Installing the foam and closing the SFGD box

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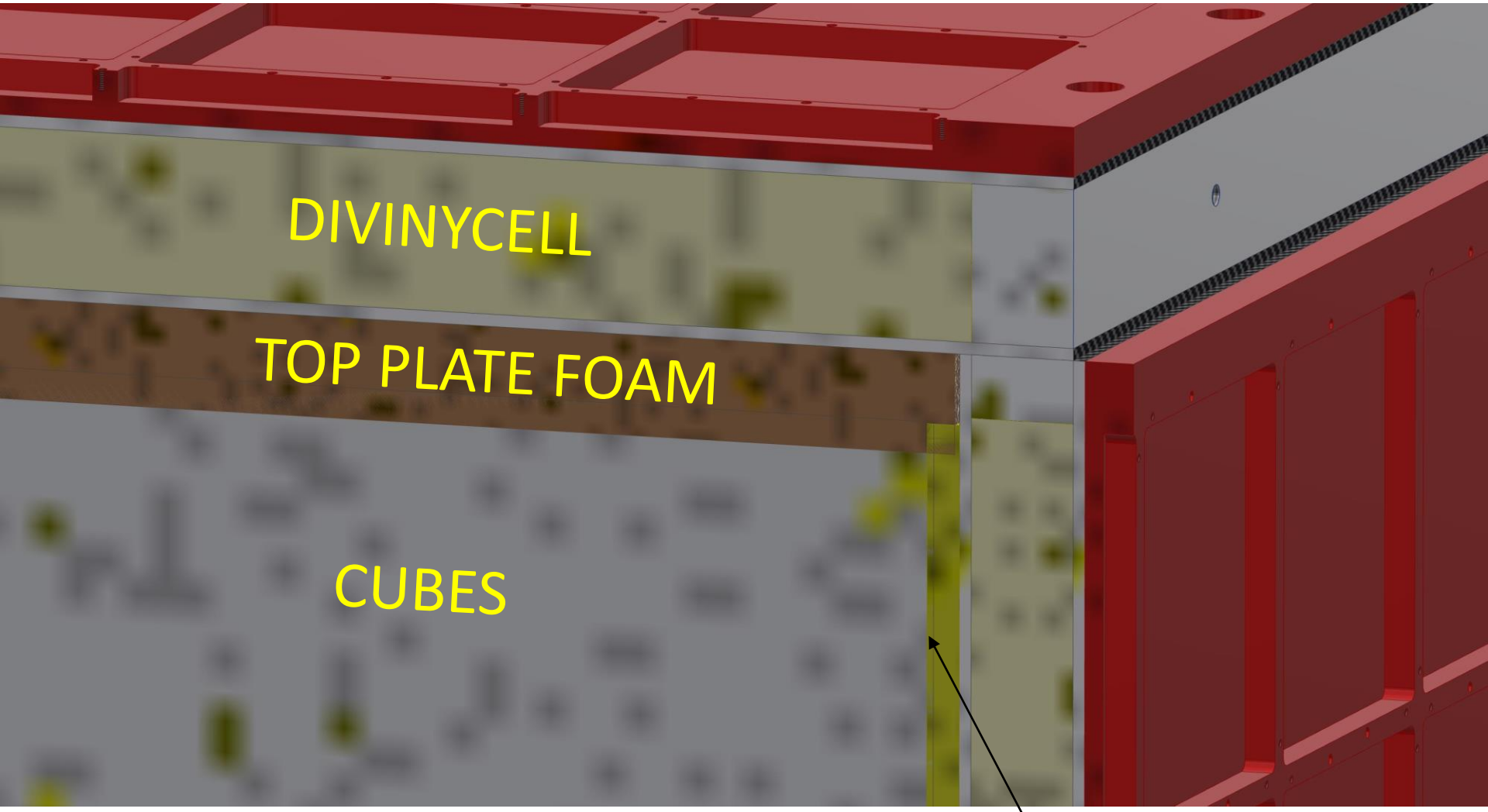
Foam assembly proposal

- I have a few proposed tools to allow the large foam pieces to be glued to the sides of the box
- I have four new glues to test for the foam assembly
  - First glue tested was not strong enough
- I have the report on the measurement of the foam and have calculated the force required to compress the foam by the expected amounts

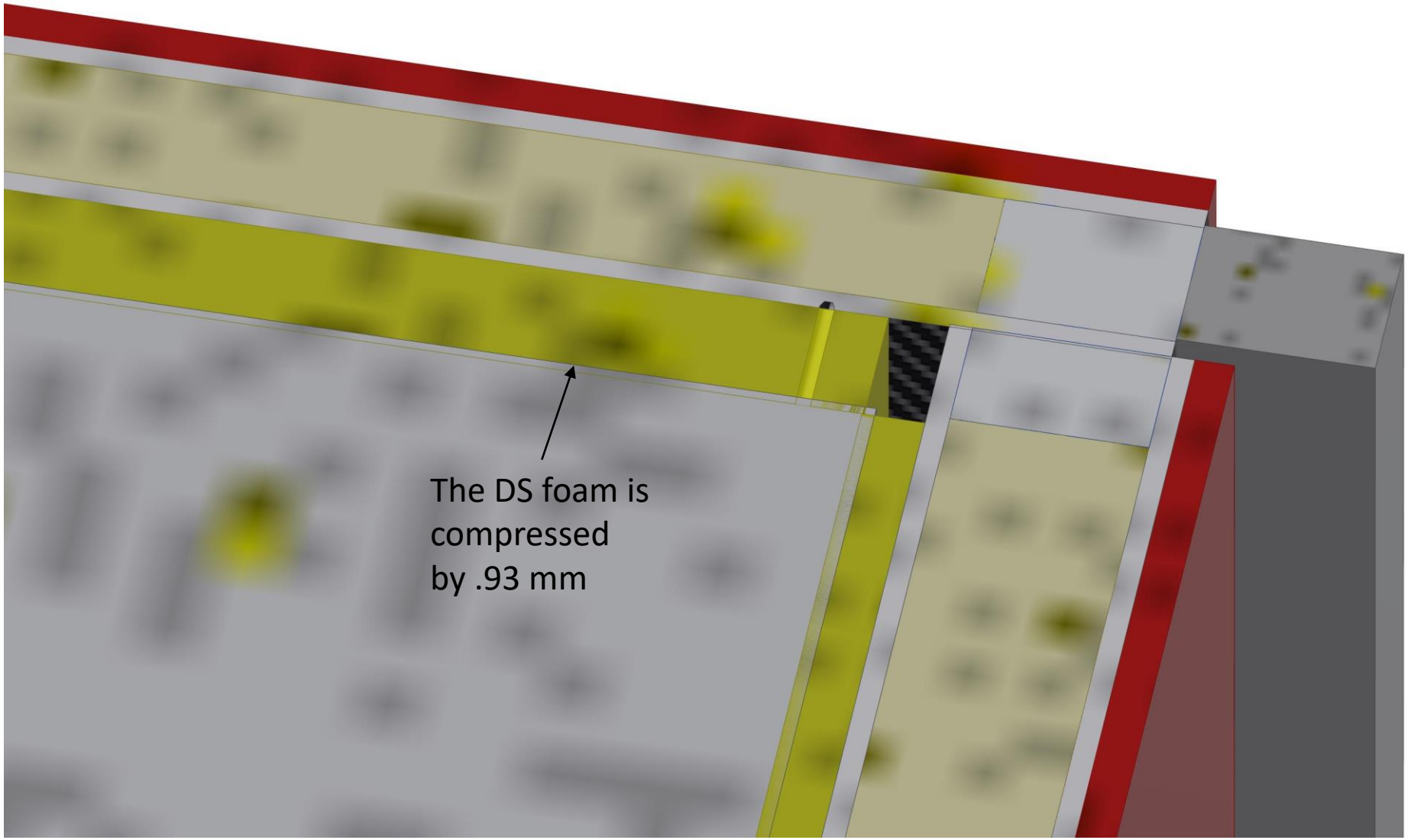
Vertical plane section view looking downstream



The top foam is .75 inches thick and is compressed by 5.9 mm

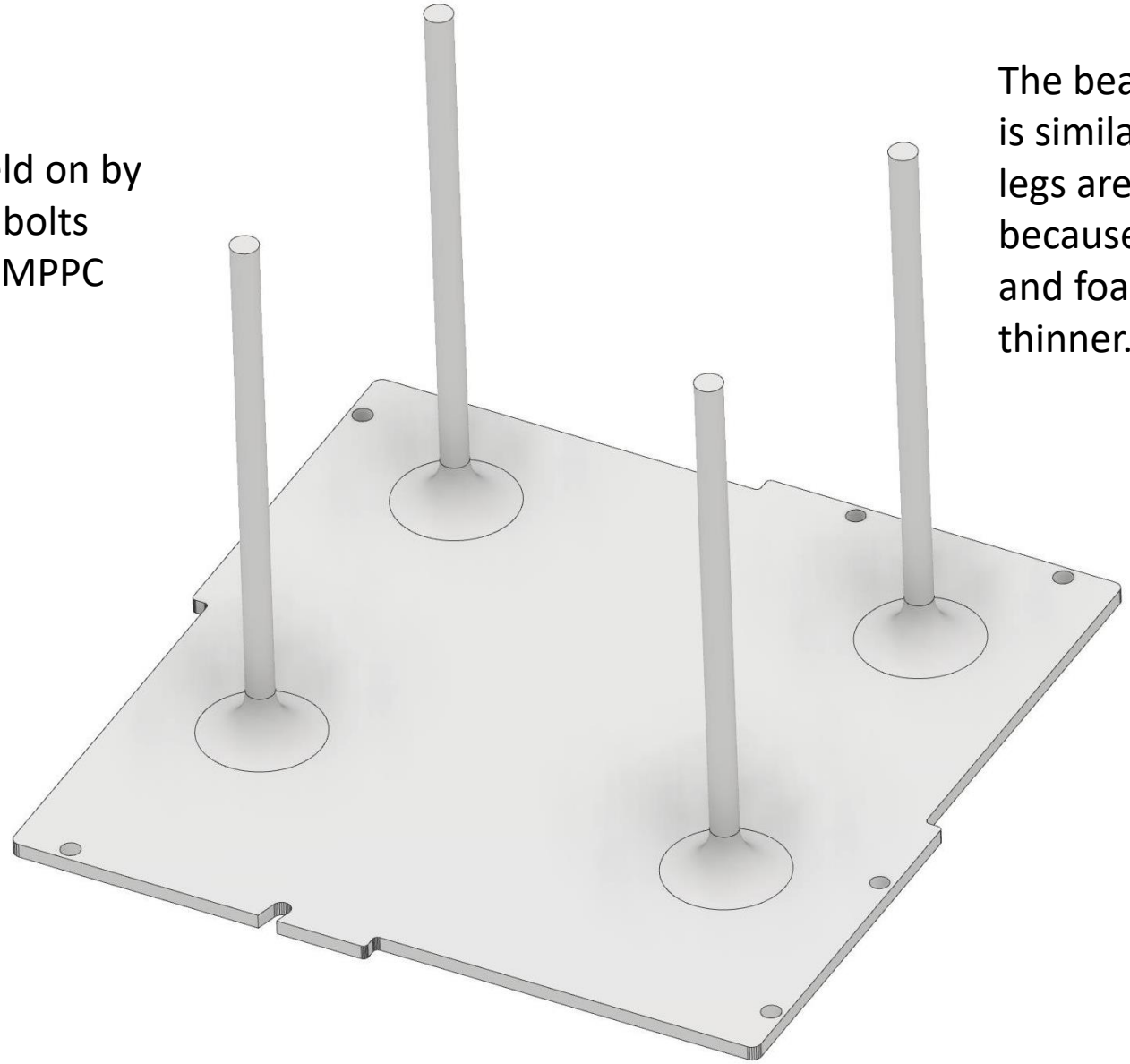
The BR foam is compressed by 1.28 mm

Horizontal plane section view showing the DS and BR intersection



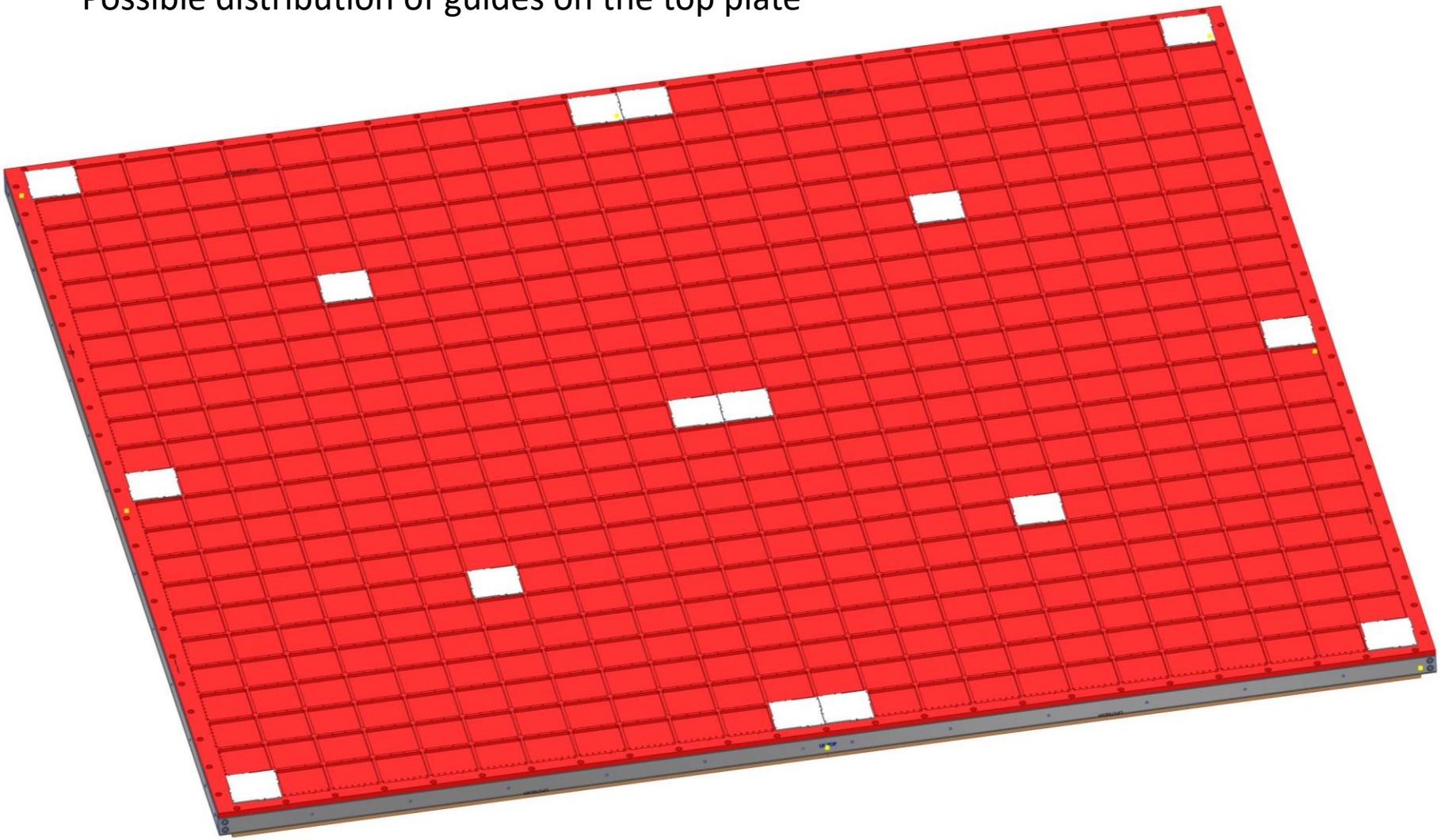
MPPC-like 3D printed tool to locate foam on the top plate

This tool is held on by the same M2 bolts that hold the MPPC boards on.



The beam right tool is similar, but the legs are shorter because the plate and foam are thinner.

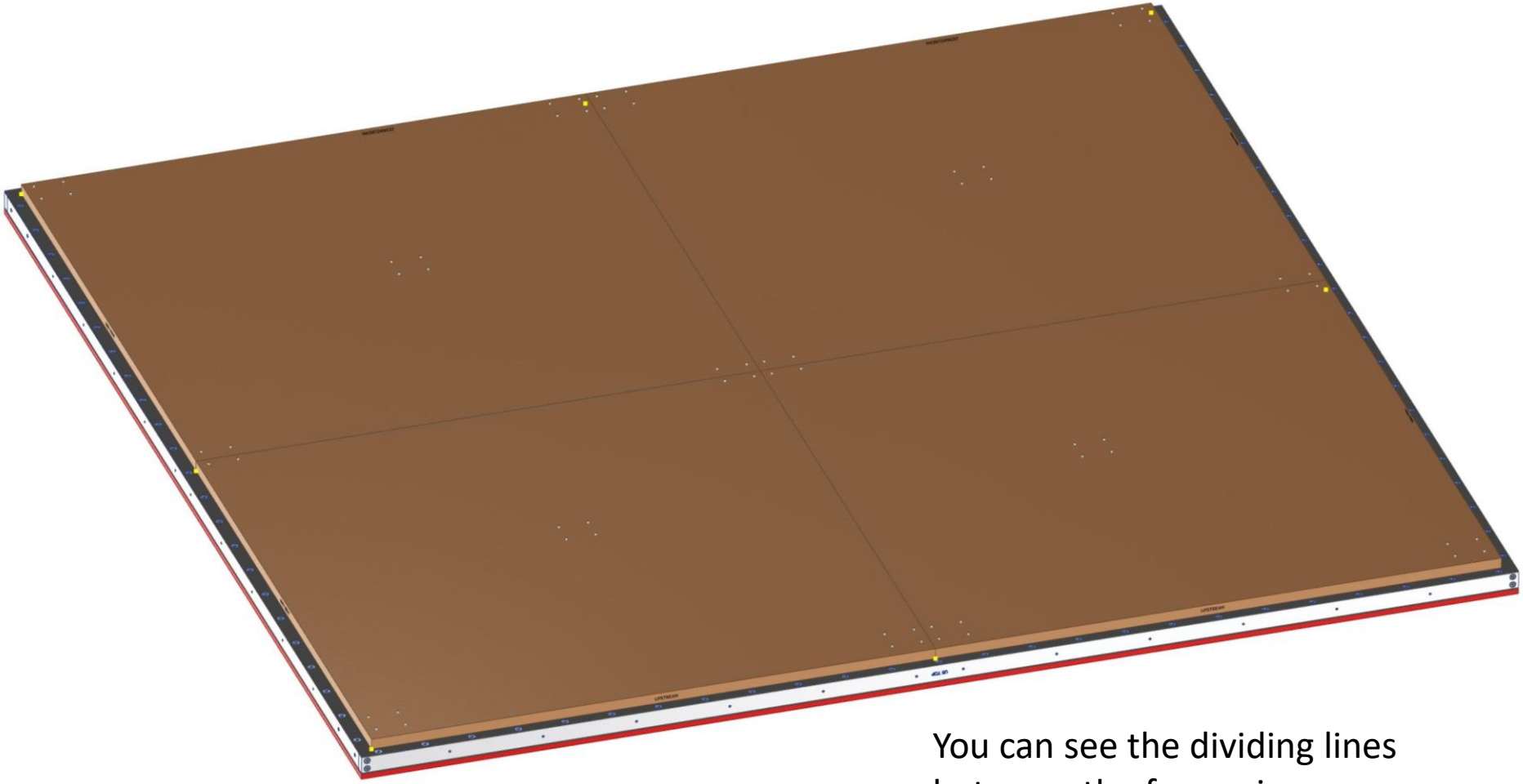
Possible distribution of guides on the top plate



There will be four pieces of .75 inch foam to attach to the top plate

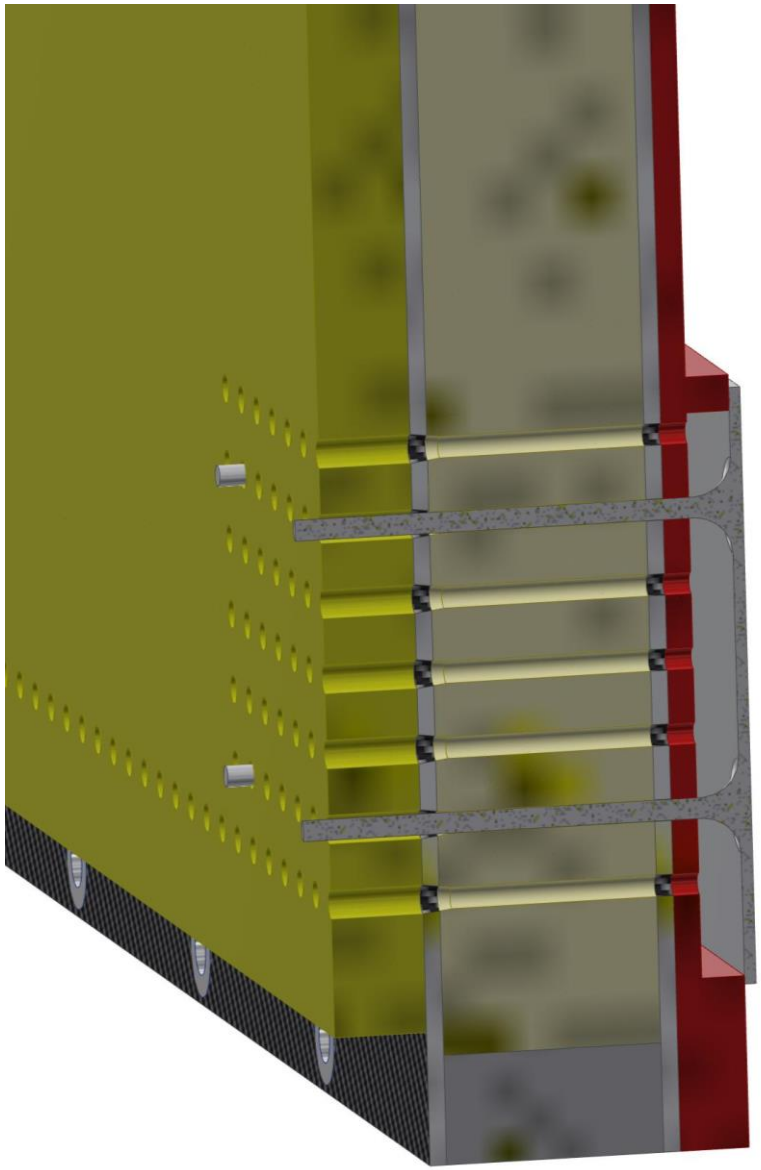
12 strips, 2 MPPCs wide might be much easier to handle with less stretching.

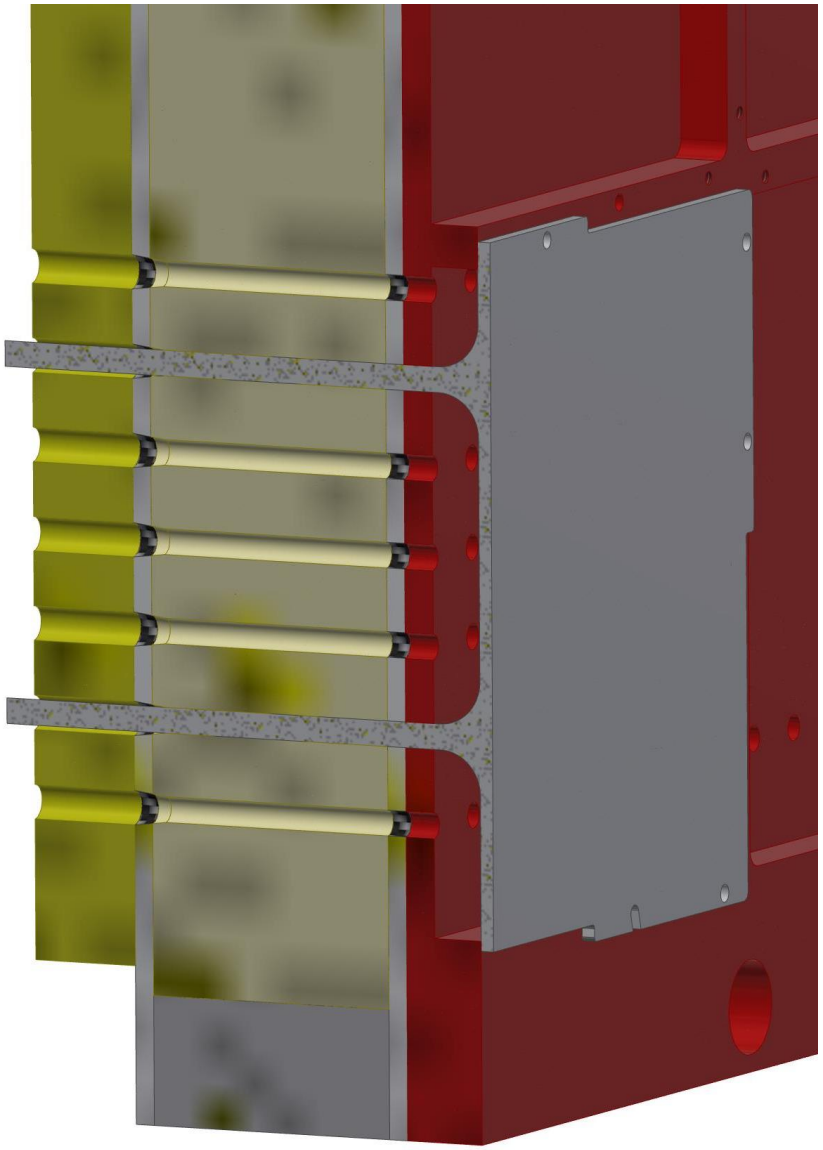
View of the foam side of the Top Plate with tools poking through



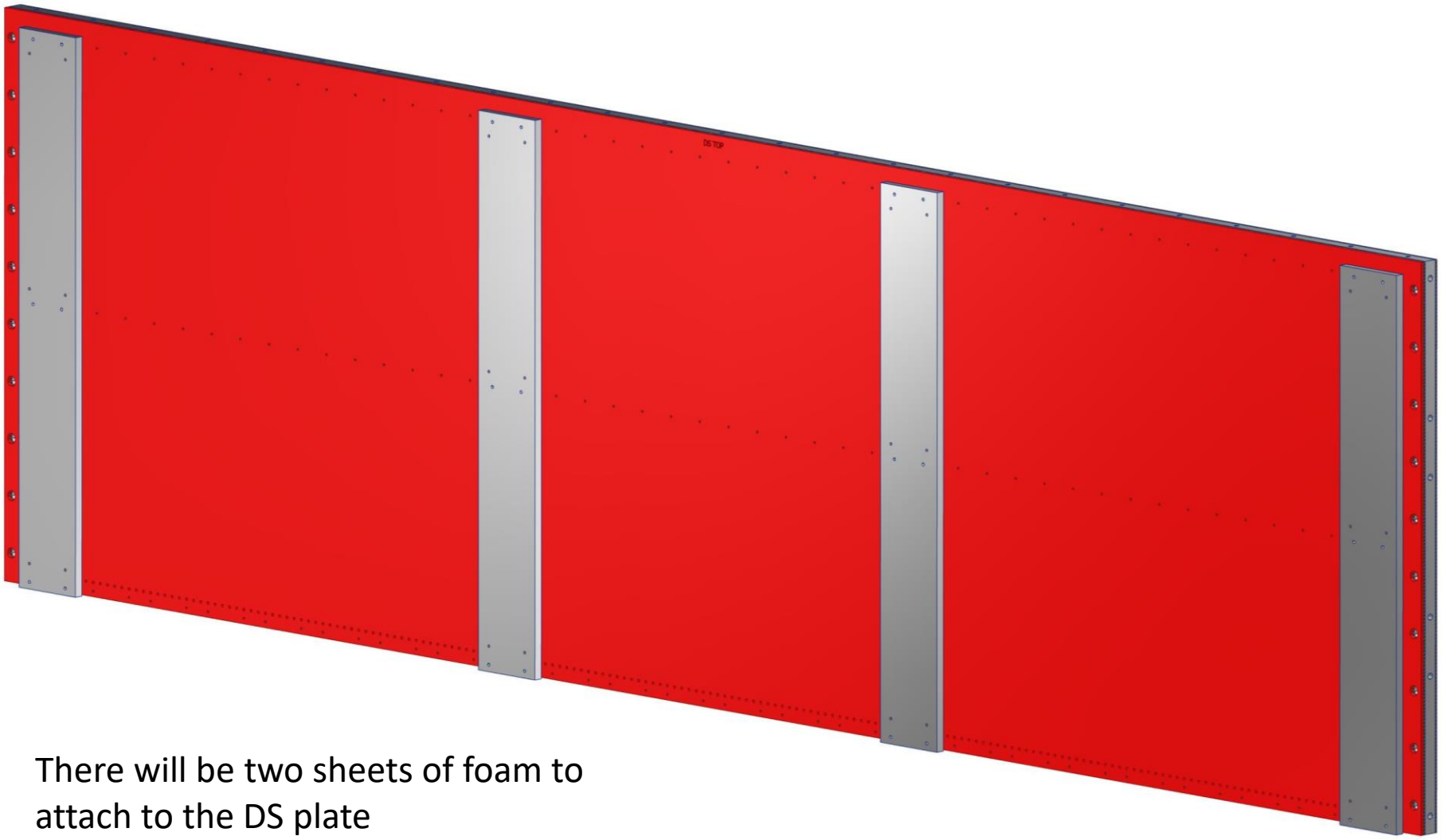
You can see the dividing lines between the foam pieces.

Two section views of the foam locating guide tool



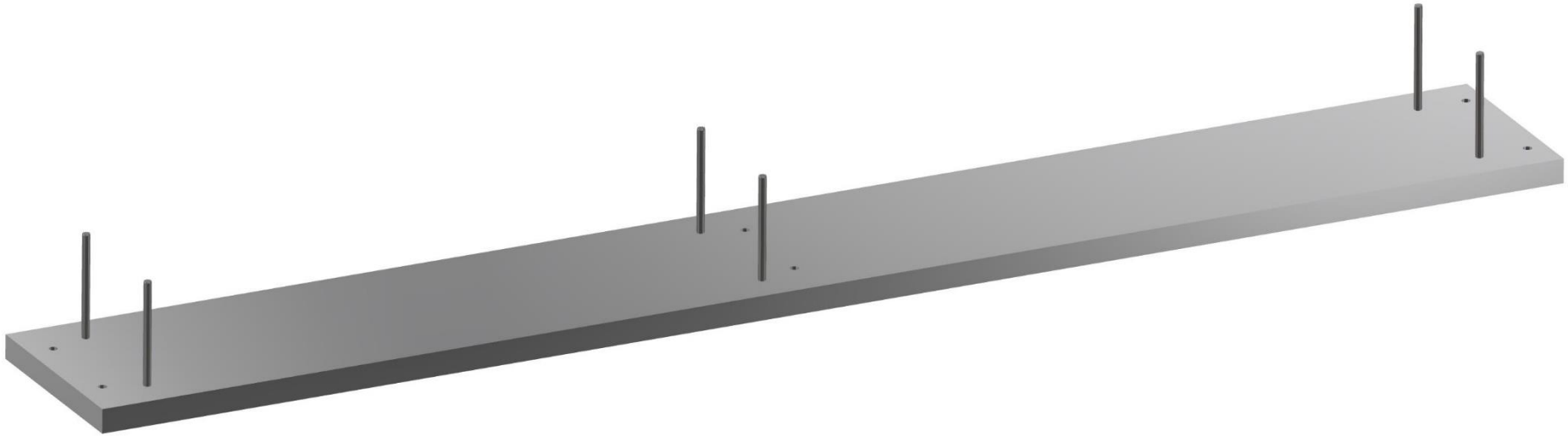


A different style of tool is needed for the DS plate



There will be two sheets of foam to attach to the DS plate

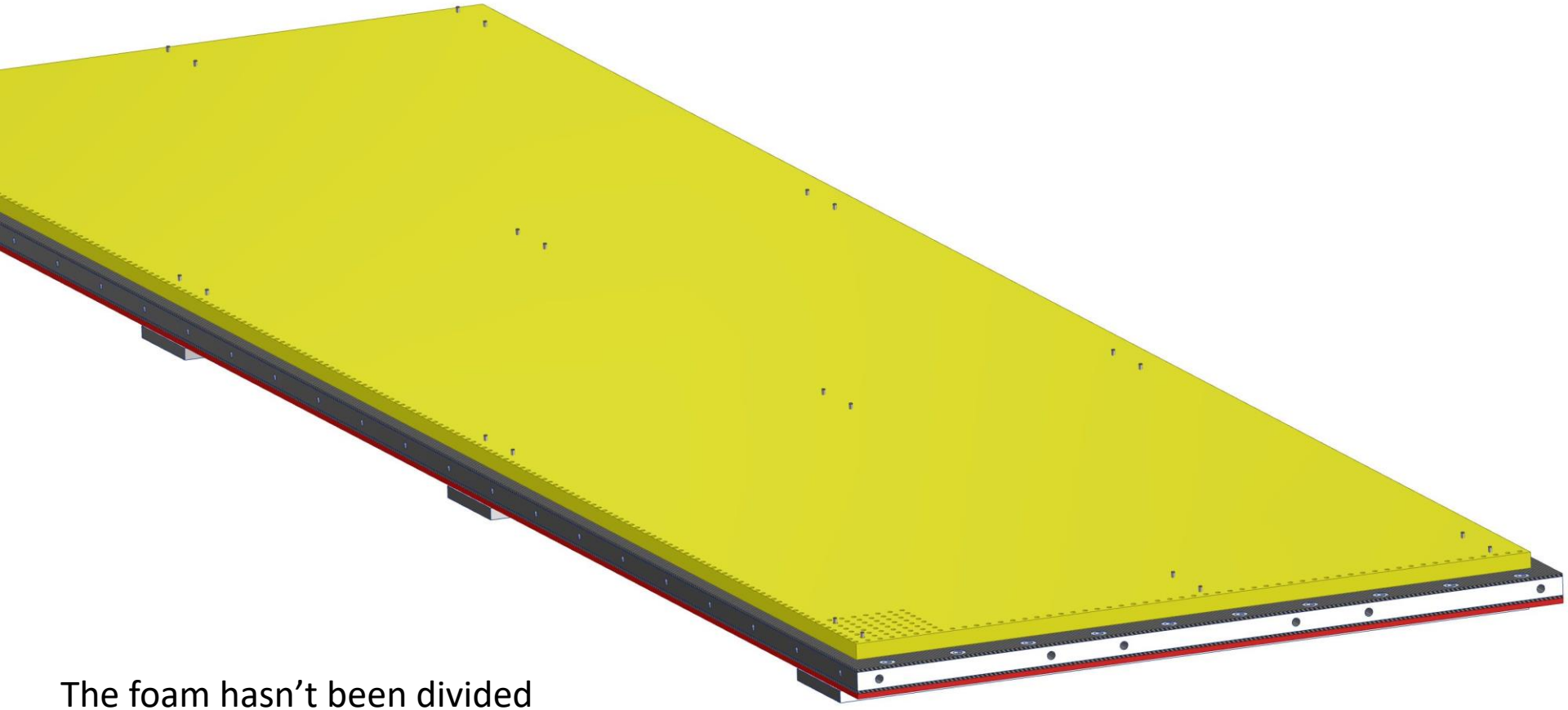
Foam guide tool that works wherever there are calibration modules



This tool is made from a plate of aluminum and six stainless M3 dowel pins 50 mm long. The dowels are press fit into the plate. The screw holes that hold it on match those for the calibration modules.

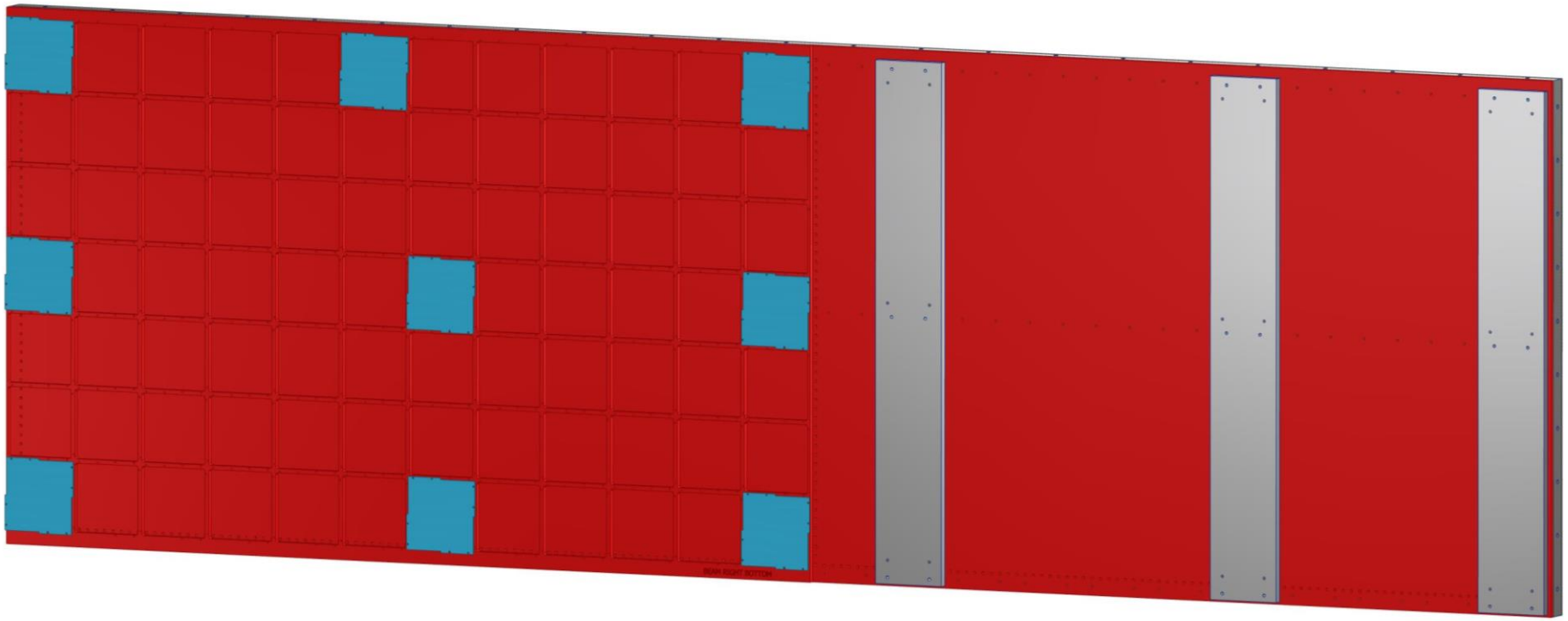
I made the plate thickness >3X the diameter of the pins to ensure they would be stable and perpendicular to the plate.

Foam-side view of the DS plate with tools poking through



The foam hasn’t been divided here yet, but it is made of two pieces.

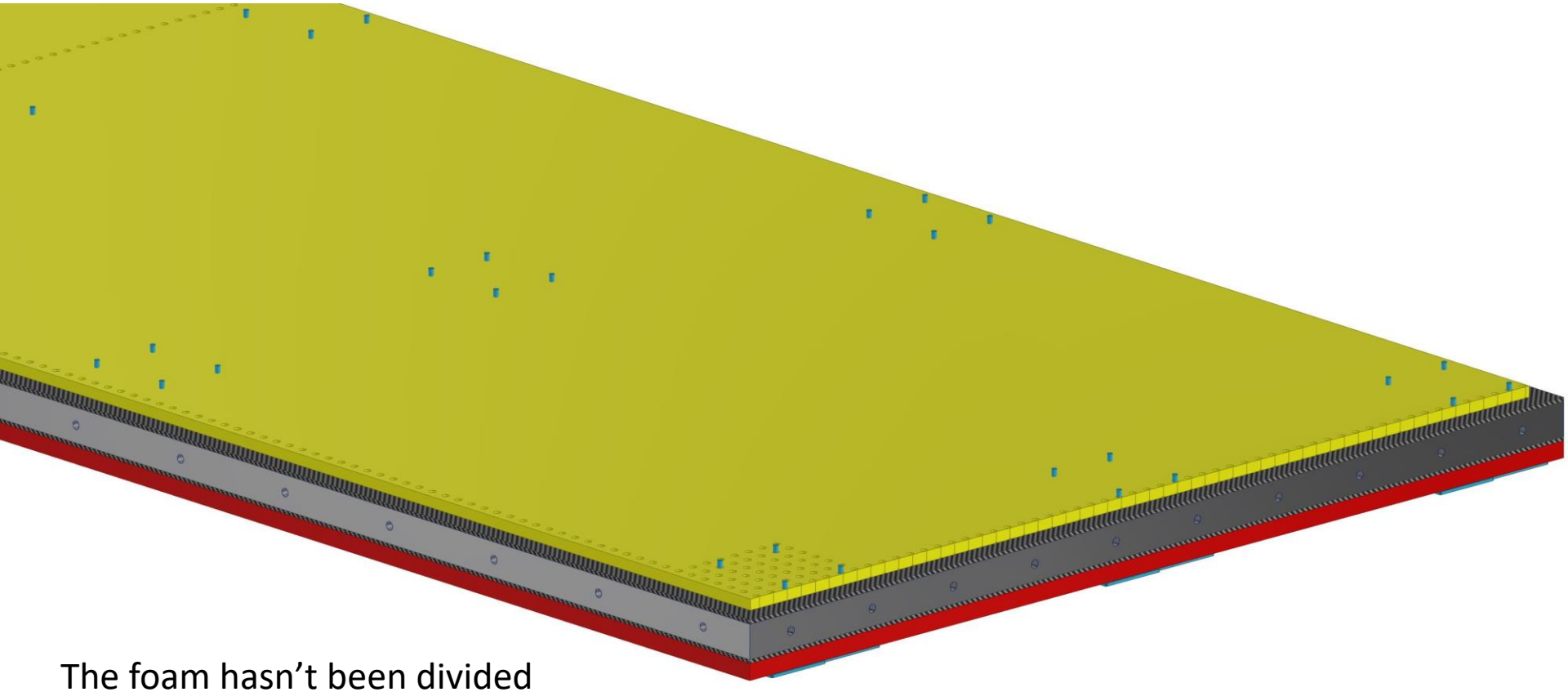
Distribution of tools on BR foam gluing



Beam right has both MPPCs and calibration modules, so it needs two different tools.

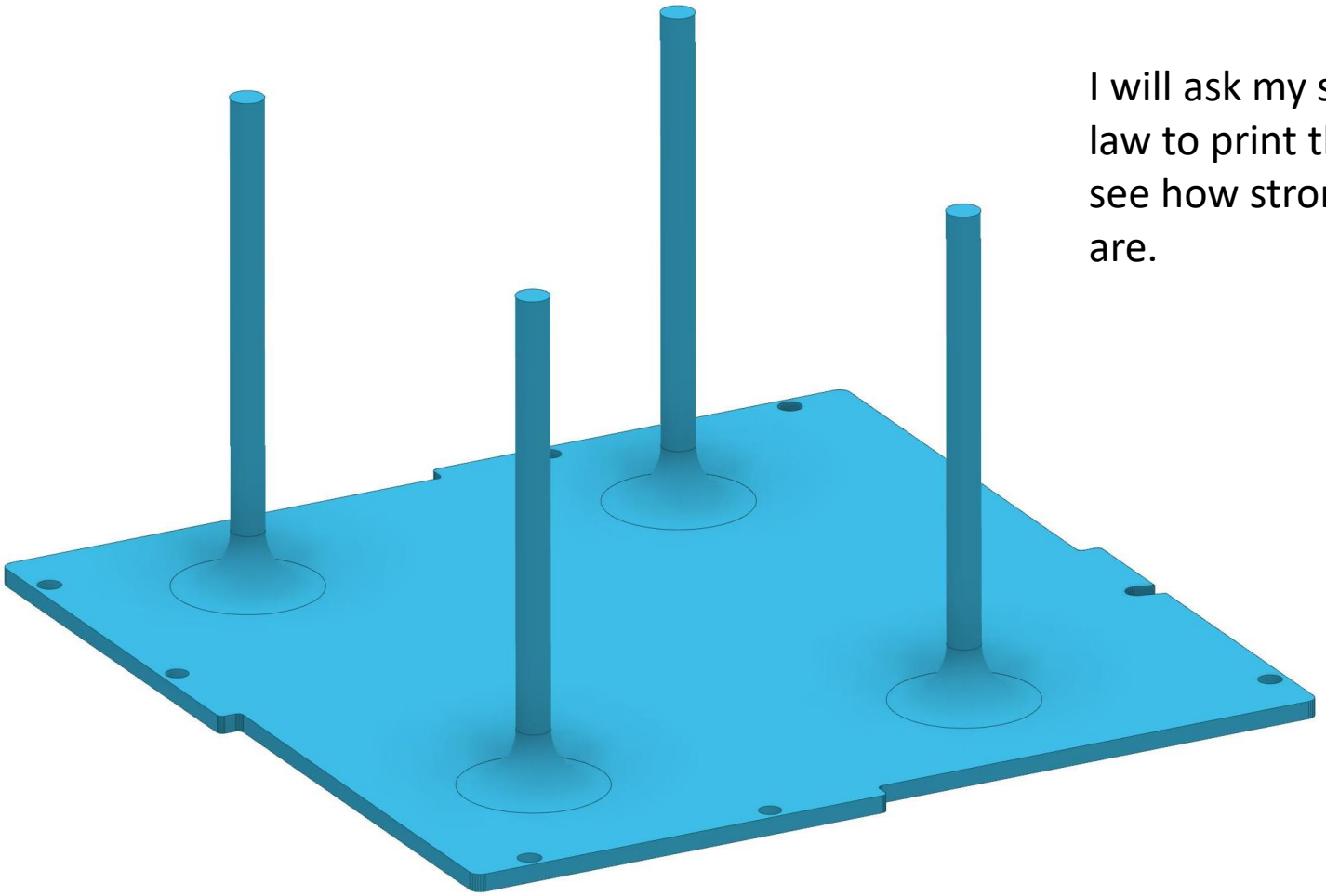
This one also has two pieces of foam to glue on.

View from the foam side of the Beam Right plate with tools poking through



The foam hasn’t been divided here yet, but it is made of two pieces.

MPPC-like 3D printed tool to locate foam on the BR plate



I will ask my son-in-law to print these to see how strong they are.

Proposed glue for foam

I purchased these glues before I went on vacation. When I get back I will test the foam samples with the carbon fiber plates I bought. I want to see if the bond strength is sufficient, if they are repositionable, and what the general application is like. In particular, I want to see if there is any possibility of plugging fiber holes.

I am favoring aerosol adhesive, unless there is a reason to avoid them.

I have received the report from the foam measurement company. They tested three different thickness samples, three times in series. Graphs of the results follow.

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Initial Report Date: July 27th, 2022
Author: Daniel Bergman
Report Number: 02342-014082-1

Photo of .25 inch thick X 30 cm X 30 cm piece of foam with .25 inch dia. holes

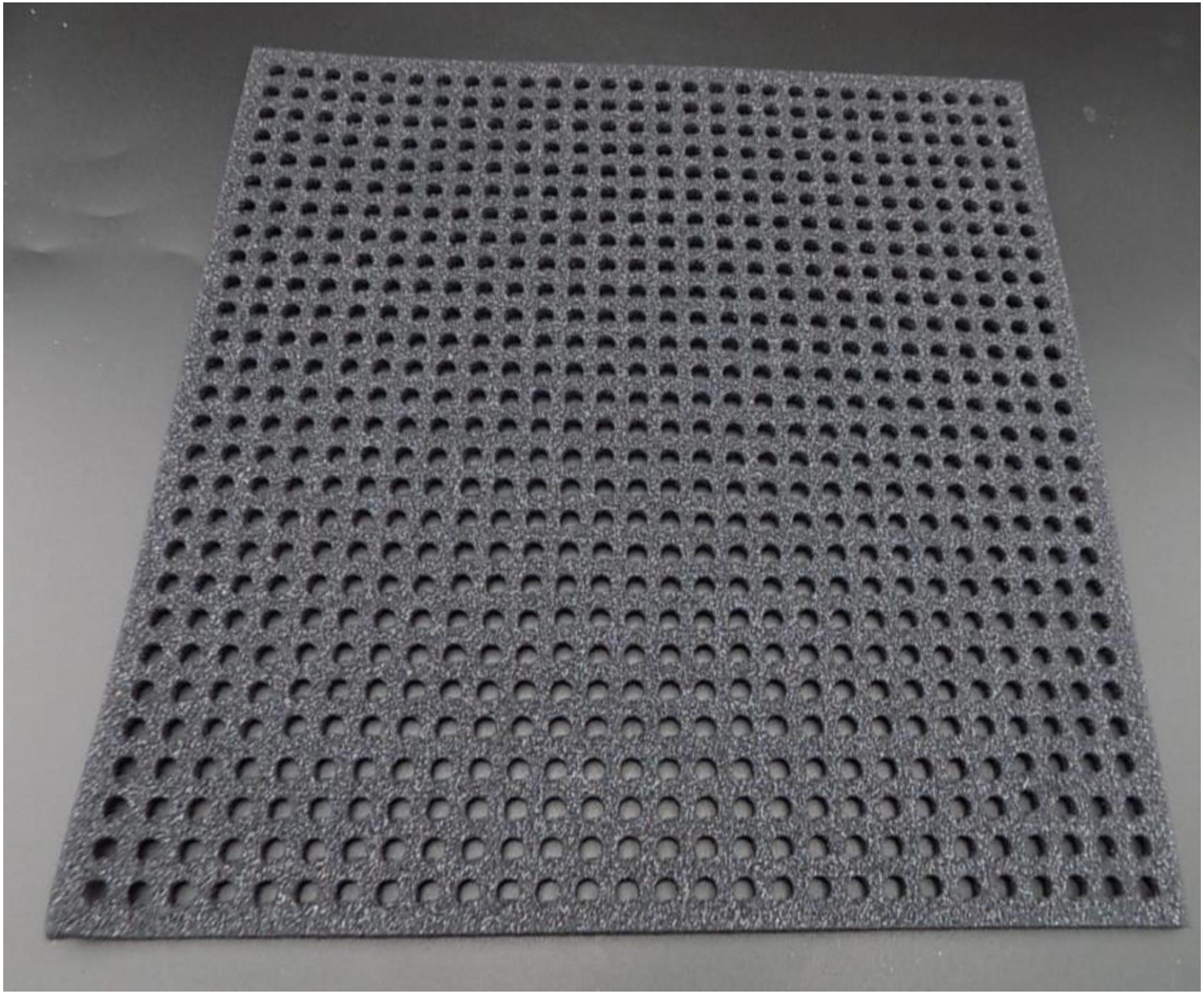
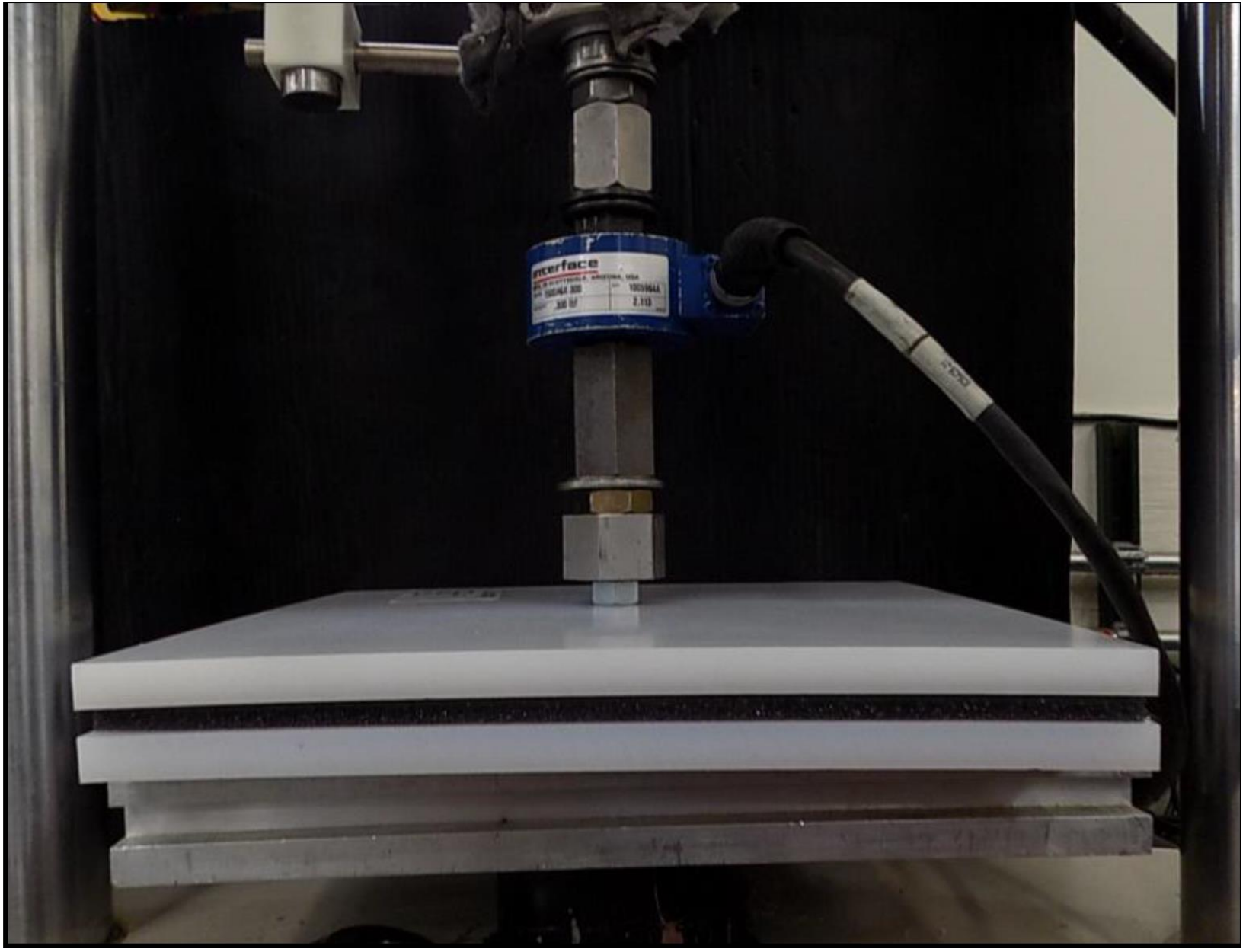
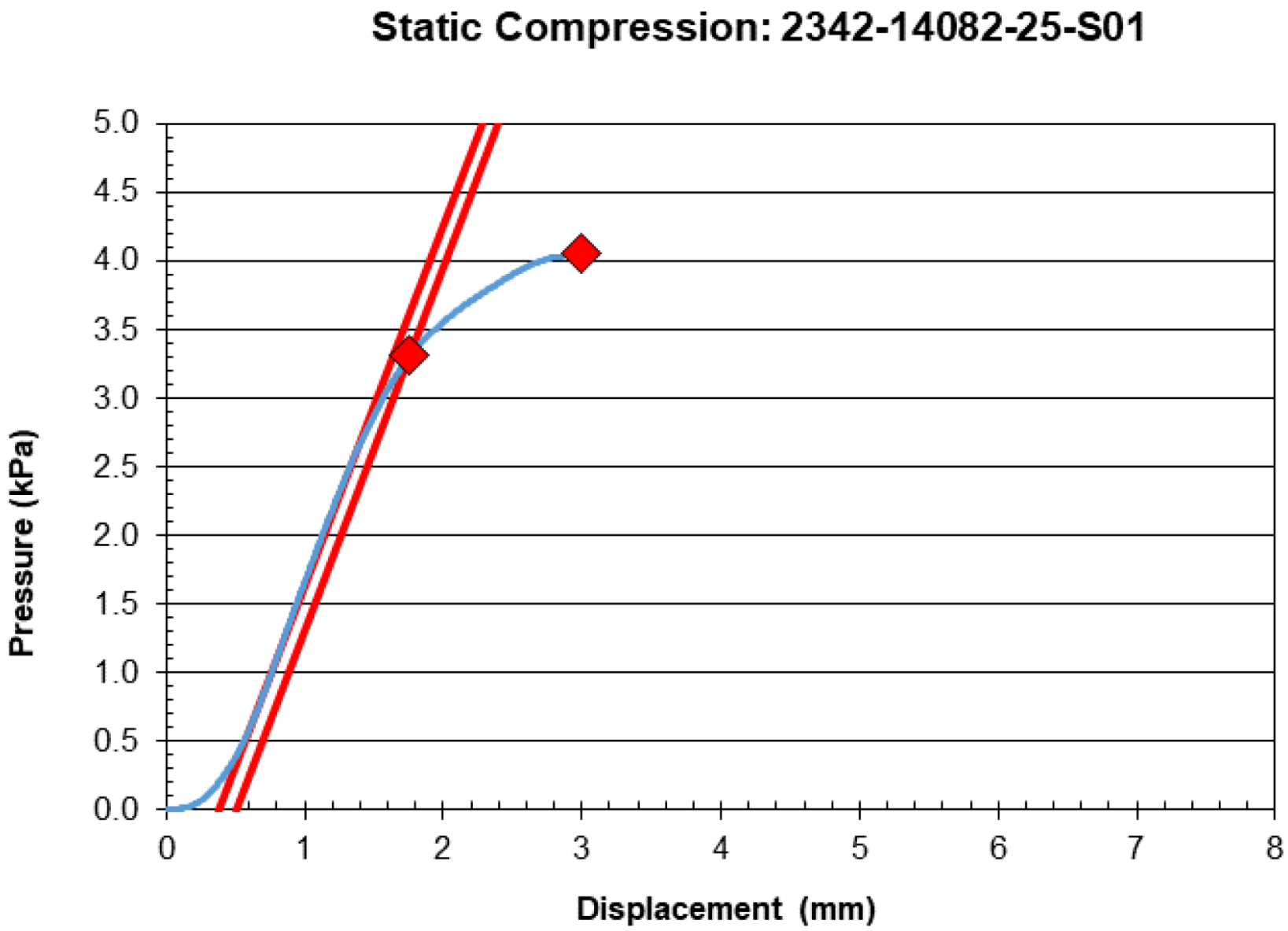


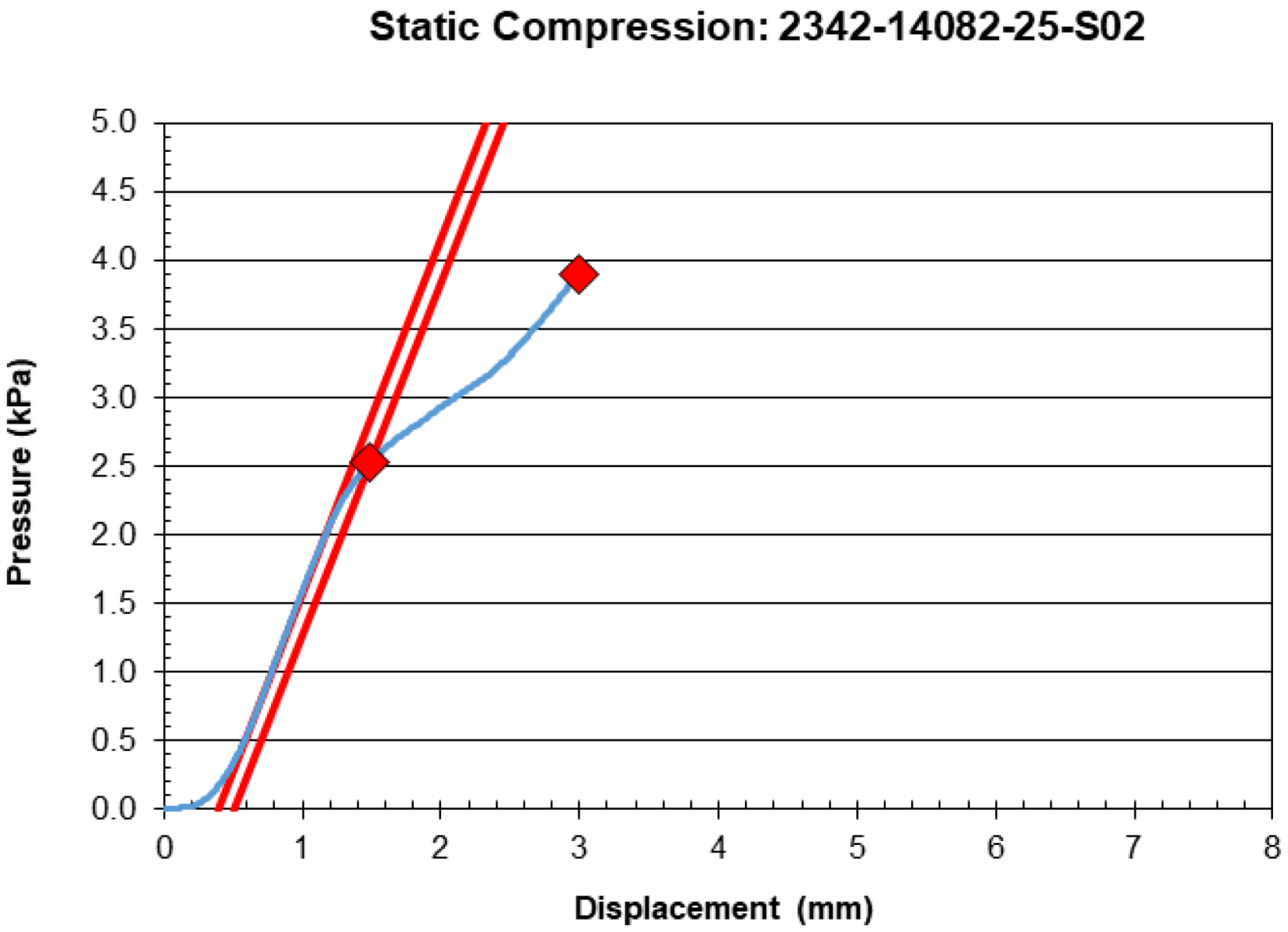
Photo of test setup to measure 30 cm X 30 cm pieces of foam



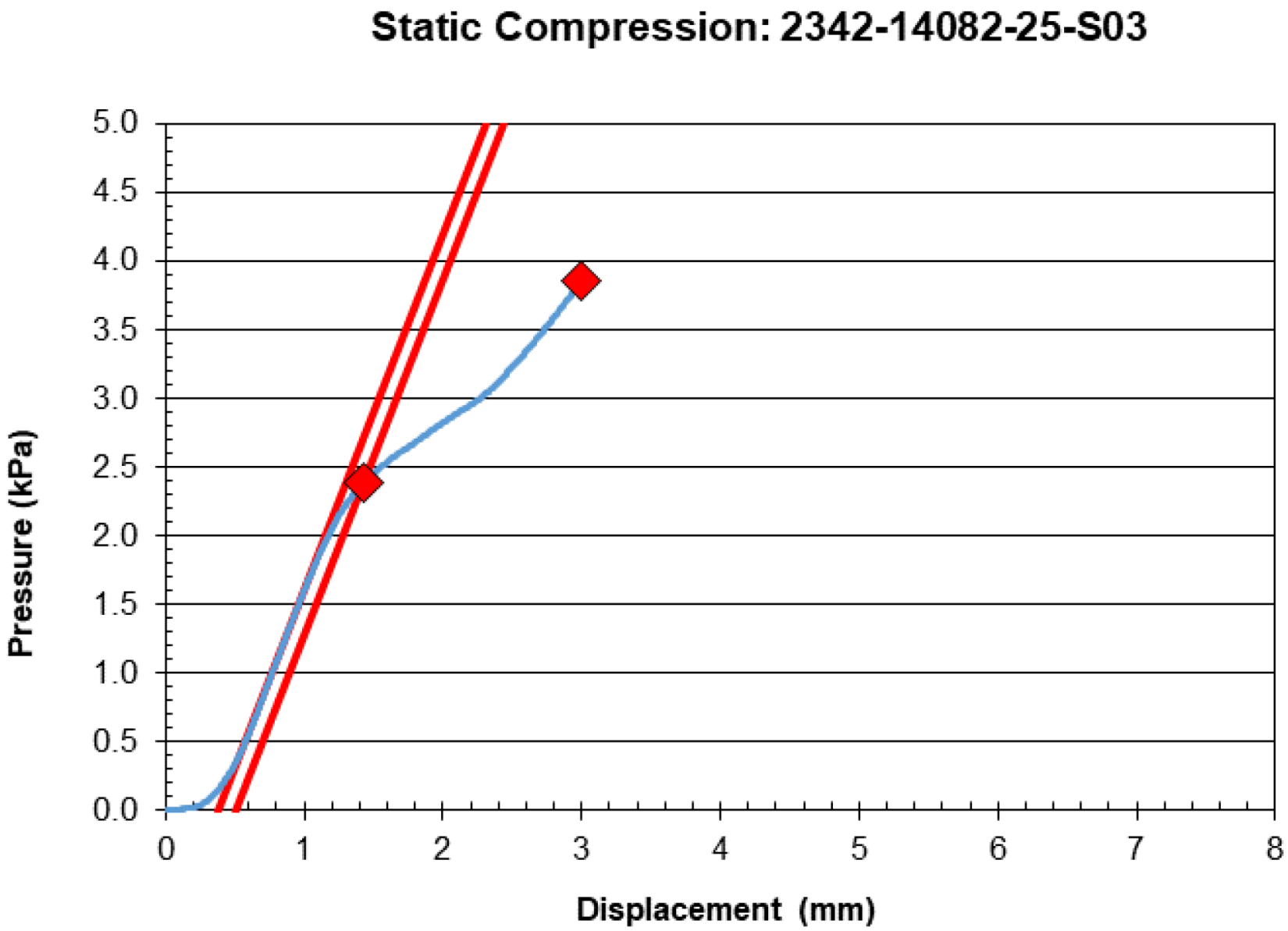
First test result for the .25 inch thick foam



Second test result for .25 inch thick foam



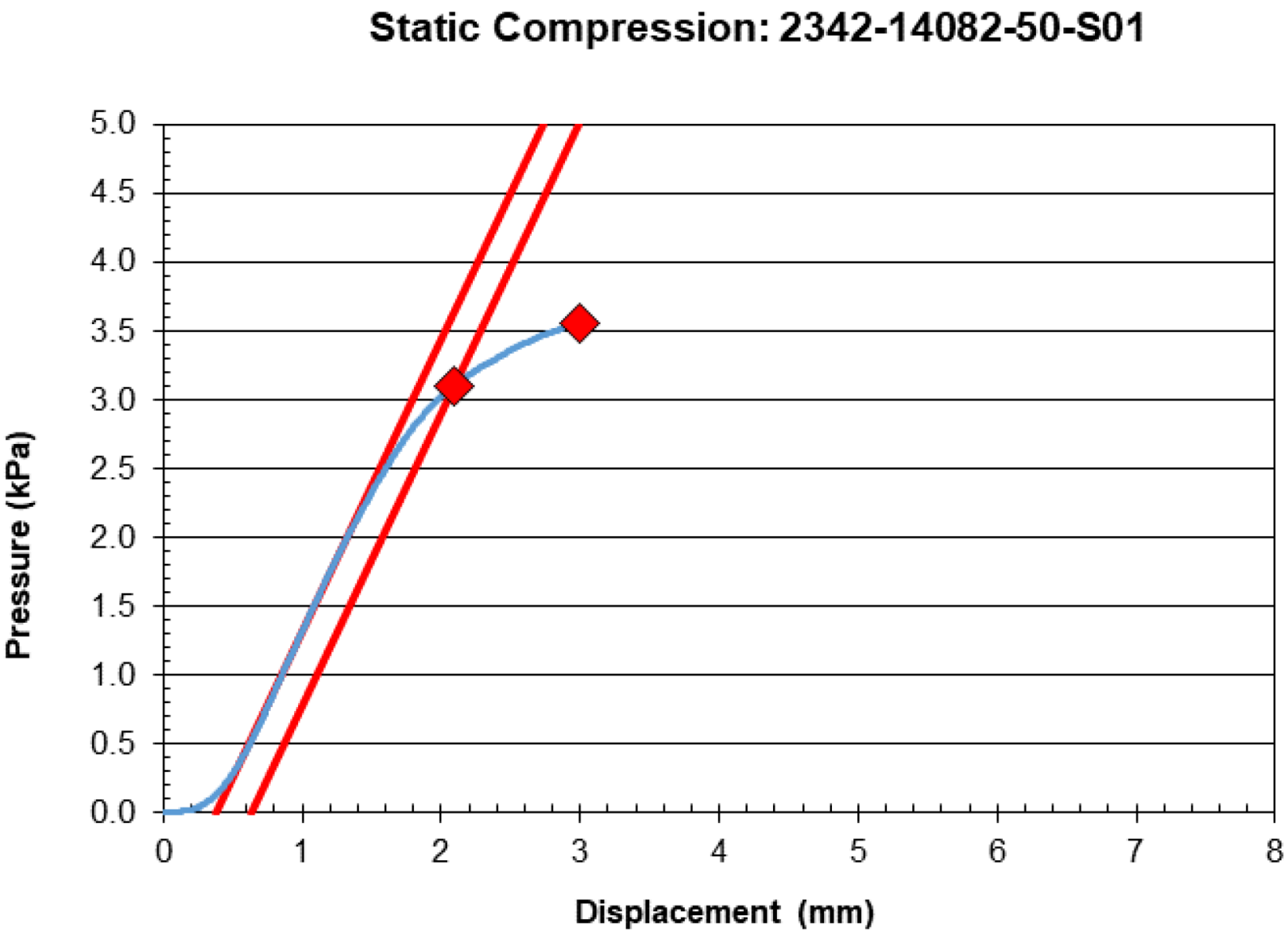
Third test result for .25 inch thick foam



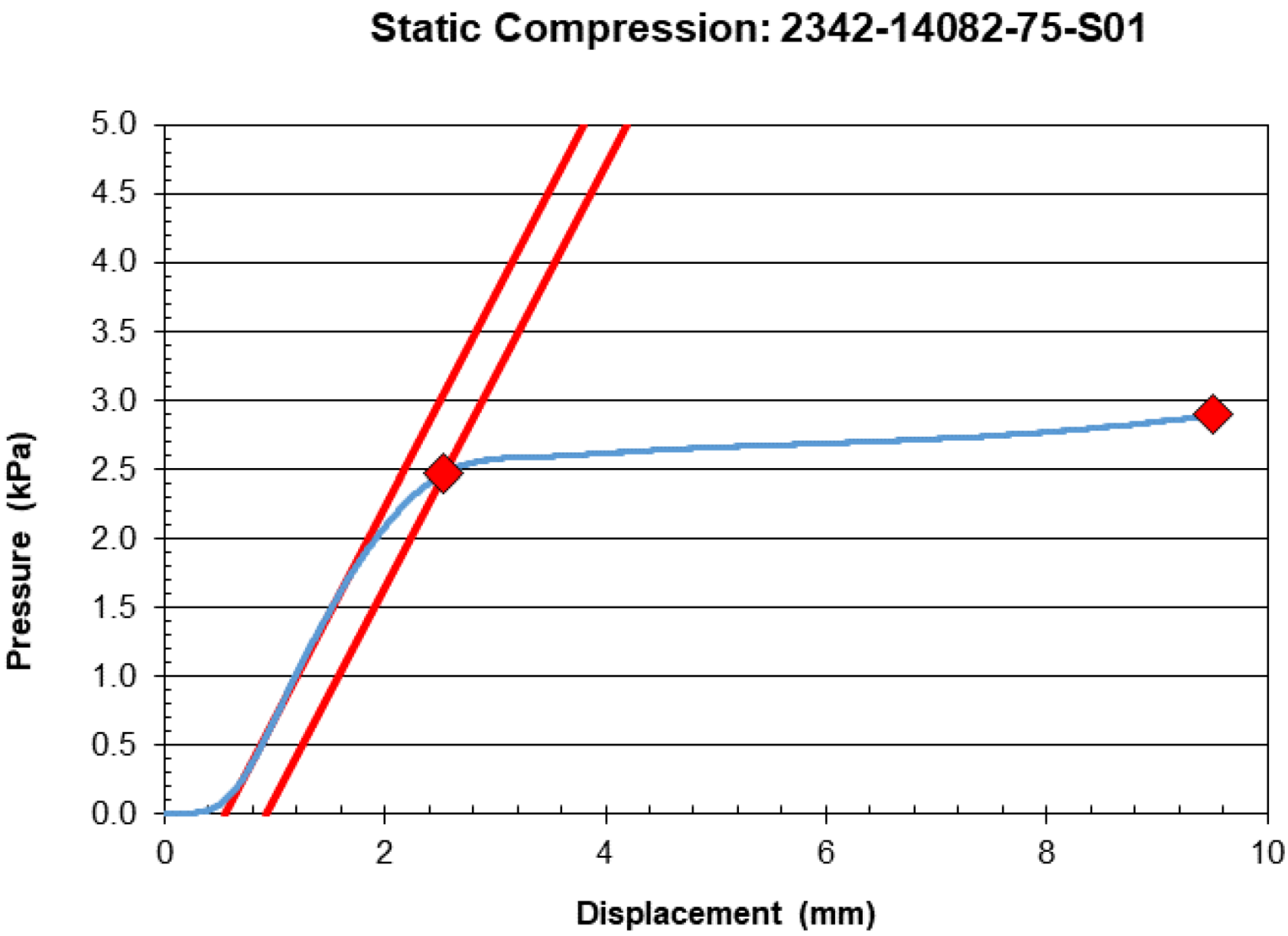
Conclusions from multiple tests

- The foam looks the stiffest the fist time it is tested
- Successive tests taken at least one minute apart show that the foam is weaker after the first compression
  - There is very little difference between the 2nd and 3rd tests
  - I used the first test compression pressure in my load calculations because when we close the box it will look like a first compression of the foam

First test results for .50 inch thick foam



First test result for .75 inch thick foam



Force calculation for the top plate

- The top foam is .75 inches thick and is expected to deflect by 5.9 mm
  - The force required to compress the top plate foam to that deflection is about 10.16 kN, or 2,285 lbs
    - This sounds like a lot, but the weight of the top plate causes the first ~1mm of deflection
  - The 96 M6 bolts that pull the top plate down can exert 374 kN of force, much more than the 10.16 kN required
  - Deflection of the bottom plate and the uneven distribution of the deflection are ignored in this calculation. The assumption is that the entire piece of foam deflects by ~6mm.

Force calculation for the DS plate

- The downstream foam is .50 inches thick and is expected to deflect by .93 mm
  - The force required to deflect this foam by that much is 1.36 kN
  - There are 20 M6 bolts, 10 on each end, pulling this plate into the assembly, which can exert 78 kN of force, 78 kN >> 1.36 kN required
  - See next slide for subtlety of assembly

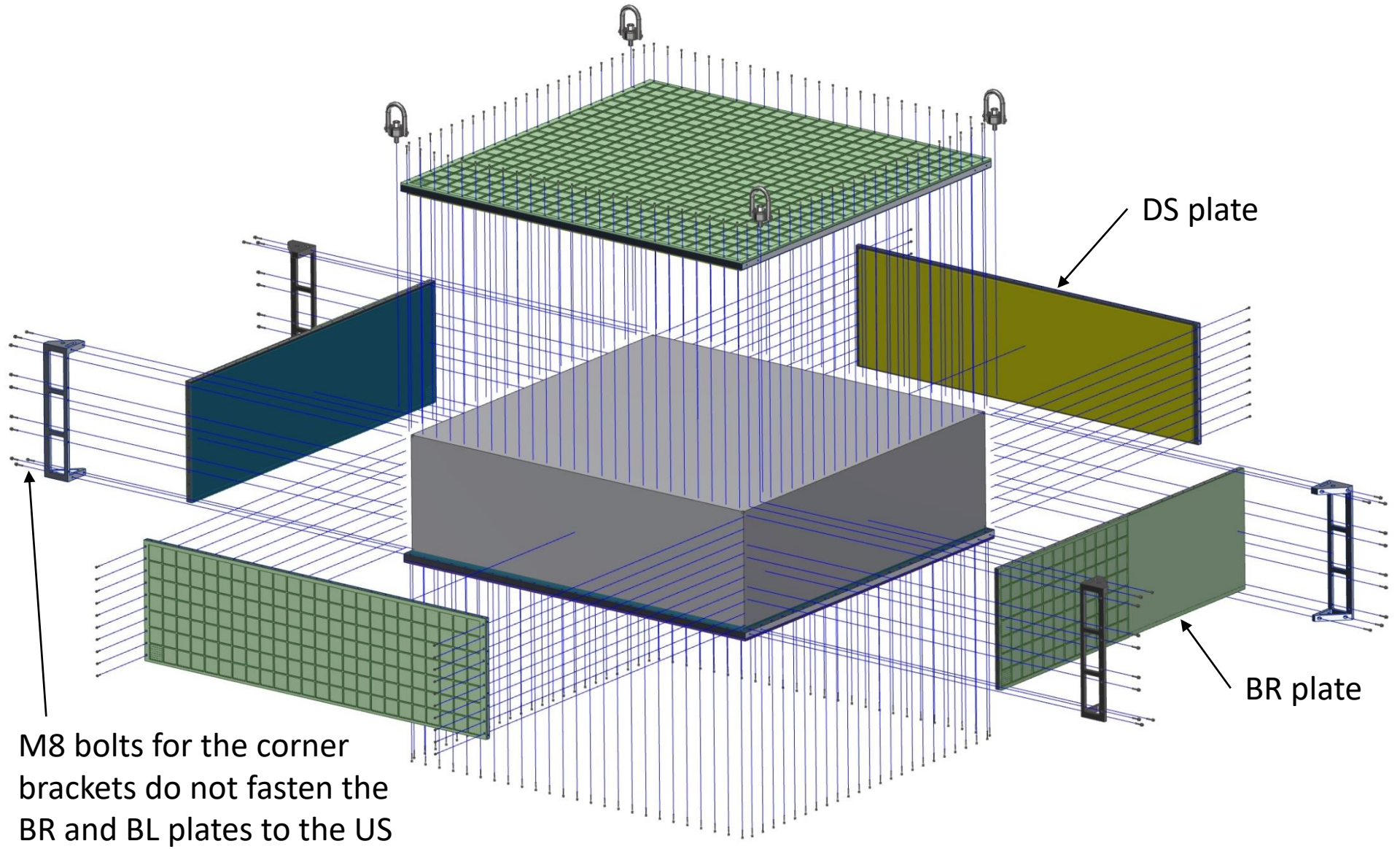
Force Calculation for the BR plate

- The beam right foam is .25 inches thick and expected to deflect by 1.3 mm
  - The force required is 2.69 kN, 605 lbs
  - This is not a large force. 1.4 M6 bolts can apply this.
- There are no bolts perpendicular to this plate that are able to pull the plate into the assembly
  - All of the bolts are in the plane of the plate
- Some form of clamping will be required to pull this plate into place
- The Beam Right and Downstream plates may need to be assembled simultaneously because 10 of the bolts that pull the DS plate in are in the BR plate

Comments on Box Assembly

- The reason we had the foam tested is because our Russian colleagues knew that they had no mechanism in the assembly platform to force the Beam Right or Downstream Plates into place if the foam required a large compression force
- I selected the weakest foam I found and its compression numbers are reasonable
- Even so, additional clamping will be needed to close the corner between the BR and DS plates

Exploded view showing the directions that bolts fasten the box plates



M8 bolts for the corner brackets do not fasten the BR and BL plates to the US and DS plates.

Example of a pipe clamp that could be applied to the box to compress the BR and DS foam

The advantage of this style of clamp is that it can be made as long as necessary by lengthening the pipe connecting the two end pieces.

Conclusion

- I have manufacturing drawings for all of the foam pieces required
- We have a quote from the Foam Factory, and a demonstration that they can cut large arrays of holes
- I am about to test more glues
- I have designed several fixtures to position foam pieces during gluing
  - Who will get these fixtures made? Who will pay?
- I have identified a subtlety with closing the box that will require some additional clamping
- We need to get feedback from our Russian colleagues