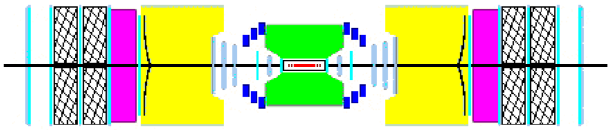
Status of $B \to \rho\,\pi$ studies in BTeV

Tomasz Skwarnicki

for Andreas Wolf

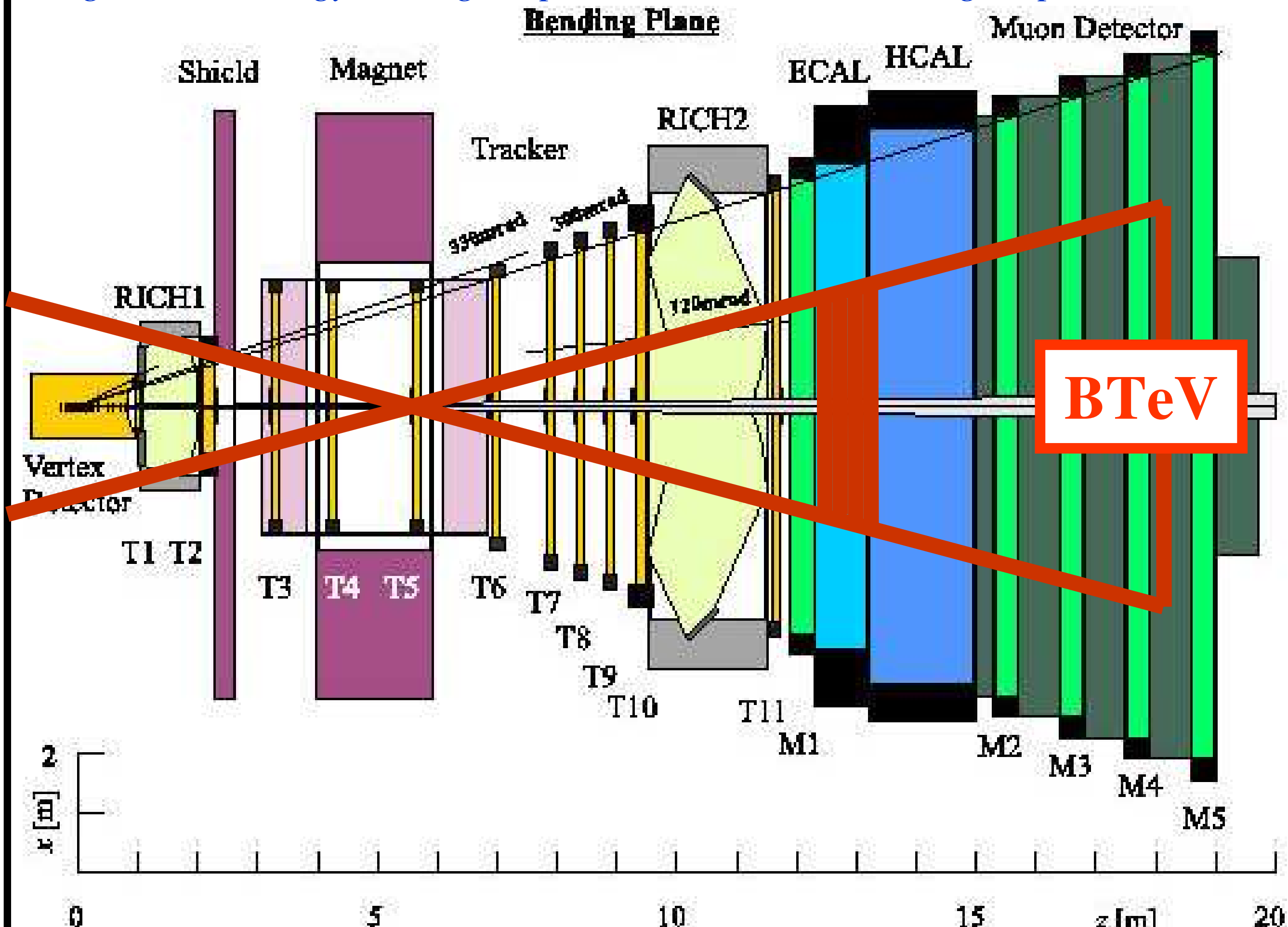


Introduction

- CKM angle α cannot be extracted from $B^0 \to \pi^+ \pi^-$ asymmetry in model independent way because of the large "penguin pollution" problem
- Time dependent analysis of interfering amplitudes in Dalitz plot for $B^0, \overline{B}^0 \to \rho^+ \pi^-, \rho^- \pi^+, \rho^0 \pi^0 \to \pi^+ \pi^- \pi^0$ will be a better method (Snyder&Quinn)
- Small BR: BR($\rho^+\pi^-$)~a few times 10^{-5} smaller for $\rho^0 \pi^0$ need:
  - Large number of tagged events
  - Good background suppression
- Detection of π^0 is the main experimental challenge at hadronic colliders
  - Central detectors (CDF, D0, CMS, Atlas) have EM calorimeters optimized for high Pt electrons and photons; in α determination from $\rho\pi$ must be able to dip into soft π^0 region
  - Some $\pi^+ \pi^-$ combinations which need to be detected are soft; difficult to trigger on and separate from background in the central region (multiple scattering)

- LHCb EM calorimeter is $large

Higher CM energy ↦ Higher particle momenta ↦ Longer spectrometer

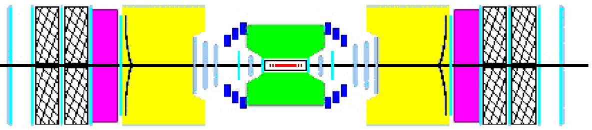


Also pre-shower detector needed for LHCb electron triggering and two RICH detectors are bad for γ detection

	Lead-tungsten crystals (BTeV)	Lead-scintillating fiber sampling calorimeter (LHCb)
Energy resolution	$\sigma_E = \sqrt{\frac{(1.6\%)^2}{E} + (0.55\%)^2}$	$\sigma_E = \sqrt{\frac{(10\%)^2}{E} + (1.5\%)^2}$
Segmentation	$(2.25\ \text{cm})^2$ at 7m	$(6 - 24\ \text{cm})^2$ at 13m

Simulation Plan

- Start with *mcfast* simulations of signal and background:
  - Parametrized EM and hadronic shower development
  - True clustering program has been recently implemented *(Andreas Wolf)*
- Refine efficiency and background estimates with GEANT simulations
- Work in progress:
  - Show today preliminary *mcfast* simulations *(Gobinda Majumder)*
  - Comment on what to expect from the near future work

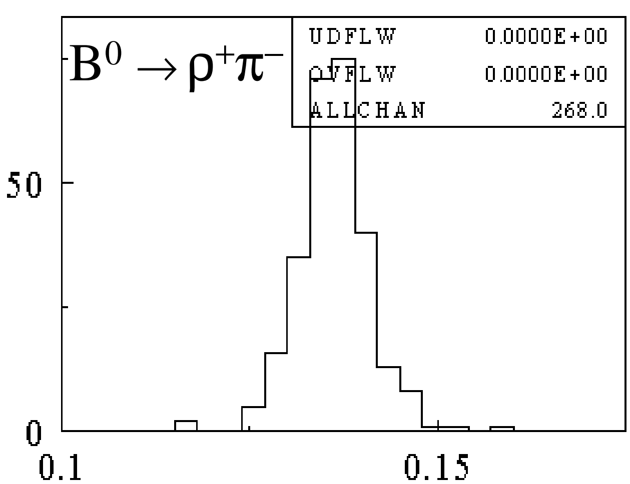


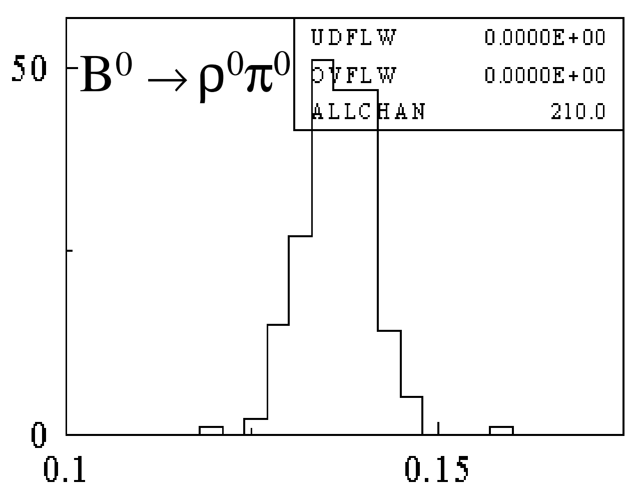
Charged Tracks Cuts

- $\pi^+ \pi^-$ essential in triggering and background suppression
- $Pt(\pi^\pm) > 0.2$ GeV, $P(\pi^\pm) > 4$ GeV
- $\pi^\pm$ must miss the primary vertex at least by 3 standard deviations (but not more than 4mm)
- A $\pi^+ \pi^-$ pair must create a vertex with $\chi^2 < 4$ detached from the primary by at least 50 μm (3D)
- No other charged track pointing to the $\pi^+ \pi^-$ vertex ($\chi^2 > 10$)
- $\pi^+ \pi^-$ vertex together with the primary vertex define B^0 direction (important for later reconstruction)

π^0 reconstruction

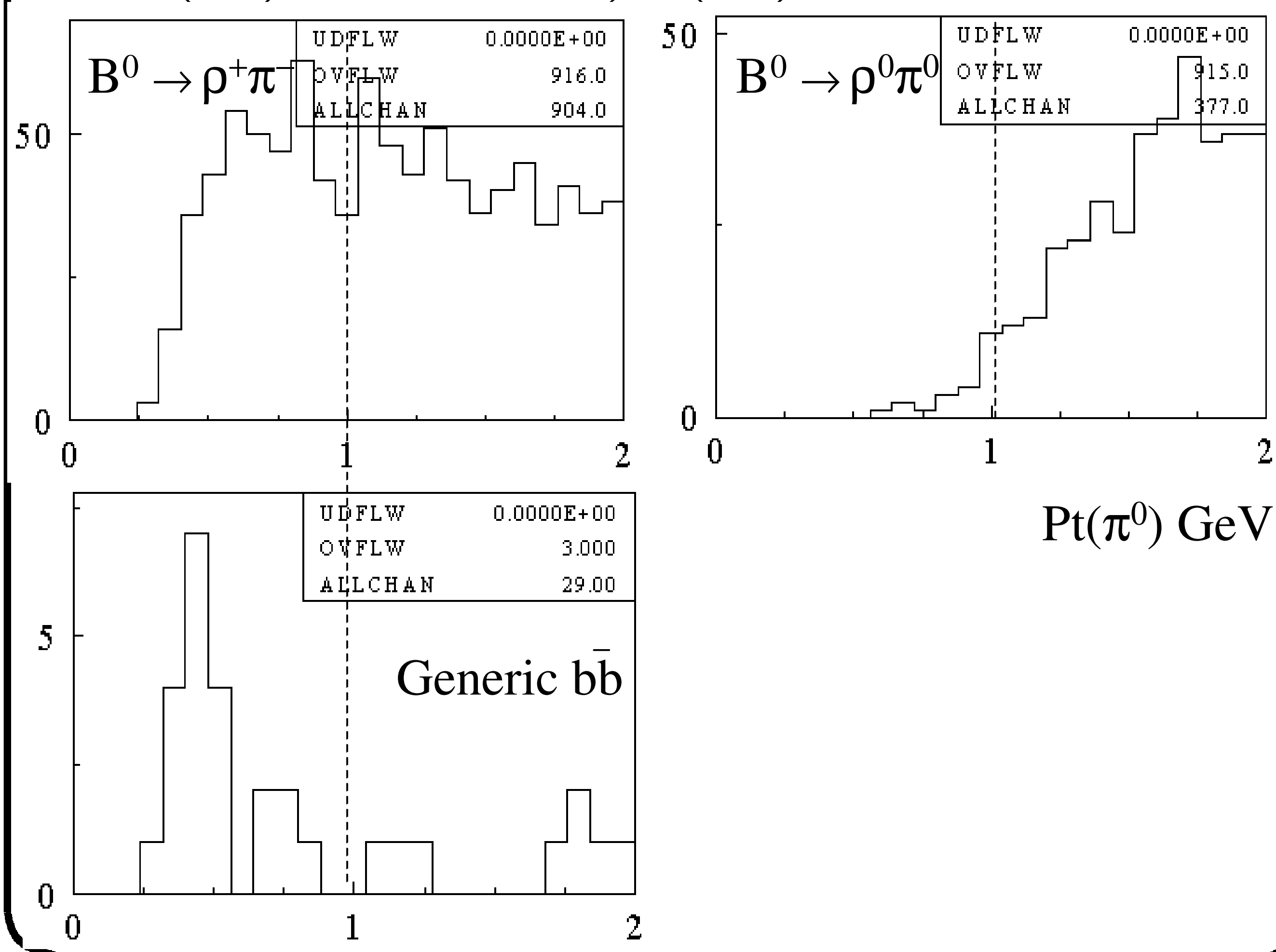
- Either out of two isolated photons (majority of slow π^0s) or overlapping photons (majority of fast π^0s)
- Neutral clusters definition: at least 10cm away from the closest charged track projection
- Isolated photon selection:
  - Only one local energy maximum
  - Transverse shower profile consistent with EM shower (E9/E25 > 0.8, E1/E9 > 0.55)
- $M_{\gamma\gamma}$ within ±9 MeV of the π^0 mass





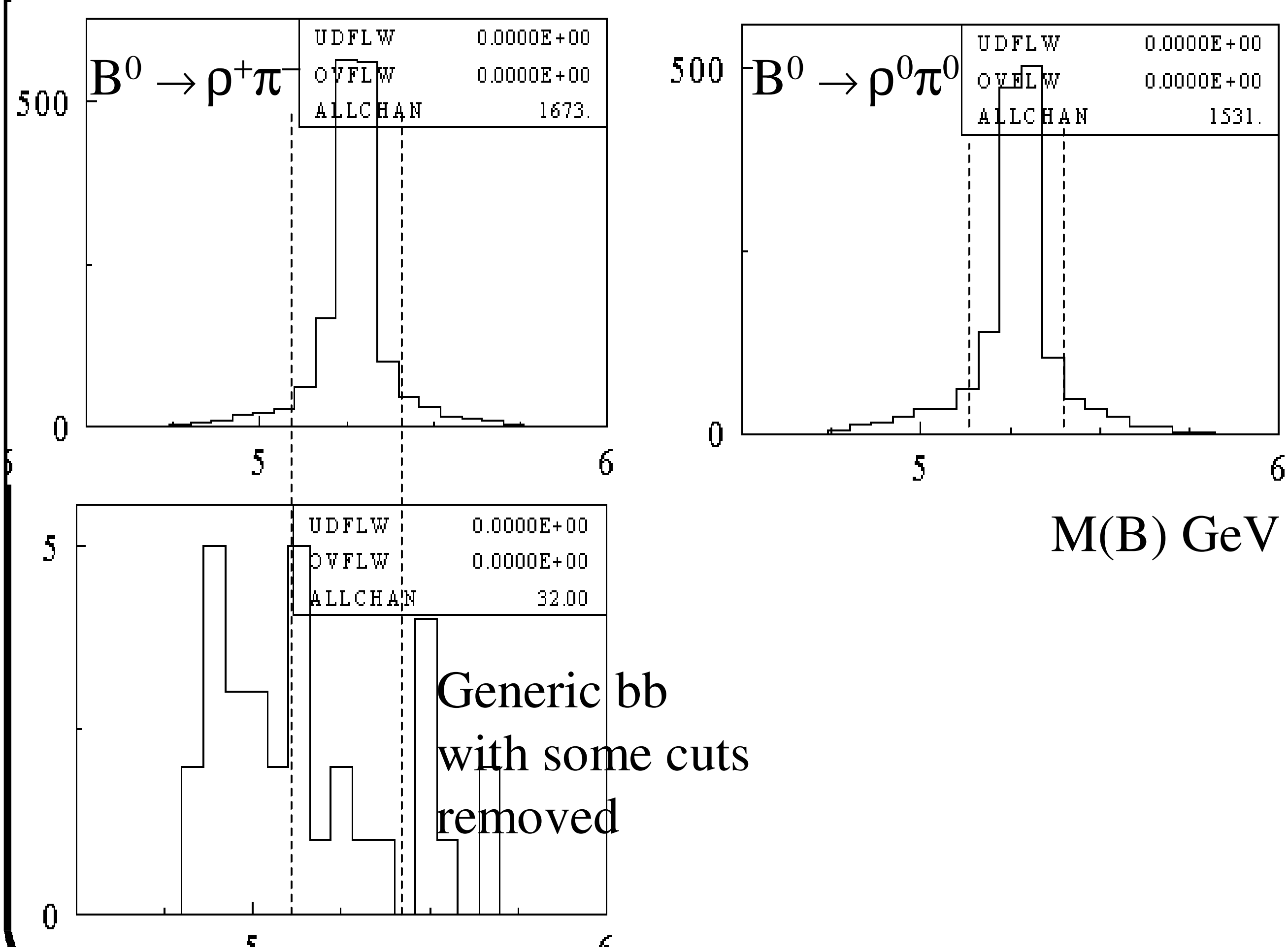
π^0 reconstruction

- Overlapping photons:
  - Need to unfold individual photon energies and directions to measure $M_{\gamma\gamma}$; not implemented in mcfast clustering yet
  - At the moment accept all clusters with two local energy maxima as π^0
- $Pt(\pi^0) > 1.0$ GeV, $E(\pi^0) > 8$ GeV

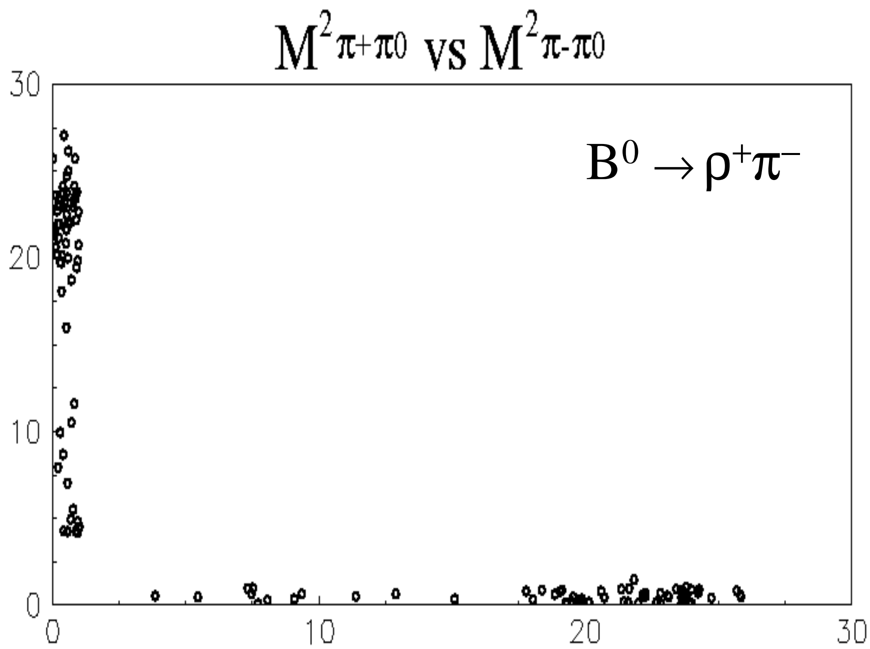


B reconstruction

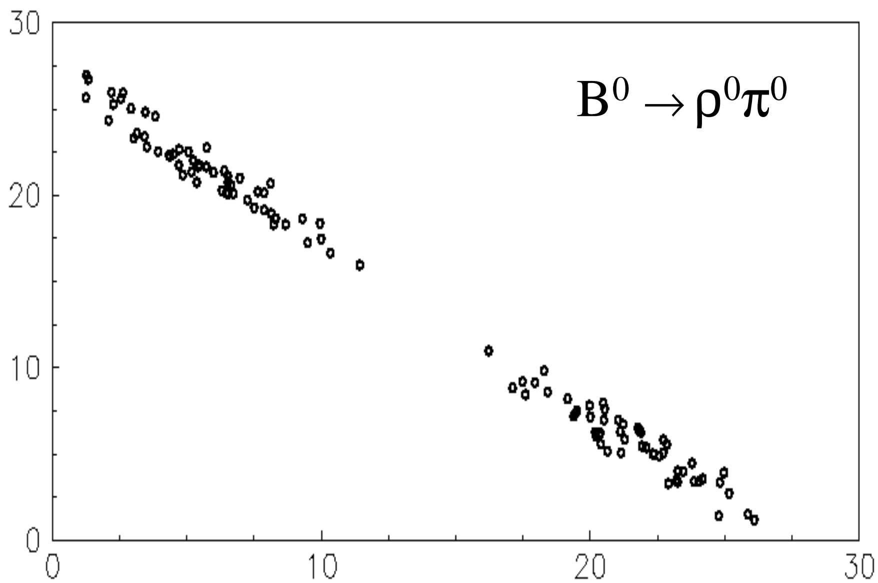
- Transverse momentum balance of $\pi^0 + \pi^+ \pi^-$ with respect to the B^0 direction: $|\Delta Px,y| < 0.5$ GeV
- Mass of $\pi^+ \pi^- \pi^0$ consistent with the B^0 mass within ±0.14 GeV



Signal efficiency



$\varepsilon = 1.1 \pm 0.1\ \%$



$\varepsilon = 1.1 \pm 0.1\ \%$

- In agreement with more naive PTDR study
- About 28,000 $\rho^+\pi^-$ events per 2 fb^{-1} (x εD^2=2,800)
- May go down with improved background simulations

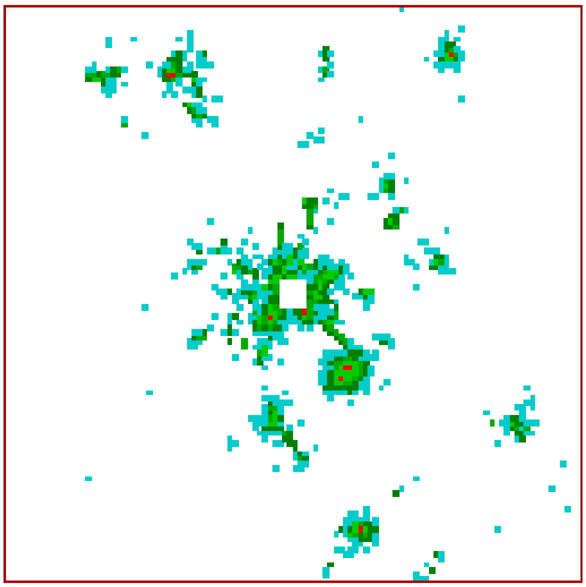
Background simulation

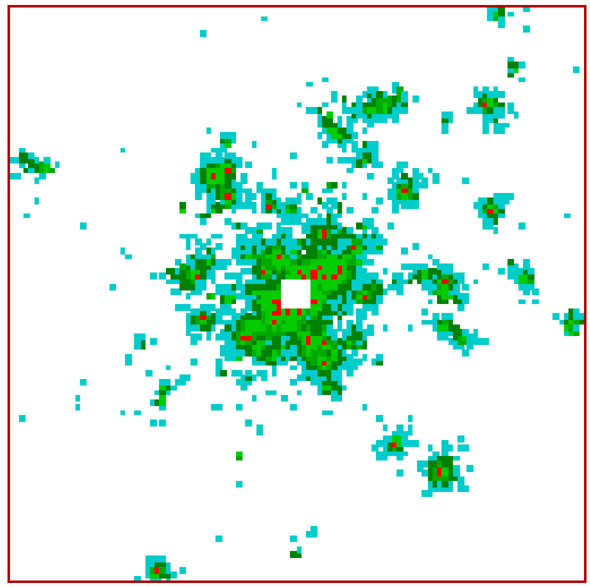
- $b\bar{b}$ events are expected to be dominant background
- Difficult to do because of small BR and small efficiency
- Should analyze about 10-100/(BR ε) = 20-200 10^6 bb events
- Without any generator level preselection we have not gotten too far:
  - for 0.3 10^6 bb no events passed the cuts
- Need to get creative with preselection of background before feeding to detector simulation:
  - Even more important for GEANT studies than for *mcslow*
  - Some ideas exist:
    - Simulate and select charged tracks (fast) before showering in calorimeter (slow)
    - Use generator info to pick up events with **low multiplicity** secondary vertex

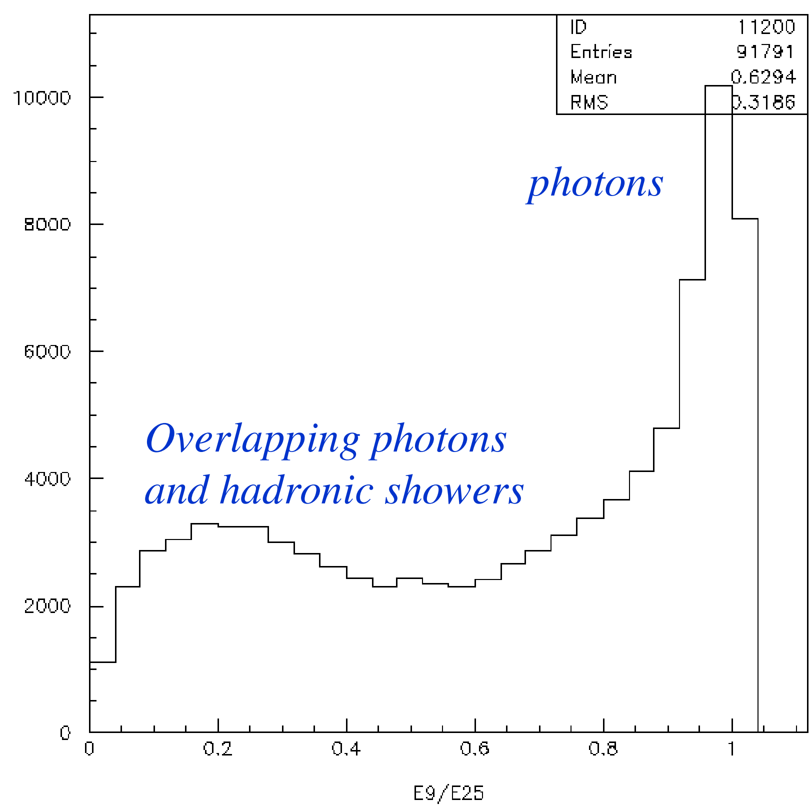
GEANT simulations

- Needed for credibility of efficiency and background estimation
- Major effort in BTeV over past few months *(Paul Lebrun, Rob Kutschke, Penny Kasper, Julia Yarba, Joel Butler, Patty McBride, Lynn Garren, Andreas Wolf, L. Nogach, K. Shestermanov, …)*
- Recently became useable:
  - Realistic representation of material in front of calorimeter
  - Charged tracks with Kalman filter fit
  - Clustering tuned up to GEANT results

GEANT simulation of calorimeter

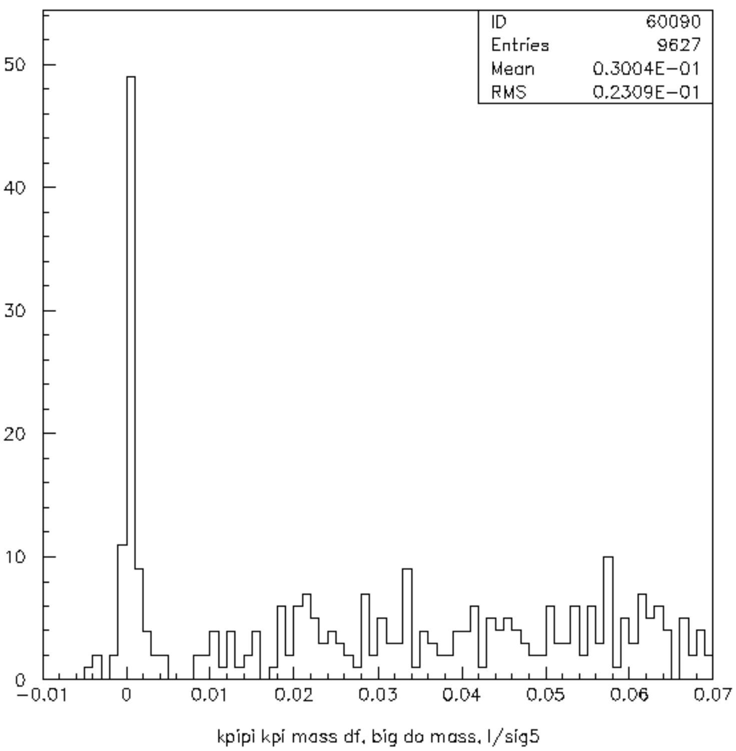






GEANT simulations

- Example of first physics simulations with GEANT *(J. Butler)*



M(D)-M(D) – nominal value GeV*

Near future work

- Background simulations with mcfast
- Signal efficiency with GEANT
- Background simulations with GEANT
- Estimates of sensitivity to α
- Other channels with neutrals e.g. $\psi\eta'$