

# STATUS OF FINUDA DATA TAKING



LNF Scientific Committee Meeting,  
S. Piano May 14, 2007

- Data taking summary
- First estimate of momentum resolution
- Status of preliminary analysis
- Status of the calibrations:
  - TOF calibrations
  - detectors alignment with cosmic rays

# FINUDA ACTIVITY

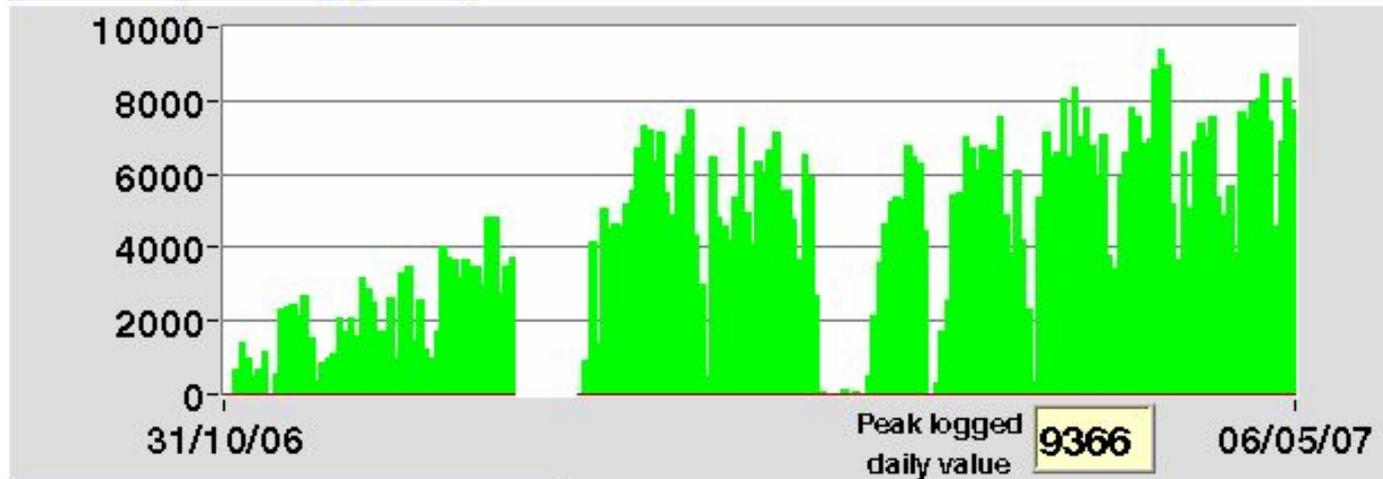
<b>2006/2007</b>	<b>TASK</b>	<b>NOTES</b>
October 02 - November 19	<b>DAFNE</b> Start up & beam tuning <b>FINUDA</b>	<i>background checks.</i> <i>Information feed-back</i>
<b>November 20- December 22</b>	<b>Data taking with colliding beams</b>	<b>HYP</b>
<b>December 23- January 2</b>	<b>cosmic rays data</b>	<b>B=0 T</b>
<b>Jan. 3 – Feb. 12</b>	<b>colliding beams</b>	<b>HYP</b>
<b>Feb 13 – Feb.14</b> <b>Feb 15 – Feb.22</b>	<b>cosmic rays data</b> <b>Maintenances</b>	<b>B=0 T</b>
<b>Feb 23 – now</b> <b>Mar. 3-5</b> <b>Mar. 21-22</b>	<b>colliding beams</b> <b>cosmic rays data</b> <b>cosmic rays data</b>	<b>HYP</b> <b>B=1 T</b> <b>B=0 T</b>

# Data Summary

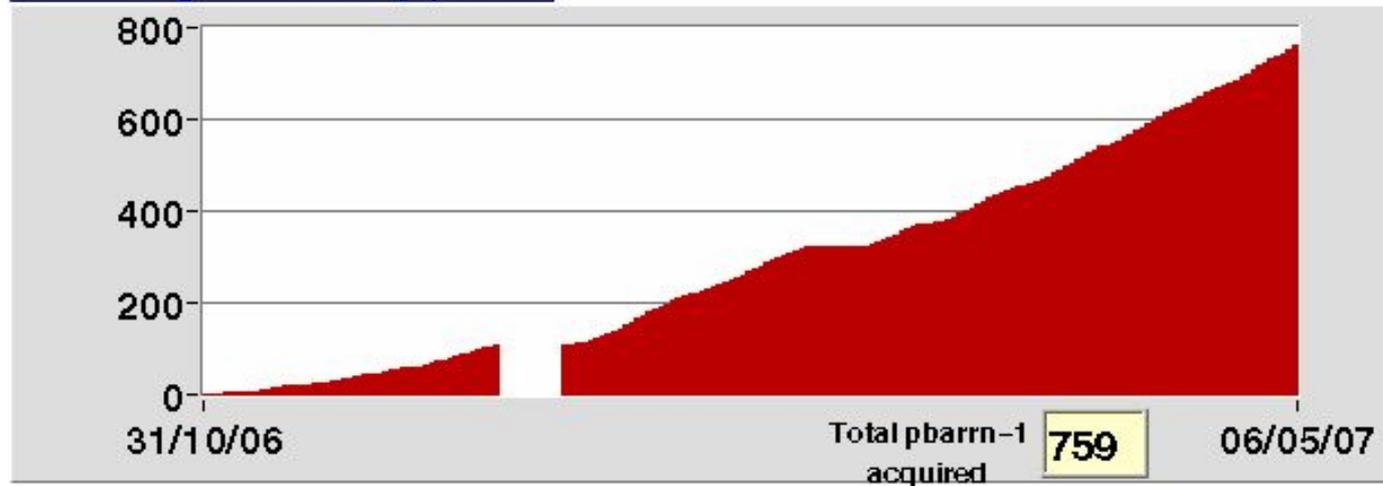
Data-Taking	2006-2007	2003-2004	Ratio
Period	20.11.06-06.05.07	01.12.03-25.03.04	-
$\int L$	<b>759 pb<sup>-1</sup></b>	220 pb <sup>-1</sup>	<b>3.5</b>
Total Collected Events in Collision x10 <sup>6</sup>	182.2	37.2	<b>4.9</b>
Total Events x10 <sup>6</sup> / $\int L$	<b>0.24 / pb<sup>-1</sup></b>	0.17 / pb <sup>-1</sup>	<b>1.4</b>
HYP x10 <sup>6</sup>	140.6	29.7	<b>4.7</b>
BHABHA x10 <sup>6</sup>	18.9	7.5	<b>2.5</b>
HYP or BHA x10 <sup>6</sup>	19.8	-	-
TOT HYP x10 <sup>6</sup>	159.0	29.7	<b>5.4</b>
COSMICS B=0 x10 <sup>6</sup>	7.9	5.5	<b>1.4</b>
COSMICS B=1 x10 <sup>6</sup>	3.4	1.8	<b>1.9</b>

# Luminosity at midnight of May 6, 2007

FINUDA Daily luminosity [nbarn<sup>-1</sup>]



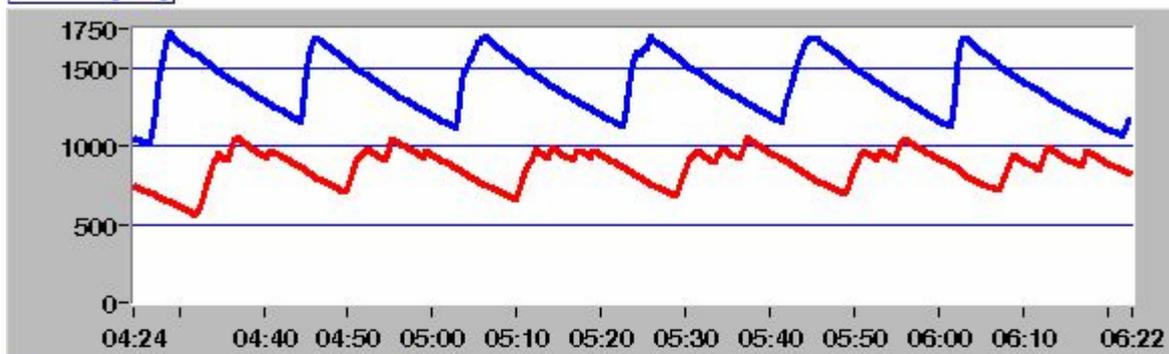
FINUDA Integrated luminosity [pbarn<sup>-1</sup>]



(add further 3 pb<sup>-1</sup> as for now)

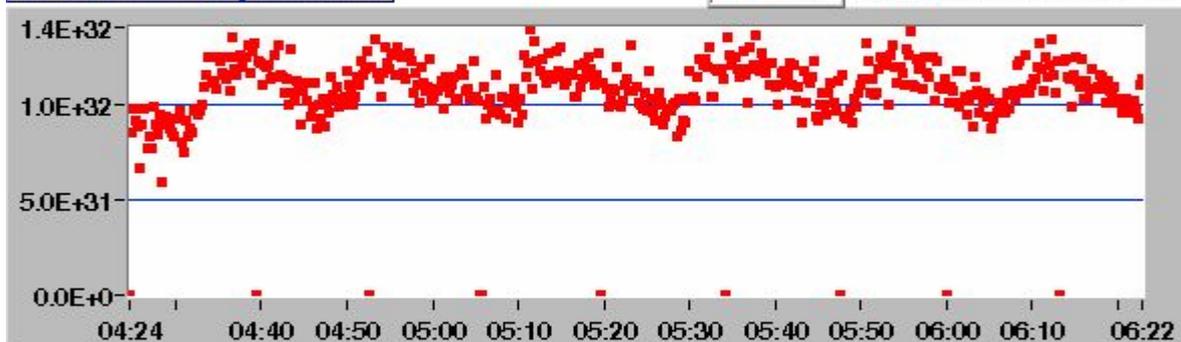
# We acknowledge the steady working condition of DAFNE at high instantaneous luminosities

Current [mA]



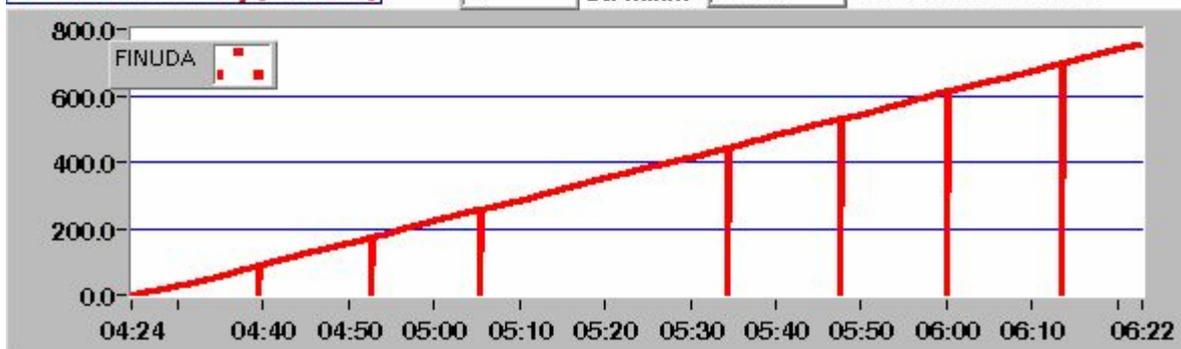
FINUDA Luminosity [ $\text{cm}^{-2} \text{s}^{-1}$ ]

1.39E+32 Acq. max Lumi in last 2 hours

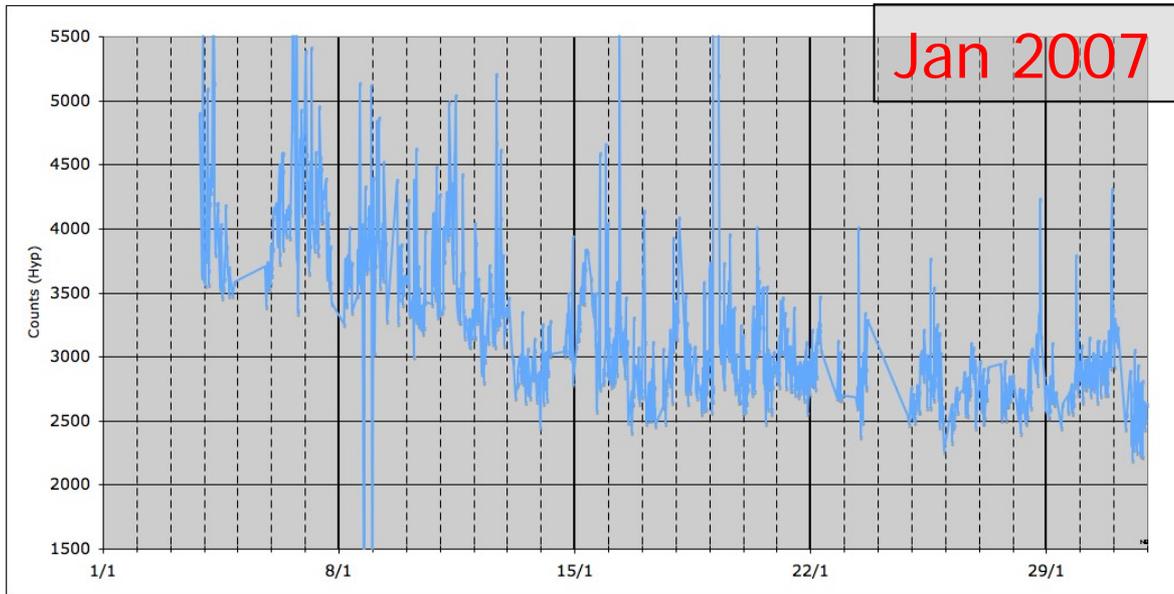


FINUDA Luminosity [nbarn<sup>-1</sup>]

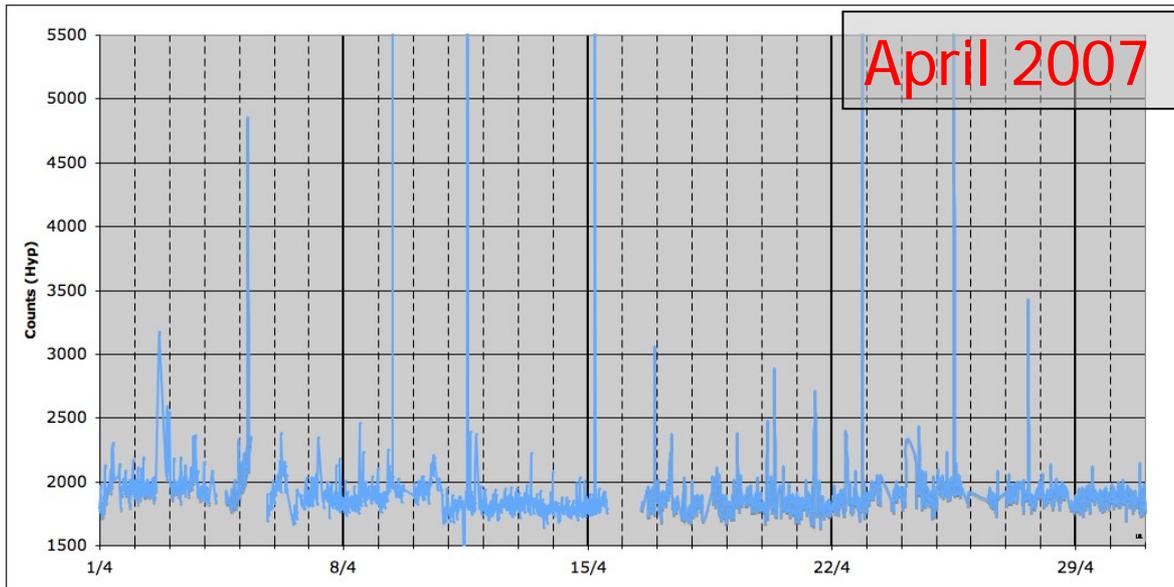
0 btf min/h 378.26 nb/h in last 2 hours



# Machine background seen by FINUDA



Machine bck level  
for HYP triggers



Better conditions  
reached in the last  
months

## Drawback

He chamber actually with steady average cont. of 27% of air

## Accidents...

Half of a silicon module side was burned (1/16 of acceptance)

## Perspectives

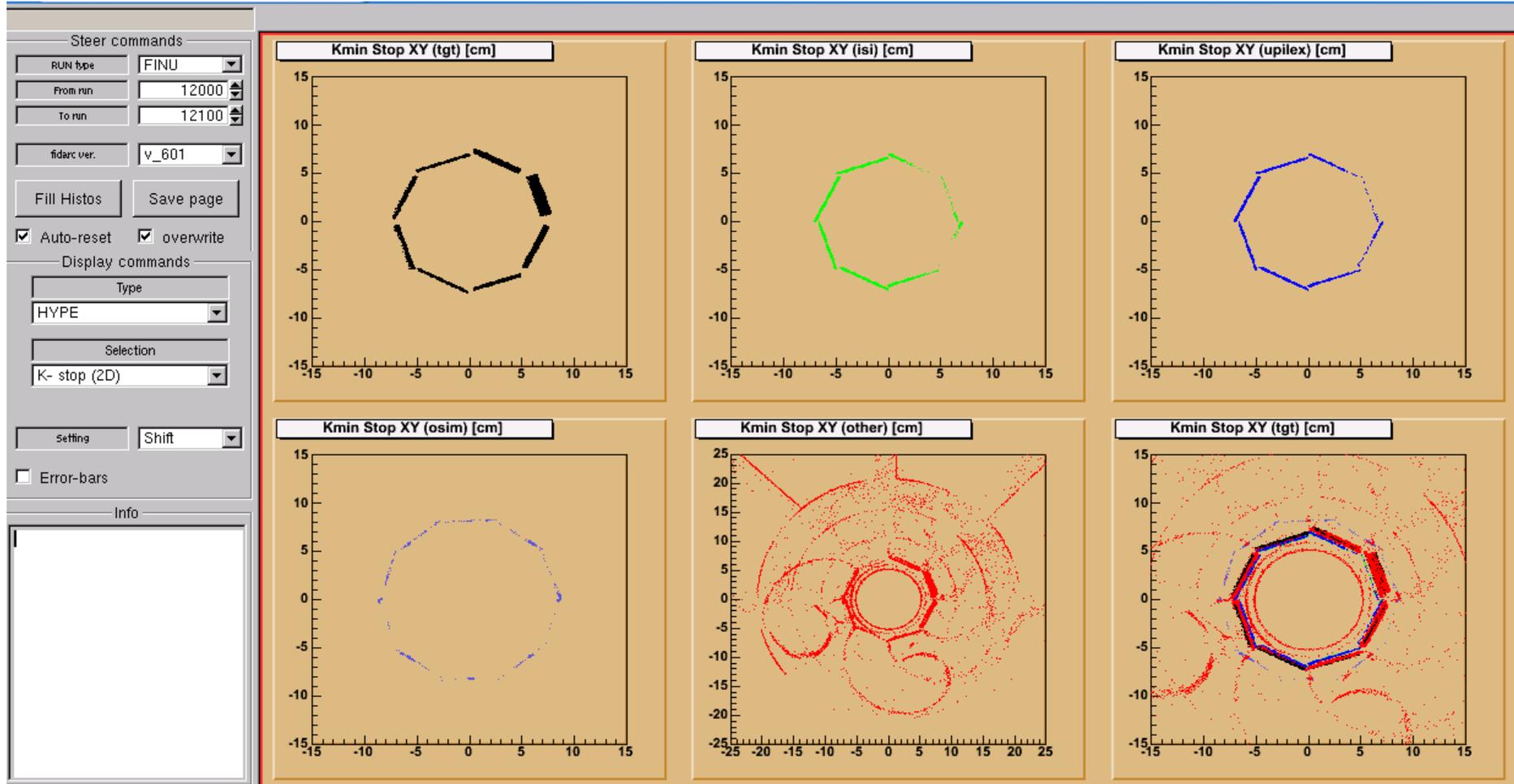
**FINUDA will reach 1 fb<sup>-1</sup> of integrated L by mid-June**

**At the end of data-taking we need 1 week of cosmic ray**

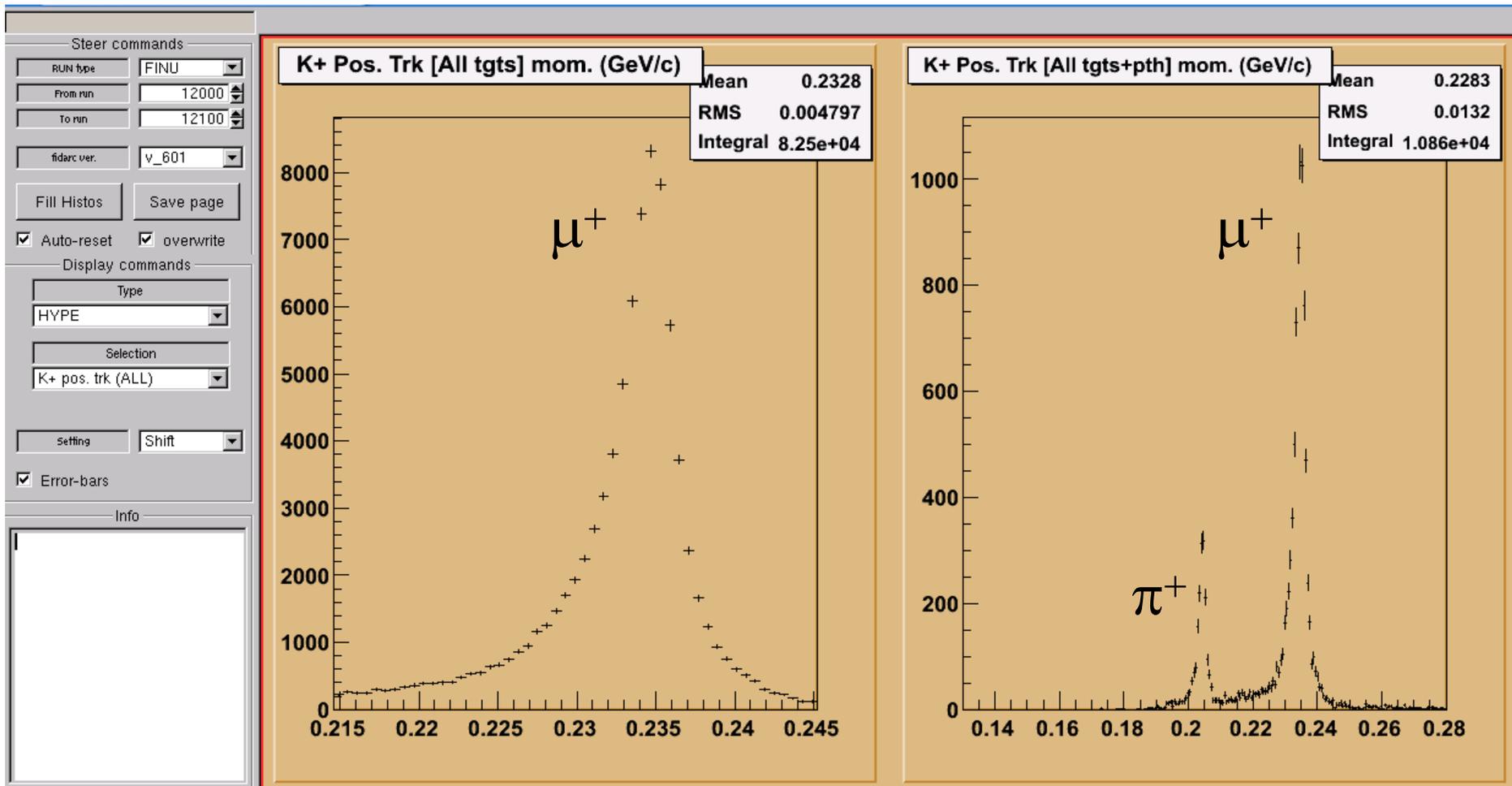
**Man power remains a challenge**

**DAQ/Detectors/Monitors stability, allowing safely one person shifts**

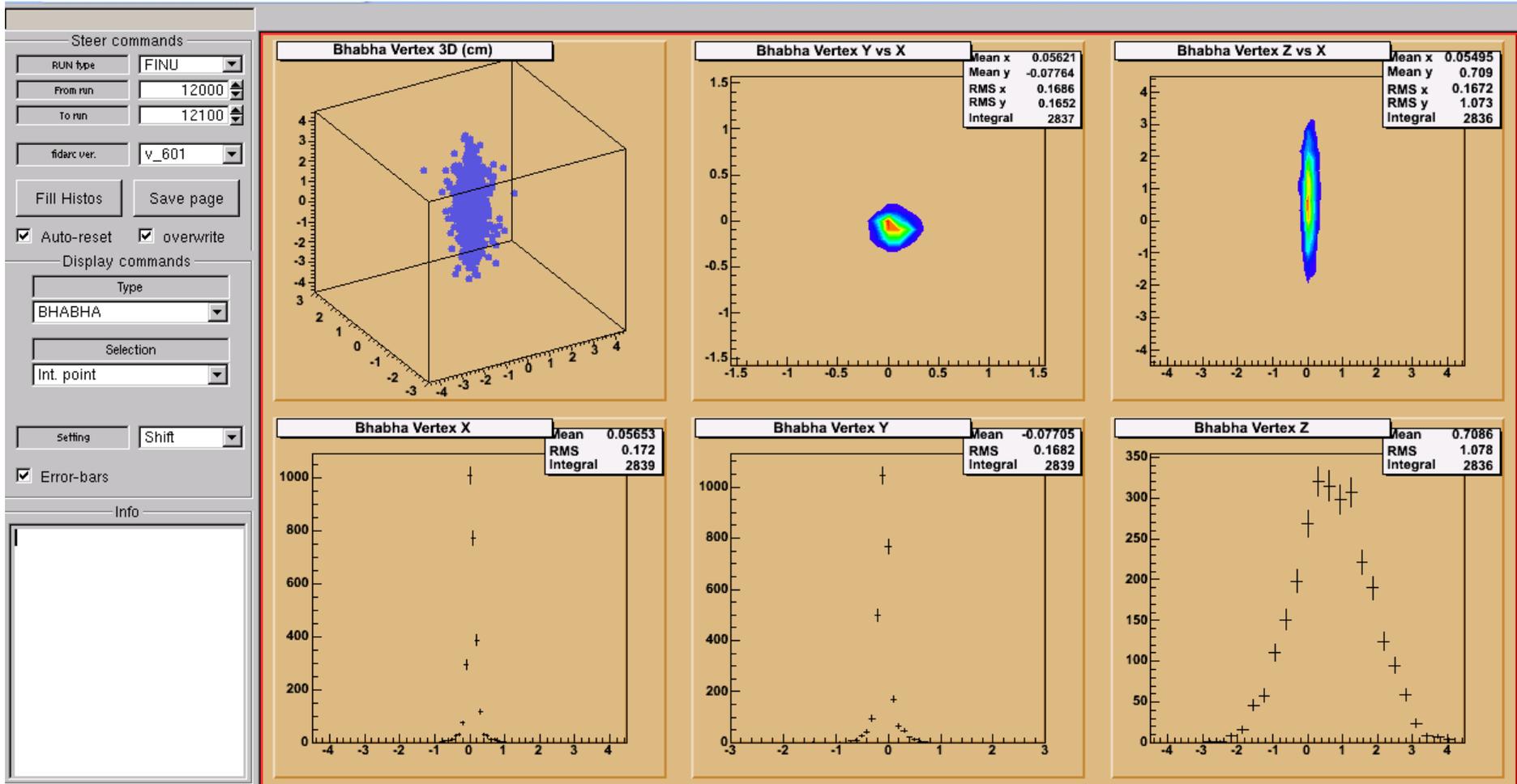
# Tools to monitor the data quality: K<sup>-</sup> and K<sup>+</sup> topology



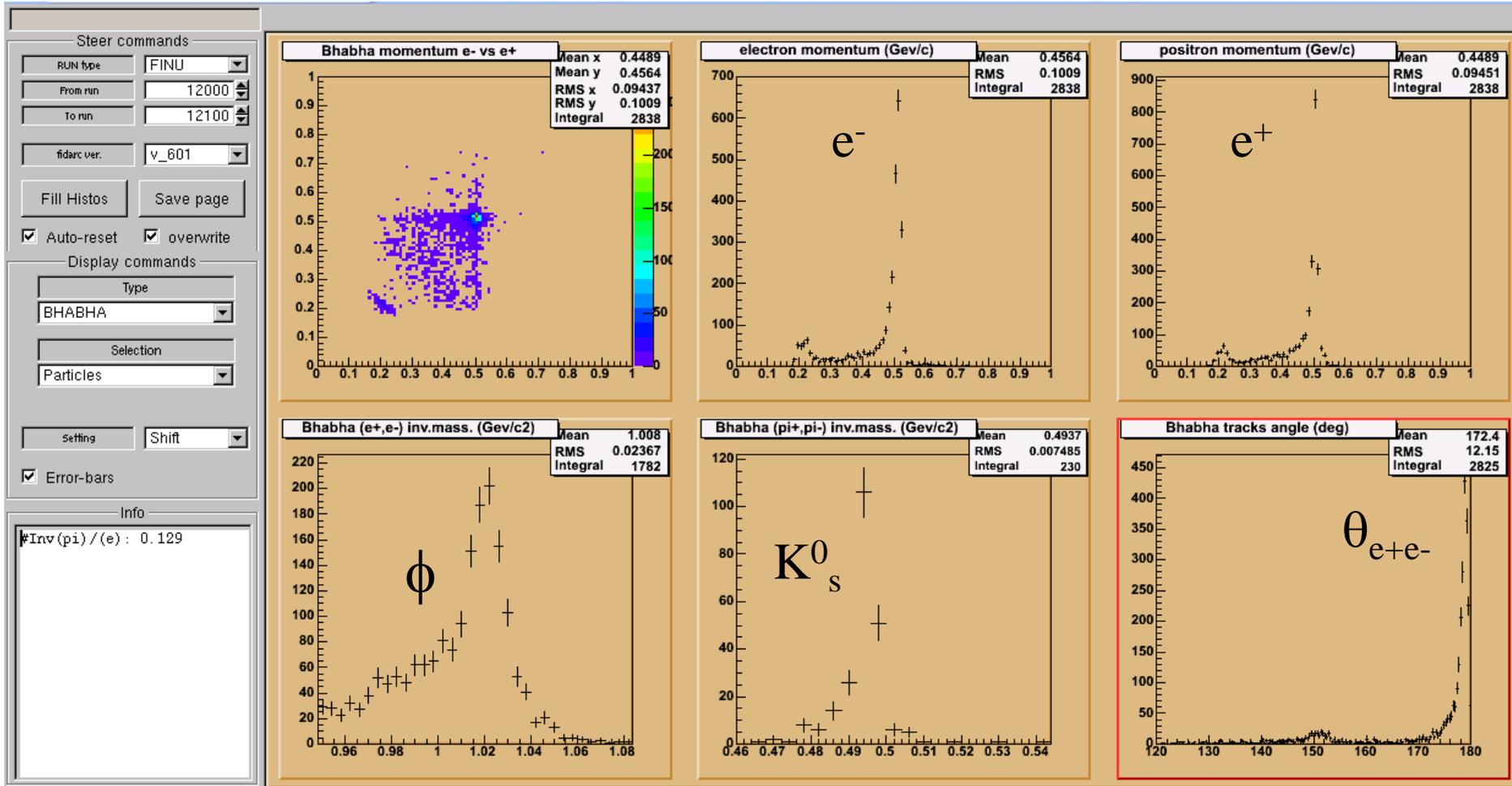
# Tools to monitor the data quality: Positive tracks from K<sup>+</sup> decay



# Tools to monitor the data quality: Beam profile from bhabha



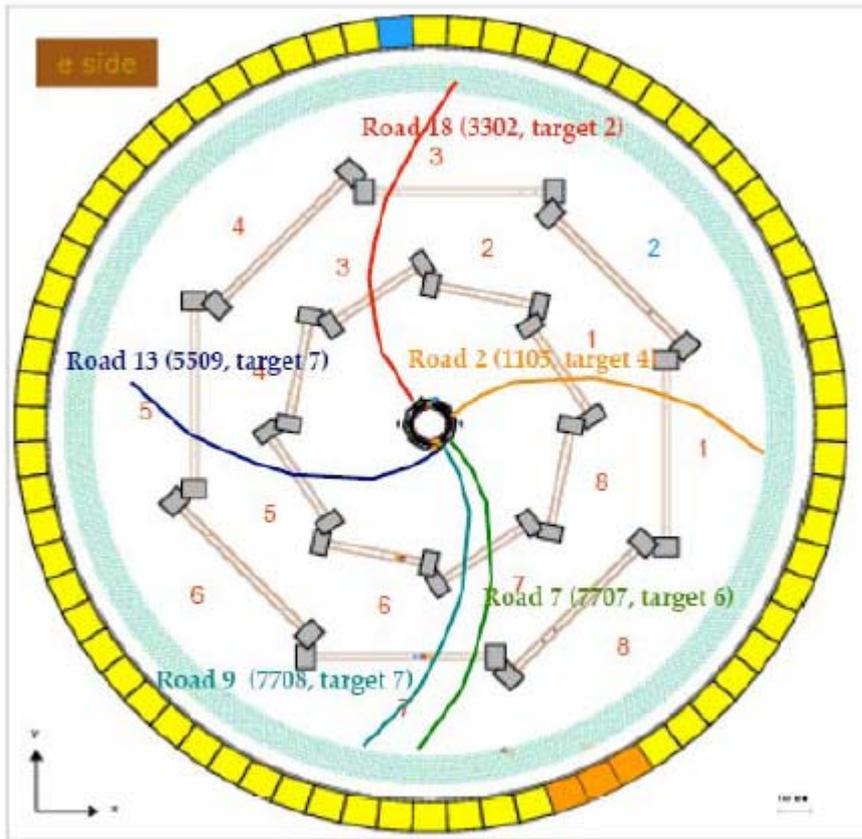
# Tools to monitor the data quality: Beam c.m. energy from bhabha



# Along with data taking...

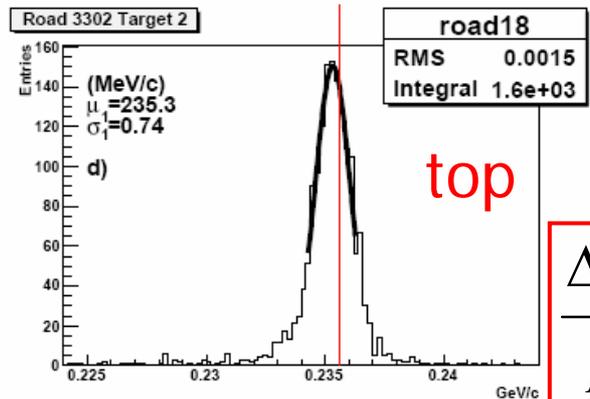
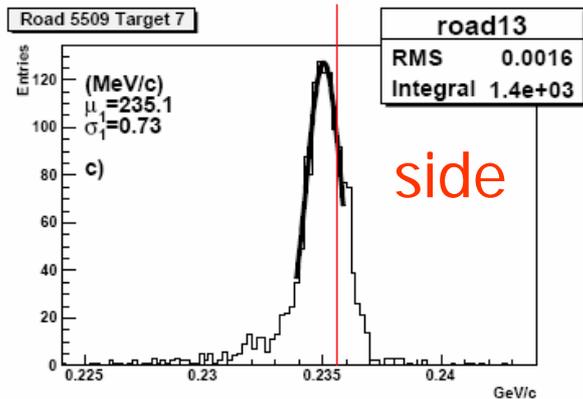
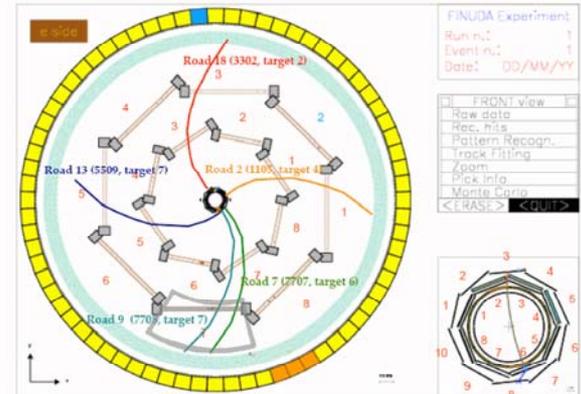
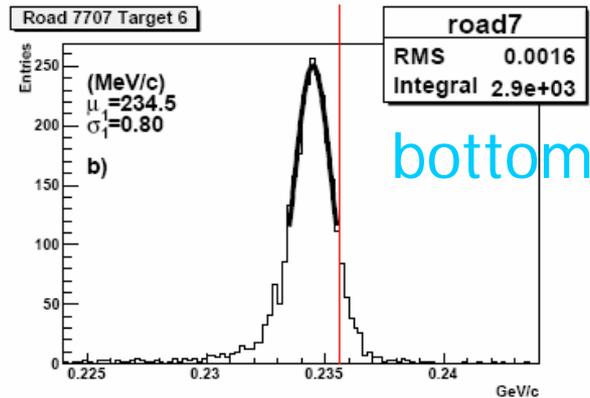
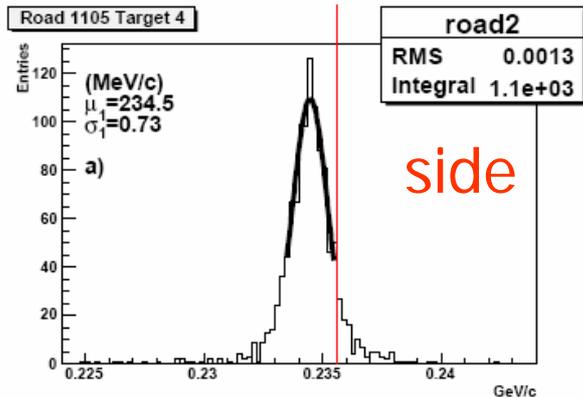
- Data analysis in progress:
  - Evaluation of momentum resolution
  - Pions and protons momentum spectra
  - $\Lambda$  invariant mass
- Status of calibrations
  - TOF Calibration
  - Alignment procedure with cosmic rays  $B=0$

# Study of momentum resolution for $\mu^+$ tracks



- Divide apparatus in different roads defined by a fixed set of sub-detectors and a given target
- to reduce distortion effects due to geometrical misalignment not yet corrected, then
- study resolution for  $\mu^+$  tracks in the defined road and in different time intervals

# Study of momentum resolution for $\mu^+$ tracks

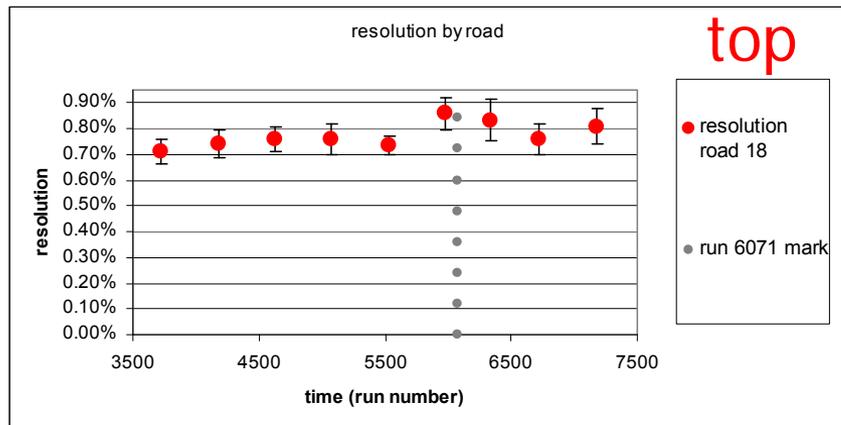


$$\frac{\Delta_p}{p} \approx (0.65 - 0.7)\% FWHM$$

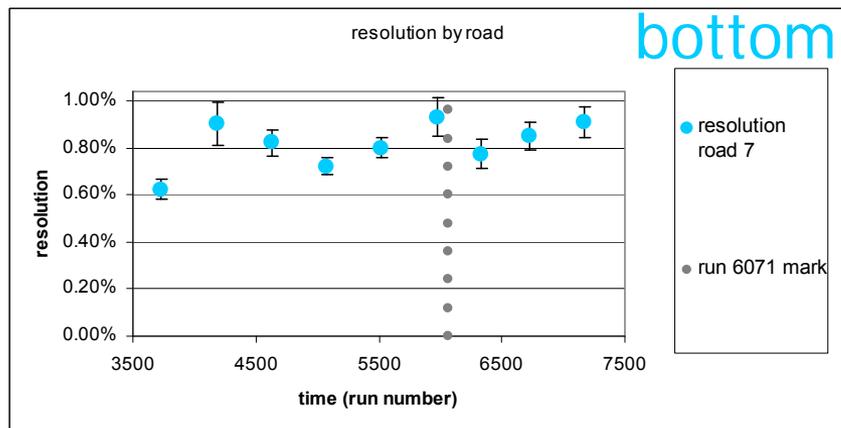
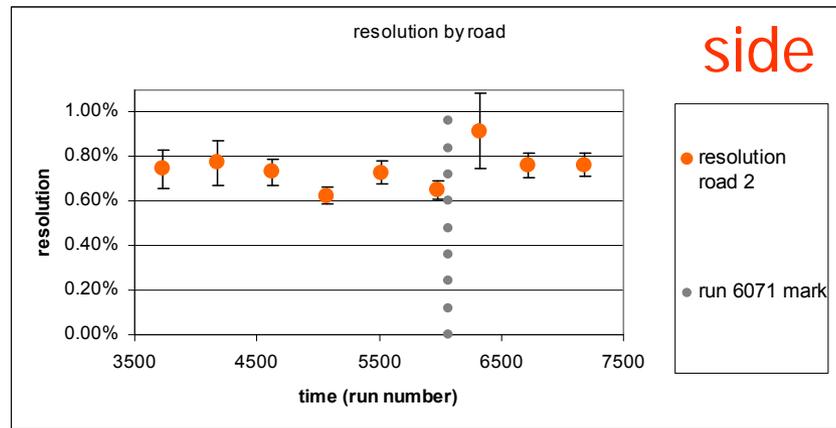
Momentum resolution, without alignment, is already close to the one foreseen with alignment (2003-2004: 0.58% FWHM)

No significant worsening related to the increase of air in the He bag.

# Study of momentum resolution for $\mu^+$ tracks



- Trend of  $\mu^+$  resolution vs time
- He bag worsening in bottom part starting at run 6071, on Jan.18, 07

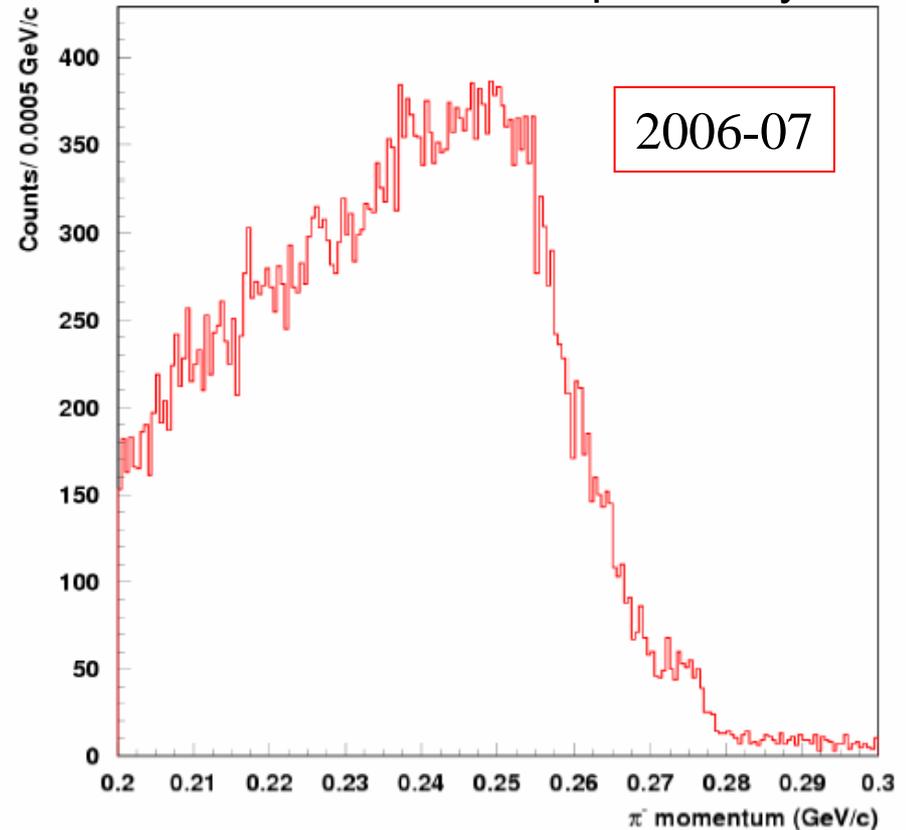
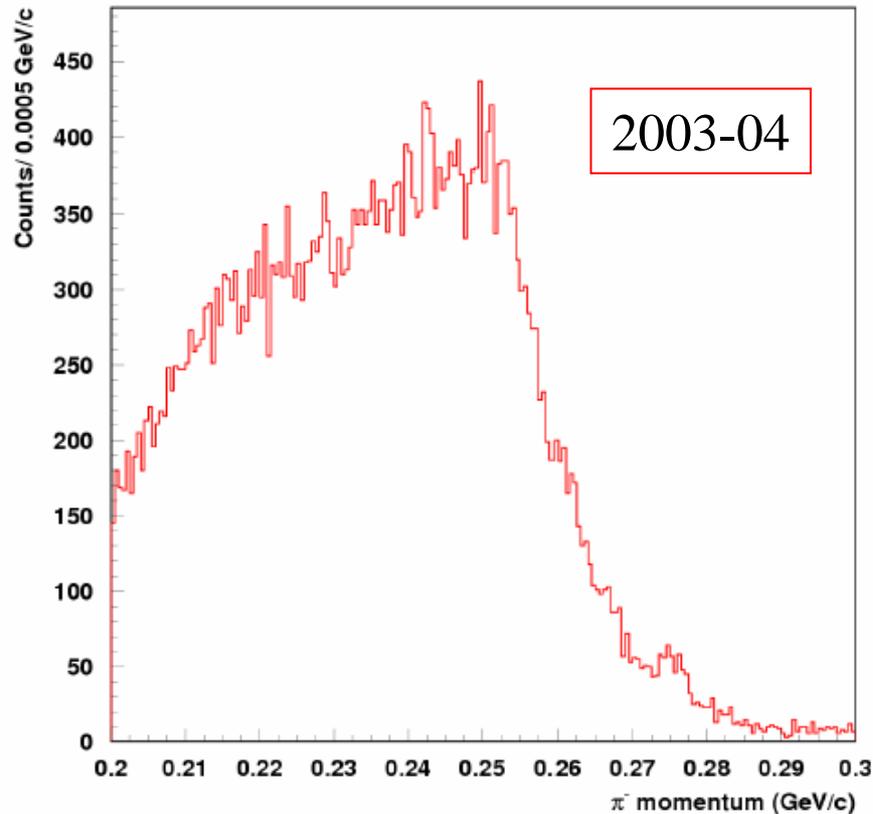


- No significant worsening of resolution due to He bag air-contamination

# $\pi^-$ momentum spectra: ${}^6\text{Li}$

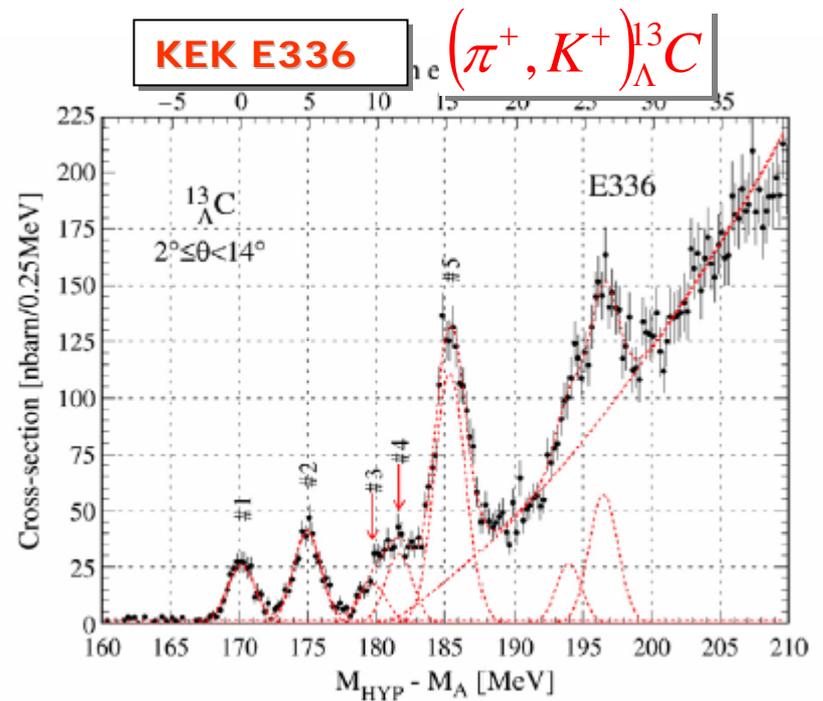
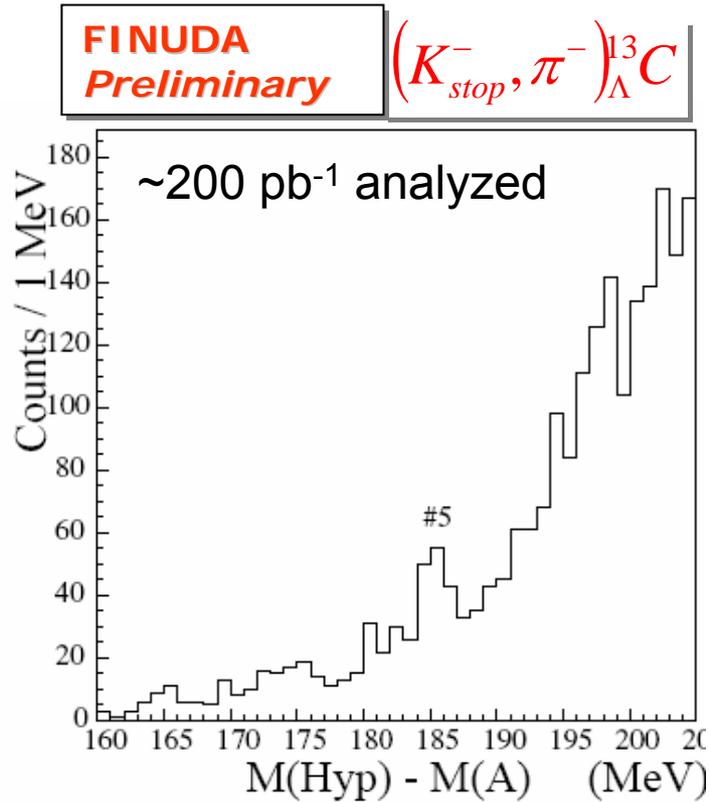
Comparison of old (2003-2004) data (after alignment) and new data (before alignment) corresponding to the same integrated luminosity on two  ${}^6\text{Li}$  targets

$\sim 200 \text{ pb}^{-1}$  analyzed



**EVEN WITHOUT FINE CALIBRATION AND ALIGNMENT  
APPARATUS EXHIBITS ROUGHLY SAME EFFICIENCY**

# $^{13}\text{C}_\Lambda$ excitation spectrum

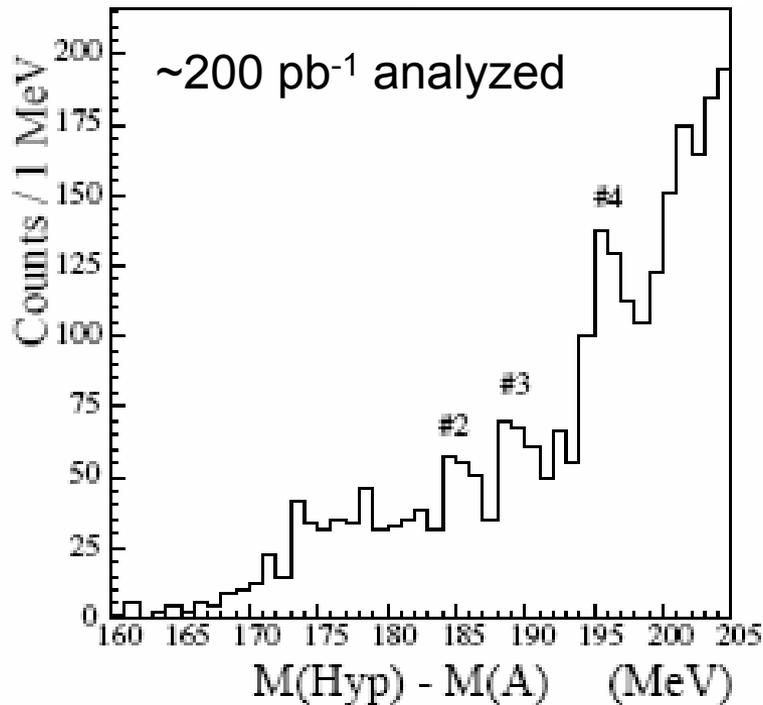


**Peak n.5 is clearly visible**

# $^{16}\text{O}_\Lambda$ excitation spectrum

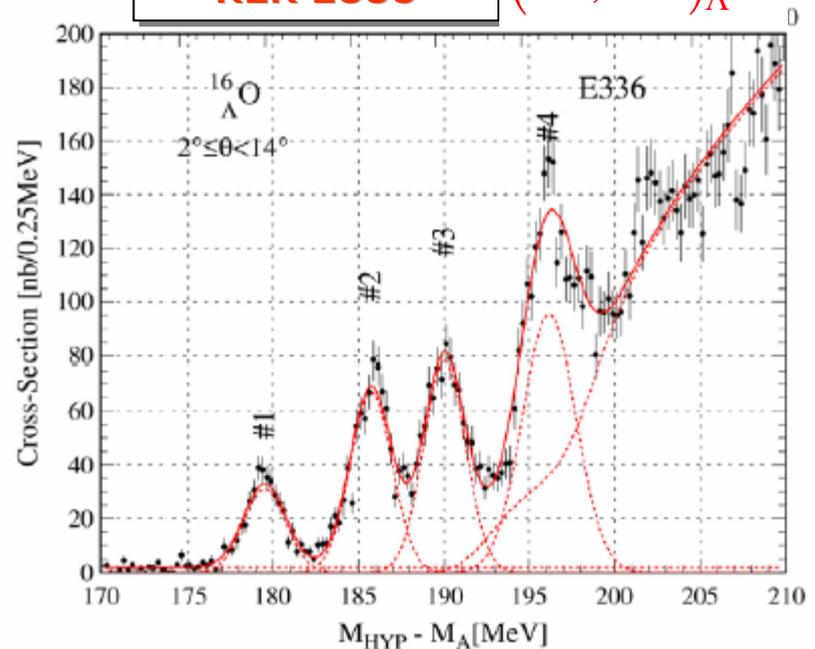
**FINUDA**  
*Preliminary*

$(K_{\text{stop}}^-, \pi^-)^{16}\text{O}_\Lambda$



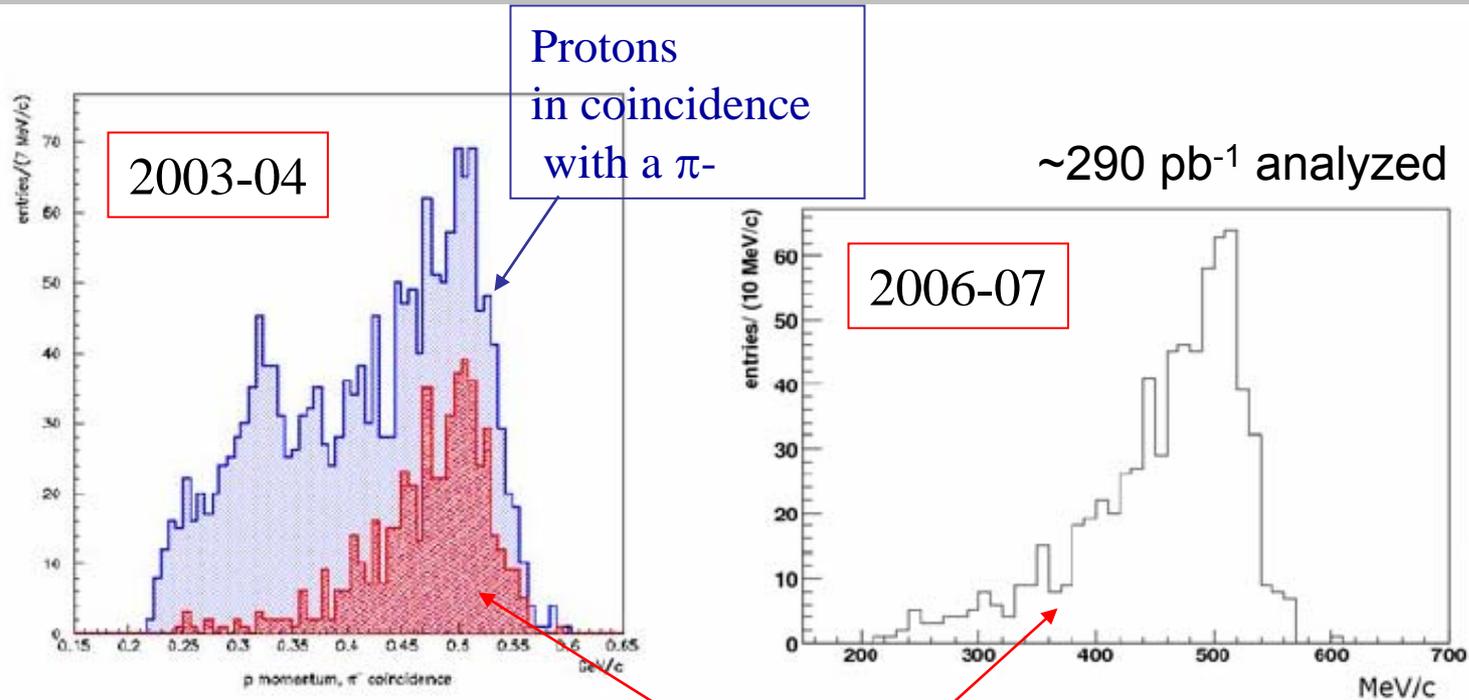
**KEK E336**

$(\pi^+, K^+)^{16}\text{O}_\Lambda$

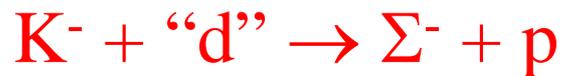


**At least 3 peaks are clearly visible**

# Proton momentum spectrum: ${}^6\text{Li}$



*FINUDA,*  
*Nucl. Phys. A775(2006)35*

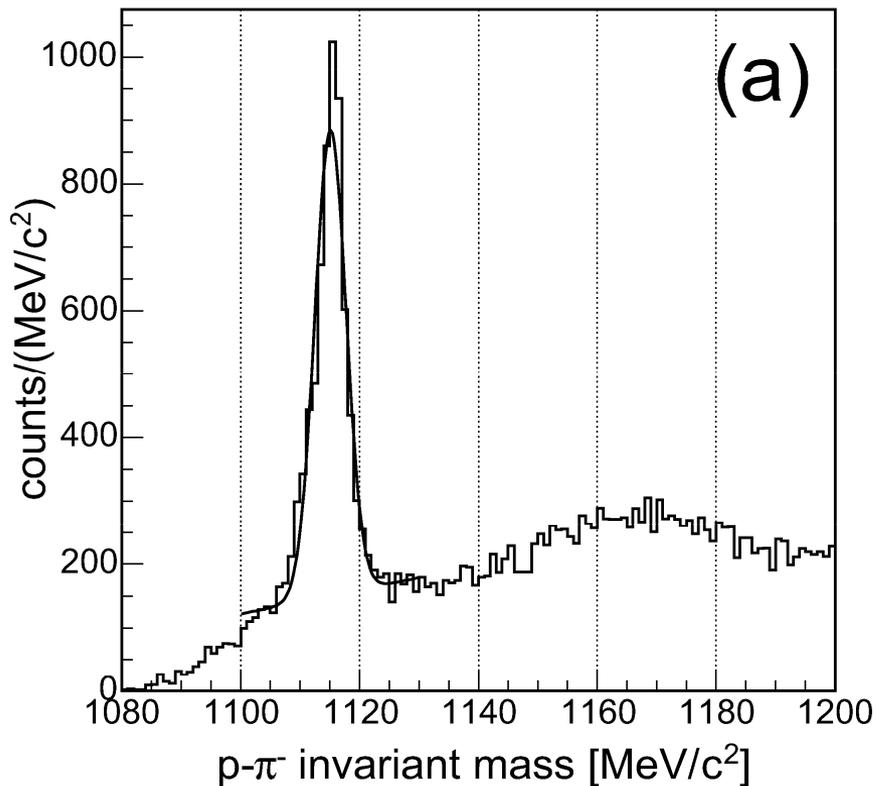


Protons  
in coincidence  
with a fast  $\pi^-$   
( $p > 275 \text{ MeV/c}$ )

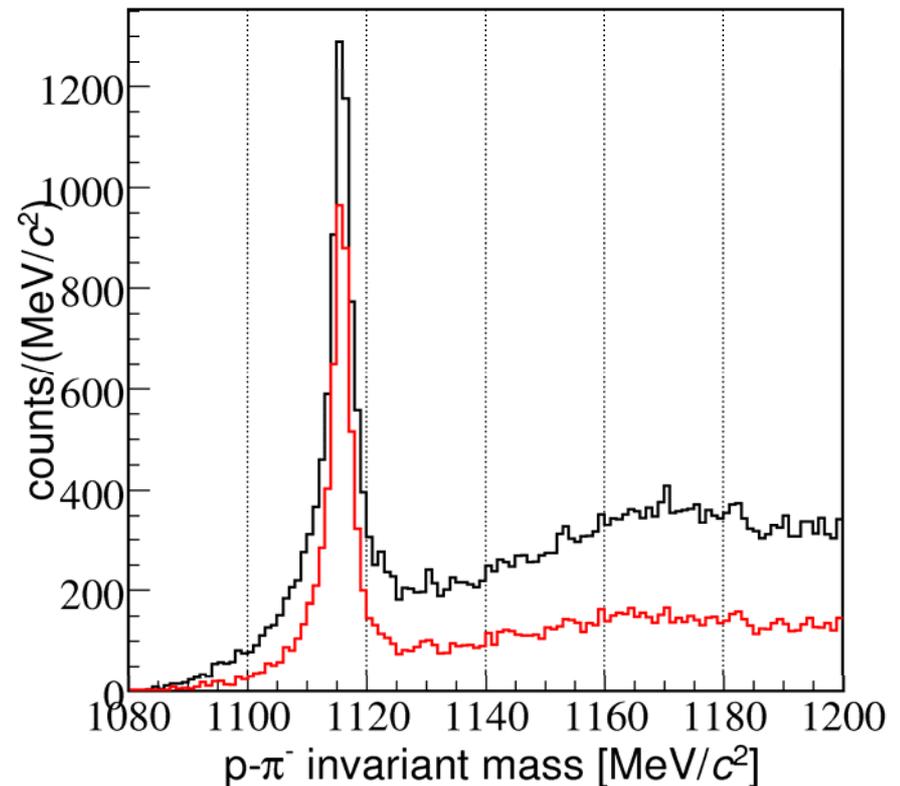
**EVEN WITHOUT FINE CALIBRATION AND ALIGNMENT  
THE NEW DATA SHOW THE SAME TREND AS THE OLD ONE**

# $\Lambda$ invariant mass: ${}^6\text{Li}$

2003-2004 DATA  
Published result  
Resolution: XX

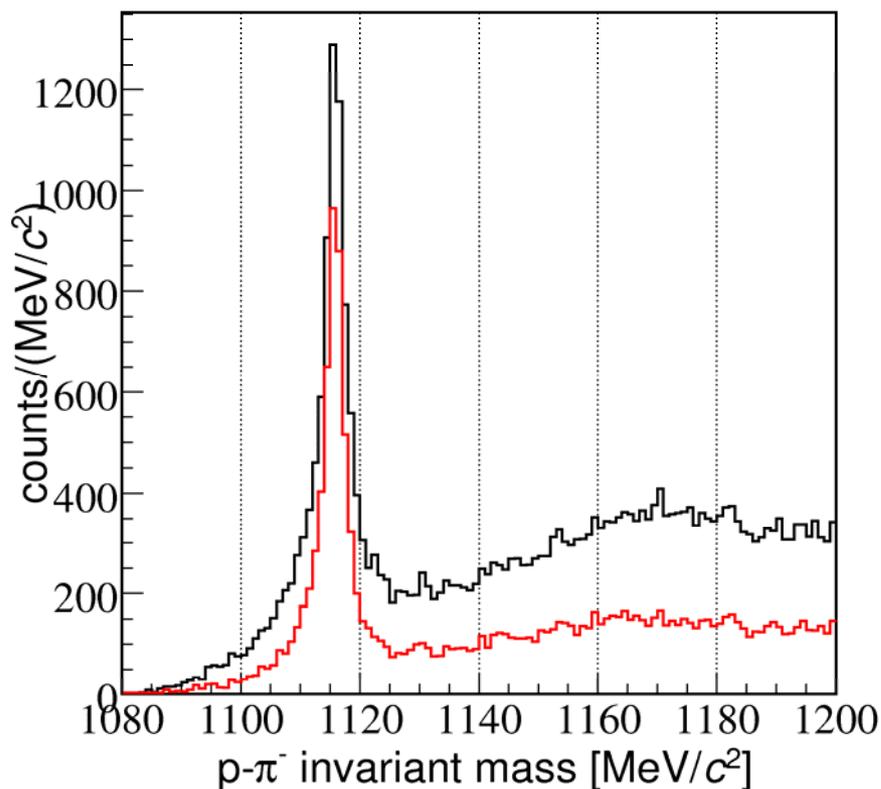


2003-2004 DATA  
New pattern recognition  
Resolution: XX  
Secondary vertex detection

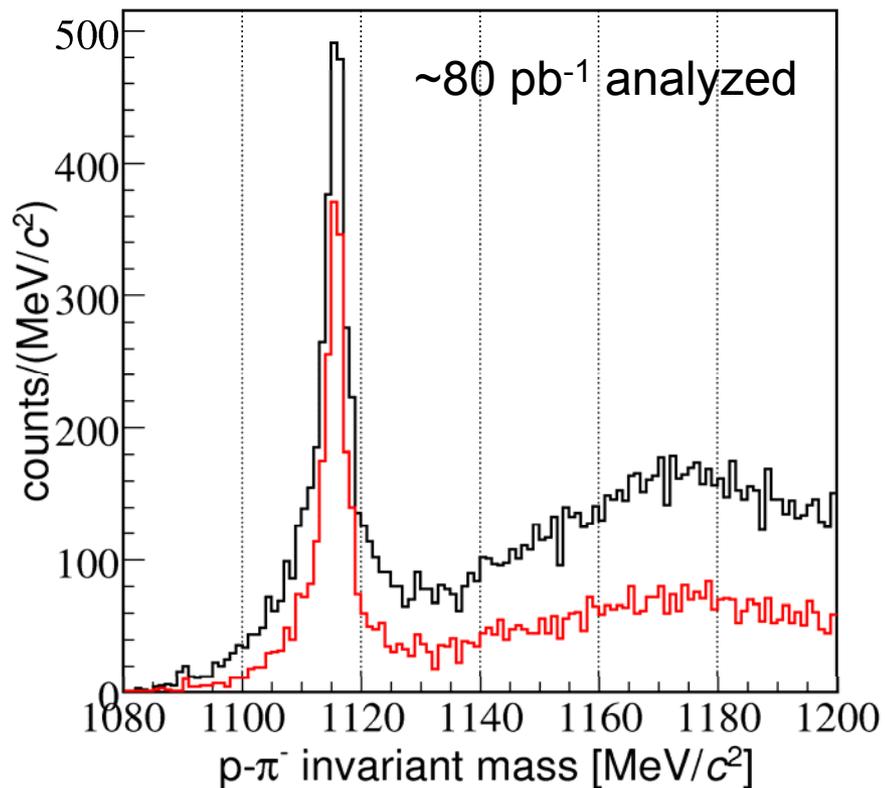


# $\Lambda$ invariant mass: ${}^6\text{Li}$

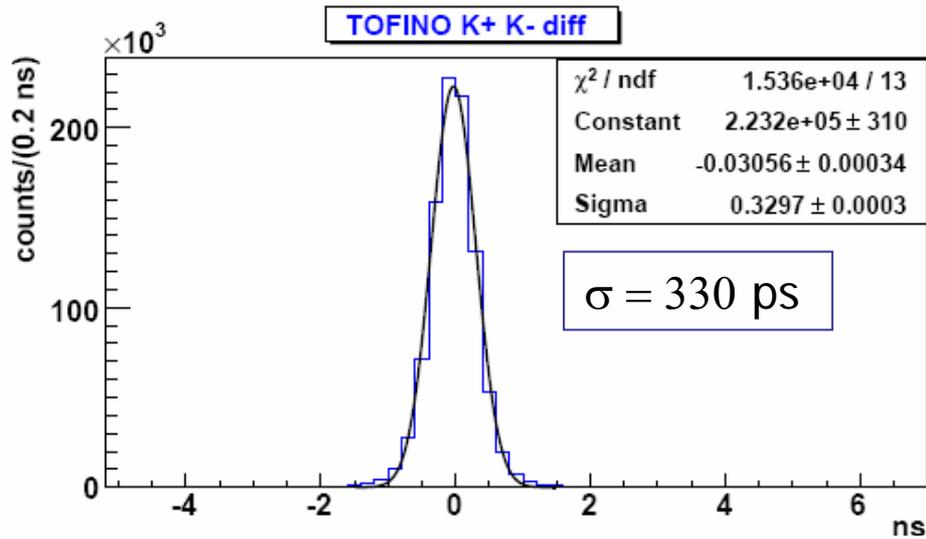
2003 DATA (aligned)  
New pattern recognition  
Secondary vertex detection



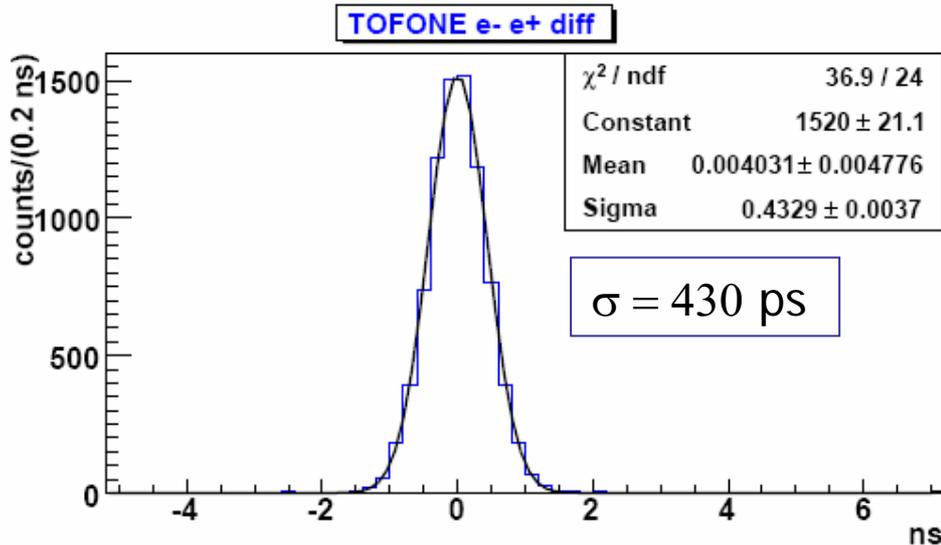
2006-2007 DATA (not aligned)  
New pattern recognition  
Secondary vertex detection



# TOF Calibration

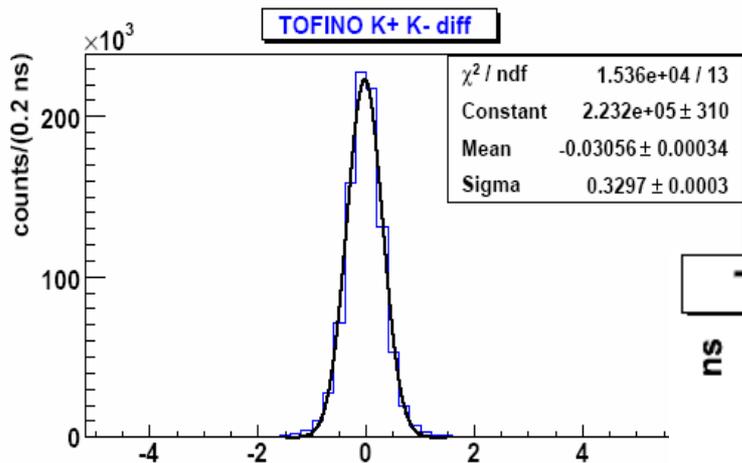


TOF Inner layer  
aligned with K+K-  
2003-2004  $\Rightarrow \sigma = 475 \text{ ps}$

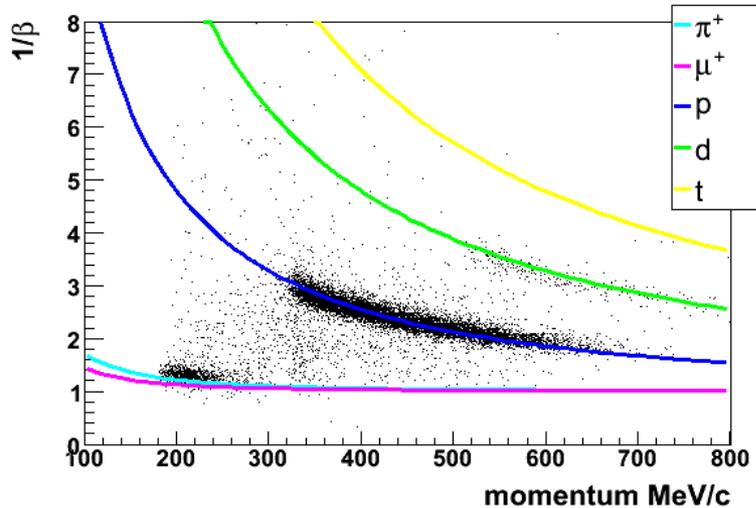
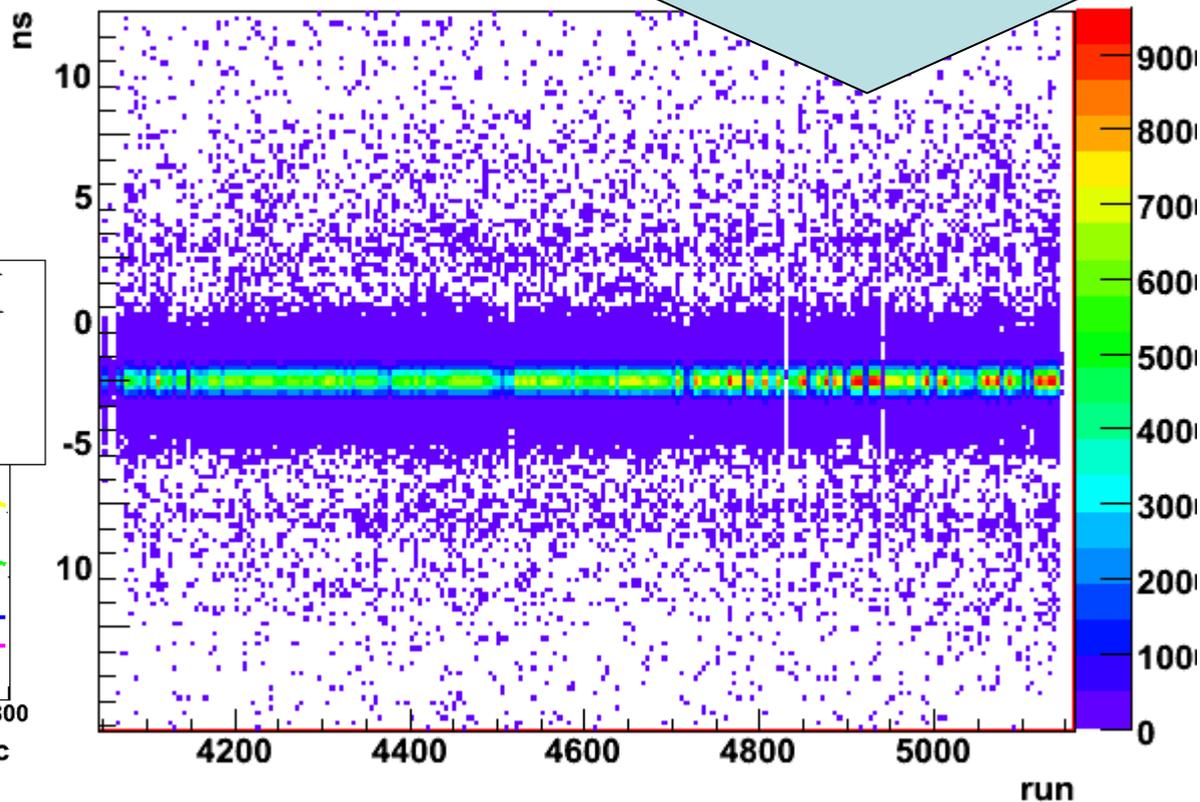


TOF Outer layer  
aligned with Bhabha  
2003-2004  $\Rightarrow \sigma = 485 \text{ ps}$

# TOF Calibration



**TOFINO k+k- diff vs run**



# Detector alignment with cosmic rays

- Use of **straight cosmic rays** collected during the run
- Iterative procedure:
  - First preliminary study to skim clean events for a reliable residuals estimation
  - Evaluation of Vertex and Chambers residuals with respect to the straw tubes system
    - Global translational & rotational offsets
    - Finer tuning of single modules
  - Evaluation of outer layers residuals with respect to microvertex detectors
  - The two procedures should lead to equivalent results when everything is correctly aligned
- **Demanding job**, procedure tested with 2003-04 data
- Work in **advanced progress**

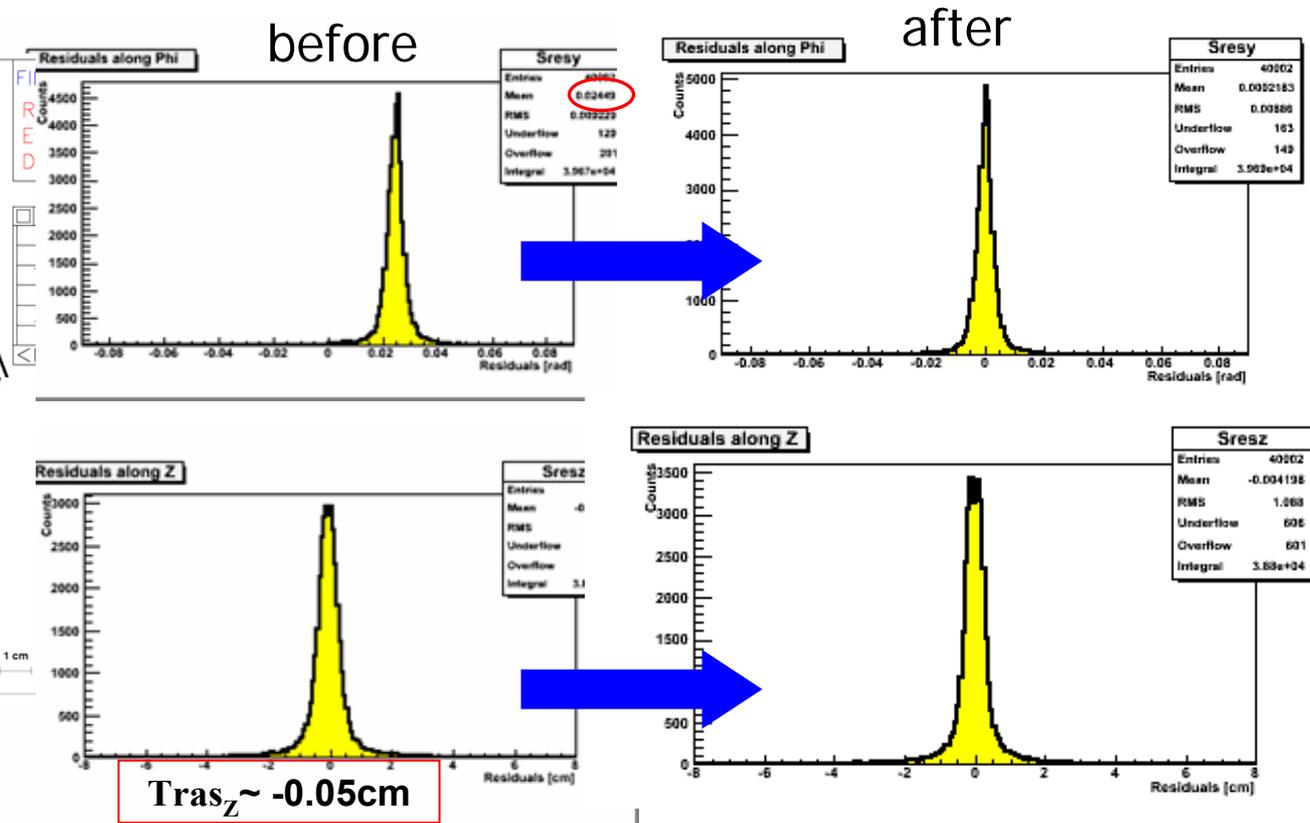
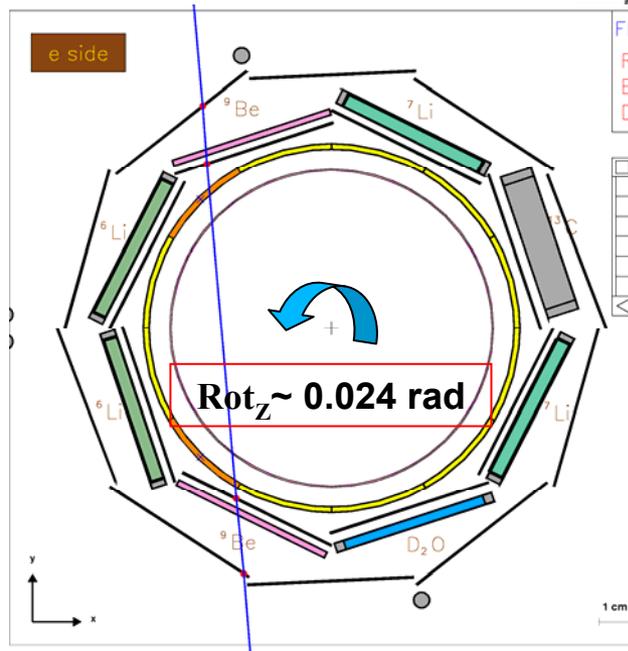
# Detectors alignment with cosmics, B=0

## first step: global translational/rotational offsets

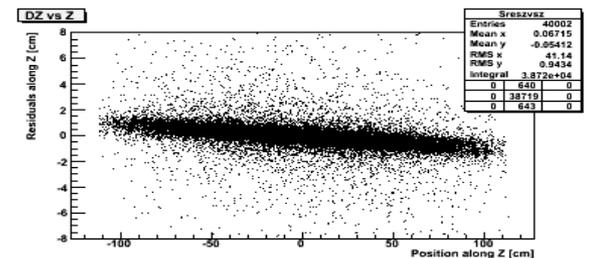
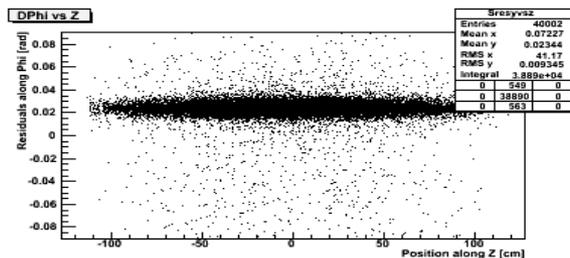
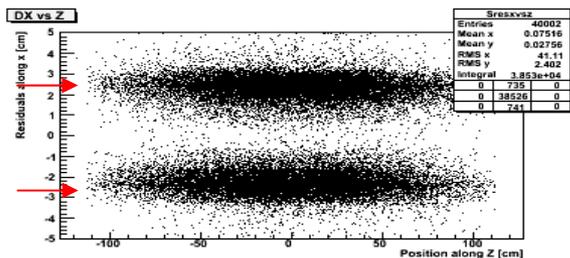
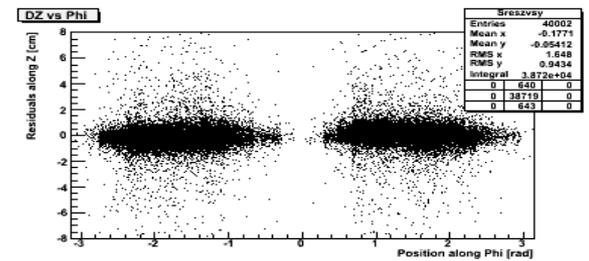
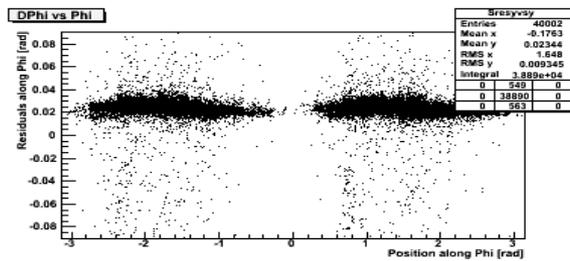
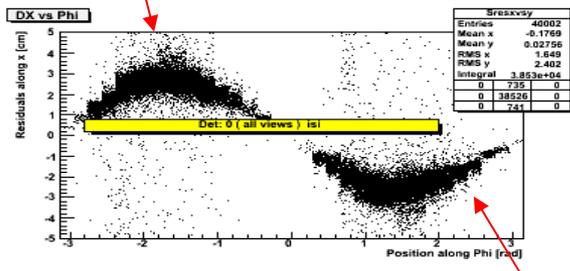
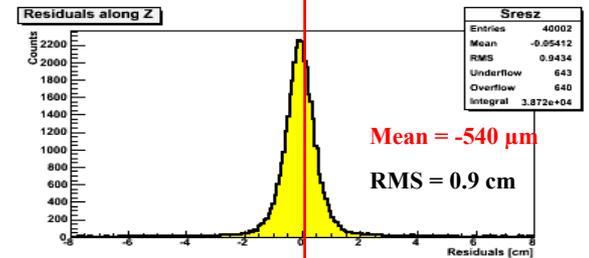
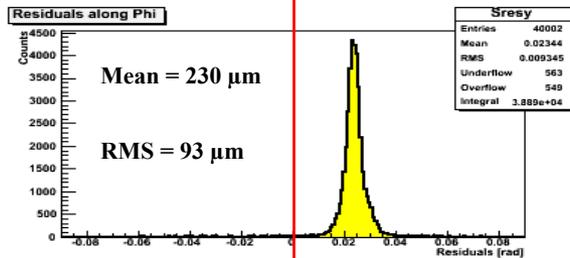
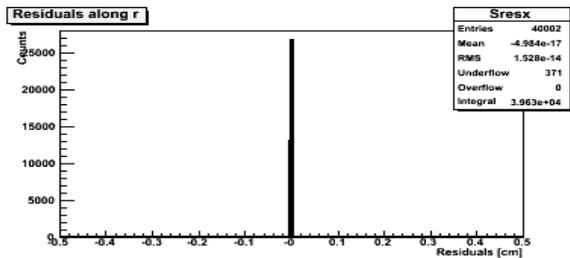
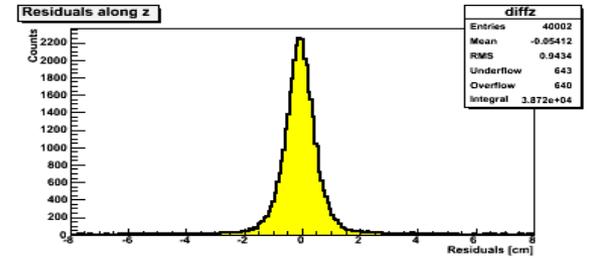
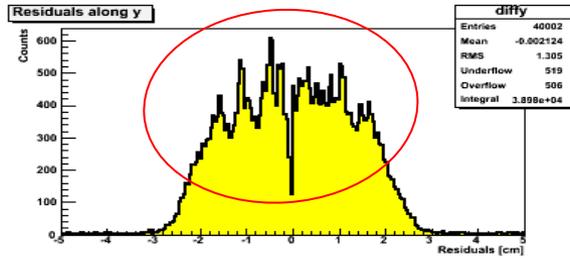
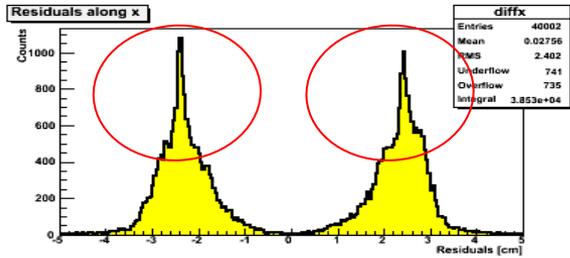
ISIM/OSIM residuals with respect to the straw tubes system



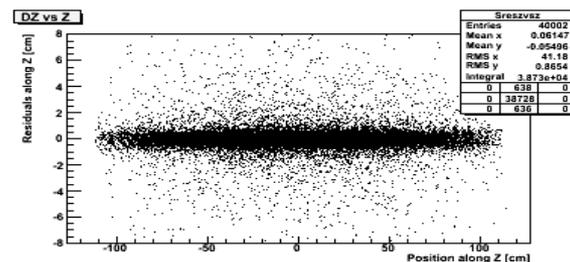
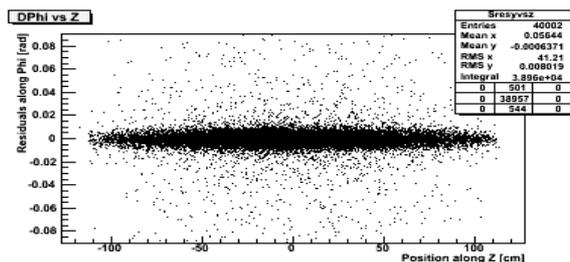
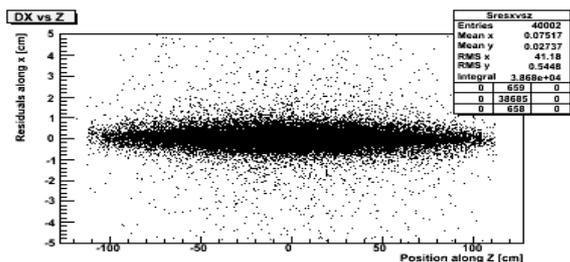
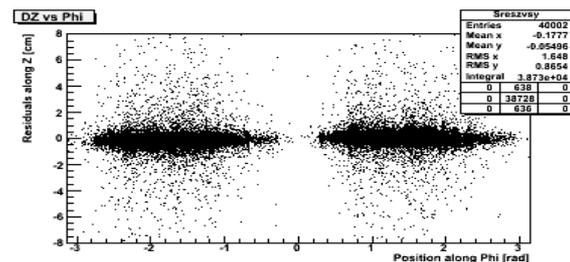
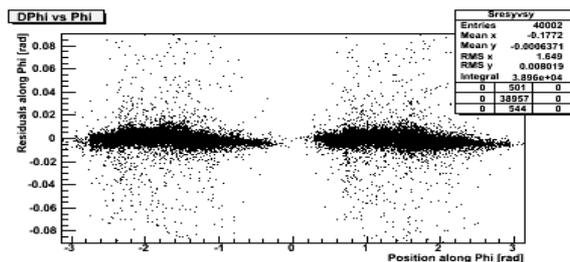
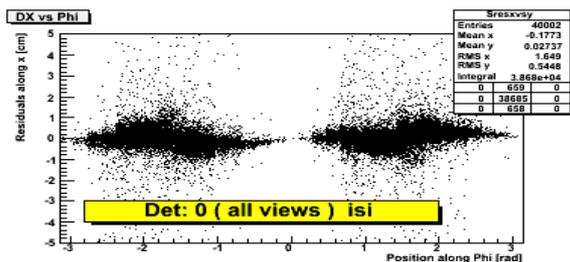
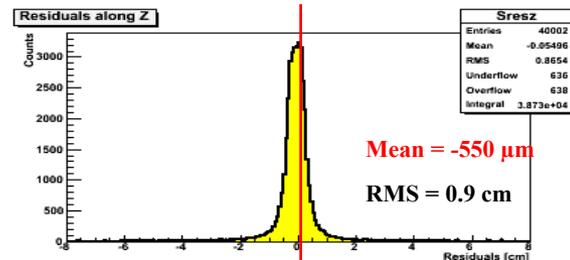
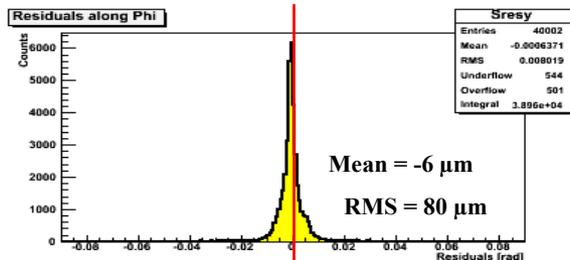
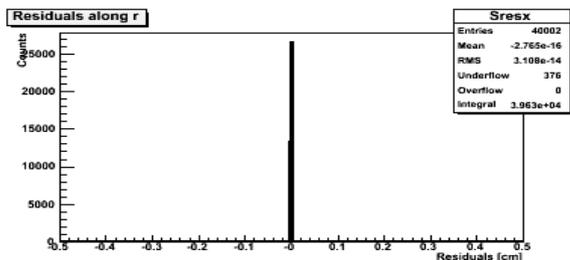
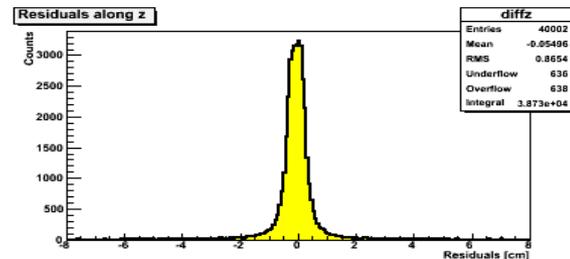
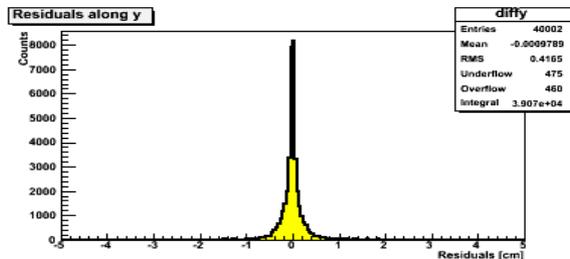
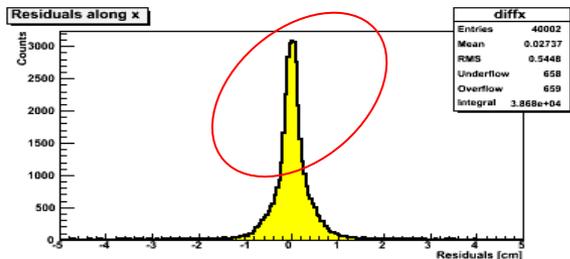
Global translational & rotational offsets



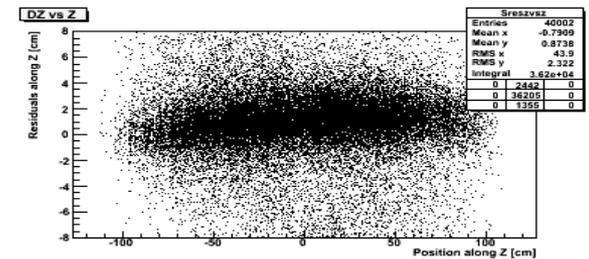
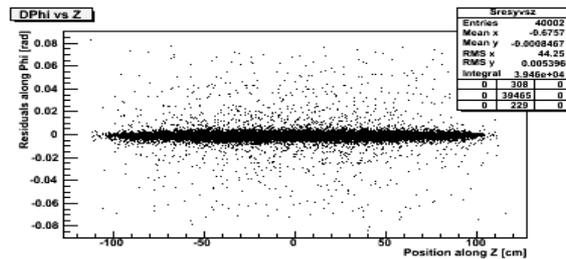
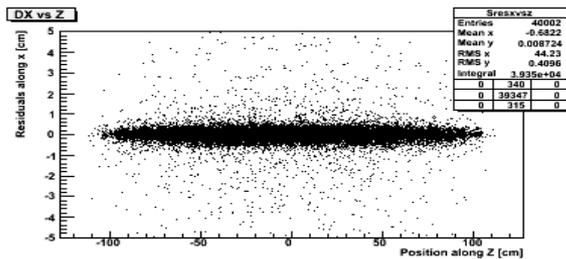
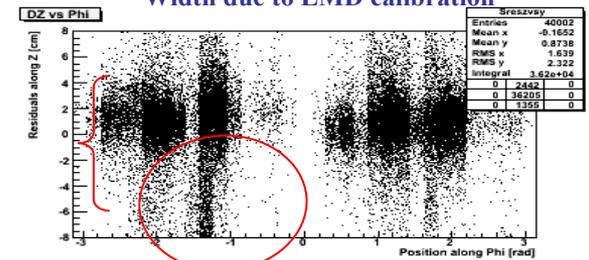
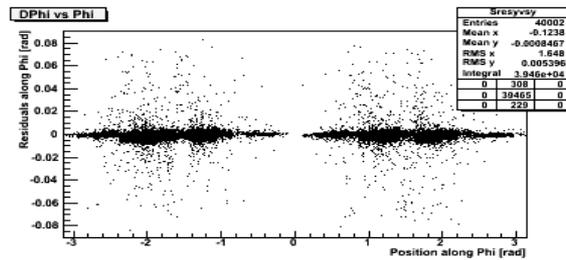
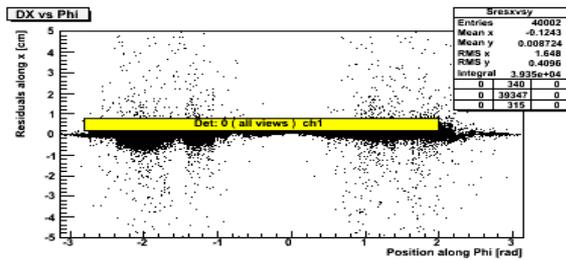
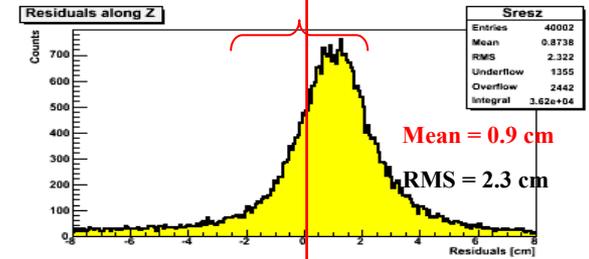
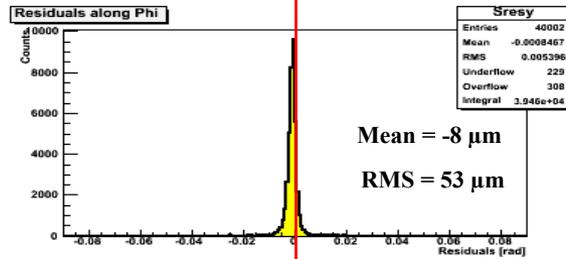
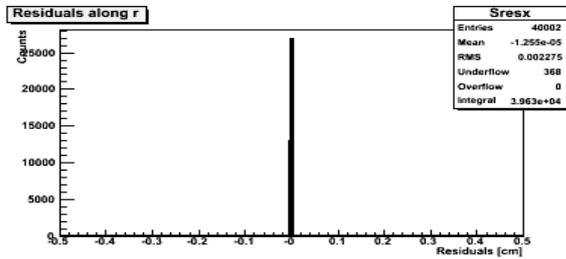
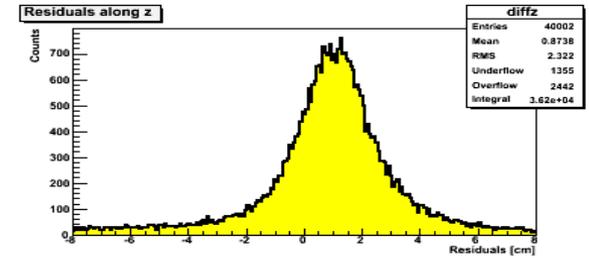
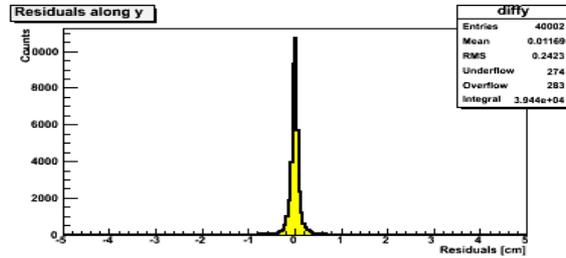
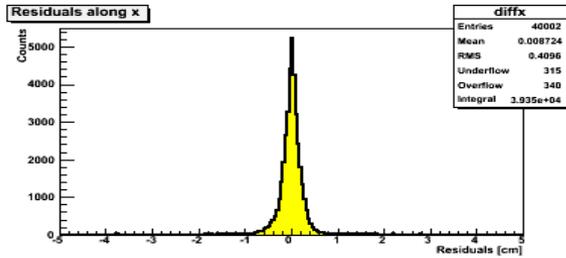
# ISIM: before global translational/rotational alignment



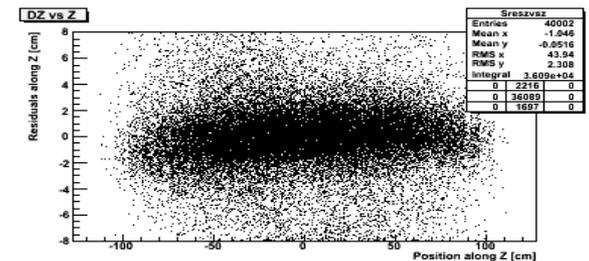
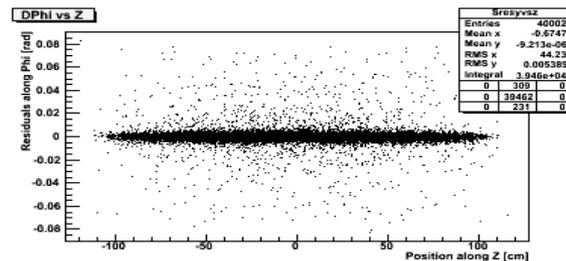
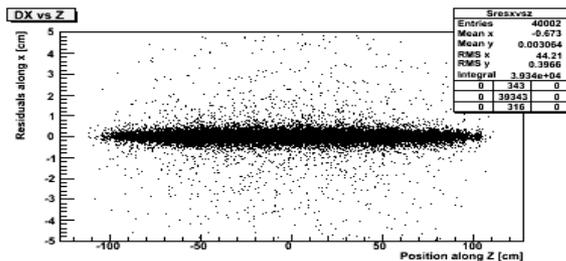
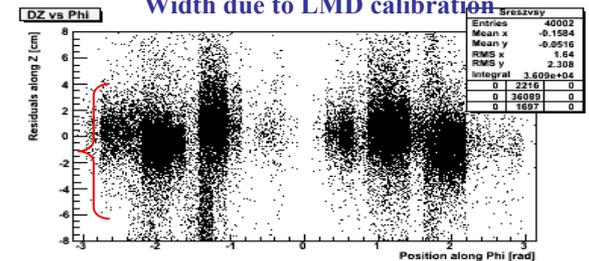
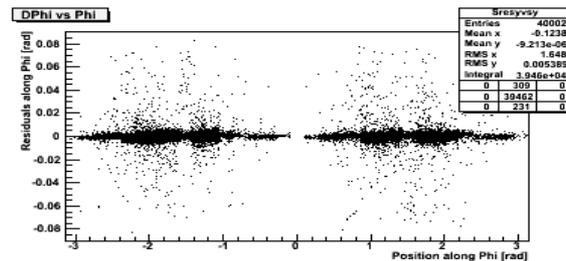
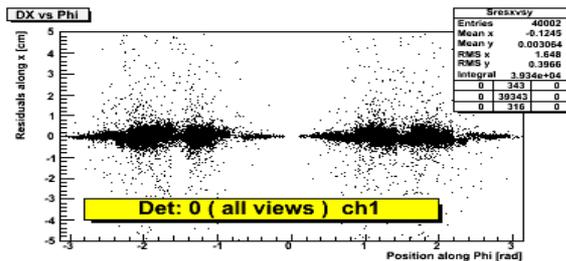
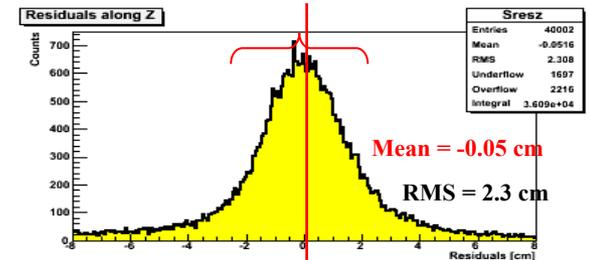
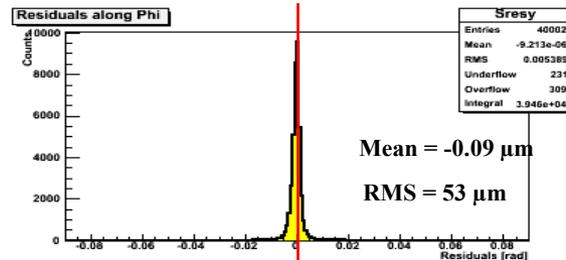
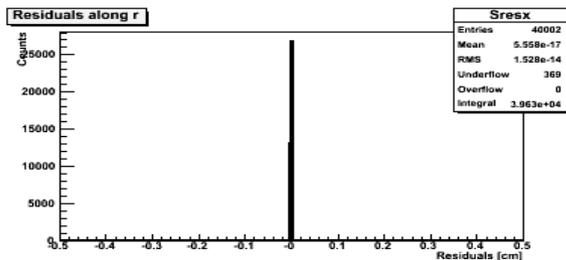
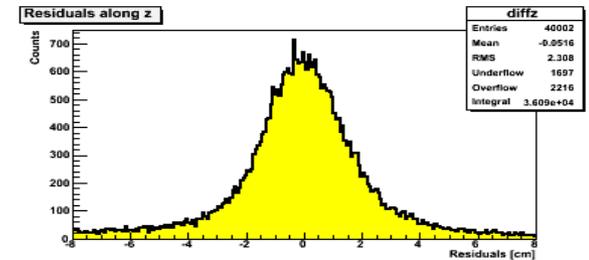
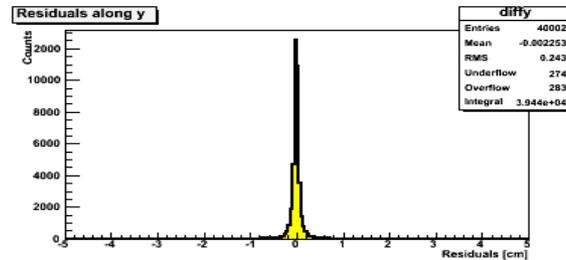
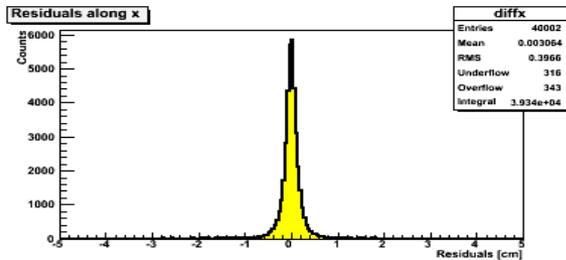
# ISIM: after global translational/rotational alignment



# DCH1: before global translational/rotational alignment

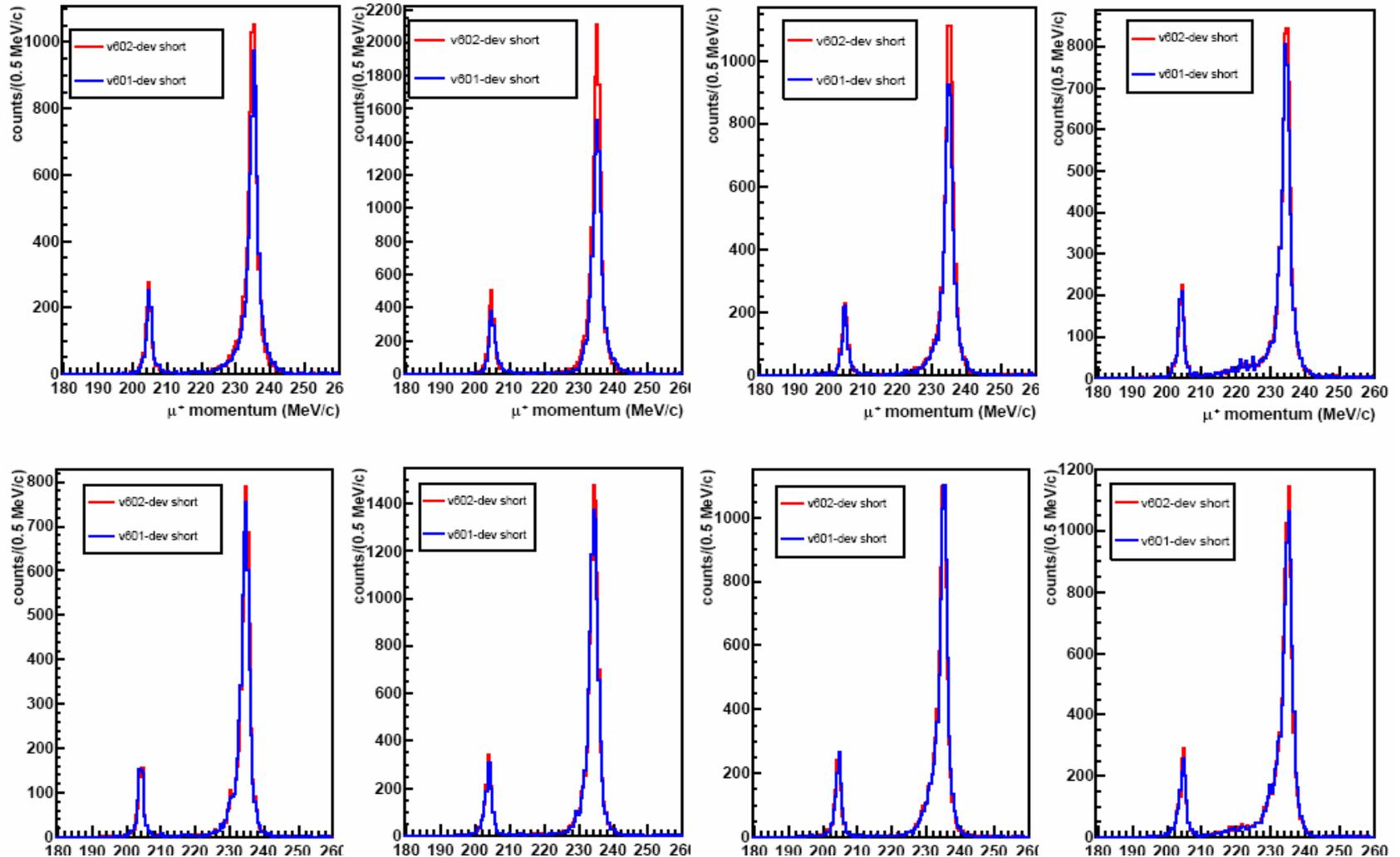


# DCH1: after global translational/rotational alignment



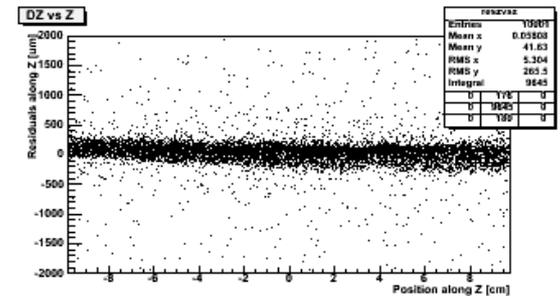
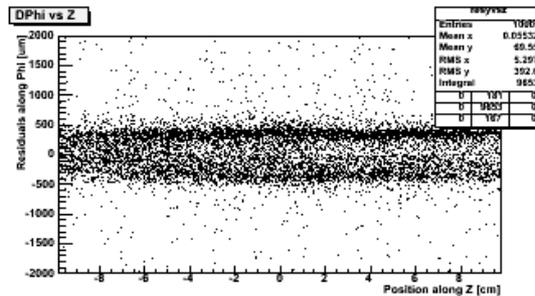
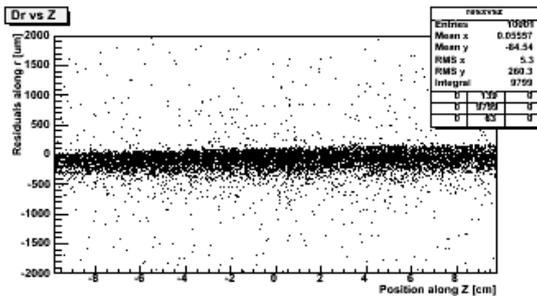
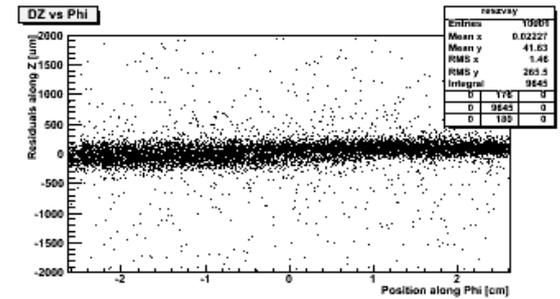
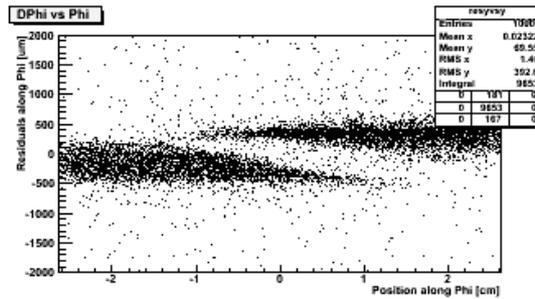
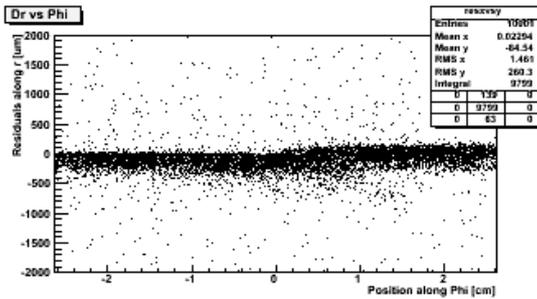
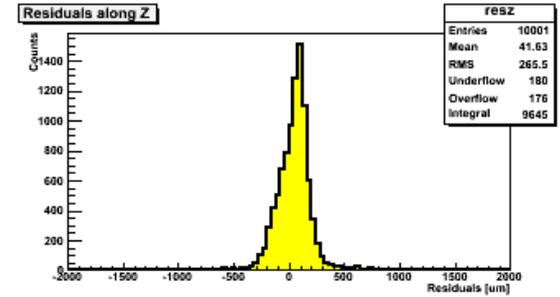
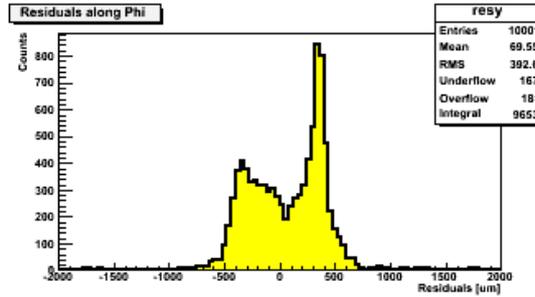
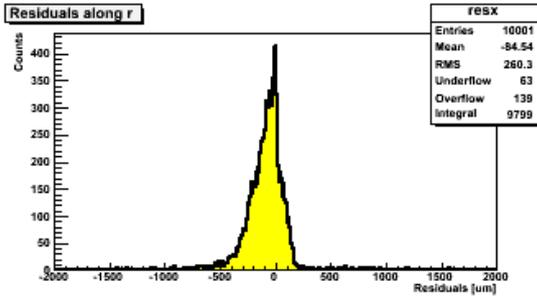
# Effects of the 1<sup>st</sup> step alignment on data quality

Comparison of  $\mu^+$  spectra for the same 500 runs **without** and **with** 1<sup>st</sup> step LMDs alignment + vtx global rototranslations



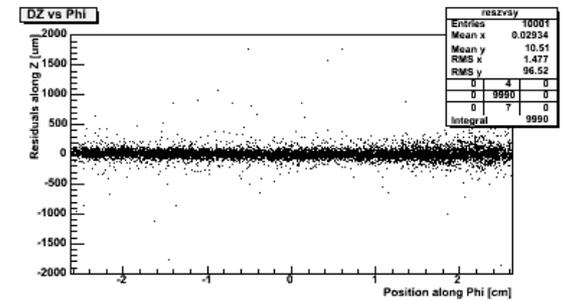
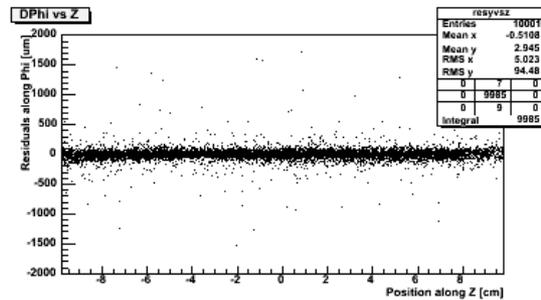
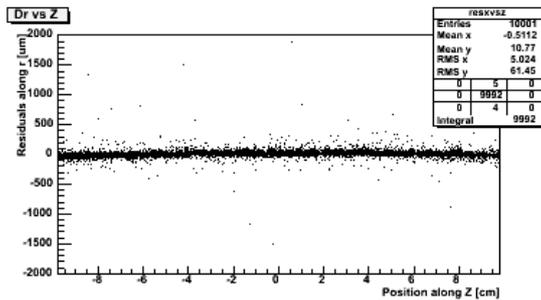
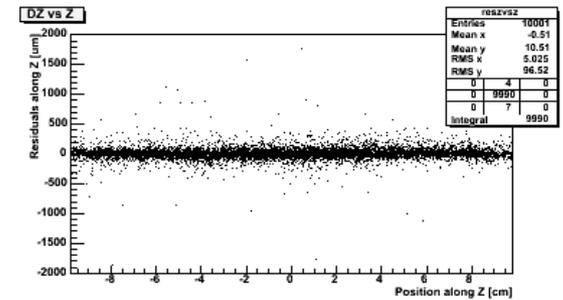
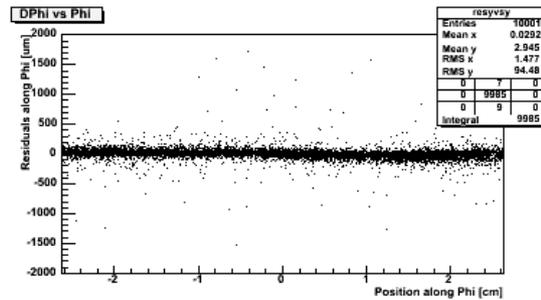
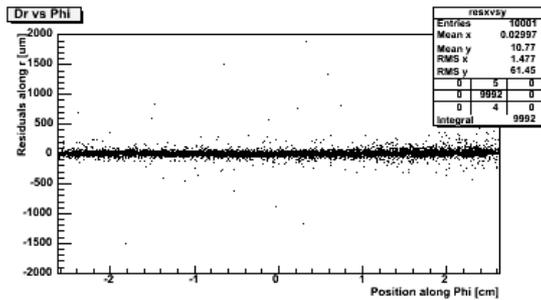
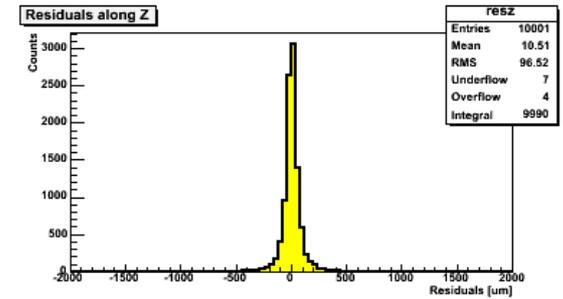
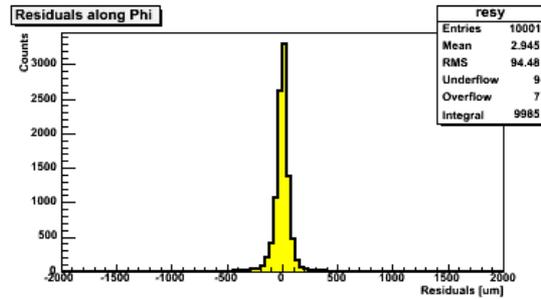
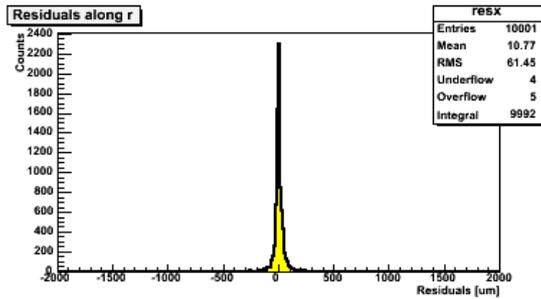
# second step: fine tuning of single modules

## Single Module of Vertex Detector Before Second Step (all views)



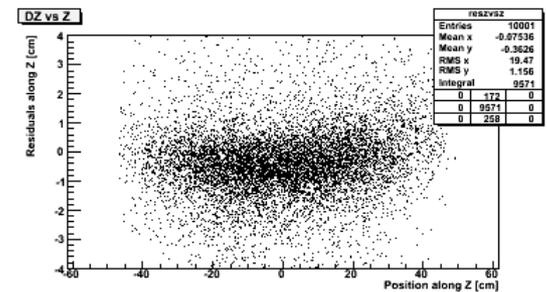
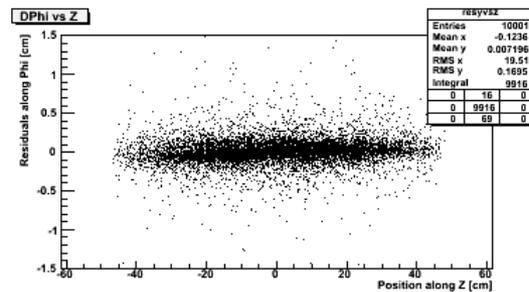
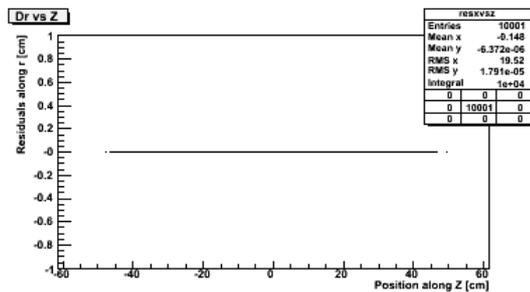
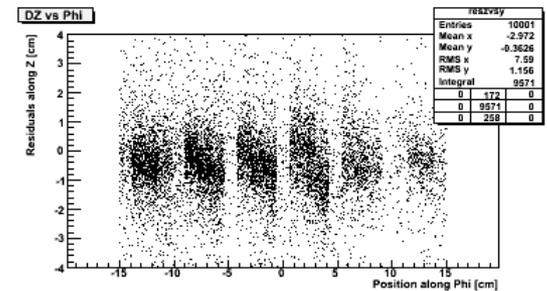
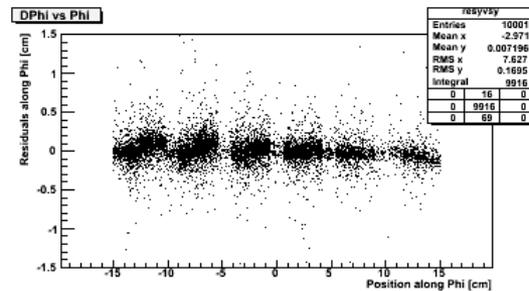
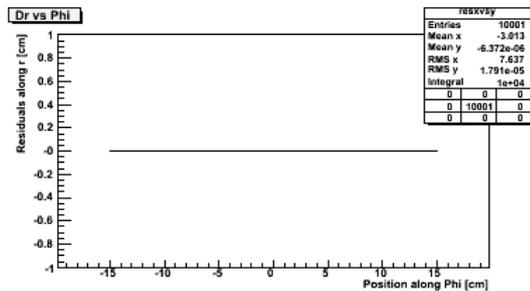
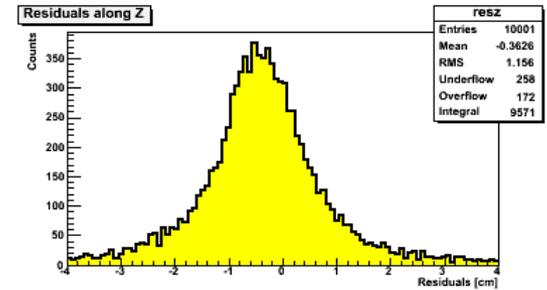
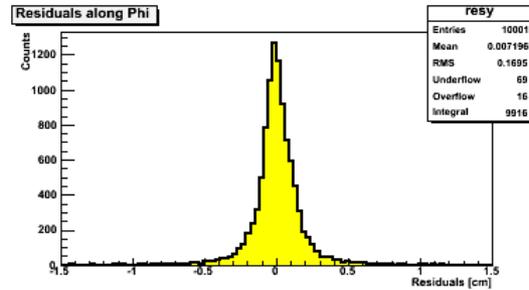
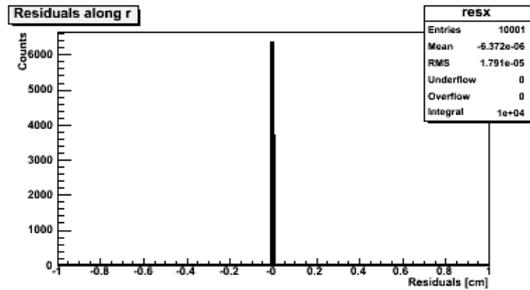
# second step: fine tuning of single modules

## Single Module of Vertex Detector After Second Step (all views)



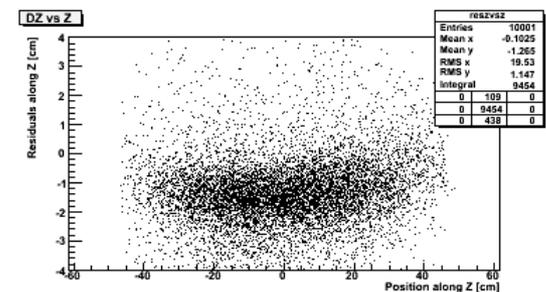
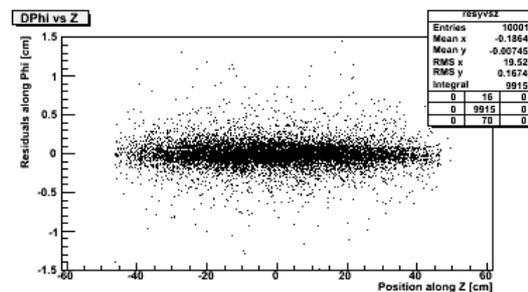
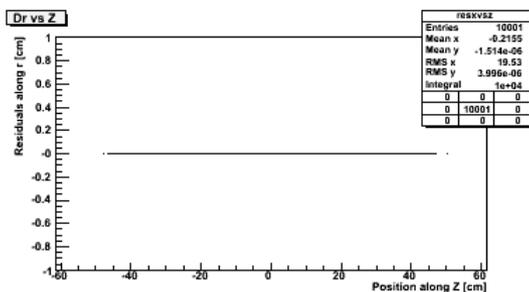
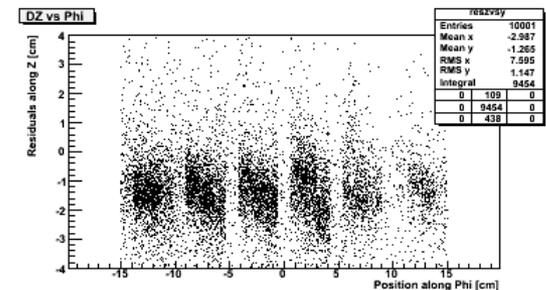
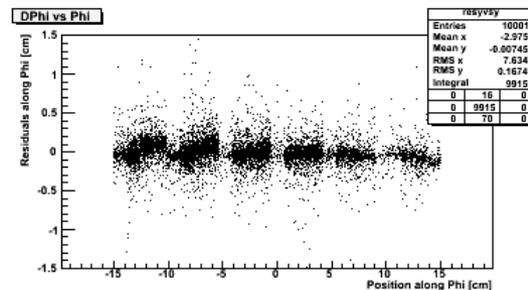
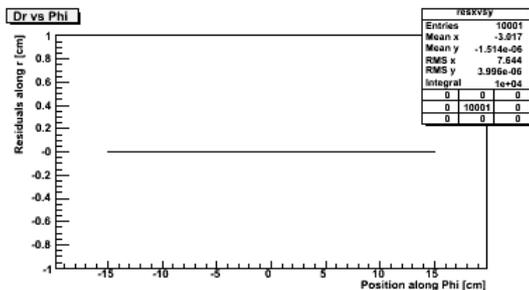
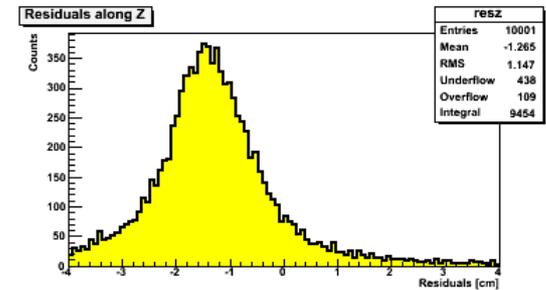
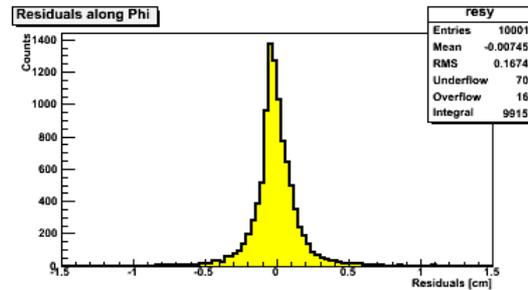
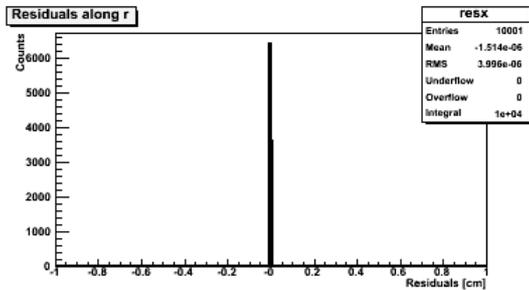
# second step: fine tuning of single modules

## Single Inner Drift Chamber Before Second Step (all views)



# second step: fine tuning of single modules

## Single Inner Drift Chamber After Second Step (all views)

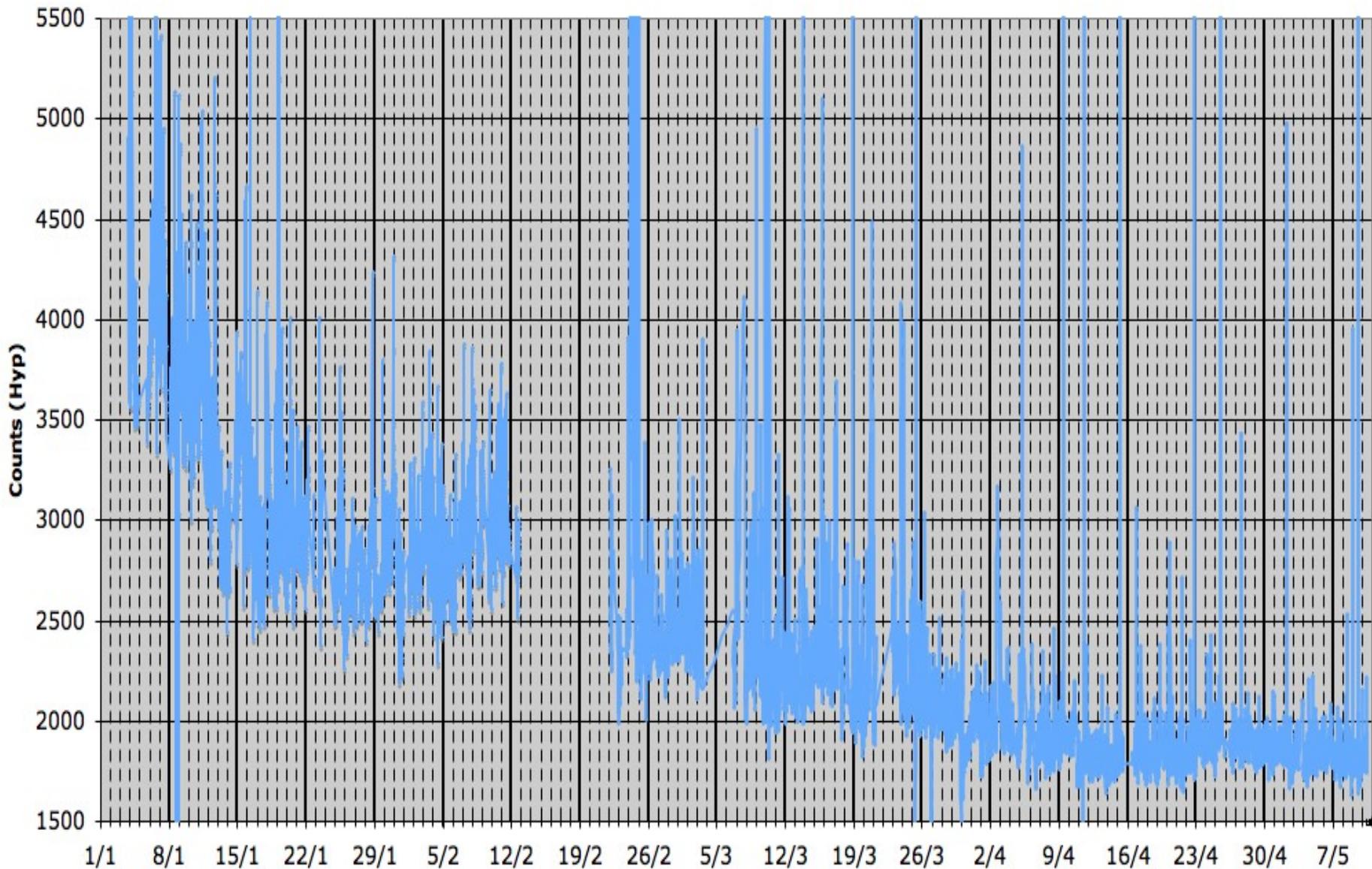


# CONCLUSIONS

- **Detectors and DAQ are performing well**
- **Good quality data has been collected so far by FINUDA (almost  $800\text{pb}^{-1}$  )**
- **Detector alignment and calibrations are in advanced progress and will improve the data quality**

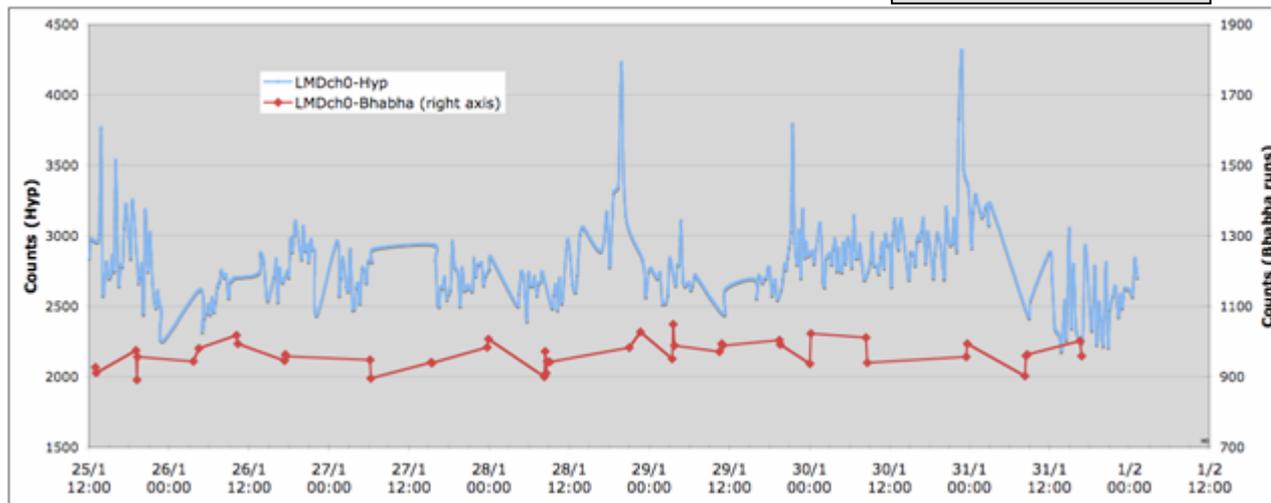
**FINUDA is looking forward to reach  $1\text{fb}^{-1}$  integrated luminosity!**

# Machine background seen by FINUDA



# Reduction of machine background

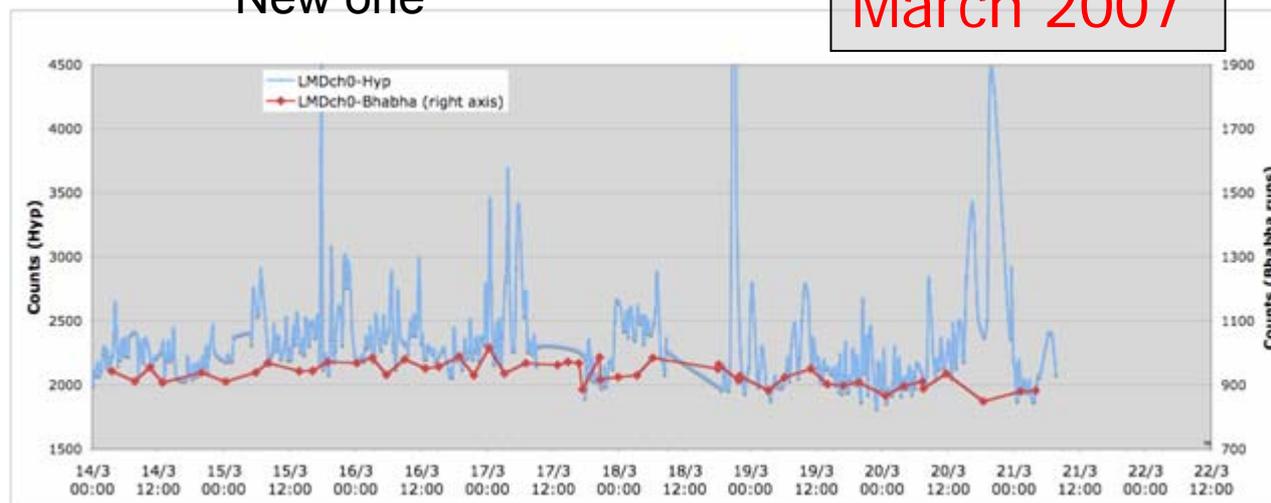
Jan 2007



FINUDA indicator  
Of the machine  
bck level for **HYP**  
and  
**BHABHA** triggers

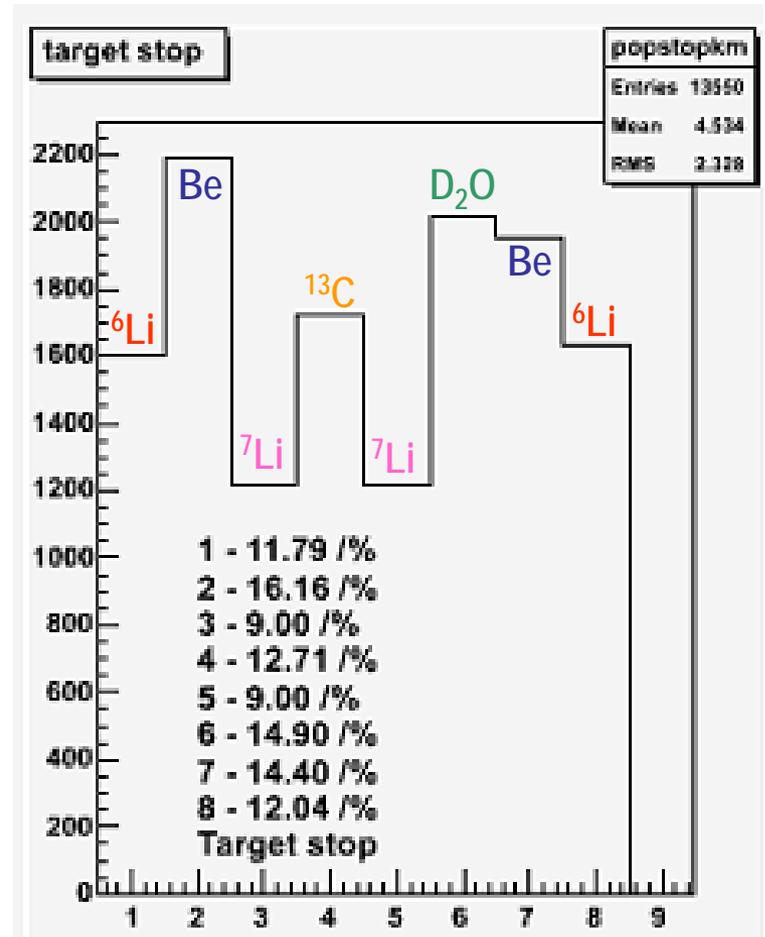
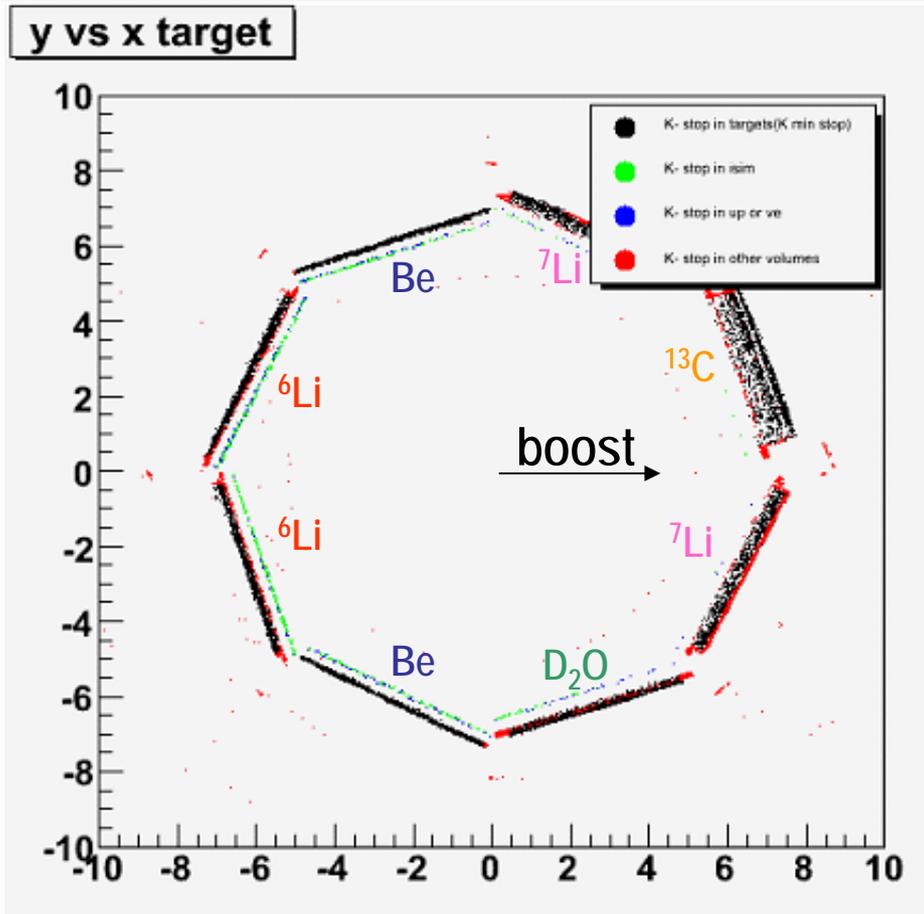
New one

March 2007

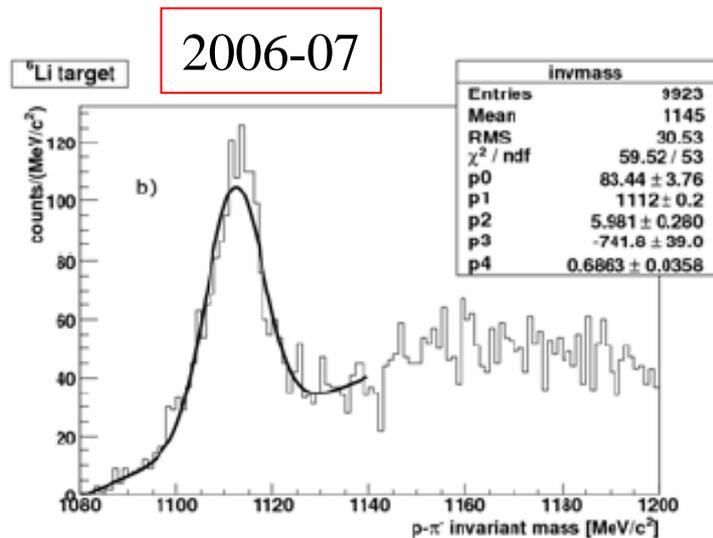
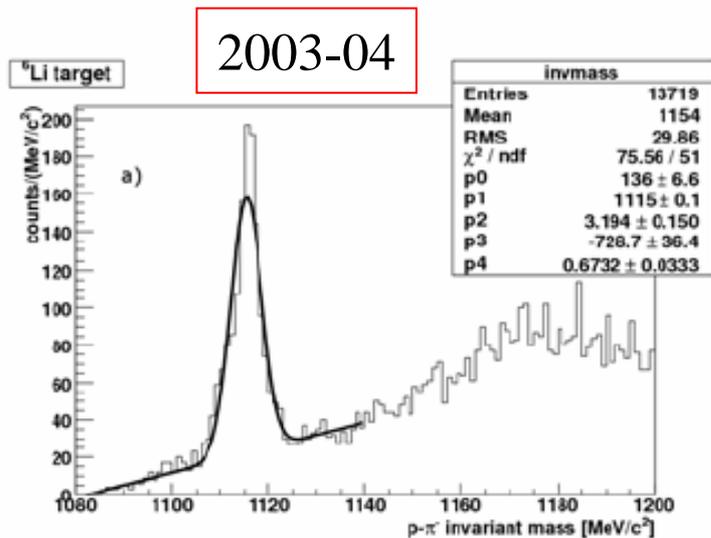


Better conditions  
reached in the last  
months

# K- stopping points



# $\Lambda$ invariant mass: ${}^6\text{Li}$



$(\pi^-, p)$  invariant mass  $\rightarrow$  lack of alignment plays important role

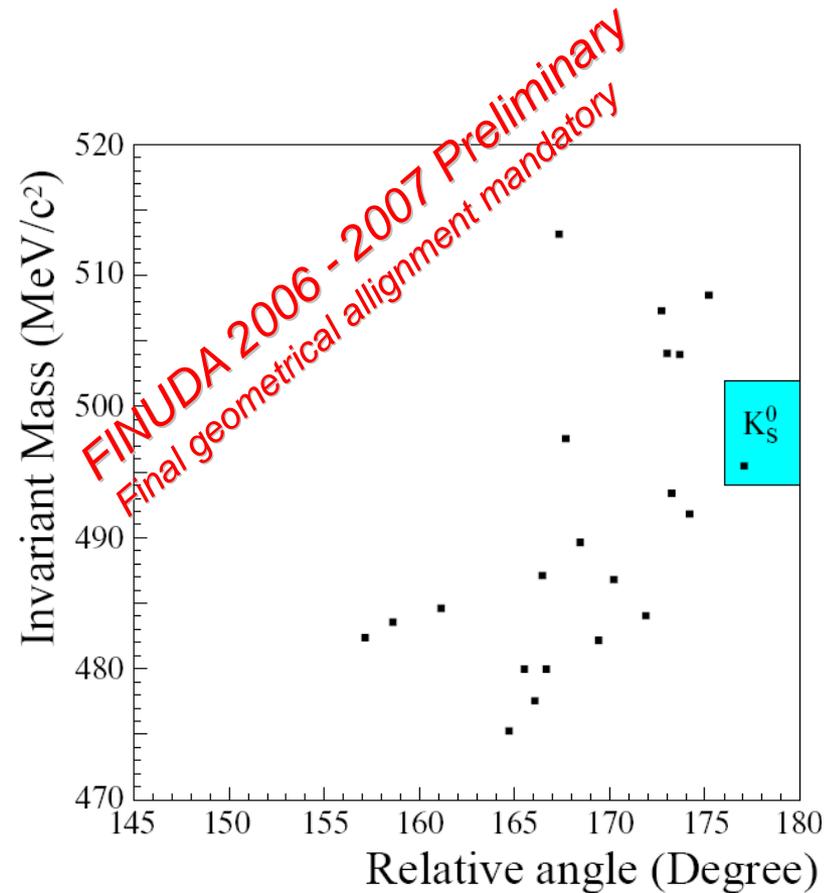
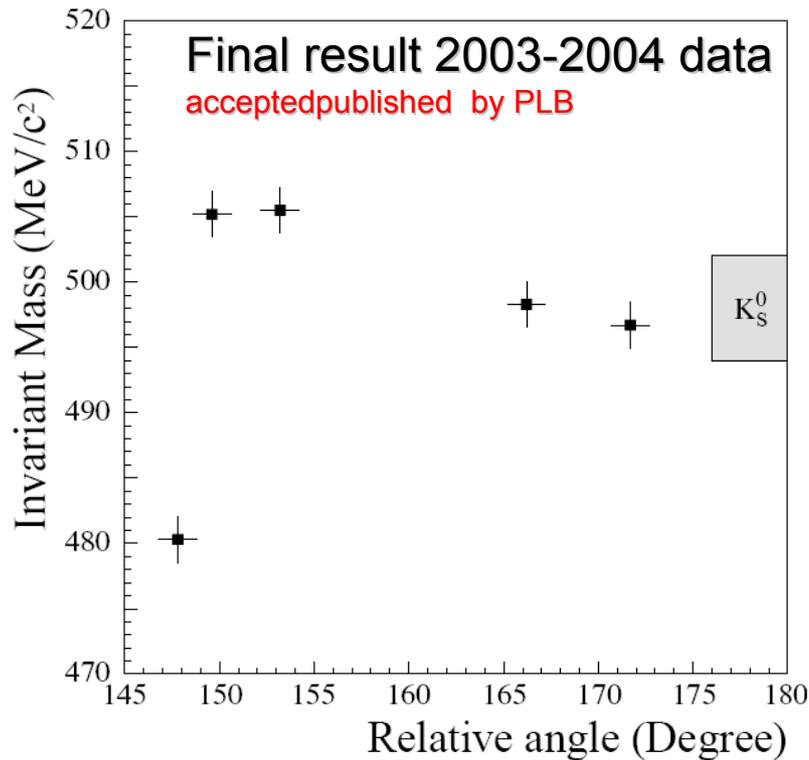
**EVEN WITHOUT FINE CALIBRATION AND ALIGNMENT  
 $\Lambda$  CLEARLY IDENTIFIED – COMPARABLE STAT. AT SAME  
LUMINOSITY**

# $K^+$ Charge Exchange Reaction



- Finuda has the capability to study the reaction ( $K^+, K^0$ ) on nuclei close to threshold (63.4 MeV/c on a free neutron), detecting the  $K^0_s \rightarrow \pi^+\pi^-$  decay:
- In the 2003-2004 data taking the only target accessible was the  ${}^7\text{Li}$  one. In the present data taking two  ${}^7\text{Li}$  targets are presents. Moreover one  ${}^{13}\text{C}$  and one  $\text{D}_2\text{O}$  target are available.
- The analysis of the 2003-2004 data allowed to set an upper limit for the reaction below 100 MeV/c of 1.89 mb at 95 % C.L., never measured before (*published by PLB2007*)

# $K^+$ Charge Exchange Reaction: ${}^7\text{Li}$



**Cross section for  ${}^7\text{Li}(K^+,K^0)X$ :**  
**<1.89 mb @ 95% C.L.**

**Present statistic:**  
**≈ 4 times higher than 2003-2004**

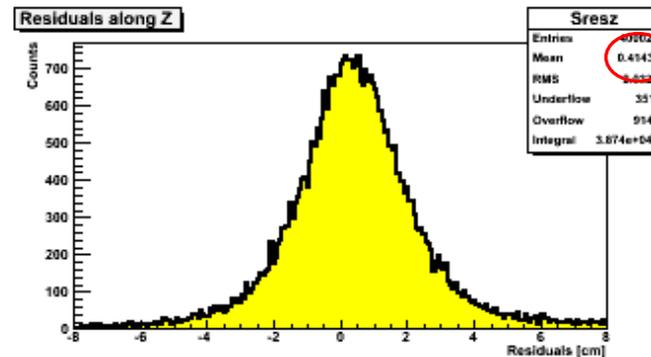
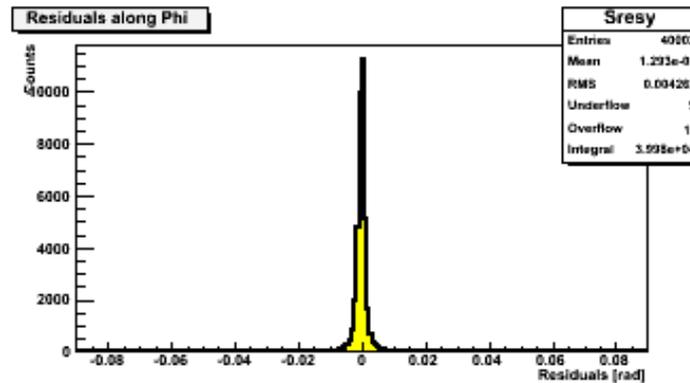
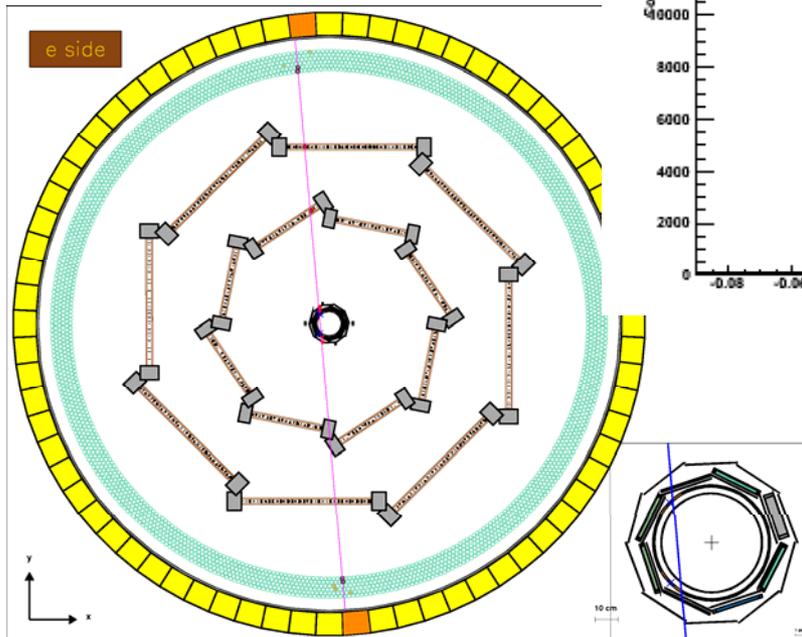
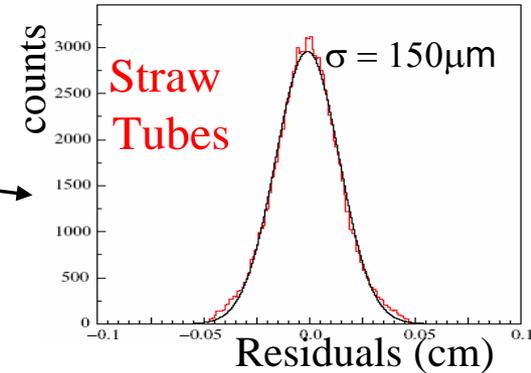
# Detectors alignment with cosmics, B=0

## first step: global translational/rotational effects

DCH residuals with respect to the straw tubes system



Global translational & rotational offsets



# Data Summary

(20.11.06 - 06.05.07)

$$\int L = 759 \text{ pb}^{-1}$$

(1.12.03-25.03.04)

$$\int L = 220 \text{ pb}^{-1}$$

Total collected events in collision (**x10<sup>6</sup>**)

182.2

(37.2)

of which, according to the Trigger selection:

HYP 1: 140.6

(29.7)

BHABHA 1: 18.9

HYP 1 OR BHABHA 1: 2.5

(7.5)

HYP 1 OR BHABHA 4: 7.6

HYP 1 OR BHABHA 6: 9.7

**TOT HYP :  $\approx$  159.0**

(29.7)

Total collected events with cosmic rays (**x10<sup>6</sup>**)

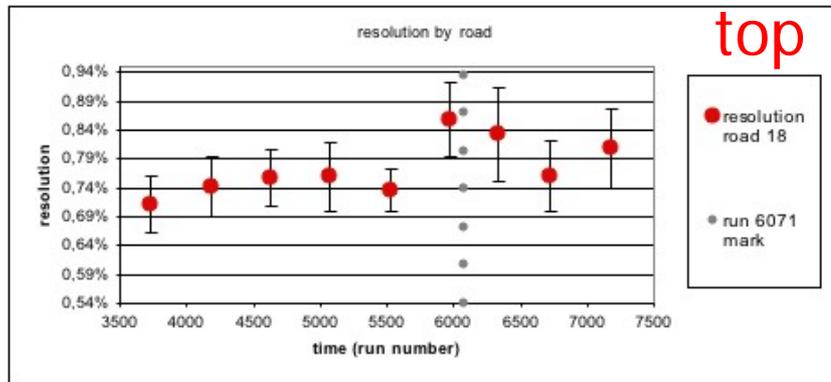
B = 0 T: 7.9

(5.5)

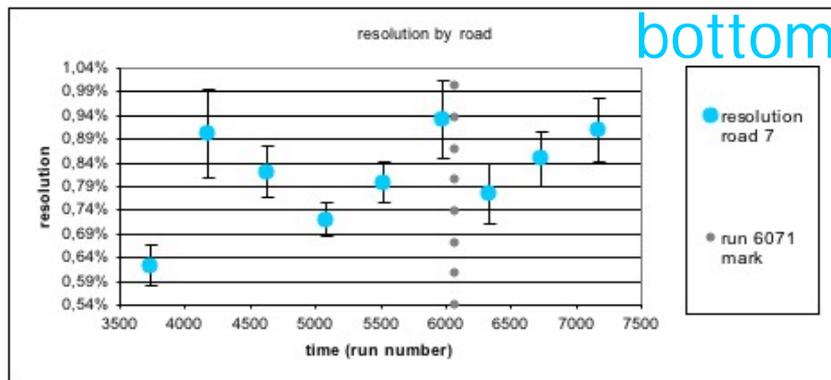
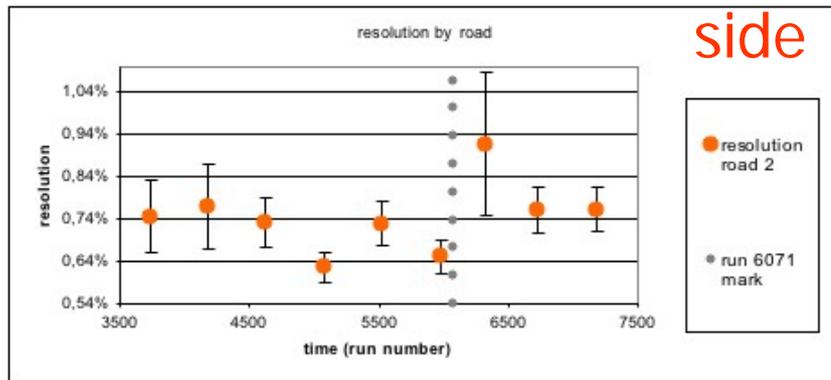
B = 1 T: 3.4

(1.8)

# Study of momentum resolution for $\mu^+$ tracks



- Trend of  $\mu^+$  resolution vs time
- He bag worsening in bottom part starting at run 6071, on Jan.18, 07



- No significant worsening of resolution due to He bag air-contamination