Grounding & Shielding in OEC Integration in Frascati

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Outline

- The Outer Endcap Grounding and Shielding approach

- The Grounding Fault Monitor (GFM)

  ◦ The GFM circuit

  ◦ The baseline procedure to follow during the integration

- The G&S in the cooling and electrical services

- The grounding scheme of the cooling circuit with the new EBs

Introduction on Endcap G&S

- G&S related to Services ([from PDR](#))

  ◦ Half-rings will be isolated from the Half-Shells (HS) by the ULTEM mounting lugs fixed to the inner surfaces of the half-shells.

  ◦ Type 0 and Type 1 electrical services will be isolated from the HS via their plastic insulating sheaths.

  ◦ Type 1 pipes and capillaries will be isolated from HSs or any other conductive surface using ULTEM clips. The design and number of such clips will follow the design of the Type-1 services assemblies.

Outer Endcaps HR G&S approach

- The local support Half-Ring is isolated from every component but the Bus Tape

- ITk reference potential to the bus tape through the Canbus Shield

- The back side of the bus tape is electrically connected to the local support through grounding pads

- Data PP0 grounded through the Twinax bundle shield
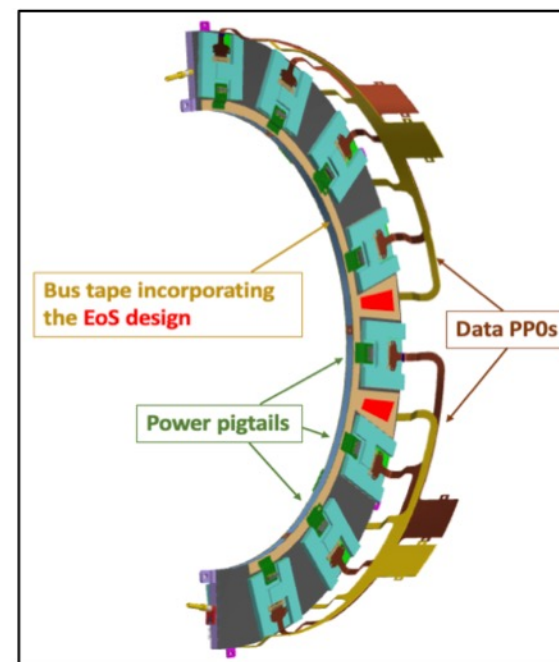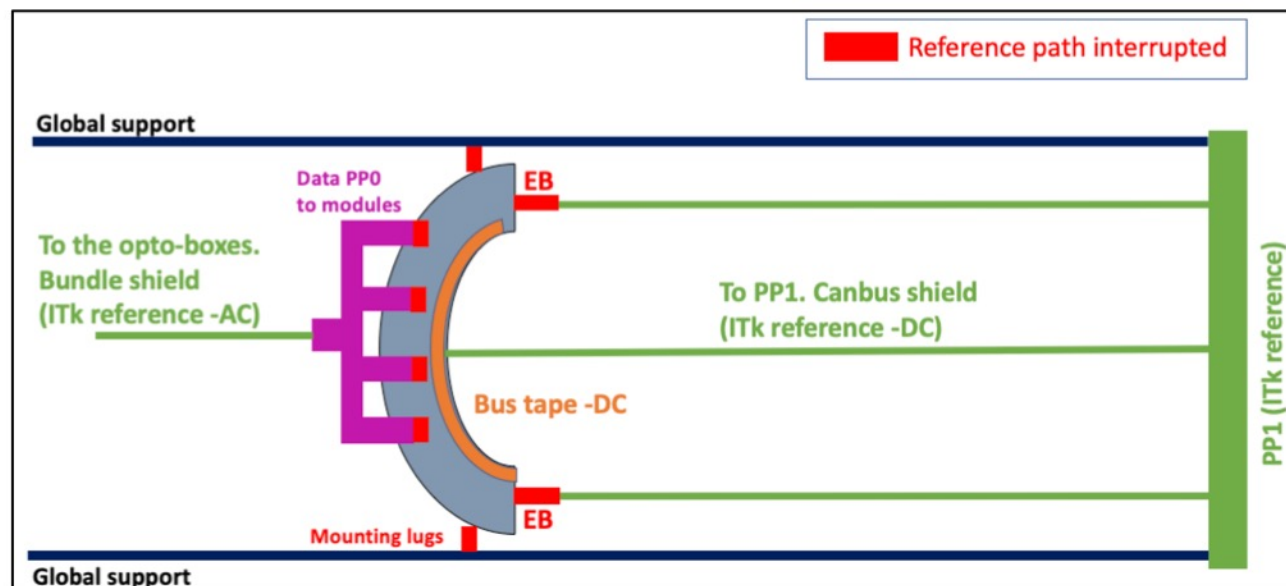
The G&S Monitoring During Integration

We have two options:

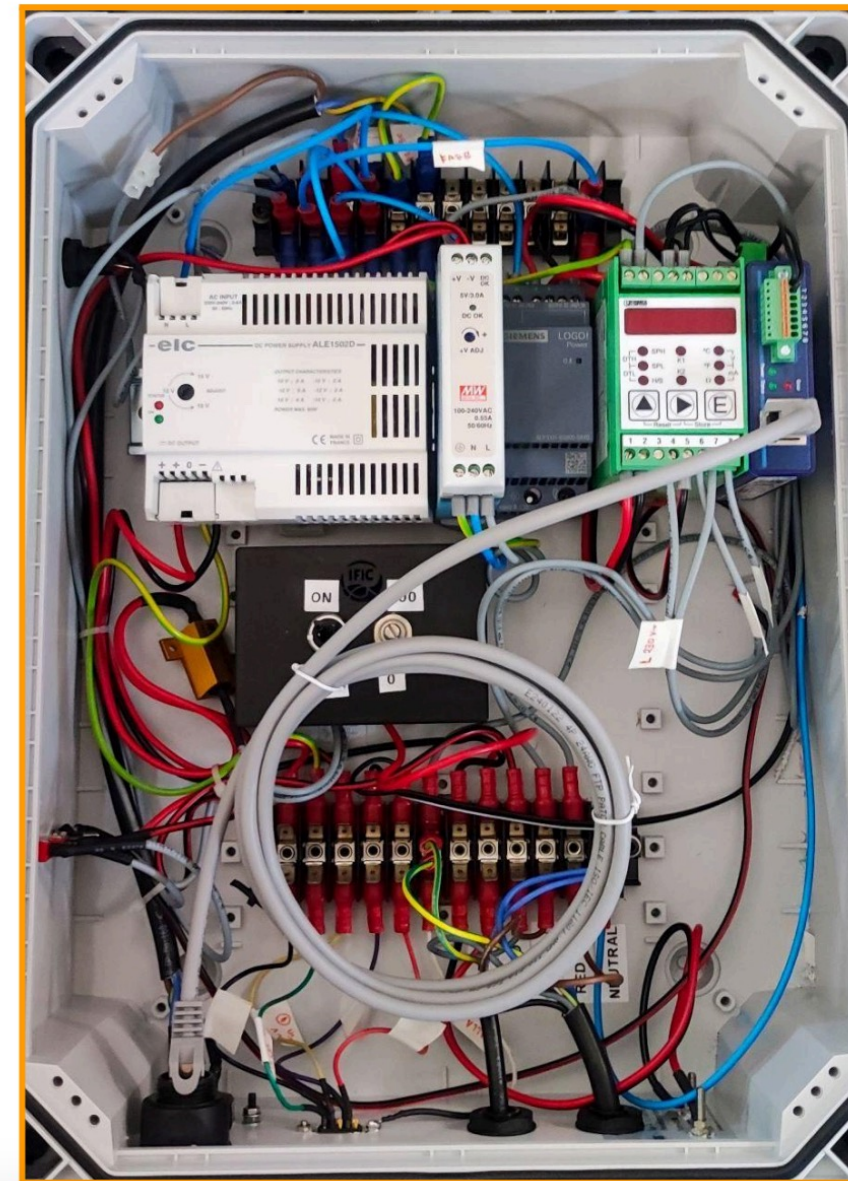A. Using a multimeter at the end of each HR installation:
   ◦ Once the HR is installed into the HS, we can spot any unwanted contact between the HR and the HS using just a multimeter.

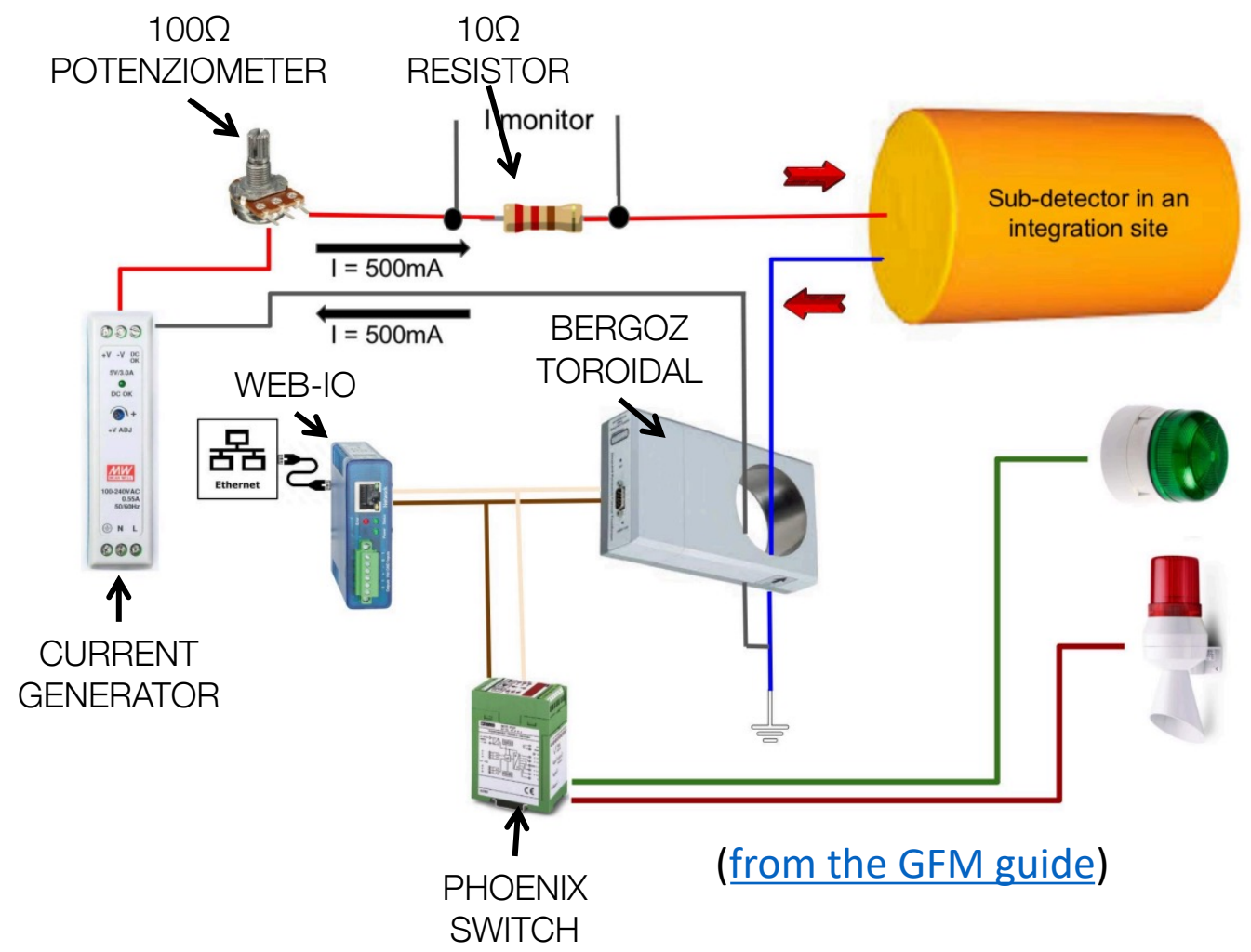B. Using the Grounding Fault Monitor:
   ◦ The tool functionality and the utilization procedure are exposed in the next slides

The Grounding Fault Monitor

- Ensuring personal and equipment safety requires grounding each sub-detector during integration and installation, with a specific configuration of connected and disconnected parts based on design specifications.

- The GFM monitor electrical connections in sub-detectors, preventing unintended connections to external parts like cooling systems or support structures.

The GFM circuit

100Ω POTENZIOMETER

10Ω RESISTOR

I monitor

I = 500mA

I = 500mA

WEB-IO

BERGOZ TOROIDAL

Ethernet

CURRENT GENERATOR

Sub-detector in an integration site

PHOENIX SWITCH

([from the GFM guide](#))

- The sub-detector is earthed in a single point. The GFM applies a current to the sub-detector reference that comes back from the earth point to the GFM

- A current sensor is continuously measuring the balance of the current and the return

The GFM utilization guidelines

The prerequisite for the utilization of the Ground Fault Monitor is that all subcomponents (e.g. local supports structures) have been tested individually for compliance with the grounding and shielding rules. Tests with an ohmmeter are sufficient to check for required electrical continuity or isolation. Using an ohmmeter during the integration is substantially more complex and risky, since this requires to remove (safety) ground connections from local supports.

The main reference point of the ITk is the Faraday cage, which has a single connection to ATLAS ground. Therefore, the Monitor has to be connected to a corresponding reference point of the setup (e.g. PP1, Bulkhead, global support etc.). At this connection, a 500mA current is injected and flows to ground.

In order to measure unwanted connections during the installation and integration of subcomponents (e.g. staves, petals, rings, longerons), the new component has to be separately grounded by an additional wire with sufficient cross section. This is anyway required due to ESD safety requirements. This connection bypasses the GFM sensor.

Assembly of local supports in the outer barrel pixel and inner system pixel: the subsystem grounding scheme requires that the local support is in contact with the global support. The modules on the local support are isolated from the local support. The isolation of the modules has to be checked in advance with an ohmmeter. The monitor should not trigger as long as the modules are isolated. This will help to continuously check the isolation.
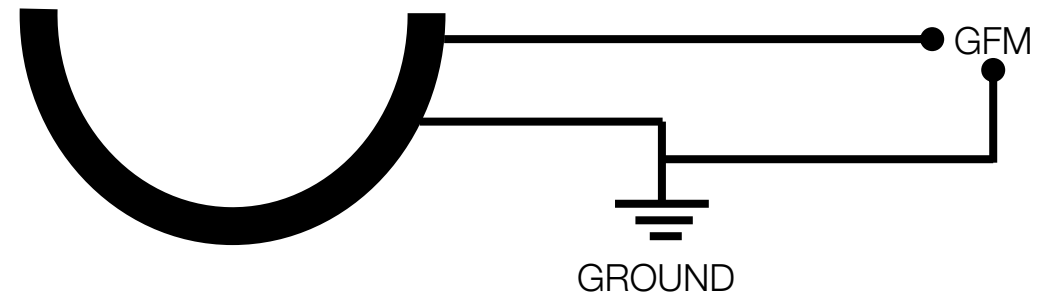
After the successful assembly, the temporary ground connection to the local support should be removed. Grounding is later achieved via the Type I cables.
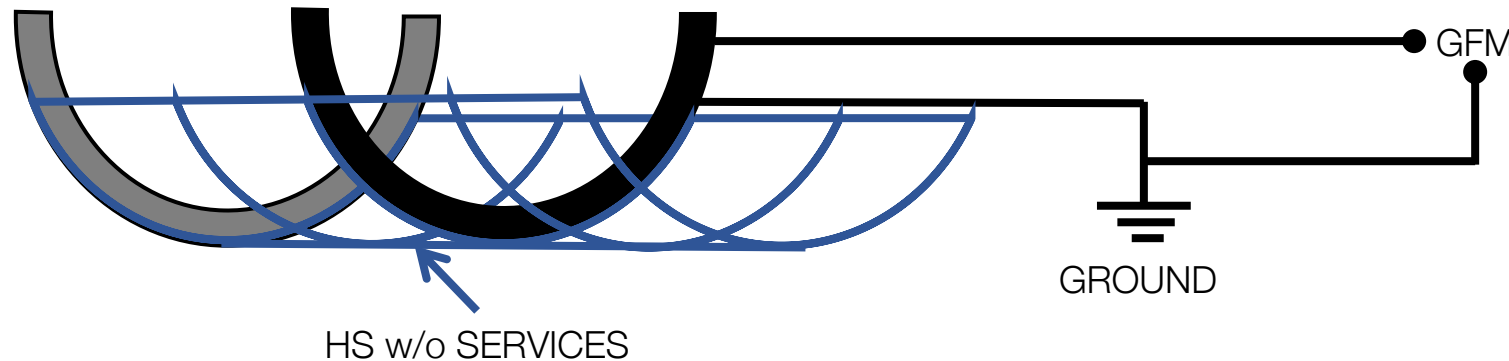
From the GFM guide

The Baseline Procedure During Integration

From the GFM user guide:

1. Connect the HR that we are ready to integrate inside the HS on the ground
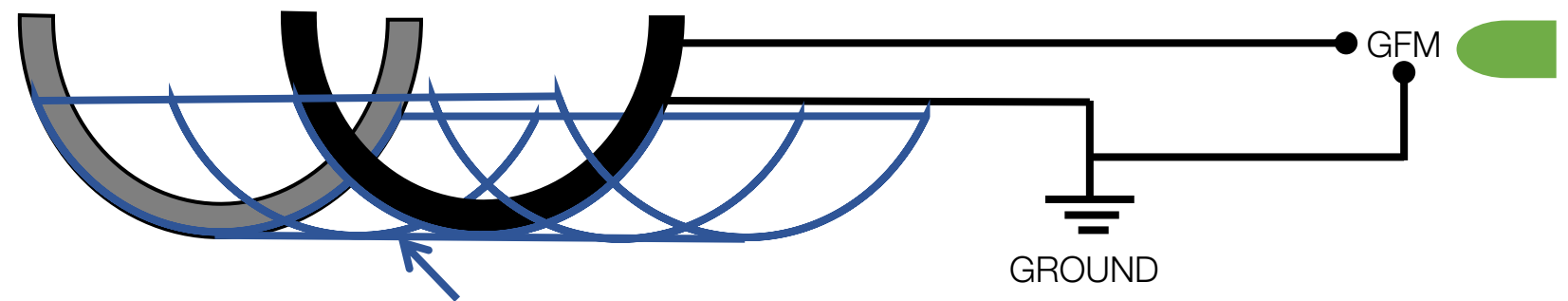
2. Connect the GFM to the HR and integrate the HR

The Baseline Procedure During Integration

3. If the green light doesn't turn to red and the siren doesn't start yelling, we are ready to disconnect the ground and the GFM from the HR and connect the Type-1 services. From that moment, the HR will get the ground from the HS


GFM

GROUND

HS w/ SERVICES

4. Let's move to the integration of a new HR following the same procedure
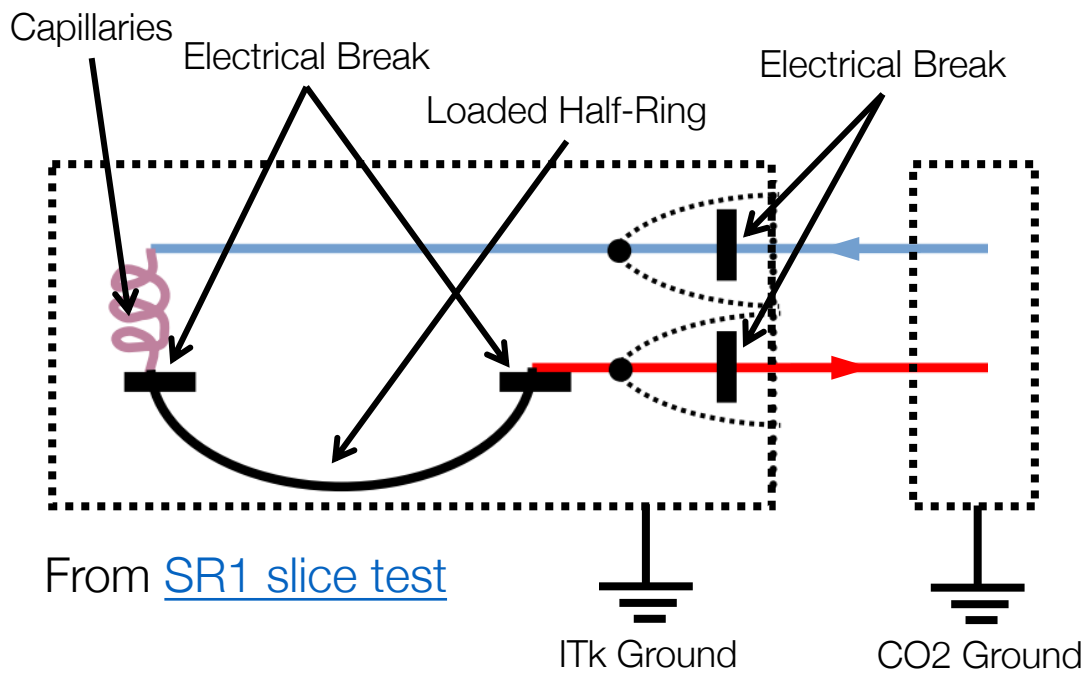

GFM

GROUND
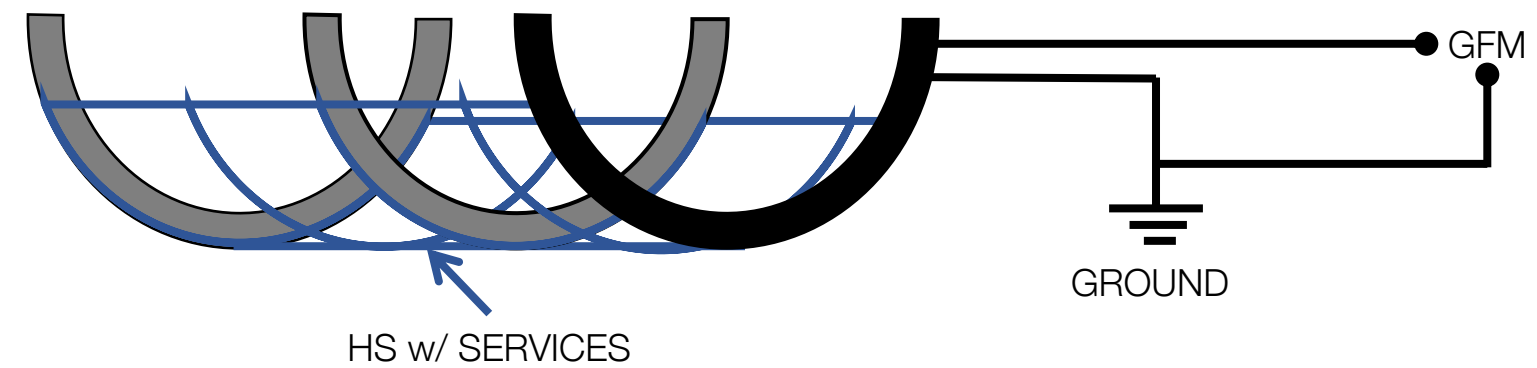
HS w/ SERVICES

G&S Checks for Services

- The GFM allows to detect unwanted ground connections via the services like cabling and cooling.

- During the installation of the electrical service, is not already designed if PP1 sockets are in touch with the integration tool which is connected to the faraday cage.

- Is it mandatory to continuously check the grounding status with the GFM during the installation of the cooling line and the electrical service or in these case could we use a multimeter?
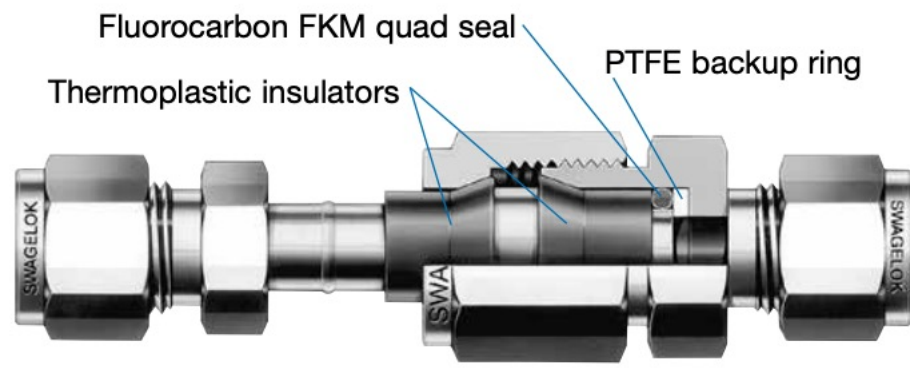

Drawing by Andrea Capsoni
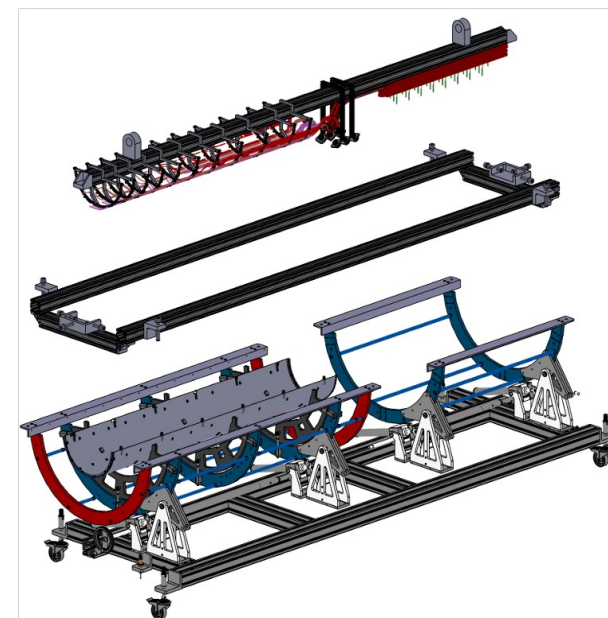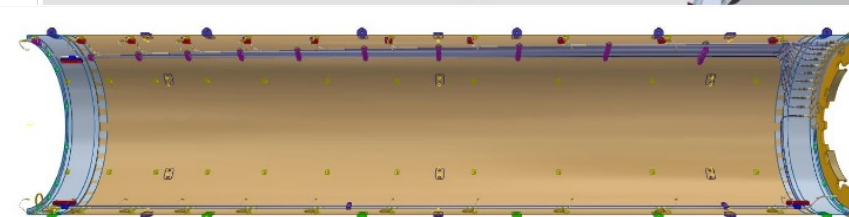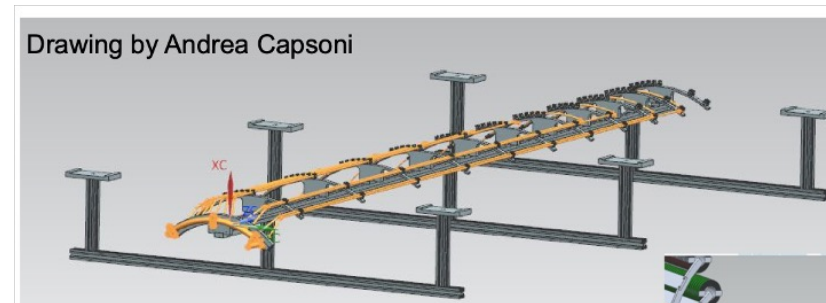
The Cooling Circuit Grounding Scheme

- The cooling is isolated with respect to the HS and then is grounded as shown in the sketch below
- The ground on the detector is not the same of the CO_2 cooling plant
- Two more EB are needed to avoid electrical noise on the pipes

Capillaries
Electrical Break
Loaded Half-Ring
Electrical Break

From SR1 slice test

ITk Ground   CO2 Ground

- To prevent any damage on the cooling circuit the Swagelok Dielectric Fittings were chosen

Fluorocarbon FKM quad seal
Thermoplastic insulators
PTFE backup ring

Open Questions and Next Steps

- Do we have to keep GFM running during the tests?

- How to connect GFM during mating of HSs?

- A GFM is currently in Frascati and we are ready to start playing with it!
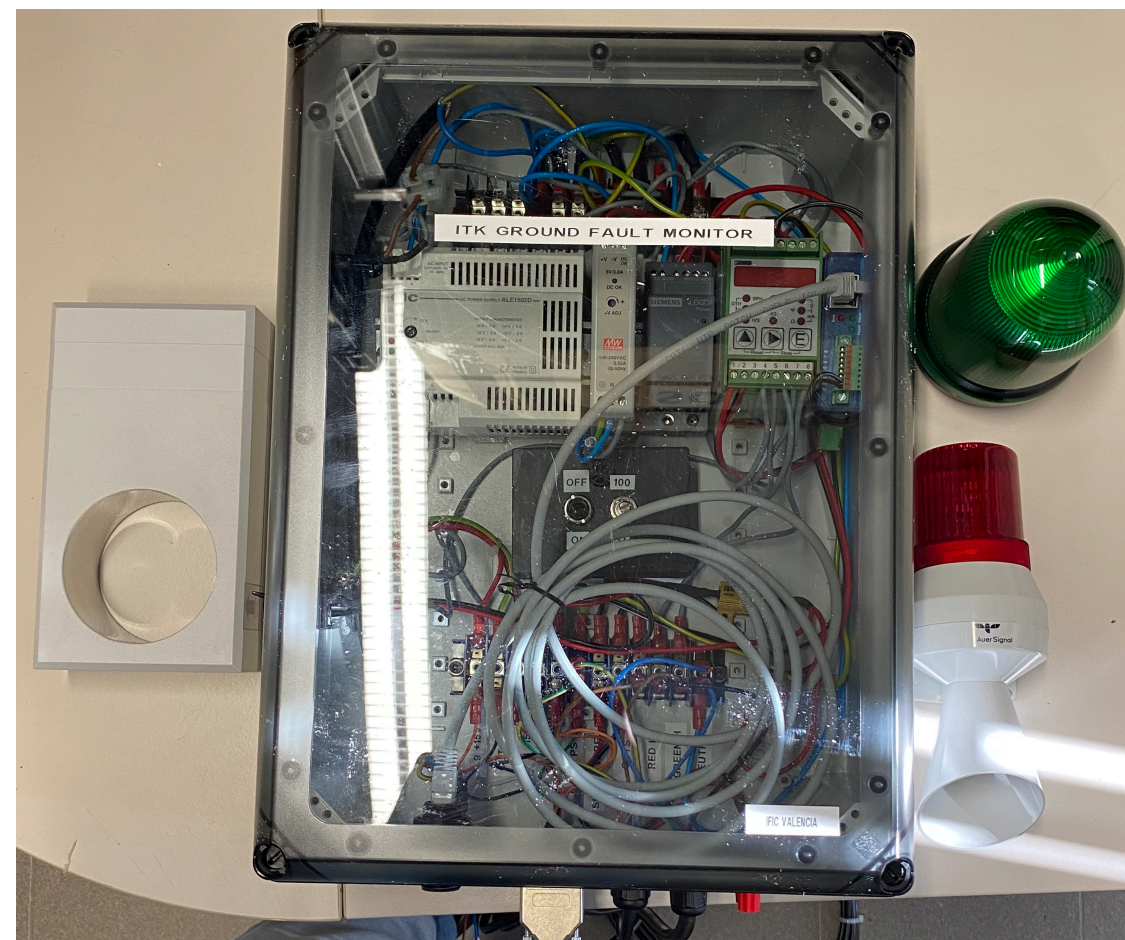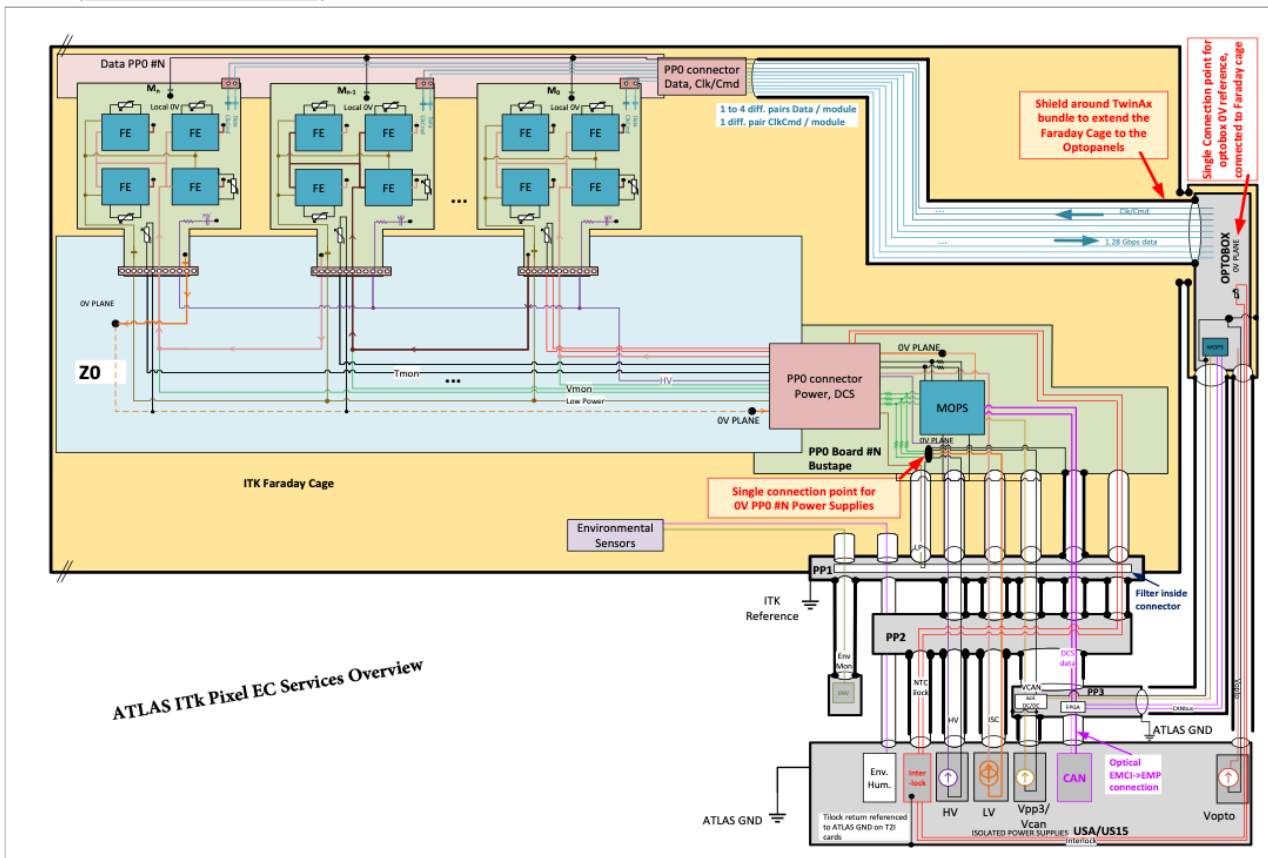
Thanks for your attention!

Any comments or questions are more than welcome!

Outer Endcaps Grounding and Shielding approach

- The grounding and Shielding approach for the ATLAS-ITk Pixel endcaps have been addressed in different reviews and has also been documented in the bare local support FDR (AT2-IP-ER-0012) and in the on-detector services FDR (AT2-IP-ER-0026)

ATLAS ITk Pixel EC Services Overview