AGIPD1.0: First results

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Outline

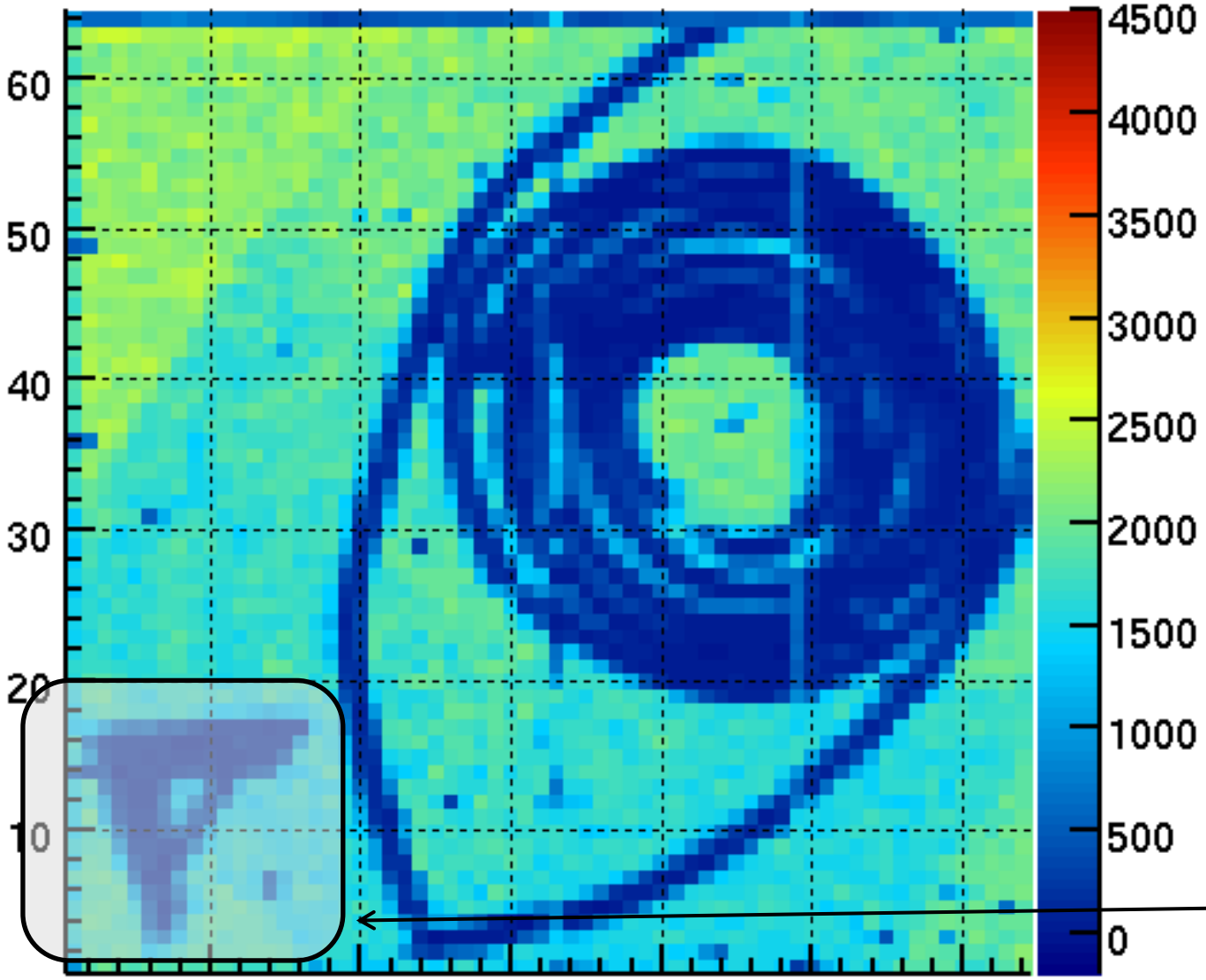
Introduction
- First image
- Pixel architecture

Open issues
- ADC Speed
- Radiation damage
- Working point, Linearity

Chip characterization
- Gain
- Noise
- Dynamic range

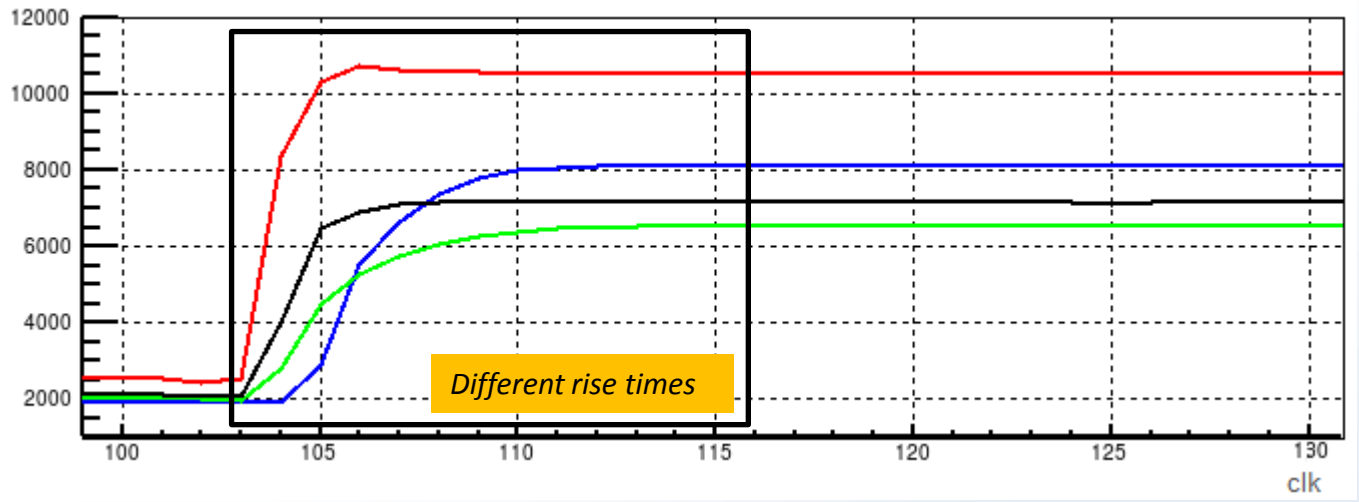
Summary

AGIPD1.0: It works!



Original AGIPD0.2 ‘A’

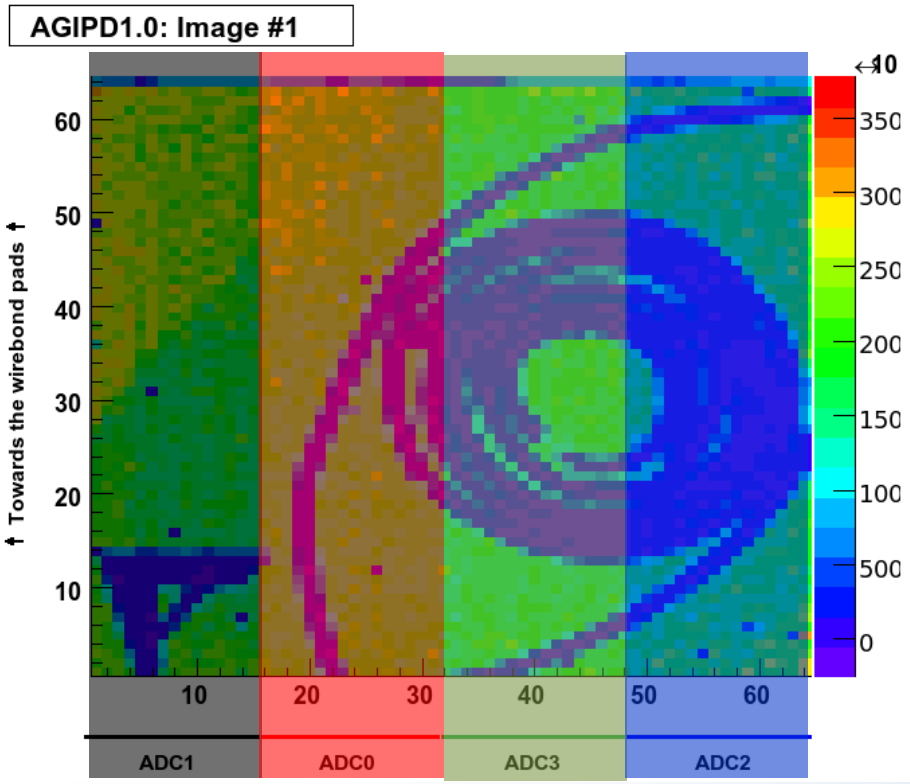
AGIPD1.0: ADC Speed



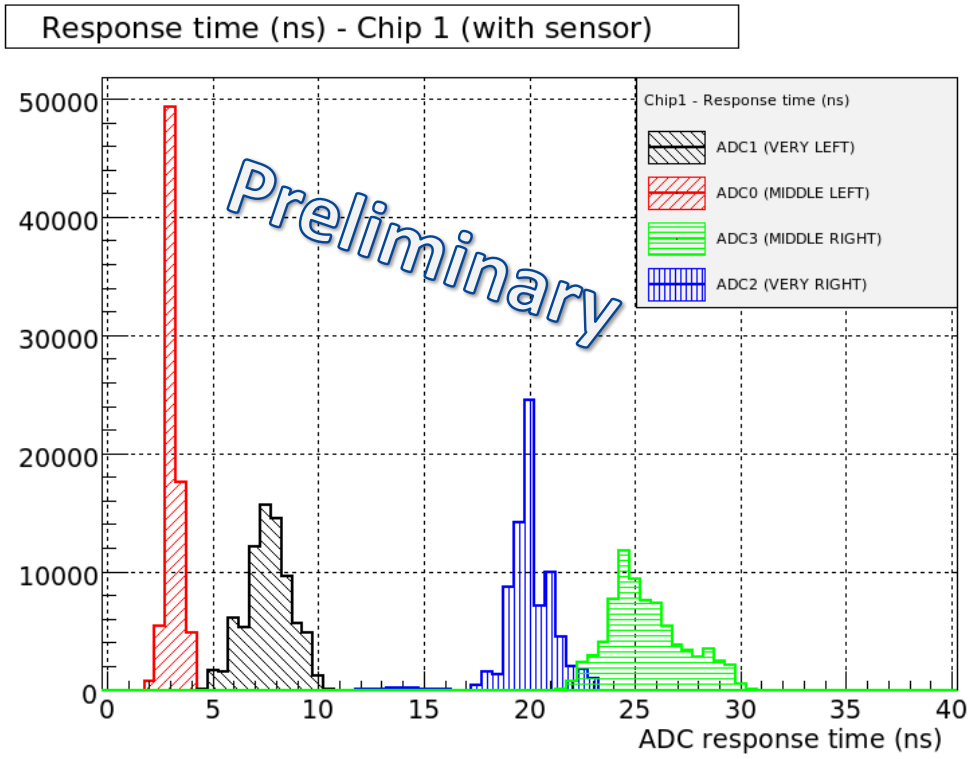
Output of the chiptester box:

- 4 ADC channels
- 1 Pixel
- 80 MHz ADC sampling

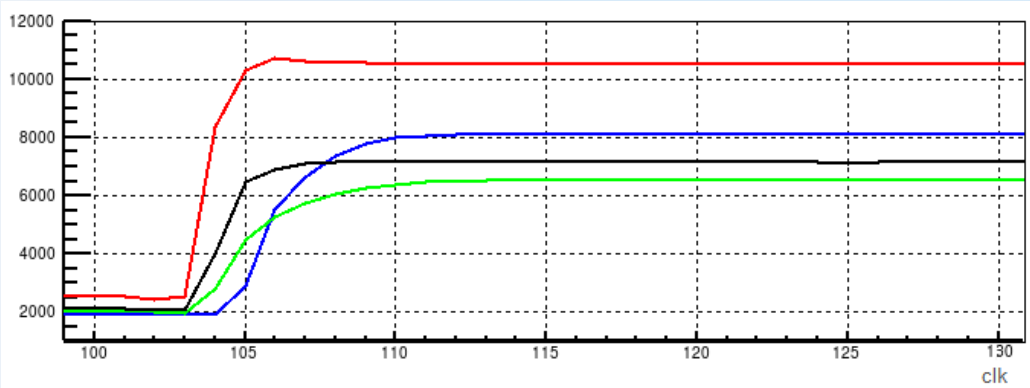
AGIPD1.0: ADC Speed



Bus towards readout

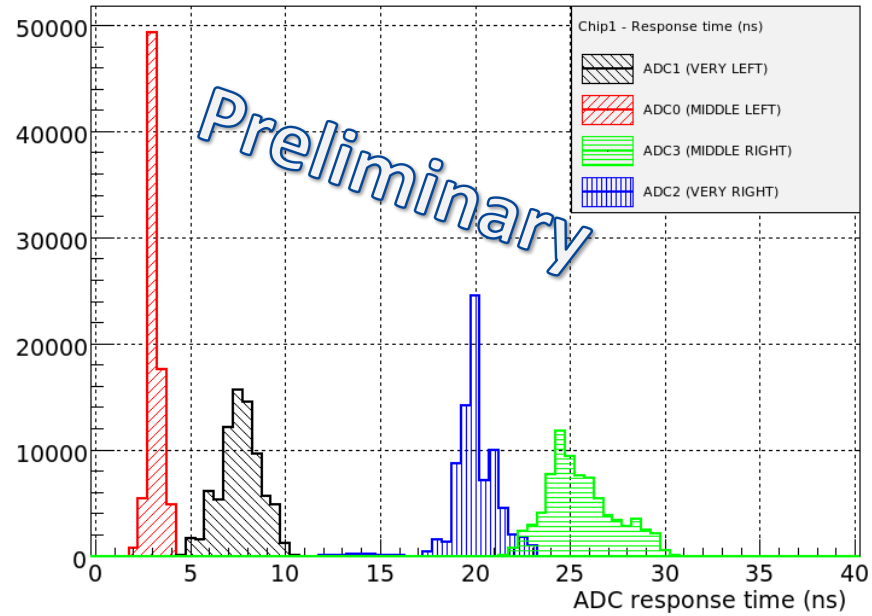


- Reason not clear!

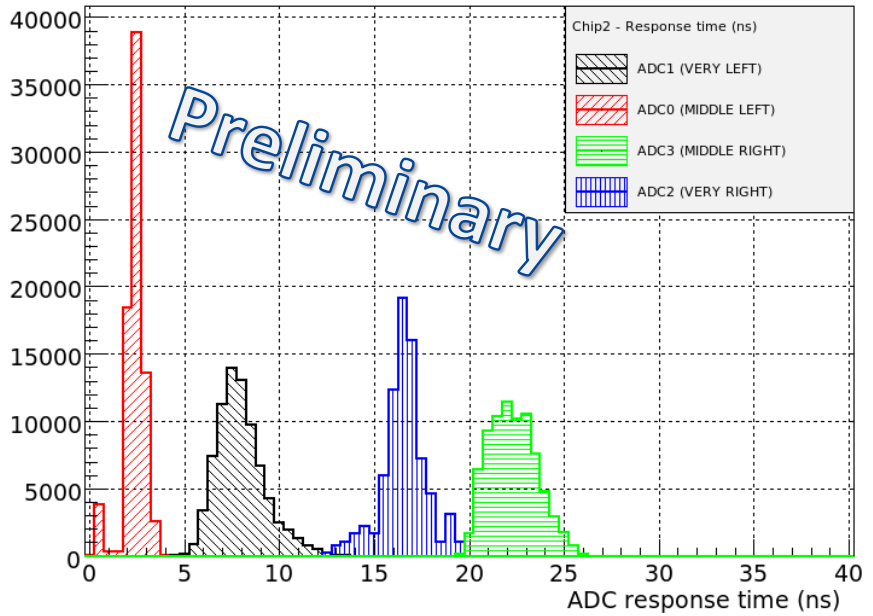


AGIPD1.0: ADC Speed

Response time (ns) - Chip 1 (with sensor)



Response time (ns) - Chip 2

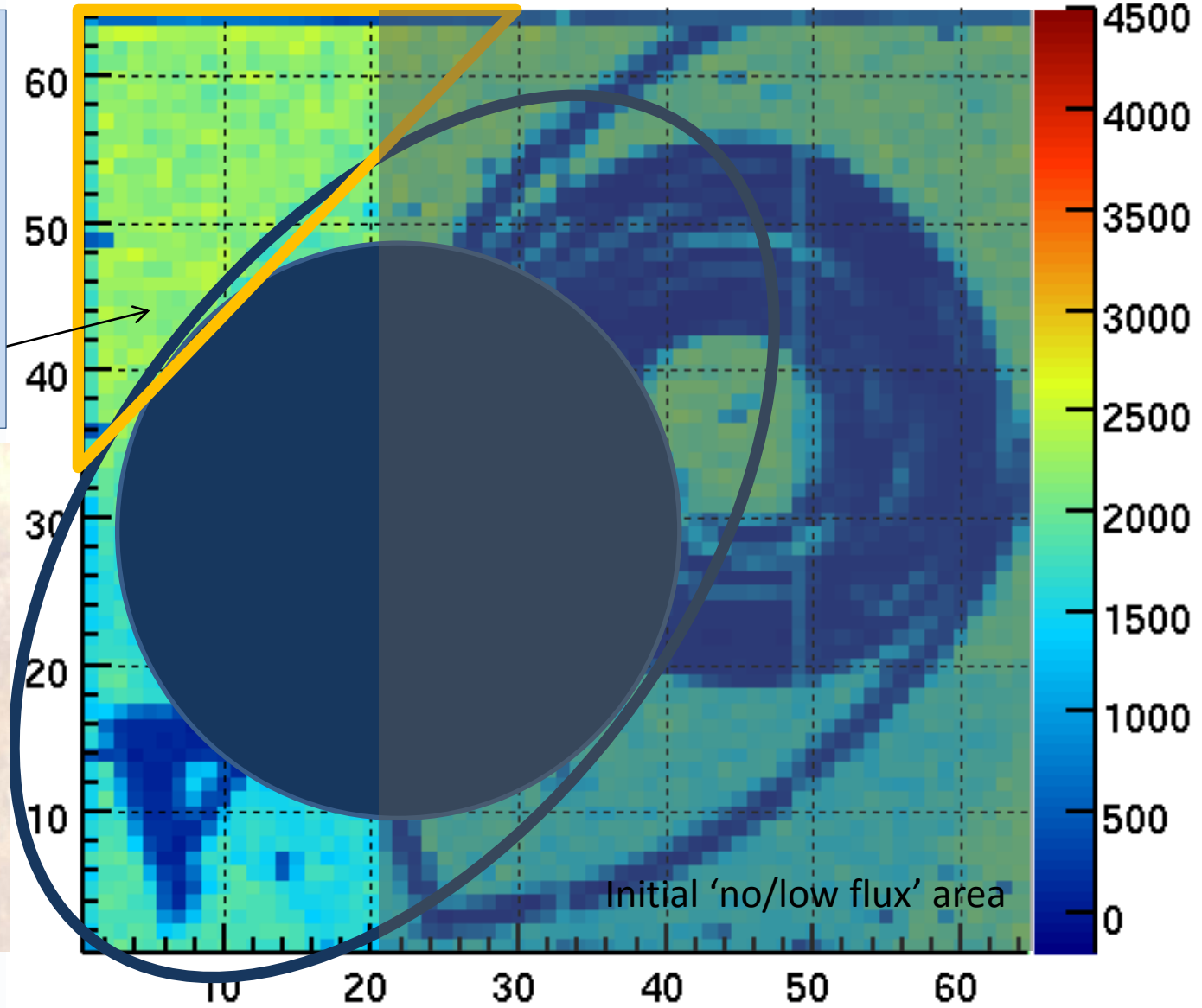


-Two different chips: Same behavior!

AGIPD1.0: Radiation damage ?

High photon flux, direct X-ray beam:
→Change in pedestal
→Sensor?
ASIC?
Capton foil?

of the 'eye'



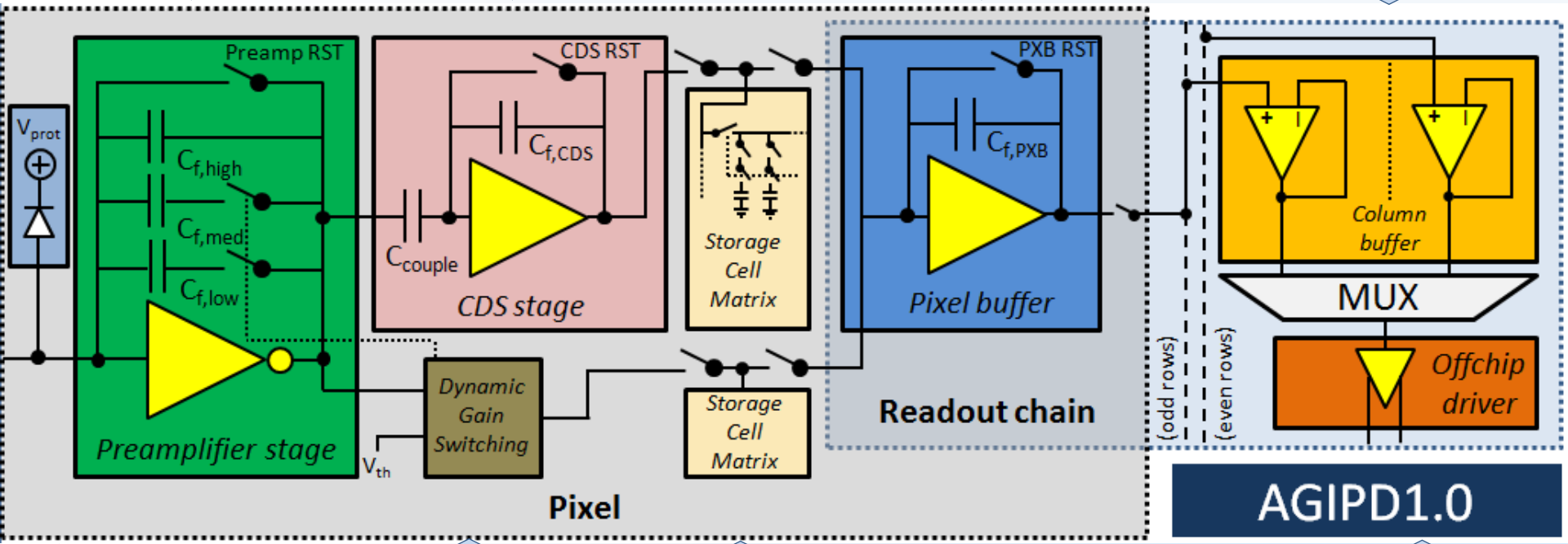
AGIPD1.0: Pixel schematics

3-fold dynamically gain switching preamplifier

CDS stage (correlated double sampling)

Pixel buffer (charge sensitive)

Column buffer (interleaved, precharging signal to bus)



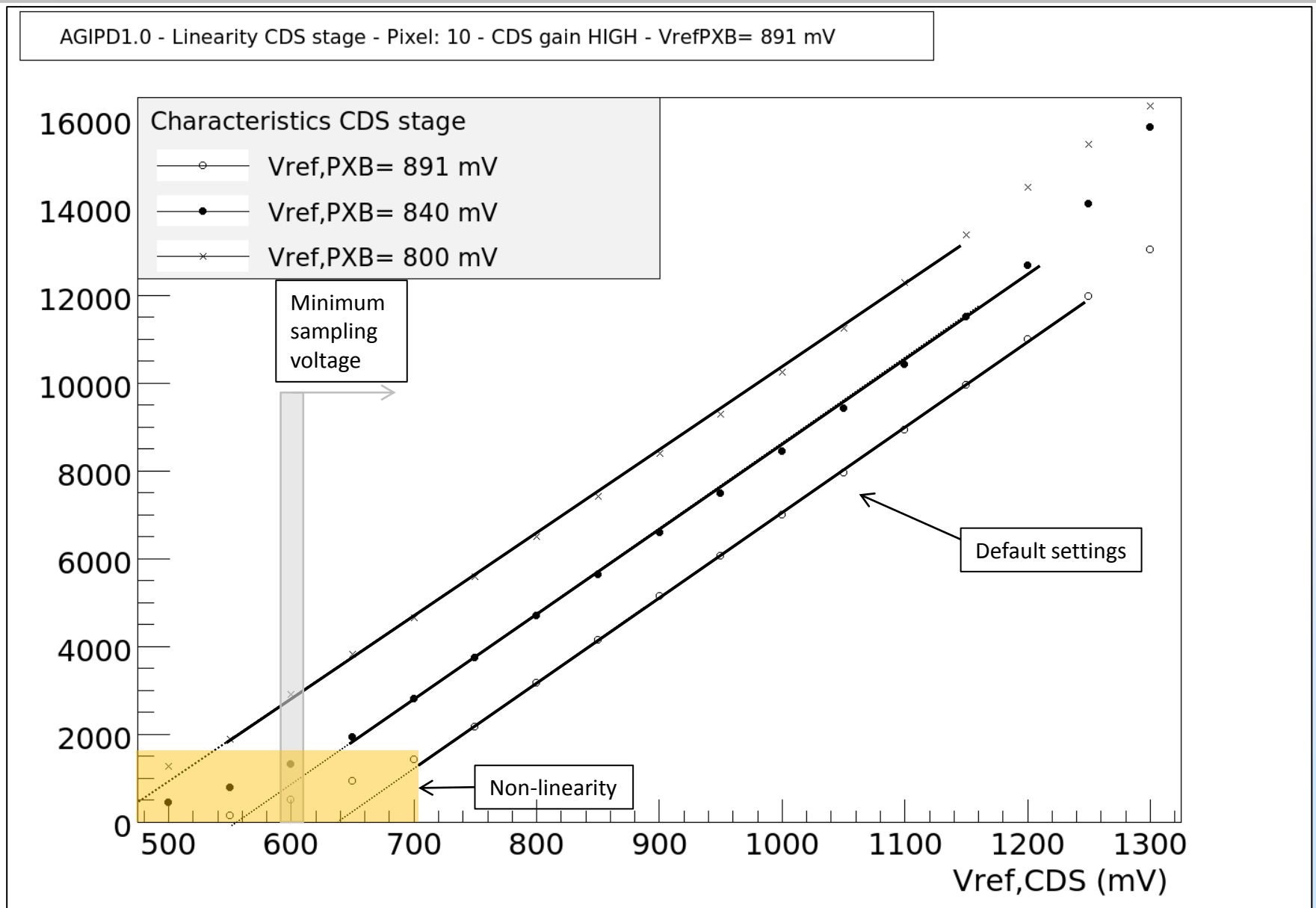
Input protection diode

Dynamic gain switching logic

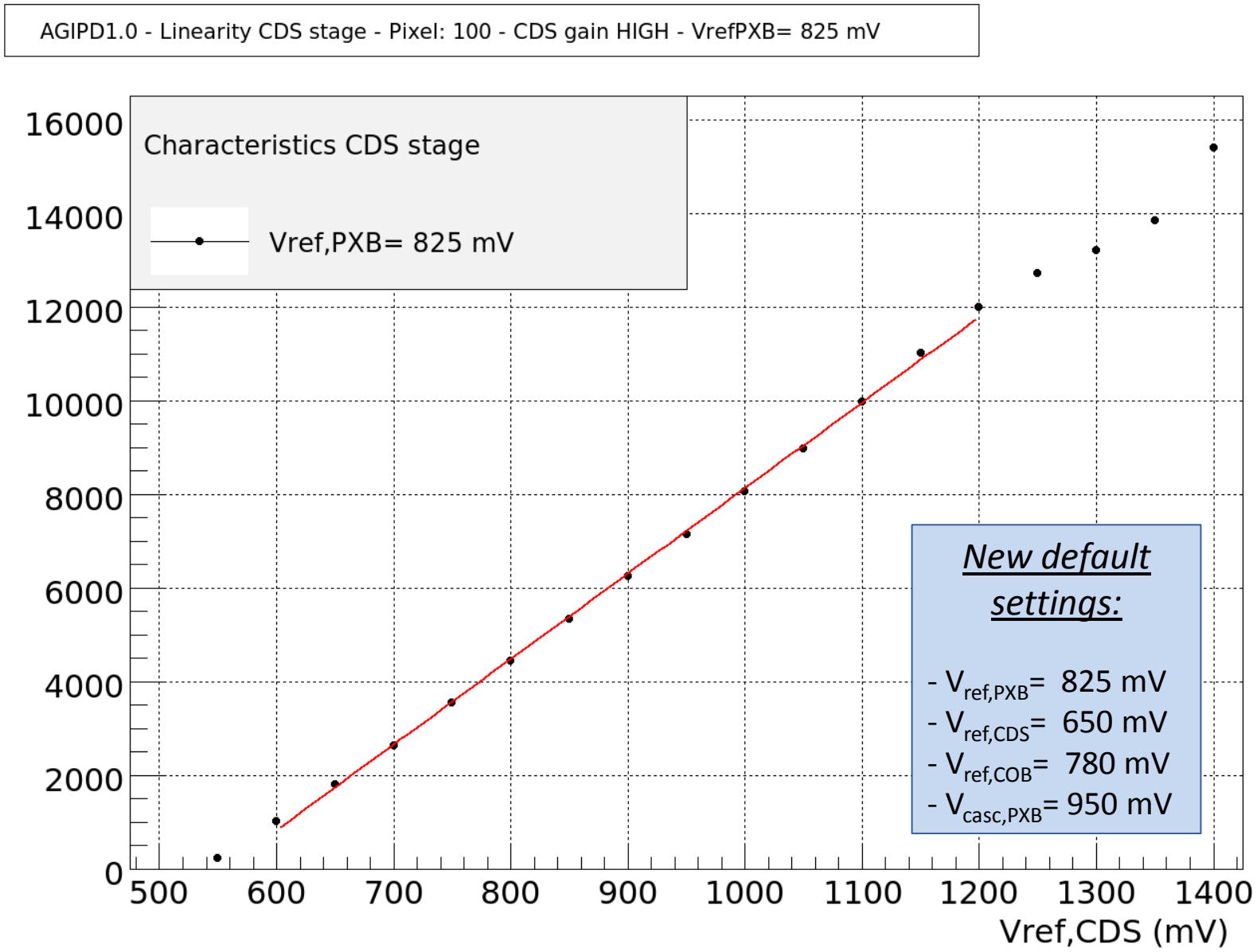
352 storage cells (radiation tolerant design)

Offchip driver (Fully differential: Can drive 100 Ω load @ 30 MHz)

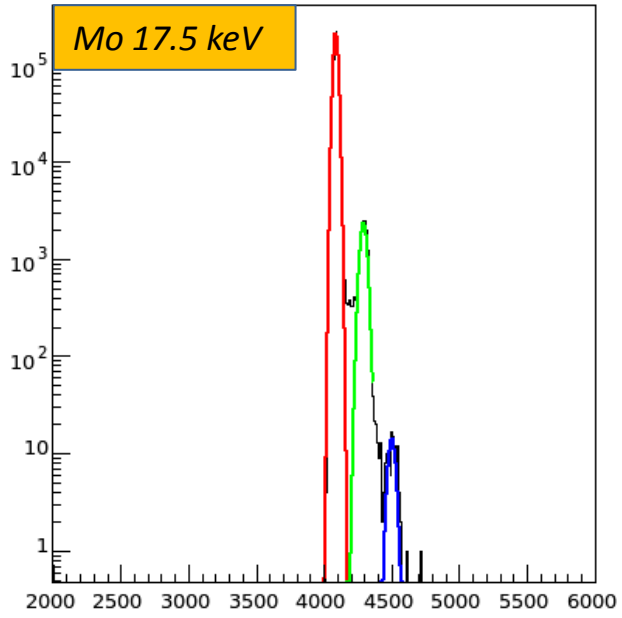
AGIPD1.0: Buffer Characteristics

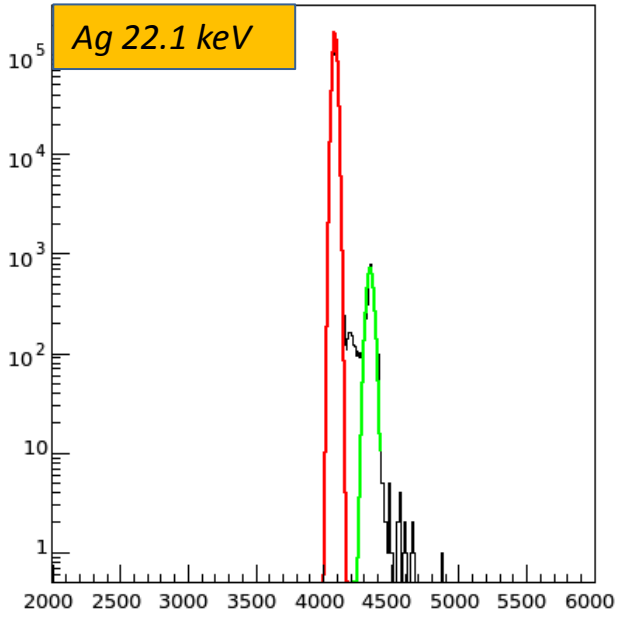


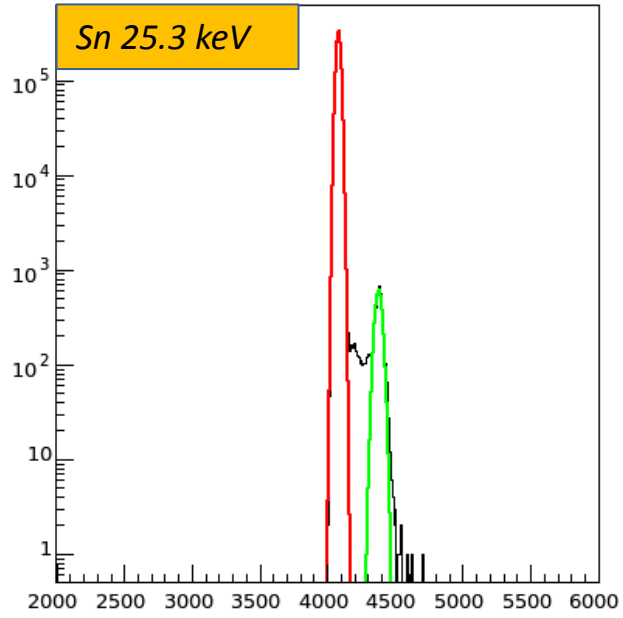
AGIPD1.0: Buffer Characteristics



AGIPD1.0: Gain & Noise (CDS gain LOW x1.5)



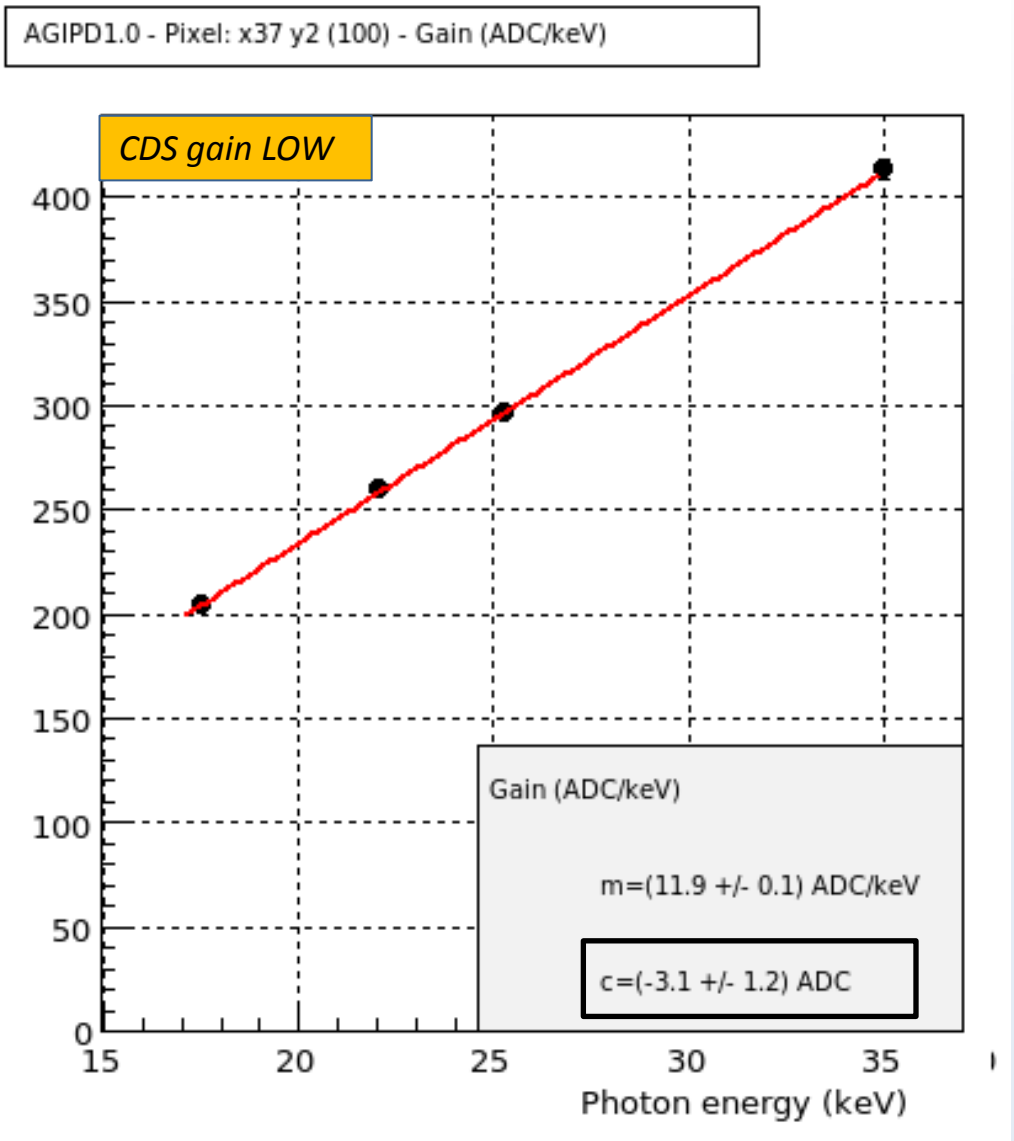




Fluorescence from :
- Mo (17.5 keV)
- Ag (22.1 keV)
- Sn (25.3 keV)

Integration time: 10 µs
$V_{ref,CDS}$= 700 mV
CDS gain LOW (x1.5)

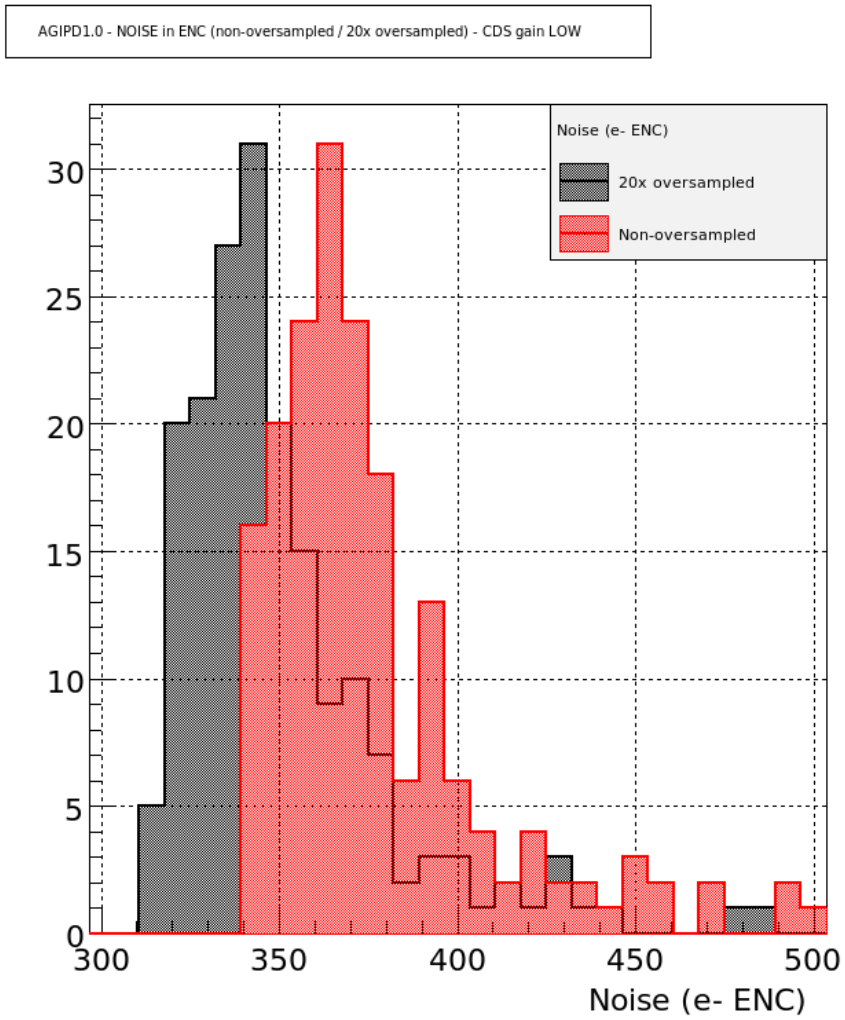
AGIPD1.0: Gain & Noise (CDS gain LOW x1.5)

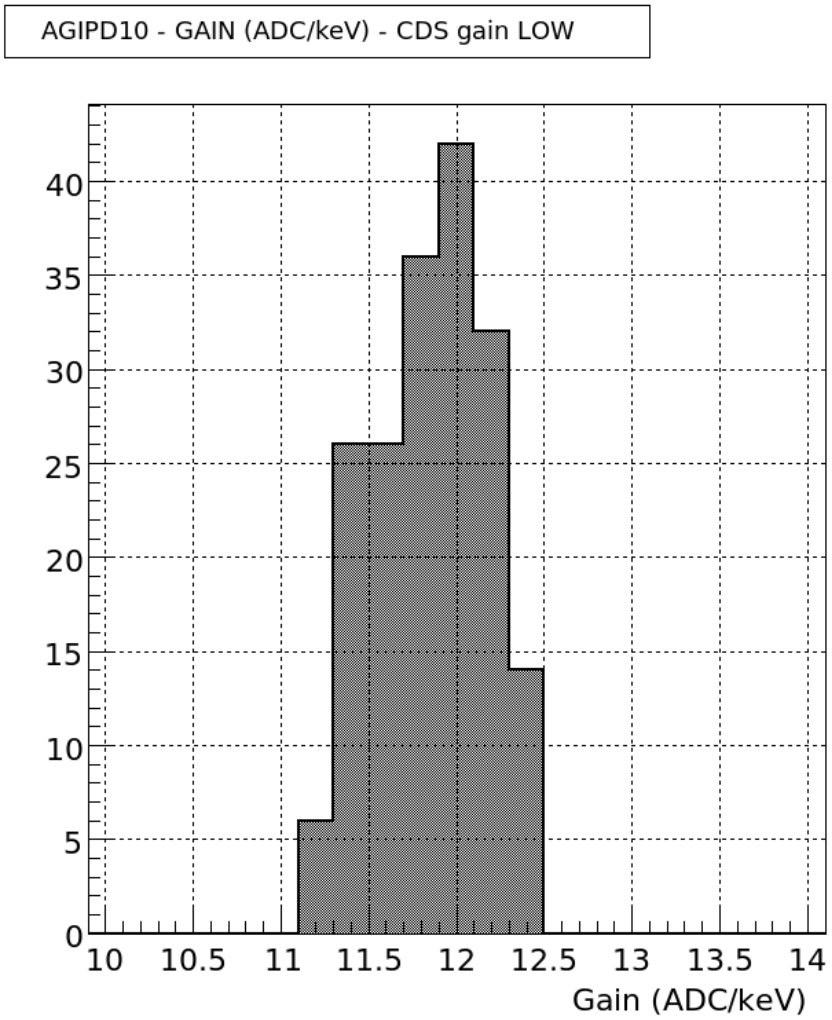


Good linearity!!

Gain= 11.9 ADC/keV
- AGIPD0.4 (CDS gain HIGH x1.8) had a gain of 16.0 ADC/keV

AGIPD1.0: Gain & Noise (CDS gain LOW x1.5)

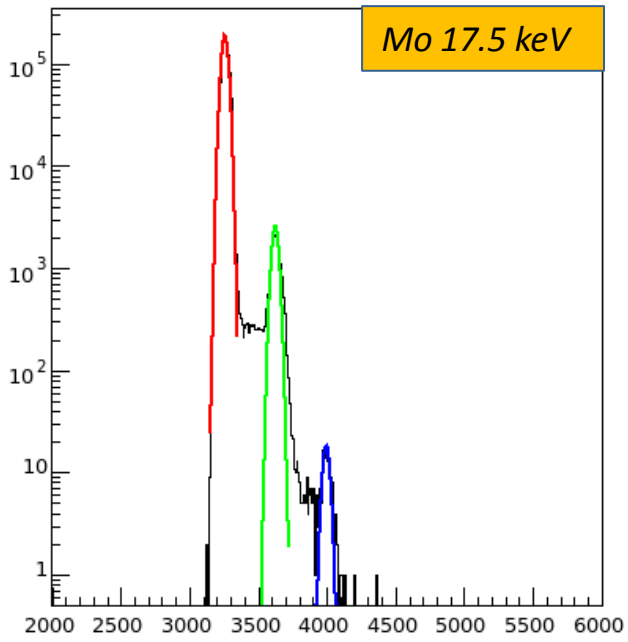


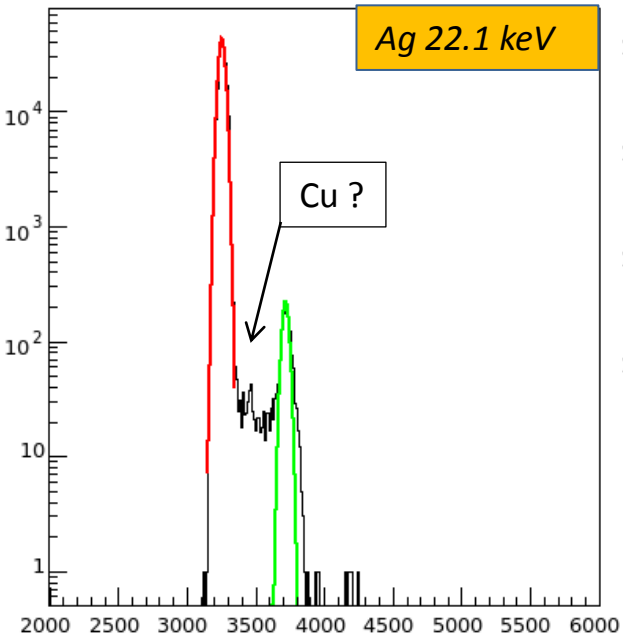


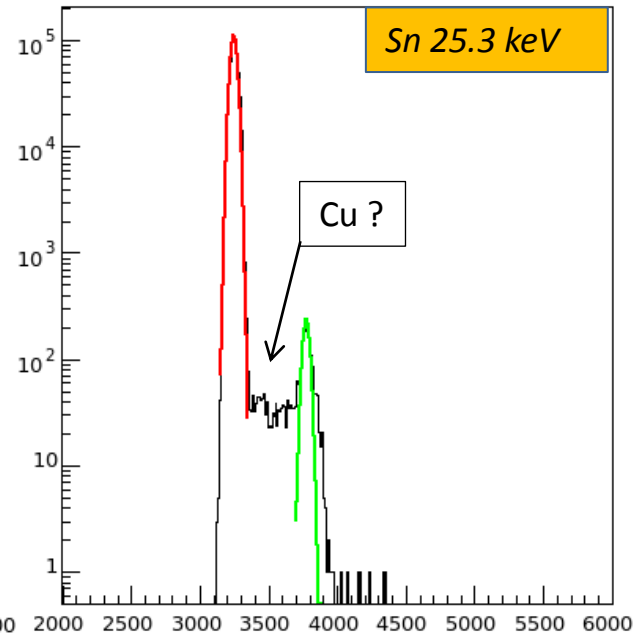
-196 Pixels investigated
- Noise (non-oversampled): 363 e⁻ ENC
- Noise (20x oversampled): 340 e⁻ ENC

Little contributions from readout chain (PXB, COLB, OFFCHIPDRIVER)

AGIPD1.0: Gain & Noise (CDS gain HIGH x3)







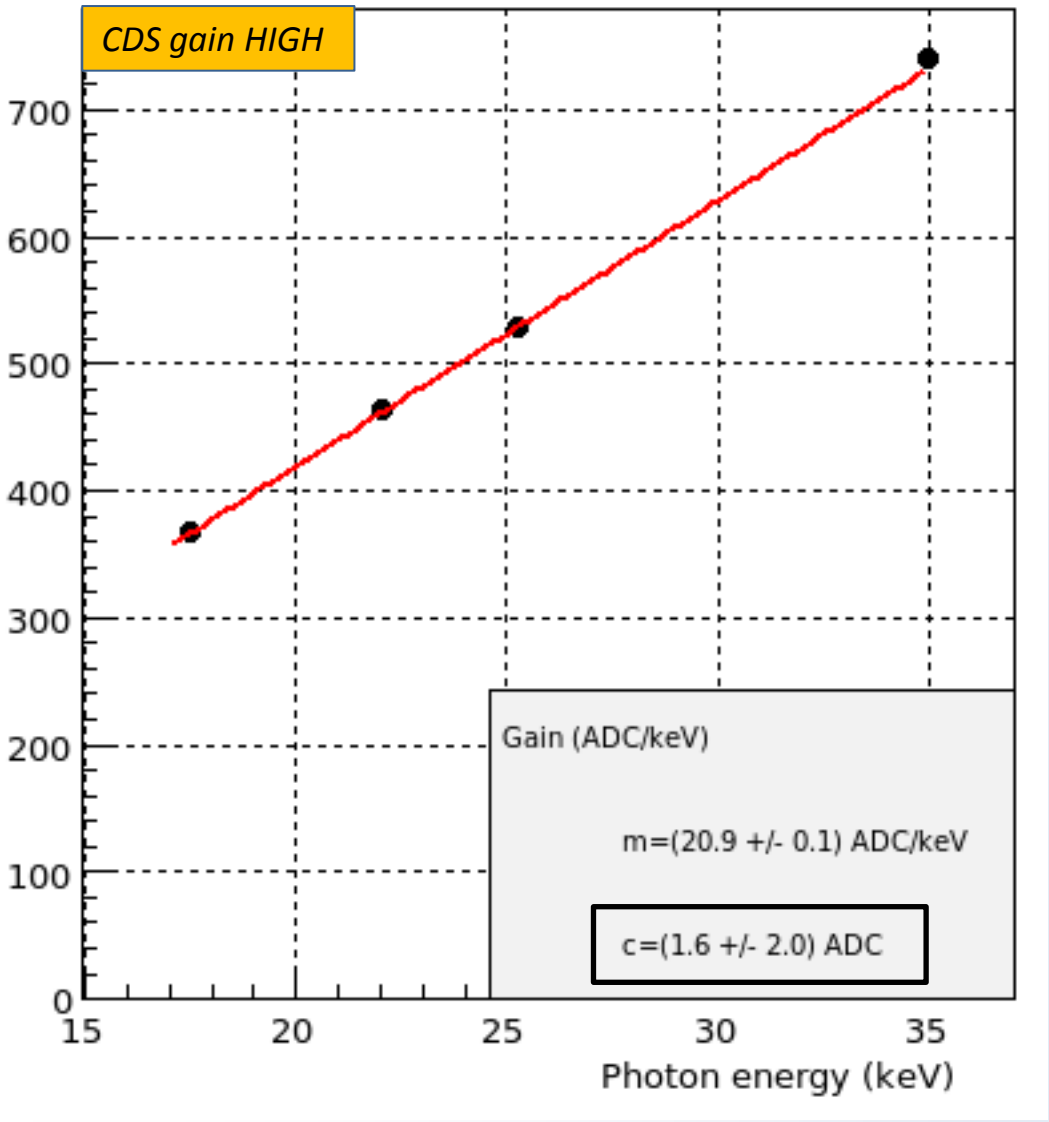
Baseline lower for CDS gain HIGH (~3250 ADC)
(compared to CDS gain LOW @ ~4100 ADC)

→ Be careful about non-linearity!

Fluorescence from :
- Mo (17.5 keV)
- Ag (22.1 keV)
- Sn (25.3 keV)

Integration time: 10 µs
$V_{ref,CDS}$= 700 mV
CDS gain HIGH (x3)

AGIPD1.0: Gain & Noise (CDS gain HIGH x3)

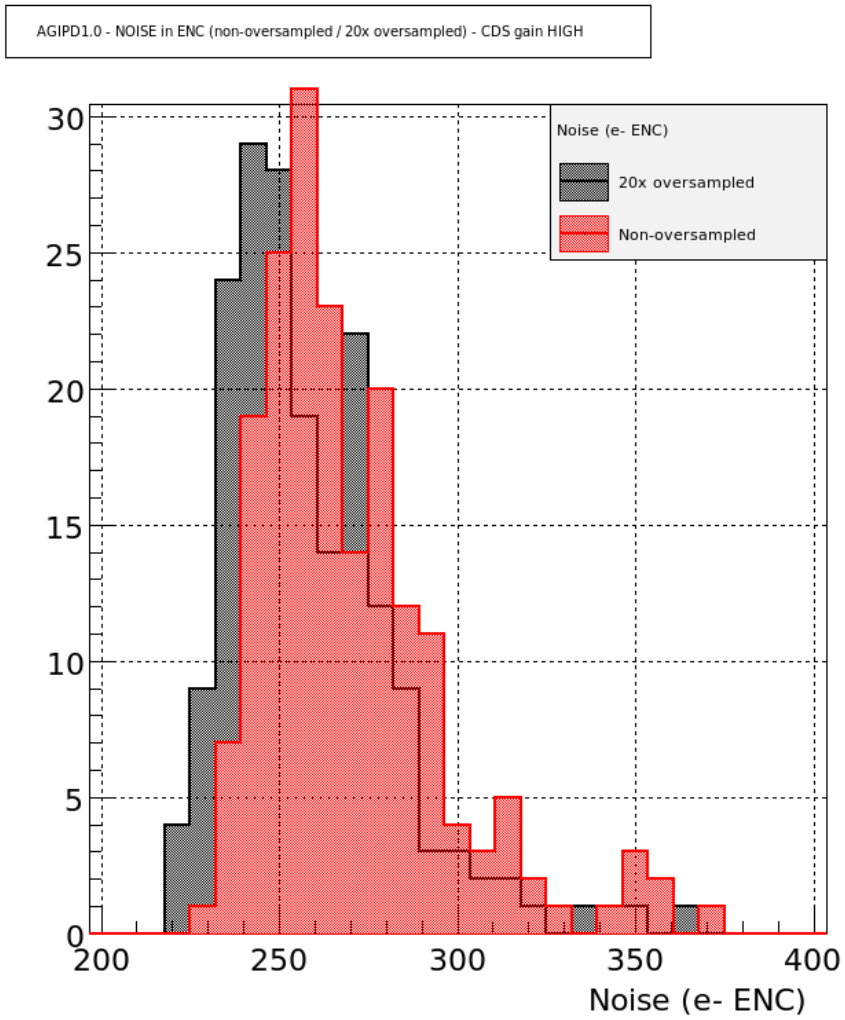


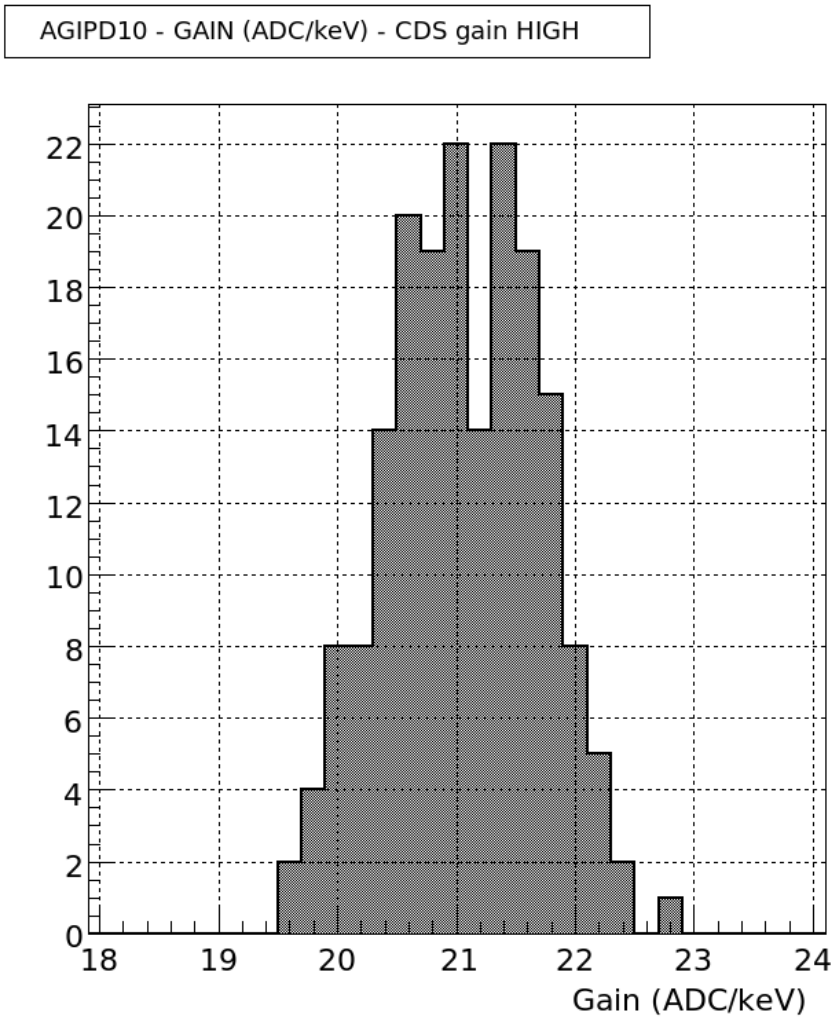
Good linearity!!

Gain= 20.9 ADC/keV

-Compared to CDS gain LOW (11.9 ADC/keV) increase by **x1.76**
- Theoretical increase x2

AGIPD1.0: Gain & Noise (CDS gain HIGH x3)

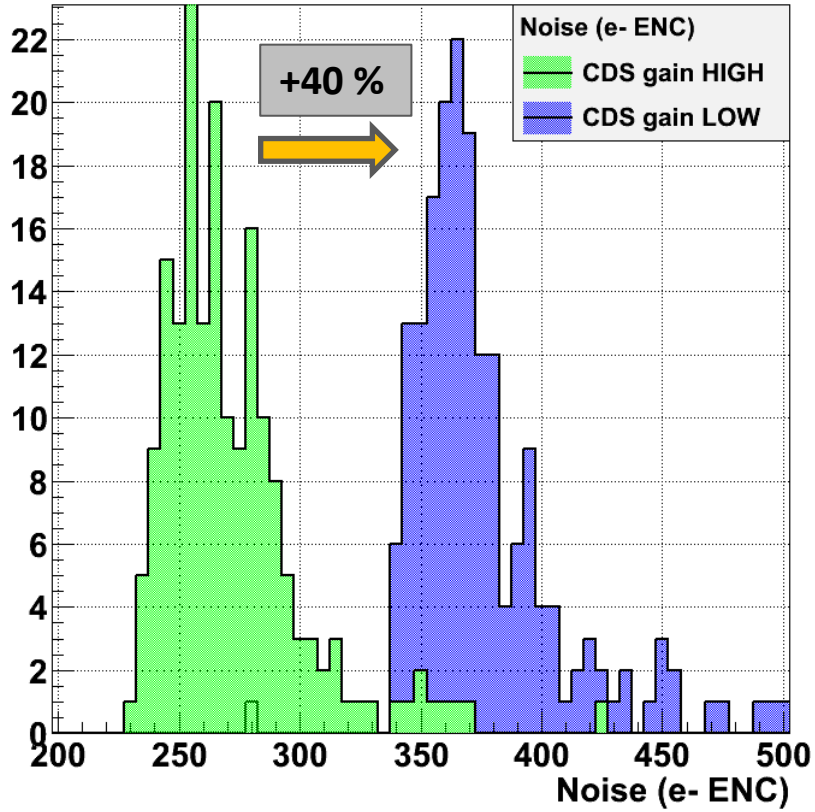


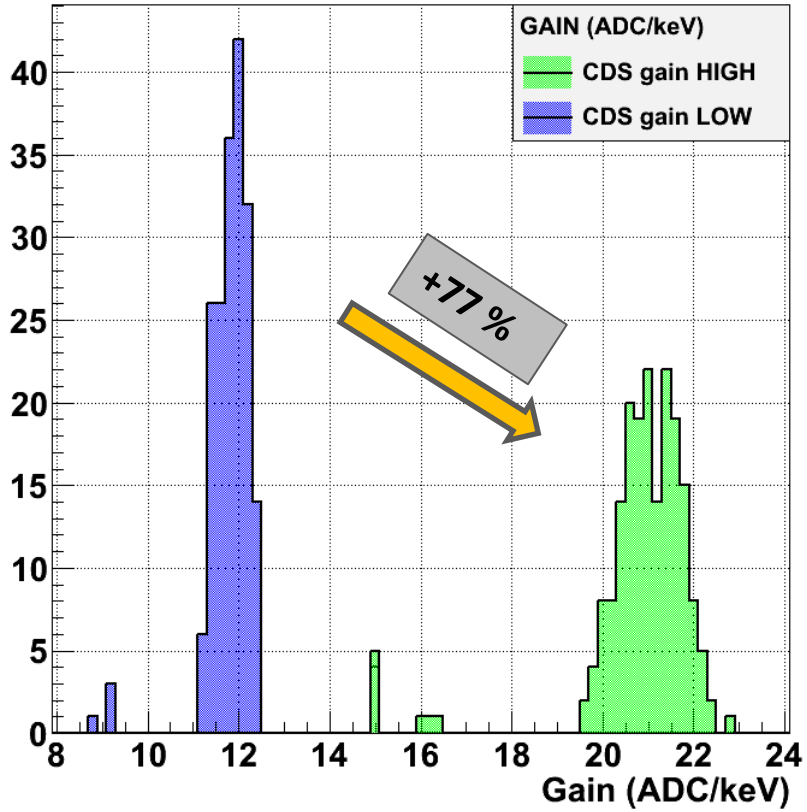


-196 Pixels investigated
- Noise (non-oversampled): 265 e⁻ ENC
- Noise (20x oversampled): 240 e⁻ ENC

It seems that the Preamplifiers noise gets dominant!

AGIPD1.0: Gain & Noise (CDS gain LOW/HIGH)





- **Noise$_{(\text{non-oversampled, CDS gain LOW})}$: (363 ± 19) e$^-$ ENC**
- **Noise $_{(\text{non-oversampled, CDS gain HIGH})}$: (265 ± 19) e$^-$ ENC**

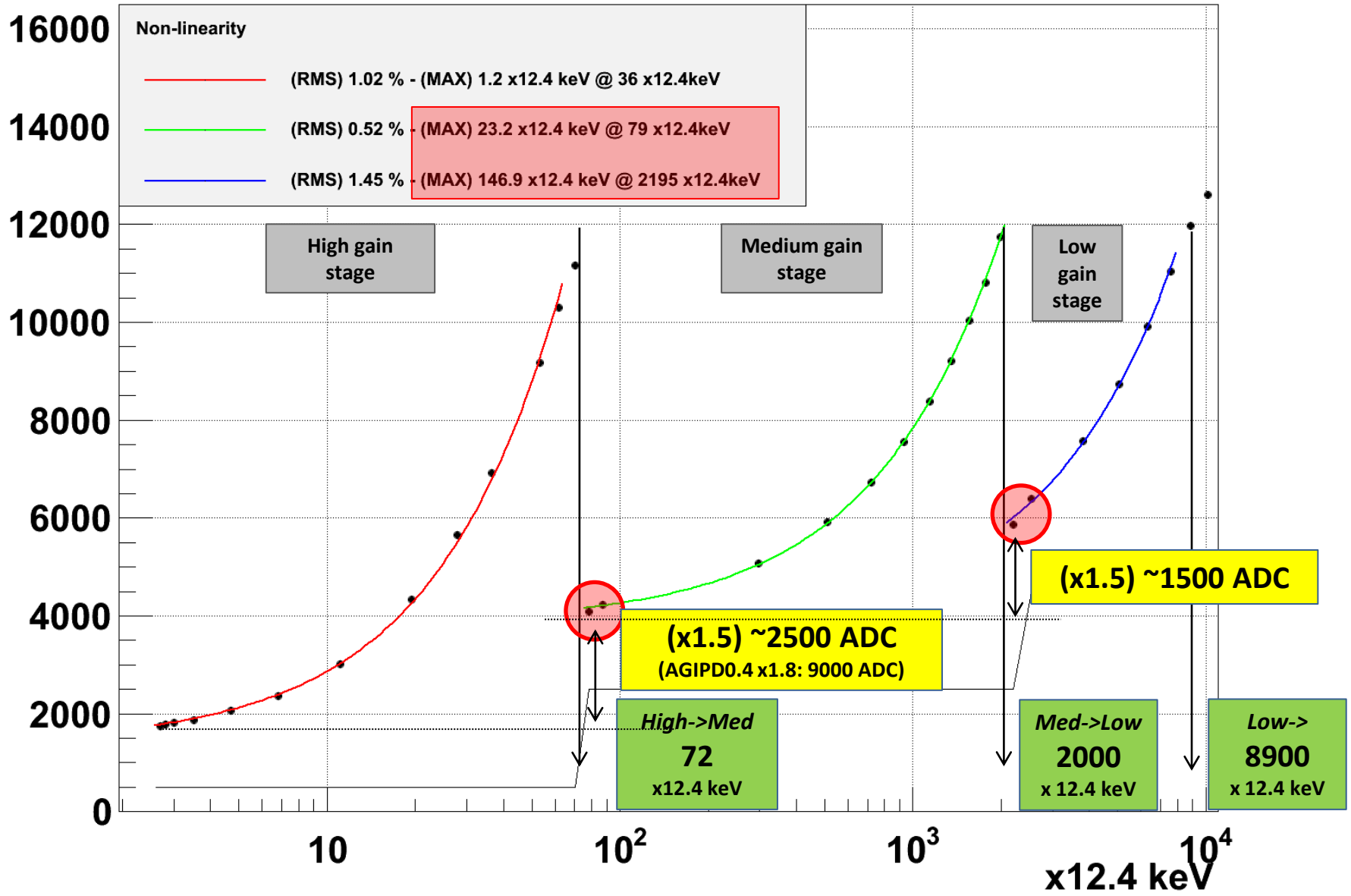
→ Overall noise doesn't profit from increased CDS gain, indicating that the noise contributions before CDS stage get dominant

→**Preamp noise gets dominant**

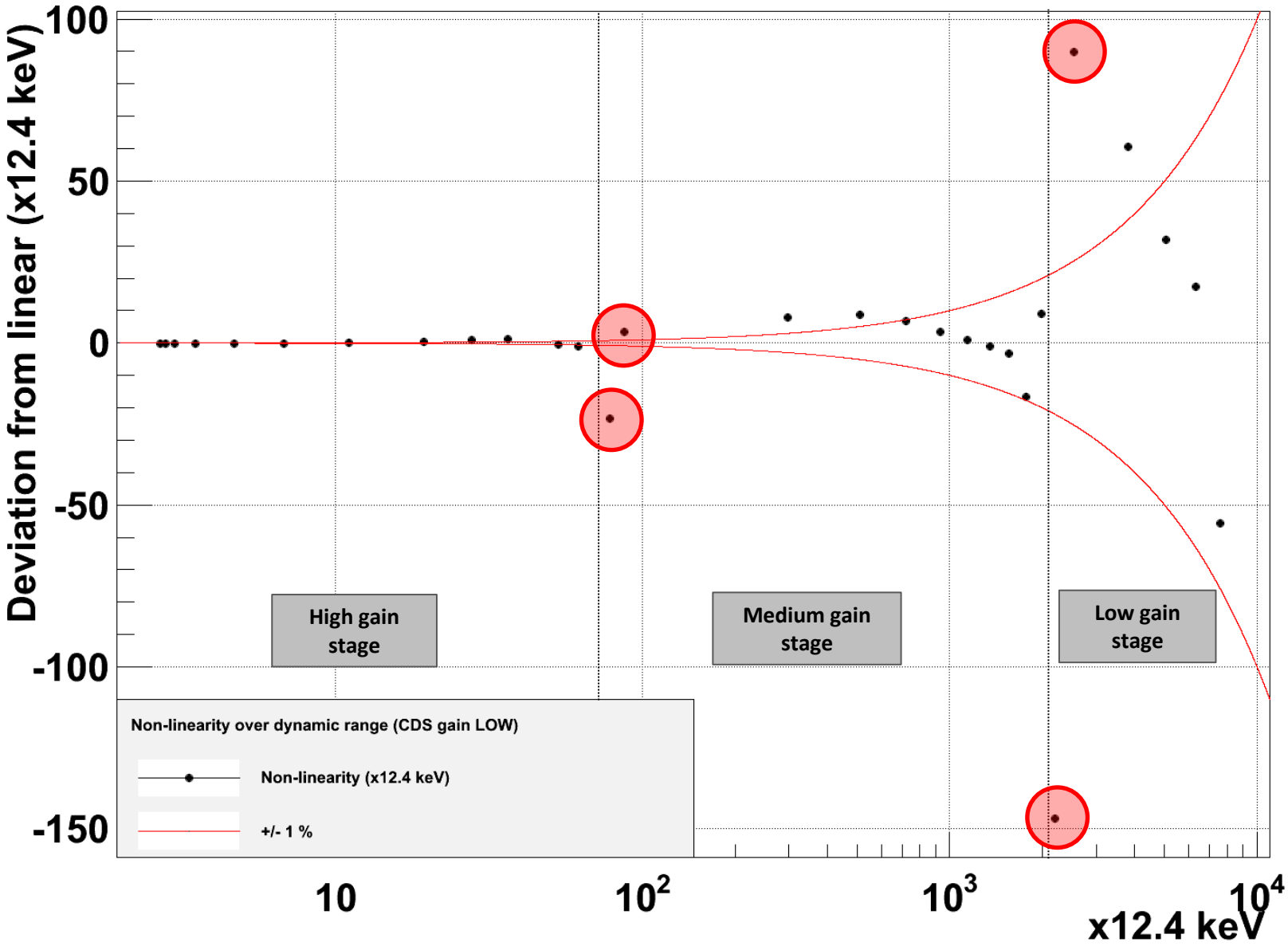
- **Gain $_{(\text{CDS gain LOW})}$: (11.9 ± 0.4) ADC/keV**
- **Gain$_{(\text{CDS gain HIGH})}$: (21.1 ± 0.7) ADC/keV**

→**Pixel-to-Pixel variation: <4 %**

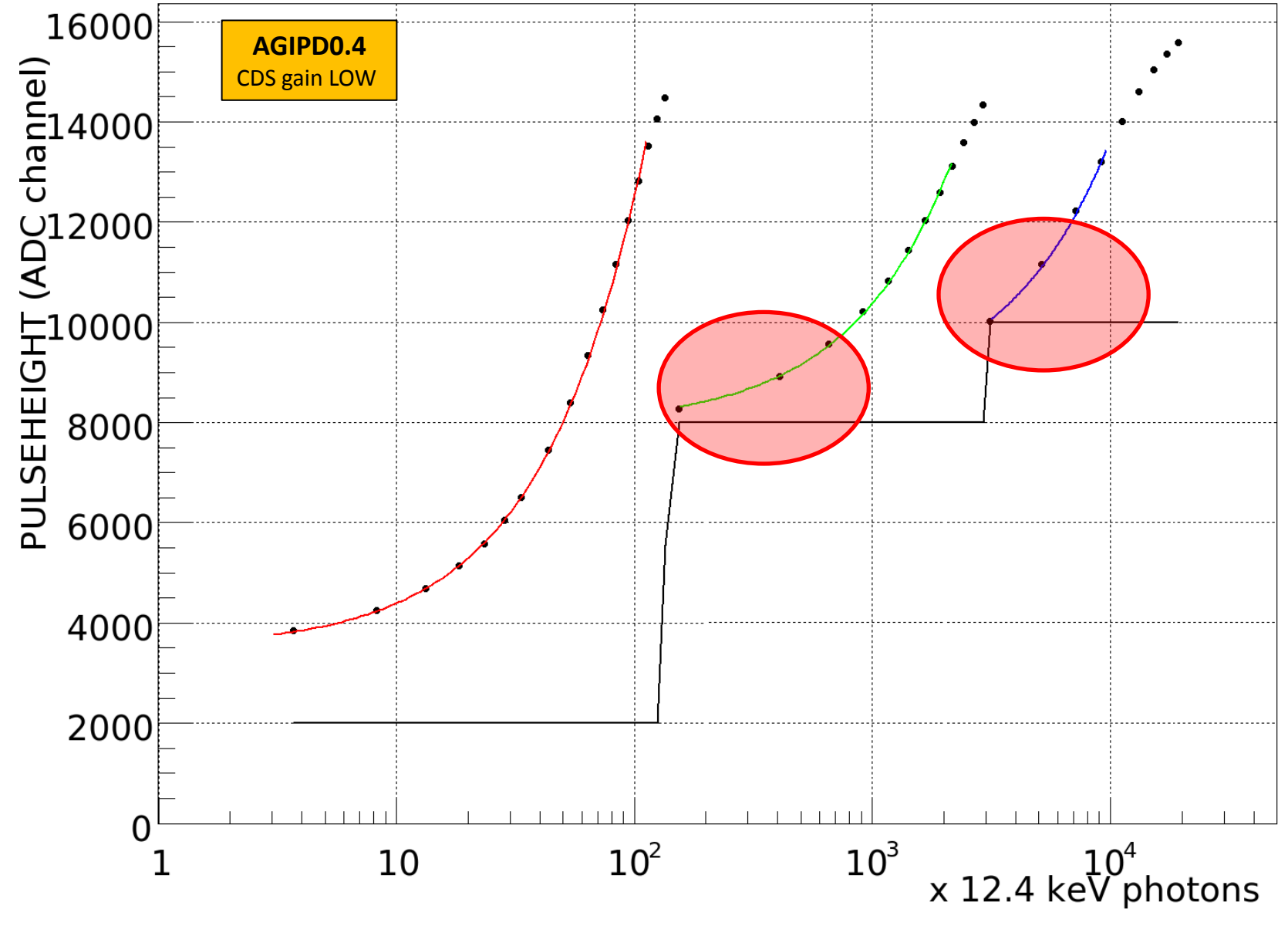
AGIPD1.0: Dynamic Range (CDS gain LOW x1.5)



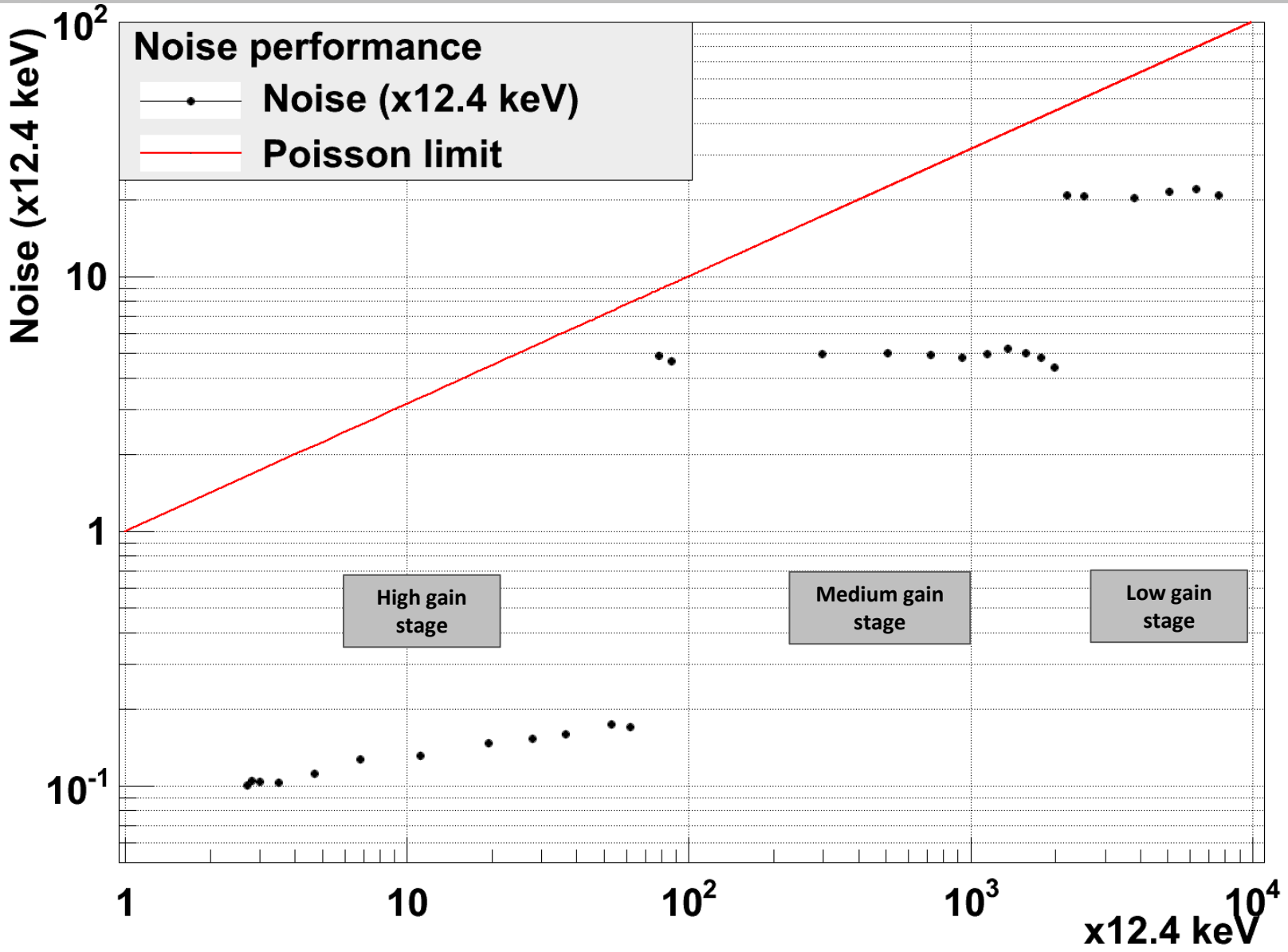
AGIPD1.0: Dynamic Range (CDS gain LOW x1.5)



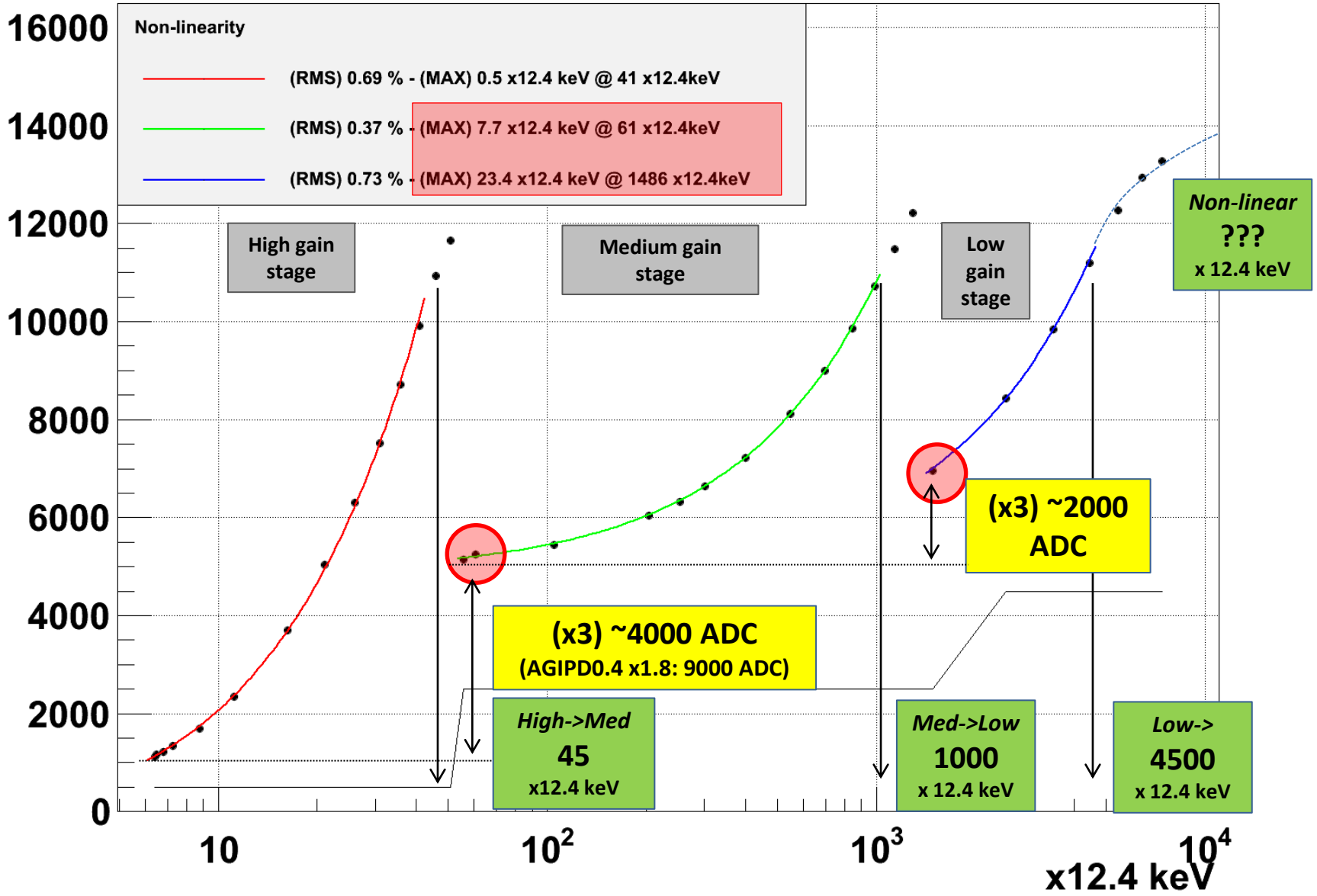
AGIPD0.4: Dynamic Range (CDS gain LOW x1.0)



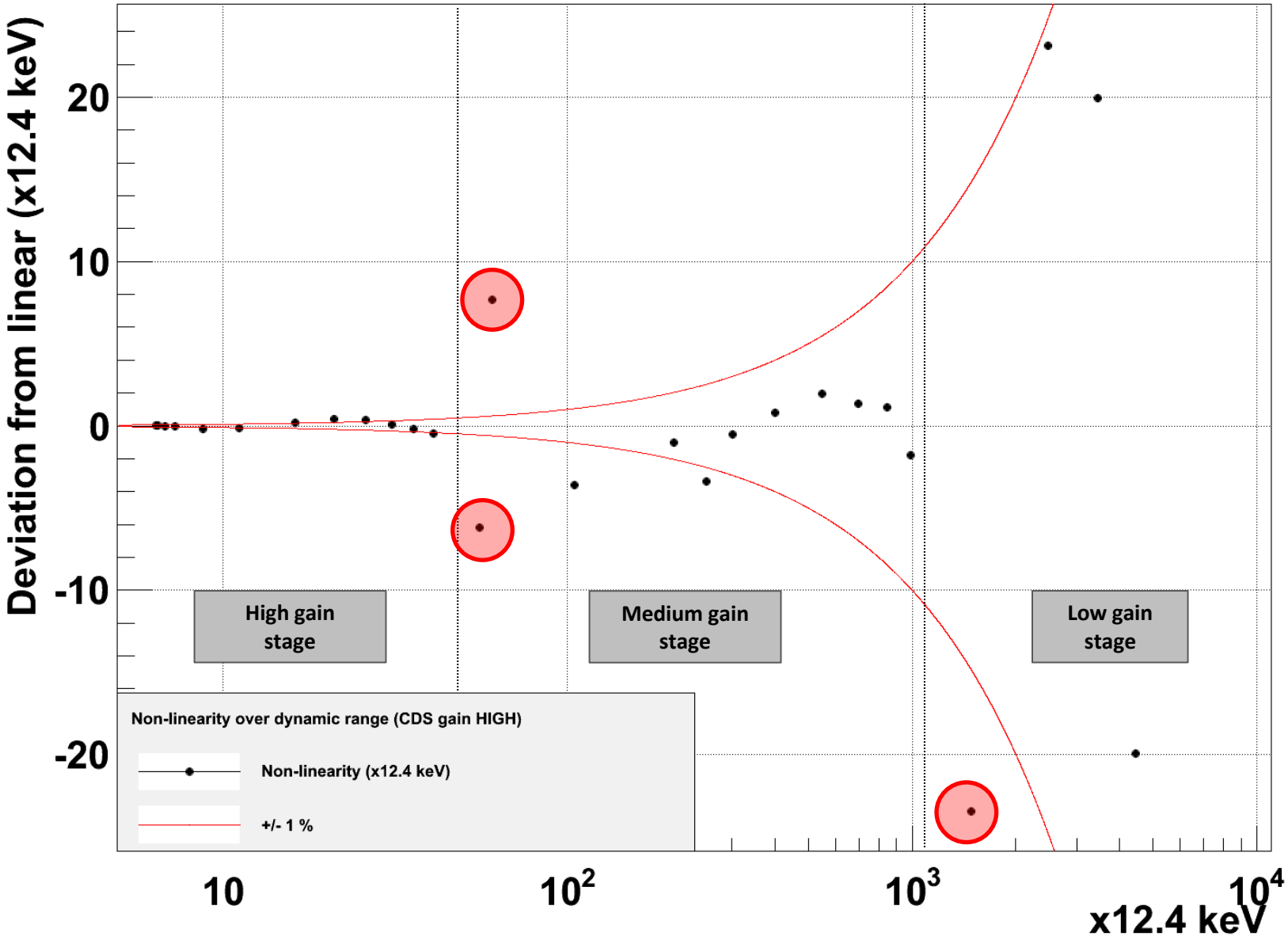
AGIPD1.0: Dynamic Range (CDS gain LOW x1.5)



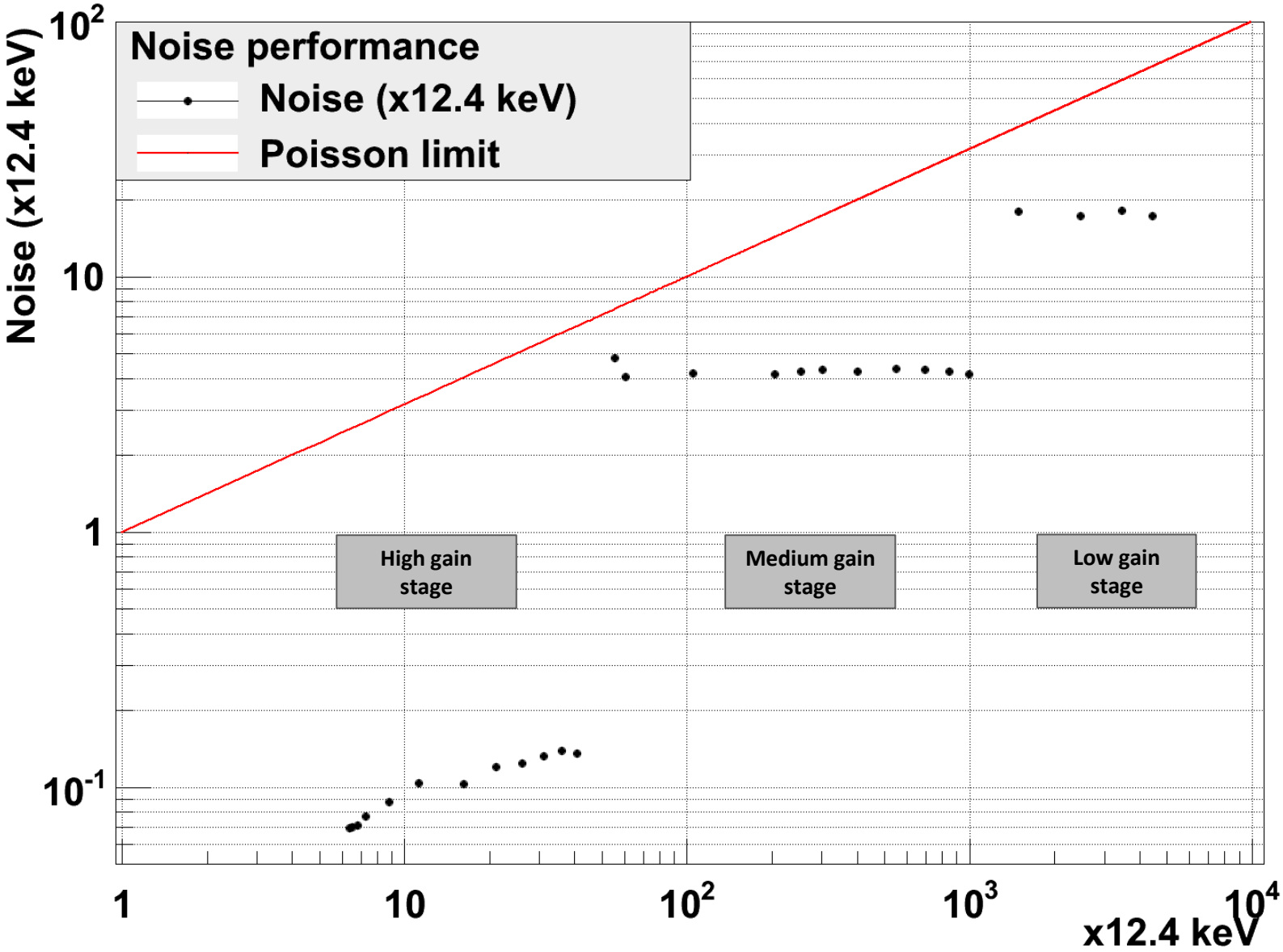
AGIPD1.0: Dynamic Range (CDS gain HIGH x3)



AGIPD1.0: Dynamic Range (CDS gain HIGH x3)



AGIPD1.0: Dynamic Range (CDS gain HIGH x3)



Summary

Chip characterization

	Gain (ADC/keV)	Noise (e- ENC)	Dynamic Range (H->M | M->L)
AGIPD1.0 (CDS gain LOW x1.5)	**11.9** ± 0.4		
AGIPD1.0 (CDS gain HIGH x3)	**21.1** ± 0.7		
AGIPD0.4* (CDS gain HIGH x1.8)	**16.0** ± 0.1	± 2	(**100** | / x12.4 keV)

Conclusion:

AGIPD1.0 is working well enough to produce module, however more time is needed to determine, whether it is good enough for a 1M system

AGIPD0.5

- Prototype chip received
- **Smaller $C_{f,high}$**
  → More gain
- **Precharging scheme**
  → Boost dynamic range
- **No pixel buffer**
  → Less noise

*AGIPD0.4: Model pixel results