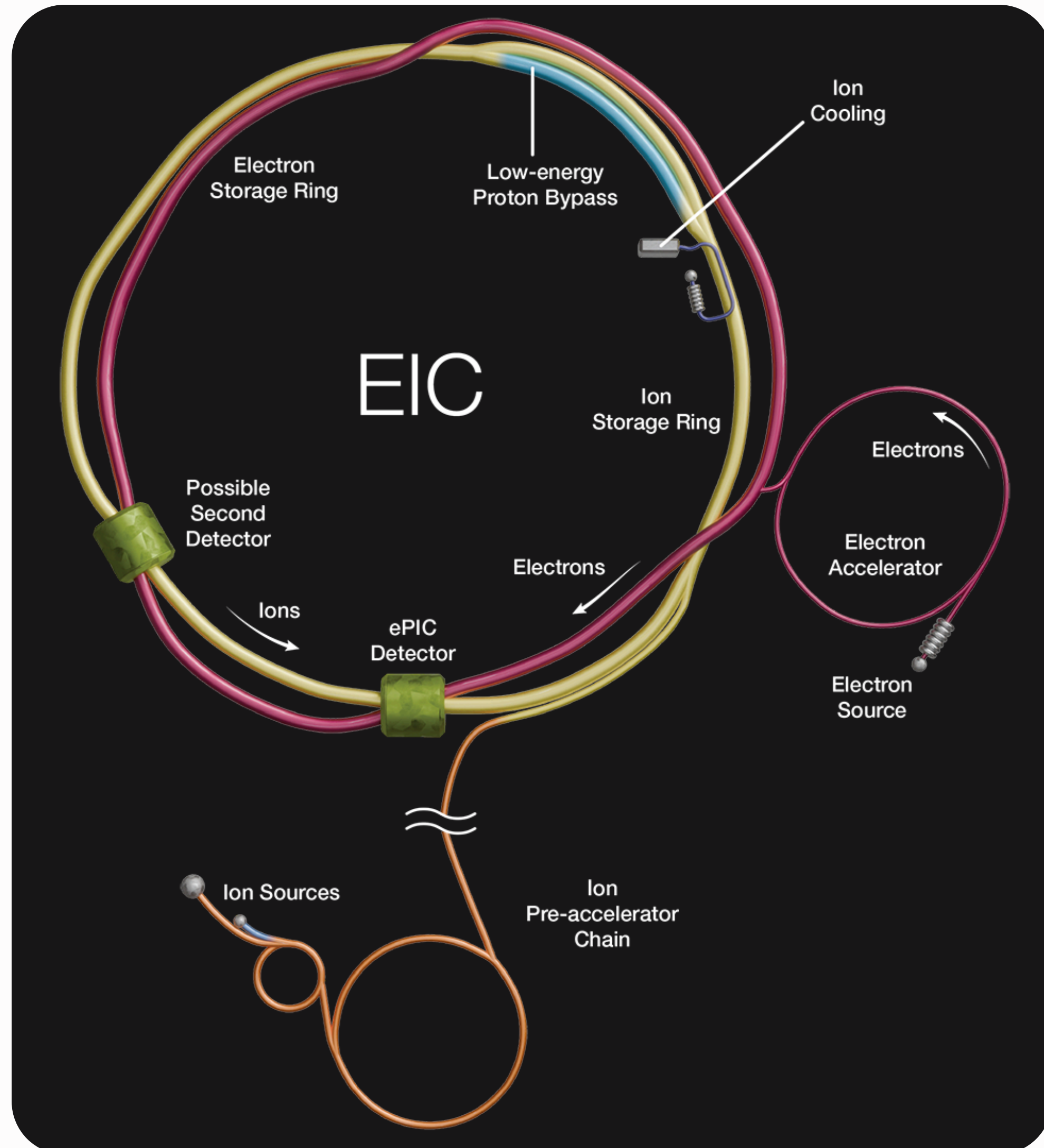
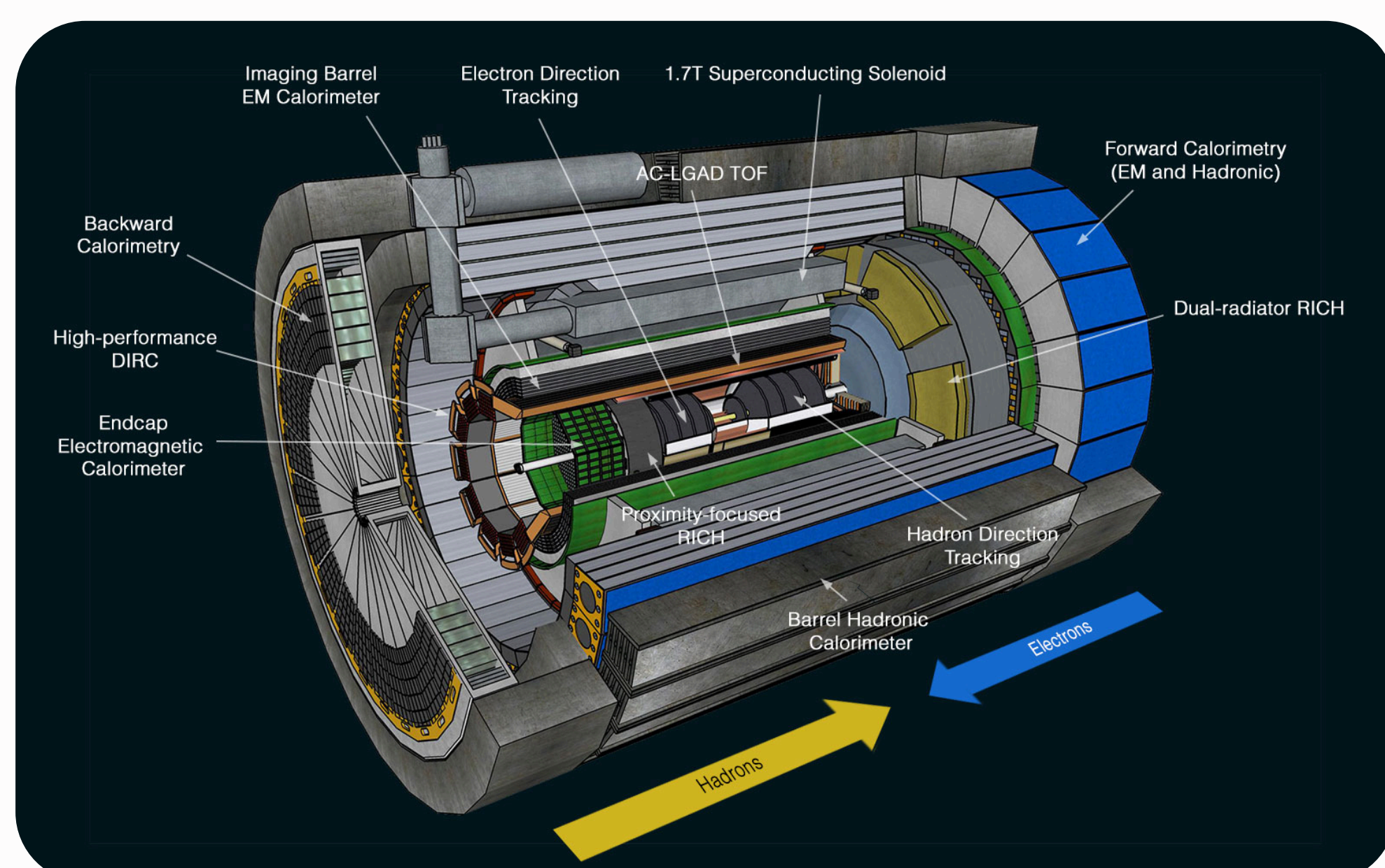


The Electron-Ion Collider (EIC)

- **The Facility:** A next-generation nuclear physics collider under construction at Brookhaven National Laboratory (USA), scheduled for operation in the early 2030s.
- **Physics Paradigm:** **World's first polarized electron-proton/ion collider** designed to map 3D nucleon structures and explore gluon confinement/saturation in QCD.

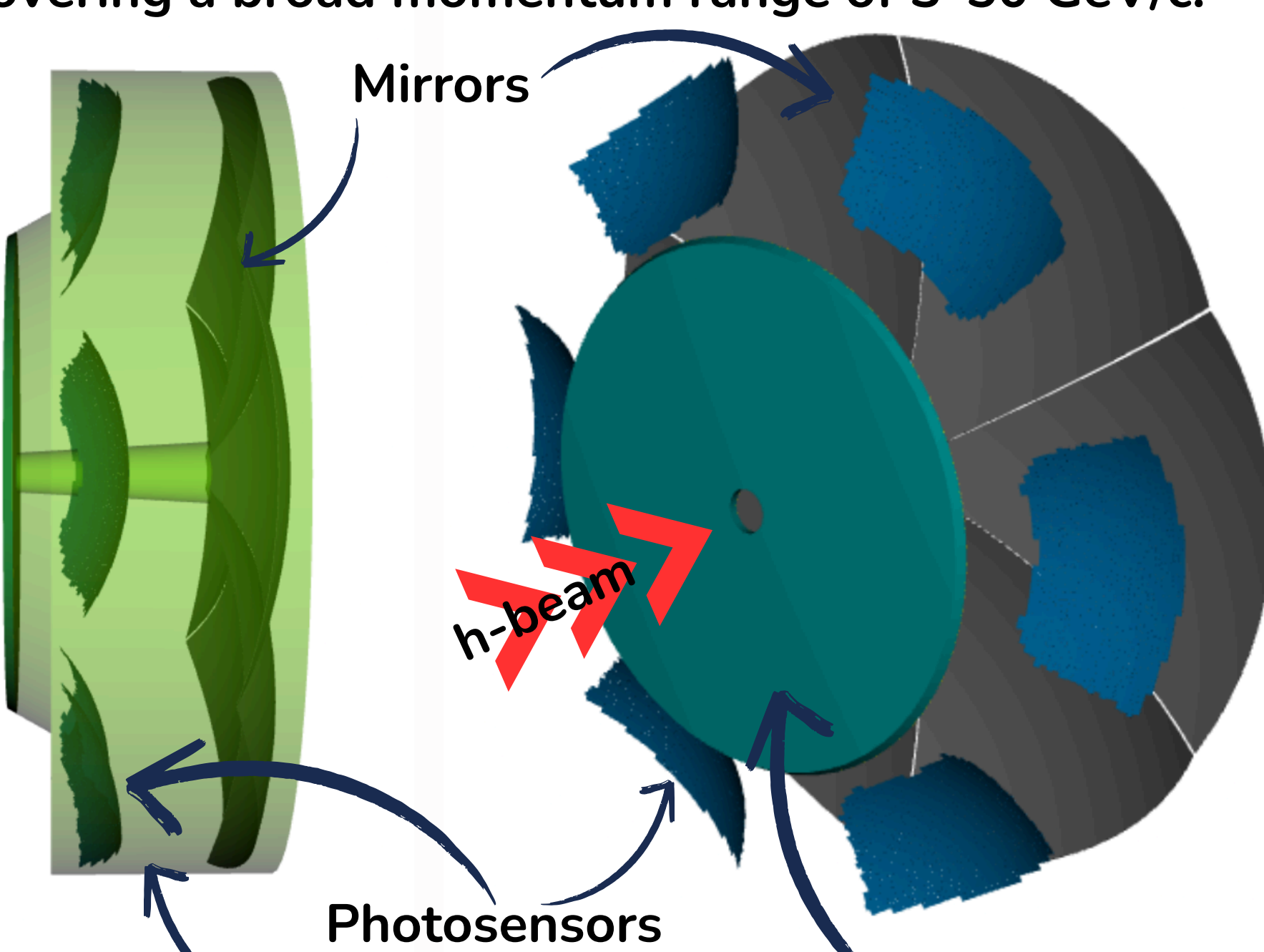


The ePIC at the EIC



The ePIC dRICH Detector

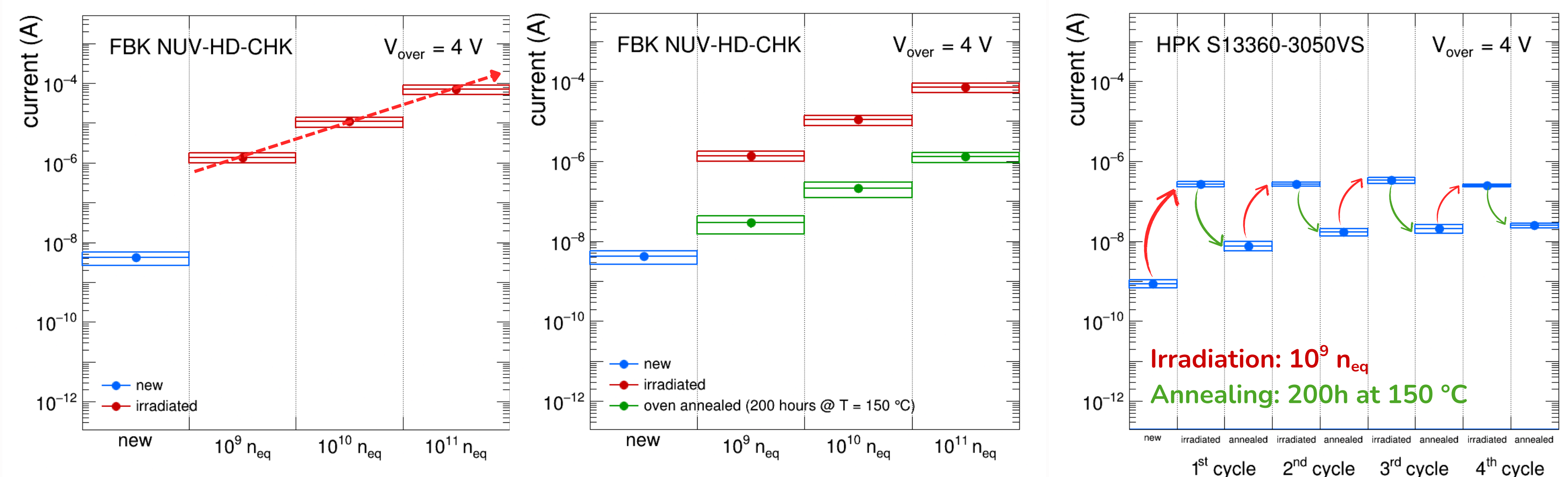
- The dRICH is a compact and cost effective solution for forward ($\eta = 1.5-3.5$) Particle Identification (PID) covering a broad momentum range of 3-50 GeV/c.



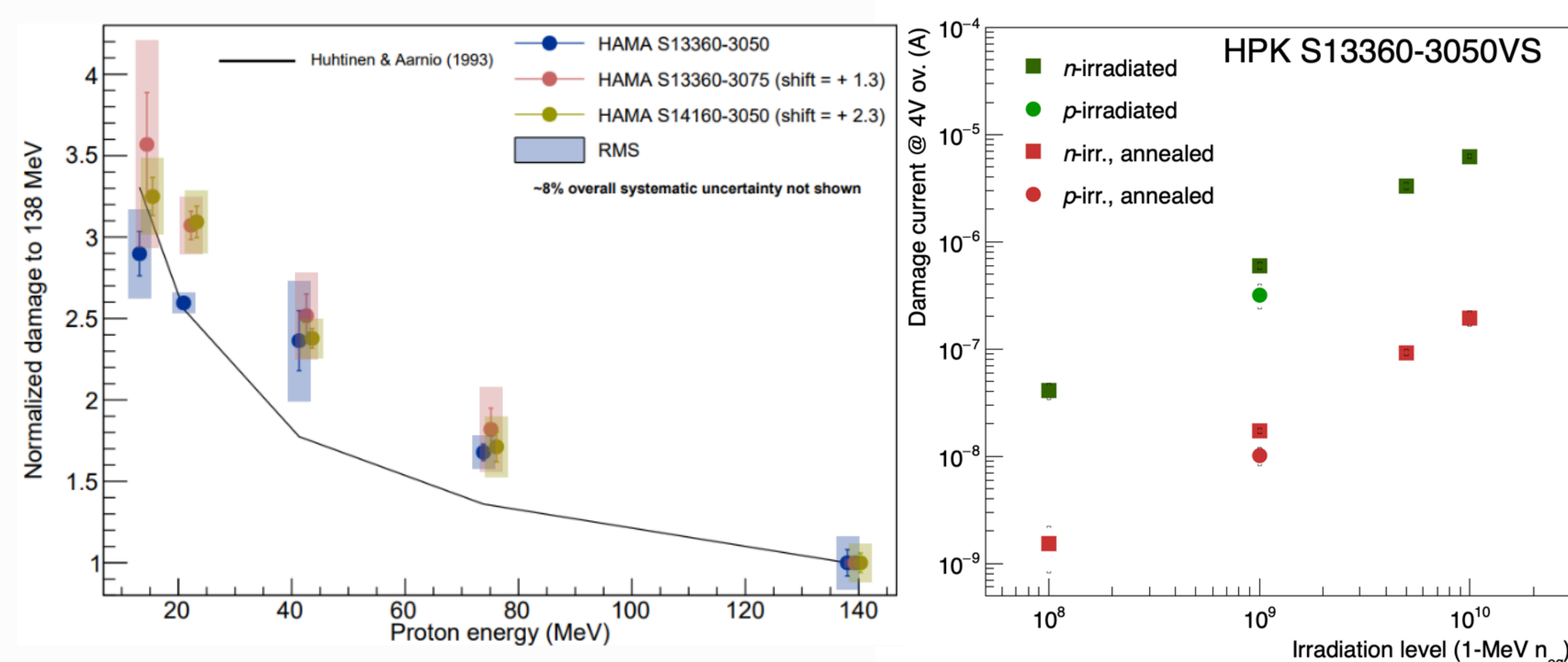
- **Radiators:** C_2F_6 ($n \sim 1.0008$) and aerogel ($n \sim 1.02$)
- **Mirrors:** large outward-reflecting, 6 open sectors
- **Sensors:** 3x3 mm² pixels of SiPM, total ~ 3 m² of photodetectors
- **Pros:**
 - Single photon sensitivity
 - Good timing performance
 - Resistive to high B field (~ 1 T)
- **Cons:** High dark count rate
 - Not radiation tolerant

Radiation damage and recovery of SiPMs with offline annealing

- **Linear increase of dark current with fluence**
- Oven annealing consistently recovers DCR up to 97% of damage after every cycle leaving a residual of ~ 15 kHz



Effects of proton and neutron irradiation on SiPMs

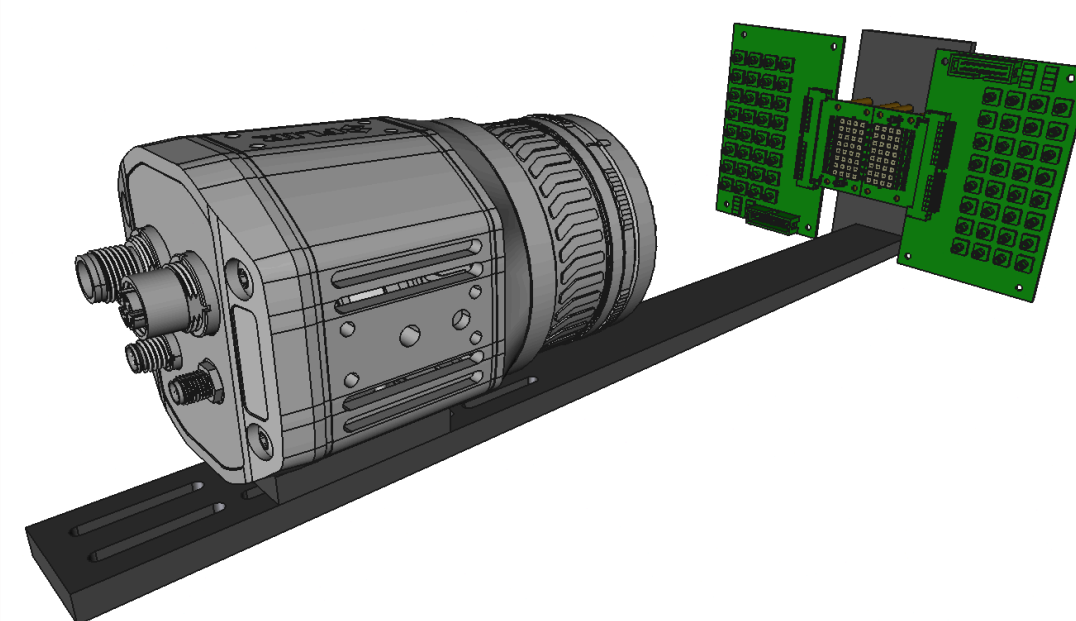


Irradiation results from protons and neutrons showed that the measured **neutron damage is slightly (a factor ~ 2) larger** than that predicted by the NIEL hypothesis when compared to that of protons.

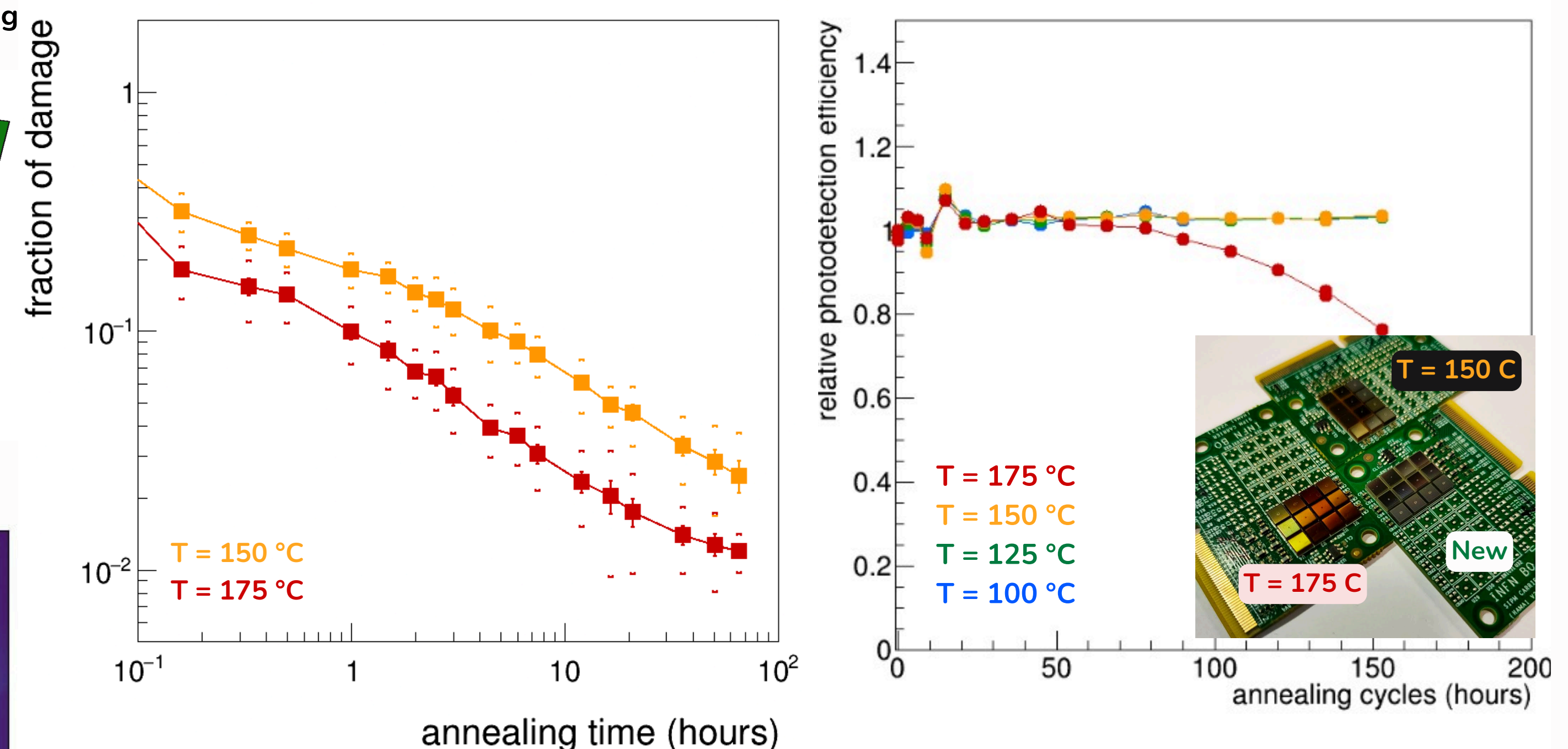
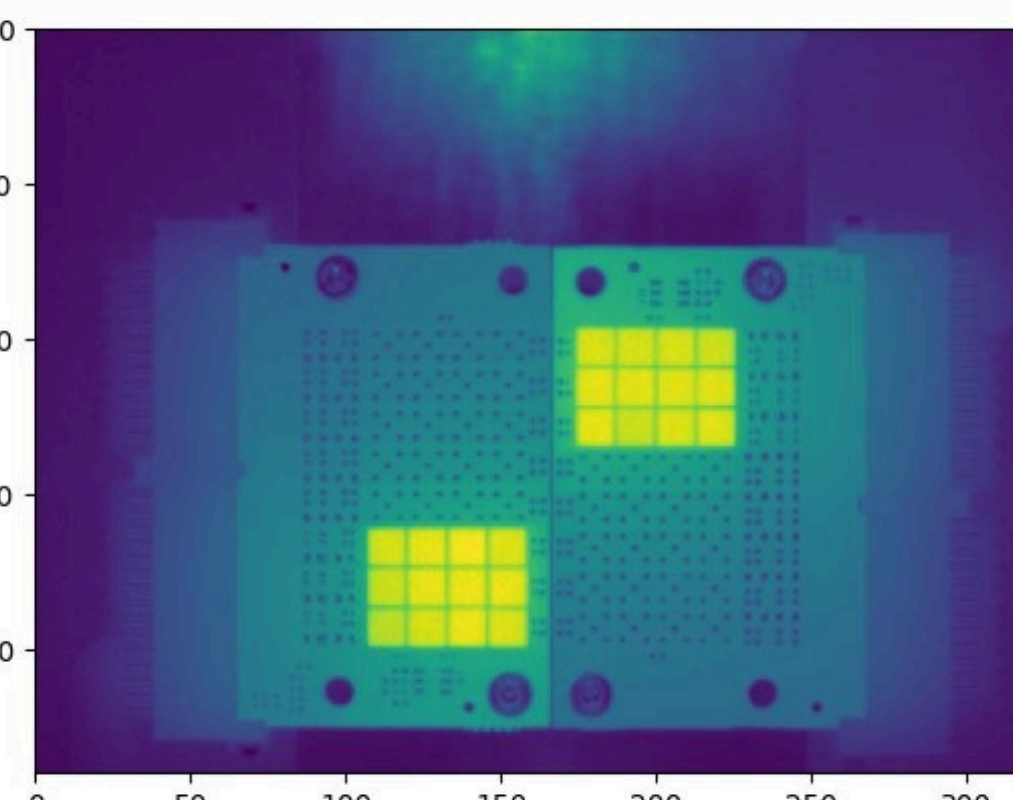
- Radiation damage on SiPMs at different proton energies: the trend and magnitude of the data indicate that NIEL scaling is valid within 30-50%.

Results from online in-situ annealing

Automated online annealing by monitoring through a thermal camera



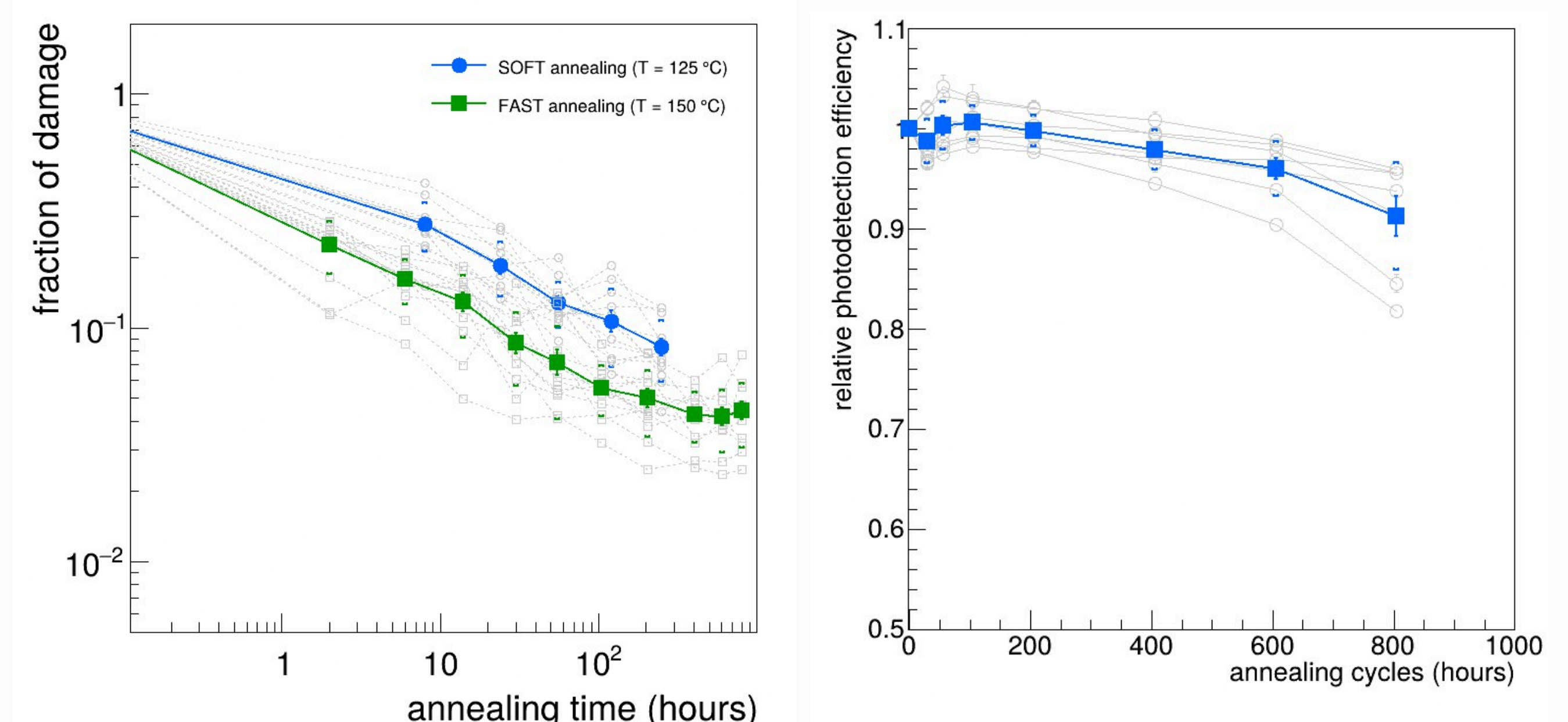
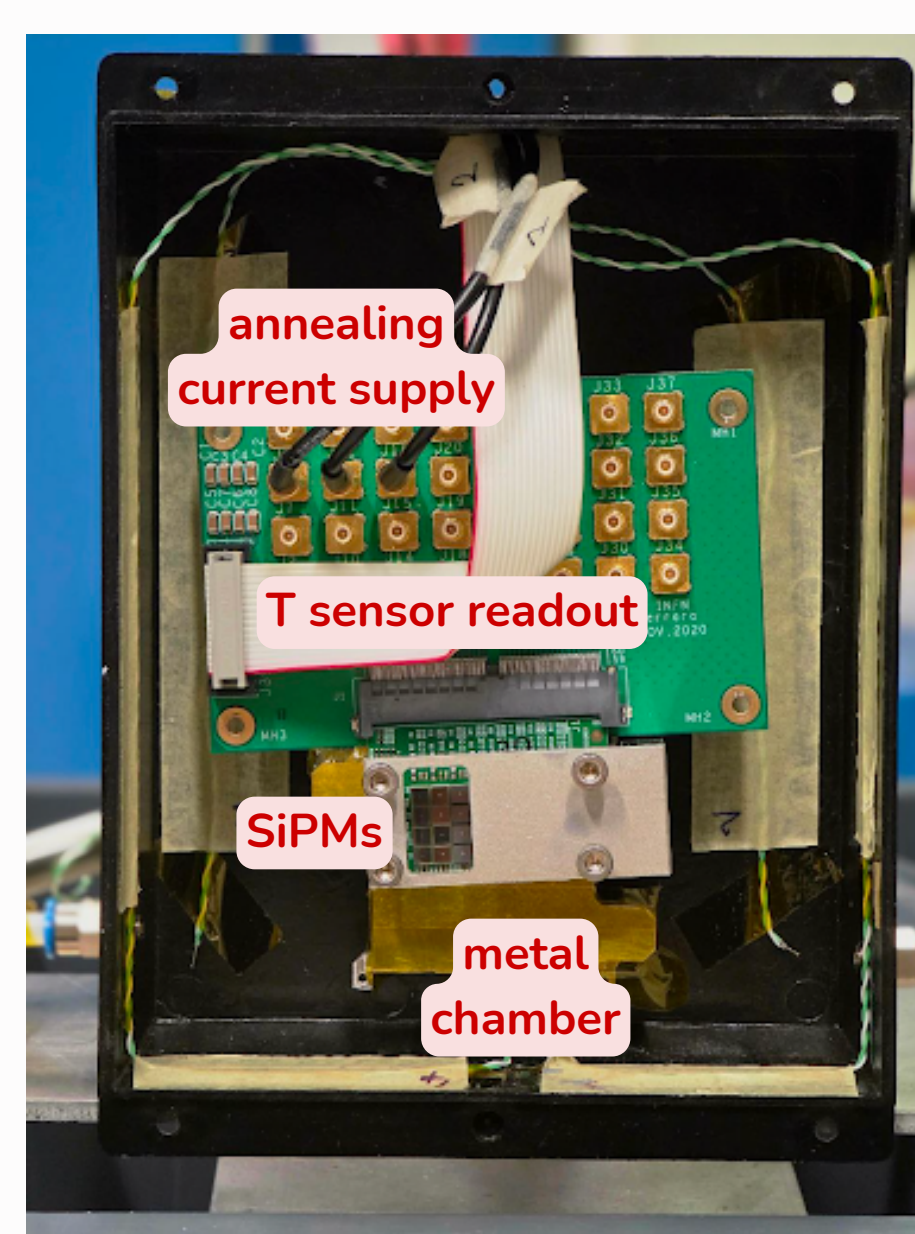
Thermal image of SiPMs during annealing



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Fluid assisted online annealing

Hybrid annealing performed in a sealed, zero-humidity enclosure utilising silicon oil thermal coupling and forward-bias current.



Atmospheric isolation did not prevent efficiency degradation. In contrast, hybrid annealing lowered the forward current threshold needed to achieve target temperatures.

Conclusion

Expected radiation damage is successfully mitigated in-situ without dismantling the sensors by repurposing the operational liquid-cooling chamber for hybrid thermal annealing. This dual-use thermal loop lowers the forward-current thresholds needed for recovery, preventing sensor burnout.