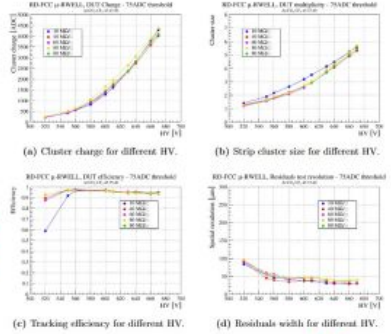
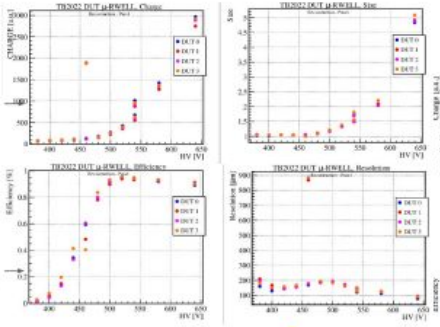
Summary analysis TB

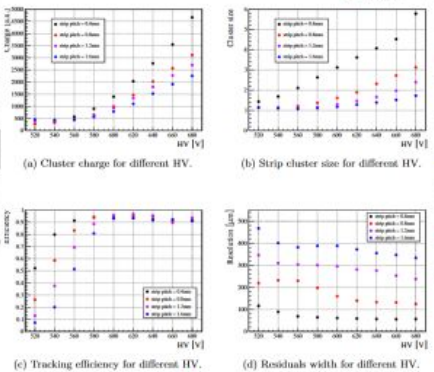
R. Farinelli

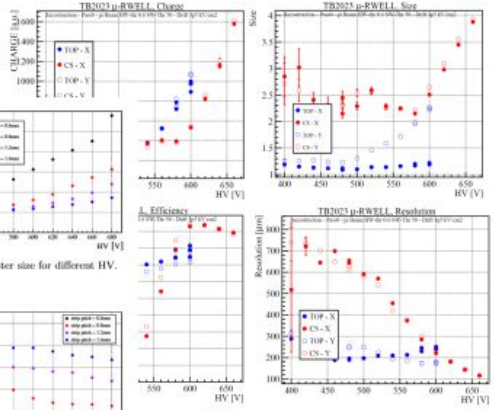
R&D for FCC

TB with DC + pre-shower + CALO+ Muon









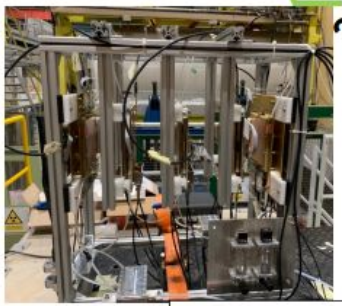
2020 — 2021 — 2022 — 2023

1D PERFORMANCE

2D performance

Resistivity Scan @ fixed pitch

Pitch Scan @ fixed resistivity & 2x1D performance

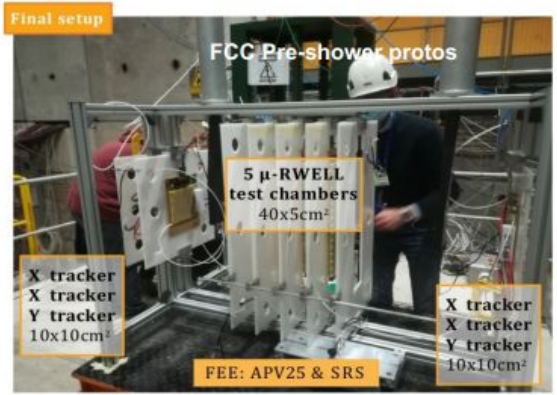


2D layouts

Resistivity Optimization

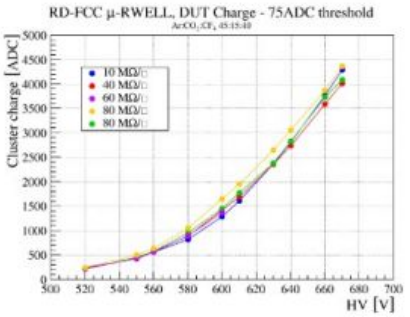
TB with DC + pre-shower + CALO+ Muon

2020 — 2021

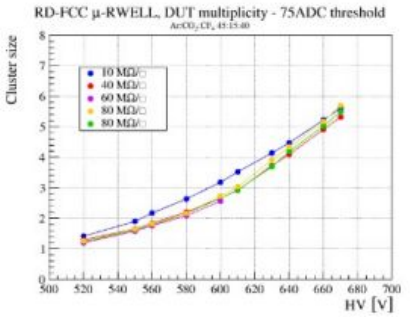


Active area= 400x50 mm2
Pre-preg thickness= 50 um
Resistivity= 10 ÷80 MΩ/
Strip pitch= 0.4 mm
Strip width = 0.150 mm
Ratio p/w= 2.66

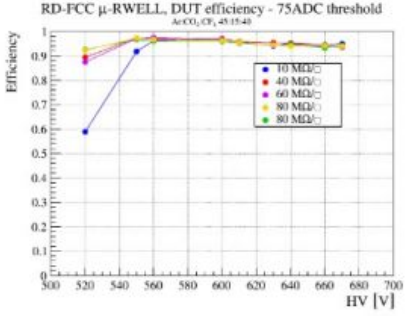
Resistivity Scan @ fixed pitch



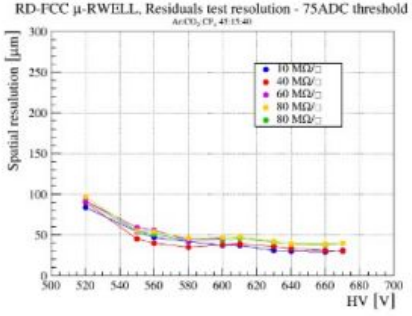
(a) Cluster charge for different HV.



(b) Strip cluster size for different HV.



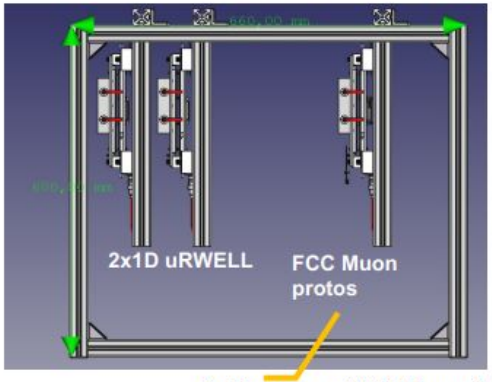
(c) Tracking efficiency for different HV.



(d) Residuals width for different HV.

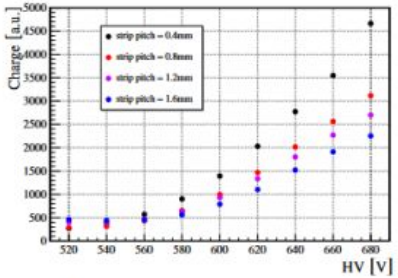
Same performance except the **10 MΩ/□ proto**
Efficiency knee @ 550 V, σ_x < 100 um

1D R/out strip pitch

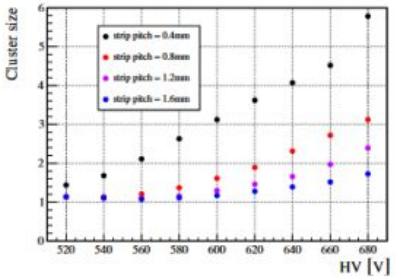


Active area= 400x50 mm2
Pre-preg thickness= 50 um
Resistivity= 30 MΩ/
Strip pitch= 0.4-1.6 mm
Strip width = 0.15 mm
p/w ratio= 2.66 – 10.66

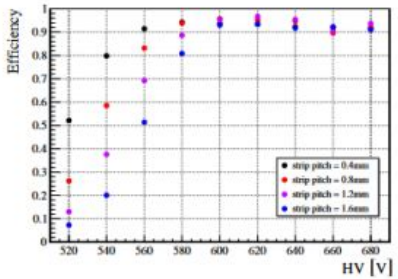
R/O pitch scan @ fixed resistivity



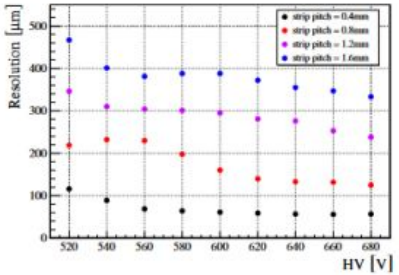
(a) Cluster charge for different HV.



(b) Strip cluster size for different HV.



(c) Tracking efficiency for different HV.



(d) Residuals width for different HV.

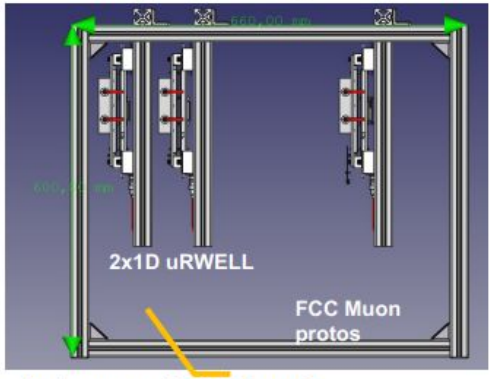
Larger is the strip pitch, lower is the charge signal requiring a higher gain to reach full efficiency.

Efficiency knee @ 600 V & σ_x < 400 um for a strip pitch = 1.6 mm

A high p/w ratio implies a worsening of the detector performance

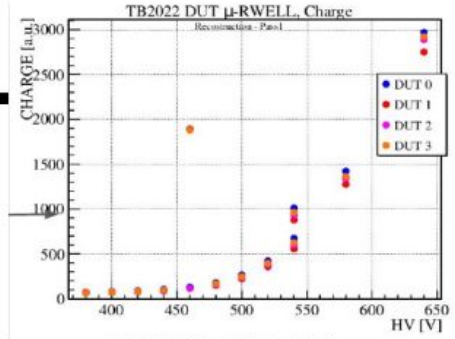
2x1D R/out

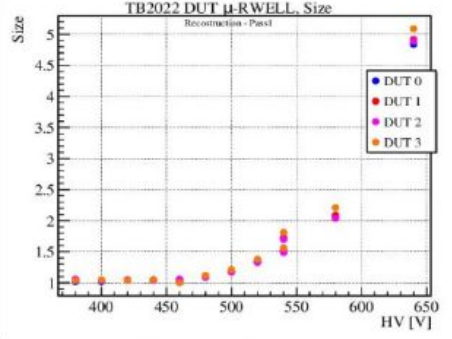
2022

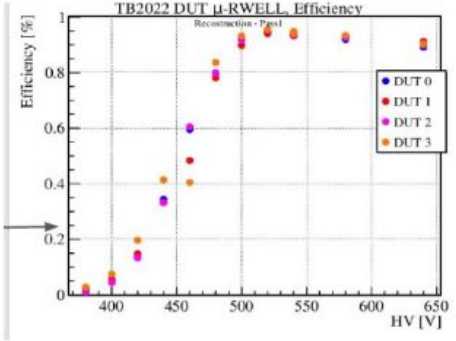


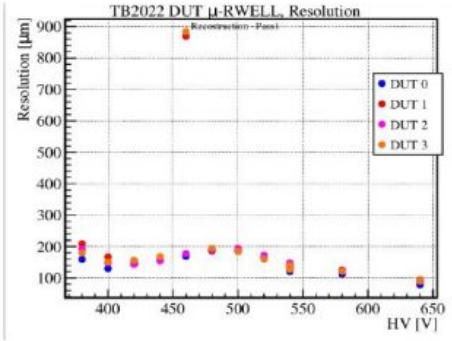
Active area= 100x100 mm2
Pre-preg thickness= 20 um
Resistivity= 50 MΩ/
Strip pitch= 0.76 mm
Strip width = 0.3 mm
Ratio p/w= 2.53

2x1D performance









The 1D proto show very good performace @ 500 V to be compared with 2D ones (TB 2023)
Efficiency knee @ 500 V & σx < 200 um for a strip pitch ~ 0.8 mm

2D R/out layout: Charge Sharing (red) e TOP (blue)

An ugual charge sharing on the X-Y coordinates is shown for both 2D r/out

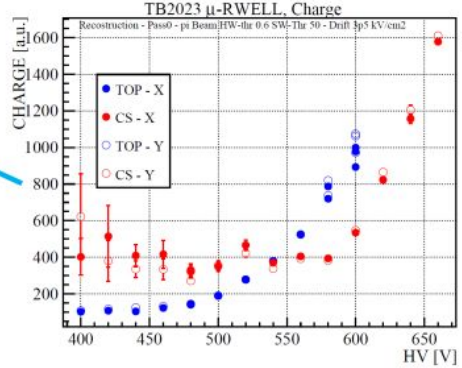
TOP r/o:

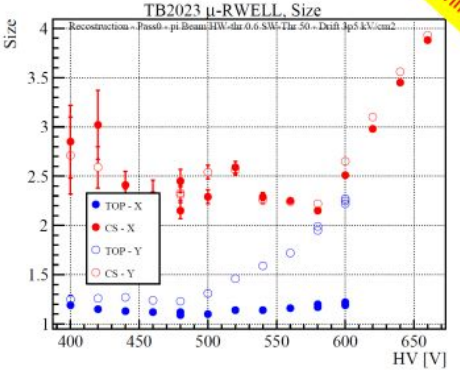
- **The total charge isn't divided between X & Y view**;
- **Efficiency knee @ 500 V** (such as 1D proto);
- **Low efficiency plateau (~70%) due to dead zone**
- Cluster Size does not change on X (TOP layer), while changing on the Y (due to the DLC spread);
- **Digital spatial resolution** on the X (Strip size ~ 1.5), strip Size>, improving on the Y (due to DLC spread)

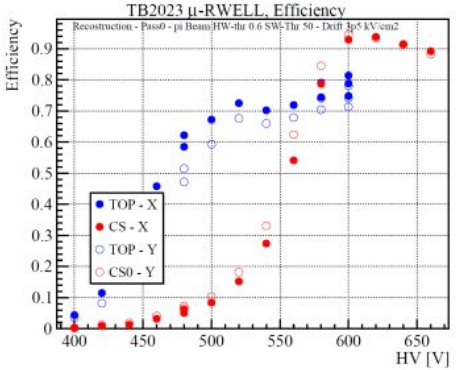
CS r/o:

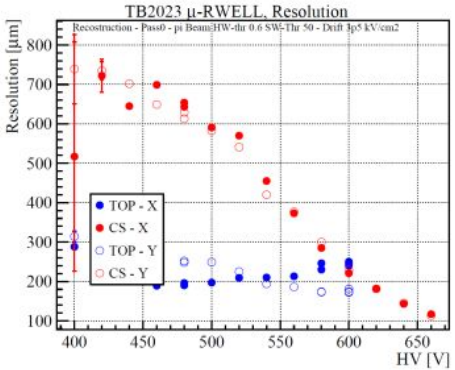
- **The total charge is divided between X & Y view**;
- **Efficiency knee @ 600 V;**
- **High efficiency plateau (~95%)**
- Cluster size increase to 4 strips (Charge Sharing mechanism work)
- **Spatial resolution** improves at higher gain reaching **150 um with a strip pitch of 1.2 mm**

preliminary









List of the TB

1. TB 2021 ⟶ resistivity scan
2. TB 2022 (a) ⟶ pitch scan
3. TB 2022 (b) ⟶ 2x1D
4. TB 2023 ⟶ 2D
5. Cremlin ⟶ cylindrical μRWELL

Analysis (1)

List of the event selections:

- 6 firing trackers (XXY fw and XXY bw)
- trk_X_fw_1 - trk_X_fw_2 in 3 sigma
- trk_X_bw_1 - trk_X_bw_2 in 3 sigma
- **line fit chi2 better than 0.1**
- efficiency selection in 10 sigma

List of the calibrations:

- XY rotation
- alignment

Optimization done:

- **Threshold scan [25,200] ADC** → selected 75 ADC
- Resolution evaluated with two method:
  - only trackers
  - all the detectors but the one under test

Missing:

- **evaluate the contribution of the tracking system**
- trk cluster size cut

Analysis (2+3)

List of the event selections:

- 4 firing trackers (XY fw and XY bw)
- **trk_X_fw - trk_X_bw in 3 sigma**
- **trk_Y_fw - trk_Y_bw in 3 sigma**
- geometrical area selection XY (border and/or PEP)
- efficiency selection in 10 sigma

List of the calibrations:

- XY rotation and alignment

Optimization done:

- Resolution evaluated with two method:
  - only trackers
  - all the detectors but the one under test

Missing:

- trk cluster size cut

Analysis (4)

List of the event selections:

- 4 firing trackers (XY fw and XY bw)
- **trk_X_fw - trk_X_bw in 3 sigma**
- **trk_Y_fw - trk_Y_bw in 3 sigma**
- geometrical area selection XY (border and/or PEP)
- efficiency selection in 10 sigma

List of the calibrations:

- XY rotation and alignment

Optimization done:

- Resolution evaluated with two method:
  - only trackers
  - all the detectors but the one under test

Missing:

- trk cluster size cut

Analysis (5)

List of the event selections:

- 4 firing trackers (XY fw and XY bw)
- **fit value selection in X and Y: |m_fit|<0.05**
- **trk cluster size <= 4**
- efficiency selection in 1 cm

List of the calibrations:

- XY rotation

Optimization done:

- Tiles alignment

To do:

List of the event selections:
- 4 or 6 firing trackers
- fit value selection in X and Y: |m_fit|<0.05
- line fit chi2 better than 0.1
- trk cluster size <= 4
- efficiency selection in 10 sigma or fix cut ?
- only two cluster in trackers

List of the calibrations:
- XY rotation and alignment

Measurement
- 2D eff.
- 2D resolution

To discuss
- trk cluster charge ?
- other rotation or alignment ?
- selection on the events ? i.e. no noisy event ?

To do:

TB 2021 pitch

- come fittare un panettone ?

TB 2021 2x1D readout

- check punto a 540V -> t/p o altro?

All:

- aggiungere gli errori alle misure
- commentare il calo di efficienza ad alta HV -> splash
- **pulizia tracciatori esterni richiedendo che ci sia un solo cluster in quell'evento (and/or X e Y)**
- check **1 gaus** or 2 gaus e calcolo efficienza con sigma tail or core
- evaluate the contribution of the tracking system
- **check dei tagli prima di applicarli a tutti soltanto a qualche run e controllare visivamente le distribuzioni**
- **studi di statistica dopo i tagli**
- CONTROLLO DEL RUMORE valor medio, rate
- check threshold su hit e su cluster?

Resistivity Optimization TB 2021

								TEST										TRK																	
# RUN	DAY	TYPE	PED	START	STOP	ANGLE	# Ev	1		2		3		4		5		1Y		2X		3X		4X		5X		6Y		QUALITY	COMMENTS
	Messo scotch x unire i settori -> HV SCAN camere di TEST																																		
74	25/10	ped	-	8:46	8:49	0	20k	500	3.5	500	3.5	500	3.5	500	3.5	500	3.5	625	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5		
75	25/10	phy	74	8:55	9:22	0	20k	500	3.5	500	3.5	500	3.5	500	3.5	500	3.5	625	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5	MIGHT BE GOOD	fascio off per 4 ore
76-81	25/10	ped	-	10.45	10.46	0	20k	500	3.5	500	3.5	500	3.5	500	3.5	500	3.5	625	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5		piedistalli per provare se la saldatura dei settori è andata bene
82	25/10	ped	-			0	20k	500	3.5	500	3.5	500	3.5	500	3.5	500	3.5	625	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5		
83		phy	82		16:20	0	42k	500	3.5	500	3.5	500	3.5	500	3.5	500	3.5	625	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5	GOOD	
84	25/10	phy	82	16.30	17.11	0	40k	520	3.5	520	3.5	520	3.5	520	3.5	520	3.5	625	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5	GOOD	
85	25/10	phy	82	17.12	17:56	0	40k	540	3.5	540	3.5	540	3.5	540	3.5	540	3.5	625	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5	GOOD	
86	25/10	phy	82	17:58	18:39	0	40k	560	3.5	560	3.5	560	3.5	560	3.5	560	3.5	625	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5	GOOD	
88	25/10	phy	82	21:51	22:14	0	40k	550	3.5	550	3.5	550	3.5	550	3.5	550	3.5	625	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5	GOOD	errore mio. non ho controllato gli hv. Gf
89	25/10	phy	82	22:17	22.41	0	40k	580	3.5	580	3.5	580	3.5	580	3.5	580	3.5	625	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5	GOOD	riprendiamo l'87 perché il fascio non è stato stabile
91	25/10	phy	82	23.10	23.30	0	30k	600	3.5	600	3.5	600	3.5	600	3.5	600	3.5	625	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5	GOOD - NO L3	trip L3, not baked (piano 5) -> tutte camere spente -> efficienze falsate
92	25/10	phy	82	23.42	00:12	0	40k	610	3.5	610	3.5	610	3.5	610	3.5	610	3.5	625	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5	GOOD - NO L3	
93	26/10	ped	-	9:13	9:15	0	20k	620	3.5	620	3.5	0	0	620	3.5	620	3.5	625	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5	GOOD - NO L3	L3 spenta a causa del problema denunciato durante il run 91
96	26/10	phy	93	11:06	11.45	0	45k	630	3.5	630	3.5	0	0	630	3.5	630	3.5	625	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5	GOOD - NO L3	L4_CAT tira anche 140nA
98	26/10	phy	93	13.55	14.28	0	41k	640	3.5	640	3.5	0	0	640	3.5	640	3.5	625	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5	GOOD - NO L3	L4_CAT tira O(120 nA), L1_TOP spike a 380 nA
99	26/10	phy	93	14.34	15.15	0	40k	660	3.5	660	3.5	0	0	660	3.5	660	3.5	625	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5	GOOD - NO L3	L4_CAT tira come al solito, L1_TOP ha fatto qualche spike, brevi, a 120, 1
100	26/10	phy	93	16.00	16.31	0	40k	670	3.5	670	3.5	0	0	670	3.5	670	3.5	625	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5	GOOD - NO L3	La HV è stata alzata a 670V appena dopo il run precedente ma senza far

								TEST										TRK													
# RUN	DAY	TYPE	PED	START	STOP	ANGLE	# Ev	1		2		3		4		5		1Y		2X		3X		4X		5X		6Y		QUALITY	COMMENTS
	RIMOSSE CAMERA L1&L7, MESSE CAMERE L2&L6. Nuovo setup: L2, L6, L3, L4,L5																														
175	30/10	phy	173	20.09	20.39	0	42k	680	0.5	680	0.5	680	0.5	680	0.5	680	0.5	620	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5		
182	31/10	phy	181	9:00	9.33	0	40k	680	3.5	680	3.5	680	3.5	680	3.5	680	3.5	620	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5	GOOD	CATODO L4 - Edrift = 3.5 kV/cm ==> 300 nA
208	31/10	PION	189	22.34	22.52	0	40k	680	0.5	680	0.5	680	0.5	680	0.5	680	0.5	620	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5	GOOD	L2 è nervosetta
209	31/10	PION	189	22.53	23.12	0	43k	660	0.5	660	0.5	660	0.5	660	0.5	660	0.5	620	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5	GOOD	
210	31/10	PION	189	23.15	23.28	0	40k	640	0.5	640	0.5	640	0.5	640	0.5	640	0.5	620	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5	GOOD	
211	31/10	PION	189	23.59	23.44	0	43k	620	0.5	620	0.5	620	0.5	620	0.5	620	0.5	620	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5	GOOD	
212	31/10	PION	189	23.45	0.01	0	42k	600	0.5	600	0.5	600	0.5	600	0.5	600	0.5	620	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5	GOOD	
213	1/11	PION	189	0.07	0.29	0	40k	600	3.5	600	3.5	600	3.5	600	3.5	600	3.5	620	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5	GOOD	
214	1/11	PION	189	0.32	0.41	0	41k	620	3.5	620	3.5	620	3.5	620	3.5	620	3.5	620	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5	GOOD	
215	1/11	PION	189	0.43	0.57	0	40k	640	3.5	640	3.5	640	3.5	640	3.5	640	3.5	620	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5	GOOD	
216	1/11	PION	189	1.00	1.13	0	40k	660	3.5	660	3.5	660	3.5	660	3.5	660	3.5	620	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5	GOOD	
217	1/11	PION	189	1.15	1.31	0	45k	680	3.5	680	3.5	680	3.5	680	3.5	680	3.5	620	3.5	585	3.5	600	3.5	600	3.5	615	3.5	590	3.5	GOOD	

Resistivity Optimization TB 2021

RUN ID	is aligned?	n evt	isFireTrk	Res < 3 sigma	chi2<100 + m_trk<0.01	size < 5	N cl < 3
83	y	42109	11555	8154	3717	2931	2699
84	y	40758	11314	8071	3729	2903	2658
85	y	40438	11098	7910	3619	2823	2548
86	y	41060	11205	7961	3548	2747	2547
88	y	40227	22312	16216	9055	7249	6552
89	y	39981	21862	15860	8860	7108	6473
91	y	31024	17249	12465	6809	5514	4984
92	y	40414	22414	16260	8909	7159	6508
96	y	45346	25369	18315	10091	8123	7387
98	y	41161	22842	16424	9039	7205	6571
99	y	40533	22599	16379	9091	7304	6678
100	y	39509	13969	10015	4993	3863	3550
175	y	41643	22804	12754	6905	3781	3295
182	y	40292	21861	12195	6565	3781	3299
208	y	40427	35757	16875	10849	6909	5569
209	y	42937	38042	17779	11569	7313	5864
210	y	40335	35682	16828	11093	7033	5603
211	y	43118	38062	17930	11586	7205	5755
212	y	41672	36972	17953	11823	7332	5811
213	y	42274	37420	23487	15591	9734	8069
214	y	41764	37138	17442	11361	7166	5733
215	y	40582	35901	16620	10639	6717	5401
216	y	40519	35825	16623	10861	6742	5395
217	y	45163	39880	18495	11988	7543	6089

1D R/out strip pitch TB 2022

	RUN INFO												TEST											
	INFO				TIME			ENVIRONMENT					D0		D1		D2		D3		M0		M1		M2		M3	
# RUN	TYPE	PED	THR	# Ev	DAY	START	STOP	TEMP	P IN	P OUT	RH IN	RH OUT	TOP	DRIFT	TOP	DRIFT	TOP	DRIFT	TOP	DRIFT	TOP	DRIFT	TOP	DRIFT	TOP	DRIFT	TOP	DRIFT
283	phys	282	.6		17.10	12.20	12:45	22	1254	987	0	30	540	3.5	540	3.5	540	3.5	540	3.5	540	3.5	540	3.5	540	3.5	540	3.5
284	rnd	282	.6	20k	17.10	12.47	12.50	22	1254	987	0	30	500	3.5	500	3.5	500	3.5	500	3.5	500	3.5	500	3.5	500	3.5	500	3.5
285	phys	282	.6	50k	17.10	12.53	13.15	22	1254	987	0	30	500	3.5	500	3.5	500	3.5	500	3.5	500	3.5	500	3.5	500	3.5	500	3.5
286	rnd	282	.6	20k	17.10	13.18	13.20	22	1254	987	0	30	420	3.5	420	3.5	420	3.5	420	3.5	560	3.5	560	3.5	560	3.5	560	3.5
287	phys	282	.6	50k	17.10	13.21	13.47	22	1254	987	0	30	420	3.5	420	3.5	420	3.5	420	3.5	560	3.5	560	3.5	560	3.5	560	3.5
288	rnd	282	.6		17.10	13.49		22	1254	987	0	30	440	3.5	440	3.5	440	3.5	440	3.5	580	3.5	580	3.5	580	3.5	580	3.5
289	phys	282	.6	60k	17.10	13.49	14.15	22	1254	987	0	30	440	3.5	440	3.5	440	3.5	440	3.5	580	3.5	580	3.5	580	3.5	580	3.5
290	rnd	282	.6	20k	17.10	14.21		22	1254	987	0	30	460	3.5	460	3.5	460	3.5	460	3.5	600	3.5	600	3.5	600	3.5	600	3.5
291	phys	282	.6	50k	17.10	14.22	14.45	22	1254	987	0	30	460	3.5	460	3.5	460	3.5	460	3.5	600	3.5	600	3.5	600	3.5	600	3.5
292	rnd	282	.6	20k	17.10	14.48	14.51	22	1254	987	0	30	480	3.5	480	3.5	480	3.5	480	3.5	620	3.5	620	3.5	620	3.5	620	3.5
293	phy	282	.6		17.10	14.57	15.15	22	1254	987	0	30	480	3.5	480	3.5	480	3.5	480	3.5	620	3.5	620	3.5	620	3.5	620	3.5
294	rnd	282	.6	20k	17.10	15.22	15.24	22	1254	987	0	30	520	3.5	520	3.5	520	3.5	520	3.5	640	3.5	640	3.5	640	3.5	640	3.5
295	phys	282	.6	50k	17.10	15.24	15.54	22	1254	987	0	30	520	3.5	520	3.5	520	3.5	520	3.5	640	3.5	640	3.5	640	3.5	640	3.5
296	phys	282	.6	50k	17.10	15.55	16.19	22	1254	987	0	30	400	3.5	400	3.5	400	3.5	400	3.5	520	3.5	520	3.5	520	3.5	520	3.5
297	rnd	282	.6	50k	17.10	16.46	16.48	22	1254	987	0	30	400	3.5	400	3.5	400	3.5	400	3.5	520	3.5	520	3.5	520	3.5	520	3.5
298	rnd	282	.6	20k	17.10	16.52	16.55	22	1254	987	0	30	380	3.5	380	3.5	380	3.5	380	3.5	480	3.5	480	3.5	480	3.5	480	3.5
299	phys	282	.6	50k	17.10	16.56	17.26	22	1254	987	0	30	380	3.5	380	3.5	380	3.5	380	3.5	480	3.5	480	3.5	480	3.5	480	3.5
300	rnd	282	.6	20k	17.10	17.32	17.34	22	1254	987	0	30	460	3.5	460	3.5	460	3.5	460	3.5	600	3.5	600	3.5	600	3.5	600	3.5
301	phys	282	.6	50k	17.10	17.35	17.58	22	1254	987	0	30	460	3.5	460	3.5	460	3.5	460	3.5	600	3.5	600	3.5	600	3.5	600	3.5
302	rnd	282	.6	20k	17.10	18.02	18.04	22	1254	987	0	30	560	3.5	560	3.5	560	3.5	560	3.5	600	3.5	600	3.5	600	3.5	600	3.5
303	phys	282	.6	48k	17.10	18.04	18.30	22	1254	987	0	30	560	3.5	560	3.5	560	3.5	560	3.5	600	3.5	600	3.5	600	3.5	600	3.5
304	rnd	282	.6	20k	17.10	18.32	18.34	22	1254	987	0	30	580	3.5	580	3.5	580	3.5	580	3.5	600	3.5	600	3.5	600	3.5	600	3.5
305	phys	282	.6	50k	17.10	18.36	19.00	22	1254	987	0	30	580	3.5	580	3.5	580	3.5	580	3.5	600	3.5	600	3.5	600	3.5	600	3.5
306	phys	282	.6	50k	17.10	19.03	19.27	22	1254	987	0	30	560	3.5	560	3.5	560	3.5	560	3.5	600	3.5	600	3.5	600	3.5	600	3.5
307	phys	282	.6	50k	17.10	19.29	19.53	22	1254	987	0	30	640	3.5	640	3.5	640	3.5	640	3.5	600	3.5	600	3.5	600	3.5	600	3.5
308	phys	282	.6	50k	17.10	19.53	23.10	22	1254	987	0	30	380	3.5	380	3.5	380	3.5	380	3.5	600	3.5	600	3.5	600	3.5	600	3.5

1D R/out strip pitch TB 2022

RUN ID	is aligned?	n evt	isFireTrk	Res < 3 sigma	chi2<4000 + m_trk<0.04	size < 5	N cl < 3
308	y	51292	39371	31197	29138	14724	14173
299	y	50024	41608	33513	31326	15865	15369
296	y	50334	41753	34802	32665	16438	15778
287	y	53038	44051	37484	35147	17679	16881
289	y	60363	49939	42970	40183	20184	19193
301	y	50341	41645	34225	32033	15951	15251
293	y	50557	41857	36535	34192	16978	16044
295	y	52507	43634	37914	35415	17488	16621
306	y	50005	41586	36210	33888	16999	16090
305	y	49645	41021	35414	33087	16301	15502
307	y	50121	41547	35532	33151	16524	15665
285	y	50257	41545	36350	33928	17152	16189
283	y	50471	41917	36861	34302	17303	16370

2x1D R/out TB 2022

	RUN INFO												TEST											
	INFO				TIME			ENVIRONMENT					D0		D1		D2		D3		M0		M1		M2		M3	
# RUN	TYPE	PED	THR	# Ev	DAY	START	STOP	TEMP	P IN	P OUT	RH IN	RH OUT	TOP	DRIFT	TOP	DRIFT	TOP	DRIFT	TOP	DRIFT	TOP	DRIFT	TOP	DRIFT	TOP	DRIFT	TOP	DRIFT
283	phys	282	.6		17.10	12.20	12:45	22	1254	987	0	30	540	3.5	540	3.5	540	3.5	540	3.5	540	3.5	540	3.5	540	3.5	540	3.5
284	rnd	282	.6	20k	17.10	12.47	12.50	22	1254	987	0	30	500	3.5	500	3.5	500	3.5	500	3.5	500	3.5	500	3.5	500	3.5	500	3.5
285	phys	282	.6	50k	17.10	12.53	13.15	22	1254	987	0	30	500	3.5	500	3.5	500	3.5	500	3.5	500	3.5	500	3.5	500	3.5	500	3.5
286	rnd	282	.6	20k	17.10	13.18	13.20	22	1254	987	0	30	420	3.5	420	3.5	420	3.5	420	3.5	560	3.5	560	3.5	560	3.5	560	3.5
287	phys	282	.6	50k	17.10	13.21	13.47	22	1254	987	0	30	420	3.5	420	3.5	420	3.5	420	3.5	560	3.5	560	3.5	560	3.5	560	3.5
288	rnd	282	.6		17.10	13.49		22	1254	987	0	30	440	3.5	440	3.5	440	3.5	440	3.5	580	3.5	580	3.5	580	3.5	580	3.5
289	phys	282	.6	60k	17.10	13.49	14.15	22	1254	987	0	30	440	3.5	440	3.5	440	3.5	440	3.5	580	3.5	580	3.5	580	3.5	580	3.5
290	rnd	282	.6	20k	17.10	14.21		22	1254	987	0	30	460	3.5	460	3.5	460	3.5	460	3.5	600	3.5	600	3.5	600	3.5	600	3.5
291	phys	282	.6	50k	17.10	14.22	14.45	22	1254	987	0	30	460	3.5	460	3.5	460	3.5	460	3.5	600	3.5	600	3.5	600	3.5	600	3.5
292	rnd	282	.6	20k	17.10	14.48	14.51	22	1254	987	0	30	480	3.5	480	3.5	480	3.5	480	3.5	620	3.5	620	3.5	620	3.5	620	3.5
293	phy	282	.6		17.10	14.57	15.15	22	1254	987	0	30	480	3.5	480	3.5	480	3.5	480	3.5	620	3.5	620	3.5	620	3.5	620	3.5
294	rnd	282	.6	20k	17.10	15.22	15.24	22	1254	987	0	30	520	3.5	520	3.5	520	3.5	520	3.5	640	3.5	640	3.5	640	3.5	640	3.5
295	phys	282	.6	50k	17.10	15.24	15.54	22	1254	987	0	30	520	3.5	520	3.5	520	3.5	520	3.5	640	3.5	640	3.5	640	3.5	640	3.5
296	phys	282	.6	50k	17.10	15.55	16.19	22	1254	987	0	30	400	3.5	400	3.5	400	3.5	400	3.5	520	3.5	520	3.5	520	3.5	520	3.5
297	rnd	282	.6	50k	17.10	16.46	16.48	22	1254	987	0	30	400	3.5	400	3.5	400	3.5	400	3.5	520	3.5	520	3.5	520	3.5	520	3.5
298	rnd	282	.6	20k	17.10	16.52	16.55	22	1254	987	0	30	380	3.5	380	3.5	380	3.5	380	3.5	480	3.5	480	3.5	480	3.5	480	3.5
299	phys	282	.6	50k	17.10	16.56	17.26	22	1254	987	0	30	380	3.5	380	3.5	380	3.5	380	3.5	480	3.5	480	3.5	480	3.5	480	3.5
300	rnd	282	.6	20k	17.10	17.32	17.34	22	1254	987	0	30	460	3.5	460	3.5	460	3.5	460	3.5	600	3.5	600	3.5	600	3.5	600	3.5
301	phys	282	.6	50k	17.10	17.35	17.58	22	1254	987	0	30	460	3.5	460	3.5	460	3.5	460	3.5	600	3.5	600	3.5	600	3.5	600	3.5
302	rnd	282	.6	20k	17.10	18.02	18.04	22	1254	987	0	30	560	3.5	560	3.5	560	3.5	560	3.5	600	3.5	600	3.5	600	3.5	600	3.5
303	phys	282	.6	48k	17.10	18.04	18.30	22	1254	987	0	30	560	3.5	560	3.5	560	3.5	560	3.5	600	3.5	600	3.5	600	3.5	600	3.5
304	rnd	282	.6	20k	17.10	18.32	18.34	22	1254	987	0	30	580	3.5	580	3.5	580	3.5	580	3.5	600	3.5	600	3.5	600	3.5	600	3.5
305	phys	282	.6	50k	17.10	18.36	19.00	22	1254	987	0	30	580	3.5	580	3.5	580	3.5	580	3.5	600	3.5	600	3.5	600	3.5	600	3.5
306	phys	282	.6	50k	17.10	19.03	19.27	22	1254	987	0	30	560	3.5	560	3.5	560	3.5	560	3.5	600	3.5	600	3.5	600	3.5	600	3.5
307	phys	282	.6	50k	17.10	19.29	19.53	22	1254	987	0	30	640	3.5	640	3.5	640	3.5	640	3.5	600	3.5	600	3.5	600	3.5	600	3.5
308	phys	282	.6	50k	17.10	19.53	23.10	22	1254	987	0	30	380	3.5	380	3.5	380	3.5	380	3.5	600	3.5	600	3.5	600	3.5	600	3.5

2x1D R/out TB 2022

RUN ID	is aligned?	n evt	isFireTrk	Res < 3 sigma	chi2<4000 + m_trk<0.04	size < 5	N cl < 3
308	y	51292	39371	31197	29138	14724	14173
299	y	50024	41608	33513	31326	15865	15369
296	y	50334	41753	34802	32665	16438	15778
287	y	53038	44051	37484	35147	17679	16881
289	y	60363	49939	42970	40183	20184	19193
301	y	50341	41645	34225	32033	15951	15251
293	y	50557	41857	36535	34192	16978	16044
295	y	52507	43634	37914	35415	17488	16621
306	y	50005	41586	36210	33888	16999	16090
305	y	49645	41021	35414	33087	16301	15502
307	y	50121	41547	35532	33151	16524	15665
285	y	50257	41545	36350	33928	17152	16189
283	y	50471	41917	36861	34302	17303	16370

2D R/out layout TB 2023

	RUN INFO							TEST									
	INFO				TIME			CS0-2D		CS1-2D		LHCB0_D		LHCB1_G		TOP0-2D	
PION BEAM																	
51	PHY	44	0,8	25k	16/06/2023	19:21	19:46	560	3,5	560	3,5	560	3,5	560	3,5	560	3,5
52	PHY	44	0,8	23k	16/06/2023	19:50	20:17	540	3,5	540	3,5	540	3,5	540	3,5	540	3,5
53	PHY	44	0,8		16/06/2023	23:02											
54	PHY	44	0,8	30k	16/06/2023	23:10	23:37	520	3,5	520	3,5	520	3,5	520	3,5	520	3,5
55	PHY	44	0,8	25k	16/06/2023	23:45	00:10	500	3,5	500	3,5	500	3,5	500	3,5	500	3,5
56	PHY	44	0,8	25K	17/06/2023	00:12	00:36	480	3,5	480	3,5	480	3,5	480	3,5	480	3,5
57	PHY	44	0,8	25K	17/06/2023	8:37		480	3,5	480	3,5	480	3,5	480	3,5	460	3,5
58	PHY	44	0,8	25k	17/06/2023	8:48	9:07	480	3,5	480	3,5	480	3,5	480	3,5	480	3,5
59	PHY	44	0,8	25k	17/06/2023	9:08	9:32	460	3,5	460	3,5	460	3,5	460	3,5	460	3,5
60	PHY	44	0,8	52k	17/06/2023	9:53	10:18	440	3,5	440	3,5	440	3,5	440	3,5	440	3,5
61	PHY	44	0,8	25K	17/06/2023	10:44	10:54	420	3,5	420	3,5	420	3,5	420	3,5	420	3,5
62	PHY	44	0.8	29K	17/06/2023	11:00	11:18	400	3,5	400	3,5	400	3,5	400	3,5	400	3,5
	TEST																
63	PED - BAD			20k	17/06/2023	11:46		600	3,5	600	3,5	600	3,5	600	3,5	600	3,5
64	PED			10k	17/06/2023			600	3,5	600	3,5	600	3,5	600	3,5	600	3,5
65	PHY	64	0,8	10k	17/06/2023	11:51		600	3,5	600	3,5	600	3,5	600	3,5	600	3,5
66	PHY	64	0,8	10K	17/06/2023	14:34	14:37	600	3,5	600	3,5	600	3,5	600	3,5	600	3,5
67	PHY	64	0,8	13k	17/06/2023	14:50	14:57	600	3,5	600	3,5	600	3,5	600	3,5	600	3,5
68	RND	64	0,8	13k	17/06/2023	15.27	15.31	600	3,5	600	3,5	600	3,5	600	3,5	600	3,5
69	PHY	64	0,8	3k	17/06/2023	15.31	16:15	600	3,5	600	3,5	600	3,5	600	3,5	600	3,5
	PION HV SCAN CS 620 - 660																
70	PHY	64	0,8	25K	17/06/2023	16:22	16:31	620	3,5	620	3,5	600	3,5	600	3,5	600	3,5
71	PHY	64	0,8	13K	17/06/2023	16:44	16:52	640	3,5	640	3,5	600	3,5	600	3,5	600	3,5
72	PHY	64	0,8	25K	17/06/2023	17:29	17:39	660	3,5	660	3,5	600	3,5	600	3,5	580	3,5
	HW THR SCAN																
73	PED			5k	17/06/2023			620	3,5	620	3,5	600	3,5	600	3,5	580	3,5
74	PHY	73	0,8	20k	17/06/2023	18:38	18:46	620	3,5	620	3,5	600	3,5	600	3,5	580	3,5
75	PHY	73	0,6	20k	17/06/2023	19.12	19:18	620	3,5	620	3,5	600	3,5	600	3,5	580	3,5
76	PHY	73	0.5	18k	17/06/2023	19:19	9:27	620	3,5	620	3,5	600	3,5	600	3,5	580	3,5
77	PHY	73	0.4	20k	17/06/2023	19:28		620	3,5	620	3,5	600	3,5	600	3,5	580	3,5

2D R/out layout TB 2023

RUN ID	is aligned?	n evt	isFireTrk	Res < 3 sigma	chi2<NO + m_trk<NO	size < 5	N cl < 3
72	y	25327	23259	5653	5653	1602	1361
71	y	13242	11986	3072	3072	929	759
70	y	25248	23066	5782	5782	1760	1438
62	y	29330	26953	6091	6091	1356	1225
61	y	25675	23399	5136	5136	1140	1013
60	y	52491	48303	11294	11294	2596	2334
59	y	25058	22279	5576	5576	1287	1101
58	y	25446	22806	5981	5981	1494	1222
57	y	25309	23296	5784	5784	1405	1190
56	y	25155	22241	6086	6086	1501	1268
55	y	25177	22276	6258	6258	1544	1262
54	y	30268	26754	7480	7480	1852	1509
52	y	23183	19922	5772	5772	1371	1156
51	y	25525	22247	6402	6402	1605	1357
46	y	25073	22826	6797	6797	1611	1360
45	y	24961	22909	6599	6599	1563	1315

To do:

- Estimate the efficiency drop due to PEP-GROOVE in TB2022 DUT chambers (PEP real dimension is 1.1mm)
- **Plot the time distribution of the cluster in events not efficient**
- Check the good results in TB 2021 (30 μm)
- Fit the panettone from MUON 2022
- Check the two dataset gain scan TB 2022 DUT

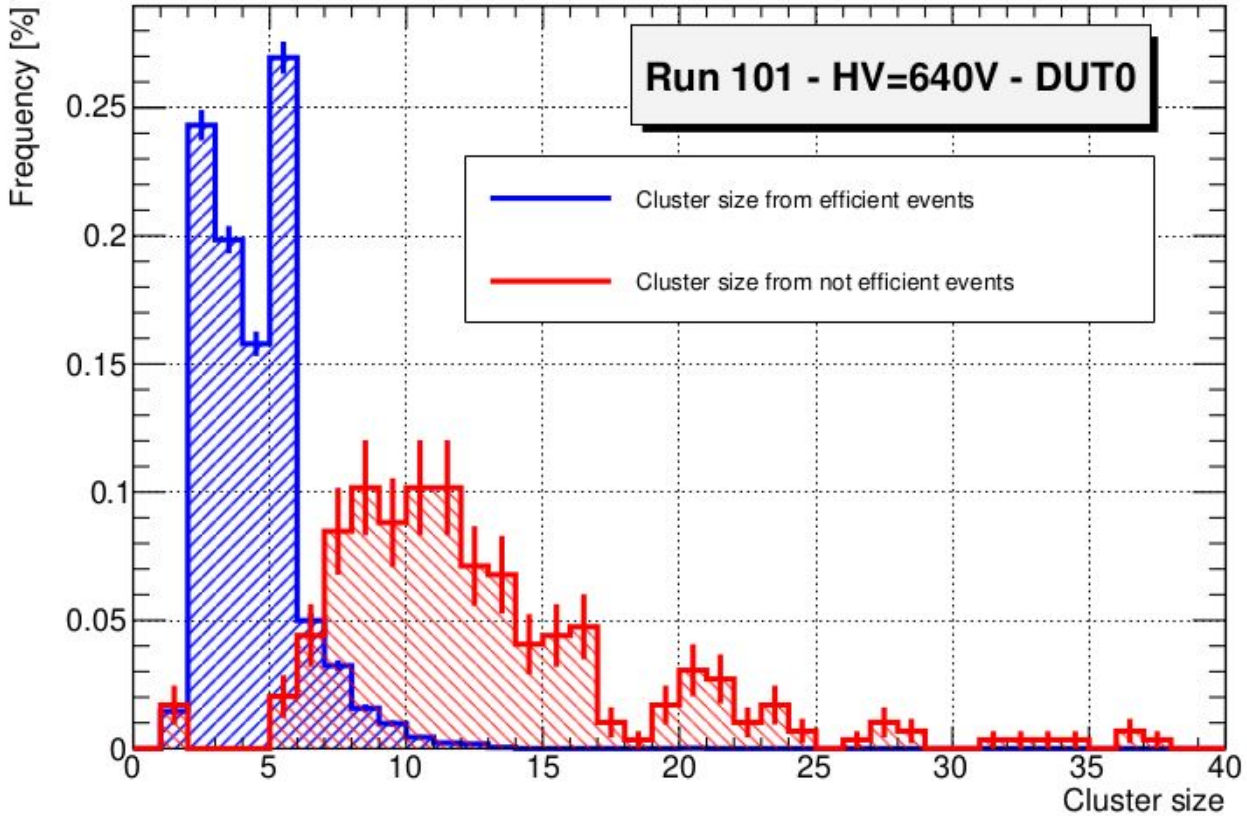
To do:

- plot charge vs strips + time vs strip
- check cluster size in DUT 0,1,2,3
- time difference IN and OUT vs HV
- efficiency in 2D for 2D detectors

Check efficienza NEW

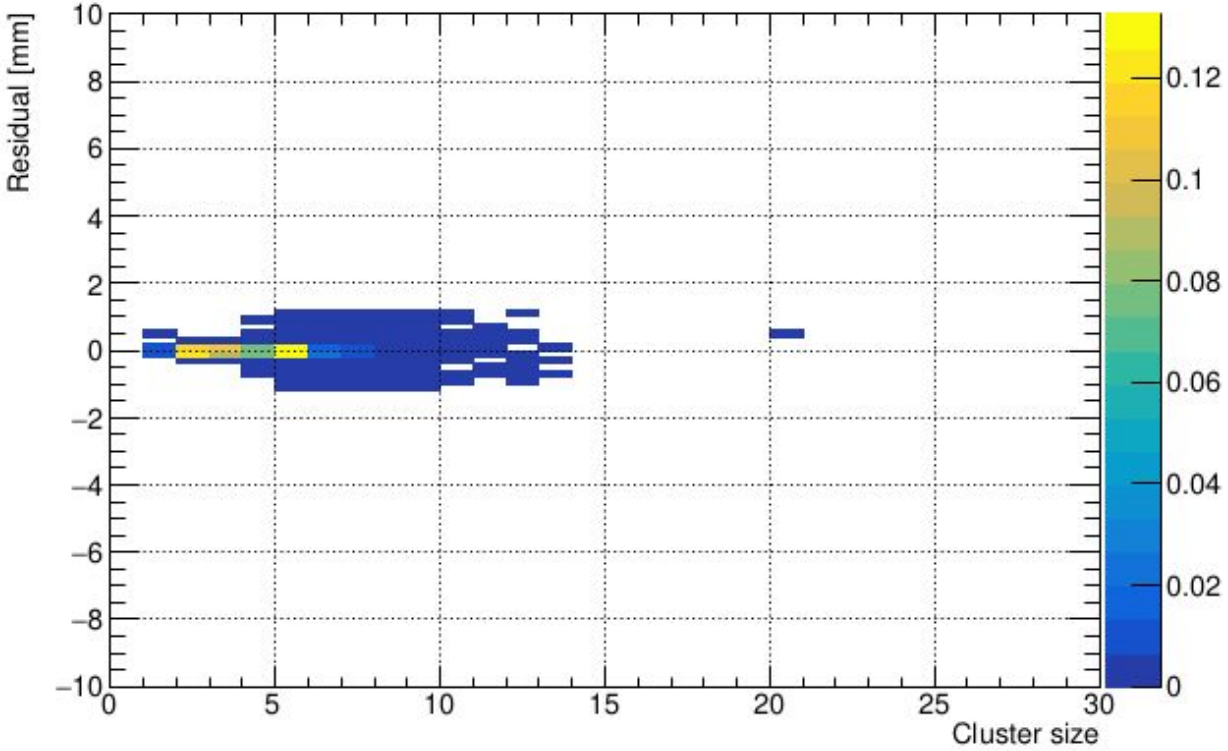
TB 2022 | run 101 | HV=640V | DUT 0

The cluster size of the NOT efficient events is about the double of the good ones



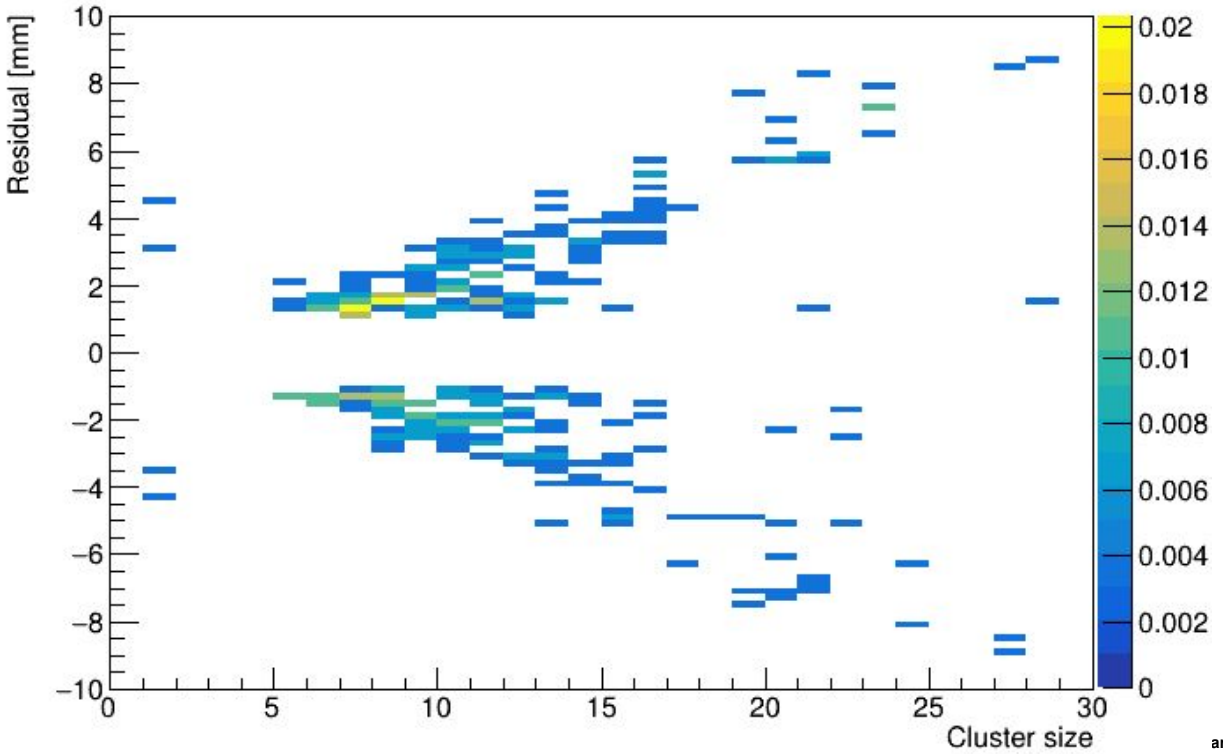
TB 2022 | run 101 | HV=640V | DUT 0

Good events have a small cluster size and the distribution is symmetric



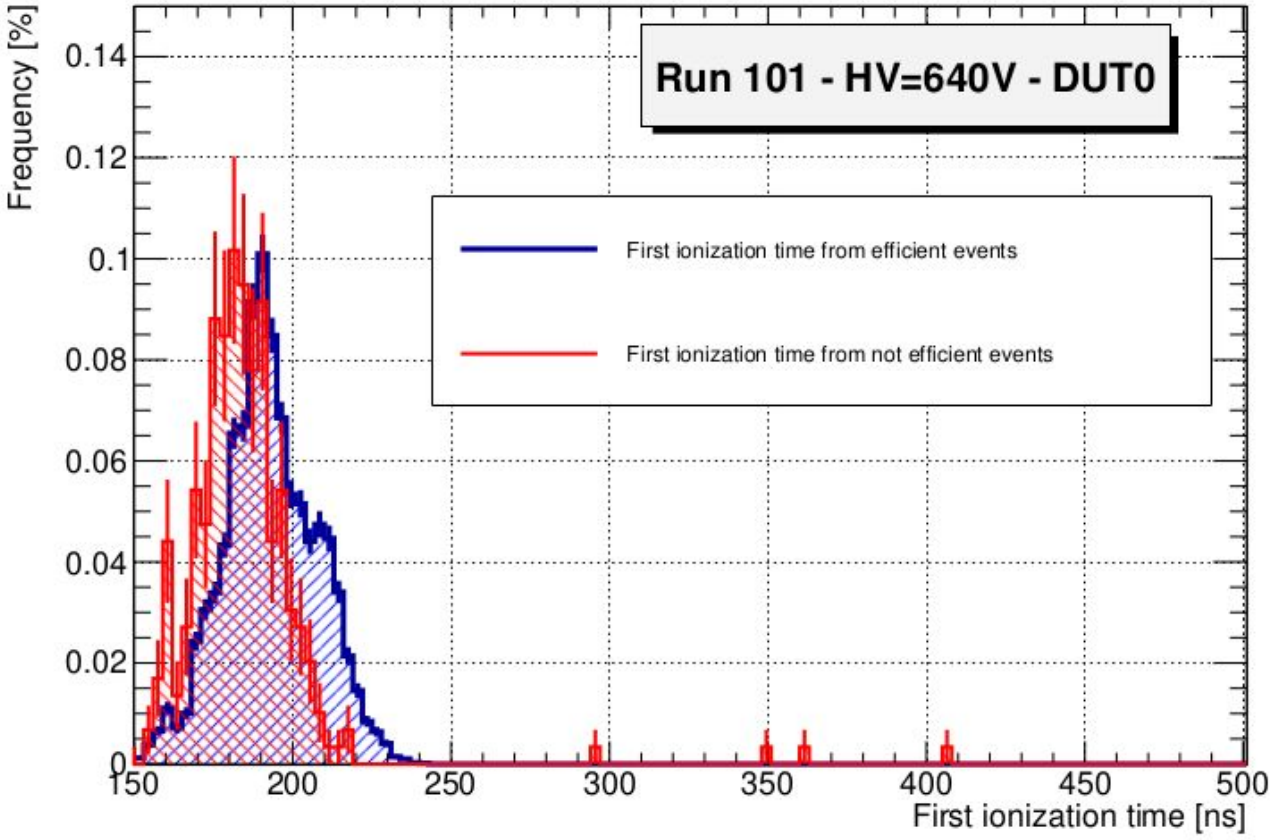
TB 2022 | run 101 | HV=640V | DUT 0

Bad events have large cluster size and the measured position is not Gaussian around the expected position.



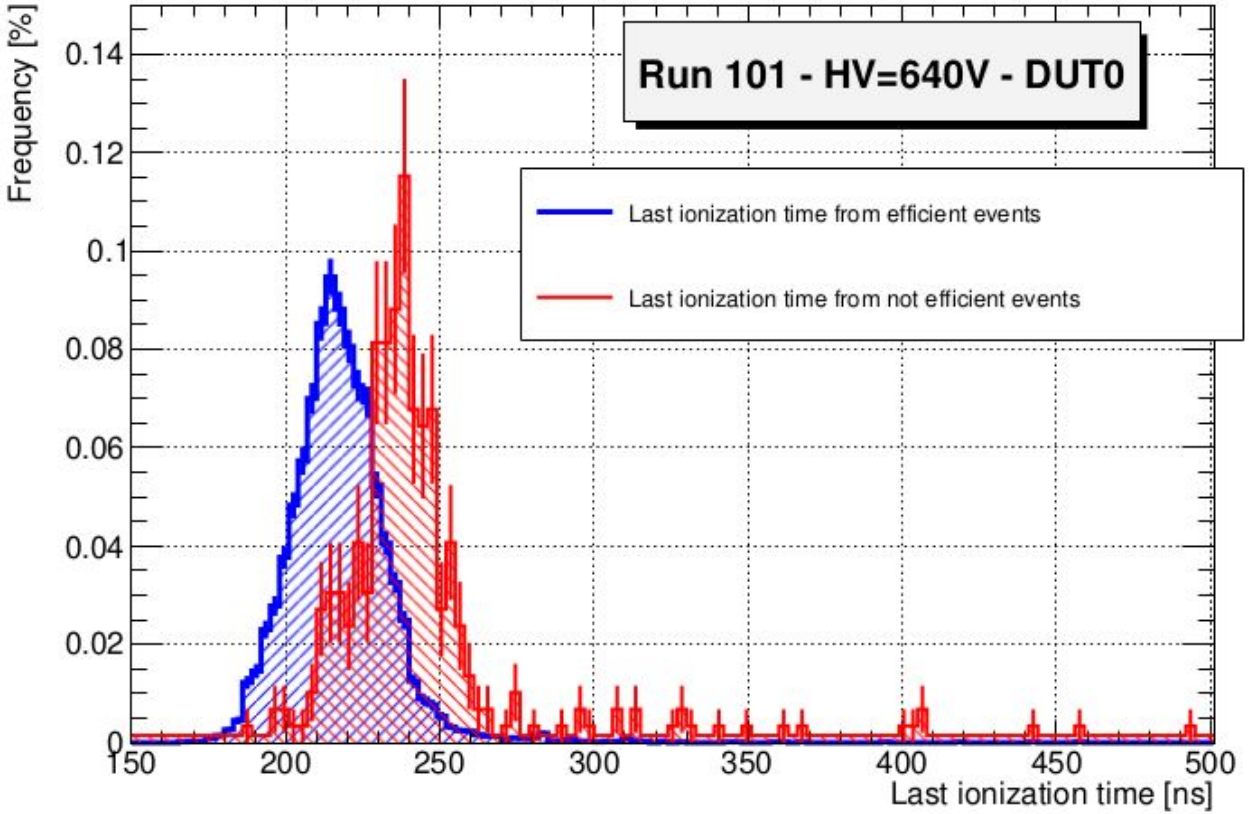
TB 2022 | run 101 | HV=640V | DUT 0

The faster time in the cluster for good and bad event is shifted of - **10~20 ns**



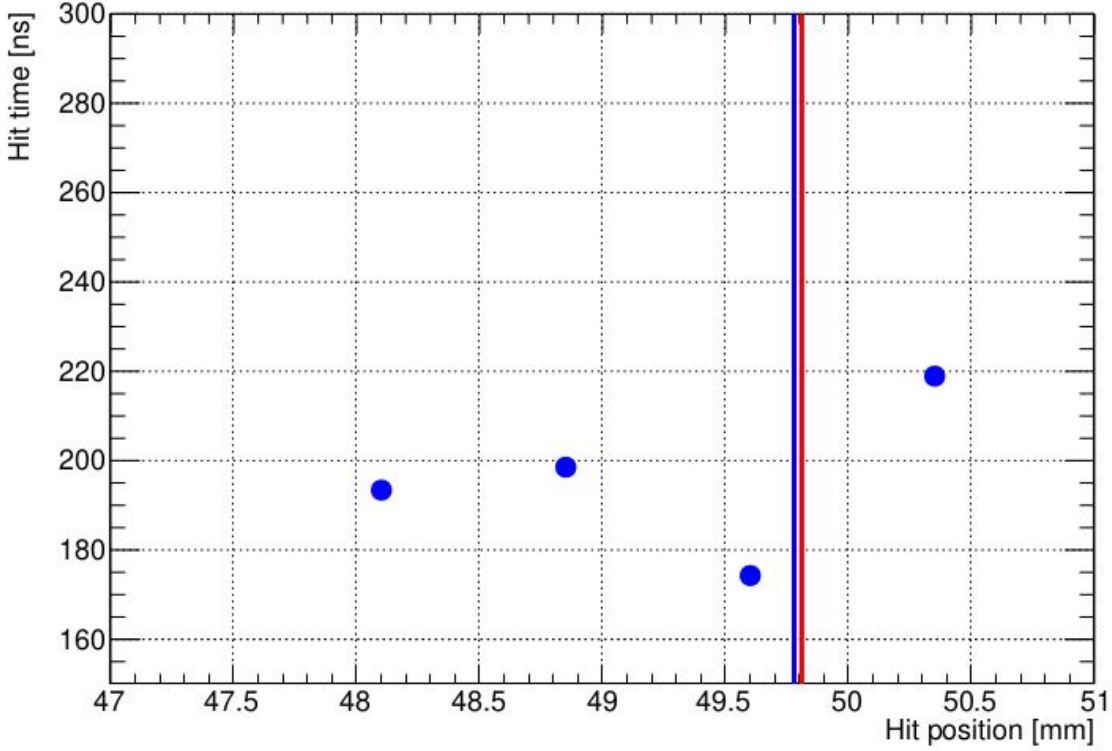
TB 2022 | run 101 | HV=640V | DUT 0

The slowest time in the cluster for good and bad event is shifted of **+ 30~40 ns**



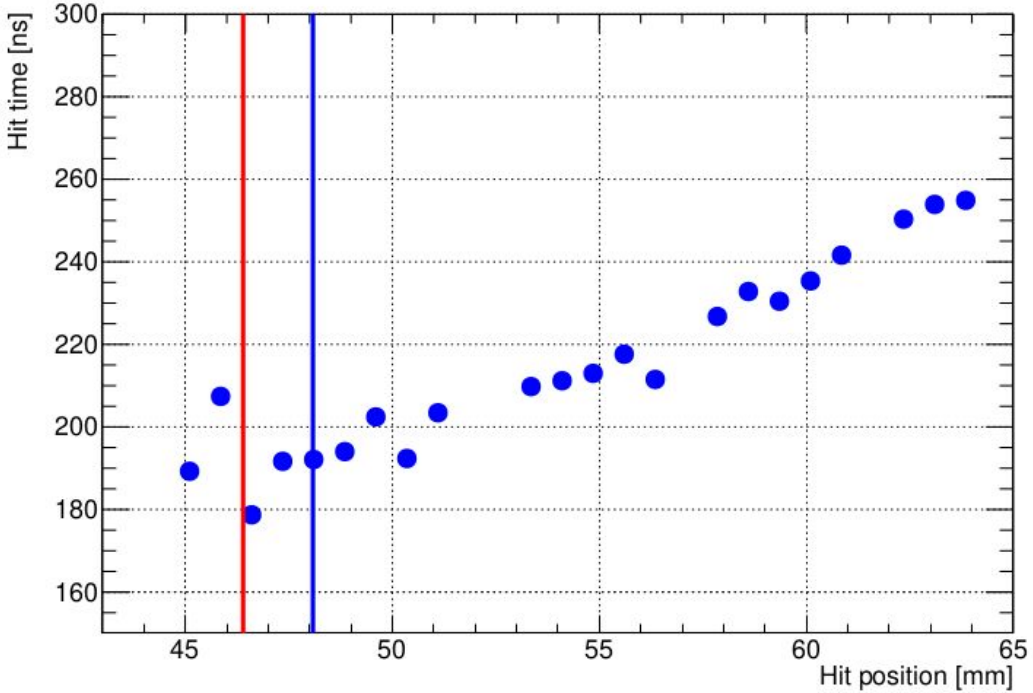
TB 2022 | run 101 | HV=640V | DUT 0

A good event example, shows the agreement between test chamber (blue line) and tracking system (red line). Charge centroid is used to evaluated the position in the test chamber.



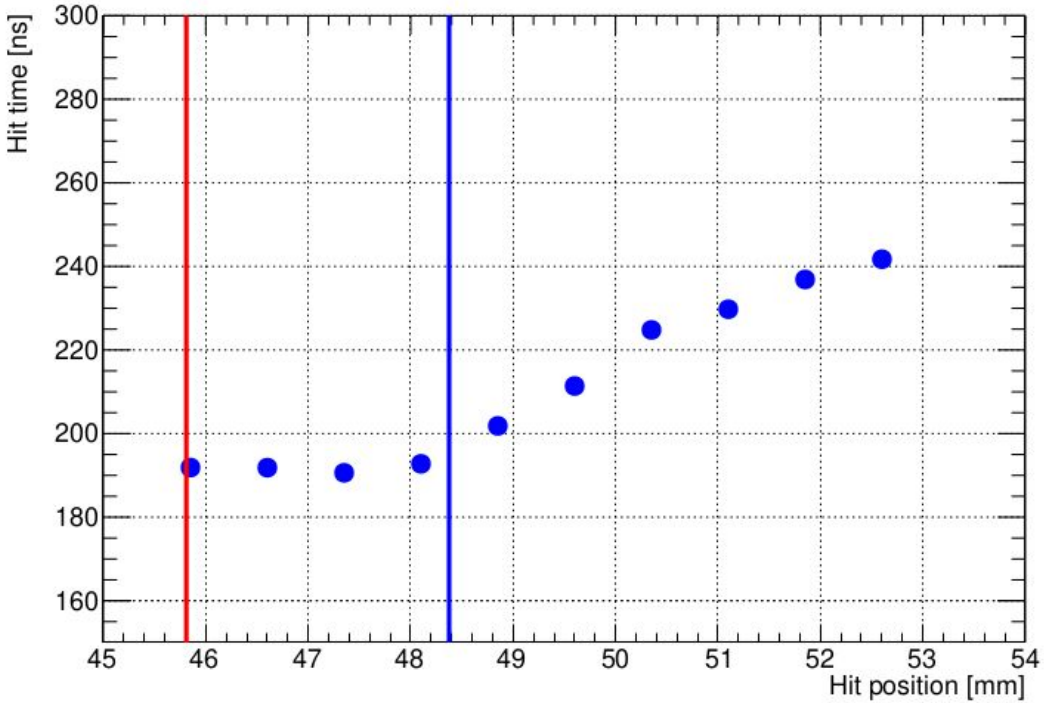
TB 2022 | run 101 | HV=640V | DUT 0

A bad event example, shows the directional displacement of the hits from the expected position (red). The blue line is the reconstructed position.



TB 2022 | run 101 | HV=640V | DUT 0

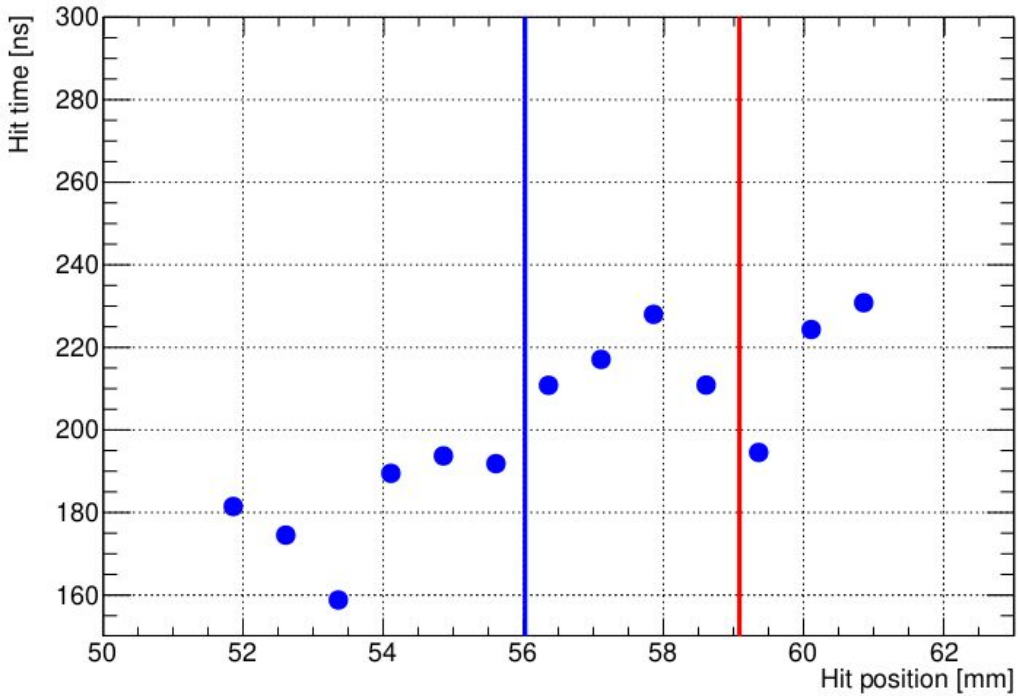
A bad event example, shows the directional displacement of the hits from the expected position (red). The blue line is the reconstructed position.



TB 2022 | run 101 | HV=640V | DUT 0

A bad event example, shows the directional displacement of the hits from the expected position (red). The blue line is the reconstructed position.

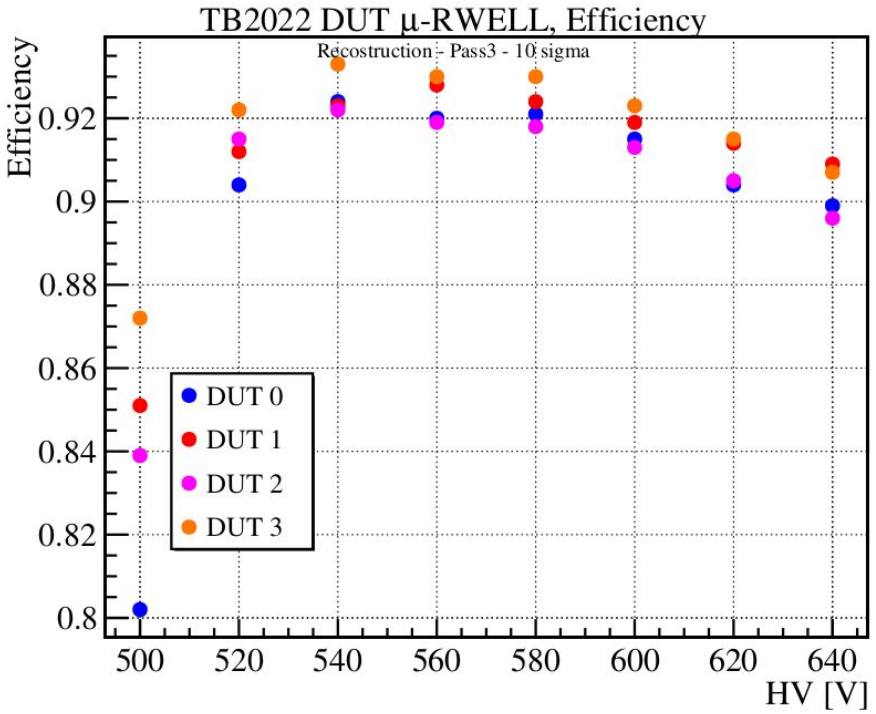
Here an example where the hits away from the red line are faster than the others.

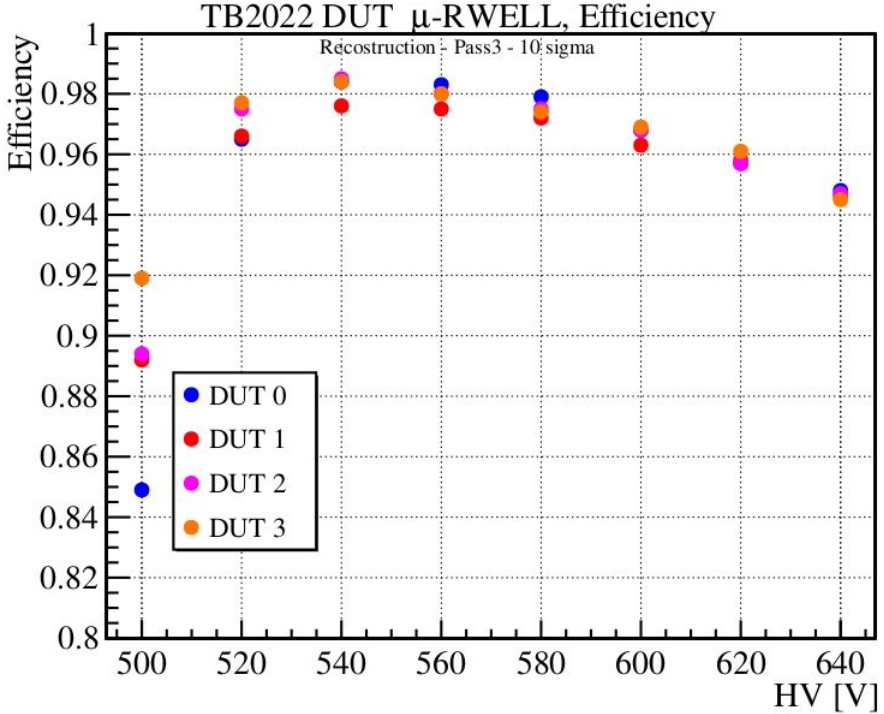


Check efficiency contribution of the PEP

TB 2022 - DUT efficiency

If only the central region is considered, then the efficiency rise up to 98%

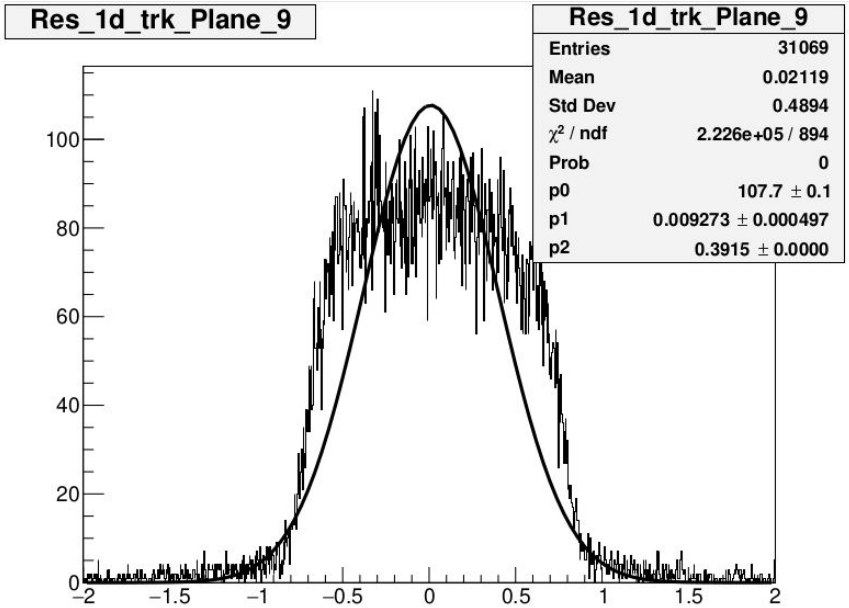


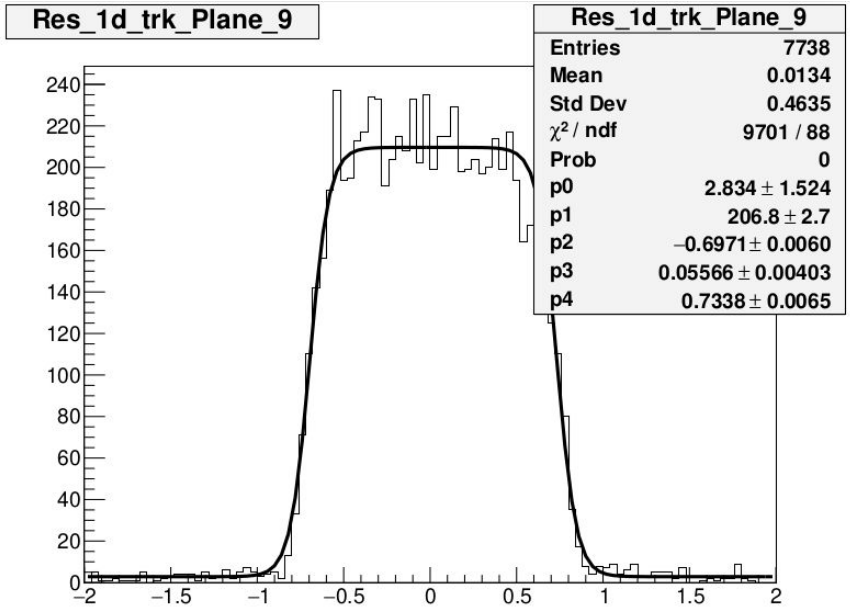


Fit panettone
MUON

TB 2022 - MUON residual

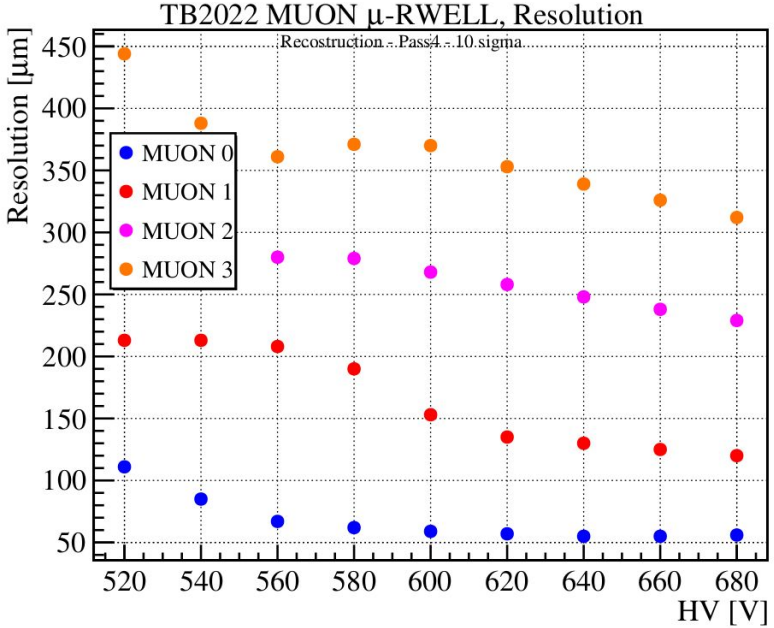
A Gaussian fit of the residual does not describe the data while a double Fermi-Dirac does. This method allows to evaluate the FWHM.

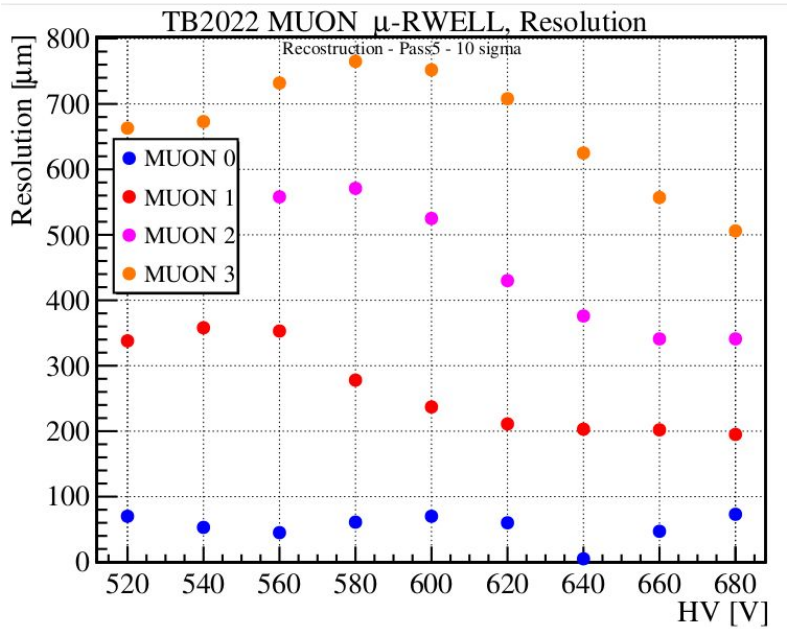




TB 2022 - MUON residual

Gaussian fit (old results) on the left, FWHM on the right. The MUON0 with 400μm pitch returns a resolution of 50μm, in agreement with the Gaussian fit.



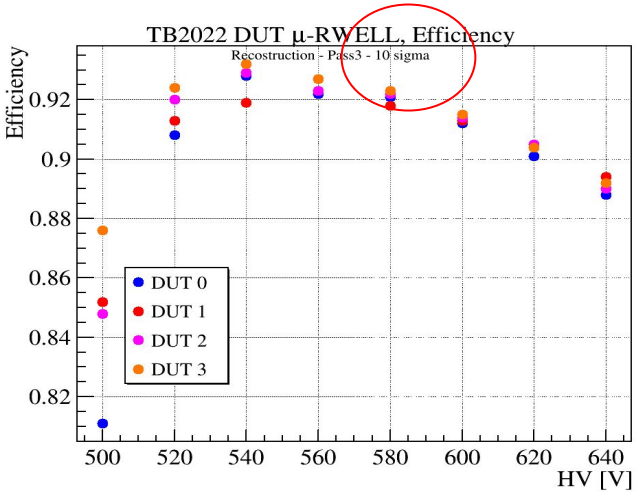


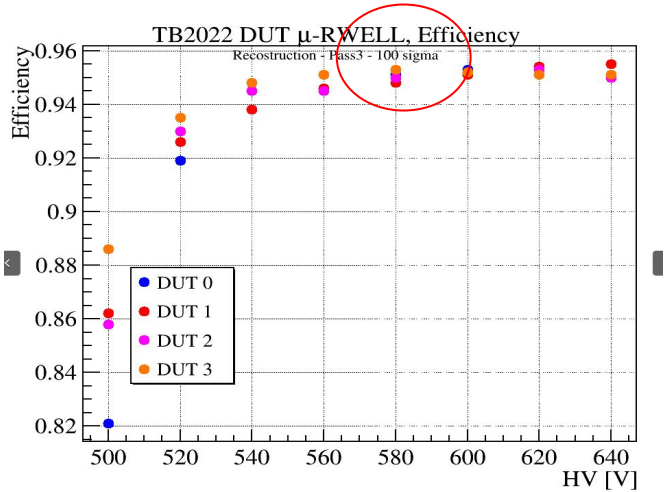
Check efficienza OLD

Check efficienza - da 10 a 100 sigma

Abbiamo analizzato l'efficienza delle DUT (μRWELL 1D - pitch 760μm - 80 MΩ/□).

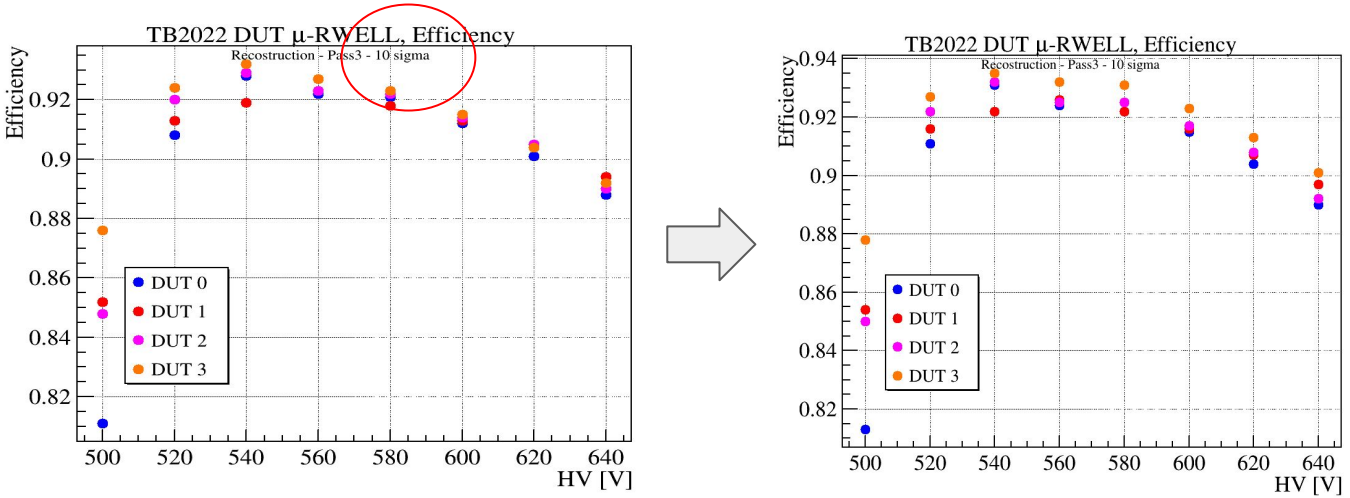
Aumentando la finestra da 10 a 100 sigma per dichiarare la camera efficiente si vede una variazione nel calo di efficienza. Questo implica che il cluster c'è ma è molto lontano.





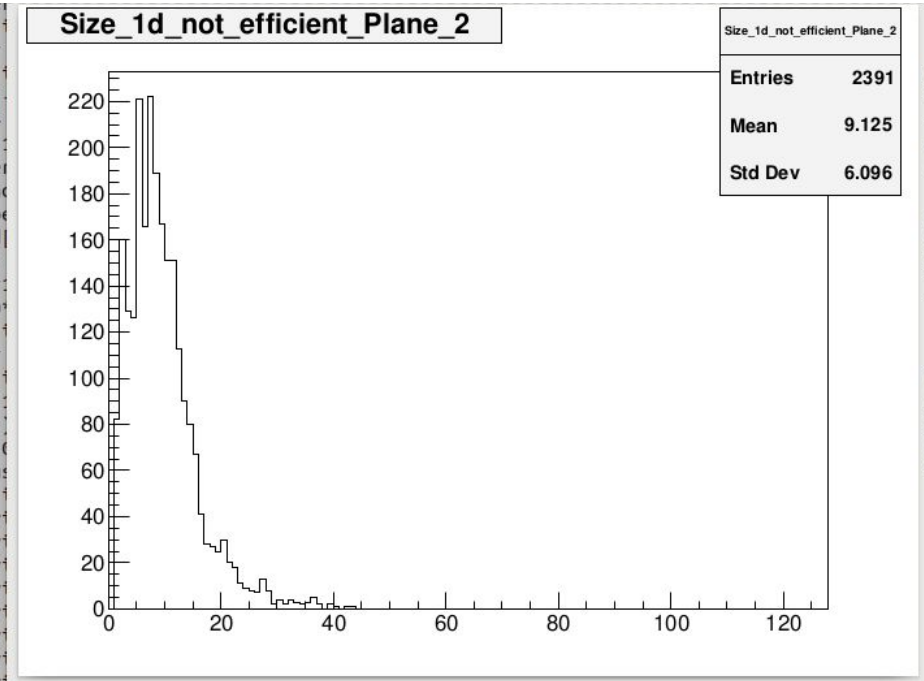
Check efficienza - bug fixed

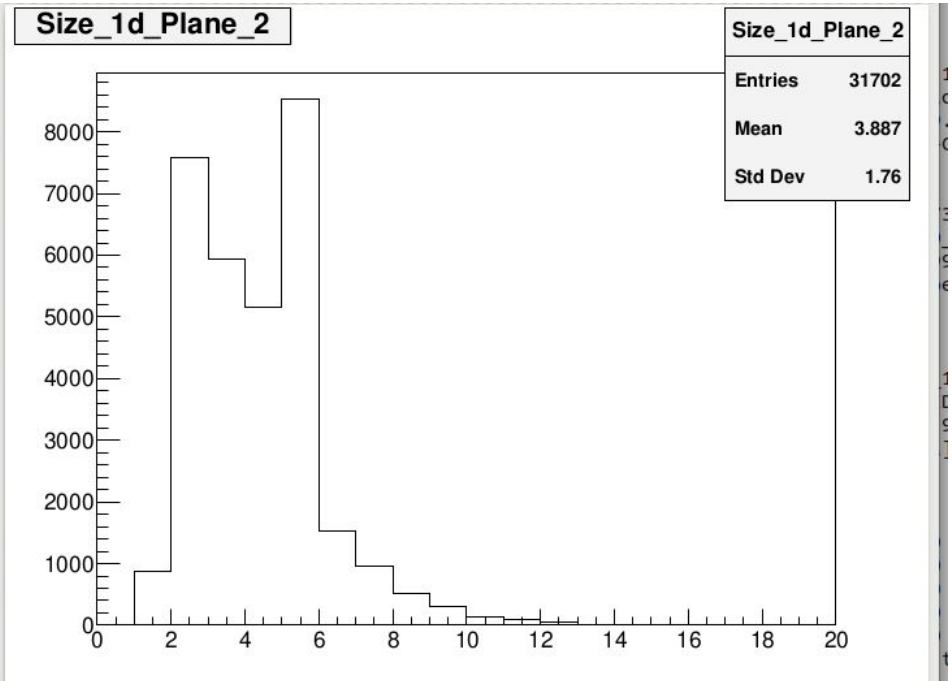
Facendo ulteriori controlli abbiamo trovato un baco nella selezione del cluster buono in alcuni eventi. Correggendo il baco abbiamo aumentato il valore massimo da 92% a 94%. Il calo di efficienza ad alti HV rimane.



Check efficienza - out size

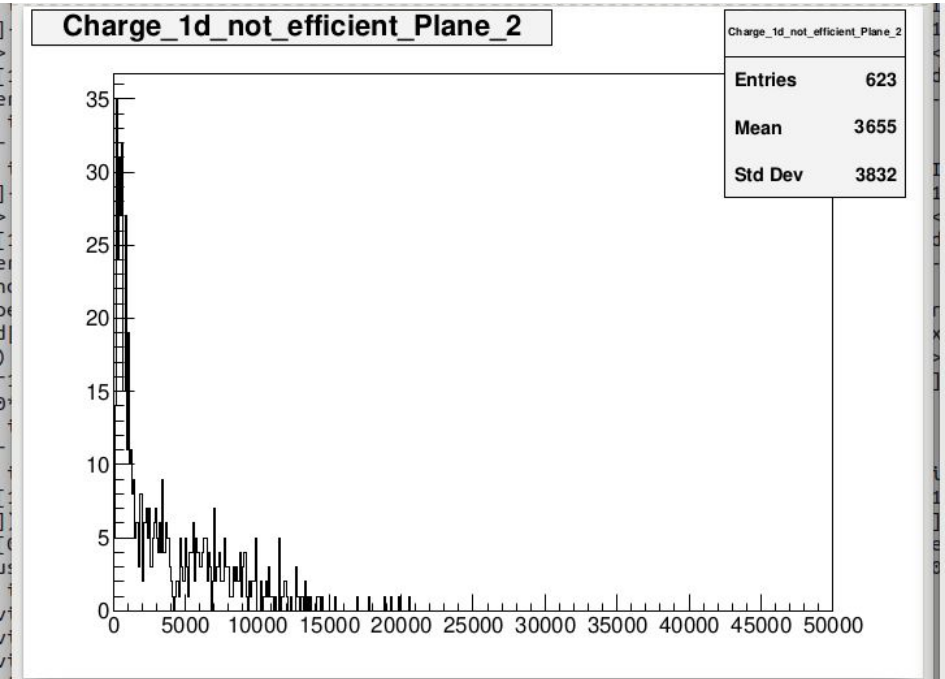
Abbiamo confrontato carica e cluster size dei cluster dentro e fuori le 10 sigma di efficienza e si è notata una differente topologia dei cluster

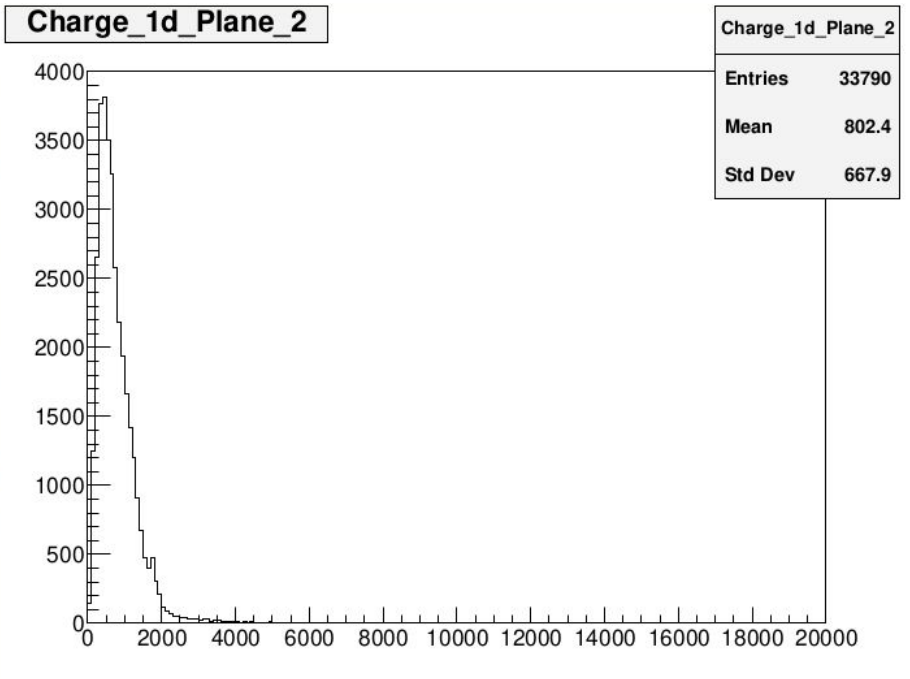




Check efficienza - out charge

Abbiamo confrontato carica e cluster size dei cluster dentro e fuori le 10 sigma di efficienza e si è notata una differente topologia dei cluster





Check efficienza - out 10 sigma

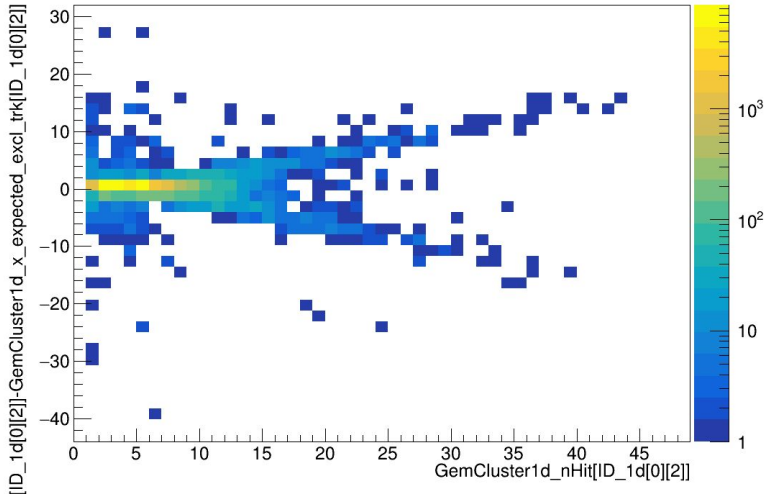
I cluster fuori le 10 sigma hanno una elevata carica e size.

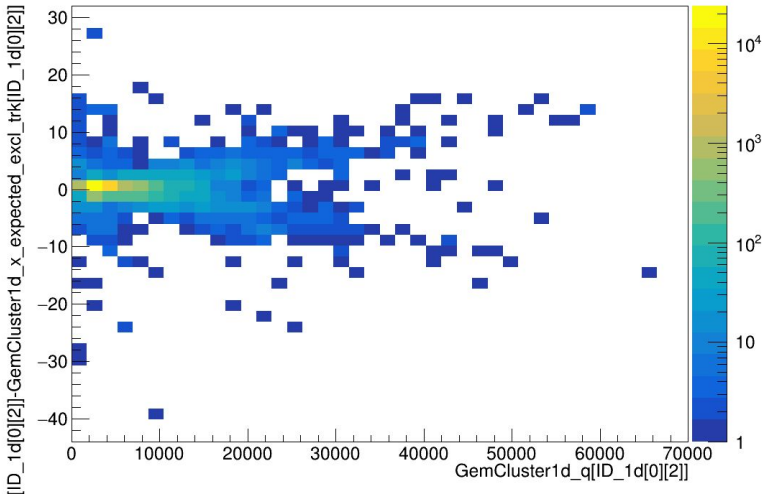
Analizzando nel dettaglio questi eventi abbiamo evidenziato i seguenti punti:

- la **forma** della distribuzione fuori le 10 sigma rimane simile a diversi HV
- la **statistica** di eventi fuori 10 sigma dipende fortemente dal HV e cresce con l'aumentare della tensione/guadagno
- il cluster è formato da strip buone più una serie di strip ad alta carica, spesso saturate
- nessun pattern temporale nelle strip ha destato sospetto o interesse
- **l'anomalia** delle strip ad alta carica **è direzionale !?!! (next slide)**

Check efficienza - out 10 sigma

La componente più interessante in questi eventi è data dalla direzionalità. Studiando il residuo in funzione della carica o della size si vede che la distribuzione non è centrata attorno allo zero ma diramate in due tipologie di eventi: destra e sinistra





Check efficienza - riflessioni

La cosa più ovvia da pensare è che questa anomalia sia generata da elettroni delta o particelle secondarie generate dall'interazione con la vetronite. Purtroppo questa ipotesi non è compatibile con la dipendenza dell'anomalia con HV poiché la ionizzazione di queste particelle dovrebbe essere più elevata di una MIP.

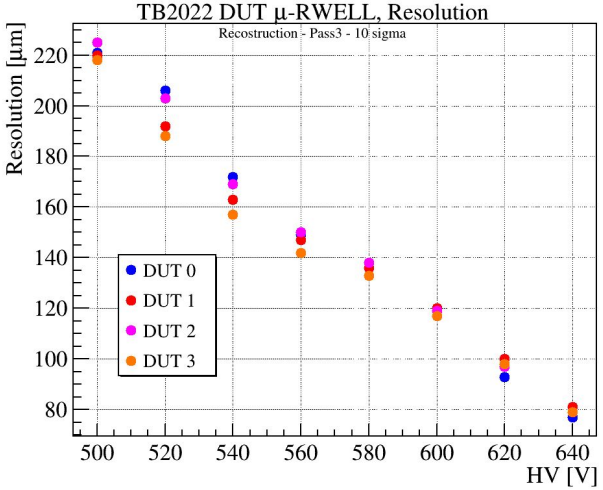
Abbiamo controllato la crosstalk-map del APV ma il pattern di strip non è riconducibile a questo.

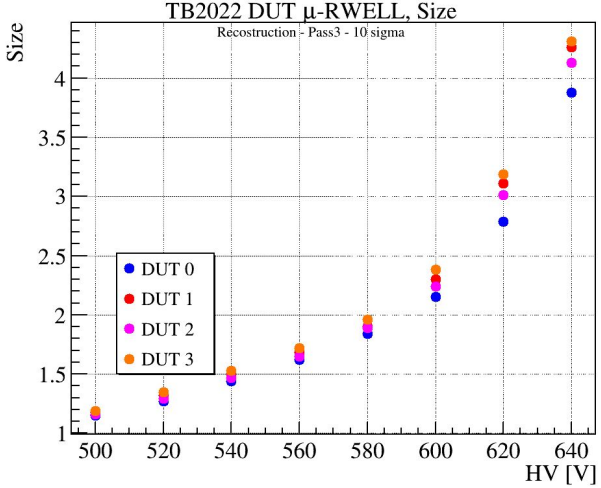
Controllando il design del rivelatore non abbiamo trovato componenti che potessero spiegare un crosstalk capace di generare e spiegare l'anomalia.

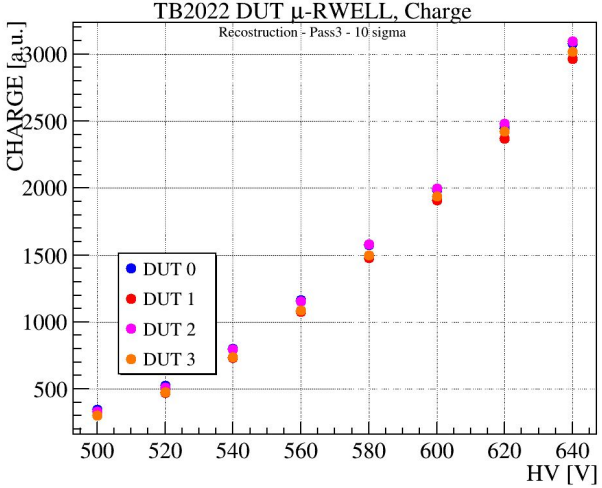
L'effetto si può vedere anche sulle camere MUON.

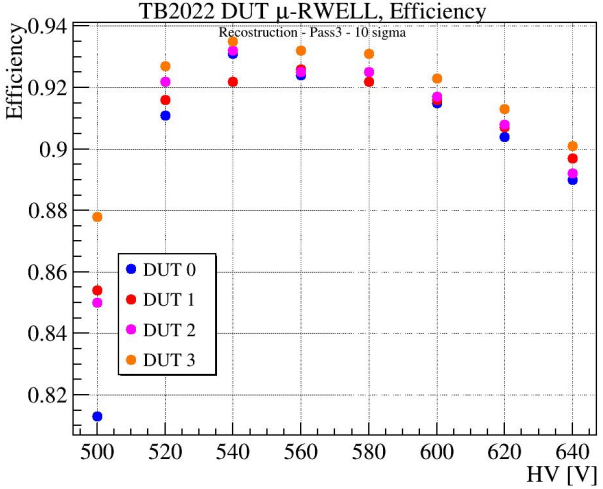
Detto ciò passiamo alla produzione di plot finali.

Plot finali TB2022 - DUT

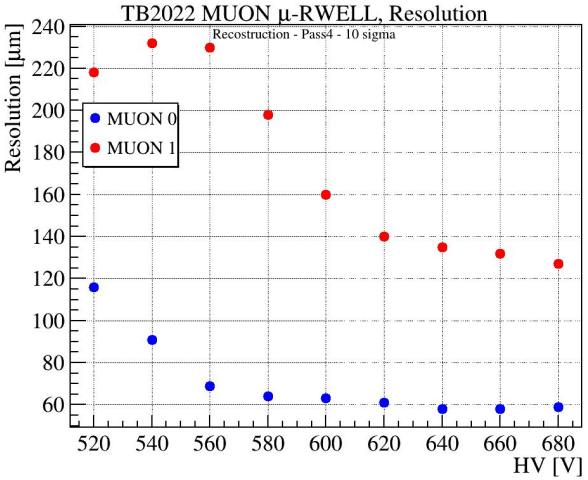


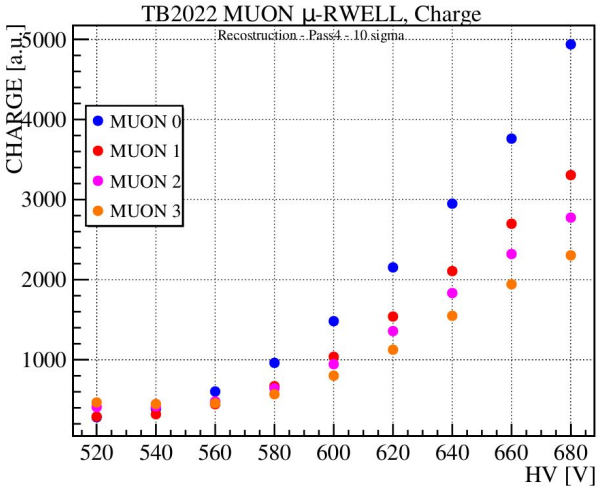


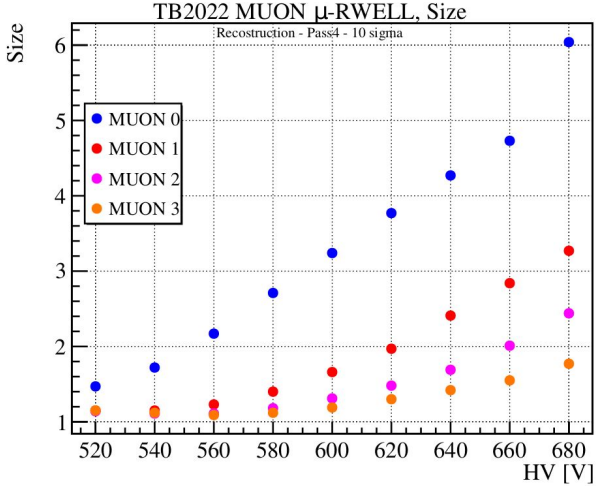


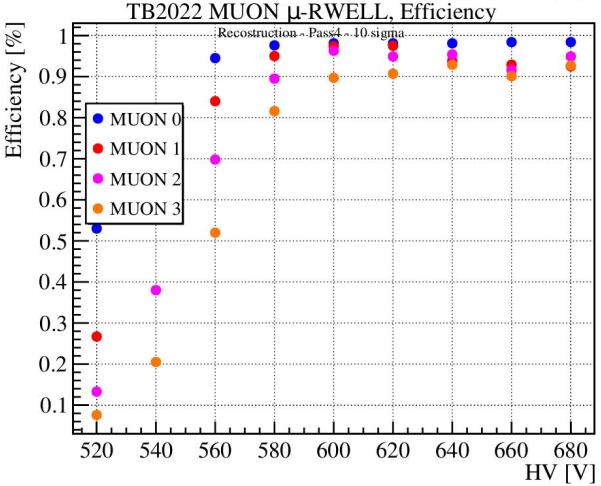


Plot finali MUON









PEP

PEP check

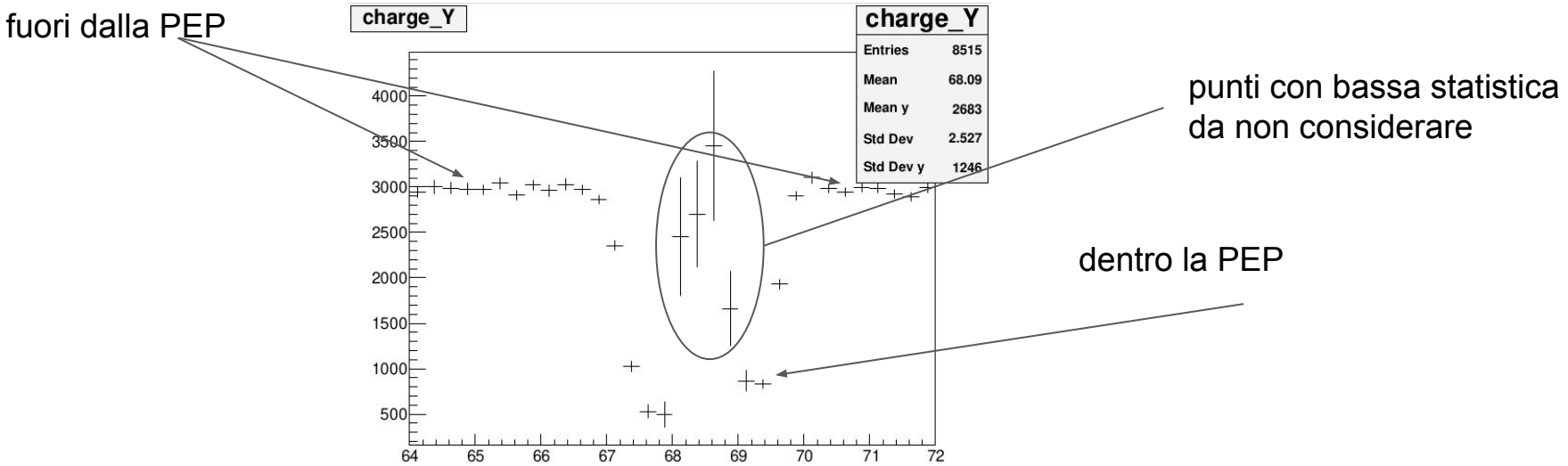
Come si comporta il nostro rivelatore attorno alla PEP? Scopriamolo!

Abbiamo analizzato le distribuzioni di carica, size, efficienza e risoluzione proiettando la camera X sulla vista Y perché la PEP è ortogonale alle strip.

PEP check - carica

Come si comporta il nostro rivelatore attorno alla PEP? Scopriamolo!

Abbiamo analizzato le distribuzioni di carica, size, efficienza e risoluzione proiettando la camera X sulla vista Y perché la PEP è ortogonale alle strip.

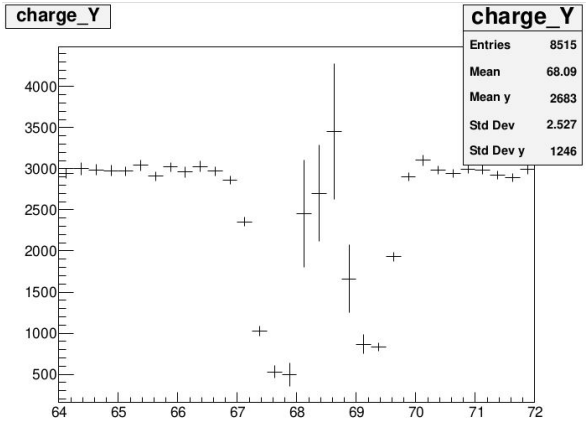


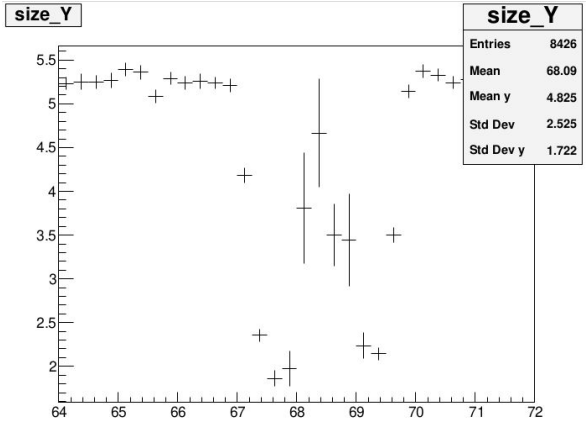
PEP check - carica, size

Run 207, HV 640V con fascio di pioni sulla PEP

CARICA
inPEP: 500
outPEP: 3000

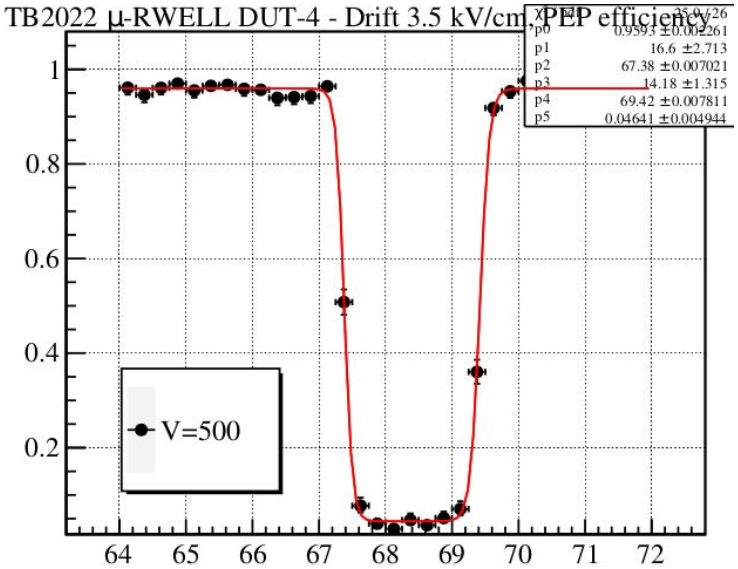
SIZE
inPEP: 2
outPEP: 5.3

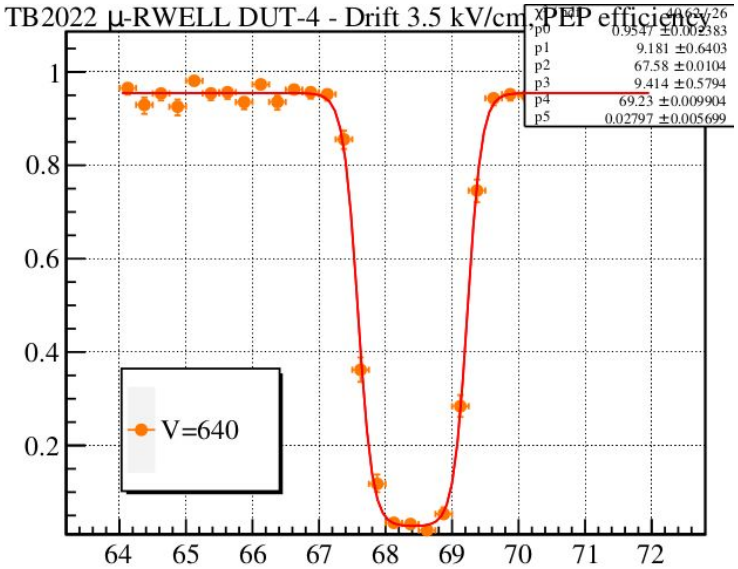




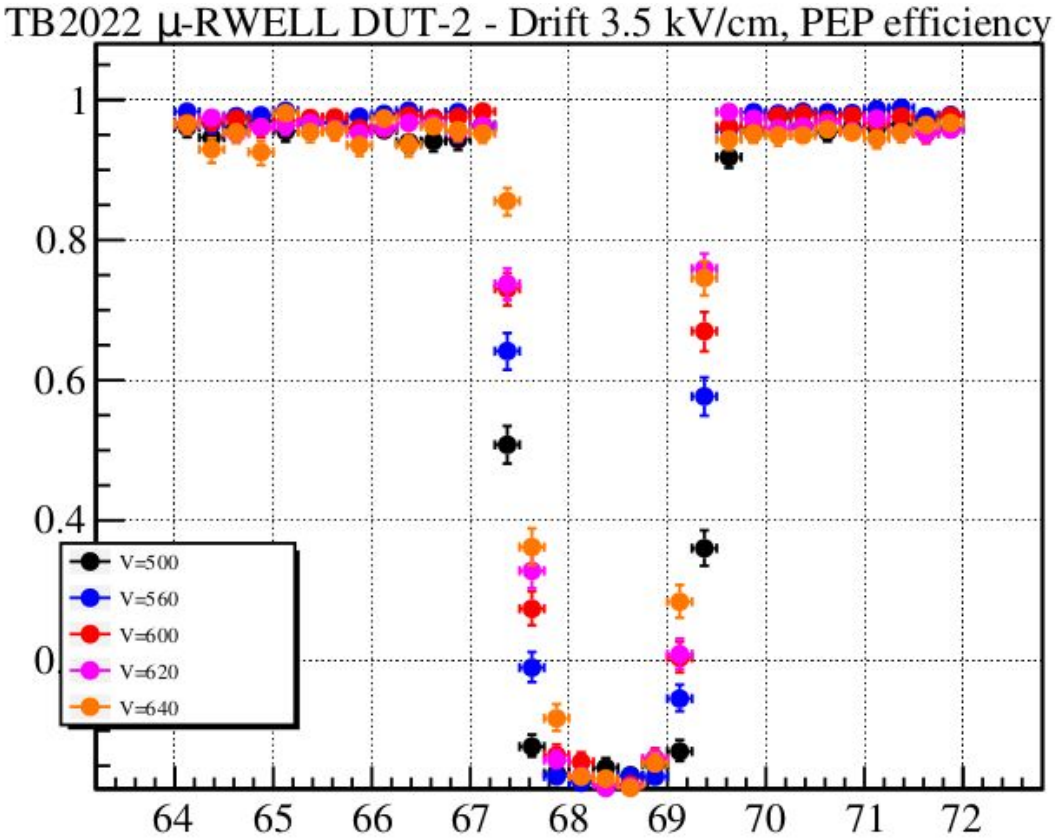
PEP check - efficienza

La PEP crea un buco di inefficienza che in funzione del HV passa 2.0mm a 1.65mm quando la dimensione fisica del buco è di 1.2mm



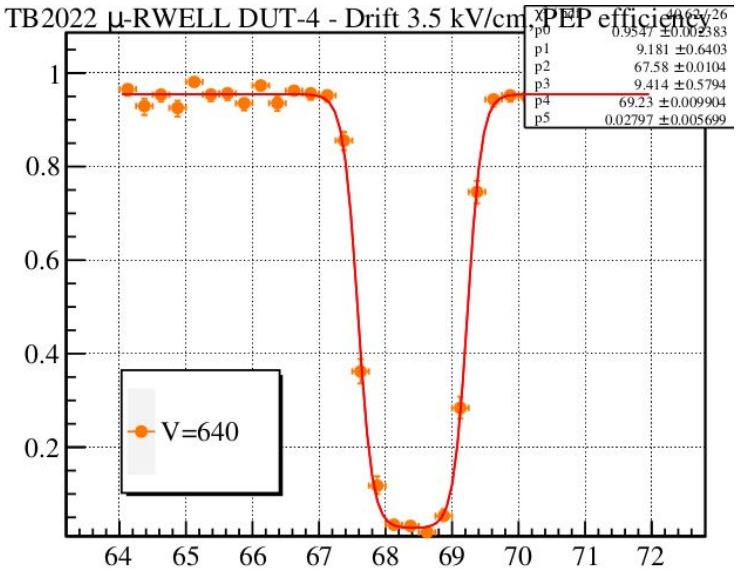


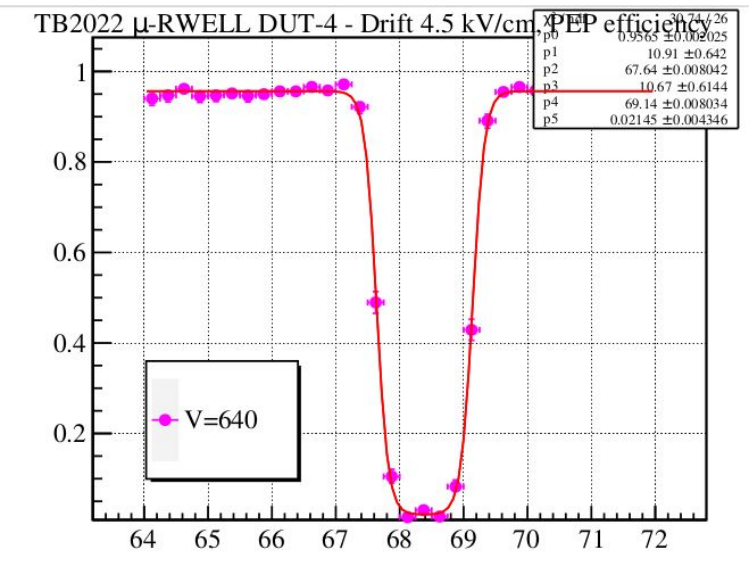
PEP check - efficienza



PEP check - efficienza

Se si aumenta il campo di deriva da 3.5 kV/cm (STD) a 4.5 kV/cm allora il buco si riduce da 1.65mm a 1.5mm. Nella prossima slide viene riportato lo scan completo.





PEP check - Width in funzione di HV e Drift per DUT2