# Dielectron Production in Au+Au-Collisions at $\sqrt{s_{NN}}$ = 39 & 62.4 GeV

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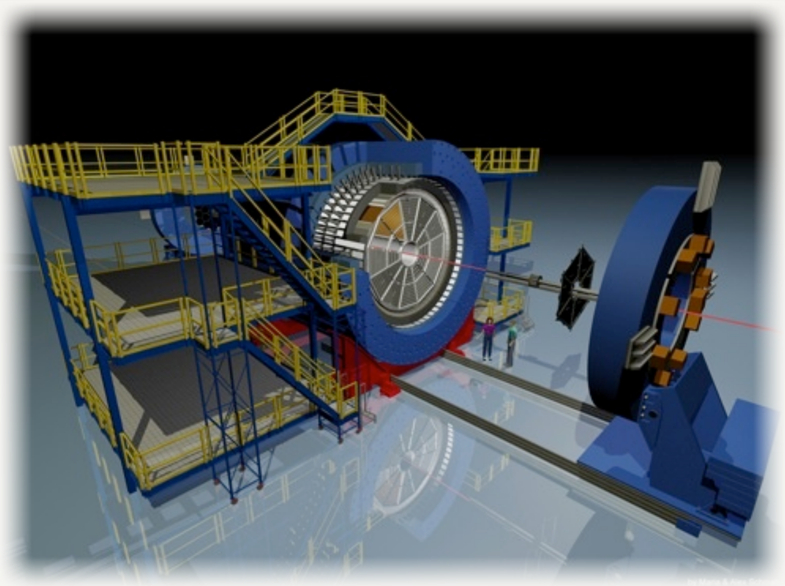
**Abstract:**
Due to their negligible strong interaction with the dense medium created at RHIC, leptons can escape the interaction region undistorted and thus, carry direct information about the space-time evolution of the fireball created in relativistic heavy-ion collisions. In the special case of dileptons, their invariant mass ($M_{ee}$) serves as an additional observable: For the RHIC BES energies, later dielectron creation times are accessible in the Low-Mass-Region (LMR, $M_{ee}$ < 1.1 GeV/c²) where the in-medium vector meson properties and possibly its connection to chiral symmetry restauration can be measured. Earlier creation times, on the other hand, can be studied in the Intermediate-Mass-Region (IMR, 1.1 < $M_{ee}$ < 3 GeV/c²) in which the continuum yield is expected to serve as a direct measure of the effective QGP temperature. In this regard, the dependence of these observables on the collision energy is of special interest. These aspects, in particular, make dielectrons favorable as a clean penetration probe for the bulk.

## STAR Detector & Datasets



Excellent electron identification feasible in STAR with large acceptance via

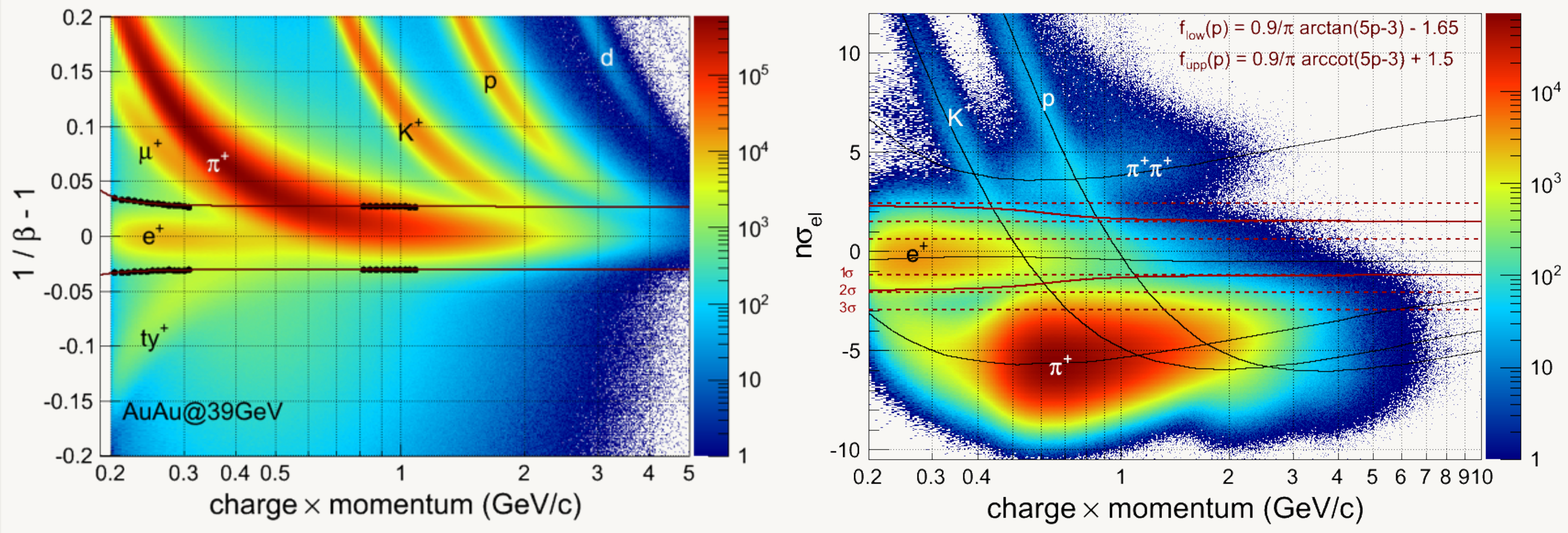
- Time-Of-Flight Detector
- Time Projection Chamber

High-Statistics Runs of 2010:

| energy | analyzed MB events |
|---|---|
| 39 GeV | 99.4 M |
| 62.4 GeV | 54.6 M |

## Electron Identification

$$n\sigma_{el} \propto \ln\left(dE/dx|_{meas} \,/\, dE/dx|_{electron}\right)$$

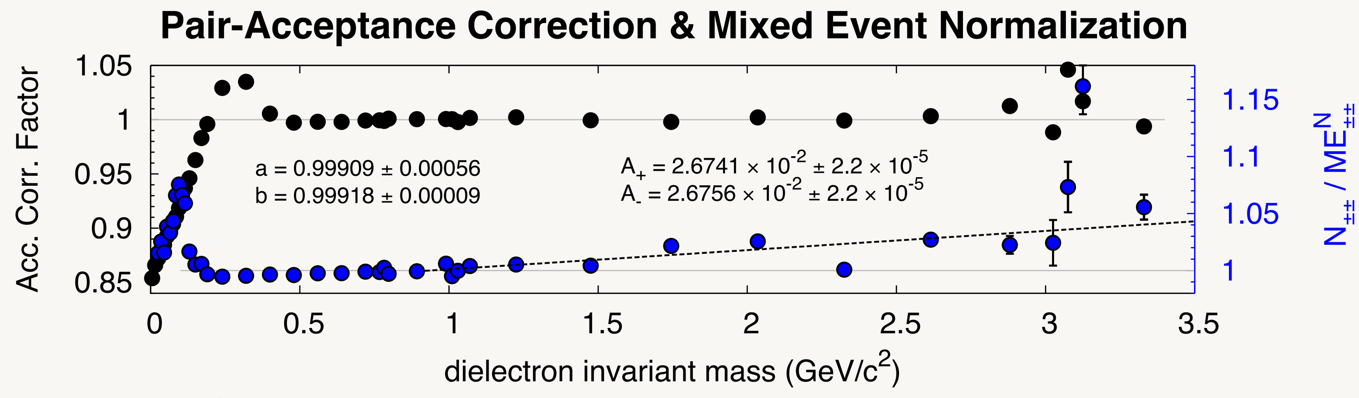


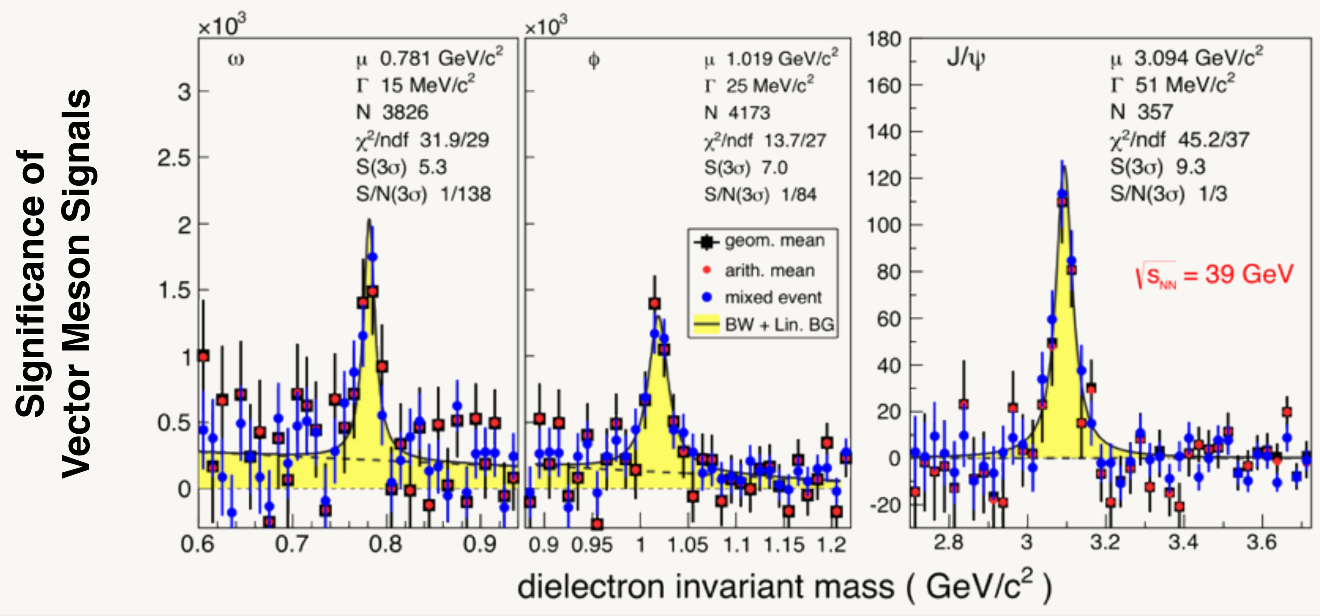

## Background Subtraction

**1) Like-Sign Same Event Method**
All like-sign pairs of one event are combined and the two charge combinations averaged. This method reproduces the background from all correlated sources. The acceptance difference of like-sign to unlike-sign pairs is corrected using the Mixed Event Technique.

**2) Unlike-Sign Mixed Event Method**
All charges from two different events within the same event class (event vertex, reference multiplicity & event plane) are combined. This method describes the background caused by the combination of uncorrelated pairs.

**Pair-Acceptance Correction & Mixed Event Normalization**



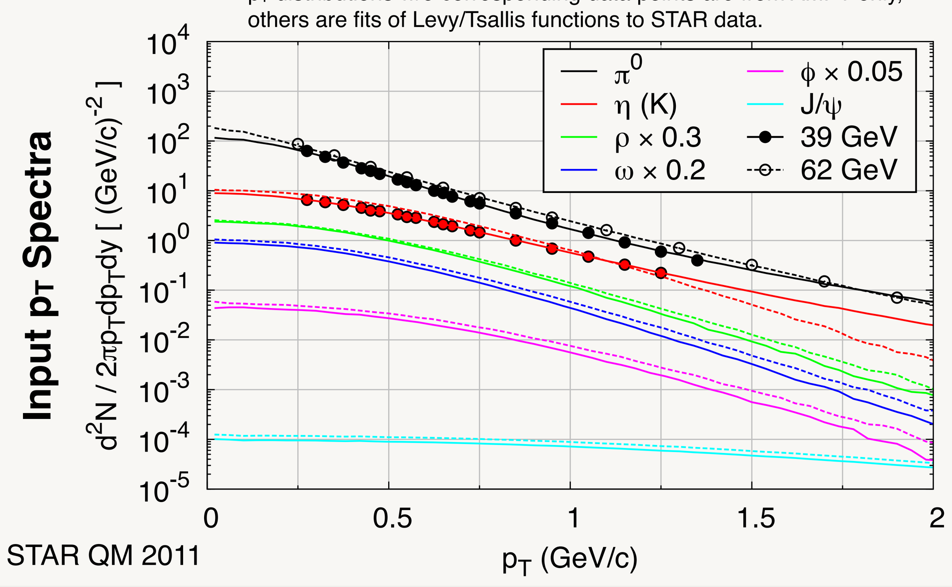




## Cocktail Simulation

- Unknown $p_T$ distributions are taken from AMPT model calculations. The according dN/dy is extrapolated from measurements at 200 GeV based on the energy dependence given by AMPT.
- Contributions due to correlated pairs from semi-leptonic decays of charmed mesons are simulated using PYTHIA and scaled to Au+Au by the number of binary collisions.
- Corresponding charm cross sections are not measured at these energies. FONLL predictions are used as lower and $\chi^2$ fits to the IMR data as upper limits of the charm continuum contributions, respectively.

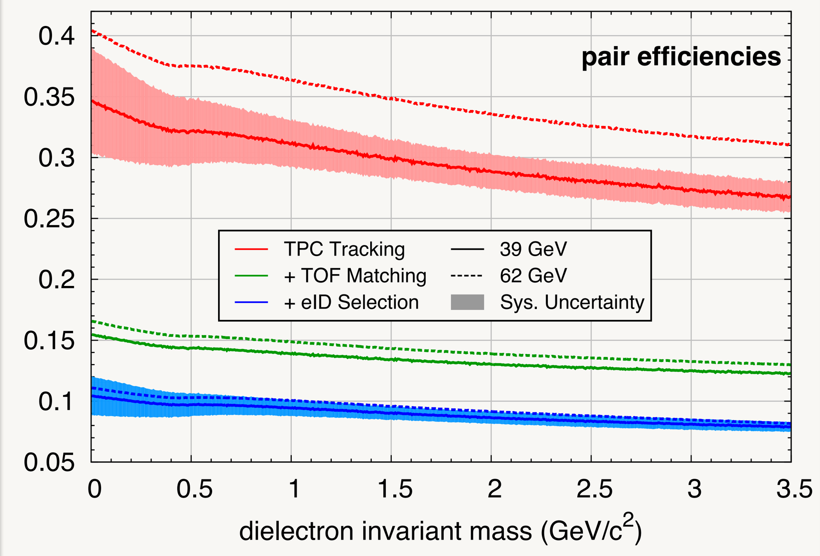
| $\sqrt{s_{NN}}$ (GeV) | Vector Meson Yields (30% uncertainty assigned) | | | | | $\sigma_{pp}^{c\bar{c}}$ (mb) ± sys. | $N_{bin}^{coll}$ |
|---|---|---|---|---|---|---|---|
| | $\pi^0$ † | $\eta$ † | $\omega$ | $\phi$ | J/ψ | | |
| 39 | 57 | 9.37 | 4.42 | 1.39 | 4.8 × $10^{-4}$ | 0.19 ± 0.11 | 243 |
| 62.4 | 72.9 | 11.4 | 5.38 | 1.79 | 1.2 × $10^{-3}$ | 0.40 ± 0.25 | 253 |

$p_T$ distributions w/o corresponding data points are from AMPT only, others are fits of Levy/Tsallis functions to STAR data.



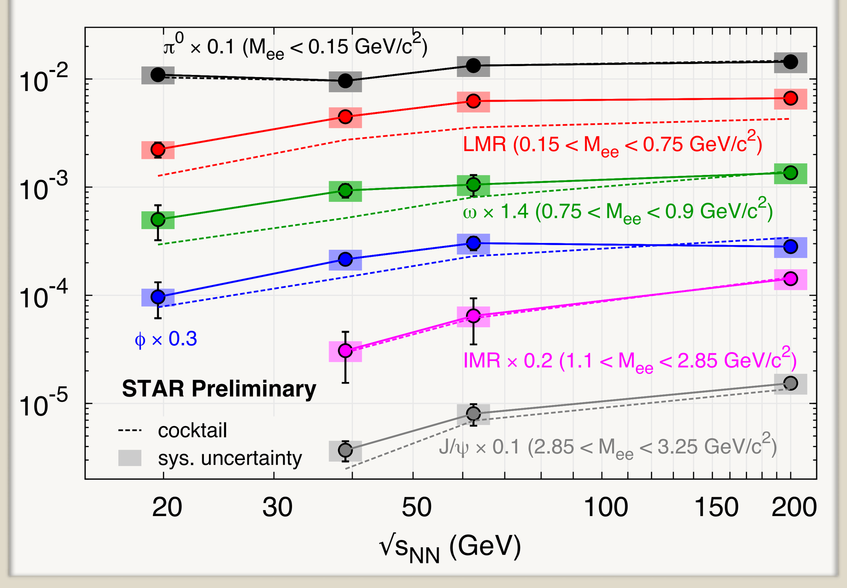

† STAR QM 2011

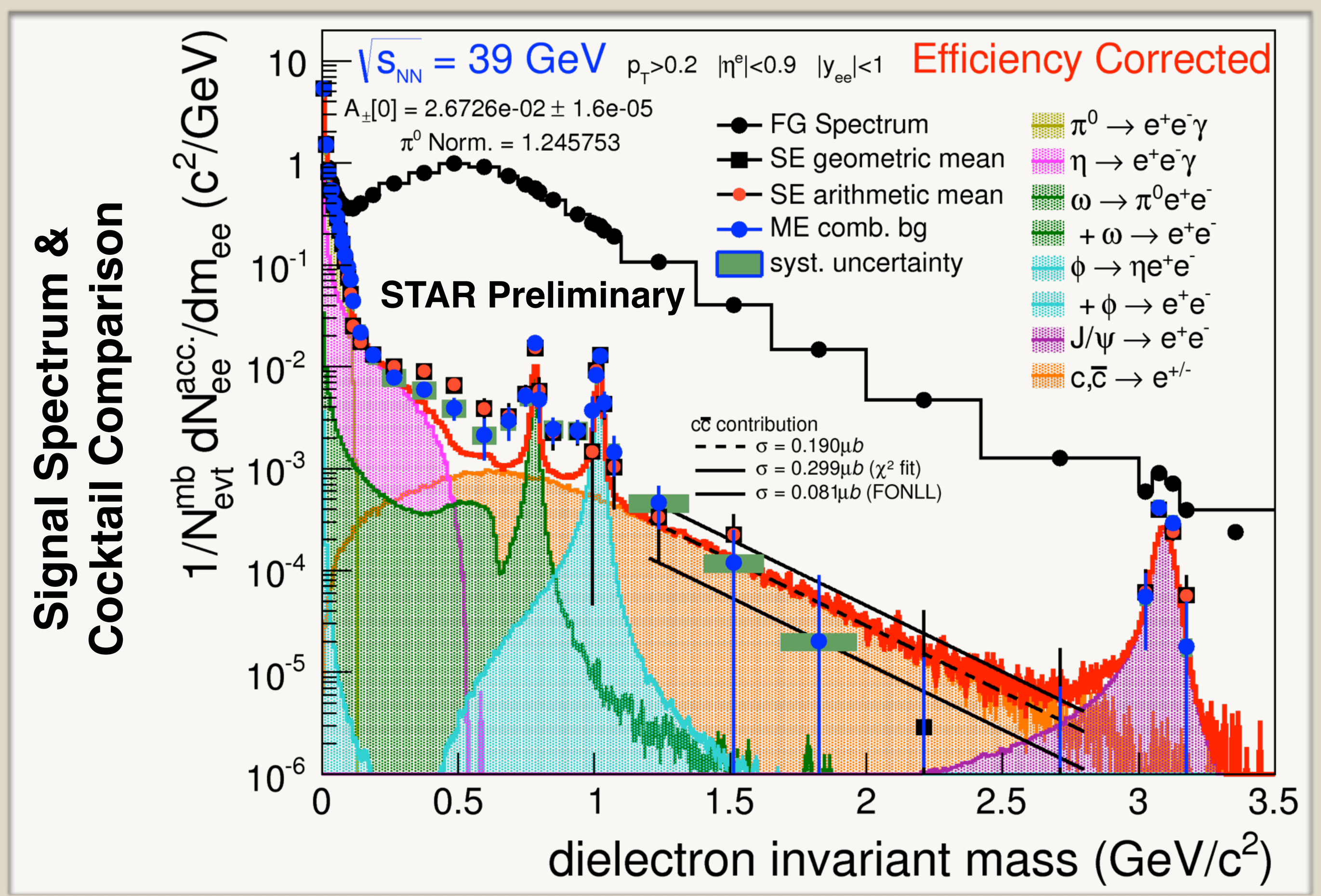
## Efficiency Correction



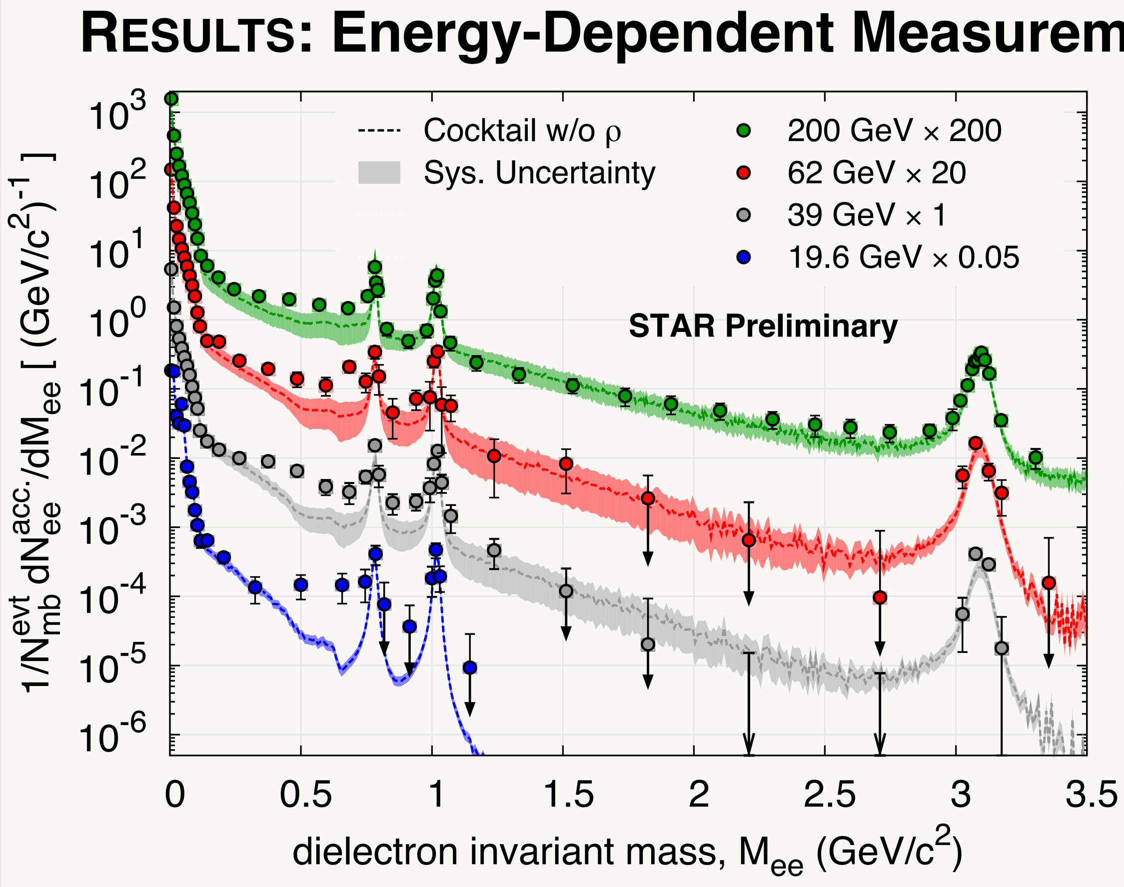

Single track efficiencies are calculated from Embedding and propagated to pair efficiencies via a MC $\gamma \to e^+e^-$ simulation.

## Integrated Invariant Yields

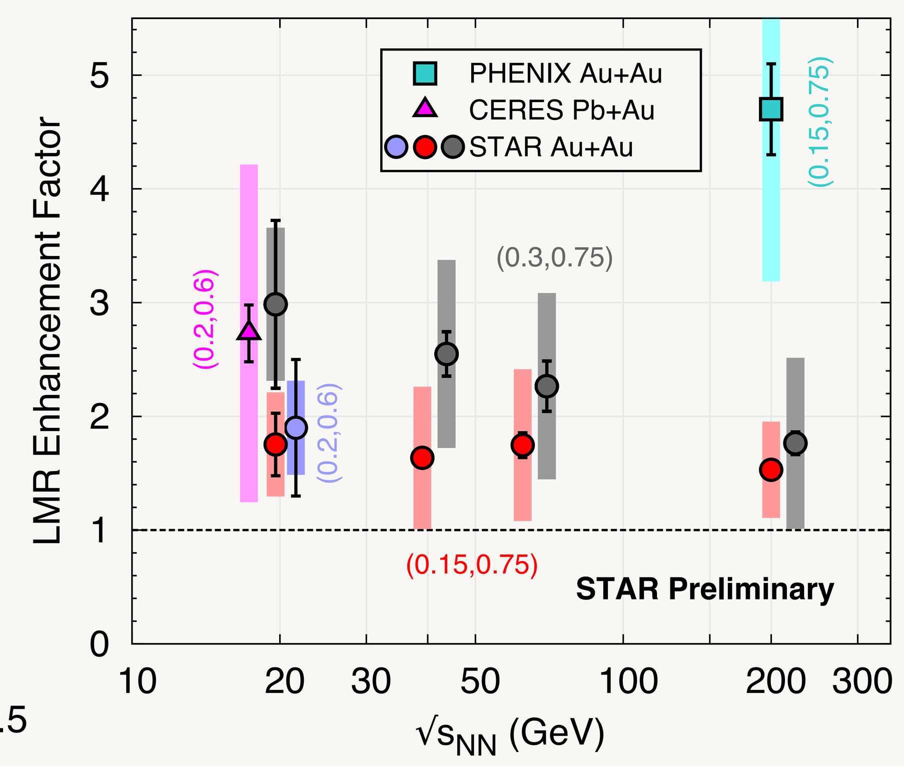



## Results: Energy-Dependent Measurements of Dielectron Production




Dielectron production for invariant masses $M_{ee}$ < 3.5 GeV/c² has systematically been measured in STAR from $\sqrt{s_{NN}}$ = 19.6 GeV up to top RHIC energy. A visible excess over a cocktail of hadronic sources (excl. $\rho \to e^+e^-$) is observed in the LMR for all energies.



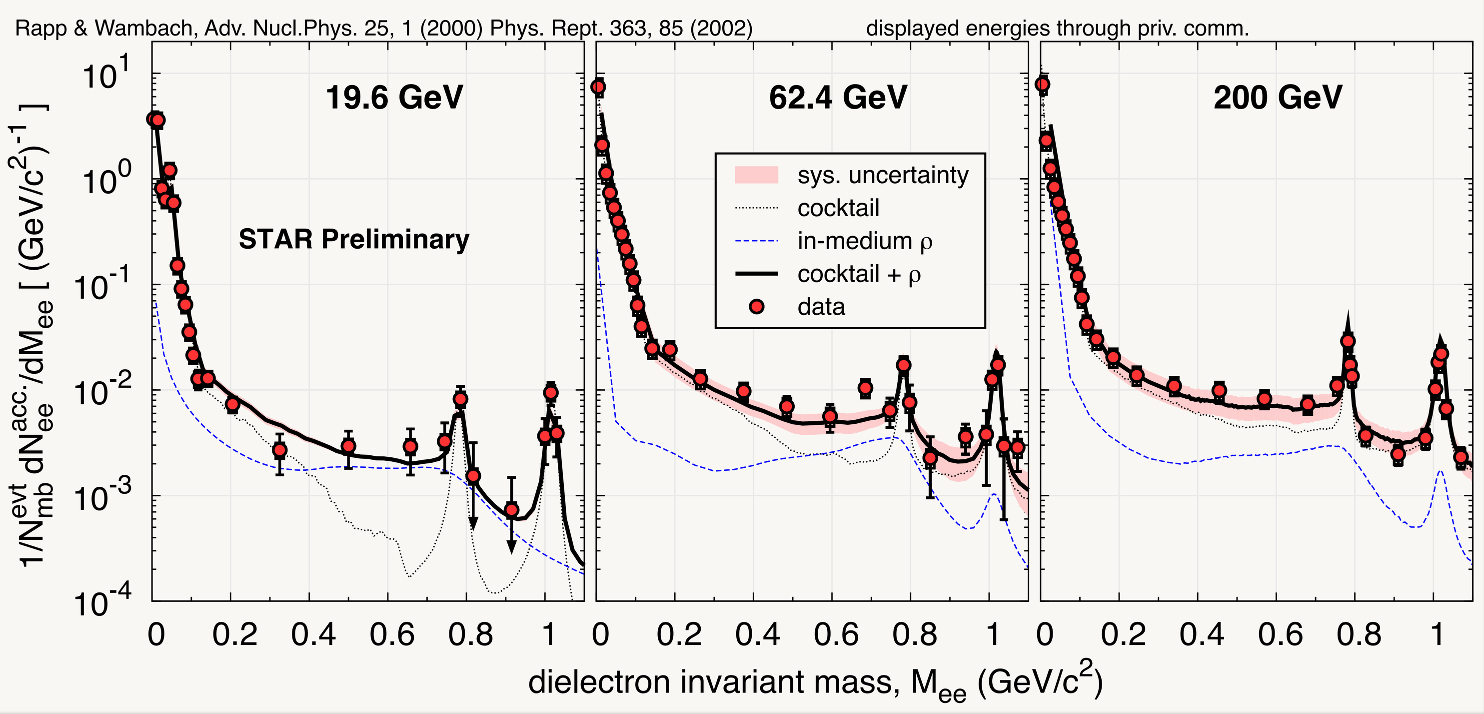

Systematic measurement of the LMR enhancement factor and comparison to published data.

- Magnitude of the enhancement in agreement with the CERES result within uncertainties.

## In-medium ρ

Systematic comparisons of LMR dielectron production to in-medium ρ calculations for three different energies. The additional yield caused by in-medium radiation is added on top of the yield from hadronic sources. Within systematic uncertainties, in-medium modifications to the ρ spectral function are able to describe the LMR excess yield over a wide energy range.

Rapp & Wambach, Adv. Nucl.Phys. 25, 1 (2000) Phys. Rept. 363, 85 (2002) — displayed energies through priv. comm.




## Summary & Conclusions

- Dielectron invariant mass spectra from Au+Au collisions measured in STAR at $\sqrt{s_{NN}}$ = 19.6, 39, 62.4 & 200 GeV and compared to cocktail calculations.
- No significant energy dependence observed for LMR enhancement factor.
- LMR excess yield can be described by in-medium modifications to the ρ spectral function across a wide range of energies.

**Outlook:** Charm continuum contribution and its possible in-medium modification need better understanding in Au+Au ⇒ STAR HFT & MTD upgrades.

The STAR Collaboration:
http://drupal.star.bnl.gov/STAR/presentations