Heavy Ion Physics with Electron Trigger

or

How does an Enhanced Level-1 Trigger make Everyone in PHENIX Happy ?

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at

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on

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Presentation Outline

- Importance of p+p for Heavy Ion Physics
- Electrons to be Triggered
- LV1 Electron Trigger Rate Evaluation
- Heavy Ion Physics Gain
  with Enhanced LV1 Electron Trigger
- RICH LV1 Trigger
- Possible EMCal+RICH Trigger Schemes
- Summary

Boundary Conditions for LV1 Trigger

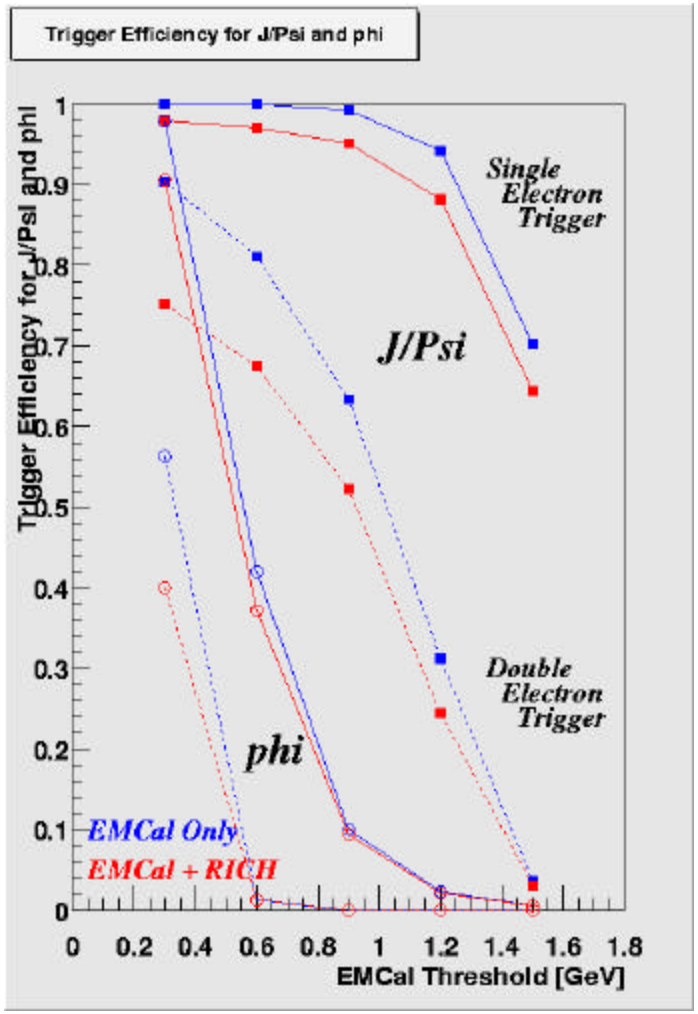
- reaction rates (w/ BBL)
  - 200 A GeV Au+Au
    - 6 barn x 2e26 $cm^{-2}sec^{-1}$ = 1.2 kHz
  - 200 GeV p+p
    - 50 mb x 8e30 $cm^{-2}sec^{-1}$ = 400 kHz (4 MHz later)
  - 500 GeV p+p
    - 60 mb x 2e31 $cm^{-2}sec^{-1}$ = 1.2 MHz (12 MHz later)
- PHENIX DAQ capability
  - designed for 25 kHz (6 kHz initially)
  - proven to work at > 1 kHz

Importance of p+p for Heavy Ion Physics

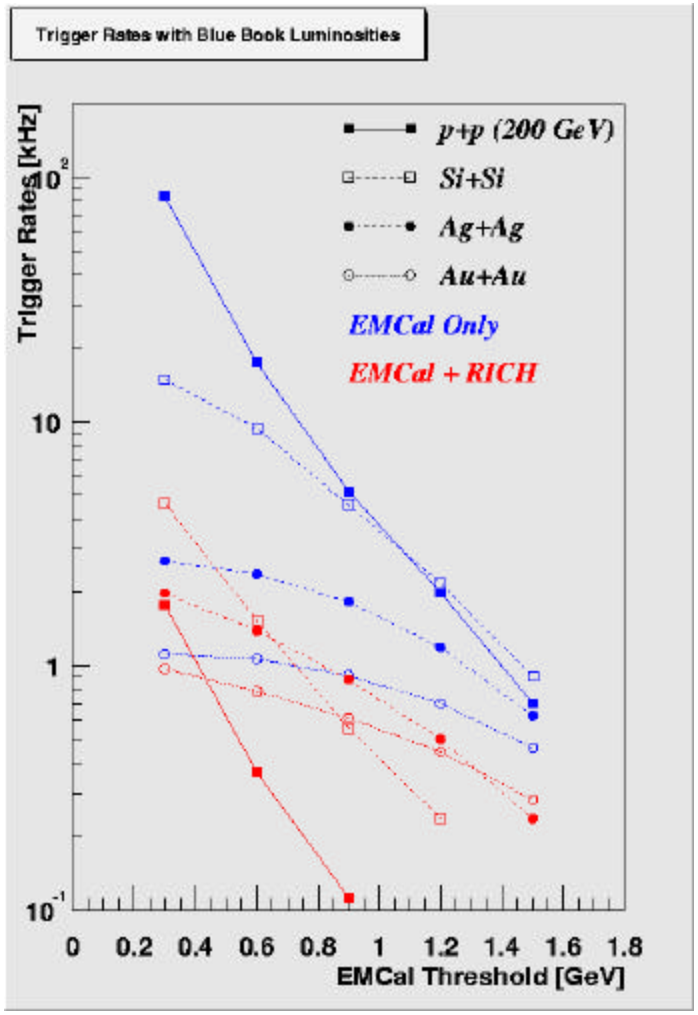
- "spin : heavy ion" ≠ "p+p : A+A"
- p+p data is essential to understand A+A data
  - no p+p data at the RHIC energy
    - only limited data at the ISR energy up to $\sqrt{s}$ = 63 GeV
  - uncertainty in p+p can easily overshadow new phenomena in Au+Au
  - true for basically all physics probes
    -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

Electrons to be Triggered

- single electron threshold for J/Ψ
  - 1 ~ 1.5 GeV
- single electron threshold for φ
  - 300 ~ 500 MeV
- single electron threshold for charm
  - 500 MeV ~ 1 GeV (study needed)



LV1 Electron Trigger Rate Evaluation



plots: LV1 single electron trigger rates with BBL

- EMCal trigger with light collision systems :
  - cannot go down « 1 GeV with BBL
  - marginal for J/Ψ
  - insufficient for ϕ, ω, ρ and charm
  - does not sustain x10 BBL
- EMCal + RIC Htrigger :
  - can go as low as ~500 MeV even with x10 BBL

Heavy Ion Physics Gain with **Enhanced** LV1 Electron Trigger

- high luminosity runs
  - p+p and light A+A
  - at BBL and with future RHIC upgrade
- lower 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

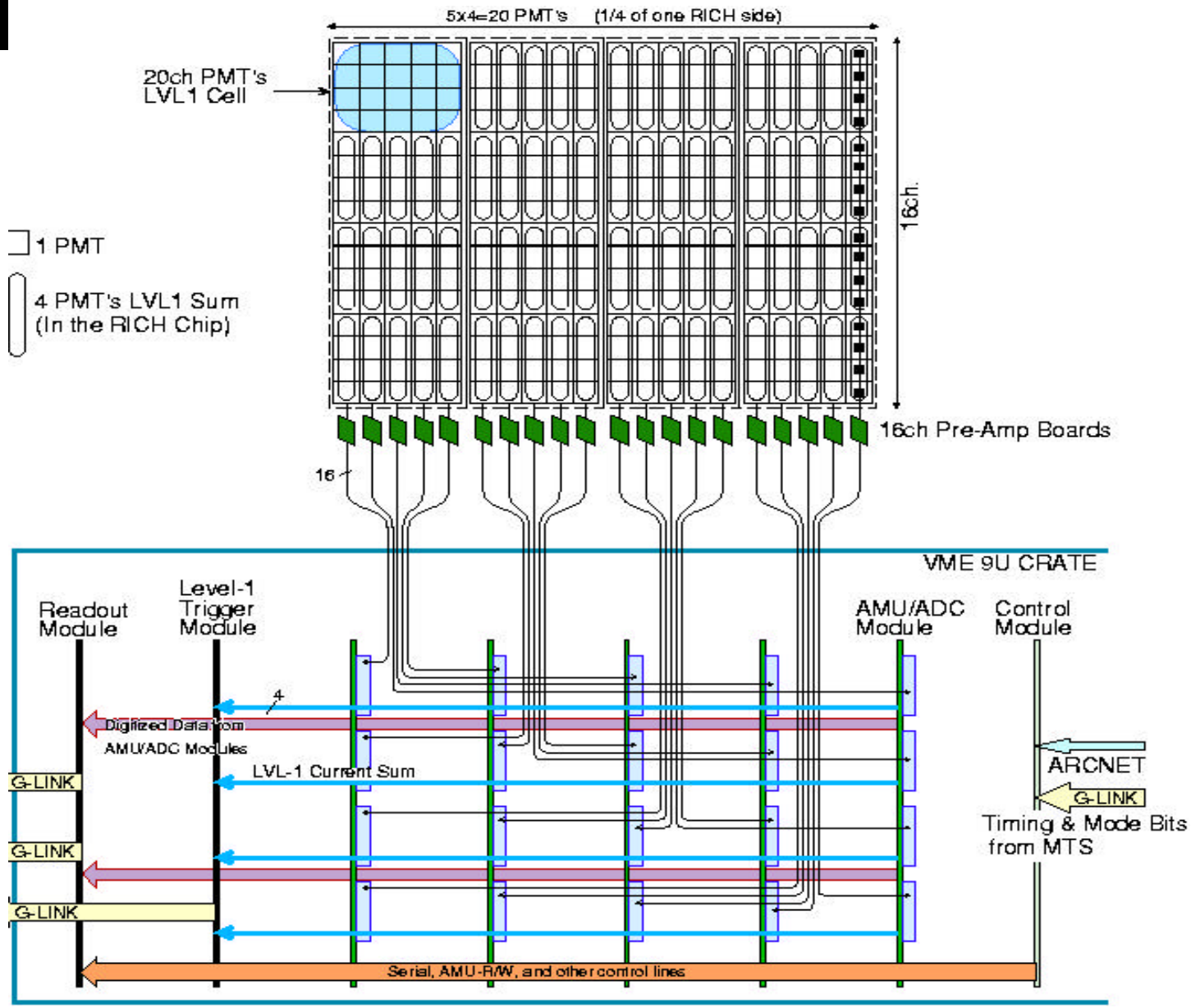
Further Consideration

(thanks to Y.Akiba for inputs, suggestions and discussions)

- Can we really measure low energy single electron in p+p ?
  - Dalitz decay and γ conversion background dominate
  - good chance of rejection with MVD
    - study by H.D.Sato
- Do we really need high statistics J/Ψ data in p+p ?
  - to better understand J/Ψ production mechanism
    - *e.g.* χ_c contribution
- Is the trigger of any use for Au+Au ?
  - very peripheral events might be interesting

RICH LV1 Trigger

- RICH FEM has non-overlapping 4x5 PMT tiles
  - analog sum made on AMU/ADC board and backplane
  - 4 (ϕ) x 8 (z) tiles per "sector"
    - analogous to EMCal FEM units (3 x 6 for PbSc, 4 x 8 for PbGl)
  - 256 segmentations
    - analogous to EMCal's 172 ETB's (108 for PbSc, 64 for PbGl)
- LV1 board development being suspended
  - flexible to accommodate trigger needs


5x4=20 PMT's (1/4 of one RICH side)
20ch PMT's
LVL1 Cell
16ch.
1 PMT
4 PMT's LVL1 Sum
(In the RICH Chip)
16ch Pre-Amp Boards
16
VME 9U CRATE
Readout
Module
Level-1
Trigger
Module
AMU/ADC
Module
Control
Module
4
Digitized Data from
AMU/ADC Modules
LVL-1 Current Sum
G-LINK
G-LINK
G-LINK
ARCNET
G-LINK
Timing & Mode Bits
from MTS
Serial, AMU-R/W, and other control lines

Possible EMCal+RICH Trigger Schemes

- input :
  - maximum 172 bits from EMCal (Ersatz) LV1
  - maximum 256 bits from RICH LV1
- EMCal - RICH look-up
  - an example : simple 1/2 sector matching (16 bits each)
    - EMCal: 3x3 (PbSc) / 4x4 bits (PbGl) OR'ed
    - RICH : 4x4 bits (= 1 readout FEM) OR'ed
  - finer segmentation for better rejection power ?
  - overlapping look-up for higher efficiency ?
- consideration :
  - trigger performance versus cost

Summary

- LV1 electron trigger wanted for HI physics, too
  - for high luminosity p+p and light A+A runs
- threshold should go down to 300 MeV ~ 1 GeV
  - to cover many physics probes J/Ψ, φ, ω, ρ, charm, …
- EMCal - RICH look-up allows it (EMCal alone does not)
  - allows electron threshold « 1 GeV
  - sustains x10 BBL
- studies needed to finalize the design include :
  - effect of trigger tile size
  - effect of inter-detector look-up scheme
  - their impact on cost

Rejection Power for Min.-Bias Events