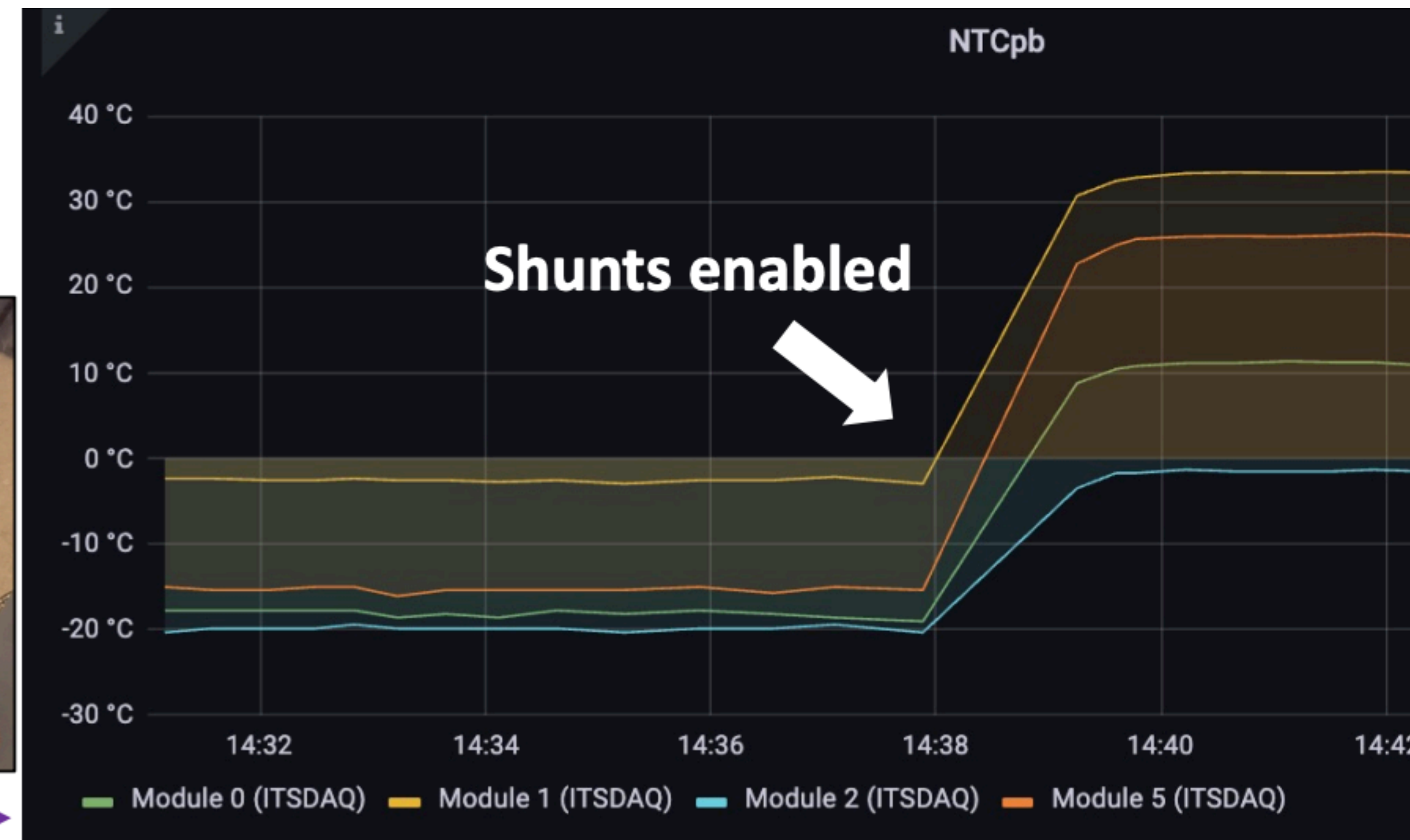


Production PBs seem hotter

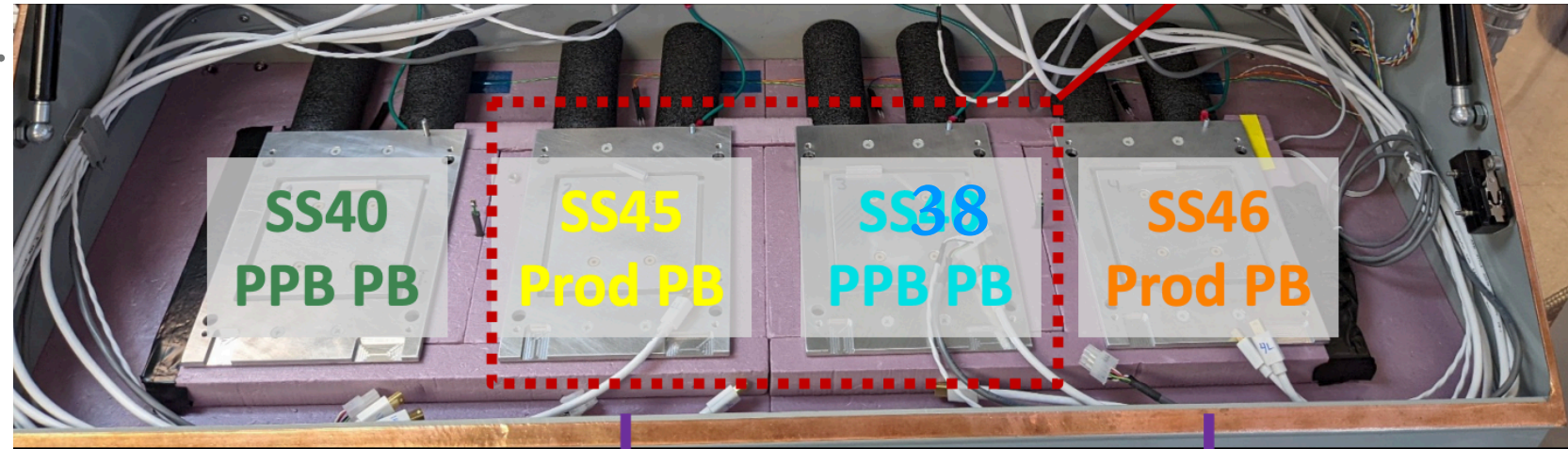
- Ian observed that the SS modules built with production PBs (500) have mild cold noise, while the same build with PPB PBs (404) do not;
 - Plus, at a larger scale (observed also at other sites), the production PBs seem to have more DCDC hot loop noise
 - Plus, the production PBs seem hotter
- Likely correlated, causality to be investigated, today focus only on the hotter issue [Plot stolen from Ian](#)

Chuck temperature @ -35C

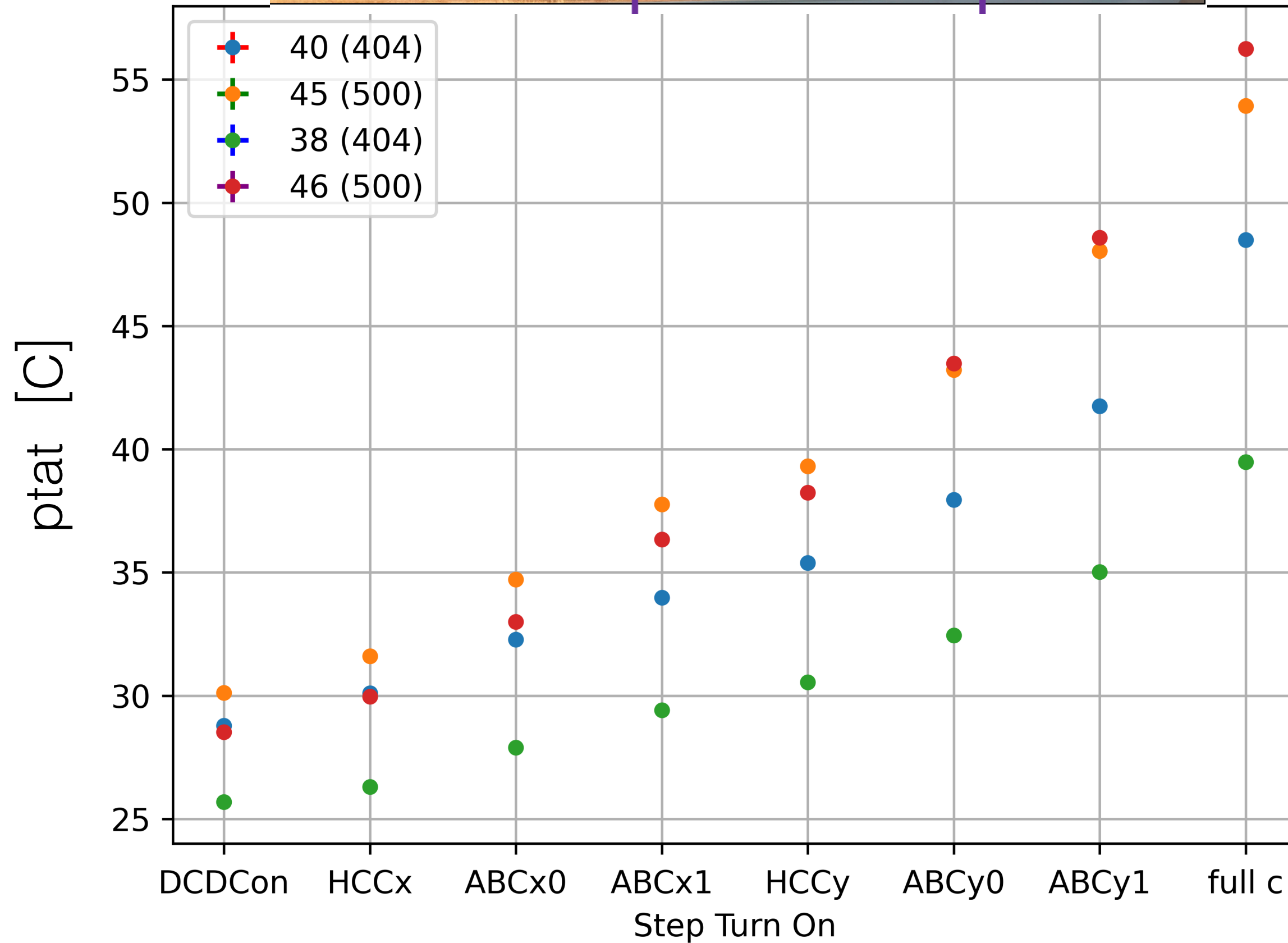


Is it real?

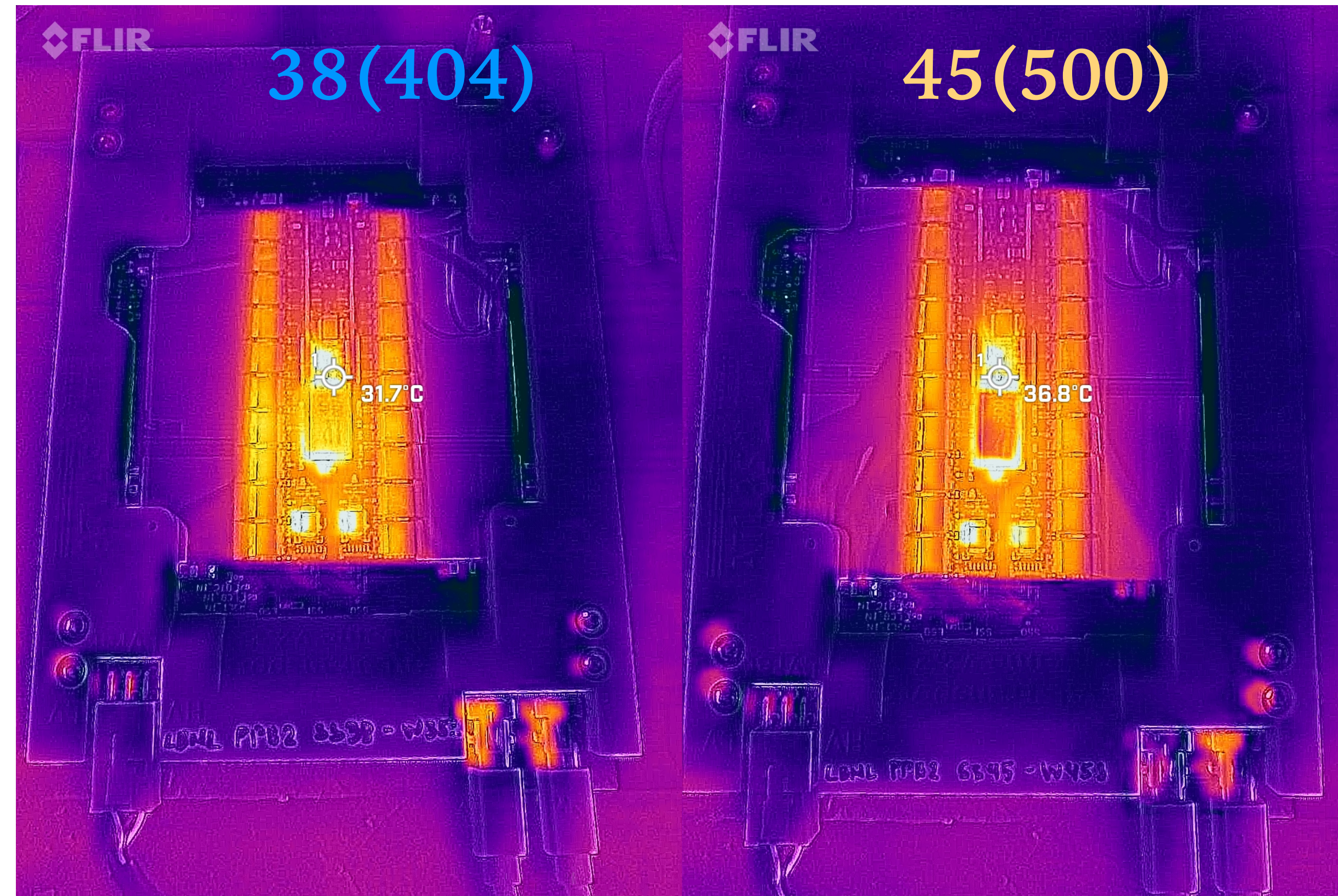
Yes, verified by other measurements



~5C higher

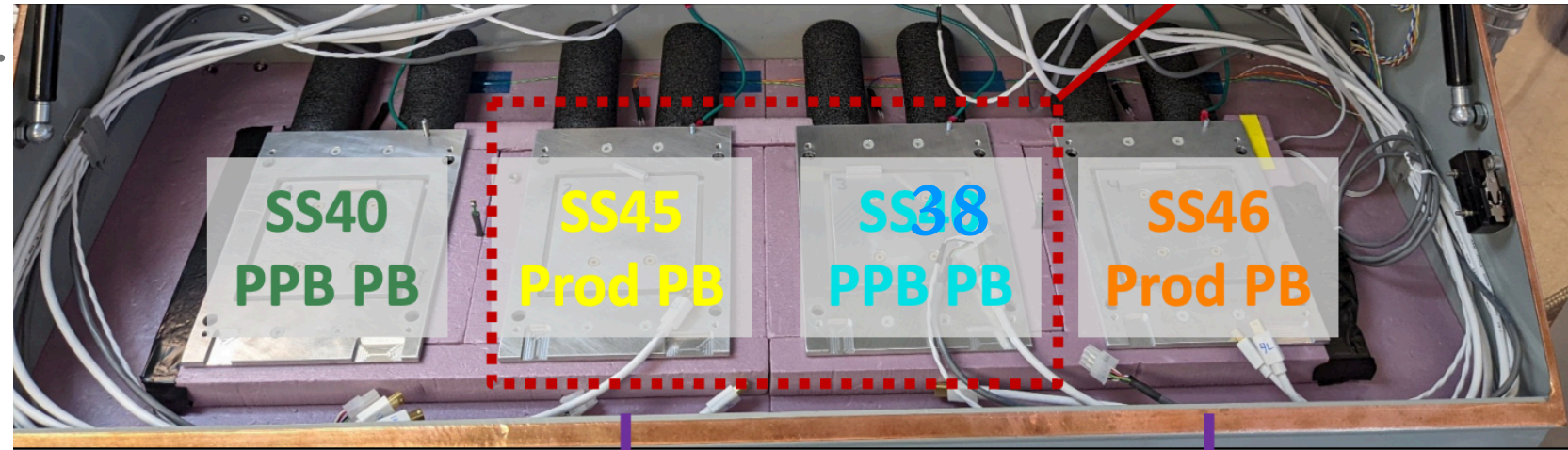


PTAT at DCDC of these 4 SS modules



Thermal Camera (photos from Shubham and Ian)

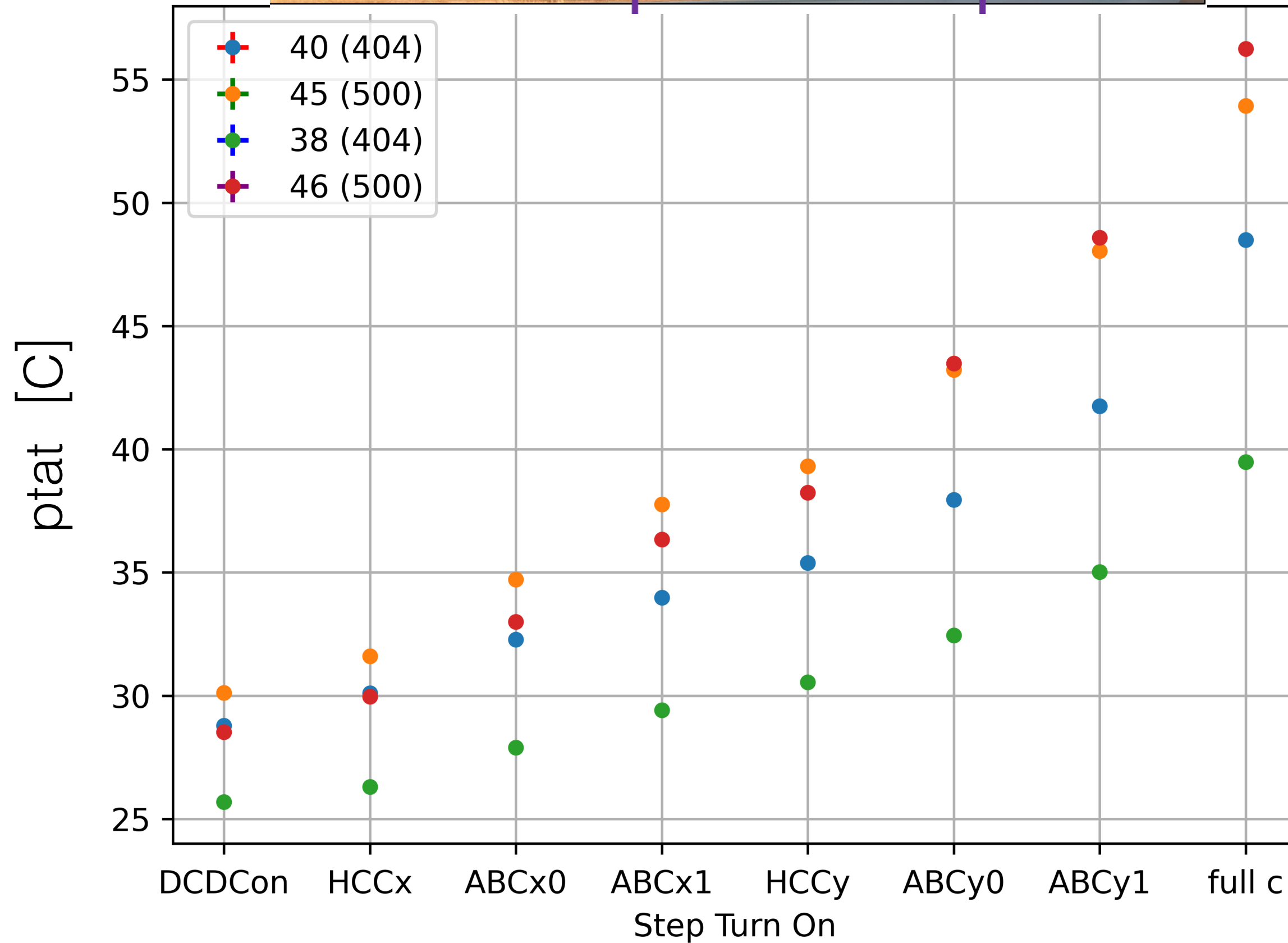
Is it real?



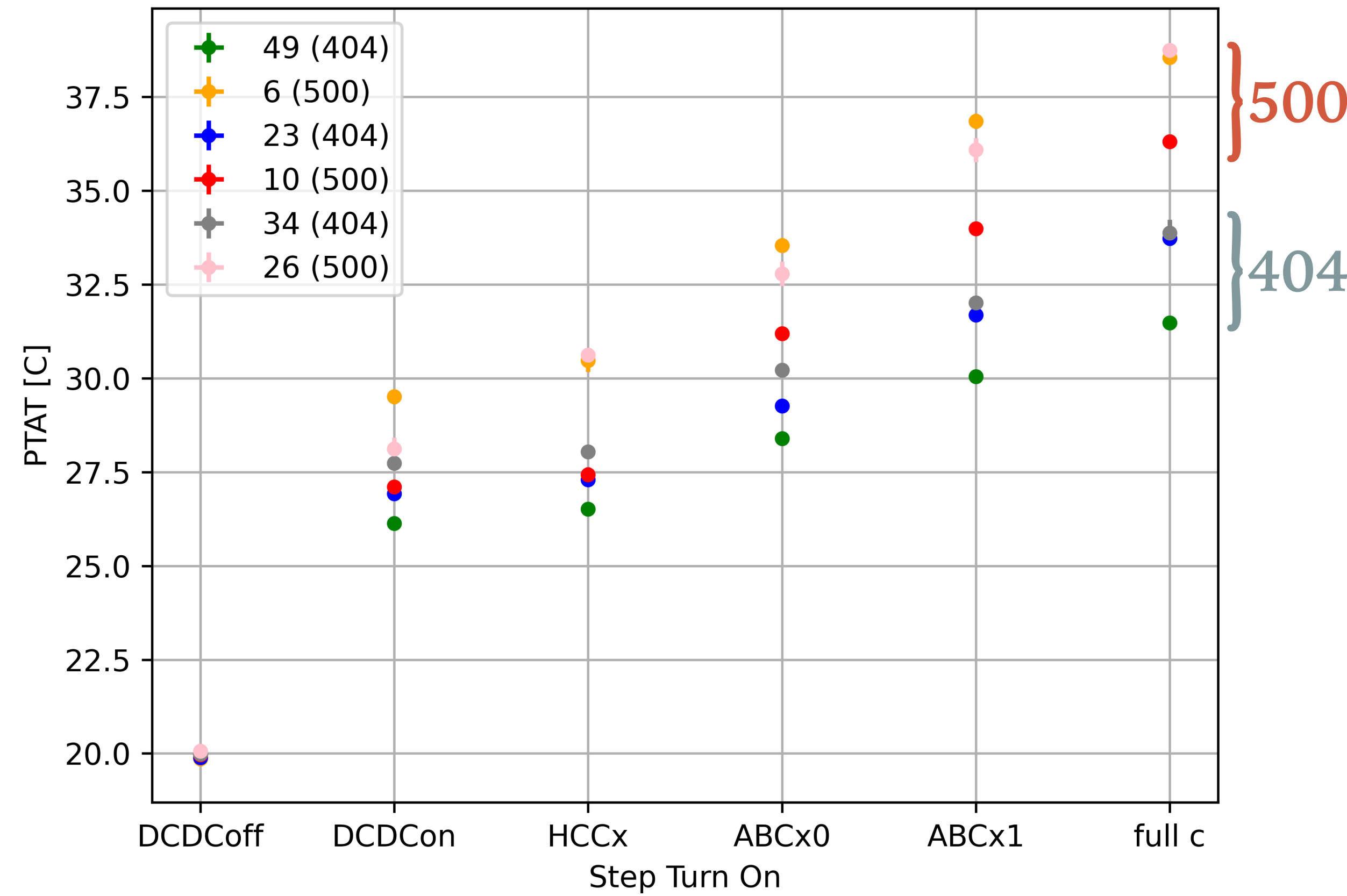
Yes, verified with more stats

Prod PBs (500) vs **PPB PBs (404)**

3-15 C higher (type dependent)



PTAT at DCDC of these 4 SS modules



PTAT at DCDC of more LS modules on the same chuck 1

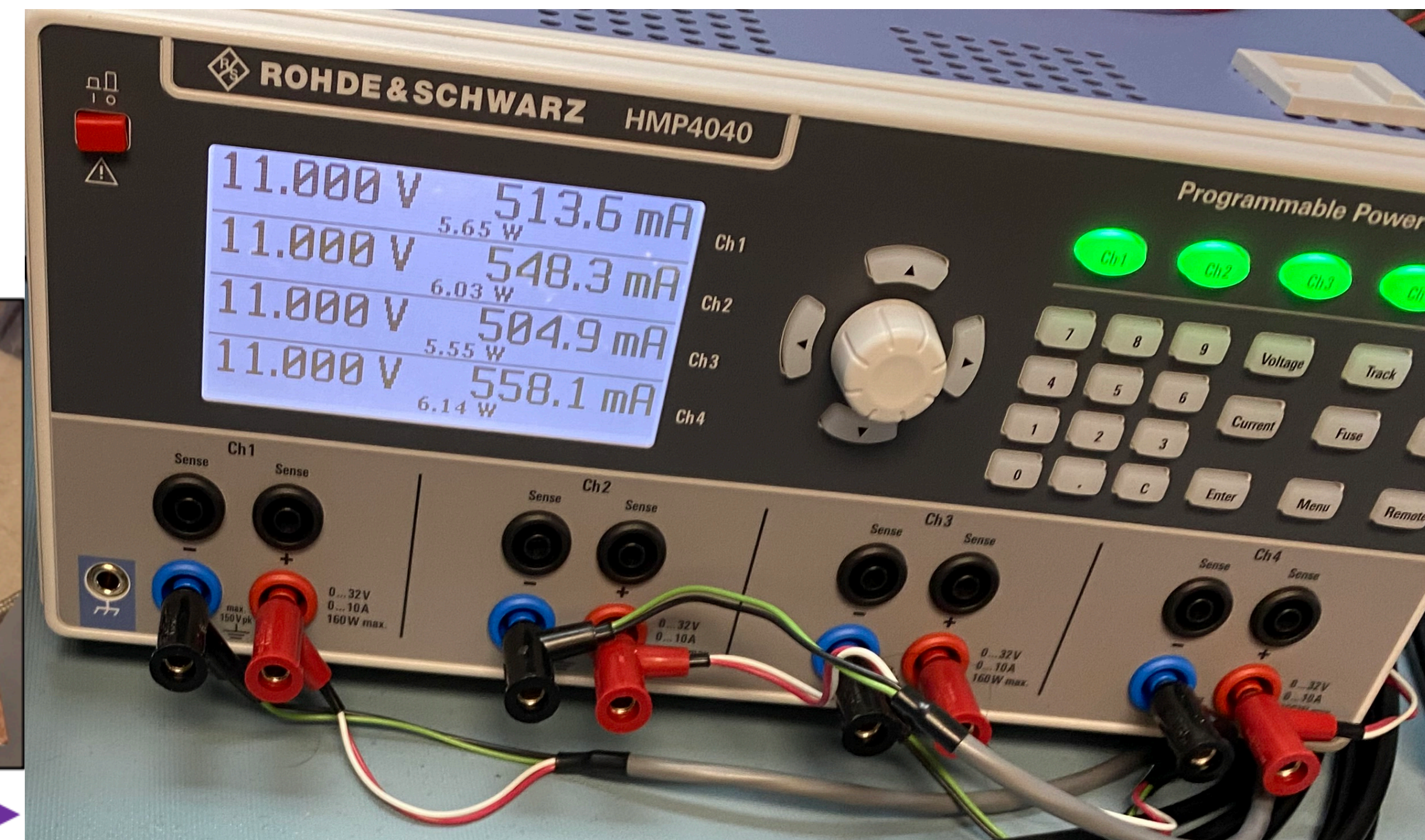
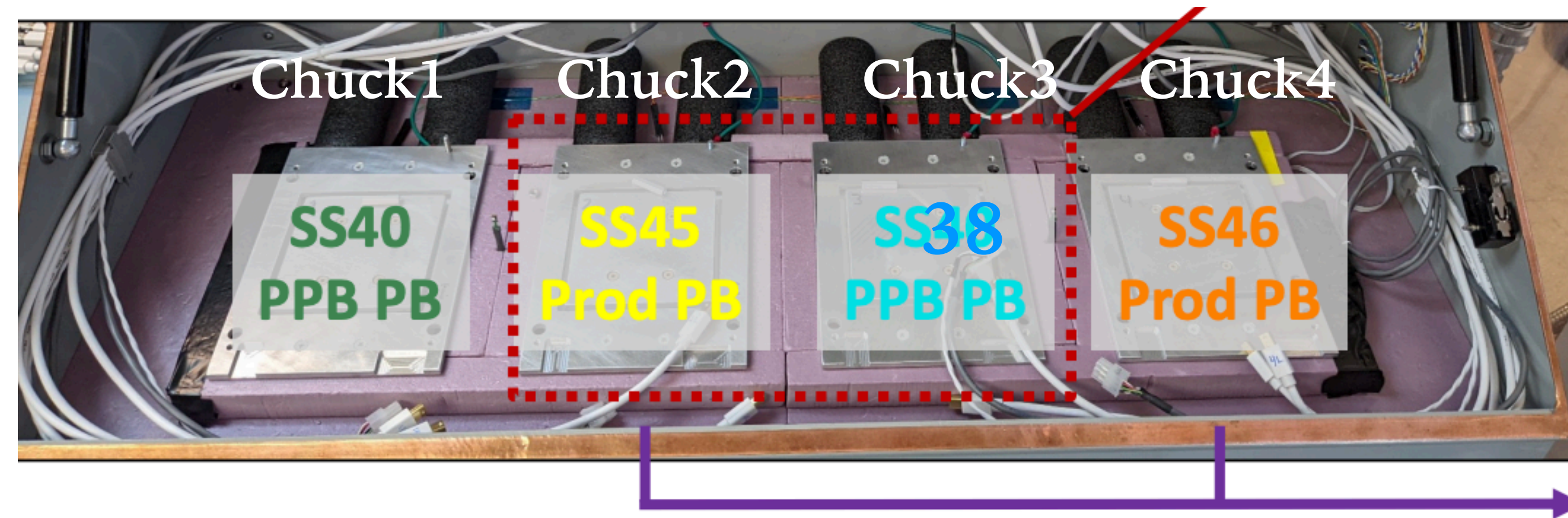
Why?

- Naive guesses
 - More power dissipation?
 - Thermal contact/cooling issue?
 -

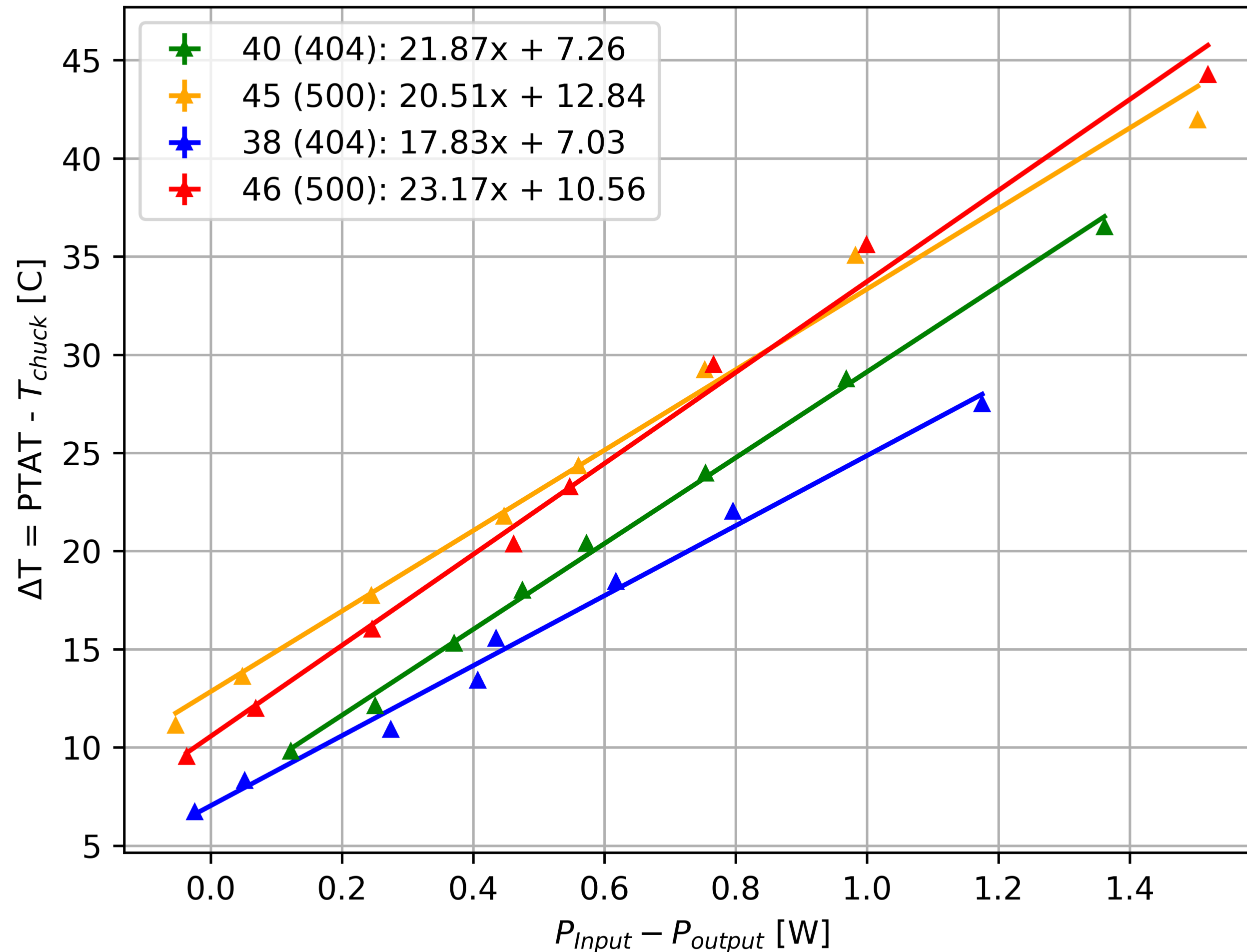
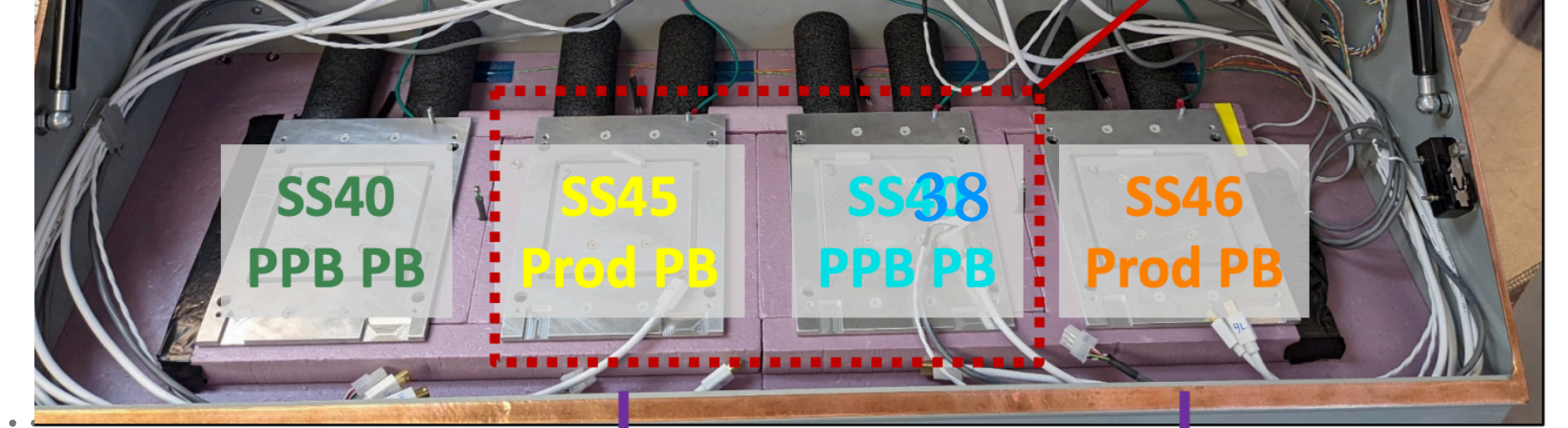
Why? More power dissipation?

Observed that modules with production PBs draw more current

- Constant voltage + higher current = more power \rightarrow higher temperature
- Why is there more power dissipation?



More power -> higher temperature ?



- A very rough estimation of the thermal resistance:

$$R_{\theta} = \frac{\Delta T}{P} \rightarrow T_{DCDC} - T_{chuck} \text{ when stable}$$

$$\rightarrow I_{in} * V_{in} - I_{out} * V_{out}$$

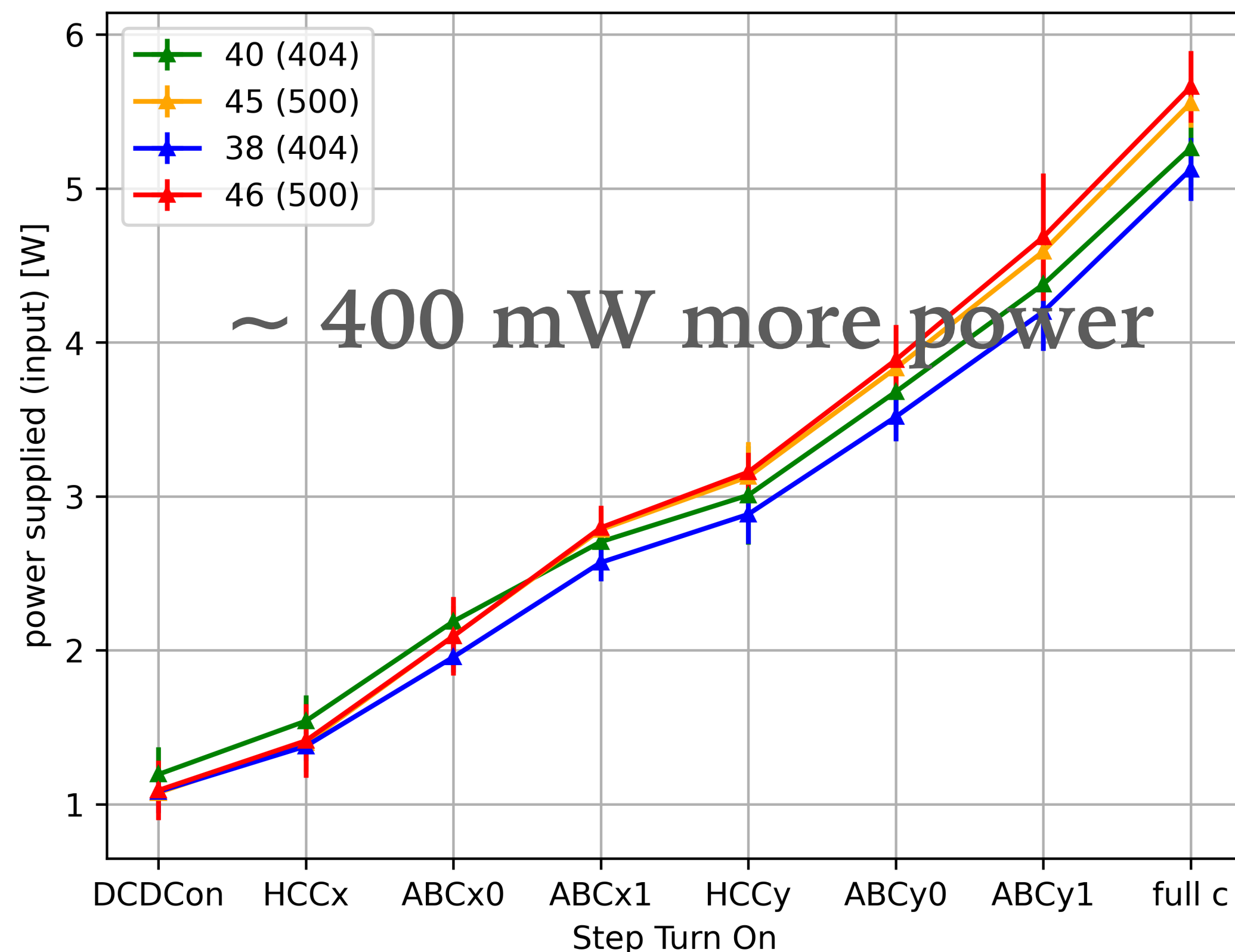
= fitted slope

- Consistent slopes observed between 404 and 500 PBs: ~ 21 C/W
 - Points to more power dissipation instead of thermal contact/cooling issue
- Cross-checked with data from burn-in crate and climate chamber (both ~ 25 C/W)

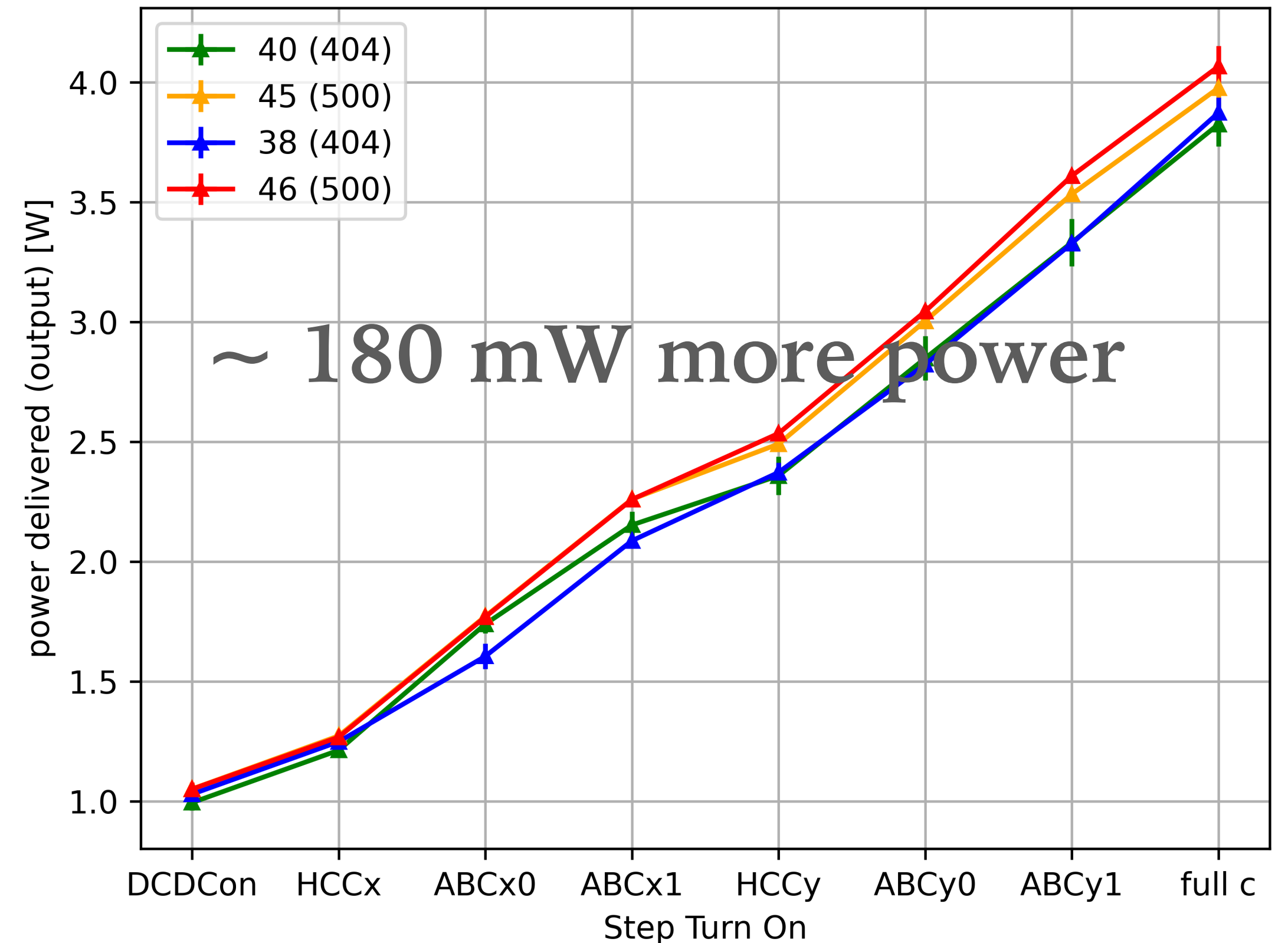
More power -> higher temperature ? Yes

Prod PBs (500) vs PPB PBs (404) $400 - 180 = 220$ mW more heat dissipation,
Result in a temperature increase of $21 \text{ C/W} \times 220 \text{ mW} \sim 5\text{C}$,
Consistent with the observation

Power supplied to DCDC (input)



Power delivered by DCDC (output)



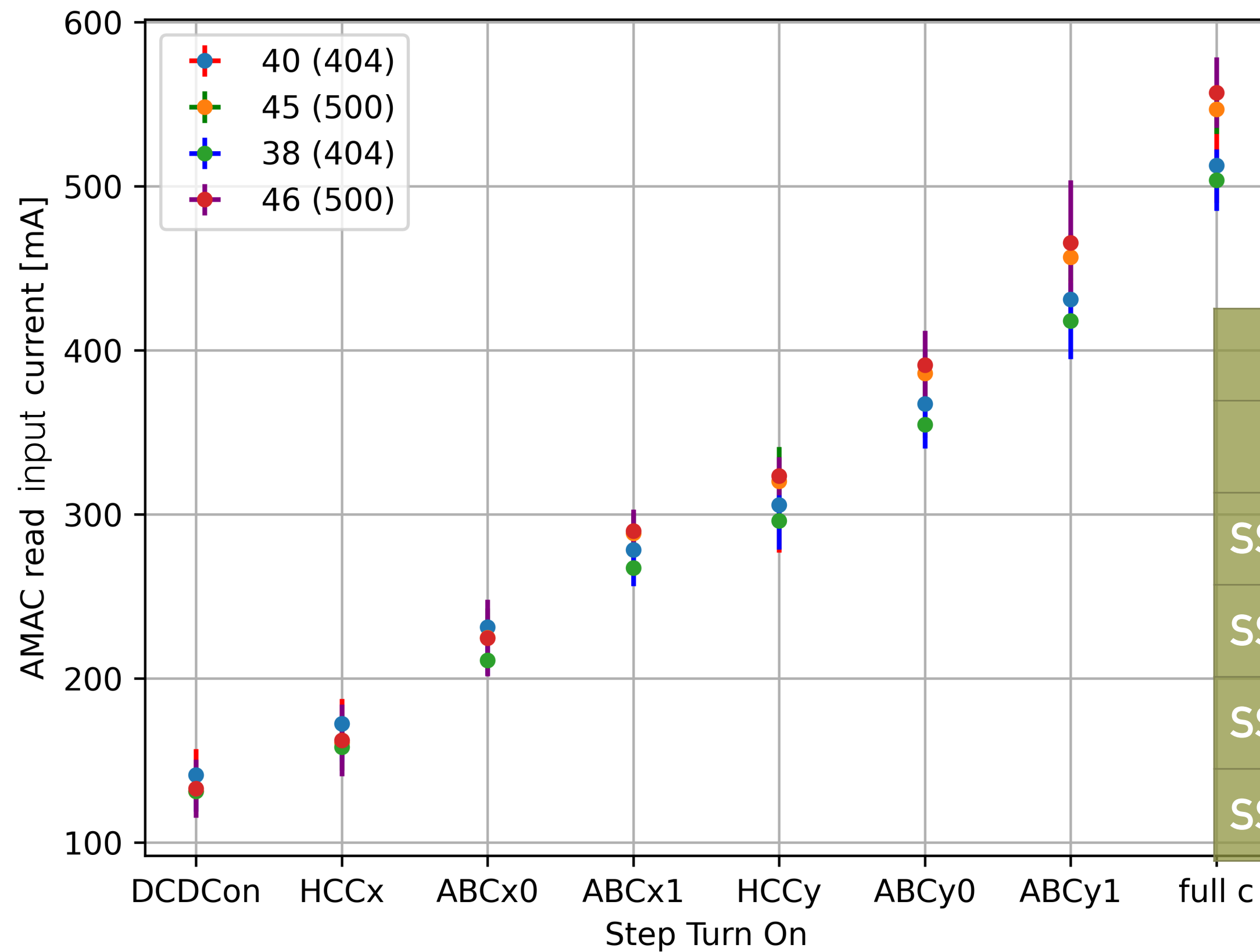
Why higher current ?

Readout ASICs pulling more current?

Nah...

DCDC input current

- Each step pulls a slightly higher current



	PB	ASIC Wafer				DCDC on	Stage Current (mA)						
		X-HCC	X-ABC	Y-HCC	Y-ABC		HCCx	ABCx 0	ABCx 1	HCCy	ABCy 0	ABCy 1	Full conf
SS40	404	1002	1173	1002	1173	141.0	31.4	58.8	47.1	27.5	61.5	63.8	81.5
SS45	500	1003	1297	1002	1173	131.2	29.6	63.9	63.8	31.7	65.7	70.8	90.1
SS38	404	1002	1173	1002	1193	131.2	26.9	52.9	56.4	28.7	58.6	63.1	85.9
SS46	500	1003	1297	1002	1193	132.7	29.5	62.4	65.2	33.5	67.6	74.5	91.6

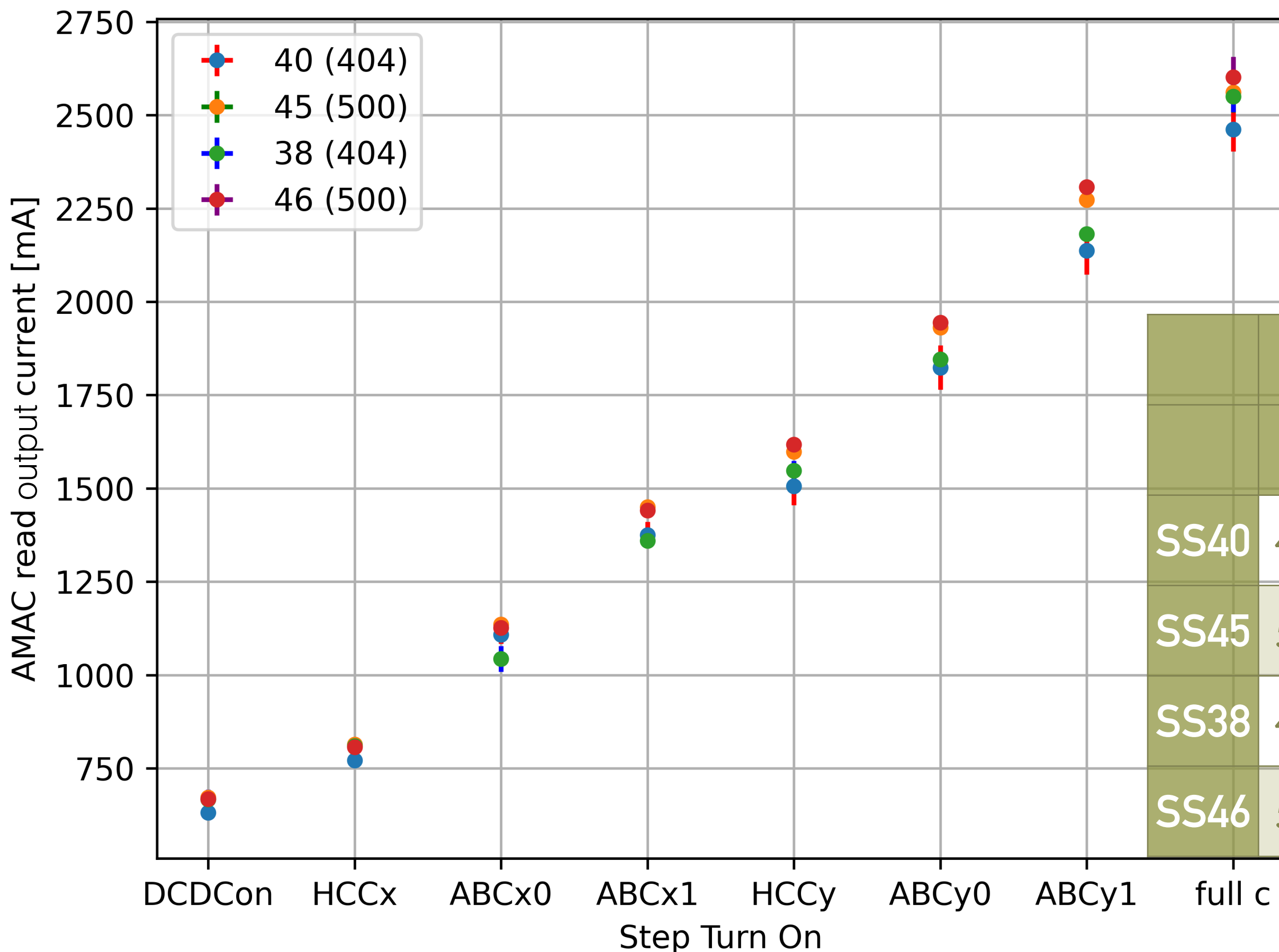
Why higher current ?

Readout ASICs pulling more current?

Nah...

DCDC output current

- Each step pulls a slightly higher current
- No significant more output current observed for modules with 500 PBs



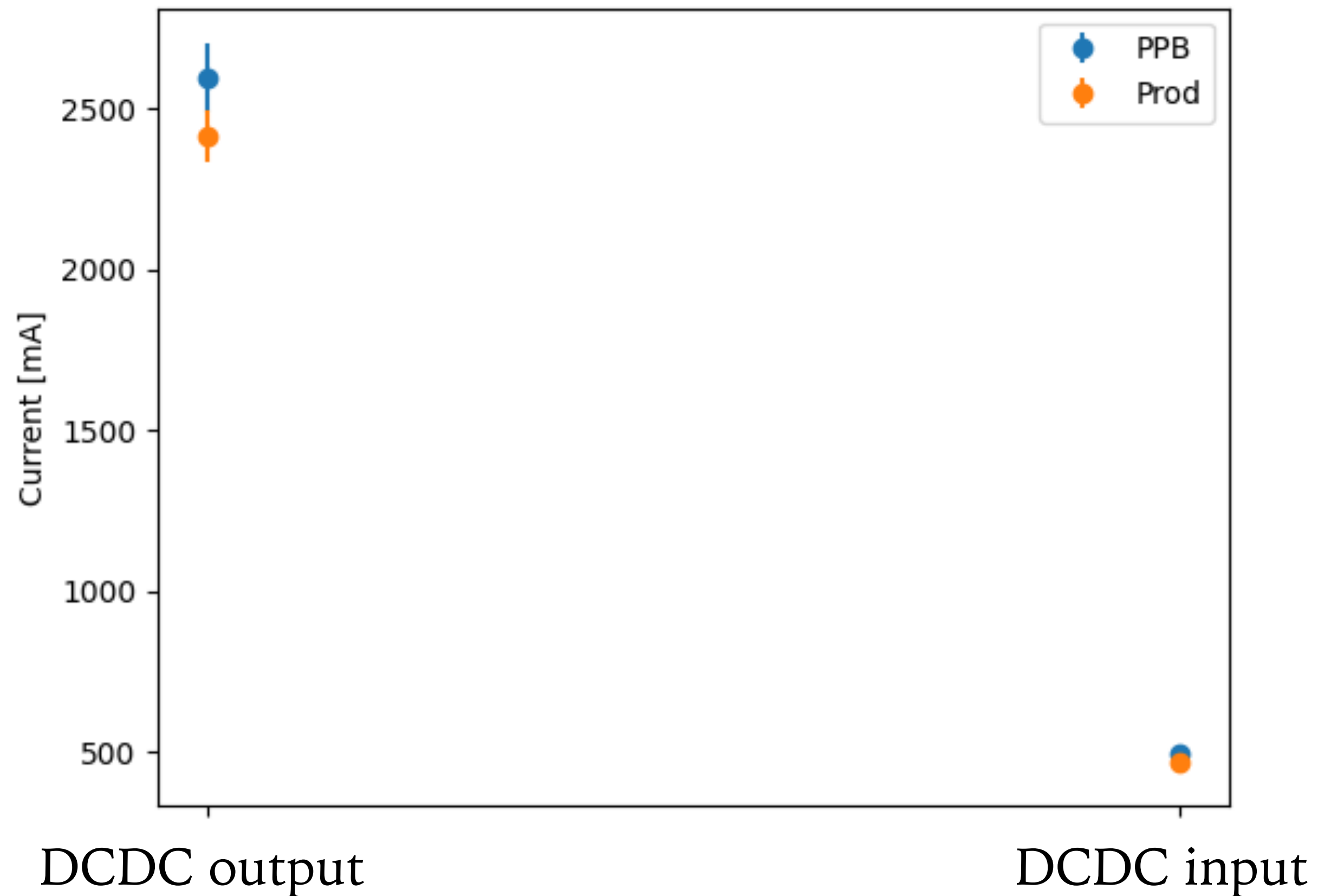
	PB	ASIC Wafer				Stage Current (mA)									
		X-HCC	X-ABC	Y-HCC	Y-ABC	DCD Con	HCC v	ABC v0	ABC v1	HCC v	ABC v0	ABC v1	Full conf		
SS40	404	1002	1173	1002	1173	632	140	336	267	131	318	313	325		
SS45	500	1003	1297	1002	1173	672	142	321	314	149	332	342	288		
SS38	404	1002	1173	1002	1193	667	143	233	317	188	298	336	368		
SS46	500	1003	1297	1002	1193	669	139	319	315	177	327	362	294		

Why higher current ?

Readout ASICs pulling more current?

Nah...

DCDC currents

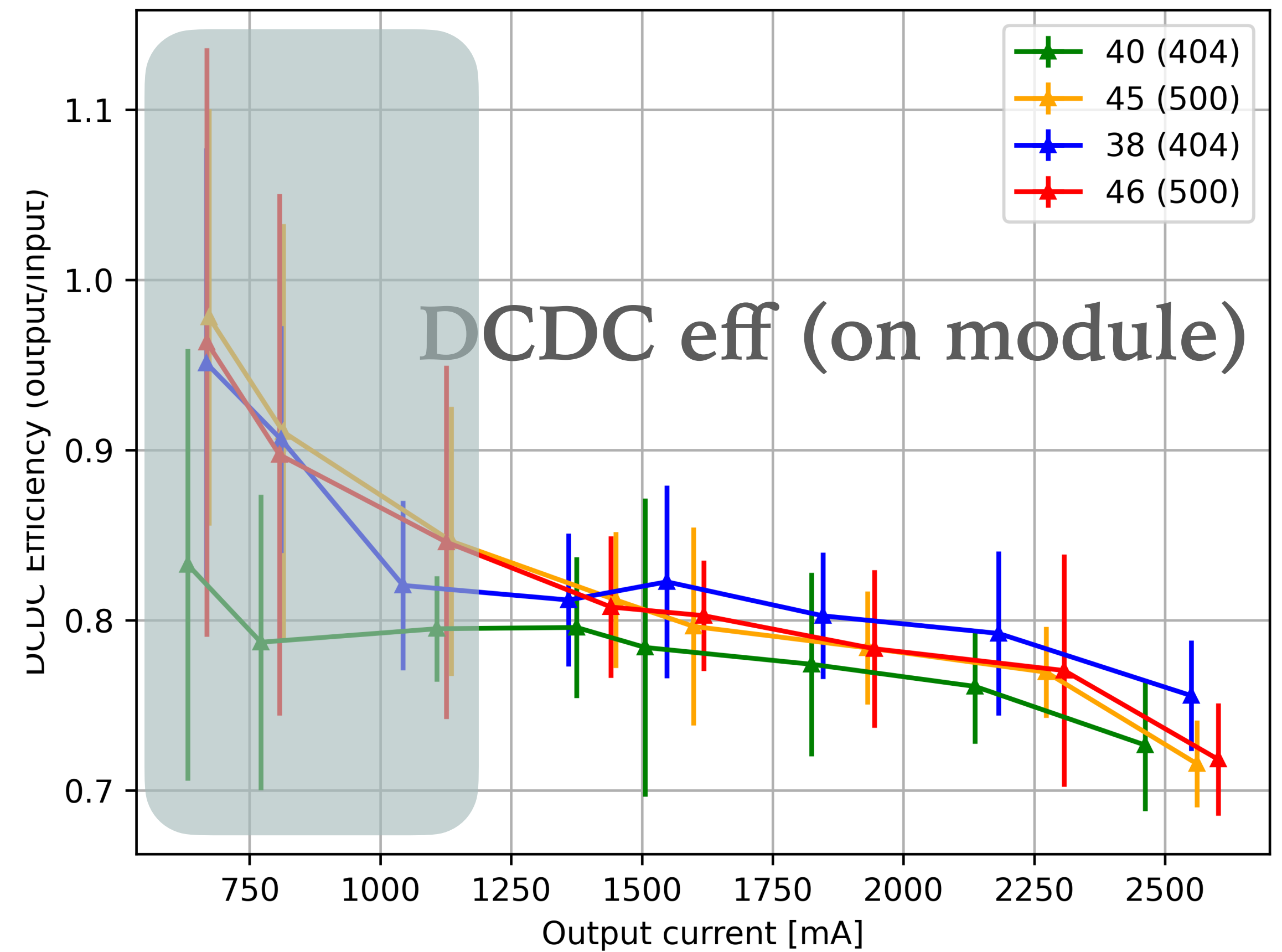
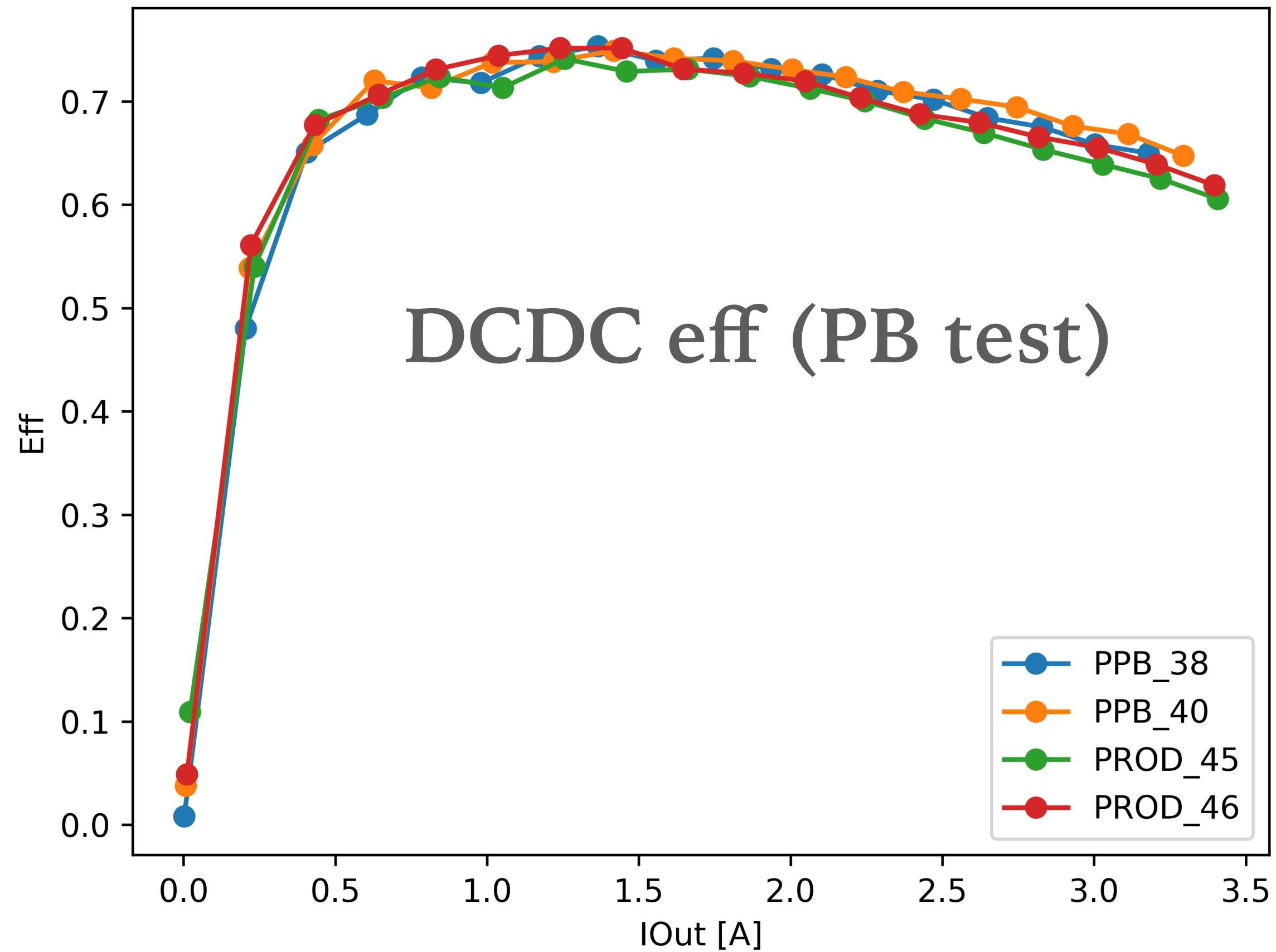


- More direct check from the burn-in setup
 - Same powerboard with production and PPB ASICs
 - Same slot and position in the burn-in crate, same environment control
 - Current readout (both input and output) is consistent with results of modules using PPB PBs

Why higher current ?

Lower Efficiency?

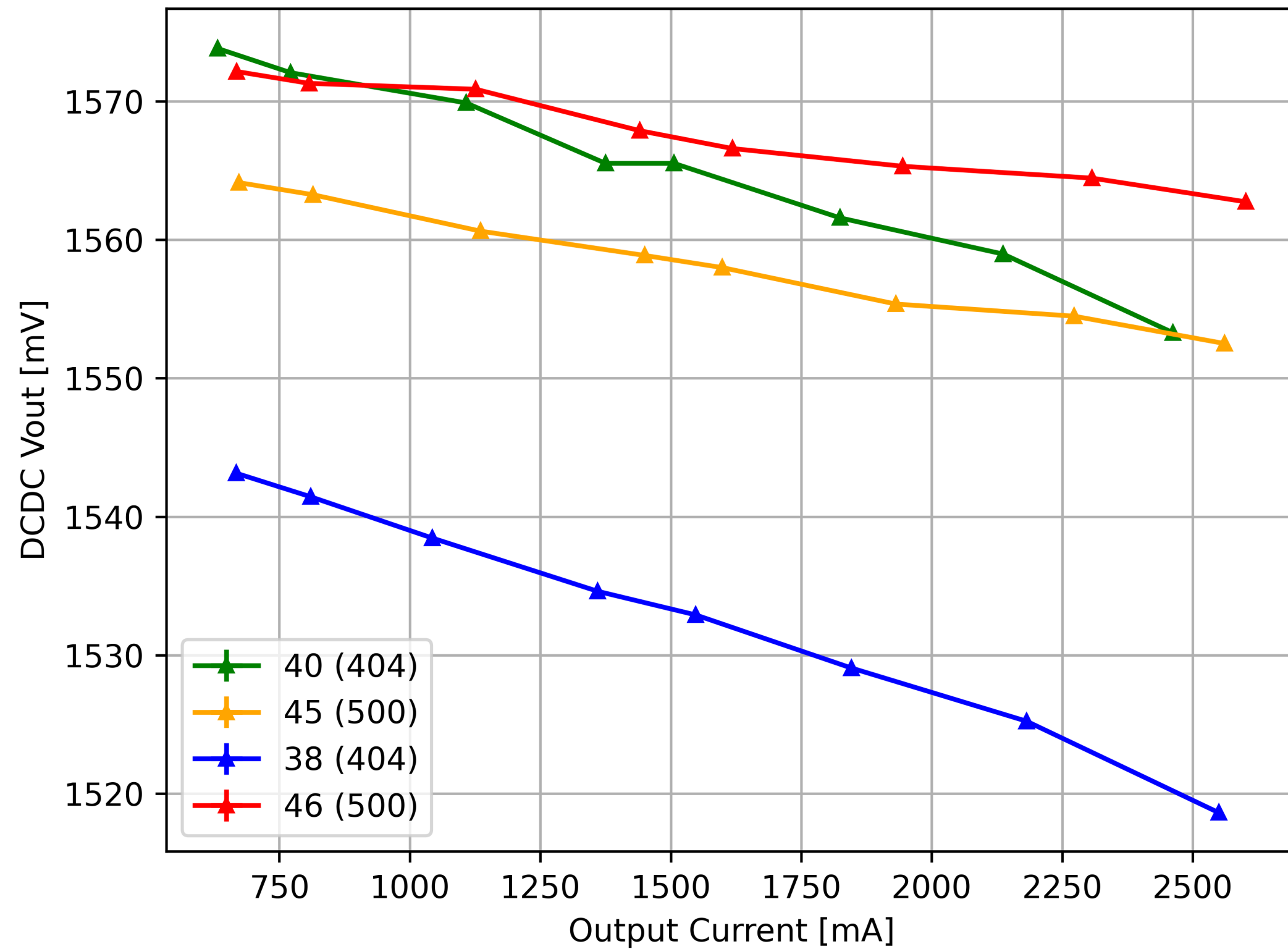
Nah...



Why higher current ?

Two features

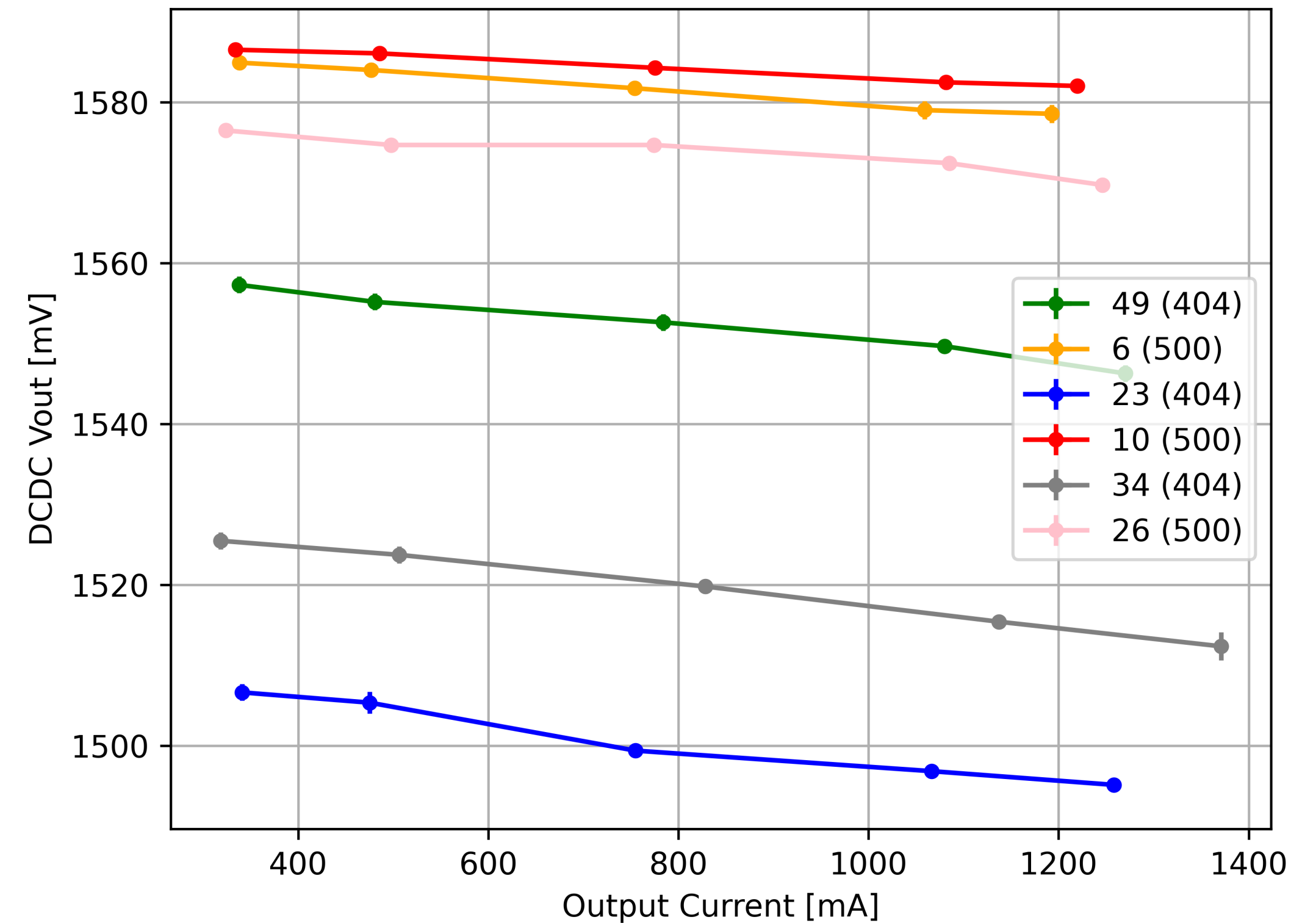
1. 500 PBs on average higher output voltage



DCDC Vout of the 4 SS modules

Higher Output Voltage?

Ha, Kind of...

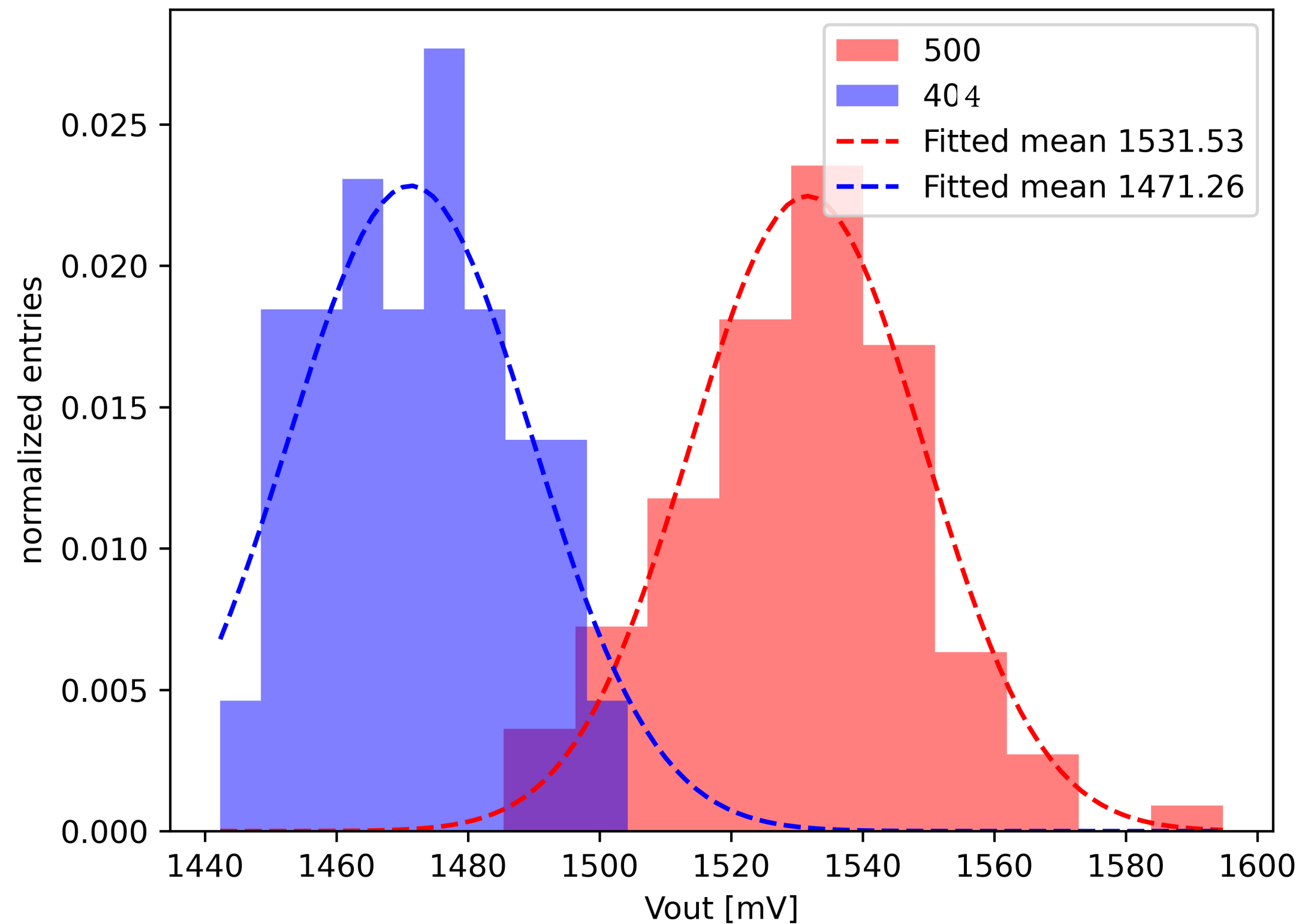


DCDC Vout of more LS modules on the same chuck 1

Why higher current ?

Two features

1. 500 PBs on average higher output voltage

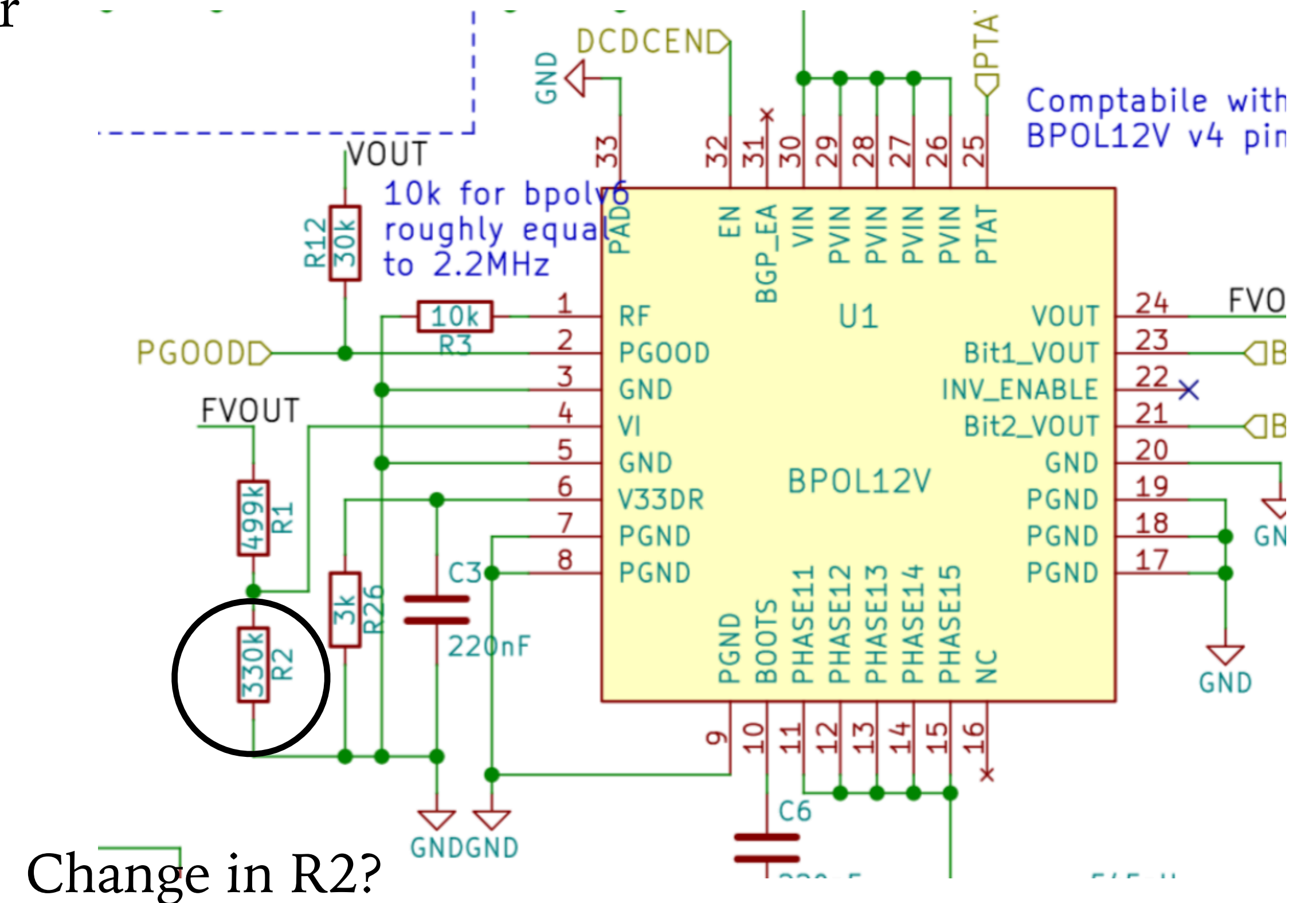


DCDC Vout at 1.5A load

Higher Output Voltage?

Ha, Kind of...

gher



Why higher current ?

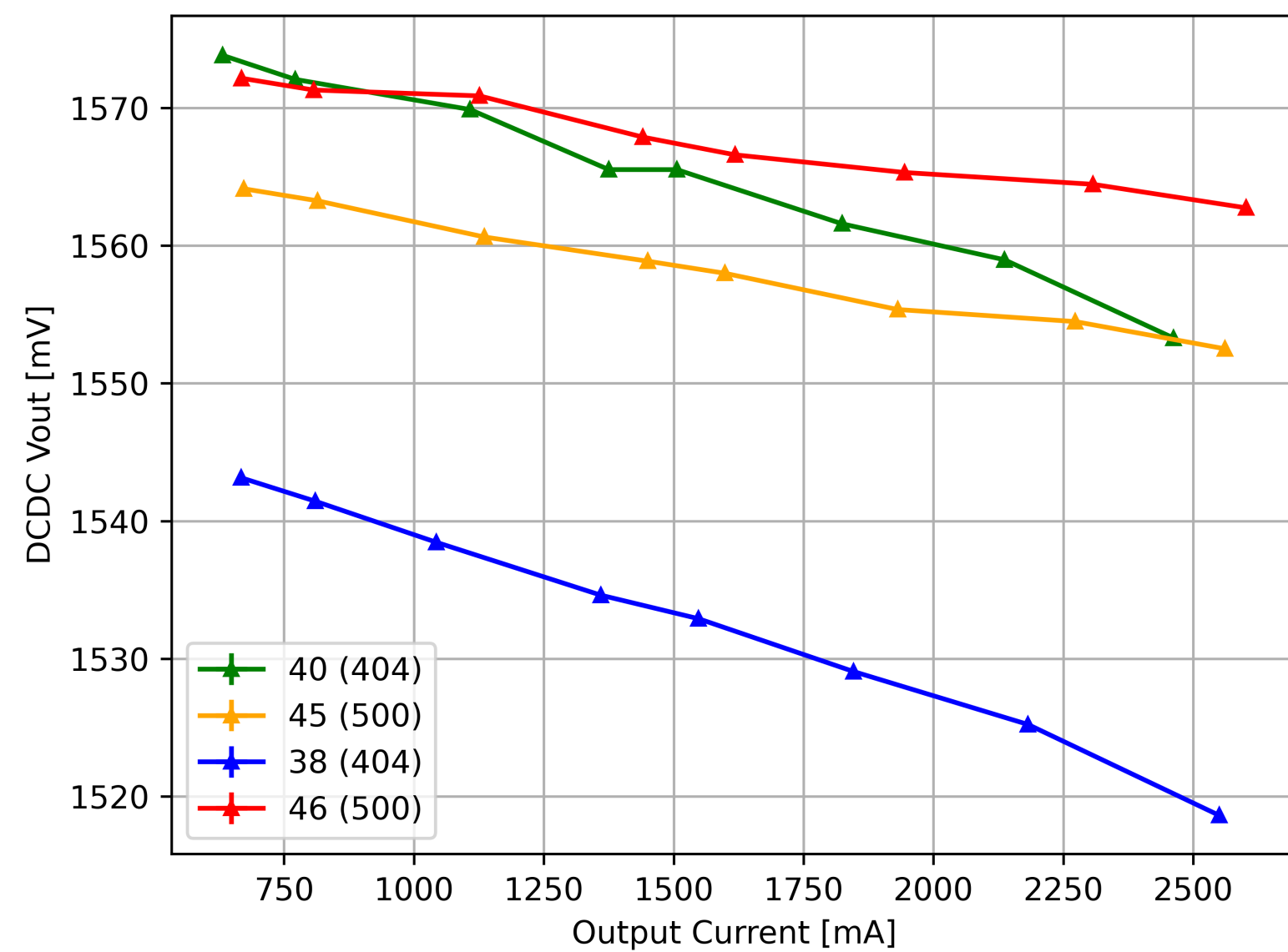
Higher Output Voltage?

Two features

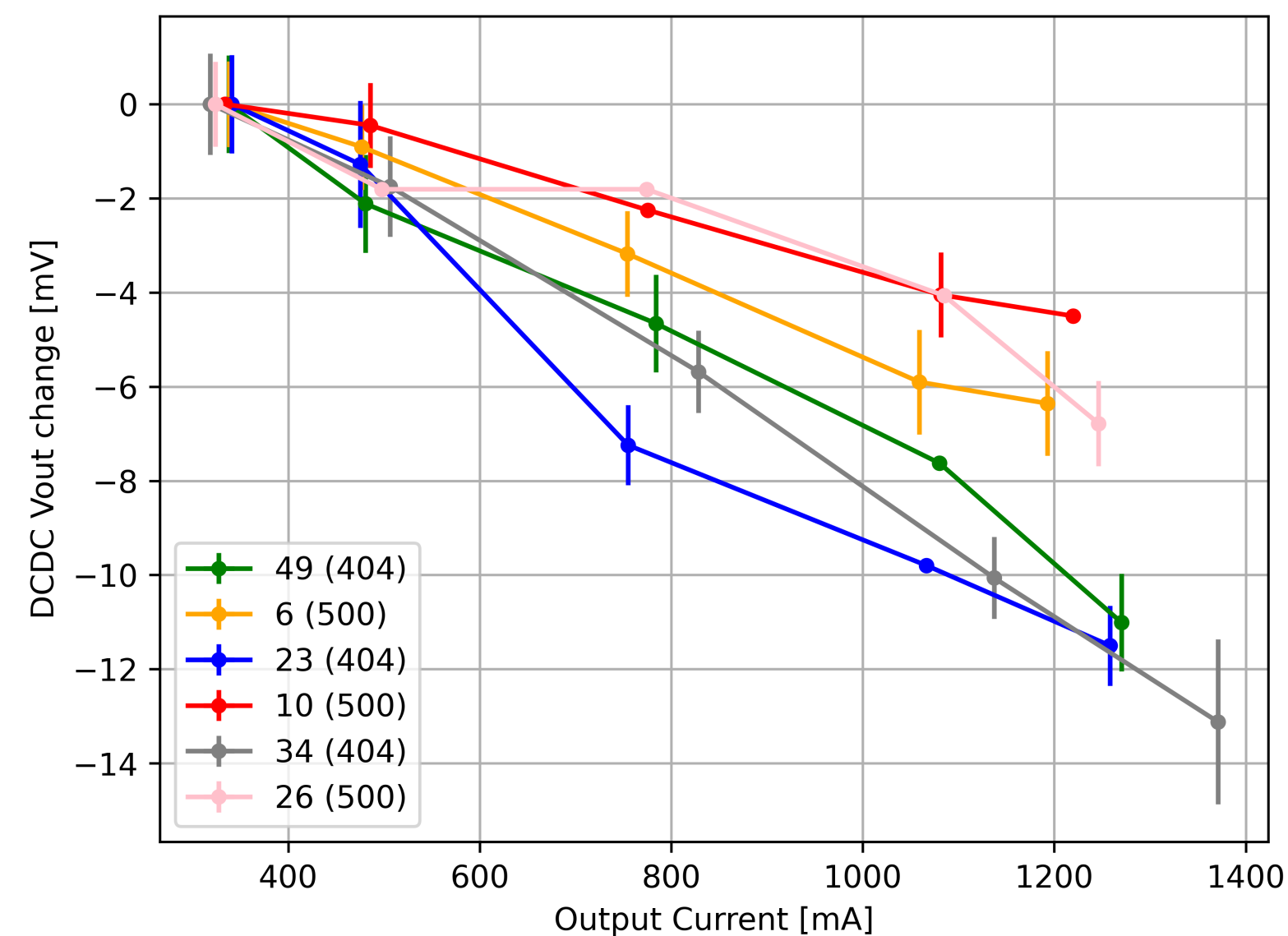
Ha, Kind of...

2. 404 PB output voltages seem drop more than 500 PBs' as load increases

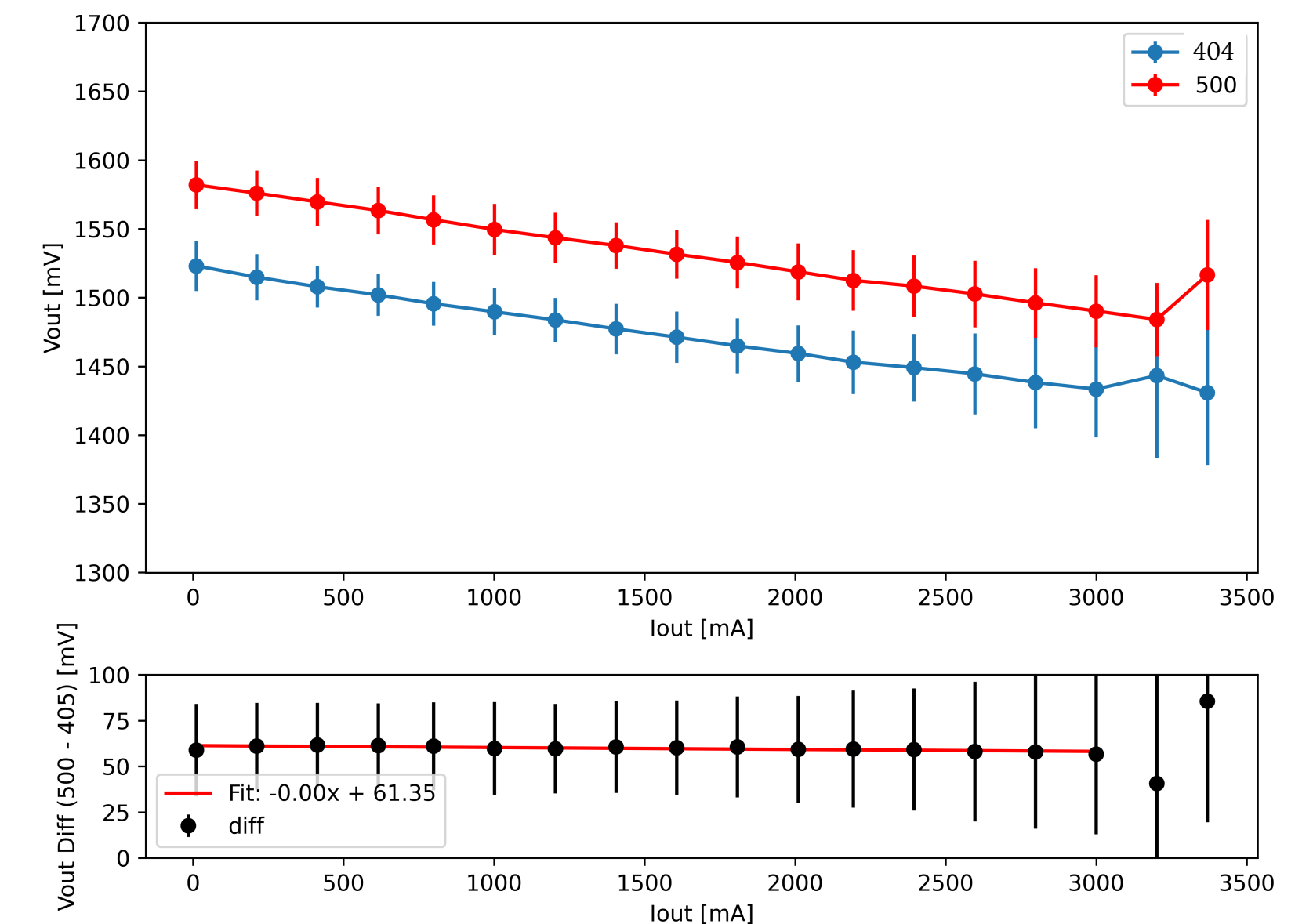
► Only observed on modules



DCDC Vout of the 4 SS modules



DCDC Vout change of more LS modules on the same chuck 1



DCDC Vout from PB tests

Constant ~ 60mV difference between 404 and 500

Why higher current ?

Higher Output Voltage?

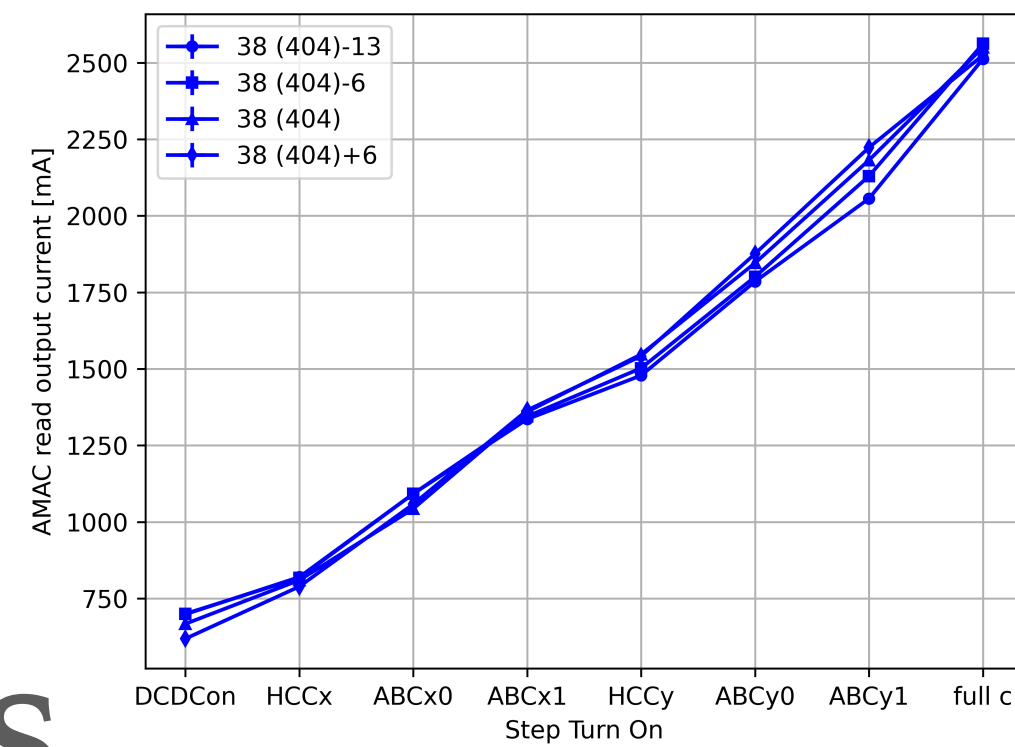
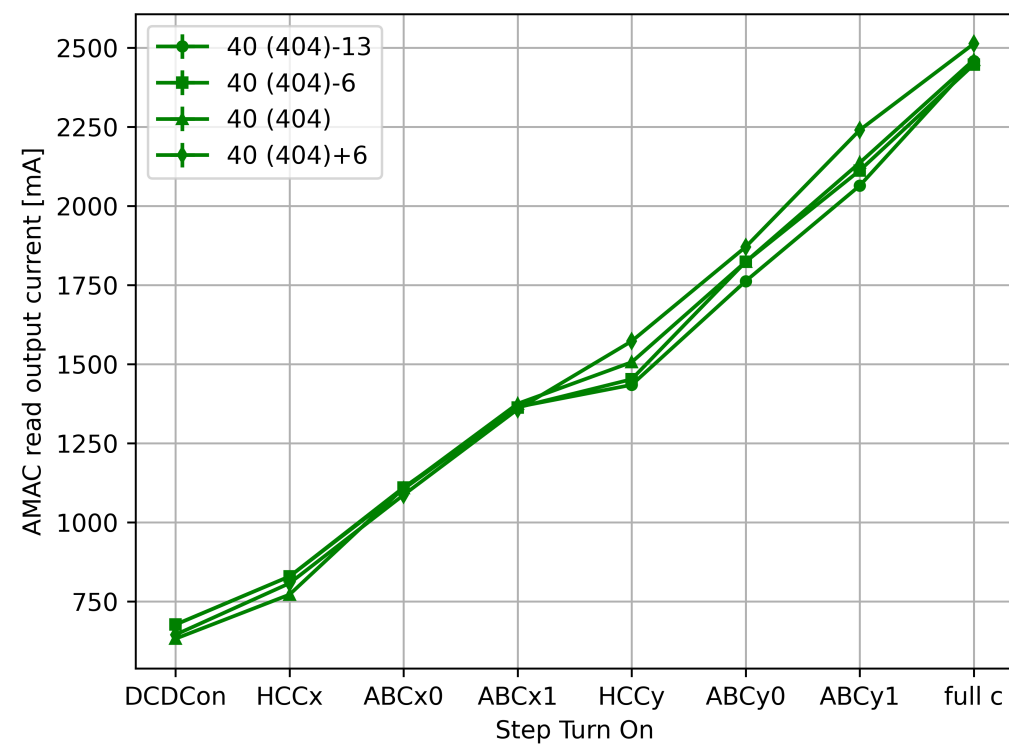
Ha, Kind of...

1. 500 PBs on average output higher voltage
 2. 404 PB output voltages drop more than 500 PBs' as load increases
- Output voltage features result in more power dissipation, but the differences (from 1+2) do not seem to be enough to cover the observed power dissipation difference
 - Anything else? Output currents?

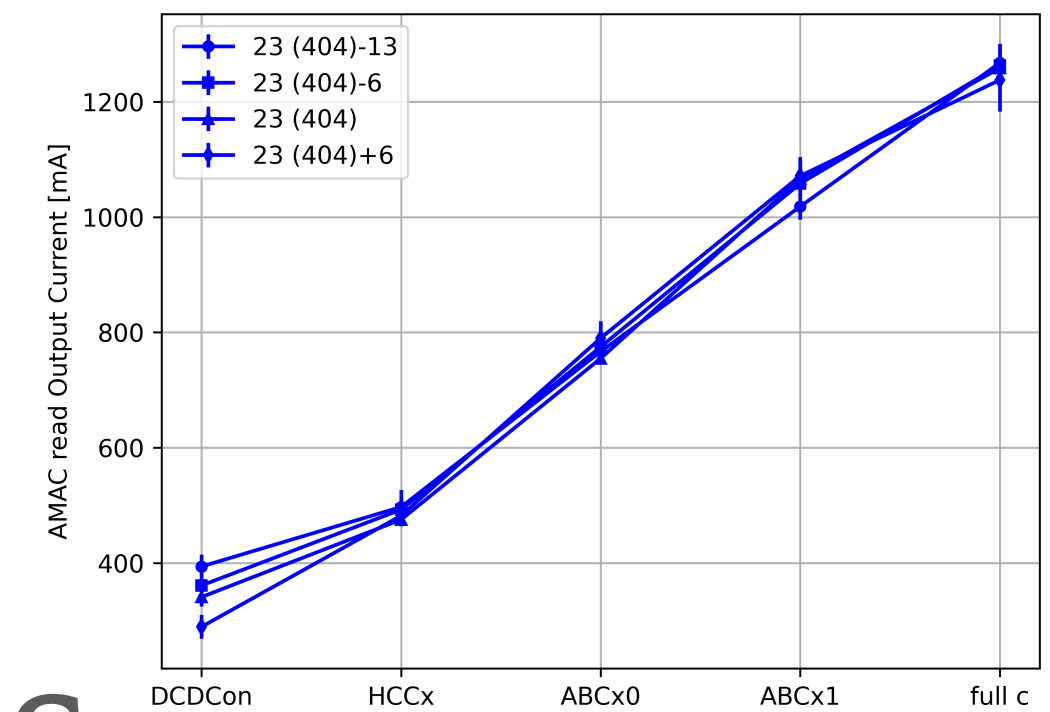
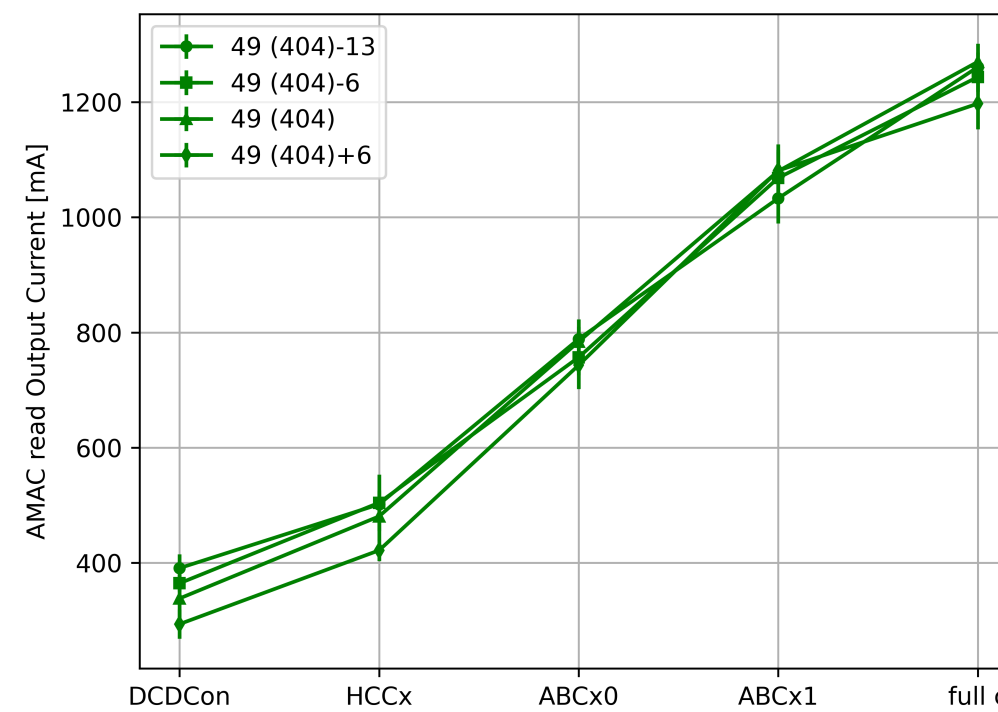
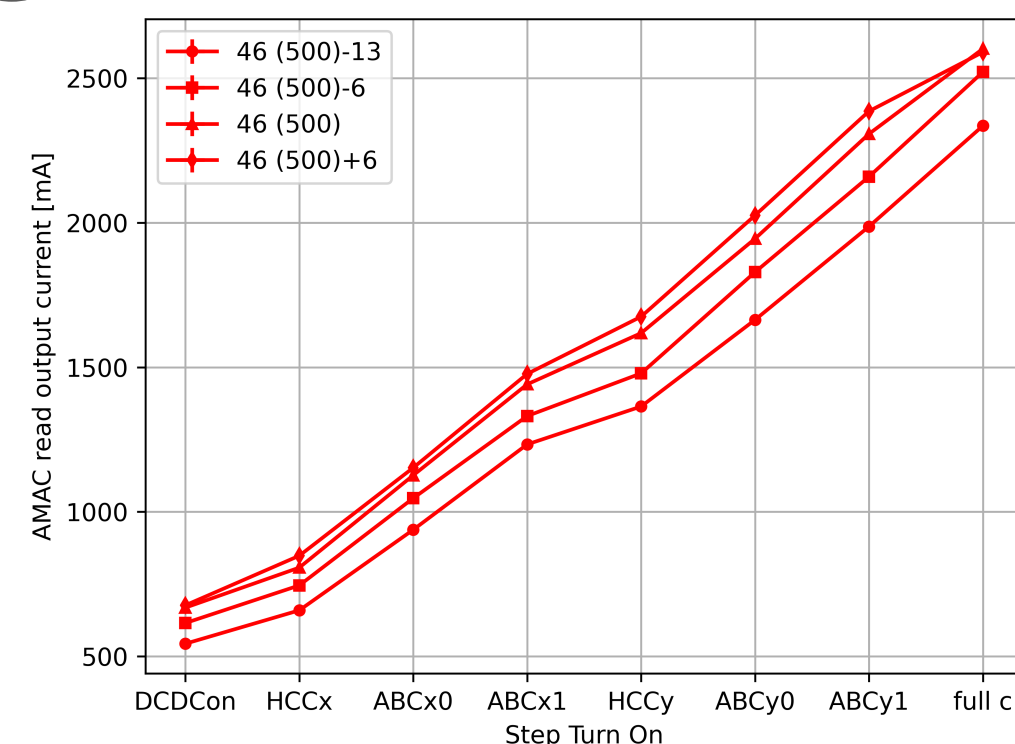
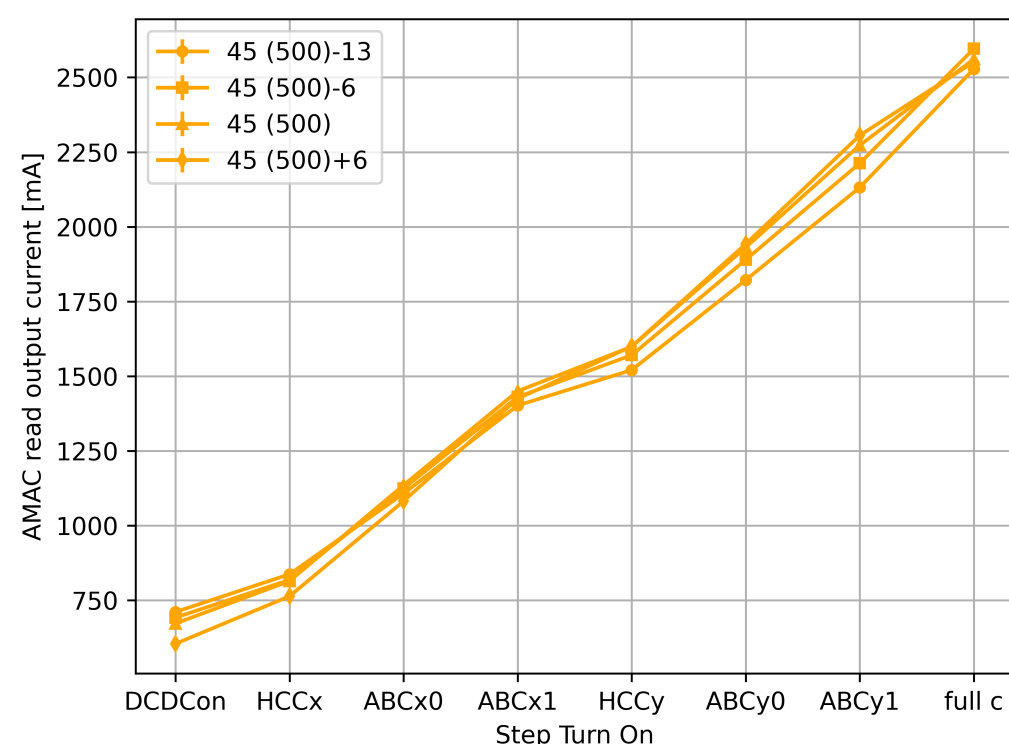
Does change in output voltage affect output current ?

- Adjust the output voltage (4 levels) and measure the output current
 - Nominal, - 13.3%, - 6.6%, + 6.6%
- Some 500 PBs (on module **SS 46**, **LS 6**) exhibits distinct current level

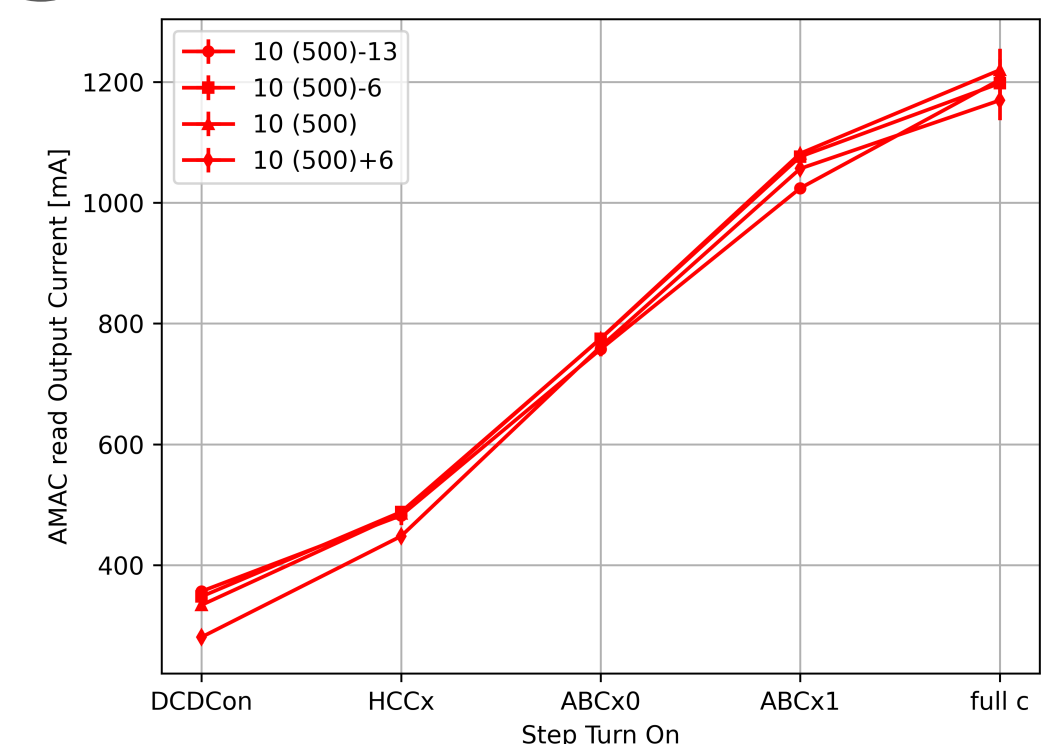
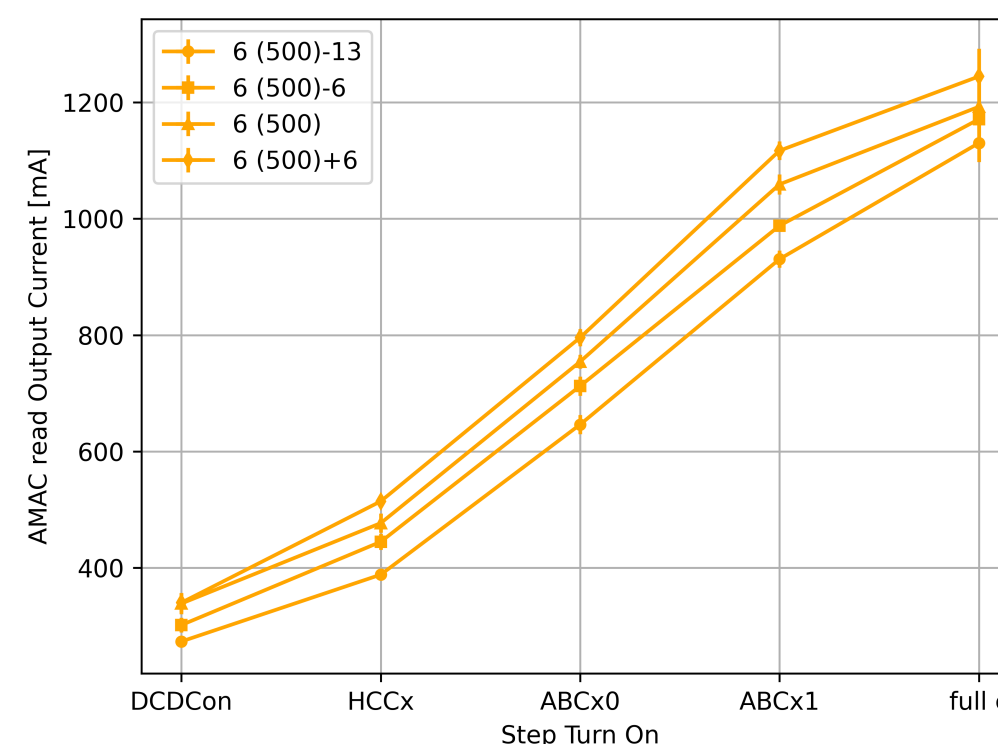
Theoretically no, but?



SS



LS



Why higher current ?

Higher Output Voltage?

Ha, Kind of...

1. 500 PBs on average output higher voltage
 2. 404 PB output voltages drop more than 500 PBs' as load increases
- Combination/self-reinforce effect?
 - Output voltage features result in more power dissipation + higher output current (?) -> more power dissipation -> higher temperature -> (?) further causing efficiency drop (?) -> more power dissipation -> ...

Back up

NTC_PB in PB burn-in

