Update on EKLM strip efficiencies

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KLM Meeting

December 5, 2022

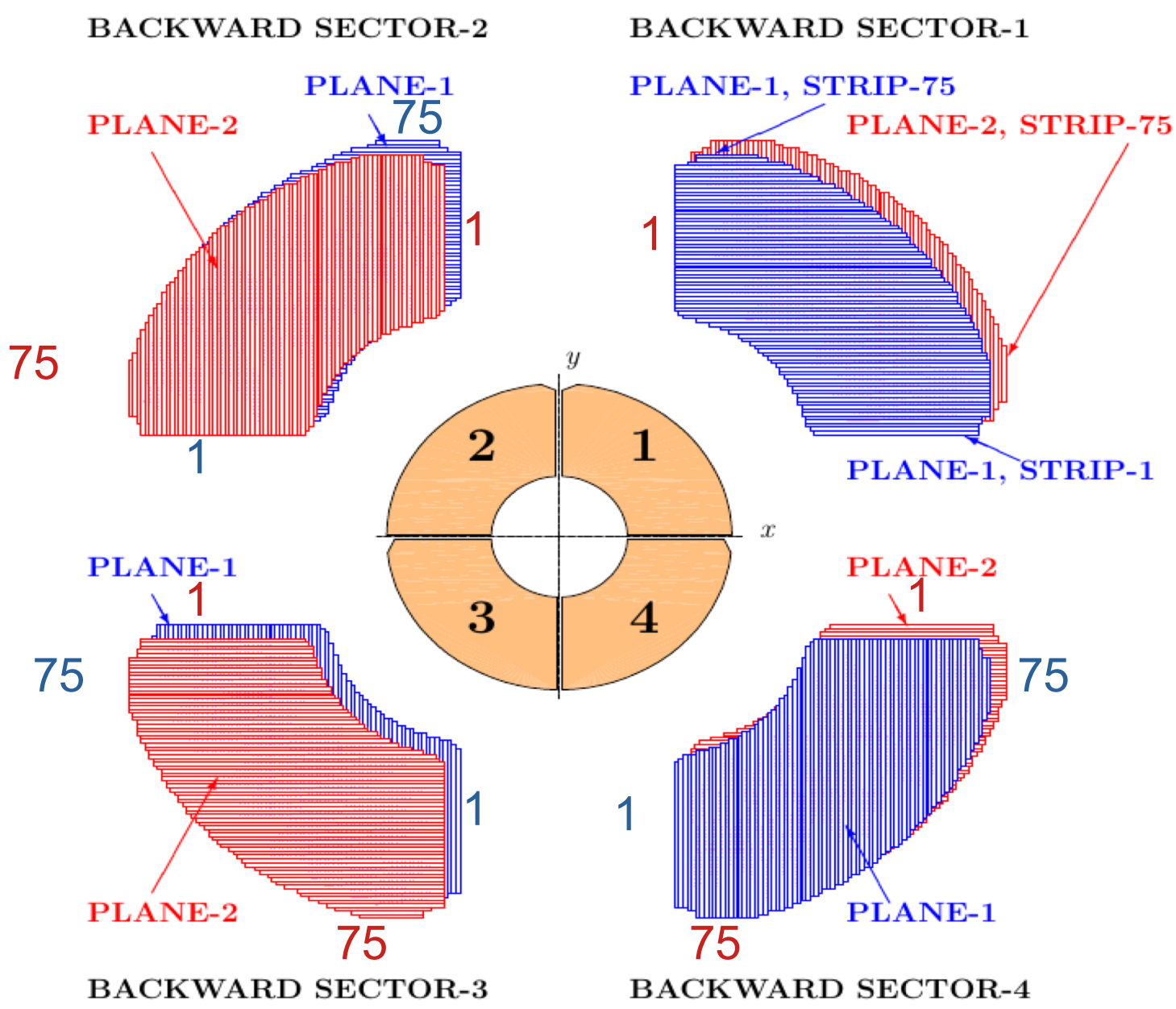
Strip numbering in EKLM

Numbering is mirrored for the forward EKLM.

Note,

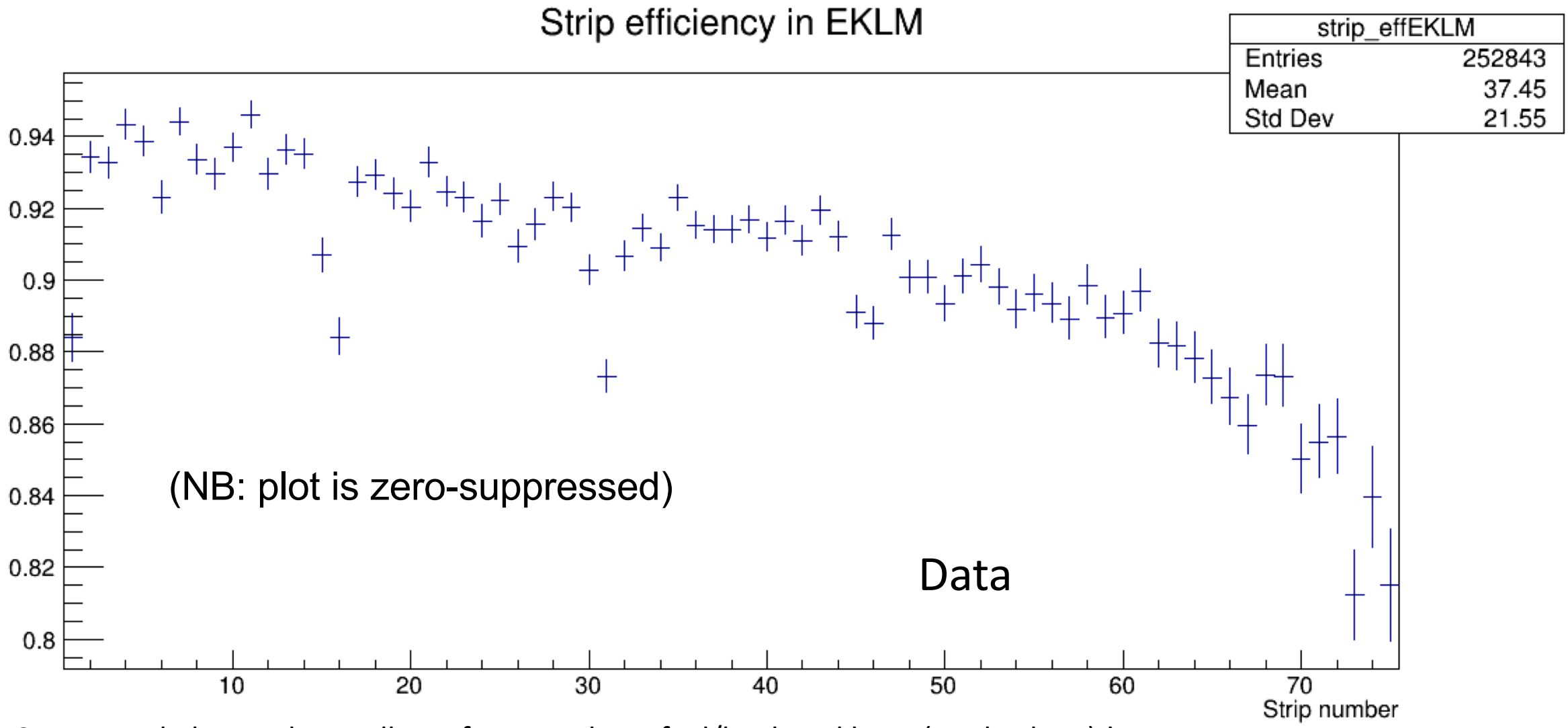
1) Both planes (1 & 2) can either be horizontal or vertical strips !!!

2) Strip 1 always has a mostly “radial” orientation, whereas strip 75 always has a mostly azimuthal orientation



The problem: EKLM efficiency (# matched hits / # extrapolated hits) decreases with strip

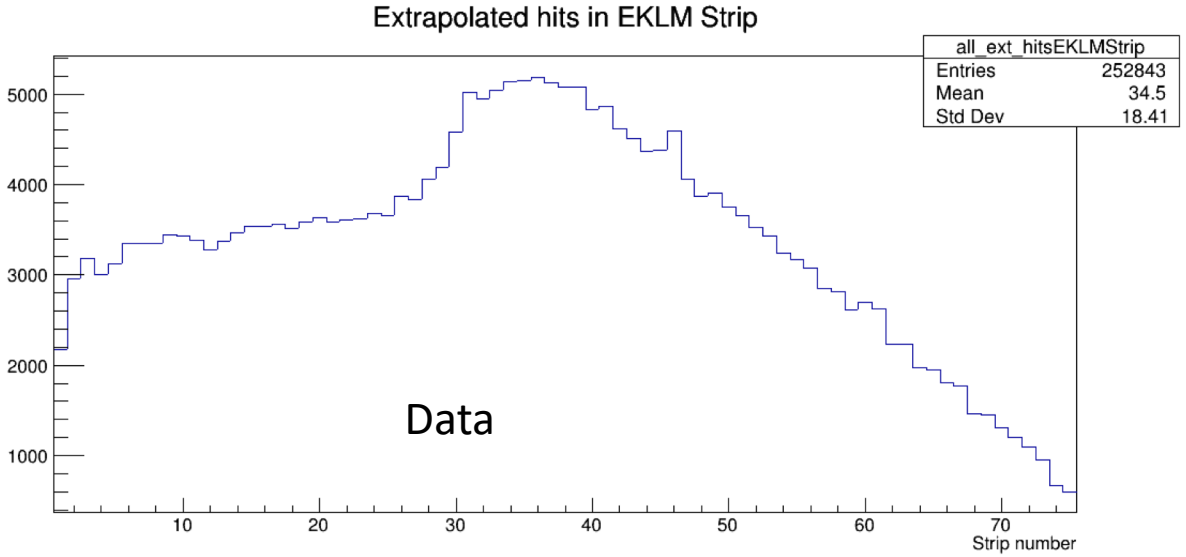
(It's been known for a long time that the average EKLM layer efficiency is only ~90%)

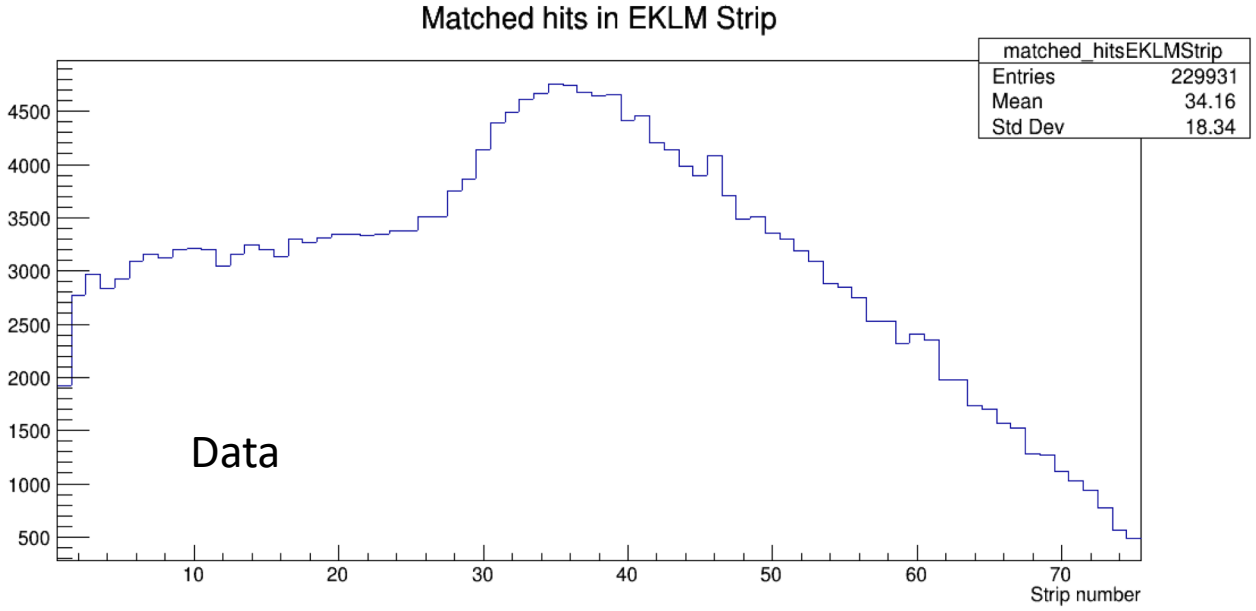


Same trend observed regardless of sector, plane, fwd/bwd, and layer (see back-up) !

Strip number occupancy distributions for Extrapolated and Matched hits

All distributions are for e+e- → mu+mu- events (data, experiment 24, run 878)
Extrapolated (expected) hits are from CDC tracks extrapolated to the EKLM.
Official code from KLM DQM efficiency plots is used.





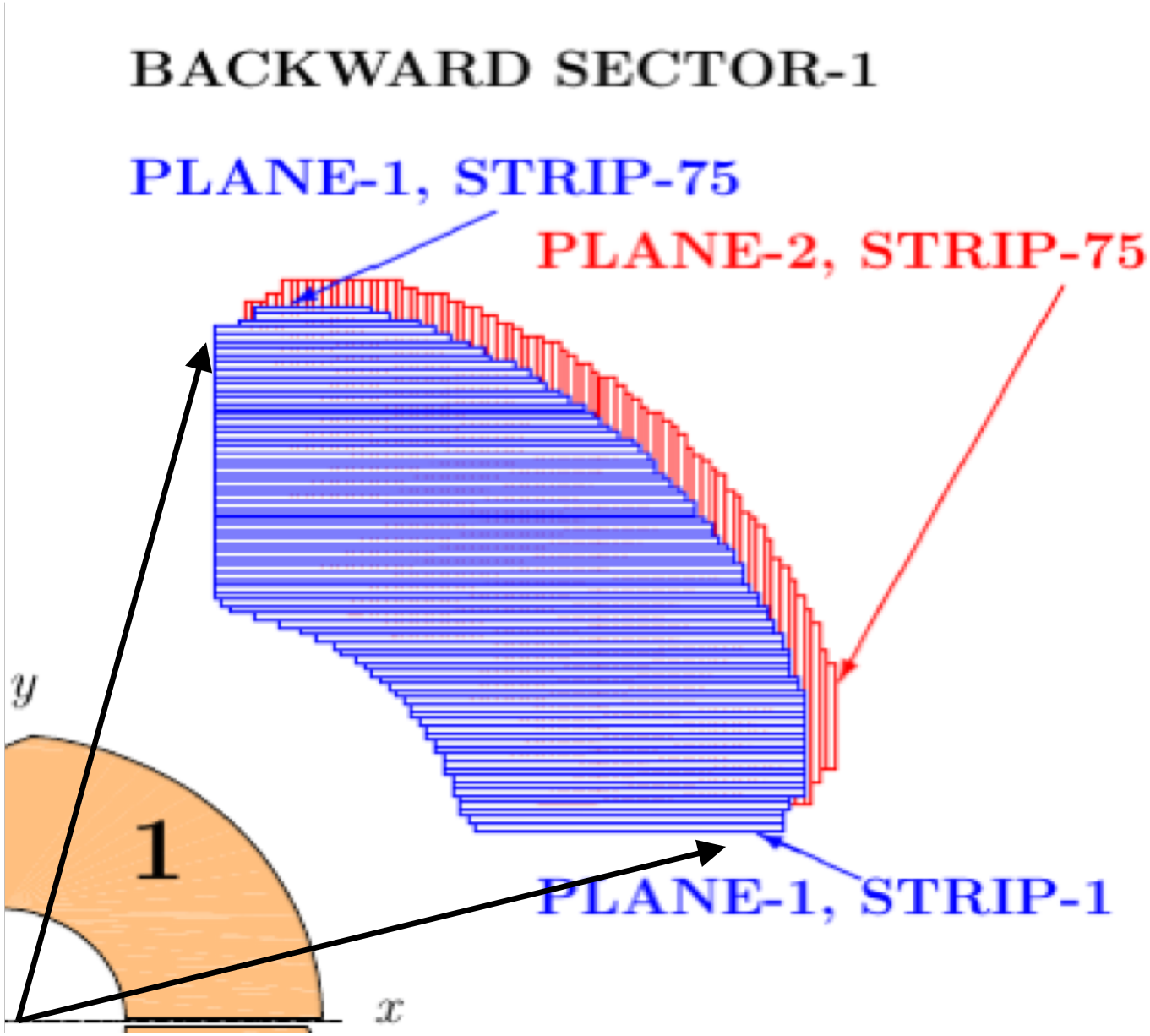
Occupancy distributions reflect strip length, location, and orientation, detector material, etc. (but mostly strip length).

Introducing multi-strip hits

- In groups of 15 strips, the strip with a hit is encoded with 4 bits (in case there's only one hit on these 15 strips), and a 5^{th} bit (TB5 or the multi-strip bit) is set to 0.
- If there's more than one hit on the 15 strips, TB5 is set to 1, and the meaning of TB1-4 changes
  - E.g., TB1 = 1 means there's a hit in the first group of 4 strips (strip 1-4), etc.
- The position resolution for multi-strip hits is 4 times worse than for regular strips
- **Multi-strip hits are not used** in 2D hit building, and therefore in the reconstruction of muon tracks or KL clusters

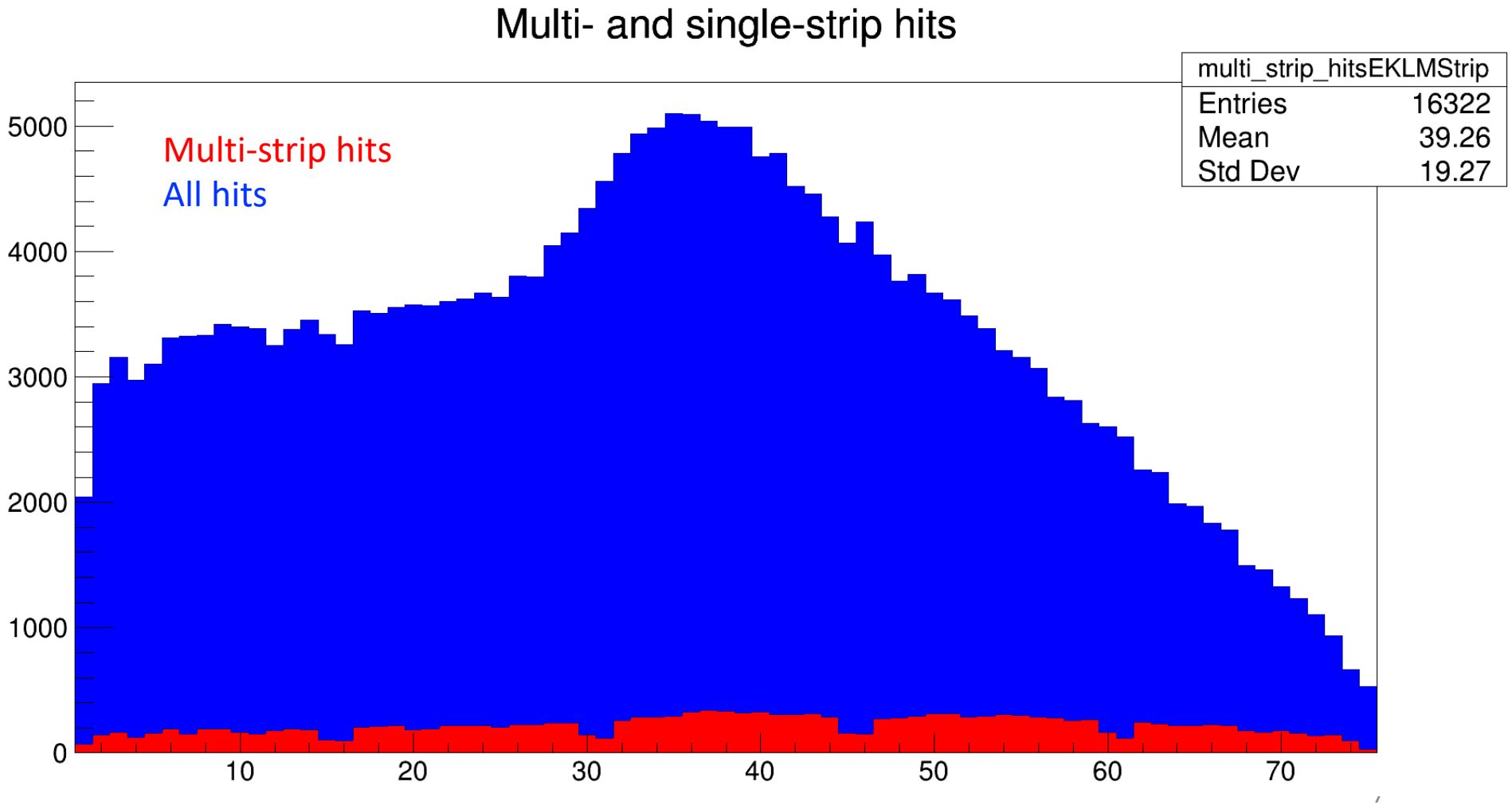
Due to the geometry, tracks from the IP have a larger chance of crossing 2 adjacent strips (aka “corner clippers”) in a plane at higher strip numbers.

This would lead to an increased fraction of multi-strip hits (and thus lower 2D hit efficiency) at higher strip numbers. (C. Ketter)



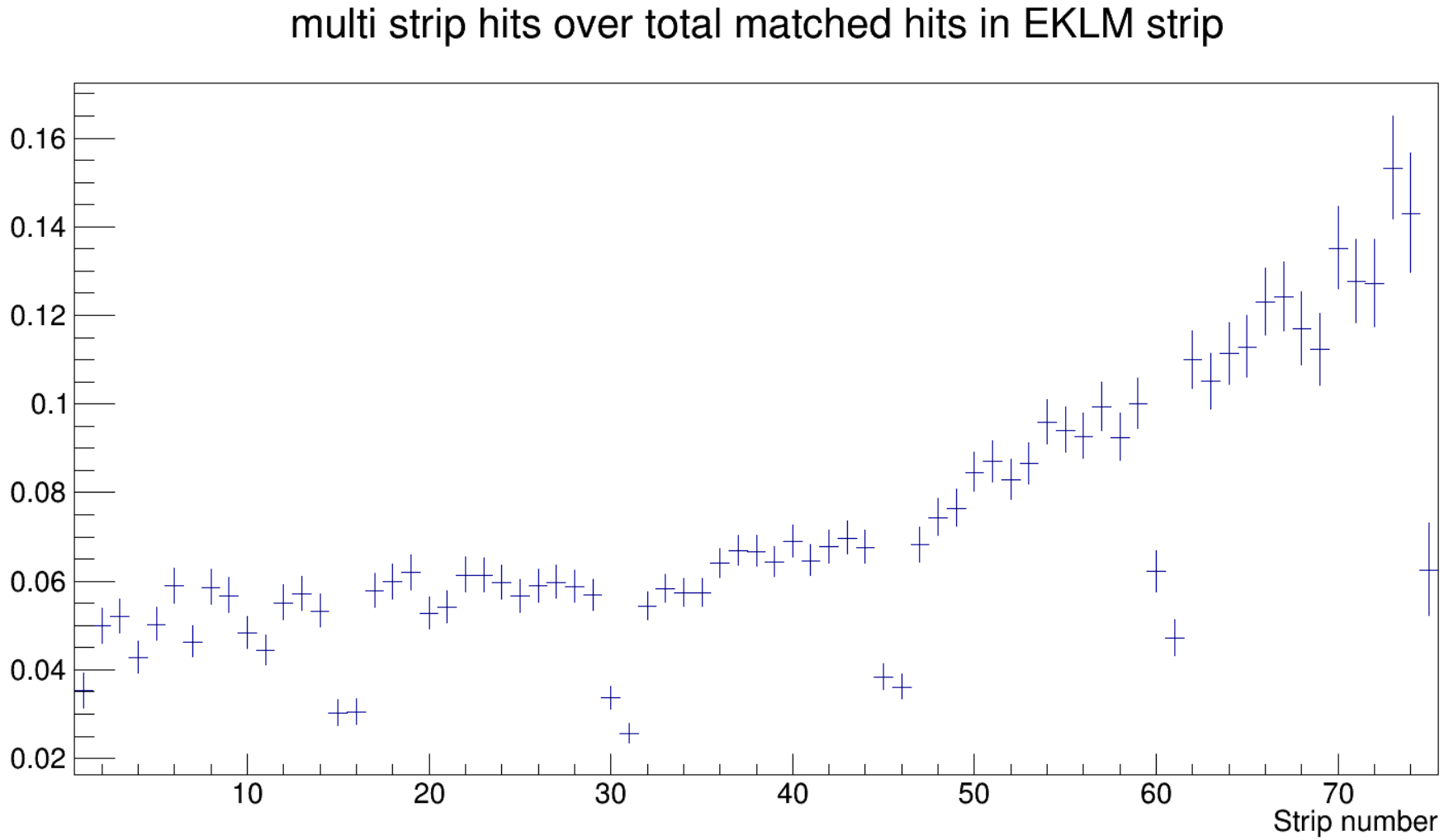
Regular and multi-strip hits vs strip number

- Multi-strip hits are present at a non-negligible fraction
- Multi-strip hits enter this histogram, if the TB for at least one group of 4(3) strips matches to a strip with an extrapolated hit



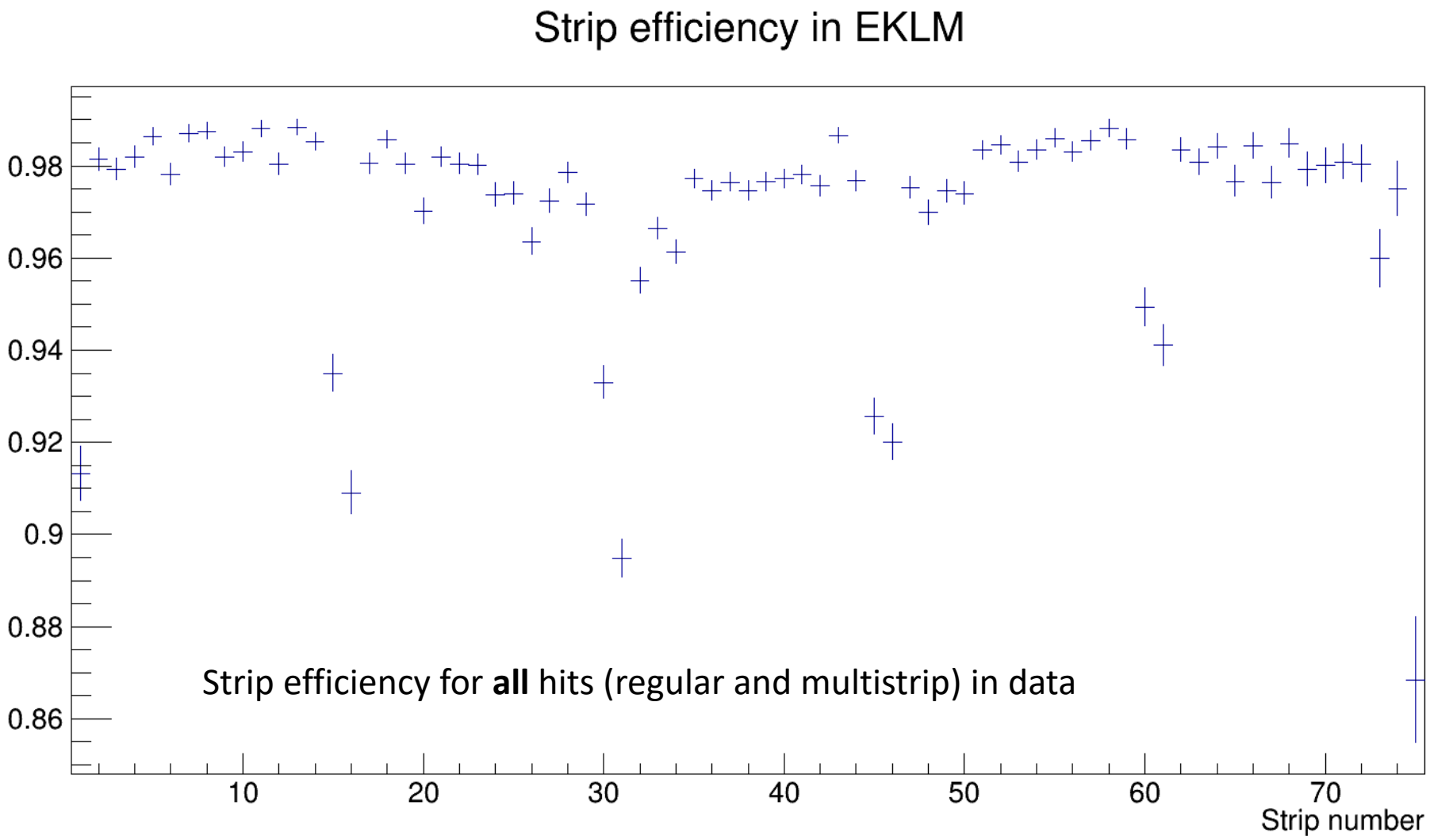
Fraction of multi-strip hits

- Fraction of multi-strip hits over all hits rises from ~5% for small strip # to ~15% at high strip numbers
- Multi-strip fraction is roughly halved at boundary of groups of 15 strips
  - Expected since 2nd hit in group can be on either side of first/last strip in the group
  - Only 2nd hit on same side will cause a multi-strip hit



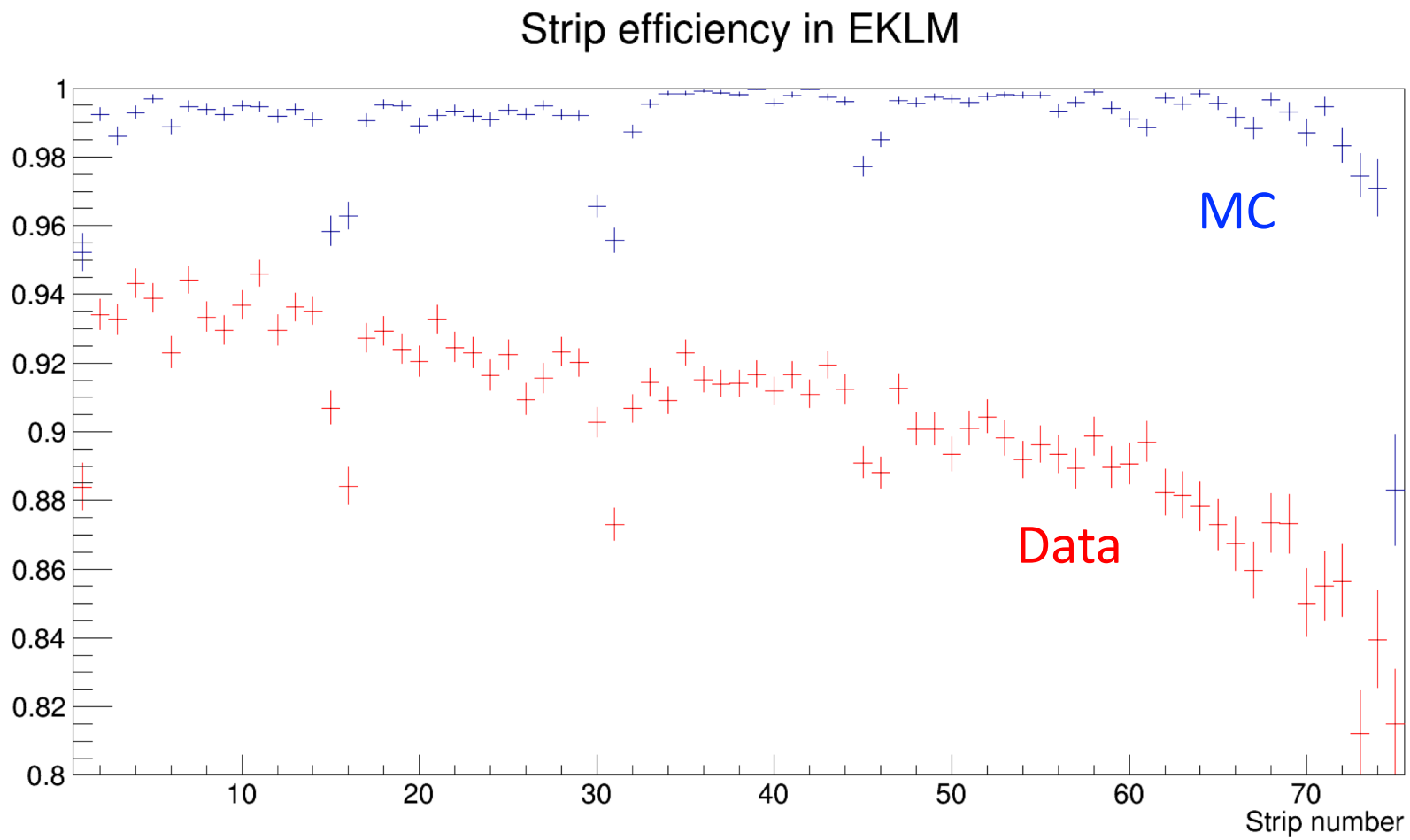
Hit efficiency with multi-strip hits included

- Hit efficiency for all hits (regular and multi-strip) shows no gradual decrease towards higher strip numbers
- Average strip efficiency around 98% (not including 15-strip group boundaries) and 86-95% at group boundaries



Multi-strip hits should be simulated in MC.

But we do not observe the same gradual drop-off in efficiency towards higher strip numbers due to multi-strip hits in MC.



Ignore the overall offset in efficiency. Calibrated layer-wise efficiencies have not been applied in this privately-generated MC.

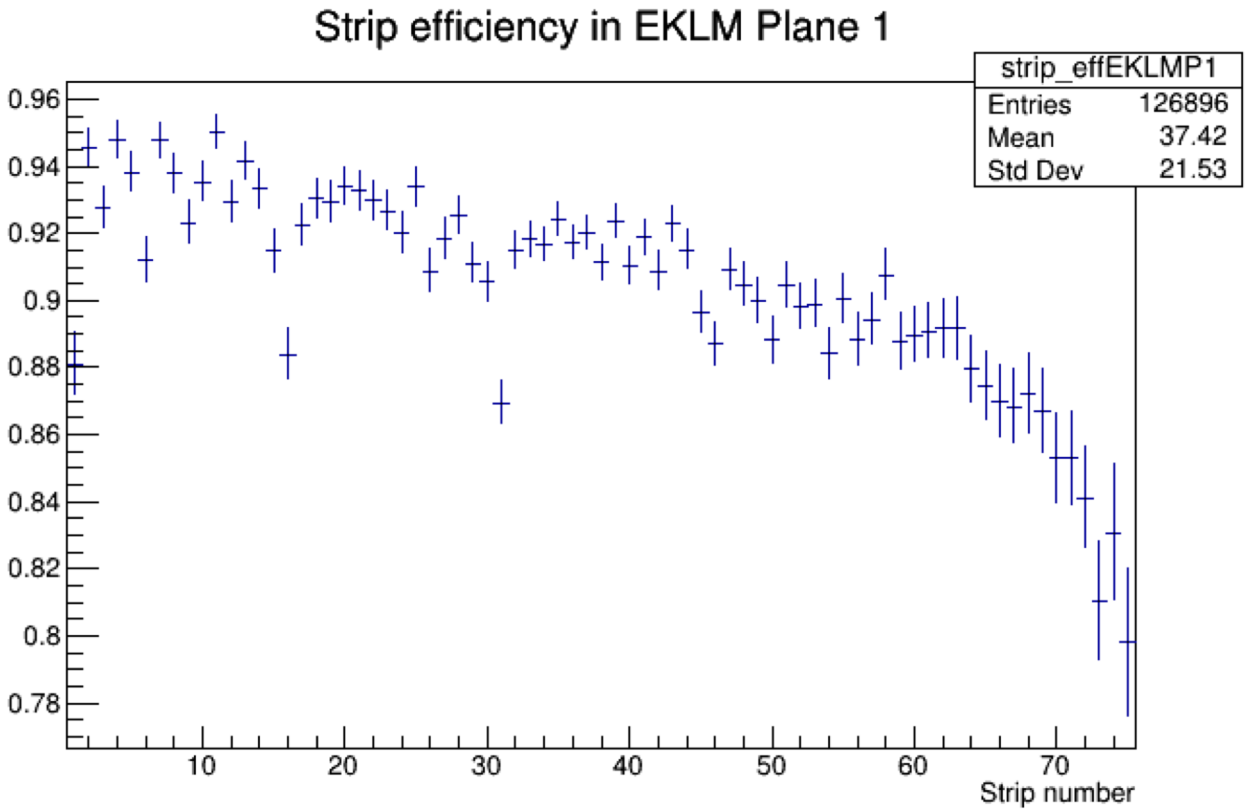
Conclusions

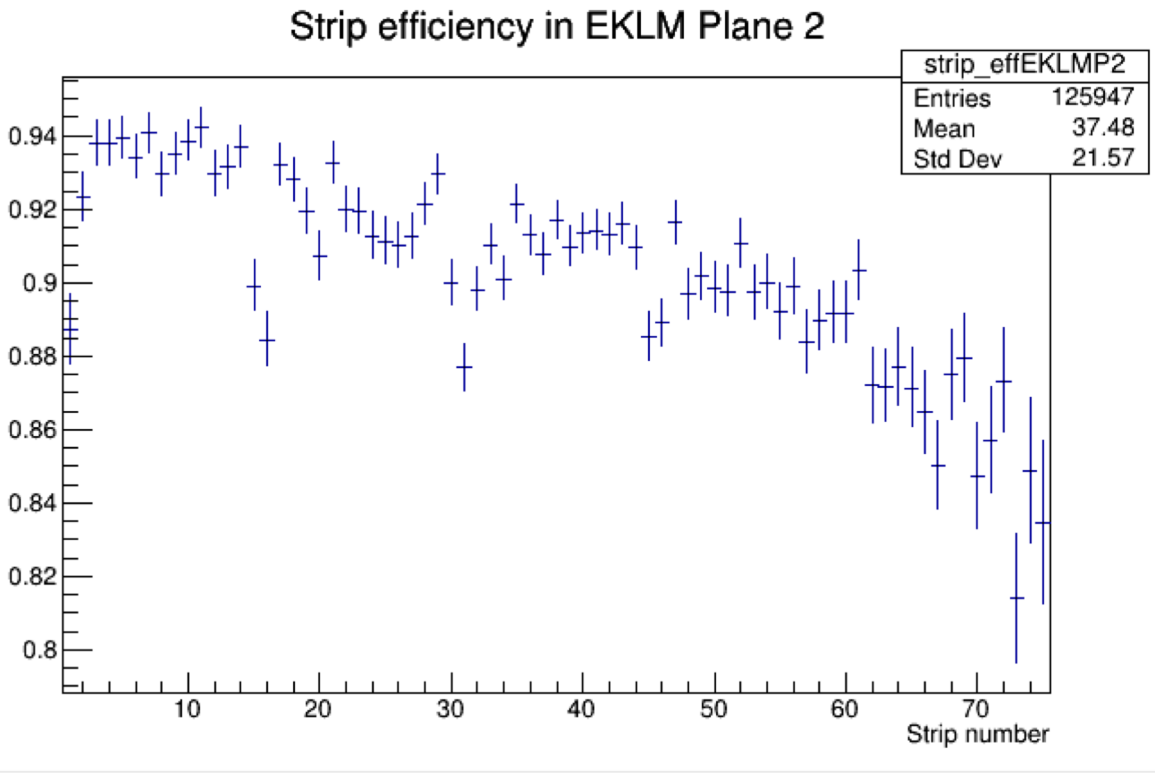
- Multi-strip hits occur mostly at higher strip numbers, which is expected from EKLM and track geometries
  - Fraction varies from 5-15% from lower to higher strip numbers
- If multi-strip hits are included in the EKLM strip efficiency calculation, the efficiency is roughly constant versus strip number at ~98%
- Since hit occupancies are still relatively low in the EKLM, it might be useful to include multi-strip hits in the building of 2D hits even if they would have a roughly 4 times worse position resolution
  - Potentially a bigger impact for K_L reconstruction and veto than for muon reconstruction

Back-up

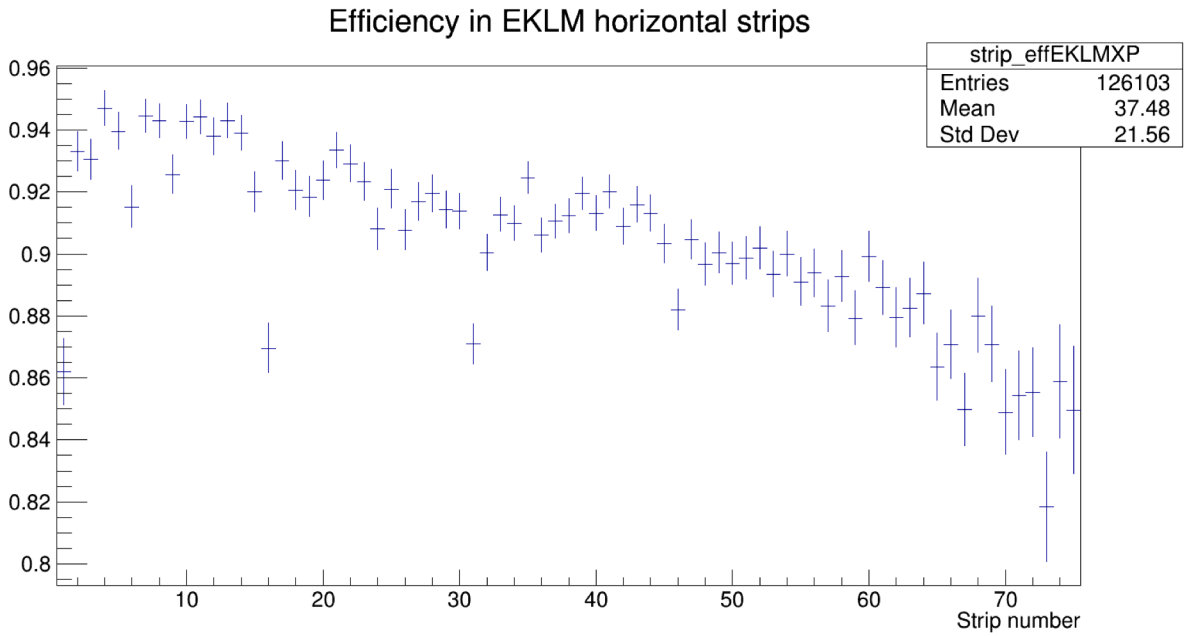
Check if efficiency variation depends on plane? No.

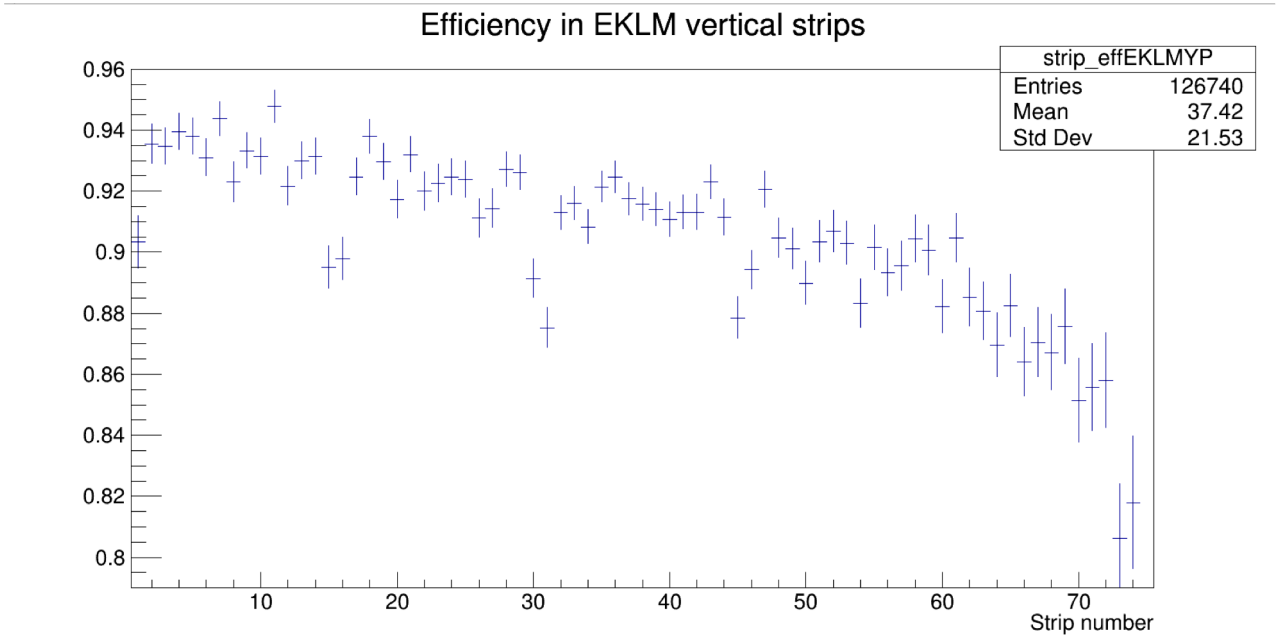
(Though these both contain both horizontal and vertical planes...)



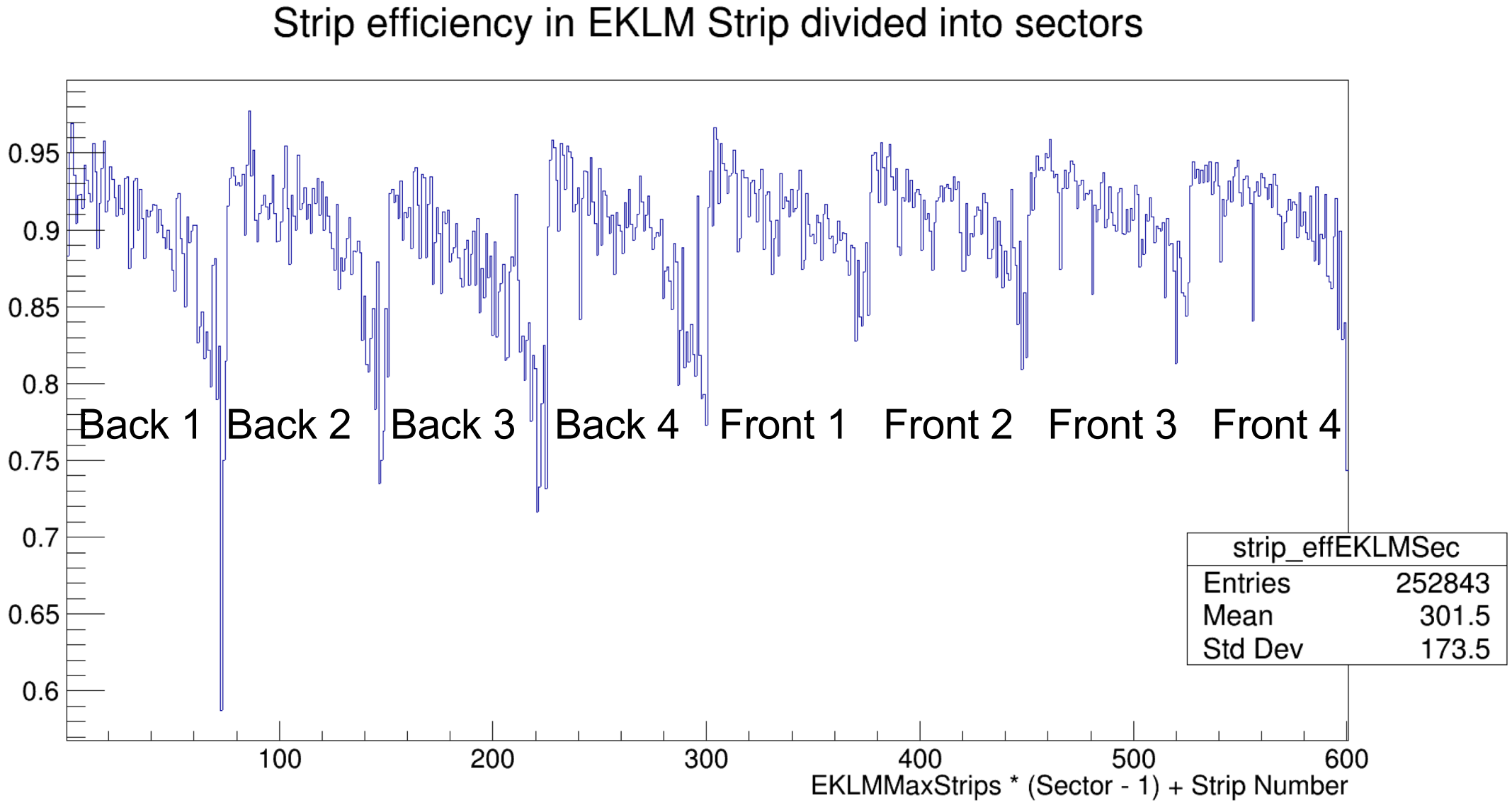


Also, not unique to plane orientation.

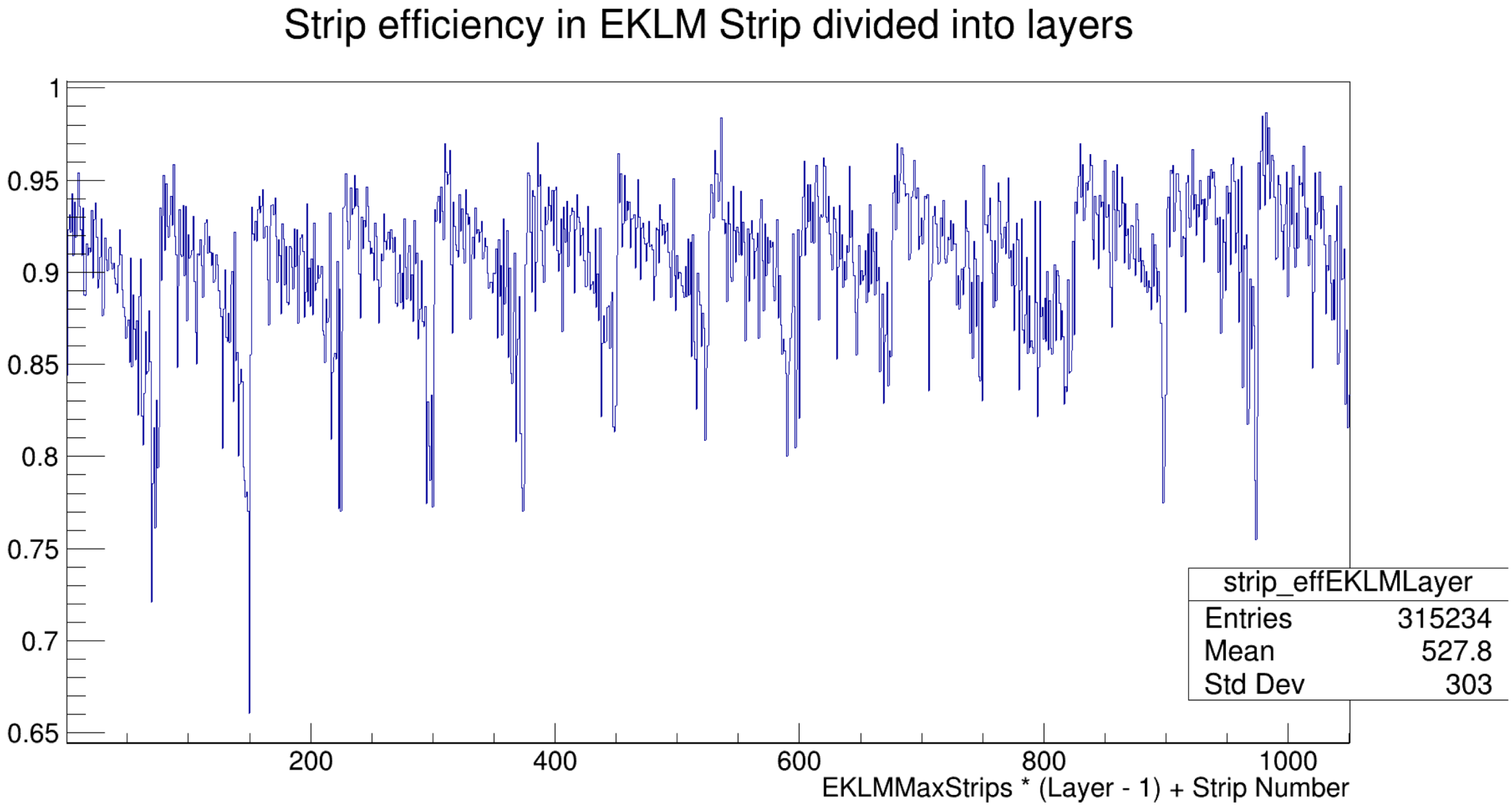




Unique to sector? Also, no !



Unique to layer? Still no.



Efficiency along a strip (horizontal strips only)

- No efficiency dependence, except in a narrow region around the ends

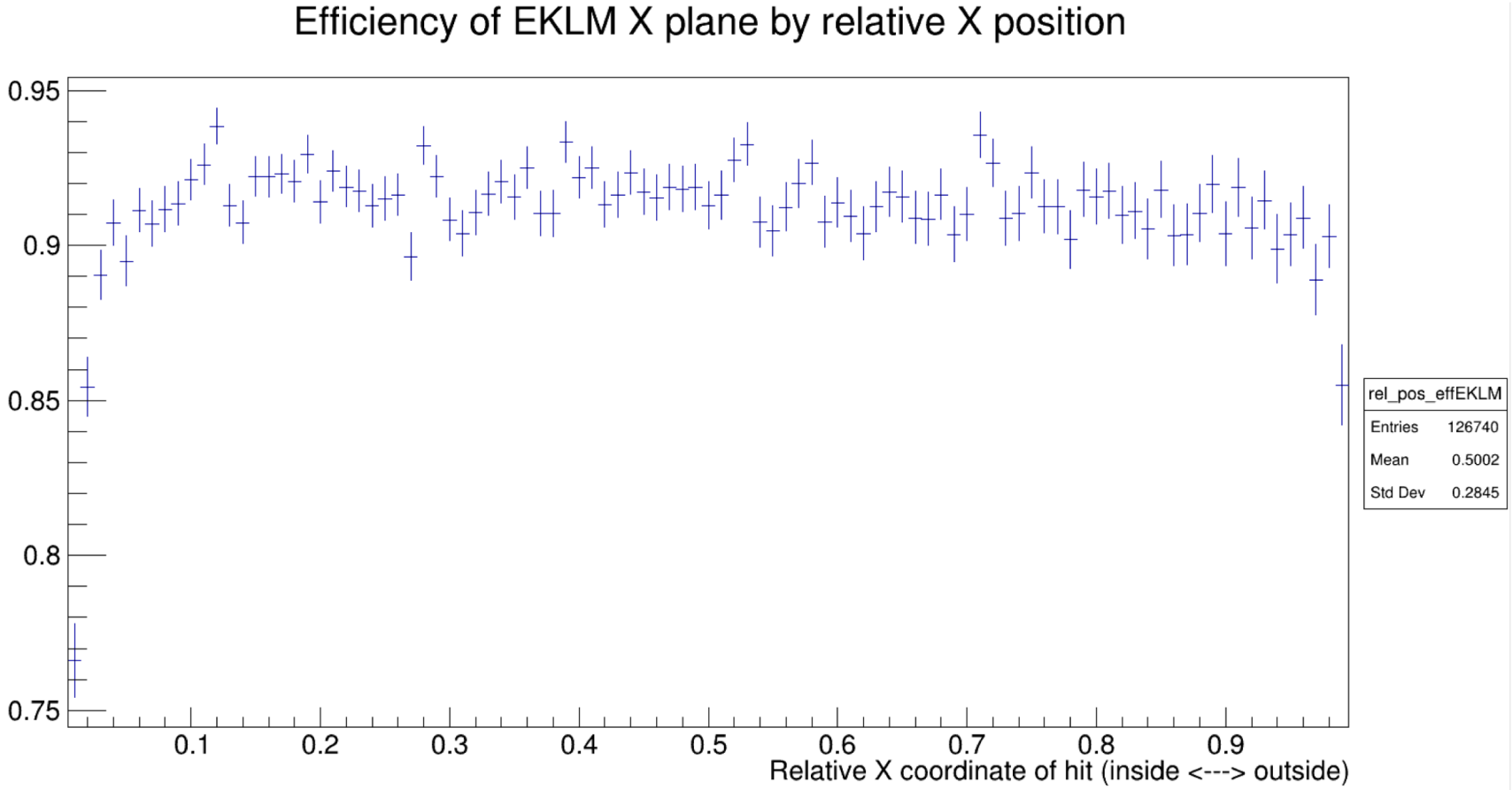


Figure 4: Efficiency of horizontal strips by X coordinate in EKLM data