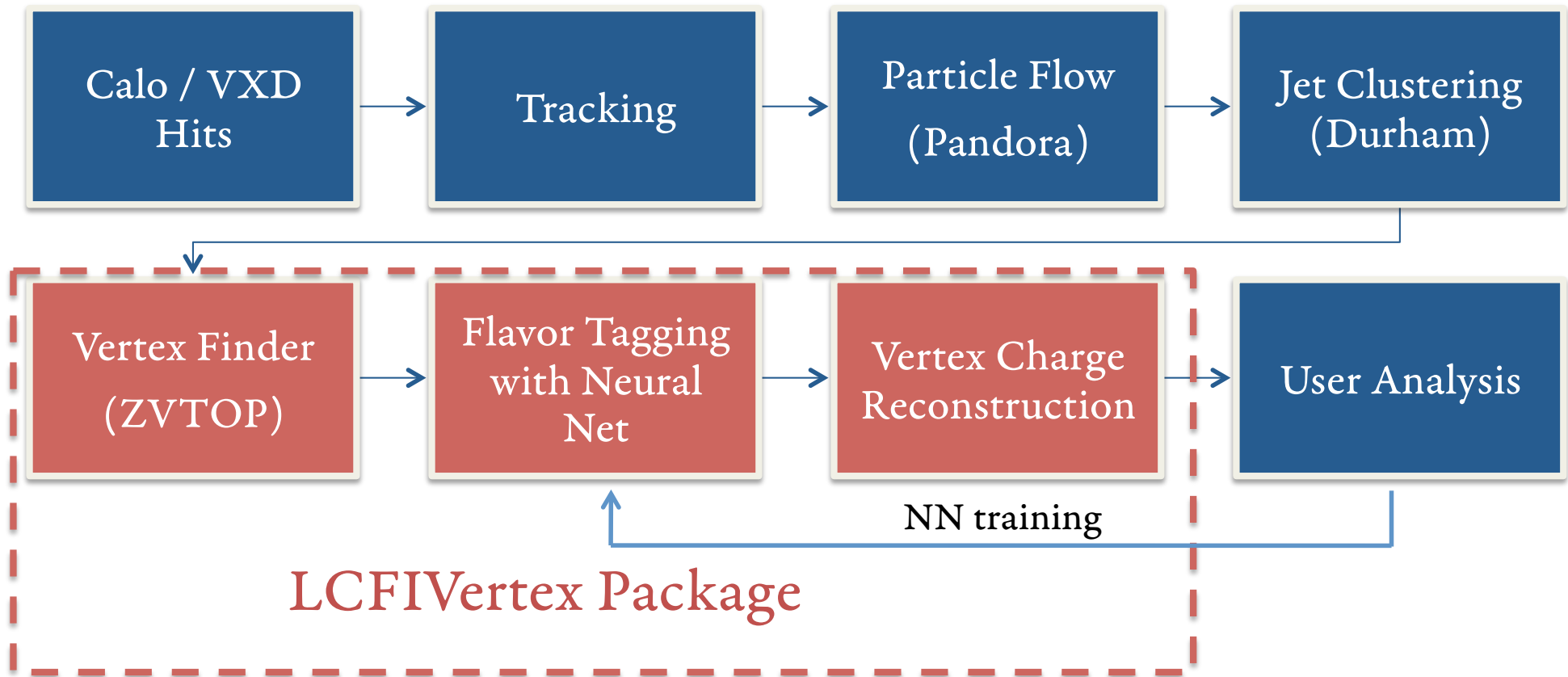


LCFIVertex Status and Plans

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T. Suehara, T. Tanabe (University of Tokyo)

ILD Workshop, Software Meeting
January 27, 2010

LCFIVertex





Status of LCFIVertex

- Work on LCFIVertex has been on hold since ~2007
- The work by UK group is now well-documented; NIM paper published
- Asia group will take over responsibilities for maintenance and development

The LCFIVertex package: vertexing, flavour tagging and vertex charge reconstruction with an ILC vertex detector

D. Bailey^f, E. Devetakⁱ, M. Grimes^a, K. Harder^{j,*}, S. Hillertⁱ,
D. Jacksonⁱ, T. Pinto Jayawardena^j, B. Jefferyⁱ,
T. Lastovickaⁱ, C. Lynch^a, V. Martin^b, R. Walsh^b

and the LCFI Collaboration:

P. Allport^e, Y. Bandaⁱ, C. Buttar^c, A. Cheplakov^c,
D. Cussans^a, C. Damerell^j, N. De Groot^h, J. Fopmaⁱ,
B. Fosterⁱ, S. Galagedera^j, R. Gaoⁱ, A. Gillman^j,
J. Goldstein^a, T. Greenshaw^e, R. Halsall^j, B. Hawesⁱ,
K. Hayrapetyan^e, H. Heath^a, J. Johnⁱ, E. Johnson^j,
N. Kunduⁱ, A. Laing^c, G. Lastovicka-Medin^g, W. Lauⁱ, Y. Liⁱ,
A. Lintern^j, S. Mandry^a, P. Murray^j, A. Nichols^j,
A. Nomerotskiⁱ, R. Page^a, C. Parkes^c, C. Perryⁱ, V. O'Shea^c,
A. Sopczak^d, K. Stefanov^j, H. Tabassam^b, S. Thomas^j,
T. Tikkanen^e, R. Turchetta^j, M. Tyndel^j, J. Velthuis^a,
G. Villani^j, T. Wijnen^h, T. Woolliscroft^e, S. Worm^j, S. Yangⁱ,
Z. Zhang^j

NIM A 610 (2009) pp. 573-589 [arxiv:0908.3019]

LCFIVertex Tasks

- fundamental improvements
 - jet-clustering, flavor-tagging
- impact on detector optimization
 - parton charge identification
 - (performance check using beam background)
- maintenance work
 - validation of LCFIVertex results when other code changes
 - (redesign LCFIVertex output for consistency with LCIO philosophy)
 - (monitoring tools)

LCFIVertex Task List

Details next slides.

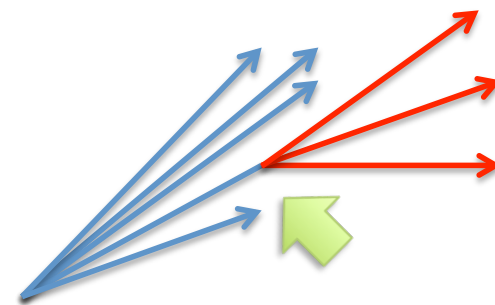
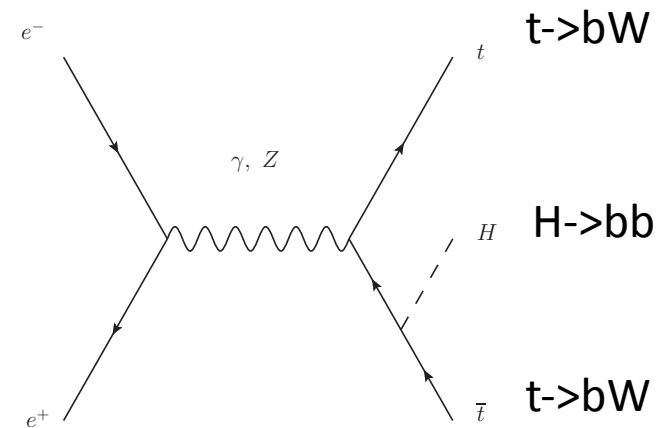
Task	Assignment
Jet Clustering / Flavor Tagging	T. Suehara, T. Tanabe
Parton Charge Identification	(TBD)
LCFIVertex Validation	Y. Takubo
Coordination	H. Ono, A. Miyamoto
FPCCD Digitizer	K. Yoshida, Y. Takubo

See talks by K. Yoshida in Detector Optimization WG Phone Meetings

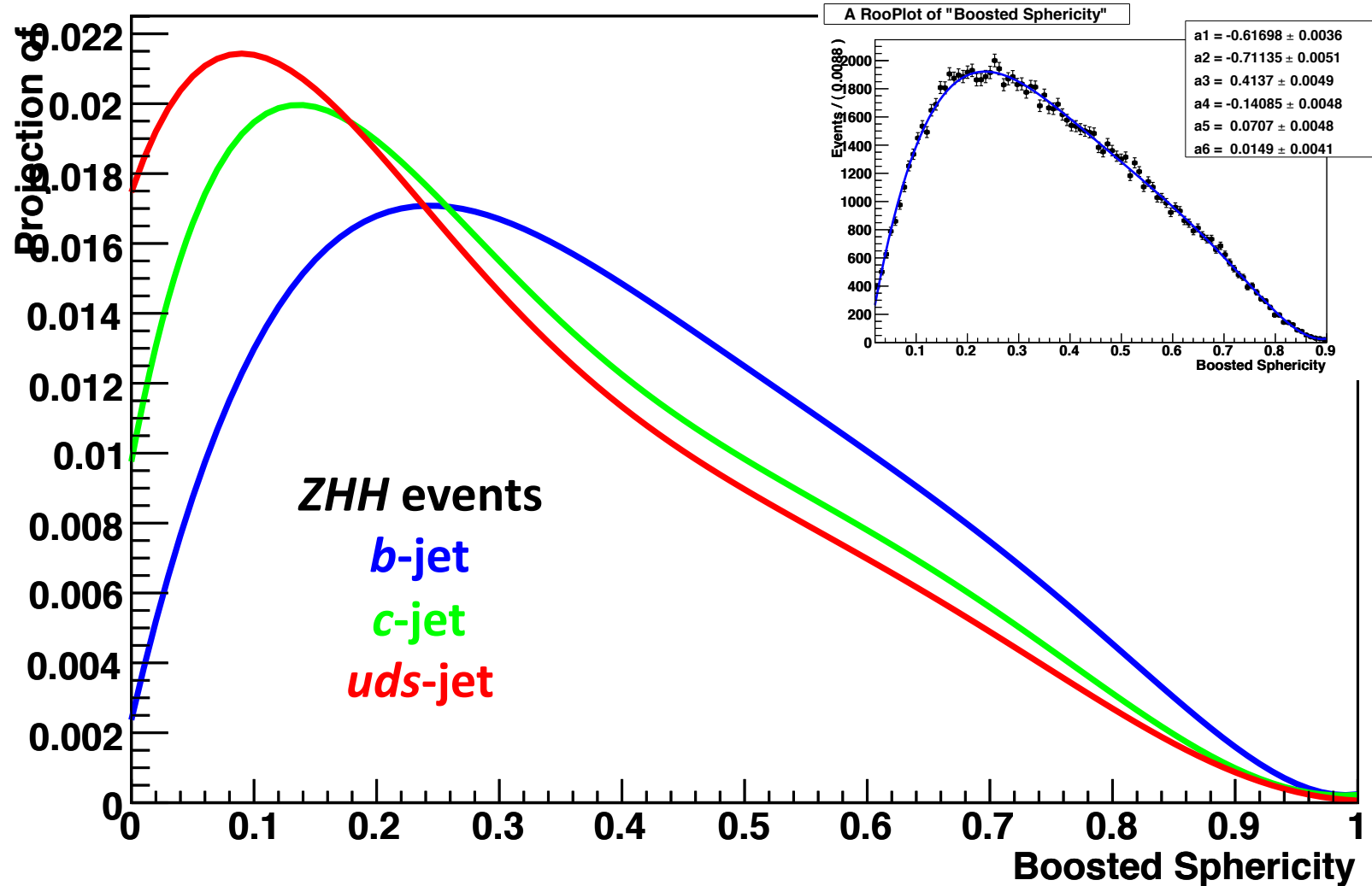
New email list for LCFIVertex development
SVN accounts are set up (thanks to Frank)
People with permanent positions are responsible

Jet Clustering & Flavor Tagging

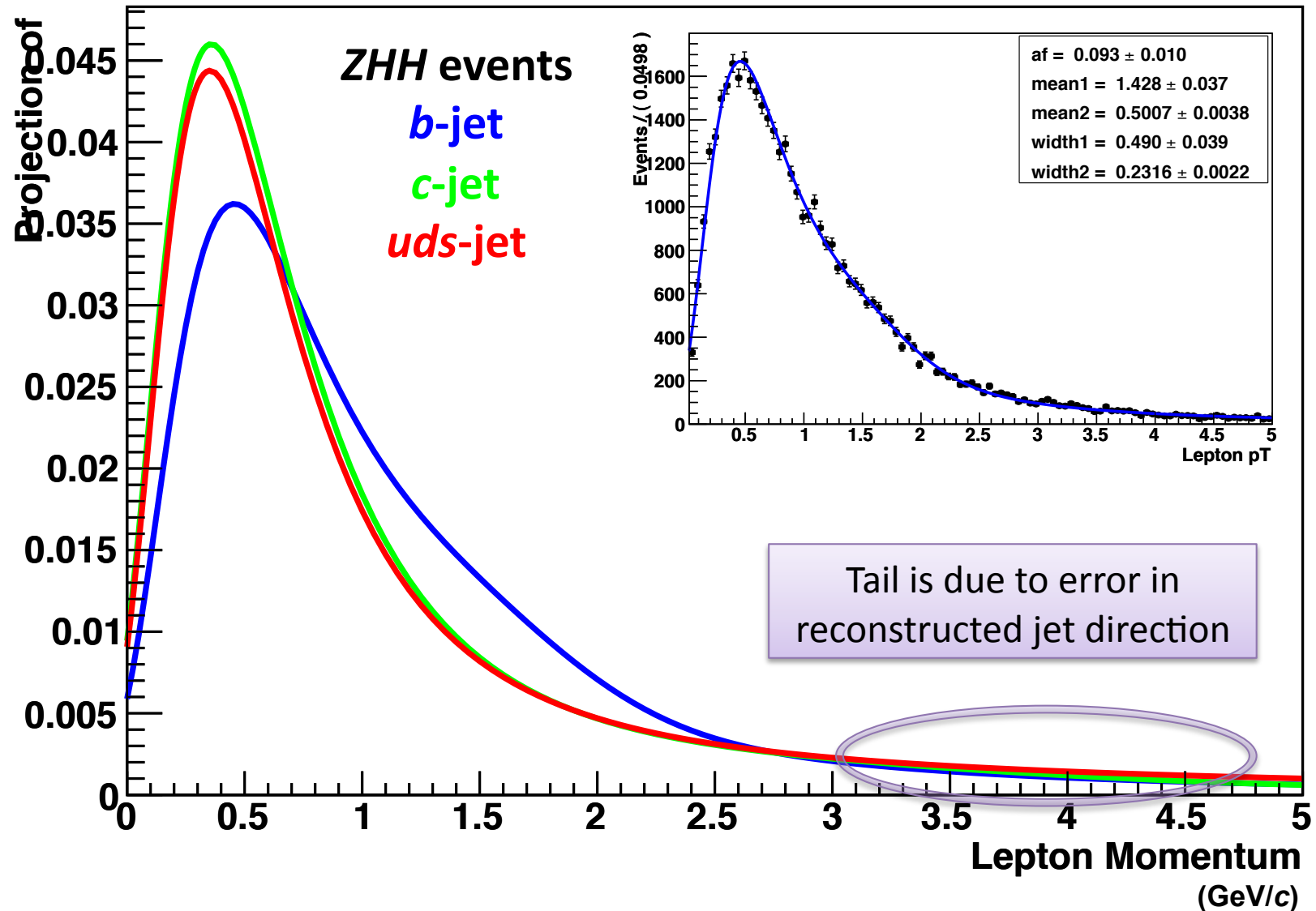
- many important analyses use ≥ 6 jets (e.g. ZHH, ttH)
 - improvement in jet-clustering/ flavor-tagging is essential in order to achieve the target precision
- jet-clustering could be improved by:
 - use of vertex information
 - physics-motivated jet finding (mass-like constraint)
- flavor-tagging could be improved by:
 - using jet substructure information (sub-jets, multiplicity)
 - using kinematic variables (which are not currently included)



Boosted Sphericity



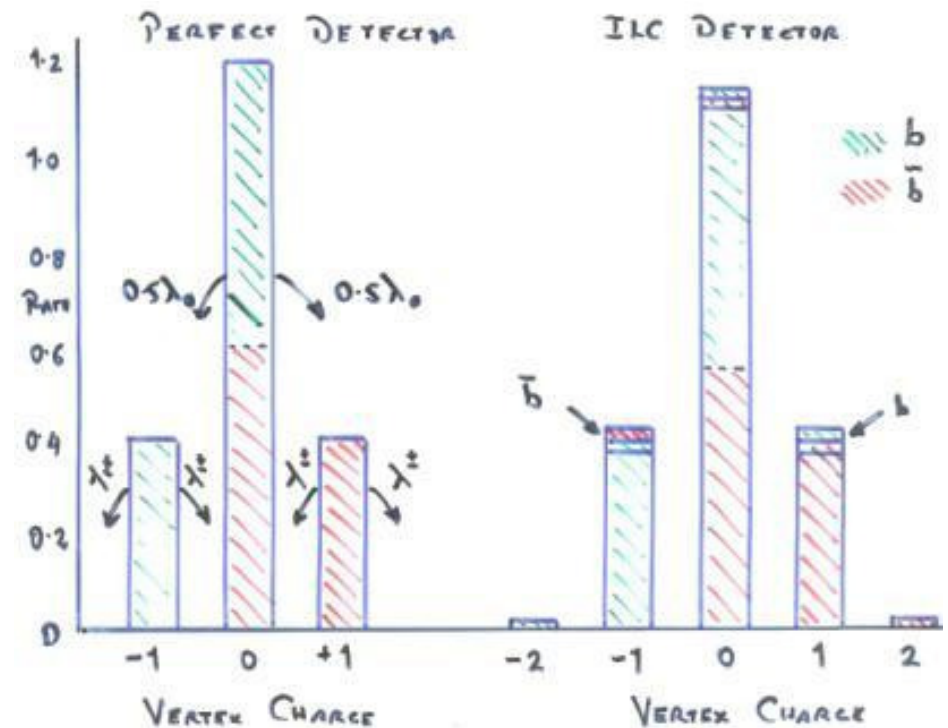
Lepton p_T Shape



Parton Charge ID

- Motivated e.g. by measurement of A_{LR} in $e^+e^- \rightarrow Z \rightarrow bb/cc$
- Provides quantitative tools to optimize the detector
 - basically the track momentum cut should be as low as possible and the beam pipe as thin as possible
- Performance check for two-jet events is available; will check for many-jet events.

imperfections e.g. due to missed tracks



Chris Damerell

Validation: v01-07 vs. v01-06

- Comparison of LCFIVertex performance between ilcsoft v01-07 and v01-06 (by Y. Takubo)
- Neural-net retraining was done using $Z \rightarrow qq$ samples
 - Independent samples are used for the training and the performance checks
- Performance seems to get worse (!) despite the distributions are similar

Neural Net Variables

$$M_{P_T} = \sqrt{M_{vtx}^2 + |p_{T,vtx}|^2 + |p_{T,vtx}|}$$

(only the primary vertex is found)

1 vertex found

c-tag

- d₀ significance most significant track
- z₀ significance most significant track
- d₀ significance 2nd most significant track
- z₀ significance 2nd most significant track b-tag
- momentum most significant track
- momentum 2nd most significant track
- joint probability in r-φ b-tag
- joint probability in z c-tag

2+ vertices found

b/c tag for N_{vtx}=3
c-tag for N_{vtx}=2

- decay length
- decay length significance
- raw momentum
- p_T-corrected mass b/c tag b-tag for N_{vtx}=2
- number of secondary vertex tracks
- secondary vertex probability
- joint probability in r-φ
- joint probability in z

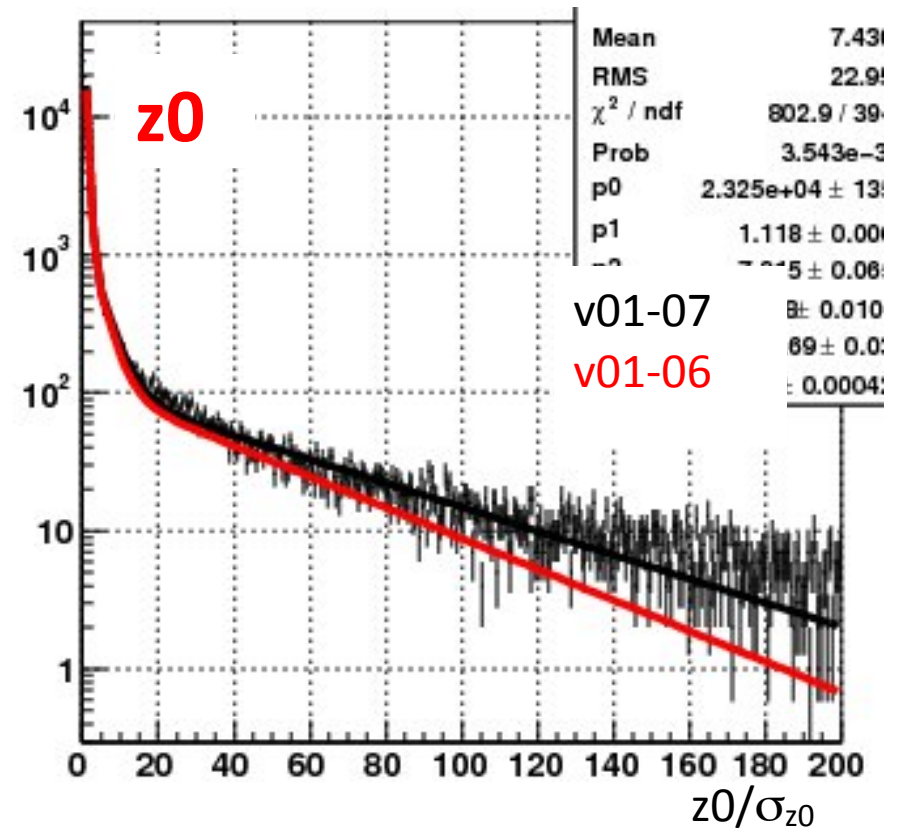
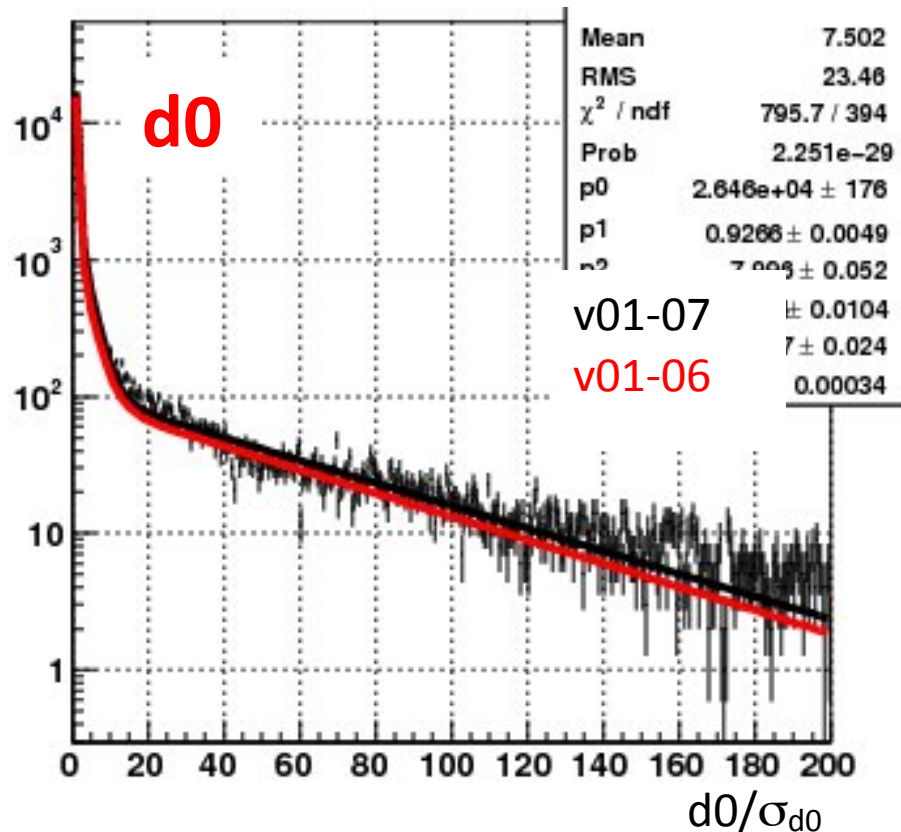
Most important variable for 2 jet samples at E_{cm}=91.2 GeV

Most important variable for 2 jet samples at E_{cm}=500 GeV

Impact Parameter Significance

The fit to the significance was performed using $Z \rightarrow qq$ samples.

- The fit result is similar to v01-06.



Neural-net retraining was done using the new fit results.

Efficiency vs. Purity

The efficiency vs. purity was checked with $Z \rightarrow bb/cc/uds$ samples.

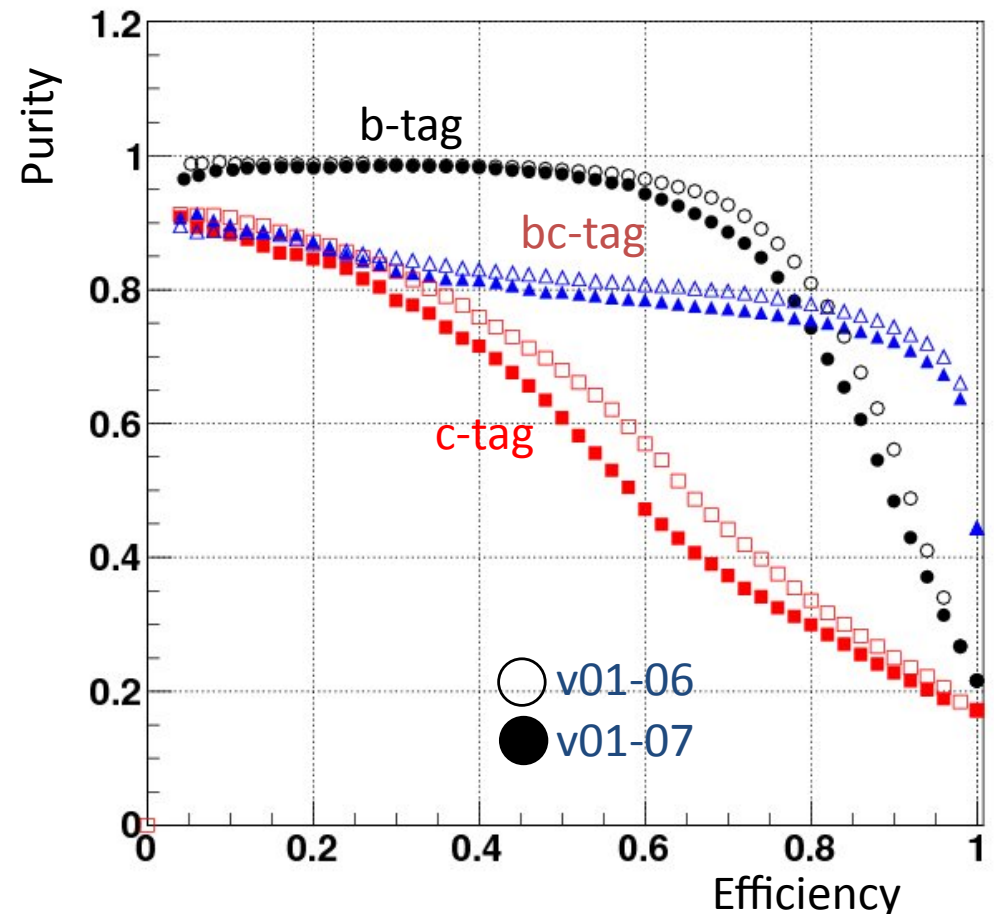
- $bb/cc/uds$ events are normalized to the BR of Z decays.

- BR(bb): 15.12%
- BR(cc): 12.03%
- BR(uds): 42.76%

- Background is defined as:

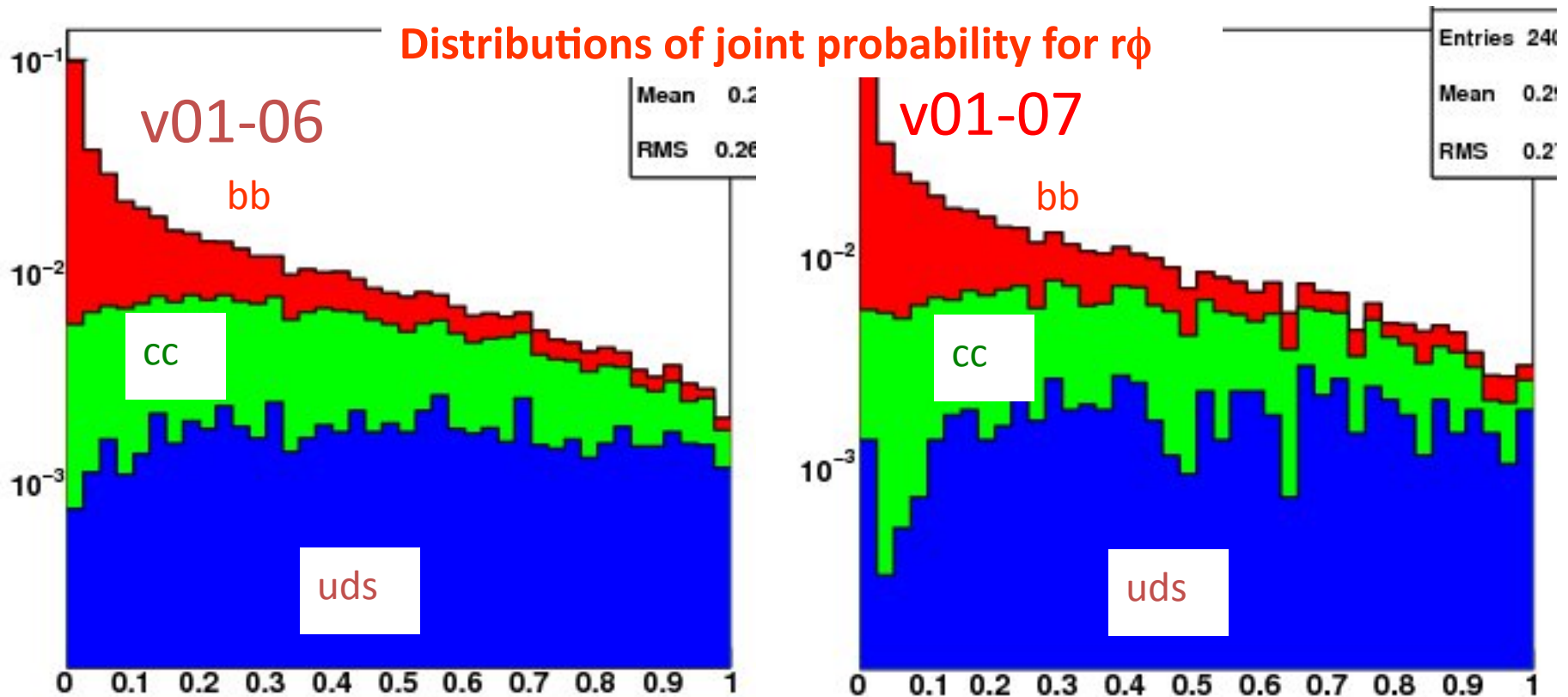
- b-tag: cc/uds
- c-tag: bb/uds
- bc-tag: bb

Purity-efficiency in v01-07 is worse compared to v01-06.

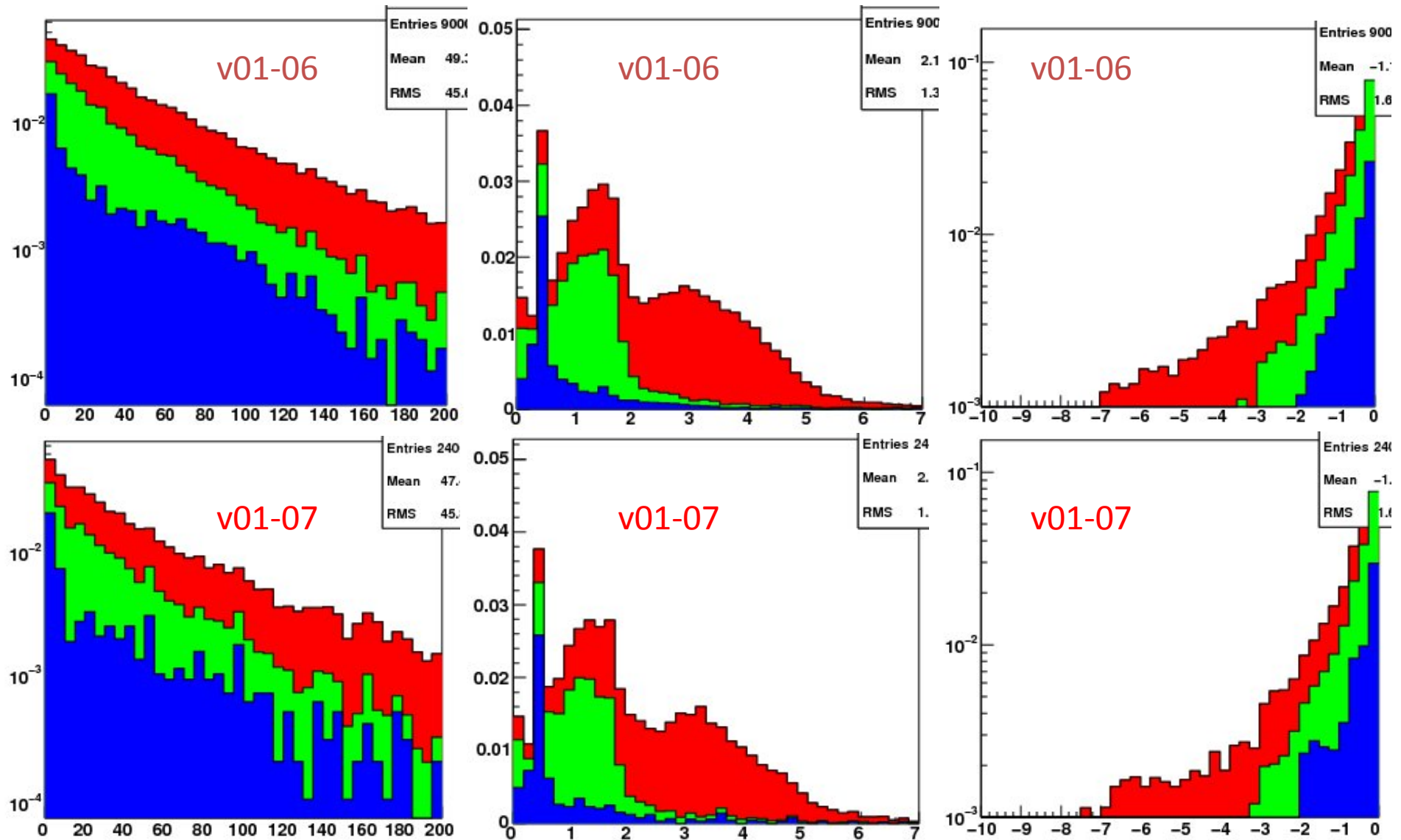


Distribution of joint probability ($r\phi$)

- The distributions of the joint probability for r - ϕ were compared with that of v01-06.
- The distributions are similar (also for r - z).



Decay Length, p_T Corrected Vertex Mass, Secondary Vertex



Summary

- After a short hiatus, the development and maintenance of LCFIVertex will now continue.
- Ongoing and planned studies for jet-clustering/ flavor-tagging/ parton charge (first round of updates around 2010 Q3-Q4)
- LCFIVertex performance gets worse in v01-07; the cause will be investigated.