The University Of Sheffield.

LECCE MEETING PIXEL OEC GM & I MAY 2024

WELDING OEC INTEGRATION

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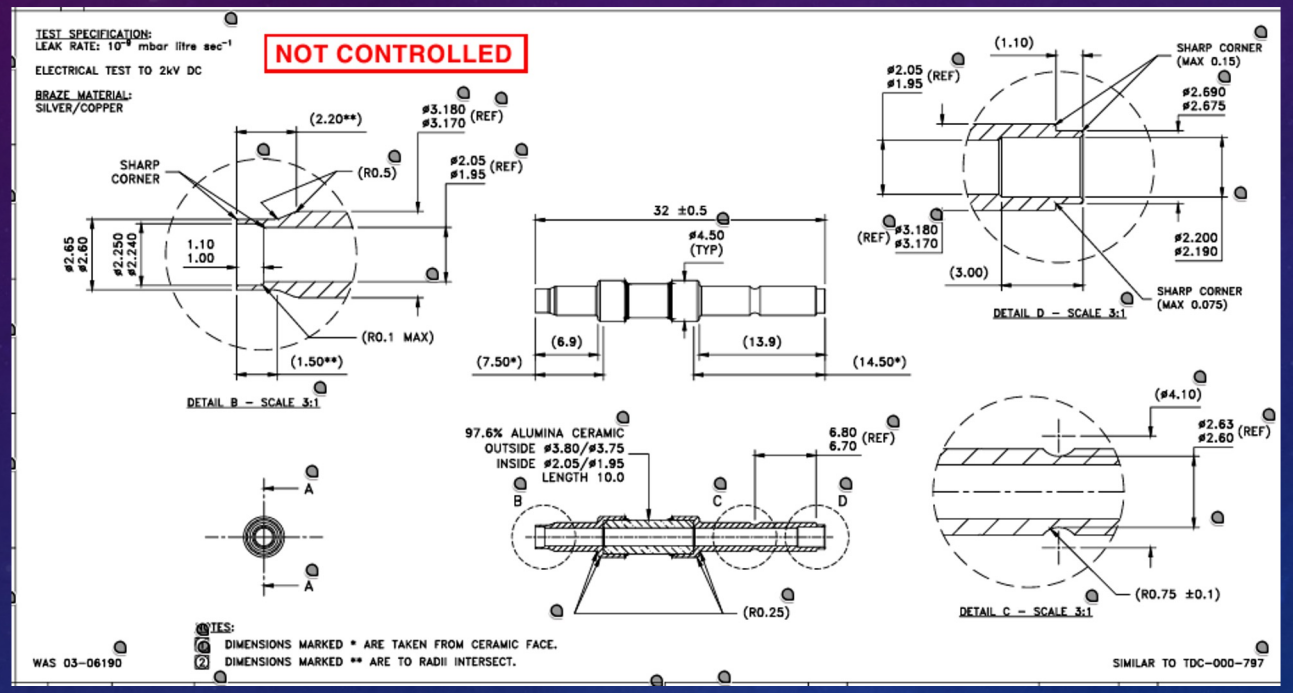
WELDING in OEC integration

1. Introduction: Overview of parts and assembly
2. Integration welding: Description & procedure
3. Repair solution: Description & validation
4. Fred fittings: Description and use

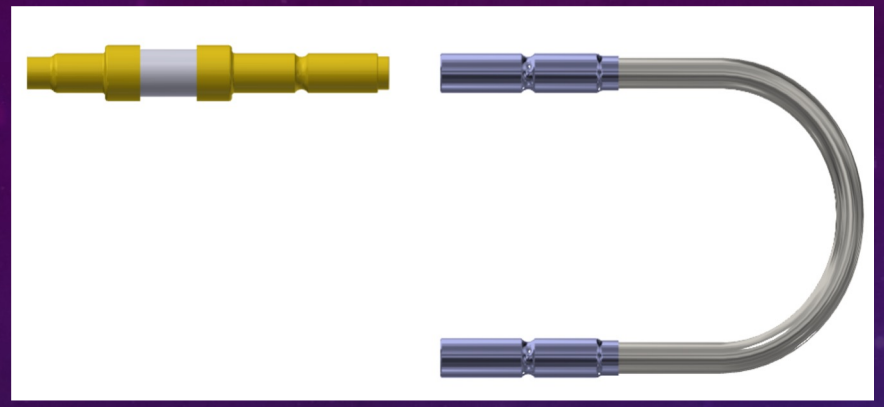
1. INTRODUCTION: Description of of parts and procedure

- During Pixel outer end cap (OEC) Integration we need to join the fully populated and mounted half ring assemblies on the half shell to the incoming/outgoing services by means of orbital welding
- Extensive R&D work has been undertaken to ensure we use the most reliable and robust welded joints at this stage

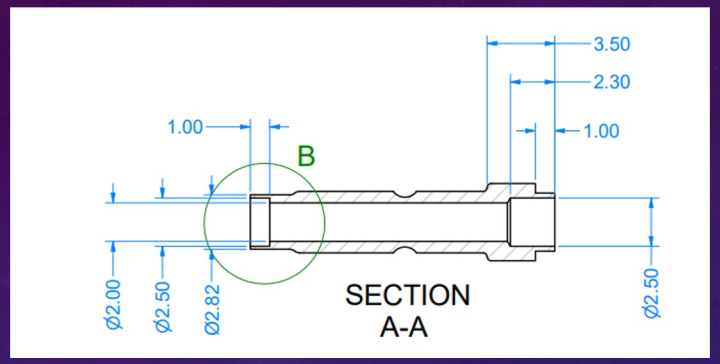


- Designs have been modified over the course of the last couple of years to the electrical break (EB) above which terminates both sides of the HR cooling rings, and its connections to the outside world

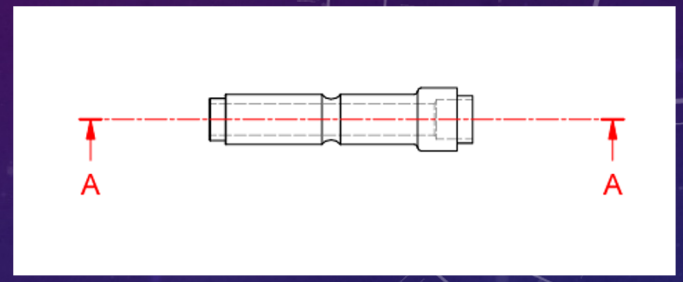
- This initiated a change to the exhaust system connection, via a U-bend assembly which itself joins to the larger Exhausts at 4mm & 5mm with another transitional fitting



Exhaust/U-bend assembly

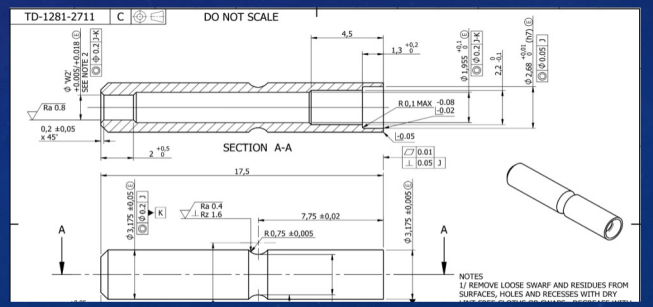


Older transition (Sleeve (B)

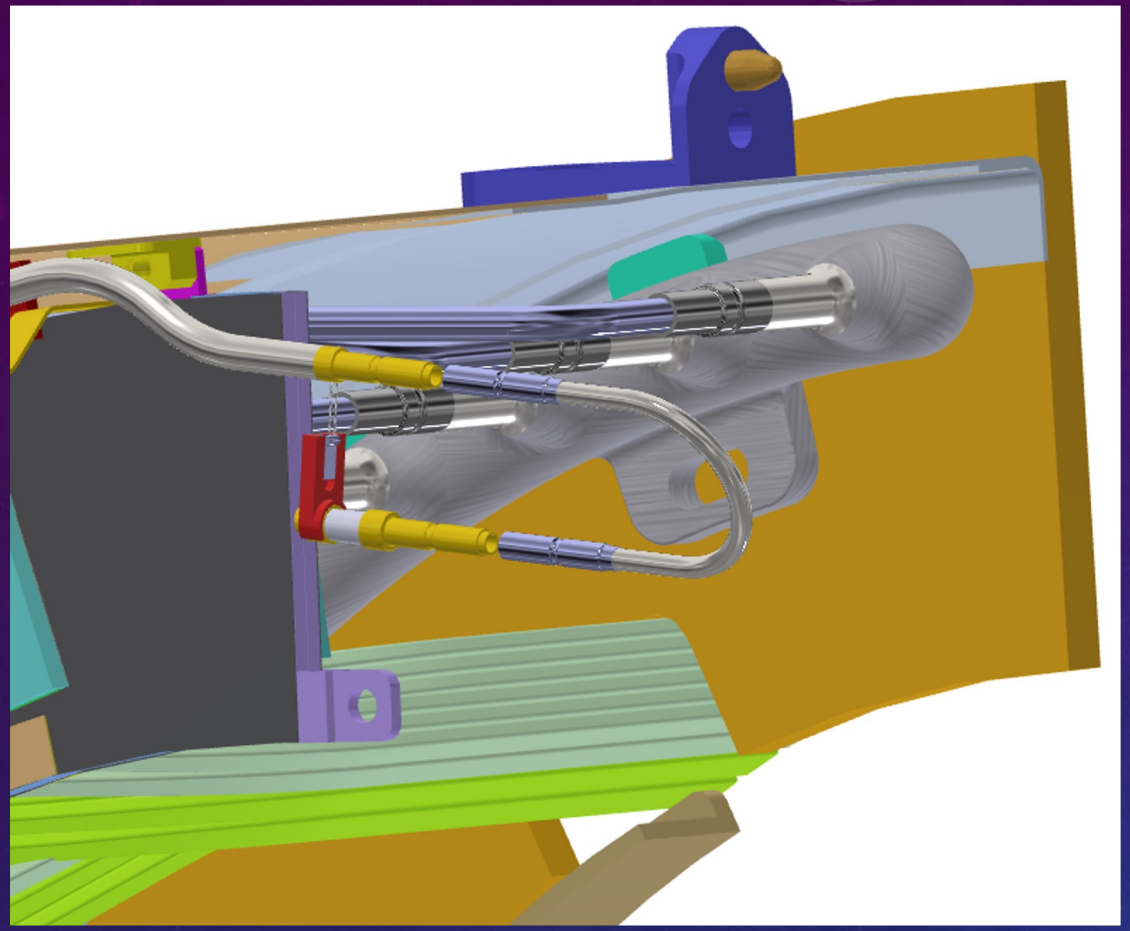


New transition design

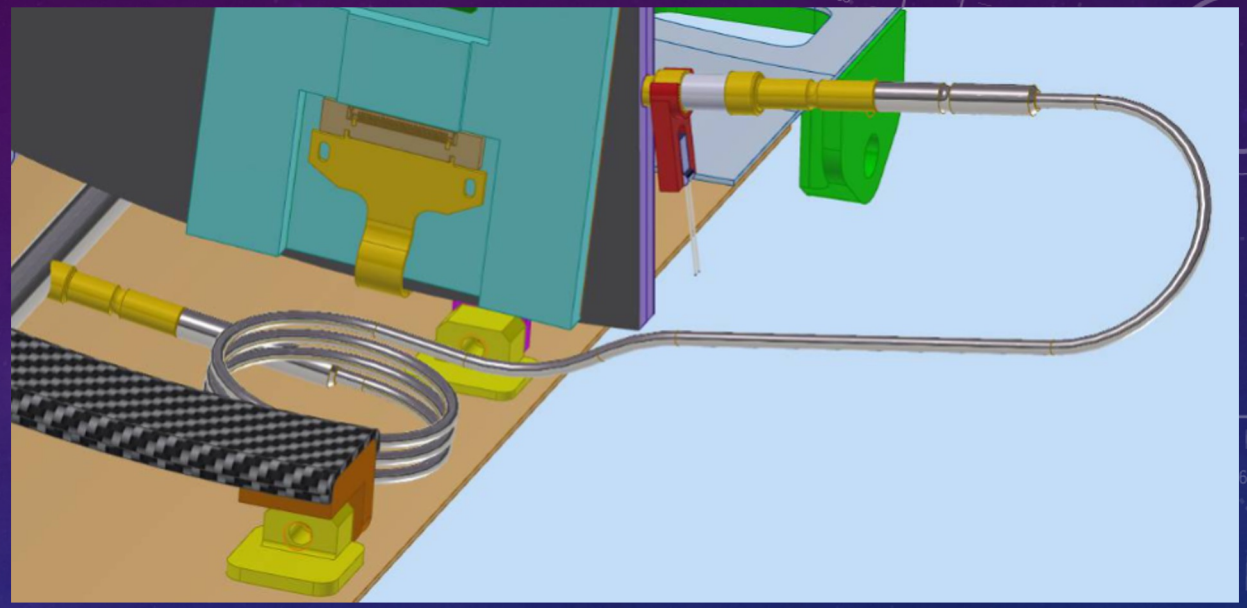
- The design of the EB joint has been subtly altered from the previous sleeve weld joint directly to the tubing to a socket/spigot joint. We have also altered the transition joint shown above (B) to a socket/spigot joint
- The mating fitting is much a more reliable option as the joint WT total is bigger at 0.5mm
- It increases the no. off welds in total but reduces the risk of the final welds from failure considerably
- The inlet capillary has the same joint to the EB on its connecting fitting
- This fitting is brazed to the capillary tubing (vacuum oven) again orbitally welded to the EB at integration
- Strip capillary fitting shown here (mods possible @ Frascati)



Exhaust schematic



Inlet capillary



- The capillary assemblies should be much simpler with vacuum brazed weld fitting attached
- These can be leak/pressure tested as necessary

- We propose to make up a number of different sized (Radii & length) U-bends to cover any alignment issues encountered
- These would be “dry-fitted” before welding
- Preferably these would be pre-welded & tested items
- The back up would be some part-welded items of various radii and with one overlength leg that could be trimmed to size on site

2. Integration welding: Description & procedure & equipment

- The design changes to the fittings already described allow for the ease of welding at integration
- The use of dedicated tooling developed for strip barrel work aids this operation
- The o-ring groove machined in the fittings allows both testing with vacuum and pressure for items but also positionally using the weld cassettes shown here

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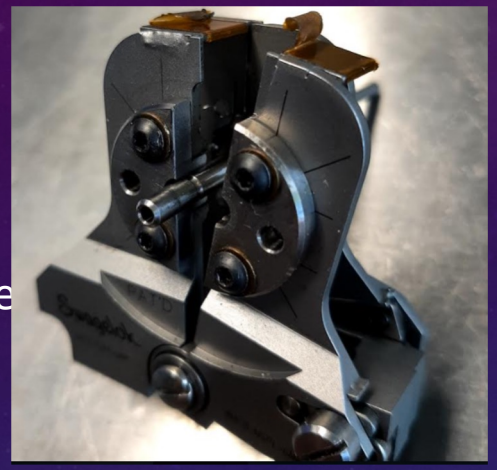
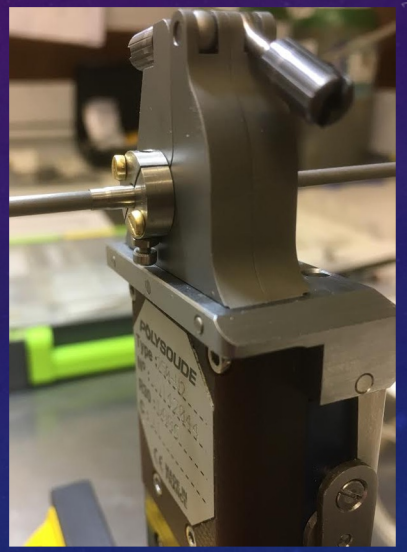


Swagelok weld cassette



Polysoude weld

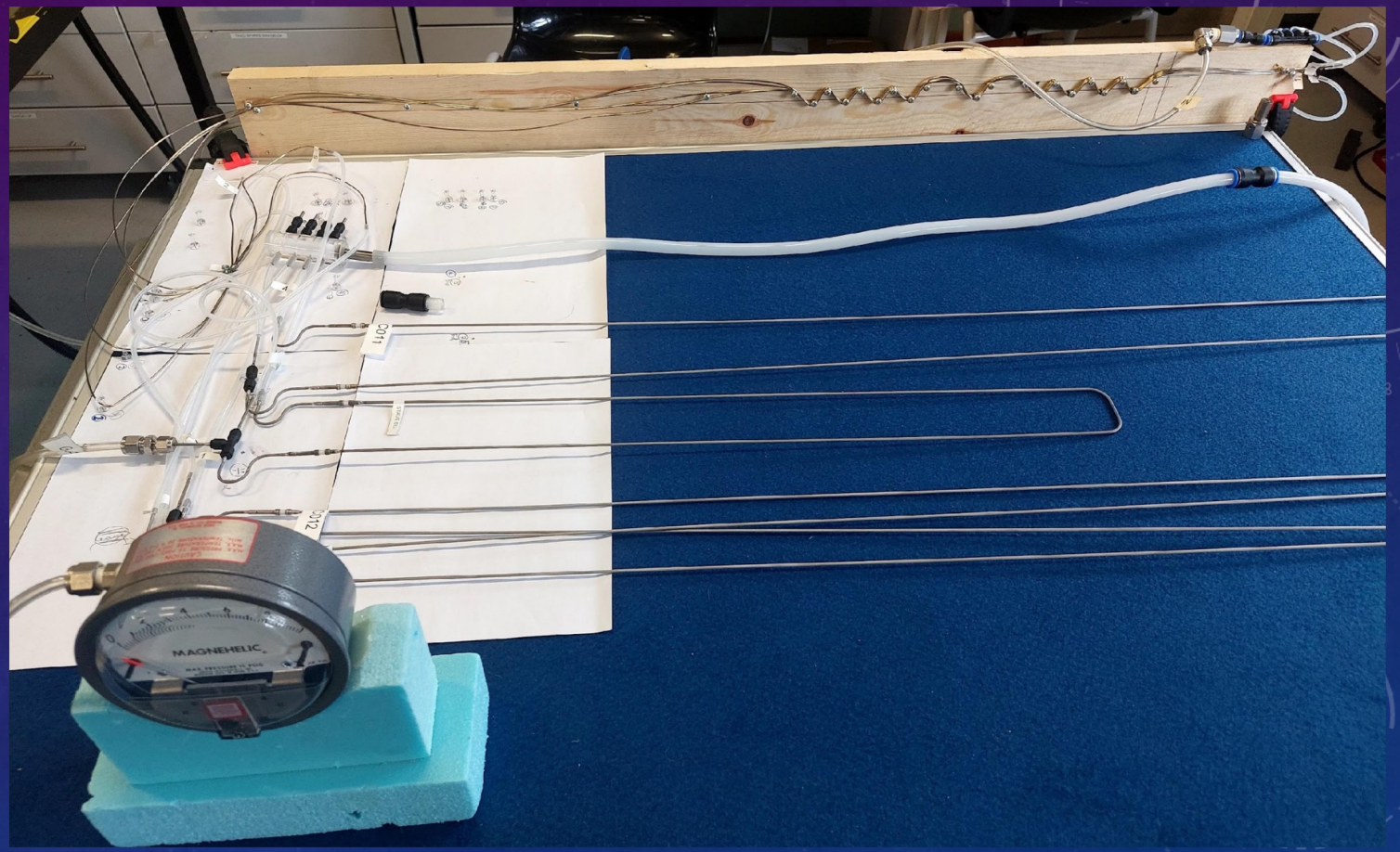
- The additional top hat here has an mating feature to the o-ring groove holding the weld fitting in the in respect to the electrode in the correct position for welding consistently
- The fittings themselves are precisely machined components which fit well together even before welding

- Note: Equipment differences UK and Italy. UK has Swagelok and Italy has Polysoude welding units and accessories
- Similar top hat fittings are required to utilise the o-ring on the Italian polysoude weld cassettes
- UoS does have some polysoude items to aid in this …….

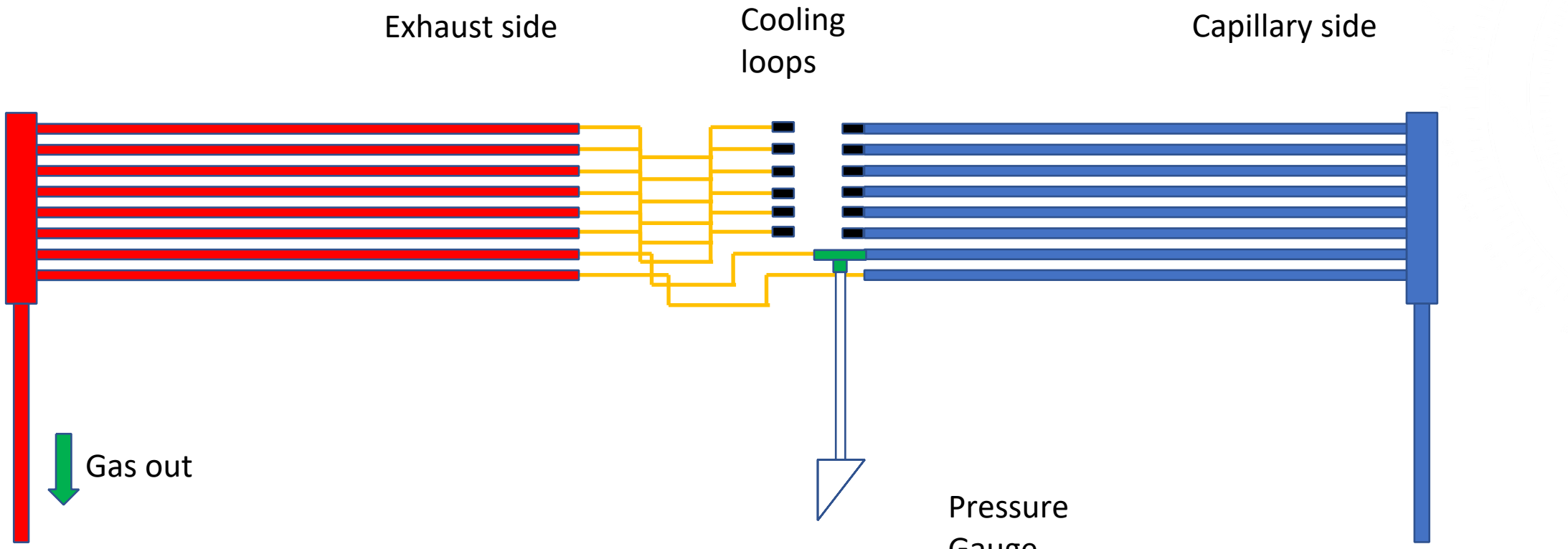
Other considerations:

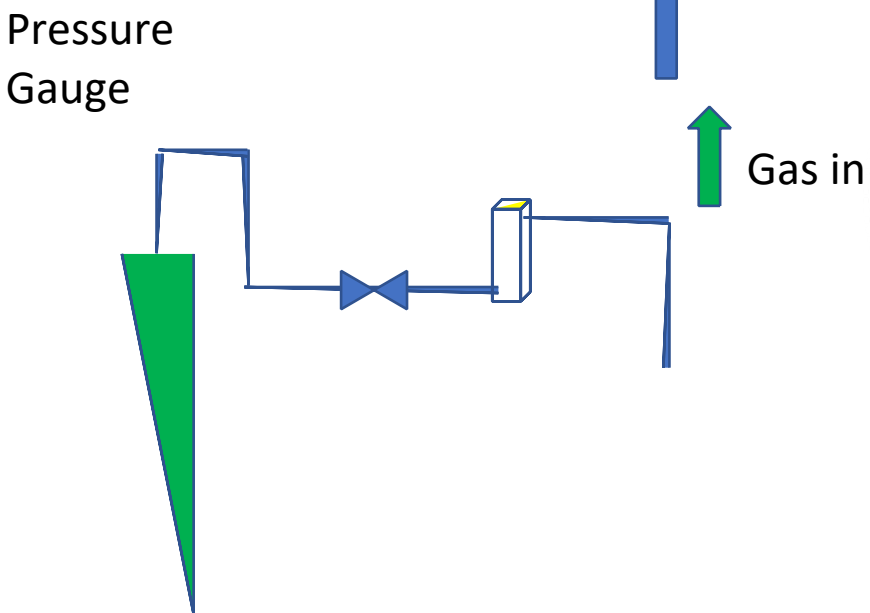
- During the welding, it is also clear that the weld head and its cabling/piping needs support
- It can not be a purely manual, requiring mechanical support from some kind of “3rd-hand” device as shown here ……
- Any device like this would need some fixing points to be incorporated into the integration setup in general at both sites
- The welding cable bundles are quite heavy and cumbersome and would tend to drag down the weld-head in operation
- Ideally the weld-head needs to be as steady and fixed as possible for the during of the welding

- The other factor at work with integration welding will be the control of the internal purge gas which has a couple of purposes: It purges the area of oxygen (improves weld quality), It acts as a cooling source and also and importantly on small thin items provides an inner pressure “holding up/supporting” the weld pool during the weld
- R&D work will be needed to establish the exact flows and pressures needed to undertake the integration welds
- Work in strips shows that welding the exhaust sections first is the way to go, with the restrictive capillaries being more problematic done afterwards
- As each capillary is added the circuit has more restriction and requires more gas flow to keep up the internal pressure, this needs careful monitoring
- Schematic from strips work on next slide shows this



Weld Setup #2 - Loop-to-Inlet Capillary





- Adding subsequent loops increases number of free paths for gas flow. **Pressure at weld point therefore drops after a loop is added.**
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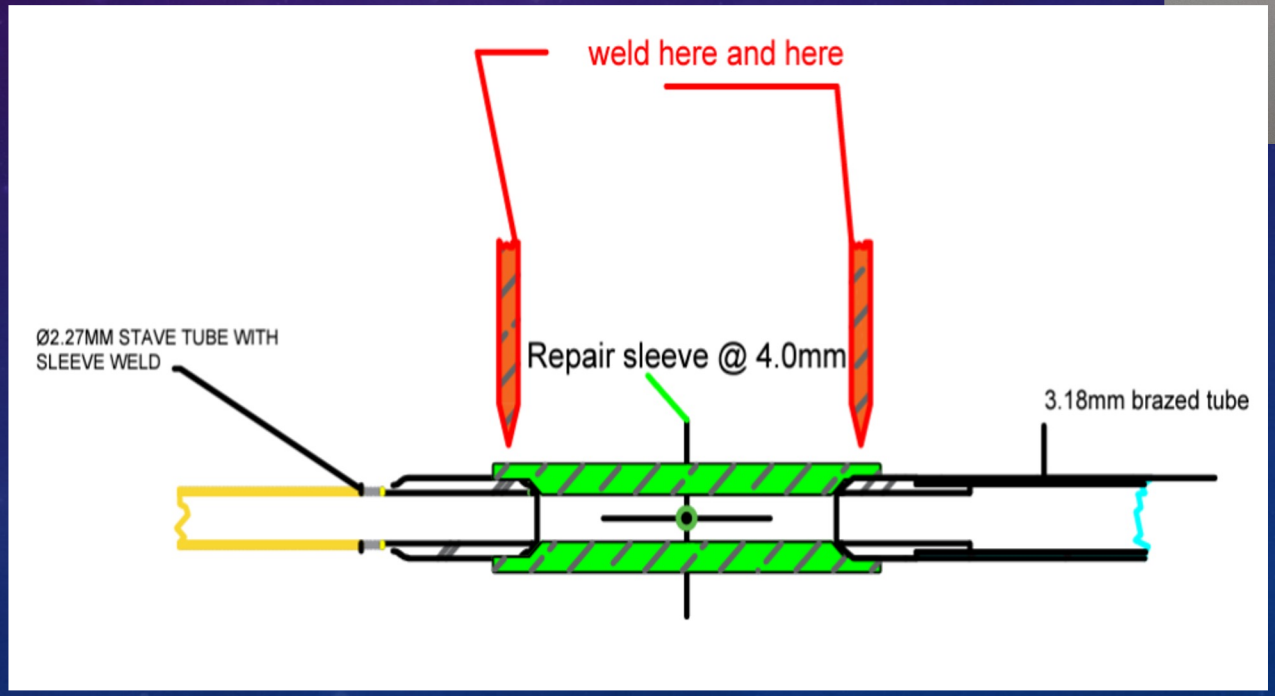
- To maintain correct weld pressure, the gas flow rate must be increased as successive loops are integrated.

3. Repair solution: Description & validation

- Work in collaboration with RAL on strip integration
- Using 4mm sleeve repair fittings to rescue a failed integration weld
- The use of the fittings with the o-ring grooves enables this
- Sharp carbide wheel slices through thinnest part of material at the groove
- Sleeve replaces material removed (1.0 mm socket each end)
- No mechanical cutter used, no dust or debris
- Proven to be relatively simple weld @ 4 mm Dia and @ 1 mm WT total
- No reason why this cannot be adopted by OEC ??
- Does increase weld no.s x 2 but no choice

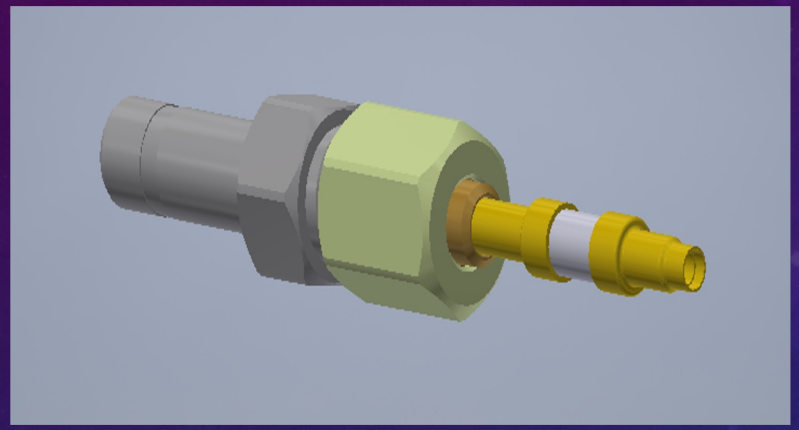
- unwelded and welded parts above

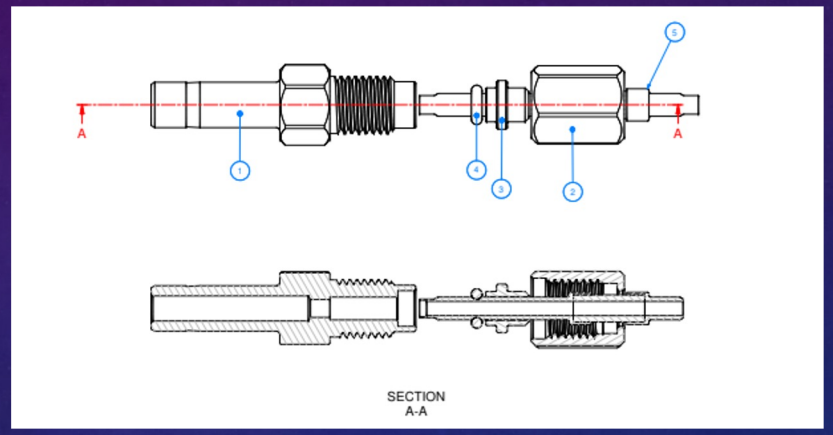
- bespoke cutter



4) TEMPORARY “FRED” FITTING

- A joint effort between QMUL and Sheffield conceived the “FRED” fitting
- This utilises the o’ring groove feature we built into the sleeve weld fittings
- The fitting is totally demountable and serves as a transition between our bespoke tubing and commercially available connections to test set-ups via a short stub at either 6mm or ¼” OD

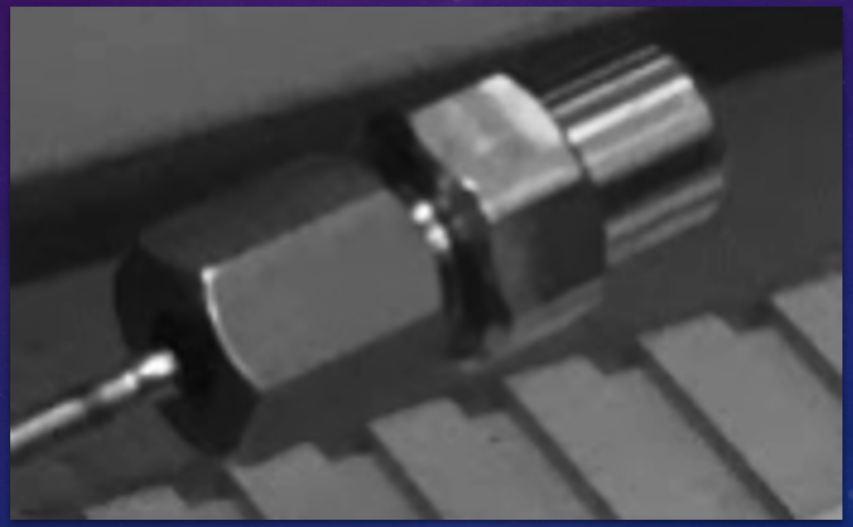




- The fittings work by compressing a captive o’ring, fitted to the weld sleeve between a brass top hat and the body of the fitting. The top hat is pushed down by the nut to compress the o’ring
- This is put together by hand with a final ¼ turn with a spanner necessary to tighten
- The o’ring sealing enables the user to rotate the whole fitting 360deg without compromising the fitting or seal
- The o‘ring choice determined mainly by pressure handling ability, spec : Nitrile 70-90 shA @2.50mm OD x 1.5mm c/s
- This design holds vacuum to 1 x 10 -10 mbar l/s and pressure levels to 200bar, with extensive testing at RAL
- The connector is now being brought into use widely in UK, Italy and the US for testing

- The fittings are also being used in their blank form to close off spare or unused legs of the exhaust and inlet manifolds (such as on slides 7 & 8)
- All the manifold fittings are terminated with the o-ring groove designs for testing purposes
- Both the exhaust and capillary will need to be welded individually and require the other conjoined legs to be shut off from the internal gas flow for example

- Blank “FRED” shown here

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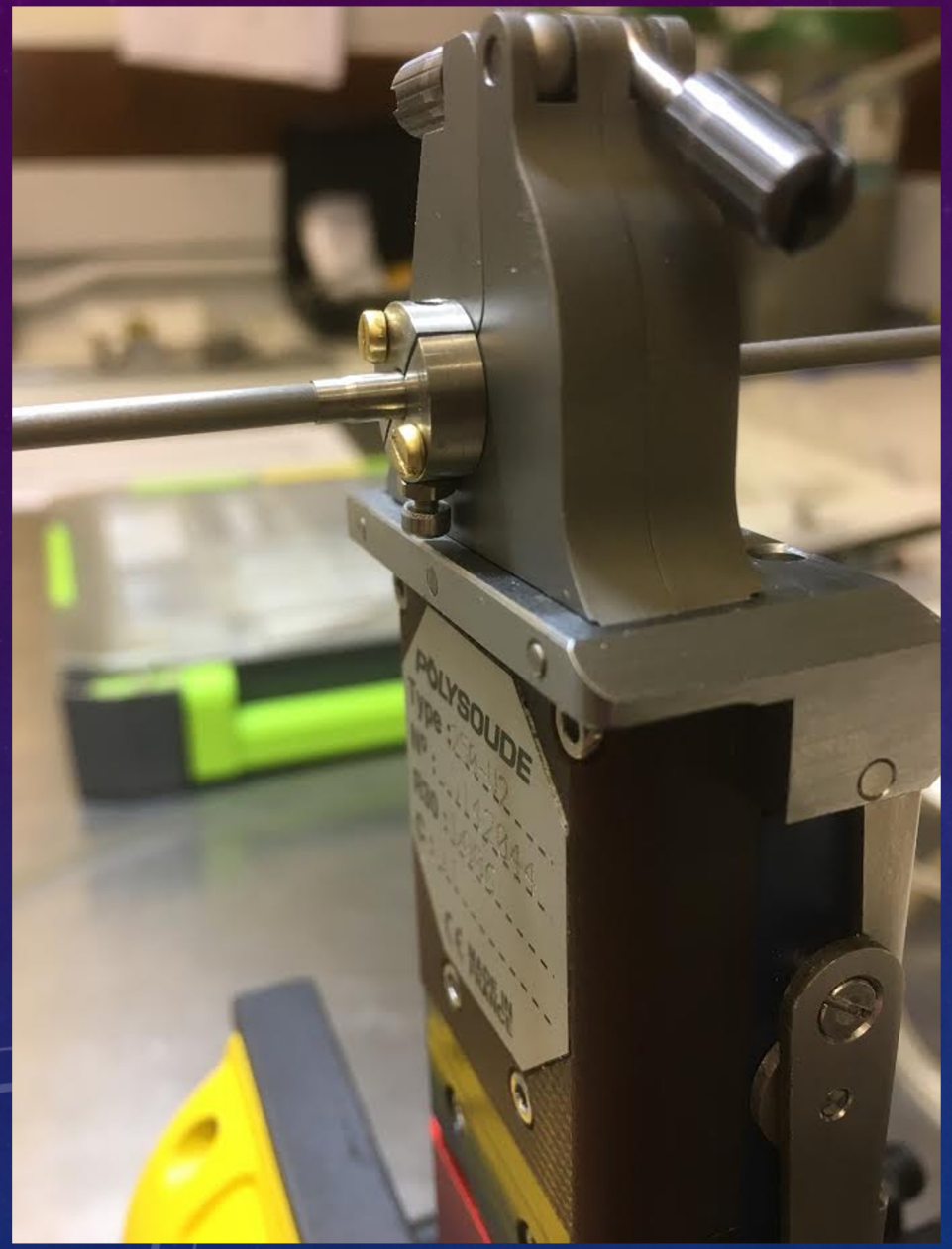
BACKUP SLIDES

PROTOTYPE TOOLING UTILISING O'RING GROOVE TO DETERMINE ELECTRODE POSITION



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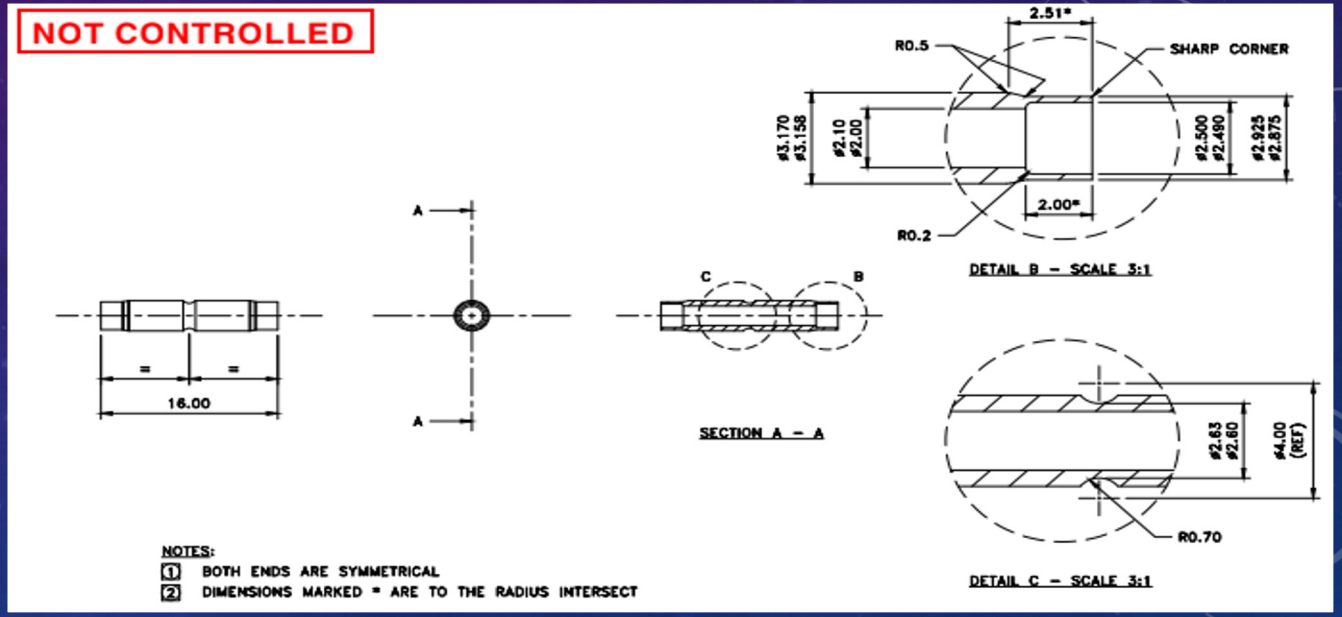
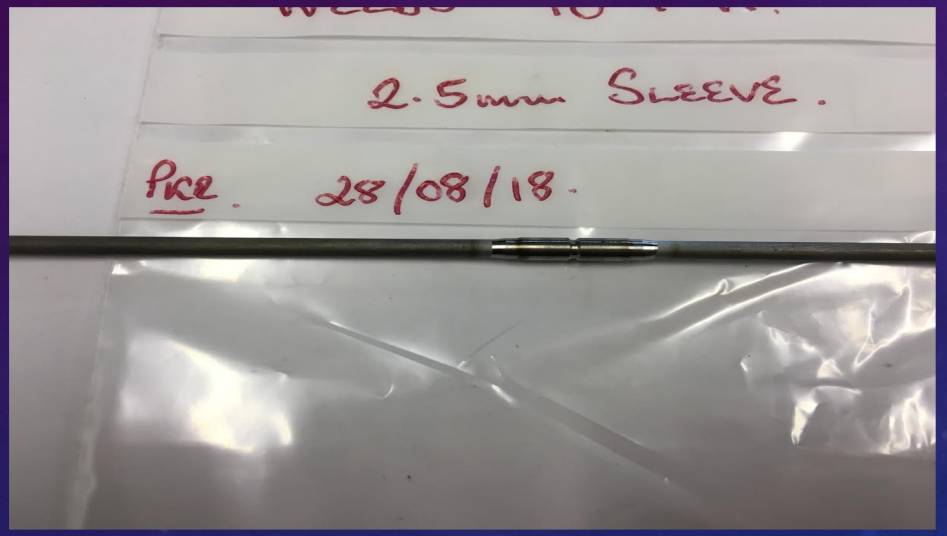
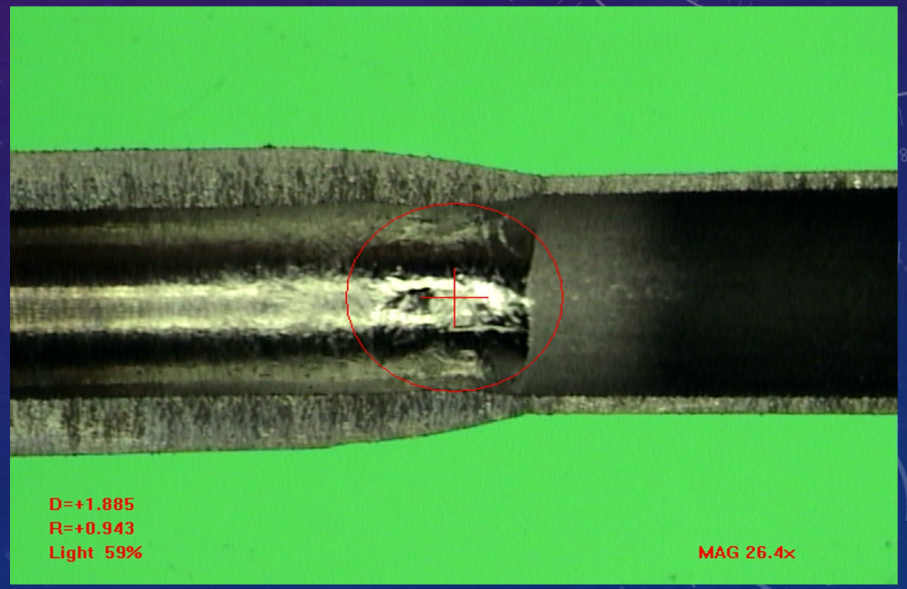
ITEMS MADE IN INDUSTRY AT CERAMIC SEALS LTD HIGHLY TOLERANCED QUALITY ITEMS AND QUALIFIED



- RESULTS SO FAR VERY ENCOURAGING
- EXTERNAL WELD BEAD ENVELOPES MOST OF SLEEVE MATERIAL AND BLENDS SMOOTHLY INTO TUBE MATERIAL WITH NO SAGGING
- NO EXCESSIVE DISCOLOURATION OF THE WELD AREA SUGGESTING OPTIMUM POWER SETTINGS



- INTERNAL VIEWS TAKEN THROUGH X-SECTION OF THE WELD JOINT SHOW THE TUBE AND SLEEVE MATERIAL TO BE FUSED SUCCESSFULLY
- FURTHER TESTING WILL REDUCE INTERNAL WELD BEAD TO REDUCE RESTRICTION TO ACCEPTABLE LEVELS



- WE WILL SHORTLY BE SENDING SAMPLES FOR MET TESTING TO QUALIFY THE 2.5MM SLEEVE JOINT.
- SIMILAR TESTS AND QUALIFICATION WILL BE NECESSARY ON 2.275MM SLEEVES BUT LESSONS LEARNT FROM THESE SAMPLE TESTS SHOULD MAKE THIS A MUCH SHORTER PROCESS.