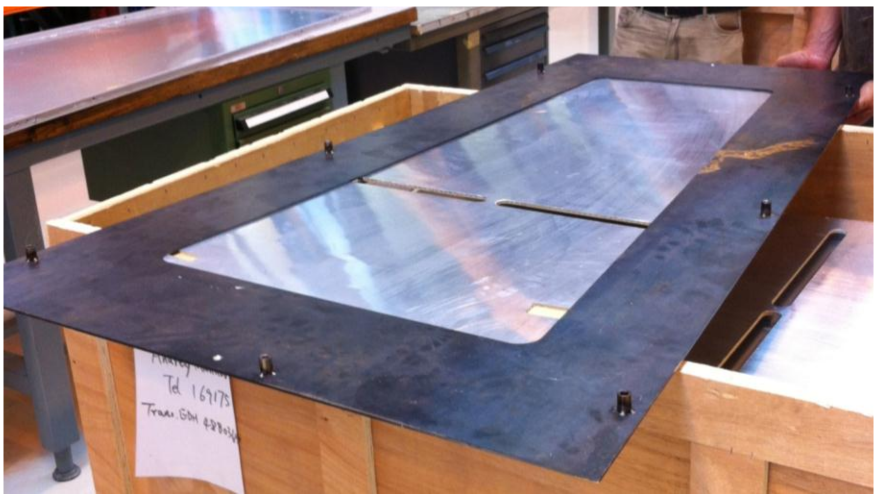
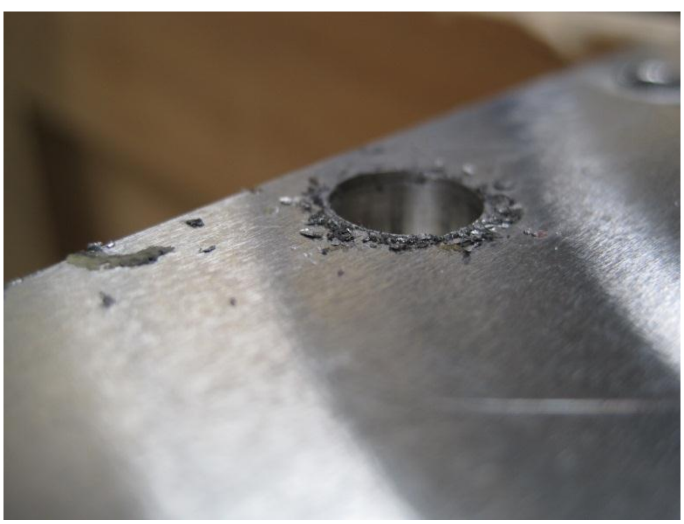
Cleaning up of the RE4 Mechanics.

SM mounting holes.

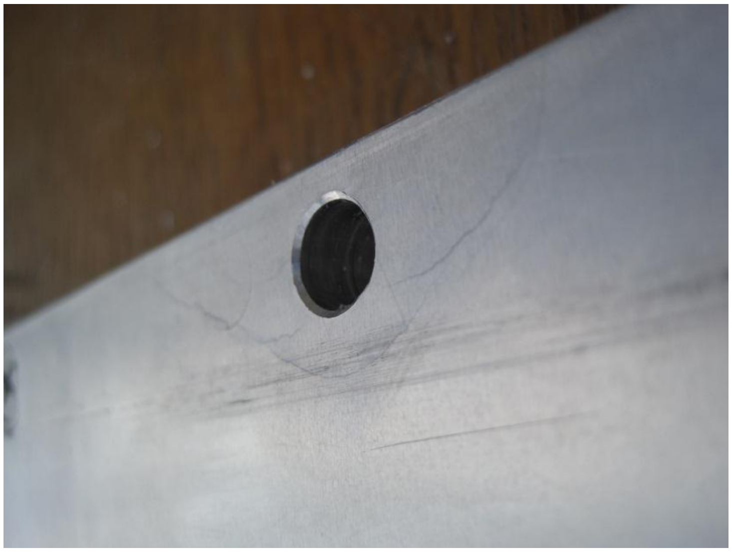
The template as designed by Luc must be used, it must be secured at each end of the HCP by 2 M6 screws. All the 7 holes will be drilled through to 8.5mm diameter.

They will then be deburred and couter sunk as specified in the drawing. The value given is XXmm.





The final results is this

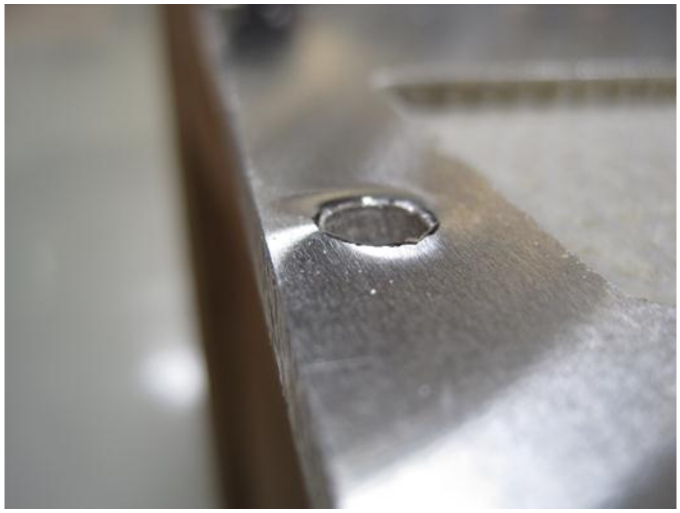


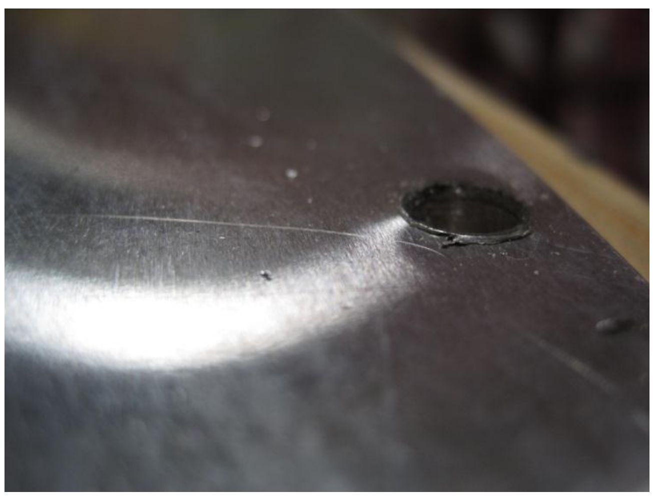
Chamfers on inner face of M6 screw holes

This work will ensure the structural rigidity of the assembled mechanics with the HPL load inside.

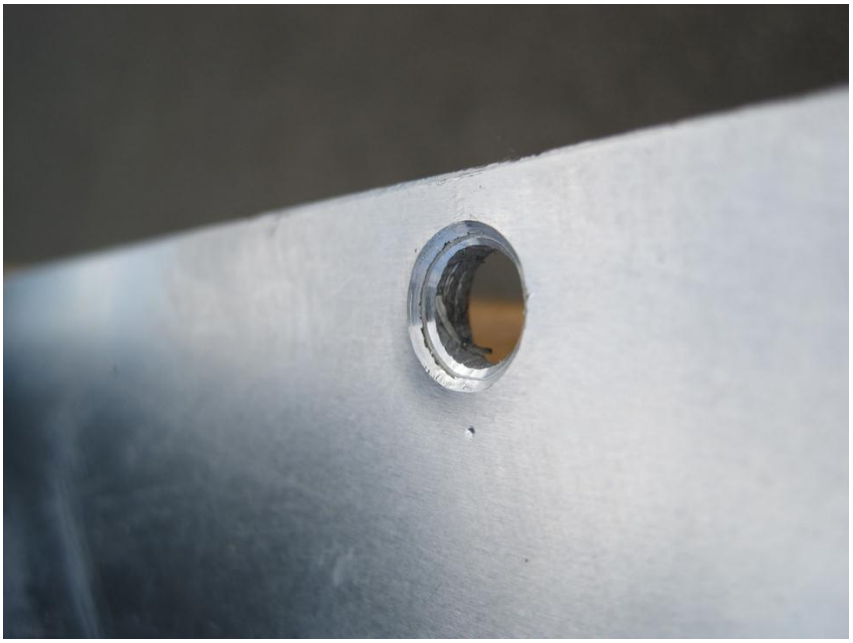
The chamfered holes should be redone with the correct tool that is not clogged with swarf.

A example of delamination while drilling through the panel.





Here the inner skin of the HCP has lifted and will not go back in place as the interstice has been filled with machine chippings/swarf. The increased height must be removed. Firstly the hole is chamberfered down to twice the skin thickness, namely 2mm. This is most easily determined by comparing with the exposed skin. This action does not remove the deformation of the skin and so a second step is the abrasion of the surface as it is quicker and easier than machining leaving more material in place.



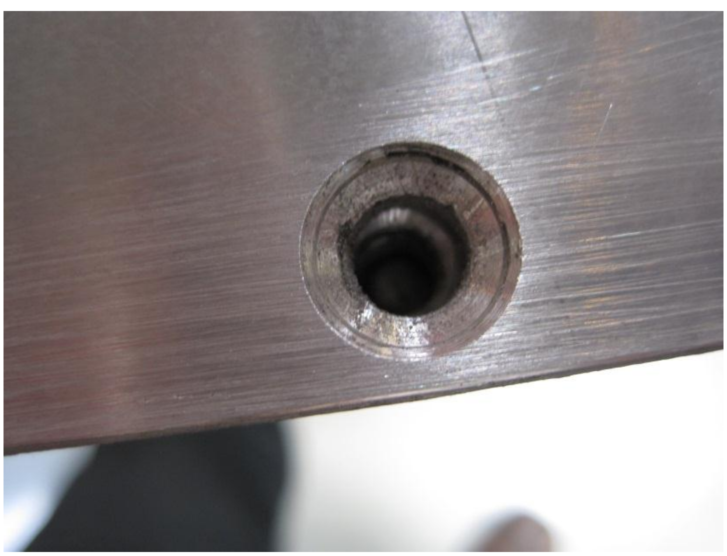
The first step of couter sinking the hole to twice the depth of the HCP skin.

The second step using 80 grade paper and a hard sanding block. Wood blocks are not sufficient. The process is hand driven requiring physical strength.

The result. The surface will be abraded right up to the edge over a radius of approx. 40mm. The ridge must be completely removed as indicated by a uniformly abraded surface.

Counter Sinking Chamfers on outer face

These Counter sunk M6 holes are mostly sufficient for the purpose of lowering the head to be flush with the HCP outer surface. A quick going over with the 80 grade paper and the hard (Metal or plastic) block to remove any sharp edges is sufficient.



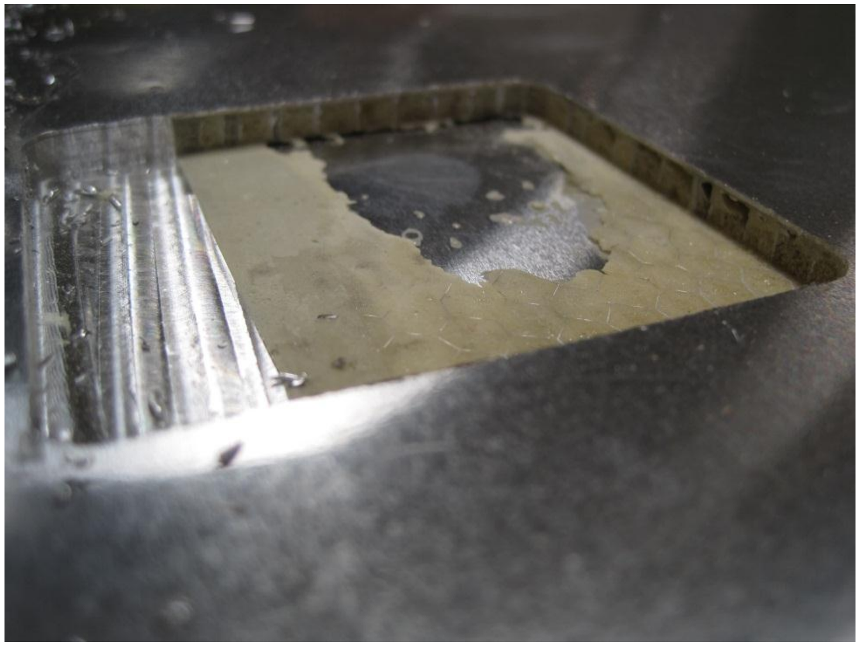
The Philips/cross head screws that come with the chamber are inappropriate to a for a high torque screw load (10Nm). The female hex head screw will ensure more rapid and easier chamber assembly.

A perfect case

An insufficiently sunk head but the work necessary to correct this is too great, so 1mm of the head beyond the surface is considered as a pass.

Chamfer on access slots, for gas and HV

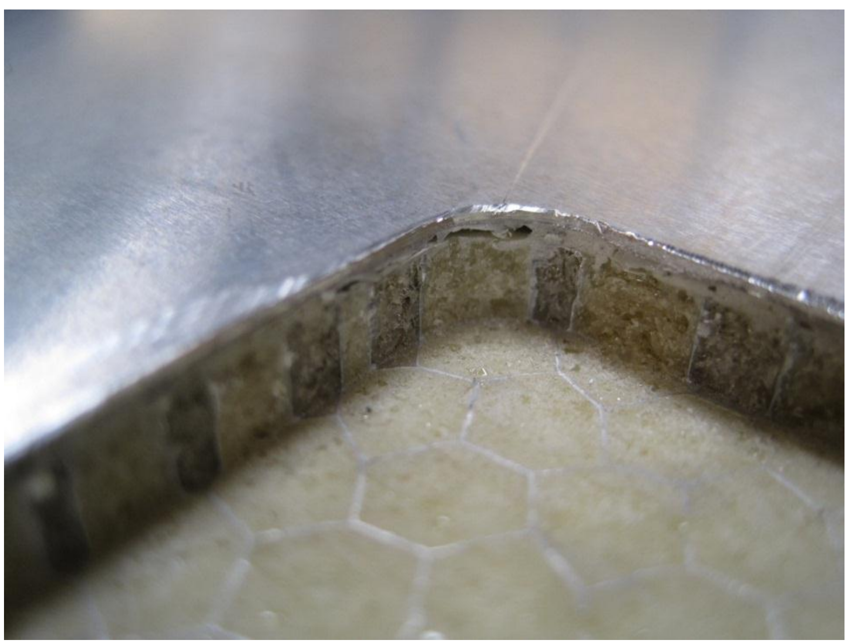
Here the slot is as cut direct from the machine



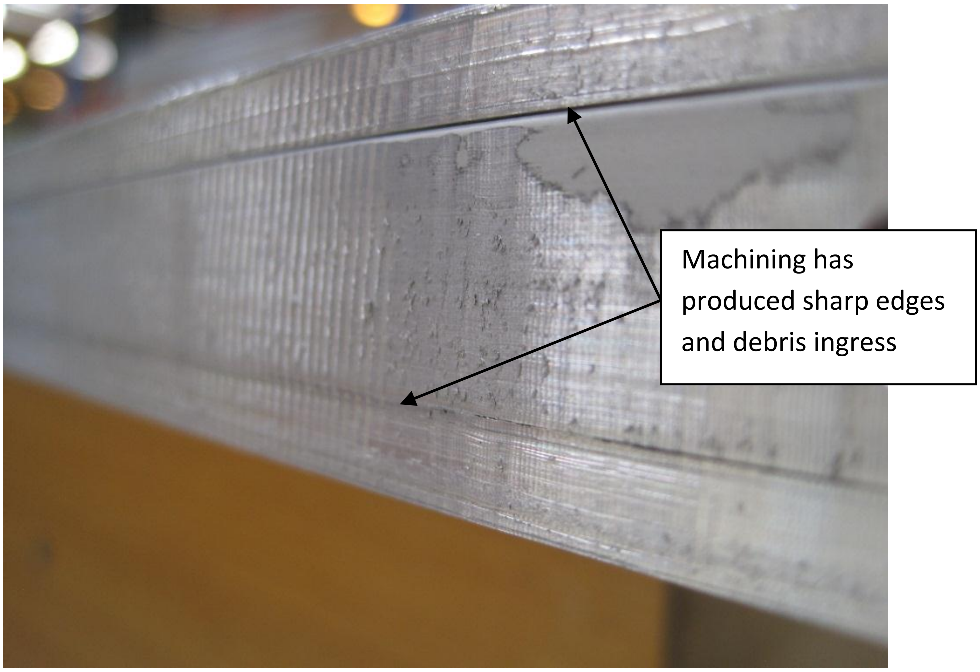
Below is an example of what will compromise the HV insulation and put pressure on the gap.

The chamfering is difficult to do correctly by hand but as shown below is sufficient.

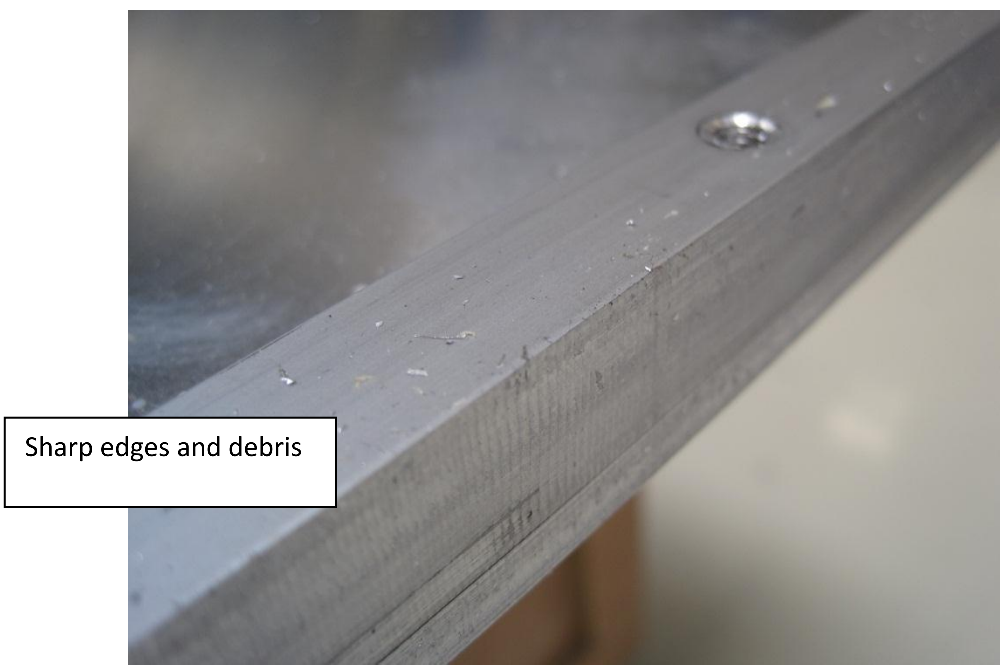
Here , below the chamfering is only just sufficient.



Inner edges of bars & HCP that have been machined.

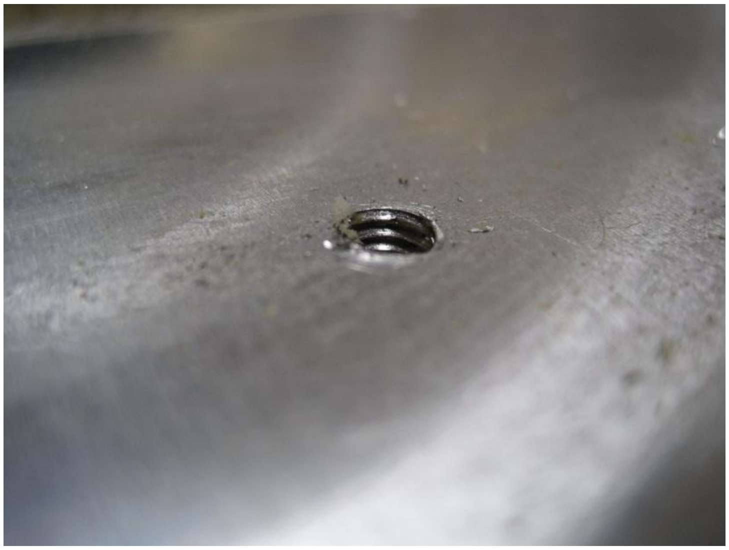


Machining carried out in the ISR.



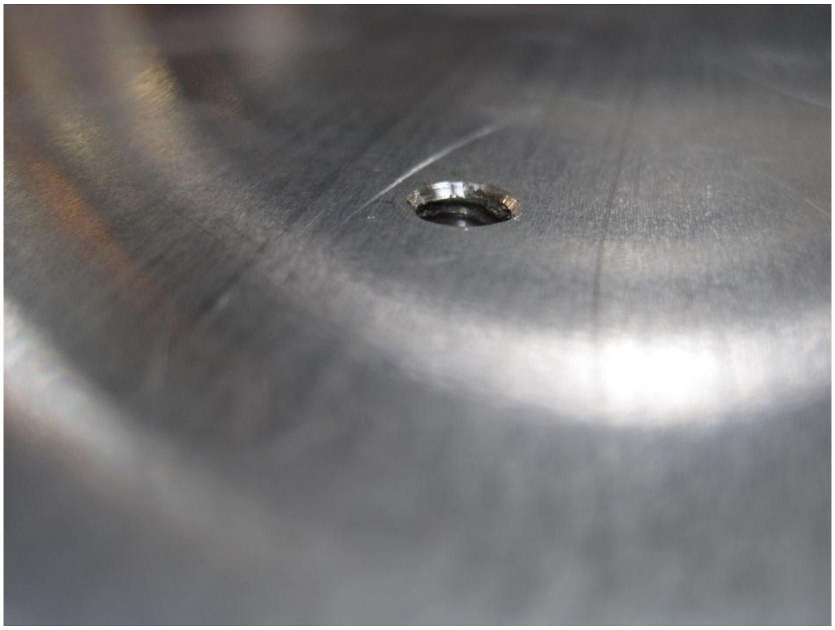
These damaged edges are to be removed so that the HCPs and panel will mate properly, this will be done with a band sander and 80 grade abrasive paper.

Threaded M5 holes on inner face, missing threads and chamfers



A sharp counter sink tool tool be used to remove the excess material

Producing a clean cut as seen below

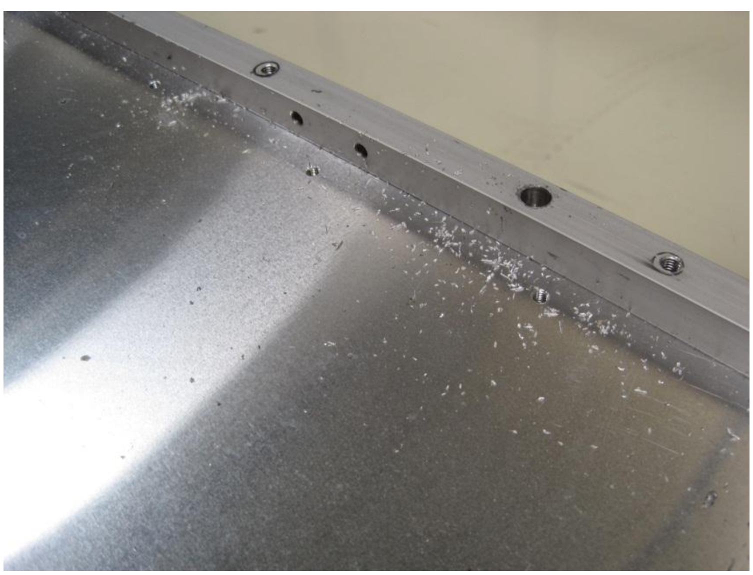


Although the appearance is very good , abrasive paper is used to remove the slightest burr

A perfect finish

Cleaning debris and degreasing

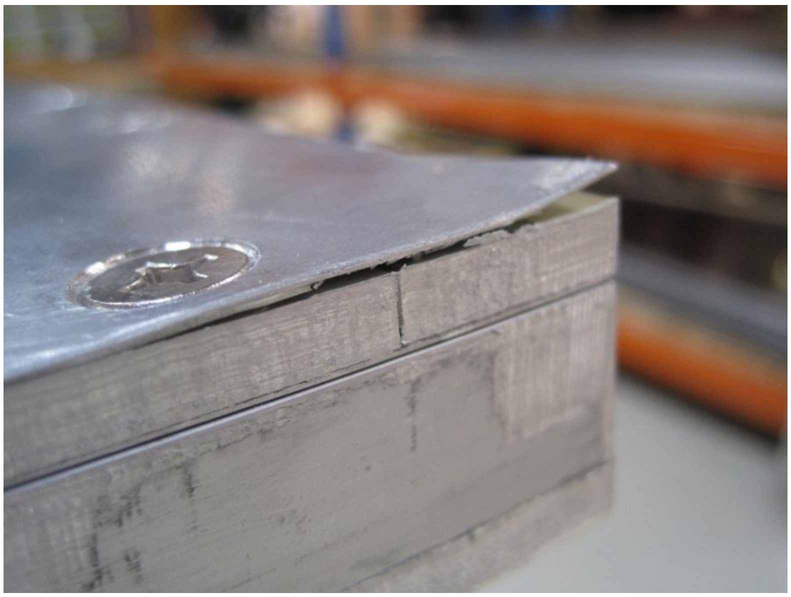
There is plenty of metallic debris in all chamber mechanics so far opened. This is associated with grease based smears , presumably from some cutting oil used during the drilling. All these products must be removed with a degreaser, whether hydro carbon based(Line 61 in the Chamber component list) or water (eg Typol, see the component list line number 60). Final cleaning is with IPA, clearly done after all the other corrective measures. A vacuum cleaner or compressed air can be used ONLY once all elements have been dissociated to avoid forcing debis into holes and interstices. Compressed air is dangerous and those involved should be informed and protected.

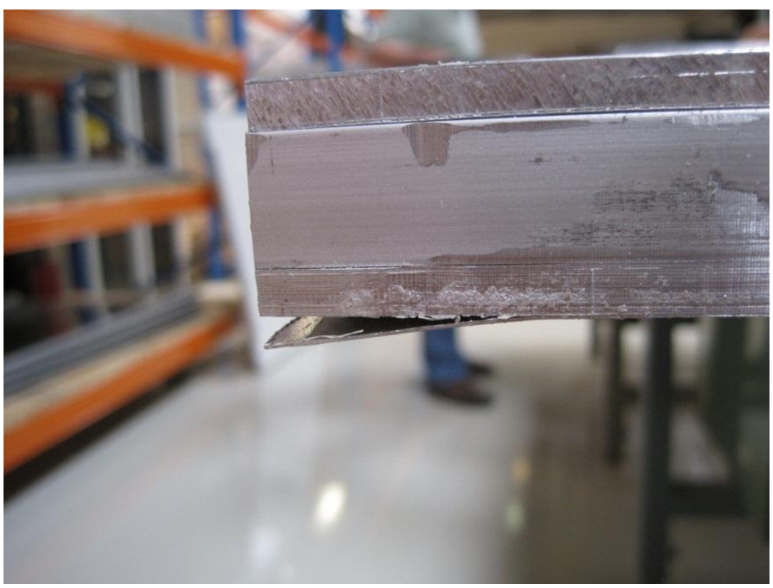


This work without the 8.5mm holes may occupy 2 people for 2hrs/chamber.

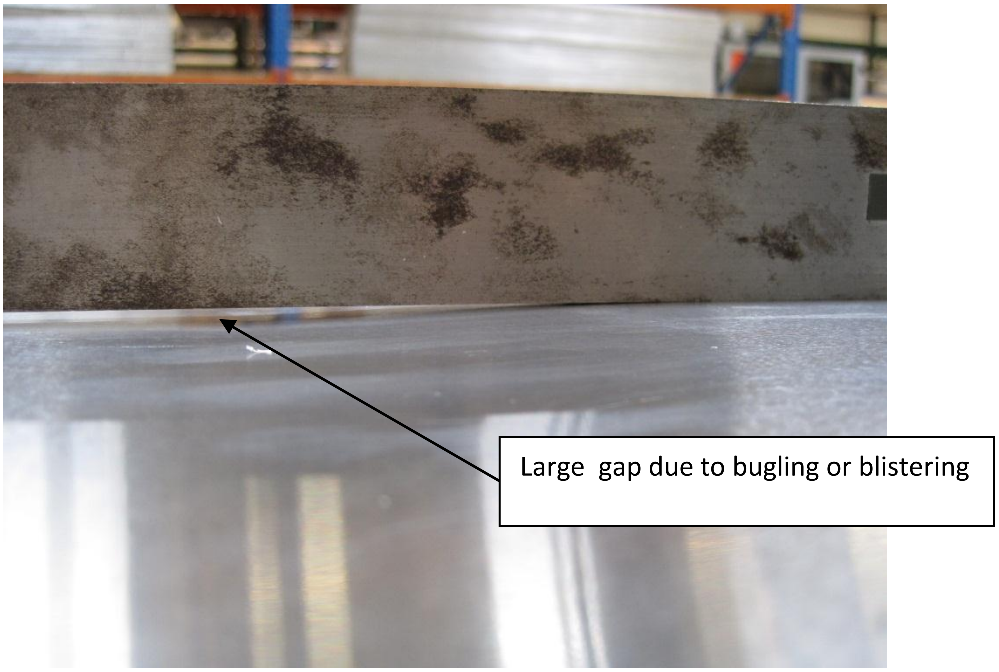
Recent faults, delamination with bulging

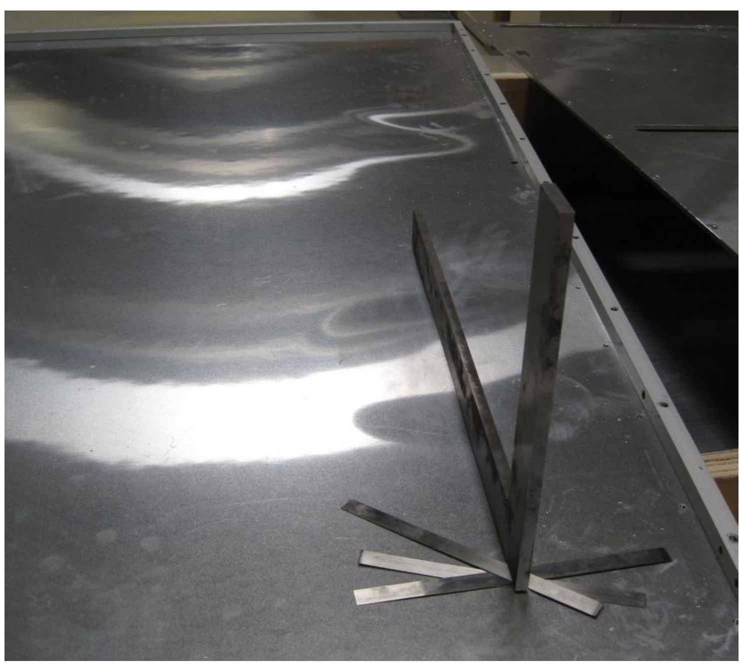
Recent faults, delamination. On the edges/corners perhaps aggrovated by handling methods involving dragging across the bench/support. Other failures recently identified are bulging. The amplitude is significant wrt the s[pace inside the mechanics for the gaps, namely 1.5mm in a number of locations on the inner faces of the HCPs. The number of affected mechanics will be known once all the retrofitting has been carried out.

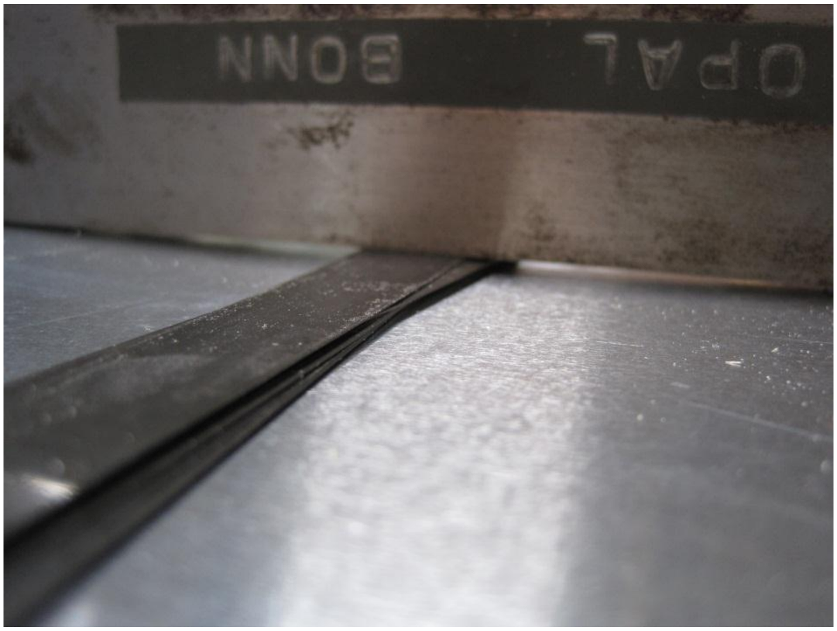




Delamination due to insufficient bonding as a result of lack of glue.





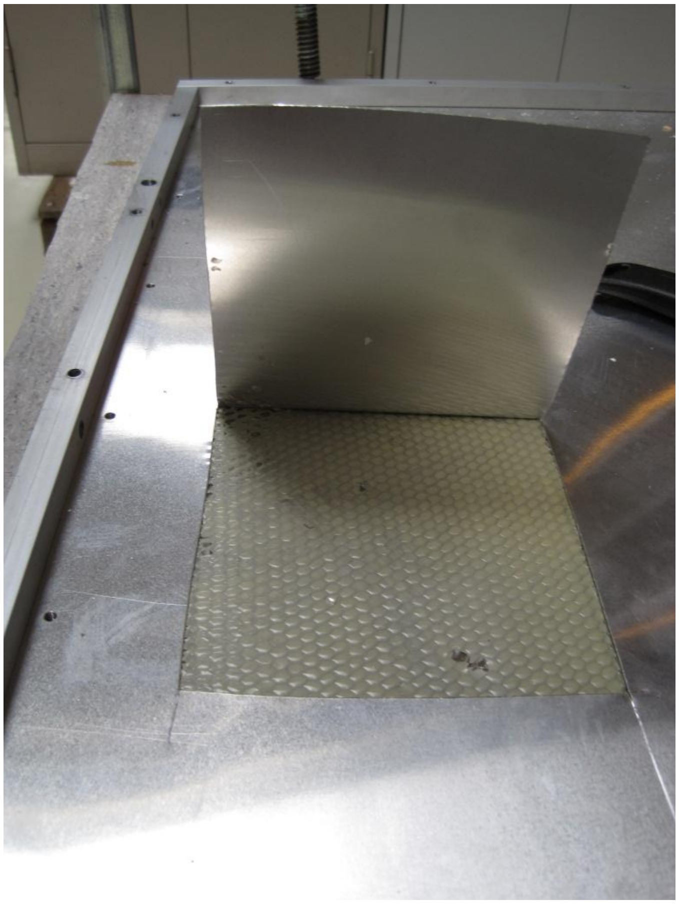


These panels should be rejected.

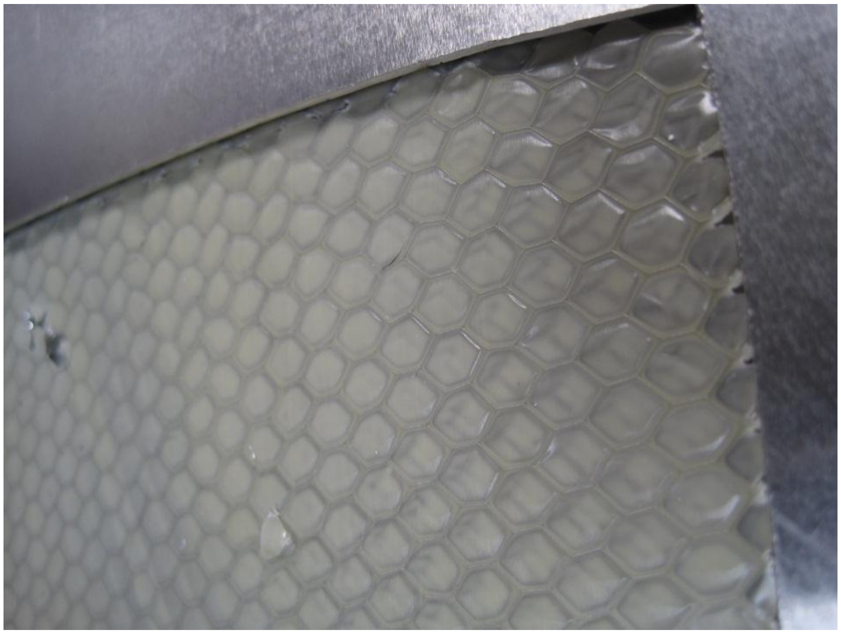
Recovery of this problem is perhaps possible but would involve drilling numerous holes in the skin, injecting an epoxy and pressing with a vacuum bag technic, as the panel sizes involved are serious. Care and an empirical approach would be needed to remove excess injected glue. Lets hope that this fault is not time dependant, meaning these errors will not appear in the future !

Investigation of the blisters found in XX/20 chambers opened.

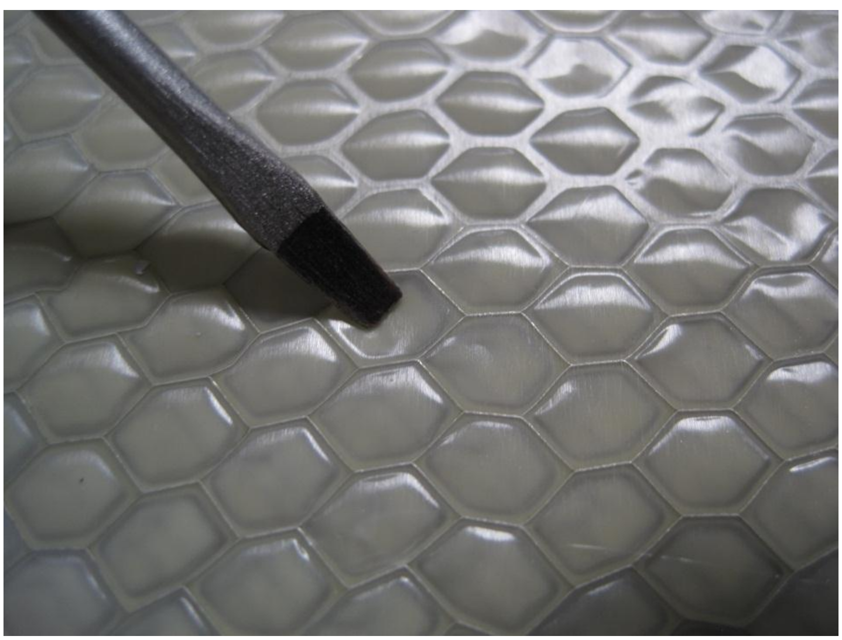
Opening of one panel with the worst case so far found (1.5mm) over an area some 300mm across.



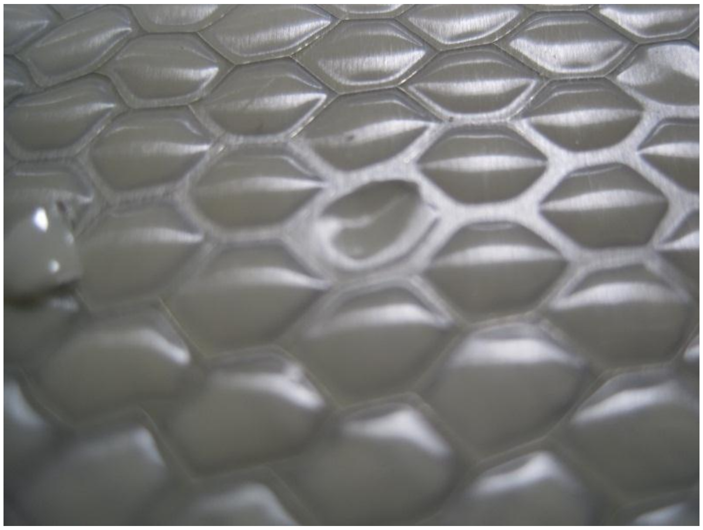
There is no indication of bonding in any of the exposed area.



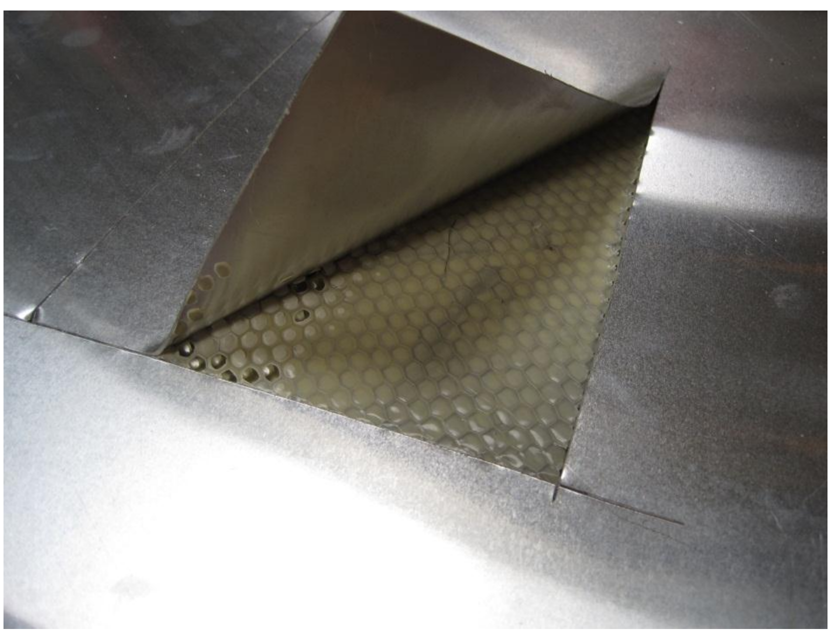
Below indications of an over pressure wrt atmosphere here at CERN. The fabrication was probably done at a lower altitude.



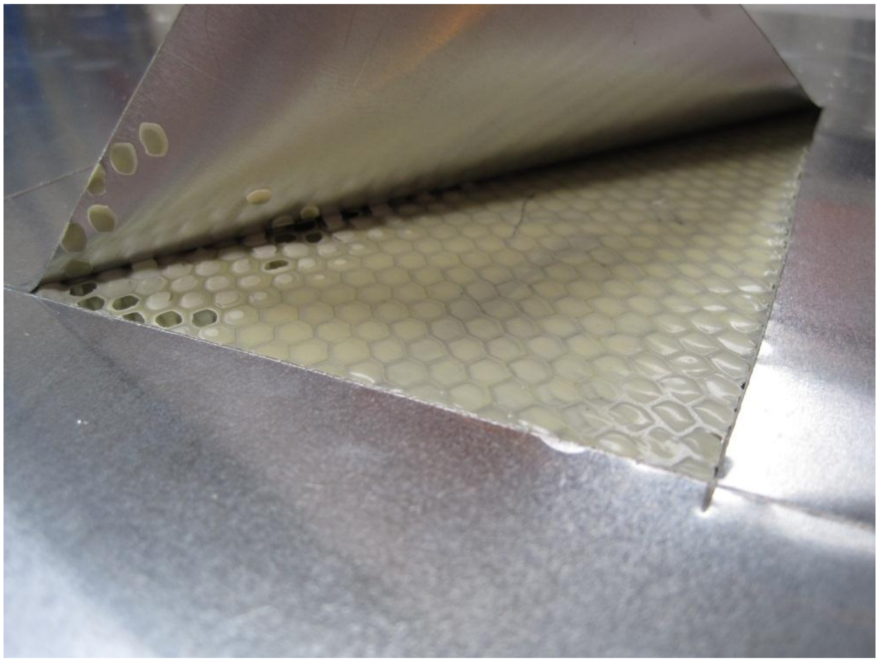
If the adhesive skin is punctured the surface is no longer elastic



For comparision an area of what appeared to be flat and well bonded skin was cut opened on the same panel.

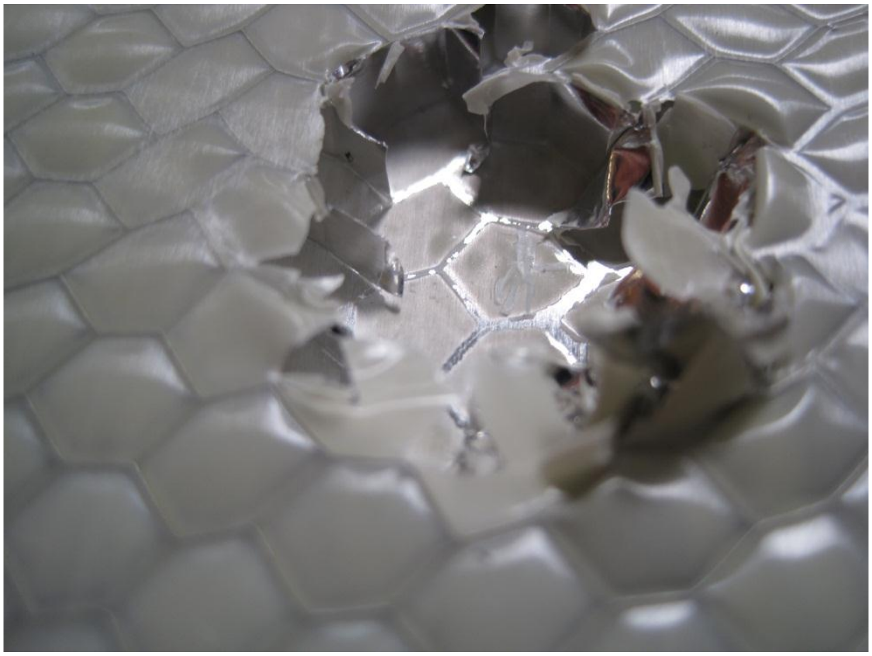


It is of concern that what should be bonded is not only over a smaller area. The bonded area is indicated by the torn open cells.



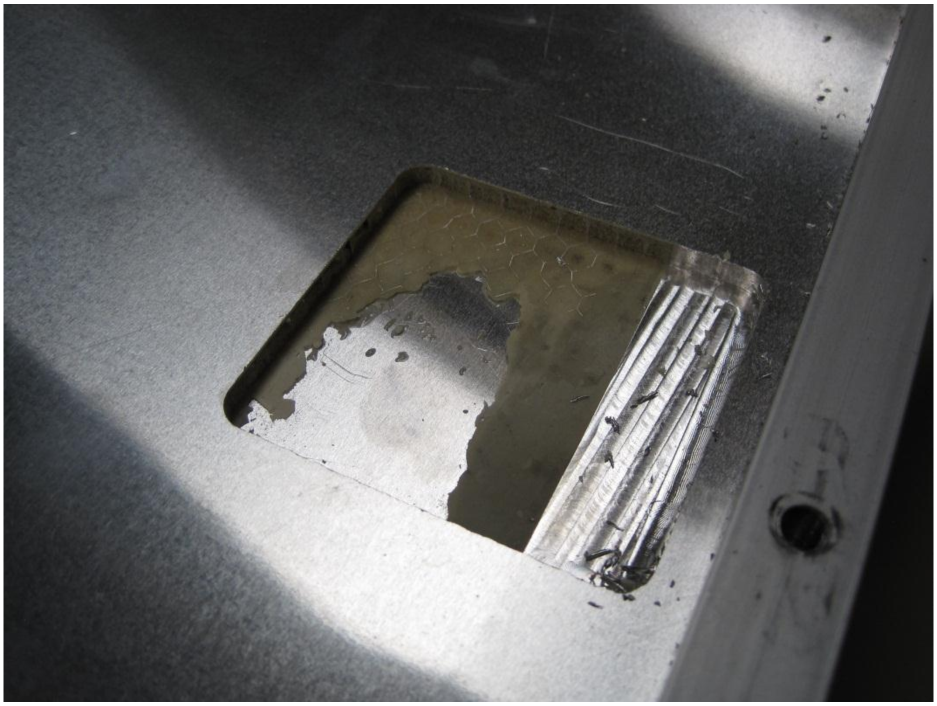
It is clear that the adhesive , after opening , is not attached over the full area of the cell, this may be due to over pressure inside the cell or partial failure of the alu/adhesive interface. Insufficient pressure during the full cure time of the adhesive may also produce such faults, namely incomplete bond area.

Going back to the fully unbonded area , on the opposite face, under the opened one, the bond is good over the entire surface, negating the previous argument.



Scatching removes the glue with some difficulty

Other nonbonded areas are to be found around the cut-out slots as shown. This could be argued as coming from the pressure exerted during the machining.

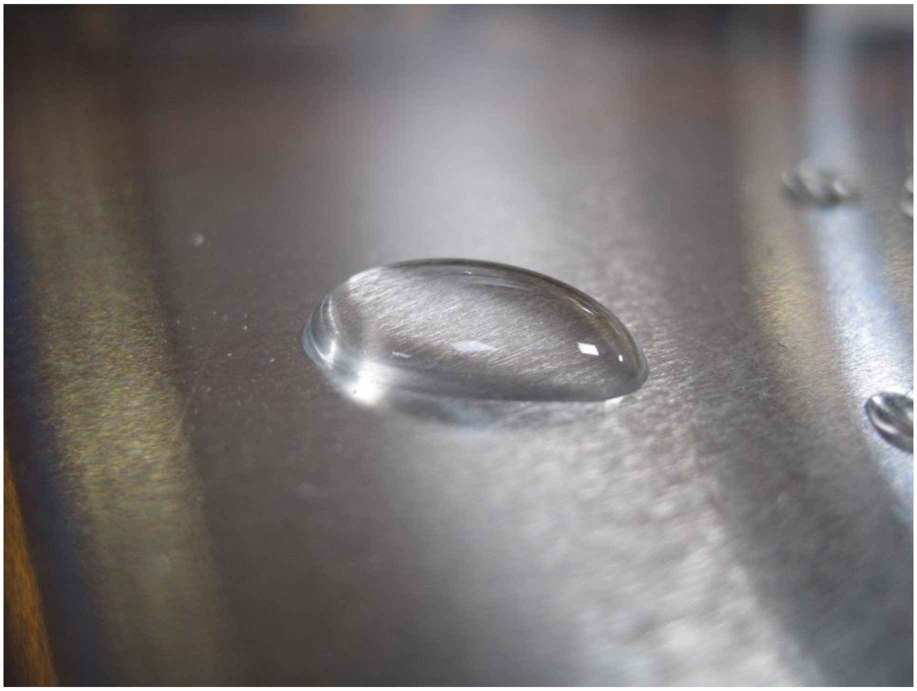


Here in the centre there are indications of a good bond but a thick layer of adhesive, poor pressure application ?

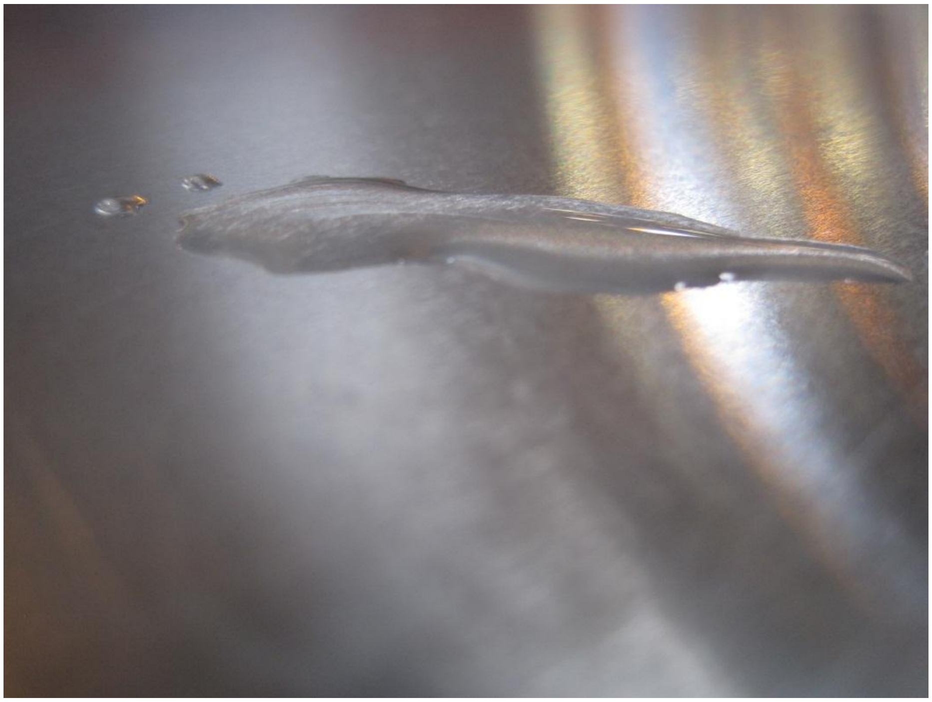
Had the surfaces been prepared for bonding ?

Using drops of distilled water as an indication of the surface energy and thus the preparation.

Water on the outer surface of the panel, illustrating a high contact angle.

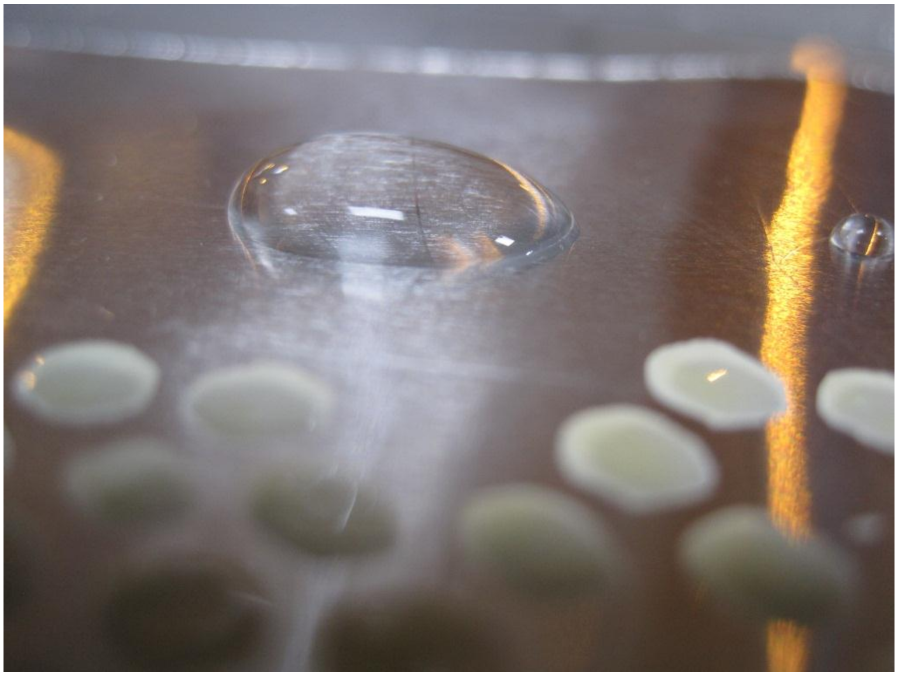


Cleaning with soft paper and alcohol already improves the surface by increasing it's energy

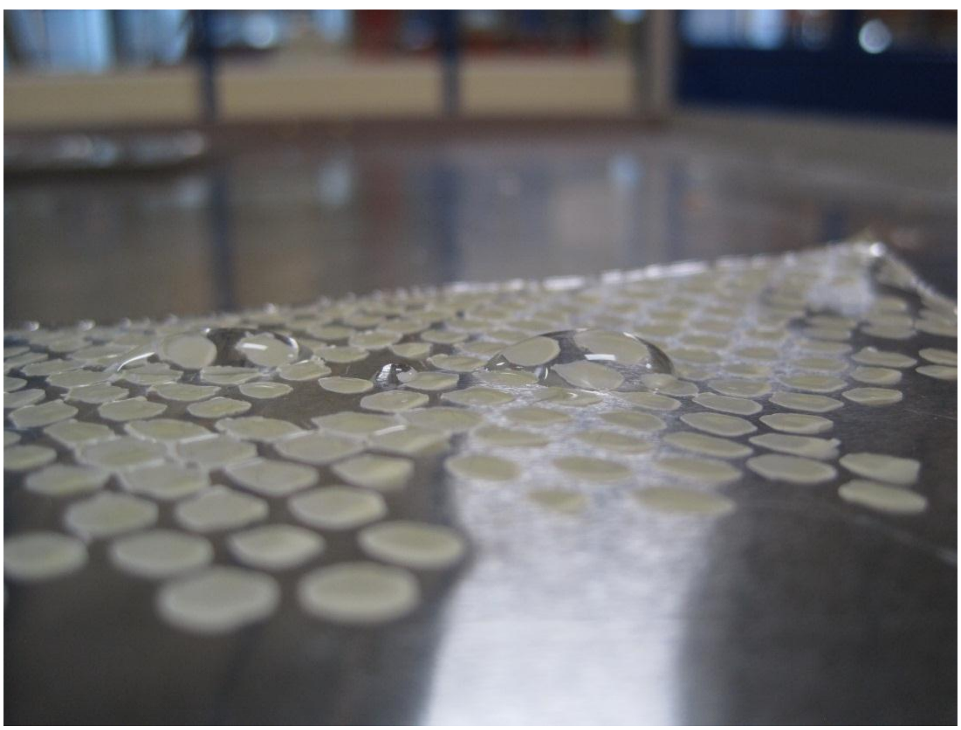


Further cleaning with abrasive paper and alcohol improve further the adherance

Next to the bonded area the contact angles are similar to the untouched outside surface indicating minimal surface preparation.



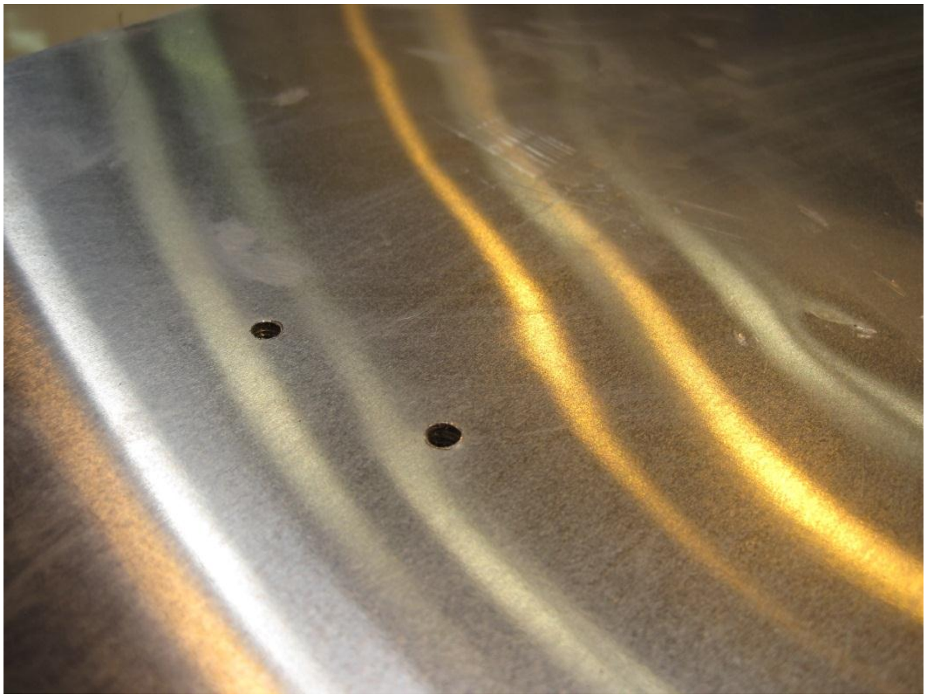
That is similar to the bonded area, so here is also minimal preparation.



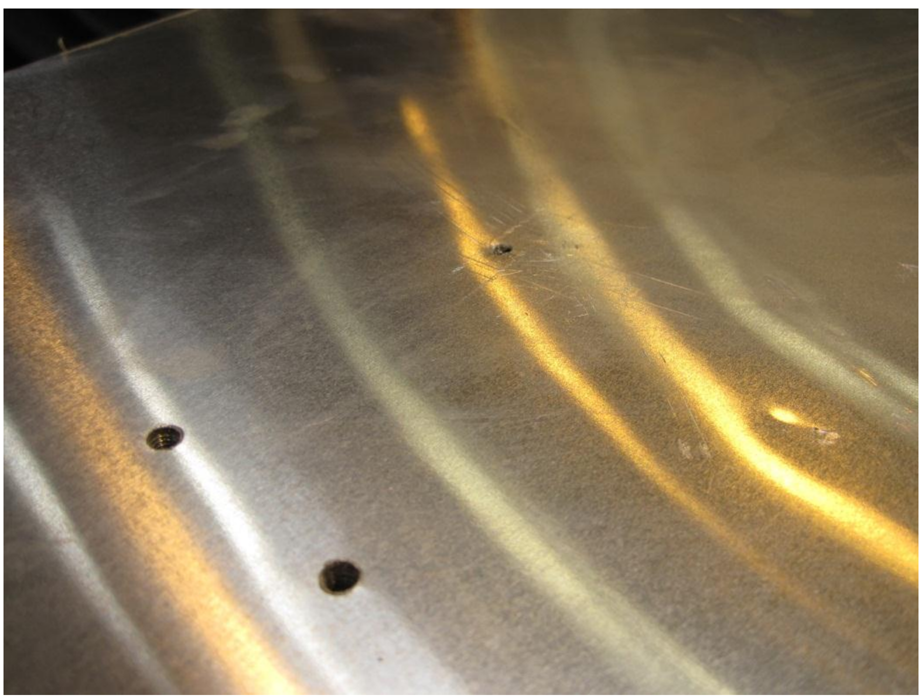
A possible partial solution to blistering.

Numerous holes were drilled in approx. 5 blisters and in almost all the blister could be made to collapse.

Here is a relatively small example, The yellow reflection gives some idea of the deformed area, before;



And after;



Larger blister have been drilled with good results.

There are questions to be addressed;

What is the long term bond strength in the remaing areas ?

While other areas out-gas as is probably the case in the present blistering ?

Ian Crotty   6 August 2012

Many thanks to Igor and Herve who have performed the corrective work so far.