# One page reminder - What is Rivet?

- Runs analyses on Monte Carlo data
- Write analysis once, run on many different generators
- Produces AIDA XML, ROOT or flat text histogram files
- Comes with AIDA and hep.xml experimental data to provide plot binning and comparison
- Loads available analyses dynamically - can plug user-written analysis in at runtime
- “Projection” system caches various observables common to different analyses
- AGILe interface to many different generators or file of HepMC events
- Main executable is called RivetGun

# Running Rivetgun

- Rivetgun checks for the available generators and analyses at runtime - a full list of the available generators, analyses and other options can be obtained with the command

```
rivetgun --help
USAGE:
   rivetgun  {-g <Herwig:6510|HerwigJimmy:6510>|-G <genfile>|-i <filename>}
             [-R] [-o <filename>] [-n <num>] [--nocolor] [-l
<logname=loglevel>] ...  [--histotype <AIDA|FLAT|ROOT>] [-H
     <name>] [-A] [-a <ALEPH_1991_S2435284|~ALEPH_1991_S2435284
|ALEPH_1996_S3486095|~ALEPH_1996_S3486095|CDF_1994_S2952106
|~CDF_1994_S2952106|CDF_2001_S4751469|~CDF_2001_S4751469...
```

- In this tutorial you may be running over a HepMC file generated in previous sessions. In that case you need the option `-i my.hepmc.file`

- An analysis can be run with the -a option, e.g. to run the Example analysis use the option

```
-a EXAMPLE
```

# Useful links

- Rivet project page:

  http://projects.hepforge.org/rivet/

- List of Rivet classes:

  http://projects.hepforge.org/rivet/code/dev/annotated.html

- The Rivet manual (work in progress) is copied in `/opt/mcnet/doc/Rivet`

# Steering generators in RivetGun

- You can use RivetGun to run a generator and analyse the events.

- Set the generator with `-g <GenaratorName>:<GeneratorVersion>`, e.g:

  `-g Pythia6:415` (runs Pythia 6 version 4.15 if installed)

- Set the incoming beams with `--beam1 <PARTICLE> --mom1 <ENERGY>`, e.g.

  `--beam1 ELECTRON --mom1 45 --beam2 POSITRON --mom2 45 g` (LEP I beam setup)

- Pass a parameter to the generator using `-p "param=value"`, e.g.

  `-p "CKIN(3)=20"` (sets the Pythia 6 hard scatter PT)

- Alternatively put all the parameters in a file and use

  `-P <PARAM_FILE>`

- Several param files are in `/opt/mcnet/share/RivetGun` and are found automatically from the installation directory

#Example Param file (no tabs please!)

```
RG:Beam1 = ELECTRON
RG:Beam2 = POSITRON
RG:Mom1 = 45.6
RG:Mom2 = 45.6
CKIN(3)=20
```

# Steering generators in RivetGun

- So, to run Pythia8 at Tevatron run I collision energy you could do

```
rivetgun -P tevatron1800.params -g Pythia8:108
```

- To run Sherpa at Tevatron run II collision energy you would do

```
rivetgun -P tevatron1960.params -g Sherpa
```

- To run Herwig++ at LHC collision energy you would need

```
rivetgun -P lhc.params -g Herwig++
```

- There are generator-specific param files that you can copy from `/opt/mcnet/setups`. The files are separated into directories by analysis and generator. Copy them to your local area and modify them as you deem sensible.

- Ask one of the generator experts about the specific generator setups

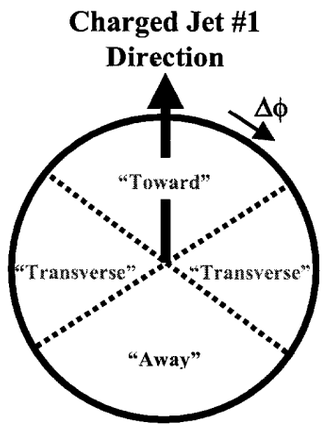
# Analysis 1: CDF Underlying event paper

- "Charged Jet Evolution and the Underlying event in Proton-Antiproton Collisions at 1.8 TeV." http://www-spires.dur.ac.uk/cgi-bin/spiface/hep/www?key=4751469

- Triggered on either minimum bias or a 20 GeV jet

- Run a cone jet algorithm on charged tracks of PT > 0.5 GeV in the central CDF tracker ($|\eta| < 1$). Rivet contains an implementation of this algorithm in a projection called TrackJet.

- In the plane transverse to the beam (x,y) define the direction of the highest (leading) PT jet ±60° as the toward region. The away region is opposite to the toward region and the transverse region lies between them.




- Plot number of charged tracks and PT sum in each region

# Analysis 1: Running the analysis

- To run the analysis on 1000 events do

```
rivetgun -g <generator> -P tevatron1800.params -P <param file> -a
CDF_2001_S4751469 -n 1000
```

- You may need to run twice to generate better statistics in both the minimum bias samples (with a hard minimum PT between 0 and 3 GeV, depending on other generator settings) and the jet 20 sample (with a hard minimum PT of around 15 GeV). Use the param files in `/opt/mcnet/setups/ue`

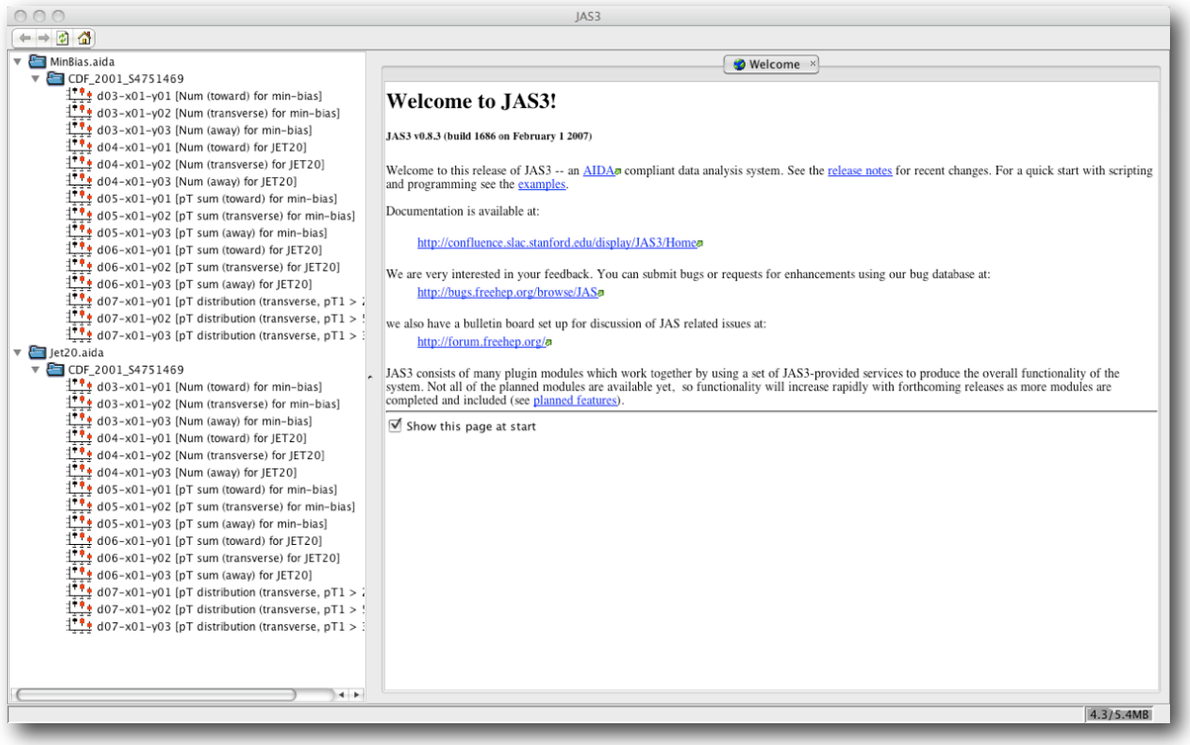
- Each run will produce a file named Rivet.aida that contains the output histograms. Do not overwrite the output of the first run with the output of the second! You can choose a different name for the histogram file with the option `-H <filename>`, e.g.

  `-H MinBias` (produces a file called MinBias.aida)

- You can open the aida files with the package JAS3 (short for Java Analysis Studio 3)

# Analysis 1:Using JAS 3

- JAS 3 should look a bit like this:




- Open the min bias and jet 20 aida files either by dragging into the panel on the left or with file➥open

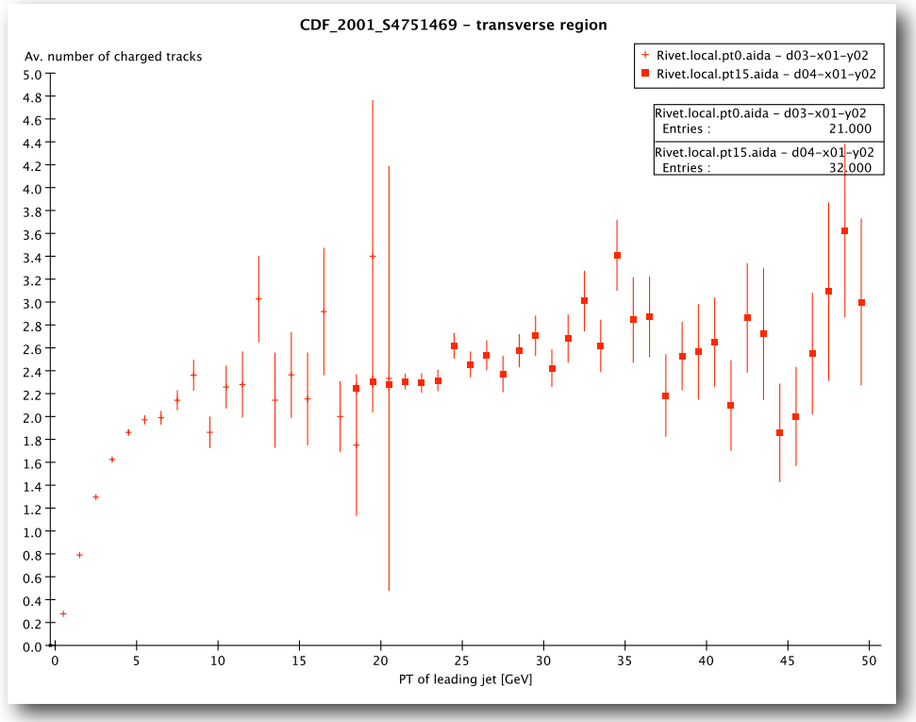
- Each plot has a unique dataset id, e.g. d03-x01-y02

- Take a look at the number of charged tracks in the transverse region first. You can overlay the Jet 20 plot (d04-x01-y02) from the Jet20.aida file on the min bias plot (d03-x01-y02) from the MinBias.aida file (right-click to overlay).

- Should give you a plot showing the average charged particle multiplicity in the transverse region Vs. the leading jet PT between 0.5 and 50 GeV. The min bias plot covers the region 0.5-20 GeV and the Jet20 plot covers 20-50 GeV.

# Analysis 1: Plots

- After adding axis labels you should end up with something like this:



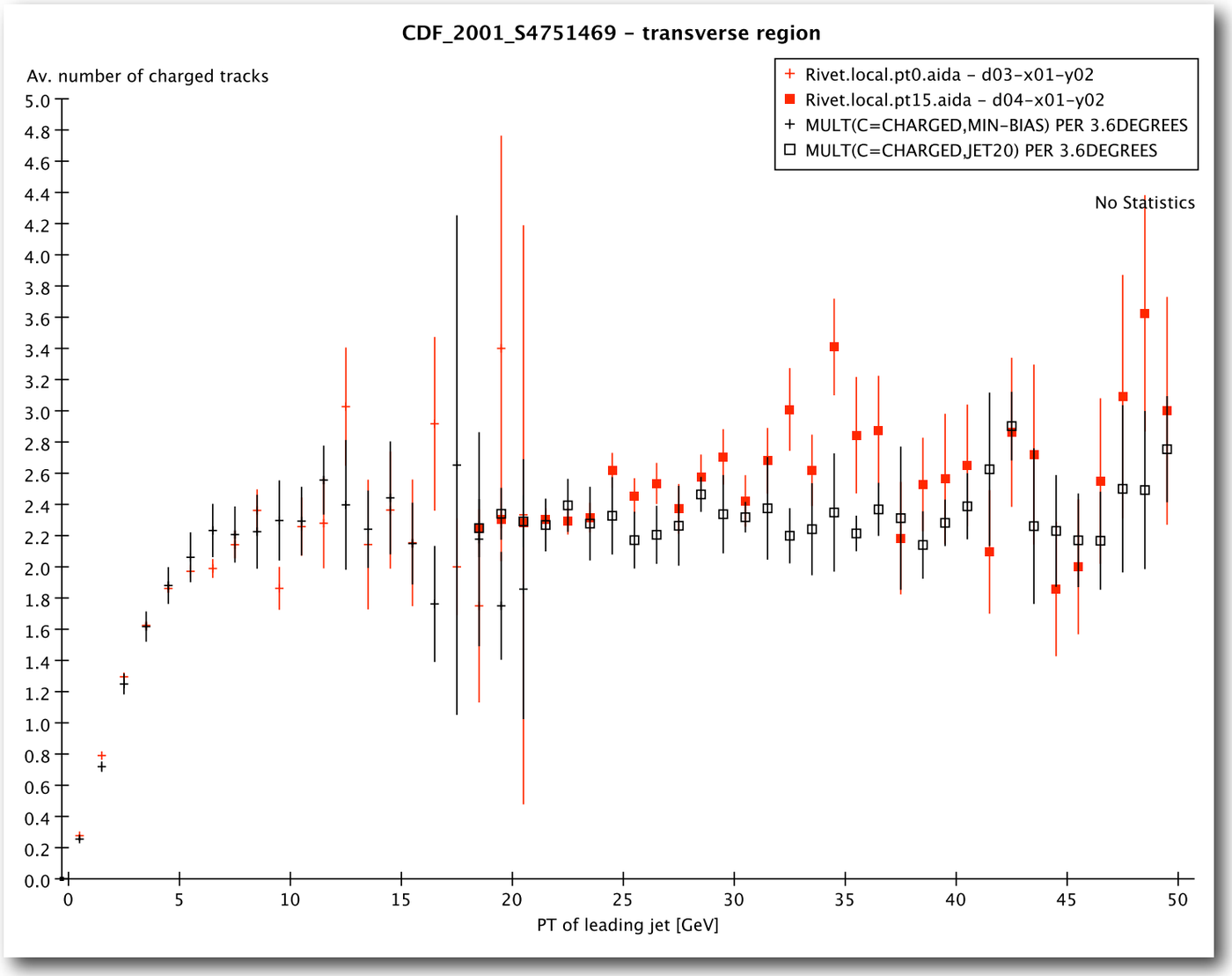

- Rivet comes with a set of reference data from the experiment that can be compared to the Monte Carlo points.

- The reference data is found in `/opt/mcnet/share/Rivet` in a file called `CDF_2001_S4751469.aida`

- Open this file in JAS 3 and overlay the reference plots for datasets d03-01-02 and d04-01-02

# Analysis 1: Comparison to reference data

- Should look something like this:




- The black points are the CDF reference paper.

# Analysis 1:More plots

- Now you can go on to look at the other plots in the away and towards regions in the same way.

- There are also plots of the scalar PT sum in each of the regions.

- If you have time, ask one of the generator experts about changing the underlying event parameters.  For example, what happens if you increase the PT scale in the Pythia8 multiple interactions class from the default 2.15 to a higher value (set with e.g. `MultipleInteractions:pT0Ref=3.0`).

- If you *still* have time, try running one of the other analyses in Rivet.  For example, the CDF colour coherence analysis is available as `CDF_1994_2952106` (http://www-spires.dur.ac.uk/cgi-bin/spiface/hep/www?key=2952106)  How do the different generators compare?