

Operation of the Belle II ARICH detector

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(On behalf of ARICH group)



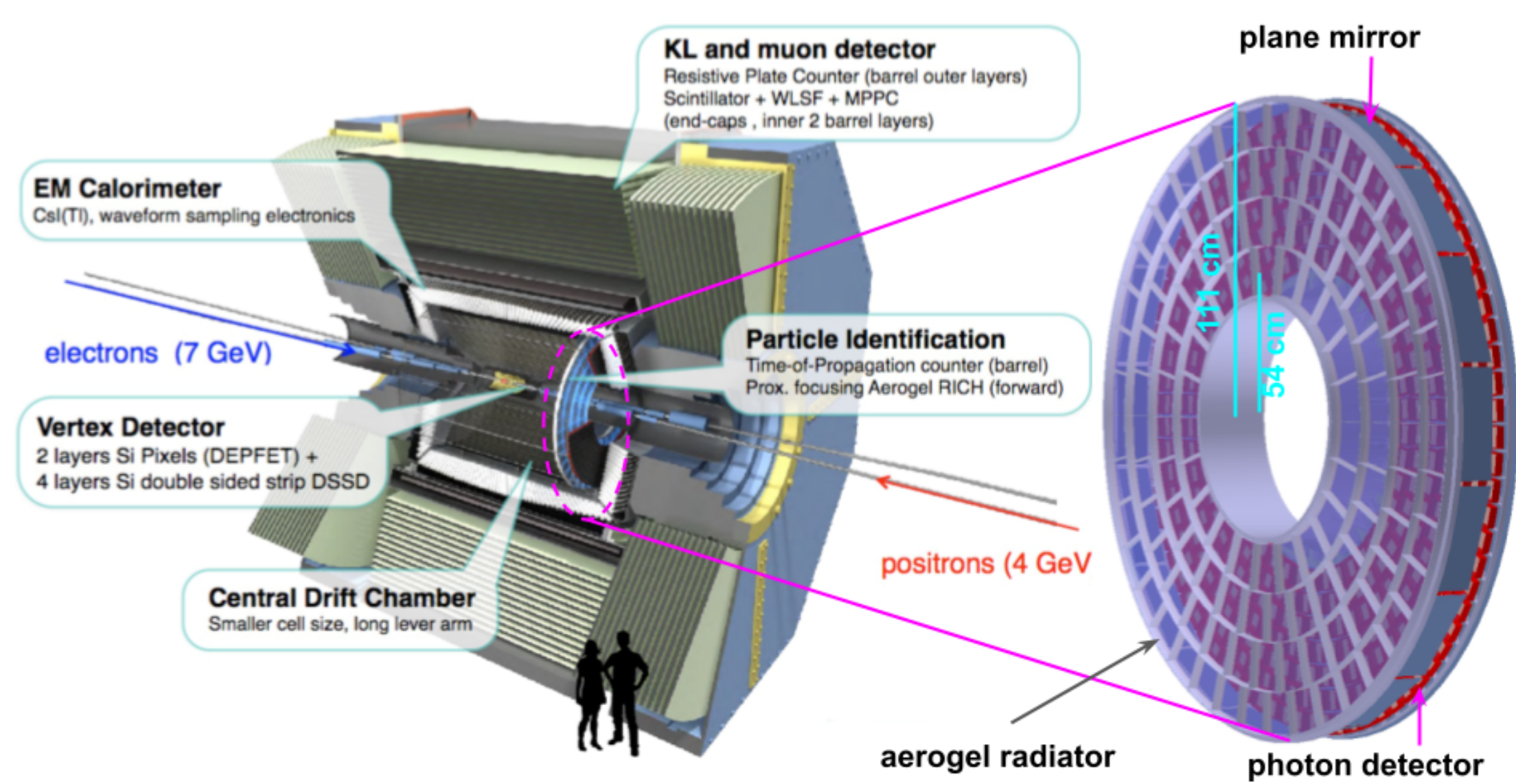
భారతీయ సాంకేతిక విజ్ఞాన సంస్థ హైదరాబాద్
आरतीय प्रौद्योगिकी संस्थान हैदराबाद
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Abstract

The Aerogel Ring Imaging Cherenkov (ARICH) detector, located in the forward endcap of the Belle II experiment, identifies charged particles, mainly distinguishing kaons from pions. It detects Cherenkov light using Hybrid Avalanche Photo-Detectors (HAPDs) and has been operating successfully since the experiment began. We report on the current status of ARICH operation, including HAPD stability, DAQ efficiency improvements, and operational issues. We also present a study comparing simulated and real muon data to investigate photon yield variations caused by gaps between aerogel tiles, enabling us to map these gaps and correct their impact on detector performance.

Belle II Detector at SuperKEKB

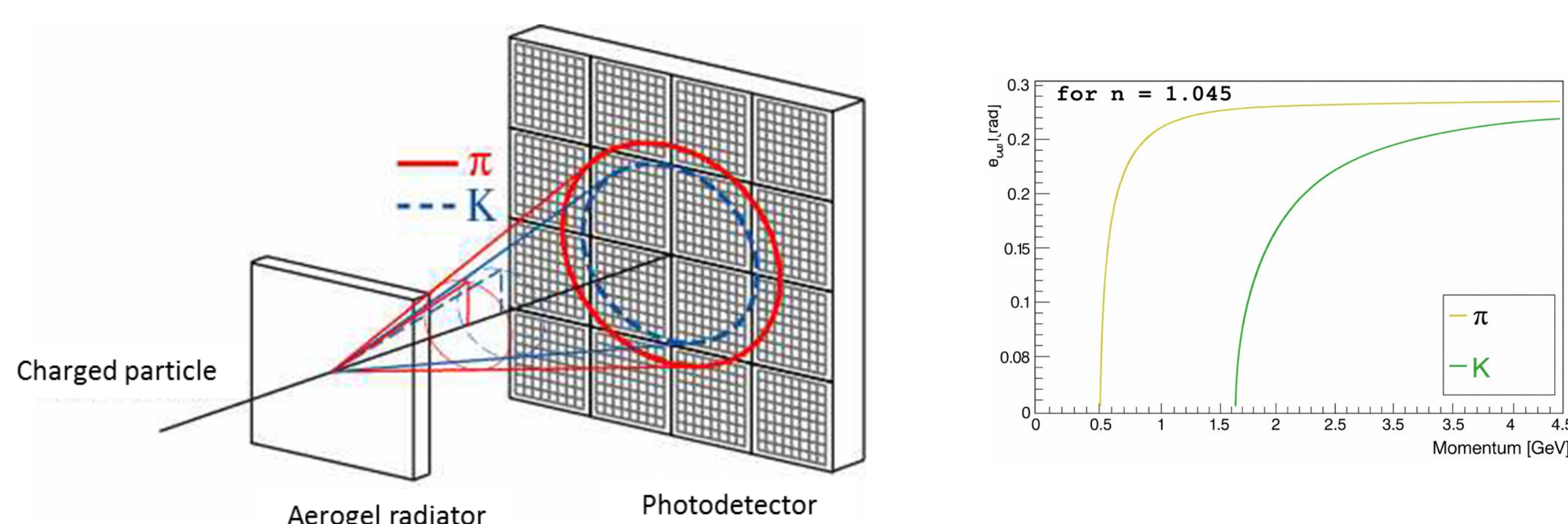
- The Belle II detector is located at the SuperKEKB energy-asymmetric e^+e^- collider in Japan.
- Belle II performs precision flavor physics measurements.
- Sensitive to rare decays and CP violation beyond the Standard Model.



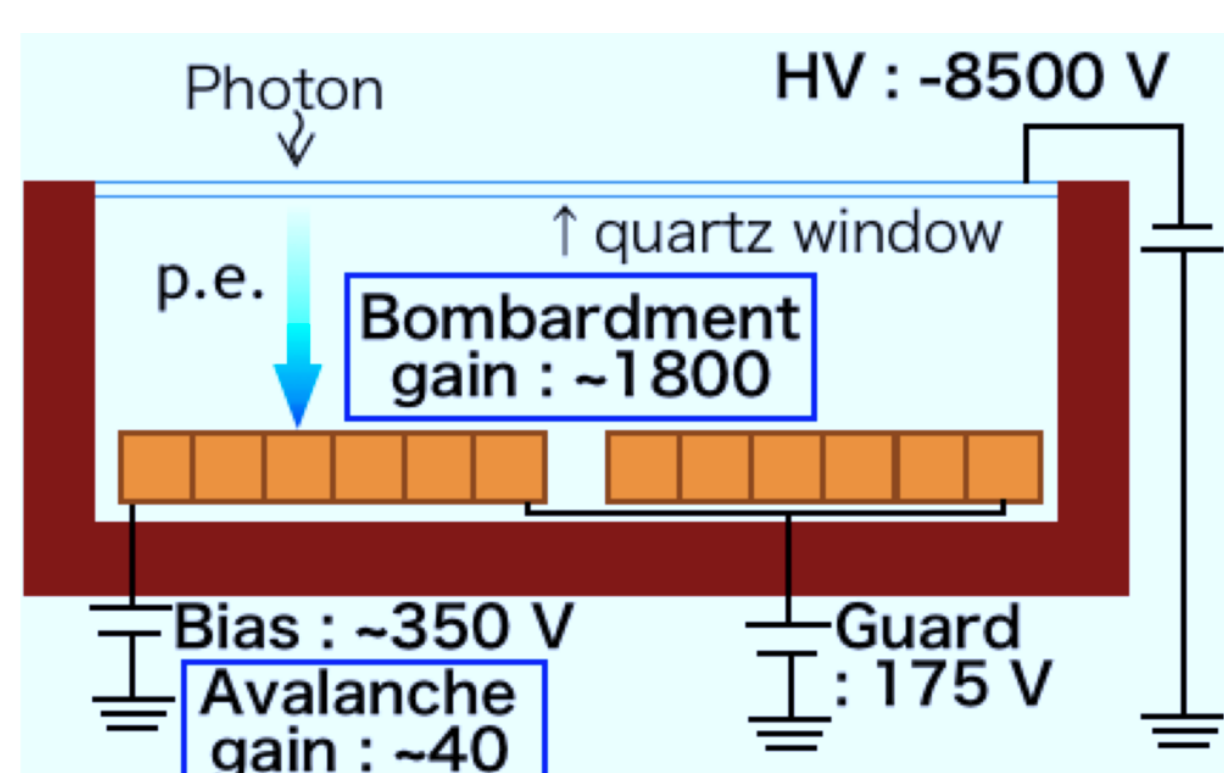
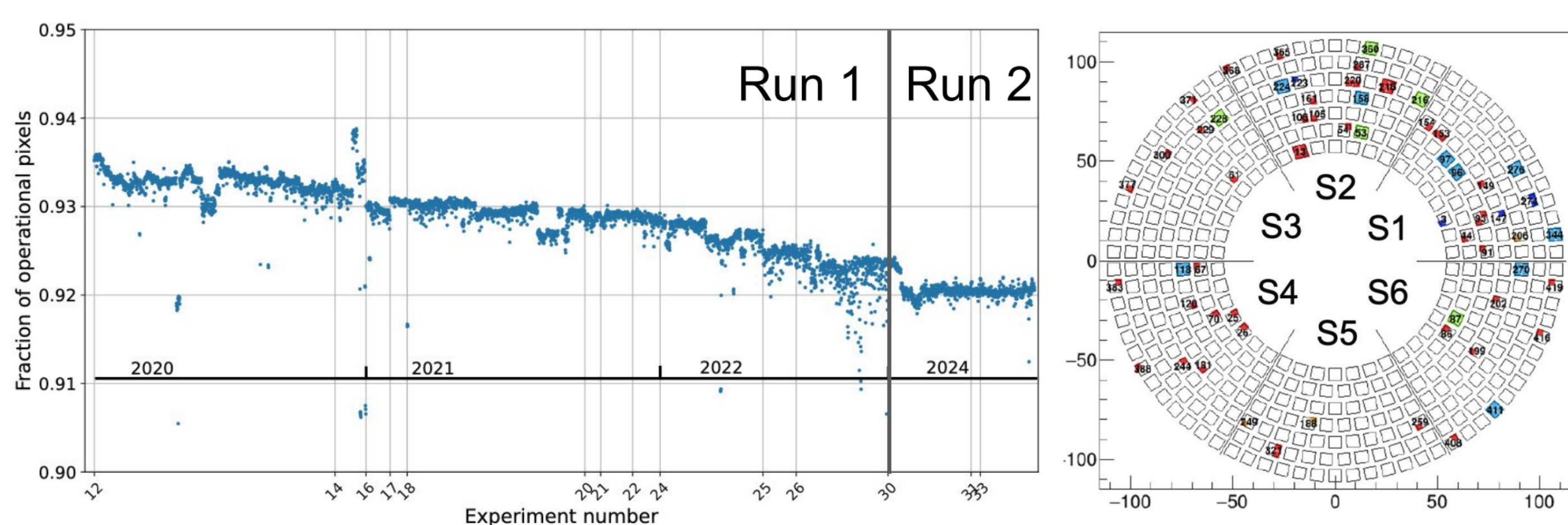
Arich constitute of 258 aerogel tiles, 420 HAPDS, and total 60K channels for electronics readout

Working Principle of ARICH sub-detector

- Cherenkov radiation:** A charged particle exceeding the speed of light in a dielectric medium emits Cherenkov radiation at a characteristic angle.
- ARICH concept:** Two 2 cm thick aerogel radiator ($n = 1.045, 1.055$) produces Cherenkov photons that form ring patterns on the photon detector, enabling particle identification.



Current status of ARICH operation



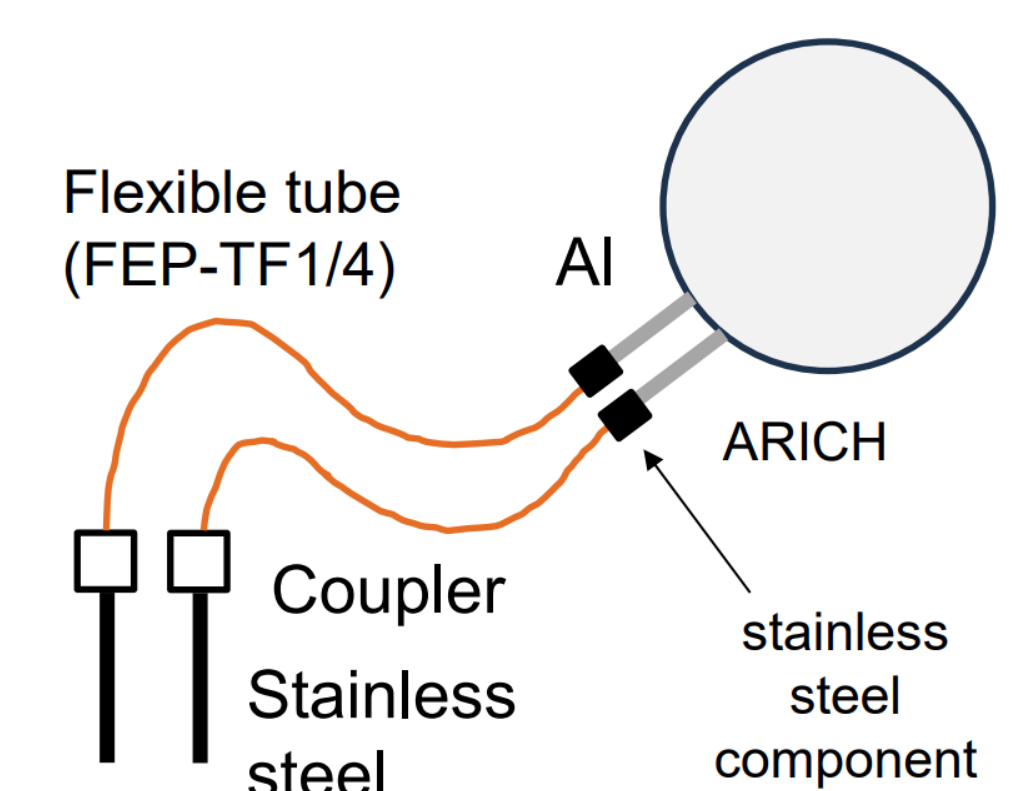
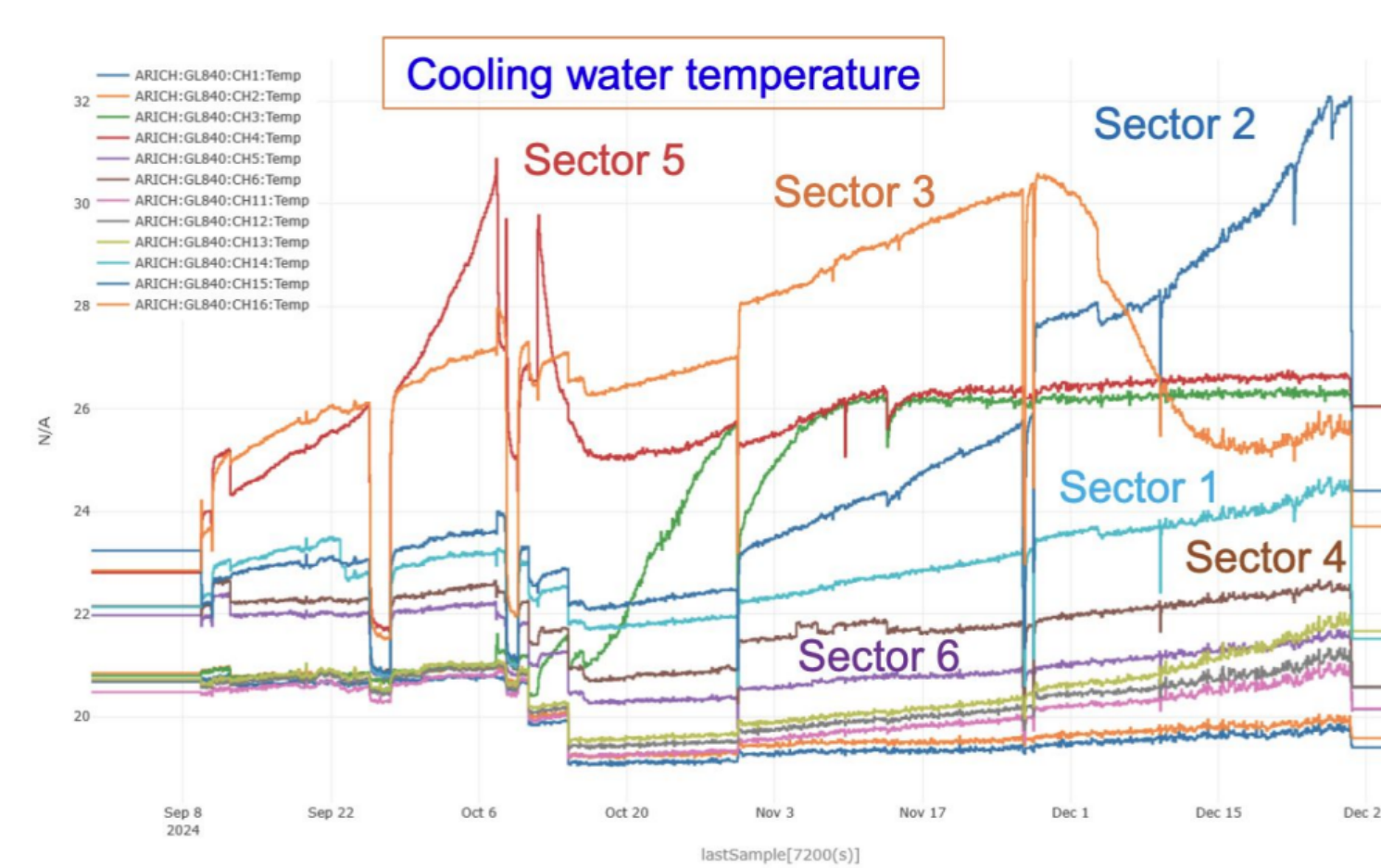
Disabled
 Red: APDs due to bias problem
 Blue: APDs due to guard problem
 Green: APDs due to HV problem
 Orange: set voltage of these APDs to 175V

Fraction of dead channels

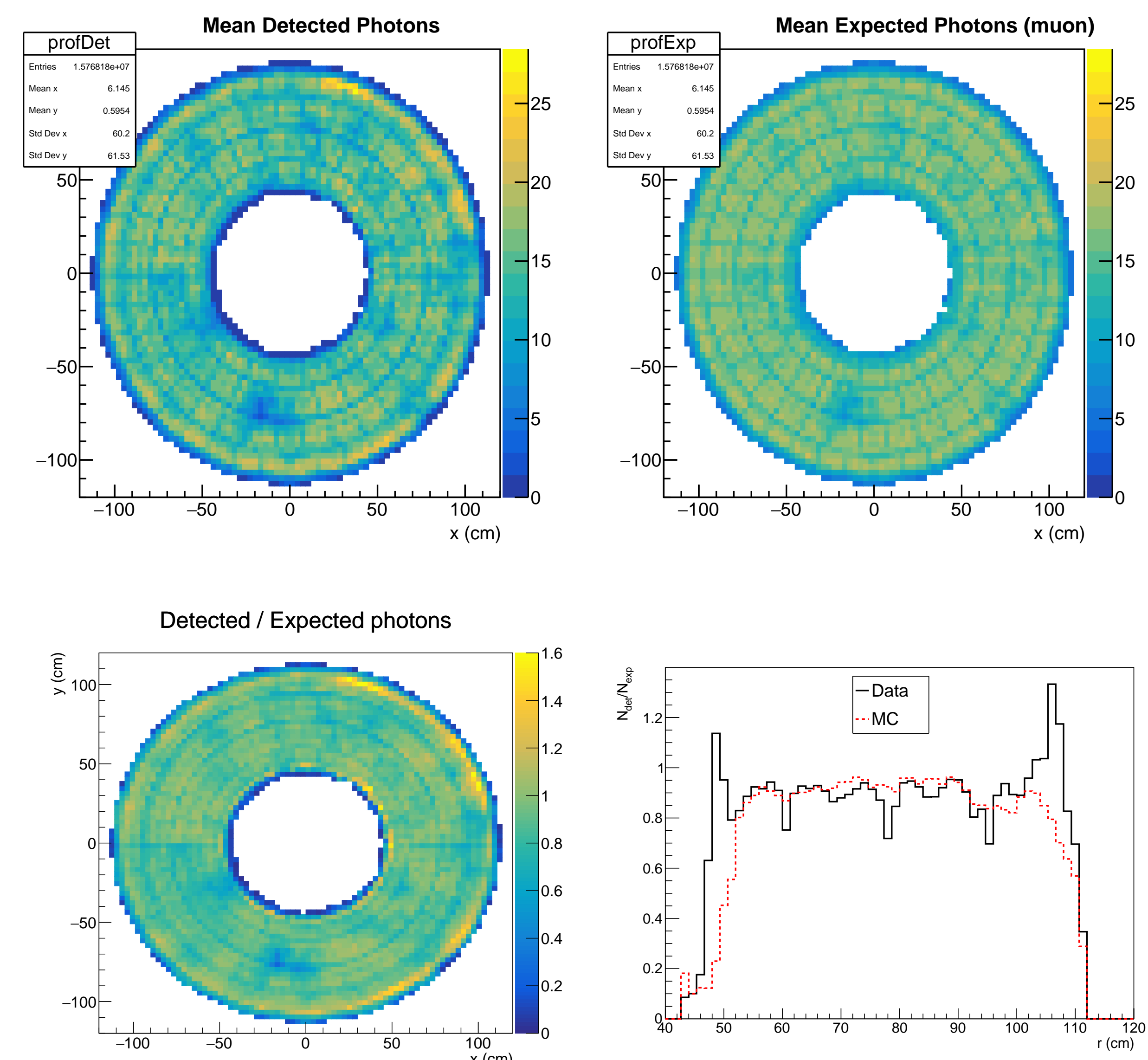
Year	2019	2020	2021	2022	2023	2024	2025
Ratio	4.8%	5.6%	6.0%	6.5%	5.4%	6.6%	6.7%

Operational Issues and DAQ improvement

- ARICH suffered a problem of the cooling water flow in autumn 2024
- Reduced flow in Sectors 3 and 5 led to the shutdown of 50% of the electronics.
- Cooling water flow issue was traced to the couplers; bypassing them fully restored the flow.
- Inspection confirmed that the flow was recovered and ARICH was fully operational in 2025 autumn run.



Investigation of photon yield variations caused by gaps between aerogel tiles



- The mean detected-to-expected photon yield ratio from the aerogel plane is studied as a function of track position.
- Localized dips observed in data indicate mismodeling of aerogel tile alignment in the nominal geometry.

Summary

- ARICH detector has been in operation since 2019 in the Belle II experiment, identifying charged particles.
- Current operation of ARICH during the physics run of 2025 autumn run is normal.
- Cooling water flow issue was solved by bypassing the couplers
- A study is going on to investigate of photon yield variations caused by gaps between aerogel tiles