Wounded nucleons and binary collisions

- nuclear physics doesn't vary with IR
- but global detectors do vary (the common ZDC's help limit this variation a bit) and sensible discussion of $N_{part,}$ N_{coll} depends on detector specifics
- basically ...
  - determining average values not impossible
  - determining fluctuations about those averages is harder
  - determining reliable systematic errors consumes most of the effort

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Numerical approaches

- we have code which implements optical approximation
  - Woods-Saxon nuclear density
  - $T_A(b)$, $T_{AB}(b)$, pdf's, statistical fluctuations all accessible
- but still leaves open the question of how to draw correspondence with real collisions as characterized by available detectors

$$T_A(b) = \int \rho(z,b)\,dz$$

$$T_{AB}(b) = \int d^2s\, T_A(s) T_B(|s-b|)$$

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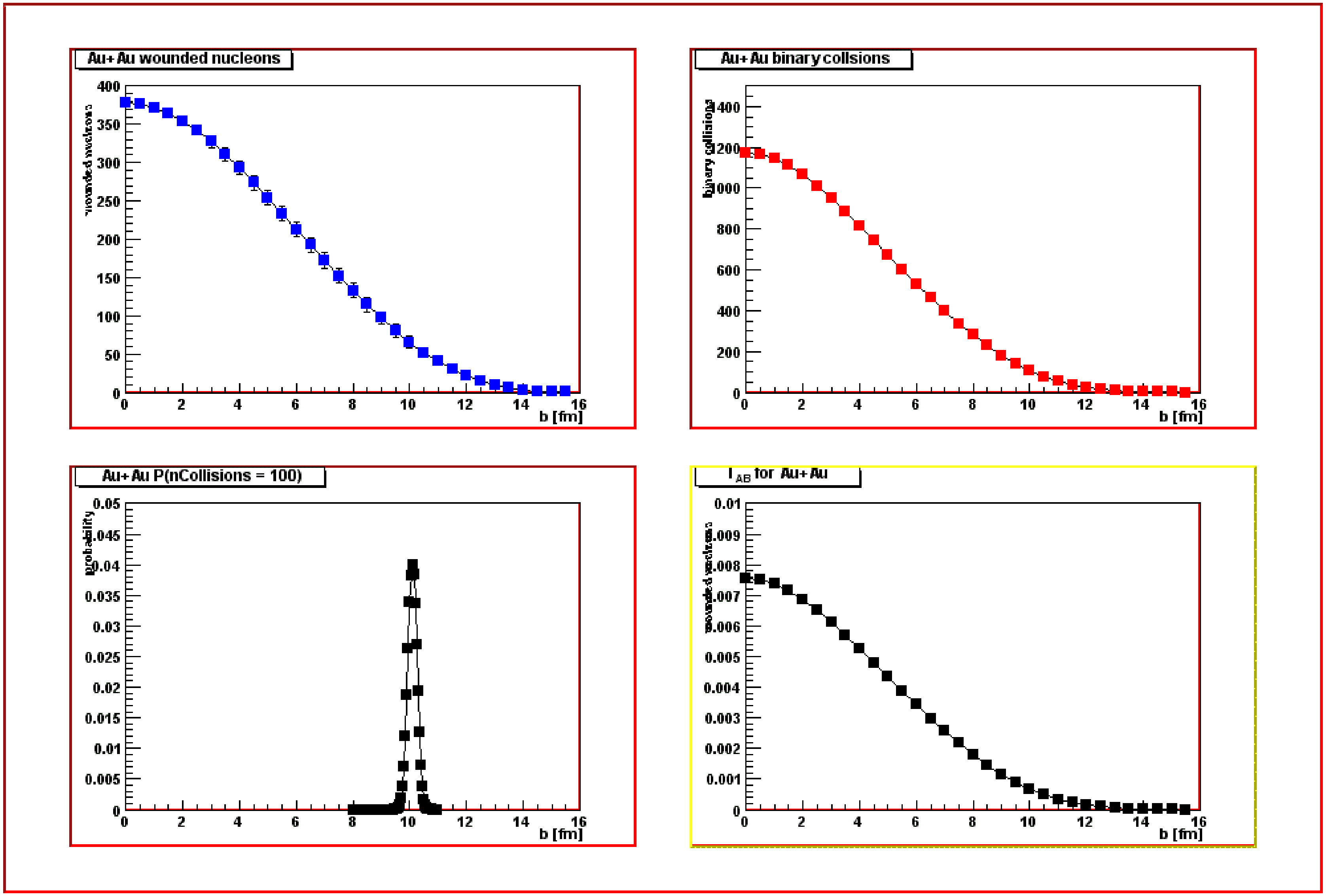


Au+Au wounded nucleons
wounded nucleons
b [fm]
Au+Au binary collsions
binary collisions
b [fm]
Au+Au P(nCollisions = 100)
probability
b [fm]
AB for Au+Au
b [fm]

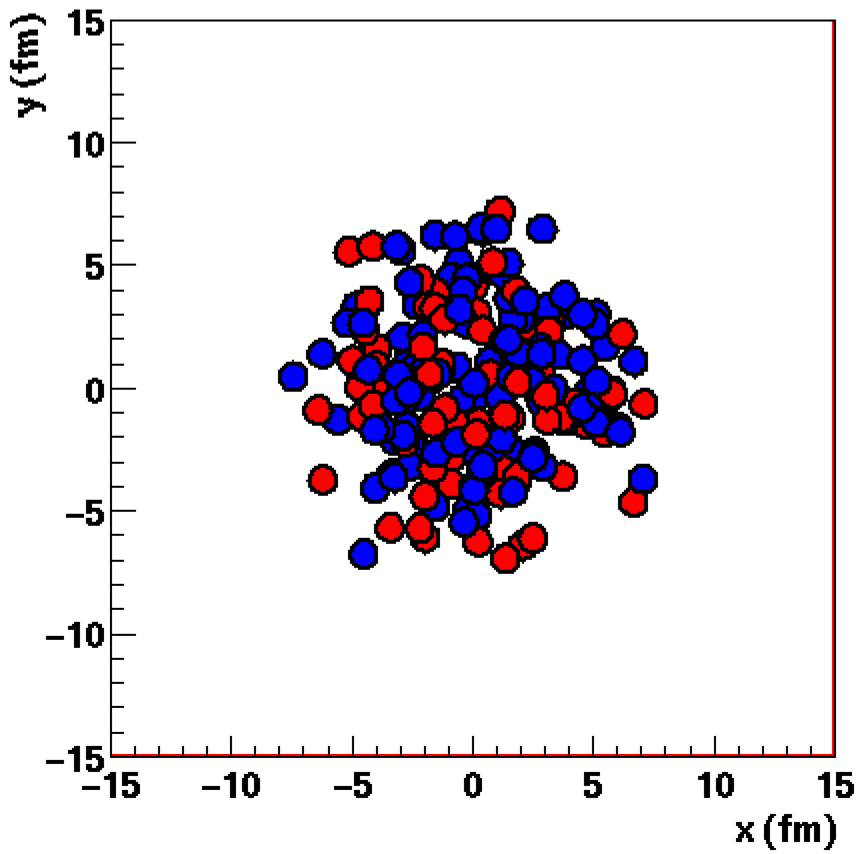
Monte Carlo methods

- this is the approach used in current analyses
  - work driven (and largely done) by Klaus Reygers
  - similar to work done for WA98
- chose to build up from simple code rather than pare down more complex one (in part because it gives us knobs we know how to twiddle)

Nuclear geometry

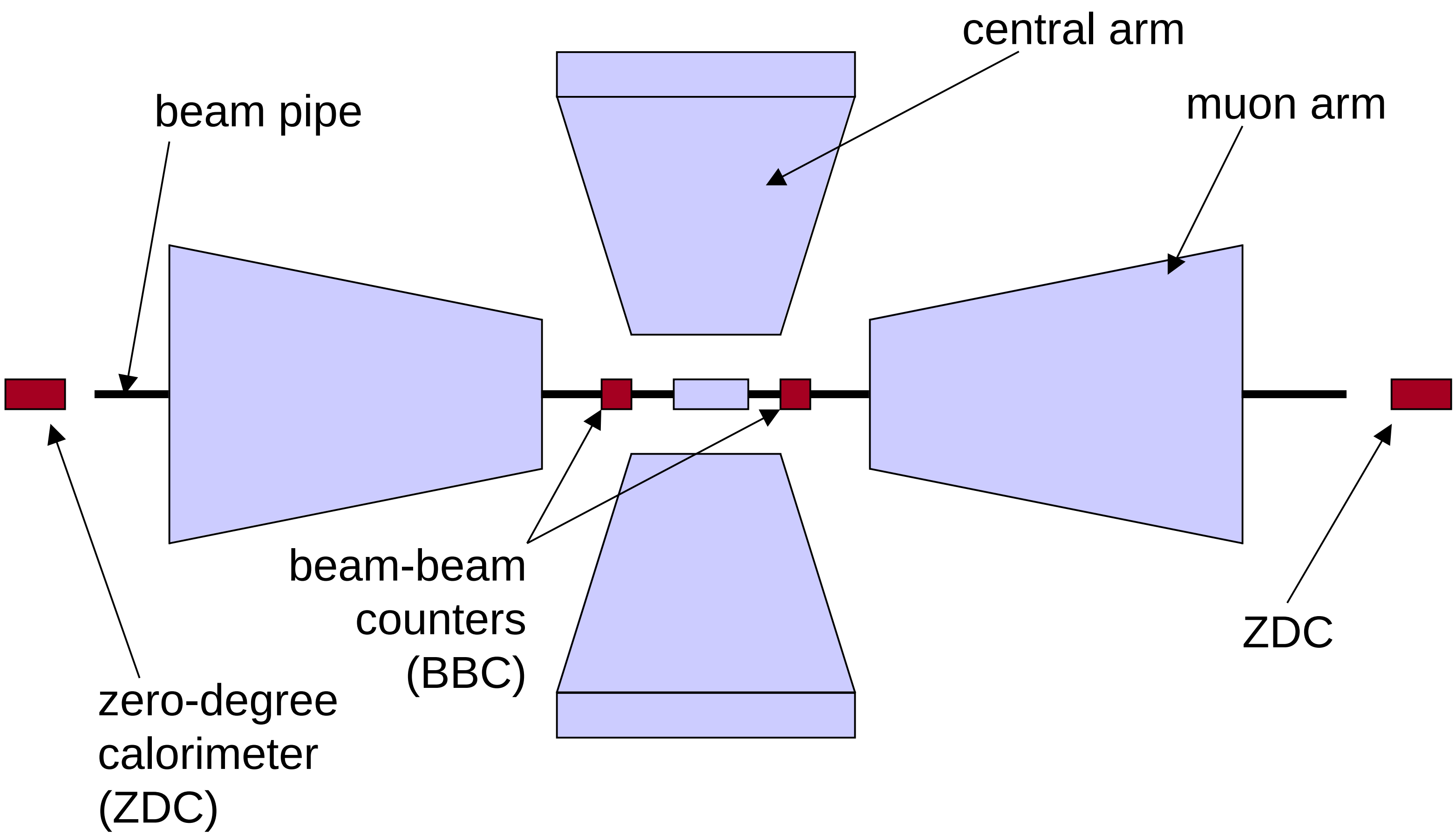
- had used parameterization as in VENUS: 6.65fm, 0.54fm
  - used also by Date, Gyulassy, Sumiyoshi, PRD32 (1985) 619
  - slightly, um, murky provenance
- MJT dug heartily into the topic
  - back to Hofstadter, Phys. Rev. 101 (1956) 1131, down through the ages
- now using 6.38fm, 0.54fm as Woods-Saxon params
- effect is covered by systematic errors; had already investigated effect of varied geometry on results

Building a nucleus



- distribute nucleons according to Woods-Saxon
- straight-line trajectories
- collisions when nucleons within distance governed by σ_{NN}
- blue and red nucleons, just like PHOBOS

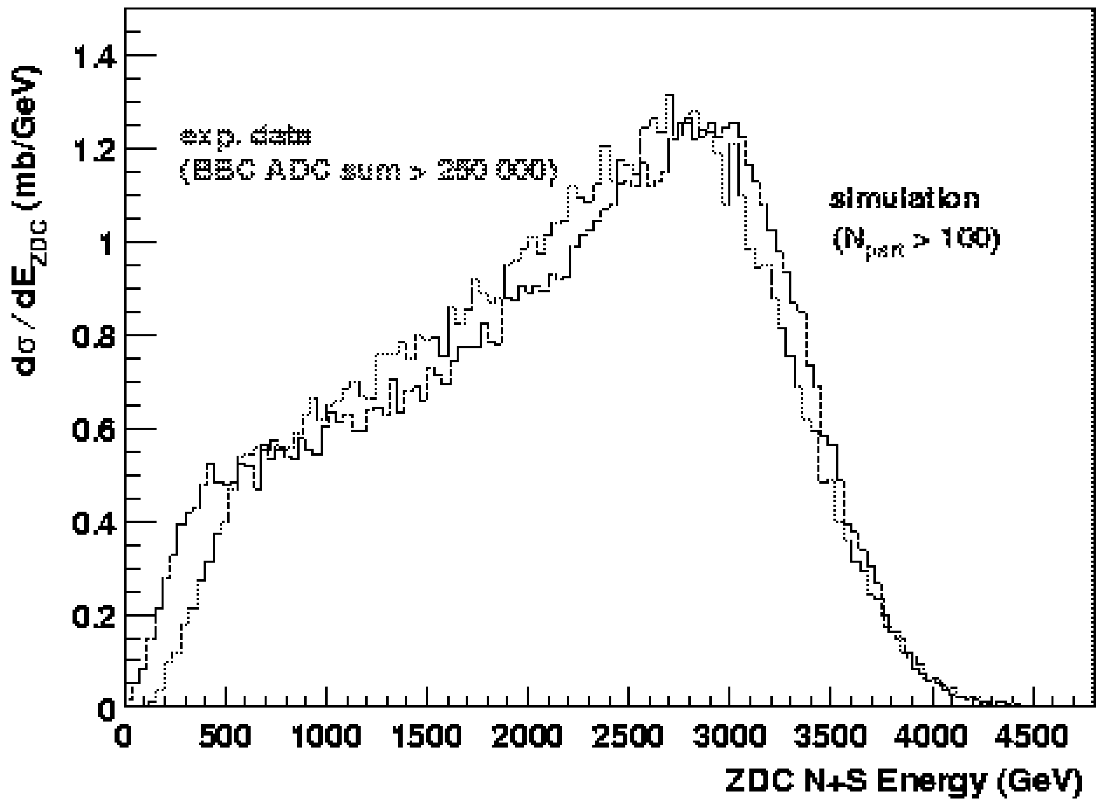
Layout of PHENIX



Forward neutrons and the ZDC

- based on measure of free neutron yield in NA49 setup, Eur. Phys. J. A2 (1998) 383
  - gives some guidance out to mid-centrality
  - 20% systematic error still leaves lots of uncertainty
  - extrapolation to peripheral collisions largely unconstrained
- comparison to JAM for central events agrees
  - JAM fine for most central 30% or so
- can reproduce shape well, overall scale 20-30% off, treated as a calibration factor

Reproducing the ZDC spectrum



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Simulating the BBC

- Beam-Beam Counter (BBC) roughly homologous to PHOBOS paddle counter
- assumed response approximately linear with N_{part}; tried different relationships to map systematic errors
- separately, convoluted Pythia p+p events through GEANT to study efficiency for detecting min bias Au+Au

Event classes

- ZDC distribution is double-valued as a function of centrality, so need add'l information
- 2D cuts in BBC vs ZDC
  - cuts perpendicular to ridge line of distribution
  - "clock face" cuts
- events near edges of bins move from one class to another depending on exact prescription used, but doesn't affect extracted results significantly

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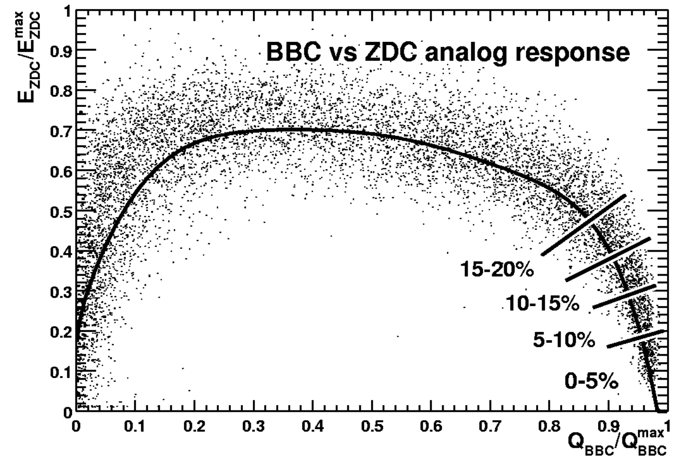
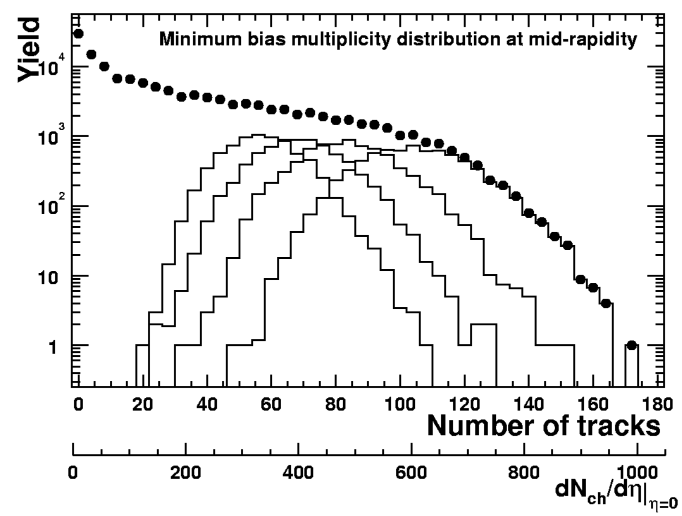
From the experiment ...

- Solid line indicates (Q_{BBC},E_{ZDC}) centroid positions for fixed Pad Chamber multiplicity
- Centrality classes were defined with cuts perpendicular to centroid-position curve





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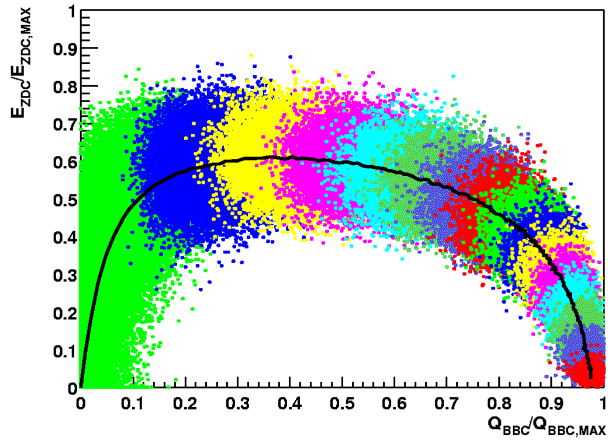
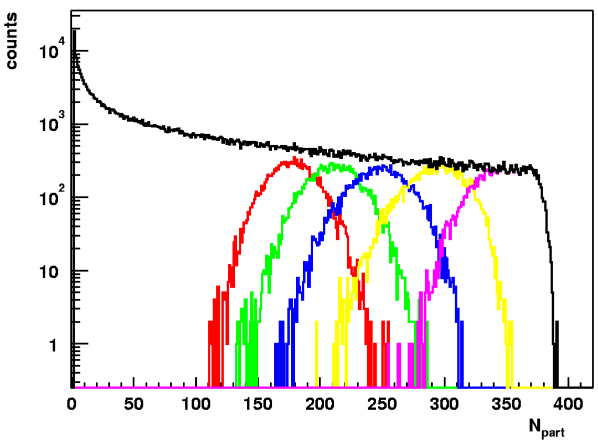
from K. Reyger's seminar

From the model ...

- Define centrality classes as in analysis of real data
- Extract mean of N_{part} and N_{coll} distribution for each class
- Estimate errors by varying model assumptions:





from K. Reyger's seminar

Estimating systematic errors

- default calculation (R = 6.38, a = 0.54, σ_{nn} = 40 mb)
- varied σ_{nn} from 37 to 43 mb, R from 6.25 to 6.65, a from 0.53 to 0.55
- BBC with and without saturation
- overlapping nucleons, hard core (0.4 fm) nucleons
- different neutron loss parameterizations, BBC response functions, experimental and theoretical centrality selections
- lots of work by Jamie Nagle, Sean Kelly, Mickey Chiu, others to study influence of fluctuations, detector response, other effects