

# Total Ionizing Dose (TID) assessment on LVDS receivers for the muon barrel spectrometer readout system

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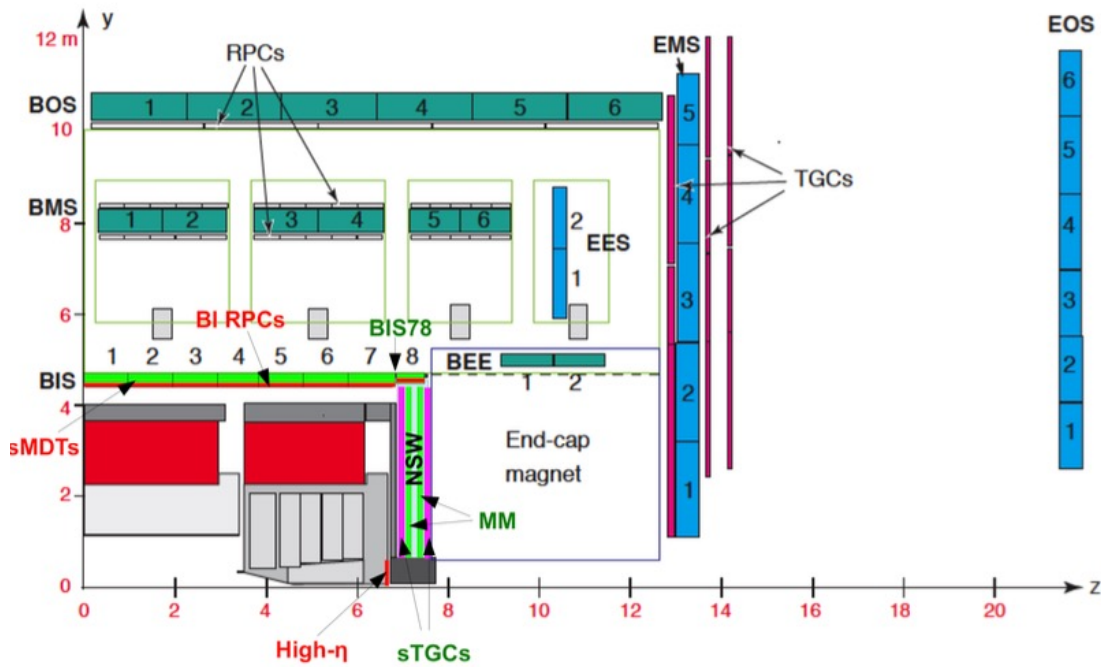
## Riunione ATLAS Napoli



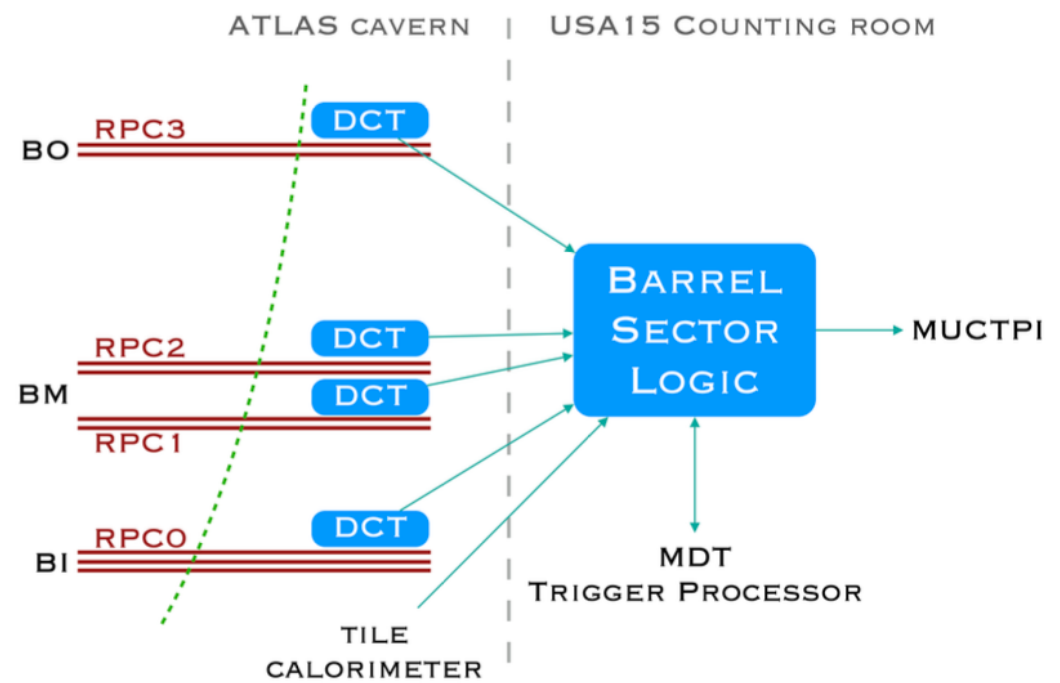
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# Phase-II upgrade

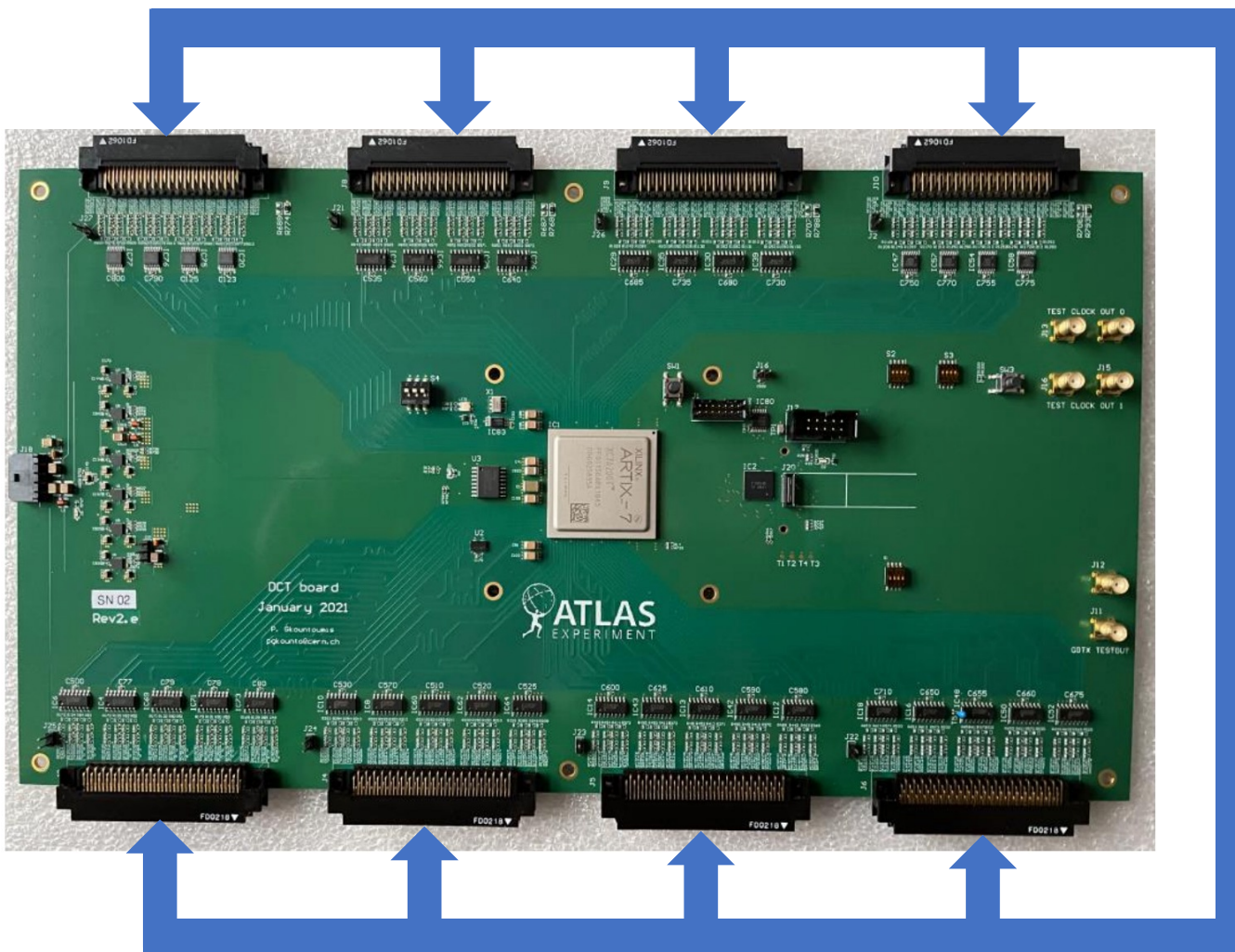
## Muon system after Phase-II upgrade



## L0 Muon Barrel Sector Logic and connections



# Data-Collector-Transmitter (DCT) board



- Readout system of the RPCs in the whole Barrel sector (BI/BM/BO)

**RPC front/end strips signals**

- DCT boards adapt RPC signals to LVDS standard and transmit data to the Barrel Sector Logic (SL) with optical fibers

- **NIEL tests.** Required for non-CMOS components (SFP+, LDOs).
  - LDOs already tested at Tapiro reactor (Enea Casaccia).
  - SFP+ irradiation test on 3 Jul 2023 at ENEA Frascati Neutron Generator (FNG).
- **SEE tests.** To test destructive effects (SEB) it is recommended to use protons with  $E > 500$  MeV. This makes the CHARM at CERN the preferred place for the test. The plan is to irradiate a single DCT plus a board with 10 SFP+. Beam time reserved on 5-19 Jul 2023. LDOs already tested for SEE at PSI.
- **TID tests.** Will be done at Co60 source at CERN.

	RPC DCT		
	TID (Gy)	NIEL*	Hadrons $>20$ *
SRL (1000)	4.59	1.80	0.35
4000 fb-1	18.36	7.20	1.38
$\chi$ (SF sim)	27.54	10.80	2.07
RTC (ASIC)	27.54	14.04	4.14
RTC (COTS)	82.6	42.1	12.4
Max at	BIL	BIL	BIL

\* ( $\times 10^{11}/\text{cm}^2$ )

	type	TID	NIEL	SEE
FPGA	Artix-7	Technology already validated, test 1 @CHARM on DCT	nr	Technology already validated, test 1 @CHARM on DCT
SFP+ optical TRX	Avago/Finsair?	test 2x10 @CHARM	test 2x10 @FNG	test 2x10 @CHARM
Flash memory		component tested for TGC PS board	component tested for TGC PS board	component tested for TGC PS board
LVDS receivers		Test 10 @Co60	nr	Will test 36 @CHARM on DCT
Level translator		test 10 @Co60	nr	Will test 3 @CHARM on DCT
fan-out for BI		test 10 @Co60	nr	nr
LDO		Done (PSI p beam)	Done (reactor)	Done (PSI p beam)
IpGBT		nr	nr	nr

## Needs for HL-LHC

- ~ 1600 DCT boards will be part of the Phase-II muon trigger front-end electronic
- Reliability of electronics under radiation is a major challenge for HL-LHC
- MC simulations predict a dose of 82.6 Gy in the Barrel Inner Large (BIL) chamber sector

6 June 2023

BM/BO DCT IDR

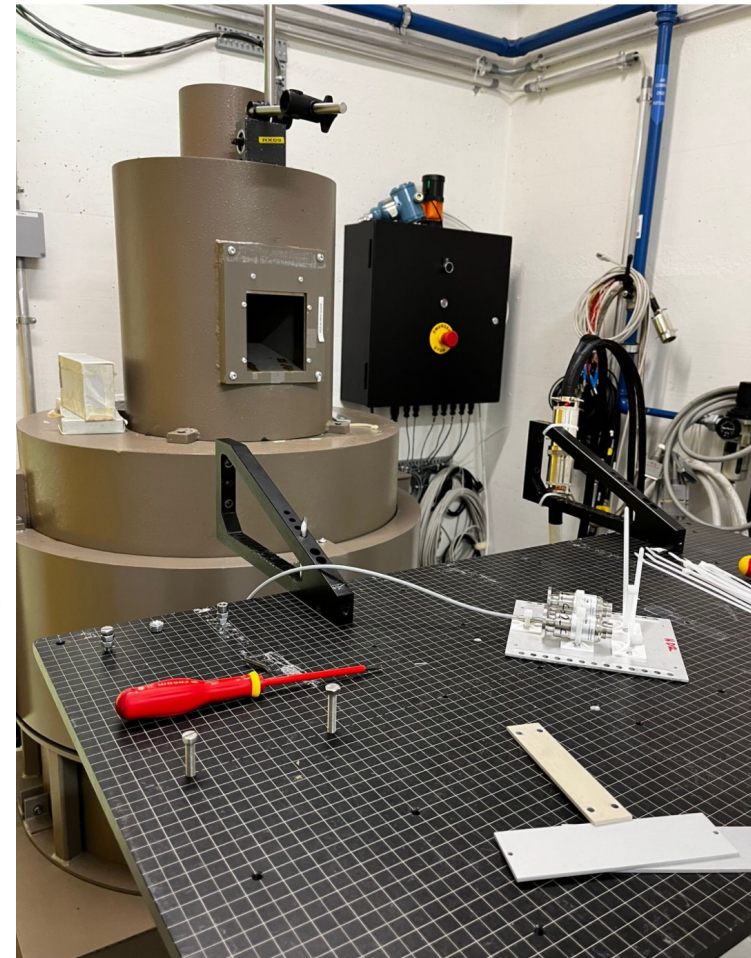
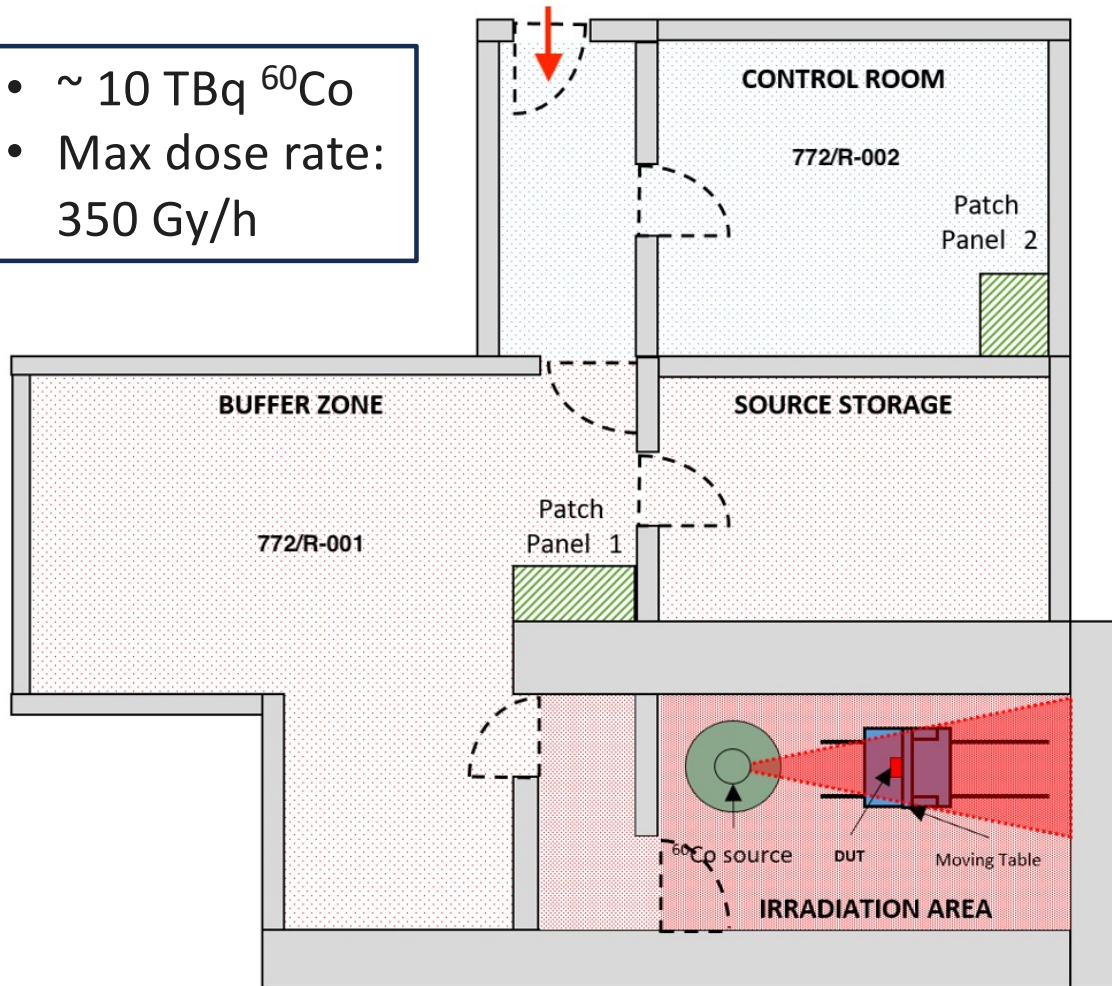
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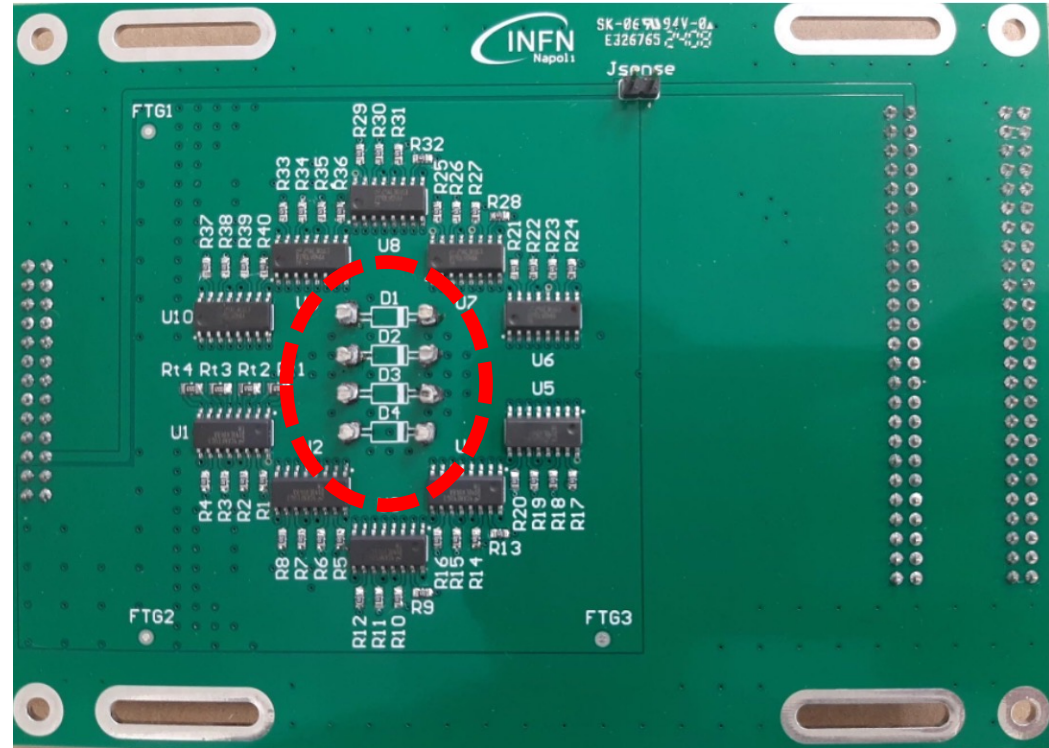
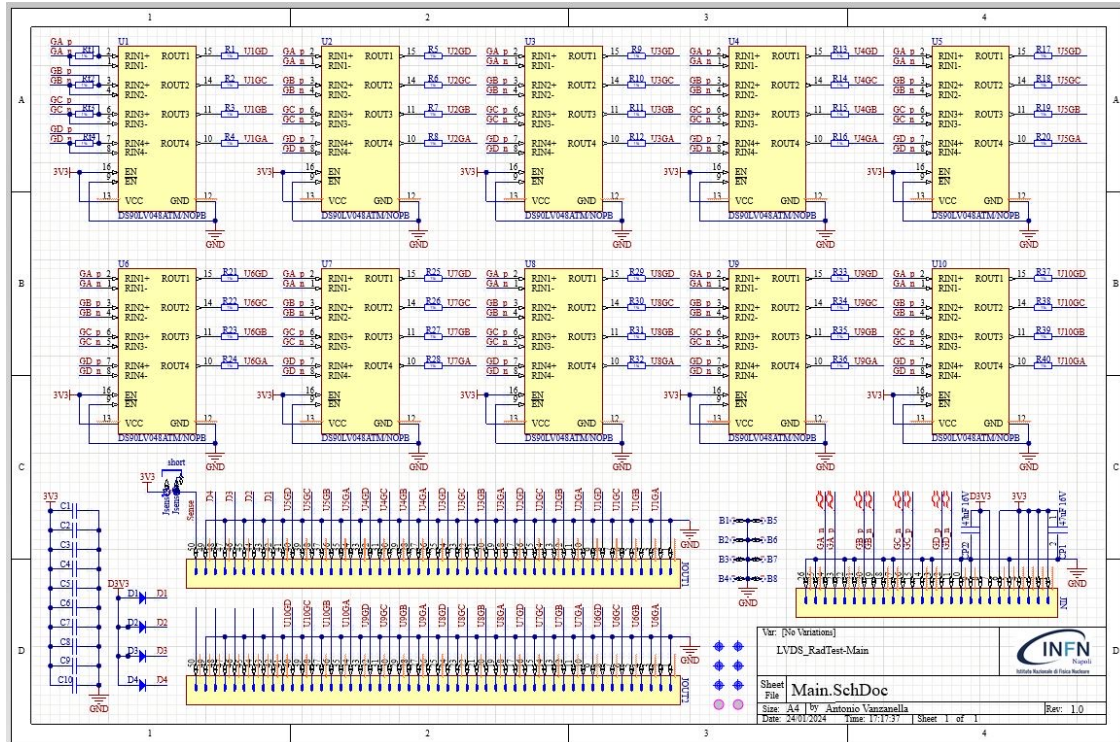
- Necessity to assess the tolerance of LVDS receivers under TID damage

# CC60 irradiation facility at CERN

- $\sim 10 \text{ TBq } ^{60}\text{Co}$
- Max dose rate: 350 Gy/h

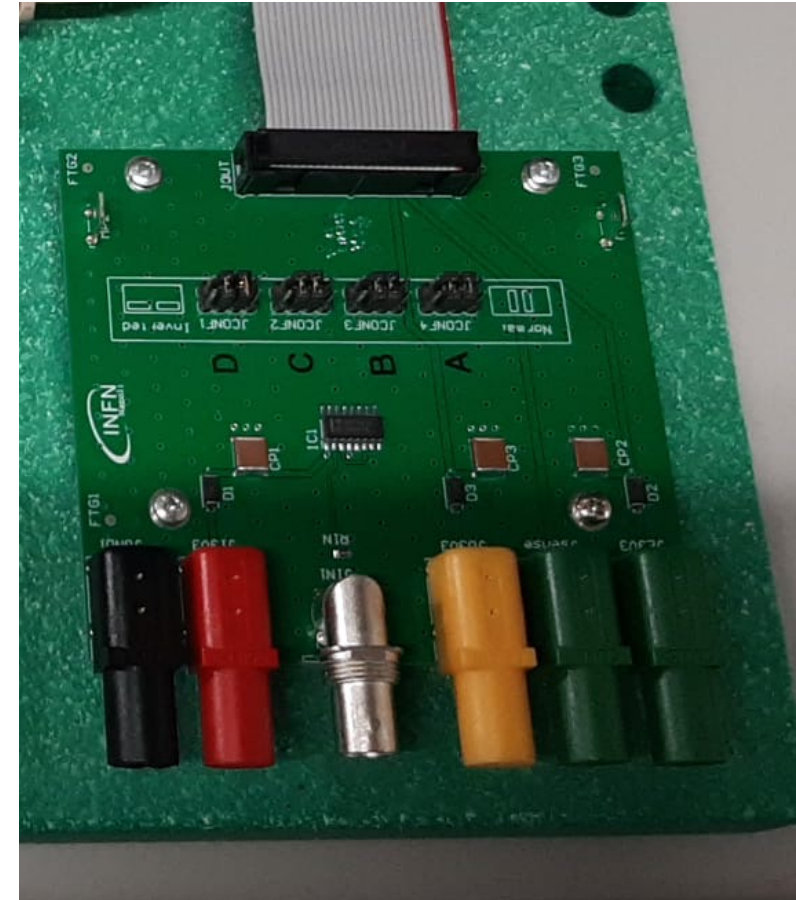
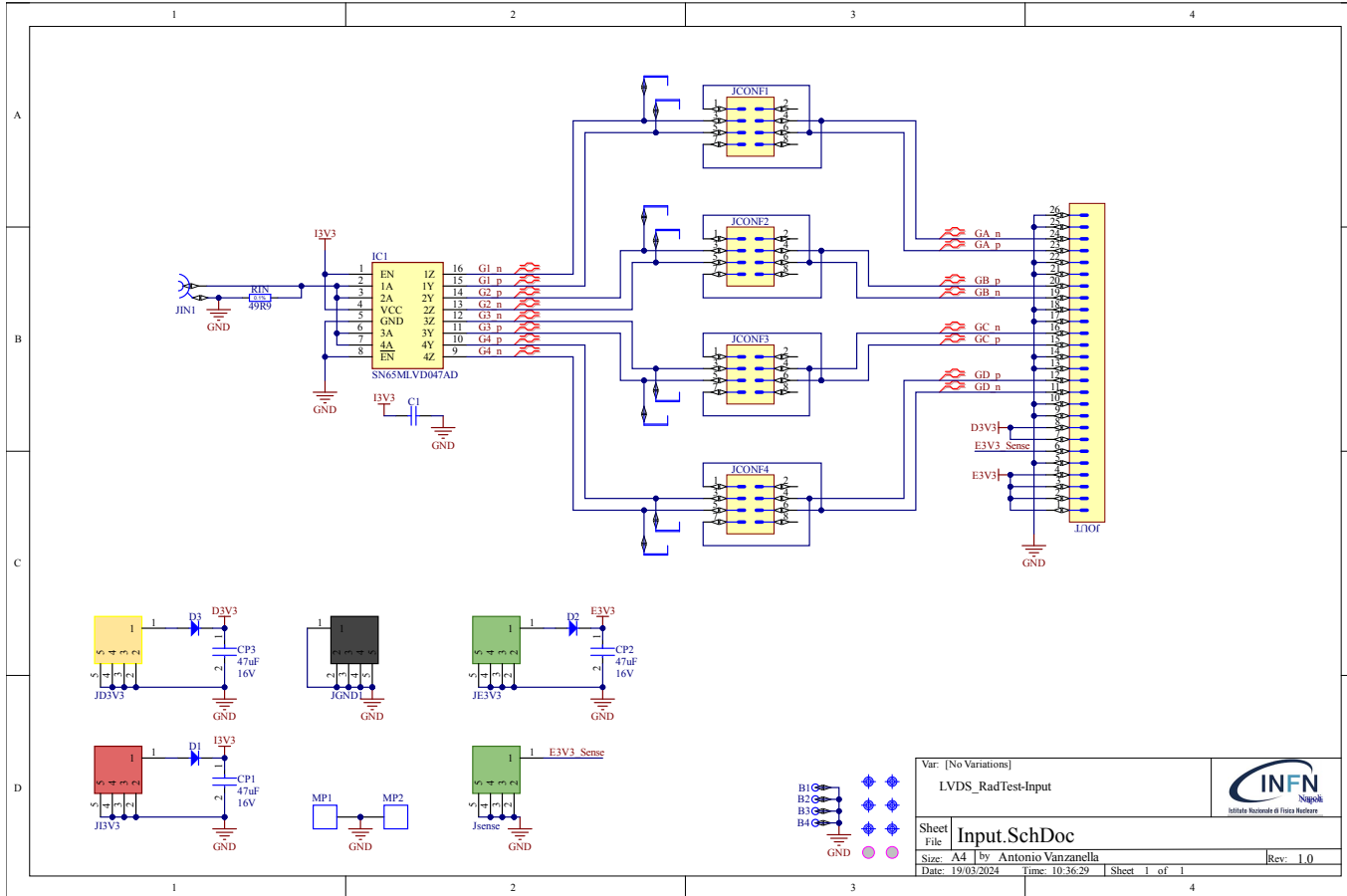


# PCB with LVDS receivers

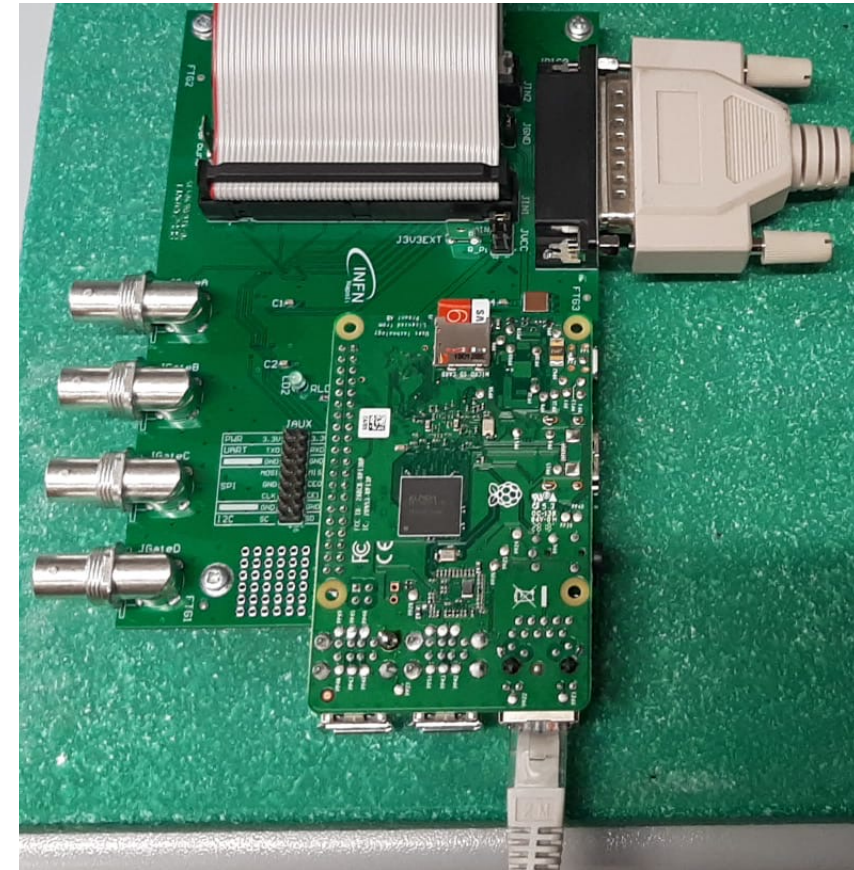
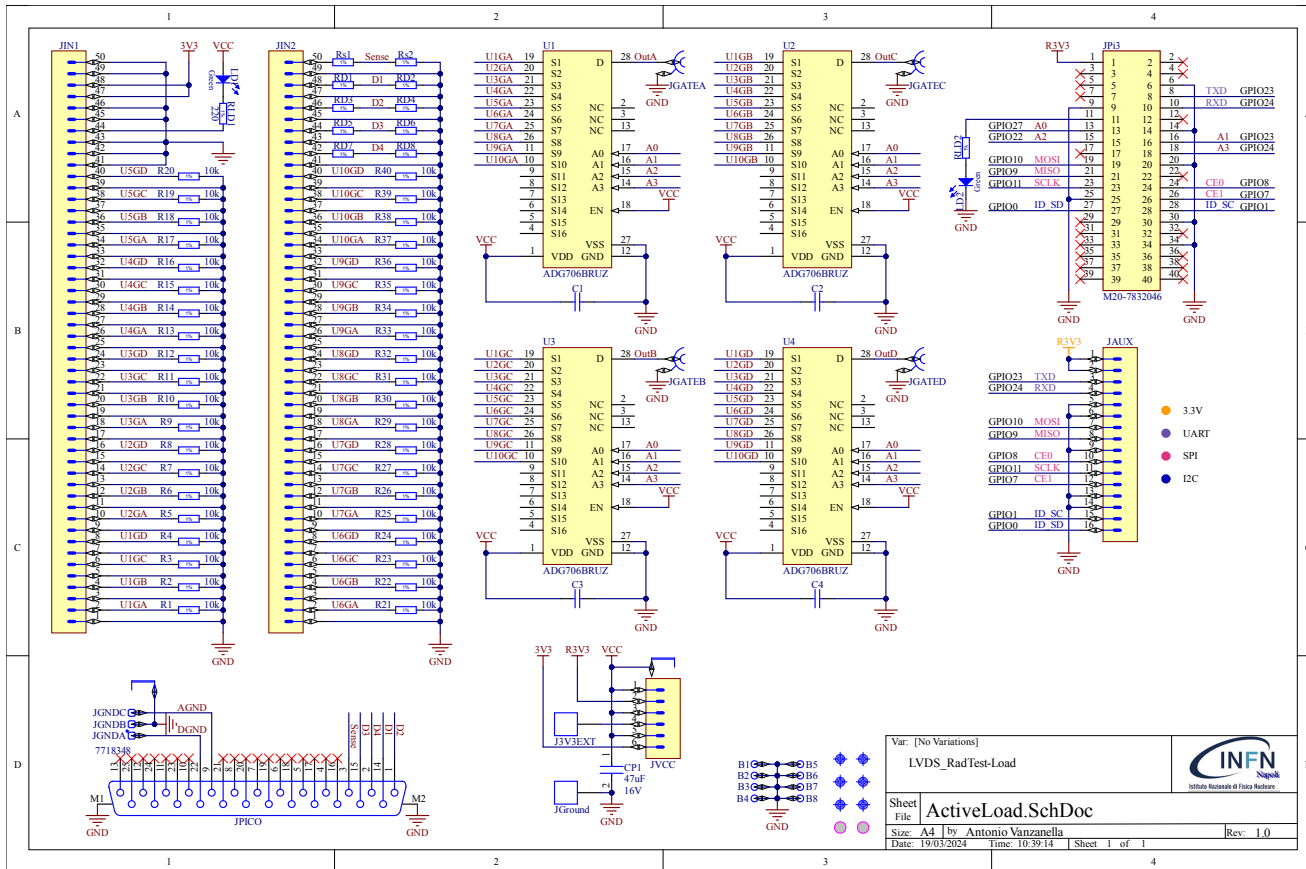


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# Input PCB



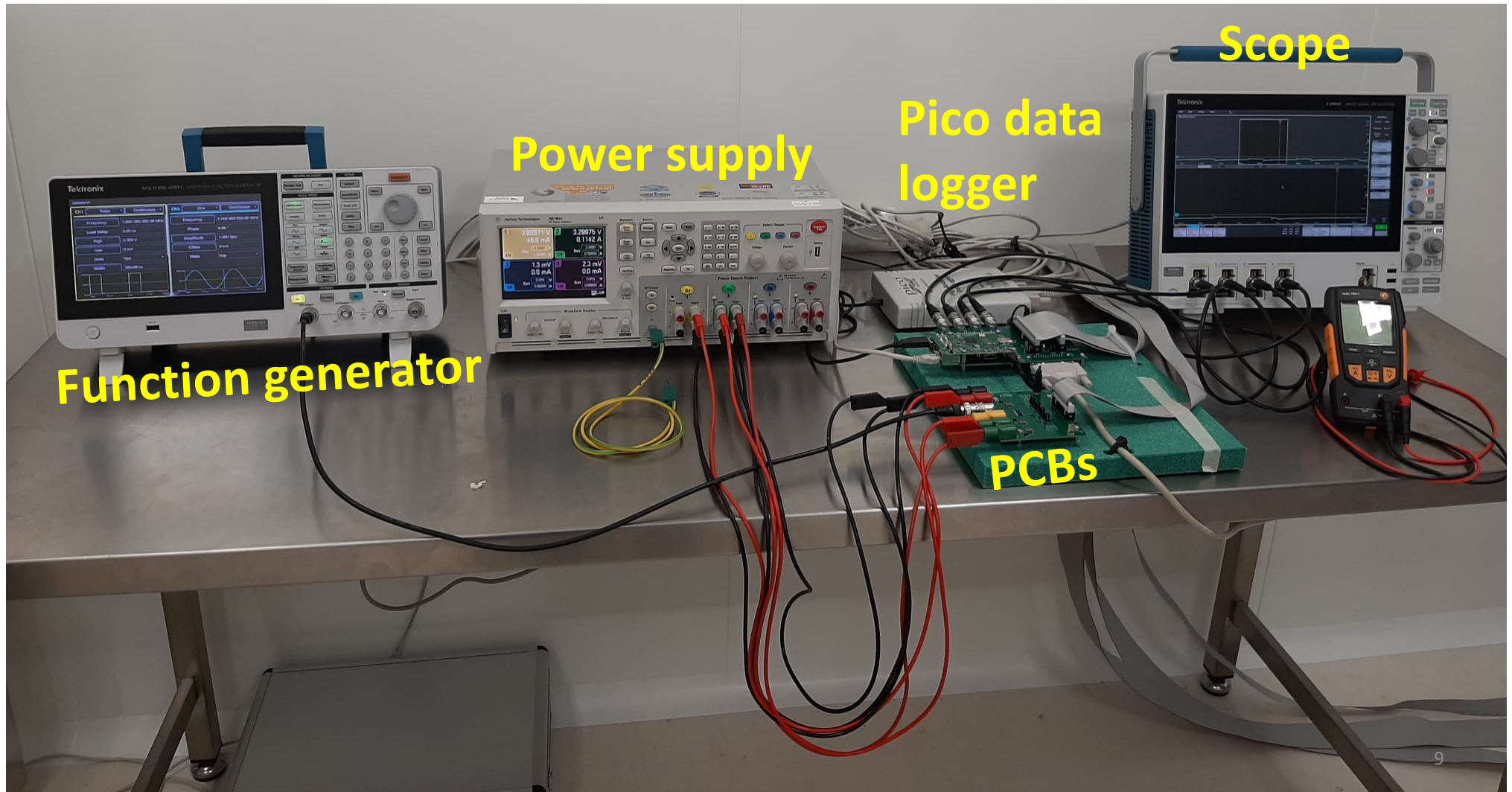
# Readout PCB



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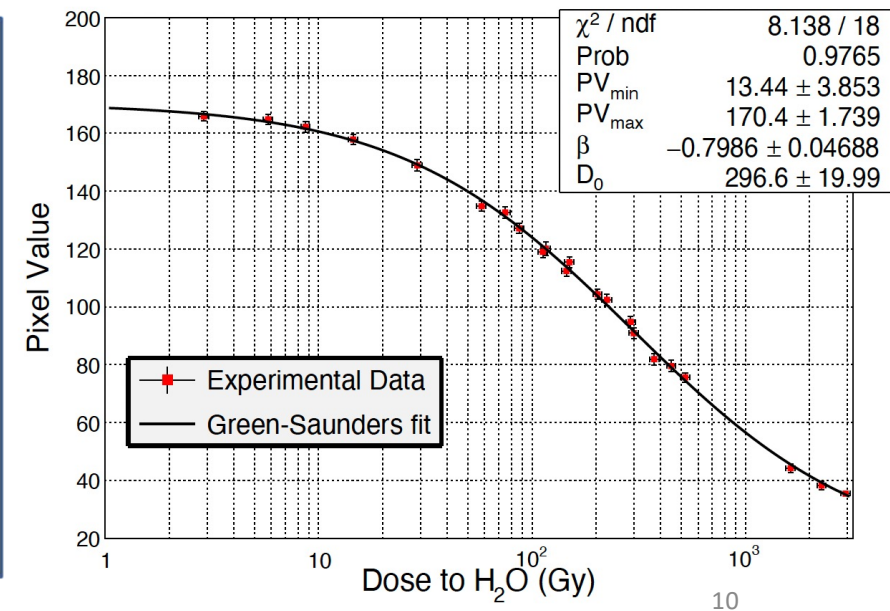
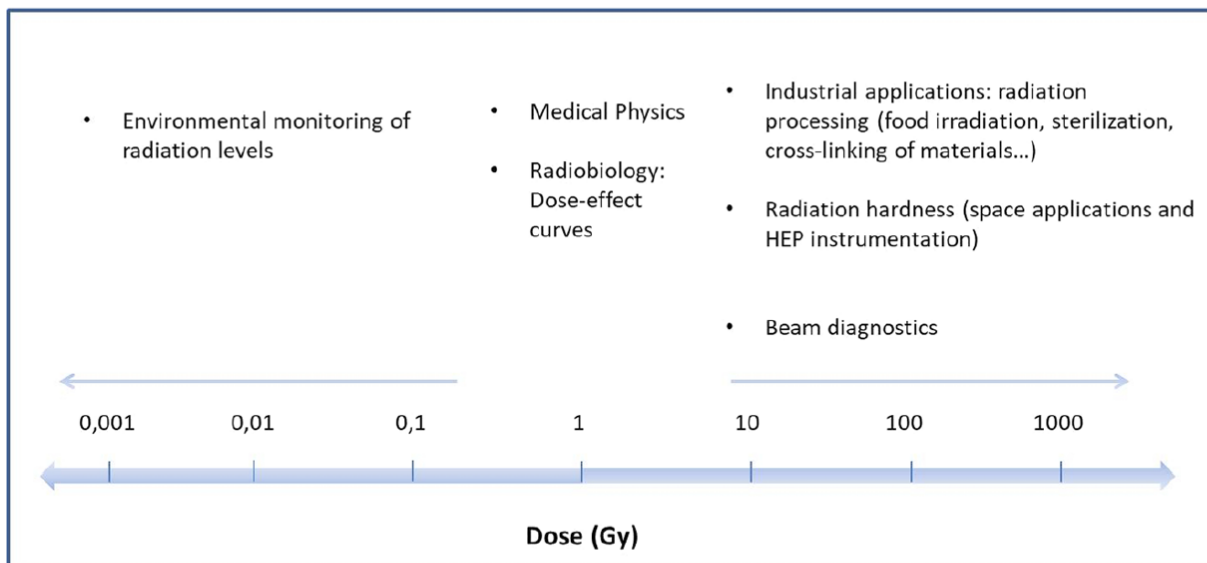
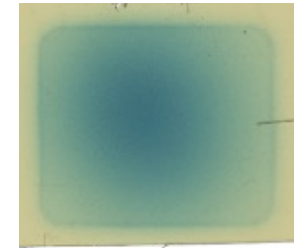


# Experimental setup

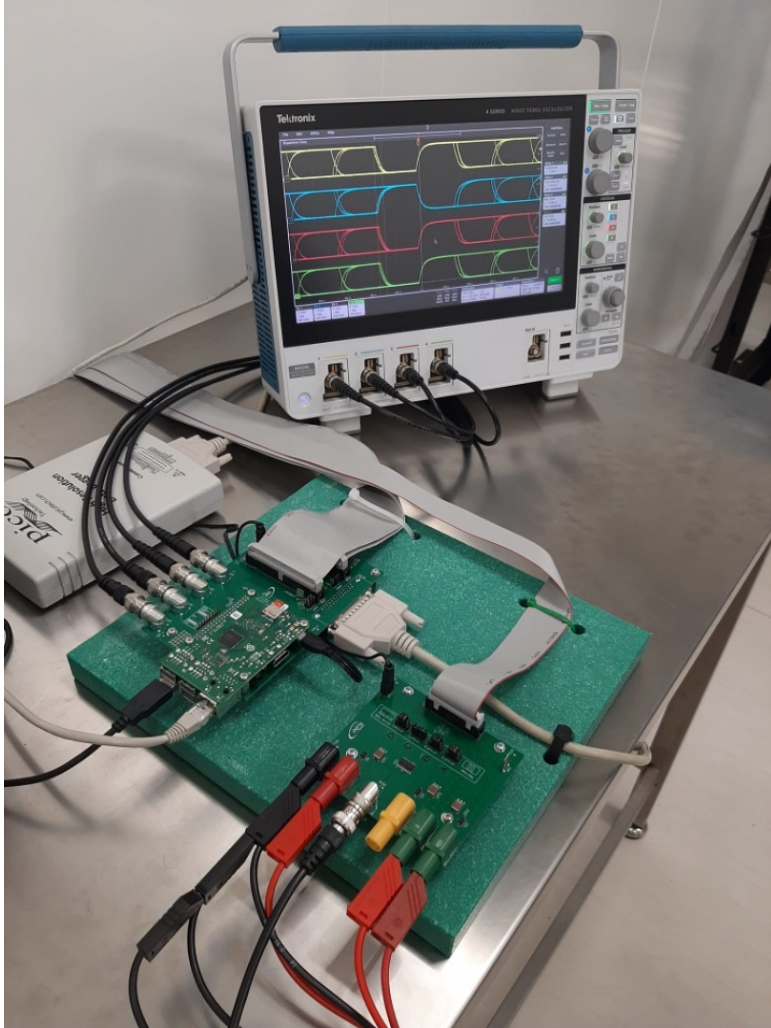


# Dosimetry “on-chip” with radiochromic films

- TID test target dose = 82 Gy
- Second run target dose = 14 kGy
- Dosimetry “on-chip” HD-V2 Gafchromic films (10-1000 Gy)
- Calibration of HD-V2 films at ISOF-CNR with  $^{60}\text{Co}$  Gammacell



# Conclusions



- Design/realization of custom PCBs for TID assessment of LVDS receivers for HL-LHC
- Only PCB with LVDS inside the irradiation room
- Continuous measurement of LVDS power consumption
- Eye diagrams: rise/fall time, jitter, signal-to-noise ratio, as well as inferring on bit error rate
- On-chip dosimetry with radiochromic films

# Back-up slide



## Radiation qualification

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fan-out for BI		test 10 @Co60	nr	nr
LDO		Done (PSI p beam)	Done (reactor)	Done (PSI p beam)
lpGBT		nr	nr	nr