APTS OpAmp Activities

Angelo Colelli (Ph.D. Student), Francesco Barile, Rajendra Patra, Shyam Kumar, Triloki Triloki
University of Bari & INFN sez. Bari

Experimental Setup

Chip: w22AO10AP44

Power supply: Rohde&Schwarz HAMEG HMP4040

Inner px readout: Rohde&Schwarz RTO1044

(BW: 4GHz Sampling Rate: 20GSa/s)

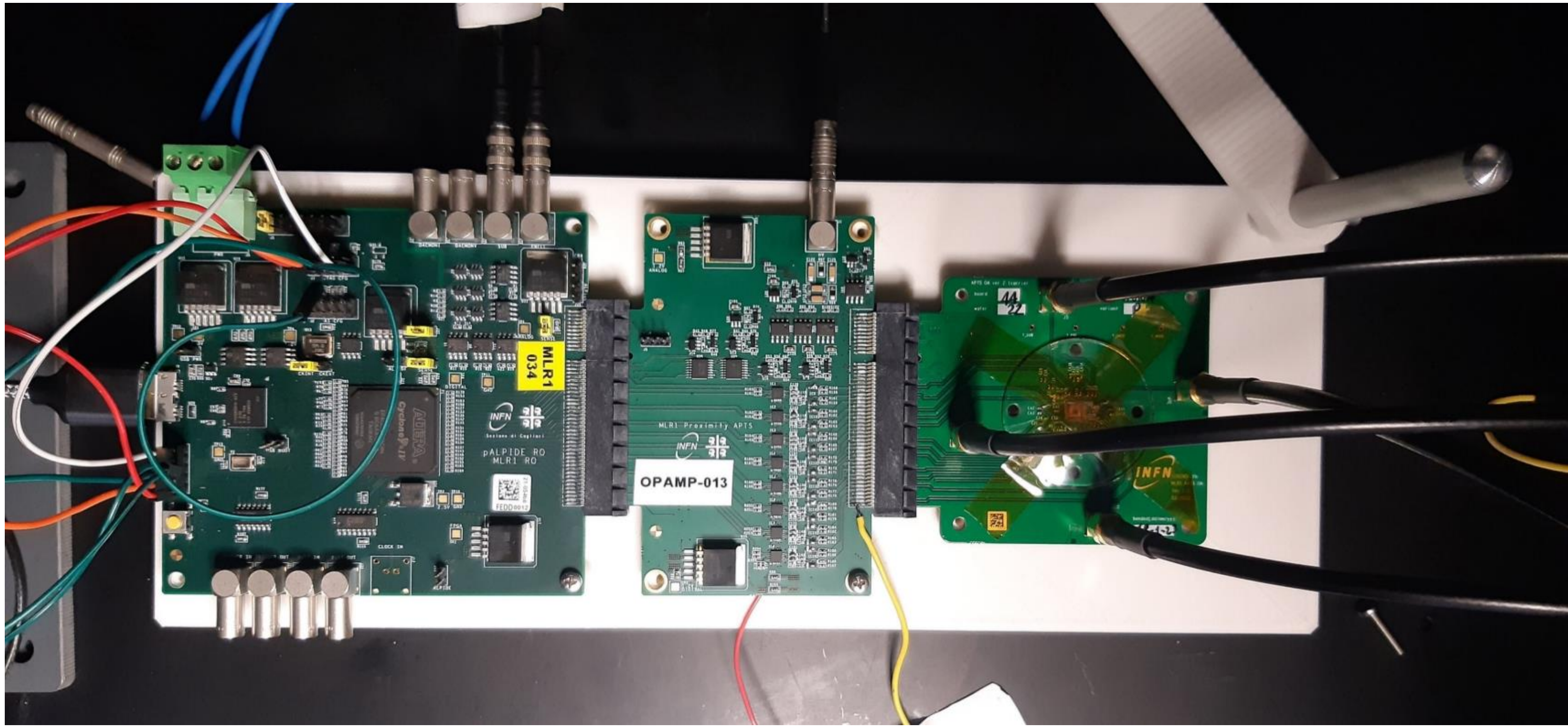
Outer pixels: ADC

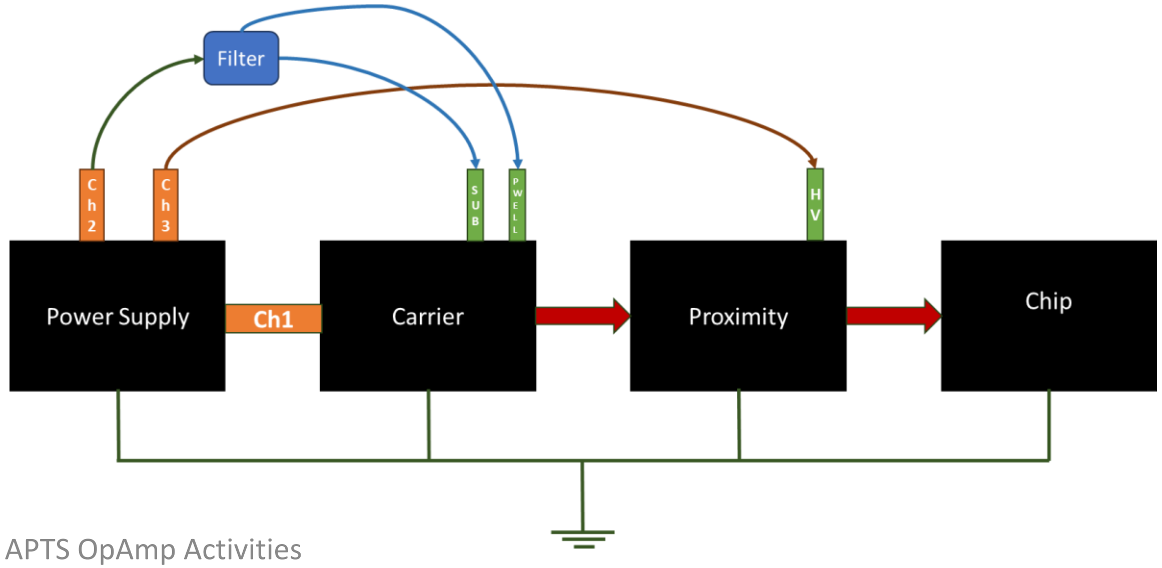
Script for testing:

apts/opamp_gain.py

apts/opamp_pulsing.py

apts/opamp_vhscan.py





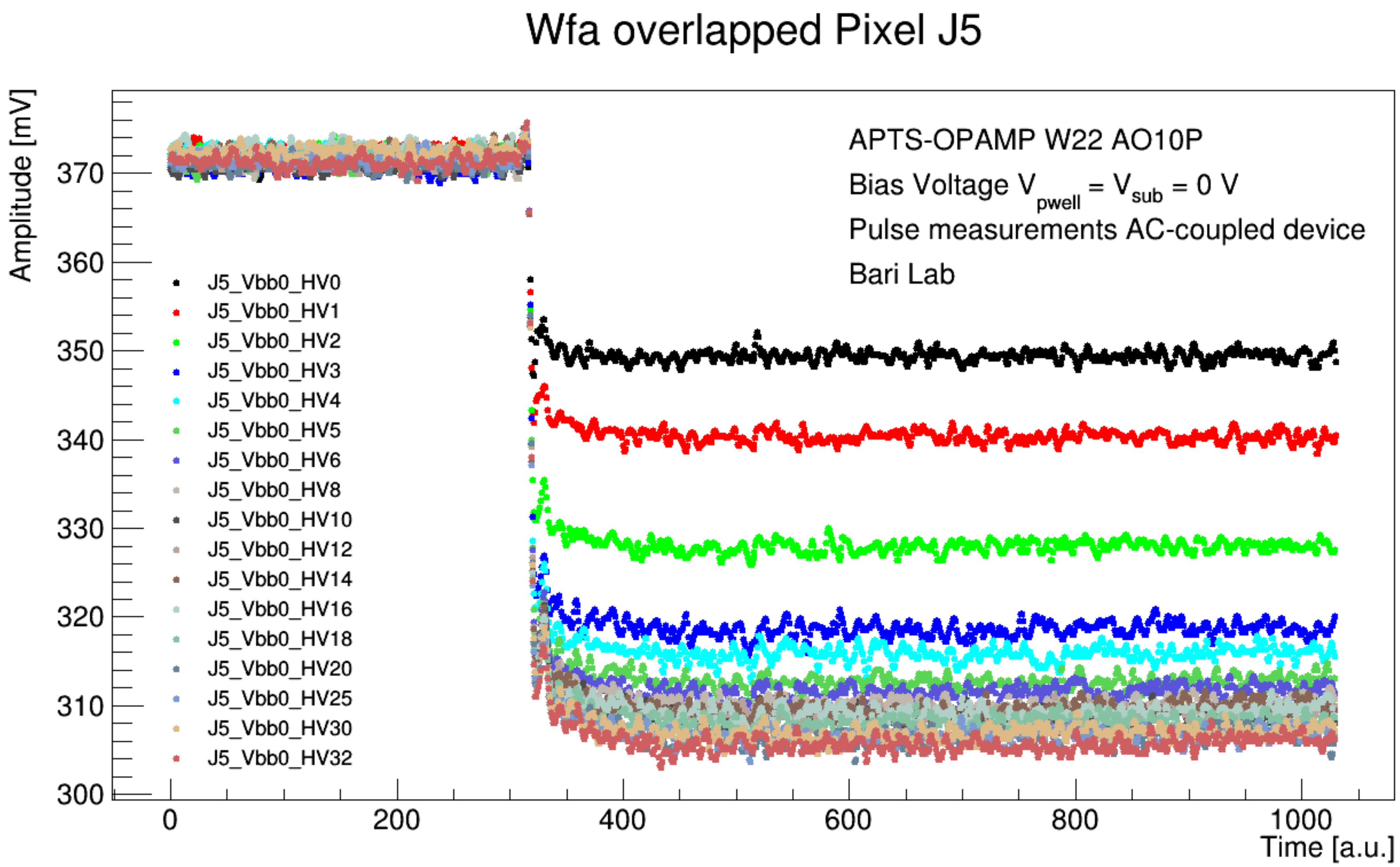
Bias:

HV : **0÷20V**

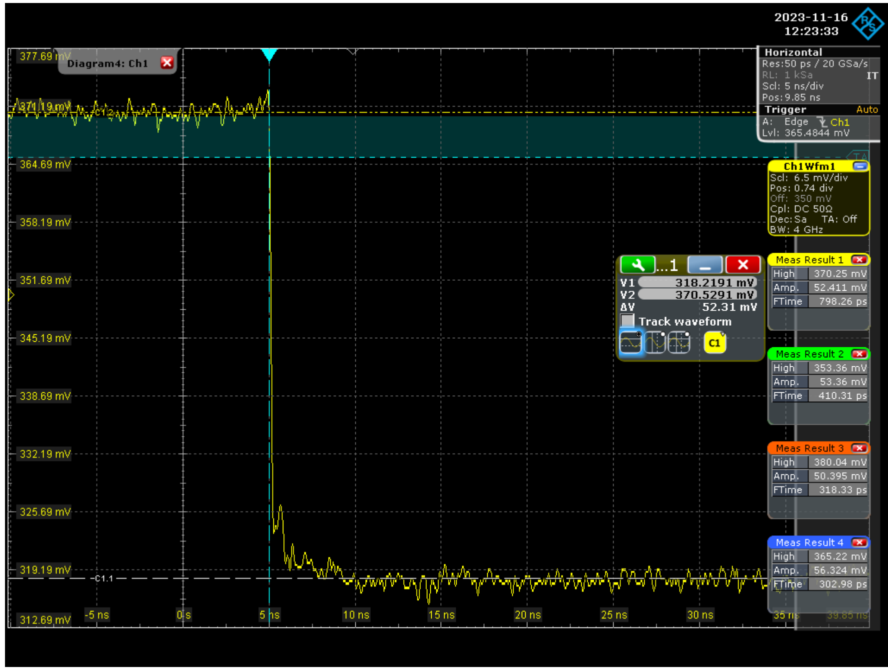
V_{sub} : **0 , -0.6V**

V_{pwell} : **0V**

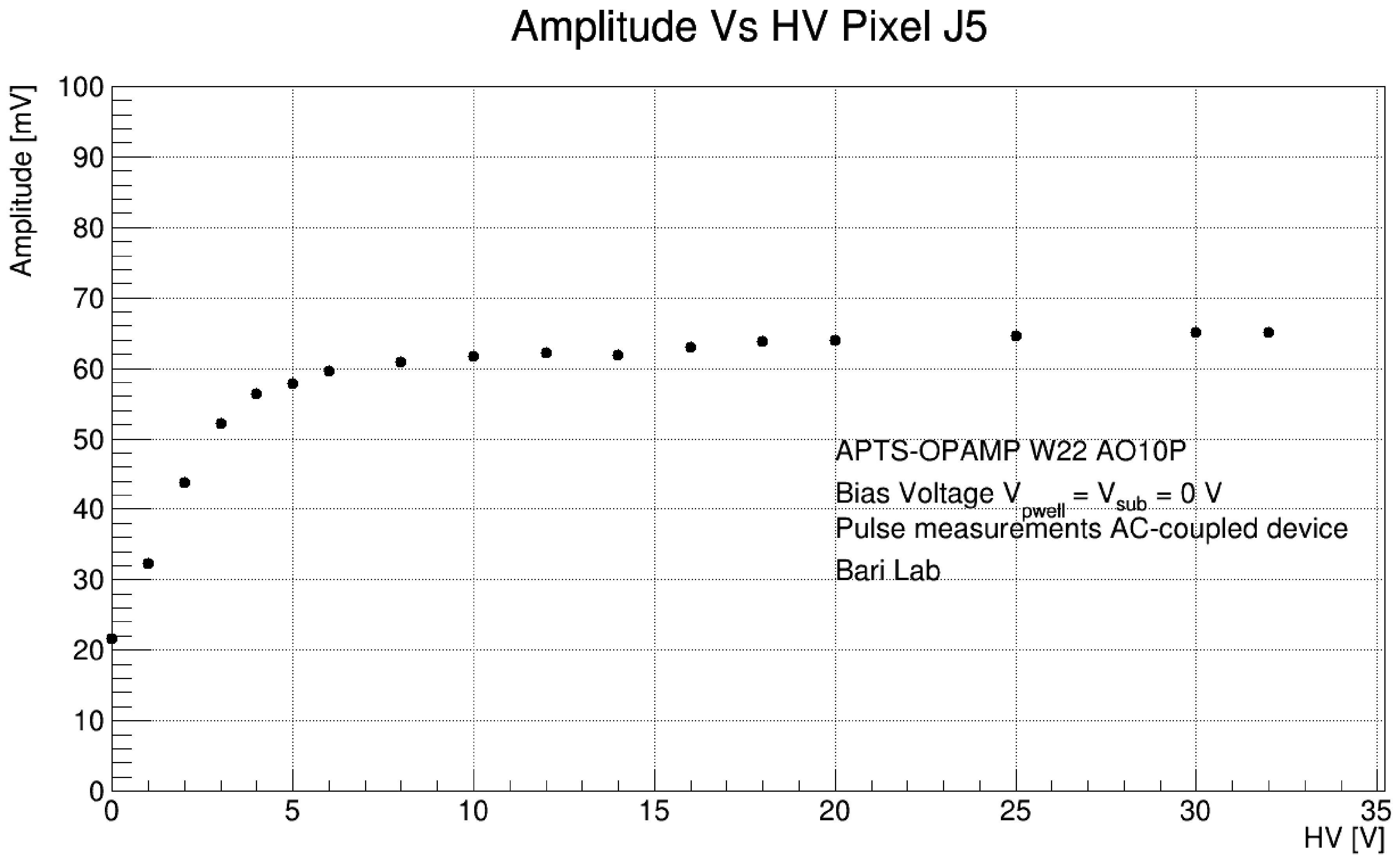
W22AO10APb44 AC Coupled Chip Inner pixel signal output



<u>single signal acquired on the scope</u>



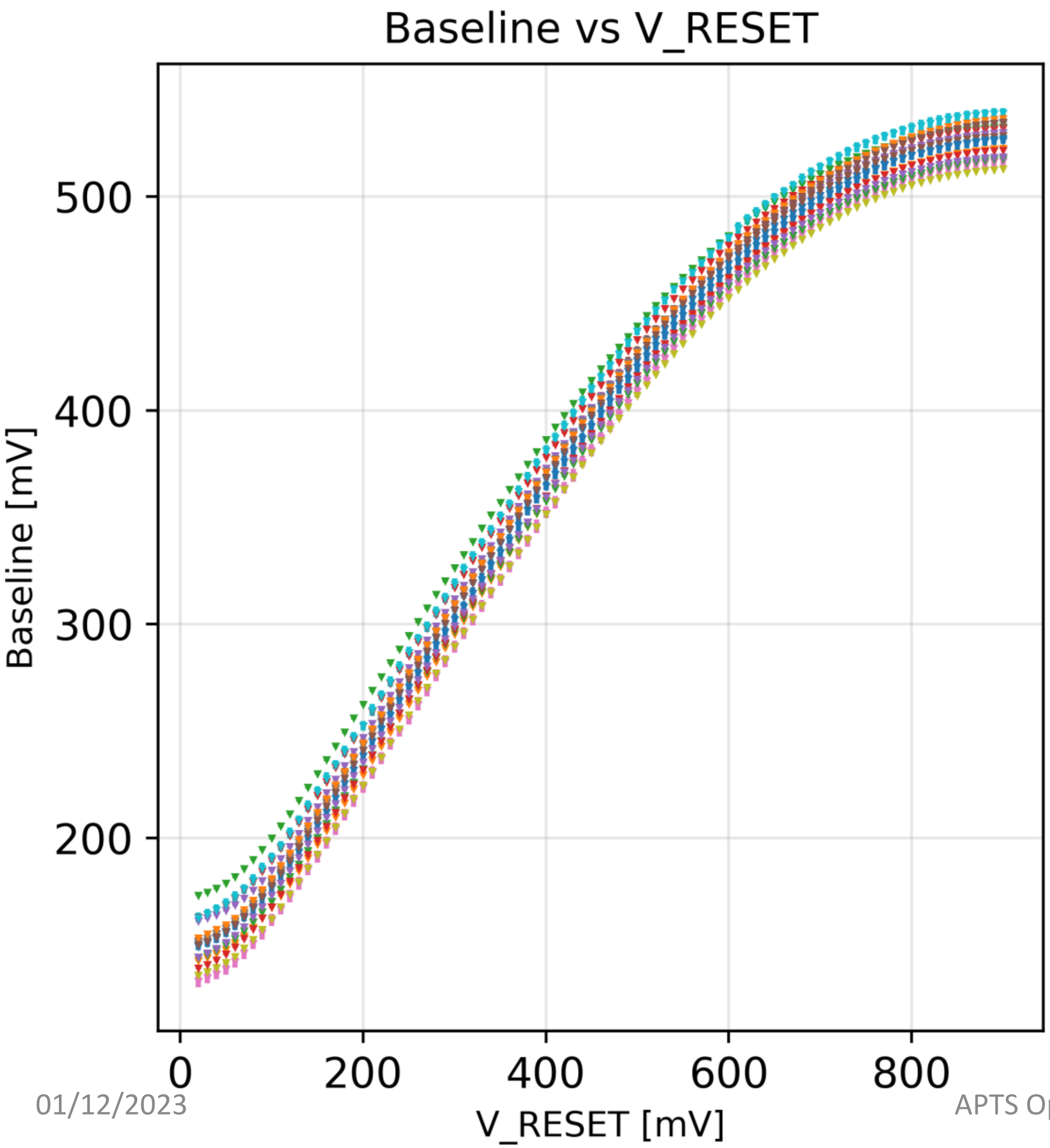
W22AO10APb44 AC Coupled Chip Amplitude vs HV

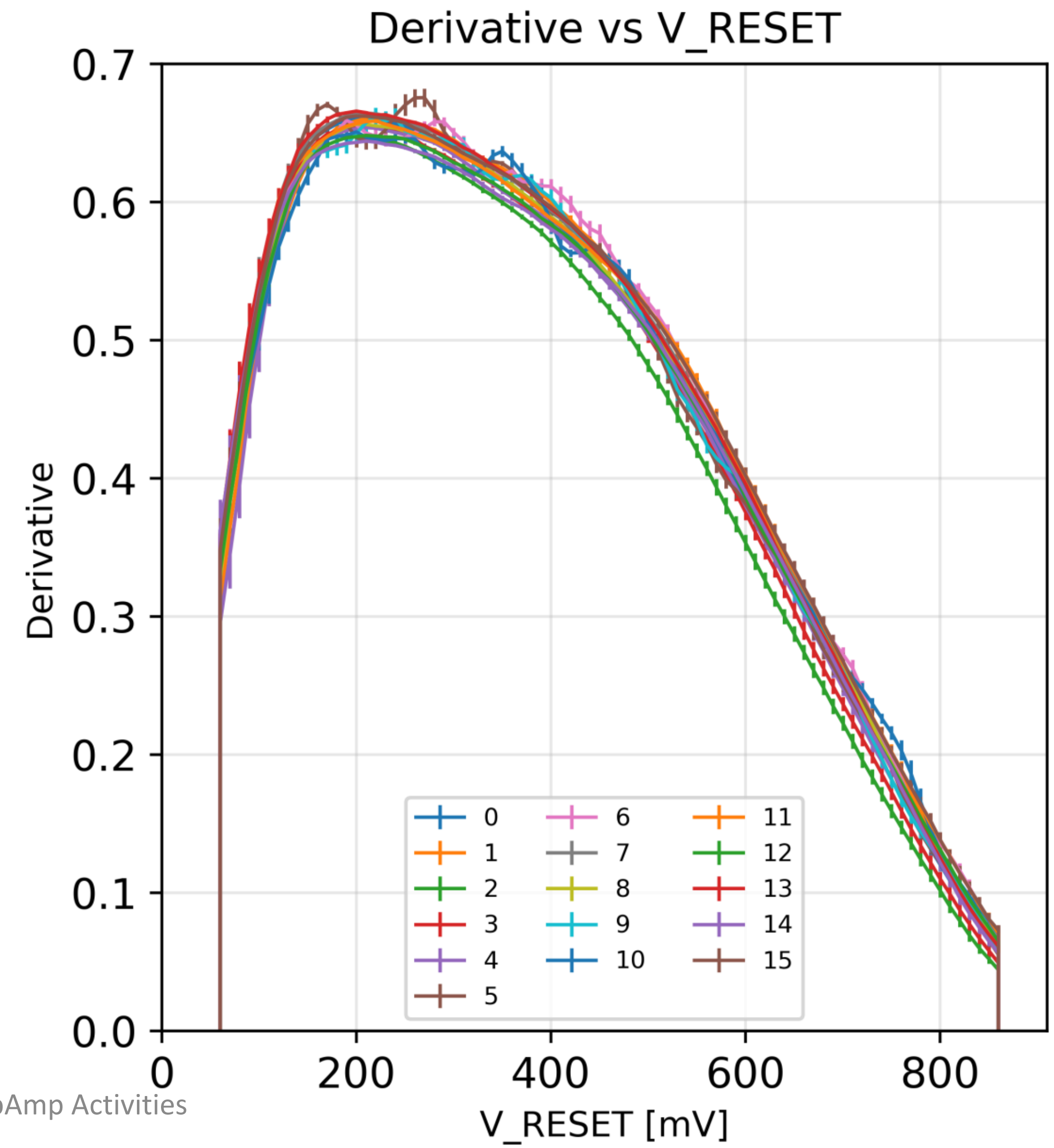


Saturation at increasing HV clearly visible

W22AO10APb44 AC Coupled Chip V_{sub}= 0V V_{pwell}= 0V HV= 20V

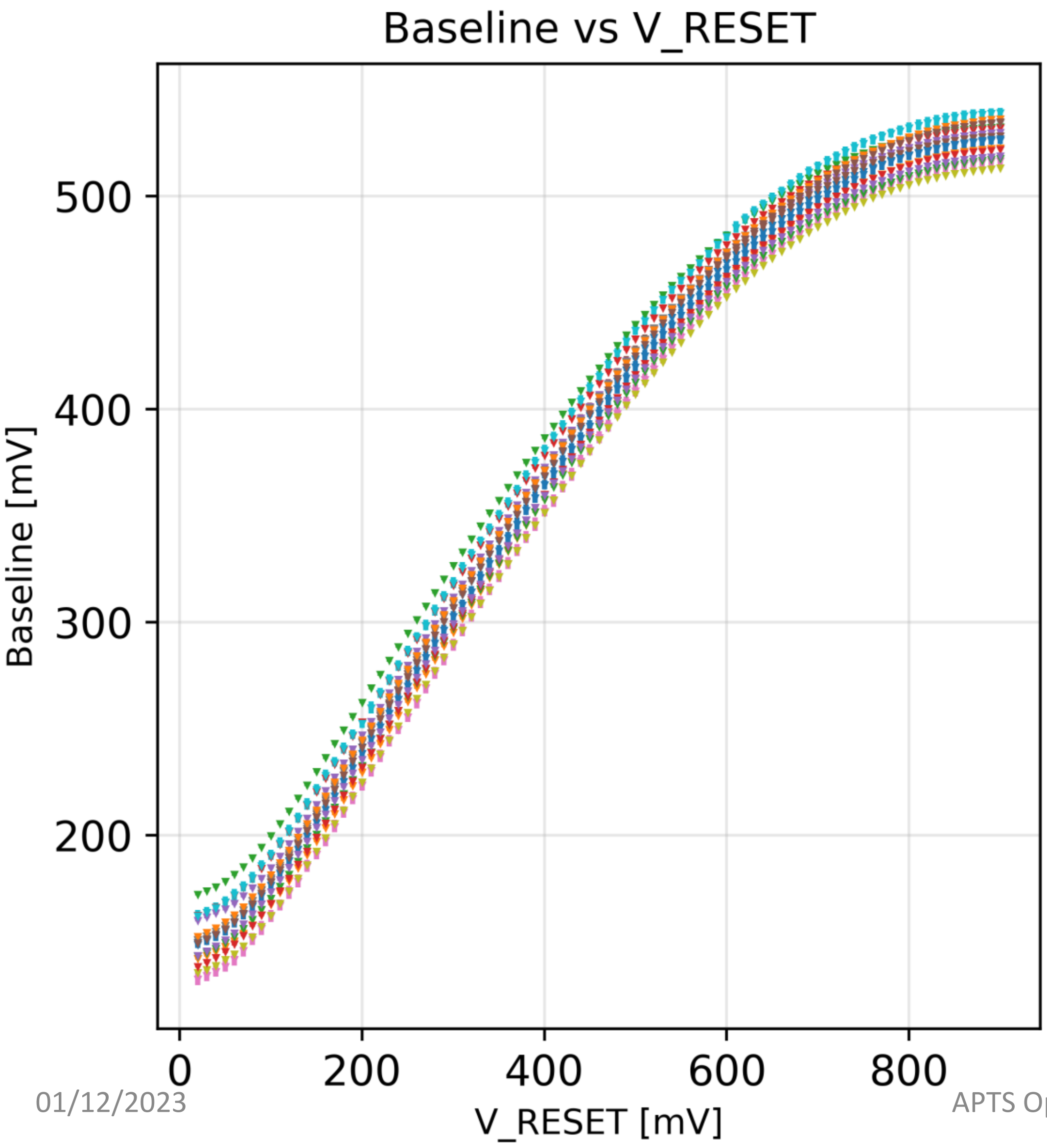
Gain Calibration

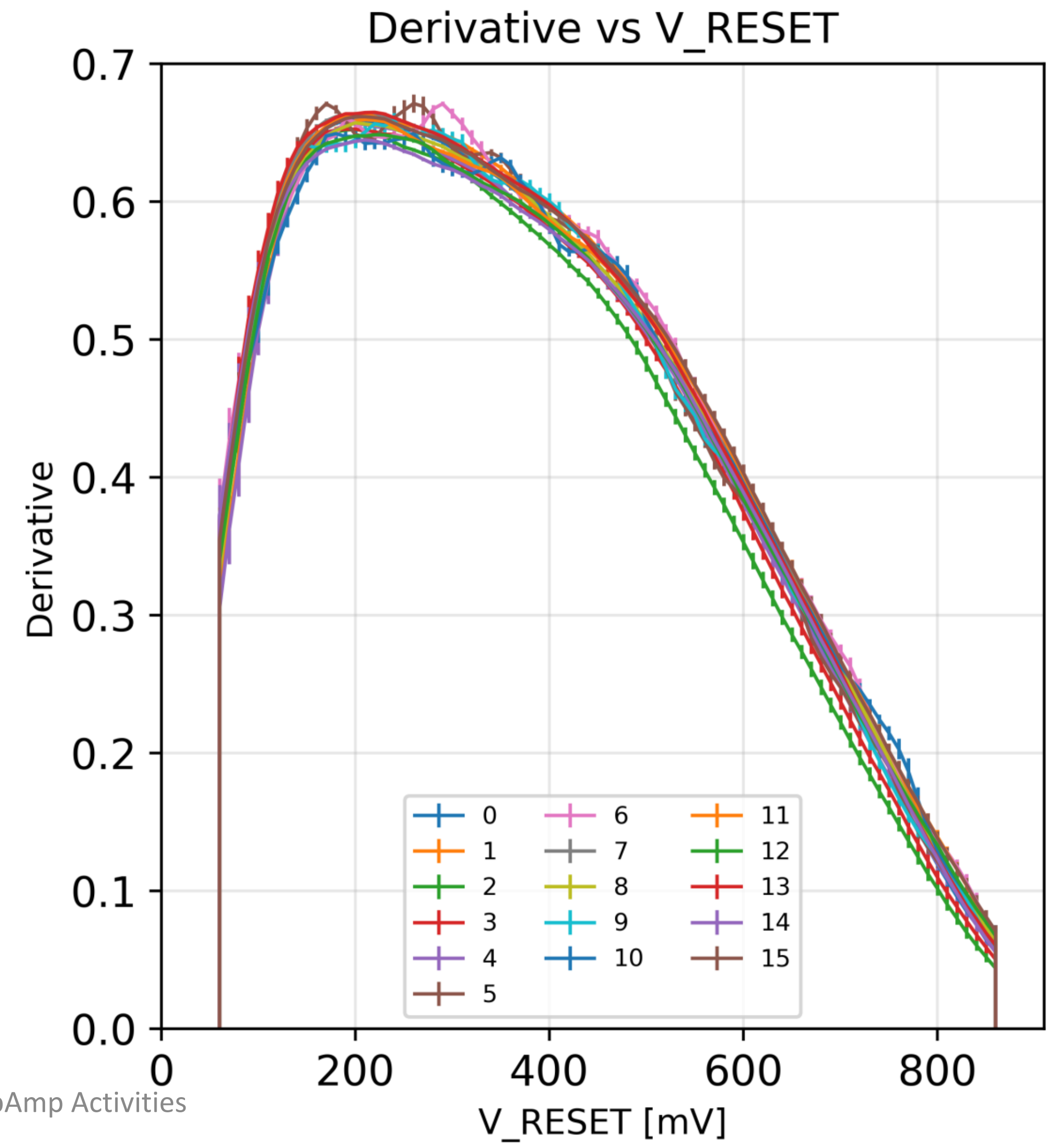




W22AO10APb44 AC Coupled Chip V_{sub}= -0.6V V_{pwell}= 0V HV= 20V

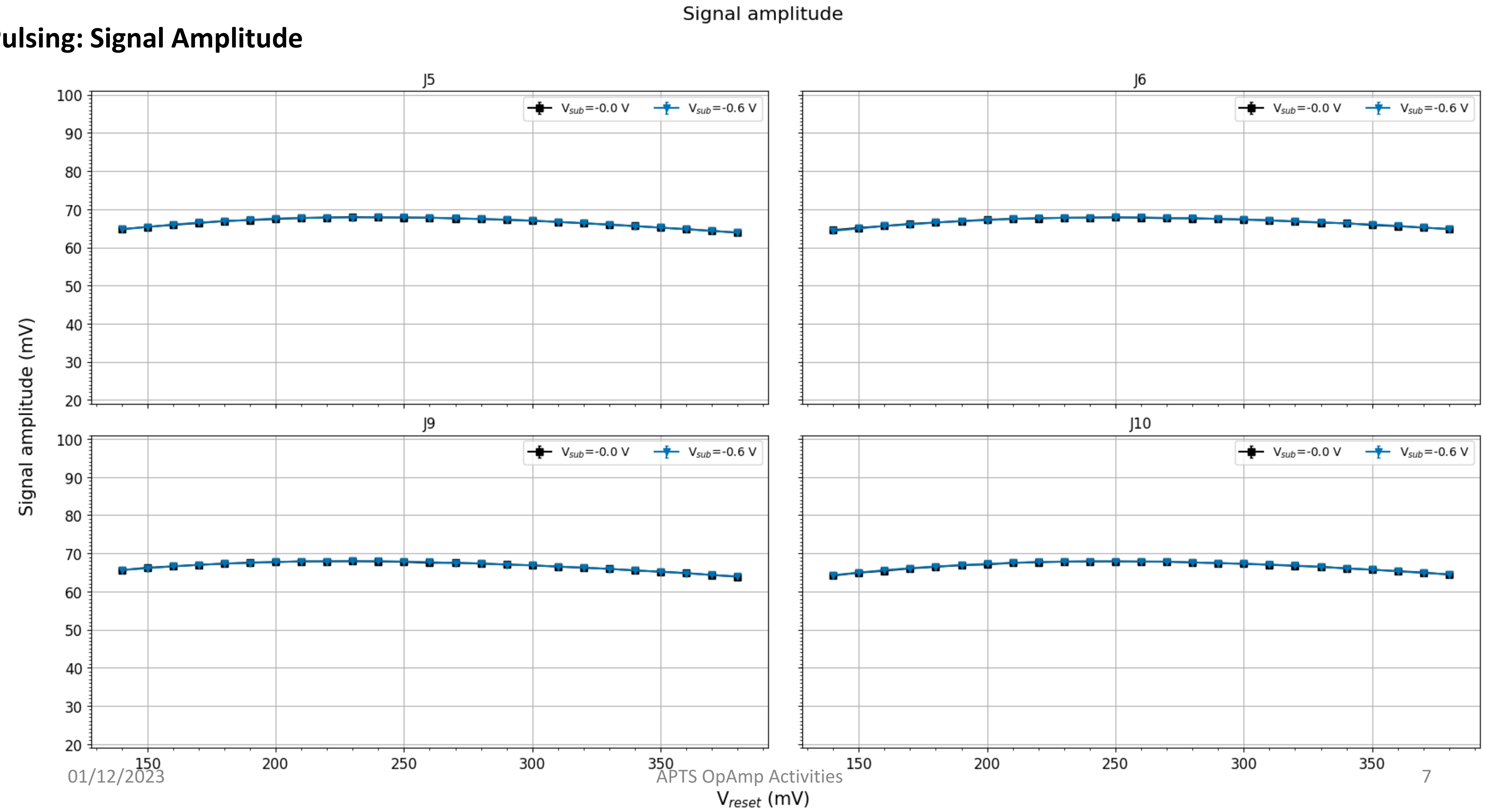
Gain Calibration





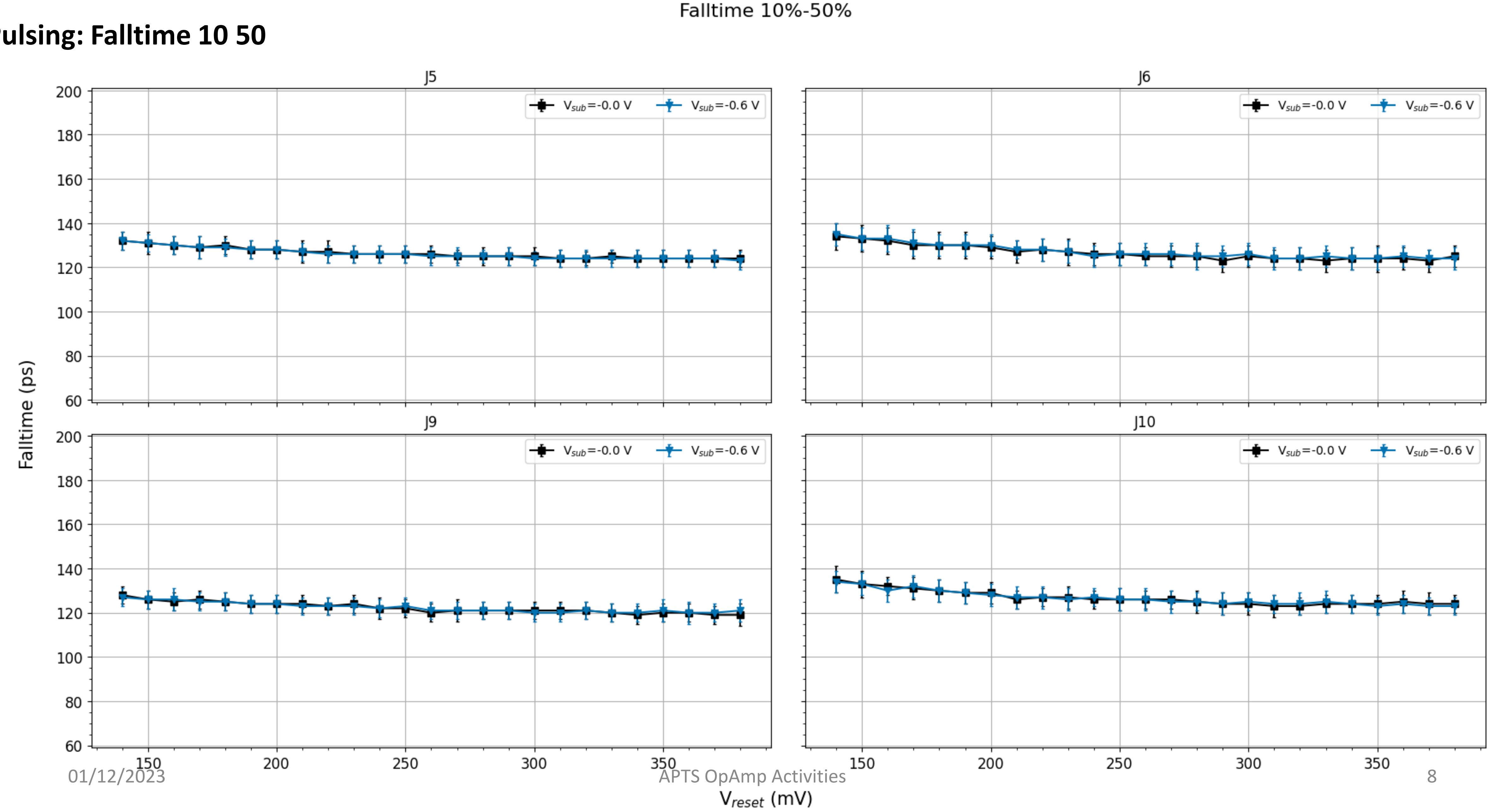
W22AO10APb44 AC Coupled Chip V_{sub}= 0;-0.6V V_{pwell}= 0V HV= 20V

Pulsing: Signal Amplitude



W22AO10APb44 AC Coupled Chip V_{sub}= 0;-0.6V V_{pwell}= 0V HV= 20V

Pulsing: Falltime 10 50

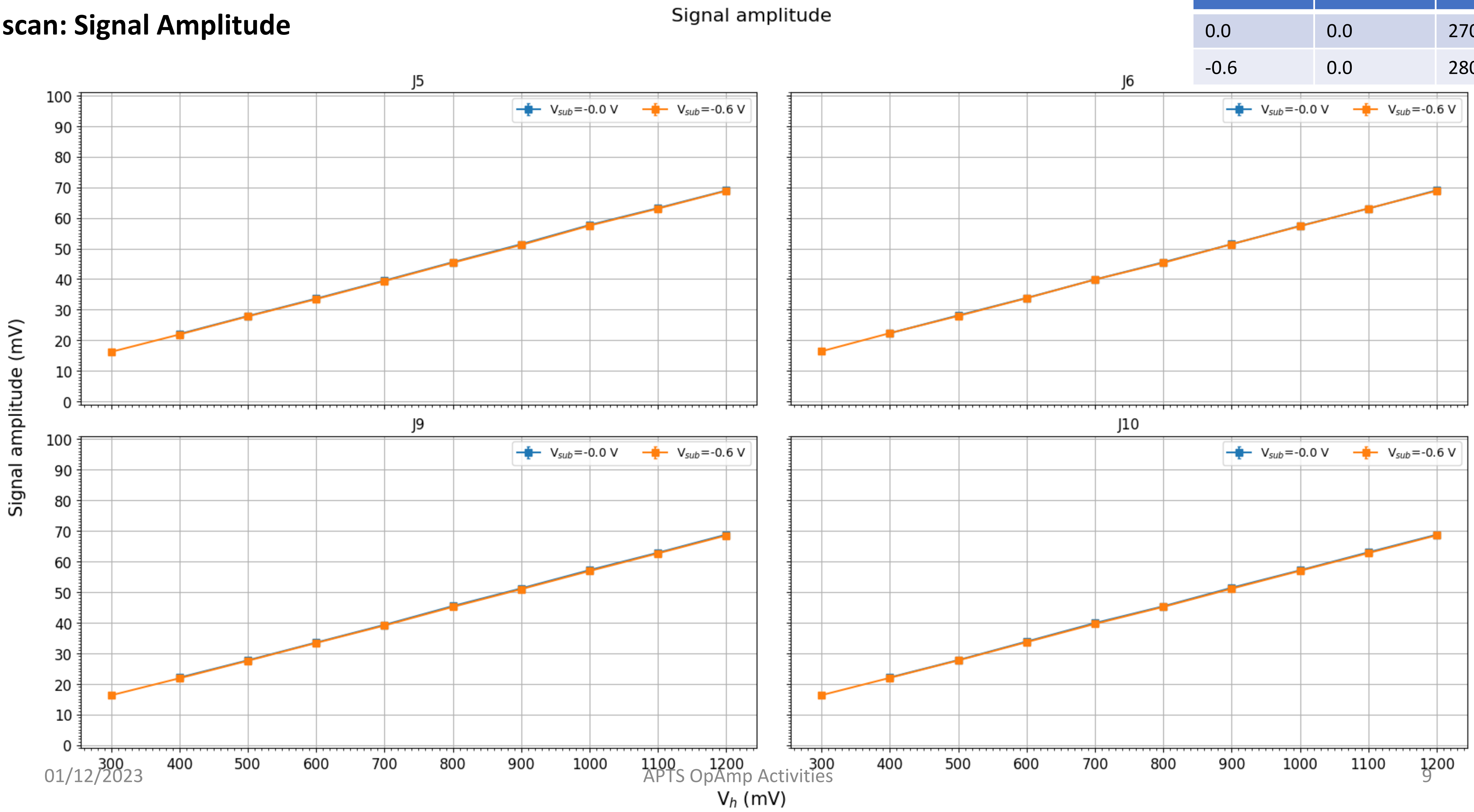


W22AO10APb44 AC Coupled Chip V_{sub}= 0;-0.6V V_{pwell}= 0V HV= 20V

Working Point

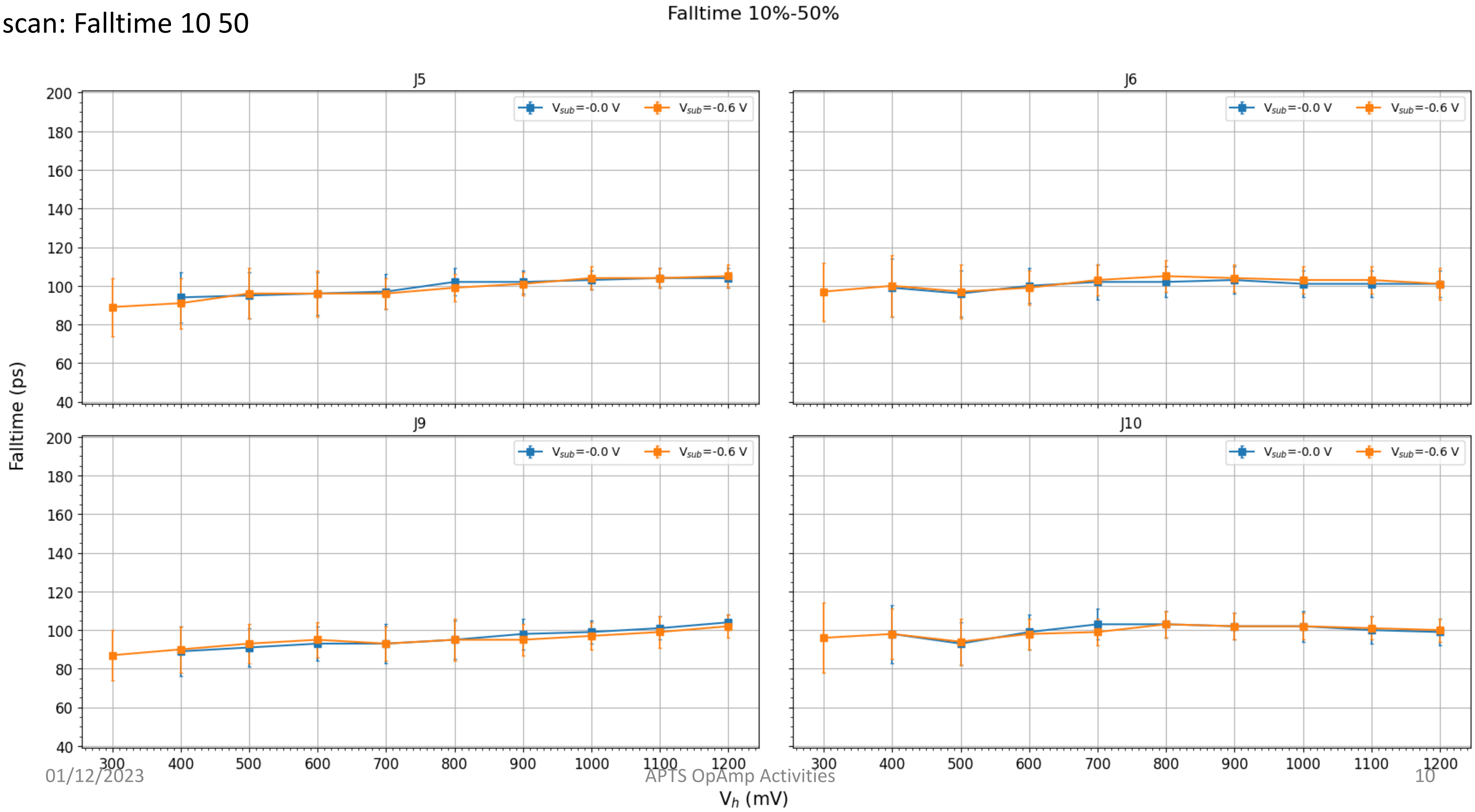
V_{sub} (V)	V_{pwell} (V)	V_{reset} (mV)
0.0	0.0	270
-0.6	0.0	280

Vh scan: Signal Amplitude



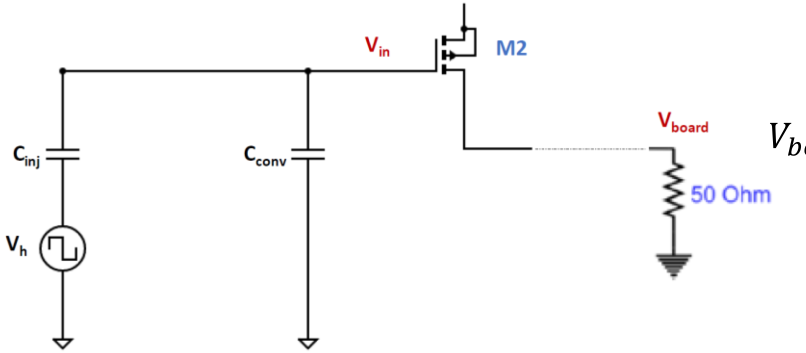
W22AO10APb44 AC Coupled Chip V_{sub}= 0;-0.6V V_{pwell}= 0V HV= 20V

Vh scan: Falltime 10 50



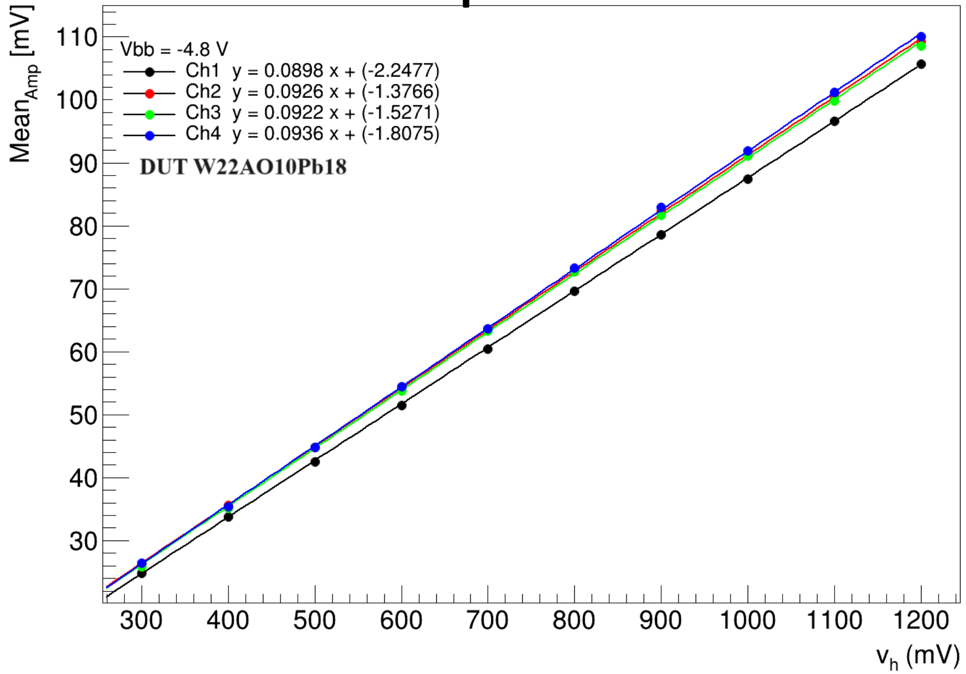
Equivalent OpAmp circuit: Injection and Conversion Capacitance

- **Test pulses:** W22AO10Pb18 DC Coupled Chip
- V_h charges the capacitance that pulses the collection electrode
- V_h scan at fixed chip operation condition has been done

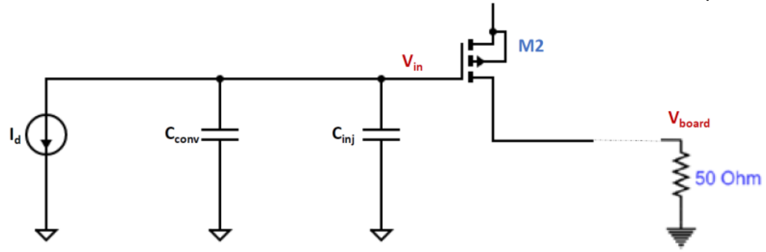


$$V_{board} = G \cdot V_{in} = G \cdot \frac{C_{inj}}{C_{inj} + C_{conv}} V_h$$

$$\rightarrow m_{test\ pulses} = G \cdot \frac{C_{inj}}{C_{inj} + C_{conv}}$$

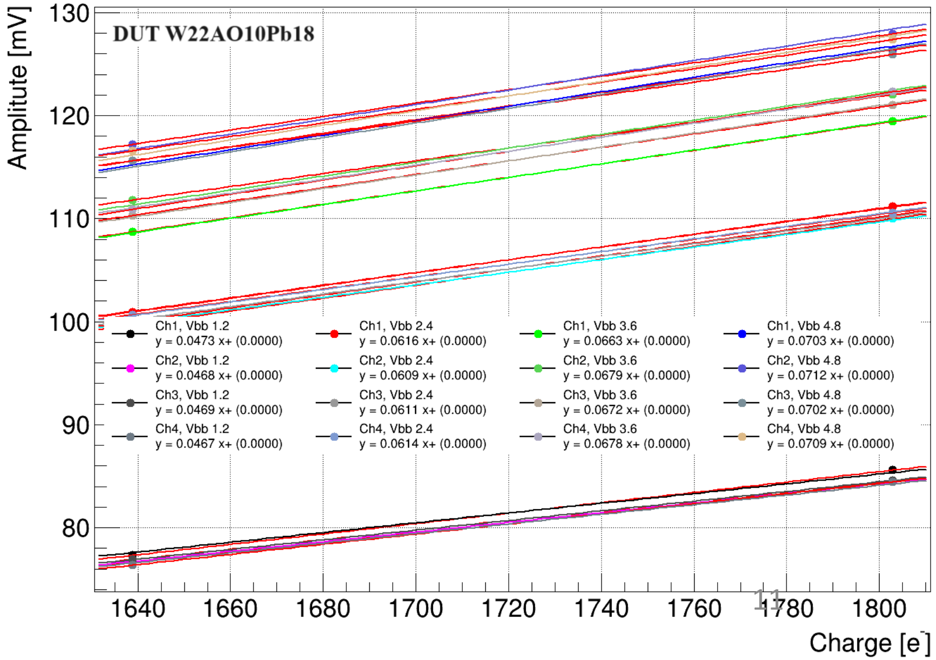


- **^{55}Fe Radioactive source:**
- A particle/photon producing a charge Q that induces a current I_d
- Mn-k_α @ 5.9keV -> 1638e^- and Mn-k_β @ 6.5keV -> 1804e^- peaks as calibration points



$$V_{board} = G \cdot V_{in} = G \cdot \frac{1}{C_{inj} + C_{conv}} Q$$

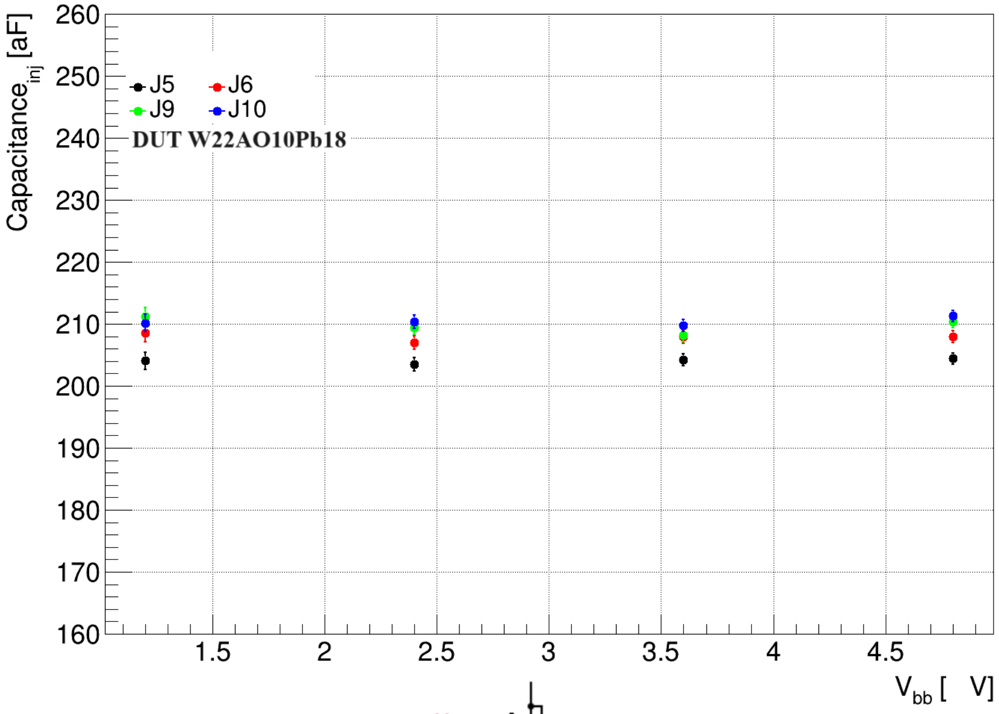
$$\rightarrow m_{55_{Fe}} = G \cdot \frac{1}{C_{inj} + C_{conv}}$$

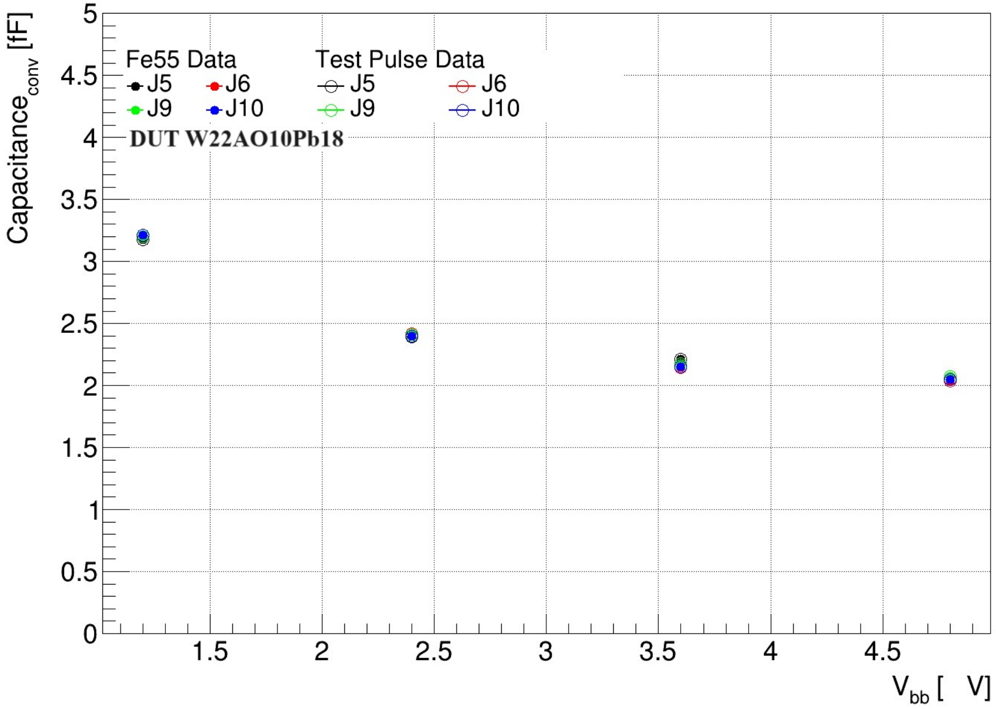


A linear behaviour should be observed in both case thus:

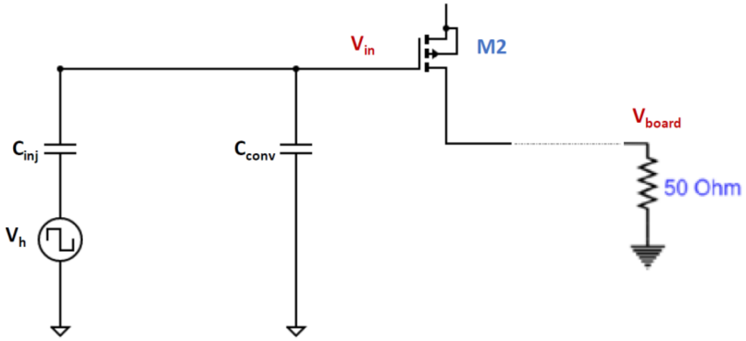
$$C_{inj} = \frac{m_{test\ pulses}}{m_{55_{Fe}}}$$

APTS OpAmp Injection and Conversion capacitance measurements





The V_{bb} influences the capacitances as expected.



$$C_{inj} = \frac{m_{test\ pulses}}{m_{55_{Fe}}}$$

$$m_{55_{Fe}} = G \cdot \frac{1}{C_{inj} + C_{conv}}$$

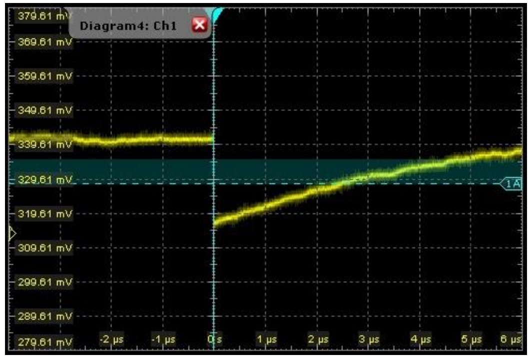
$$\rightarrow \boldsymbol{C_{conv}} = \frac{\boldsymbol{G}}{\boldsymbol{m_{55_{Fe}}}} - \boldsymbol{C_{inj}}$$

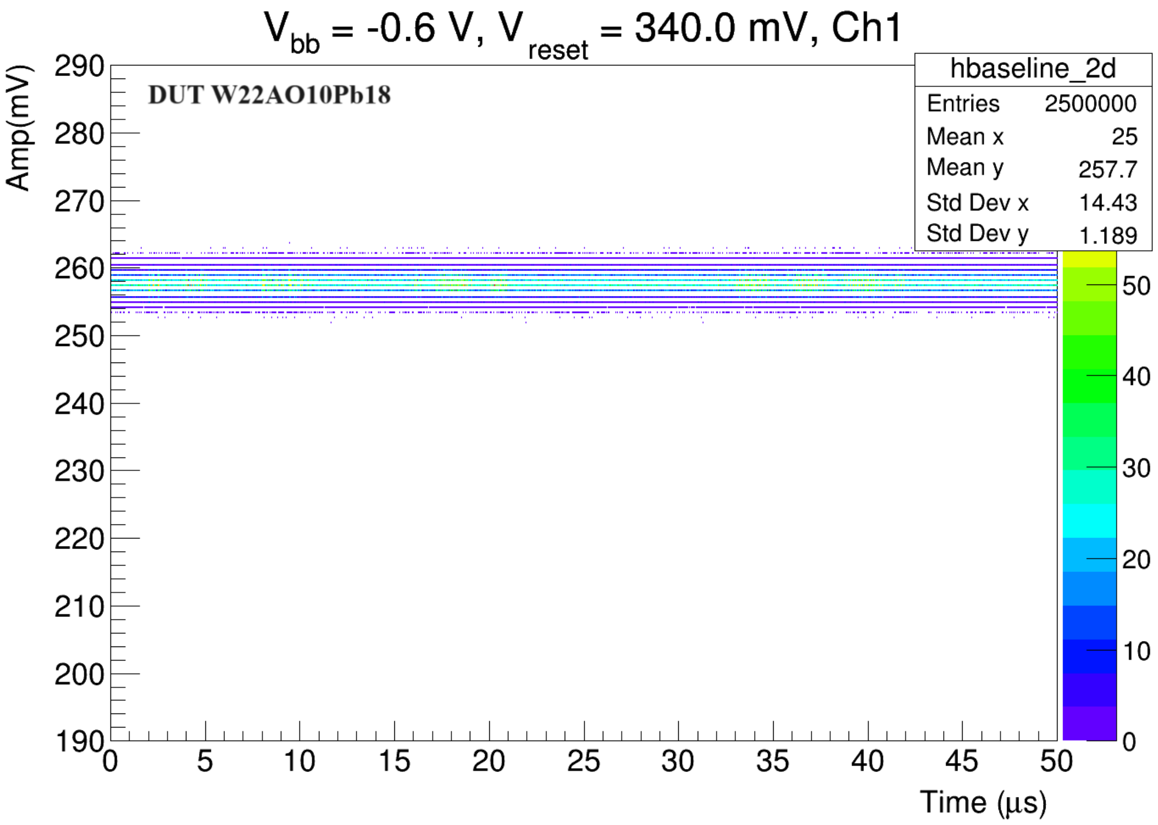
$$m_{test\ pulses} = G \cdot \frac{C_{inj}}{C_{inj} + C_{conv}}$$

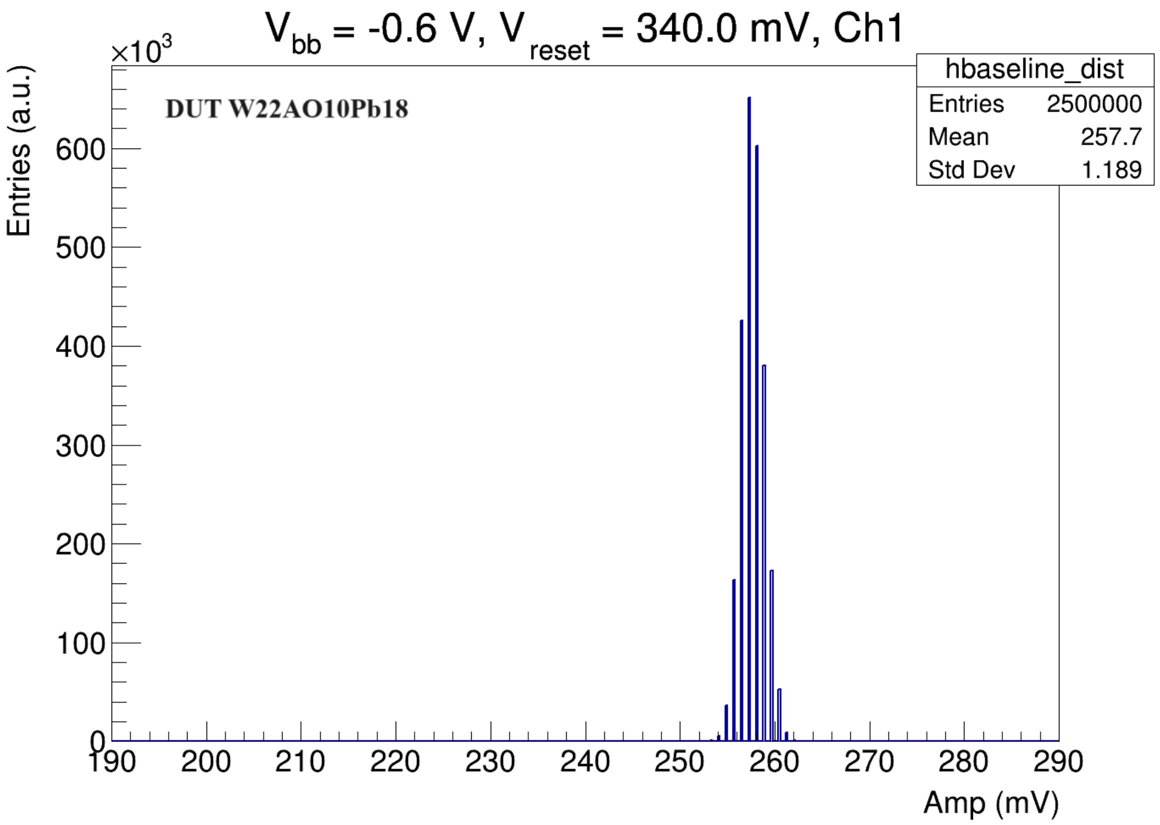
$$\rightarrow \boldsymbol{C_{conv}} = \left(\frac{\boldsymbol{G}}{\boldsymbol{m_{test\ pulses}}} - \boldsymbol{1}\right) \cdot \boldsymbol{C_{inj}}$$

APTS OpAmp Baseline studies for noise estimation

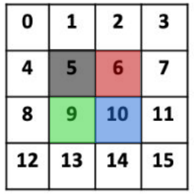
- Fluctuation of baseline is observed.
- Further investigations in progress.

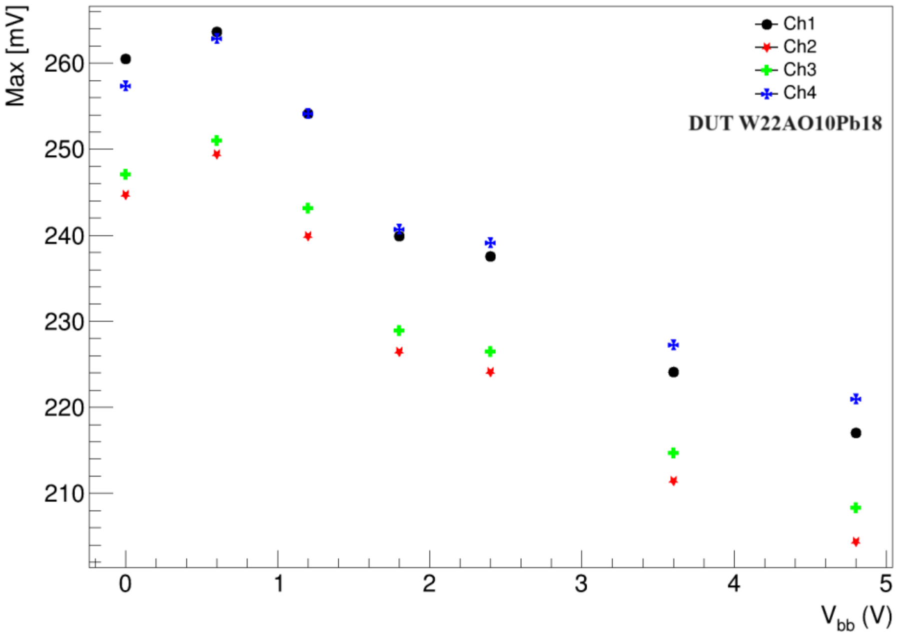


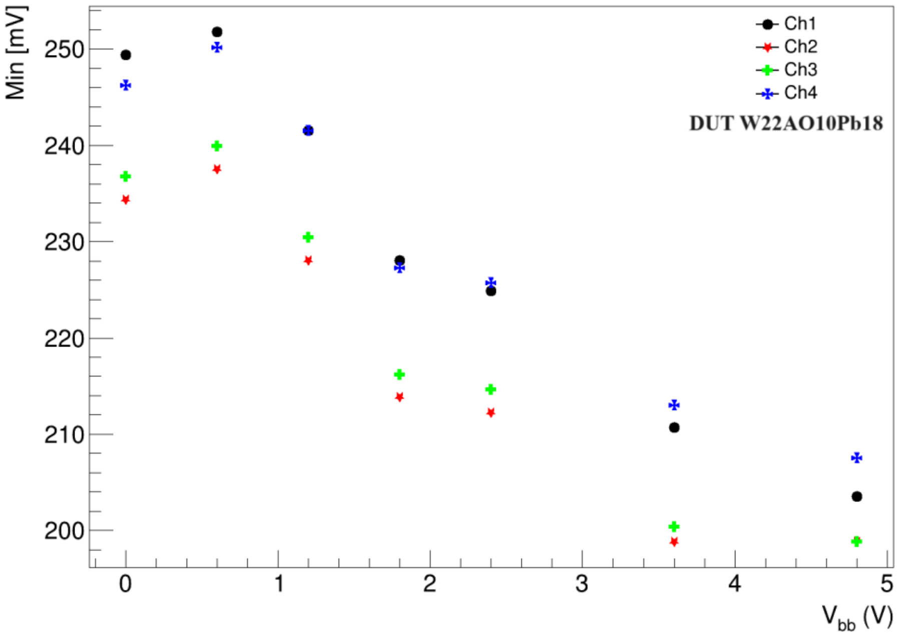


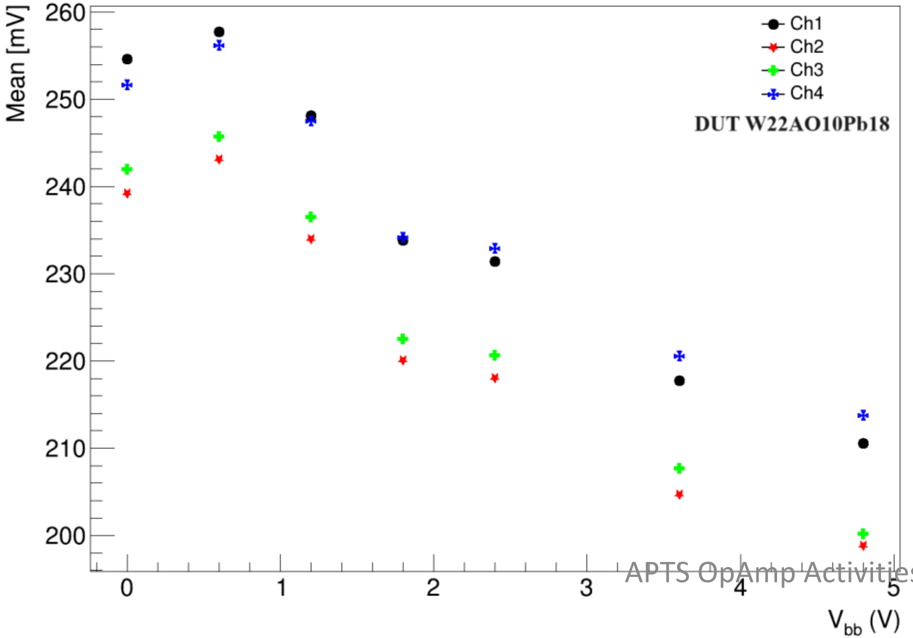


APTS OpAmp Baseline studies for noise estimation

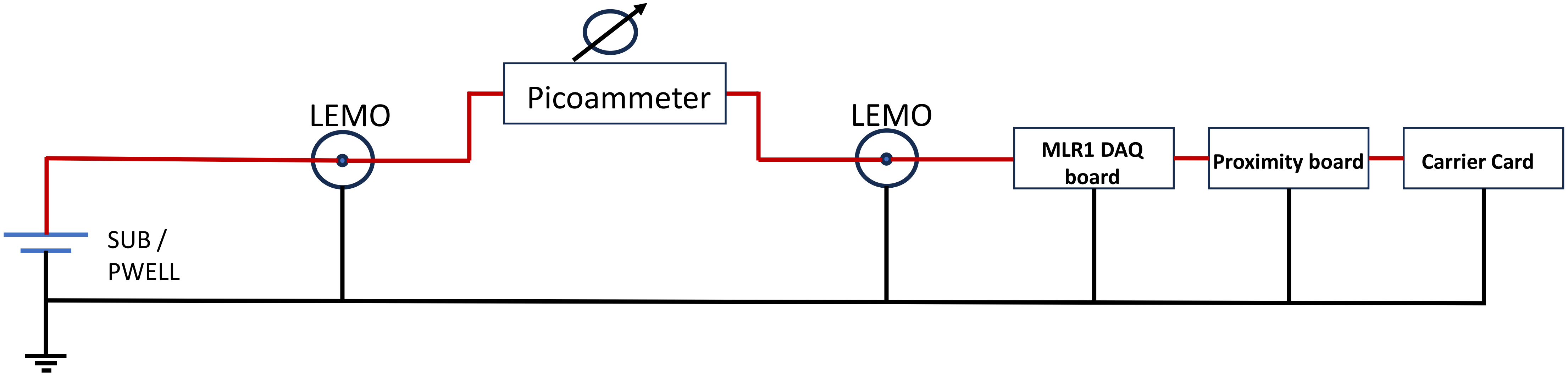


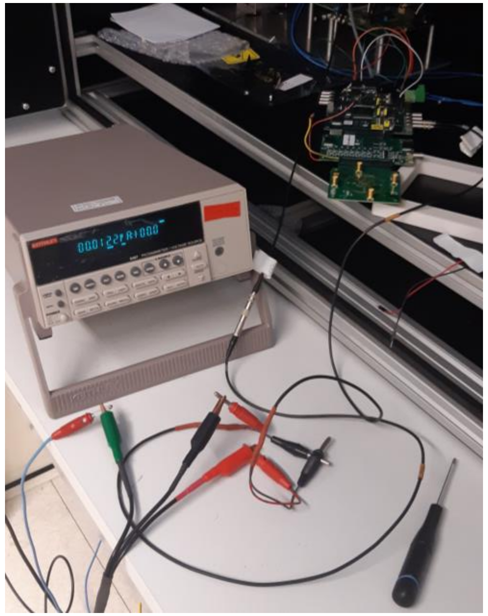




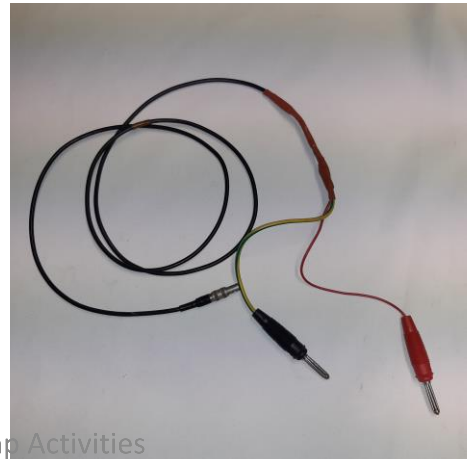


APTS OpAmp Experimental Setup for SUB and PWELL I-V measurements



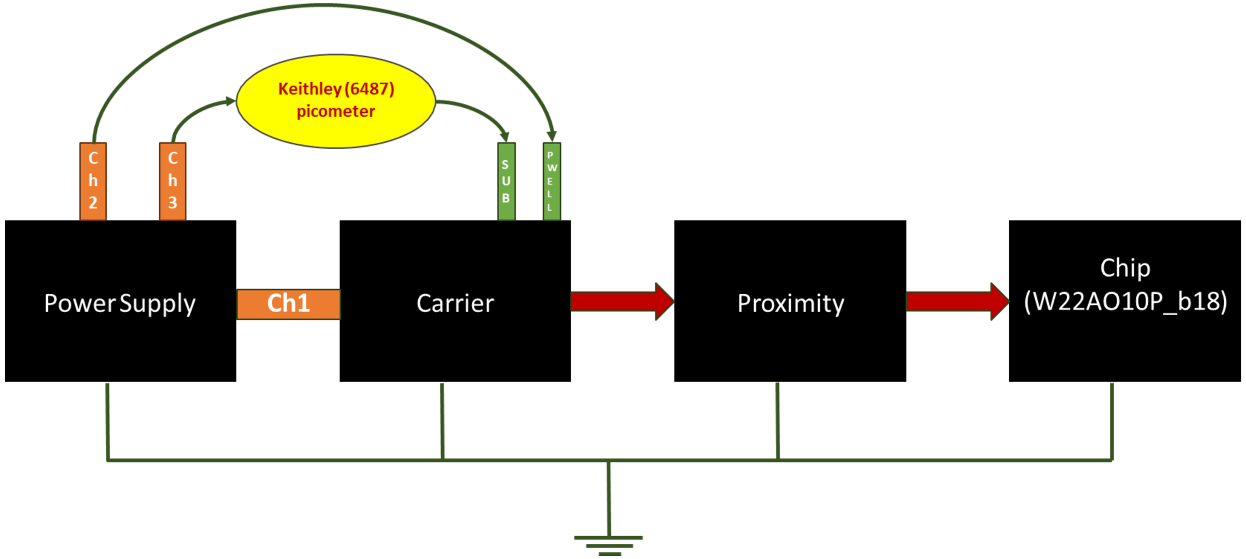


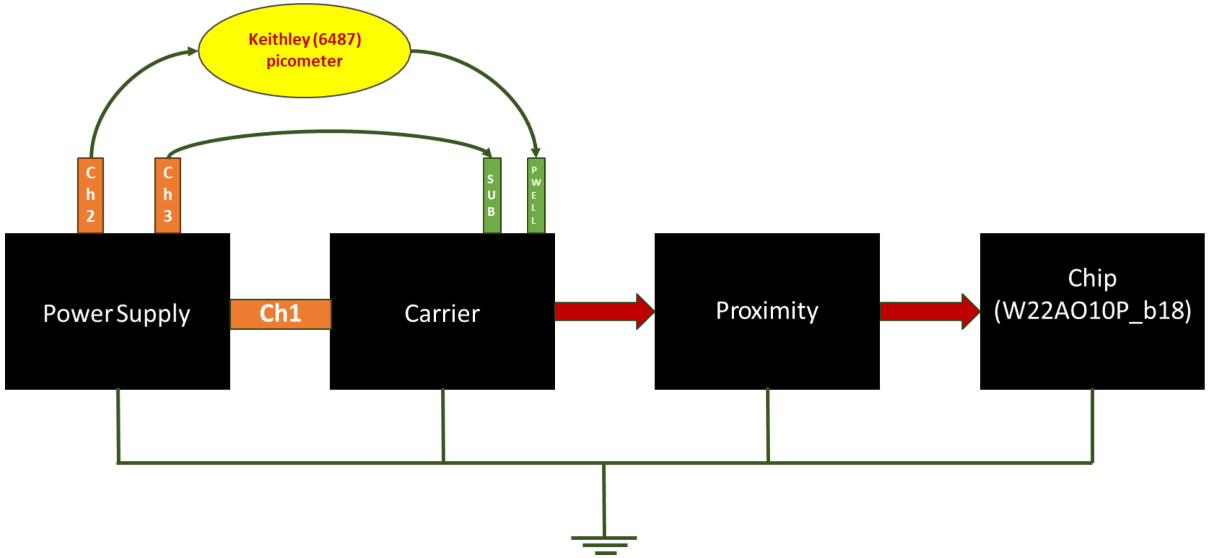
I-V Measurements of SUB and PWELL currents :
DAQ
DAQ + Proximity
DAQ + Proximity + Chip



Picoammeter
Keithley 6487

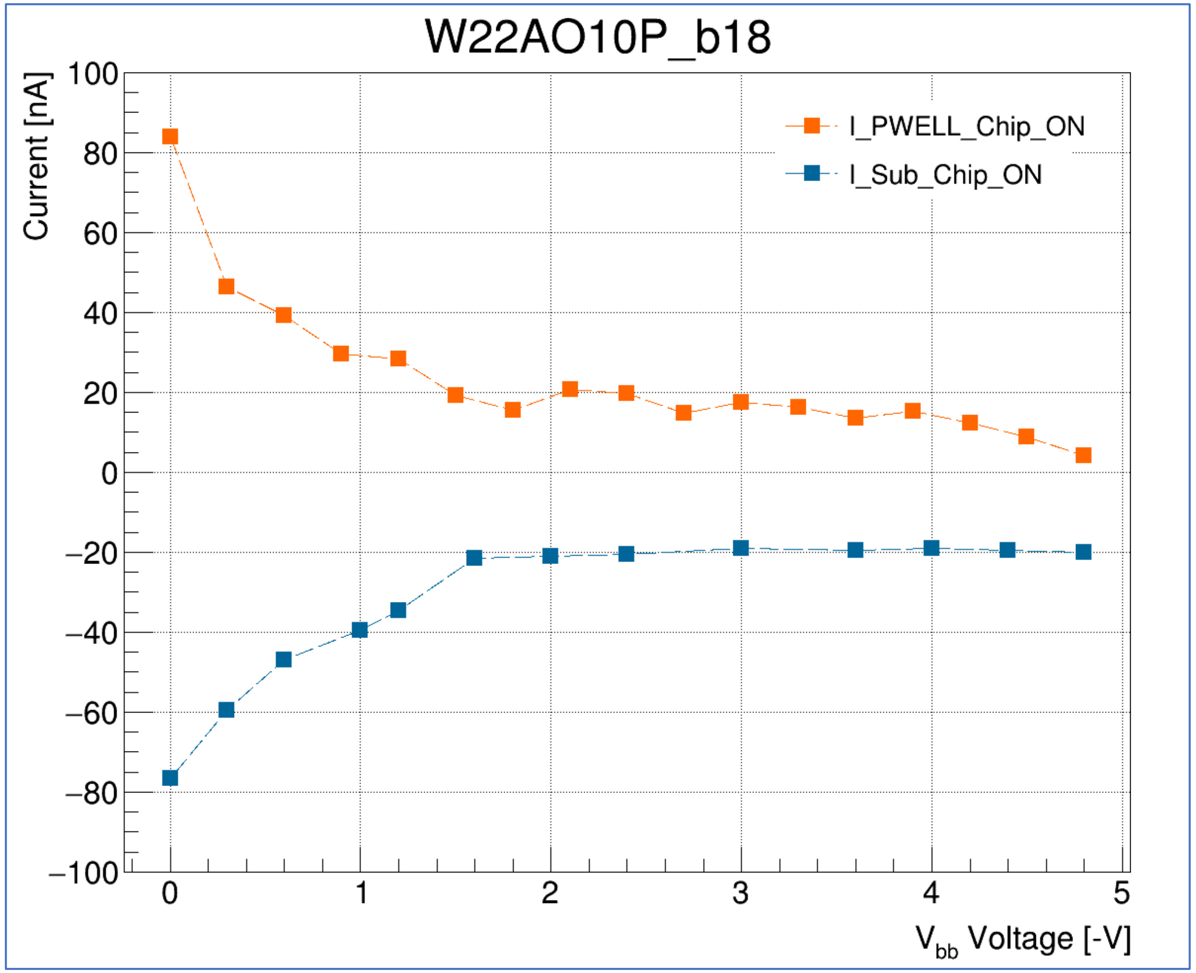
Schematic of measurements: I_{sub} and I_{pwell}



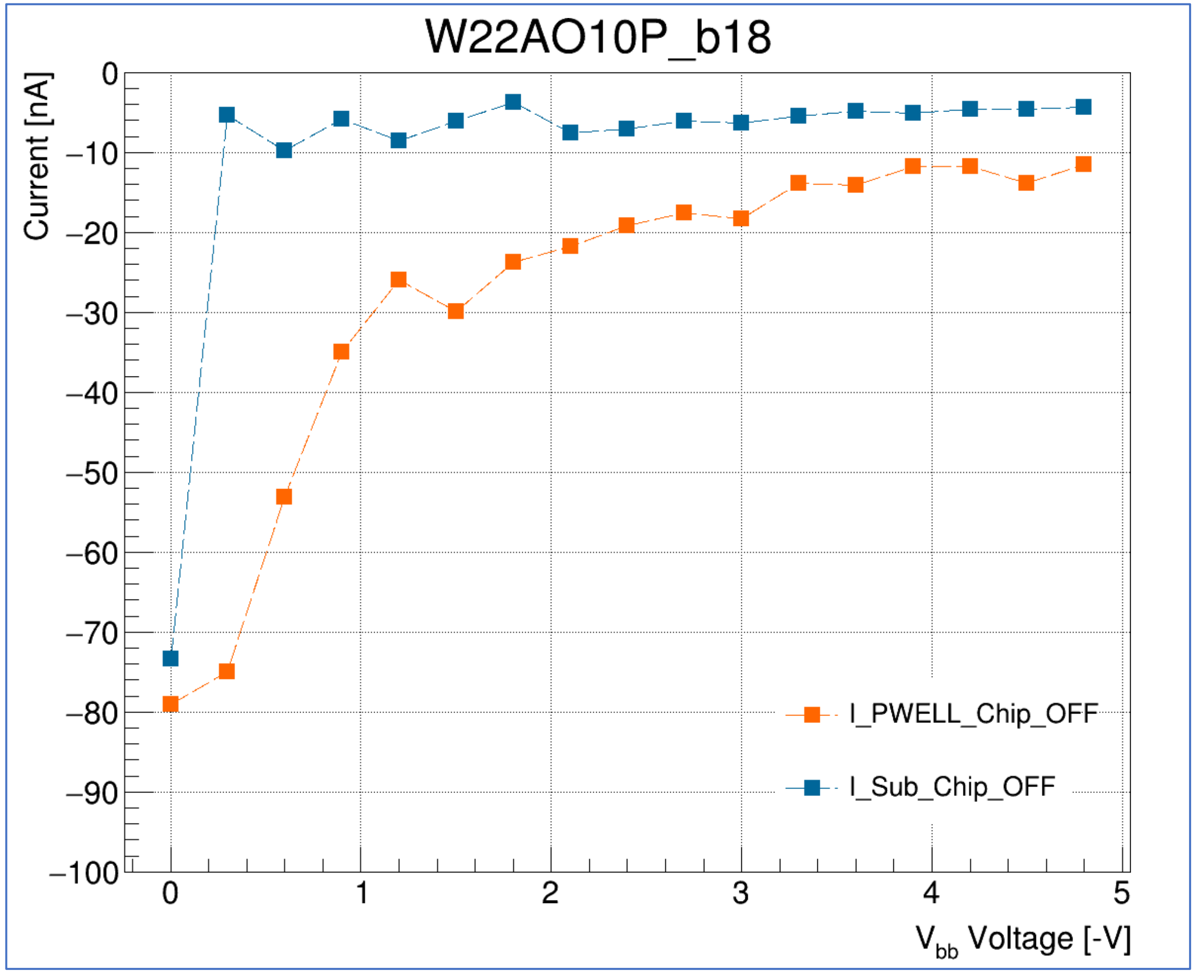


OpAmp Bari – Power ON/OFF Comparison

Carrier (ON) + Proximity + Chip (ON)



Carrier (ON) + Proximity + Chip (OFF)



Next Steps

- Increase configuration for AC Coupled Chip : HV (0÷20V) and PSUB (0,-0.6,-1.2,-1.8,-2.4V)
- Start 55Fe data acquisition for direct chip investigation
- VI Measurements: testing python script for picoammeter data acquisition