

Geometry Board Overview

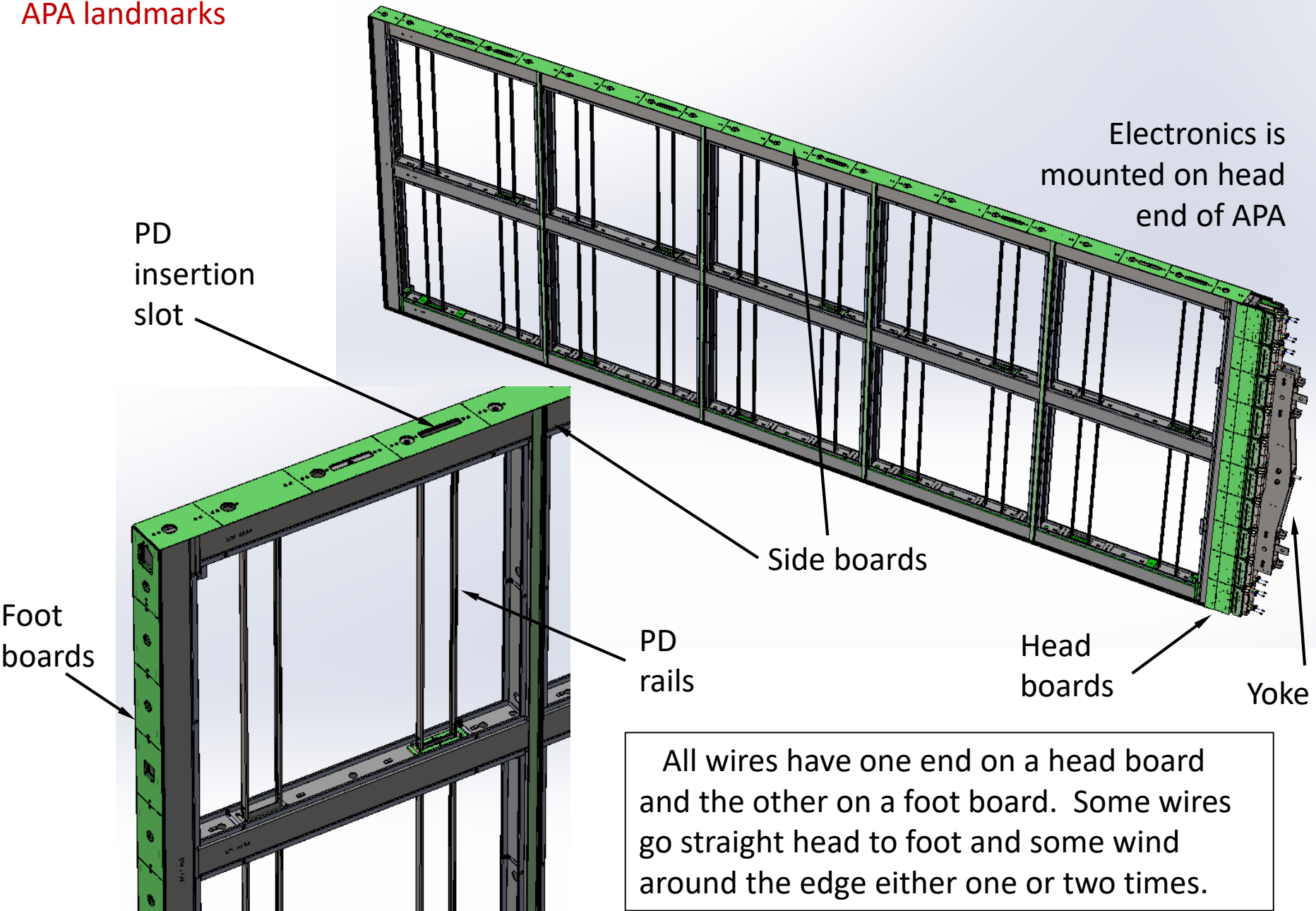
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APA landmarks

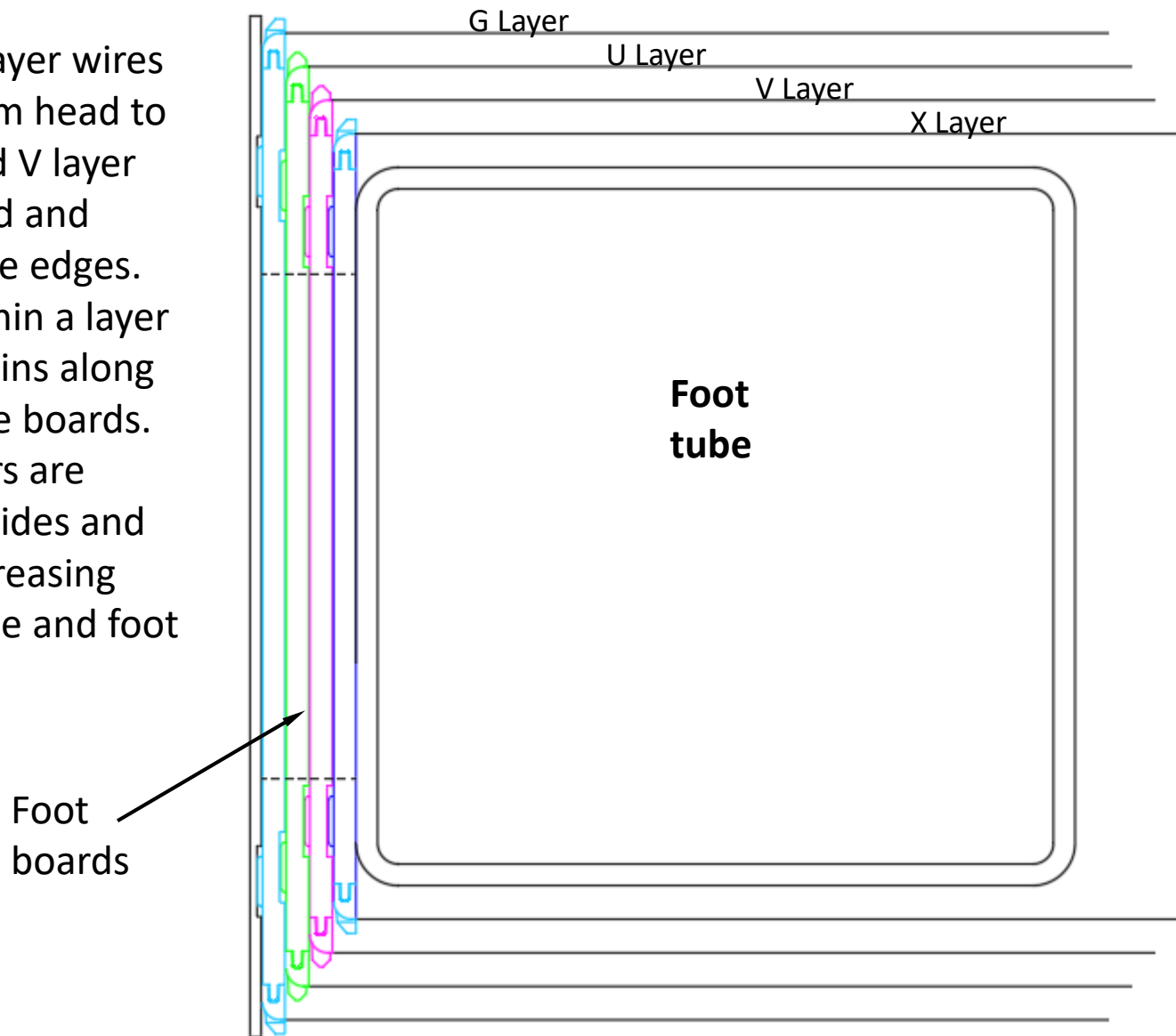


Wire layers

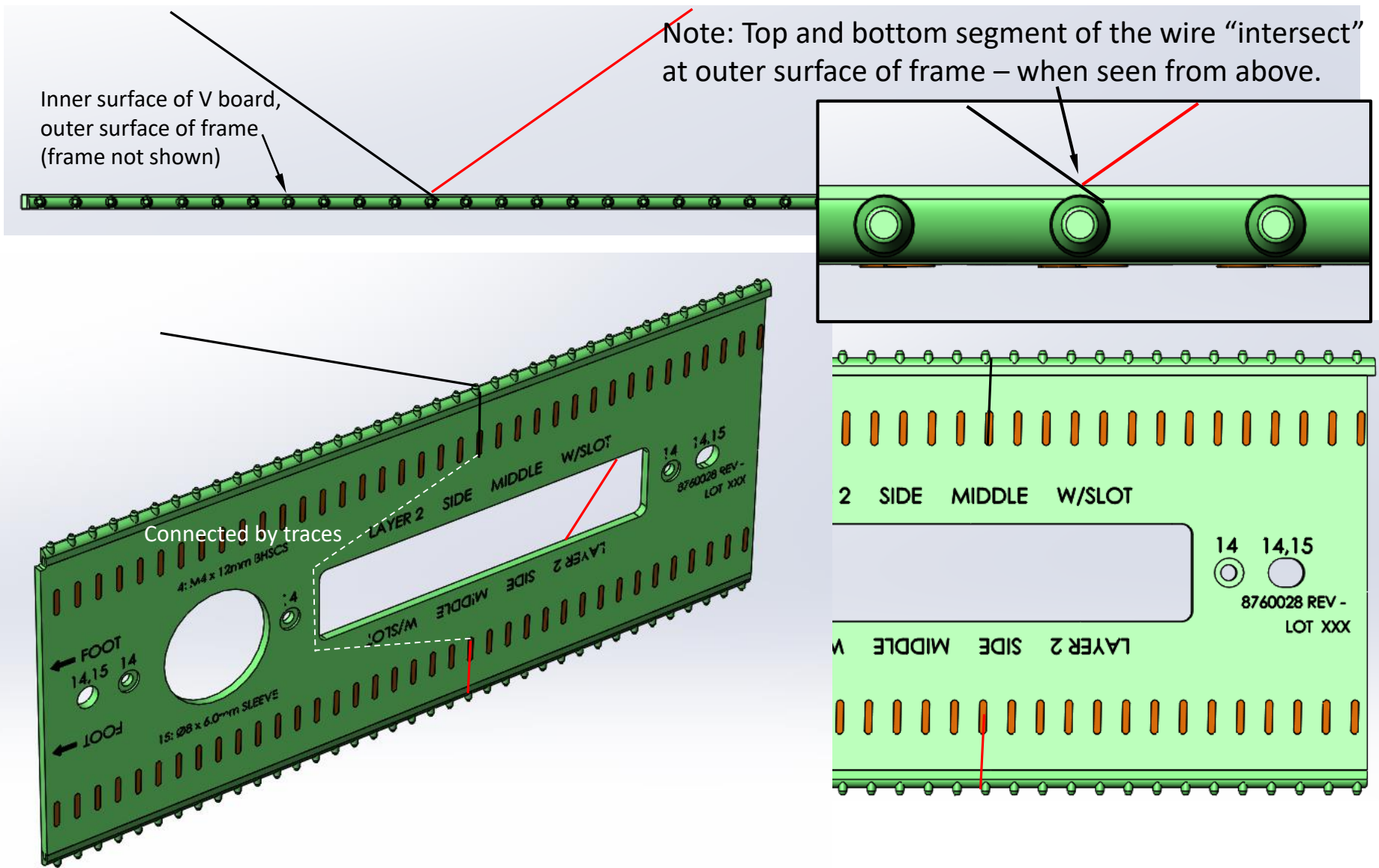
The X and G layer wires run straight from head to foot. The U and V layer wires are angled and wrap around the edges.

The wires within a layer are spaced by pins along the edges of the boards.

The wire layers are spaced, at the sides and foot, by the increasing width of the side and foot boards.



Wires wrapped around V side board

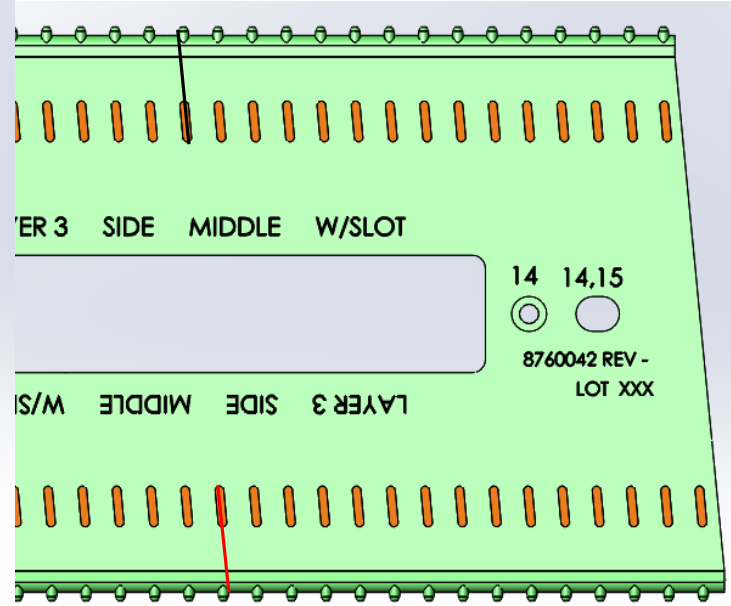
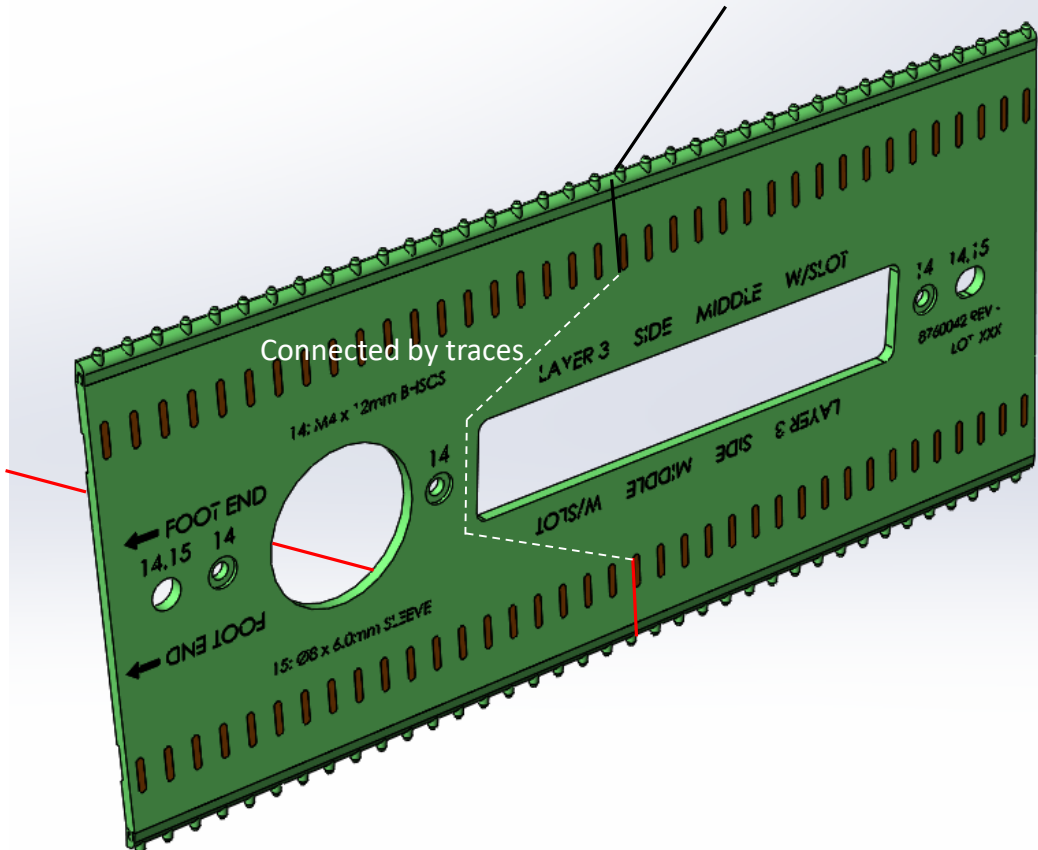
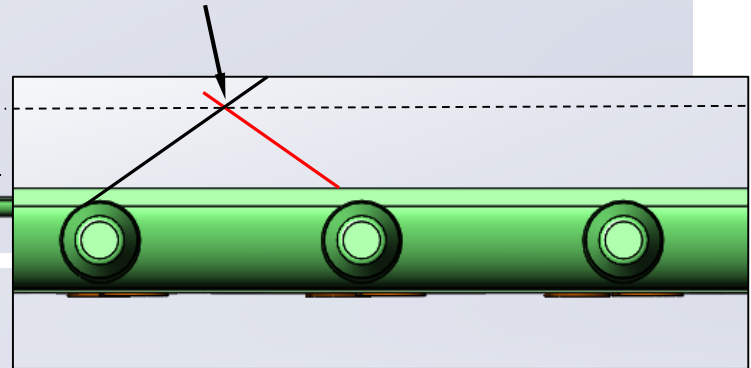
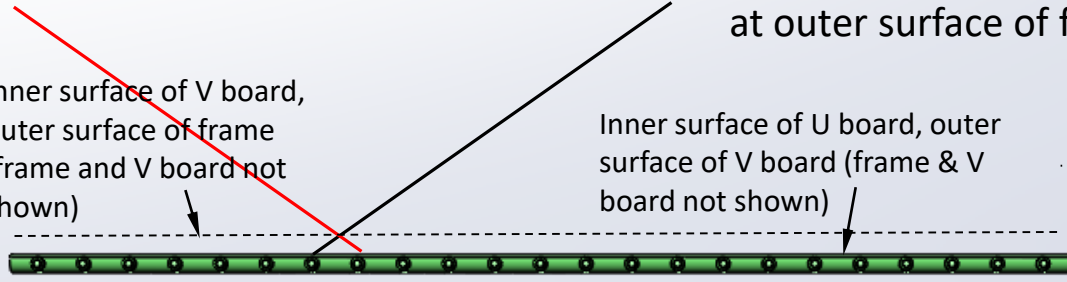


Wires wrapped around U side board

Note: Top and bottom segment of the wire still “intersect” at outer surface of frame – when seen from above.

Inner surface of V board, outer surface of frame (frame and V board not shown)

Inner surface of U board, outer surface of V board (frame & V board not shown)



Ends of U boards slanted to match wire path.

Board types

On one APA there are:

- 80 head boards
- 84 side boards
- 40 foot boards
- A total of 204 boards in one APA

But, there are:

- Several different variations of boards in each layer
 - Ends
 - Middles
 - Special photon detector openings
- For a total of 29 different boards

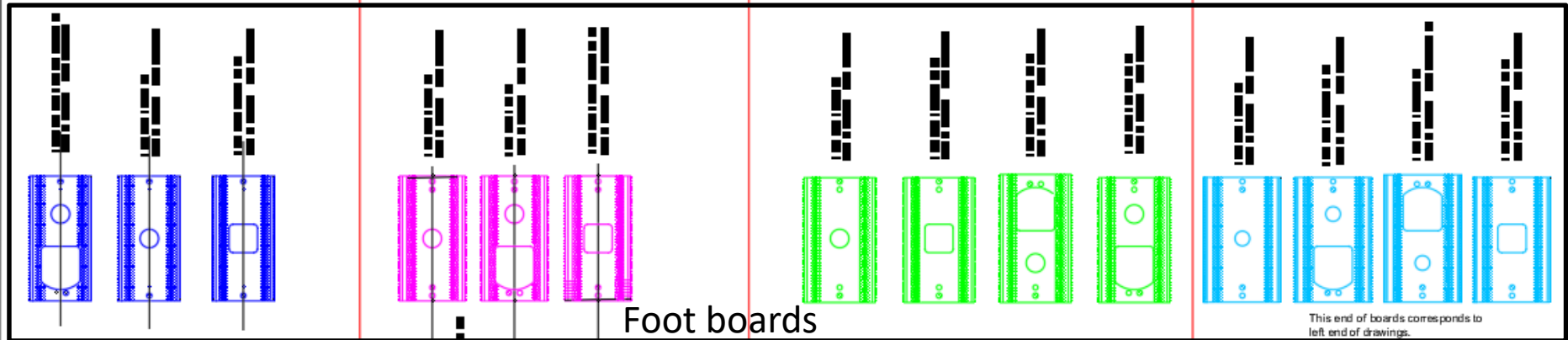
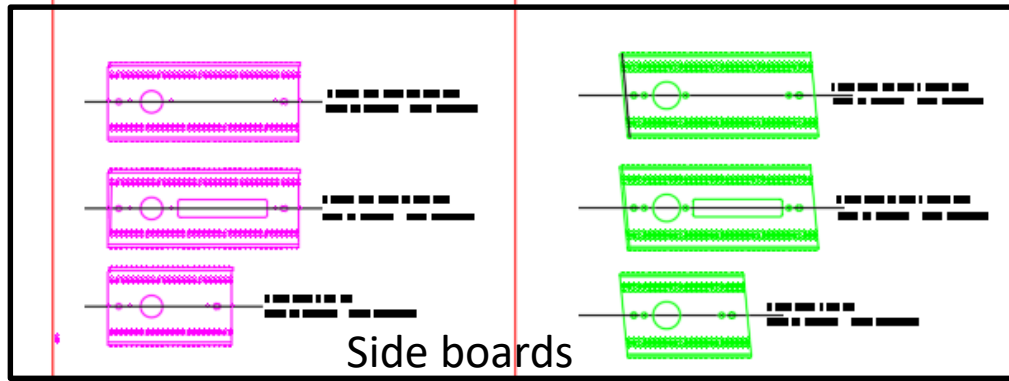
Board types

X layer

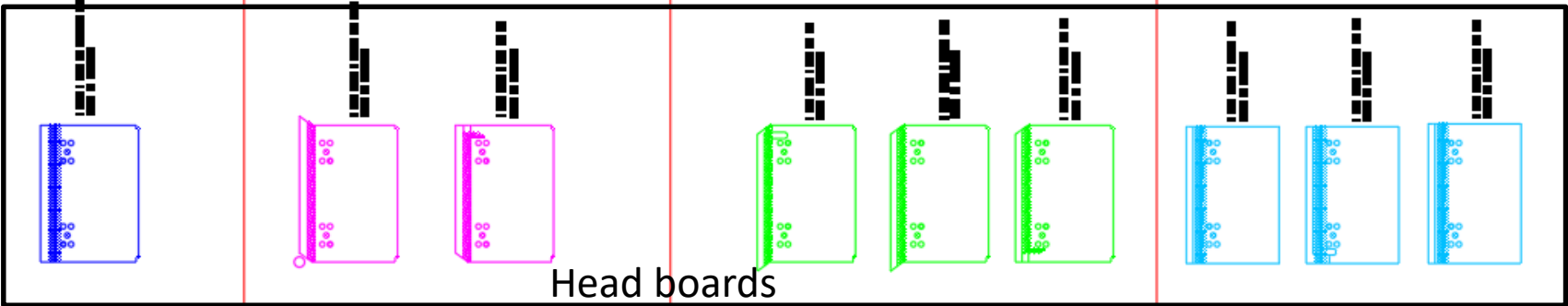
V layer

U layer

G layer

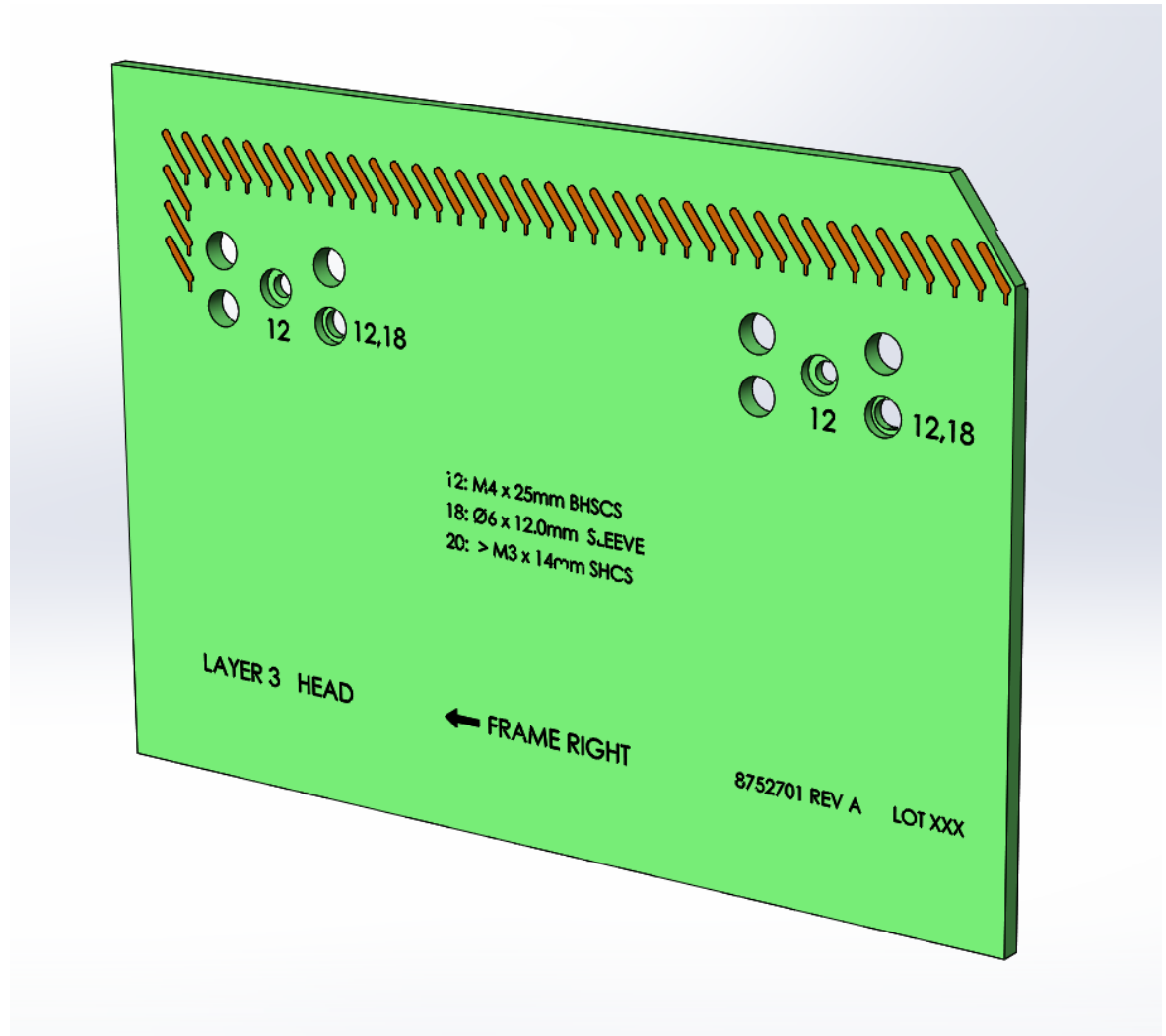


This end of boards corresponds to left end of drawings.

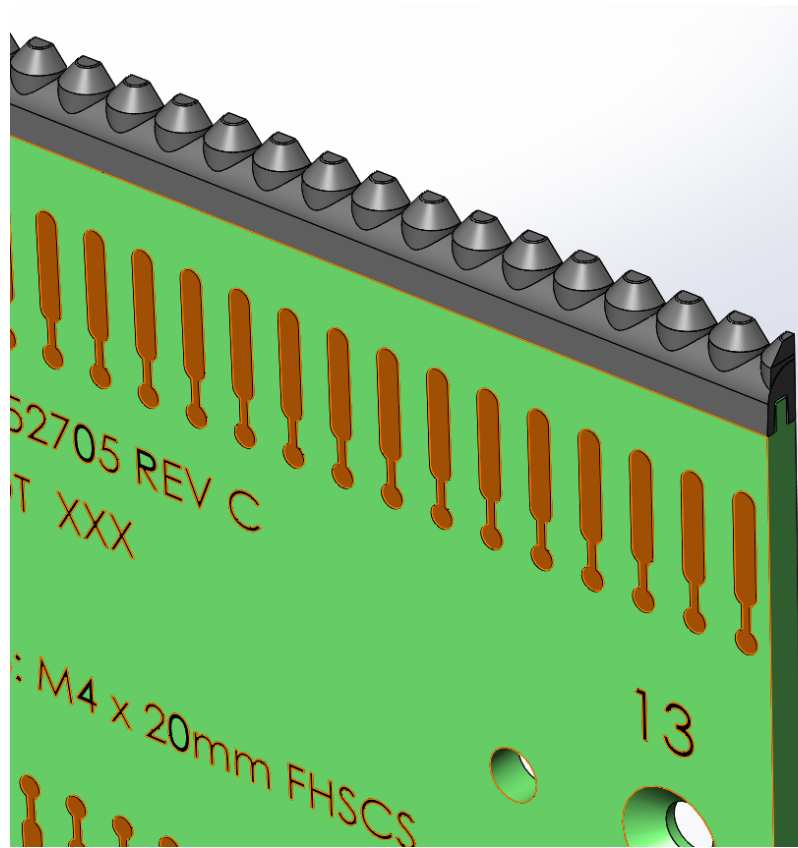


Tooth strips

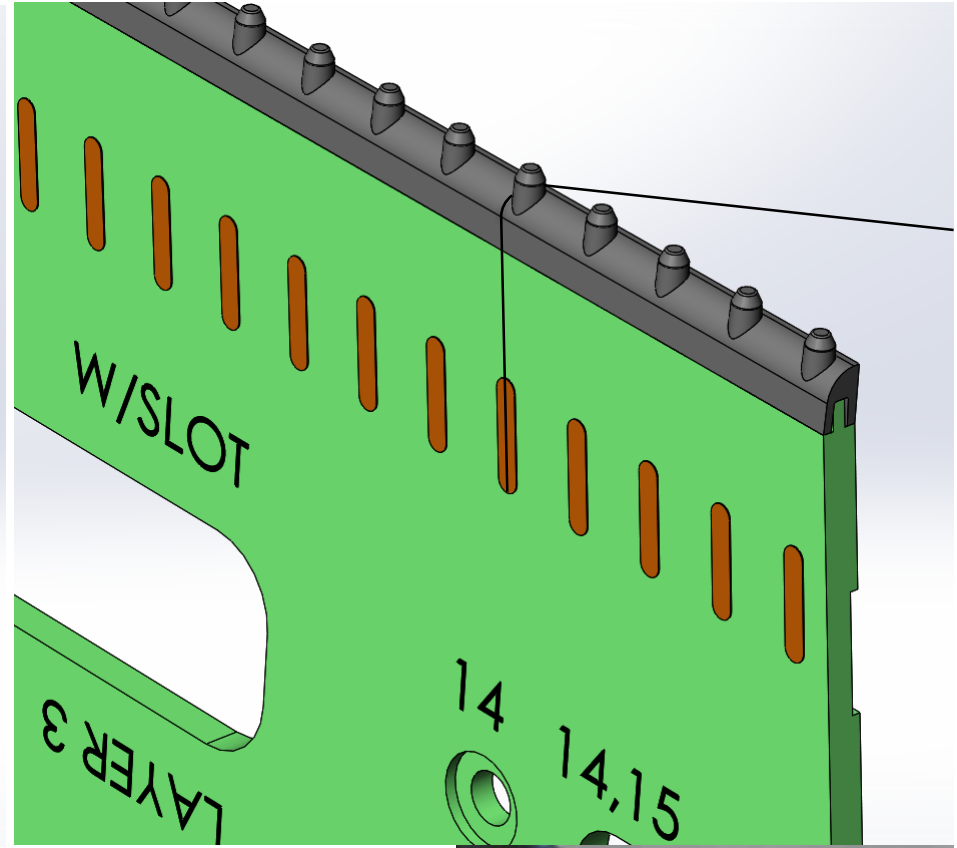
The head boards, like this U head board, have no teeth on them.



Tooth strips



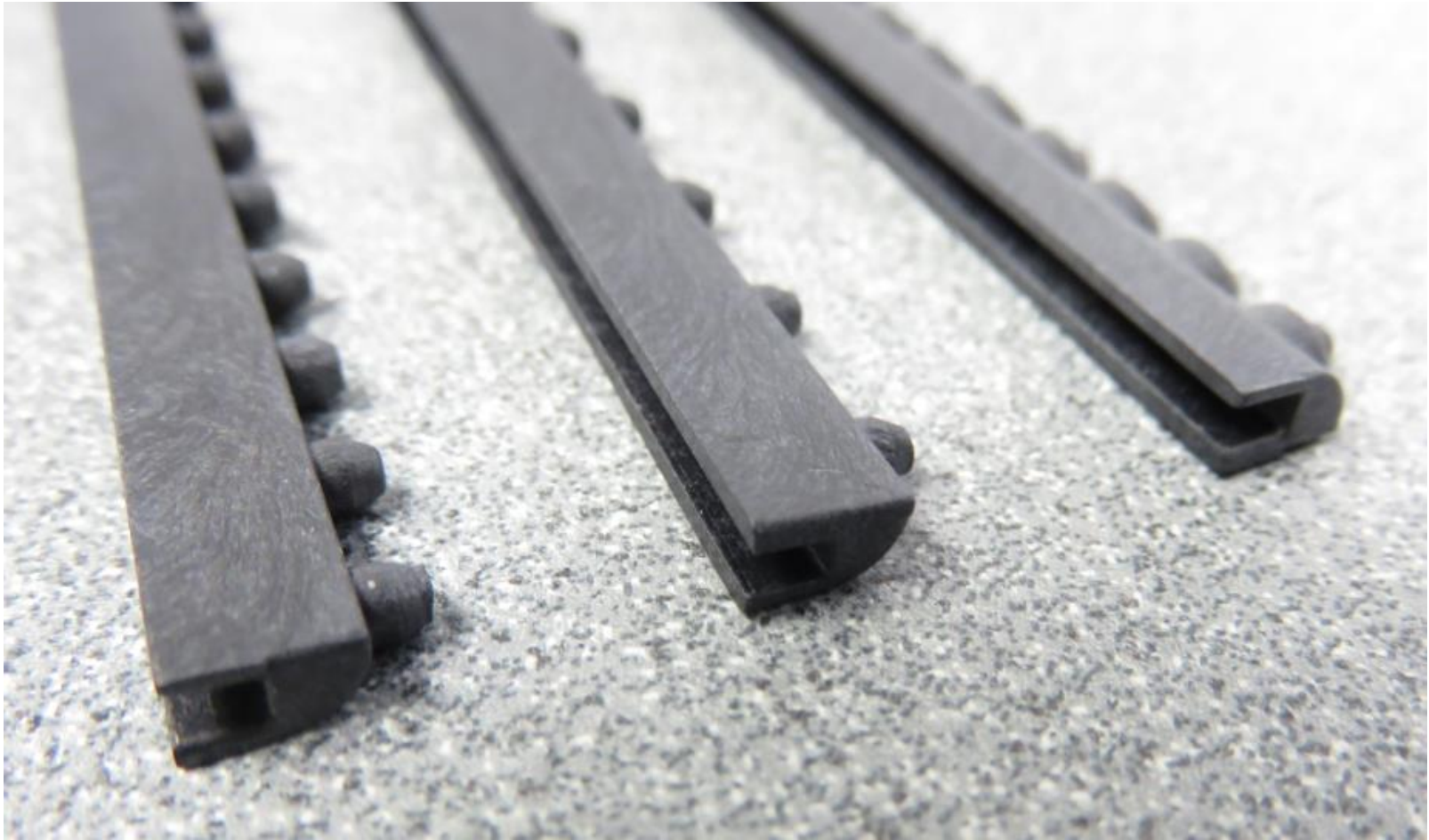
The X (and G) layer foot boards have teeth with a small slot that precisely locates the wire.



The U (and V) boards have “pins”. The angled wires are pulled against the pins for accurate location.



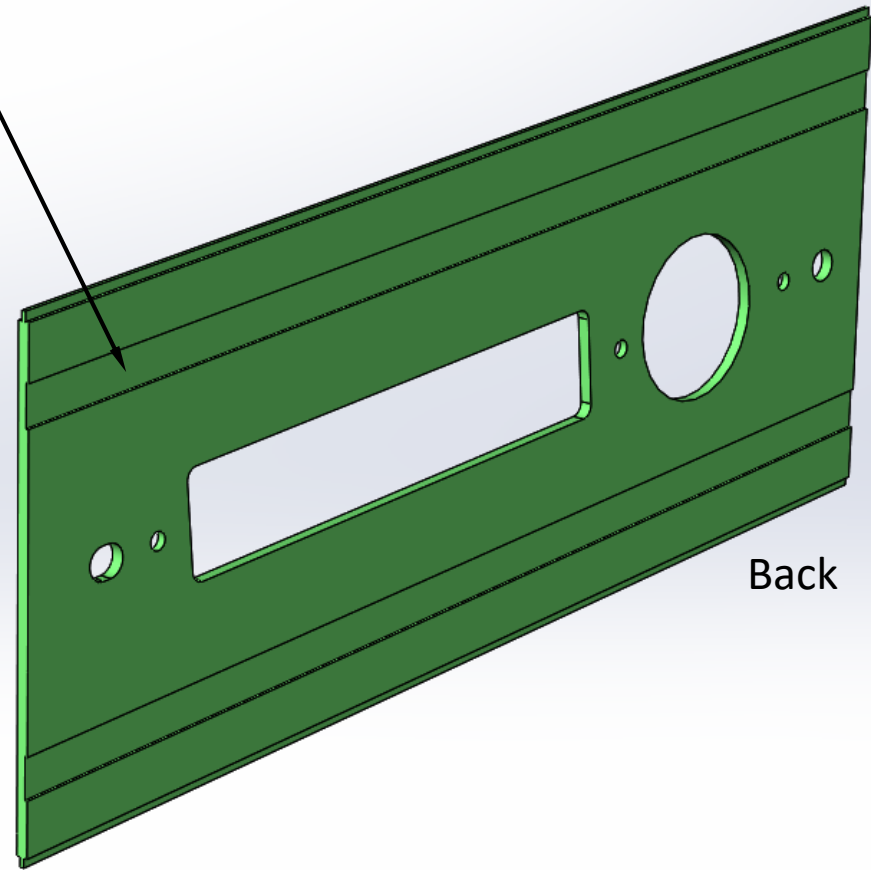
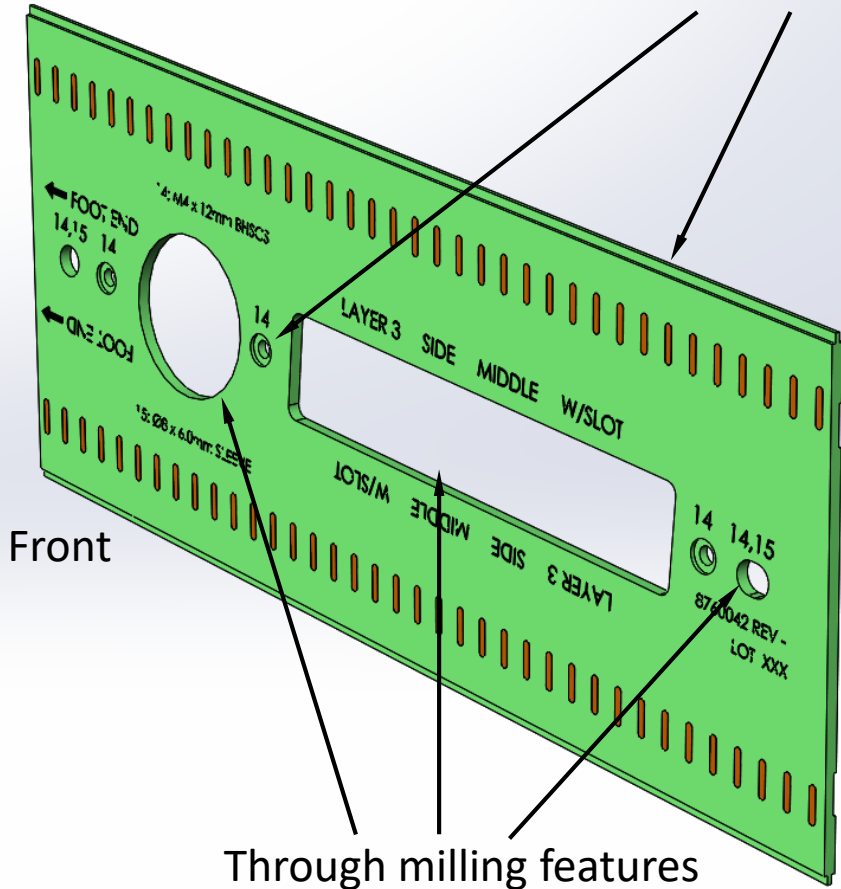
Tooth strips



The tooth strips are injection molded from 30% glass-filled LCP plastic (trade name Vectra E130i).

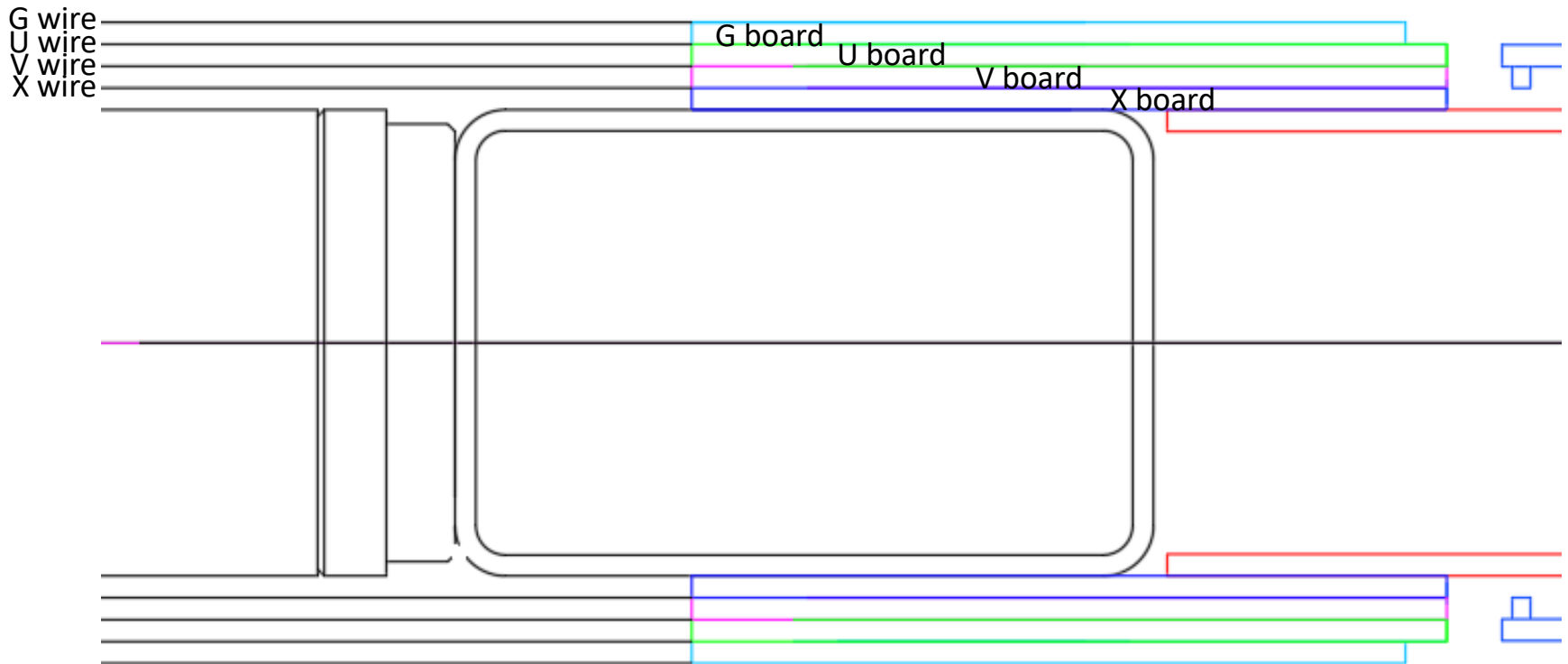
Board dimensional issues

Controlled depth milling features



The side and foot boards, as ordered from the board fabricator, have a combination of through milled features and controlled depth milled features. Board houses are good at through milling, but not as accurate with controlled depth milling.

Board dimensional issues



The wires attach to the top surface of a board, and that board rests on top of the board below. This means that board thickness determines the wire spacing.

Board houses are not used to holding boards to close thickness tolerance – it's not as critical for most applications.

The electrical group at PSL is working with board fabrication companies to find those:

- that can perform accurate controlled depth milling,

and
- ones able to provide material of closer than usual thickness tolerance

Another option is to find machining companies willing to do post-machining to the boards. Finding a single board fabricator that can do everything is preferable.

Wire Segment To Channel Mapping

Wire segment to channel mapping

- In a stack of boards at the head of the APA there are:
 - 48 wires on the X board,
 - 40 wires on the V board,
 - 40 wires on the U, and
 - 48 on the G
- Since the G wires don't connect to electronics there are $48+40+40=128$ channels in a stack of boards.
- With an additional 48 wires on each G board, there are 176 total wires coming from a board stack.
- With 20 stacks of boards on an APA there are $20(128)=2560$ channels.
- There's one extra G wire on each side of the APA for a total of $20(176)+2=3522$ wires in an APA.

This is counting each wire that starts at a head board and ends at a foot board as a single wire. However, the diagonal wires wrap around the edges so they are broken in to either two or three segments. (All straight head to foot wires are a single segment.)

There are 6526 wire segments in an APA.

Wire segment to channel mapping

Wires are most easily defined by:

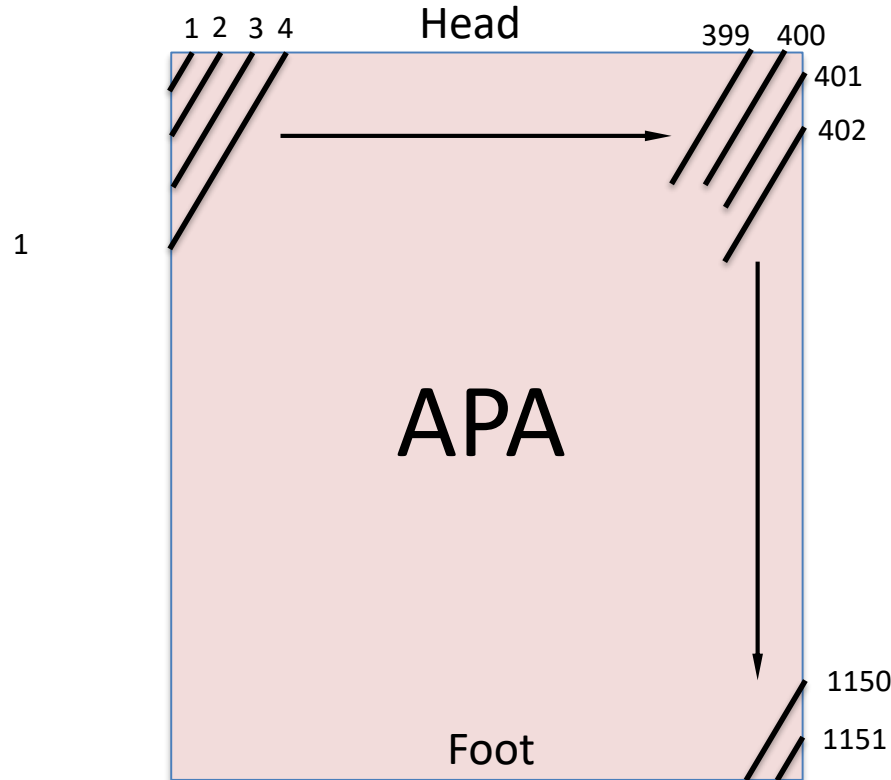
- Layer (X, V, U, or G)
- Board number (1 – 20 in an APA)
- Pad number (1 – 48 in X and G, 1 – 40 in U and V)

Straight wire segments are simple: Since each wire has one segment the numbering of X and G wire segments is the same as X and G wires.

Wire segment to channel mapping

Diagonal wire segments are more complicated:

The wire segments are counted across the top of the APA and down one edge. Doing this on both faces of the APA numbers all the wire segments in a diagonal layer.



There are $1151+1151=2302$ V wire segments and the same number of U wire segments in an APA.

Wire segment to channel mapping

The geometrical coordinates of the start and end point each wire segment, and a cross reference between channel numbering and wire segment numbering, can be found in DocDB 15787.

An explanation of nomenclature is included.

Great beach reading!

