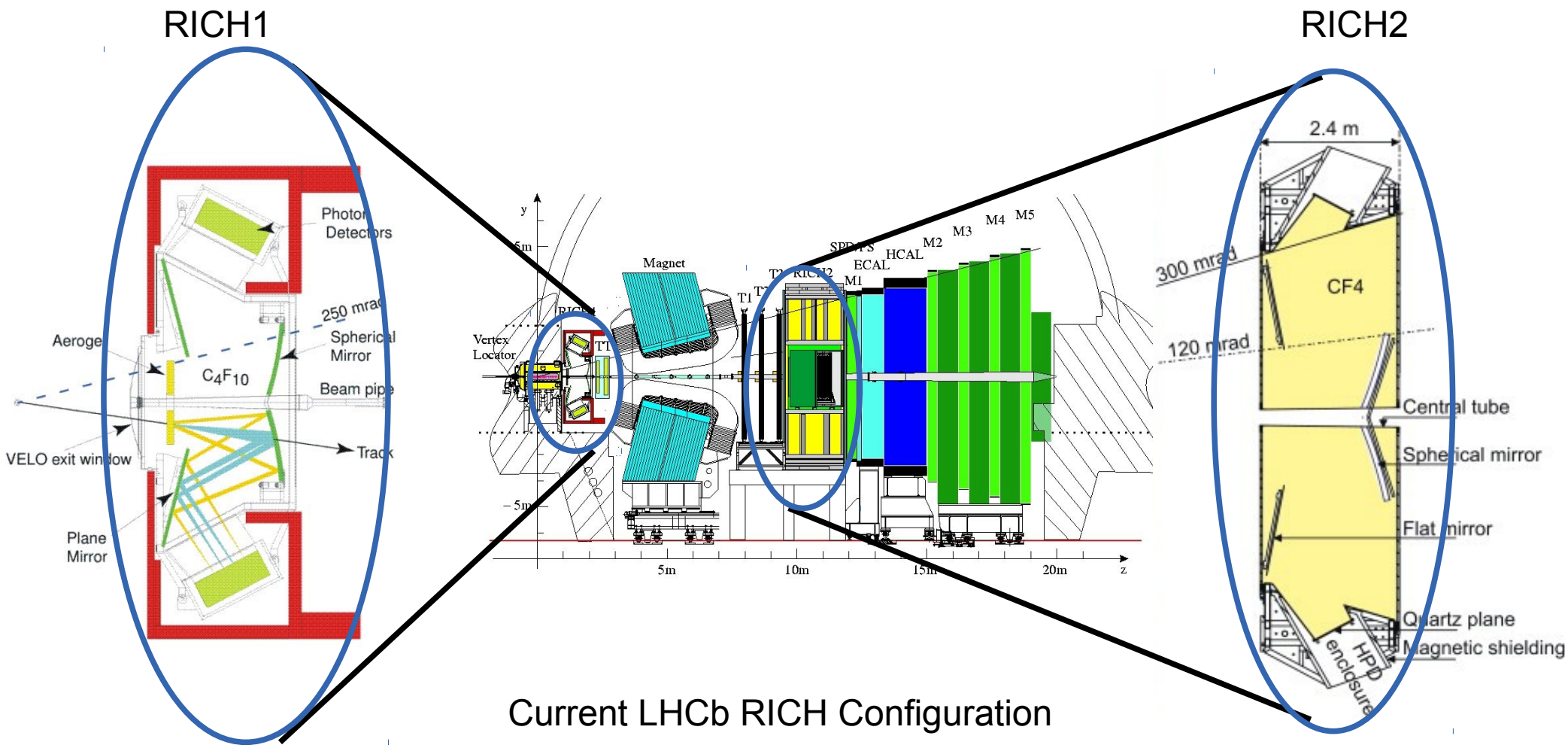
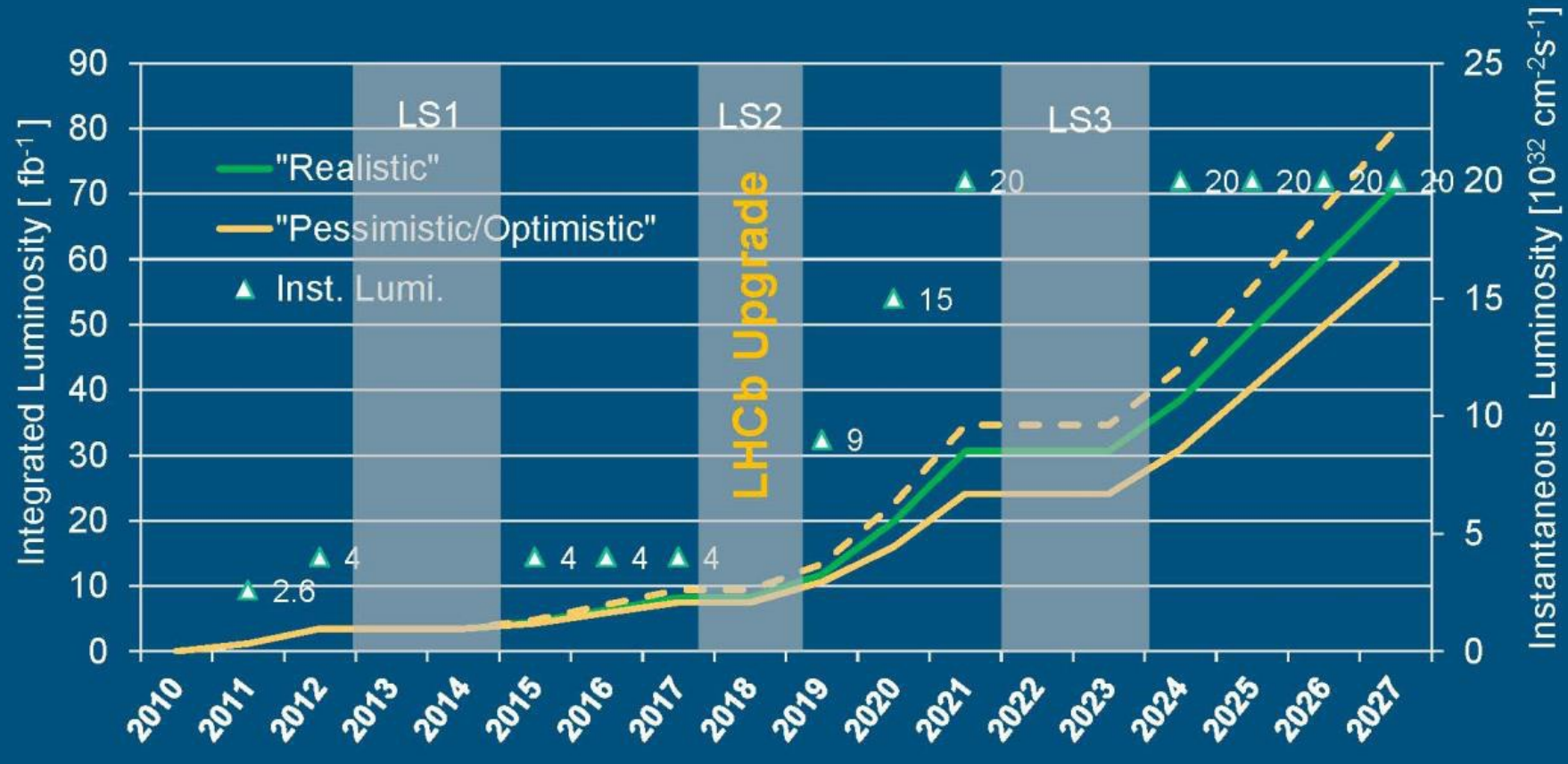
LHCb RICH Upgrade



Current LHCb RICH Configuration

Integrated luminosity for Run 2

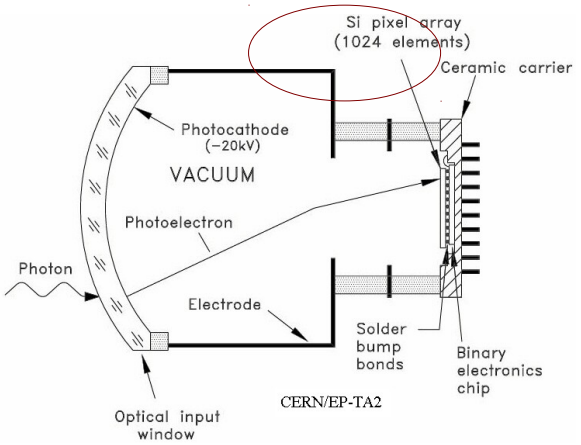
- Luminosity projection based on experience in Run 1 and updated schedules:

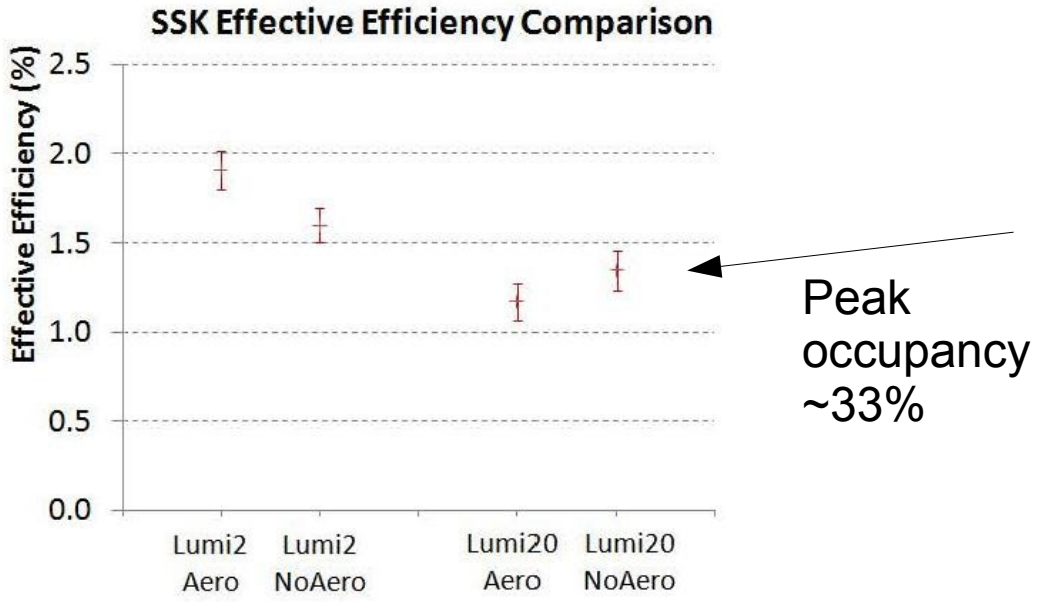


- Ideally collect 10 fb^{-1} before LS2, thus another 7 fb^{-1}
- → Attractive to extend Run 2 by ~one year or so
- → Note, however that the LHCb expected system lifetime (trackers) at 10 fb^{-1}

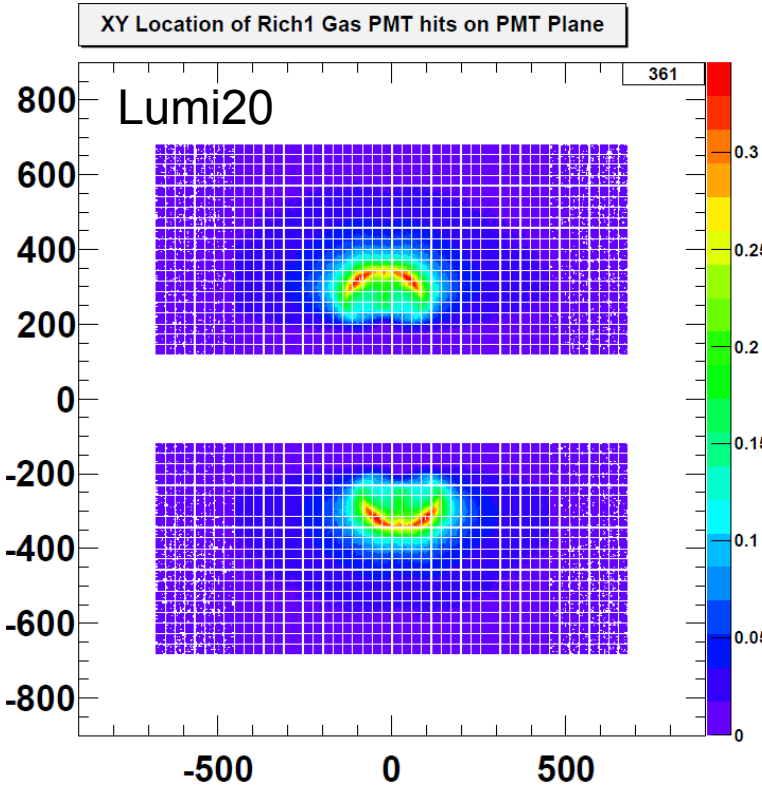
RICH Upgrade Motivation

- Amount of recorded data limited by trigger rate ⇒ upgrade the electronics to 40MHz trigger rate
- RICH HPD have embedded FE electronics limited at 1 MHz ⇒ replace
- Luminosity increase from 4 to 20 10^{32} $cm^{-2}s^{-1}$
  - ⇒ Degradation due to high occupancy
    - Change the design
  - ⇒ Aerogel material degrades the tagging performance
    - Remove





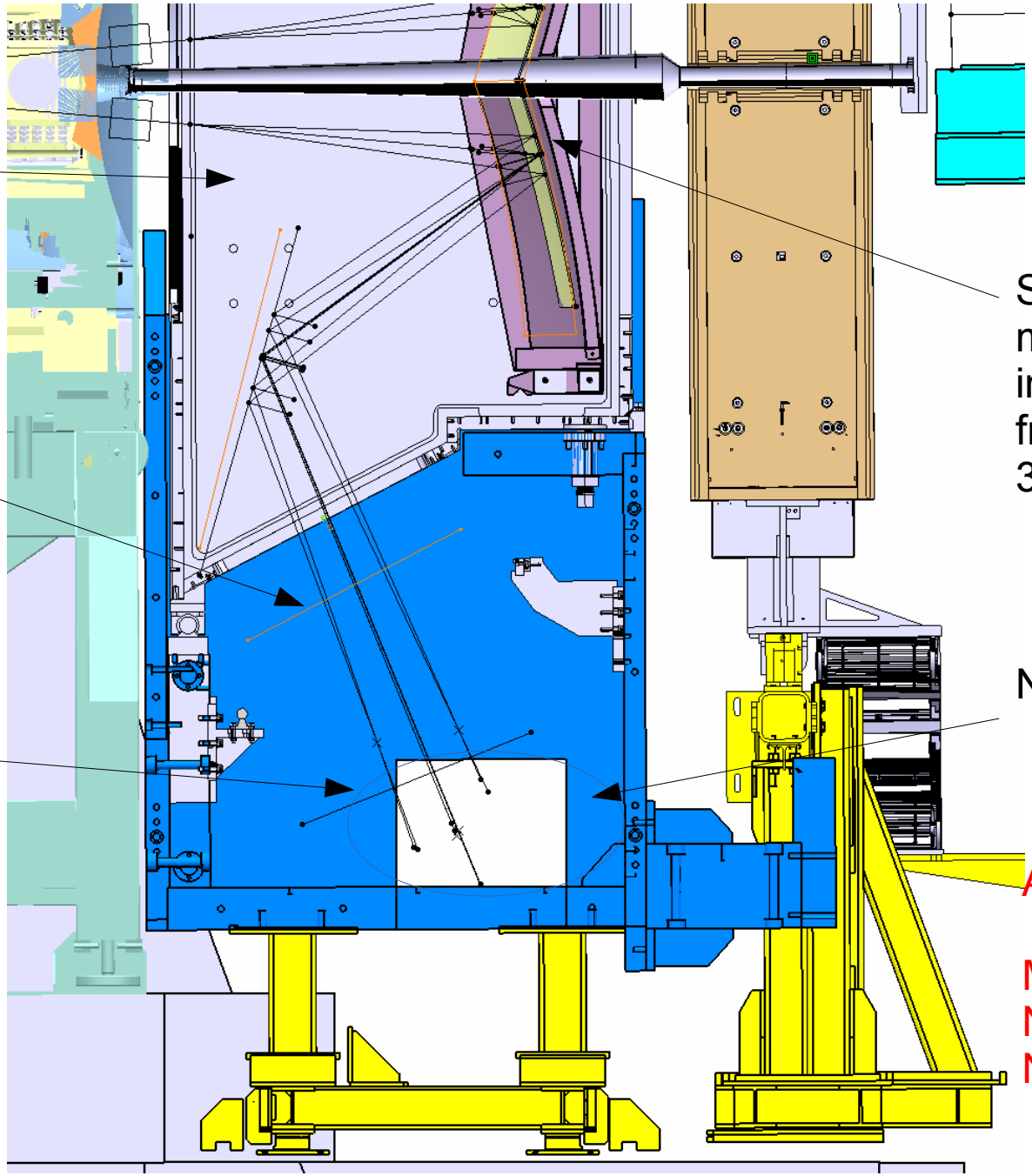
Peak occupancy ~33%



Aerogel Removal and HPD maintenance

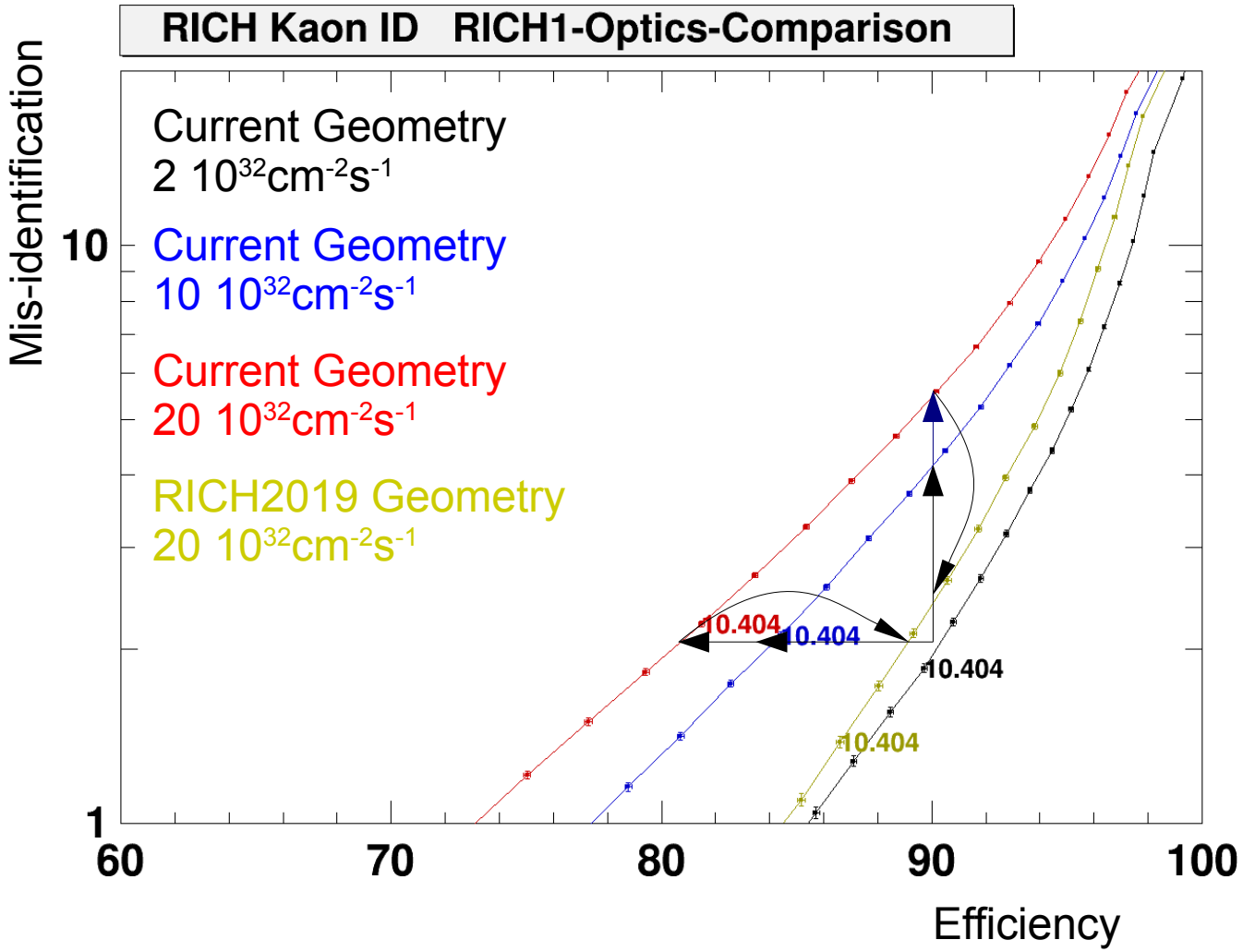
- Even at low luminosity aerogel contribution to PID performance is marginal
  - Limited to low momentum tracks
  - Slow reconstruction => cannot be used in HLT to reduce the charm rate
  - Calibration difficult due to diffusion of CF4 inside aerogel
  - Blocks 10-20% of the Cherenkov photons from the gas
    - Removing it will improve the kaon pion separation at high momenta
- => Aerogel will actually be removed before the start of run2
- Support for HPD maintenance from Electronics Shop in September 2014
  - G.Rampazzo and P.L.Zatti

RICH2019 concept: RICH1 optics



RICH2019 simulated performance

- Peak occupancy reduced from 35% to 25%



MaPMT

- 2 types of 64 channel MaPMT: R11265 (1'x1'), H12700(2'x2')h
  - To reduce the cost at a modes reduction of performance
- R11265 was shown to be suitable for the RICH
- ~2000 MaPMT
- Padova [A. Bertolin, G. Simi] involved in the characterized and QA of the detectors before installation
  - Absolute Gain :to couple detectors in the same HV channel (margin to adjust gain to counter ageing)
  - Gain/Noise: to determine the efficiency of the 5sigma threshold
  - Effective area, QE: to determine absolute efficiency
  - Cross talk

PMT test station

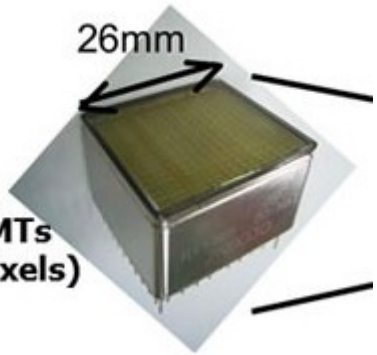
PiLas laser

DARK BOX

XY stage

- High Quality Stepper Motor
- Better than 5 µm Positioning
- Compact, Low Profile Design

Collimatore



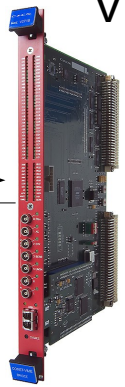
Array 64 amplif

ADC 5Gs/s

+monocromator

Calibrated PMT or diode

VME Bridge



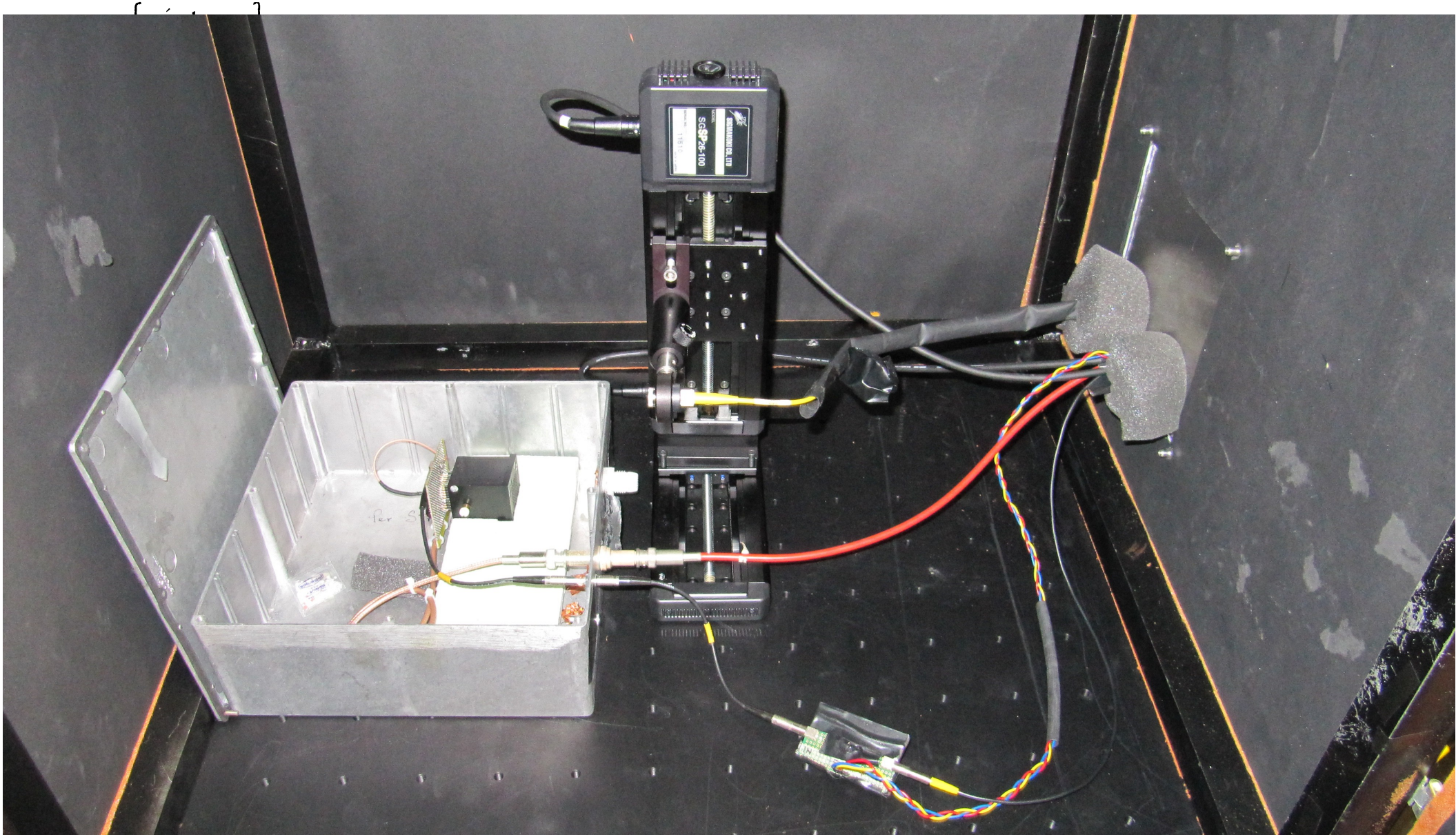
XY Controller

- Dual 50 W 2-Phase Bi-Polar Stepper D
- Encoder Feedback for Closed Loop P
- Seamless Operation with Thorlabs and 3rd Party Motors/Stages

optical

serial

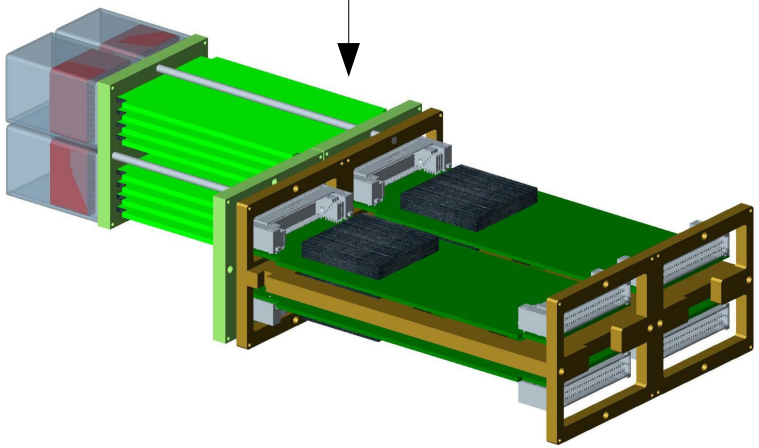
Test station setup in progress



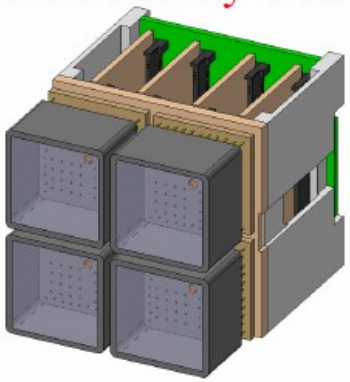
Mechanical desing of elementary cell

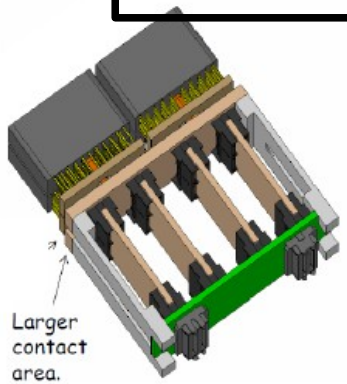
Padova
Genova
Ferrara

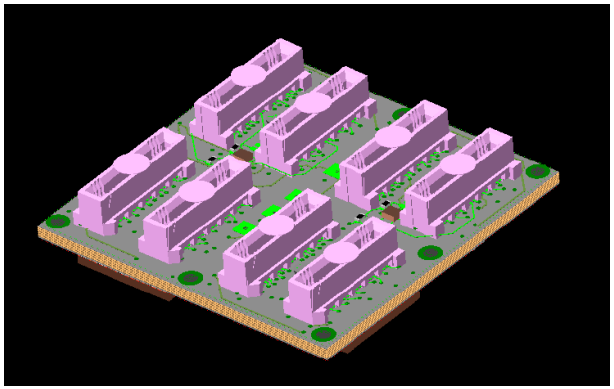
- From conceptual design to engineering design



The Elementary Cell

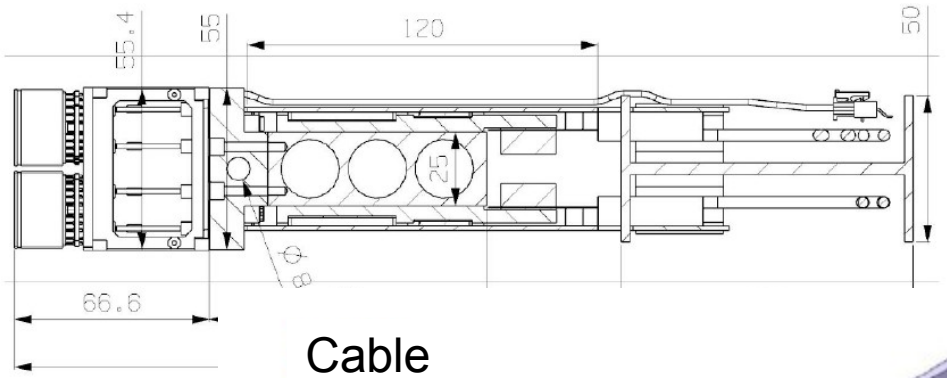






Front-end board
already produced

General Mechanical Design



M. Benettoni
Padova

Design suited for RICH2 but also for RICH1

Cable Routing

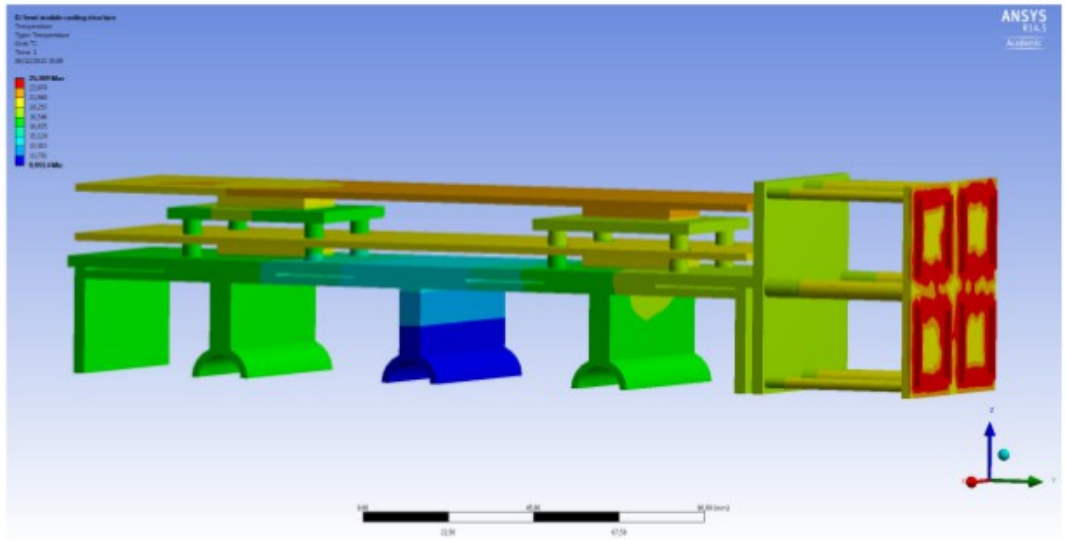
Cooling Support structure

Elementary Cell

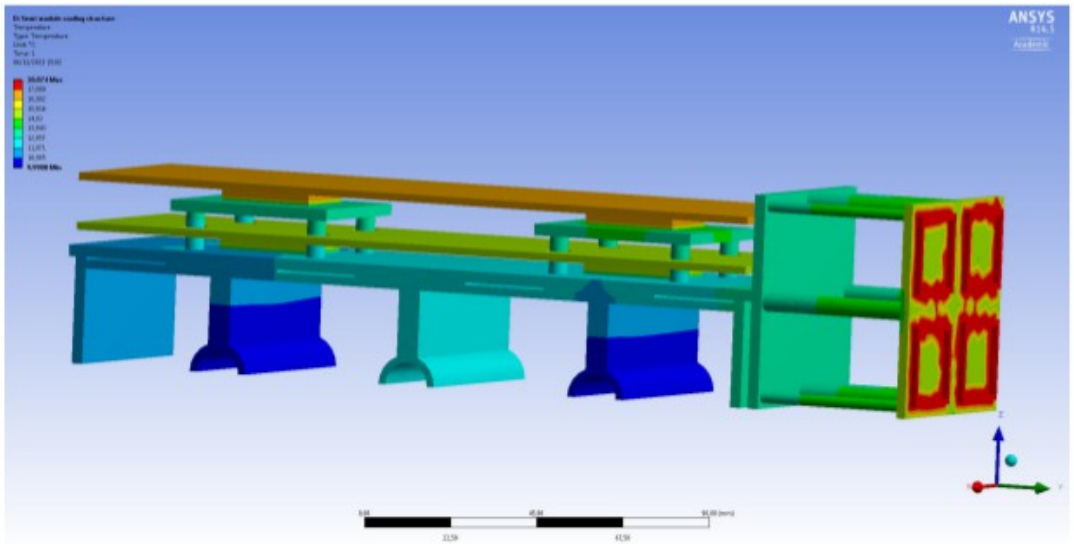
Thermal Simulation

c) Semi-modules mounted on a cooling+support bar

Max Dtemp = 14ˆC on baseboard, with one cooling duct intermediate between digital chips



Max Dtemp = 9ˆC on baseboard, with two cooling ducts



7

Production of first structures

- Forseen at the end of 2014/start of 2015
- Fabrication of support structures can be obtained by extrusion or by mechanical etching
  - The first structures will help decide about the most appropriate technology
- Thermal performance critical for ageing of PMT
  - Thermal performance will be verified on the first structures produced
- Test beam will also make use of the general mechanical design so mechanical structures need to be produced for it

Requests 2015

- Costruzione Apparati
  - Meccanica generale RICH2:
    - 35KE per struttura meccanica generale e interfaccia con cella elementare
    - 15KE SJ al completamento del design dell'elettronica digitale
- Consumi:
    - 5KE per costruzione mockups meccanici
- Servizi
  - Progettazione meccanica
    - 40% M.Benettoni
    - 2 m.u. disegnatore
  - Officina meccanica
    - 6mu per costruzione mockups e prime strutture meccaniche
  - Officina elettronica
    - 1mu per completamento costruzione PCB con amplificatori per stazione di test + supporto di F. Dal Corso