eRD109 update: dRICH RDO

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ePIC DAQ meeting
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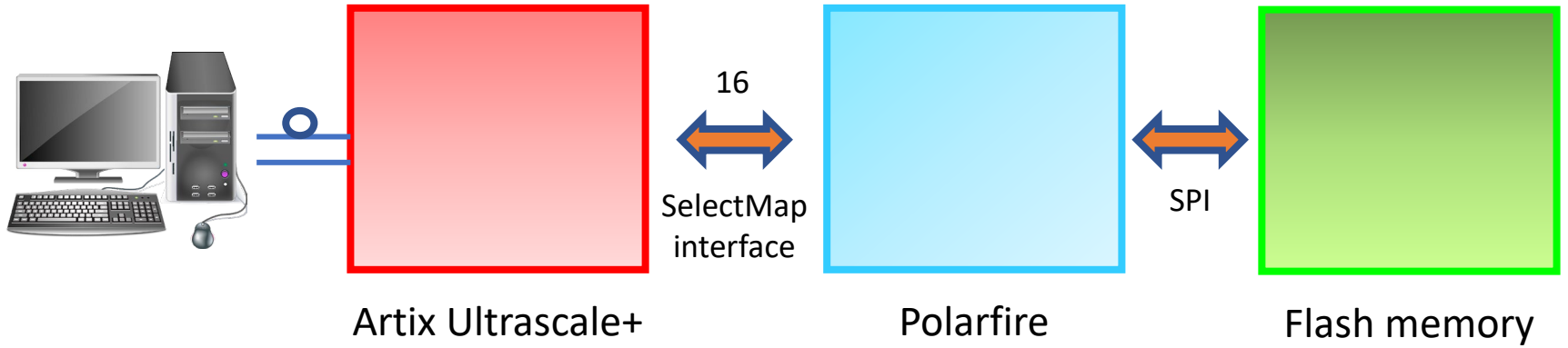
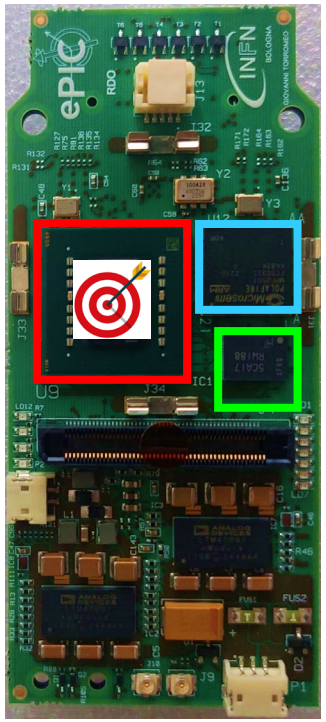
RDO: scrubbing

- We had an irradiation test with protons in Trento (Centro di ProtonTerapia) 10 days ago:
  - **28 March 2026**

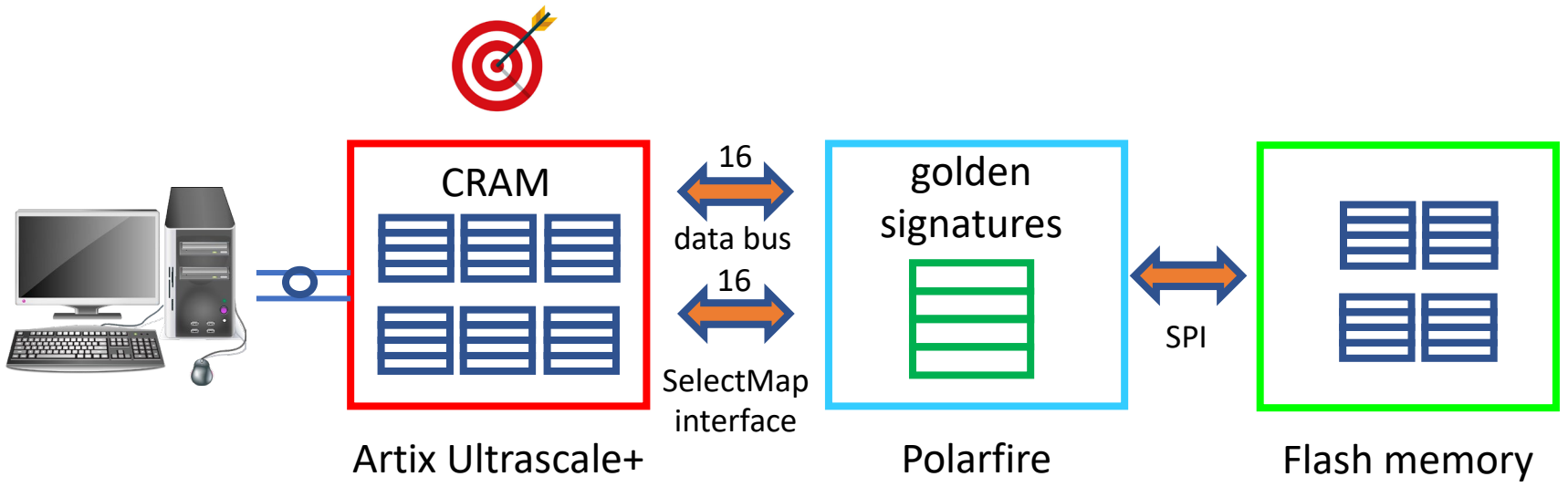
- First goal was to irradiate the Artix Ultrascale+ with Polarfire-based scrubbing in place



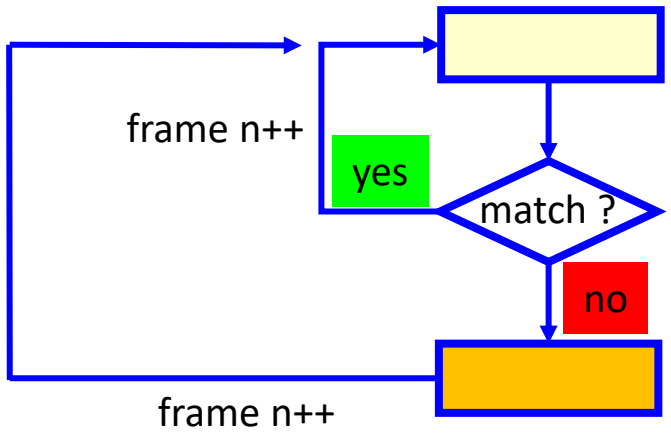


The goal of the scrubbing is to keep the CRAM of the Artix US+ clean

RDO: scrubbing



The Artix US+ CRAM features ~14500 frames (each one contains 93 words of 32 bits each)



the Polarfire reads frame **n**, calculates a signature on the fly and compares it to a golden signature stored in a BRAM

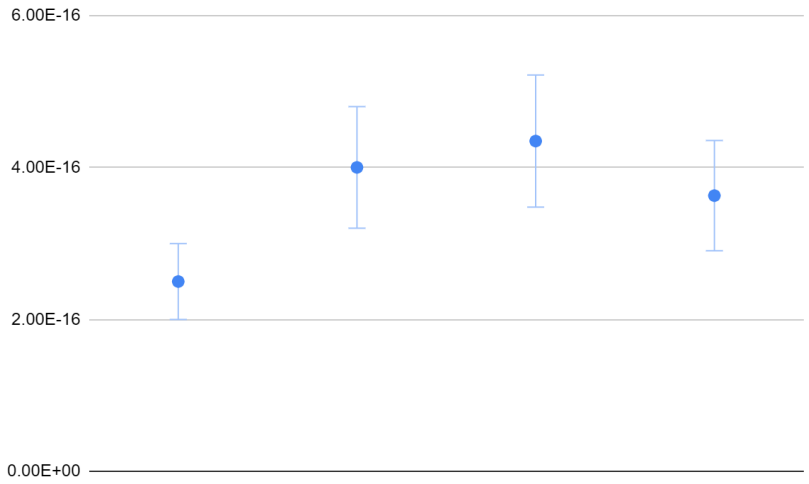
the Polarfire reads frame **n** from the FLASH and writes it to the Artix US+ via the SelectMap bus

RDO: scrubbing

70 MeV proton beam on one Artix Ultrascale+ device

Run	Start	Stop	Duration (s)	Total Protons	Fluence on DUT (/cm2)	TID (krad)	Dose rate (krad/min)	I (nA)	SEU	PWC	DEAD LINK
1	09:06:28	09:06:40	12.00		0.00E+00	0.00E+00	0.00E+00	1 nA			
2	09:07:00	09:17:00	600.00	3.42E+09	9.51E+08	1.16E-01	1.16E-02	1 nA	8	0	0
3	09:24:41	09:44:41	1,200.00	1.39E+10	3.86E+09	4.72E-01	2.36E-02	2 nA	52	0	0
4	09:48:35	09:54:15	340.00	3.93E+09	1.09E+09	1.34E-01	2.36E-02	2 nA	16	1	0
5	09:58:00	10:02:00	240.00	2.59E+09	7.21E+08	8.82E-02	2.21E-02	2 nA	1	0	1
6	10:04:53	10:16:35	702.00	7.95E+09	2.21E+09	2.70E-01	2.31E-02	2 nA	27	0	0
SUM						**1.08E+00**					

CRAM SEU cross section



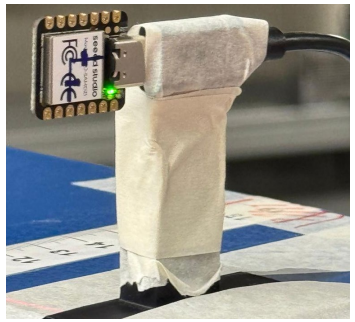
$$\sigma_{SEU} = 3.5\ 10^{-16}\ \frac{cm^2}{bit}$$

$$AMD\ estimate: (2.67 \pm 0.48) 10^{-16}\ \frac{cm^2}{bit}$$

Irradiation targets: SAMD21

100 MeV proton beam on 2 SAMD21 devices

SAMD21:
low power 32-bit ARM Cortex microcontroller from Microchip with 256 Kbytes of Flash and 32 Kbytes of SRAM



protons delivered: 6.05E+11
dose delivered: 23.59 Krad

$$\sigma_{SEU} = 3.0\ 10^{-14}\ \frac{cm^2}{bit}$$

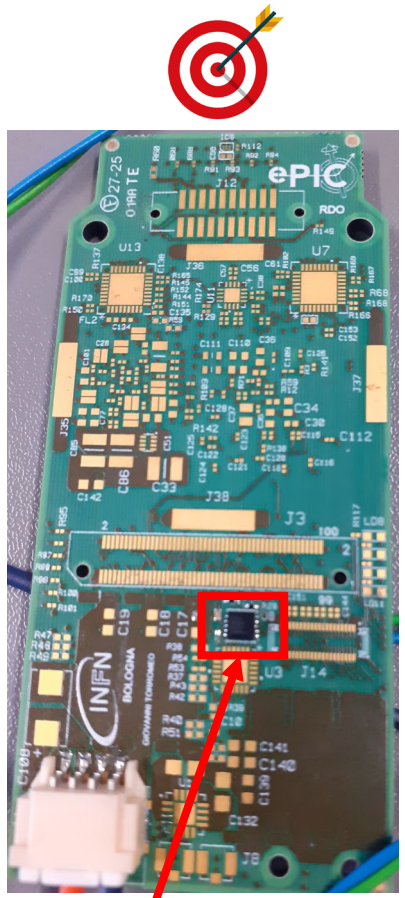
4.0E+11 protons have been delivered while the devices were OFF (also with a dose rate of 50 rad/s): both devices survived !

from January 2026 report about last irradiation session of SAMD21

Full analysis in progress, however:

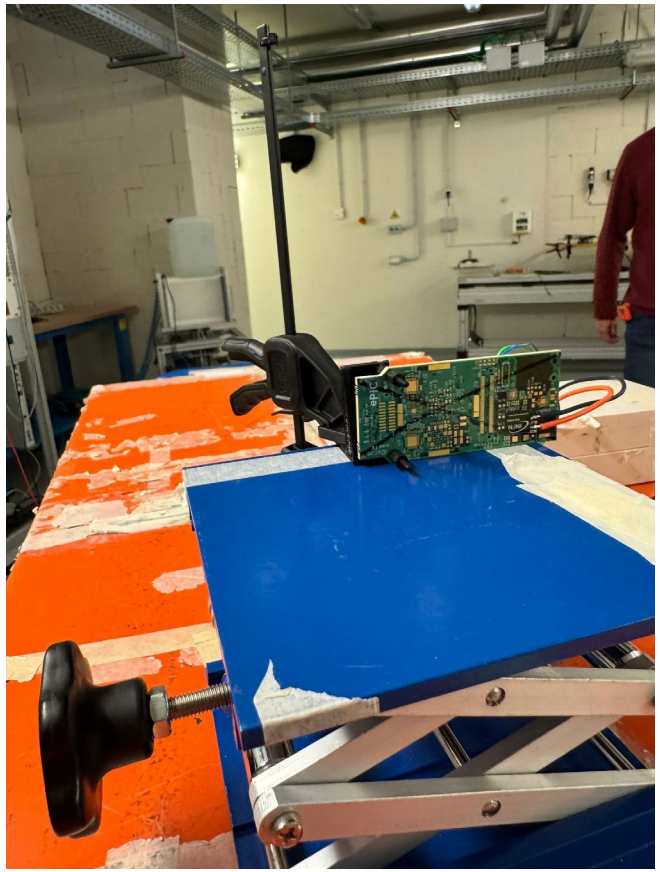
- SEU c.s. (RAM) ~ 3-4E-14 cm2/bit
- TID → worked ok up to 8 krad (~ 16 times TID expected at dRICH)
- failed at very high doserate (124 rad/s) → next run will be tested not powered when at high doserate

Irradiation targets: charge pump



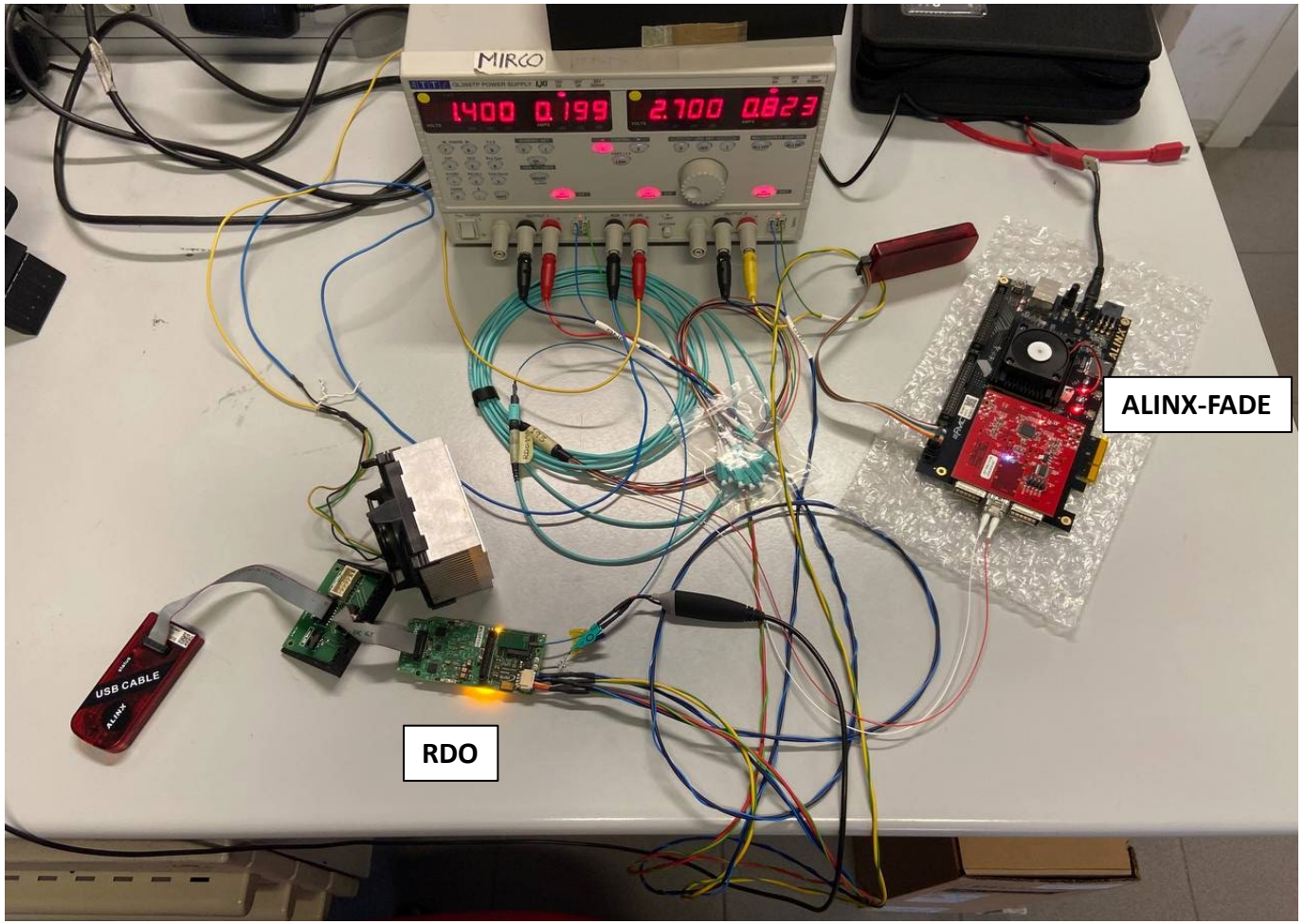
100 MeV proton beam
on 1 charge pump device

protons delivered: 6.05E+11
dose delivered: 25.92 Krad



We checked the charge pump voltage output and power consumption:
No relevant changes: we just noted an increase/decrease on the median voltage by 20 mV → to be checked

RDO – Alinx setup



- now checking data transmission on the high-speed link between RDO -Alinx-Fade:
  - 10 Gbps uplink
  - 2.5 Gbps downlink

Next steps

- begin studying lpGBT/full protocols
- implement the remote programming of the Artix US+