



*Heavy Ion Physics*  
*with*  
*PHENIX Electron Trigger Upgrade*

**Kenta Shigaki** (KEK)

at

PHENIX Electron Trigger Upgrade Internal Review

on

August 9, 2000

# Presentation Outline

- Needs for Electron Trigger in PHENIX
  - Trigger Needs for Heavy Ion Physics
- Trigger Performance Simulations
  - EMCal Trigger Threshold Requirements
  - Rejection against Minimum-Bias Events
  - Trigger Rates
  - Rejection against Peripheral Au+Au
- Summary of Heavy Ion Physics Gain

# Needs for Electron Trigger in PHENIX

- reaction rates at blue book luminosities
  - 200 A GeV Au+Au
    - $6 \text{ barn} \times 2 \times 10^{26} \text{ cm}^{-2}\text{sec}^{-1} = 1.2 \text{ kHz}$
  - 200 GeV p+p
    - $50 \text{ mb} \times 8 \times 10^{30} \text{ cm}^{-2}\text{sec}^{-1} = 400 \text{ kHz}$  (4 MHz later)
  - 500 GeV p+p
    - $60 \text{ mb} \times 2 \times 10^{31} \text{ cm}^{-2}\text{sec}^{-1} = 1.2 \text{ MHz}$  (12 MHz later)
- DAQ capability
  - level-1 limit : 25 kHz (6 kHz initially)
  - level-2 limit : 20 Mbyte/sec ~ 100 Hz minimum-bias Au+Au
- required level-1 rejection power
  - order of  $10^2 \sim 10^3$  for heavy ion physics

# Trigger Needs for Heavy Ion Physics

- **p+p and light A+A**
  - reaction rate well over DAQ capability
  - essential to understand Au+Au data
    - **no p+p data** at RHIC energy
      - only limited data at 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 QCD phase transition occurs

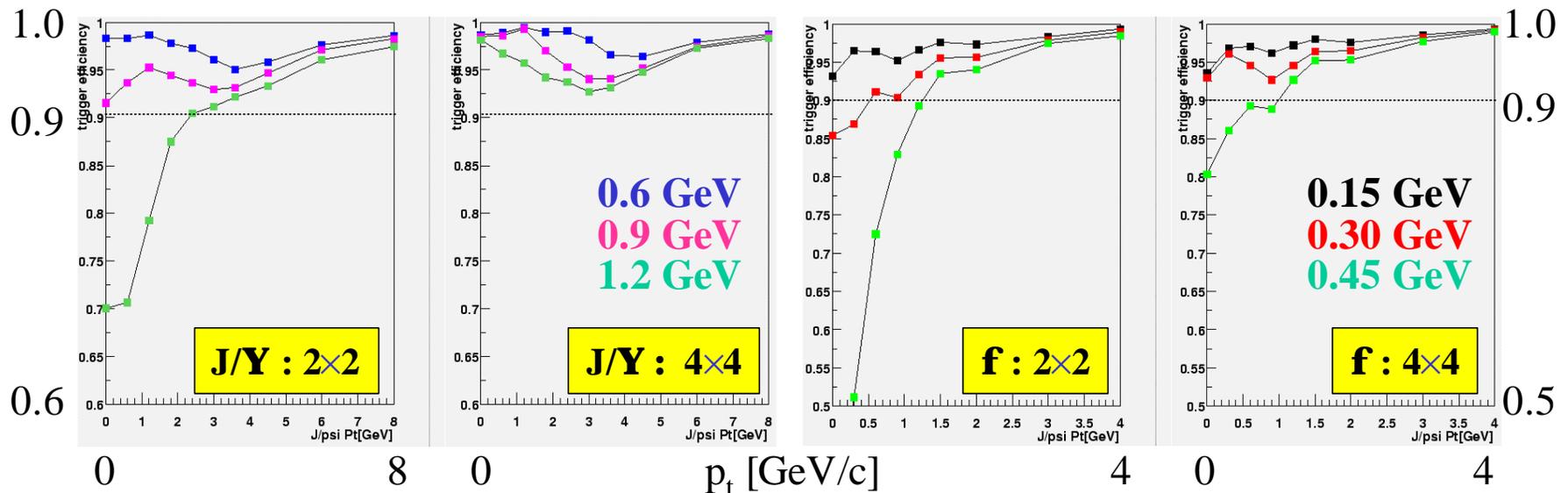
# Trigger Performance Simulations

- MDC-2 and its follow-up at RCF
  - requested by M.Rosati, K.Barish; processed by I. Ojha *et al.*
  - 778 single  $J/\Psi \rightarrow e^+ e^-$ , 700 single  $\phi \rightarrow e^+ e^-$  from RV generator
- MDC-J-2 at PHENIX-CC-J
  - requested by K.Shigaki; processed by N. Hayashi *et al.*
  - 12 K minimum-bias HIJING Au+Au, 6 K Ag+Ag, 12 K Si+Si
  - 85 K minimum-bias PYTHIA p+p
- VRDC at PHENIX-CC-J / RCF
  - requested by K.Shigaki; processed by N. Hayashi *et al.*
  - 60 K single  $J/\Psi \rightarrow e^+ e^-$ , 54 K single  $\phi \rightarrow e^+ e^-$  at fixed  $p_t$
  - 200 K minimum-bias p+p

# EMCal Trigger Threshold Requirements

- single electron trigger with 16 bits + 16 bits matching
- upper limits of threshold to effectively trigger on  $J/\Psi$  and  $\phi$
- EMCal  $2\times 2$  and overlapping  $4\times 4$  (not capable of low enough threshold) sum studied

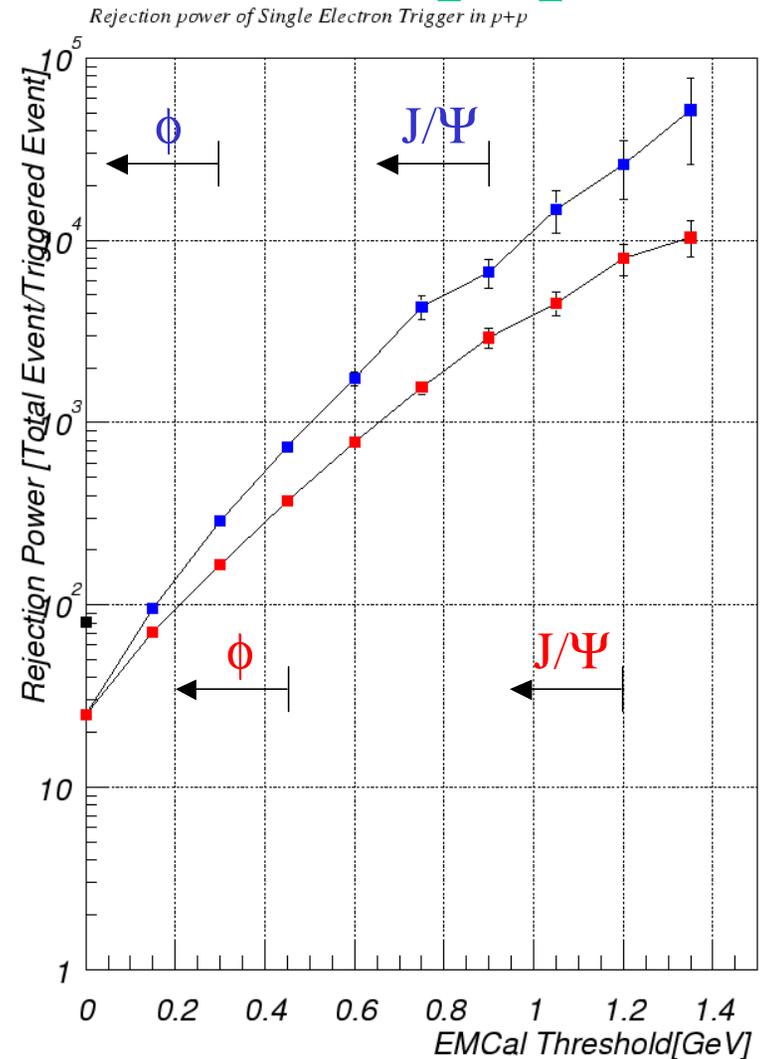
EMCal	$2\times 2$ sum	$4\times 4$ sum
$J/\Psi$	0.9 GeV	1.2 GeV
$\phi$	0.3 GeV	0.45 GeV



# Rejection against Minimum-Bias p+p

- trigger conditions
  - minimum-bias p+p at  $\sqrt{s} = 200 \text{ GeV}$
  - single electron trigger
  - 16 bits + 16 bits matching
  - EMCal  $2 \times 2$  and  $4 \times 4$  sum
- $J/\Psi$  trigger
  - rejection  $\sim 7000$  with  $2 \times 2$
- $\phi$  trigger
  - rejection  $\sim 300$  with  $2 \times 2$

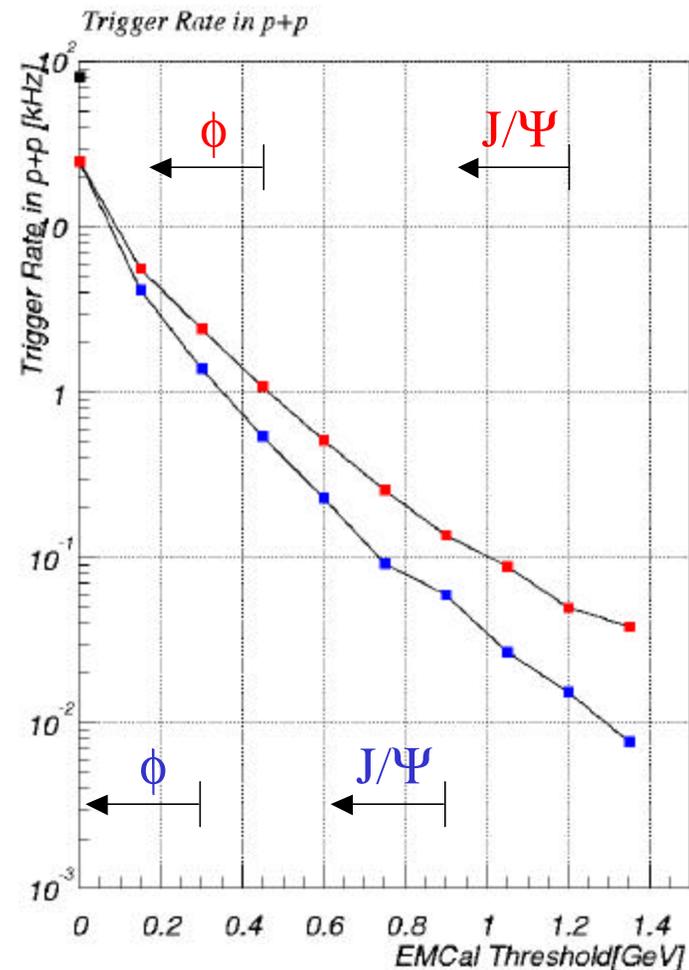
blue : RICH + EMCal  $2 \times 2$   
 red : RICH + EMCal  $4 \times 4$   
 black : RICH only (double)



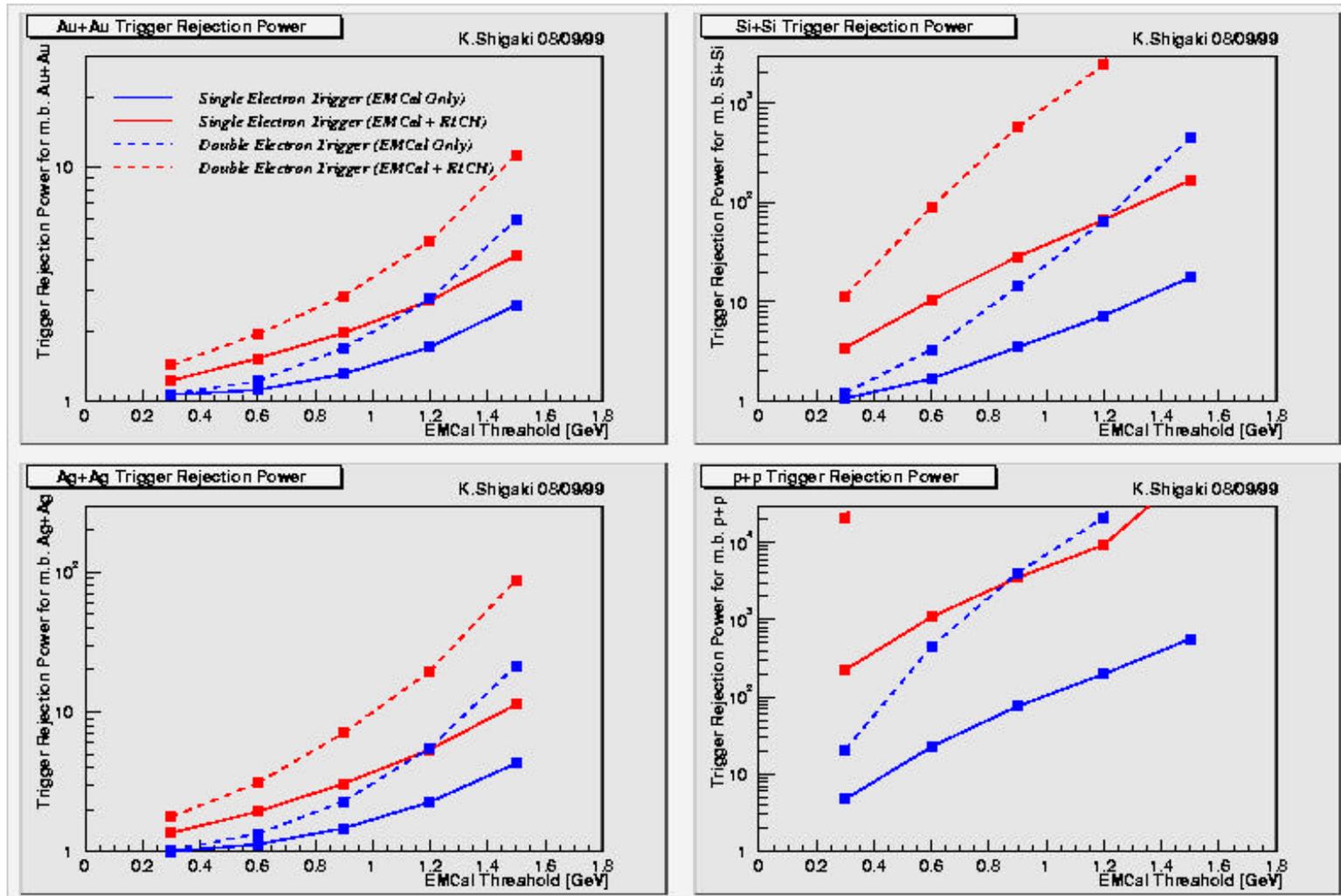
# Trigger Rate in p+p at $\sqrt{s} = 200$ GeV

- trigger conditions
  - same as in previous slide
- blue book luminosity
- J/ $\Psi$  trigger
  - sufficient even with future RHIC luminosity upgrade
- $\phi$  trigger
  - sufficient for p+p running at blue book luminosity
  - some pre-scaling may be needed in future

blue : RICH + EMCal 2x2  
 red : RICH + EMCal 4x4  
 black : RICH only (double)

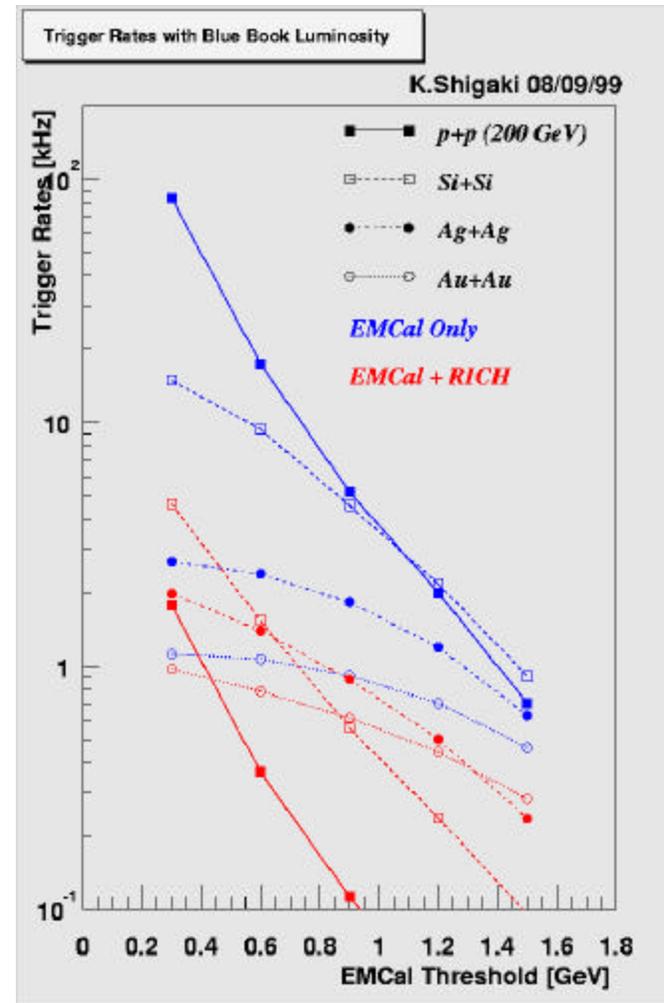


# Rejection against Minimum-Bias A+A

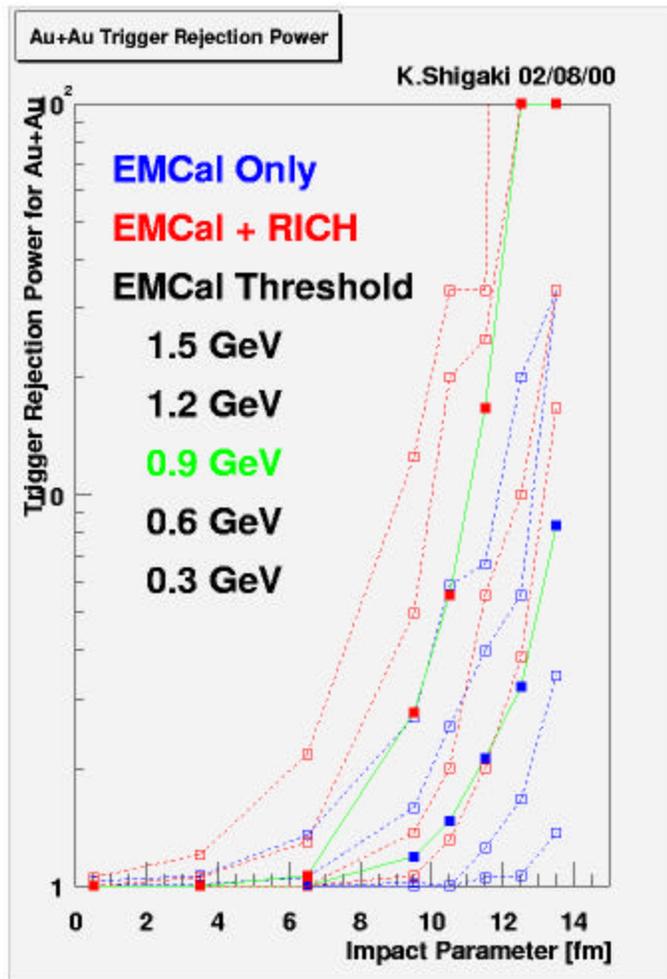


# Trigger Rate in A+A

- trigger conditions
  - single and double electron trigger
  - 16 bits + 16 bits matching
  - EMCal cluster energy (nearly identical to 4×4 sum)
- blue book luminosity
- light A+A (such as Si+Si) requires RICH + EMCal electron trigger



# Rejection against Peripheral Au+Au



- trigger conditions
  - single and double electron trigger
  - 16 bits + 16 bits matching
  - EMCal cluster energy (nearly identical to 4×4 sum)
- possible use of electron trigger in Au+Au running
- peripheral Au+Au
  - might be where QCD phase transition occurs

# Summary of Heavy Ion Physics Gain

- prominently for high luminosity runs
  - p+p and light A+A
  - at blue book luminosity and with future RHIC upgrade
- possible use to trigger on peripheral Au+Au
- low electron threshold is vital requirement
  - required to go down  $\ll 1$  GeV
  - possible and effective with RICH + EMCal 2x2 sum
- access to rare probes
  - $J/\Psi$ ,  $\phi$ ,  $\omega$ ,  $\rho$  (di-electron)
  - charm (single electron)
- essential to systematic studies of virtually all single- and di-electron channels