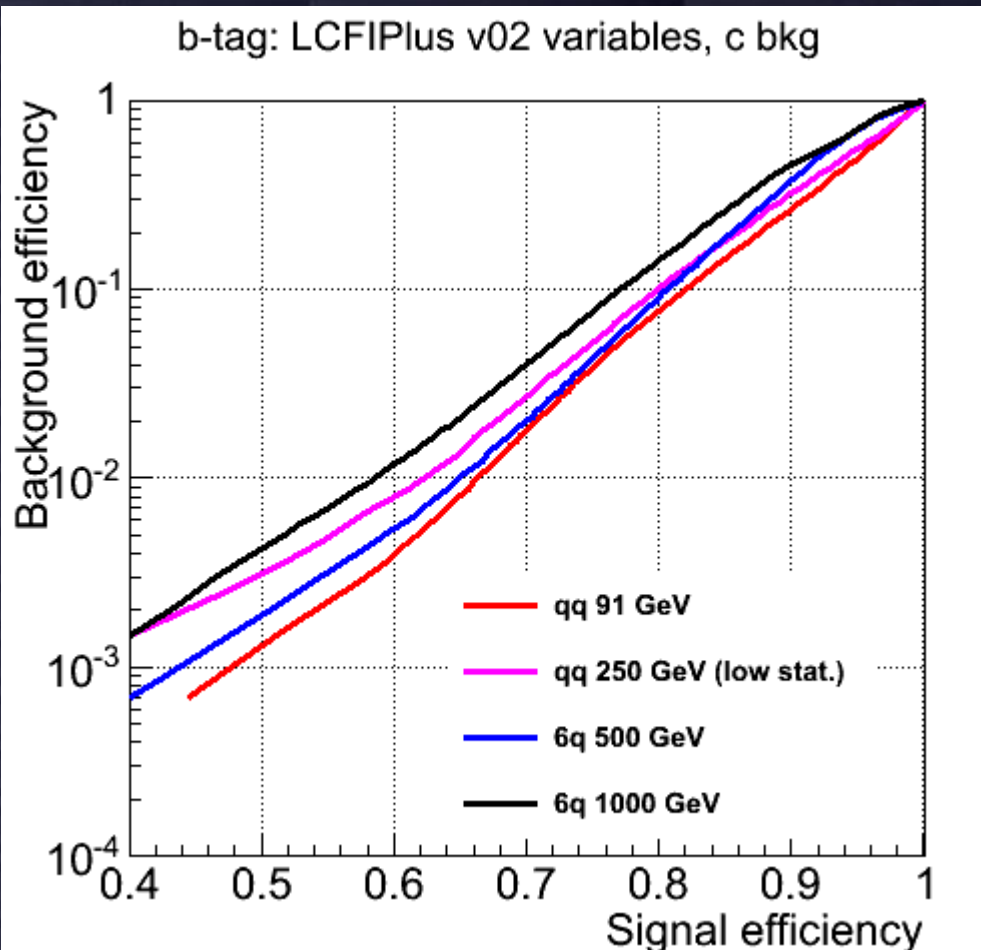
ILD (DBD)
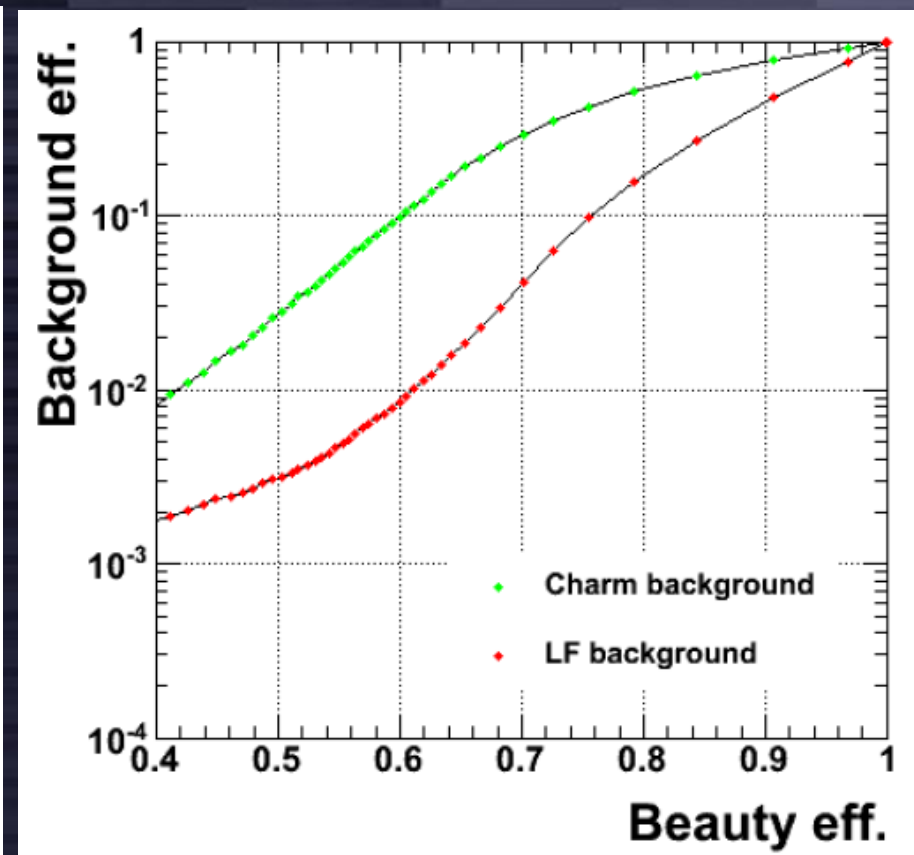
CLIC (1.4 TeV, 6q, with $\gamma\gamma \to h$)

# Issues / Vertex finder (cont.)

- Refitting tracks
  - may improve the vertex separation
  - Need tracker hits (not available in DSTs)
  - Kalman filter or ...
- Speed of vertex finder
  - Vertex fitter is slow
    - 2 loops of Minuit minimization
  - Vertex finder is also slow
    - trying every pair of tracks

Issues / Jets, Leptons

- Jet clustering
  - implement more, kT or something
  - Interface to external? eg. Fastjet?
  - Color-singlet? kinematic constraint? More?
- Lepton finder
  - Currently very simple one for flavor tagging
  - Should be more mature
    (leptons 'in jet' is not so easy)
  - Using hits? (again not available in DSTs)
  - Also taus
  - LCFI+ internal or implement outside?

Issues / flavor tagging

- Joint probability
    - Probability of all tracks coming from primary using d0/z0 significance
    - Fitted by distribution of primary tracks
    - Currently fixed by old parameter to be tuned for each detector configuration
    - Already implemented, need bugfix
- Other optimizations...
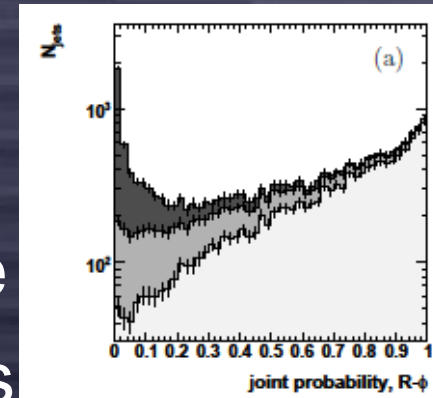
Issues / others

- Systematic errors from flavor tagging
  - Only 'ballpark estimate' available
  - Should be studied in control samples
  - Application to each physics analysis

- Interface to LCIO/Marlin
  - Some problem from multiple PFO collection
  - External jet clustering
  - External lepton finder etc.

- Documentation!

Manpower

- Long task list: not possible for us two
- We are going to expand LCFI+ group soon after paper finalized
  - Some of our colleagues in physics analysis
  - Some overseas?
  - We will consult soon! be prepared... (or self-recommendation of course welcome)