Trigger on Electromagnetic Form Factors and other EM channels

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1. Trigger for Rare Signal
2. Veto/Downscaling
   for specific Background
   (similar signature)
3. Veto/Downscaling
   for general Background
   (not similar signature but high σ)

1. Rare Signal (electromagnetic Probe, suppression by α_{EM}^2):
So far concentrate on Target Spectrometer
pbar p → $e^+ e^-$ (EM FF), BaBar Fr., PANDARoot in progress
10^6 to 10 per campaign (q^2 = 5.4 to q^2=22 $(GeV/c)^2$)
pbar p → $\mu^+ \mu^-$ (EM FF) -> Maria Pia Bussa
pbar p → $\tau^+ \tau^-$ (EM FF, polarisation)
pbar p → $e^+ e^- \pi^0$ (EM FF, TDAs), BaBar Fr., PANDARoot in progress
pbar p → $e^+ e^- \gamma$ (EM FF, TDAs, GPDs)
pbar p → $\gamma\gamma$ (GPDs, M. Düren)
pbar p → $e^+ e^- + X$ (Drell-Yan)
. . .
2. Specific Background
possible to eliminate in analysis
pbar p → $\pi^+ \pi^-$, about 10^6 higher than signal (J. Vandewiele, S. Ong)
$\pi^+\pi^-$ 10^{11} to 10^7 per campaign
pbar p → $\pi^0 \pi^0$, about 10^6 higher than signal (J. Vandewiele, S. Ong)
pbar p → $\pi^+ \pi^- \pi^0$, about 10^6 higher than Signal (J. Vandewiele, S. Ong)
10^{11} events per campaign
pbar p → $k^+ k^-$, not studied on this level
...
3. Unspecific Background
for example:
pbar p → $\pi^+ \pi^- 5\pi^0$, σ even much higher,

Signal:
pbar p → $e^+ e^-$ (EM FF), BaBar Fr., PANDARoot in progress
10^6 to 10 per campaign ($q^2 = 5.4$ to $q^2=22$ $(\mathrm{GeV}/c)^2$)

Very close kinematics to pbar p → $\pi^+ \pi^-$
only a few mrd difference and
$\Delta p=10$ MeV/c all all angles and energies

Analysis: Need FULL PID capability of PANDA-detector
Different PID-variables cut at different kinematical situations

Not one single PID-observable sufficient for all momenta

Trigger: Two charged tracks
- Multiplicity

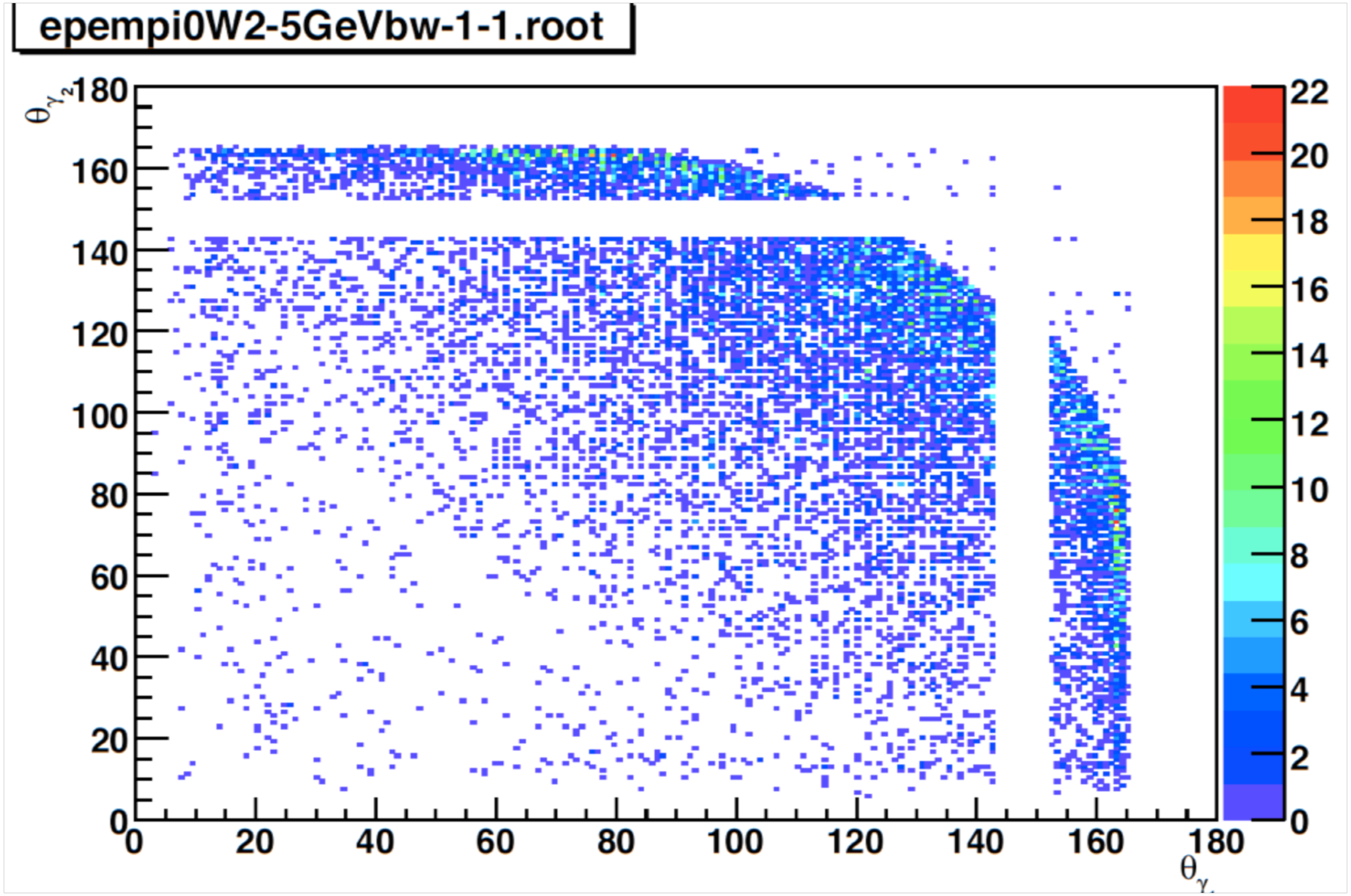
Veto:
- E/p (threshold on E/p, idea by Bertram Kopf)
electrons: electromagnetic shower
pions: 30% Bethe-Bloch dE/dx BUT 70% EMC equiv. to $1\lambda_{\mathrm{Nucl}}$
Tracking information available on-line for momentum?
- DIRC?

- dE/dx from all tracking detectors (MVD, STT, TPC, GEMs)?
For dx on-line information on reconstructed track necessary
- TOF?

- Shower Shape?

- kinematical Fits/constraints?

Photons at Backward Angle pbar p → $e^+ e^- \pi^0$ (TDAs)



Maria Carmen Mora Espi

2. Specific Background for 3 body channel

- $\pi^+\pi^-\pi^0$ is about 10^6 higher (J. Vandewiele, S. Ong, fitted to data) → a few 10^{11} events per campaign!
- Reduction of this background necessary
- similar kinematics
- Again full PID-information necessary in Analysis
- In Progress

3. Unspecific background

- But also $\pi^+\pi^-$ $n\pi^0$
  - Kinematics is different → easy to eliminate by kine fit
  - σ even much higher (at T=1 GeV, $\sigma(5\pi^0)$=12 mb) → 2 10^{13} events $\pi^+\pi^-$ $5\pi^0$ per campaign
  - Simulations by Ronald Kunne and Thierry Hennino

Principle of simulation (R. Kunne)

1. Generate E/p distributions with single tracks (100 Kevents e and π) $0.2<p<5$ GeV/c $5°<\theta<140°$

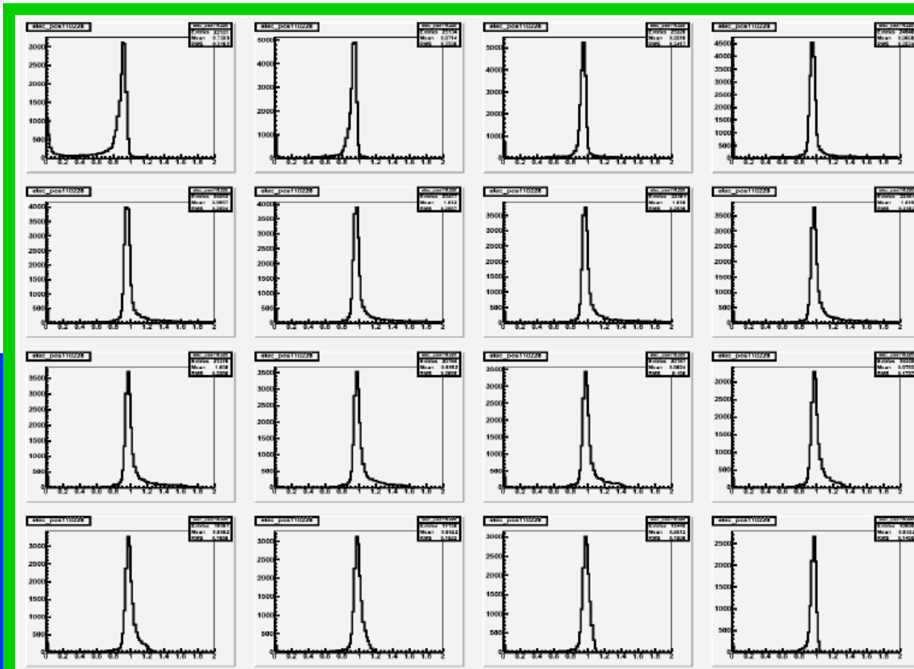
2. Generate phase space pbar p → $\pi^+\pi^-(n)\pi^0$ reaction events

- Decay the π^0 into γs
- Generate E signals from E/p distribution for charged pairs (signal e^+e^- and $\pi^+\pi^-$)
- Smear the γ energy according to the Proto60 resolution curve measured at Mainz
- Store the energy of all particle energy deposit in ECAL

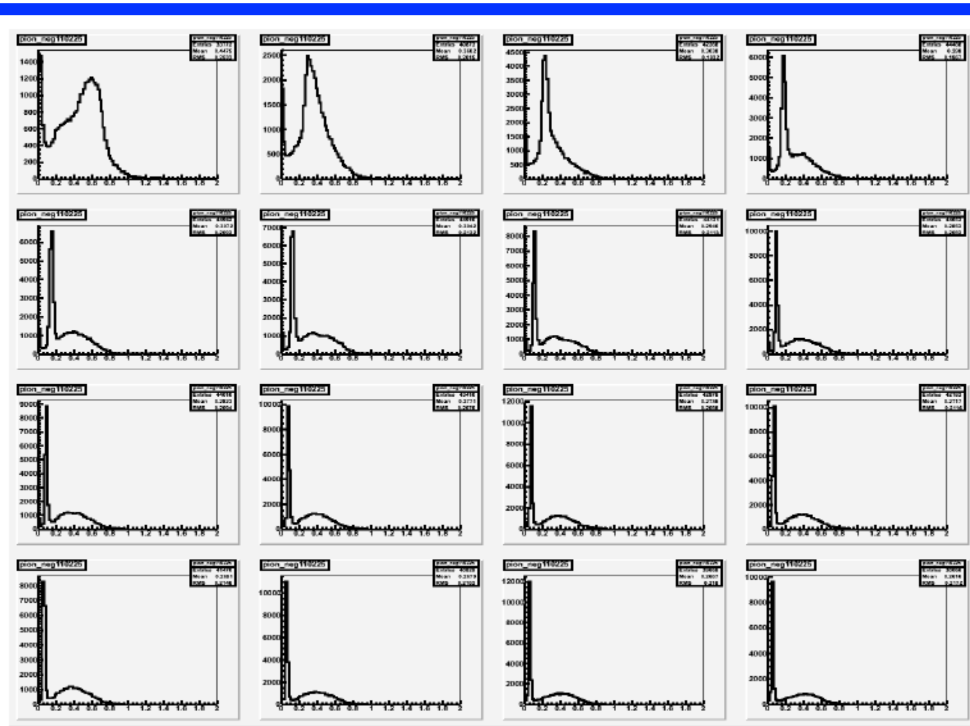
Energy deposit for electrons and pions
(R. Kunne, Th. Hennino)

Electrons

0.2 < p < 5 GeV/c



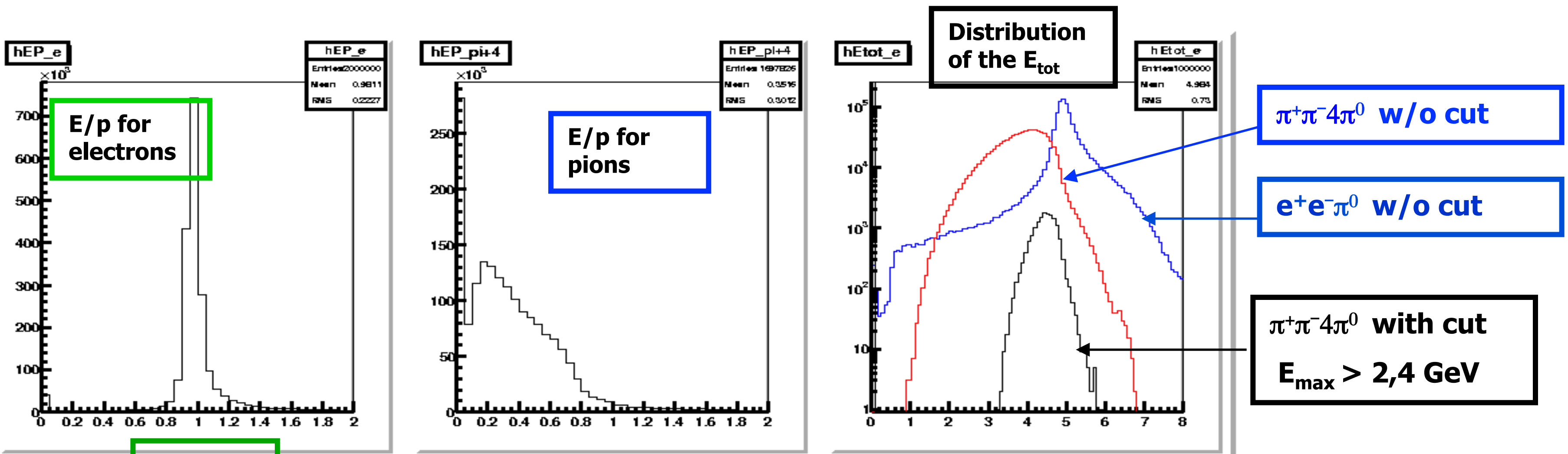
Charged Pions 0.2 < p < 5 GeV/c

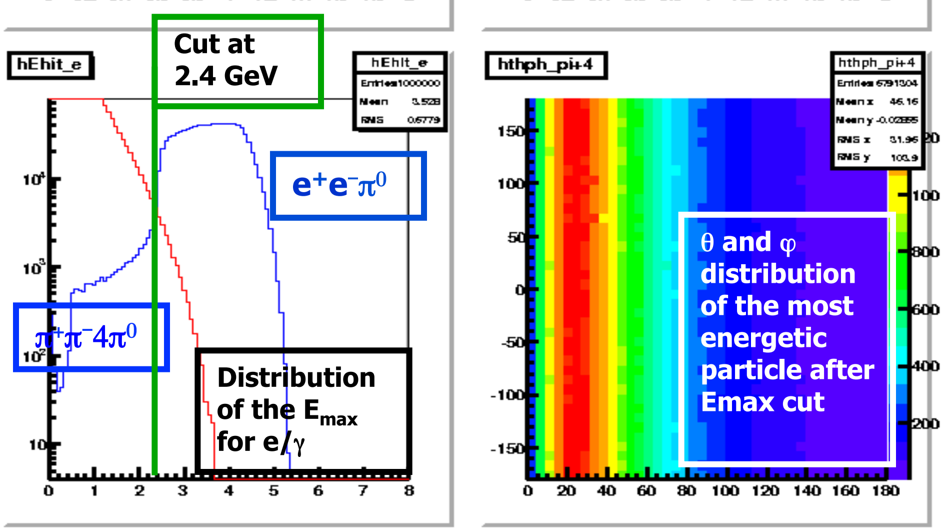


Idea for the selection/rejection (R. Kunne, Th. Hennino)

- Fast Simulation: DONE
- Calculate the sum E_{tot} of the energy deposit in ECAL
- Determine the most energetic cluster E_{max}
- Use cuts on E_{tot} and E_{max}
- TO BE STUDIED
- Use more elaborate cuts on the distribution of all ECAL clusters in θ and φ.
  - Define several regions (e.g. 16 sector in φ in the barrel + FEC and BEC, etc…)
  - Use multiplicity or distribution cuts to reject bckg

Results for $4\pi^0$ at P_{inc}=4 GeV/c





E_{max} distribution have very different behavior

→Cut at E_{max} = 2.4 removes bckg

E_{max}>2.4 GeV and E_{tot} >4 GeV Cut

(R. Kunne, Th. Hennino)

First results for p=4 GeV/c

- E_{max} > 2.4 and E_{tot} > 3 GeV
  - 95% of e+e-π0 events left
  - 1% of π+π-4π0 events left only
- Emax > 2.4 and Etot > 5 GeV
  - 50% of e+e-π0 events left, but....
  - 6 10^{-5} of π+π-4π0 events left only !
  - 6 10^{-4} of π+π-3π0 events left only !

(R. Kunne, Th. Hennino)

Summary

- EM-Probe: Need on-line suppression factor of 10^4 or higher for background channels

- In analysis, we need full PID-information
- What PID-information is available online?
- Kinematical constraints possible (resolution)?
- Cross correlations of Vetos:

Our Veto might cut into other signals?