

# Considerations from machine protection and the ELQA teams

*First inputs for the discussion*

- Radiation
- ‘cul de sac’ – no alternative escape route in case of a helium release etc.
- O<sub>2</sub> deficiency

Electrical Quality Assurance is a set of tests:

- Insulation test (HV)
- Frequency transfer function measurement
- Polarity, continuity and resistance
  - Magnets
  - Current leads
  - Instrumentation
  - Quench heaters
  - Entire circuits
  - DFBs

- ELQA requires access to the same points as the power converter and QPS
  - It can be done in a radiation free area (i.e. UA)
  - The preference is that the two units are not far away from each other
  - PC has to be disconnected
- HV test
  - If the test is performed from the PC side, it includes the DC warm cables, which may have an important leakage current and may hide fault precursors. For air cooled cables it is less problematic.
  - No such problems in case of a SC link
- Current lead temperature sensors
  - In the current design of standard current leads the Pt100 is at the potential of the current lead.
  - This connection and the sensor itself are checked by ELQA
  - Access to temperature sensors is needed in the radiation free area

- All instrumentation needs to be accessible from the radiation free area
  - V-taps used by QPS
  - Quench heaters
  - DC warm cables
  - Temperature sensors
- High voltage withstand
  - The voltage withstand of link conductors must match the test voltage requirement of the magnets!
  - All current leads, connectors and feedthroughs need to ensure the voltage withstand to ground, between circuits and between circuit terminals!

- Access to the local zone may be needed **in case of faults**
- Solutions
  - Is it better to route the instrumentation at the warm part or cold part?
    - Faults in the cold part are not less likely to occur
    - Faults in the cold part are more difficult to repair and more risky in radiation areas
  - Clean routing at the warm part ensures less faults and improves maintainability
  - Route only simple 1-1 cables with robust connectors between the magnets and the radiation free area
  - Connections on IFS boxes could be designed such that they can be potentially manipulated with a robot
  - Redundancy helps to minimise the likelihood of faults that must be repaired
  - Proper design and extensive testing of the prototype is necessary
    - Everything counts – isolation materials, soldering flux, cross section of wires, feedthrough system etc.
  - Proper testing during the assembly and before the beam operation is critical

- The DFBXs are very densely packed
- Multiple unnecessary connections, patches and boxes are present
- Access from behind is necessary to reach certain connections
- Routing of DC cables of correctors:
  - Current lead -> patch panel (above the QRL) -> Proper DC cable -> PC

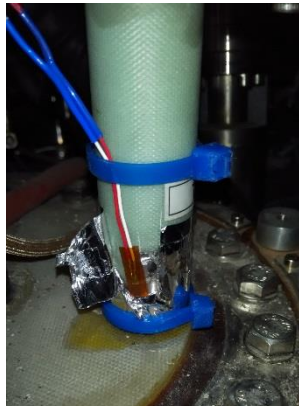
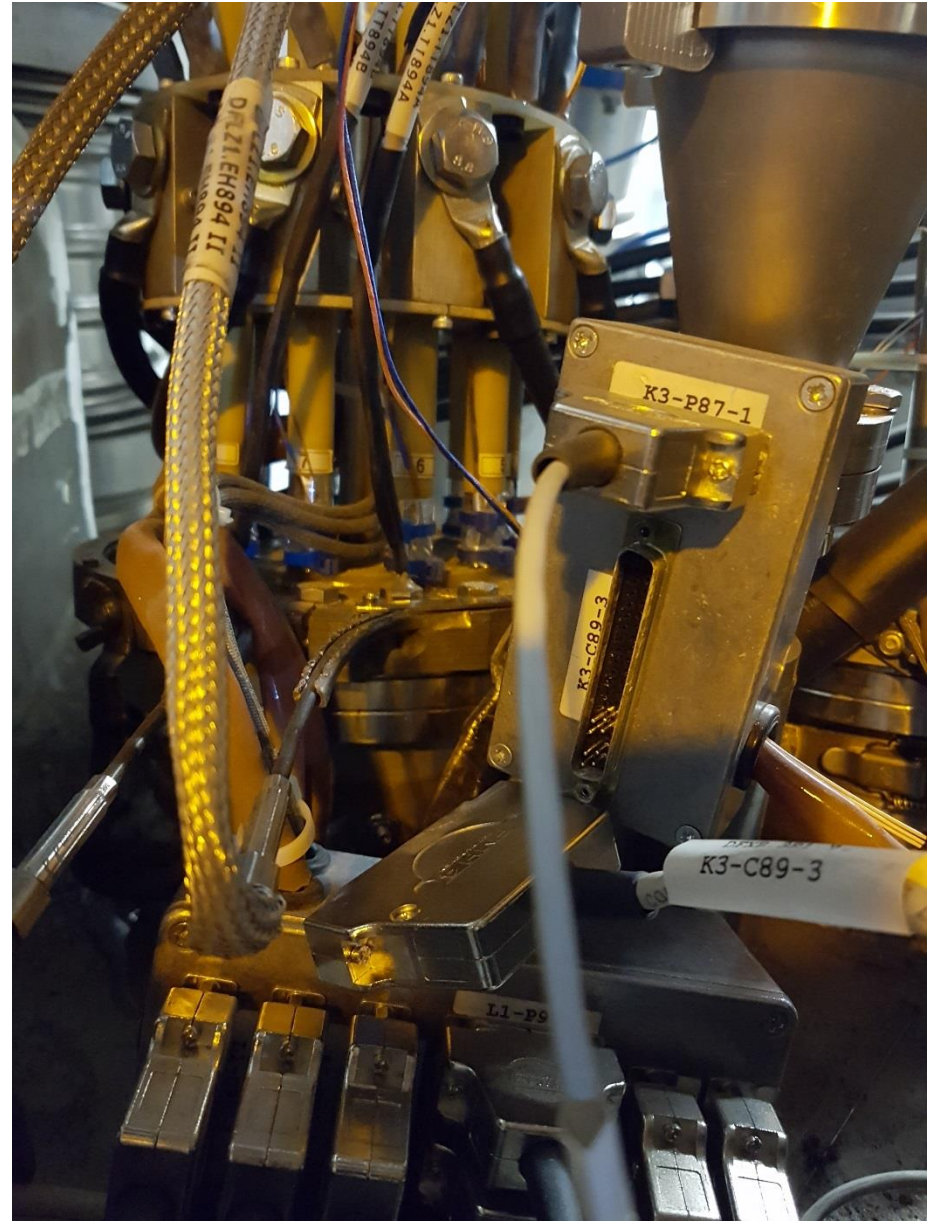
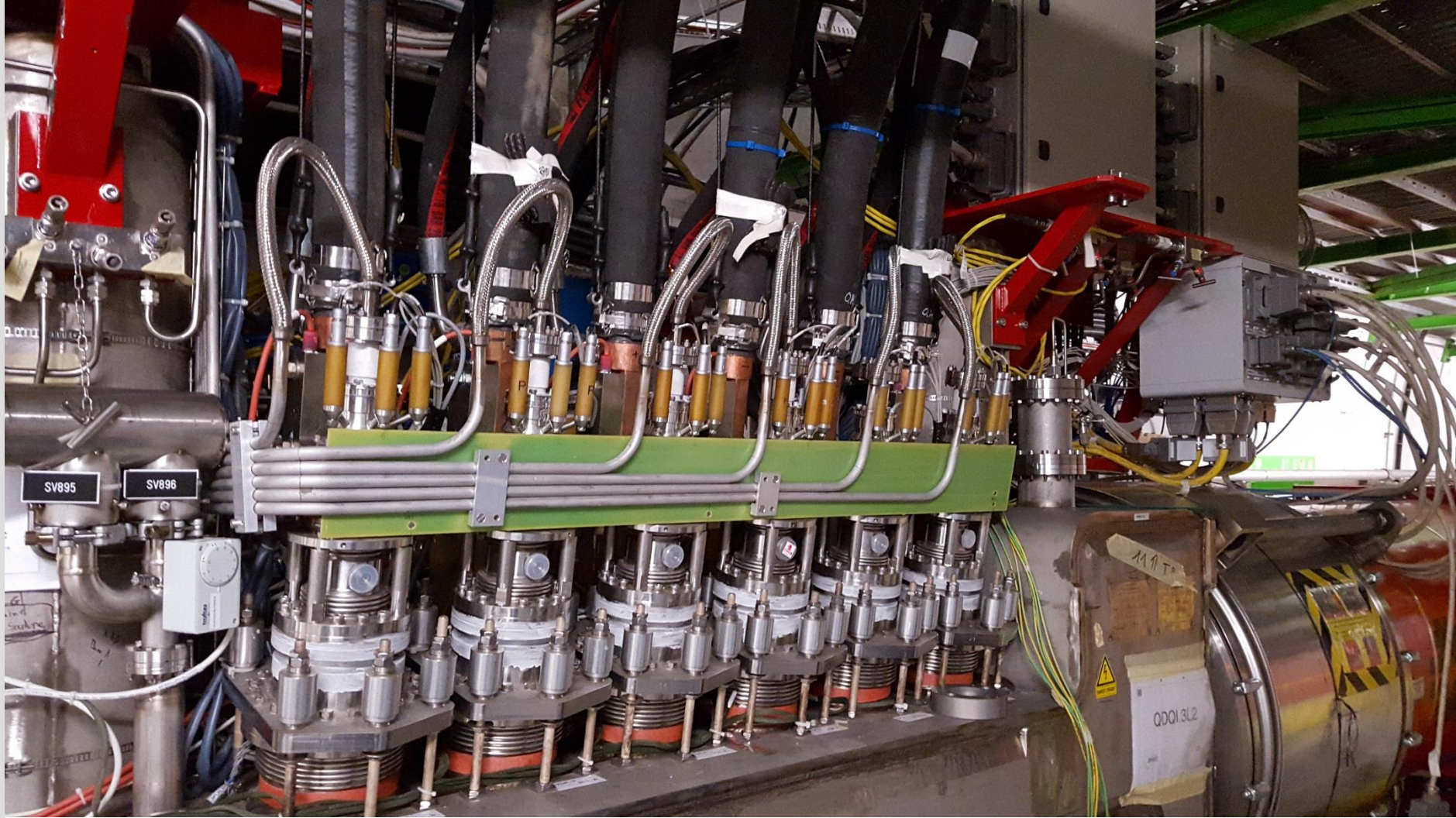






Image taken in the test hall, not in the tunnel.  
In the tunnel the assembly is much more crowded!





Q1-DFX 18/08/2017, Mateusz Bednarek, TE/MPE-EE



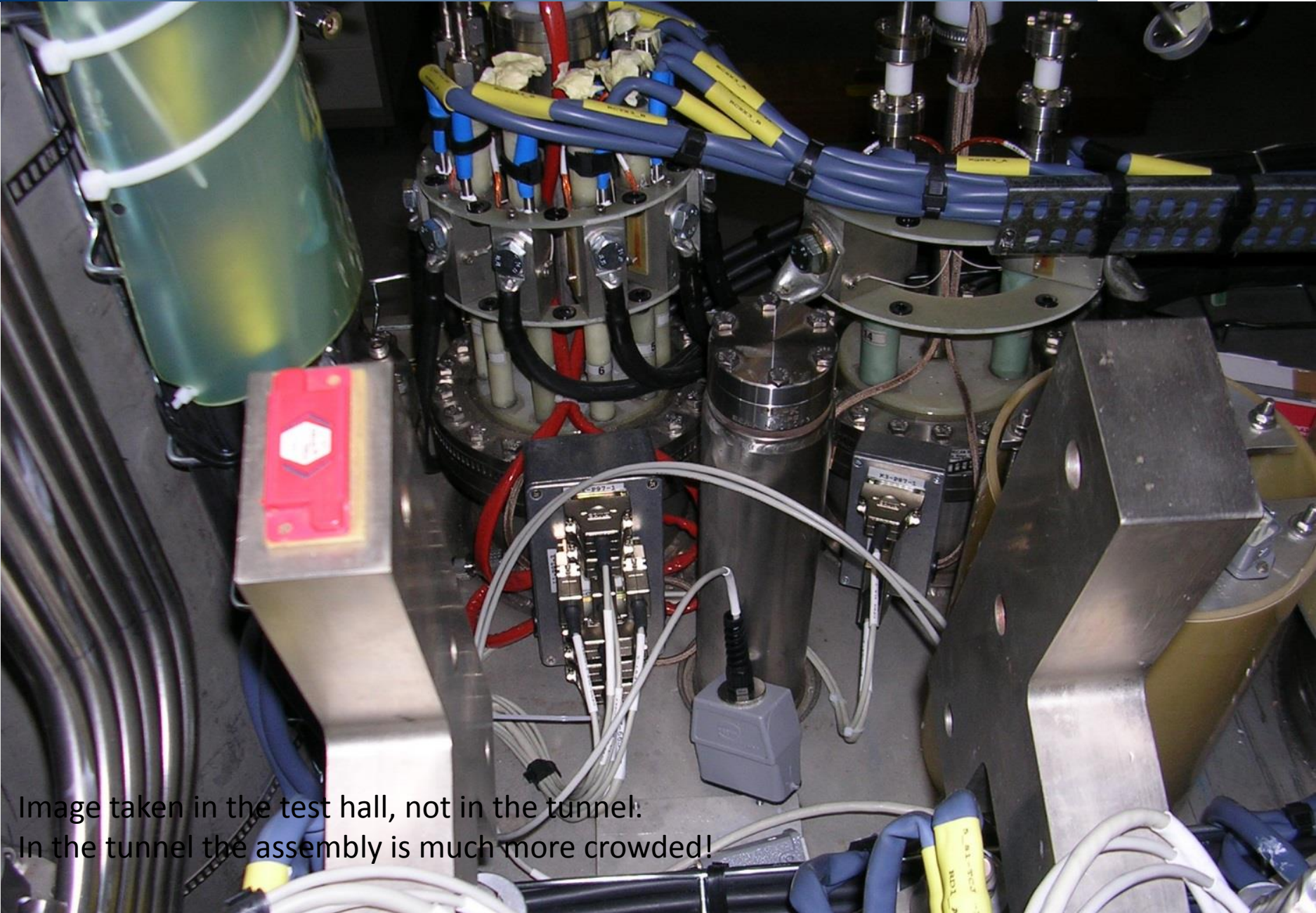


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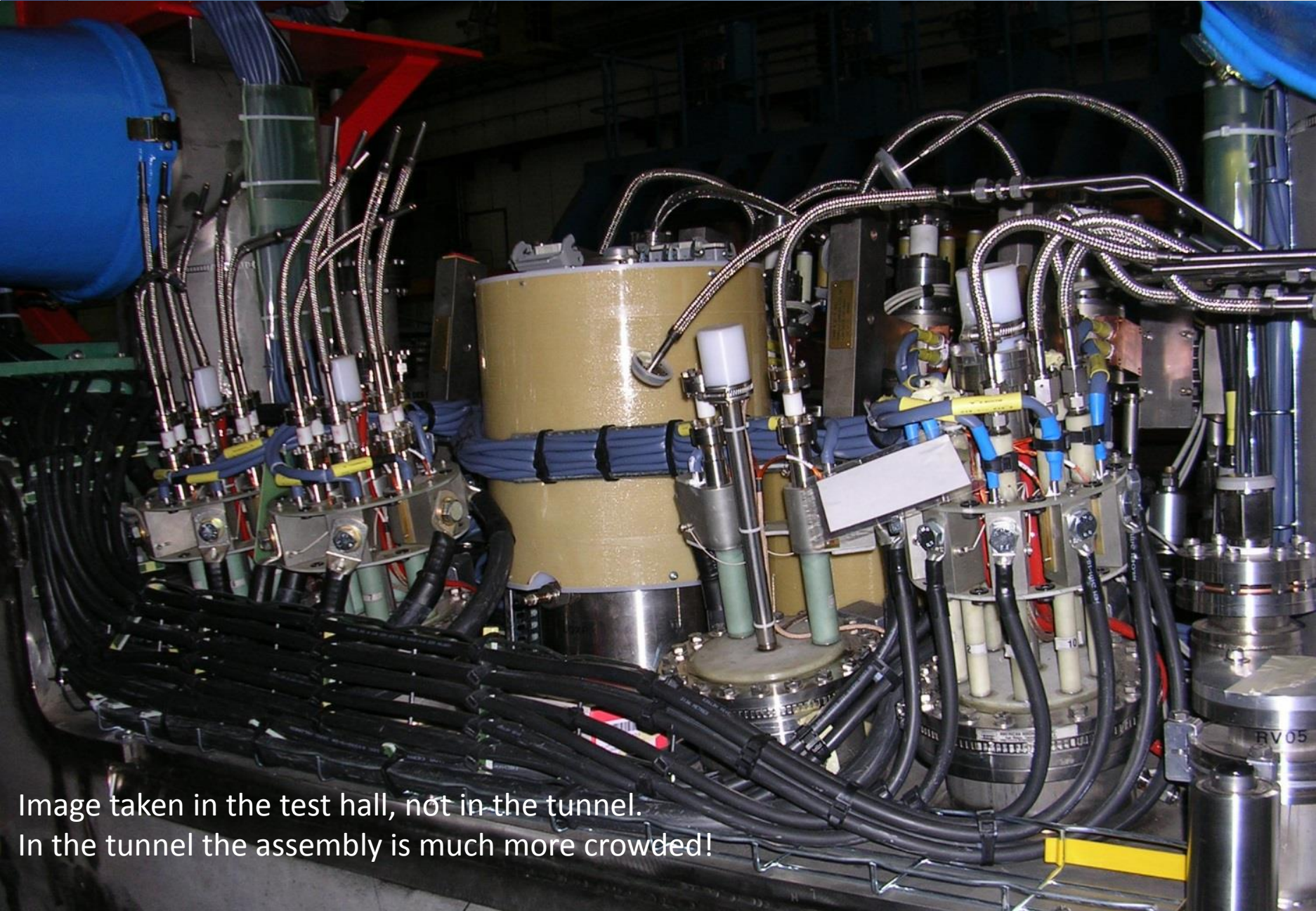
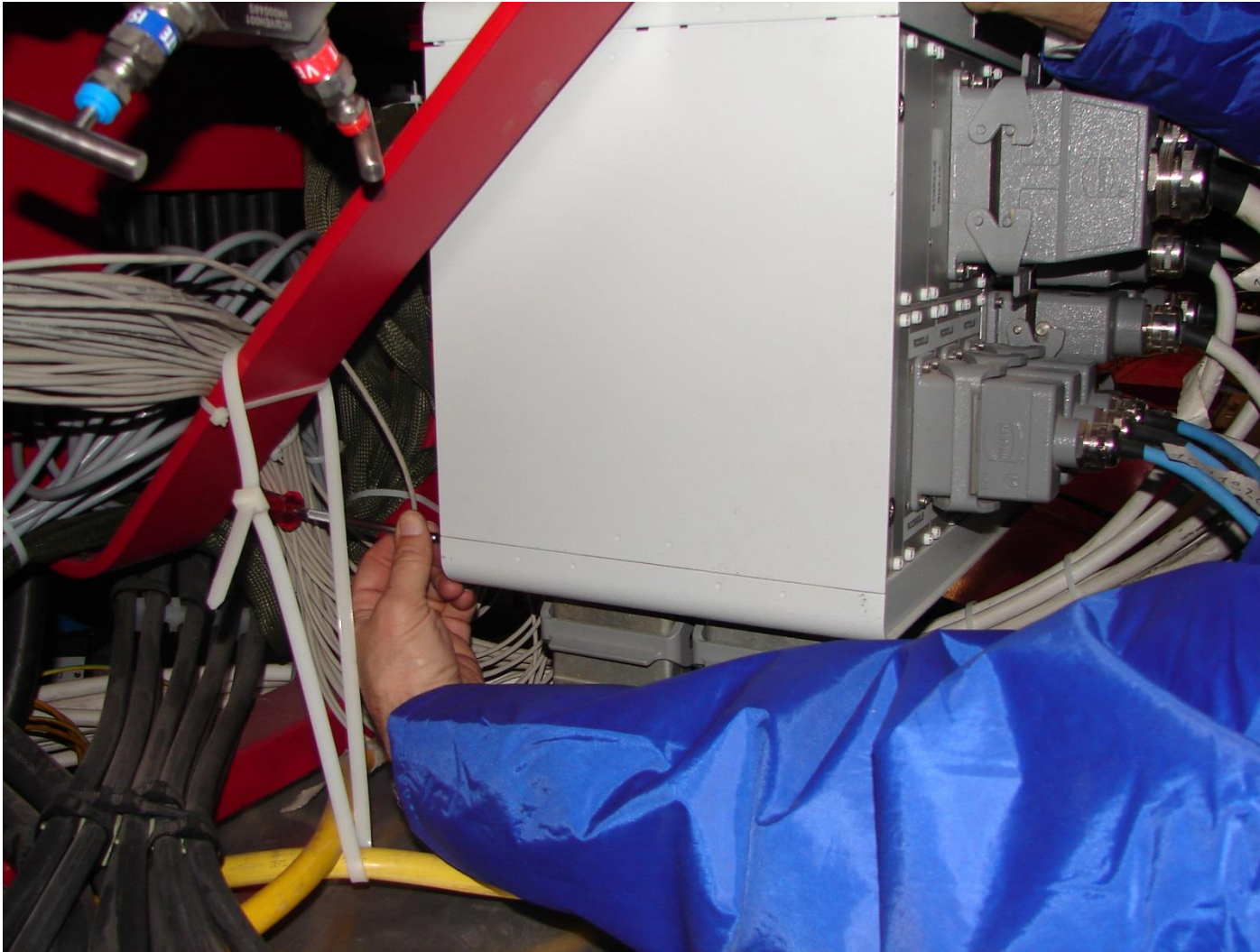


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In the tunnel the assembly is much more crowded!

- Low maintainability
  - Difficult access to many connections
  - Many connections, hard to identify the fault
- These DFBS were not designed to be repaired
  - Issues nevertheless arise and are very problematic
- Pinout conventions are different than in standard DFBs
- Current leads are different, connectors different, heaters different etc.



Switching to the spare Pt100 sensor is not trivial in such packed configuration!





# Simple intervention example

