Cu+Au Collisions at RHIC-- a way to mitigate the centrality fluctuations in searches for critical phenomena?

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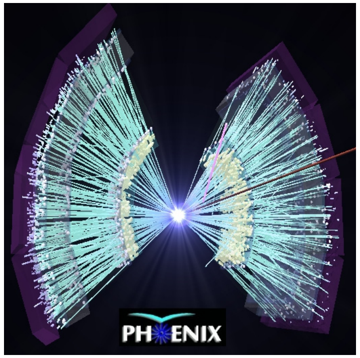
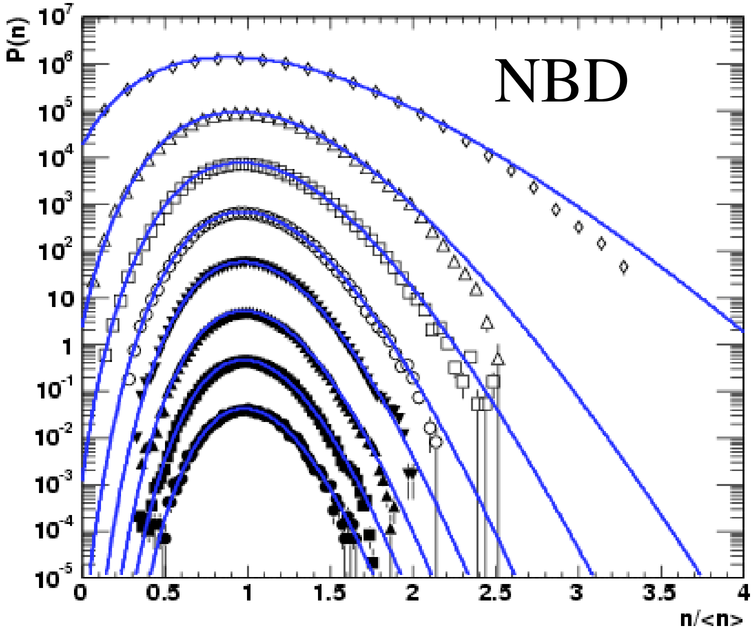
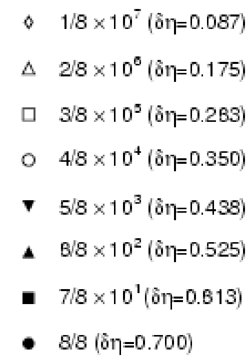


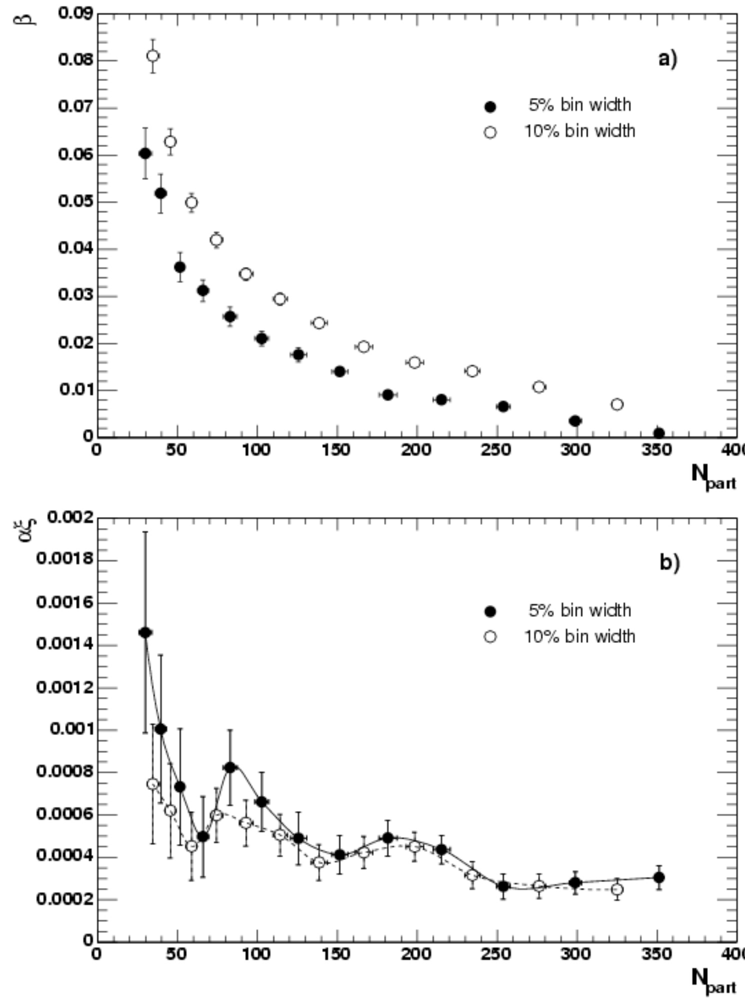
Quark Matter 2009
Knoxville, TN, USA

Centrality fluctuations dominate any other fluctuations so far observed at RHIC





$$\frac{\sigma^2}{\mu^2} - \frac{1}{\mu} = \frac{1}{k}$$

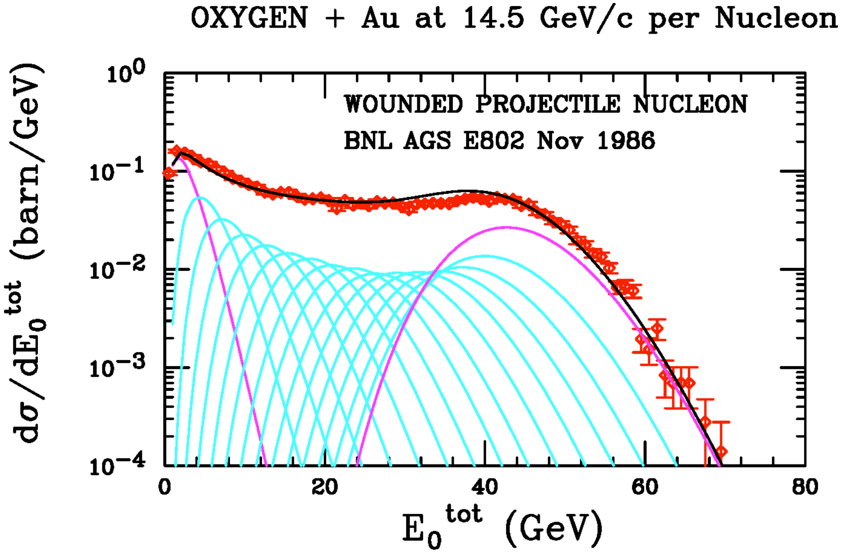


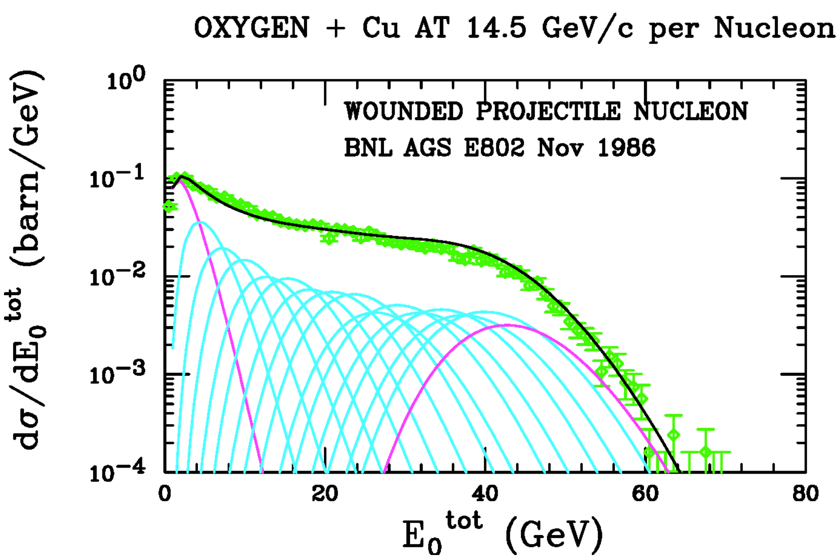
PRC76 (2007) 034903

$$1/k = F_2 - 1 = \frac{2\alpha\xi^2(\delta\eta/\xi - 1 + e^{-\delta\eta/\xi})}{\delta\eta^2} + \beta$$

$$k(\delta\eta) = \frac{1}{2\alpha\xi/\delta\eta + \beta} \qquad (\xi \ll \delta\eta)$$

Famous plot from QM1987--E802-AGS



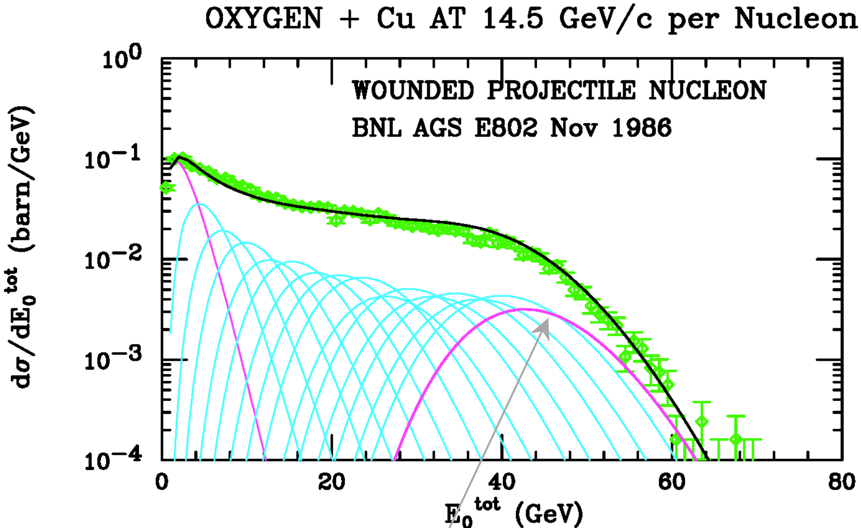


O+Au energy distribution in PbGl array covering:
$-0.5<\eta_{cm}<0.7 \quad \Delta\phi=2\pi$
$(1.25 < \eta_{lab}<1.44)$
p+Au was measured also
not corrected for response

E802 PLB197(1987)285
ZPC38(1988) 35-43

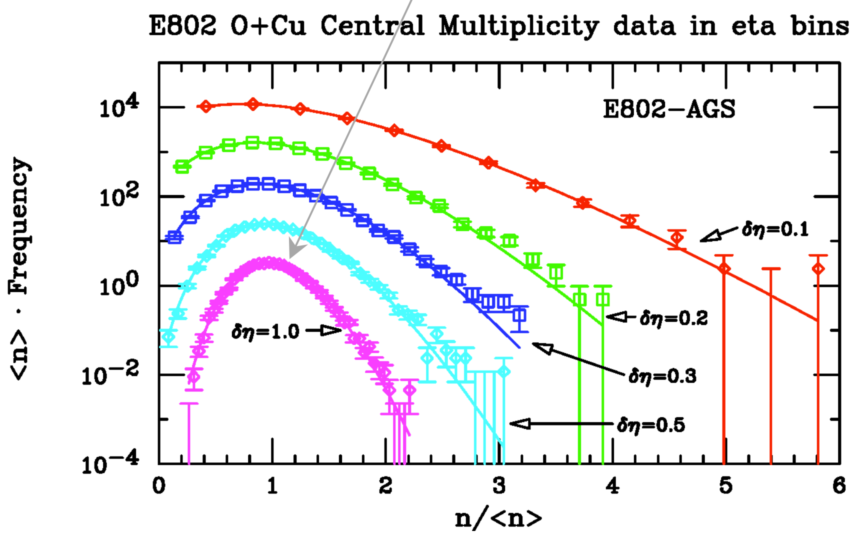
16 projectile participant peak visible, 14% of cross section in O+Au. Maximum E in O+Cu same as O+Au indicates O nucleus stops in Cu, [more precisely stops emitting particles at mid-rapidity in Cu]

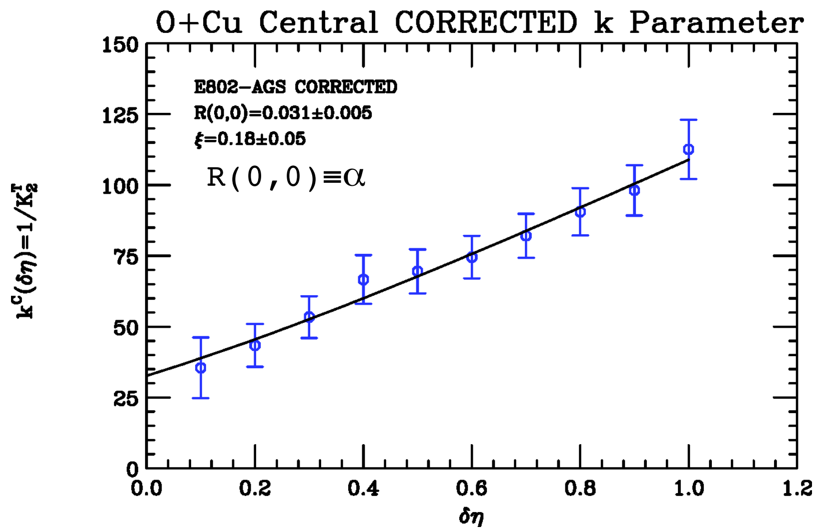
O+Cu central (ZCal=0) are effectively 16 wpn



Select central collisions in O+Cu using ZCal< 1 spectator
Measure evolution of central multiplicity with δη

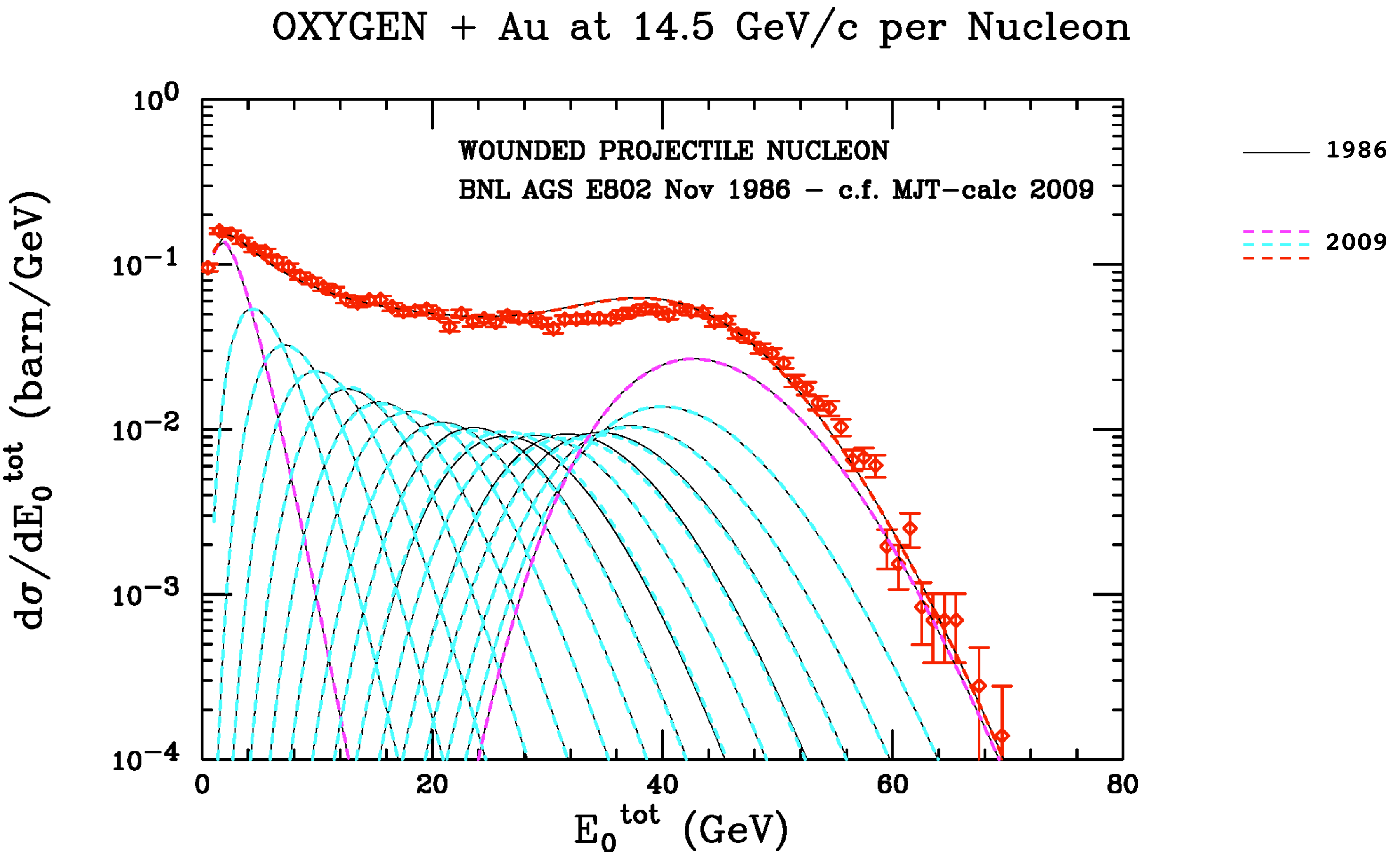
E802 PRC52(1992)2663





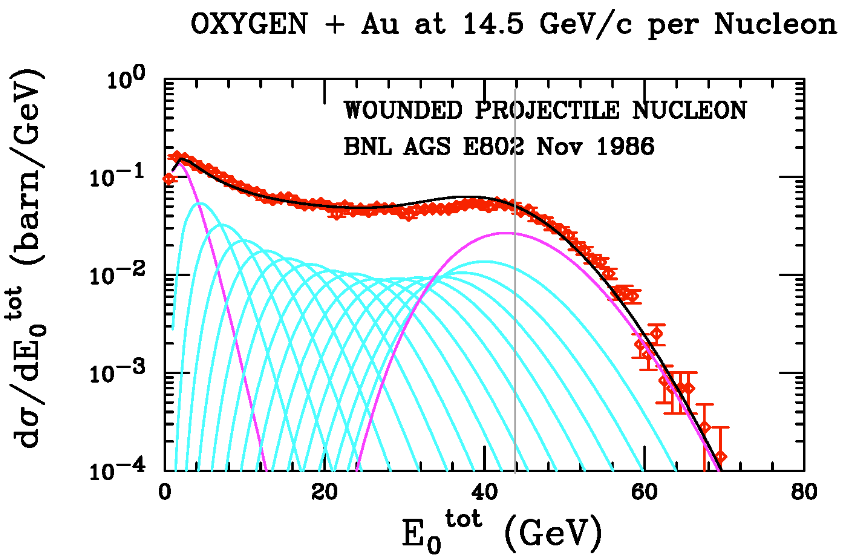
$$k\left(x=\frac{\delta\eta}{\xi}\right)=\frac{x^2}{2\alpha[x+(e^{-x}-1)]}$$

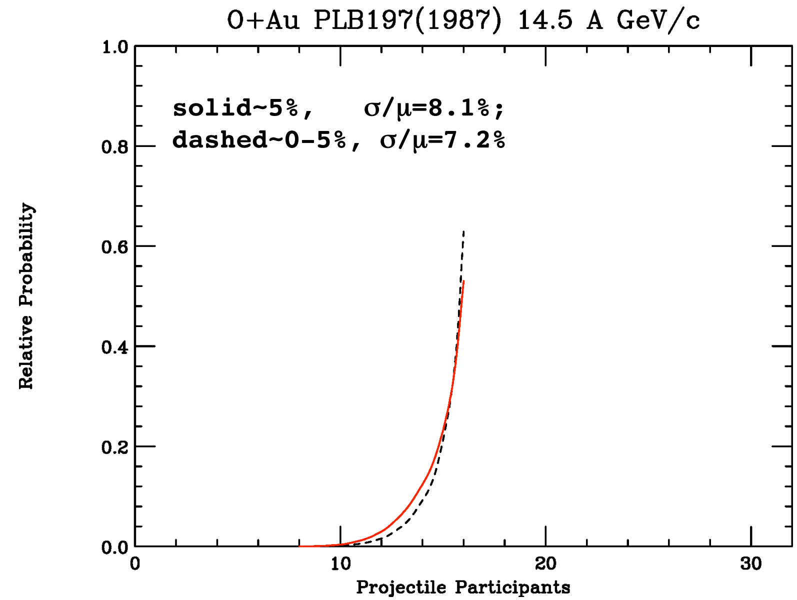
New calculation cf. QM1987--E802-AGS

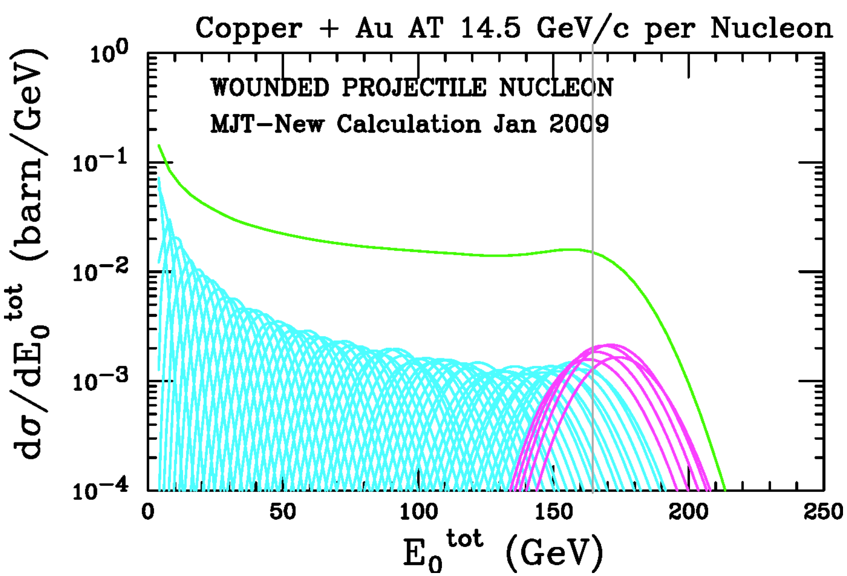


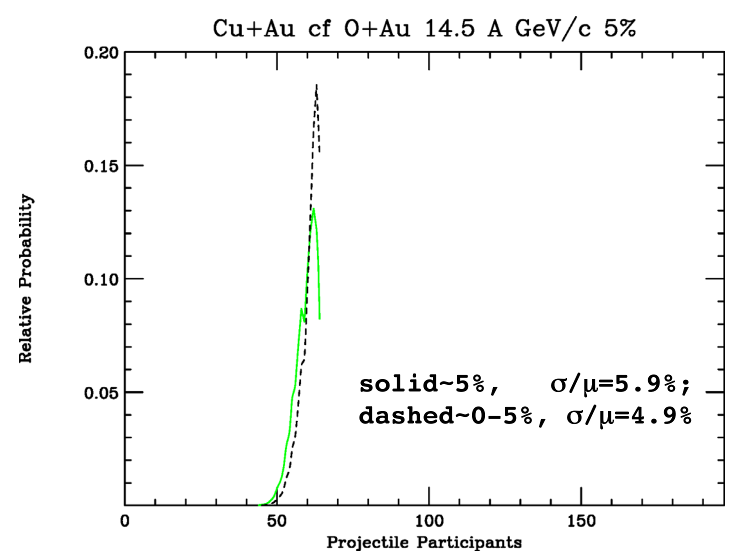
New calculations 2009 agree with original 1986

Calculation of CuAu vs OAu at AGS energy

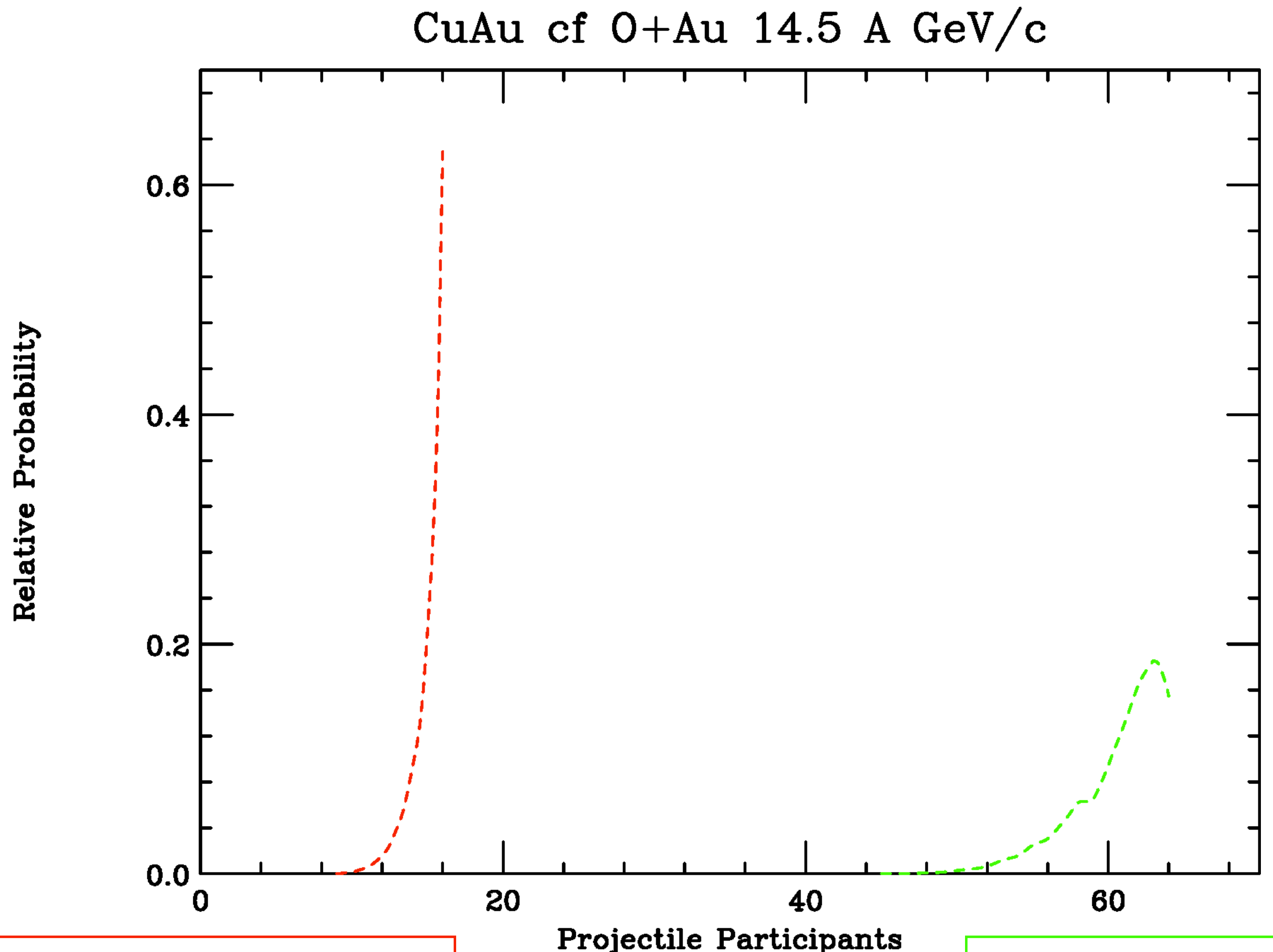








Participant Distribution 0-5% centrality



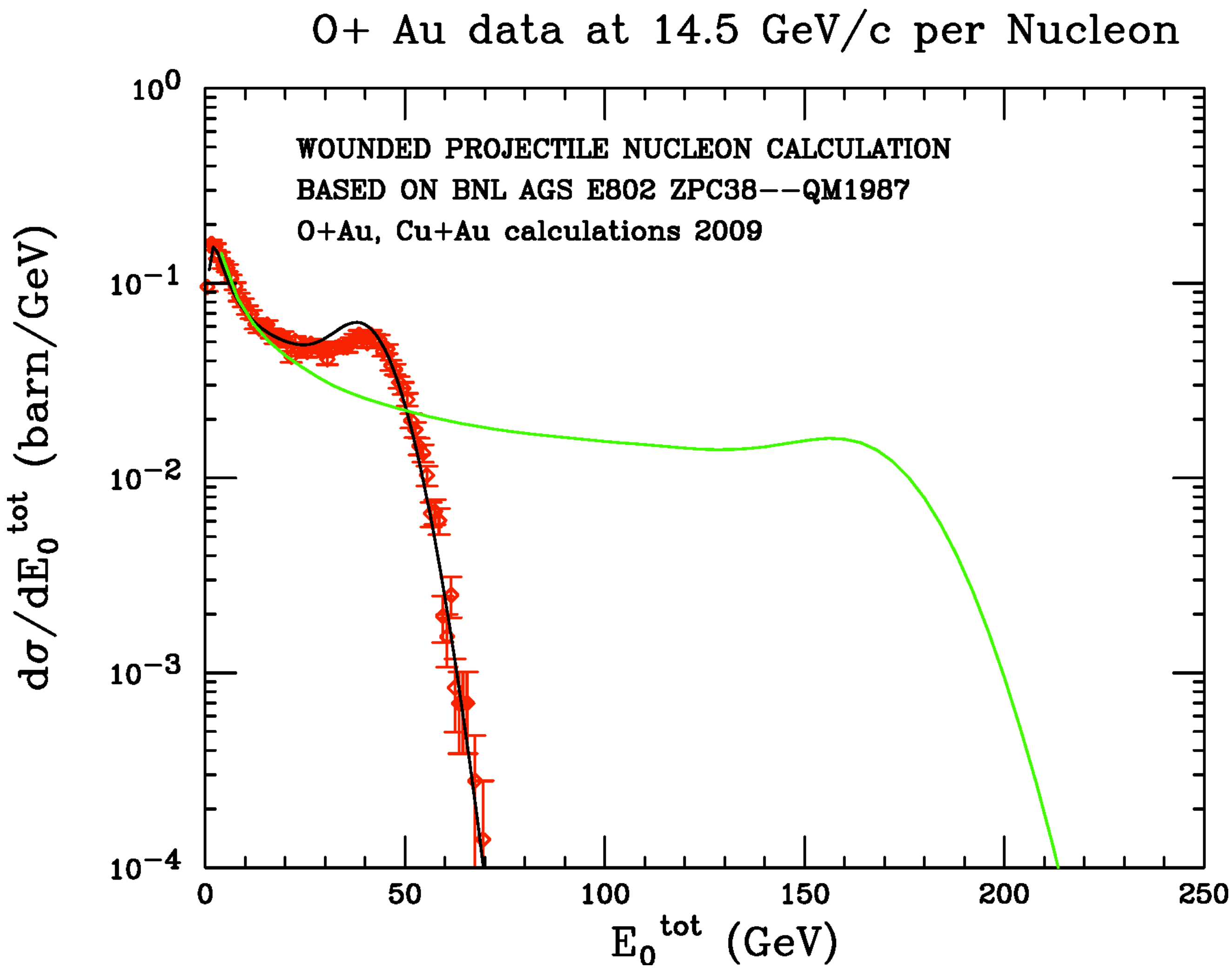
$\mu = \langle N_{pp} \rangle = 15.4 \quad \sigma/\mu = 7.2\%$

$\mu = \langle N_{pp} \rangle = 60.7 \quad \sigma/\mu = 4.9\%$

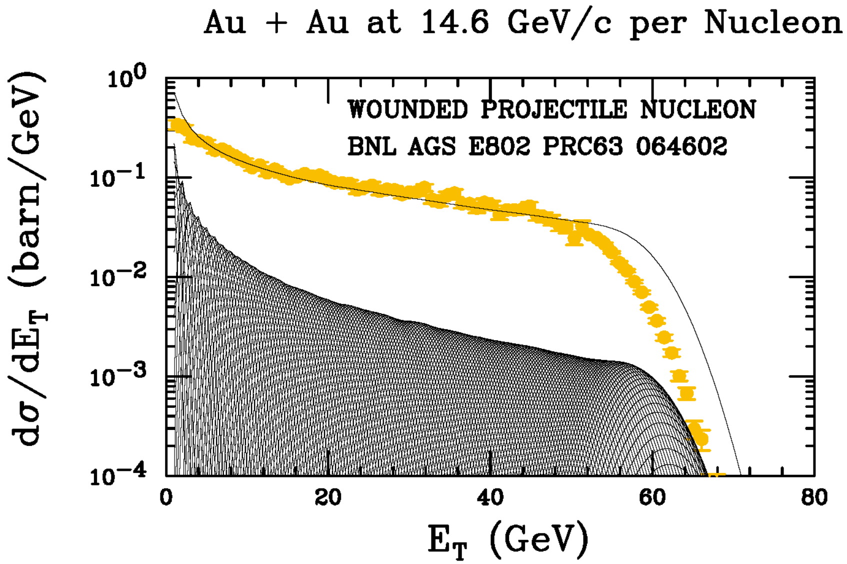
This looks great but $\sigma=1.1$ for $\mu=15.4$ gives large σ/μ

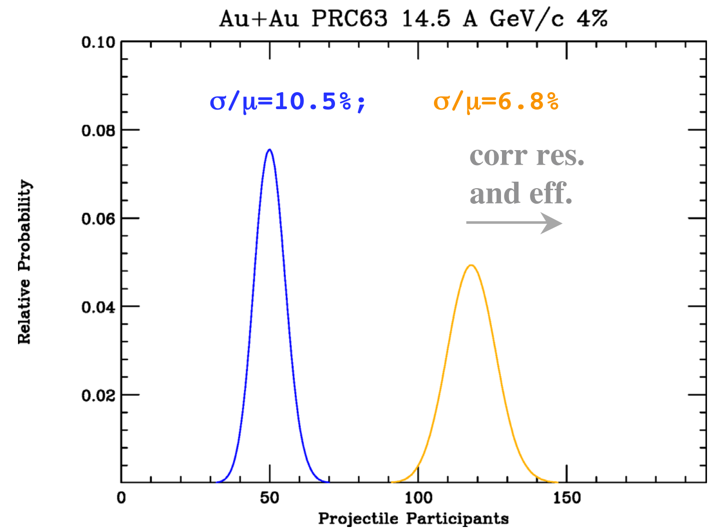
This looks wider but $\sigma=3.0$ for $\mu=60.7$ gives smaller σ/μ

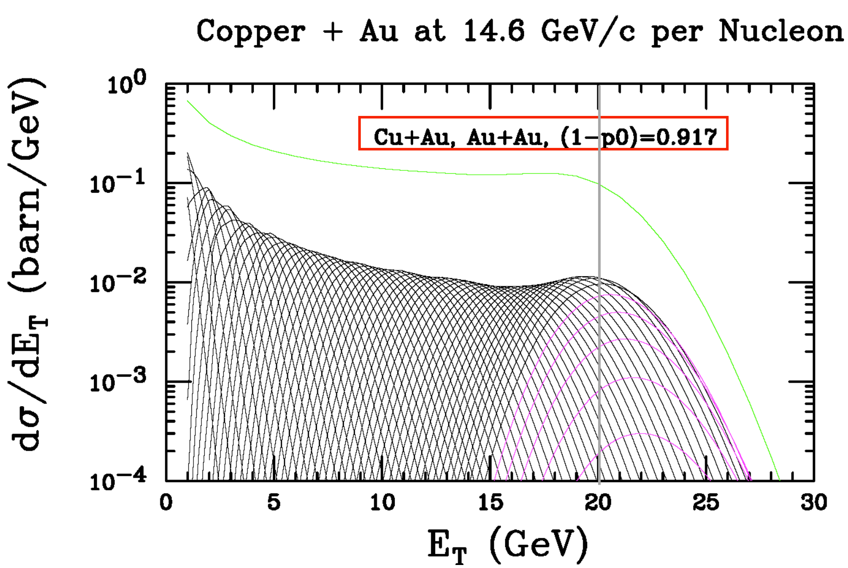
Cu+Au calculation cf. O+Au

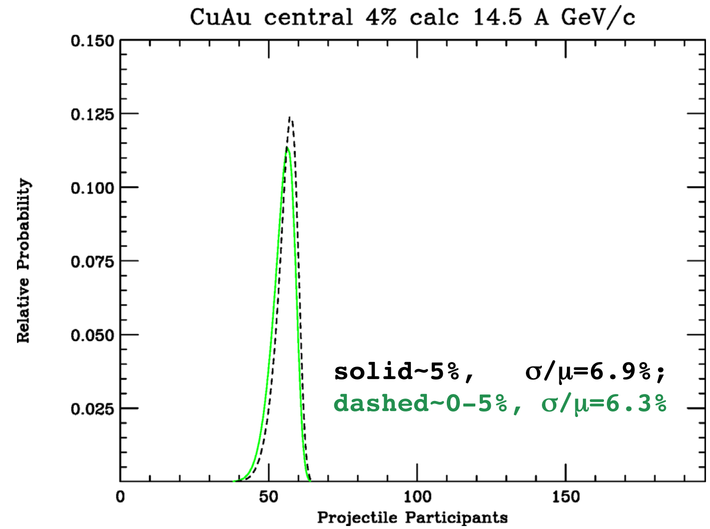


Au+Au E_T at 14.6 A GeV/c cf CuAu



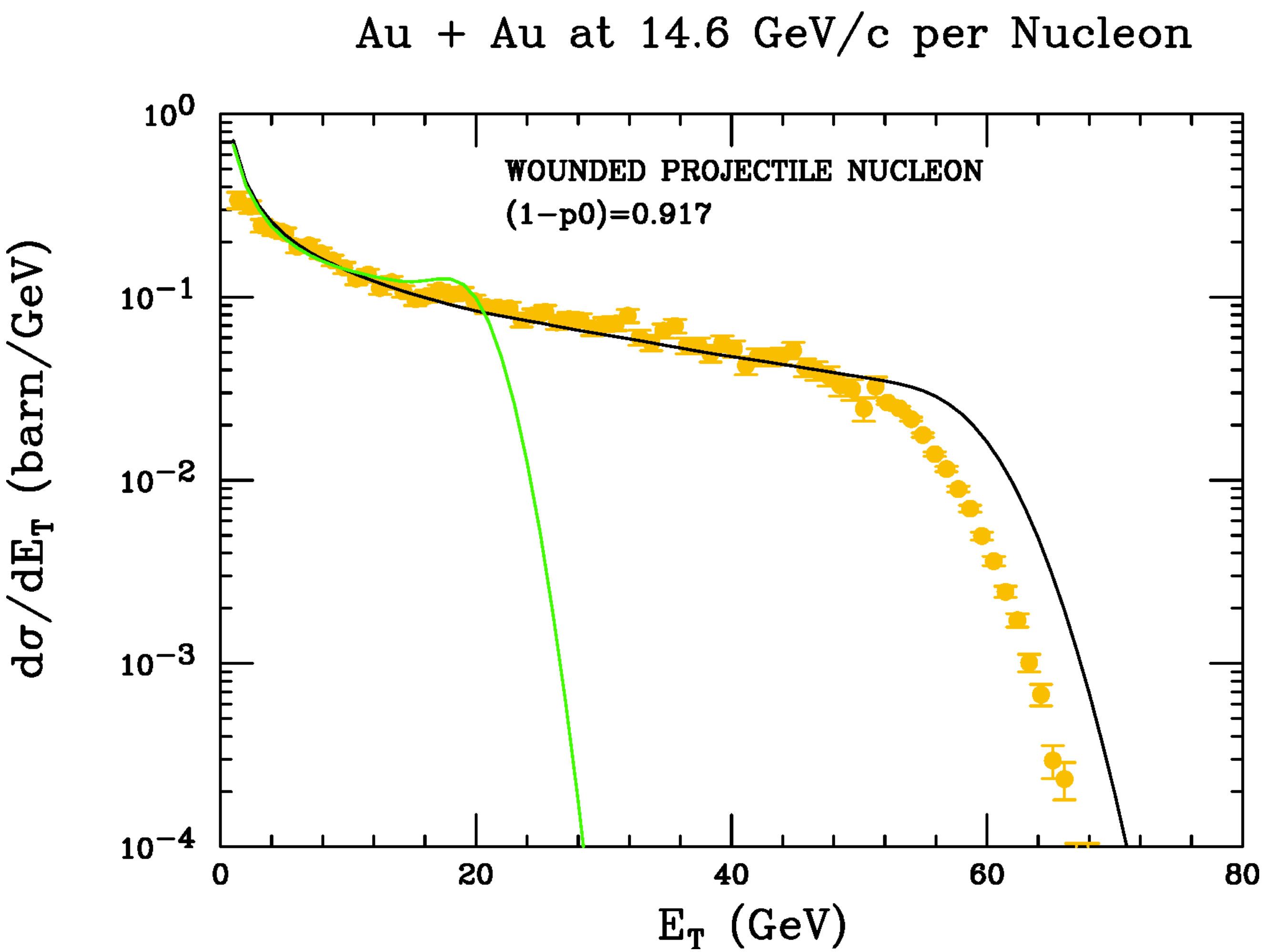




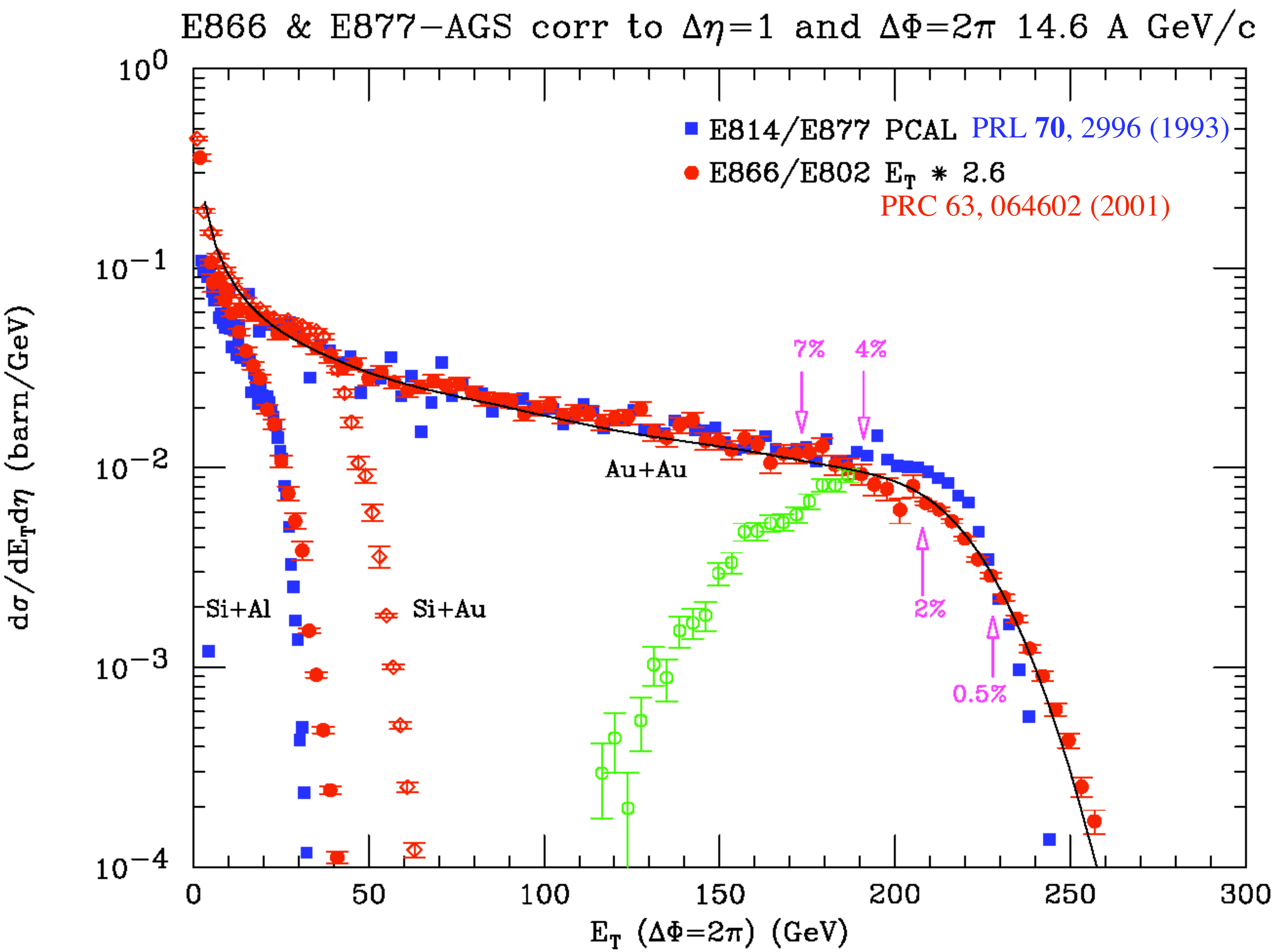


Realistic distributions and efficiencies reduce the improvement

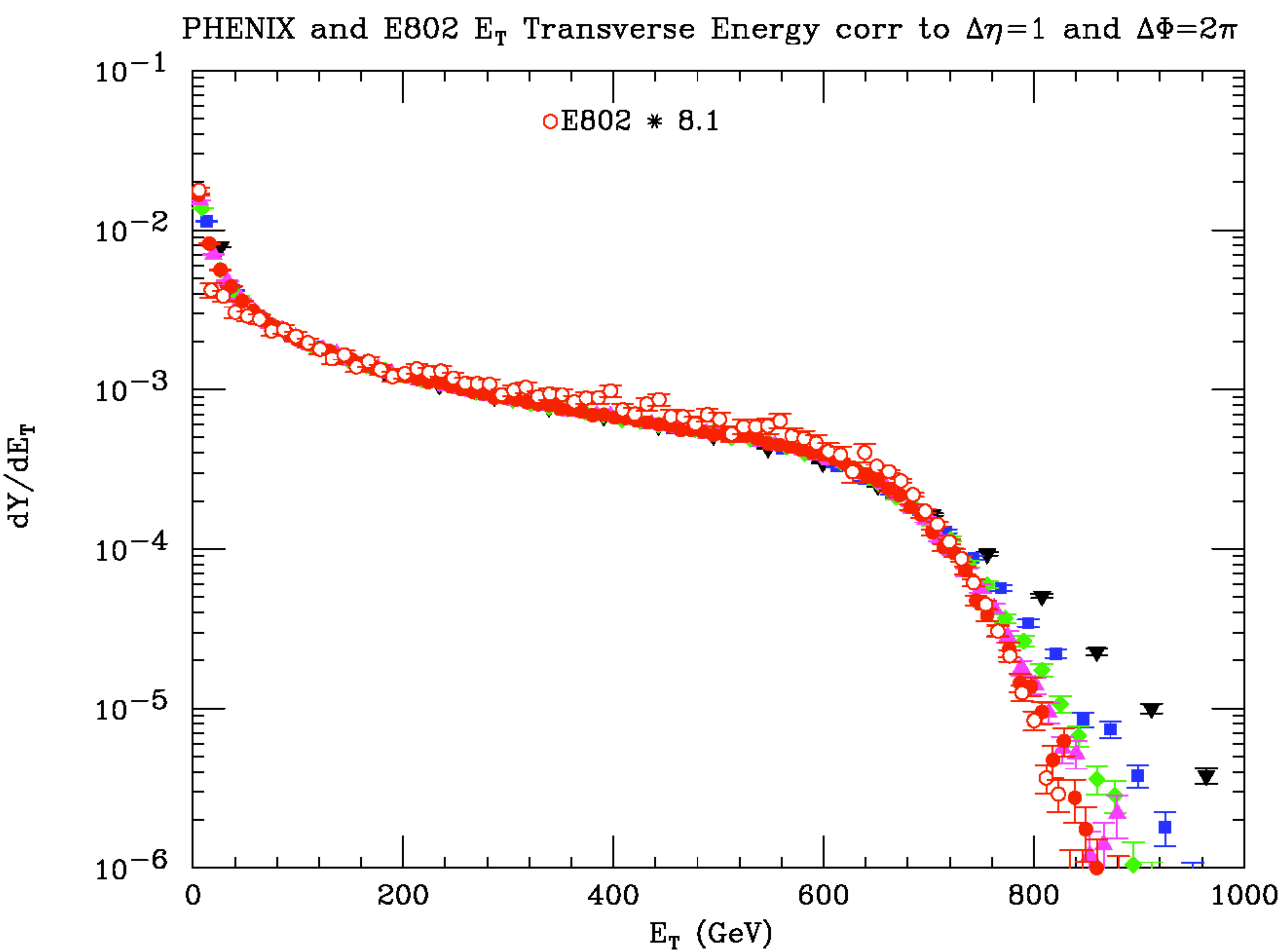
Au+Au E_T at 14.6 A GeV/c cf CuAu



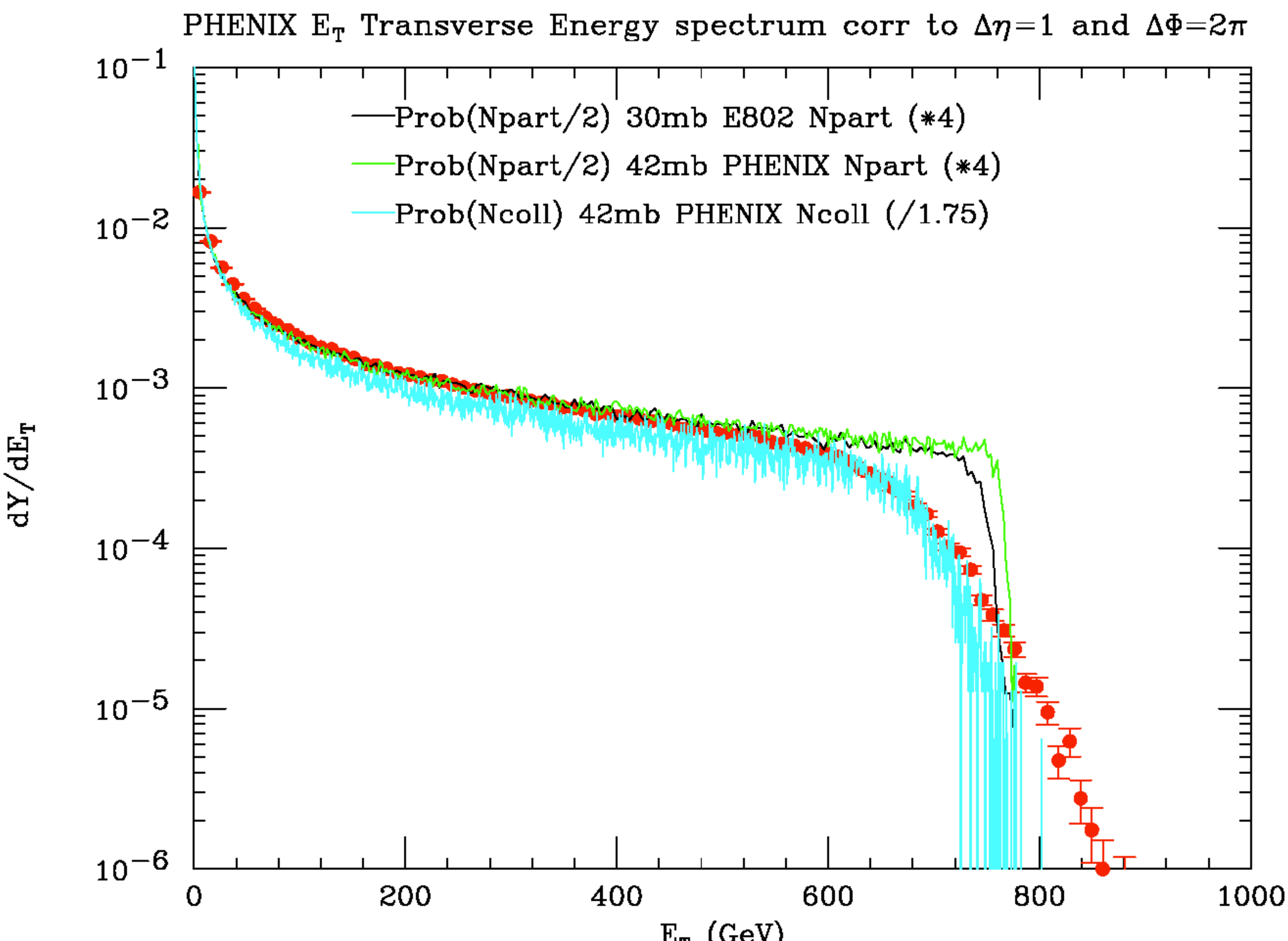
Typical E_T distributions in RHI collisions



Au+Au E_T spectra at AGS and RHIC are the same shape!!!



RHIC 2-3 times more E_T than WNM but:



Conclusion

♣ CuAu is a (modest) improvement over AuAu in fluctuations of Npart, $\sigma/\mu \sim 7\% \rightarrow 5\%$

♠ CuAu or even AuAu with a real ZDC +FCal which detected forward going protons + neutrons would be much better.

♦ A real (like fixed target) ZDC +FCal for low energy running would probably be a better investment than CuAu collisions.

♥Even just an FCal to select events with <1 or ≤ 1 forward protons might be useful for precision centrality definition and should be investigated from previous or future RHIC A+A data.

♥ The Ultimate might be FCal + CuAu, if warranted.