Istituto Nazionale di Fisica Nucleare
SEZIONE DI TORINO

TOP Summary

Umberto Tamponi
tamponi@to.infn.it

INFN - Sezione di Torino

TOP operations

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The TOP operations were quite smooth

→ 1-3 experts permanently on-call at KEK

→ 2-3 power-cycles per week (∼ 1.5 hrs each)

→ Stable for trigger rates up to ∼5kHz

→ On the long run, up to 5 boardstacks have to masked (8% of the detector)
  → **None** of them is permanently bad

→ Included in every single luminosity run and background scan taken so far

TOP as a background monitor

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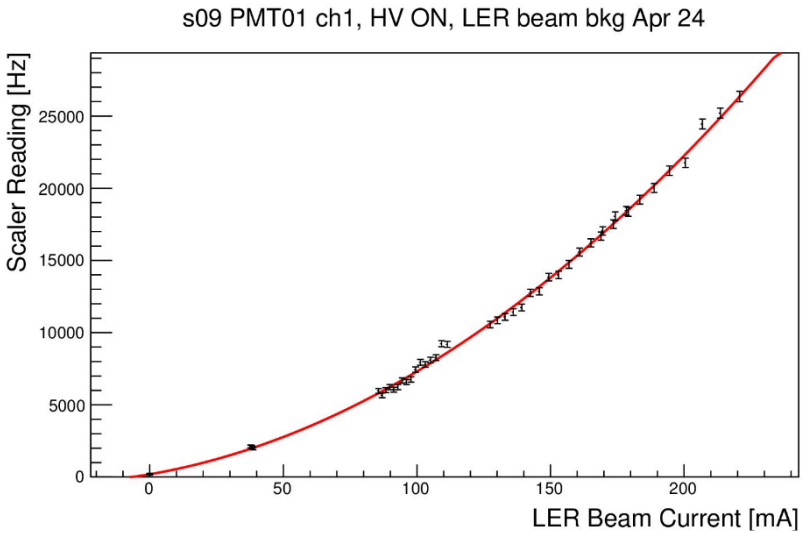
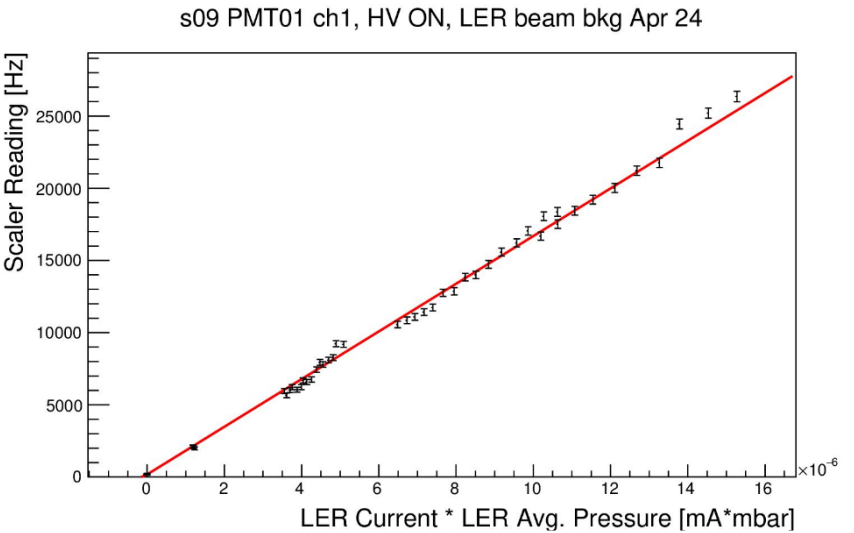
- Analysis on trigger scaler data: rate of hits above ASIC channel threshold
  - via SLC registers: slow, but channel-by-channel granularity
  - Via broadcasted EPICs PV: slot-by-slot granularity, updated ~every second
- Fitting channel-by-channel data
  - Vs. Beam Current (2nd order polynomial)
  - Vs. Beam Current * Avg. Pressure (1st order polynomial)





TOP as a background monitor

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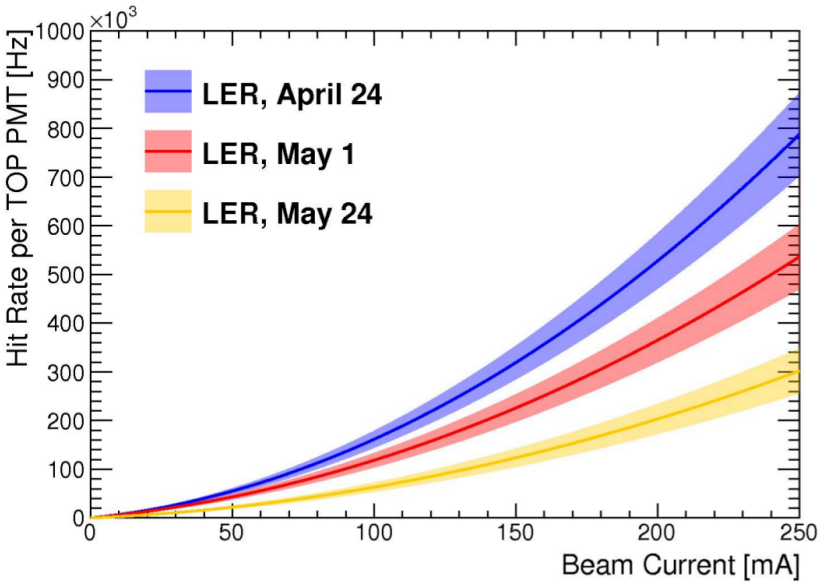
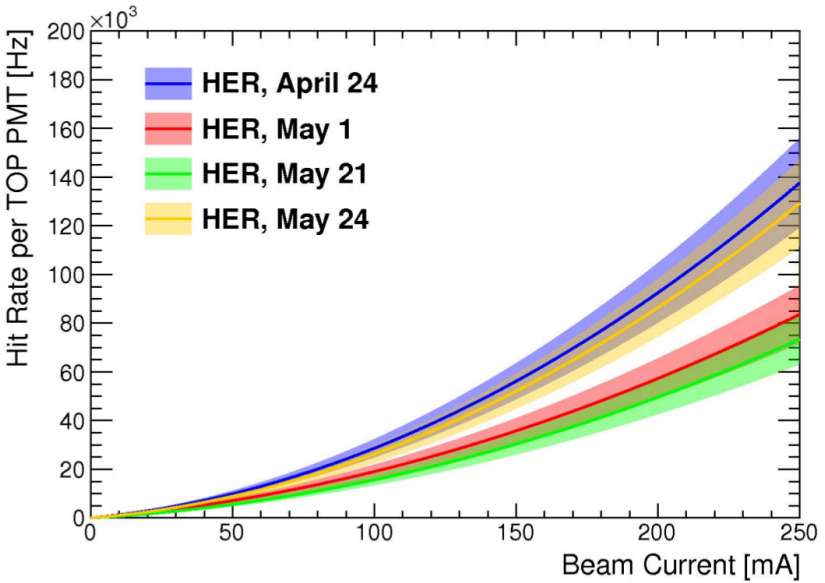
- From separate LER/HER current scans
- Showing average of all fits (>90% of channels give good fits)

O. Hartbrich





Matching our data with the accelerator conditions is an issue: lots of manual work involved

Few ideas about including the TOP in the Beast monitoring page

TOP tiggers

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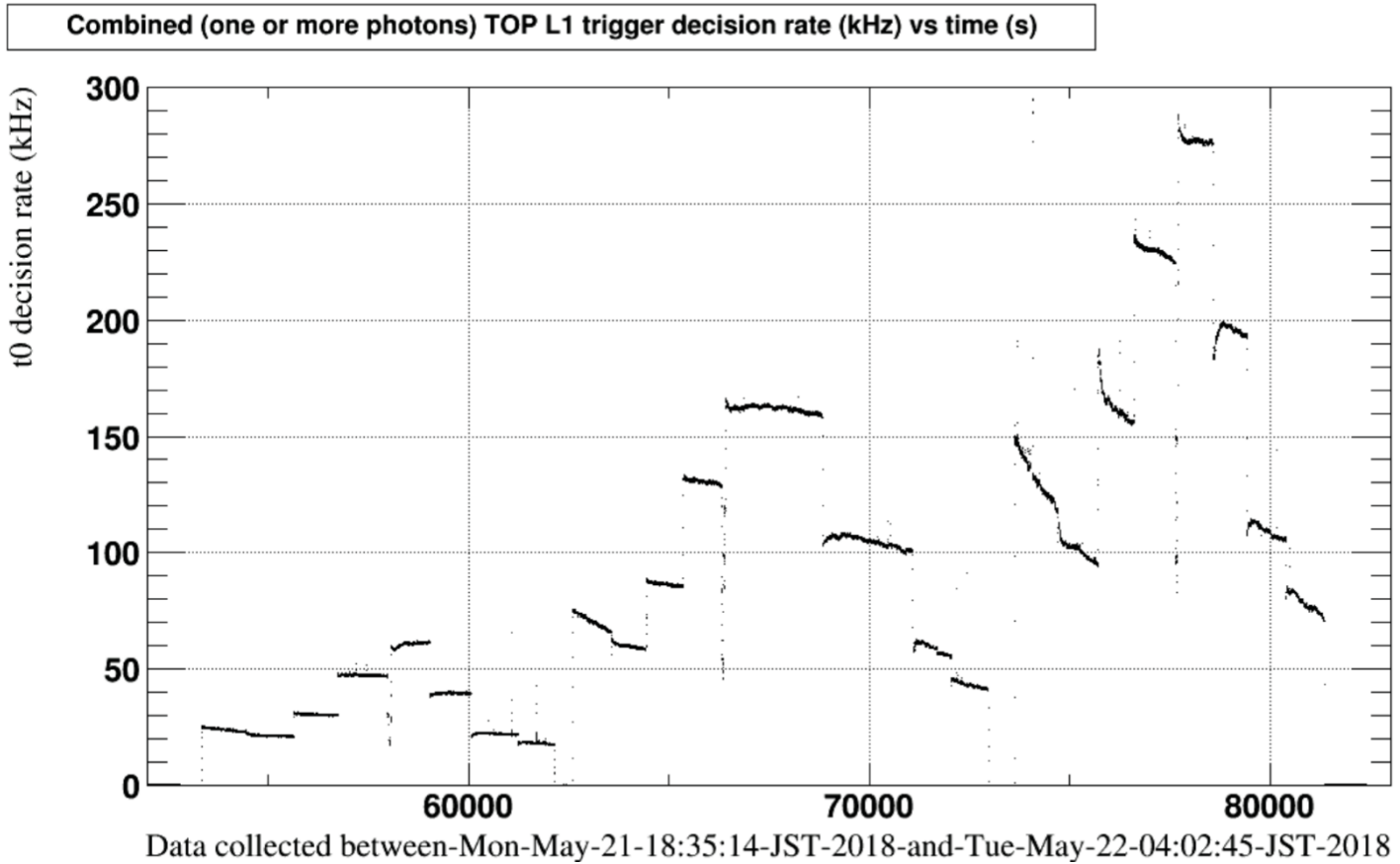
The TOP is successfully, constantly generating trigger primitives



TOP Data

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If everything is so smooth, why so many bad runs?

00677	2018-05-04 21:05:50	2018-05-04 21:35:01	1746	ALL	30.25	55299	54999	TOP (no calibration)
00684	2018-05-04 22:41:59	2018-05-04 22:46:16	253	ALL		6823	6531	TOP (no calibration)
00685	2018-05-04 22:47:57	2018-05-04 22:50:37	157	ALL	35.25	5169	4664	TOP (no calibration)
00686	2018-05-04 23:19:03	2018-05-05 00:05:45	2799	ALL	36.00	102897	102290	TOP (no calibration)
00781	2018-05-06 17:07:12	2018-05-06 17:15:58	519	ALL	26.00	15656	15583	
00782	2018-05-06 17:20:09	2018-05-06 17:46:51	1599	ALL	25.00	45199	44868	
00783	2018-05-06 18:50:02	2018-05-06 19:51:42	3691	ALL-PXD	28.00	114092	113290	
00784	2018-05-06 20:29:45	2018-05-06 20:31:59	125	ALL-PXD		3976	3869	
00785	2018-05-06 20:33:33	2018-05-06 21:23:11	3599	ALL-PXD	22.80	99421	94917	TOP (no calibration)
00786	2018-05-06 21:53:39	2018-05-06 22:32:55	2348	ALL-PXD	29.00	77655	75571	
00969	2018-05-08 22:16:12	2018-05-08 22:31:40	919	ALL	47.00	46180	45833	SVD
00970	2018-05-08 22:33:15	2018-05-08 22:53:54	1230	ALL	43.50	53673	53485	SVD
00971	2018-05-08 23:35:24	2018-05-08 23:44:36	542	ALL	56.75	32182	31882	SVD
00972	2018-05-08 23:49:00	2018-05-09 00:04:15	906	ALL	41.75	45777	45422	
01158	2018-05-10 22:34:15	2018-05-10 22:51:12	1010	ALL	37.50	44212	43615	
01159	2018-05-10 22:55:00	2018-05-10 23:25:22	1815	ALL	34.50	63314	62861	TOP (no calibration)
01160	2018-05-11 00:06:18	2018-05-11 00:07:53	84	ALL		540	4	TOP (no calibration)
01162	2018-05-11 00:13:25	2018-05-11 01:01:59	2905	ALL	40.50	147480	147058	
01315	2018-05-12 18:04:00	2018-05-12 18:22:03	1070	ALL-ARICH	25.00	31291	30863	bad for TOP until prod3
01327	2018-05-12 18:38:11	2018-05-12 18:43:43	322	ALL-ARICH	40.60	14925	14748	bad for TOP until prod3
01330	2018-05-12 18:50:46	2018-05-12 18:52:05	68	ALL-ARICH	39.25	4402	4418	bad for TOP until prod3

TOP calibration needs

The first look at the PID in the collision data showed non-sense performances

https://www.phys.hawaii.edu/elog/iTOP+Cosmic+Ray+Telescope/3308

This is due to two major residual miscalibrations that are affecting our data:

→ **Carrier-by-carrier offset**

At each power-cycle few carrier pick up a +1 writewindow shift (~ 48 ns)

https://www.phys.hawaii.edu/elog/iTOP+Cosmic+Ray+Telescope/3295

https://www.phys.hawaii.edu/elog/iTOP+Cosmic+Ray+Telescope/3311

→ **Common T0 offset**

The TOP as a whole is shifted by 0.5 ns with respect to the RF clock

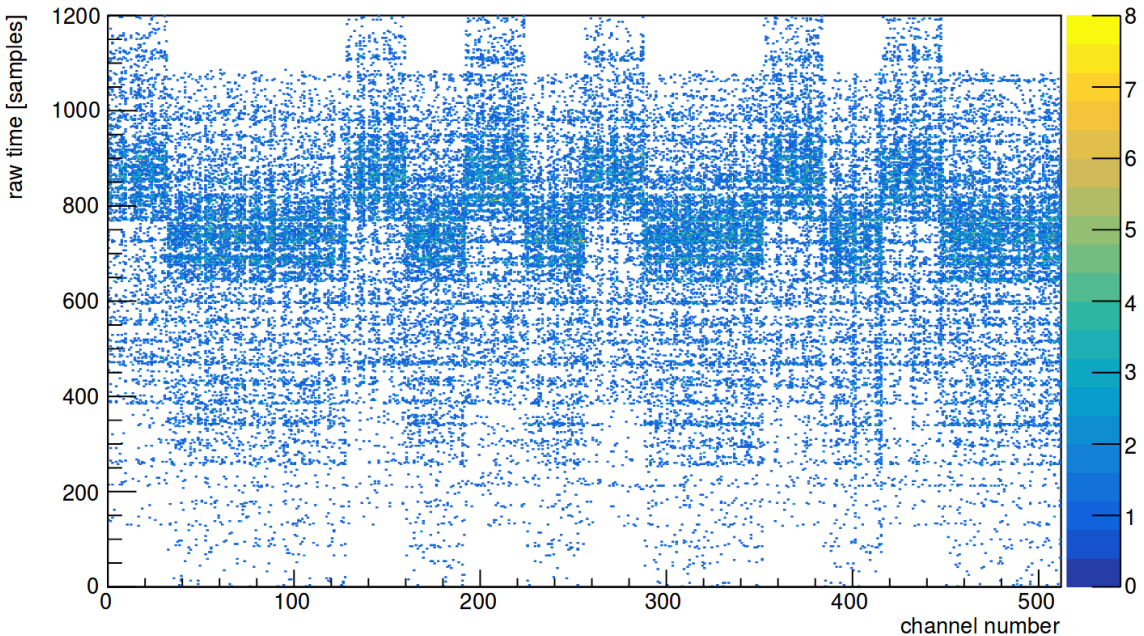
https://www.phys.hawaii.edu/elog/iTOP+Cosmic+Ray+Telescope/3318

Marko Staric showed that both the effects can be corrected using the data

https://www.phys.hawaii.edu/elog/iTOP+Cosmic+Ray+Telescope/3319

Carrier offset correction

We can process the cdst files of the collision data, flag the shifted carrier and modify the LocalT0 calibration accordingly



A new calibration must be provided <u>after every powercycle</u>

CommonT0 correction

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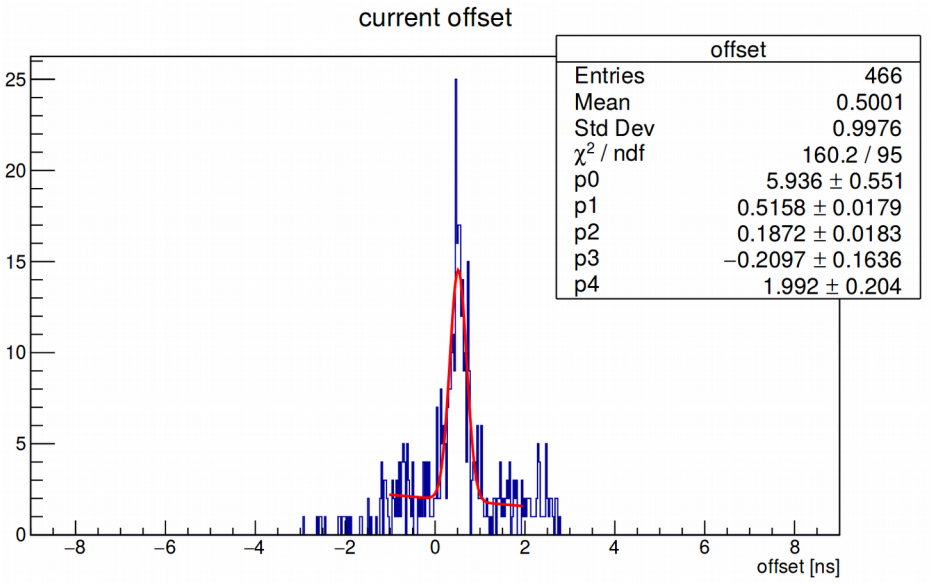
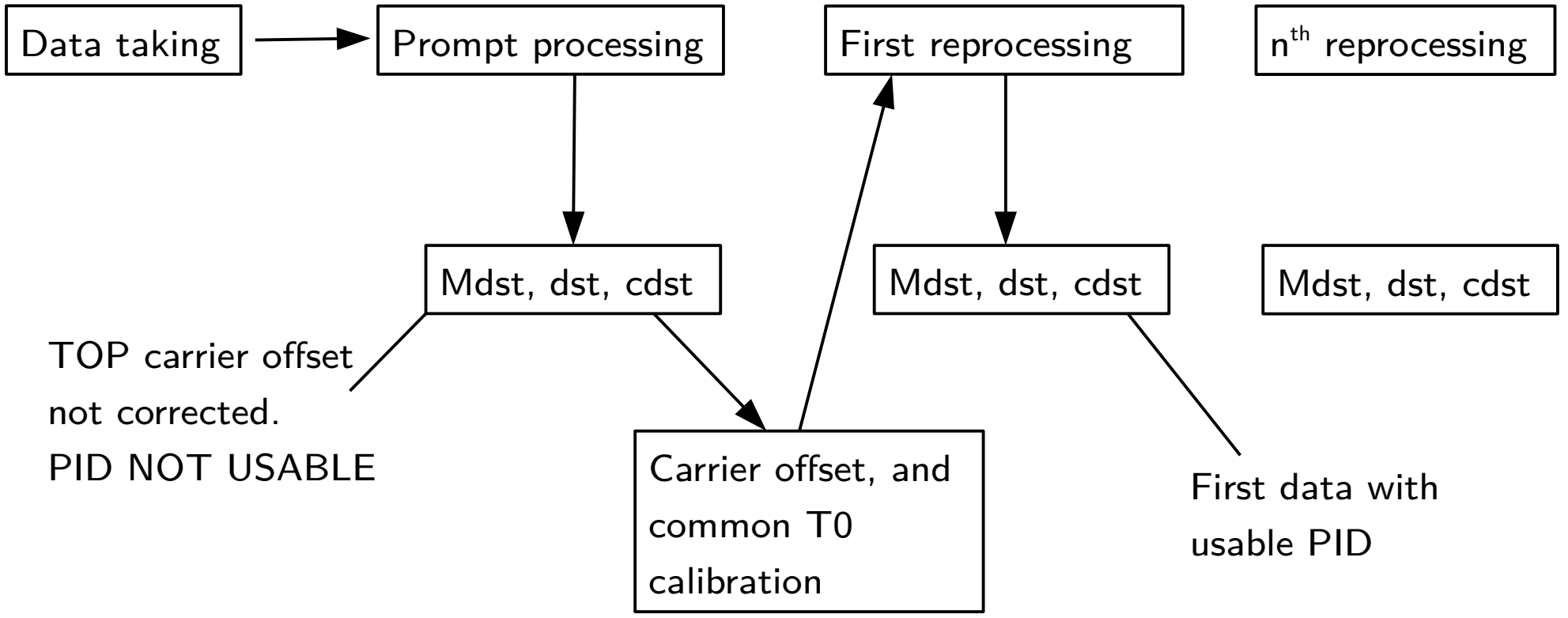
Determine the shift from the bunchFinder offset using two-tracks events
(bunch finder estimation of the interaction time – time closest bunch crossing)

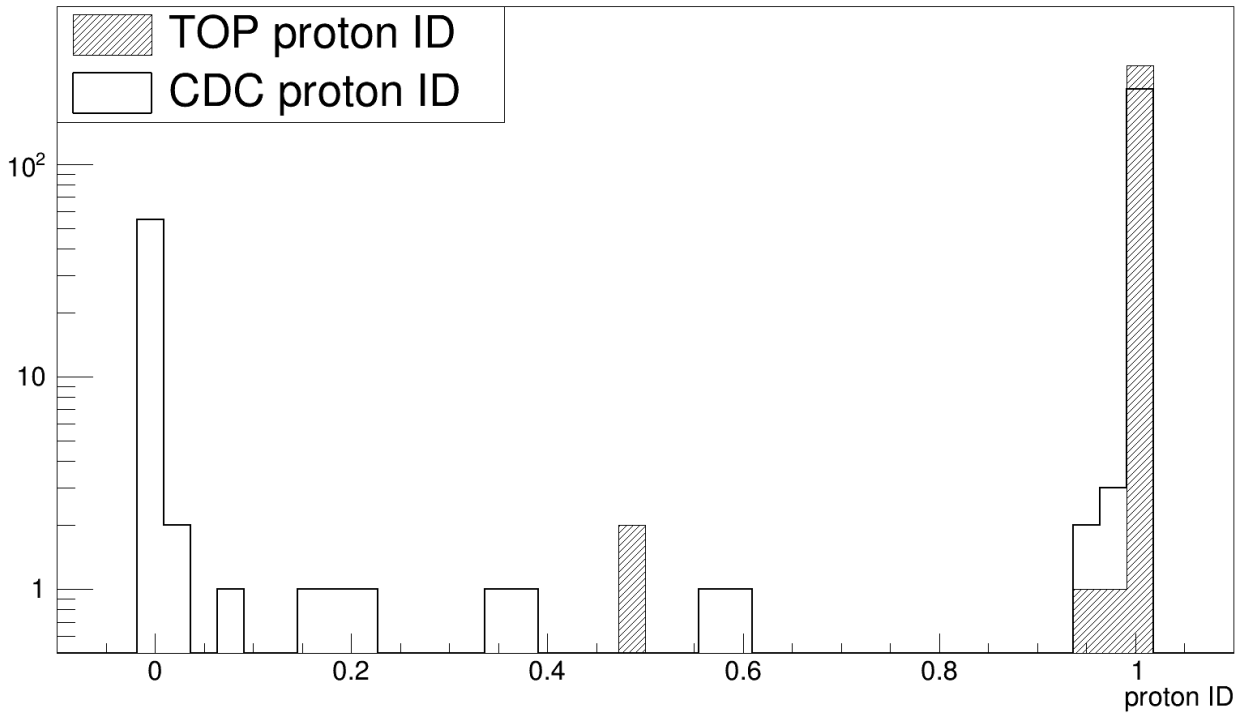


Works surprisingly well even without correcting for the carrier shifts!

TOP calibration workflow



What does "broken PID" means?

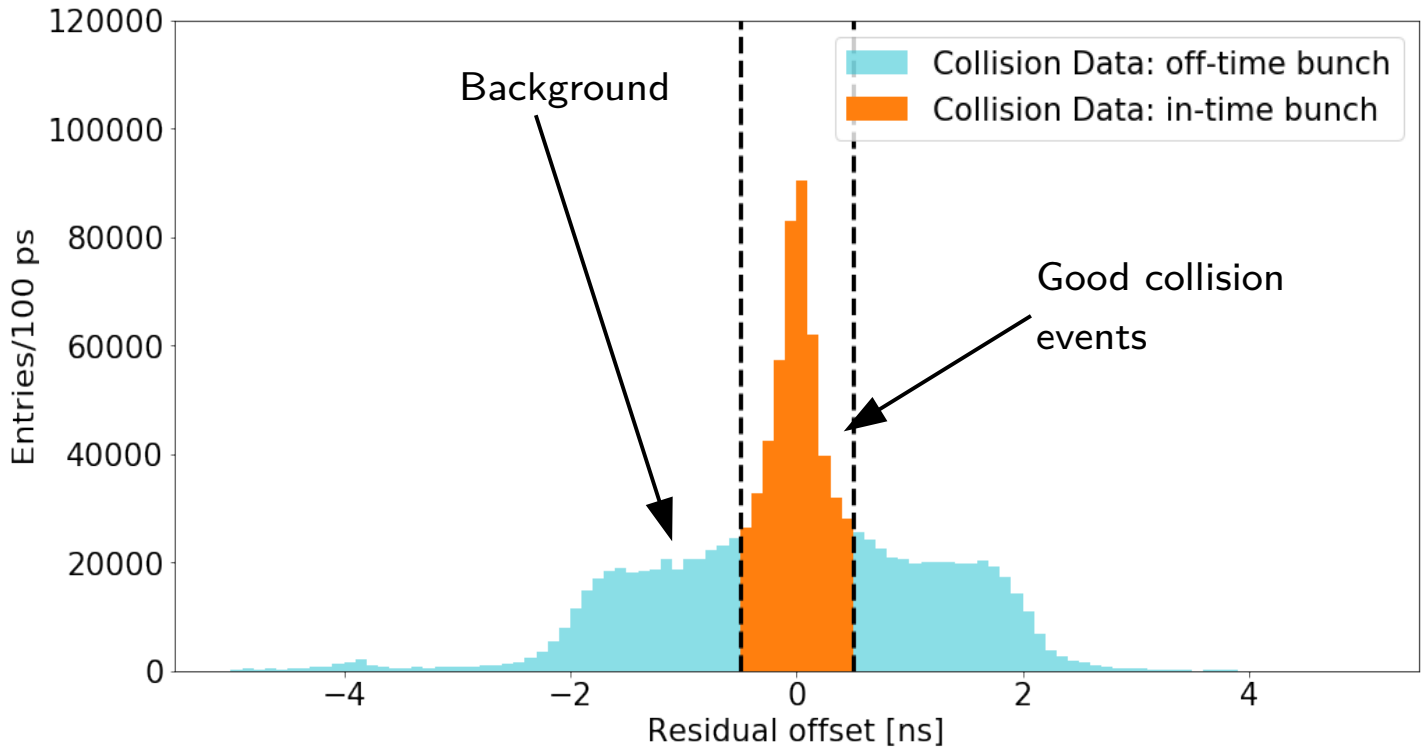


The TOP assigns a very high proton ID to almost any track in the un-corrected data

TOP Bunch finder performances

The new calibrations have been uploaded to the Global Tag for the second reprocessing, that took place over the week-end.

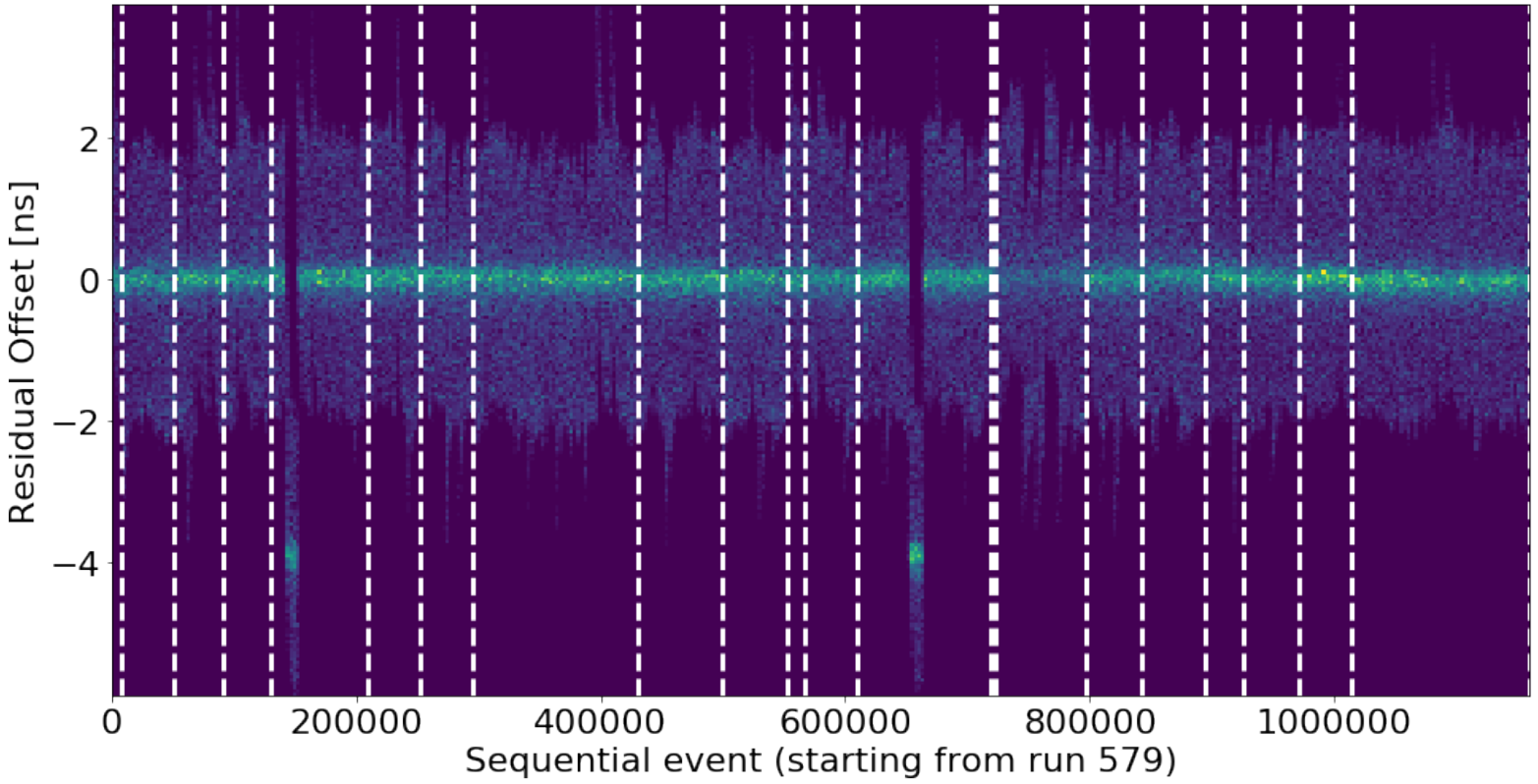
The bunch offset is now correctly centered at zero (most of the time)



We can use the residual offset time to distinguish between collision and beam gas (or other bkg) events

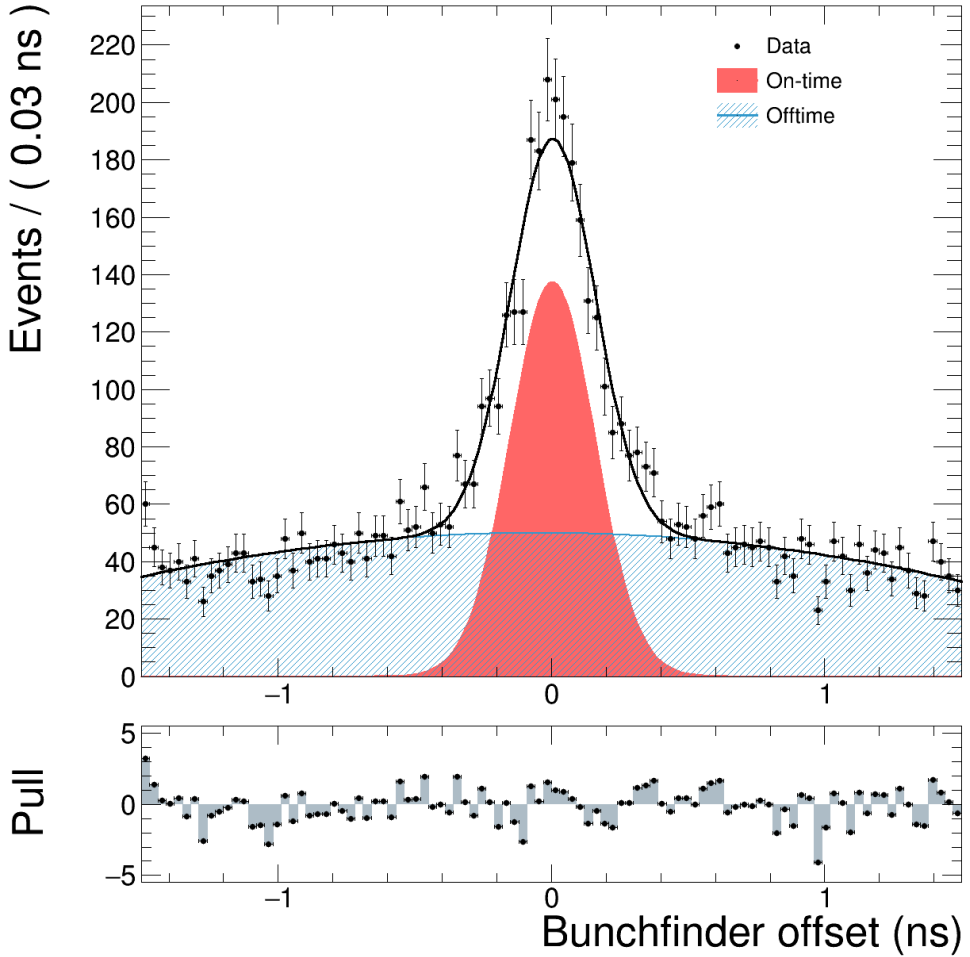
TOP Bunch finder performances

The calibrated offset is quite stable in time (white lines separate different runs)



For two runs the commonT0 changed phase suddenly for a while.

CommonT0: quantitative estimations



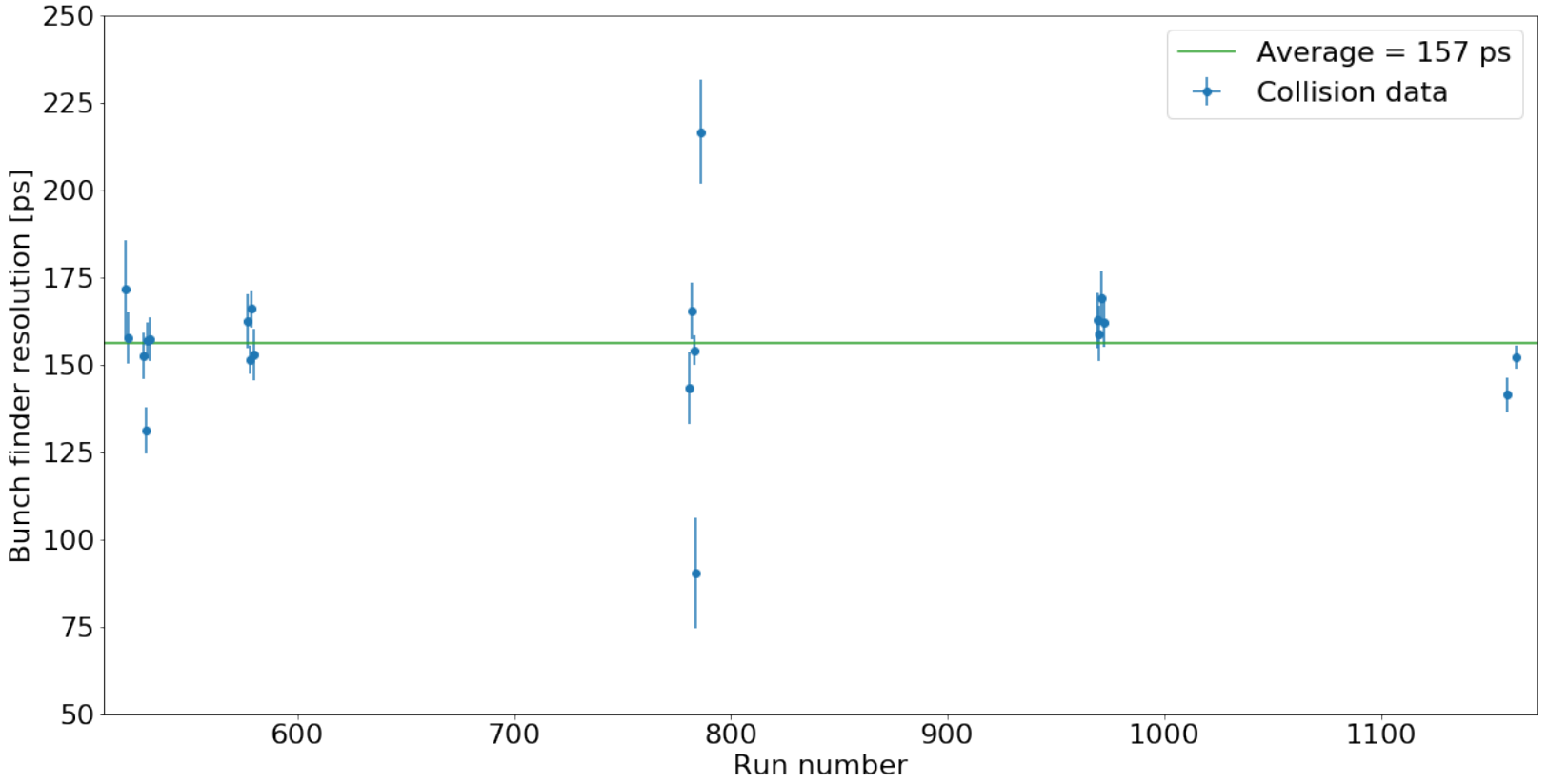
I have analyzed the bunch finder offset <u>after</u> all the new calibrations have been applied

Mean: should be 0. Sensitive to the systematic shifts in the CommonT0

Error on the mean: statistical error on the CommonT0

Width: resolution on the bunche-finder at the event level

Bunch finder resolution



This is the resolution on the single event. The actual resolution on the calibration itself is much smaller (resolution on an average...)

Calibration validation in data: big picture

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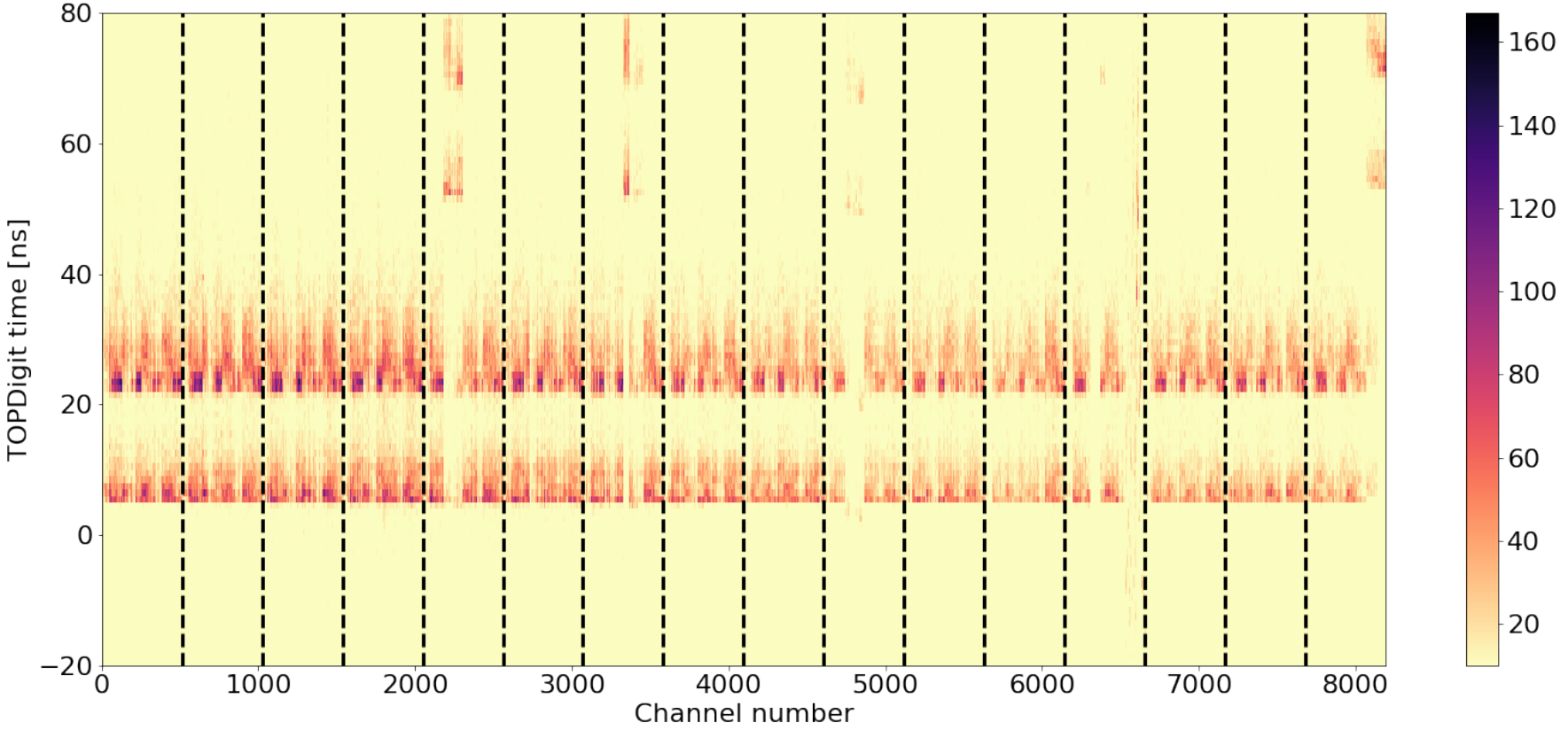
6 BS seem to be 48 ns off-sync or generically bad:

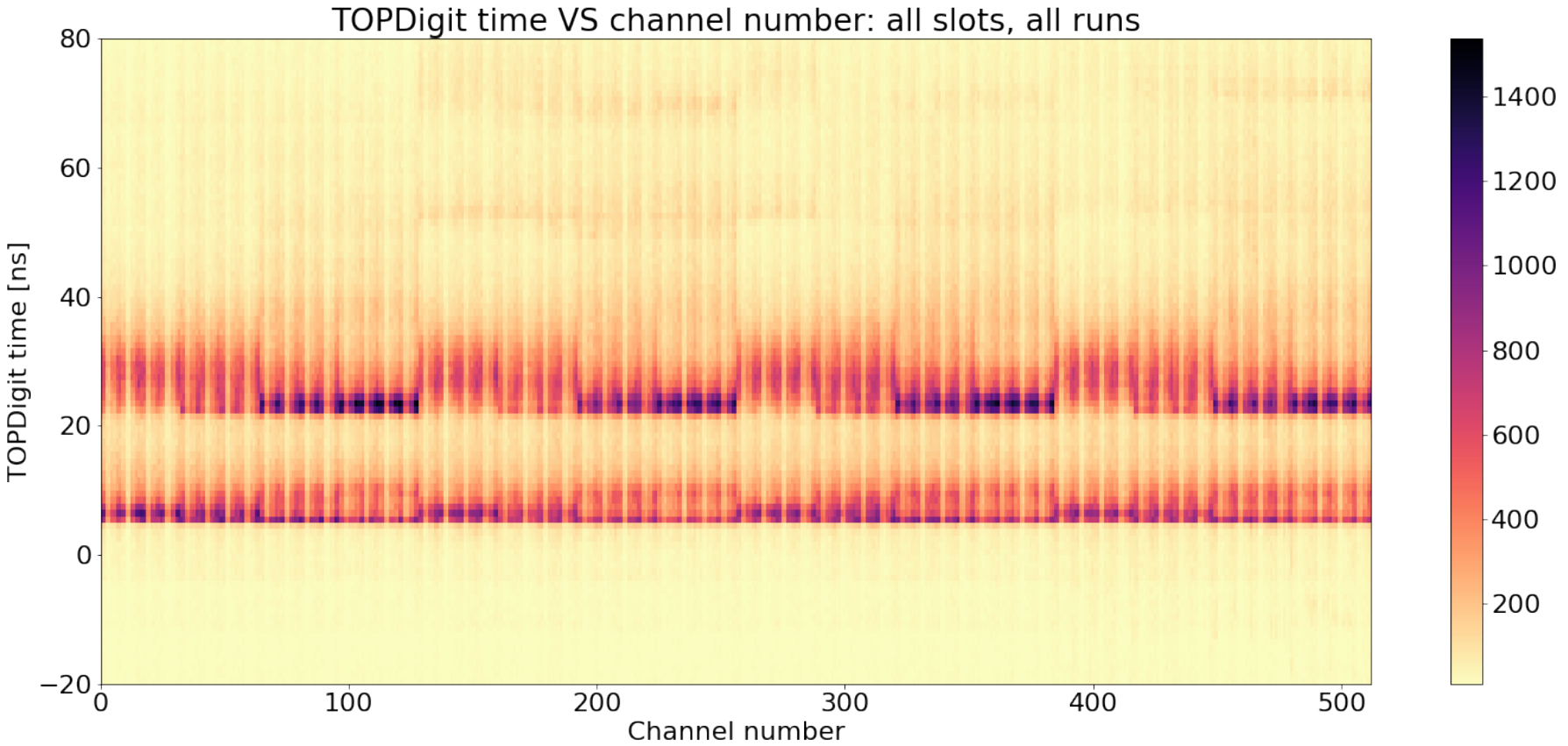
s05b, s07c, s10b, s13b, s13d, s16d



Calibration validation: localT0

Integrating over all the slots

→ **The localT0 from the laser is ok!**



The very first look at the TOP PID

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Runs:

521, 522, 529, 530, 531, 532, 577, 578, 579, 580, 781, 782, 783, 784, 786, 969, 970, 971, 972, 1158, 1162

Luminosity: $\sim 4\ pb^{-1}$

I have analyzed the TOP only PID performances selecting

$K_s \rightarrow \pi\pi$

$D^0 \rightarrow K\pi$

from the collision data sample

Basic idea: use the resonance to tag a particle type, and see the TOP response.

Event-level selection criteria

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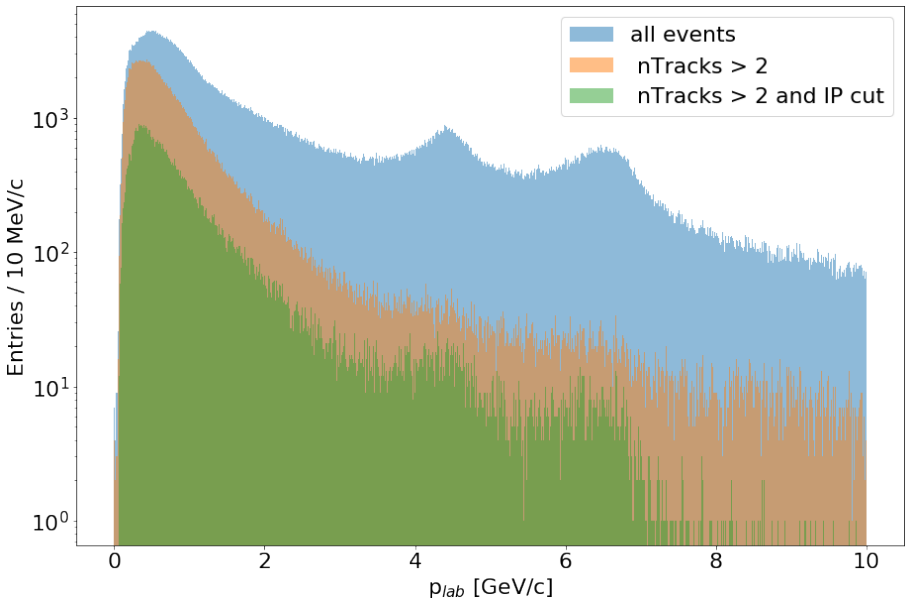
Very basic selection to pick up the hadronic (like) events:

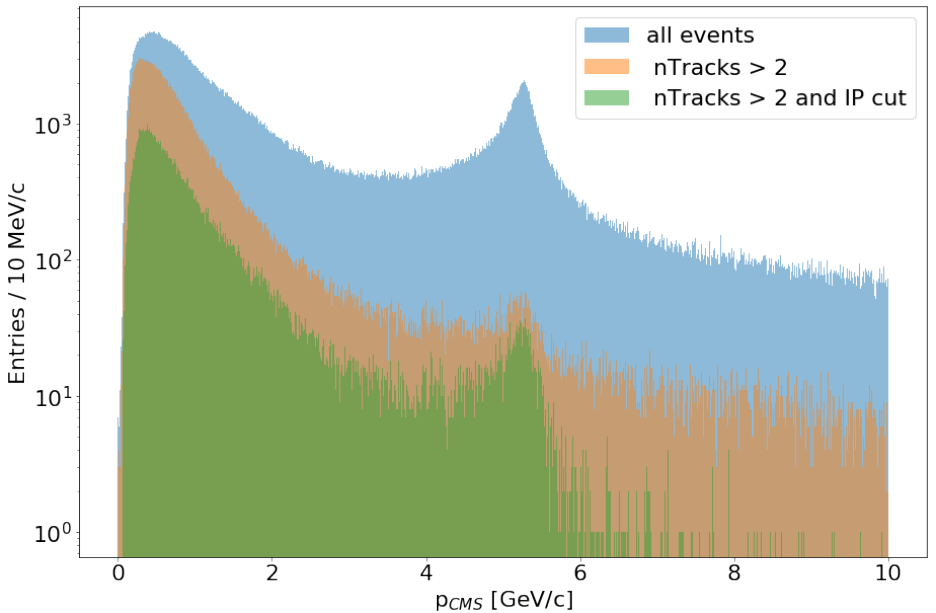
nTracks > 2

In the selection of the D^0 I require also

$|\Delta z - 1| < 2$ cm

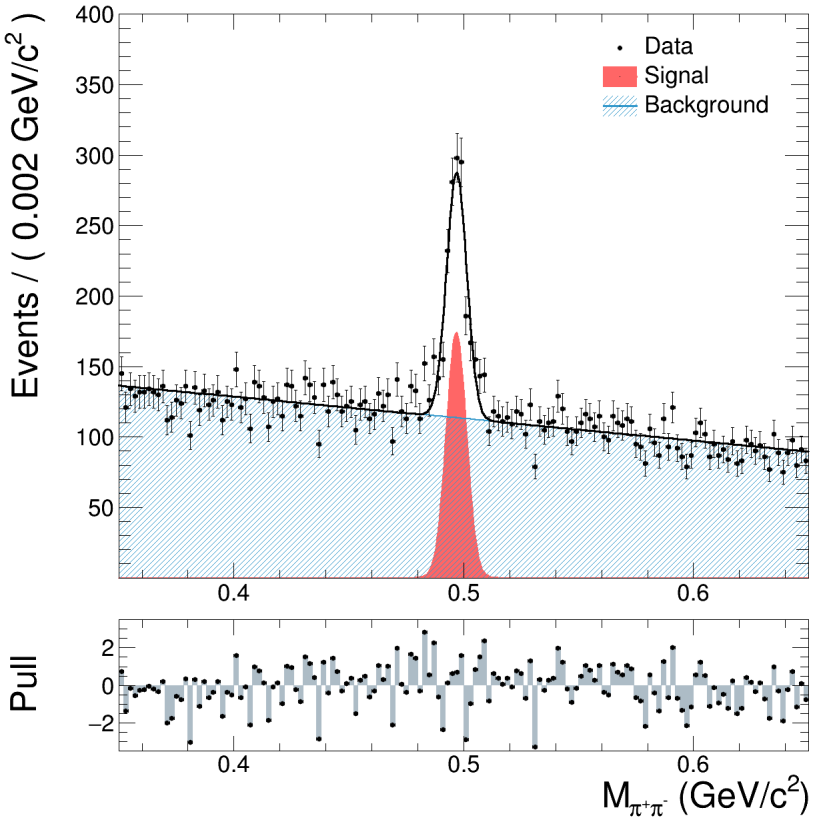
$|\Delta r| < 2$ cm

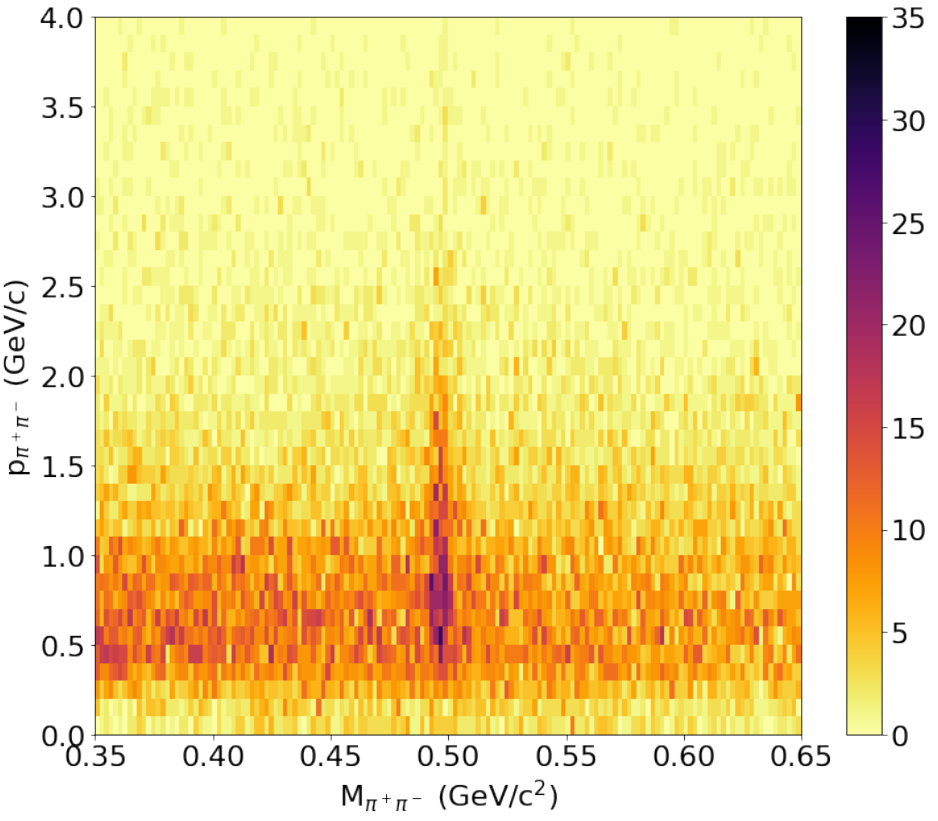




The Ks

All the Ks candidates in my sample





The Ks

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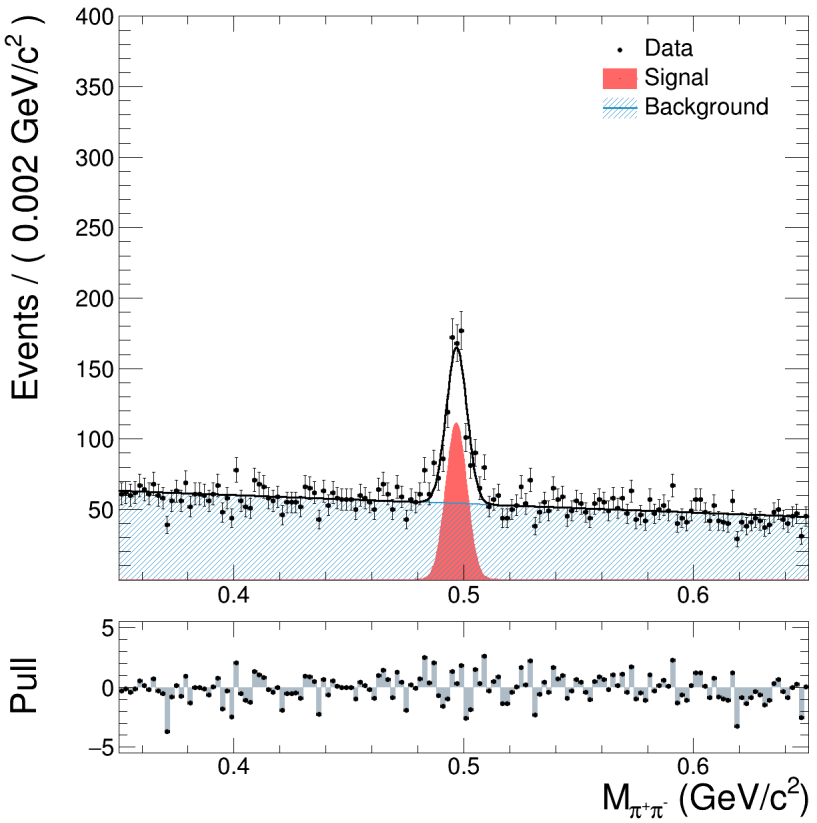
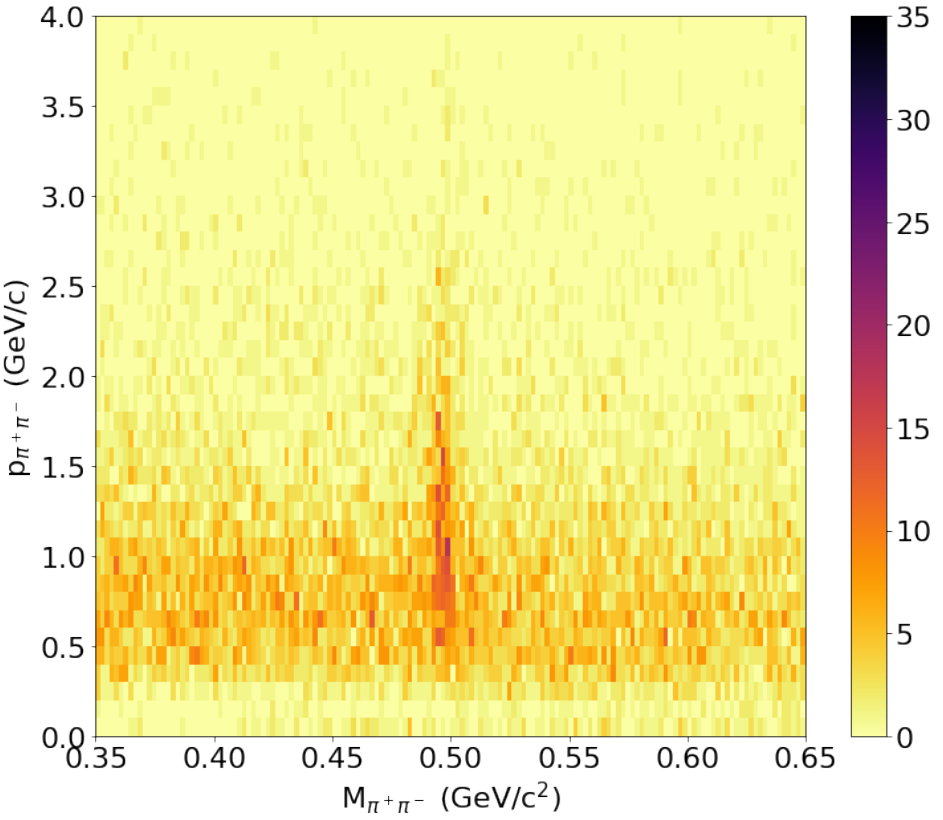
All the Ks candidates in my sample that have

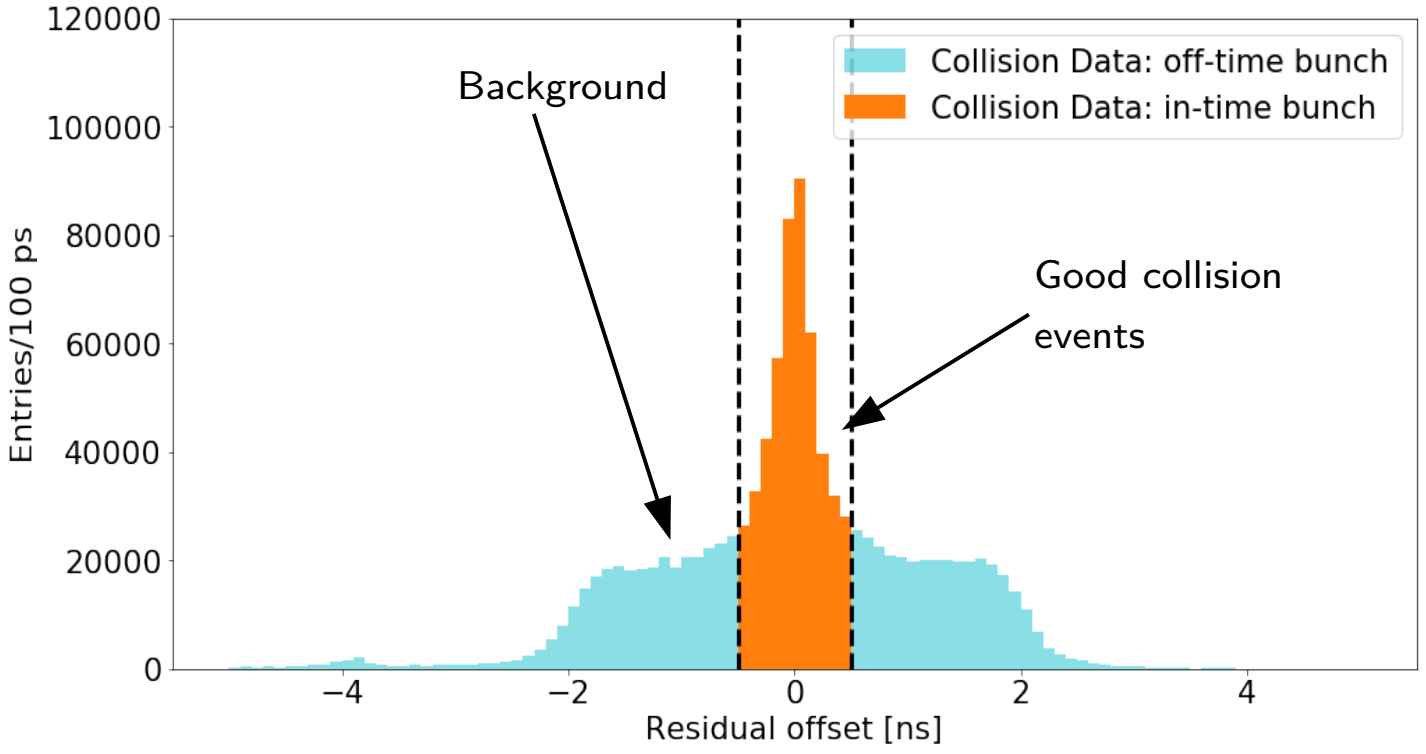
<u>the first pion daughter in the TOP acceptance</u>





Off-time background

We can get rid of most of the background selecting the "on time" events by looking at the top bunch-finder time offset



The Ks: on-time VS off-time

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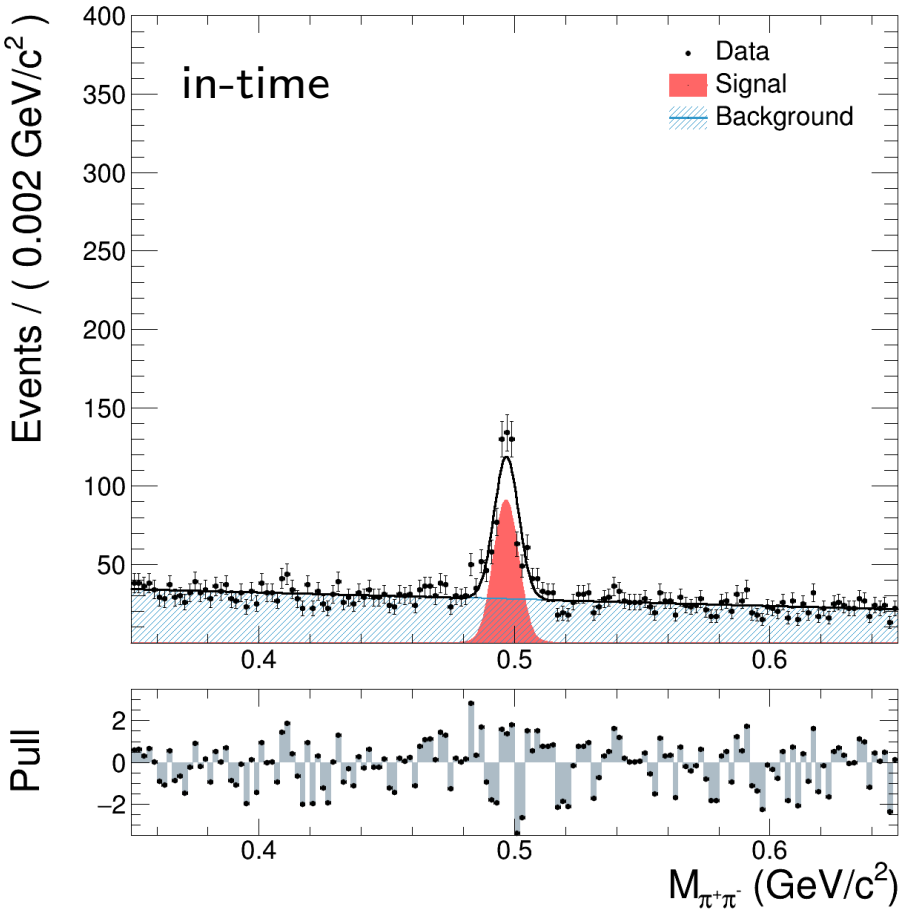
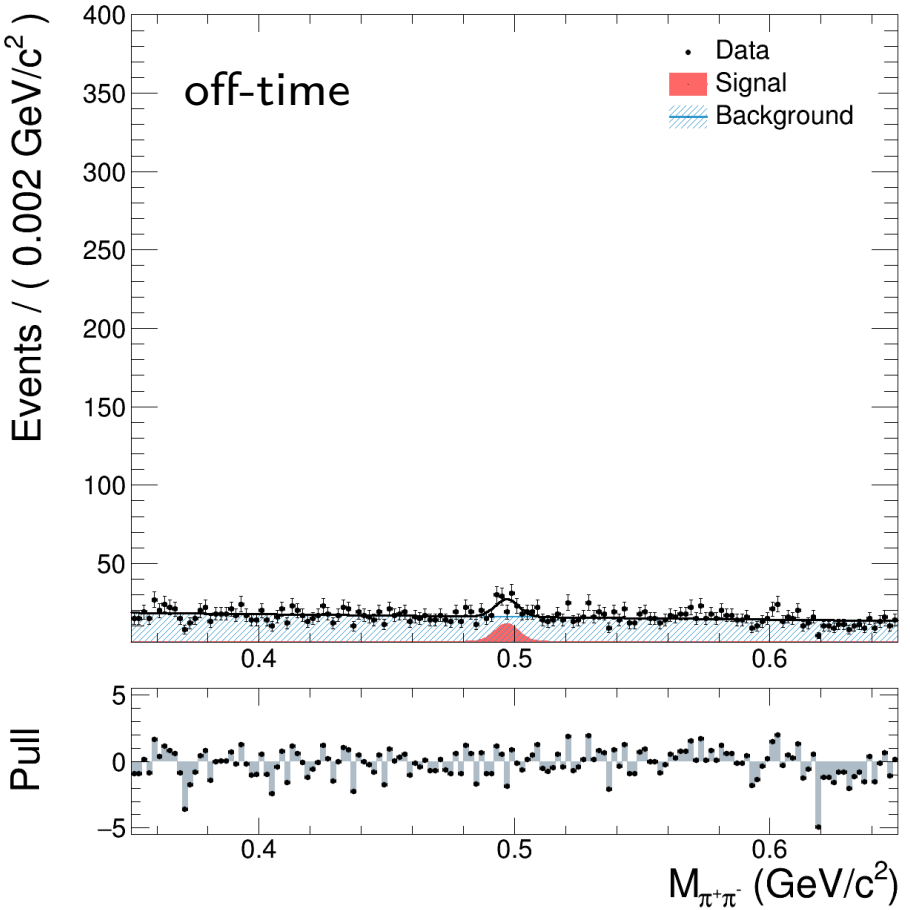
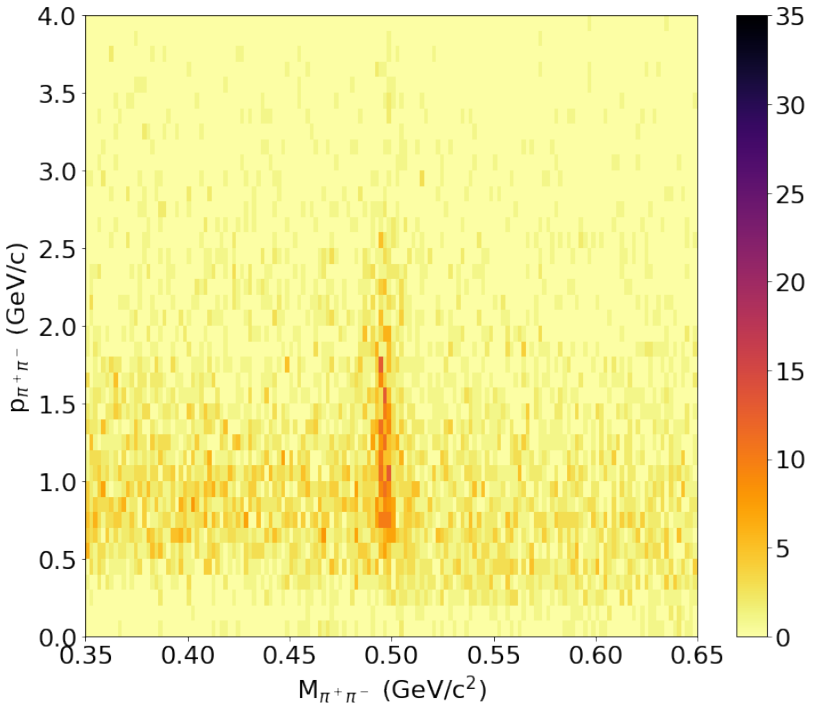
Timing cut: $|\text{offset}| < 0.5$ ns





The Ks: Final yields


```
                                  total number of Ks : 953
                           total number of Ks on-time : 787  (83%)
                          total number of Ks off-time : 88   (9%)
                 total number of Ks with the pion in the TOP : 620  (65%)
 total number of Ks with pion in the TOP and on-time : 545  (57%)
total number of Ks with pion in the TOP and off-time : 64   (7%)
```



The Ks: The first look at the TOP PID

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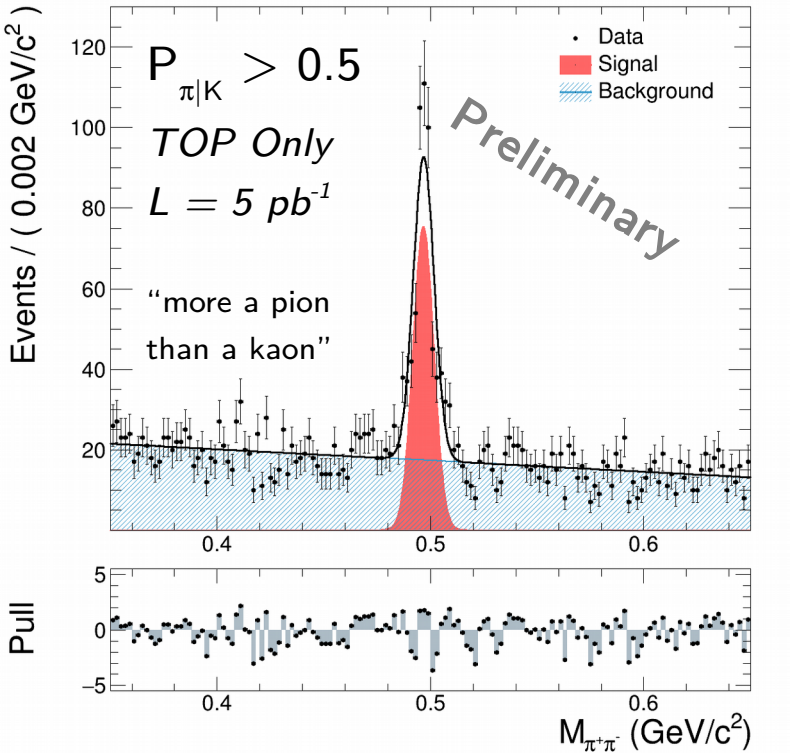
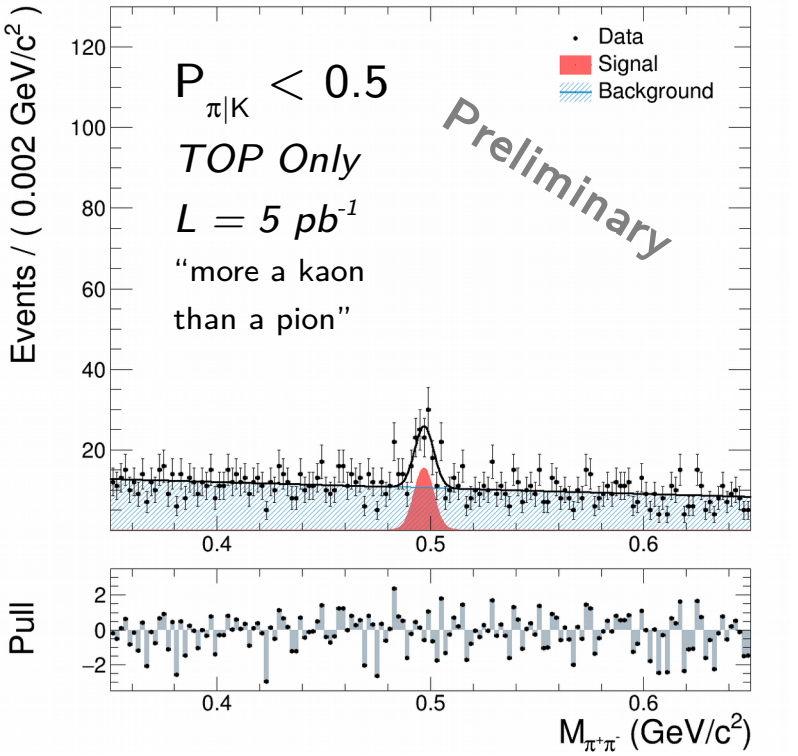
First obvious cut: Ask for pionID > 0.5 or pionID < 0.5

$\rightarrow$ pionID $= P_{\pi|K} = L_\pi / (L_\pi + L_K)$ using the TOP information only

$\rightarrow$ Only one of the two pions is probed





The Ks: The first look at the TOP PID

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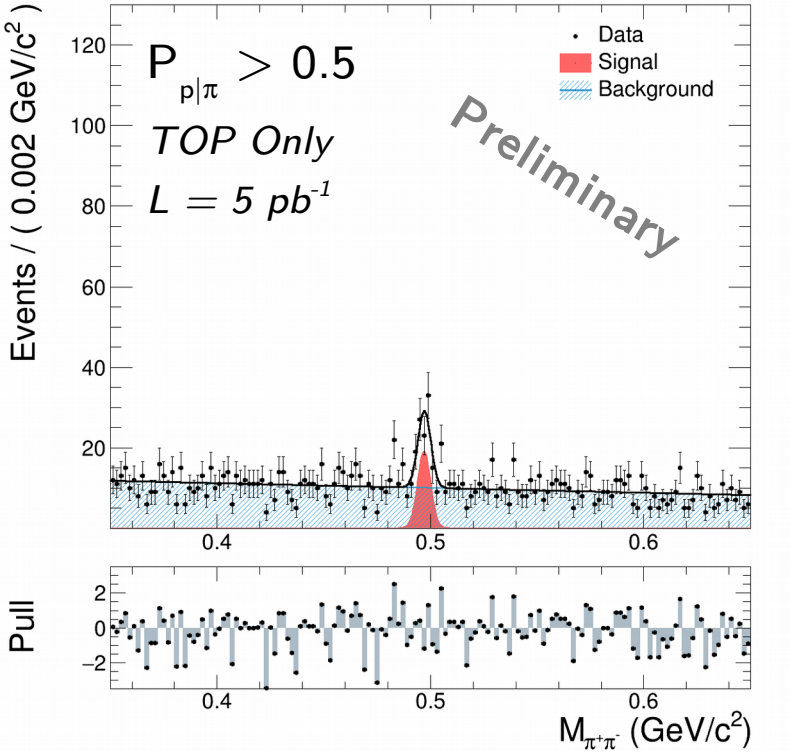
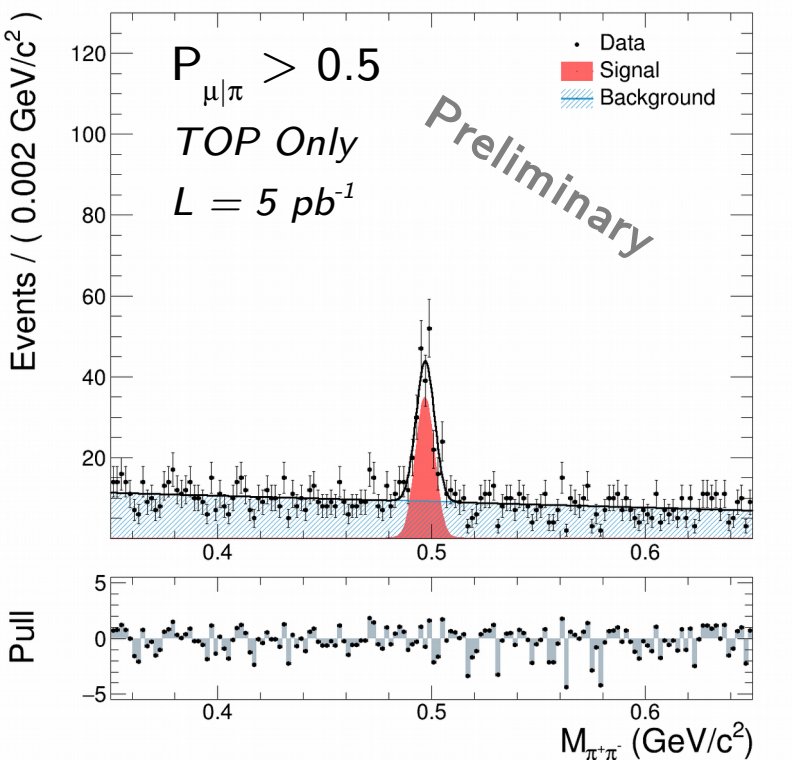
Along the same line, we can try to select protons or muons from the Ks sample

→ Only one of the two pions is probed

"more a proton than a pion"



"more a muon than a pion"



Kaon ID: Looking at the $D^0 \to K\pi$

In our sample we also have a little bit of untagged D^0

Extra selections:

$\to$ $|\Delta z - 1| < 2$ cm

$\to$ $|\Delta r| < 2$ cm

$\to$ momentum(kaon candidate) $>$ momentum(pion candidate)

For the study, I will focus on the kaon candidate only, and I will require that it is within the TOP acceptance

$D^0 \rightarrow K\pi$

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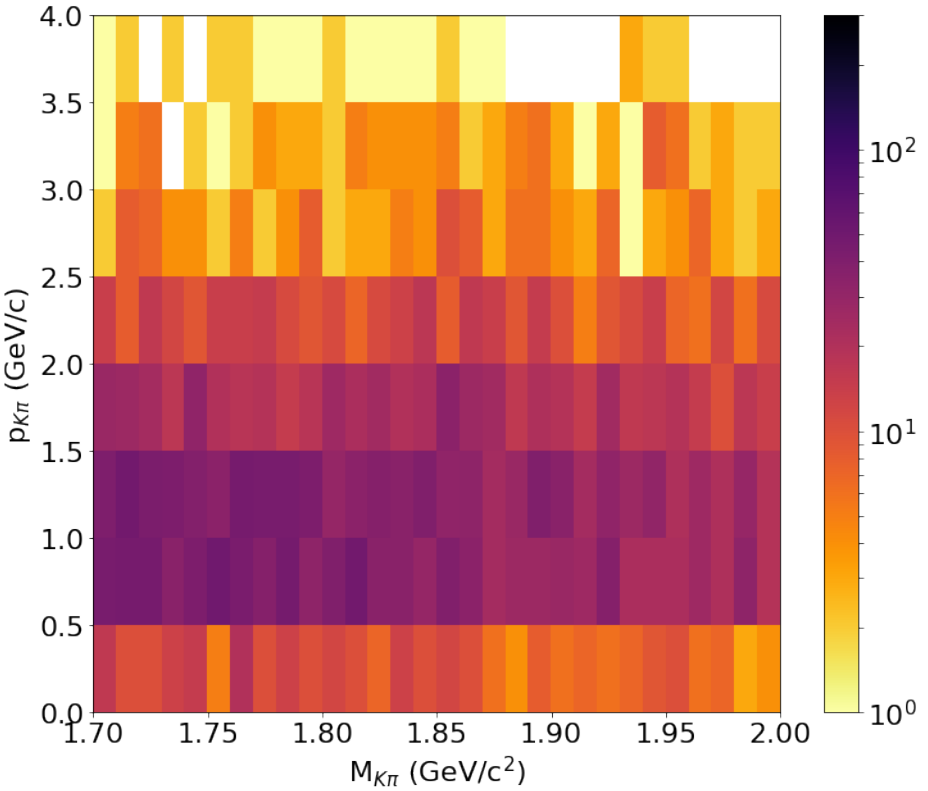
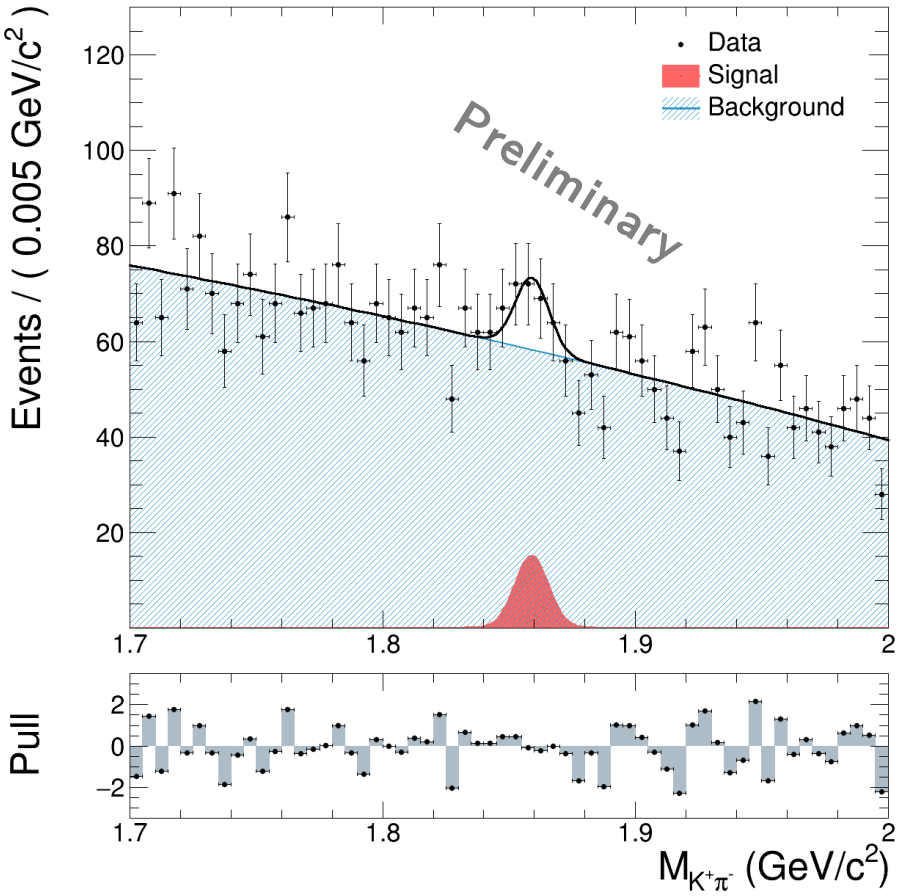
Data sample with all the cuts, and no PID at all





Kaon ID with $D^0 \rightarrow K\pi$

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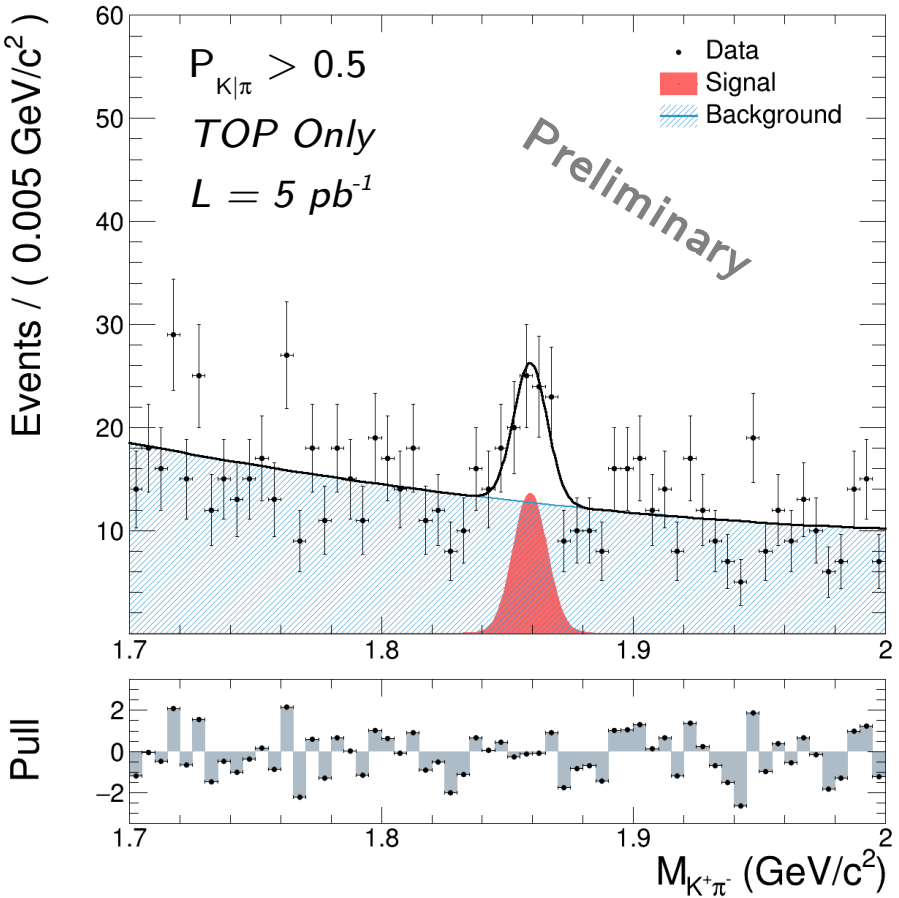
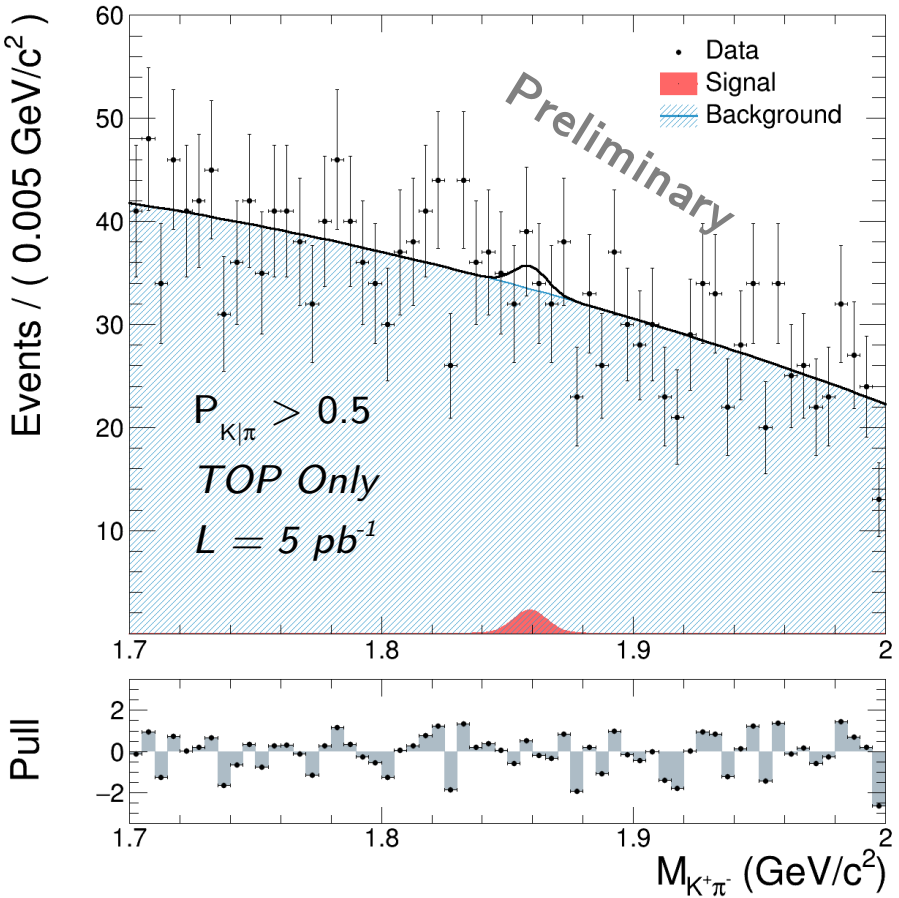
What happens if we ask the kaon to be identified as kaon rather than a pion ($P_{K|\pi} > 0.5$)?





Conclusions (II)

The TOP is smoothly taking data

→ The calibrations provided by the laser system and derived from the CRT are working quite well

→ **For the very first time, we have clear evidences of K/π from the TOP.**

→ The data processing is slowed down by the extra off-line calibrations that we need to make sense of the data

→ Partially due to FW issues

→ Considered to be the highest priority at the moment

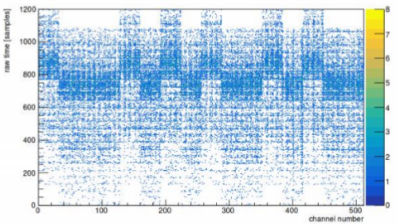
Backup

Data Quality and Further FW Work

- Heap memory: some calculations of memory locations were incorrect, gave incorrect heap windows out.
  - New version possibly fixes this… pushed to KEK for testing.
  - Verified locally at UH with scripts that should be identical to KEK scripts.
  - Tested up to 10 kHz in short runs.
- Carrier offsets: sampling clock on ASICs can come up shifted.
  - Related to revolution marker synchronization protocol.
  - Firmware fix tested locally in Hawaii.
  - Did not run properly at KEK… Luca and Kurtis investigating data corruption issues, need to provide some extra debug pathways.
- Short waveforms:
  - Waveforms at edges of 64 sample windows are too short (16 samples vs. 32).
  - More complicated to address… Trying to get "low hanging fruit" above first.

Carrier offset correction

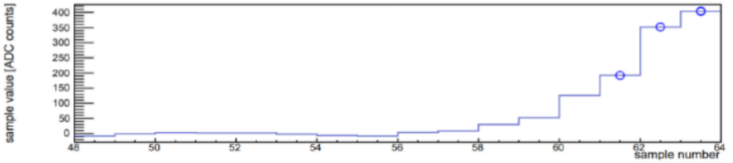
We can process the cdst files of the collision data, flag the shifted carrier and modify the LocalT0 calibration accordingly



A new calibration must be provided after every powercycle

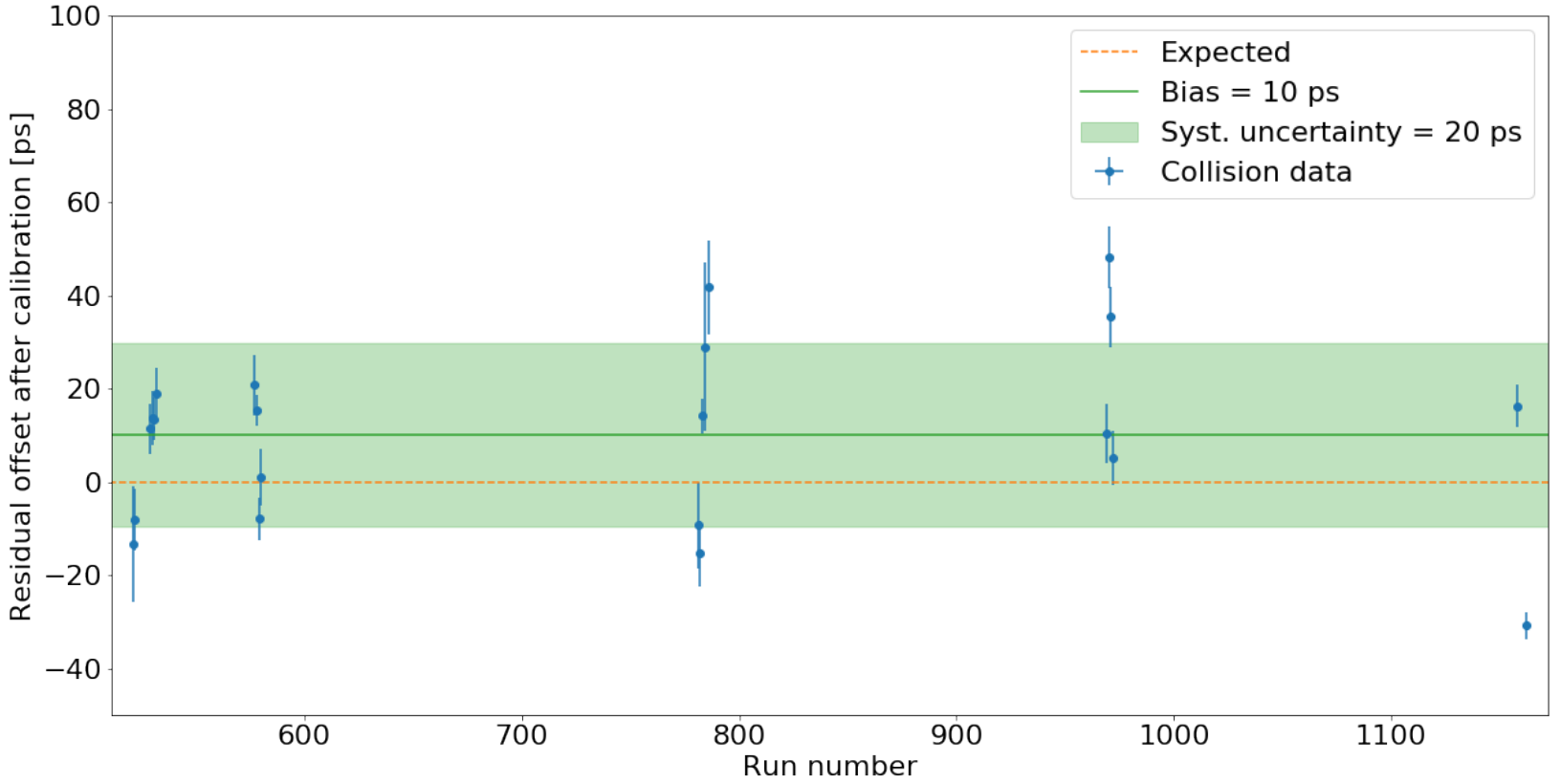
Please log somewhere (elog, mail, phone call, post-it…) the Run Numbers comprising a powercycle (not only the time!!!)

****Calibrations have been shown capable of working around these issues, but inconvenient.**



****Results in loss of efficiency for hits of ~10%.**

Common T0: residual offset (systematics)



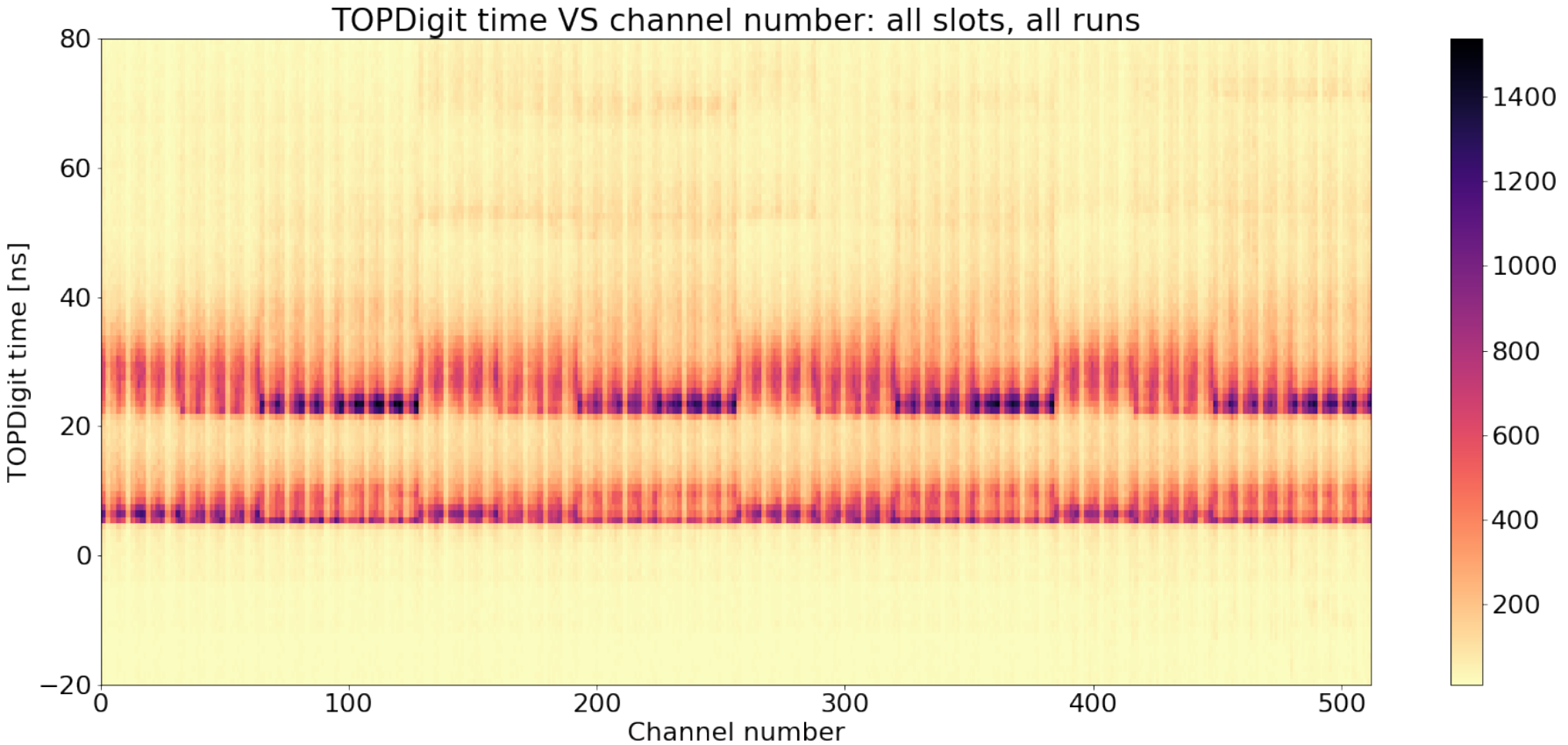
The residual offset (11 ps) is of the same size of the target resolution.

Due to the carrier offset that is not corrected for when we derive the CommonT0?

Calibration validation: Digit Time in each slot

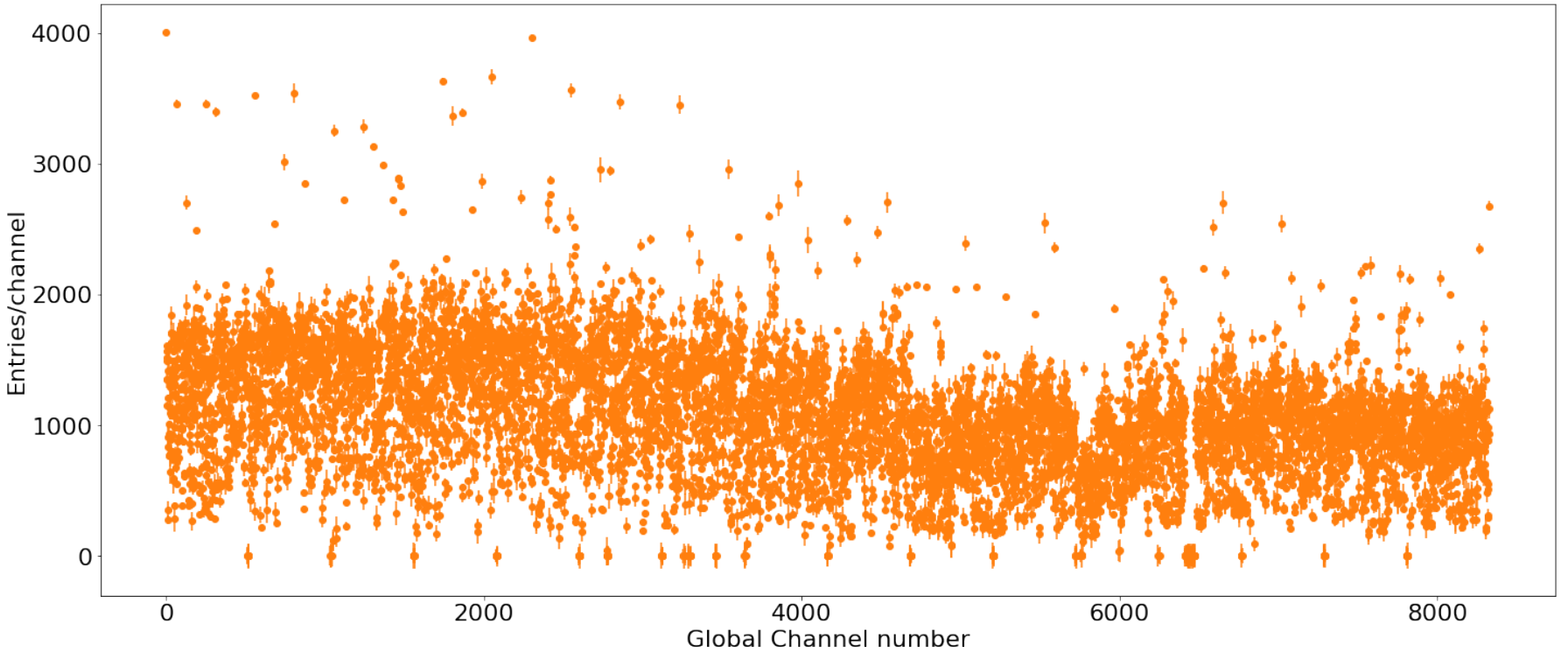
Integrating over all the slots

→ **LocalT0 is ok!**



Whole detector occupancy

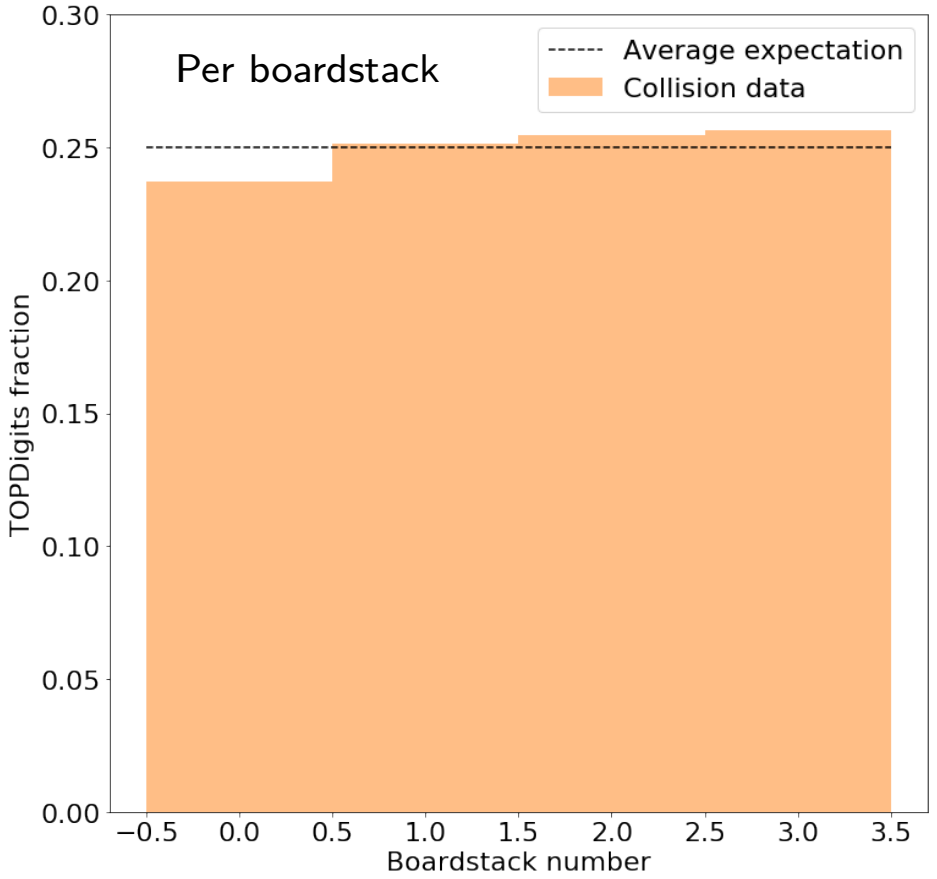
Selecting only in-time digits

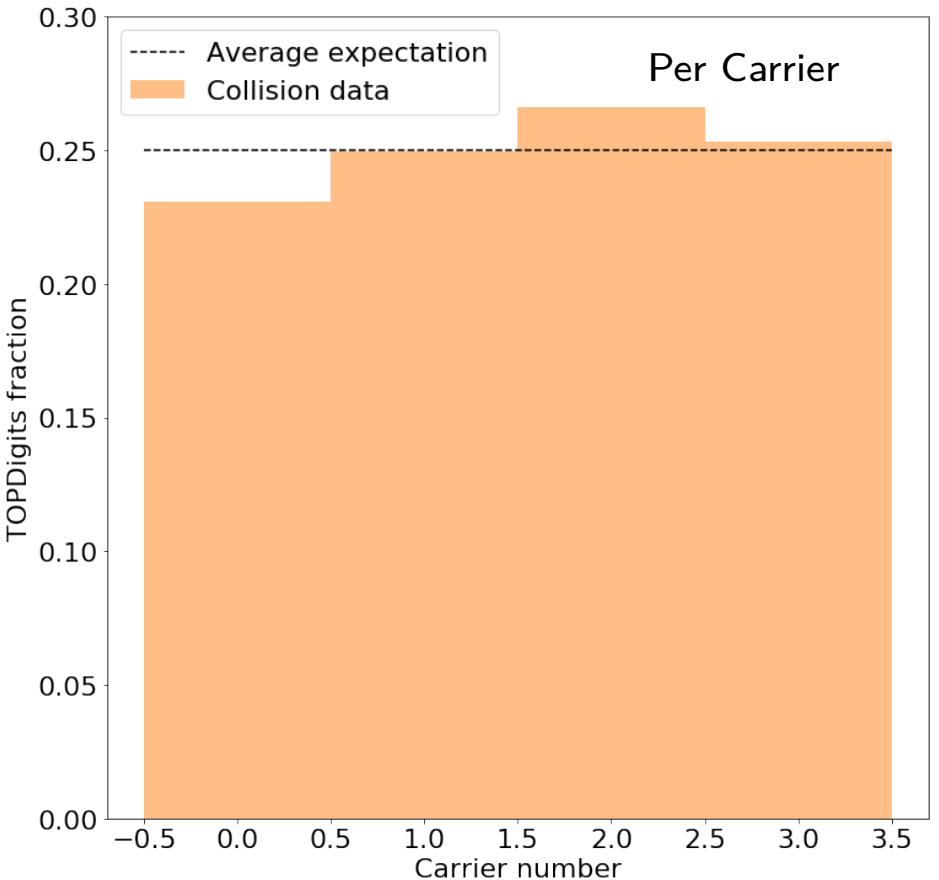


Mild asymmetry as expected

More occupancy plots

Selecting only in-time digits, integrating over all the slots





More occupancy plots

Selecting only in-time digits, integrating over all the slots

$\rightarrow$ Why is the occupancy across the asic channel number no flat?