CMS-CSC longevity studies at GIF++

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for the CMS CSC longevity team

Annual GIF++ User Meeting
01/12/22

Goals of longevity and performance studies at GIF++

Assess longevity of CSCs with the nominal gas for HL-LHC lifetime

=> completed

Find eco-friendlier modus operandi at HL-LHC

(CERN directive: reduce GHG footprint by 70%)

- **with adequate performance (efficiency, timing, spatial resolution)**
- **with adequate longevity**

=> Option A: reduce amount of CF4

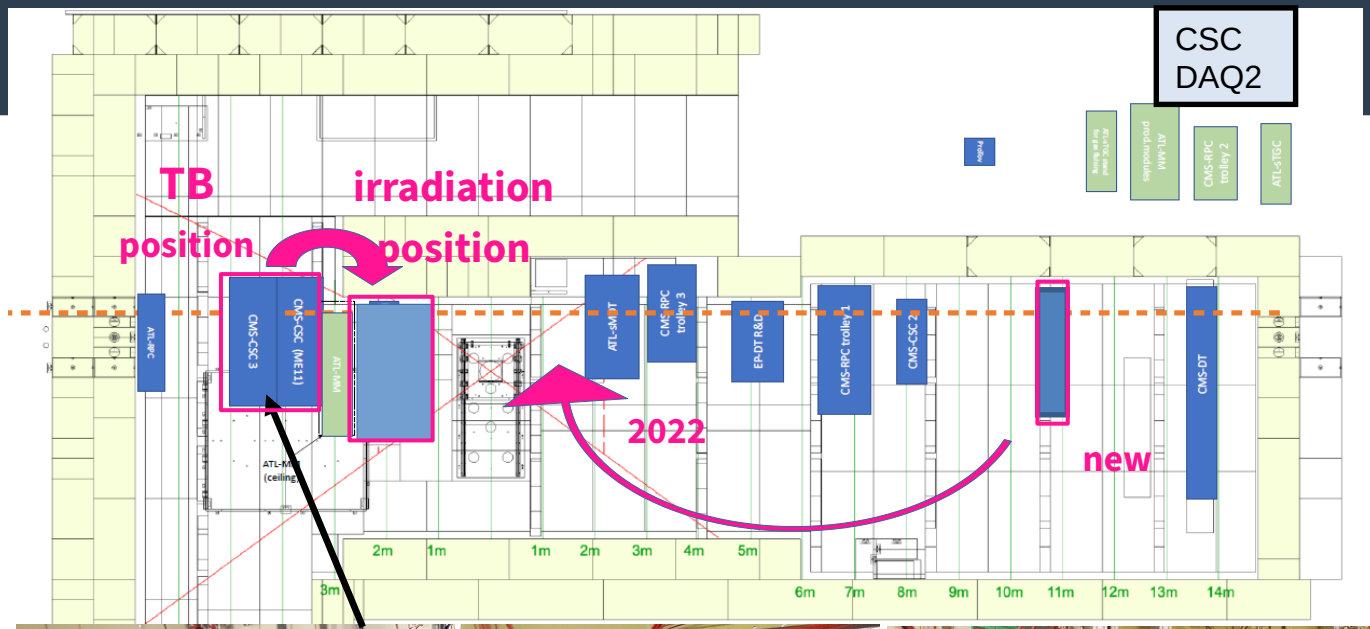
=> Option B: replace CF4 with a "greener" gas

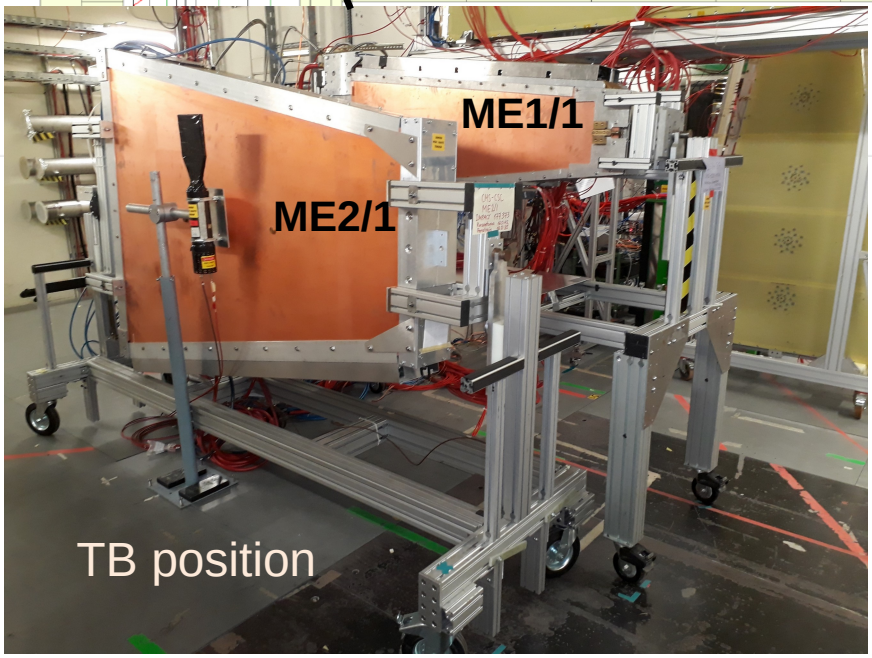
Three ways to reduce or eliminate CF4 use or exhaust:

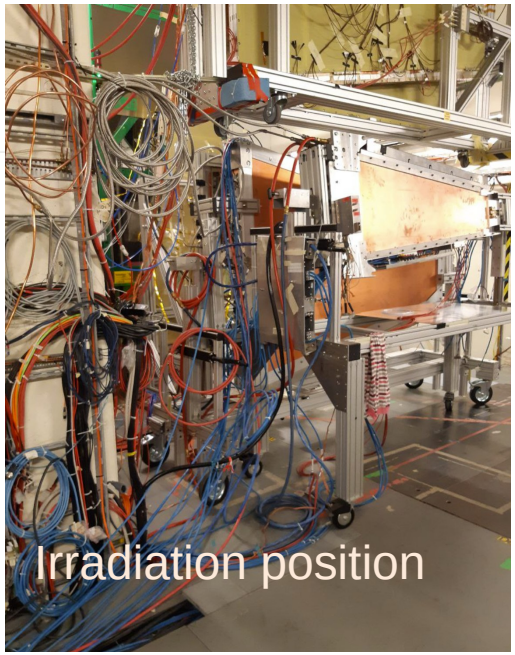
- **CF4 recuperation**: EP-DT – efficiency of the CF4 recuperation plant was increased from 30% to ~60% during LS2
- **CF4 reduction**:
  - lab studies with small prototypes ('miniCSC')
  - tests with full-scale production chamber at **GIF++**
- **Searches for CF4 substitutes**
  - just started, the study sequence will be the same as for CF4 reduction

Auxiliary: study chamber/electronics performance at HL-LHC-like rates

CMS-CSC at GIF++







- Downstream setup:
  - since 2015…
  (ME2/1 was not present in 2019-2020)

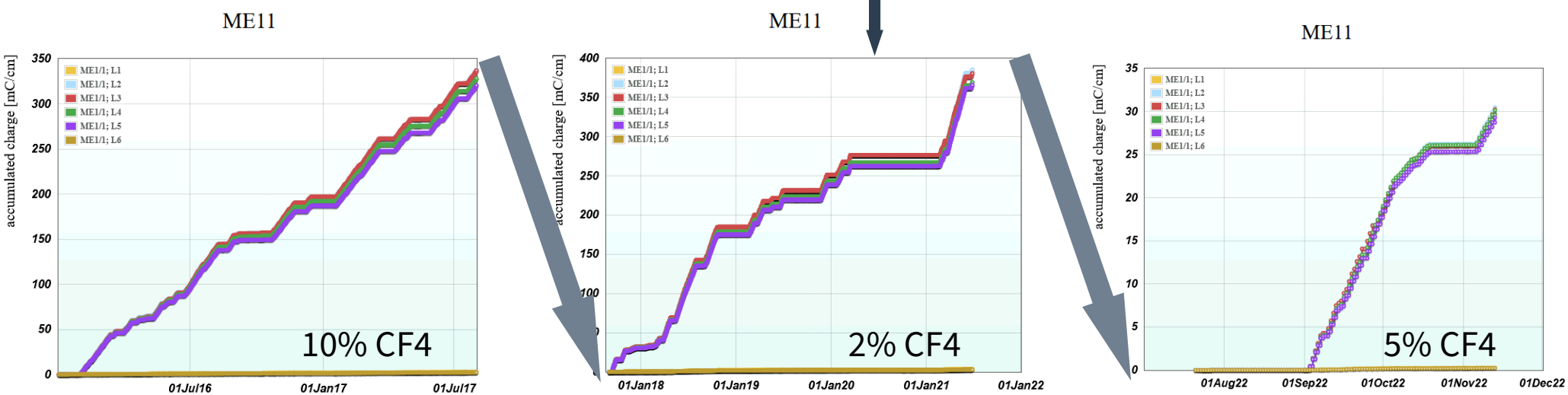
- Upstream – installed in 2021. Removed to prep.area due to DAQ problem with extended cables, work on cable extension to be resumed in 2023 in prep area

longevity studies at GIF++ (downstream)

For two CSC types which exposed to the highest BG flux at CMS

Lab systematic tests with small prototypes and 10-5-2-0 % CF4

2% CF4 was observed to be risky in lab tests



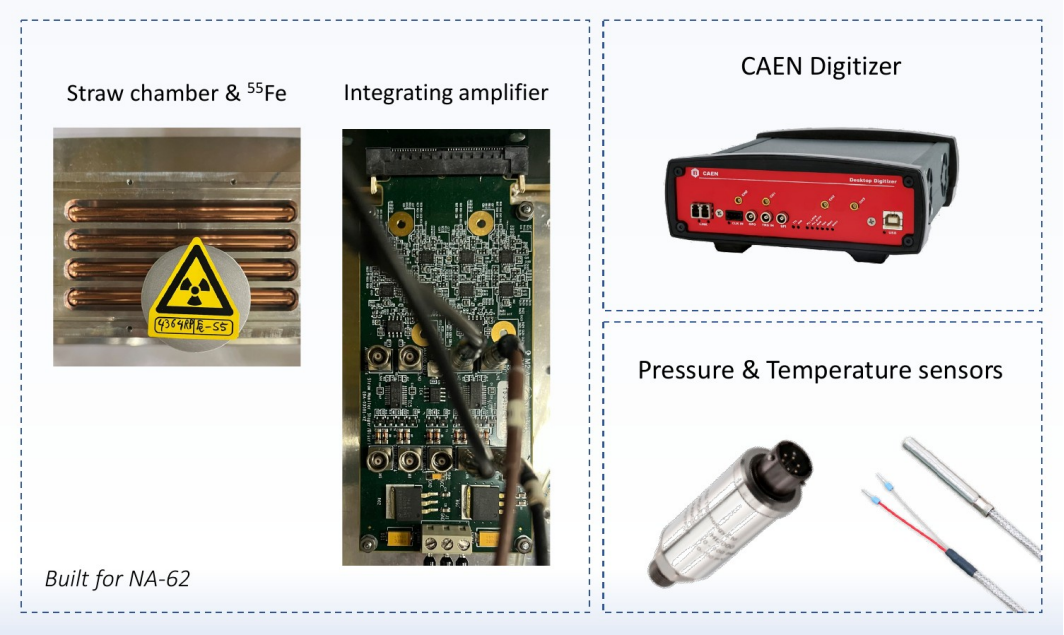
ME1/1:
Q(HL-LHC) ~ 0.20 C/cm
Q(10%CF4) ~ 0.33 C/cm
Q(2%CF4) ~ 0.37 C/cm
Q(5%CF4) ~ 0.03 C/cm, **ongoing**

ME2/1:
Q(HL-LHC) ~ 0.13 C/cm
Q(10%CF4) ~ 0.33 C/cm
Q(2%CF4) = 0 C/cm
Q(5%CF4) ~ 0.04 C/cm, **ongoing**

Experienced problems

- All of them are related to the gas
  - Gas gain instability during the TB2021
  - ME2/1 Malter currents in close loop

- => we need guaranteed good and stable gas quality for both the irradiation and TB measurements => straw-based gas monitor



Monitoring SW and testing is ongoing in 904

Goal is to install at GIF++ gas rack in the exhaust line end 2022-beginning 2023
Requires 55Fr source permanently installed, was blessed by the RP

CMS-CSC plans for 2023

- **Downstream**: continue irradiation, focusing on ME2/1 chamber with 5% CF4 have to be **as close as possible to the source** to reach at least 1-1.5 mC/day

- **Regular testbeam measurements** to monitor longevity (the beginning, mid and the end of the SPS oepration year)

- **Upstream**: the setup will serve searches for eco-friendly gas CSC gas mixture
  Lab studies to be done with various gas mixtures followed by
  - Performance measurements with GIF++ test beams
  - Longevity studies with small prototypes
  - Longevity studies with ME1/1add (not earlier than second half of the year)
    ...will require **installation of the second gas system** to be run in parallel with the downstream Ar/CO2/CF4 longevity program...
    => subject of available manpower... we'll see during the year

and

- We are very grateful to Martin and Giuseppe for really outstanding support!!!
- We really enjoy the muon beam rates and running stability – many thanks to Nikos!
- And many thanks to the EP-DT group for their help and advices on the gas system!

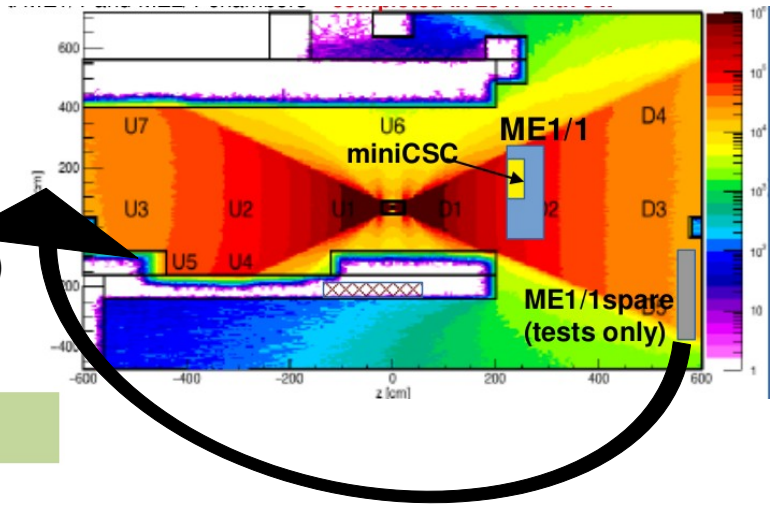
Backup

Additional studies of Malter current (moving to upstream)

Studies of spontaneous self-sustaining discharges (so-called **Malter effect**) at the irradiation intensities corresponding to HL-LHC conditions – **require low source intensity**.

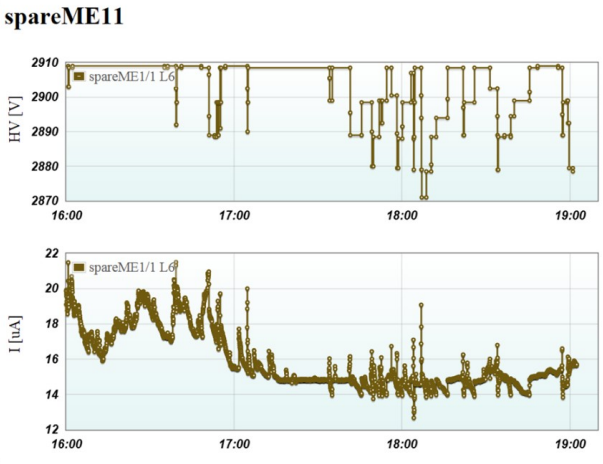
Original downstream position required att.6-10.

In 2020 the chamber was relocated to the extended upsteram area
We still need to provide infrastructure (gas, cabling, DAQ in prep.area)



GIF++: automatic HV training of ME1/1_add layer having Malter current

Program interface setting up HV training limits, current Dispersion etc.



Layer current lowered during HV training

In dowstream the training time was limited by the "source scan mode" duration, in upstream we hope to run tests at the nominal irradiation intensity