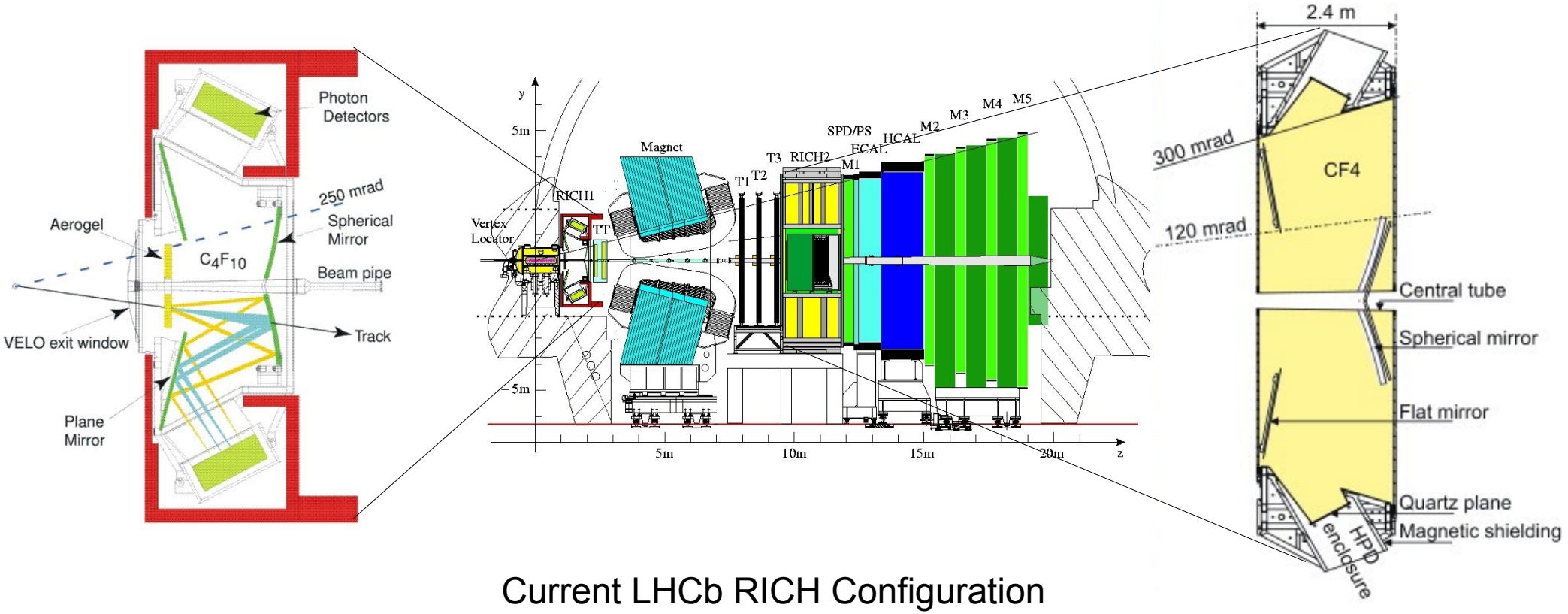
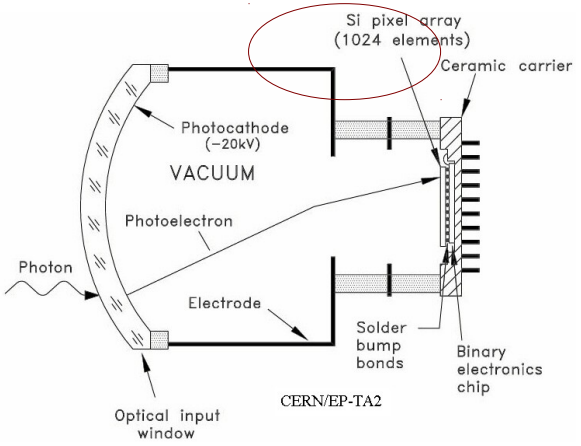
LHCb RICH Upgrade

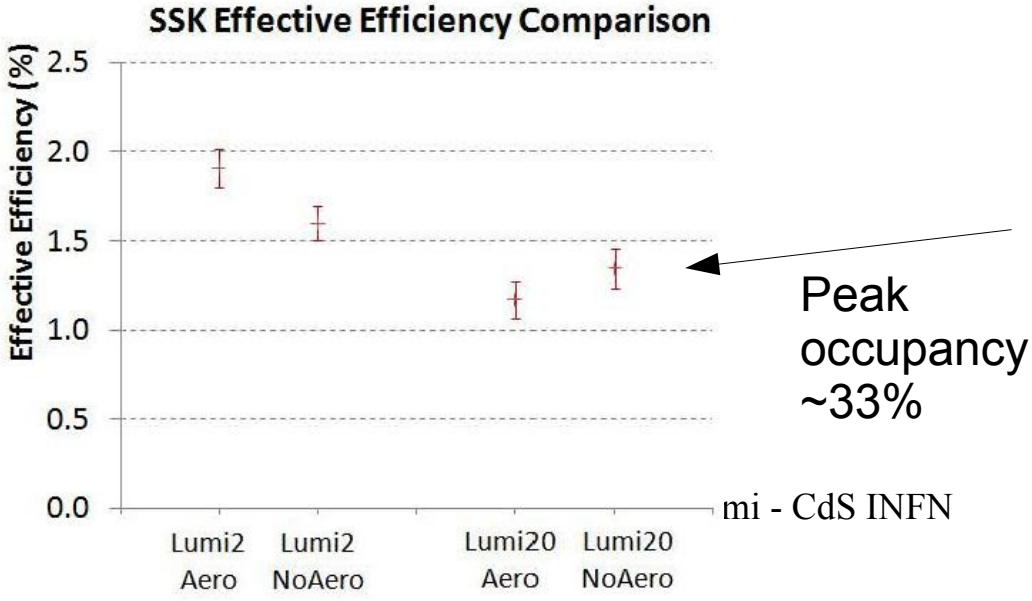


Current LHCb RICH Configuration

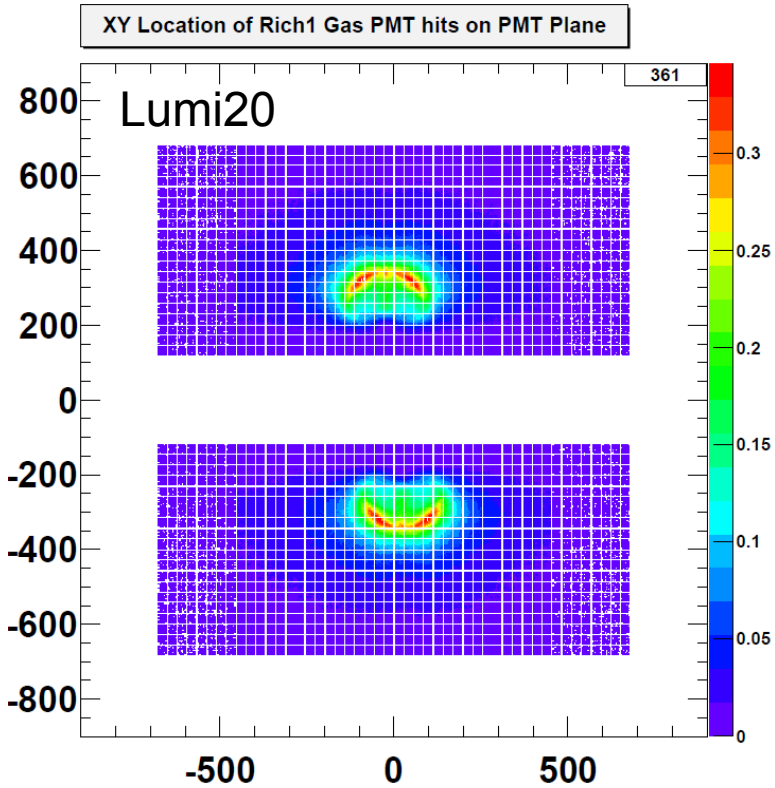
RICH Upgrade Motivation

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





Peak occupancy ~33%

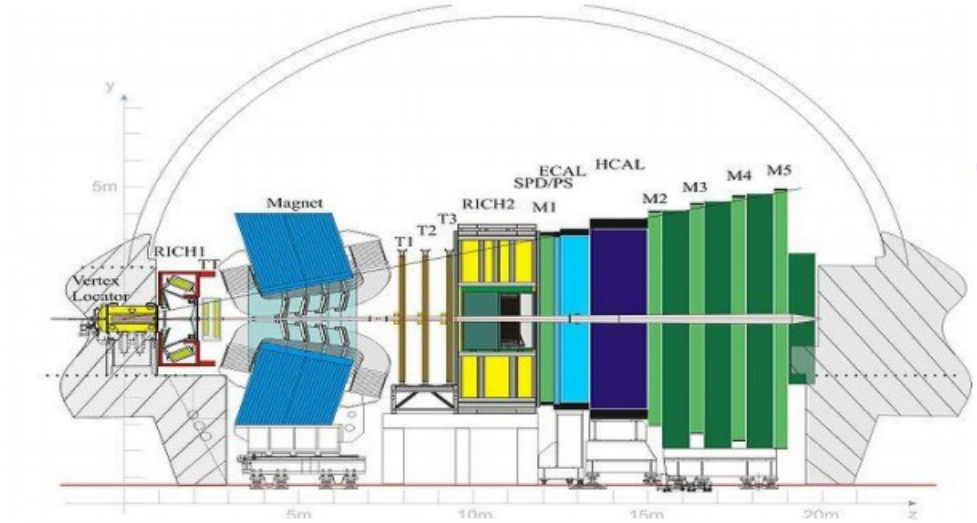


Integrated luminosity for Run 2

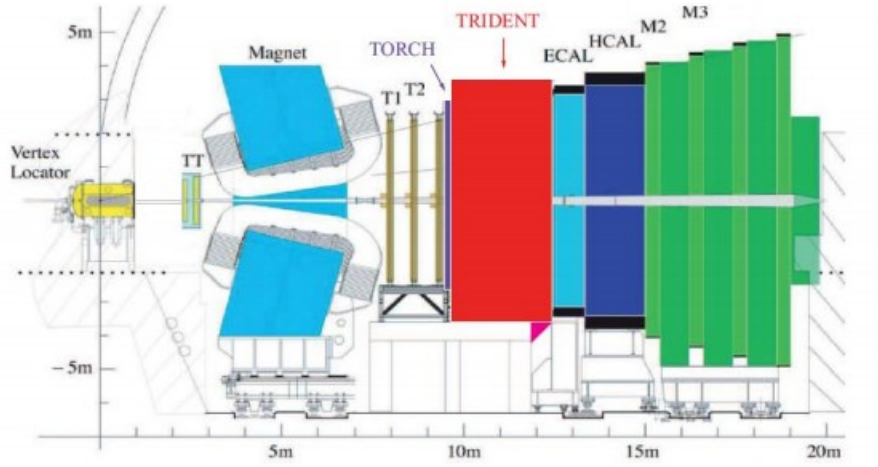
- Luminosity projection based on experience in Run 1 and updated schedules:

- 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 Options



"RICH2019"



"TRIDENT"

Purpose of the review meeting

RICH upgrade geometry design: 3 options

1) Retain current RICH-1 & RICH-2 geometry

   -> This option is much less preferred on grounds of reduced performance.

2) Re-design RICH-1 with new optical system

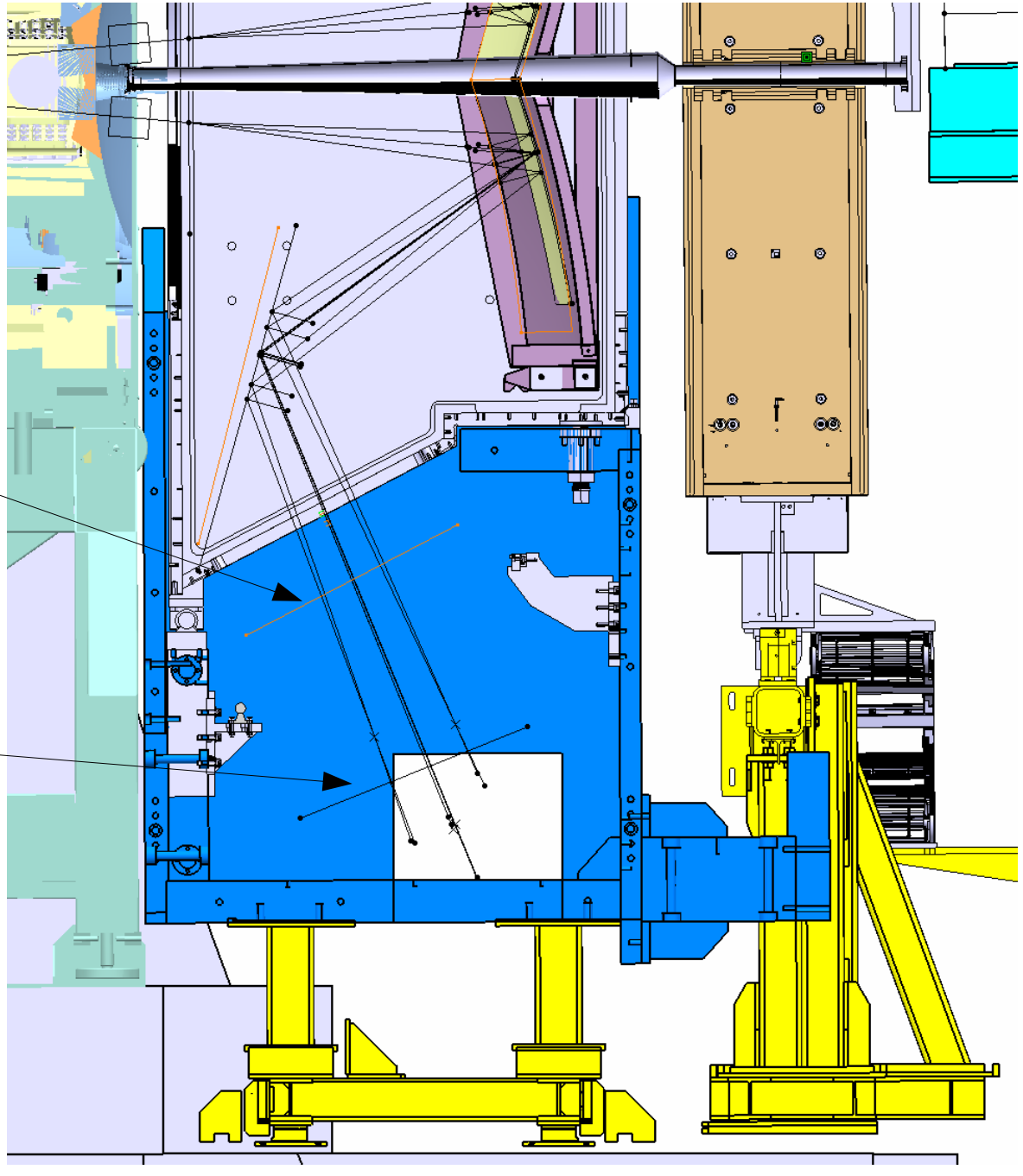
   -> We have now converged on a vertical configuration

3) Single RICH : "TRIDENT" concept

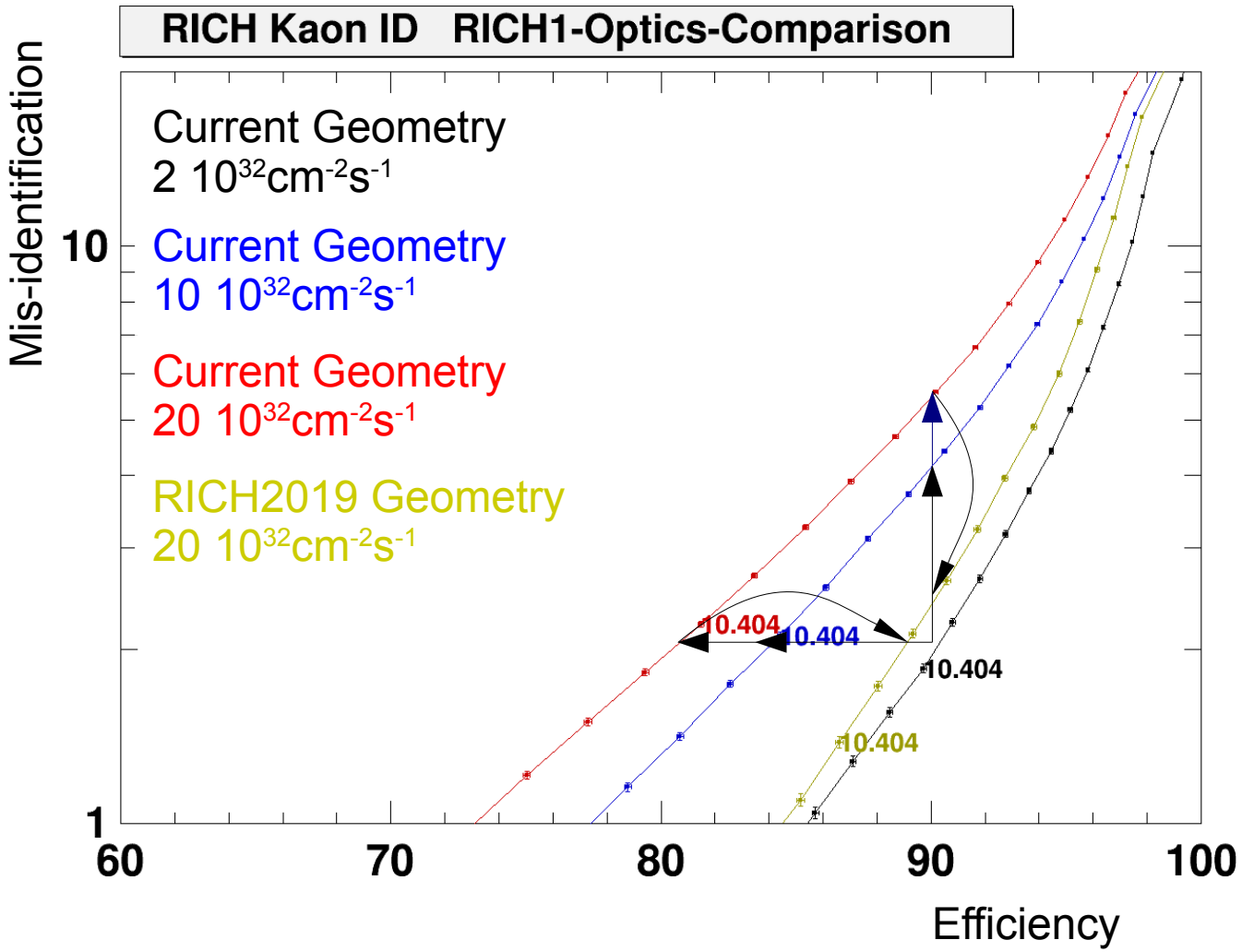
   -> Innovative design, possibly with improved performance over alternative

Today we need to converge on a solution to which the RICH group should reach consensus.

RICH2019 concept



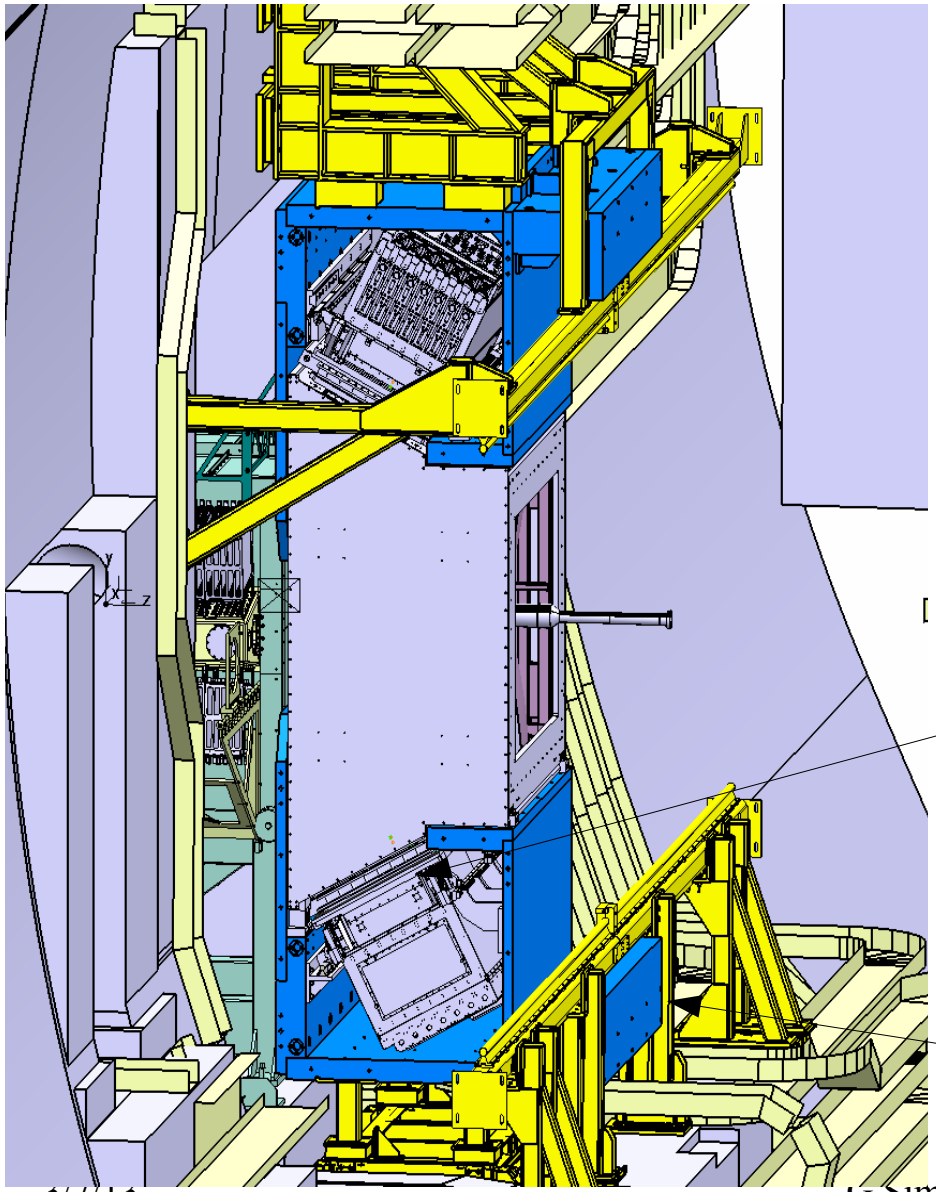
RICH2019 performance

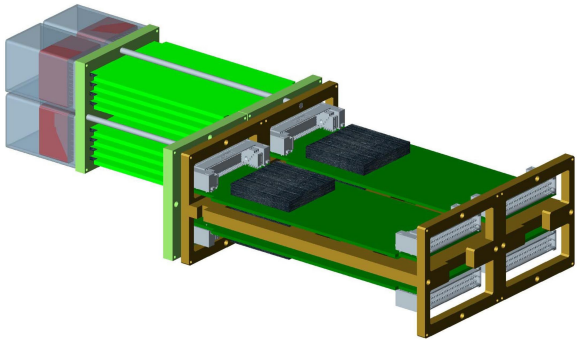


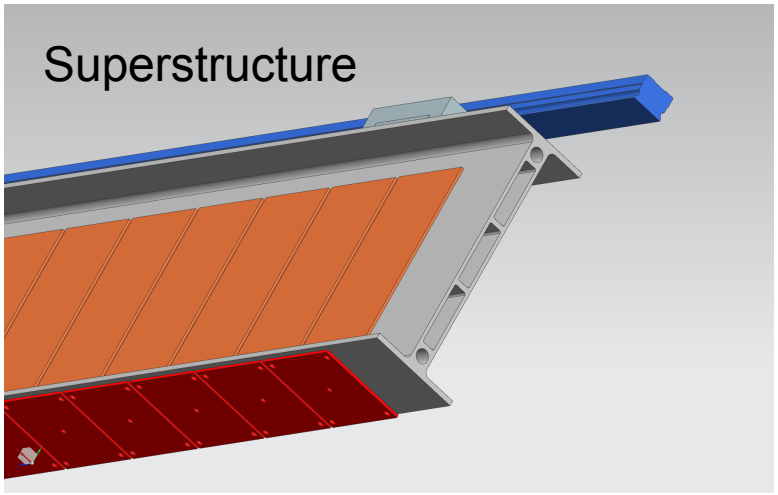
INFN Involvement in the RICH

- Design of front-end electronics (CLARO chip) [MI Bicocca, FE]
- PhotoDetector Module Assembly [GE]
- PDM mechanical superstructure, cooling, magnetic screening, extraction system [PD]
- MaPMT characterization [MI,FE,PD]
- Simulation [PD]

Padova Involvement: Mechanics



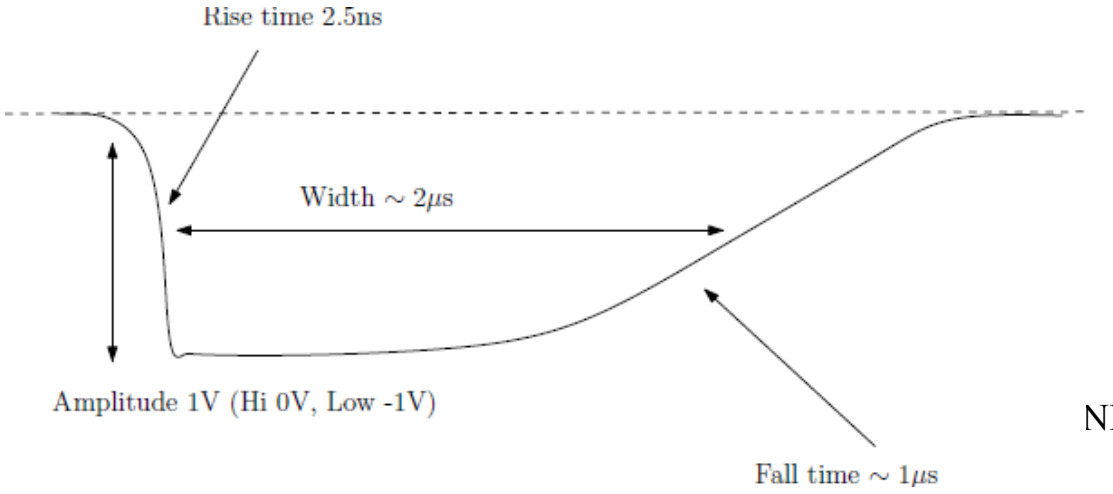


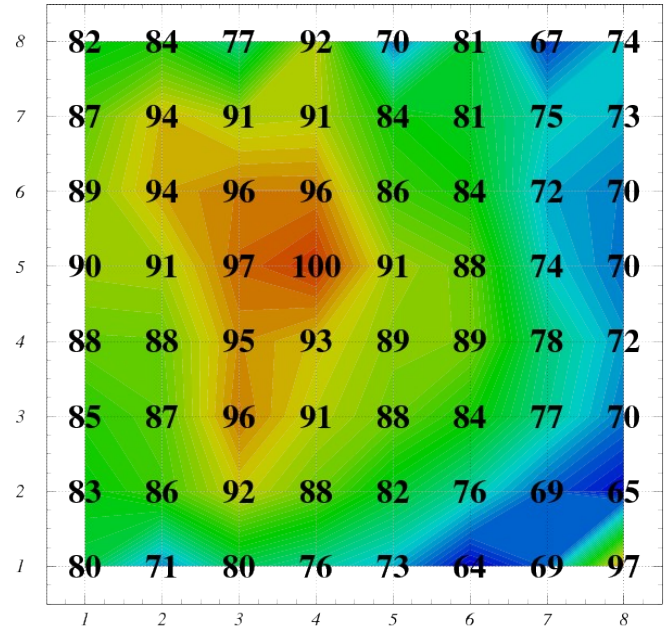


Sistema di convogliamento del flusso di B

Padova involvement: calibration of PMT response

- Idea by G.Collazuol
  - Use the dy12 pin to inject a charge signal on each pixel anode
  - Generate the signal using a 1V step function signal
- The response to the charge injection on dy12 is equivalent to a single photon signal
- With our setup (HV=1000V) and a wide bandwidth voltage amplifier the response to a single photon is
  - Pulse height=~60mV
  - FWHM=~1.3ns
- Check the uniformity of the response as a function of the position of the pixel
- Can be done with HV=0

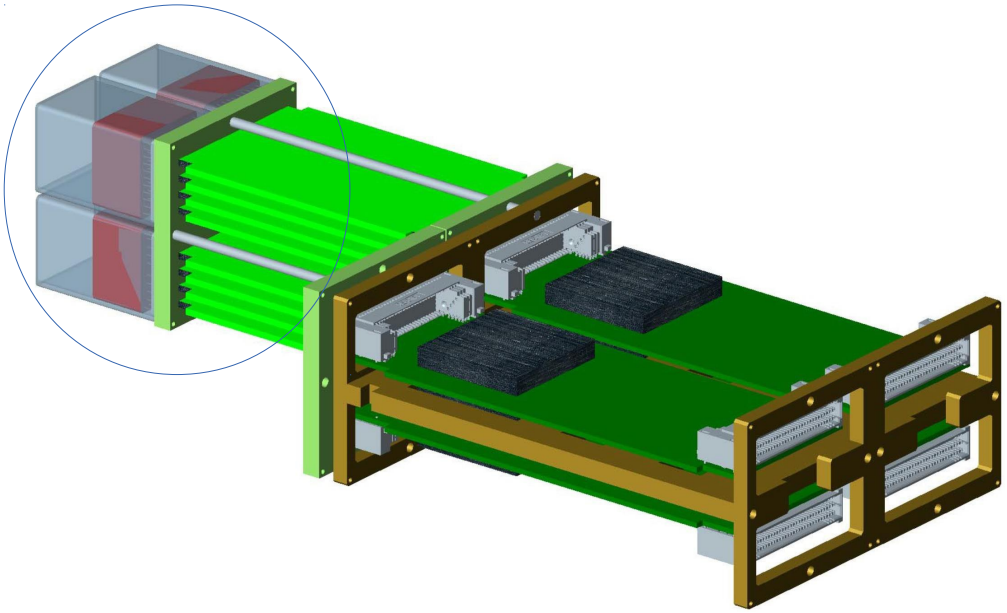


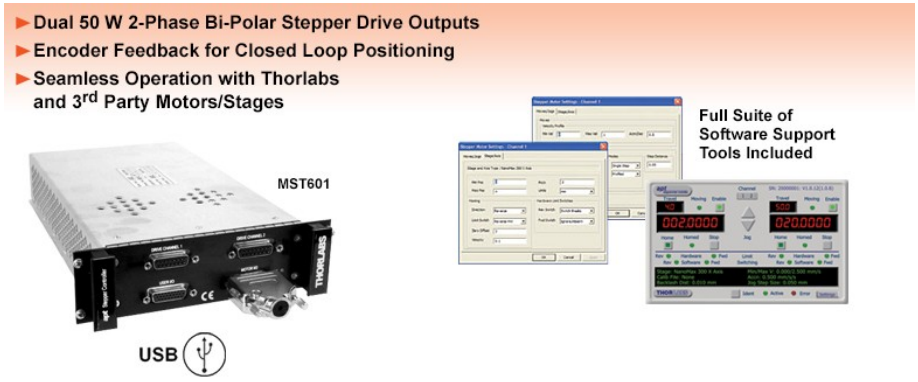


G.Simi
R.Stroili

Padova Involvement: MaPMT

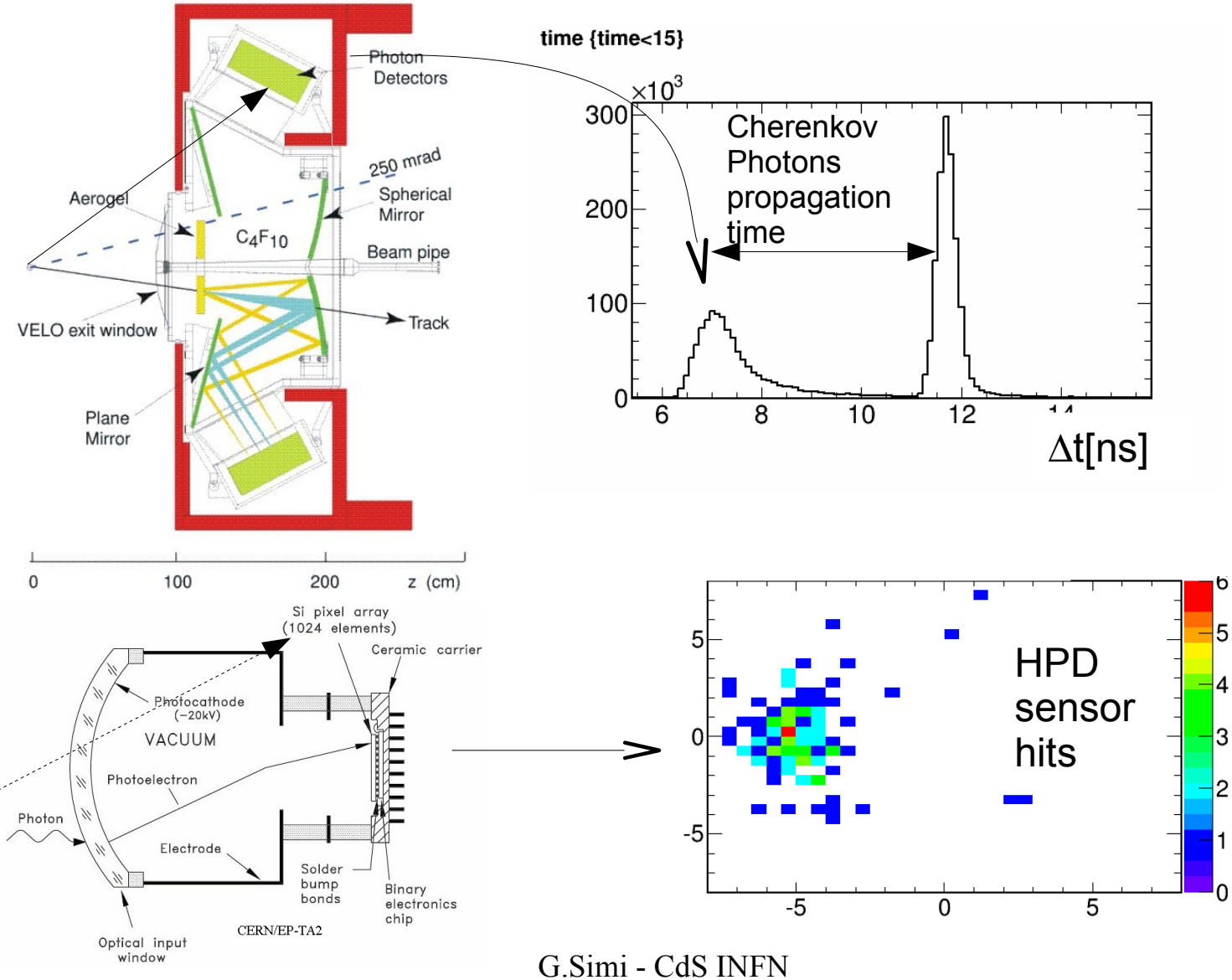
- Shield optimizaton
- Characterization
- ~5k MaPMT → automated setup in various institutions





M.Rotondo
R.Stroili

Padova Involvement: Simulation



Milestones

30/09/2013	Prototype Elementary Cell operating in the lab with readout board and prototype mechanics.
31/07/2014	Fully functional and complete prototype of a photo-detector module (PDM).
31/12/2014	Mechanics and front-end chip boards preproduction completed and qualified. Prototype supporting structure.
31/07/2015	Final design and qualification of EC, PDM and supporting structure.
31/12/2015	Mechanics and front-end boards production completed and qualified.
31/12/2016	50% of EC, PDM and supporting structure assembled and tested.
31/12/2017	Mechanics and front-end chip production completed and qualified
30/04/2019	Upgraded RICH installed and commissioned, ready for data taking

Servizi e richieste 2014

- Meccanica
  - 40% M.Benettoni
  - ~9 mesi u. disegnatore
  - ~9 mesi u. officina meccanica
  - Preproduzione superstruttura meccanica: 20KE
- Stazione test MaPMT
  - 33kE a luglio su fondi ex-SuperB (non parte del core LHCb upgrade)
  - 3-6 mesi u. di tecnico elettronico di laboratorio + 0% Flavio per supporto progettazione amplificatori
  - 2 mesi serv. progettazione Elettronica x
    - Amplificatore 64 ch per MaPMT
    - Scheda x circuito iniezione carica
- Completamento stazione su fondi 2014:
  - 5.4kE per HV, 14kE per 2 teste per laser PiLas
- Costruzione apparati: alcuni acquisti anticipati al 2014
  - MaPMT: ~45KE (da discutere lunedi')

Backup

Richieste x stazione test (anticipabili al 2013 su fondi ex SuperB)

item	quantità	costo
Tavolo con smorzamento vibrazioni	1	€ 2,000.00
assi movimentazione x-y	1	€ 6,000.00
digitizer caen V1742	1	€ 7,000.00
dark box + accessori ottici	1	€ 3,000.00
aggiornamento sistema di misura dell'efficienza quantica (fotomoltiplicatore calibro, amplificatore, PC, fibre)	1	€ 5,000.00
fototubi Hamamatsu R11265	2	€ 4,000.00
costruzione amplificatori	64	€ 5,000.00
bobina di Helmotz	1	€ 1,000.00
TOTALE		###

In discussione, da finalizzare entro la prox settimana

Upgrade tasks

		Bristol	Glasgow	RAL	Birmingham	Oxford	Edinburgh	Cambridge	Imperial	CERN	Milano	Genoa	Padua	Ferarra
WP1: Simulation, optimisation & reconstruction														
	1.1 Optimizing geometrical layout													
	1.2 Optimisation of photon optics						X							
	1.3 Simulation - Gauss							X						
	1.4 Pattern recognition and ring reconstruction		X					X						
	1.5 Offline monitoring		X					X						
WP2: Photon Detectors														
	2.1 Characterisation of photon detectors						X	X						
	2.2 Testbeam verification		X			X	X	X						
	2.3 Simulation of photon-detector properties						X							
	2.4 Photon detector production testing		X				X							
	2.5 Photon detector monitoring						X							
	2.6 Magnetic shields						X							
WP3: Detector Mechanics and Optics														
	3.1 Mechanical support structure for photon detectors					X	X							
	3.2 Mechanical design of RICH structure/ gas enclosure					X								
	3.3 RICH optics mechanical design					X							??	
	3.4 Mirror mounts					X	X						??	
	3.5 Lenses						X							
	3.6 Seals to beam pipe/exit/entrance windows					X								
	3.7 Mechanical superstructure for photon detectors and services					X								
	3.8 Cooling					X								
	3.9 Optical monitoring and alignment gear					X								
	3.1 MDCS					X	X							
	3.11 RICH installation equipment					X								
WP4: Electronics Readout & Data Acquisition														
	4.1 Front-end electronics readout, Claro/MAROC & evaluation						X	X						
	4.2 Production of Claro/MAROC cards							X						
	4.3 Prototype/design and fabricate front-end (“Level-0”) readout board					X		X						
	4.4 Front-end FPGA firmware & data suppression					X	X	X						
	4.5 Data links and off-detector readout (Tell-40)					X		X						
	4.6 HV													
	4.7 LV							X						
	4.8 Experimental control (ECS)/ readout software/ configuration software					X		X						
	4.9 Detector (slow) control (DCS)													
	4.1 Demonstration of the full PID readout chain at 40 MHz (Testbeam)					X	X	X						