Update on testbeam analysis for TI-LGAD and HGTD proton Irradiation

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HGTD Meeting 23/04/2026

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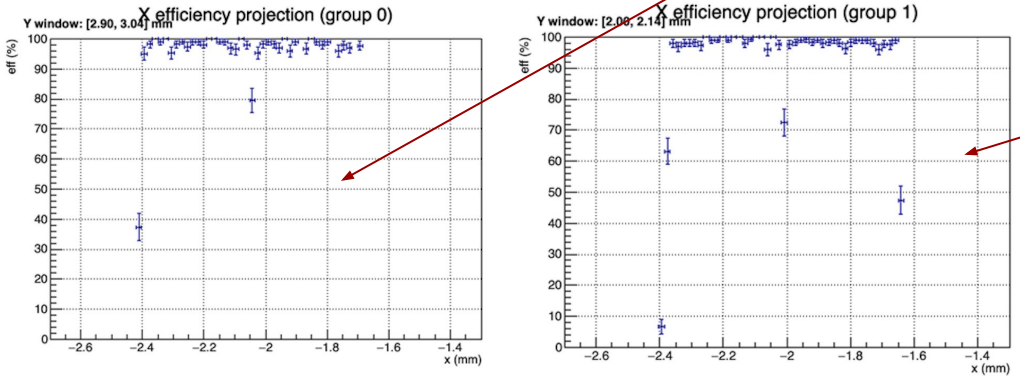
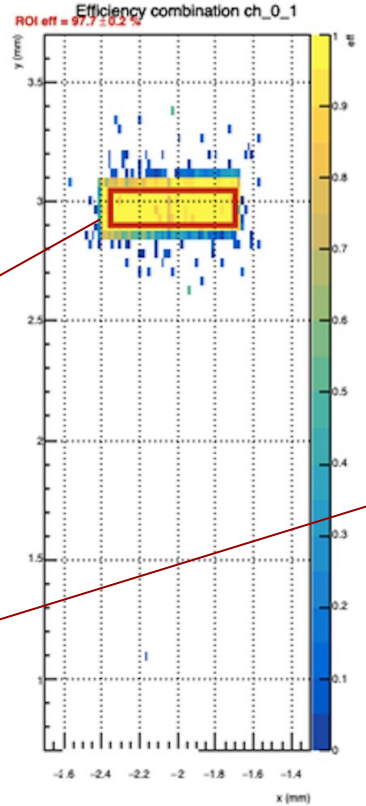
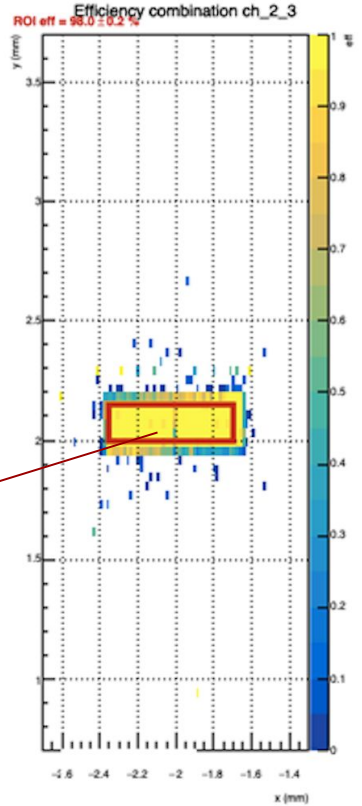
April TB-> Run 607 – Strict TREF-Anchored Efficiency Analysis

Analysis settings:

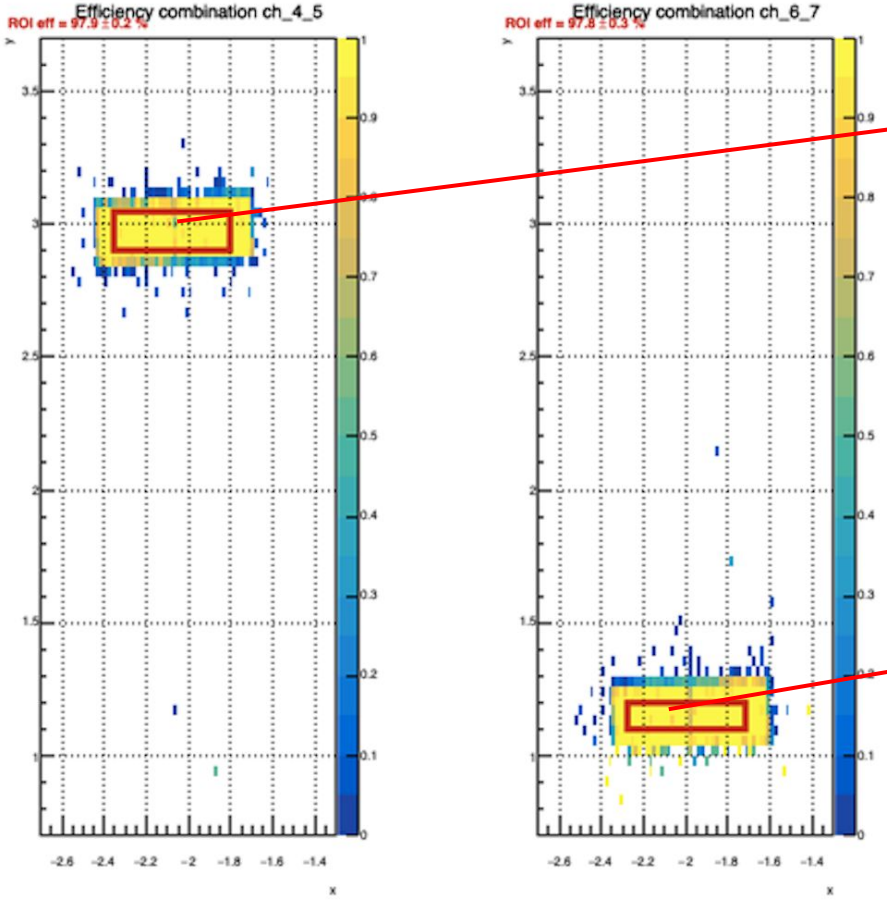
- Baseline subtraction on all channels
- TREF anchor from CFD50 on wf8/wf9
- Strict cuts:
  - (Design and performance of the Fermilab Constant Fraction Discriminator ASIC)
  - Using timing from both channels (Interaction position, time, and energy resolution in organic scintillator bars with dual-ende readout) -> averaging two time estimates
  - interpolated value between samples corresponding to 50% of the maximum value on the rising edge of the pulse

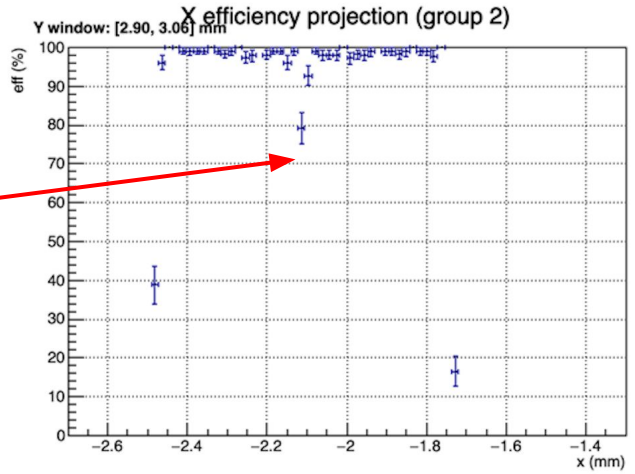


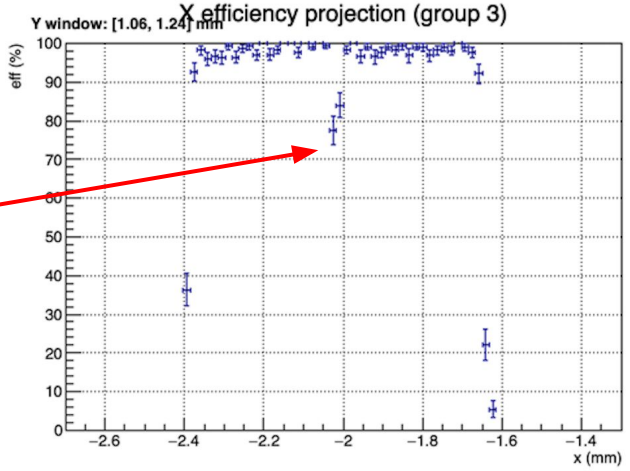




Irradiated structure to 1.5E15 neq/cm2 -> efficiencies



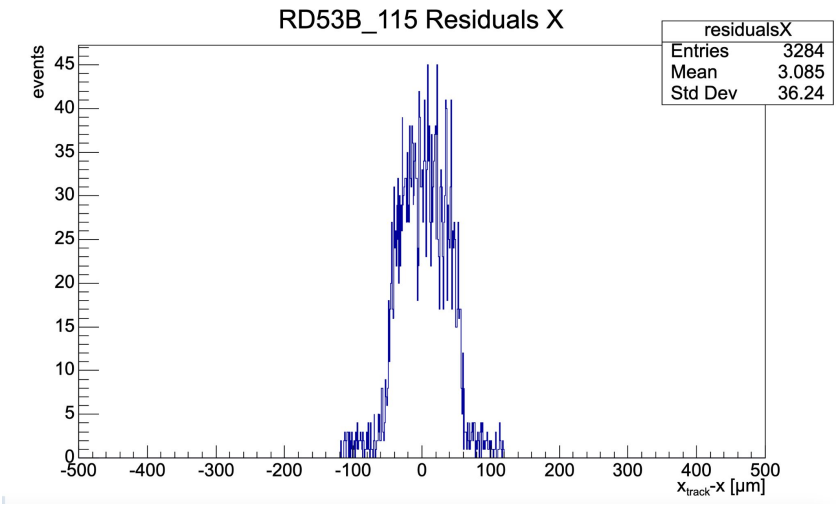


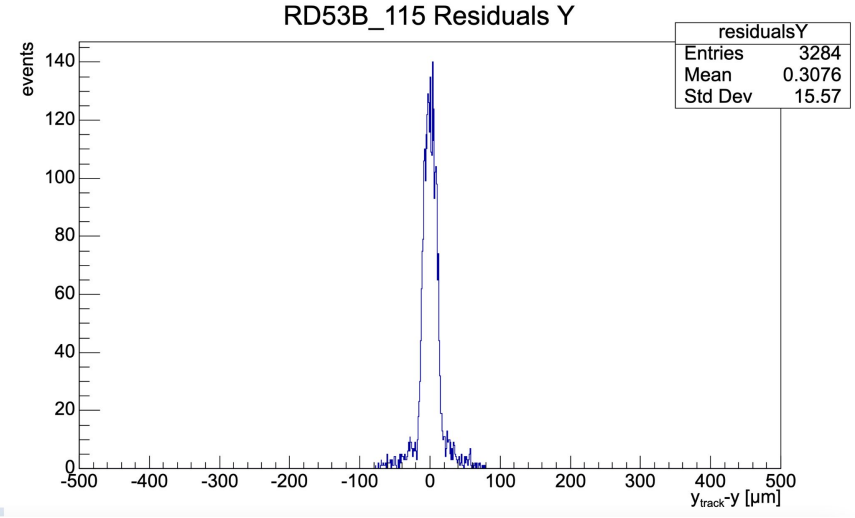


Batch 1 -> March TB 2026; 100 um x 25 um CROC

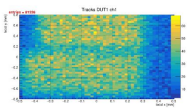
Batch 1							
Wafer	**Version**	**Trench parameter**	**Fluence**	**# daughterboard**	**Chubut CH1,2**	**Chubut CH3,4**	
W5	V2	TW1-2			V2TW1	V2TW2	
W5	V2	TW1-2			V2TW1	V2TW2	Angled
W5	V1-V2	TW5			V1TW5	V2TW5	
W5	V1-V2	TW5			V1TW5	V2TW5	Angled

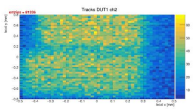
HV plane 1 (V) TREF1 - Genova	HV plane 2 (V) DUT1 - UZH	HV plane 3 (V) DUT2 - UZH	HV plane 4 (V) DUT3 - UZH	HV plane 5 (V) DUT4 - UZH
200V; 0.07uA	240V; 11.3uA	240V; 12.9uA	200V; 13.2uA	200V 20.0uA

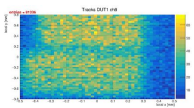


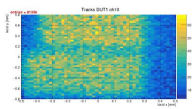


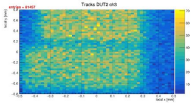
Batch 1 -> March TB 2026; 100 um x 25 um CROC, tracks and hits per channel

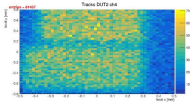


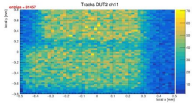


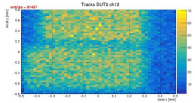


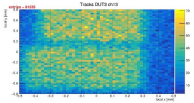


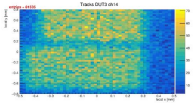


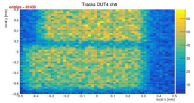


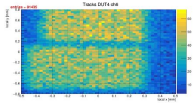


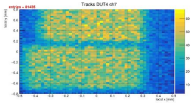


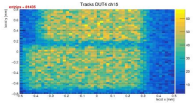


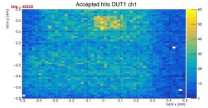


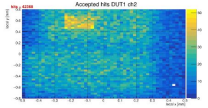


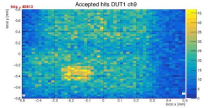


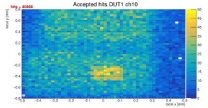


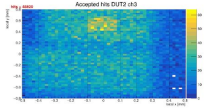


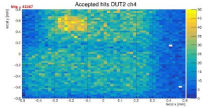


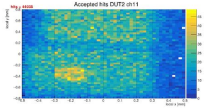


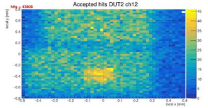


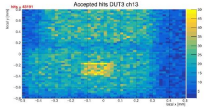


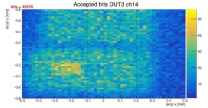


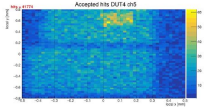


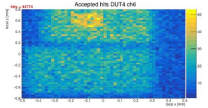


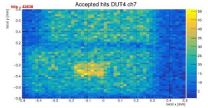


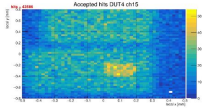




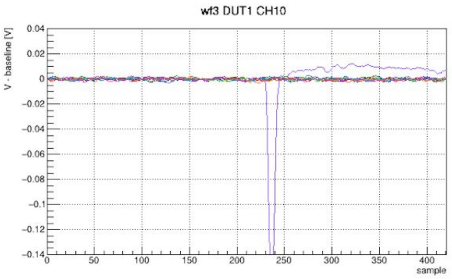


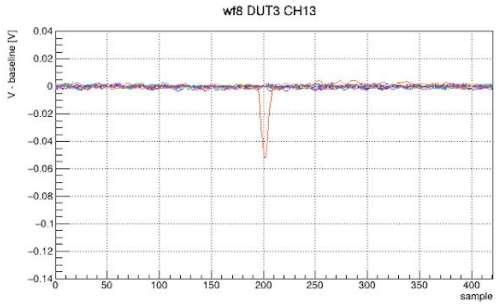


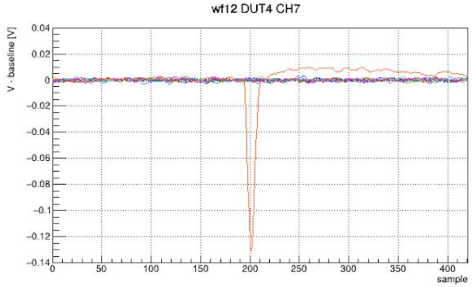


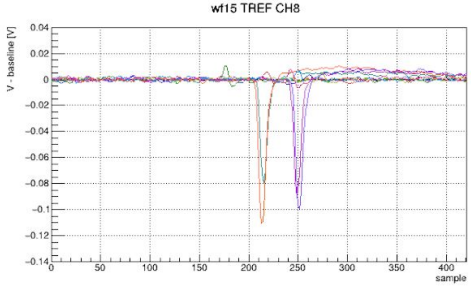


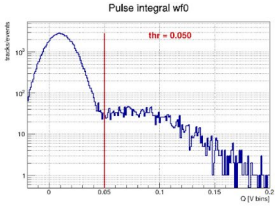
Batch 1 -> March TB 2026

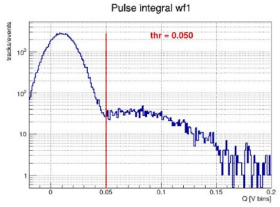









Pulse integral wf0
thr = 0.050
tracks/events
Q [V bins]


Pulse integral wf1
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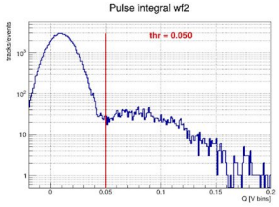
tracks/events
Q [V bins]


Pulse integral wf2
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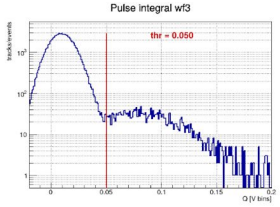
tracks/events
Q [V bins]


Pulse integral wf3
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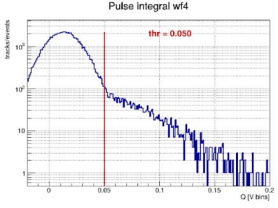
tracks/events
Q [V bins]


Pulse integral wf4
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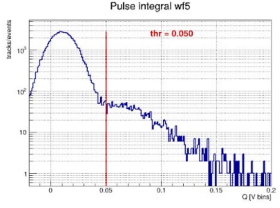
tracks/events
Q [V bins]


Pulse integral wf5
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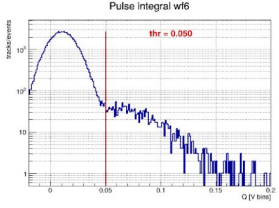
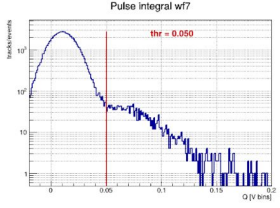
tracks/events
Q [V bins]


Pulse integral wf6
thr = 0.050
tracks/events
Q [V bins]


Pulse integral wf7
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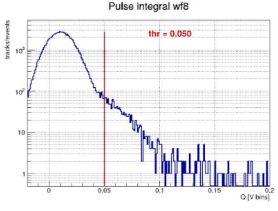
tracks/events
Q [V bins]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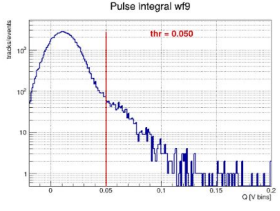
tracks/events
Q [V bins]


Pulse integral wf9
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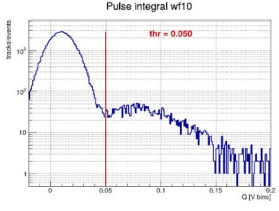
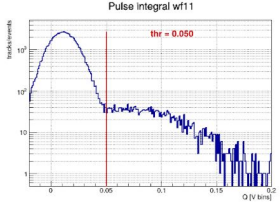
tracks/events
Q [V bins]


Pulse integral wf10
thr = 0.050
tracks/events
Q [V bins]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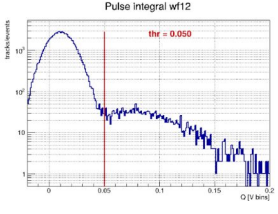
tracks/events
Q [V bins]


Pulse integral wf12
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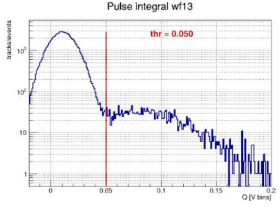
tracks/events
Q [V bins]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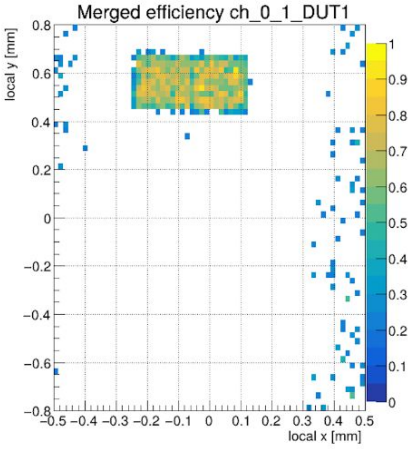
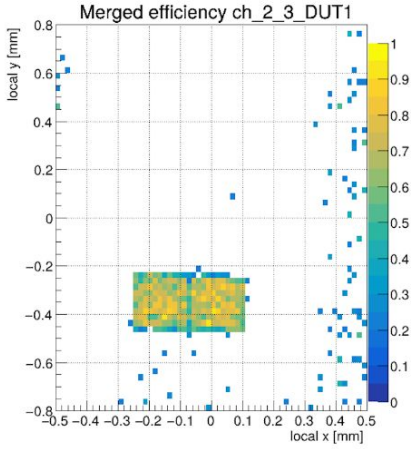
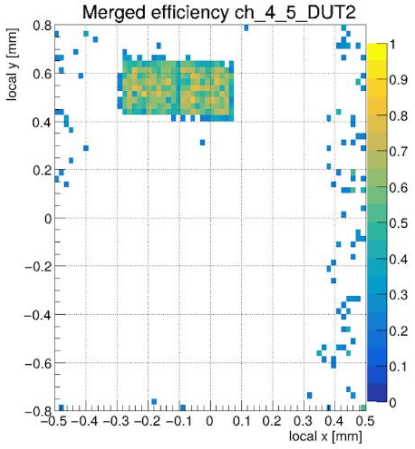
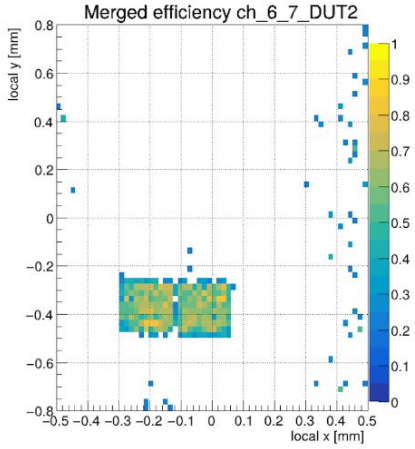
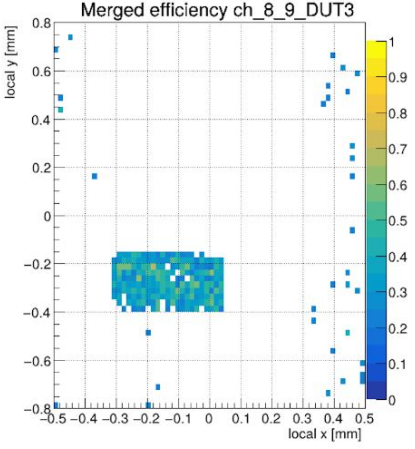
tracks/events
Q [V bins]

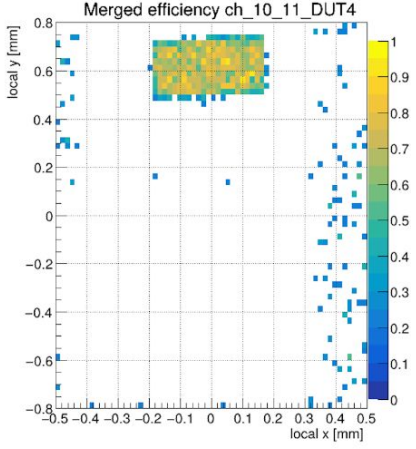

Merged efficiency ch_0_1_DUT1
local y [mm]
local x [mm]

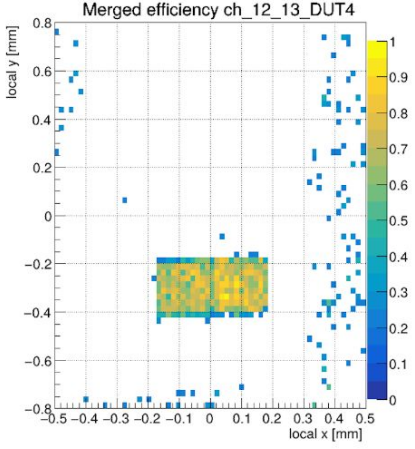

Merged efficiency ch_2_3_DUT1
local y [mm]
local x [mm]

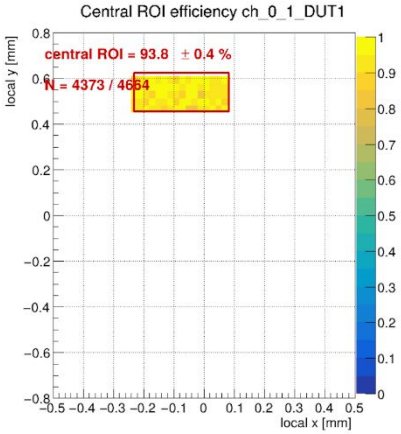

Merged efficiency ch_4_5_DUT2
local y [mm]
local x [mm]

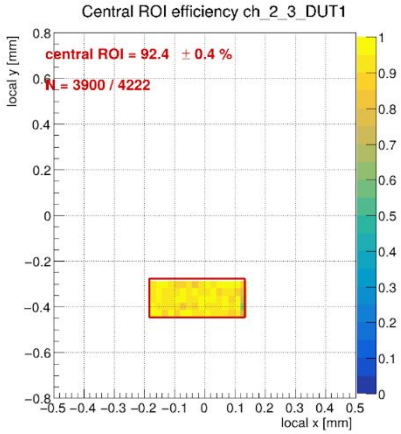

Merged efficiency ch_6_7_DUT2
local y [mm]
local x [mm]

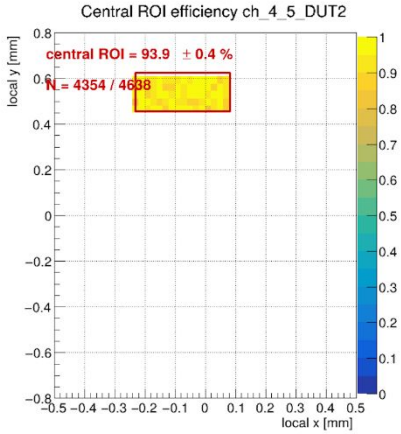

Merged efficiency ch_8_9_DUT3
local y [mm]
local x [mm]

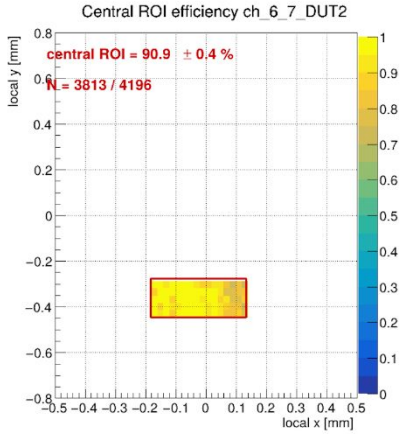

Merged efficiency ch_10_11_DUT4
local y [mm]
local x [mm]

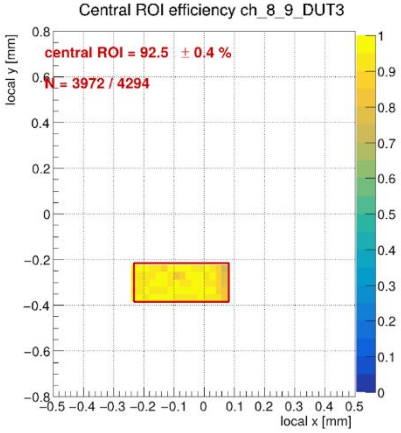

Merged efficiency ch_12_13_DUT4
local y [mm]
local x [mm]

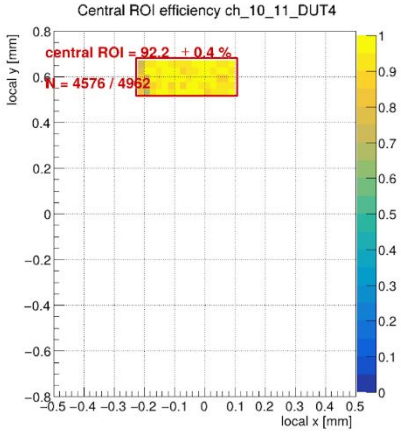

Central ROI efficiency ch_0_1_DUT1
central ROI = 93.8 ± 0.4 %
N = 4373 / 4664
local y [mm]
local x [mm]

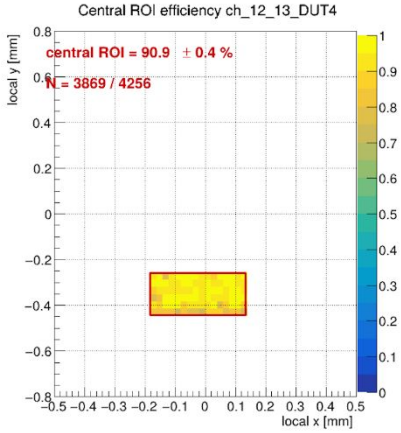

Central ROI efficiency ch_2_3_DUT1
central ROI = 92.4 ± 0.4 %
N = 3900 / 4222
local y [mm]
local x [mm]


Central ROI efficiency ch_4_5_DUT2
central ROI = 93.9 ± 0.4 %
N = 4354 / 4638
local y [mm]
local x [mm]

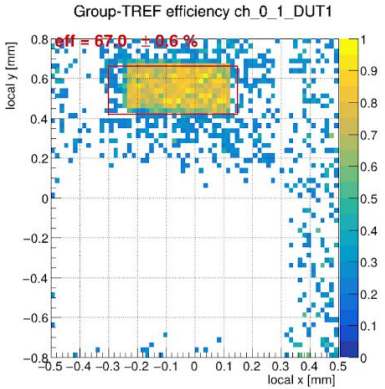

Central ROI efficiency ch_6_7_DUT2
central ROI = 90.9 ± 0.4 %
N = 3813 / 4196
local y [mm]
local x [mm]

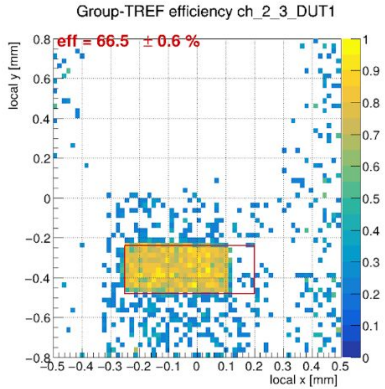

Central ROI efficiency ch_8_9_DUT3
central ROI = 92.5 ± 0.4 %
N = 3972 / 4294
local y [mm]
local x [mm]

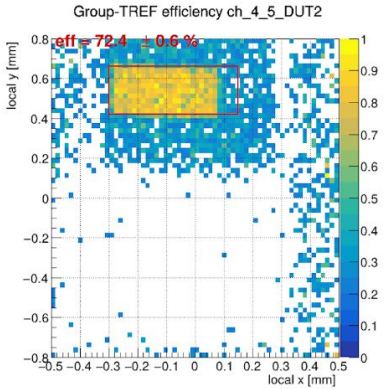

Central ROI efficiency ch_10_11_DUT4
central ROI = 92.2 ± 0.4 %
N = 4576 / 4962
local y [mm]
local x [mm]

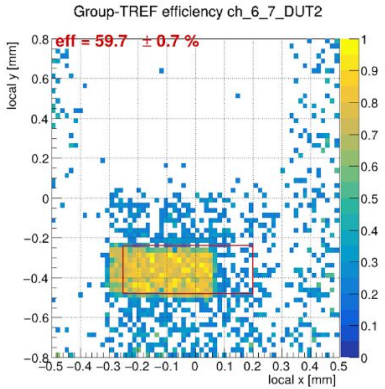

Central ROI efficiency ch_12_13_DUT4
central ROI = 90.9 ± 0.4 %
N = 3869 / 4256
local y [mm]
local x [mm]

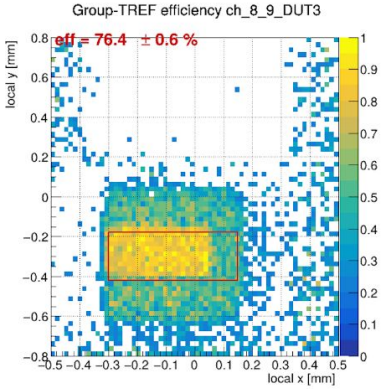
TREF anchored analysis -> every CAEN group uses one TREF branch

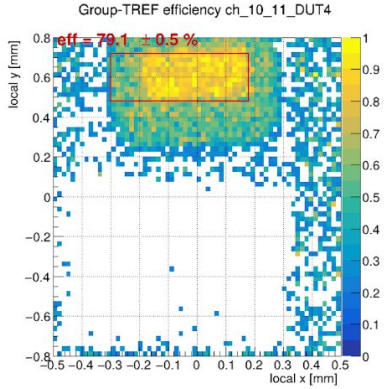


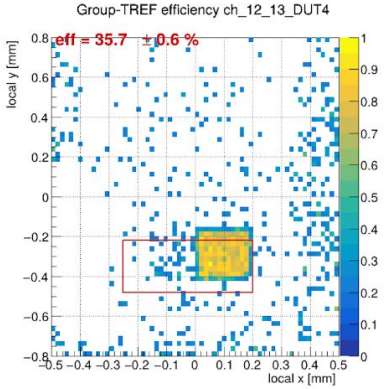




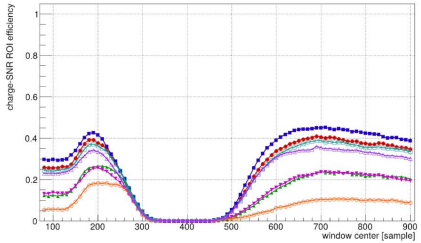


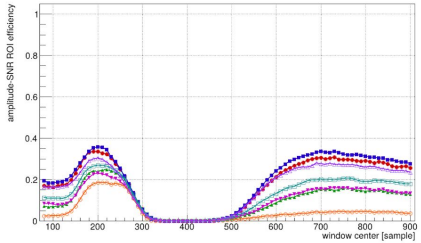


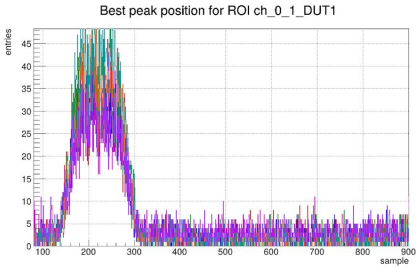


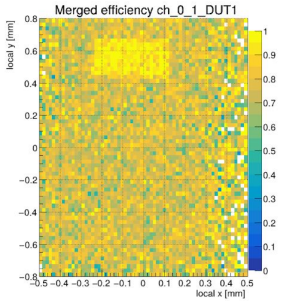


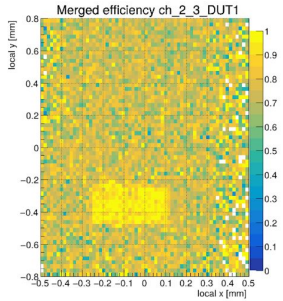
If I integrate around this part of the waveform,
how many ROI tracks look like hits?

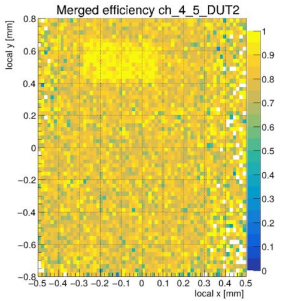


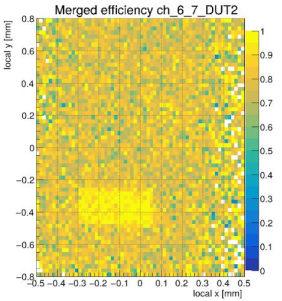


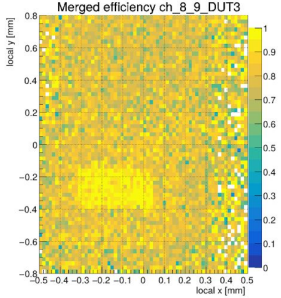


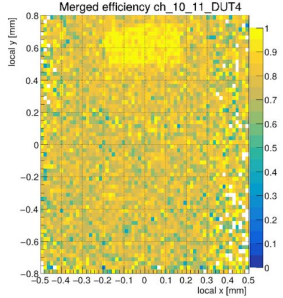


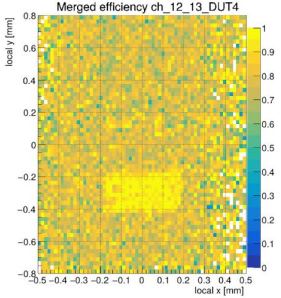




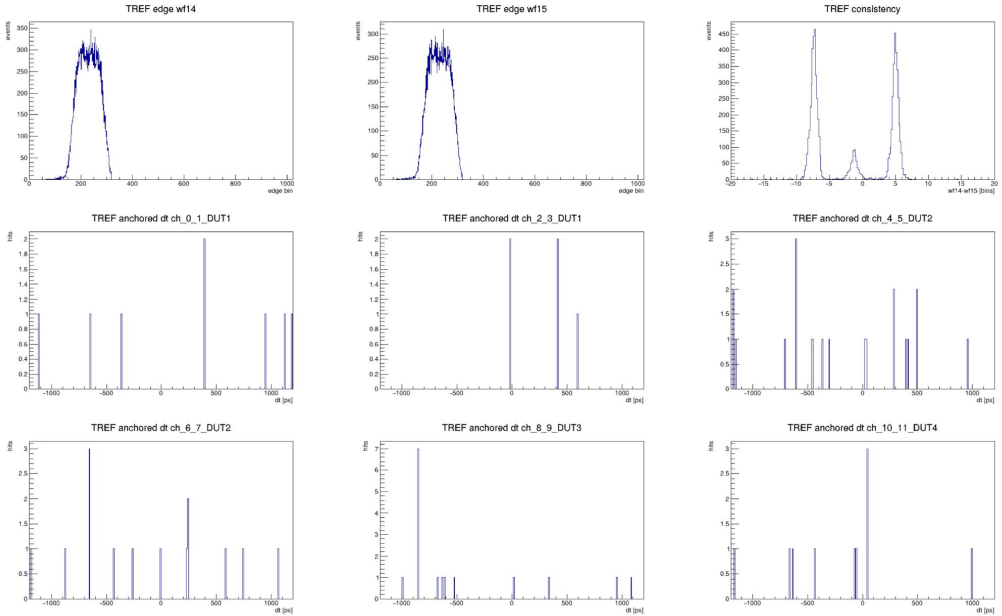


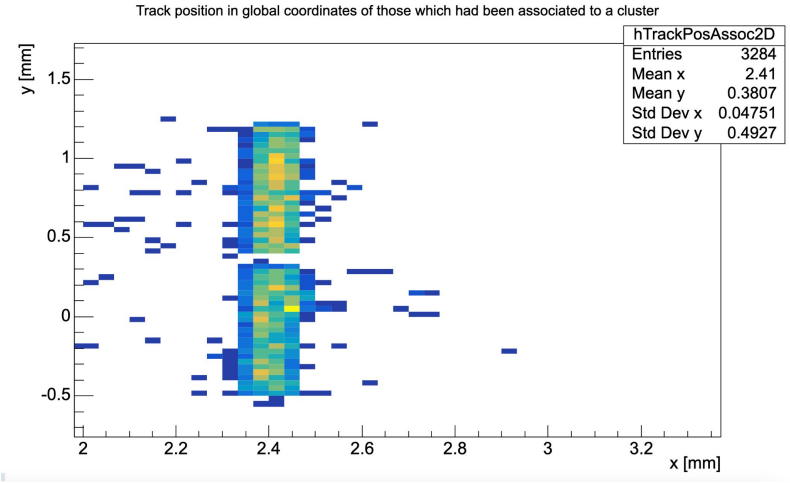


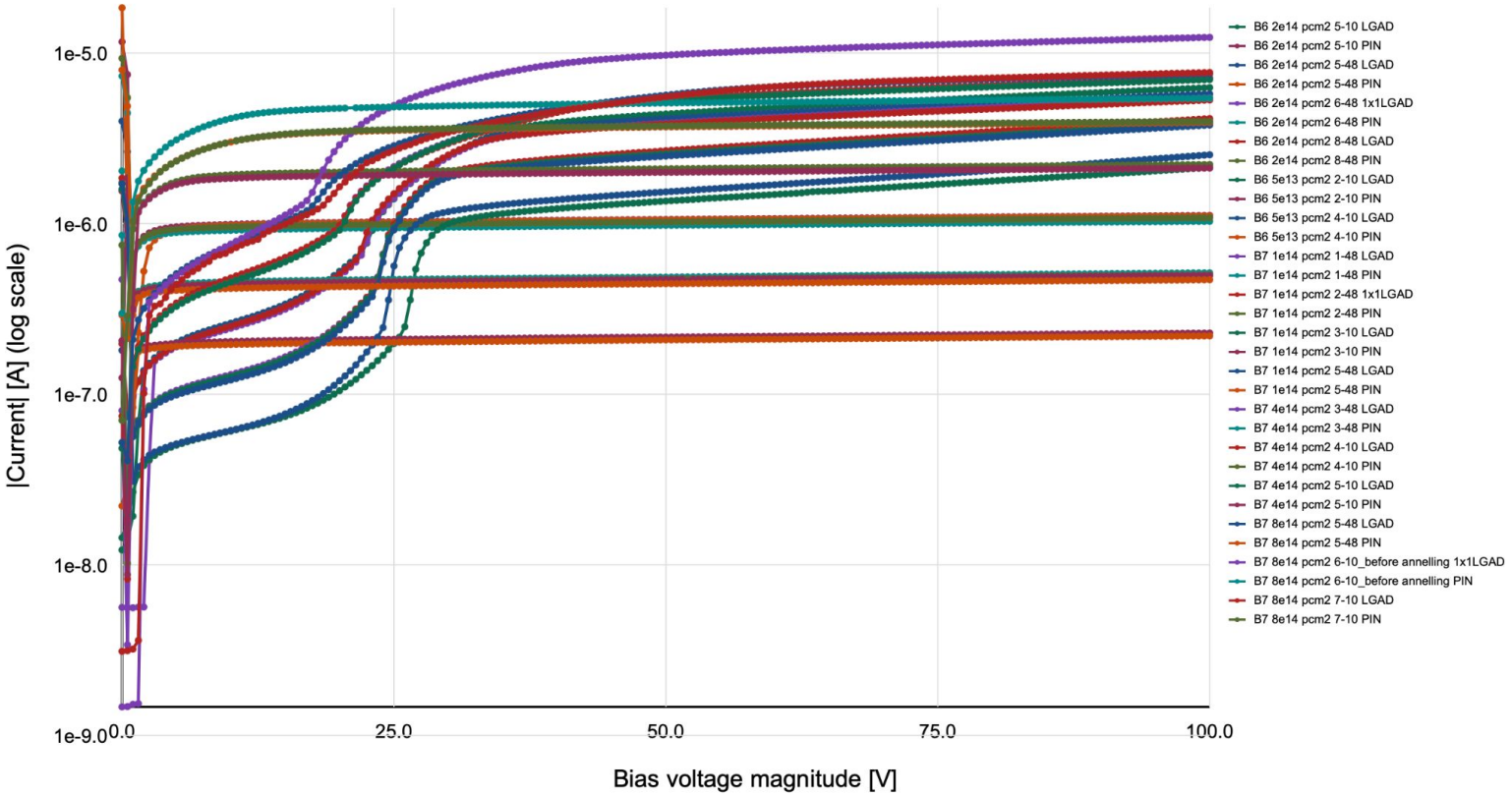




Batch 1 -> March TB 2026; 100 um x 25 um CROC, efficiency plots






1e-5.0
1e-6.0
1e-7.0
1e-8.0
1e-9.0
|Current| [A] (log scale)
0.0
25.0
50.0
75.0
100.0
Bias voltage magnitude [V]
B6 2e14 pcm2 5-10 LGAD
B6 2e14 pcm2 5-10 PIN
B6 2e14 pcm2 5-48 LGAD
B6 2e14 pcm2 5-48 PIN
B6 2e14 pcm2 6-48 1x1LGAD
B6 2e14 pcm2 6-48 PIN
B6 2e14 pcm2 8-48 LGAD
B6 2e14 pcm2 8-48 PIN
B6 5e13 pcm2 2-10 LGAD
B6 5e13 pcm2 2-10 PIN
B6 5e13 pcm2 4-10 LGAD
B6 5e13 pcm2 4-10 PIN
B7 1e14 pcm2 1-48 LGAD
B7 1e14 pcm2 1-48 PIN
B7 1e14 pcm2 2-48 1x1LGAD
B7 1e14 pcm2 2-48 PIN
B7 1e14 pcm2 3-10 LGAD
B7 1e14 pcm2 3-10 PIN
B7 1e14 pcm2 5-48 LGAD
B7 1e14 pcm2 5-48 PIN
B7 4e14 pcm2 3-48 LGAD
B7 4e14 pcm2 3-48 PIN
B7 4e14 pcm2 4-10 LGAD
B7 4e14 pcm2 4-10 PIN
B7 4e14 pcm2 5-10 LGAD
B7 4e14 pcm2 5-10 PIN
B7 8e14 pcm2 5-48 LGAD
B7 8e14 pcm2 5-48 PIN
B7 8e14 pcm2 6-10_before annelling 1x1LGAD
B7 8e14 pcm2 6-10_before annelling PIN
B7 8e14 pcm2 7-10 LGAD
B7 8e14 pcm2 7-10 PIN

batch	fluence_label	sample	estimated_vfd_V	evaluation_bias_V	current_at_vfd_plus_20_A	current_at_vfd_plus_20_ı	fluence_from_iv_neq_cm2	fluence_from_iv_e14_n	alpha_cm_inv	area_cm2	thickness_cm
B6	2e14 pcm2	5-10	6.24	26.24	1.03E-06	1.028	3.06E+14	3.058	4.00E-17	1.68E-02	5.00E-03
B6	2e14 pcm2	5-48	6.65	26.65	1.02E-06	1.019	3.03E+14	3.033	4.00E-17	1.68E-02	5.00E-03
B6	2e14 pcm2	6-48	5.42	25.42	9.47E-07	0.947	2.82E+14	2.818	4.00E-17	1.68E-02	5.00E-03
B6	2e14 pcm2	8-48	6.23	26.23	9.93E-07	0.993	2.95E+14	2.954	4.00E-17	1.68E-02	5.00E-03
B6	5e13 pcm2	2-10	5.35	25.35	2.10E-07	0.21	6.26E+13	0.625	4.00E-17	1.68E-02	5.00E-03
B6	5e13 pcm2	4-10	5.88	25.88	2.02E-07	0.202	6.01E+13	0.601	4.00E-17	1.68E-02	5.00E-03
B7	1e14 pcm2	1-48	5.54	25.54	4.71E-07	0.471	1.40E+14	1.403	4.00E-17	1.68E-02	5.00E-03
B7	1e14 pcm2	2-48	5.77	25.77	4.59E-07	0.459	1.37E+14	1.367	4.00E-17	1.68E-02	5.00E-03
B7	1e14 pcm2	3-10	5.56	25.56	4.56E-07	0.456	1.36E+14	1.358	4.00E-17	1.68E-02	5.00E-03
B7	1e14 pcm2	5-48	6.23	26.23	4.31E-07	0.431	1.28E+14	1.284	4.00E-17	1.68E-02	5.00E-03
B7	4e14 pcm2	3-48	9.85	29.85	2.03E-06	2.027	6.03E+14	6.031	4.00E-17	1.68E-02	5.00E-03
B7	4e14 pcm2	4-10	9.68	29.68	2.04E-06	2.042	6.08E+14	6.077	4.00E-17	1.68E-02	5.00E-03
B7	4e14 pcm2	5-10	9.74	29.74	1.95E-06	1.947	5.80E+14	5.796	4.00E-17	1.68E-02	5.00E-03
B7	8e14 pcm2	5-48	21.77	41.77	3.64E-06	3.642	1.08E+15	10.841	4.00E-17	1.68E-02	5.00E-03
B7	8e14 pcm2	6-10_before anne	22.72	42.72	5.02E-06	5.021	1.49E+15	14.943	4.00E-17	1.68E-02	5.00E-03
B7	8e14 pcm2	7-10	23.26	43.26	3.70E-06	3.698	1.10E+15	11.007	4.00E-17	1.68E-02	5.00E-03