

PXD Irradiation Effects

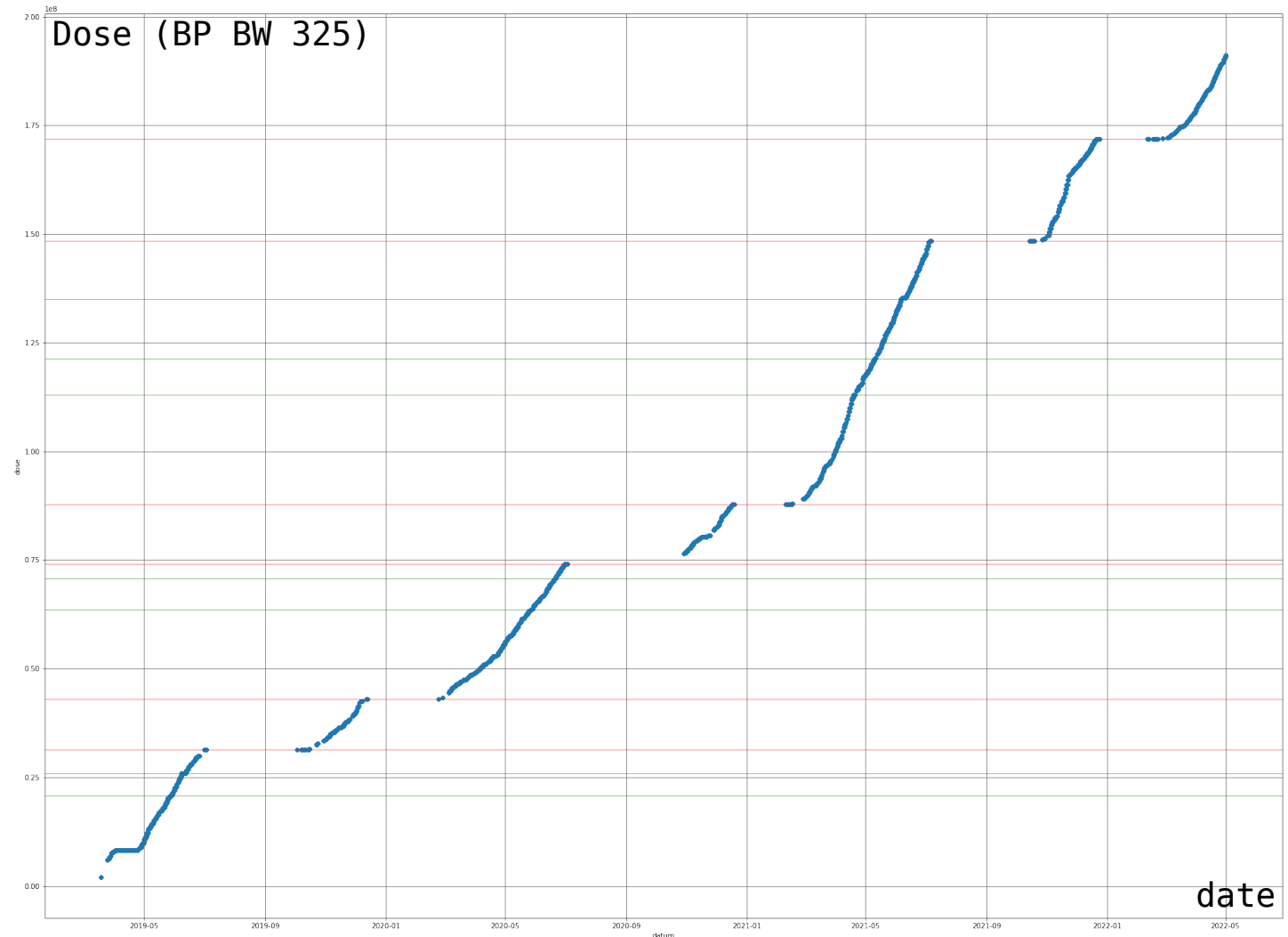
PXD/DEPFET Meeting
16-18.5.2021

Bjoern Spruck, JGU Mainz

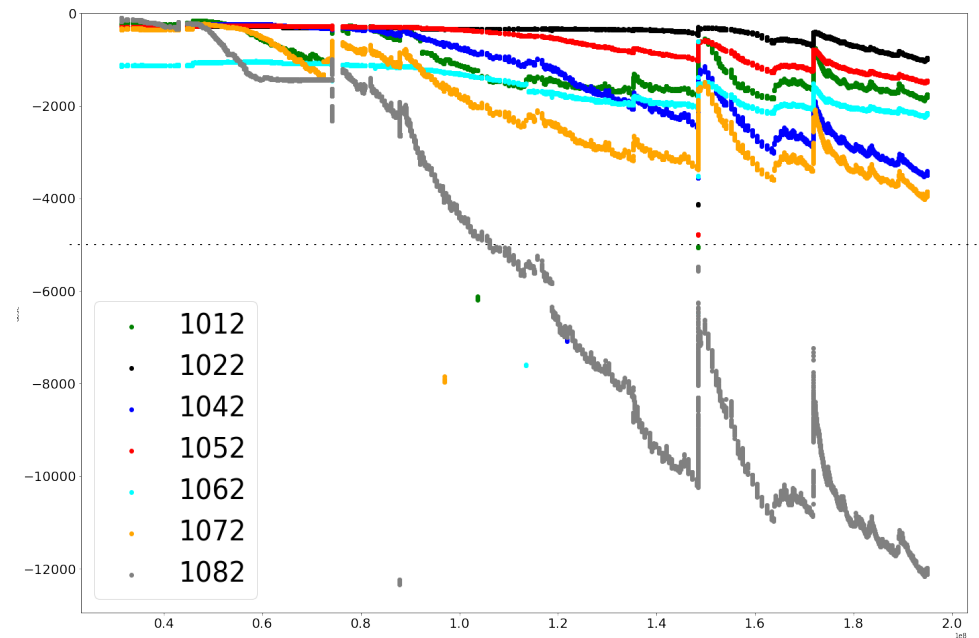
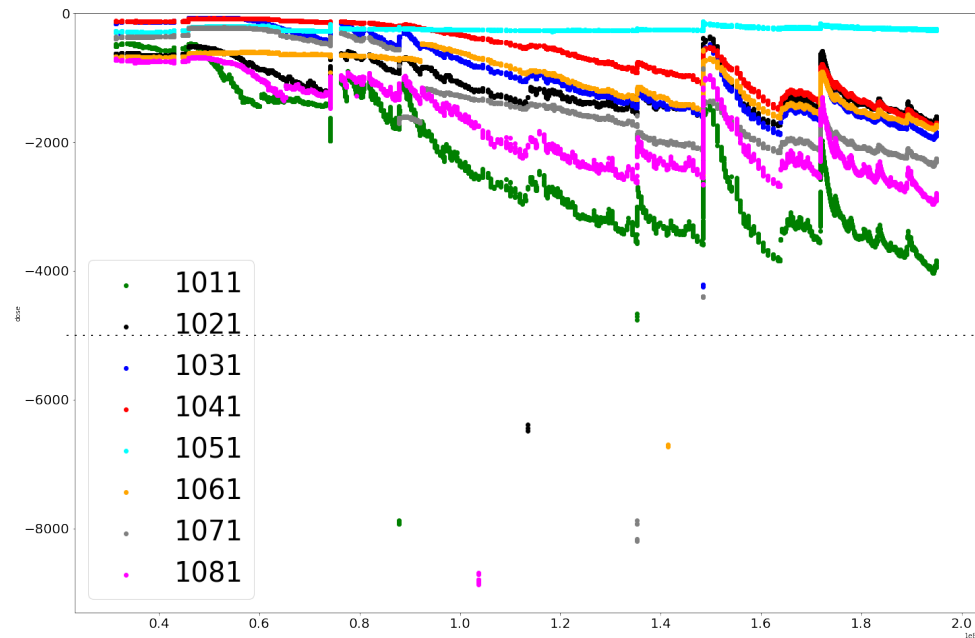
Updates on ...

- Doses
- HV Currents
- Pedestals
- ASIC Currents
- Not covering: SEUs in ASICs, PSU, other electronic

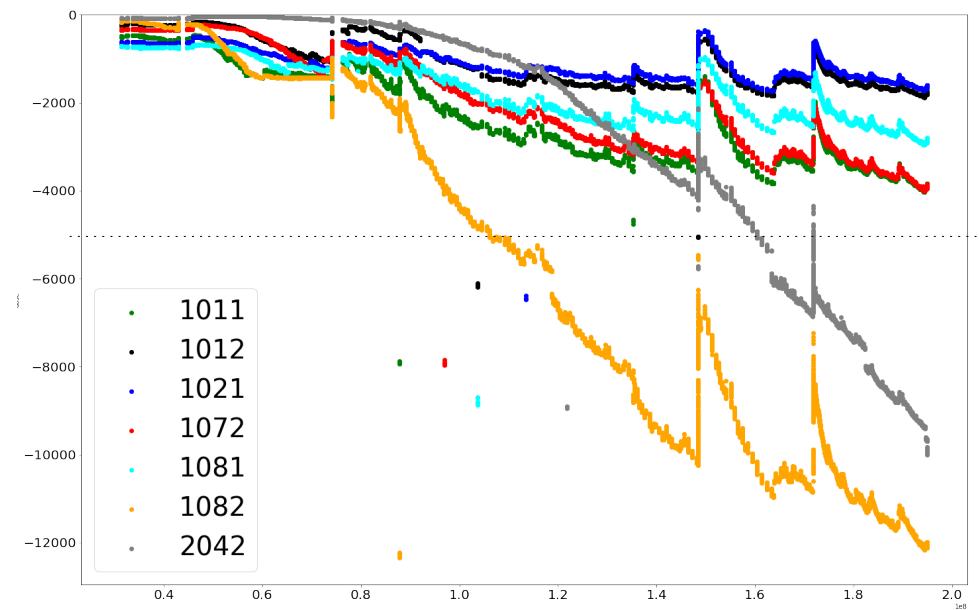
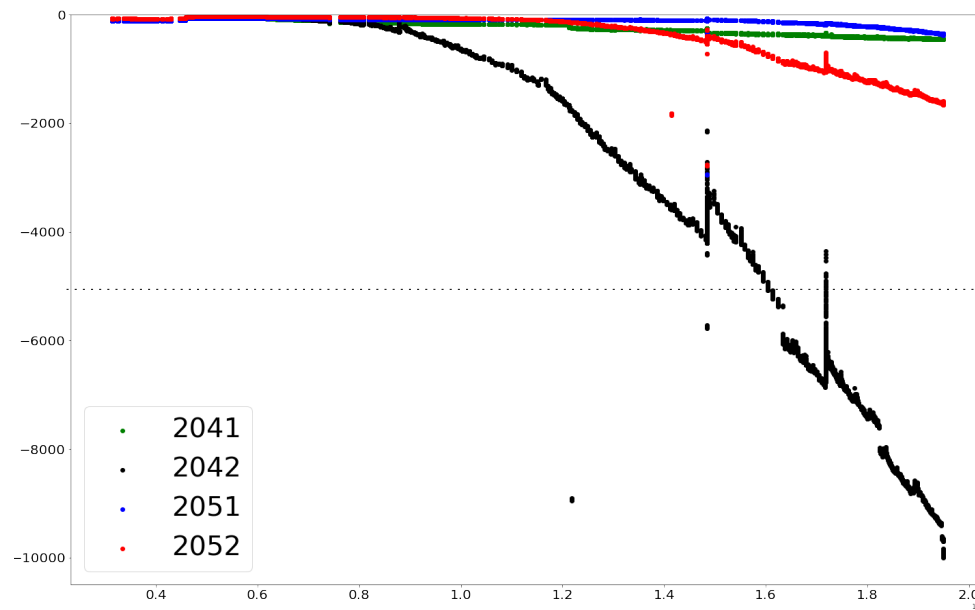
- Doses measured by Diamond sensor, 2021c/2022 not proper calibrated
- No module wise correction
- Some plots contain integrated dose only from 2020 on.
- Per module dose → Yannik



High Voltage Currents vs Dose (NOT Module Wise)



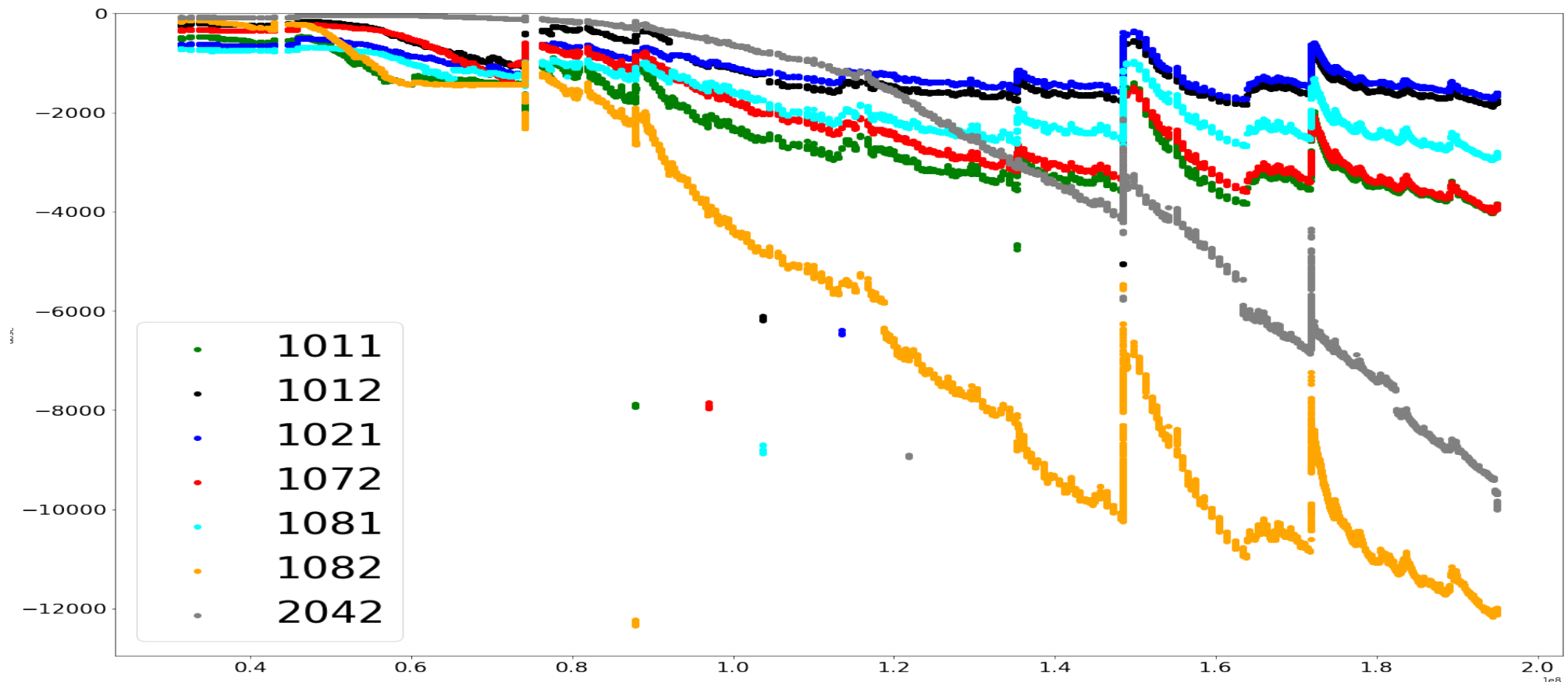
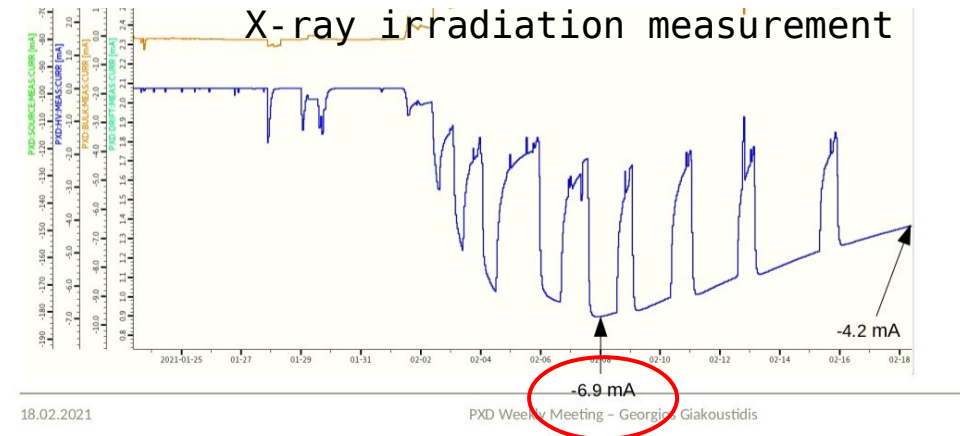
(attention, different y axis scale)



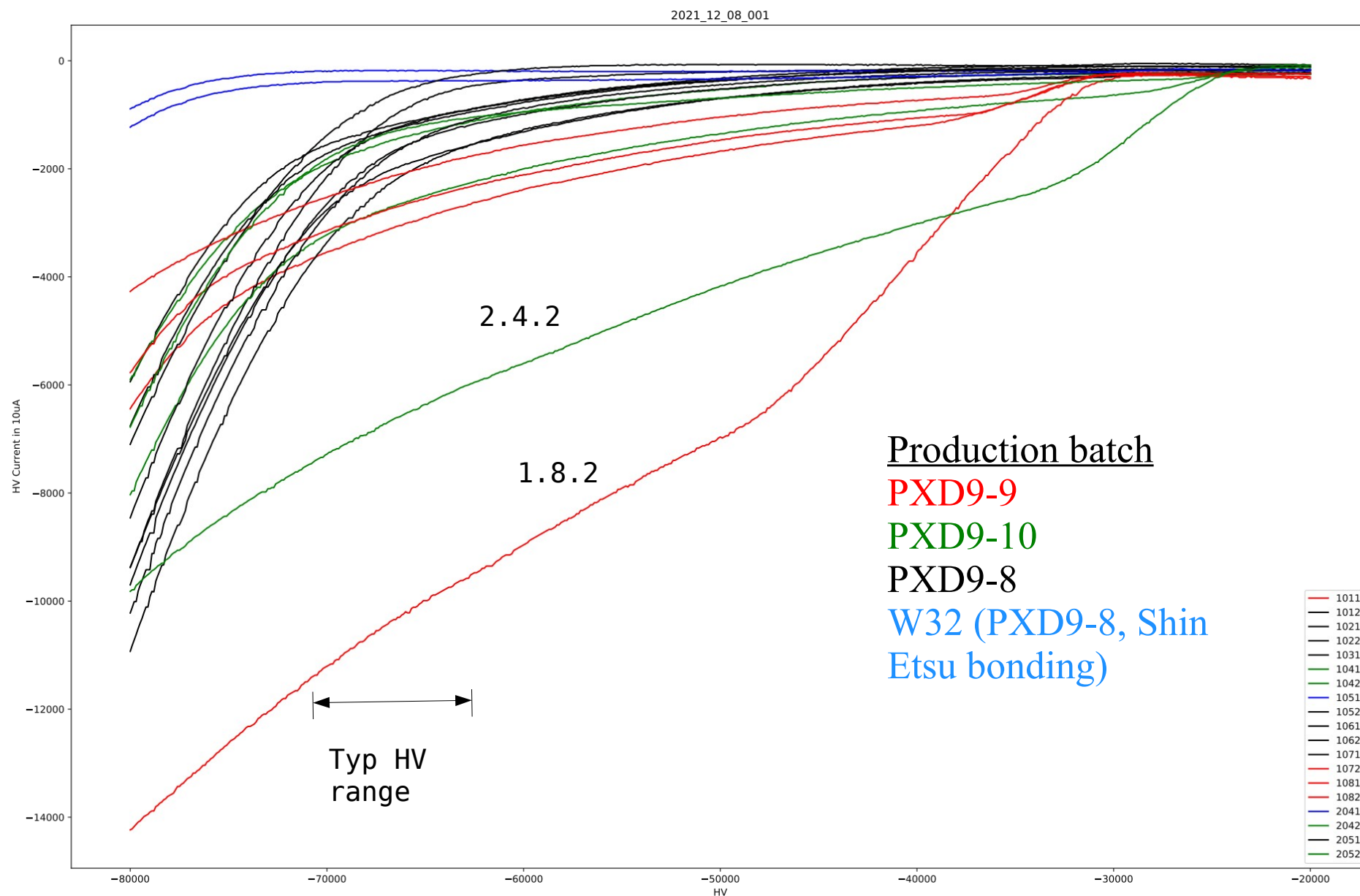
Calibration of current is not exact after PSU modifications!

High Voltage Currents

- HV currents further increasing in 2022
 - 1.8.2 & 2.4.2 PS Unit modified for max 28mA (others 14mA)
 - Saturation effect for some modules, depending on instant radiation dose?



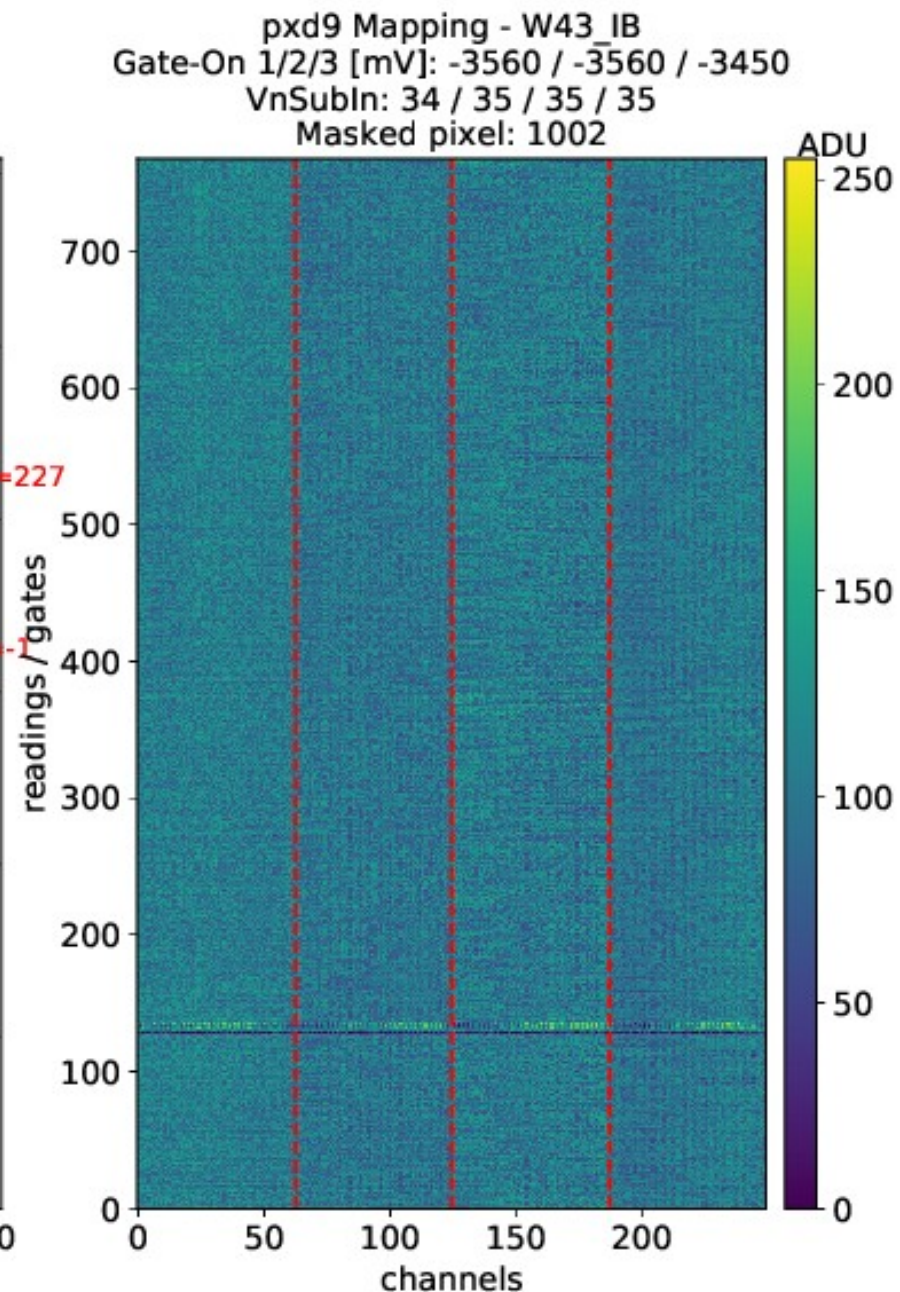
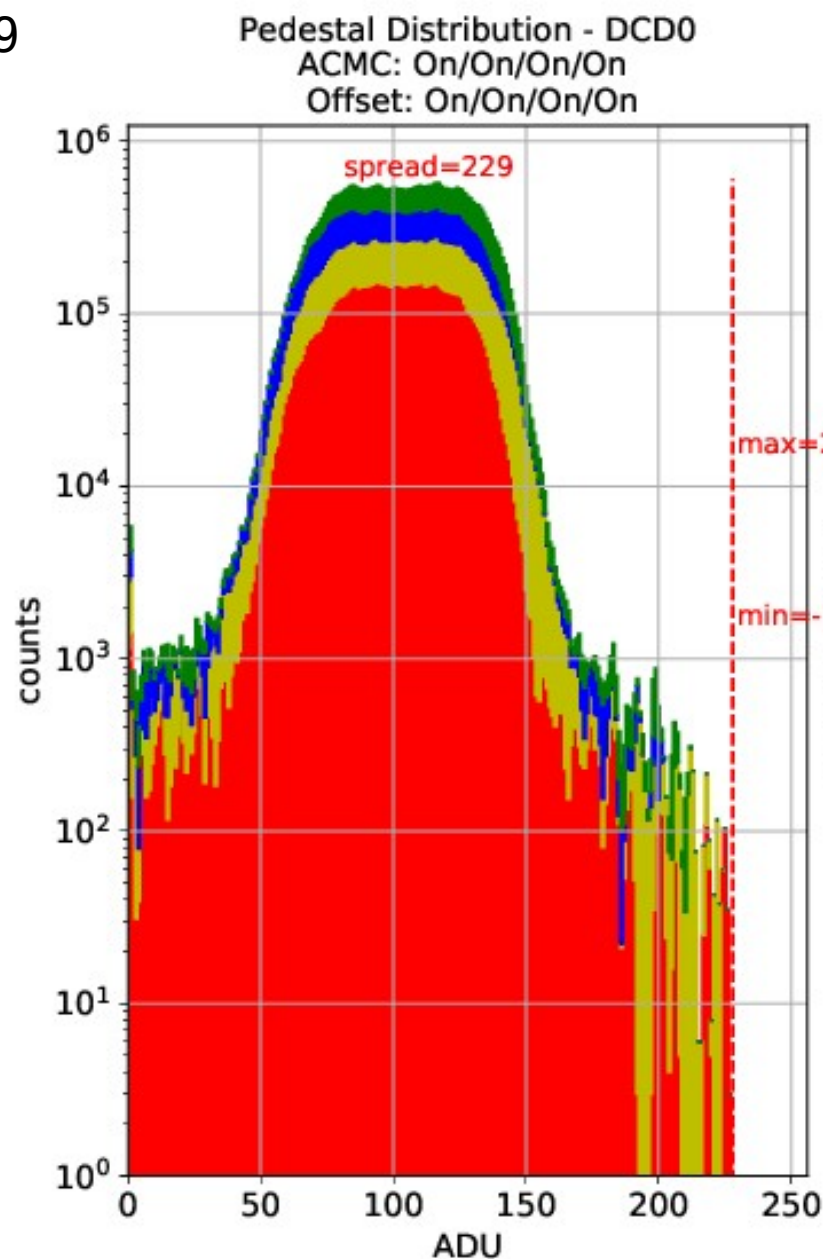
● Wafer/production batch dependence



- Two modules are close to the 14mA limits
 - Extrapolation to July 2022: wont reach 20mA
 - Other modules most likely wont reach 14mA
- Saturation? Hard to judge, saturation may depend on instant doses.
- Problem for PXD2
 - We expect the same dose (2019-2022) within shorter time and cannot predict the maximum current we may reach in years of operation

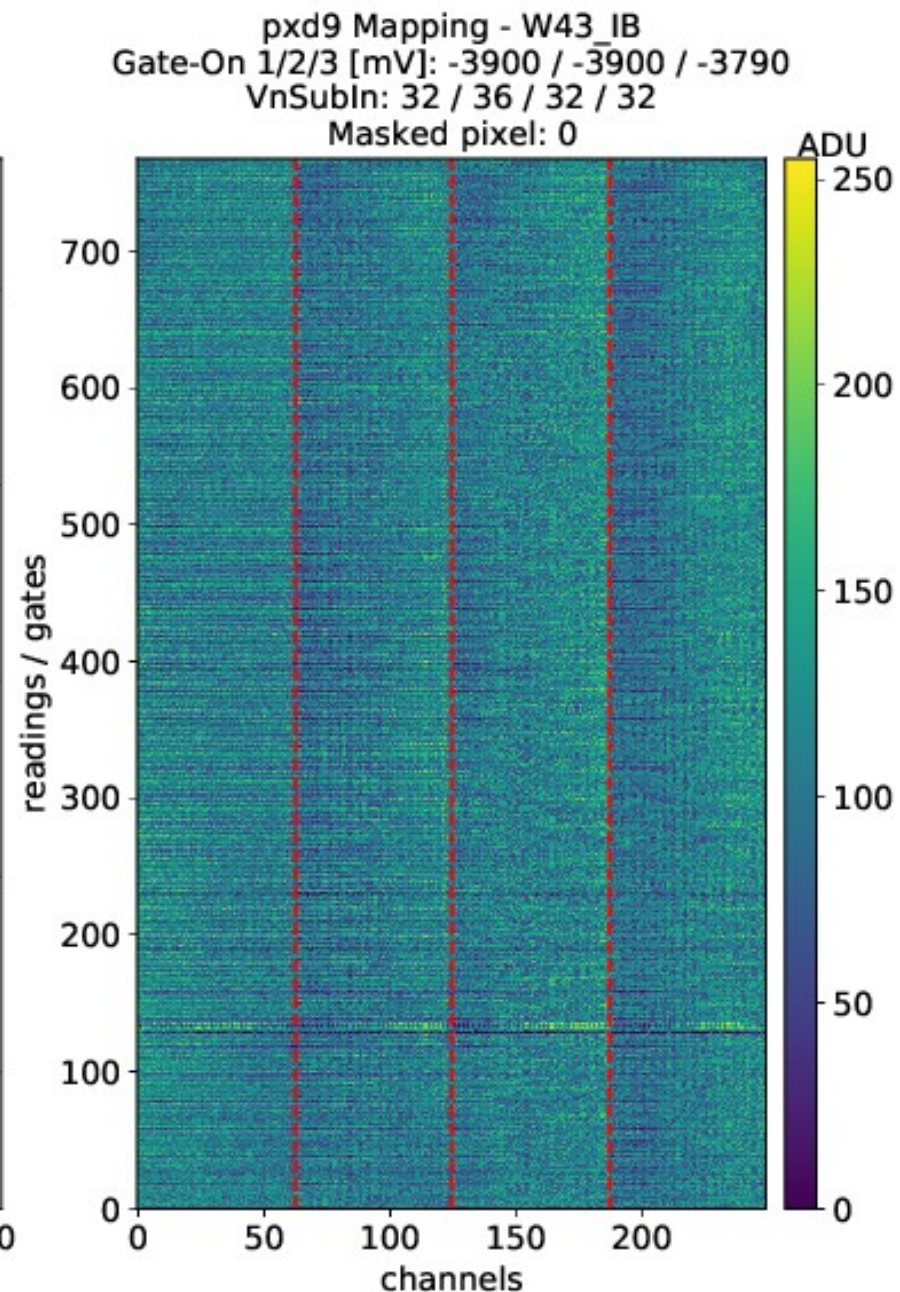
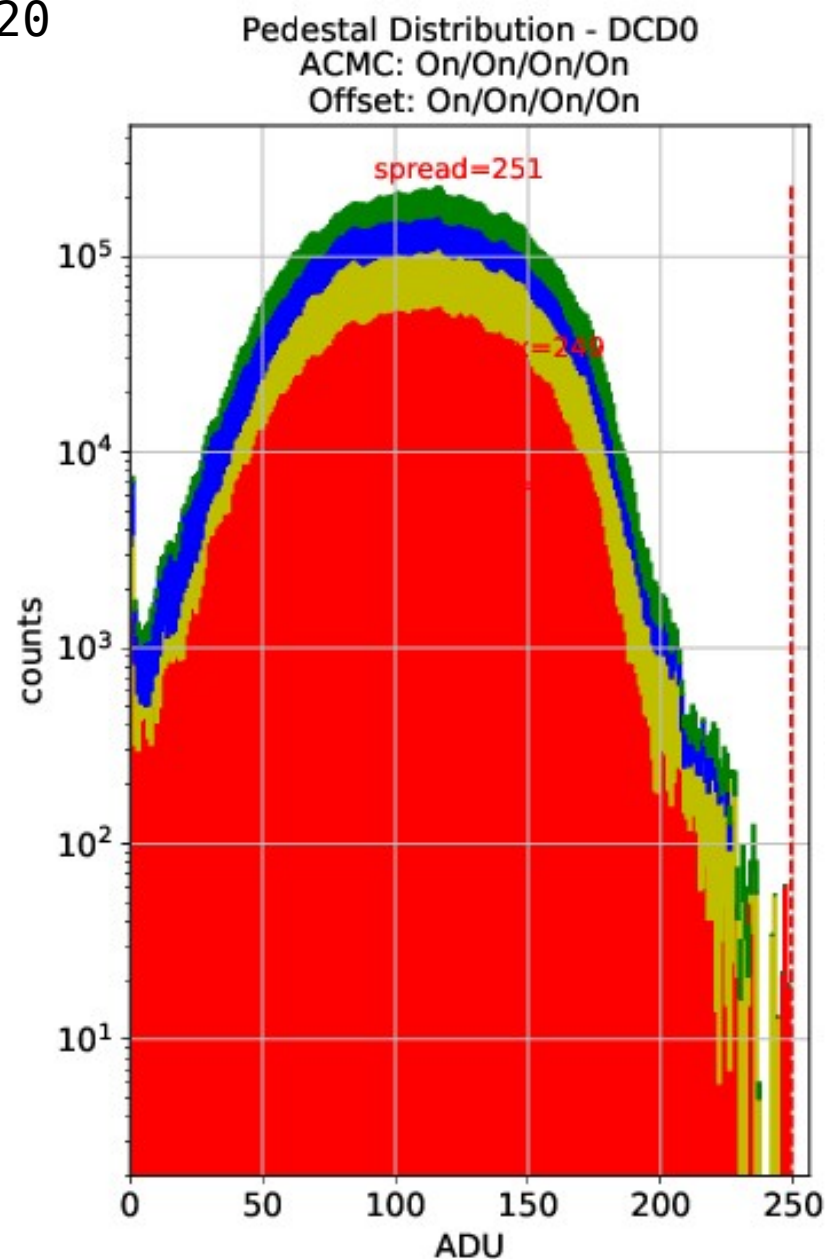
Pedestal Evolution 1.01.2 / 2019

1.01.2
1.10.2019



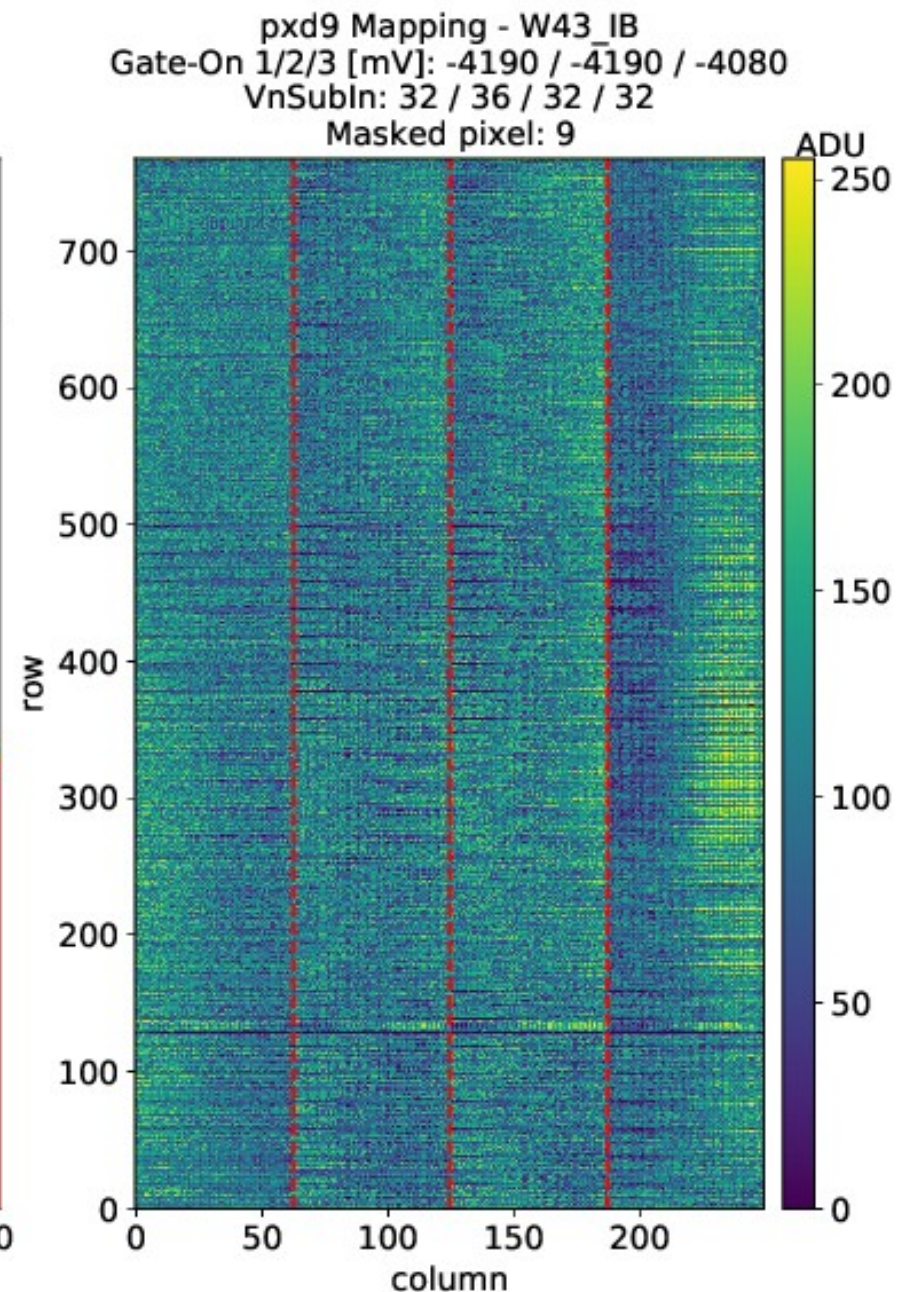
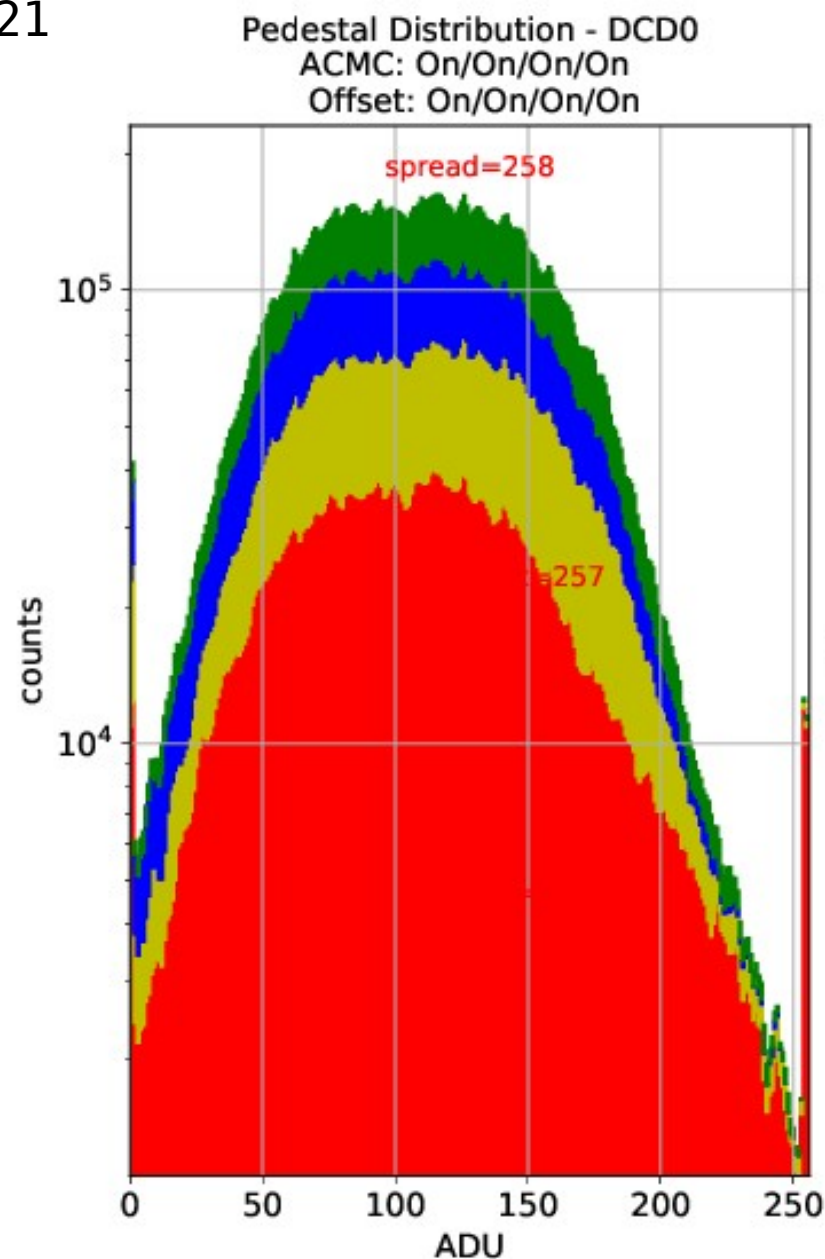
Pedestal Evolution 1.01.2 / 2020

1.01.2
19.11.2020



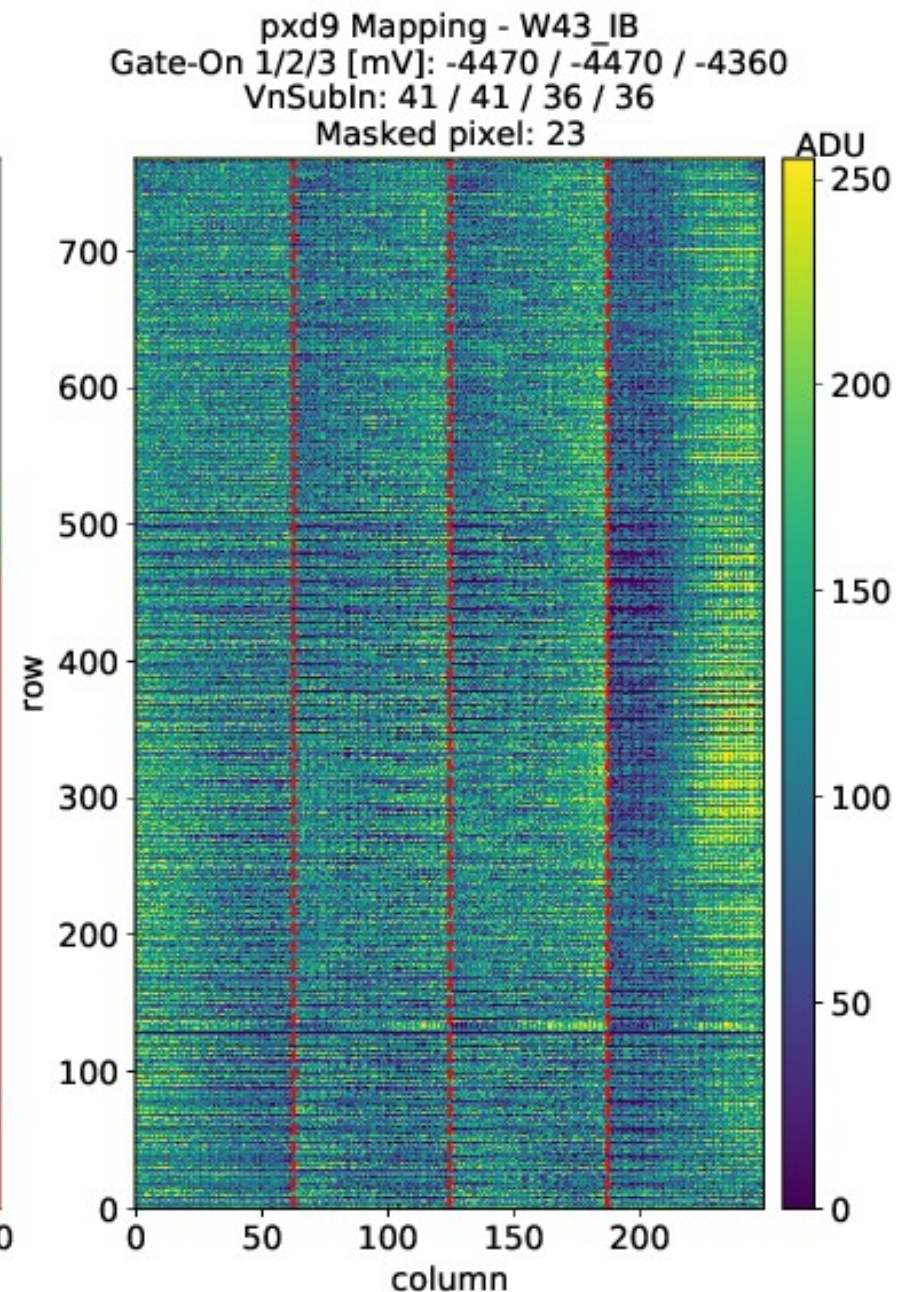
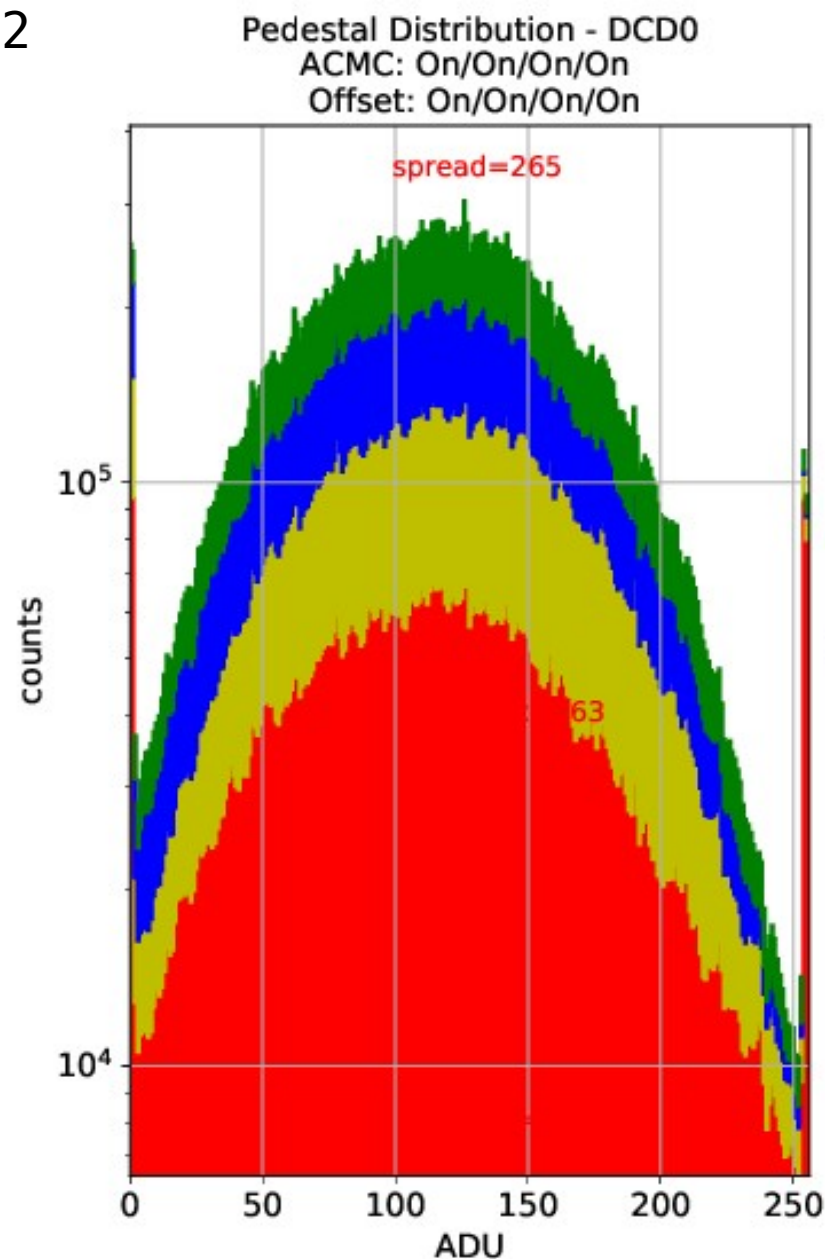
Pedestal Evolution 1.01.2 / 2021

1.01.2
28.10.2021



Pedestal Evolution 1.01.2 / 2022

1.01.2
14.5.2022

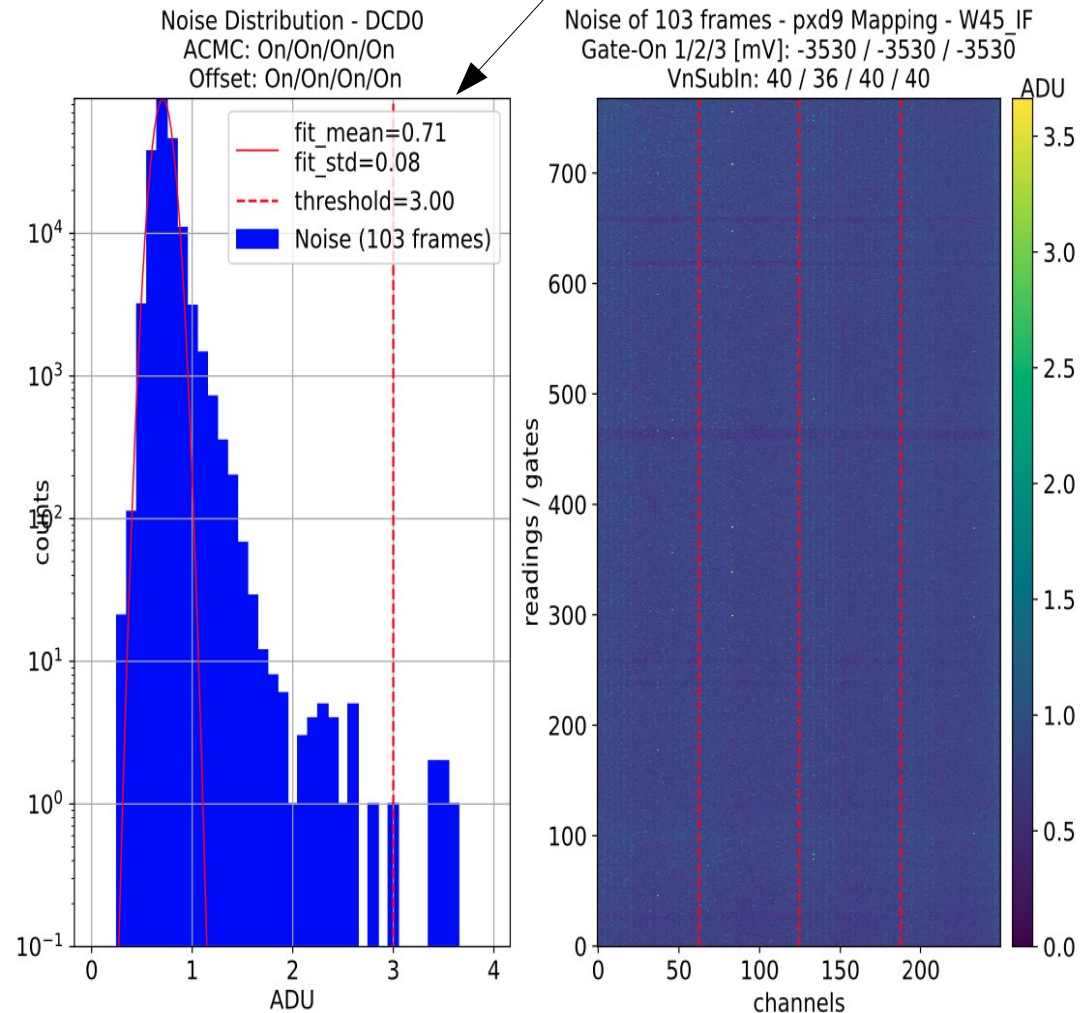


Pedestals Noise Trend

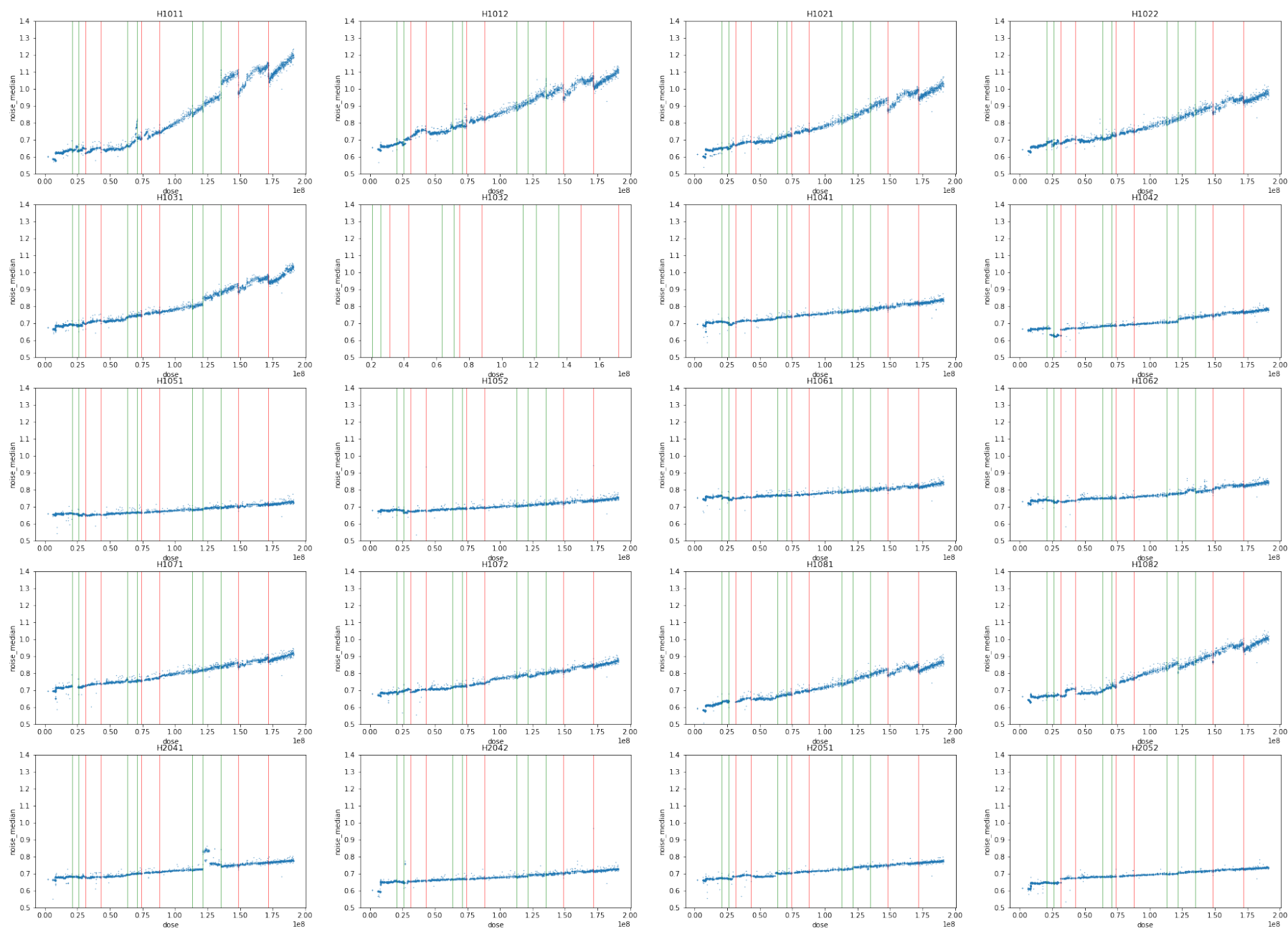
- Claim we have noise < 1 ADU
- But this has changed!
- In the following, I do not do a fit (with a upper cut) but just take the median and mean for comparison
- After-run-pedestals (Peak! Avoid local study data)
- Analysed data on Localdaq in proper format available for Exp12 on only
- Raw data for exp 7-11 from tape, partly reprocessed on kekcc (with nearly same parameters, excl noise masks)

Our claim (was):

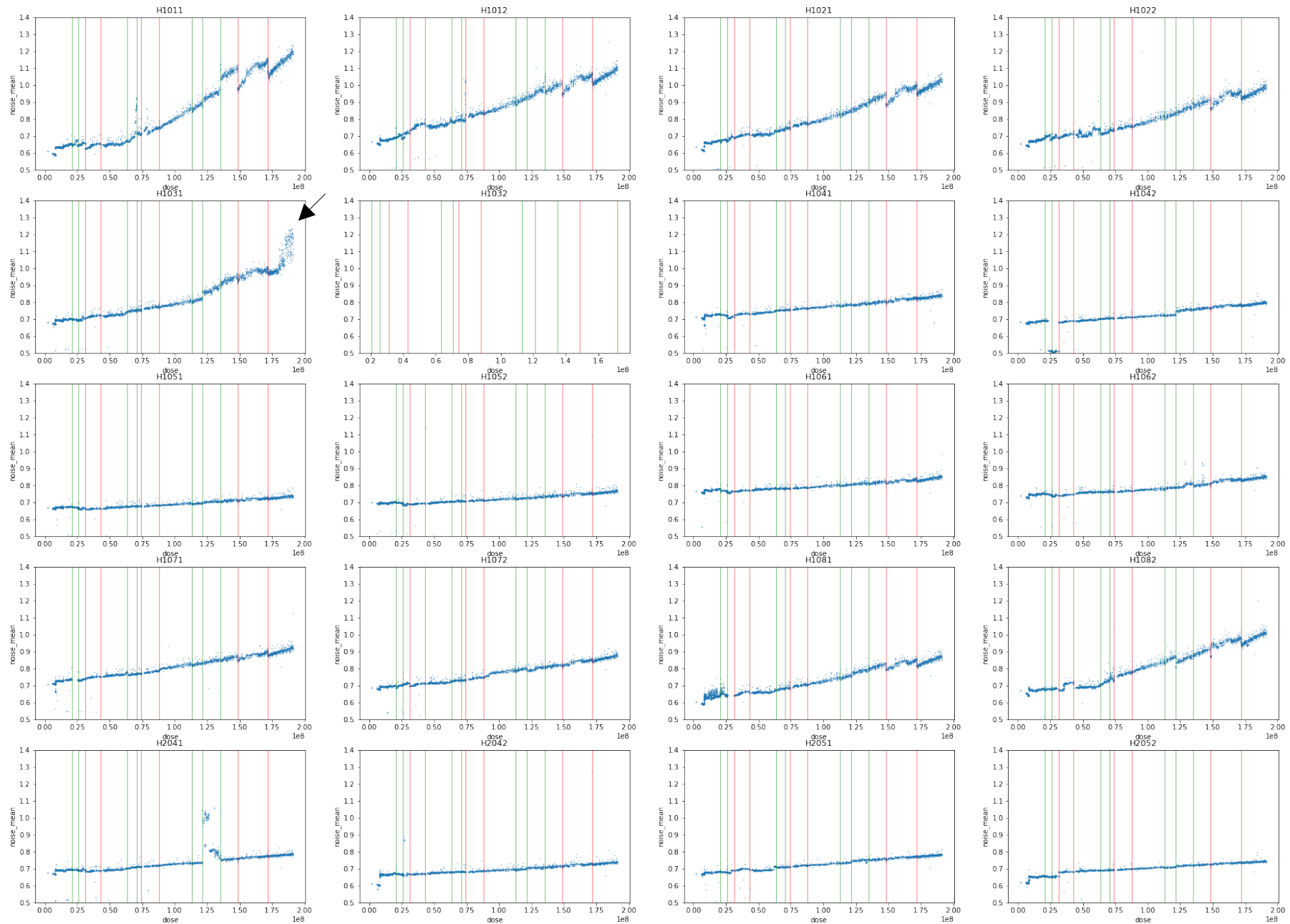
Noise of 0.7 ADU



Pedestal Noise – Median

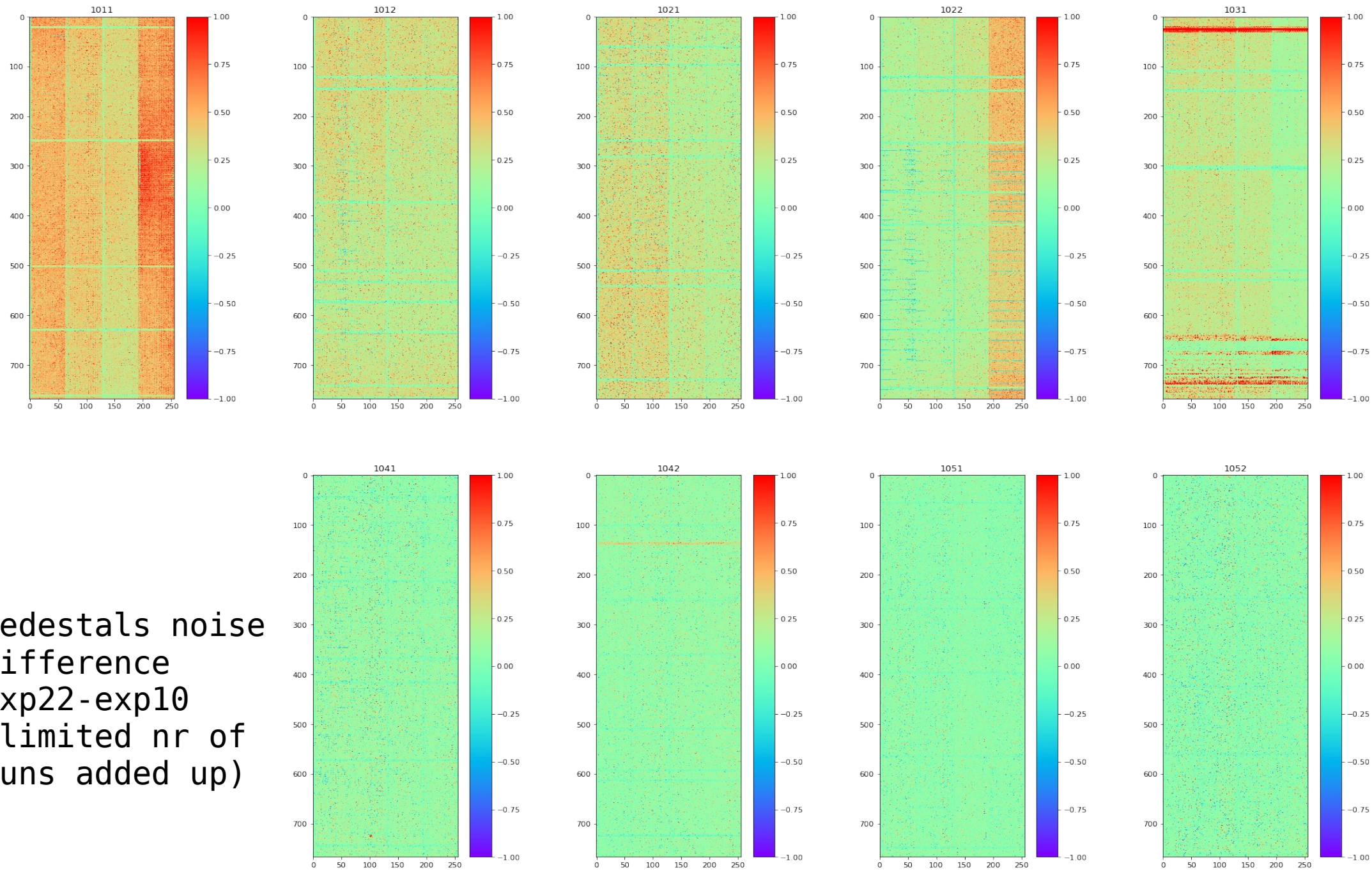


Pedestal Noise – Mean



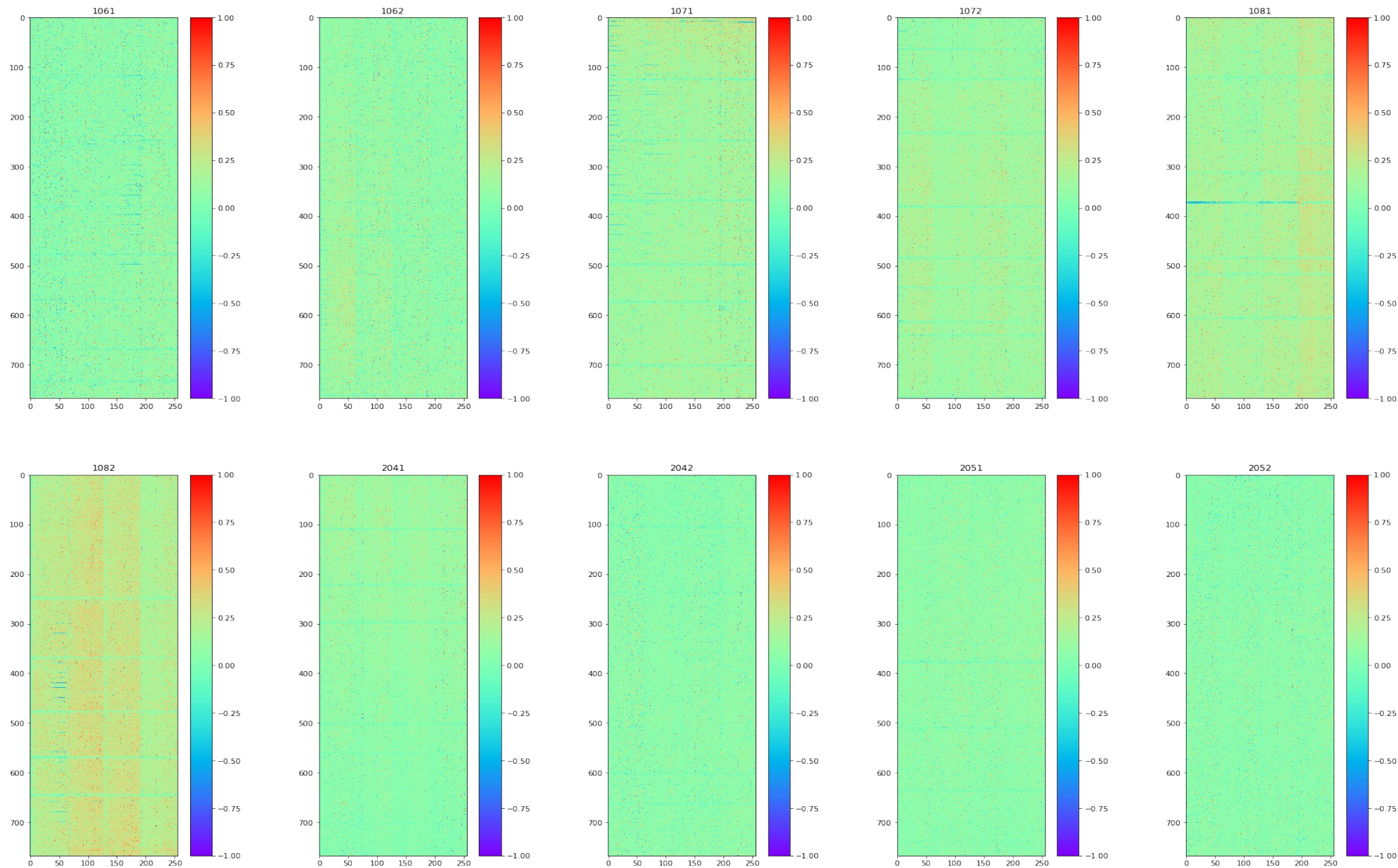
Mean is sensible to outliers

Pedestals noise difference exp22-exp10

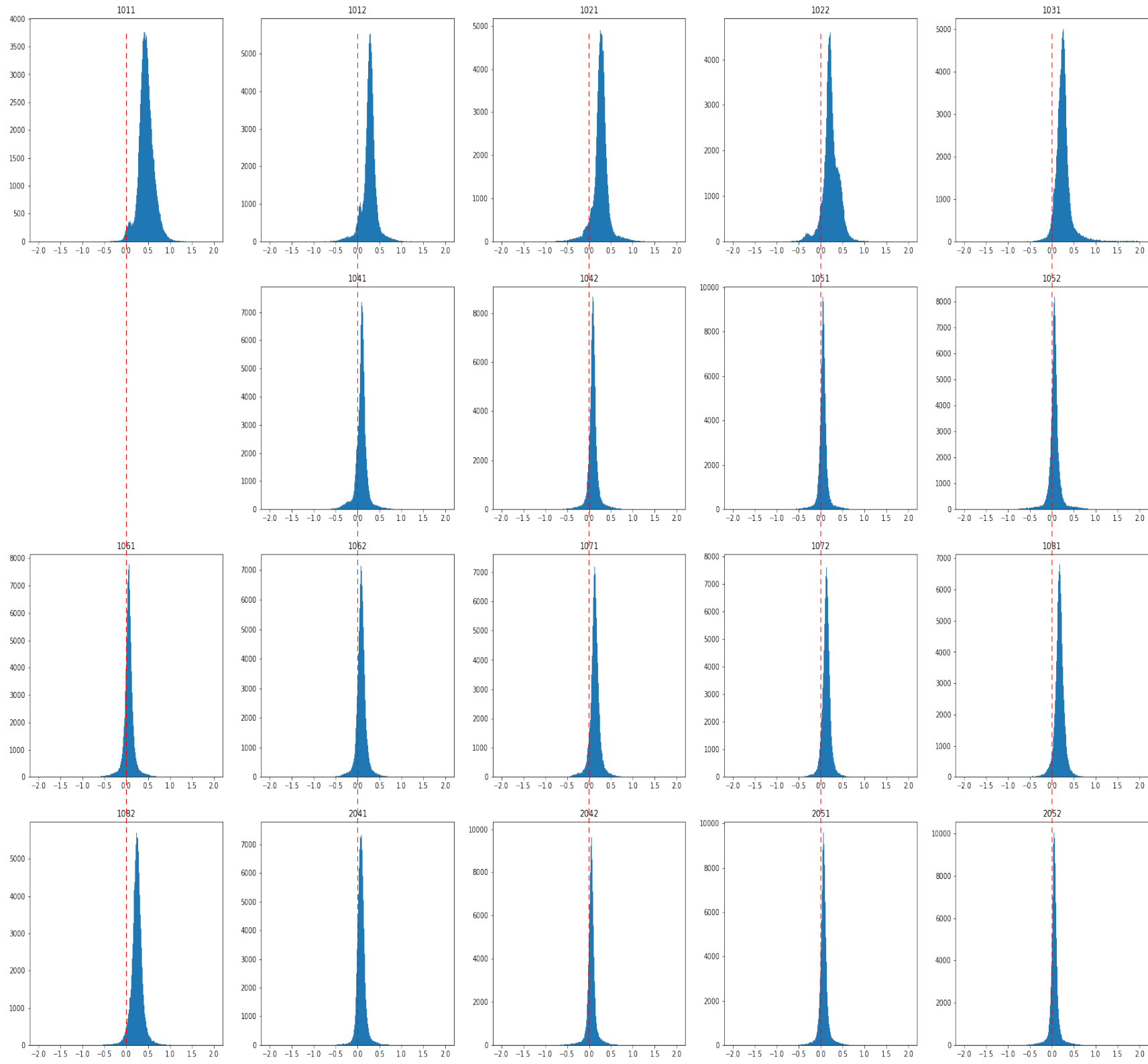


Pedestals noise
difference
exp22-exp10
(limited nr of
runs added up)

Pedestals noise difference exp22-exp10



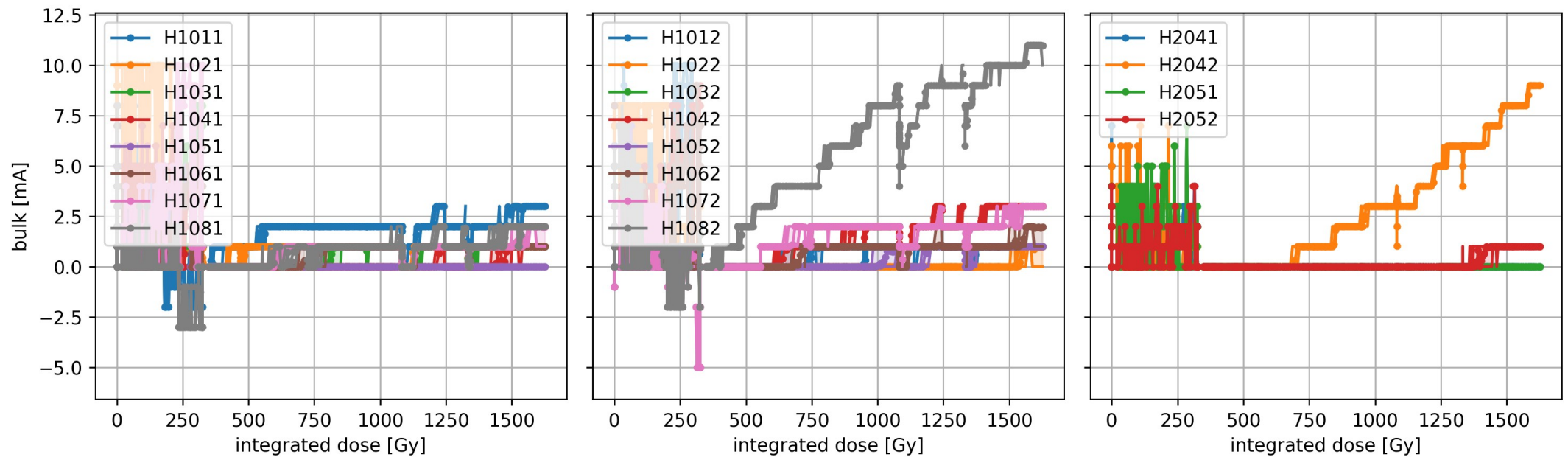
Pedestals
noise
difference
exp22-exp10
(limited nr of
runs
added up)



Pedestals – Conclusion?

- Pedestals get broader – no proper working mitigation yet
 - Offset correction etc., reduce gain?
 - Problem for operation: pixels in limit → dead pixels, efficiency loss
- Pedestal noise changed by factor 2 for most irradiated modules
- Linear with dose(?), jumps can be understood by beam incidents
- Was this expected? No
- SNR was monitored in irradiation campaign, no such large effect observed?
- Reason unclear:
 - DCD irradiation?
- Effect from hot regions, dead gates?
 - No!
 - Mostly uniform increase of noise, but DCD structures clearly visible!
 - But: larger drift in noisy region of 1.01.1!
- Problem for operation? Noise level is well below threshold.

bulk Current in PEAK vs Integrated DCU BP_BW_325 Dose (2020+)

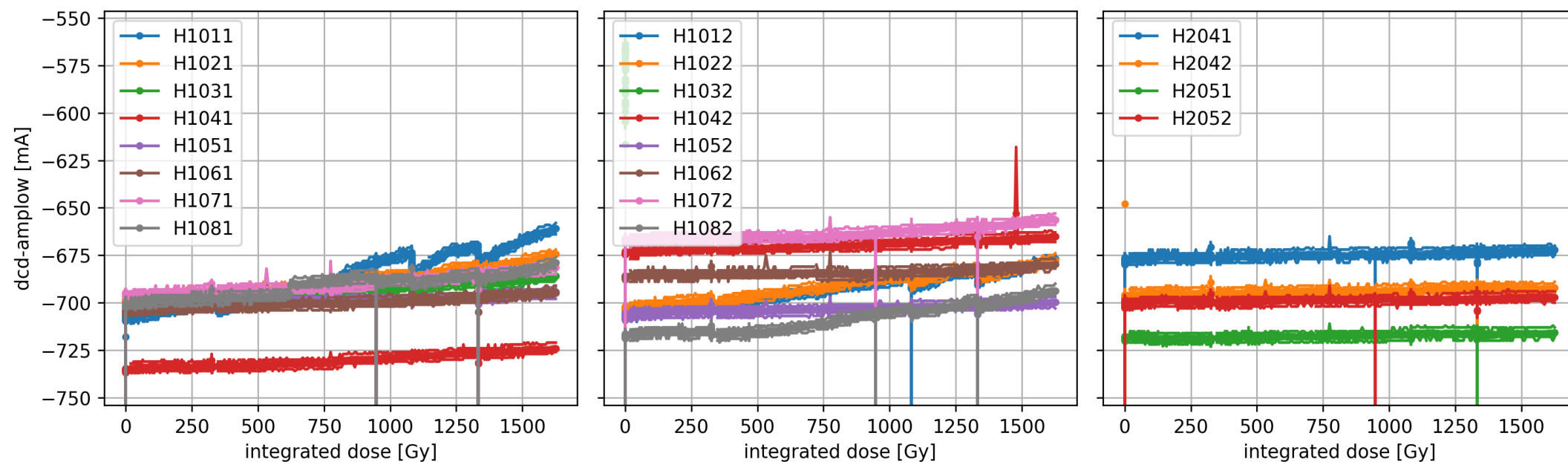


Bulk follows/compensates HV current.

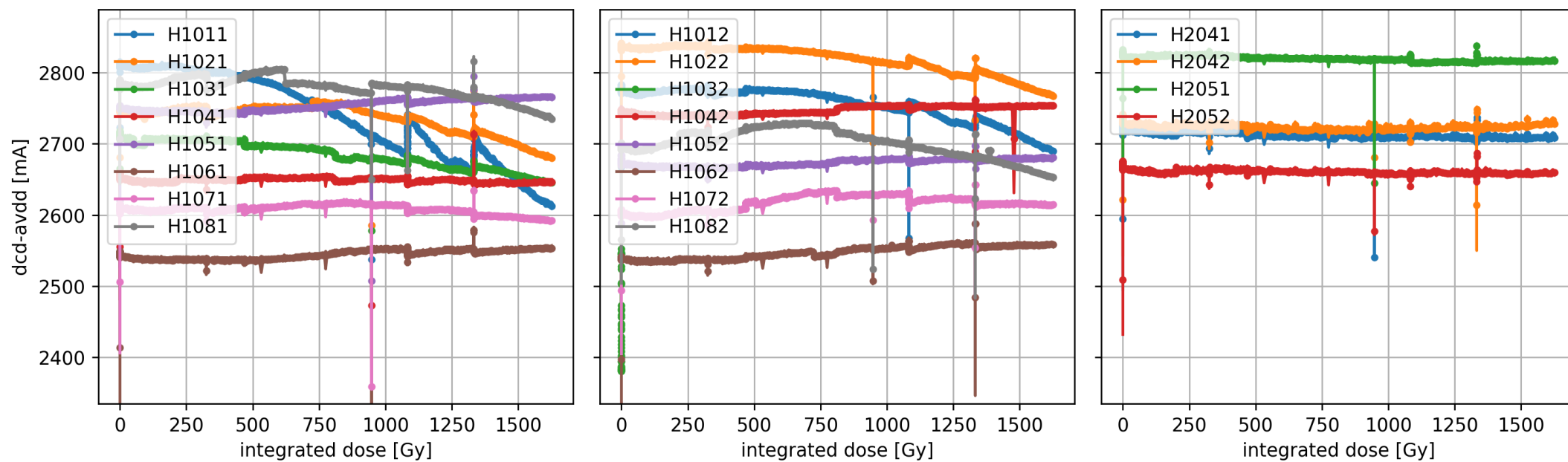
Plots provided by Arthur

https://pxd.belle2.org/USER/Arthur/ps_currents_monitoring/

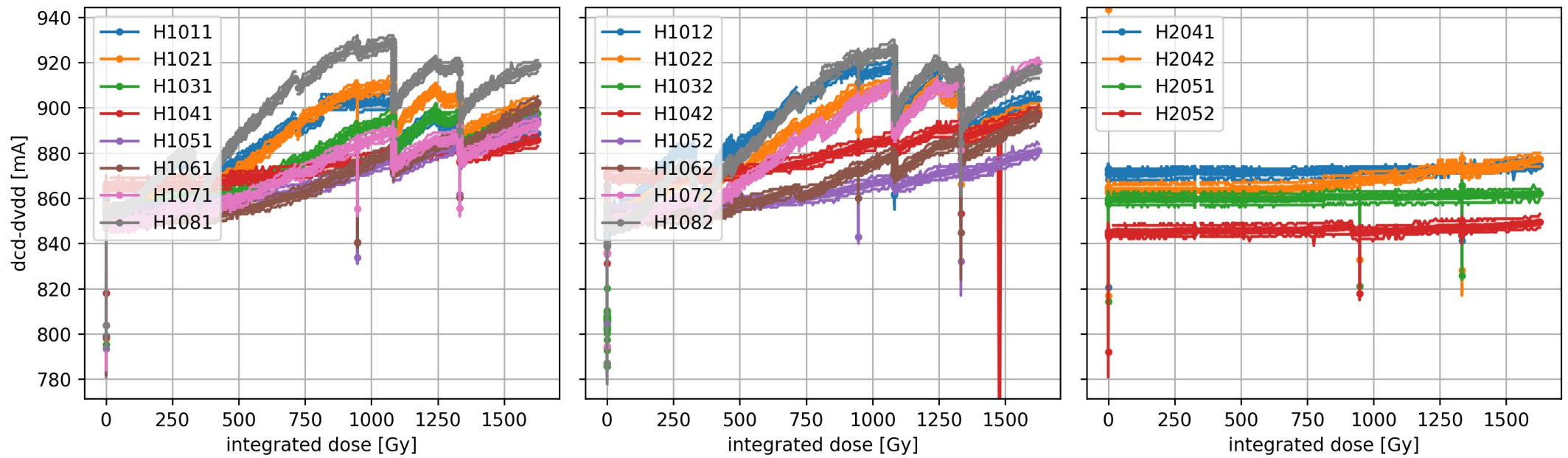
dcd-amplow Current in PEAK vs Integrated DCU BP_BW_325 Dose (2020+)



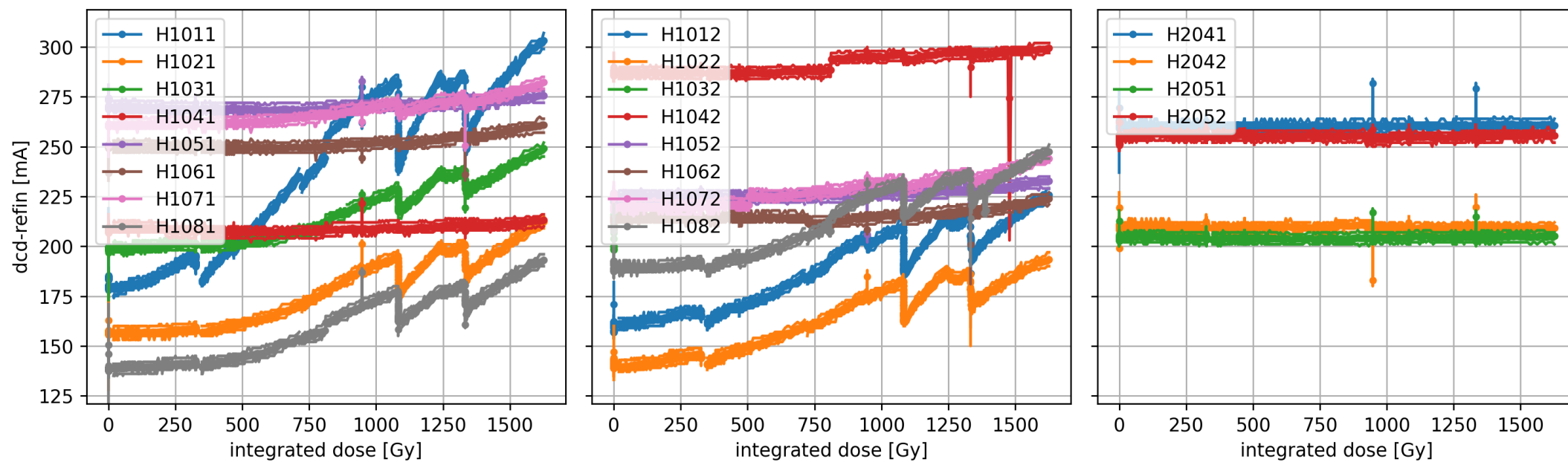
dcd-avdd Current in PEAK vs Integrated DCU BP_BW_325 Dose (2020+)



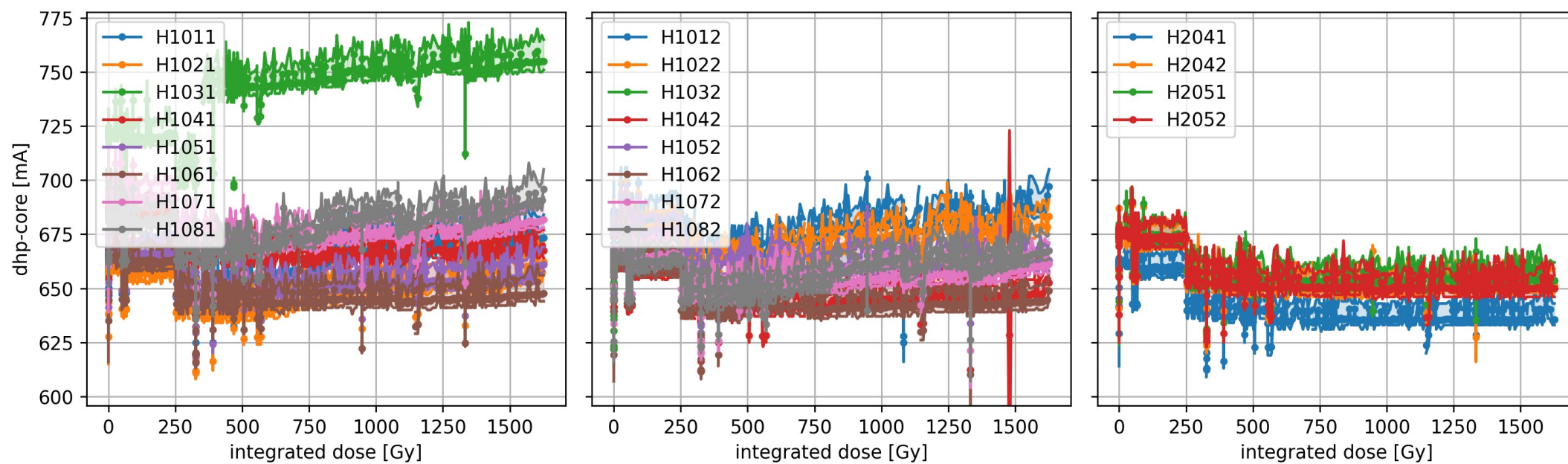
dcd-dvdd Current in PEAK vs Integrated DCU BP_BW_325 Dose (2020+)



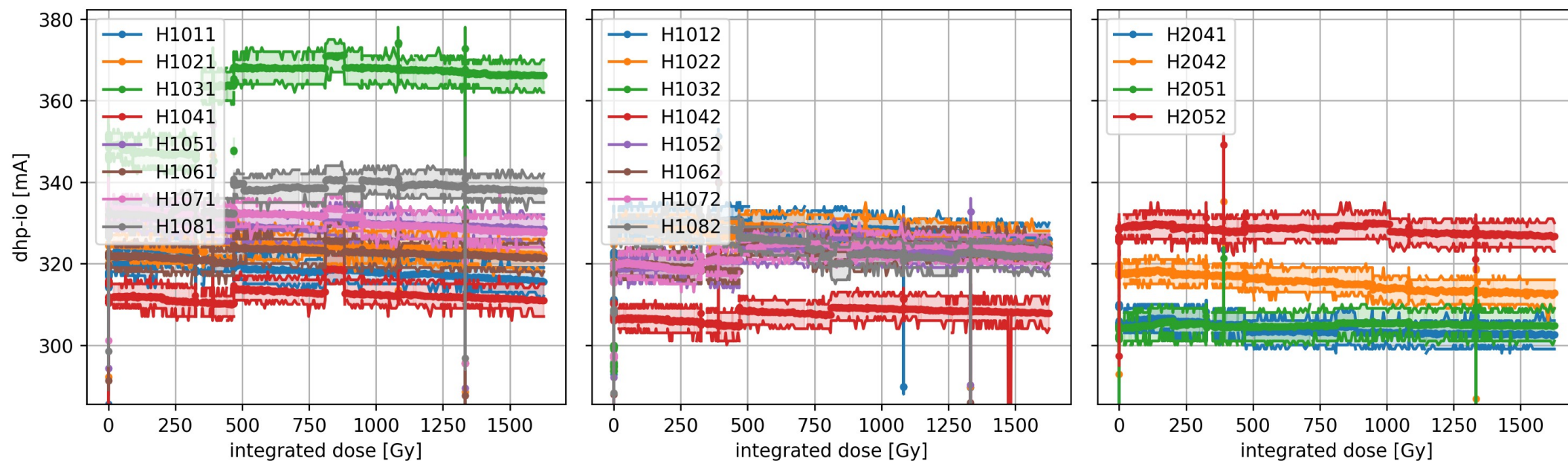
dcd-refin Current in PEAK vs Integrated DCU BP_BW_325 Dose (2020+)



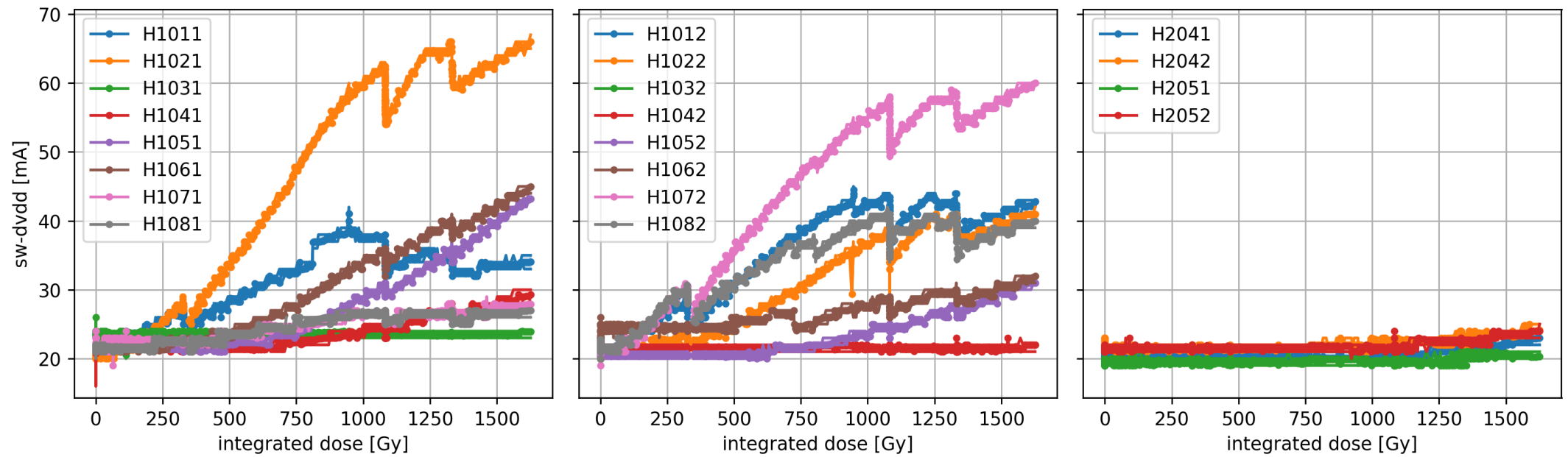
dhp-core Current in PEAK vs Integrated DCU BP_BW_325 Dose (2020+)



dhp-io Current in PEAK vs Integrated DCU BP_BW_325 Dose (2020+)



sw-dvdd Current in PEAK vs Integrated DCU BP_BW_325 Dose (2020+)



- Not much. We have to keep an eye on this.
- Limits need to be (or have already been) changed