Japan and Europe Network for Neutrino and Intensity Frontier Experimental Research, H2020
Consortium General Meeting, Tsukuba, Japan, 5.10.2017

EU grant n.644294

Status of the ARICH commisioning

Rok Pestotnik

Jožef Stefan Institute, Ljubljana

on behalf of the Belle2 ARICH group:

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Outline

Introduction

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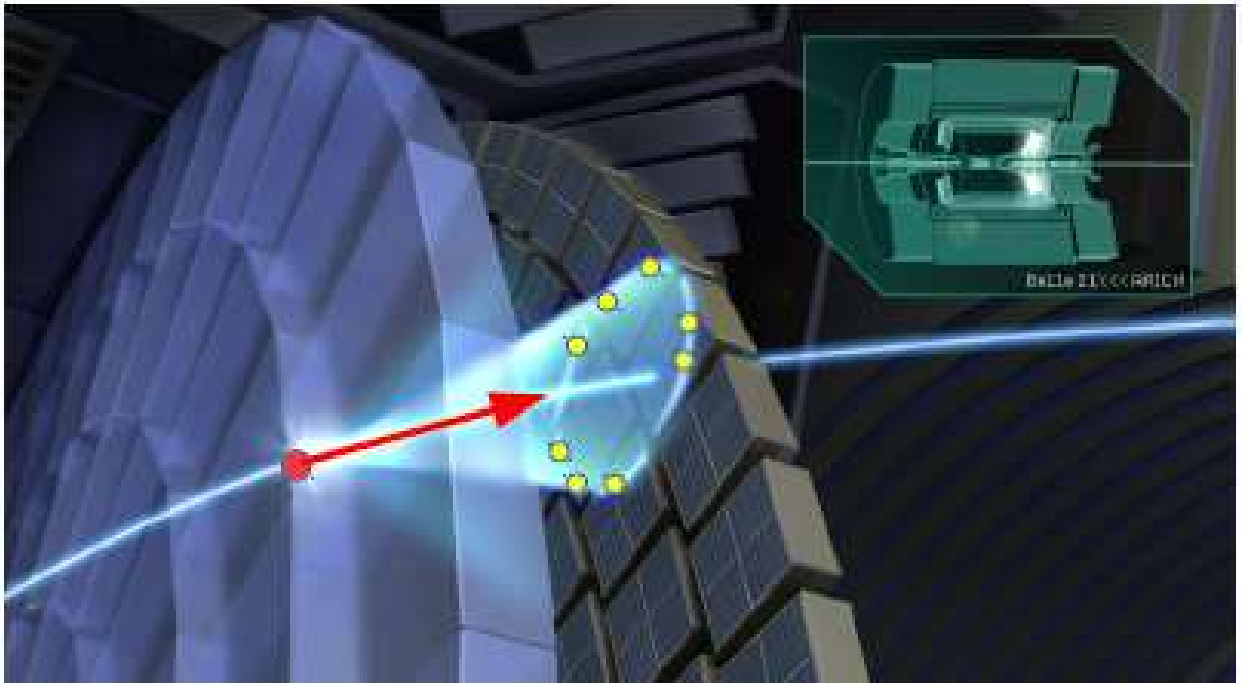
Summary



JENNIFER deliverables - ARICH part:

full commissioning and calibration → march 2018

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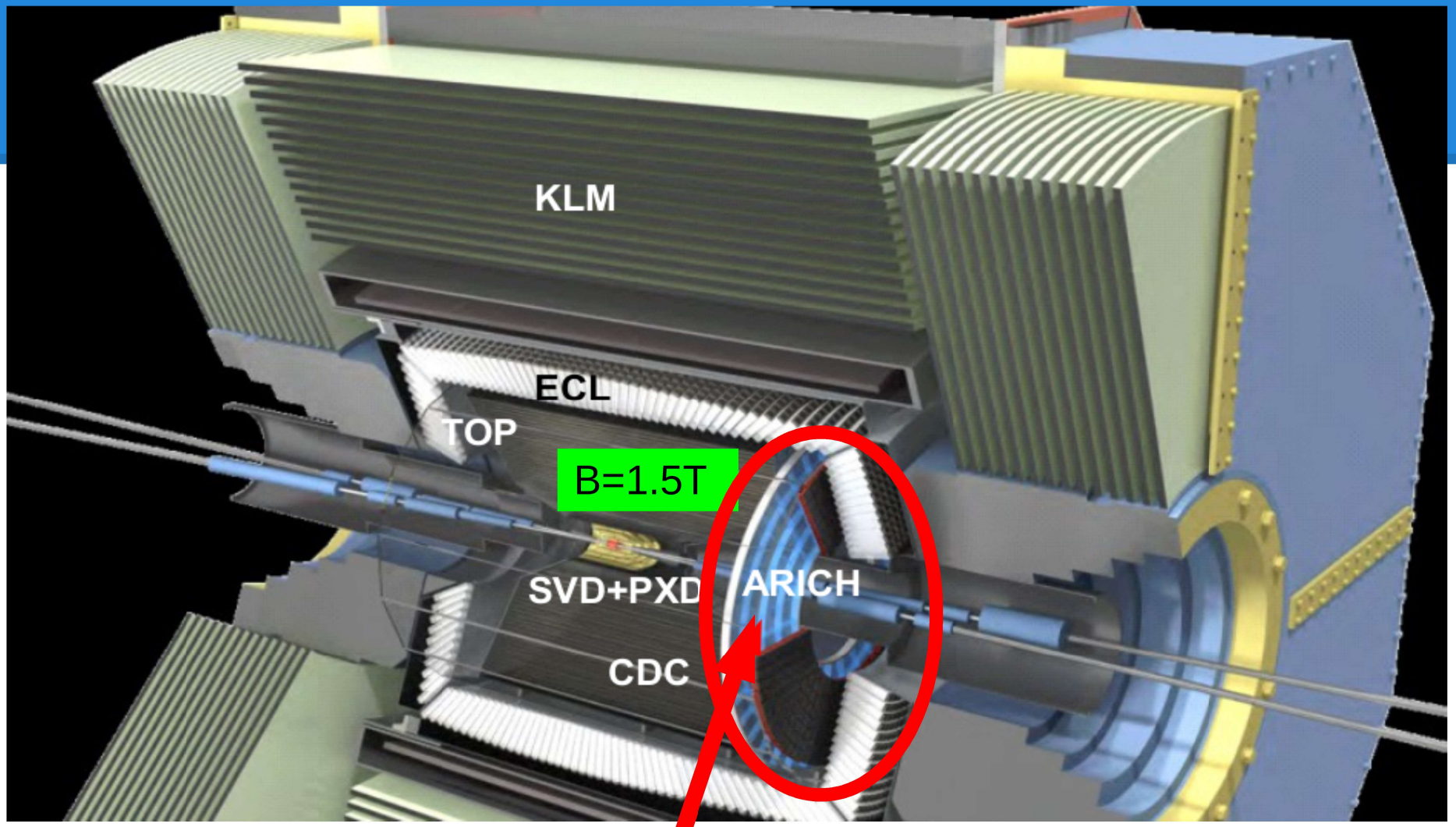
Particle identification in Belle II



Two dedicated particle ID devices - both RICHes – designed to fit into available space:

- Barrel: imaging Time-Of-Propagation (TOP)
- End-cap: **Proximity focusing Aerogel RICH (ARICH)**

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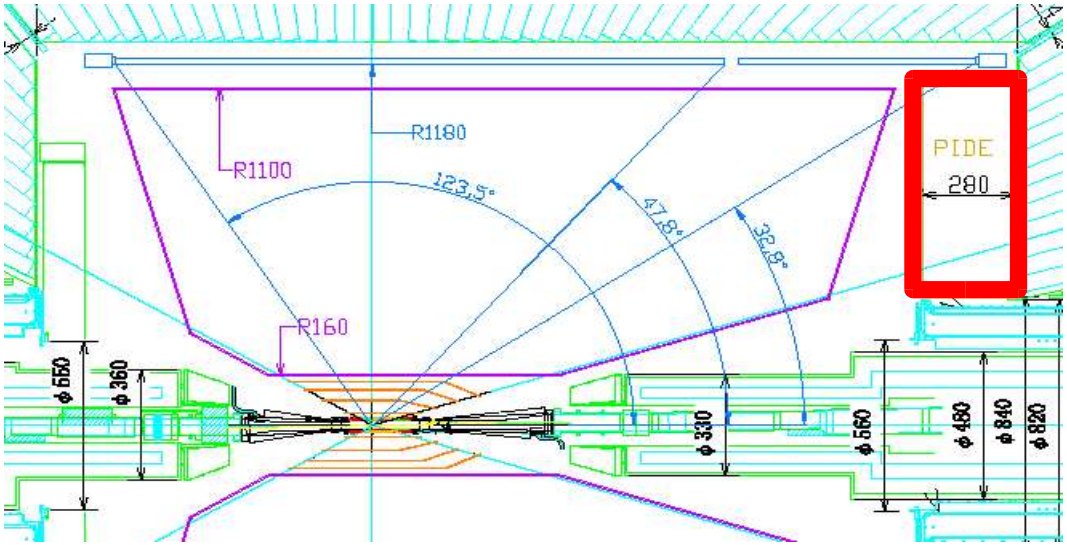
Introduction : Aerogel RICH

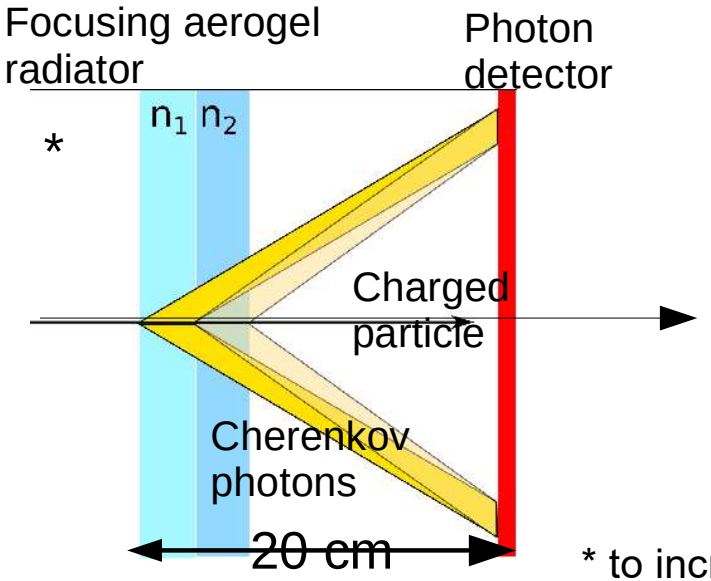
Goals and constraints:

- > 4 σ K/π separation @ 1-3.5 GeV/c
- operation in magnetic field 1.5T
- limited available space ~280 mm
- radiation tolerance (n,γ)



Selected type:

proximity focusing aerogel RICH



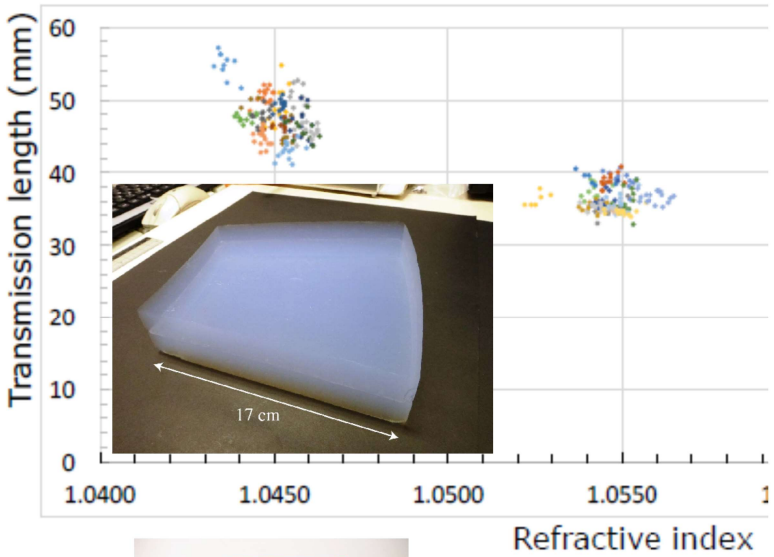
- <n> ~ 1.05
- $\theta_c(\pi) \approx 307$ mrad @ 3.5 GeV/c
- $\theta_c(\pi) - \theta_c(K) = 30$ mrad @ 3.5 GeV/c
  - pion threshold 0.44 GeV/c,
  - kaon threshold 1.54 GeV/c
- neutron fluence: up to ~10^{12} n/cm2
- radiation dose: up to ~1000 Gy

* to increase the number of photons without degrading the resolution

ARICH components

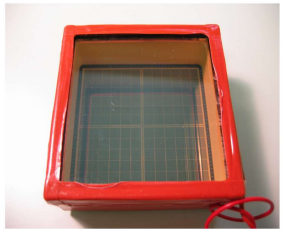
Aerogel radiator:

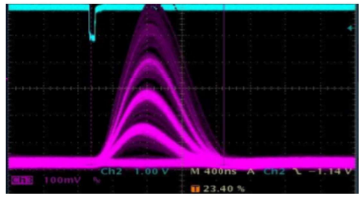
- Two 2cm thick layers n_1= 1.045 n_2= 1.055
- Optical transparency limited due to Rayleigh scattering
- large tiles 18x18x2cm^3 to minimize photon losses at the edges

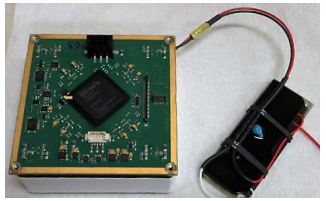


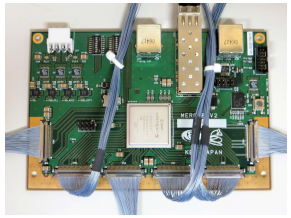
Hybrid Avalanche Photo Detector - HAPD

- QE: 30%
- 144 channels, total area 7cm x 7cm
- Excellent separation of single photoelectrons
- Works in a magnetic field of 1.5T
- 7 kV HV + 4x ~300 V bias + 175 V guard ring







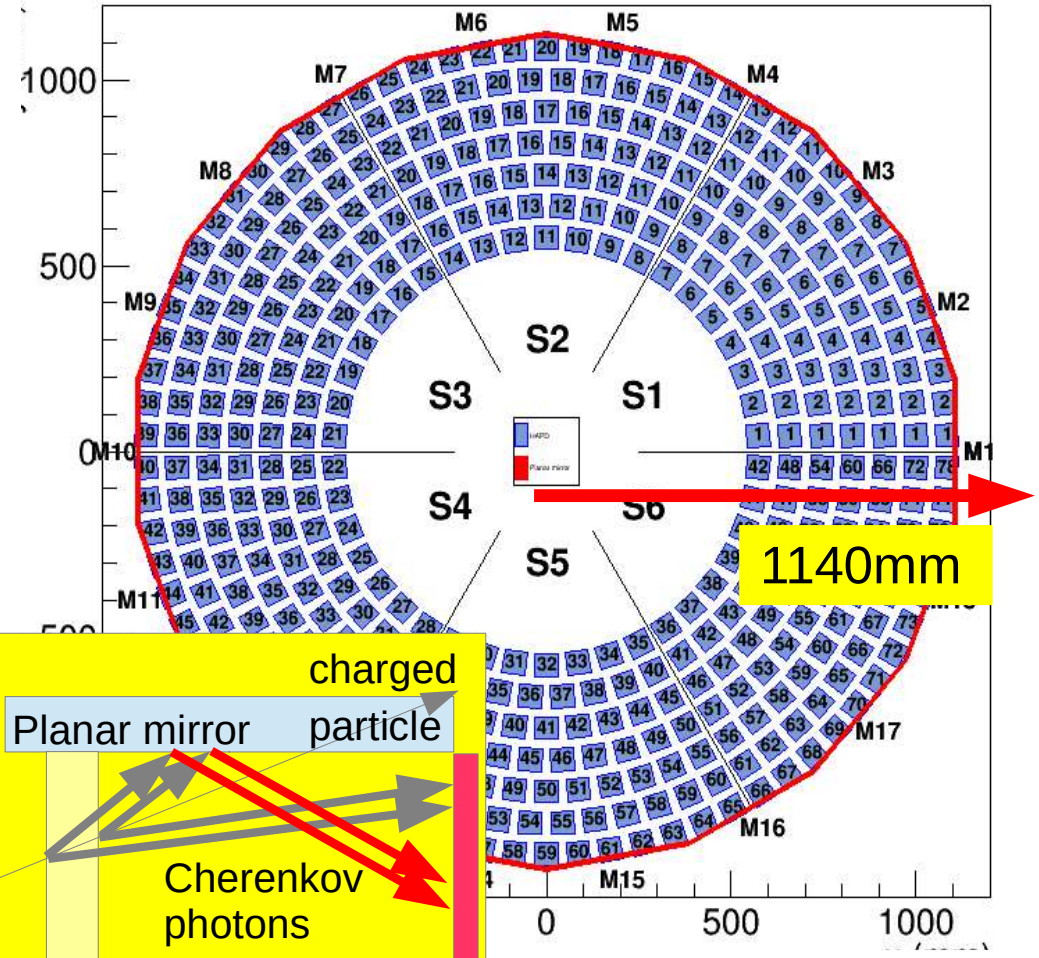


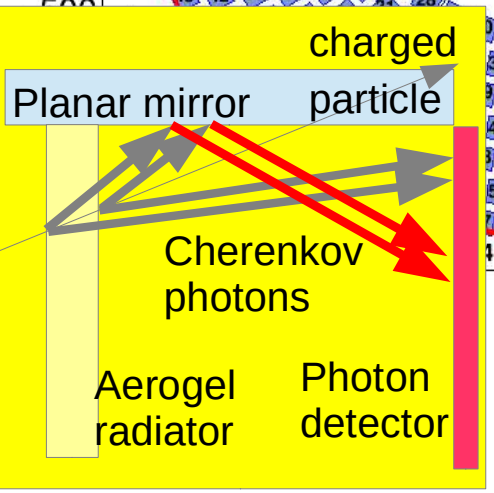
Readout Electronics: limited space behind the HAPD- 5cm

- Front-end board with 4 ASICs and Spartan6 FPGA
- Merger board prototype with Virtex5 FPGA:
  JTAG, optical link, trigger in, front-end connector

ARICH geometry design

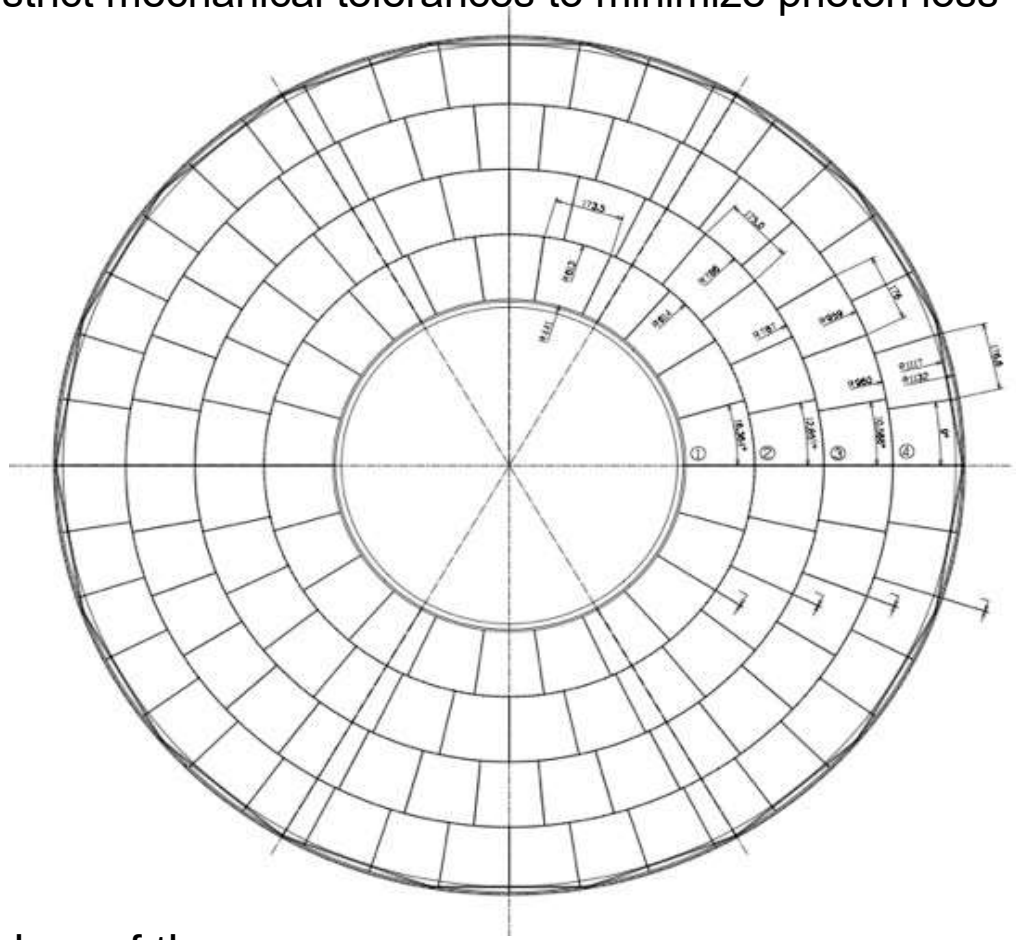
420 HAPD modules in 7 rings





Aerogel : 124x 2 layers
-wedge shape

strict mechanical tolerances to minimize photon loss



Planar mirrors on the edge of the detector to improve photon detection

Status of the ARICH installation/commisioning

October 2016 - July

Installation of major components:
Aerogel tiles installed in the mechanical frame
420 HAPDs + FEBs + HV divider boards, 72 merger boards, supply cables, polyethylene shield, LED monitor system

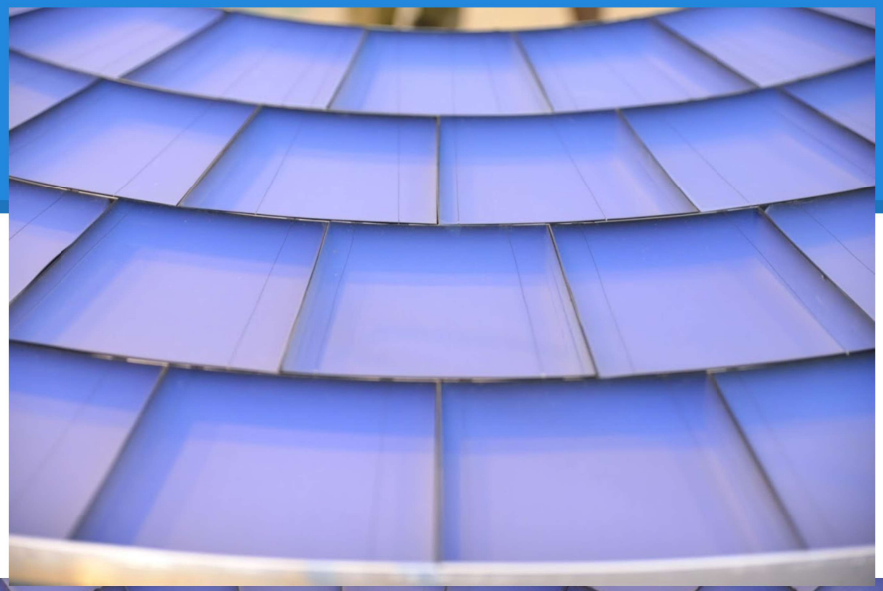
August:

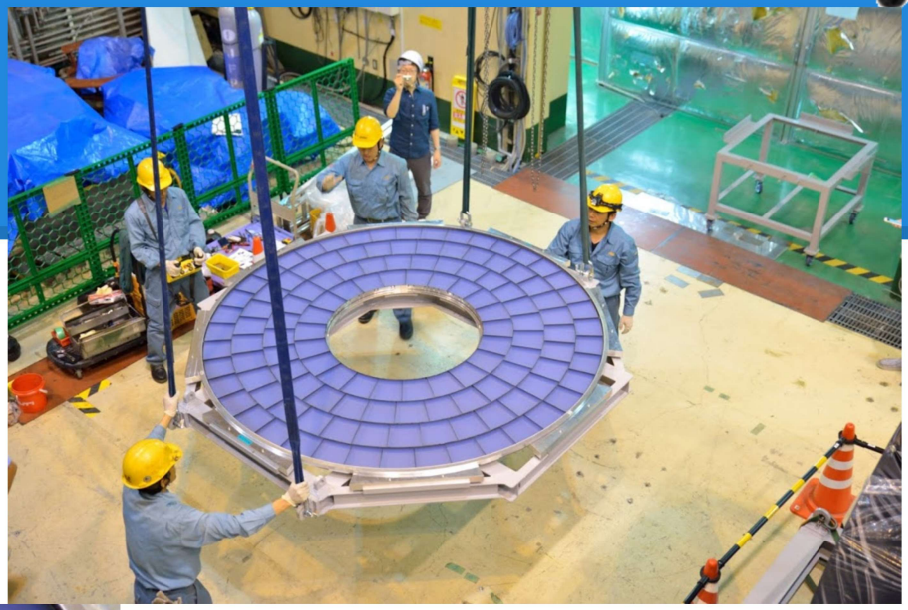
Missing detector cables installed
Planar front surface mirrors and side plates installed.
Assembly: aerogel side combined with the HAPD side.
DAQ and HV test with one sector setup: Nominal bias + 4-6 kV HV

September:

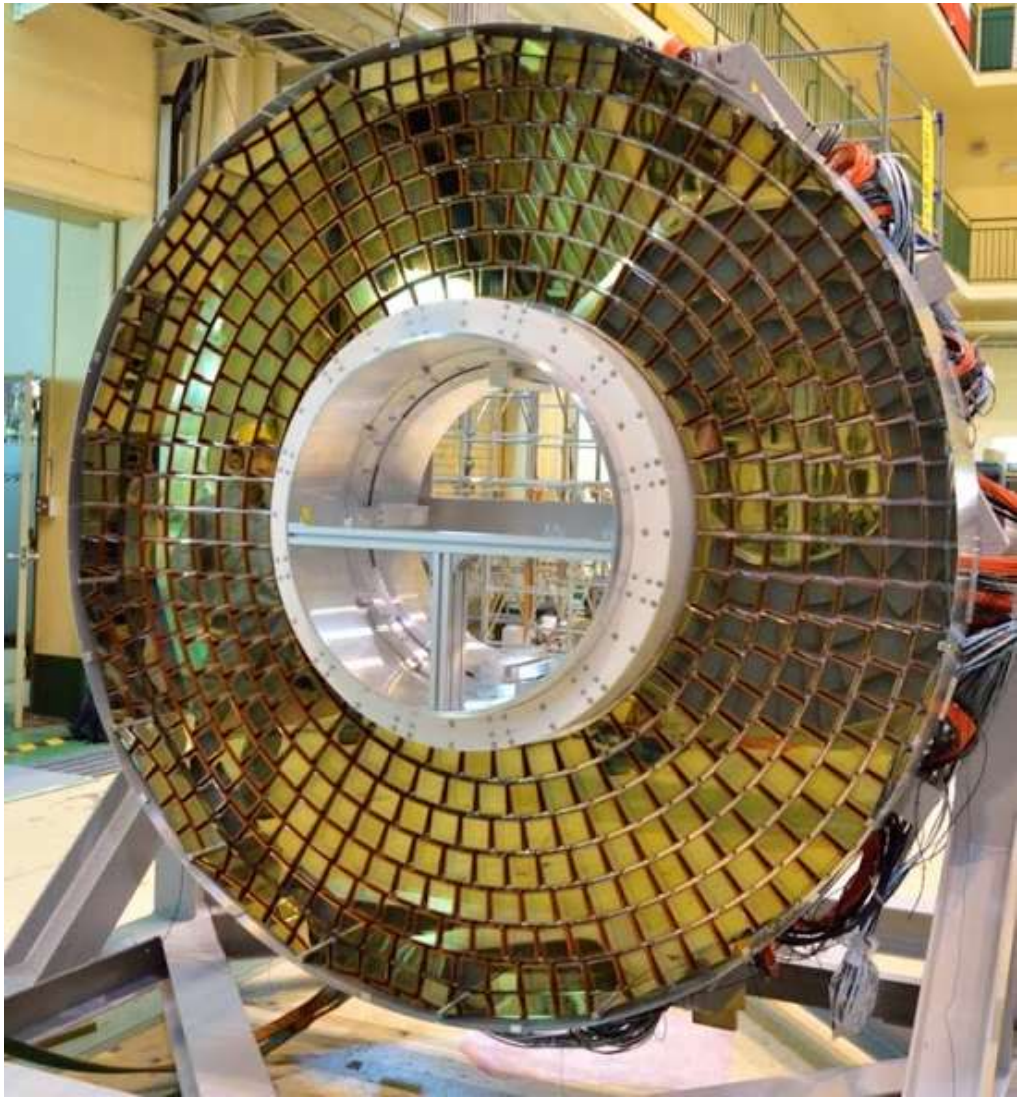
ARICH and forward ECL combined and transferred to the IR.
Test the movement to the final end-cap position

Aerogel Plane





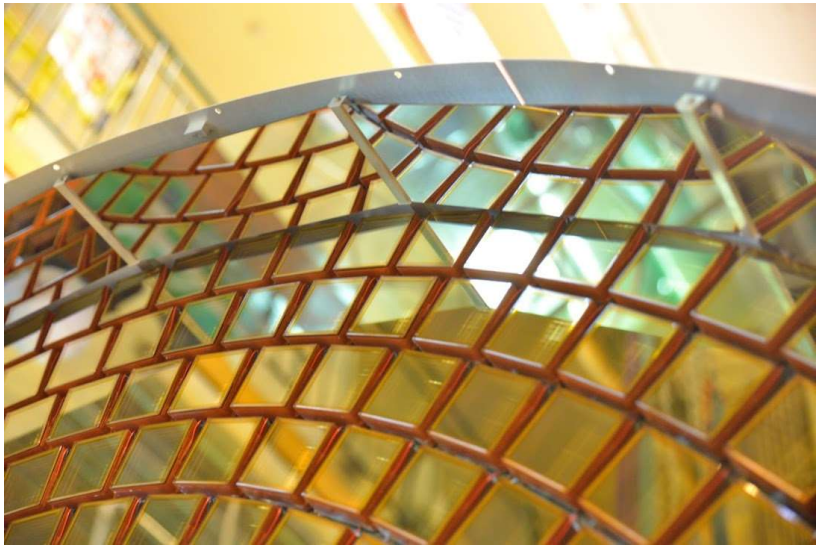
Photon detector



HAPD Modules

Polyethylene shield

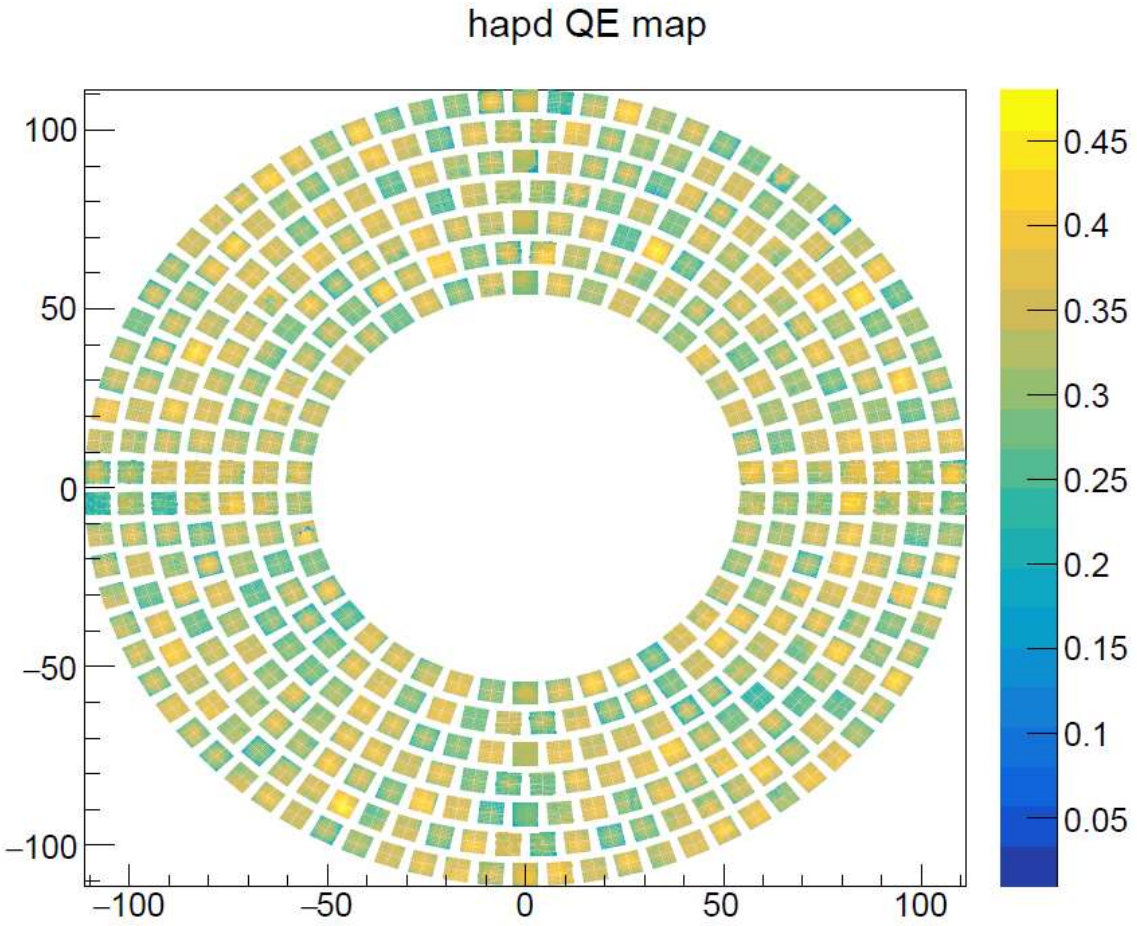
Planar Mirrors at the edges

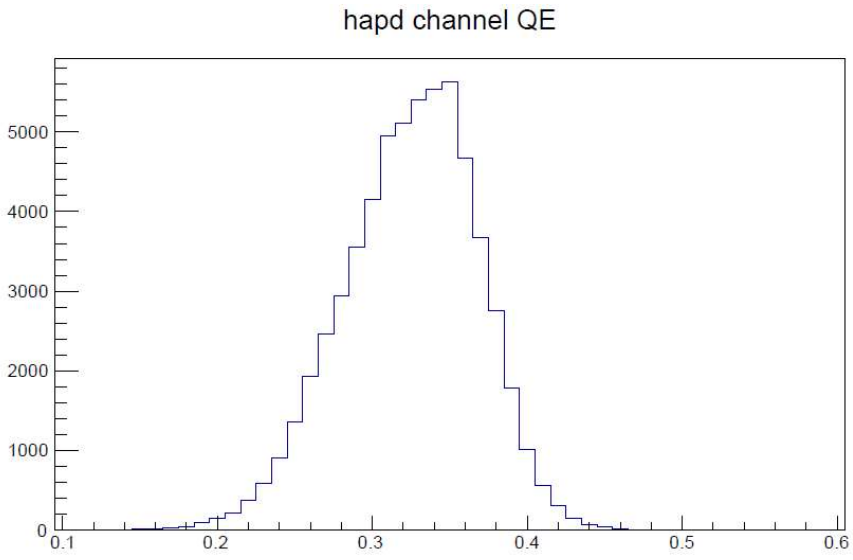


ARICH Database

Operational & geometrical parameters and mappings of the consisting elements are kept in the centralized common Belle II database.

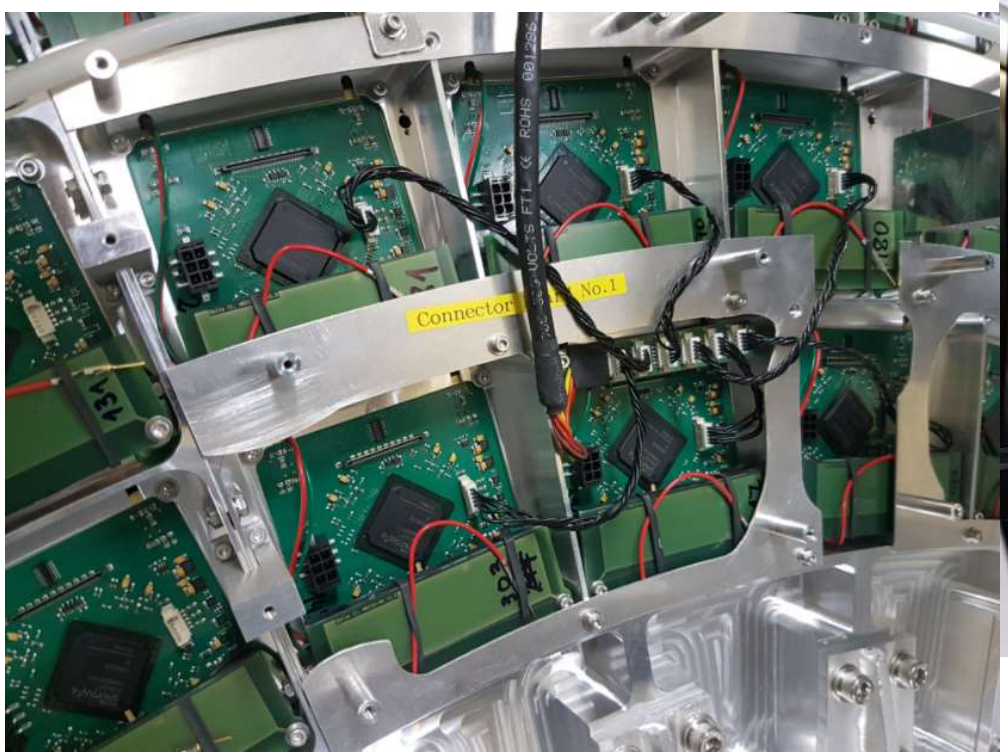
Example: quantum efficiency of the channels



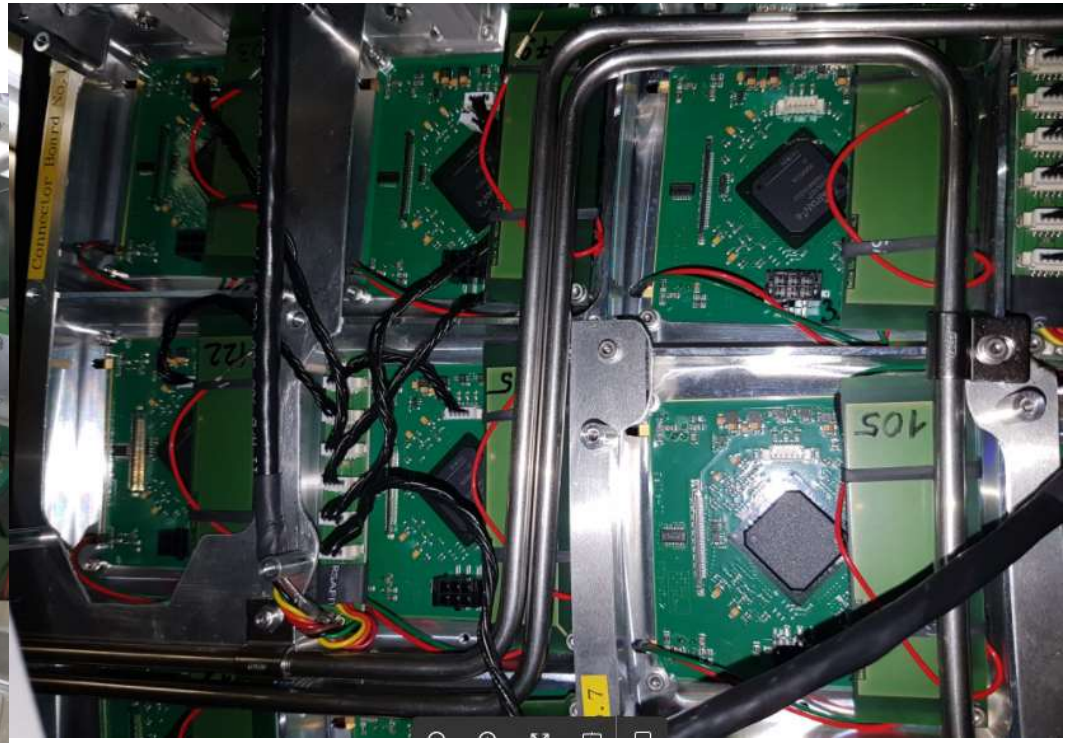


Installation of services

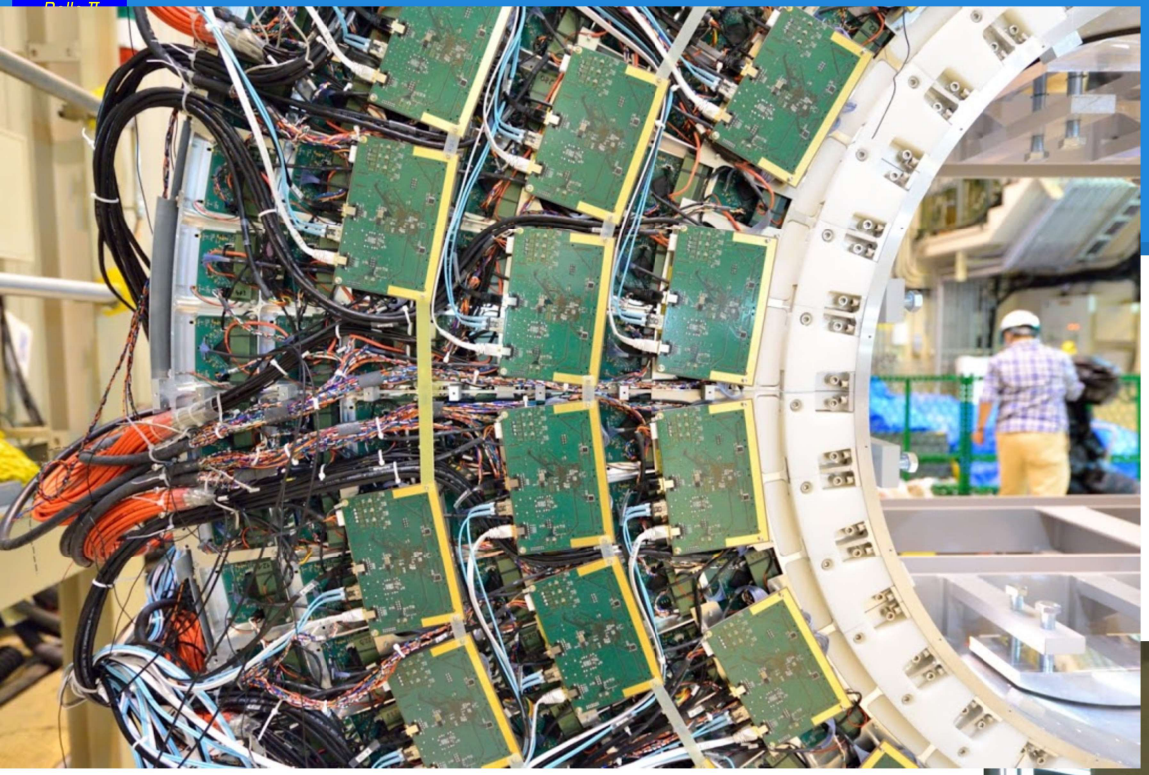
Front end boards
HV divider boards,
FEB Power supply distribution
Merger support

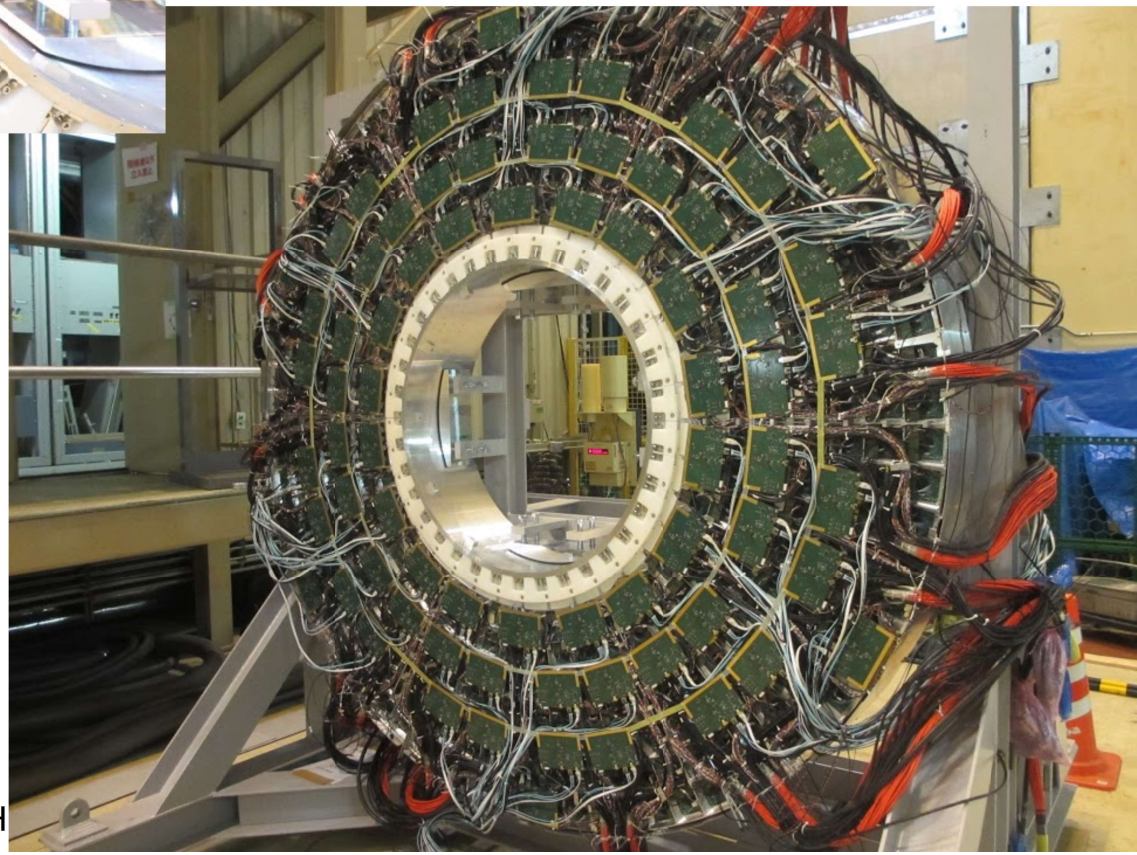


Cooling pipe

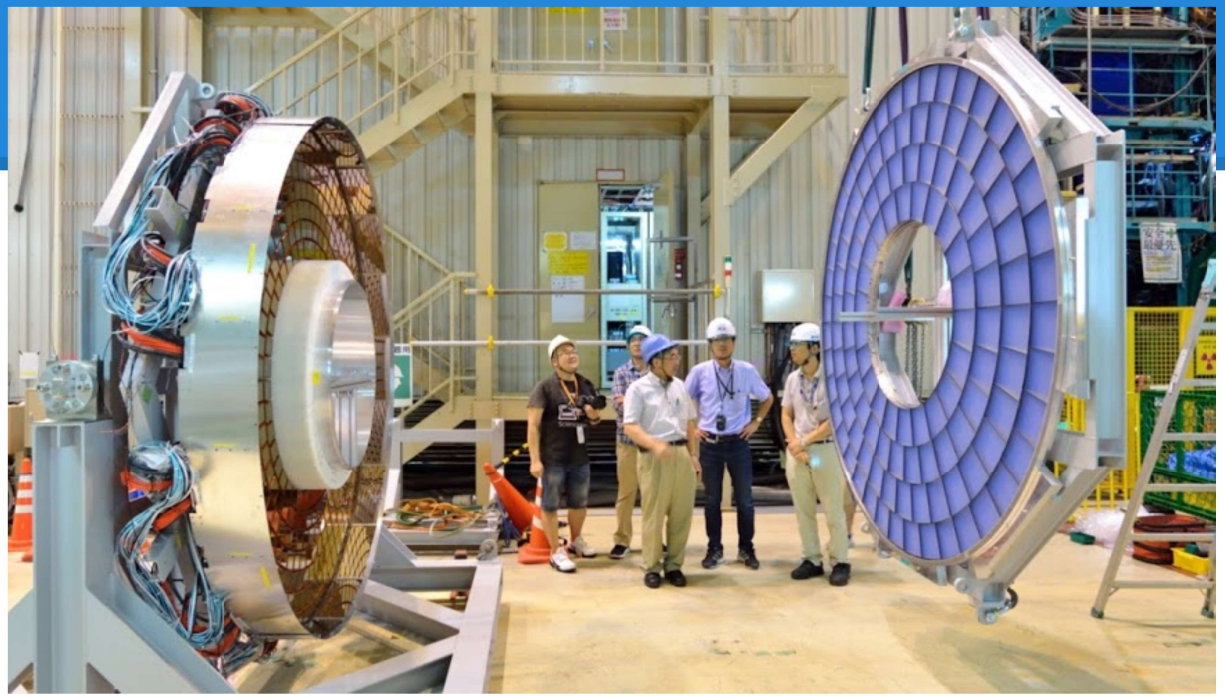


Backside of the photon detector with all the cables





Integration of photon detector and aerogel plane



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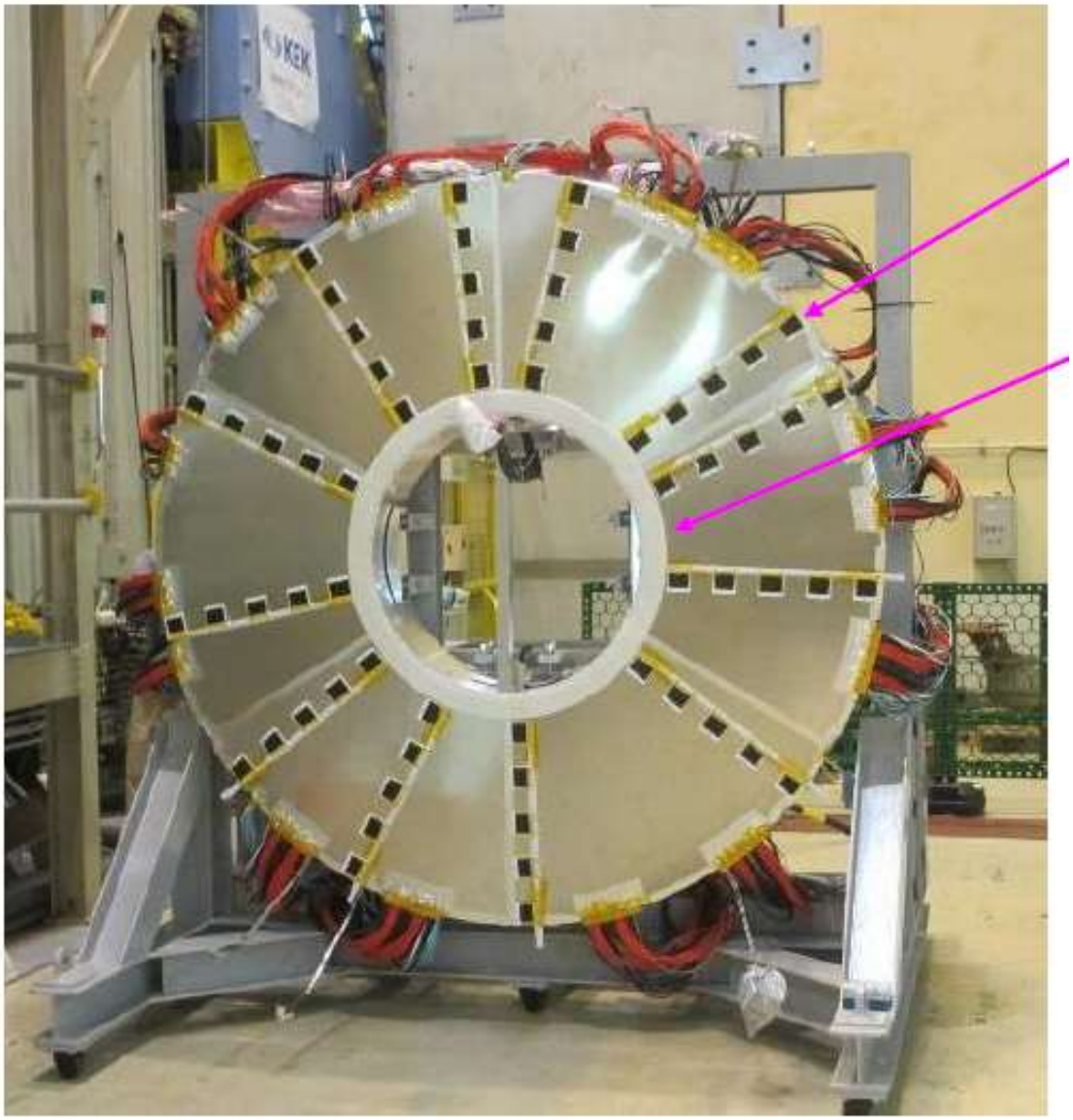
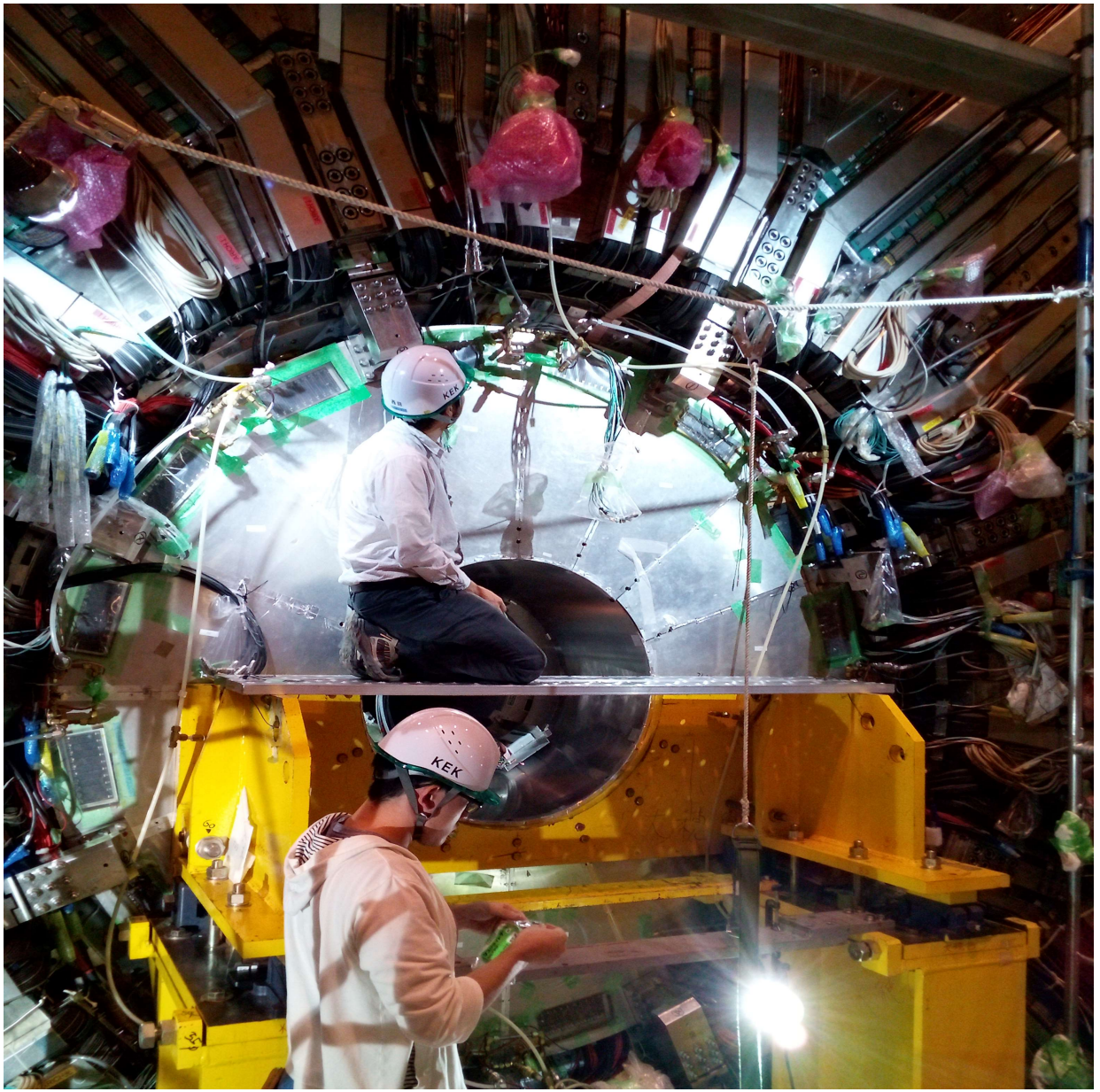
Integration with forward ECL



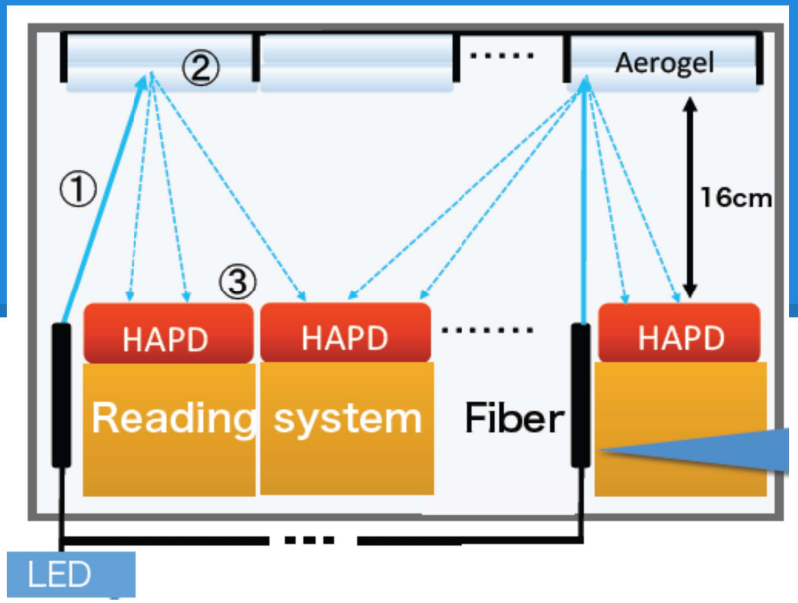
Radiation monitors

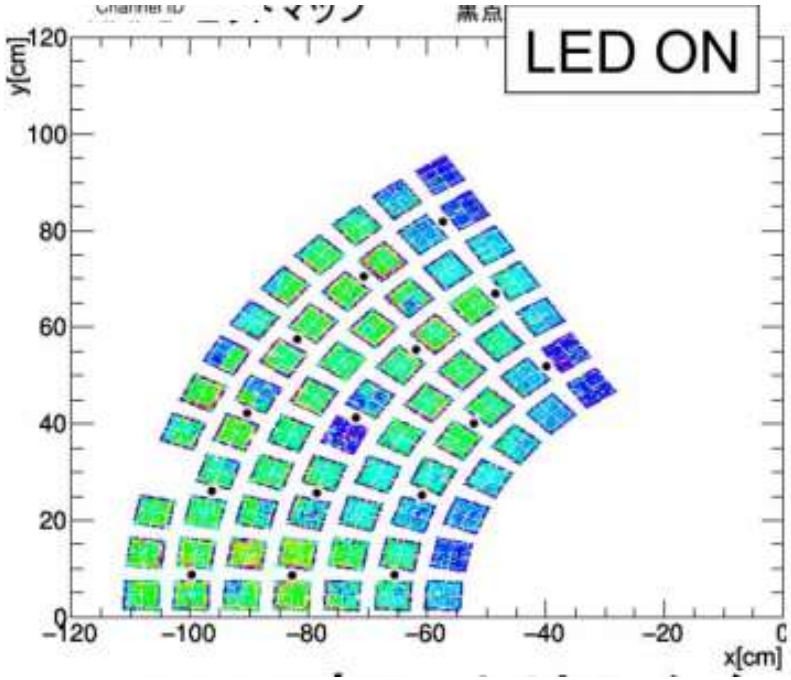
Additional polyethylene shield

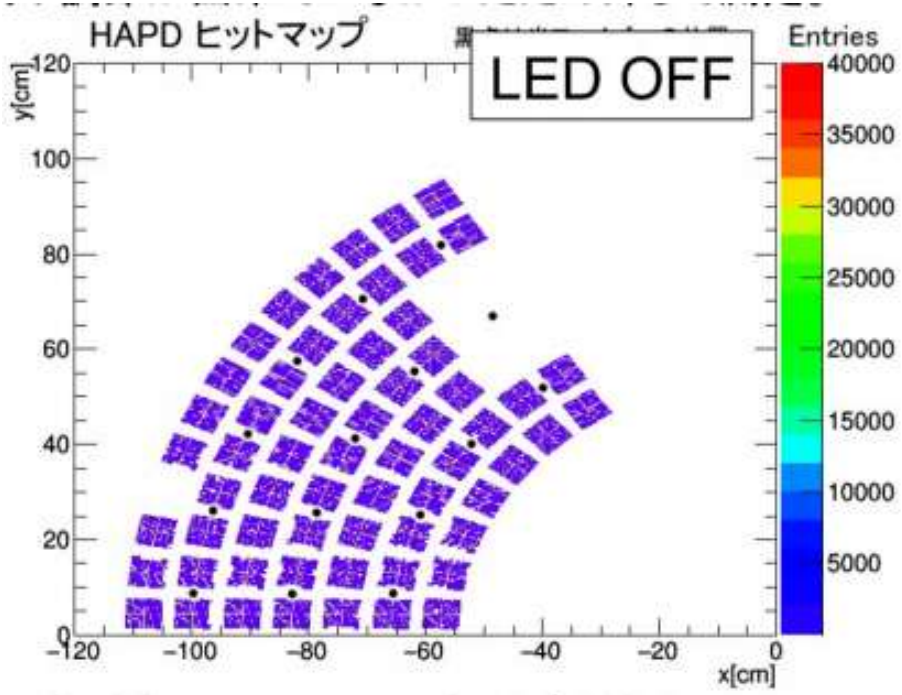
Integration in the Belle II spectrometer



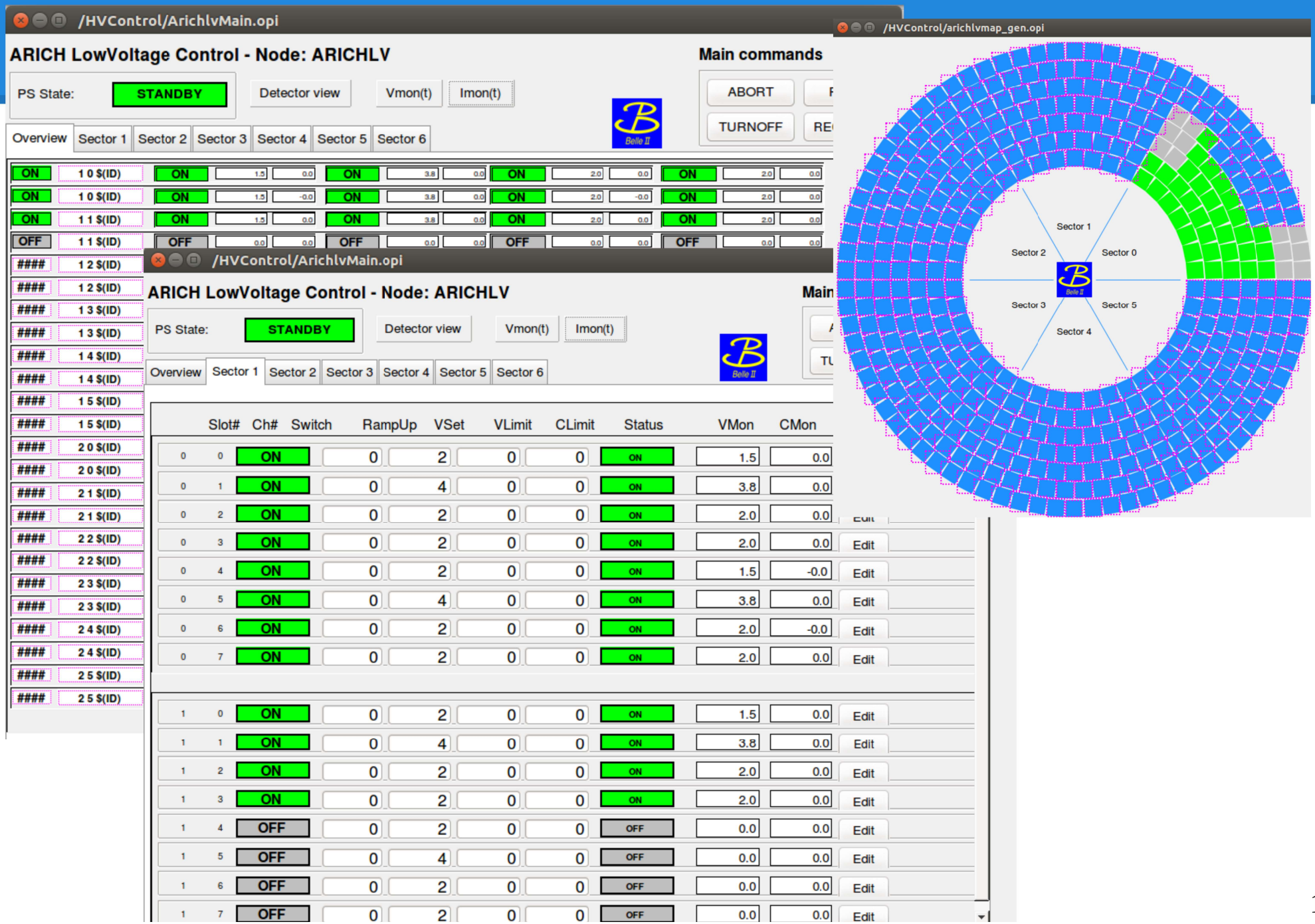
LED monitoring system







Power Supply Control system



Schedule

- Move ARICH in the final end-cap position
- Installation of LV and HV connections to the electronic hut
- Installation and test of the full LV and HV system

- Data acquisition integration tests
- Test of the LED monitoring system
- Test of operability of each sector
- Data taking
- Commissioning of the software:
  - Calibration and Alignment based on the acquired data
- Ready for physics data taking

Impact of the JENNIFER secondments

Direct impact:

Jennifer secondments enable
- crucial on-site presence during construction and commissioning of the ARICH,
- young researchers: extended stays possible
- face-to-face cooperation with group members from other countries

Indirect impact:

Enable the European institution to be part of the leading groups in the particle identification instrumentation by Cherenkov radiation:

- Jožef Stefan Institute organized the most important conference in the area of Ring Imaging Cherenkov Detectors – RICH 2016, Sep. 4-9, Bled, Slovenia
- Samo Korpar → invited talk at the RICH 2016
- 12 contributions from the group on the RICH 2016

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Summary

- Proximity focusing RICH with an aerogel as a radiator will be employed for efficient particle identification in the forward end-cap of the Belle2 spectrometer
- The beamtest results and the detector simulations:

  excellent kaon ID efficiency >95% for p=0.5 ..3.5 GeV/c @ low pion mis-ID prob. of 1%

- Status
  - The photon detector and aerogel radiator installation is almost finished.
  - Commissioning of HV, LV and DAQ system in progress

- Installation of ARICH is progressing as planned
- No delay is expected to finish the commissioning of the ARICH by the deadline
- Jennifer enables to participate the researchers from European Institute (JSI) in R&D , the installation and the commissioning of the detector, and to share their expertise with the Japanese collaborators.

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