PIPE JOINING MEETING @ CERN

WELDING TECHNIQUES ELECTRICAL BREAKS AND SLEEVE JOINTS 18/05/2018

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HISTORY: COMPONENT DEVELOPMENT AT SHEFFIELD.

Previous concept to date…

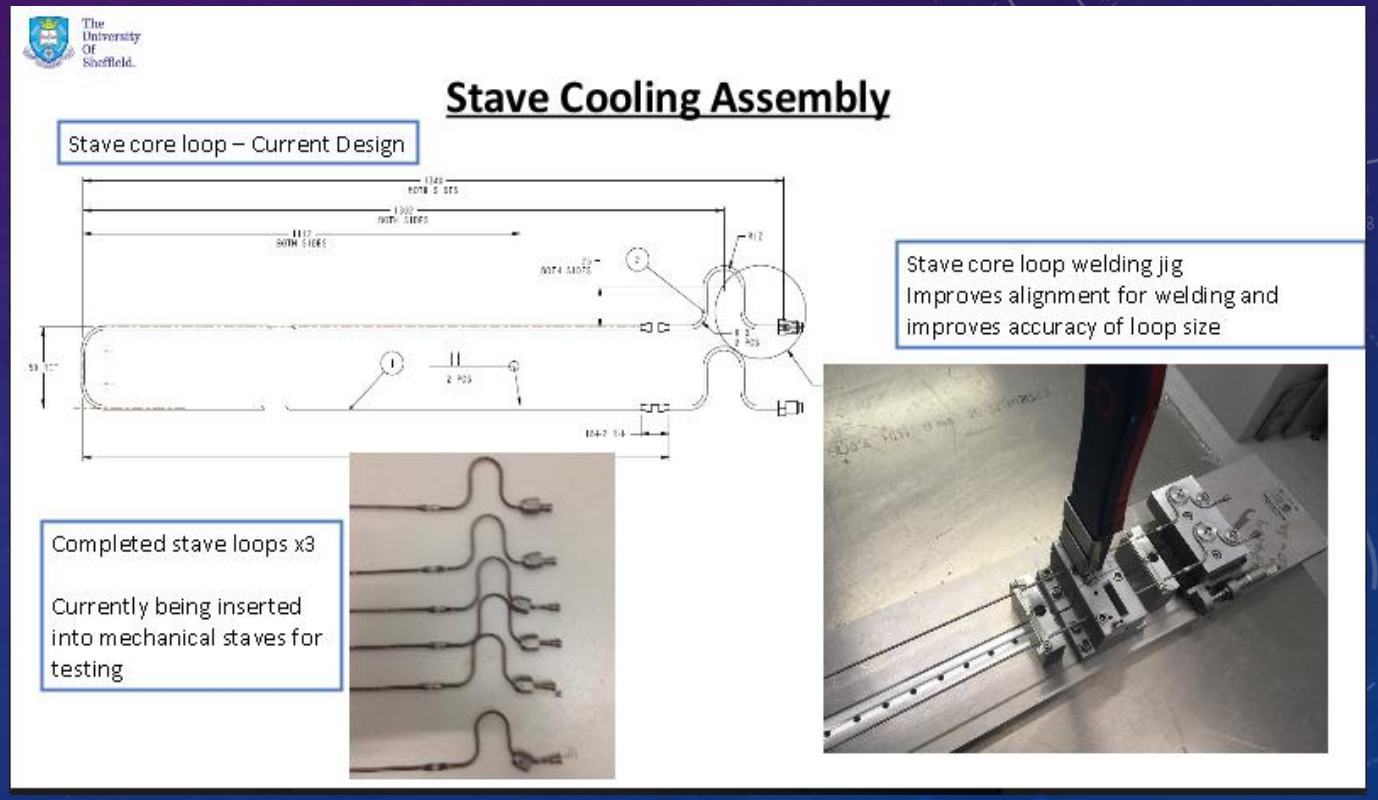
1.Create & produce robust and accurate on bench tooling with supporting jigs.

2.Use a “one hit” accurate and clean cutting process for Stave tube loops.

3.Two piece construction of stave tube loops and electrical break/wiggle.

4.Use, then removal of temporary bought in VCR fittings.

5.Different design components for stave and forward pixel cooling.



Problems arising from butt welded pipe jointing

- Need for near perfect end of tube finish and alignment , best performed on bench jig
- Joints doubly difficult if particular angular alignment necessary.
- Difficulty in maintaining internal gas pressure (critical in process) pre-set in WPS.
- Increased risk of blown joints on thinner walled tube
- On-site welds and repairs very difficult, IE. removal of vcr fitting at install subsequent reworking of pipe ends.

PROPOSED DESIGN IMPROVEMENTS: TUBE JOINTING UTILISING SLEEVE JOINT OVER BUTT WELD.

The University Of Sheffield.

ADVANTAGES:

1. **EASE AND RELIABILITY OF WELD PROCEDURE DUE TO ABILITY TO IMPROVE ALIGNMENT.**
2. **REMOVES NEED FOR ABSOLUTE PRECISION TUBE PREPARATION. (qualify)**
3. **STABILISATION OF THE INTERNAL PURGE GAS FLOW.**
4. **NEW DESIGN TO INCORPORATE A TEMPORARY REMOVABLE PRESSURE TEST FITING "FRED".**
5. **CAN BE ULITILISED ONSITE AT INSTALL .**
6. **COULD BE A SOLUTION FOR REPAIR TO DAMAGED TUBING.**
7. **TRANSFERABLE FITTINGS ACROSS STAVE AND PIXEL .**
8. **RELATIVELY CHEAP, EASILY MACHINED COMPONENTS. (QUOTATION: 100-OFF @ £10 EA, 1000-OFF @ £4.50 EA)**
9. **MUCH INCREASED SUCCESS RATE !! (AS TESTING INDICATES)**

DISSADVANTAGES:

1. **SLIGHT INCREASE OF TITANIUM METAL MASS TO STAVE/PIXEL TUBING. (@~Z+1.4M)**
2. **EARLY STAGES OF FULL VALIDATION, TO DO LIST:**

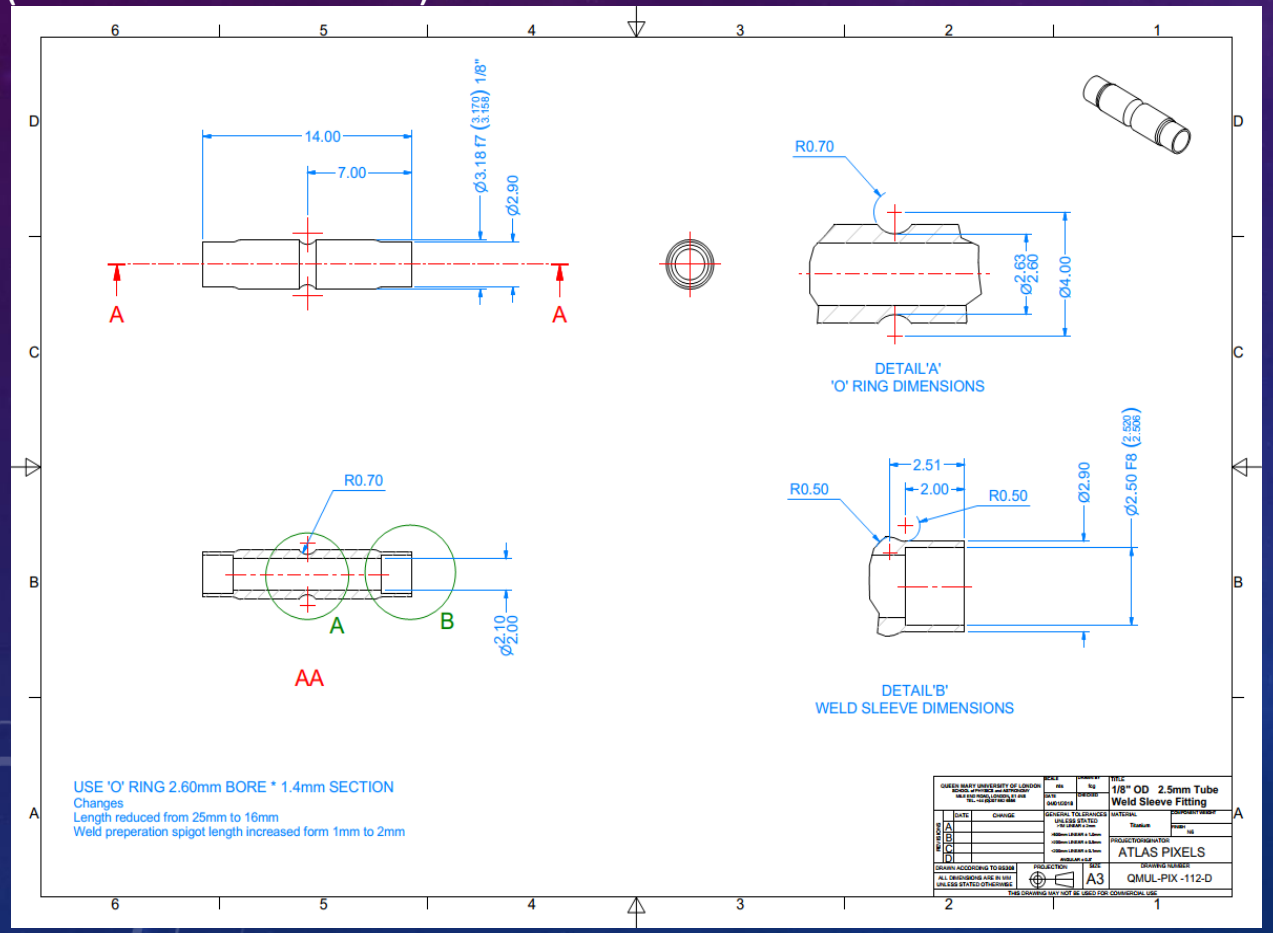
- **Metallurgical testing**
- **Pressure testing**
- **Repeatability testing (yield) with high stats.**

3. **REQUIRES MACHINING TIME FOR PROTOTYPES.**

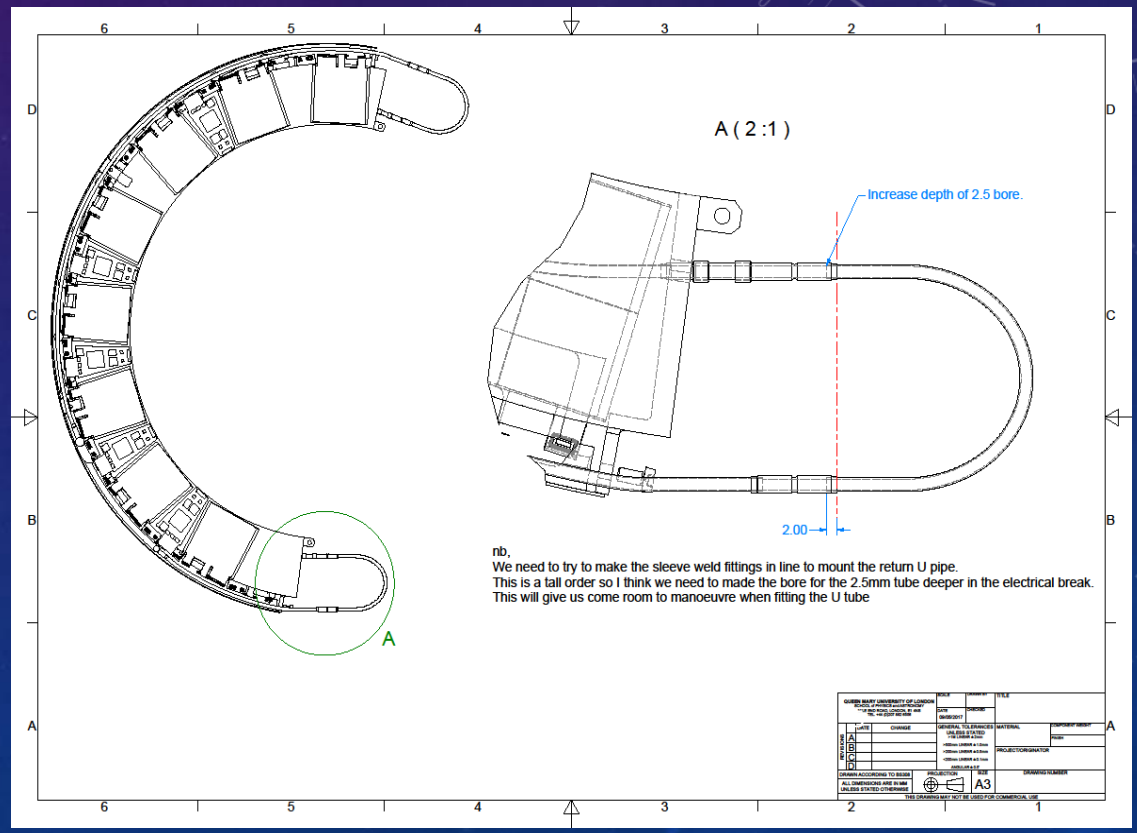
(EST LEAD TIMES APPROX 4-5 WEEKS FROM ORDER)

SLEEVE JOINT DESIGN AND INTERGRATION.

SLEEVE FITTING WITH O'RING GROOVE FOR TESTING AND POSITIONING. OBTAINING QUOTATION NOW WITH A VIEW TO MANUFACTURE 150 OFF OF THESE ITEMS FROM "CERAMIC SEALS" UK MANUFACTURER (EXP APPROX £10 EA.)

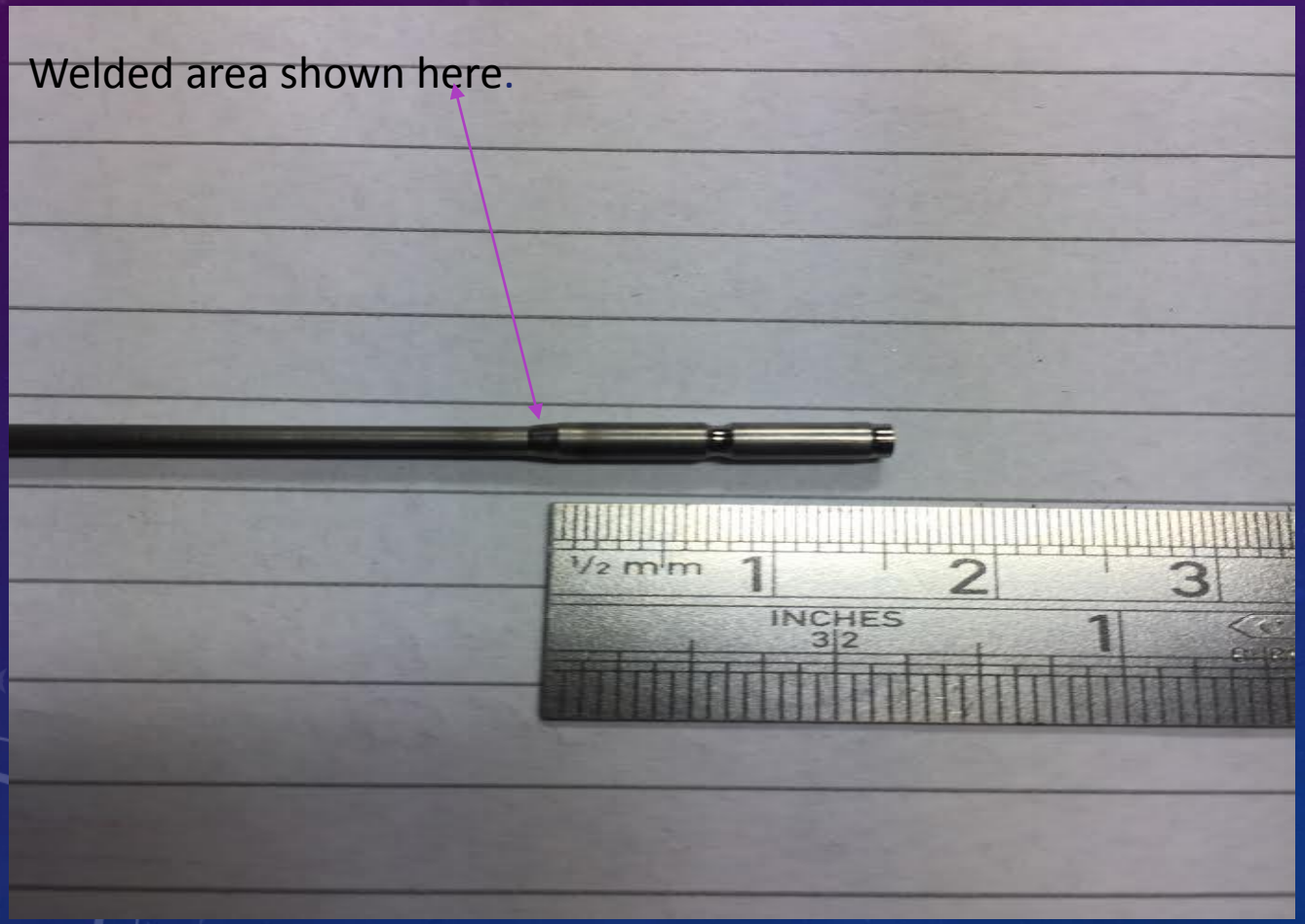


SHOWING FORWARD PIXEL CLOSE OUT, U-BEND WITH AN E-B AND SLEEVE FITTING.

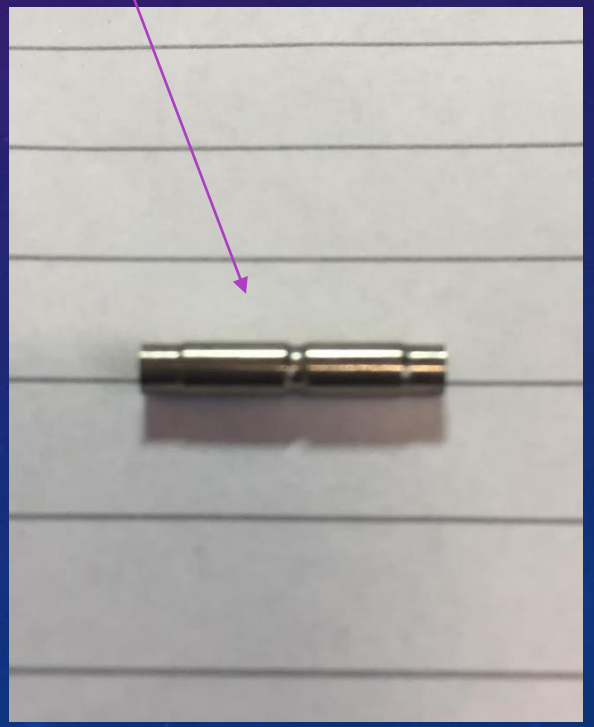


NEW SLEEVE WELD JOINT PROGRESS SO FAR.

Overall dimensions of 14mm Long and 3.2 mm diameter with an o”ring groove machined in.
This would allow use as a test fitting and a possible location point to reference the tip of the electrode for the welding process.



Blank sleeve

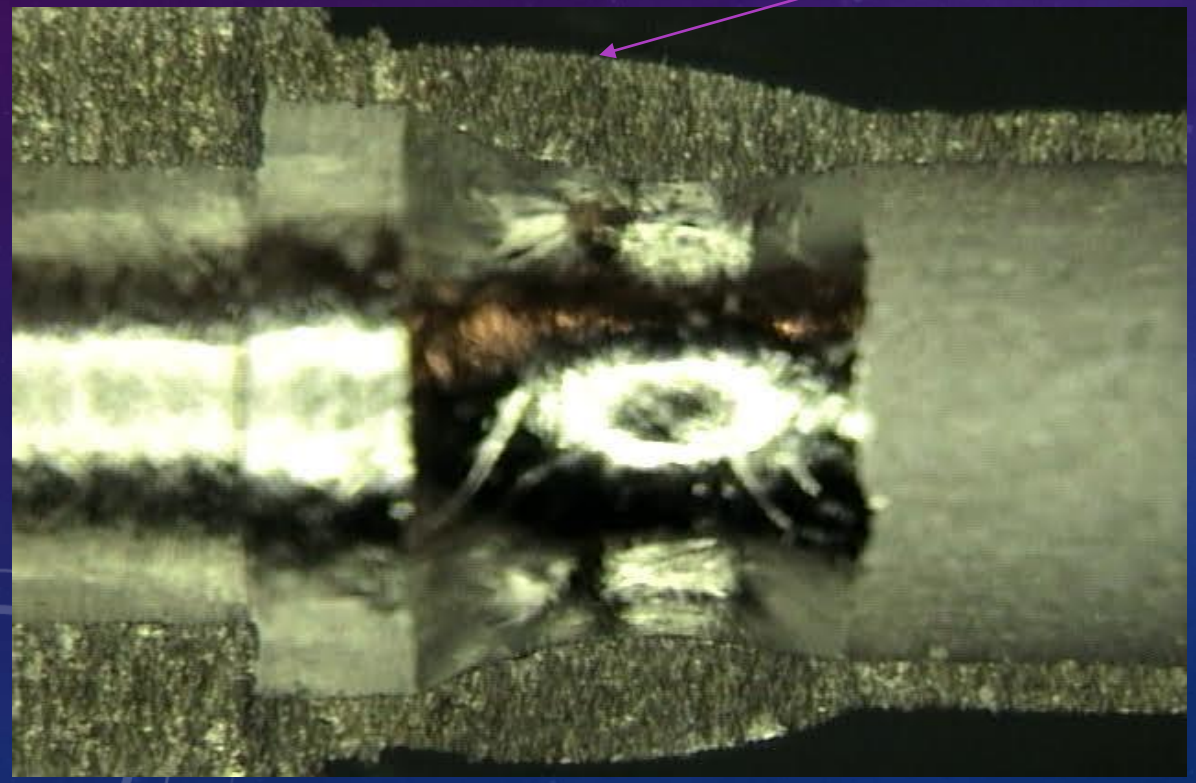


O”ring groove to accept 2.60mm bore x 1.4mm c/s o”ring.

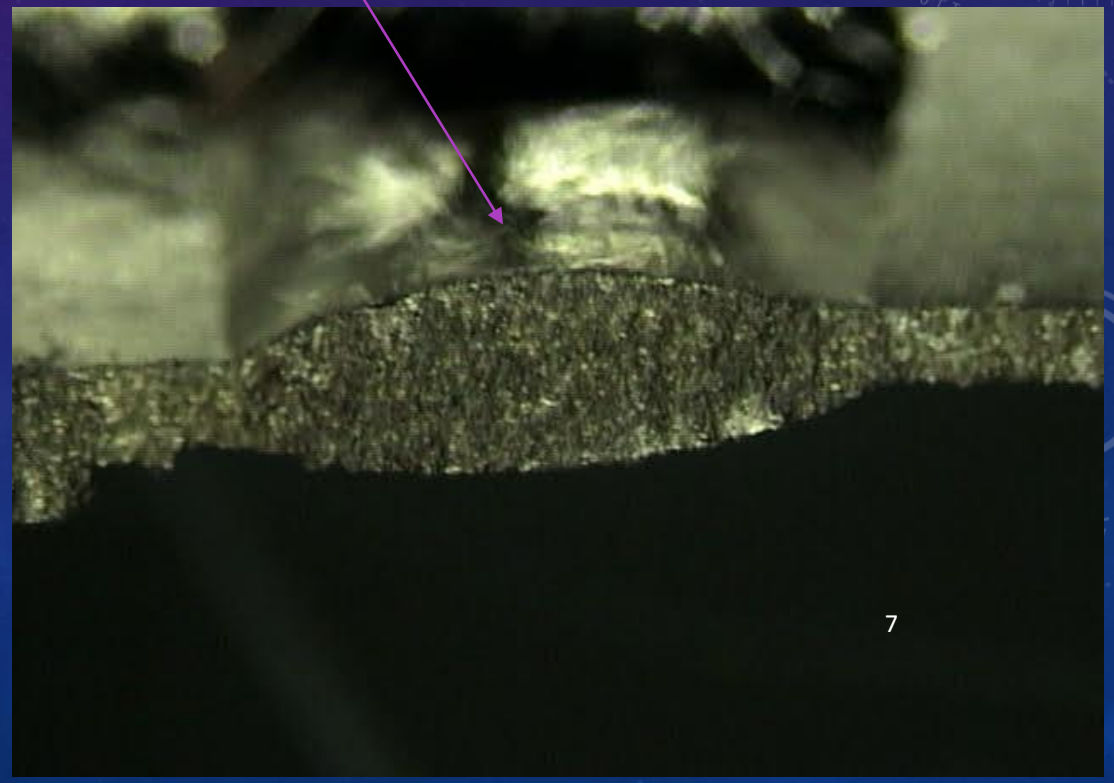
EXAMPLE CUT THROUGH SLEEVE WELD SAMPLE ON SMARTSCOPE.

PICTURES COURTESTY OF SAM EDWARDS IN SHEFFIELD TAKEN ON "OGP SMARTSCOPE CNC FLASH 200" AT 40X ZOOM.

CROSS SECTION THROUGH 2.50MM X 0.178MM WALL TUBE AND SLEEVE FITING AT WELDED JOINT AREA



SLEEVE WELD JOINT AREA SHOWING NO FISSURES AND CONSISTANT GRAIN STRUCTURE.



PROPOSED NEW ELETRICAL BREAK: INCORPORATING TEMPORARY TEST FITTING.

ADVANTAGES:

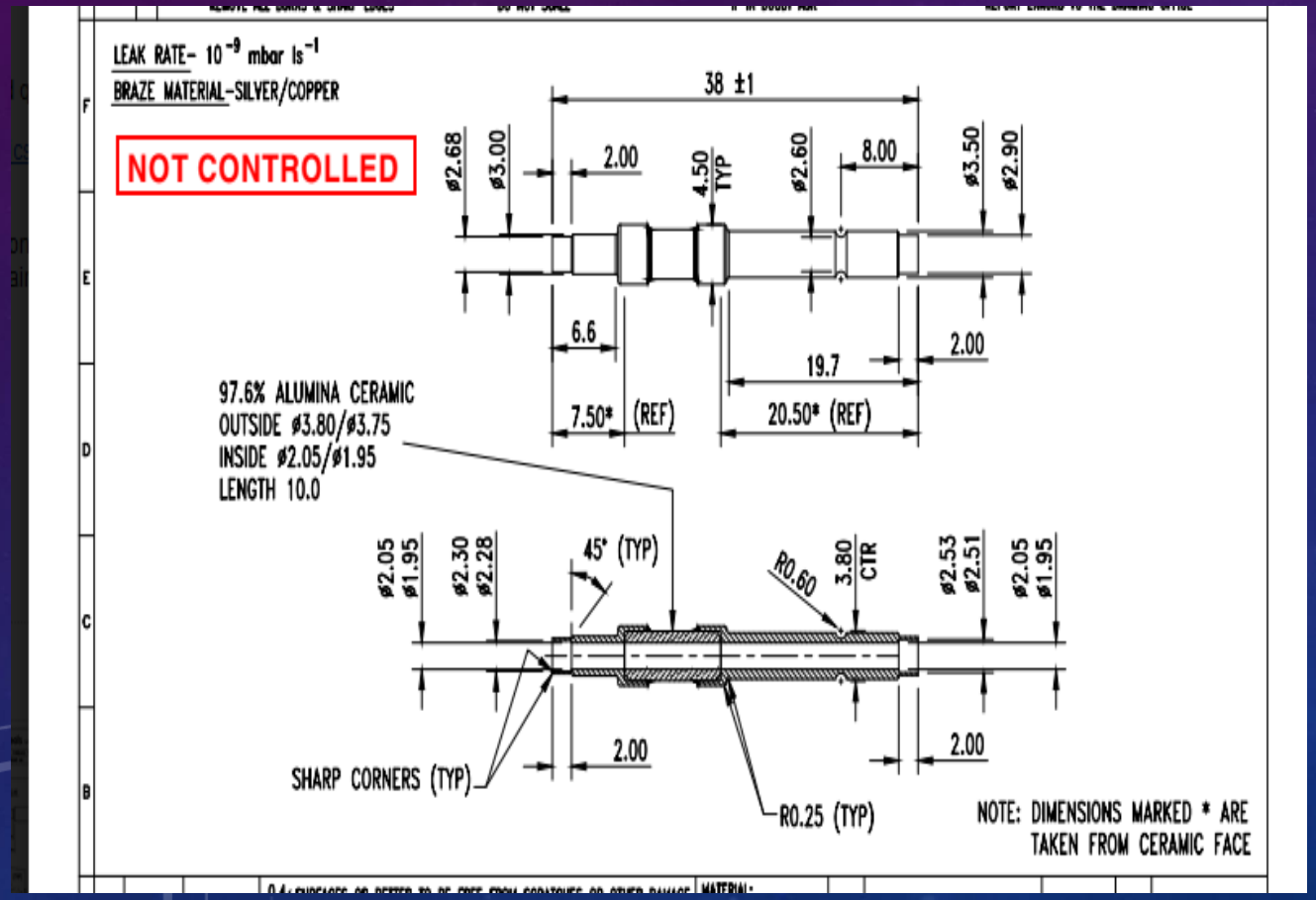
- 1. MULTI-FACETED COMPONENT , IE. WELD FITTING , EB , AND TEST FITTING IN ONE.
- 2. POTENTIAL REMOVAL OF TWO WELD JOINTS INSIDE STAVE CORE AREA.
- 3. MASSIVE REDUCTION IN SIZE OF COMPONENT. (COST IMPLICATION.)
- 4. USE OF THE PREVIOUS PROVEN CERAMIC TECHNOLOGY.
- 5. USE IN BOTH STAVE AND FORWARD PIXEL.(NB. COULD BE SIMILAR BUT SUBTILY DIFFERENT)
- 6. DESIGN COULD PROVIDE ADDITIONAL STABILTIY TO END OF STAVE AREA (IF NECESSARY.)
- 7. ALSO USED AS A TRANSITIONAL JOINT FROM ONE TUBE DIAMETER TO ANOTHER.

DISSADVANTAGES:

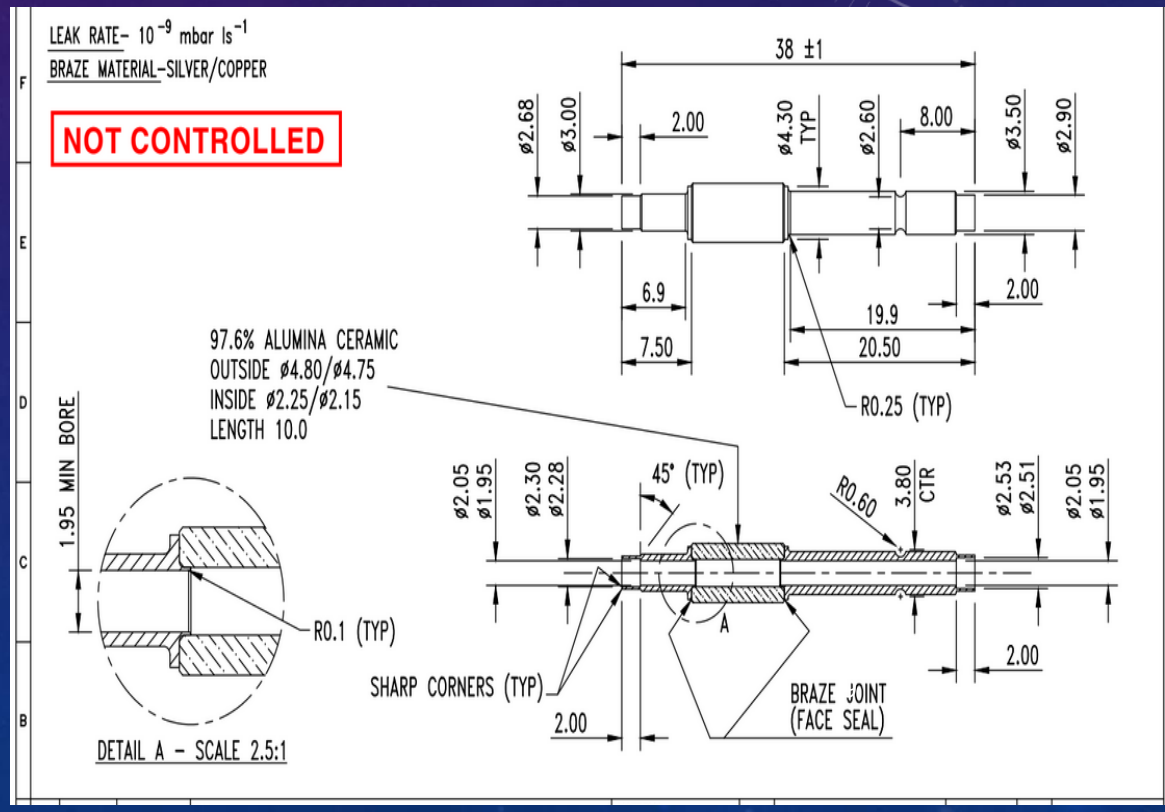
- 1. NO SIGNIFICANT PROBLEMS FORSEEN.
- 2. TESTS AND METROLOGY NOT YET UNDERWAY.
- 3. WILL HAVE TO FOLLOW DEVELOPMENT CYCLE AS PREVIOUS FITTIINGS TO ENSURE ROBUSTNESS.
- 4. DEVELOPMENT TIME ?

ELECTRICAL BREAK PROPOSALS……

CURRENT ELECTRICAL BREAK PROPOSED BY SHEFFIELD & QMUL. (TEMPORARLY ON HOLD, DUE TO POSSIBLE PIPE DIAMETER CHANGES…)



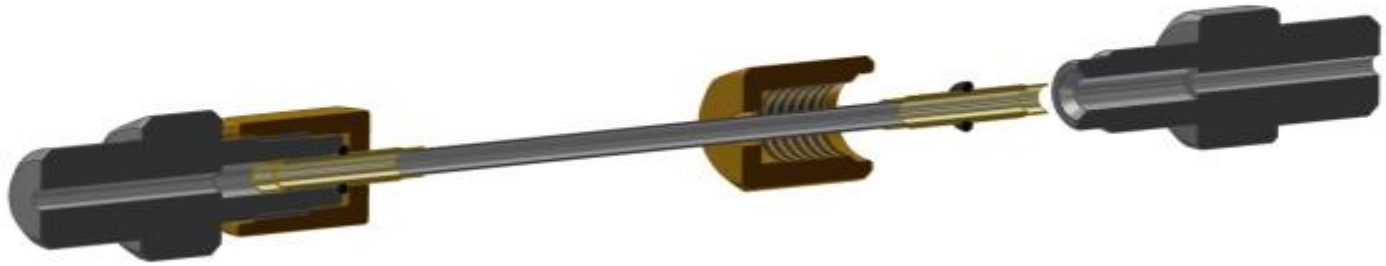
ALTERNATIVE EB SOLUTION FEATURING A LARGER CERAMIC SUITABLE (ELECTRICAL ISOLATING) AT STAVE END CLOSE OUT AREA.



TEMPORARY OR “FRED” FITTING

TEST PORTION WITH STANDARD CONNECTION TO PRESSURE OR LEAK TESTING UNIT.

BLANK “FRED” FITTING.



- UTILISING THE O’RING GROOVE ON BOTH THE SLEEVE AND EB’s.
- PROTOTYPES HAVE BEEN PRODUCED BY QMUL IN BRASS AND NOW STAINLESS STEEL.
- HAVE ACHIEVED PRESSURE TESTING VALUES OVER 200 BAR (WATER) AT RAL.
- THEY NEED FURTHER QUALIFICATION IE. HELIUM LEAK CHECKING ETC.
- THESE ARE TEMPORARY TEST FITTINGS ONLY !!…. THE WELD SLEEVE IS THEN USED ONCE REMOVED.

WELDING MACHINES AND TECHNIQUES USED AND DEVELOPED AT SHEFFIELD.

VBC IP50 : CUSTOM MADE

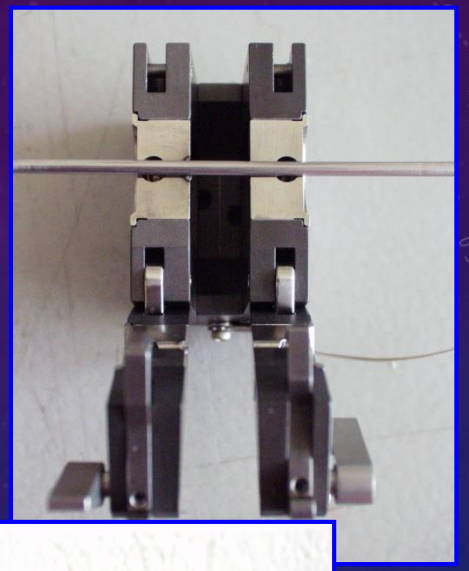
SWAGELOK M200

TIG ORBITAL WELDING OF CP2 TI

SWAGELOK M200 Orbital welder setup

power supply

PC control &
Programming
for weld schedule



THIS COMERCIALLY AVAILBLE UNIT WAS INTIALLY USED AND WORKED WELL ON TUBE DIAMETERS DOWN TO 1/8TH "/ 3.0MM WITH WT @ 200 MICRON. BELOW THESE FIGURES HOWEVER THINGS PROVED TRICKY. THE MACHINE WAS NOT SENSITIVE ENOUGH TO COPE WITH THE LOWER CURRENTS REQUIRED.

NEW WELDING SYSTEM DEVELOPMENT, REQUIRED FOR ITK.

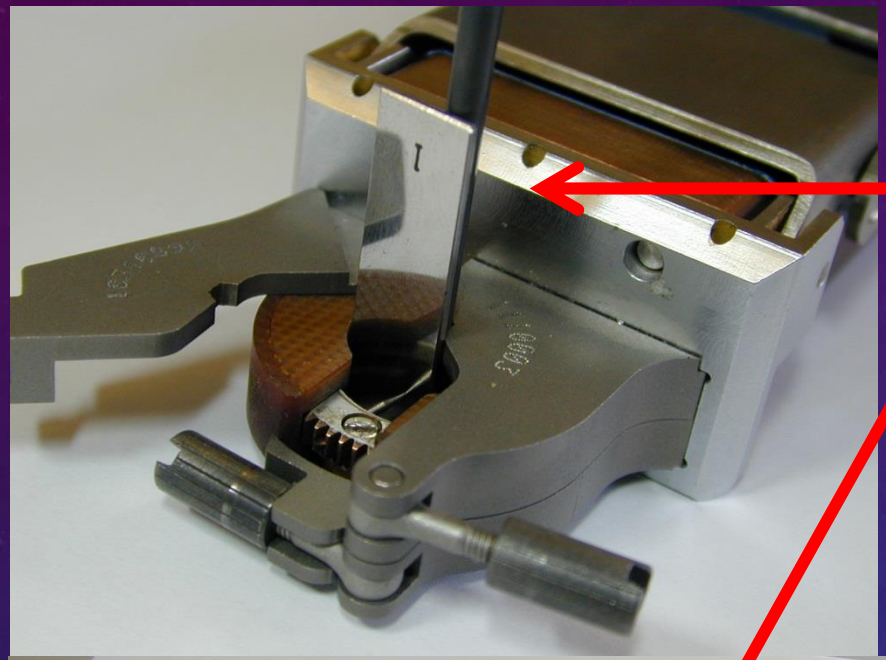
- Over the past few years in conjunction with our industrial partner Sheffield has developed an fully automatic TIG welding system that produces accurate low current narrow bead welds sourced from our partners aerospace joining knowledge. It was obvious that nothing like this was commercially available.
- From the use of high frequency pulsing interposed within the pulsed weld current gives the system its unique characteristic and is capable of joining two razor blade edges together without distortion.
- The benefit of this technique is that increased arc force or penetration is achieved with a lower input current which is crucial to thin wall Ti tube welding by allowing for improved heat management on critical welds whist still attaining full penetration.
- Has additional grounding to previous high arc start voltages through work piece
- Production version fully tested in Sheffield available to ATLAS Upgrade for R&D.
- Capable of joining >125 um Ti using minimal power.
- ~0.3A, 30v on 250um CP2 Ti tube (automatic weld)

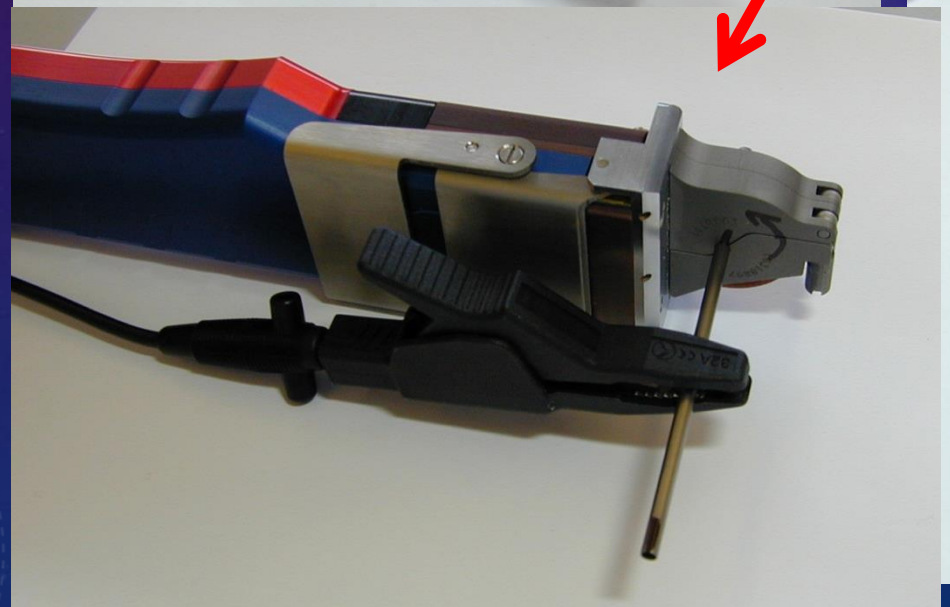
SYSTEM DETAILS

- Initial Current 0.1 – 60 Amps
- Upslope time 0.0 – 20 Seconds
- Downslope time 0.0 – 20 Seconds
- Finish Current 0.1 – 60 Amps
- Finish time 0.0 – 25 Seconds
- Pre purge gas 0.0 – 100 Seconds
- Post purge gas 0.0 – 100 Seconds
- Main Current 0.1 – 60 Amps
- Background Current 0.1 – 60 Amps
- Main time 0.01- 5 Seconds
- Background time 0.01- 5 Seconds
- InterPulse Current 0.0 – 60 Amps
- Time per level 0.01- 99.9 Seconds
- Supply 230Volts 13 Amps 50Hz

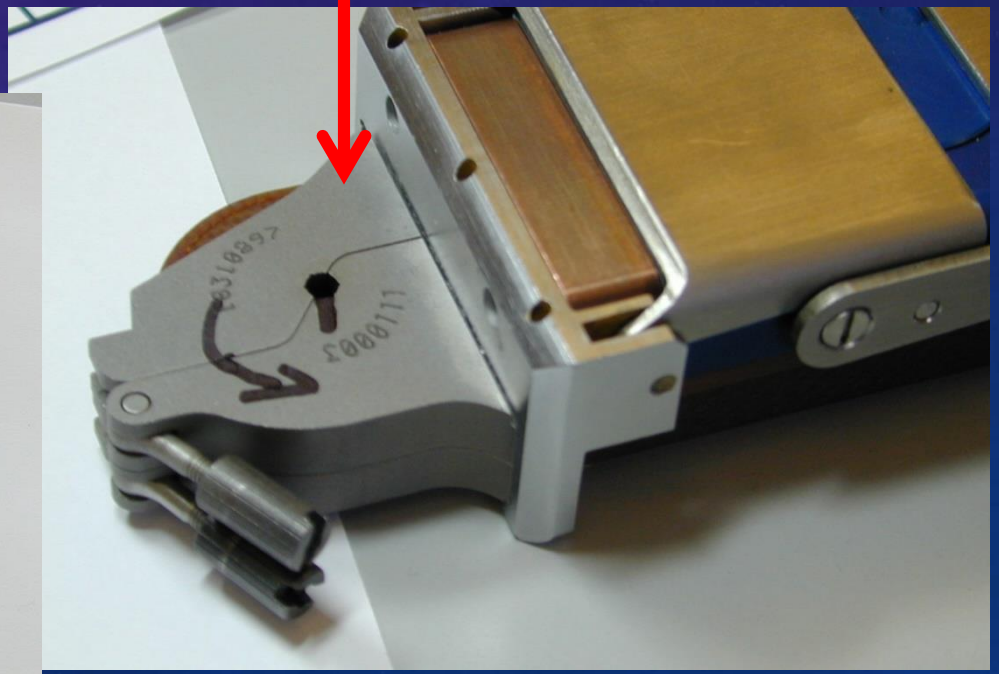
2.275mm OD tube weld cassette & head with arc start grounding

POLYSUDE WELD HEAD





- Set up of electrode distance with shim – needs refining, tooling being designed now.
- Additional clamp for grounding during arc start.
- Clamping cassette only 13mm wide allowing easy access to difficult areas.
- Modifications to cassette necessary for electrode positioning (use o’ring groove as a reference point)



COMMON FAULTS DISCOVERED DURING R&D INTO TI TUBE JOINING – TIG WELDING

Titanium welding work has progressed: Highly repeatable in 180µm wall Ti, and going as small as 120µm wall Ti with some success. There are two main problem areas.

Argon purge gas:

- Ag used is BOC Pureshield. From variable welds on thin wall tube, the transfer lines were holding moisture varying arc temp.
- Changing to BIP Ag from Airproducts with all 316L gas transfer lines gave immediate improvement.

Electrode burn-out.

- High arc temperature required for Ti welds is causing burn-out of Ciriated Tungsten electrodes.
- Changed to Thoriated electrodes that we make in house at Sheffield with the correct length and tip.
- These tungsten electrode contains 2% Thorium which is slightly radioactive. Processing of these electrodes should not be done without extraction.
- The new electrodes and allow for a cooler arc during welding. This improved weld quality without depositing tungsten into the weld. Lower power could be used and weld and HAZ reduced.

CUTTING PROCESS OPTIONS CURRENTLY AVAILABLE ……

- DRY ABRASIVE WHEEL CUTTING AND SWAGELOK CARBIDE TIPPED FINISHING TOOL: METHOD CURRENTLY EMPLOYED FOR MOST APPLICATIONS FOR TEST PIECES ETC, WHERE ACCURACY IS NOT IMPORTANT BUT FINISH TO TUBING IS.

- WIRE EDM @ SHEFFIELD: USED WHEN AN ACCURACY AND FINISH ARE EQUALLY IMPORTANT BUT LIMITED TO SHORT LENGTHS OF TUBING >500MM, AS CONSTRAINED BY THE TANK OF THE MACHINE.

- "SPECTROGRAPHIC" PRECISION CUTTER WITH RUBBER BONDED ABRASIVE WHEEL, CUTTING USING DEIONISED WATER AS COOLANT (AS TUBE SUPPLIERS USE): SHOULD BE ABLE TO ADAPT MACHINE WITH JIGS TO ACCOMMODATE THE STAVE LOOPS TO TRIM TO LENGTH.

THAT'S ALL FOLKS !!