Monitor Issues

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MICHIGAN STATE UNIVERSITY

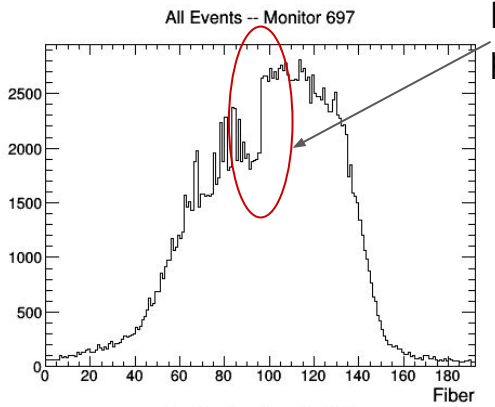
DUNE DEEP UNDERGROUND NEUTRINO EXPERIMENT

Introduction

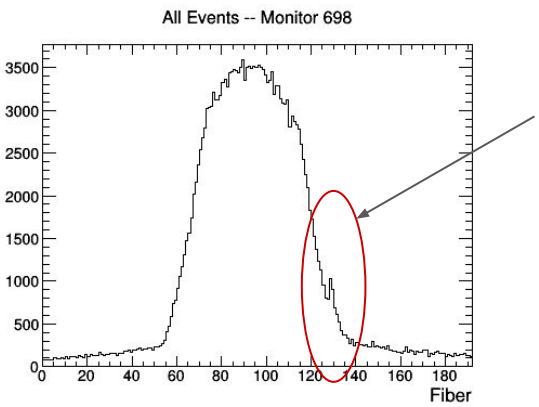
From last week: Found a few issues regarding the beamline profile monitors

- Strange jump in rate in first momentum spectrometer monitor
- Extra activations of fibers in some groups of fibers
    - Reminder: readout of the 192 fibers performed by 6 x 32-channel ASICs, encoded as 6 x 32-bit words in data
    - This issue is due to a software glitch

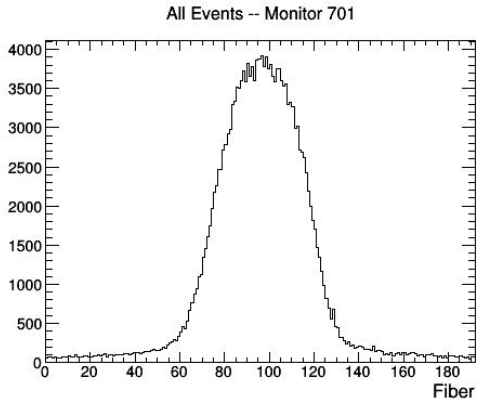
2 Separate Issues?

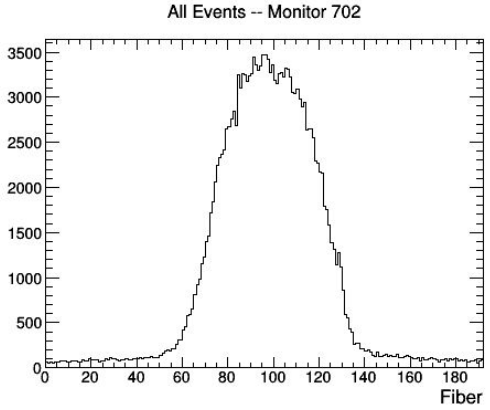


Maybe physical?



Software glitch



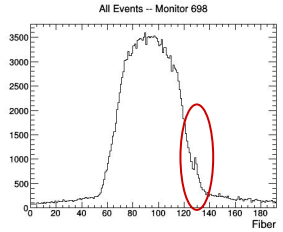


Software Bug

Cursory glance: Found a couple instances of the 5th 32-bit word being repeated between subsequent events

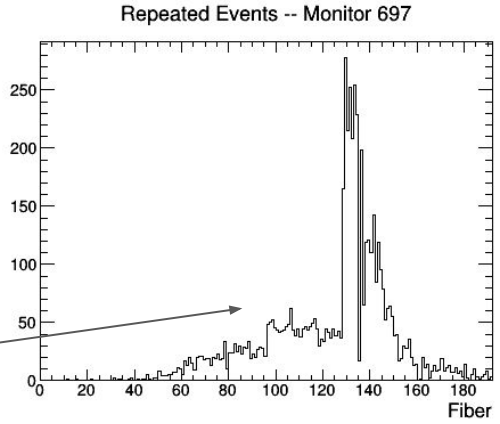
I think the issue manifests itself as active fibers being ‘held over’ to another event

Single fiber repeating is possible/physical, but the fact that the **same 2** are repeated is highly unlikely

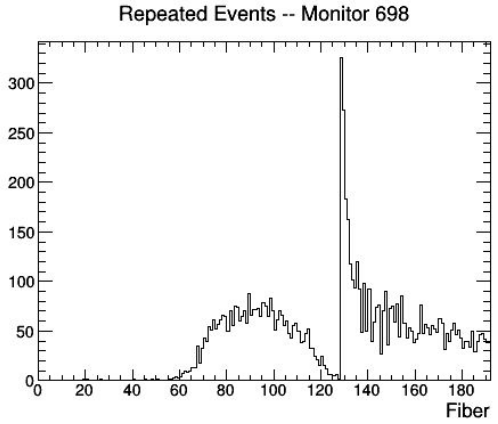


[1539840498.9030044]	-1	-1	-1	-1	[10]		-1			
[1539840498.9506893]	-1	-1	-1	[15]		-1	-1			
[1539840498.9829087]	-1	-1	-1	-1	[7]		-1			
[1539840499.022586]	-1	-1	-1	[11]		-1	-1			
[1539840499.0870402]	-1	-1	-1	[24]		[20, 5]		-1		
[1539840499.1382678]	-1	-1	[29]		-1	[20, 5]		-1		
[1539840499.1408312]	-1	-1	-1	[30]		-1	-1			
[1539840499.1610453]	-1	-1	[10]		-1	-1	-1			
[1539840499.198975]	-1	-1	-1	-1	[2]		-1			
[1539840499.2412484]	-1	-1	-1	[13]		-1	-1			
[1539840499.2881212]	-1	-1	-1	[13]		-1	-1			
[1539840499.3942833]	-1	[21]		[17, 9]		-1	-1	-1		
[1539840499.4199429]	-1	-1	-1		-1	[1]		-1		
[1539840499.4612713]	-1	-1	[22]		-1	[1]		-1		
[1539840499.480137]	-1	-1	[13]		-1	-1	-1			
[1539840499.496152]	-1	-1	-1	[27]		-1	-1			

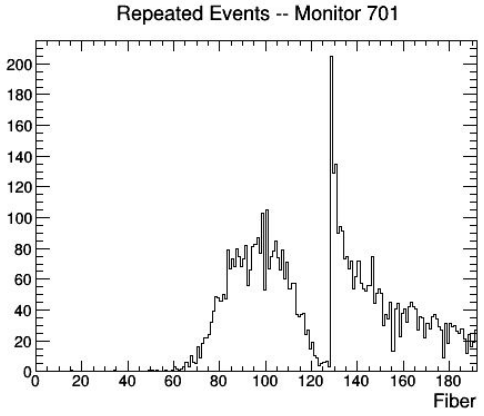
Repeated Fibers

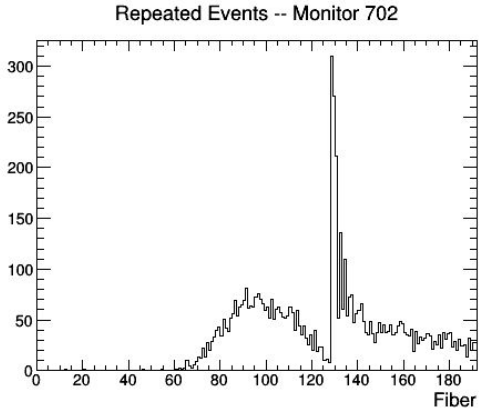


Last 2 words are likely to be immediately repeated



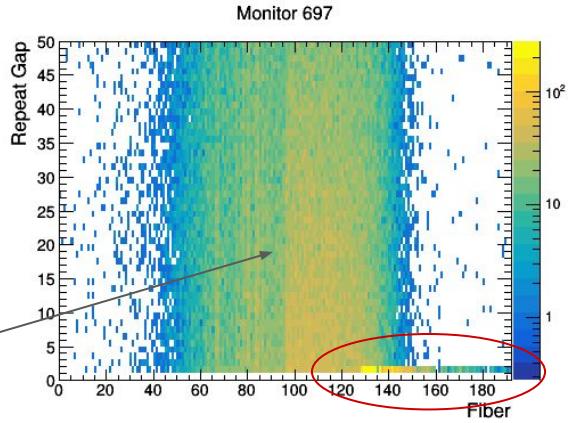
Related to other issue (later)

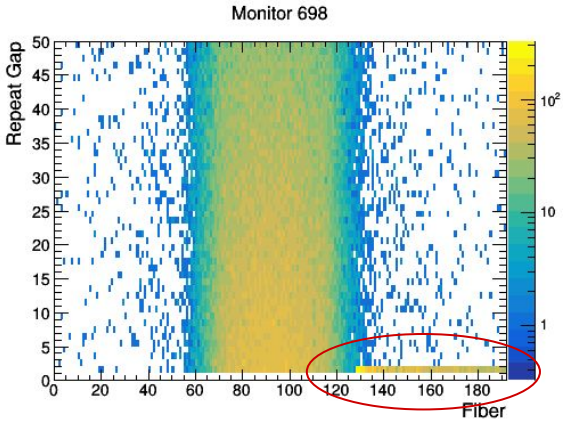


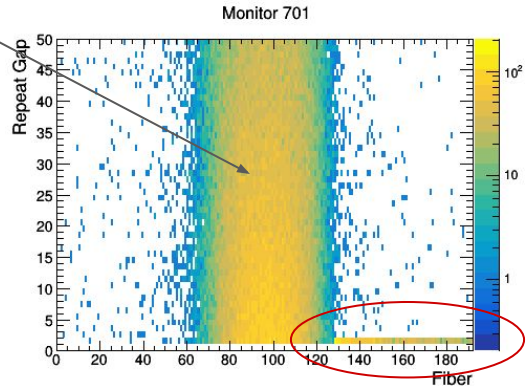


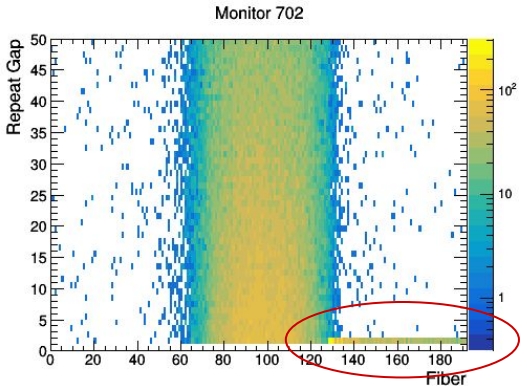
Gap Between Repeated Fibers

Total rate “folded in”



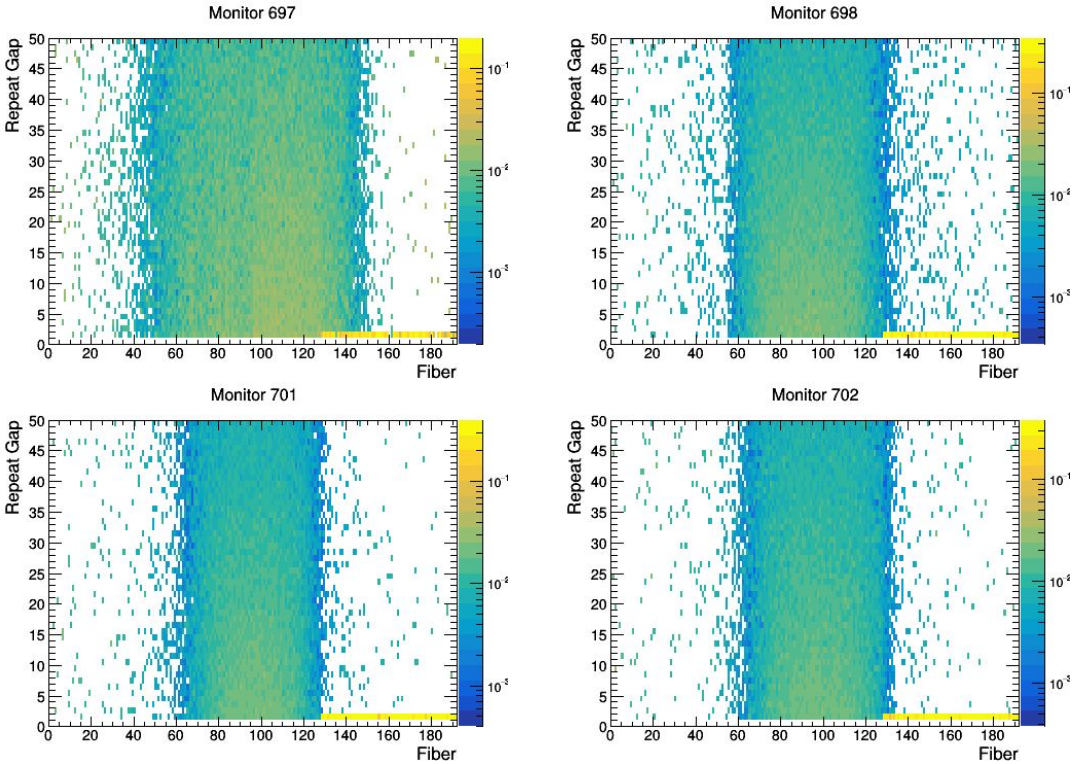






Gap Between Repeated Fibers -- Normalized

Divided by total rate in each monitor to highlight repeating bug



Separate Issue in 697

The software/repeating fiber issue is common to all monitors, but the jump in 697 @ 96 is not.

→ Appears to not be a software issue

Is this a change in efficiency?

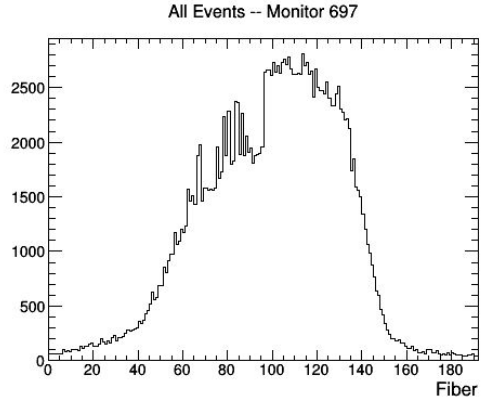
→ Higher rate:

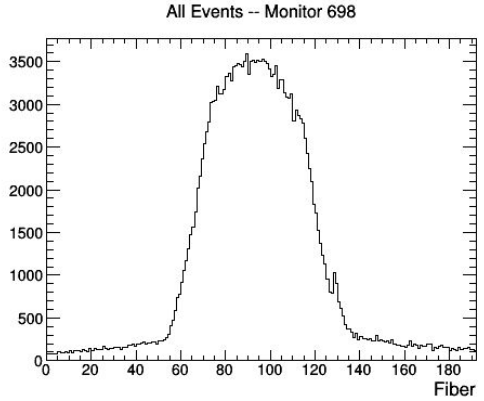
$N_{Fiber} \sim (\Phi_{Fiber} \times \varepsilon_{Fiber})$

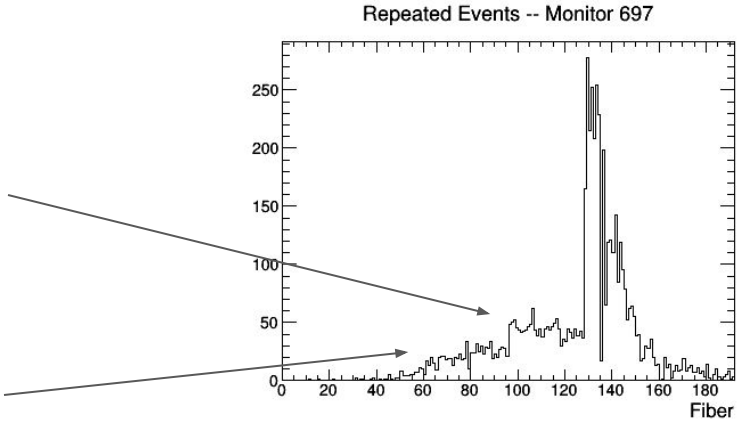
Also explains higher chance to repeat in this range

$N_{Repeat} \sim (\Phi_{Fiber} \times \varepsilon_{Fiber})^2$

Repeats in bins 0-95 suppressed by lower efficiency







Efficiency Difference

Hinted at in Inaki's thesis (below)

Does the aluminum coating increase efficiency?
→ Better at containing scintillation photons?

Was this monitor one of the prototypes? Or was it manufactured similarly?

> These prototypes of the XBPF have half of the fibres covered with a $\sim 100\,\text{nm}$ aluminium coating to avoid optical crosstalk: fibres 1 to 96 are coated, while fibres 97 to 192 have no treatment. The motivation for this layout is to investigate the impact of crosstalk in the monitor and the effectiveness of the aluminium coating. For this reason, the fibre-hit histograms in fig. 7.23 and fig. 7.24 are analysed for the totality of fibres (Total Multiplicity) and the two halves (Multiplicity A and Multiplicity C). However, this analysis by halves is still under development and no data has been yet extracted from it.

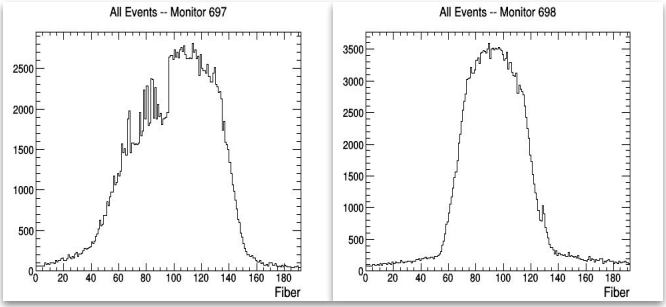
Efficiency Difference

Inaki clarified:

1. The fibers are not coated differently
2. But… There were configuration issues in the Front End boards controlling the photomultipliers in the profilers that could manifest as this issue

To be determined:

1. Is the shape difference somehow related?
2. Or is this from something else in the beamline? (i.e. upstream magnet not focusing as much)



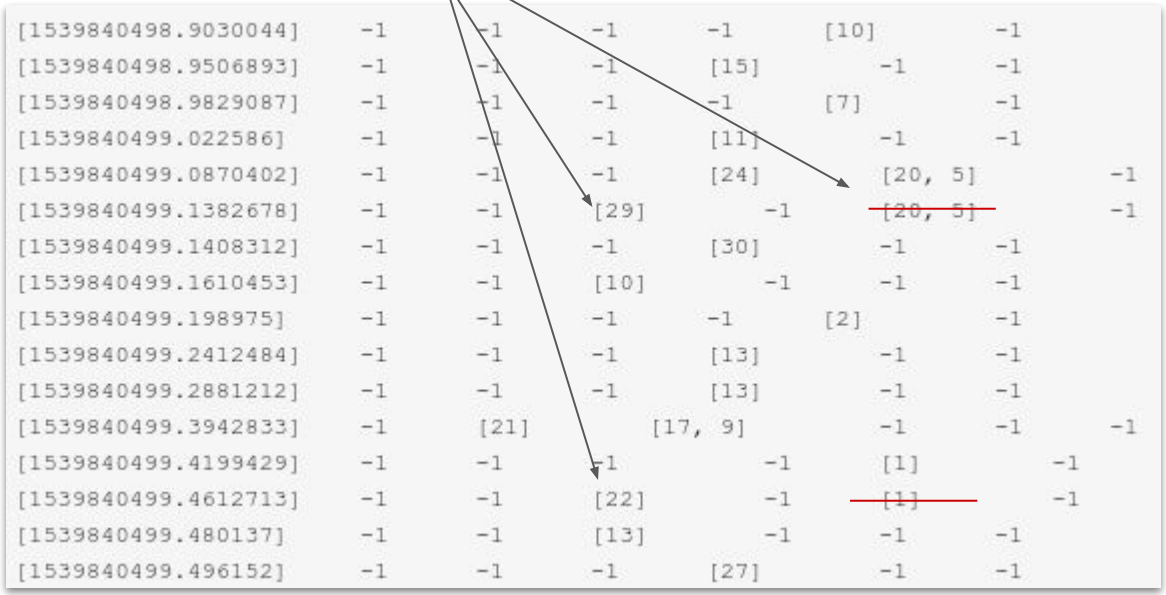
Multiplicity) and the two halves (Multiplicity A and Multiplicity C). However, this analysis by halves is still under development and no data has been yet extracted from it.

Mitigating the issue

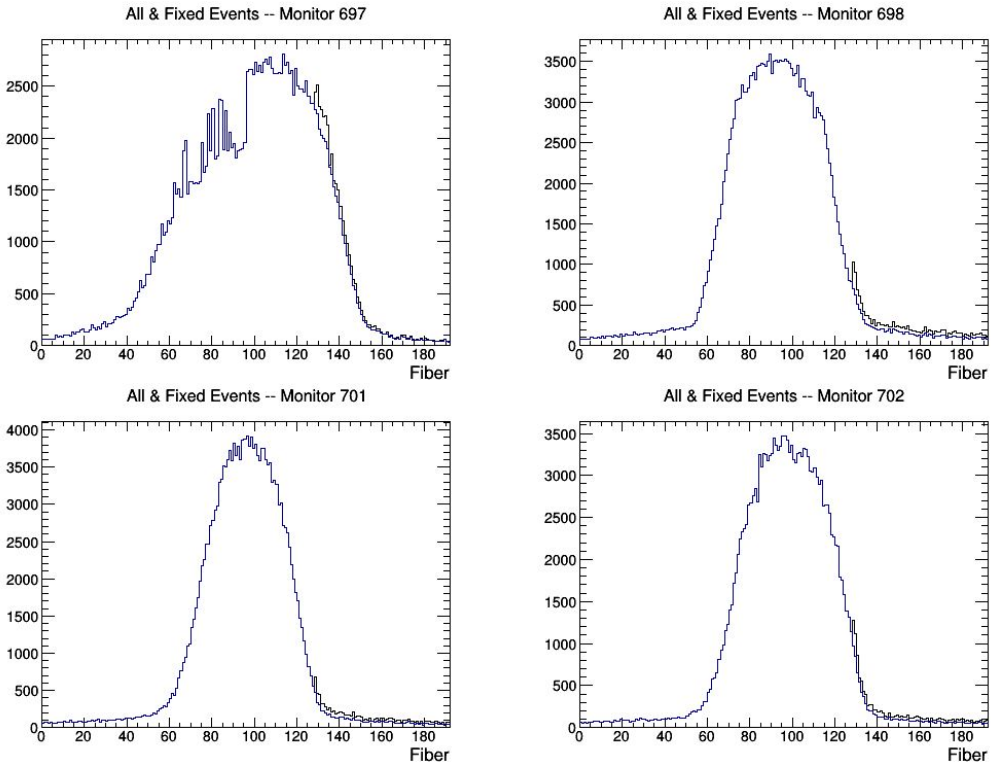
Idea for software workaround:

For each monitor acquisition/trigger in the spill:

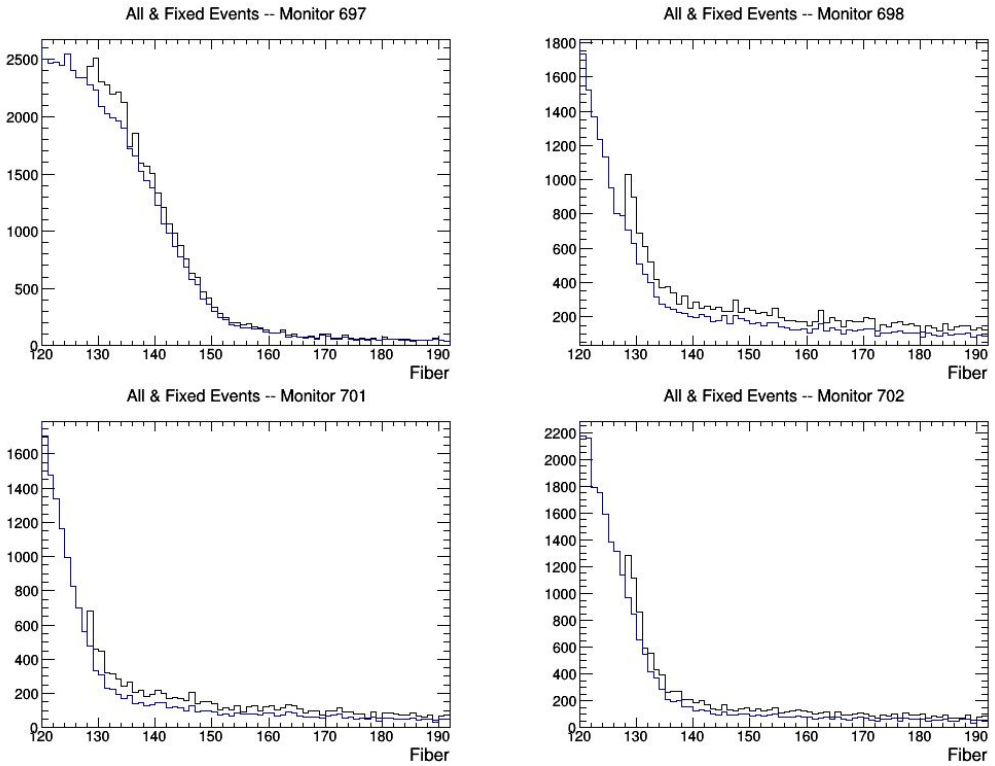
1. Check if any active fibers from words 5 & 6 were repeated from the previous trigger
2. Mask these/throw them out
3. Treat any other active fibers as “truly” active



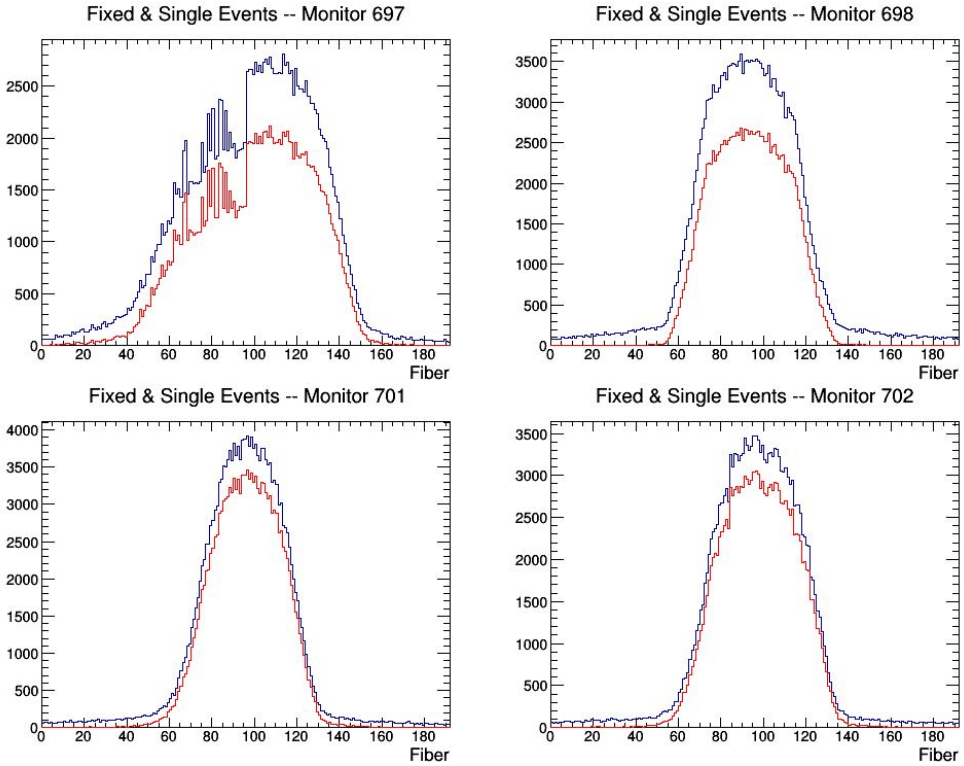
Mitigation Attempt



Mitigation Attempt



Mitigation Attempt



Conclusion

Identified how the extra-activation issue in fibers manifests itself

- Fiber activations are repeated in the next event/trigger in 2 of the 32-bit fiber sets

Have a potential workaround for this issue

- If repeats occur for these 2 sets of fiber, ignore them
- Treat other activated fibers as truly activated

Still investigating issues with Monitor 697

- Rate or efficiency difference within fibers
  - Due to ASIC configuration
- Shape differences between monitors and between data/MC
  - Related to ASIC configuration?
  - Some other cause from within the beamline?

Thanks for listening