Beamline Systematics

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Introduction

The ProtoDUNE beamline provides for beam-related analyses:

- Momentum measurement
- Location at the face of the TPC
  - Cutting out wrongly-tagged beam particles
- PID of beam particles

Need to understand beamline performance and systematics (i.e. momentum resolution)

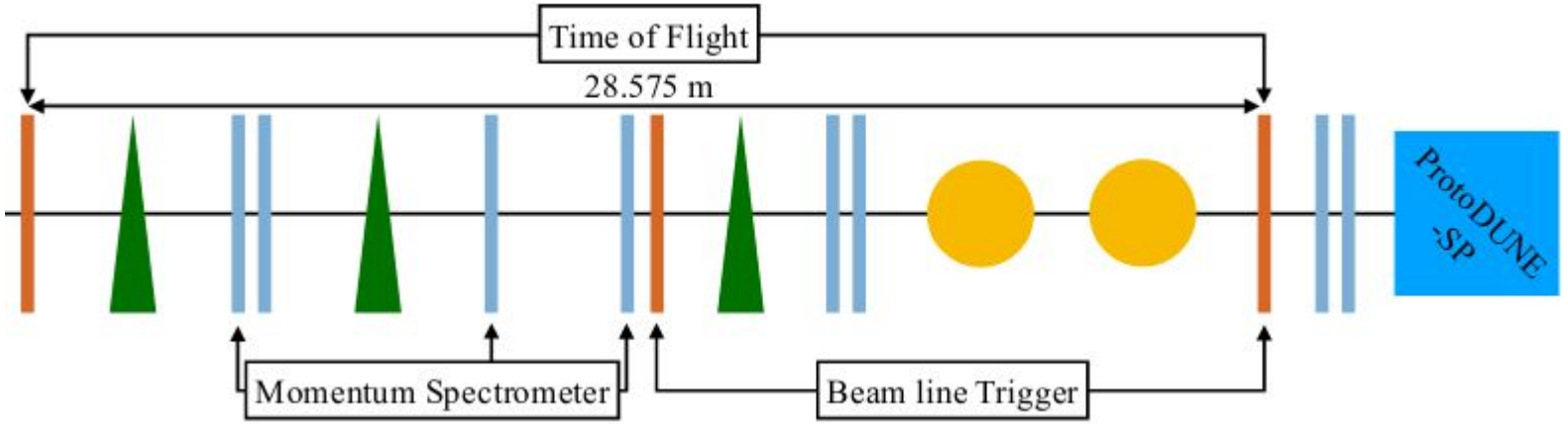
Beamline Layout

Bending Magnets

Scintillator Profile Monitors For Momentum/Tracking

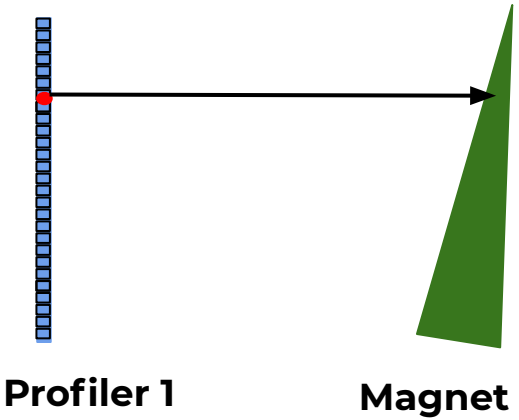
Scintillator Planes for TOF and Trigger

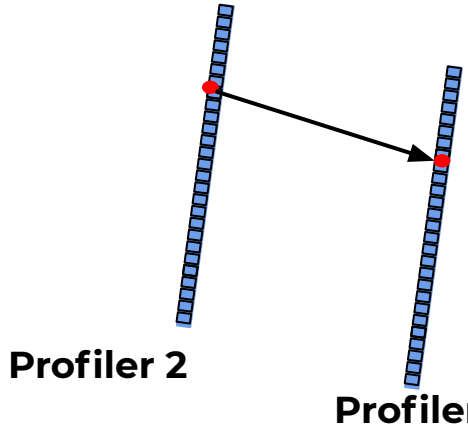
Cerenkov Devices for Particle ID (PID)

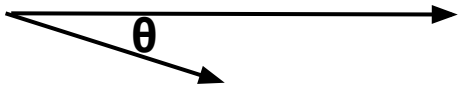


Momentum Calculation

- Project hit in Profiler 1 to magnet, connect hits in Profilers 2,3
  - Get **θ** between these trajectories
- Get current in magnet: $\mathbf{I_B}$
- Momentum: p ~ f($\mathbf{I_B}$) / **θ**



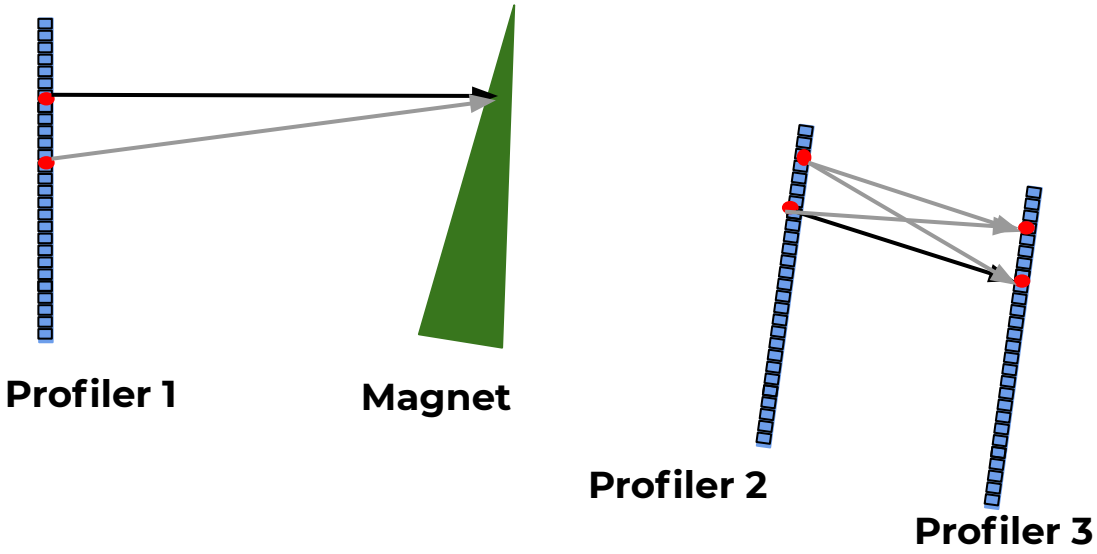




Momentum Errors

Multiple hits in profilers → multiple trajectories w/ different **θ**

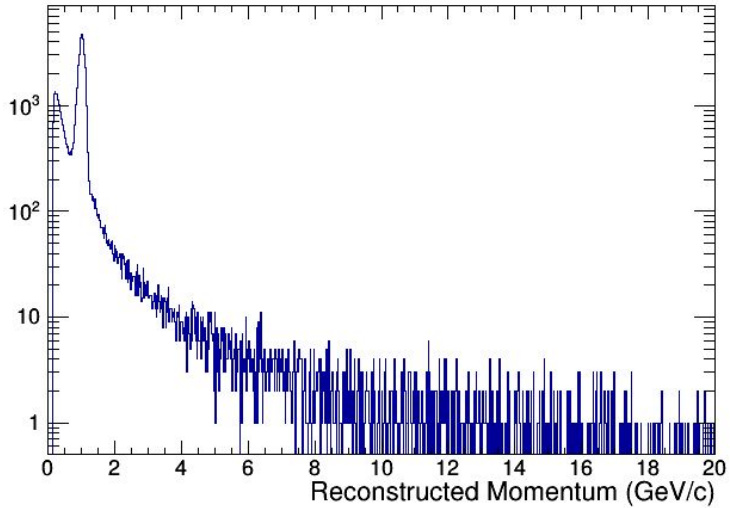
1) Which **θ** to choose?
2) Sometimes drastically different momentum reconstructed (next page)

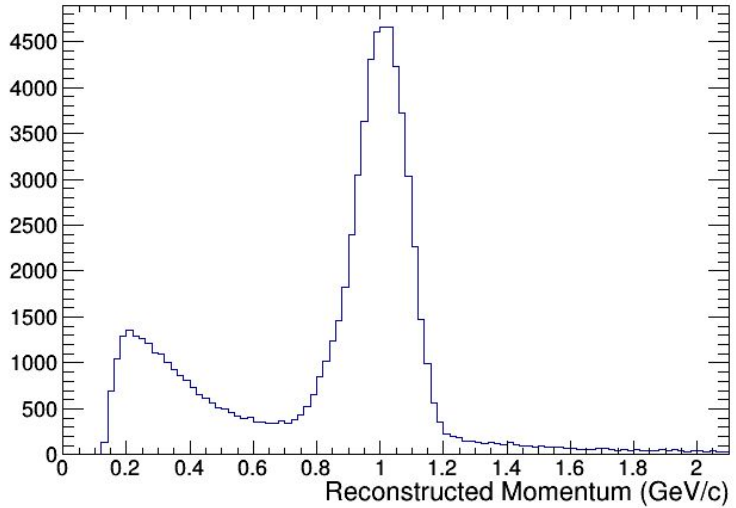


Momentum Errors

Without requiring singular reconstructed momentum:

- Distribution can extend quite high
- Has a strange peak in the lower end

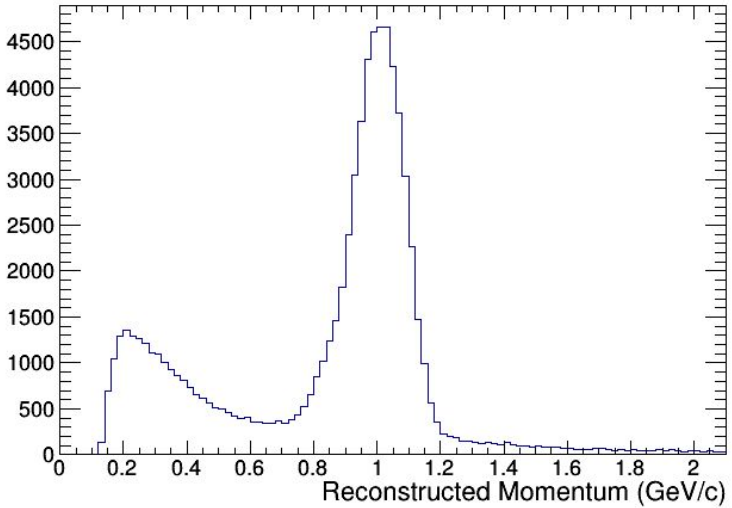


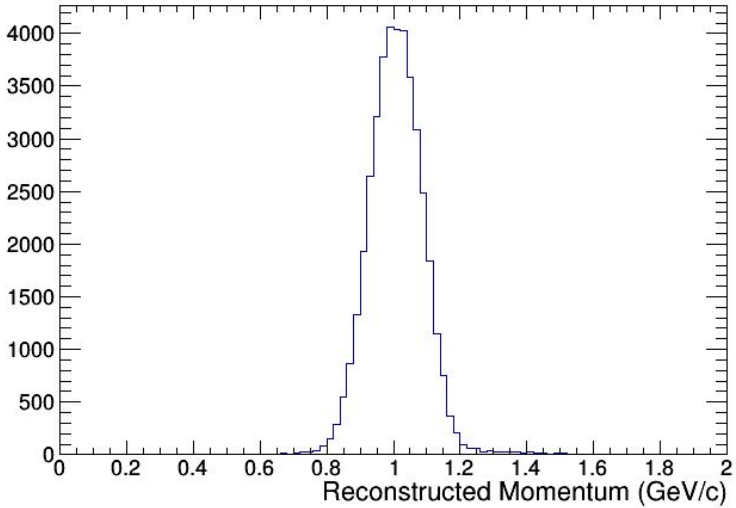


Momentum Errors

Requiring 1 reconstructed momentum fixes the distribution

Need to determine the efficiency of this (later slides)

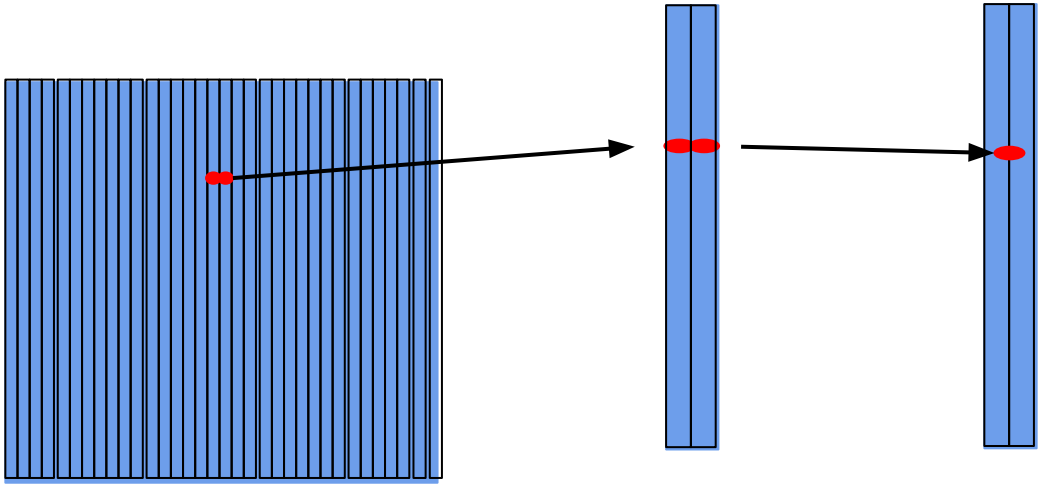




Neighboring Hits

Normally, position of hits in monitors are placed at center of fiber (1mm width). Neighboring hits → Condense to boundary between fibers.

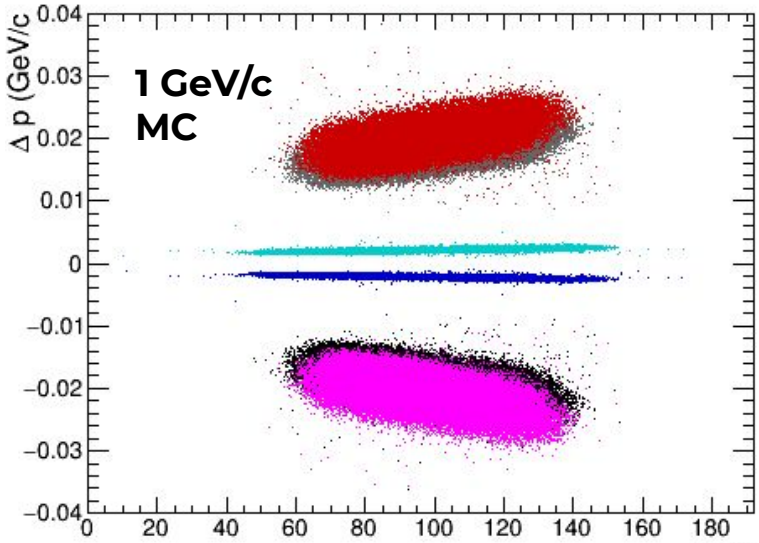
Represents a ±0.5mm shift in the position → How does this affect momentum reconstruction?



Neighboring Hits

For each fiber, shifted position by ±0.5mm in the 3 different monitors (separately)

Blue/Teal: First Red/Magenta: Second Black/Grey: Third



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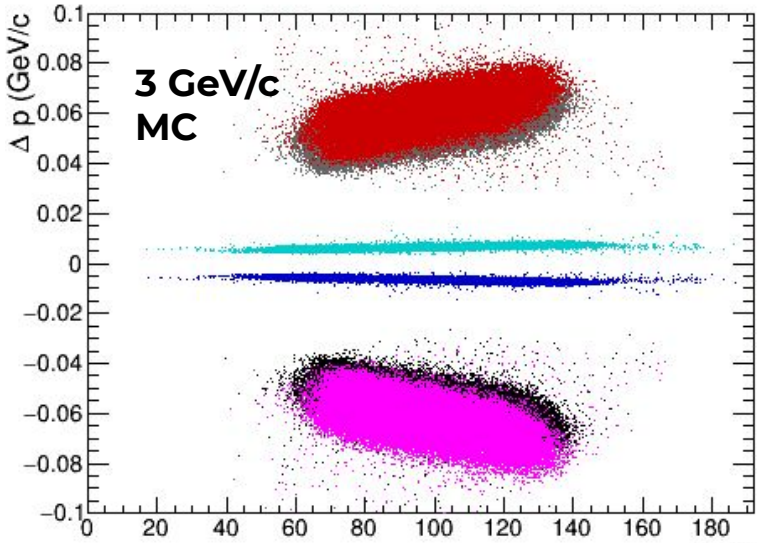

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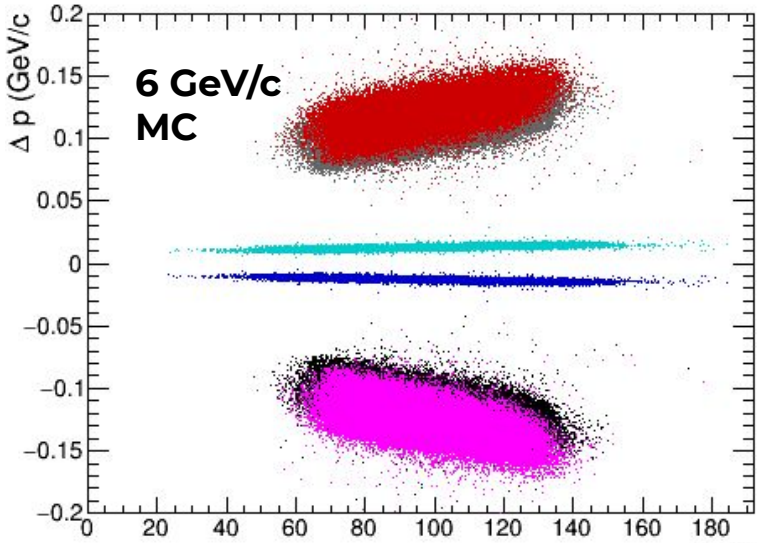


Neighboring Hits

Shift amounts to:

~0.3% in Profiler 1

~2.5% in Profiler 2

Can we just cut these all out? → Need to see how often neighboring hits occur (next slide)

Efficiency

Requiring “Perfect” pion-like events (1 fiber in each momentum spectrometer monitor -- 1 track from tracking monitors)

~60% efficient

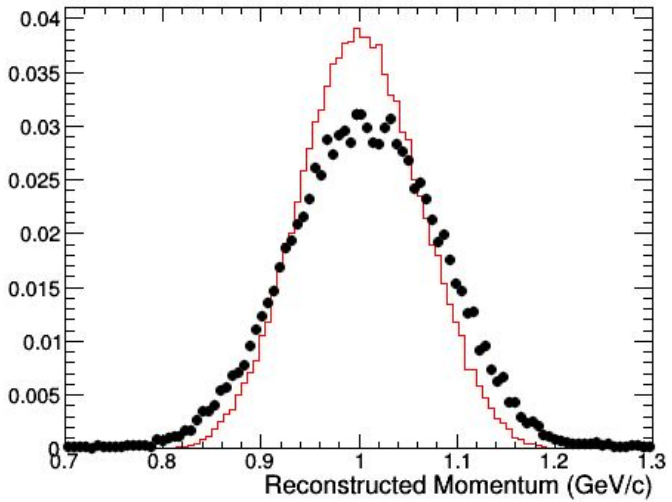
	Momentum (GeV/c)			
	1	2	3	6
	Run Number			
	5387	5432	5786	5770
π-like	26594	33517	84602	88086
	100	100	100	100
1 Momentum	23567	30573	77938	79104
	88.62	91.22	92.12	89.80
1 Track	17569	24297	61086	60694
	66.06	72.49	72.20	68.90
1 Track, 1 Momentum	15704	22306	56637	55203
	59.05	66.55	66.95	62.67
1-Fiber in Spec.	14943	21265	54074	52680
	56.19	63.44	63.92	59.81

Total
Percent

Comparison to MC

Compared run 5387 data to beam simulation files (used as input for our event generation)

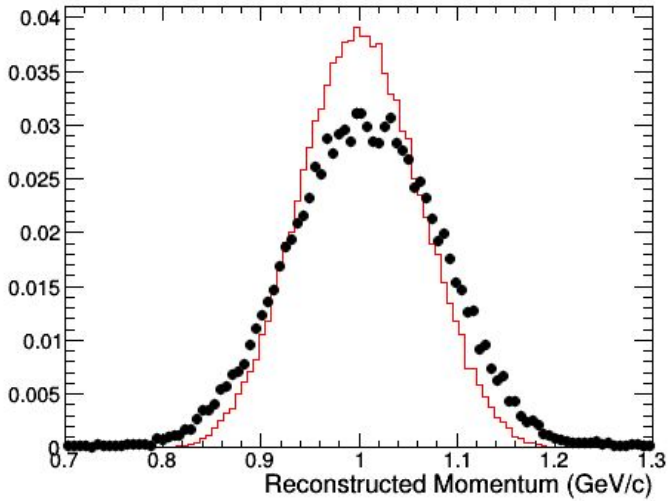
Data is slightly wider than MC (Agrees with what beam experts see)



Comparison to MC

Note: Even if these disagree, if the event-by-event resolution (predicted ~2-2.5%) agrees, then we're "ok"

Need to understand why these disagree → Could be coupled to event-by-event resolution

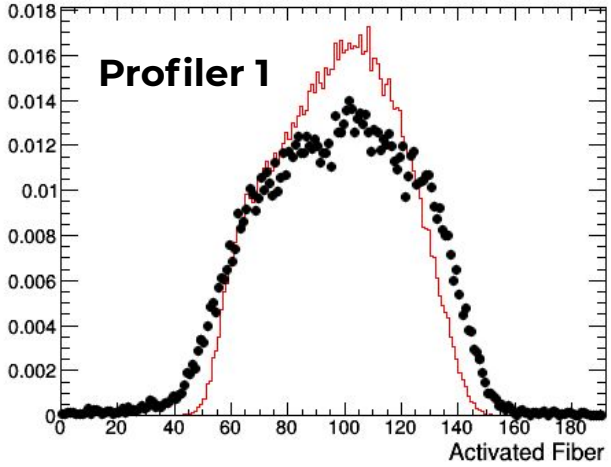


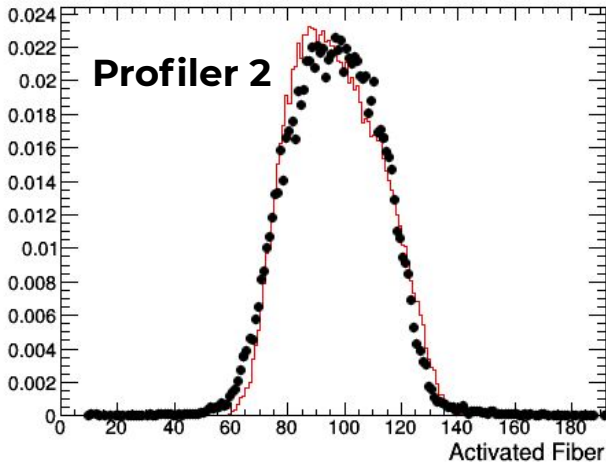
Comparison to MC

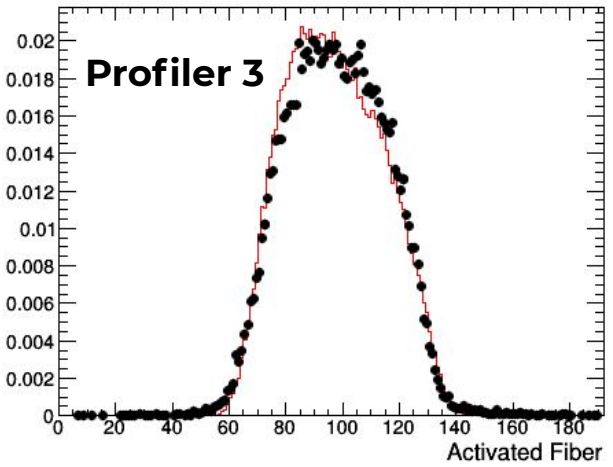
Tried digging into what was causing the spread

Looked at activated fibers in the 3 monitors

Required single reconstructed momentum





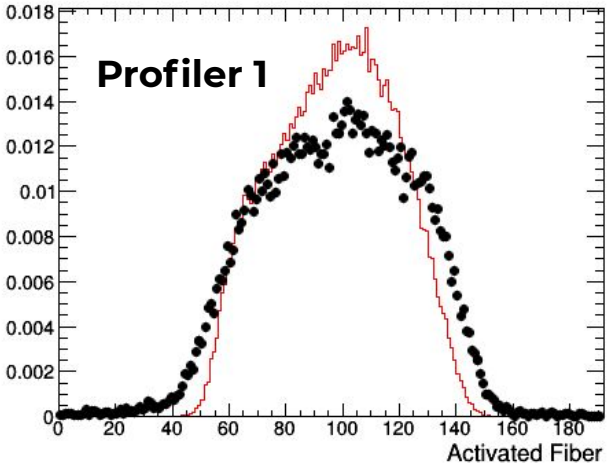


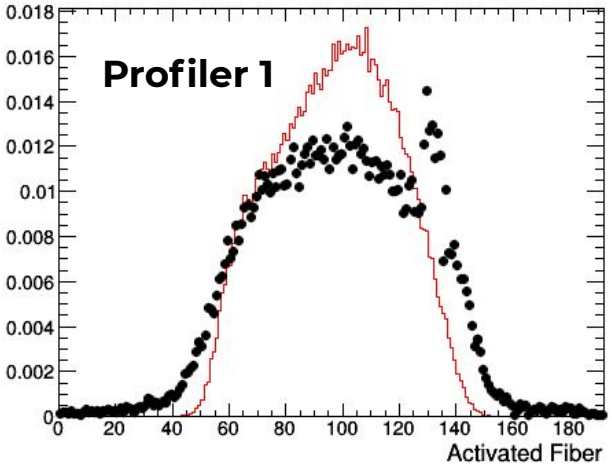
Comparison to MC

In addition to spread, noticed a few peculiarities

1) Gap at Fiber 96 (Left)
2) Bump present when observing duplicate hits (Right)

In talks with experts to determine cause/solution





Conclusion

Can keep ~60% events while requiring “perfect” events

Noticed some issues with some instrumentation

- In contact with experts to diagnose this

Thanks for listening