PHENIX Electron Trigger
for
Heavy Ion Physics

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at

PHENIX Trigger Meeting

on

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Presentation Outline

- ## Needs for Electron Trigger in PHENIX
  - Trigger Needs for Heavy Ion Physics

- ## Electron Trigger Algorithm

- ## Simulation Studies
  - Electrons to be Triggered
  - Rejection for Minimum-Bias Events
  - Minimum-Bias Trigger Rates
  - Rejection for Peripheral Au+Au

- ## Heavy Ion Physics Gain with Electron Trigger

- ## Summary

Needs for Electron Trigger in PHENIX

- reaction rates (w/ blue book luminosity)
  - 200 A GeV Au+Au
    - 6 barn x 2e26 cm^{-2}sec^{-1} = 1.2 kHz
  - 200 GeV p+p
    - 50 mb x 8e30 cm^{-2}sec^{-1} = 400 kHz (4 MHz later)
  - 500 GeV p+p
    - 60 mb x 2e31 cm^{-2}sec^{-1} = 1.2 MHz (12 MHz later)

- DAQ capability
  - LV1 limit : 25 kHz (6 kHz initially)
  - LV2 limit : 20 Mbyte/sec ~ 100 Hz min.-bias Au+Au

Trigger Needs for Heavy Ion Physics

- **p+p and light A+A**
  - essential to understand Au+Au data
    - no p+p data at the RHIC energy
      - only limited data at the ISR energy up to $\sqrt{s} = 63$ GeV
    - uncertainty in p+p can easily overshadow new phenomena in Au+Au
    - true for basically all physics probes
      - J/Ψ, ϕ, ω, ρ, charm, …

- **peripheral Au+Au ?**
  - might be where the QCD phase transition occurs

Electron Trigger Algorithm (1)

- front-end
  - EMCal Ersatz LV1
    - 172 bits from overlapping 4x4 PMT sums
    - *ref*. G.Young at this Trigger Meeting
  - RICH LV1
    - 256 bits from non-overlapping 4x5 PMT sums
    - *ref*. T.Matsumoto at Trigger Meeting in December '99
    - *ref*. T.Matsumoto/K.Oyama at this Trigger Meeting

Electron Trigger Algorithm (2)

- **EMCal-RICH look-up**
  - was not in original GL1
  - a really simple scheme: 1/2 sector matching
    - EMCal: 3x3 (PbSc) / 4x4 bits (PbGl) OR'ed
    - RICH: 4x4 bits (= 1 readout FEM) OR'ed
    - look-up: simple 1-to-1 AND of 16 bits + 16 bits
    - *ref*. K.Shigaki at Heavy/Light and Spin PWG's in August '99
  - studies to finalize specifications
    - finer segmentation for better rejection power ?
    - overlapping look-up for higher efficiency ?
   - single/double electron trigger ?

Simulation Studies

- **vector meson signals**
  - MDC-2 and its follow-up at RCF
    - requested by M.Rosati, K.Barish; processed by I. Ojha *et al.*
    - 778 J/Ψ, 700 ϕ from RV generator

- **minimum-bias backgrounds**
  - MDC-J-2 at PHENIX-CC-J
    - requested by K.Shigaki; processed by N. Hayashi *et al.*
    - 12,117 Au+Au, 6,120 Ag+Ag, 12,211 Si+Si, 85,203 p+p

- **more vector meson signals for systematic study**
  - VRDC at PHENIX-CC-J / RCF
    - requested by K.Shigaki; processed by N. Hayashi *et al.*
    - 60K J/Ψ, 54K ϕ at fixed p_t

# Electrons to be Triggered (MDC-2)
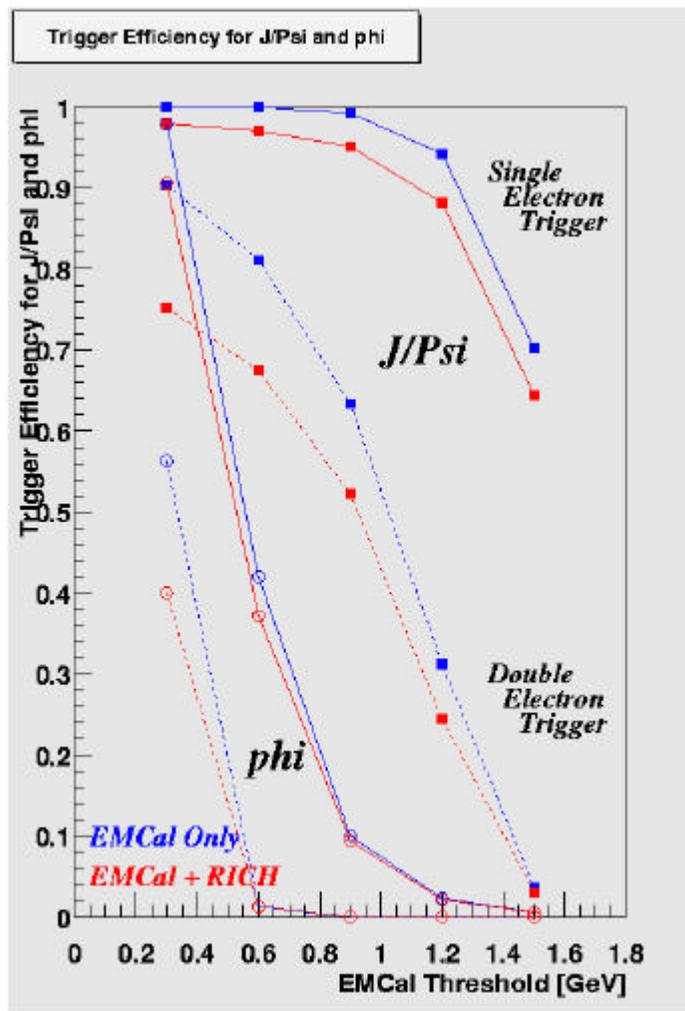
- for J/Ψ
  - single electron threshold < 1 GeV
- for φ
  - single electron threshold < 500 MeV
- for charm
- further study ongoing in VRDC
  - as a function of p_t
 - acceptance cut
  - pair reconstruction

Rejection for M.B. Events (MDC-J-2)

Minimum-Bias Trigger Rates (MDC-J-2)

Trigger Rates with Blue Book Luminosities

- p+p (200 GeV)
- Si+Si
- Ag+Ag
- Au+Au

EMCal Only
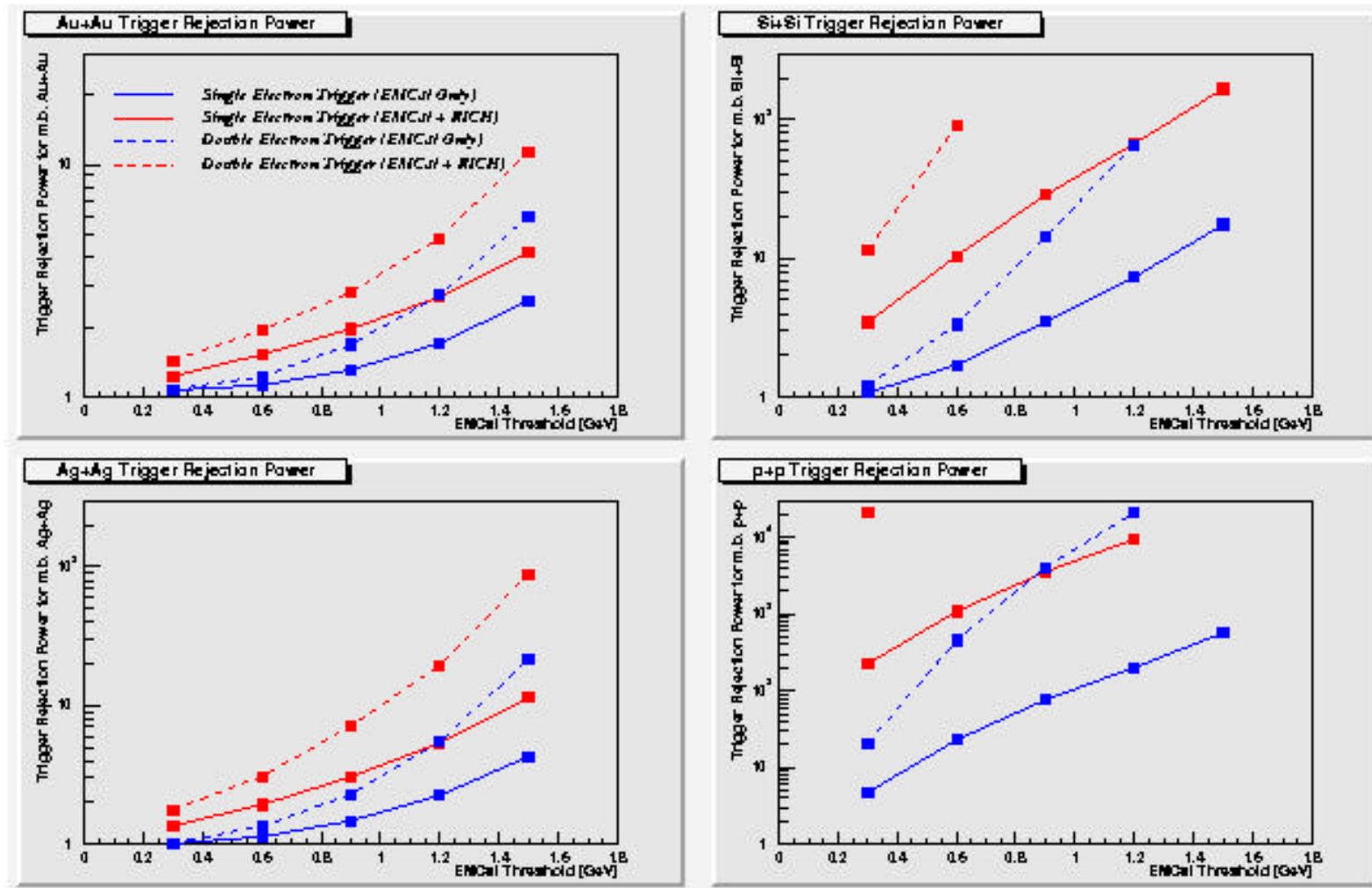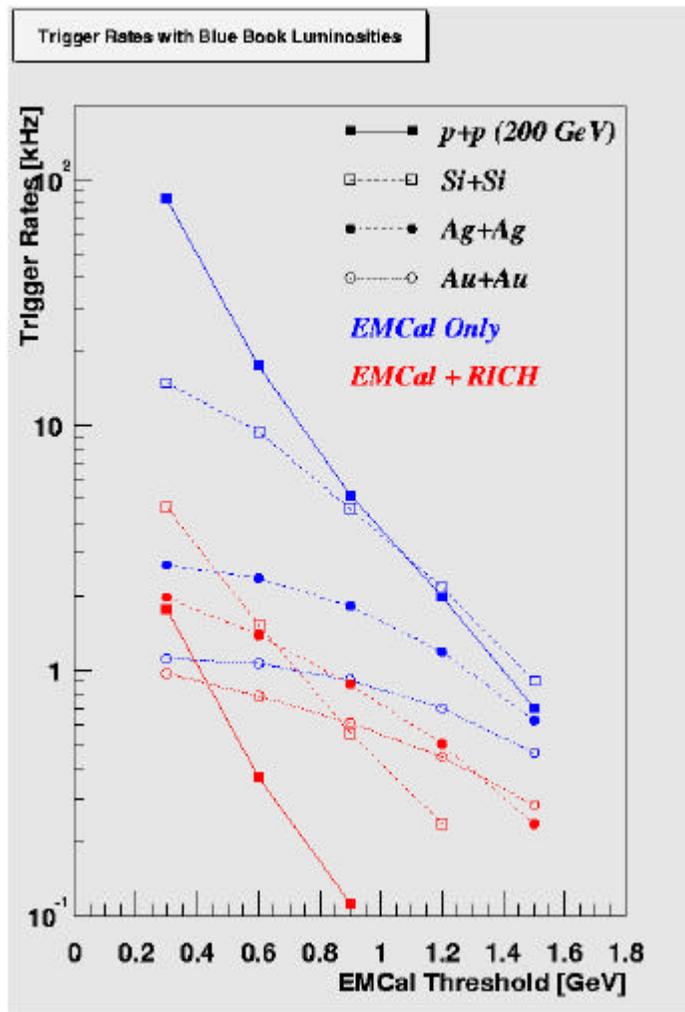
EMCal + RICH

- **plots: single electron trigger rates with blue book luminosity**

- **EMCal trigger with light collision systems:**
  - marginal for J/Ψ
  - insufficient for φ (and c ?)
  - does not sustain x10 luminosity

- **EMCal + RICH trigger:**
  - works even for φ from x10 luminosity p+p

Rejection for Peripheral Au+Au
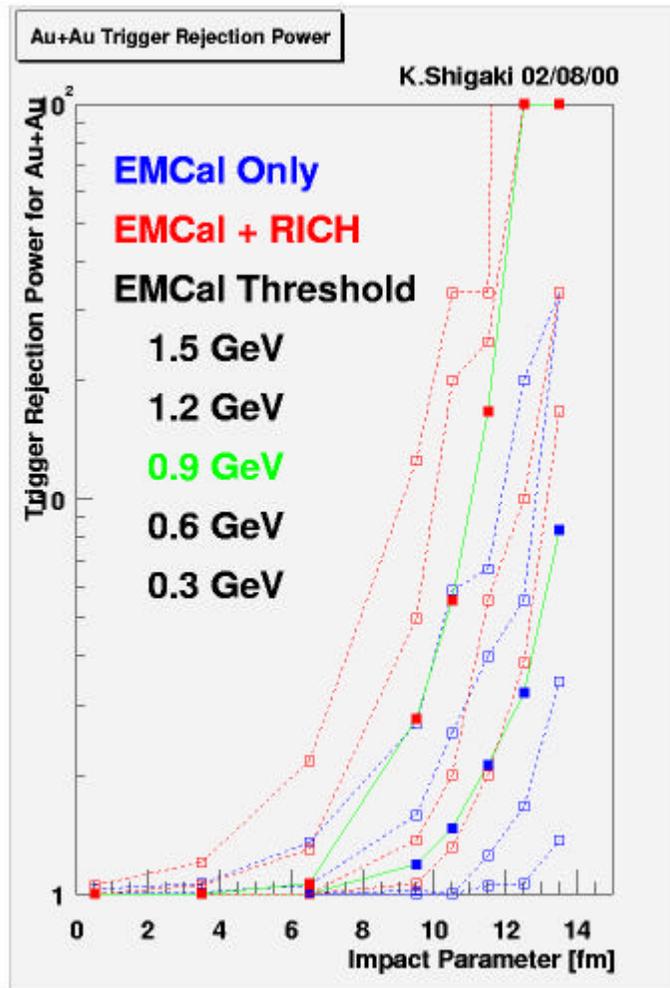
- **any use of the trigger in Au+Au running ?**
  - rejection power exists for peripheral Au+Au events, which might be where the QCD phase transition occurs

HI Physics Gain with Electron Trigger

- high luminosity runs
  - p+p and light A+A
  - at BBL and with future RHIC upgrade
- possible use for peripheral Au+Au
- low electron threshold
  - can go down « 1 GeV
- access to rare probes
  - J/Ψ, ϕ, ω, ρ (di-electron)
  - charm (single electron)
- essential to systematic studies of virtually all single/di- electron channels

Summary

- **electron trigger for heavy ion physics**
  - essential for systematic studies with light A+A, p+p
  - can be useful to trigger peripheral Au+Au
- **simple EMCal-RICH look-up does** (EMCal alone does not) **cover many physics probes** (J/Ψ, ϕ, ω, ρ, charm, …)
  - allows electron threshold « 1 GeV with light collision systems
    - required for ϕ and charm (single electron) trigger
  - sustains x10 blue book luminosity
- **look-up scheme being studied to finalize hardware specifications**