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First Level Trigger

Run'98 performance

- Run'98 program
- Run'98 minimal detector configuration
  - muons
  - electrons
- Acceptance for reduced detector
- Conclusions / Remaining problems

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Run'98 Goals
(as stated)

- Physical: optimization for maximum efficiency for B cross section at moderate interaction rate (electrons and muons!)
- Methodical: maximization of information for debugging of trigger, DAQ, calibration, alignment, pattern recognition software

Questions to be answered:

- What is a minimal configuration to detect J/ψ?
- What is a strategy for following detector installation?

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Muons in Run'98

minimal configuration

- μ - pretrigger (MU3+MU4) is required to start a standard procedure
- MU1 superlayer is required to suppress random coincidences in MU3 and MU4

what additional tracker superlayers are required for a track kinematic reconstruction?

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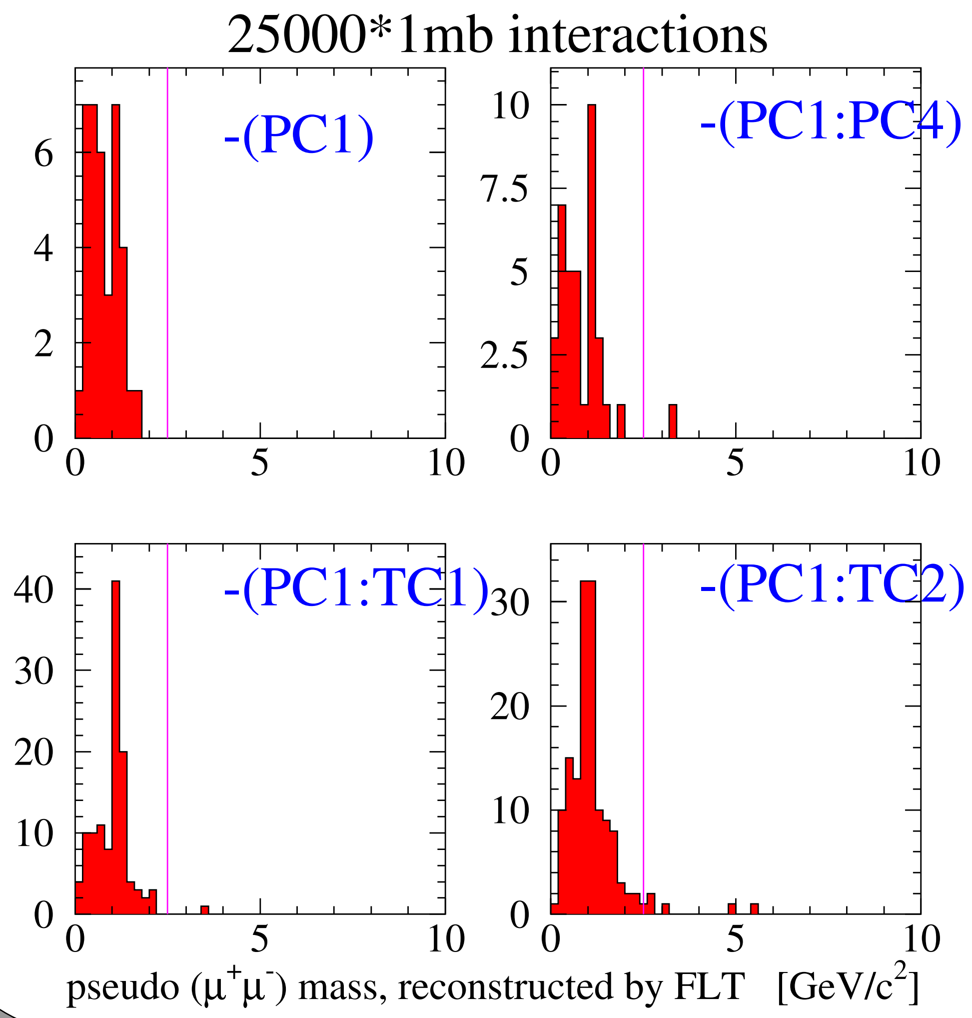
Muons in Run'98

remove tracker one SL by one

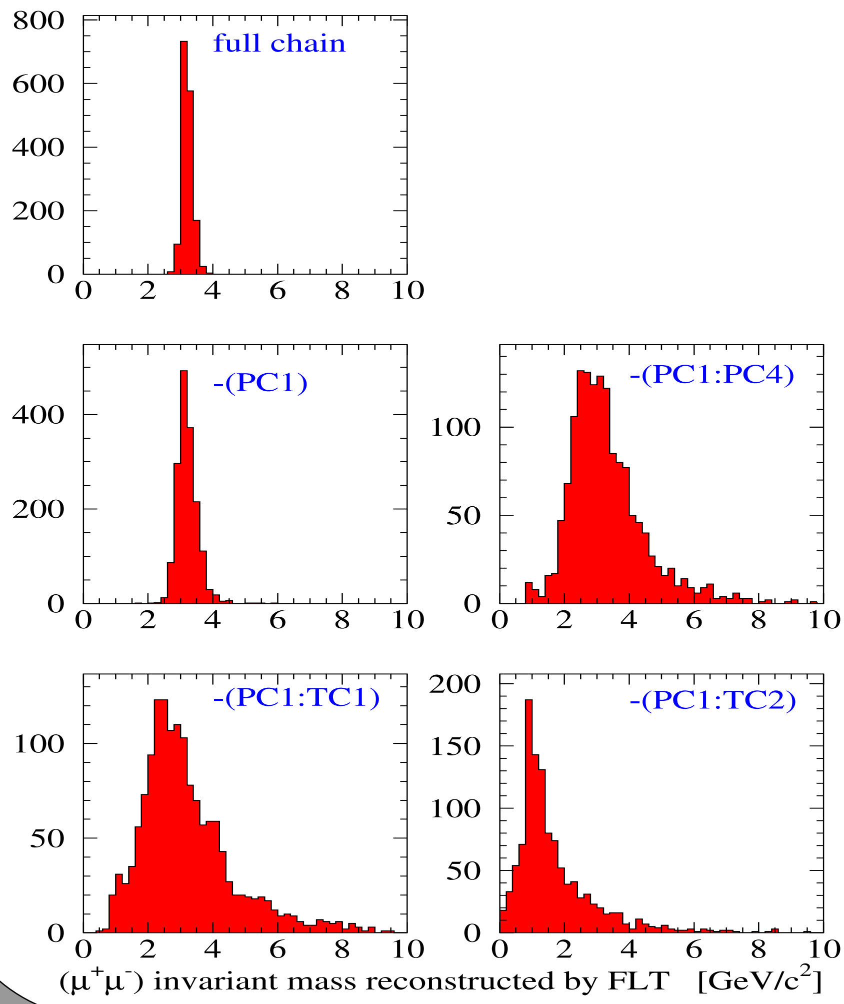


each accepted event costs here $4 \cdot 10^{-5}$
in suppression factor

Suppression of order $O(10^{-5})$ could be achieved using tracker superlayer TC2 only

Muons in Run'98

J/ψ mass resolution with reduced detector

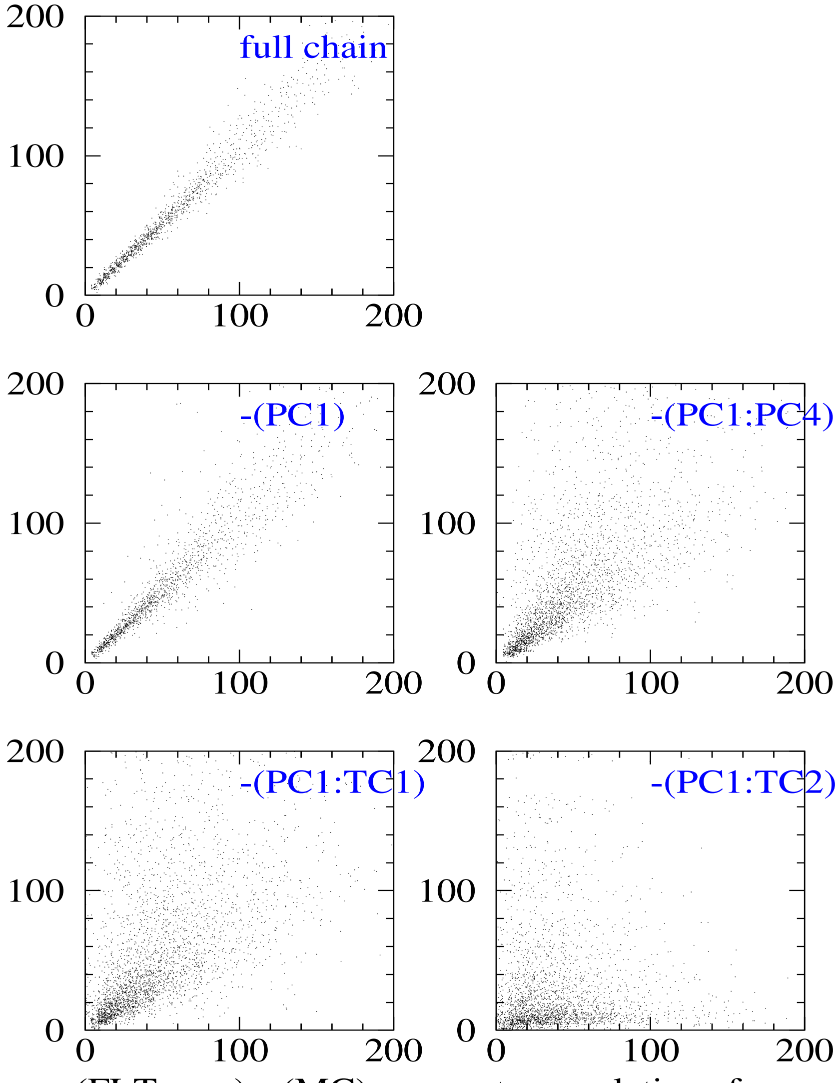


- No J/ψ signal without tracker
- small effect of TC1 (small base TC1-TC2)

efficiency $\approx 25\%$ **for** $M(\mu^+\mu^-) > 2.5\ GeV/c^2$

Muons in Run'98

reconstructed momentum vs true one



(FLT reco)vs(MC) momenta correlations for μ

No correlation without tracker information

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Electrons in Run'98
minimal configuration

- ECAL provides both position and energy for electron candidate, that is all the necessary to reconstract track kinematics
- Reject TFU modules from the standard chain:
  $ECAL \rightarrow (Brem\ \ reco) \rightarrow TPM \rightarrow TDU$
  - standard hardware modules are used directly
  - test ECAL/TPM/TDU components without tracker
  - tracker layers will be easily incorporated on availability

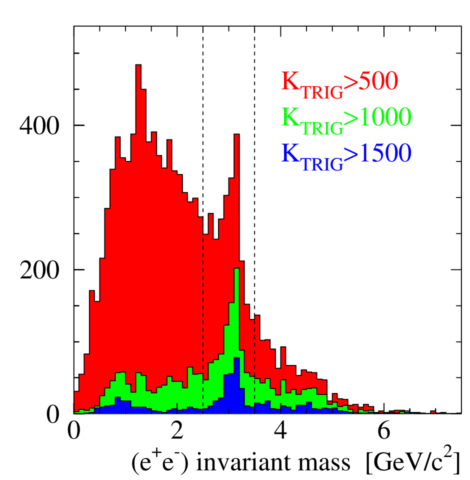
Minimal configuration to start actual FLT studies

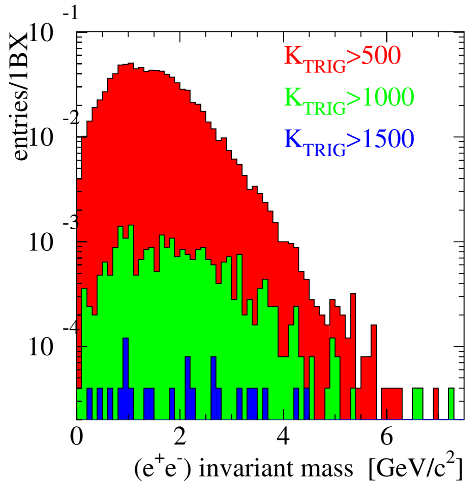
Minimal configuration to look for

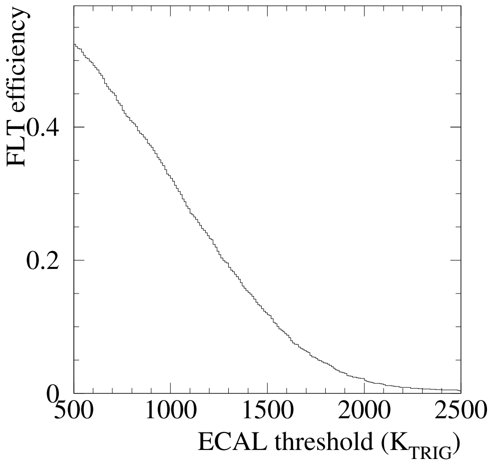
our first J/ψ

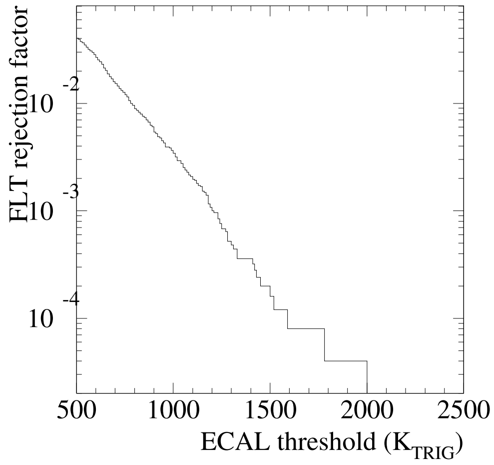
Electrons in Run'98

signal $(1 J/\psi + 1mb)$/background (1mb) estimates









Efficiency is overestimated due to radiative photons contribution

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Electrons in Run'98
magnetic field

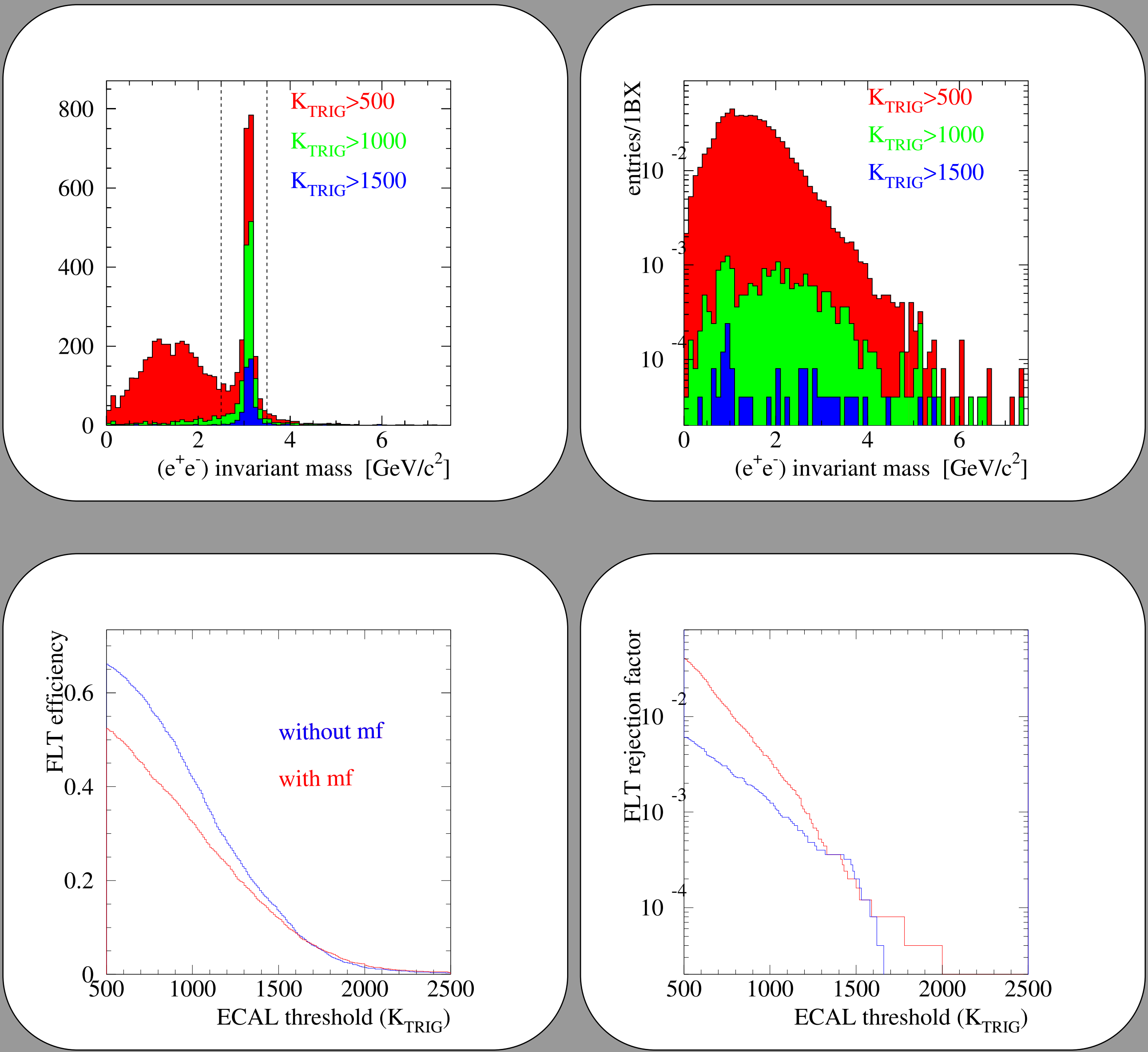
Effects of the magnet:

- Two track candidates per every pretrigger cluster (charge uncertainty) – combinatorical background
- bremsstrahlung photons decrease both resolution and efficiency
- useless untill tracker will be installed
- takes money for operation

Magnet is obsolete in this direct operation mode of ECAL

Electrons in Run'98

signal/background estimations without magnet



Clear signal with the same background

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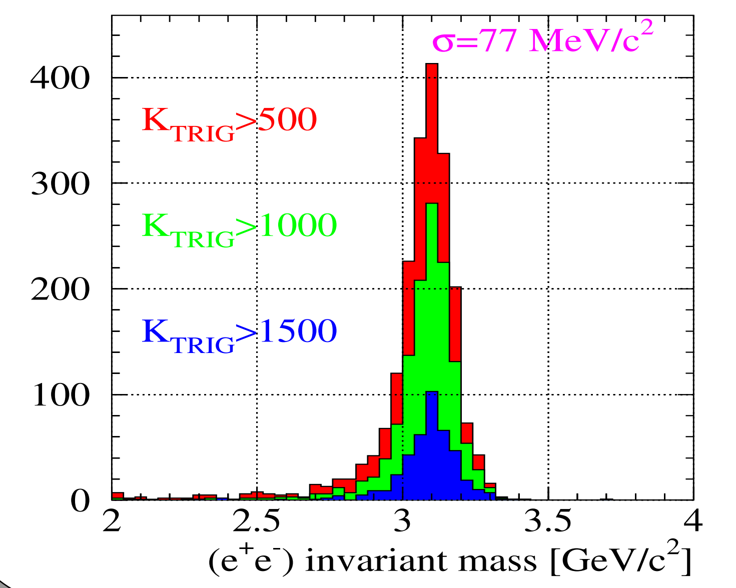
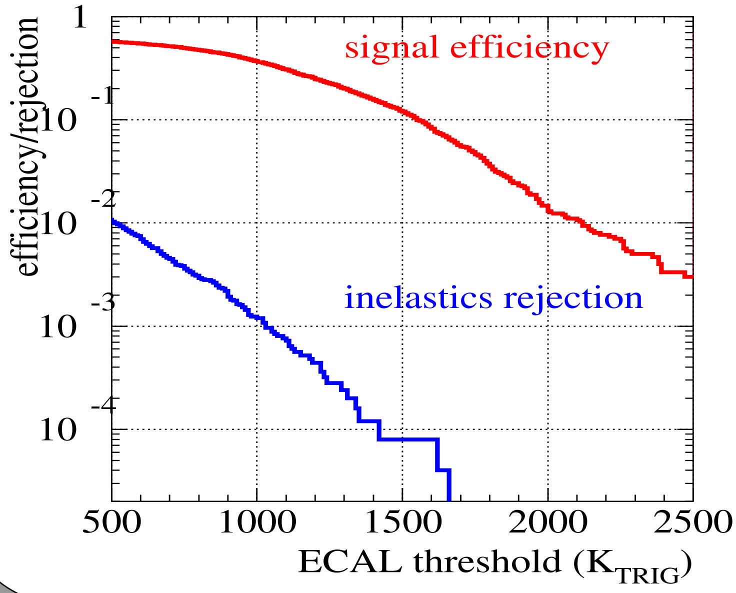
Electrons in Run'98

signal/background estimations without magnet

mass interval: $M_{J/\psi} \pm 2\sigma$





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Run'98 Goals

Direct J/ψ production

$$\frac{N_{J/\psi}}{N_{inel}} = \frac{\sigma(pN \to J/\psi\ X)}{\sigma_{inel}} \cdot Br(J/\psi \to l^+l^-) \cdot R_{ee}$$

- R_{ee} – trigger rejection power ($eff/rejection \approx 1.2 \cdot 10^3$)

$$\frac{N_{J/\psi}}{N_{inel}} = \frac{350nb}{13mb} \cdot 6 \cdot 10^{-2} \cdot 0.8 \cdot R_{ee} =$$
$$\frac{N^{direct}_{J/\psi}}{N_{inel}} = 1.6 \cdot 10^{-6} \cdot R_{ee} \approx 2 \cdot 10^{-3}$$

$5 \cdot 10^4$ J/ψ's in the signal are required to provide a 10σ effect

($\approx$ 17 hours of HERA-B running at 0.5 int/BX)

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Run'98 Goals

J/ψ from B decays vs inelastics

$$\frac{N_{J/\psi}}{N_{inel}} = \frac{\sigma(pN \to bb)}{\sigma_{inel}} \cdot$$
$$2 \cdot Br(B \to J/\psi\ X) \cdot Br(J/\psi \to e^+e^-) \cdot R_{ee} \cdot R_{VX} \cdot R_{match}$$

- R_{ee} – trigger rejection power ($eff/rejection \approx 1.2 \cdot 10^3$)
- R_{VX} – vertex rejection power ($eff/rejection \approx 2 \cdot 10^3$ (?))
- R_{match} – track matching in Si ($eff/rejection \approx 10$ (?))

$$\frac{N_{J/\psi}}{N_{inel}} = 10^{-6} \cdot 2 \cdot 10^{-2} \cdot 6 \cdot 10^{-2} \cdot R_{ee} \cdot R_{VX} \cdot R_{match} =$$
$$1.2 \cdot 10^{-9} \cdot R_{ee} \cdot R_{VX} \cdot R_{match} \approx 2.9 \cdot 10^{-2}$$

3500 J/ψ's in the signal are required to provide a 10σ effect

($\approx$ 3.2 months of HERA-B running at 0.5 int/BX)

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Run'98 Goals

J/ψ from B decays vs direct J/ψ

$$\frac{N^B_{J/\psi}}{N^{direct}_{inel}} = \frac{\sigma(pN \to bb) \cdot 2 \cdot Br(B \to J/\psi\ X)}{\sigma(pN \to J/\psi\ X)} \cdot R_{VX}$$

$$\frac{N^B_{J/\psi}}{N^{direct}_{inel}} = \frac{13mb \cdot 10^{-6} \cdot 2 \cdot 10^{-2}}{350nb} \cdot R_{VX}$$

$$\frac{N^B_{J/\psi}}{N^{direct}_{inel}} = R_{VX}/1400 \approx 1.4$$

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Electrons in Run'98

summary

HERA-B ECAL may operate in stand alone mode and provide:

- efficiency of J/ψ reconstraction $\approx 10\%$
- inelastic background suppression $\sim O(10^{-5})$
- operation without magnetic field

Any tracker device in front of ECAL (like TRD) will provide additional suppression of hard photons

This configuration may be used for data taking untill tracker starts the operation.

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Detector Geometry for Run'98

Two main approaches for a detector in run'98:

- all components of detector are installed
  but with very reduced acceptance:
  debugging of detectors and algorithms

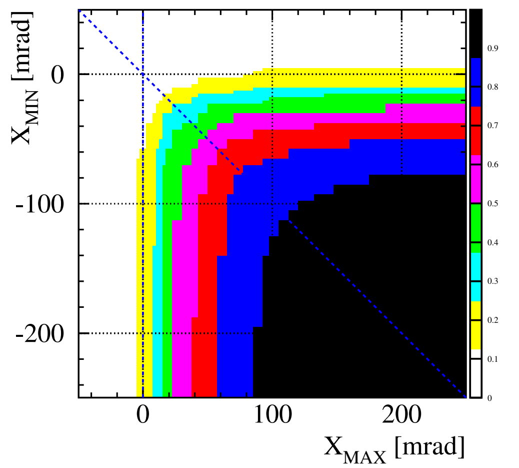
- only necessary components are installed
  but with maximal acceptance:
  Physical data taking mode

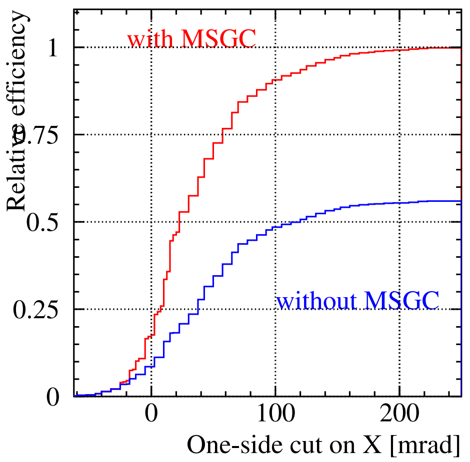
Second mode could be used for debugging as well...
what will be the efficiency for reduced detector?

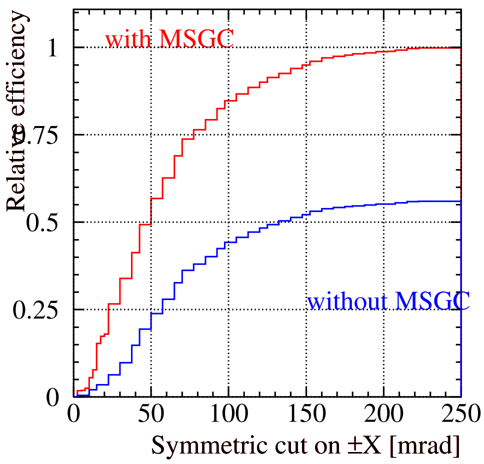
Detector Geometry for Run'98

X cut off strategy

consider acceptance:
in X: restricted
from X_{min} to X_{max},
in Y: full range







One side half of the detector is equivalent to symmetrical detector $\pm 25\ mrad$ only
Not the best selection...

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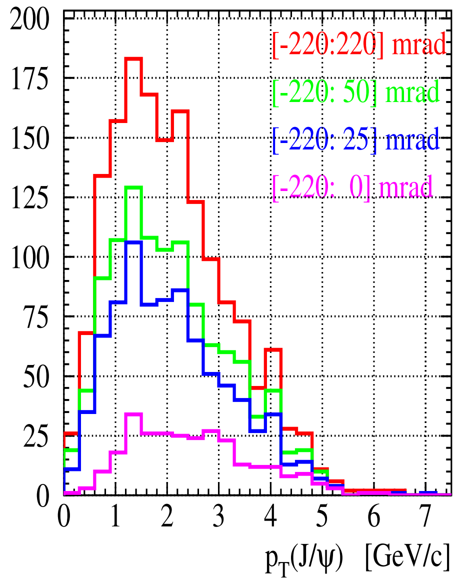
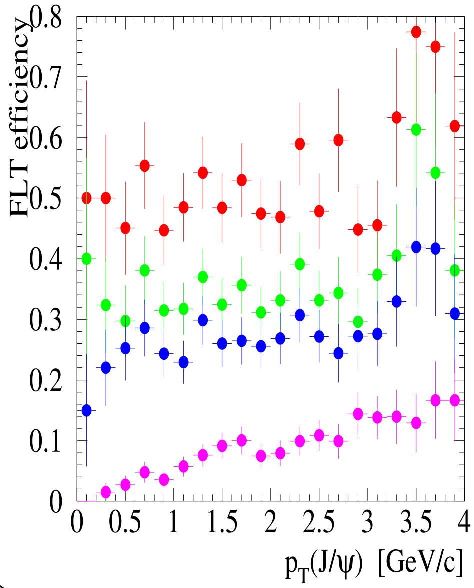
Detector Geometry for Run'98

P_T dependency





Not flat acceptance $\Rightarrow$
uncertainties in result interpretations

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To be Done

a lot...

- J/ψ from charm production in pN interactions
- Si detector: vertex fit, following suppression
- Full trigger/reconstruction chain
- Optimal tracker distribution
- etc., etc...

Time scale: yesterday

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Possible run'98 scenario

- start with minimal ECAL configuration without magnet
  - study ECAL, TPM, TDU
  - look for $J/\psi \to e^+e^-$
- fill maximum of TC2 with tracker chambers, switch the magnet on, use minimal MU configuration
  - study μ-system, TFU
  - look for $J/\psi \to \mu^+\mu^-$
- fill the rest of the tracker in limited acceptance
  - methodical studies in full range
  - seach for $B \to J/\psi$

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Conclusions

- Muon system require tracker for its operation
- ECAL provides inelastics suppression of order 10^{-5} and reasonable efficiensy ($\sim 10\%$) in stand alone (+FLT) mode.
- The acceptance of reduced detector geometry should be large enough for physical measurements
- A lot of studies should be made to establish the run'98 real physical program