PVDIS GEM occupancies update

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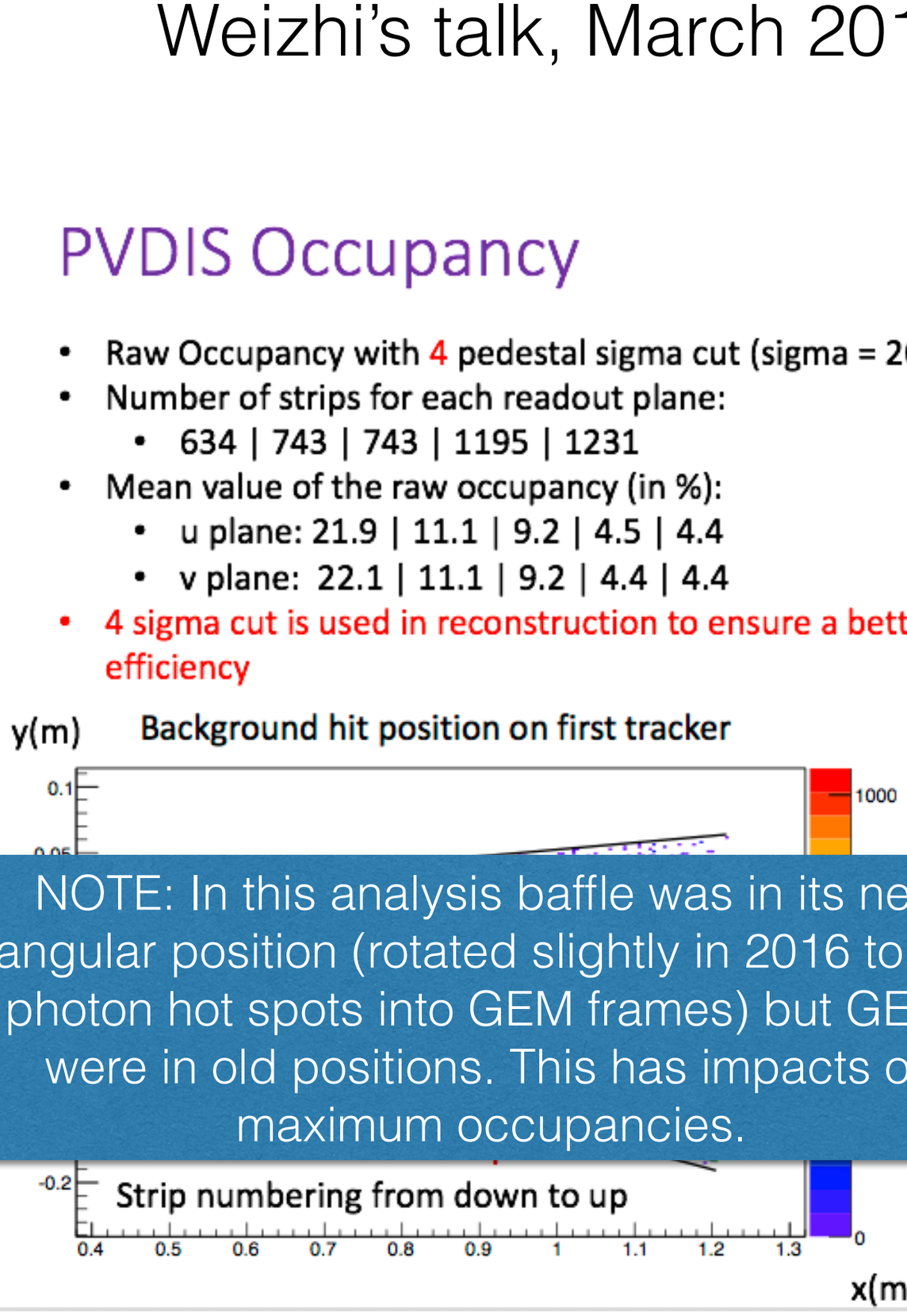
SoLID collaboration meeting 10/14/2017

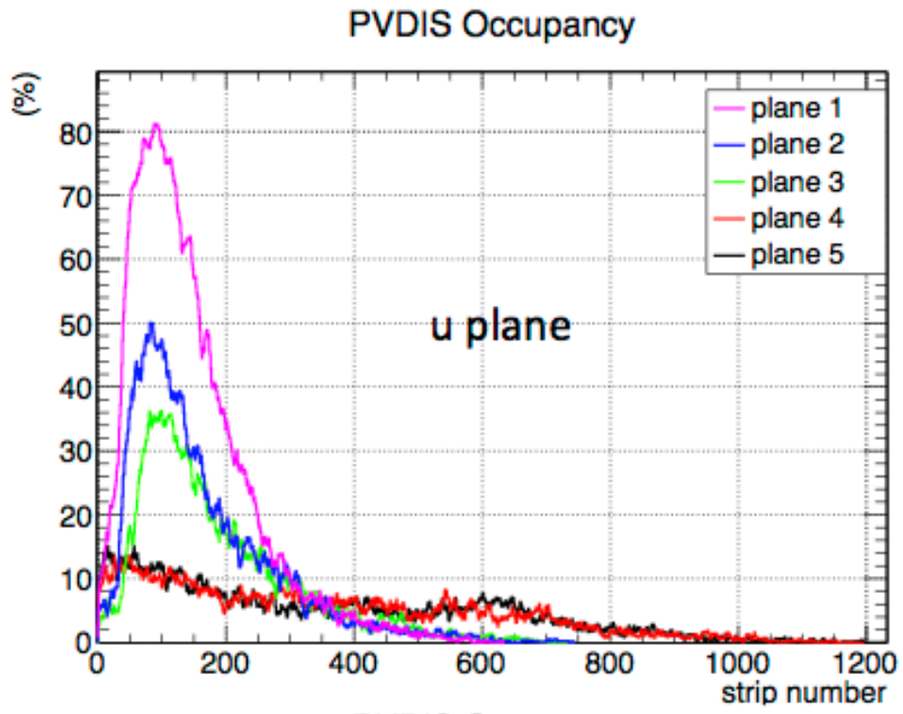
Weizhi's talk, March 2017 collaboration meeting

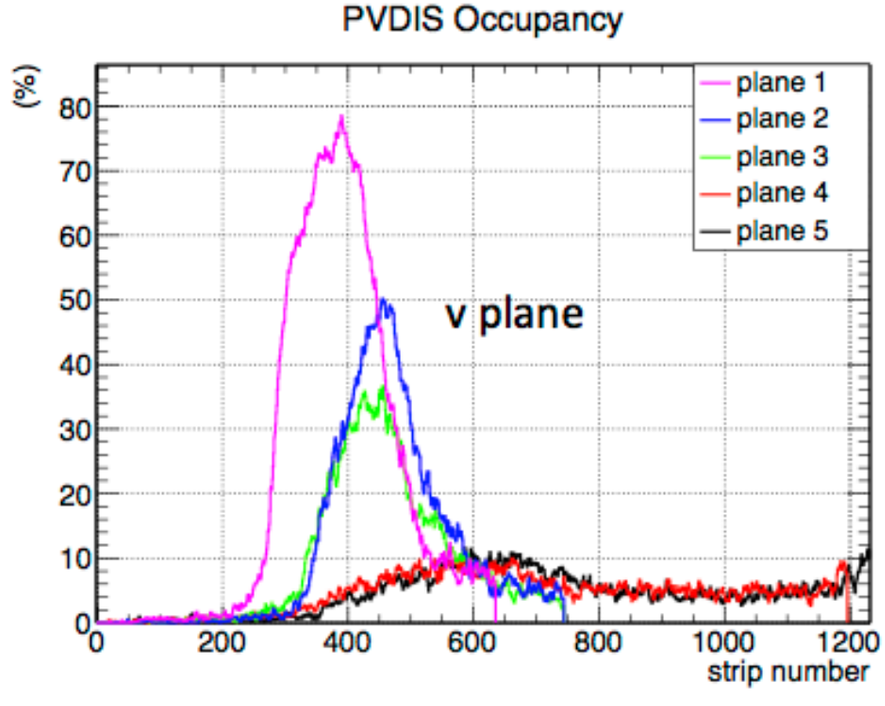
PVDIS Occupancy

- Raw Occupancy with 4 pedestal sigma cut (sigma = 20.7)
- Number of strips for each readout plane:
  - 634 | 743 | 743 | 1195 | 1231
- Mean value of the raw occupancy (in %):
  - u plane: 21.9 | 11.1 | 9.2 | 4.5 | 4.4
  - v plane: 22.1 | 11.1 | 9.2 | 4.4 | 4.4
- 4 sigma cut is used in reconstruction to ensure a better efficiency



NOTE: In this analysis baffle was in its new angular position (rotated slightly in 2016 to put photon hot spots into GEM frames) but GEMs were in old positions. This has impacts on maximum occupancies.





GEM digitization enhancements

- Dead areas can be arbitrary polynomials. (Previously rectangles only; In addition, edges deadened to account for GEM frames.)

- Strips can be divided into two substrips, avalanche charge is integrated over length and width of substrip.

- Increases cost and hardware complexity, but not by much if only a small range of strips are divided.

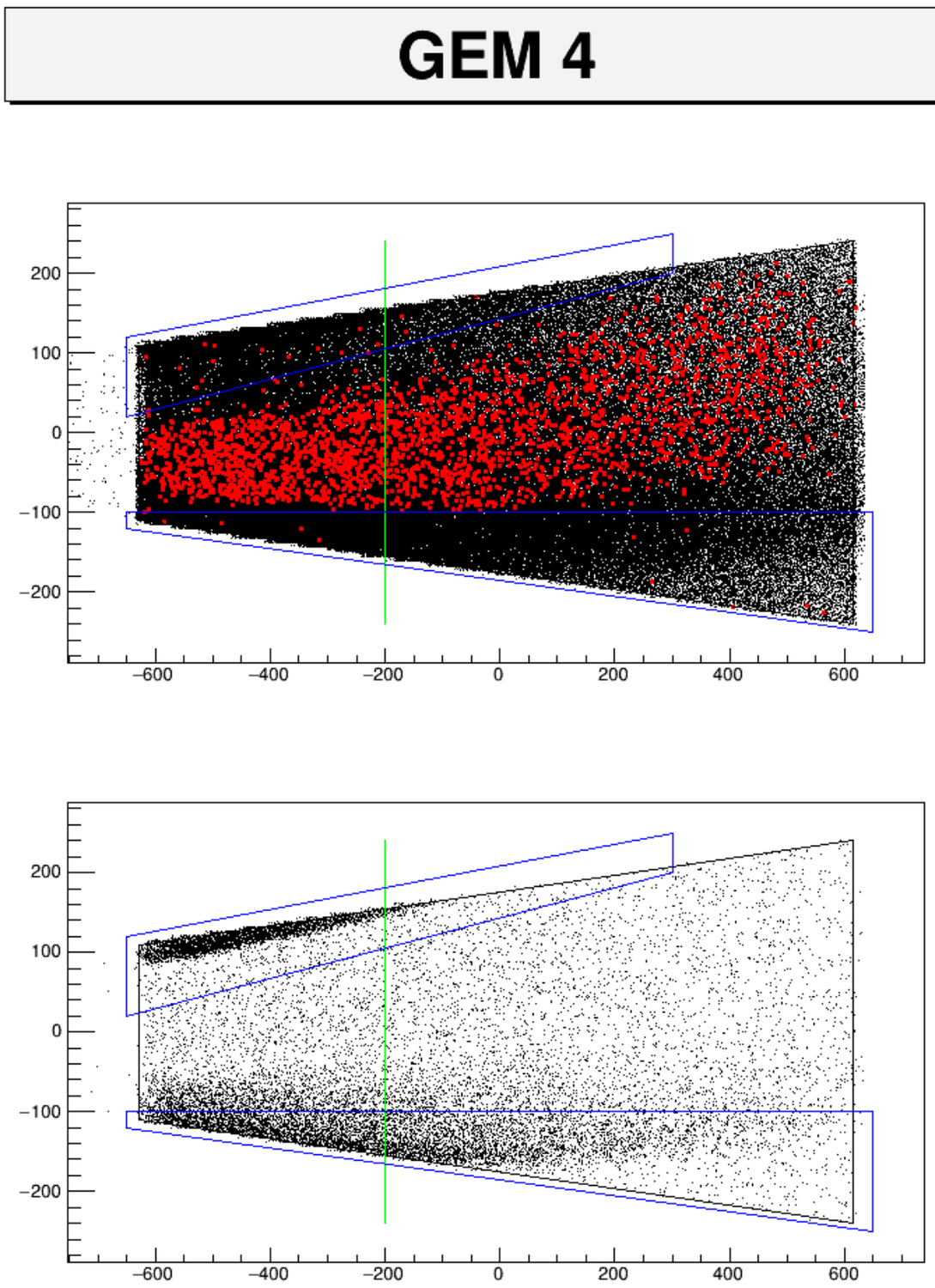
- This will require non trivial changes to matching and clustering algorithms. Workaround for present: Divide all strips.

Hit positions in GEM 4 (flux detector)

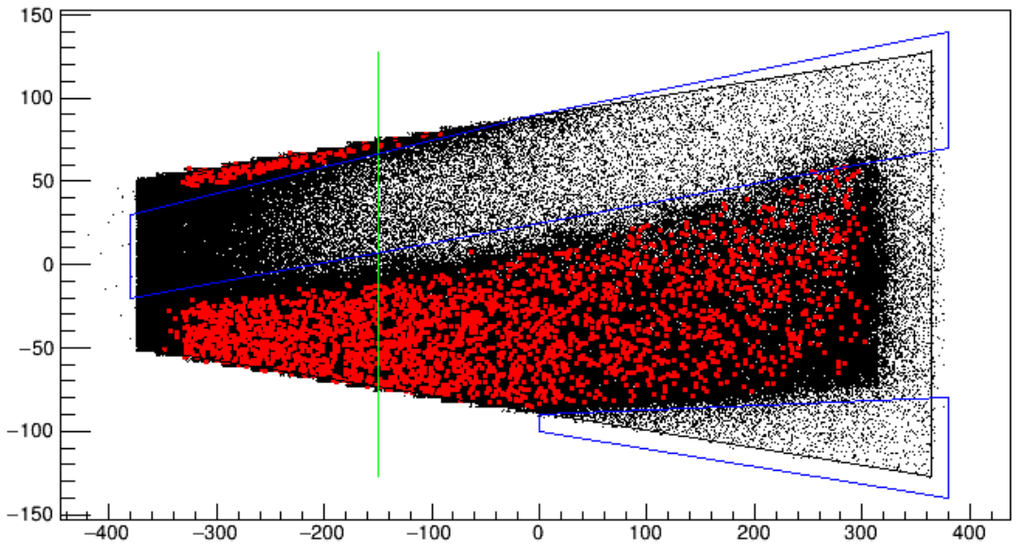
Top: Data from DIS generator, red dots are primary e^- with $Q^2>6$ GeV^2, W>4 GeV, x>0.55

Bottom: Data from GEANT beam on target

Green line: Division segment (actually not used for downstream GEMs here)
Blue boxes: Dead regions



GEM 1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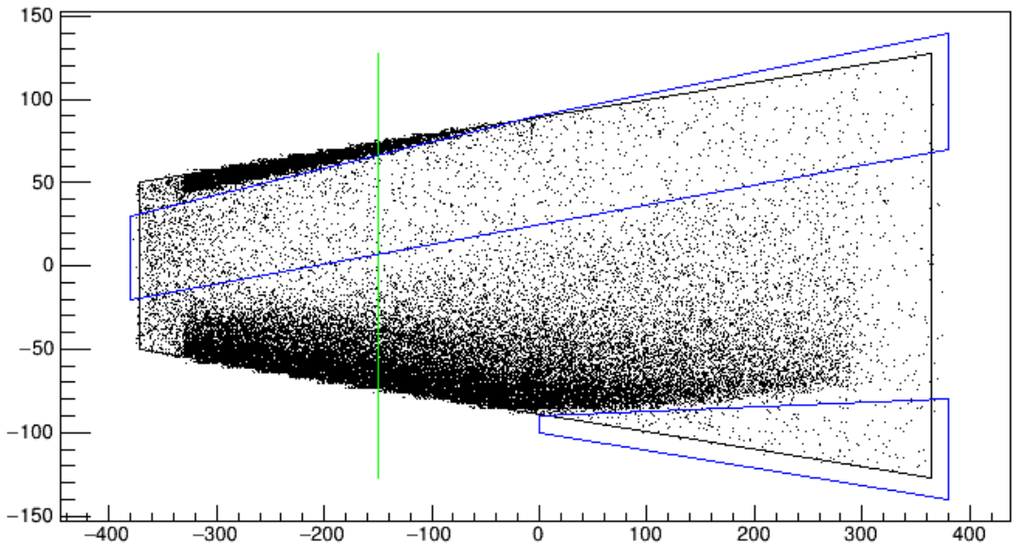
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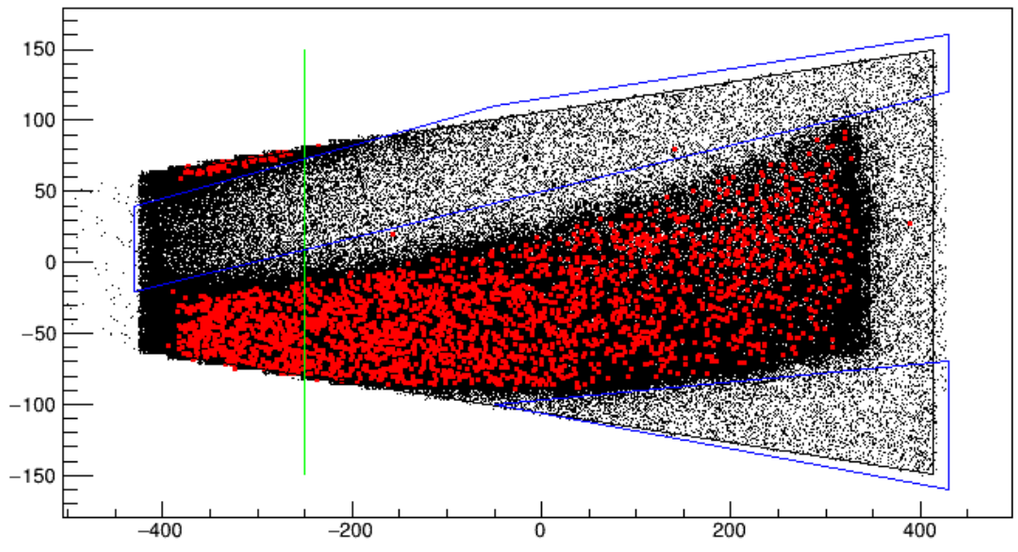
GEM 2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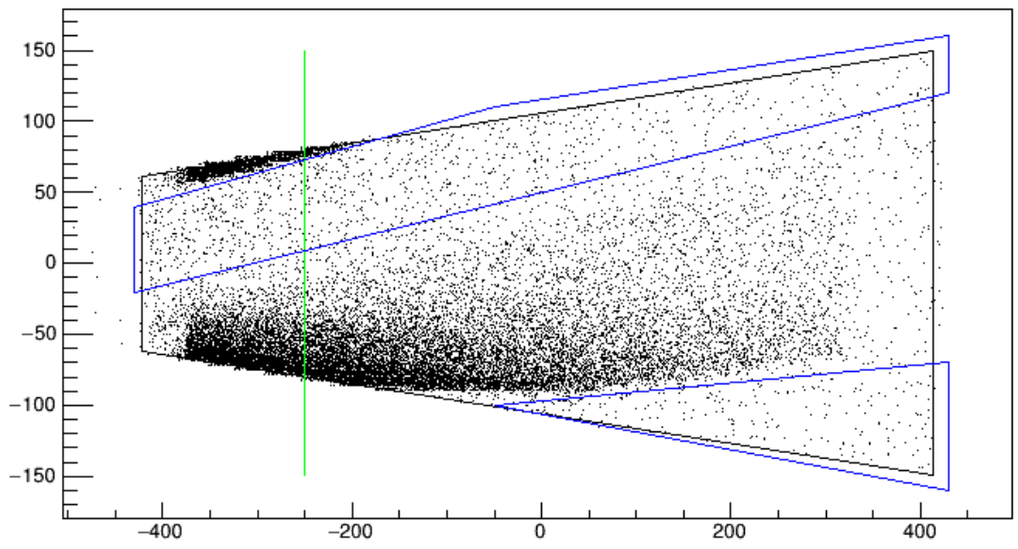
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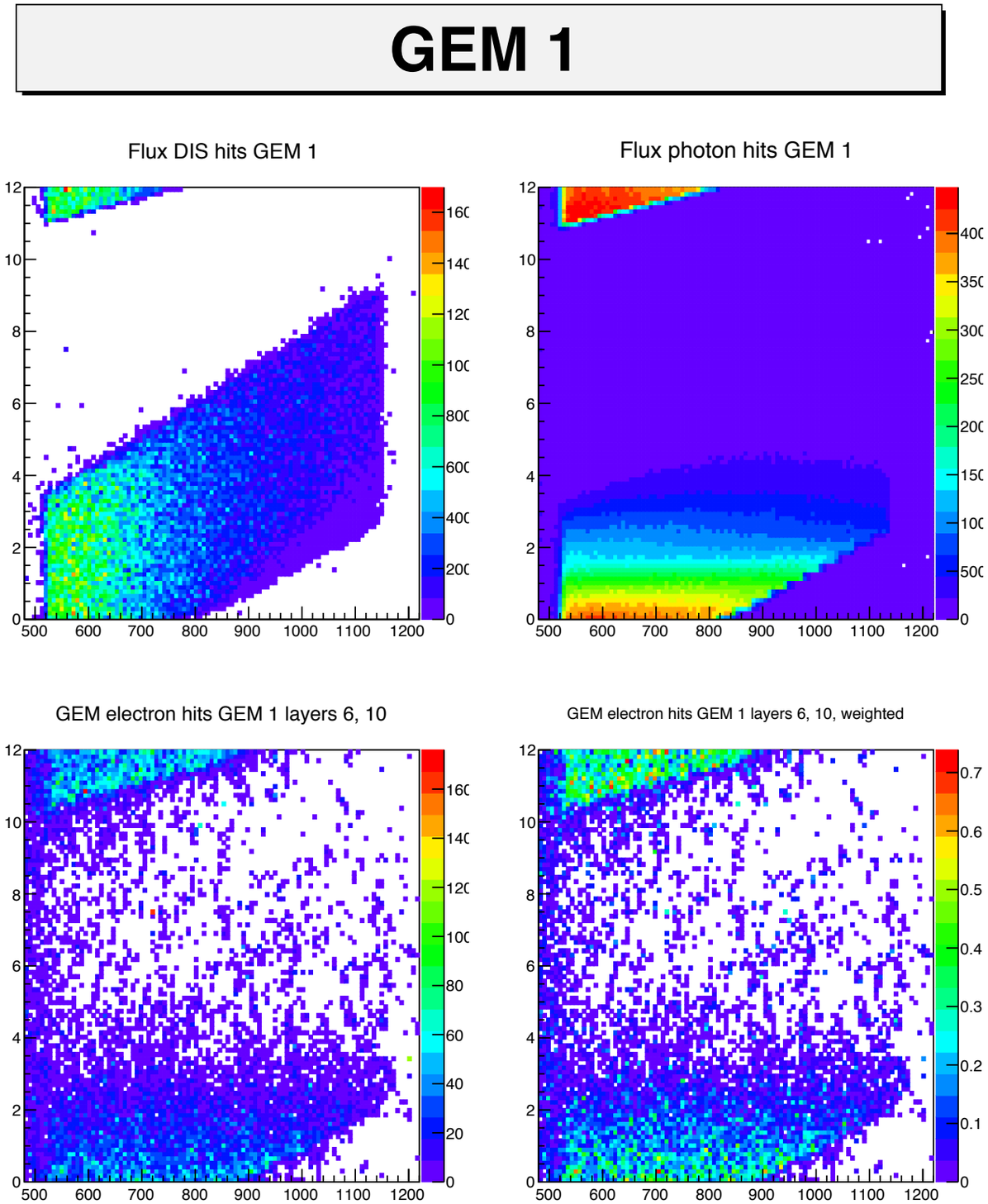
But flux detector positions are not what we detect…

Top: Flux positions, this time ϕ vs r (for DIS and background)

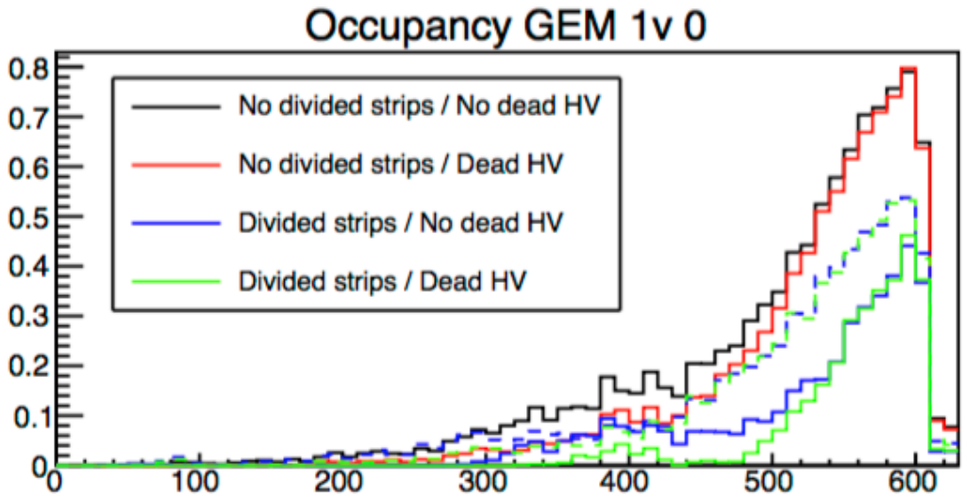
Bottom: Positions of energy deposition in GEM gas layers (for background, without/with energy weighting)

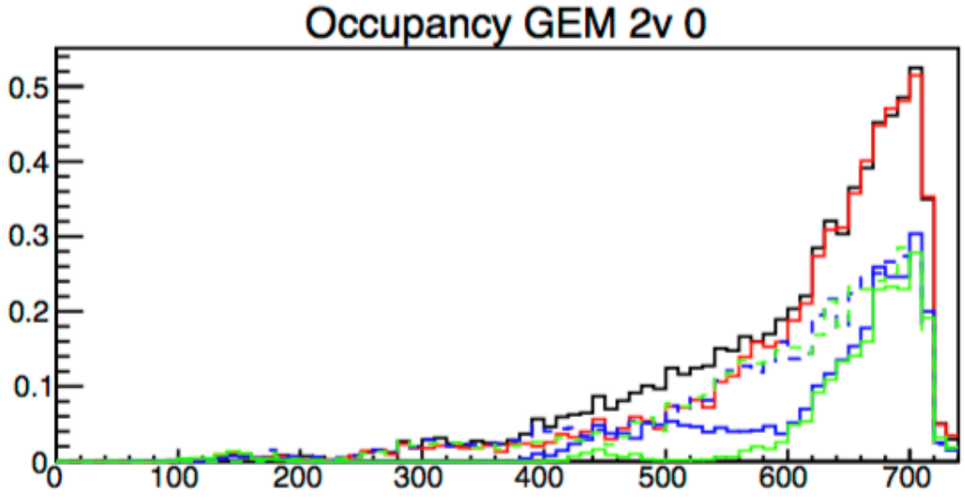
Energy deposition is significantly smeared.

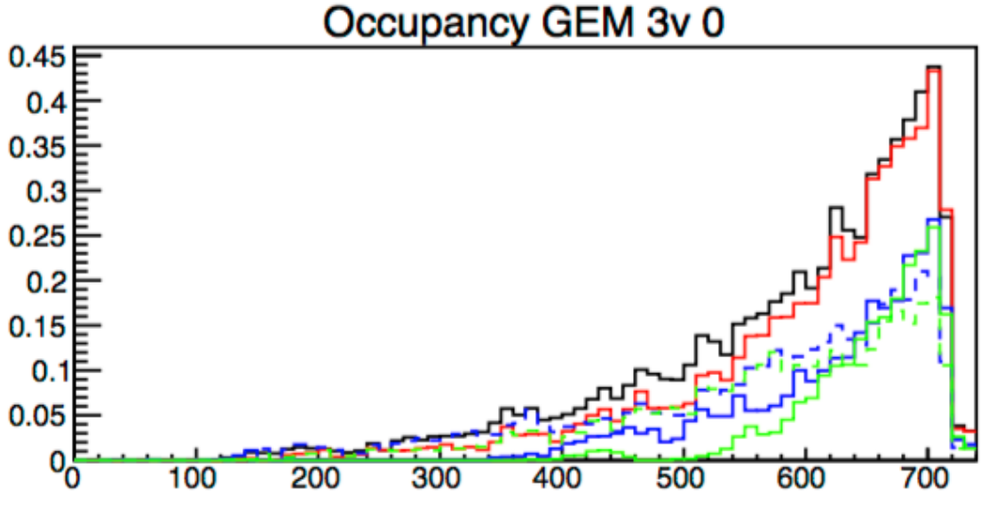


V Strips, GEMs 1–3

- Occupancy is fraction of events with (sub)strip over threshold
- 4 sigma thresholds
- GEM1 maximum occupancy ~80% with no divided strips, no dead regions
- Dead regions have little effect on maximum occupancies
- Reduced to ~40%–50% with divided strips
- GEMs 2–3 maximum ~45% -> ~25%

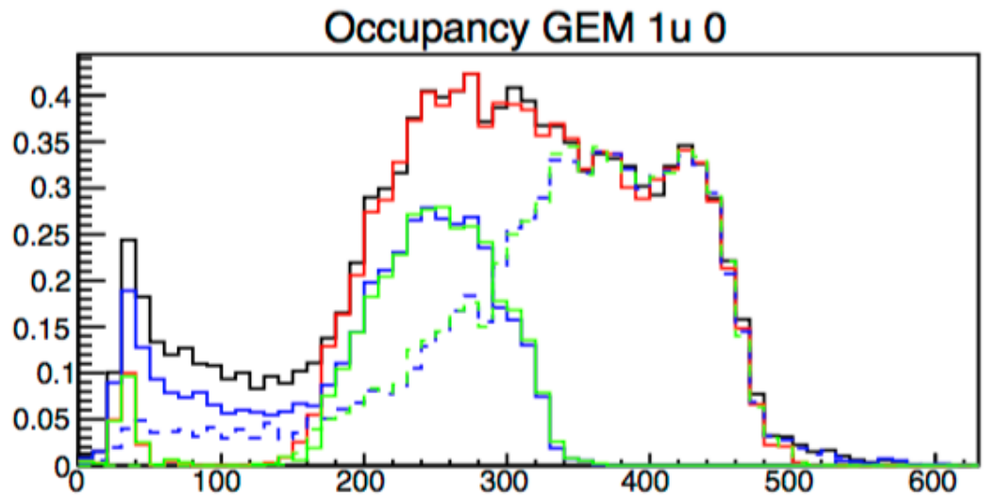


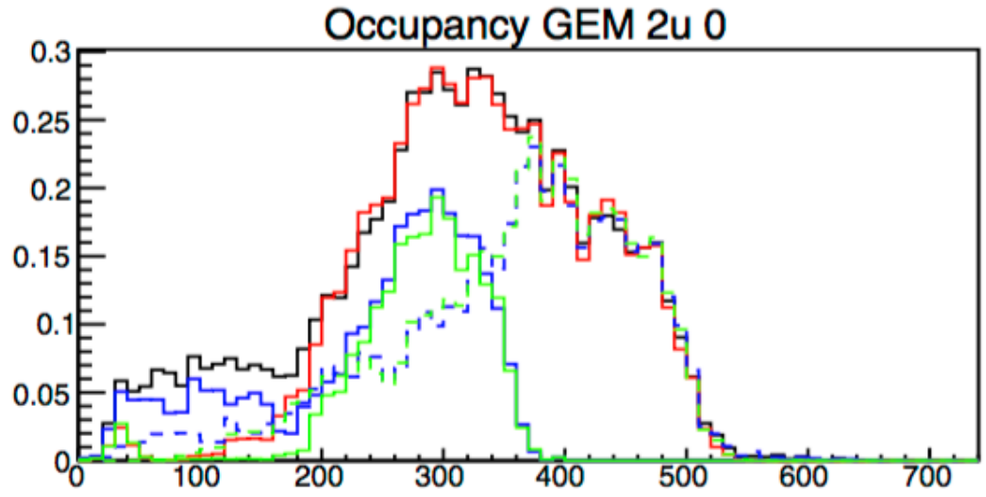


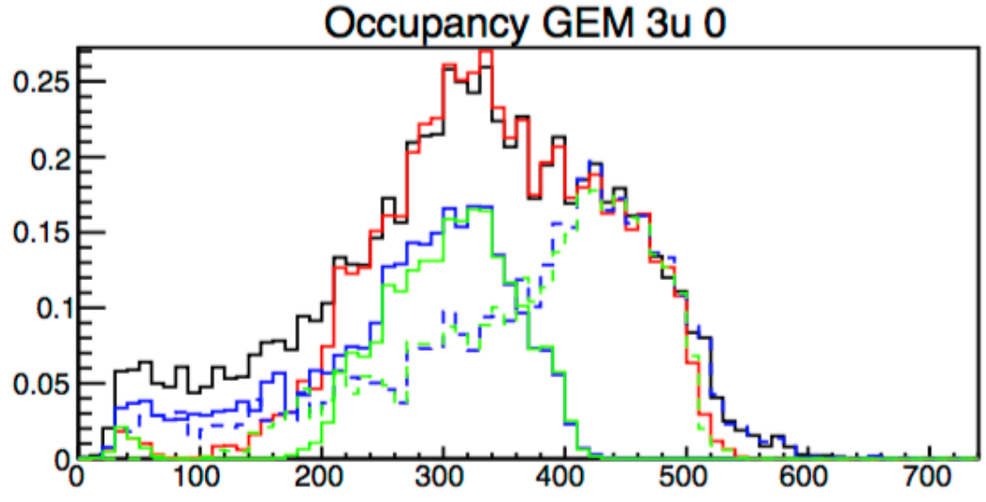


U Strips, GEMs 1–3

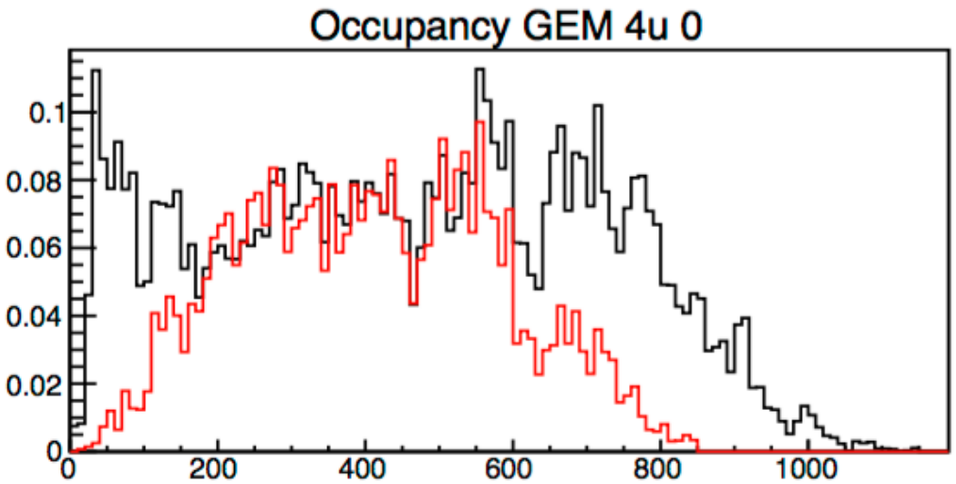
- GEM1 maximum ~40% -> ~30%
- GEMs 2–3 ~25% -> ~18%

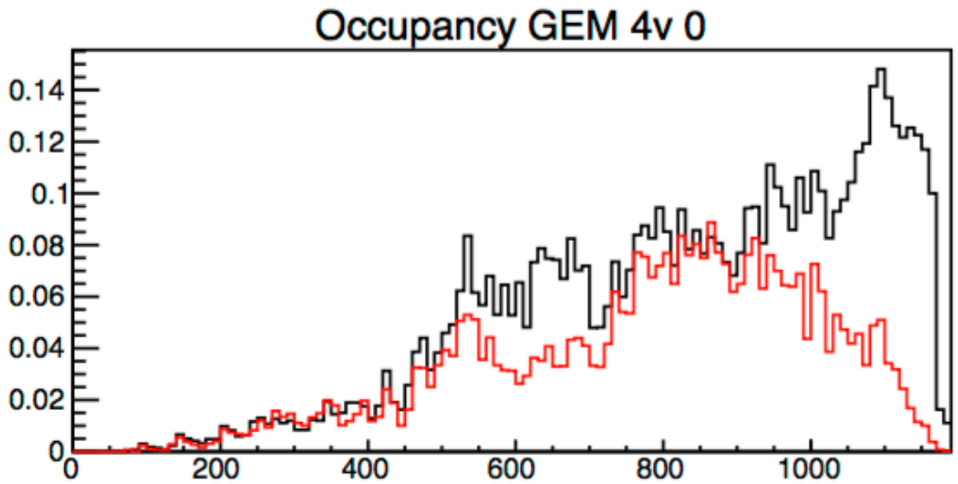


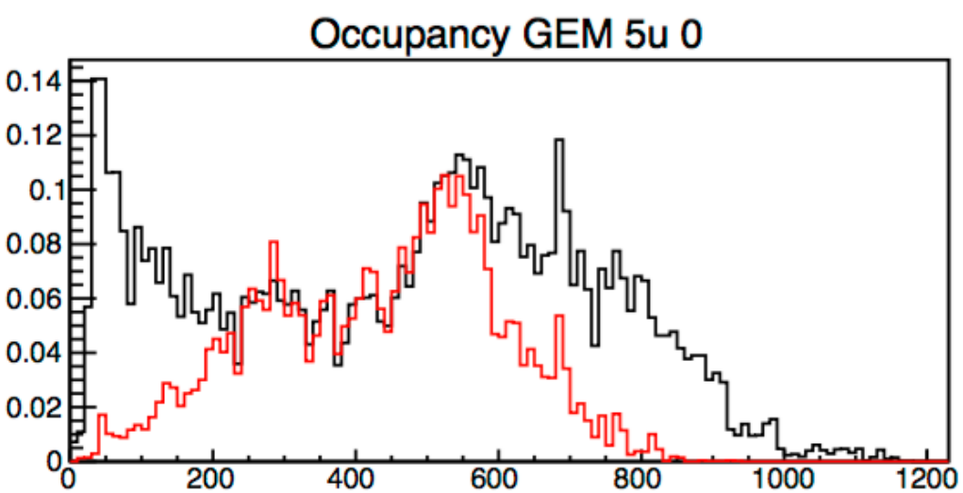


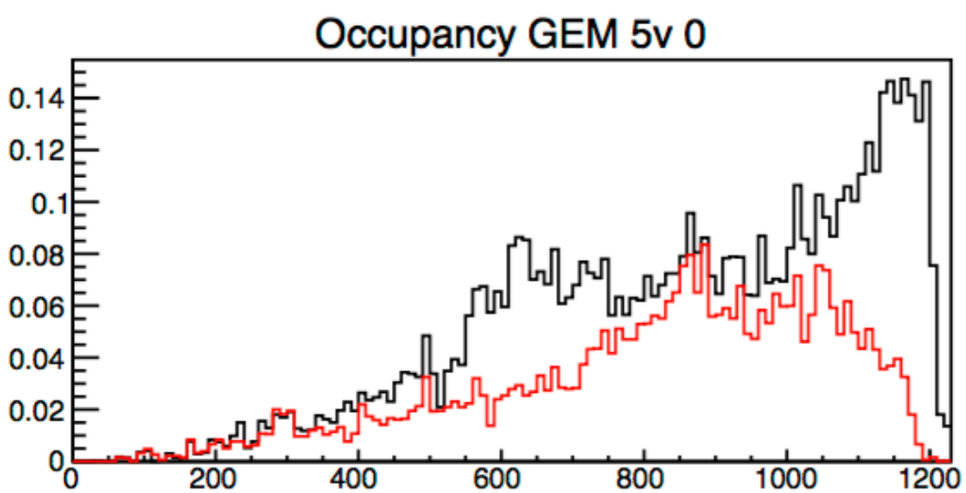


GEMs 4–5 dead regions (no divided strips) reduce maximum, ~14% -> ~8%









- Dead areas reduce (already low) occupancies downstream.

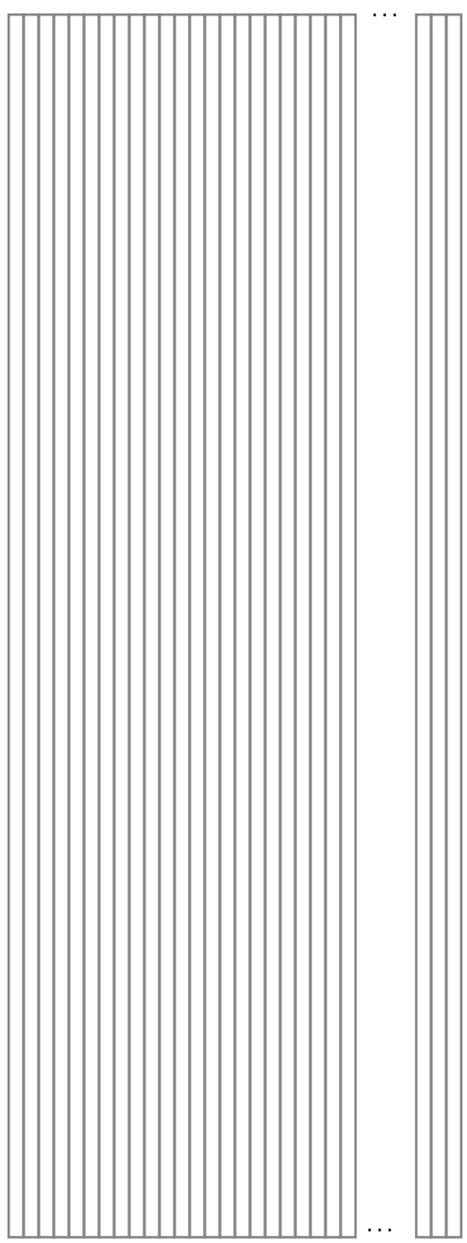
- Divided strips reduce (high) occupancies upstream — is it enough?

- Should we revisit angular offsets? We lose some signal putting upstream photon hot spots into GEM frames. Better to keep them in live area with divided strips?

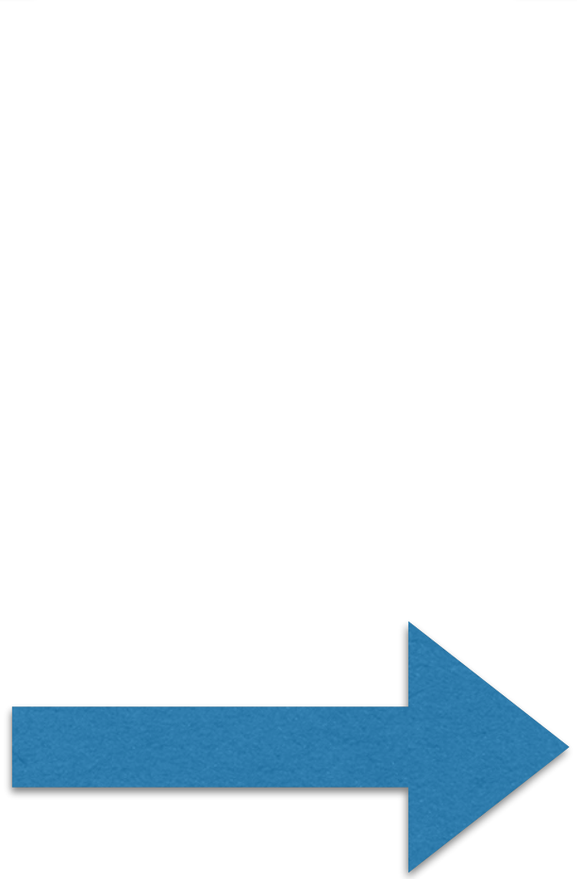
- Digitization improvements completed, debugged, and ready for tracking studies.

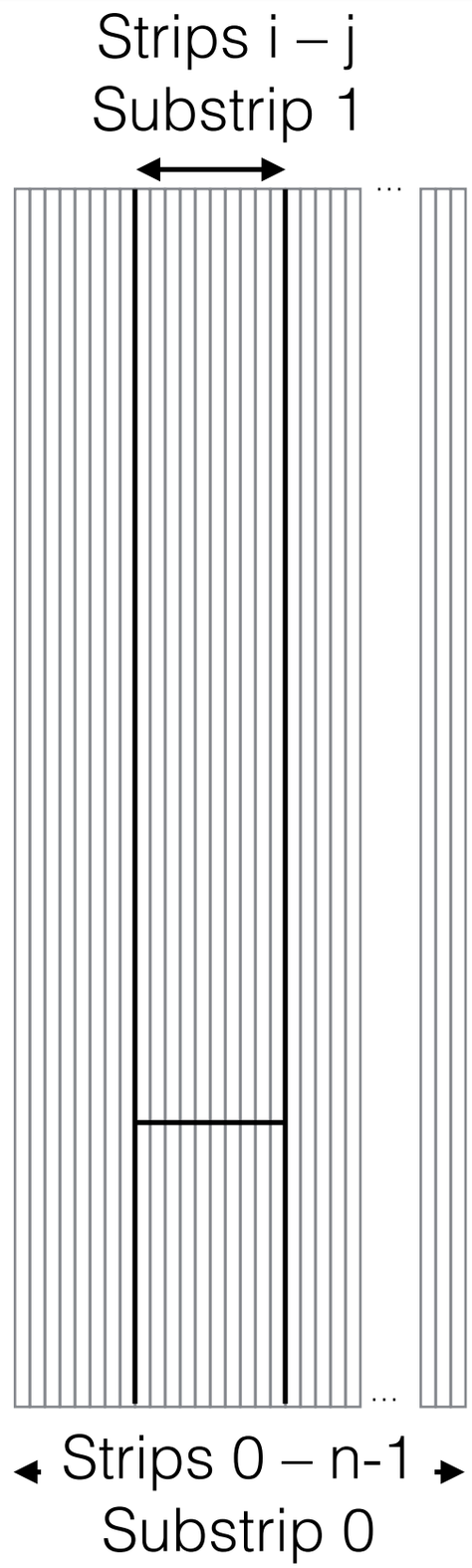
Extra

Undivided strips

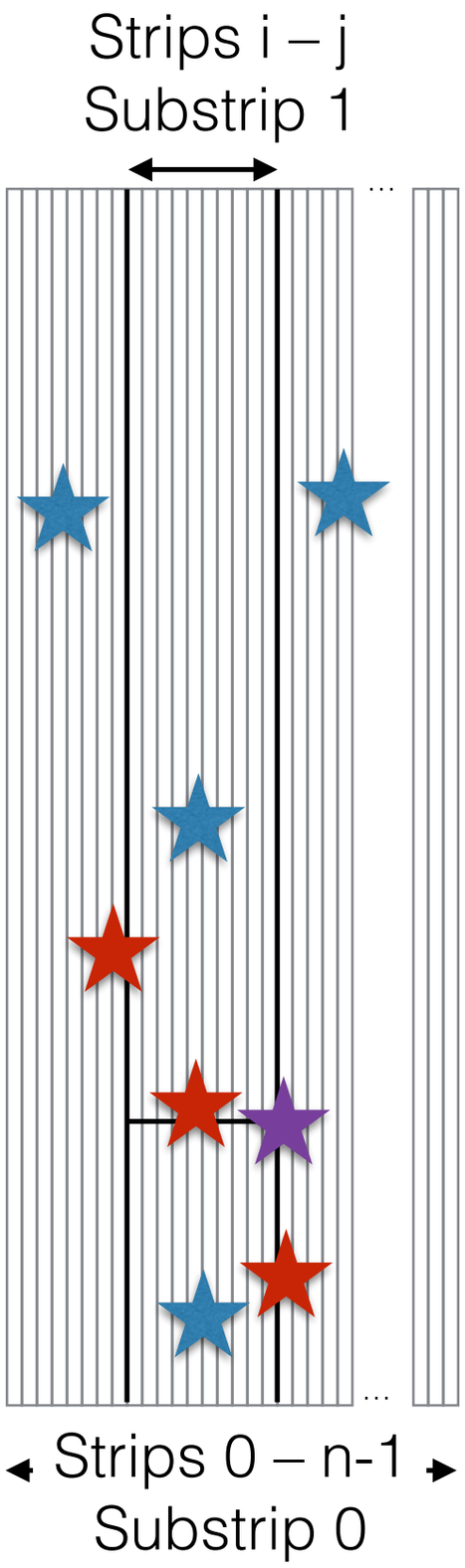


Divided strips





Clustering/Matching — Divided strips



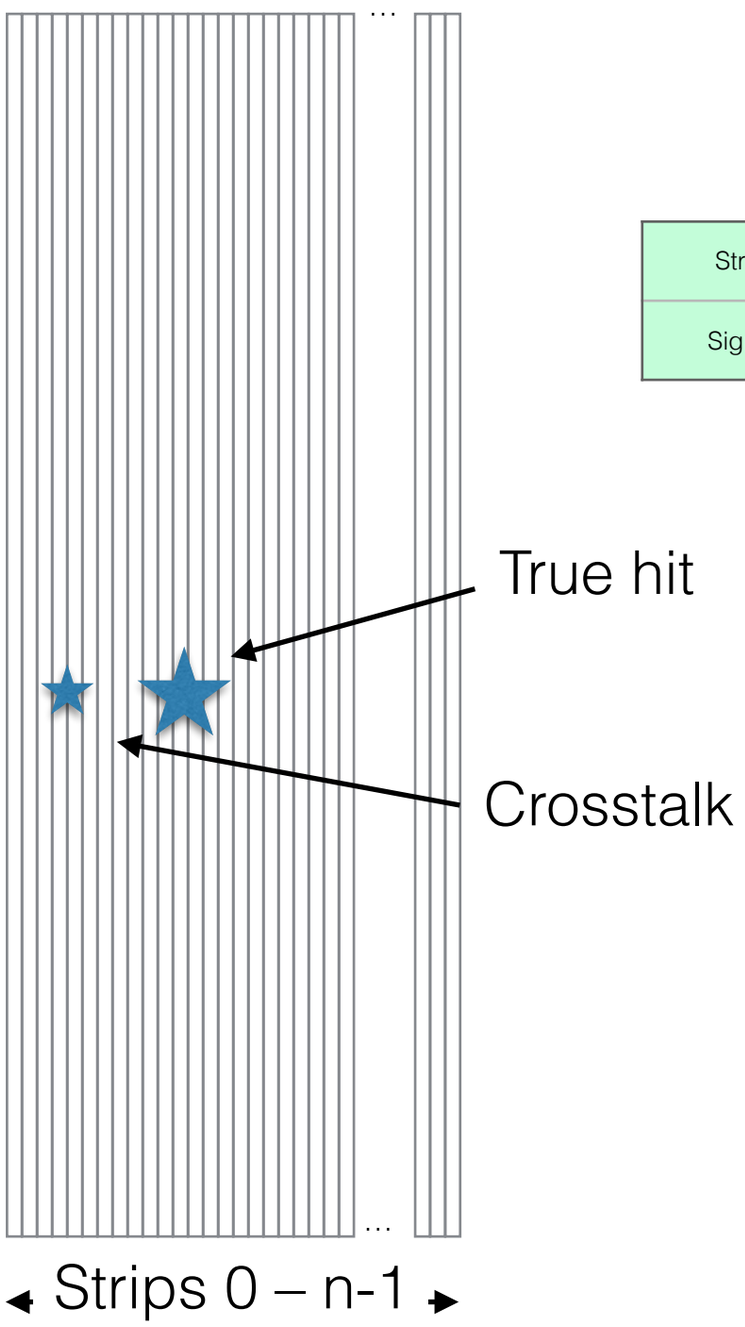
Must develop clusters from non-homogeneous substrip groups

- Cluster in homogeneous substrip group
- Cluster in two substrip groups
- Cluster in three substrip groups

Partial 2-dimensional information to be matched with partial 2-dimensional information from other plane

Non trivial changes to matching and clustering algorithms. Workaround for present: Divide all strips

Crosstalk — Undivided strips

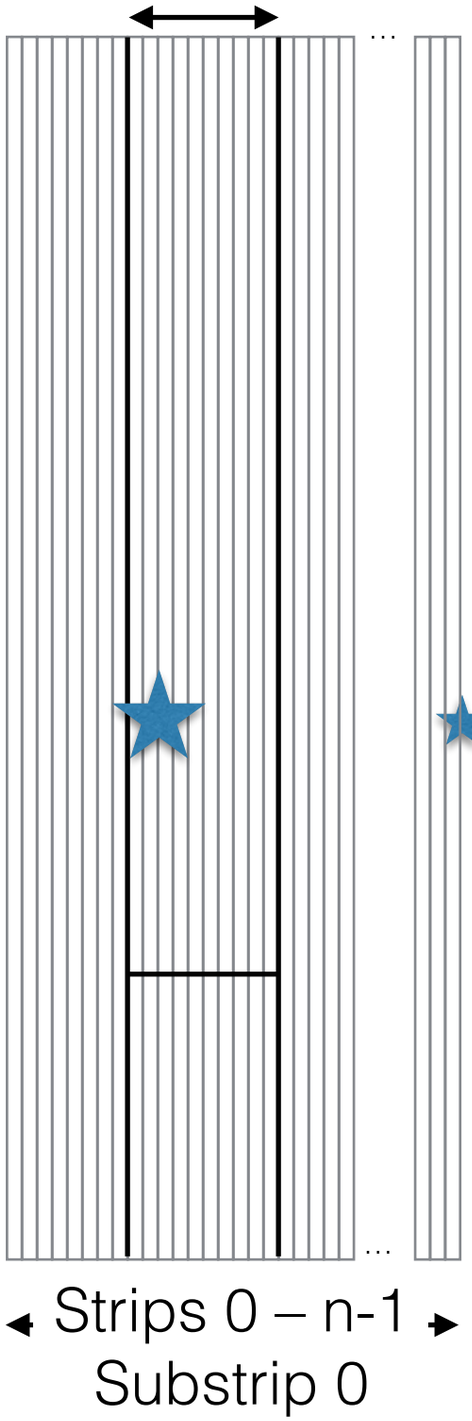


Strip	0	1	2	3	4	5	…	30	31	32	33	34	35	36	37	38	39	…	n-2	n-1
Signal	0	13	77	45	19	24	…	43	84	123	89	102	94	72	31	32	29	…	6	10

Crosstalk, any two strips separated by 32

(Really should be only between strips in one APV.)

Crosstalk — Divided strips

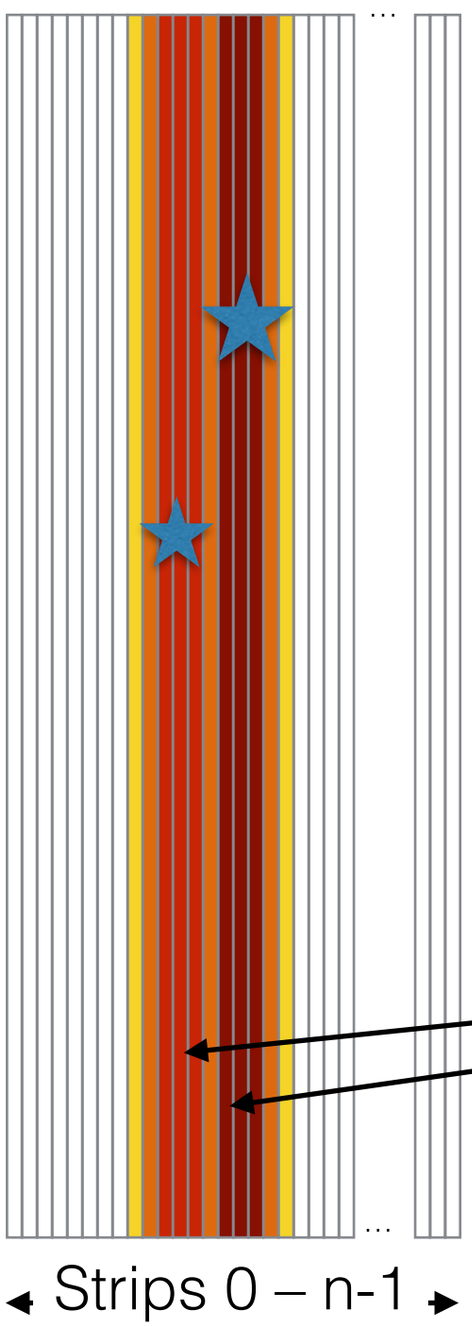


Strip	0	1	2	3	4	5	…	n-2	n-1	i	i+1	i+2	i+3	i+4	…	i+28	i+29	i+30	…	j
Substrip	0	0	0	0	0	0	…	0	0	1	1	1	1	1	…	1	1	1	…	1
Signal	0	13	77	45	19	24	…	43	84	123	89	102	94	72	…	32	29	13	…	10

Crosstalk, any two channels separated by 32

(An arrangement that interleaves substrips 0 and 1 would be easy to code and give less goofy results, but still not entirely realistic.)

Clustering/Matching — Undivided strips



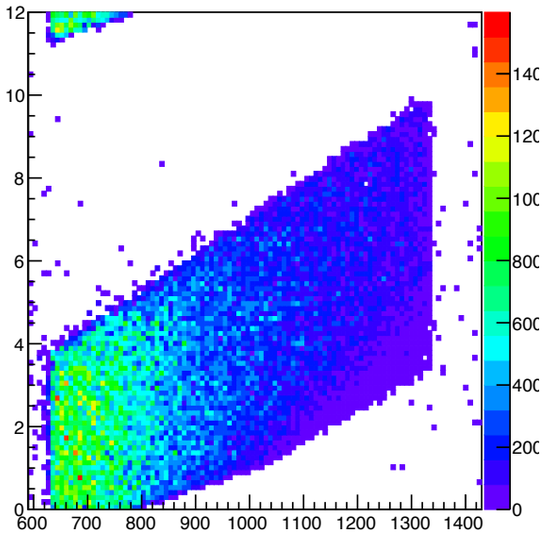
(done in tracking package, not digitization)

Strips around a local maximum are mapped to a coordinate in a single dimension. Matched based on strip crossings with other plane to generate hit coordinates in two dimensions.

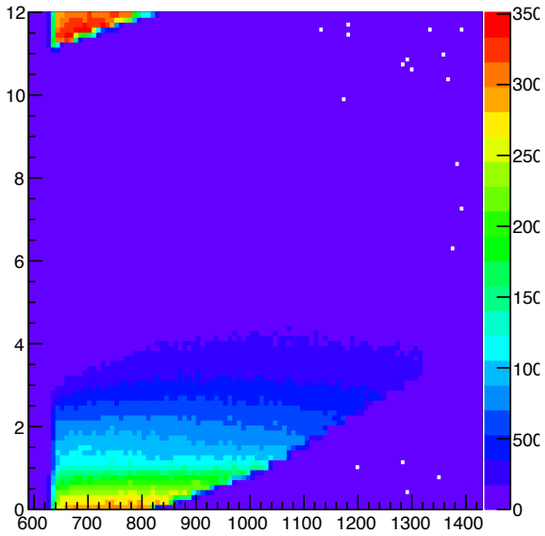
2 clusters

GEM 2

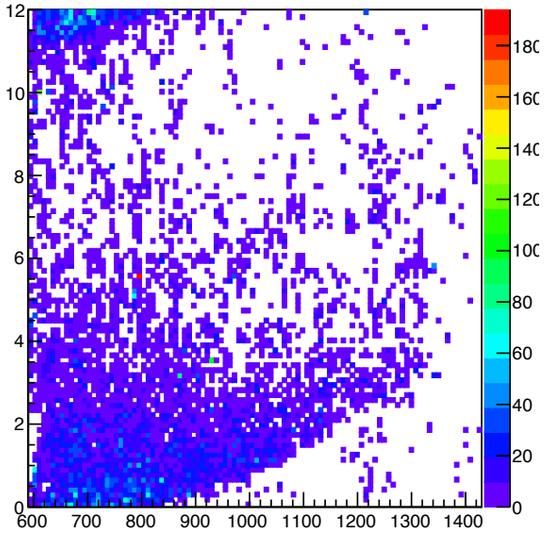
Flux DIS hits GEM 2



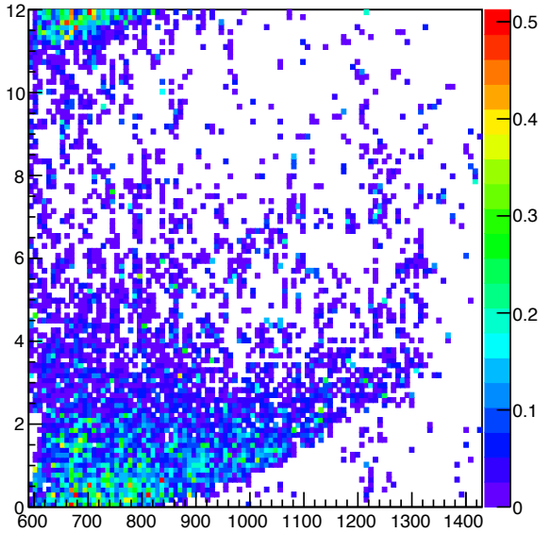
Flux photon hits GEM 2



GEM electron hits GEM 2 layers 6, 10

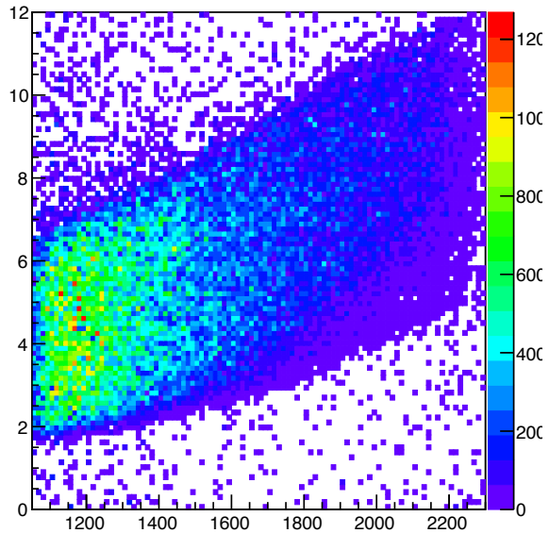


GEM electron hits GEM 2 layers 6, 10, weighted

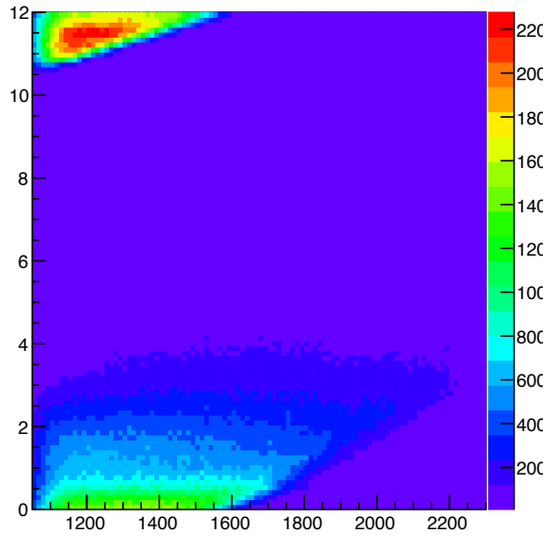


GEM 4

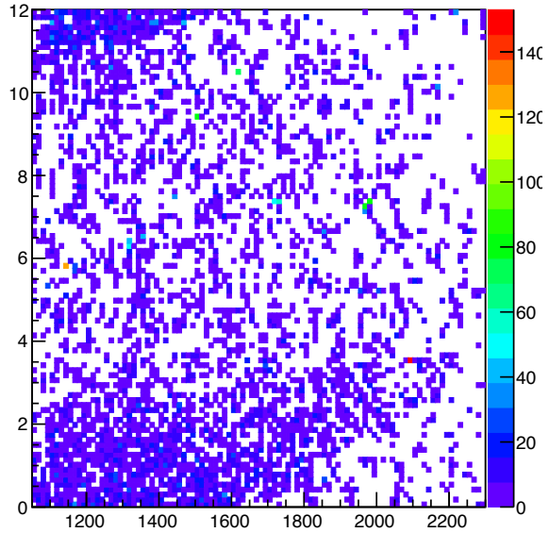
Flux DIS hits GEM 4



Flux photon hits GEM 4



GEM electron hits GEM 4 layers 6, 10



GEM electron hits GEM 4 layers 6, 10, weighted