RAVE – First Vertexing and b-Tagging Results with LCIO Data

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We demonstrate the potential of the RAVE event reconstruction toolkit for the ILC experiments. RAVE has been run embedded both in the Marlin and the org.lcsim frameworks. It has been used to reconstruct primary as well as secondary interaction vertices – the first results with LCIO data are promising. RAVE already has a lengthy and diverse list of platforms on which it has been run – it is portable. RAVE is ready for the ILC challenges.

1 Introduction

RAVE (Reconstruction in an Abstract Versatile Environment) is a project for creating a detector-independent embeddable event reconstruction toolkit that could be used by a wide range of high energy physics collision experiments. Originating from the CMS vertex community, it features powerful novel adaptive algorithms. RAVE has been successfully integrated both in the Marlin [1] and the org.lcsim [2] frameworks.

2 Input data

The following analyses have been performed against 10000 Zh_{120} di-jet events, with both heavy (b and c) and light quark flavors. Marlin's standard track reconstruction method has been employed.
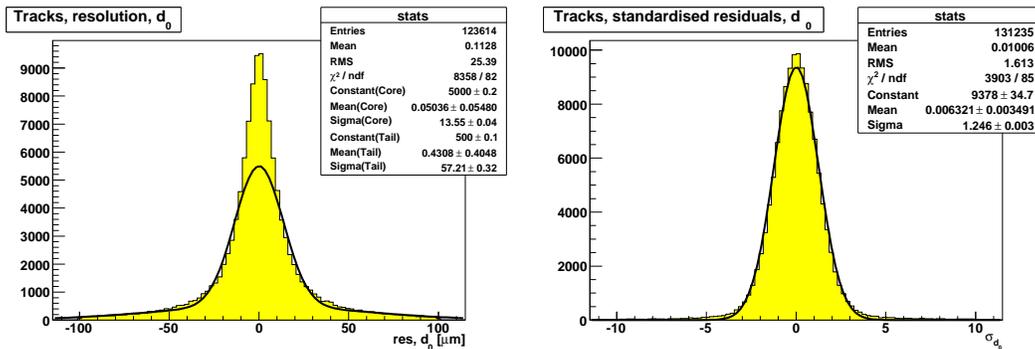

Figure 1: Track resolutions (left) and standardised residuals (right) of the tracks transverse impact parameters (d_0).

Fig. 1 shows the resolutions and the standardised residuals ("pulls") of the tracks' transverse impact parameters d_0. The impact parameters d_0 are systematically underestimated by about 25 %. The same is true for all other track parameters, see [3].

3 Algorithms

On the vertex reconstruction side, the following algorithms are available in RAVE:

- A standard least squares kalman filter [4].

- An adaptive method – implemented as an iterative, re-weighted kalman filter [5].

- An iterative adaptive method, calling the adaptive method iteratively, in order to both find and fit vertices (see [6]).

- A multi-vertex method [7] which fits several vertices concurrently at once.

  Work is in progress for making the ZvRes algorithm [8] available within RAVE.

  In this paper, only results from the adaptive and iterative adaptive methods are shown.

4 Fitting the primary interaction point

All di-jet events have been used to fit the collision point. No prior selection has been applied on the tracks. Note that this cannot be considered the optimal reconstruction technique, since under such circumstances heavy flavor events tend to worsen the resolutions of the interaction points. Such effects must be kept in mind but are graciously ignored in this paper. Fig. 2 shows the resolutions and the standardised residuals ("pulls") of the z coordinate of the reconstructed vertices. It can be seen that resolutions of $6\ldots7\mu$m can be expected in this coordinate. The standardised residuals are similar to those of all track parameters; the systematic bias in the errors has propagated from the tracks to the vertices. Identical results (apart from rounding errors) have been obtained both within Marlin and org.lcsim, see [3].
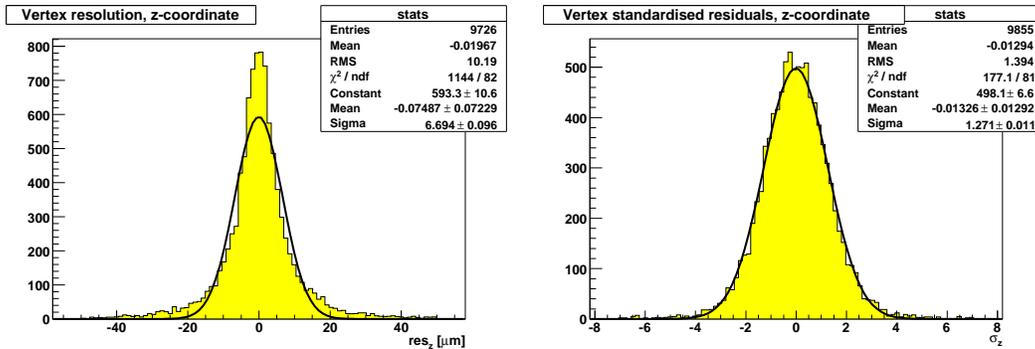

Figure 2: Fitting the interaction points with the adaptive method; the resolution (left) and the standardised residuals (right) of the z coordinates of the reconstructed vertices

5 Secondary Vertices and Flavor Tagging

It has been tried to find and fit the decay (secondary) vertices, also. Here we restrain ourselves to depicting a screenshot of a successful reconstruction of all interaction vertices

(Fig. 3) of a charmed di-jet event. The iterative adaptive method has been employed in this example with default parameter settings.
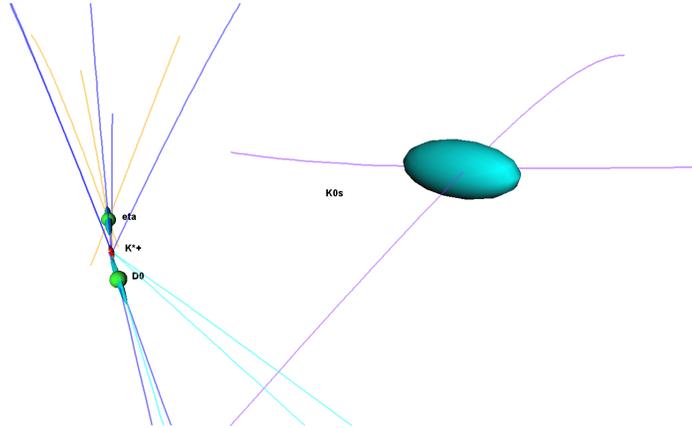

Figure 3: A screenshot of a fully reconstructed charmed di-jet event; all interaction vertices have been reconstructed successfully – the ellipsoids depicted the reconstructed vertices' errors, magnified by a factor of ten.

A simple b-tagging algorithm has been tried on the event samples. For very preliminary results see [3].

6   Availability

RAVE has been successfully tested on Intel and on PPC CPUs, on two Linux platforms (Debian, Scientific Linux 4) and Mac OS X. Recently, native Windows DLLs have successfully been created and used. RAVE has been reported to compile and run on SLAC Linux workstations [9].

The RAVE toolkit has been used from C++, Java, and Python. Interface to the latter two languages are provided via the SWIG [10] interface generator. RAVE interfaces ("glue code") exist for Marlin [11] and org.lcsim [12].

RAVE is now hosted at HepForge [13]. It can be downloaded from there.

7   Conclusions and Outlook

RAVE has been shown to be easily embeddable into two major ILC reconstruction frameworks. It compiles and runs on various platforms. Application of the standard vertex reconstruction techniques with standard parameter settings immediately produced acceptable results. RAVE vertex reconstruction is thus ready for several applications, such as the reconstruction of the primary interaction point, or secondary vertex finding and fitting. It could be shown that RAVE's flavor tagging indeed works; this part of RAVE should still be considered experimental, though.

Refitting the tracks with the information of the reconstructed vertex ("smoothing") is a near-term goal. Also, using the information of the interaction region (i.e. the "beamspot

constraint") to improve upon the vertex reconstruction is a feature that will appear soon in RAVE. Longer term developments are a production-quality flavor tagger, and kinematic fitting.

Acknowledgments

References

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