SIPM irradiation and annealing

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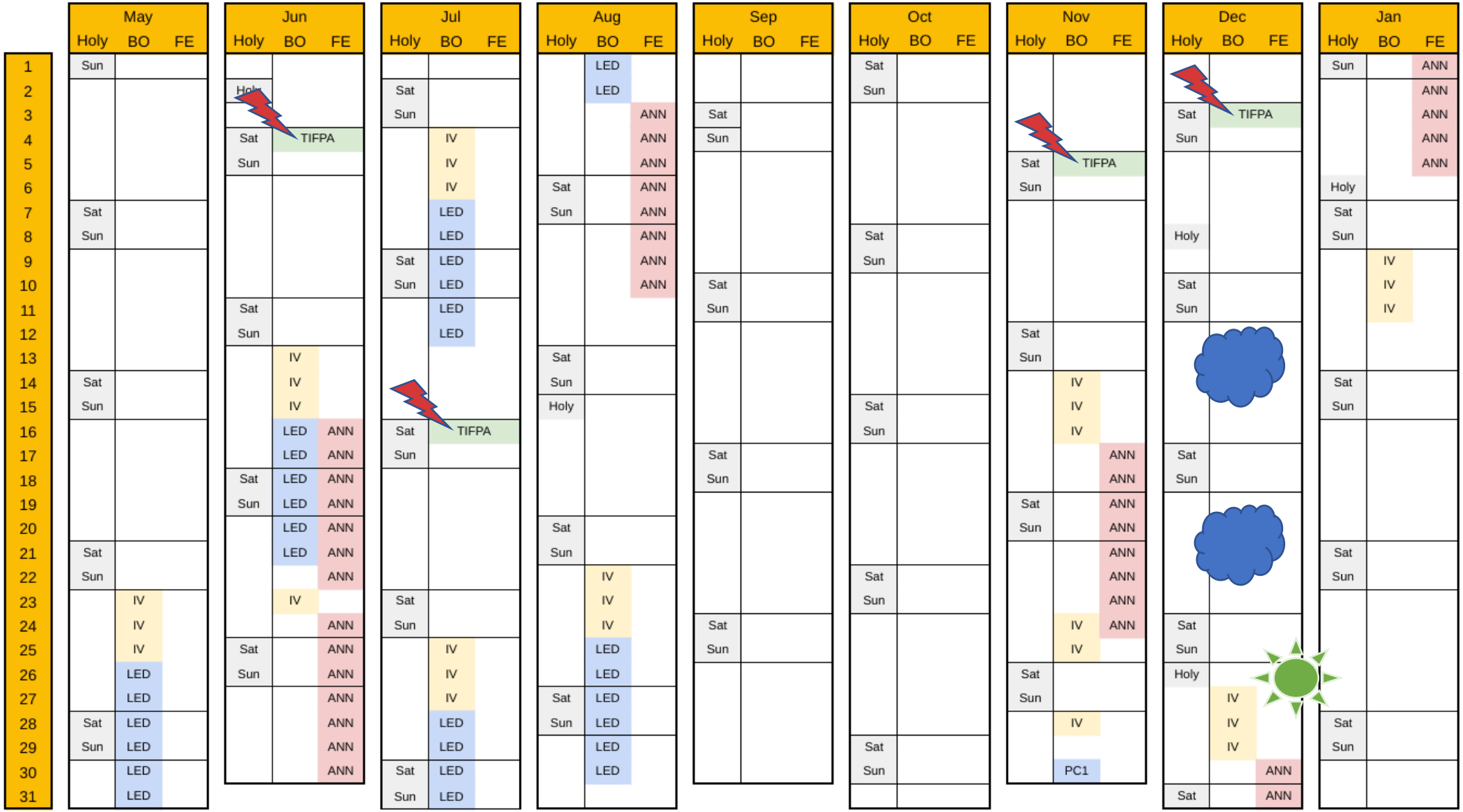
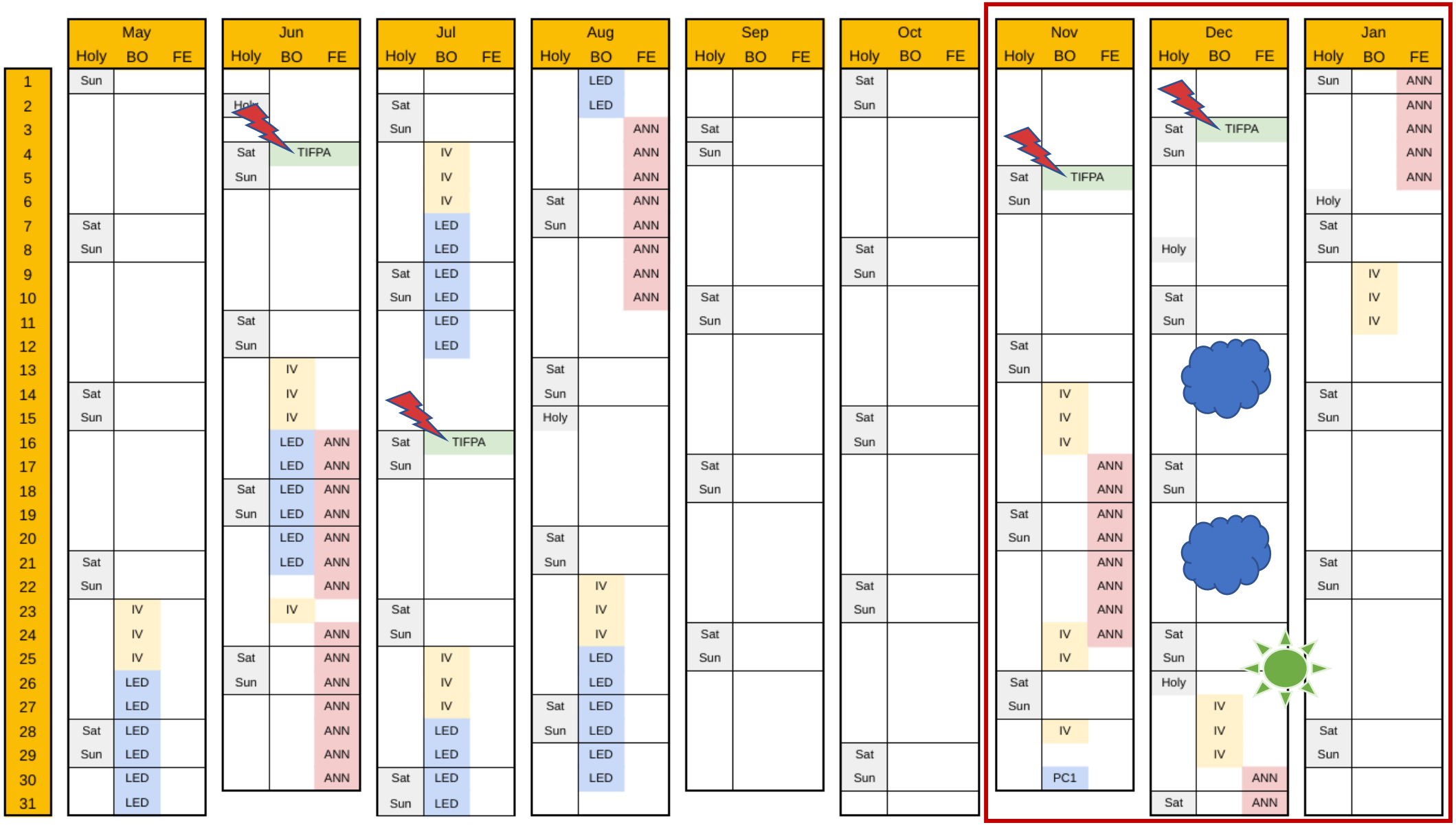
Full 2022 irradiation / characterization calendar: 4 irradiation cycles



Full 2022 irradiation / characterization calendar: 4 irradiation cycles

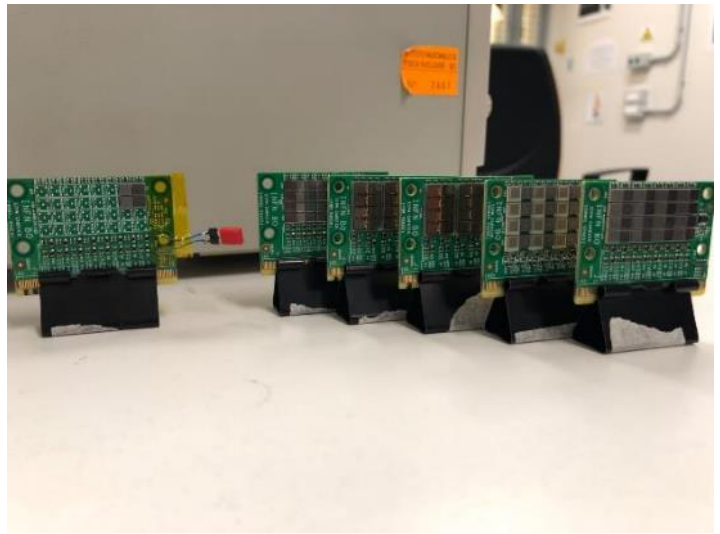


5/11 3rd irradiation cycle **completed**

	Nov			Dec			Jan		
	Holy	BO	FE	Holy	BO	FE	Holy	BO	FE
1							Sun		ANN
2									ANN
3				Sat	TIFPA				ANN
4				Sun					ANN
5	Sat	TIFPA							ANN
6	Sun						Holy		
7							Sat		
8				Holy			Sun		
9								IV	
10				Sat				IV	
11				Sun				IV	
12	Sat								
13	Sun								
14		IV					Sat		
15		IV					Sun		
16		IV							
17			ANN	Sat					
18			ANN	Sun					
19	Sat		ANN						
20	Sun		ANN						
21			ANN				Sat		
22			ANN				Sun		
23			ANN						
24		IV	ANN	Sat					
25		IV		Sun					
26	Sat			Holy					
27	Sun				IV				
28		IV			IV		Sat		
29					IV		Sun		
30		PC1				ANN			
31				Sat		ANN			

4/12 4th irradiation cycle **completed**

Last cycle of **2022**.
HPGe (**TIFPA**) detector was not working thus they **can't release** the boards.
2 weeks delay



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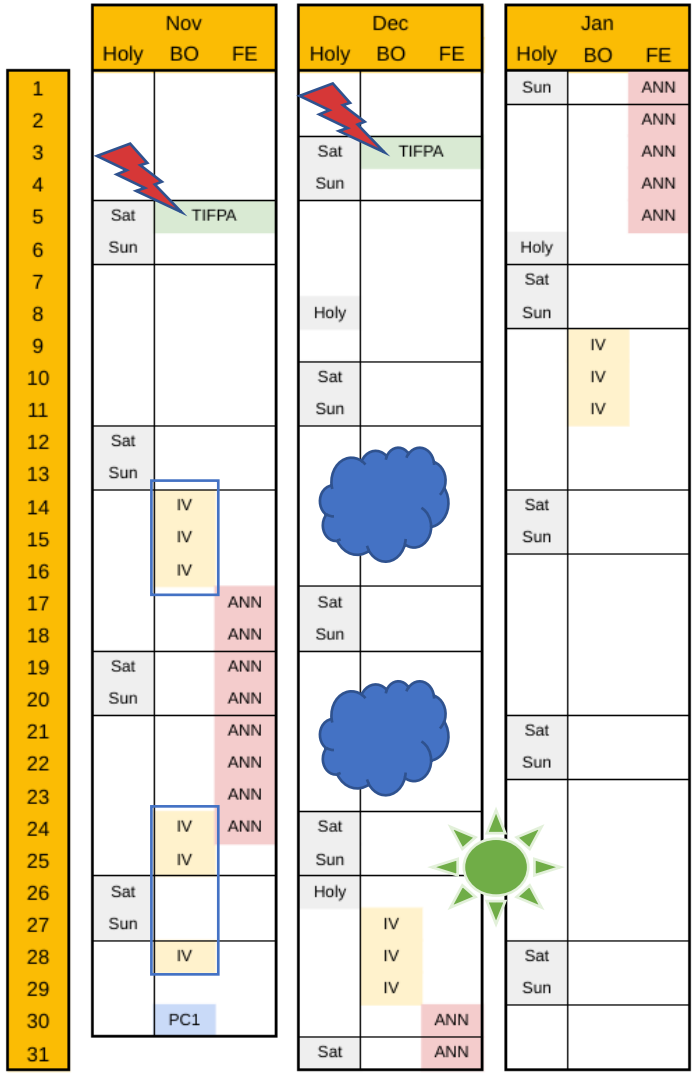

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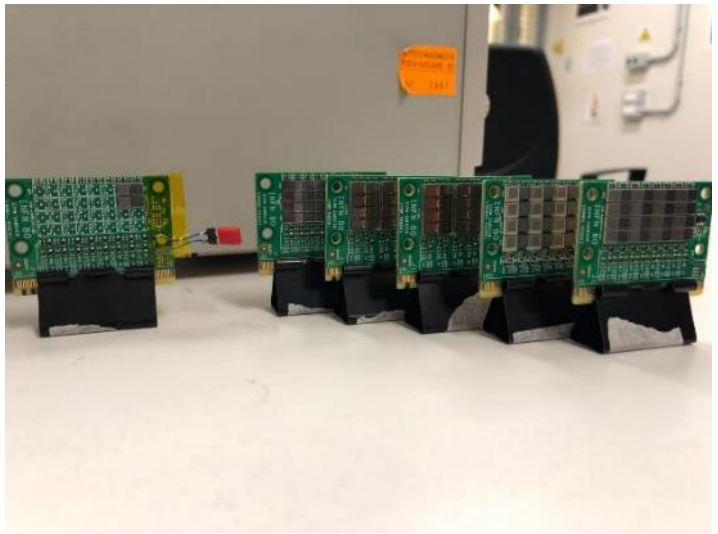
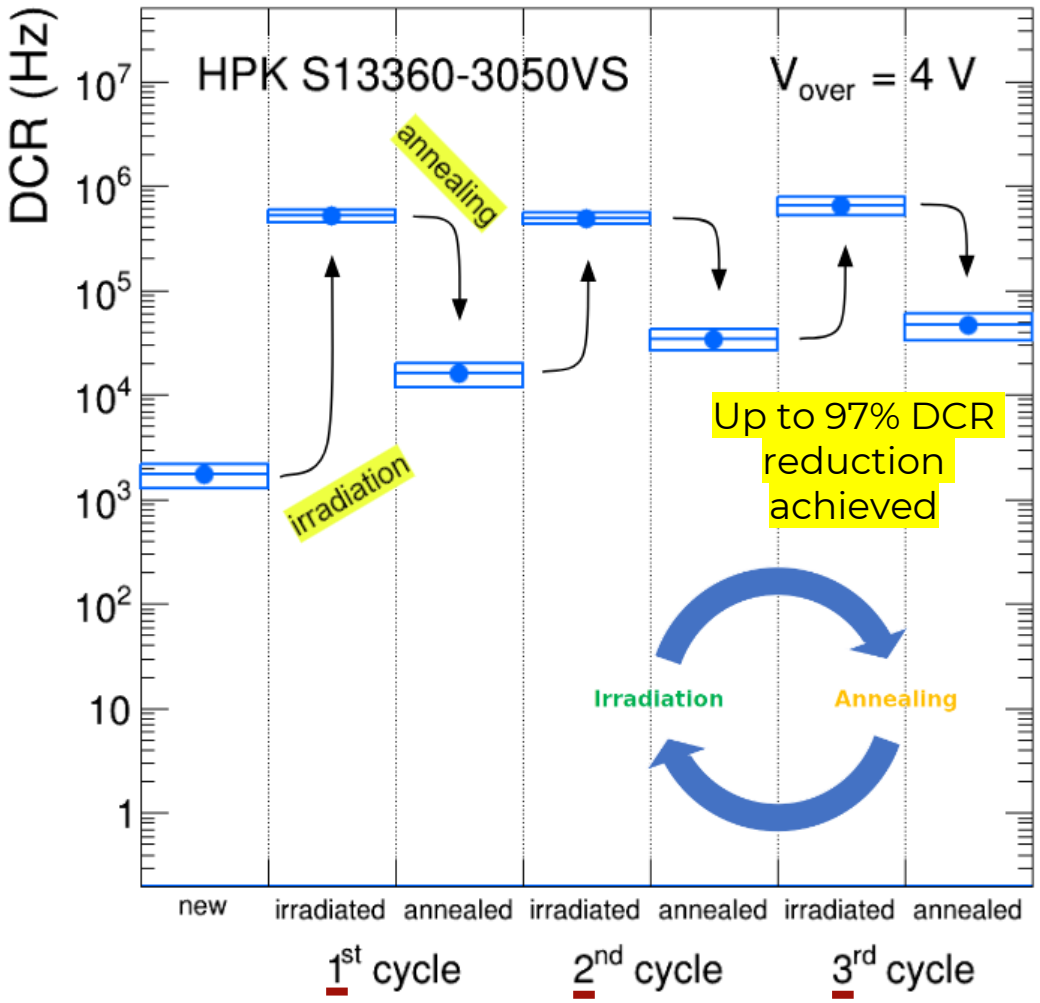


Repeated irradiation-annealing cycles



Main goal of 2022 irradiation campaign

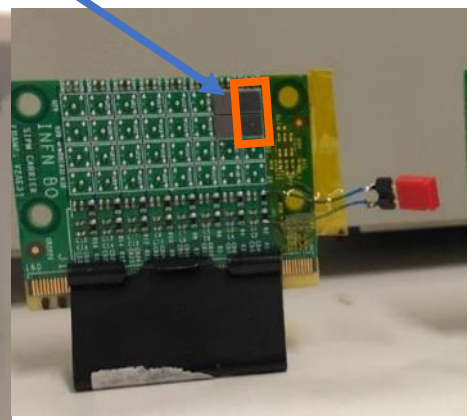
Test reproducibility of repeated irradiation-annealing cycles

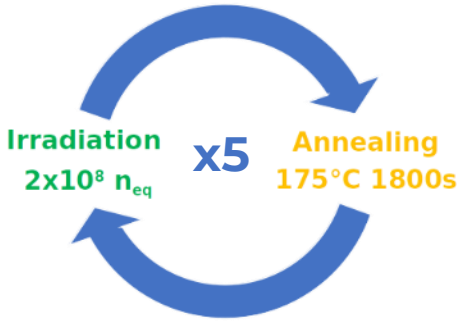
simulate a realistic experimental situation

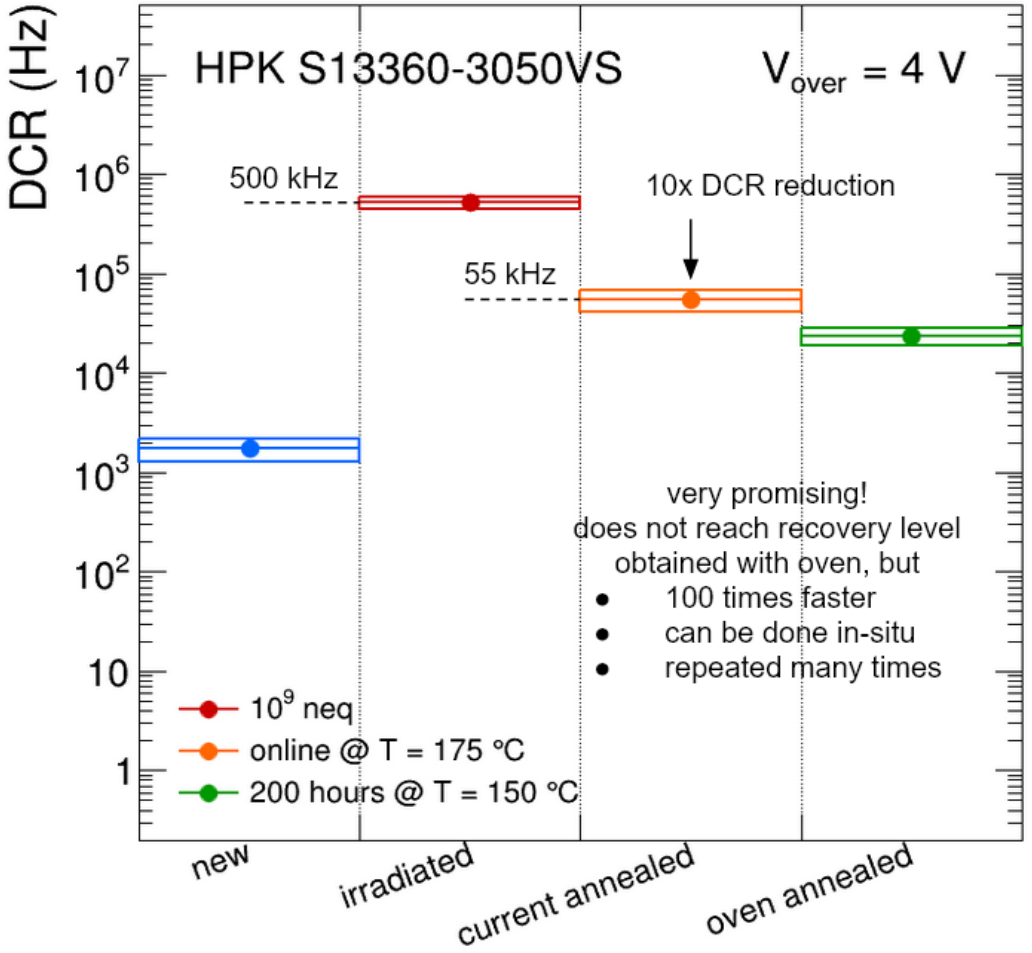
- campaign is almost concluded
  - last (4th) irradiation cycle done on 3/12
  - partial results reported here
- 3 cycles analyzed so far
  - irradiation fluence/cycle of 10^9 n_{eq}
  - annealing in oven for 150 hours at 150 °C
- interleaved with full characterization
  - new
  - after each irradiation
  - after each annealing

Online annealing explorative study during irradiation campaign

Direct current annealing

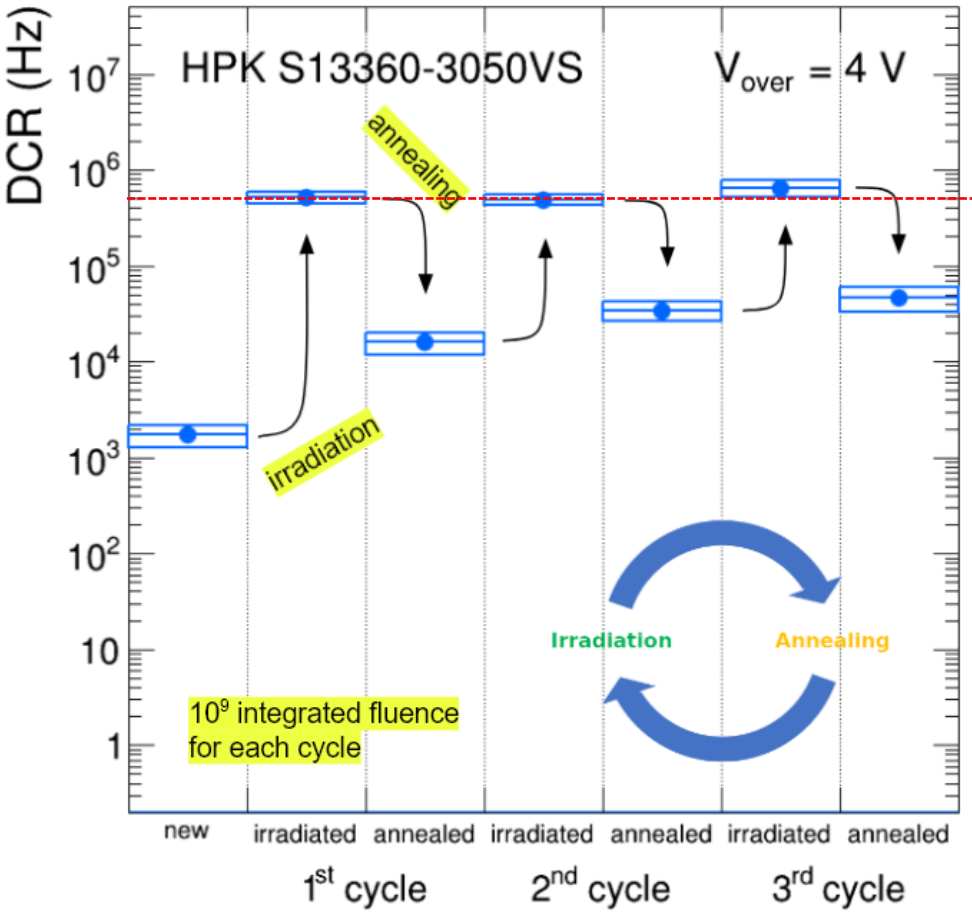




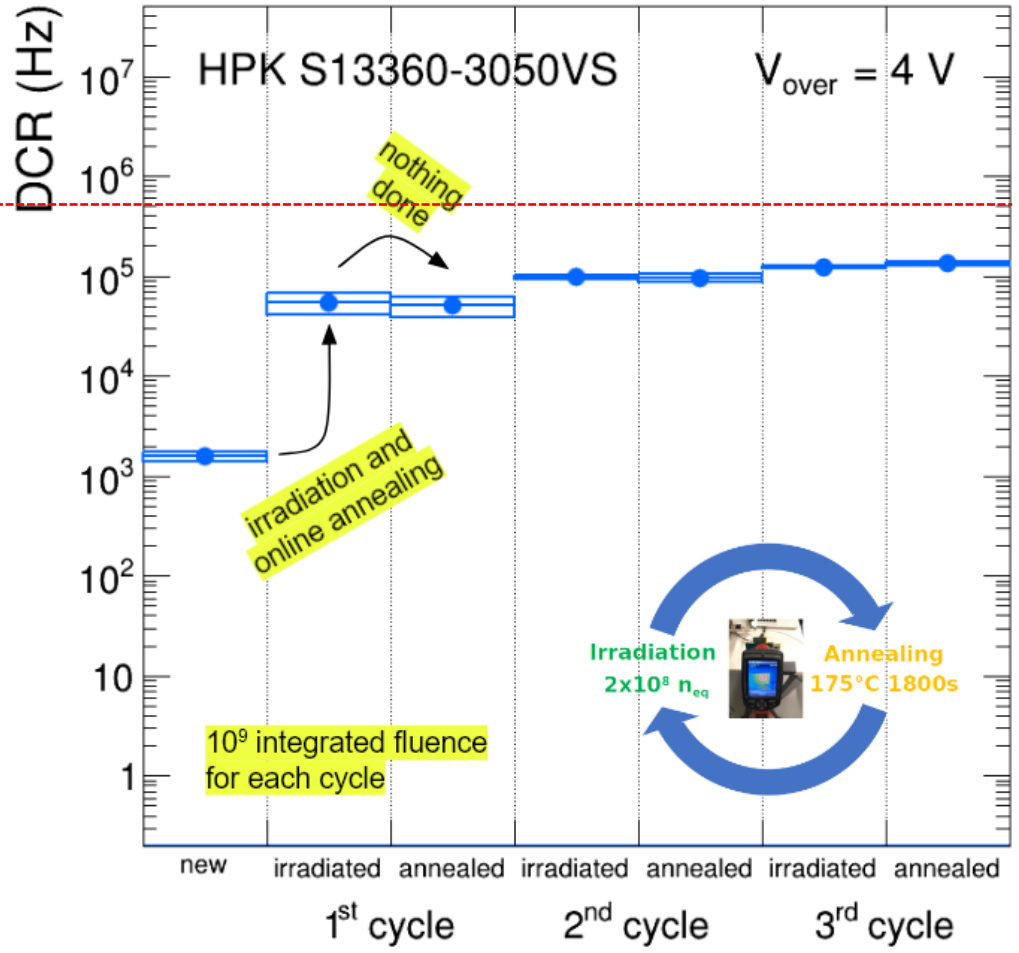


Repeated online irradiation-annealing cycles

Oven



Online annealing keeps DCR low



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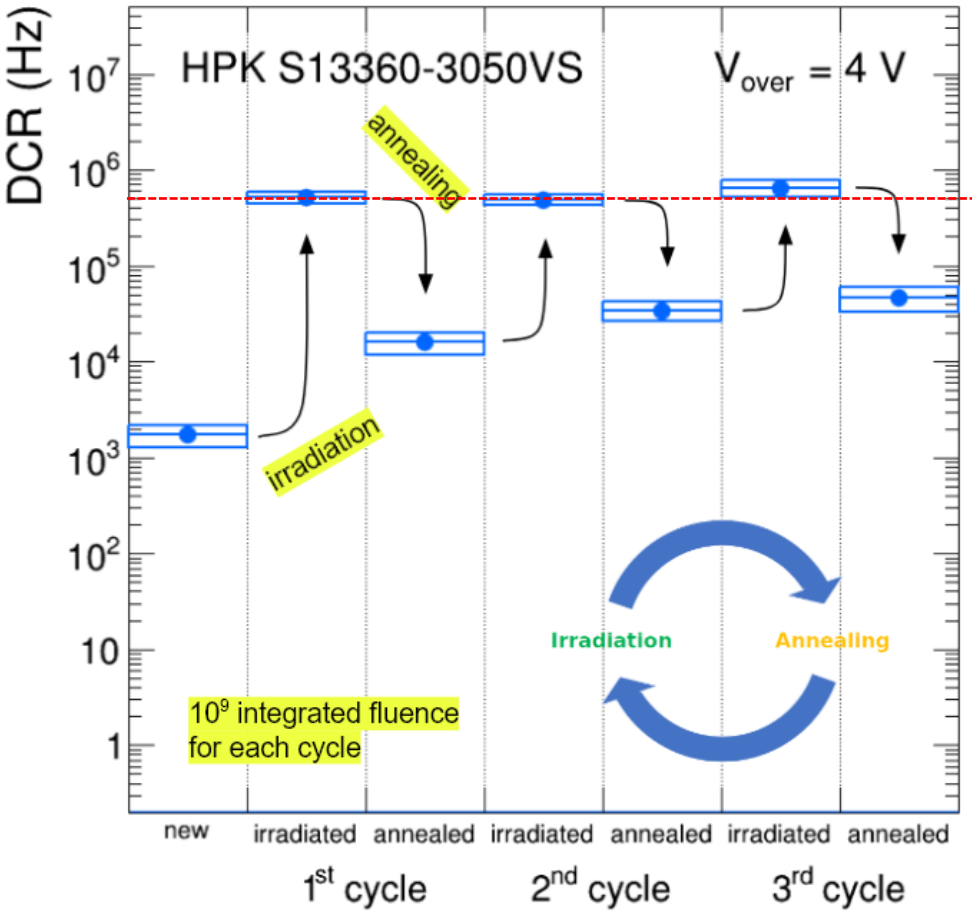

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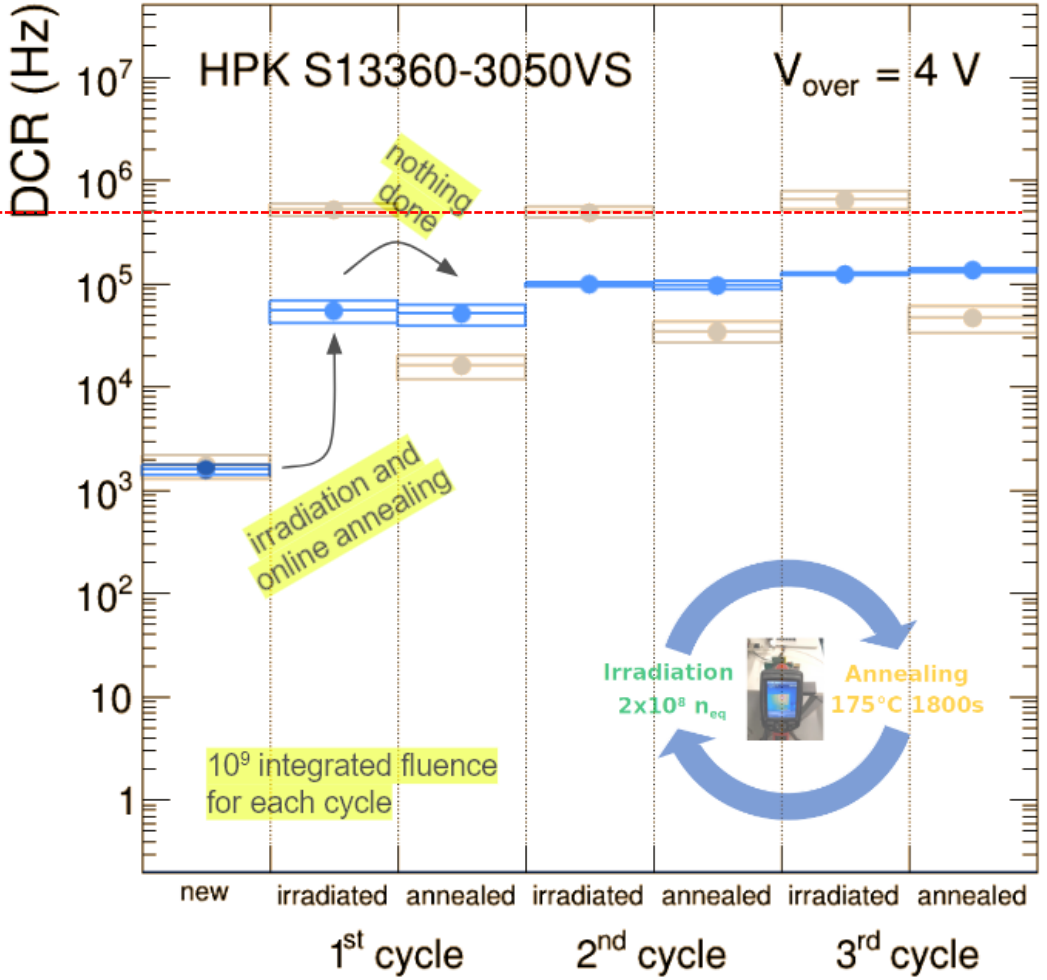
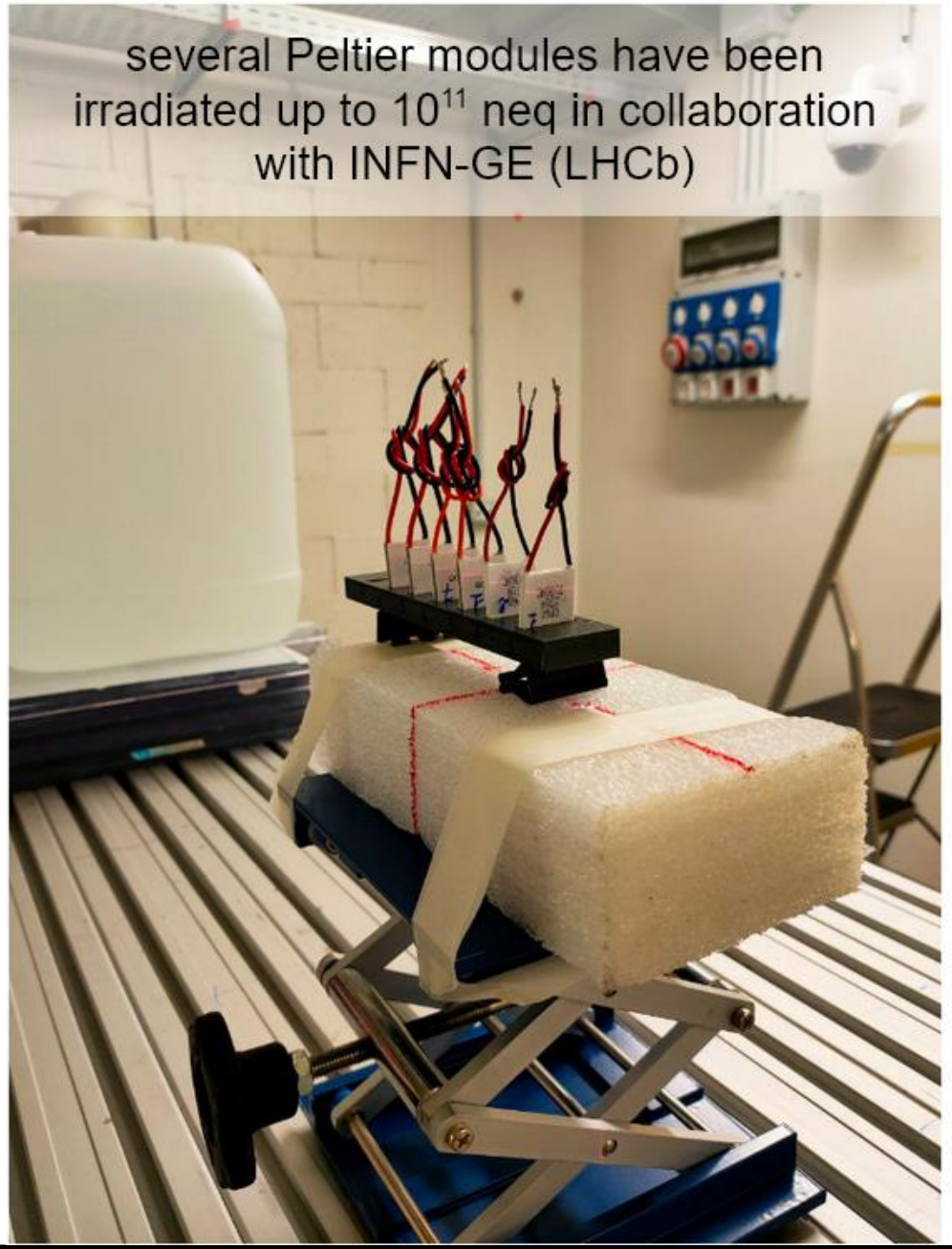


Collaboration with other groups in preparation for 2023



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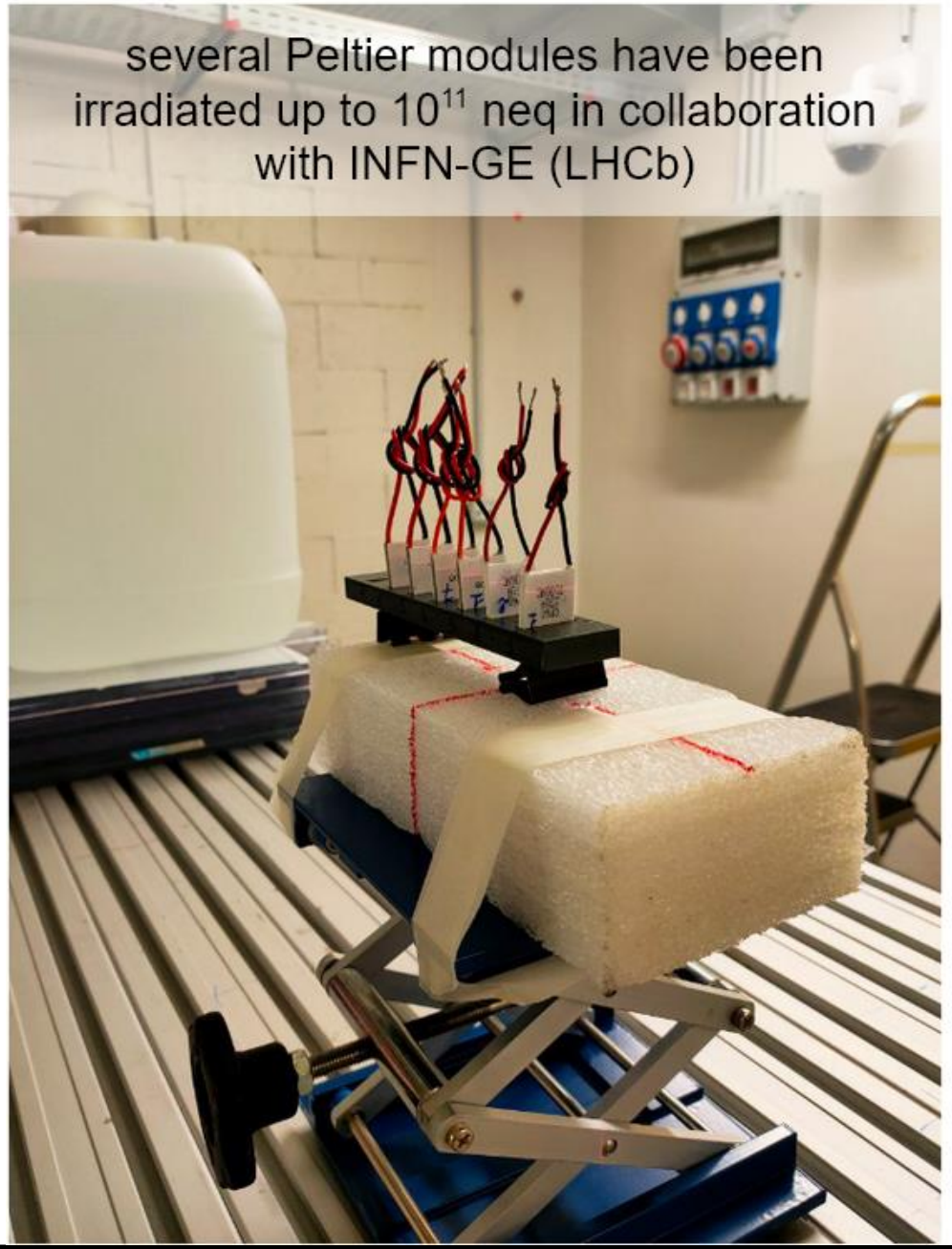
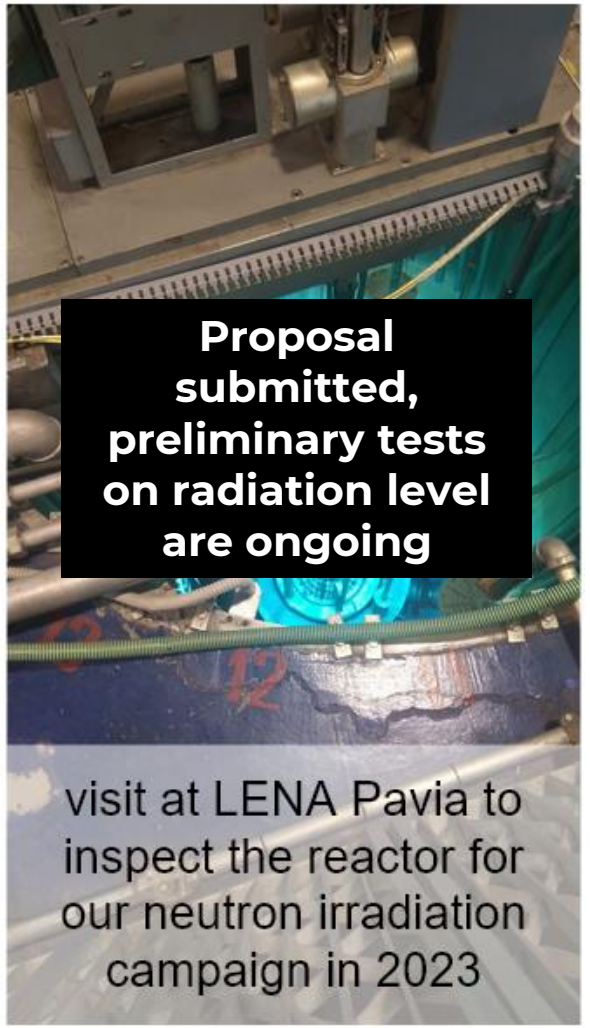
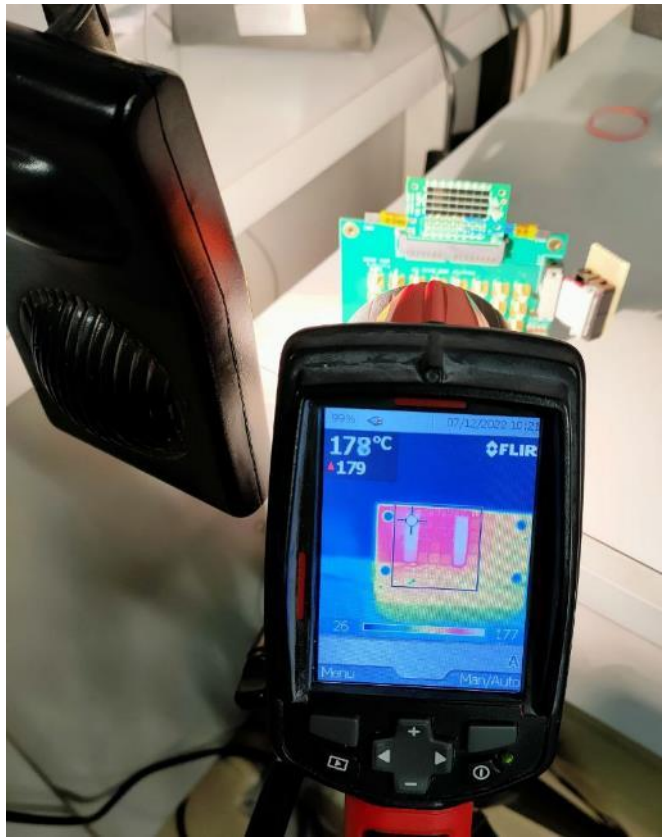




Direct and inverse current annealing

Preview of the next year program

Bachelor student thesis on the difference between **direct** and **inverse** current annealing. We used a **BCOM AFBR** 30 um board irradiated at 10^9 n_{eq} in June.



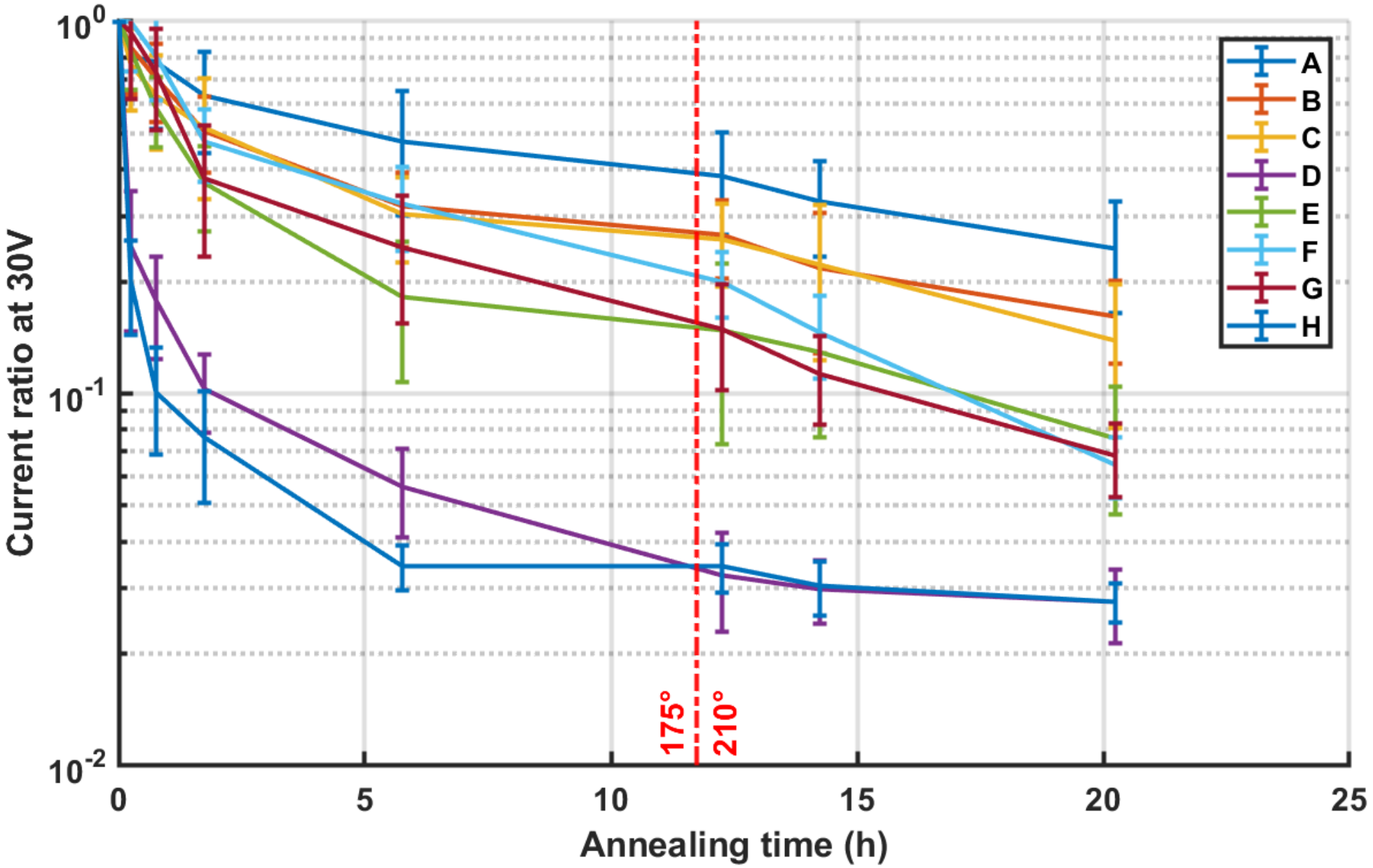
- ***4* sensors** (**H** row) direct current.
- **4 sensors** (**D** row) inverse current. SiPMs are polarized ≈6 V above the breakdown voltage in presence of a strong light source
- **9** annealing-characterization cycles (**PC#**) with different annealing durations (15 m to 6 h) and **2** increasing temperatures **175° C** at first and **210° C** at last
- **IV** measured
- The **ration** between the **dark current @30 V after** the procedure and for the **irradiated** sensor used as **figure of merit**
- 5.5 W per row, 4 W when both powered (175° C) and 7 W/5 W (210° C)
- 50-ohm bias filter resistors bypassed

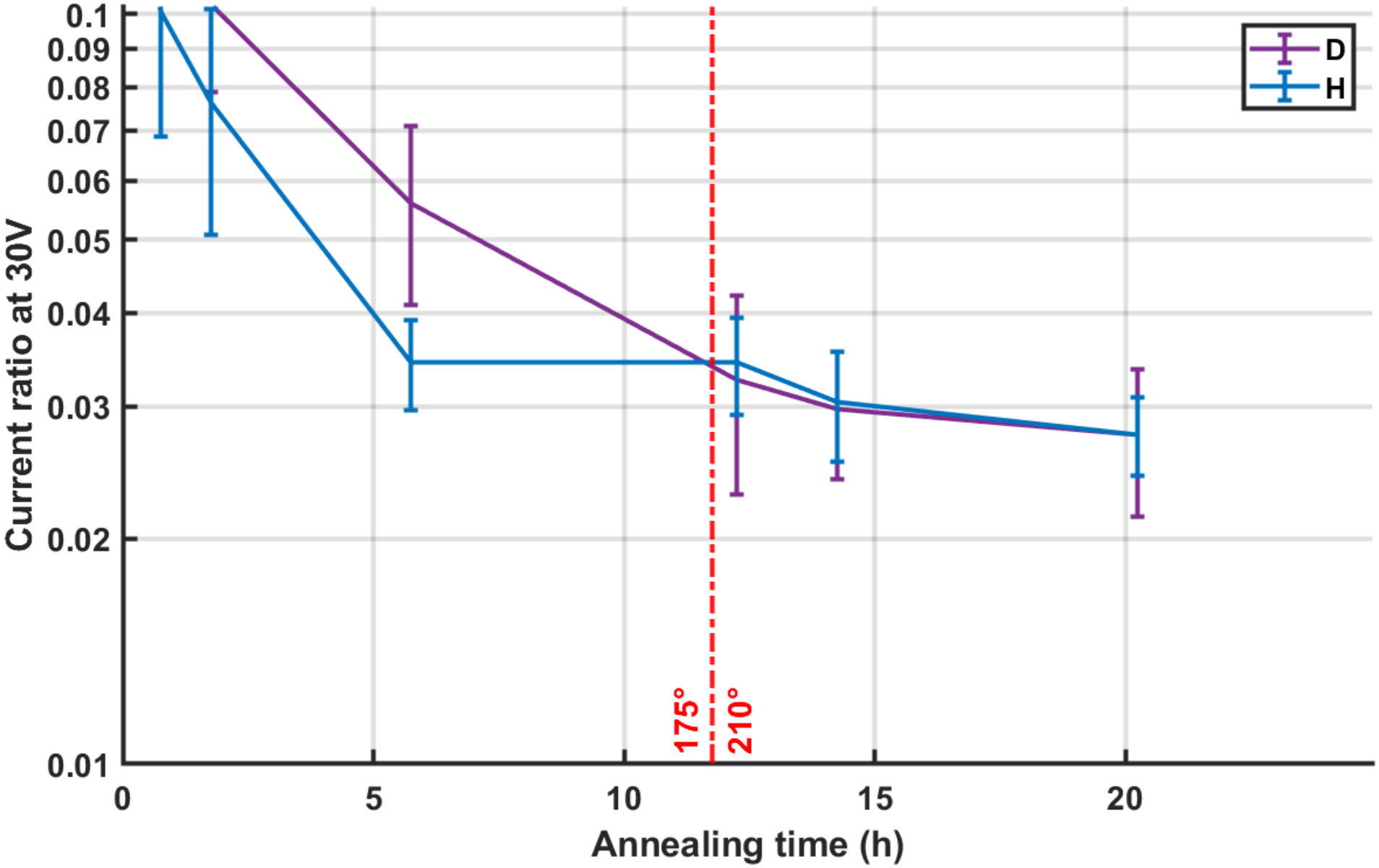
All the **results** are **preliminary** but show some interesting facts.

PC1 reference
(irradiated device)

D inverse current

H direct current



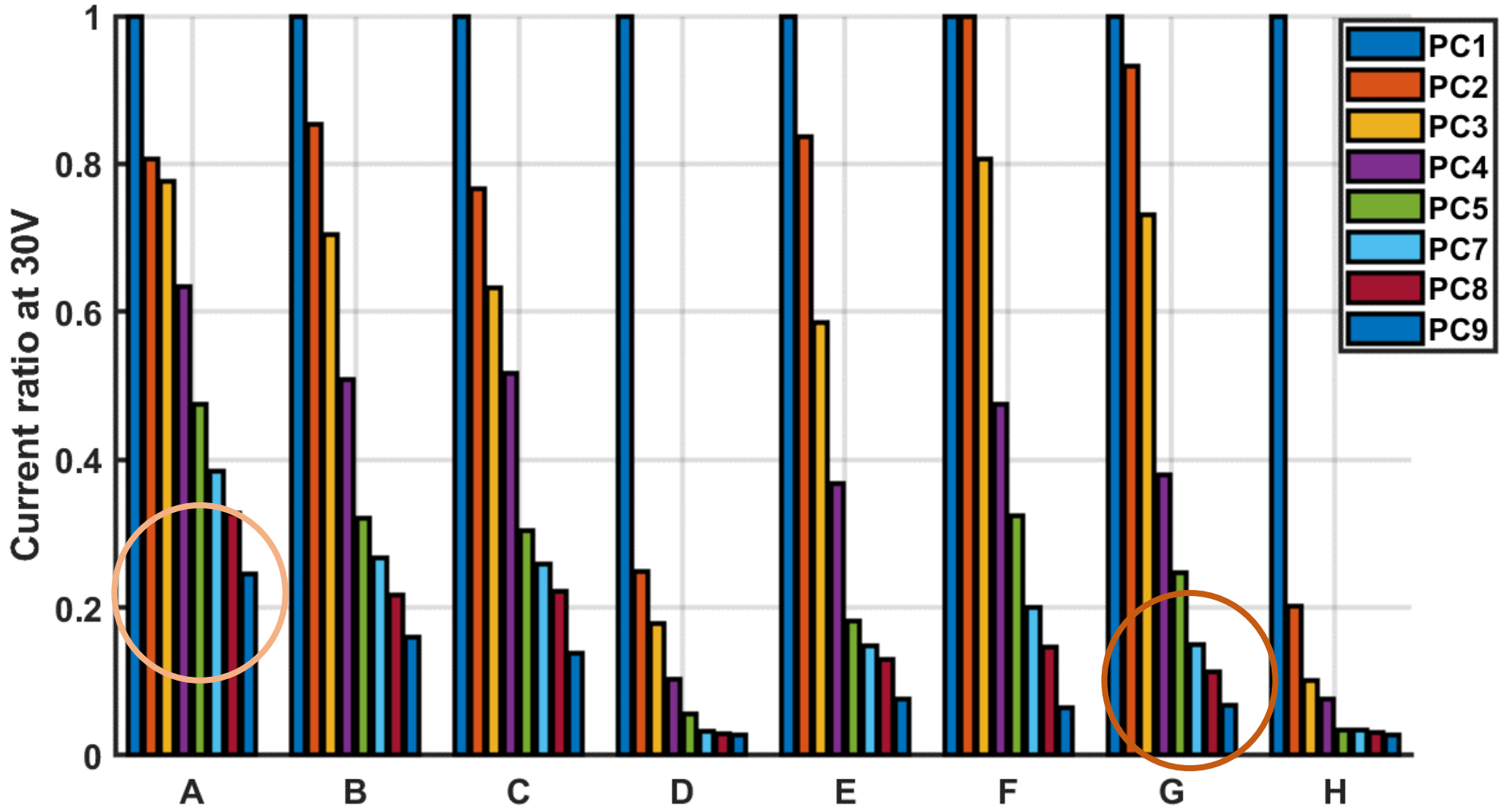


With both methods we reach a **97% reduction** in the dark current after **20 h** of annealing.

This agrees with the 150° C 150 h oven annealing

At **175° C**, the **direct current** annealing seems to be **faster** but in the **long run** (and at high temperature) the **two methods** lead to the **same results**

Due to the **heat** dissipated by the annealed sensors, we observed a reduction in the dark current in the neighbors' ones. This is proportional to their **distances** to the **D** and **H** rows



H4 shows a weird behavior after the fifth cycle (still 175° C). An increase in the leakage current could be due to some failure in the soldering of the SiPM or close components.

The results plot are made excluding H4 after PC5