

Design of the HV Divider Board for Proto-DUNE Dual Phase Field Cage

Animesh Chatterjee

M.Hibbard, J. Yu, D.Zenger, Mathew Rapp

University of Texas at Arlington

C.Cantini, A.Gendotti, S. Murphy, L.M. Bueno

ETH Zurich

F. Pietropaolo

CERN

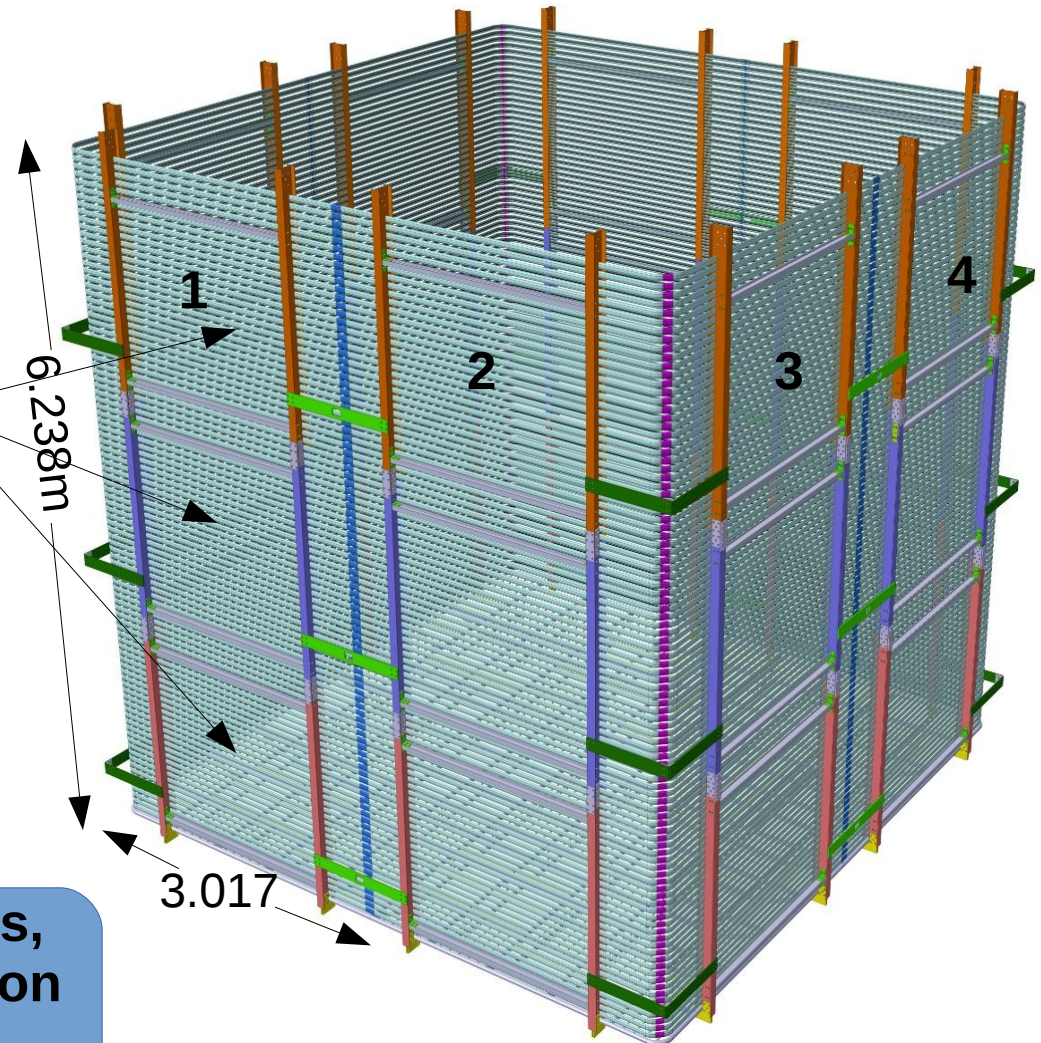
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Outline

- Motivation
- Modification on the board design
- Module zero construction plan
- Conclusion

Overview of DP-FC

- Total 8 modules.
- 2 modules in each detector side.
- Size of each module is 6.2m x 3.0 m.
- Each module is composed of 3 sub-modules.
- **Each module has 98 profiles.**
- Center to center distance between two profiles is 60mm.



**Profiles are connected with clips,
Continuity of Electrical connection
across 4 sides of the
Module.**

HV Divider Board: Motivation

- To generate uniform electric field of 500 V/cm across the entire drift volume.
- Use the printed circuit board
 - Easy handling and installation, robust mechanical and electrical connections
 - perform and survive in LAr for a long time.
 - ample redundancy
- Important issues before the design of the board:
 - High Voltage power supply.
 - Total number of profiles, or total number of gaps (stages) including the connection with cathode.
 - Center to center distance between two profiles (60 mm).
 - Current flow across the circuit.

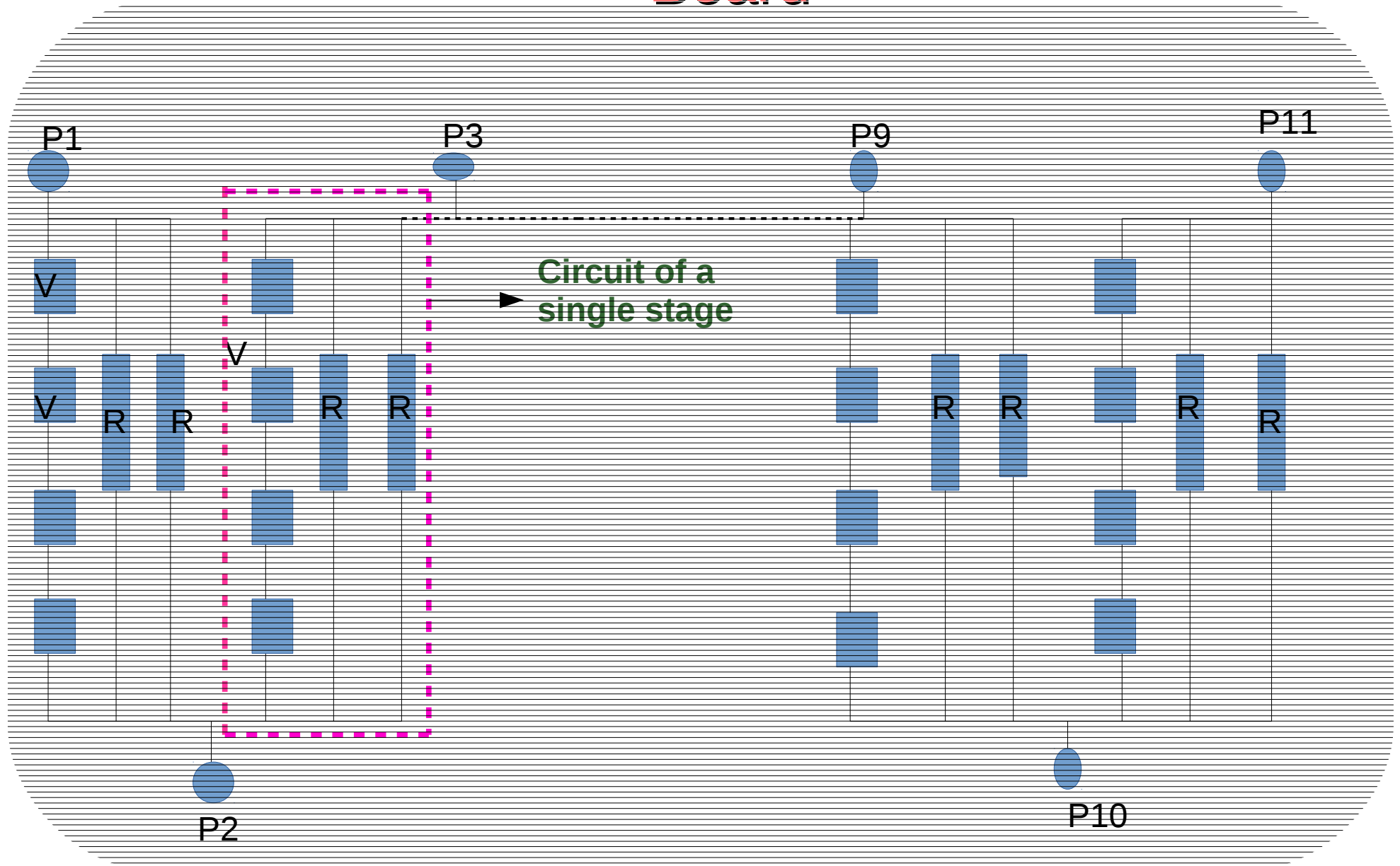
Summary from Last meeting

- Designed has been approved and signed off.
- **Few Modifications:**
 - Initially the detector will run with -300 kV, then in run2 it will run with 600 kV power supply without any major reassembly of the detector.
 - Some modification require for operating the board at 600 kV.
 - modification on the fixing slot of the Divider Board.
- **Changes in 600 kV :**
 - Current will be double (12 uA) with two boards in parallel.
 - Voltage difference in each stage will be 6 kV.

Modifications

- Changes in the components
 - Resistors with higher voltage and power rating.
 - We will use **THICK FILM RESISTOR, 2GOHM, 2.5W, 1%, part number SM108032007FE.**
 - **Voltage rating of the resistor is 20 kV.**
 - **We have to use 4 varistors in series each with clamping voltage 1.8 kV, because in case of 3 varistors in series, the total clamping voltage is less than 6 kV.**
 - **Use the same varistors, add one more in each stage.**
- **modification on the fixing slot of the Divider Board.**

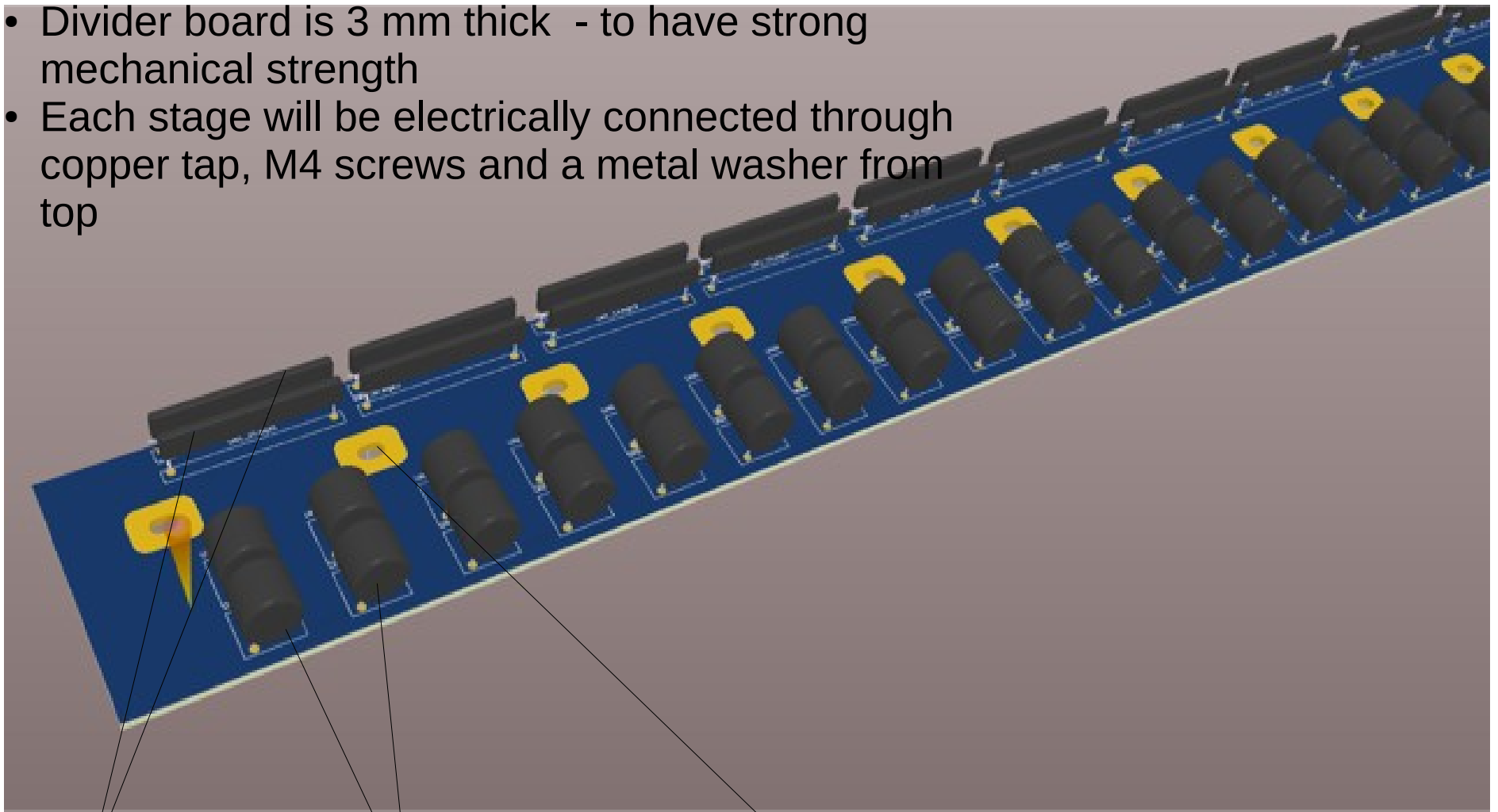
Modified Schematic diagram of the HV Divider Board



R= 2 Gohm, V= varistors, P1, P2, .. P11 connections with each profile

Modified 3D image of the Divider Board: Top layer

- Divider board is 3 mm thick - to have strong mechanical strength
- Each stage will be electrically connected through copper tap, M4 screws and a metal washer from top

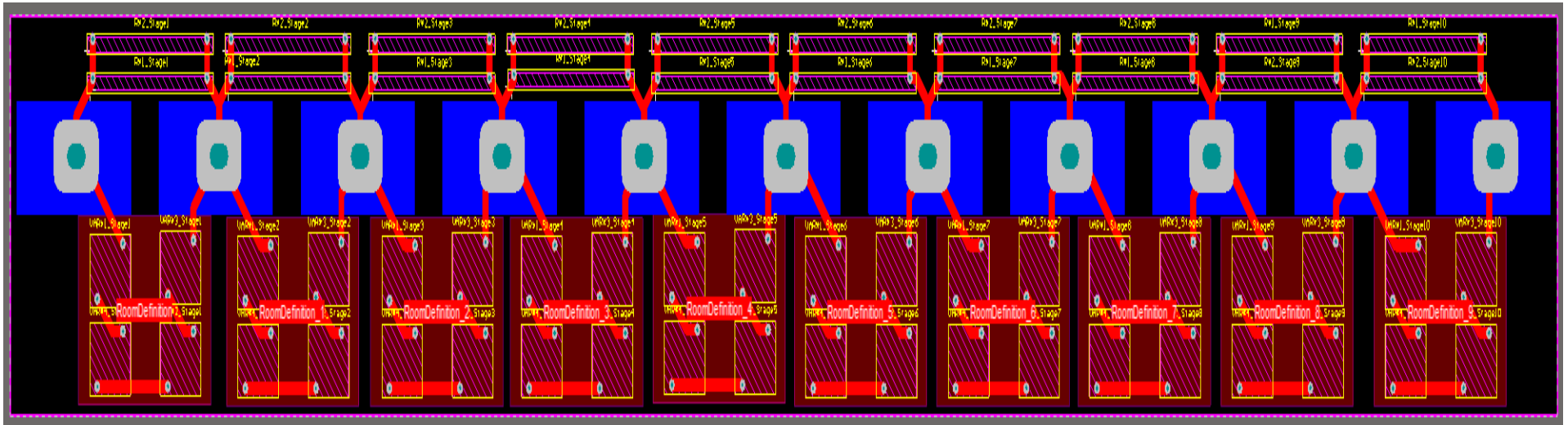


Two 2G Resistors

4 Varistors in series

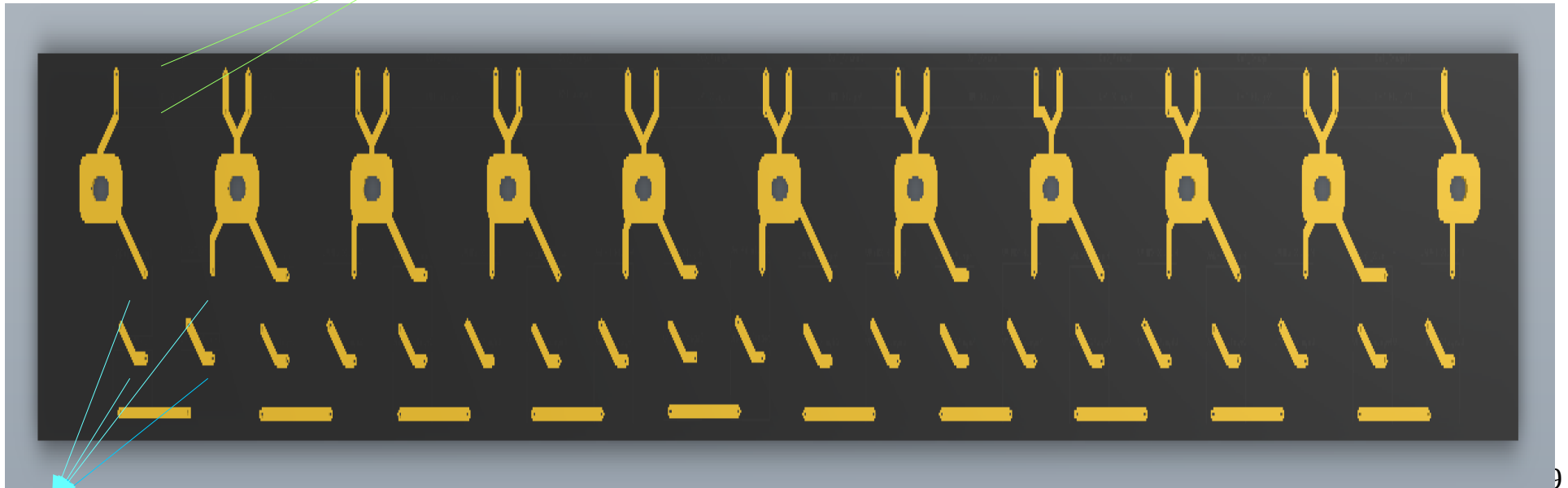
Copper tap Connections with the profiles

Top and Bottom view



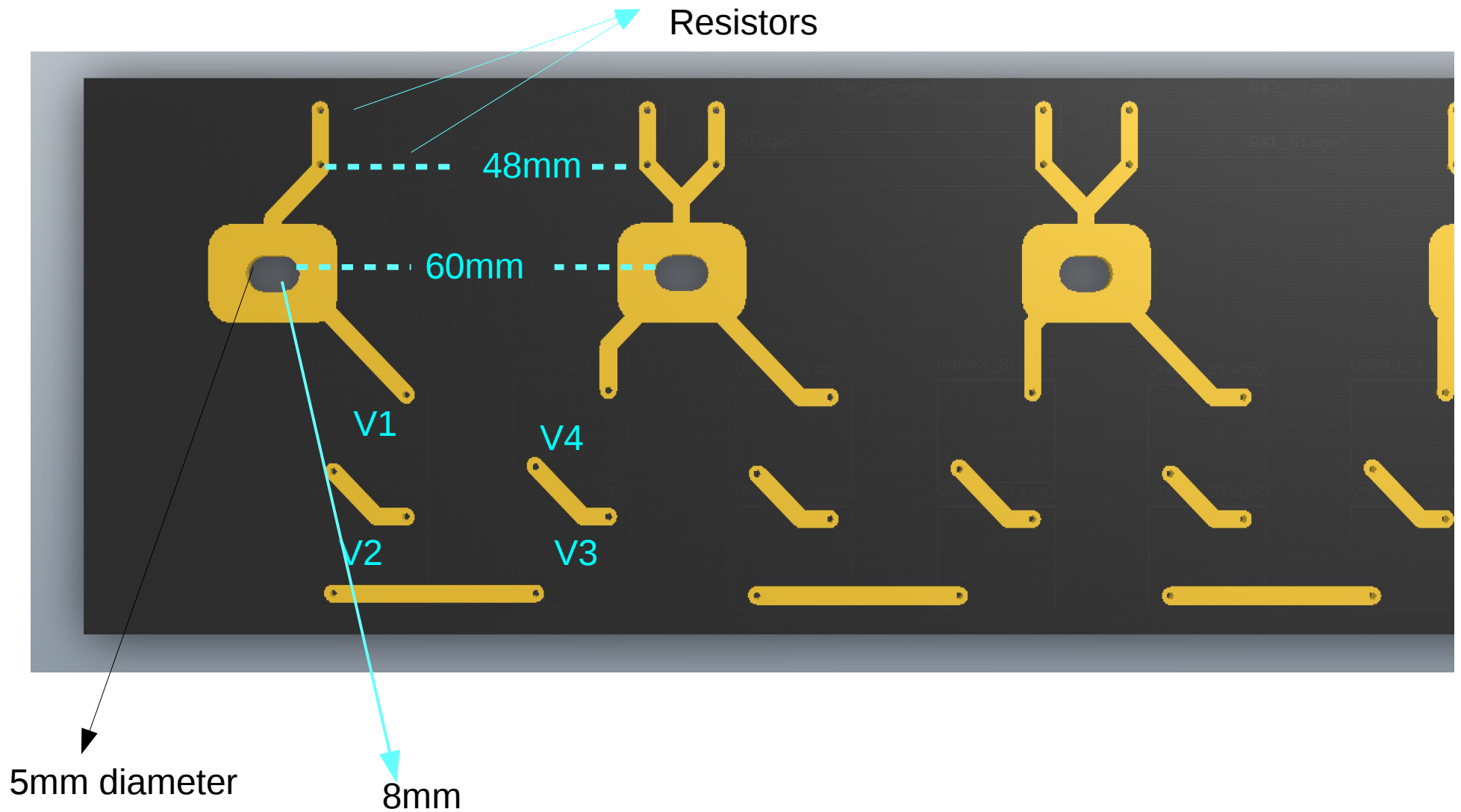
Bottom view

Resistors



4 Varistors in series

Bottom layer :Zoom



Testing and Production Plan of electrical components

Test the divider boards, resistors, and varistors both in warm and cold.

- **Testing plan**

Resistors :

- Measure the resistance from I-V curve both in warm and cold for each individual resistors, repeat the process for 3 times.
- Select the appropriate one within its tolerance.
- Test the varistors, divider board

Status

- Placed order for Resistors and varistors, few of them arrived.
- Placed an order for divider board.
- In the stage to start testing components.

Module zero production status

- Clean room conversion complete. Took over the occupancy.
- All tools purchased, including the construction stand.
- Profiles are at DFW customs, awaiting for customs clearance. CERN needs to take an action quickly.
- Screws and slip nuts ready for purchase.



Module zero production status

- I-beams are being produced at two different vendors - Rochling and EFI.
- Expected delivery from Rochling soon.
- UTA student studied material comparison for I-beams, Liberty P looks promising.
- DPFC mechanical and electrical design and production review on April 24-25 at CERN.

	DEF I	Creative P.	Liberty P.	Haysite ^a	Glastic
24hr Water Absorption (% max)	0.45	0.6	0.6	0.2	0.3
Density (lb / in ³)	0.62 - 0.07	0.06-0.07	0.0656	0.065	0.065
Coefficient of Thermal Exp. (in/in/C) x 10 ⁶	5	8	8	-	-
Dielectric Strength:					
LW KV / in	35	40	35	60	45
PF volts / mil	200	200	200	550	200
Dielectric Constant (@60Hz)	5	5.2	-	4.4	-

Conclusion

- Board design has been signed off.
- Modifications of the board and the components for 600 kV power supply complete.
- Module zero production in progress.
- Test all the electrical components and the board in warm and cold condition.
- Complete the production of the modules and board within time-schedule.