Proposed Planicon Anode Design for Fast-Sampling Read-Out

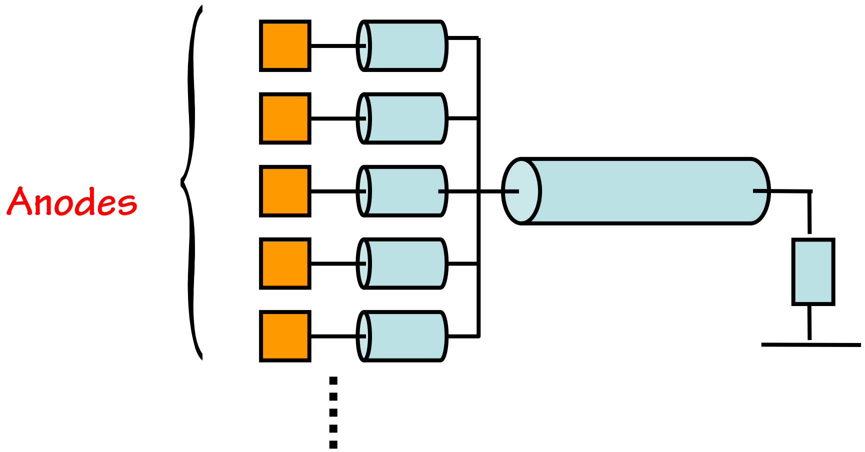
Fukun Tang (UC)

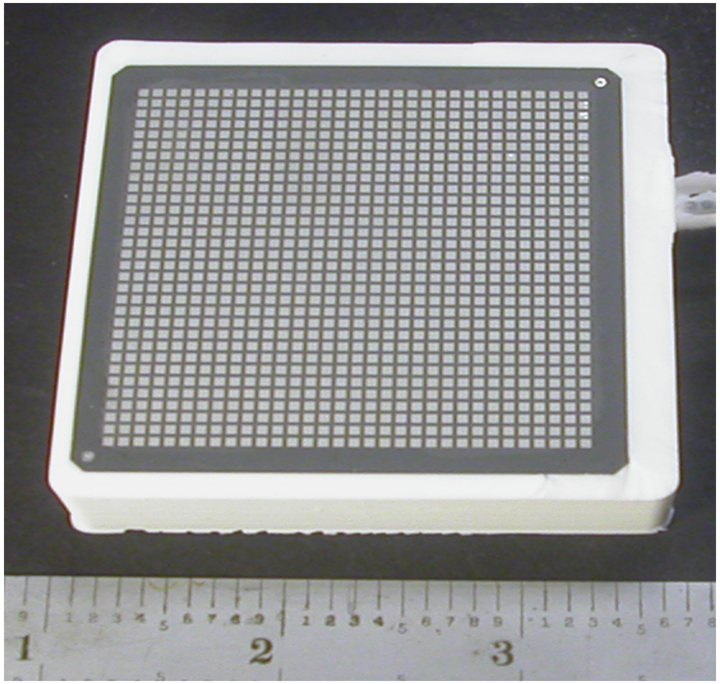
H. Frisch, J-F. Genat (UC)
J. Anderson, K. Byrum, G. Drake and C. Ertley (ANL)

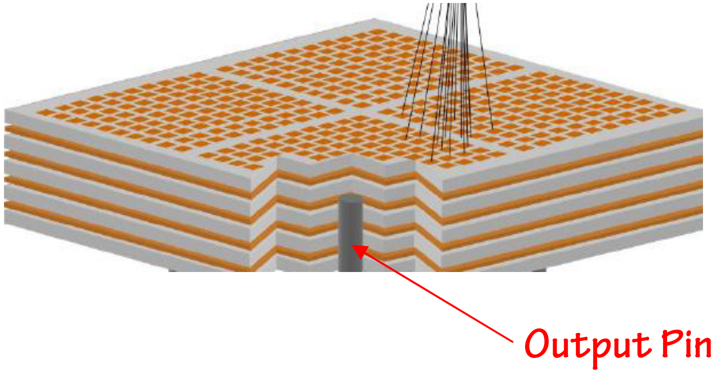
- History of equal timing anode designs
- Planicon anode design & its readout
- Planicon anode simulations
- Summary & plan

History of Equal Timing Anode Design

Diagram of equal timing anode







(1) 256 to1 without ground grid

(2) 64 to1 with ground grid

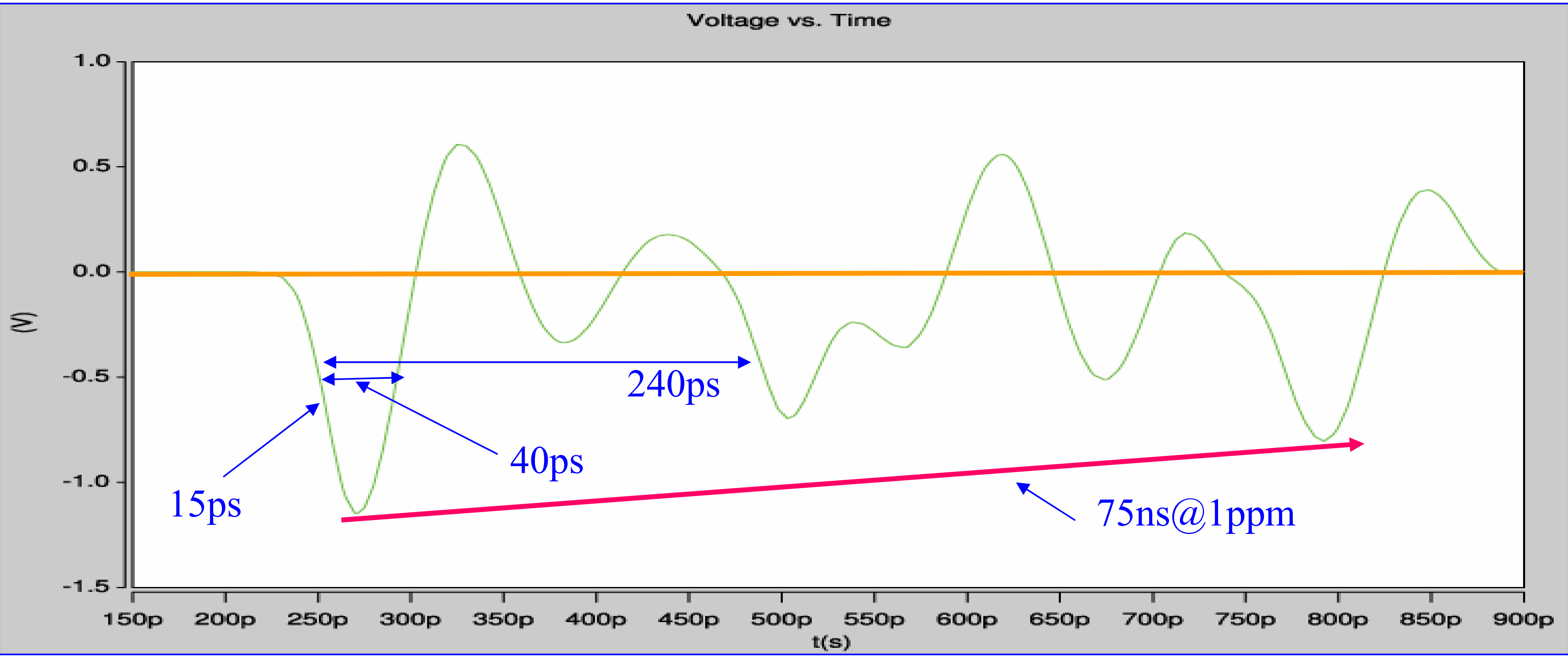
(3) 32 to1 with ground grid

(4) 1,4,16 to1 with ground grid

Characteristics of MCP-PMT Output Signal

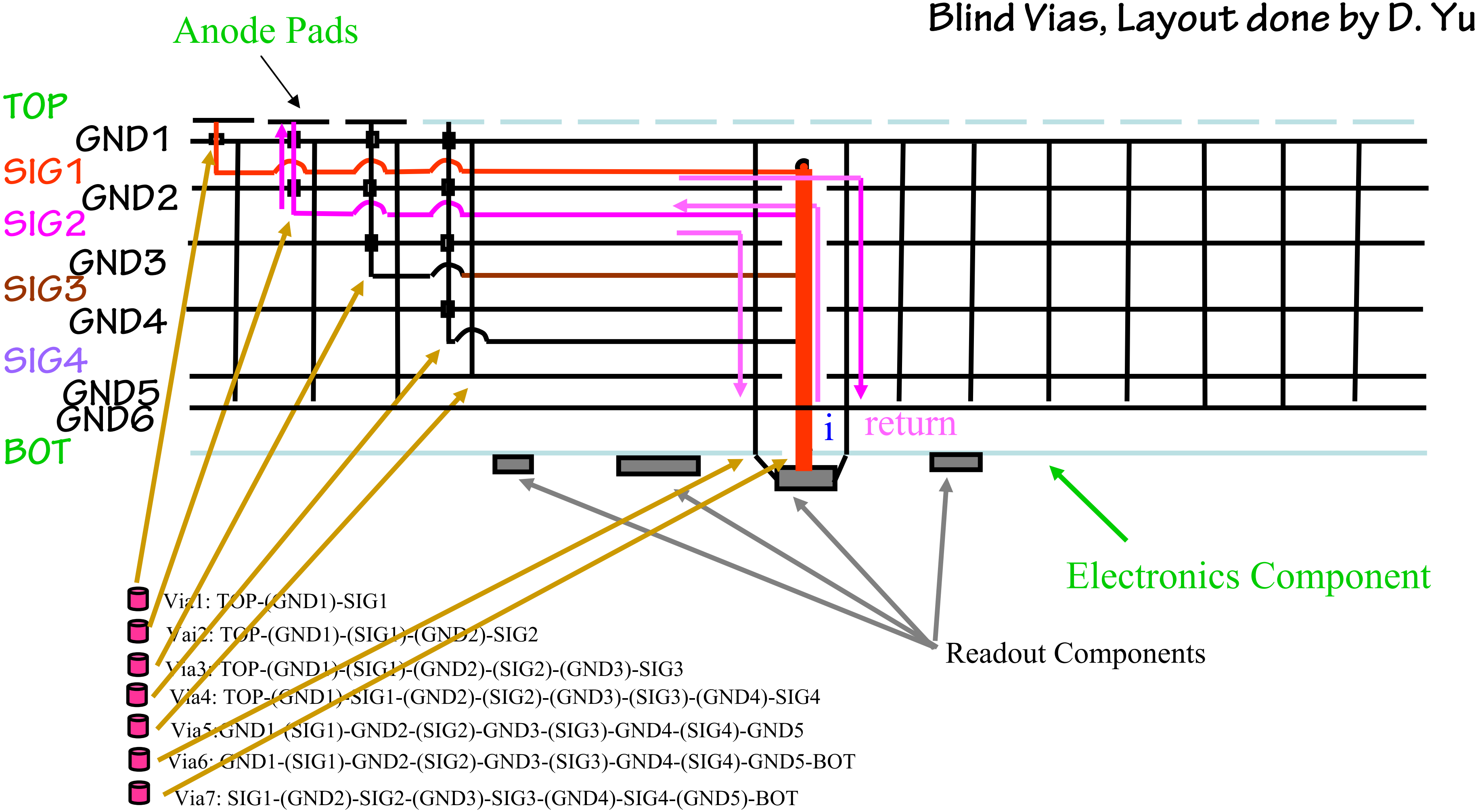
MCP-PMT output signal from Tim Credo' simulation

- Rise time 25ps
- Pulse width (FWHM): 40ps
- Reflection coefficient: -0.98 (Load=100 ohms)
- Reflection time delay (round trip): 240ps
- Recovery time: 75ns (Settled at 1ppm)



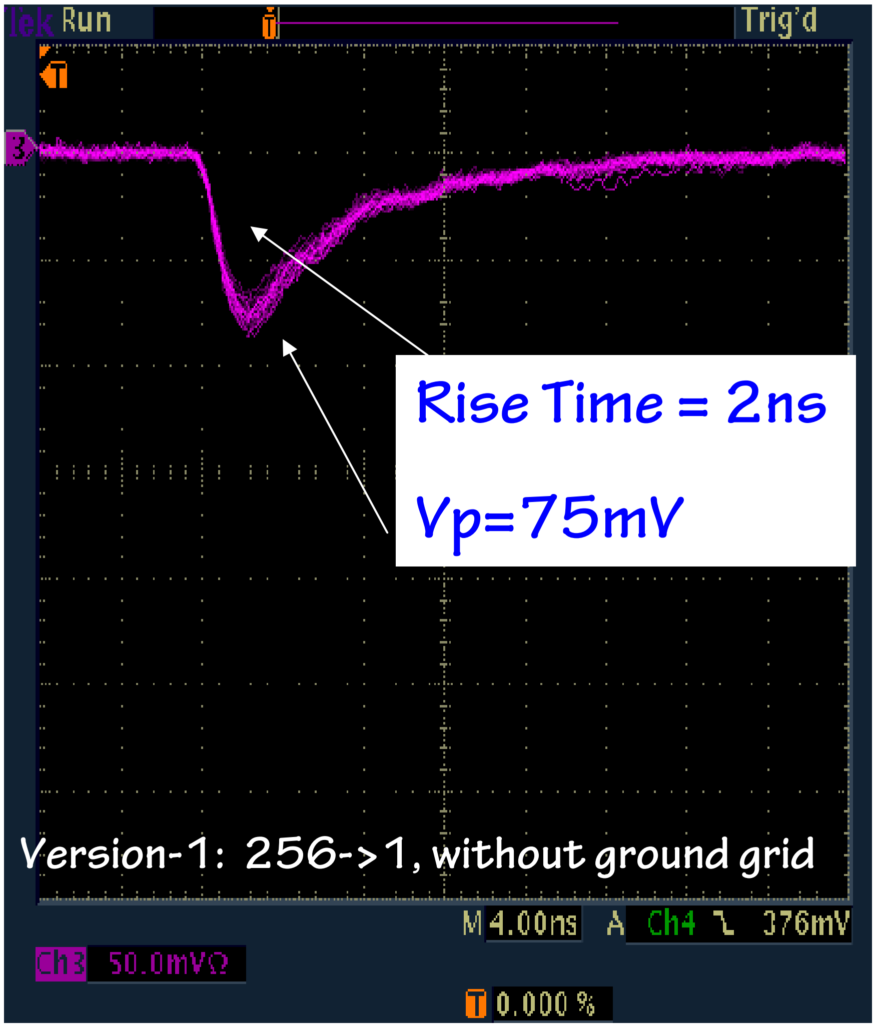
Layout of First Equal Timing Anode Board

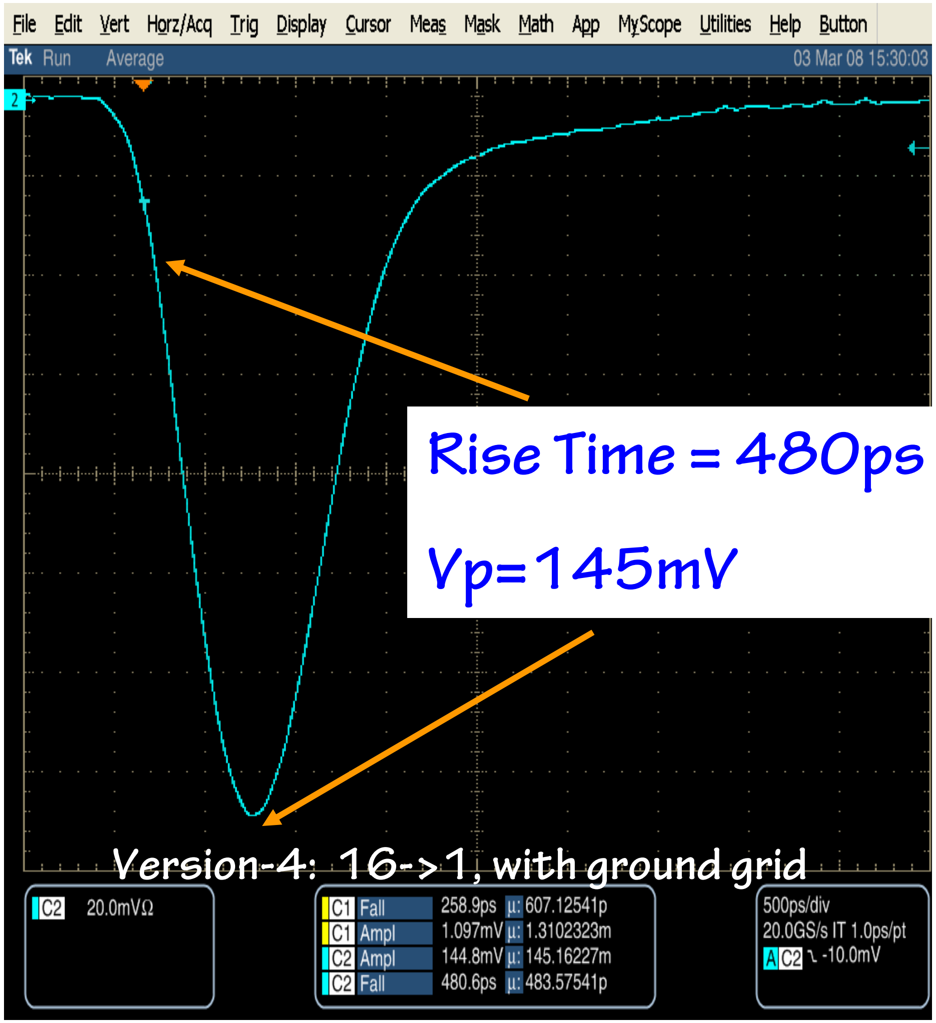
12 Layers Board with Buried, Blind Vias, Layout done by D. Yu



Comparison of Tube Outputs: Version-1 Vs. Version-4

J. Vavra, C. Ertley

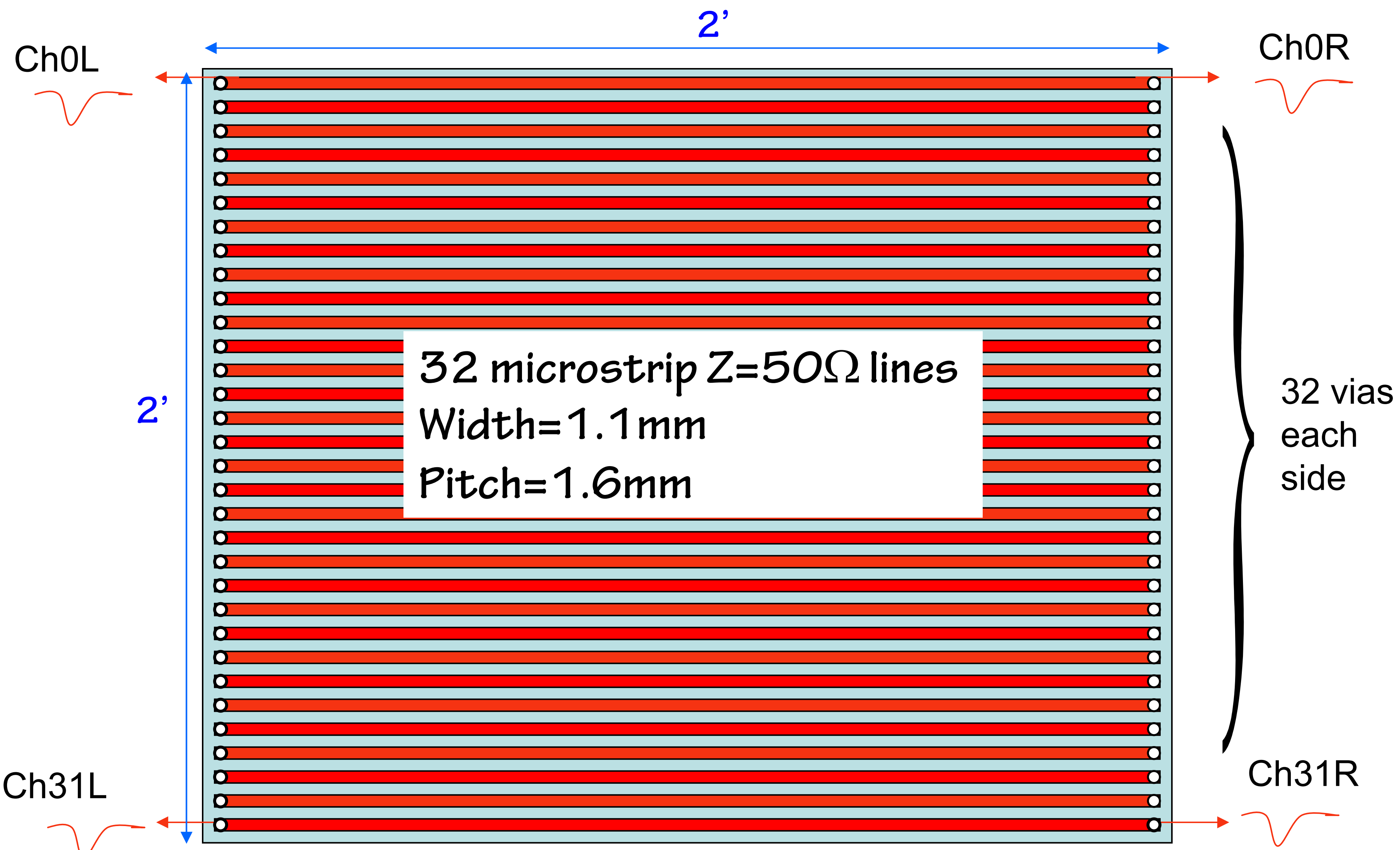




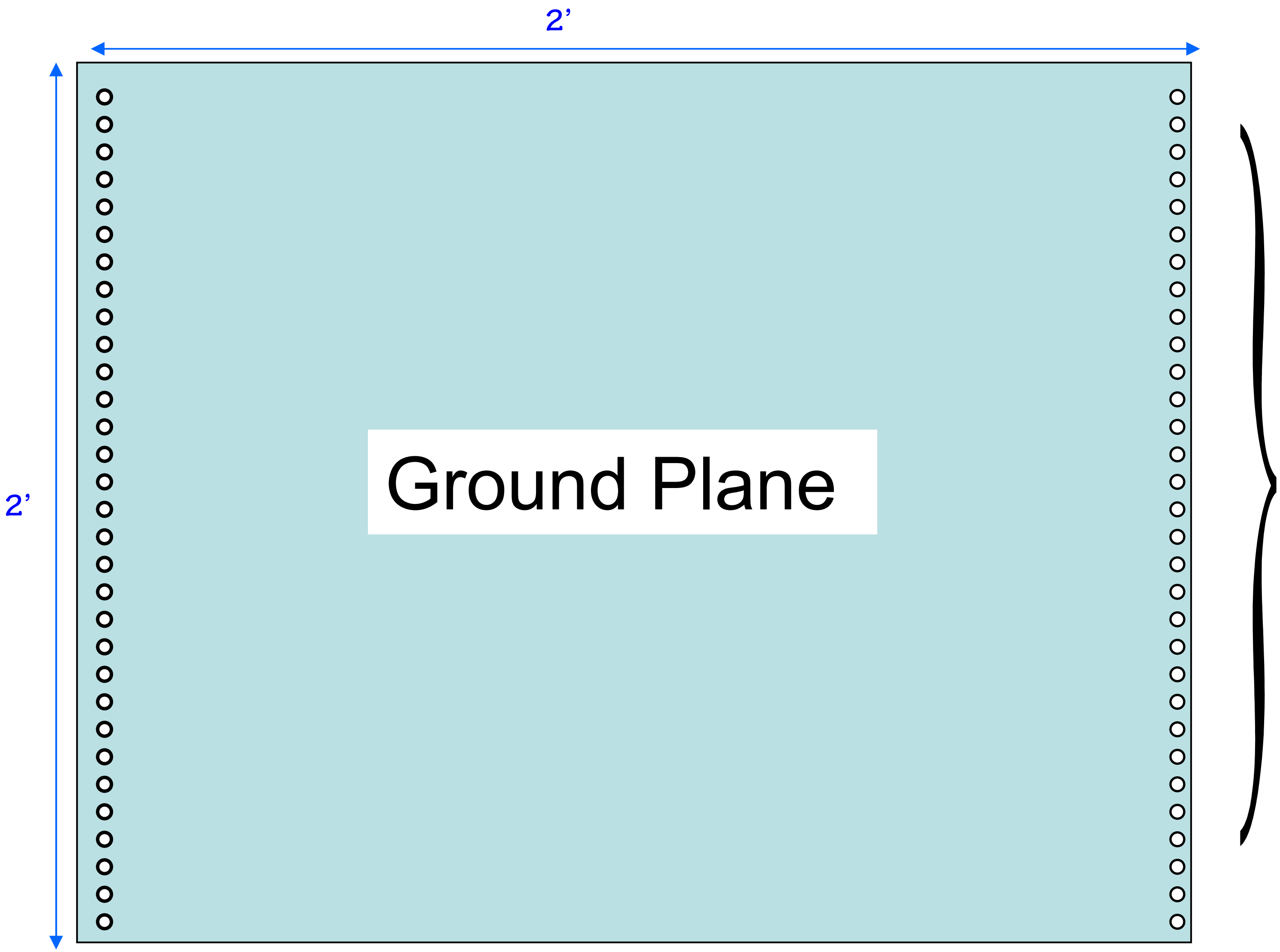
Proposed Planicon MCP-PMT Anode

- Very different comparing to conventional and equal timing anodes.
- Timing, position and energy information
- Higher detector efficiency
- Fewer readout channels

Proposed Planicon Anode Board (top review)

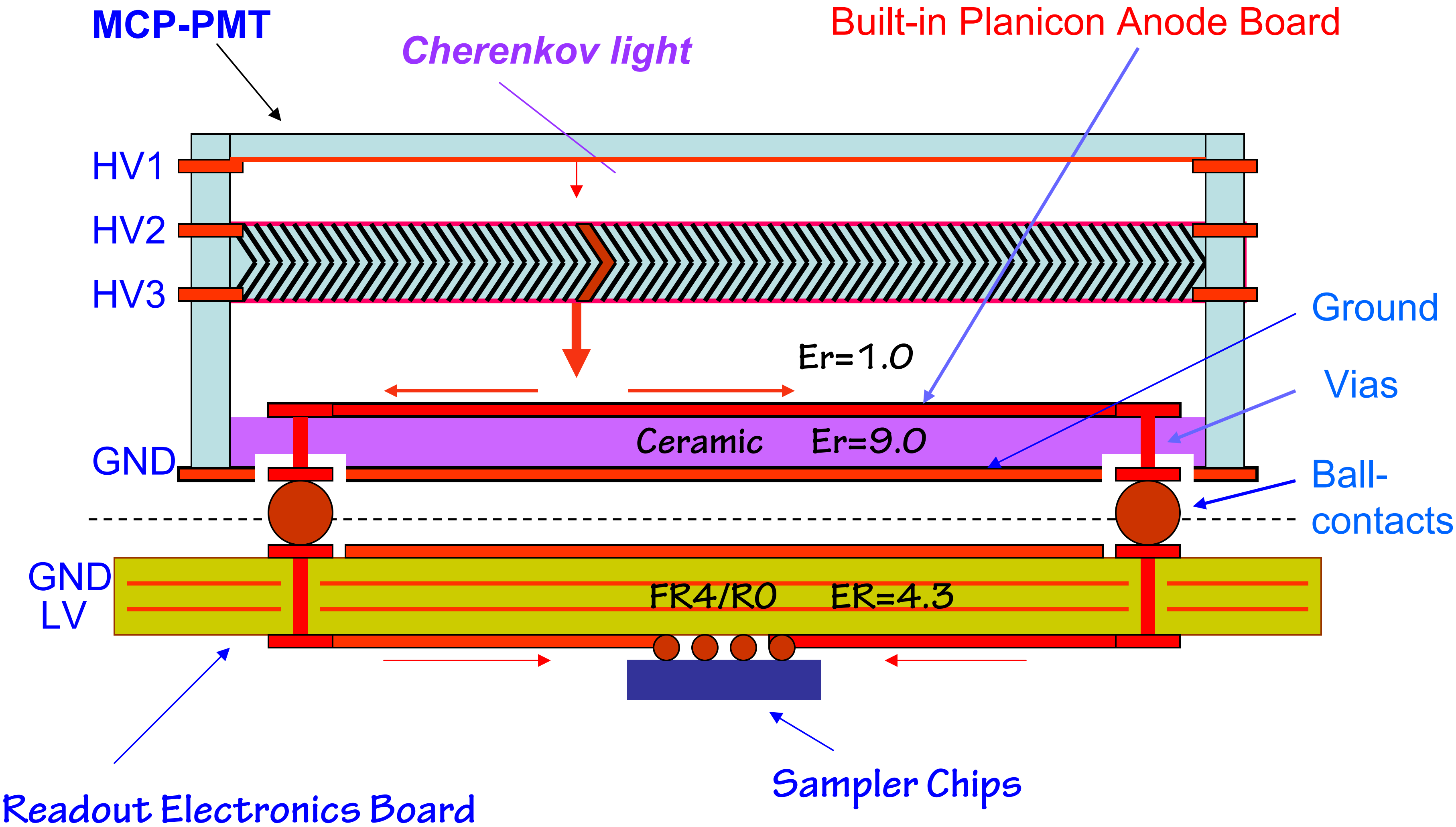


Proposed Anode Board (bottom review)

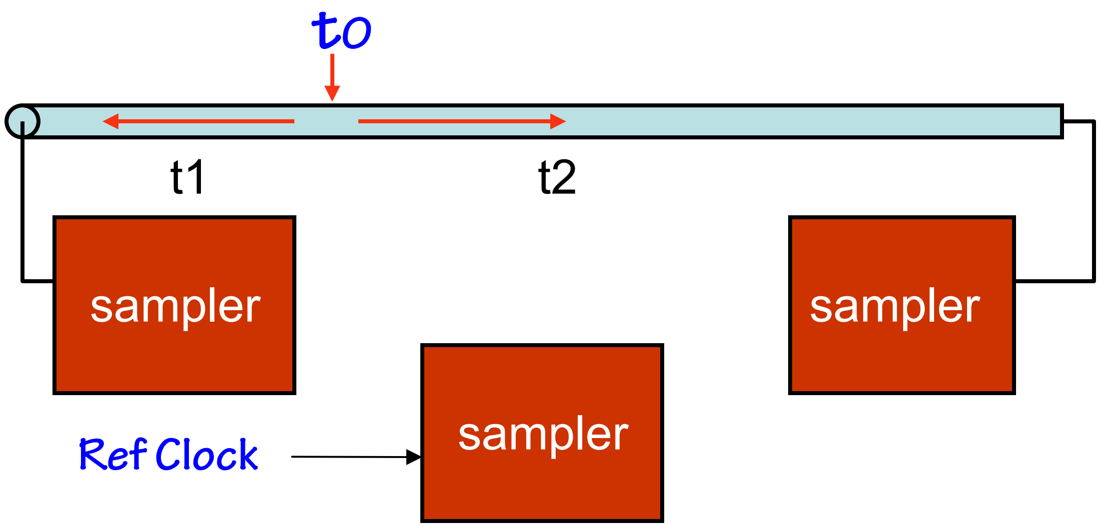


32 ball-contacts each side feed signal to front-end electronics board

Built-in Planicon Anode and Readout Board



Principle of Planicon Anode Readout



Timing:
(Overtop sampling)

$$t_0 = \frac{t_1 + t_2}{2}$$

Position:

$$x_i = \frac{t_1 - t_2}{t_1 + t_2}$$

Energy:
(Full waveform sampling)

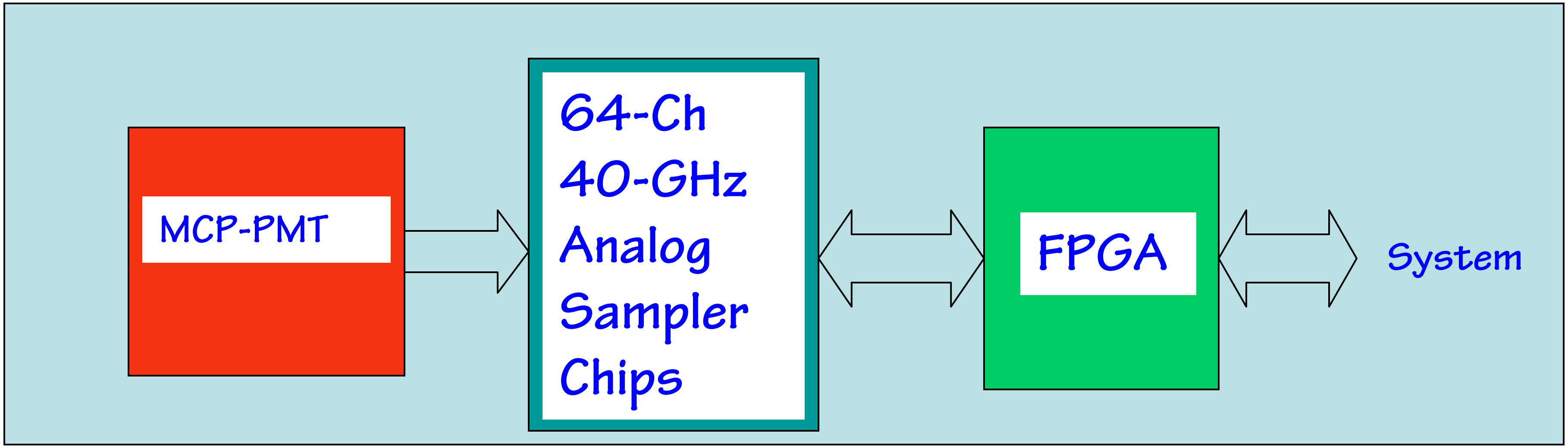
$$E_i = q_1 + q_2$$

Readout Diagram with Planicon Anode and Fast Sampling

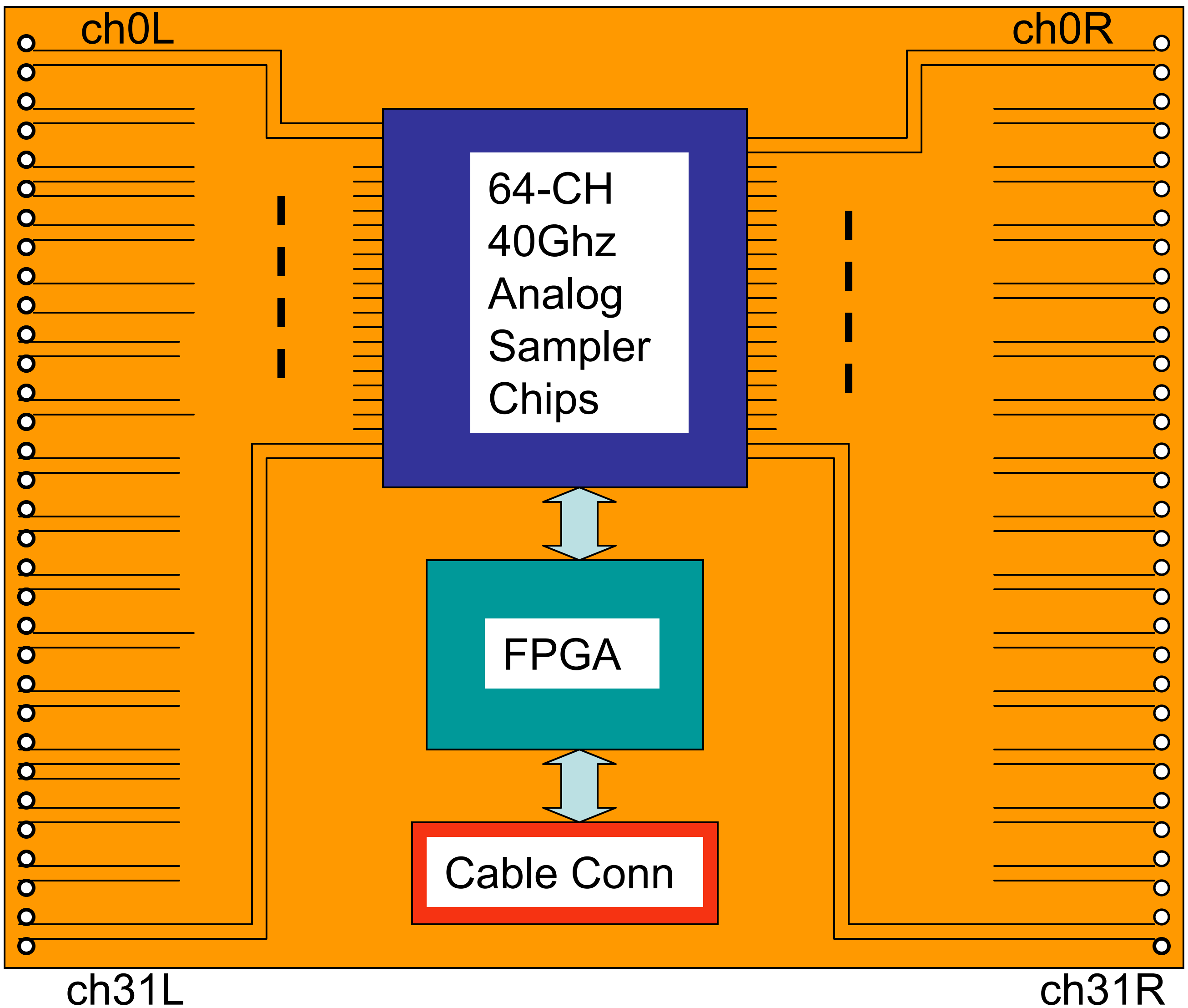
Total Electronics Channels per MCP-PMT:

64 readout channels

1 reference channel

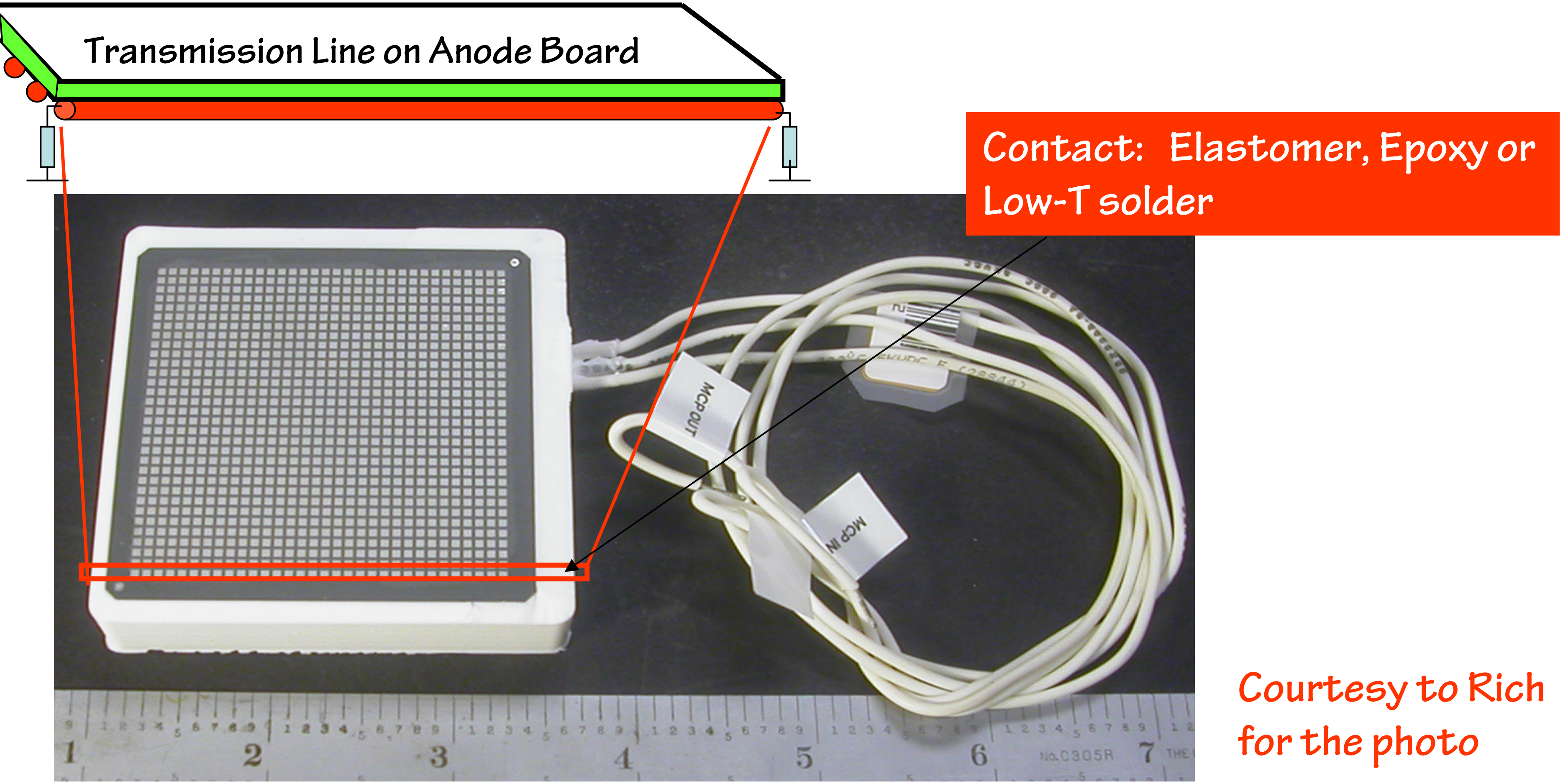


Readout Electronics Board (top review)



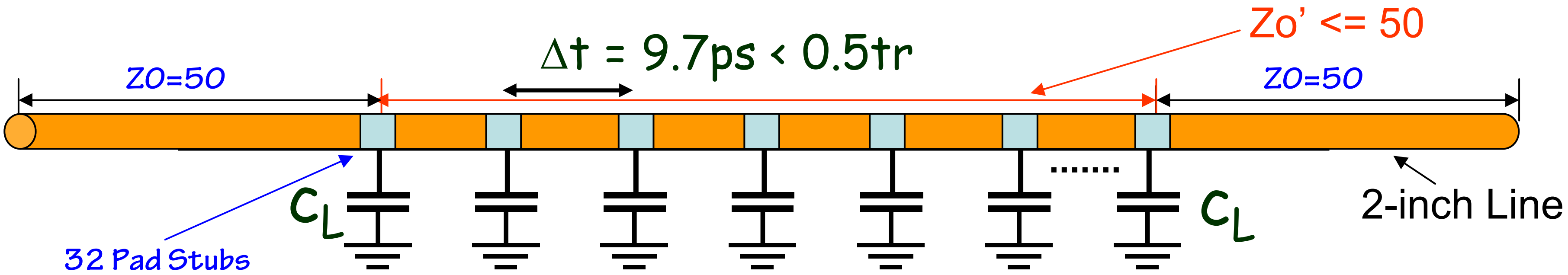
A total of 64 ball-contacting pads on bottom side receive signals from anode board

Prototype Planicon Anode Board Design And Simulations Based on Existed 2'x2' 1024 Anodes Tube



Courtesy to Rich for the photo

Bandwidth of Equal Distributed Capacitive Loads on Transmission Line



Equal distributed 32 C_L=100f along 2-inch line, It reduces impedance to Zo', However, it also reduced the BW.

$$Z' = \sqrt{\frac{L}{C+\alpha C_L}}$$

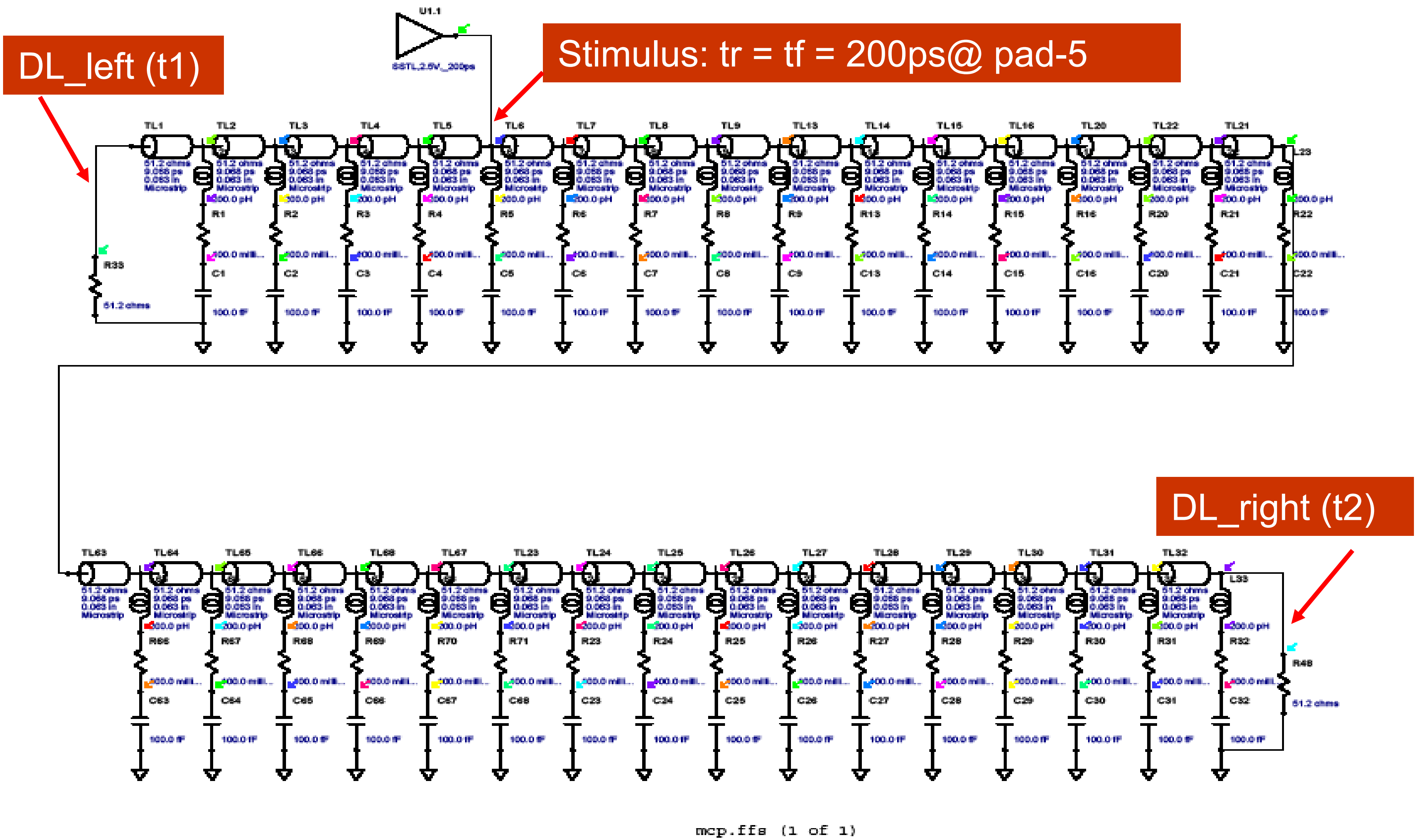
$$Tr = 2.2\tau = 2.2\frac{Z_0}{2}\alpha C_L \approx 100\,ps$$

$$\alpha = \frac{nC_L}{Length}$$

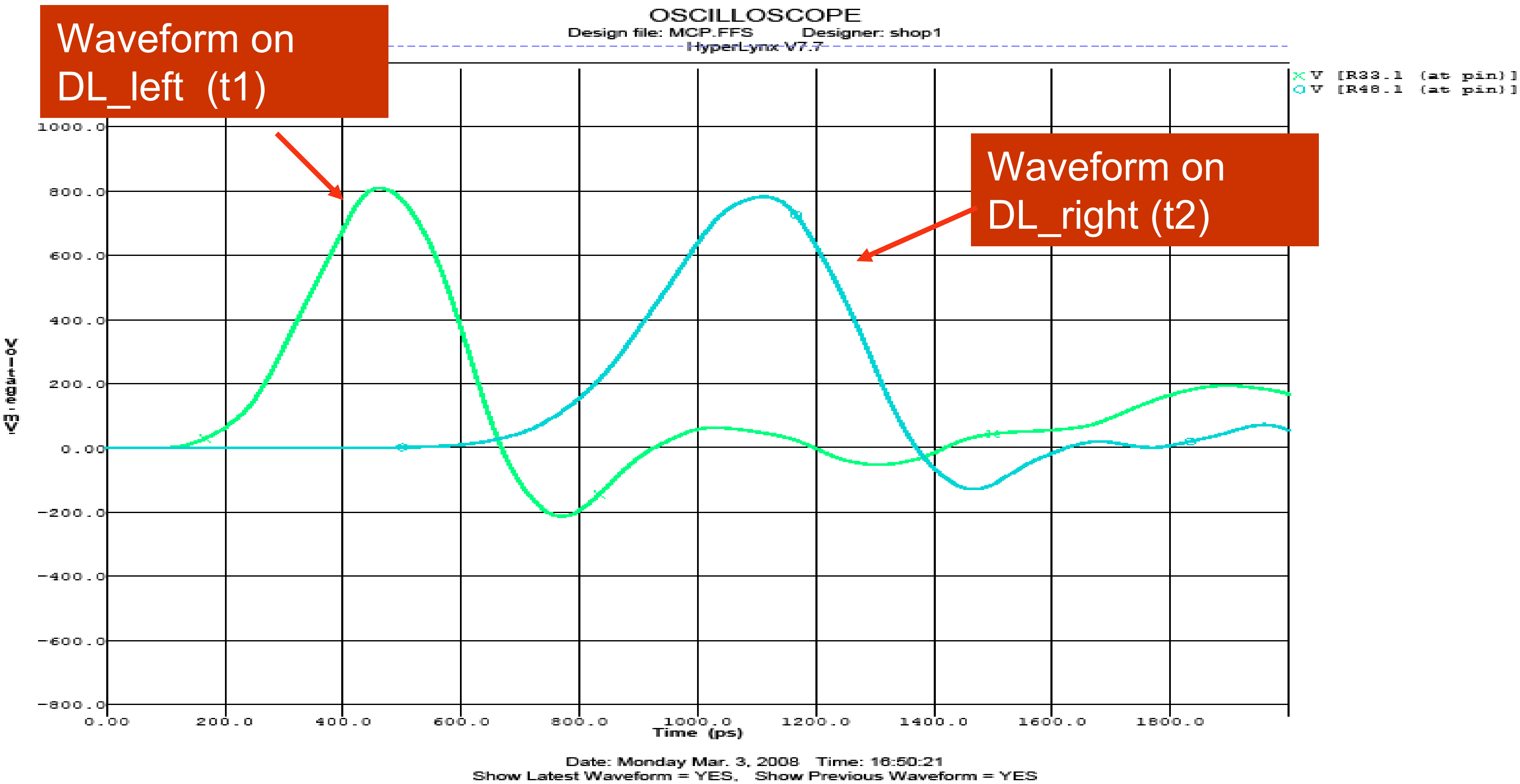
$$BW \approx 3.5GHz$$

$$\alpha C_L = 1.6p$$

A Single Channel of Microstrip Anode Modeling



Waveforms on Both Ends of Microstrip Anode With Input Force of Tr=tf=200ps on Pad-5

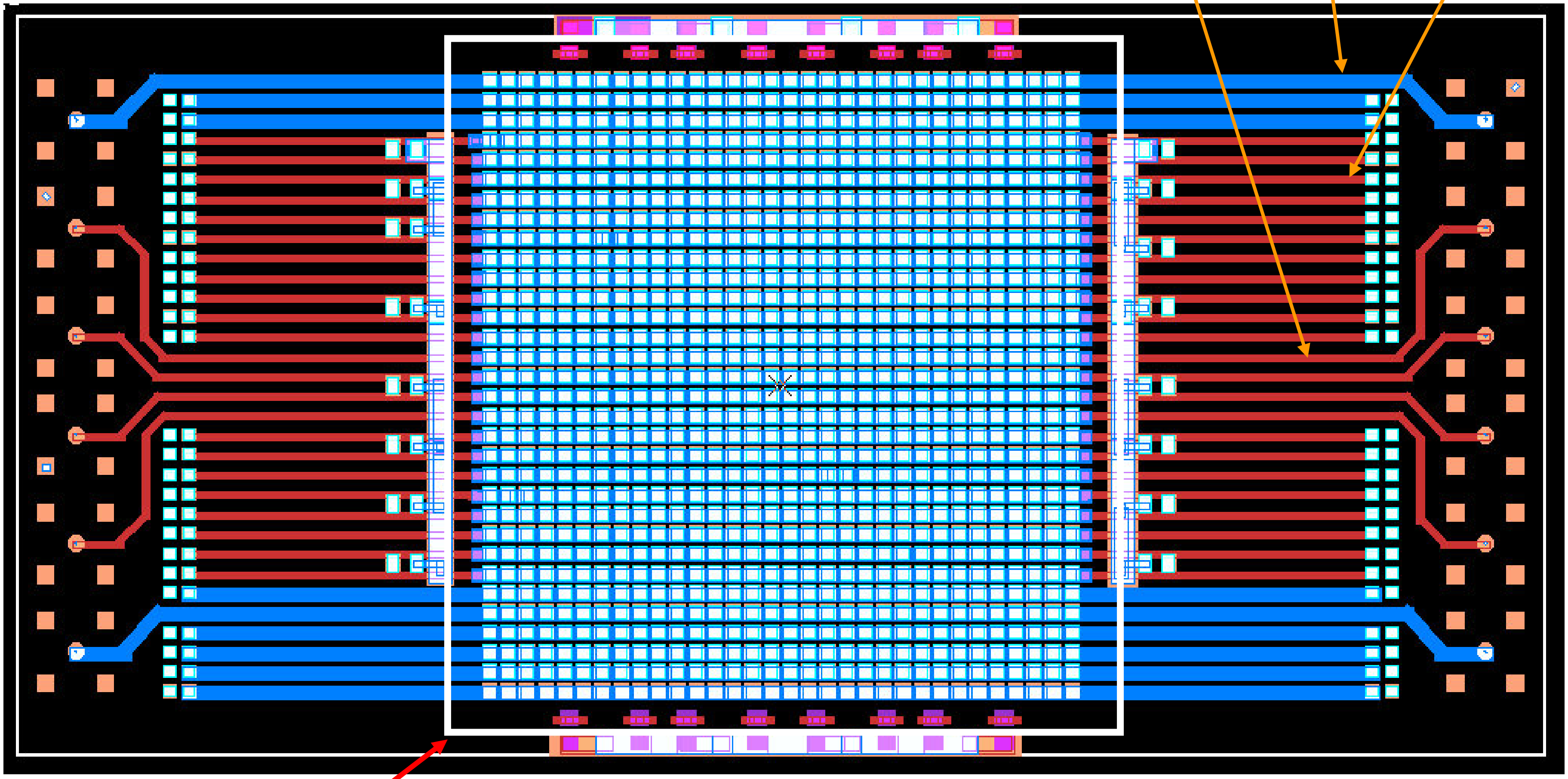


Layout of Prototype Board

Board Size: 130x60mm

Board Thickness: 1.2mm

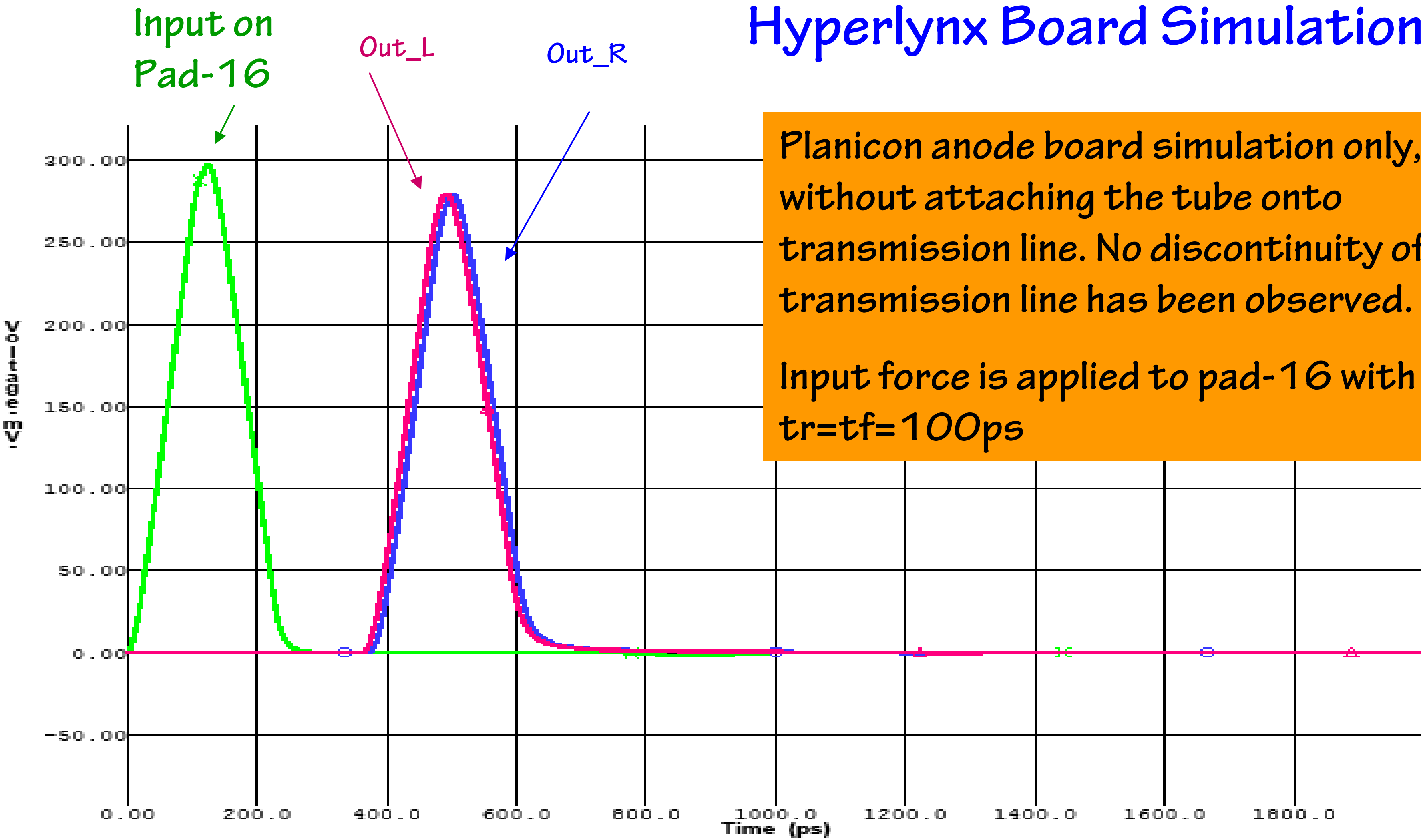
Trace length: 5.36', 4.83' , 3.97'



Tube Outline 58x58mm

T32 Responses without Anode-Stubs

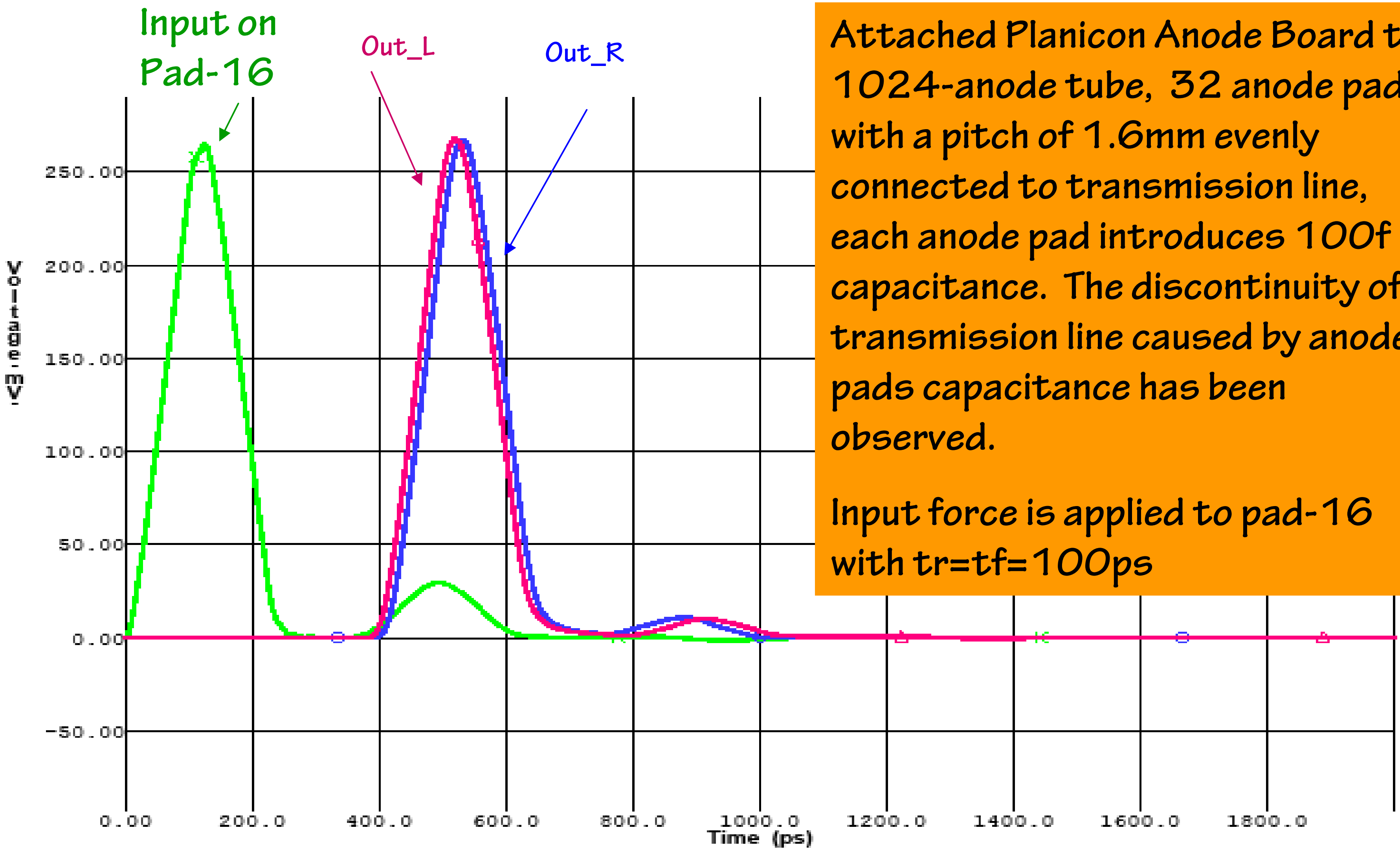
Hyperlynx Board Simulation



Planicon anode board simulation only, without attaching the tube onto transmission line. No discontinuity of transmission line has been observed.

Input force is applied to pad-16 with tr=tf=100ps

T32 Responses with Anode-Stubs



Attached Planicon Anode Board to 1024-anode tube, 32 anode pads with a pitch of 1.6mm evenly connected to transmission line, each anode pad introduces 100f capacitance. The discontinuity of transmission line caused by anode pads capacitance has been observed.

Input force is applied to pad-16 with tr=tf=100ps

Hyperlynx Board Simulation

Summary

Advantages:

- Timing, position and energy information (more applications)
- Less readout electronics channels
- Higher detector efficiency (more signal collecting areas)
- Higher signal bandwidth
- Easy matching impedance all the way to the chip input
- Easy anode board layout
- Easy interconnection between the anode and the electronics board

Disadvantages:

- No referenced design and real test data available

Plan for Planicon Anode Design and Test:

1. Prototype Planicon Anode Board with SMA Outputs (UC)
2. Prototype Board with Two LAB2 or Two DRS4 Chips (on board 2x interleaving?)
3. Built-in Planicon Anode Design and Simulation (work with Paul)
4. Others