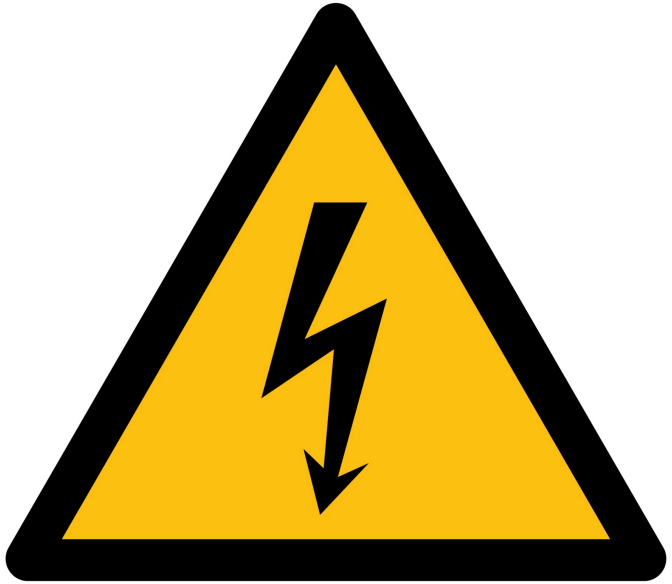
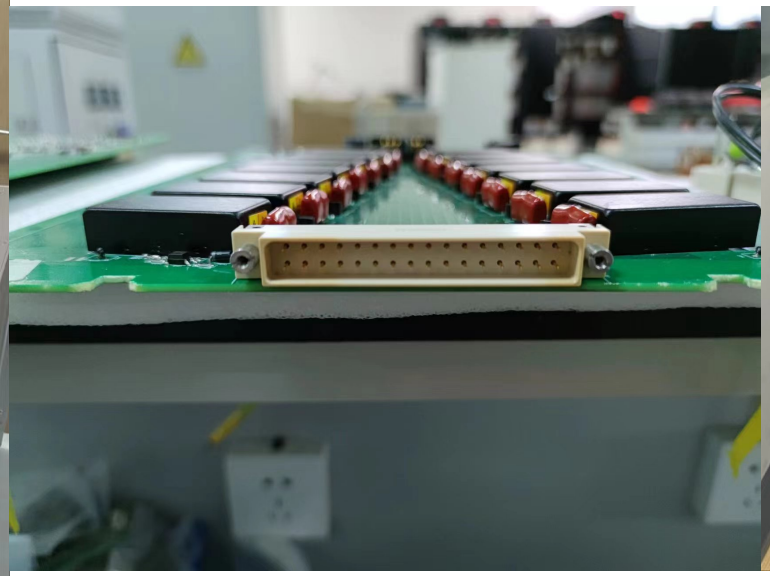
HGTD High Voltage Status

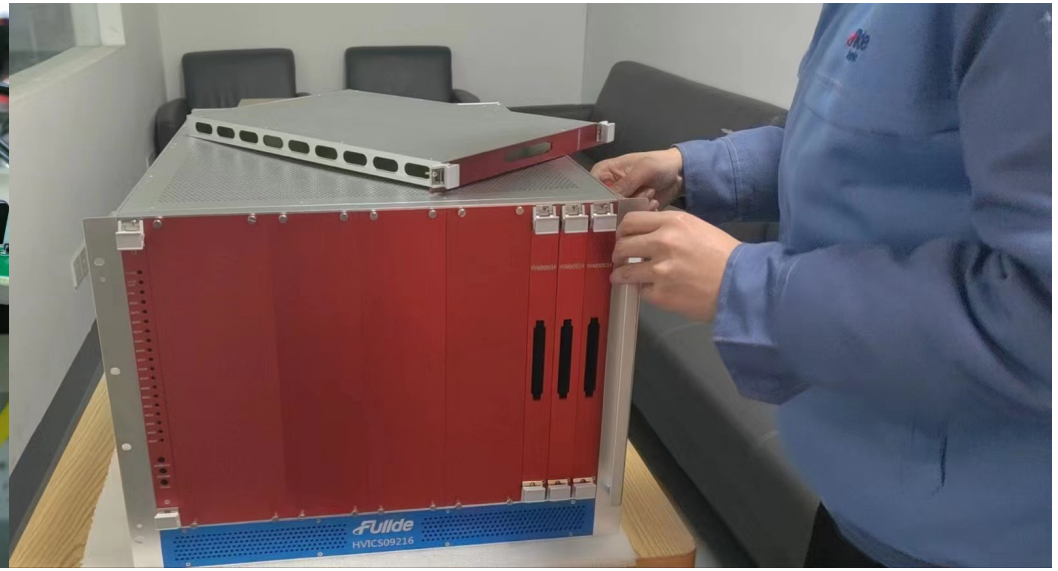


Ricardo Gonçalo (LIP/Univ. Coimbra) for the HV PS and PP teams

HGTD Week at CERN, February 2023

High-Voltage Power Supplies

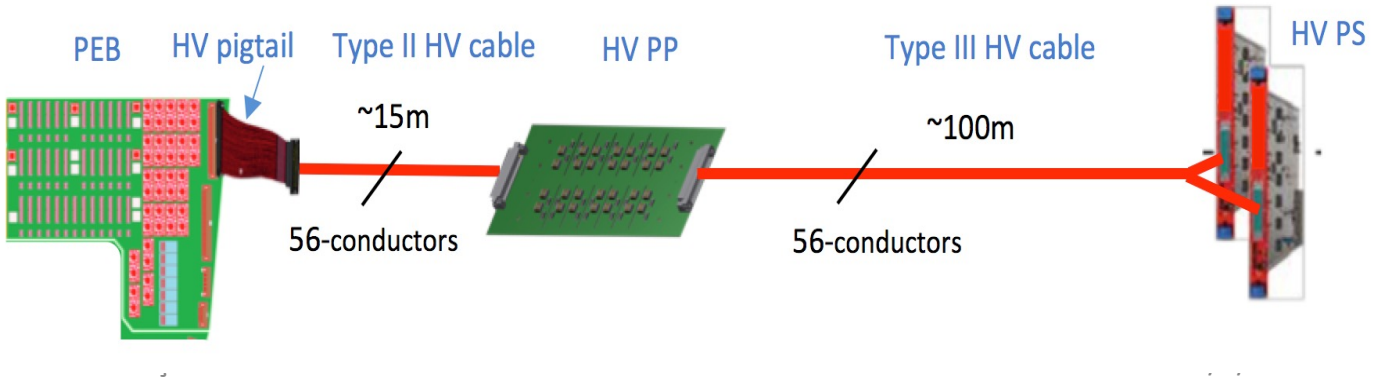


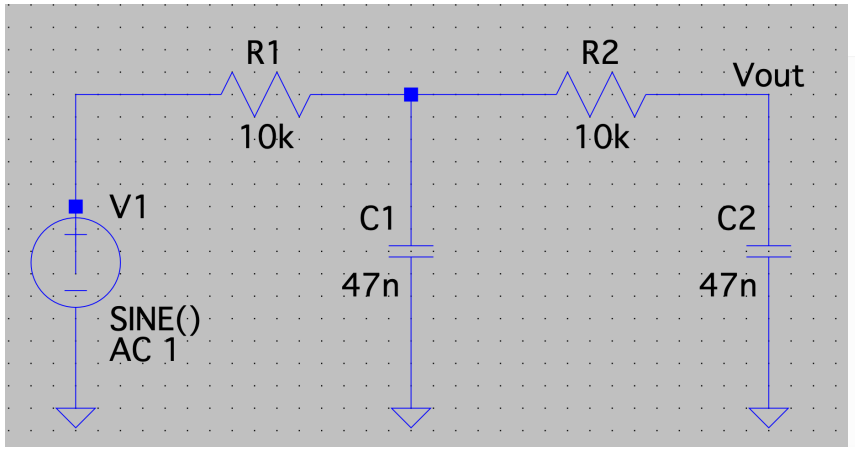


- Power supplies undergoing ageing tests at the factory
- To be finished by the end of February
- After that will proceed with power supply tests

High voltage Patch Panels

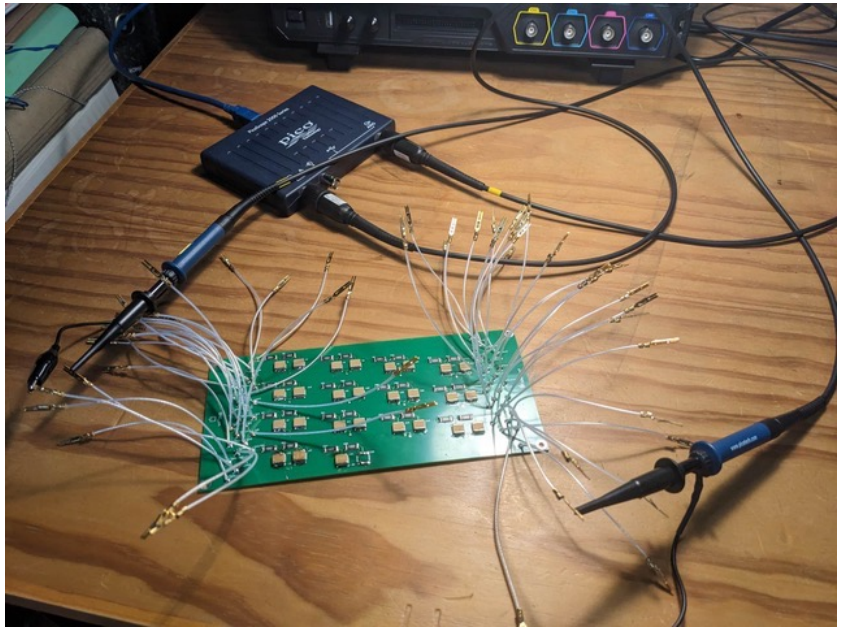
- HV filtered and routed between input long cables from USA15 and short cables to detector
  - 2nd order RC-RC low-pass filter to suppress AC noise
  - 8032 HV channels: at least 574 boards of 14 filters each
- MSc student (Antonio Caramelo) setting up automated testing station for QC
  - Earlier prototype being used for developing tests
- New prototype going for production soon – should be ready for tests in few weeks

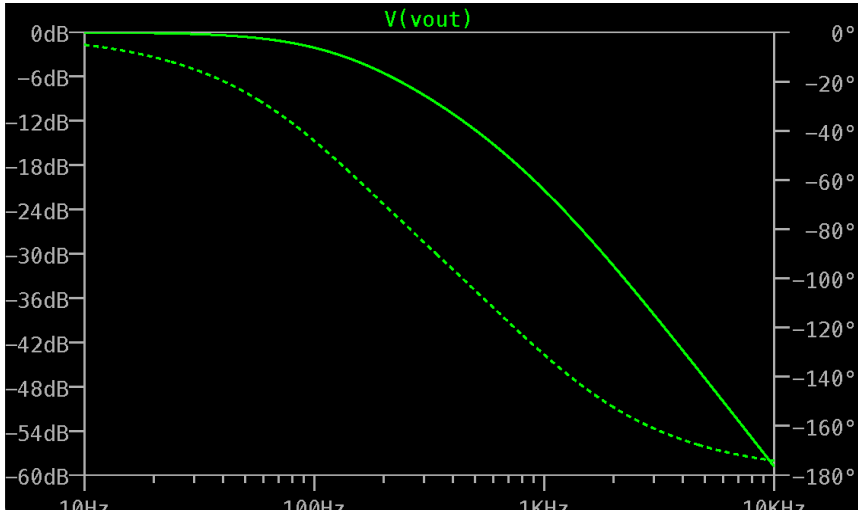


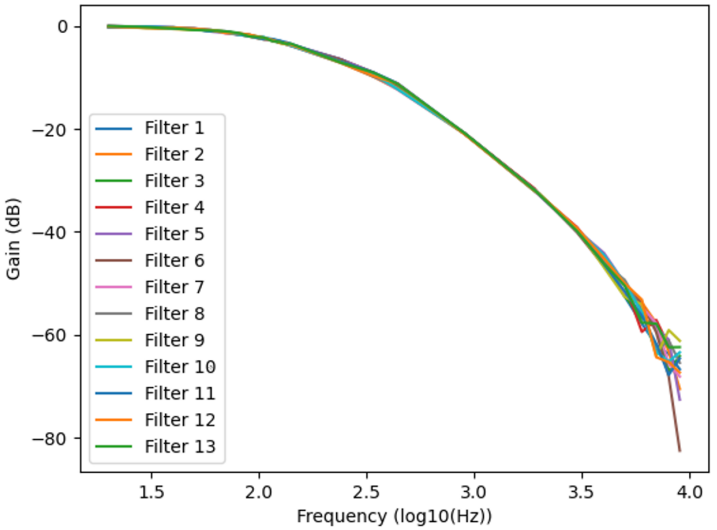


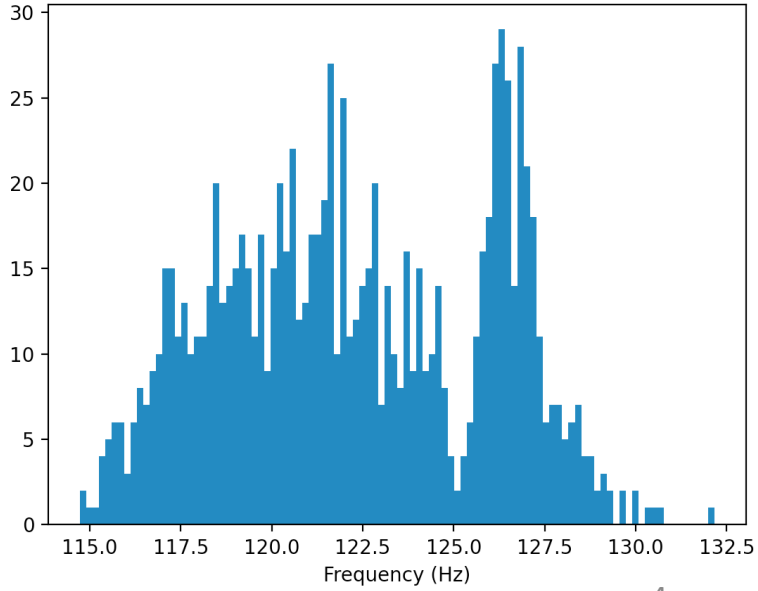
Patch Panel Tests

- Using usb oscilloscope to generate and acquire waveform and attenuation curve
- Extract cutoff frequency (-3 dB) to use as measure of filter quality
  - Expect f_{3db}=126,4 Hz and -40dB/decade for this example
  - Get 122.4±4 and investigating extra peak at the moment





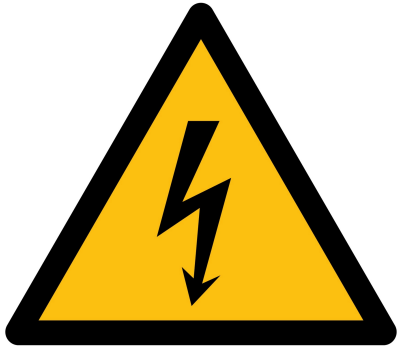


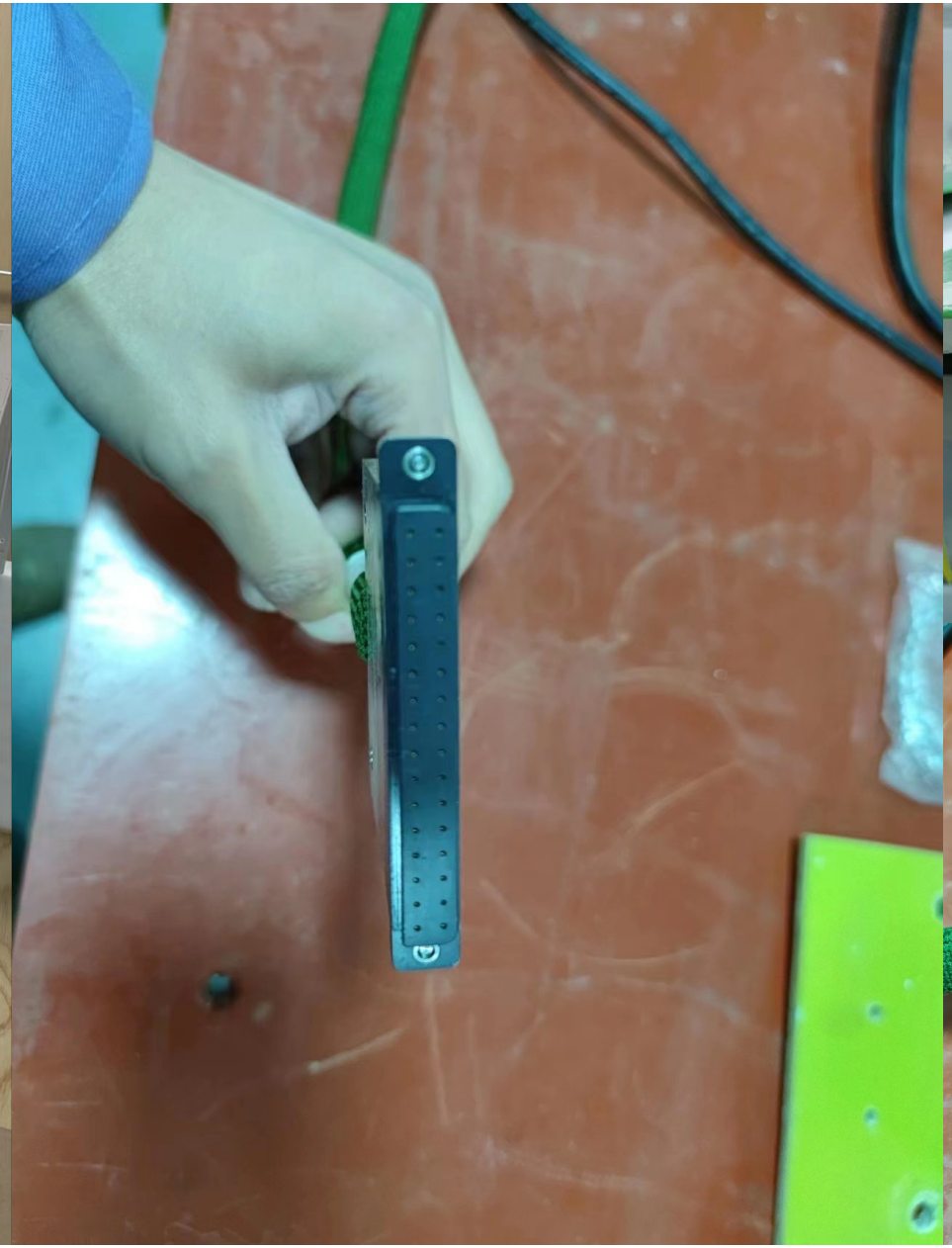
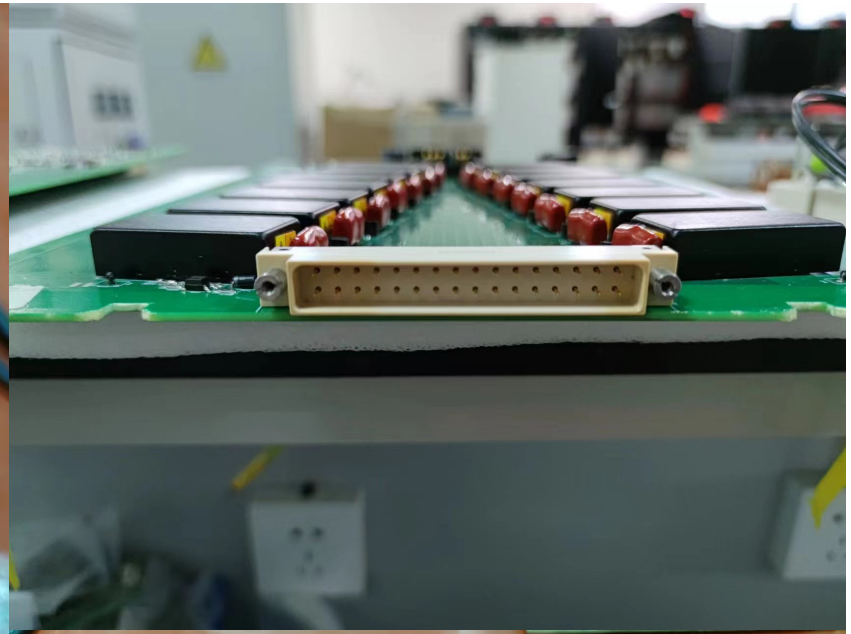
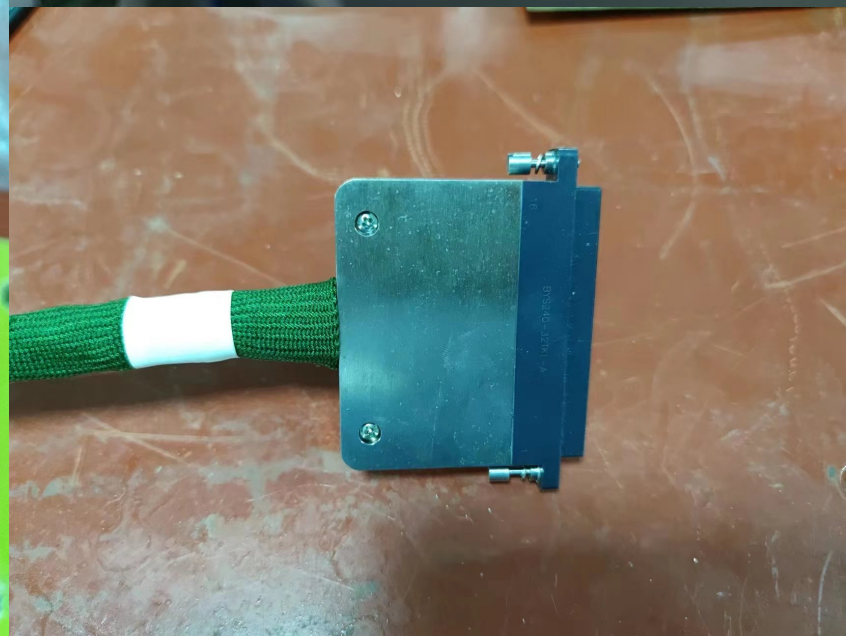


Next Steps

- HV Power Supplies:
  - Ageing tests in February followed by testing of full HV supply units and noise tests
  - Finalize HV supply specifications in June
- Patch panels:
  - New (hopefully final) prototype next month: 1 month delay but no technical problems
  - Further tests: leakage current, cross talk, rad. hardness and magnetic field, ageing
  - QC progressing
- High Voltage PDR passed in August 2022:
  - https://indico.cern.ch/event/1190013/
  - https://edms.cern.ch/ui/file/2775726/1/HGTD-HVPS-PDR_docx_cpdf.pdf
- HV supply FDR meeting on 7 July 2023; PP FDR on 29 August (merge?)

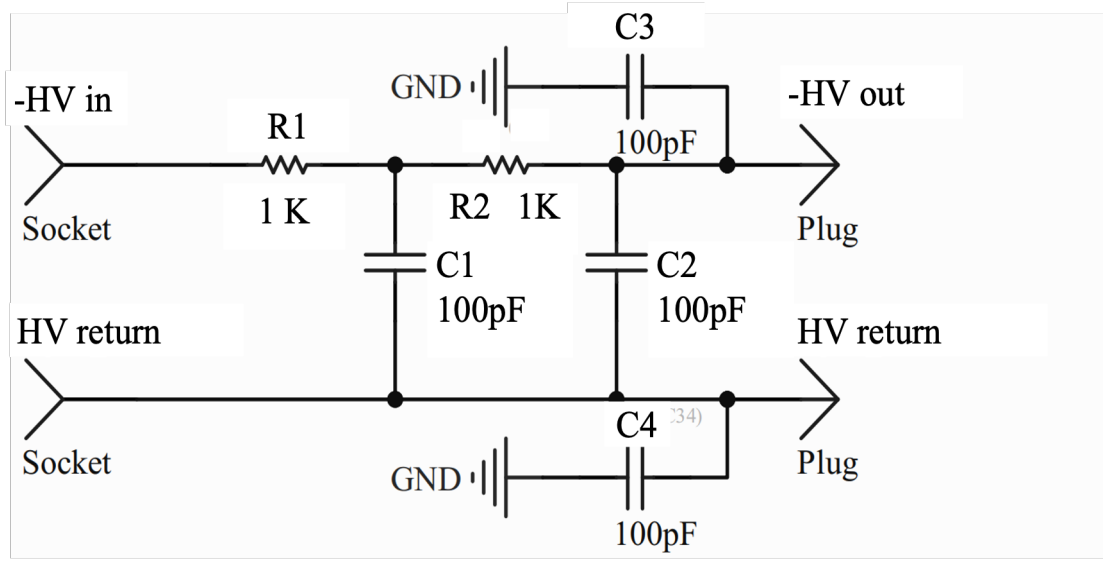
Bonus slides




Fullde
VOLTAGE RANGE 220V~
FREQUENCY 50HZ
INPUT CURRENT 7.5A MAX
CAUTION
Before any operation read technical manual.
Refer servicing to qualified personnel only.
AC INPUT 220V
USB
RJ45




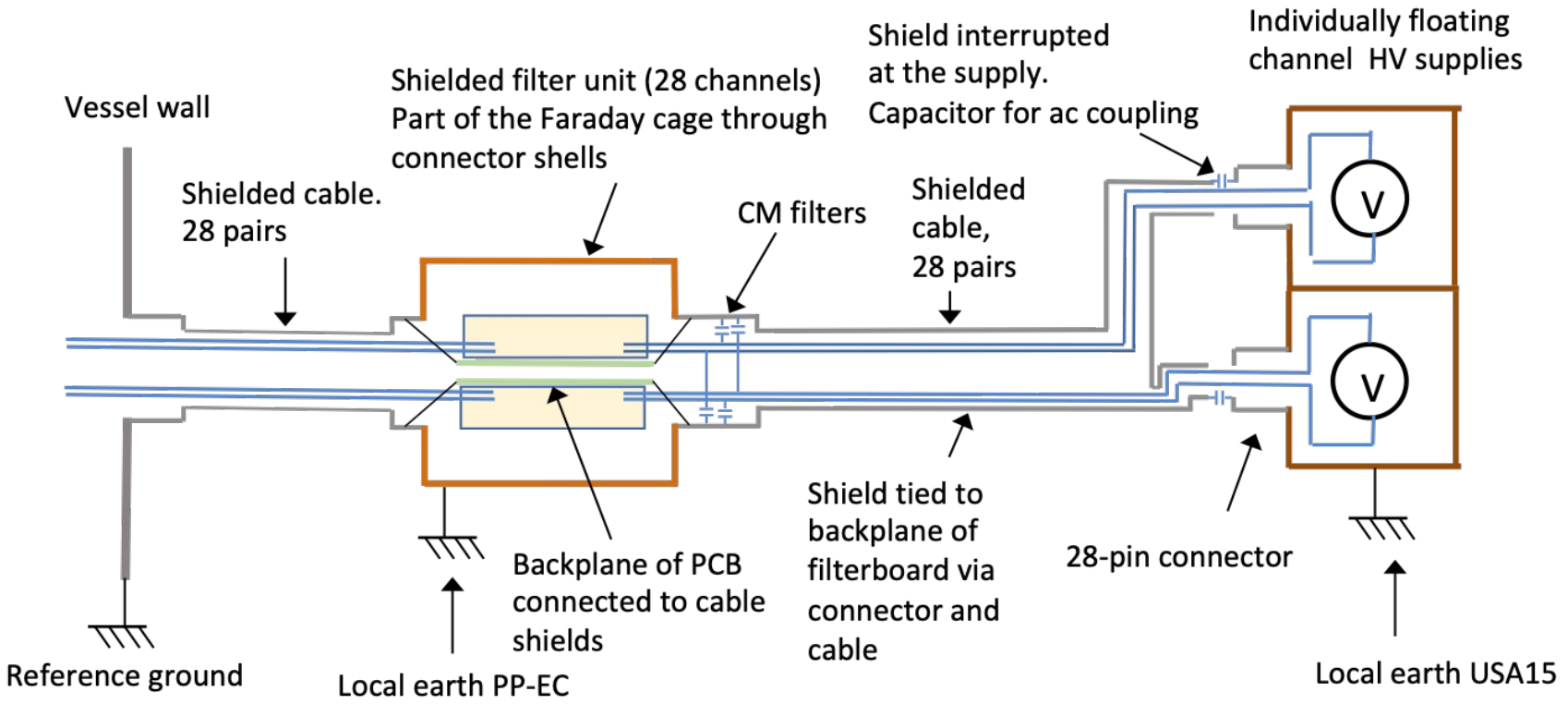
Patch Panel Filter Design For PDR

- HV routing through fixed wire connections between input long cables from USA15 and short cables to detector modules
- 2nd order RC-RC low-pass filter to suppress AC noise
  - Up to -900 V with, no significant leakage, supply currents up to 3 mA per channel
- Decoupling capacitors to suppress common-mode noise (C3, C4)



Patch Panel Grounding & Shielding

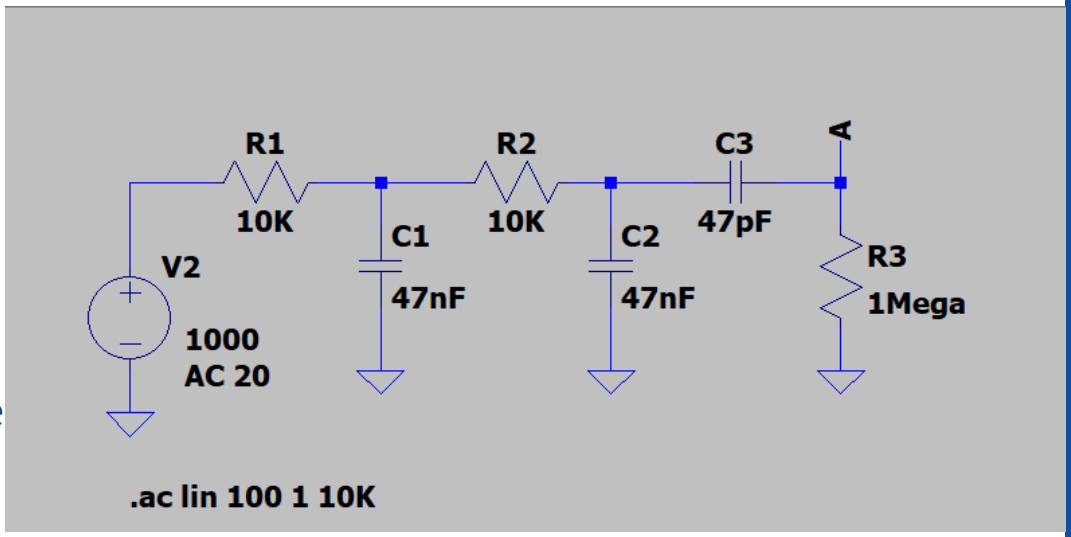
- Use filter module boxes as continuation of vessel Faraday cage
  - Also DC connecttion of filter boards backplane to cage
- DC connection of Faraday cage to local TileCal earth
  - DC current not as bad as HF AC noise
- Move common-mode filter capacitors to filter input instead of output
  - Filter common mode current at input



Prototype tests and quality control

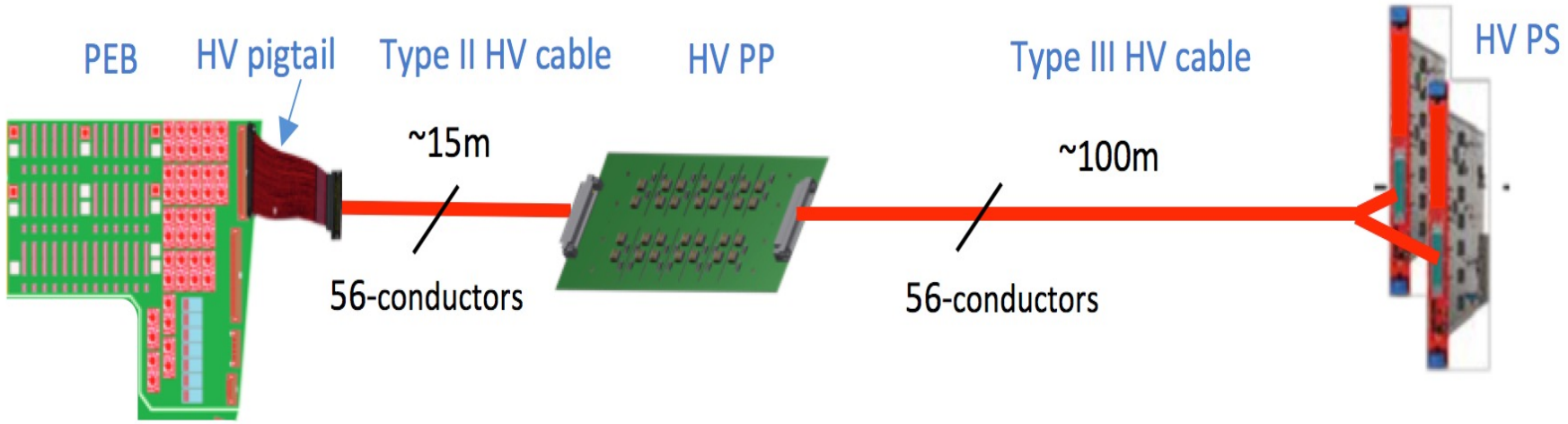
- Planned tests:
  - Connectivity of components and filter performance tested by measuring the filter response as function of frequency and load
  - Leakage current
  - Insulation between internal and external ground.
  - Cross talk between channels
  - Temperature under load
  - Long term reliability including enhanced aging by temperature cycling in a climate chamber
  - Radiation and magnetic field tolerances
  - NEW: test with and without DC ground

- For production:
  - Based on prototype results will establish set of quality control benchmarks to be done in production and upon delivery



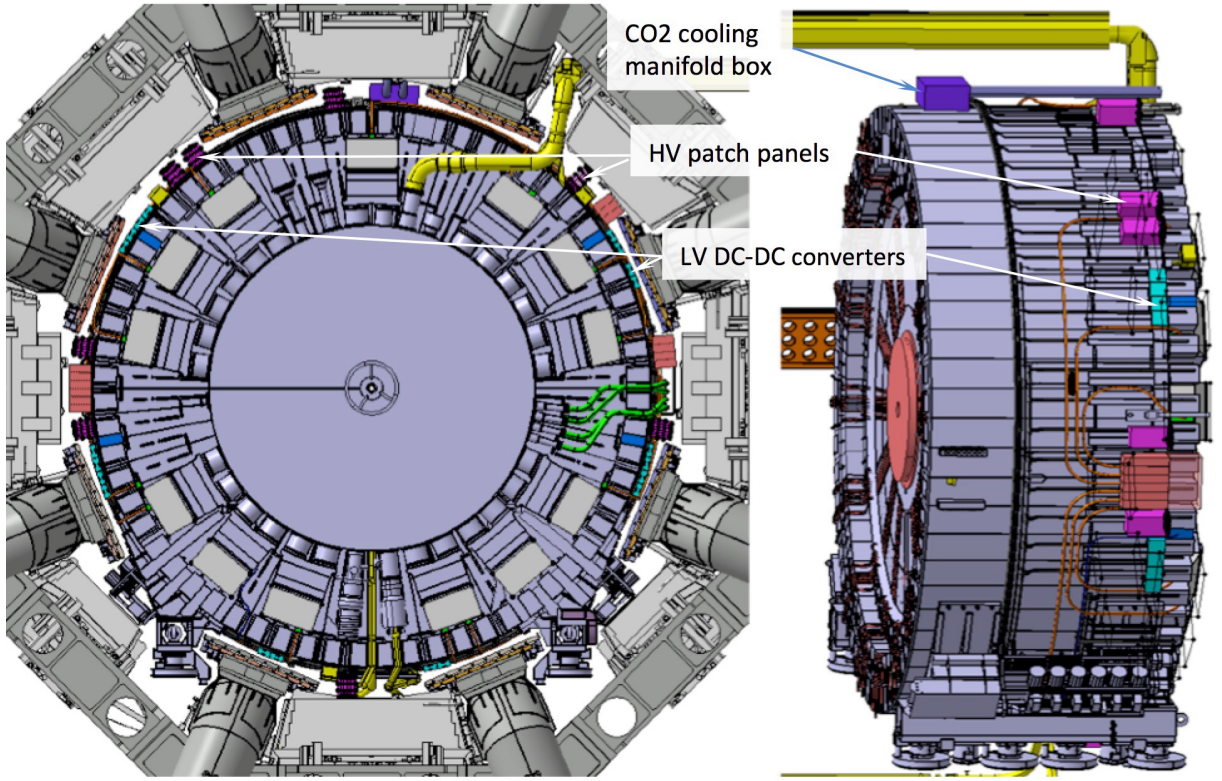
HGTD HV Patch Panels

- Each of the 8032 HGTD modules will need a bias voltage between -300 V and -900 V, adjusted individually
- Electronic noise induced in the DC bias voltage at the power supply or in the cables between USA15 and the detector must be filtered out.
- Filter modules (EC-PP) will be installed on the end-cap calorimeter surfaces – filter noise and allow HV channel routing



Patch Panel design parameters

- Materials to withstand radiation and magnetic field:
  - TID 15.0 Gy and 1 MeV neq fluence 1.0×10^{12} cm^{-2}
  - Magnetic field up to 0.5 Tesla
  - Avoid easily activated and magnetic materials
  - Avoid extensive use of dielectrics
- Mechanical stability and ease of access during shutdowns
  - Robust connectors
  - Fixation to Tilecal and cable strain relief staves – to be studied together with Technical Coordination
- Space constraints
  - Around 20cm free in radial direction
- Number of wires should present good match to cables from HV supplies



Patch Panel Units Design

- A modular design is proposed for the patch panels
- Individual modules are aluminium boxes containing two filter boards and connectors
  - Provide mechanical support and insulate each pair of boards within separate Faraday cage
  - Easy to construct, handle and access for maintenance
  - 14 RC-RC low-pass filters in each filter board
  - Means one 56-wire cable connected to each module: = 28 HV channels = 14 channels x 2 boards
  - Routing of individual HV channels through wires connecting cables to each filter board