Updates on pion contamination in step I

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Evolution since CM35

- CM35: https://indico.cern.ch/getFile.py/access?contribId=12&sessionId=4&resId=0&materialId=slides&confId=222409
- It was understood that the velocity measurements provided by TOF & Ckov were redundant and the Ckov was removed from the analysis
- It was agreed to present only one of the two KL based measurements, the one using the whole KL distribution
- However the measurements in data were not in particular good agreement with the simulation and this somehow stopped the paper preparation

Status:

summarized in MICE-NOTE-DET-416

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Measurement of the pion contamination in the MICE beam

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Note summary

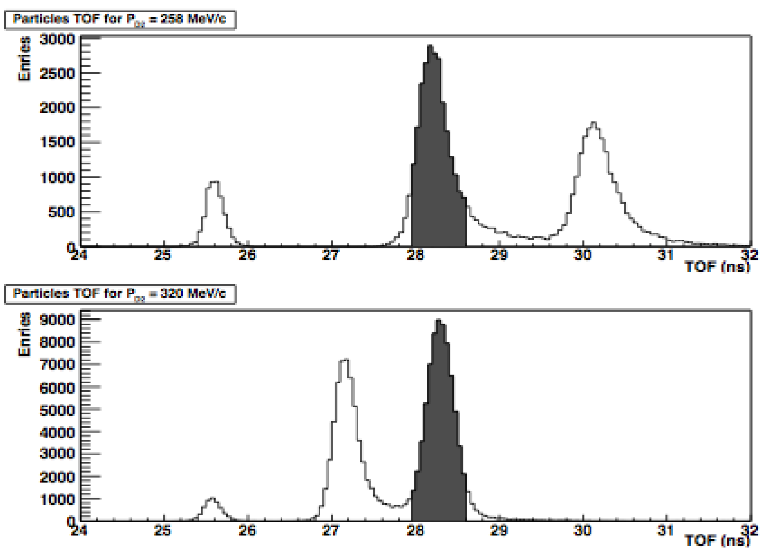
- Ole's simulation with G4beamline is used
  - to draw the expected TOF distributions for the different particles in MICE beam and the associated momentum spectrum
  - To evaluate the pion contamination for different momenta at different positions along the beamline

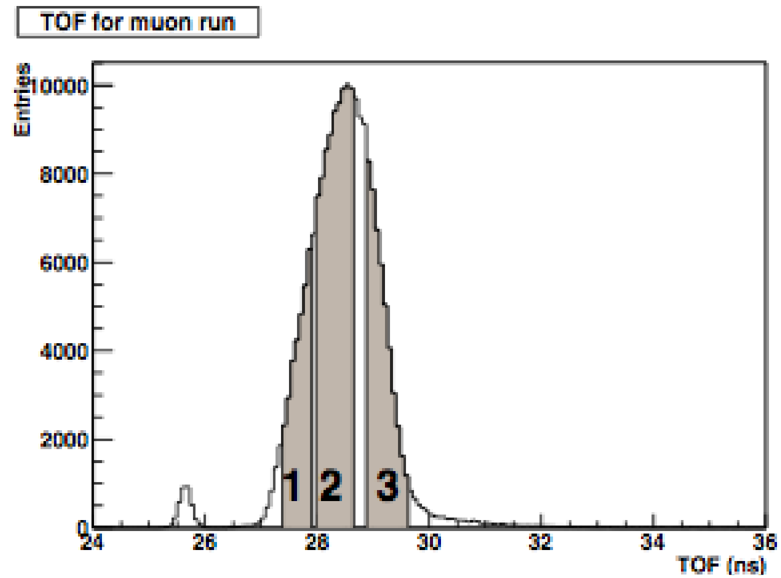
Table 3. Particle counts at the entrance of the MICE apparatus (TOF1) in a 6 mm · rad muon beam, at various momenta, as deduced from TOF0–TOF1 time-of-flight Monte Carlo simulations. Simulations for positive-beams at 200 and 240 MeV/c include respectively a 83 and a 147 mm proton absorber. A cut between 26.2 and 36 (33) ns on the time–of–flight between TOF0 and TOF1, for 140 (200,240) MeV/c momentum beams, is applied.

p_μ (MeV/c)	No. e	No. μ	No. π	π contamination (%)
140 (-ve)	14	16025	6	0.04 ± 0.02
200 (-ve)	10	13392	17	0.13 ± 0.03
240 (-ve)	15	20000	65	0.32 ± 0.04
140 (+ve)	4	16171	50	0.31 ± 0.04
200 (+ve)	59	97041	459	0.47 ± 0.02
240 (+ve)	15	14102	95	0.67 ± 0.07

Note summary II

- Pion runs are "paired" in order to select pions or muons with the same TOF
- Pion and muon KL distributions (templates) in TOF intervals are compared to MICE muon beam ones





	TOF interval, ns	muon runs with P_{D2} (MeV/c)	no. of events (10^3)	pion runs with P_{D2} (MeV/c)	no. of events (10^3)
Point 1	27.4 – 27.9	294	354	362	448
Point 2	28.0 – 28.6	258	235	320	265
Point 3	28.9 – 29.6	222	195	280	167

Note summary III

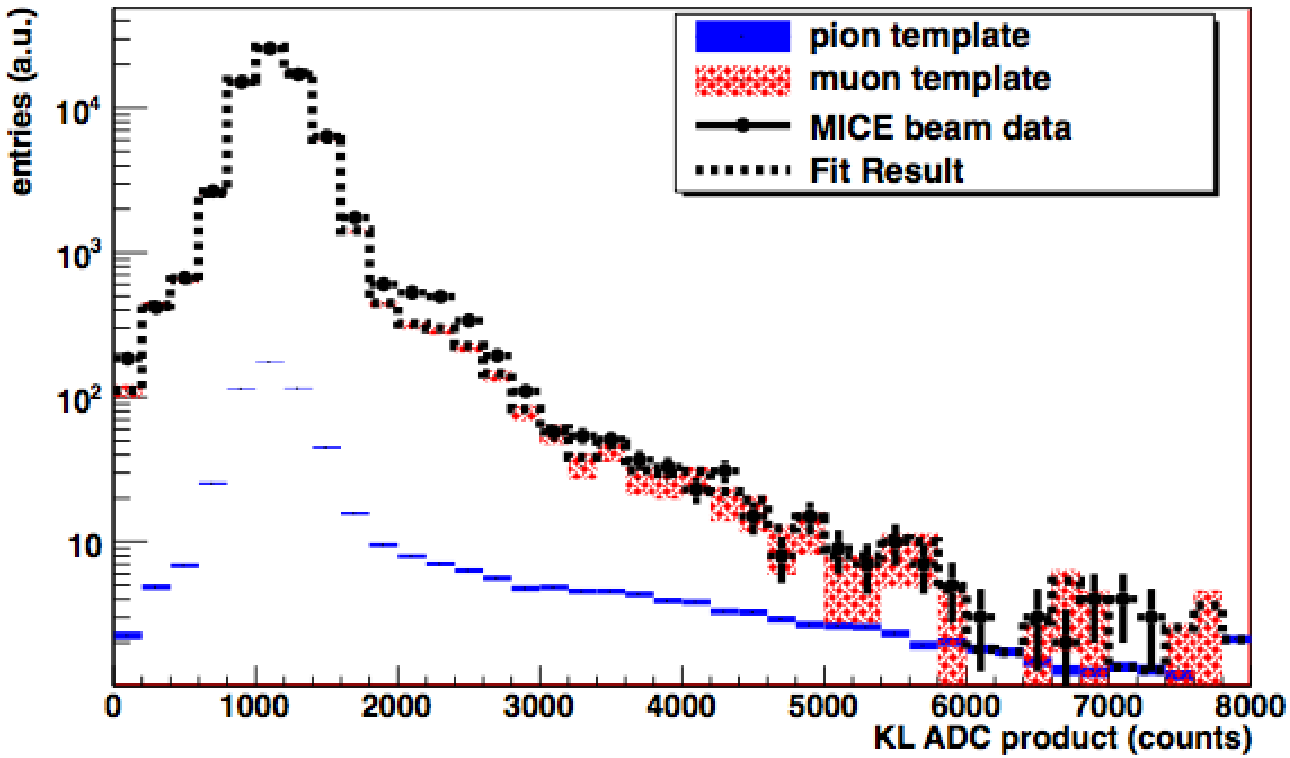
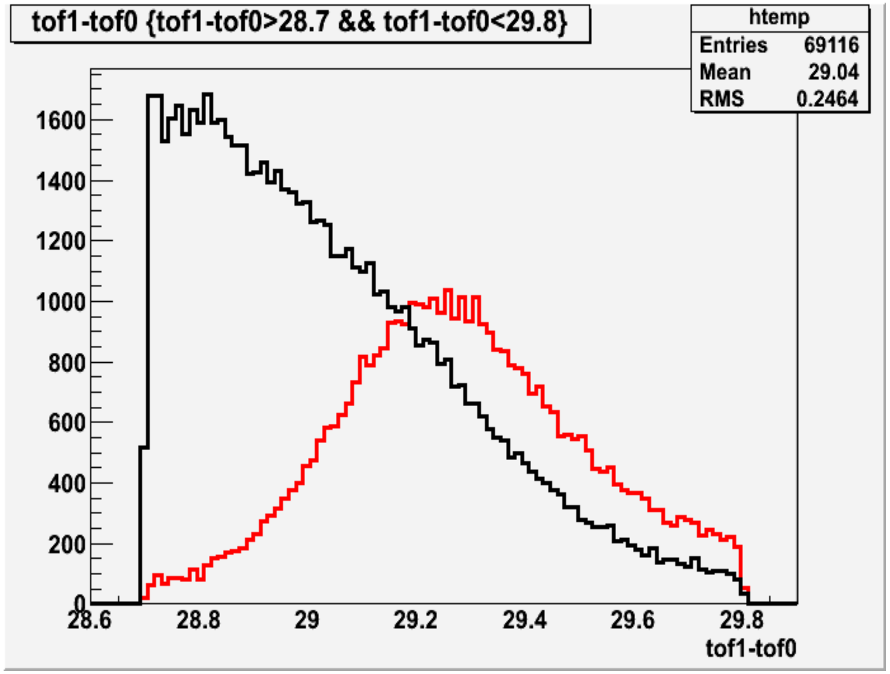
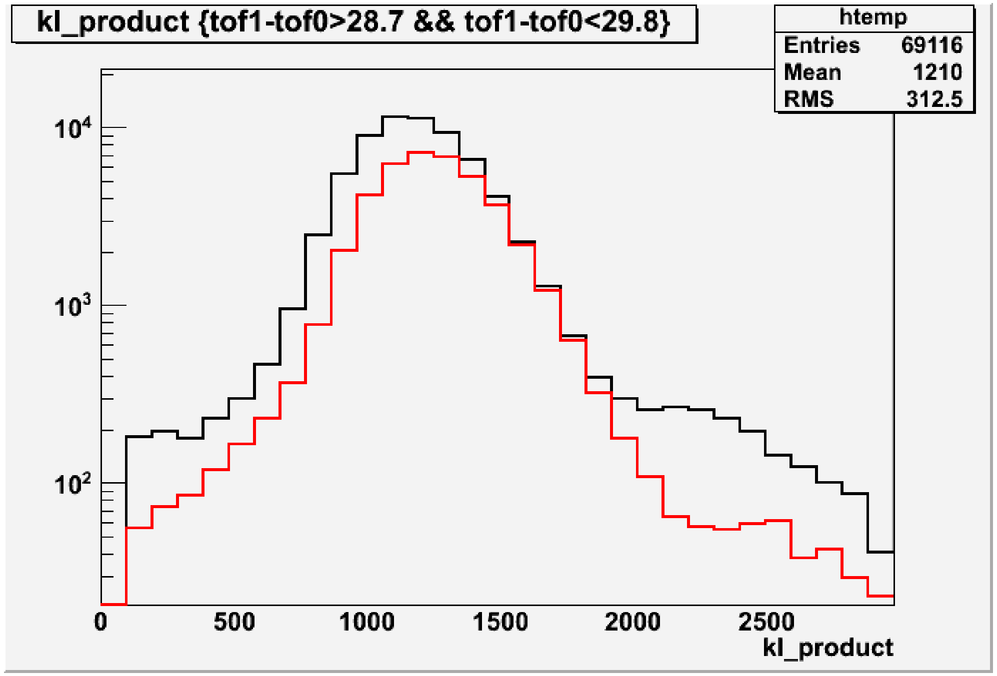


Figure 8. MICE beam data (black dots), muon (red dotted area) and pion (blue solid area) fractions, are normalised to the the template fit (black histogram) performed to the KL product spectrum excluding the window from 1900 to 2700 counts.

Note summary IV

- It was found that the TOF distribution in the third point was rather different between muon template and MICE muon beam and that KL m.i.p. peak was shifted





The muon template was shifted by -70 counts to improve the fit quality.
The pion contamination did not change.

Note summary V

Method	$\pi(\%)$ at Point 1	$\pi(\%)$ at Point 2	$\pi(\%)$ at Point 3 (%)	average π cont. (%)
analysis	$0.65 \pm 0.46 \pm 0.30$	$0.84 \pm 0.27 \pm 0.34$	$1.87 \pm 0.35 \pm 0.80$	$1.11 \pm 0.19 \pm 0.32$
cross-check	$0.46 \pm 0.52 \pm 0.57$	$0.44 \pm 0.31 \pm 0.57$	$1.69 \pm 0.53 \pm 1.04$	$0.81 \pm 0.24 \pm 0.44$
MC	0.78 ± 0.07	0.13 ± 0.02	0.28 ± 0.04	0.33 ± 0.03

TOF increases, momentum decreases

Open issues

- The data seem to show an increase of the pion contamination at lower momenta (higher TOF), but data suffer from serious stat limitations
- The muon template and the muon beam data show a double peak structure (excluded from the fit)
- Fit Chi2/NDOF are far from impressive: 80/38, 125/38, 51/38 at the three points
- ALL the muon templates are taken from runs with DS off... (3250 to 3256)

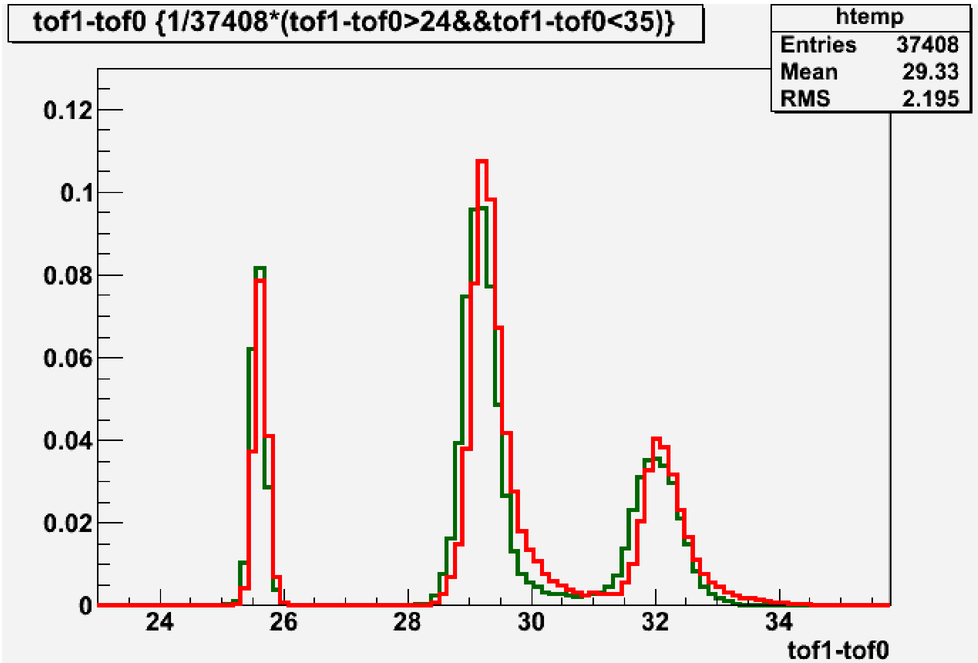
Check of the DS effect

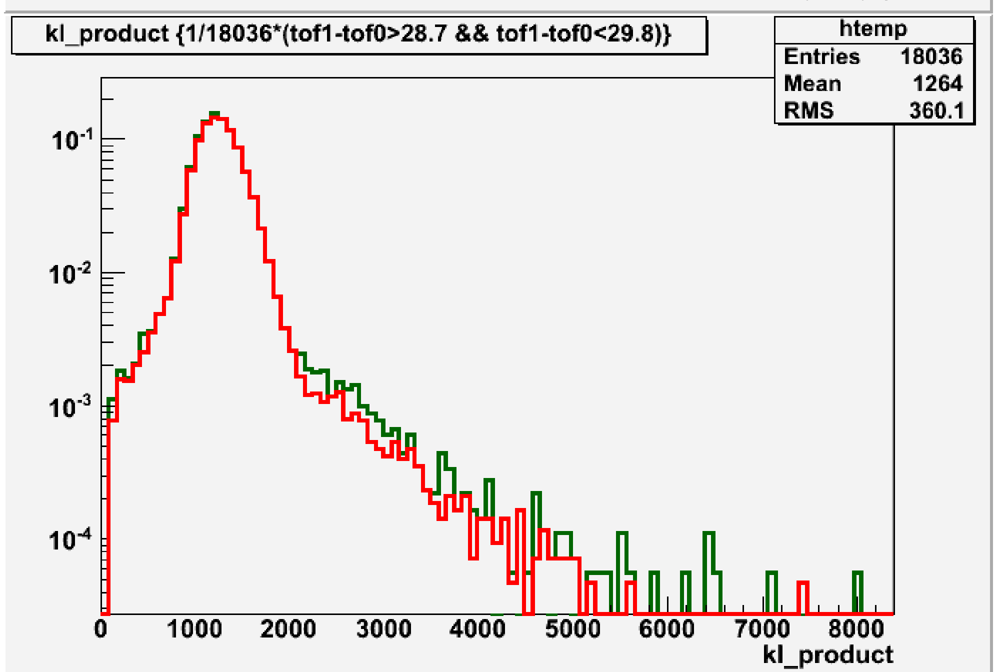
- Found two pion runs with same momentum, very similar beam settings, and DS on/off: 3379/3256

	A	O	P	Q	R	S	T	U	V	W	X	Y	Z	AA	AB	AC	AD	AE
1		*Beamline data*																
2	Run Numbers	Beamline Species	Proton absorber thickness (mm)	Momentum at Tgt (MeV/c)	Momentum at D1 (MeV/c)	Momentum at D2 (MeV/c)	Q1	Q2	Q3	D1	DS	D2	Q4	Q5	Q6	Q7	Q8	Q9
1923	3256	pions	29	229.12	224.99	222	48.41	88.48	54.13	169.11	0	84.45	147.28	197.51	130.87	126.61	191.46	163.35
1951	3379	pions	29	229.12	225	222	56.95	71.11	49.44	169.27	370.94	88.12	147.28	197.51	130.87	126.61	191.46	163.35

- Mariyan produced the missing ntuple for run 3379

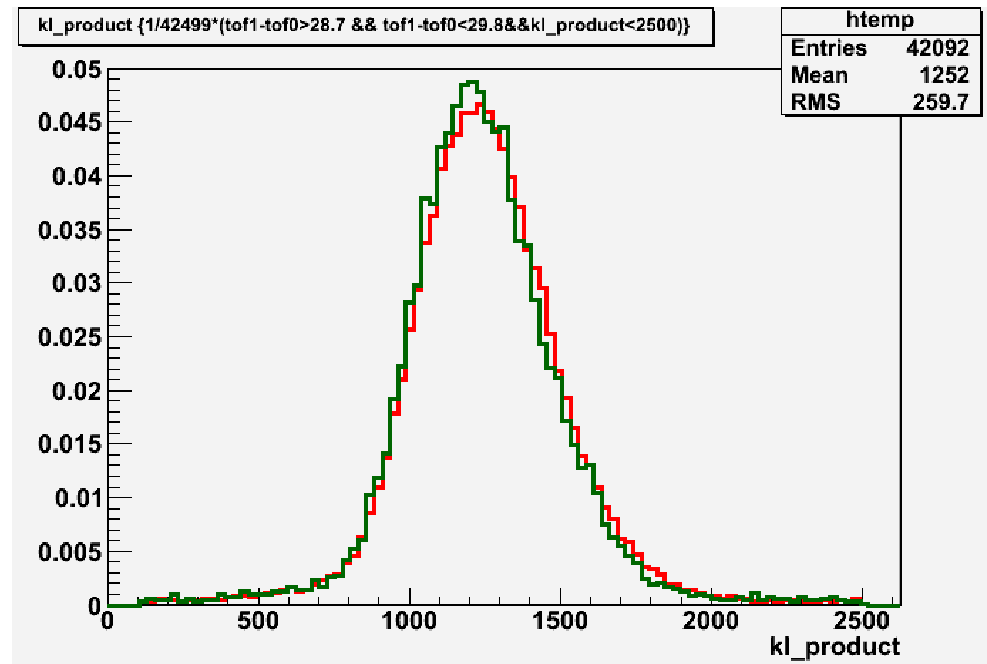
Check of the DS effect II





Run 3379 DS on

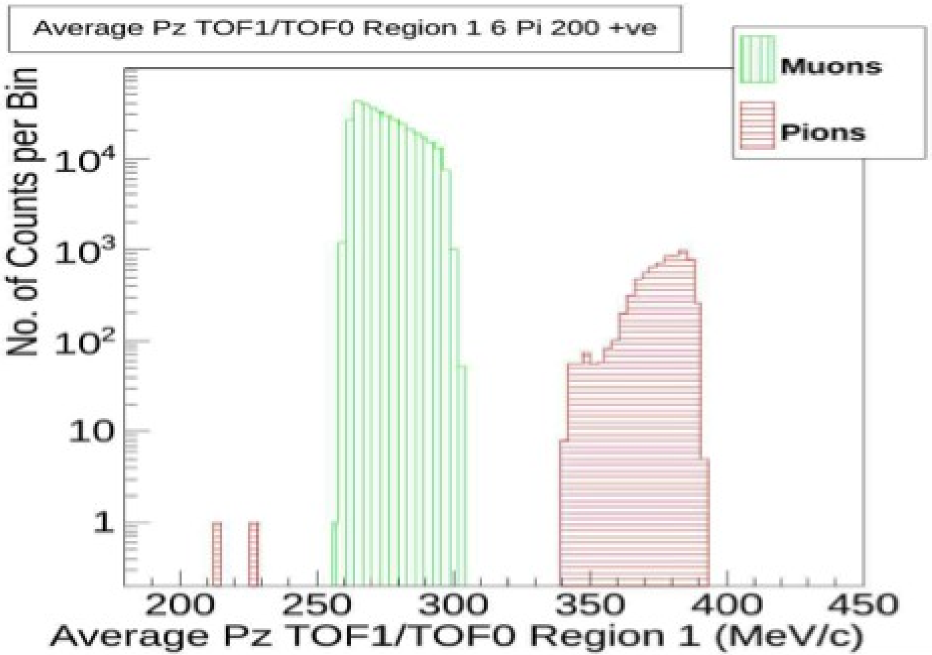
Run 3256 DS off

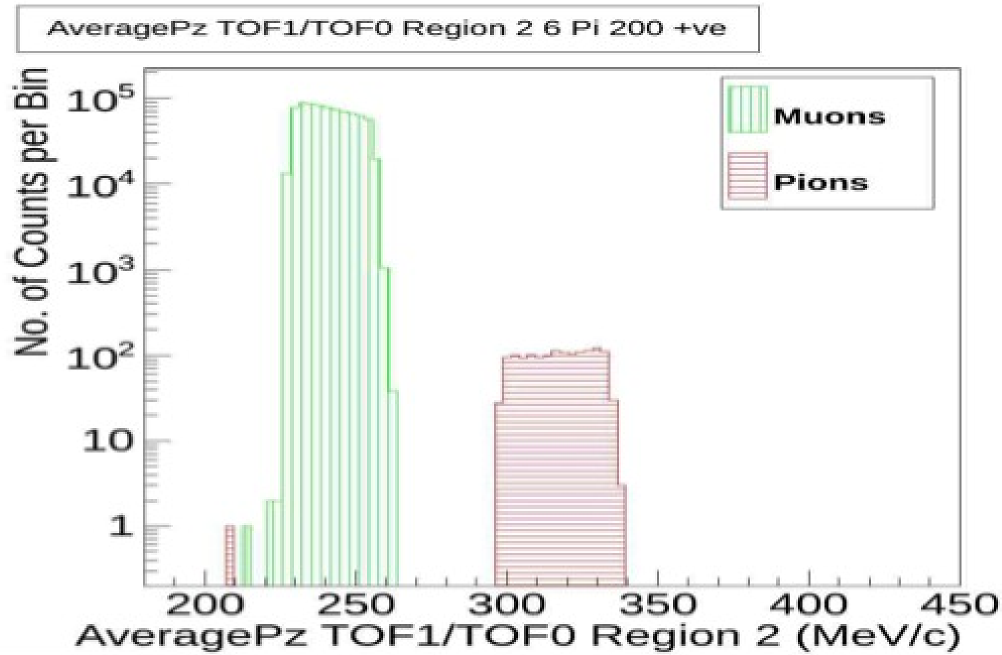


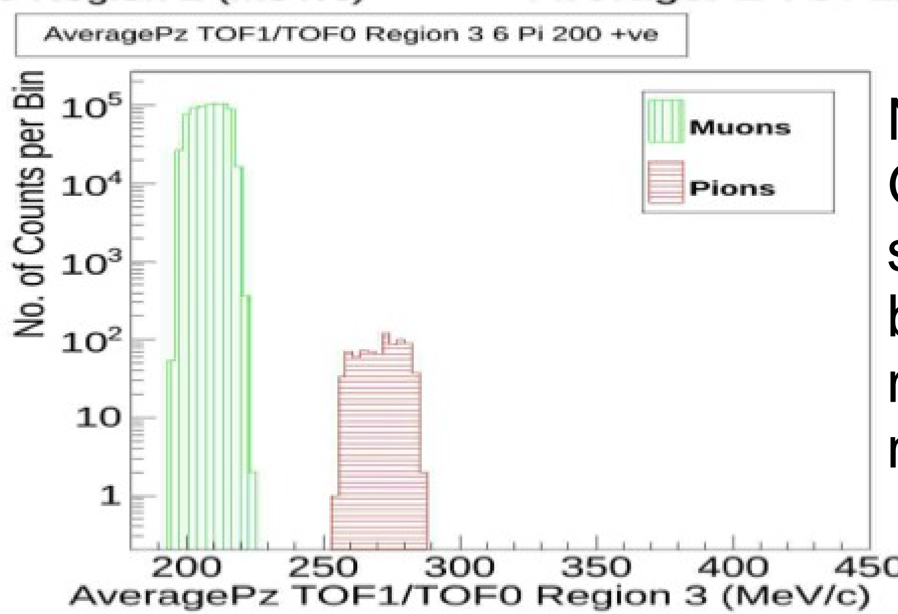
Using 3379 instead of 3256 in the fit and shifting the template just by another -40 counts gives a null pion contamination at Point 3 with Chi2/NDOF=103/38

Is this an "accident" or we really need to use DS ON runs?

Updates on simulation (from John)







New high statistics G4beamline simulations being run by **John Nugent** (see recent analysis meeting 17/10/2013)

G4Beamline Studies of MICE Stage I John Nugent

Updates on simulation II

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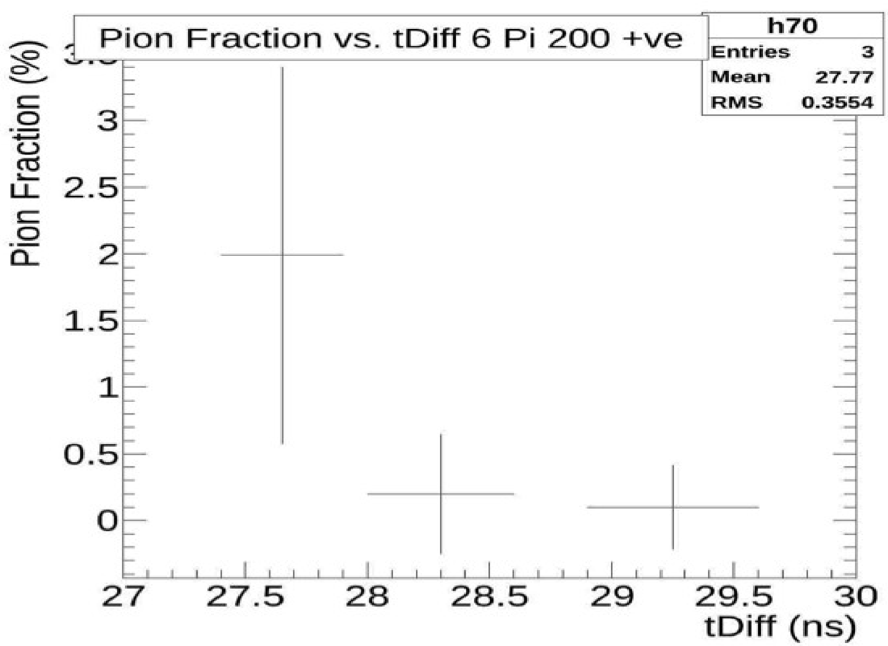
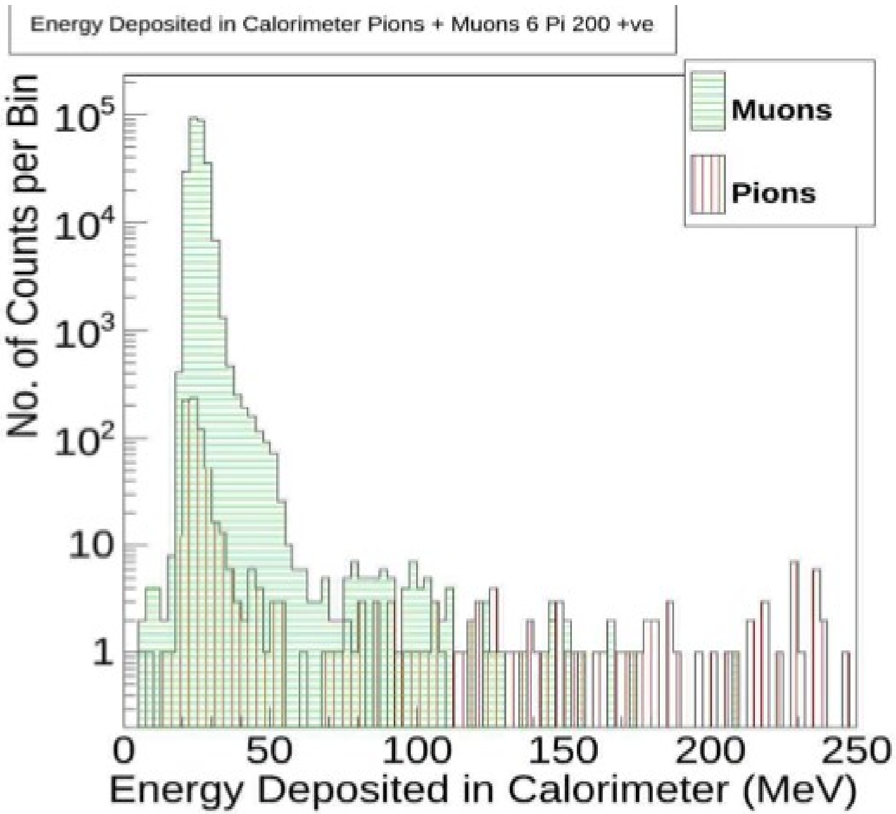
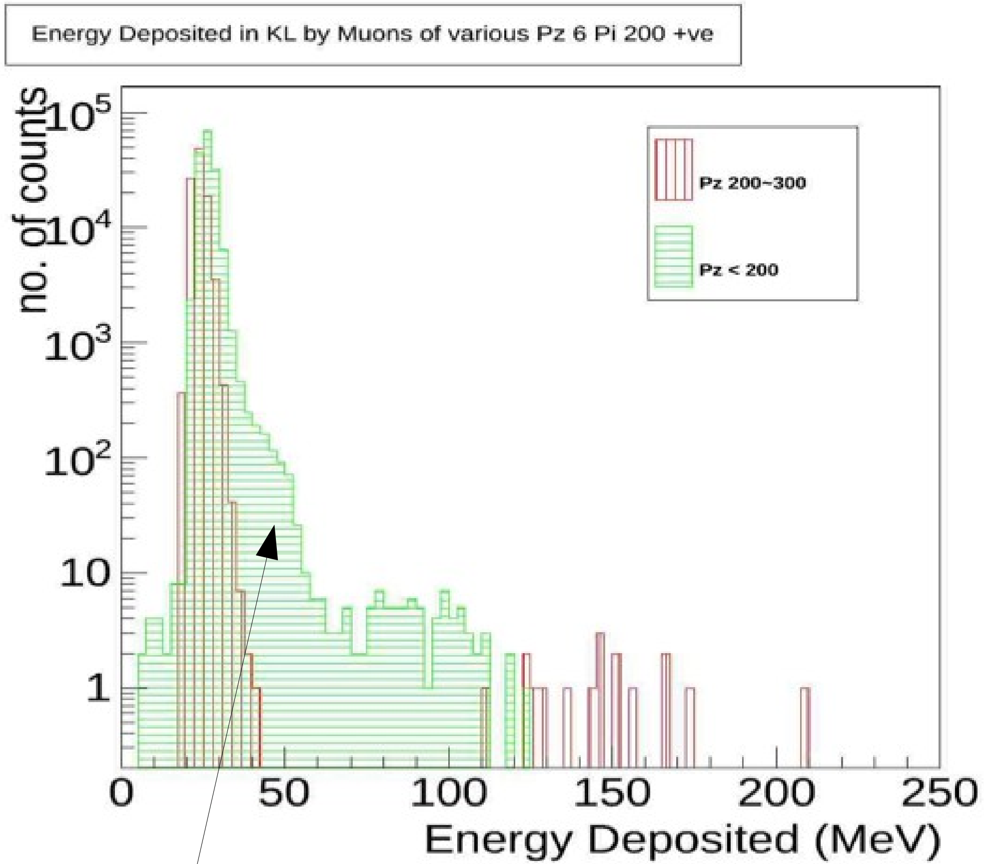
MC	0.78 ± 0.07	0.13 ± 0.02	0.28 ± 0.04	0.33 ± 0.03
G4beamline (JN)	2.00(0.02)	0.20(6x10-3)	0.10(4x10-3)	0.37(0.02)



(ignore the error bars)

Updates on simulation III





A possible hint on the origin of the second peak?

Next steps in collaboration with John

- Check on simulation the effect of the DS on muon templates. Are we entitled to use DS off runs for muon templates?
- Check on simulation the origin of the “second peak” in the muon KL distribution
- Investigate the lack of tails in KL distribution: only a resolution effect or stopping particles not taken into account in this study?
- Move asap to full detector response and reconstruction