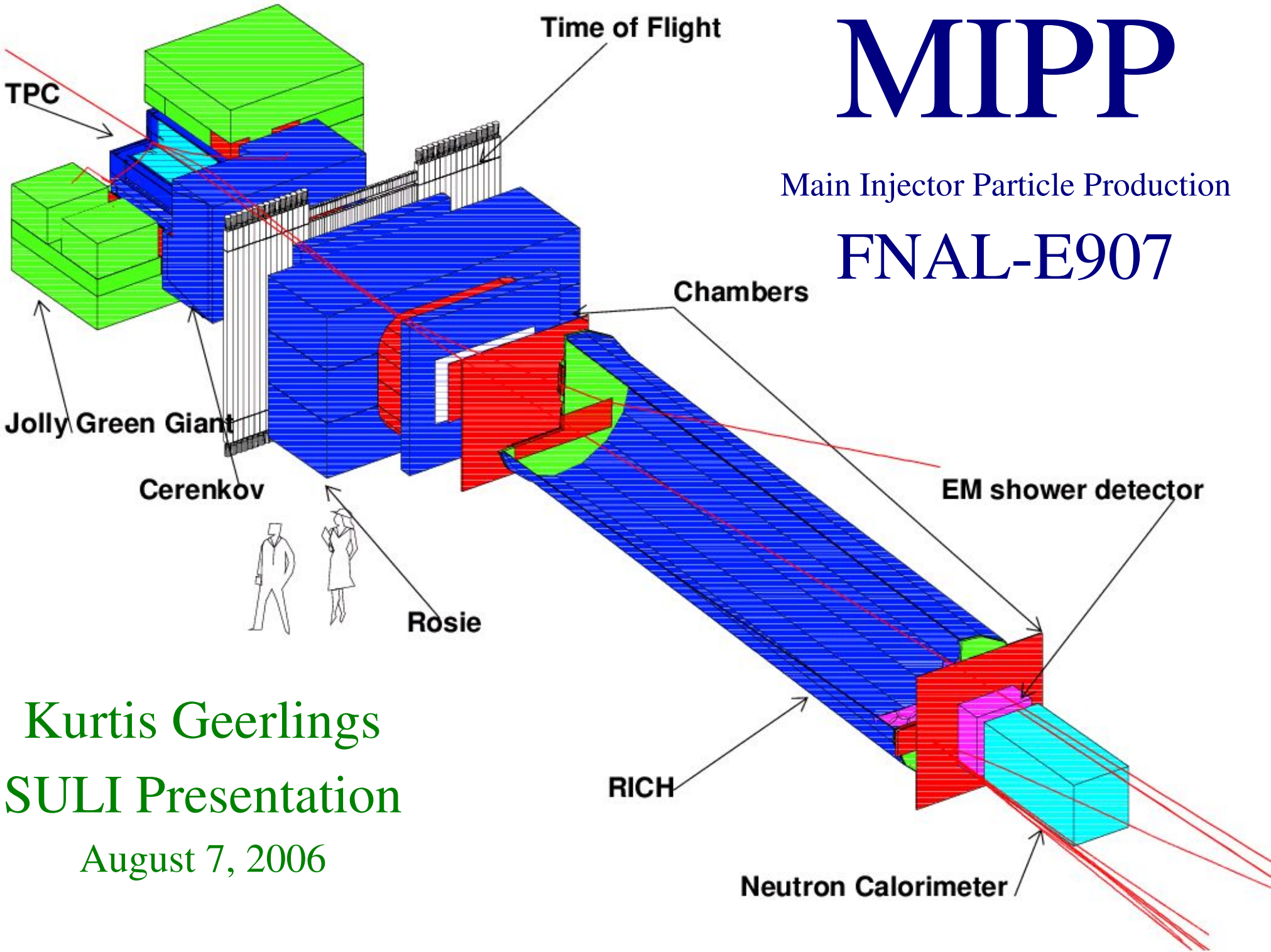
MIPP

Main Injector Particle Production

FNAL-E907



Kurtis Geerlings

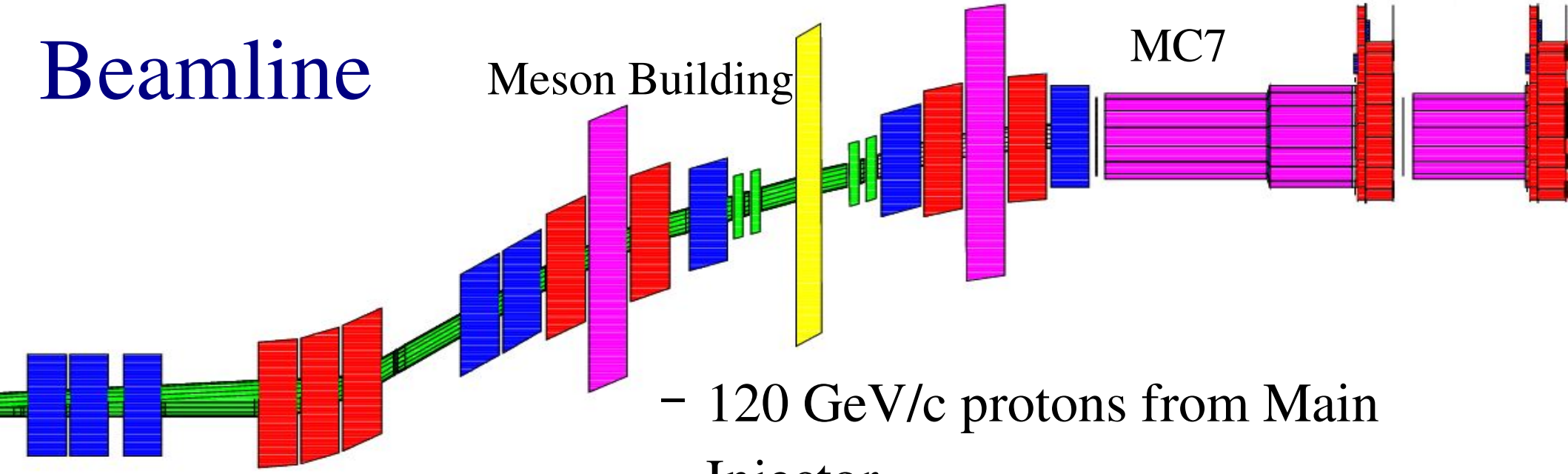
SULI Presentation

August 7, 2006

Motivation

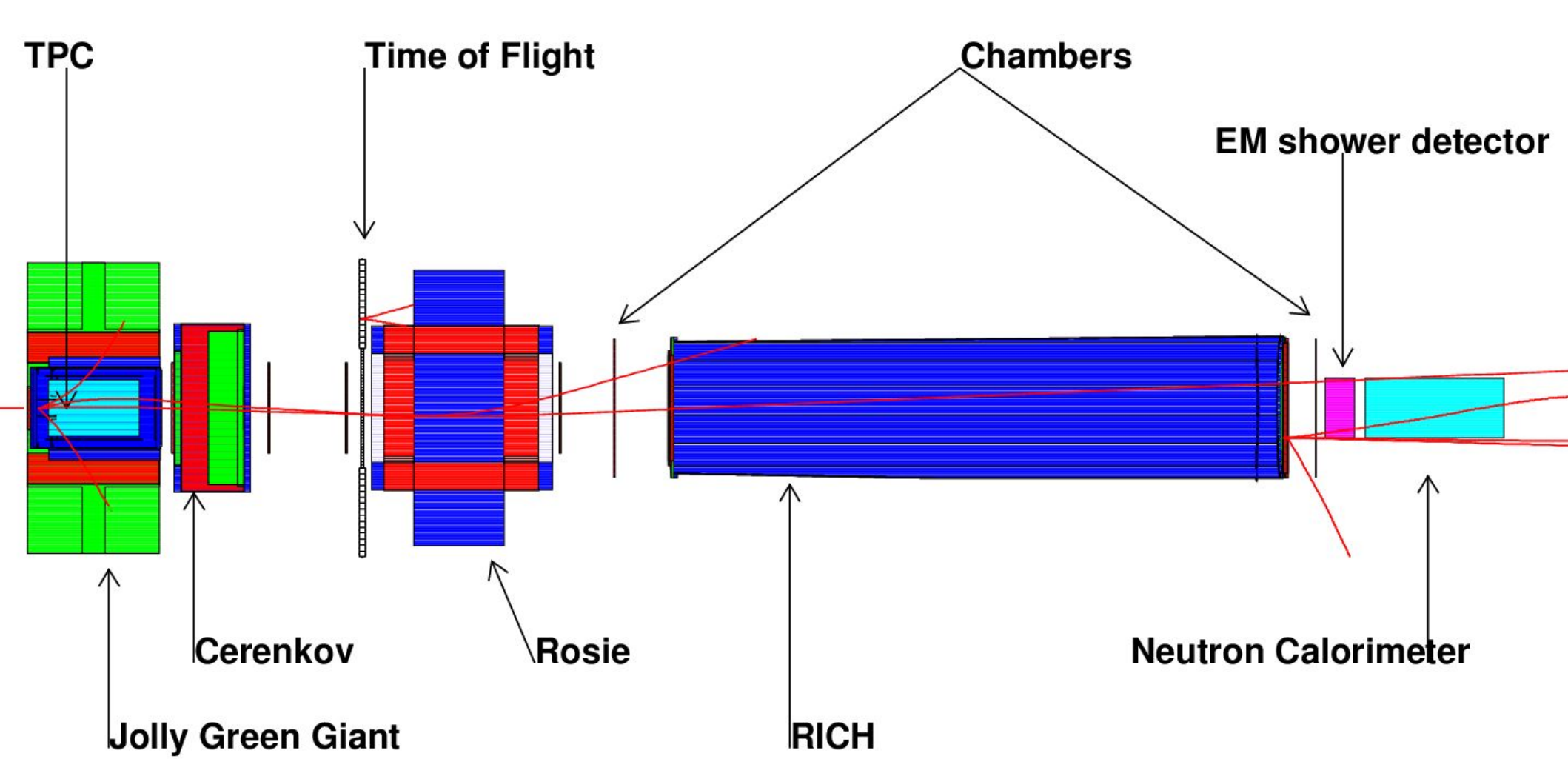
- Input to Neutrino experiments
  - Atmospheric neutrino flux
  - NuMI target,...
- proton radiography
  - Stockpile Stewardship
  - Homeland security applications
- hadron spectroscopy
- light meson spectroscopy
  - Search for missing resonances, di-baryons, glue-balls, etc.
- non-perturbative QCD
  - particle fragmentation scaling law
- nuclear physics
  - y-scaling
- heavy ion physics

Beamline



- Beam Chambers
- trims
- Beam Cerenkovs
- Quadrupole(4Q)
- Quadrupole(3Q)
- Dipole
- Collimator

- 120 GeV/c protons from Main Injector
- 20cm Cu target produces secondary beam
- Adjustable momentum selection collimator
  - 5-120GeV/c
- Targets: LH_2, N_2, O_2, Cu, Pb, D_2, Be, C, U, NuMI...

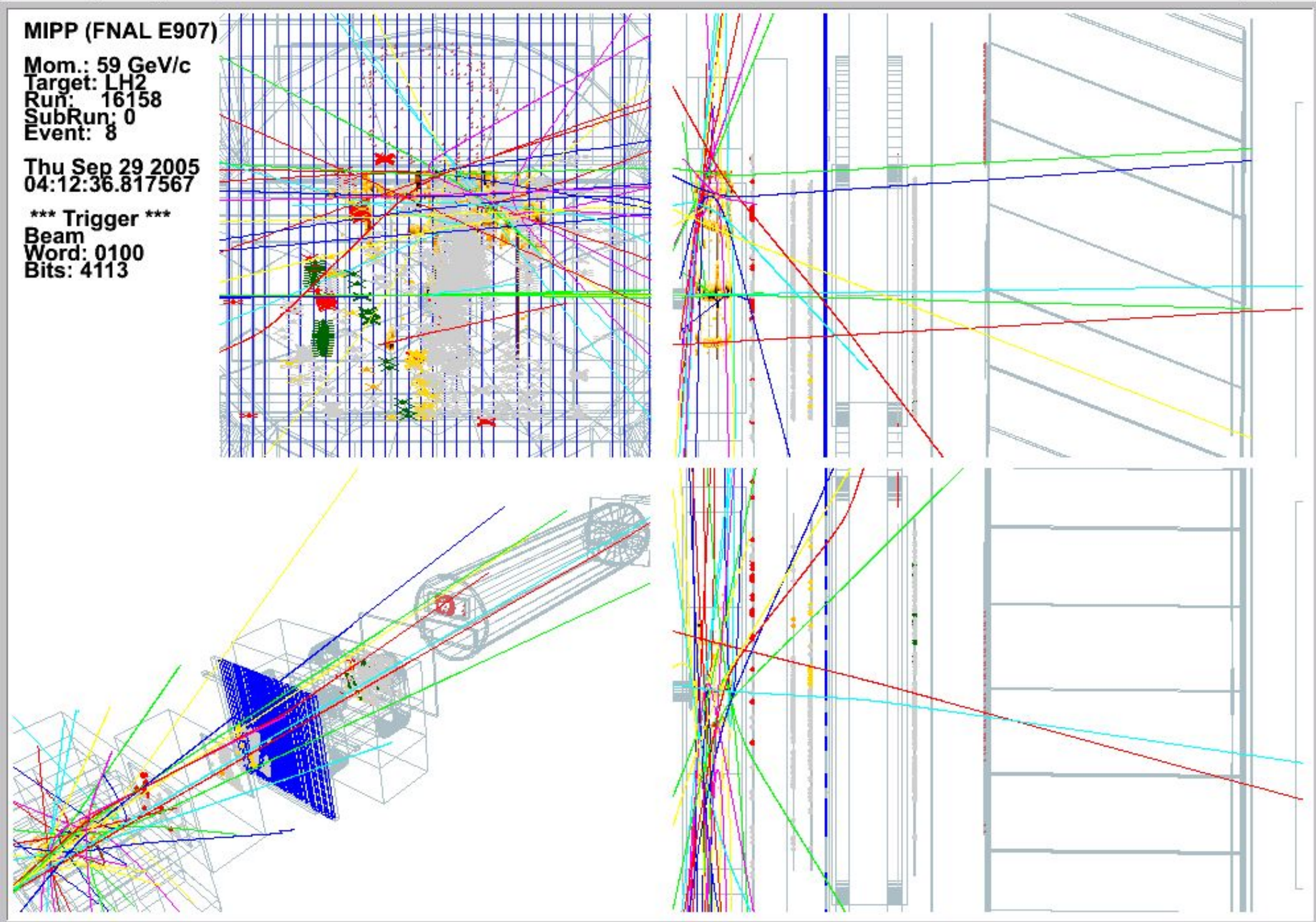


Momentum Acceptance Ranges (GeV/c)

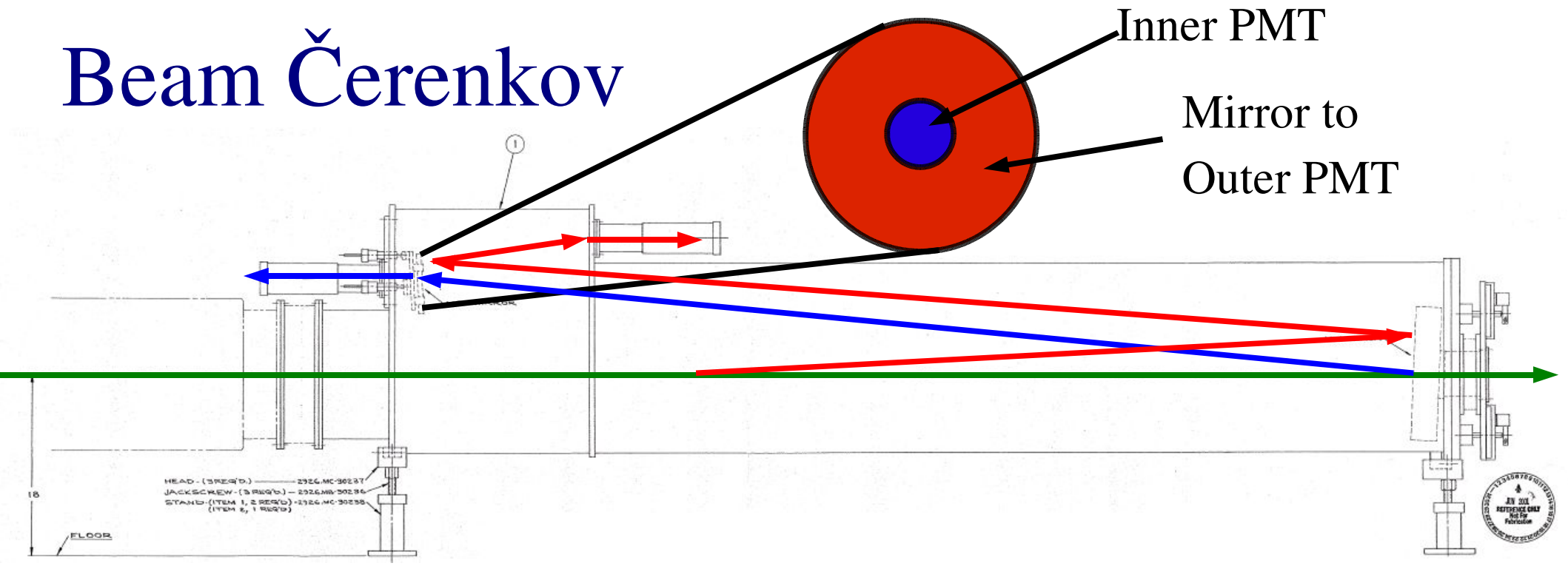
Particle	TPC	TOF	CKOV	RICH
π	0.1 – 0.7	0.7 – 2.7	2.5 – 7.5	5 – 80
K	0.1 – 0.7	0.7 – 2.7	2.5 – 4.6	7.5 – 80
p	0.1 – 1.1	0.7 – 4.6	7.5 – 17.5	17 – 120

File Edit Window Job Help

<-Previous | Next-> | Reload | /disks/10/kurtisg/dst/good/mipp00016158.0000.out.root | [Run/Event]= 16158 8 | Go | Print



Beam Čerenkov



- Used to tag initial π, K, and p in beam
- Two Counters set up so that:
  - π's radiate in counter 1, while K's and p's do not
  - π's and K's radiate in counter 2, p's do not
- Gas and pressure depend on beam momentum and charge

Time Projection Chamber

- How it works:
  - charged particles ionize gas
  - electrons travel to wires due to E fields
  - B-field to bend tracks for momentum determination
- 3-dimensional reconstruction of tracks
- Use dE/dx to separate π, K, and p for momenta < 1 GeV/c

File Edit Window Job Help

<-Previous | Next-> | Reload | /disks/10/kurtisg/dst/good/mipp00016158.0000.out.root | [Run/Event]= 16158 8 | Go | Print

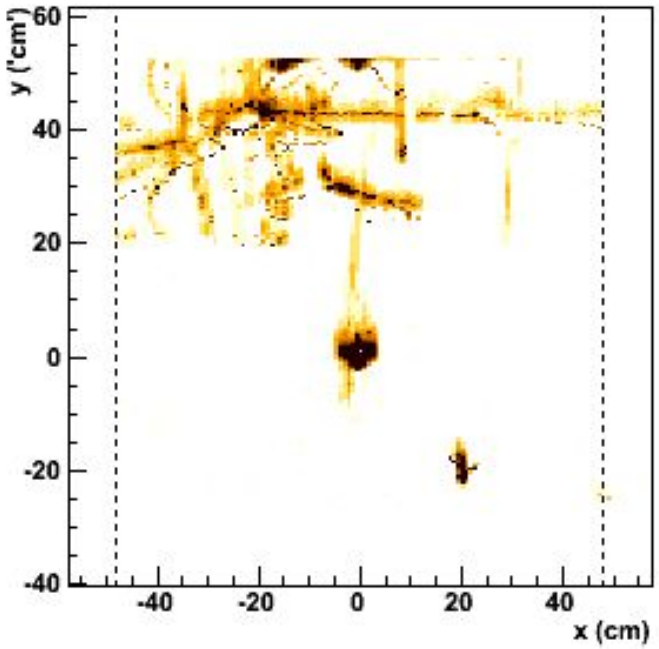
MIPP (FNAL E907)

Mom.: 59 GeV/c
Target: LH2
Run: 16158
SubRun: 0
Event: 8

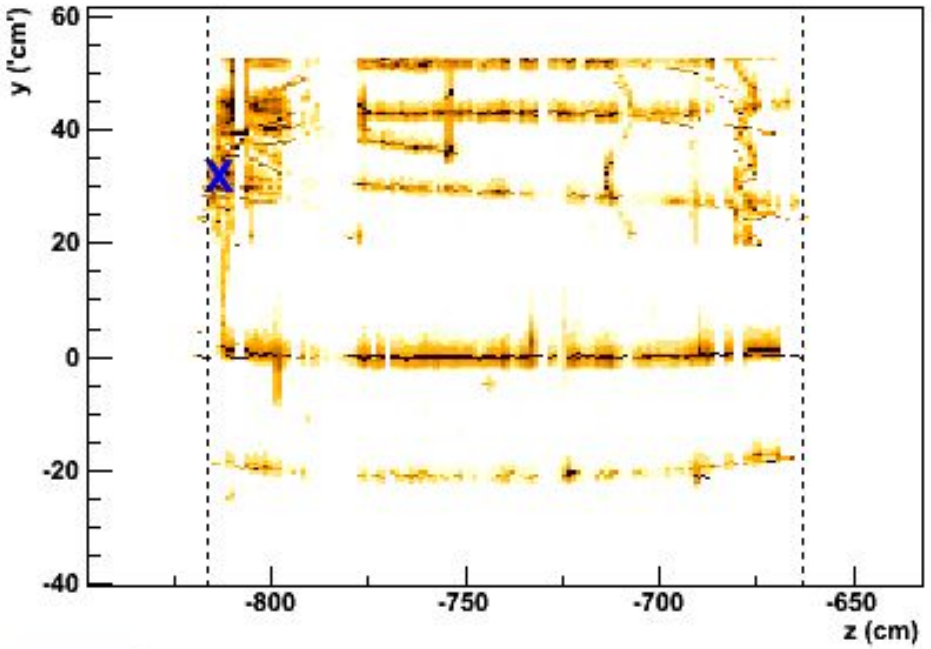
Thu Sep 29 2005
04:12:36.817567

***** Trigger *****
Beam
Word: 0100
Bits: 4113

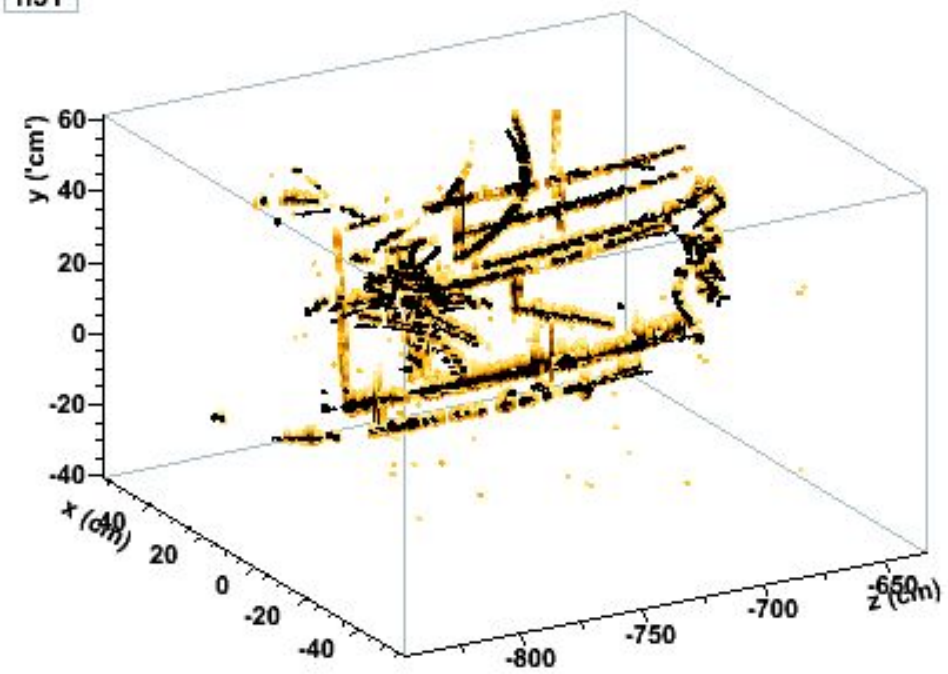
TPC Front



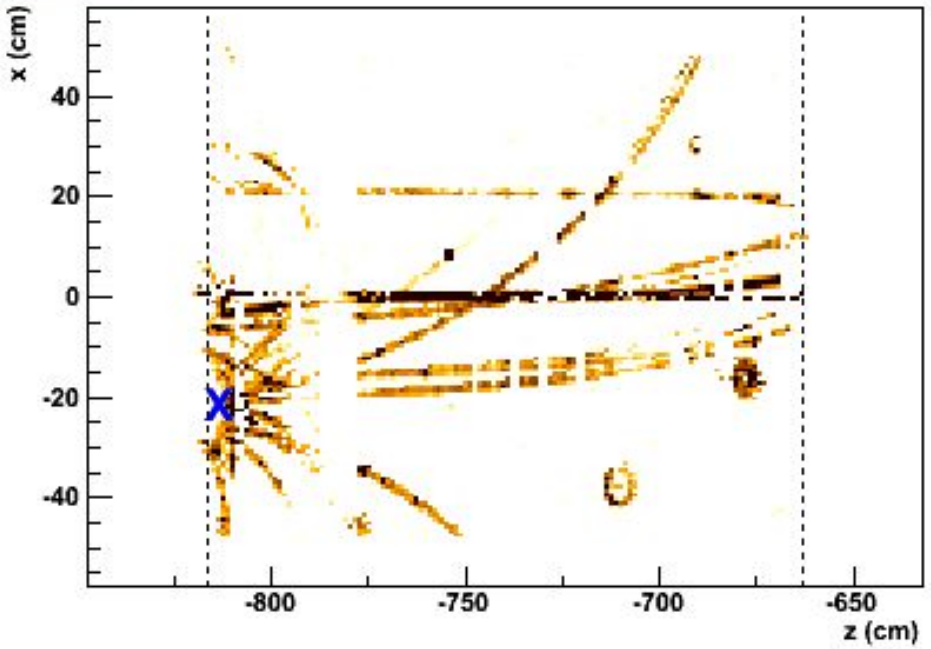
TPC Side



h31



TPC Top

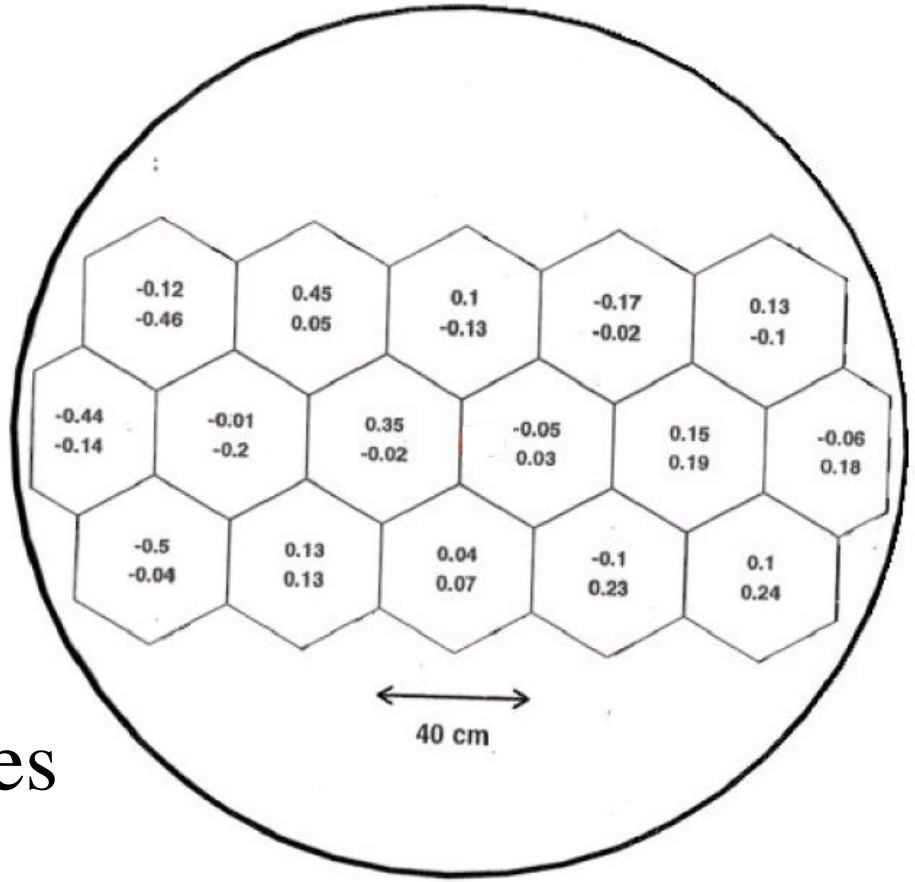


Threshold Čerenkov

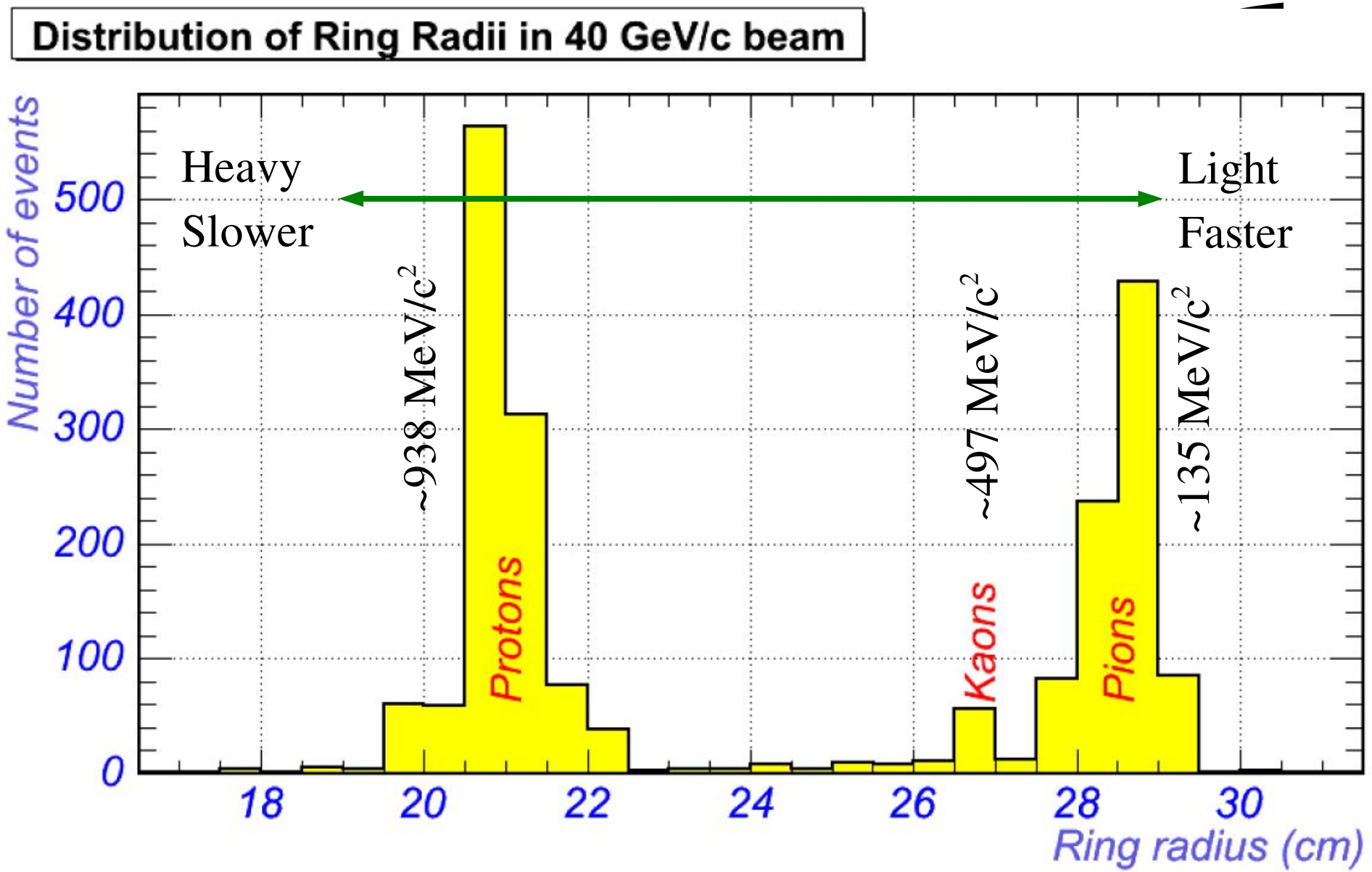
- **Filled with C_4F_{10} gas (perfluorobutane)**
  - **Thresholds: π: 2.6 GeV/c, K: 9.0 GeV/c, p: 17GeV/c**
- **Used to identify particles by the number of photoelectrons at middle-range momenta**
- **96 mirrors and PMTs**
  - **ADC -> number of photoelectrons**
  - **TDC -> timing information**

RICH

- Ring Imaging Čerenkov
- Contains array of nearly 3,000 PMTs
- Software fits rings of Čerenkov radiation, use radius to identify particles



RICH PID


Distribution of Ring Radii in 40 GeV/c beam
Number of events
0
100
200
300
400
500
18
20
22
24
26
28
30
Ring radius (cm)
Heavy
Slower
Light
Faster
~938 MeV/c²
~497 MeV/c²
~135 MeV/c²
Protons
Kaons
Pions

File Edit Window Job Help

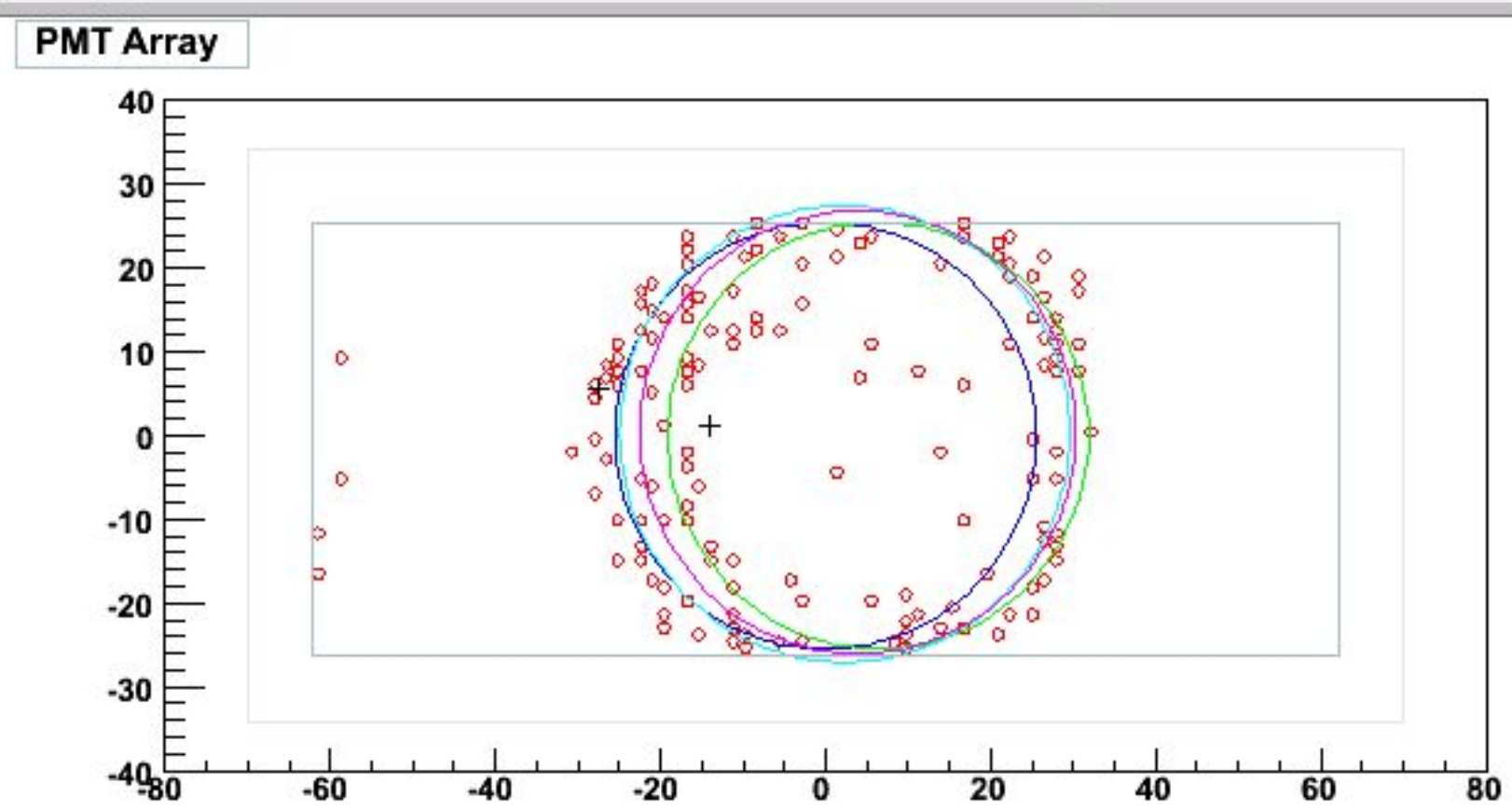
<-Previous | Next-> | Reload | /disks/10/kurtisg/dst/good/mipp00016158.0000.out.root | [Run/Event]= 16158 | 8 | Go | Print

MIPP (FNAL E907)

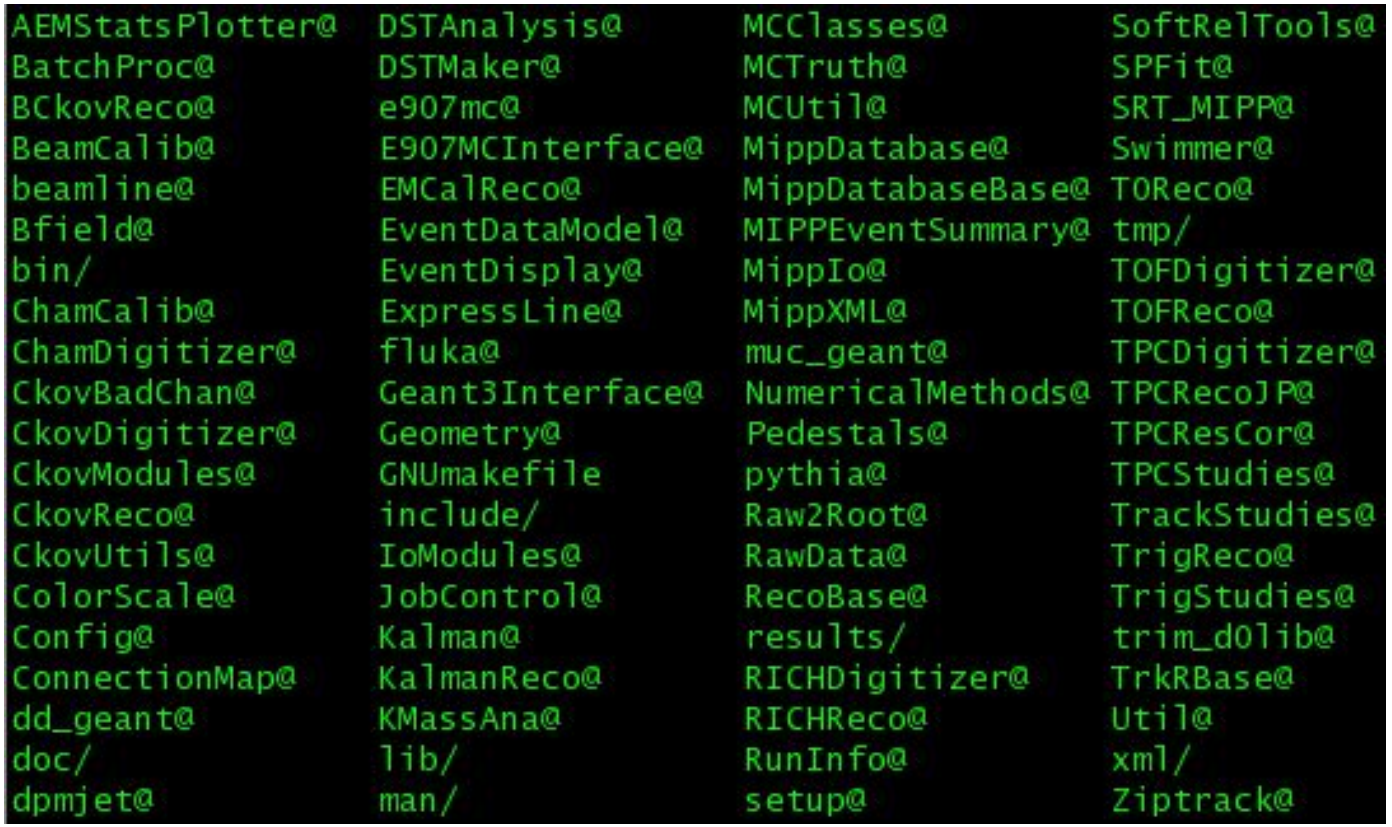
Mom.: 59 GeV/c
Target: LH2
Run: 16158
SubRun: 0
Event: 8

Thu Sep 29 2005
04:12:36.817567

*** Trigger ***
Beam
Word: 0100
Bits: 4113



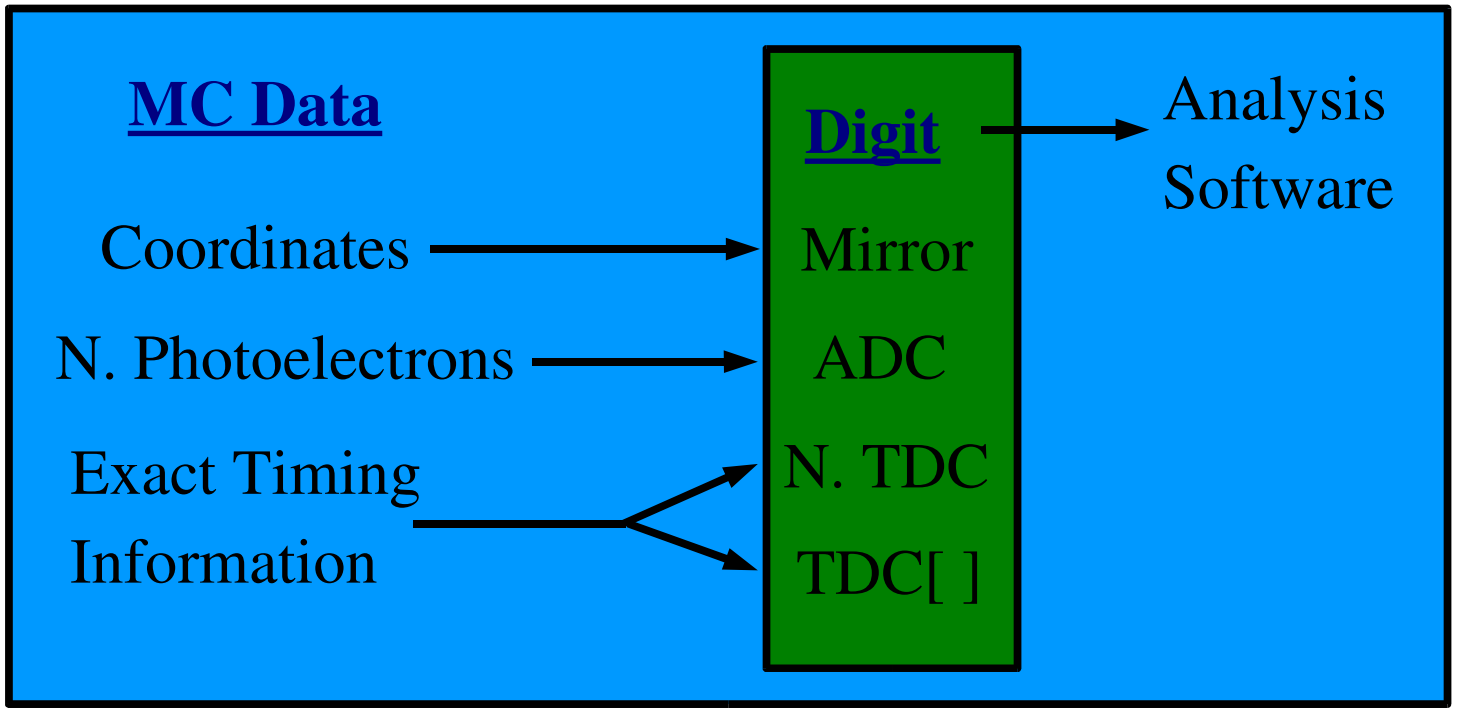
Software

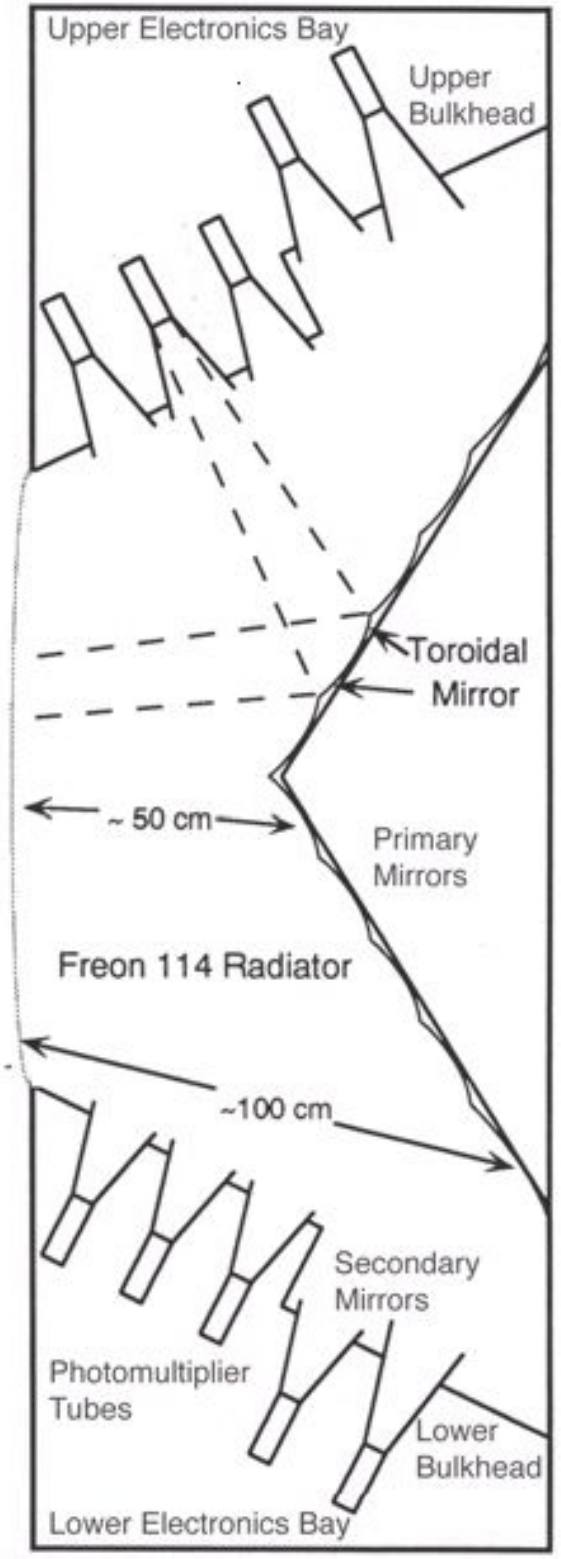


- MIPP Software contains packages to:
  - reconstruct TPC tracks
  - fit RICH rings
  - find vertex coordinates
  - analysis: calculate PID
  - monte carlo simulations
  - digitize monte carlo
  - read database files
  - create summary files for events

Ckov Digitization

- Make MC data like real data
  - Found several bugs and errors
  - Added avg pedestal information





Event Display Comparison

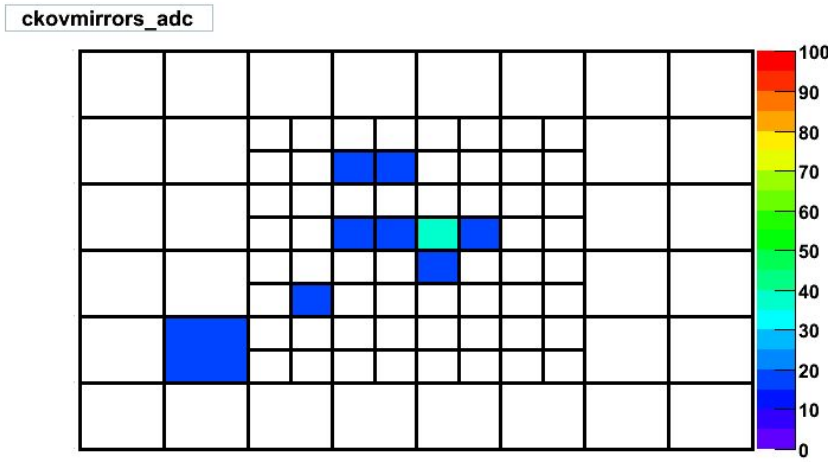
MC

MIPP (FNAL E907)

Mom.: 0 GeV/c
Target:
Run: 10000000
SubRun: 0
Event: 11

Thu Jul 20 2006
09:13:36.600961

*** Trigger ***
Undefined
Word: unknown

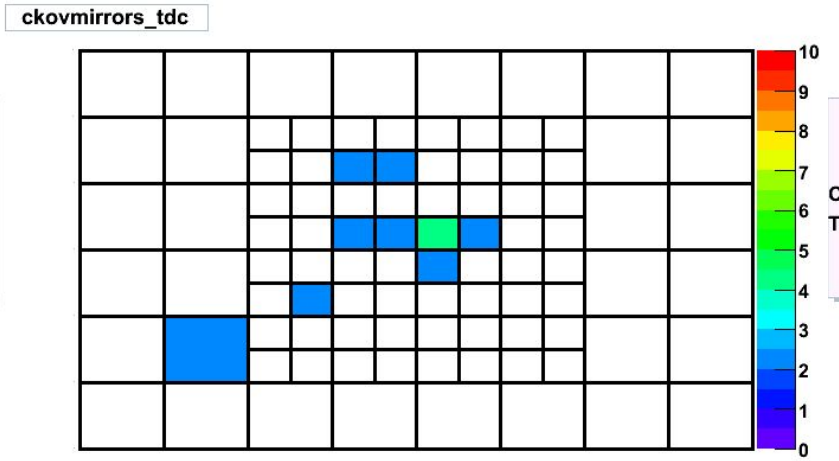


MIPP (FNAL E907)

Mom.: 59 GeV/c
Target: LH2
Run: 16200
SubRun: 0
Event: 42

Mon Oct 03 2005
18:09:39.911591

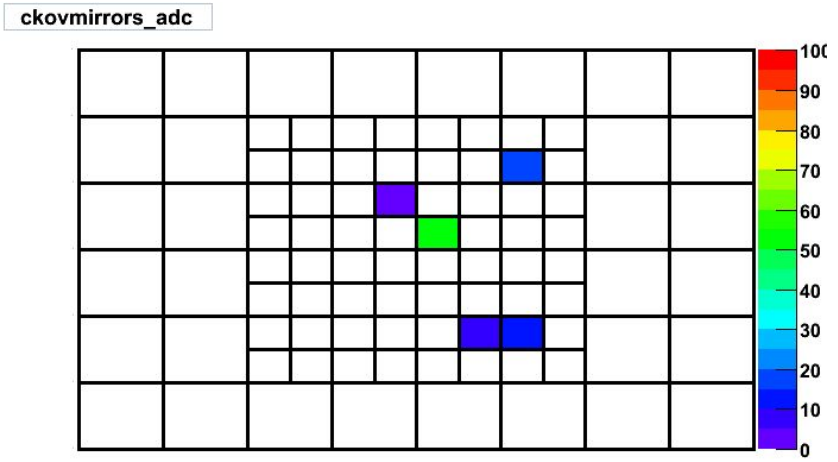
*** Trigger ***
Beam
Word: 0200
Bits: C227

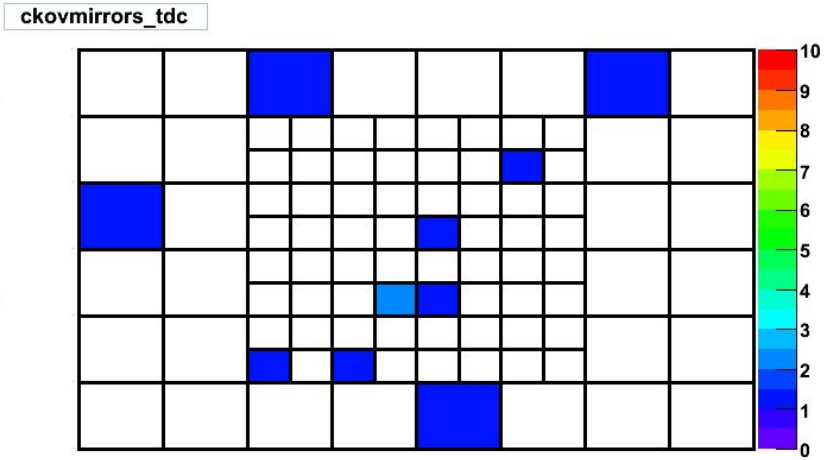


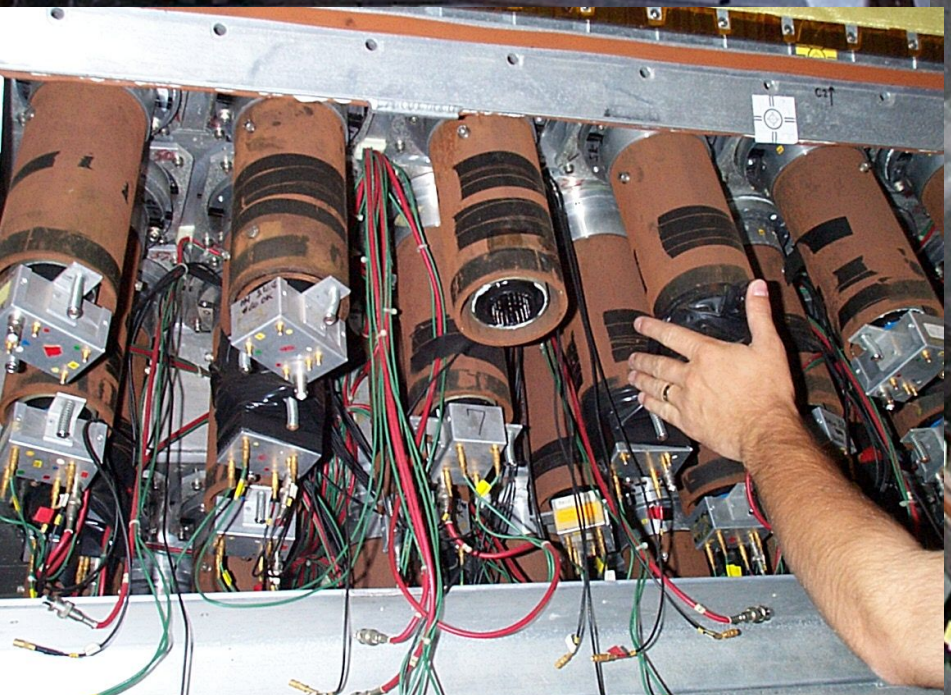
Ckov digits=91
TDC hits=20
in time=20

Ckov digits=96
TDC hits=160
in time=11

Data

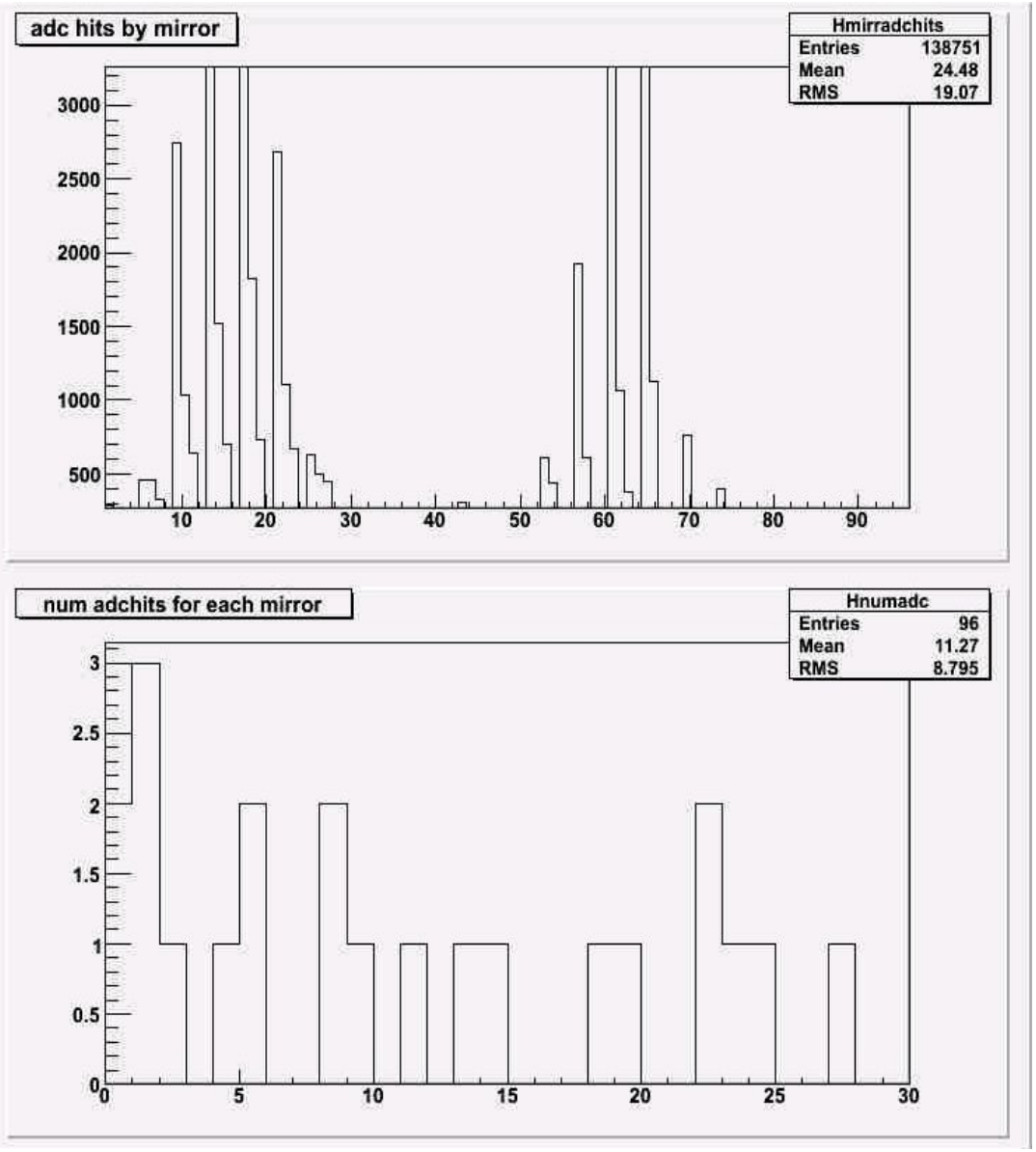






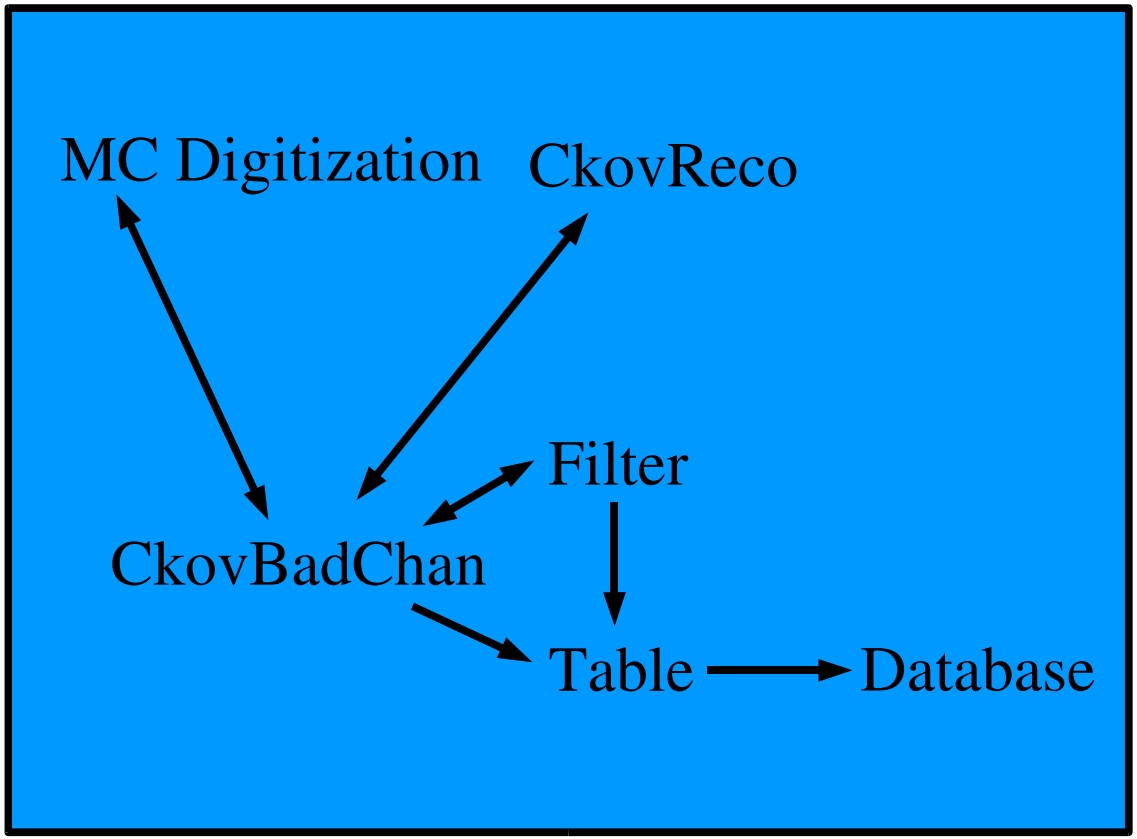
Ckov Bad Channels

- Some PMT channels are bad
  - either dead or hot
- Not enough statistics from 83 runs
- Pending a job to use all data



A New Package

- I created a new package to deal with bad channels
  - reads bad channels from database
  - filters out digits from bad channels
- Works with both MC and Data Reconstruction

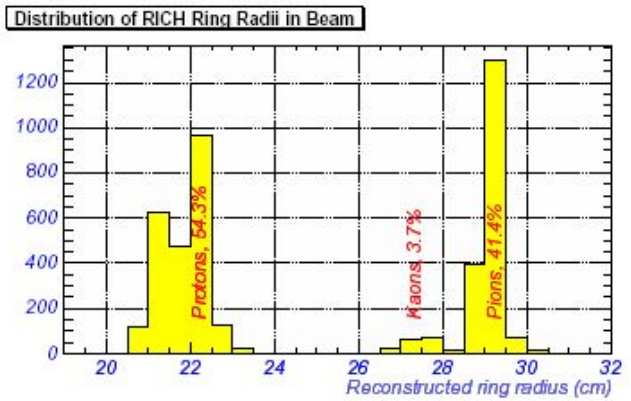


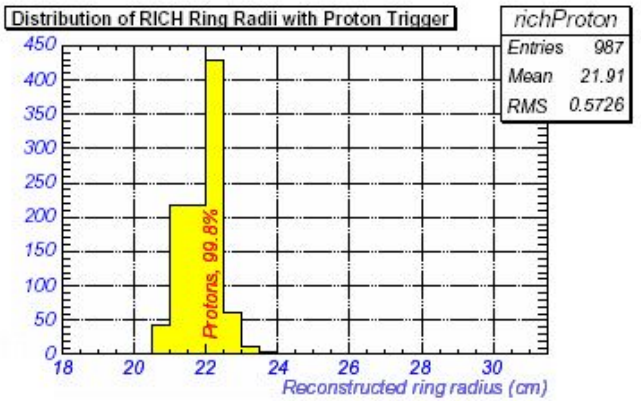
Debugging

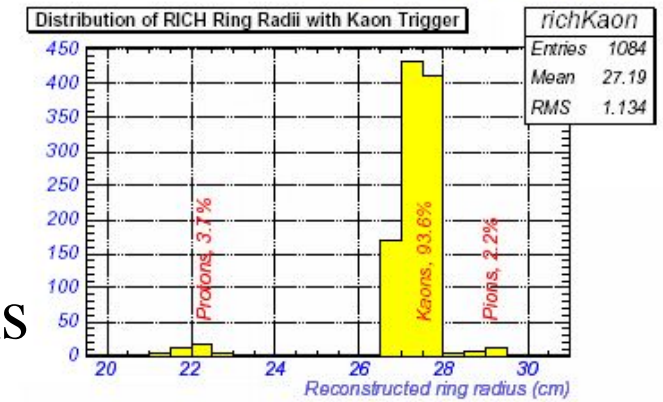
- Fixed Bugs in
  - DSTMaker
  - Event Display
  - Beam Track Summary
  - Beam Čerenkov PID
  - others...

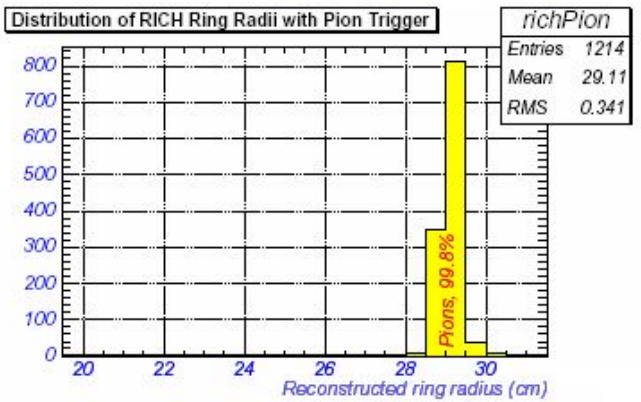
A Better RICH PID

- ROOT macros to find best RICH PID
- cuts on
  - ADC
  - TDC
  - Beam Angle
  - Number of Tracks
  - Anything...









Conclusion

- Finished taking data in February 2006
- MIPP Analysis is coming along well. People are working on all parts of the software.
- Pass 2 is running, contains more calculated values and calibrated data (Pass 3 is final)
- First results (multiplicity studies – Nick Solomey) are coming out now