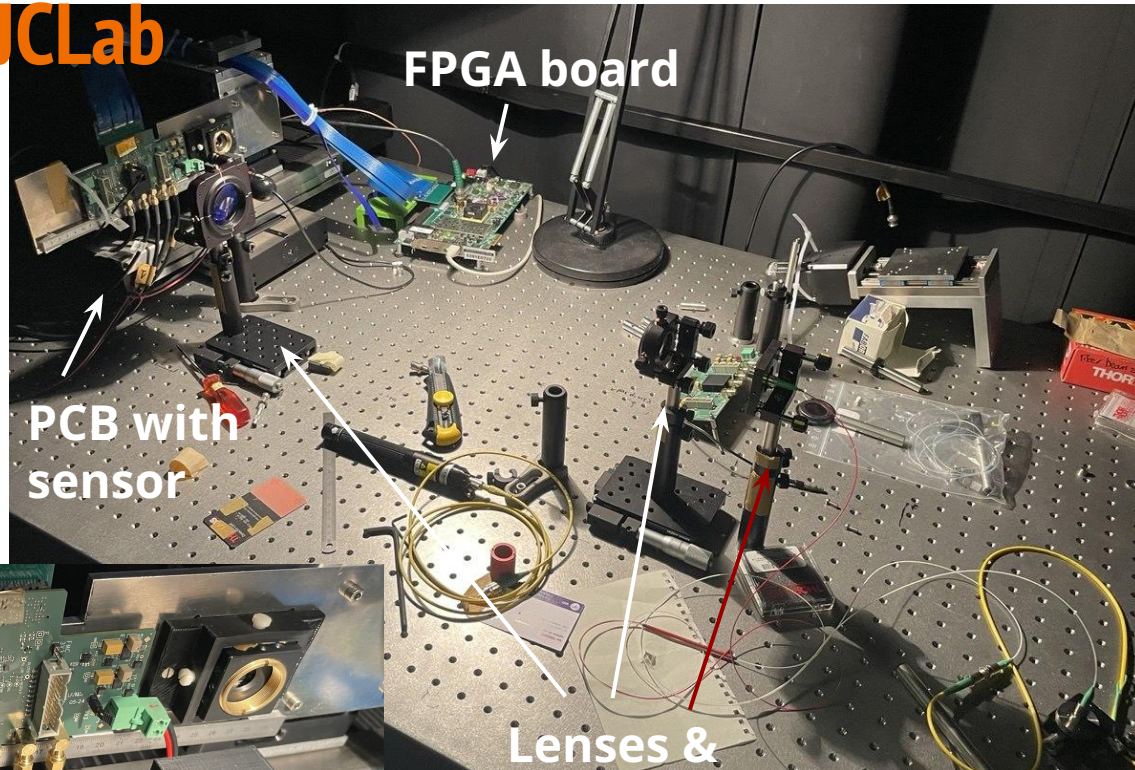
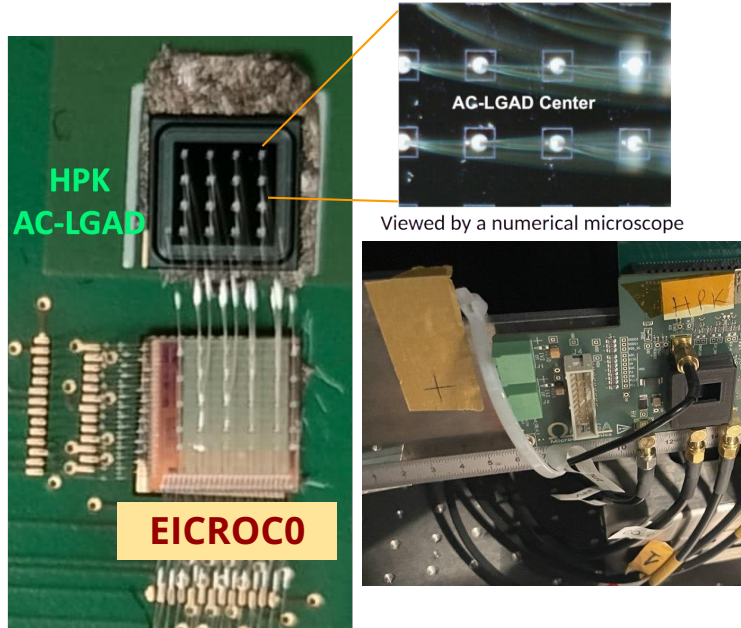

Analysis of EICROCO and EICROCOA

— Chiara Pinto, Dominique Marchand, Laurent Serin —
IJCLab

25 September 2026

Experimental setup @IJCLab

- **EICROCO**; PCB #2
- sensor: HPK wirebonded at KEK



pulsed infrared laser $\lambda = 1056 \text{ nm}$,
 $\phi \lesssim 20 \text{ mm}$

Also thanks to: O. Brand-Foissac, V. Chaumat, D. Hohov, A. Torrento

EICROCO

**Analysis of laser data at different
intensity (laser attenuation)**

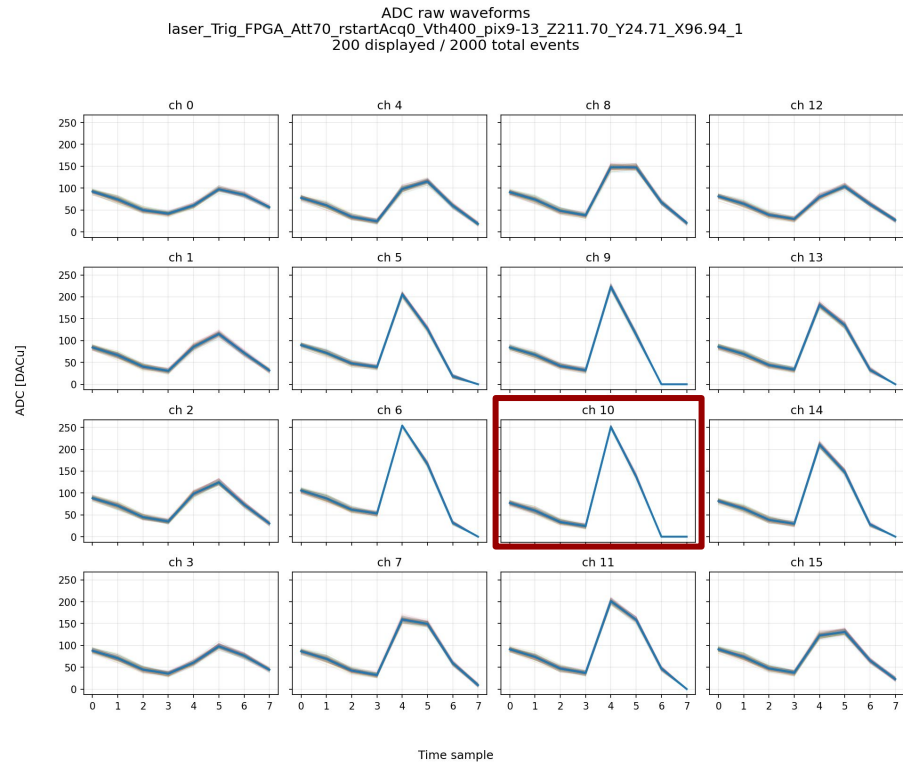
- goal: laser attenuation scan (from 70% to 87%)
- above 87% no data because we took data with $N = 0$ (1 trigout among 16 channels)

Analysis of:

- reconstructed positions,
- resolution of position reconstruction,
- TDC distributions (mean value and time jitter)

ADC raw distributions vs attenuation

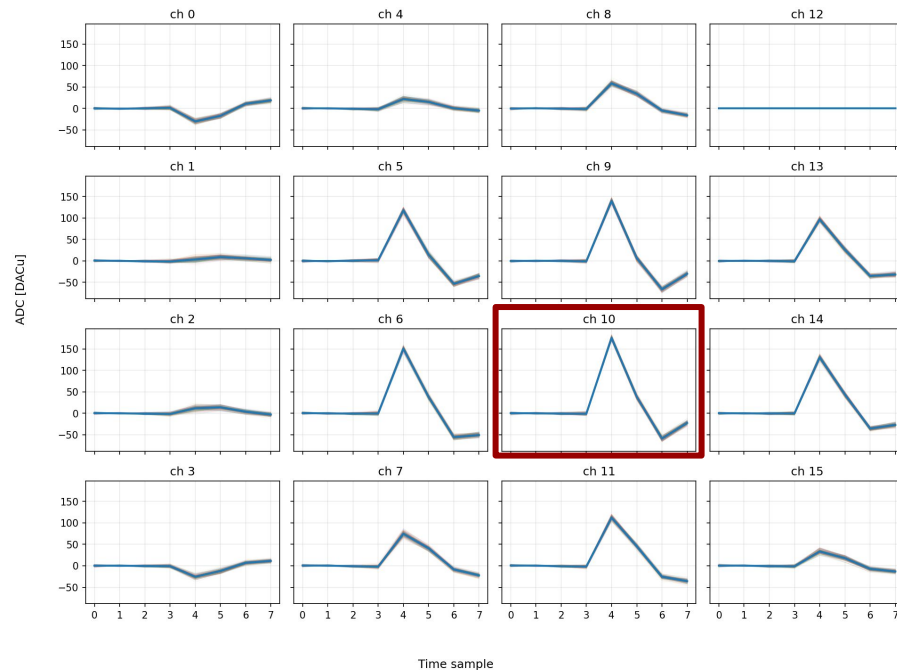
- raw distributions for different laser attenuation values
- 200 events are displayed, but mean (blue line) is obtained analysing 2000 events
- laser pointing on ch#10-ch#06; around is charge sharing
- positions in local coordinates of the table wrt laser: X = 96.94 mm; Y = 24.71 mm; Z = 211.7 mm



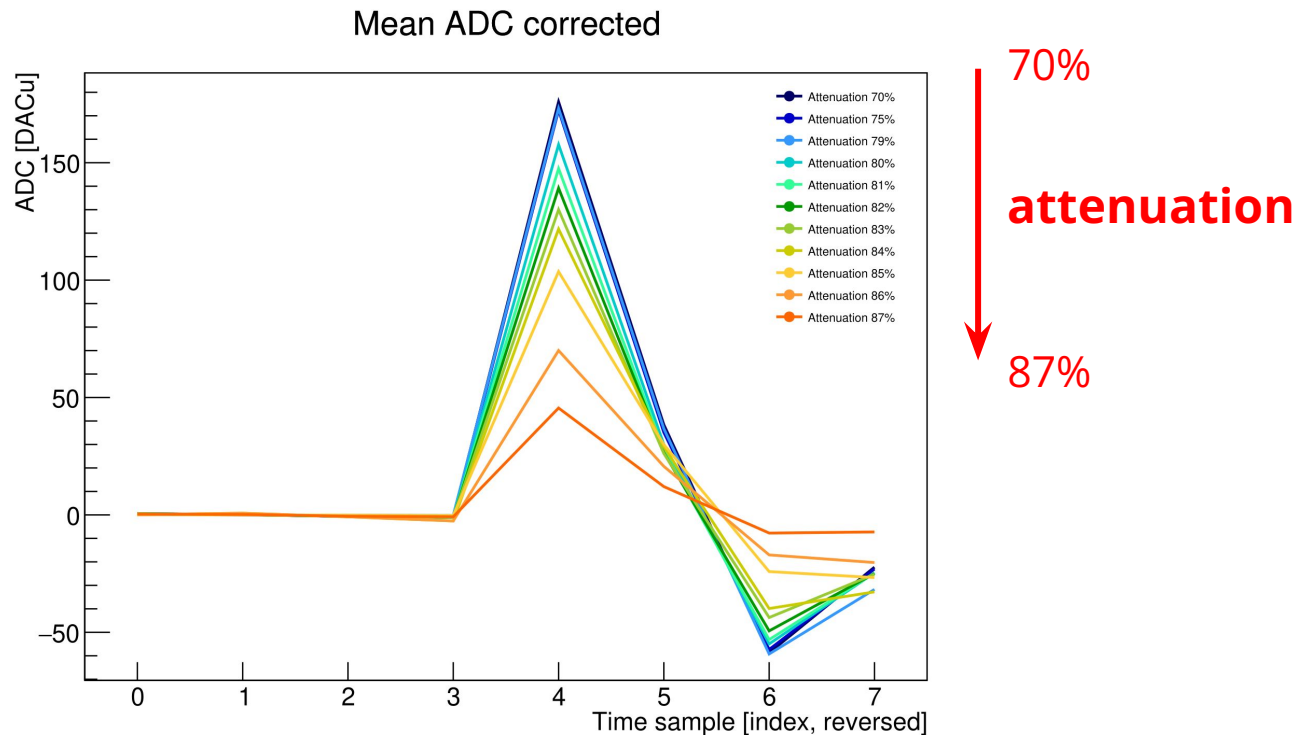
ADC corrected and shifted distributions vs attenuation

- after **pedestal subtraction**
using ch#0 or #12 as far pixel
- event-by-event **shift** of the ADC distribution, computed from the ADC mean of 3 first time samples to remove the common **baseline**
- laser pointing on ch#10-ch#06;
around is charge sharing
- positions in local coordinates of the table wrt laser: X = 96.94 mm; Y = 24.71 mm; Z = 211.7 mm

ADC after pedestal subtraction from ch 12 and event-by-event shift (TS 0,1,2)
laser_Trig_FPGA_Att70_rstartAcq0_Vth400_pix9-13_Z211.70_Y24.71_X96.94_1
200 displayed / 2000 total events



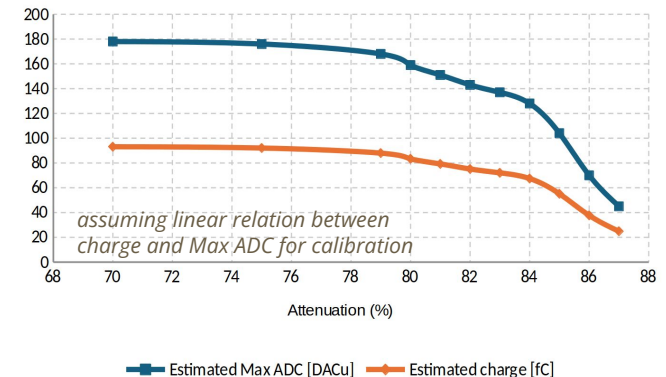
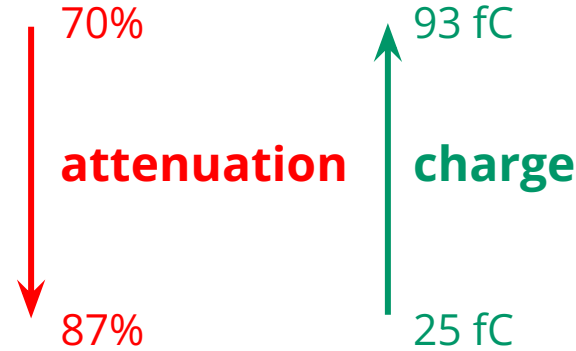
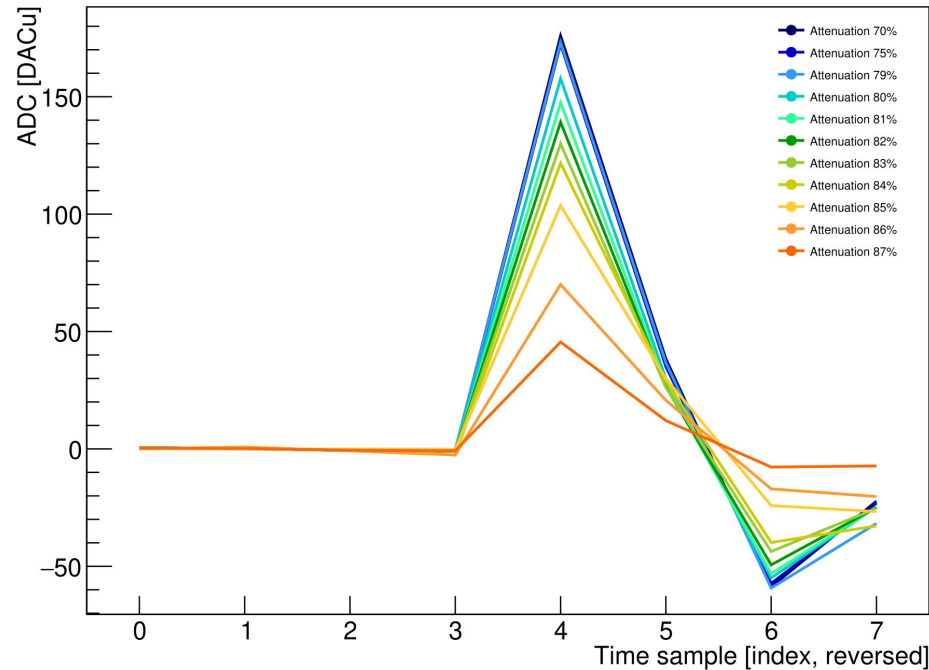
ADC corrected and shifted distributions



- Comparison of corrected ADC distributions in **ch#10** (laser pointed on)

ADC corrected and shifted distributions

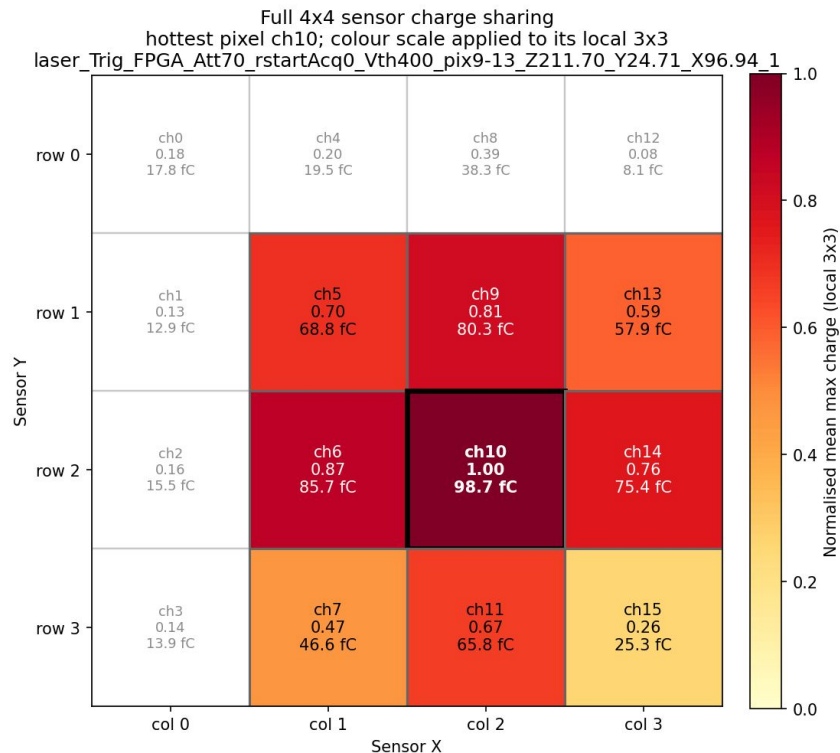
Mean ADC corrected



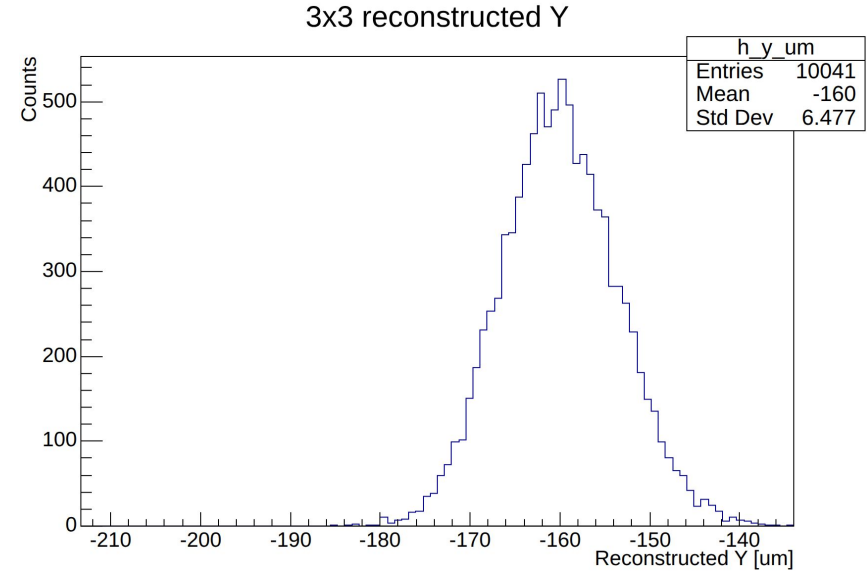
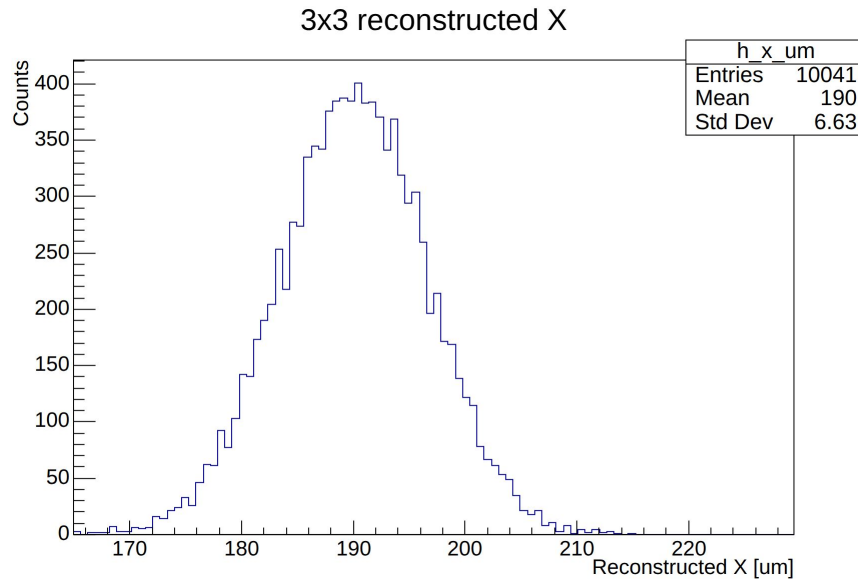
- Comparison of corrected ADC distributions in **ch#10** (laser pointed on)

Charge sharing

- charge sharing matrix 4x4 pixels
- laser pointing on ch#10; around is charge sharing
- Charge is computed using the max ADC and then converted to charge using a linear calibration
- Normalization is done such that the pixel with the largest mean charge is exactly 1; all other pixels are expressed relative to that pixel
- Need to compute normalization from the total charge in the full cluster/cross instead of 1 pixel



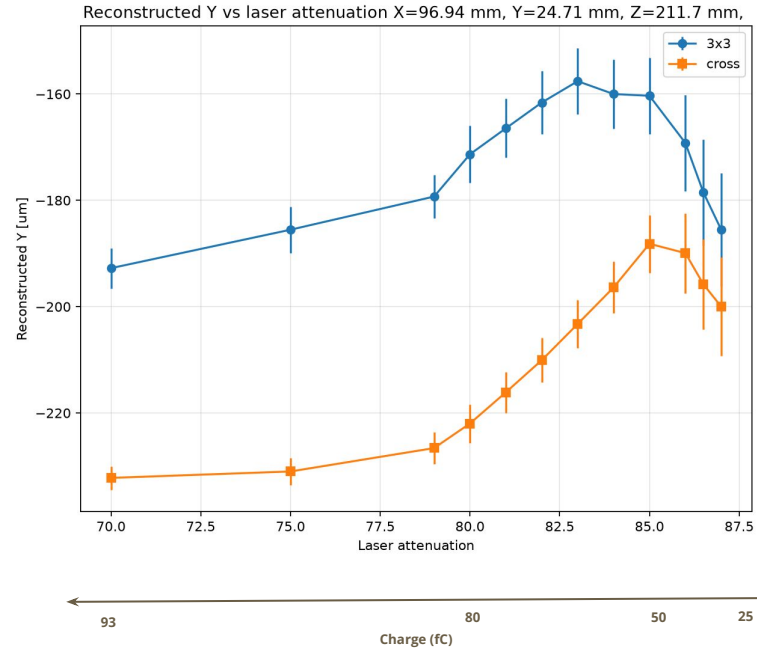
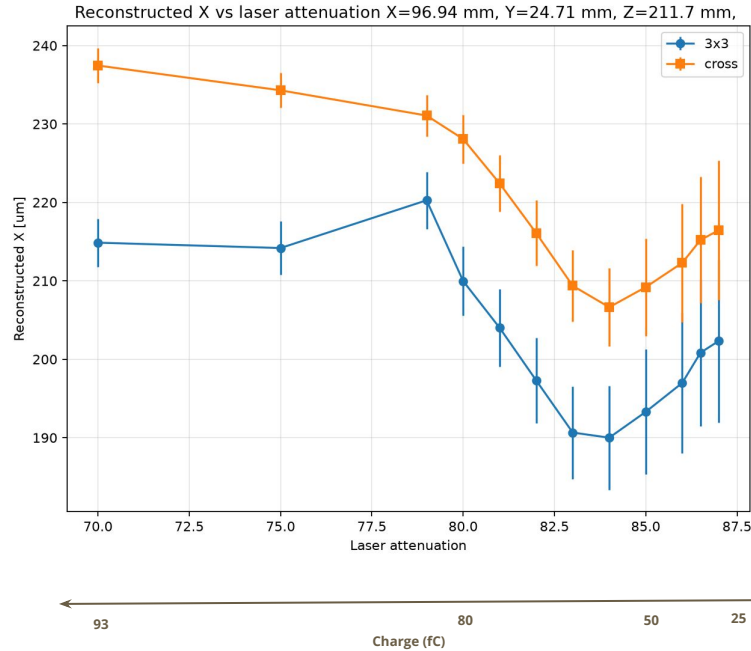
Reconstructed X and Y positions



- X and Y are reconstructed event by event as the charge-weighted barycentre of the 3x3 pixel cluster / cross using a 500um pixel pitch
- event-by-event positions fill the X and Y distributions, which are fitted with Gaussian functions: the fitted mean gives the reconstructed position and the fitted sigma characterizes its spatial spread

Reconstructed positions vs laser attenuation

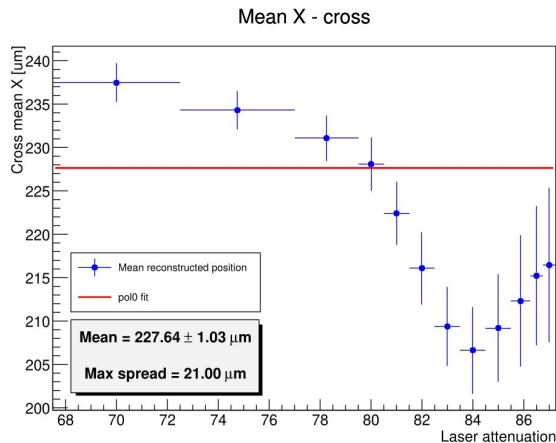
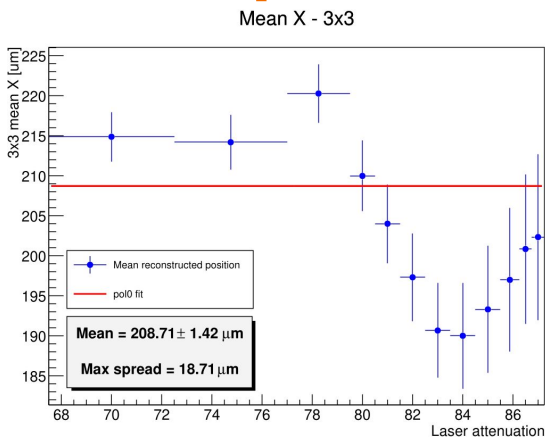
- Reconstructed positions in X and Y depend on the laser attenuation (!)



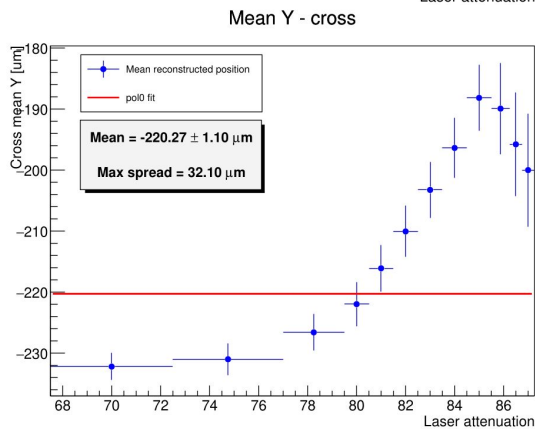
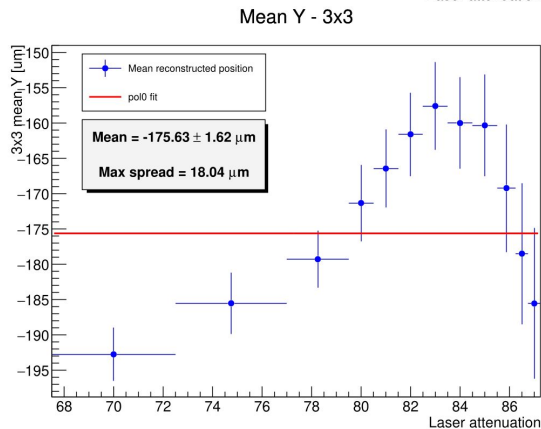
Reconstructed positions vs laser attenuation - fit results

EICROCO

X



Y



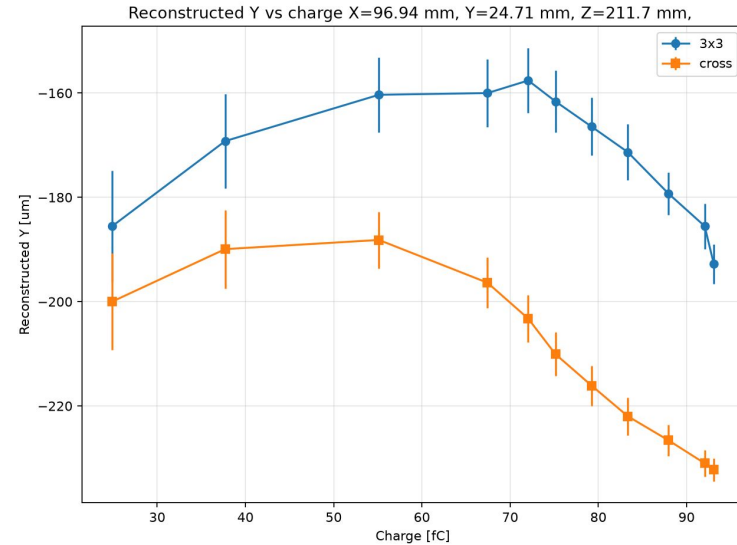
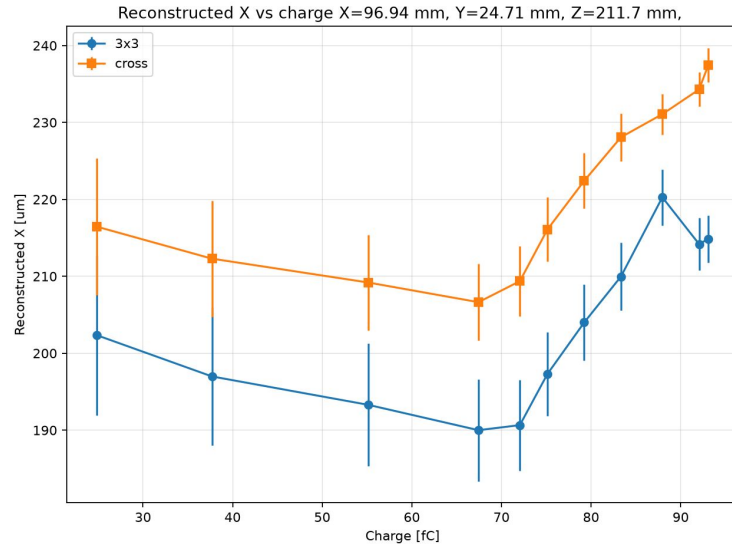
Fitted with a pol0
and computed
the max spread
wrt the mean
value

3x3

CROSS

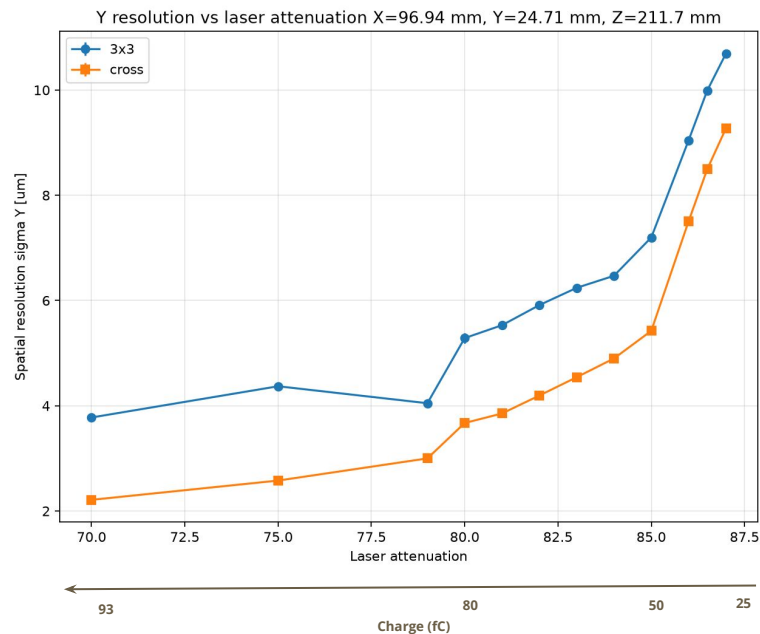
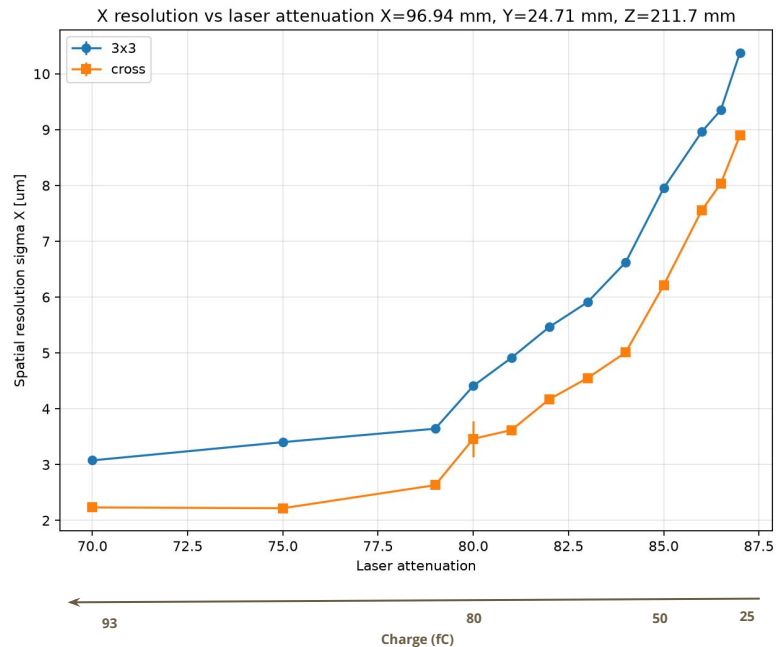
Reconstructed positions vs charge

- Reconstructed positions in X and Y vs charge



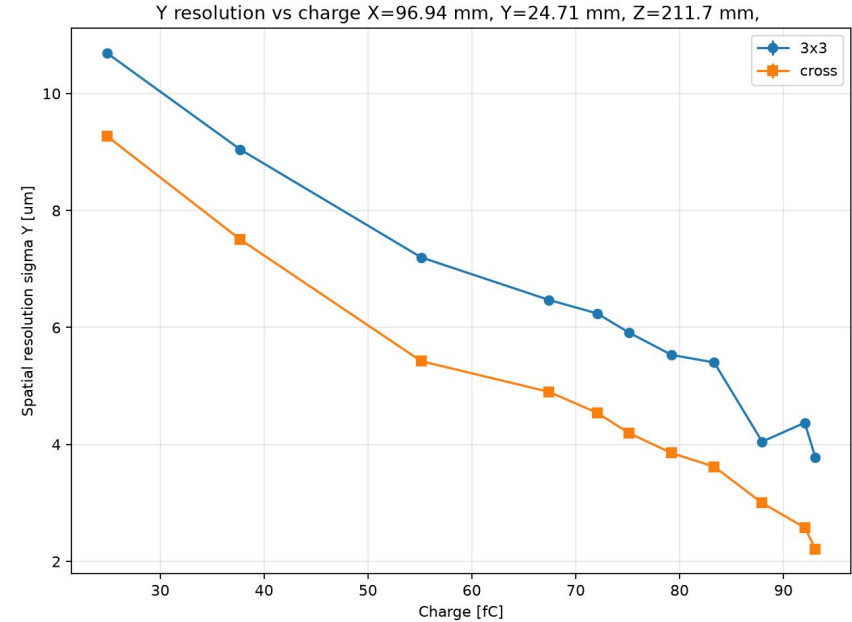
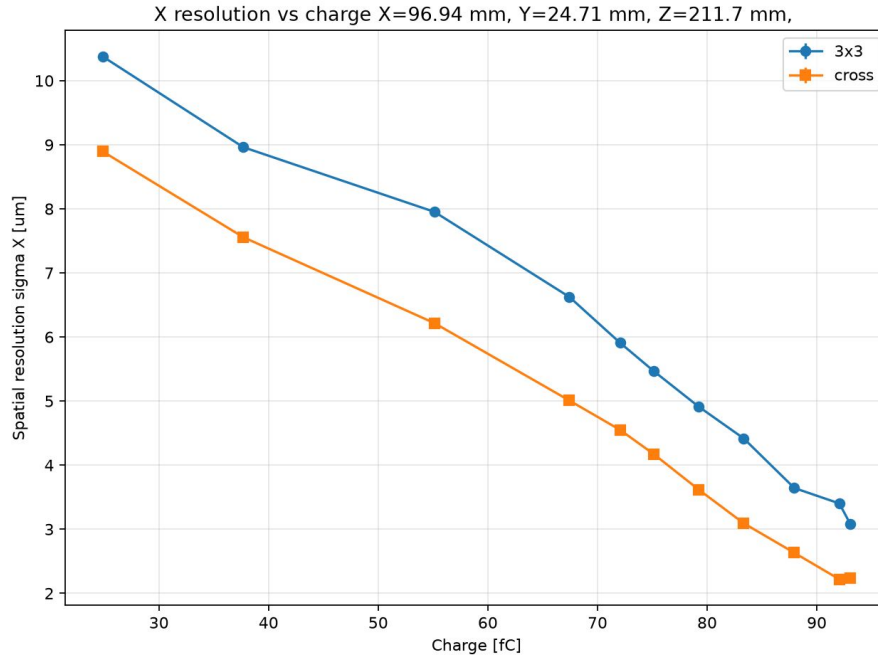
Spatial resolutions X and Y vs attenuation

- The spatial resolution is estimated from the width σ of the event-by-event reconstructed position distributions, using the two reconstruction methods: the 3×3 cluster and the cross methods



Spatial resolutions X and Y vs charge

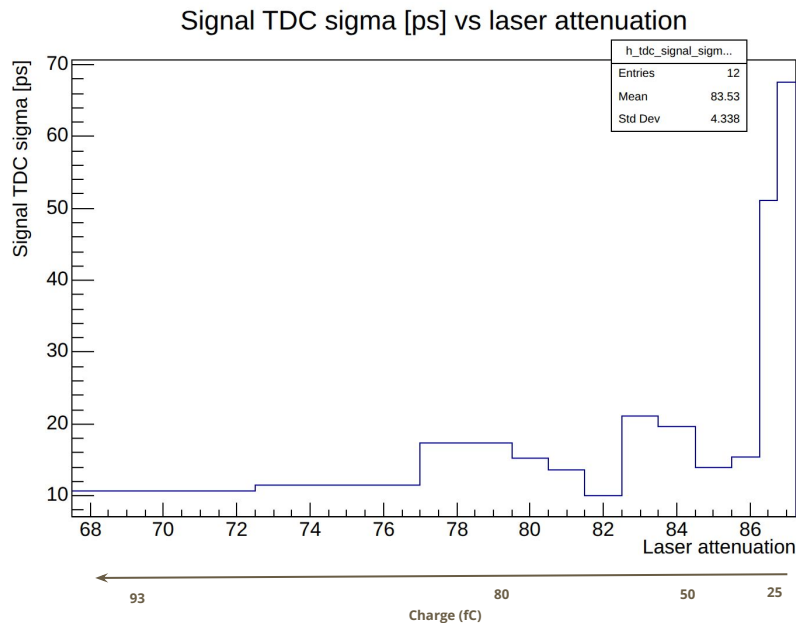
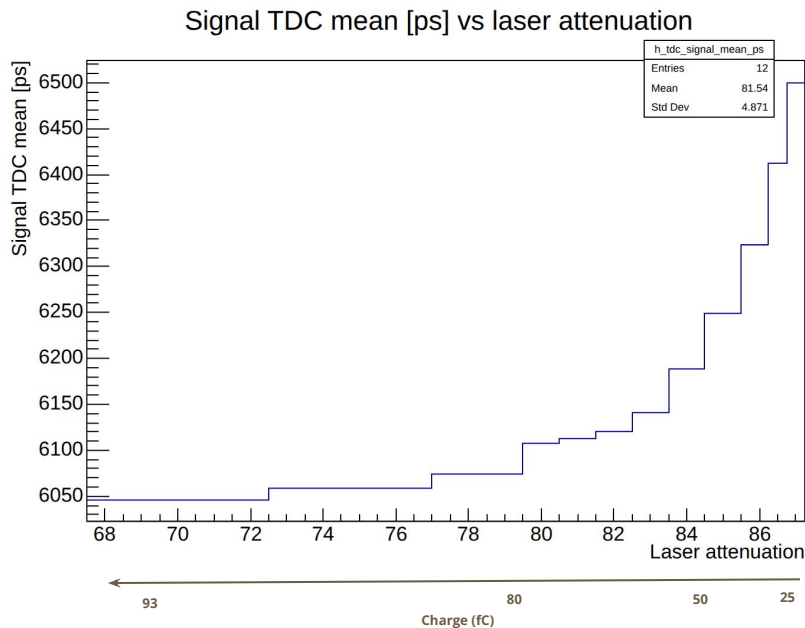
- The spatial resolution is estimated from the width σ of the event-by-event reconstructed position distributions, using the two reconstruction methods: the 3×3 cluster and the cross methods



TDC distribution mean and sigma vs laser attenuation

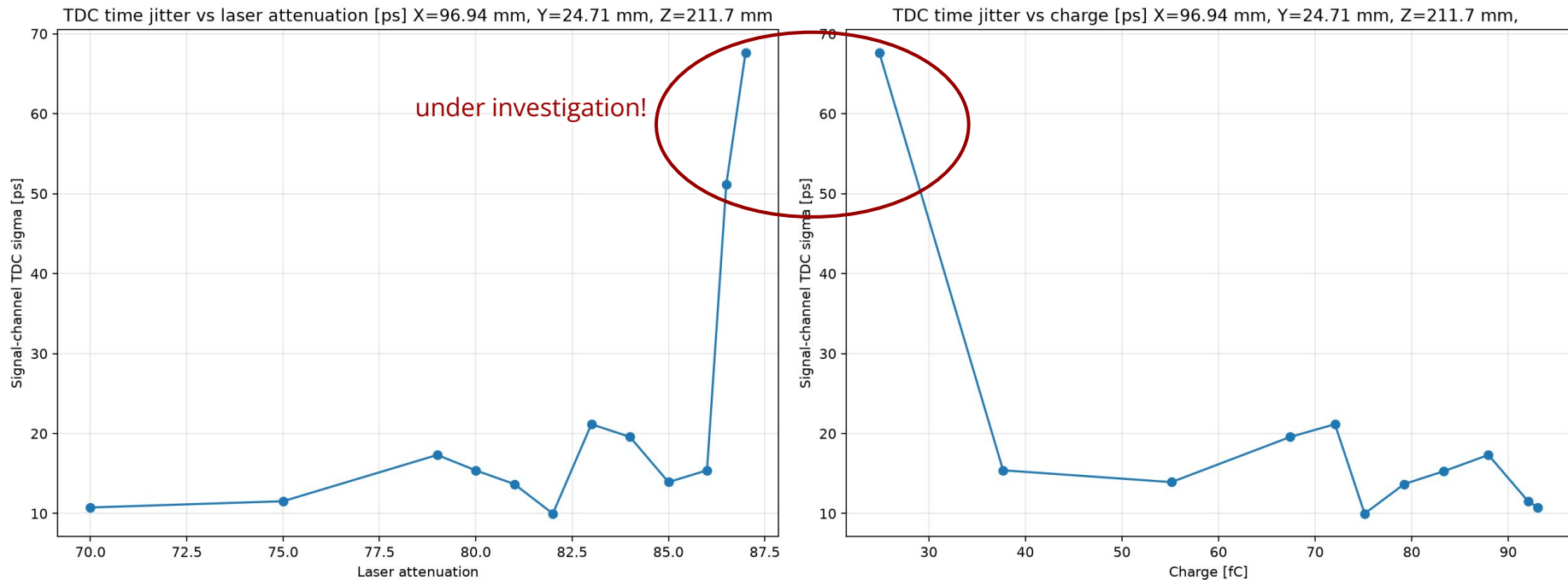
EICROCO

- The TDC distribution values are converted to ps (TDC units * 25 ps)



Time jitter TDC

- The time jitter is obtained from the width σ of the TDC distribution and converted to ps (TDC units * 25 ps)

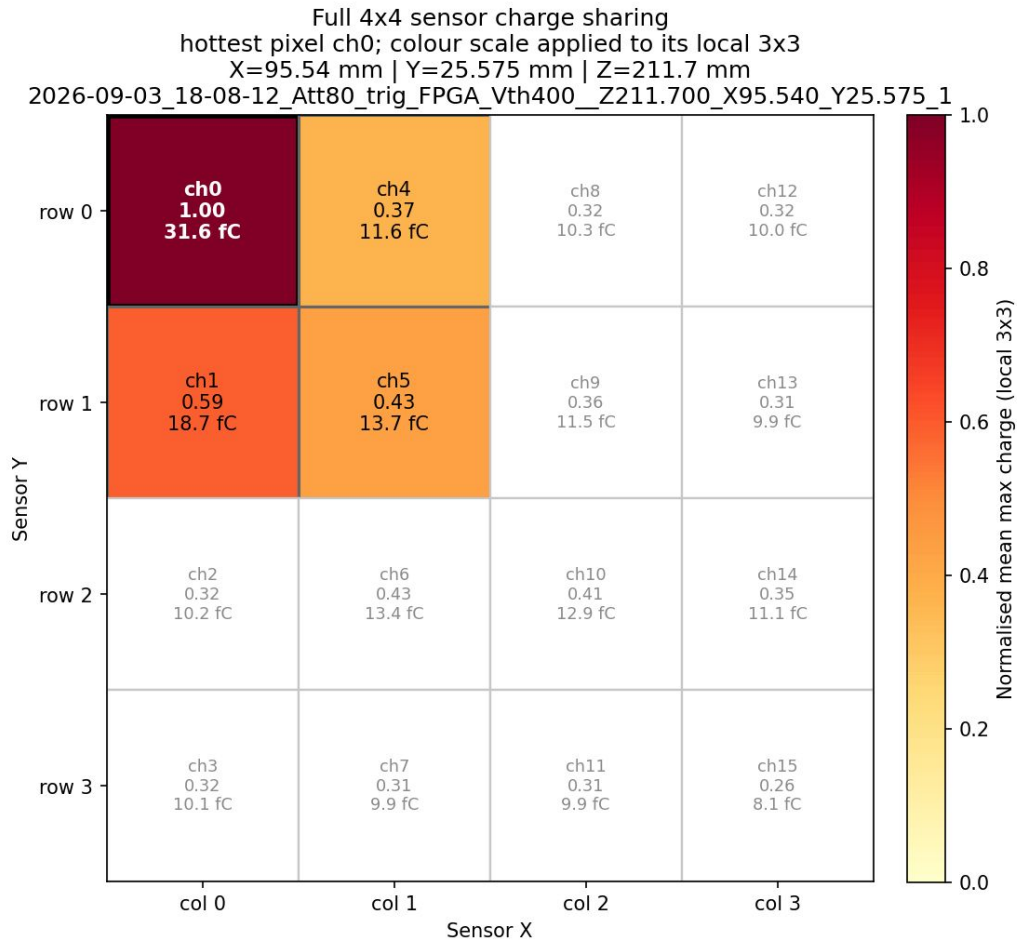


Next steps

- analysis ongoing for **position scan**
- we moved the laser between
(X=97.54, Y=25.55) mm

(X=95.54, Y=23.55) mm

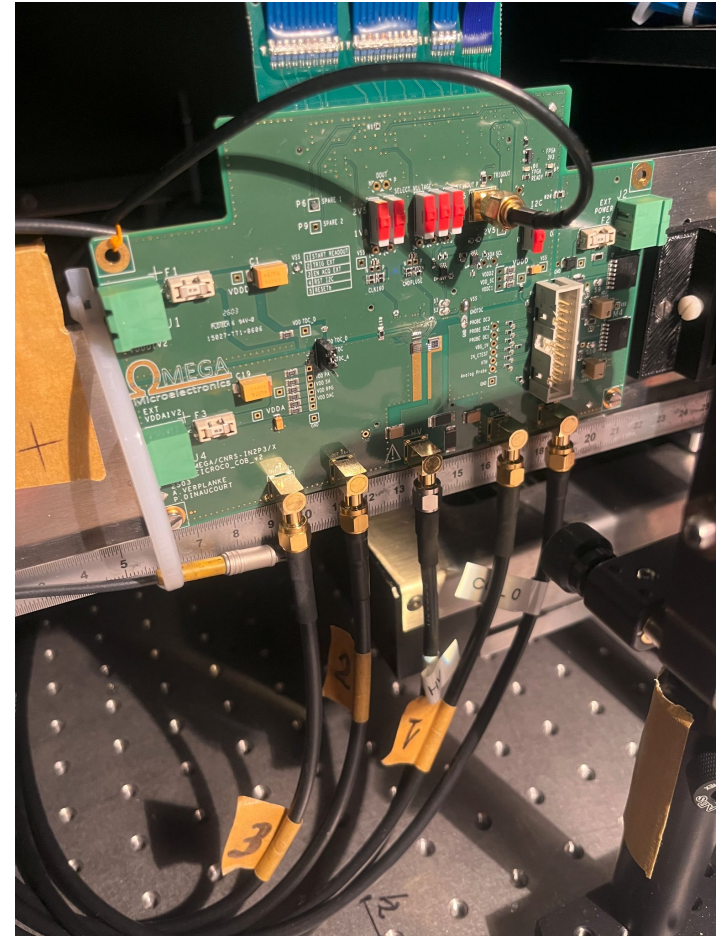
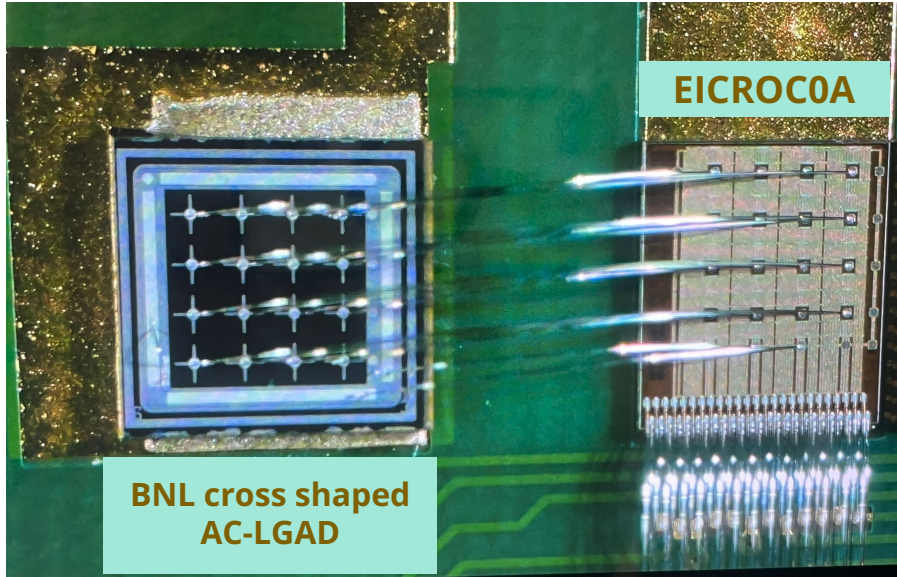
in steps of 25um in X and 200um in Y



EICROCOA

Experimental setup - II

- Installed in the same laser test bench setup
- **EICROCOA**; PCB #2
- sensor: BNL cross shaped AC-LGAD

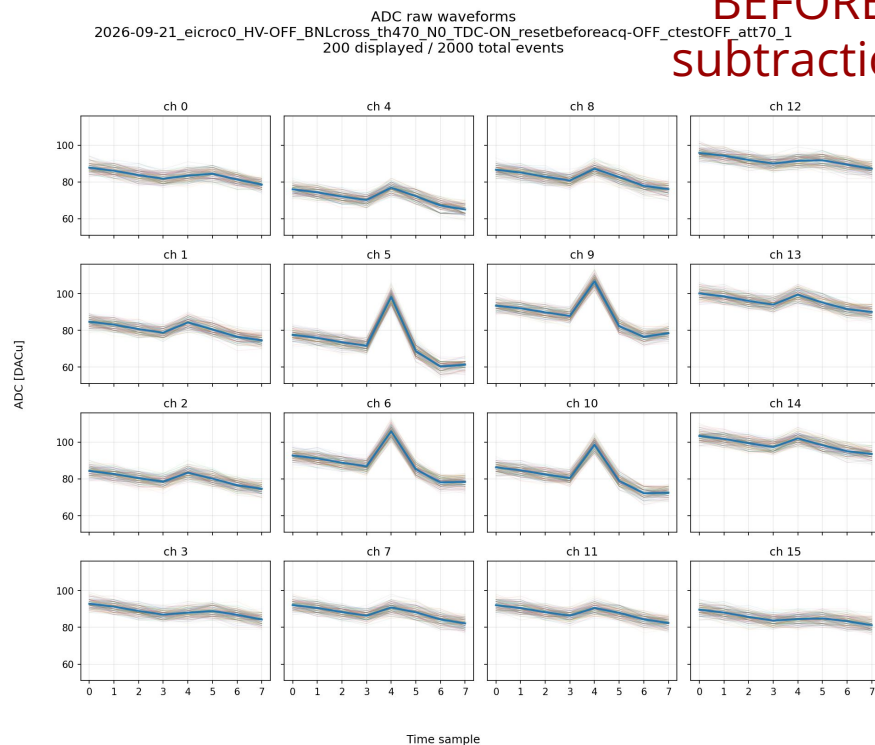


ADC WFs before and after pedestal subtraction (far pixel)

EICROCOA

- Laser attenuation = 70%

BEFORE
subtraction

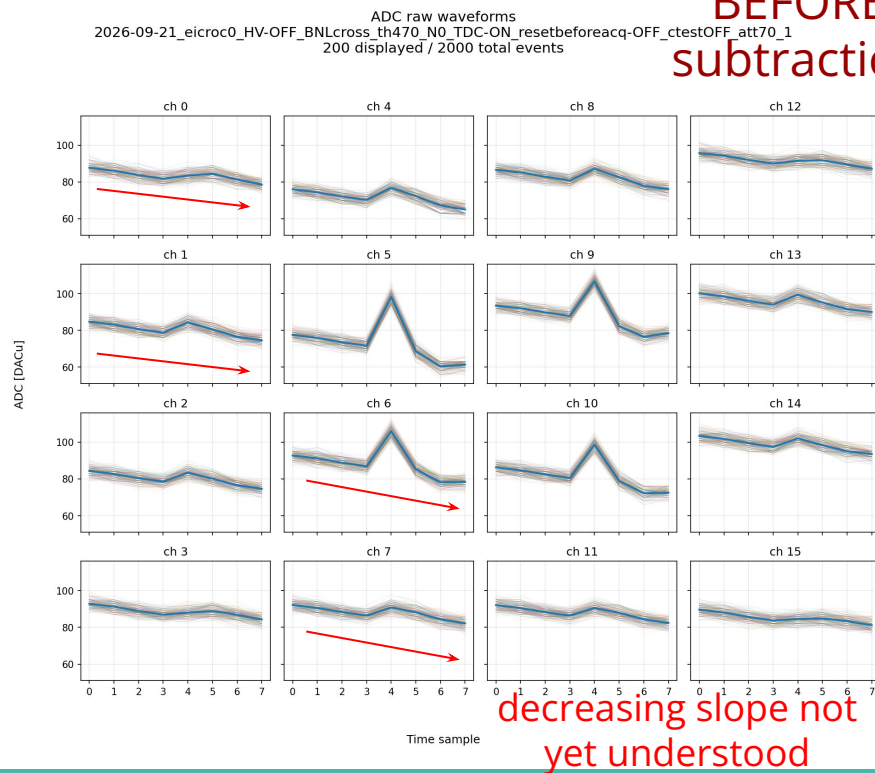


ADC WFs before and after pedestal subtraction (far pixel)

EICROCOA

- Laser attenuation = 70%

BEFORE
subtraction



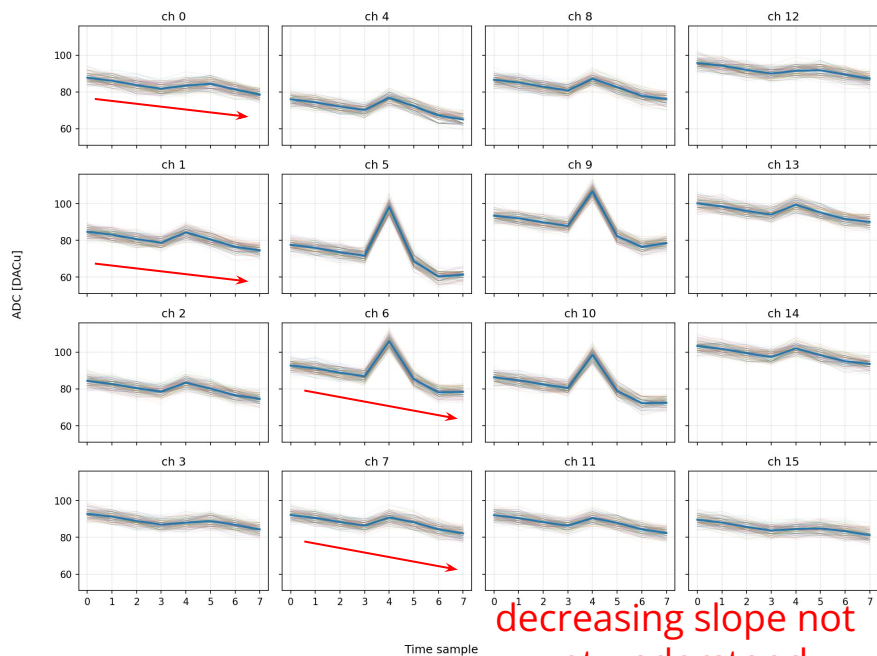
ADC WFs before and after pedestal subtraction (far pixel)

- Laser attenuation = 70%
- far pixel: ch #3

EICRO0A

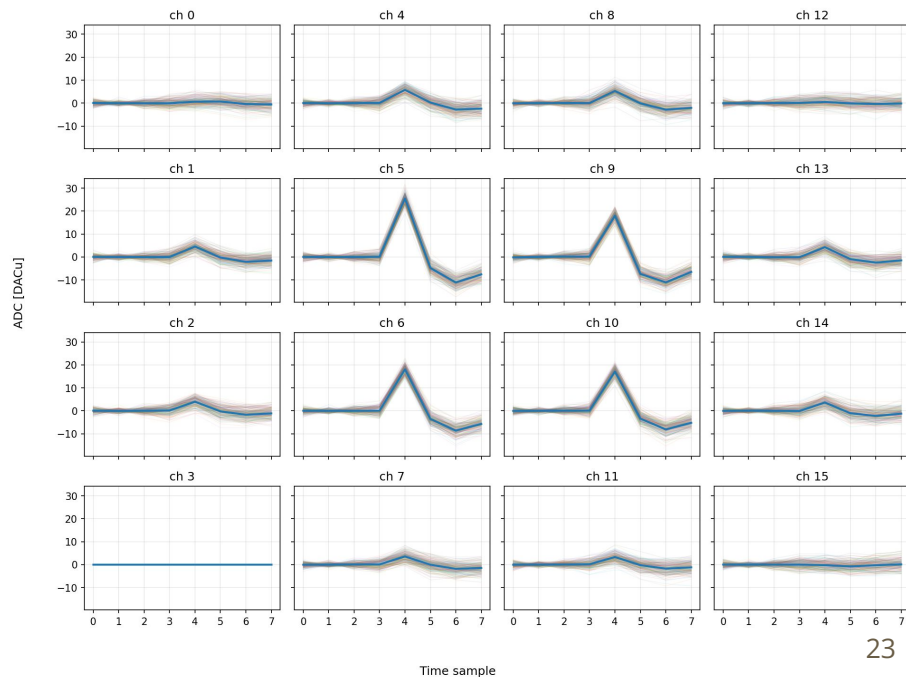
BEFORE
subtraction

ADC raw waveforms
2026-09-21_eicroc0_HV-OFF_BNLcross_th470_N0_TDC-ON_resetbeforeacq-OFF_ctestOFF_att70_1
200 displayed / 2000 total events



AFTER
subtraction

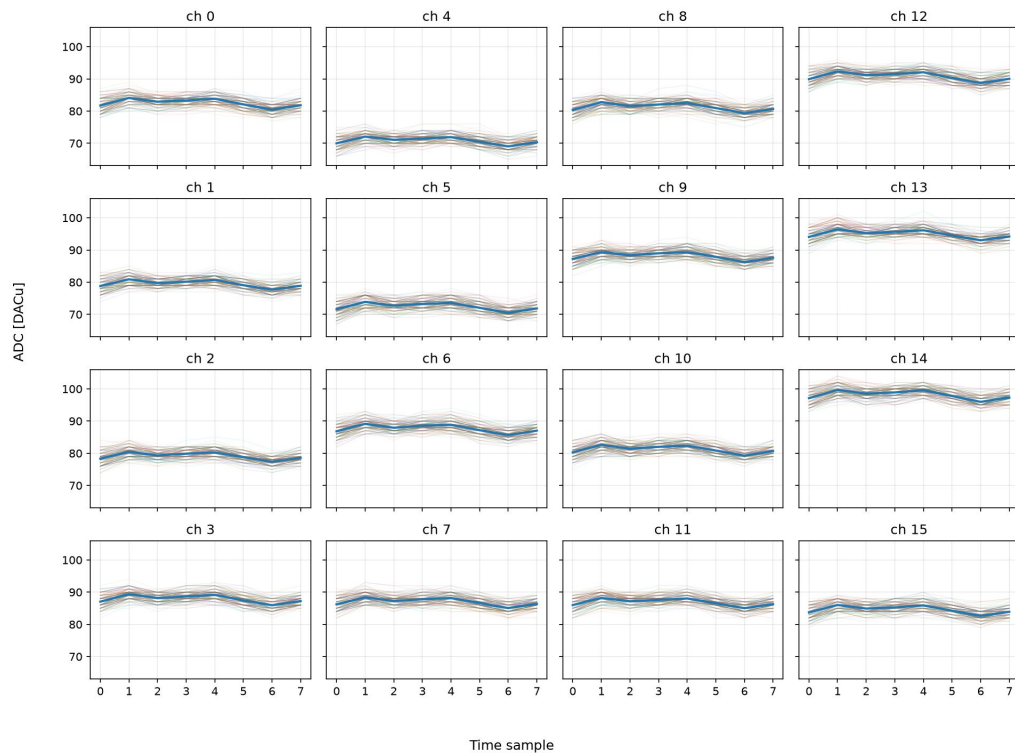
ADC after pedestal subtraction from ch 3 and event-by-event shift (TS 0,1,2)
2026-09-21_eicroc0_HV-OFF_BNLcross_th470_N0_TDC-ON_resetbeforeacq-OFF_ctestOFF_att70_1
200 displayed / 2000 total events



Raw ADC WFs – laser OFF

EICROC0A

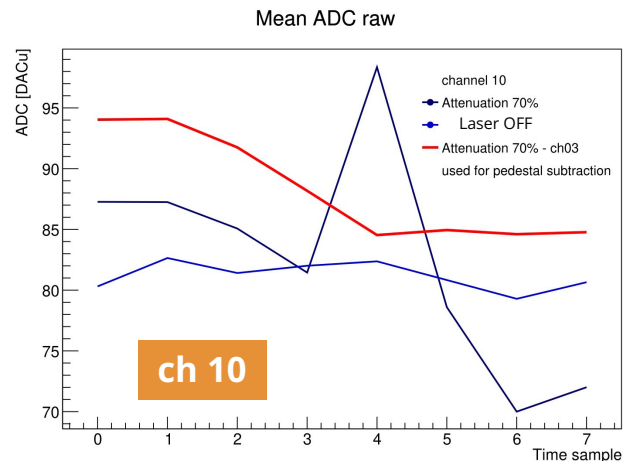
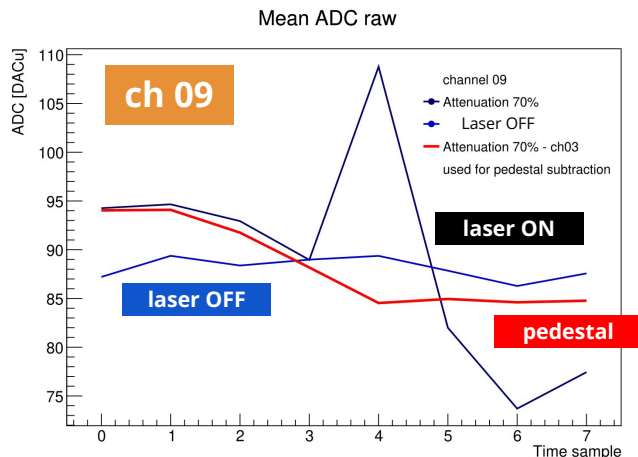
ADC raw waveforms
2026-09-21_eicroc0_HV-OFF_BNLcross_th470_N1000_TDC-ON_resetbeforeacq-OFF_ctestOFF_laserOFF_1
200 displayed / 1000 total events



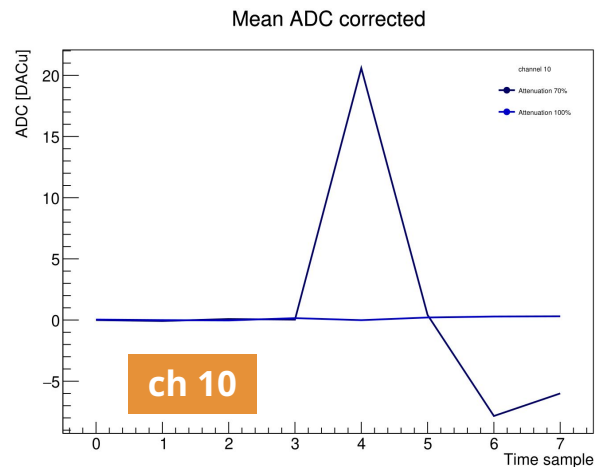
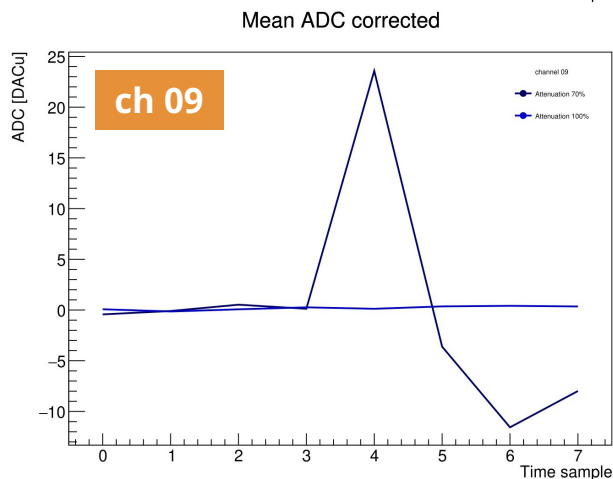
- same as before but:
 - laser and HV OFF
- slope in ADC disappears

Comparison of ADC WFs w/ and w/o laser

raw



corrected

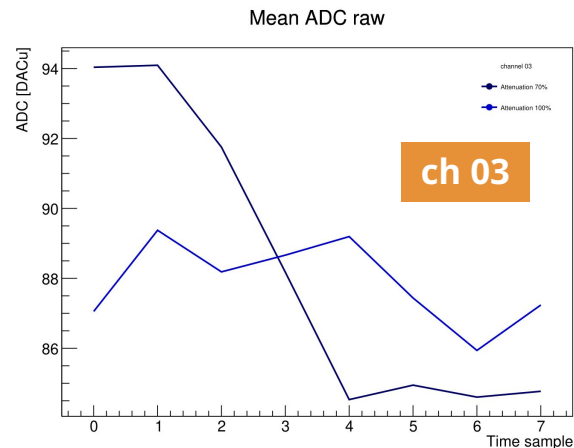
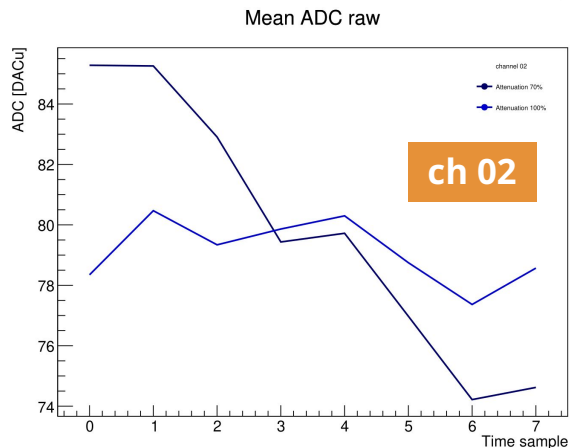
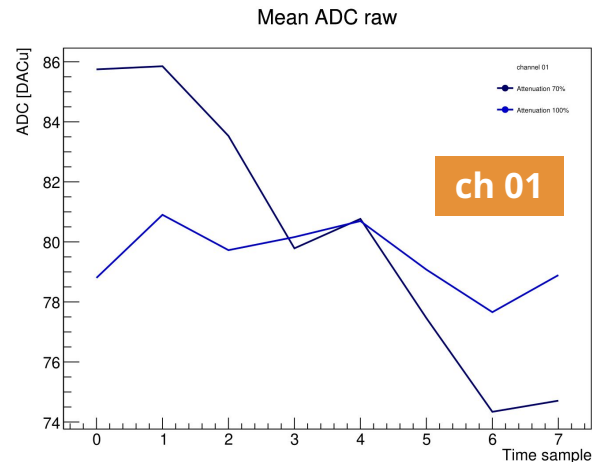
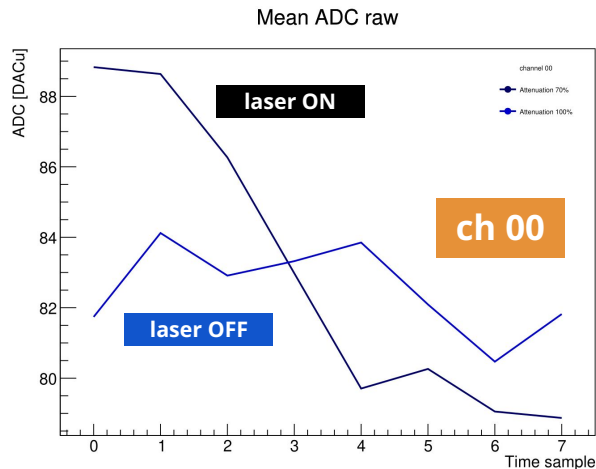


comparison ch by ch of data
shown in the previous 2 slides

Comparison of raw ADC WFs w/ and w/o laser

channels with no
laser signal on
(first column)

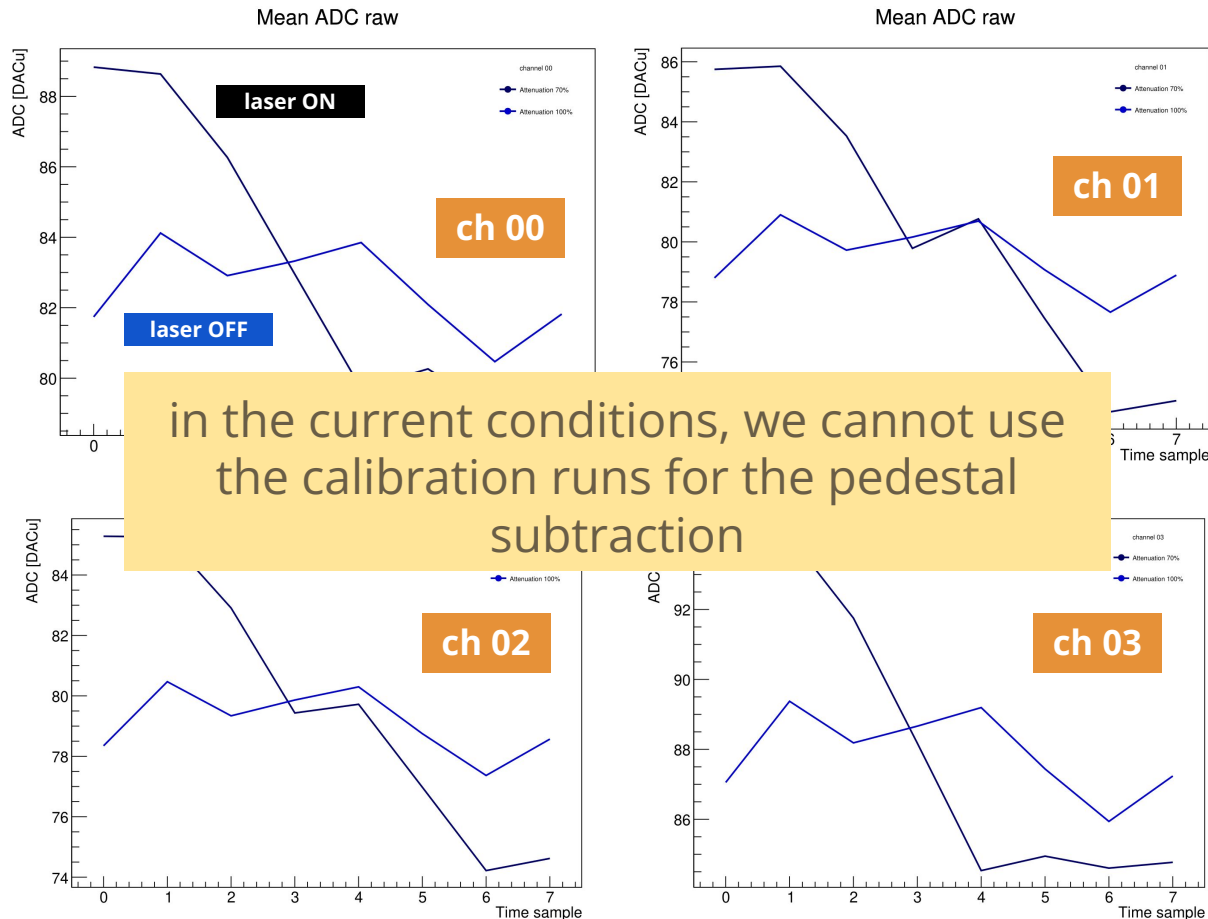
raw



comparison ch by ch of data
shown in the previous 2 slides

Comparison of raw ADC WFs w/ and w/o laser

raw

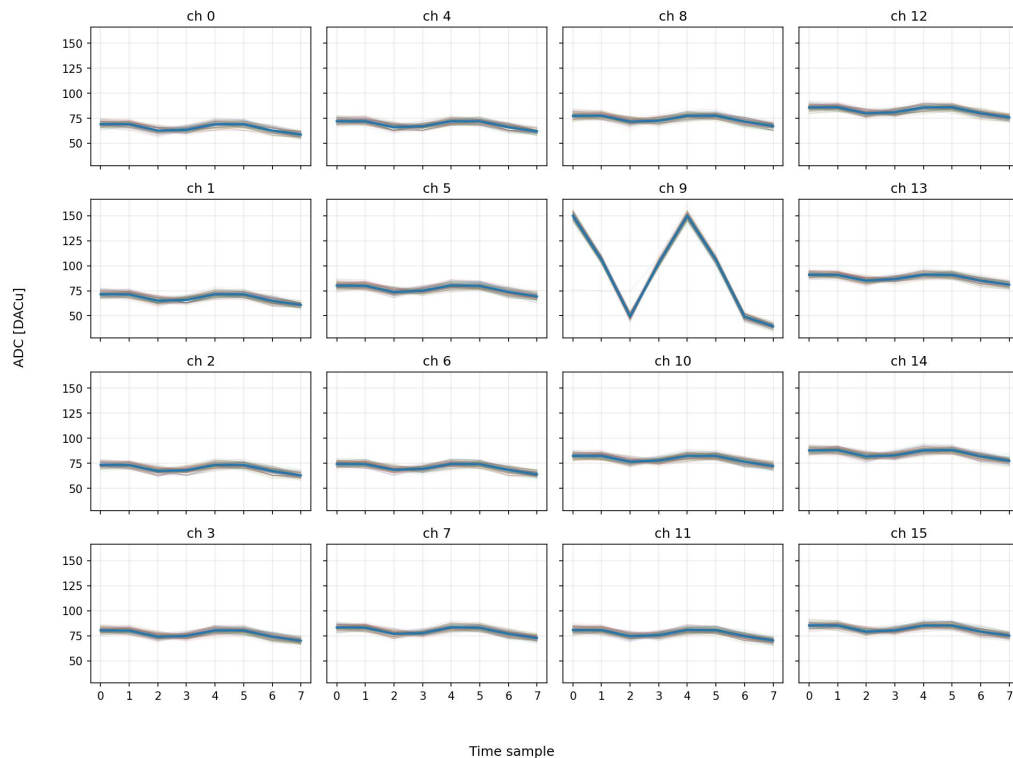


comparison ch by ch of data
shown in the previous 2 slides

Raw ADC WFs – check ctestON

EICROC0A

ADC raw waveforms
2026-09-21_eicroc0_PCB3_HV-OFF_BNLcross_th470_N0_TDC-ON_resetbeforeacq-OFF_ctestONch9_laserOFF_1
200 displayed / 1000 total events



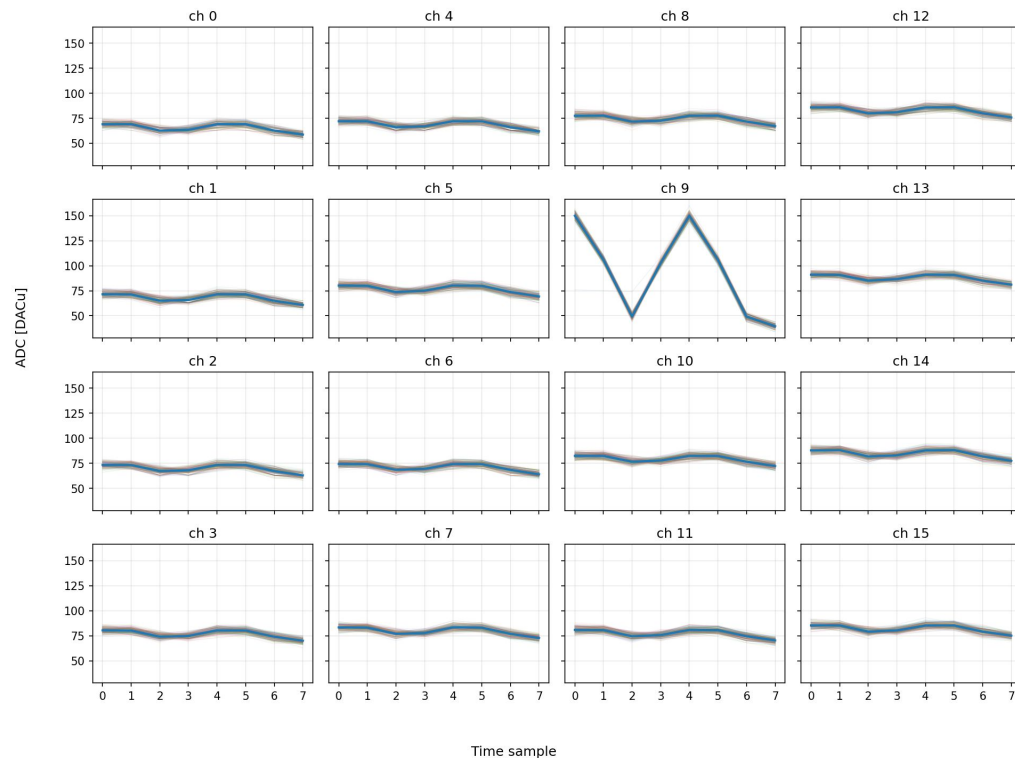
- ctest ON - on channel #9
- DAC pulser = 0 (~ 0.34 fC)
- laser and HV OFF

→ slope in ADC disappears in channels without ctestON

Raw ADC WFs – check ctestON

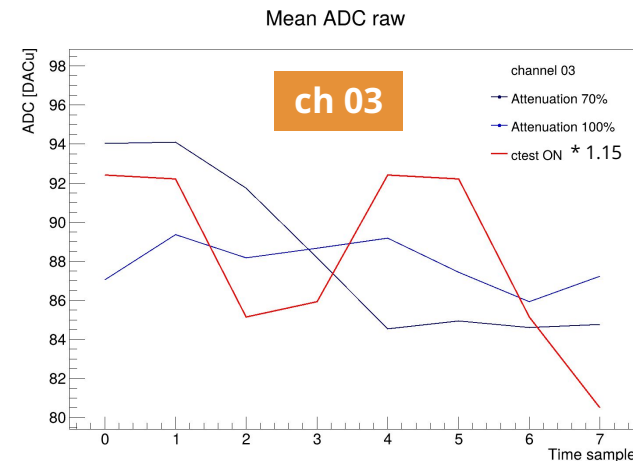
EICRO0A

ADC raw waveforms
2026-09-21_eicroc0_PCB3_HV-OFF_BNLcross_th470_N0_TDC-ON_resetbeforeacq-OFF_ctestONch9_laserOFF_1
200 displayed / 1000 total events



- ctest ON - on channel #9
- DAC pulser = 0 (~ 0.34 fC)
- laser and HV OFF

→ slope in ADC disappears in channels without ctestON



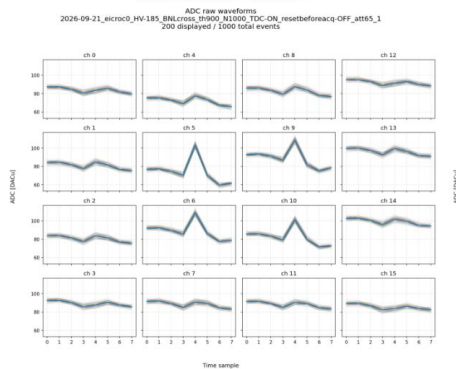
Online monitoring is being developed

EIROC ONLINE DATA QUALITY DASHBOARD

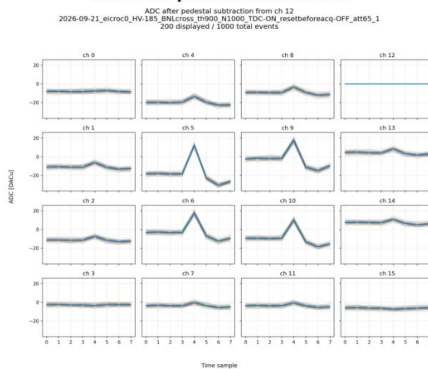
2026-09-21_eiroc0_HV-185_BNLCross_th900_N1000_TDC-ON_resetbeforeacq-OFF_att65_1

ongoing development!

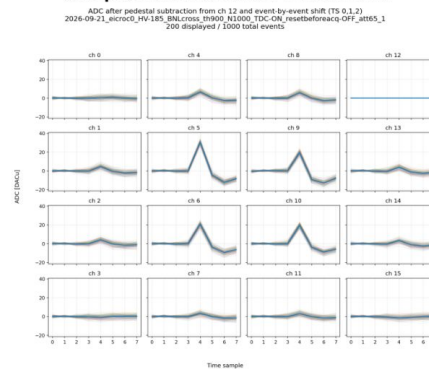
ADC raw waveforms



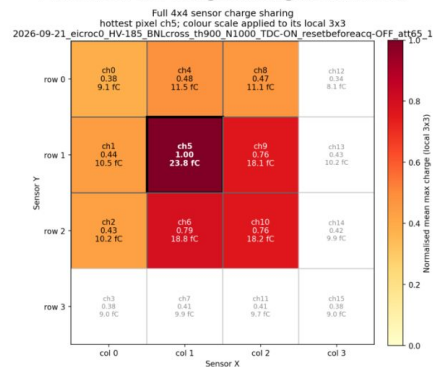
ADC after pedestal subtraction



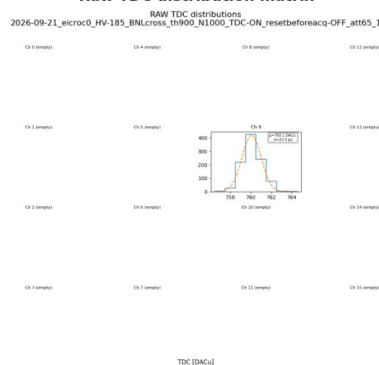
ADC pedestal subtraction + event shift



Full sensor 4x4 charge sharing (normalised)



Raw TDC distribution matrix



Summary

File date/time : 2026-09-21 16:44:34 CEST
File : 2026-09-21_eiroc0_HV-185_BNLCross_th900_N1000_TDC-ON_resetbeforeacq-OFF_att65_1.dat

XYZ not found in filename 3x3 position:
2026-09-21_eiroc0_HV-185_BNLCross_th900_N1000_TDC-ON_resetbeforeacq-OFF_att65_1
Y = -59.18 +/- 6.35 um

Events available : 1000
Events analysed : 1000
Signal channel : 5
Reference channel: 12

Cross position:
X = 46.21 +/- 6.22 um
Y = -44.46 +/- 6.34 um

3x3 charge : 131.40 +/- 5.94 fC
Cross charge: 82.76 +/- 3.71 fC

Central ADCmax : 30.43 DACU
Baseline noise : 0.93 DACU
ADCmax / noise : 32.63
ADC saturation : 0.000 %

No automatic red flags found.

Conclusions and next steps

- ongoing work for EICROC0: time jitter, resolutions, position scan, ...
- with EICROC0: beta-source test foreseen
- for EICROC0A we will wait for the metal fix

Thank you!

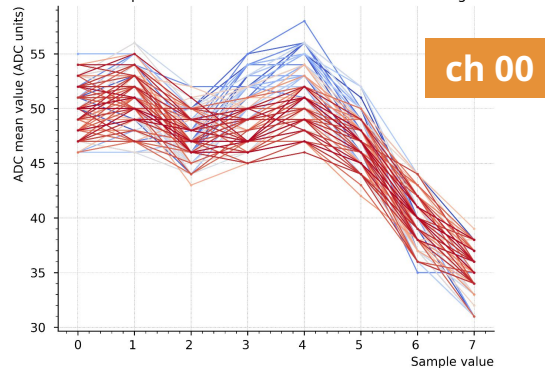
Additional slides

Mean ADC WFs vs event samples

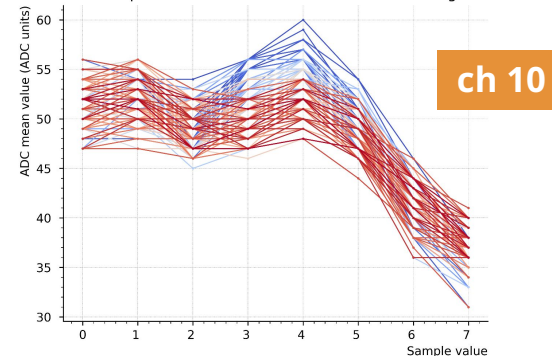
EICRO0A

DAC pulser = 0
(~0.34 fC)

ADC mean value vs event samples for a Threshold of 470 DACu and a Charge of 0.34 fC in channel 0

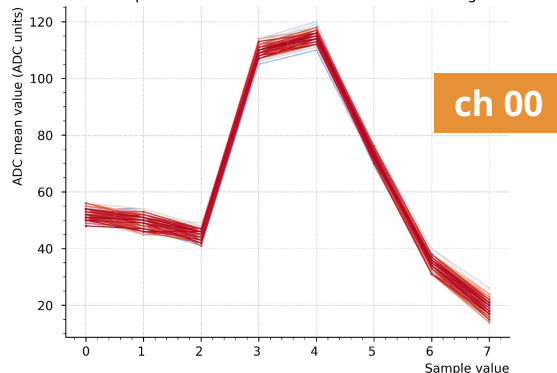


ADC mean value vs event samples for a Threshold of 470 DACu and a Charge of 0.34 fC in channel 10

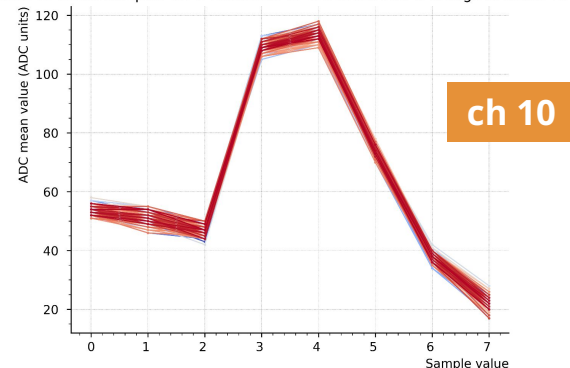


DAC pulser = 32
(~32.92 fC)

ADC mean value vs event samples for a Threshold of 470 DACu and a Charge of 32.92 fC in channel 0



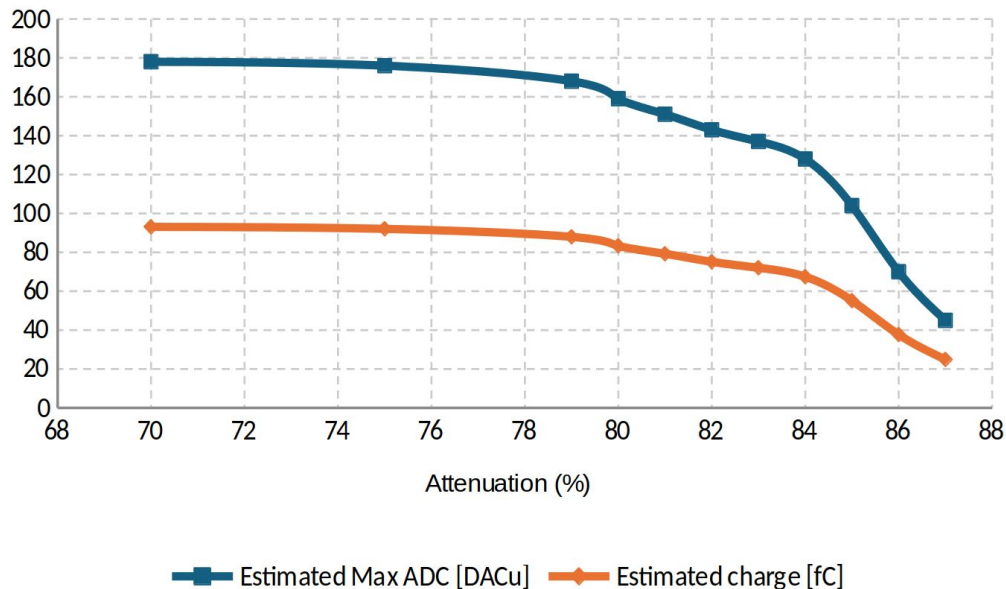
ADC mean value vs event samples for a Threshold of 470 DACu and a Charge of 32.92 fC in channel 10



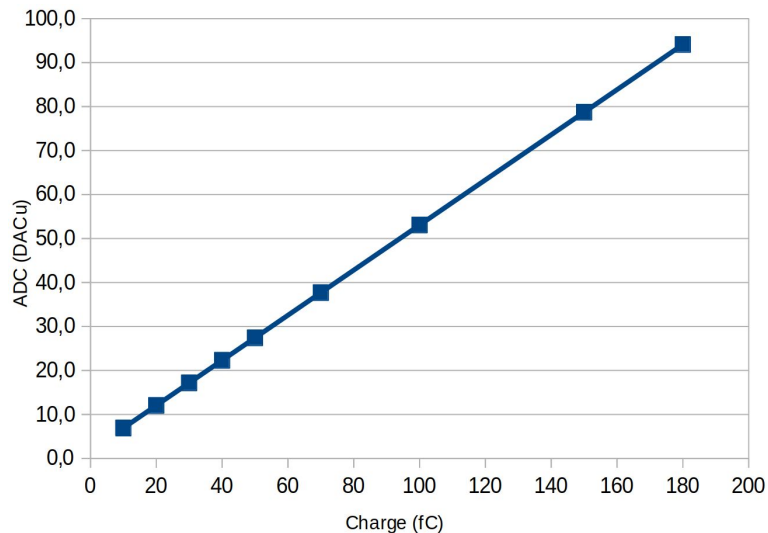
cmd pulse adds a small slope

Charge corresponding to laser attenuation

Estimated charge vs attenuation

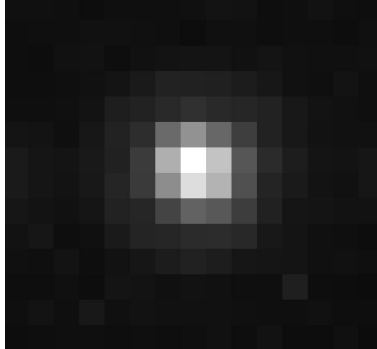


using this calibration for HPK sensor & EICROC0:

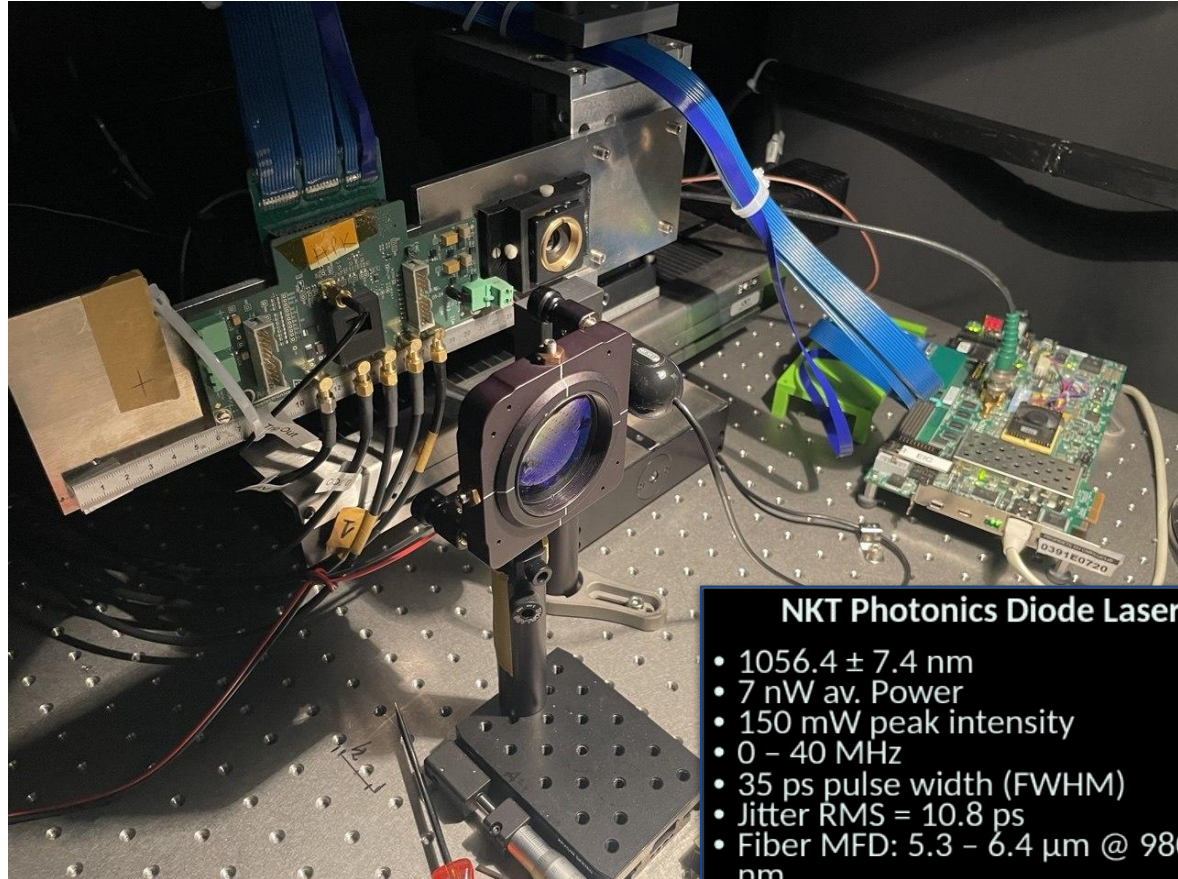


Laser specifications

Laser spot
with CMOS camera



- Clean spot
- $\phi \lesssim 20 \text{ mm}$
(CMOS pixel = 3.75 mm)



NKT Photonics Diode Laser

- $1056.4 \pm 7.4 \text{ nm}$
- 7 nW av. Power
- 150 mW peak intensity
- 0 - 40 MHz
- 35 ps pulse width (FWHM)
- Jitter RMS = 10.8 ps
- Fiber MFD: $5.3 - 6.4 \text{ }\mu\text{m}$ @ 980 nm

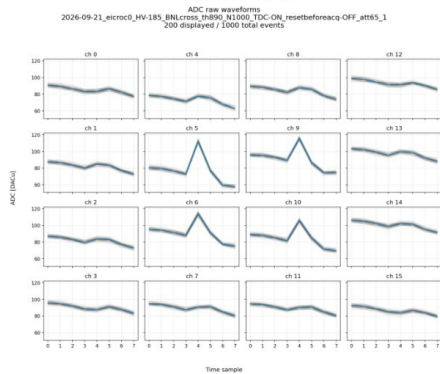
ADC WFs, charge sharing and TDC: Vth=890, attenuation=65%

EICROC ONLINE DATA QUALITY DASHBOARD

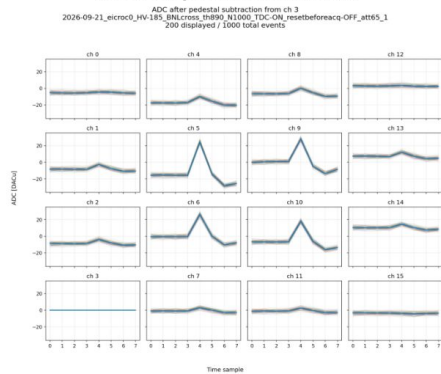
2026-09-21_eicroc0_HV-185_BNLcross_th890_N1000_TDC-ON_resetbeforeacq-OFF_att65_1

EICROC0A

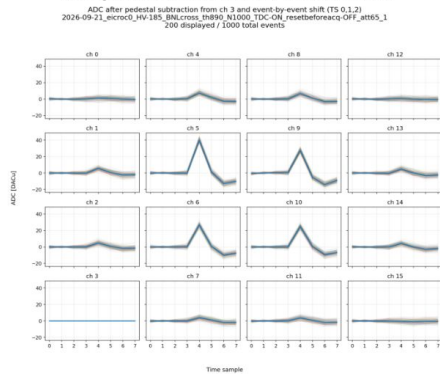
ADC raw waveforms



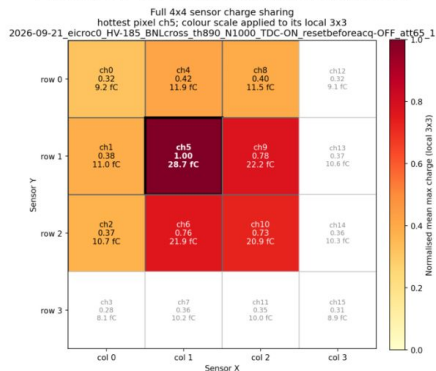
ADC after pedestal subtraction



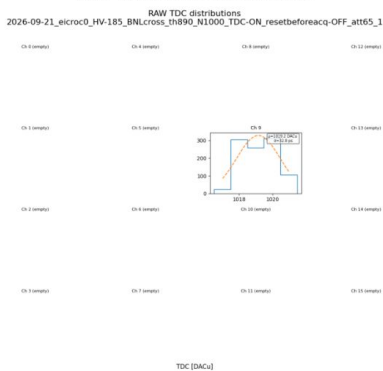
ADC pedestal subtraction + event shift



Full sensor 4x4 charge sharing (normalised)



Raw TDC distribution matrix



Summary

File date/time : 2026-09-21 16:36:35 CEST
File : 2026-09-21_eicroc0_HV-185_BNLcross_th890_N1000_TDC-ON_resetbeforeacq-OFF_att65_1.dat

XYZ not found in filename 3x3 position:
2026-09-21_eicroc0_HV-185_BNLcross_th890_N1000_TDC-ON_resetbeforeacq-OFF_att65_1
Y = -70.21 +/- 5.87 um

Events available : 1000
Events analysed : 1000
Signal channel : 5
Reference channel: 3

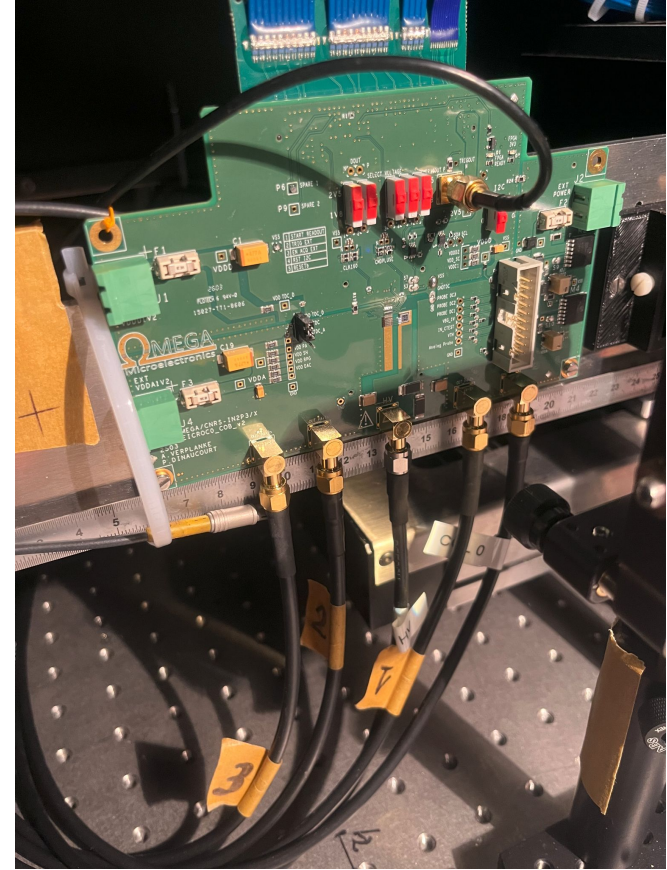
Cross position:
X = 58.77 +/- 5.50 um
Y = -51.88 +/- 5.87 um

3x3 charge : 147.98 +/- 6.19 fC
Cross charge: 95.72 +/- 3.79 fC

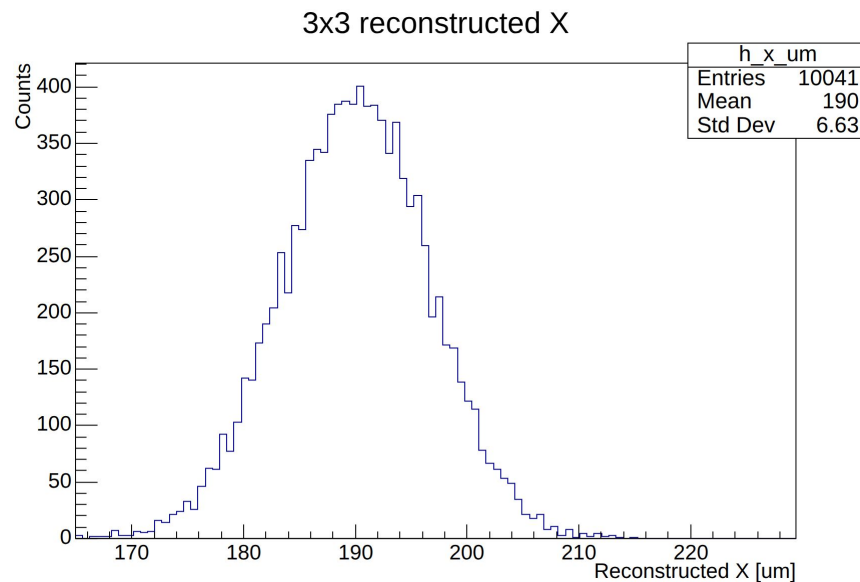
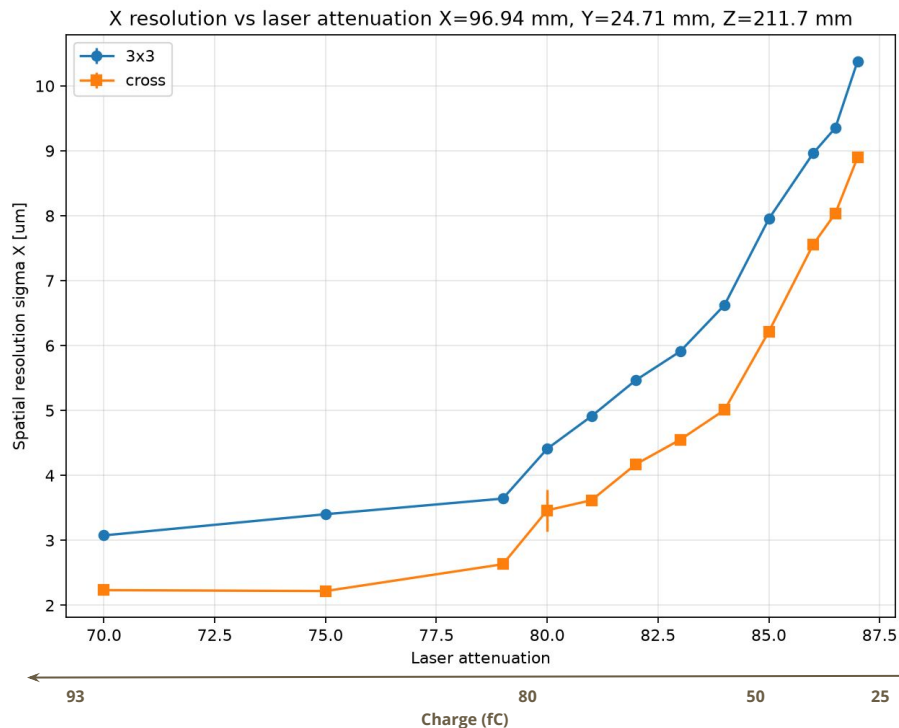
Central ADCmax : 39.86 DACu
Baseline noise : 0.95 DACu
ADCmax / noise : 41.92
ADC saturation : 0.000 %
No automatic red flags found.

General information

- **EICROCOA**; PCB #2
- signal channel = between #5 and #9
- V_{th} = variable; HV = -185 V
- for all channels:
 - V_{refcor} = 56
 - V_{thcor} = 78
- positions in local coordinates of the table: X = 102.975 mm; Y = 12.325 mm; Z = 217.8 mm

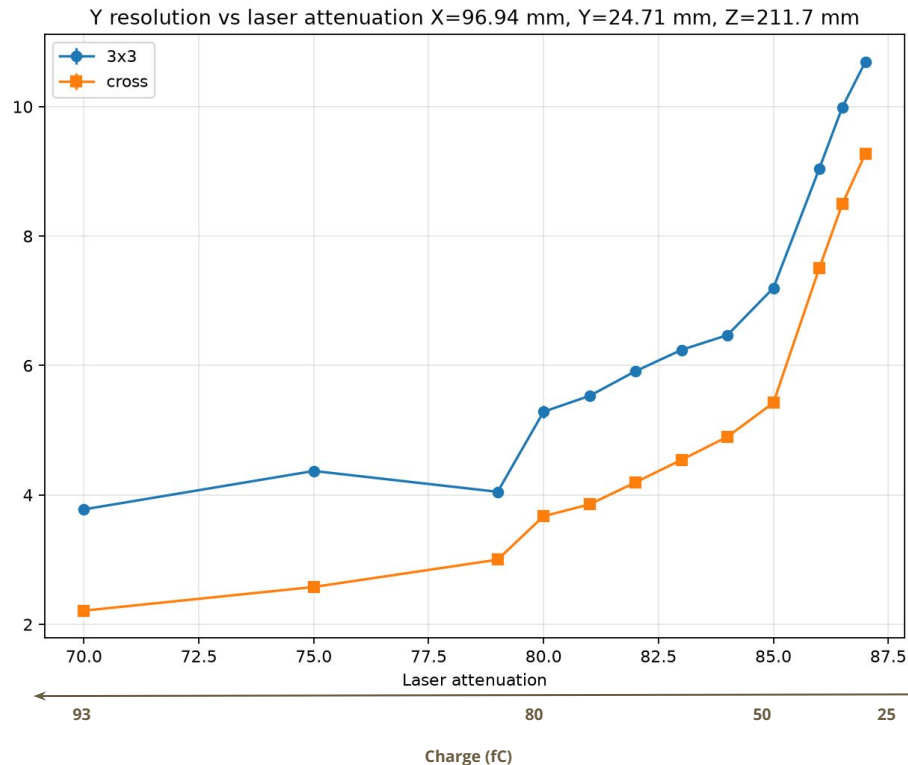
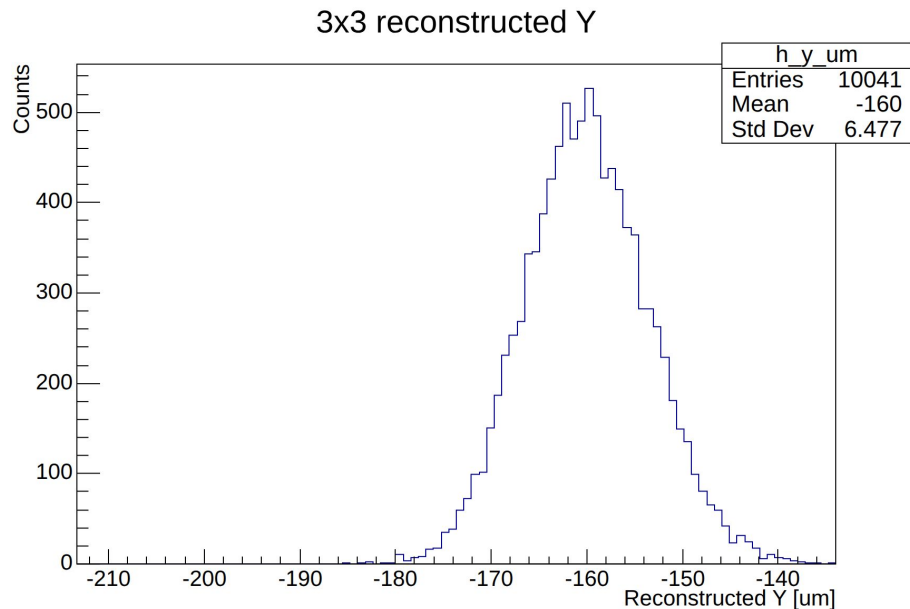


- The spatial resolution is estimated from the width σ of the event-by-event reconstructed position distributions, using the two reconstruction methods: the 3×3 cluster and the cross methods



Resolution in Y

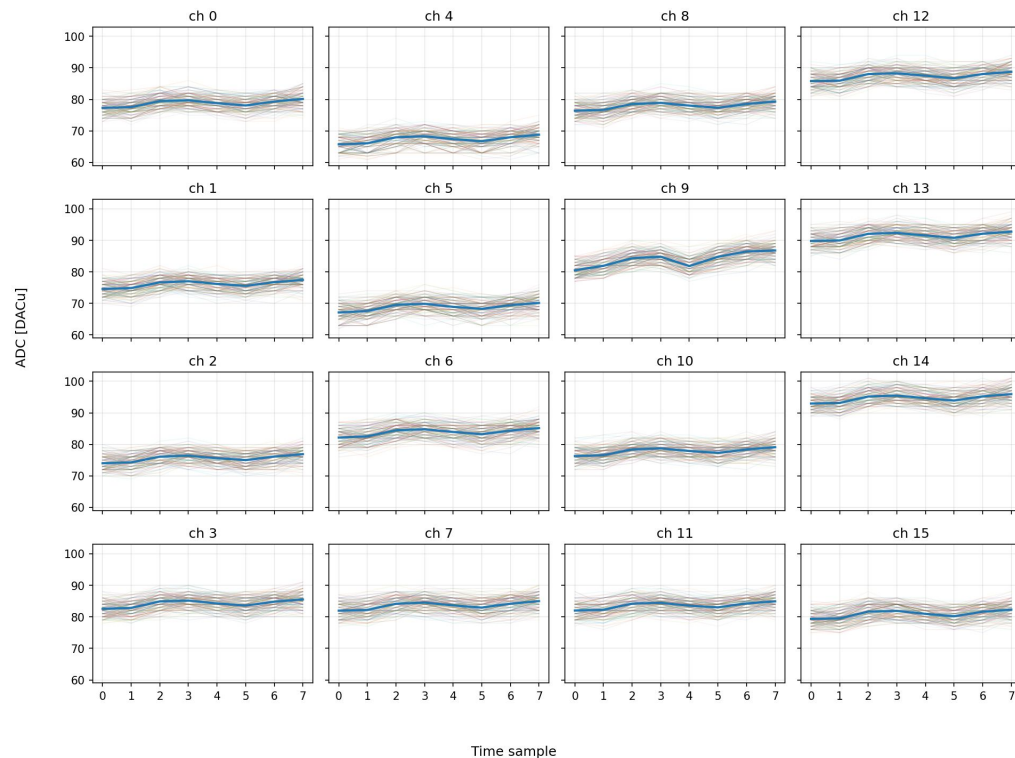
- The spatial resolution is estimated from the width σ of the event-by-event reconstructed position distributions, using the two reconstruction methods: the 3x3 cluster and the cross methods



Raw ADC WFs – check w/ TDC and discrimi

EICROC0A

ADC raw waveforms
2026-09-21_eicroc0_HV-OFF_BNLcross_th470_N1000_d30_TDC-OFF_discr-OFF_1
200 displayed / 1000 total events



- TDC and discriminator = OFF
 - laser and HV also OFF
 - reset before acquisition ON (giving us a number of problems last week, turned it OFF for the rest of figures and analysis)
- slope in ADC disappears