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# TRACK finding and CALIBRATION of MUON SPECTROMETER

* The algorithm for track finding in Muon Spectrometer (DATSPC = Digital, Analog and Time measurement in SPectrometer)
  - goals
  - description
  - results
* Low momentum muons
* Calibration of the spectrometer
  - drift time / drift path correlation in streamer tubes
  - calibration with momentum defined beam of muons

(* in progress — I will not talk about this.)

* Summary and further development

## * Goals of DATSPC

- make use of this huge amount of information (not only Dr. Ch.)
- complementary tracks finding (to STUTR
- reconstruction of low momentum tracks

## * Algorithm of track finding

1) Track segments in gaps in each projection

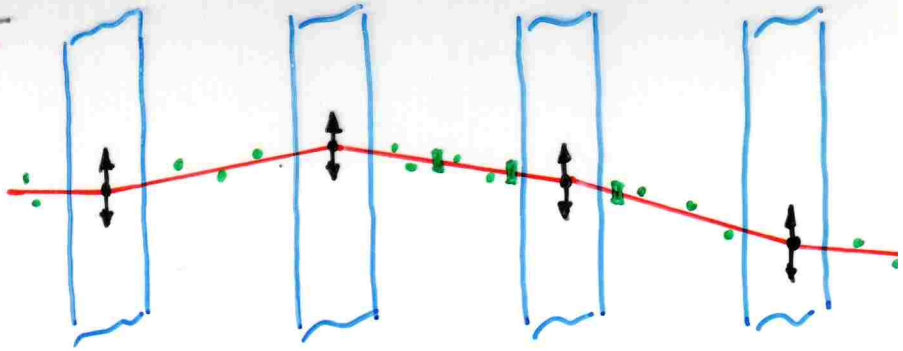
- at least 2 digital points + 0 ÷ 4 analog points
- straight line is fitted to these
- sign of dr. path in streamer tubes is chosen and dr. time information is used to obtain better precision
- straight line is fitted again ⇒ track segment (in each gap in each projection)

2) Projection candidates.

So called TREE algorithm is used.
Segments are combined in PROJECTION tracks on the basis of distance between 2 consecutive segments at magnet's middle plane and difference in their SLOPES.

(temporary constrain: length of the track ≥ 3 gaps could be easily lifted out)

3) BROKEN line



Broken line is fitted to points belonging to a projection candidate ($\Rightarrow \chi^2$)

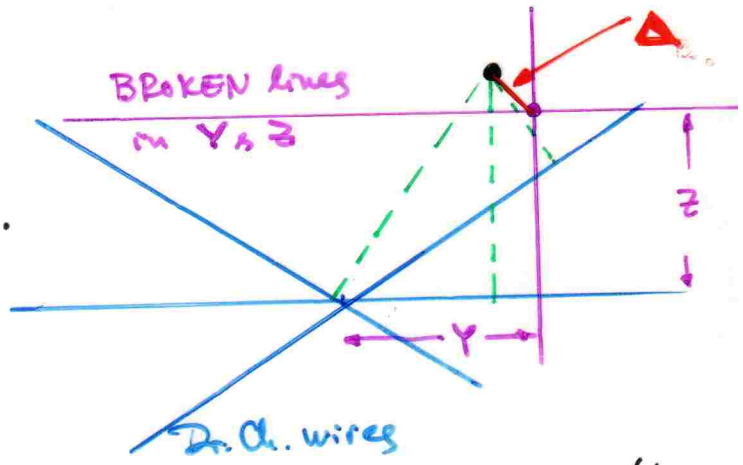
It is used to perform cleaning of projection candidates at this stage of track finding

4) SPACE candidates

- look at Dr. Ch. points, which are points in SPACE

Y-Z pairs of BROKEN lines are selected which have matching Dr. Ch. hits.

$\Rightarrow$ SPACE candidates




5) Split SPACE candidates into families with the same set of corresponding Dr. Ch. hits
The best BROKEN line ($\chi^2$) in the family is found
$\Rightarrow$ final DAFSPC space track

6) Find the closest to the best BROKEN line hits in Dr. Chambers and supply them to SAMTRA to reconstruct the track momentum

How many isolated tracks (muons ?) do we have in the spectrometer?

# tracks found by original SATRA $n(S)$

# tracks found by DATSPC $n(D)$

all tracks : $N = n(S) + n(D)$

Ask for coordinates of Dr. Ch. points of each tracks and compare them with those for all other tracks. If they are close enough ($\Delta \leq 3.5$) consider these two track as IMAGES of one and the same PHYSICAL track and label them with the same number

$m_i \in [1, M]$

$i = 1, \ldots, N$ ; $M \leq N$

Finally we have the bank JTSMS:

| dw1 | dw2 | dw3 | dw4 | dw4+1 | dw4+2 | ... | dw4+N |
|---|---|---|---|---|---|---|---|
| N | n(S) | n(D) | M | $m_1$ | $m_2$ | .... | $m_N$ |

= 2 levels of daughter banks with detailed information for each track

We have at this end point associated solutions (by SATRA and/or DATSPC) for "every" physical track.

* **Results:** 1299 main trigger events (RUNs 1607, 1637, 1638) have been processed

| | 1 track (muon) |
|---|---|
| * of events with: | 745 |
| * of SMUTRA tracks: n(S)=1 | 722 |
| * of DMTSPC tracks n(D)=1 | 706 |
| * of events with: n(D) < n(S) ∅" | 51 |
| * of events with: n(S) < n(D) ∅" | 31 |

$$\varepsilon\,(\text{DMTSPC}/\text{SMUTRA}) = \frac{722-51}{722} = (93\pm 1)\%$$

$$\varepsilon\,(\text{SMUTRA}/\text{DMTSPC}) = \frac{706-31}{706} = (96\pm 1)\%$$

**Di-muons:** 38 di-μ events found in Runs 1607 + 1638 (scan) (all triggers)

| tracks found: | 0 | 1 | 2 | > 2 |
|---|---|---|---|---|
| by SMUTRA | 5 | 7 | 24 | 2 |
| by DMTSPC | 6 | 9 | 22 | 1 |

Using both SMUTRA and DMTSPC we can find as much as 30% more di-muons ...

## Summary and future development

- complementary to SAMURAI algorithm for track finding is developed with ~ the same efficiency;

- Using both SAMURAI and DAFSPC we obtain higher efficiency for reconstructing one-track and multi-track events in the Spectrometer

- One might expect better prediction from DAFSPC to CALO track finding, because of dealing with vectors in the first gap, but this has to be proved yet.

- New fitting procedure can be developed either by:
  - providing fake Dr. Ch. hits for SAMURAI

  or
  - writing a new code for fitting

- next step ⇒ test of DAFSPC on Monte Carlo events

# Low momentum tracks

- SANTRA is able to reconstruct momentum when there are hits in at least 3 Dr. Ch. (one point is available to it in each gap)

- DRSPC deals with vectors in each gap
  → One-magnet-fit could be performed!

- IDEA: Use end points of track segments in each gap and provide SANTRA with fake Dr. Ch. hits at the begining and end of each gap = 4 Dr. Ch. hits for one-magnet-fit.

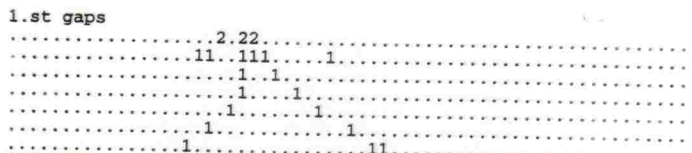
  (Technical problem: the # ∇ of Dr. Chambers is hardwired everywhere in the code of SANTRA modified for CLOUDS ...)

- # Tracks not passed the first magnet: track segments could be used to help track finding in CALO.

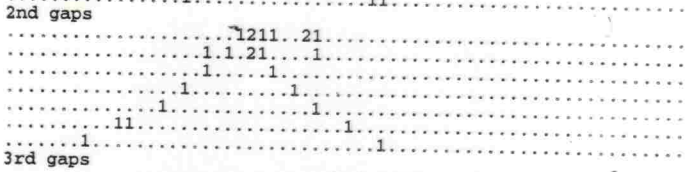
SANTRA level

w. # 19

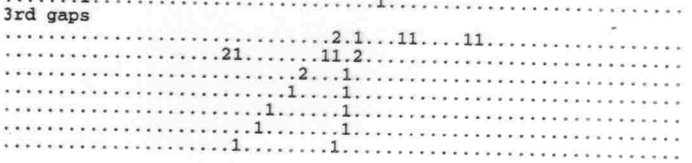
1.st gaps



2nd gaps

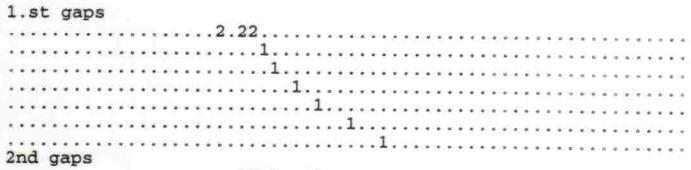


3rd gaps

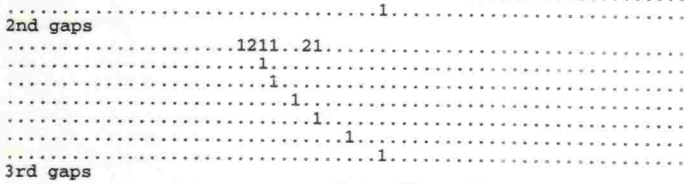


all Dr. Ch. hits

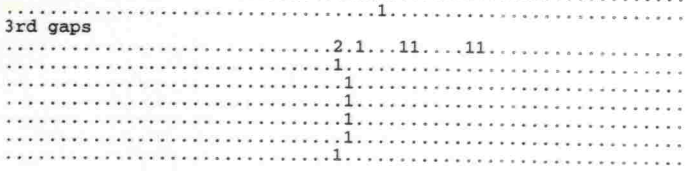
1.st gaps



2nd gaps

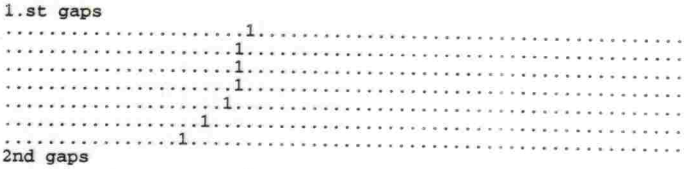


3rd gaps

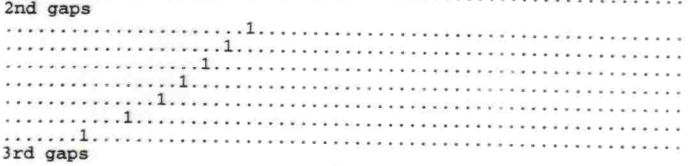


Hits supplied to SANTRA for track # 1

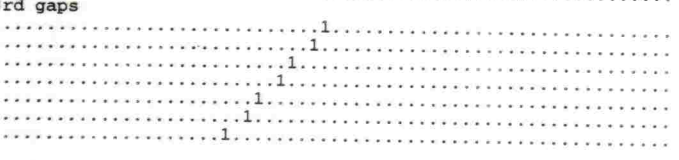
1.st gaps



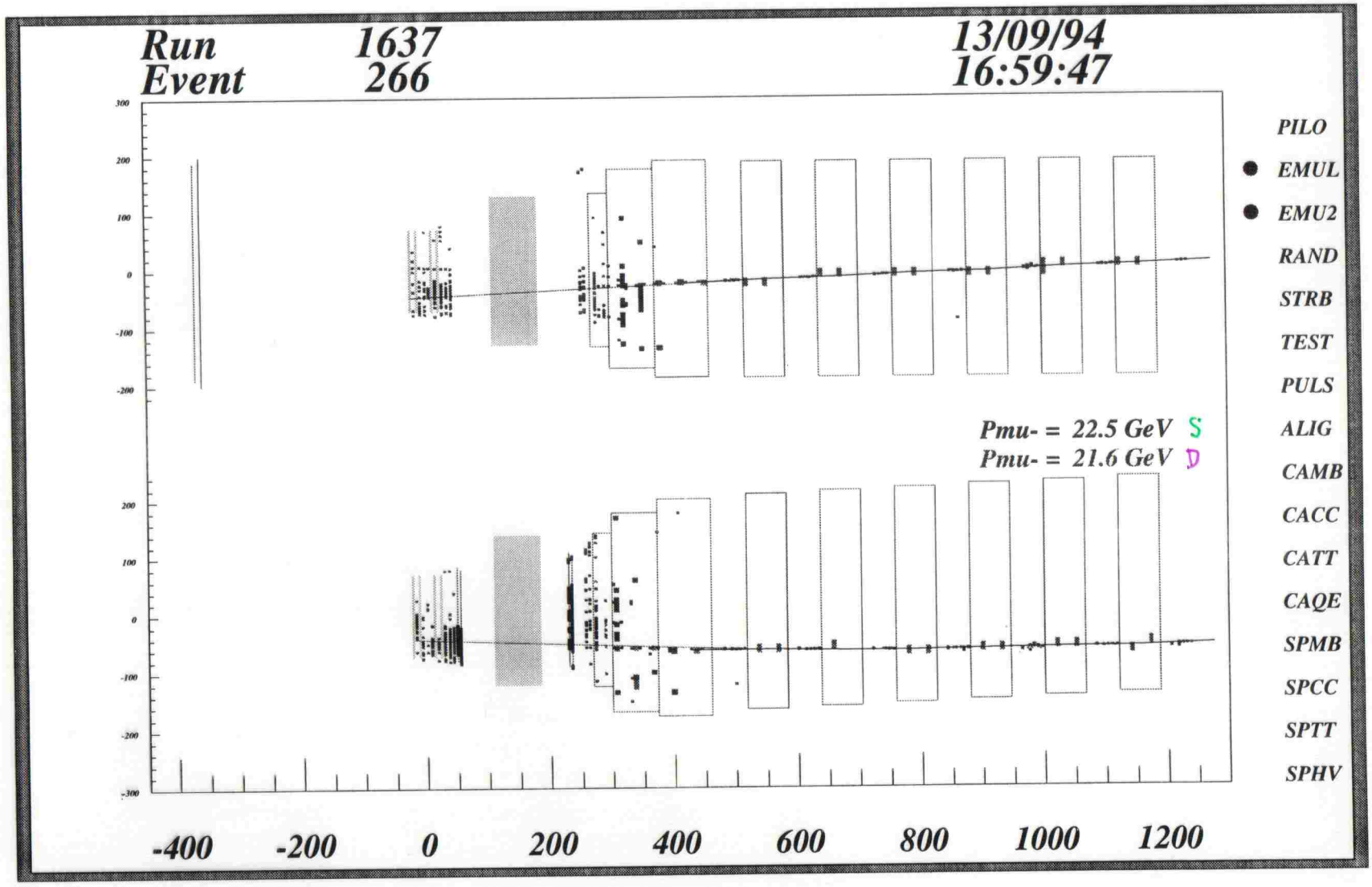
2nd gaps

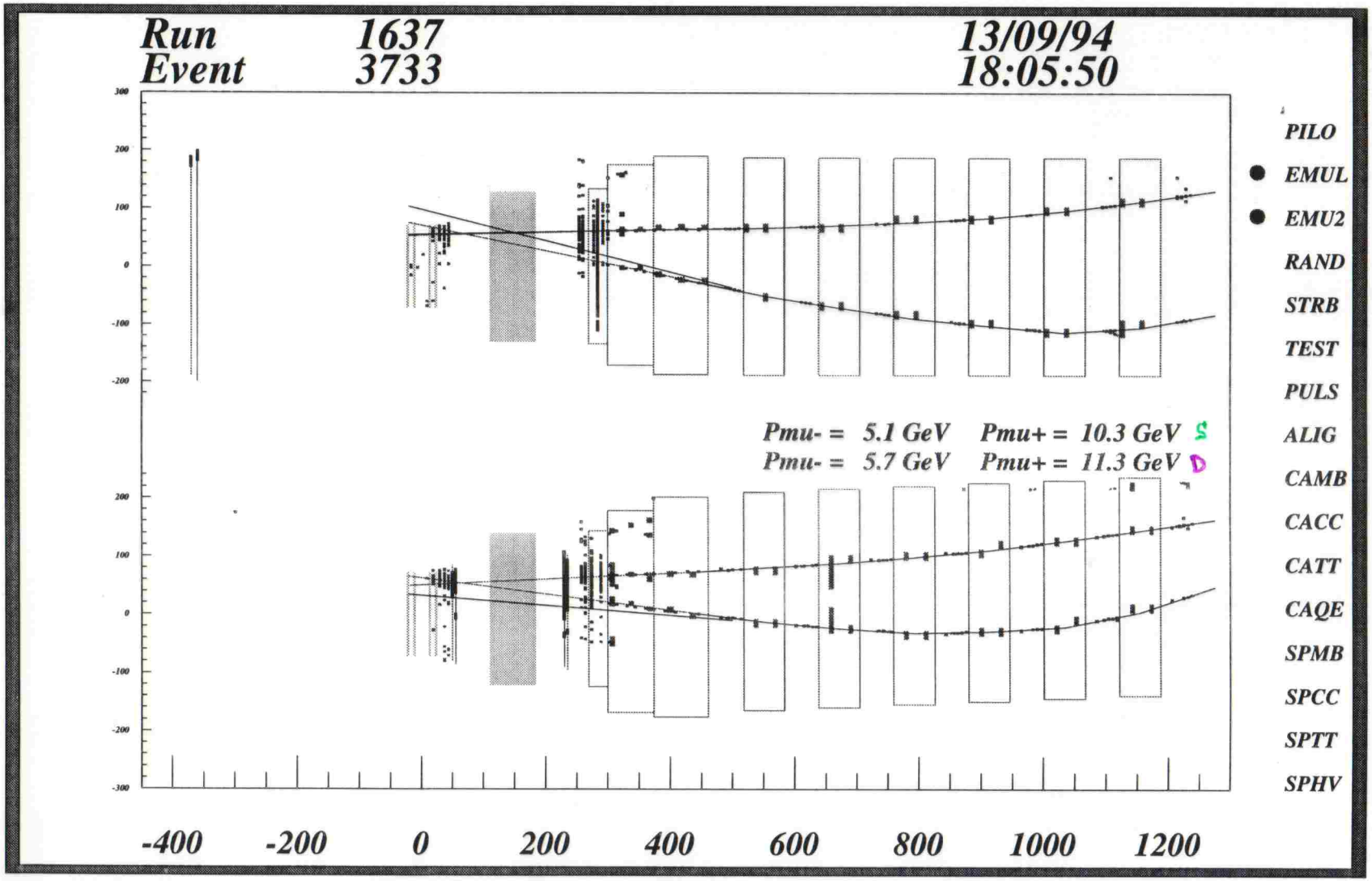


3rd gaps

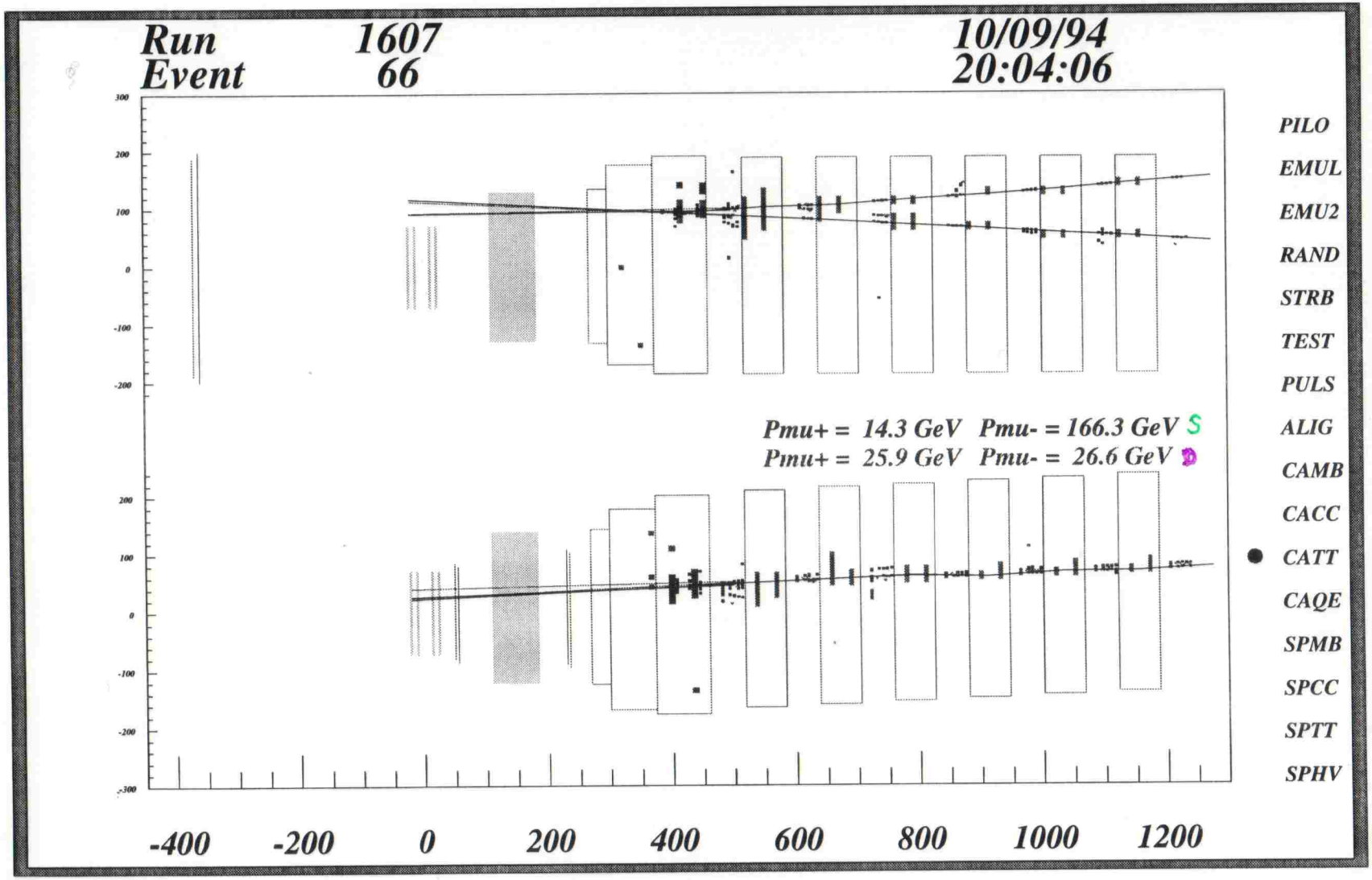


Hits supplied to SANTRA for track # 2

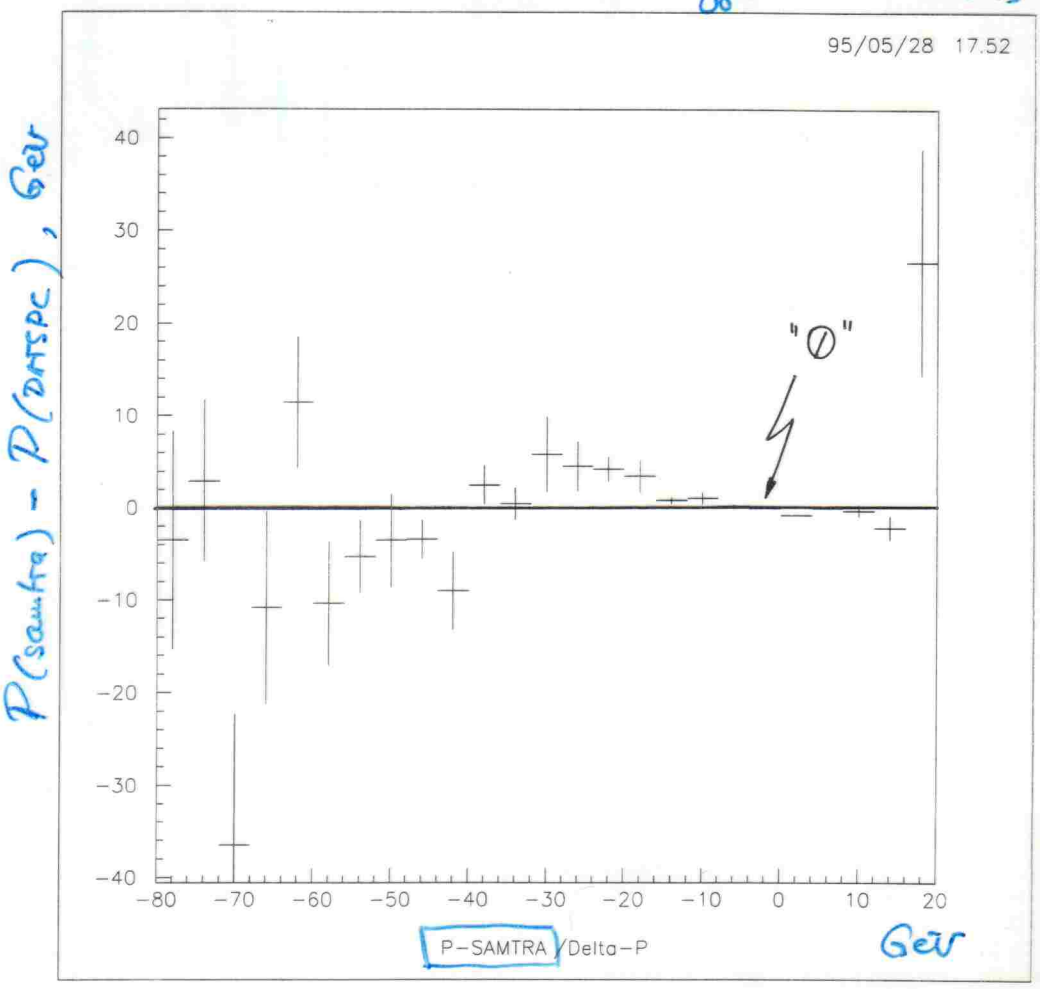

Run 1637
Event 266
13/09/94
16:59:47
Pmu- = 22.5 GeV S
Pmu- = 21.6 GeV D
PILO
EMUL
EMU2
RAND
STRB
TEST
PULS
ALIG
CAMB
CACC
CATT
CAQE
SPMB
SPCC
SPTT
SPHV
300
200
100
0
-100
-200
200
100
0
-100
-200
-300
-400
-200
0
200
400
600
800
1000
1200


Run 1637
Event 3733
13/09/94
18:05:50
Pmu- = 5.1 GeV Pmu+ = 10.3 GeV S
Pmu- = 5.7 GeV Pmu+ = 11.3 GeV D
PILO
EMUL
EMU2
RAND
STRB
TEST
PULS
ALIG
CAMB
CACC
CATT
CAQE
SPMB
SPCC
SPTT
SPHV
-400
-200
0
200
400
600
800
1000
1200

3μ event

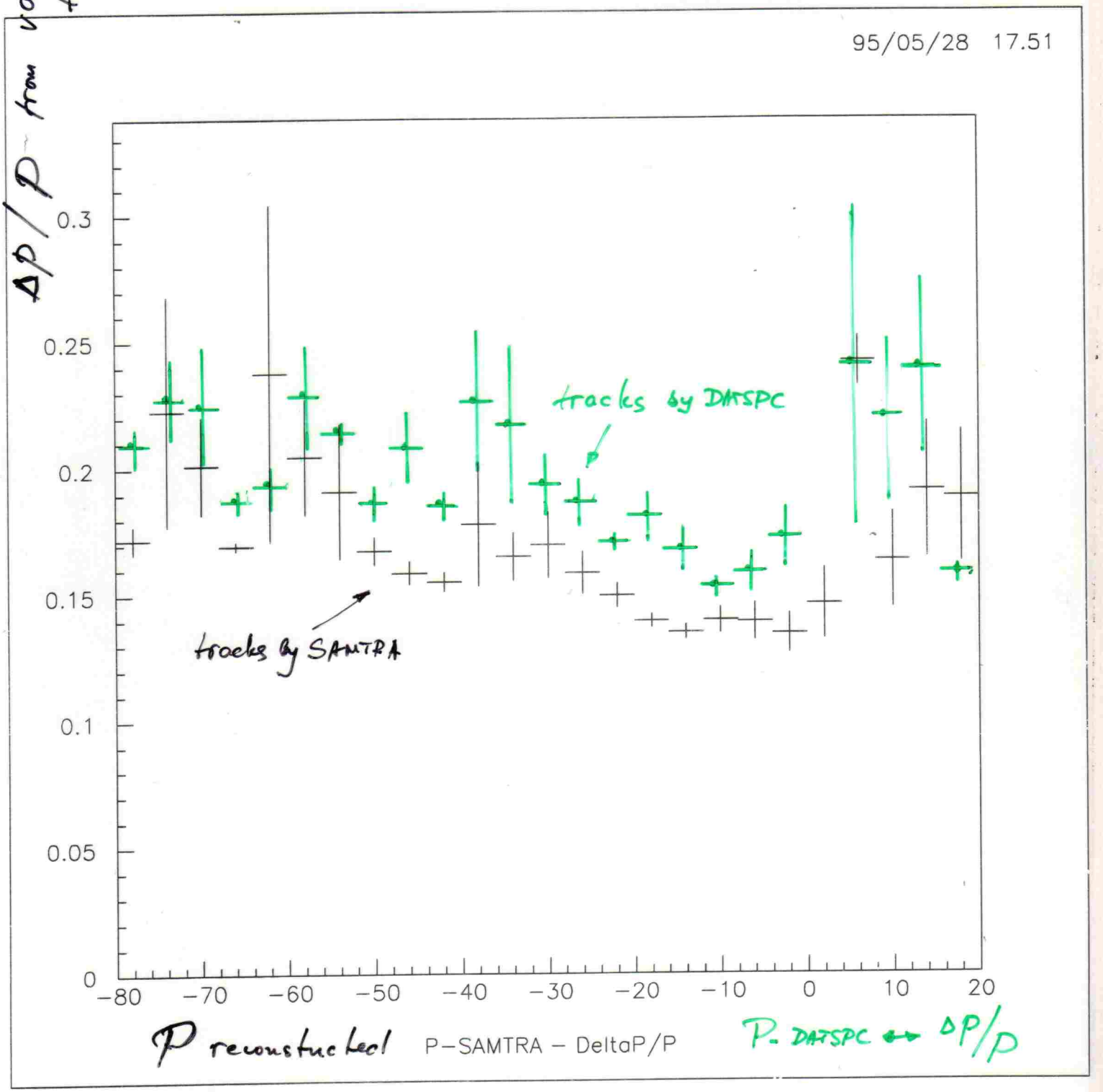

Run 1607
Event 66
10/09/94
20:04:06
Pmu+ = 14.3 GeV Pmu- = 166.3 GeV S
Pmu+ = 25.9 GeV Pmu- = 26.6 GeV D
PILO
EMUL
EMU2
RAND
STRB
TEST
PULS
ALIG
CAMB
CACC
CATT
CAQE
SPMB
SPCC
SPTT
SPHV
300
200
100
0
-100
-200
200
100
0
-100
-200
-300
-400
-200
0
200
400
600
800
1000
1200

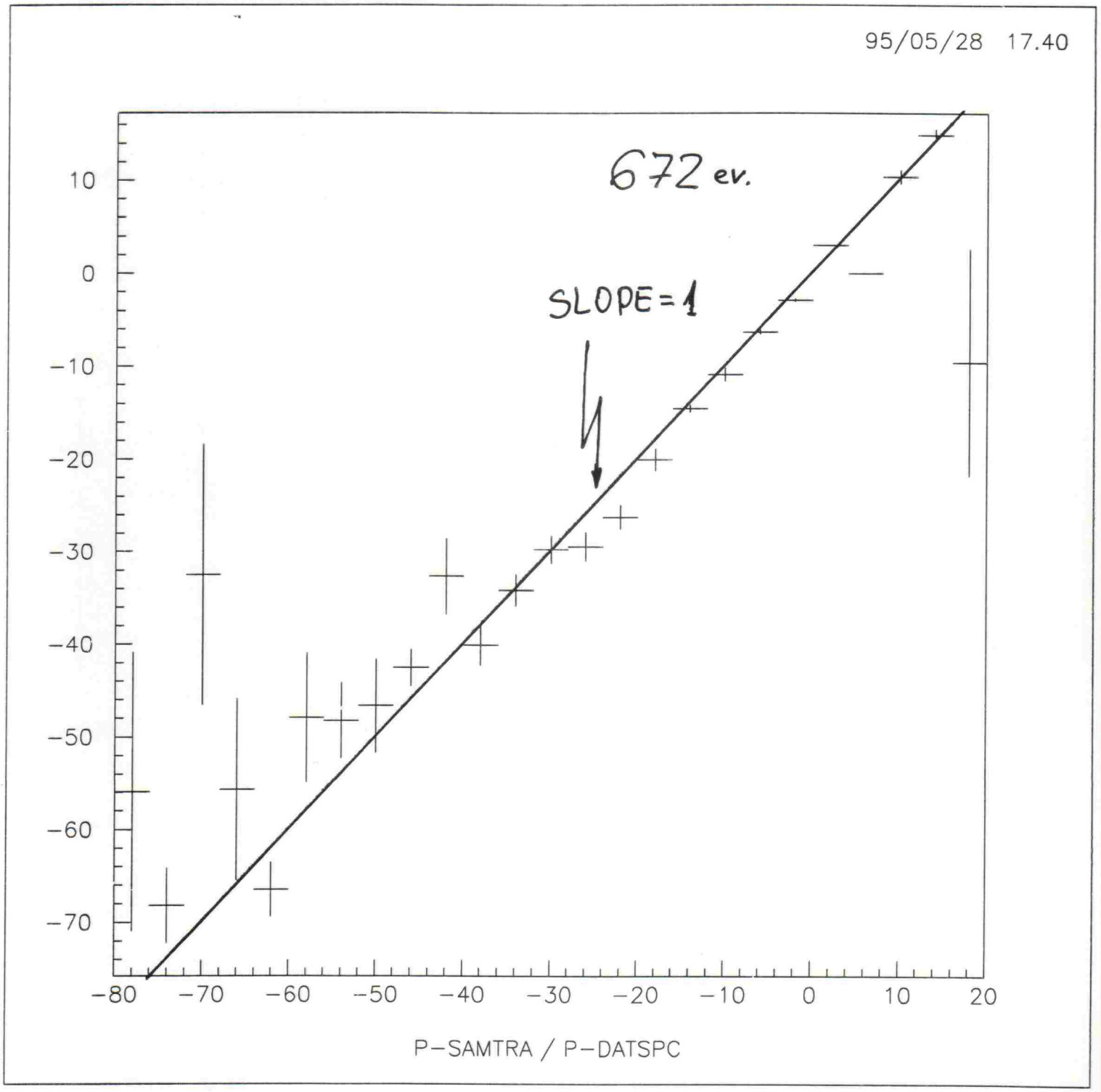
main trigger 672 events



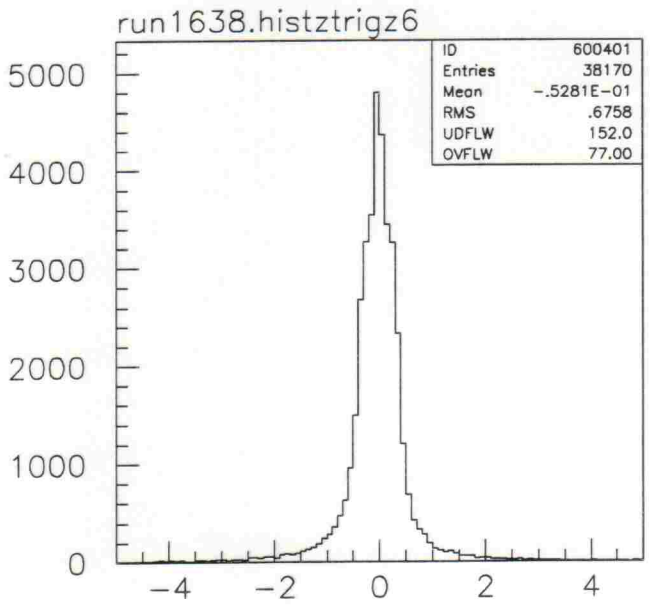
Δp/p from variance of the fit (1/P)

746 ev.

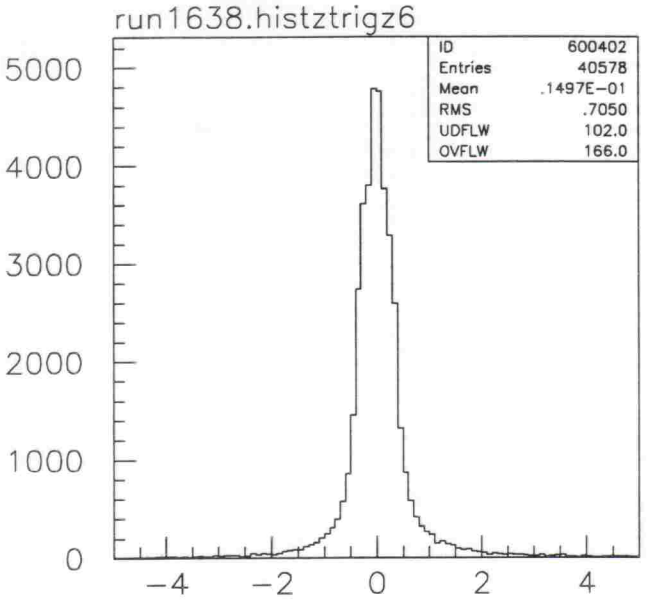



95/05/28 17.40
672 ev.
SLOPE=1
10
0
-10
-20
-30
-40
-50
-60
-70
-80
-70
-60
-50
-40
-30
-20
-10
0
10
20
P-SAMTRA / P-DATSPC

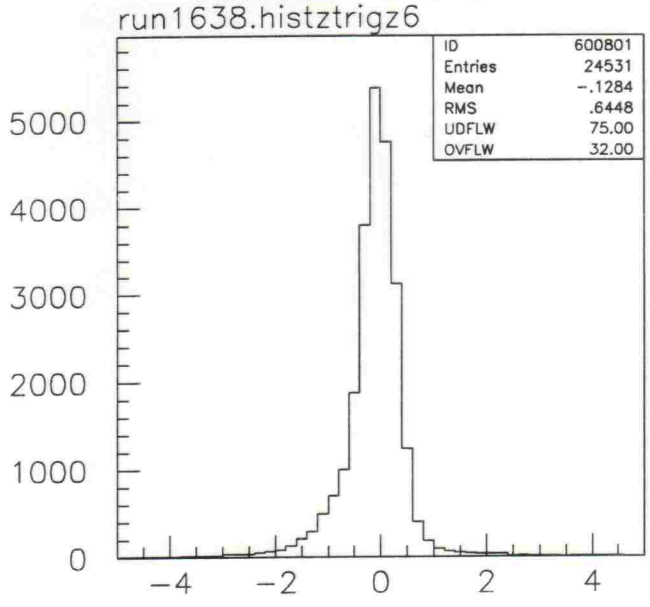
95/05/28 17.38



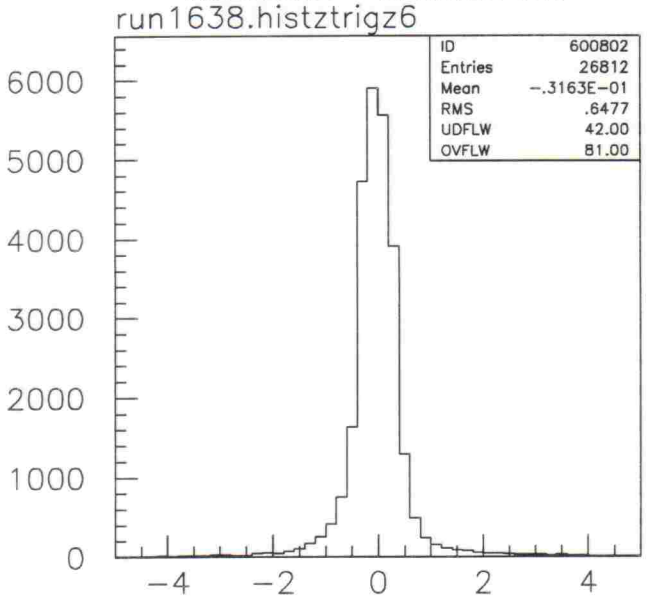

Residuals – BROKEN line




Residuals – BROKEN line

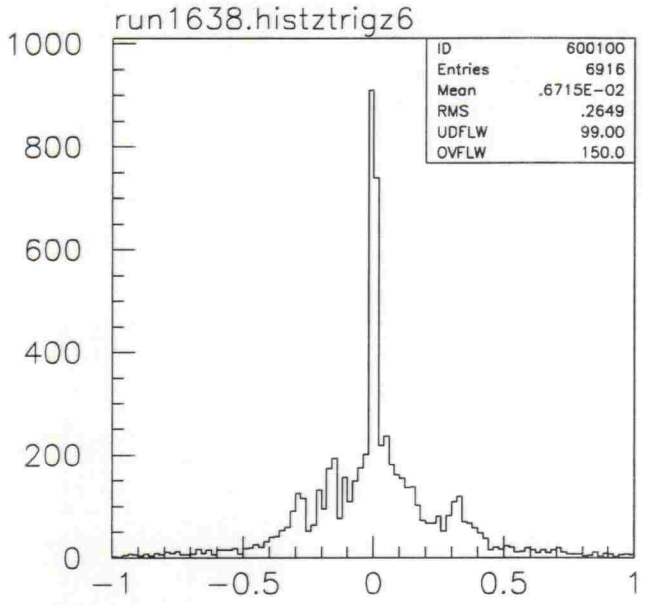



Residuals – rf BROKEN line

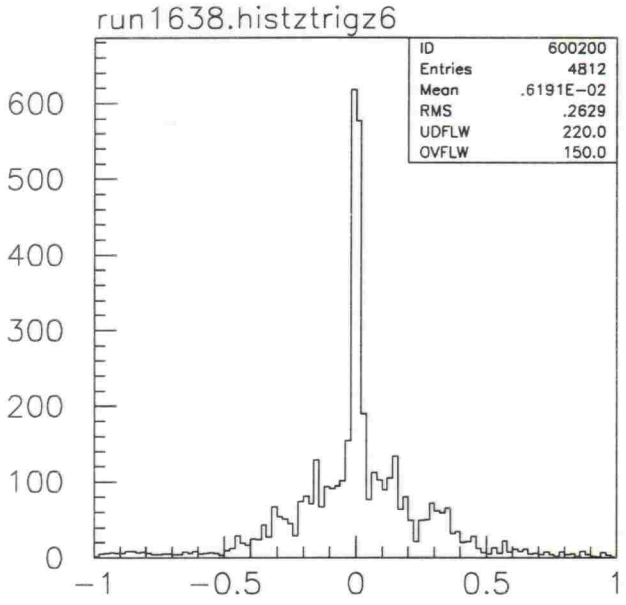



Residuals – rf BROKEN line

95/05/28 17.38




RESDA IPR=1




RESDA IPR=2