2020 Test Beam Data Validation

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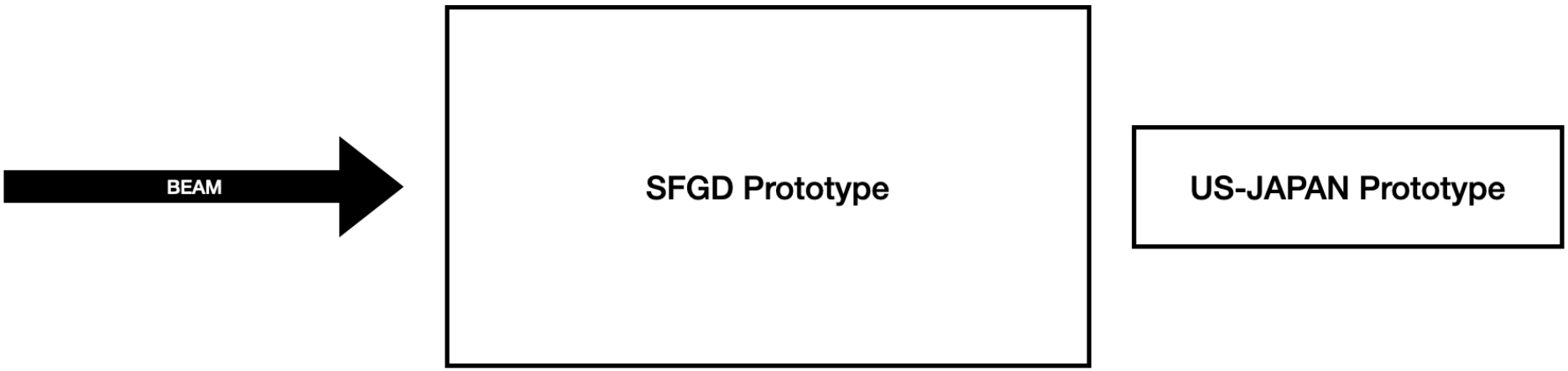
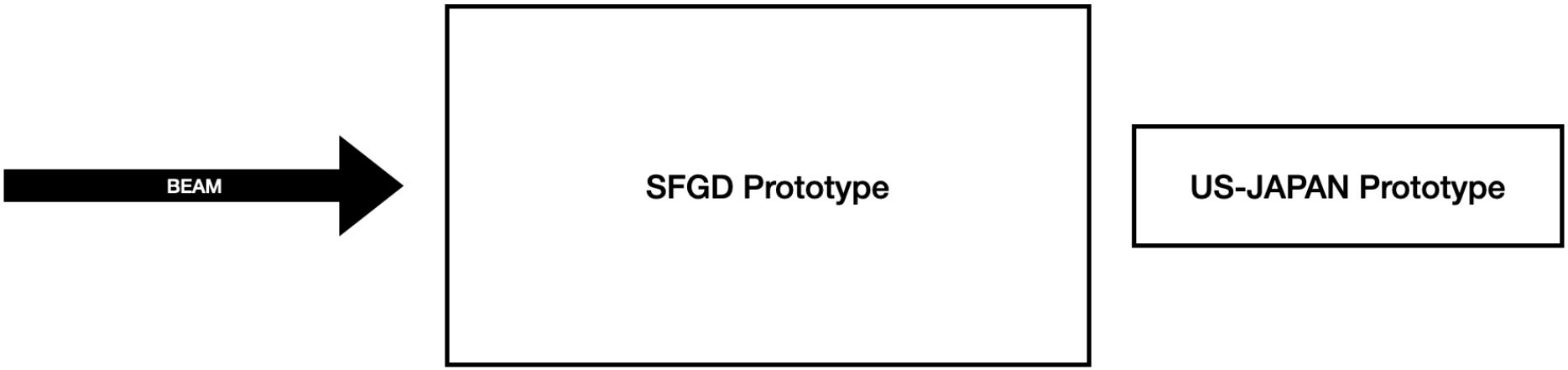
Data taken in 2019

- One/two weeks of data taken in following configuration used for total neutron cross-section measurement:



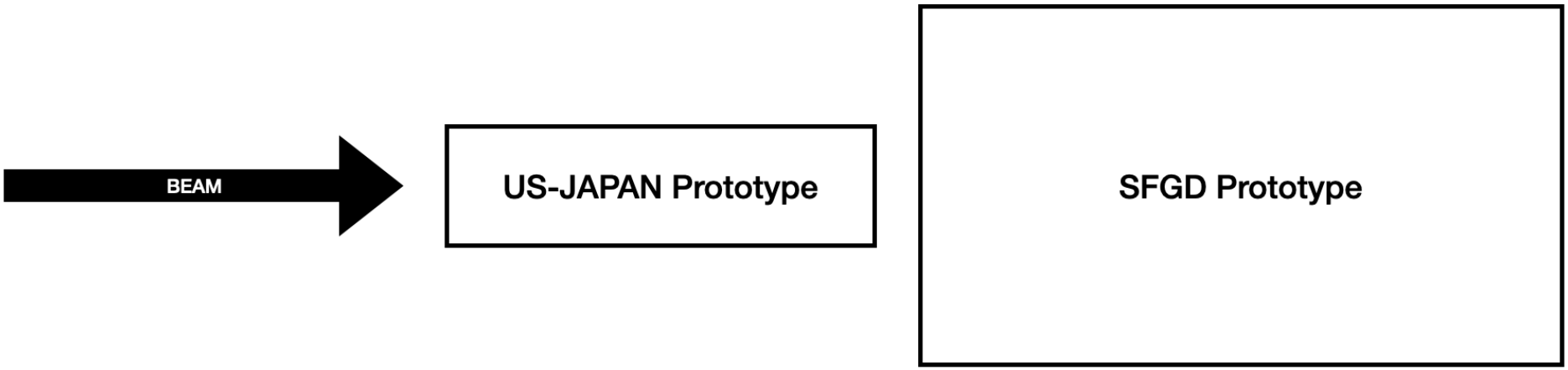
Data taken in 2020

- Additional $\sim$4 days of data taken in this configuration:



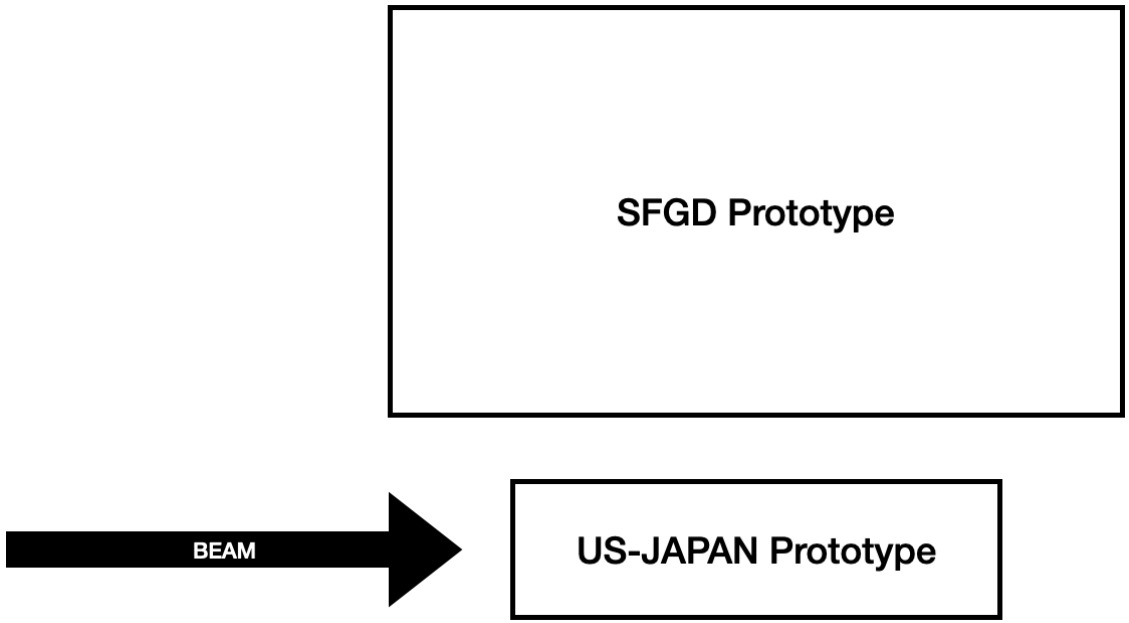
Data taken in 2020

- Also took ∼9 days of data in the following configuration:



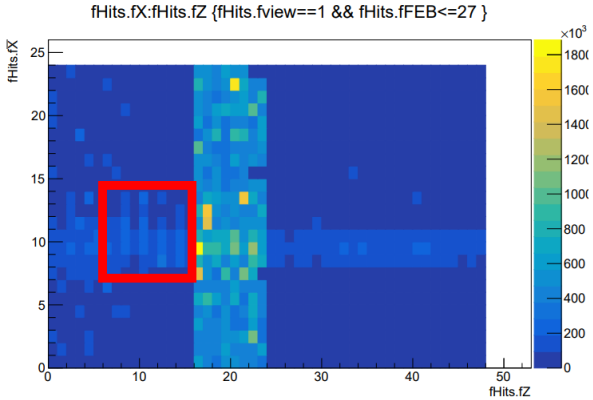
Data taken in 2020

- Took ∼1.5 days of data in this configuration:

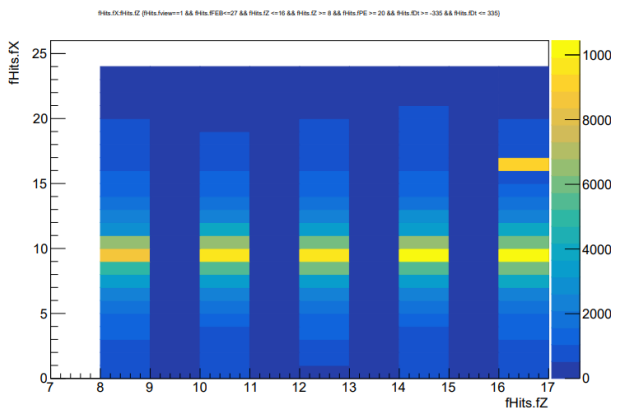


Reminder: FEB4 issue in 2020 Nick Whitney

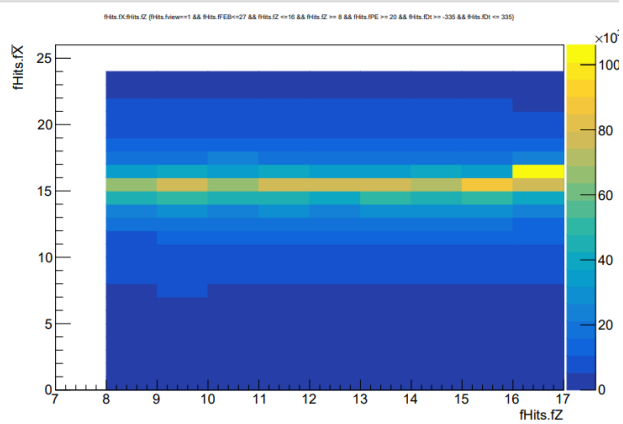
2020 All Z layers:



2020 Z layers 8-16:



2019 Z layers 8-16:

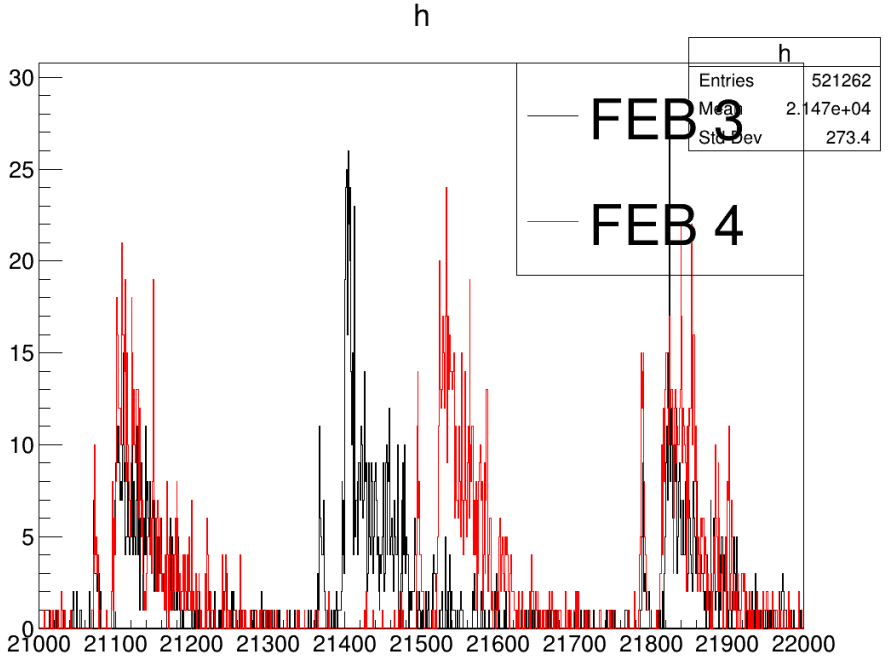


- Looking at hit distribution in XZ view we saw layers with very few hits
  - → Not seen in 2019 data
- Layers correspond to Z values of 9,11,13,15
  - → Number of layers read out by a single FEB = 4

Reminder: FEB4 issue in 2020

- FEB4 was a new board installed in 2020
  - → FEB3 (v1) firmware version 6.5 (SVN438)
  - → FEB4 (v2) firmware version 7.1 (SVN535)
- Looking at hit time relative to the start of the spill, we saw a shift in FEB4 every other micropulse compared to other FEBs

HitTimeFromSpill:

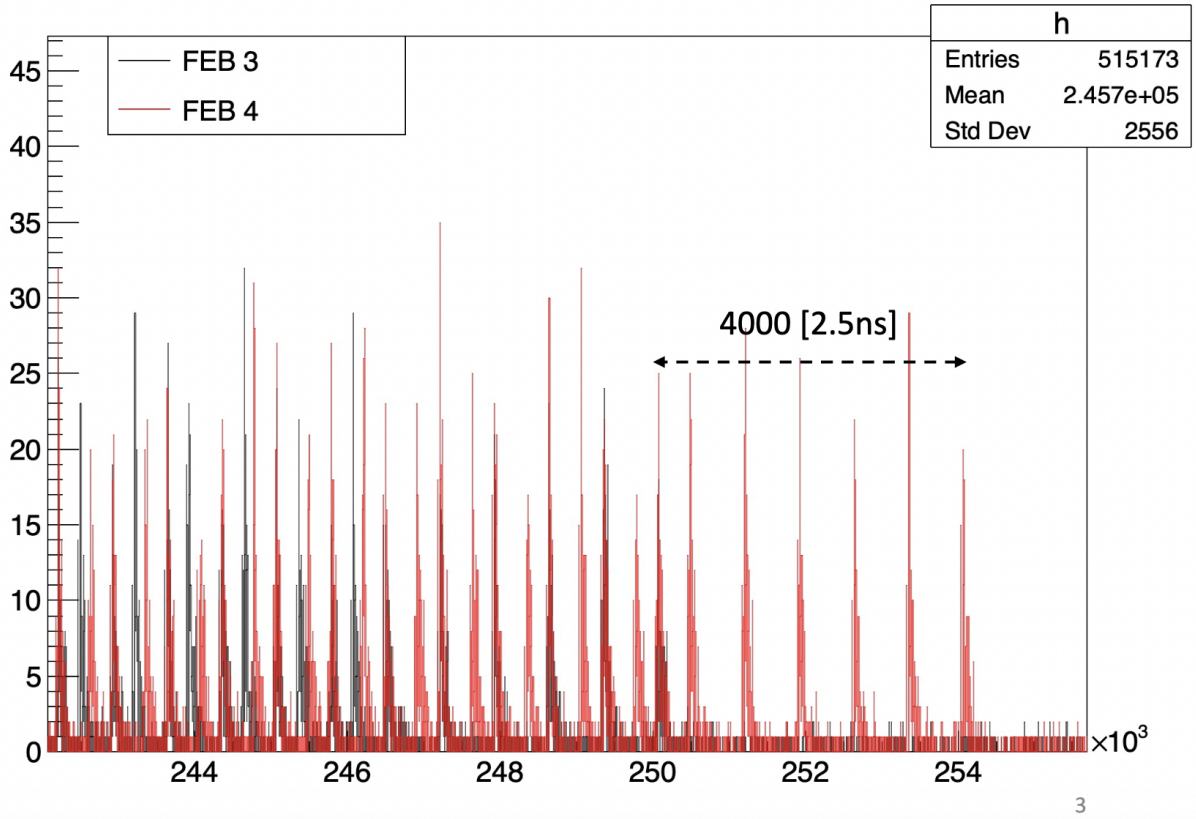


Reminder: FEB4 fix

Dana Douqa

Investigation..

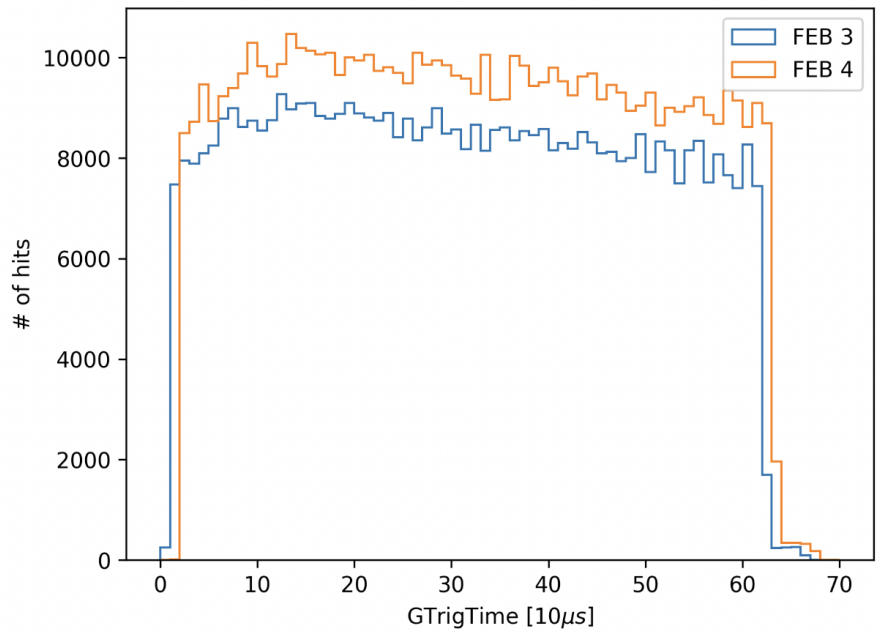
- The displacement between the last black peak and last red peak is ~4000 [2.5ns] = 10 µs which is equivalent to 1 GTrigTag
- This implies there's a shift in GTrigTag between the two FEBs...

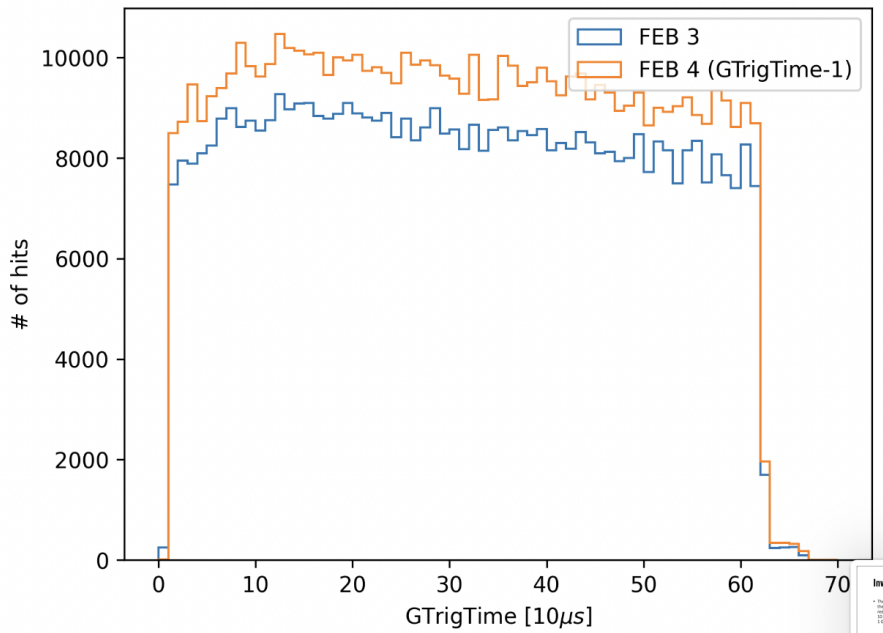


Reminder: FEB4 fix

Dana Douqa

Yep..





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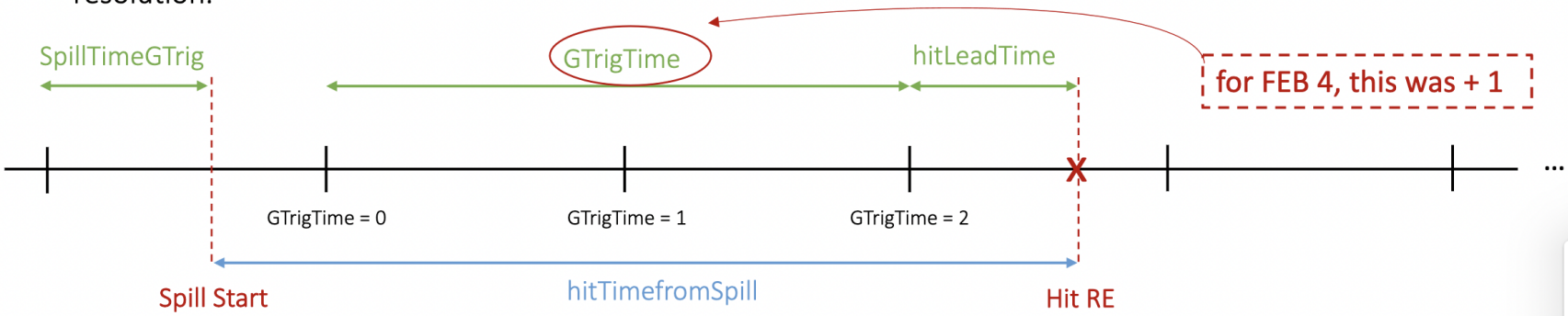
How that affects hitTimefromSpill..

The hit time from the beginning of the spill is a variable we calculate (not obtained from electronics directly)..

hitTimefromSpill [2.5 ns] = hitLeadTime + 4000(1+GTrigTime) – 4*SpillTimeGTrig

where,

- hitLeadTime = rising edge time wrt current GTrigTag in units of [2.5 ns].
- GTrigTime = tag assigned by the global trigger to the hit in units of [10 µs]. In this case the global trigger resets with each spill. (# of Gtrigs between hit and spill start)
- SpillTimeGTrig = relative time measurement of the GTrig signal from the spill start for each hit, with a 10 ns resolution.



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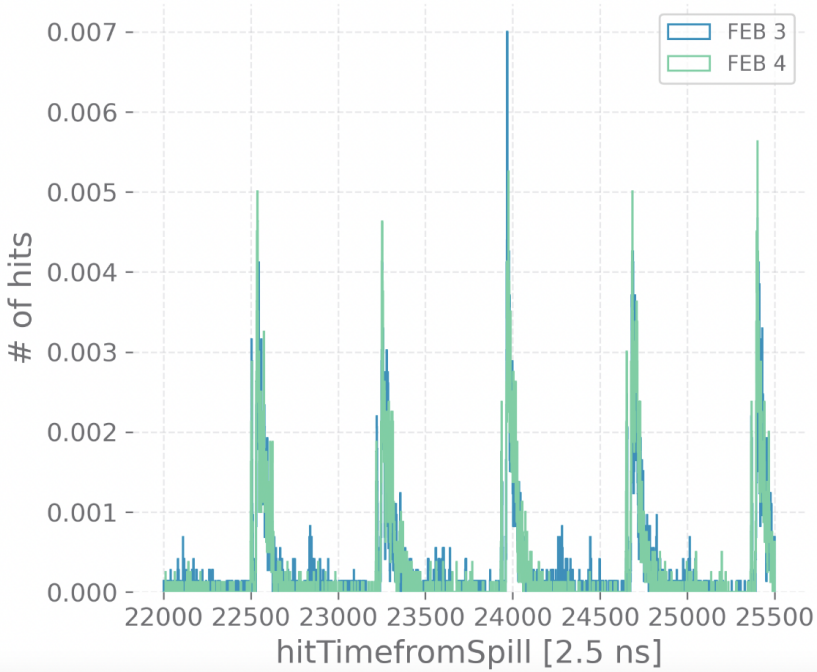
Test..

- For FEB 4, set GTrigTime = recorded GTrigTime -1..

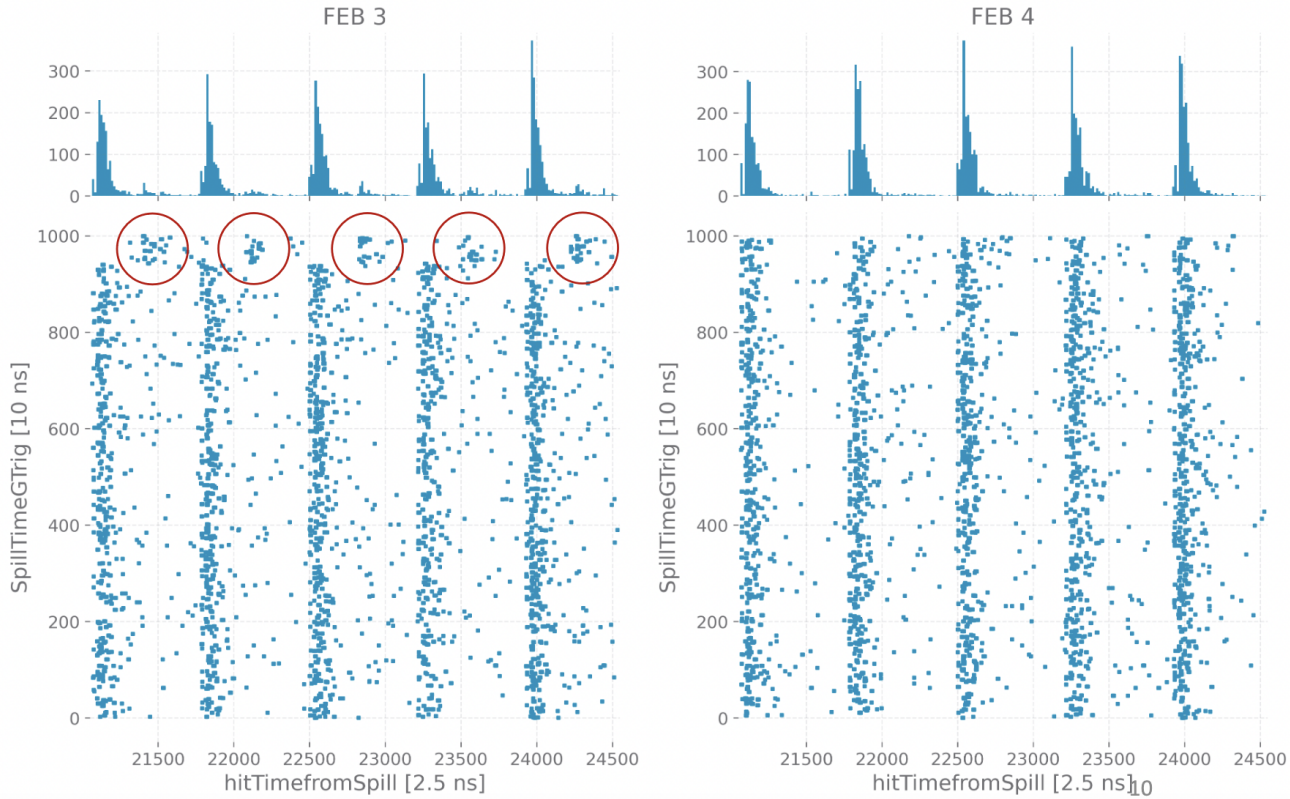


Now the two distributions align better..but there are peaks in FEB 3 that do not exist in FEB 4..

→ **Issue #2**

Looking at SpillTimeGTrig

The issue is specific to the cases where the spill starts towards the end of a GTrig (in the last ~0.5 µs).



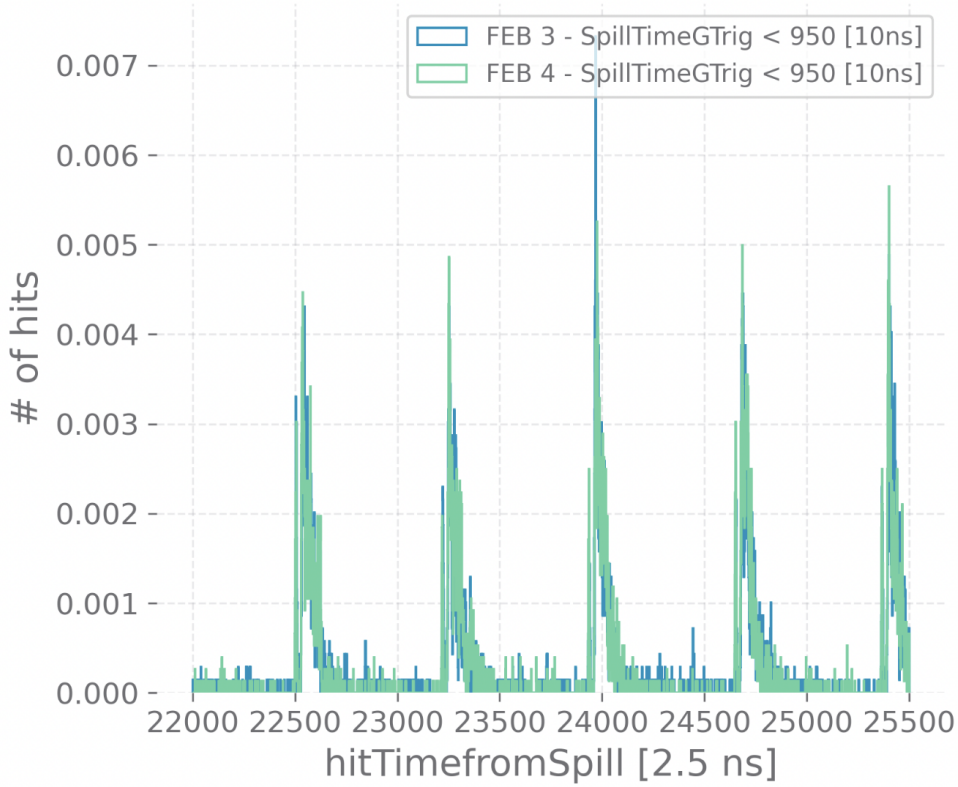
Suggested Fix..

Just cut them out..

Since the issue is fixed in newer FEBs, probably not worth digging deeper..

For this run, only 5% of spills are affected..

A doable sacrifice!



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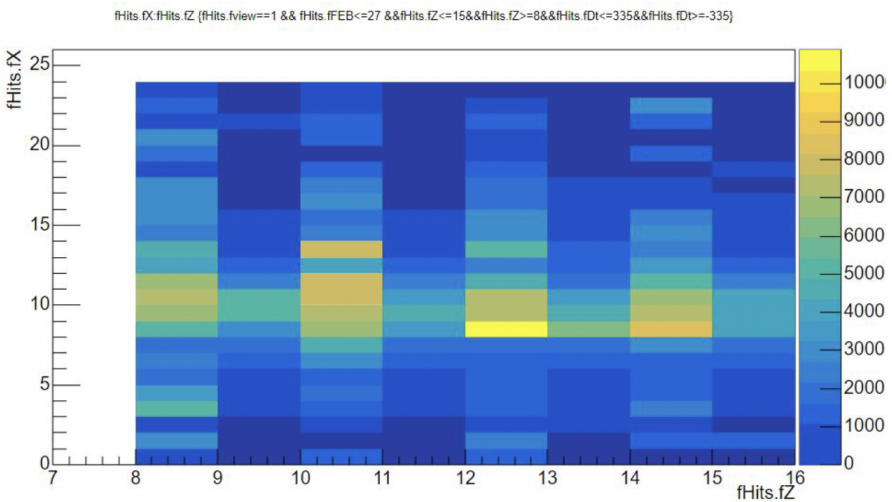
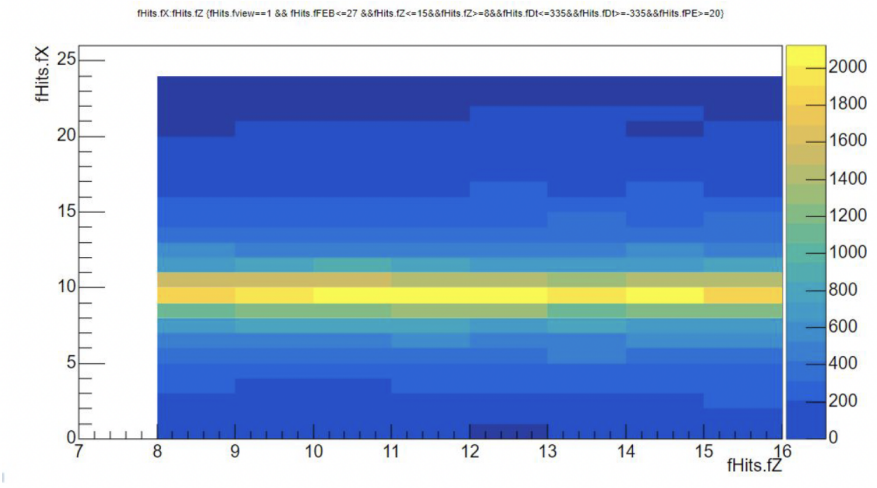
With Dana's Fixes

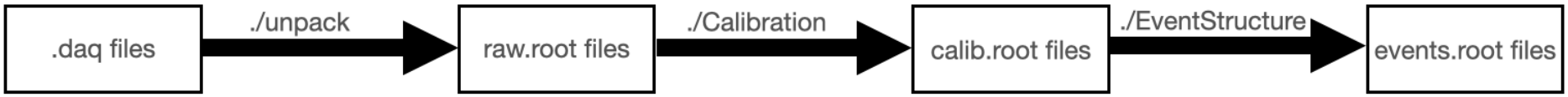
Nick Whitney

- Plotting hits directly with Dana's fixes (left) gives us hits from FEB4
- Adding PE $>$ 20 cut (right) shows similar number of hits in FEB4 and neighbouring FEBs



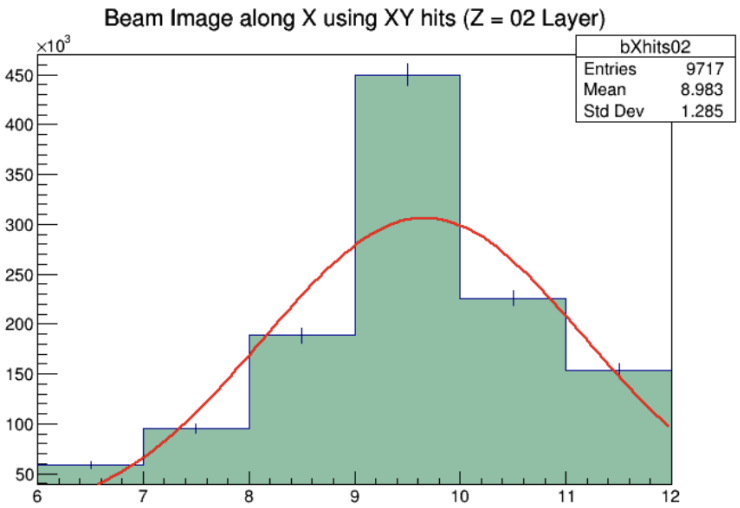


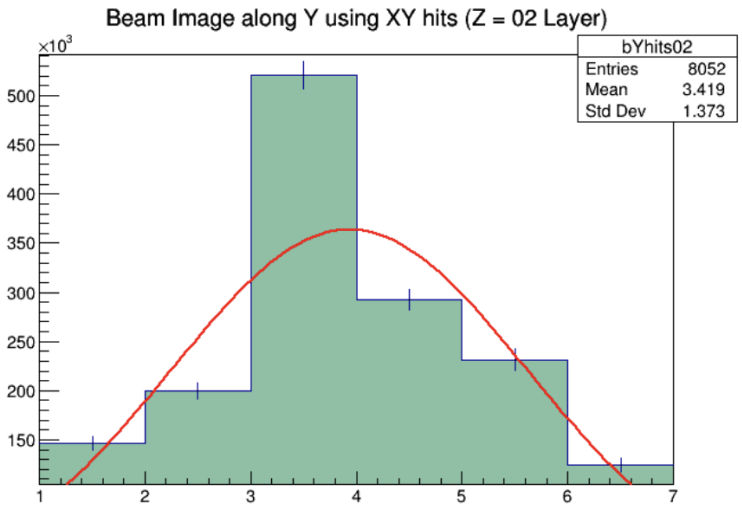
2020 Data Unpacking Status



- All steps tested on a couple of files, looks broadly sensible
- ./unpack complete for all runs
  - → Issue found with subrun 00 for all runs - only FEBs 0-4 being saved
  - → Seems to be a configuration issue in jobs, running manually doesn't have this issue
- ./Calibration complete for about two thirds of runs
  - → Only works for SFGD prototype at the moment, unclear why US-Japan causes issues, to be investigated
- ./EventStructure to be started soon

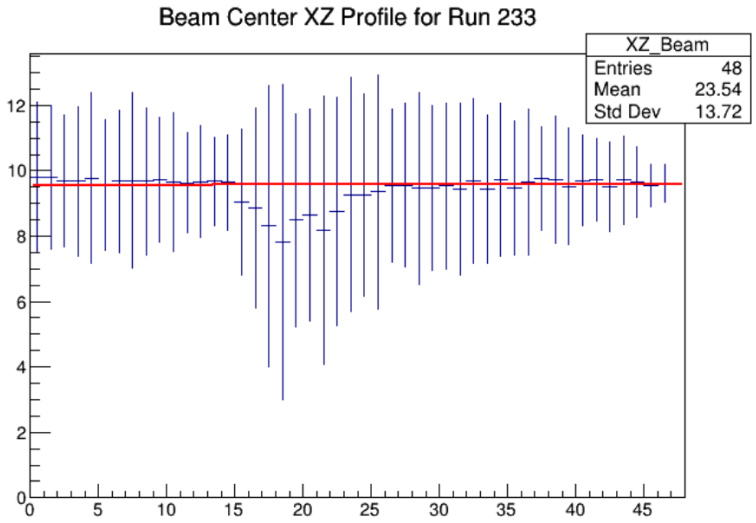
Beam Profile

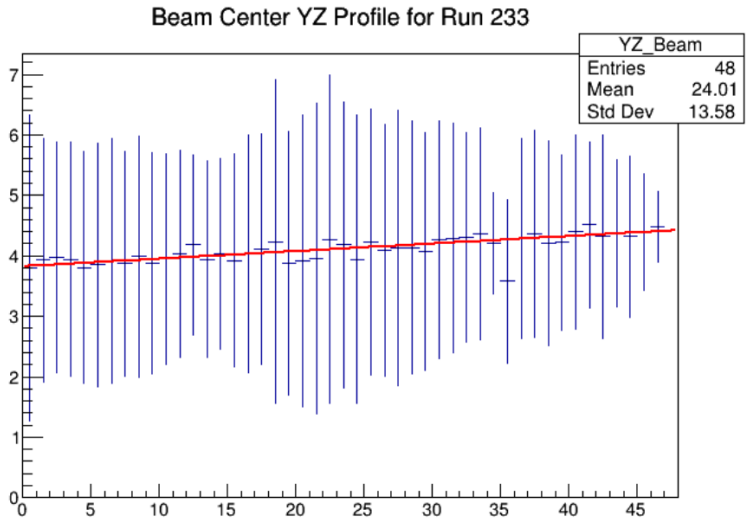




We can perform gaussian fits on the x and y hit distributions to find the beam centre in each z layer

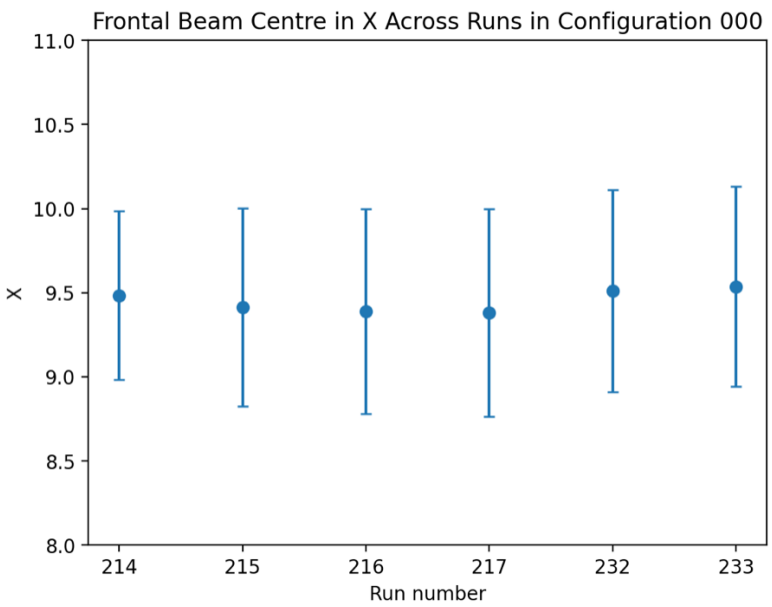
Beam Profile In XZ and YZ

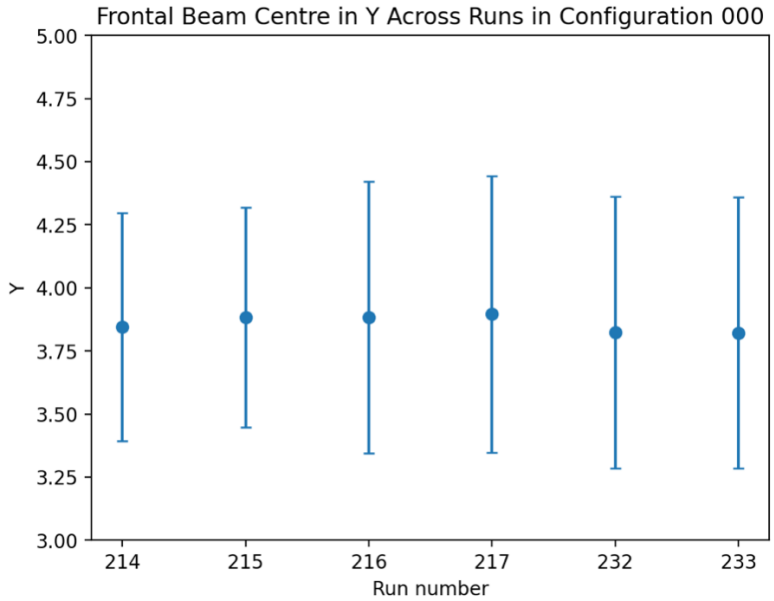




A linear fit performed on gaussian means of each layer is used to extract the beam centre. Error bars are the gaussian standard deviation σ
Possible cause of dip in X around X=17 – 24: Type III MPPC

Comparison between runs

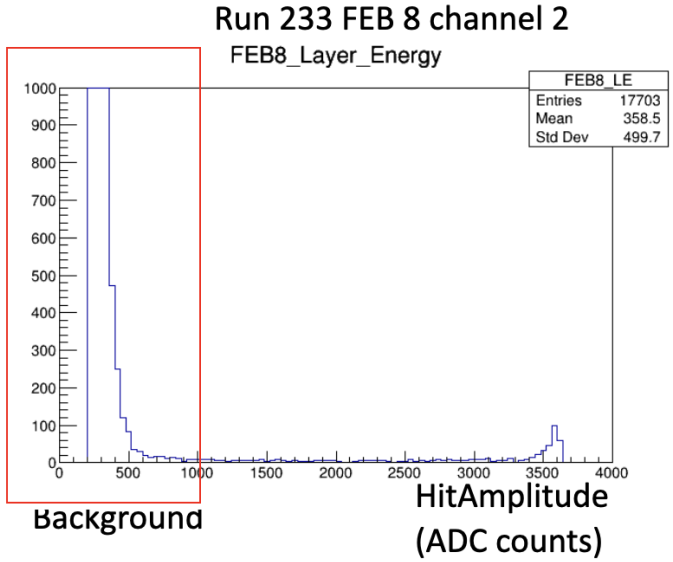




The beam centre is stable within a single configuration, so it is possible to find and use one beam centre for each configuration

Hit asymmetry for Type III MPPC

- The shift of hit location average in X is likely a voltage issue
- Plotted HitsAmplitude distribution to see the behaviour in different channels for Type III MPPC
- Guang: Voltage from power supply continues to drop after being switched on, this may have lasting (and disproportionate) effects on Type III MPPCs



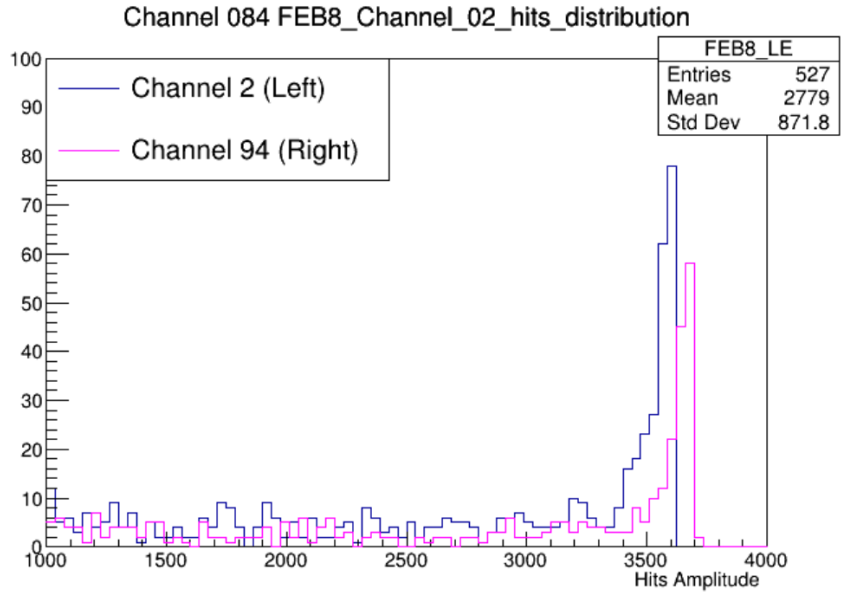
2020 Beam Center Study

Haowei Zheng

Run Number	Left(02) (E+06)	Right(094) (E+06)	Ratio (L/R)	Configuration
010				cosmic
020	0.89	2.079	0.428	001
036	0.888	1.94	0.458	001
084	1.46	0.98	1.49	001
101	1.09	0.82	1.329	011
164	1.43	1.028	1.401	011
173	1.144	0.769	1.487	011
233	1.74	1.03	1.689	000

- Asymmetry exists in most runs
- Hit counts weighted by HitsAmplitude (like in BeamCenterStudy) for channels in different runs
- Center shifts to the right in run 20, 36, and left for other runs tested

Example:



Plans

- Continue investigation of remaining issues:
  - → Unpacking issue for subrun 00
  - → Calibration issue for US-Japan FEBs
  - → Asymmetry in hits observed in beam center study
- Once unpacking is complete can start making comparisons of 2019 and 2020 data for the same configuration:
  - → Variables used in selection and cross-section measurement
- Check similar distributions in other configurations
- Use data in physics studies!

BACKUP