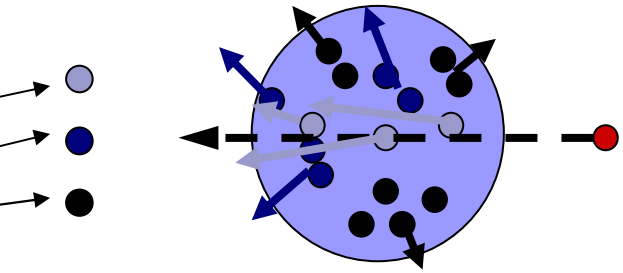
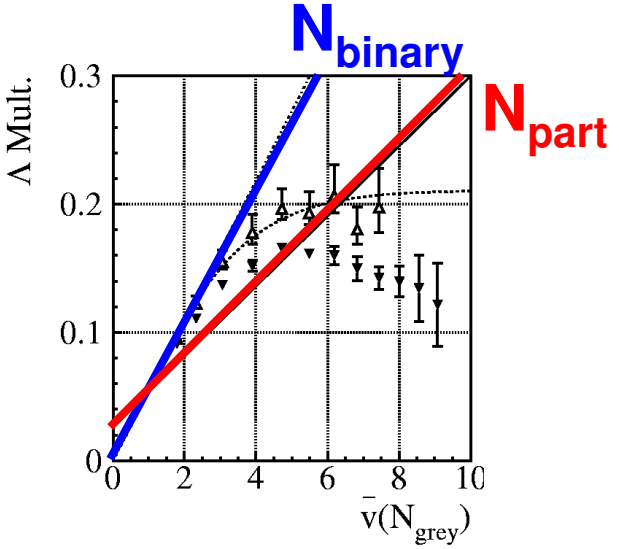
The Physics Pitch

- PHENIX AA centrality derived from ZDC/BBC+glauber
  - Hard processes proportional to N_{binary}
  - Soft processes proportional to N_{par}
- pA centrality same basic idea
  - $N_{par} - 1 = N_{binary} = \nu$
  - Use grey/black tracks
  - Normalization to pp differs by factor of 2
- Best example of physics from pA centrality is E910
  - PRL 85 (2000) 4868
  - PRC 60 (1999) 024902
- Best physics case for PHENIX may be J/Ψ
  - Others: high pt, Cronin effect, strangeness, etc.

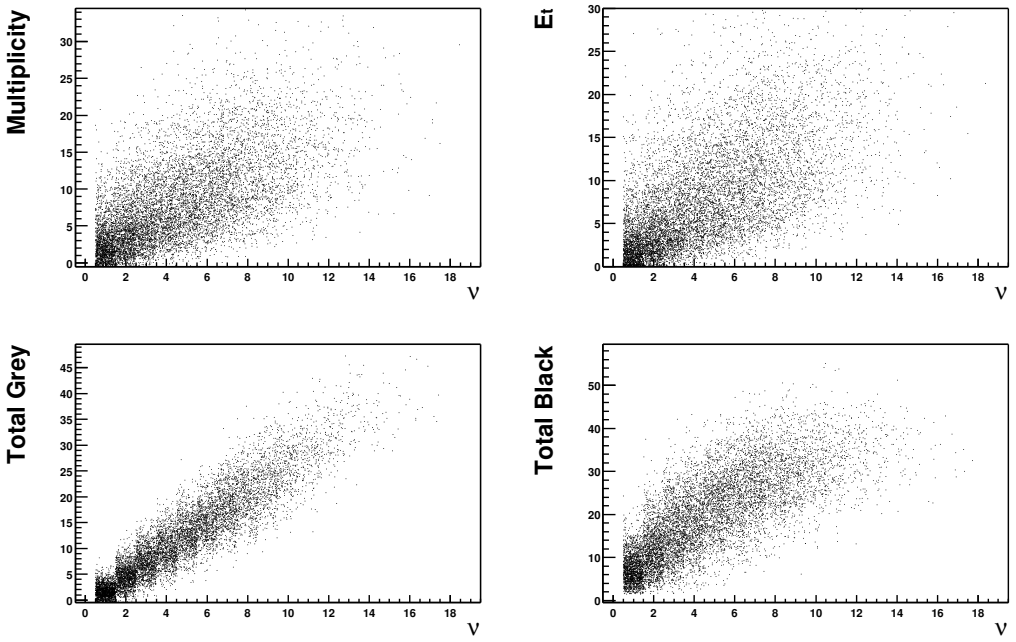


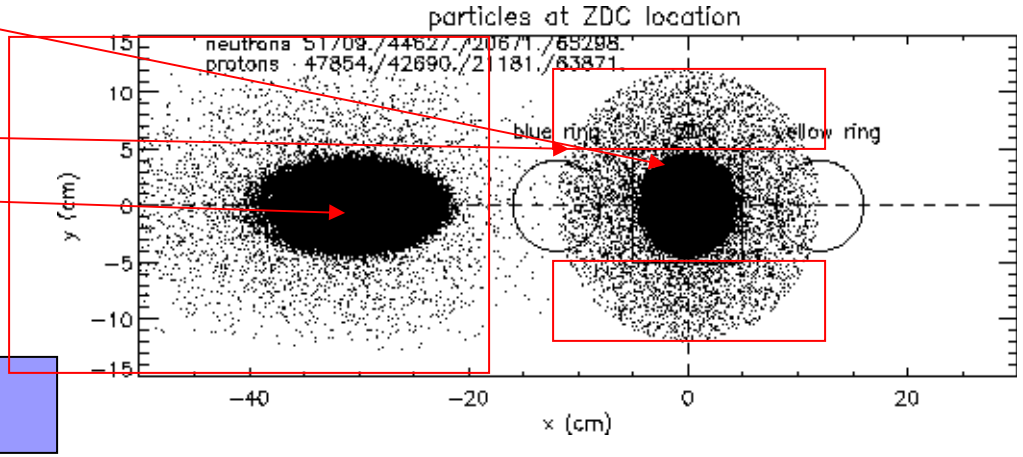


Need to measure grey/black nucleons for centrality measurement

ZDC is Insufficient

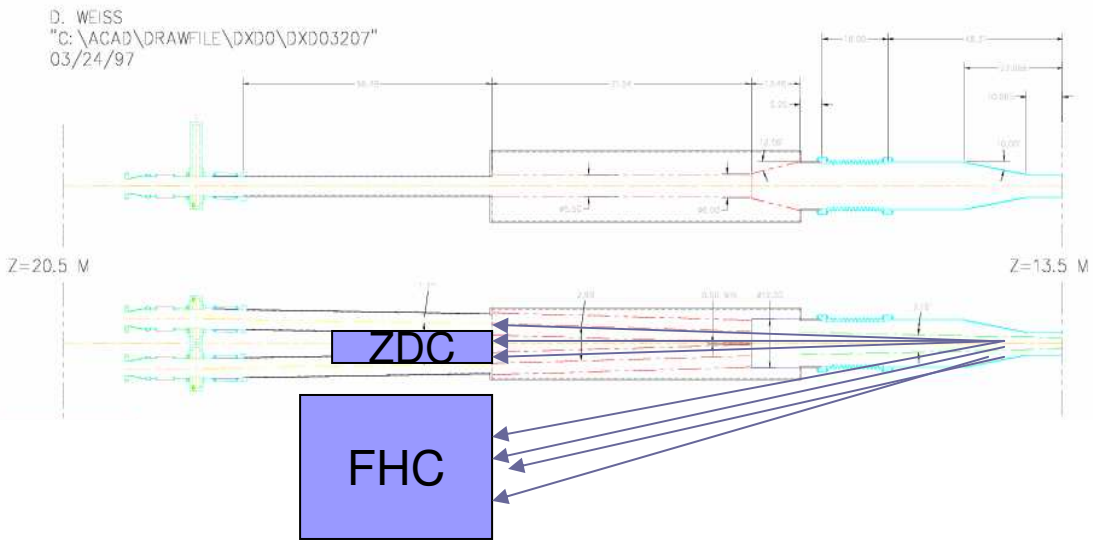
- Simple model results from last time
  - Centrality (ν) is most directly related to the number of grey nucleons
  - Black neutron relation is smeared
  - E_t and multiplicity provide very little leverage
- ZDC measures black nucleons (by design)
- Grey neutrons significantly covered by rings
- Black and grey protons separated and measurable





Grey protons look most promising

Position:



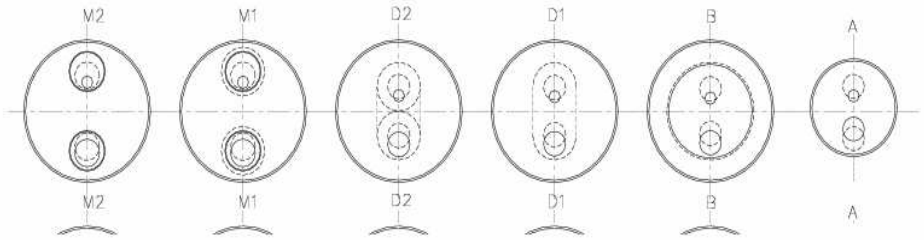


Figure 1: DX-D0 Interconnect

- Large multiple scattering between bending magnet and upgrade in DX-D0 interconnect wall
  - Change of DX-D0 interconnect wall? Not this year.
  - Measure total energy, not individual protons?
  - Simulations ongoing
- Phototubes are above ZDC.
  - Geometry of grey neutron measurement is difficult
  - Geometry for protons is easy

Scroung-a-cal

- Specifications:
  - Large (60 x 60 cm face – 8-10λ_{INT} deep.)
  - Fair energy resolution
  - Fair timing resolution
  - Cheap, easy and available

- Possibilities:
  - Small Cu calorimeter at BNL (Test beam calorimeter)
  - Large Fe calorimeter at FNAL (E609/E683)
  - Large Pb calorimeter (E864)

E609/683 – Jets at FNAL fixed target (400 GeV protons)

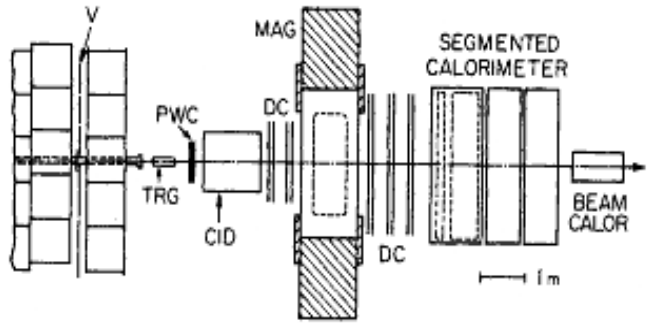


FIG. 1. Plan view of the E-609 experiment. *V*, veto counters; TRG, hydrogen target; DC, drift chambers.

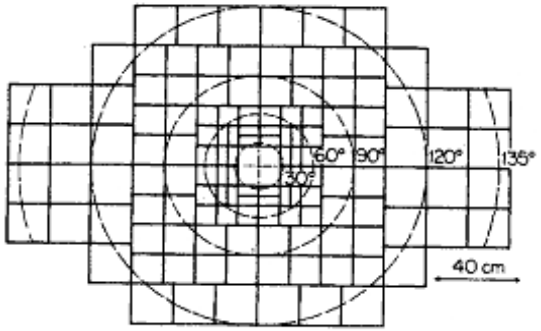


FIG. 2. Cross section of the front face of the calorimeter showing the transverse segmentation of the array. The circles show center-of-mass polar angles for 400-GeV/*c* *pp* interactions.

- Segmented Fe-Sci calorimeter
  - Segmentation radiation depth (6-8 Λ_I) and L_{Sci}/L_{Fe} dependent on position relative to beam

$$\frac{\partial E}{E} = \frac{70\%}{\sqrt{E}}$$

  - Construction started in 1982 (IEEE NS-29, `82)
  - Data collection ended 10 years later

Scheduled for the scrap heap

- Unused for 10 years.
- Stephen Pordes (Deputy Head of the Particle Physics Division) tried to quickly scrap it in early December.
- Calorimeter sitting outside for a few weeks, but most components look ok.
- Finer segmentation modules were shielded from the elements.
- LLNL crew trip to FNAL (February) to excise modules of interest from interior of calorimeter.
- Modules are being packed and can be shipped RSN.
  - Looking for space at BNL

E864 Calorimeter (most promising)

- Details:
  - Pb-Sci fiber
  - 10cm x 10cm face
  - 750 modules

$$\frac{\partial E}{E} = 3.5\% + \frac{34\%}{\sqrt{E}}$$

$$\partial t = 400\,ps$$

- Acquired help from G. Kunde to get info on current status
- Need ~40 channels
  - Enough channels for all 4 RHIC experiments on both sides (if necessary)
- Bases have built in discriminator with ADC/TDC info

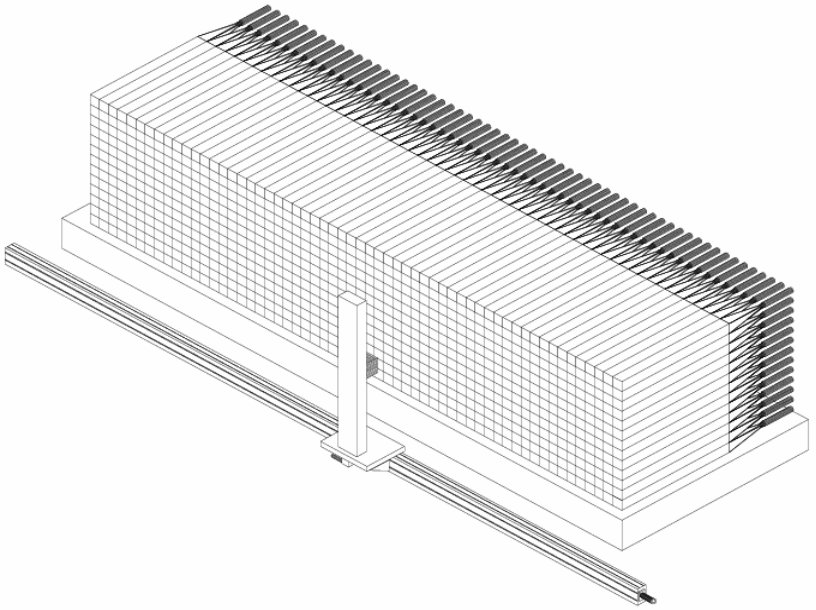
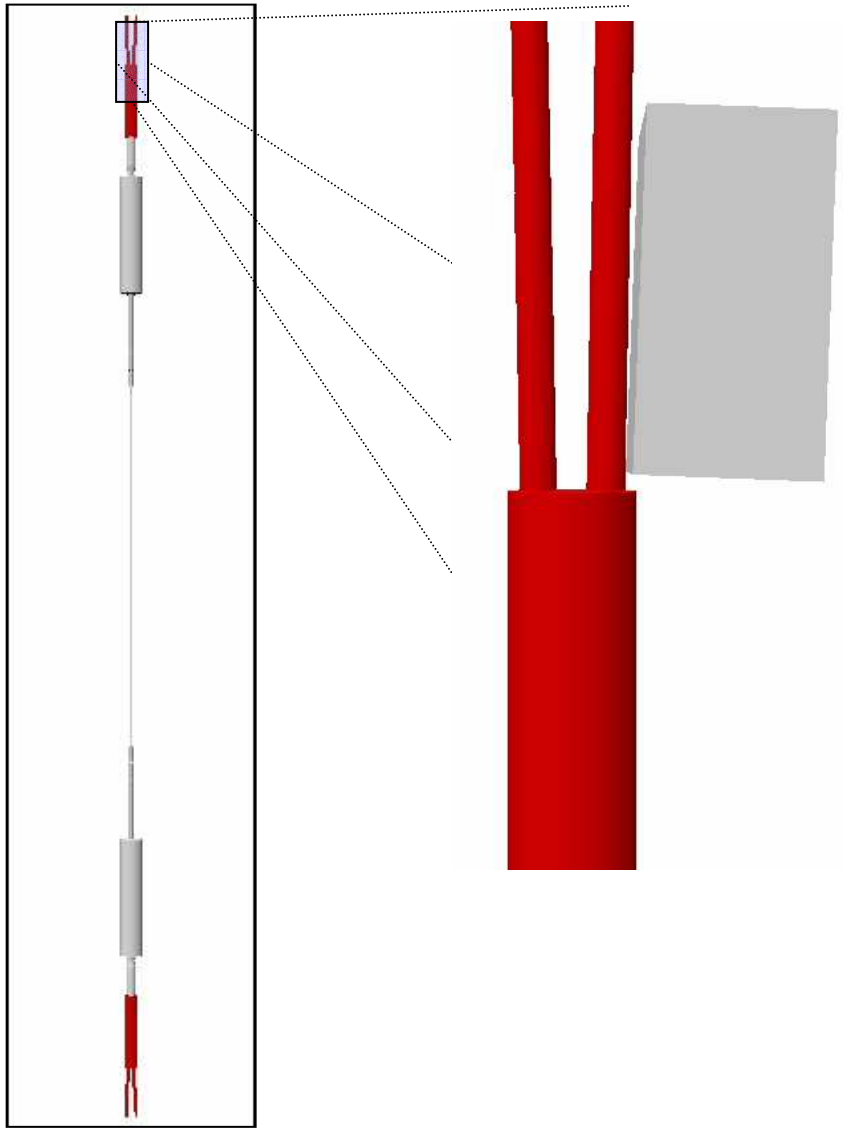
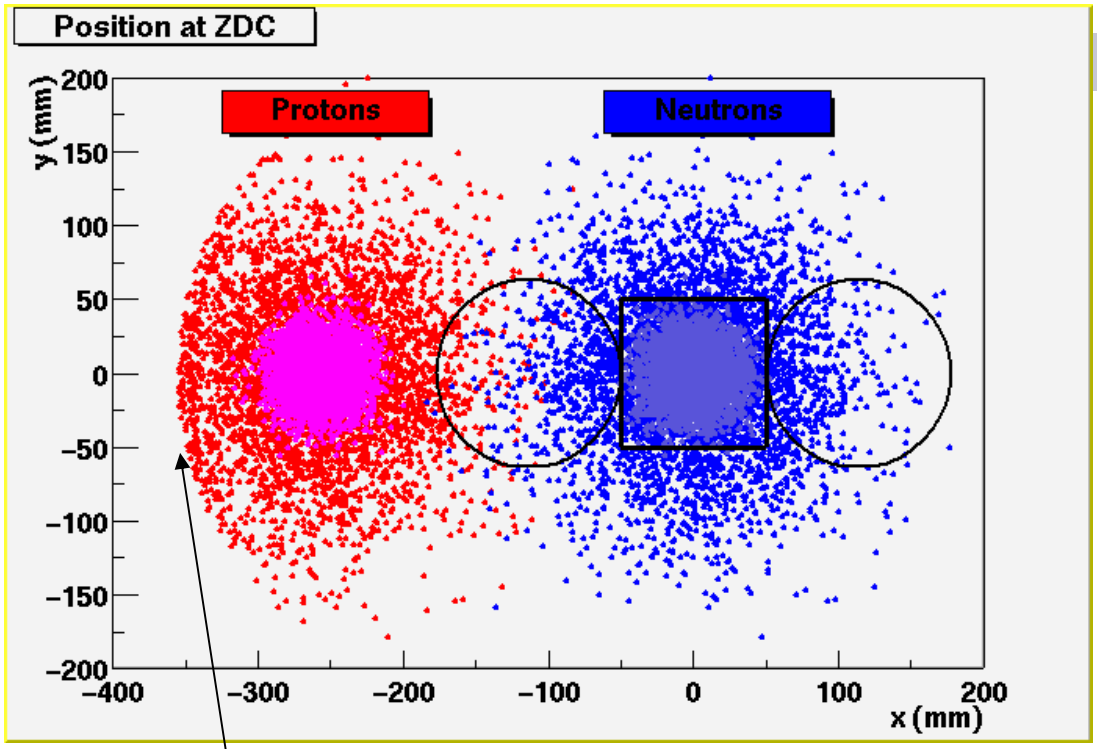


Fig. 2. View of the E864 Calorimeter and ^{60}Co source transport calibration system. The calorimeter comprises 58×13 towers mounted in a close packed geometry with no gaps between them. The tower design is based on a "spaghetti" design discussed in the text. Each tower is read out with a single PMT at the back.

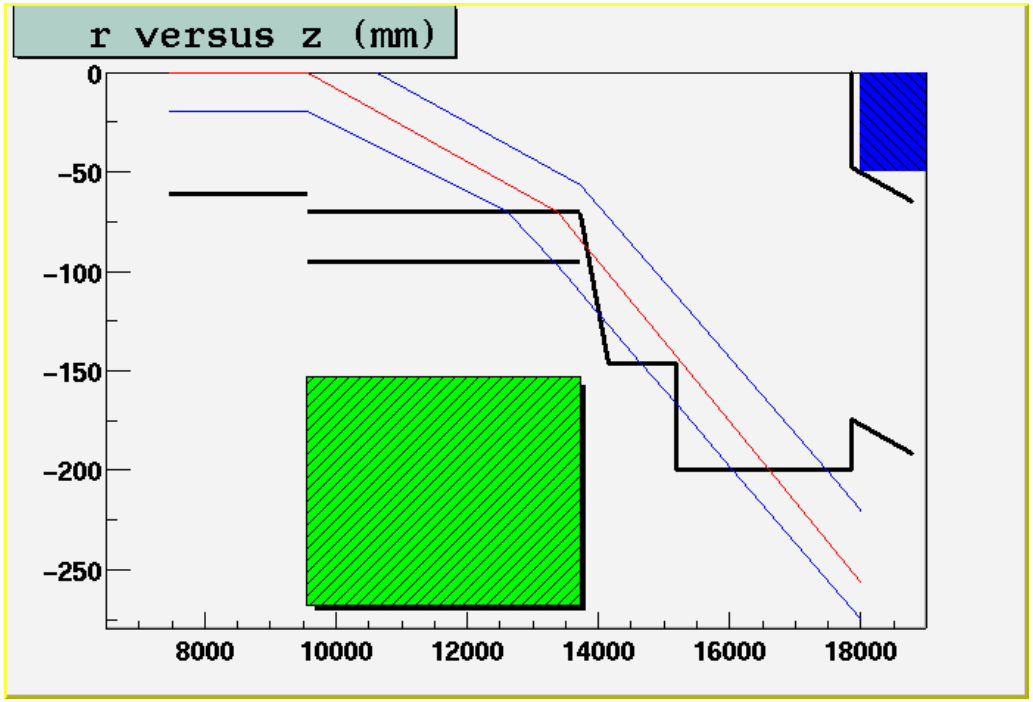
Simulations ongoing in Geant 4



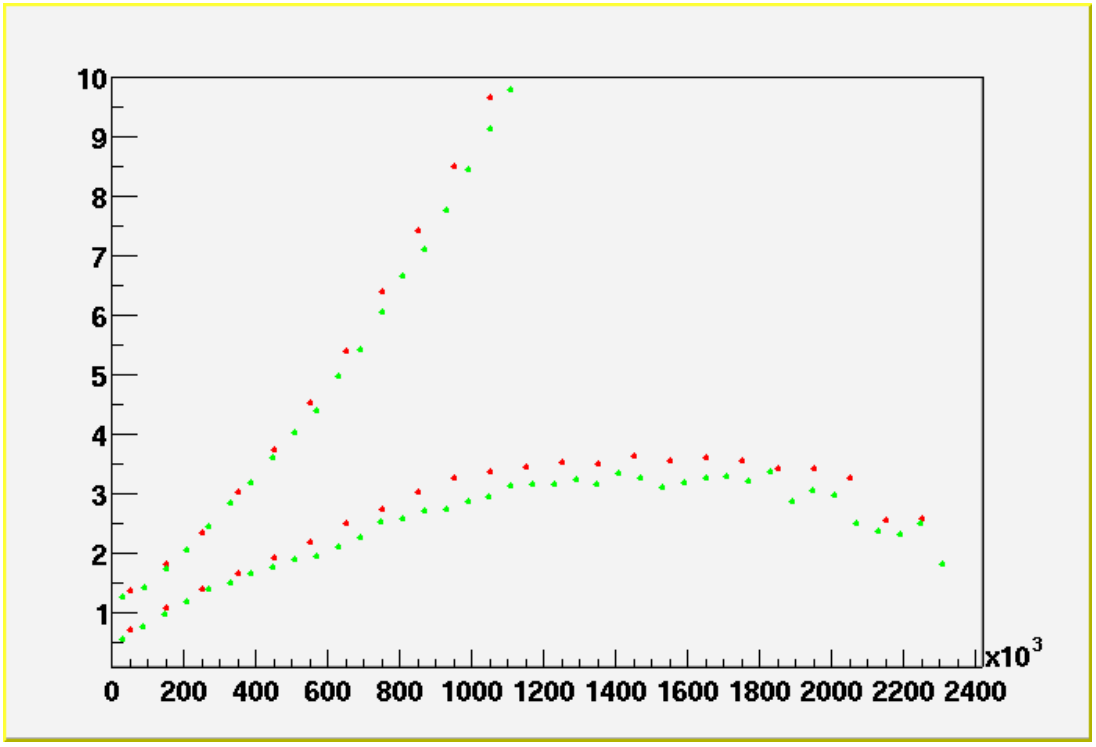
- Use HIJING as simple Glauber with Nch, Et, Nbinary, Npart information
- Use E910 parameterization of <Ngrey(ν)> (PRC 60, 024902)
  - Binomial distribution
  - Assume energy independence
- E. Stenlund and I. Otterlund, Nucl. Phys. B198 (`82) 407 for relation between Ngrey and Nblack.
  - Emulsion data
  - Scaled from AgBr to Au
- Swim through geometry from ZDC studies
- Add simplified 864 calorimeter (sampling instead of spaghetti)
  - 6x6 modules (60cmx60cm) – a little big


Position at ZDC
Protons
Neutrons
y (mm)
x (mm)
200
150
100
50
0
−50
−100
−150
−200
−400
−300
−200
−100
0
100
200

Unphysical??


r versus z (mm)
0
−50
−100
−150
−200
−250
8000
10000
12000
14000
16000
18000

25
20
15
10
5
0
500
1000
1500
2000
2500
3000
x10^3


10
9
8
7
6
5
4
3
2
1
0
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
x10^3