HGTD HV Patch Panels Status

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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 × 10¹² 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 Filter Design

- 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 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



Patch Panel design parameters

- Differential HV channels, insulated from the patch panel unit
 - Module aluminium boxes act as Faraday cage, electrically connected to the Tilecal surface
 - HGTD earth extends through cable sleeve to filter board backplanes
 - HGTD/Filter earth insulated from module earth (=Tilecal earth) to avoid ground loops



Initial (pre-)prototype tests

RC–RC filter: 10 k Ω x 33 nF or 47 nF

 Note R and C not final – must be defined together with sensors and tested together

Assuming 3 mA maximum current means:

- 60 V voltage drop
- 180 mW max. dissipation per channel
- I.e. 5 W / 24-channel box

Ideal response:

- f_c = 338 Hz (33 nF) or 482 Hz (47 nF)
- -40 dB / decade
- Achieved this when tested inside shielding box





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









Prototype tests

- Response improves with shielding (Faraday cage)
- Closer to -40 dB / decade

Response flat above 10 kHz

Other tests foreseen:

- Leak current under HV bias waiting for precision HV module to be free, to ease measurement
- Final tests must be done with HGTD HV source prototype





20°

0

-60

-80

Optimising design

- Also tried an alternative design to:
 Ease assembly: reduces production time and manufacture errors
 Improve robustness: assess robustness of routing cables / soldering
 Add decoupling capacitors against common-mode noise in each channel
- Lower cost:
 - Especially by reducing length of cable for HV routing Trying routing in 4-layer PCB



Connectors

Found potentially interesting connectors from Farnell:

http://www.farnell.com/datasheets/2916873.pdf

REF:516-120-000-101 REF: 516-056-000-301 REF: 516-120-000-402 REF: 516-056-000-402 REF: 516-230-512 REF:516 230-556

Unit price (120 pins, small quant.): 53 € plug; 45 € pins; 26 € connector

To be used for this prototype and replaced later



516 SERIES

RACK AND PANEL CONNECTOR (PLUG AND RECEPTACLE)

Specifications:

Insulator Material	Diallyl Phthalate, Thermoplastic Polyester or Polycarbonate UL 94V- 0
Color	Green or Grey
Contact Material	Copper Alloy
Contact Plating	Gold Plating over Nickel over entire contact
Current Rating	8.5 Amperes
Contact Resistance	10 milliohms maximum
Withstanding Voltage	2000 VAC rms at sea level
Insulation Resistance	5000 Megaohms minimum
Operating Temp	-40°C to +125°C (Diallyl Phthalate Only)
Operating Temp	-40°C to +105°C
Insertion & Withdrawal Force	2 to 16 Oz (0.56 to 4.45N) per contact position

Measurements

Difficult to measure low-frequency behaviour with our current setup due to output capacitor in waveform generator

