DPTS timing performance 2023-05 @ PS Beam Test

07. Nov. 2023

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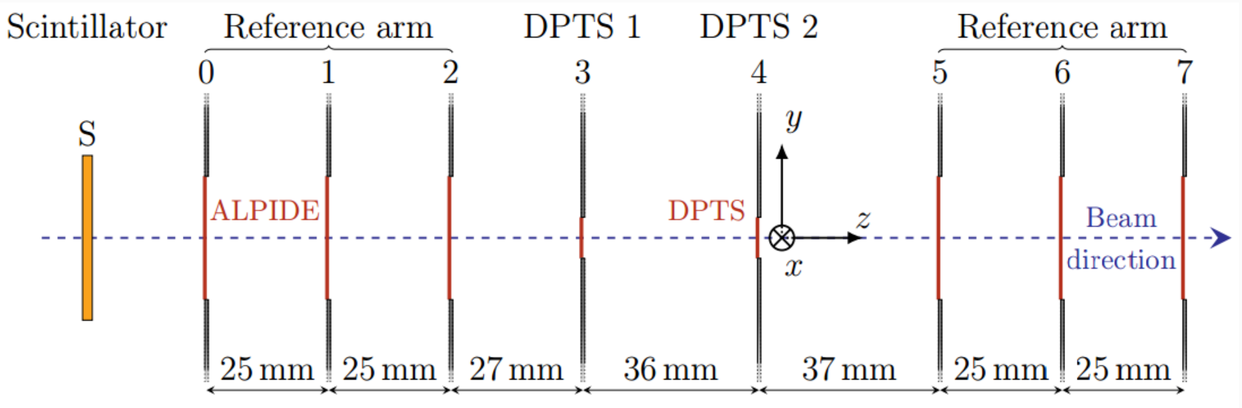
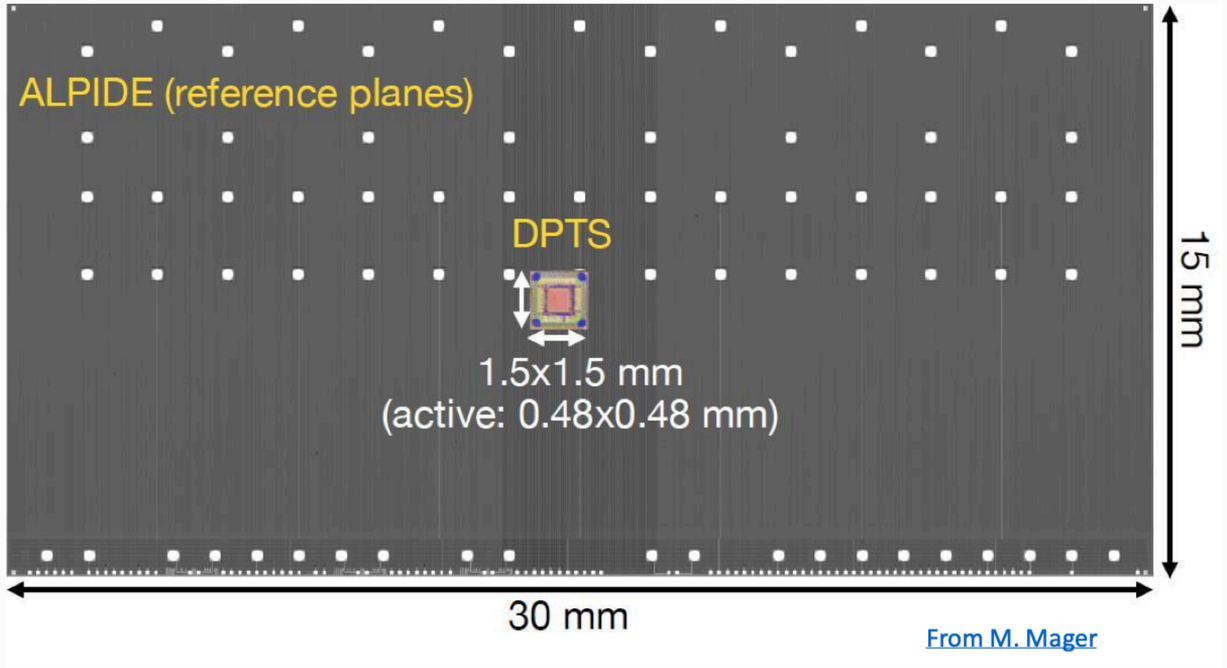
UC Berkeley

Beam test setup

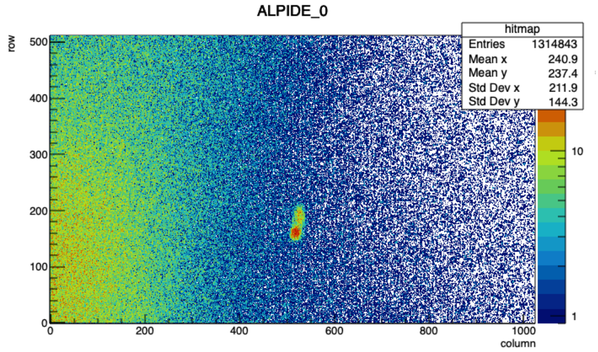


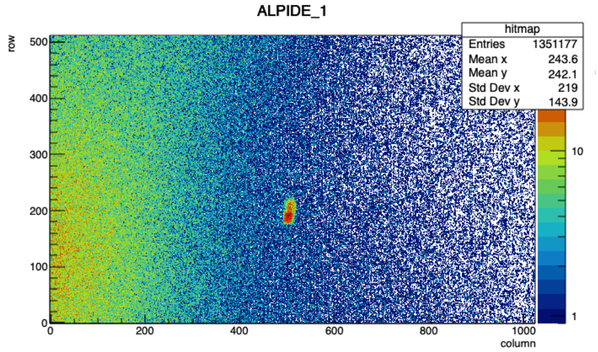


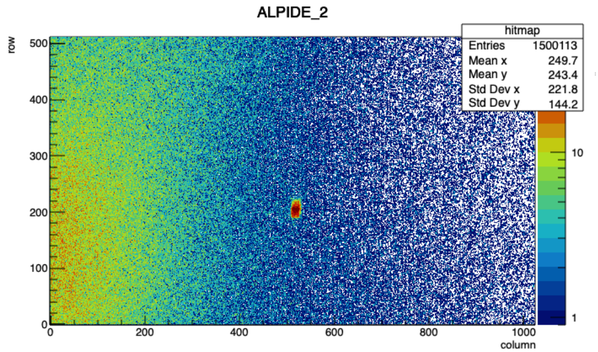
From M. Mager

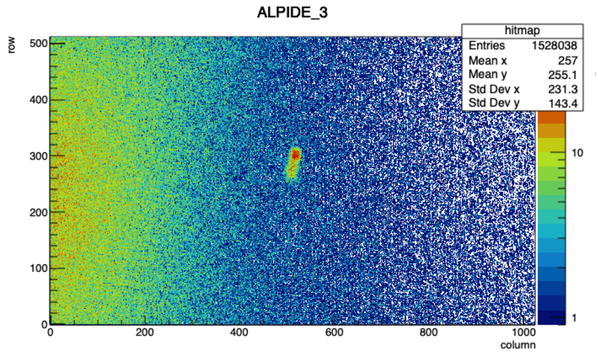
- ALPIDE telescope:
  - 3 planes before the Device(s) Under Test (DUT)
  - 3 planes after the DUT(s)
  - 2.5 cm distance between planes
  - 3 μm tracking resolution on the DUT plane
- DPTS 1 as TRG (DPTSOW22B6/Vbb = -1.2V)
- DPTS 2 as DUT:
  - DPTSOW22B7
  - DPTSXW22B34
- 10 - 12 GeV hadron beam @ PS

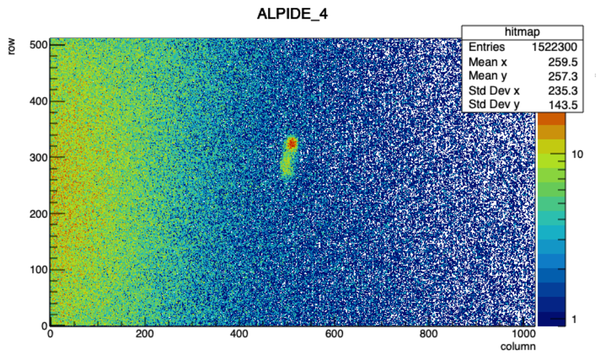
Hit maps: ALPIDEs (local coordinates)

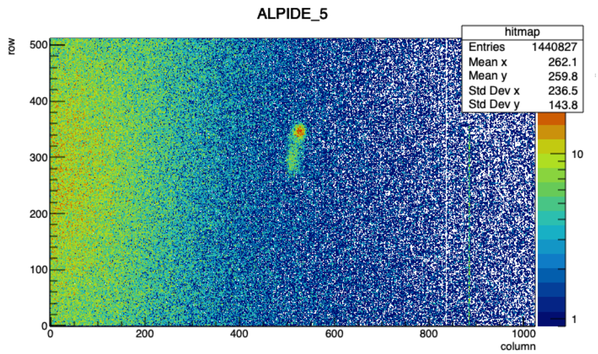


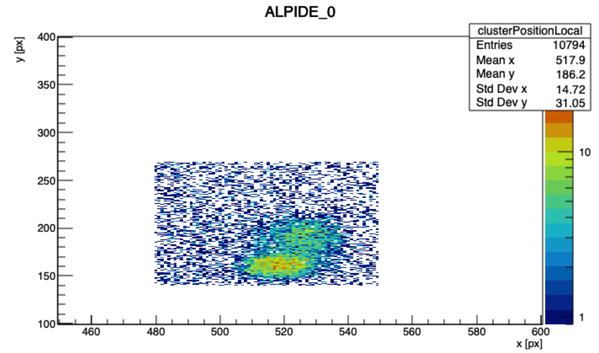


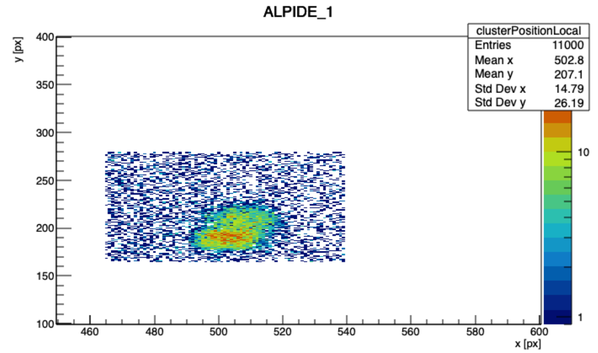


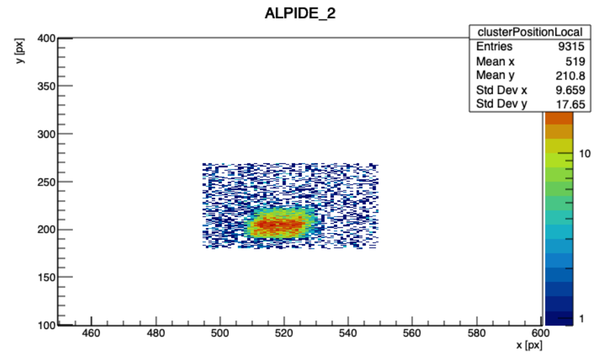


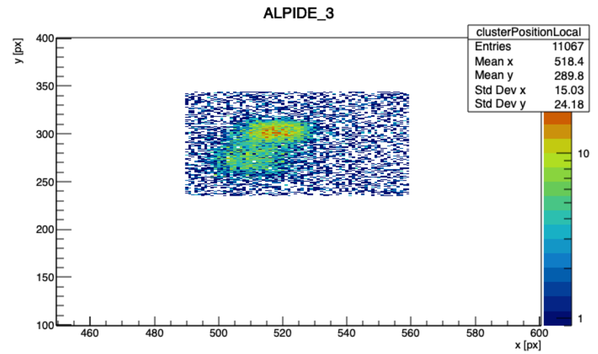


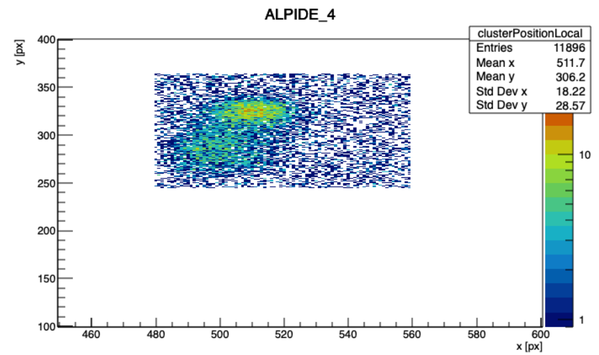


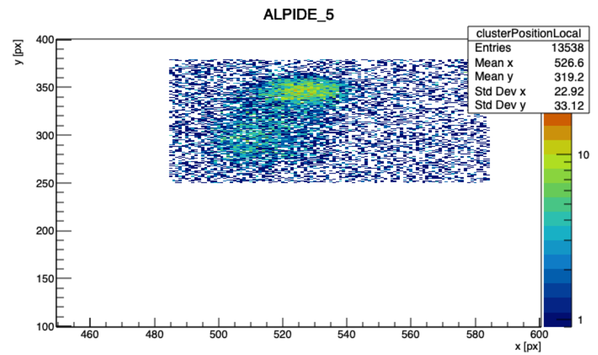




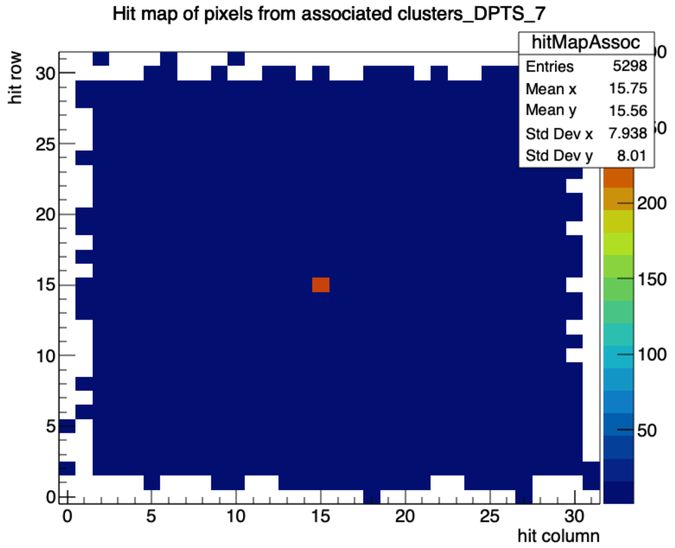


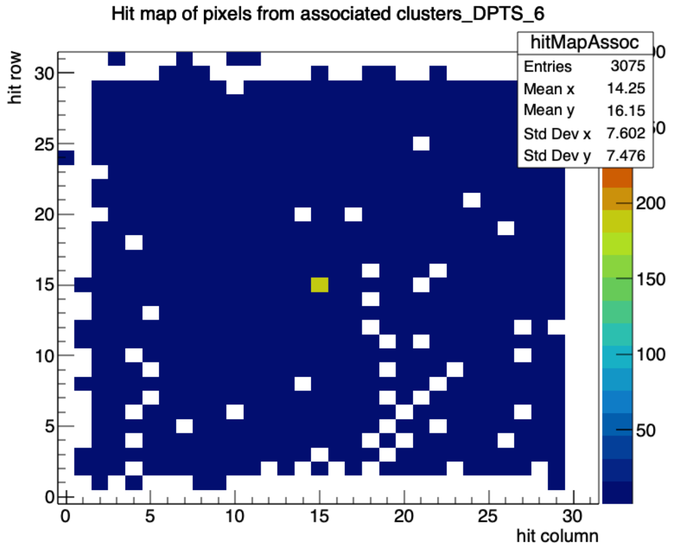


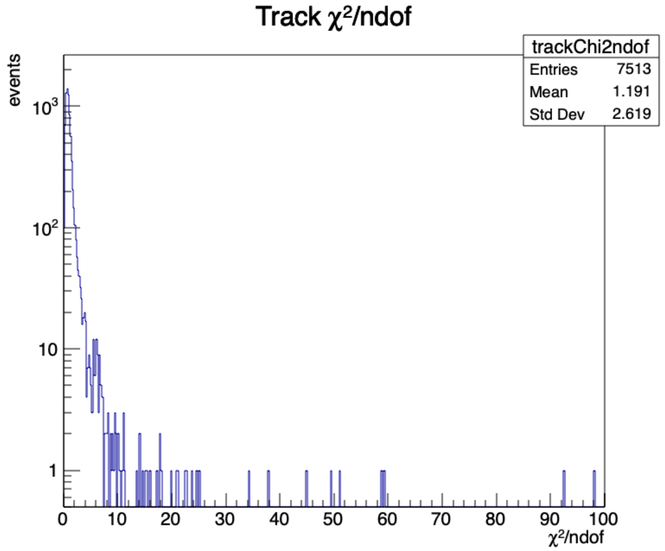


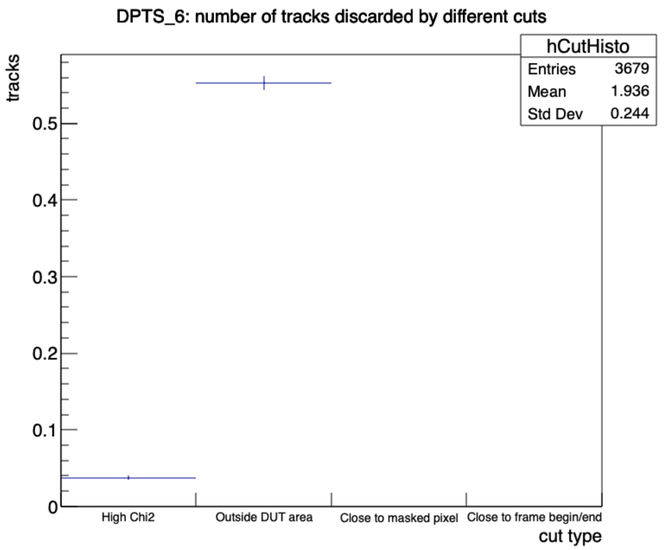


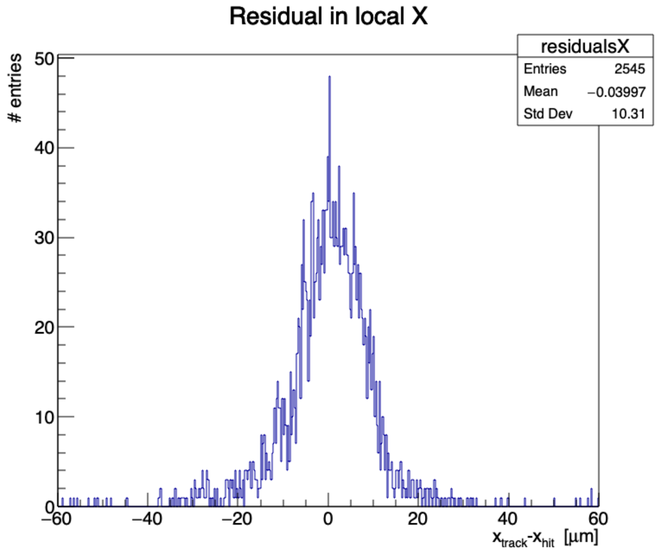
QA on DPTSs and tracking

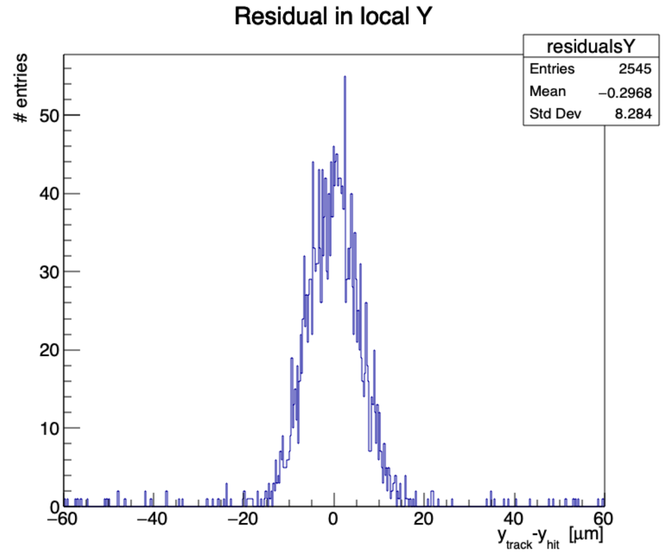




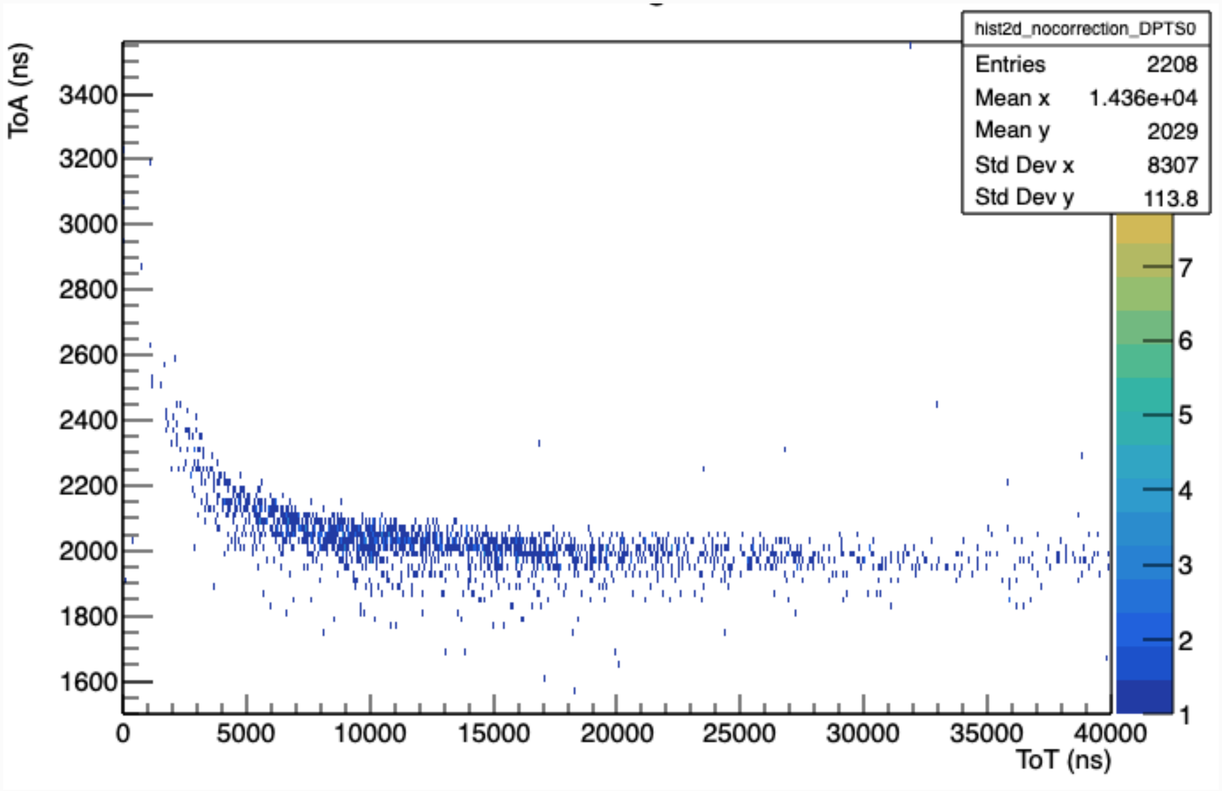


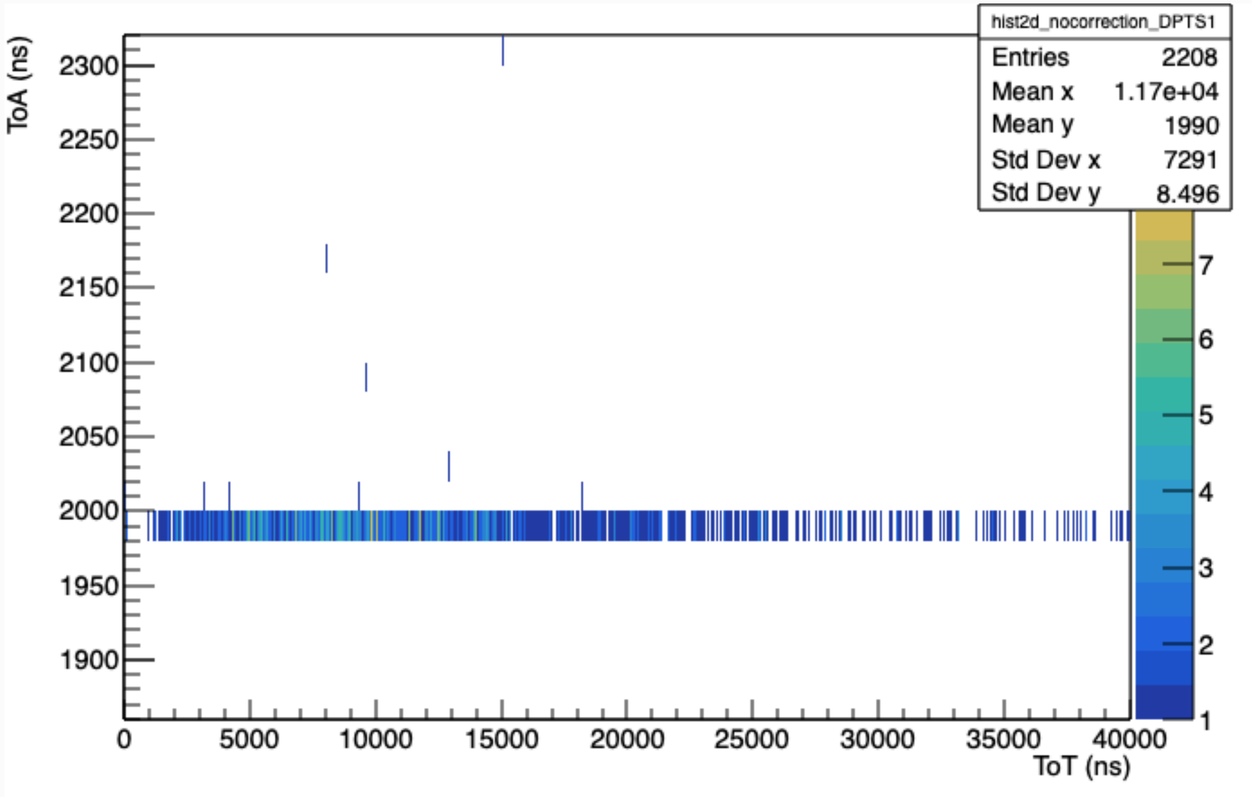




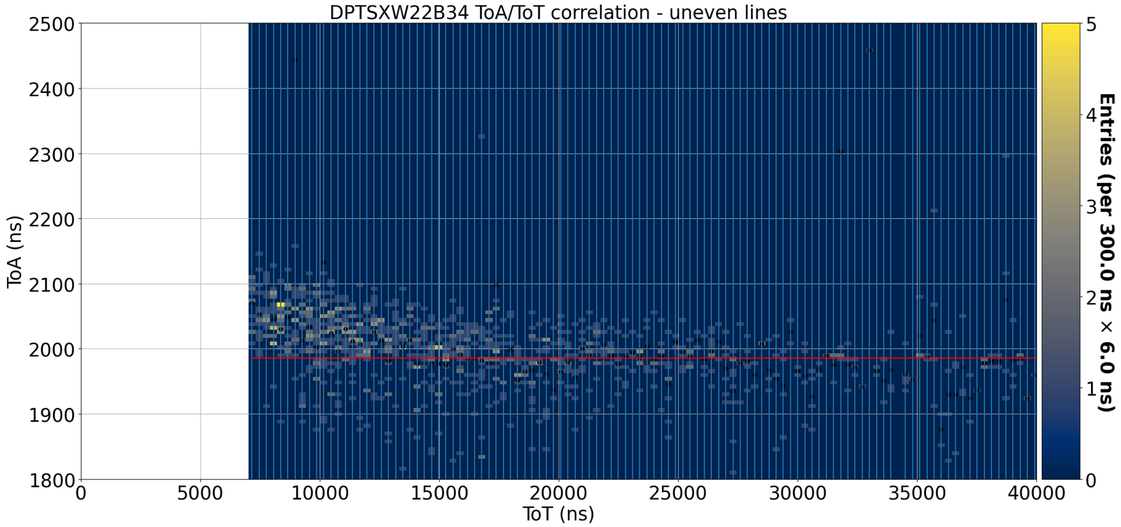


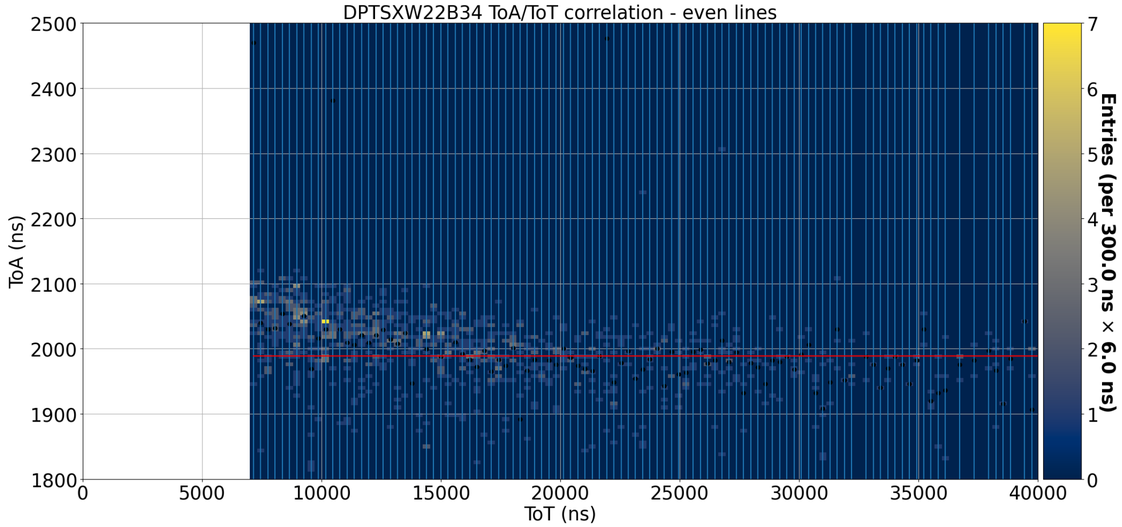
ToA vs. ToT (no correction)

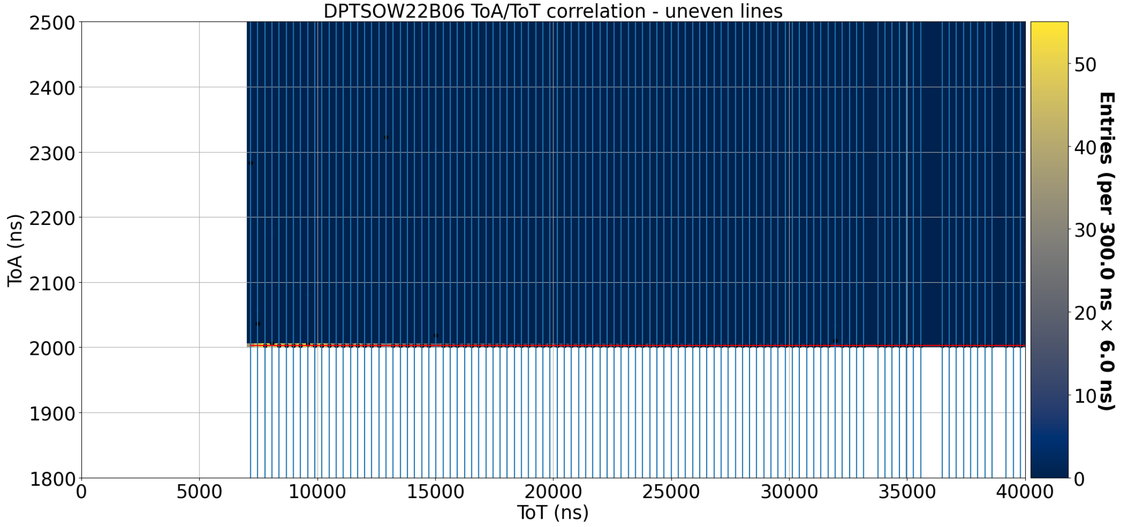


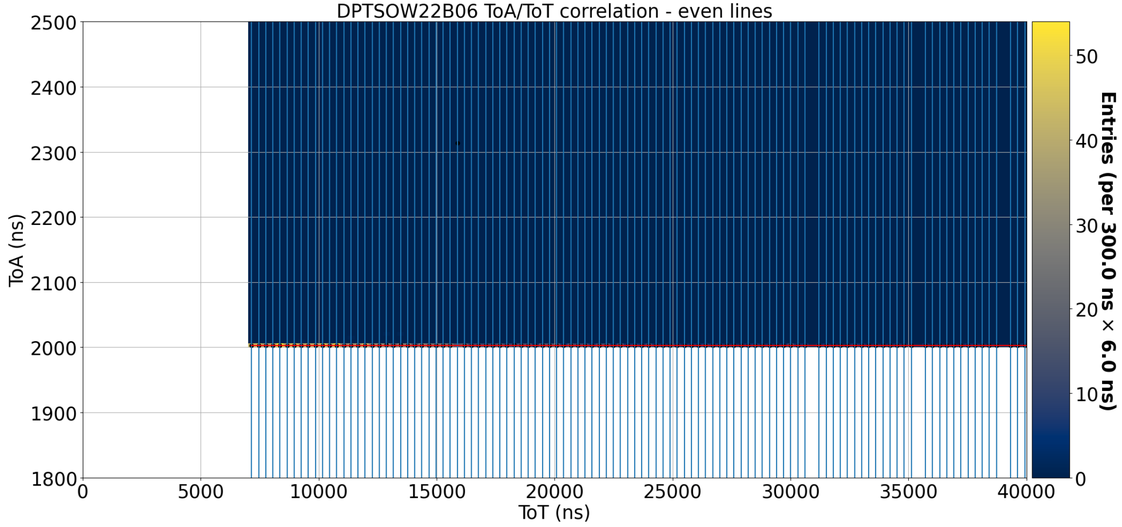


ToA vs. ToT for offset correction

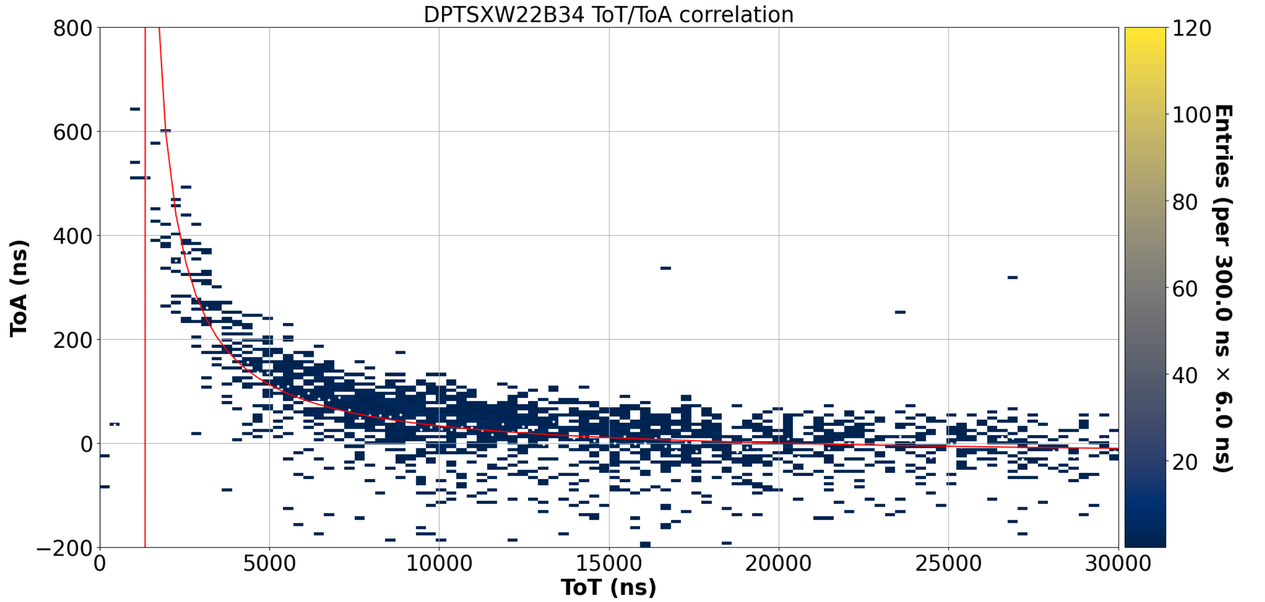


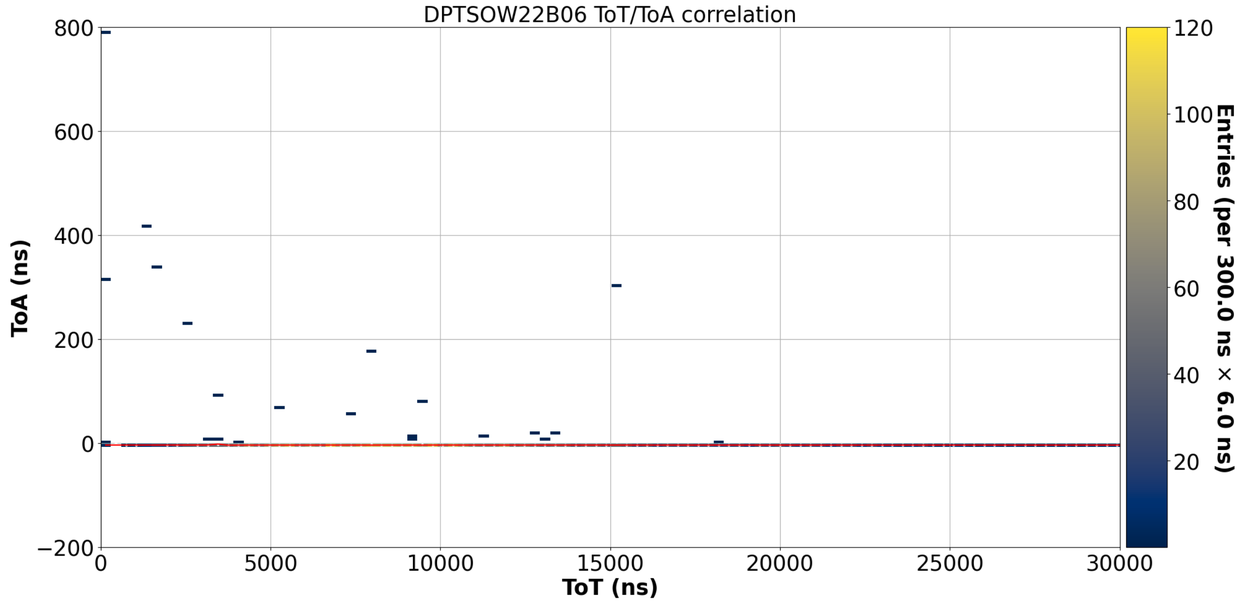


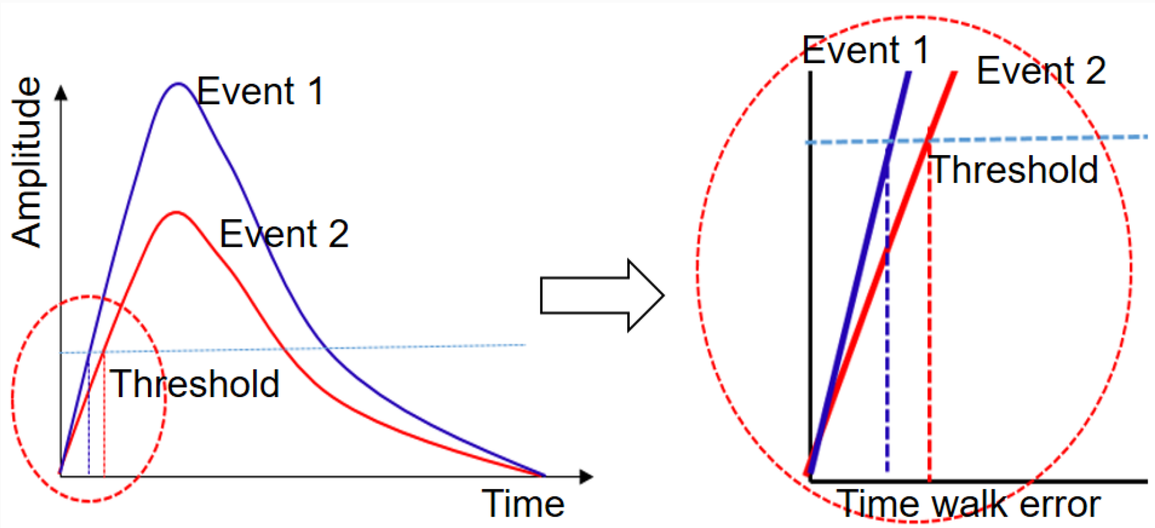




ToA vs. ToT (after offset correction)

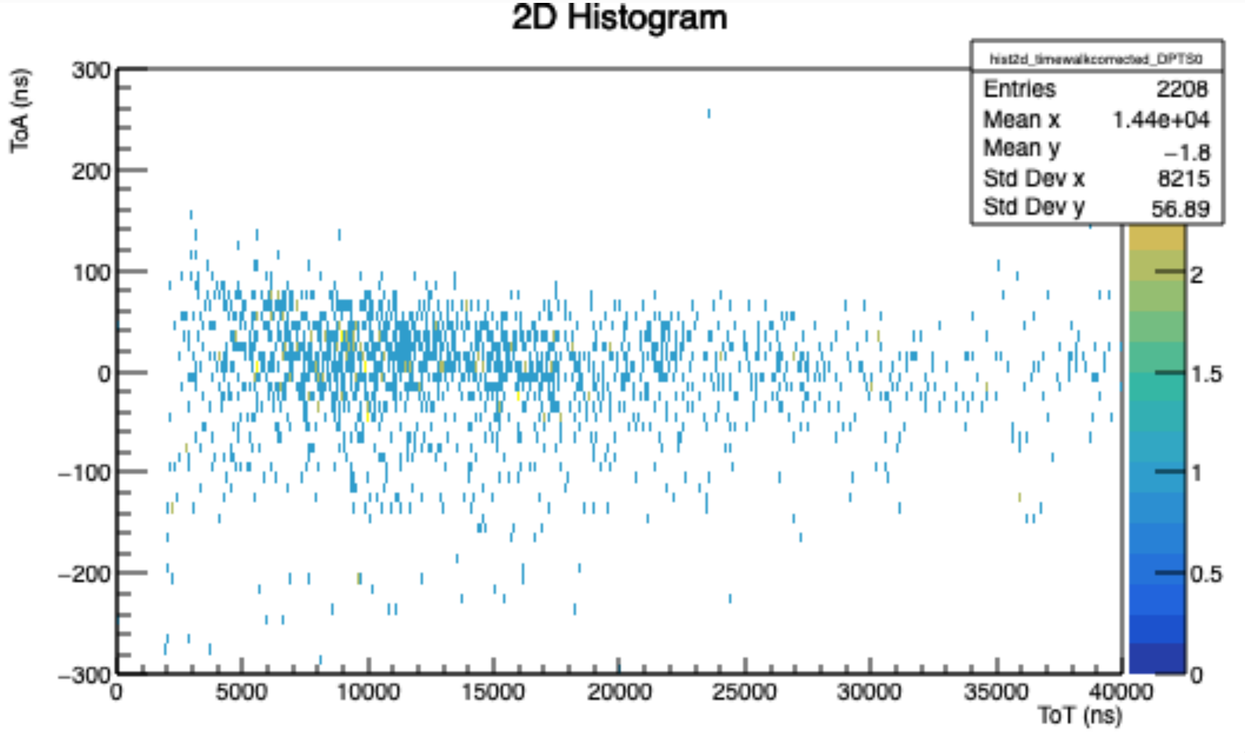


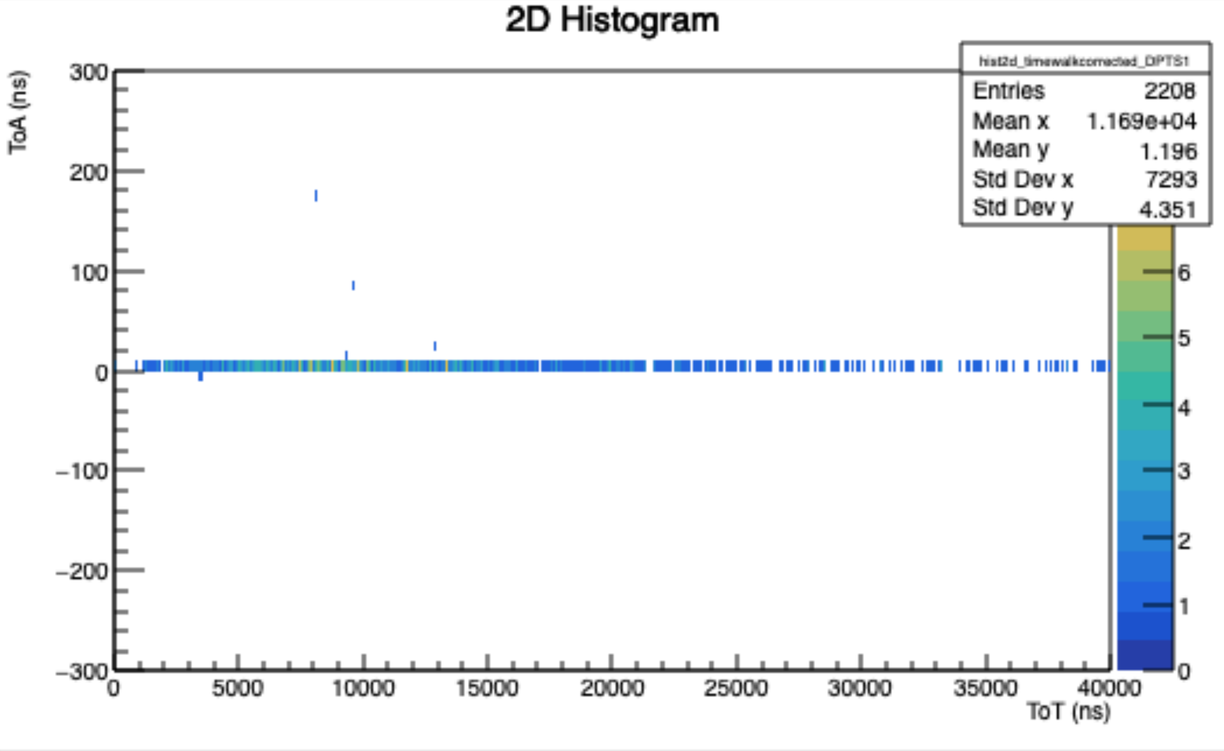




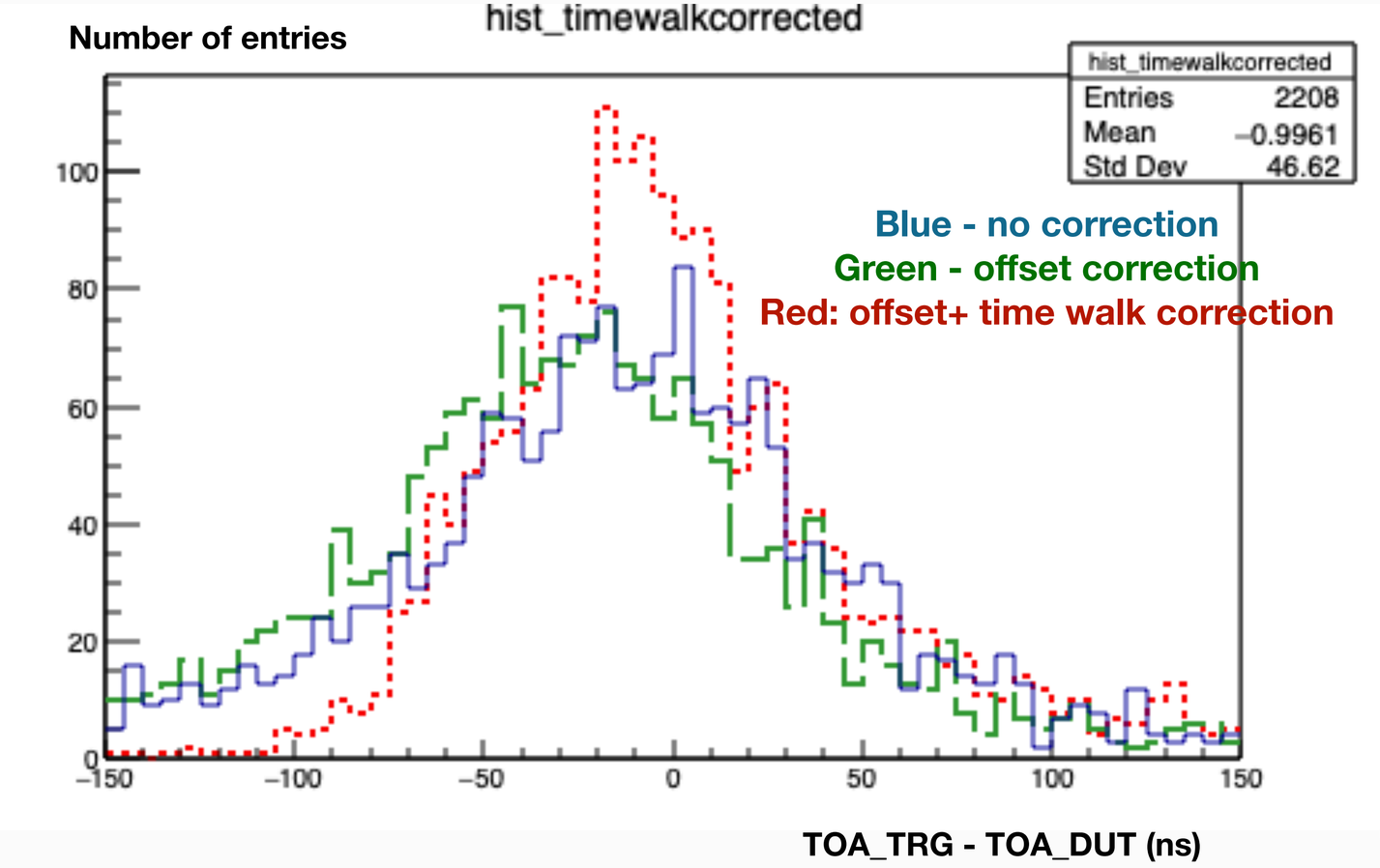
- Next step: Time walk correction

ToA vs. ToT (after offset and timewalk correction)





Timing resolution



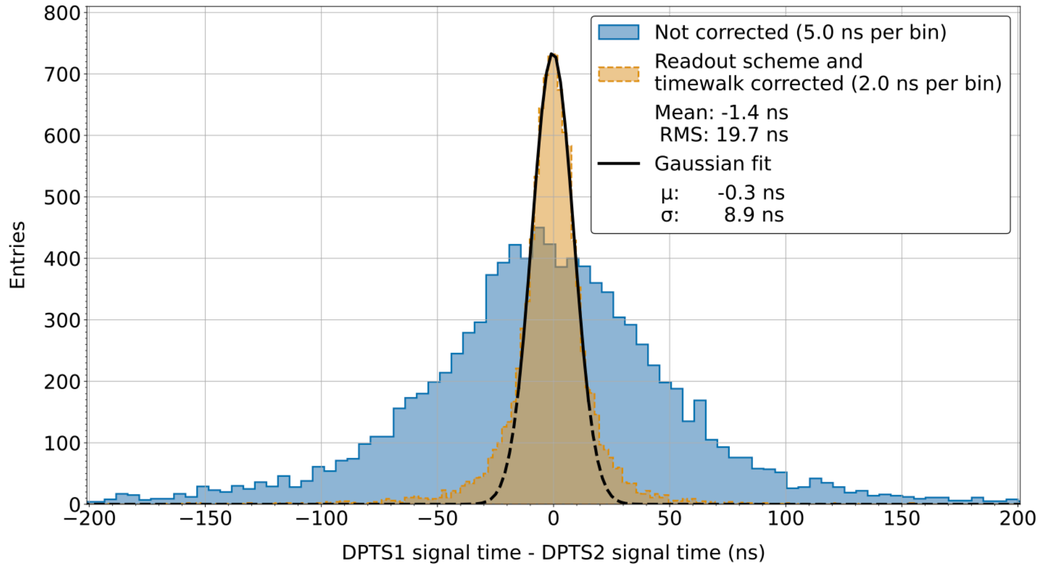
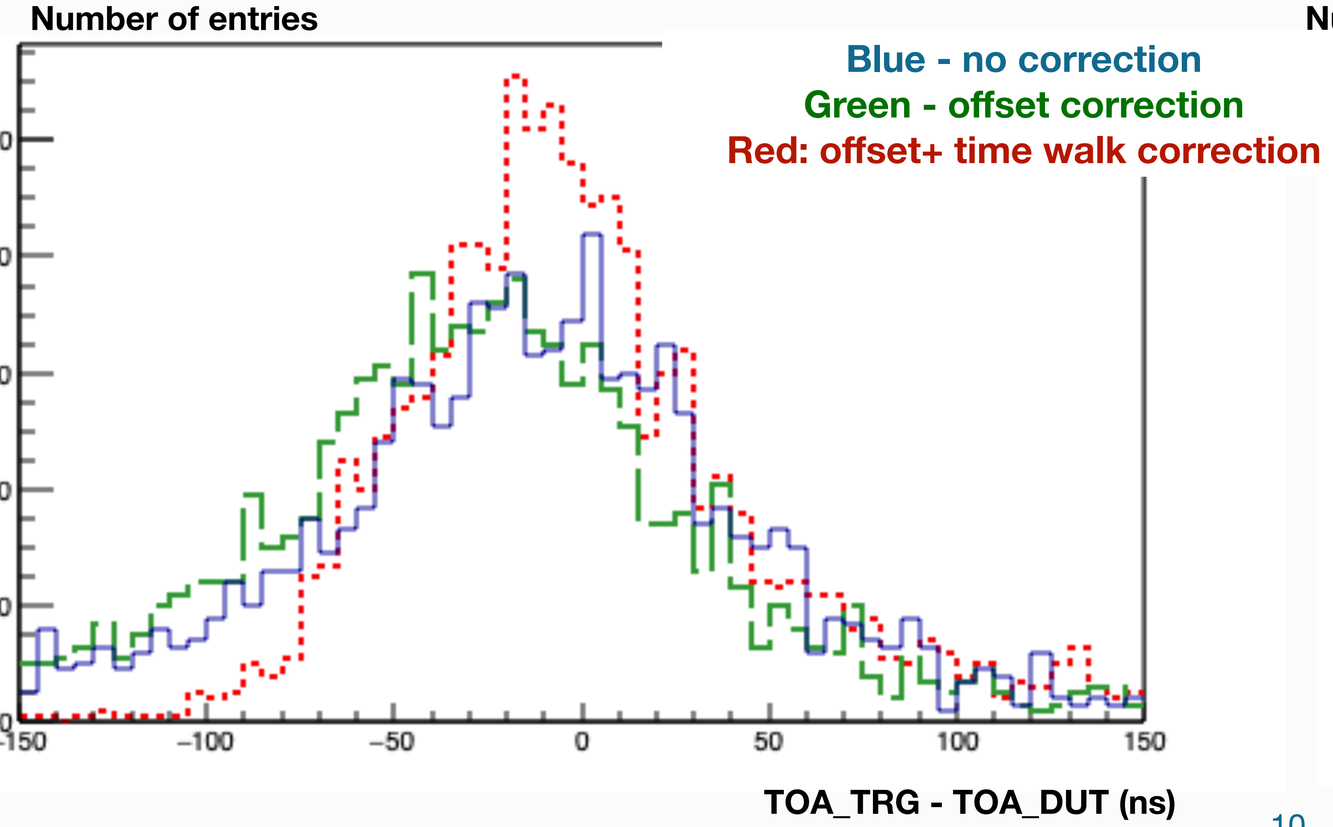
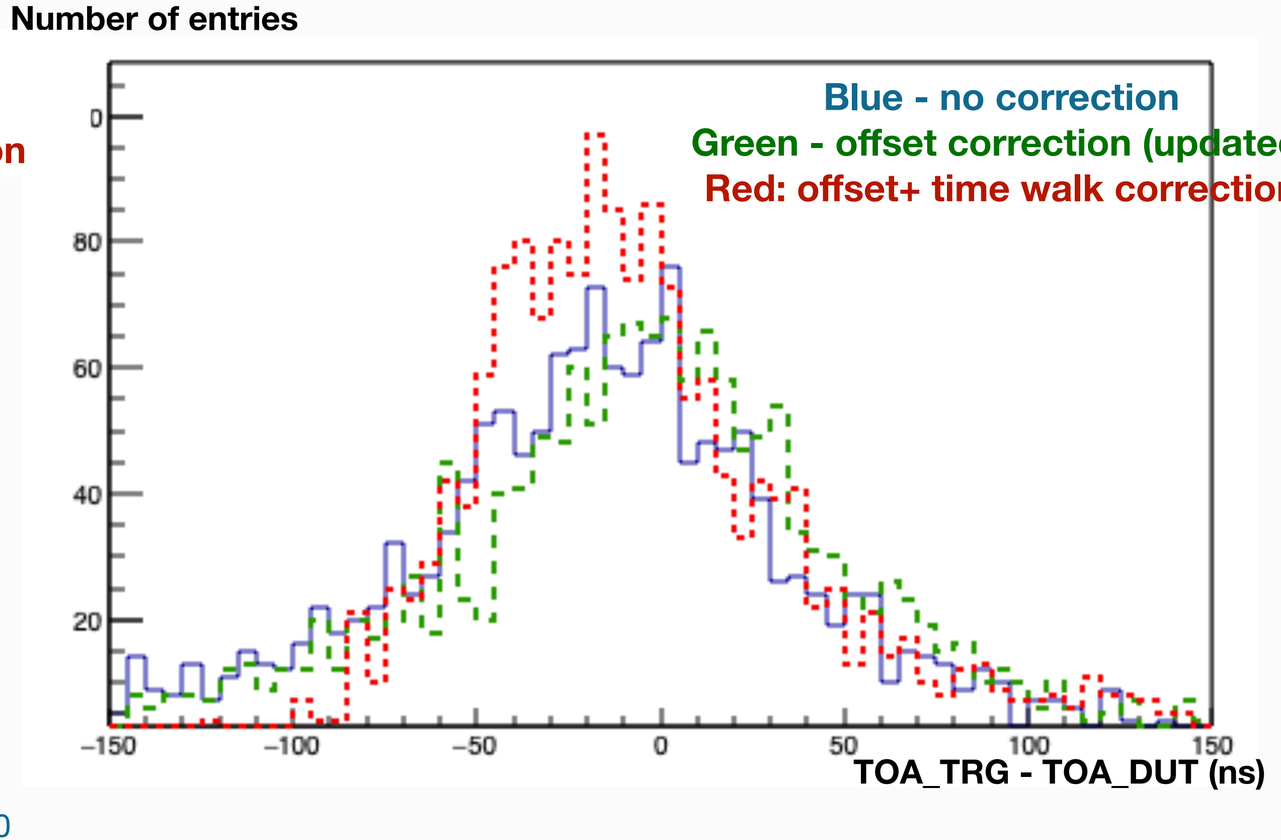


Figure 20: Time residuals distributions of two DPTSs measured with 5.4 GeV/c electrons w
no corrections (blue) and with readout scheme and time walk corrections applied (orang
The corrected distribution is fitted with a Gaussian function in the time residuals range fr
−15 ns to 15 ns (black solid line, dashed line for points outside the fit range).

To do

- Improve fit quality: Move to the sample with larger statistics (with a lower threshold (higher VCASB, say 350 mV))
- Update raw data processing (time and spatial cuts adjustment)





createmask.conf

```
[Corryvreckan]
log_level  = "INFO"
log_format = "DEFAULT"

detectors_file =  ""
histogram_file = ""

number_of_events = -1


detectors_file = "../geometry/2023-05-PS_3REF-2DPTS-3REF.conf"
detectors_file_updated = "../geometry/2023-05-PS_3REF-2DPTS-3REF_mask.conf"
histogram_file = "maskcreation.root"

[Metronome]
triggers=1

[EventLoaderEUDAQ2]
file_name = "/global/cfs/cdirs/alice/mjkim/BeamTest/DPTS/DPTSXW22B34/IBIAS100nA_opt/vbb1.2/vcasb200/run186223284_230507053506.raw"
# Here the most common train time cut values, to know the values for each setting see
# https://indico.cern.ch/event/1293487/contributions/5438206/attachments/2660321/4608454/WP3_06062023_CutOnTime.pdf
train_time_cut_low_ch0=1000
train_time_cut_high_ch0=4000
train_time_cut_low_ch1=1000
train_time_cut_high_ch1=4000

[MaskCreator]
frequency_cut=1000
```

prealign.conf

```
[Corryvreckan]

detectors_file = "../geometry/2023-05-PS_3REF-2DPTS-3REF_mask.conf"
detectors_file_updated = "../geometry/2023-05-PS_3REF-2DPTS-3REF_prealign.conf"
histogram_file = "prealign.root"

number_of_events = -1

[Metronome]
triggers=1

[EventLoaderEUDAQ2]
file_name = "/global/cfs/cdirs/alice/mjkim/BeamTest/DPTS/DPTSXW22B34/IBIAS100nA_opt/vbb1.2/vcasb200/run186223284_230507053506.raw"
# Here the most common train time cut values, to know the values for each setting see
# https://indico.cern.ch/event/1293487/contributions/5438206/attachments/2660321/4608454/WP3_06062023_CutOnTime.pdf
train_time_cut_low_ch0=1000
train_time_cut_high_ch0=4000
train_time_cut_low_ch1=1000
train_time_cut_high_ch1=4000

[Clustering4D]
time_cut_abs=10s
charge_weighting=true
reject_by_roi=true

[Correlations]
do_time_cut=false

[Prealignment]
method = gauss_fit
fit_range_rel = 200
max_correlation_rms=6mm
time_cut_abs = 1e99
```

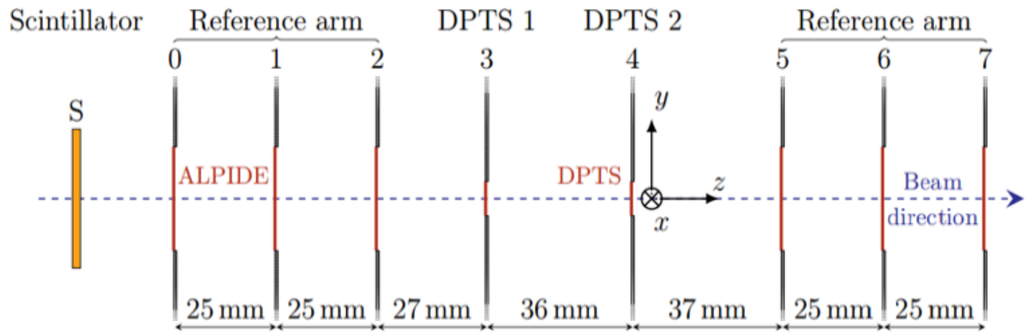
Test setup

- 2023-May @ PS: https://twiki.cern.ch/twiki/bin/viewauth/ALICE/ITS3WP3PS2023May

Telescope B2 - DPTS

Position	Designation	z [mm]	Proximity board	DAQ Board	Serial Number	Chip Serial	ChipID	Vbb[V]	Thickness [µm]	VCLIP	ITHR	VCASN	VCASN2	Threshold
1	ALPIDE_0	0		MLR1-026	DAQ-00090101054B3009	705691W04R36	16	-3.0	50	60	60	110	122	10.10 ± 1.61
2	ALPIDE_1	25		daq-fs-99	DAQ-000904250102133C	?	16	-3.0	50	60	60	109	121	9.88 ± 1.73
3	ALPIDE_2	50		daq-fs-130	DAQ-000909250959071E	700789W10R07	16	-3.0	50	60	60	110	122	10.29 ± 1.38
4	DPTS_1	77	DPTS-010	MLR1-043	DAQ-00090101054B2107	DPTSOW22B6		-1.2						
5	DPTS_0	113	DPTS-006	MLR1-005	DAQ-000901010542282A	DUT								
6	ALPIDE_3	150		MLR1-025	DAQ-00090101054B1F08	705691W04R37	16	-3.0	50	60	60	108	120	10.47 ± 1.87
7	ALPIDE_4	175		daq-fs-110	DAQ-00090611004E160B	700789W10R16	16	-3.0	50	60	60	107	119	9.58 ± 1.44
8	ALPIDE_5	200		daq-fs-132	DAQ-000909250959201E	T968879W04R05	16	-3.0	50	60	60	111	123	10.01 ± 1.77

- Sketch of the Testbeam setup with plane distances:



- DUT for this analysis: DPTSXW22B34

runs_B34

RunName	Momentum	RunEventLimit	Comment	DUT	TRG	VBB	VCASB	VCASN	IRESET	IBIAS
run186223284_230507053506.raw	10	10000	insert	DPTSXW22B34	DPTSOW22B6	1.2	200	600	5	1

align.conf

```
[Corryvreckan]
log_level  = "INFO"
log_format = "DEFAULT"


detectors_file = "../geometry/2023-05-
PS_3REF-2DPTS-3REF_prealign.conf"
detectors_file_updated = "../geometry/2023-05-
PS_3REF-2DPTS-3REF_align.conf"
histogram_file = "align.root"


[Metronome]
triggers=1

[EventLoaderEUDAQ2]
file_name = "/global/cfs/cdirs/alice/mjkim/BeamTest/DPTS/
DPTSXW22B34/IBIAS100nA_opt/vbb1.2/vcasb200/
run186223284_230507053506.raw"
# Here the most common train time cut values, to know the values
for each setting see
# https://indico.cern.ch/event/1293487/contributions/5438206/
attachments/2660321/4608454/WP3_06062023_CutOnTime.pdf
train_time_cut_low_ch0=1000
train_time_cut_high_ch0=4000
train_time_cut_low_ch1=1000
train_time_cut_high_ch1=4000

[Clustering4D]
time_cut_abs     = 10s
charge_weighting = true
reject_by_roi    = true

[Correlations]
do_time_cut=false
```

```
# To align everything together
[Tracking4D]
track_model          = "gbl"
time_cut_abs         = 1e99
spatial_cut_abs      = 0.5mm,0.5mm
require_detectors    = "ALPIDE_0", "ALPIDE_1",
"ALPIDE_2","DPTS_6","DPTS_7", "ALPIDE_3", "ALPIDE_4", "ALPIDE_5"
min_hits_on_track    = 8
exclude_dut          = false
momentum             = 10GeV
unique_cluster_usage = true  # only use a cluster for one track.
In case of multiple assignment, the track with the best chi2/ndof
is kept. Default to falsed
reject_by_roi        = true
max_plot_chi2        = 100    # default to 50

[AlignmentMillepede]
residual_cut         = 0.05mm
residual_cut_init    = 1mm
iterations           = 3
dofs                 = true, true, false, false, false, true
sigmas               = 50um, 50um, 50um, 0.005rad, 0.005rad,
0.005rad
exclude_dut          = false
number_of_stddev     = 0
convergence          = 10e-5
```

analysis.conf

```
[Corryvreckan]
log_level  = "INFO"
log_format = "DEFAULT"


detectors_file = "../geometry/2023-05-PS_3REF-2DPTS-3REF_align.conf"
histogram_file = "analysis.root"


number_of_events = -1

[Metronome]
triggers=1

[EventLoaderEUDAQ2]
file_name = "/global/cfs/cdirs/alice/mjkim/BeamTest/DPTS/DPTSXW22B34/
IBIAS100nA_opt/vbb1.2/vcasb200/run186223284_230507053506.raw"
eudaq_loglevel="INFO"
# Here the most common train time cut values, to know the values for
each setting see
# https://indico.cern.ch/event/1293487/contributions/5438206/
attachments/2660321/4608454/WP3_06062023_CutOnTime.pdf
train_time_cut_low_ch0=1000
train_time_cut_high_ch0=4000
train_time_cut_low_ch1=1000
train_time_cut_high_ch1=4000
#include_bad_trains=1 # for efficiency
include_bad_trains=0 # for spatial resolution, but in this case as we
are computing the in-pixel efficiency I keep this one!

[Clustering4D]
time_cut_abs     = 10s
charge_weighting = true  # if true, calculate a charge-weighted mean
for the cluster centre. If false, calculate the simple arithmetic
mean. Default to true
reject_by_roi    = true #MJ for debugging

[Correlations]
do_time_cut=false
```

```
[Tracking4D]
track_model          = "gbl"
time_cut_abs         = 1e99
spatial_cut_abs      = 0.5mm,0.5mm
min_hits_on_track    = 6
exclude_dut          = true
require_detectors    = "ALPIDE_0", "ALPIDE_1", "ALPIDE_2",
"ALPIDE_3", "ALPIDE_4", "ALPIDE_5"
momentum             = 10GeV
unique_cluster_usage = true  # only use a cluster for one
track. In case of multiple assignment, the track with the
best chi2/ndof is kept. Default to falsed
reject_by_roi    = true #MJ for debugging
max_plot_chi2        = 100

[FilterEvents]
max_tracks=1

[DUTAssociation]
spatial_cut_abs=480um,480um # for efficiency
#spatial_cut_abs=45um,45um # for spatial resolution
time_cut_abs=1e99
use_cluster_centre = true

[AnalysisDUT]
#time_cut_frameedge=1000s
chi2ndof_cut=3
n_time_bins = 200
spatial_cut_sensoredge=2
```

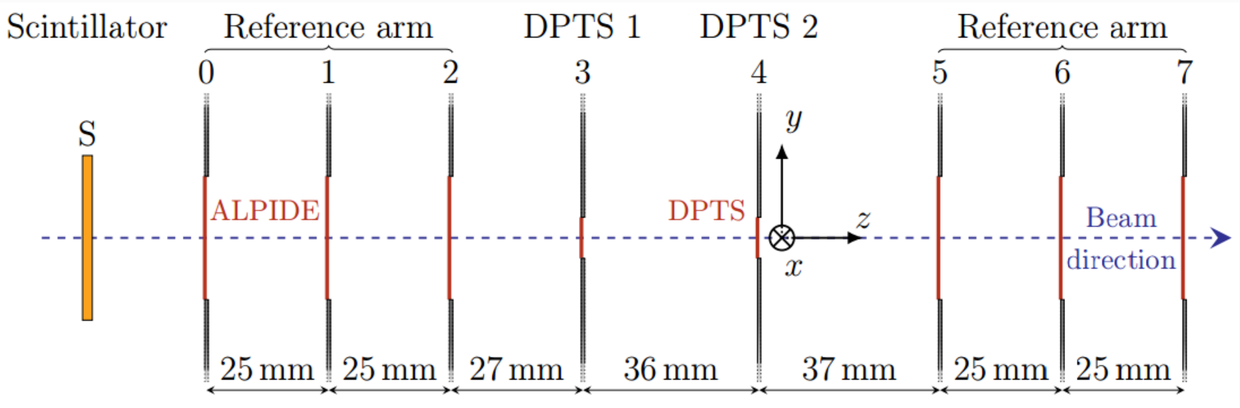
geometry.conf (2023-05-PS_3REF-2DPTS-3REF.conf)

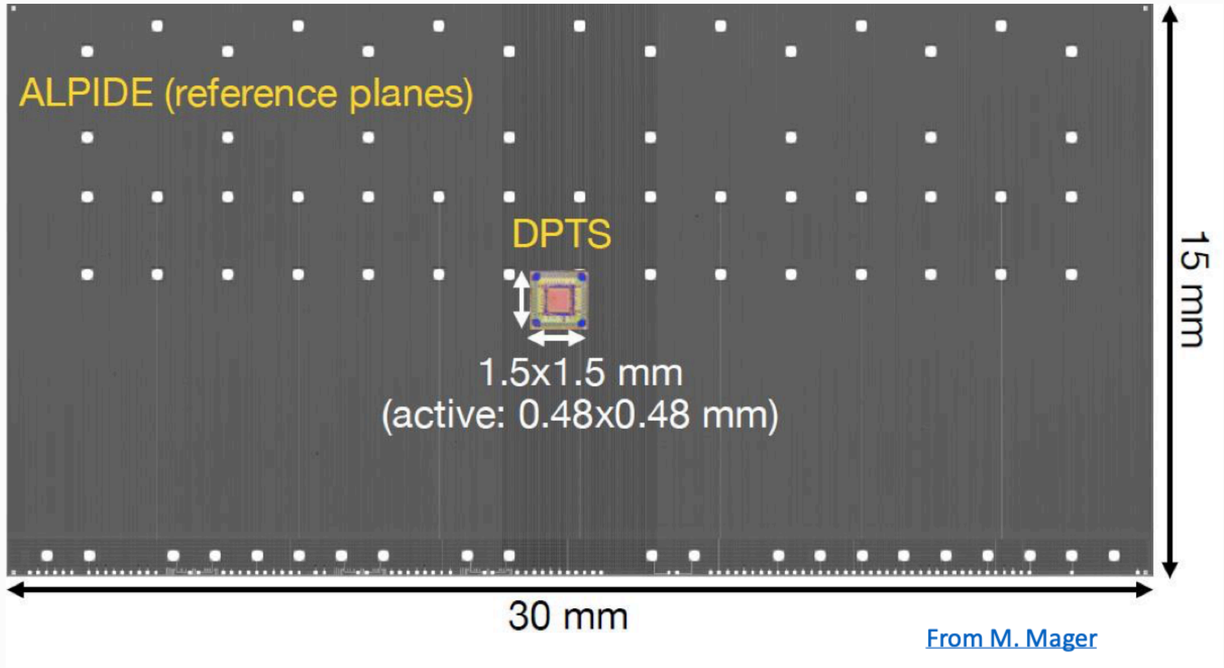
```
[ALPIDE_0]
type = "ALPIDE"
role = "reference"
number_of_pixels = 1024,512
position = 0um,0um,-113mm
pixel_pitch = 29.24um, 26.88um
spatial_resolution = 5.00um, 5.00um
time_resolution = 2us
material_budget = 0.0005
coordinates = "cartesian"
orientation_mode = xyz
mask_file = "../masks/ref-plane0.txt"
roi = [480,140], [480,270], [550,270], [550,140]

[ALPIDE_1]
type = "ALPIDE"
number_of_pixels = 1024,512
position = 0um,0um,-88mm
pixel_pitch = 29.24um, 26.88um
spatial_resolution = 5.00um, 5.00um
time_resolution = 2us
material_budget = 0.0005
coordinates = "cartesian"
orientation_mode = xyz
mask_file = "../masks/ref-plane1.txt"
roi = [465,165], [465,280], [540,280], [540,165]

[ALPIDE_2]
type = "ALPIDE"
number_of_pixels = 1024,512
position = 0um,0um,-63mm
pixel_pitch = 29.24um, 26.88um
spatial_resolution = 5.00um, 5.00um
time_resolution = 2us
material_budget = 0.0005
coordinates = "cartesian"
orientation_mode = xyz
mask_file = "../masks/ref-plane2.txt"
roi = [495,180], [495,270], [550,270], [550,180]
```

```
[DPTS_7]
type = "DPTS"
role = "dut"
number_of_pixels = 32,32
position = 0um,0um,-36mm
pixel_pitch = 15um, 15um
spatial_resolution = 3.87um, 3.87um
time_resolution = 2us
material_budget = 0.0005
coordinates = "cartesian"
orientation = 0deg,0deg,90deg
orientation_mode = xyz
mask_file = "../masks/trg-plane7.txt"
#calibration_file = "../calibration/2023-05_PS/
DPTSxxW22Bx/2023-05_PS_Bxx_BB6_x.xV_Xx.calib"
calibration_file = "/global/cfs/cdirs/alice/mjkim/
BeamTest/DPTS/testbeam_analysis_tools/configs/2023-05-
CERN-PS/calibration/2023-05_PS_B34_B6_1.2V_new.calib"

[DPTS_6]
type = "DPTS"
role = "dut"
number_of_pixels = 32,32
position = 0um,0um,0mm
pixel_pitch = 15um, 15um
spatial_resolution = 3.87um, 3.87um
time_resolution = 2us
material_budget = 0.0005
coordinates = "cartesian"
orientation = 0deg,0deg,90deg
orientation_mode = xyz
mask_file = "../masks/dut-plane6.txt"
#calibration_file = "../calibration/2023-05_PS/
DPTSxxW22Bx/2023-05_PS_Bxx_BB6_x.xV_Xx.calib"
calibration_file = "/global/cfs/cdirs/alice/mjkim/
BeamTest/DPTS/testbeam_analysis_tools/configs/2023-05-
CERN-PS/calibration/2023-05_PS_B34_B6_1.2V_new.calib"
```

```
[ALPIDE_3]
type = "ALPIDE"
number_of_pixels = 1024,512
position = 0um,0um,37mm
pixel_pitch = 29.24um, 26.88um
spatial_resolution = 5.00um, 5.00um
time_resolution = 2us
material_budget = 0.0005
coordinates = "cartesian"
orientation_mode = xyz
mask_file = "../masks/ref-plane3.txt"
roi = [490,235], [490,345], [560,345], [560,235]

[ALPIDE_4]
type = "ALPIDE"
number_of_pixels = 1024,512
position = 0um,0um,62mm
pixel_pitch = 29.24um, 26.88um
spatial_resolution = 5.00um, 5.00um
time_resolution = 2us
material_budget = 0.0005
coordinates = "cartesian"
orientation_mode = xyz
mask_file = "../masks/ref-plane4.txt"
roi = [480,245], [480,365], [560,365], [560,245]

[ALPIDE_5]
type = "ALPIDE"
number_of_pixels = 1024,512
position = 0um,0um,87mm
pixel_pitch = 29.24um, 26.88um
spatial_resolution = 5.00um, 5.00um
time_resolution = 2us
material_budget = 0.0005
coordinates = "cartesian"
orientation_mode = xyz
mask_file = "../masks/ref-plane5.txt"
roi = [485,250], [485,380], [585,380], [585,250]
```

Beam test setup





From M. Mager

- ALPIDE telescope:
  - 3 planes before the Device(s) Under Test (DUT)
  - 3 planes after the DUT(s)
  - 2.5 cm distance between planes
  - 3 μm tracking resolution on the DUT plane
- DPTS 1 as TRG (DPTSOW22B6/Vbb = -1.2V)
- DPTS 2 as DUT:
  - DPTSOW22B7
  - DPTSXW22B34
- 10 - 12 GeV hadron beam @ PS