



Leptons: aMus(e)ing my career

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Young Scientific Forum – aMuse GM

09/18/2024

“Design and characterization of the UV-extended custom SiPM arrays for the Mu2e electromagnetic calorimeter”

Master Student

- Characterization of 6x6 mm² SiPMs from Hamamatsu
- SiPMs neutron irradiation @ HZDR up to $6 \times 10^{11} n_{1\text{MeV}}/\text{cm}^2$
- CsI crystal characterization and Irradiation

“Study of the Mu2e sensitivity to the $\mu^- \rightarrow e^+$ conversion process”

PhD

- QA/QC of pre-production and production of calorimeter components
- Assembly, testing with CR and test beam of the Module-0. Evaluation of calorimeter performance
- Evaluation of the sensitivity of the Mu2e experiment to the $\mu^- \rightarrow e^+$ conversion process

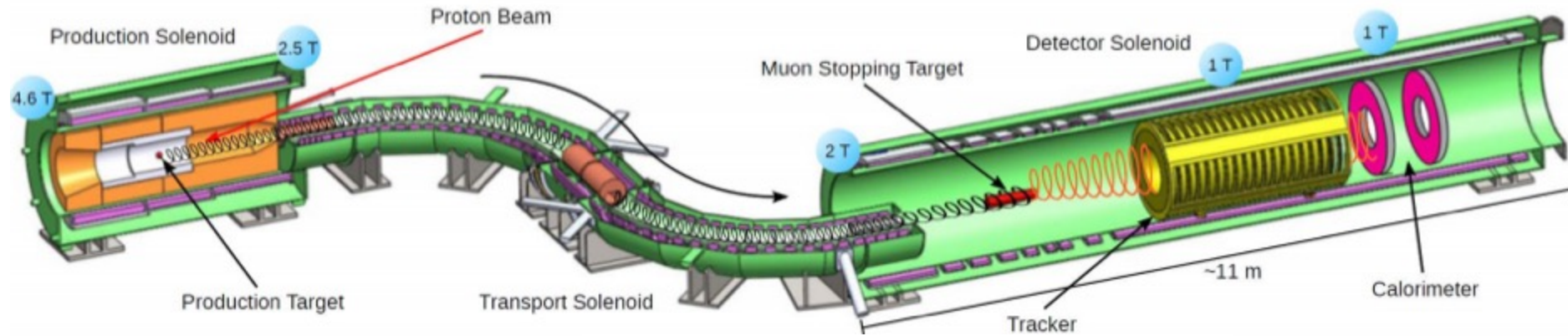
Post-doc

- Development of the reconstruction strategies to measure RMC photon spectrum with the calorimeter and integration of Module-0
- Responsible of the QC in situ
- Responsible of the operation and installation of the Read-Out Units (ROUs)
- Part of the Crilin calorimeter team!

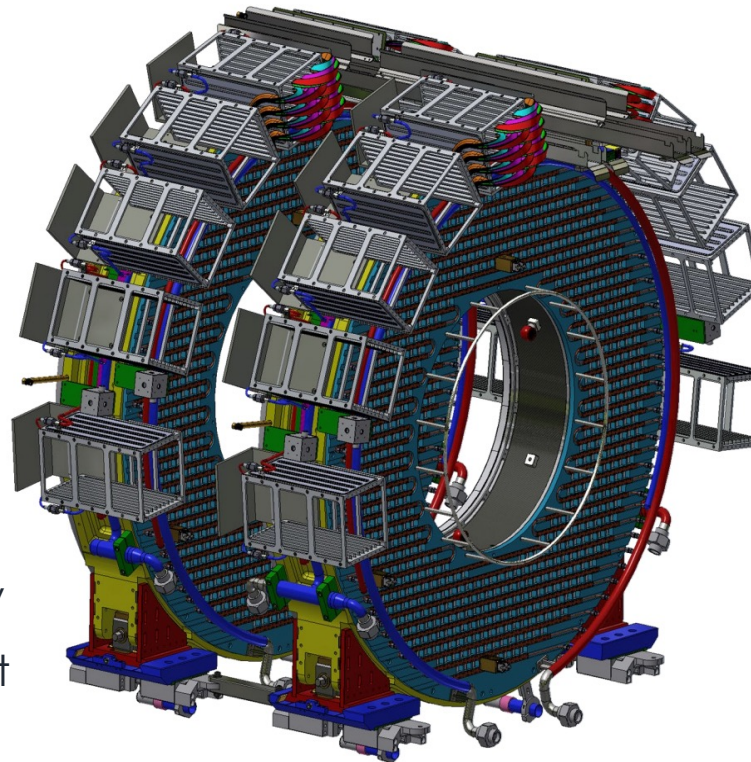
Technologist

Working at the Beam Test Facility of LNF but still involved in the Mu2e and Mucol experiment

THE MU2E EXPERIMENT



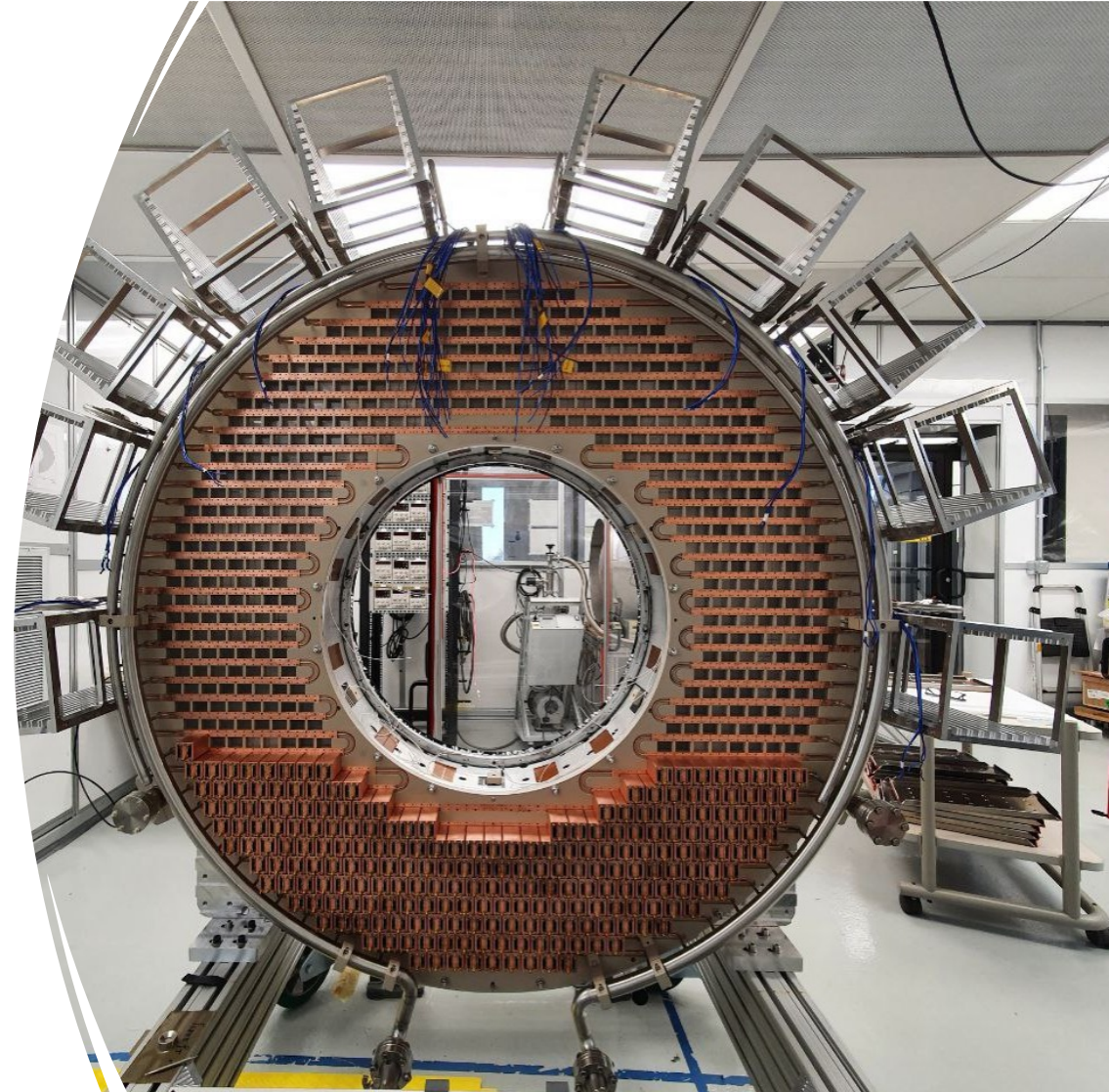
- 2 annular disks filled with 674 pure CsI crystals ($34 \times 34 \times 200 \text{ mm}^3$) each;
- Each crystal readout by 2 custom array of UV-extended SiPMs
- $R_{IN} = 35.1 \text{ cm}$ $R_{OUT} = 66 \text{ cm}$
- Depth = $10 X_0$ (200 mm)
- Disk separation $\sim 75 \text{ cm}$
- 1 FEE / SiPM , Digital readout on crates
- Radioactive source and laser system provide absolute calibration and monitoring capability
- Withstand a dose of 15 krad/year in the hottest region and a neutron flux (1 MeV_{eq})



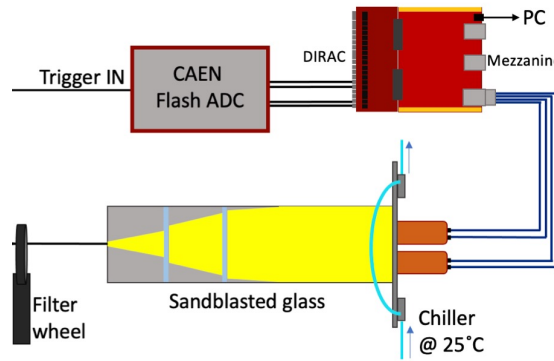
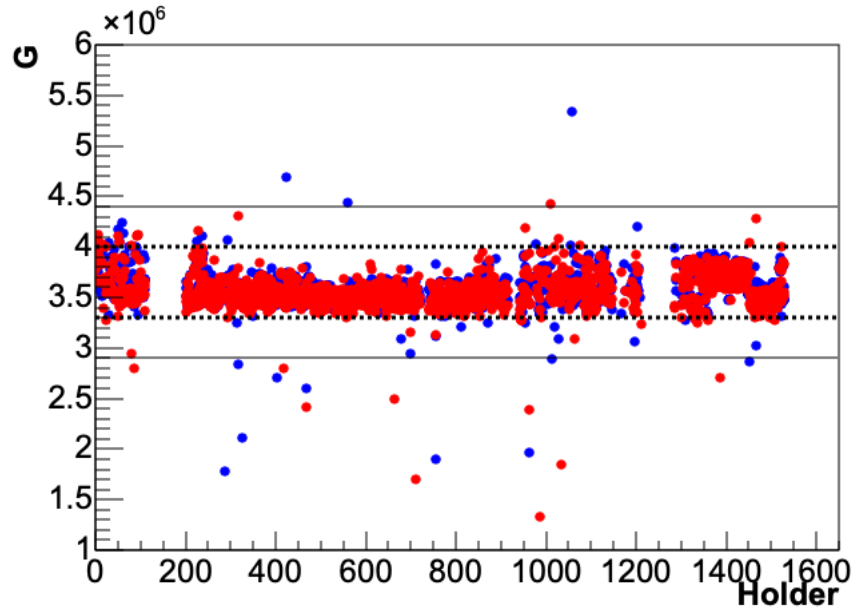
The calorimeter

- PID to distinguish e/μ
- Seed for track pattern recognition
- Independent trigger
- Work in 1 T field
- 10^{-4} Torr vacuum
- Withstand a very harsh radiation environment
 - Up to 100 krad,
 - $10^{12} \text{ n/cm}^2/\text{year}$
- High acceptance for CE signal
- $\sigma_E/E = \mathcal{O}(10\%)$ for CE
- $\sigma_T < 500 \text{ ps}$ for CE
- $\sigma_{X,Y} \leq 1 \text{ cm}$

- Outgassing and installation of Mu2e calorimeter
- Development of DCS for the calorimeter



MU2E READ-OUT UNITS

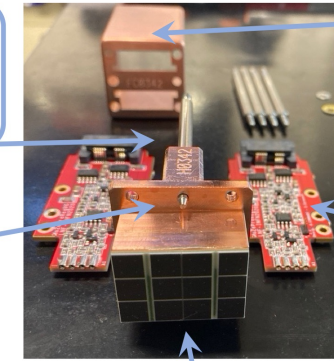


Fiber optic coupler for the secondary distribution layer of the laser calibration system

Copper thermal block for SiPM cooling and for mechanical support

Faraday cage for shielding

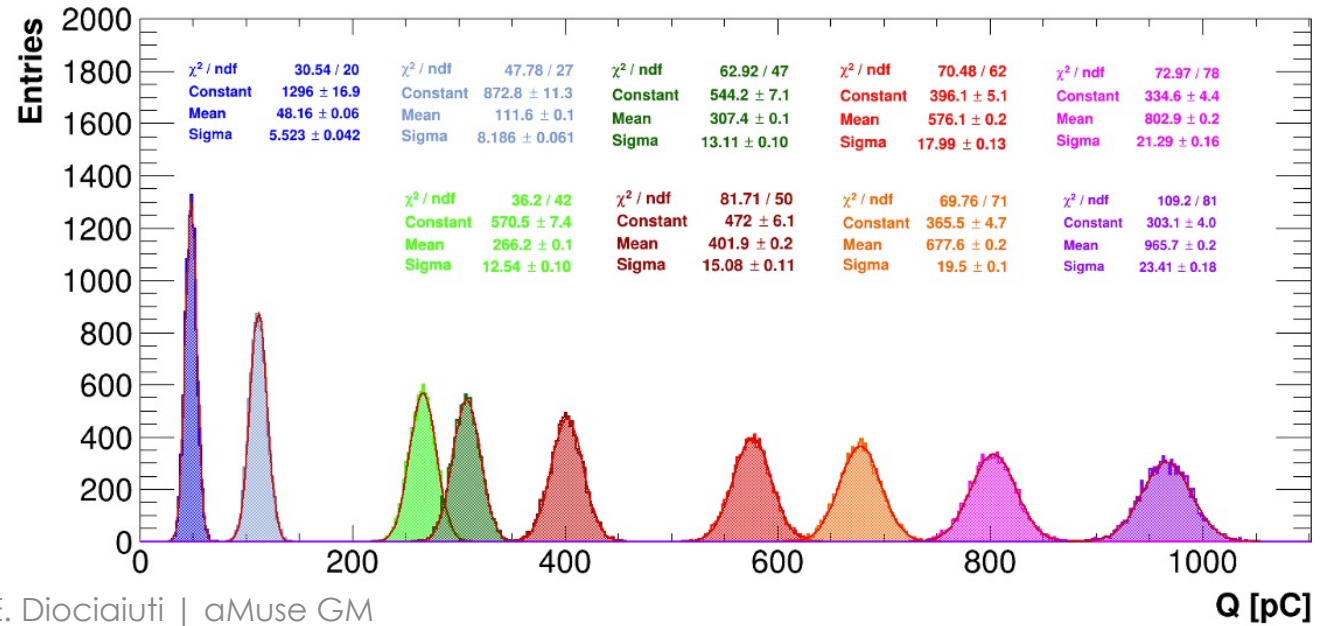
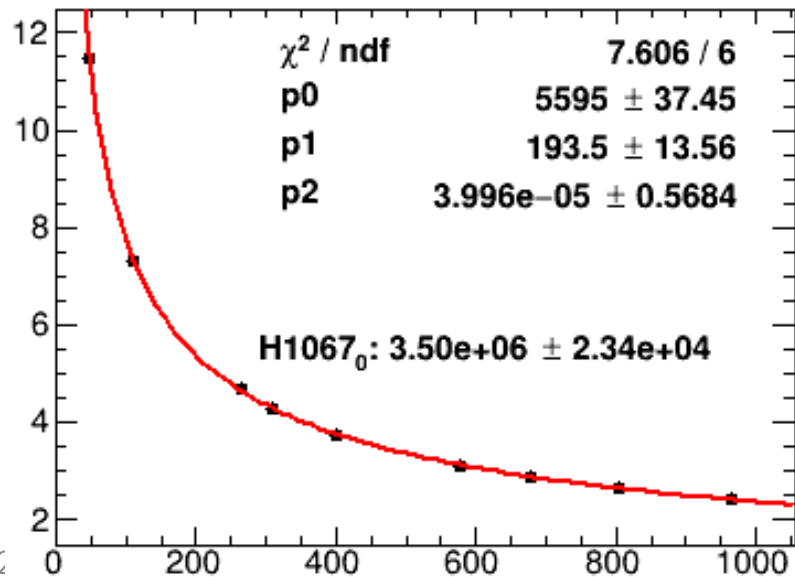
Two Front End Electronics Boards (FEE)



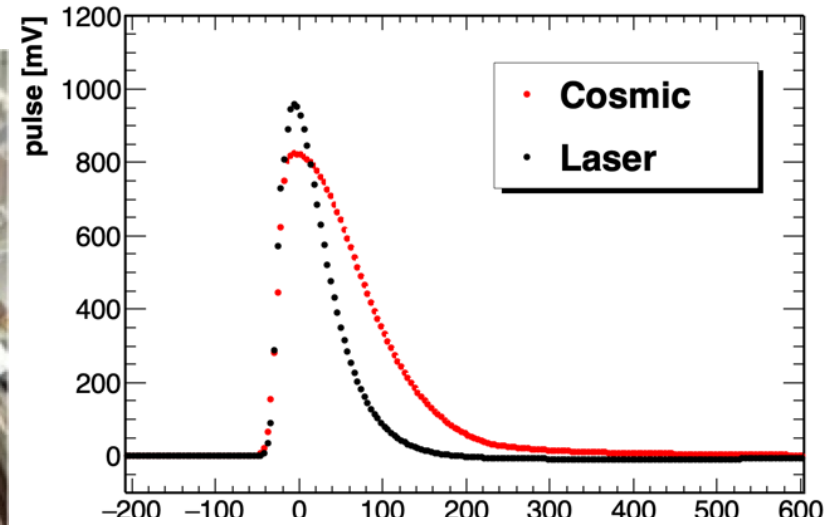
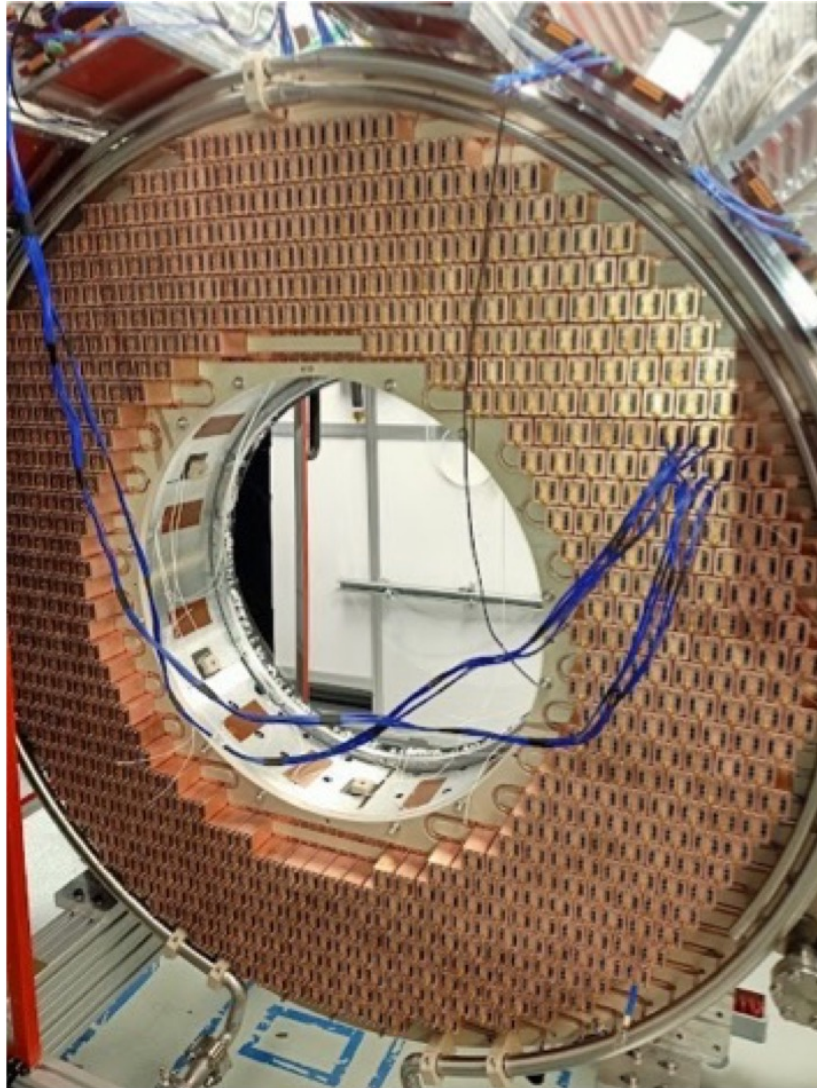
Two Hamamatsu UV-extended 2x3 matrices of SiPMs

Measurements performed:

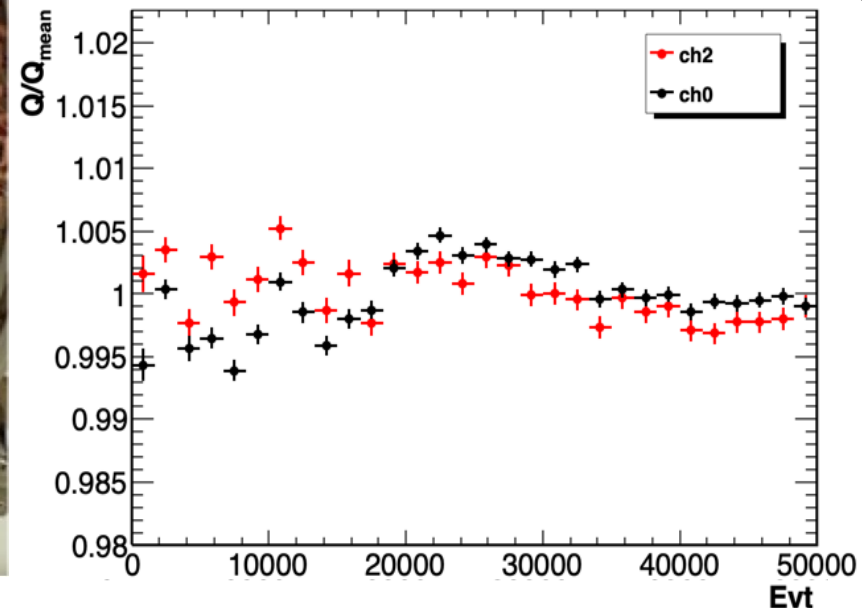
- 7 HV positions $\Rightarrow V_{op} - 4V$ to $V_{op} + 2V$ in 1V intervals.
- 9 filters scan per HV value $\Rightarrow 10^4$ events acquired/HV point for each filter position (1 minute)



ROU OUTGASSING AND INSTALLATION

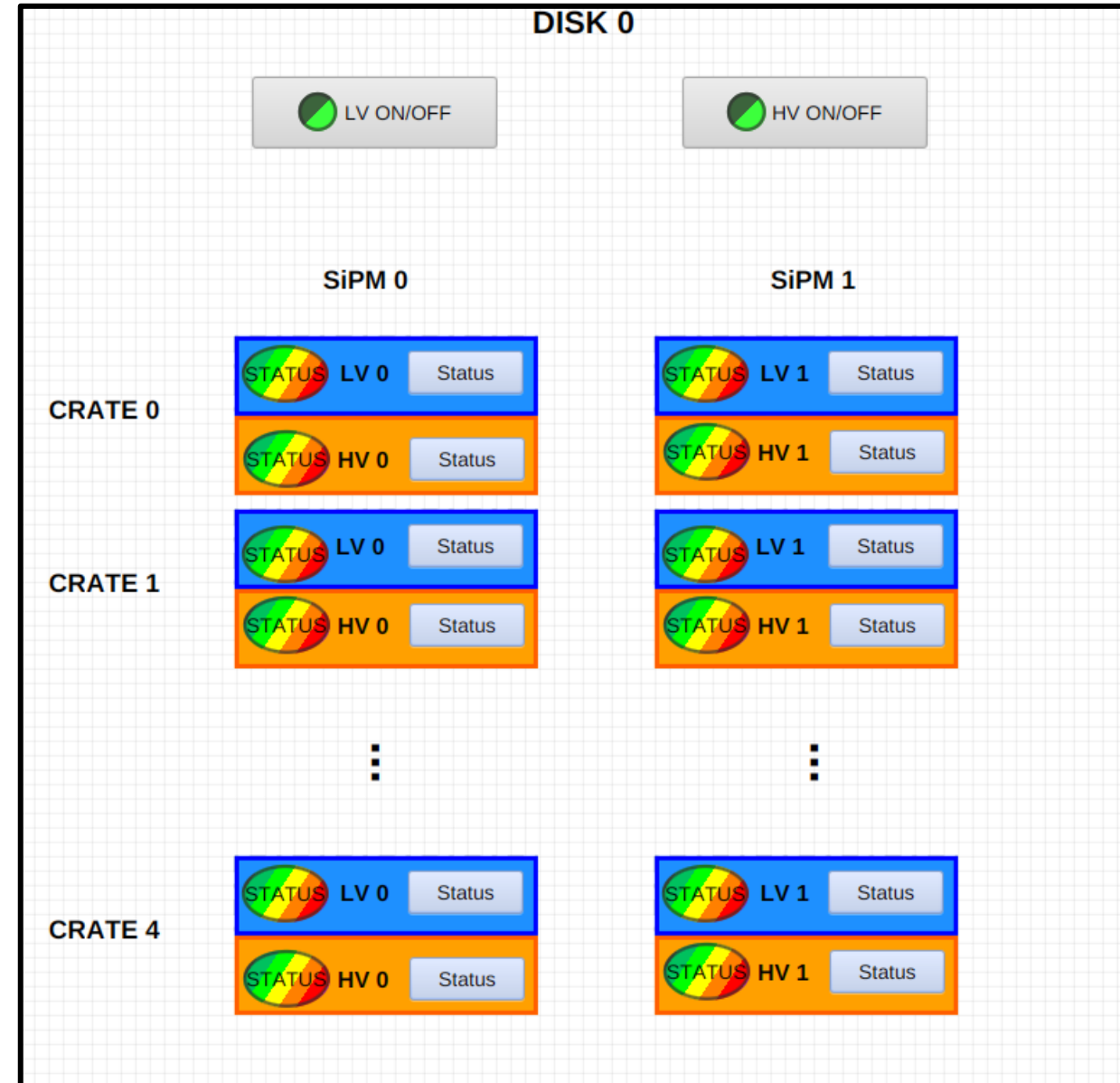
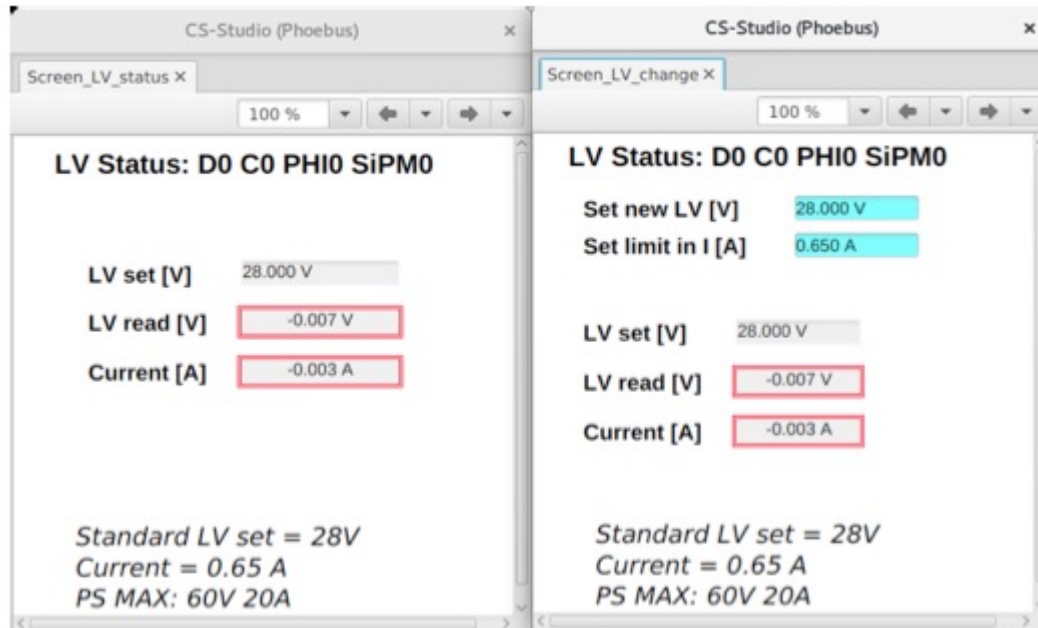
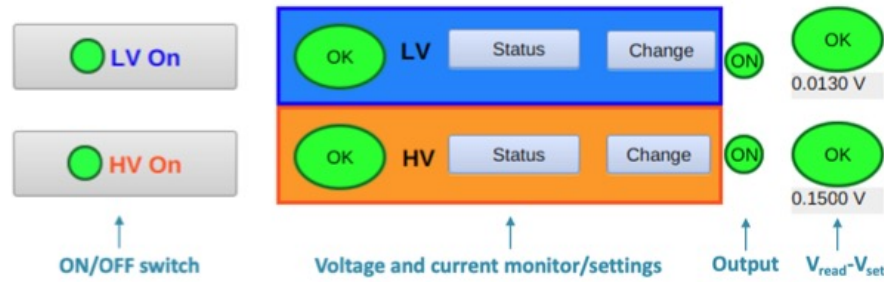


- Outgassing of all the calorimeter components up to 10^{-5} mbar
- Crystals assembly completed in June 2022
- ROU assembly completed in December 2022
- Cosmic and Laser test started in February 2023
 - Stability at the level of 1% obtained with laser run

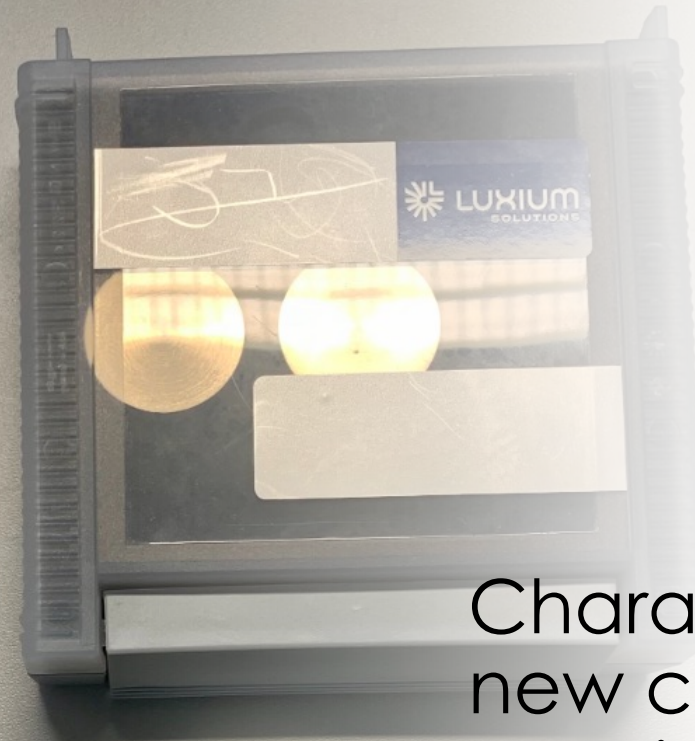


DCS @ SIDET

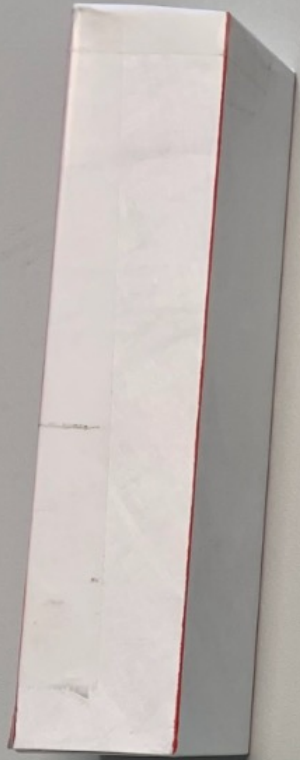
A first small-scale prototype an EPICS IOC has been developed for two PS, one HV and one LV



WP-2 Activities



Characterization and test of new crystal option for the calorimeter



BaF₂

GA49 CRY18



PbF₂



LaBr₃

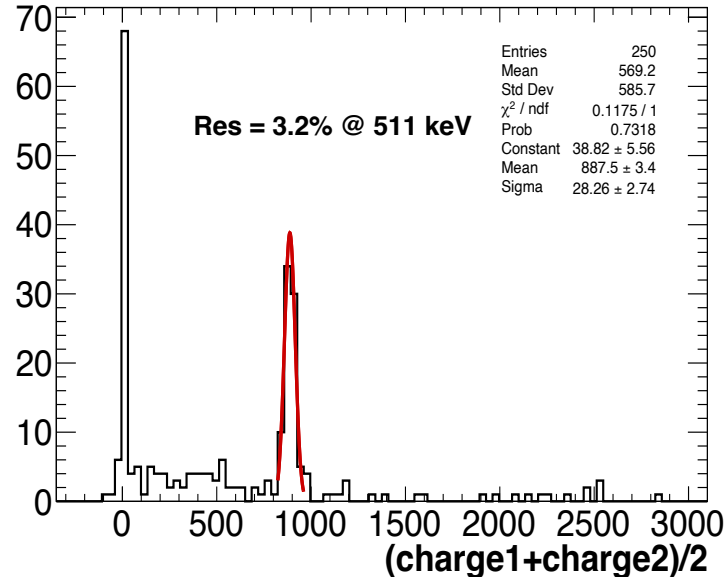


LYSO

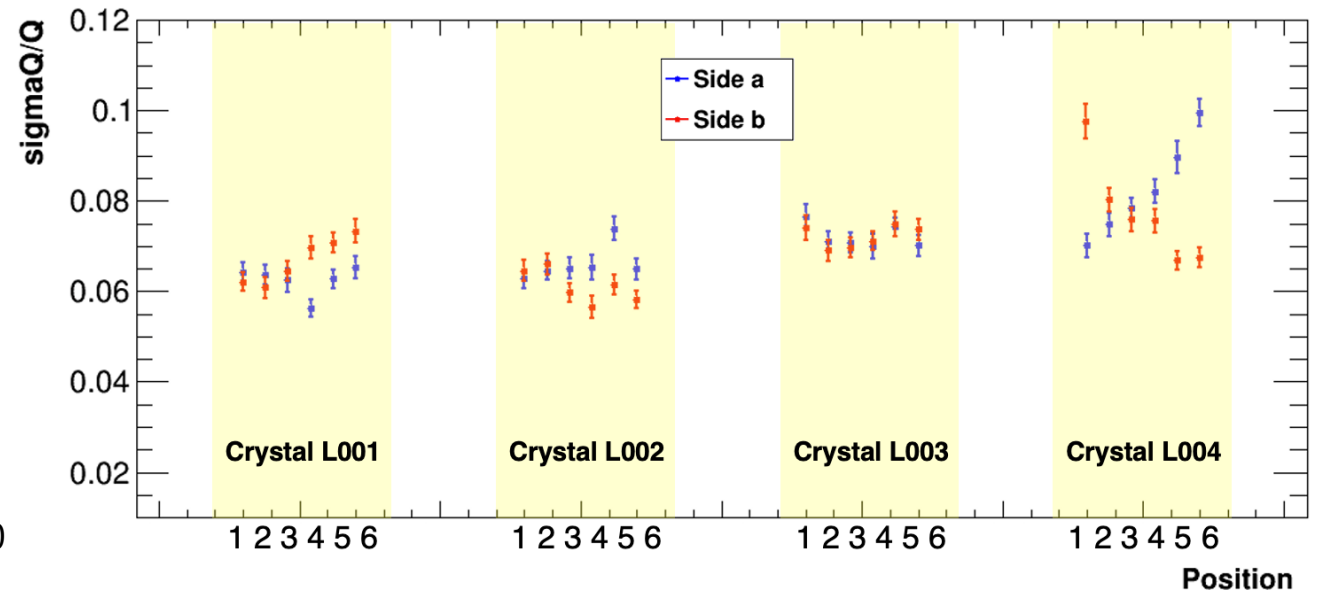
LaBr LY evaluation

- Crystal performance tested using Mu2e SiPMs
 - LYSO: 3.4
- Exposed to a ^{22}Na source (511 keV annihilation photons)

LaBr₃

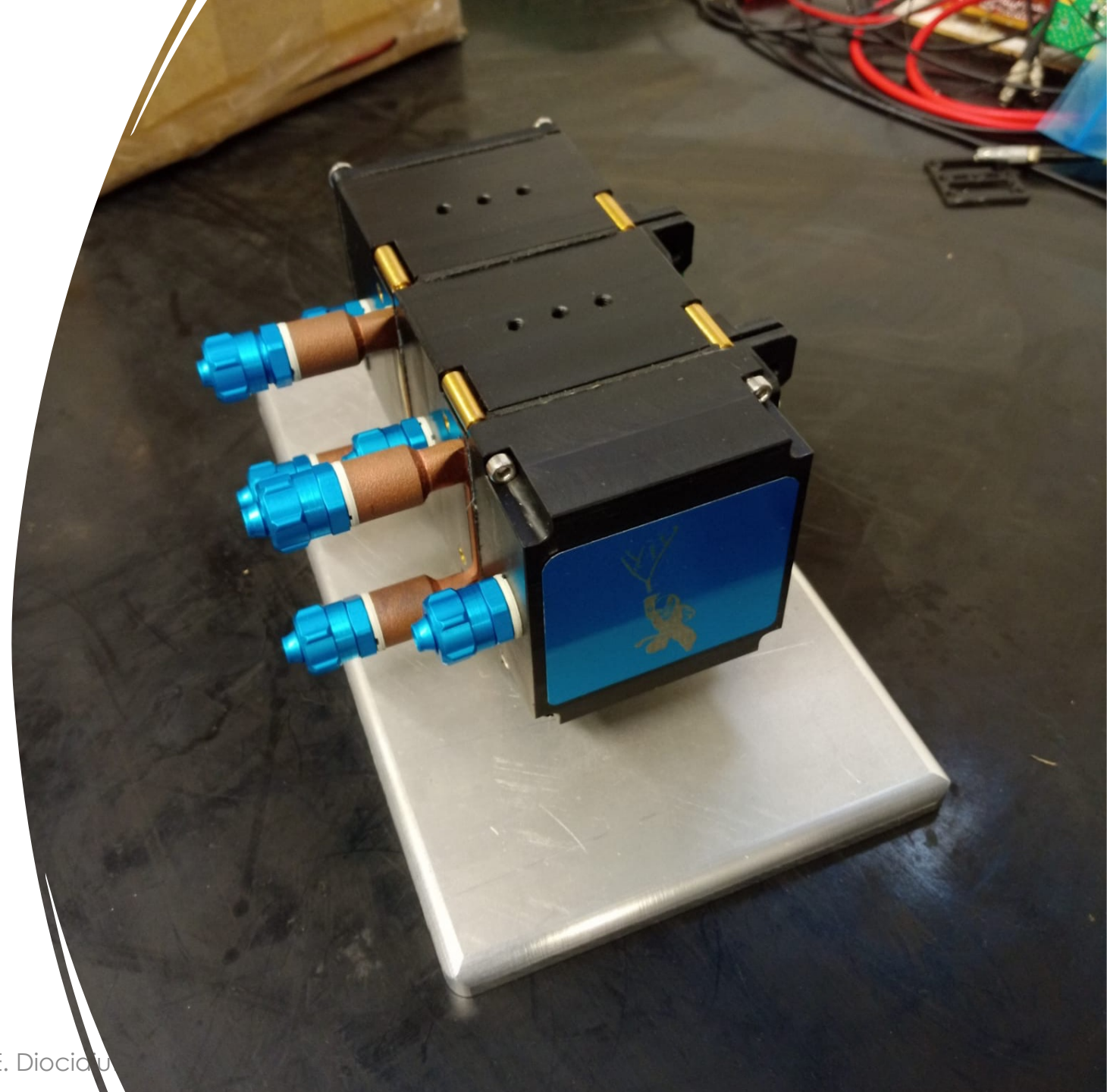


LYSO

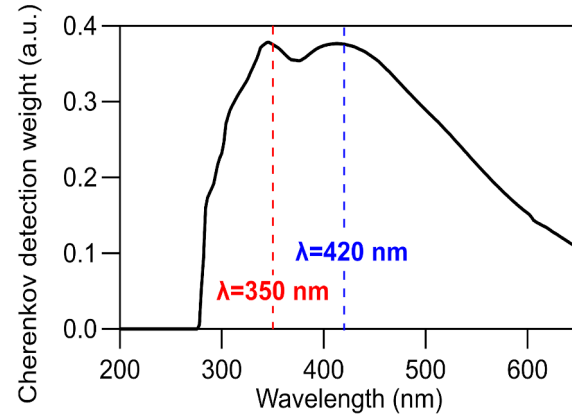
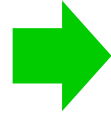
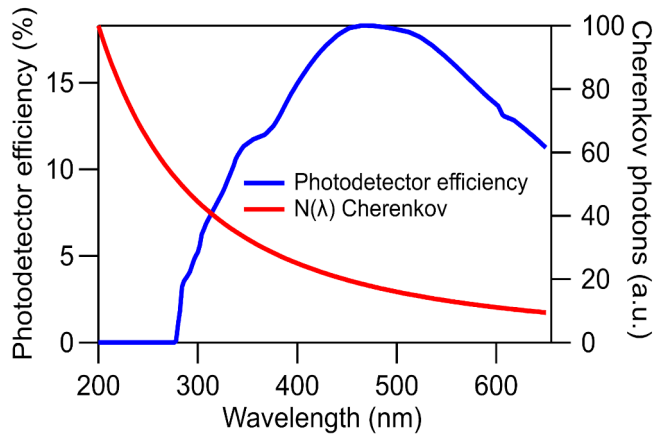


WP-3 Activities

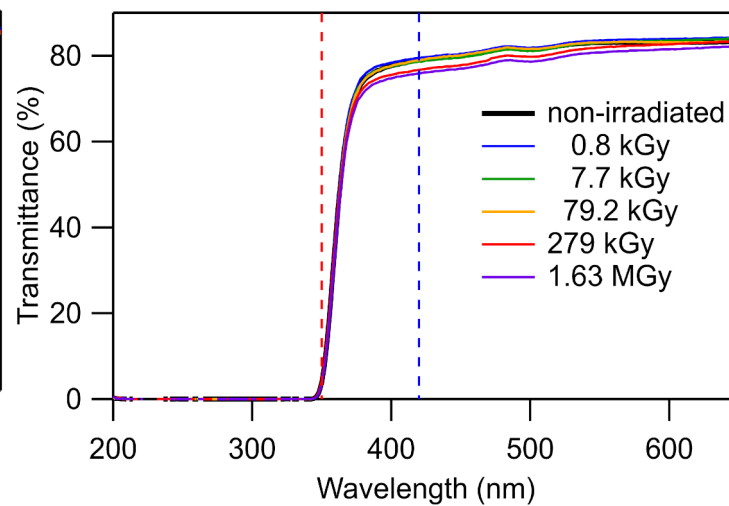
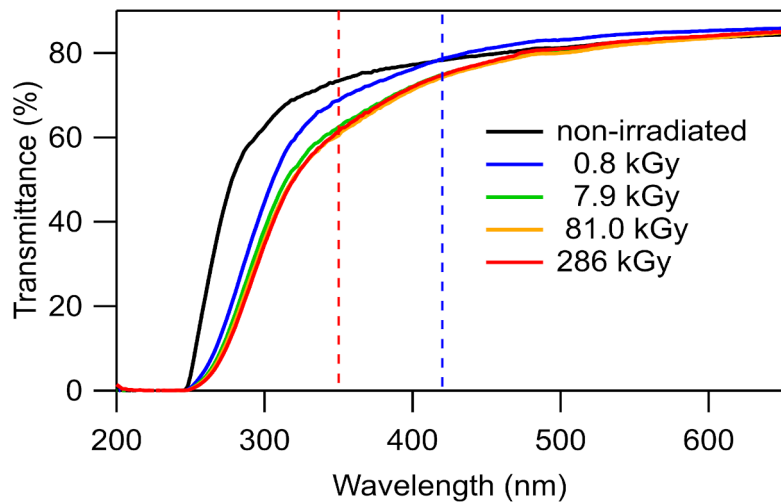
- Part of the group working on the development of CRILIN, an alternative solution for the Muon Collider EMC



Radiation Resistance of crystals



PbF ₂		
Dose (kGy)	T @ 350 nm	T @ 420 nm
before irr.	73.4	78.3
0.8	68.7	78.6
7.9	62.5	74.9
81.0	60.4	74.2
286.0	61.5	74.8



PWO-UF	
Dose (kGy)	T @ 420 nm
before irr.	79.0
0.8	79.5
7.7	78.6
79.2	79.0
279.0	76.7
1628	75.8

Conclusions

- Still not sure I should have present in the YSF but...
- My work is composed of several activities strongly related with different aMuse WP:
 - I am part of the team working on the Mu2e calorimeter
 - I am also involved in the future development of detector for its upgrade Mu2e-II
 - I work also on the development of a very interesting alternative to the baseline solution of MuCol EMC

