

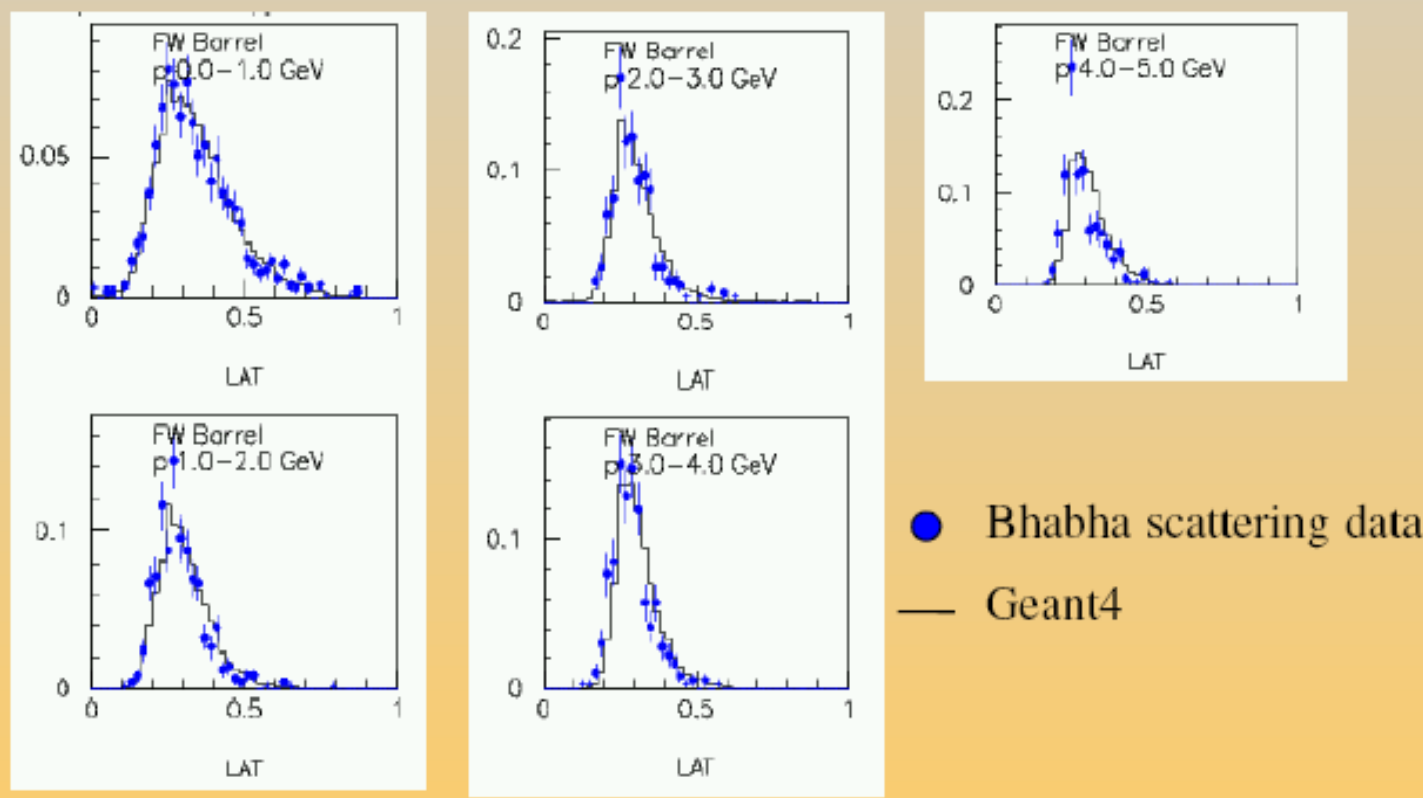
Overview

- G4 simulation in the BaBar-like software
 - physics list
 - validation
- Electron identification with the EMC (december 2006)
 - e/p and shower shape
 - neural network
 - results for a test sample (march 2007)
 - status and possible improvements
- e+e- analysis
 - reconstruction efficiency
 - $\pi^+\pi^-$ background study

- BaBar-like software with G4.7.1
- All detectors of the present favoured design implemented
 - apart from Cherenkov detectors in forward direction
- Physics list
 - took over the list used by BaBar
 - em processes for e⁻: G4MultipleScattering, G4eIonisation, G4eBremsstrahlung (G4 standard)
 - em processes for e⁺: G4MultipleScattering, G4eIonisation, G4eBremsstrahlung, G4eplusAnnihilation (G4 standard)
 - em process for π^- and π^+ : G4MultipleScattering, G4hIonisation
 - hadronic interactions for π^- and π^+ :
 - hadr. elast. interactions for all hadrons: G4HadronElasticProcess with G4LElastic model
 - hadr. inelast. interactions unique to each hadron: G4PionPlusInelasticProcess and G4PionMinusInelasticProcess with Bertini model

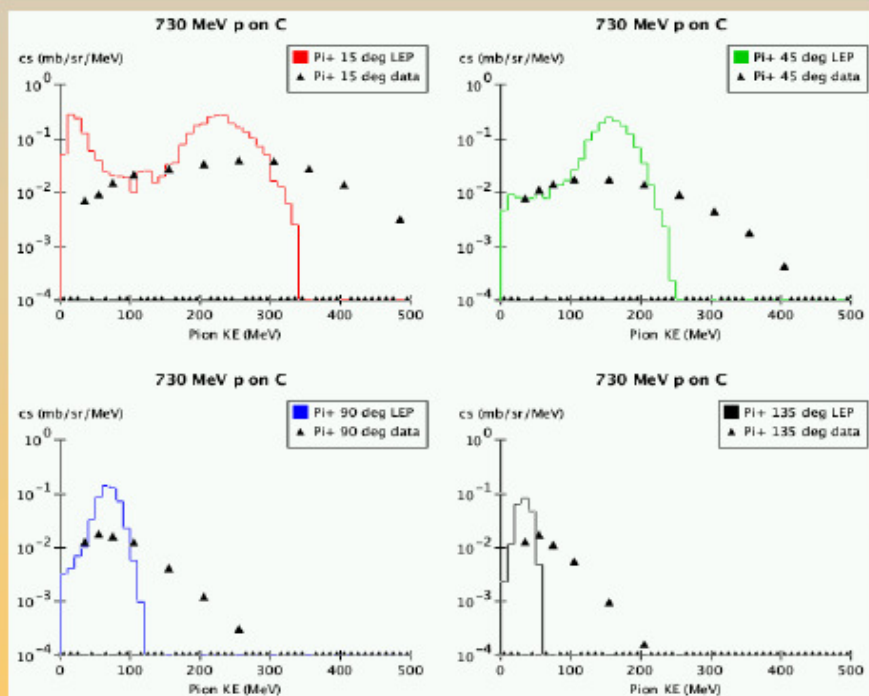
Dennis Wright (SLAC): G4 Tutorial, 8-10 March 2004

BaBar EM Calorimeter (EM shower shapes)

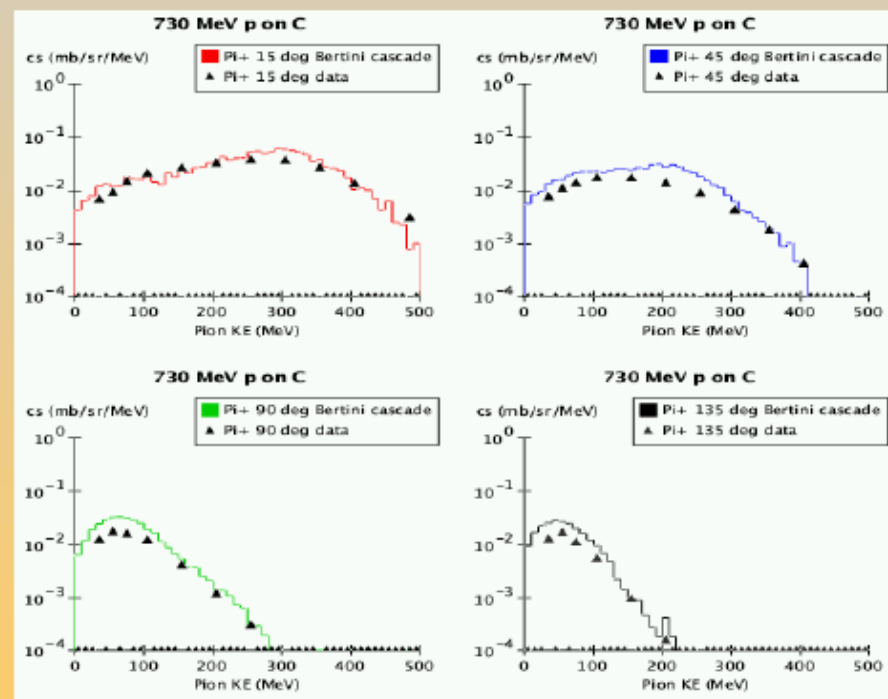


Dennis Wright (SLAC): G4 Tutorial, 8-10 March 2004

π Production from 730 MeV p (LEP Model)

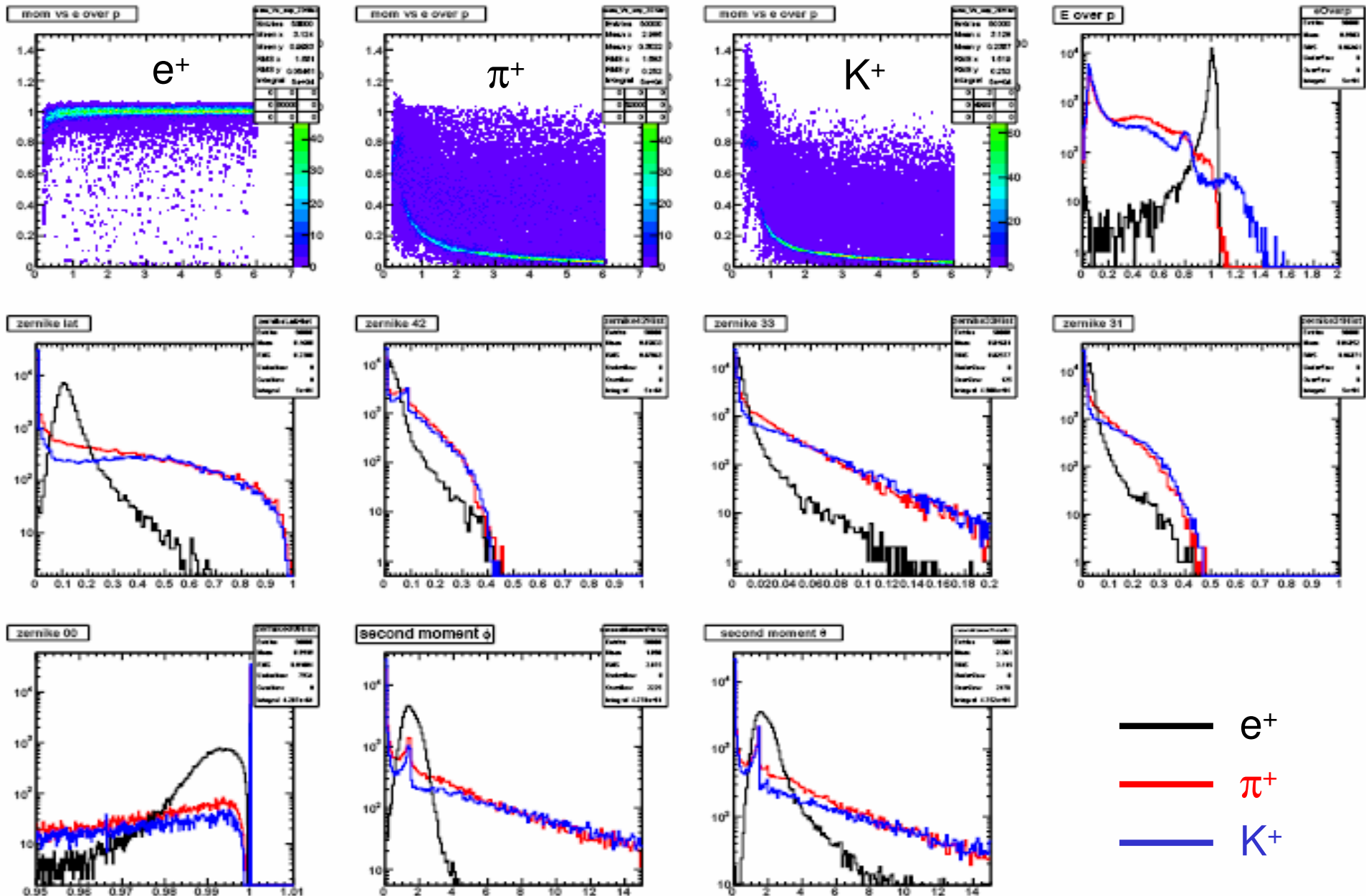


π Production from 730 MeV p (Bertini Model)



- Full simulation chain
 - G4 simulation with the complete detector, digitization, full reconstruction for the EMC
 - single particles between 0.2 ... 6.0 GeV/c and $\cos(\Theta) = -0.7 \dots 0.7$
 - appr. 100k e^+ , π^+ , K^+ each
- Electron can be identified via
 - E/p (E: energy deposit of the cluster; p: reconstructed momentum of the track)
 - shower shape of the cluster
- Studies based on
 - complete EMC reconstruction
 - reconstructed energy deposit of the cluster
 - reconstructed shower shape of the cluster (Zernike momenta)
 - events with exactly one cluster and no multi-bump cluster
(no split offs, no e^+ which produces one or more photons via bremsstrahlung, ...)
 - tracking not taken into account
 - no matching of the charged track with the cluster
 - MC truth momentum

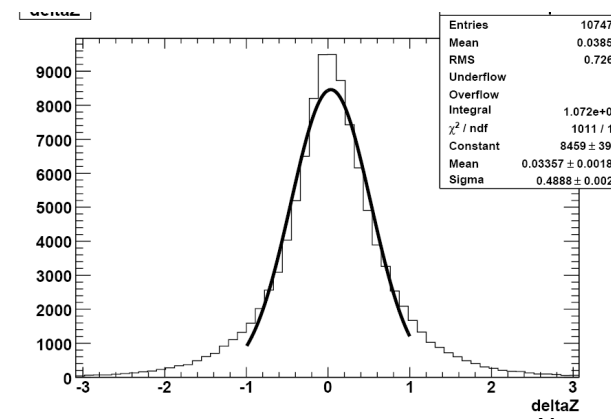
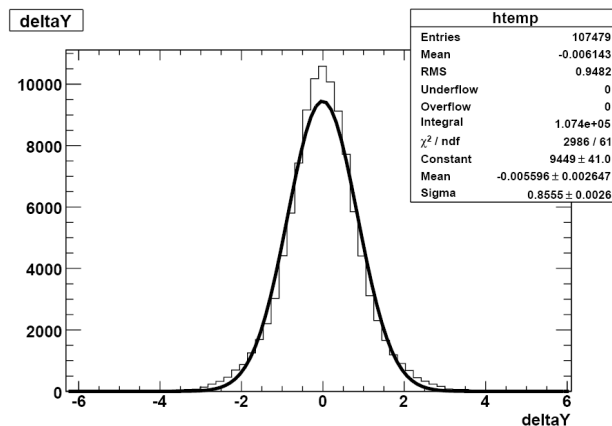
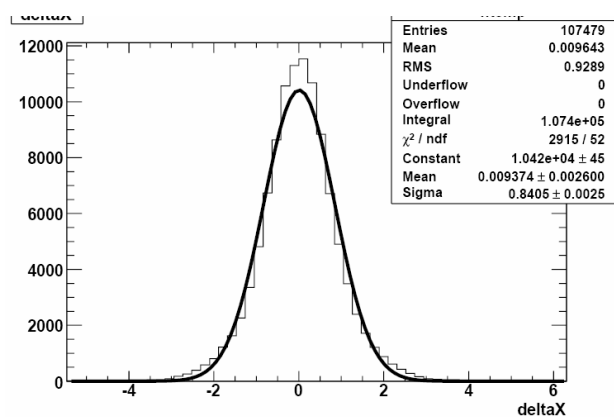
e identification with EMC



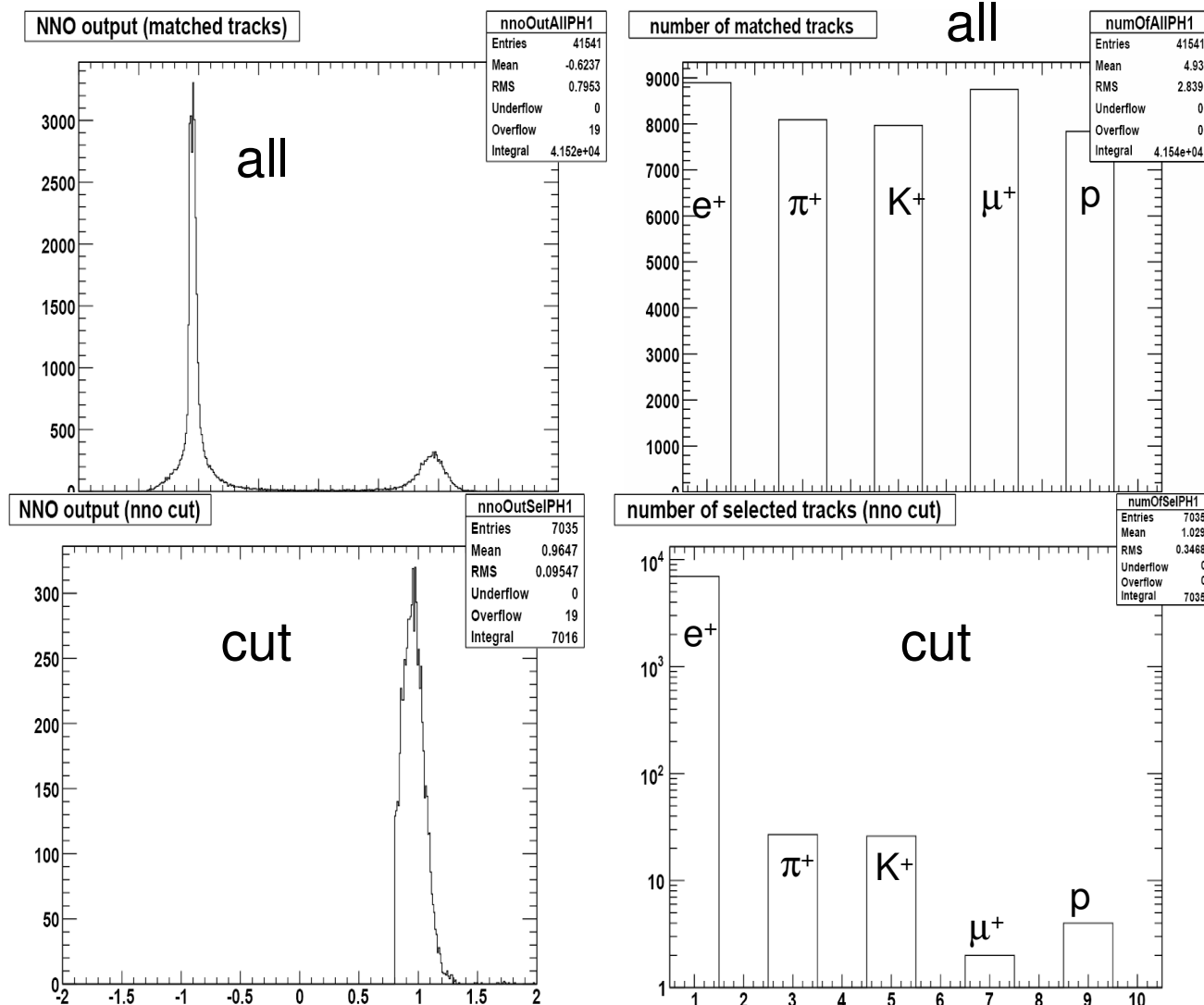
- Suitable properties for electron ID
 - e/p , p , Zernike momenta of the cluster
- Problem
 - how to find the optimal cut parameters in the multi-dimensional space
 - possible solution: usage of neural networks
- BaBar like software
 - 8 different (supervised and non supervised) neural networks available
 - first training of a multi layer perceptron (MLP) already done
 - training files: ~90k for e^+ , π^+ , K^+ each
 - 9 input parameters: e/p , p , Zernike00, 31, 33, 42 and Zernike lateral, 2. momentum Φ , 2. momentum Θ
 - net response = 1 for „good“ tracks (electrons)
 - net response = -1 for „bad“ tracks (π, K)

Test sample

- Test files (March 2007)
 - single particles between 0.2 ... 6.0 GeV/c and $\cos(\Theta) = -0.966 \dots 0.966$
 - 10k e^+ , π^+ , K^+ , μ^+ , p each
- Reconstructed and Kalman fitted STT tracks used
 - Θ coverage: $\sim 15^\circ$ - 170°
 - pion @ 0.5 GeV/c : $\sigma(p_T) / p_T \sim 1.3\%$, $\sigma(d_0) \sim 560 \mu\text{m}$, $\sigma(z_0) \sim 5260 \mu\text{m}$
 - combined fit with MVD without and with material site also possible but not yet used
 - pion @ 0.5 GeV/c (without material): $\sigma(p_T) / p_T \sim 0.66\%$, $\sigma(d_0) \sim 41 \mu\text{m}$, $\sigma(z_0) \sim 42 \mu\text{m}$
 - pion @ 0.5 GeV/c (with material) : $\sigma(p_T) / p_T \sim 0.42\%$, $\sigma(d_0) \sim 35 \mu\text{m}$, $\sigma(z_0) \sim 37 \mu\text{m}$
- Track matching with EMC
 - association of the reconstructed track with the corresponding bump



Test sample



cut: net output > 0.8



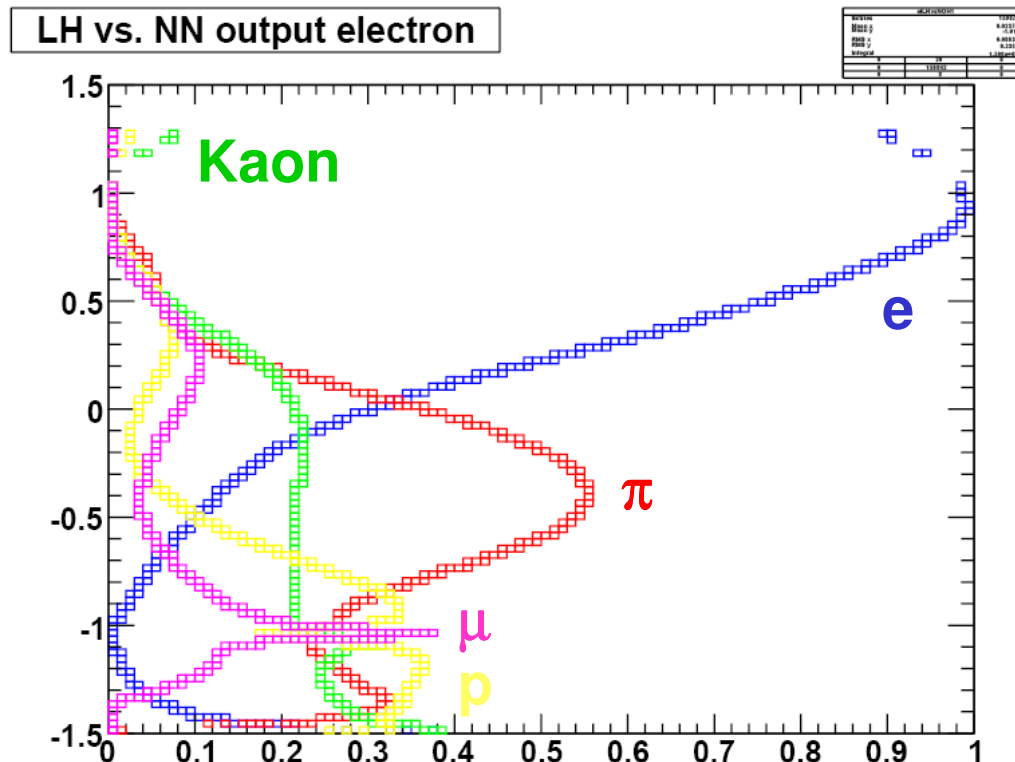
	all	EMC match	identif. as e^+
# e^+	10k	8895	69,8%
# π^+	10k	8092	0,27%
# K^+	10k	7966	0,26%
# μ^+	10k	8753	$2 \cdot 10^{-4}$
# p	10k	7835	$4 \cdot 10^{-4}$

Status and possible improvements

- Electron ID via e/p and shower shape seems to work
- Background in the order of 10^{-3} for equal fluxes
- Improvements possible
 - complete tracking and track matching should be included for the training files
 - additional/other properties as input for NN
 - how many hidden nodes for the MLP?
 - test with other neural networks
 - combination with other detectors (e.g. dE/dx, tof, cherenkov)

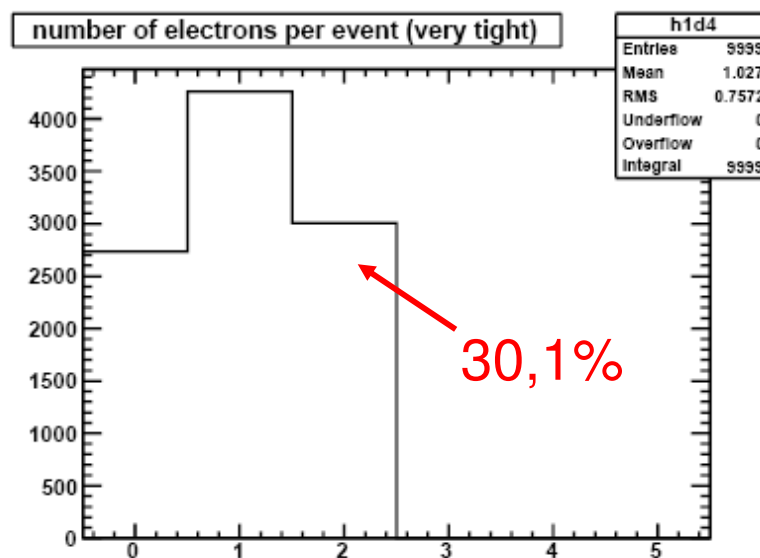
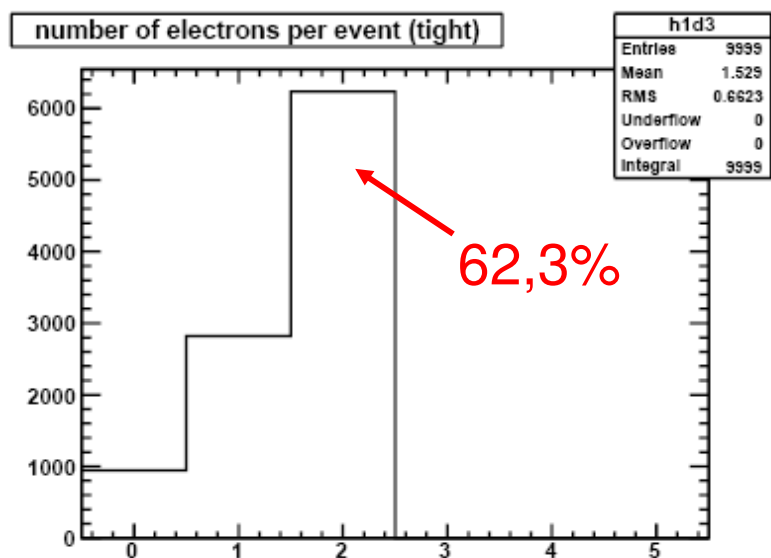
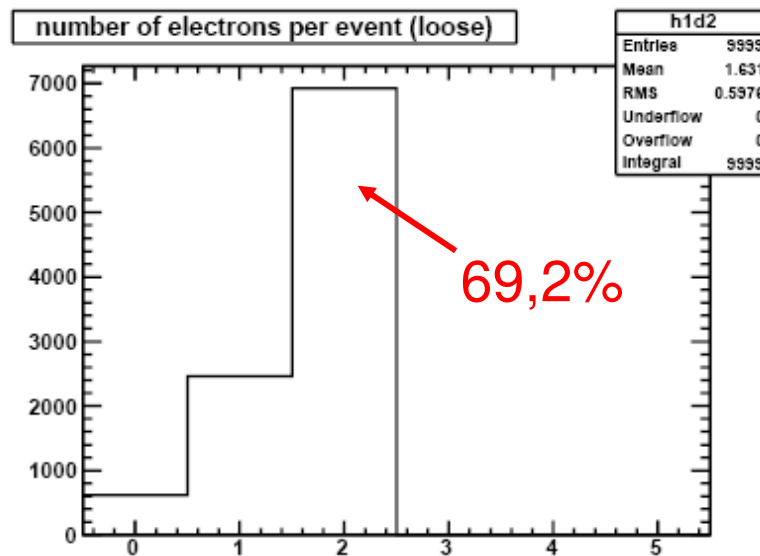
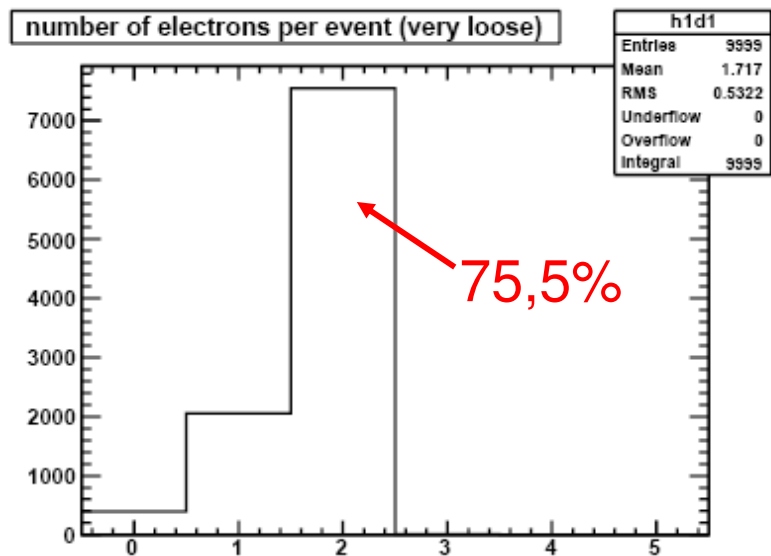
- 4 different BtaElectronCandLists based on NN (part of reconstruction)

- veryLoose: LH for electronId > 5%
- loose: > 75%
- tight: > 90%
- veryTight > 98%



- 10k e+e- events @ η_C (phasespace)
- 910k $\pi^+\pi^-$ background events @ η_C (phasespace)

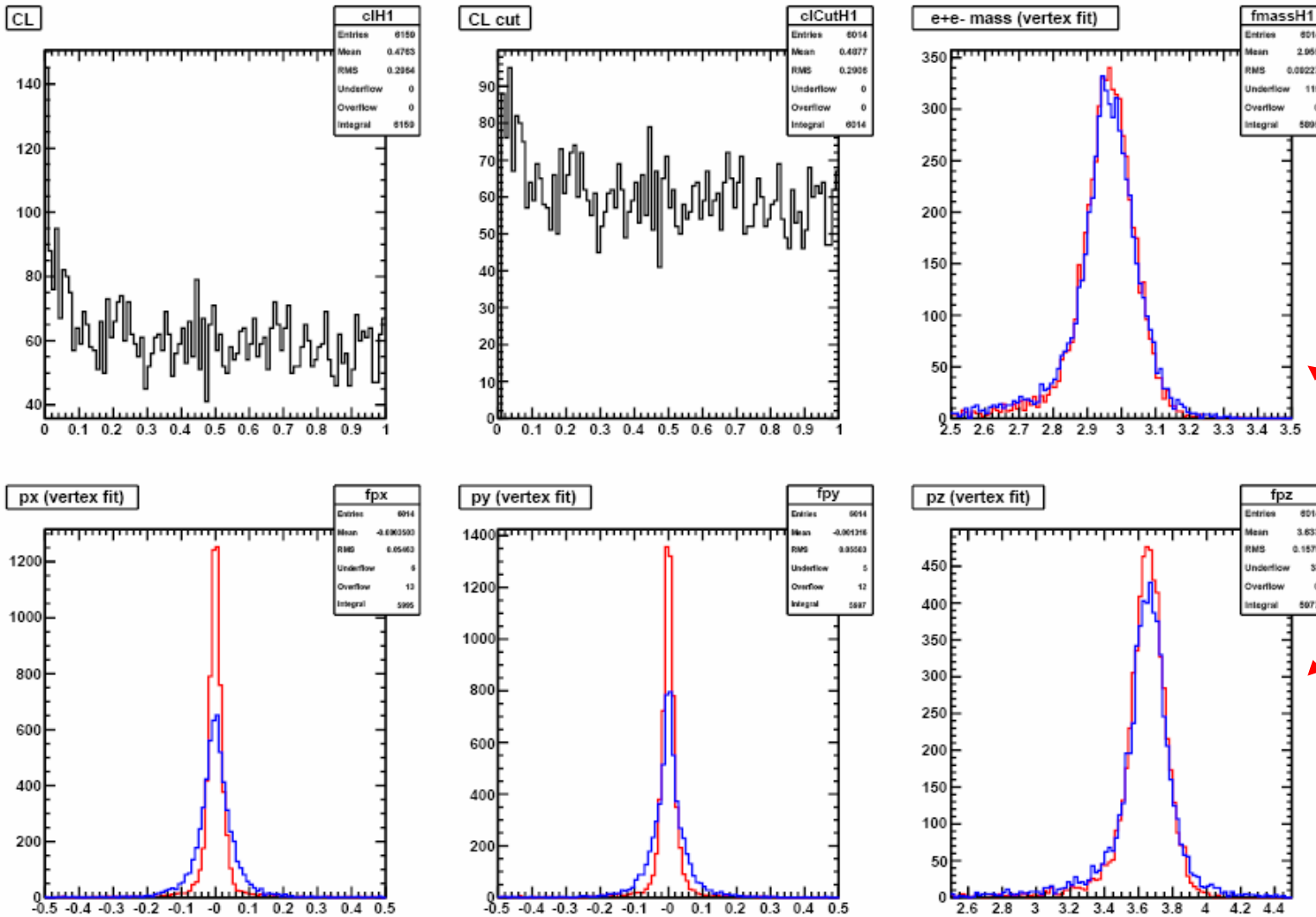
- 10k e+e- events @ η_C (phasespace)



e+e- analysis



- vertex and kinematic fitting works



vertex fit only based on STT reco tracks

e+e- analysis: $\pi^+\pi^-$ background

- 910k $\pi^+\pi^-$ events @ η_C (phasespace)

