

Brief report about the ongoing infrastructure mitigation works for AdV+

I. Fiori, M. Tringali, F. Paoletti

Virgo-KAGRA PEM meeting – 28 Aug. 2020

List of ongoing activities:

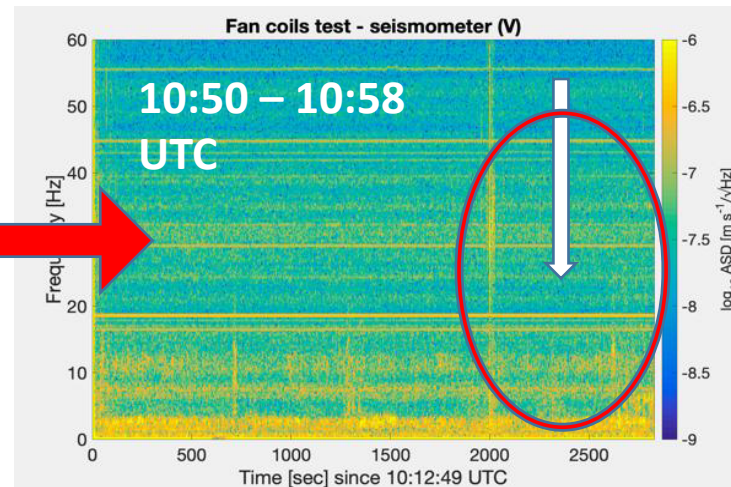
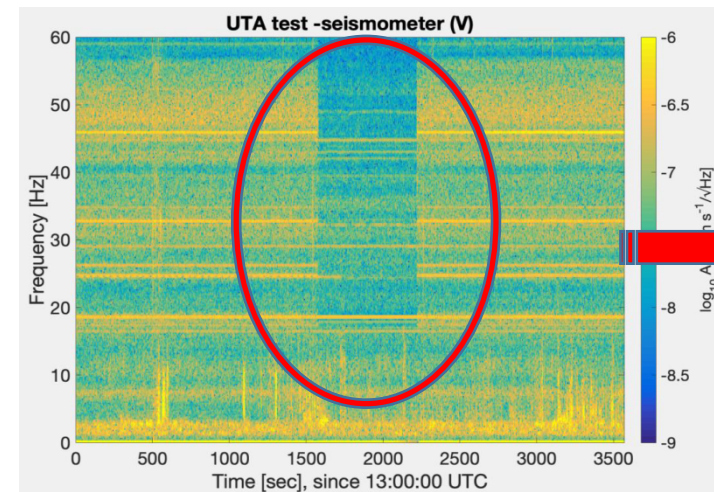
- change of the **old noisy AHU** machine for cooling down **DAQ-room** (impacting in **Hrec**) with **two little Fan-Coil units**
- built a **big coil** to generate **greater magnetic field**
- **lightning stroke** on experimental area, with **damage to many equipments** and also of external magnetometers
- general mitigation works on **CEB, NEB** and **WEB** HVAC machines
- put in operation of a big insulation transformer to avoid **mains 50Hz sidebands** contamination in **Hrec**
- ...

DAQ AHU: lines at 24.8 and 26.2 Hz were visible in Hrec



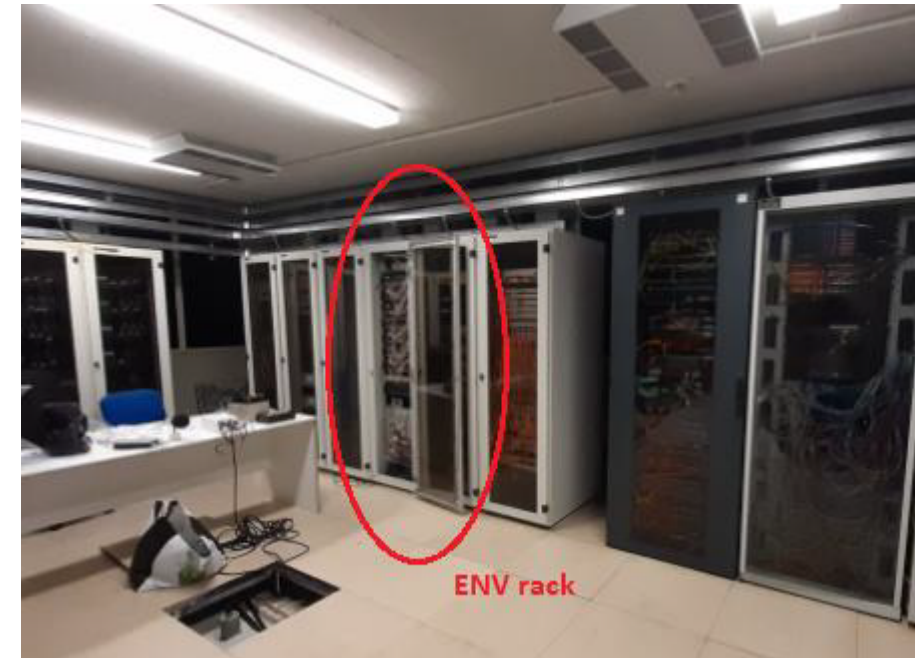
Temperature test performed, it works fine.

- Only one rack had a temperature increase, due to the high numbers of electronic units inside. Opening the front door (all racks are without back doors) solved the problem.
- Some units will be moved soon in another rack



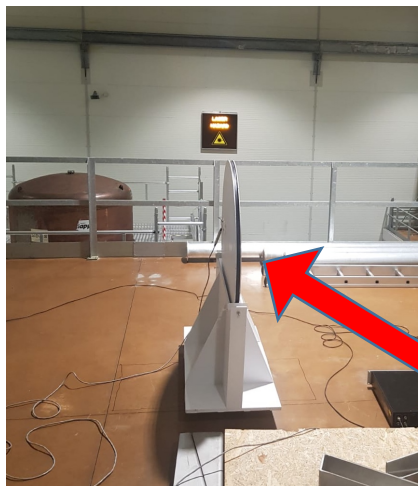
Switch-off test of old DAQ AHU:
frequency peaks at **24.8 Hz, 26.2 Hz, 32.8 Hz, 46 Hz** disappears

Switch-off test of new fan-coils:
no changes are visible



built a big coil to generate greater magnetic field

NEW ~5m side 86 turns square coil



OLD 1m diameter 50 turns coil

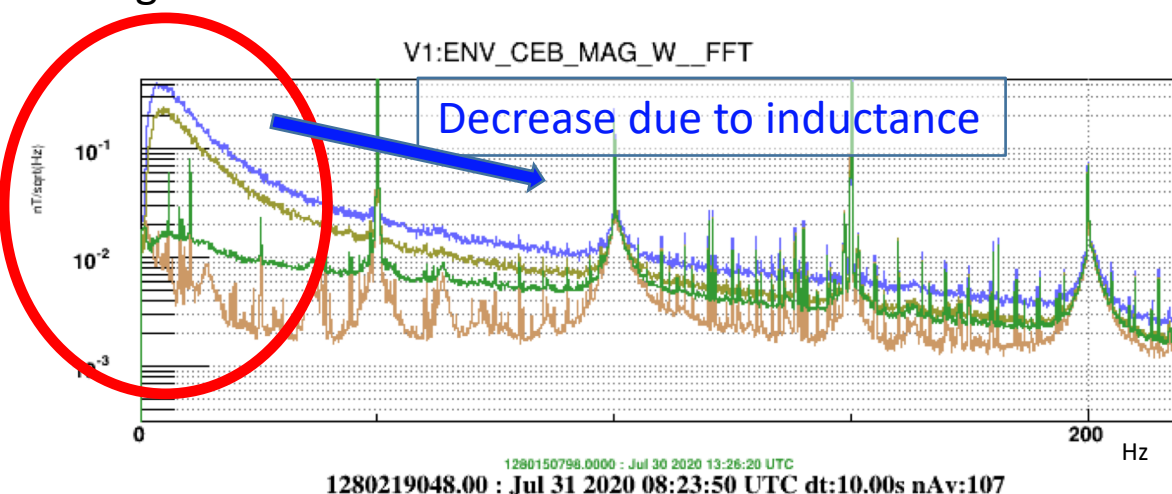


The old coil used for magnetic injection was too small (1m diameter), we were unable to generate a strong magnetic field

New coil, using the same current, is planned to generate a mag field **~50 times greater** – it use 1500m of wires (86 turns)

Side effect: new coil has a higher inductance (L changed from 10mH to 100mH), and to inject a high frequency current it needs a high voltage amplifier (~ 100Vrms to get 1A @ 200Hz)

- We will buy it soon

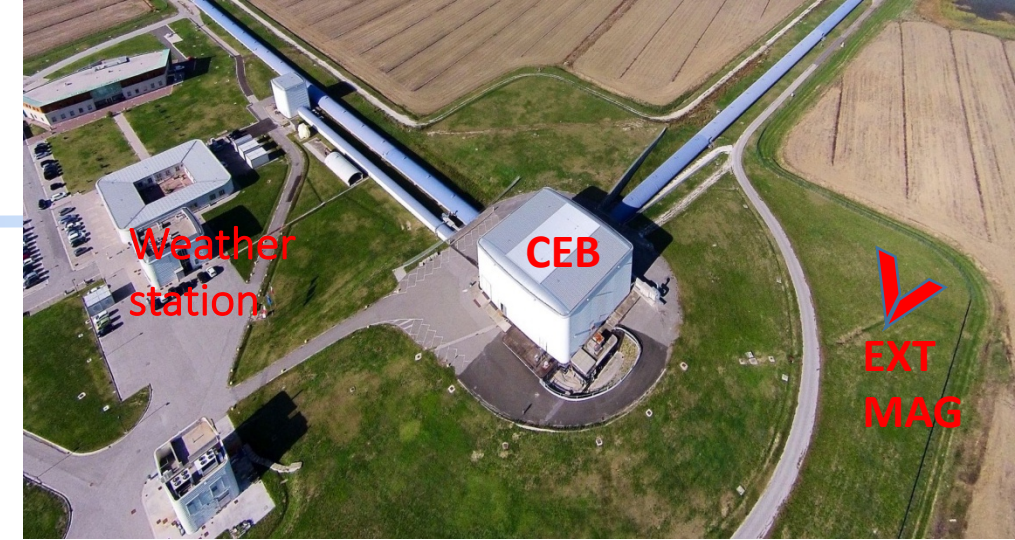
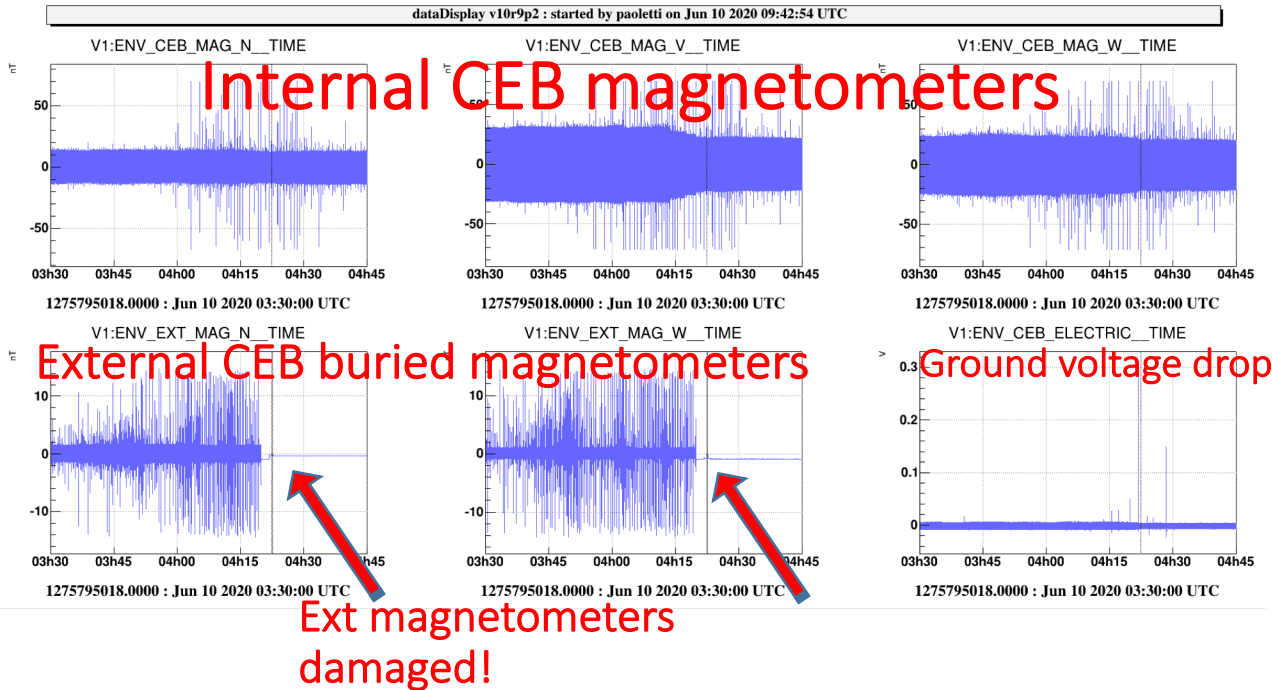


Results:

BLUE new 5m side coil (constant voltage driving)

GREEN old 1m coil (constant current driving)

lightning stroke on experimental area



10 June 2020 thunderstorm over Virgo area

- 04:19:47 UTC a lightning out on E-side (maybe) of Central Building – External BURIED magnetometers went OFF
- 04:21:48 UTC a second one hit the weather station on the roof of the Computing Room

Other damages:

- the ethernet interfaces on various servers flapped at the time indicated
- an electrical mains line went in protection causing the down of the TCS cameras and of a switch connecting rtpc17
- some glitches have been seen on the Timing distribution for 100MHz Clock used in the CEB
- the IRIG-B is no longer available on EGO-Optic-lab
- outdoor security cameras no longer work

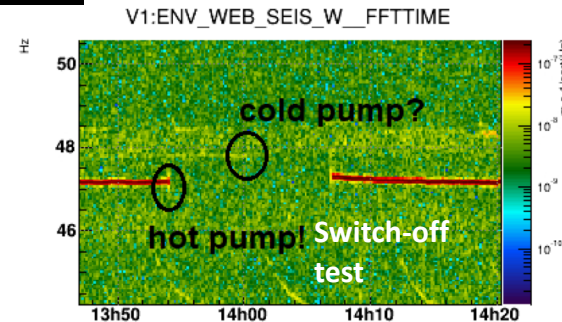
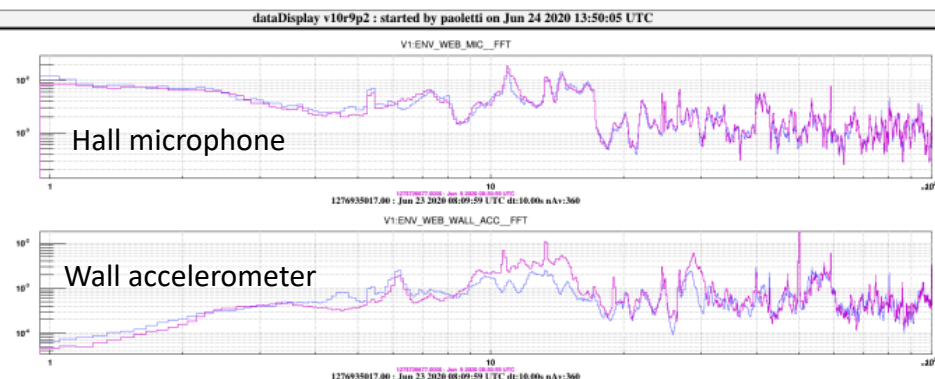


General mitigation works on HVAC machines

Many works **done**, **ongoing** or **planned** to reduce as much as possible HVAC noise into experimental halls – some example given:



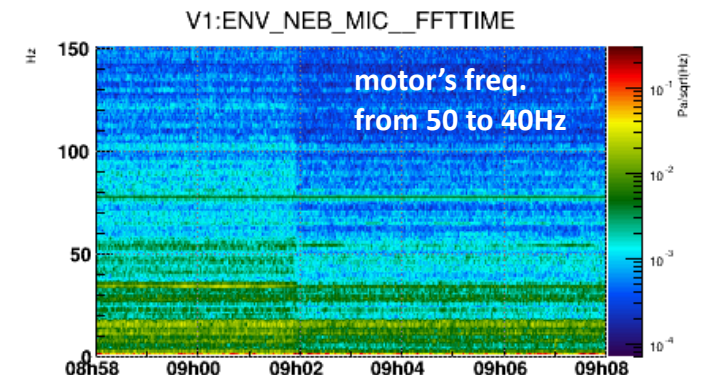
Large **acoustic** noise in terminal building because of HVAC. Thought one cause could be **wall vibration** because of air ducts touching the wall. We decoupled ... but almost no improvement. Next actions: try to reduce air turbulence inside ducts.



Damped springs under water pumps reducing ground seismic coupling



Installation of **mains inverters** on HVAC motors in order to control the speed (= the air flux): the goal is to reduce it as much as possible, keeping the temperature still constant but also reducing the air turbulence noise



big insulation transformer in Mode Cleaner Building

This is a long story:

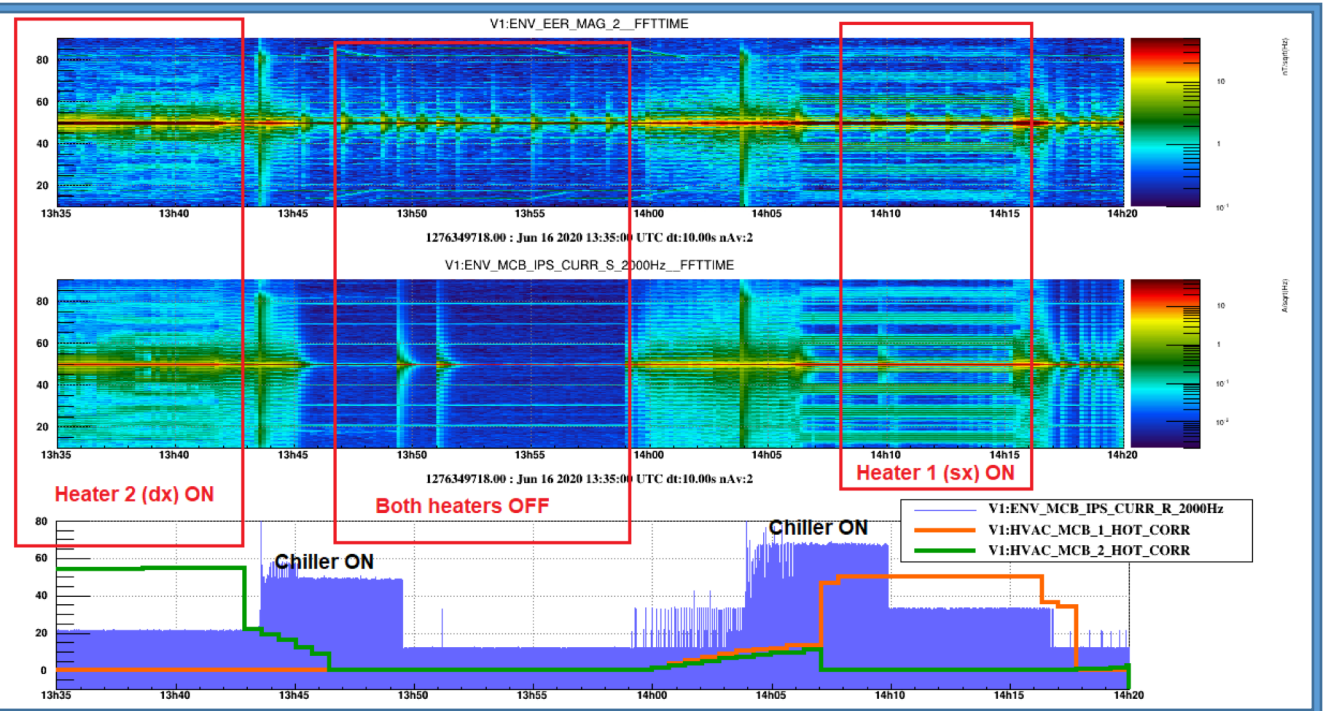
- We had mains sidebands in Hrec. Some source has been found and eliminated ([elog 47079](#))
- Other sidebands remained, and we know they are associated to **MCB HVAC heater system** (PWM controlled)
- Many measurements lead to suspect a mains stray current flowing into the MC vacuum pipe, then coupling in CEB to Hrec (being it visible also in CEB magnetometers)
- Proof with a **magnetometer placed OVER the MC vacuum pipe**: perfect clone of the MCB mains current sensors



Magnetic field measure OVER the Mode Cleaner vacuum tube connecting MCB with CEB

MCB mains current sensor (with mains sidebands due to PWM controlled heaters)

GREEN and **RED** are heaters PWM control signals



big insulation transformer in Mode Cleaner Building

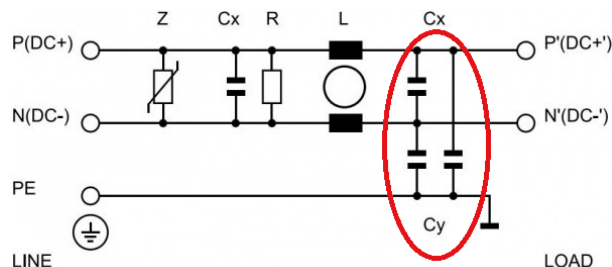
Why we should have a stray current? Where is it coming from ?

- MCB and the CEB share the same low voltage 230Vac mains circuit

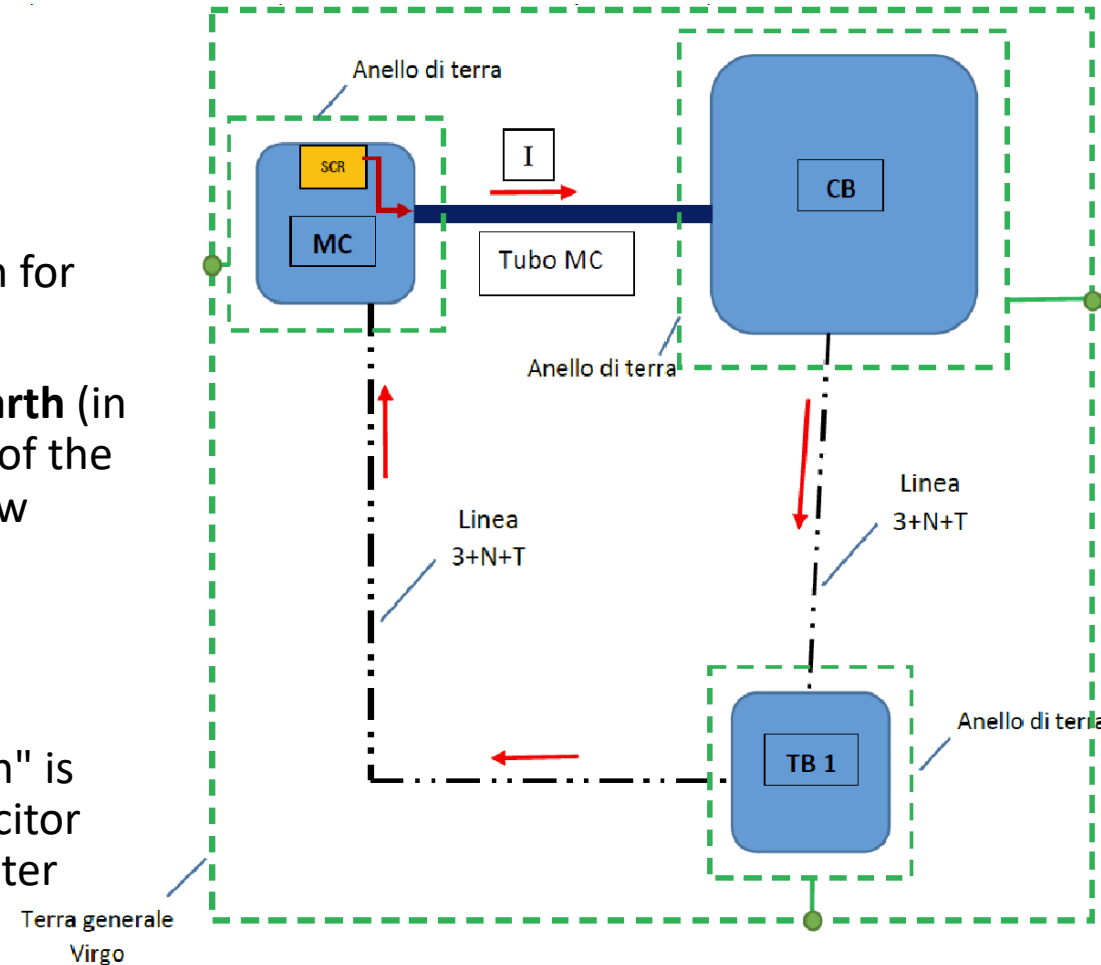
Hypothesis:

- any imbalance in the three phases uses the neutral wire as a return for the unbalanced current.
- If there is **a connection between the Neutral and the Protective Earth** (in addition to that foreseen in Technical Building 1 on the star center of the mains transformer), this return current will use all the "available low resistance connections" to return to the technical building.
- The Mode Cleaner pipe can actually be the lowest resistance path, chosen by the unbalanced current

Note that "a connection between the neutral and the Protective Earth" is not necessarily a physical galvanic connection: it could also be a capacitor used as a bypass in an Electro-Magnetic Compatibility (EMC) mains filter



Example of EMC filter
with capacitors
between all mains
wires



MCB and CEB metallic structures are connected (also)
with the 150 meters long vacuum pipe ("Tubo MC")

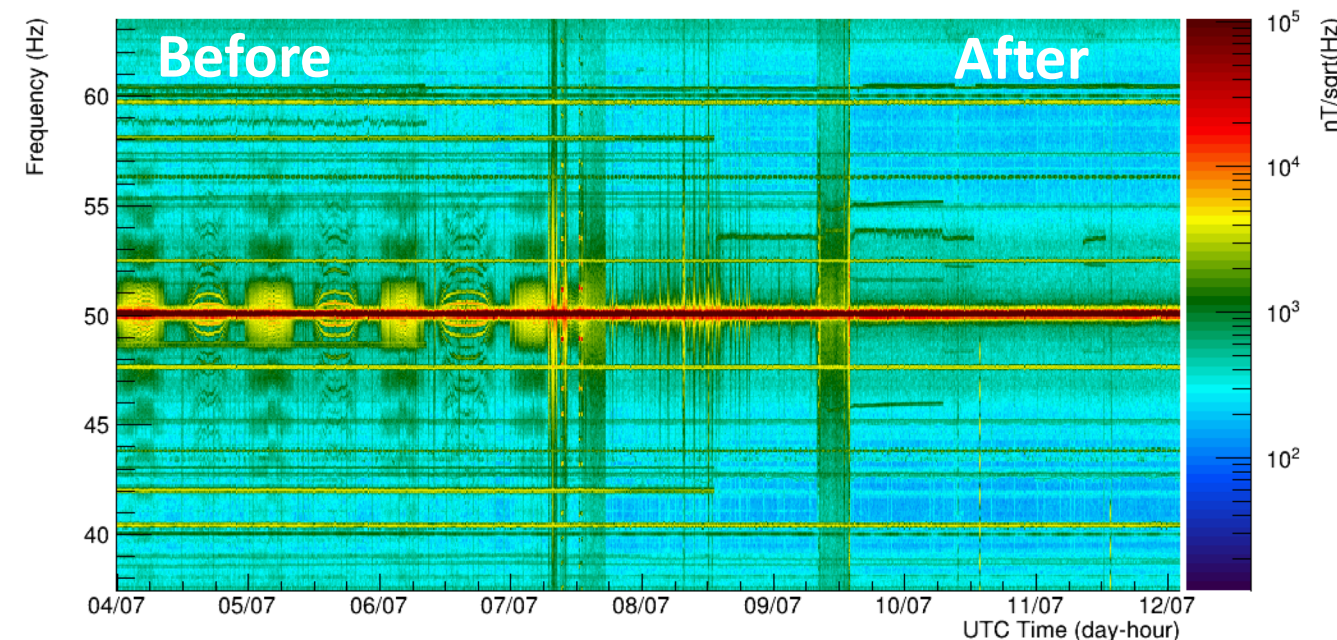
big insulation transformer in Mode Cleaner Building

Since it is practically impossible to find out all the possible connections between the **Neutral** and the **Protective Earth**, we have prepared a quick test with an available (oversized!) three-phases insulation transformer (primary side is triangle, secondary side is star)

The goal is to interrupt the Neutral line, creating a new local one just for the Mode Cleaner Building.

All unbalanced currents will return to the star center of this transformer, avoiding any current from flowing into the MC tube.

Spectrogram of V1:spectro_ENV_CEB_MAG_N_300_100_0_0 : start=1277855950.000000 (Fri Jul 3 23:58:52 2020 UTC)



The test has been successfully:

- all the mains sidebands visible (also) in CEB magnetometers **disappeared**.

We now have installed a new well-sized insulation transformer in the MCB

