



Forward Pixel Detector

HDI/VHDI Circuits

http://ppd.fnal.gov/experiments/forward_pixel/Presentations/HDI_VHDI_CMS_ER_20041111.pdf

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Plaquettes and Panels [1]

- VHDI circuits laminated onto silicon wafer, populated with passive components, diced, then populated with bump-bonded detectors to become plaquettes.
- Plaquettes laminated onto HDI circuit (already laminated onto beryllium substrate) to become a panel.

Plaquettes and Panels [2]

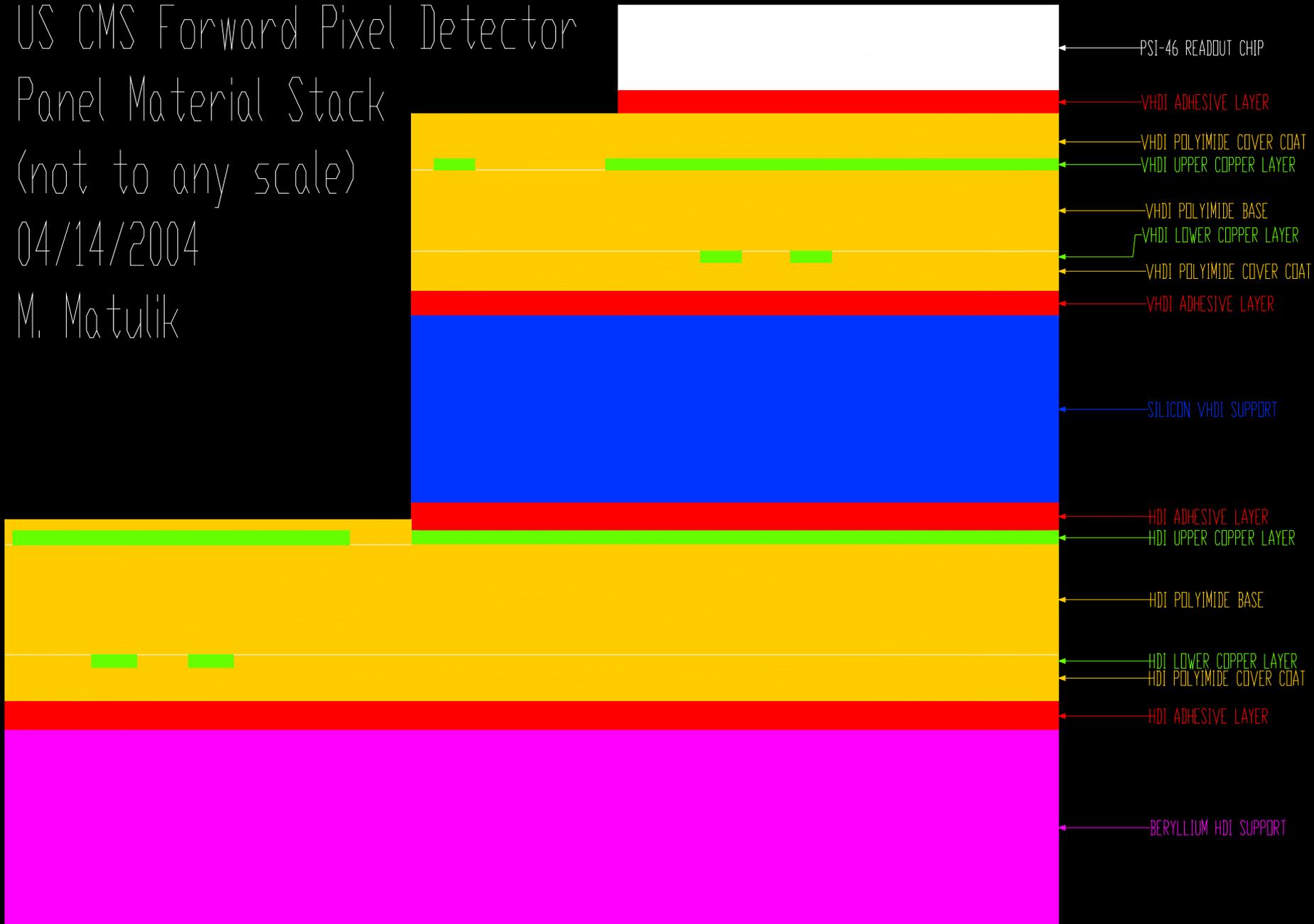
- Signal traces span both VHDI and HDI circuit types.
 - ◆ Characteristic impedance of traces should be the same to maintain signal fidelity.
 - ◆ Trace width can be modulated.
 - ◆ Adhesive layer thickness can be modulated.
 - ◆ How to treat the bulk silicon?

US CMS Forward Pixel Detector

Panel Material Stack (not to any scale)

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HDI/VHDI Trace Characterization [1]

- Trace characterization test structures laminated to pieces of aluminum to emulate possible HDI/VHDI constructions.
 - ◆ Flexible printed circuits with traces of various widths.
 - ◆ Various adhesive thicknesses.
 - ◆ Silicon included in construction.
 - ◆ TDR measurements of Z_0 match predicted values.

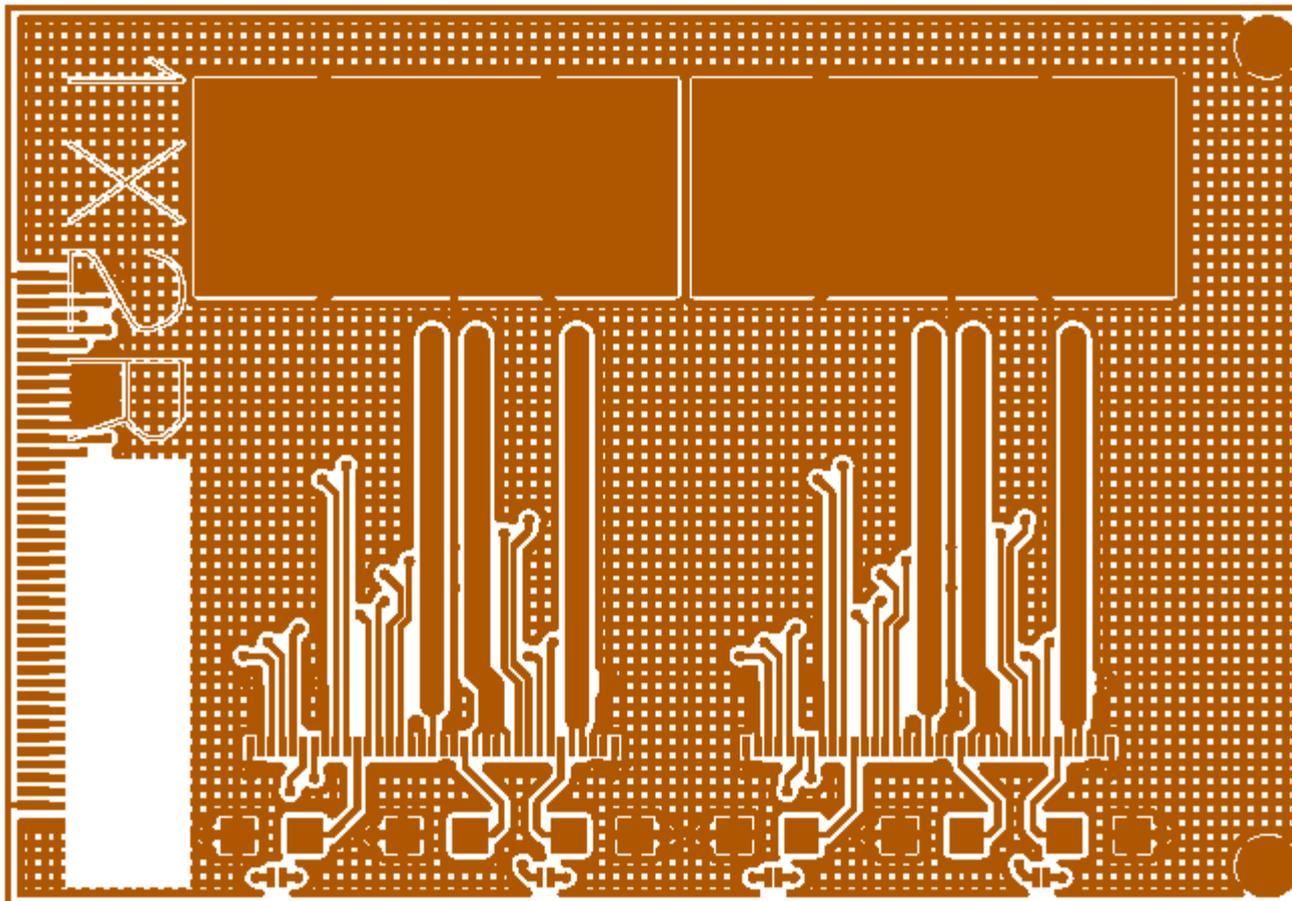
HDI/VHDI Trace Characterization [2]

- Using recommended adhesive thicknesses can obtain $Z_0 = \sim 45\Omega$ in both VHDI and HDI circuits.
 - ◆ VHDI trace width = 0.100mm
 - ◆ HDI trace width = 0.080mm

VHDI Circuit Construction

- VHDI circuits designed as flexible printed circuits.
 - ◆ Small via/pad (0.075mm/0.125mm) diameters.
 - ◆ Two copper trace layers.
 - ◆ Trace width requirements (based on characteristic impedance requirements) are easily met.
 - ◆ Thin finished circuit thickness (~ 0.1 mm).
 - ◆ Radiation resistant construction.

1x2 Right Hand VHDI



VHDI Status

- Seven different but similar circuits are required to cover all plaquette types.
- What are believed to be the final version of the gerber files (files sent to printed circuit board fabricators) for all seven VHDI circuits are in hand and undergoing review.

VHDI Panelization

- Details about placing multiple VHDI circuit types on a panel that can be laminated to a silicon wafer are being finalized.
- Once these details are finalized, gerber files for the various panels will be sent for quotation/production.

HDI Construction

- HDI circuits designed as flexible printed circuits.
 - ◆ Small via/pad diameters.
 - ◆ Three copper trace layers.
 - ◆ Trace width requirements (based on characteristic impedance requirements) are easily met.
 - ◆ Minimizes finished circuit thickness.
- Prototype version of 3 plaquette right-handed HDI circuit nearly complete.

HDI Design Issues [1]

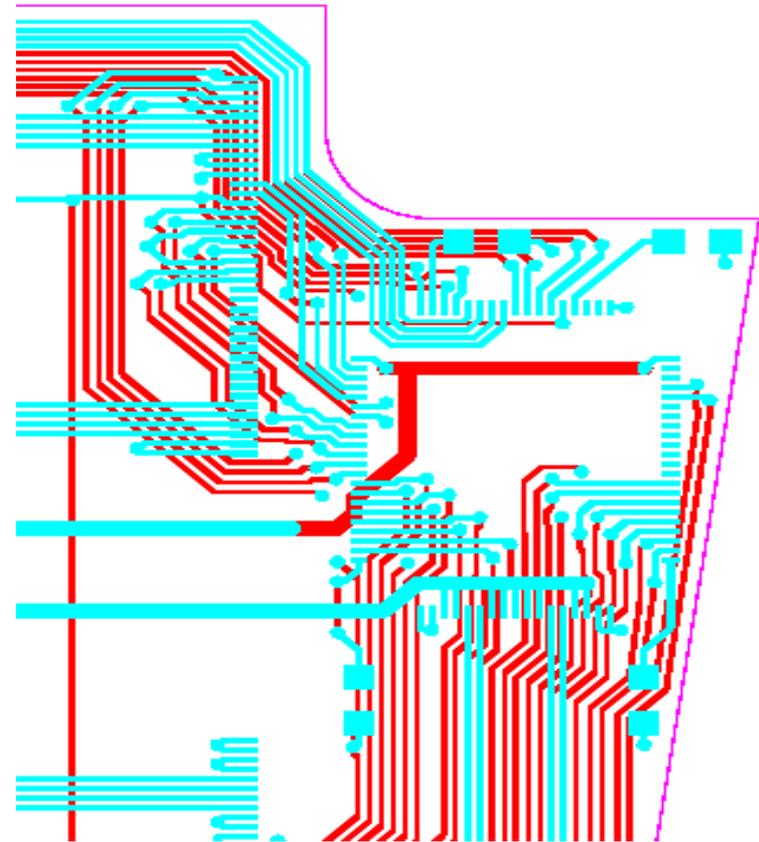
- The 3RX HDI prototype requires 3 copper layers to permit routing of traces in the area surrounding the TBM.
 - ◆ Violates initial design goal of 2 copper layers for both VHDI and HDI circuits.
 - ◆ Radiation resistance of construction methods for flexible printed circuits with greater than 2 copper layers is uncertain. Sample of one possible construction for multi-layer flexible printed circuits is awaiting radiation testing. A second construction for multi-layer circuits that appears to be similar to that used for two-layer circuits is being evaluated.

HDI Design Issues [2]

- The experience of laying out the 3RX HDI circuit has revealed that completion of an HDI circuit for 4-plaquette panels may be extremely difficult without relaxing design criterion.
 - ◆ There may not be enough room in the area of the TBM to permit connections to a fourth plaquette.

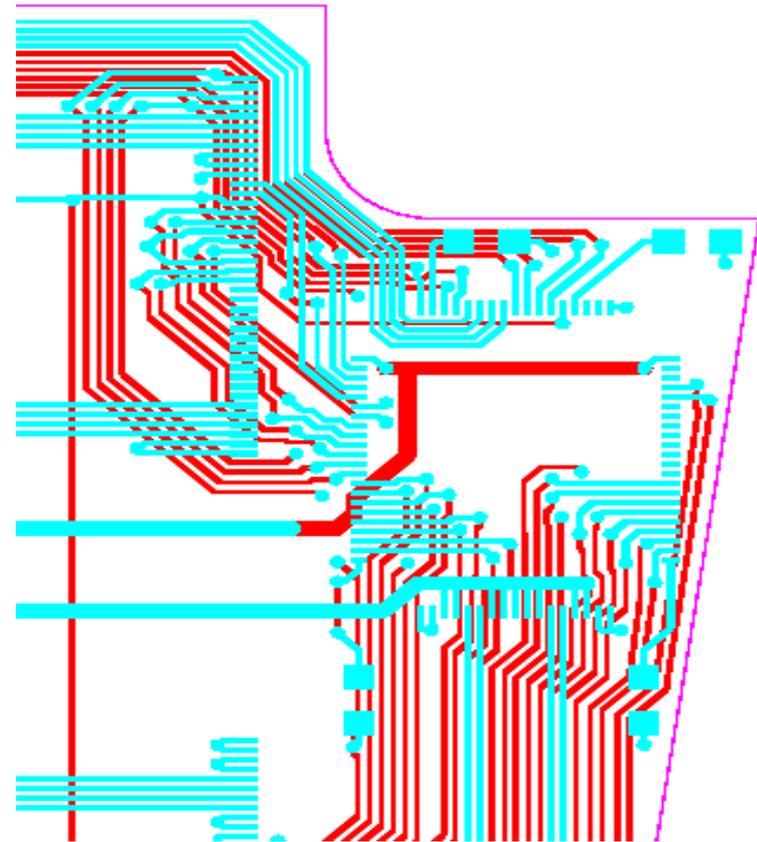
HDI Design Issues [3]

- Current circuit outline in magenta.
- Upper copper layer traces/pads in cyan.
- Lower copper layer traces/pads in red.
- Only 3 of the 4 “ports” on the TBM are used in a 3 plaquette panel.



HDI Design Issues [4]

- Little room in the area to make connections to a fourth plaqueette.
- Adding a fourth copper layer doesn't appear to provide the solution and impacts thermal aspects of HDI.
- May have to ask that the beryllium substrate grow along the edge that the TBM exists to provide space for traces to fourth plaqueette.



Plaquelette Test Fixture

- A version of the PSI-46 based right handed plaquelette test fixture that incorporates active buffering of the Analog_Out and Token_Out pairs has been designed.
- A purchase requisition for this printed circuit board has been generated and signed.

Conclusions

- VHDI circuit design is considered to be complete. Layout of the circuits onto panels is under way and could be completed with in a week.
- A circuit to interface plaquettes with the Test System provide by Rutgers has been implemented on a plaquette test fixture. This circuitry can easily be ported to subsequent designs for burn-in and production testing fixtures.
- A prototype HDI design for a 3RX panel is for all intents complete. Once minor mechanical and detector bias voltage routing constraints are overcome, this circuit can be submitted for fabrication.