MC/data comparison for $B \to D^{(*)} l \nu X$ decays

Alessandro Cerri, Hung-Chung Fang

0. Intro / Contents

- Data-MC comparison in the context of reconstructing $B \to D^{**} l \nu$ decays

0. Intro
- l-$D^{(*)}$ kinematic variables
- The π^* control sample

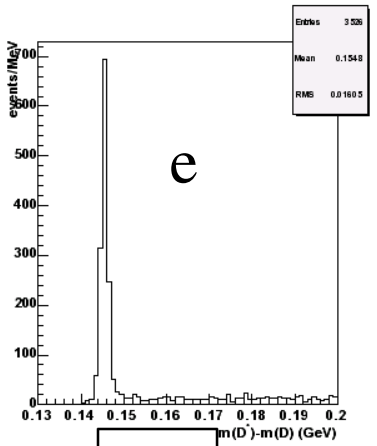
1. l-D^* kinematic variables

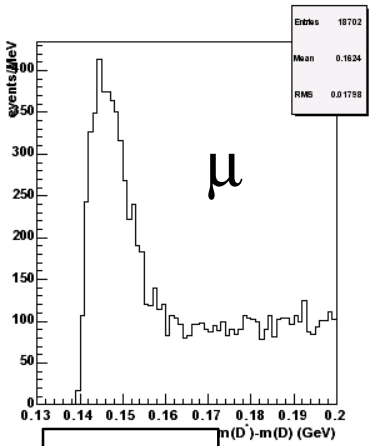
$lD^{(*)}$ reconstruction

- l-$D^{(*)}$ reconstructed in 4 channels
  - l-D^* channels: $D^* \rightarrow D^0\pi^*$
    1. $D^0 \rightarrow K\pi$
    2. $D^0 \rightarrow K\pi(\pi^0)$ satellite
    3. $D^0 \rightarrow K\pi\pi\pi$
  - l-D^+ channel
    1. $D^+ \rightarrow K\pi\pi$
- K-pi swap duplicates removed in K3pi sample
- D-finding cuts (not optimized for π^{**} finding)
  - 1 lepton/event
  - m(l-D) < 5, ΔR(D) < 1.2
  - D vtx prob > 1e-6, B vtx prob > ie-6
  - L_{xy}(B) > 0.05, L_{xy}(D) > 0.02, L_{xy}(D$\rightarrow$B)>-0.02

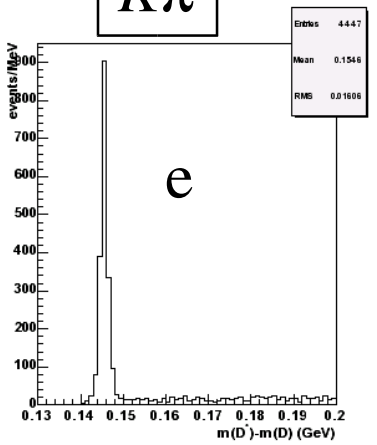
Dataset & Initial Selection

- Dataset:
  - jbot2h/0i: muon + SVT
  - jbot8h/4i: electron + SVT
- Refit:
  - KAL (fixed), beamline 19
  - ISL, L00 hits dropped
  - COT scaling:
    $(curv, d_0, \phi_0, \lambda, z_0) = (5.33, 3.01, 3.7, 0.58, 0.653)$
- LeptonSvtSel: default cuts

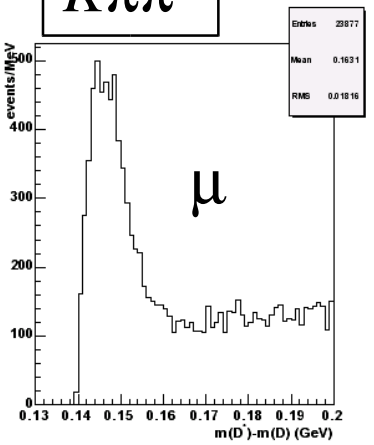


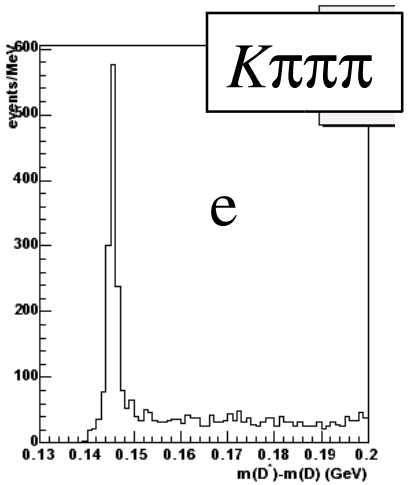


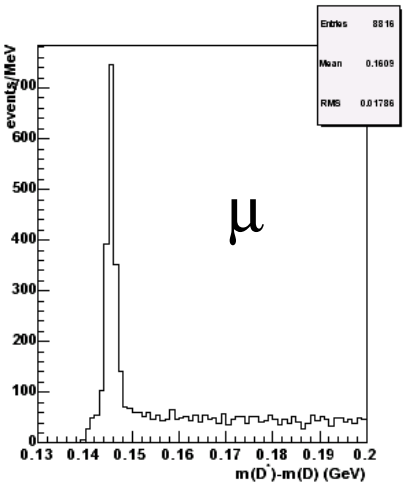
$K\pi$

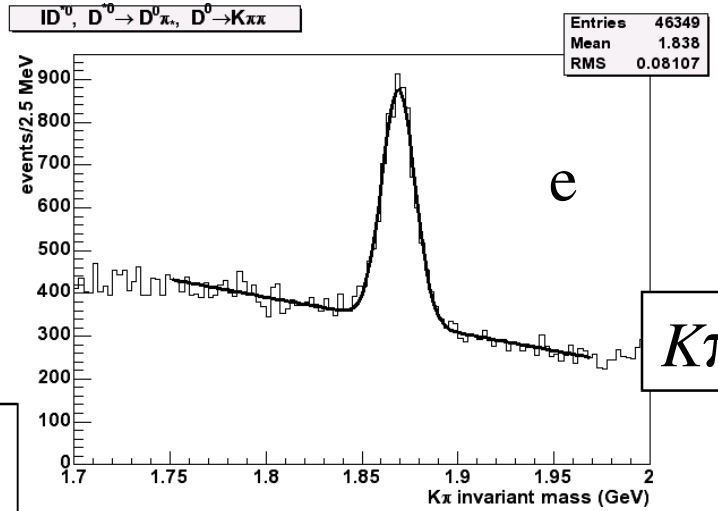


$K\pi\pi^0$

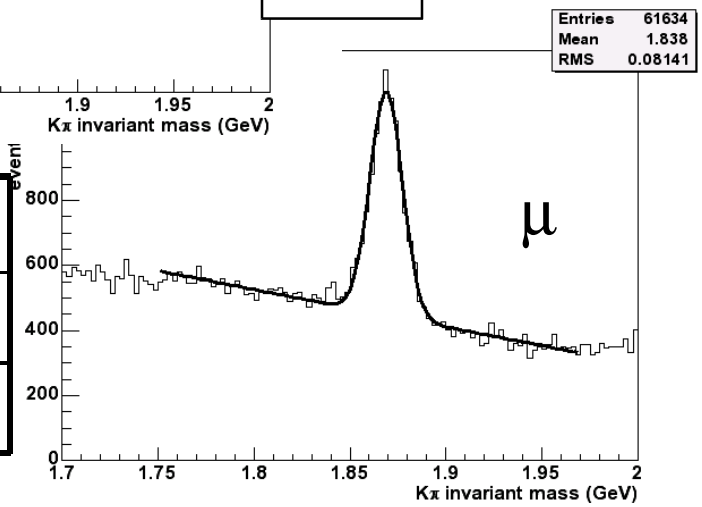








$K\pi\pi$



Need systematic error due to fit shape

	$K\pi$	$K\pi\pi^0$	$K\pi\pi\pi$	$K\pi\pi$
e	1451 ± 38	4521 ± 69	1114 ± 38	4721 ± 115
μ	1763 ± 44	4304 ± 77	1507 ± 45	5855 ± 130

MC-data comparison

- Detailed comparison of data and MC in kinematic variables of the 4 l-$D^{(*)}$ samples
- MC samples: $B^+/B^0 \rightarrow l\text{-}D^{(*/**)}\,\nu$
  - Detailed simulation:

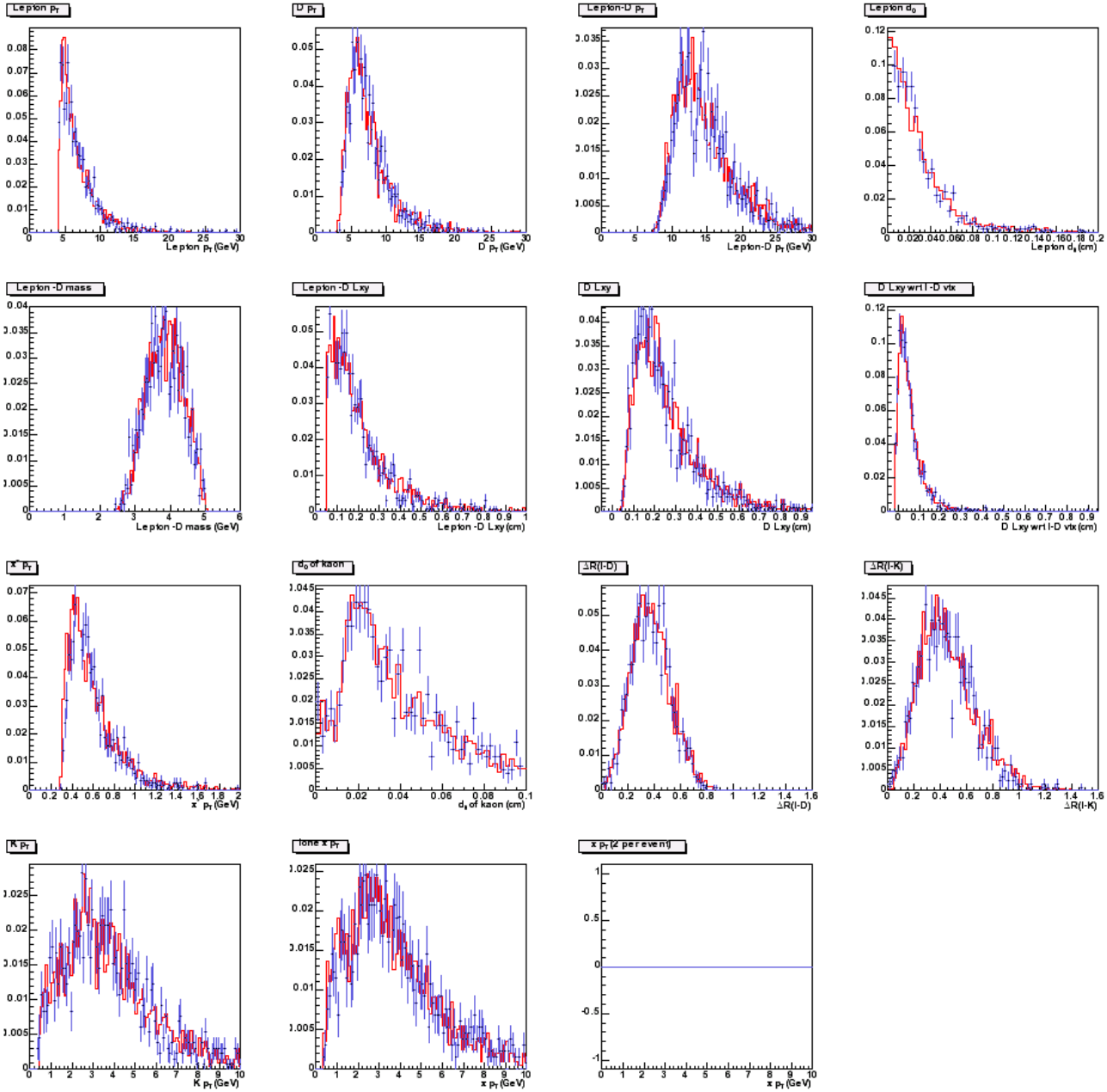
    bgen $\rightarrow$ EvtGen $\rightarrow$ cdfSim $\rightarrow$ L2filter

    $\rightarrow$ trgSim++ $\rightarrow$ L3 $\rightarrow$ Prod

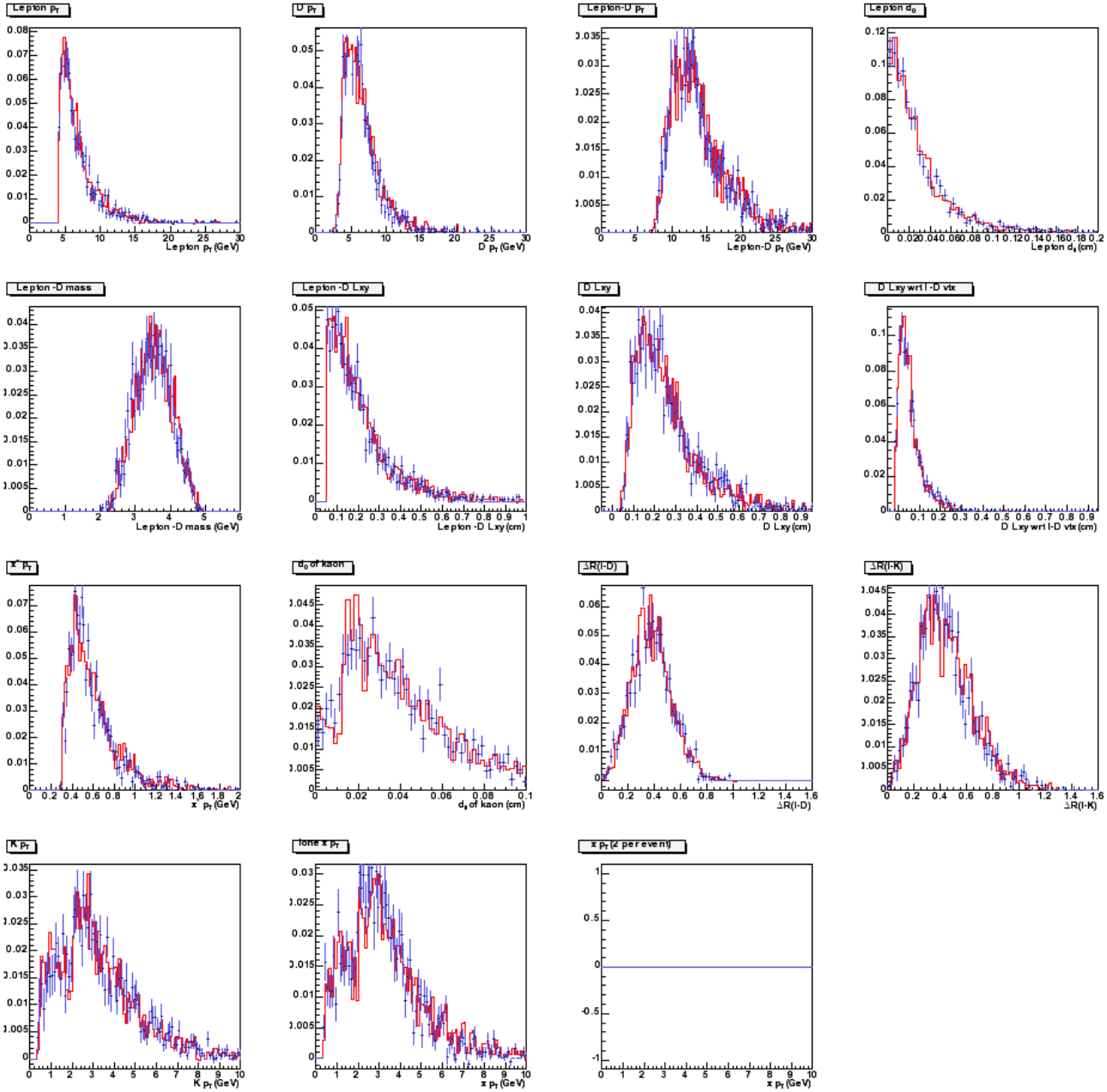
    (90M gen level, 600k reconstructed)
  - Unbiased semileptonic table (EvtGen):

    (4 resonant +2 non-res) D^{**} states + D^* + D
  - Decays forced only at $D^{0/+}$ level
- Judging by eye: all $lD^{(*)}$ -channel plots agree well
- Compute χ^2-probability of matching
- Better treatment of bins with low statistics in comparison– put bins in tail with < 5~10 events each into one bin

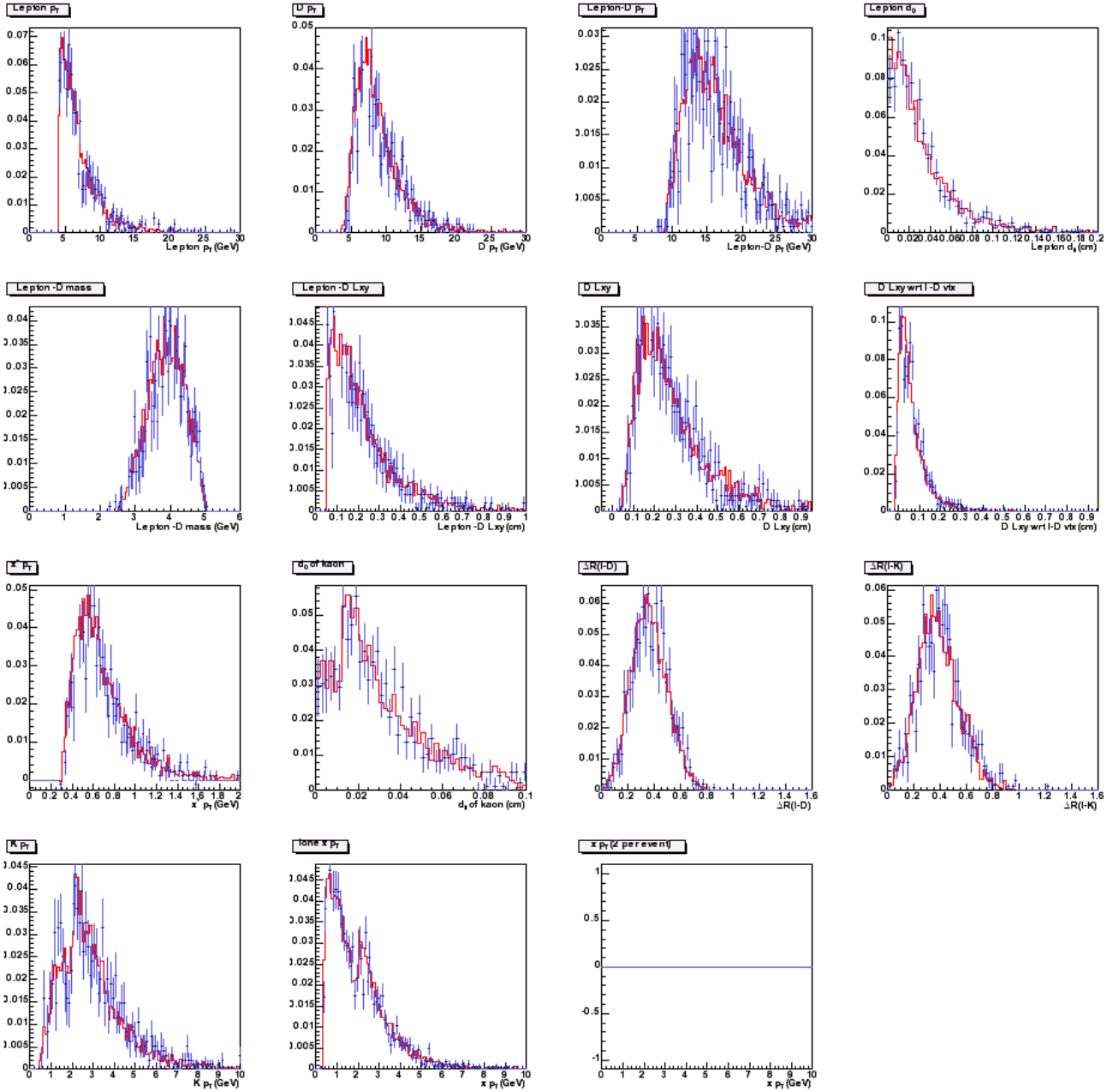
Kinematic comparisons: lD^*, $D^0 \rightarrow K\pi$



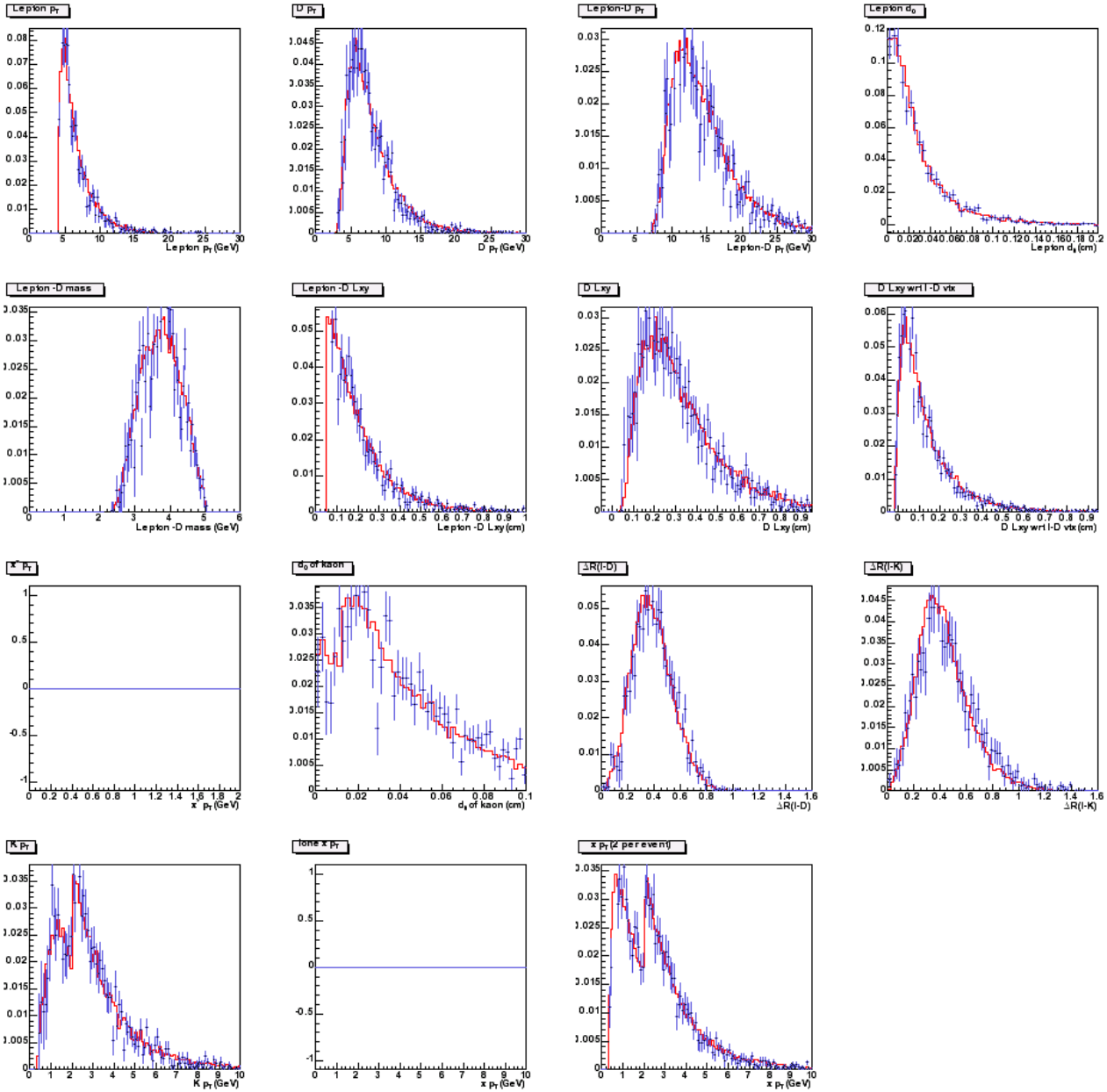
Kinematic Comparisons lD^*, $D^0 \rightarrow K\pi\pi^0$



Kinematic comparisons lD^*, $D^0 \rightarrow K\pi\pi\pi$



Kinematic Comparisons: lD^+

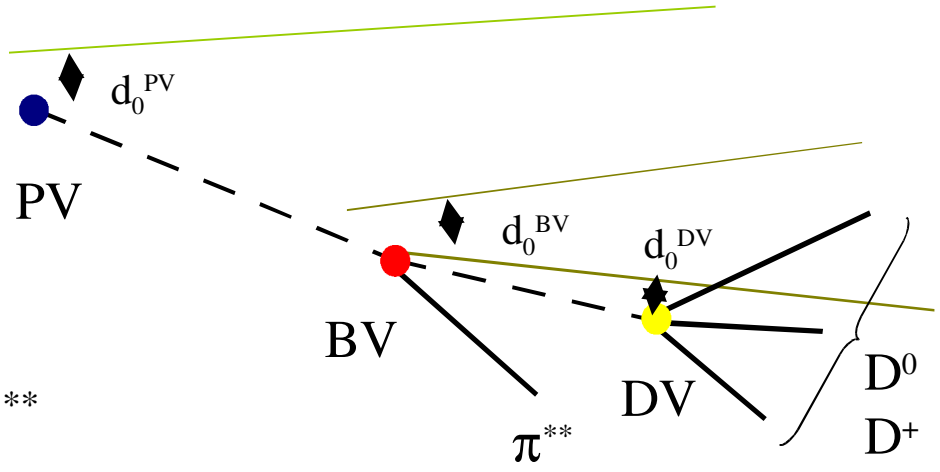


Matching-χ^2 prob (%)	Kπ		Kπ(π^0)		Kππ		Kπ	
	e	μ	e	μ	e	μ	e	μ
$p_T(l)$	4	12	43	40	38	11	16	1
p_T(D)	3	7	8	2	6	79	12	4
$p_T(l$-D)	41	17	30	2	49	22	9	4
$d_0(l)$	10	92	75	27	30	4	95	2
m(l-D)	2	3	50	61	48	69	16	42
$L_{XY}(l$-D)	48	23	41	12	32	69	29	0.07
L_{XY}(D)	23	88	69	99	95	47	87	2
L_{XY}(B to D)	61	29	6	13	17	89	24	2
$p_T(\pi^*)$ >0.4 GeV	28	42	21	70	38	1	–	–
d_o(K)	68	72	83	54	74	15	17	72
ΔR(l-D)	34	29	26	51	86	33	57	30
ΔR(l-K)	17	12	33	66	38	2	29	2
p_T(K)	22	20	49	52	83	10	25	15
p_T(unique π)	90	20	14	59	2	8	–	–
$p_T(2\pi)$	–	–	–	–	–	–	67	64

2. The π^* control sample

Kinematics

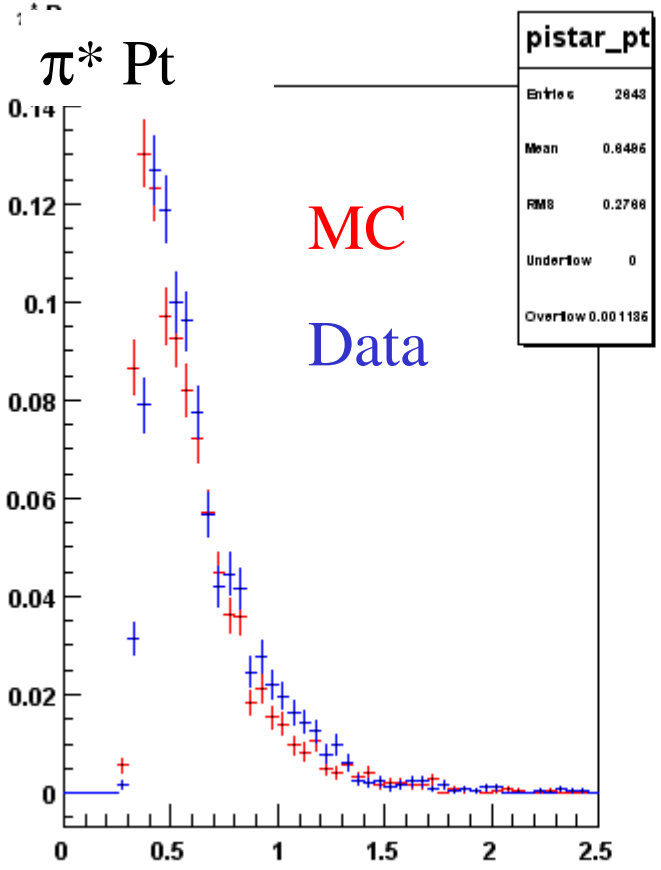
- π^* is an unique probe:
  - Large statistics
  - Low background
  - "Similar" spectrum to π^{**}
  - Can reconstruct with minimal cuts (e.g. COT only)

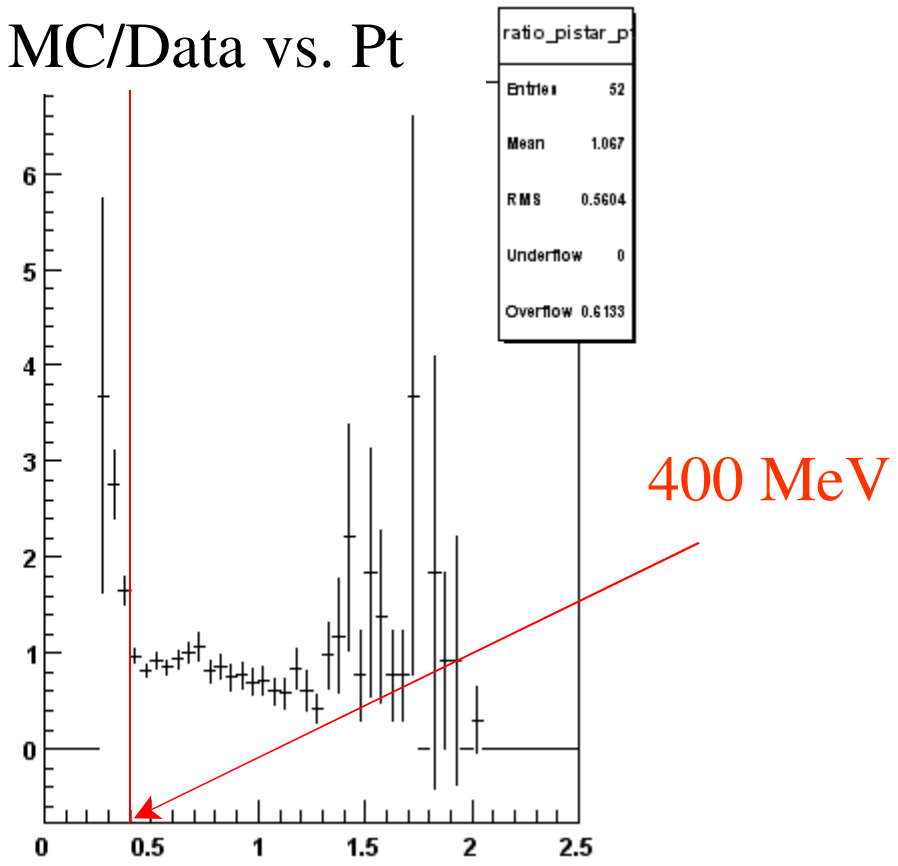


- Technique:
  - Search for π^* with very loose cuts
  - Exclude from *B* vertex
  - Study biases to kinematics from tracking
  - Study IP resolution(*data &MC*): Primary, B & D vertices
  - Study ε*(data & MC)* vs selection criteria

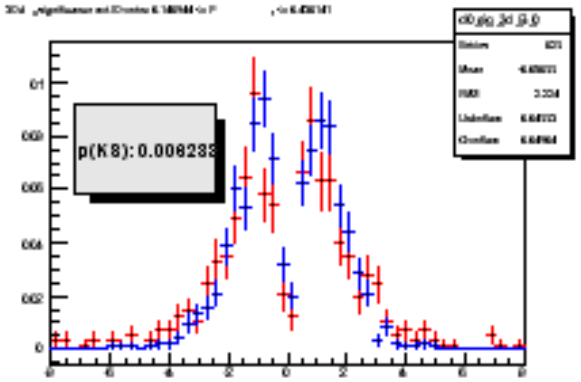
Kinematics: MC vs. data

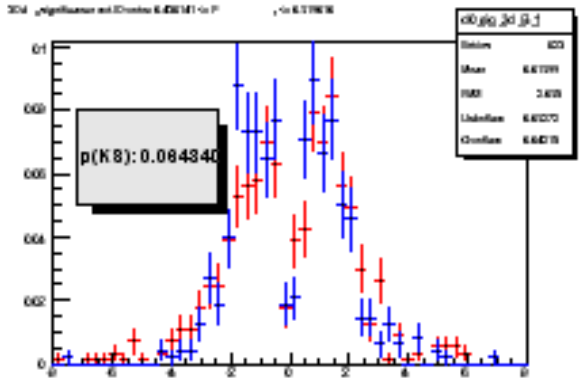
- Can we rely on kinematical biases estimated from MC?
- Remember: we don't care about absolute scales
- Pt dependent MC/data ratio:

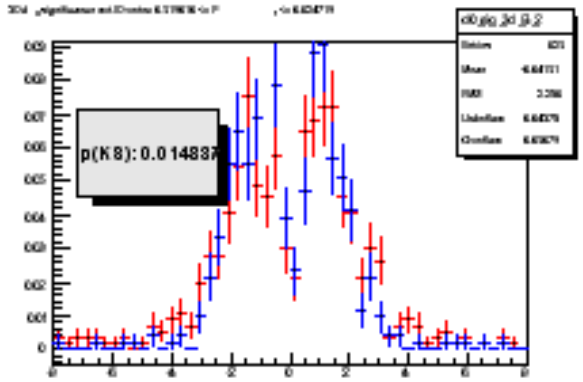


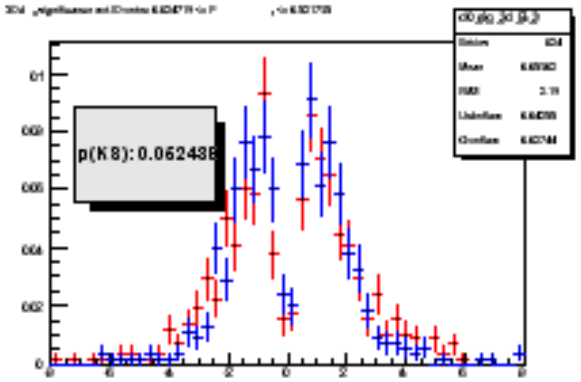


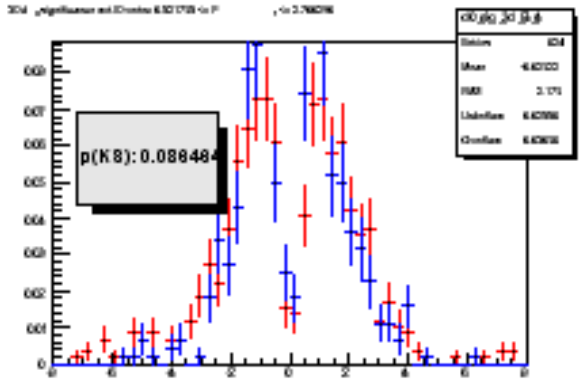
3D Impact Parameter Significance
WRT B vertex (Pt bins)

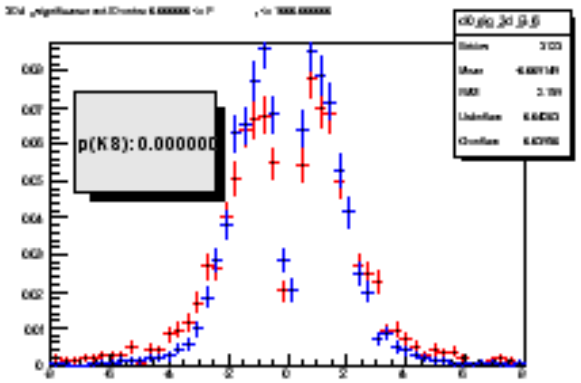








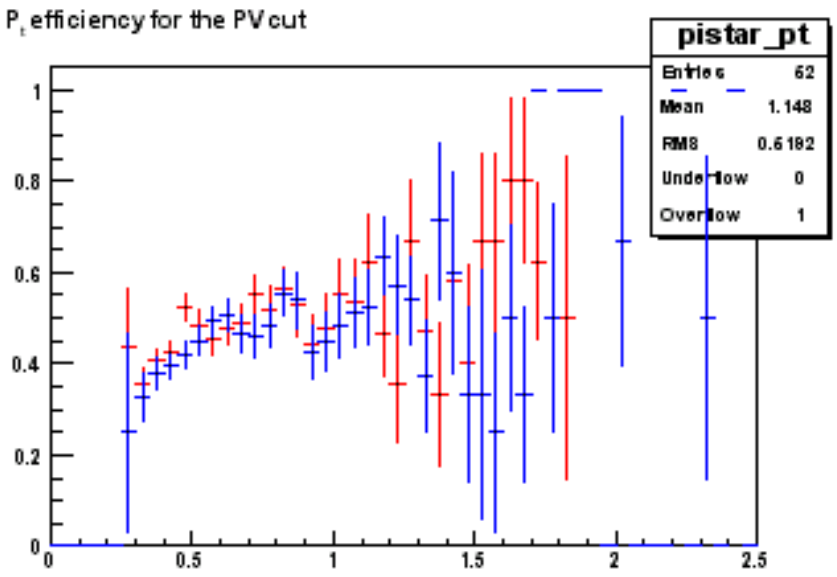


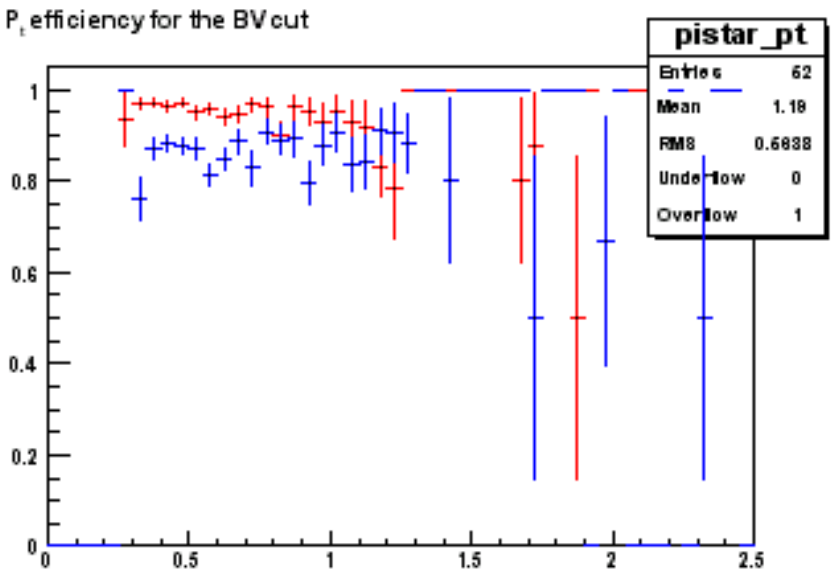


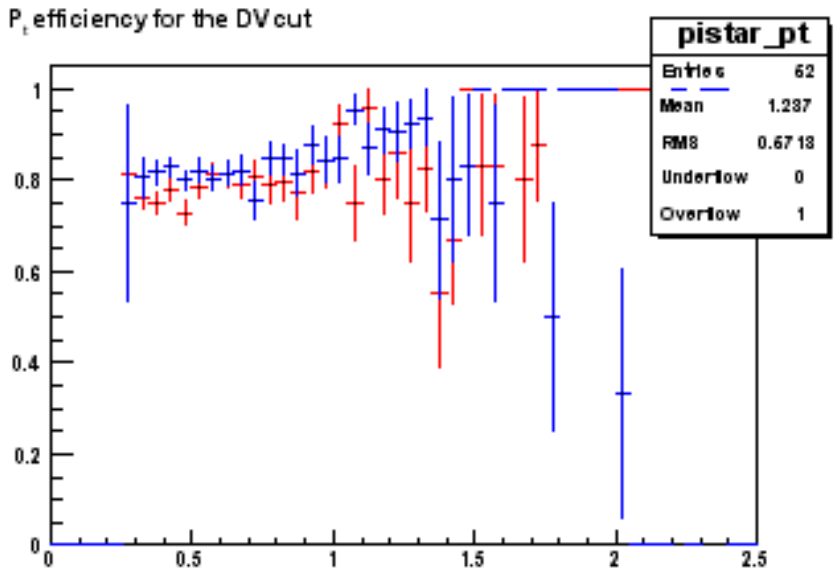
NB:

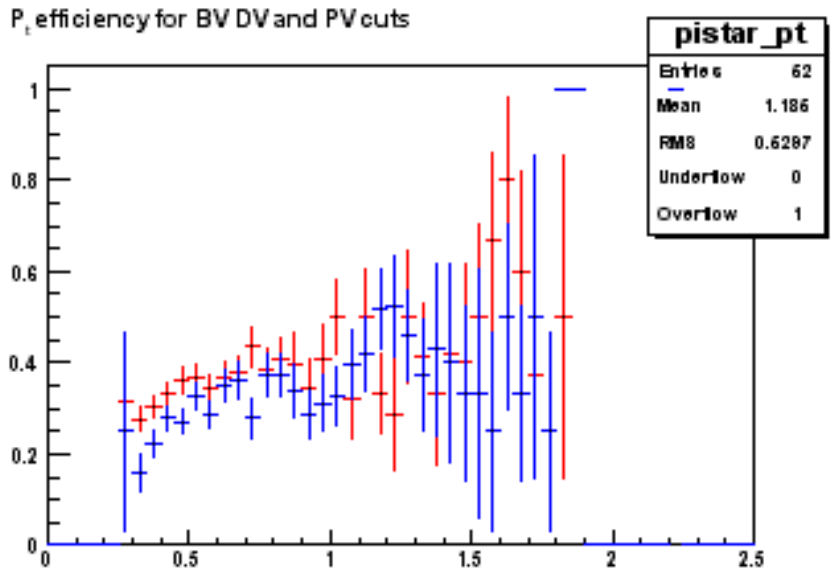
- sign convention is arbitrary
- Slightly different resolutions: can correct for difference in acceptance

ε(*data or MC*) vs. selection criteria

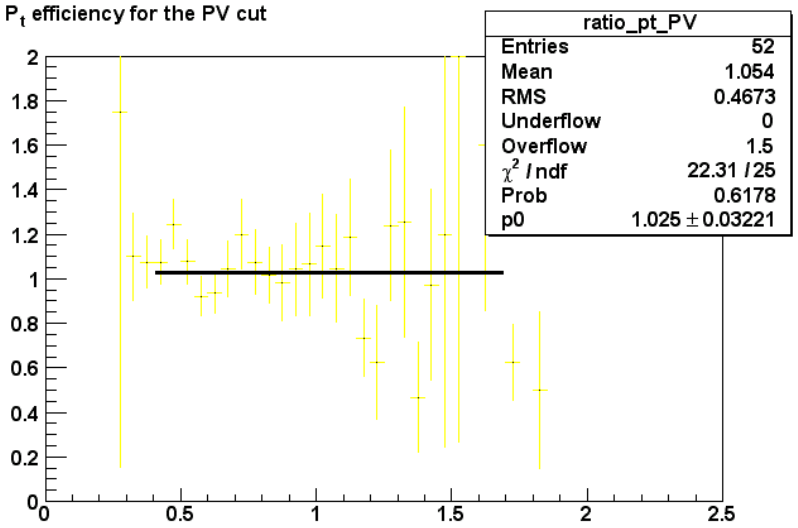


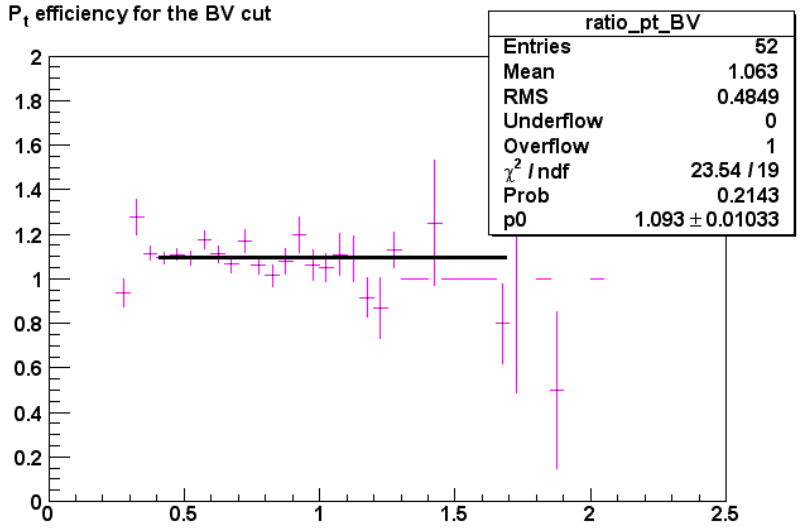


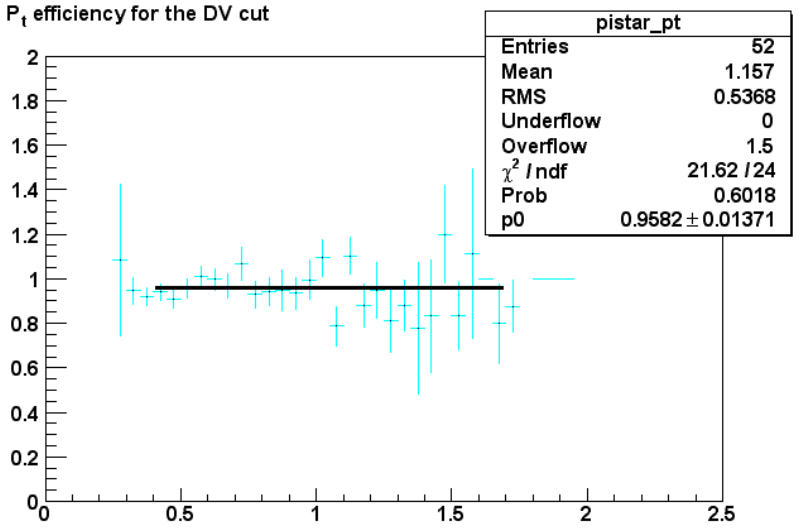


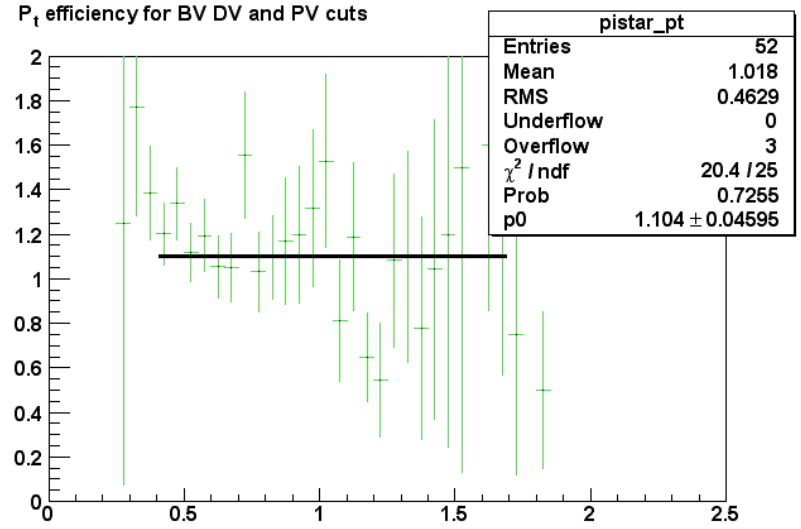


Selection efficiencies again: ε(MC)/ ε(data)









Selection efficiencies again: ε(MC)/ ε(data)