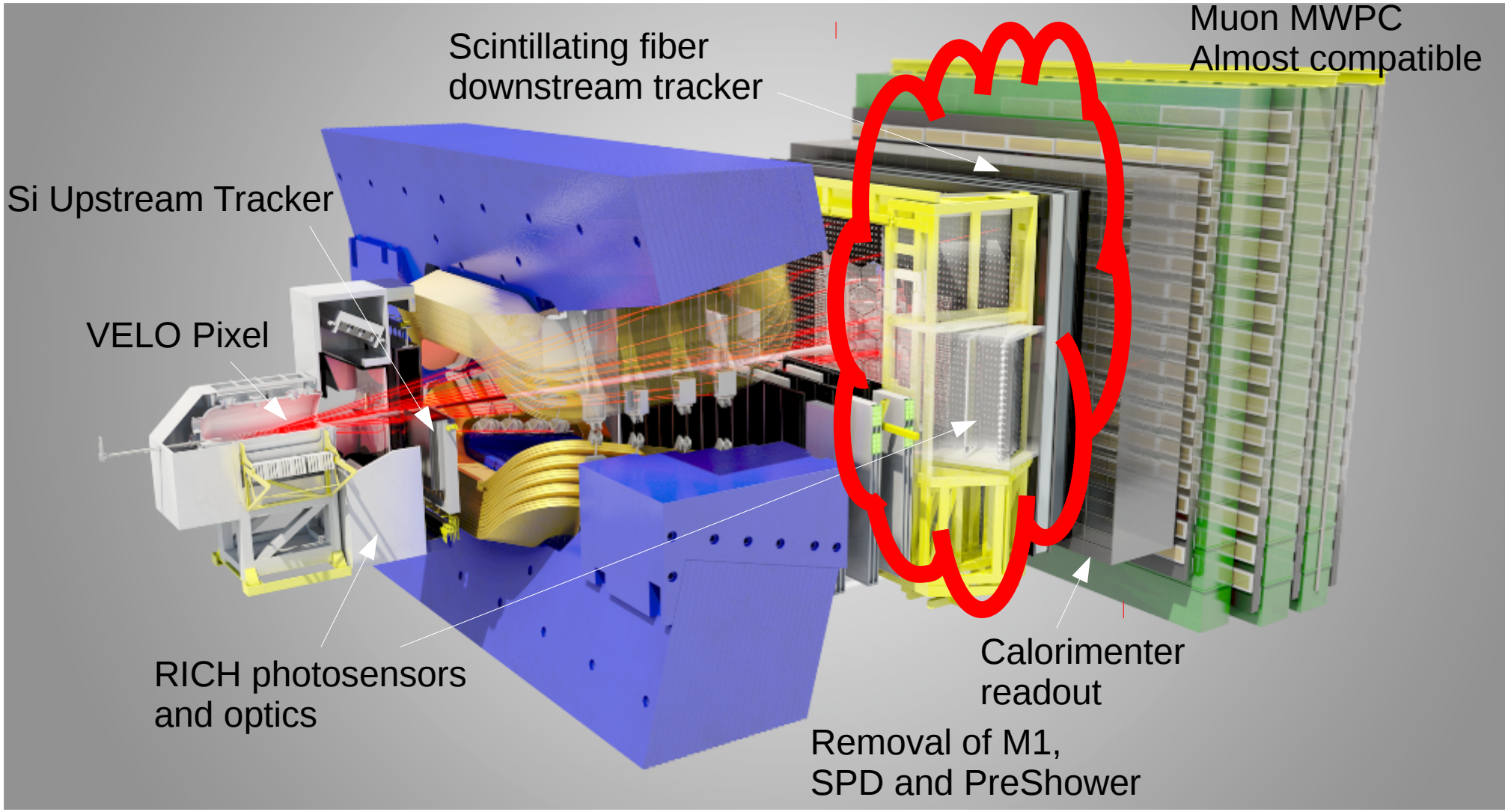
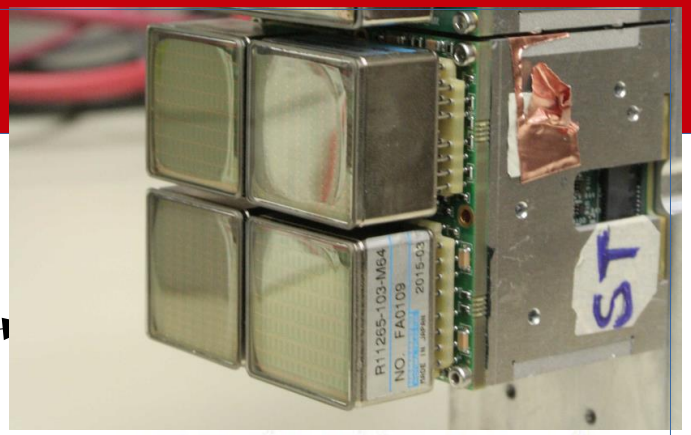
# LHCb RICH Detector upgrade

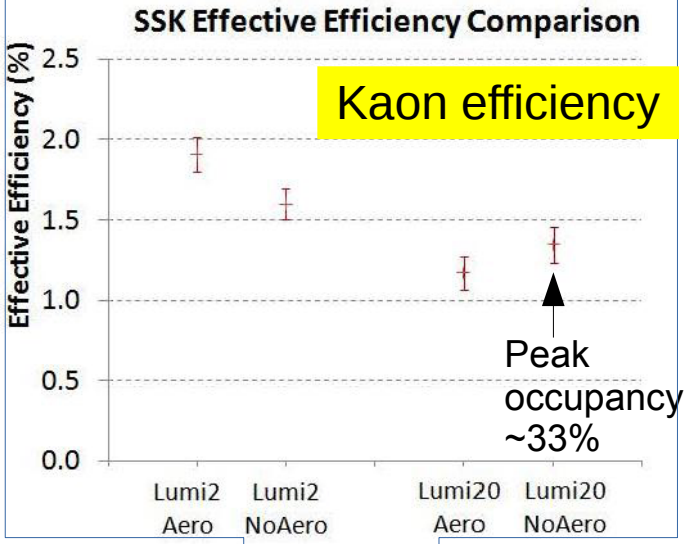
G. Simi
Consiglio di sezione INFN Padova
Riunione preventivi - Luglio 2019



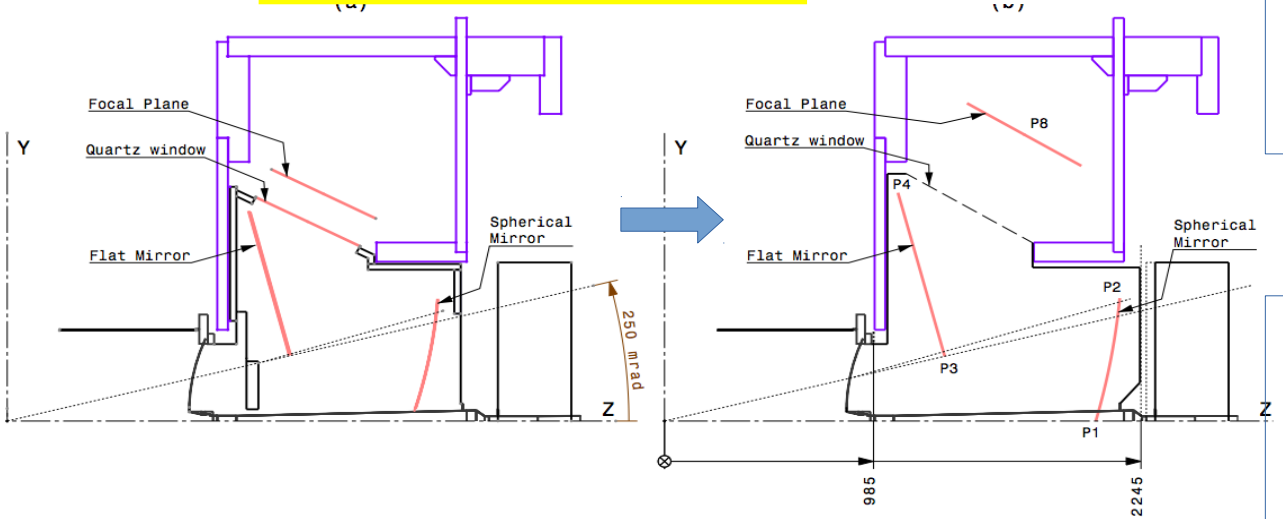
# RICH Upgrade

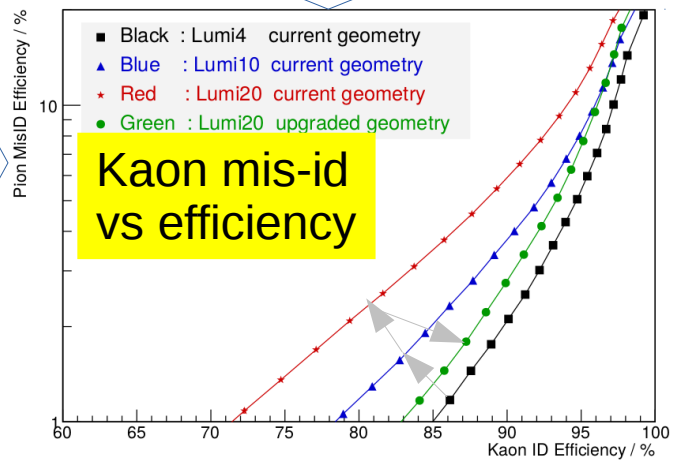
- Amount of recorded data limited by trigger rate ⇒ **upgrade the electronics to 40MHz trigger rate**
- RICH HPD have embedded FE electronics limited at 1MHz ⇒ **replace HPD with MaPMT**
- Luminosity increase from 4 to 20 $10^{32}$ $cm^{-2}s^{-1}$
  - ⇒ Degradation due to high occupancy
  - ⇒ **Modify rich1 optics to spread-out Cerenkov photons** to maintain current excellent PID performance
- Challenging mechanical design to cope with existing space constraints




Modifications to optics



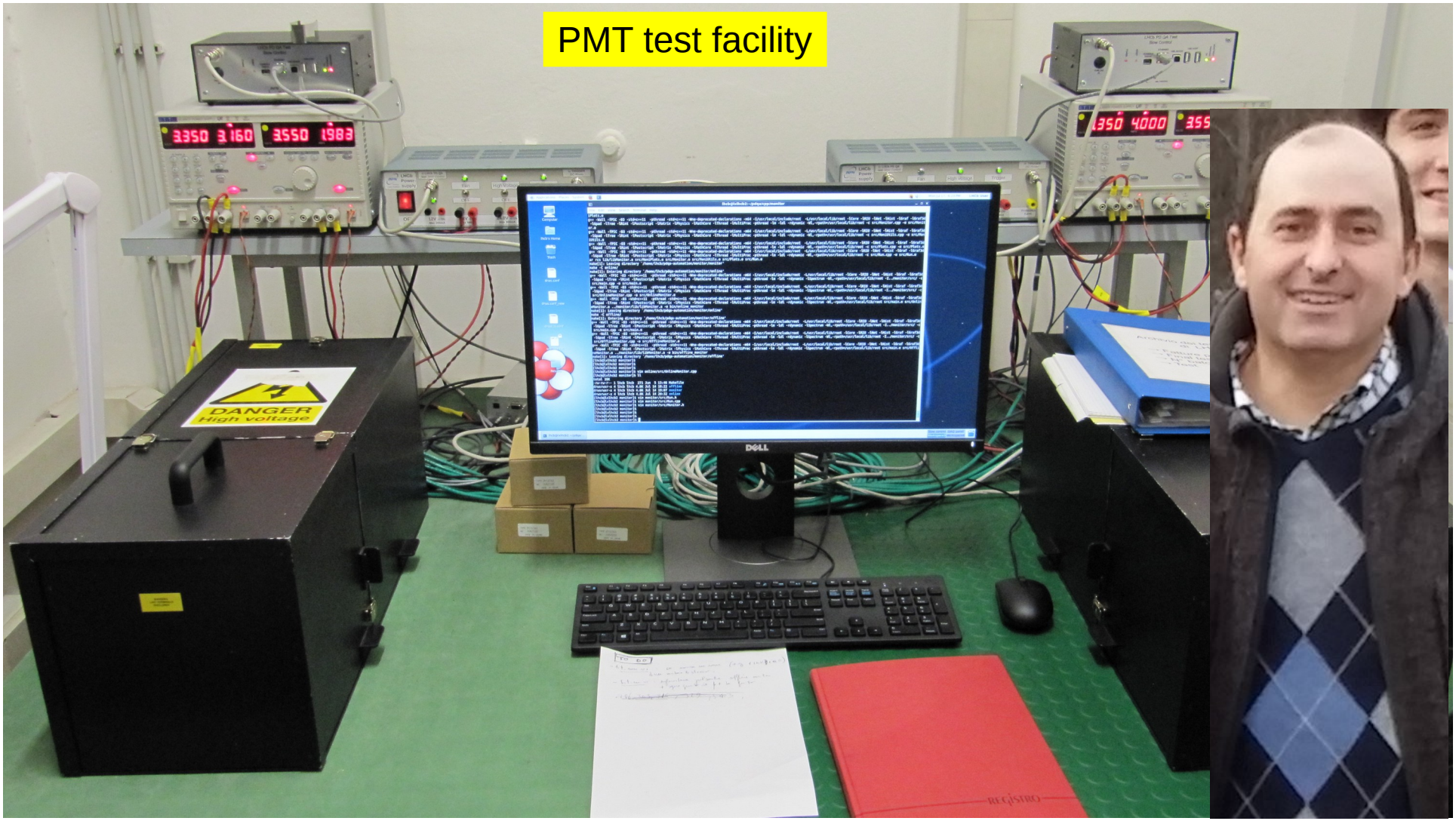
# LHCb RICH Padova activities and responsabilities

- Ongoing
  - Photo-detector characterization (→2019)
    - Main responsibility shared with Edinburgh
  - Mechanical Design and construction (→ 2020)
    - Main Responsibility For RICH2 and parts in common with RICH1
  - Cooling Design and construction (→ 2020)
    - Main responsibility
  - Test beam and detector Integration (→2019)
    - Mechanics and Cooling
    - Detector and electronics
  - Calibration and reconstruction algorithms (2018-2020)
  - Installation (2019-2020)
- Planned
  - Commissioning (2020-2021)

# PMT Characterization: the facility

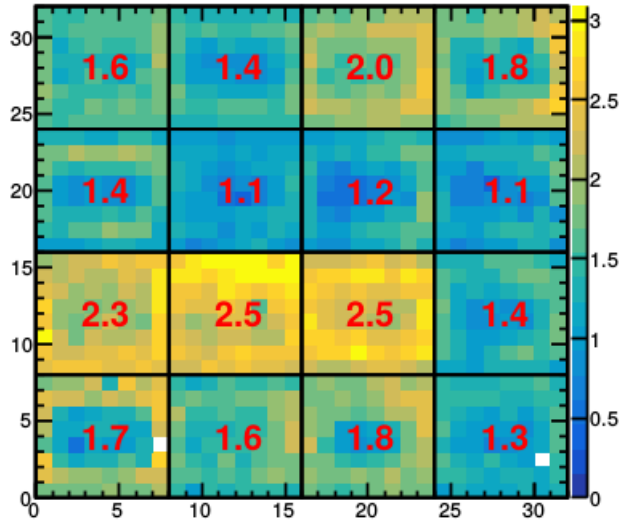
- PMT characterization facilities fully operational
  - Test of 1' PMT in parallel with 2' PMT ongoing

G.Simi
S.Gallorini
A.Lupato
L. Modenese

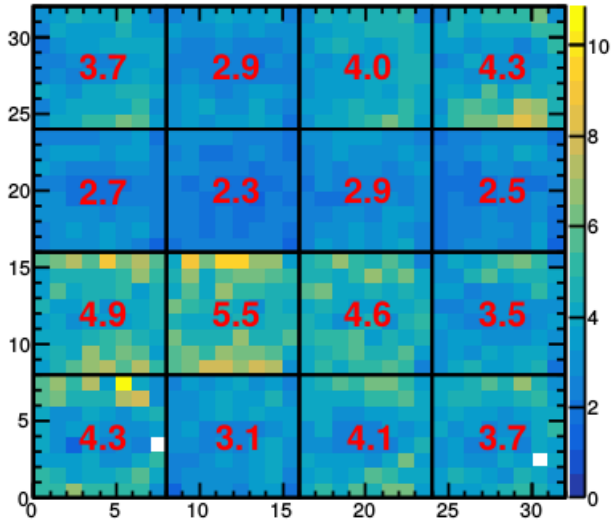


# PMT Characterization: the results

## Measured Gain

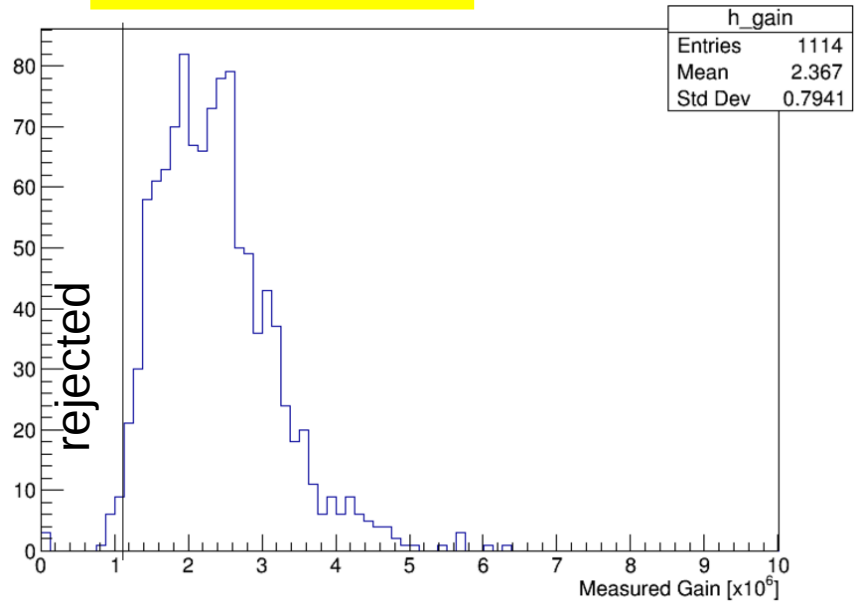



## Measured Peak/Valley

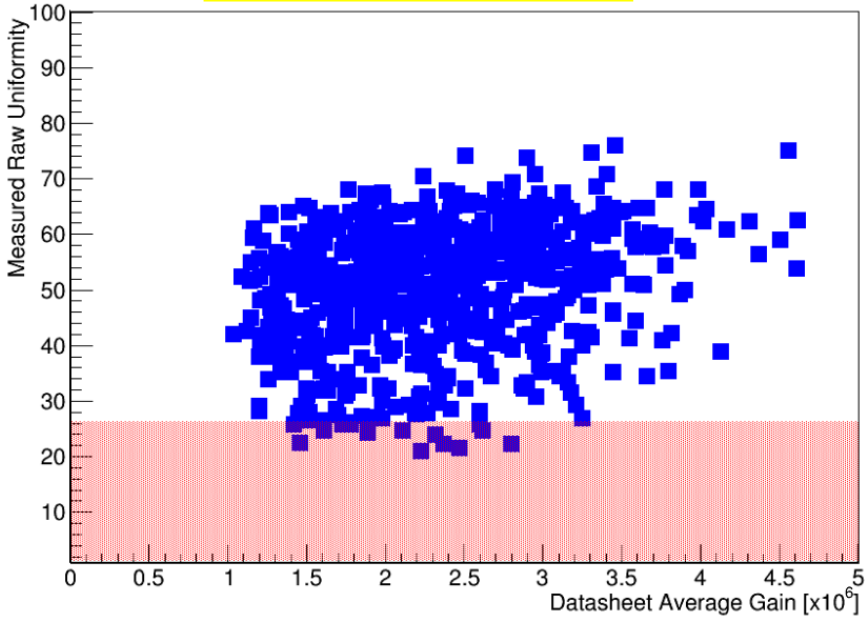



G.Simi
A.Lupato
S.Gallorini
L. Modenese

## Gain distribution



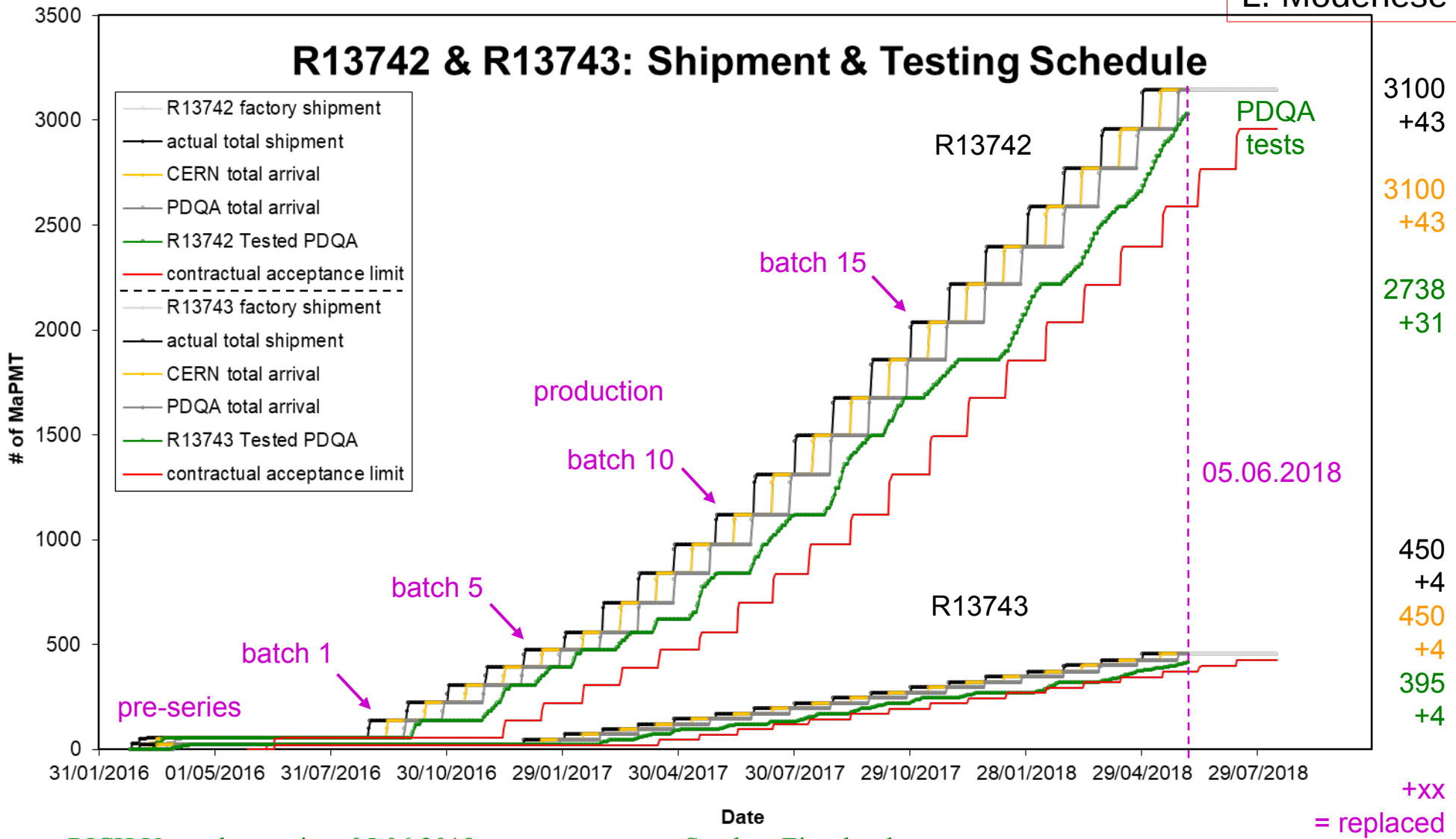

## Uniformity vs Gain



# PMT Characterization: total production

G.Simi
A.Lupato
S.Gallorini
L. Modenese

- PMT characterization facilities fully operational




RICH Upgrade meeting, 05.06.2018 Stephan Eisenhardt

# RICH 2 mechanics: support frame and services

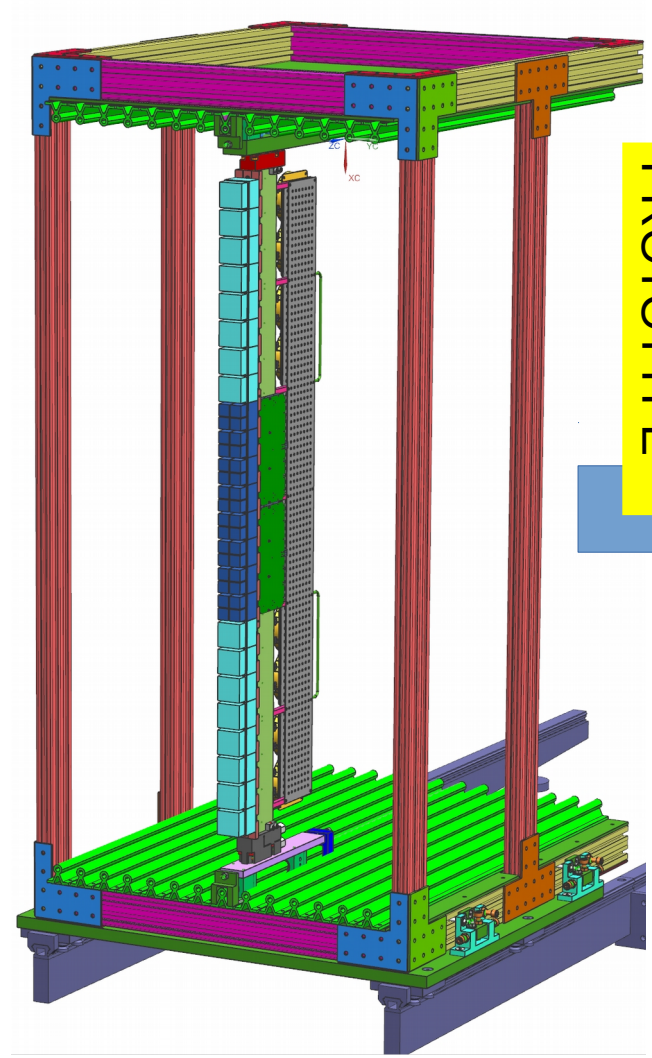
M. Benettoni
M. Zago
D. Aggiuaro

- Mechanics Production Readiness Review held in February 2018
- RICH II mechanics prototype constructed and used for review and detailed studies on services and cables

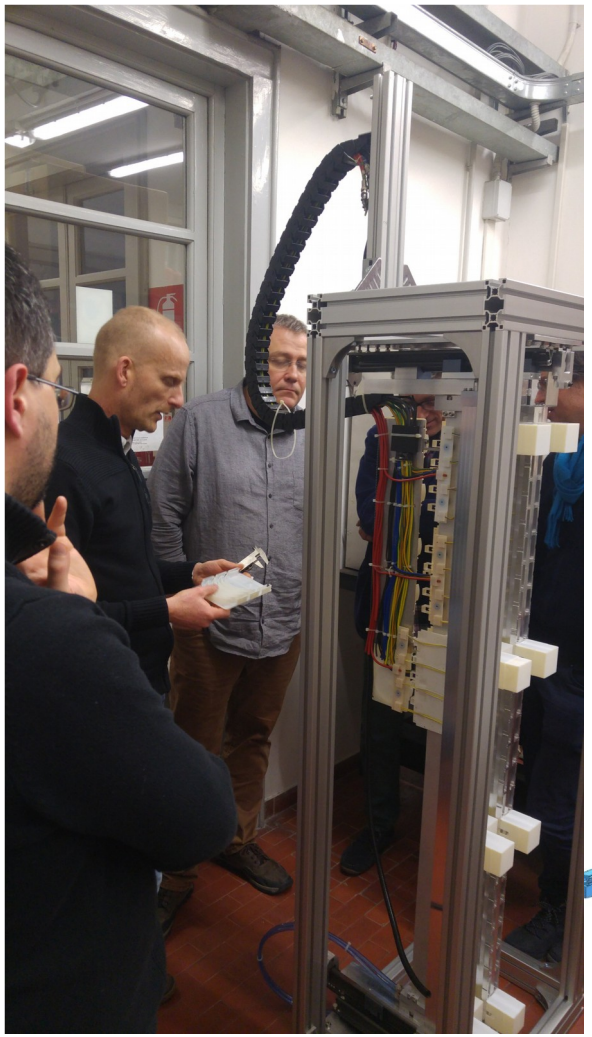
DESIGN

REVIEW

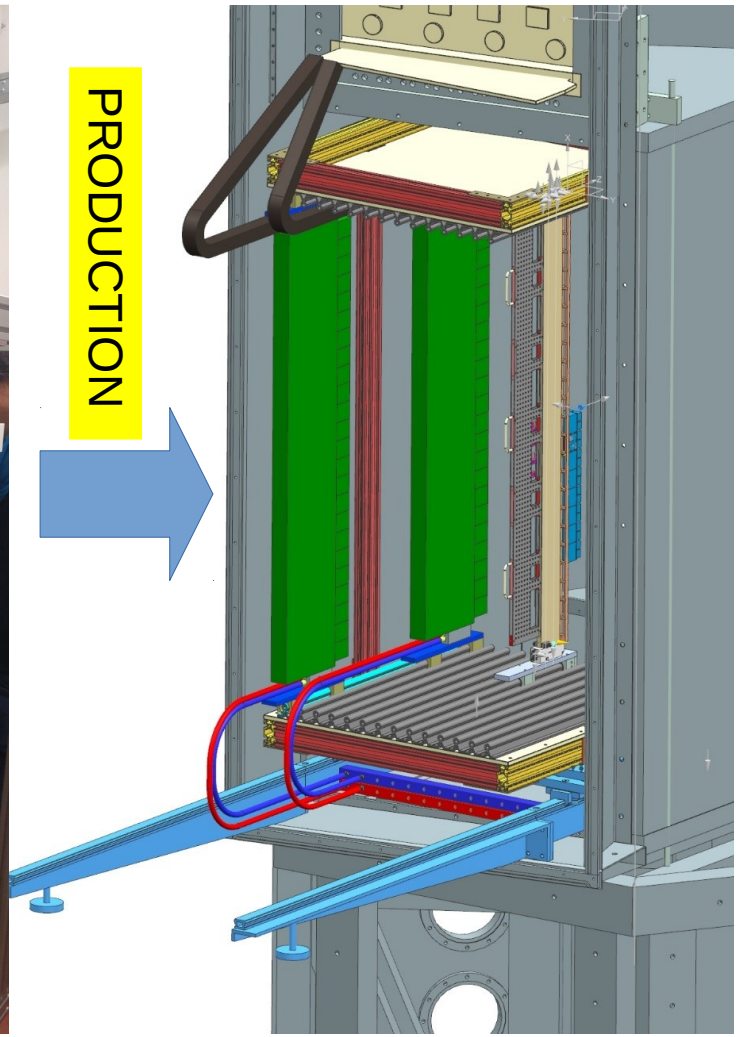
INSTALLATION



PROTOTYPE



PRODUCTION

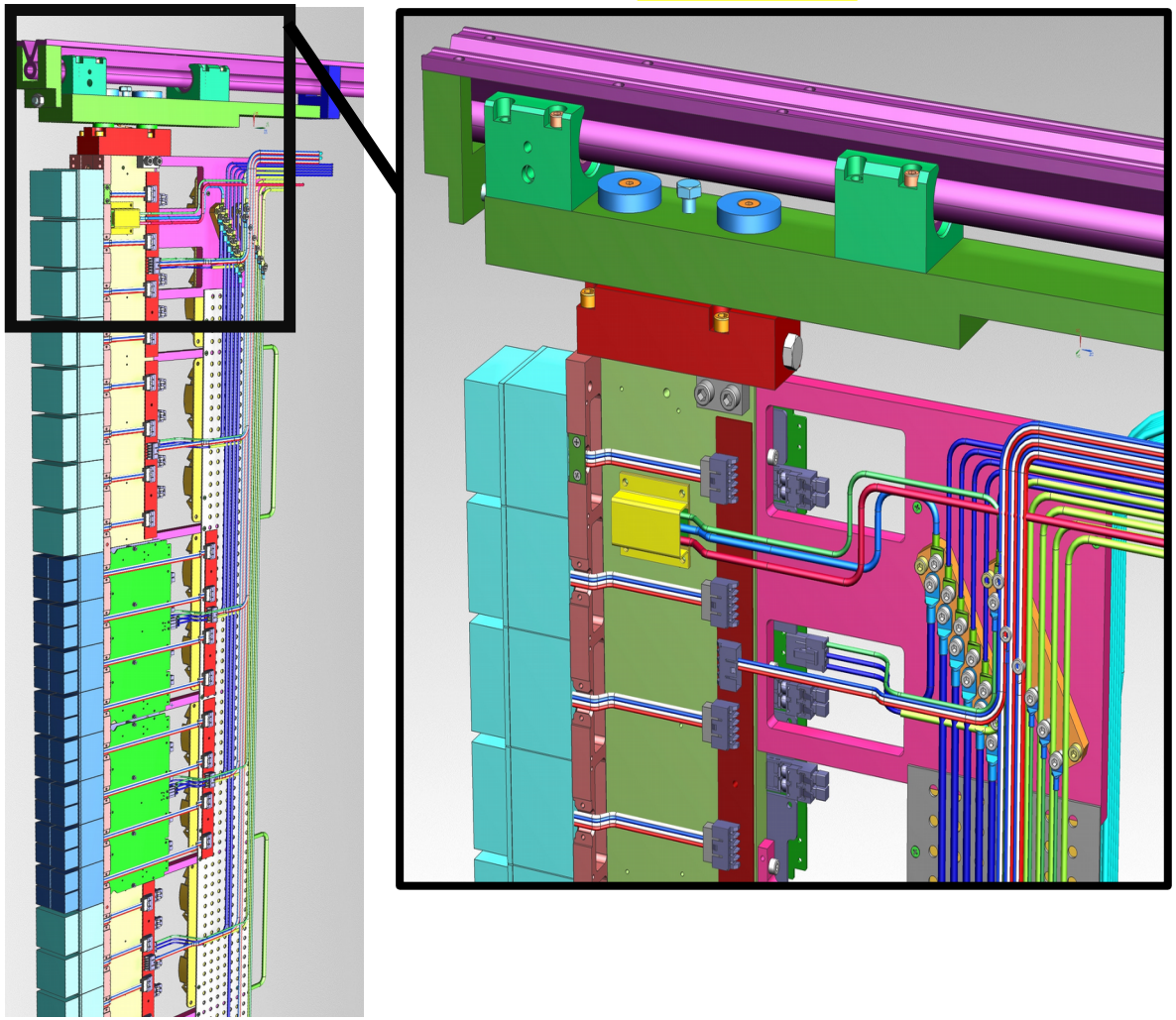


# RICH 2 mechanics: T-Bar dressing

M. Benettoni
R. Guida

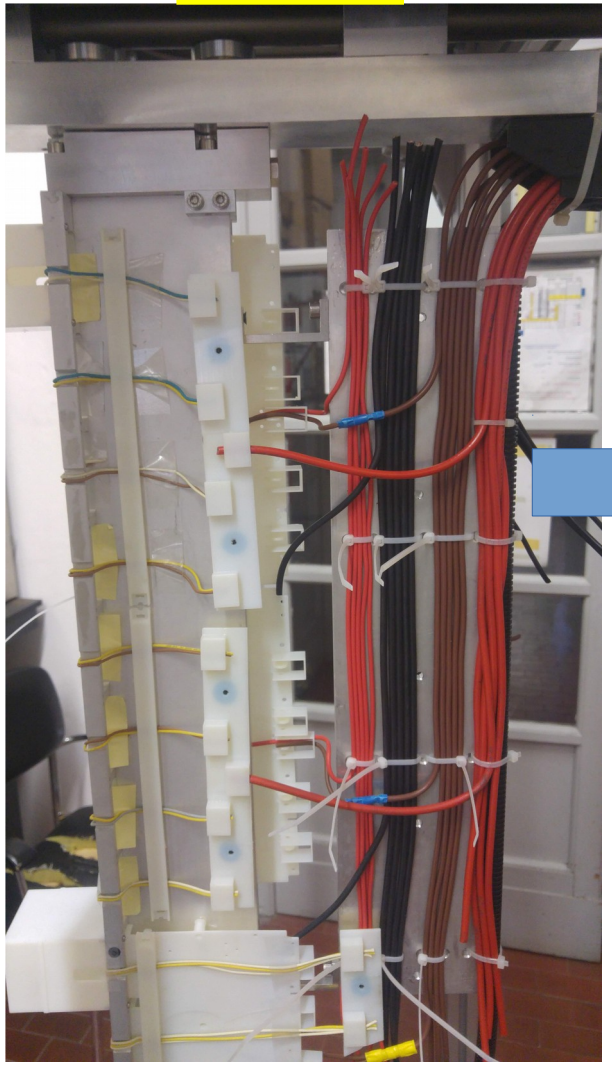
- Mechanics Production Readiness Review held in February 2018
- RICH II mechanics prototype constructed and used for review and detailed studies on services and cables

DESIGN



PROTOTYPE

REVIEW



PRODUCTION

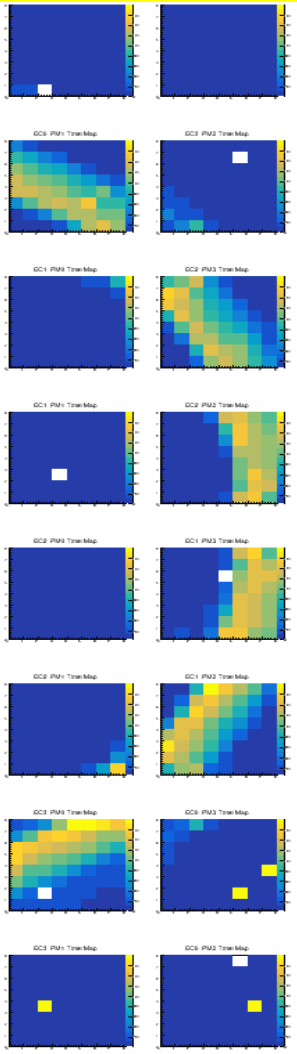
8

# PMT+readout prototype: integrationat the pit

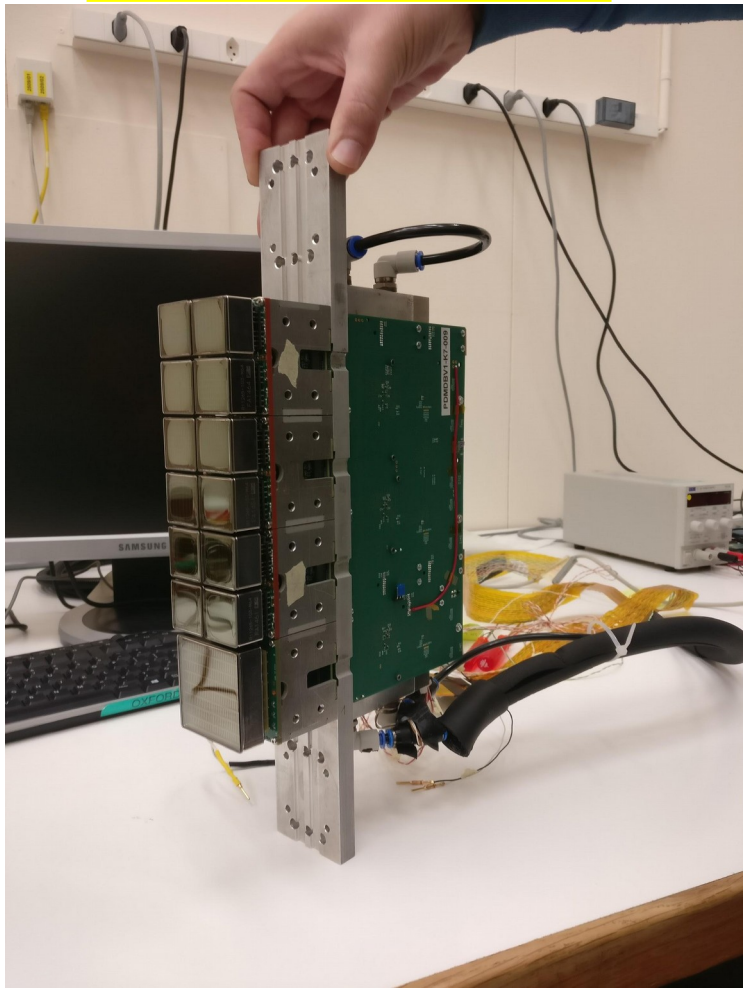
- Test beam prototype adapted to be installed in the pit alongside the HPD detectors: should see light trough the cracks of the current system => real environment test of prototype

S.Gallorini
A. Lupato

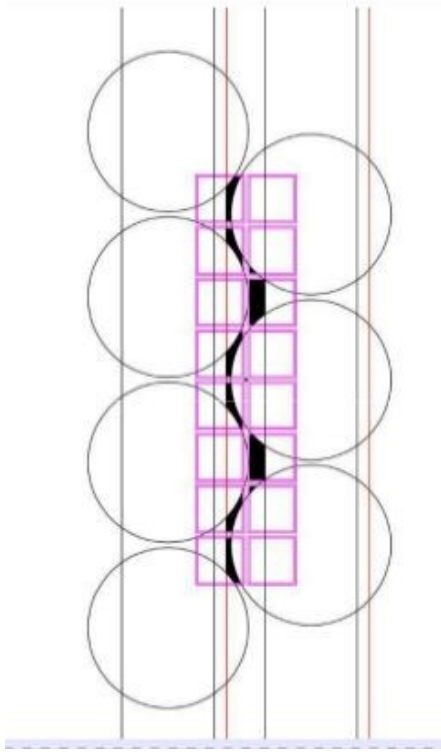
Last year prototype



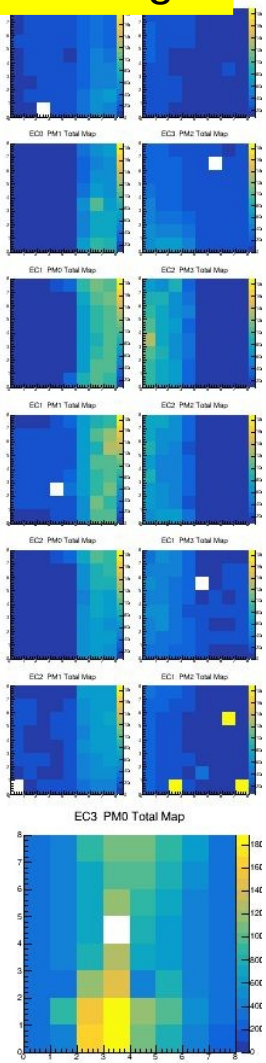
Adapted for installation



Installed at the Pit



Sees light

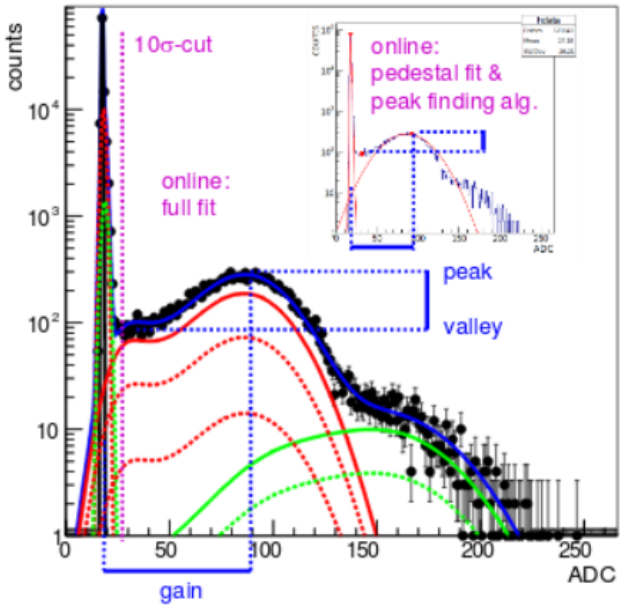


# Threshods Calibration: preparing for commissioning

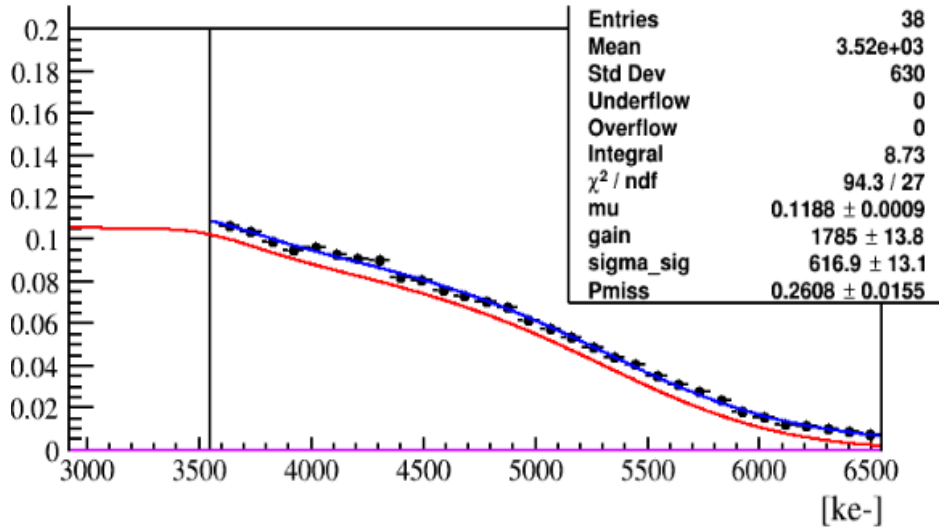
- The readout in RICH upgrade will be done by CLARO chip which gives a binary signal whenever the charge collected by PMT is above a threshold.
- The threshold scan fit is necessary:
  - to set the working point of the PMTs;
  - to monitor the PMTs characteristics over time.
- Useful check: compare PMT parameters measured in PDQA with the ones measured by the final readout (using the same fit model)

S.Gallorini
A. Lupato

Pulse height spectrum fitted to model to extract PMT characteristics




Normalized counts over thresholds fitted to integral of the same model



# Future Upgrades: Tracking at LH-LHC

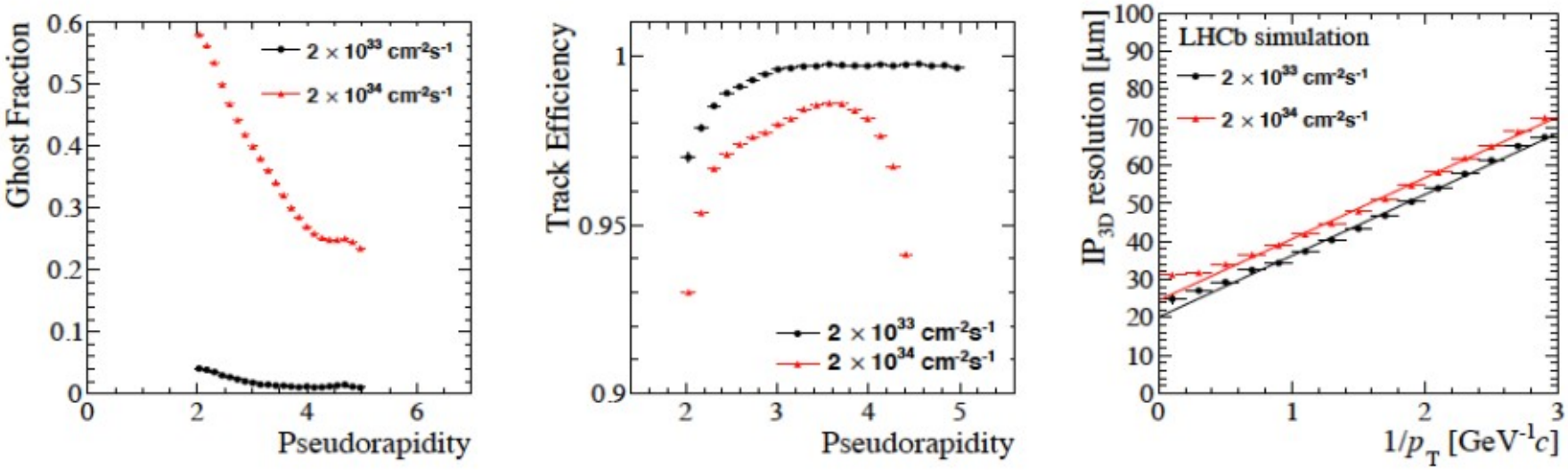



Fig. 1 – Performance of the Phase-I upgrade LHCb Vertex detector at Phase-II conditions [3].

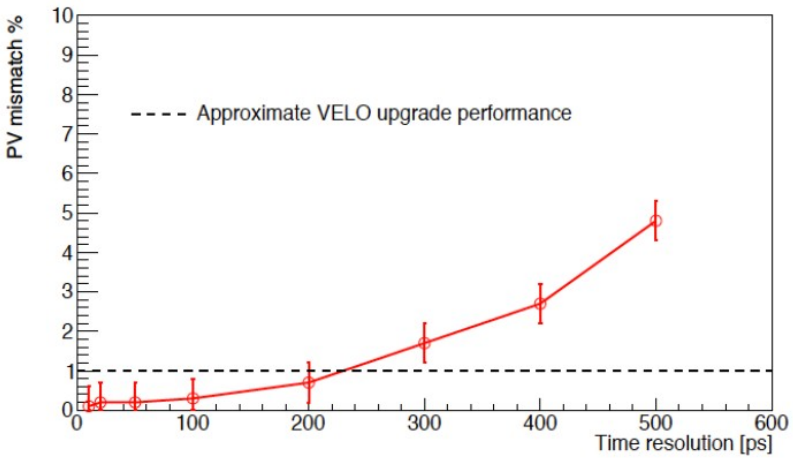
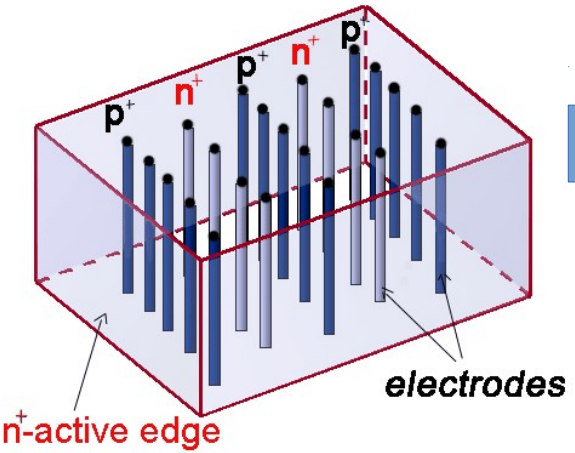



Fig. 2 – Re-gaining LHCb Phase-I upgrade performance by means of high resolution time measurements [3].

3D Silicon Pixel Sensors




Progetto Gr5
TIMESPOT
TIME-Space Operating Tracker

G. Simi, A. Lupato, S. Gallorini, G. Collazuol, [S. Mattiazzo]

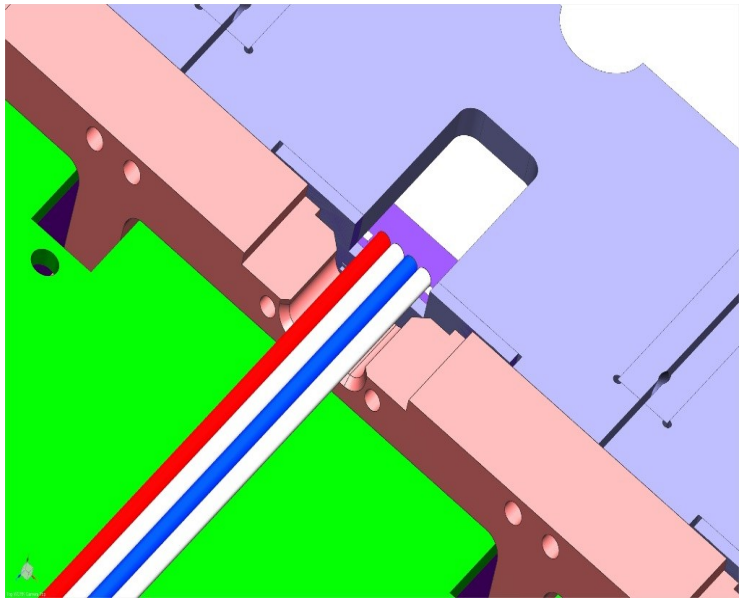
# Resources

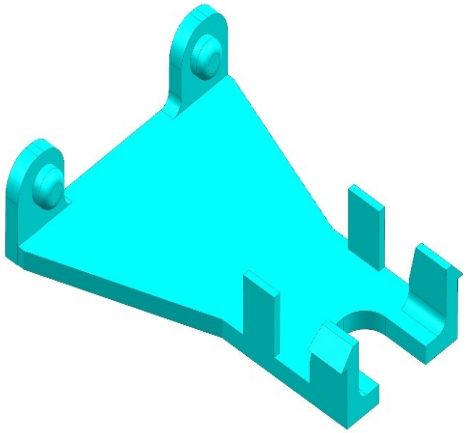
- **LHCb RICH present group composition**
  - S. Gallorini (Post. Doc), M.Morandin(DR), G.Simi(PA), A.Lupato(Post Doc)
- **Produzione meccanica per RICH2**
  - **50kE al CERN come contributo per ordine comune con Inglesi RICH1 + RICH2**
- **Richieste 2018**
  - **Servizi**
    - **Progettazione meccanica**
      - 40% M.Benettoni
      - 2 m.u. disegnatore x disegni esecutivi finali
    - **Officina meccanica**
      - 1mu per installazione strutture meccaniche @ CERN
    - **Elettronica**
      - 1mu x riconversione di una delle stazioni di test PMT in stazione di test Celle elementari
  - **Fondi**
    - 1kE consumo: dischi x backup dei dati di test dei PMT
    - 2kE inventariabile: x riconversione stazione di test
    - 5kE consumo per miscellanea parti per installazione meccanica @ CERN
- **Post Doc (ongoing) in 2107-2018** spending part of its time at CERN, working on:
  - PMT characterization
  - Detector Integration
- **Post Doc in 2019-2020** focusing on:
  - Detector Installation
  - Detector Commissioning

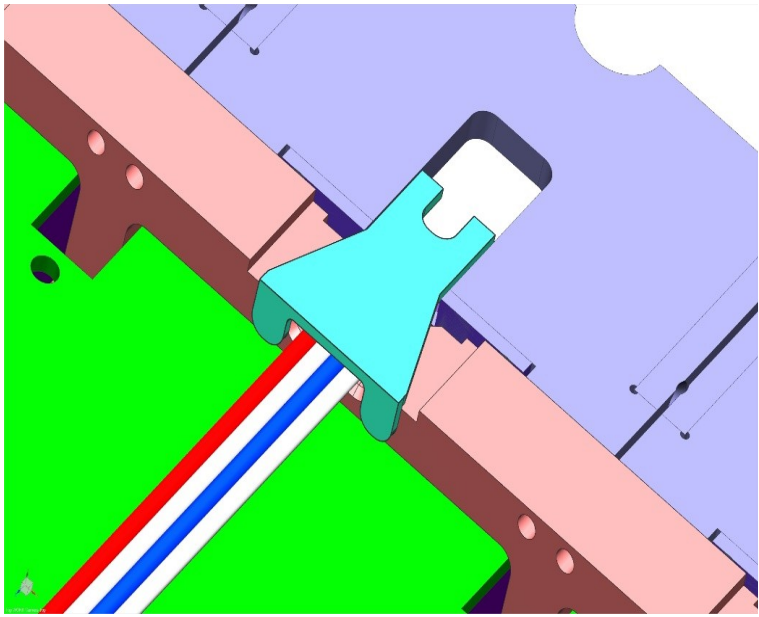
# Backup

# ng of ECs HV cables without SCREWS!

rinted or injection moulding plastic clips

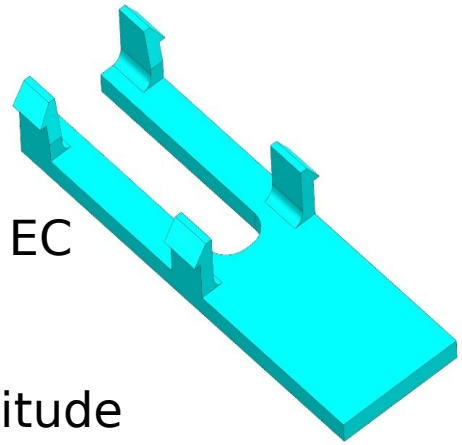


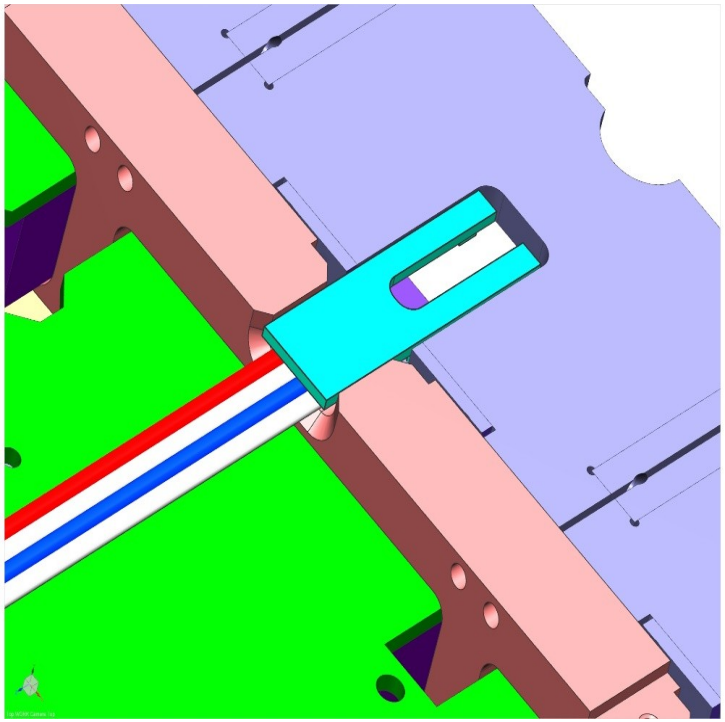




a) Clip to be engaged between T-bar and EC

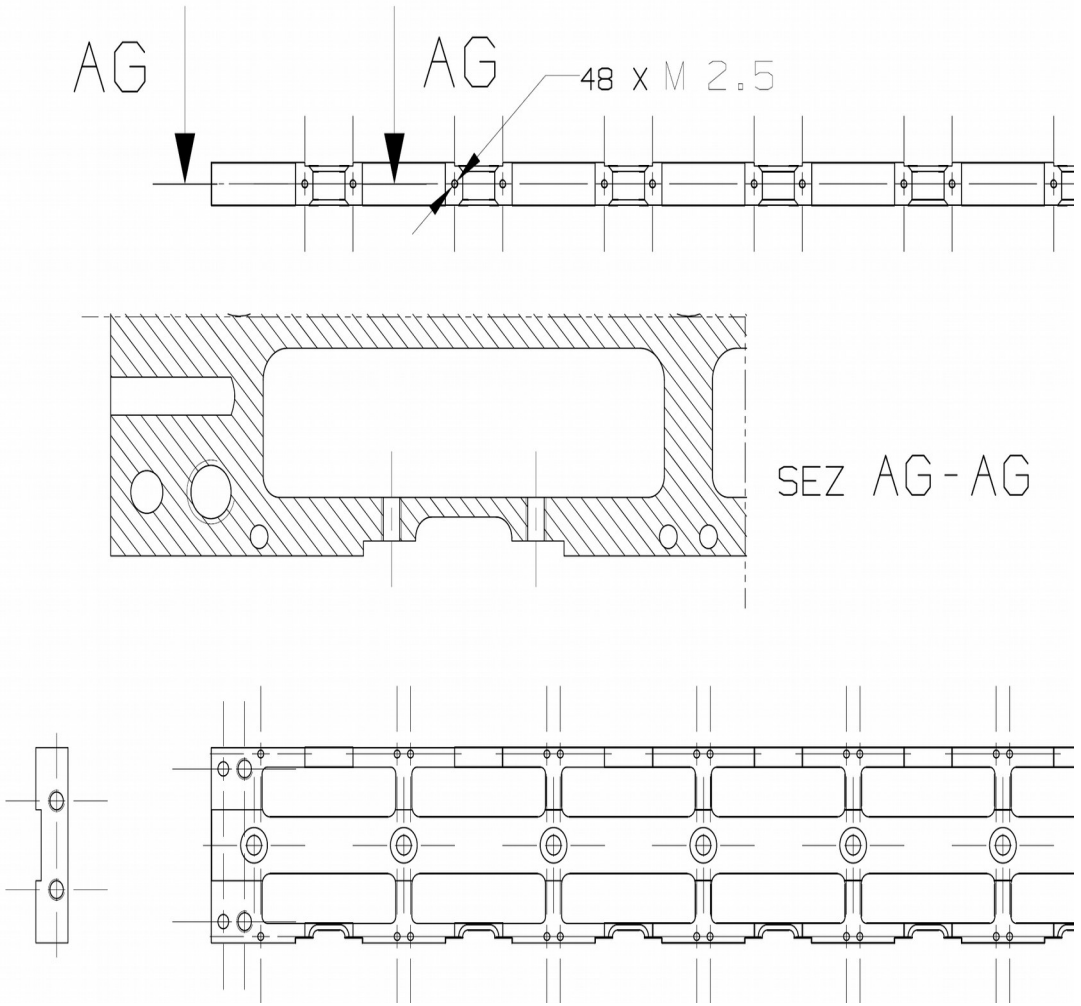
b) Clip to insert in the EC slot avoiding machining in the T-bar Plastic clip touch the Feb inside EC

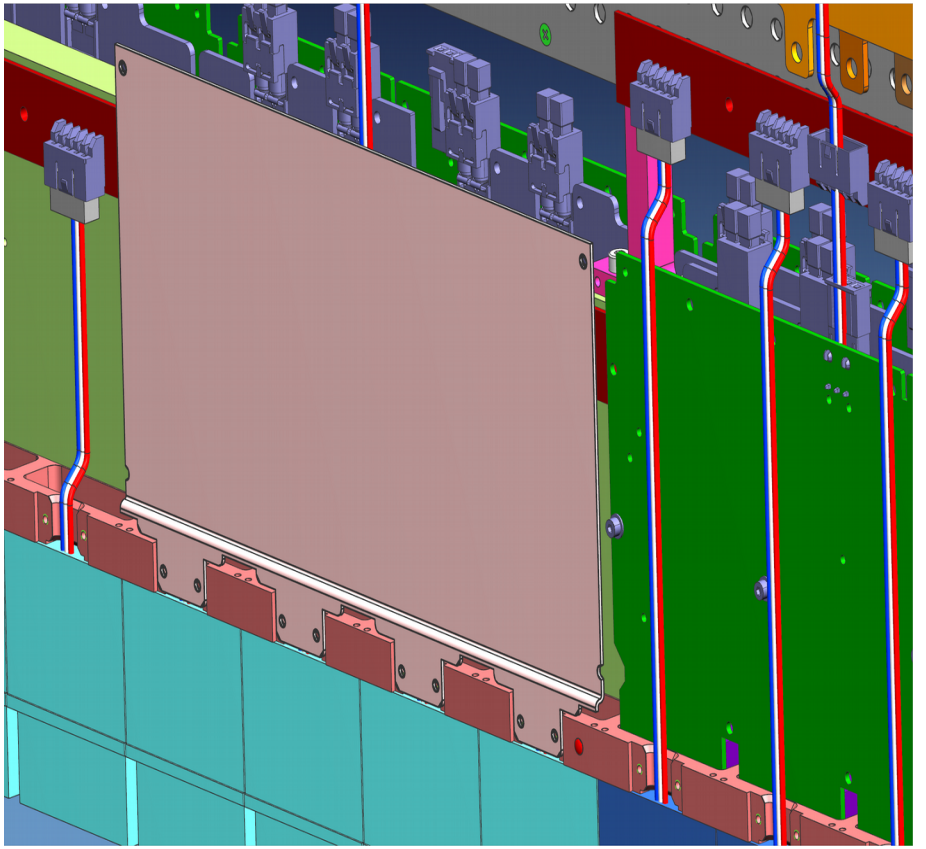


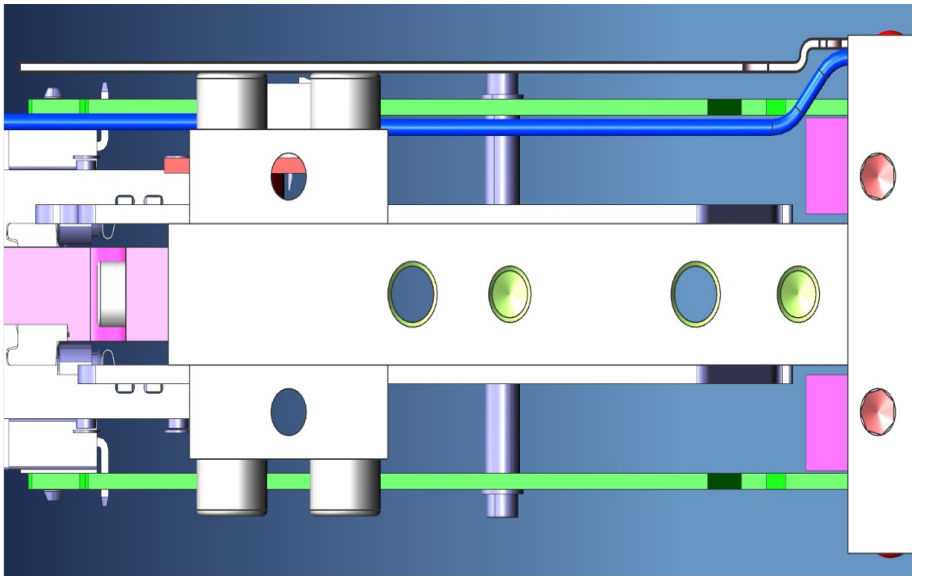


Will keep more conservative attitude preserving redundant machining

# xing of ECs HV cables



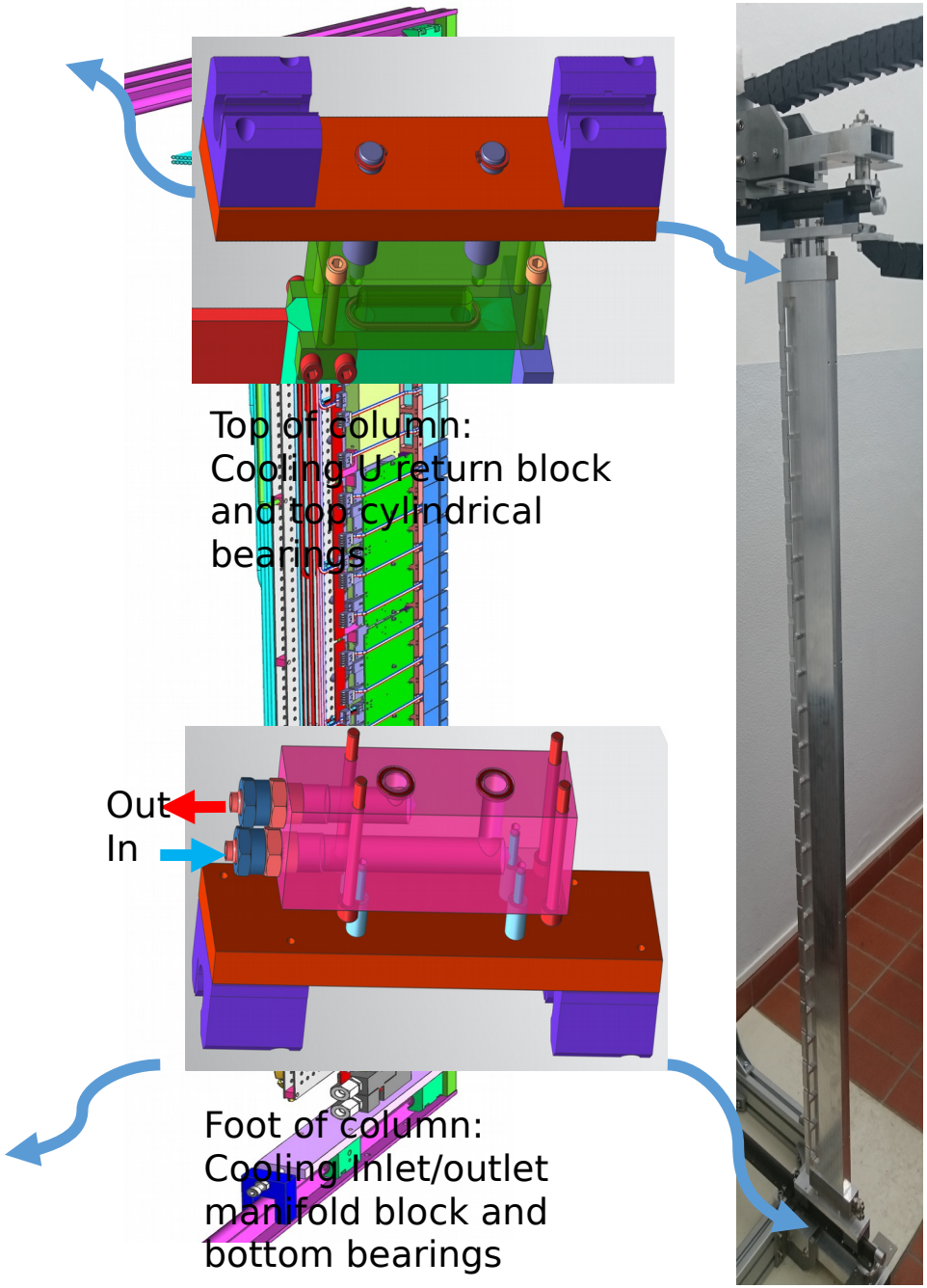





Cover fixed either on 4 corners or 2 far corners and each “finger”
(Here showed ridundand fixing holes)

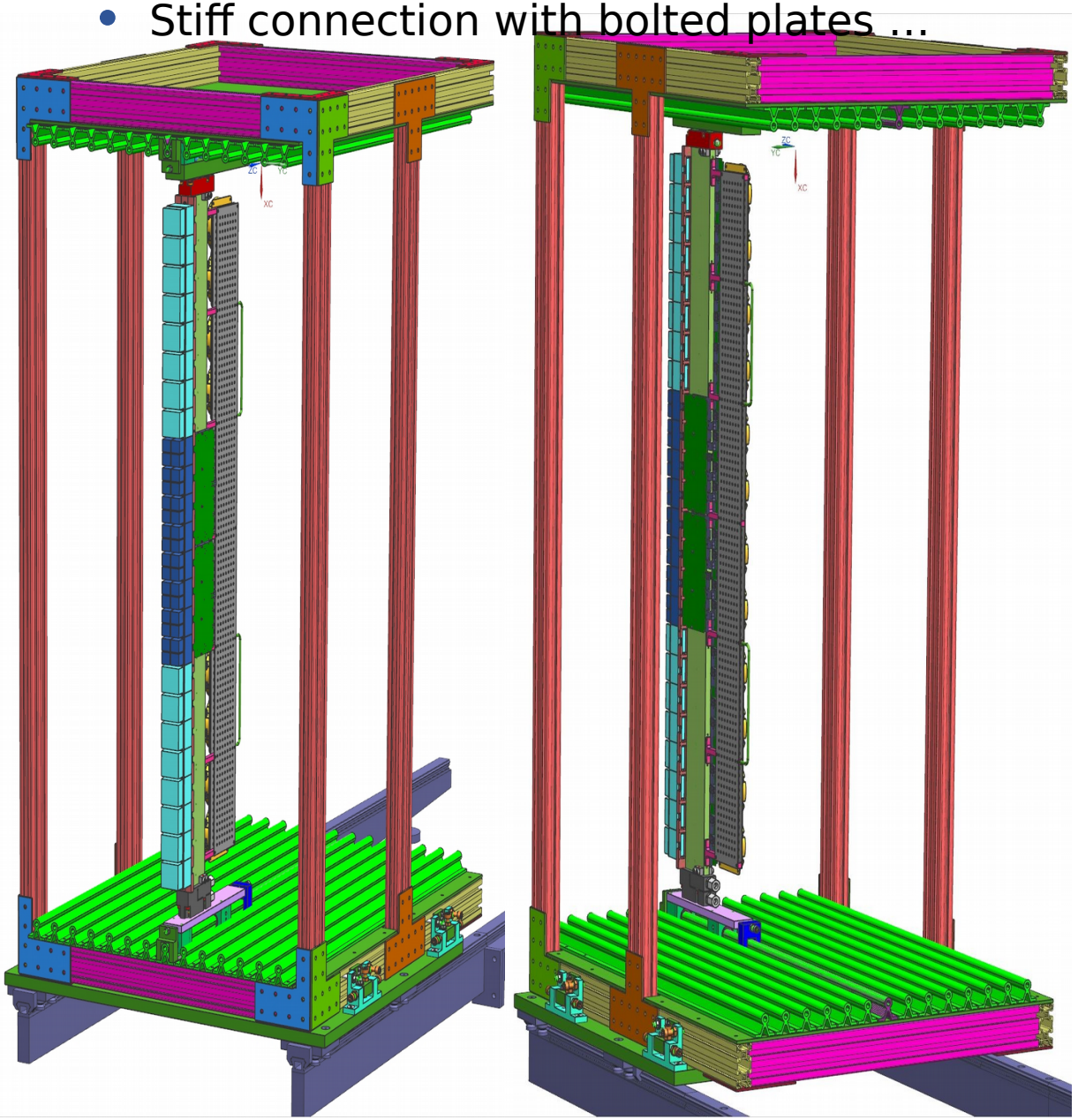
Can act as containement for HV cables running on DBs
Likely 0.8 -1 mm thick aluminium
Bended plate to increase plate stiffness and

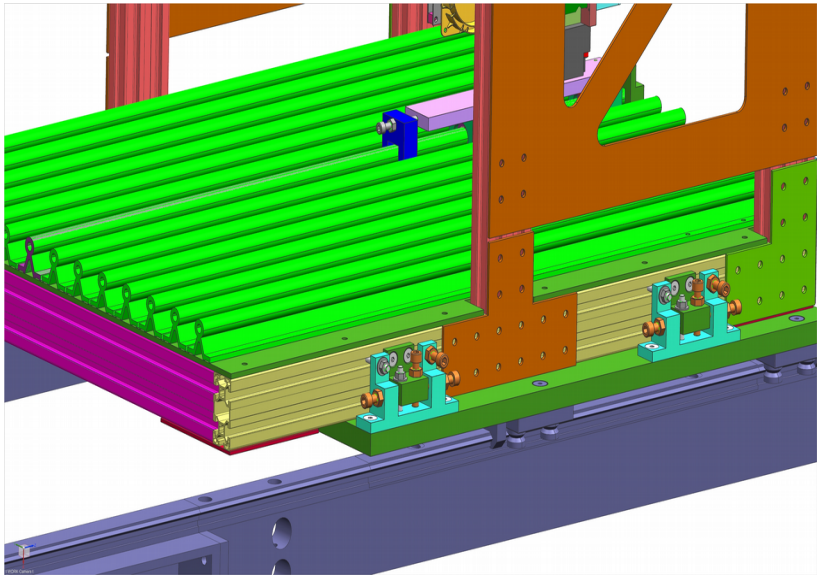
# Column endblocks: support bearings and cooling connections

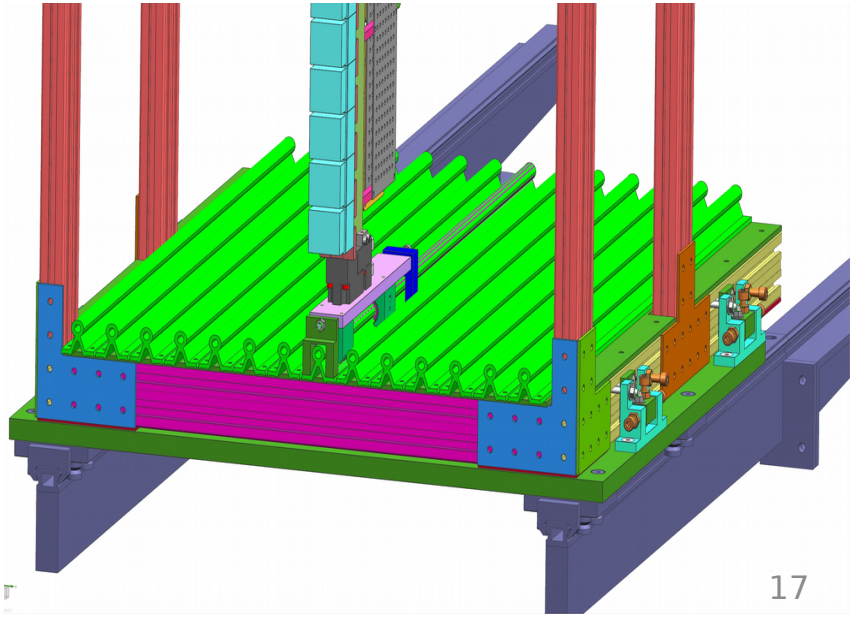


# Rack structure

- Bolted aluminium profiles, width dimensioned to lodge up to 14 columns for further upgrade
- Stiff connection with bolted plates …

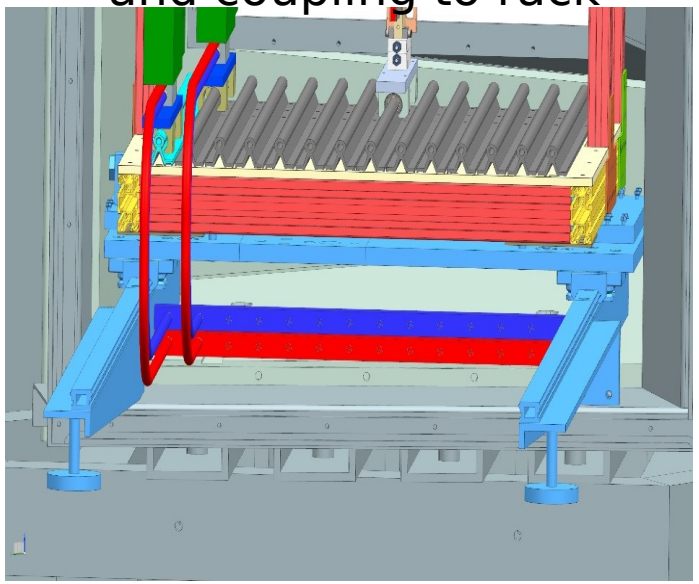


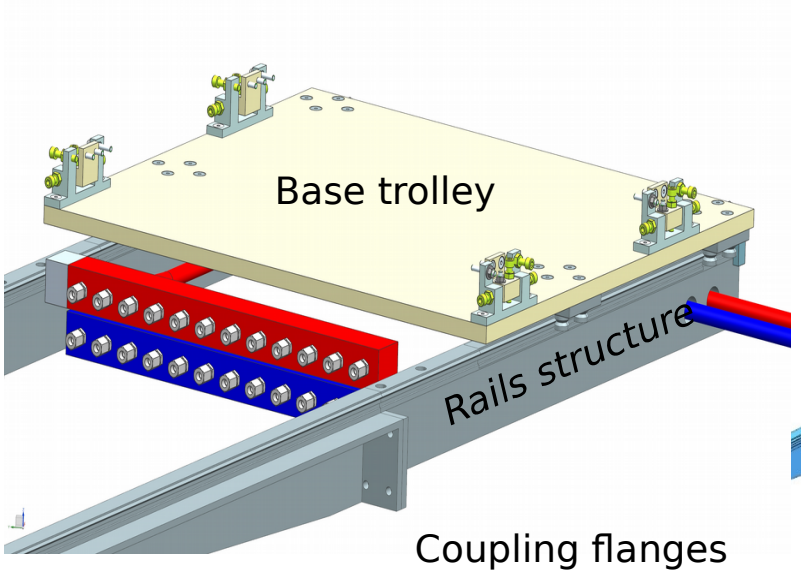


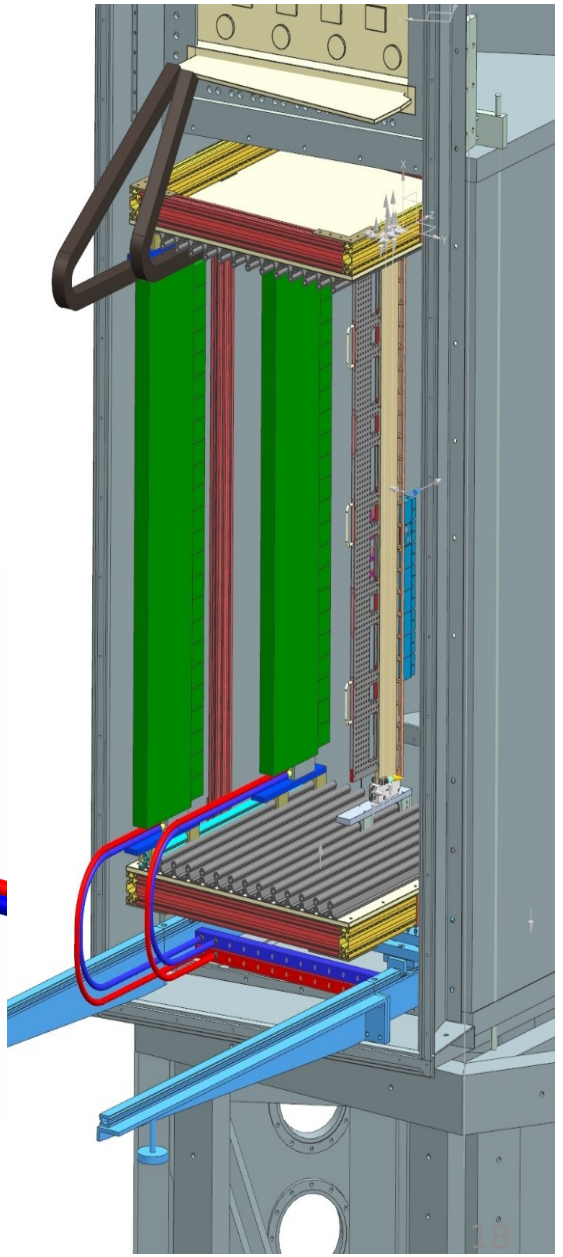


# Rack rails and “base trolley”

- Will re-use current rails and bearings
- Rails displaced at increased pitch w.r.t. current ones to:
  - allow cooling manifold lodgement in between
  - improve stiffness of rack to rails coupling, hopefully
- Inlet and outlet cooling manifolds below rails level
- Coupling flange on rails structure to allow extension rail coupling
- Provisional extension rails to allow rack mounting on base trolley outside detector doors
- Base trolley similar to current one, modified dimension and coupling to rack

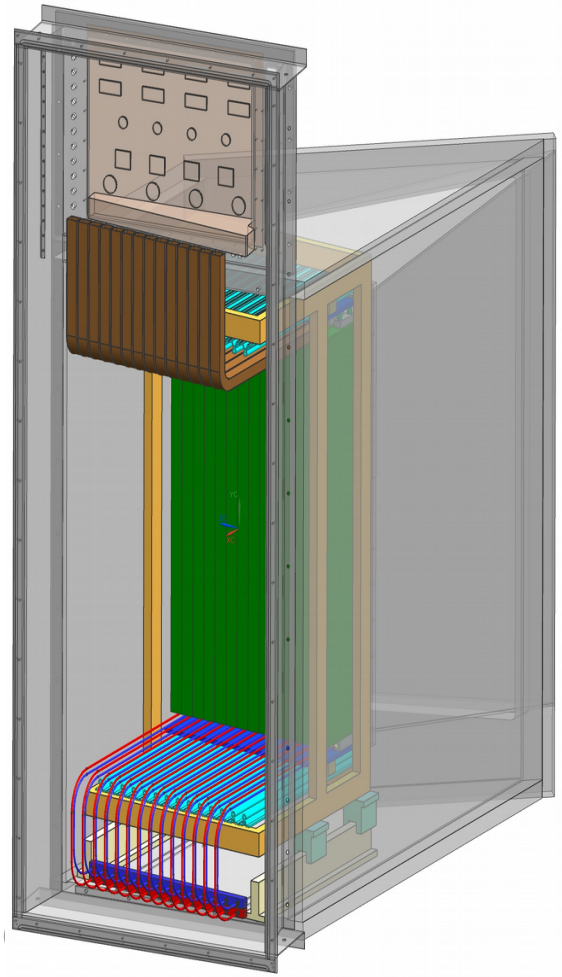




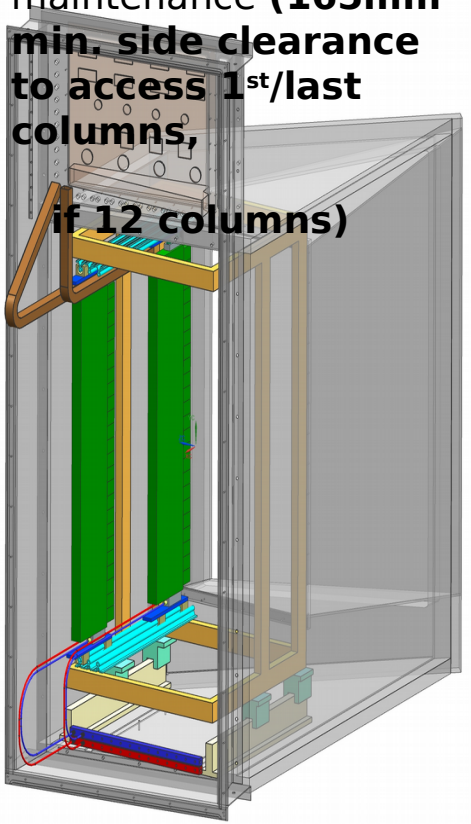
# RICH2 “in situ” maintenance: ECs and DBs replacement

- Columns maintenance shall be possible without disconnect services
- Disconnecting/unsealing cooling circuit should “never” be needed.
- Disconnecting services (HV,LV,fibers) should “never” be needed.
- Disconnection of services required only to remove/replace one full column, or removal of the full rack …
- Updating design (increased rack depth) to avoid full rack displacement, full access with rail extension

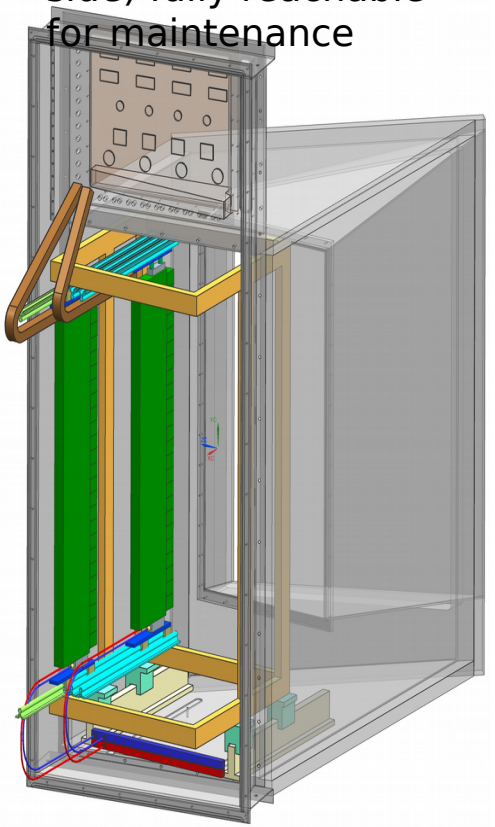


Single column retracted, columns in the middle fully reachable for maintenance **(165mm min. side clearance to access 1st/last columns,**

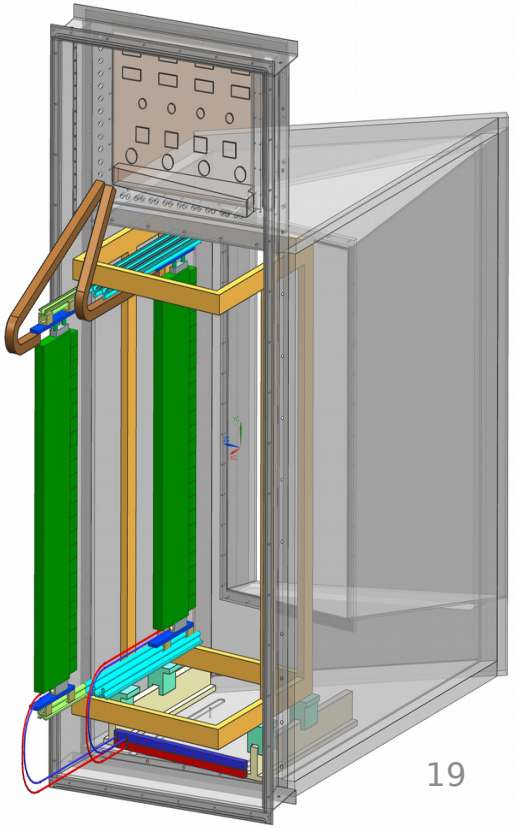
**if 12 columns)**



Single column <u>and full rack retracted</u>, columns in the middle and one side (Velo side) fully reachable for maintenance



Full rack retracted, single column retracted <u>on rail extension</u>, all columns fully reachable for maintenance



# RICH2 column design: bearings and rails

Sliding coupling btw column and top bearings to compensate pitch mismatching btw rails

Preloaded spring to avoid clearance => smooth movement

Bearings Igus OJUM-06-20 (low friction plastic)

Rails Igus AWMU-20 (drawn aluminum)

Electrical Insulating bearings, T-bar connection to GND needed