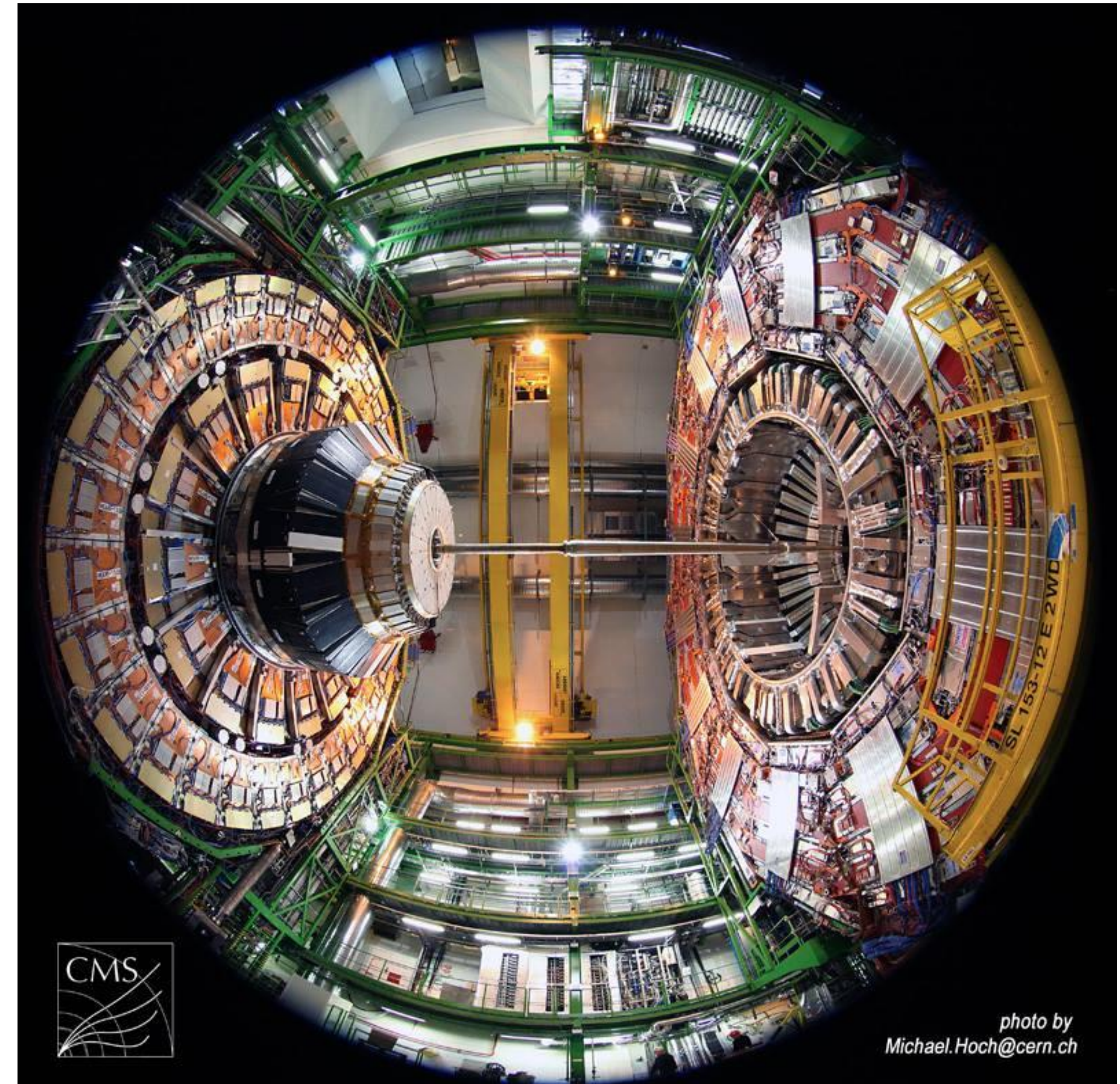


Muon System @ GIF++

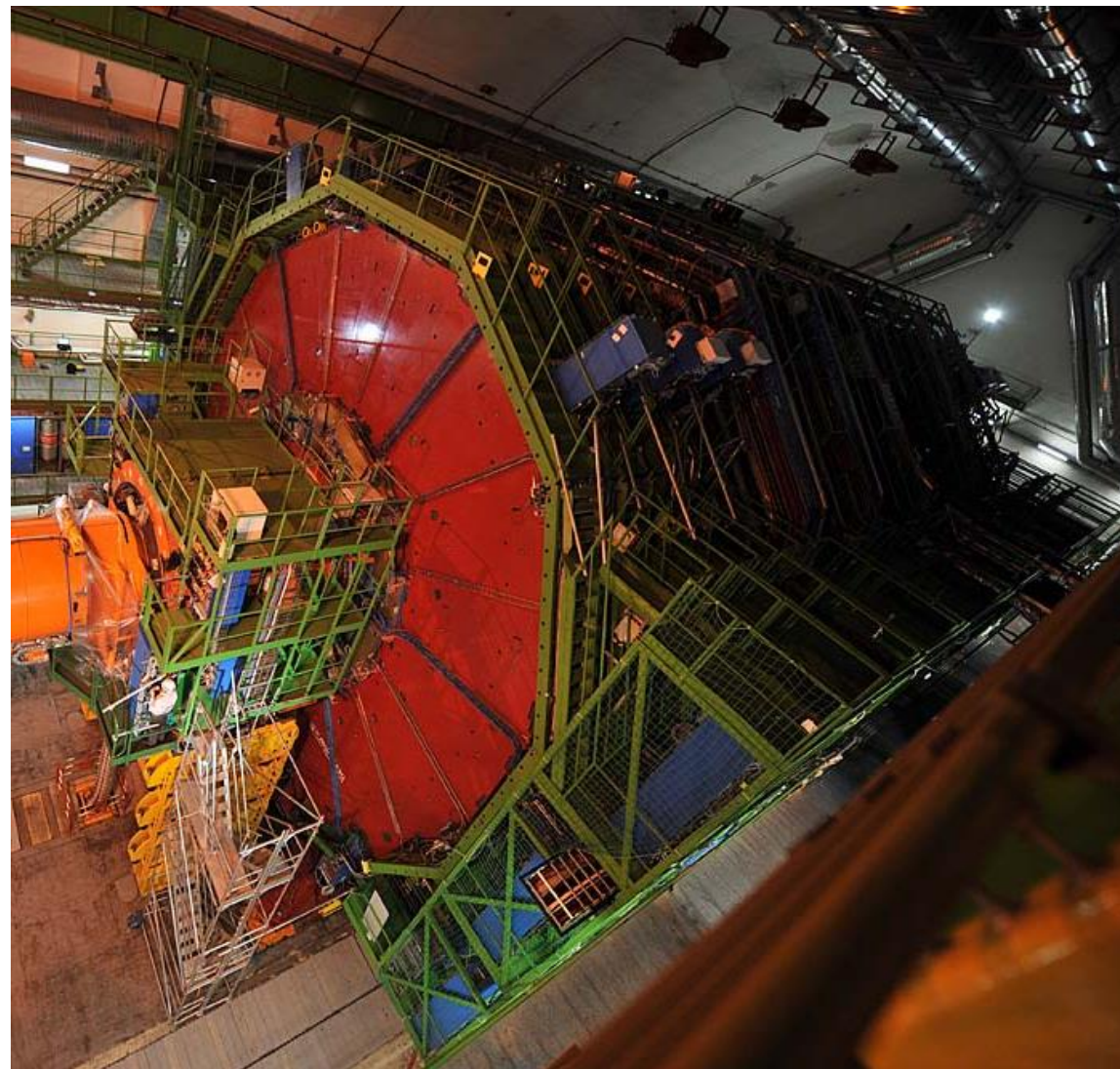
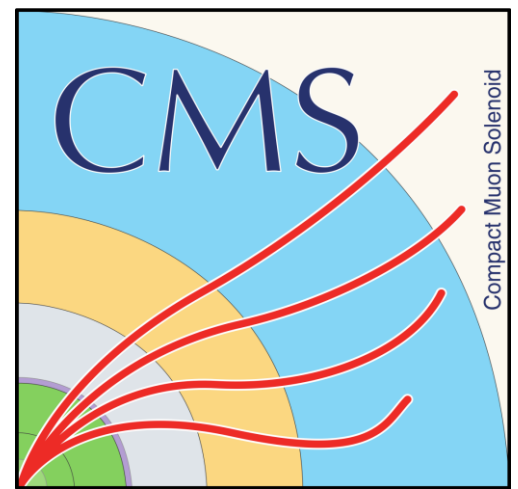
Gabriella Pugliese
INFN and Politecnico of Bari

on behalf of the CMS Muon group

5th Annual GIF++ User Meeting



The CMS Muon spectrometer @ LHC



The CMS Muon spectrometer was designed to provide **muon identification, timing and momentum measurements and excellent triggering** at LHC conditions (with a nominal luminosity of 10^{34} Hz/cm²) ...

...and to be a robust and redundant system

Barrel region:

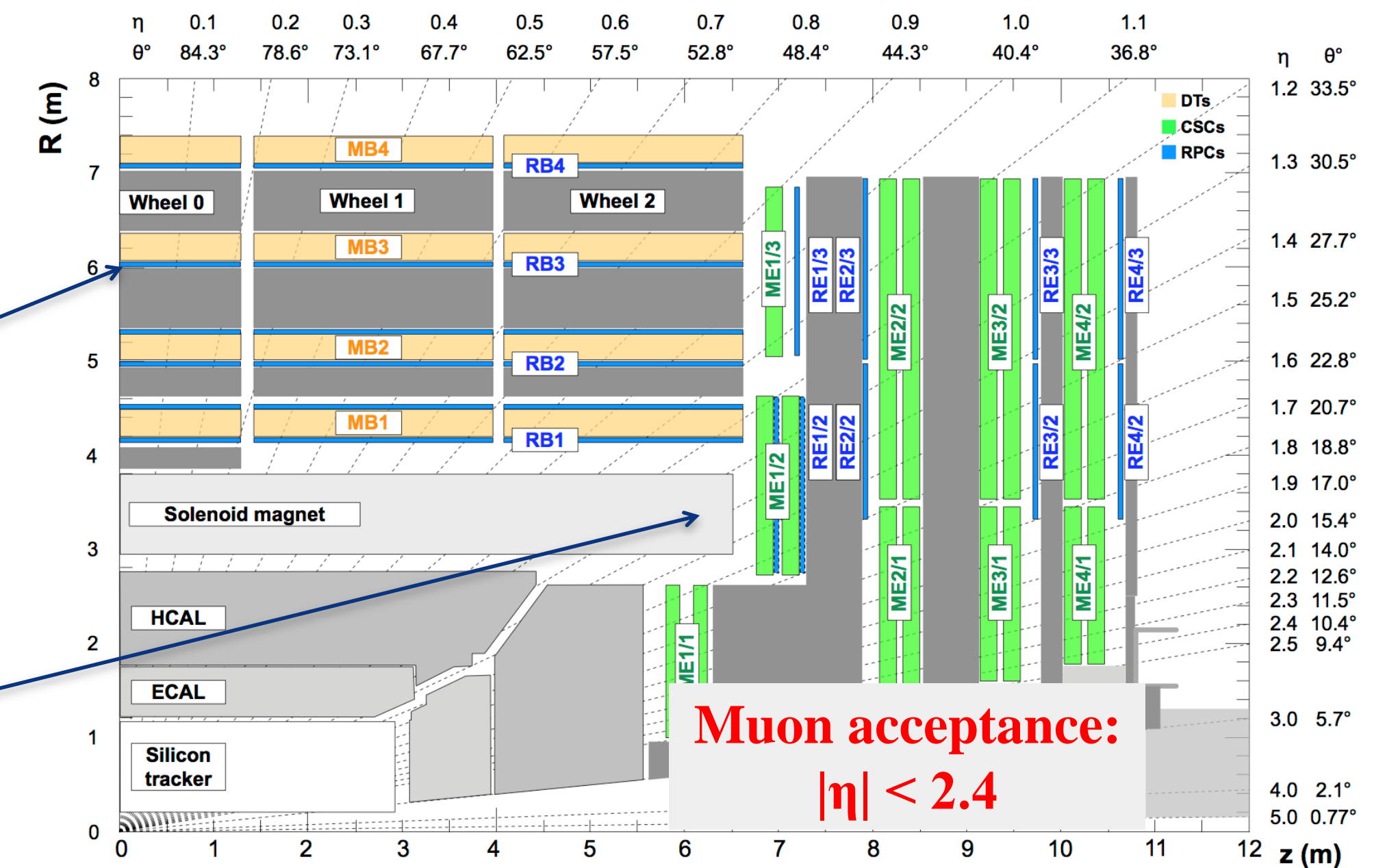
Drift Tube & Resistive Plate Chamber

4 coaxial stations interleaved with the steel return yoke plates, grouped into **5 wheels** around the beam line

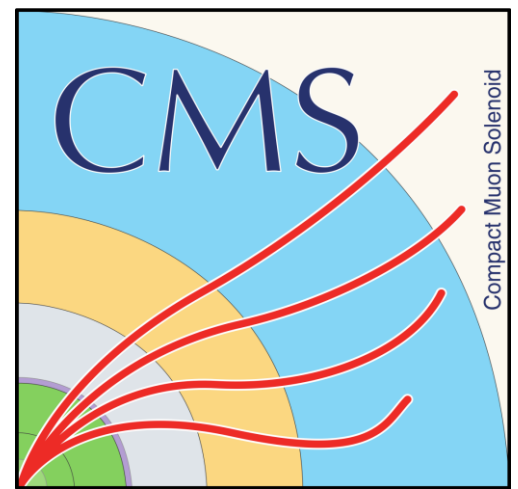
Endcap region:

Cathode Strips Chambers & RPC

4 planar stations (disks) interleaved with the steel return yoke plates



The muon Upgrade Project for HL-LHC



A reminder of the Muon Upgrade Project scope:

1. Longevity and ecological gas mixture studies

2. New electronics for the legacy detectors:

DT: replace all on-board electronics (OBDT), BE

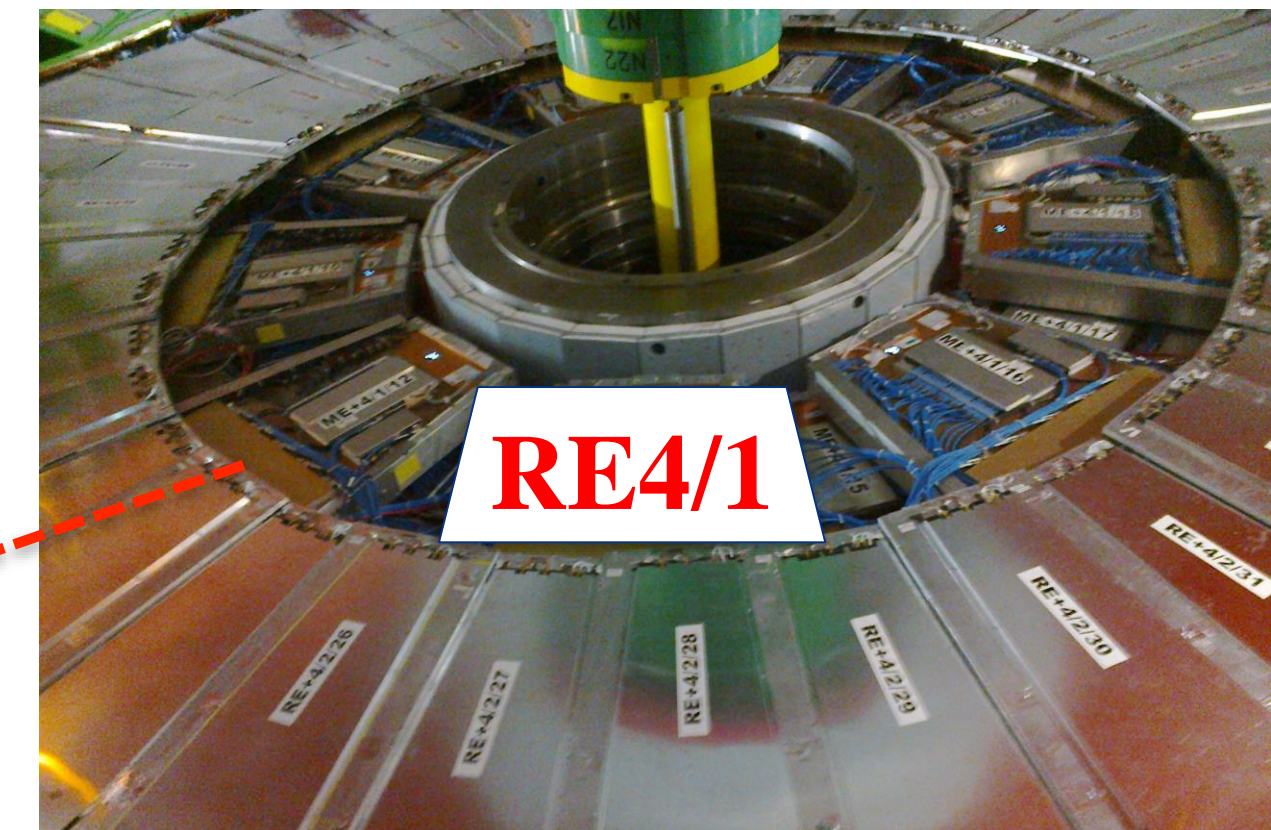
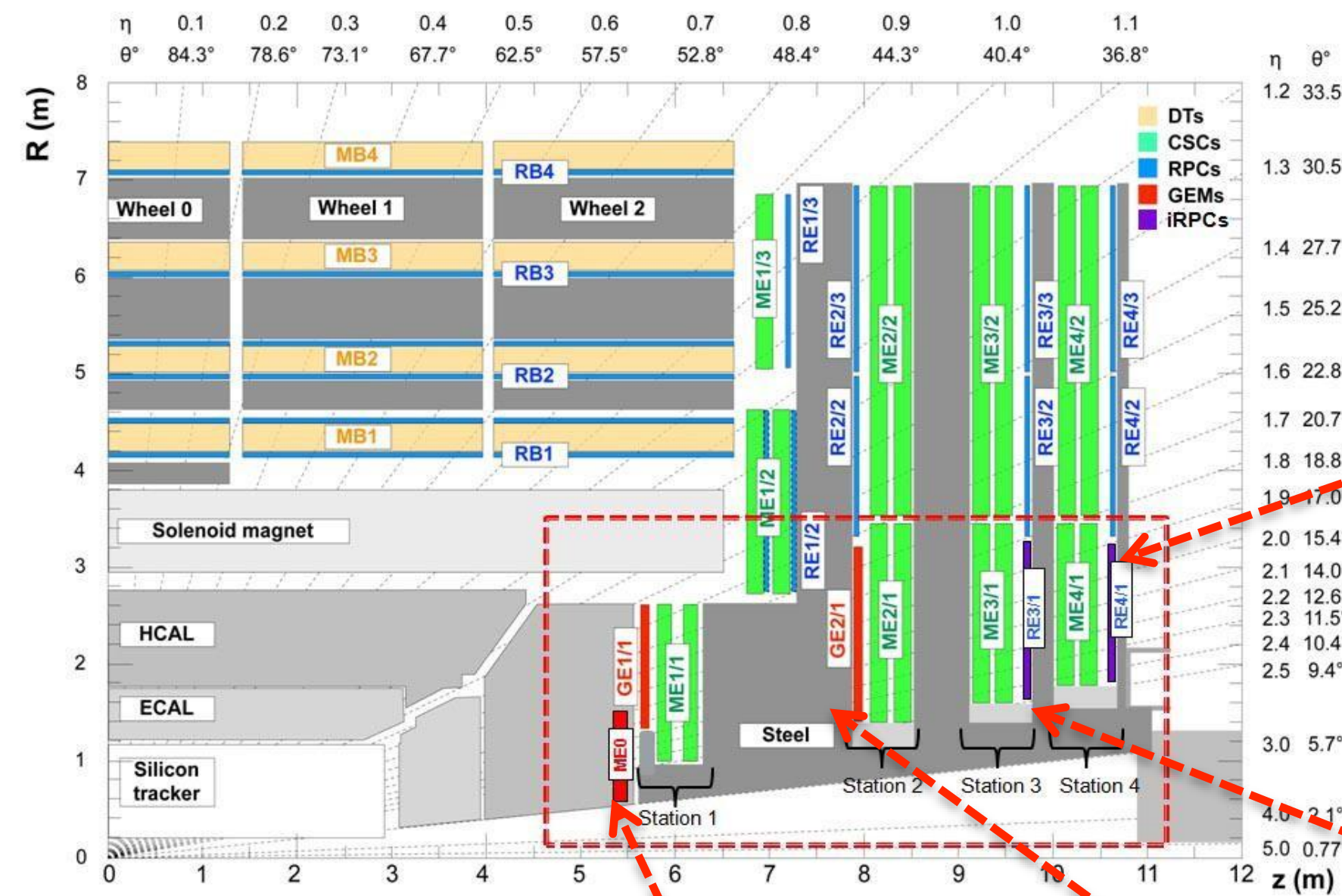
RPC: replace all off-chamber electronics, BE

CSC: replace selected FE boards, replace all BE

3. New detectors to enhance the challenging forward region:

restore redundancy and extend the muon coverage up $\eta = 2.8$

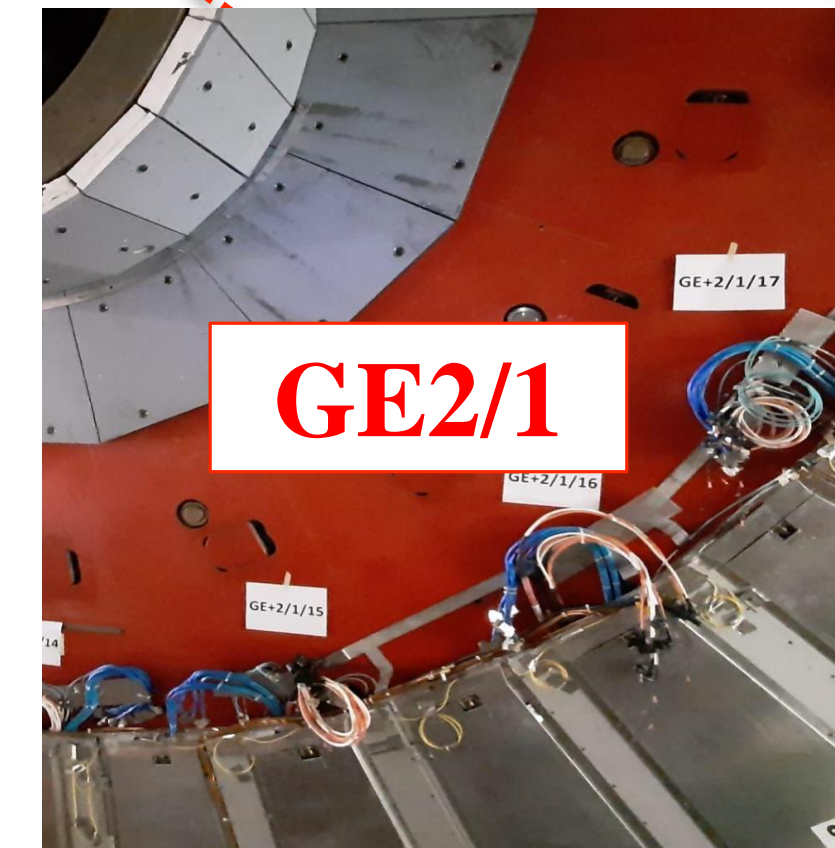
GE1.1 station installed in LS2



ME0



GE1/1

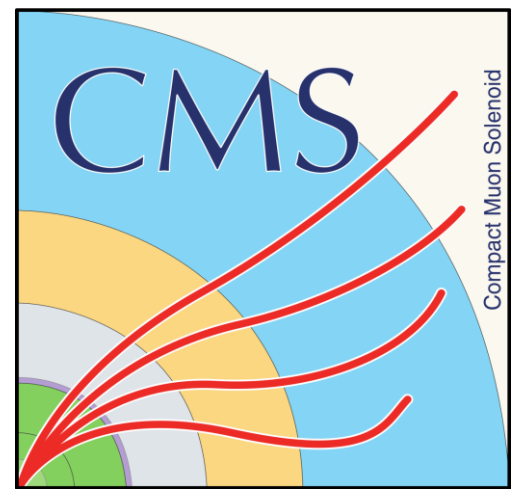


GE2/1



RE3/1

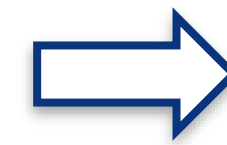
Why new longevity studies are important for the CMS Muon System



- In view of the HL-LHC a new certification is needed:

CMS Muon TDR: CERN-LHCC-97-032

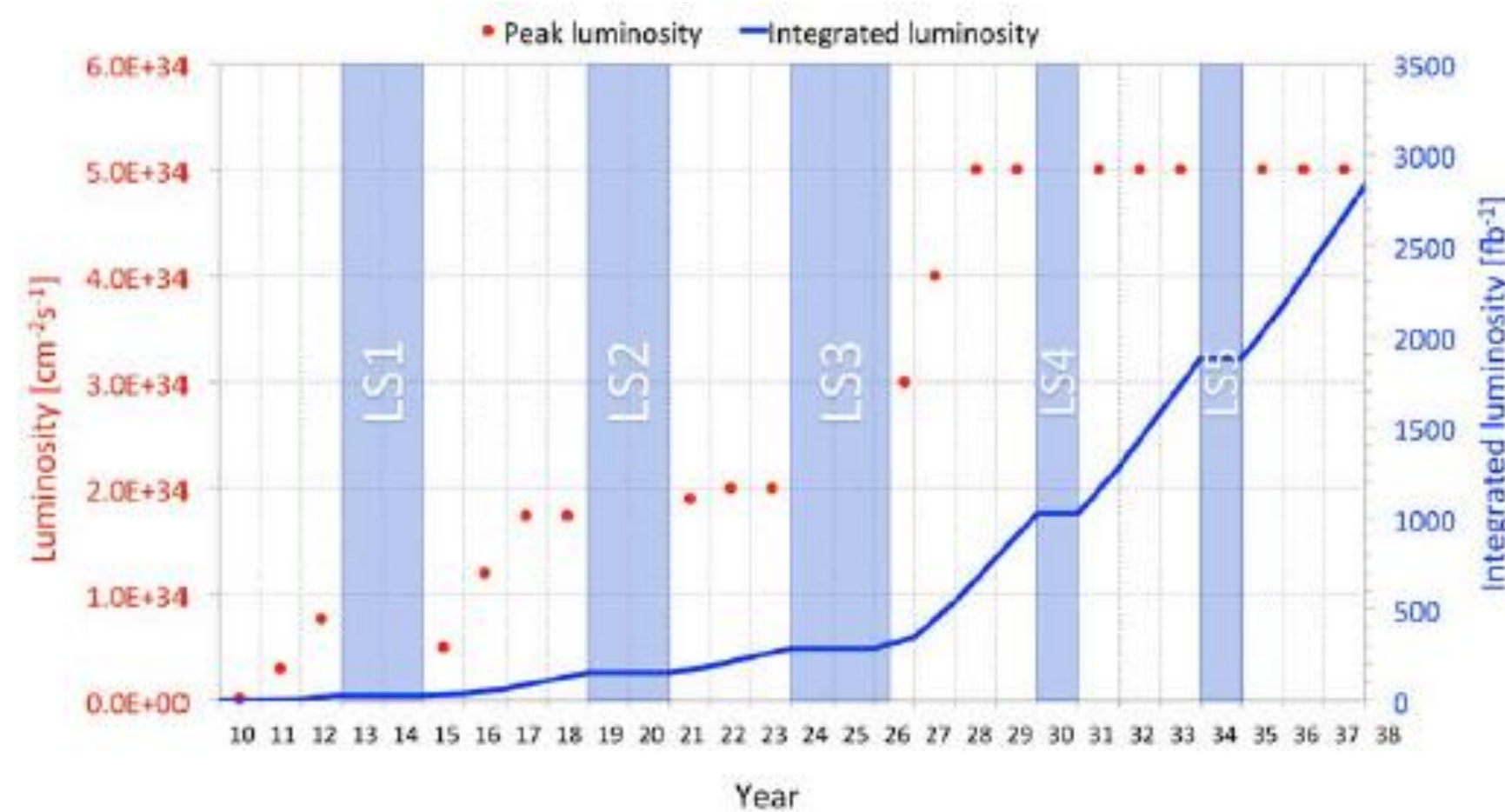
- Muon stations certified for 10 year of LHC (up to 2020).
- Maximum luminosity of $10^{34} \text{cm}^{-2}\text{s}^{-1}$
- Integrated luminosity 300fb^{-1}



Phase 2 Muon TDR

➤ **From 10 to 28 years**

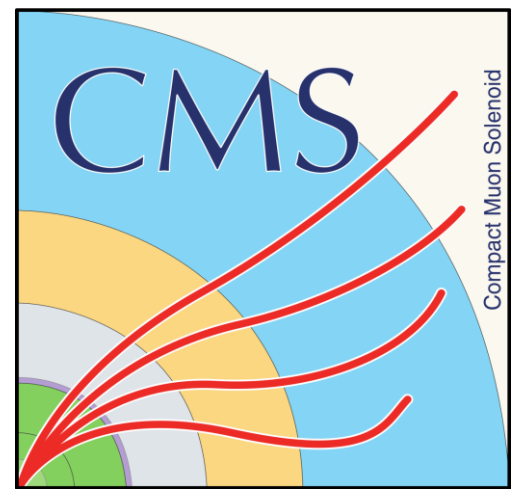
- Maximum luminosity up to 5 (7.5) $10^{34} \text{cm}^{-2}\text{s}^{-1}$
- Integrated luminosity 3000 (4000) fb^{-1}



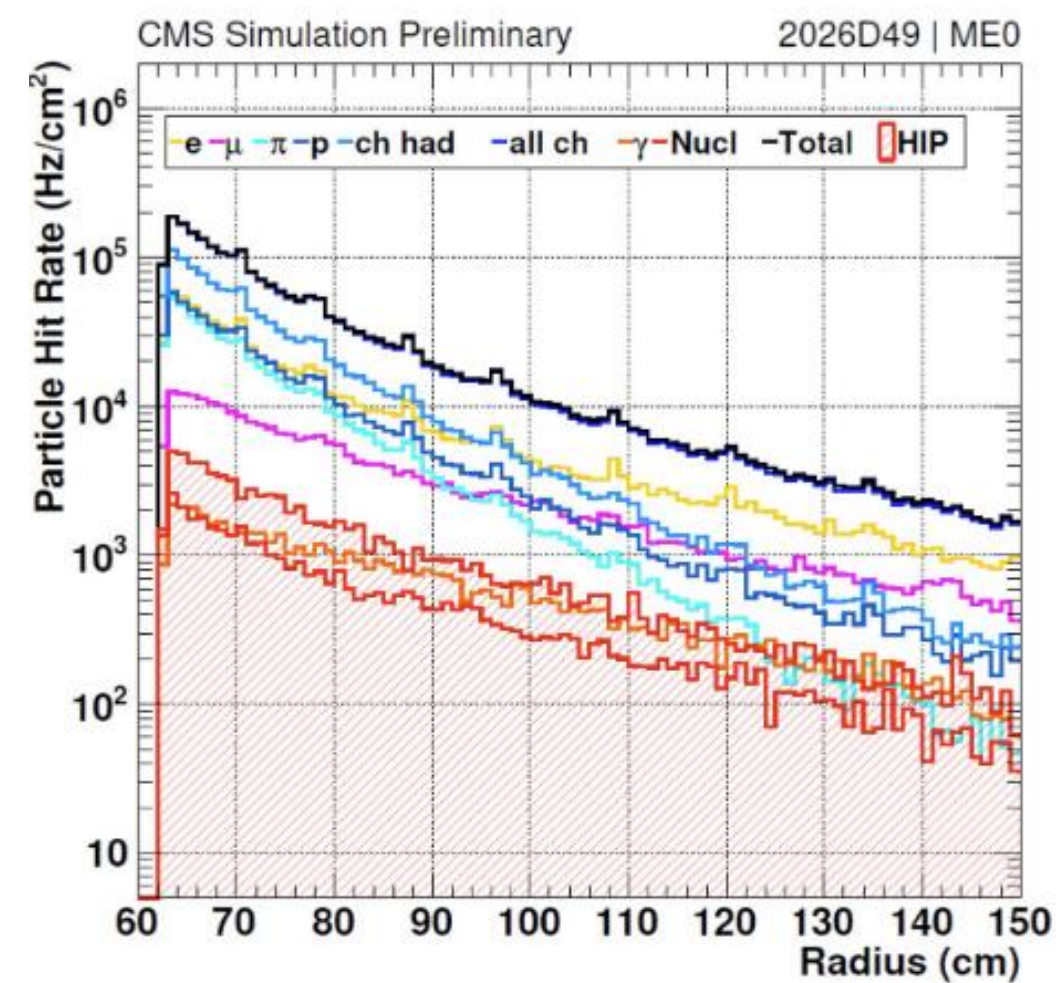
- In view of a reduction of the Green House Gaseous emission an R&D program to search for a new gas mixtures is needed.

CSC and RPC detectors use gas mixture with fluorine component.

New gaseous detector in the high eta region of CMS

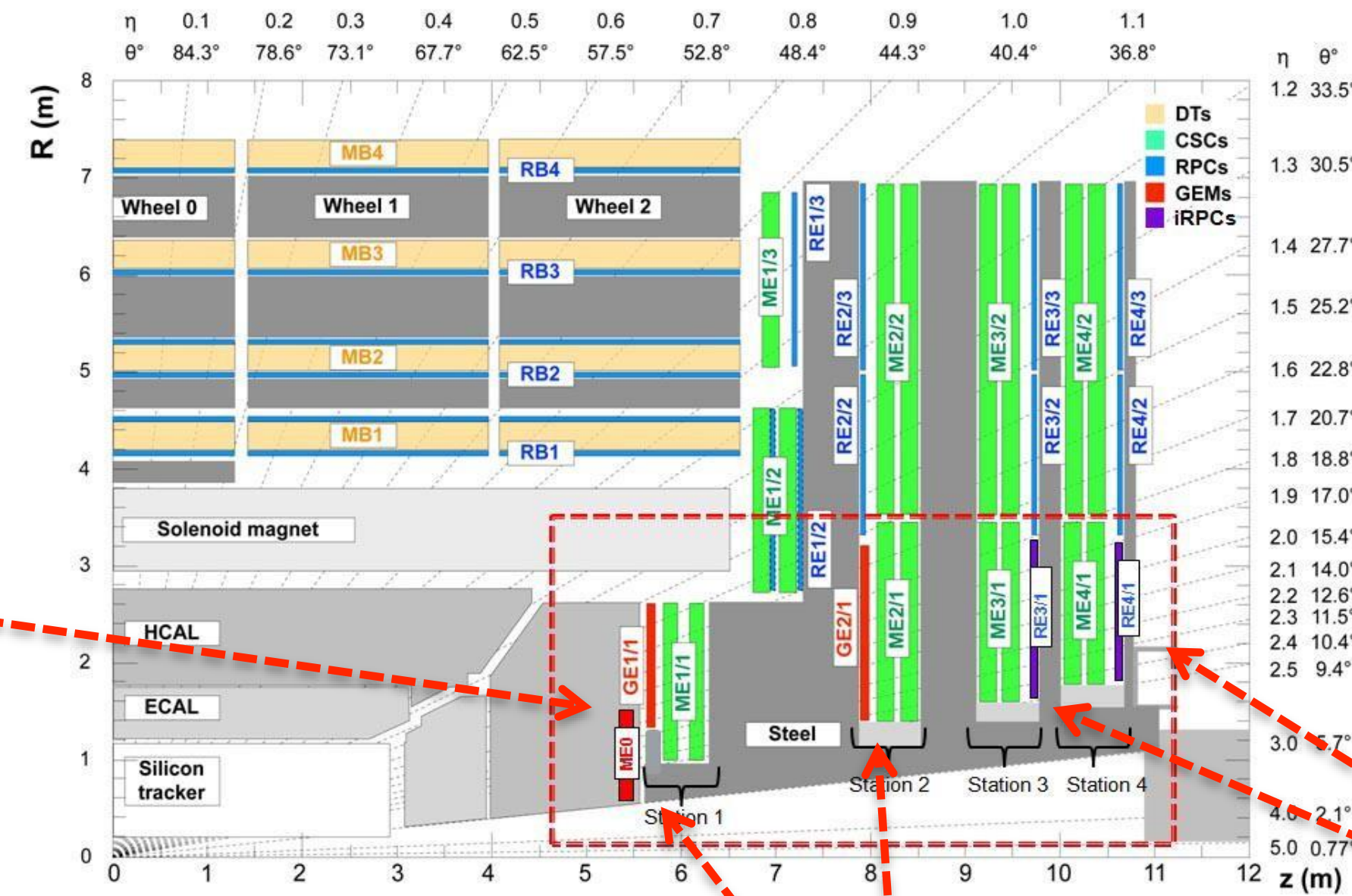


High background:



ME0 Station:

- 36 chambers
- Extends eta coverage to [2.4 - 2.8]
- 20 deg chambers
- 6 layers
- Detector layout targeted to high hit rate



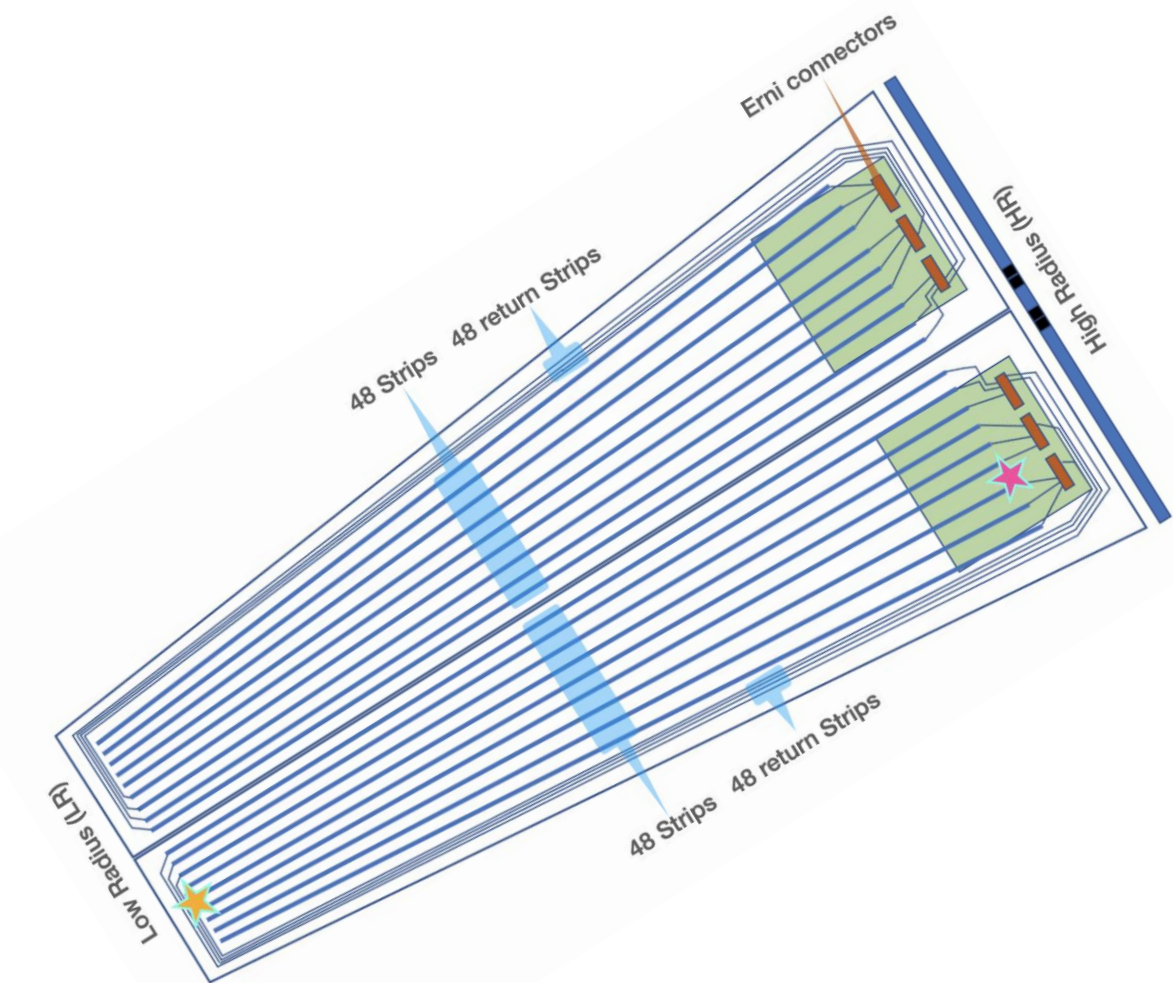
New detectors:

GE2/1 Station:

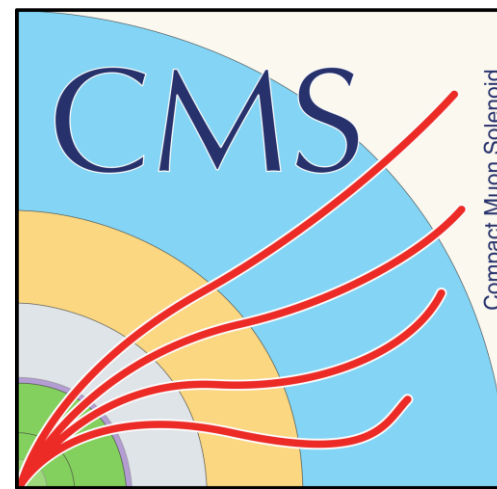
- 72 chambers
 - 20° chambers
 - Arranged in 2 layers
 - 4 triple GEM modules/chamber
- Detector layout similar to GE1/1

RE3/1 and RE4/1 Stations:

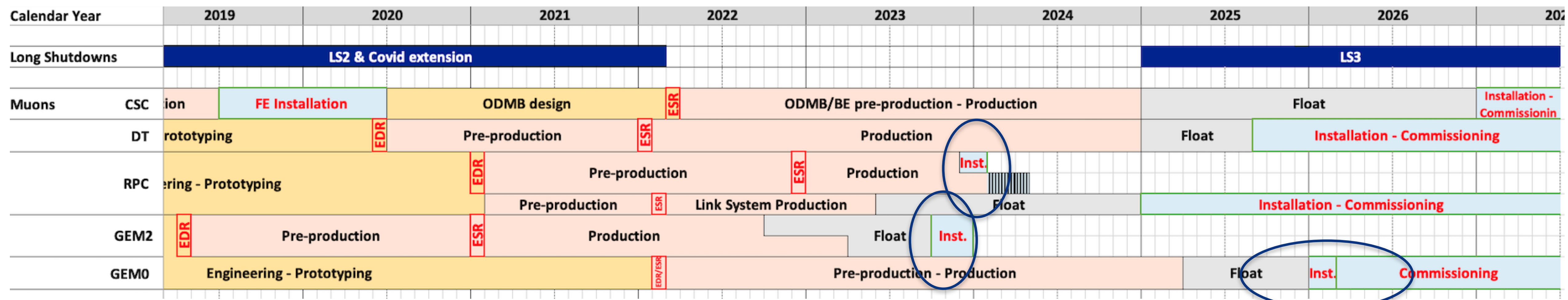
- 36 + 36 = 72 chambers
 - 20° chambers
 - One layer
- Detector layout Improved RPC



The schedule of the Muon Upgrade project

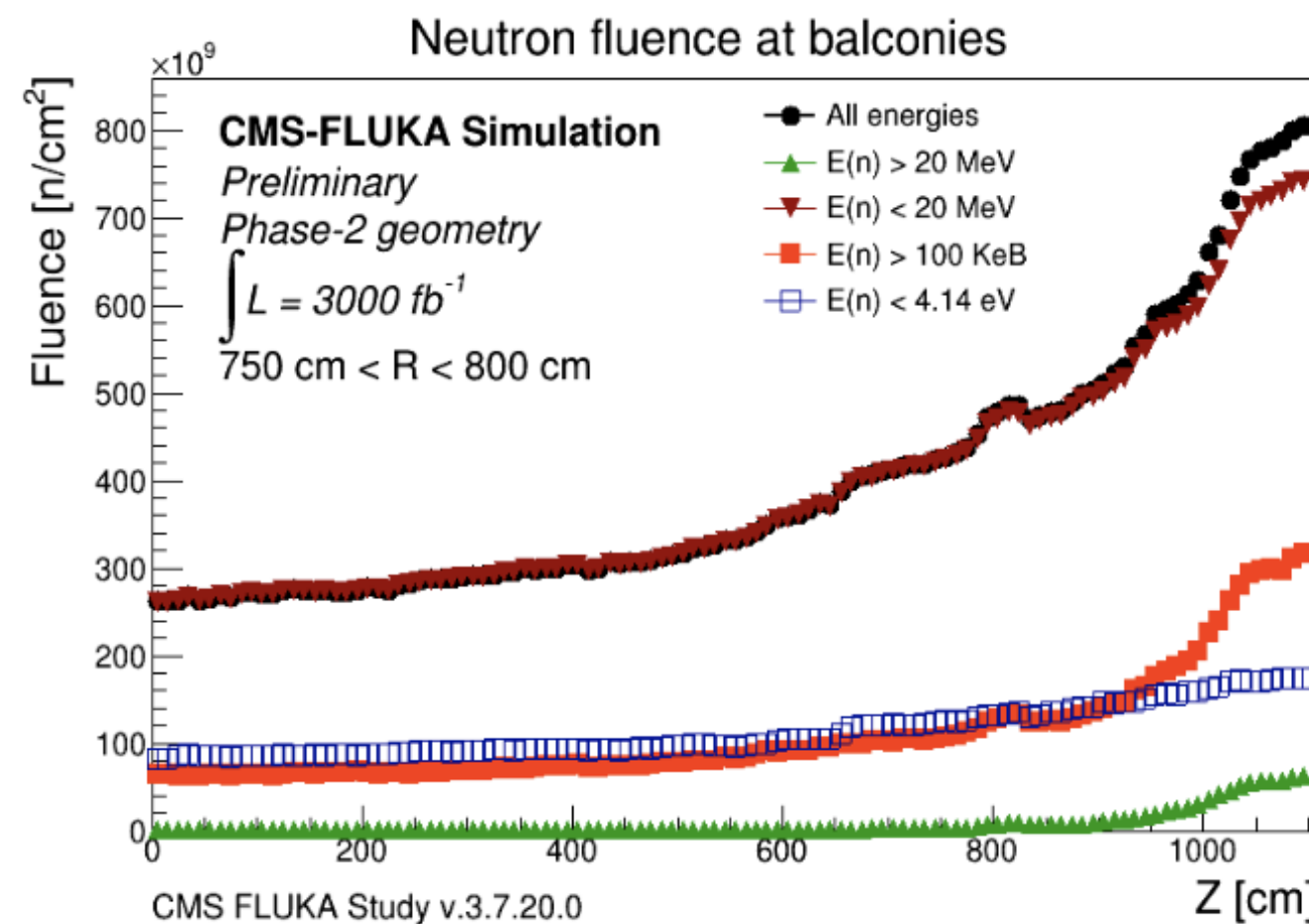
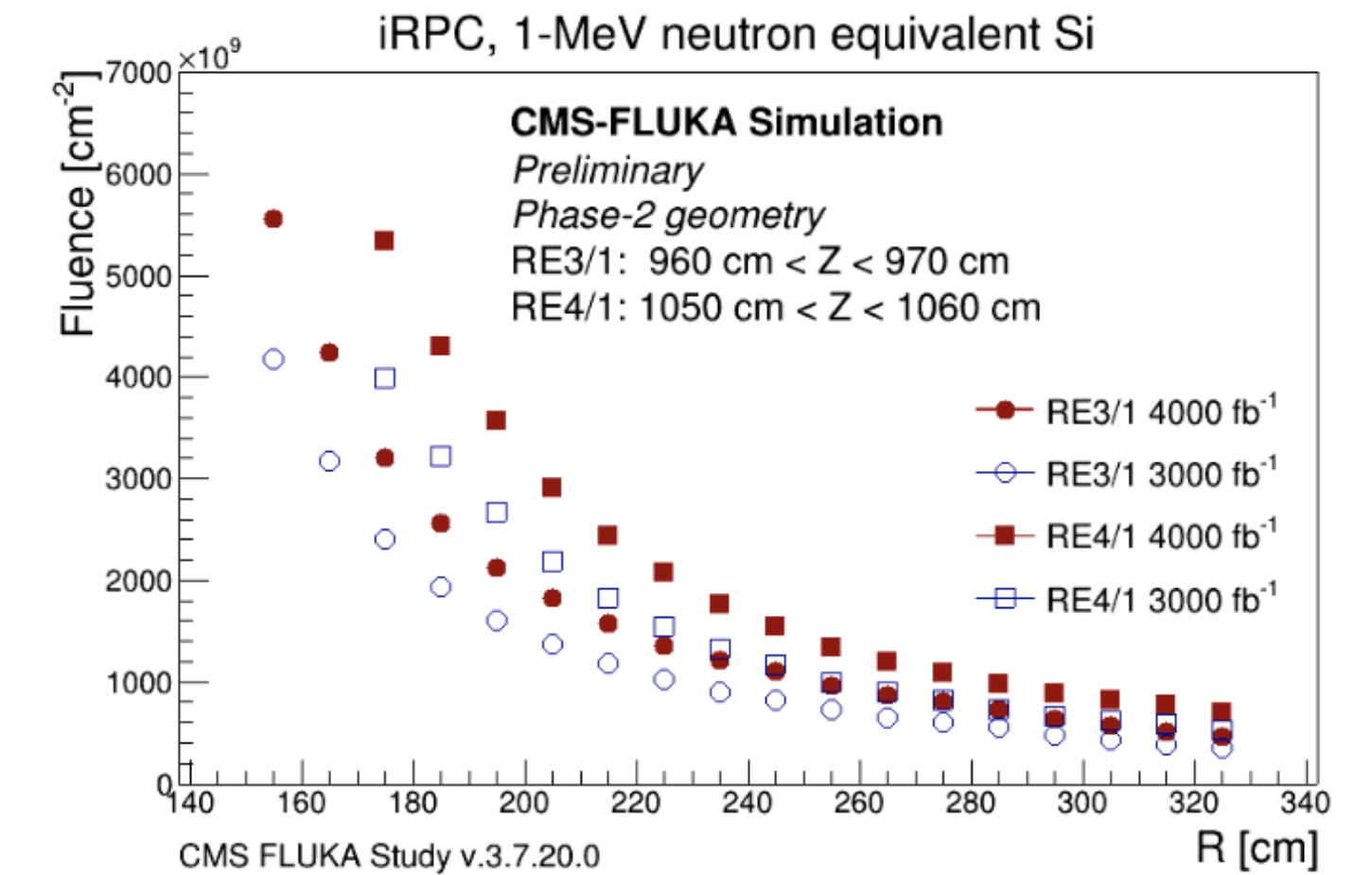
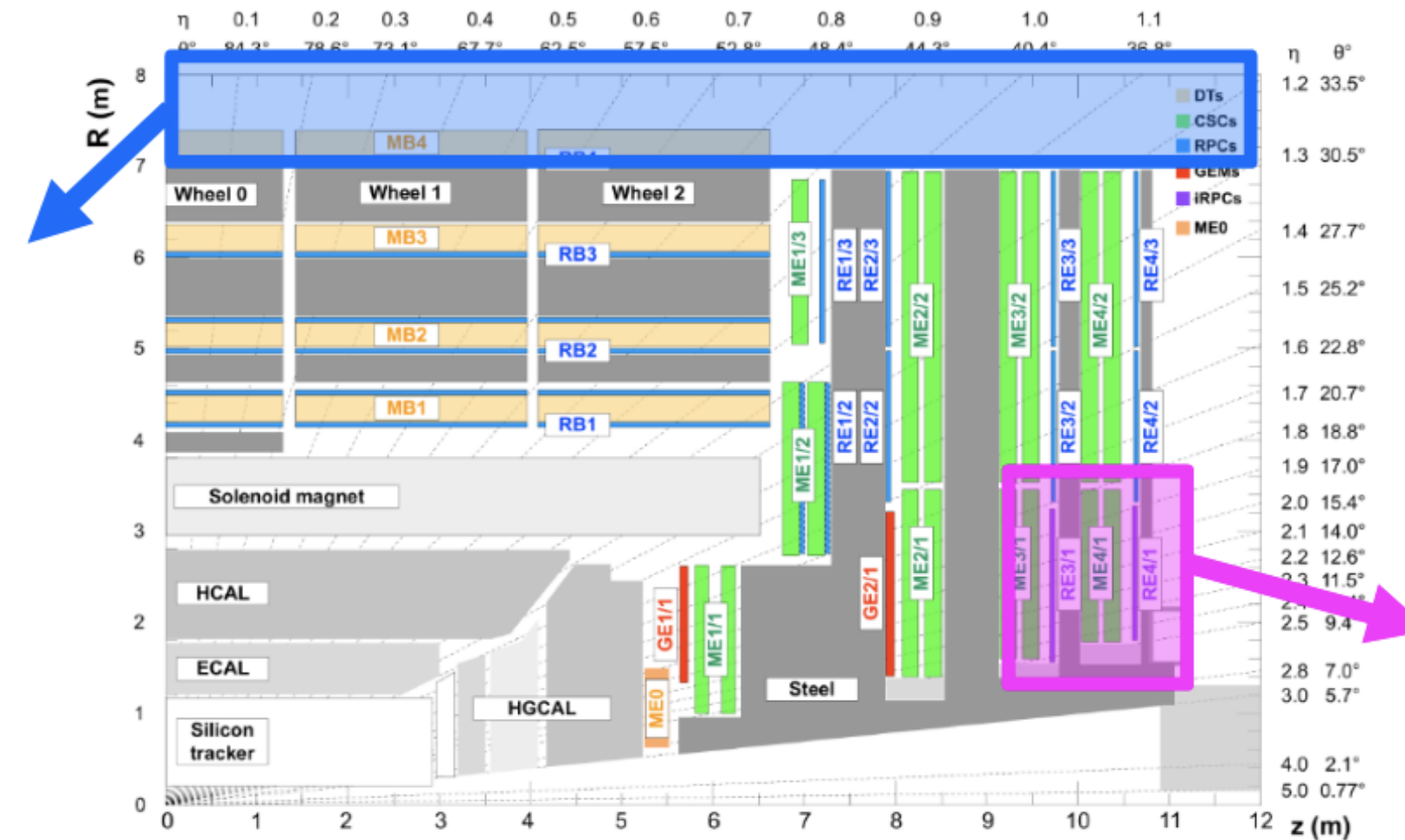
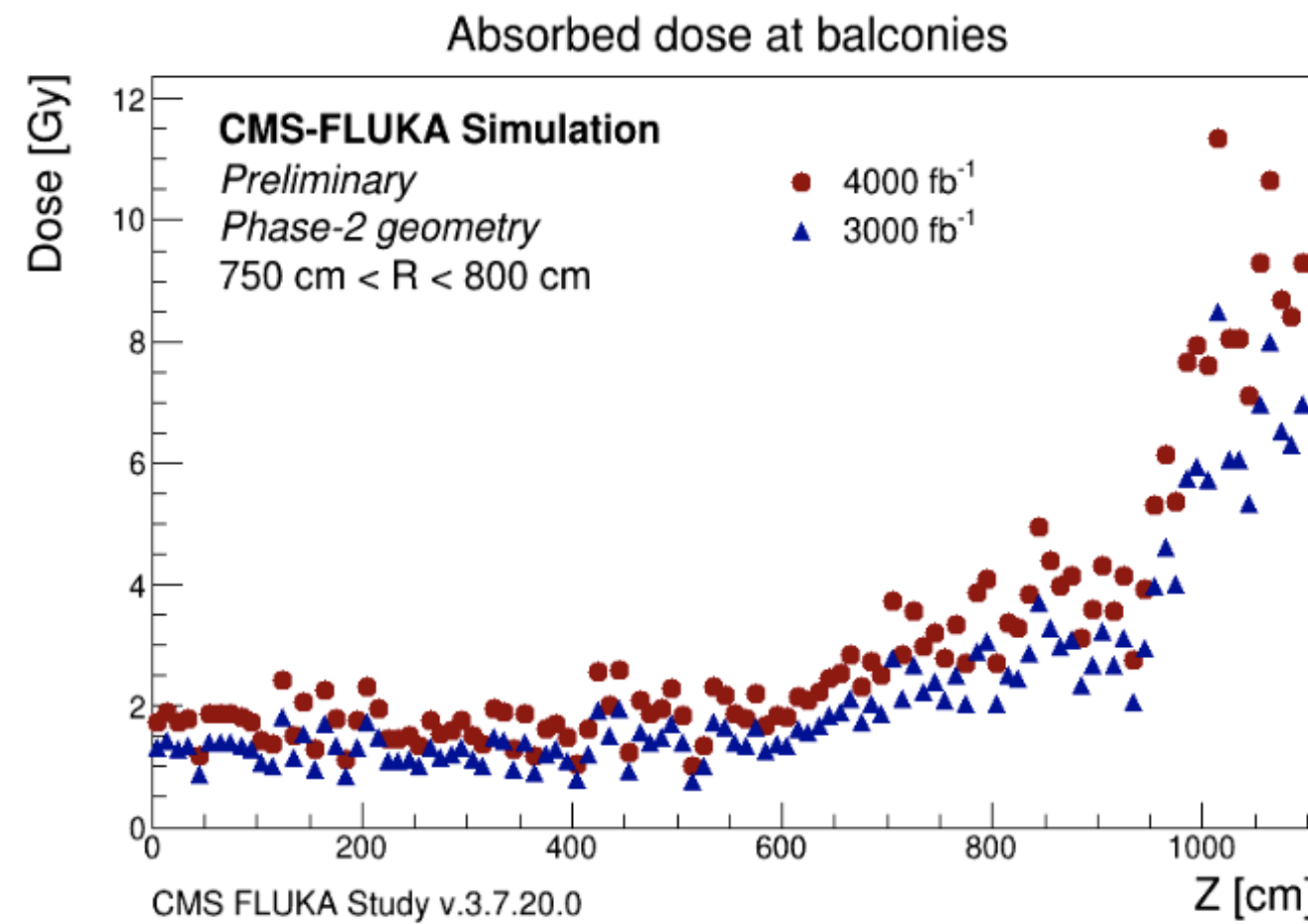


- GE2/1 and RE3/1, RE4/1 installation planned for EYETS 2023-24
- ME0 installation planned for LS3

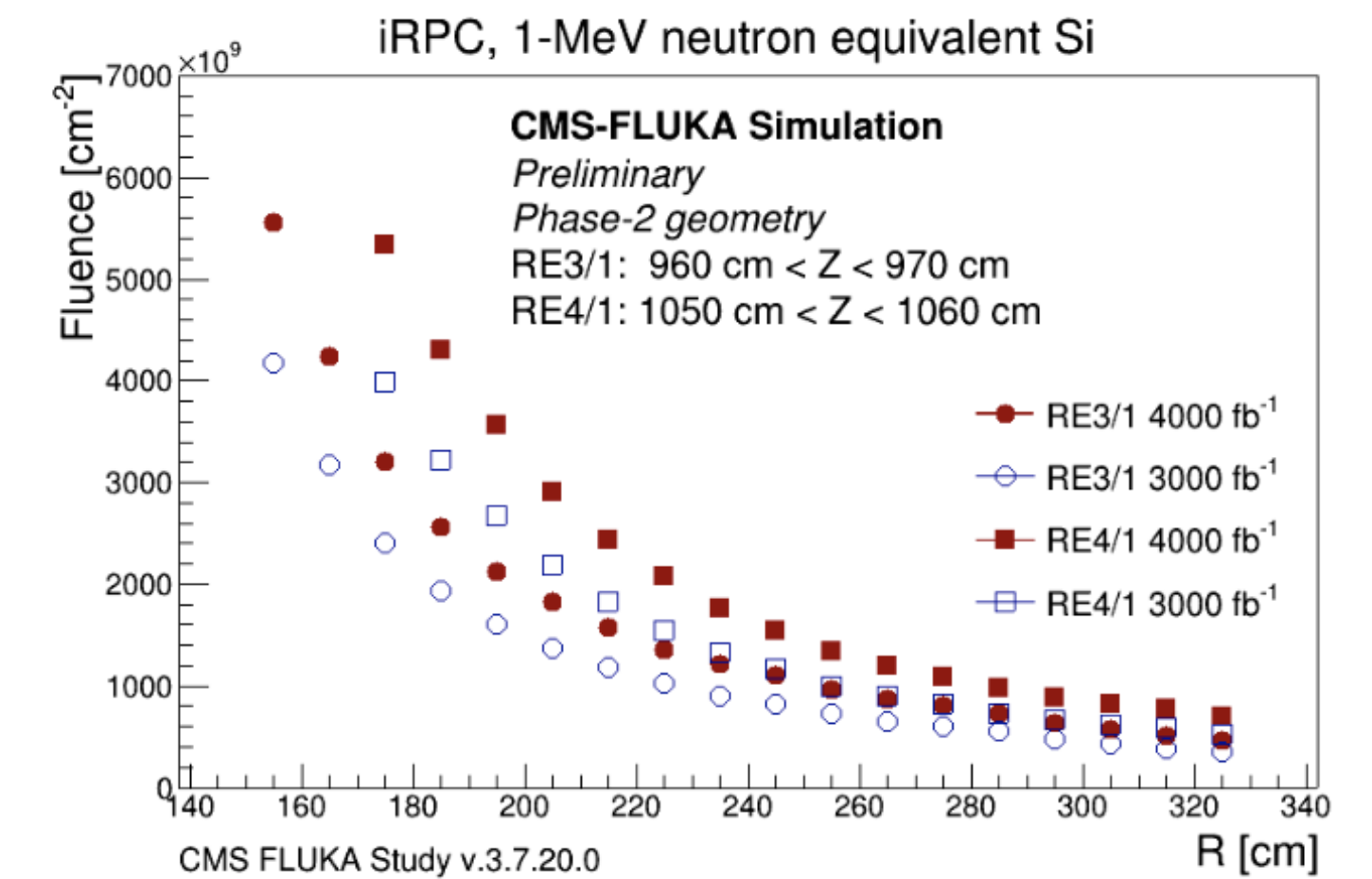


SPARES

Expected Fluence and Dose at HL-LHC



- **Expected fluence and dose (RE34/1 FEBs)**
 - at R=303 cm for RE3/1 is **~ 4.3 (5.8) $\times 10^{11}$ n/cm²**, and
 - at R=304 cm for RE4/1 it is about **6.2 (8.2) $\times 10^{11}$ n/cm²**,
 - at R=303 cm for RE3/1 is **~ 10 (13.6) Gy**
 - at R=304 cm for RE4/1 it is about **18 (24) Gy**
 - where R=303 (304)cm are the expected FEB positions
- **Expected fluence and dose (Balcony)**
 - The total irradiation fluence **$800 \times 10^9 \text{ cm}^{-2}$**
 - Maximum integrated dose is about **10 Gy**



csc Upgrade Scope

LS2

Anode Local Charged Track electronics: replace mezzanine cards to **increase latency capability and output bandwidth**

LS2

Low Voltage Distribution Boards: replace to provide voltages and currents for Digital Cathode Front End Boards

LS2

Trigger Motherboard: replace with optical Trigger Motherboard to receive Digital Cathode Front End Board trigger data, increased algorithmic power

LS2

Cathode Front End Boards: replace with Digital Cathode Front End Boards with **increased latency and rate capabilities**

LS3

Data Motherboard: replace with optical Data Motherboard to receive Digital Cathode Front End Board data

LS3

Front End Driver: **increased data volume**, number of links

Maratons, junction boxes in UXC

