

XXXVIII International Symposium on Multiparticle Dynamics

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# Extreme multiplicity studies in the SVD-2 experiment

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On behalf of SVD-2 Collaboration (JINR, SINP MSU, JHEP)

# Of blessed memory

## P.F. Ermolov



1932 - 2008





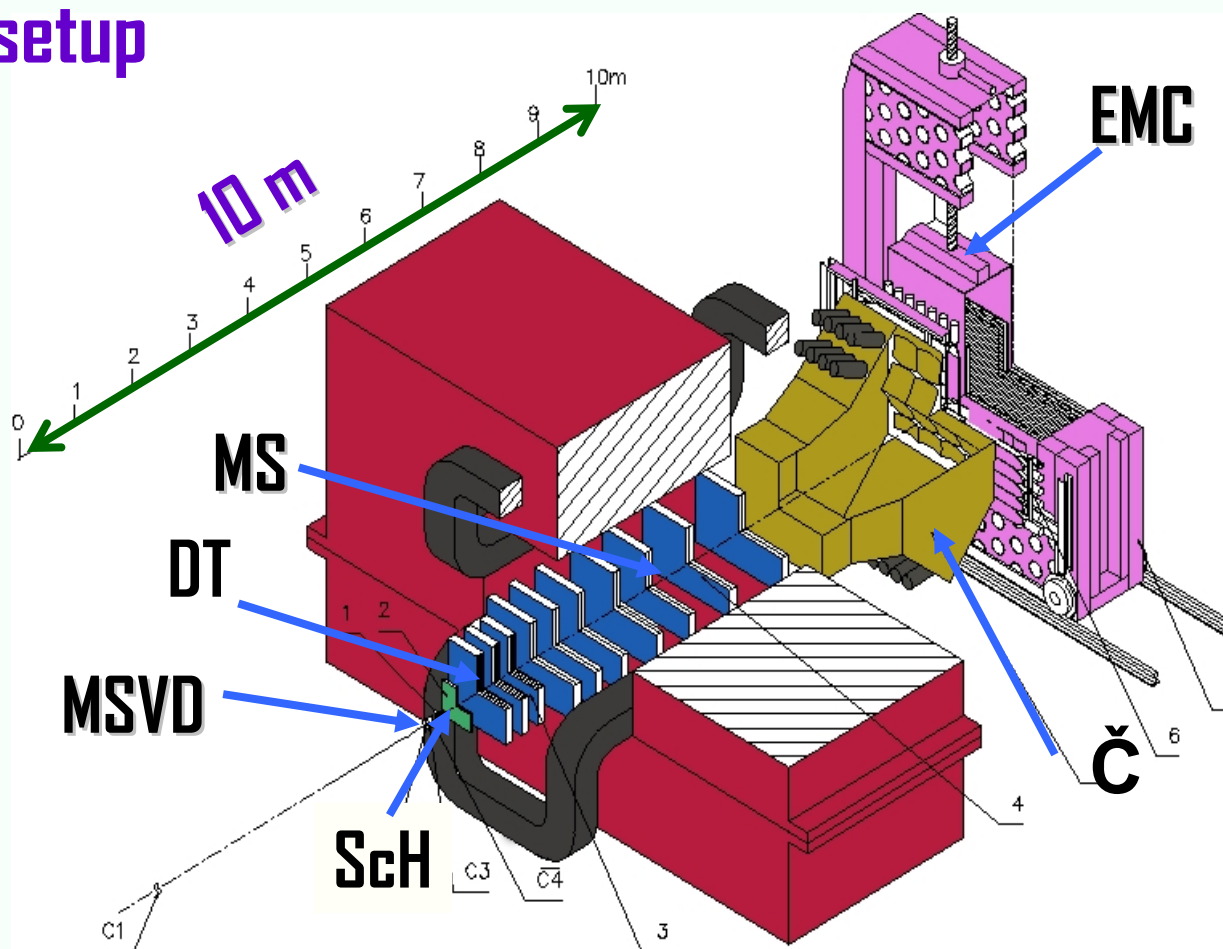
## Scientific programme:

multiparticle dynamics study in  $p+p(A)$  interactions with the extreme multiplicity (more than mean multiplicity) with 50-70 GeV proton beam on U-70 of IHEP (Protvino).





## SVD-2 setup





8. Micro Strip VD,  
10000 channels.

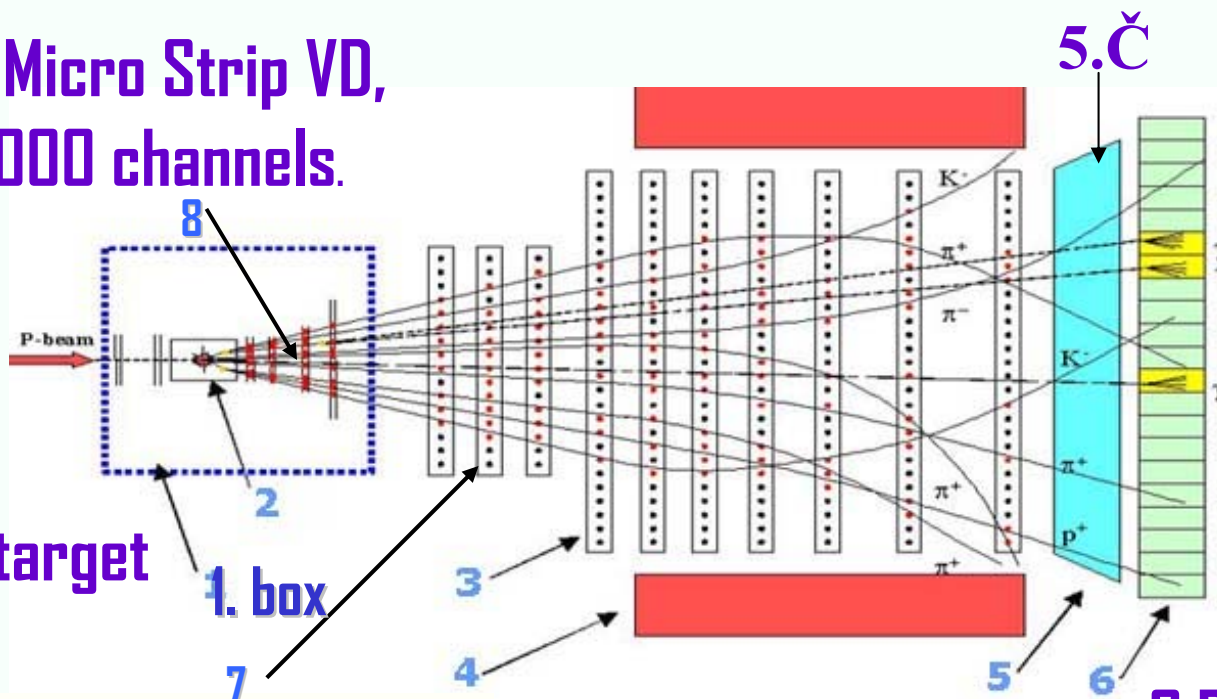
2.  $H_2$ -target

1. box

7. Drift Tubes tracker,  
2400 channels

3.4. Magnetic  
Spectrometer

6. DeGa, 1536  
channels



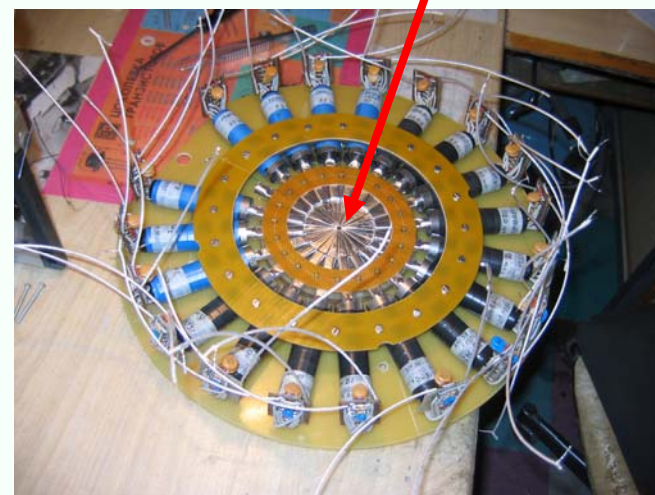
SVD-2 setup



Scintillation hodoscope  
("camomile") for the registration  
of rare events with HM:



20 elements ("petals"):  
triangle  $h=18$ , 1.8 mm thick.



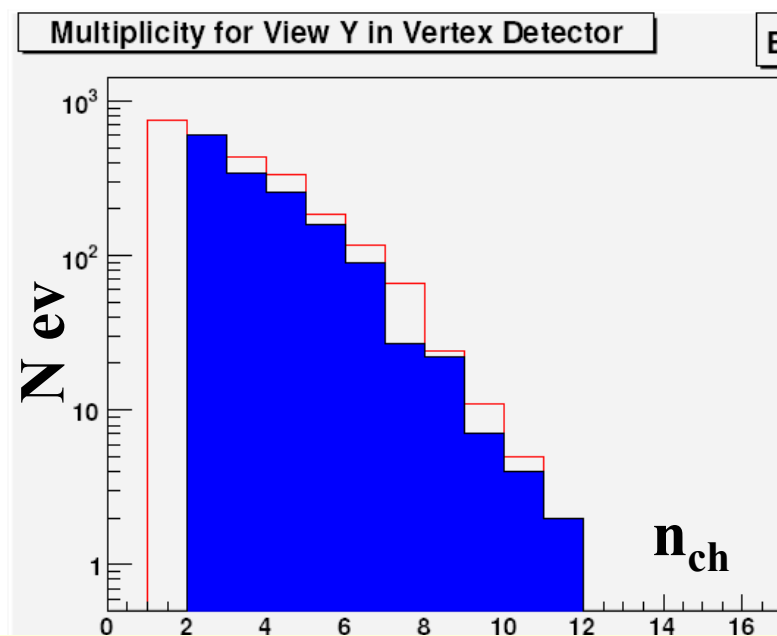
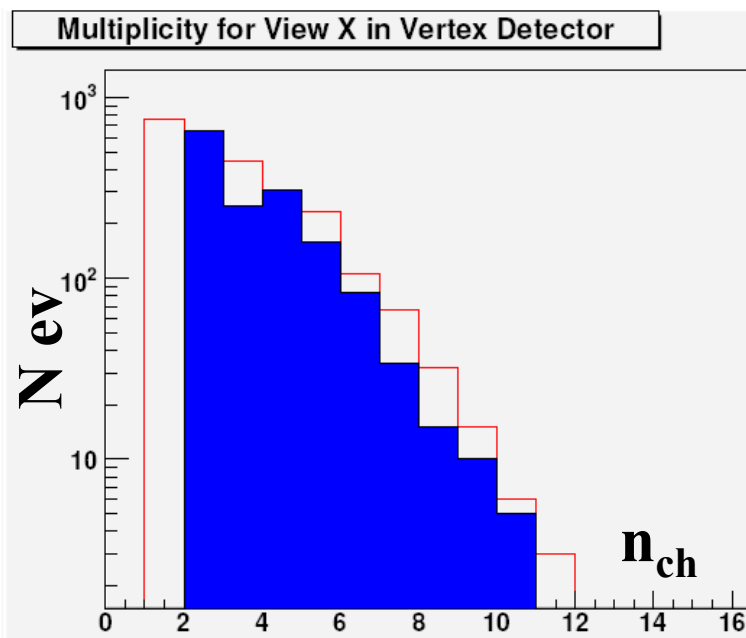
Liquid hydrogen target





## SIMULATION:

- Making of Monte Carlo event generator for modeling of setup elements;
- Software design of data taking and data processing for HM events;
- Use of JEANT-3 generator for analysis of program packages of event reconstruction;
- the 2006 – 2008 runs on U-70.

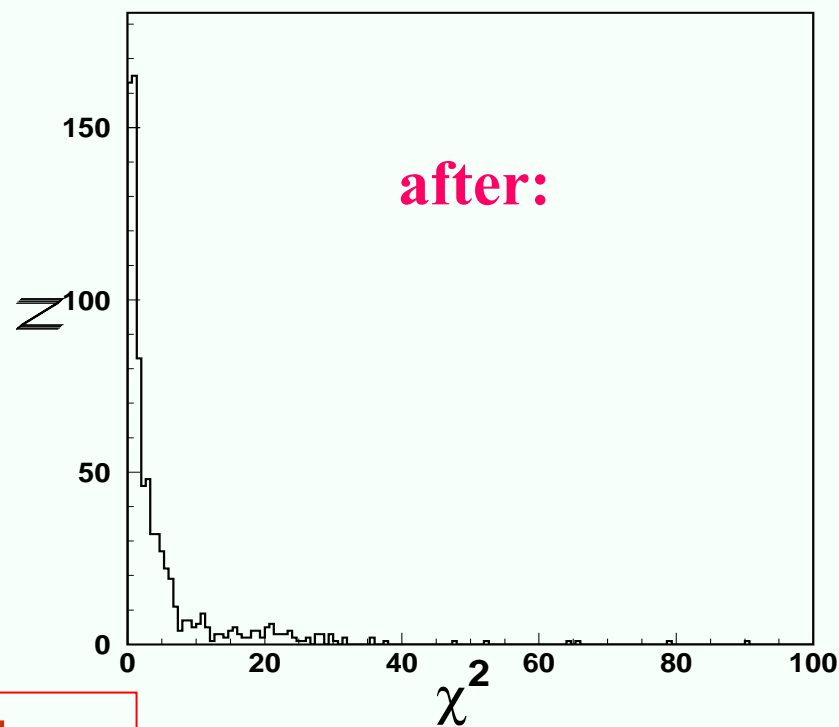
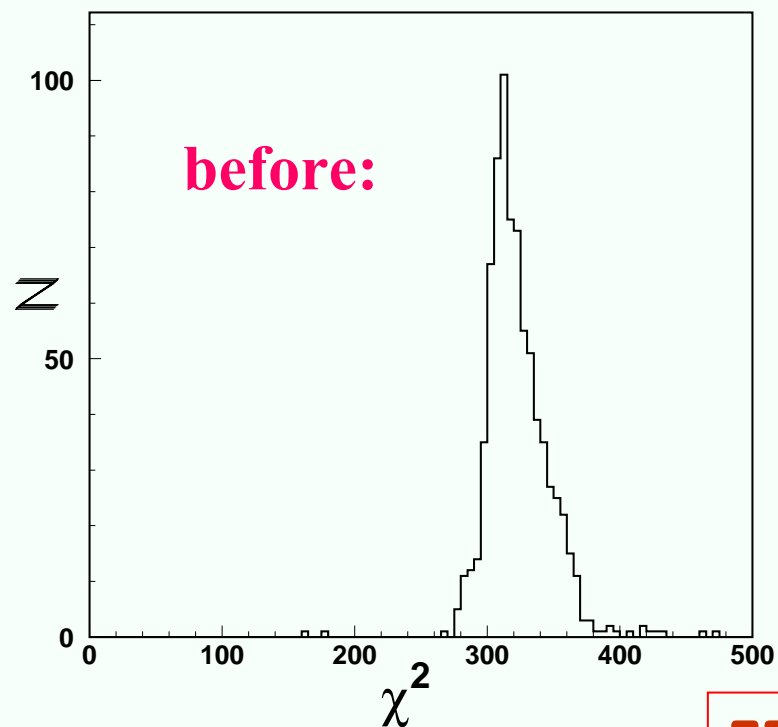


**MD of simulated (red) and reconstructed (blue) events for Vertex Detector on X and Y projections**





**Alignment task**: is an essential  
step in the track reconstruction:



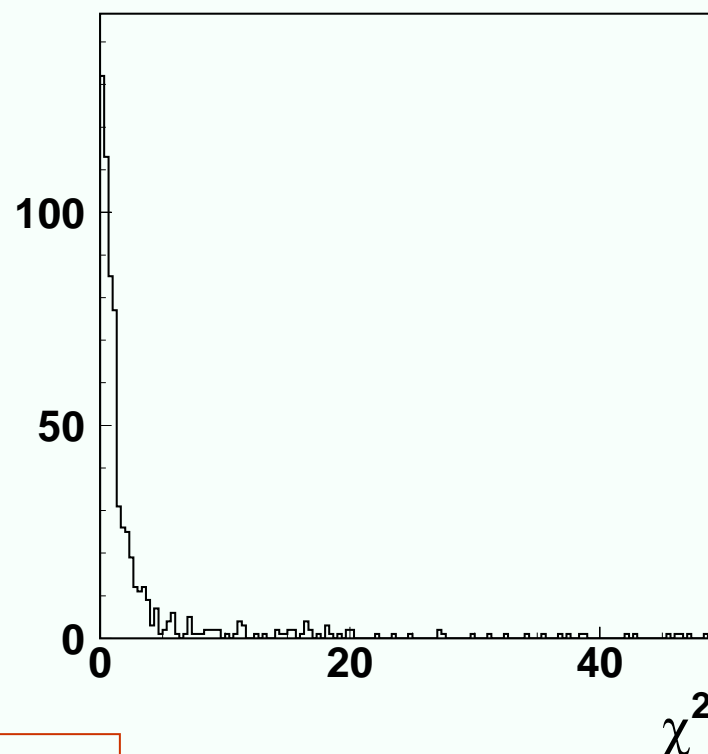
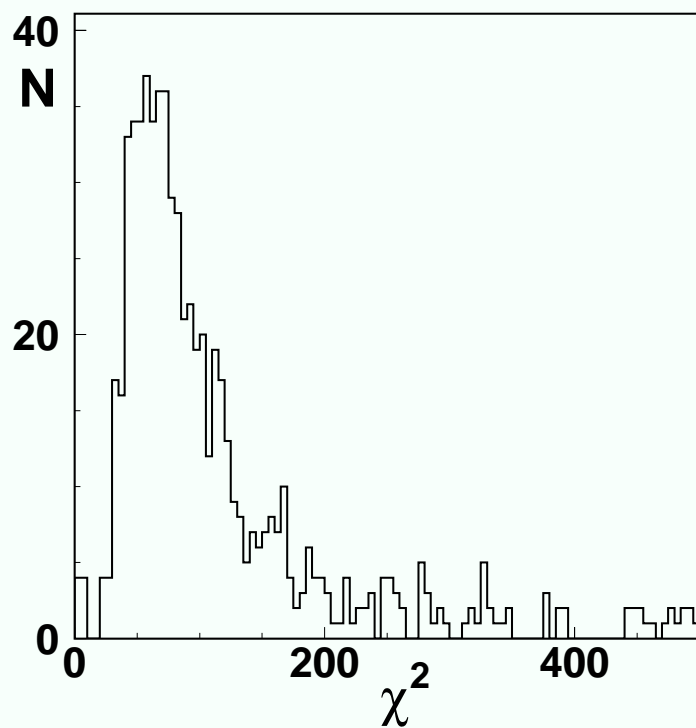
2006 data



before:

Alignment:

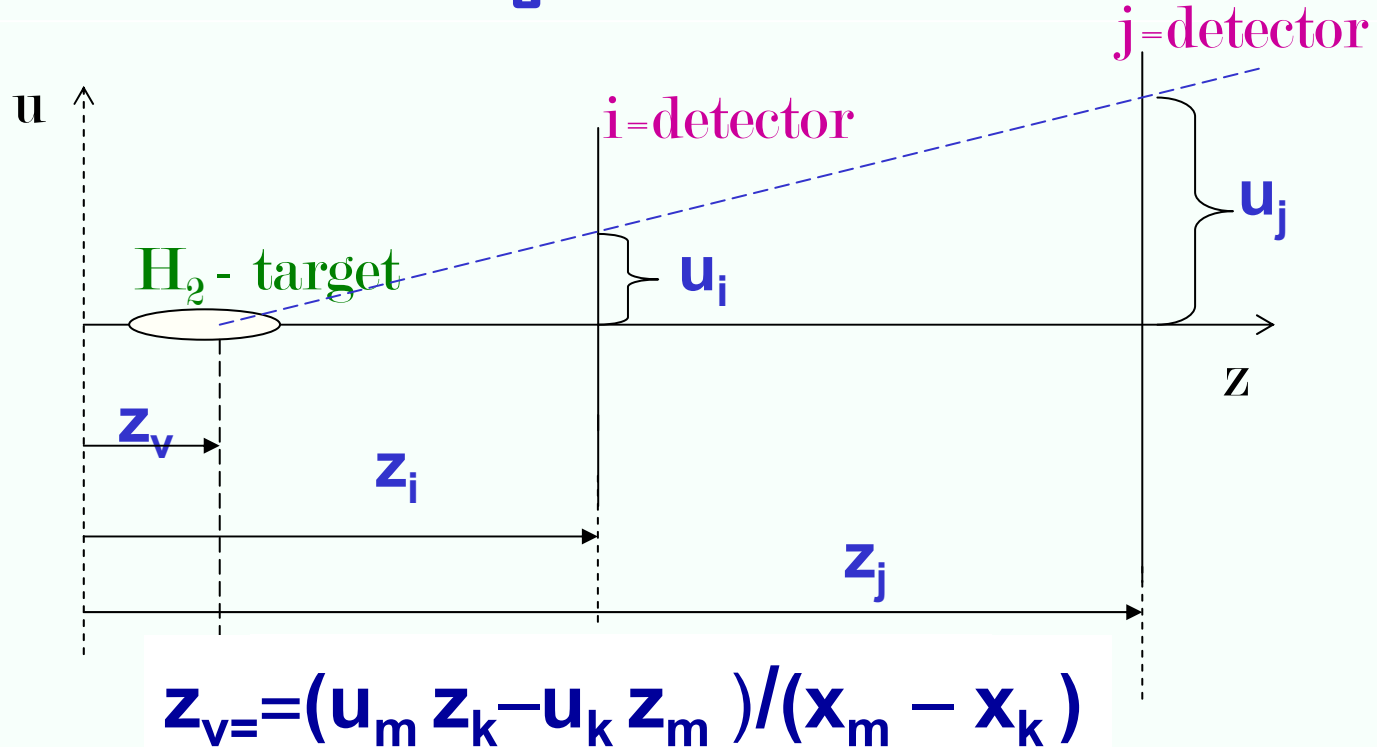
after:



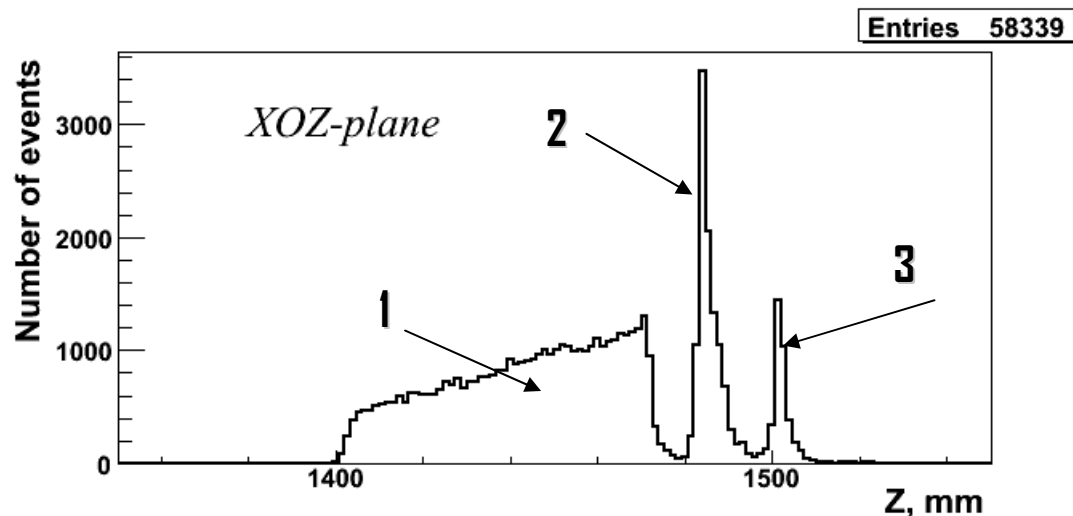
2007 data



Sequential histogramming method and also: Kalman filter and others reasonable algorithms for track reconstruction .

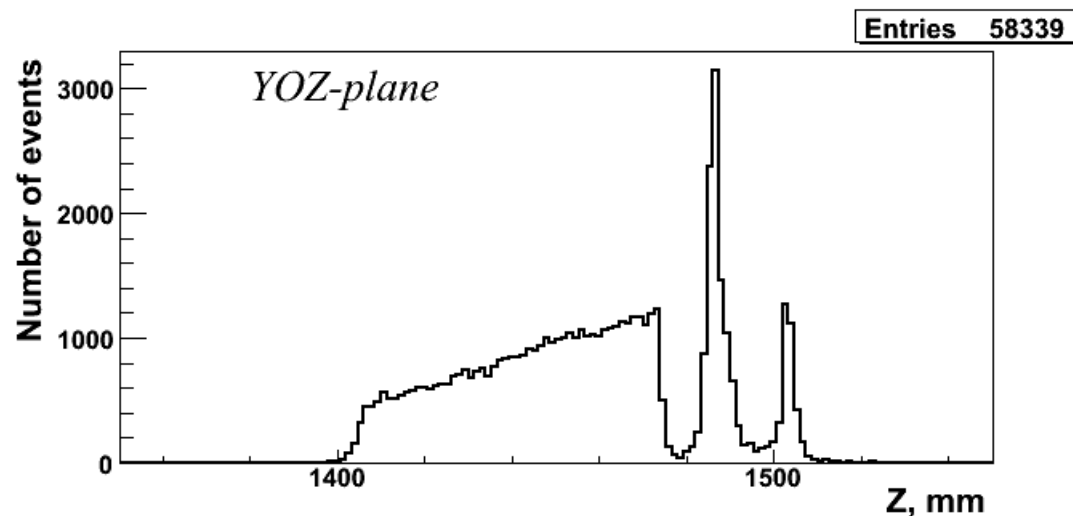


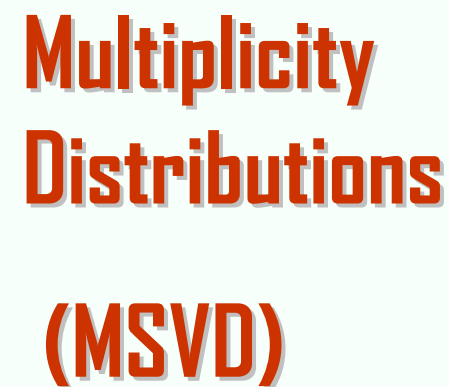


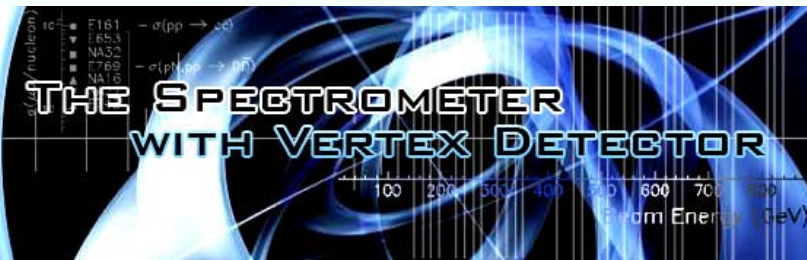


**MSVD:**

z - coordinate of  
interaction vertex:  
1) hydrogen target,  
2) shell and  
3) hodoscope.

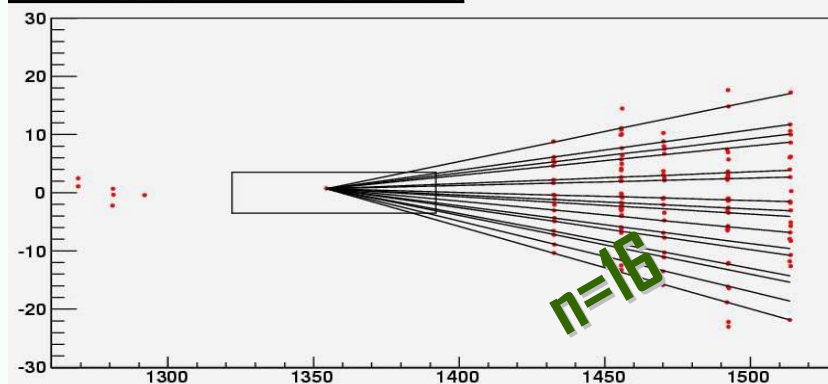




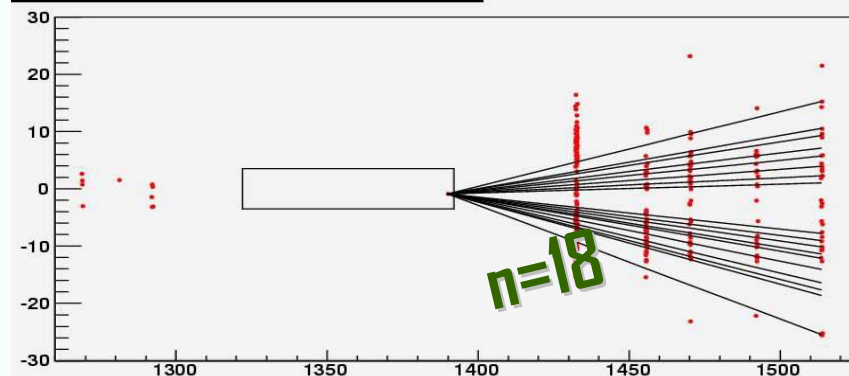


## Reconstructed HM - events (examples)

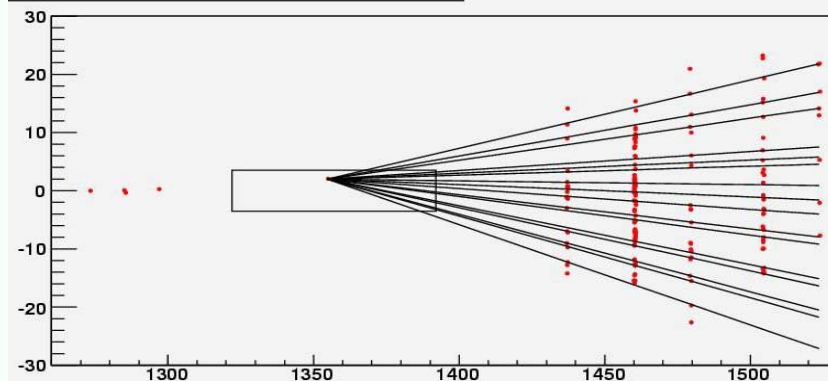
n=316 pp X vs Z Nevent=16961 Ntracks=16



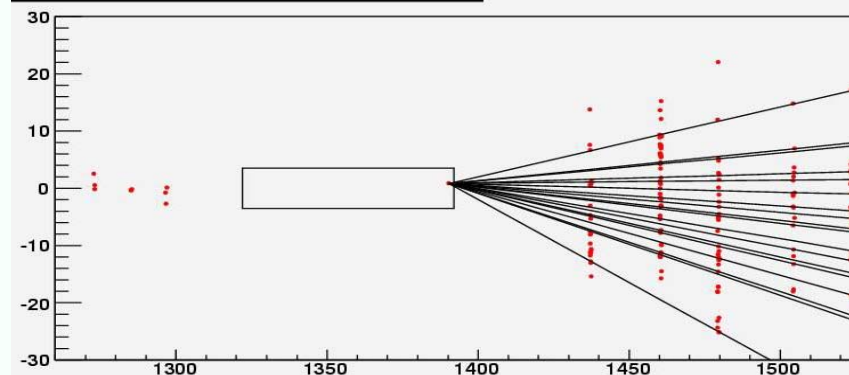
n=312 pp X vs Z Nevent=36756 Ntracks=18



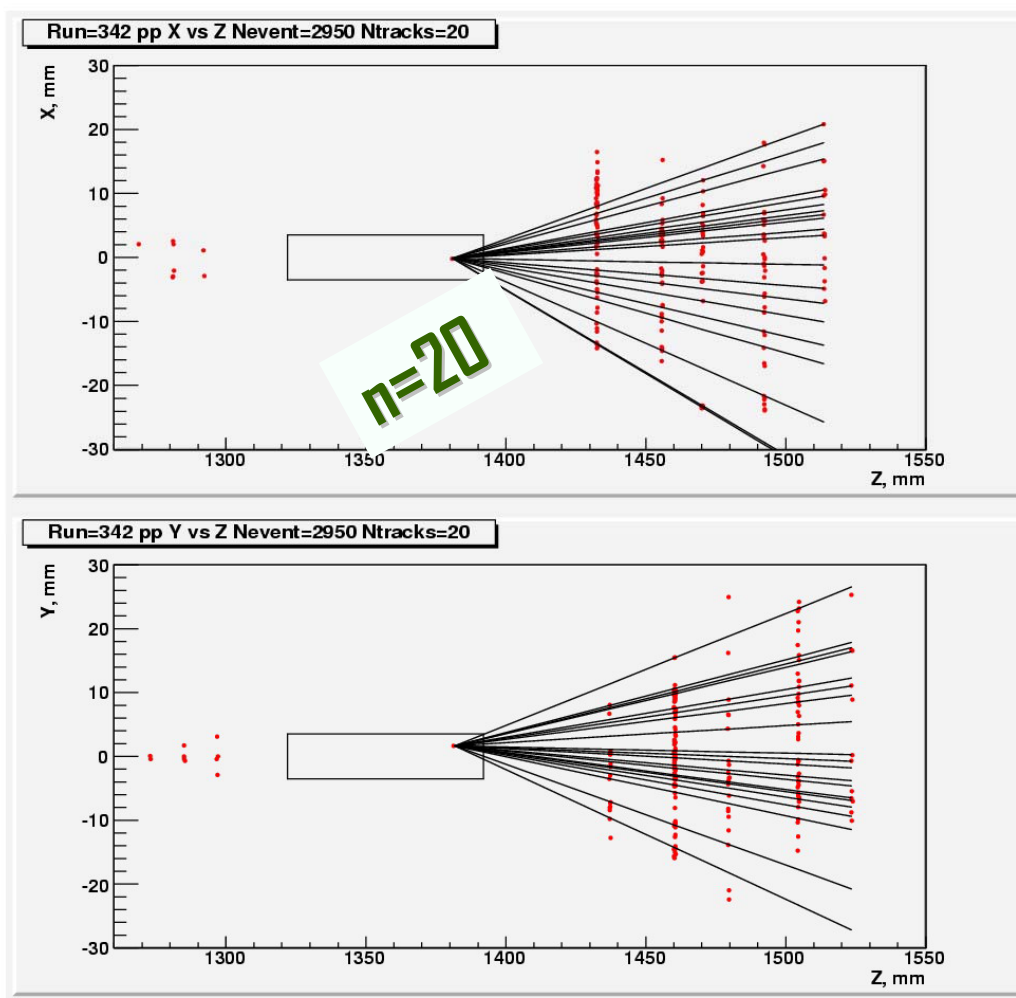
n=316 pp Y vs Z Nevent=16961 Ntracks=16



n=312 pp Y vs Z Nevent=36756 Ntracks=18

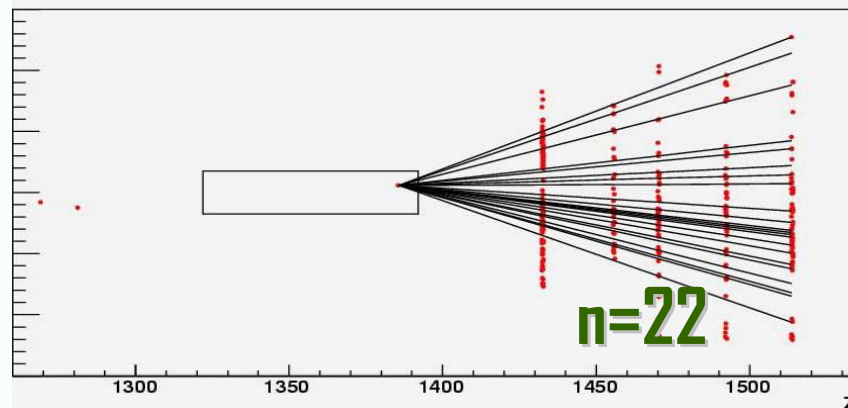




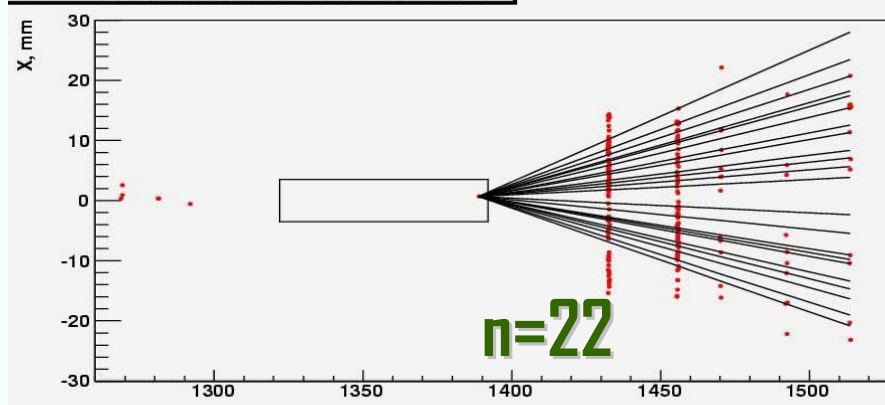




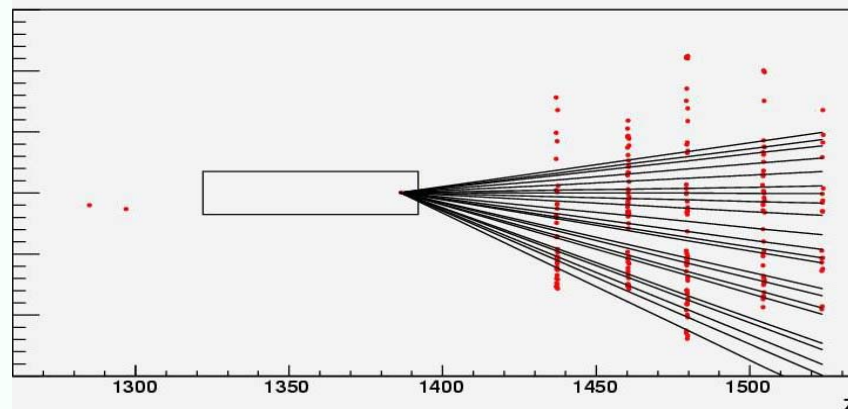
16 pp X vs Z Nevent=8252 Ntracks=22



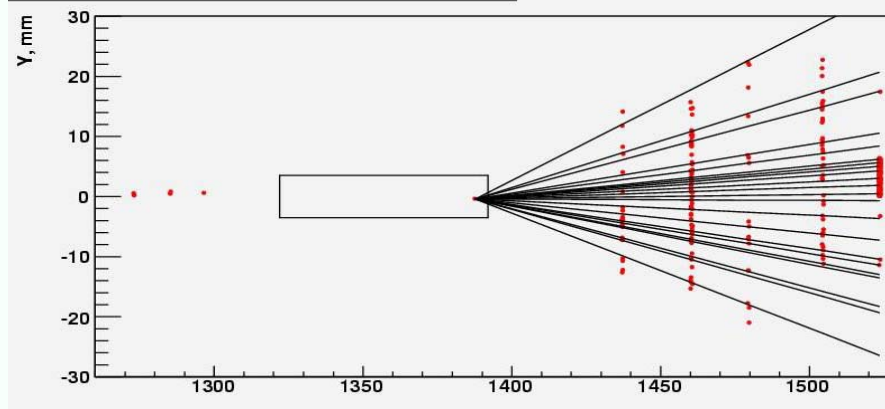
Run=322 pp X vs Z Nevent=15414 Ntracks=22



16 pp Y vs Z Nevent=8252 Ntracks=22

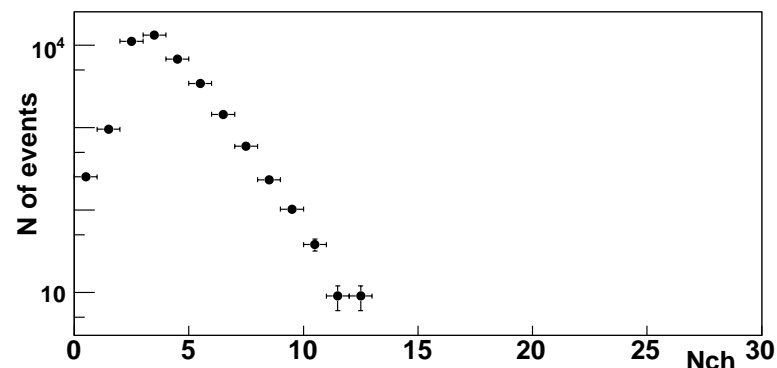
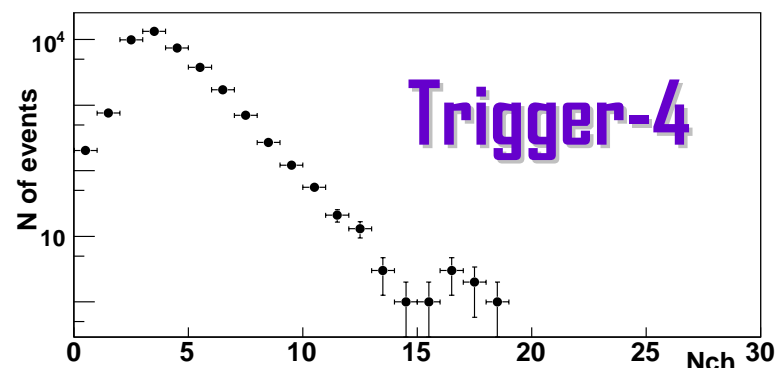
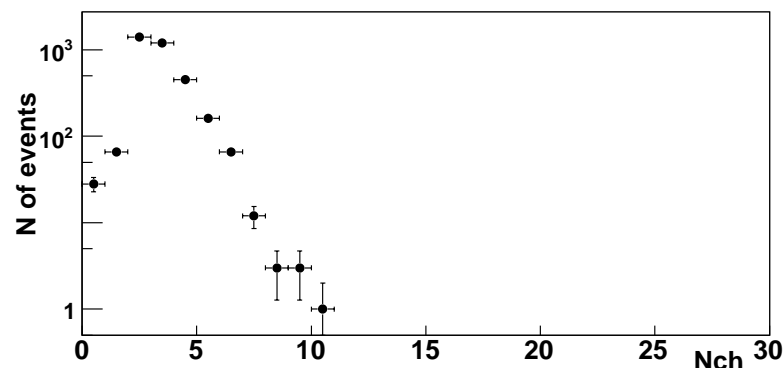
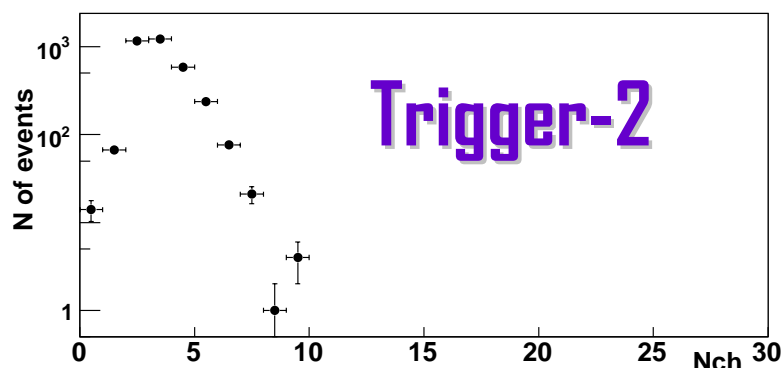


Run=322 pp Y vs Z Nevent=15414 Ntracks=22

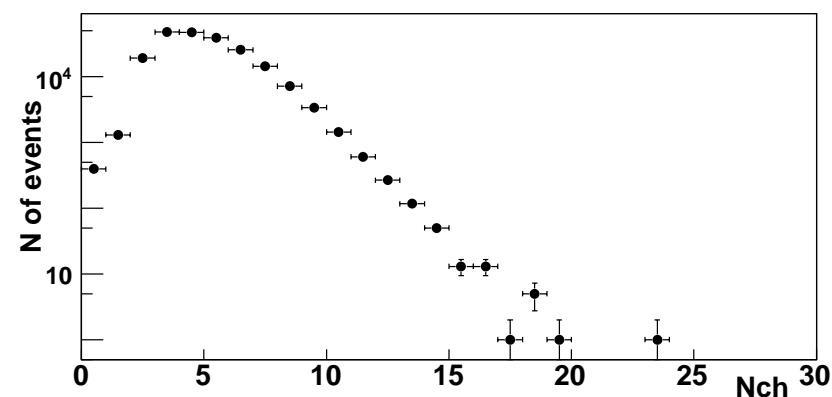
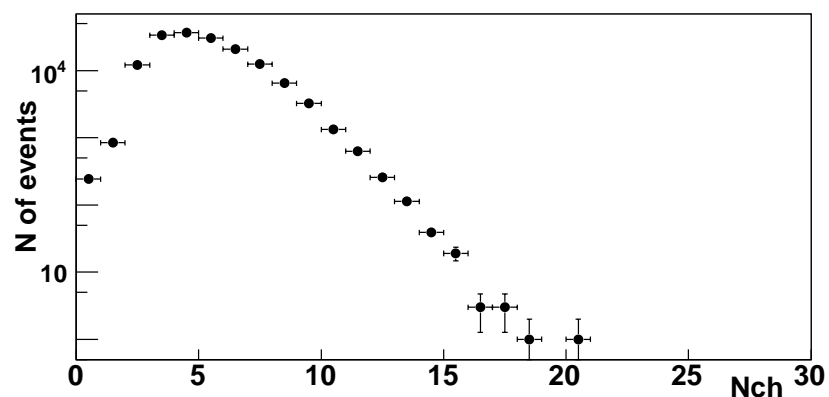
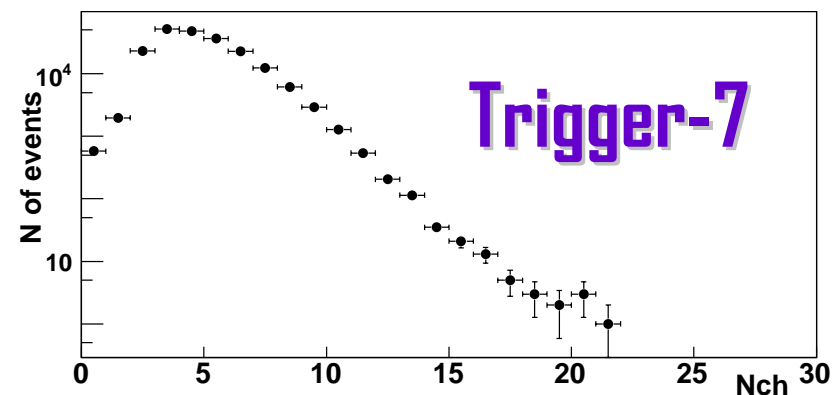
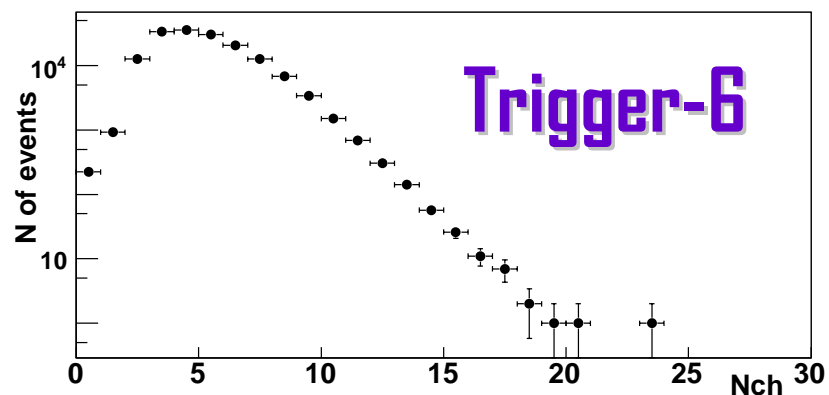




**HM Trigger level determines the bottom boundary of registered multiplicity ( $n > 2, 4, \dots$ )**

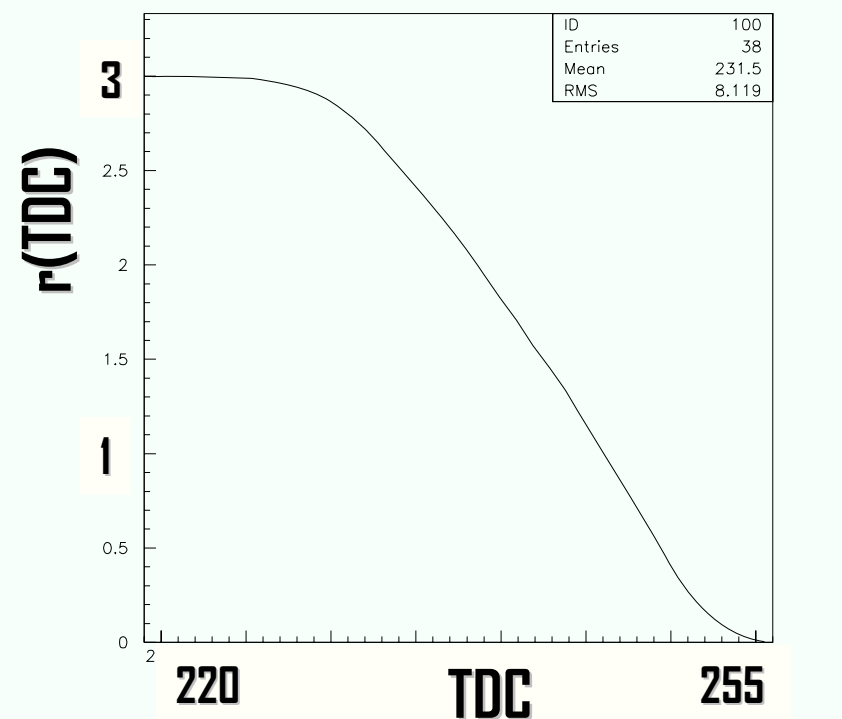






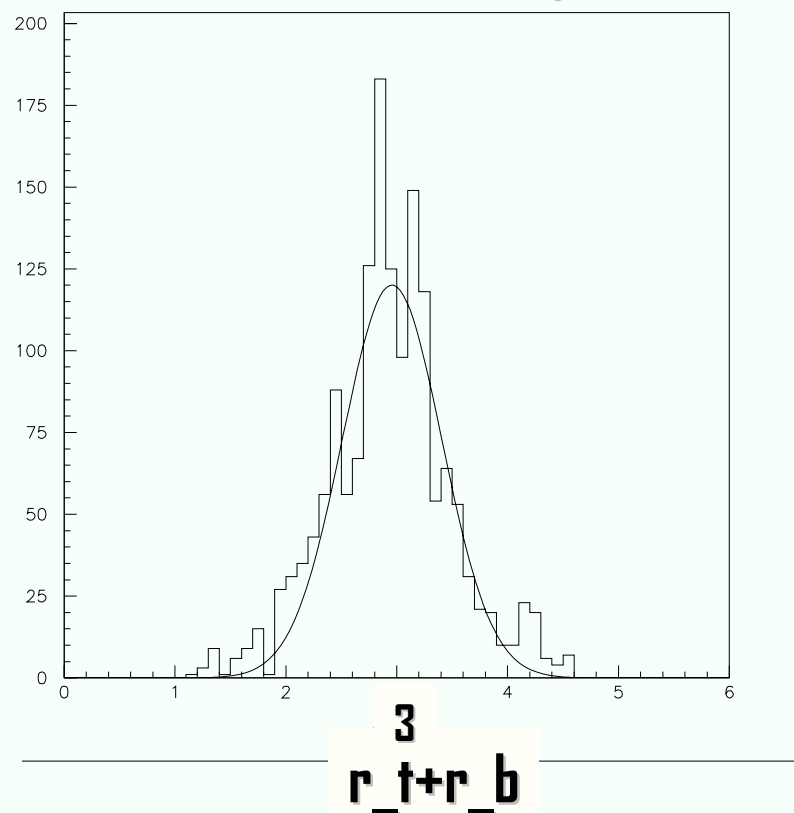


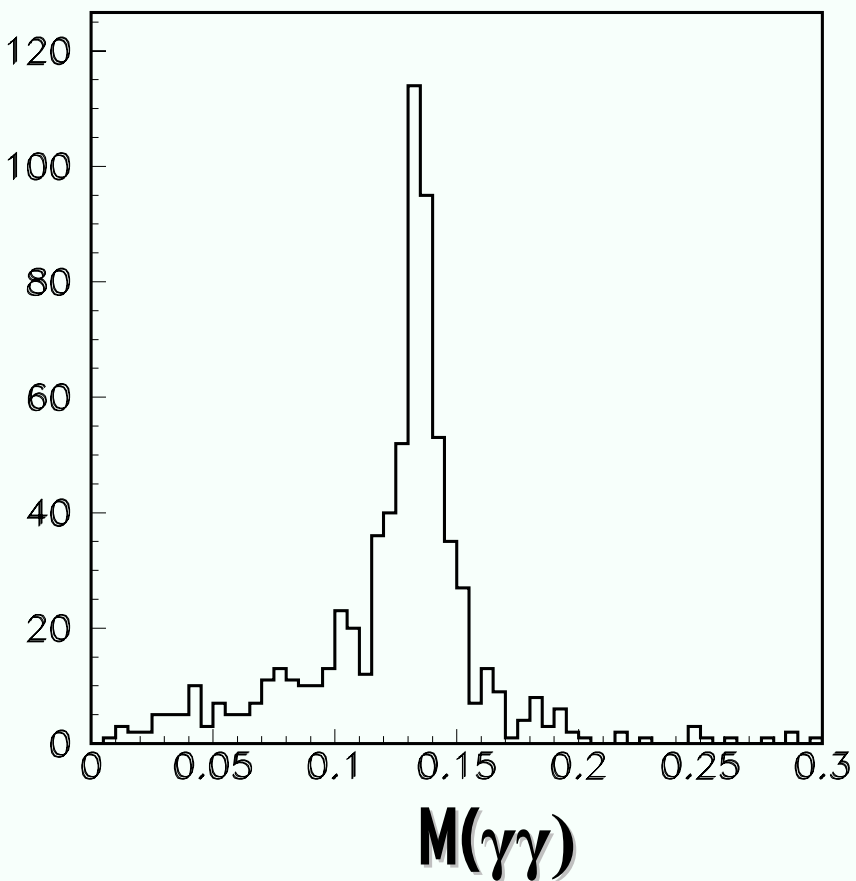
## DT calibration function



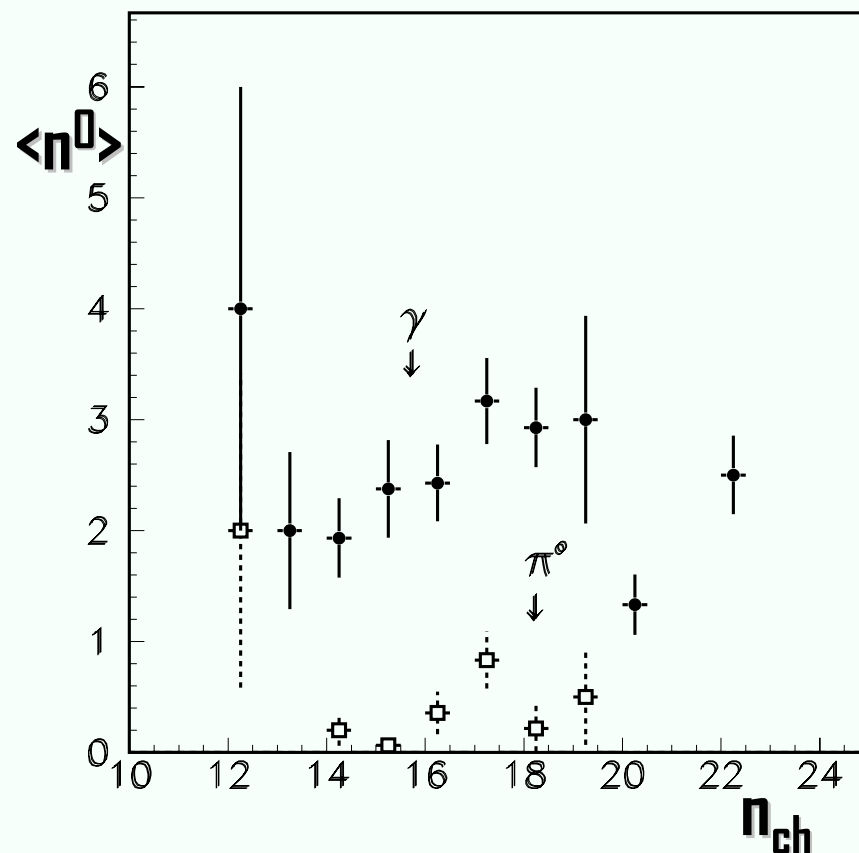
**Drift tubes: the efficiency  
of the registration ~ 99%**

## Resolution $\sim 200 \mu\text{m}$





$$M_{\pi^0} = 0.1349 \pm 0.009 \text{ (GeV)}$$



**Detector of gamma-quantum,  
2006 run.**



## Statistics:

more than  $8 \times 10^6$  events and  $\sim 6 \times 10^6$  from them with trigger level 6, 7, 8 and 10 were recorded.

We continue data taking and data processing.

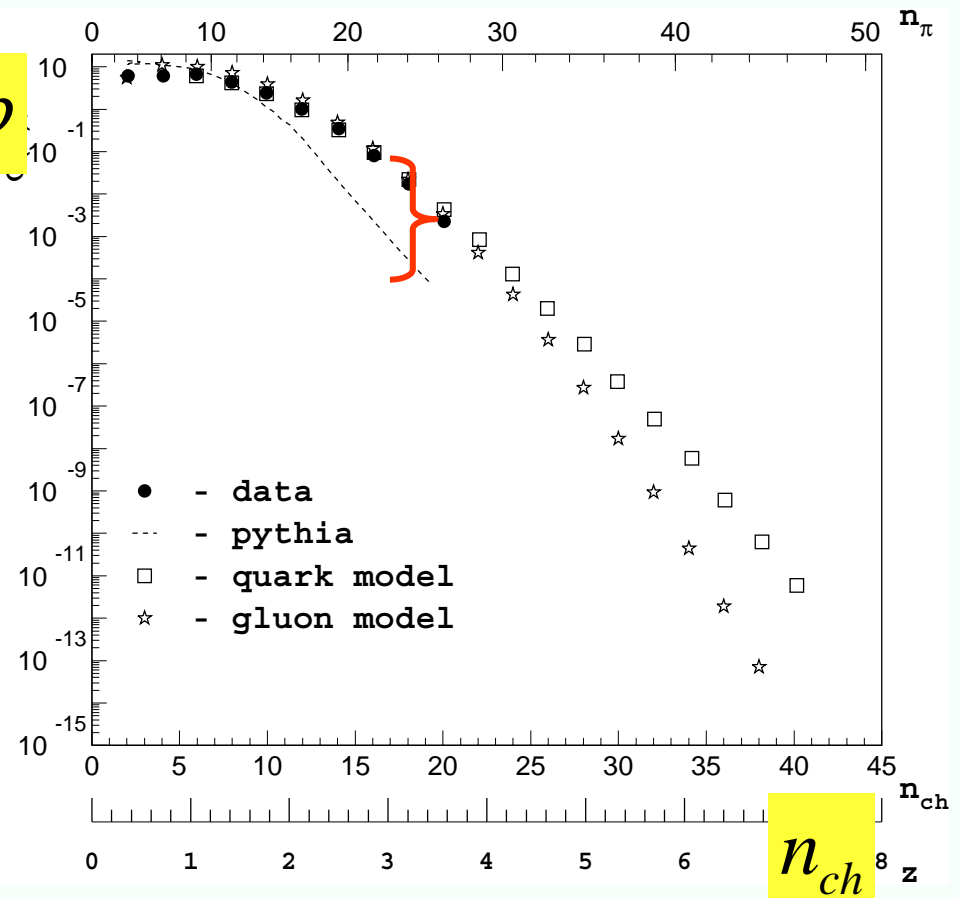




**GDM:**

multiparticle dynamics,  
predictions of charged  
and neutral MD, QCD-  
cascade, hadronization  
mechanisms.

$$\sigma(n_{ch})mb$$





**Base of GDM:** We use the unified approach to the multiplicity description at HEP. It is based on essentials of QCD and on the main experimental phenomena in multiparticle dynamics.

We are interested the extreme multiplicity region:  
 $n > \bar{n}(s)$ .



## GDM for hadron interactions:

- ❖ Quarks of initial protons are staying in leading particles. Multiparticle production (MP) is realized by **active gluons** (behavior of hadronization parameters).
- ❖ Recombination mechanism of hadronization.
- ❖ Particle production limits.



- ❖ The dominance of active gluon plenty in central nuclei collisions leads to the new kind of matter – **QGP**.
- ❖ Cluster superposition consisted from one, two or more gluon fission (increasing of MD width).
- ❖ We believe the realization of our program will be successful and unique for MP study.



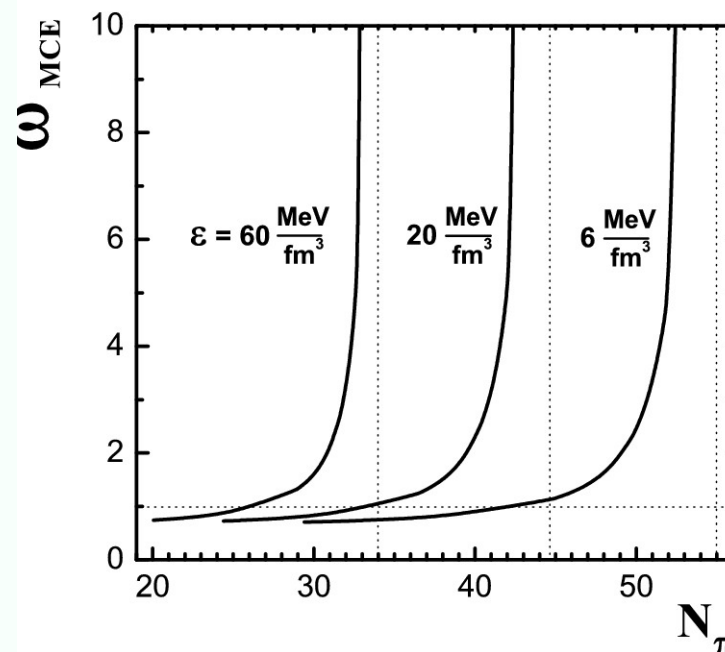
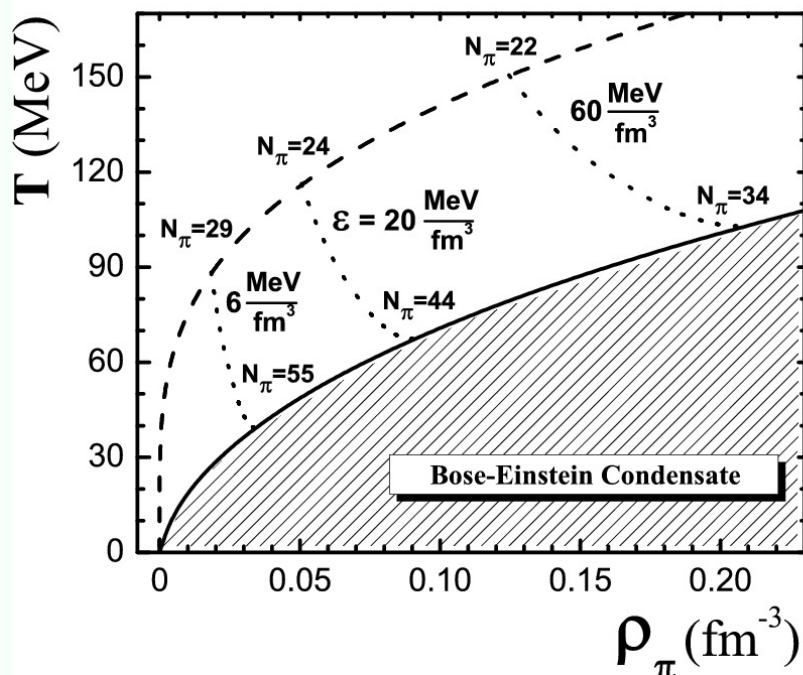


## Search for collective phenomena:

1. BEC (condensation).
2. Ring events (Cherenkov gluon).
3. The excess of soft photon yield.
4. Clustering of secondaries.
5. Turbulence phenomena.



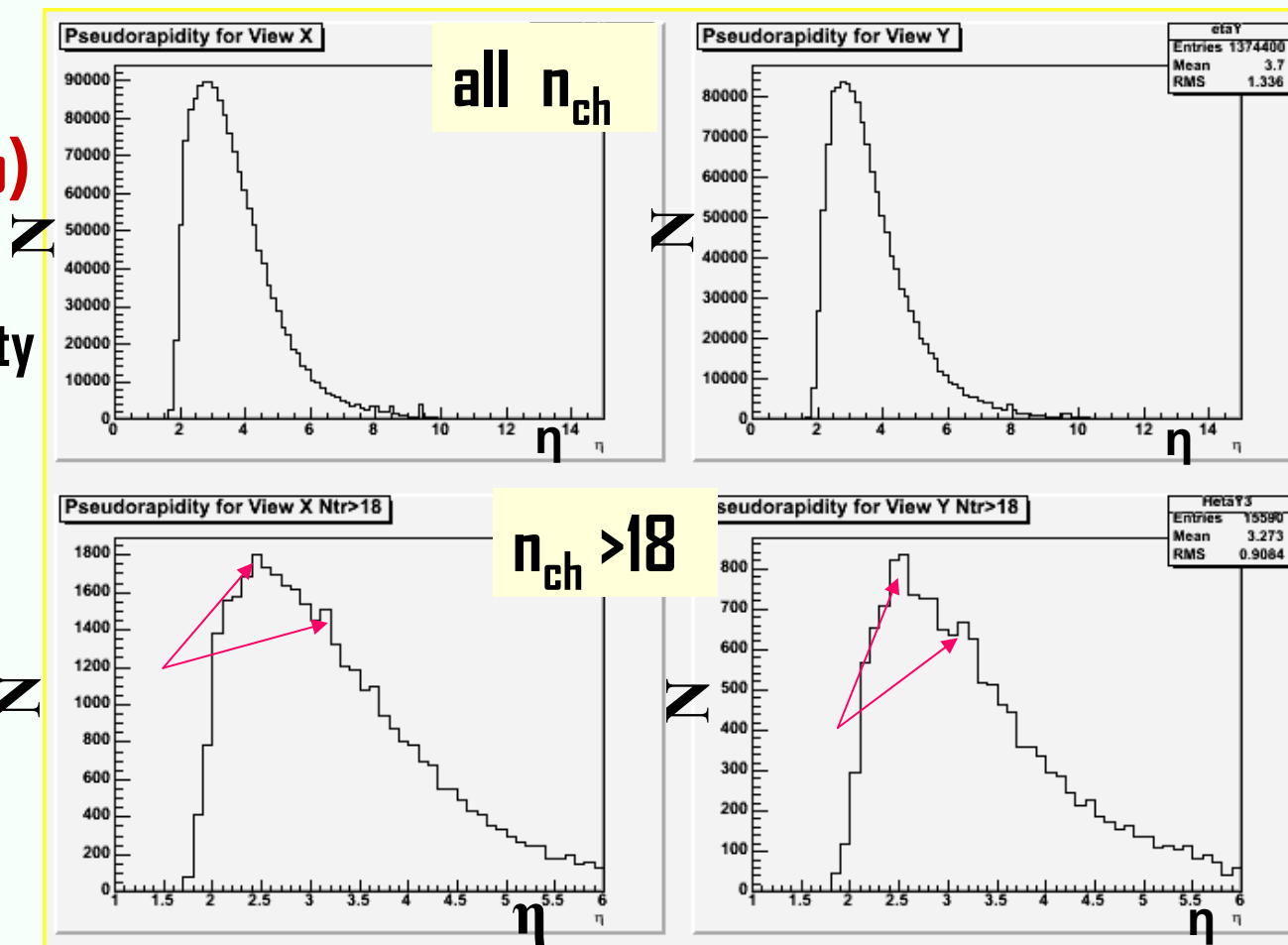
1) M.I.Gorenstein & V.V.Begun [Phys.Lett.B651:114-118,2007]:  
at HM the experimental manifestation of BEC may be founded by  
the abrupt and anomalous increase of the scaled variance  $\omega^0$  of  
neutral and charged pion fluctuations in the vicinity of BEC-line.





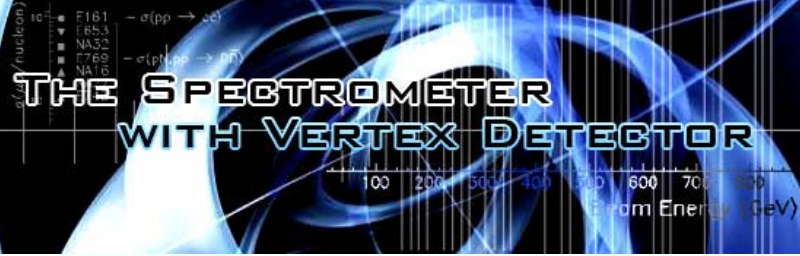
run 2002:  
pA (C, Si, Pb)

$\eta$ - pseudorapidity



Theory of  
I. Dremin:  
ring-events  
(Cherenkov  
gluons  
radiation).

2) Ring-event searching.



### 3) Soft Photons: $p_t \leq 0.1 \text{ GeV} / c, x \leq 0.01$

$\sigma(\text{SP})$  are 5-8 times larger than expected ones from QED.

$$\sigma_\gamma \approx 4 \text{ mb}, \sigma_{in} \approx 40 \text{ mb}, \sigma_\gamma \approx n_\gamma(T) \cdot \sigma_{in} \rightarrow n_\gamma \approx 0.1$$

**Assumption:** QGS or excited new formed hadrons set in almost equilibrium state during a short period. That is why we use the black body emission spectrum:

$$\frac{dn_\gamma}{d\nu} = \frac{8\pi}{c^3} \frac{\nu^3}{e^{\frac{h\nu}{T}} - 1}.$$





## Soft photons ( $p < 50 \text{ MeV}$ ) excess

The number of SP is estimated by MVB density  $\rho(T) = n(T)/V$ :

$$n_\gamma(T) = 0.244 \cdot V \left( \frac{2\pi kT}{hc} \right)^3, \quad T_r = 2.725 \text{ K (MVB)} \rightarrow n_\gamma(T_r)/V = 4.112 \cdot 10^8 \text{ m}^{-3}$$

$$T = p \approx p_t \cdot \sqrt{2}$$

$$L^3 \cdot \rho(T) \approx n_\gamma \rightarrow L(T)$$

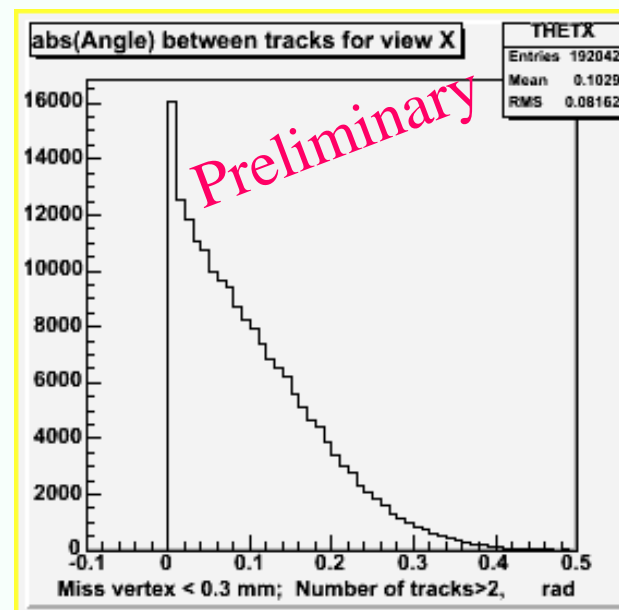
- ❖ estimation of SP emission region  $\sim 4\text{-}6 \text{ fm}$ ;
- ❖ SP excess is the manifestation of kinematical freeze out.

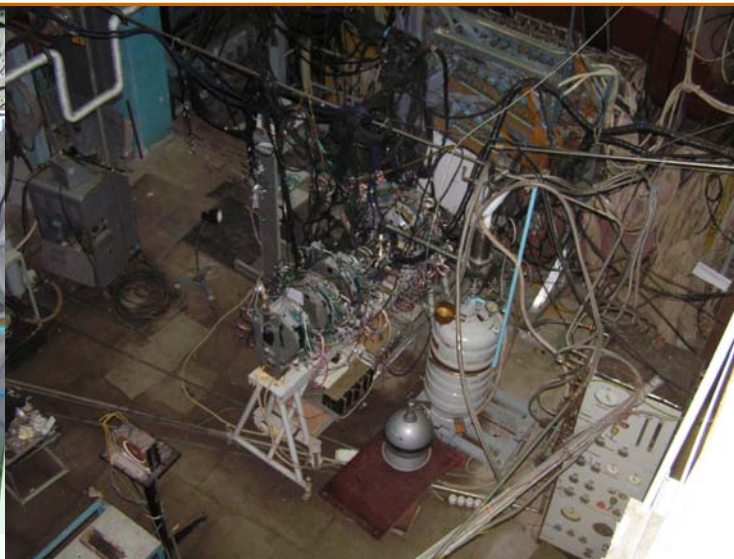
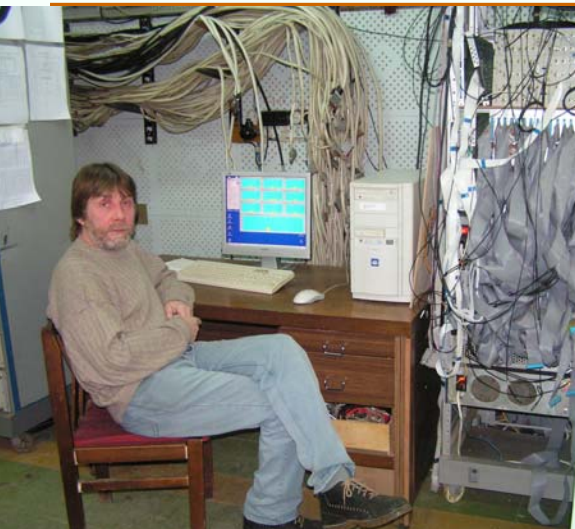
M.Volkov, E.K., E.Kuraev.

Part. & Nucl. Let., 5 (2004)122



**4) RUN 2002:**  
 the indication to the  
 grouping of secondary in  
 the certain direction  
 (clustering) in pA (Pb).  
 [hep-ph/0612364].





**We think on successful accomplishment of our program.**



THANK YOU

