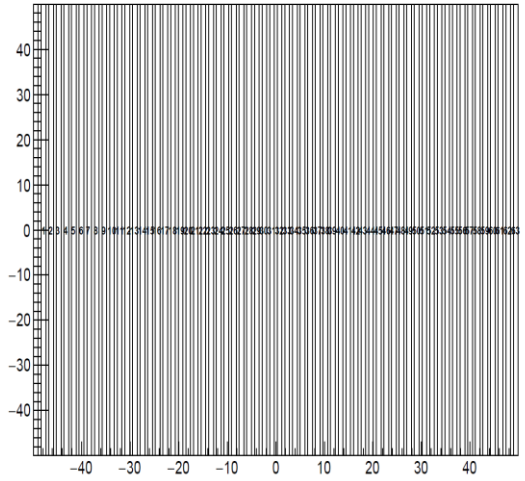
Muography: detector analysis

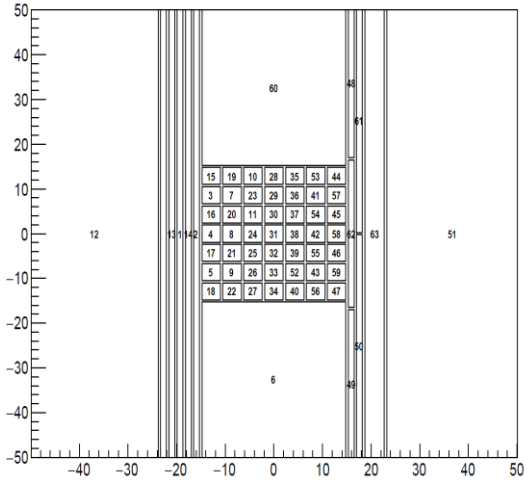
LouMu meeting 19-10-2021

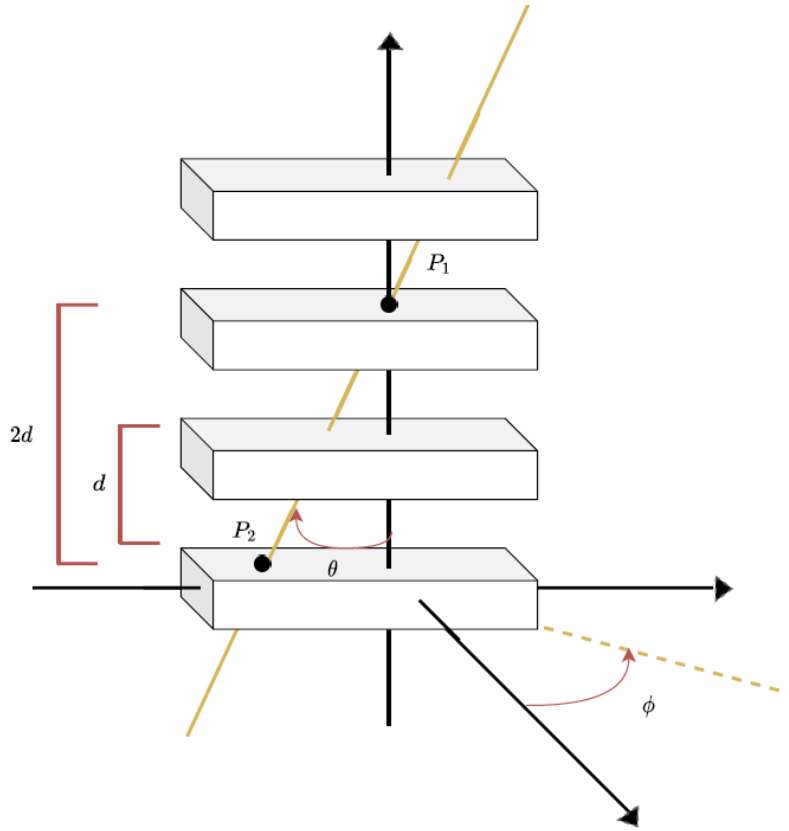
Detector

Plane 0



Planes 1, 2 and 3

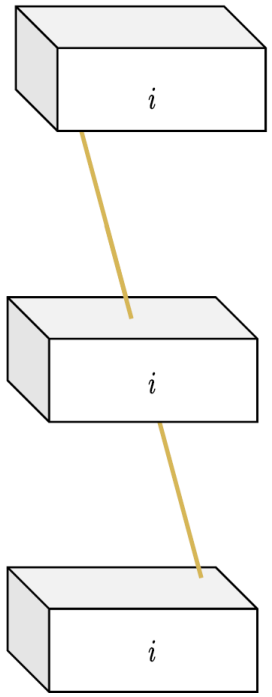




Vertical efficiency

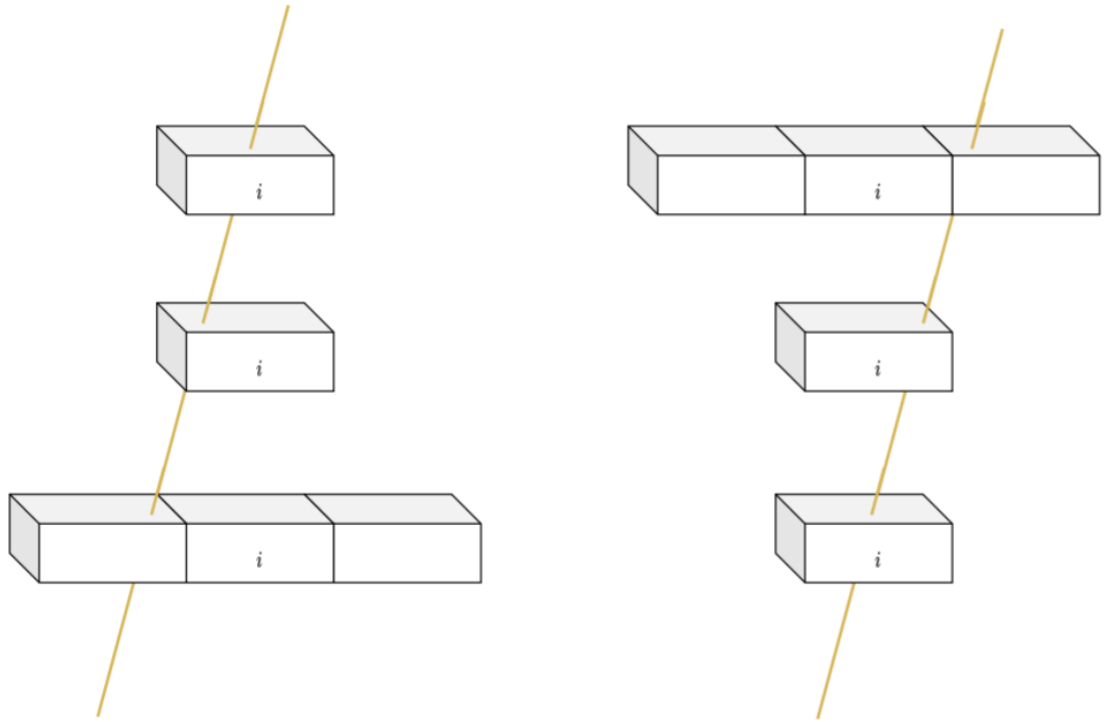
Initial formulation

$$\epsilon_2 [i] = \frac{N123 [i]}{N13 [i]}$$



Vertical efficiency

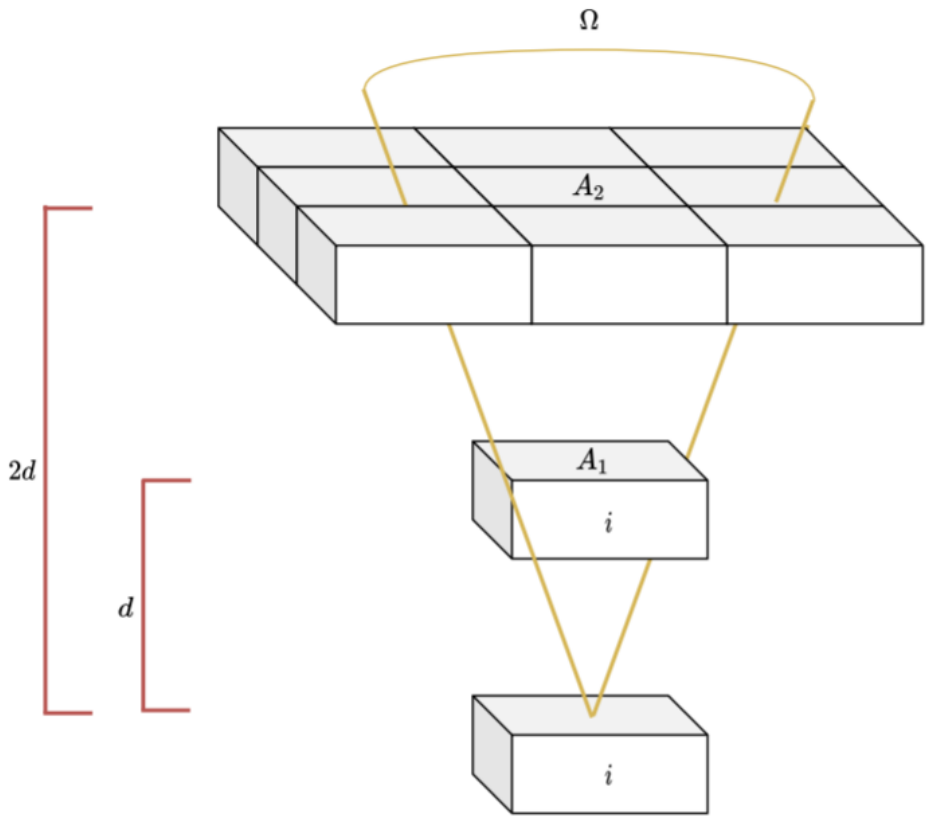
Initial formulation



Vertical efficiency

Initial formulation

$$\epsilon_k\left[i\right] = \frac{Nklm\left[i\right]}{G_k Nlm\left[i\right]}$$



Increases of 2 – 5 %

Acquisition period	ϵ_1		ϵ_2		ϵ_3	
	Mean	Uncertainty	Mean	Uncertainty	Mean	Uncertainty
August 2020	-	-	-	-	80.7	0.6
September 2020	-	-	-	-	76.0	0.7
November and December 2020	81.9	0.5	77.8	0.5	81.8	0.5
January and February 2020	83.5	0.4	78.1	0.5	85.0	0.4
April and May 2021	84.0	0.6	78.1	0.7	82.6	0.6
May and June 2021	80.3	0.5	72.0	0.5	79.2	0.5
1 - 14 September 2021	82.3	0.8	71.7	0.9	79.6	0.8
15 - 26 September 2021	76.8	0.8	67.5	0.9	76.0	0.8

Acquisition period	ϵ_1		ϵ_2		ϵ_3	
	Mean	Uncertainty	Mean	Uncertainty	Mean	Uncertainty
August 2020	-	-	-	-	82.4	0.7
September 2020	-	-	-	-	78.7	0.7
November e December 2020	84.0	0.5	80.6	0.6	83.4	0.5
January and February 2020	85.7	0.4	82.5	0.5	87.1	0.4
April and May 2021	86.2	0.7	81.2	0.8	84.3	0.7
May and June 2021	84.8	0.5	75.5	0.6	80.8	0.5
1 - 14 September 2021	85.3	0.9	75.8	1.0	81.7	0.9
15 - 26 September 2021	80.1	0.9	72.1	1.0	78.6	0.9

Vertical efficiency
Calculation optimization: plane 0 as a filter

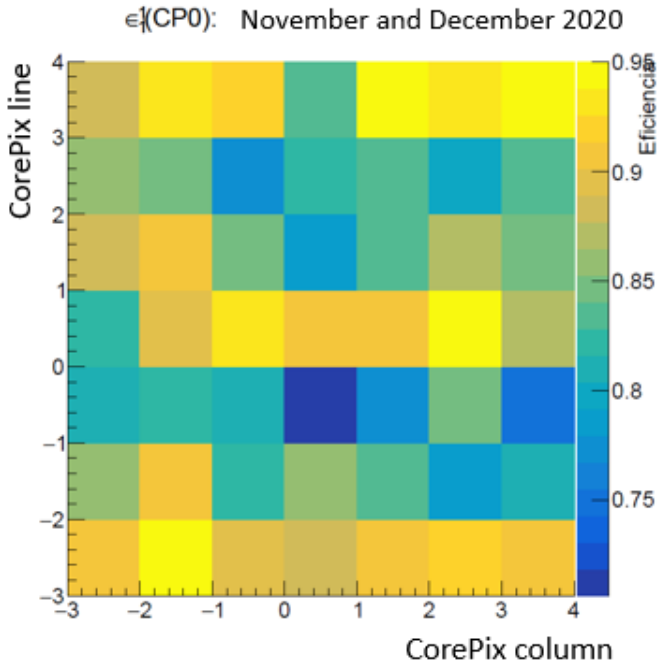
Increases of 2 – 3 %

Acquisition period	ϵ_1		ϵ_2		ϵ_3	
	Mean	Uncertainty	Mean	Uncertainty	Mean	Uncertainty
August 2020	-	-	-	-	82.4	0.7
September 2020	-	-	-	-	78.7	0.7
November e December 2020	84.0	0.5	80.6	0.6	83.4	0.5
January and February 2020	85.7	0.4	82.5	0.5	87.1	0.4
April and May 2021	86.2	0.7	81.2	0.8	84.3	0.7
May and June 2021	84.8	0.5	75.5	0.6	80.8	0.5
1 - 14 September 2021	85.3	0.9	75.8	1.0	81.7	0.9
15 - 26 September 2021	80.1	0.9	72.1	1.0	78.6	0.9

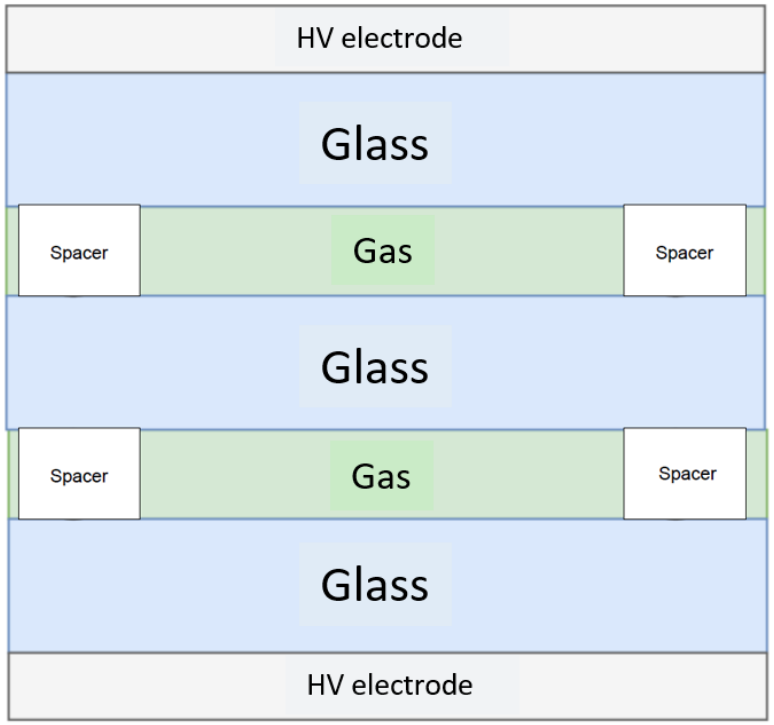
Acquisition period	ϵ_1		ϵ_2		ϵ_3	
	Mean	Uncertainty	Mean	Uncertainty	Mean	Uncertainty
August 2020	-	-	-	-	85.4	0.7
September 2020	-	-	-	-	81.6	0.8
November and December 2020	86.3	0.5	82.9	0.6	86.4	0.5
January and February 2020	88.1	0.5	84.9	0.5	90.3	0.5
April and May 2021	86.1	0.7	81.2	0.8	84.9	0.7
May and June 2021	84.7	0.5	75.5	0.6	81.4	0.5
1 - 14 September 2021	85.2	0.9	75.8	1.0	82.3	0.9
15 - 26 September 2021	80.0	0.9	72.0	1.0	79.2	0.9

Vertical efficiency
Calculation optimization: misalignments

Vertical efficiency
Calculation optimization: spacers

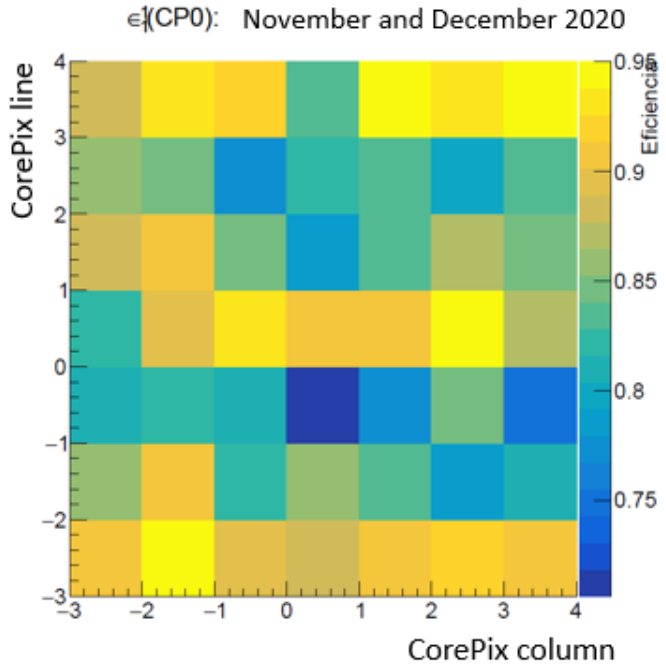


Vertical efficiency
Calculation optimization: spacers

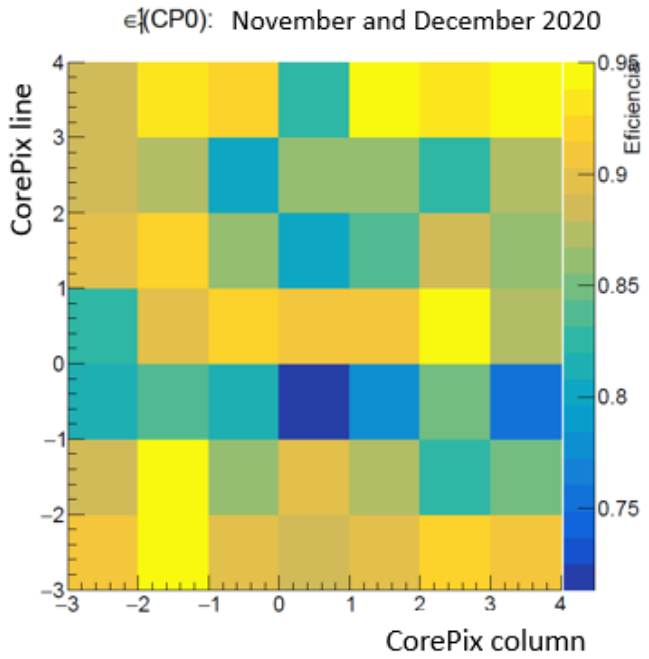


15	19	10	28	35	53	44
3	7	23	29	36	41	57
16	20	11	30	37	54	45
4	8	24	31	38	42	58
17	21	25	32	39	55	46
5	9	26	33	52	43	59
18	22	27	34	40	56	47

Vertical efficiency
Calculation optimization: spacers



Not accounting for spacers



Accounting for spacers

Vertical efficiency

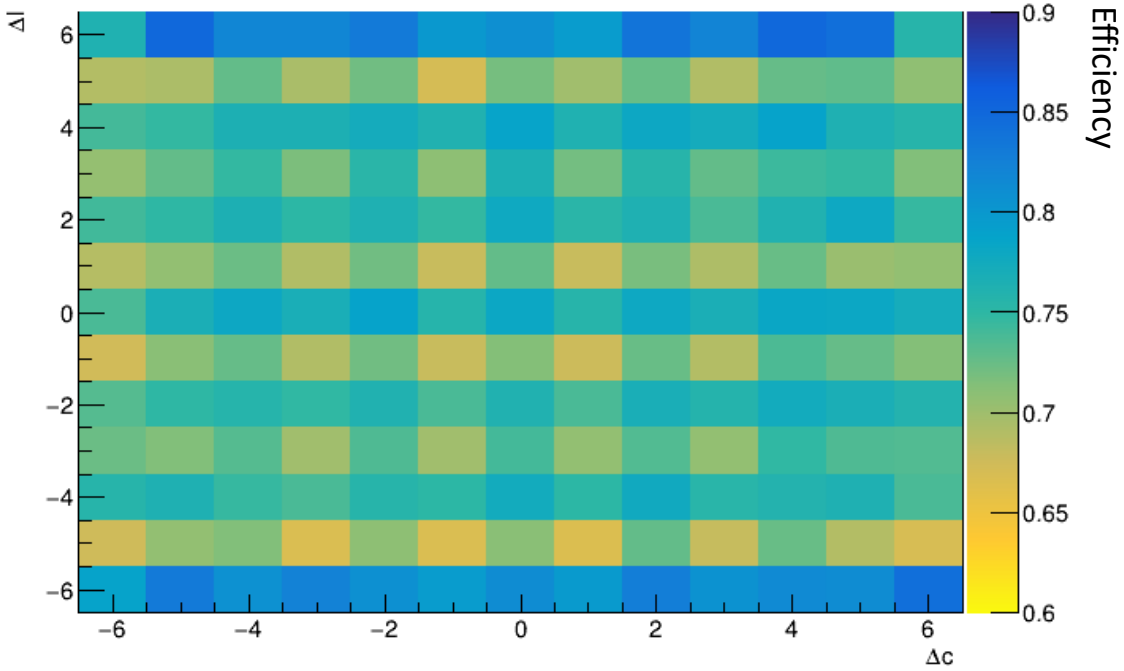
Detector optimization: modification of the electronic gains

Goal	Action		Consequences
Uniformize the CorePix	Modification of the CorePix gains	Using the pad with the highest charge median as reference	.Increase of the efficiencies .Increase of the number of events with multiple hits .Pad saturation
		Using the mean of the charge medians as reference	. Uniformization of the CorePix
Inviabilize cross-talk by the exterior pads	Modification of the exterior gains (inactivation of the exterior pads)		.Decrease of the efficiencies

$$\hat{\epsilon_2}(\theta_m) = \frac{\sum_{i,j\ such\ that\ \theta=\theta_m} \left(\frac{\sum_{k=1}^{M_{ij}} N_{ijh_k}}{Nij} \right)}{\sum_{i,j\ such\ that\ \theta=\theta_m} 1}$$

- i and j are the pads crossed in planes 1 and 3
- h_k is a pad physically crossable in plane 2 in accordance with the trajectory traced by i e j
- M_{ij} is the maximum number of h_k existent for the pair i and j

General efficiency for plane 2



General efficiency

Initial formulation

$$\hat{\epsilon_2}(\theta_m) = \frac{\sum_{i,j\ such\ that\ \theta=\theta_m} \left(\frac{\sum_{k=1}^{M_{ij}} N_{ijh_k}}{Nij} \right)}{\sum_{i,j\ such\ that\ \theta=\theta_m} 1}$$

- i and j are the pads crossed in planes 1 and 3
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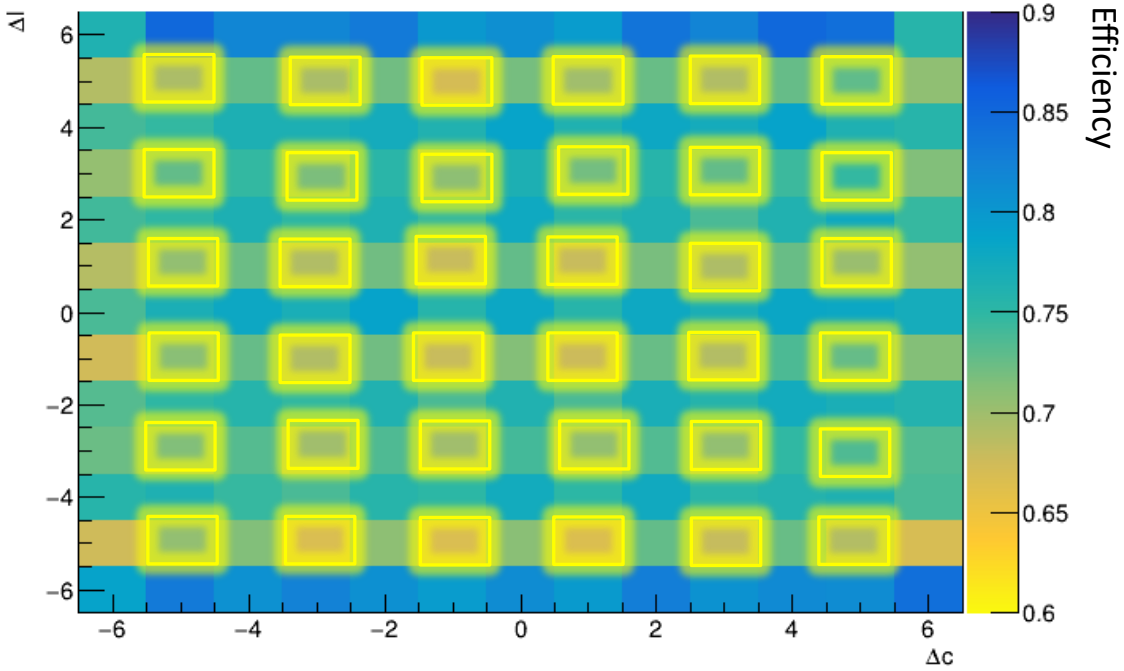
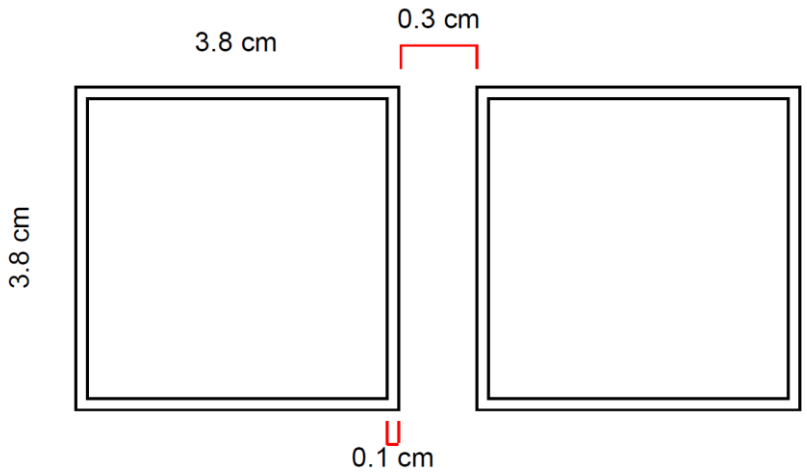
General efficiency for plane 2



General efficiency

Initial formulation

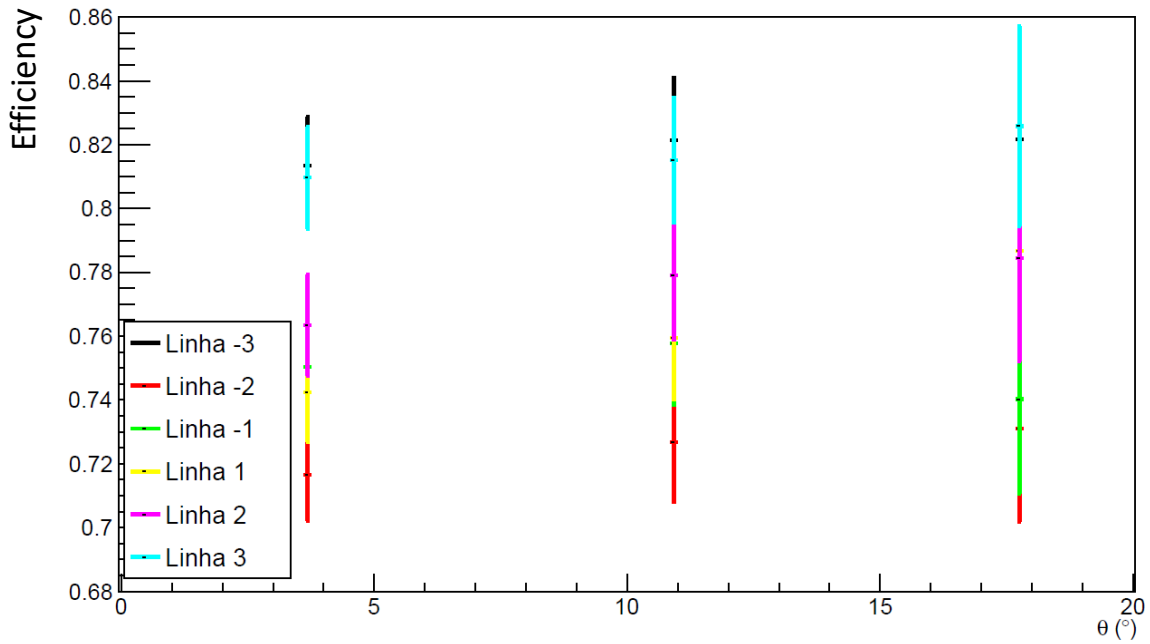


15	19	10	28	35	53	44
3	7	23	29	36	41	57
16	20	11	30	37	54	45
4	8	24	31	38	42	58
17	21	25	32	39	55	46
5	9	26	33	52	43	59
18	22	27	34	40	56	47

General efficiency

Dead area and spacers

General efficiency for plane 2: case between columns

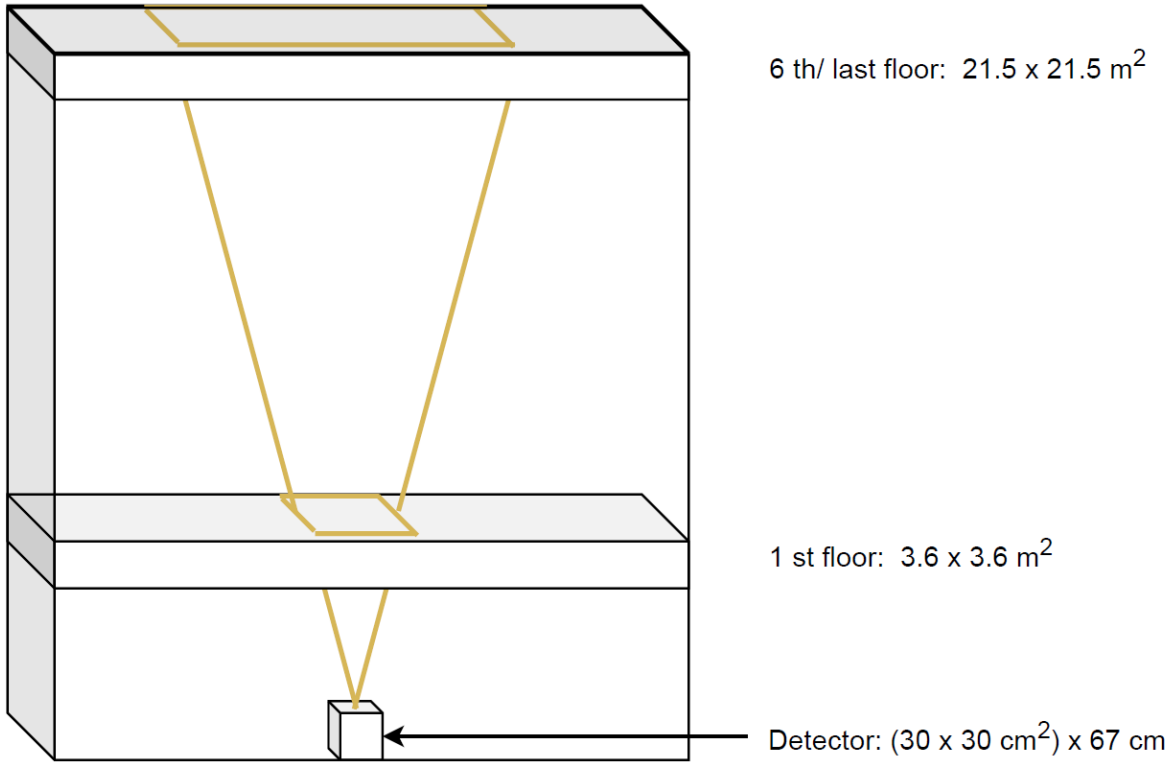


- It’s possible to characterize the spacers effect per line
- The inactive area due to the spacers goes to 3x the spacers physical volume
- The dead area between neighbor pads is, approximately, 70% of that same region

General efficiency
Dead Area and spacers

Building reconstruction

Simulated reconstruction



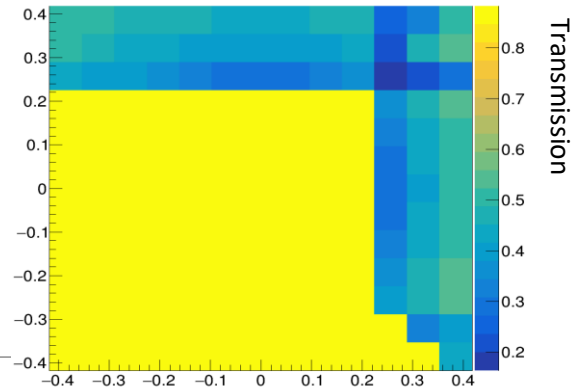
(Not up to scale)

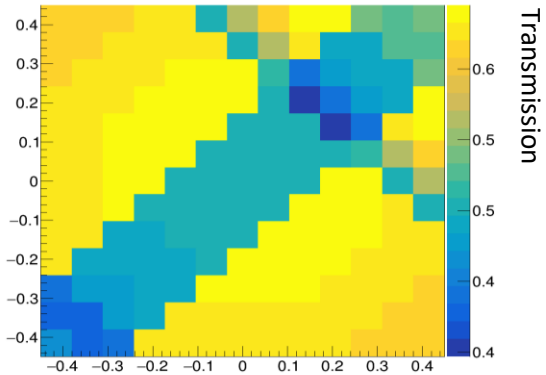
Building reconstruction

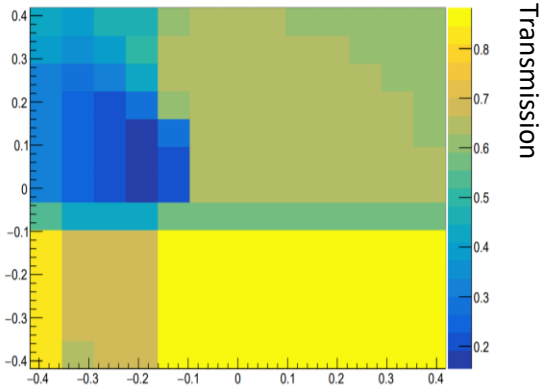
Simulated reconstruction

Building structures considered:

- walls
- ceilings
- beams
- columns
- stone benches



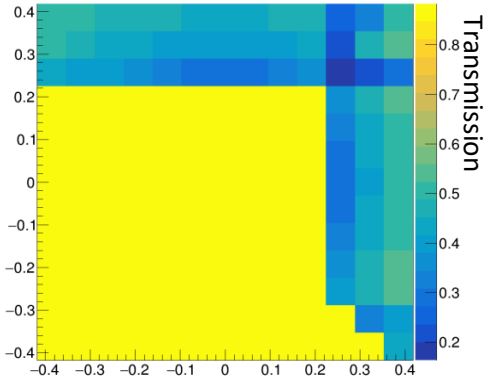


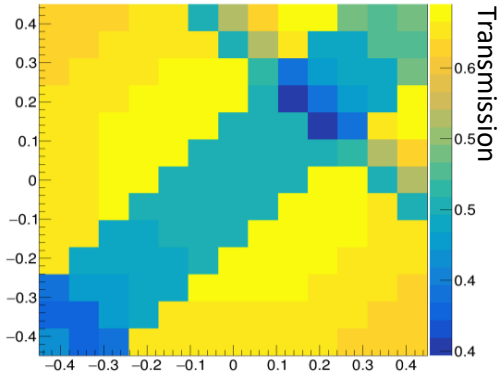


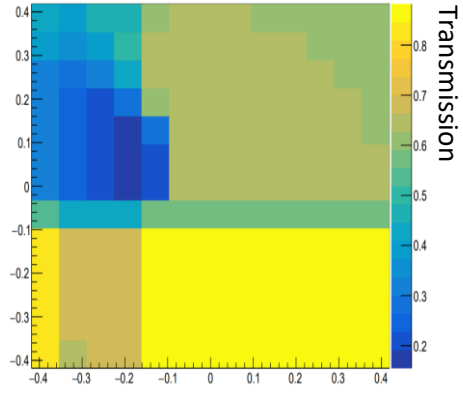
Building reconstruction

Simulated reconstruction *versus* experimental reconstruction

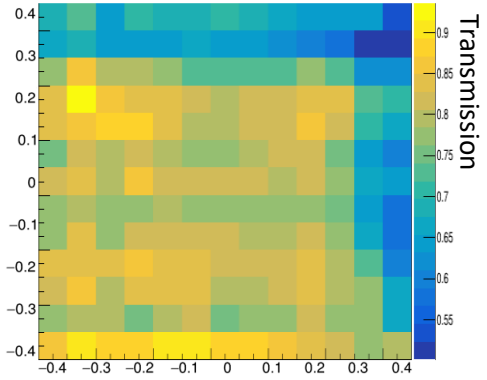
Simulation

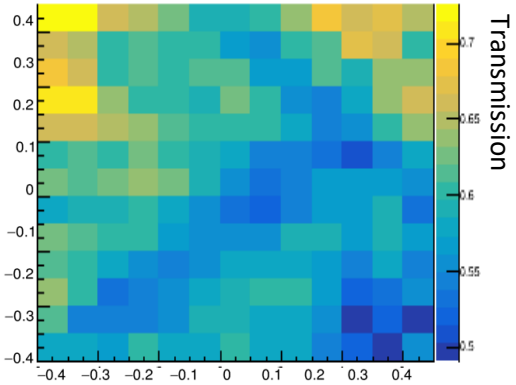


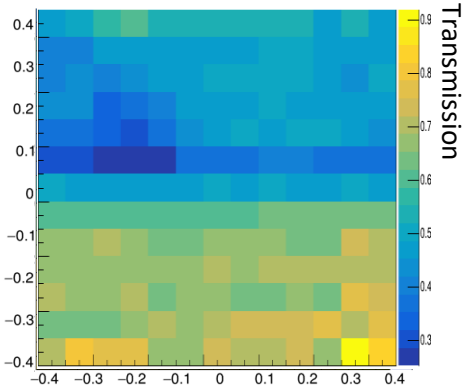




Data







Questions

- why does plane 2 have a lower efficiency ?
- how do exterior pads influence interior pads?
- do spacers affect beyond their physical volume?
- are there any more structures than the ones considered in the simulation?

Thank you for listening

Any questions?