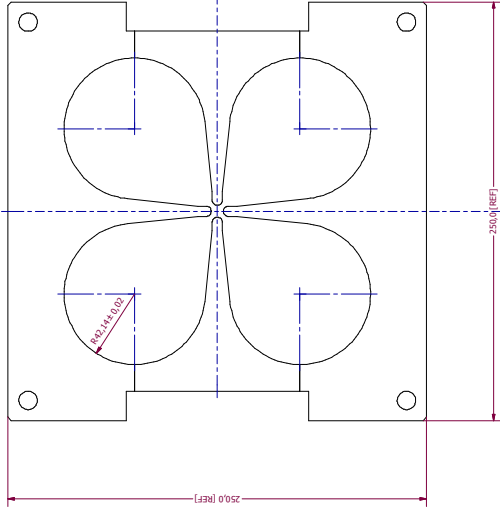
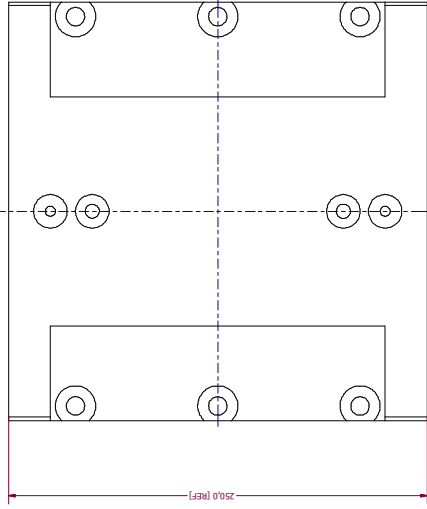


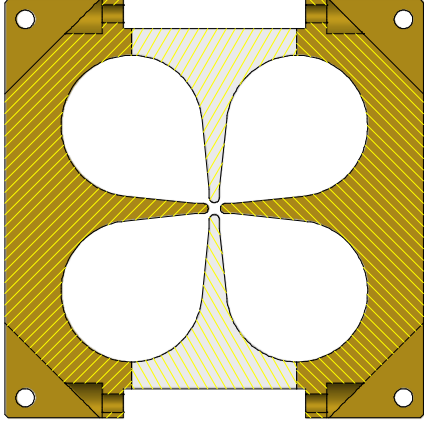
END VIEW



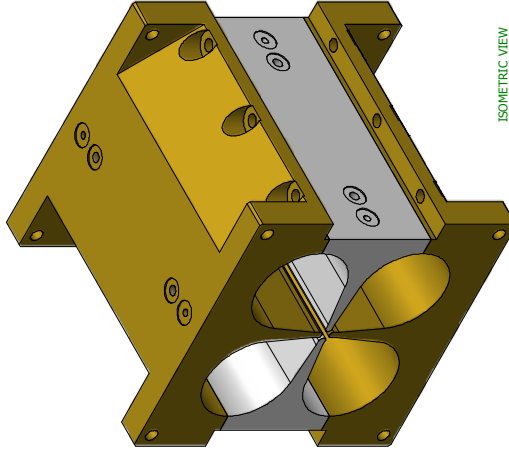
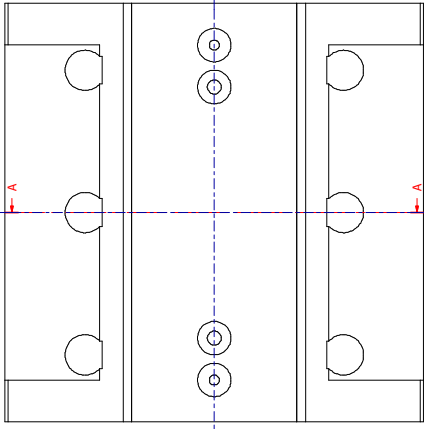
TOP/BOTTOM VIEW



SECTION VIEW  
A-A



SIDE VIEW



ISOMETRIC VIEW

**Material: Wrought High Conductivity Copper Alloy C10100**  
Also known as Oxygen-Free Electronic (OFE). This is a 99.99% pure copper with 0.0005% oxygen content. It achieves a minimum 101% IACS conductivity rating. This copper is finished to a final form in a carefully regulated, oxygen-free environment.

**Defined in:**  
UNS - Unified Numbering System  
ASTM - American Society for Testing and Materials

**Why Oxygen Free?**  
In particle accelerator applications, the release of oxygen (and/or other impurities) can cause undesirable chemical reactions with other materials in the local environment.

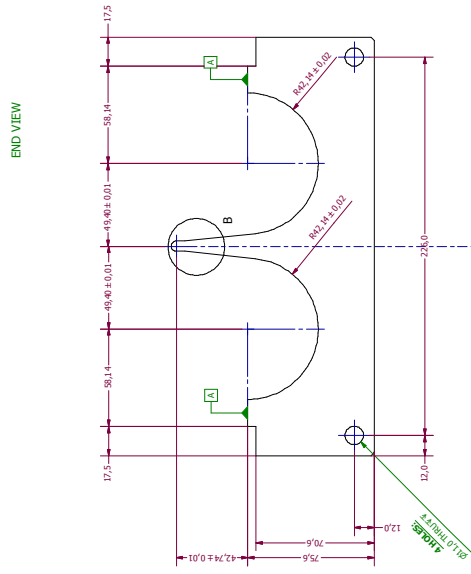
## VERSION 2

### Joint Test Model - Overview

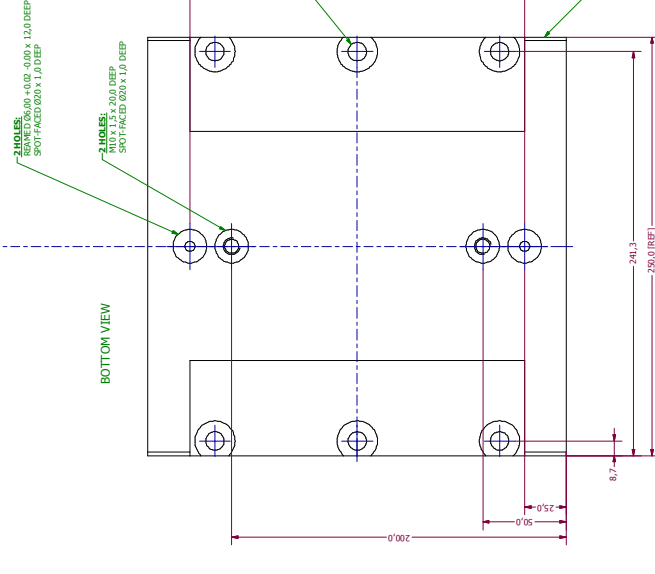
|                          |                       |                        |                                             |
|--------------------------|-----------------------|------------------------|---------------------------------------------|
| Drawn by:                | P. Savage             | Projection:            | Third angle                                 |
| Designed by:             | P. Savage             | Model file:            | WeldModl_Simple.m                           |
| Checked by:              | N/A                   | Drawing file:          | WeldModl_Version2.dwg                       |
| Date:                    | 25 May 2010           | Version number:        | 1                                           |
| Manufactured by:         | Oxygen Free Cu C10100 | Project:               | FETS / Blank                                |
| Material:                | Oxygen Free Cu C10100 | Sheet number:          | 1 / 20                                      |
| Remove all burrs         | Remove all burrs      | Number of:             | 4 Complete Assemblies                       |
| Scale:                   | Do not scale          | Drawing number:        | JC-REF P 25, FETS, BB_0001                  |
| Notes:                   | Remove all burrs      | Dimensions in:         | mm                                          |
| Unless otherwise stated: |                       | Dimensional tolerance: | X ± 0.5 mm<br>X.X ± 0.2 mm<br>X.XX ± 0.1 mm |
| Angular tolerance:       |                       |                        | ± 0.5°                                      |
| Hole centres:            |                       |                        | ± 0.05 mm                                   |
| Surface finish:          |                       |                        | 1.6 microns                                 |
| Dimensions in:           |                       |                        | mm                                          |

**Four complete assemblies to be made for the following tests:**

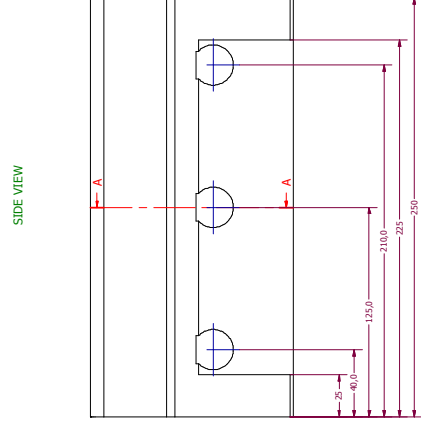
- 1) Electron beam welding
- 2) Laser welding
- 3) Vacuum brazing
- 4) Bolting



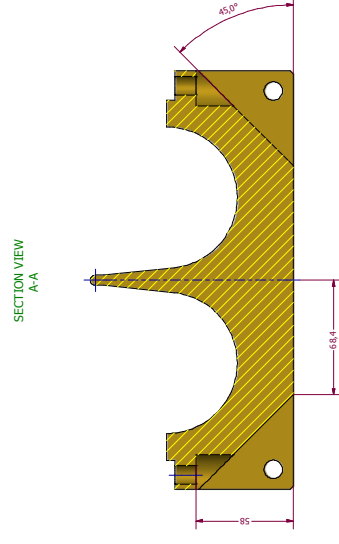
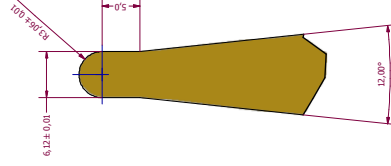
END VIEW



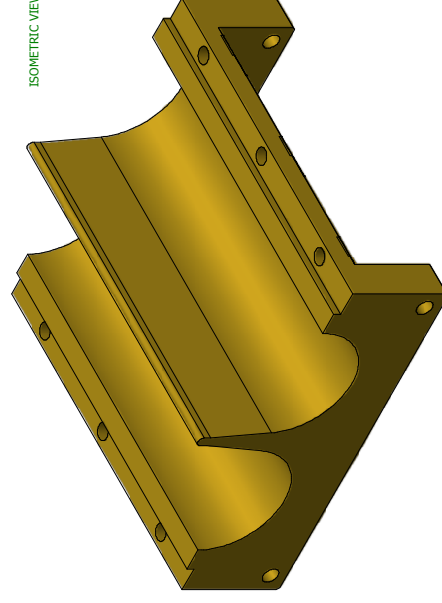
**BOTTOM VIEW**



**SIDE VIEW**

SECTION VIEW  
A-A

DETAIL VIEW  
B  
VANE TIP REGION



ISOMETRIC VIEW

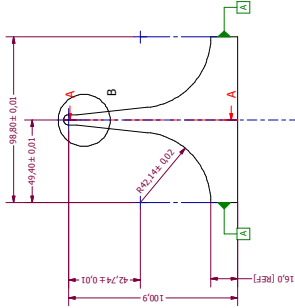
# VERSION 2

|                               |                                                                                   |                 |                               |  |  |  |  |
|-------------------------------|-----------------------------------------------------------------------------------|-----------------|-------------------------------|--|--|--|--|
| Joint Test Model - Major Vane |                                                                                   |                 |                               |  |  |  |  |
| Name                          | P. Savage                                                                         | Model file:     | test_angle                    |  |  |  |  |
| Drawn by:                     | P. Savage                                                                         | Project file:   | REQ_MajorVane_Voelkert_Simple |  |  |  |  |
| Designed by:                  | P. Savage                                                                         | Drawing file:   | Workbook_Vanetw.dwg           |  |  |  |  |
| Checked by:                   | N/A                                                                               | Version number: | REV / Banno                   |  |  |  |  |
| Date:                         | 23 May 2018                                                                       | Sheet number:   | 1 / 26                        |  |  |  |  |
| Manufactured by:              | Oxygen Free Cu-Cl1009                                                             | Number of:      | 9                             |  |  |  |  |
| Material:                     | Copper alloy bars                                                                 | Drawing number: | K-FP-75-FR15-BB-0000          |  |  |  |  |
| Scale:                        | Do not scale                                                                      |                 |                               |  |  |  |  |
| Note:                         |                                                                                   |                 |                               |  |  |  |  |
| Contact:                      | p.savage@imperial.ac.uk    (work) +44(0)203 755 7437    (home) +44(0)788 484 8058 |                 |                               |  |  |  |  |

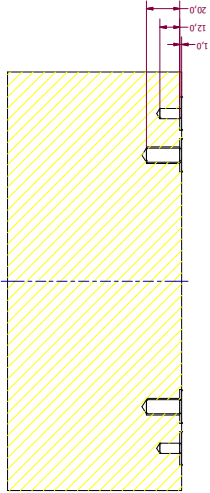
**NOTES:**

**NOTES:**  
FACES 'A' TO BE MACHINED FLAT AND COPLANAR TO  $\pm 0.01\text{mm}$   
WHERE ONE SIDE ONLY IS DIMENSIONED SYMMETRY IS ASSUMED  
PROTECT INTERNAL FACES & JOINT INTERFACES AFTER MACHINING

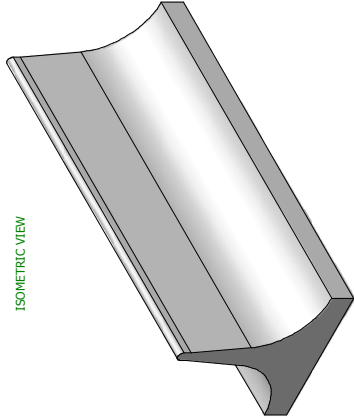
END VIEW



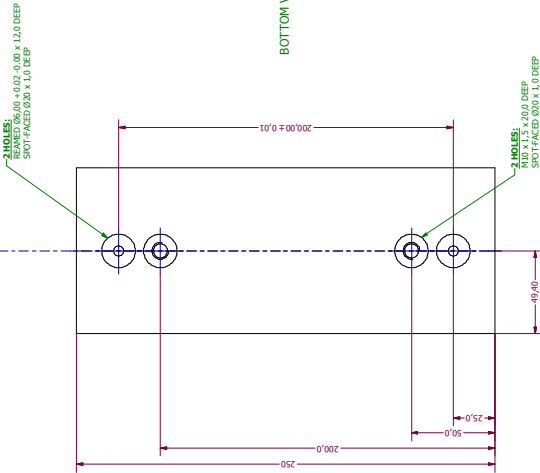
SIDE SECTION  
VIEW A



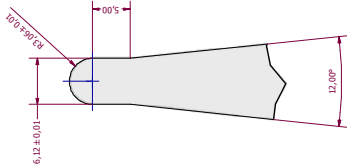
ISOMETRIC VIEW



BOTTOM VIEW



DETAIL VIEW  
B  
VANE TIP REGION



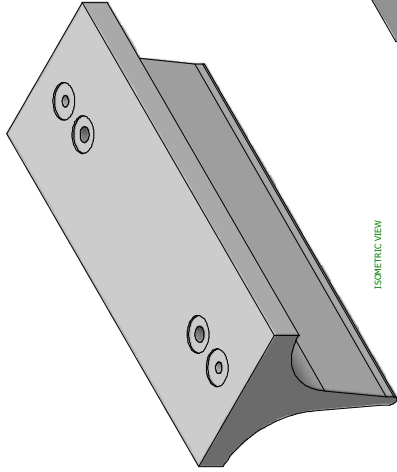
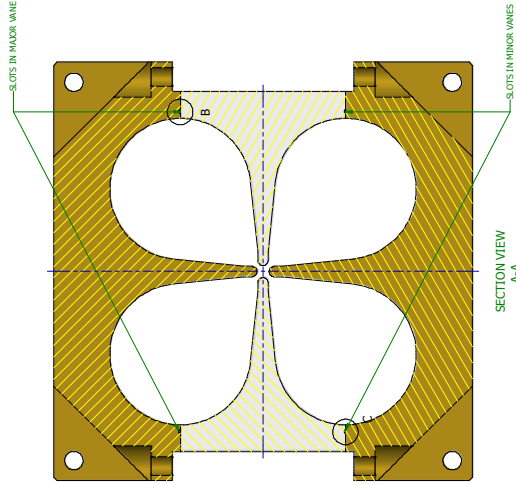
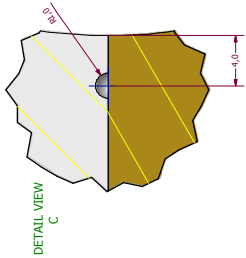
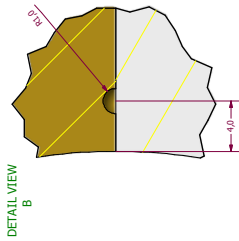
## NOTES:

FACES 'A' TO BE MACHINED FLAT AND PARALLEL TO ± 0.01mm  
WHERE ONE SIDE ONLY IS DIMENSIONED SYMMETRY IS ASSUMED  
PROTECT INTERNAL FACES & JOINT INTERFACES AFTER MACHINING

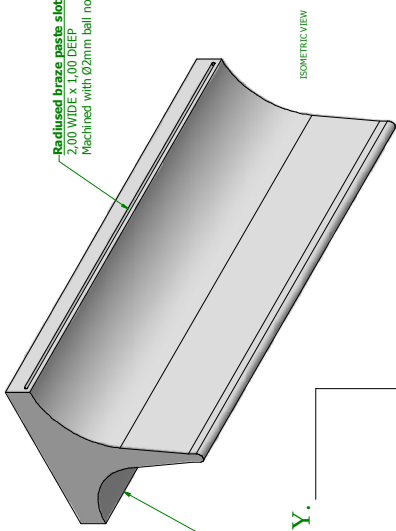
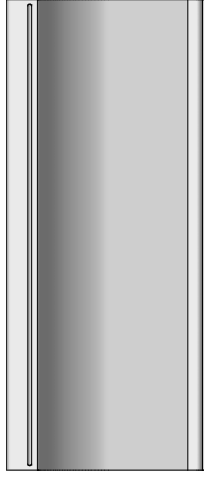
## VERSION 2

| Title            |                         | Joint Test Model - Minor Vane |                                  |
|------------------|-------------------------|-------------------------------|----------------------------------|
| Drawn by:        | P. Savage               | Projection:                   | Third angle                      |
| Designed by:     | P. Savage               | Model file:                   | RFQ_MinorVane_VidTest_Simple.dwg |
| Checked by:      | N/A                     | Drawing file:                 | VidTestModel_Version2.dwg        |
| Date:            | 25 May 2010             | Version number:               | 1                                |
| Manufactured by: | Oxygen Free Cu Cl 0100  | Project:                      | FETS / Blank                     |
| Material:        | Oxygen Free Cu Cl 0100  | Sheet number:                 | 3 / 20                           |
| Remove all burrs |                         | Number of:                    | 8                                |
| Scale:           | Drawn scale             | Drawing number:               | XC-FET-2-35_FETS_05_0003         |
| Notes:           |                         | Notes:                        |                                  |
| Contact:         | p.savage@imperial.ac.uk | (Ver 1) 10/04/2007 09:47:37   | (Ver 2) 10/04/2007 14:08:00      |

| Unless otherwise stated: |               |
|--------------------------|---------------|
| Dimensional tolerance:   | X ± 0.5 mm    |
|                          | X.X ± 0.2 mm  |
|                          | X.XX ± 0.1 mm |
| Angular tolerance:       | ± 0.5°        |
| Hole centres:            | ± 0.05 mm     |
| Surface finish:          | 1.6 microns   |
| Dimensions in mm         | C             |



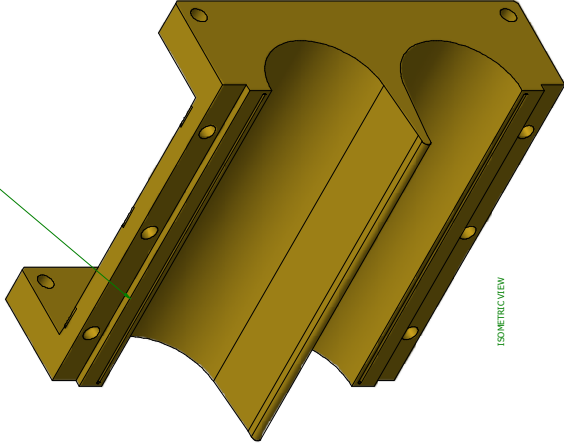
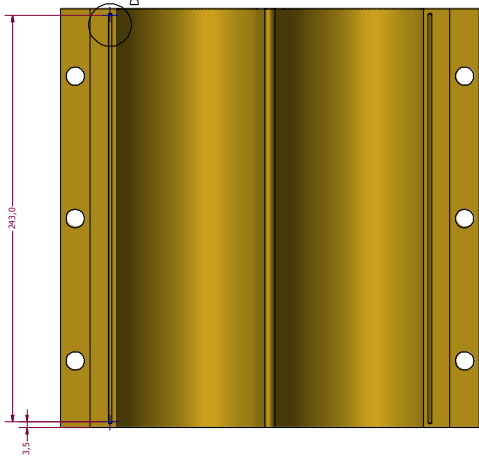
SIDE VIEW



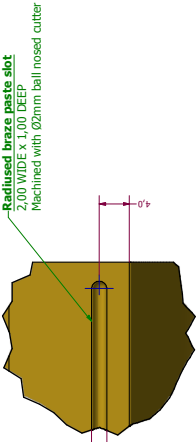
Radiused braze paste slot  
2.00 WIDE X 1.00 DEEP  
Machined with 02mm ball nosed cutter

**Minor Vane slots for vacuum braze paste:**  
On BOTH Minor Vane parts: machine 1 slot ONLY.

**Major Vane slots for vacuum braze paste:**  
On one Major Vane part ONLY: machine 2 slots.



DETAIL VIEW D



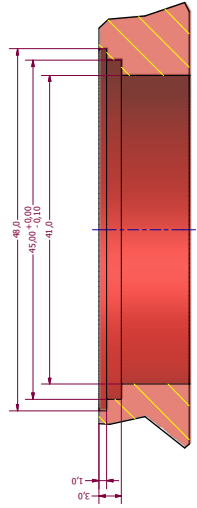
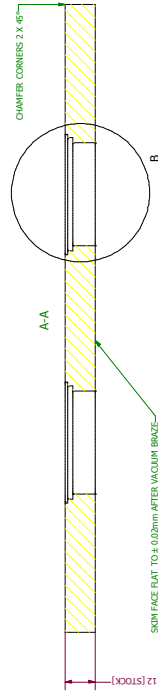
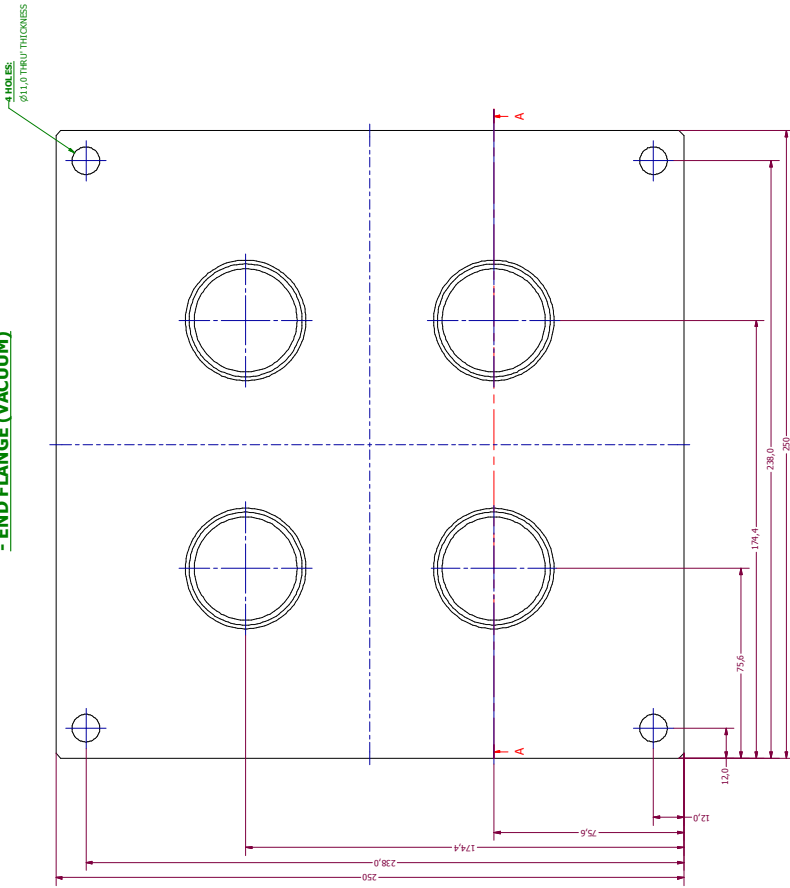
Radiused braze paste slot  
2.00 WIDE X 1.00 DEEP  
Machined with 02mm ball nosed cutter

## VERSION 2

|                                                                                            |                                  |
|--------------------------------------------------------------------------------------------|----------------------------------|
| Title: Joint Test Model - Braze Slot Detail                                                |                                  |
| Drawn by: P. Savage                                                                        | Projection: Third angle          |
| Designed by: P. Savage                                                                     | Model file: MechMod_VedProc_1m   |
| Created by: N/A                                                                            | Drawing file: MechMod_Ver2m2.dwg |
| Date: 25 May 2010                                                                          | Version number: 2                |
| Manufactured by: Bland                                                                     | Project: FETS / Bland            |
| Material: Oxygen Free Cu C10100                                                            | Sheet number: 4 / 20             |
| Remove all burrs                                                                           | Number of: 4 complete assemblies |
| Scale: As shown                                                                            | Number of: 12 FETS, 26, 0004     |
| Drawn scale: 1:1                                                                           | Drawing number: 12_FETS_26_0004  |
| Notes:                                                                                     | Dimensions in mm                 |
| Contract: P. Savage@imperial.ac.uk (Ver 2) HICP(4300) Rev 7917 (Nobis) HICP(4300) Rev 8038 |                                  |

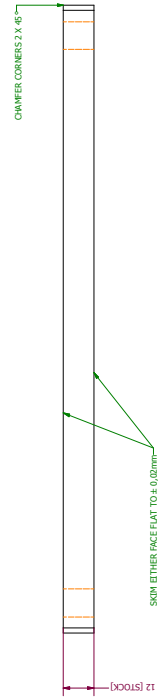
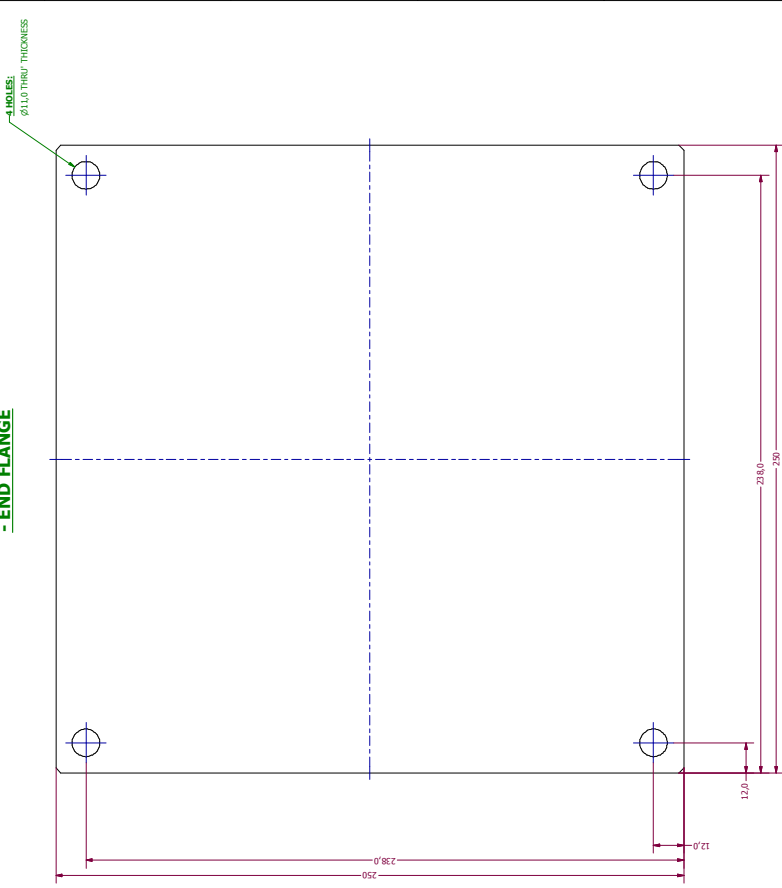
|                          |               |
|--------------------------|---------------|
| Unless otherwise stated: |               |
| Dimensional tolerance:   | X ± 0.5 mm    |
|                          | X.X ± 0.2 mm  |
|                          | X.XX ± 0.1 mm |
| Angular tolerance:       | ± 0.5°        |
| Hole centres:            | ± 0.05 mm     |
| Surface finish:          | 1.6 microns   |
| Dimensions in mm:        | C             |

## INDIUM SEALING TEST - END FLANGE (VACUUM)



**NOTES:**  
1) 2 OFF  
2) SEE FILE: WeldTestEndFlange.igs  
3) Flange holes to match from Leybold  
D440UR flange (PART 86634)

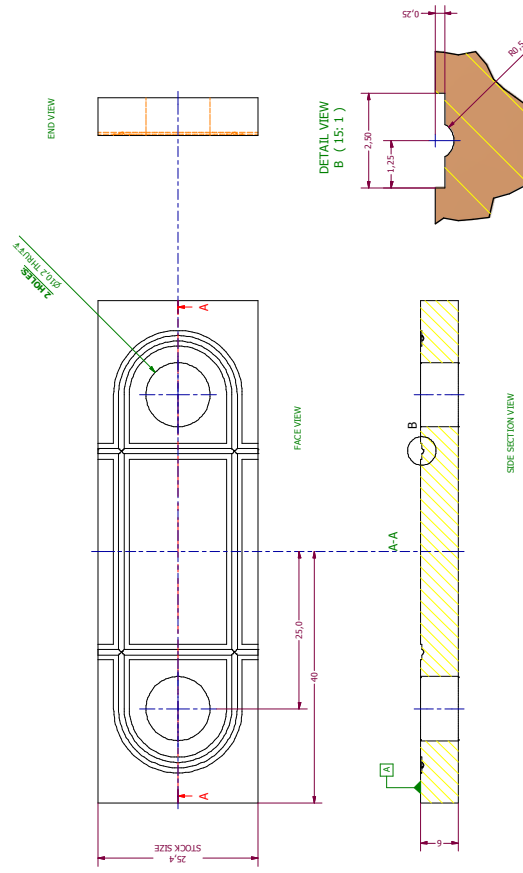
## INDIUM SEALING TEST - END FLANGE



|                                                                                                |                                           |
|------------------------------------------------------------------------------------------------|-------------------------------------------|
| Title: Indium Sealing Test - End Flanges                                                       |                                           |
| Drawn by: P. Savage                                                                            | Projection: Third angle                   |
| Designed by: P. Savage                                                                         | Model file: WeldTestEndFlange.igt         |
| Checked by: N/A                                                                                | Drawing file: WeldModel_Vers02.dwg        |
| Date: 7th June 2010                                                                            | Version number: 1                         |
| Manufactured by: I. Clark, BEP workshop                                                        | Project: Front End Test Stand             |
| Material: C30100 Copper                                                                        | Sheet number: 5 / 20                      |
| Remove all burrs                                                                               | Number off: 2 each                        |
| Scale: Drawn scale                                                                             | Drawing number: ICL_FET2.FTS_FETS_BE_0005 |
| Notes:                                                                                         | Notes: Dimensions in mm                   |
| Contact: p.savage@imperial.ac.uk (Ver 1.0) (14/03/2017) Rev 7/17 (Nelson) 14/03/2018 JAB 80358 |                                           |

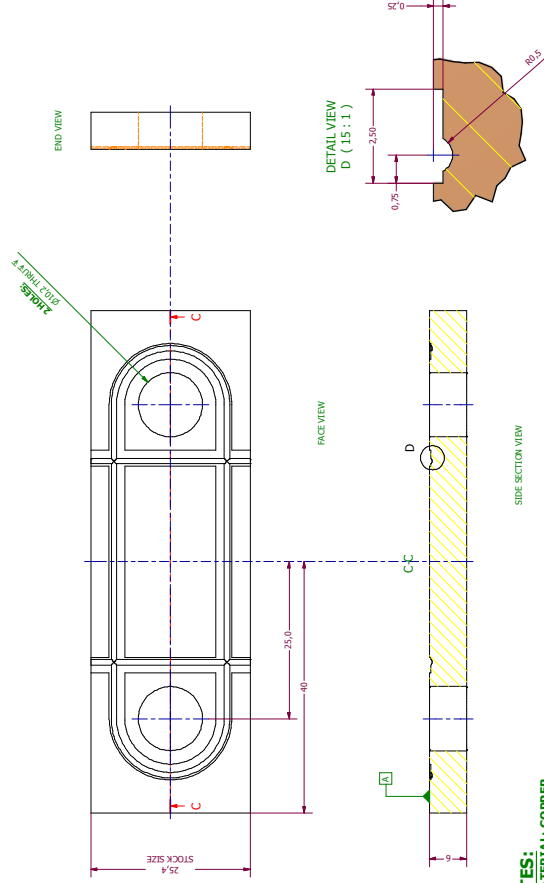
**NOTES:**  
1) 2 OFF  
2) SEE FILE: WeldTestEndFlange.igs

# INDIUM SEALING TEST - CENTRED GROOVE



- NOTES:**
- 1) MATERIAL: COPPER
  - 2) MACHINE FACE 'A' (INDIUM GROOVE FACE) FLAT
  - 3) 1 OFF
  - 4) GROOVE DETAILS IN FILE: IndiumTest\_Centred.igs

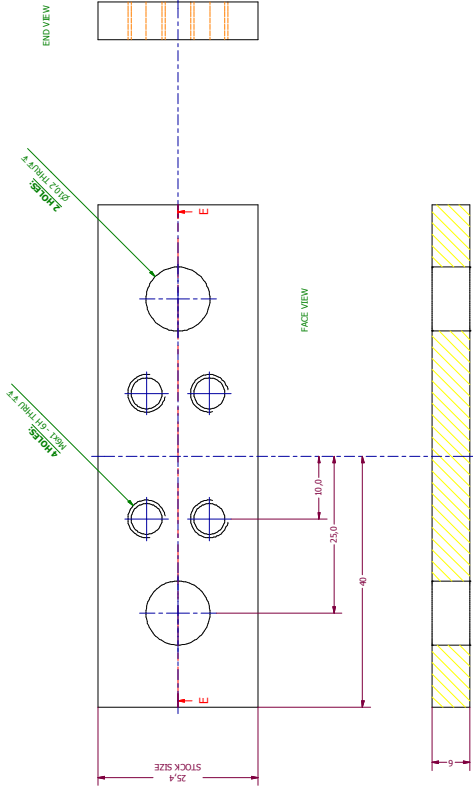
# INDIUM SEALING TEST - OFFSET GROOVE



- NOTES:**
- 1) MATERIAL: COPPER
  - 2) MACHINE FACE 'A' (INDIUM GROOVE FACE) FLAT
  - 3) 1 OFF
  - 4) GROOVE DETAILS IN FILE: IndiumTest\_Offset.igs

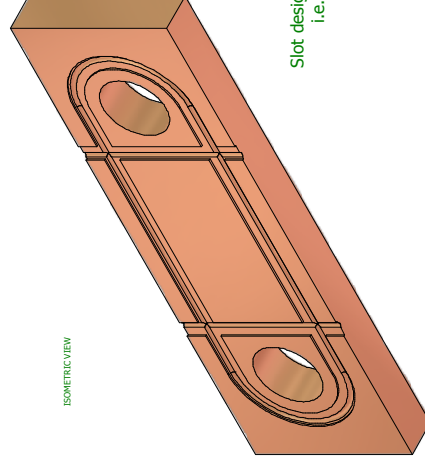
# FRONT END TEST STAND (F.E.T.S.)

<http://fets.lis.lis.rl.ac.uk/>



- NOTES:**
- 1) MATERIAL: COPPER
  - 2) MACHINE ONE FACE FLAT
  - 3) 4 OFF
  - 4) SEE FILE: IndiumTest\_Closing.igs

# INDIUM SEALING TEST - CLOSING PLATE



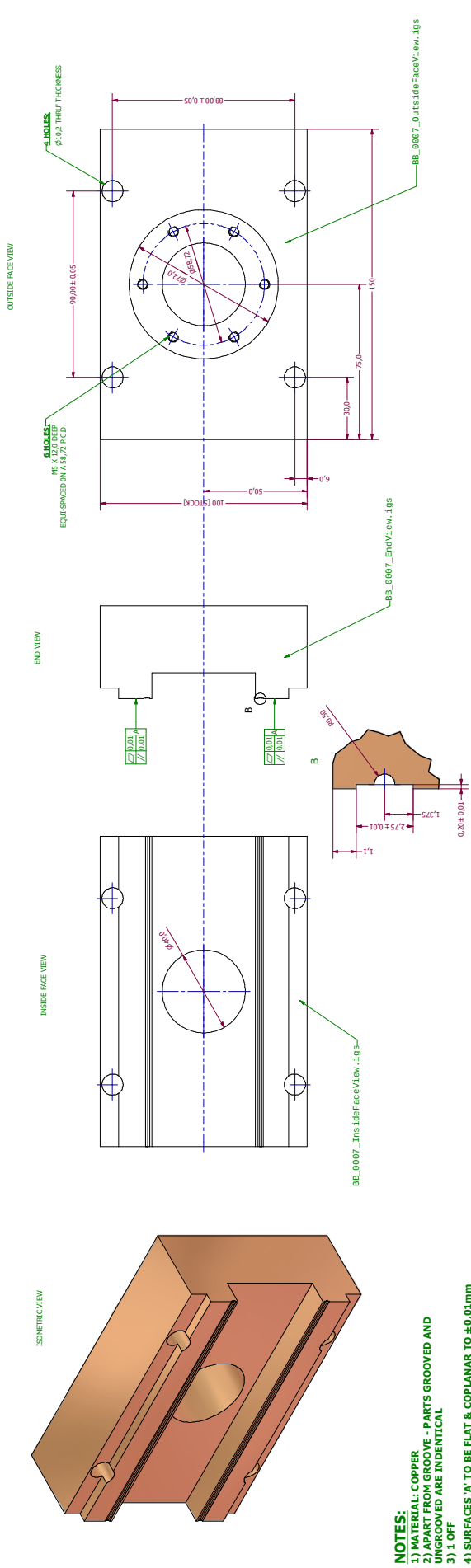
Slot designed to create fill area of 0.78mm<sup>2</sup>  
i.e. to suit Ø1.00 mm Indium wire

## Indium Sealing Test

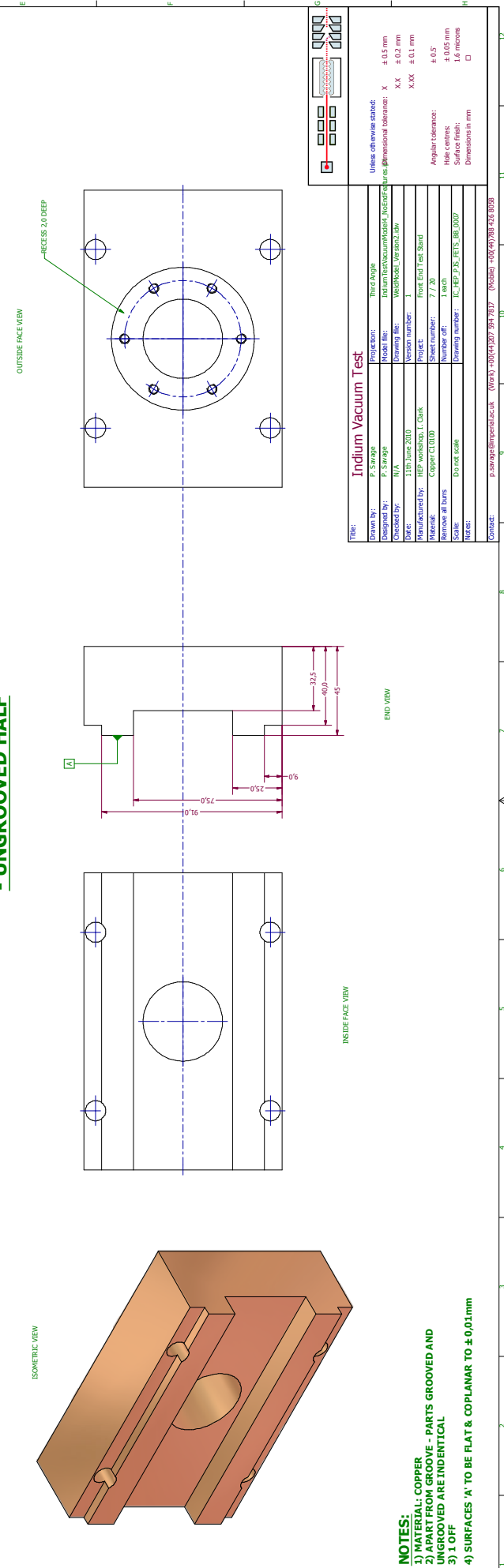
|                          |                         |                              |                               |
|--------------------------|-------------------------|------------------------------|-------------------------------|
| Drawn by:                | P. Savage               | Projection:                  | Third angle                   |
| Designed by:             | P. Savage               | Model file:                  | IndiumTestProc1.ipt           |
| Checked by:              | N/A                     | Drawing file:                | IndiumTestProc1.dwg           |
| Date:                    | 7th May 2010            | Version number:              | 1                             |
| Manufactured by:         | I. W. Clark             | Project:                     | Front End Test Stand          |
| Material:                | Copper                  | Sheet number:                | 6 / 20                        |
| Remove all burrs         |                         | Number of:                   | 3 + 1 + 1                     |
| Scale:                   | Drawn scale             | Drawing number:              | IC-FE2725-FETS_06_0006        |
| Notes:                   |                         |                              |                               |
| Unless otherwise stated: |                         |                              |                               |
| Dimensional tolerance:   | X                       | ± 0.5 mm                     |                               |
|                          | X.X                     | ± 0.2 mm                     |                               |
|                          | X.XX                    | ± 0.1 mm                     |                               |
| Angular tolerance:       |                         | ± 0.5°                       |                               |
| Hole centres:            |                         | ± 0.05 mm                    |                               |
| Surface finish:          |                         | 1.6 microns                  |                               |
| Dimensions in mm         |                         |                              |                               |
| Contact:                 | p.savage@imperial.ac.uk | (Ver 1.0) (4/2010) Rev 79/77 | (M3600) (10/07/08) (20080808) |

## INDIUM VACUUM SEALING TEST - GROOVED HALF

FRONT END TEST STAND (F.E.T.S.)  
<http://fets.lsis.rl.ac.uk/>



## INDIUM VACUUM SEALING TEST - UNGROOVED HALF



|                  |                        |                                                                               |                                       |
|------------------|------------------------|-------------------------------------------------------------------------------|---------------------------------------|
| Title            |                        | Indium Vacuum Test                                                            |                                       |
| Drawn by:        | P. Savage              | Projection:                                                                   | Third Angle                           |
| Designed by:     | P. Savage              | Model file:                                                                   | IndiumTestVacuumFogel7_NutCracker.dwg |
| Checked by:      | N/A                    | Drawing file:                                                                 | IndiumTestVacuumFogel7_Verion2.dwg    |
| Date:            | 11th June 2010         | Version number:                                                               | 1                                     |
| Manufactured by: | HEP Workshop, I. Clark | Project:                                                                      | Front End Test Stand                  |
| Material:        | Copper C1020           | Sheet number:                                                                 | 7 / 20                                |
| Remove all burrs |                        | Number of:                                                                    | 2 each                                |
| Scale:           | Drawn scale            | Drawing number:                                                               | IC-FET-7-5_FETS_BB_0007               |
| Notes:           |                        |                                                                               |                                       |
| Contact:         |                        | p.savage@imperial.ac.uk (Work) +44(0)207 592 7937 (Mobile) +44(0)798 326 8058 |                                       |

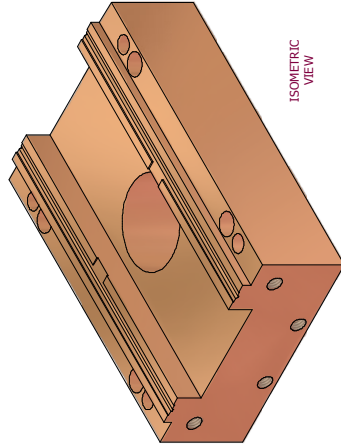
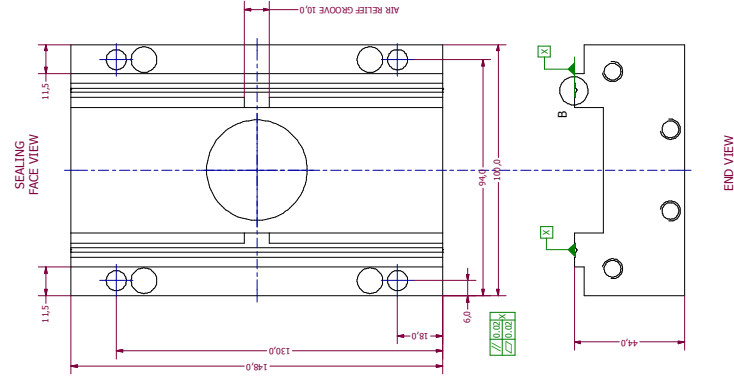
|                          |                          |
|--------------------------|--------------------------|
| Unless otherwise stated: |                          |
| Dimensional tolerance:   | X $\pm 0.5\text{ mm}$    |
|                          | X.X $\pm 0.2\text{ mm}$  |
|                          | X.XX $\pm 0.1\text{ mm}$ |
| Angular tolerance:       | $\pm 0.5^\circ$          |
| Hole centres:            | $\pm 0.05\text{ mm}$     |
| Surface finish:          | 1.6 microns              |
| Dimensions in:           | mm                       |



## 2mm Ø INDIUM VACUUM SEALING TEST

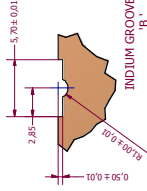
### Grooved Half

1 off



ISOMETRIC VIEW

- Operations:**
- 1) Mill 1mm from each end Y.
  - 2) Mill 1mm from faces X.
  - 3) Mill indium groove.
  - 4) Mill air relief groove.
  - 5) Extend recesses to 11.5mm.
  - 6) Drill 4 off Ø8 x 18 deep holes\*.



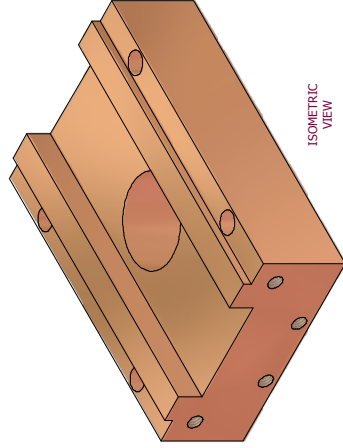
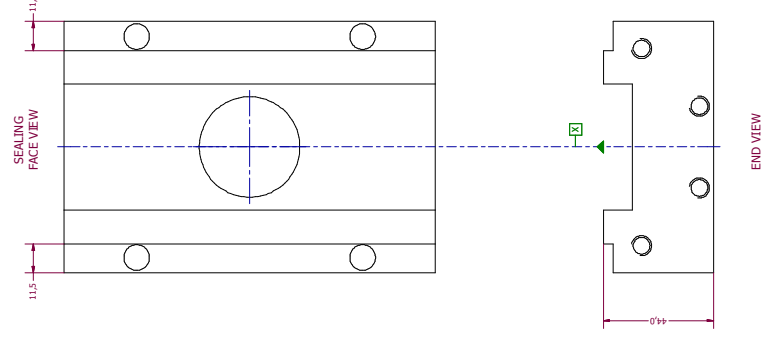
INDIUM GROOVE DETAIL

Material: Copper

## 2mm Ø INDIUM VACUUM SEALING TEST

### Ungrooved Half

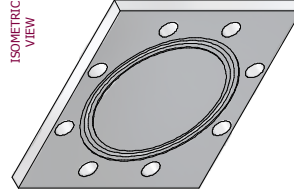
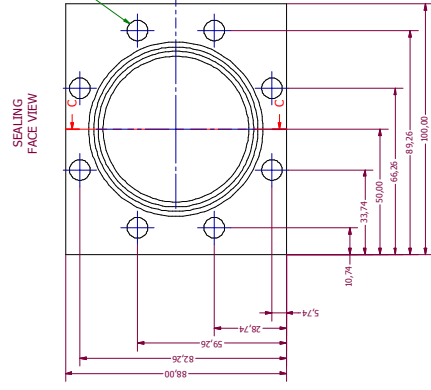
1 off



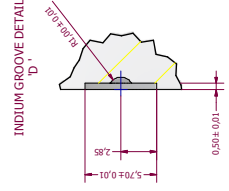
ISOMETRIC VIEW

- Operations:**
- 1) Mill 1mm from each end Y.
  - 2) Mill 1mm from faces X.
  - 3) Extend recesses to 11.5mm.

Material: Copper



ISOMETRIC VIEW



INDIUM GROOVE DETAIL

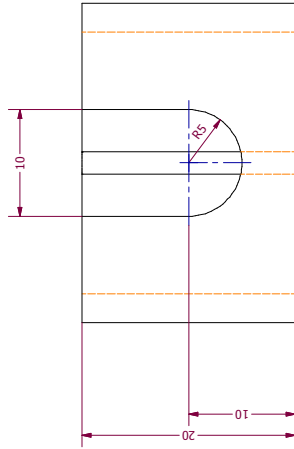
Material: Cast Aluminium Tooling Plate

| Indium Vacuum Test 3     |                                                                                |
|--------------------------|--------------------------------------------------------------------------------|
| Drawn by:                | P. Savage                                                                      |
| Designed by:             | P. Savage                                                                      |
| Checked by:              | N/A                                                                            |
| Date:                    | 1st November 2010                                                              |
| Version number:          | 3                                                                              |
| Project:                 | Front End Test Stand                                                           |
| Sheet number:            | 9 / 20                                                                         |
| Number of:               | Modification of existing                                                       |
| Drawings:                | XC-REF-2-25-FE15-000009                                                        |
| Notes:                   | 1) 12 2mm diameter Indium wire                                                 |
| Contact:                 | p.savage@imperial.ac.uk (Work) +44(0)20 759 79 77 (Mobile) +44(0)7788 726 8058 |
| Unless otherwise stated: |                                                                                |
| Dimensional tolerance:   | X ± 0.5 mm                                                                     |
|                          | X.X ± 0.2 mm                                                                   |
|                          | X.XX ± 0.1 mm                                                                  |
| Angular tolerance:       | ± 0.5°                                                                         |
| Hole centres:            | ± 0.05 mm                                                                      |
| Surface finish:          | 1.6 microns                                                                    |
| Dimensions in mm         | □                                                                              |

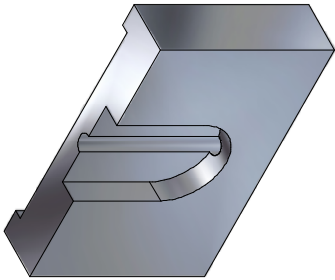
## 2mm Ø INDIUM CUTTING GUIDE

Straight

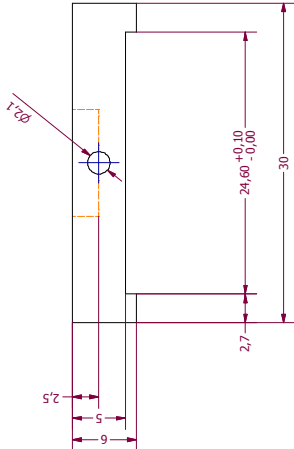
#BB\_0010



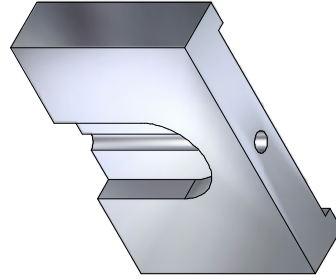
TOP VIEW



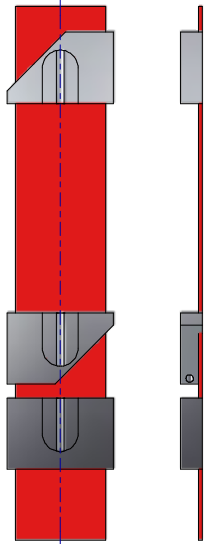
ISOMETRIC VIEWS



END VIEW



**Material:** Aluminium alloy or brass  
**Quantity:** 2 off



TOP VIEW



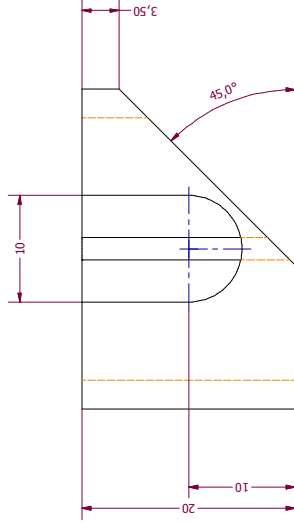
END VIEW

Cutting guides shown on  
steel rule

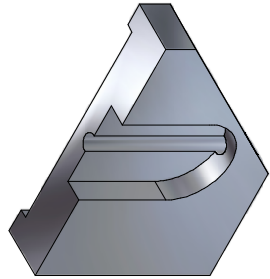
## 2mm Ø INDIUM CUTTING GUIDE

45°

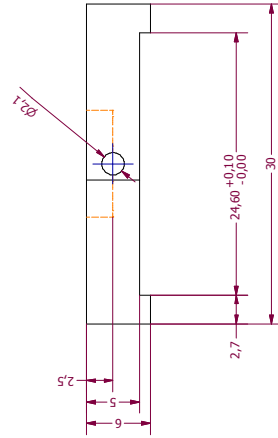
2 off



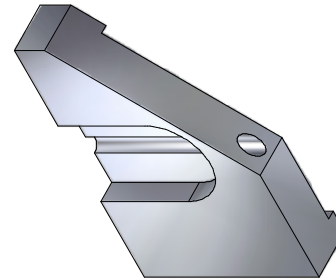
TOP VIEW



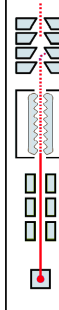
ISOMETRIC VIEWS



END VIEW



**Material:** Aluminium alloy or brass  
**Quantity:** 2 off



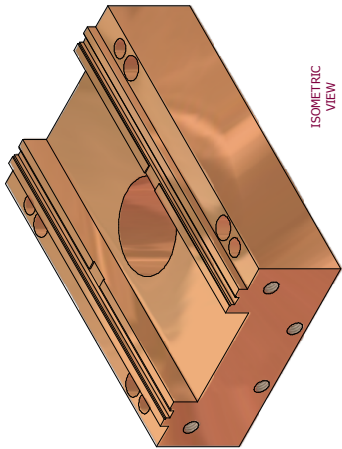
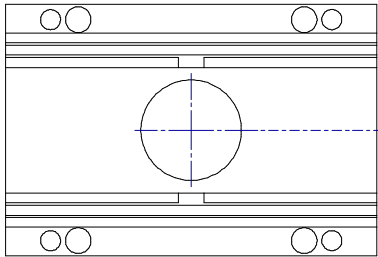
### Indium Vacuum Test - 2mm cutting guides

|                  |                                                                                 |                 |                         |
|------------------|---------------------------------------------------------------------------------|-----------------|-------------------------|
| Drawn by:        | P. Savage                                                                       | Projection:     | Third angle             |
| Designed by:     | P. Savage                                                                       | Model file:     | IndiumCutting.jgiam     |
| Checked by:      | N/A                                                                             | Drawing file:   | WeldModel_Version2.dwg  |
| Date:            | 18th Nov 2010                                                                   | Version number: | 1                       |
| Manufactured by: | I. Clark, HEP workshop                                                          | Project:        | Front End Test Stand    |
| Material:        | Al alloy or brass                                                               | Sheet number:   | 10 / 20                 |
| Remove all burrs |                                                                                 | Number off:     | 2 each type             |
| Scale:           | Do not scale                                                                    | Drawing number: | IC_HEP_PIS_FETS_BB_0010 |
| Notes:           |                                                                                 |                 |                         |
| Contact:         | p.savage@imperial.ac.uk (Work) +00(44)207 594 7817 (Mobile) +00(44)888 426 8058 |                 |                         |

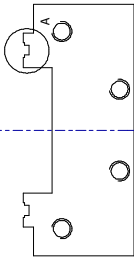
### 3D 'O' RING VACUUM SEALING TEST

#### Grooved Half

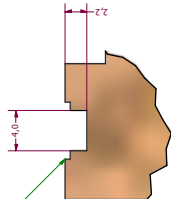
2 off



ISOMETRIC VIEW



EXTRA STEP IS LEFT  
OVER FOR REMOVAL  
PREVIOUS TEST



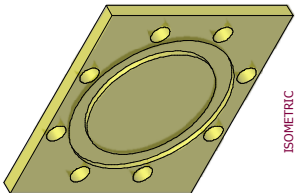
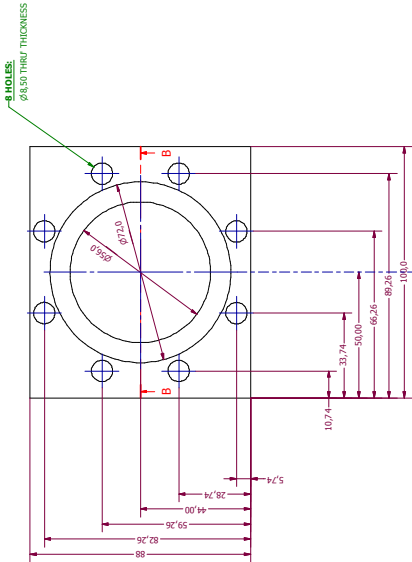
Ø3.0mm 'O' RING GROOVE DETAIL 'A'

MODIFICATION  
OF EXISTING  
TEST PIECE

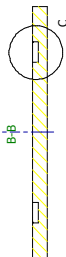
### 3D 'O' RING VACUUM SEALING TEST

#### End flange

2 off



ISOMETRIC VIEW



B-B

CUSTOM MADE SQUARE RING  
GROOVE DETAIL 'C'



#### FRONT END TEST STAND (F.E.T.S.)

<http://fets.isis.rl.ac.uk/>

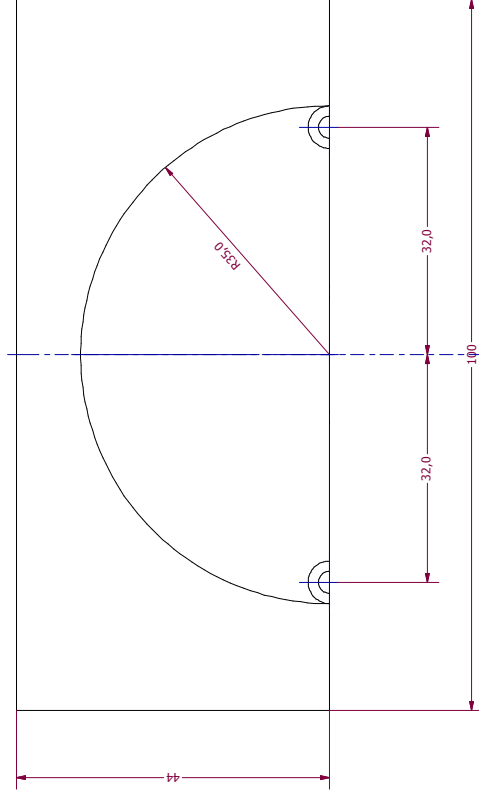
|                  |                         |                             |                            |
|------------------|-------------------------|-----------------------------|----------------------------|
| File:            | Projection:             | Model file:                 | BoxsetO Ring test.dwt      |
| Drawn by:        | Checked by:             | Drawing file:               | Weldcode_Ver2.dwg          |
| Date:            | Version number:         | Project:                    | 11 / 20                    |
| Manufactured by: | Material:               | Sheet number:               | 11 / 20                    |
| Remove all burrs | Number of:              | Drawing number:             |                            |
| Notes:           |                         |                             |                            |
| Contact:         | p.sanger@imperial.ac.uk | (Ver 1) 10/04/2007 09:17:37 | (M360) 10/04/2007 09:18:08 |

|                          |               |
|--------------------------|---------------|
| Unless otherwise stated: |               |
| Dimensional tolerance:   | X ± 0.5 mm    |
|                          | X.X ± 0.2 mm  |
|                          | X.XX ± 0.1 mm |
| Angular tolerance:       | ± 0.5°        |
| Hole centres:            | ± 0.05 mm     |
| Surface finish:          | 1.6 microns   |
| Dimensions in mm         | □             |

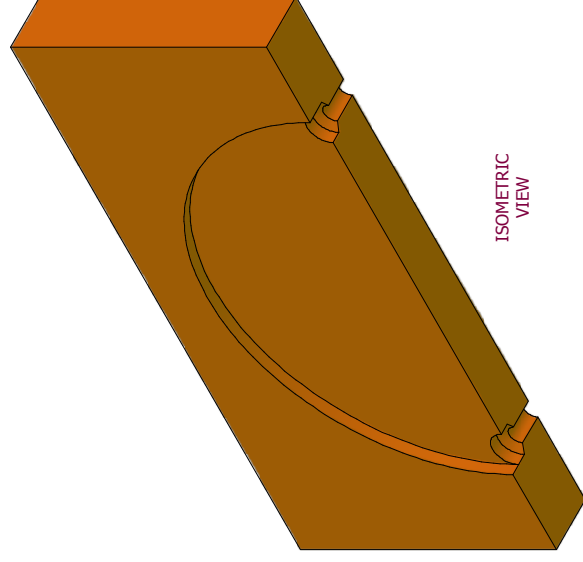
## 3D 'O' RING BONDING JIG

## CAST ALUMINIUM TOOLING PLATE

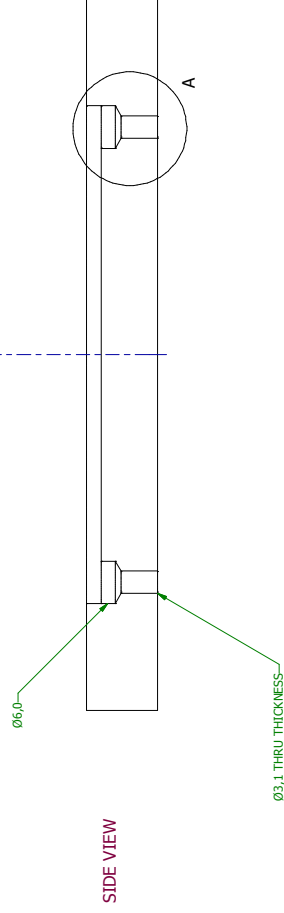
2 off



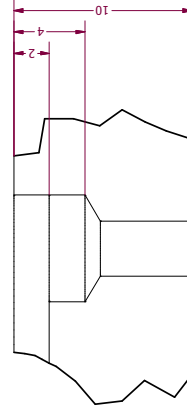
## PLAN VIEW



ISOMETRIC  
VIEW



## SIDE VIEW



DETAIL  
VIEW 'A'

**FRONT END TEST STAND (F.E.T.S.)**

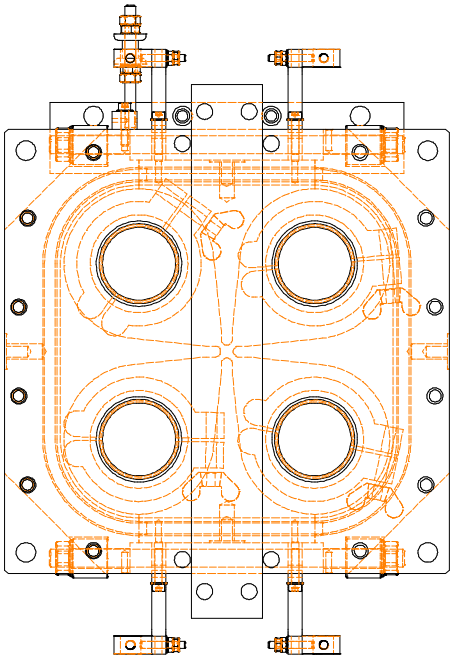
<http://fets.isis.rl.ac.uk/>

|                                |                                                                                 |                 |                        |
|--------------------------------|---------------------------------------------------------------------------------|-----------------|------------------------|
| <b>3D 'O' Ring Bonding Jig</b> |                                                                                 |                 |                        |
| Title:                         |                                                                                 |                 |                        |
| Drawn by:                      | P. Savage                                                                       | Projection:     | Third angle            |
| Designed by:                   | P. Savage                                                                       | Model file:     | BondingJig.rpt         |
| Checked by:                    | N/A                                                                             | Drawing file:   | WeldModel_Version2.dwg |
| Date:                          | 13th December 2010                                                              | Version number: | 1                      |
| Manufactured by:               | 1 Clark, HEP workshop                                                           | Project:        | Front End Test Stand   |
| Material:                      | Cast alu tooling plate                                                          | Sheet number:   | 12 / 20                |
| Remove all burrs               |                                                                                 | Number off:     | 2                      |
| Scale:                         | Do not scale                                                                    | Drawing number: | TC_HEP_PDS_FFS_B80012  |
| Notes:                         |                                                                                 |                 |                        |
| Contact:                       | p.savage@imperial.ac.uk (Work) +00(44)207 594 7817 (Mobile) +00(44)788 426 8058 |                 |                        |

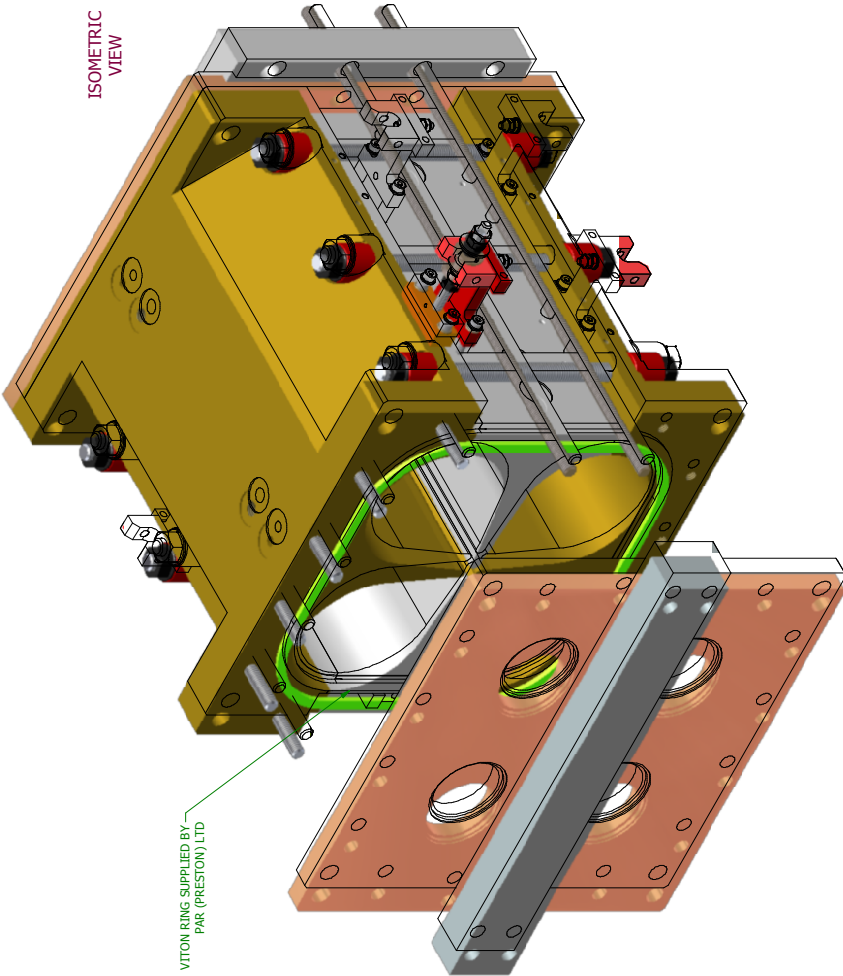
### 3D 'O' RING TEST ASSEMBLY OVERVIEW

FRONT END TEST STAND (F.E.T.S.)  
http://fets.isis.rl.ac.uk/

END VIEW

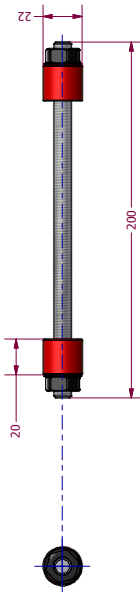


ISOMETRIC  
VIEW



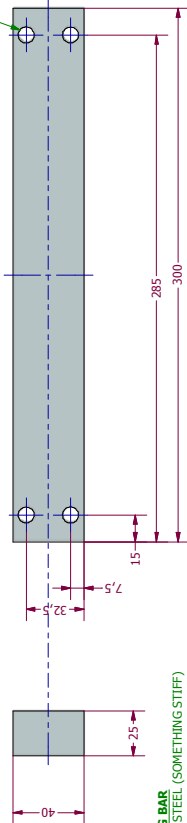
VITON RING SUPPLIED BY:  
PAR (PRESTON) LTD

M8 x 45 LONG STUDDING,  
RS PART NO. 303-1029  
24 OFF



M10 x 200 LONG STUDDING,  
6 ASSEMBLIES

4 HOLES:  
Ø9 THRU THICKNESS

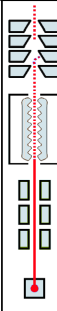


**CLAMPING BAR**  
MATERIAL: STEEL (SOMETHING STIFF)  
QUANTITY: 2 OFF  
DIMENSIONS ARE FLEXIBLE  
MUST PASS BETWEEN KF40 FLANGES

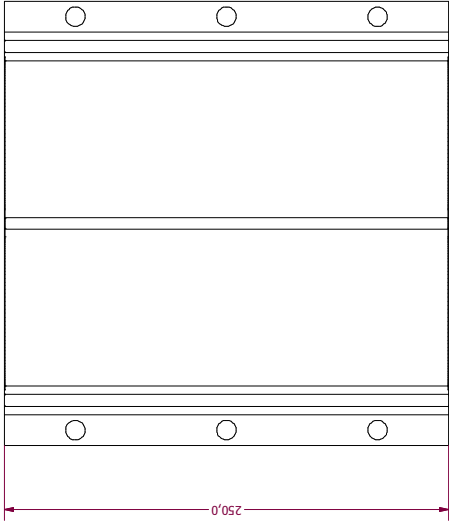
### 3D 'O' Ring Test - Overview

|                  |                                                                                 |
|------------------|---------------------------------------------------------------------------------|
| Title:           | 3D 'O' Ring Test - Overview                                                     |
| Drawn by:        | P. Savage                                                                       |
| Designed by:     | P. Savage                                                                       |
| Checked by:      | N/A                                                                             |
| Date:            | 20th January 2011                                                               |
| Manufactured by: | 1. W. Clark, HEP                                                                |
| Material:        | 304SS per part                                                                  |
| Sheet number:    | 13 / 20                                                                         |
| Remove all burrs | 1 complete assembly                                                             |
| Scale:           | Do not scale                                                                    |
| Notes:           |                                                                                 |
| Contact:         | p.savage@imperial.ac.uk (Work) +00(44)207 594 7817 (Mobile) +00(44)288 426 8058 |

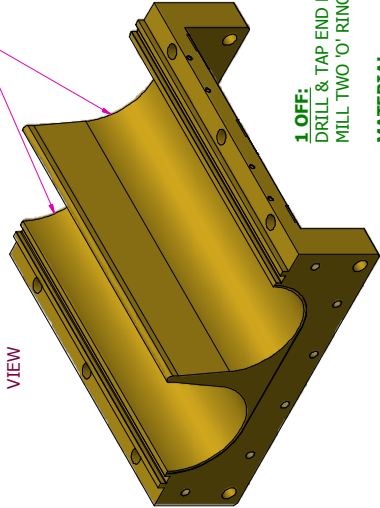
Unless otherwise stated:  
Dimensional tolerance: X ± 0.5 mm  
X.X ± 0.2 mm  
X.XX ± 0.1 mm  
Angular tolerance: ± 0.5°  
Hole centres: ± 0.05 mm  
Surface finish: 1.6 microns  
Dimensions in mm □



PLAN VIEW

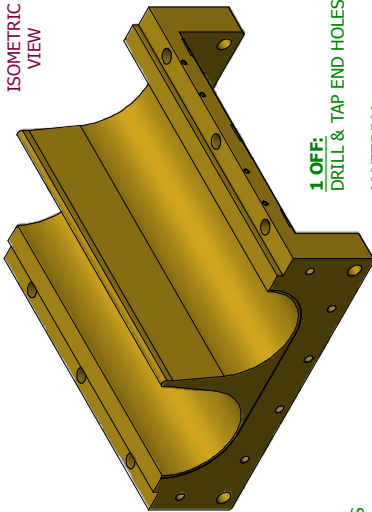


ISOMETRIC  
VIEW



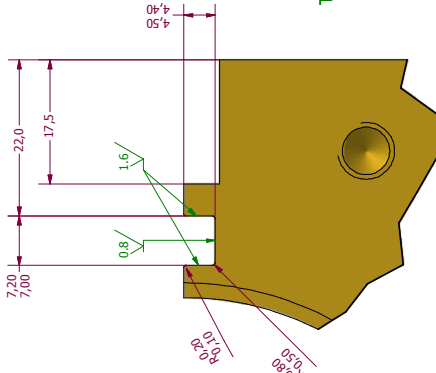
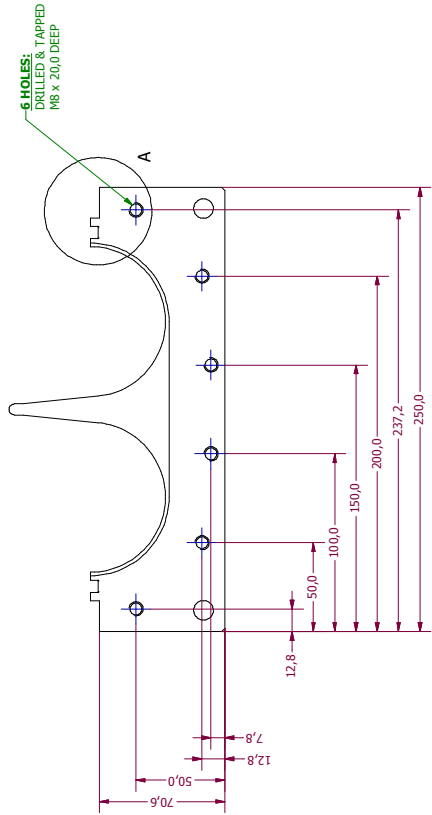
**1 OFF:**  
DRILL & TAP END HOLES  
MILL TWO 'O' RING GROOVES  
**MATERIAL:**  
OXYGEN FREE COPPER

ISOMETRIC  
VIEW



**1 OFF:**  
DRILL & TAP END HOLES  
**MATERIAL:**  
OXYGEN FREE COPPER

END VIEW

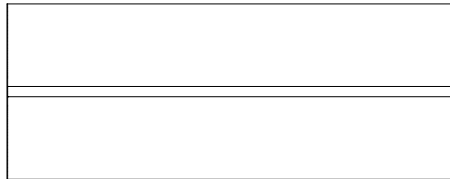


**'O' RING GROOVE**  
DETAIL VIEW 'A'  
TO SUIT Ø5,7 ±0,12 VITON 'O' RING CORD  
RS PART NO. 245-9678

3D 'O' Ring Test - Major Vane

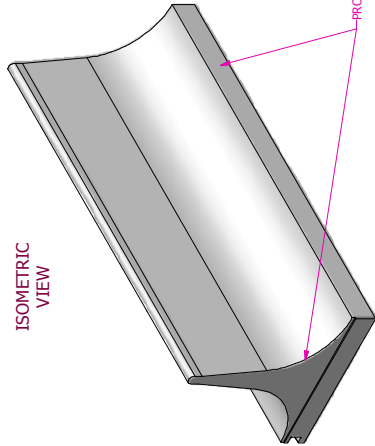
|                  |                                                                                |                 |                                    |
|------------------|--------------------------------------------------------------------------------|-----------------|------------------------------------|
| Title:           | 3D 'O' Ring Test - Major Vane                                                  | Projection:     | Third angle                        |
| Drawn by:        | P. Savage                                                                      | Model file:     | RFQ_MajorVane_Viertest_OringGroove |
| Designed by:     | P. Savage                                                                      | Drawing file:   | WeldModel_Version2.dwg             |
| Checked by:      | N/A                                                                            | Version number: | 1                                  |
| Date:            | 20th January 2011                                                              | Project:        | Front End Test Stand               |
| Manufactured by: | I. Clark, HEP workshop                                                         | Sheet number:   | 14 / 20                            |
| Material:        | Oxygen Free Copper                                                             | Number off:     | 2                                  |
| Remove all burrs |                                                                                | Drawing number: | IC_HEP_PIS_FETS_BB_0014            |
| Scale:           | Do not scale                                                                   |                 |                                    |
| Notes:           |                                                                                |                 |                                    |
| Contact:         | p.savage@imperial.ac.uk (Work) +00(44)207 594 7817 (Mobile) +00(44)88 426 8058 |                 |                                    |

|                          |                                             |
|--------------------------|---------------------------------------------|
| Unless otherwise stated: |                                             |
| Dimensional tolerance:   | X ± 0.5 mm<br>X.X ± 0.2 mm<br>X.XX ± 0.1 mm |
| Angular tolerance:       | ± 0.5°                                      |
| Hole centres:            | ± 0.05 mm                                   |
| Surface finish:          | 1.6 microns                                 |
| Dimensions in mm         | □                                           |



PLAN VIEW

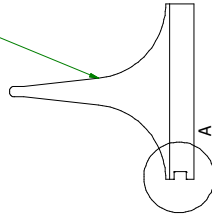
ISOMETRIC  
VIEW



**2 OFF:**  
MILL ONE 'O' RING GROOVE

**MATERIAL:**  
OXYGEN FREE COPPER

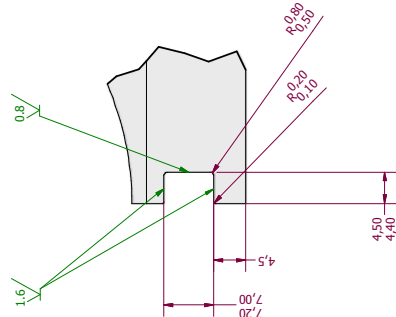
PROTECT VANE SURFACES



END VIEW

'O' RING GROOVE  
DETAIL VIEW 'A'

TO SUIT  $\phi 5,7 \pm 0,12$  VITON 'O' RING CORD  
RS PART NO. 245-9678



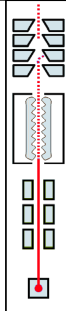
3D 'O' Ring Test - Minor Vane

|                  |                                                                                 |
|------------------|---------------------------------------------------------------------------------|
| Title:           | 3D 'O' Ring Test - Minor Vane                                                   |
| Drawn by:        | P. Savage                                                                       |
| Designed by:     | P. Savage                                                                       |
| Checked by:      | N/A                                                                             |
| Date:            | 20th January 2011                                                               |
| Manufactured by: | I. Clark, HEP workshop                                                          |
| Material:        | Oxygen Free Copper                                                              |
| Remove all burrs |                                                                                 |
| Scale:           | Do not scale                                                                    |
| Notes:           |                                                                                 |
| Contact:         | p.savage@imperial.ac.uk (Work) +00(44)207 594 7817 (Mobile) +00(44)288 426 8058 |

## 3D 'O' RING TEST

### MINOR VANE

|                          |                          |
|--------------------------|--------------------------|
| Unless otherwise stated: |                          |
| Dimensional tolerance:   | X $\pm 0.5$ mm           |
|                          | X.X $\pm 0.2$ mm         |
|                          | X.XX $\pm 0.1$ mm        |
| Angular tolerance:       | $\pm 0.5^\circ$          |
| Hole centres:            | $\pm 0.05$ mm            |
| Surface finish:          | 1.6 microns              |
| Dimensions in mm         | <input type="checkbox"/> |



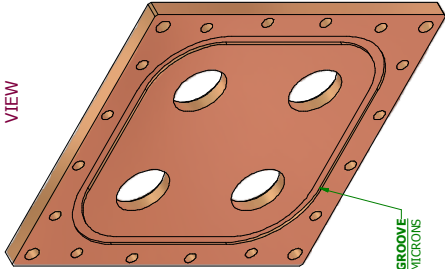
# 3D 'O' RING TEST

## COPPER END PLATES

### 2 off - PLAIN

### 2 off - WITH DN40KF VACUUM FLANGES

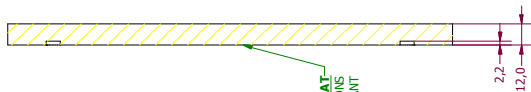
ISOMETRIC  
VIEW



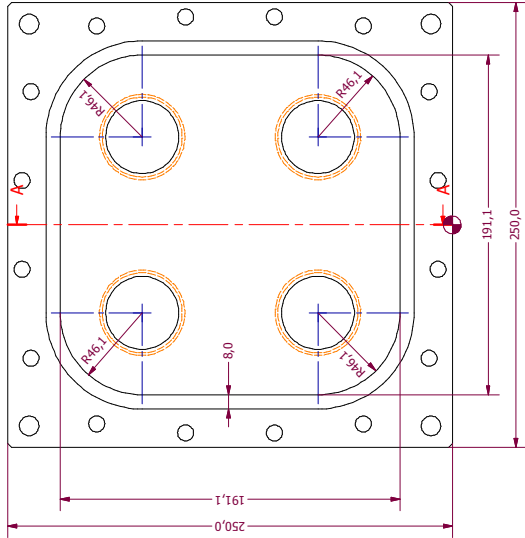
VITON FLAT RING GROOVE  
SURFACE ROUGHNESS < 0.8 MICRONS

SIDE SECTION  
VIEW

A-A (1:2)

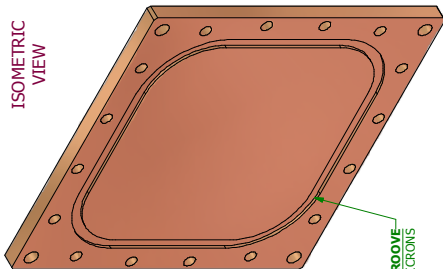


SEALING FACE  
VIEW



SKIM FACE UNTIL FLAT  
SURFACE ROUGHNESS < 1.0 MICRONS  
FINAL THICKNESS NOT IMPORTANT

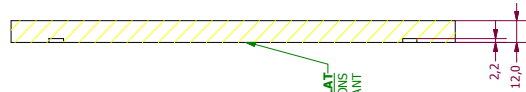
ISOMETRIC  
VIEW



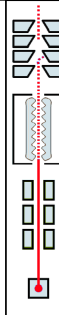
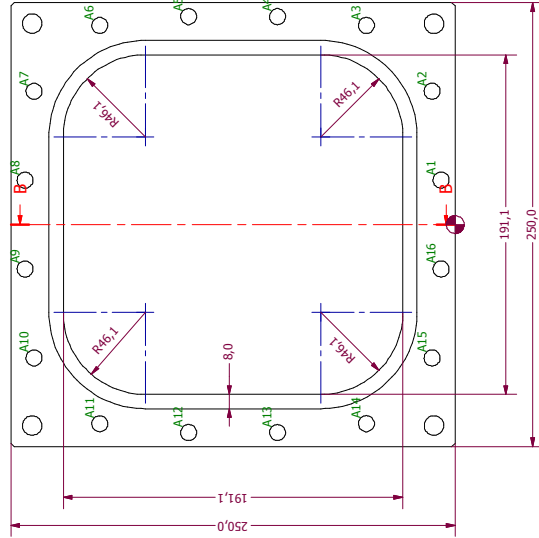
VITON FLAT RING GROOVE  
SURFACE ROUGHNESS < 0.8 MICRONS

SIDE SECTION  
VIEW

B-B (1:2)



SEALING FACE  
VIEW



Unless otherwise stated:

Dimensional tolerance: X ± 0.5 mm  
X.X ± 0.2 mm  
X.XX ± 0.1 mm

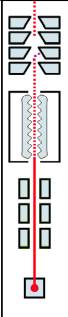
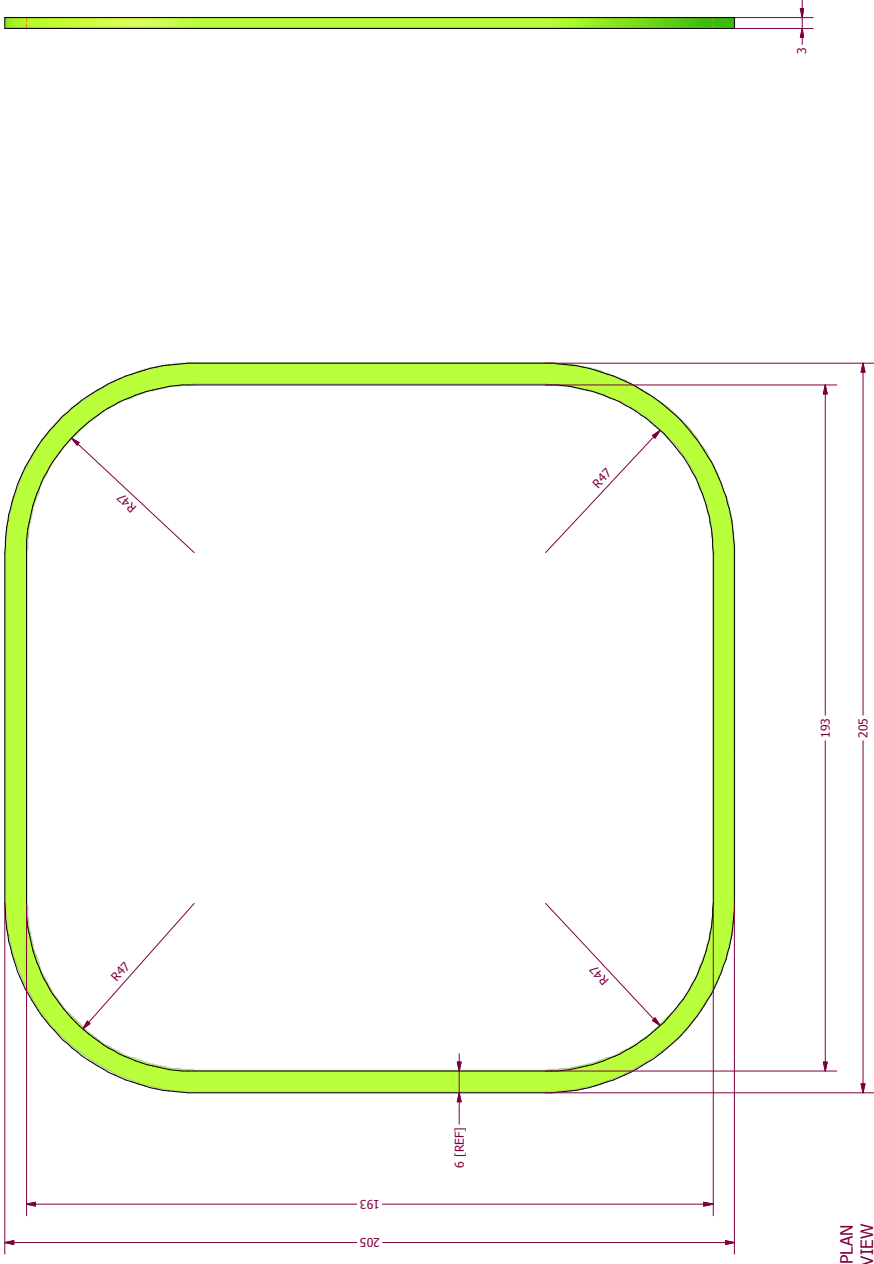
Angular tolerance:

± 0.5°  
Hole centres: ± 0.05 mm  
Surface finish: 1.6 microns

Dimensions in mm

## 3D 'O' Ring Test - End Flanges

|                  |                                                                                 |
|------------------|---------------------------------------------------------------------------------|
| Title:           | 3D 'O' Ring Test - End Flanges                                                  |
| Drawn by:        | P. Savage                                                                       |
| Designed by:     | P. Savage                                                                       |
| Checked by:      | N/A                                                                             |
| Date:            | 19th January 2011                                                               |
| Manufactured by: | I. Clark, HEP workshop                                                          |
| Material:        | Copper                                                                          |
| Sheet number:    | 16 / 20                                                                         |
| Remove all burrs | 2 each type                                                                     |
| Scale:           | Do not scale                                                                    |
| Notes:           | IC_HEP_PIS_FETS_BB_0016                                                         |
| Contact:         | p.savage@imperial.ac.uk (Work) +00(44)207 594 7817 (Mobile) +00(44)888 426 8058 |



|                                                                                          |                                         |
|------------------------------------------------------------------------------------------|-----------------------------------------|
| Title: 3D 'O' Ring Test - End Flange Viton Ring                                          |                                         |
| Drawn by: P. Savage                                                                      | Projection: Third angle                 |
| Designed by: P. Savage                                                                   | Model file: EndFlangeORing.ipt          |
| Checked by: N/A                                                                          | Drawing file: WeldModel_Version2.dwg    |
| Date: 19th January 2011                                                                  | Version number: 1                       |
| Manufactured by: PAR (Preston) Ltd                                                       | Project: Front End Test Stand           |
| Material: Viton                                                                          | Sheet number: 17 / 20                   |
| Remove all burrs                                                                         | Number off: 8                           |
| Scale: Do not scale                                                                      | Drawing number: IC_HEP_PIS_FETS_BB_0017 |
| Notes:                                                                                   |                                         |
| Contact: p.savage@imperial.ac.uk (Work) +00(44)207 594 7817 (Mobile) +00(44)888 426 8058 |                                         |

|                          |                                             |
|--------------------------|---------------------------------------------|
| Unless otherwise stated: |                                             |
| Dimensional tolerance:   | X ± 0.5 mm<br>X.X ± 0.2 mm<br>X.XX ± 0.1 mm |
| Angular tolerance:       | ± 0.5°                                      |
| Hole centres:            | ± 0.05 mm                                   |
| Surface finish:          | 1.6 microns                                 |
| Dimensions in mm         | □                                           |



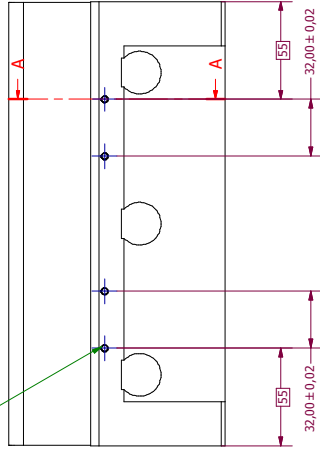
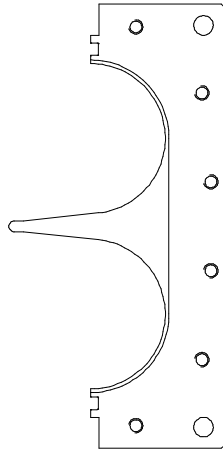
## 3D 'O' RING TEST

### MAJOR VANE & MINOR VANE MODIFICATIONS

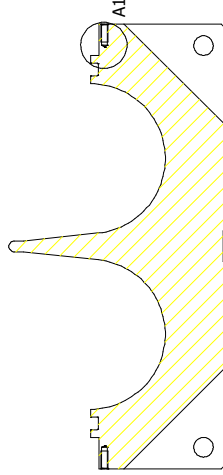
**FRONT END TEST STAND (F.E.T.S.)**

<http://fets.isis.rl.ac.uk/>

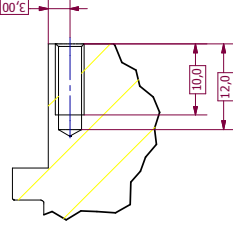
8 HOLES  
M4 X 0.7 - 6H X 10.0 MIN DEEP  
TAP DRILL 12.0 DEEP



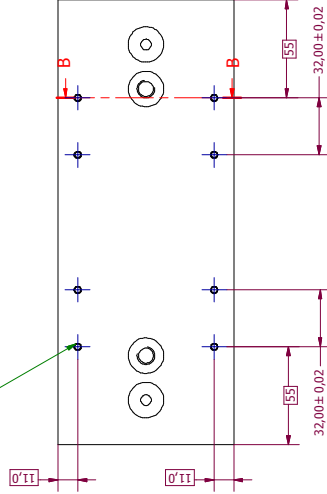
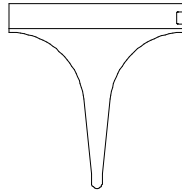
A-A (1:2)



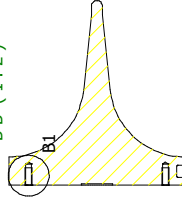
A1 (2:1)



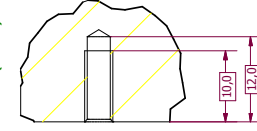
8 HOLES  
M4 X 0.7 - 6H X 10.0 MIN DEEP  
TAP DRILL 12.0 DEEP



B-B (1:2)



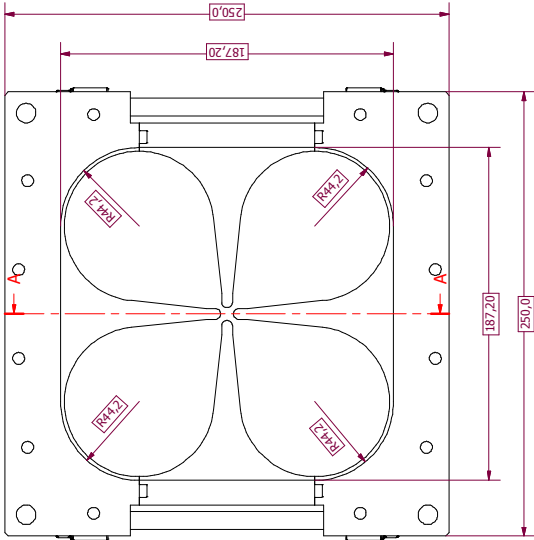
B1 (2:1)



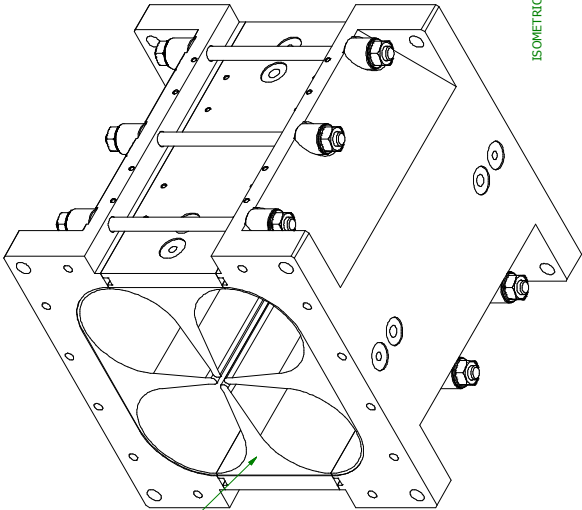
### 3D 'O' Ring Test - Vane modifications

|                          |                                             |
|--------------------------|---------------------------------------------|
| Title:                   | 3D 'O' Ring Test - Vane modifications       |
| Drawn by:                | P. Savage                                   |
| Designed by:             | P. Savage                                   |
| Checked by:              | N/A                                         |
| Date:                    | 13th May 2011                               |
| Manufactured by:         | I. Clark, HEP workshop                      |
| Material:                | OF C                                        |
| Remove all burrs         |                                             |
| Scale:                   | Do not scale                                |
| Notes:                   |                                             |
| Projection:              | Third angle                                 |
| Model file:              | RfQ_MajorVane_WebTest_OringGroove.plt       |
| Drawing file:            | WebTest_Version2.dwg                        |
| Version number:          | 1                                           |
| Project:                 | Front End Test Stand                        |
| Sheet number:            | 19 / 20                                     |
| Number off:              | N/A                                         |
| Drawing number:          | IC_HEP_PIS_FETS_BB_0019                     |
| Unless otherwise stated: |                                             |
| Dimensional tolerance:   | X ± 0.5 mm<br>X.X ± 0.2 mm<br>X.XX ± 0.1 mm |
| Angular tolerance:       | ± 0.5°                                      |
| Hole centres:            | ± 0.05 mm                                   |
| Surface finish:          | 1.6 microns                                 |
| Dimensions in mm         | □                                           |

ADDITION OF 8 TAPPED HOLES FOR BOTH MAJOR VANES AND  
BOTH MINOR VANES. TAPPED HOLES WILL ENABLE TEST OF  
ASSEMBLY ALIGNMENT BLOCKS.



END VIEW

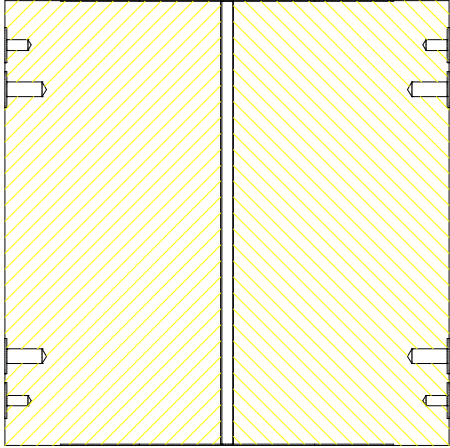


RECESS 0.5 DEEP

ISOMETRIC VIEW

## 3D 'O' RING TEST ASSEMBLY END RECESSES

SIDE SECTION  
A-A (1:2)



### PROCEDURE

- 1) Place assembly vertically on surface plate
- 2) Align vane internal surfaces to best position by eye and by touch
- 3) Clamp together and check alignment
- 4) Clamp to milling machine bed
- 5) Machine top face until it completely cleans up
- 6) Machine 0.5 deep recess
- 7) Turn over - protect machined surface
- 8) Repeat steps 4, 5 and 6

### FRONT END TEST STAND (F.E.T.S.)

<http://fets.isis.rl.ac.uk/>

### 3D 'O' Ring Test - Assembly End Recesses

|                  |                                                                                 |
|------------------|---------------------------------------------------------------------------------|
| Title:           | 3D 'O' Ring Test - Assembly End Recesses                                        |
| Drawn by:        | P. Savage                                                                       |
| Designed by:     | P. Savage                                                                       |
| Checked by:      | N/A                                                                             |
| Date:            | 25th May 2011                                                                   |
| Manufactured by: | I. Clark, HEP workshop                                                          |
| Material:        | OF C                                                                            |
| Remove all burrs |                                                                                 |
| Scale:           | Do not scale                                                                    |
| Notes:           |                                                                                 |
| Contact:         | p.savage@imperial.ac.uk (Work) +00(44)207 594 7817 (Mobile) +00(44)888 426 8058 |

|                          |                                             |
|--------------------------|---------------------------------------------|
| Unless otherwise stated: |                                             |
| Dimensional tolerance:   | X ± 0.5 mm<br>X.X ± 0.2 mm<br>X.XX ± 0.1 mm |
| Angular tolerance:       | ± 0.5°                                      |
| Hole centres:            | ± 0.05 mm                                   |
| Surface finish:          | 1.6 microns                                 |
| Dimensions in mm         | □                                           |