Search for Heavy Neutrinos

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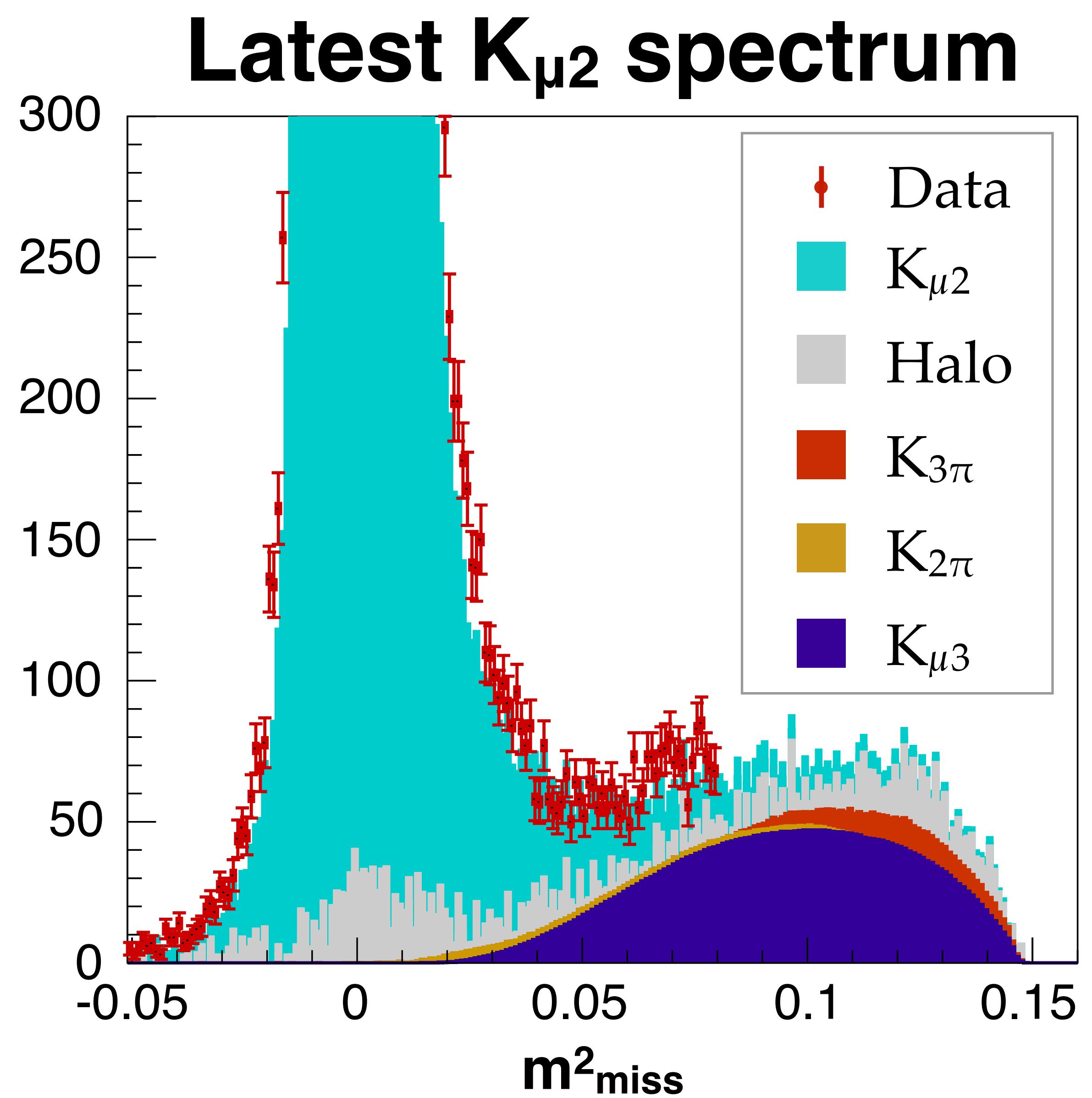
AKL - first investigation
DCH - far tails in $K_{2\pi}$
HALO - simulation

AKL: $K_{\mu 3}$

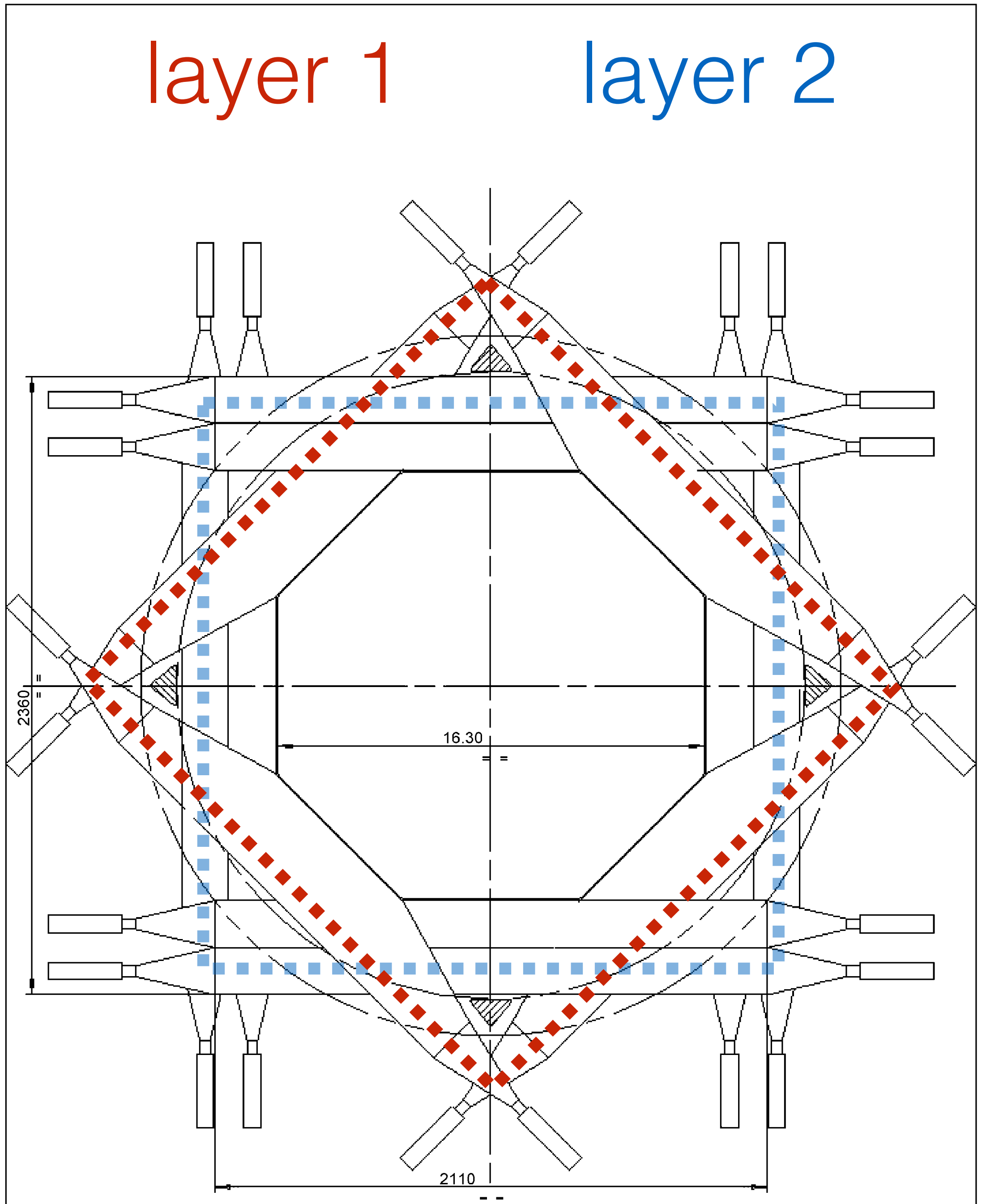
- After $K_{\mu 2}$ selection, $K_{\mu 3}$ events remain in which photons have missed the LKr

- AKL counters could be used as a large angle photon veto



AKL: definition

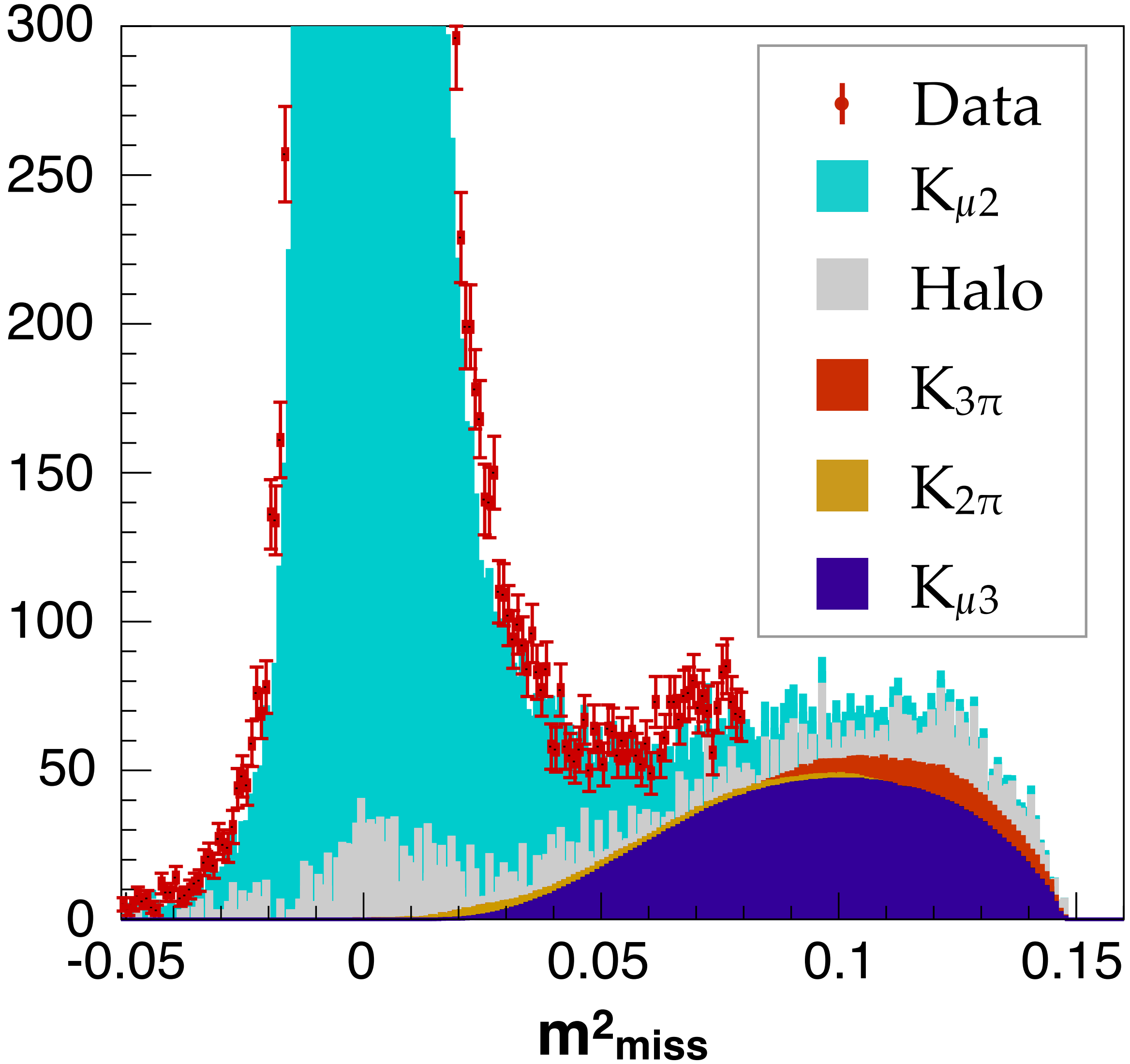
- Following Luigi Di Lella(2007-08-09), look at the AKL PU, in my $K_{\mu 2}$ selection
- Might help with $K_{\mu 3}$
- look at PU[15], bit[7], slice 6, 7
- OR of (OR of 2 layers) for all 7 pockets



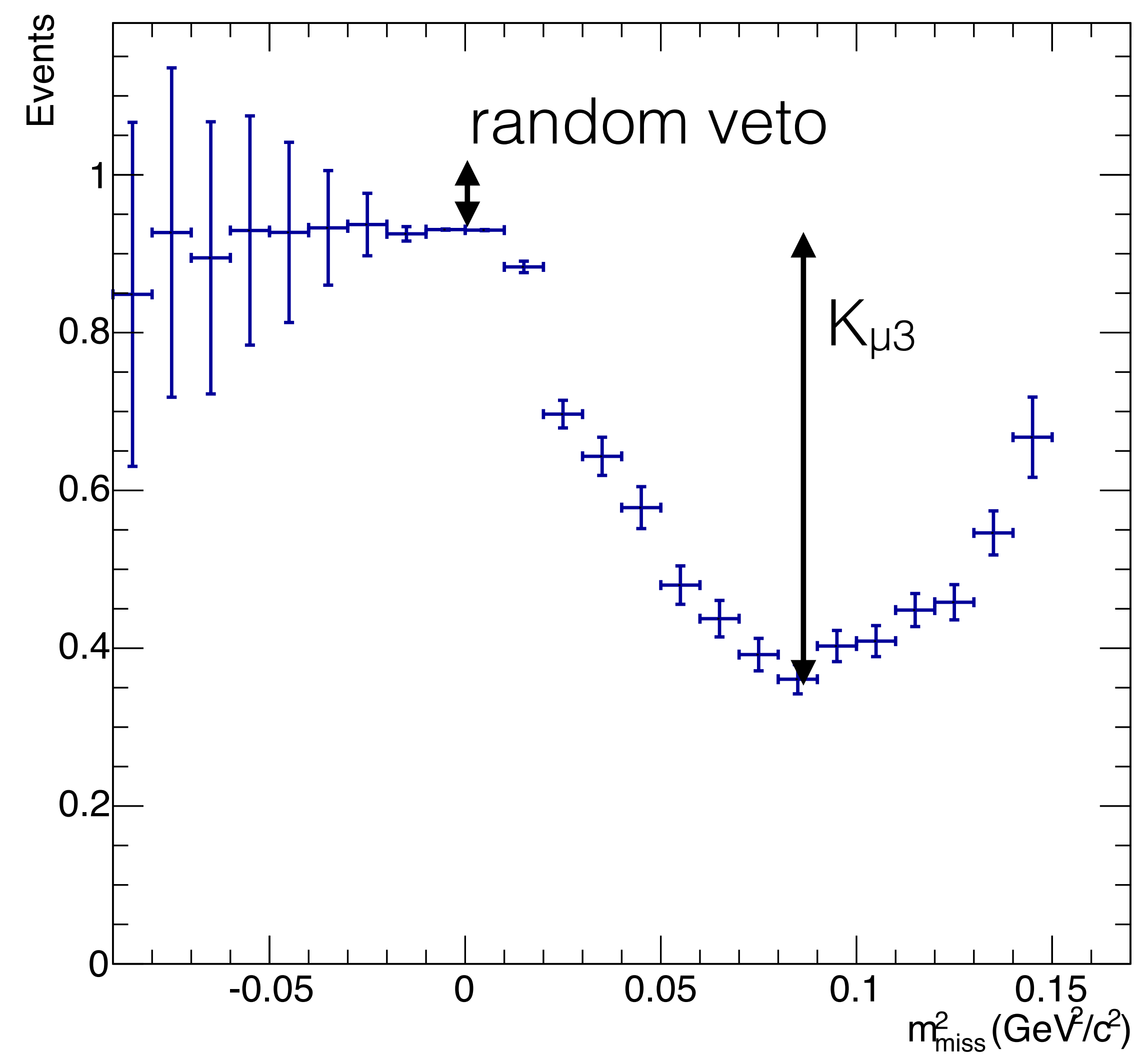
1 AKL pocket

AKL: impact

Latest $K_{\mu 2}$ spectrum



Data with AKL veto / without



- It looks like a large fraction of $K_{\mu 3}$ has been removed, with reasonable efficiency for $K_{\mu 2}$

AKL: extraction

- Very rough estimates
  (remove 80% of $K_\mu 3$, 10% systematic uncertainty)
  → O(2) improvement in limit possible
- More detailed study requires AKL hits
- Not present in SCMP, so copy from CMP
- Available for P5 data, might need to run MC again

Pattern Unit

PU channel 15 is dedicated to AKL

ANDs ORs

10010000 **1**01110000

OR of the 7 bits to the right

AND of the two layers in AKL POCKET 2

OR of the two layers in AKL POCKET 3

AKL: hits

```
AKL Hits
11011100 11111100

PU CHANNEL:     15
00000000 00000000
00101000 10111110
10101000 10111010
00000000 00000000
00000000 00000000
00000010 10000110
10000010 10000010
00000000 00000000
00000000 00001000
00000000 10001000
```

AND OR

```
AKL Hits
11000000 11000000

PU CHANNEL:     15
00000000 00100000
10100000 10100000
00000000 00000000
00000000 00000000
00000000 00000000
00000000 00000000
00000000 00000000
00000000 00000000
00000000 00000000
00000000 00000000
```

AND OR

time slice

AKL: Pockets

AKL:

2	6936
3	8506
4	5922
5	4551
6	2305

PU:

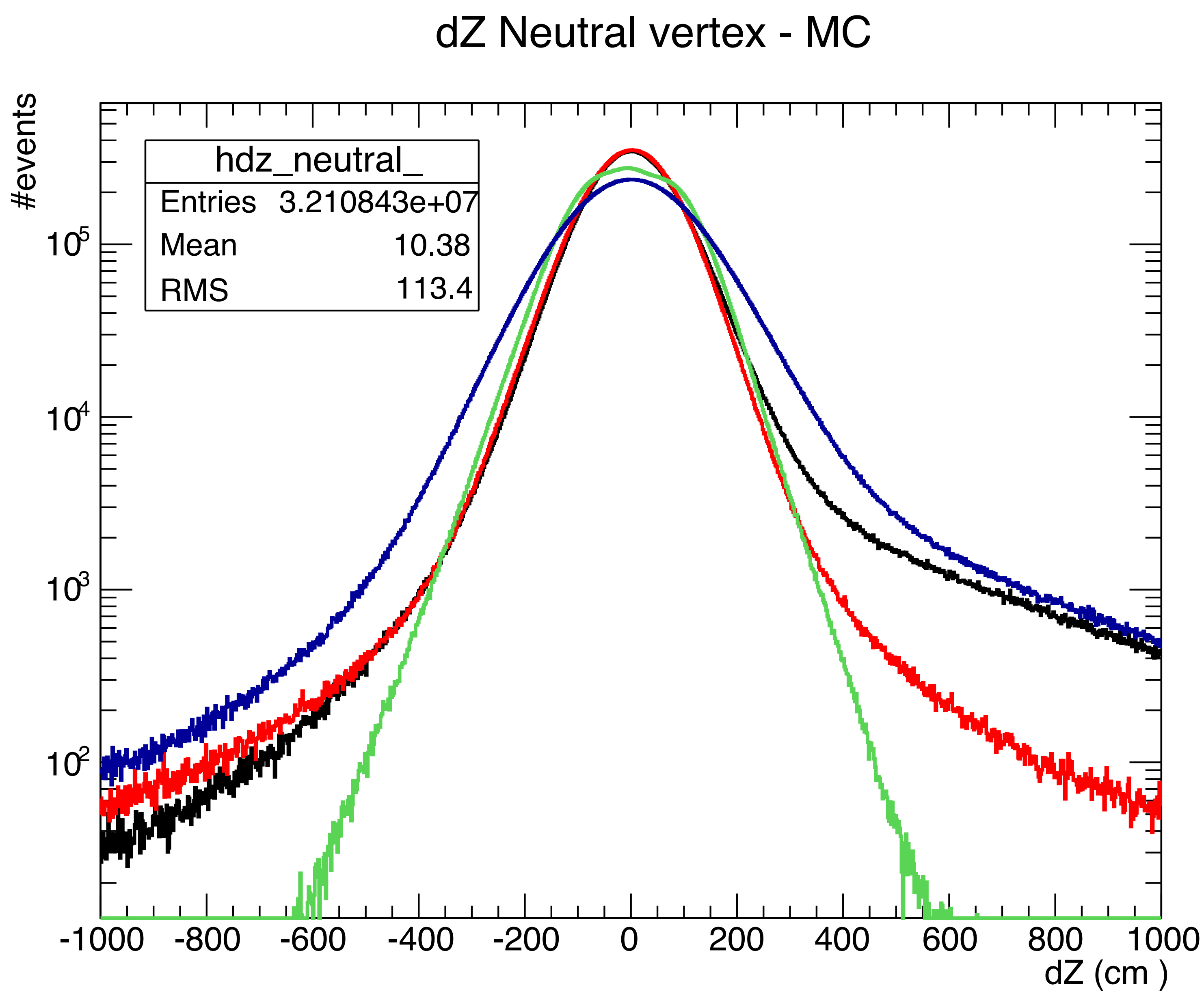
1	2363
2	2347
3	2518
4	2247
5	1151

- In both AKL data and PU, we only see 5 pockets
- Is there any reason to expect this?

DCH

- Study tails of DCH resolution, using pure $K_{2\pi}$ events selected using LKr
- Look at $\Delta p_{\pi+}$ between DCH measurement and LKr reconstruction
- Also look at endpoint of $p_{T\pi+}$ measured in DCH

DCH: z vertex



mc.p5.k2pig

neutral - charged

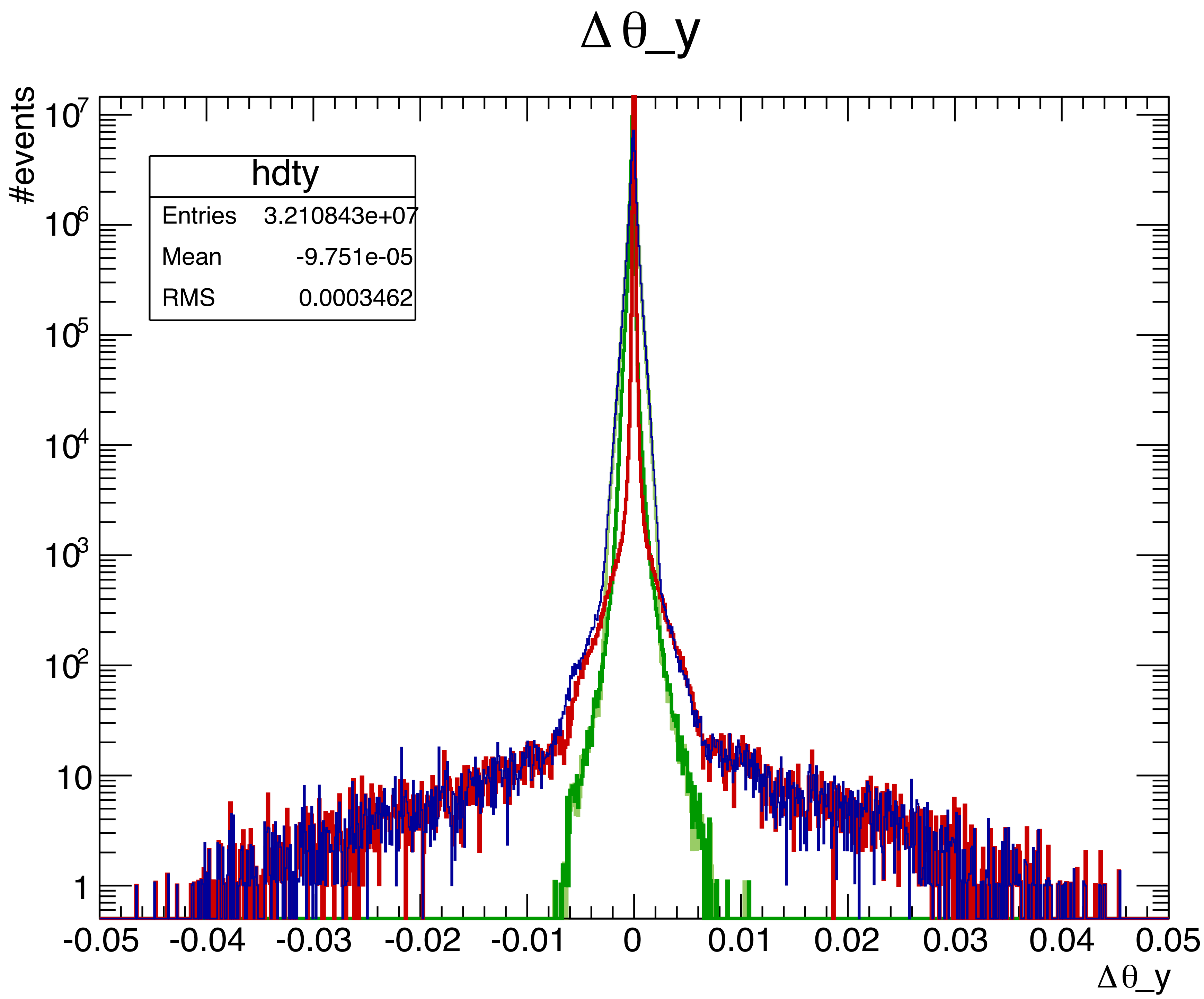
neutral - MCtruth

charged - MCtruth

MCtruth pions (effect of kaon spread)

- Non-zero mean dZ for neutral vertex is probably due to asymmetric far tails rather than a systematic reconstruction error

DCH: θ_y

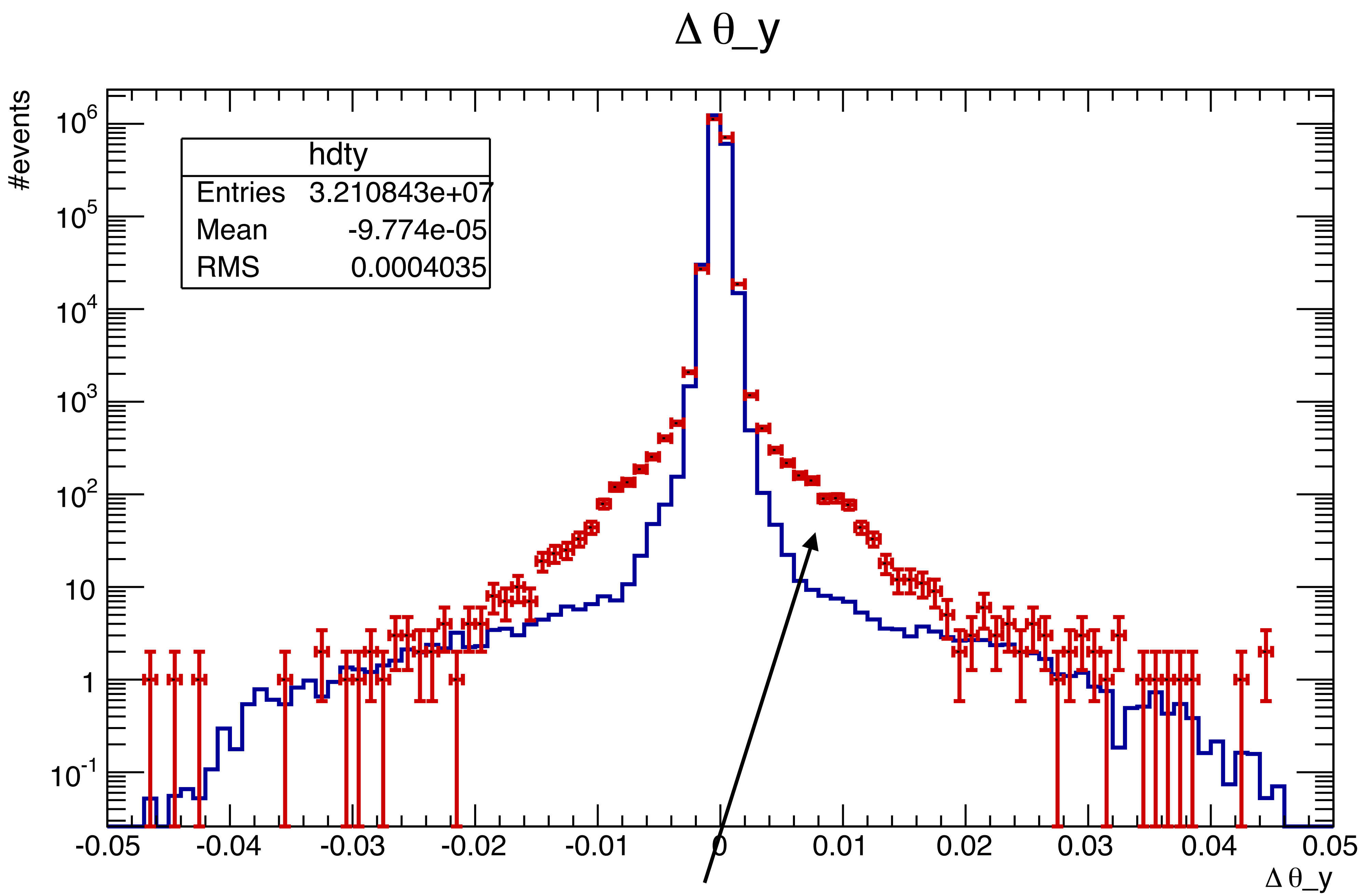


DCH - LKr

DCH resolution

Lkr and Kaon resolutions

DCH: θ_y - data vs MC

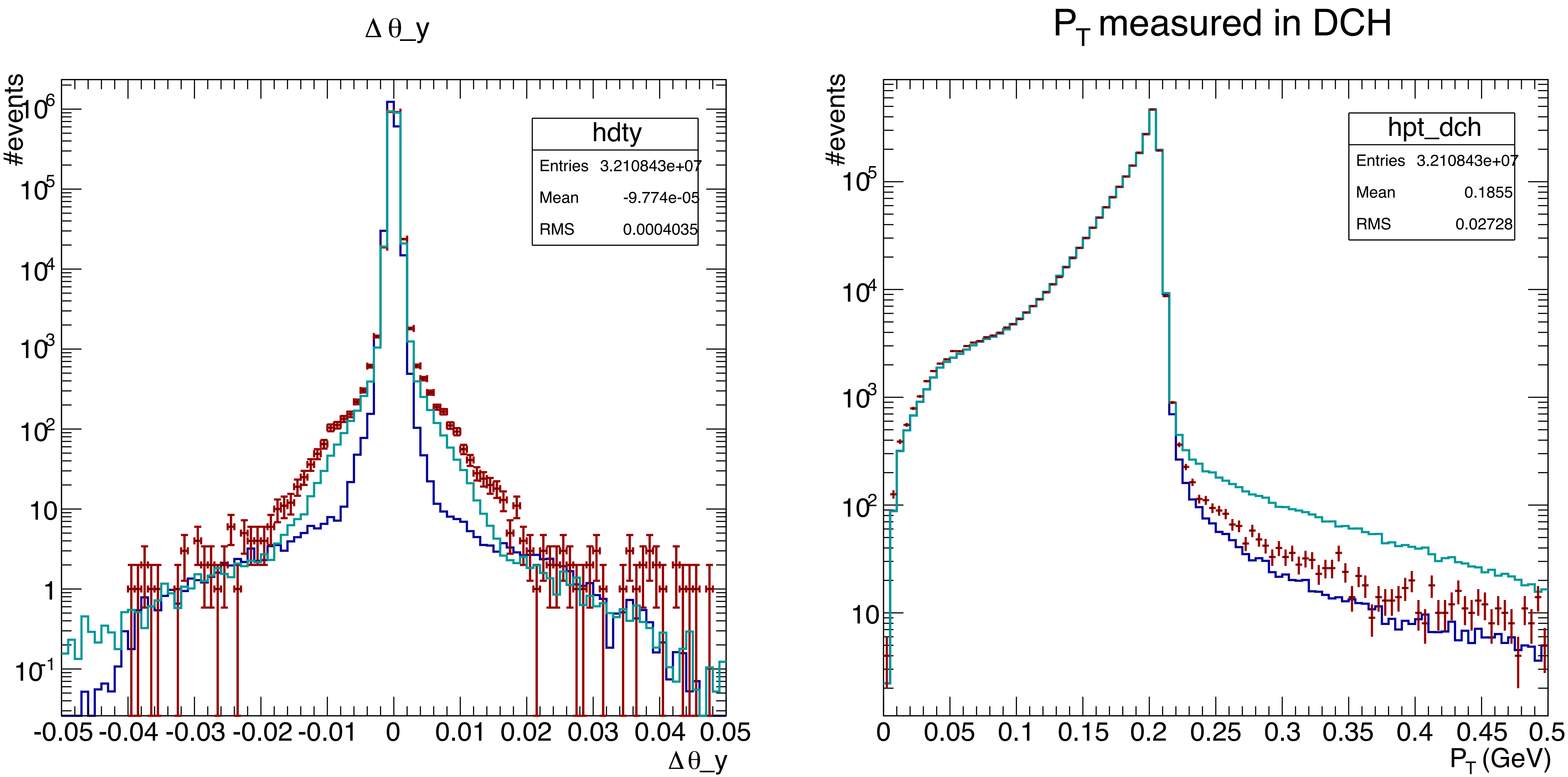


Fill this gap by kicking a subsample of pi+ in the DCH

DCH: extra scattering

Do dydz → dydz + K, with p(K) = r x Gauss(0, σ)+(1-r)δ(0)

$r = 3x10^{-3}$; $\sigma = 5x10^{-3}$



DCH

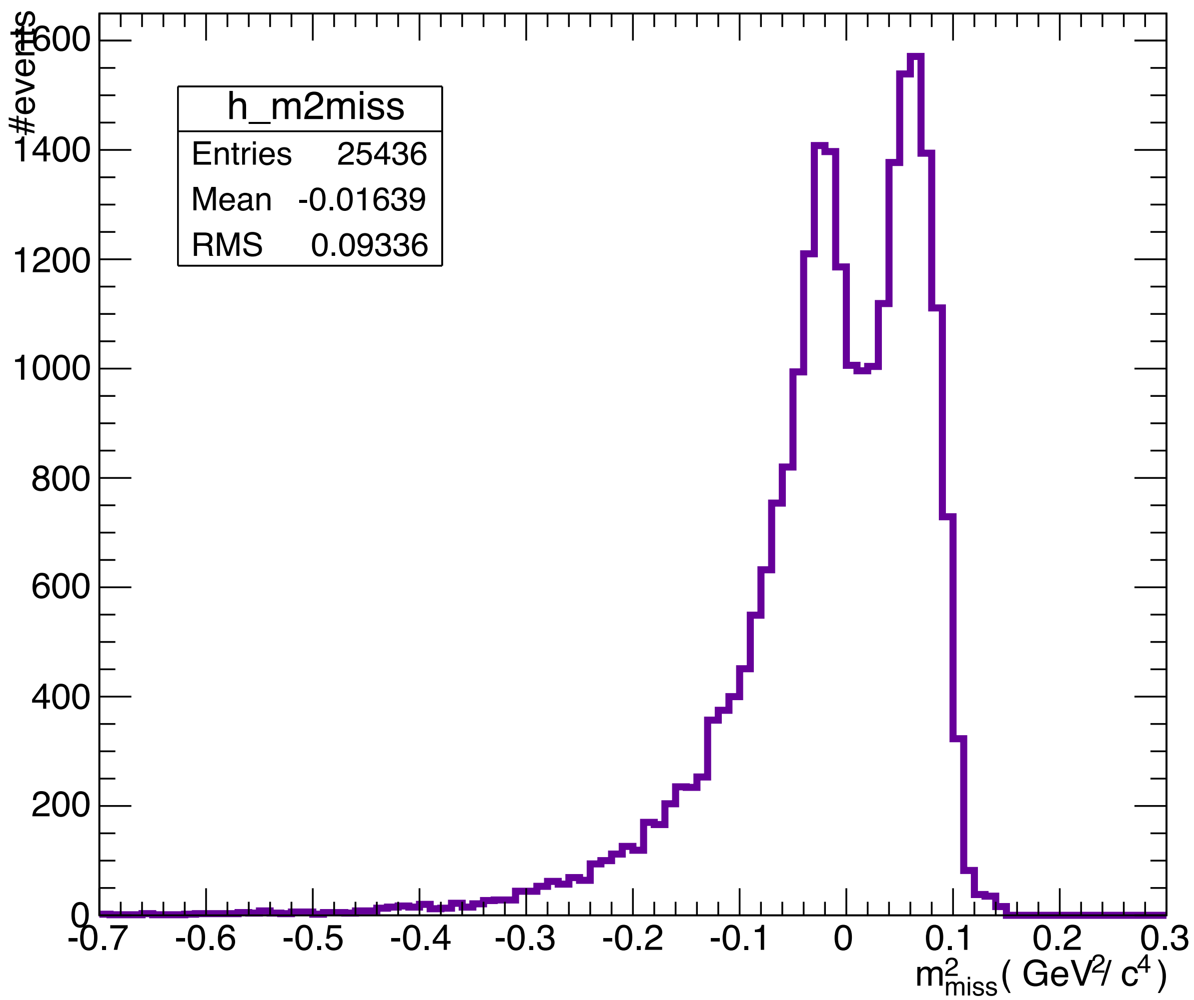
- Tails in θ_y can be filled by performing a gaussian distributed kick on a fraction of events.
- But P_T spectrum is disturbed too much
- Are there other contributions to θ_y which are imperfectly reproduced in MC?
- Conservative solution: use the fit from θ_y and apply to $K_{\mu 2}$ even though it over corrects the P_T spectrum

Halo: simulation

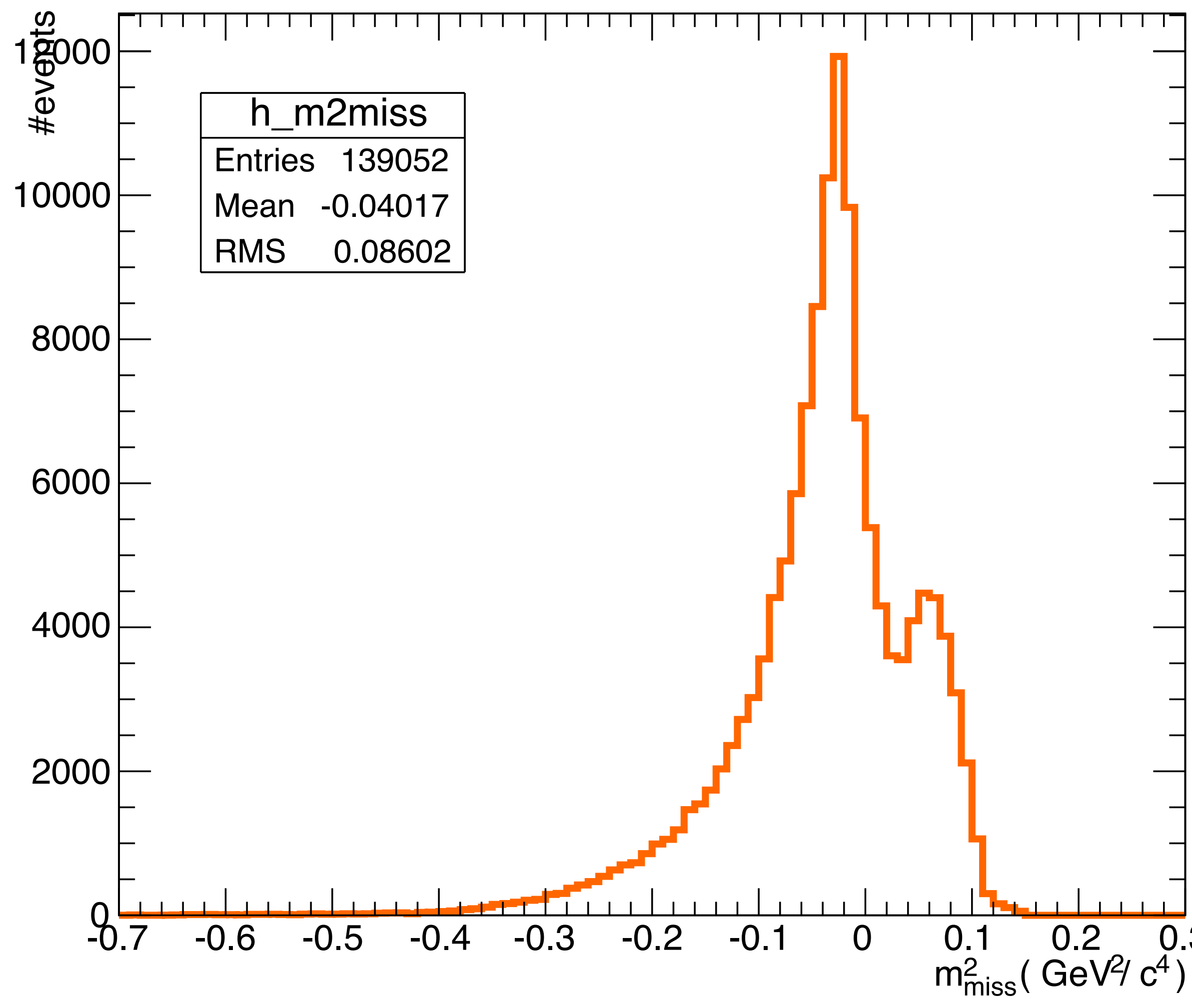
- Using HALO program as an alternative to data driven estimation of background
- Used BlueBear facility at Birmingham to generate large samples of K^+ and PI^+
- Quite inefficient as most particles don't reach DCH
  - simulated 125×10^9 each of K+, PI+
  - plotted 25×10^3 K+ and 139×10^3 Pi+

Halo: results

K+

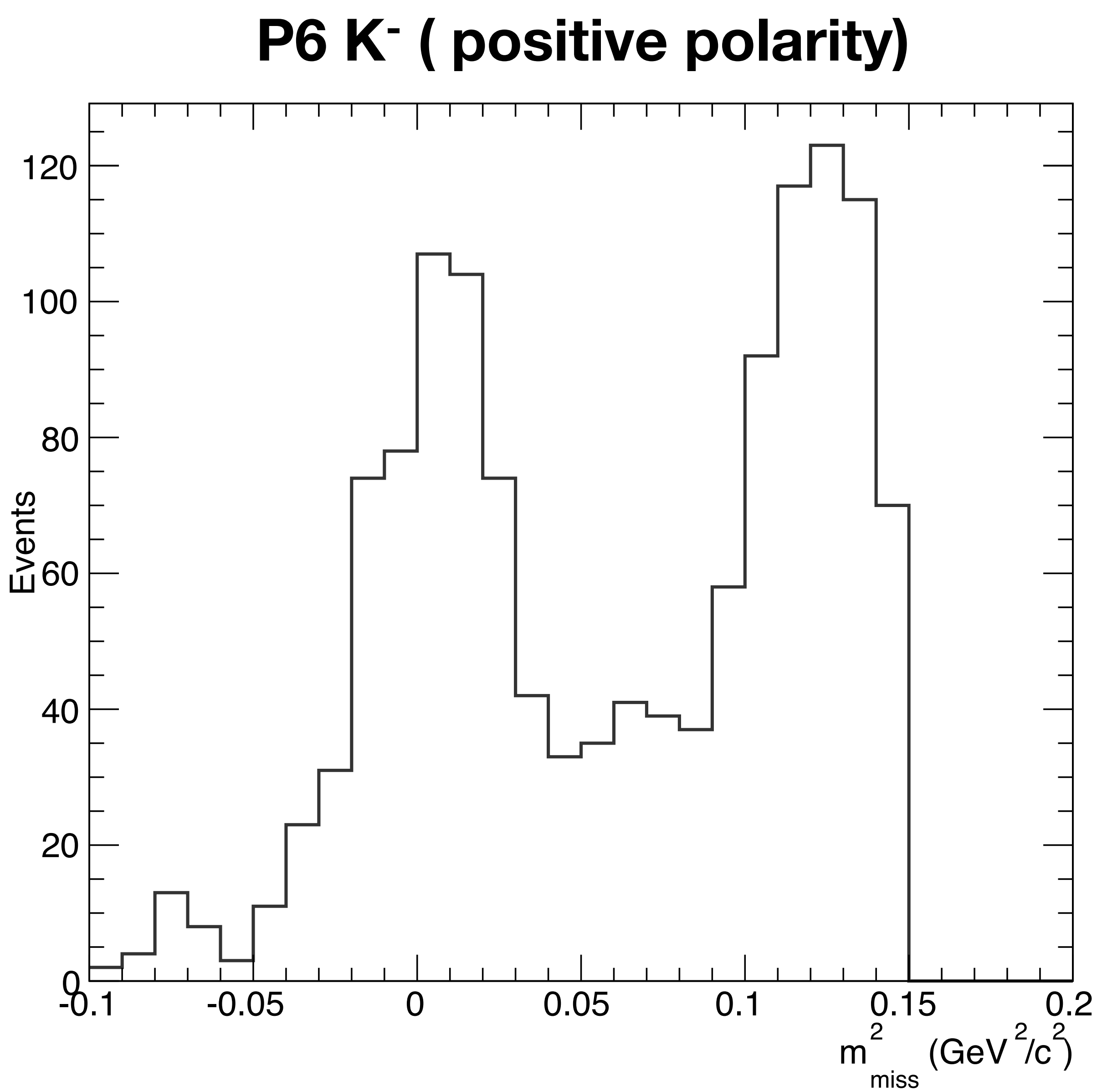


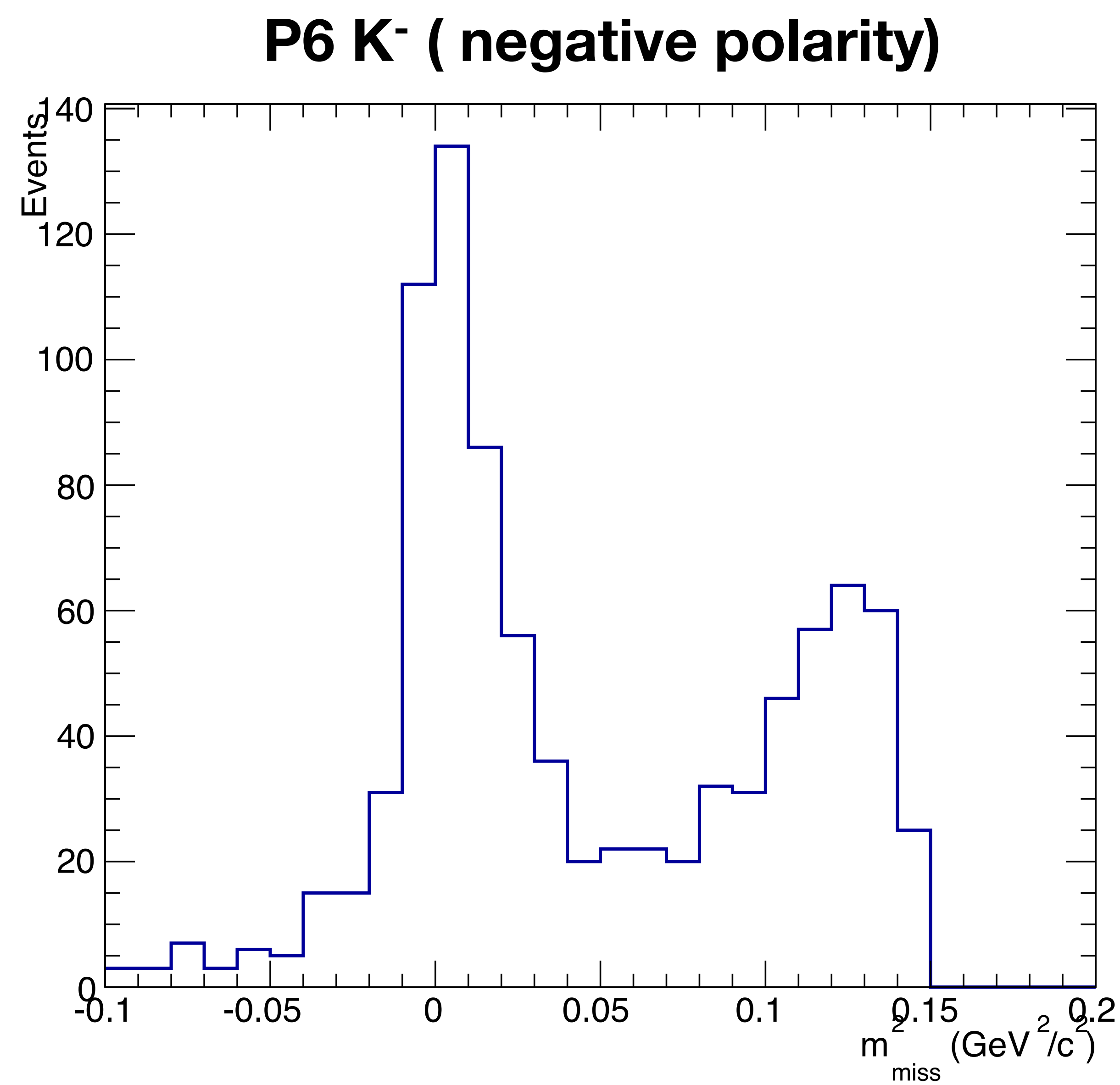
π^+



- Both have a double peak structure but with a different shape

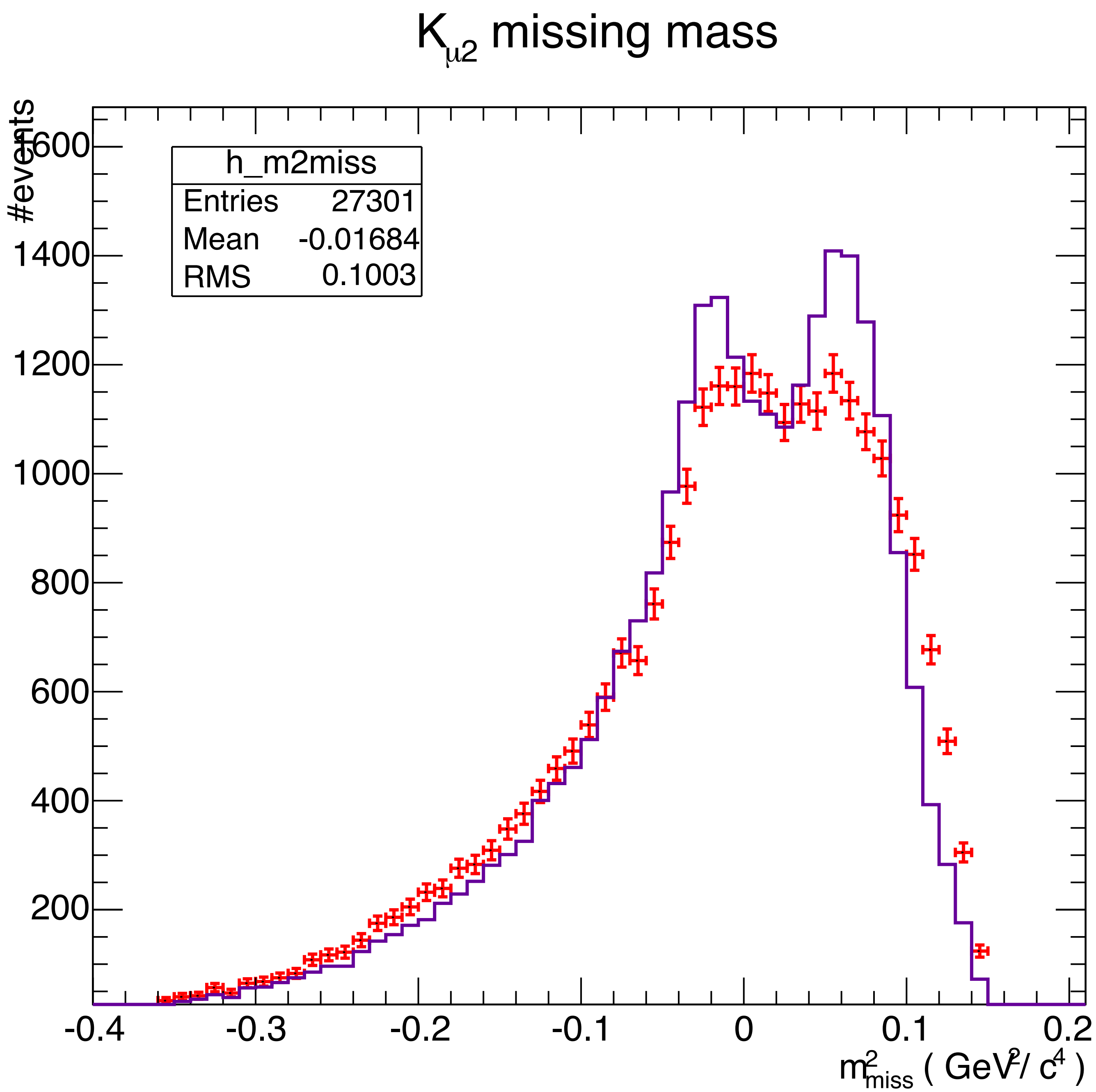
Halo: polarity





- Data (with very tight kinematic cuts) also shows double peak structure
- Does beam polarity affect π/K ratio?

Halo: data vs MC



- Data looks similar to simulated kaons alone
- Peaks are smeared out

Halo: next

- π/K ratio:
  - Need understand simulation forced decay
  - what are the values in data? are they fixed?
  - What is the effect of beam polarity
- Could I apply extra smearing → smoother mass spectrum?
- Is there another source to consider

Conclusions

- AKL looks promising, O(2) improvement in limit possible
- DCH can be (over-) corrected in MC
- Approximate halo distribution can be reproduced using HALO