

## Exercise 8: Cut based analysis: Resonance search

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Please send your solutions to [nberger@physi.uni-heidelberg.de](mailto:nberger@physi.uni-heidelberg.de) until 5. 12. 2011, 12:00. Put your answers in an email (subject line *SMIPP:Exercise08*).

1. **Bump hunting** On the course website, you find two root files, named `tree_ex8A.root` and `tree_ex8B.root`. They contain made-up analysis *N-tuples*, i.e. a series of numbers for each measured event. Measured was a three particle final state. For each pair of particles, the invariant mass is given (*mass ij* variables) and for every particle, the energy loss per unit distance (*dE/dx*), a relative time of flight (*tof*) and the fraction of the particle energy deposited in the electromagnetic calorimeter (*efrac*) is given. Explore these data in interactive root. You easily access files by creating a `TBrowser` object on the command line. You can also draw the distributions for each variable by clicking it in the `TBrowser`. You can also draw distributions using the command line, giving the name of the tree (in this case `searchTree`) and using the `Draw` command, e.g.

```
> searchTree->Draw("mass12");
```

You can plot correlations by specifying two variables,

```
> searchTree->Draw("mass12:dedx1");
```

You can apply cuts in the second argument

```
> searchTree->Draw("mass12:dedx1","mass23 < 2");
```

and you can specify drawing options in the third argument

```
> searchTree->Draw("mass12:dedx1","mass23 < 2","BOX");
```

Explore the given data.

The two particle masses were generated equidistributed between 1 and 3 MeV/ $c^2$ . In addition, in one or both of the files, a relatively narrow resonance in one (or two) particle combinations with a Breit-Wigner shape was added. Through applying suitable cuts, find in which file(s) the resonance(s) are hiding and what its mass(es) are (not necessarily the same in both files). Produce mass spectrum plots of your findings.

(Attach a list of your cuts, name the file(s) with a resonance and produce suitable plots)

2. **Bump hunting II** What can you do to avoid biases when searching for bumps in your data?