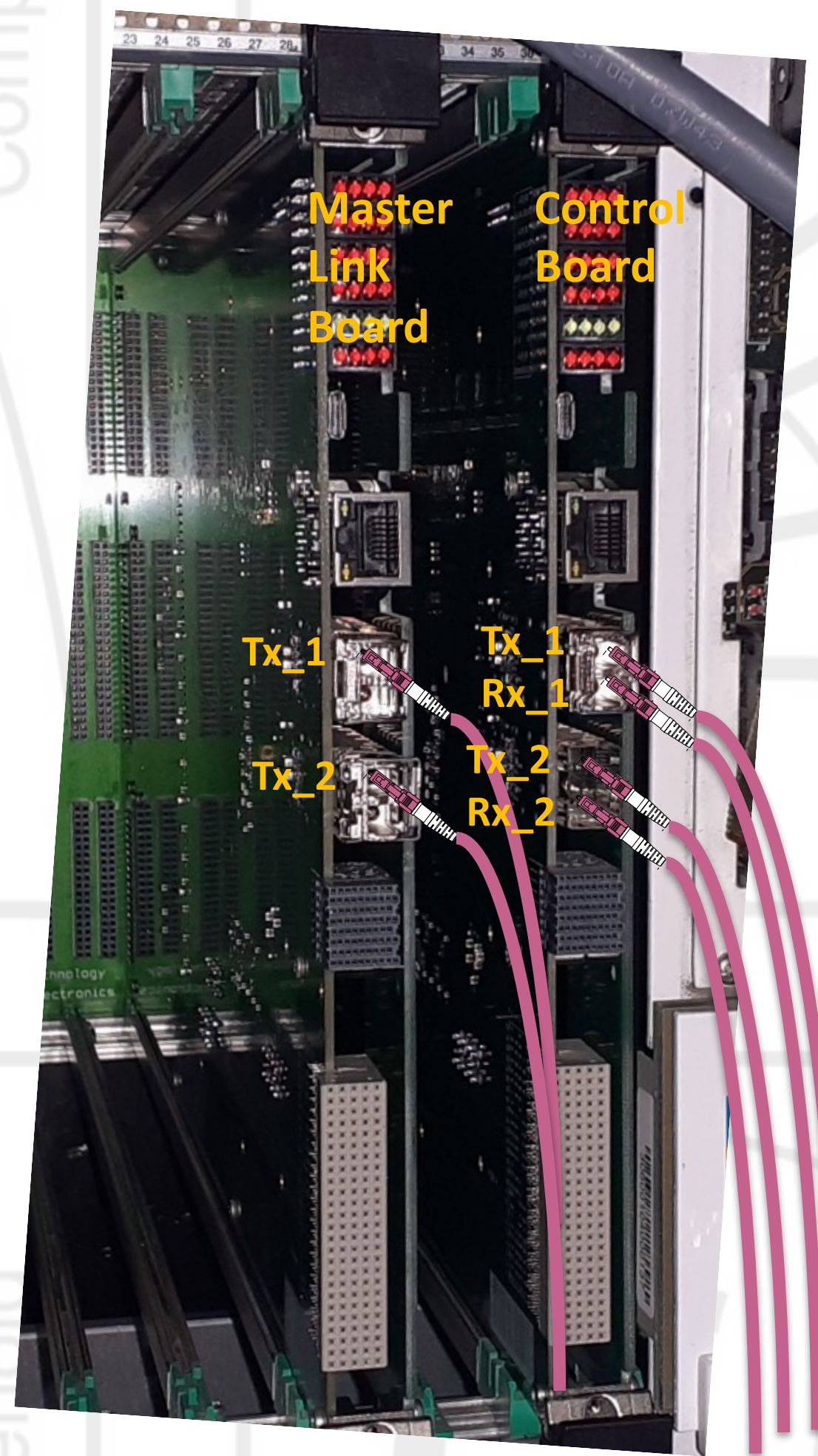
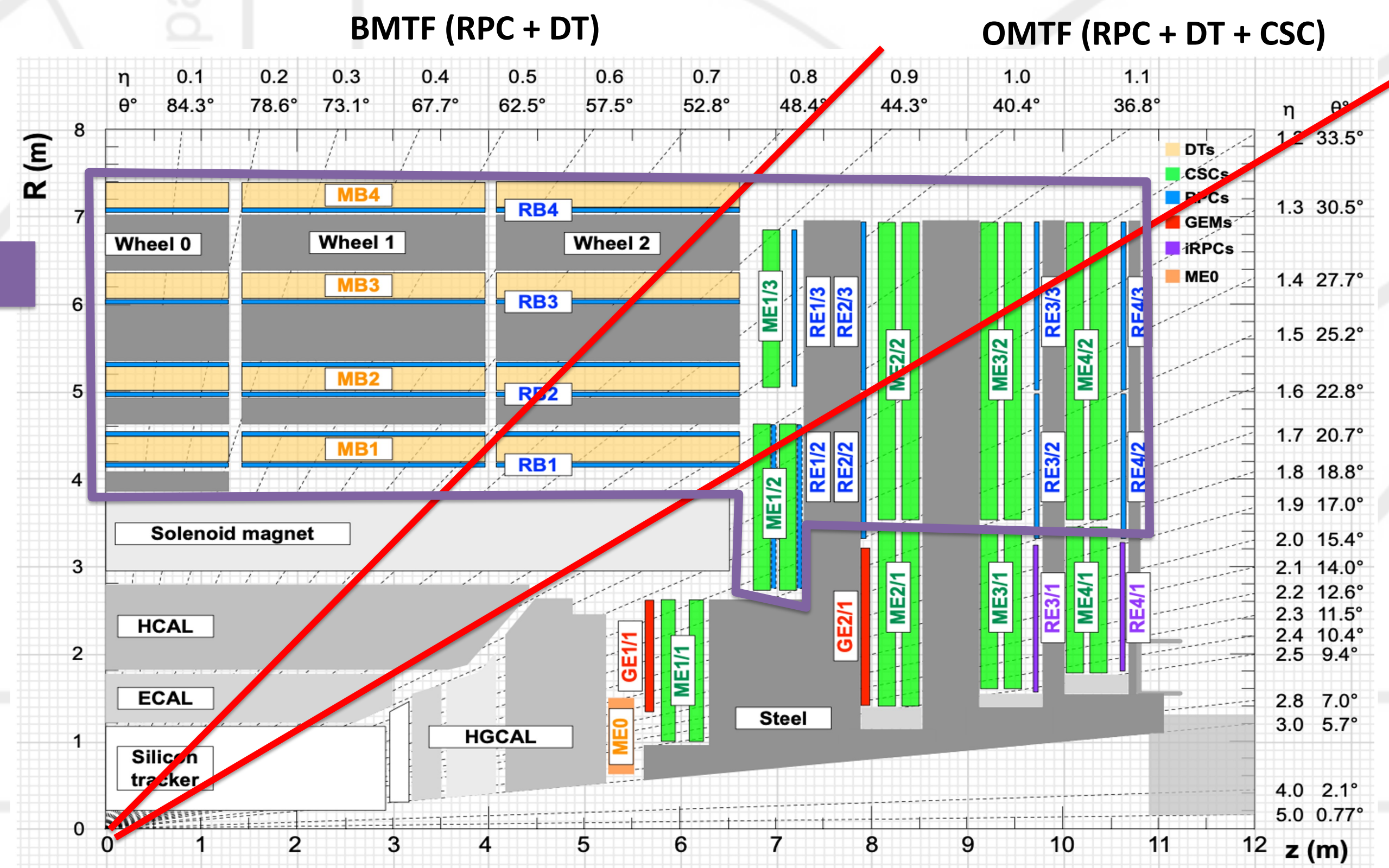
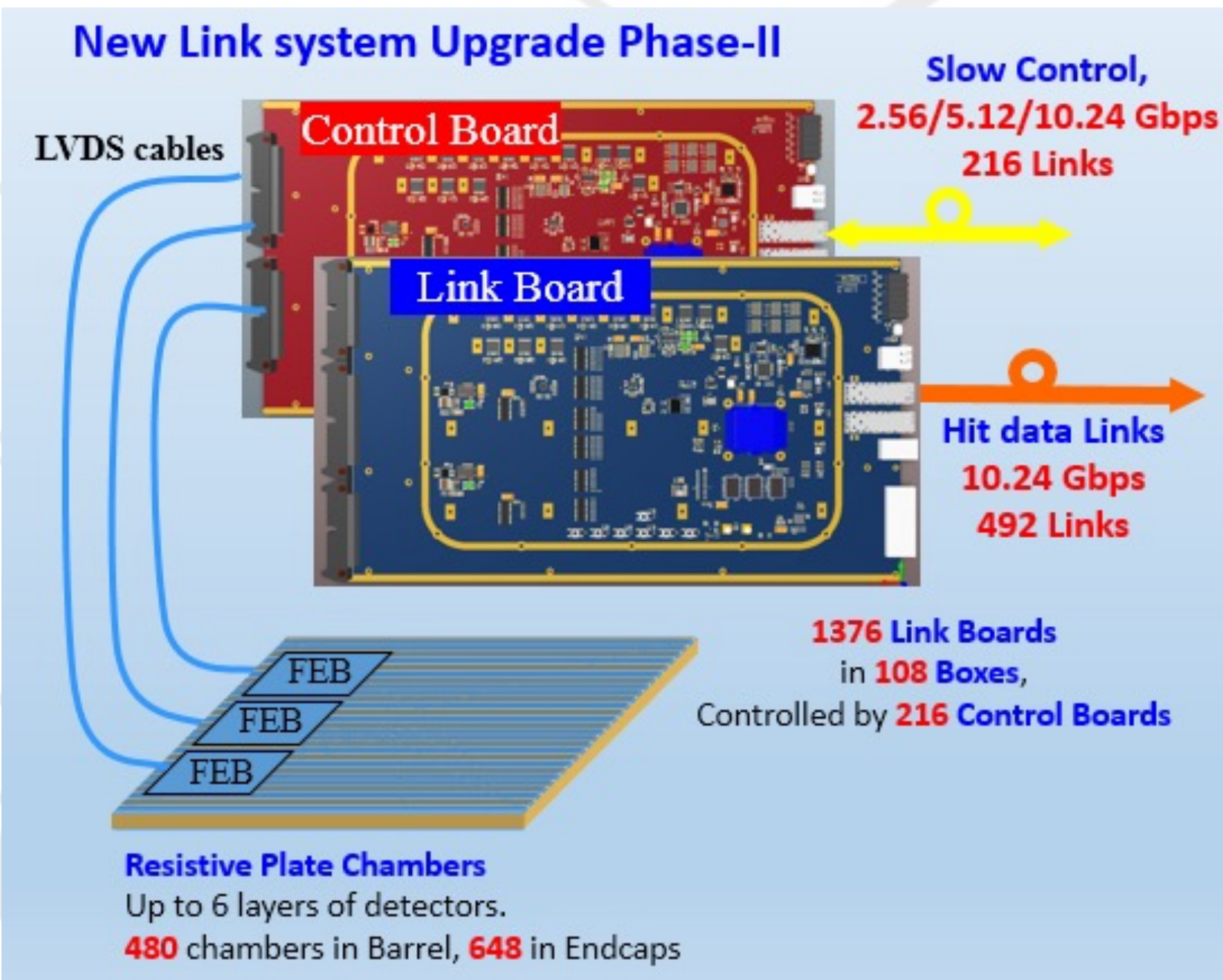


# CMS RPC Link System fiber planning and qualification

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On behalf of the CMS Collaboration



## RPC Link System Upgrade



The new Link System will replace the present RPC Link system during LS3 using high-performance electronics.

**Key parameters:**

- This will improve the time resolution from 25 ns to 1.56 ns.
- Data transmission will be increased from 1.6 Gbps to 10.24 Gbps for the Master Link board
- Control Board communication with RPC Backend electronics: 4.8 Gbps

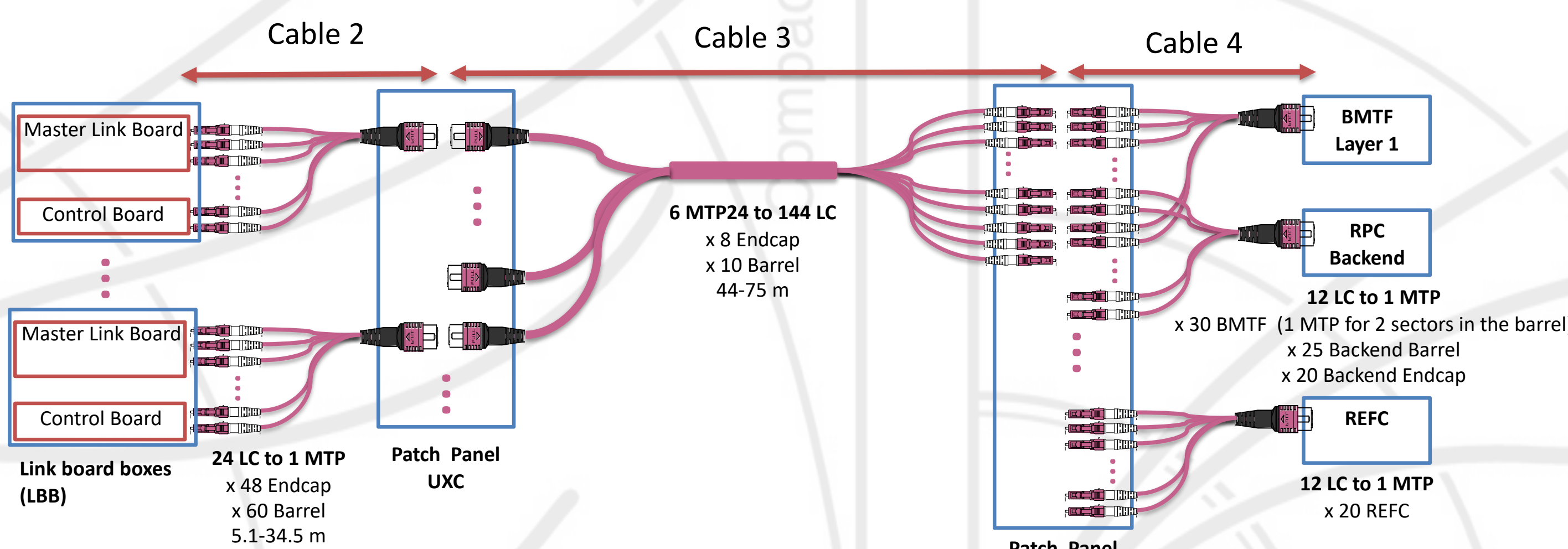
- The Master Link board design includes a redundant transmission channel (Tx<sub>2</sub>)
- The Control board design includes two redundant channels, one for transmission (Tx<sub>2</sub>) and one for reception (Rx<sub>2</sub>).
- The splitting of the signal is needed for OMTF, this is solved with the additional Tx<sub>2</sub>.

## Fibers to be procured for the new Link System

Barrel	Used	For redundancy	Spares	Total
Fibers per Sector	9	9	6	24
Fibers per Trigger tower	54	54	36	144
Total Fibers Barrel	540	540	360	1440

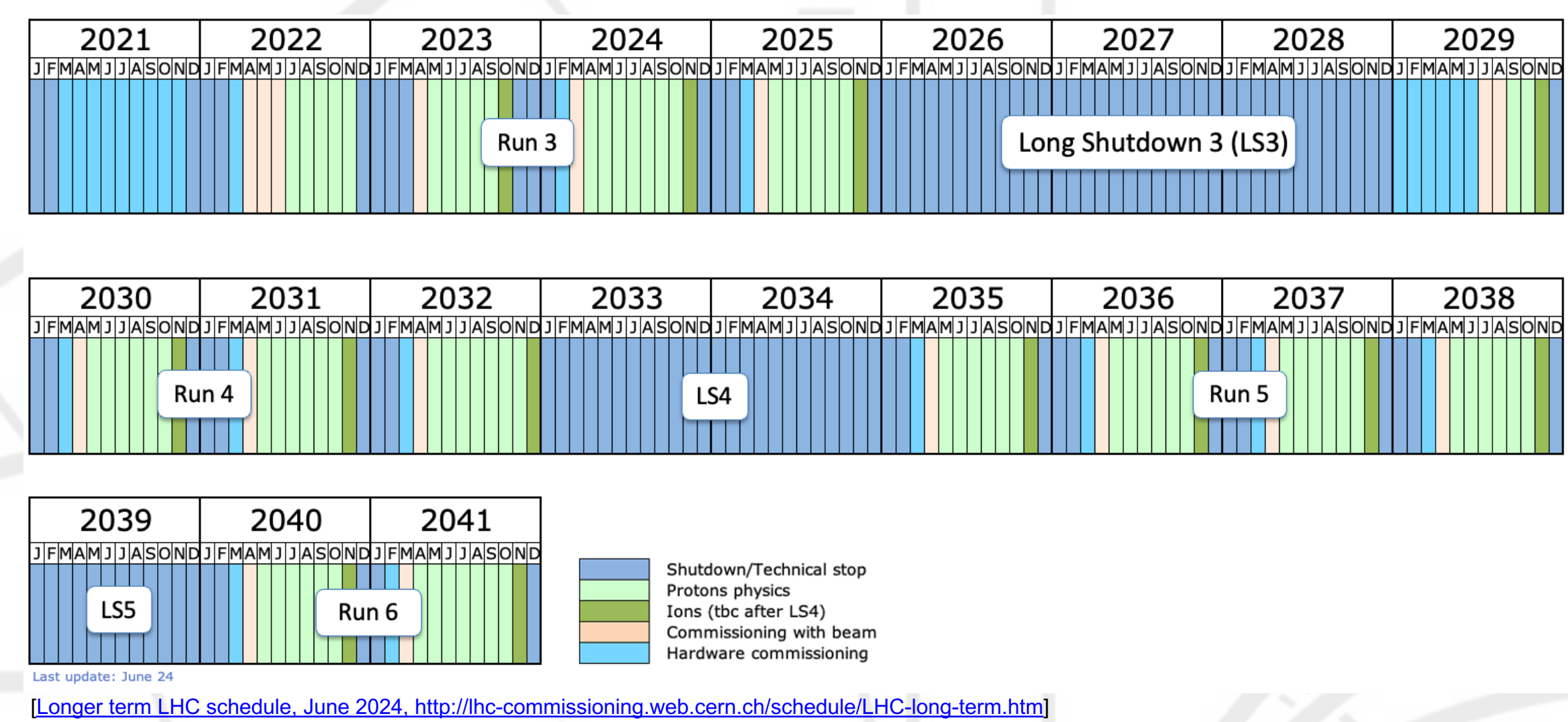
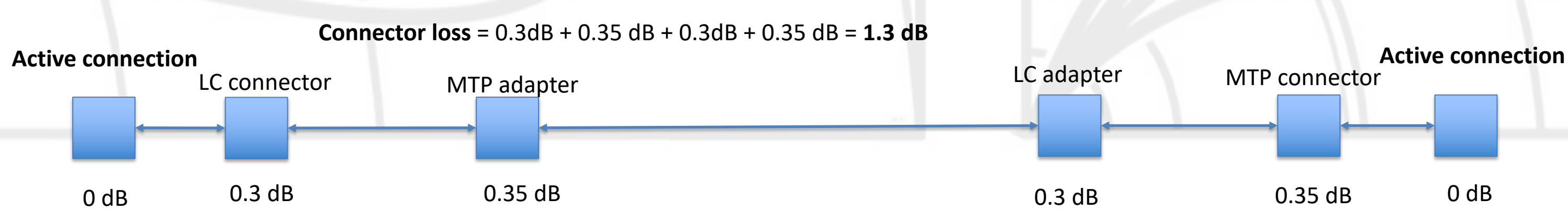
Endcap	Used	For redundancy	Spares	Total
Fibers per Sector	8	8	8	24
Fibers per Trigger tower	48	48	48	144
Total Fibers Endcap	384	384	384	1152

- A total of 1440 (barrel) and 1152 (endcap) OM4 fibers (including spares) to connect the RPC Master Link boards and Control boards in UXC to:
  - RPC Backend for fibers from the Control boards.
  - Barrel Layer 1 (BMTF L1) for fibers from the Barrel Master Link boards.
  - RPC Endcap Cluster Finder (REFC) for fibers from the Endcap Master Link boards.



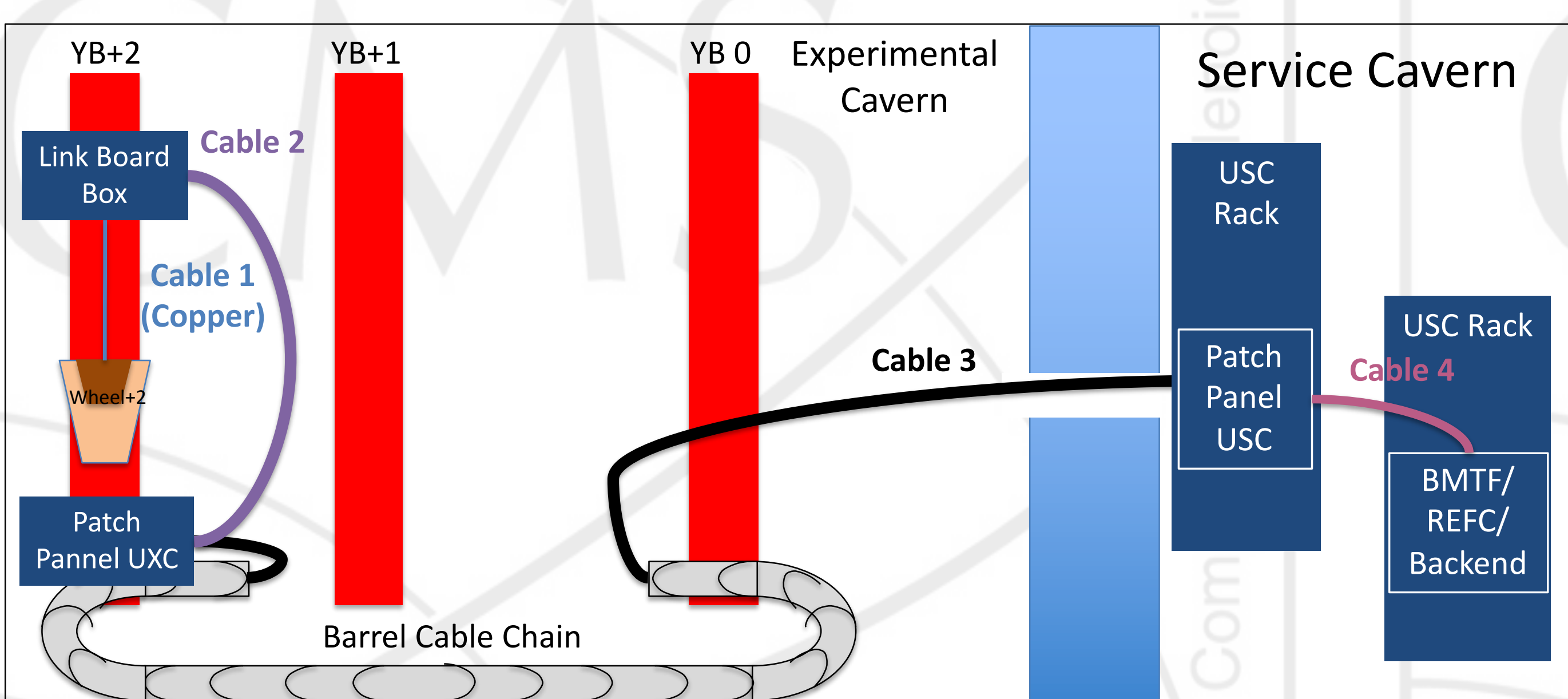
**General requirements for the fibers**

- OM4 multimode fiber
- Cores phosphorous-free
- Cables with Low Smoke Zero Halogen (LSZH) jacket

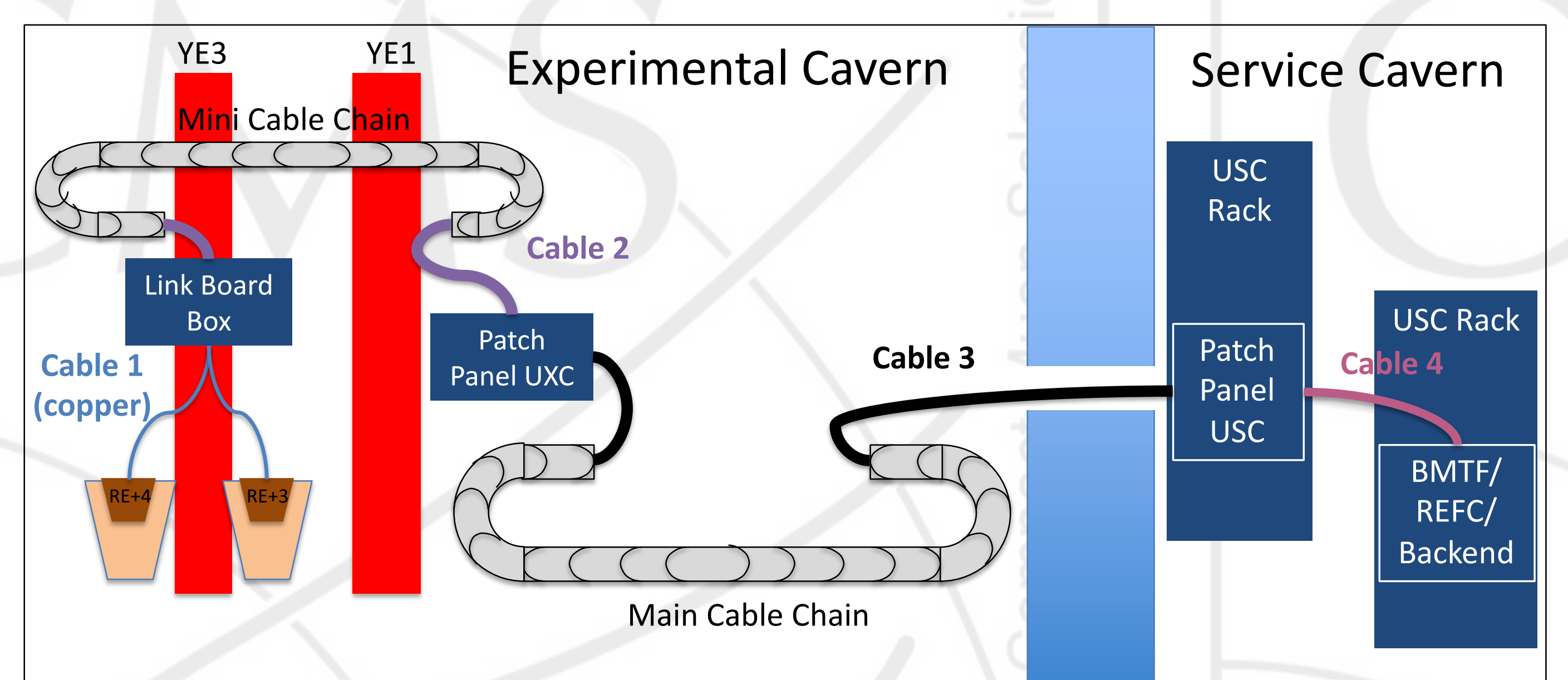


Maximum fiber length = 120 m  
Fiber type = OM4  
Total channel insertion loss = (fiber length x loss) + Connector loss + Splice loss  
= 120 m x 2.5 dB/km + 1.3 dB + 0 dB  
= 0.3 dB + 1.3 dB = 1.6 dB

## Fiber routing schematic for the Barrel

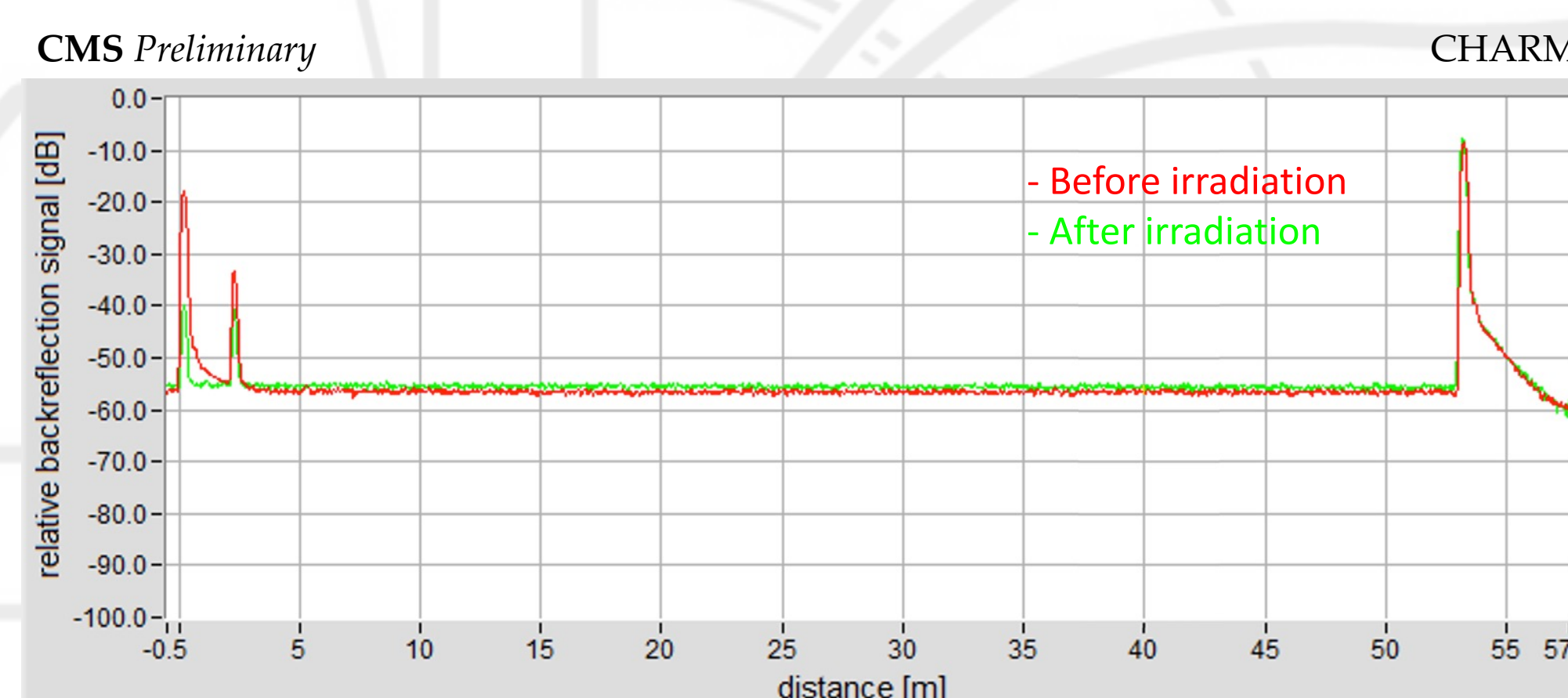
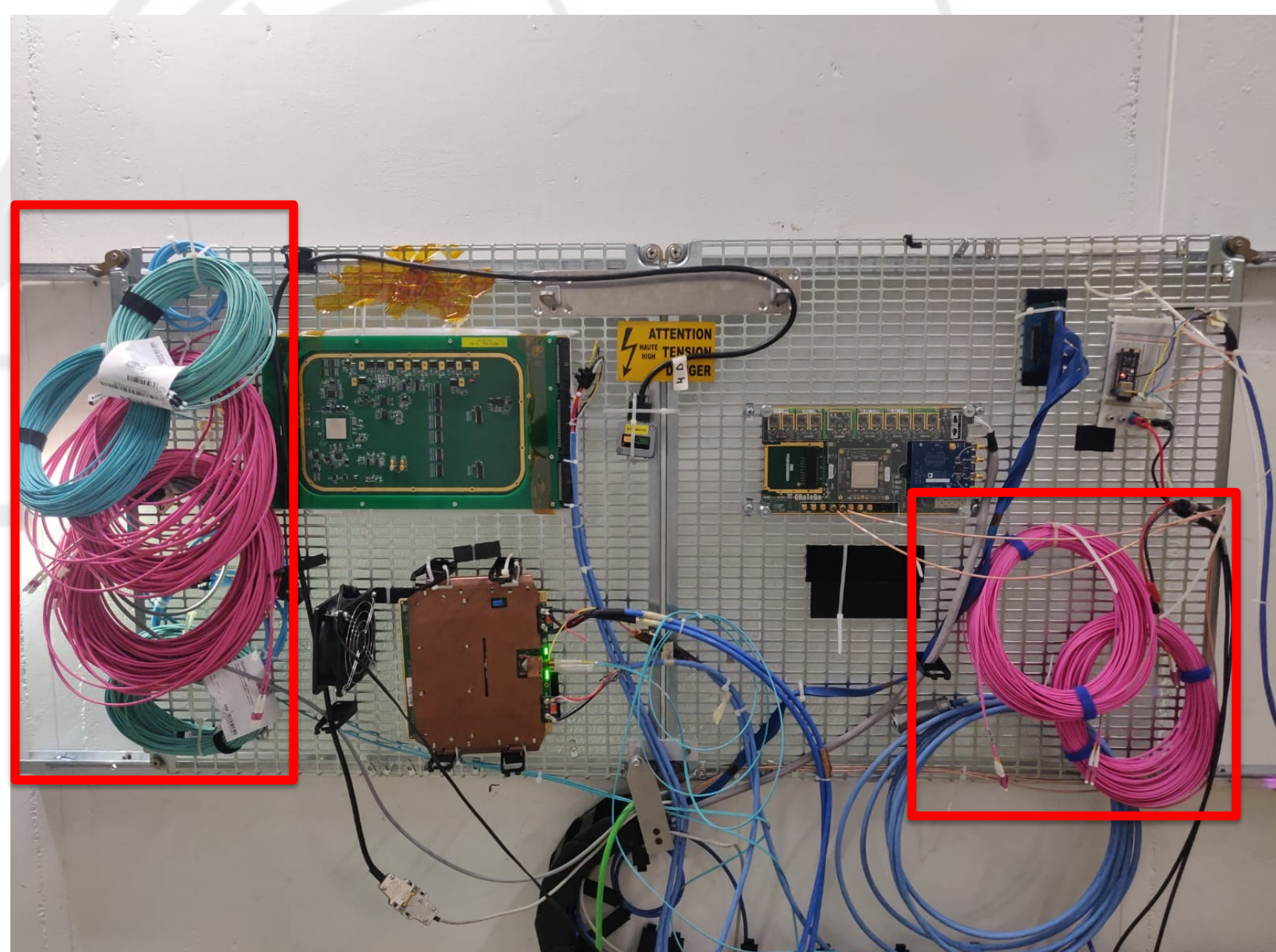


## Fiber routing schematic for the Endcap



## Irradiation test at CHARM with fiber samples

CHARM (CERN High energy Accelerator Mixed field facility) is a CERN radiation test facility.



The data obtained with the OTDR (optical time domain reflectometer) show no significant attenuation effect on the optical fiber after the CHARM irradiation period, corresponding to 147 Gy of received dose. Based on this result, these fibers meet the total integrated dose requirements equivalent to ten years of HL-LHC operation, 10-12 Gy, with a safety factor close to 15.

**Acknowledgments**

We thank the CERN accelerator department for its efforts to provide an excellent LHC performance and the CMS collaboration for the outstanding operation of the CMS detector. In addition, we thank the administrative department of Science, Technology and Innovation of Colombia (COLCIENCIAS) for the financial support provided.

## Conclusion

The installation and testing of the optical fibers is a crucial step to achieve the commissioning of the new Link System that will be installed during the LHC LS3. The design and routing for the optical fiber connection between the new Link System and the RPC backend/BMTF/REFC is ready. The CHARM test shows that the effect of attenuation due to radiation is not significant. The next step, which is acquiring the fiber, is in process.