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LABORATORY FOR ELEMENTARY-PARTICLE PHYSICS

Suez and the Event Display

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Outline for this talk

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- Overview of Suez
- Demonstration of Suez with the Event Display
- Raw data versus Pass2
- Walk-through of creating a processor for analysis
- Filling histograms
- Homework: repeat this presentation!

Suez (where CLEOpatra lives)

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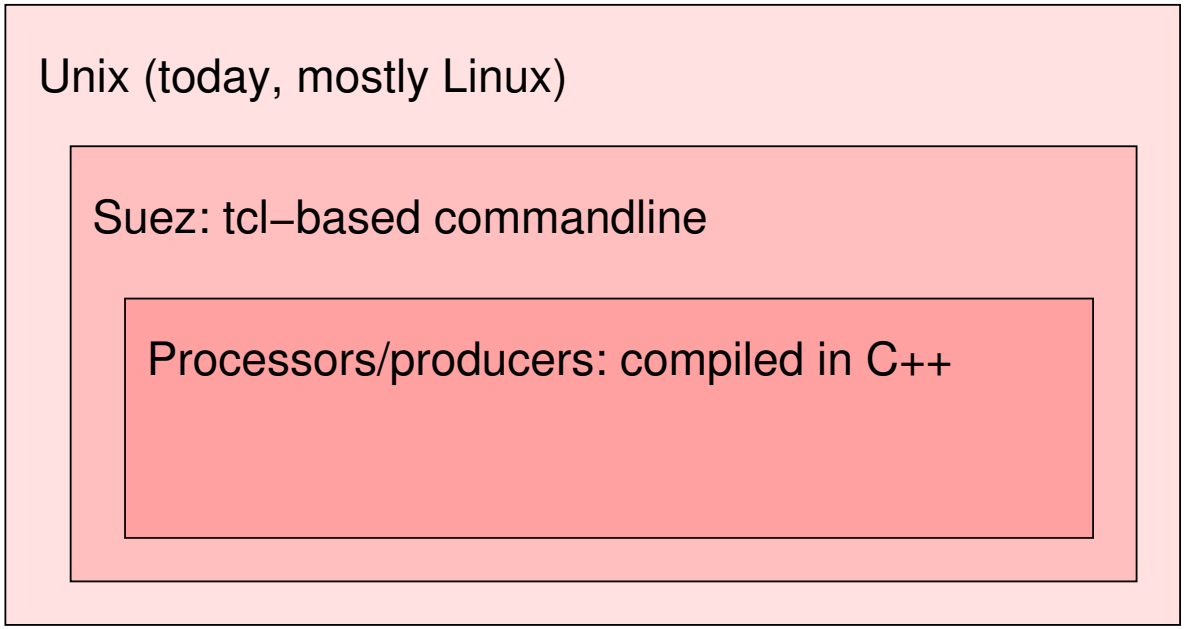
Software framework for accessing CLEO data

Generalized 'for' loop:

- you select data for processing
- select processors to perform operations on events
- type 'go'
- suez loops over events, applying requested operations

You can write your own processors (we will today)

Software environment



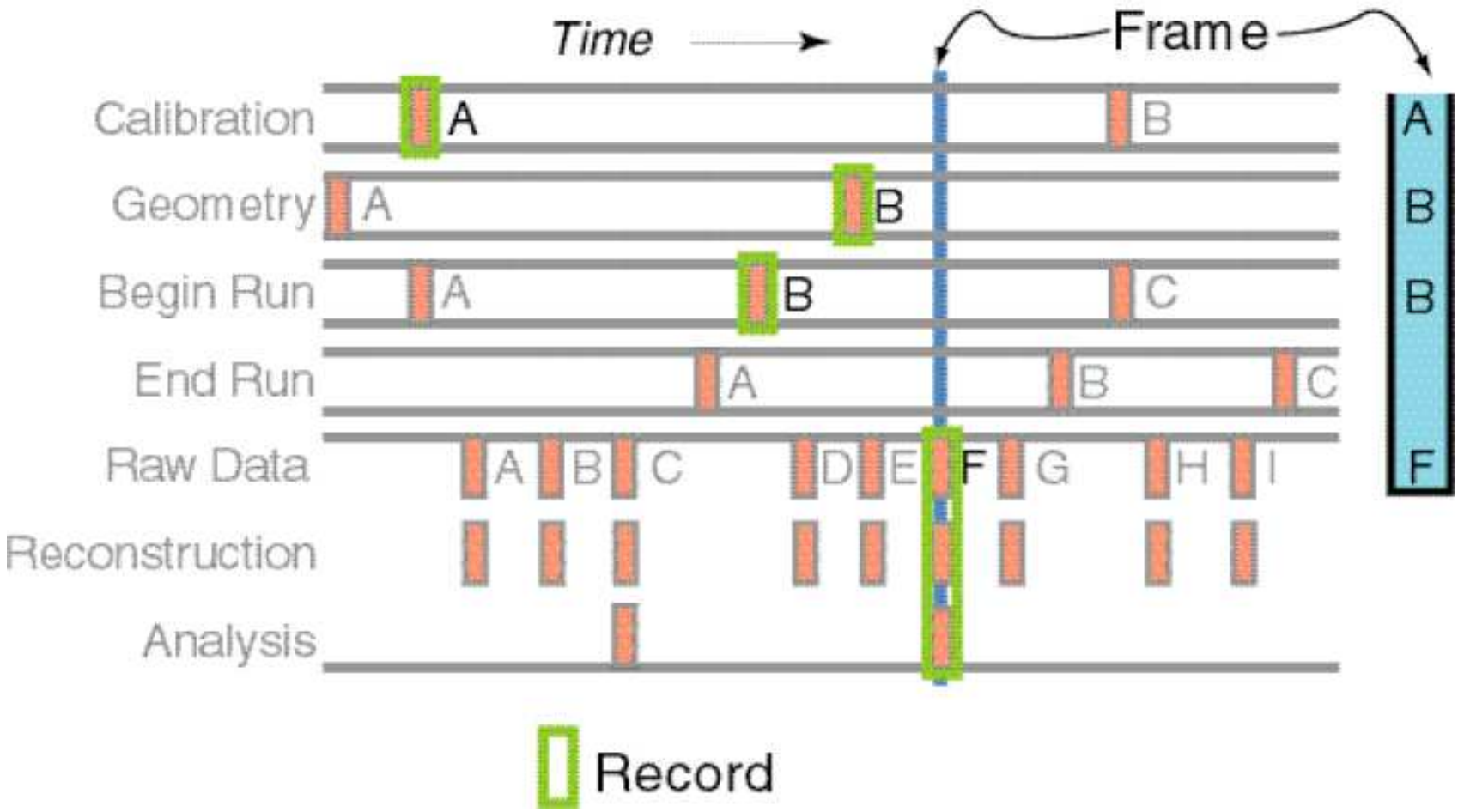
This means a text editor will be your dearest friend

though some processors have GUI interfaces

- Event Display
- HistogramViewer

Suez data-access model

Data which is valid for a given event is accessible through the Frame (like a movie frame), and obsolete data is inaccessible.



CMS, an LHC Detector Experiment

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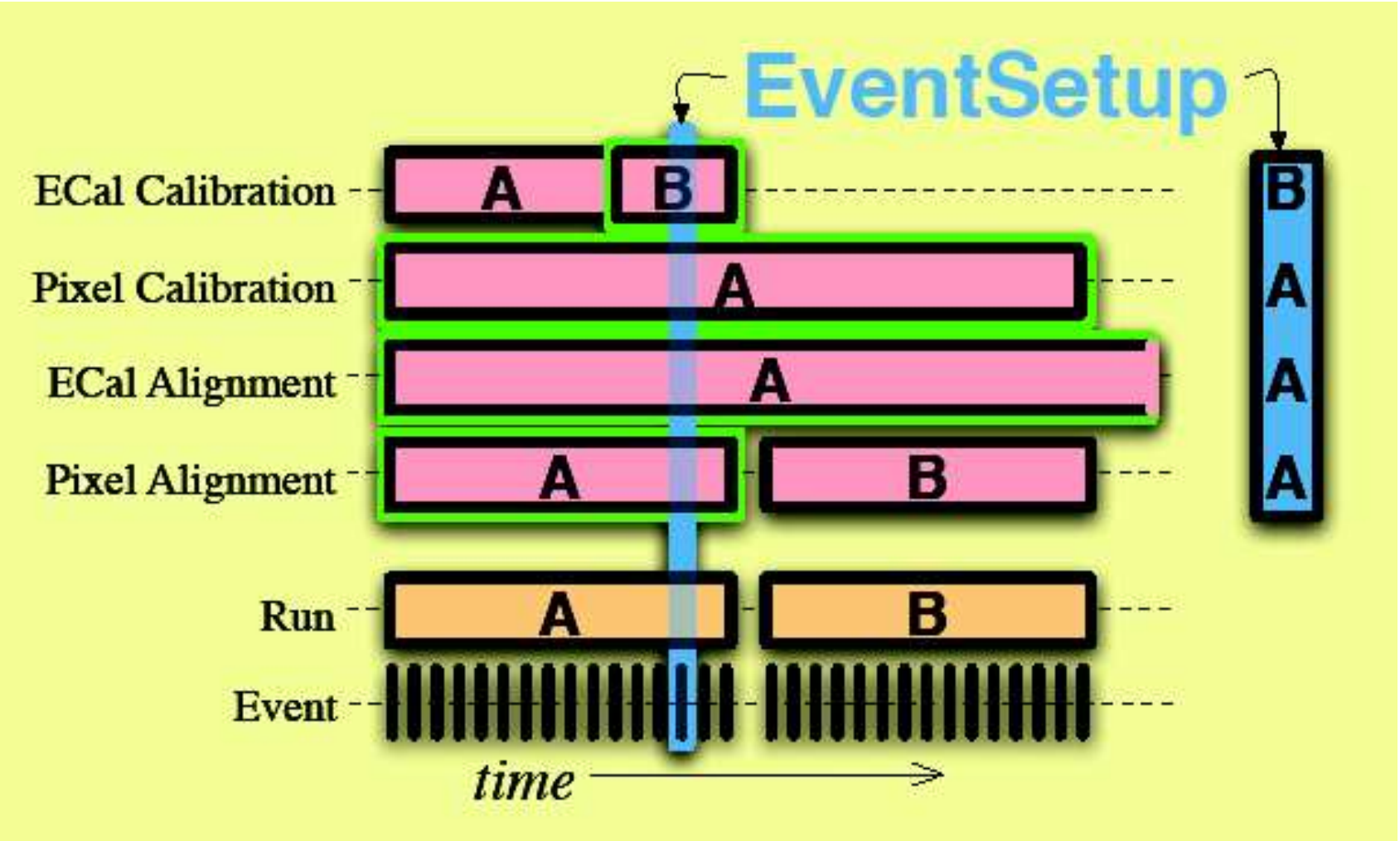
Follows the same model (thanks to Chris Jones)



Suez data processing model

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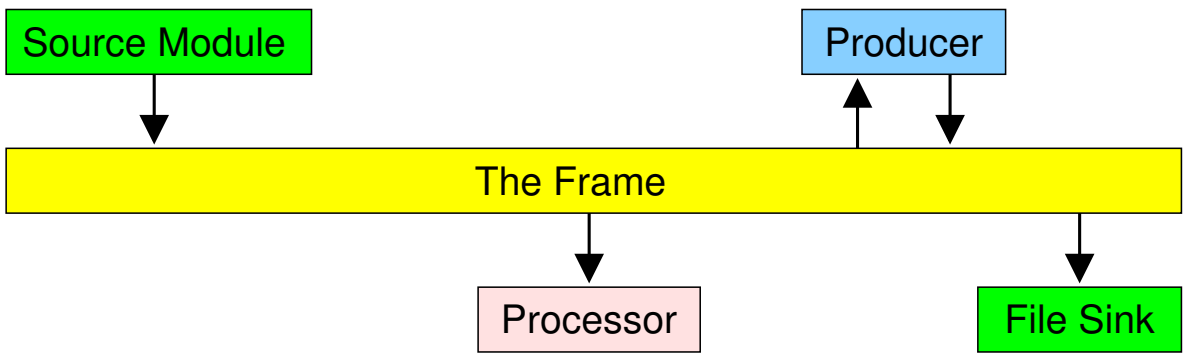
processors are called in the event loop, extract data from the Frame, fill histograms, and filter events

producers are called when data is requested, extract what they need, and insert the desired results into the Frame

modules are the most general; we usually use them to read data from disk (EventStoreModule) and manage histogram output (RootHistogramModule)



A typical tcl (suez control file)

- `module GoGetDataModule`
- `prod sel CalibrateDataProd`
- `prod sel IdentifyTracksProd`

} order does not matter

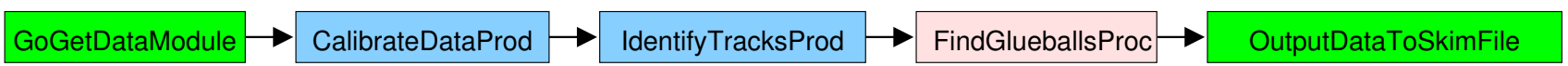
- `proc sel FindGlueballsProc`
- `proc sel MakePlotsOfGlueballsProc`

} order matters

- `go`

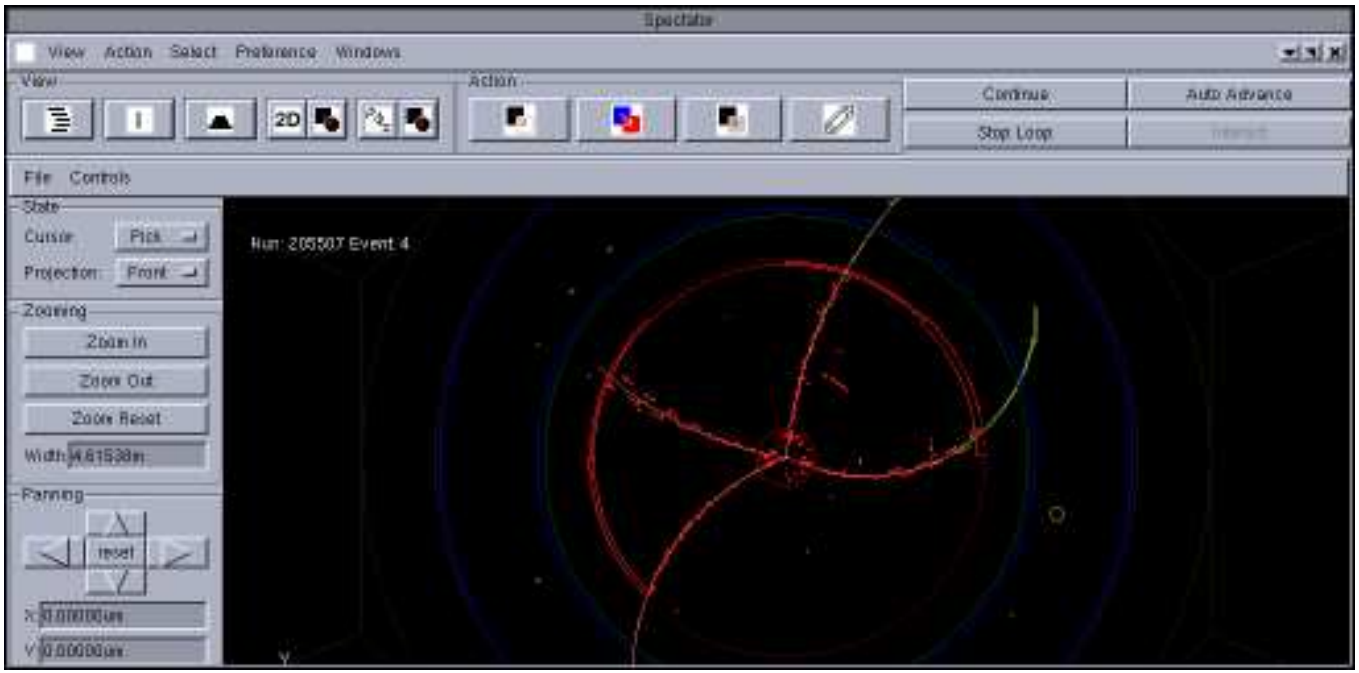
A typical tcl (suez control file)

- `module GoGetDataModule`
- `prod sel CalibrateDataProd`
- `prod sel IdentifyTracksProd`
- `proc sel FindGlueballsProc`
- `file out ToSkimFile`
- `go`



Later, you can run `MakePlotsOfGlueballsProc` on your skim file

Demonstration: The Event Display



The Event Display is a set of processors that draw CLEO data on the screen, event by event. It's useful for

- Data sanity check (e.g. during data-taking)
- Identifying backgrounds
- **Introduction to CLEO/data analysis**

Setup (review of yesterday)

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Connect to a Linux computer

For **bash/sh** users (type "`echo $SHELL`" to identify),

- `. /nfs/cleo3/Offline/scripts/cleo3logins`
- `. /nfs/cleo3/Offline/scripts/cleo3defs`
- `c3rel 20060224_FULL_2`
- `export USER_SRC=$HOME/my_src`
- `export USER_BUILD=/cdat/tem/mccann/build/$C3LIB`
- `export USER_SHLIB=$USER_BUILD/Linux/shlib`
- `c3rel $C3LIB` *(yes, again!)*

Be sure to make the following directories (all shells):

- `mkdir -p $HOME/my_src`
- `mkdir -p $HOME/my_tcl`

Setup (review of yesterday)

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Connect to a Linux computer

For **tcsh/csh** users (type "`echo $SHELL`" to identify),

- `source /nfs/cleo3/Offline/scripts/cleo3login`
- `source /nfs/cleo3/Offline/scripts/cleo3def`
- `c3rel 20060224_FULL_2`
- `setenv USER_SRC $HOME/my_src`
- `setenv USER_BUILD /cdat/tem/mccann/build/$C3LIB`
- `setenv USER_SHLIB $USER_BUILD/Linux/shlib`
- `c3rel $C3LIB` *(yes, again!)*

Be sure to make the following directories (all shells):

- `mkdir -p $HOME/my_src`
- `mkdir -p $HOME/my_tcl`

Create a tcl file

- `cd $HOME/my_tcl`
- `favorite_text_editor hitsandeverything.tcl &`

Fill it with the following:

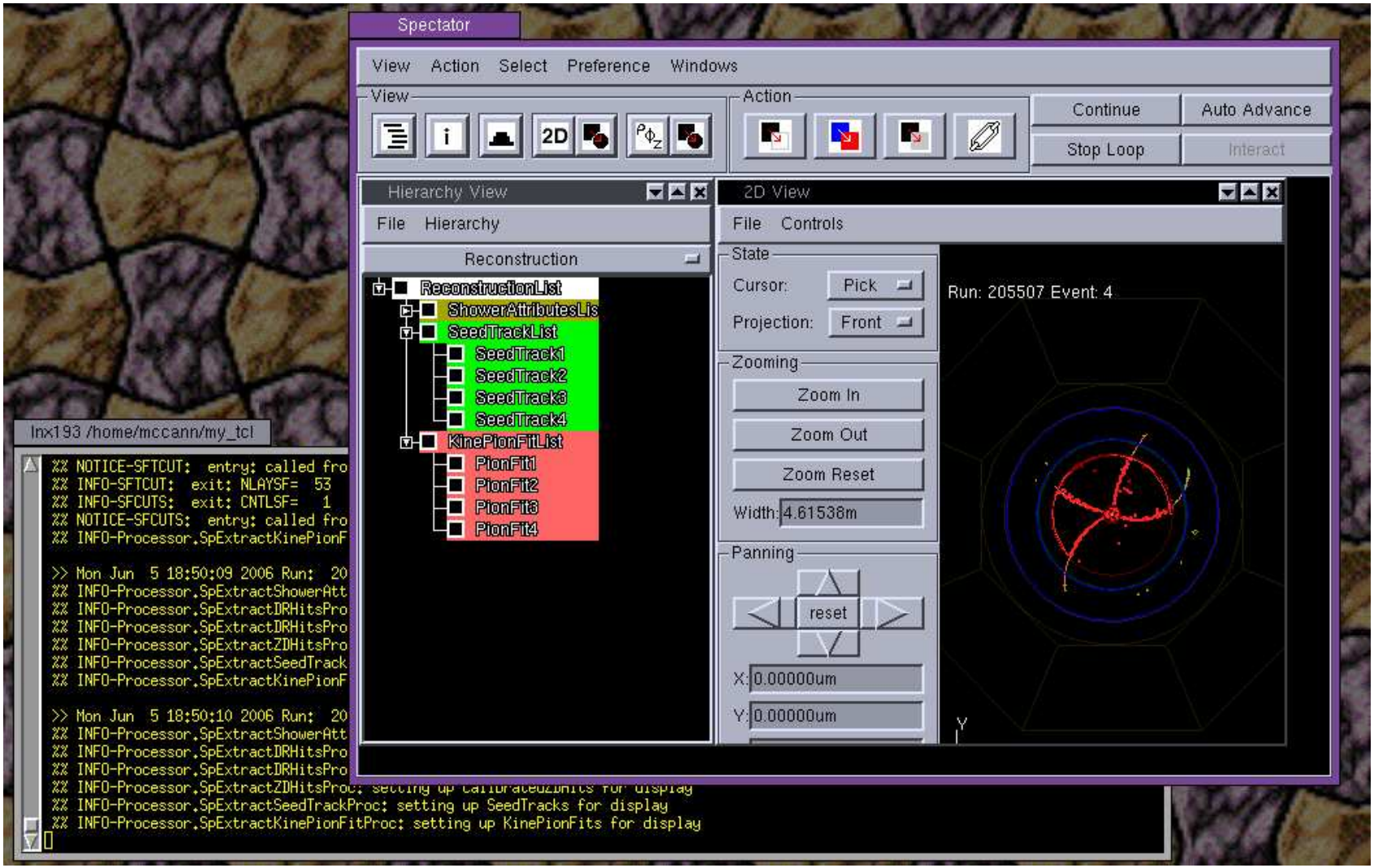
```
# Get raw events so we can look at hits
module sel EventStoreModule
eventstore in 20060601 daq all runs 205507 217380

# All the things you need to process raw data
run_file $env(C3_SCRIPTS)/getNewestConstants.tcl
run_file $env(C3_SCRIPTS)/trackingDataFull.tcl
run_file $env(C3_SCRIPTS)/CcP2.tcl

# Run the event display
run_file $env(C3_SCRIPTS)/view_command.tcl
view -display_only ShowerAttributes DRHits ZDHits SeedTrack
                           KinePionFit DBEventHeader StandAloneGeom
go
```

Run Suez

- `suez -f hitsandeverything.tcl`



Things to do with the Event Display

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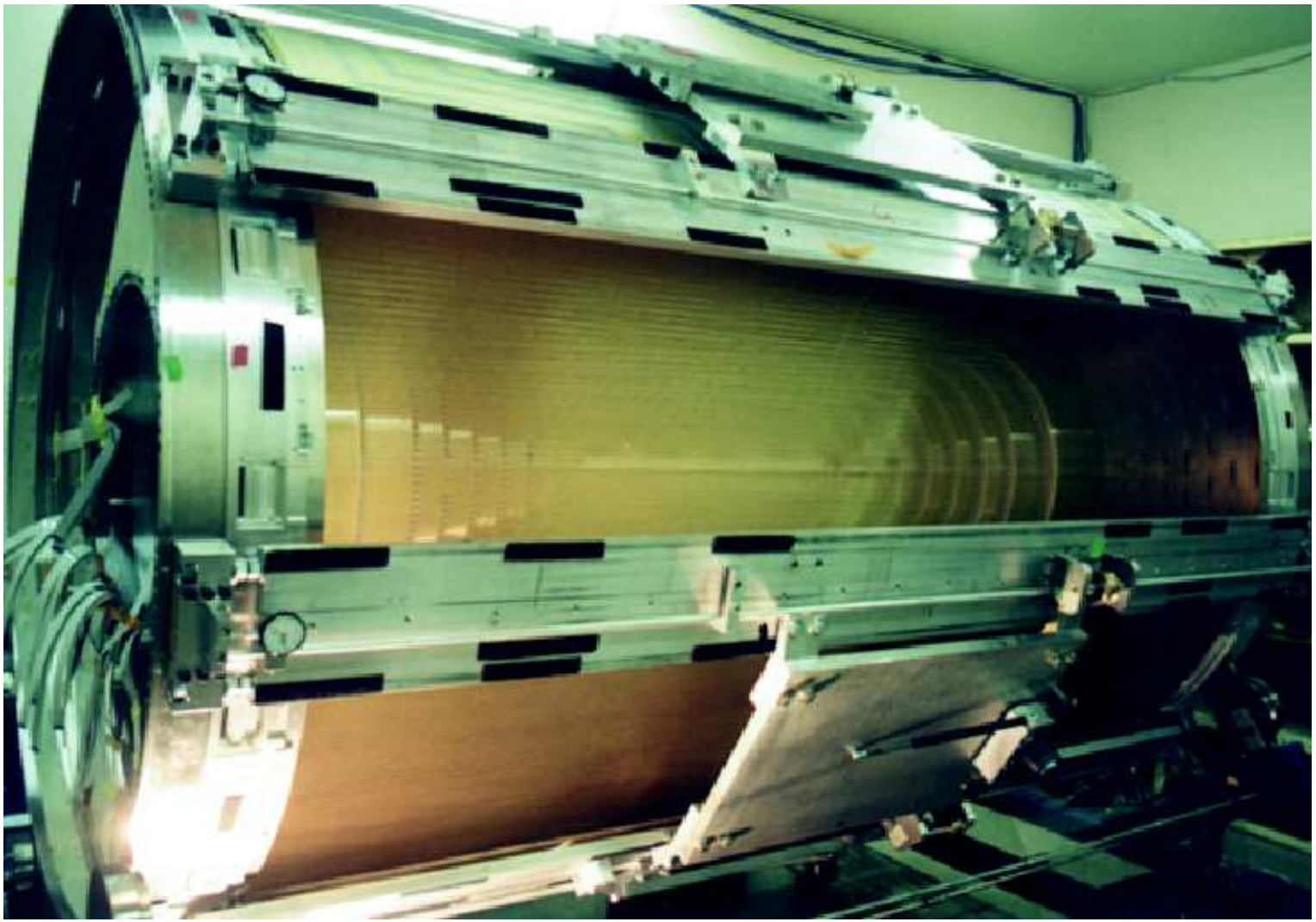
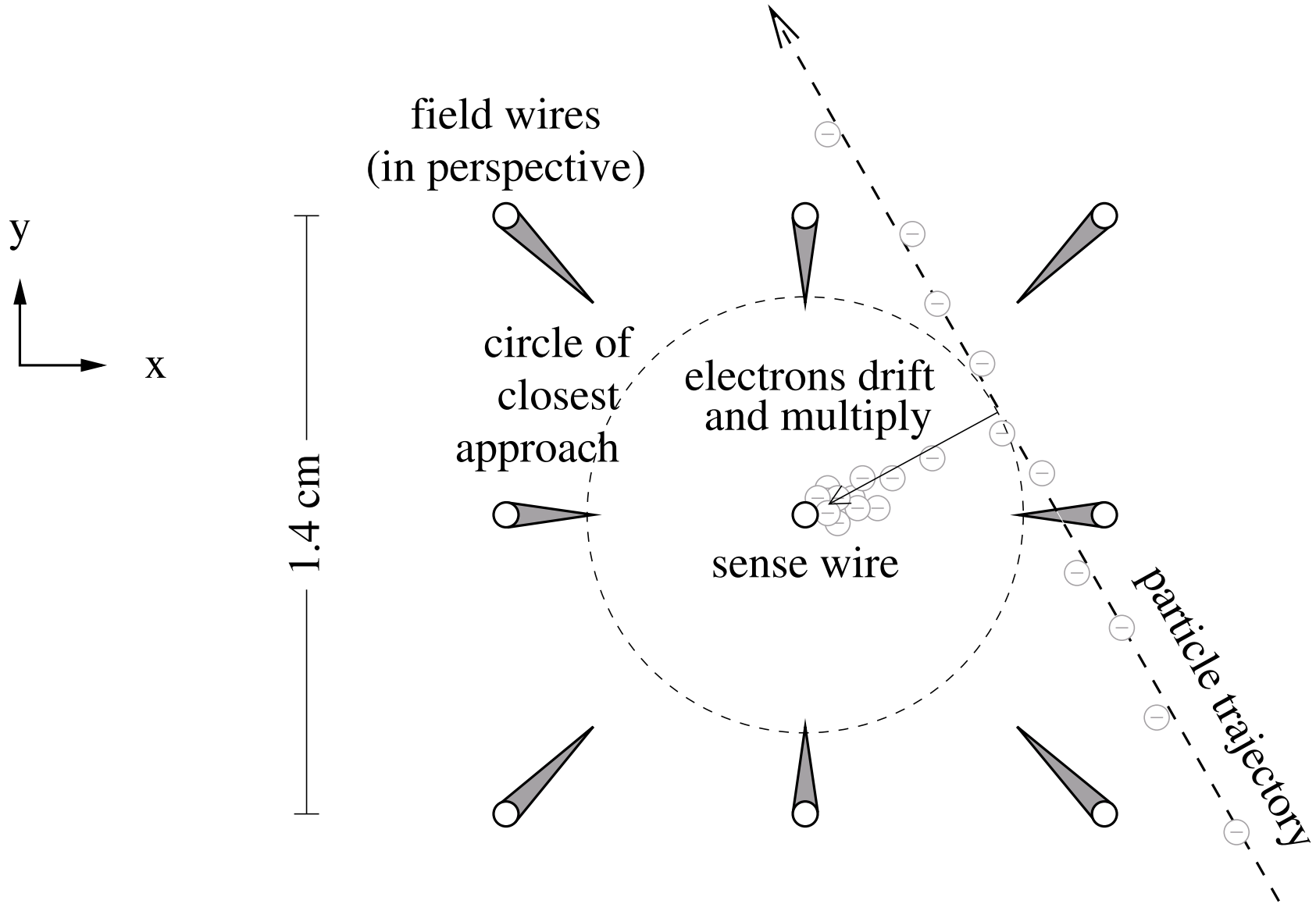
1. Move windows within windows, zoom around, look at side view, select hits
2. Step through events ("Continue" button); zip through them ("Auto Advance" button)
3. SeedTracks (green) versus fitted tracks (KinePion, pink)
4. Calorimeter shower representation: label with energy
5. Make DR hits circles
6. Make ZD hits lines

The Drift Chamber

Wires strung between two endplates report time of hit which yields distance of closest approach of charged particle

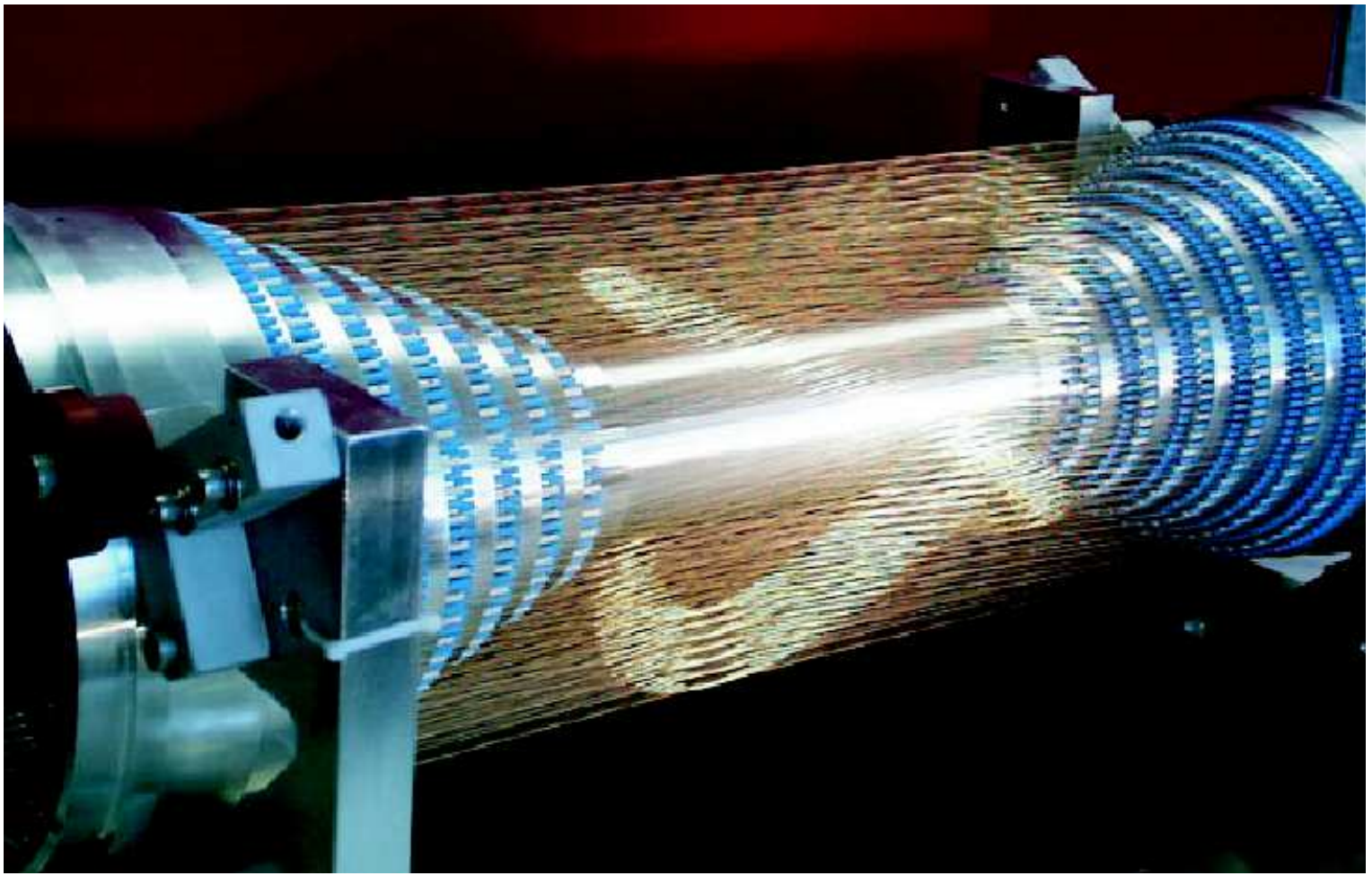


The Drift Chamber

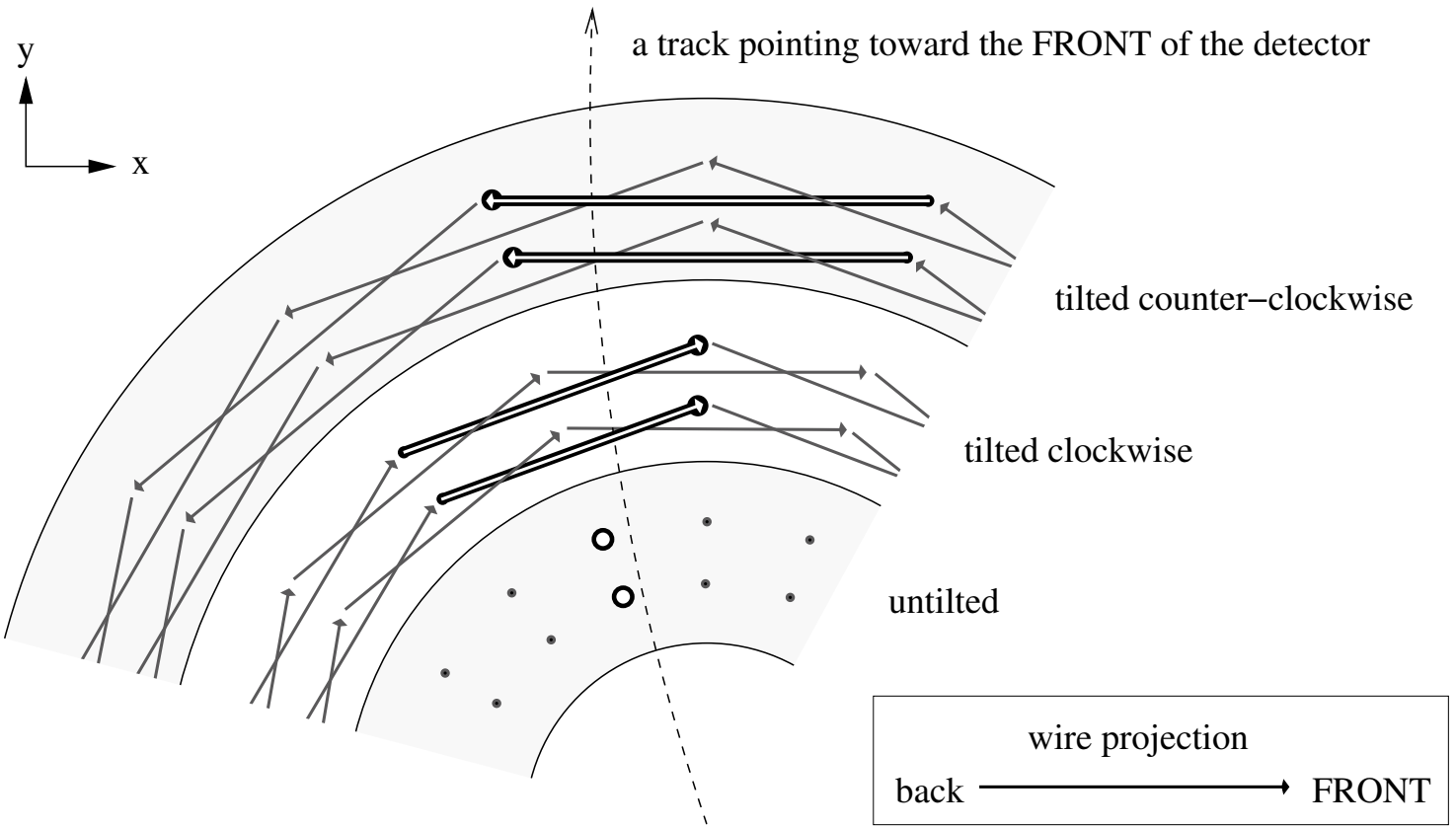


The ZD

A small drift chamber with an extreme angle between the wire end positions (stereo angle)



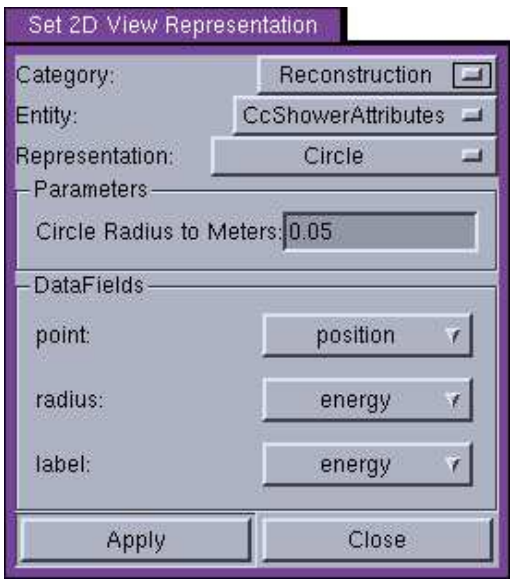
Stereo angle (detailed explaination)

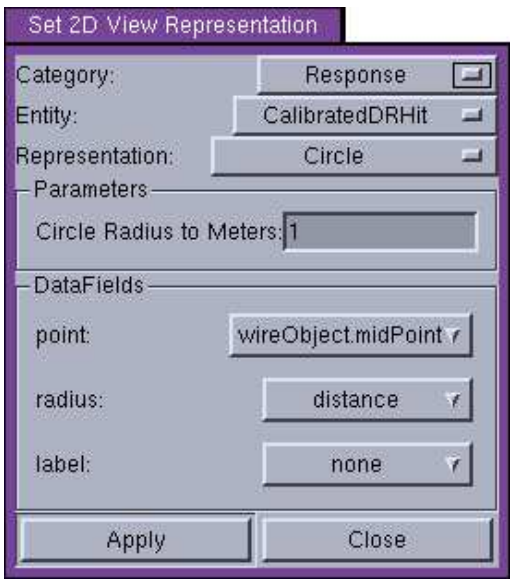


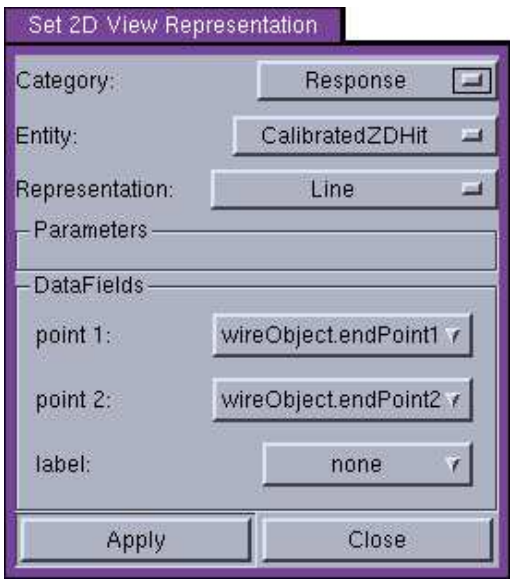
Using tilted wires to obtain z information in the outer drift chamber/ZD. Tilted wires extrude lines in the x-y projection; position along a tilted wire indicates the z of the track helix near that wire. The closest wires to the track (in three dimensions) are highlighted.

Cheat Sheet for 4, 5, and 6

View menu → Set 2D Representation...







Pre-processed data: pass2

- `cd $HOME/my_tcl`
- `favorite_text_editor afterpass2.tcl &`

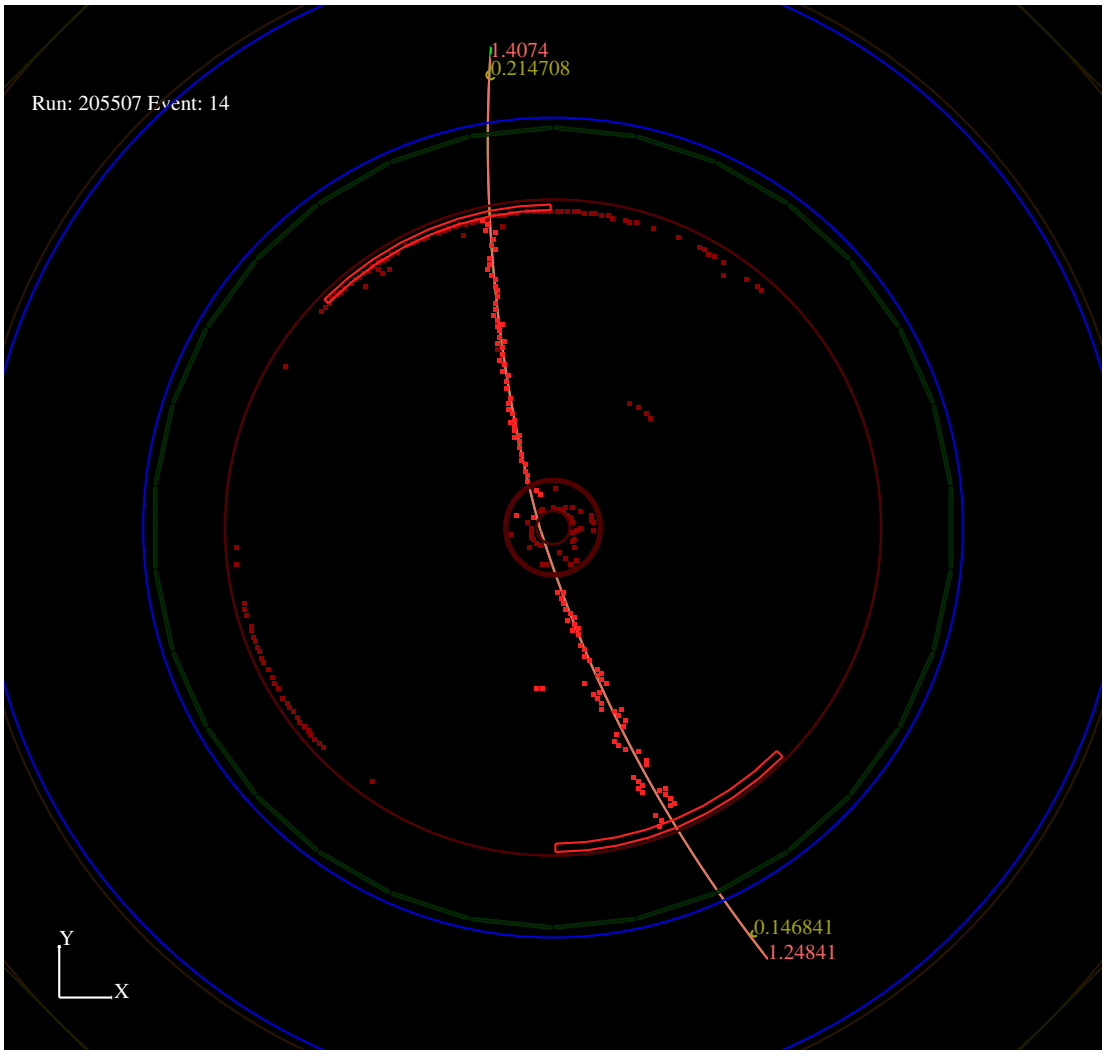
```
# Get pass2'ed events (no hits, but much faster!)
module sel EventStoreModule
eventstore in 20050316 physics all

# Setup standard analysis and event display
setup_analysis

# Run the event display
run_file $env(C3_SCRIPTS)/view_command.tcl
view -display_only Pass2

go
```

- `suez -f afterpass2.tcl`

1. Note the missing hits
2. See what happens when you press "Auto Advance"

First Data Analysis

Many events look like this:



- 2 tracks
- minimal calorimeter energy ($E/p \lesssim 10\%$)
- misses the beamspot

Select Cosmic Rays

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We will make a processor that identifies cosmic rays

- `cd $HOME/my_src`
- `mkproc -track -shower -histogram MySecondProcessor`
- `favorite_text_editor MySecondProcessor/Class/MySecondProcessor.cc &`

The processor is already filled with a lot of example code. We'll ignore that and add the following block at the beginning of the `MySecondProcessor::event` method (line 153). Before editing, the code looks like this:

```
ActionBase::ActionResult
MySecondProcessor::event( Frame& iFrame ) // anal3 equiv.
{
  report( DEBUG, kFacilityString ) << "here in event()" << endl;

                    → insert new code here ←

  // Create a table of tracks and fill it.
  FATable< NavTrack > trackTable;
  extract( iFrame.record( Stream::kEvent ) , trackTable );
```

The New Code (page 1)


```
int number_of_tracks = 0;
double closest_to_beamline = 1000.; // meters

FATable<NavTrack> tracks;
extract(iFrame.record(Stream::kEvent), tracks);

for (FATable<NavTrack>::const_iterator track = tracks.begin();
       track != tracks.end();
       ++track) {

   double distance_from_beamline = fabs(track->pionHelix()->d0());
   if (distance_from_beamline < closest_to_beamline) {
      closest_to_beamline = distance_from_beamline;
   }

   double track_momentum = track->pionFit()->momentum().mag();
   if (track_momentum > 1.)  { // greater than 1 GeV/c
      number_of_tracks++;
   }
}
```

The New Code (page 2)

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```
FATable<NavShower> showers;
extract(iFrame.record(Stream::kEvent), showers);

double biggest_shower_energy = 0.; // GeV

if (showers.size() > 0)
{
   // the showers table is sorted by energy
   biggest_shower_energy = showers.begin()->attributes().energy();
}

// Now filter the events
if (number_of_tracks == 2 &&            // two tracks above 1 GeV/c each
    closest_to_beamline > 0.05 &&       // more than 5 cm from beamline
    biggest_shower_energy < 0.3)        // less than 300 MeV
{
   return ActionBase::kPassed;
}
else
{
   return ActionBase::kFailed;

}
```

Compile and Run

- `c3make`
- `cd $HOME/my_tcl`
- `favorite_text_editor afterpass2.tcl &`

In `afterpass2.tcl`, add the processor after setting up the view command but before calling it:

```
run_file $env(C3_SCRIPTS)/view_command.tcl
proc sel MySecondProcessor
view -display_only Pass2
```

Run suez

- `suez -f afterpass2.tcl`

and press the "Auto Advance" button in the Event Display. See how you have biased the events!

Histogram track ϕ

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1. In `$HOME/my_src/MySecondProcessor/MySecondProcessor/MySecondProcessor.h`, add `HIHist1D* m_histphi;` after `HIHist1D* m_histo1;`

2. In `$HOME/my_src/MySecondProcessor/Class/MySecondProcessor.cc`, add `m_histphi = iHistoManager.histogram("phi", 100, 0., 2.*M_PI);` at the end of `MySecondProcessor::hist_book(){ }` (line 144)

3. Also add the following just before your `return ActionBase::kPassed;` (line 181)

```
for (FATable<NavTrack>::const_iterator track =
        tracks.begin(); track != tracks.end(); ++track)
{
   m_histphi->fill(track->pionHelix()->phi0());
}
```

4. Recompile (described on previous page)

Histogram track ϕ (continued)

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5. At the beginning of `$HOME/my_tcl/afterpass2.tcl`, add

```
# Load a histogram manager.
module sel HbookHistogramModule
hbook file myhistograms.rzn
hbook init
```

6. Also add `proc sel HistogramViewerProc` after

```
proc sel MySecondProcessor.
```

7. Run `suez -f afterpass2.tcl` in your `$HOME/my_tcl` directory.

8. Select Root $\longrightarrow$ MySecondProcessor $\longrightarrow$ phi from the heirarchy on the left of the HistogramViewer window

9. Click "Continue" HistogramViewer and "Auto Advance" in the Event Display

Homework

1. Walk through the demonstrations on your own.
2. Study $e^+e^- \longrightarrow \mu^+\mu^-$: plot the $\cos\theta$ distribution.

   Hints:

   - Collision-borne muons deposit the same energy in calorimeter showers as cosmic ray muons.
   - But $e^+e^- \longrightarrow \mu^+\mu^-$ events must come from the beam
   - Given a `FATable<NavTrack>::const_iterator track`, the momentum vector components are obtained by `track->pionFit()->momentum().x()`, `.y()`, and `.z()`.
   - θ is the polar angle between $\sqrt{x^2+y^2}$ and z.
   - p. 137 Peskin & Schroeder: $P(\cos\theta) \propto 1 + \cos^2\theta$

Shopping for data

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Very important webpages/directories

- Member functions:
  - `http://www.lns.cornell.edu/restricted/webtools/doxygen/Offline/html/hierarchy.html`
- Looking at the code:
  - `http://www.lns.cornell.edu/restricted/webtools/cleo3/`
  - `ls $C3_CVSSRC/`
  - `ls $C3_OTHER/`
- Producers to add to your `.tcl`:
  - `http://www.lns.cornell.edu/~cleo3/current/data/proxiesOfProducers.txt`
- Event classification:
  - `http://www.lns.cornell.edu/restricted/CLEO/CLEO3/soft/hints/CLEOIIIEventClassificationDescription.html`