Low-mass di-electron production in Au+Au collisions at $\sqrt{S_{NN}}$ = 19.6 GeV at STAR

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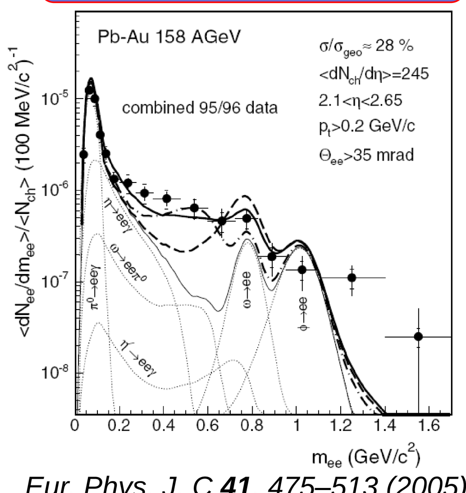
Abstract

An enhancement of low-mass di-electron production which is compared to expected yields from known hadron sources was observed by the CERES experiment at CERN SPS in 158 A GeV central Pb+Au collisions $\sqrt{S_{NN}}$ =17.3GeV). More recently, NA60 reported their di-muon measurements in 158 A GeV In+In collisions. The enhancement of di-muon at M < 1 GeV/c² can be described by a broadened spectral function. At RHIC, PHENIX experiment observed a significant enhancement in the di-electron continuum in Au+Au collisions at 0.15 < M_{ee} < 0.75 GeV/c² and p_T < 1 GeV/c. The models, which describe the SPS di-lepton data, have not been able to consistently describe the PHENIX data. STAR has recently presented preliminary results on the di-electron production in Au+Au at 200 GeV [1], which was made possible by the addition of full-coverage time-of-flight detector. The Beam Energy Scan program covering beam energies down to SPS energies, and STAR's large acceptance, allow for measurements that can provide invaluable insights in this subject.

In this poster, we present the mid-rapidity di-electron measurements in the M<1.2 GeV/c² mass region in Au+Au collisions at $\sqrt{S_{NN}}$ = 19.6 GeV taken in 2011 with the full Time-Of-Flight detector coverage at STAR. The di-electron production is compared to hadronic cocktail simulation. Comparisons to model calculations with in-medium vector meson modifications are made.

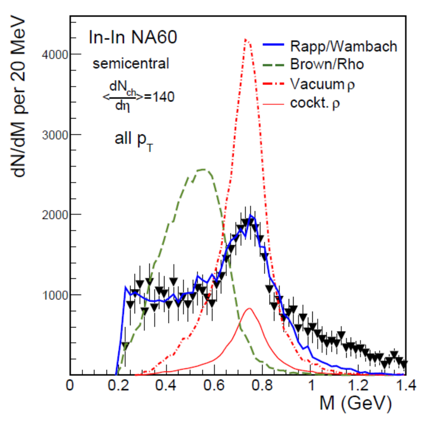
[1] Jie Zhao (for the STAR collaboration) 2011. J. Phys. G: Nucl. Part. Phys. 38 124134

Introduction



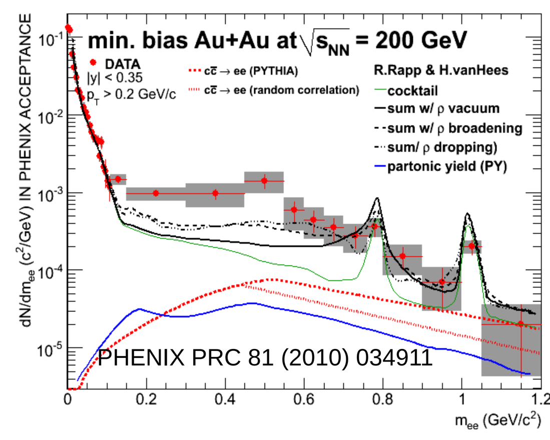
Eur. Phys. J. C **41**, 475–513 (2005)

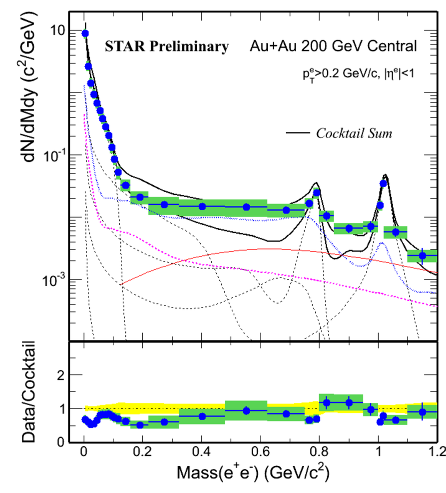
Di-electron enhancement at low mass region can be explained by both scenarios of broadening and dropping mass of ρ meson in CERES.



NA60: PRL **96**, *162302 (2006)*

NA60 precise measurement shows broadening scenario can match data very well.

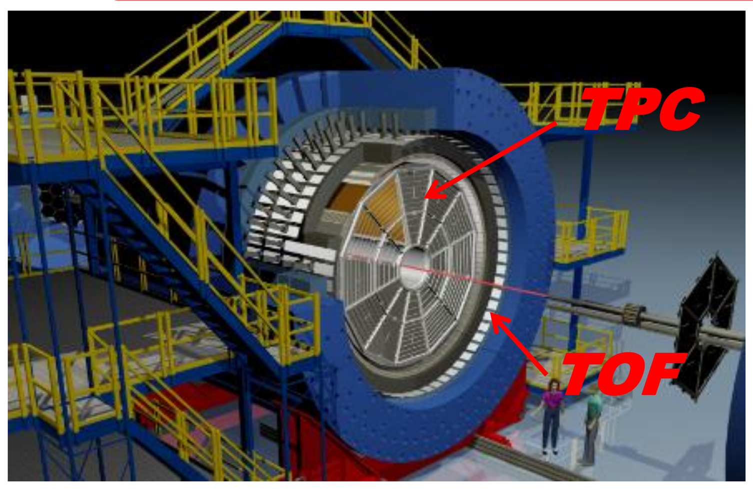




PHENIX Au+Au 200 GeV results can not be described by those scenarios. But STAR recent results from the same energy can be described reasonably well by the broadening scenario. This discrepancy drives us to study the di-electron production at 19.6 GeV since this energy is comparable to the center of mass energy for the CERES and NA60 results.

	Minbias (value ± stat ± sys)	Central (value ± stat ± sys)
STAR	1.53 ± 0.07 ± 0.41 (w/o ρ) 1.40 ± 0.06 ± 0.38 (w/ ρ)	1.72 ± 0.10 ± 0.50 (w/o ρ) 1.54 ± 0.09 ± 0.45 (w/ ρ)
PHENIX	4.7 ± 0.4 ± 1.5	7.6 ± 0.5 ± 1.3
Difference	2.0 σ	4.2 σ

Data set and PID



Au+Au 19.6 GeV: 34 M

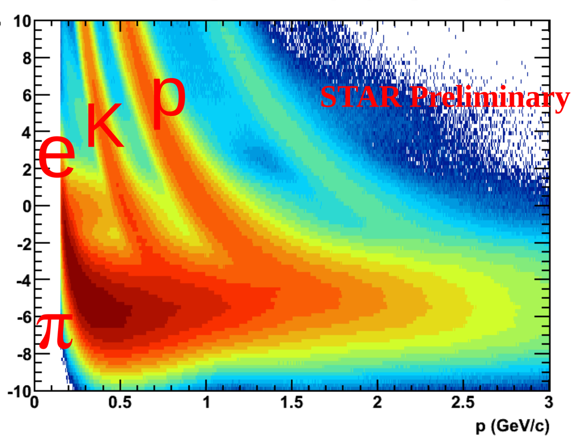
Minibias 0-80%:

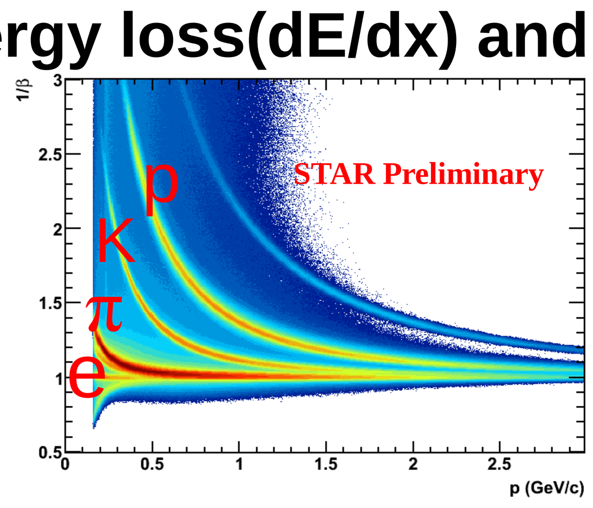
|vertexZ|<70 cm

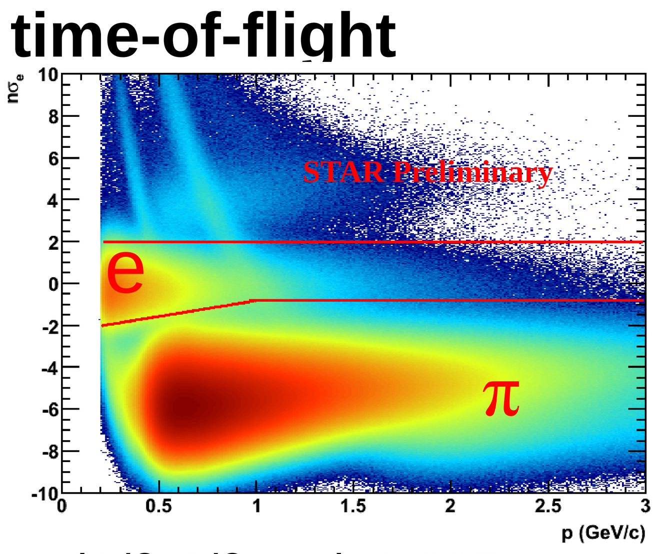
p_T>0.2 GeV/c

|η|<1

PID : Ionization energy loss(dE/dx) and time-of-flight







Good electron identification with TOF.

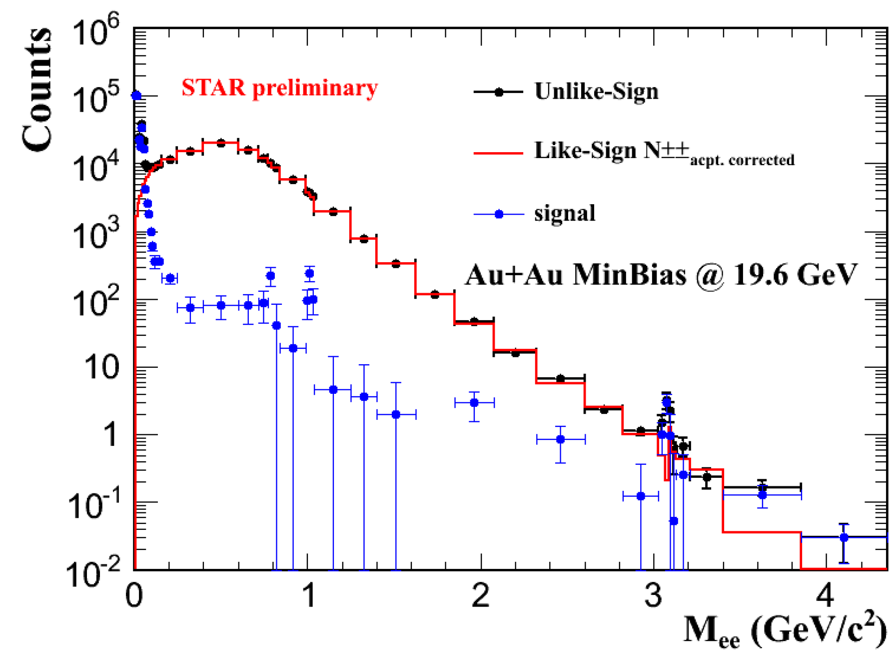
|1/β-1/$β_{mean}$|<0.025

$n\sigma_e = \ln(dE/dx/I_e)/R_e$

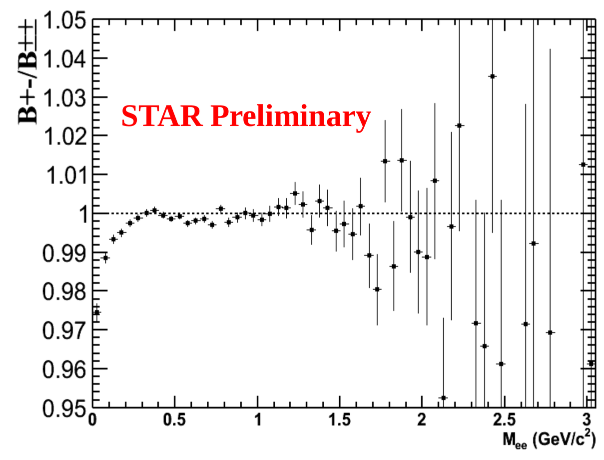
Analysis

Background subtraction:

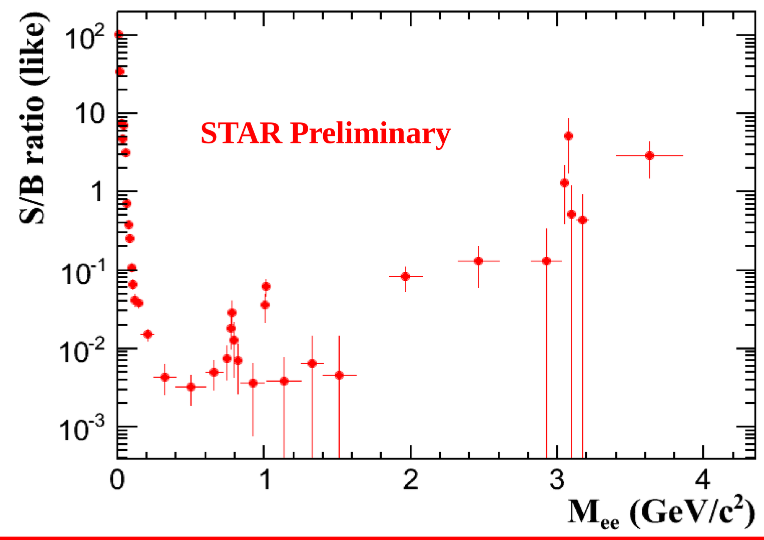
Subtract like-sign with acceptance correction in all mass range.



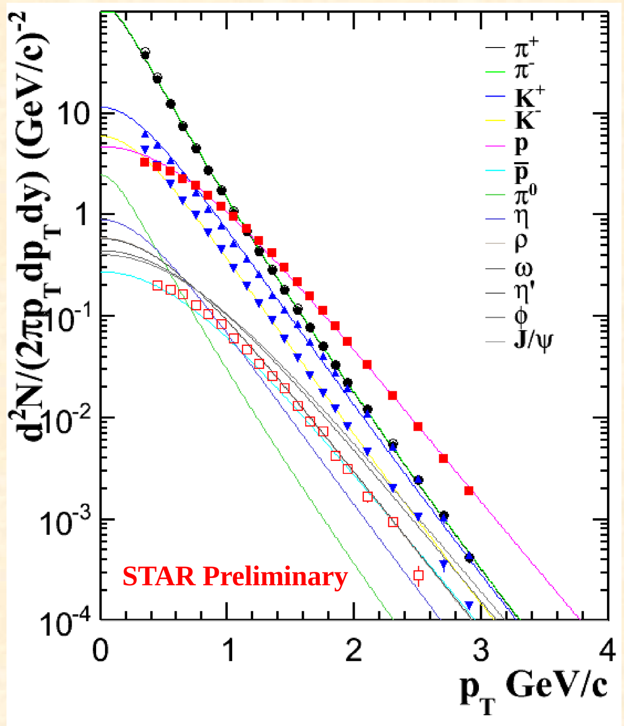
Like-sign acceptance correction:



$$B_{LikeSign} = 2\sqrt{N_{++}\cdot N_{--}}\cdot\frac{B^{Mix}_{+-}}{2\cdot\sqrt{B^{Mix}_{++}\cdot B^{Mix}_{--}}}$$



Simulation



Data: NA49 *Phys.Rev.C77:034906,2008*

Fit method: Z. Tang et al., *Phys.Rev.C79,051901(2009)*

For mesons: input Tsallis-blast-wave(TBW) fit spectra of each meson, reconstruct e⁺e⁻ pairs after they decay in the STAR simulators. Same cuts have been applied as in data. π yield is from STAR π measurement in Au+Au at 19.6 GeV. Ratios to π⁰ are from NA45 and STAR measurements.

Meson	Ratio to π⁰
η	0.085
ρ	0.094
ω	0.069
Φ	0.01244
η'	0.0078

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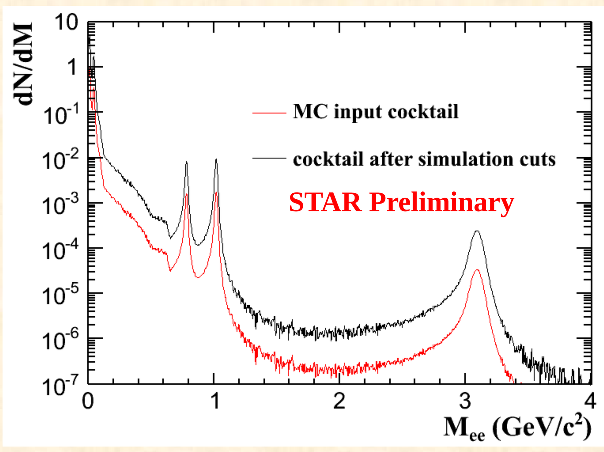
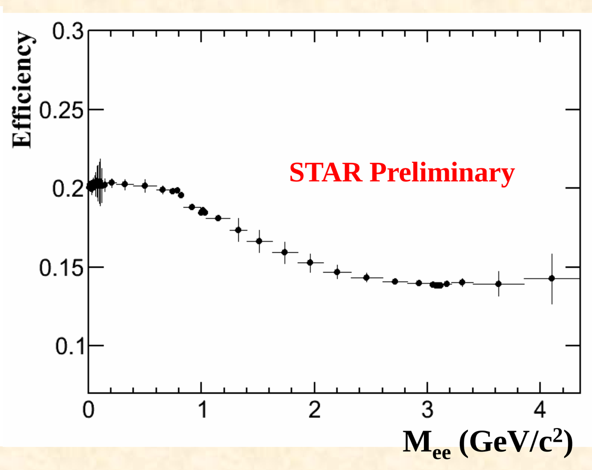
Phys. Rev. C **79** *(2009) 64903*



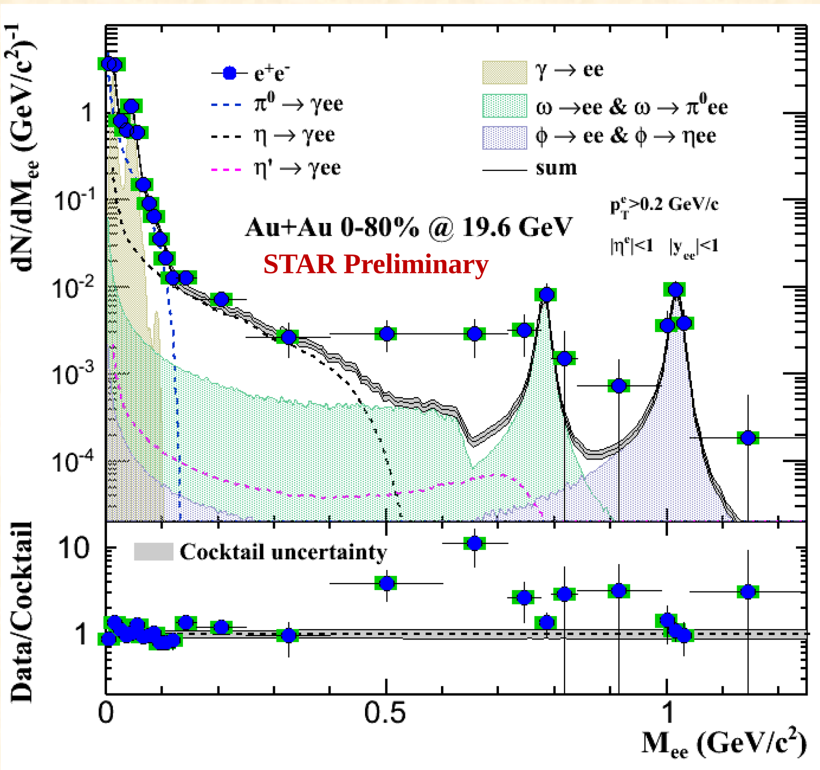


Efficiency as a function of M_{ee}

Source of uncertainty	Relat. Error
Tracking efficiency	7%
Tof matching	5%
Pair uncertainty:	
Efficiency to di-electron	15%
TOF to di-electron	10%
nSigmaE cuts	2%
Sum of pair uncertainty:	17%

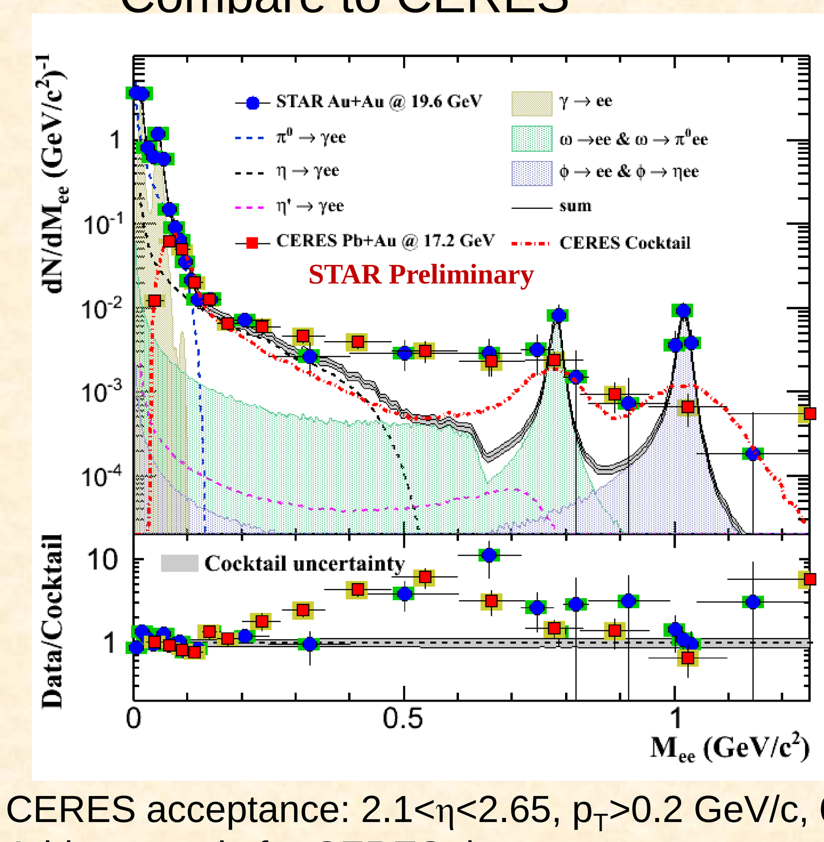
Simulation has a uncertainty of 12-20% due to the pion yield and other meson ratios to pion uncertainty.

Results



Spectra within STAR acceptance.

Compare to CERES



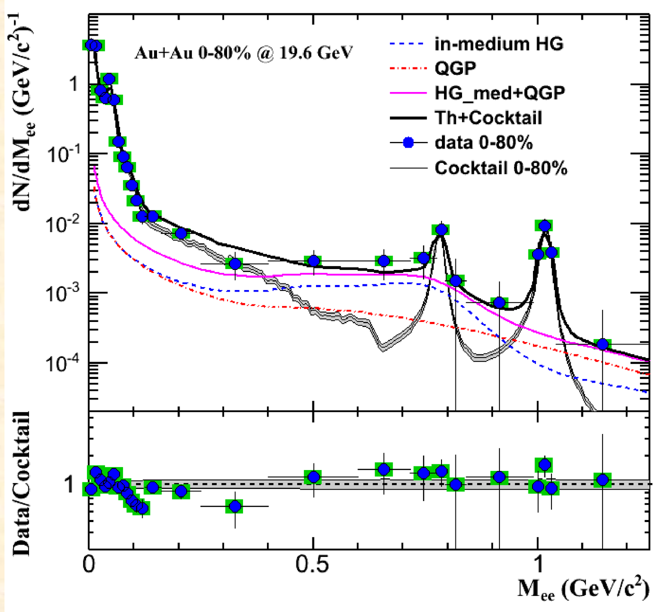
CERES acceptance: 2.1<η<2.65, p_T>0.2 GeV/c, θ_{ee}>35 mrad. Arbitrary scale for CERES data.

Enhancement factor	0.2<M_{ee}<1.1 GeV/c²(value±stat. ±syst.)	0.2<M_{ee}<0.6 GeV/c²(value±stat. ±syst.)
STAR	2.1 ± 1.0± 0.5	1.9 ± 0.6± 0.4
CERES	2.31 ± 0.19±0.55±0.69[decays]	2.73 ± 0.25±0.65±0.82[decays]

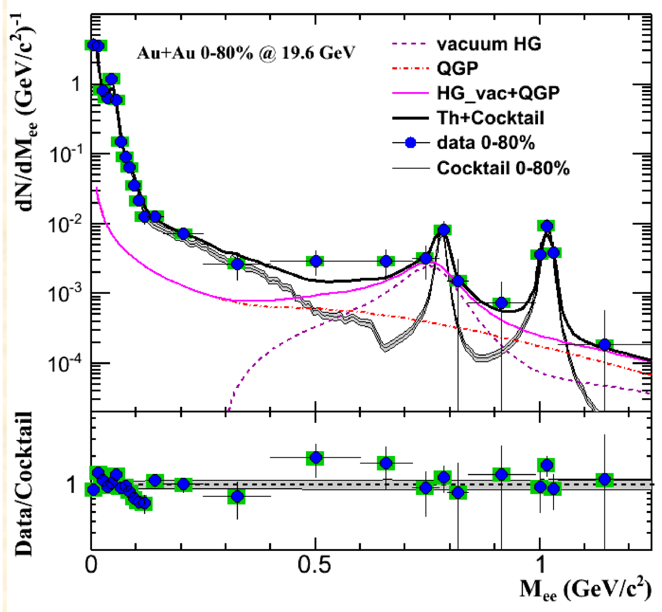
Compare to theoretical calculations by Ralf Rapp (private communication):

Adv. Phys. **25, 1 (2000)**

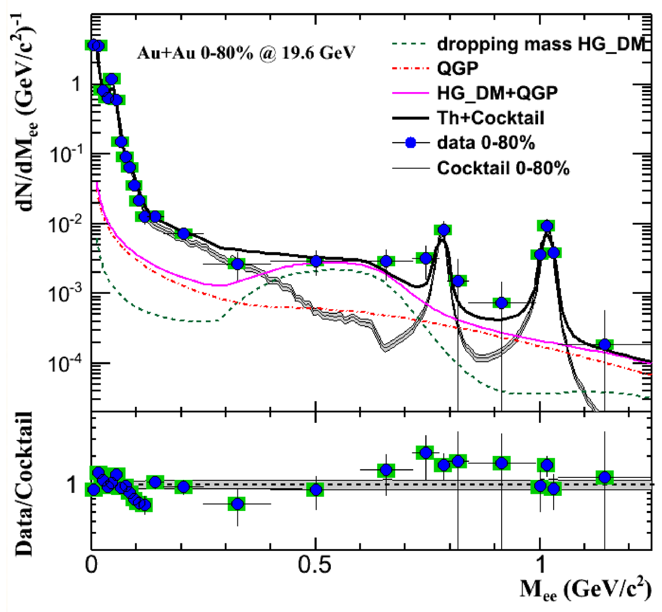
Phys. Rept. **363, 85 (2002)** arXiv:nucl-th/0204003v1



Brodening ρ



Vacuum ρ



Dropping mass ρ

Conclusions

1. Di-electron continuum is obtained from 19.6 GeV Au+Au collisions.
2. Compared to cocktail simulation, di-electron production shows a similar magnitude of enhancement in the low mass region as CERES measurement.
3. Theoretical calculations are consistent with our measurement. Limited statistics of our data does not allow to distinguish three different scenarios.