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Separation of Showers in the SiD MAPS Digital ECal

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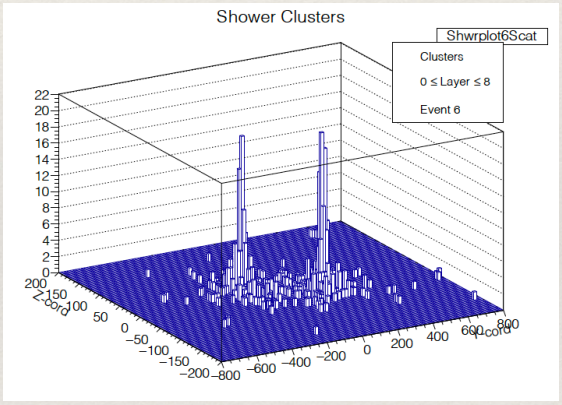
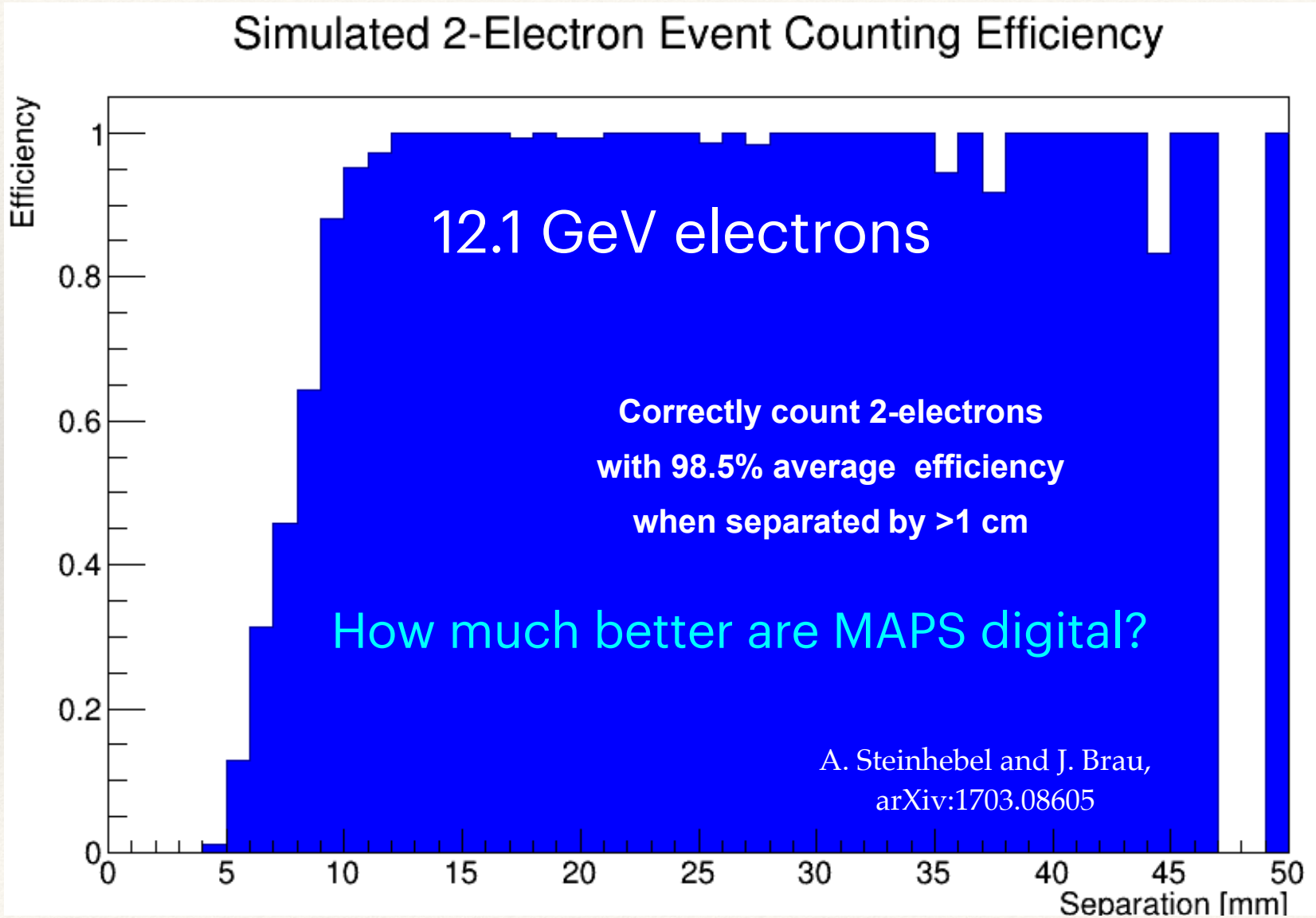
Introduction

- Study of two shower separation in SiD MAPS Digital ECal.
- Two 10 GeV electron showers.
  - Modeled after SiW 12.1 GeV beam test studies.
- Variable separation with random relative angle.
  - 20 mm.
  - 10 mm.
  - 5 mm.
  - 2 mm.
  - And random separation: 0-5 mm.
- Excellent separation down to 2 mm.
  - Some degradation of resolution.
- Check false separation for one 20 GeV shower.
  - Very little effect.
- Early activity in clusters can be used to refine process.



SiD TDR SiW ECal (beam test)

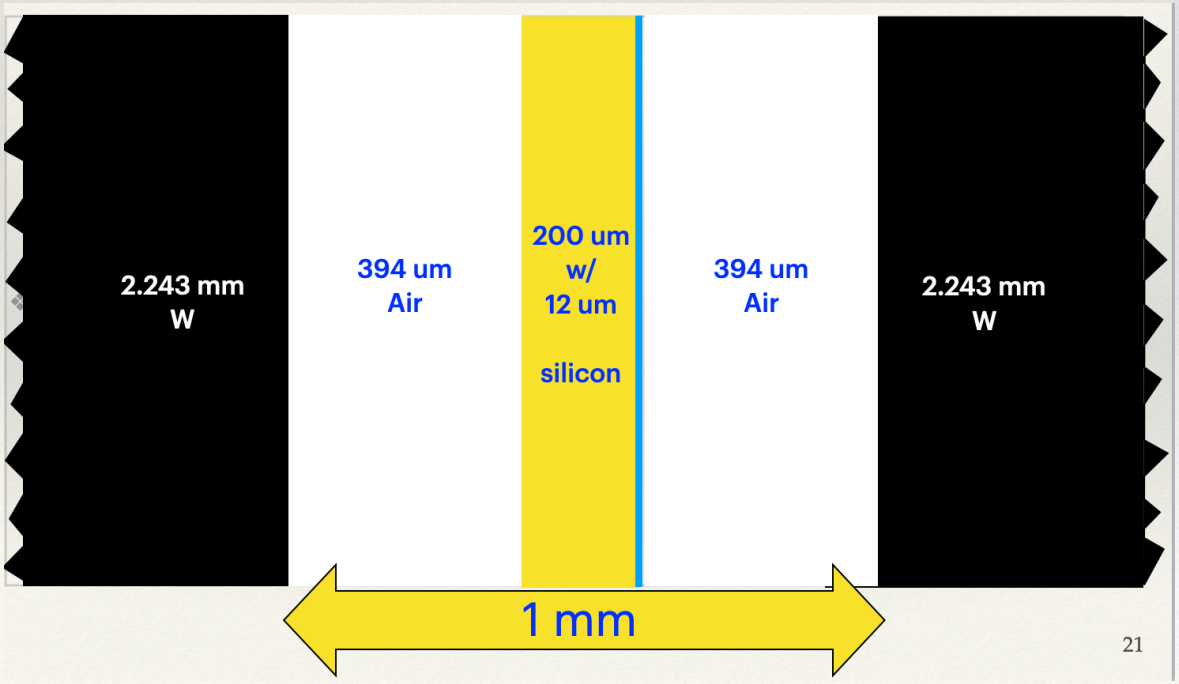


Layout - SiD MAPS Digital ECal

- 20 layers of 2.243 mm W, + 10 layers of 4.486 mm W.

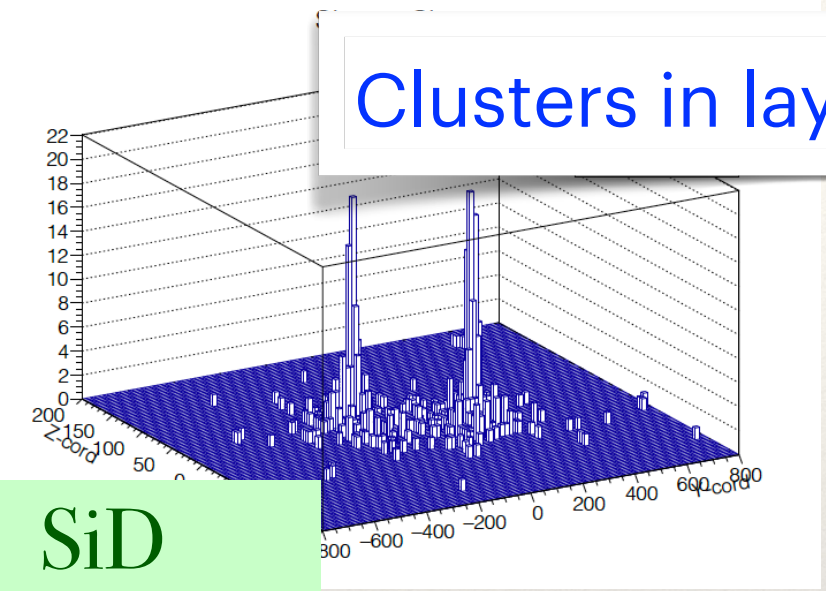
Total = 27 X_O

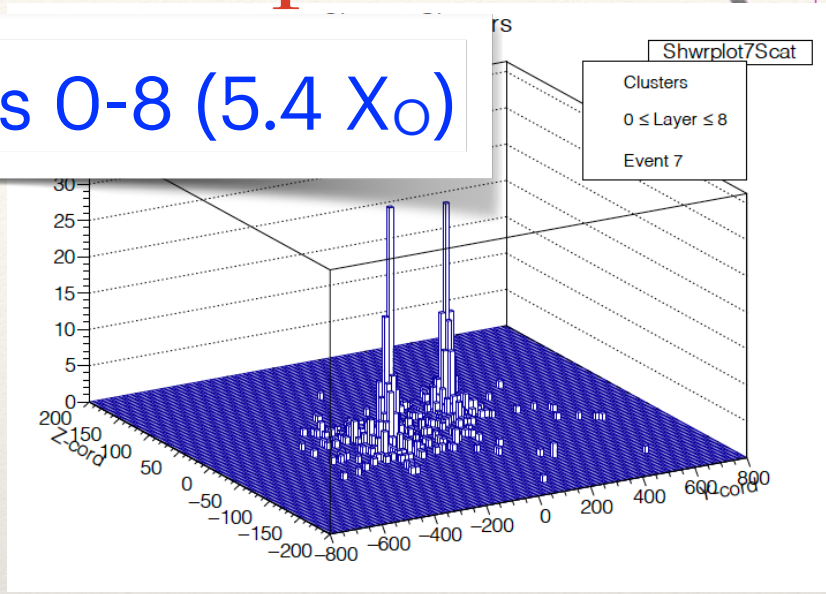
Each silicon gap structure:

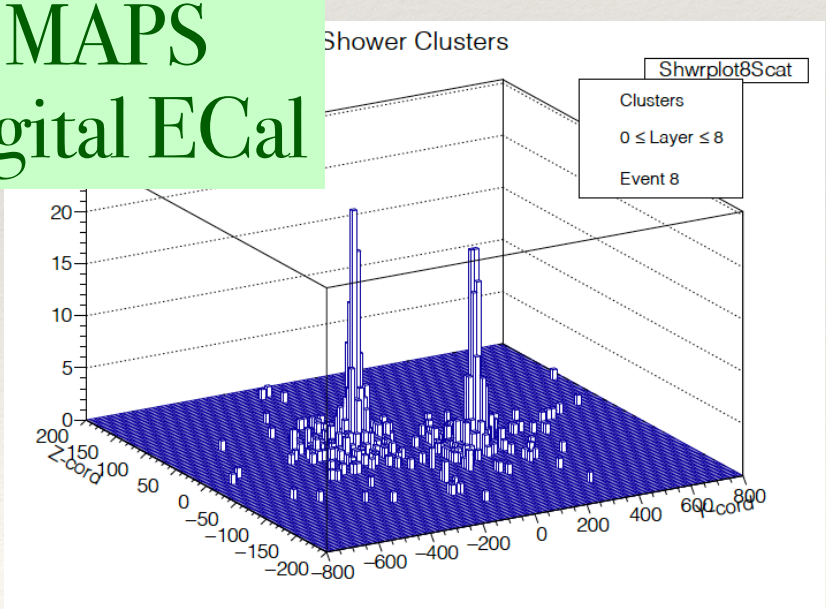


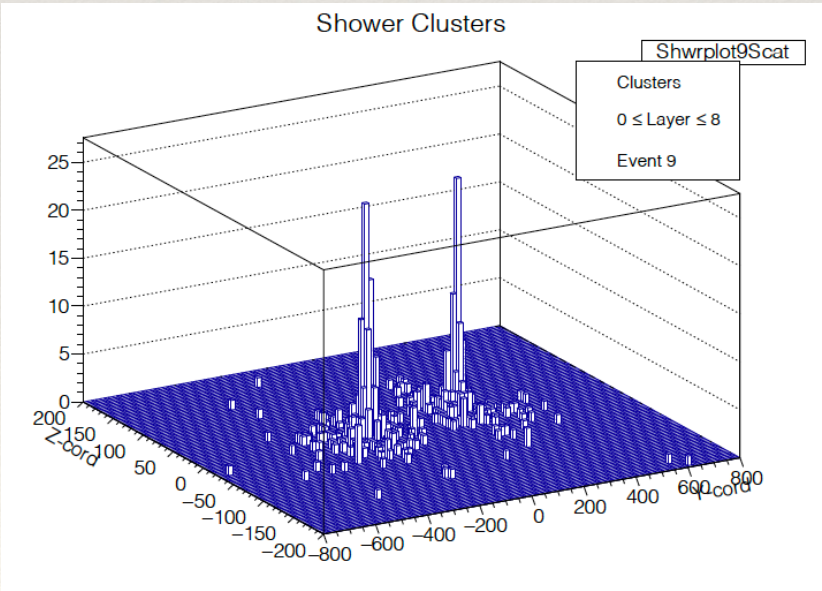
Two 10 GeV showers - 1 cm separation

Clusters in layers 0-8 (5.4 X_0)









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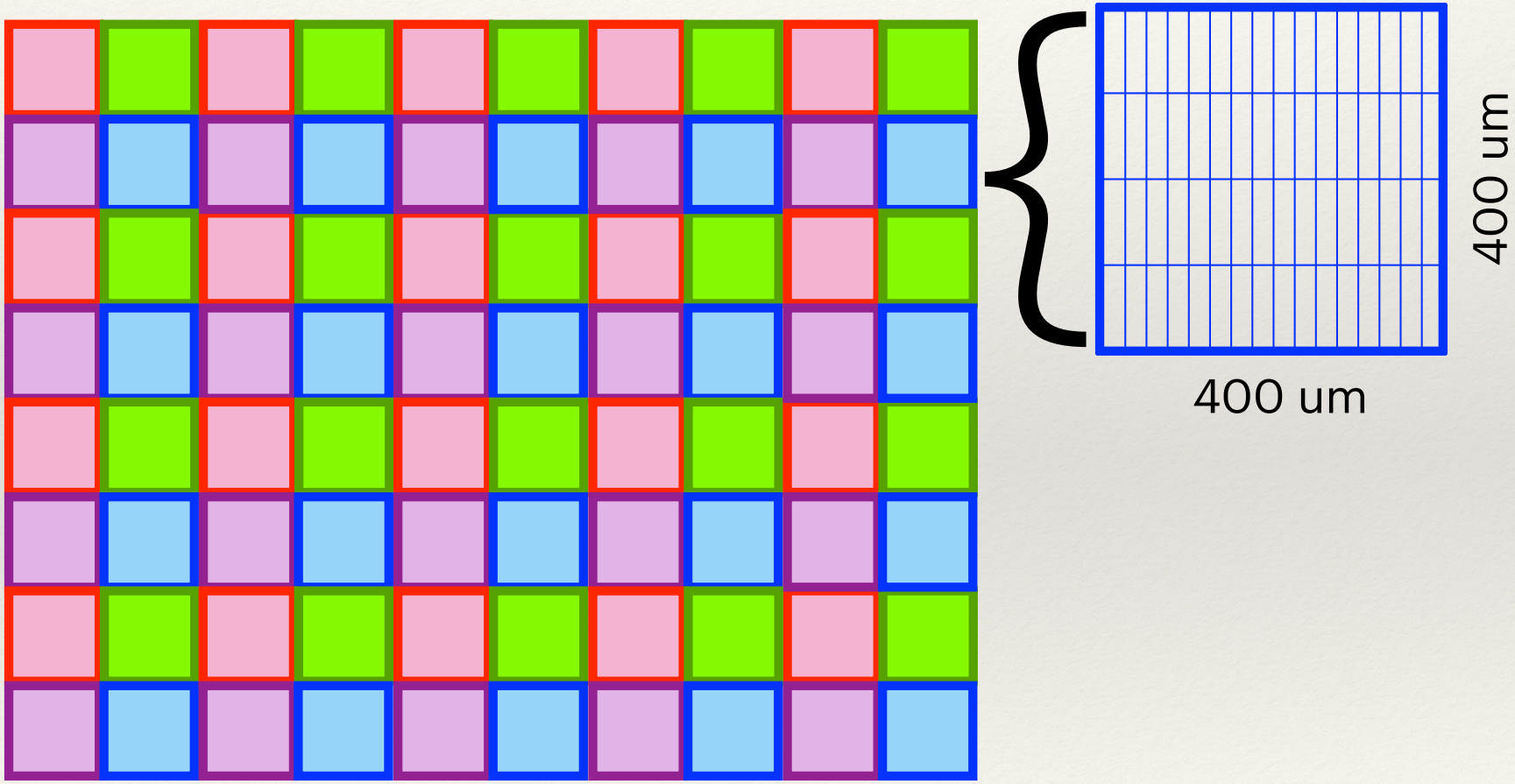
Shower reconstruction technique

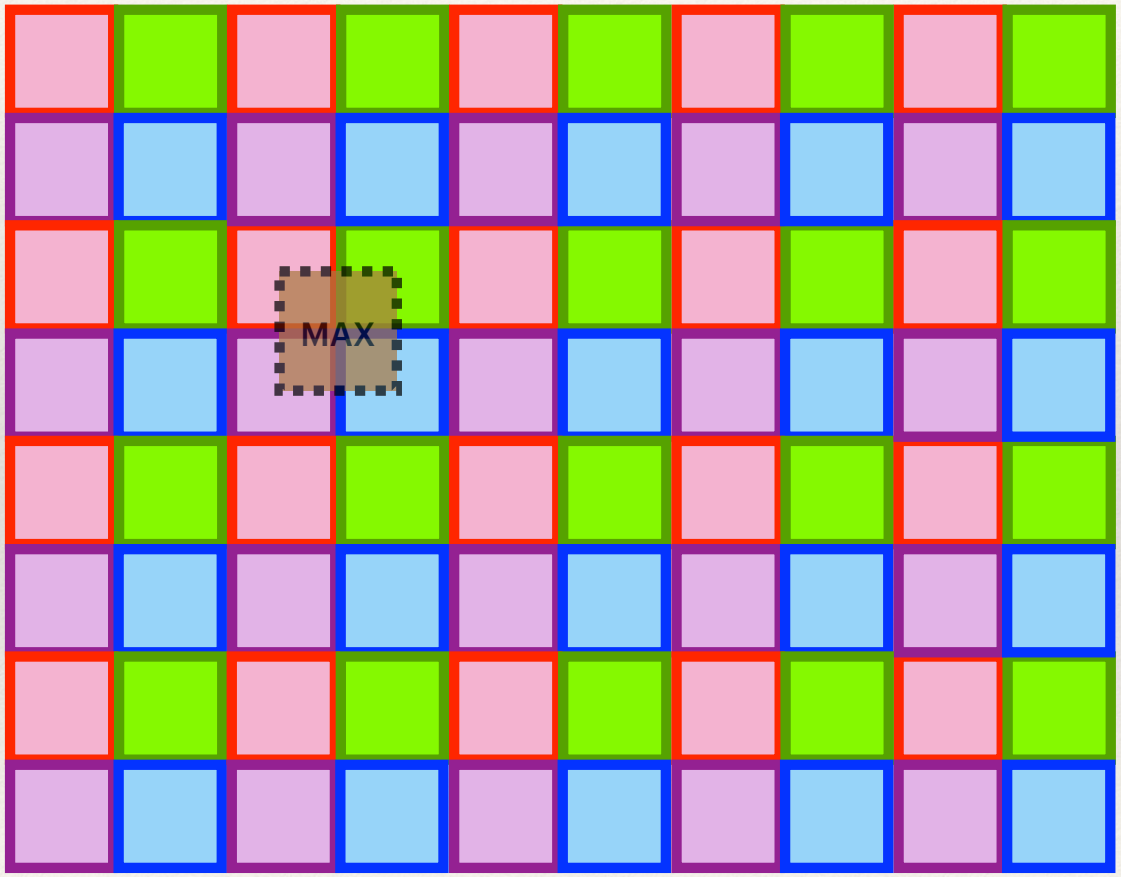
- Use layers 0-8 (5.4 X_O) to seed shower search.
- Search for maximum cluster count, and 2nd highest, in 16y x 4z pixel cluster count cells (400 um x 400 um).
- Search through matrix of sensors shifting in steps of 8y and 2z.
- Require separation of max and 2nd cluster cells of at least 24y or 6z pixels (600 um x 600 um).
- Find central value of clusters in max and 2nd (layers 0-8).
- Measure shower energies by assigning each cluster to the closest center for all layers (0-29).

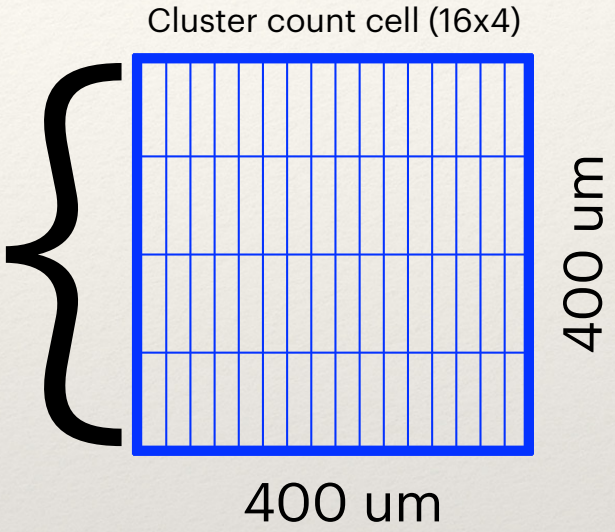
Search algorithm
1. Define cluster count cell



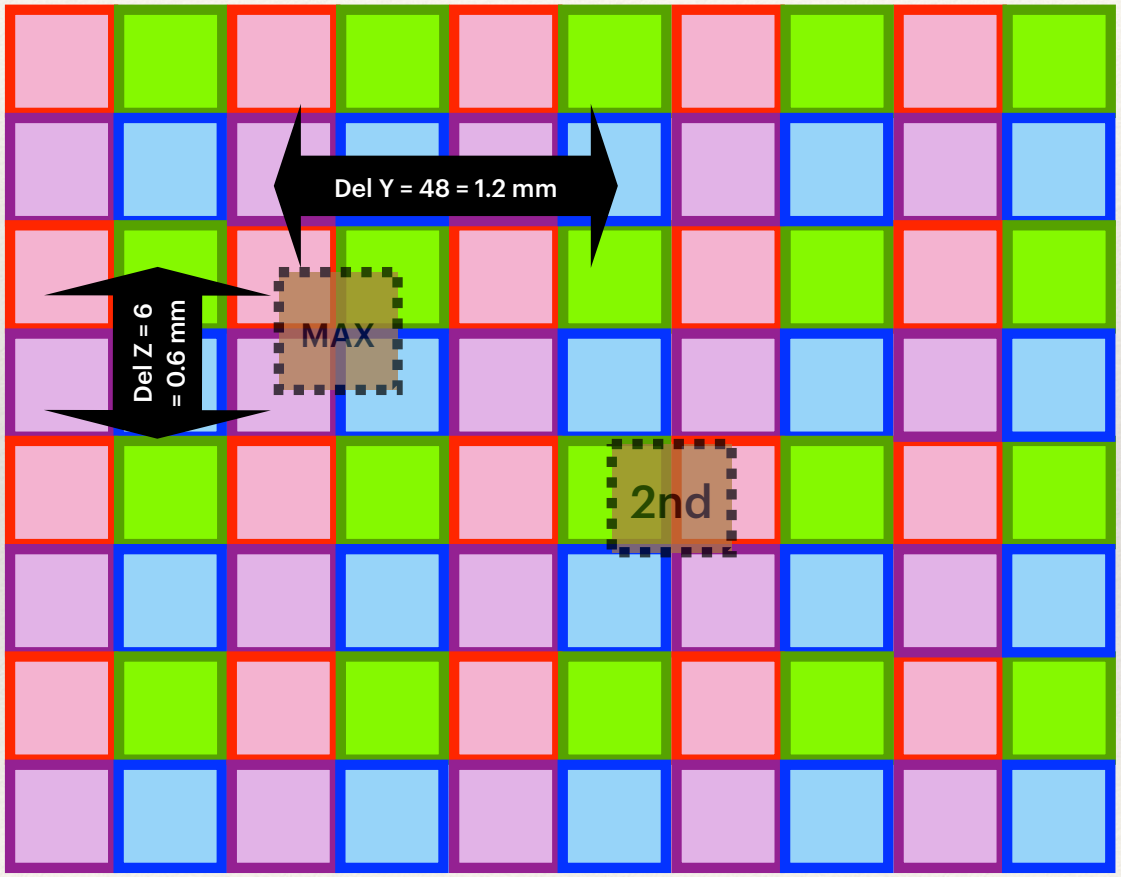
Search algorithm

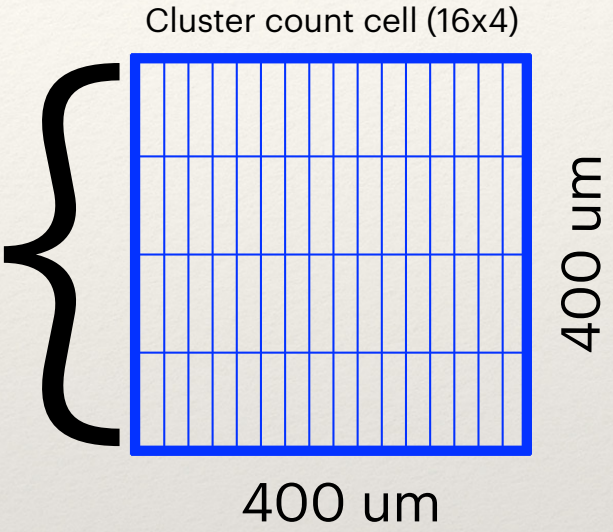
2. Find max cluster count for seed 1





Search algorithm:
3. Find 2nd largest cluster count* for seed 2



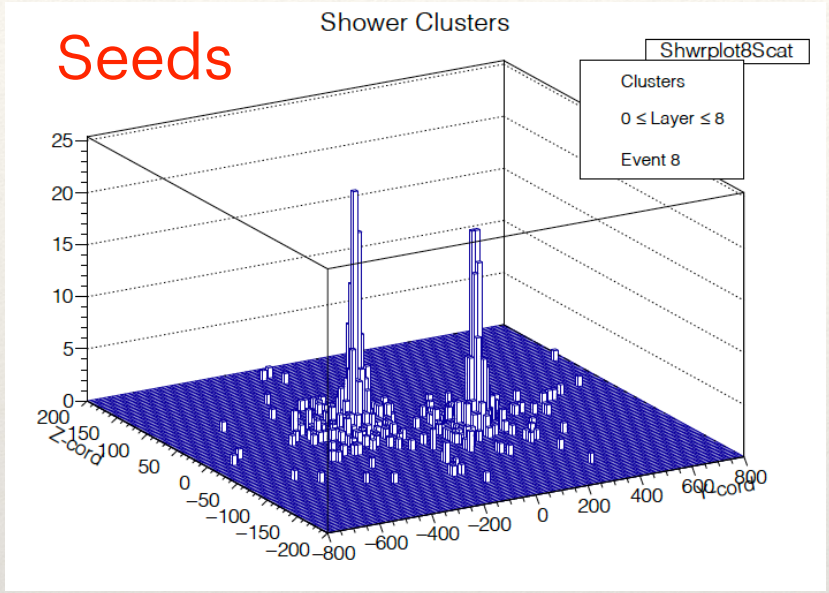


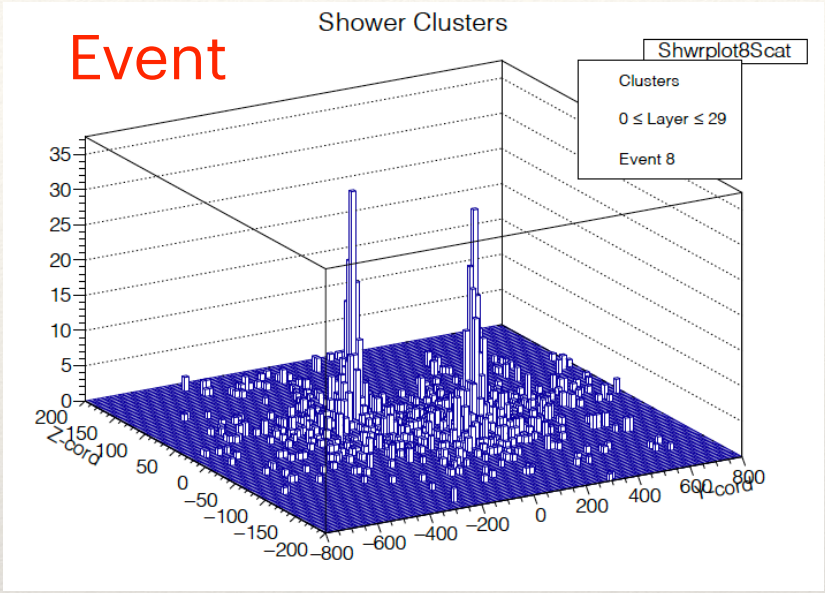
REQUIRED SEPARATION
DelY ≥ 24 = 0.6 mm
or
DelZ ≥ 6 = 0.6 mm

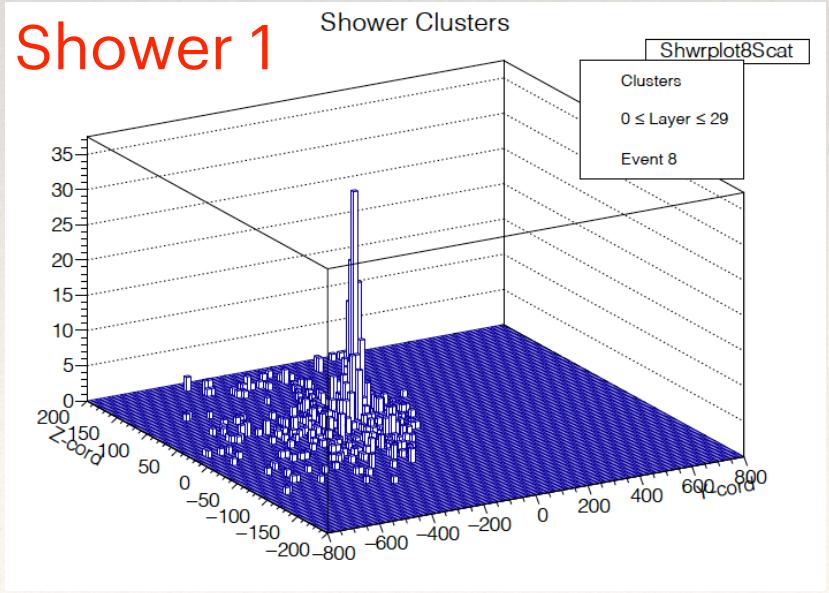
* Subject to separation requirement

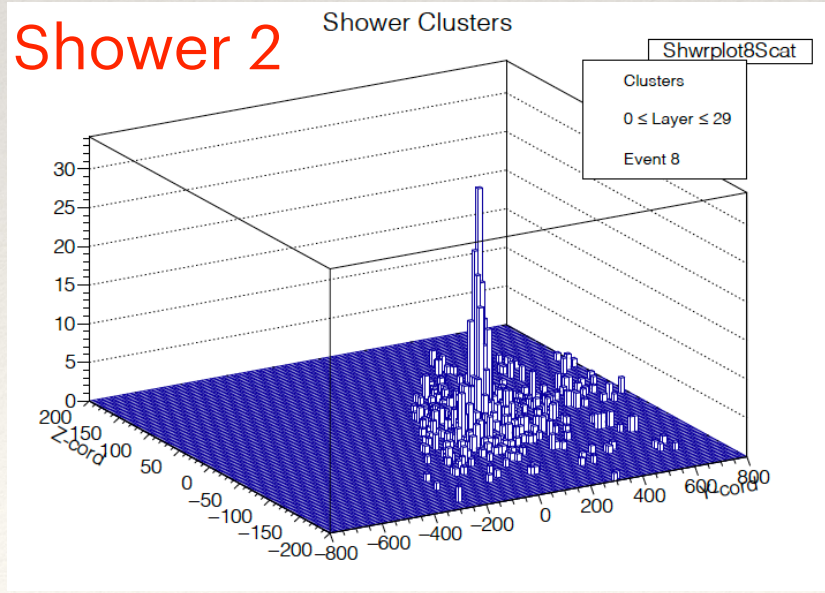
Search algorithm:

4. Assign all clusters to nearest of two "seeds"

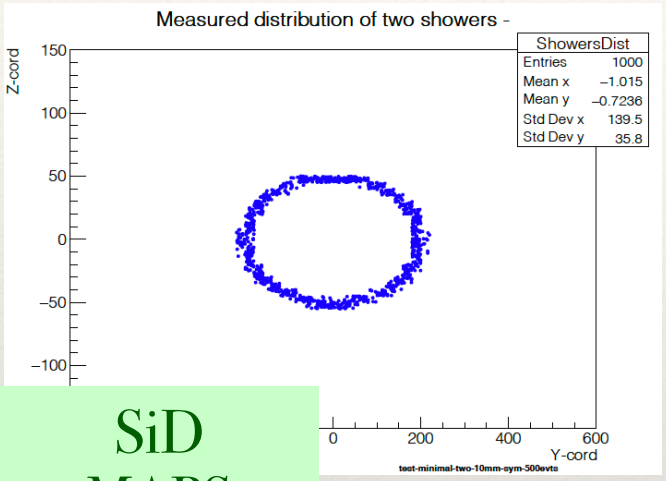


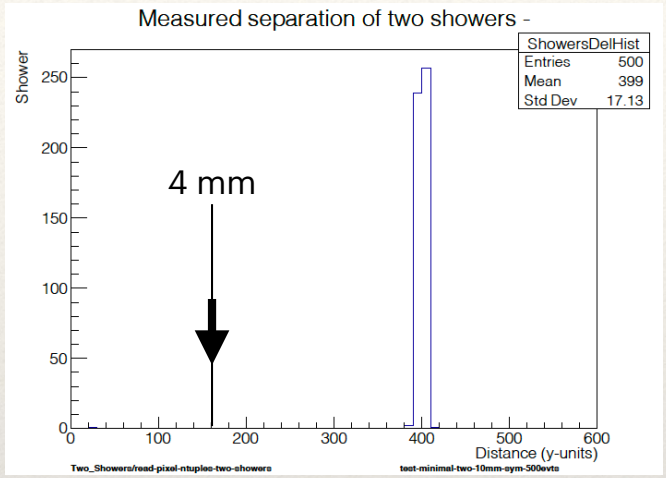


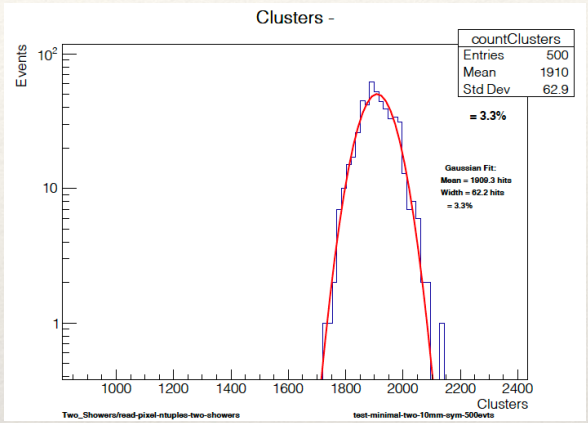




Two 10 GeV showers - 1 cm separation







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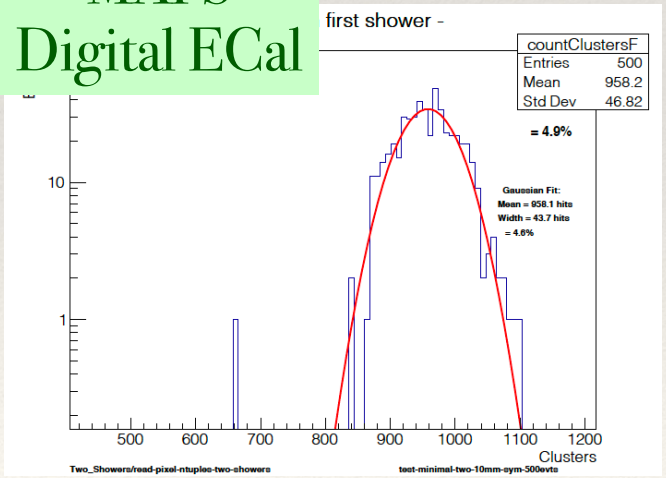
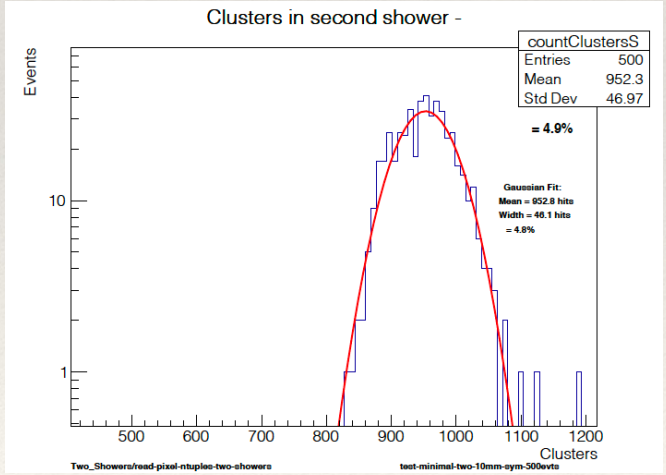
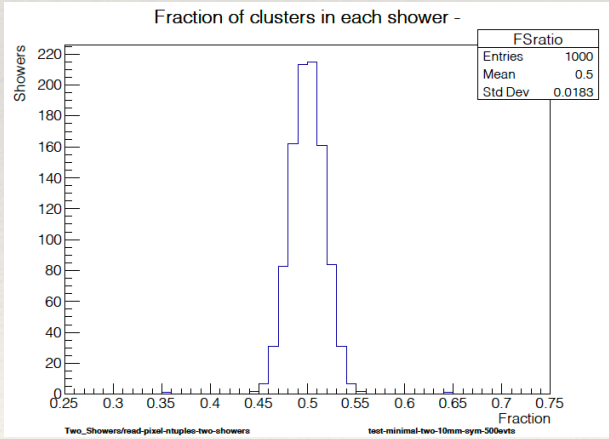
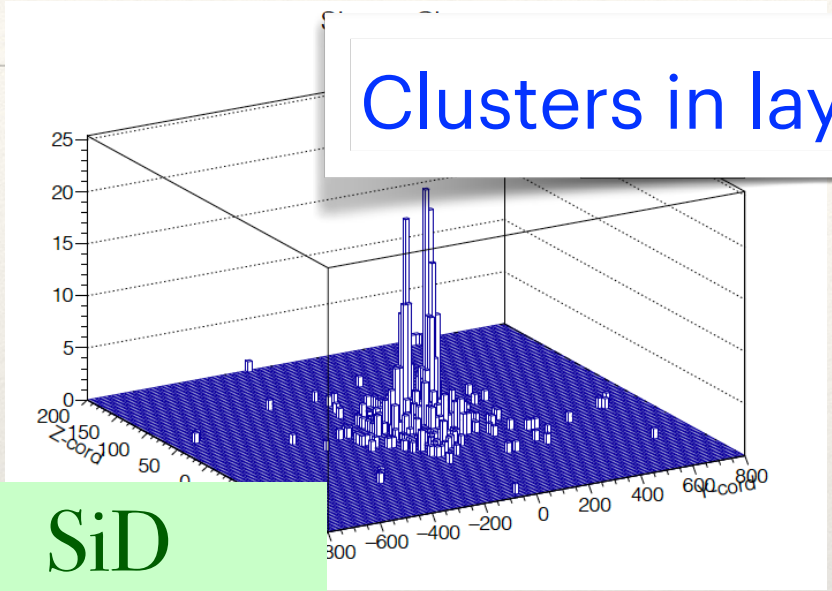


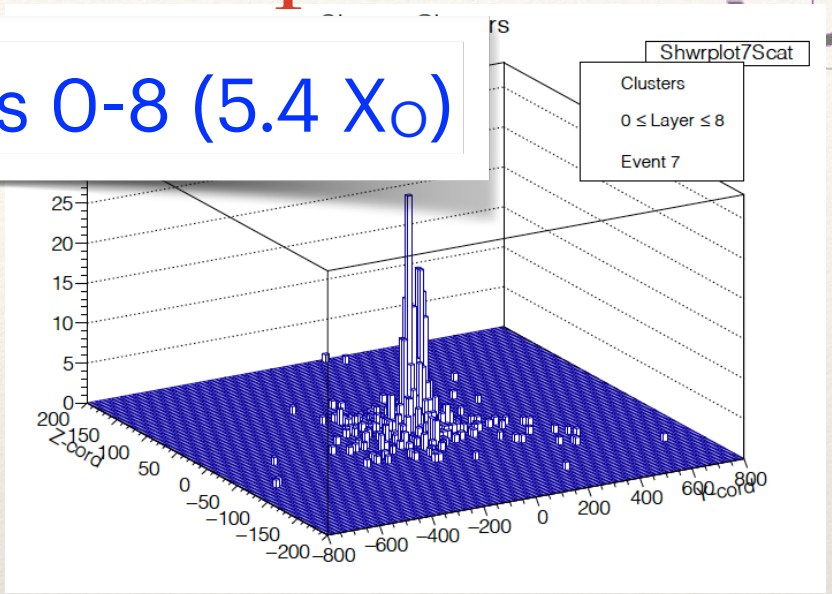




Two 10 GeV showers - 2 mm separation

Clusters in layers 0-8 (5.4 X_0)





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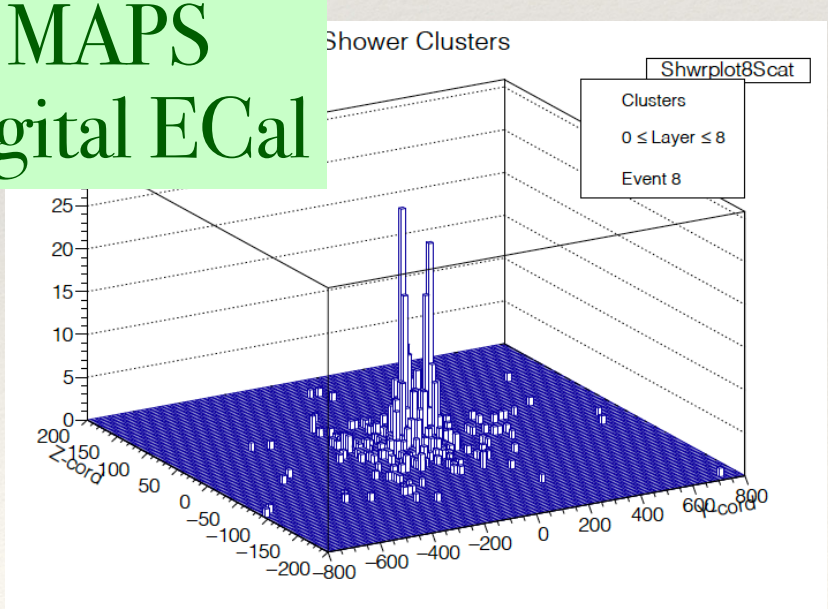
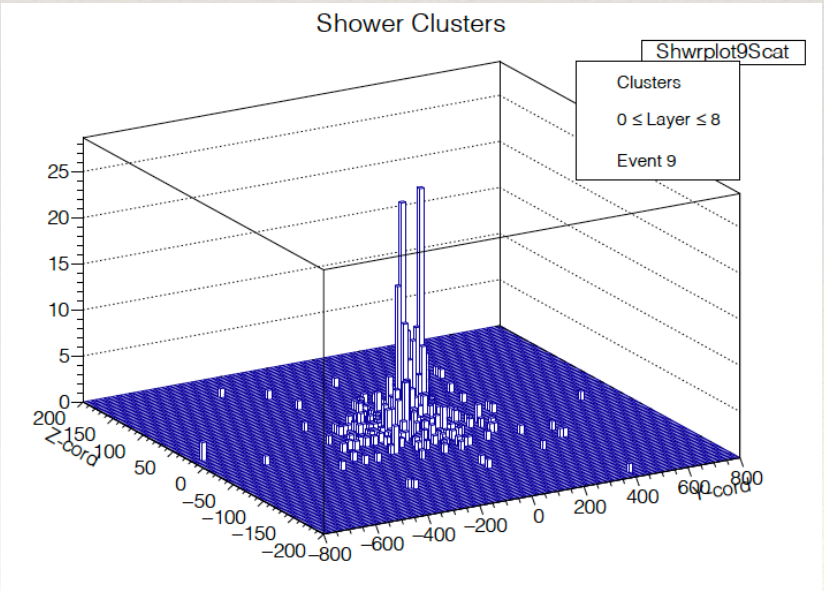
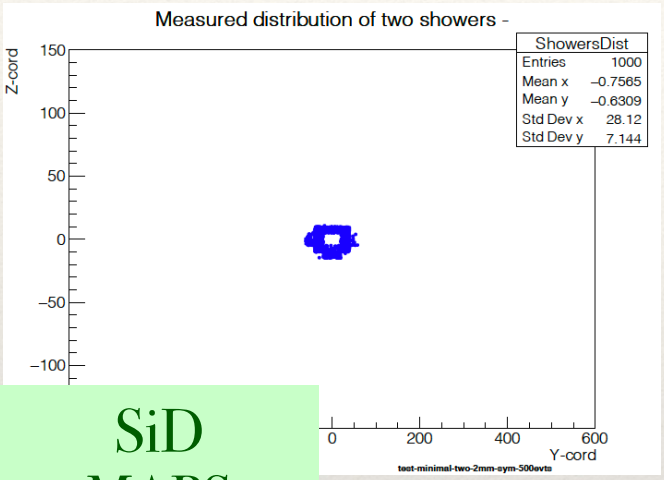
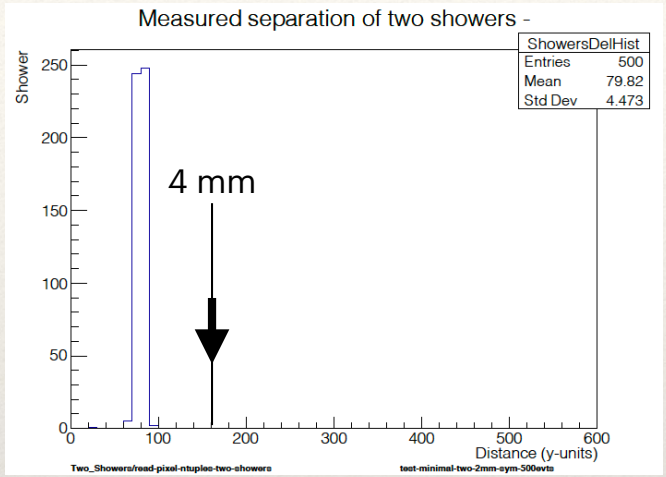
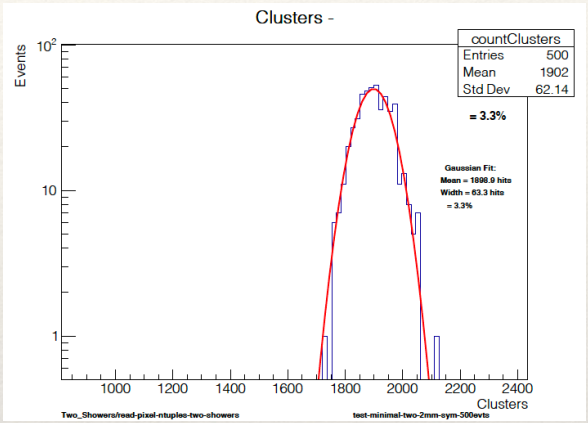




Two 10 GeV showers - 2 mm separation







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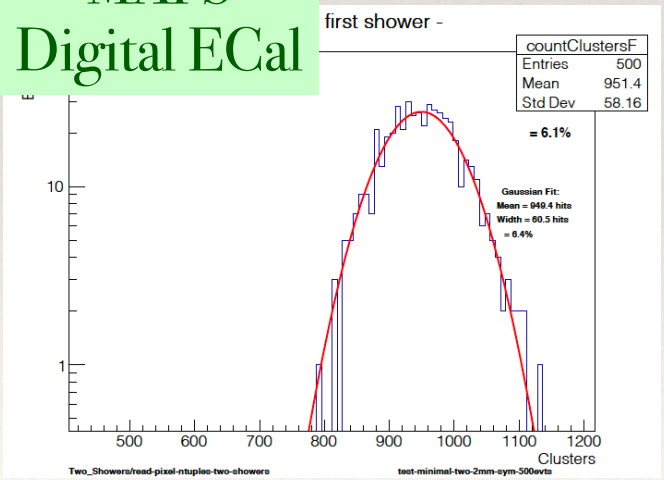
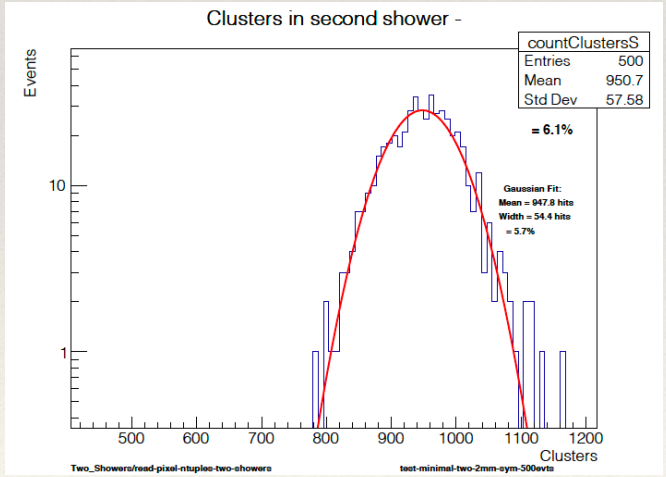
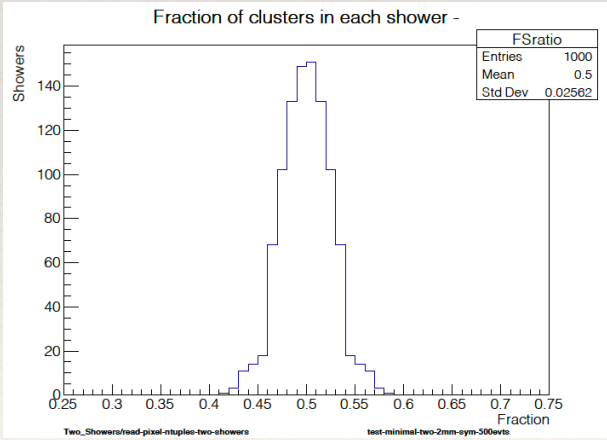
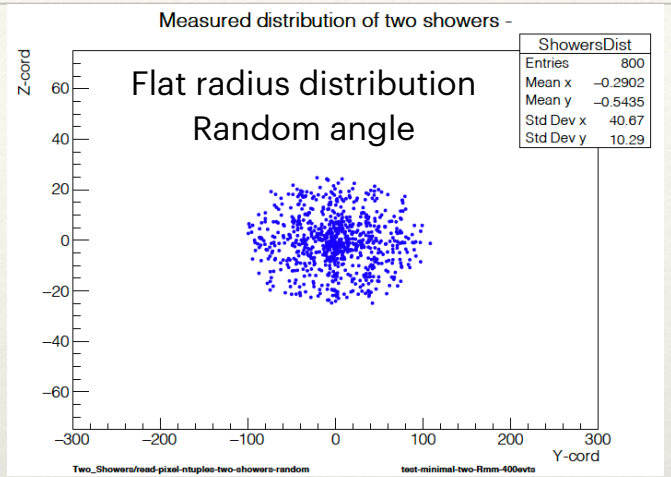




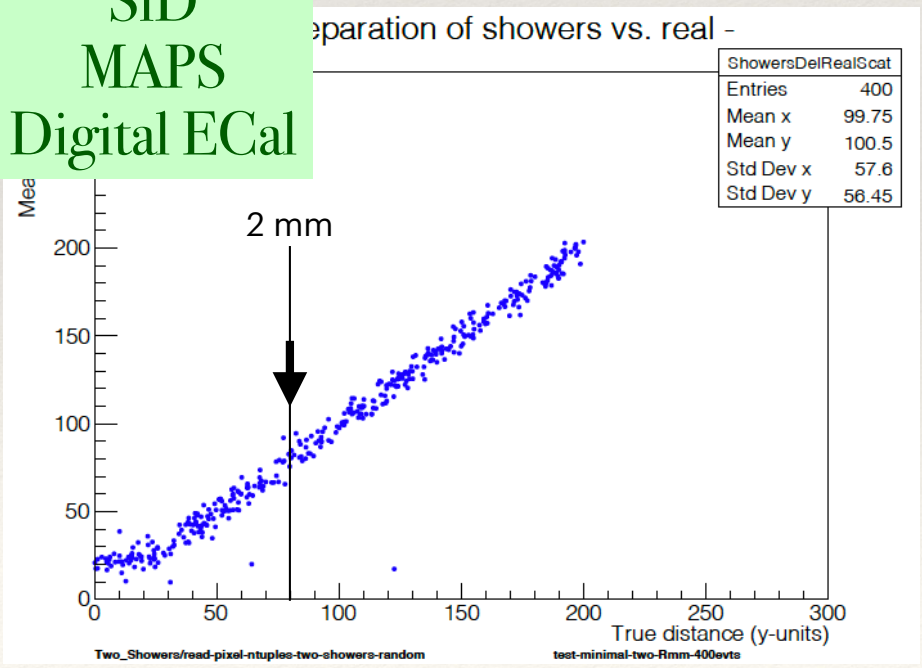


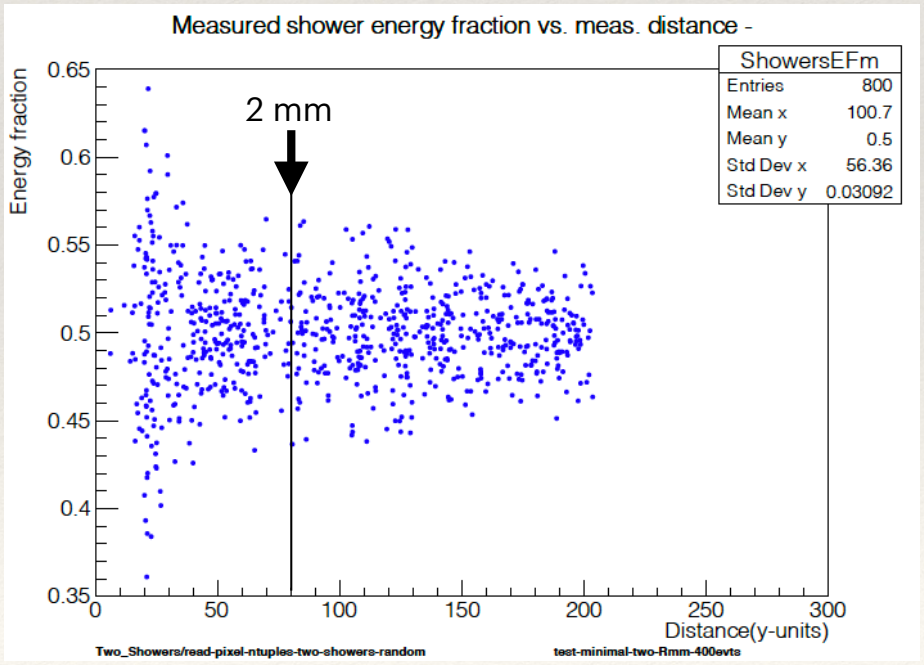
Two 10 GeV showers - random separation

- How does separation behave for very close electrons?

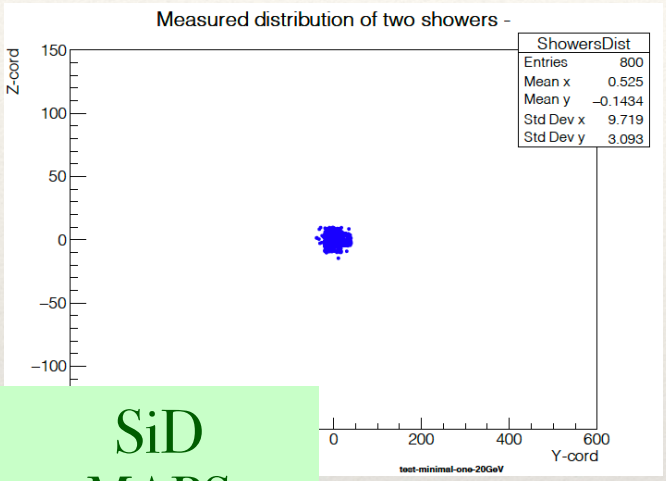


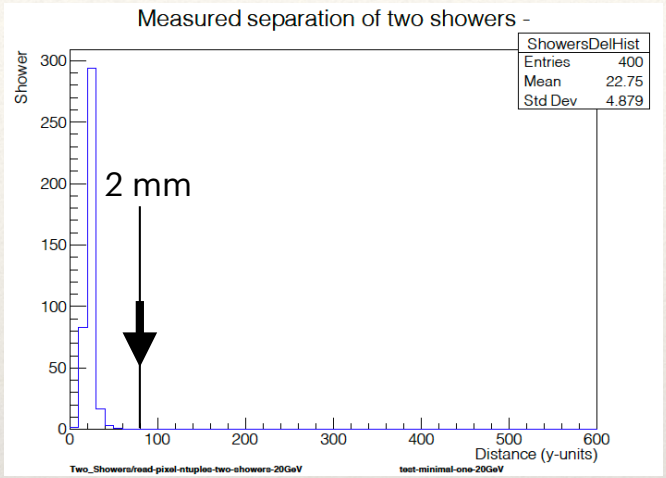
SiD MAPS Digital ECal

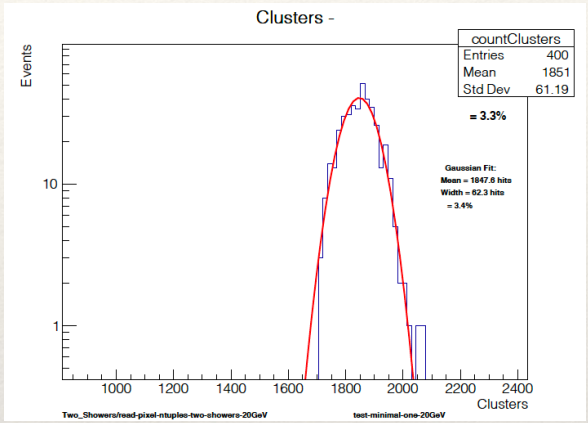




One 20 GeV shower - try to split







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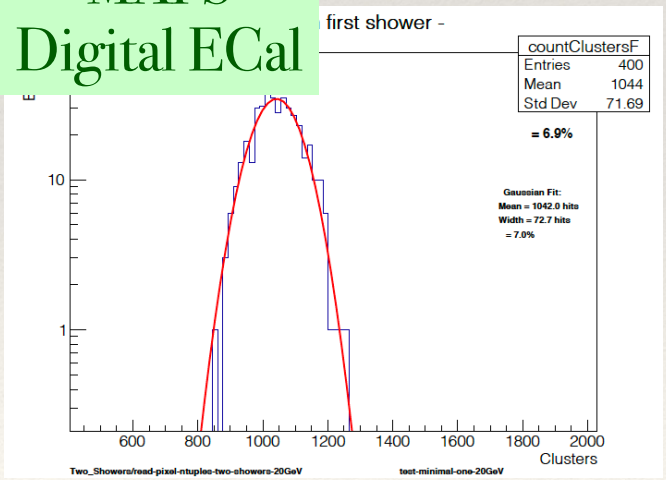
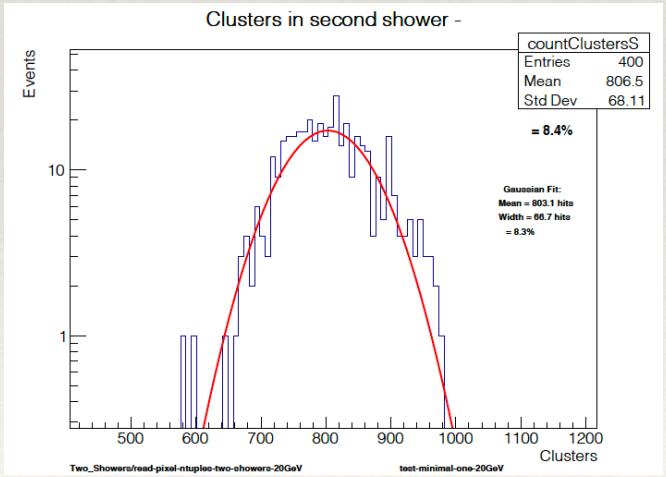
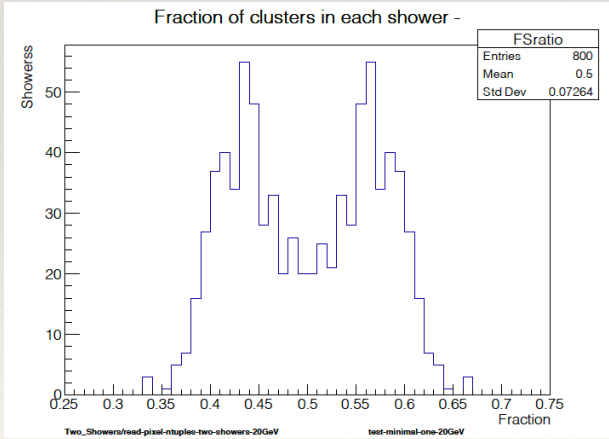
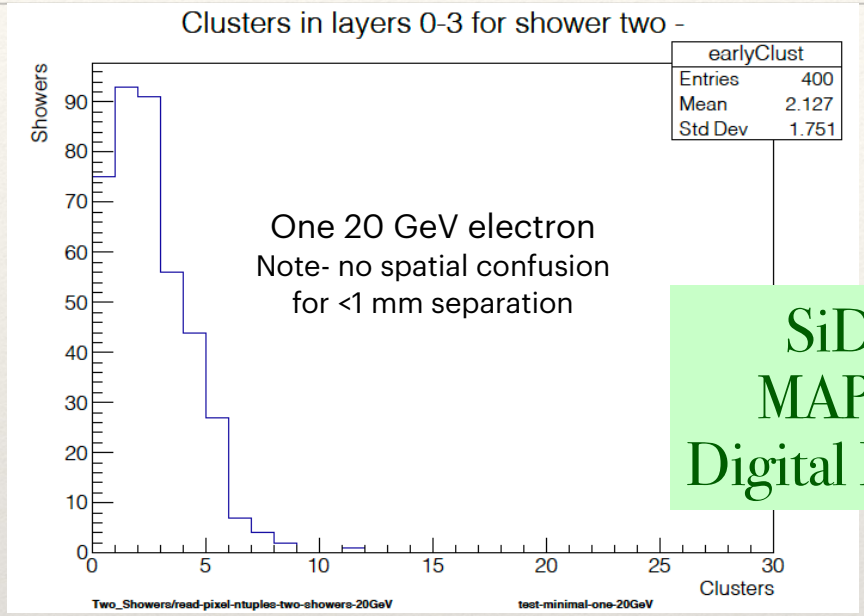
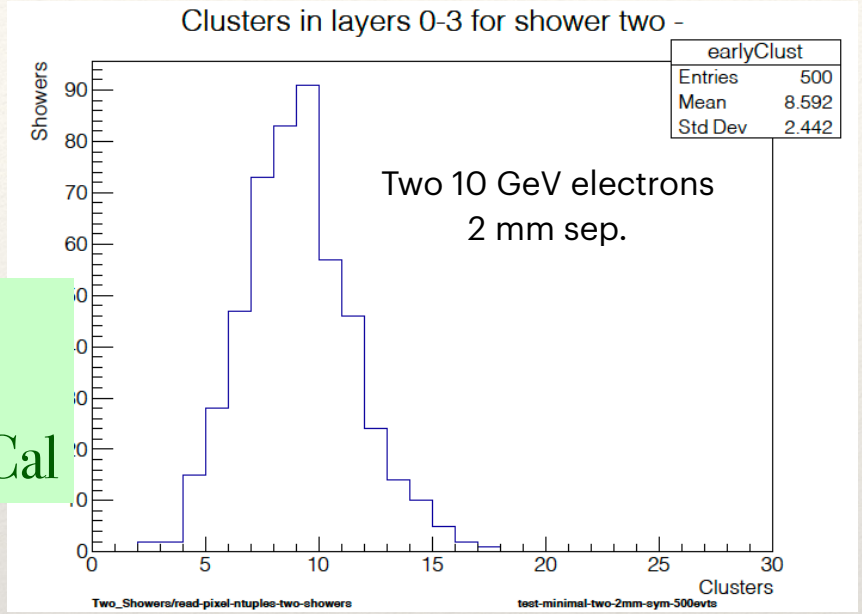






What about early clusters?
Layers 0-3 (2.7 X_0)





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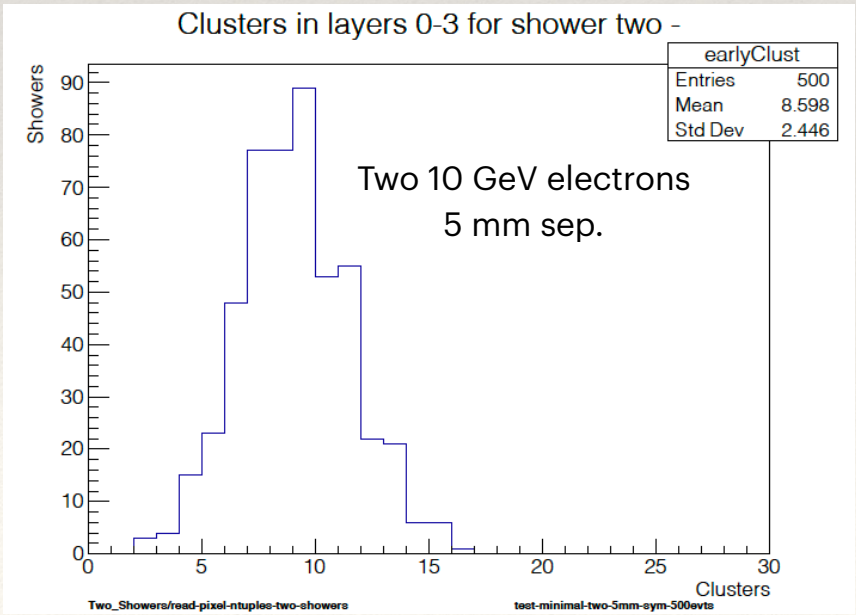
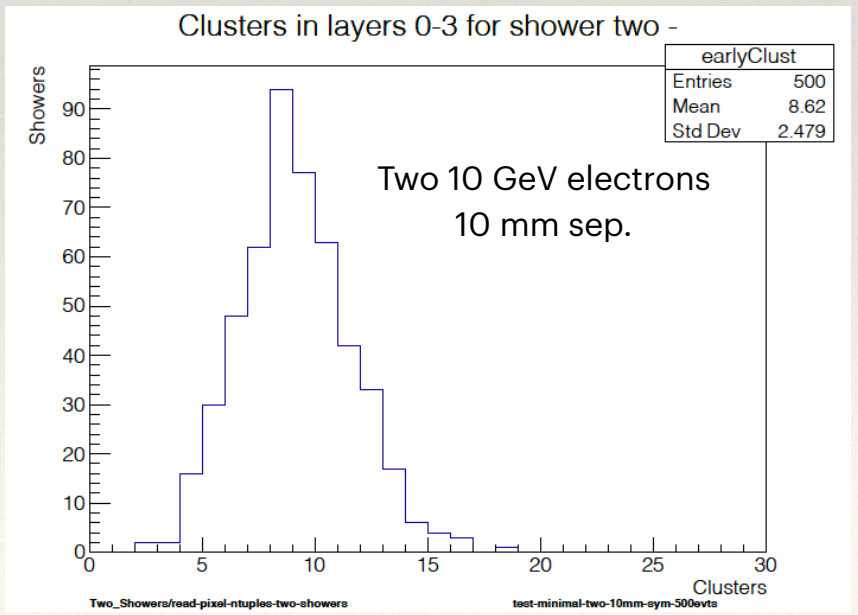
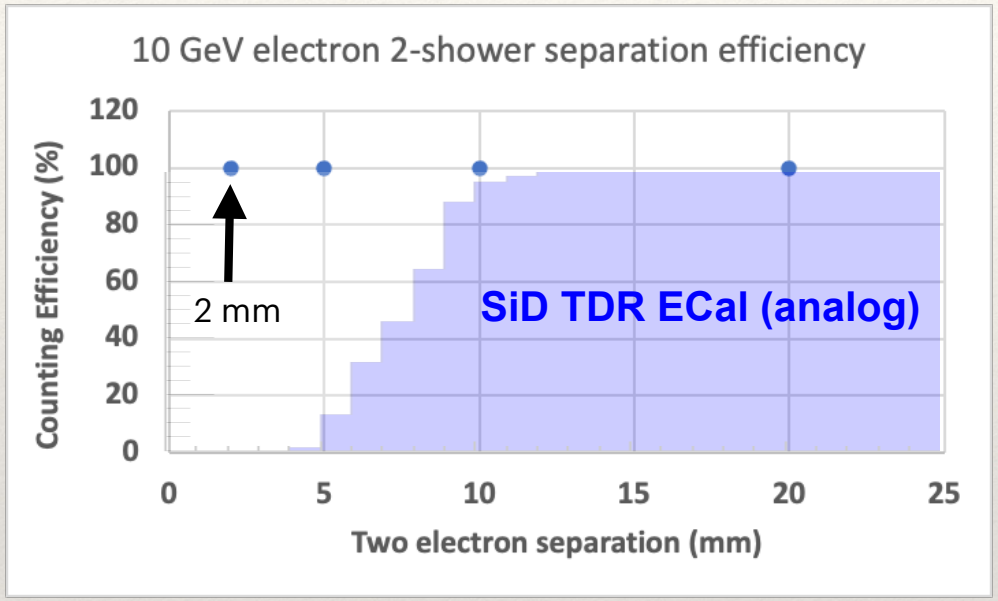
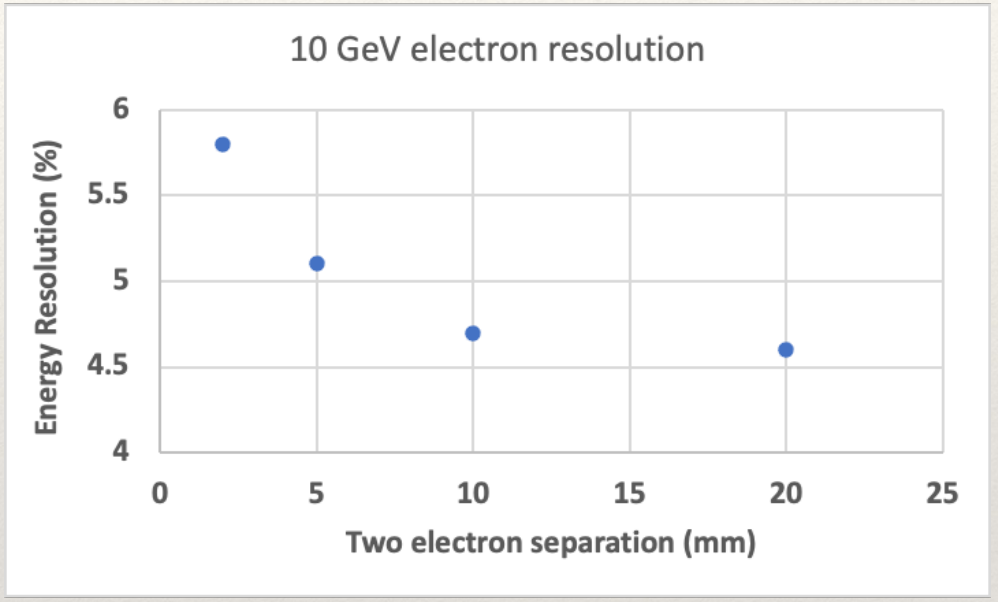




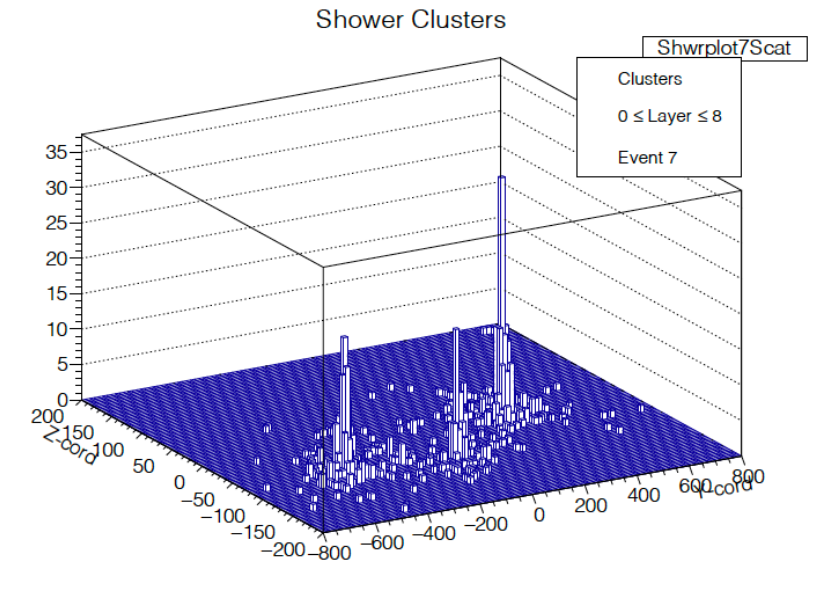
Performance summary
Two nearby 10 GeV electrons in SiD MAPS ECal

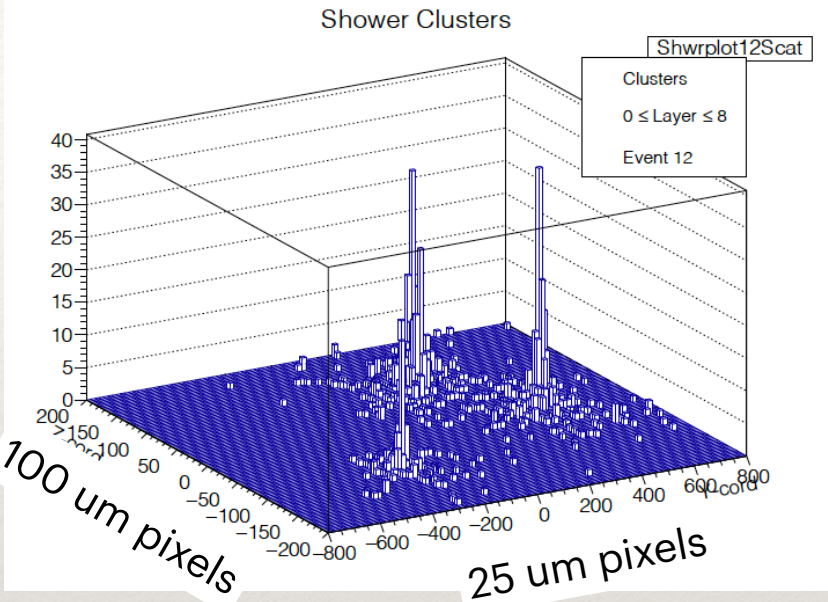


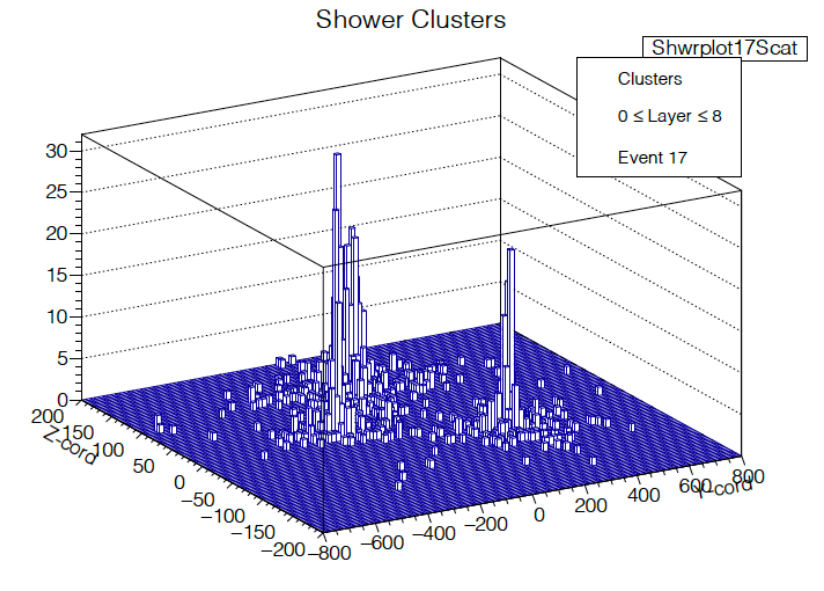


- Excellent performance!
- Note - very little optimization:
  - Separation studies started just one week ago:

Beam test sim - random number
Spatial distribution rms = 8 mm







Shower Count							
Electrons		0	1	2	3	4	5
	1	2	152	0	0	0	0
	2	0	1	145	3	0	0
	3	0	0	1	70	1	0
	4	0	0	0	1	24	0