

**Fine tuning of the hit finder algorithm in TPC of the NICA  
MPD experiment aimed to improve the particle momentum  
resolution**

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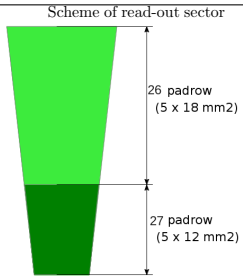
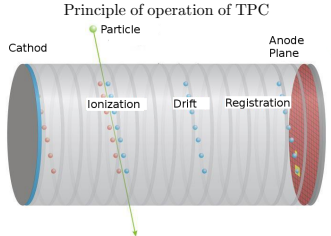
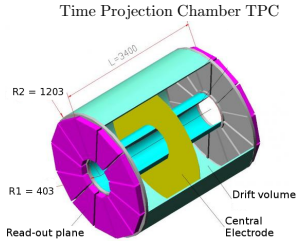
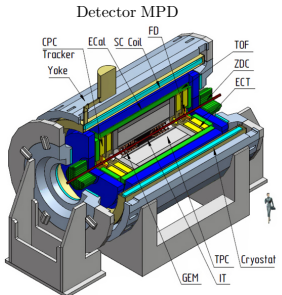
**June 2-8, 2014**

# Plan of report

The Research Work consists of the following basic stages:

- ① Analysis of residuals depending on  $(\phi, \theta)$ -angles
- ② Analysis of Edge Effects
- ③ Normalization of errors obtained from the algorithm
- ④ Preliminary results on the Particle Momentum Resolution

# MPD and TPC



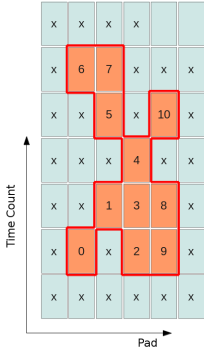
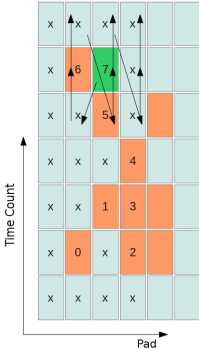
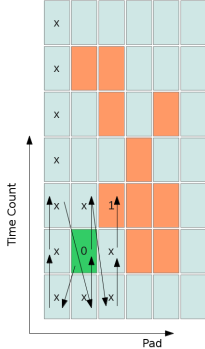
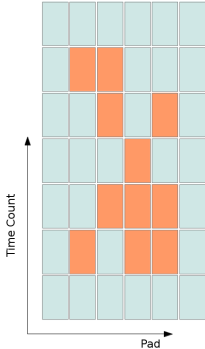
# Reconstruction algorithm of responses of TPC ...

... consists of three stages:

- ① Search of extended clusters in the space «Pad-Time» for each padrow
- ② Search of peaks in the time profile in the extended cluster
- ③ Merging of the neighbouring peaks into hits to make a subsequent calculation of their coordinates

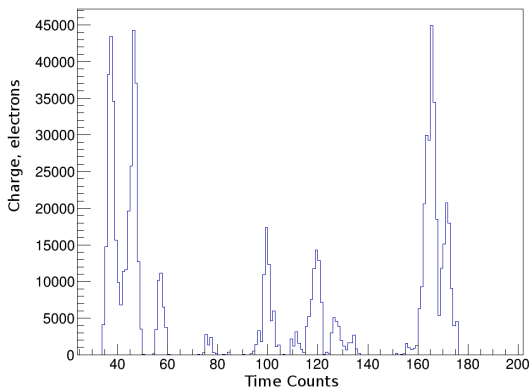
# Search of extended clusters

## Flood fill algorithm schematic view



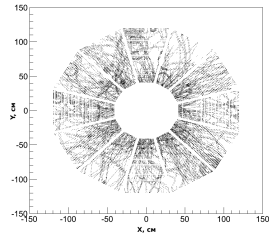
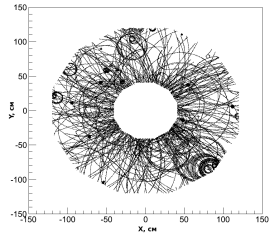
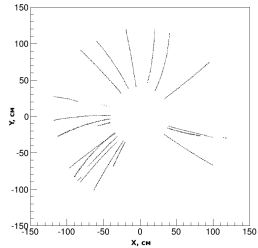
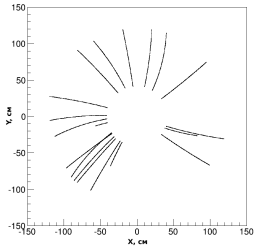
# Search of peaks in the found extended clusters

## Pad Time Profile



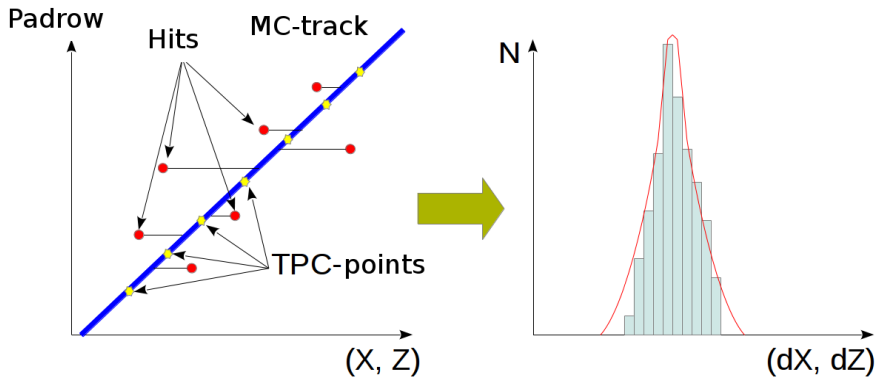
- 1 A signal value should be higher than the threshold value
- 2 Peaks are formed by making use of the «up-down» method
- 3 The peak should have at least two time counts

# Hit Finder Algorithm, QA (View in XY-plane)



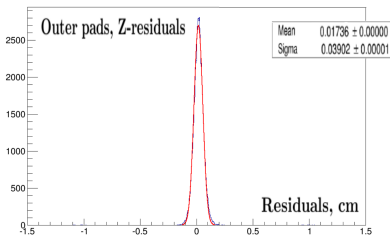
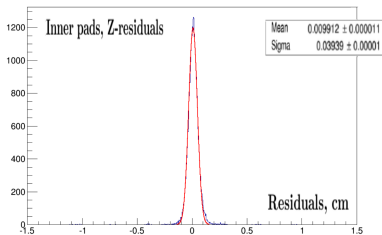
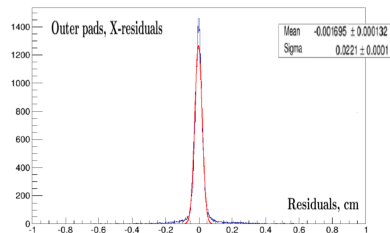
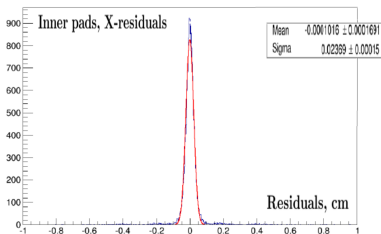
# Hit Finder Algorithm, QA

Residual: What is it?

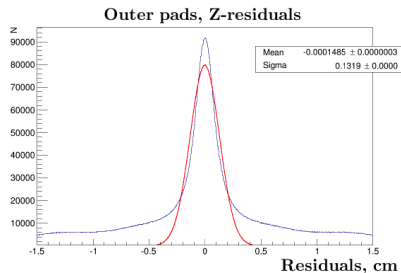
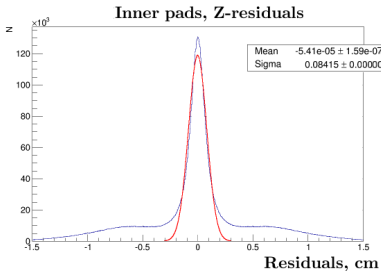
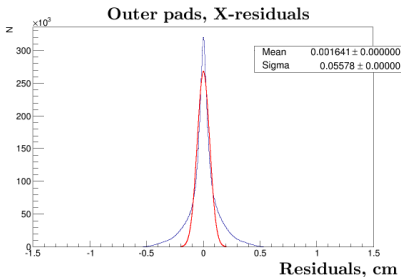
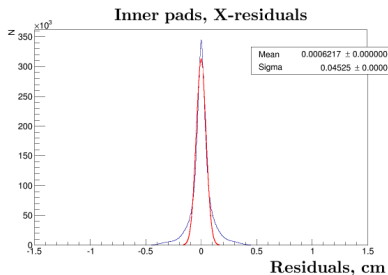




# Residuals, $\theta = 90^\circ$ , $\phi = 90^\circ$

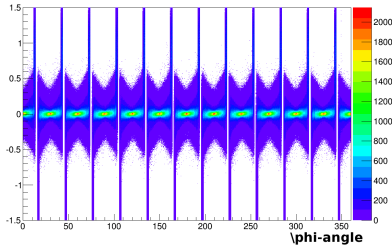


# Residuals, $\theta = 30^\circ..150^\circ$ , $\phi = 0^\circ..360^\circ$

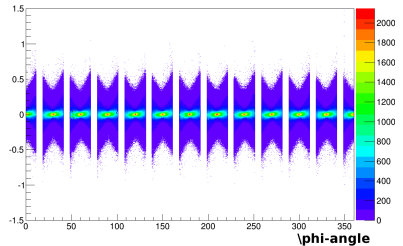


# Edge Effects

X-residuals distribution as a function of the  $\backslash\phi$ -angle



X-residuals distribution as a function of the  $\backslash\phi$ -angle



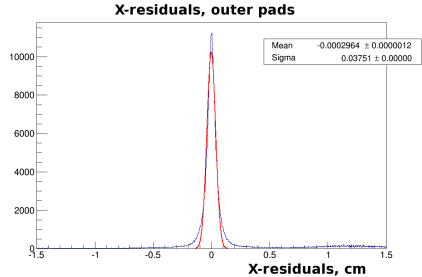
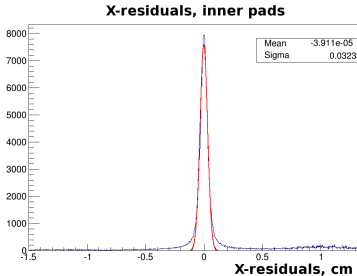
Edge Effects **ARE NOT**  
**TAKEN** into account

Edge Effects **ARE**  
**TAKEN** into account

Applied cuts:

3° from each side  
of a sector were  
removed

# Edge Effects (continuation)



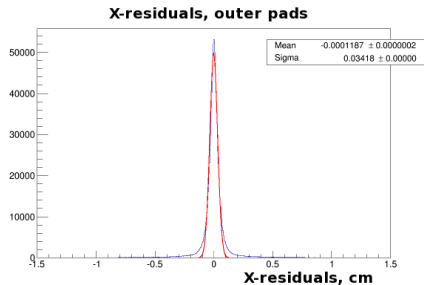
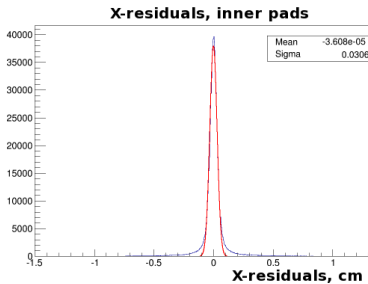
**Influence of Edge Effects:**

**Edge Effects are NOT taken into account**

# Edge Effects (continuation)

Influence of Edge Effects:

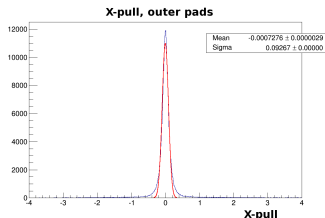
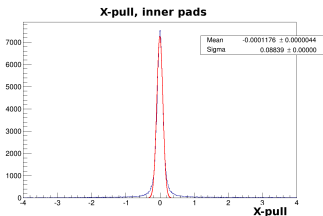
Edge Effects are taken into account



# Normalization of errors

$X_{pull}$  applied to estimate a balance between  $X_{resid}$  and  $X_{err}$

$$X_{pull} = \frac{X_{resid}}{X_{err}} \qquad Z_{pull} = \frac{Z_{resid}}{Z_{err}}$$



It is required to have:

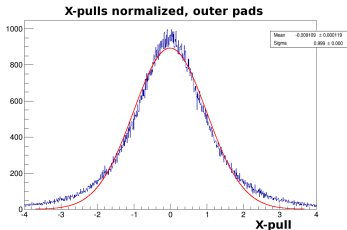
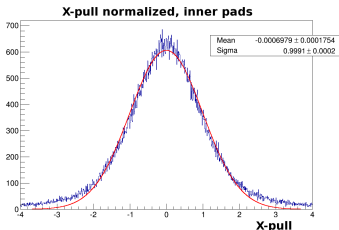
- 1  $\mu_{fit}$  (should be near 0) - **OK!**
- 2  $\sigma_{fit}$  (should be near 1) - **NOT OK!**

Maybe there are some problems with errors derived from the algorithm...

# Normalization of errors (continuation)

Normality Condition used:

$$\sigma_{fit \text{ corrected}} = \sigma_{fit} \left( \frac{X_{pull}}{C_x} \right) \sim 1$$



- 1  $\mu_{fit}$  (should be near 0) - **OK!**
- 2  $\sigma_{fit}$  (should be near 1) - **OK!**

# Particle Momentum Resolution (PMR)

Approach used to estimate the particle momentum resolution:

① Some samples of events at different  $P_t$  with previously defined parameters were simulated: ( $N = 50k$ Events,  $\phi = 0^\circ..360^\circ$ ,  $|\eta| \leq 1.1$ )

② For each  $P_t$  momentum resolution is estimated by the formula:

$$\frac{\Delta p_t}{p_t}, \% = \frac{p_t^{rec} - p_t^{sim}}{p_t^{sim}} \cdot 100\% \quad (1)$$

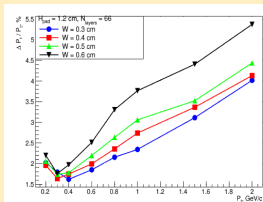
③ A distribution given by the formula (1), is fitted to the Gauss function

④ Finally,  $\sigma_{fit}$  considered as an estimated value  $\frac{\Delta p_t}{p_t}$ , is derived from the fit and put on separate plot

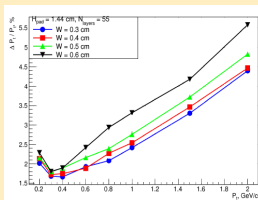


# Particle Momentum Resolution (continuation)

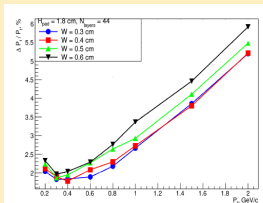
$H_{pad} = 1.2 \text{ cm}, N_{layers} = 66$



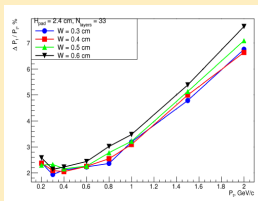
$H_{pad} = 1.44 \text{ cm}, N_{layers} = 55$



$H_{pad} = 1.8 \text{ cm}, N_{layers} = 44$

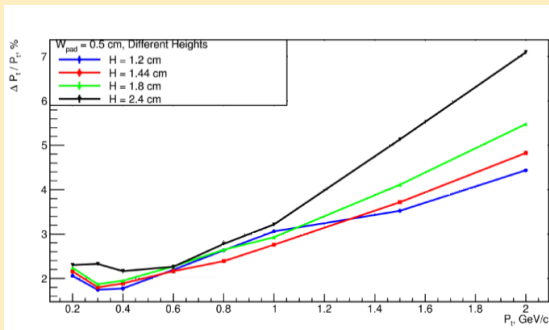


$H_{pad} = 2.4 \text{ cm}, N_{layers} = 33$



# Particle Momentum Resolution (continuation)

PMR by making use of the MpdTpcClusterFinderTask:

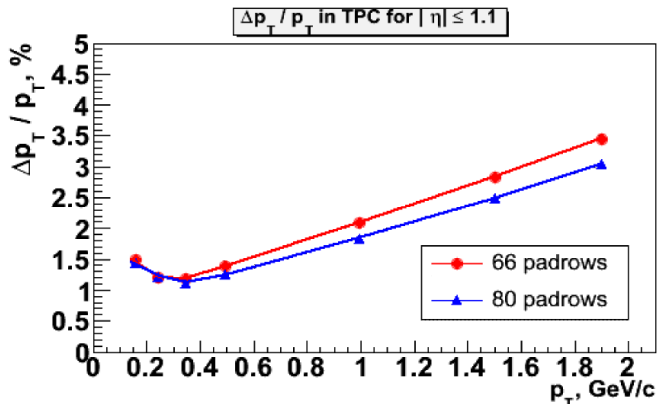


**Green Line** corresponds to:

$$H_{pad} = 1.8 \text{ cm} \quad W_{pad} = 0.5 \text{ cm} \quad N_{layers} = 44$$

# Particle Momentum Resolution (continuation)

PMR by making use of the MpdTpcHitProducer:



# General Conclusions

- 1 Hit Finder Algorithm applied to TPC was developed.
- 2 Analysis of residuals applied to the TPC of the MPD experiment showed a good agreement of the results obtained with other experiments (ALICE, STAR).
- 3 Presence of edge effects should be taken into account due to their big influence on the calculated residuals and, finally, on tracking procedure.
- 4 Correction of errors giving by the algorithm to the found spatial coordinates of hits is required to use them subsequently in the tracking.
- 5 Preliminary results on the Particle Momentum Resolution by making use of the algorithm were obtained and they are in a good agreement with the results obtained earlier. It gives a strong hope to be sure that the algorithm works fine.

**Thank you for your Attention!**

**To learn more about the experiment and the software used,  
you are welcomed to:**

**<http://mpd.jinr.ru>**