Extreme multiplicity at high energies

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

XIX INTERNATIONAL BALDIN SEMINAR ON HIGH ENERGY PHYSICS PROBLEMS

Relativistic nuclear Physics & Quantum Chromodynamics Dubna, Russia, September 29 – October 4, 2008

Of blessed memory
P.F. Ermolov

1932 - 2008

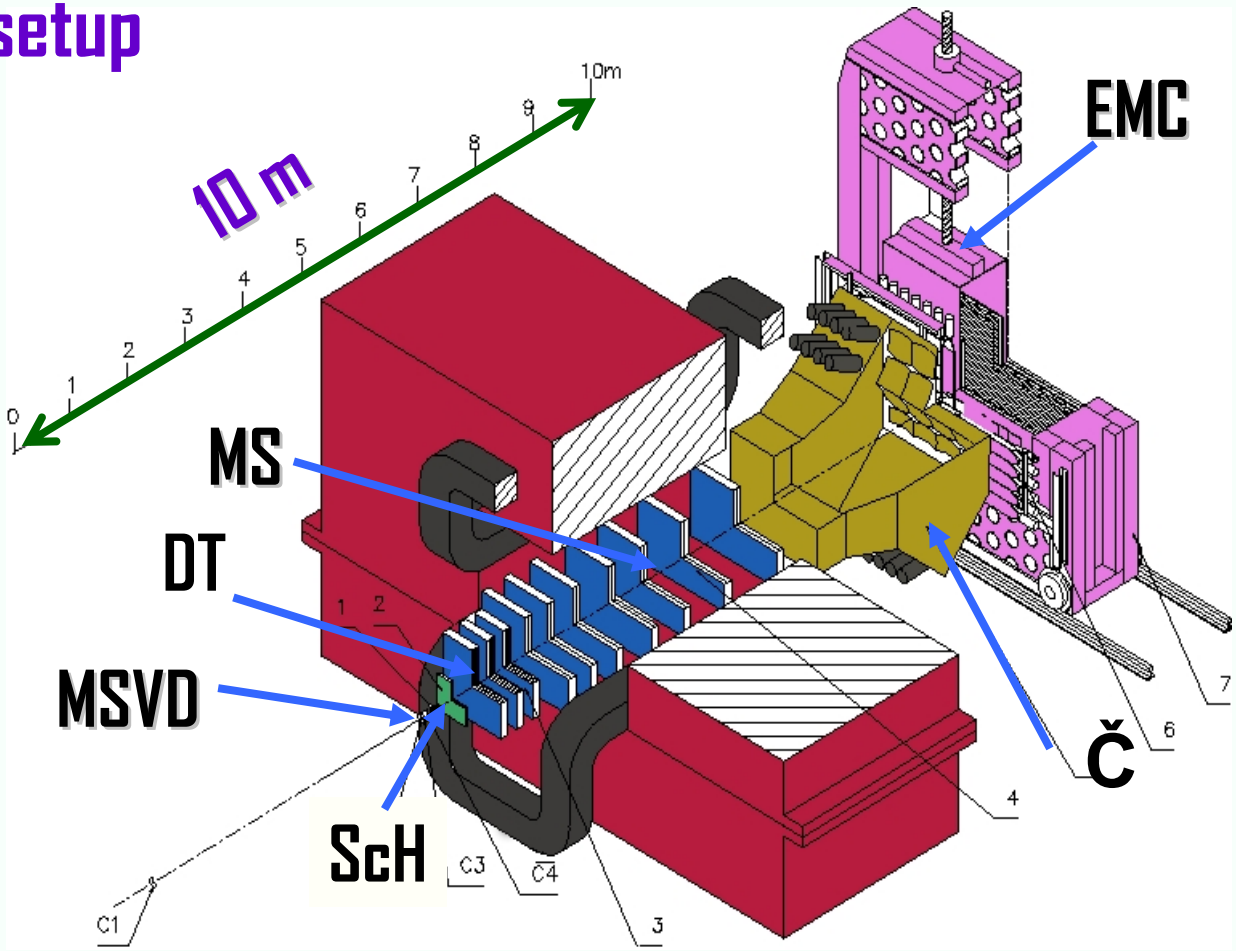
ICHEP (Rochester), Moscow, 2006

2004 run, Protvino

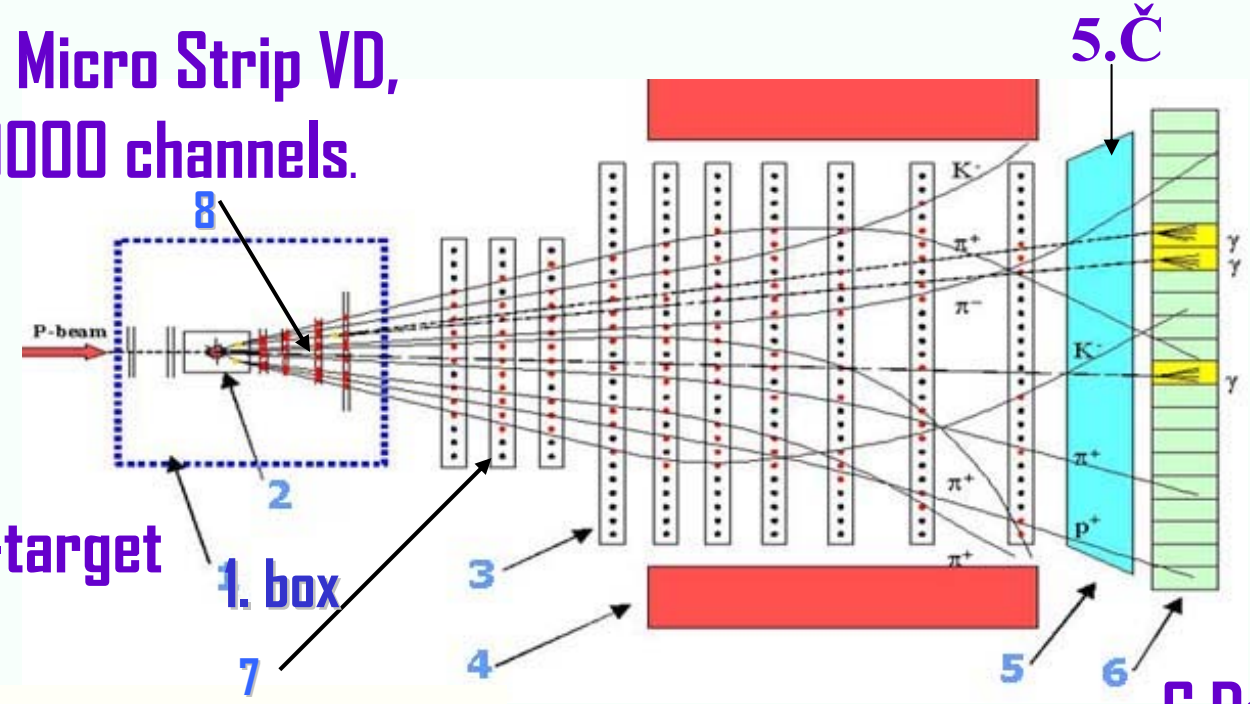
Scientific programme:

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

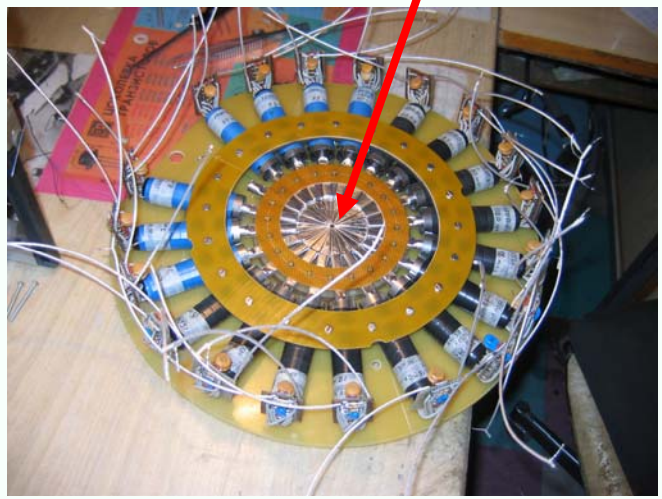
3.4. Magnetic Spectrometer

6.DeGa, 1536 channels

SVD-2 setup

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

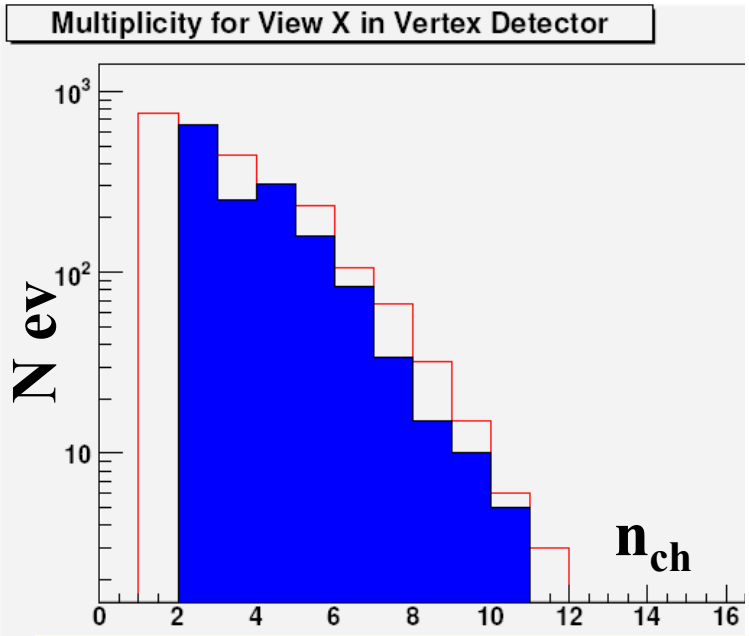
20 elements ("petals"): triangle h=18, 1.8 mm thick.

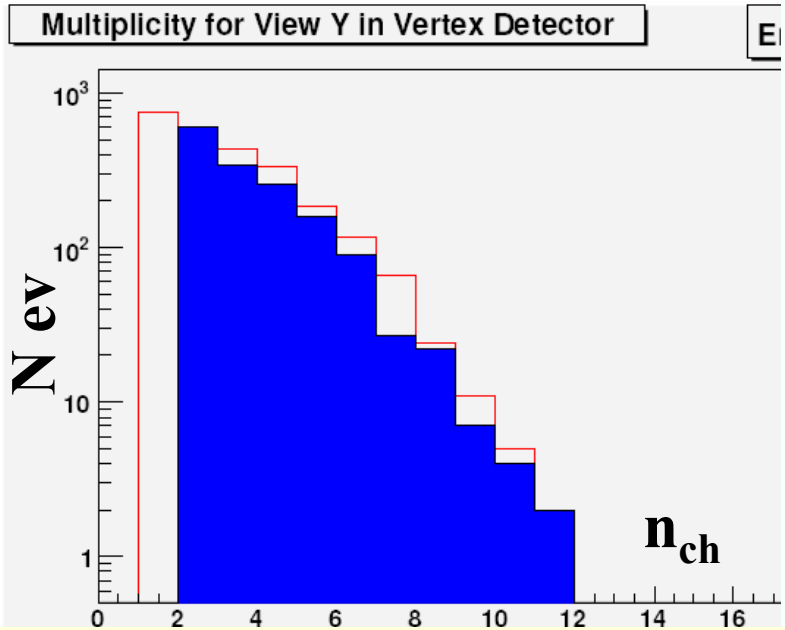


Liquid hydrogen target

SIMULATION:

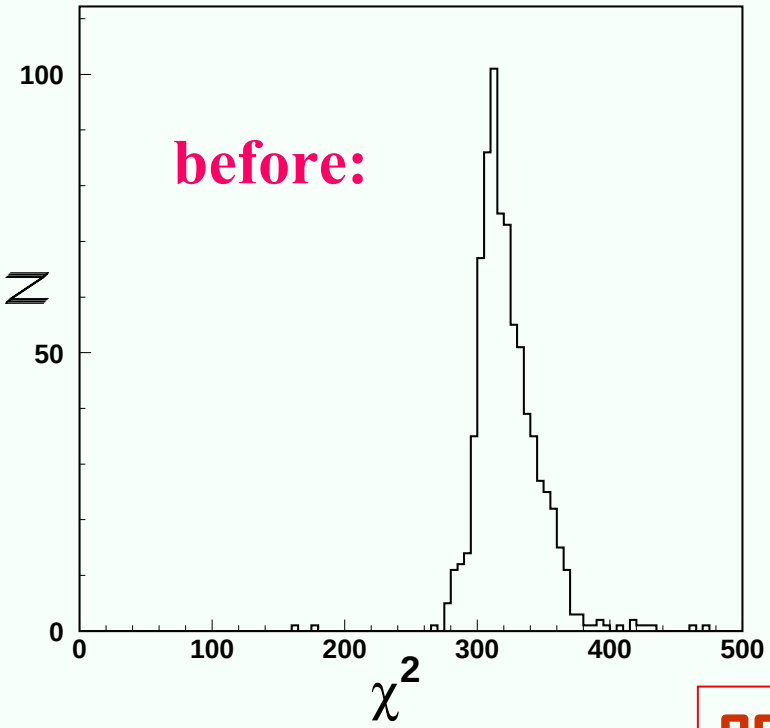
- Making of Monte Carlo event generator for modeling of setup elements;
- Software design of data taking and data processing for HM events;
- Use of JEANT-3 generator for analysis of program packages of event reconstruction;
- the 2006 – 2008 runs on U-70.

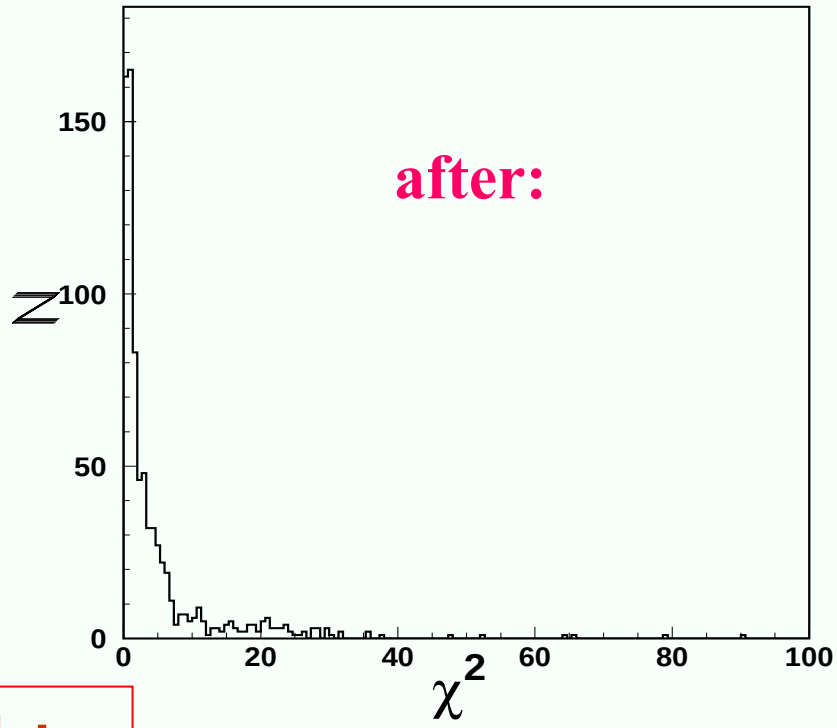




MD of simulated (red) and reconstructed (blue) events for Vertex Detector on X and Y projections

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

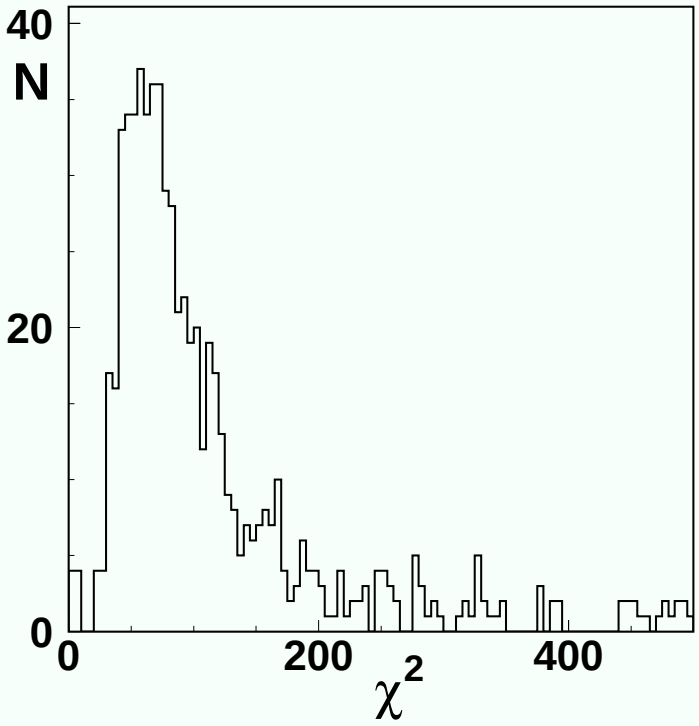




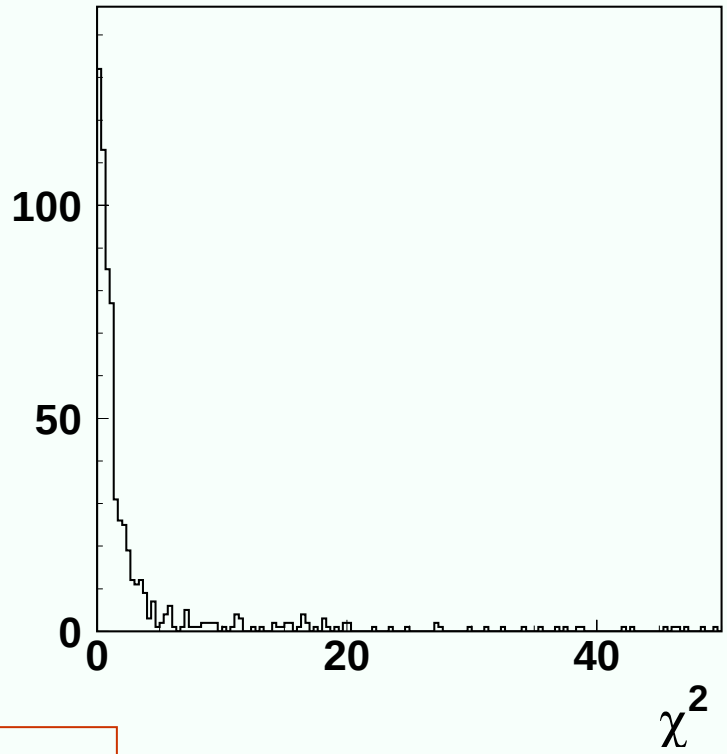
2006 data

Alignment:

before:

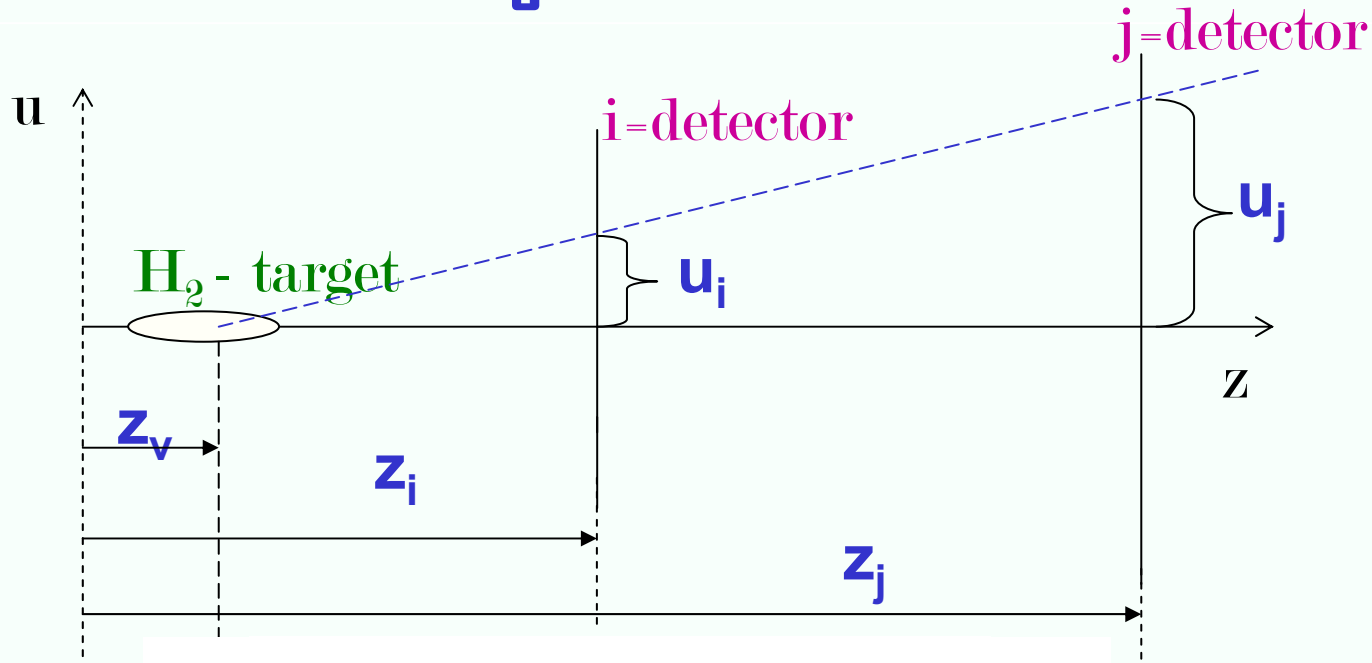


after:

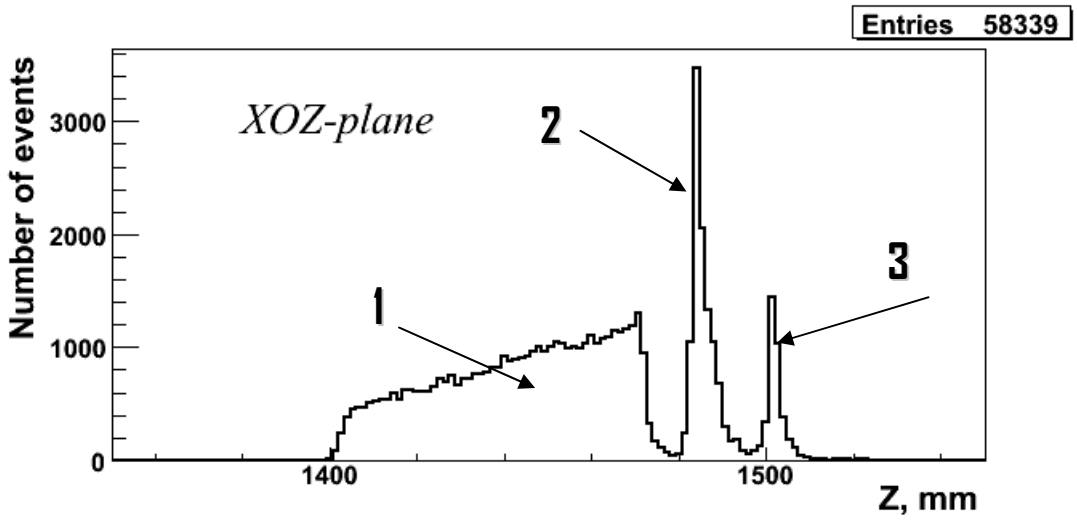


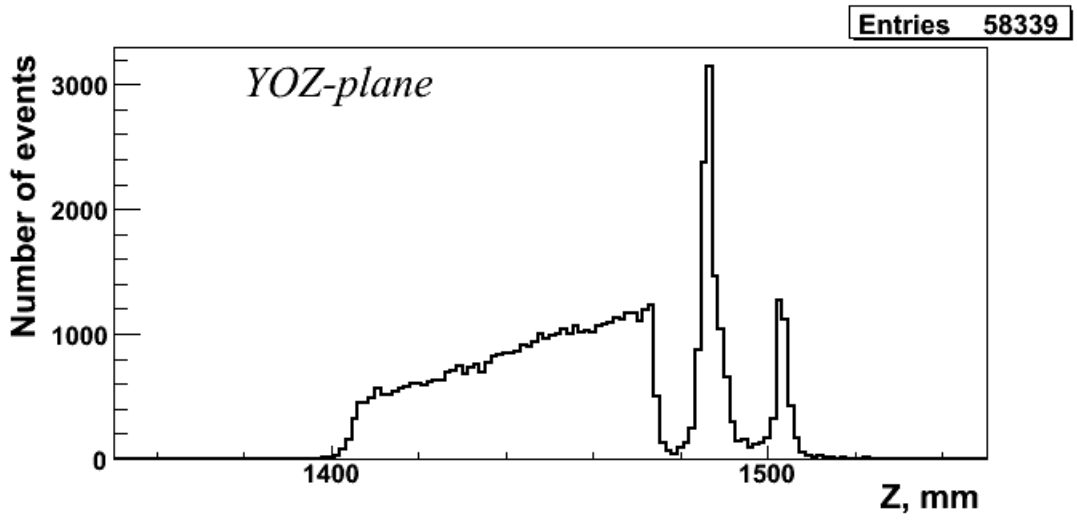
2007 data

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



$$z_{v=}=(u_m z_k - u_k z_m)/(x_m - x_k)$$

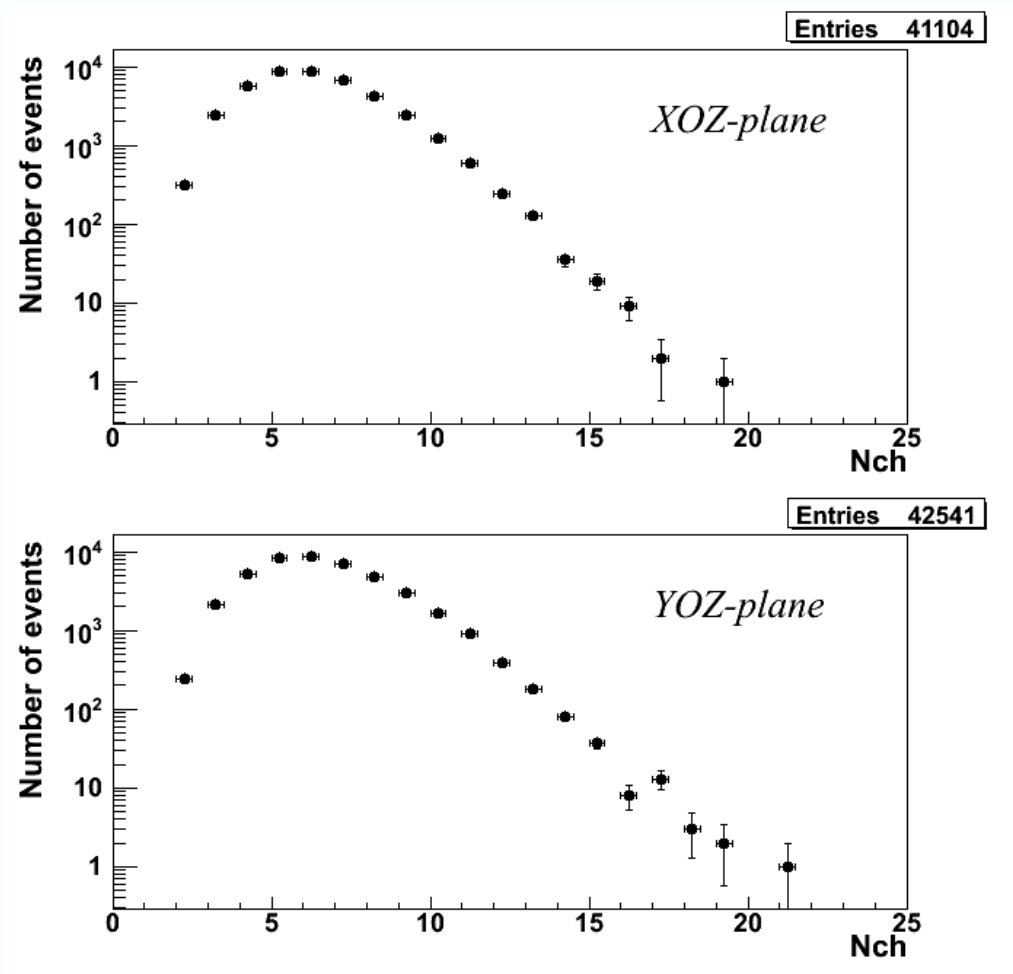




MSVD:

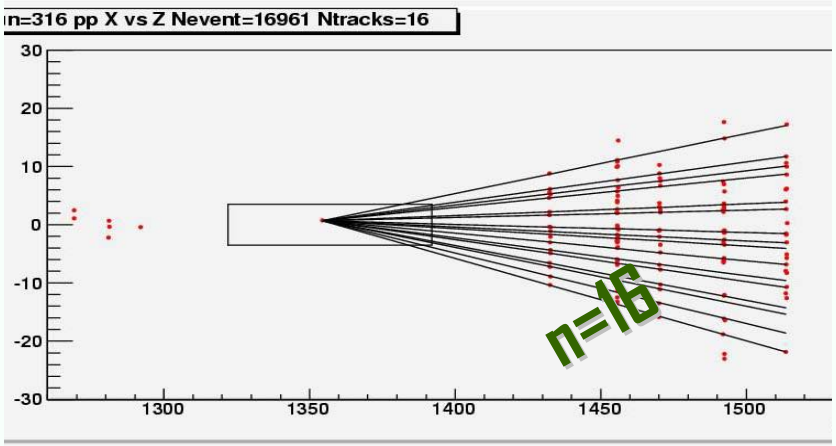
z - coordinate of interaction vertex:

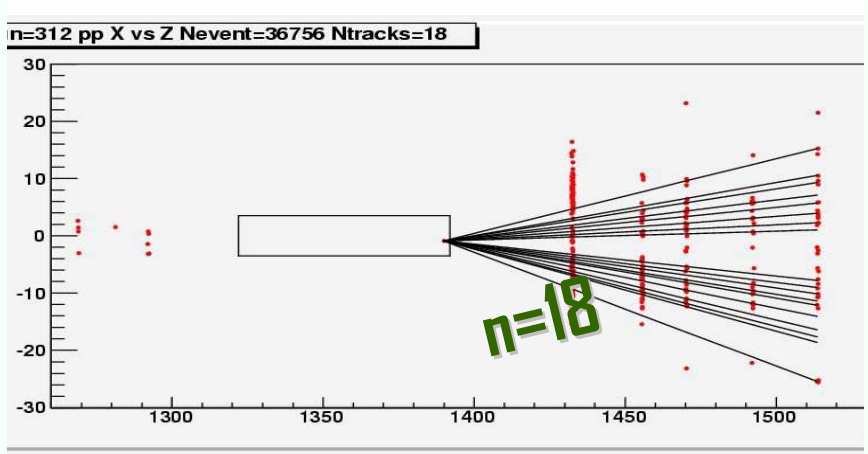
1) hydrogen target,
2) shell and
3) hodoscope.

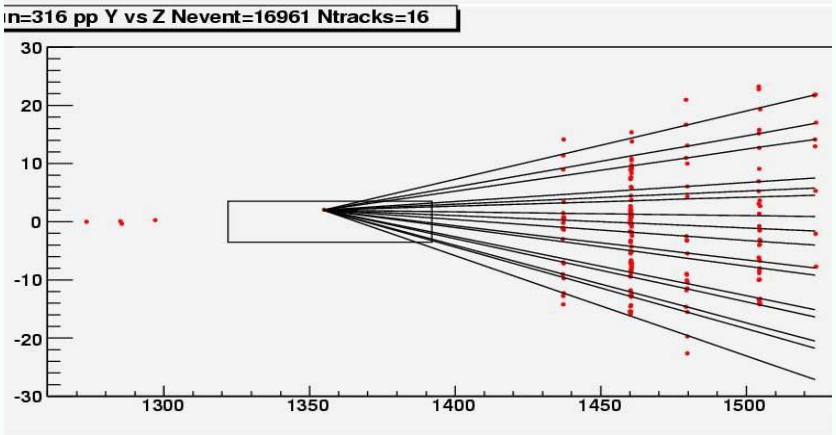


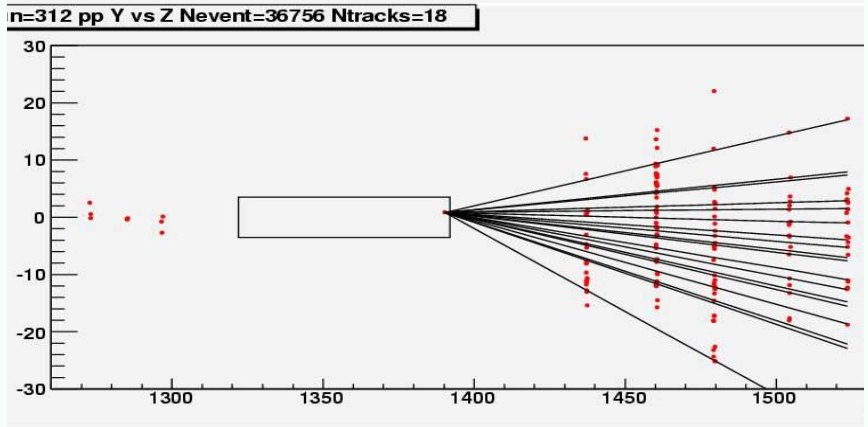
Multiplicity Distributions (MSVD)

Reconstructed HM - events (examples)



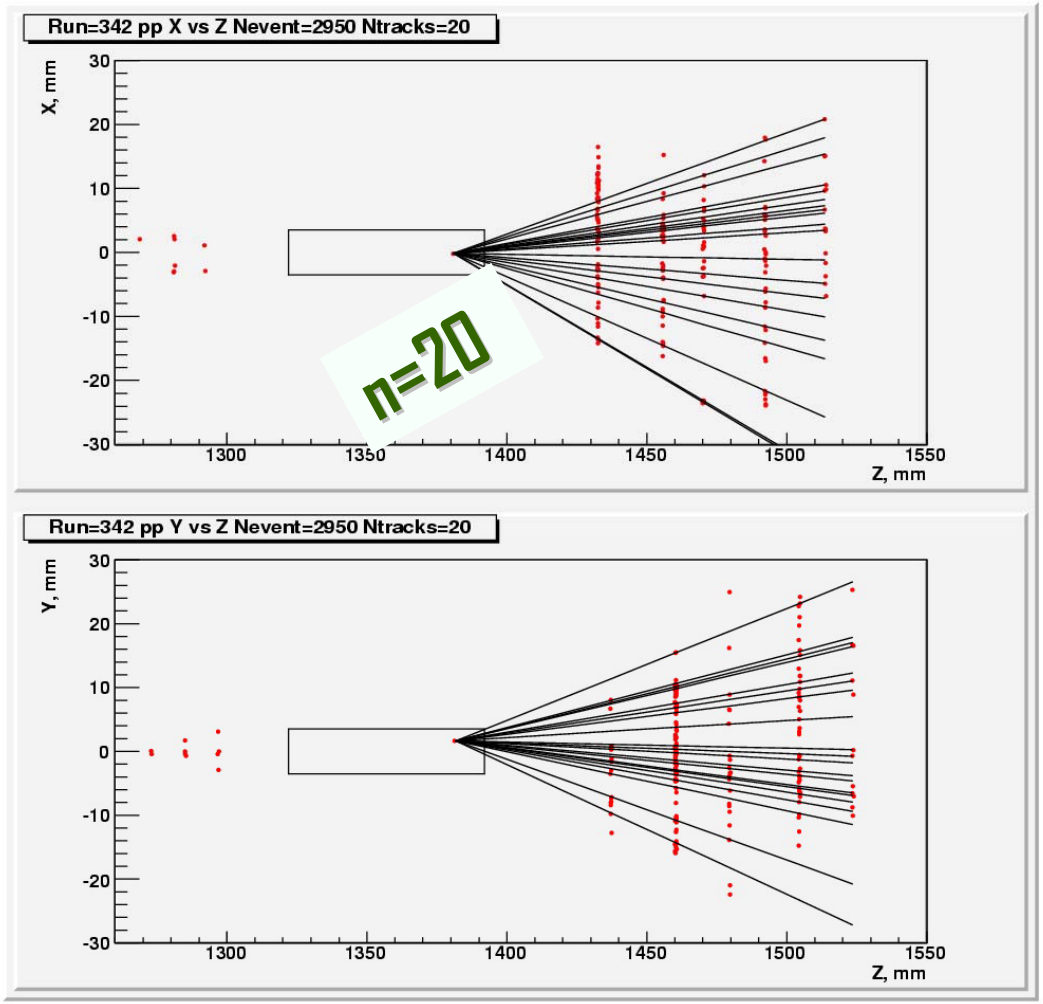




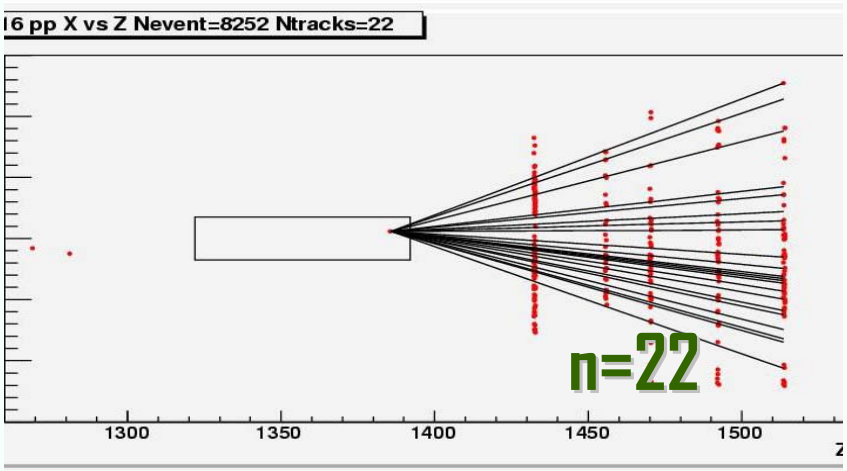


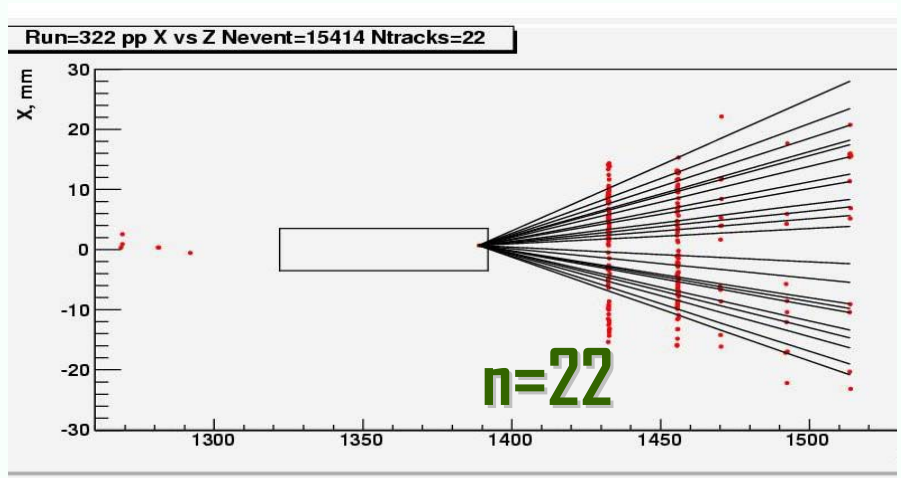

SVD
THE SPECTROMETER
WITH VERTEX DETECTOR

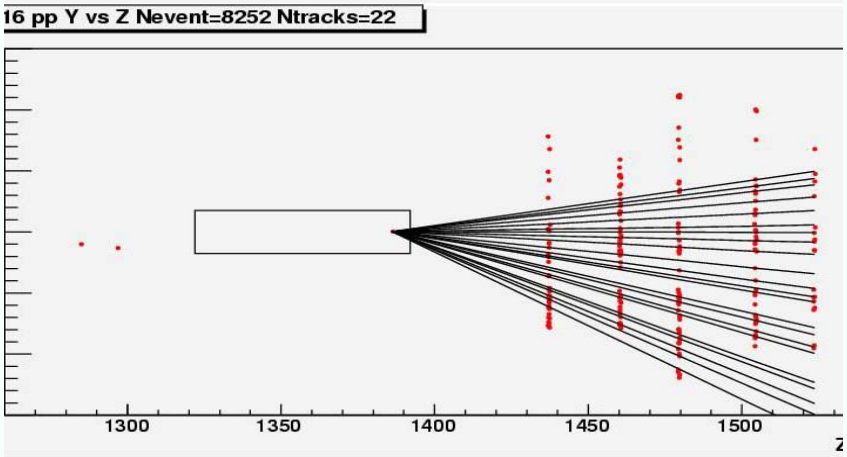
ИФВЭ IHEP

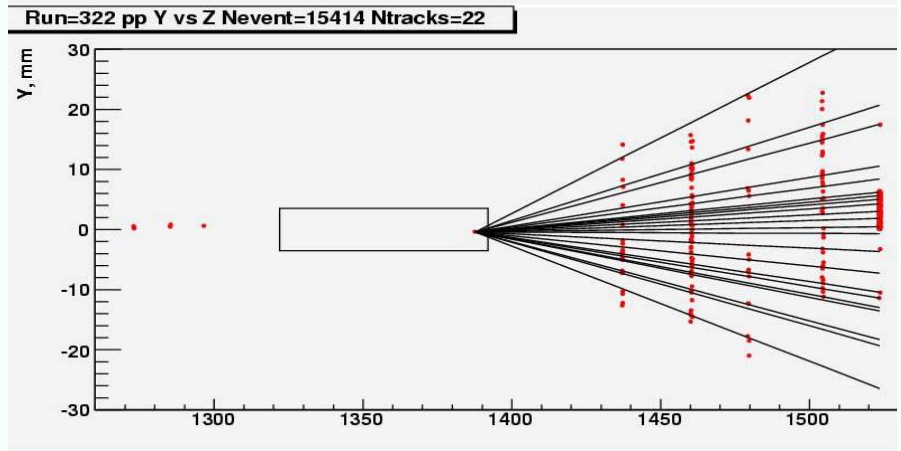

Run=342 pp X vs Z Nevent=2950 Ntracks=20
X, mm
Z, mm
n=20
Run=342 pp Y vs Z Nevent=2950 Ntracks=20
Y, mm
Z, mm


SVD
THE SPECTROMETER
WITH VERTEX DETECTOR

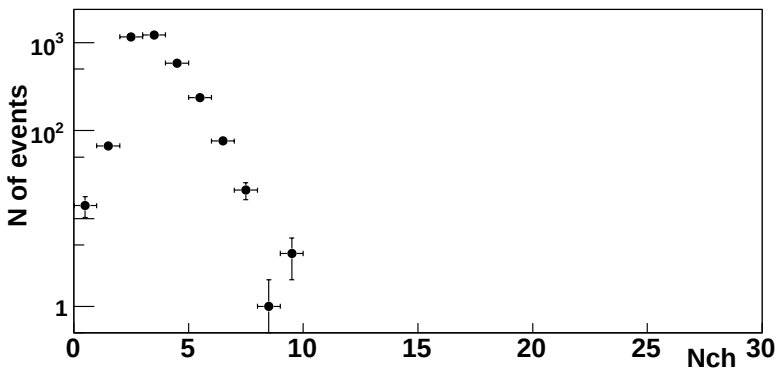

16 pp X vs Z Nevent=8252 Ntracks=22
n=22
1300
1350
1400
1450
1500

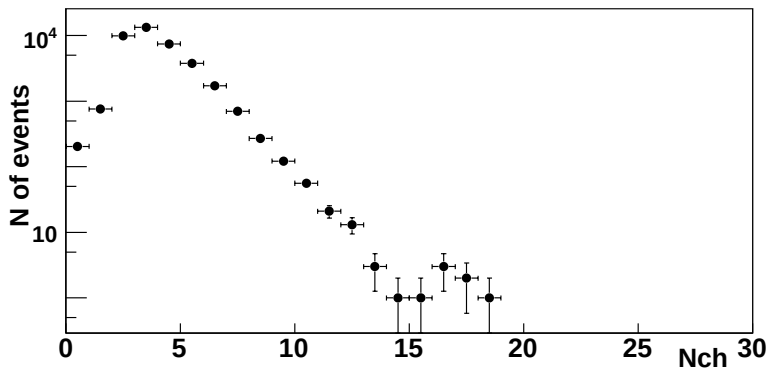

Run=322 pp X vs Z Nevent=15414 Ntracks=22
X, mm
n=22
30
20
10
0
-10
-20
-30
1300
1350
1400
1450
1500


16 pp Y vs Z Nevent=8252 Ntracks=22
1300
1350
1400
1450
1500

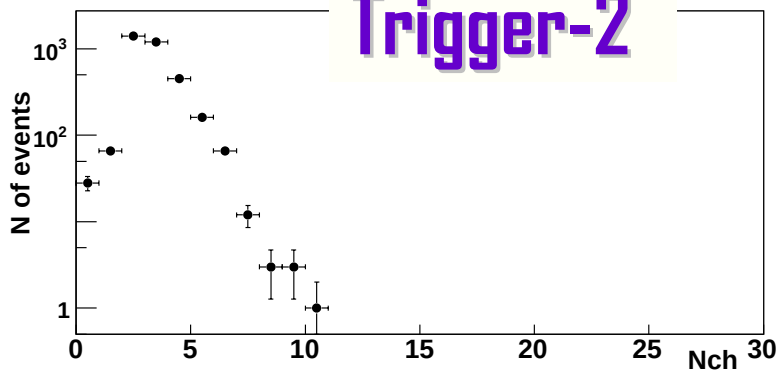

Run=322 pp Y vs Z Nevent=15414 Ntracks=22
Y, mm
30
20
10
0
-10
-20
-30
1300
1350
1400
1450
1500

HM Trigger level determines the bottom boundary of registered multiplicity (n>2, 4, …)

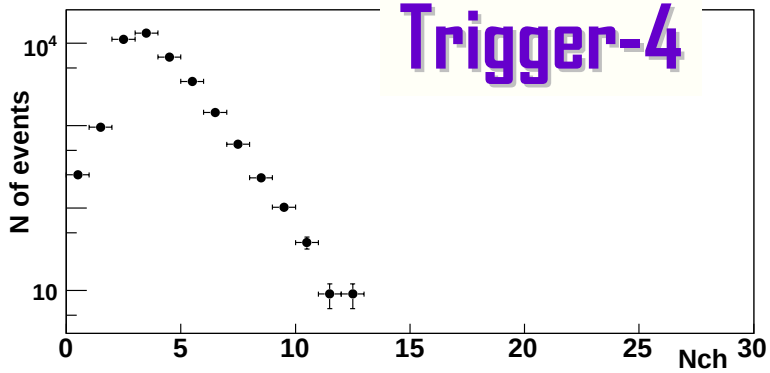


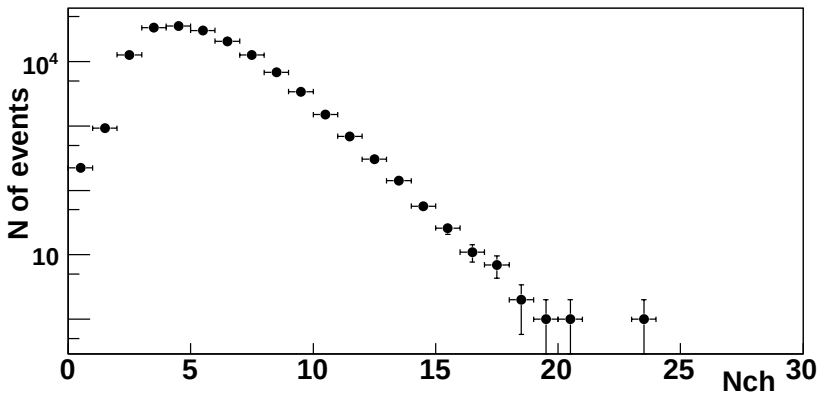


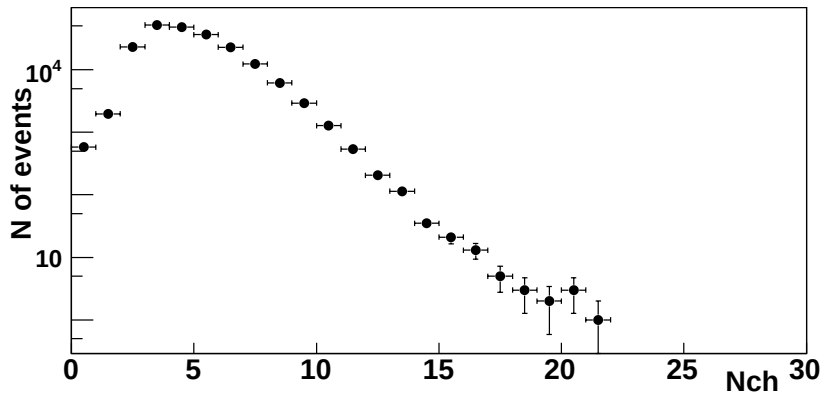
Trigger-2



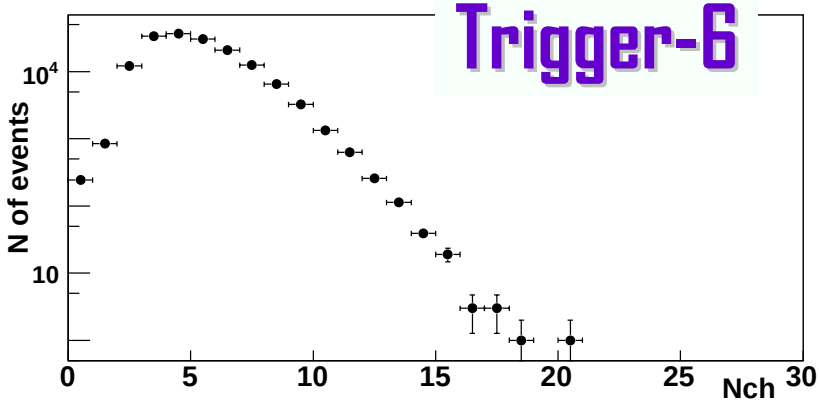
Trigger-4



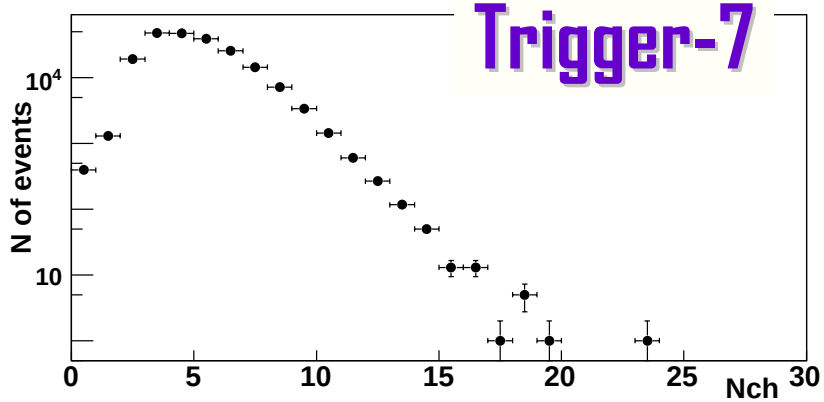




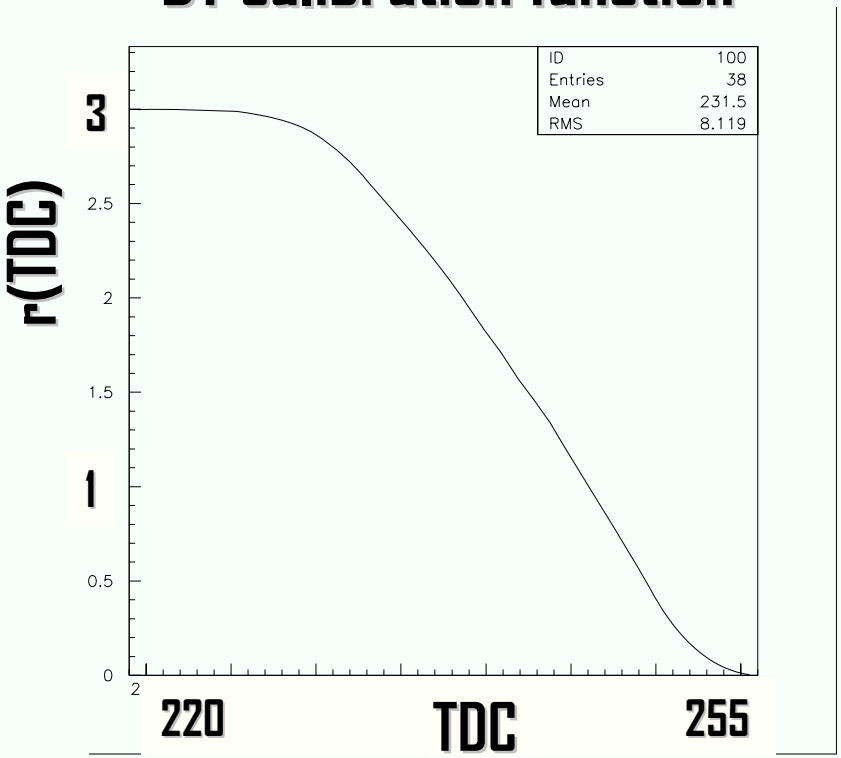
Trigger-6



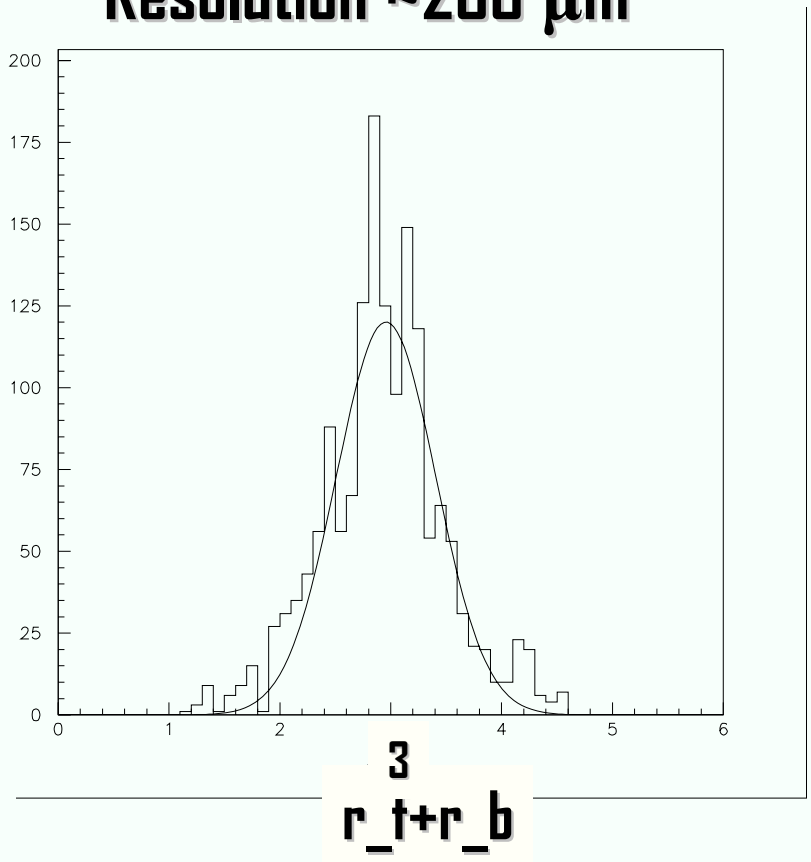
Trigger-7



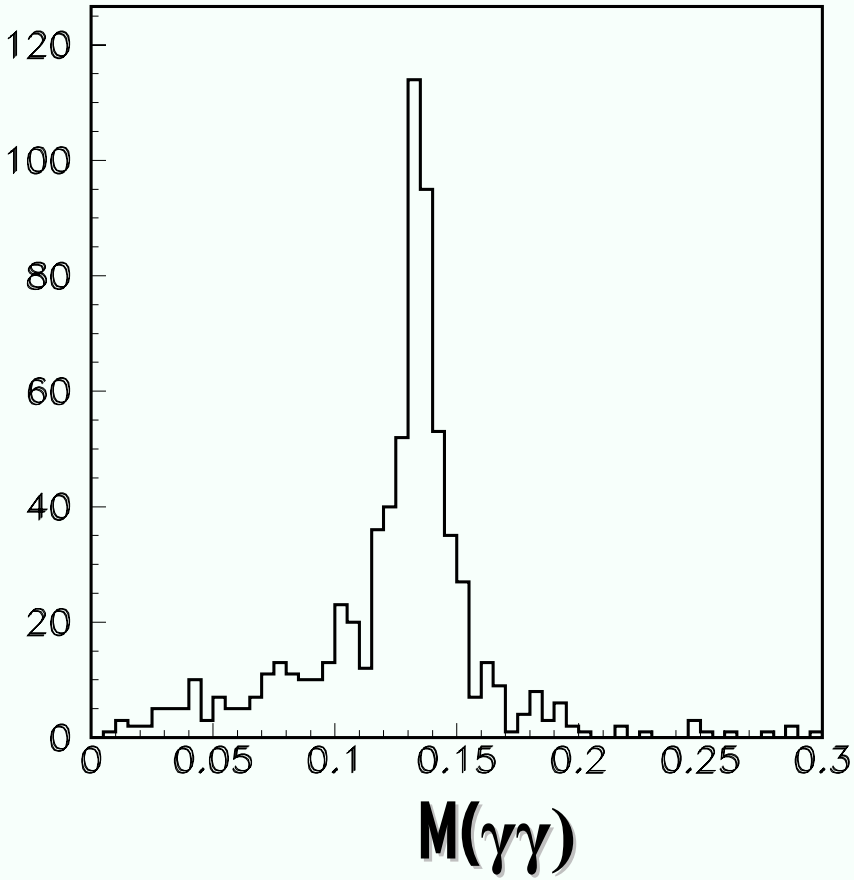
DT calibration function



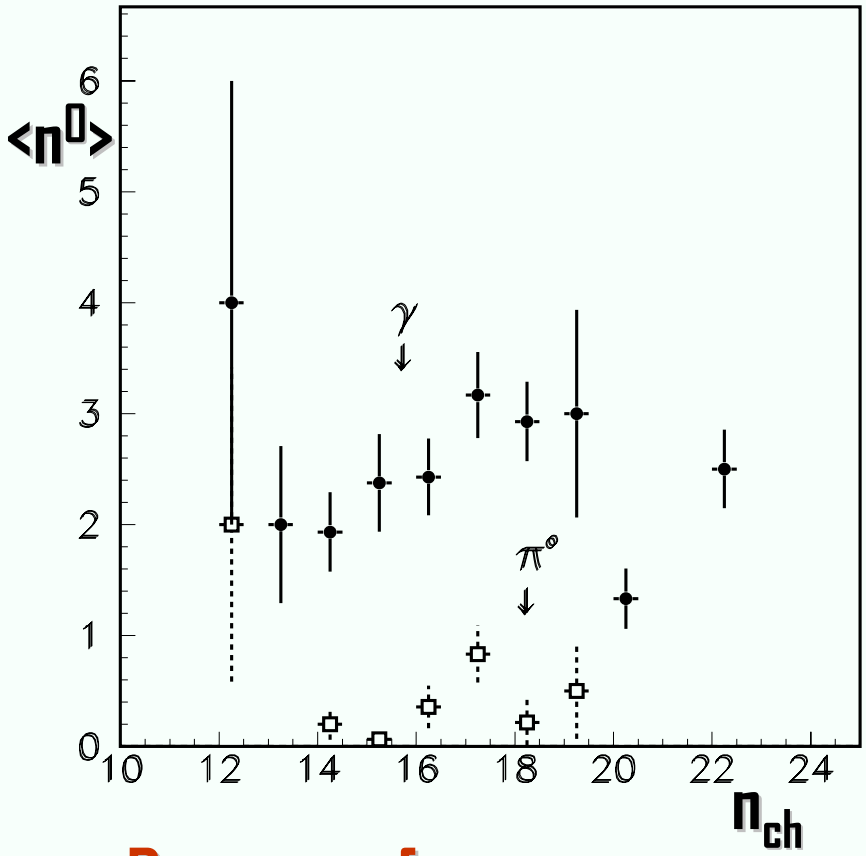
Resolution ~200 μm



Drift tubes: the efficiency of the registration ~ 99%



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



Detector of gamma-quantum, 2006 run.

Statistics:

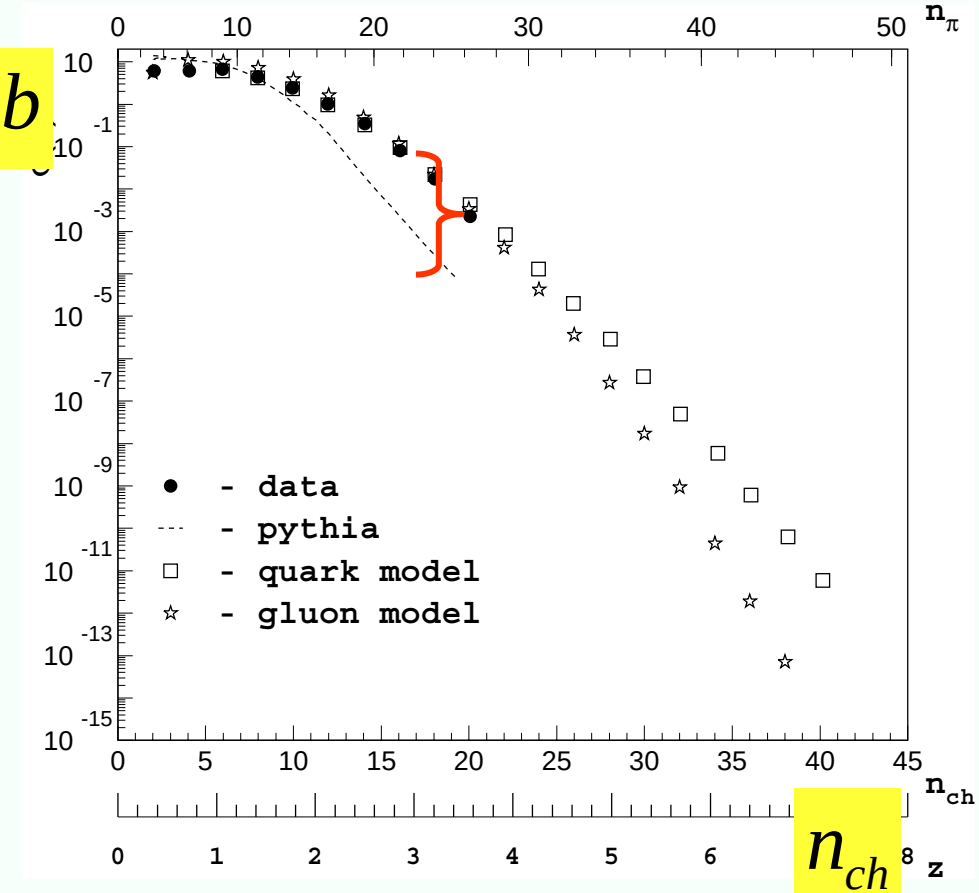
more than 8×10^6 events and ~ 6×10^6 from them with trigger level 6, 7, 8 and 10 were recorded.

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.

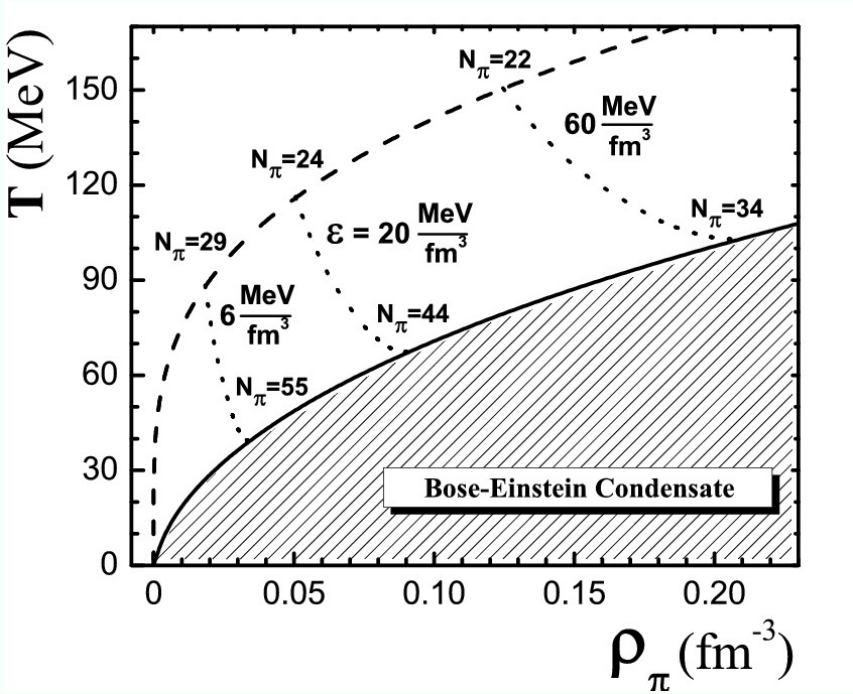
- The dominance of active gluon plenty in central nuclei collisions leads to the new kind of matter – QGP or Glasma.
- Cluster superposition consisted from one, two or more gluon fission (increasing of MD width).

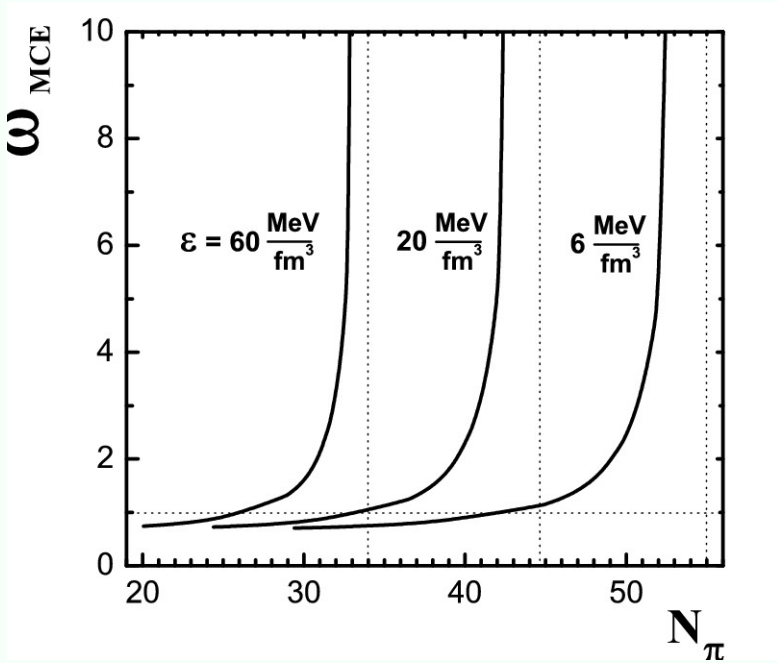
Search for collective phenomena:

1. BEC (condensation).
2. Ring events (Cherenkov gluon).
3. The excess of soft photon yield.
4. Clustering of secondary.
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 ω^0 of neutral and charged pion fluctuations in the vicinity of BEC-line.

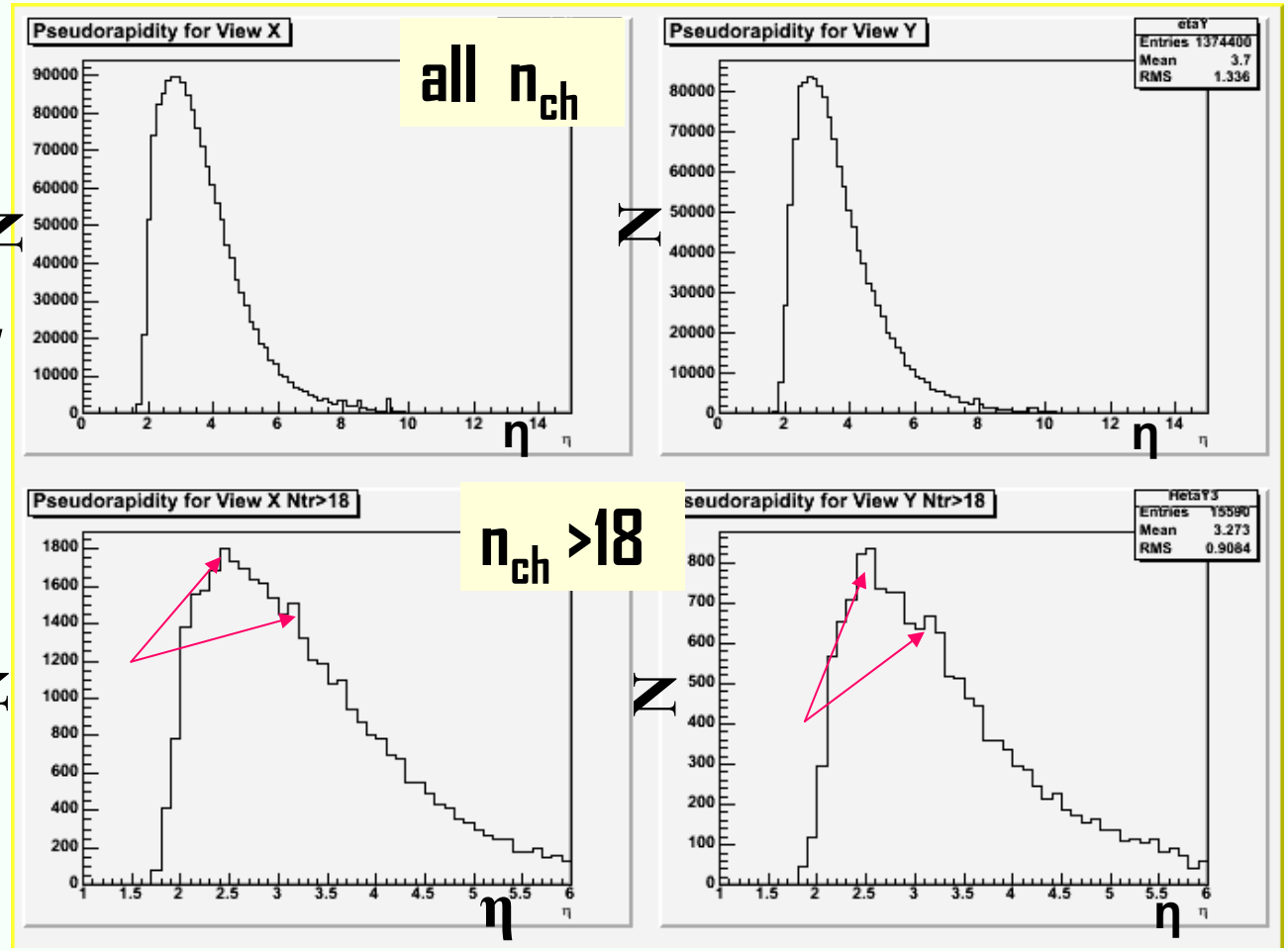




run 2002:
pA (C, Si, Pb)

η- pseudorapidity

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



2) Ring-event searching.

3) Soft Photons: $p_t \le 0.1 GeV/c,\ x \le 0.01$

σ(SP) are 5-8 times larger than expected ones from QED.

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

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 MeV) excess

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

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

$$T = p \approx p_t \cdot \sqrt{2} \qquad L^3 \cdot \rho(T) \approx n_\gamma \rightarrow L(T)$$

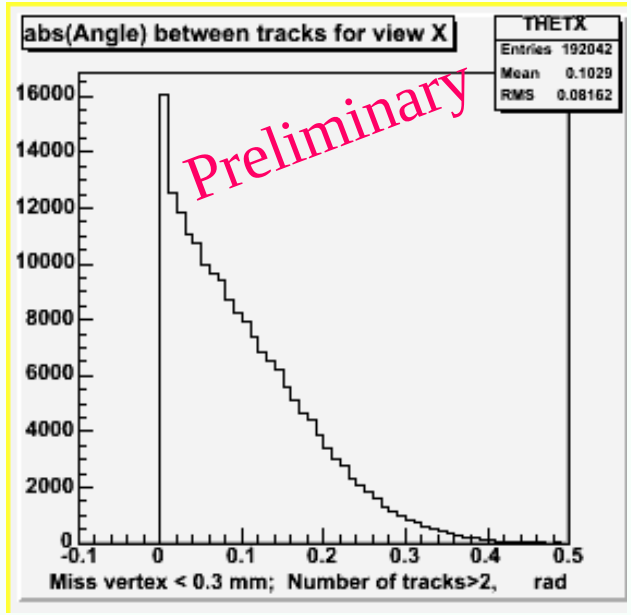
- estimation of SP emission region ~ 4-6 fm;
- SP excess is the manifestation of kinematical freeze out.

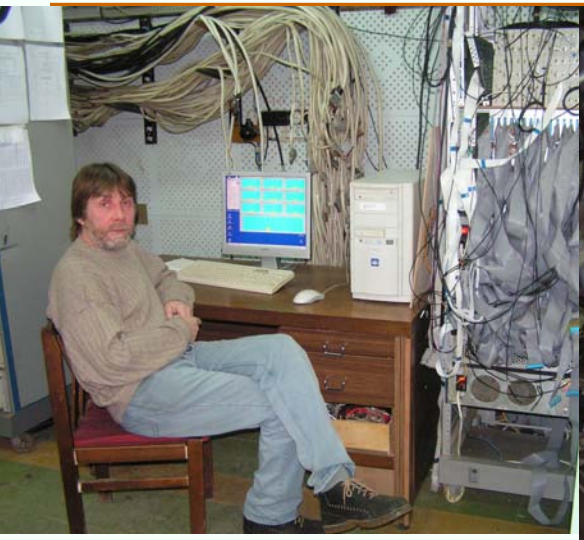
M.Volkov,E.K., E.Kuraev.
Part. & Nucl. Let., 5 (2004)122

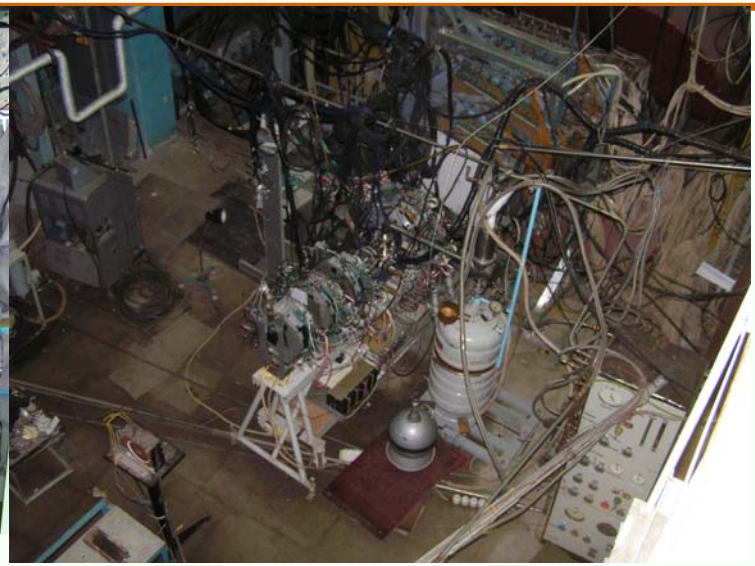
4) RUN 2002:

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 experimental program.


THANK YOU
ISMD 2009 GOMEL, BELARUS