e^+e^- pairs from open heavy flavor in *p*+*p* and *d*+Au collisions at 200 GeV

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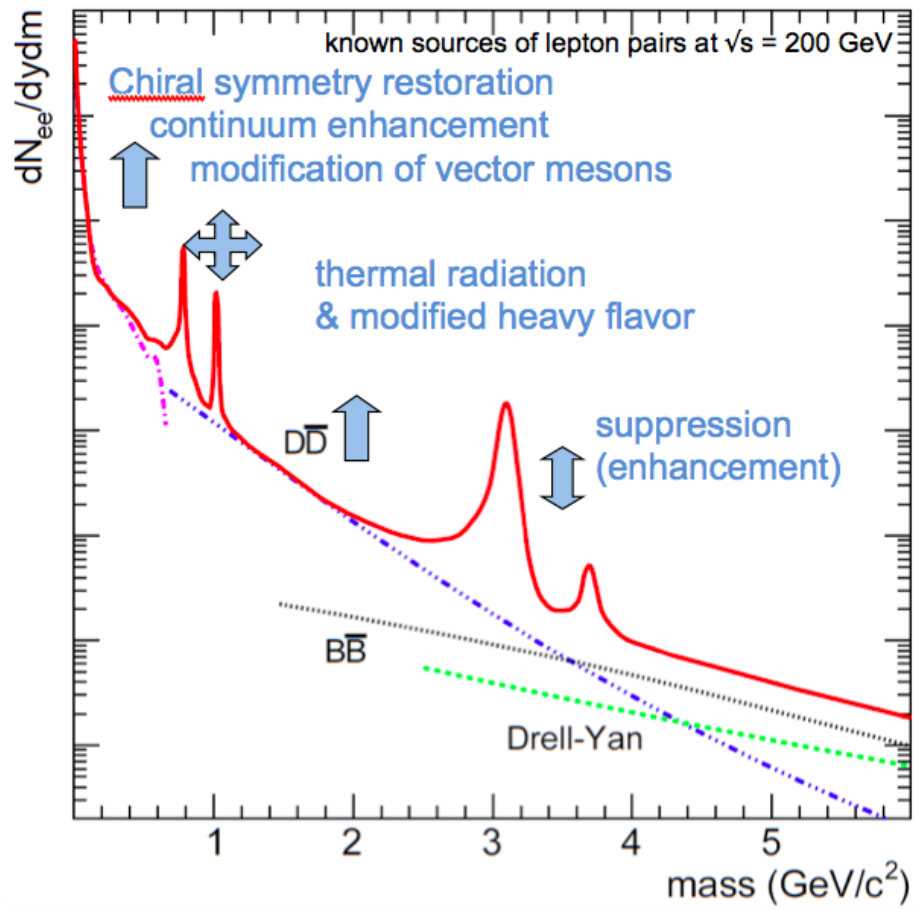
Outline

- Motivation
- PHENIX experimental set-up
- e^+e^- pair spectrum
- Charm and bottom extraction and separation
- Summary and outlook

Motivation

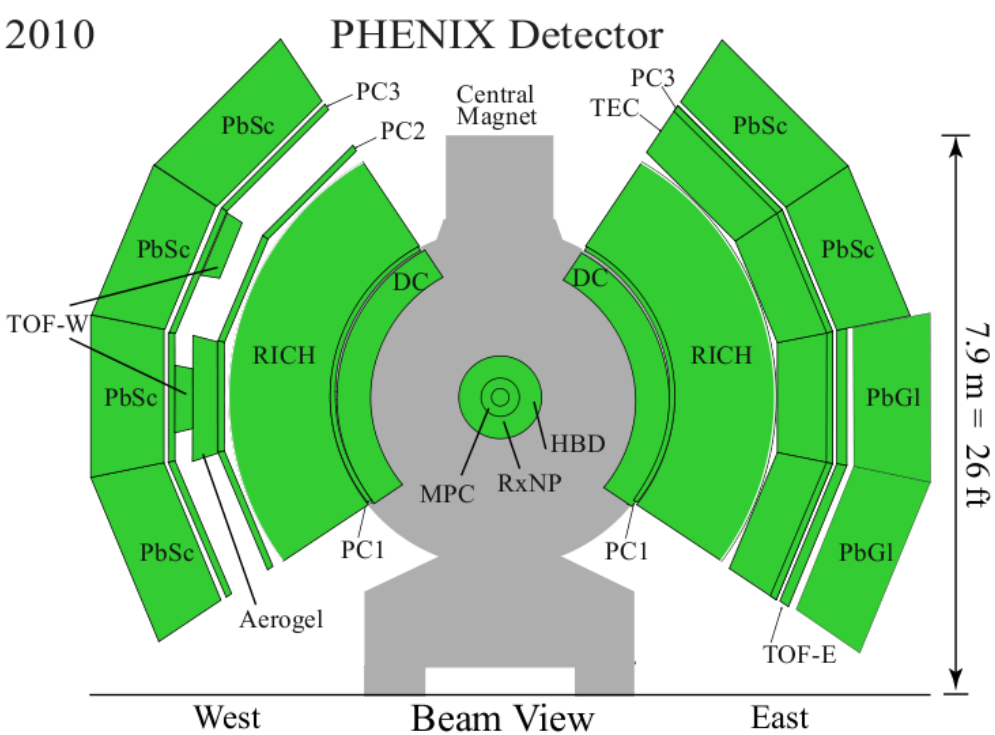
- Dileptons is a unique probe
  - modifications due to QCD phase transition

- Focus on mass regions (1-3GeV, 4-8GeV);
  - dominated by open heavy flavor decays,
  - clean measurement due to isolation from other hadronic contributions



- *p*+*p* measurement tests pQCD calculations and serve as a baseline for heavy ion collisions
- Comparison between *p*+*p* and *d*+Au tests for cold nuclear matter effects.

PHENIX experimental set-up



PHENIX central arms acceptance:

- $-0.35 < \eta < 0.35$
- 2π in ϕ

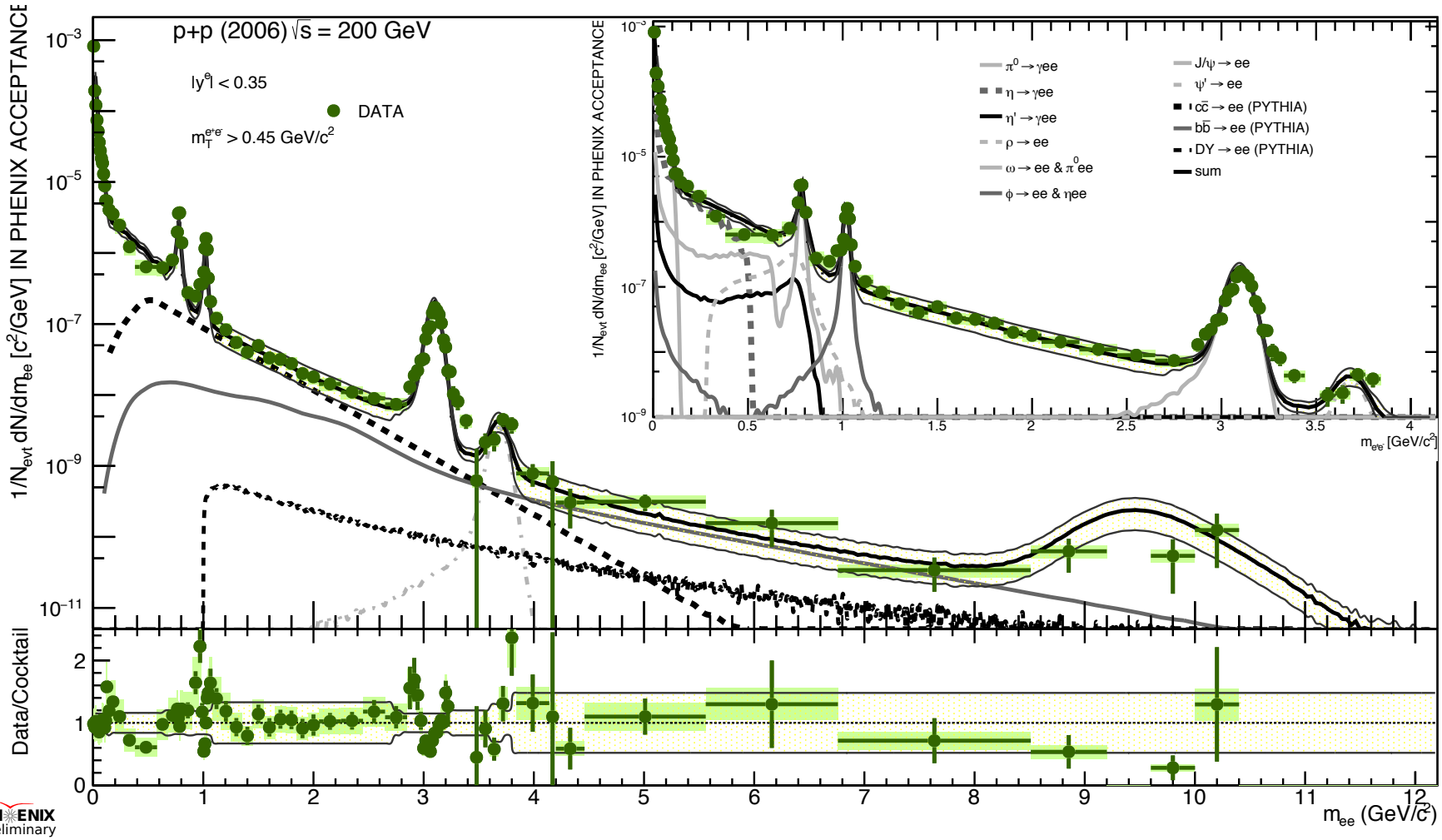
- Vertex: BBC
- Tracking: DC/PC1
- $p_e > 0.2$GeV/c

Electron identification based on:

- RICH (Ring Imaging Cerenkov Detector) (e/π rejection>1000)

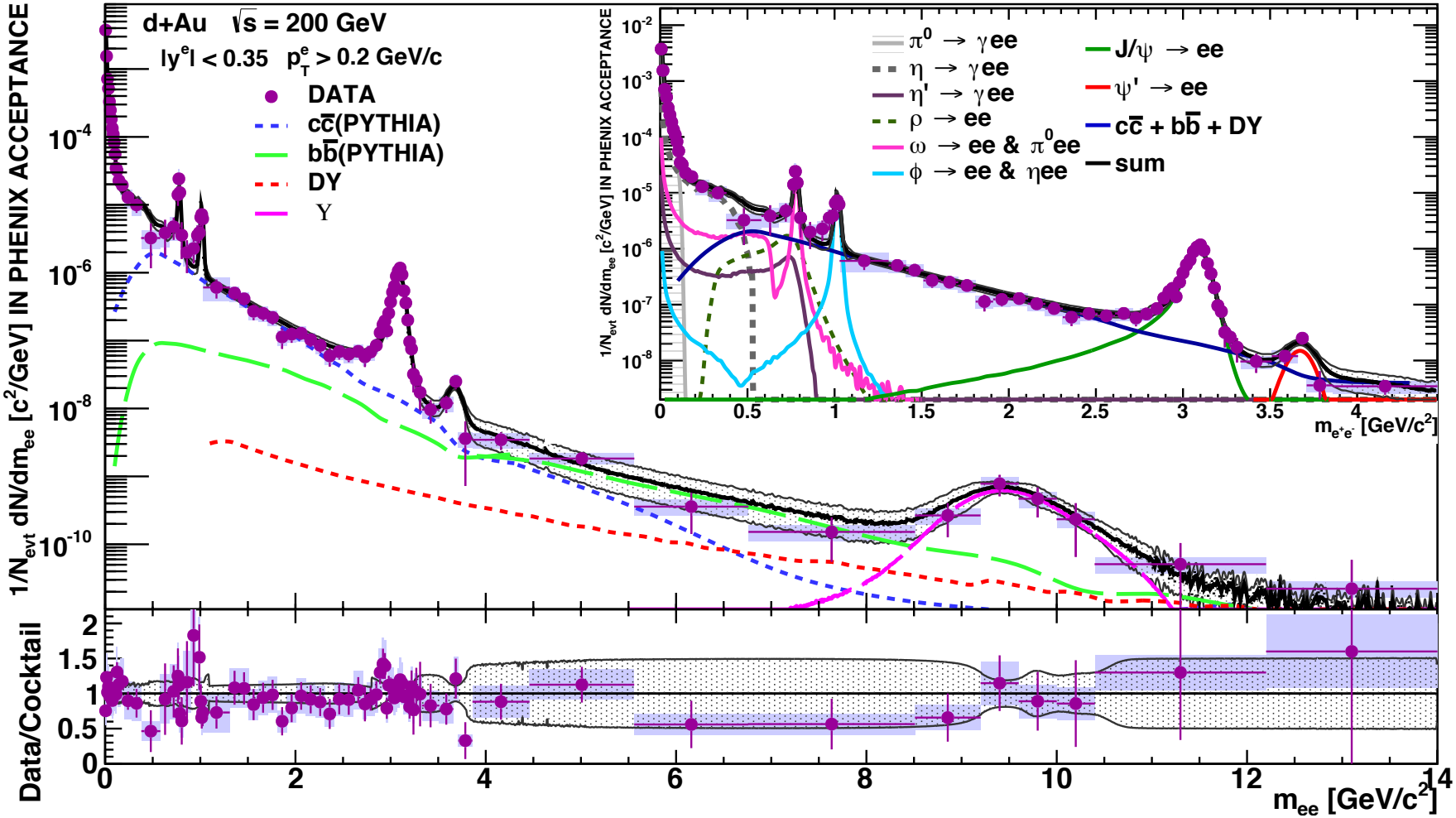
- EMCal (Electromagnetic Calorimeter) (E-p matching, e/π rejection ~10)

Dielectron mass spectrum, *p+p* collisions



- Normalization fixed from existing data if available
- Cross-sections for charm and bottom as explained in following slides.
- Good agreement with the expected cocktail of known hadron decays

Dielectron mass spectrum, *d*+Au collisions



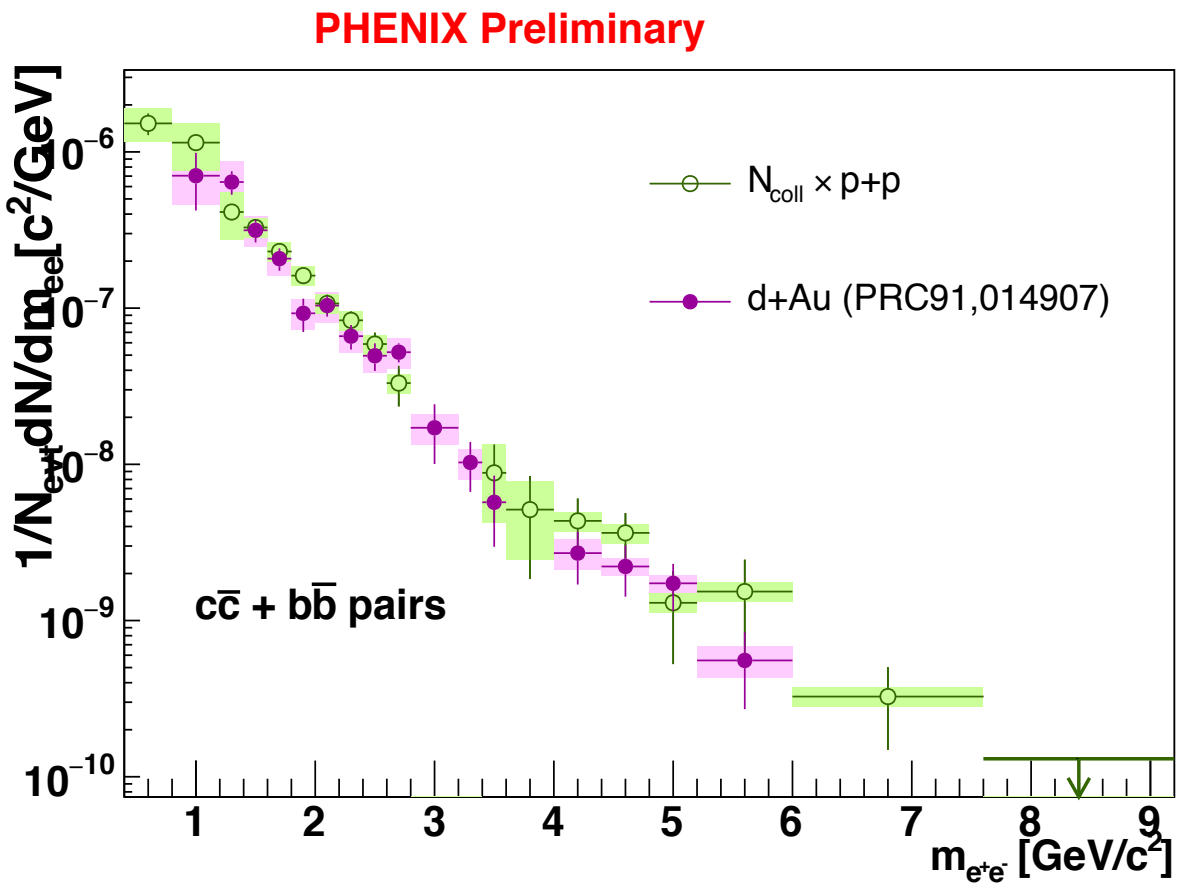
- Good agreement with the expected cocktail of known sources.

Comparison of open heavy flavor yield from *p*+*p* and *d*+Au

- Subtract yields of
  - Vector meson
  - Pseudoscalar meson
  - Drell-Yan

  from e^+e^- mass and p_T spectra in data

- Remaining e^+e^- pairs from open heavy flavor fitted in mass, p_T with PYTHIA and MC@NLO for cross-section extraction.

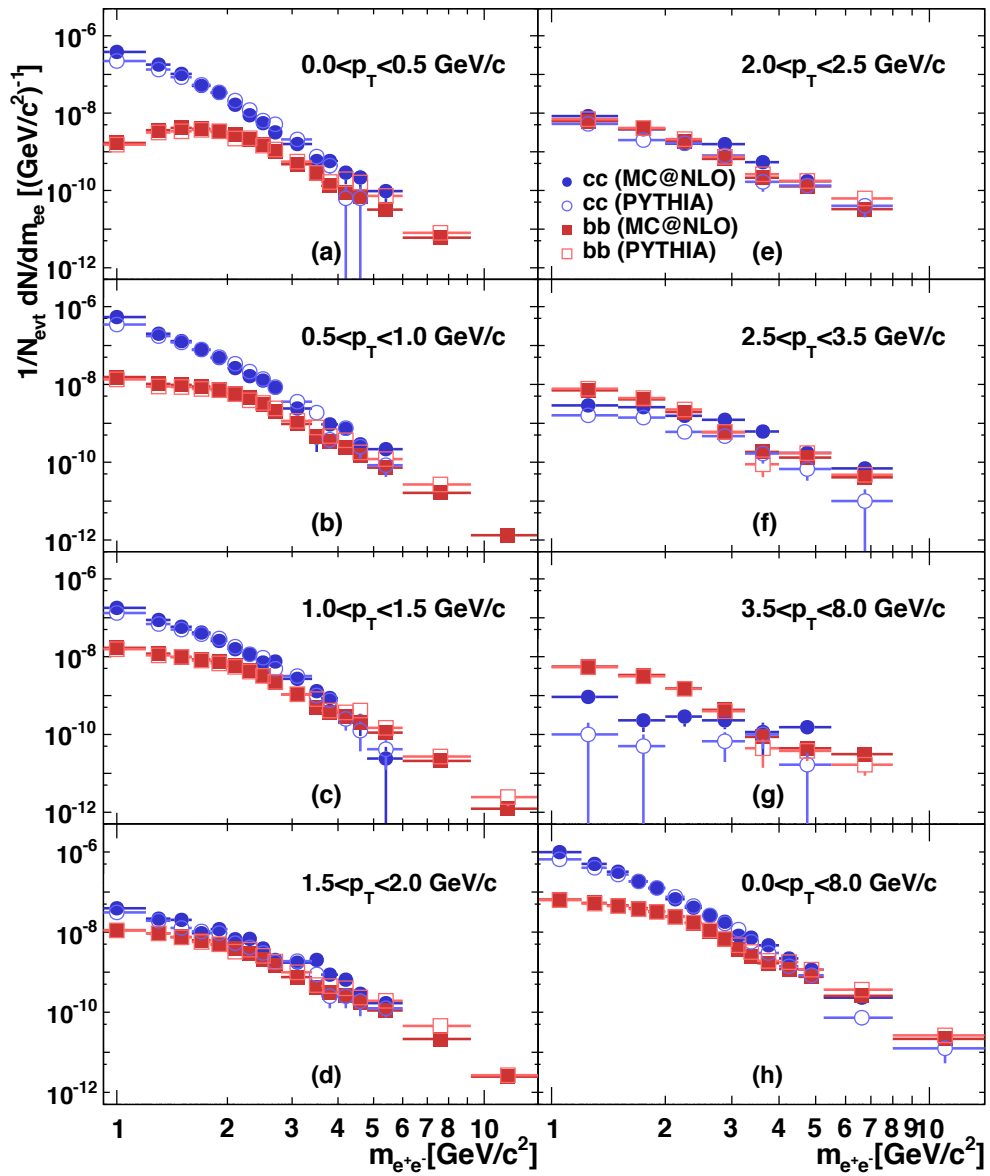


Comparison of mass spectra in **p+p**(scaled by N_{coll} = 7.6) and **d+Au** collisions

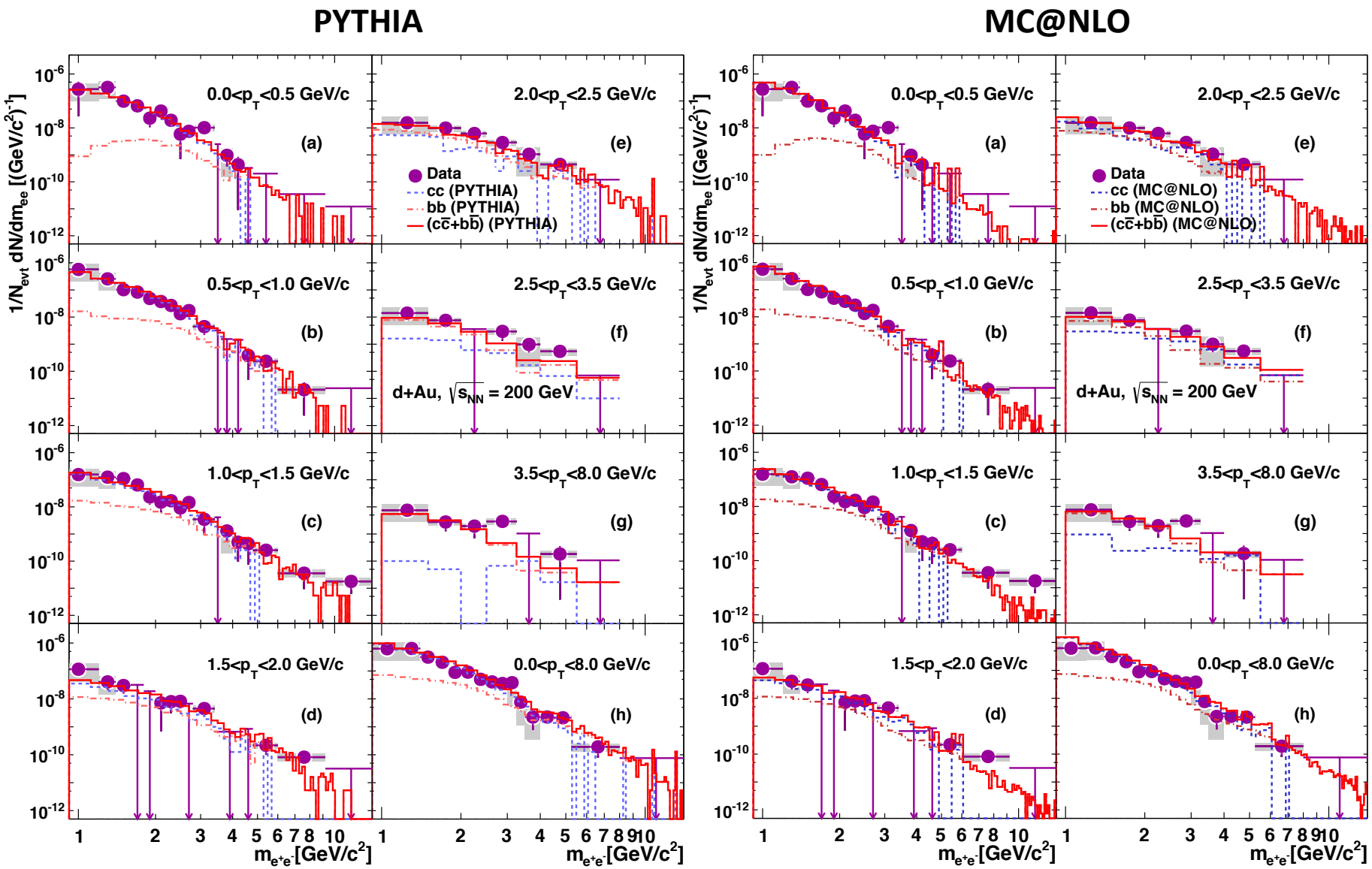
Separating charm and bottom through e^+e^- correlations

- Mass and p_T spectra of charm and bottom generated using PYTHIA and MC@NLO

- Charm dominates at:
  - low mass, low p_T
- Bottom dominates at:
  - high mass, low p_T
  - low mass, high p_T

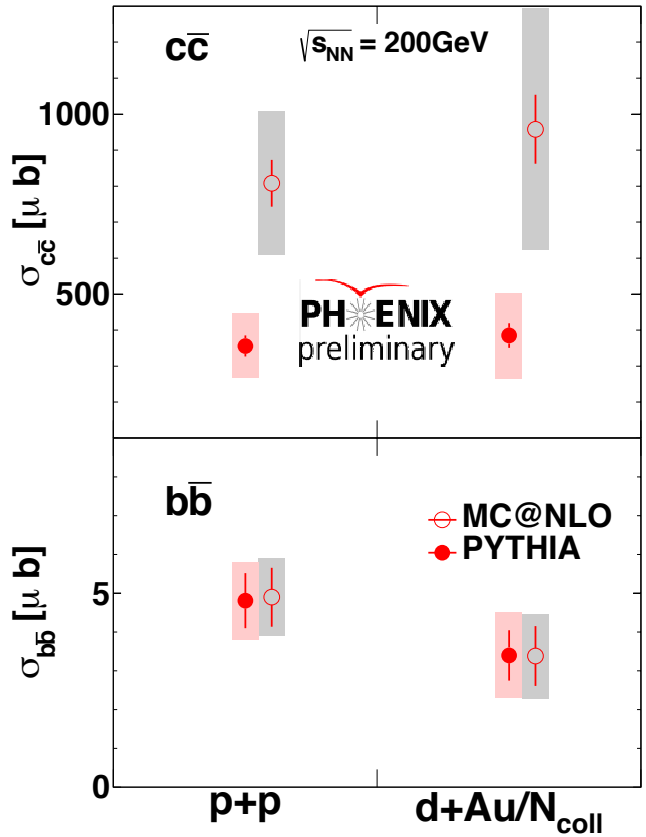


Data and fits: *d*+Au collisions



- PYTHIA and MC@NLO both describes the data reasonably well.

Charm and bottom total cross-sections



Summary of $c\bar{c}$ and $b\bar{b}$ cross-section measured in p+p and d+Au collisions

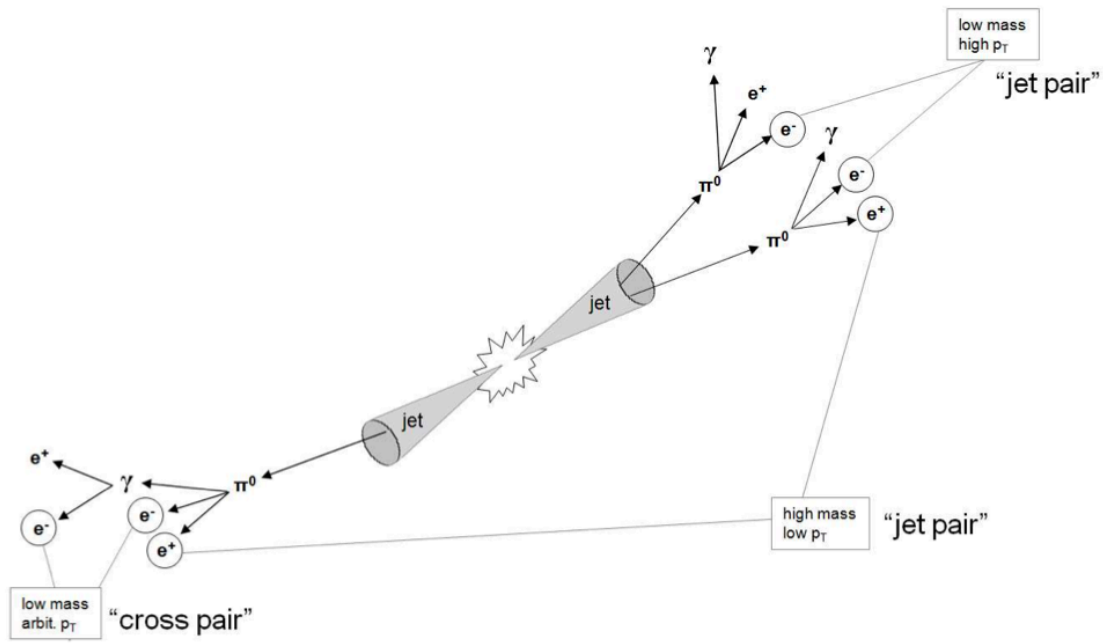
- The extrapolation for $c\bar{c}$ cross-section exhibits a stronger model dependence than $b\bar{b}$
- Within statistical precision the p+p(scaled by N_{coll}) and d+Au measurements agree with each other

Summary and outlook

- Summary
  - Dilepton correlations are a unique probe to study heavy flavor production.
  - Charm and bottom decays dominate different parts of mass, p_T space.
  - Both leading order (PYTHIA) and next-to-leading order calculations(MC@NLO) describe the data reasonably well.
  - Extrapolation for cross-sections for charm is much more model-dependent compared to bottom.
- Outlook
  - Similar analysis is underway via dimuons.
  - Extend analysis to other systems.

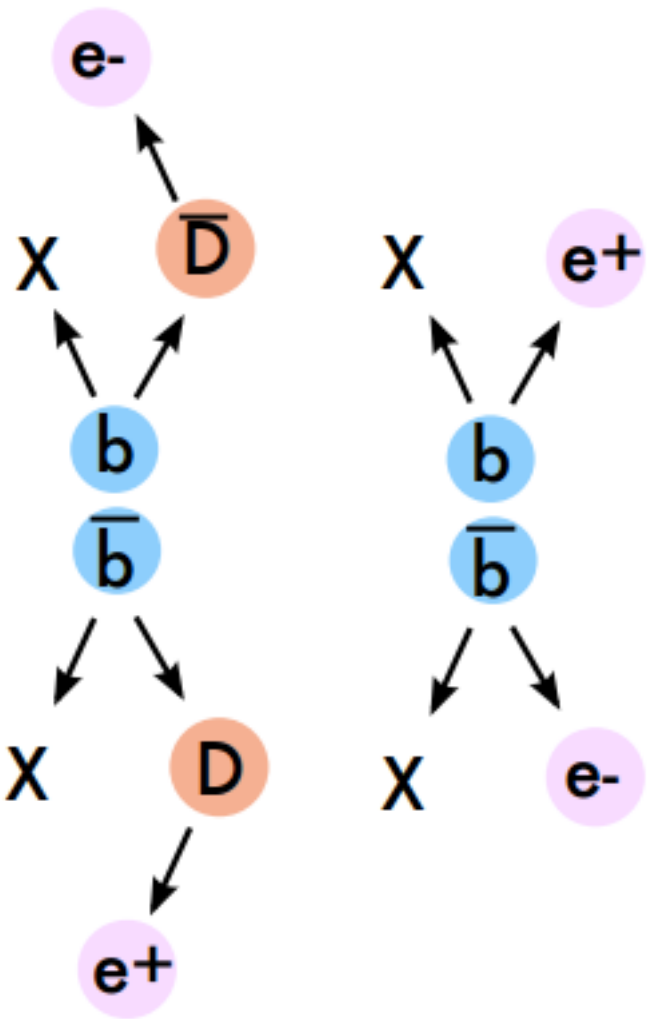
Backup: Background subtraction

- Uncorrelated Combinatorial background: arises from all combinations where the origin of the two electrons are completely uncorrelated
- Correlated background:
  - Cross pairs: originates from hadronic decays that result in two e^+e^- pairs. Main source is π^0 double Dalitz decay ($\pi^0 \to \gamma^*\gamma^* \to e^+e^-e^+e^-$)
  - Jet pairs: correlated jets via jets formed in initial hard scattering

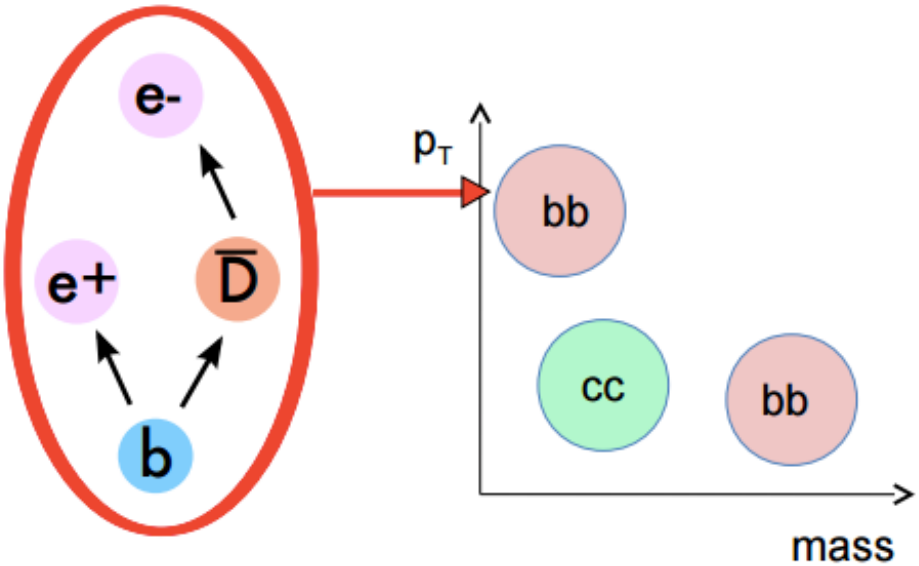


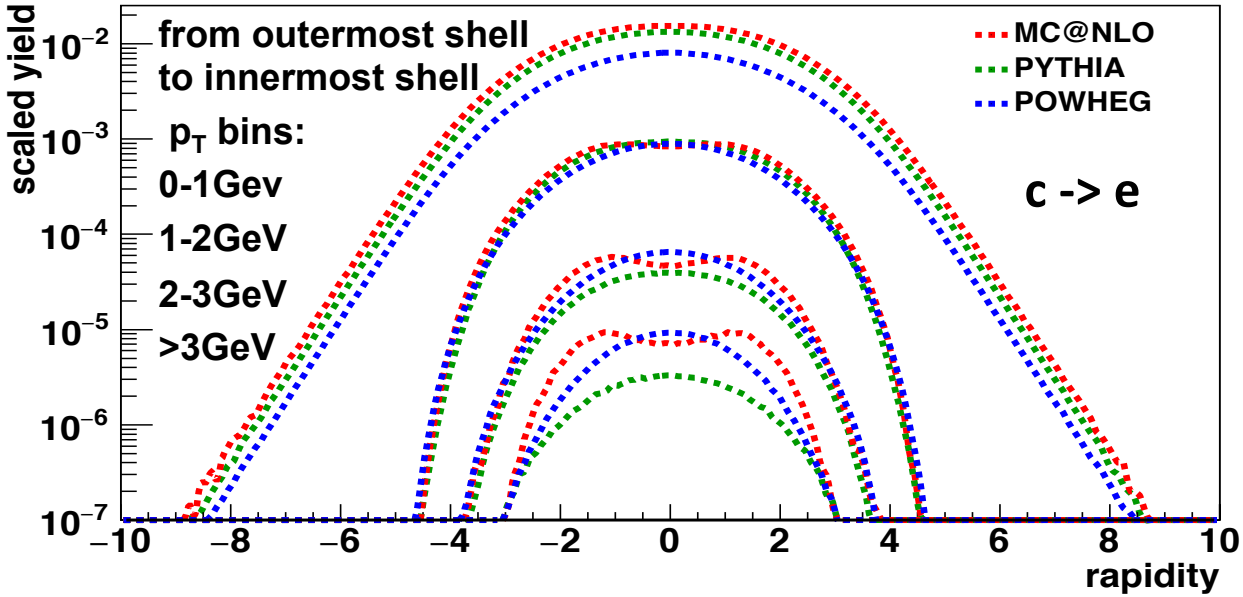
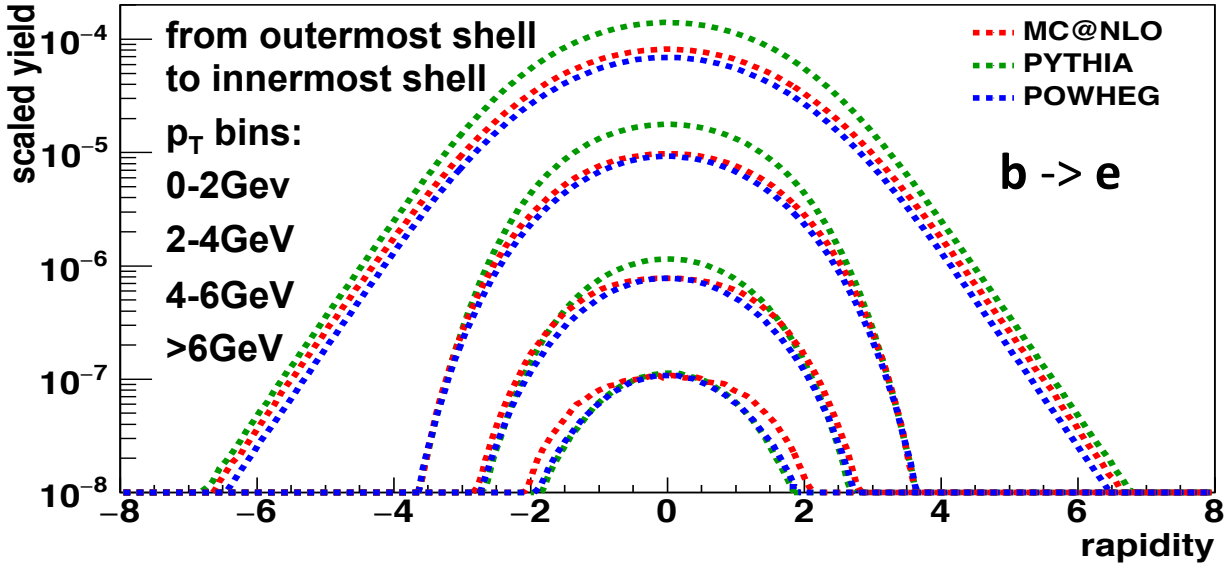
- Two methods used to estimate the background
  - **Like-sign subtraction technique** takes into account both combinatorial and correlated background. Need to correct for acceptance relative to unlike-sign.
  - **Event mixing technique** produces the combinatorial spectrum with extremely high statistics. Need to determine proper normalization and subtract additional correlated backgrounds estimated from simulations

Backup: Separating charm and bottom through e^+e^- correlations



- Multiple ways to produce e^+e^- from bottom
- All contribute similar total pairs
- But they populate different regions of mass, p_T space



Backup: Rapidity vs p_T for electrons from heavy flavor decays for different event generators(PYTHIA, MC@NLO, POWHEG)

- Extraction of total cross-section may be unreliable due to:
  - differences in rapidity distributions
  - differences in p_T distributions
    - high p_T: dominated by NLO effects
    - low p_T: lack of data points but dominates yield