Progress on the

Pion contamination paper

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MICE CM38

DS ON/OFF comparison

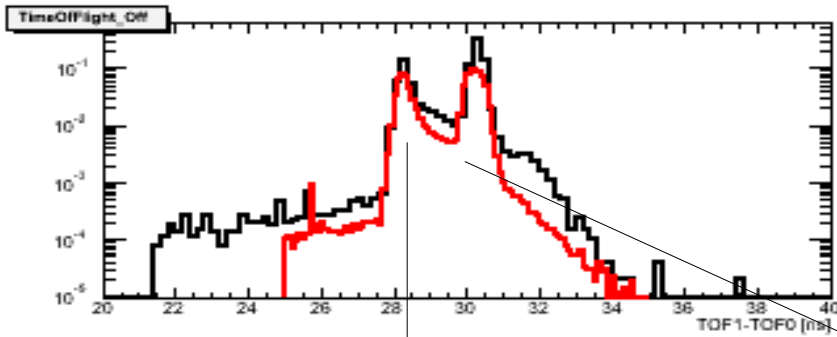- **In the analysis a mixture of templates with DS on/off was used**

Following the discussion in CM37 simulations for the settings of the following runs have been produced

- **3250 – used for P2 muons**

- **3253 – used for P1 muons**

Both with Decay Solenoid (DS) on and off

The purpose is to verify that, <u>despite this important difference</u>, after the Time Of Flight (KL) cuts selecting muons or pions, the KL distribution templates are in good agreement.
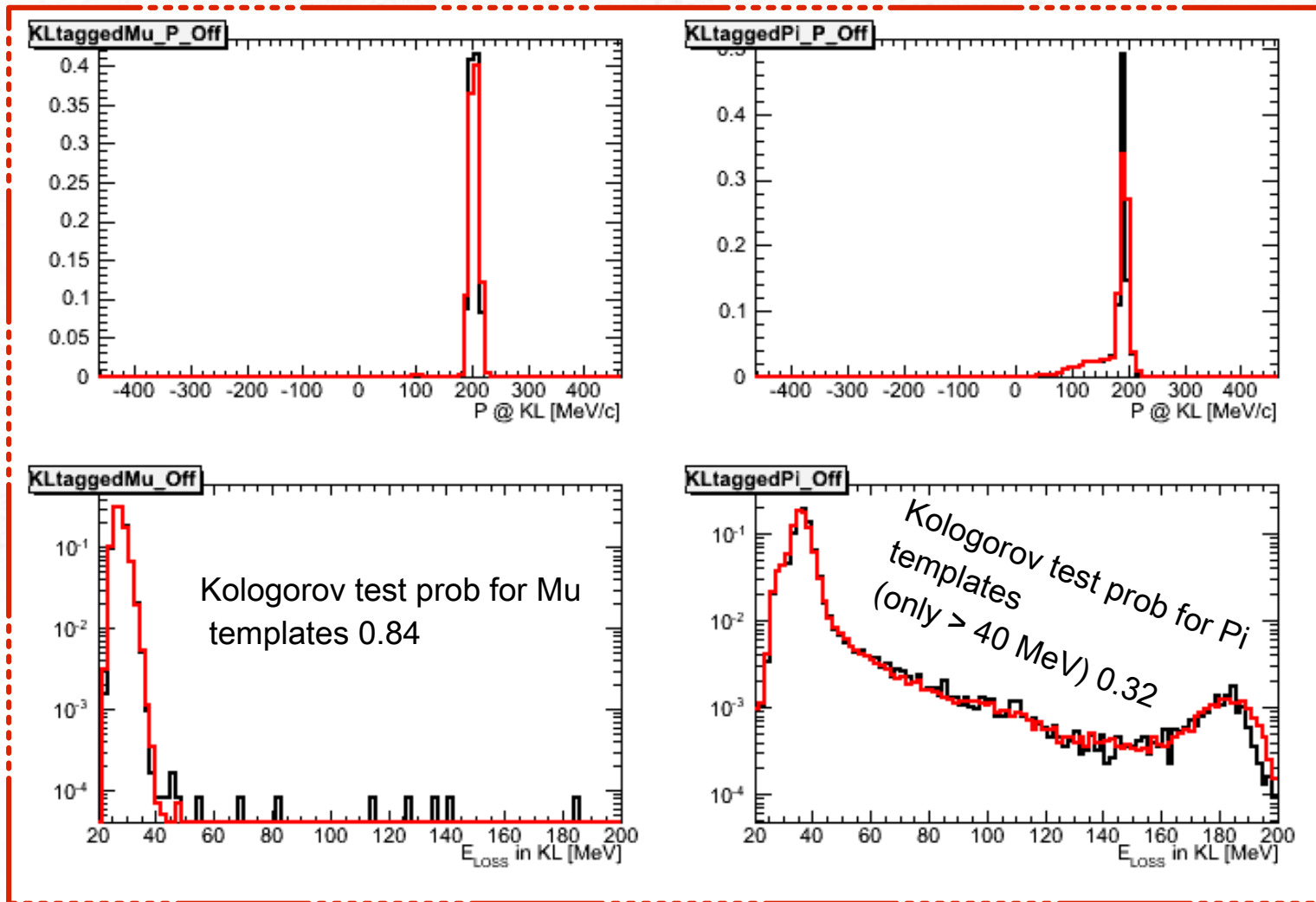
Settings of run 3250 (p=258MeV@D2)

3250 settings
DS ON
DS OFF
appear very different

Muon candidates

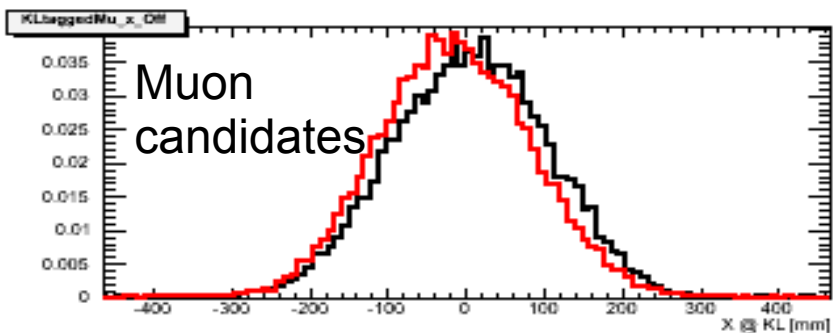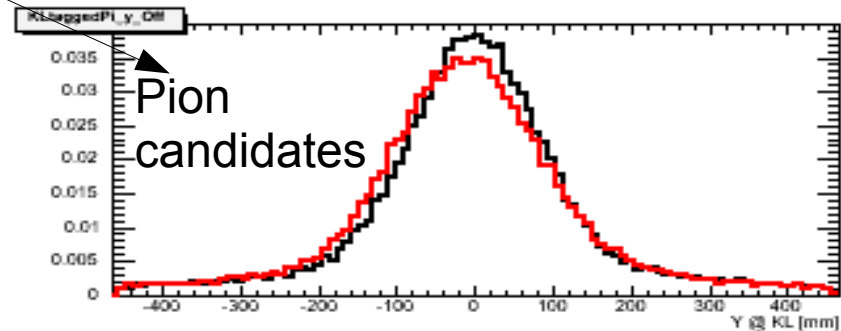Pion candidates

Muon candidates

Pion candidates
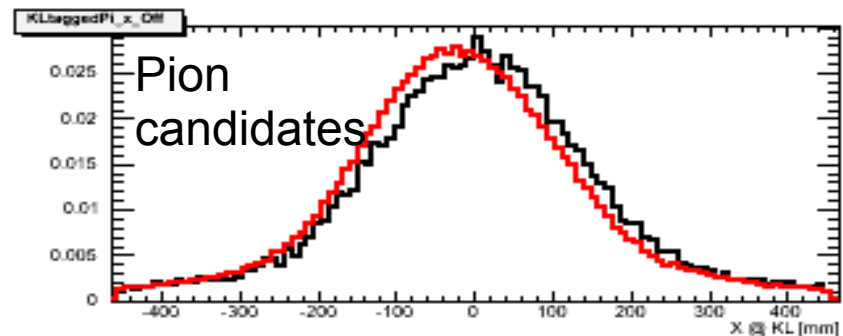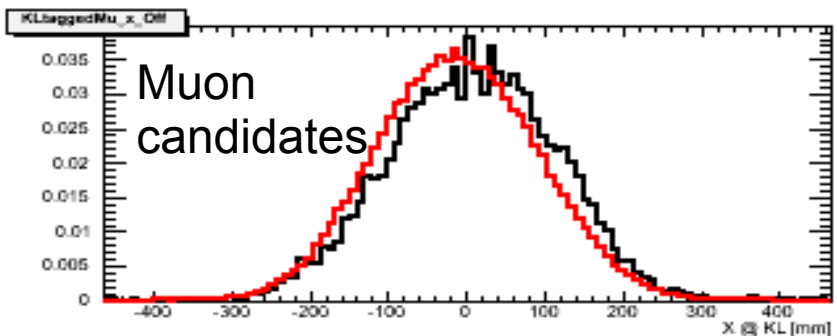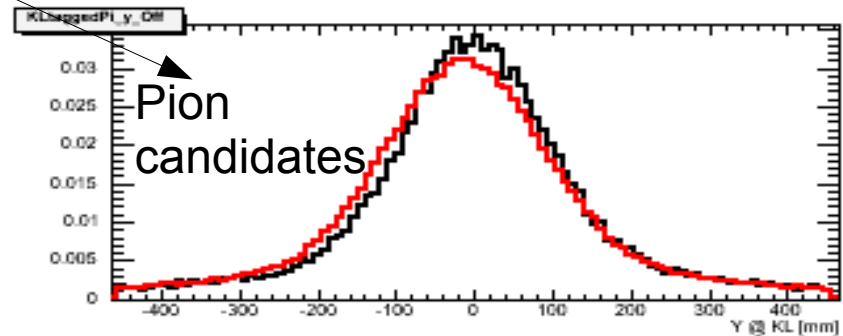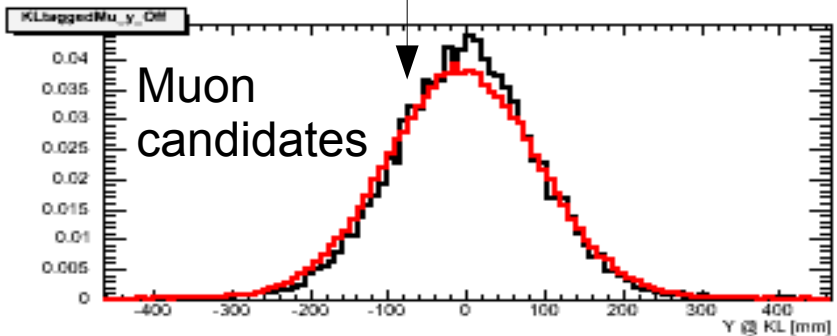
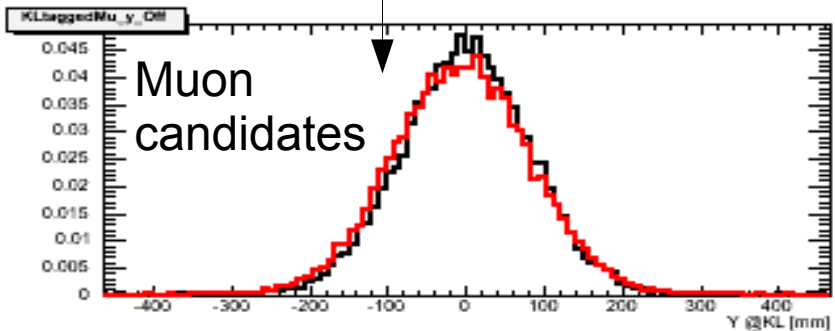# Settings of run 3250 (p=258MeV@D2)

Settings of run 3253 (p=294MeV@D2)

3253 settings
DS ON
DS OFF
appear very
different

Muon candidates

Pion candidates

Muon candidates

Pion candidates

Settings of run 3253 (p=294MeV@D2)

KLtaggedMu_P_Off

KLtaggedPi_P_Off

KLtaggedMu_Off

Kologorov test prob for Mu Templates 0.92

KLtaggedPi_Off

Kologorov test prob for Pi templates (only > 40 MeV) 0.37
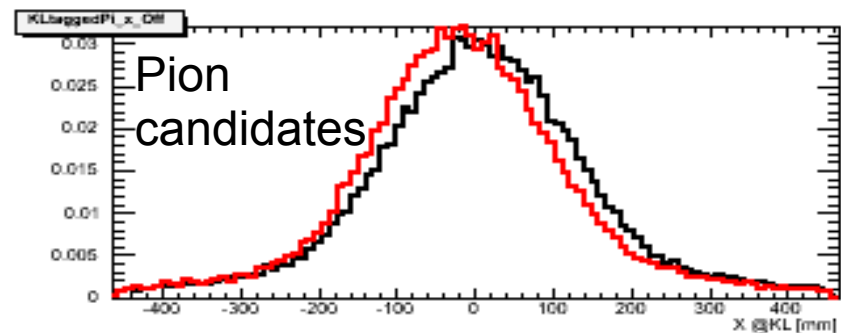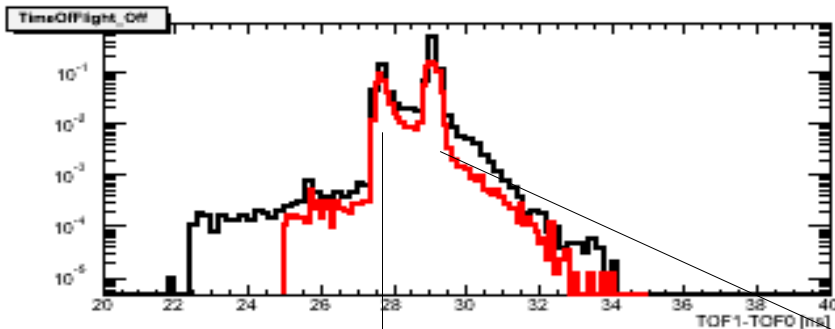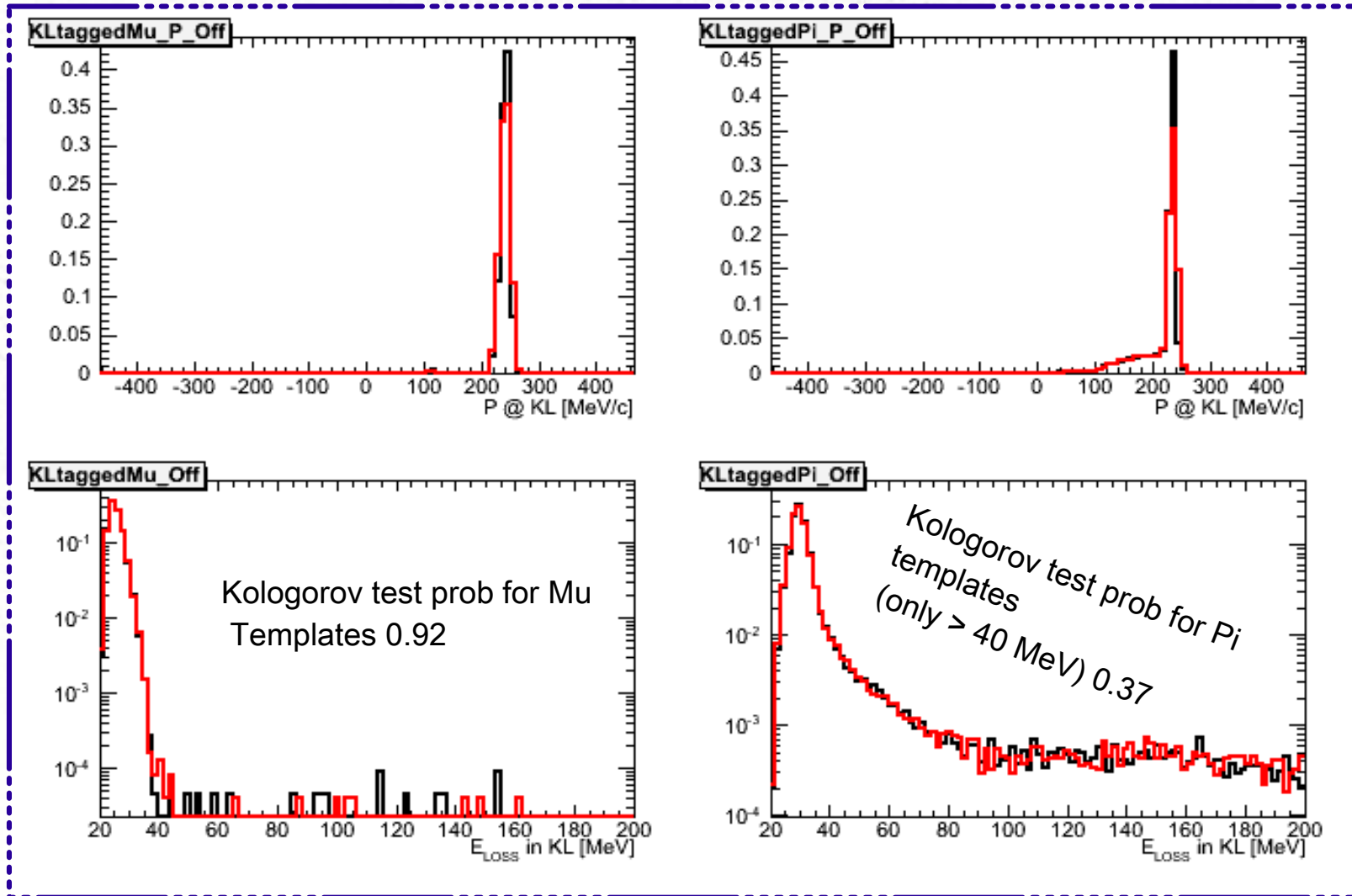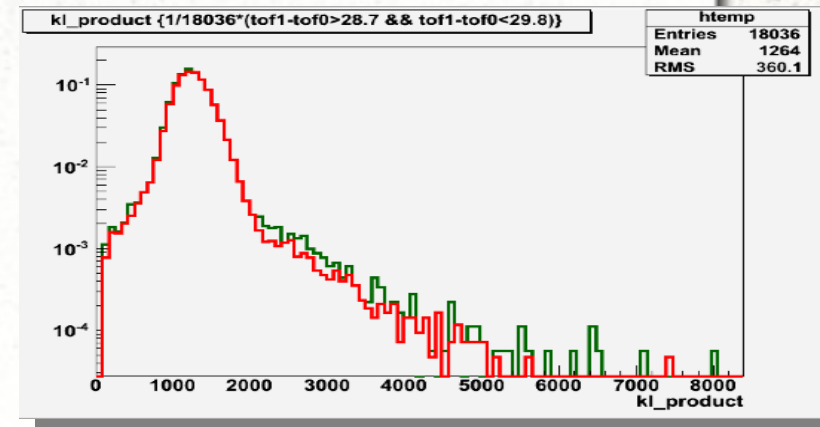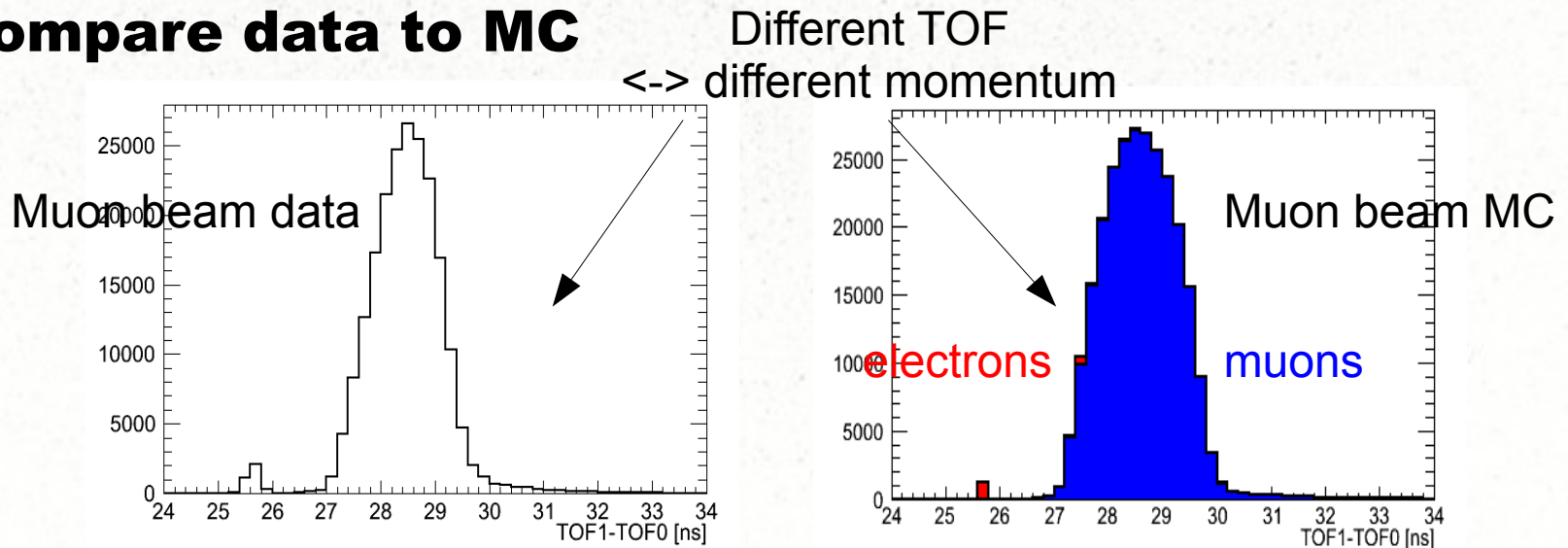
DS ON/OFF comparison

- We are now more confident that templates are not sensitive to the Decay Solenoid being ON or OFF

- The differences observed in data for DS ON/OFF when comparing runs **3379** and **3256** (Kolmogorov prob for the compatibility of the muon templates 5e-8!) can be treated as systematics
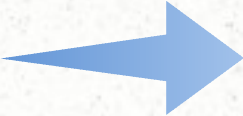   - Muon tail x 2
    - Pi cont form 1.6% to 0

Validation with MC

- **MC is not ready yet to reproduce data**

  - **Mariyan Bogomilov is currently working on KL digitisation**

- **But also introducing some digitisation effects it will take time for the fine tuning needed to directly compare data to MC**

Different TOF <-> different momentum

Muon beam data

Muon beam MC

electrons   muons

Two-fold approach

Mariyan Bogomilov is working on KL digitisation (timescale ~ month)

- **Improve MC and data/MC comparison ➡ beyond the scope of the PID paper**

- **Certify the pion contamination measurement in the paper using MC**

Extraction of templates from MC

- **Select muons and pions for the templates usig the TOF as in data**

- **Register the purity of the templates from truth at TOF1**

- **Fill the KL templates using the energy lost in KL volume – only for charged particles reaching the KL front face**

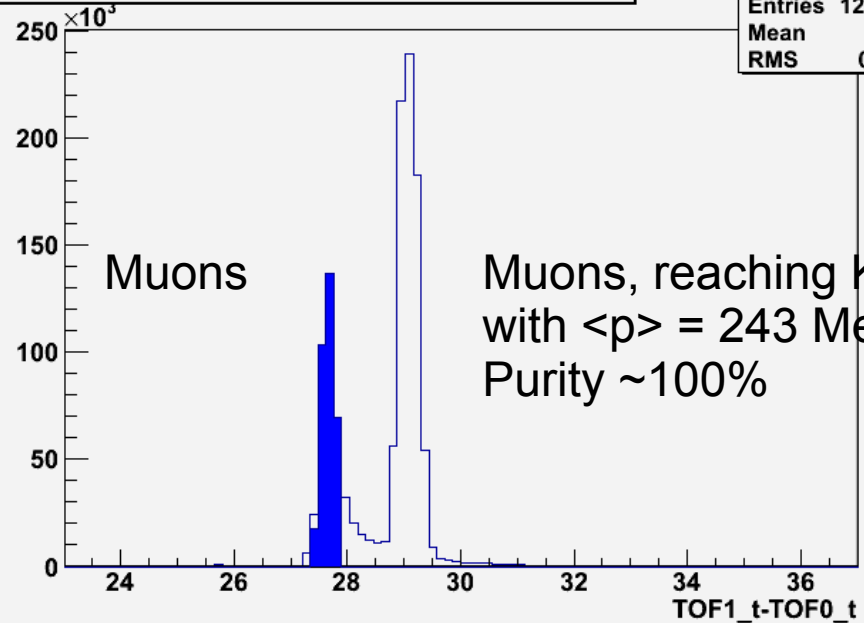- **Use truth information at the exit of KL as truth PID**

P1 TOF selection

TOF1_t-TOF0_t {abs(TOF1_t-TOF0_t-30)<6}
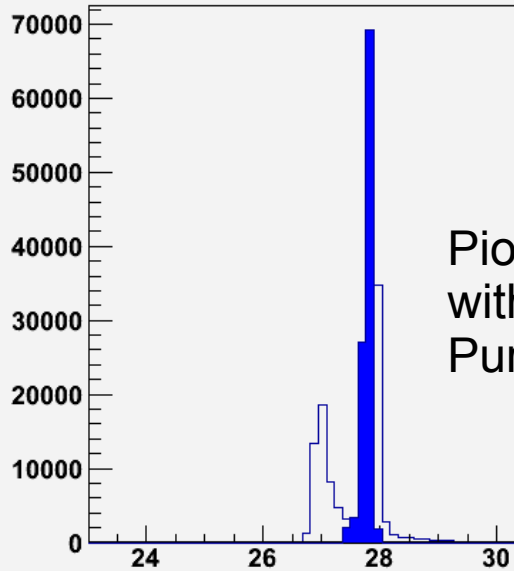
htemp	
Entries	191736
Mean	27.65
RMS	0.4324

Pions, reaching KL
with <p> = 313 MeV
Purity ~ 66%

TOF1_t-TOF0_t {abs(TOF1_t-TOF0_t-30)<6}

htemp	
Entries	1230990
Mean	28.63
RMS	0.7415

Muons

Muons, reaching KL
with <p> = 243 MeV
Purity ~100%

TOF1_t-TOF0_t
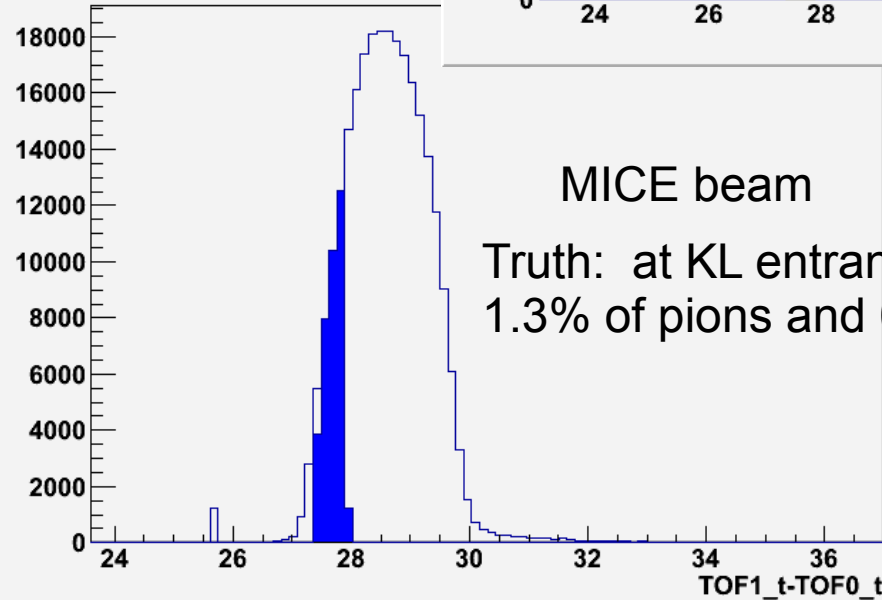
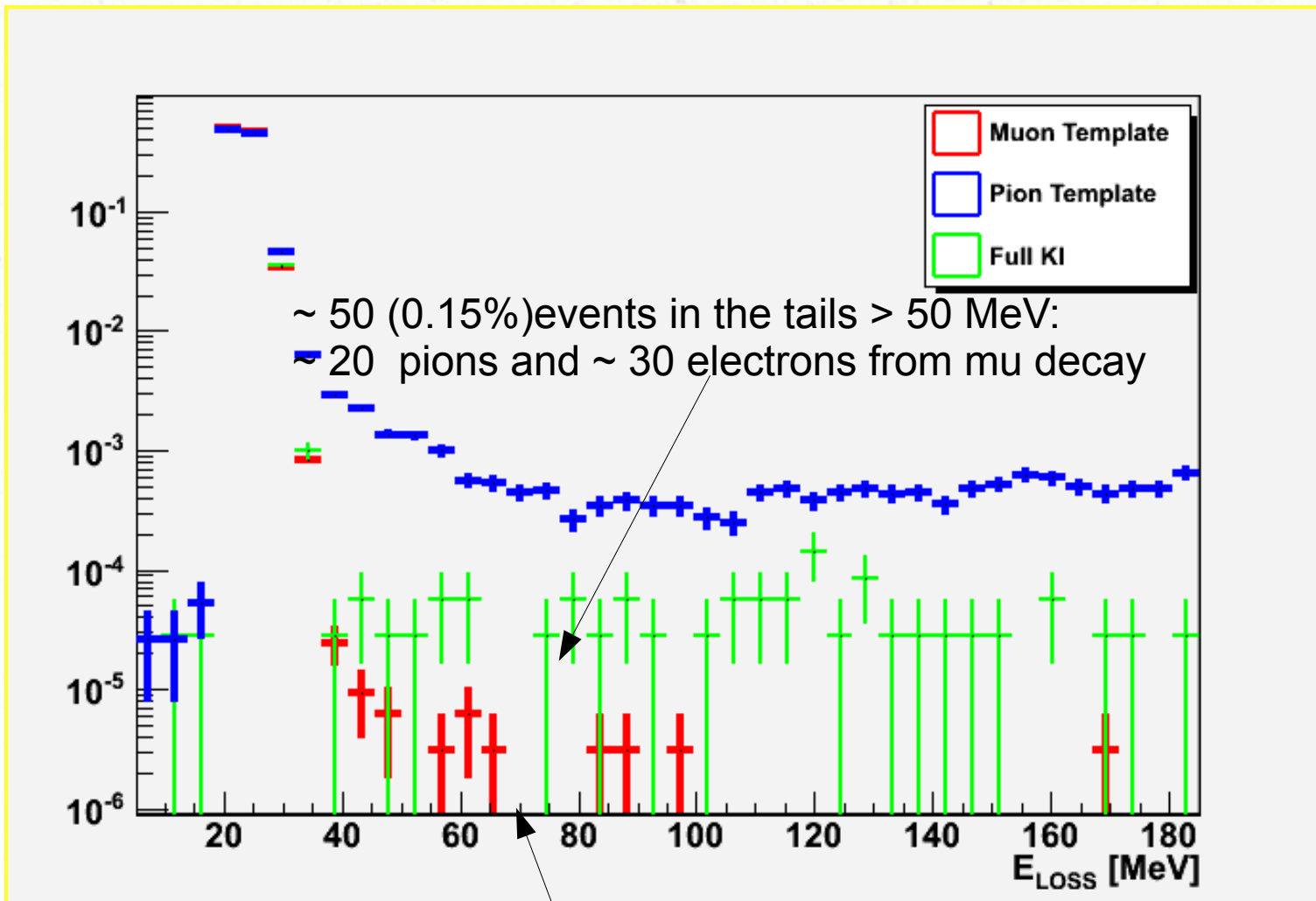**TOF1_t-TOF0_t {abs(TOF1_t-T...**

MICE beam

Truth: at KL entrance 98.6% of muons
1.3% of pions and 0.1% of electrons

TOF1_t-TOF0_t

P1 KL distributions

~ 50 (0.15%)events in the tails > 50 MeV:
~ 20 pions and ~ 30 electrons from mu decay

Why don't we see these electrons in the muon template?

P1 fit

Muon fraction 94.5%
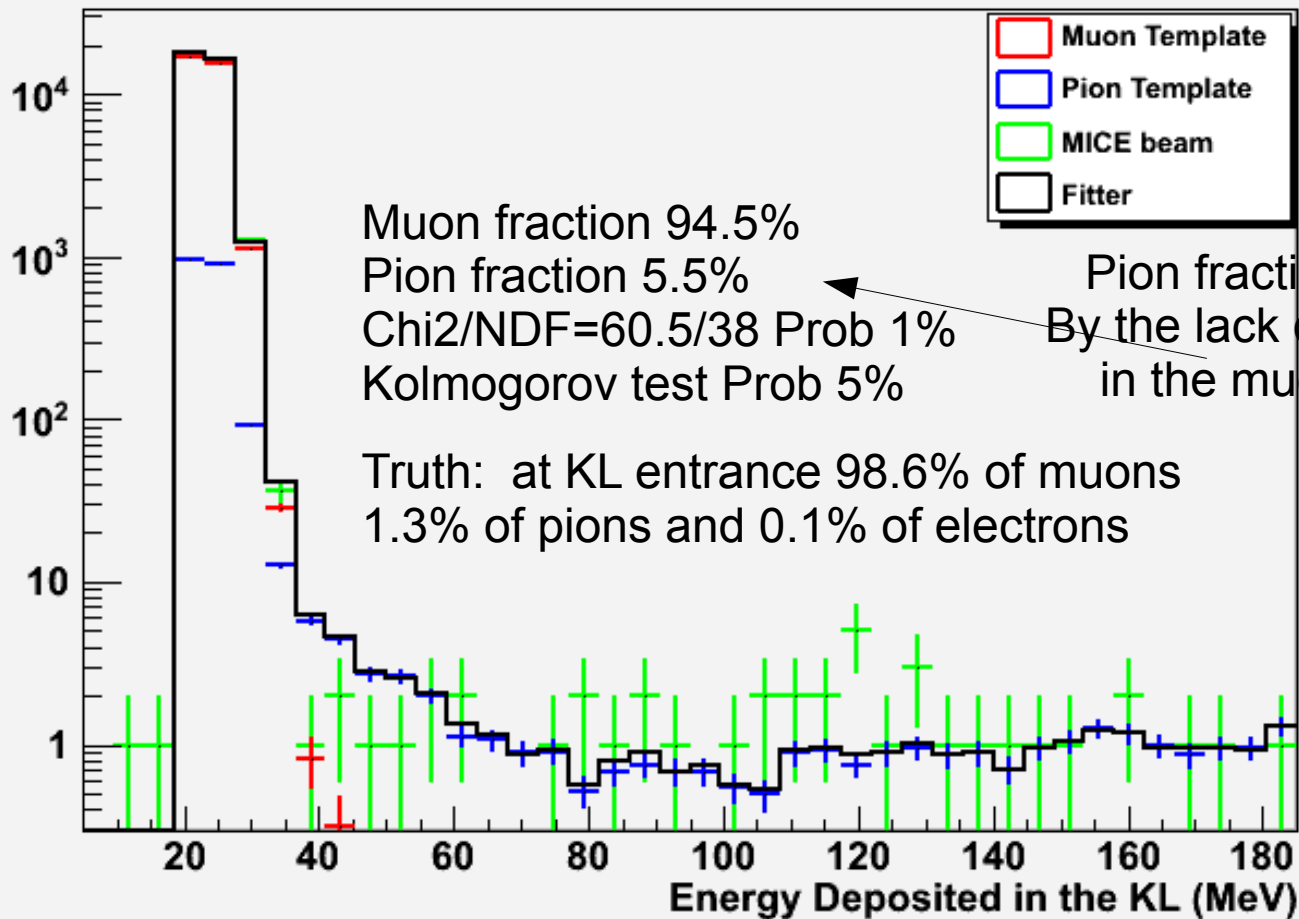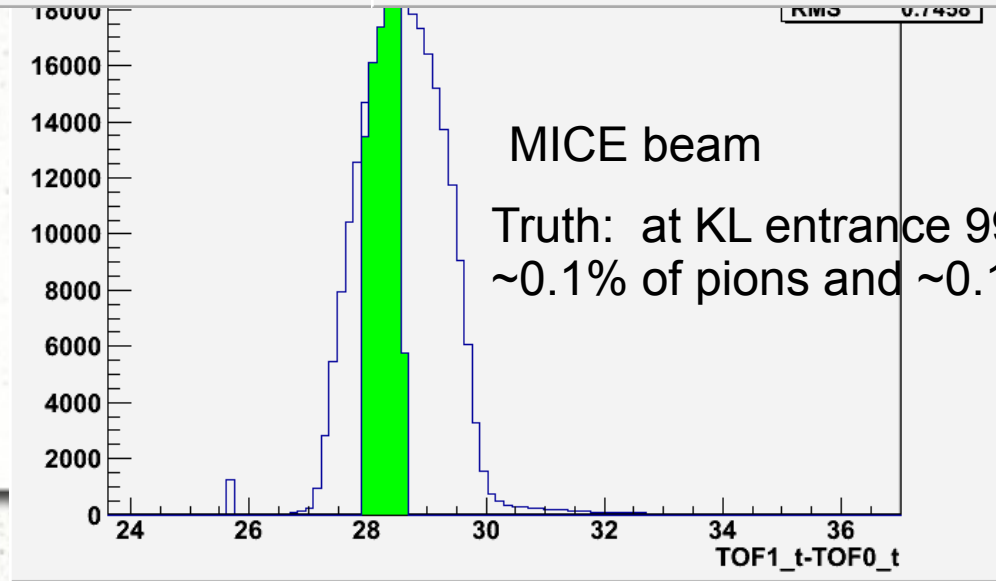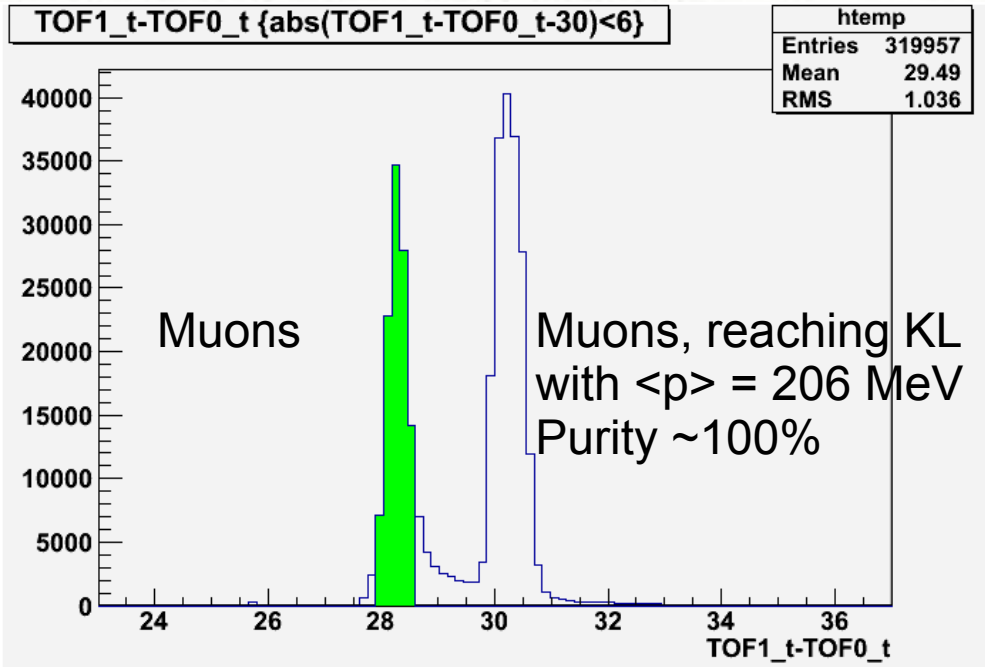Pion fraction 5.5%
Chi2/NDF=60.5/38 Prob 1%
Kolmogorov test Prob 5%

Truth: at KL entrance 98.6% of muons
1.3% of pions and 0.1% of electrons

Pion fraction pushed up
By the lack of electron tails
in the muon template?

P2 TOF selection

Pions, reaching KL with <p> = 267 MeV Purity ~ 66%

Muons

Muons, reaching KL with <p> = 206 MeV Purity ~100%

MICE beam

Truth: at KL entrance 99.8% of muons ~0.1% of pions and ~0.1% of electrons

P2 KL distributions

The tail is populated mostly by electrons from muon decay

Why do we see less electrons in the muon template?

P2 fit

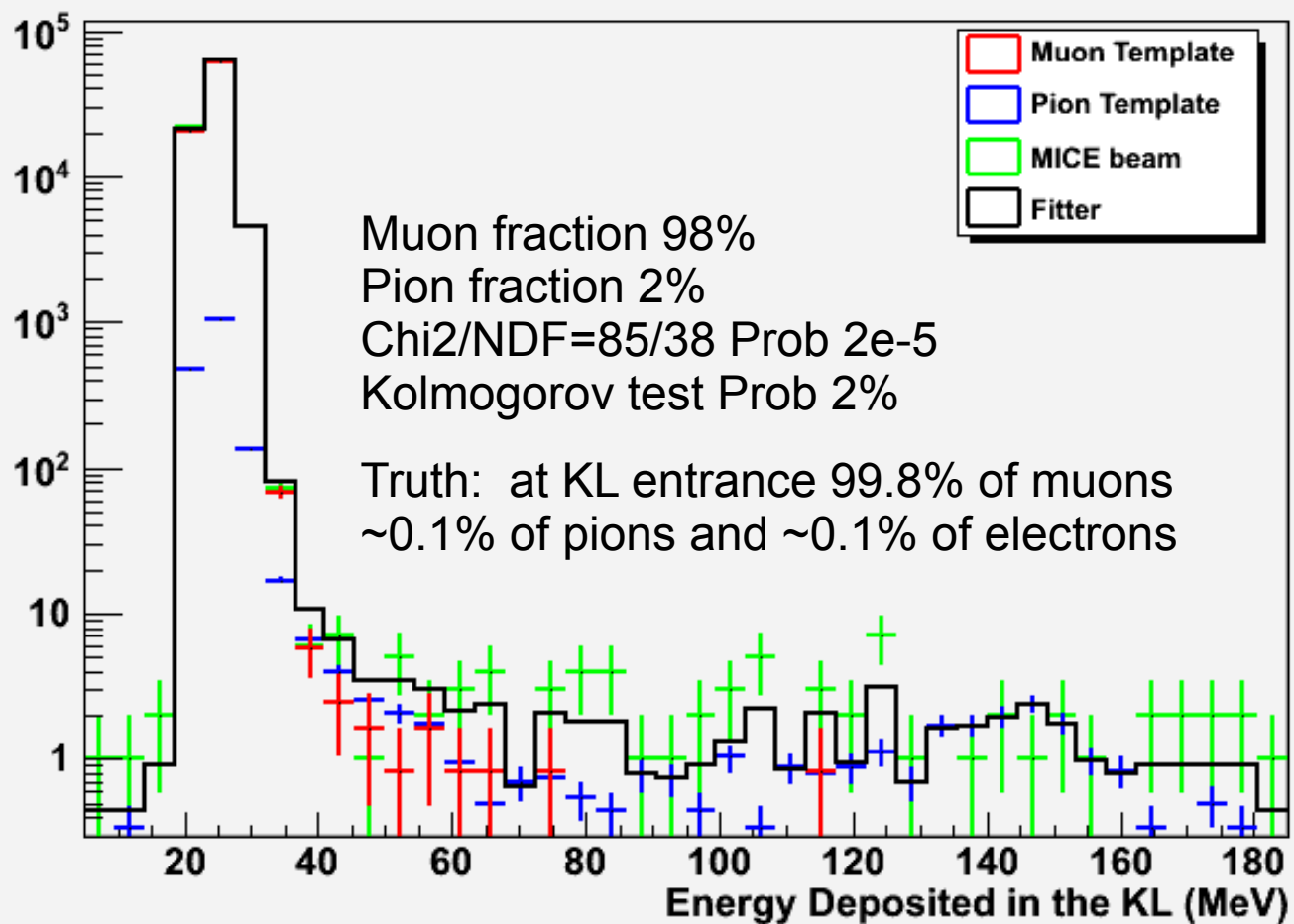# Summary

- Although the simulation in use does not include the digitisation it is already giving very important hints to the pion contamination analysis

- It has been checked that templates are not sensitive to the DS ON/OFF

- Very first "closure tests" of the template method on MC are ongoing.

  - It seems that the KL tail is heavily contaminated by electrons, but need to understand why they are not in muon template as well.

  - It could be due to different target cuts in the simulations.