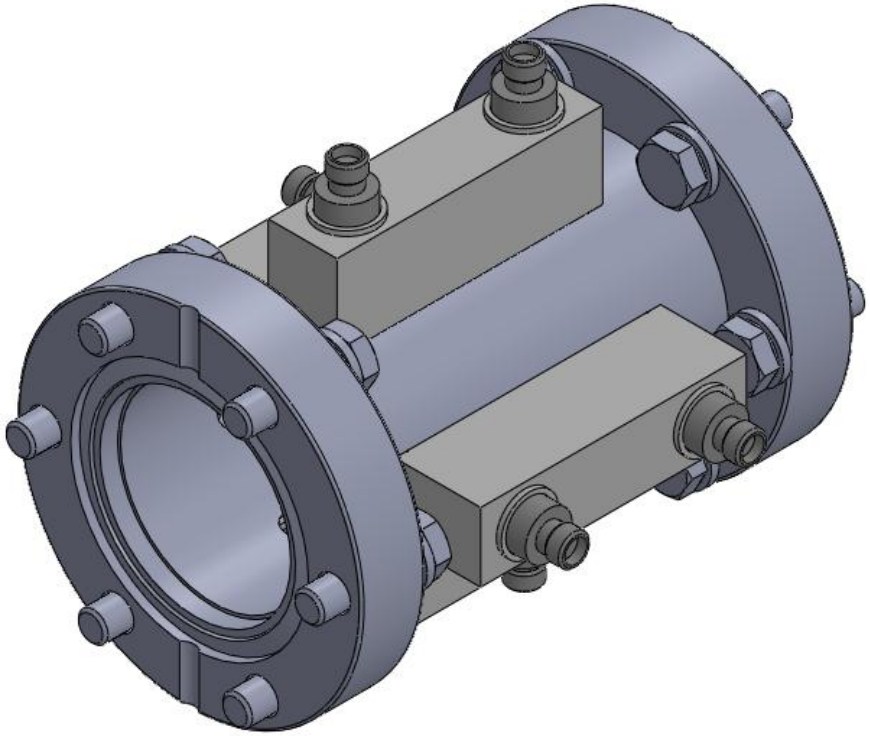


BPM

Manufacturing

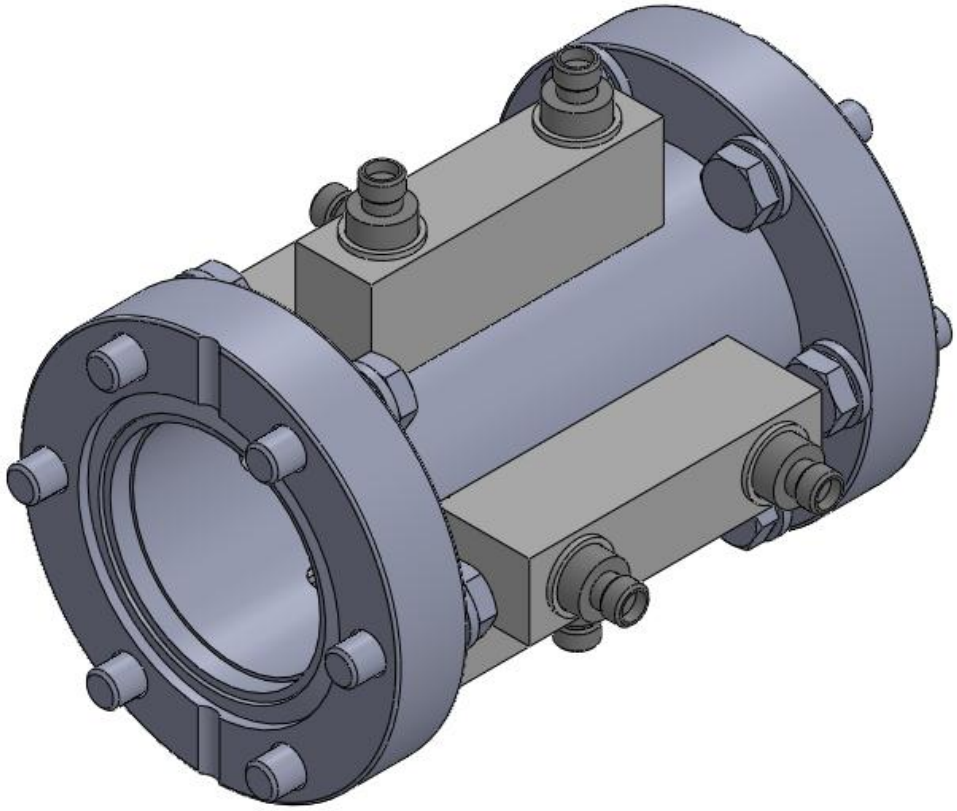
Zamudio, 12/07/17

Arturo Ortega, Igor Rueda

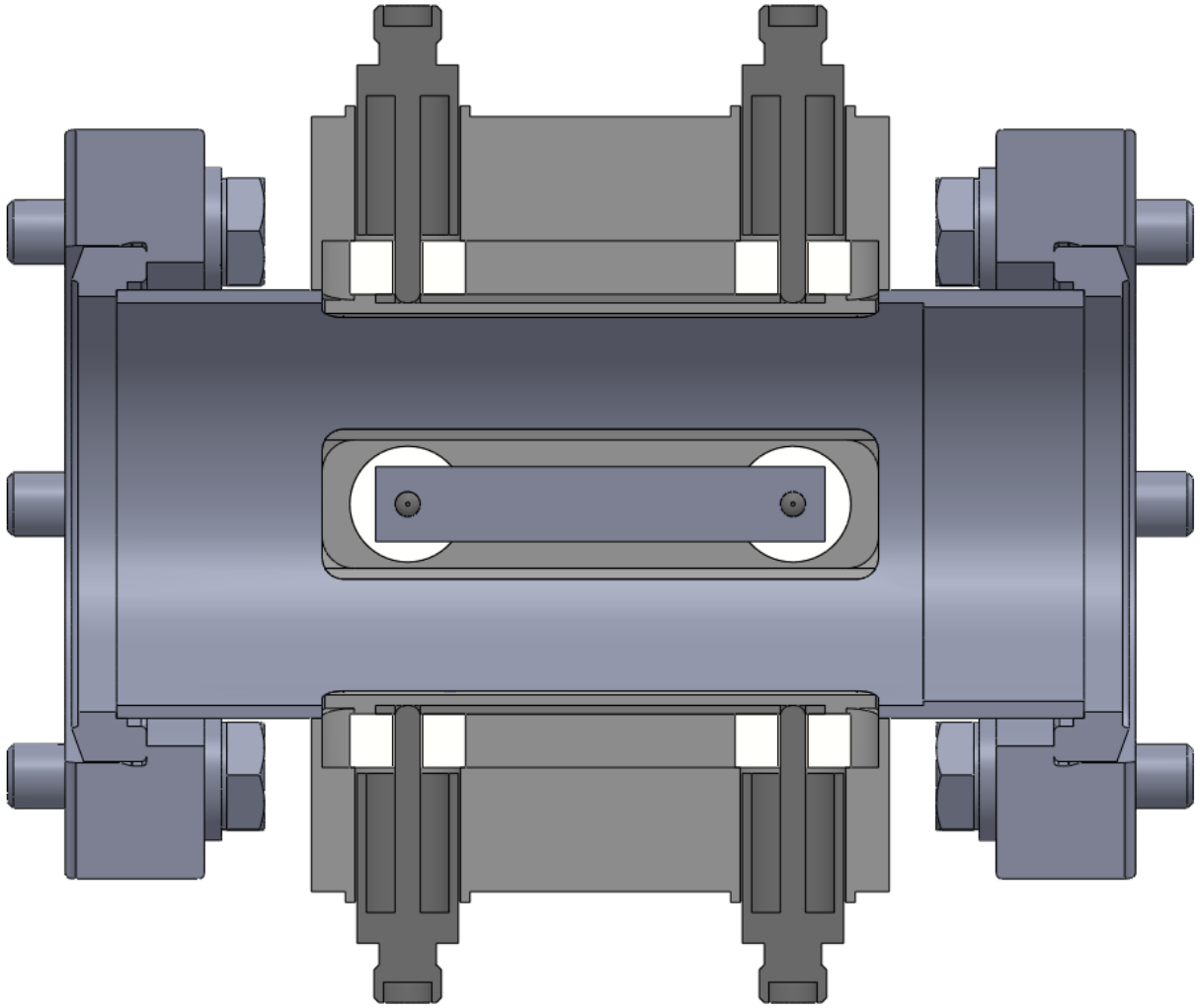
Index

1. Design
2. Parts Machining → QA
3. E-Beam Welding
4. Vacuum Tests → QA
5. Troubleshooting

Design (I)

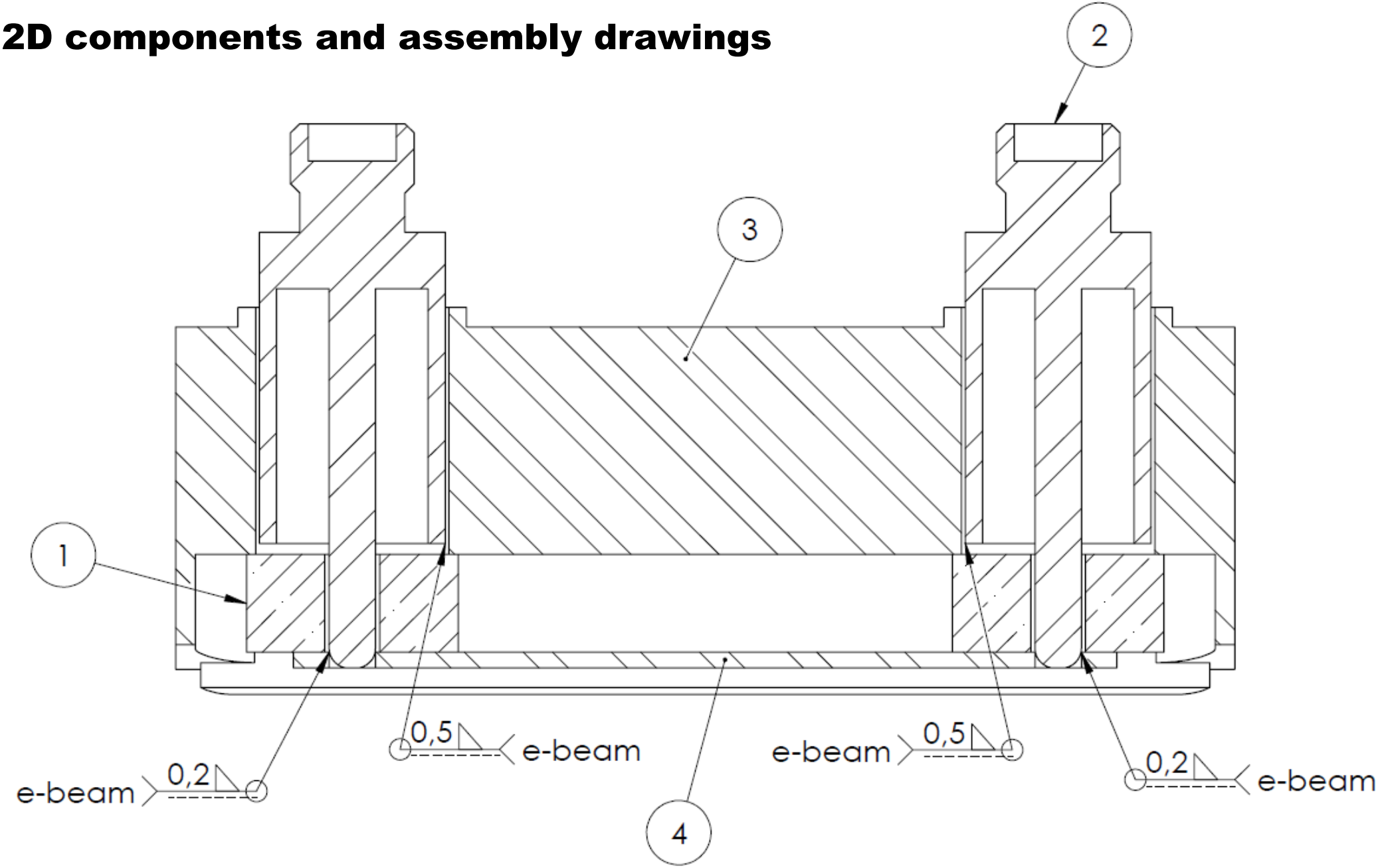


3D Model



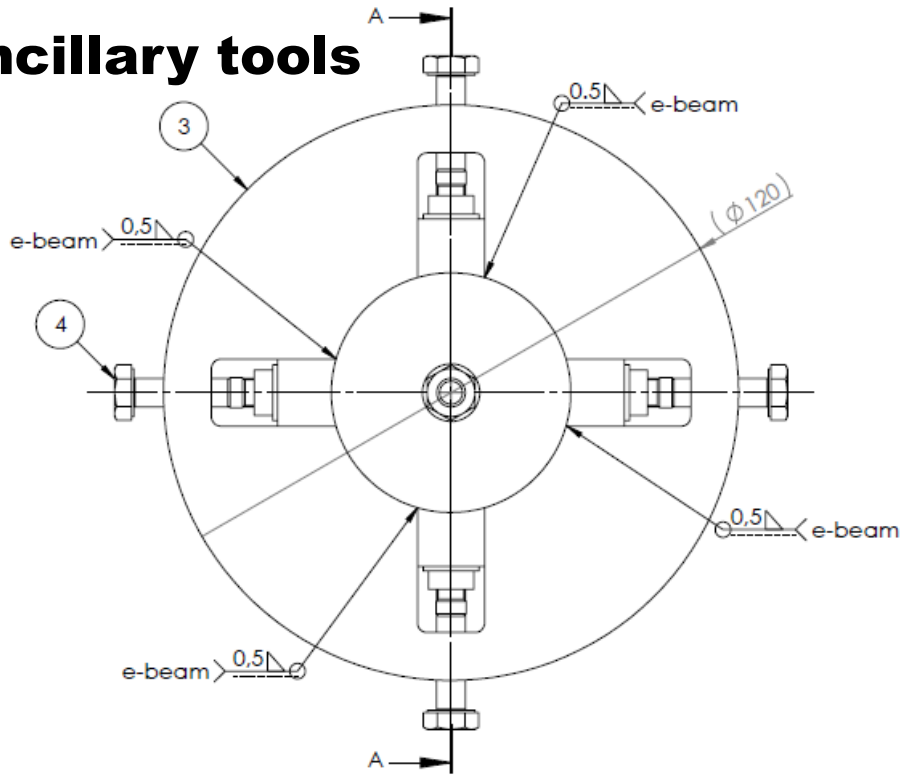
Design (II)

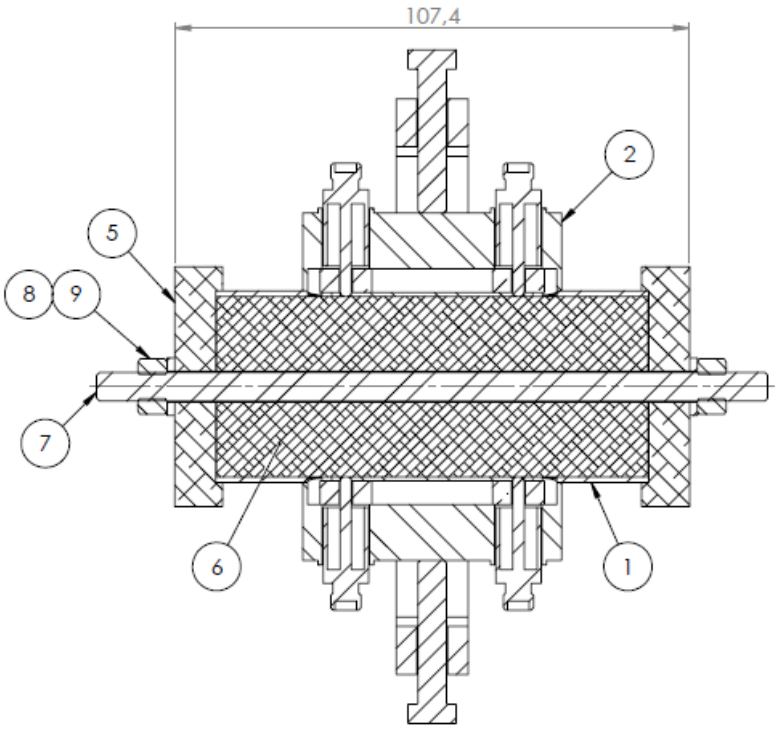
2D components and assembly drawings



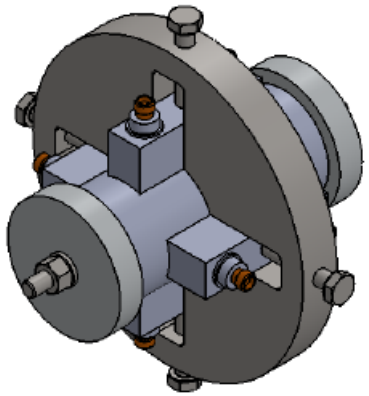
Design (III)

2D ancillary tools





SECCIÓN A-A



N.°	DESCRIPCIÓN	PLANO	MATERIAL	UDS.
1	BPM Tube	MEBT-BP-0201-ESS.02-MEC	AISI 316 L	1
2	BPM Stripline Box Assembly	MEBT-BP-0100-ESS.00-EBW	-	4
3	Ring	MEBT-BP-0116-ESS.00-MEC	AISI 304	1
4	Bolt ISO 4014_M6x30	-	-	4
5	Custom Flange	MEBT-BP-0117-ESS.00-MEC	Aluminum	2
6	Inner Cylinder	MEBT-BP-0118-ESS.00-MEC	Aluminum	1
7	Threaded Rod DIN 975_M6x140	-	-	1
8	Washer DIN 125_A 6.4	-	-	2
9	Nut ISO 4034_M6	-	-	2

Acabado — Rebarbar y romper aristas

Tolerancias generales en roscas DIN 13: 6H - 6g
Tolerancias dimensionales generales: ISO 2768 - 1(m)
Lineales

> / ≤	0.5 / 6	6 / 30	30 / 120	120 / 400	400 / 1000	1000 / 2000	2000 / 4000
fol	±0.1	±0.2	±0.3	±0.5	±0.8	±1.2	±2

Radio/Chaflán

> / ≤	0.5 / 3	3 / 6	6 / -
fol	±0.2	±0.5	±1

Angulares

> / ≤	0 / 10	10 / 50	50 / 120	120 / 400	400 / -
fol	±1°	±30'	±20'	±10'	±5'

Tolerancias geométricas generales: ISO 2768-2(K)

Medidas en milímetros

Rugosidad

Ra	50	12.5	6.3	3.2	1.6	0.8	0.4	0.2
DIN	~							

ESS-BILBAO
Este plano, su formato y su contenido es propiedad de ESS-Bilbao y para uso estrictamente confidencial. No debe copiarse o distribuirse a terceros sin el permiso escrito de ESS-Bilbao.

	Nombre	Fecha
Diseñado	S. Varnasseri	23/11/2015
Dibujado	A. Zugazaga	23/11/2015
Verificado	A. Ortega	23/11/2015
Aprobado	I. Rueda	23/11/2015

ESS bilbao — ADVANCED WELDING FACILITY

Polígono Ind. Júndiz
Calle Basaldea, 23
01015 Vitoria - SPAIN
Phone: +34945290840
www.essbilbao.org

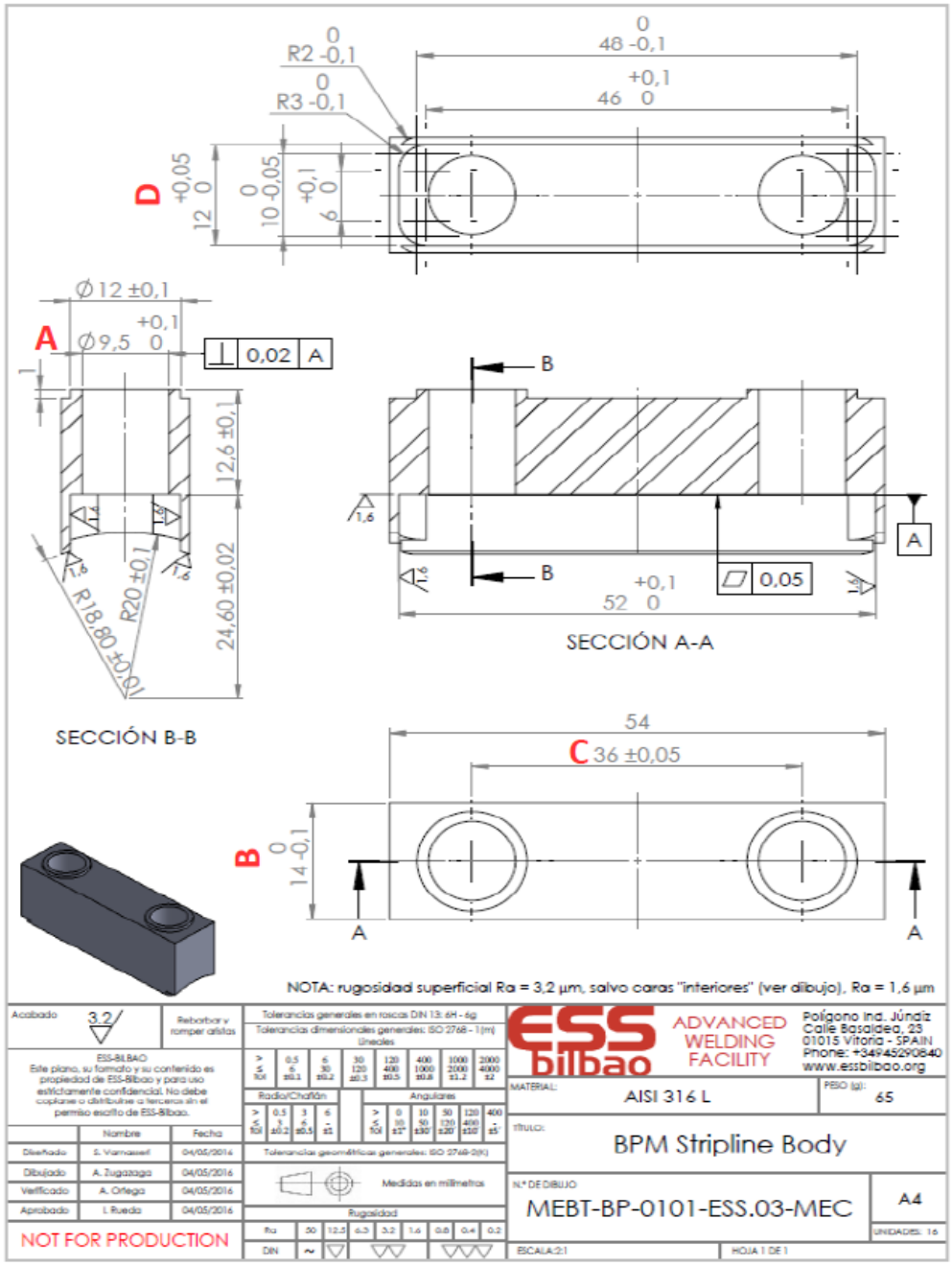
MATERIAL: *Ver Lista de Materiales
PESO (g): -

TÍTULO: BPM Tube Assembly

Nº DE DIBUJO: MEBT-BP-1000-ESS.01-EBW
A3
UNIDADES: -

ESCALA:1:1
HOJA 1 DE 1

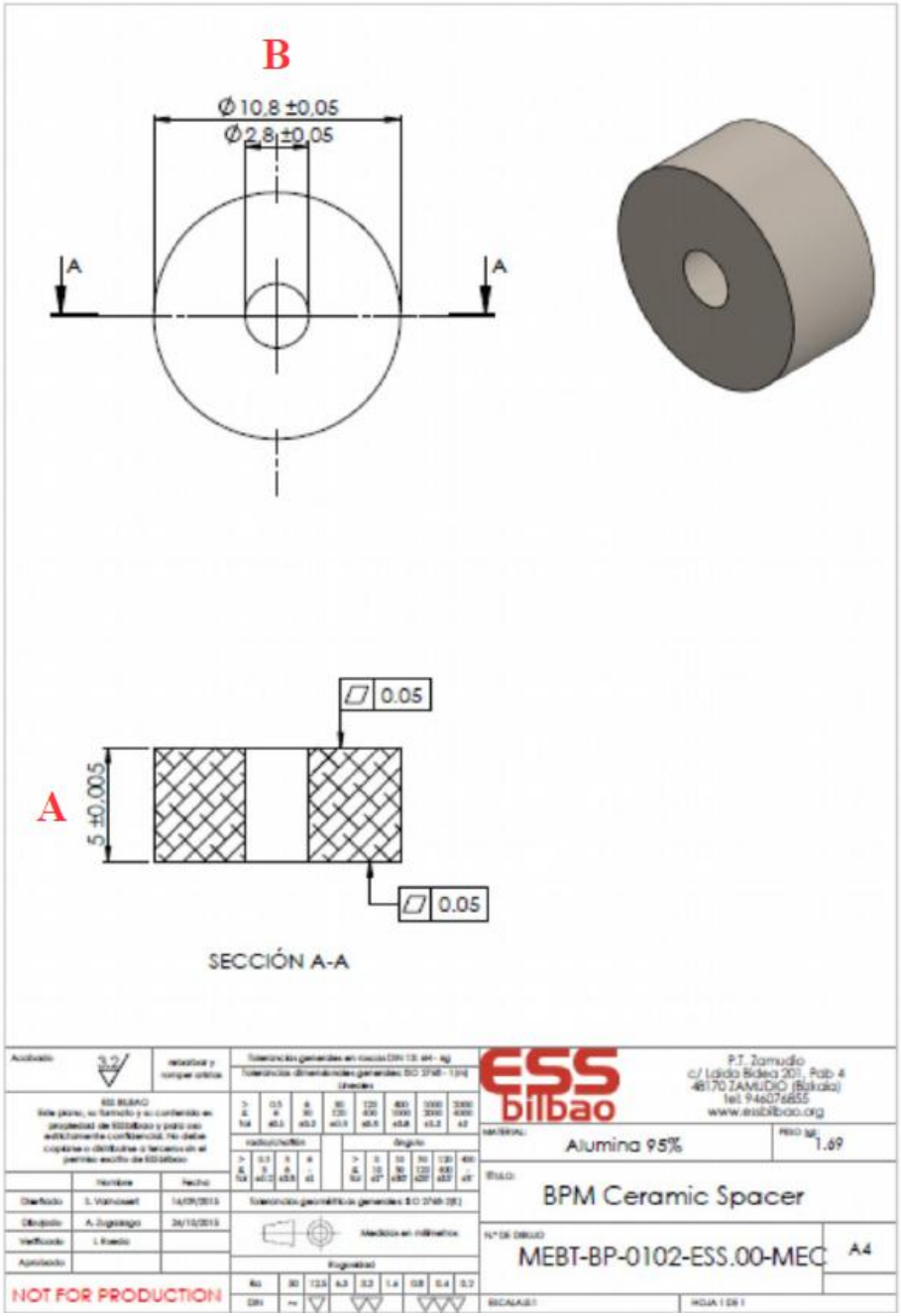
Parts Machining → QA (I)



1st Acceptance for components

N.º Pieza	Referencia Plano				
	A (9,5 / 9,6)		B (13,9 / 14,0)	C* (35,95 / 36,05)	D (12,00 / 12,05)
	1	2			
1	9,48	9,49	13,95	36,01	11,90
2	9,49	9,49	14,00	35,98	11,95
3	9,48	9,48	14,04	36,02	11,95
4	9,48	9,50	14,02	35,99	11,94
5	9,50	9,48	14,03	35,98	11,95
6	9,49	9,48	13,94	35,99	11,92
7	9,48	9,49	13,96	36,00	11,94
8	9,48	9,48	13,95	35,99	11,94
9	9,48	9,48	13,95	36,01	11,93
10	9,47	9,48	14,03	36,02	11,92
11	9,49	9,48	13,95	35,97	11,95
12	9,49	9,48	14,07	35,98	11,93
13	9,49	9,49	14,06	35,94	11,92
14	9,48	9,48	13,94	35,98	11,95
15	9,49	9,49	14,00	35,99	11,94
16	9,48	9,49	13,99	36,01	11,92
17	9,48	9,50	14,05	36,01	11,96

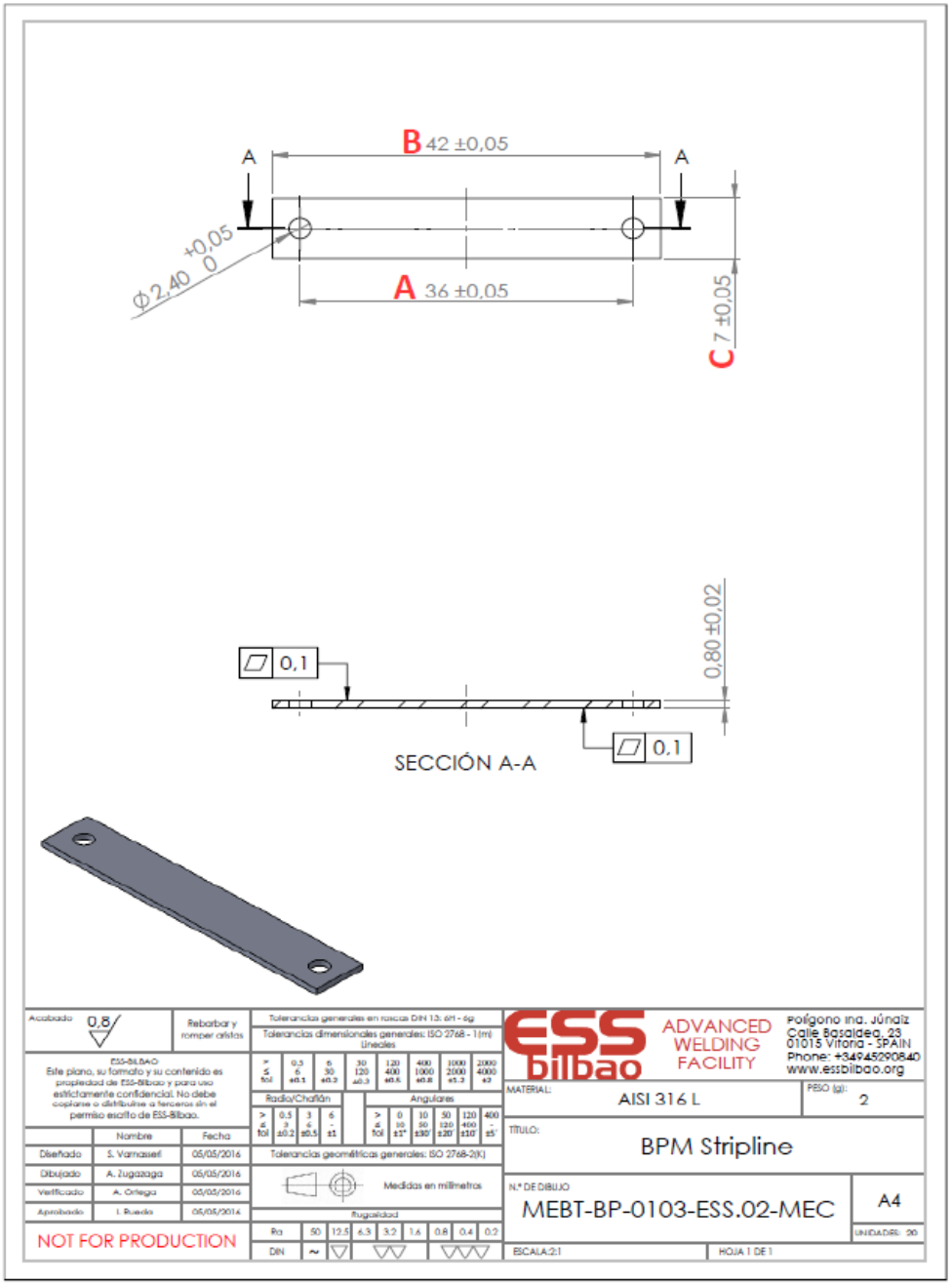
Parts Machining → QA (II)



N.º Pieza	Referencia Plano A (4,995 / 5,005)	B (10,75 / 10,85)
F1	4,99	10,79
F2	4,99	10,83
F3	4,99	10,8
F4	4,985	10,78
F5	4,985	10,81
F6	4,985	10,82
F7	4,98	10,8
F8	4,995	10,8
F9	4,985	10,8
F10	4,995	10,815
F11	4,98	10,8
F12	4,985	10,75
F13	4,98	10,8
F14	4,99	10,82
F15	4,98	10,81
F16	4,99	10,82
F17	4,99	10,77
F18	5	10,805
F19	4,99	10,81
F20	4,965	10,81
F21	4,985	10,8
F22	4,985	10,825
F23	4,985	10,785
F24	4,99	10,835
F25	4,99	10,805
F26	4,985	10,83
F27	4,97	10,785
F28	4,99	10,795
F29	4,985	10,805
F30	4,98	10,835
F31	4,985	10,77
F32	4,99	10,78
F33	4,98	10,8
F34	4,99	10,785
F35	4,99	10,835
F36	4,965	10,8
F37	4,99	10,765
F38	4,99	10,805
F39	4,99	10,78
F40	4,99	10,805

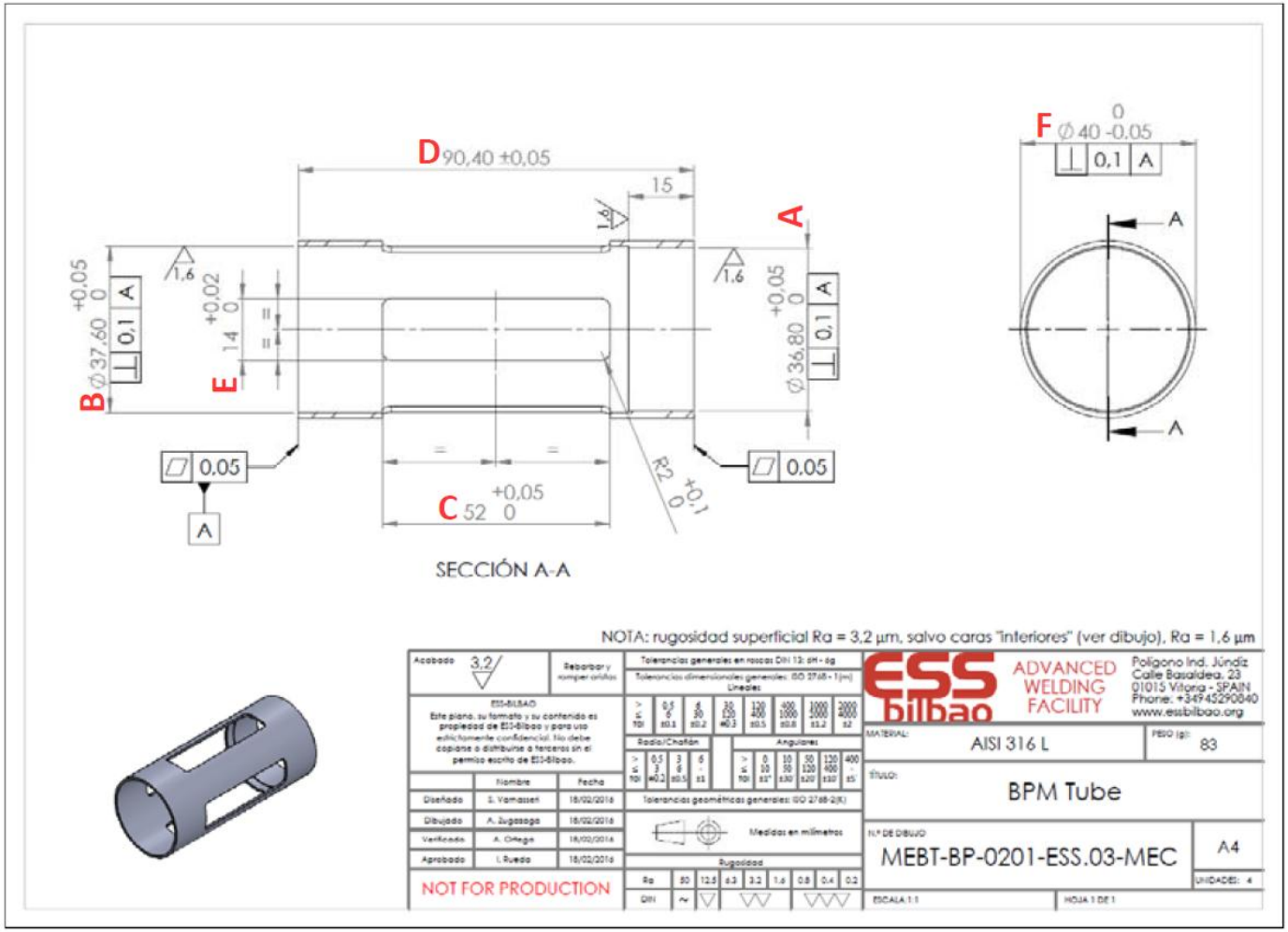
N.º Pieza	Referencia Plano A (4,995 / 5,005)	B (10,75 / 10,85)
B1	5	10,785
B2	5	10,79
B3	5	10,785
B4	5	10,815
B5	5	10,81
B6	5	10,795
B7	5	10,775
B8	5	10,805
B9	5	10,81
B10	5	10,8
B11	5	10,805
B12	5	10,81
B13	5	10,795
B14	5	10,8
B15	5	10,805
B16	5	10,795

Parts Machining → QA (III)



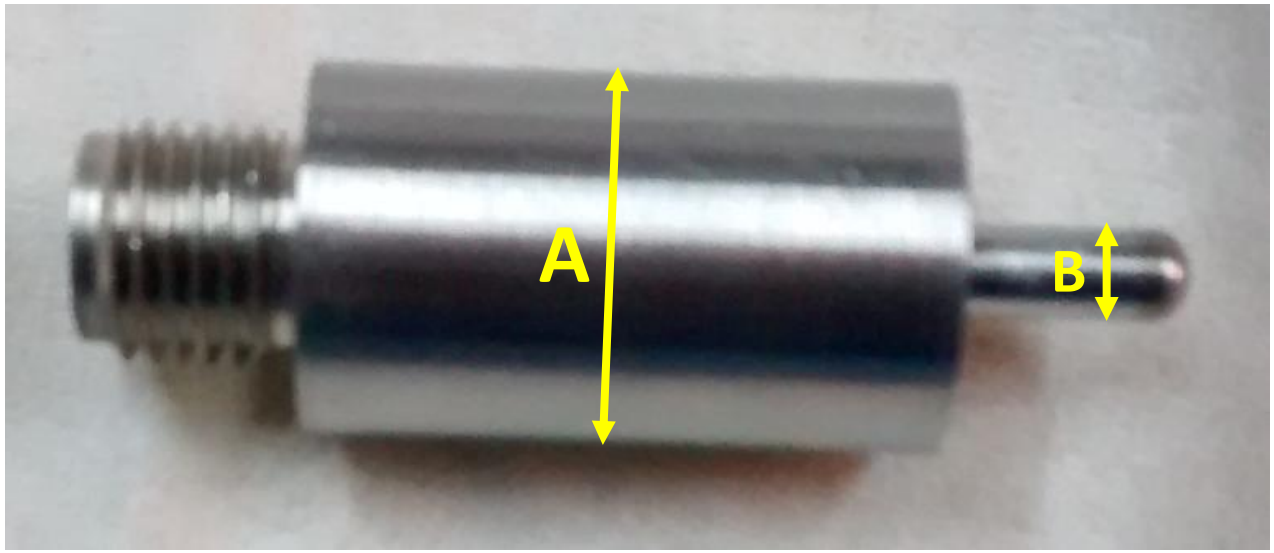
N.º Pieza	Referencia Plano		
	A (35,95 / 36,05)	B (41,95 / 42,05)	C (6,95 / 7,05)
1	35.90	OK	OK
2	35.90	OK	OK
3	35.78	OK	OK
4	35.90	OK	OK
5	35.87	OK	OK
6	35.90	OK	OK
7	35.88	OK	OK
8	35.90	OK	OK
9	35.82	OK	OK
10	OK	OK	OK

Parts Machining → QA (IV)



N.º Pieza	Referencia Plano					
	A (36,80 / 36,85)	B (37,60 / 37,65)	C (52,00 / 52,05)	D (90,35 / 90,45)	E (14,00 / 14,02)	F (39,95 / 40,00)
1	OK	OK	OK	OK	OK	OK
2	OK	OK	OK	OK	OK	OK
3	OK	OK	OK	OK	OK	OK
4	OK	OK	OK	OK	14.05	OK

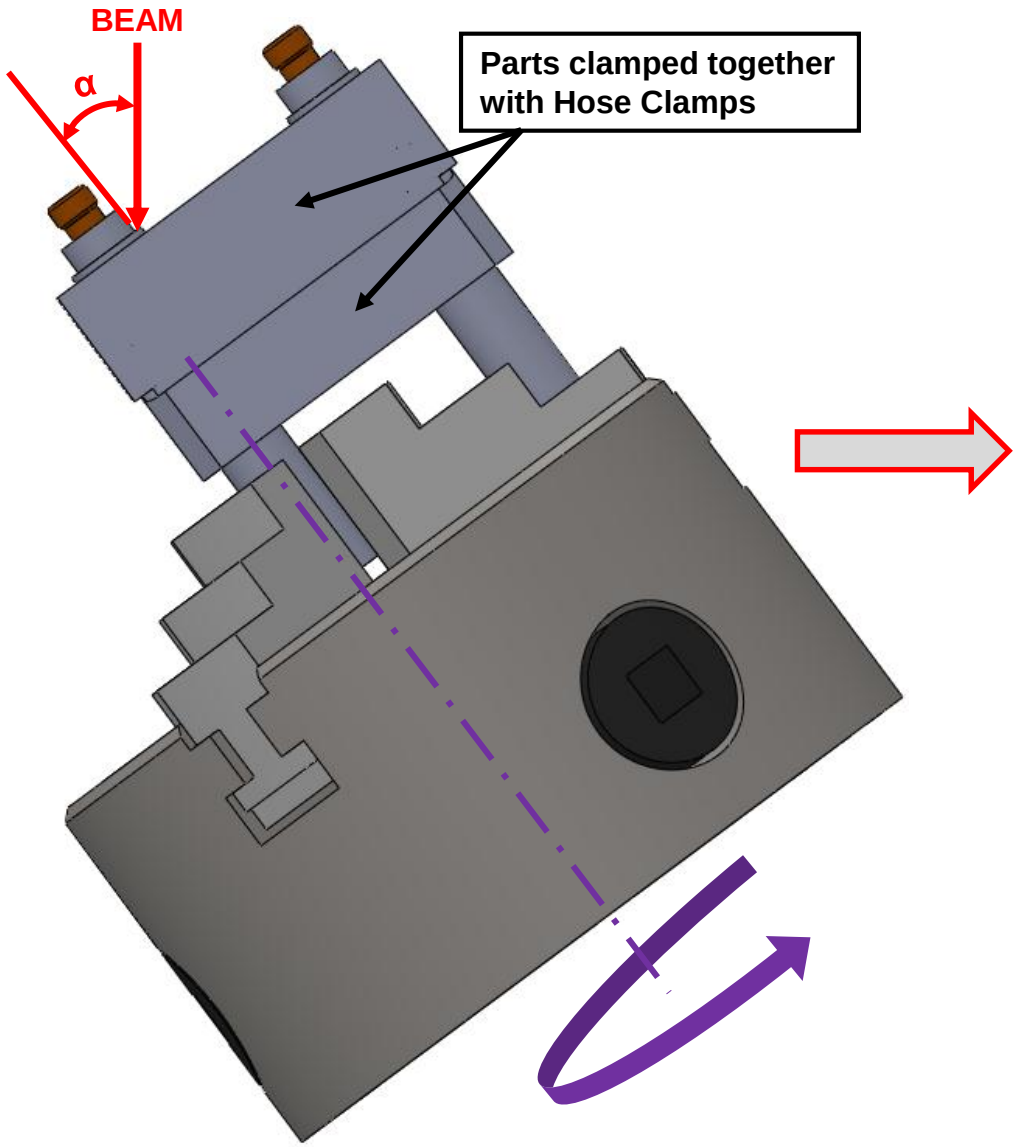
Parts Machining → QA (V)

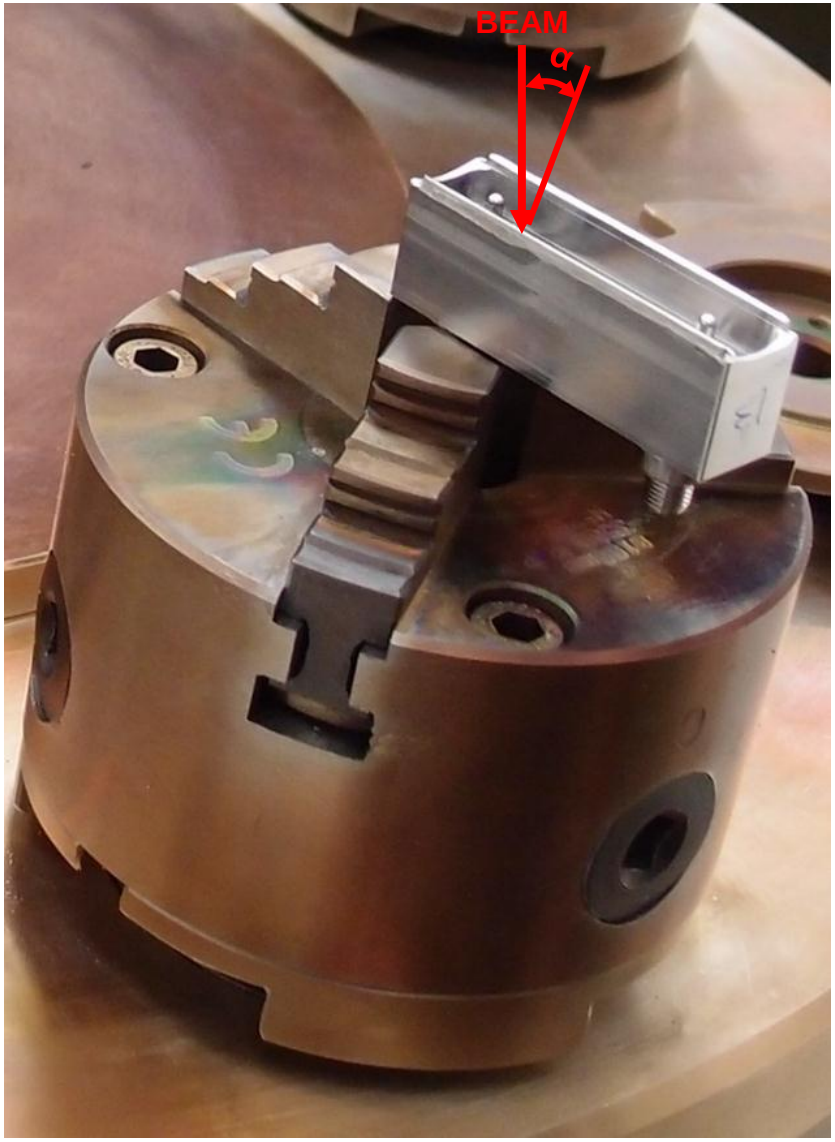


REFERENCIA	A	B
F1	9,46	2,4
F2	9,48	2,41
F3	9,485	2,41
F4	9,48	2,41
F5	9,48	2,4
F6	9,477	2,41
F7	9,461	2,41
F8	9,45	2,4
F9	9,457	2,41
F10	9,45	2,4
	9,468	**2,406**

E-Beam Welding (I)

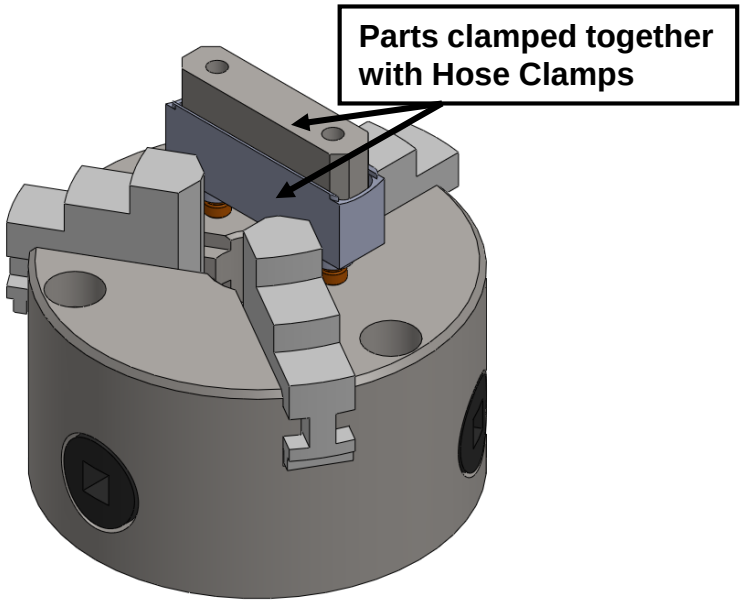
WELD #1: Connector Body to Box

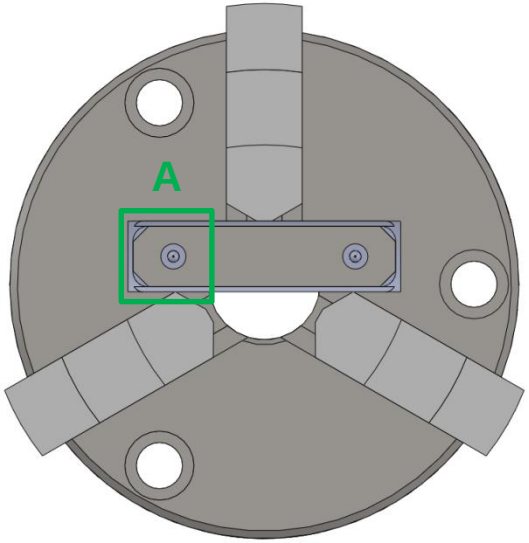


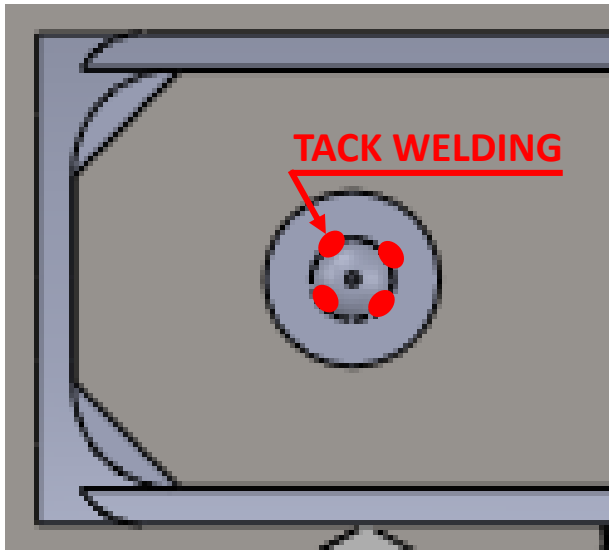


E-Beam Welding (II)

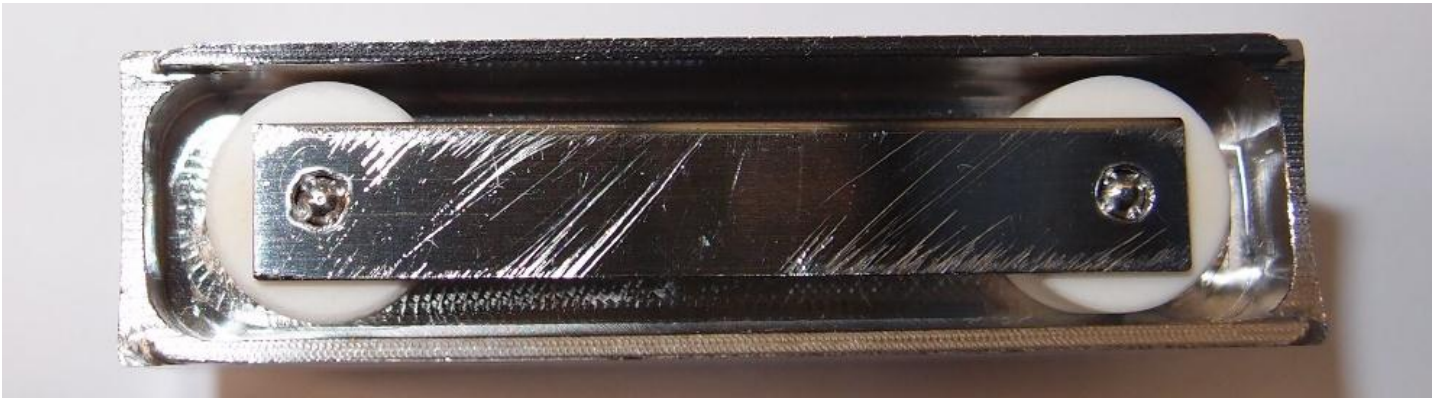
WELD #2: Conductor to Stripline





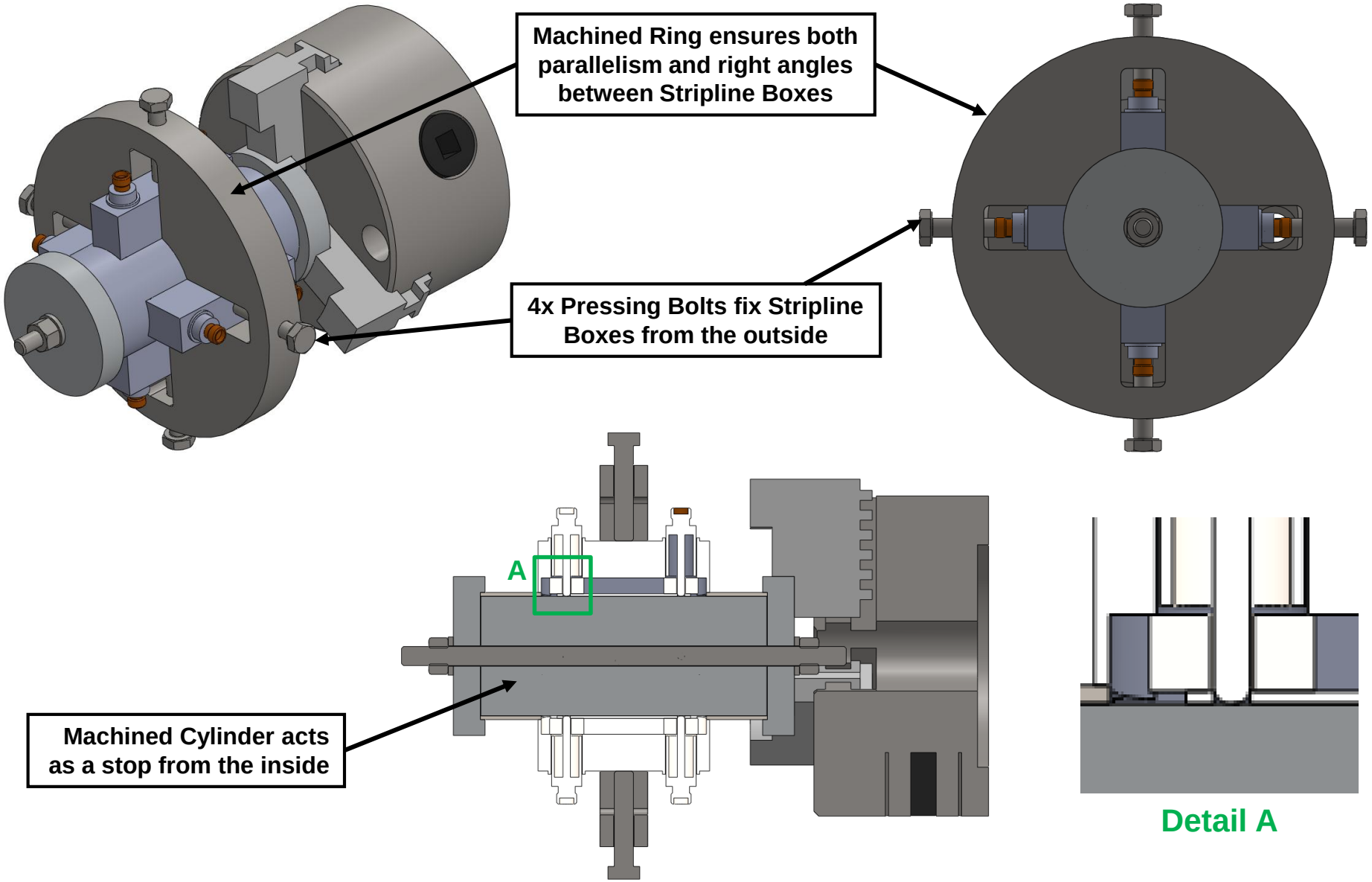


Detail A

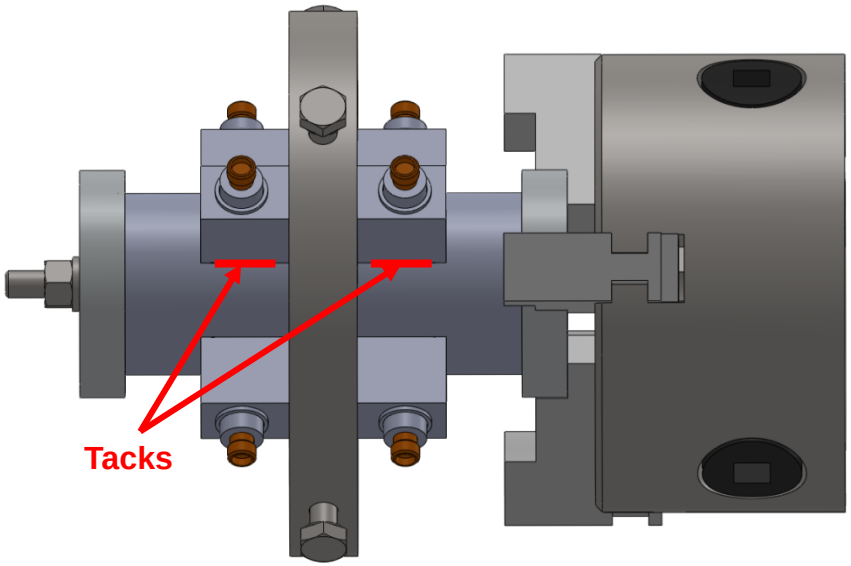


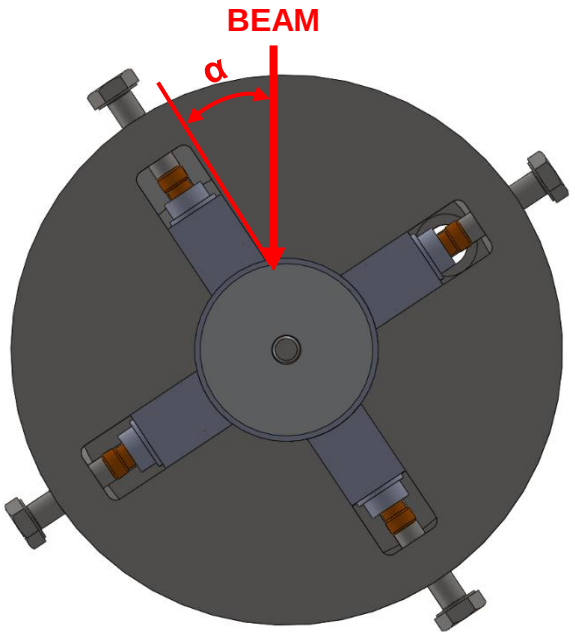
E-Beam Welding (III)

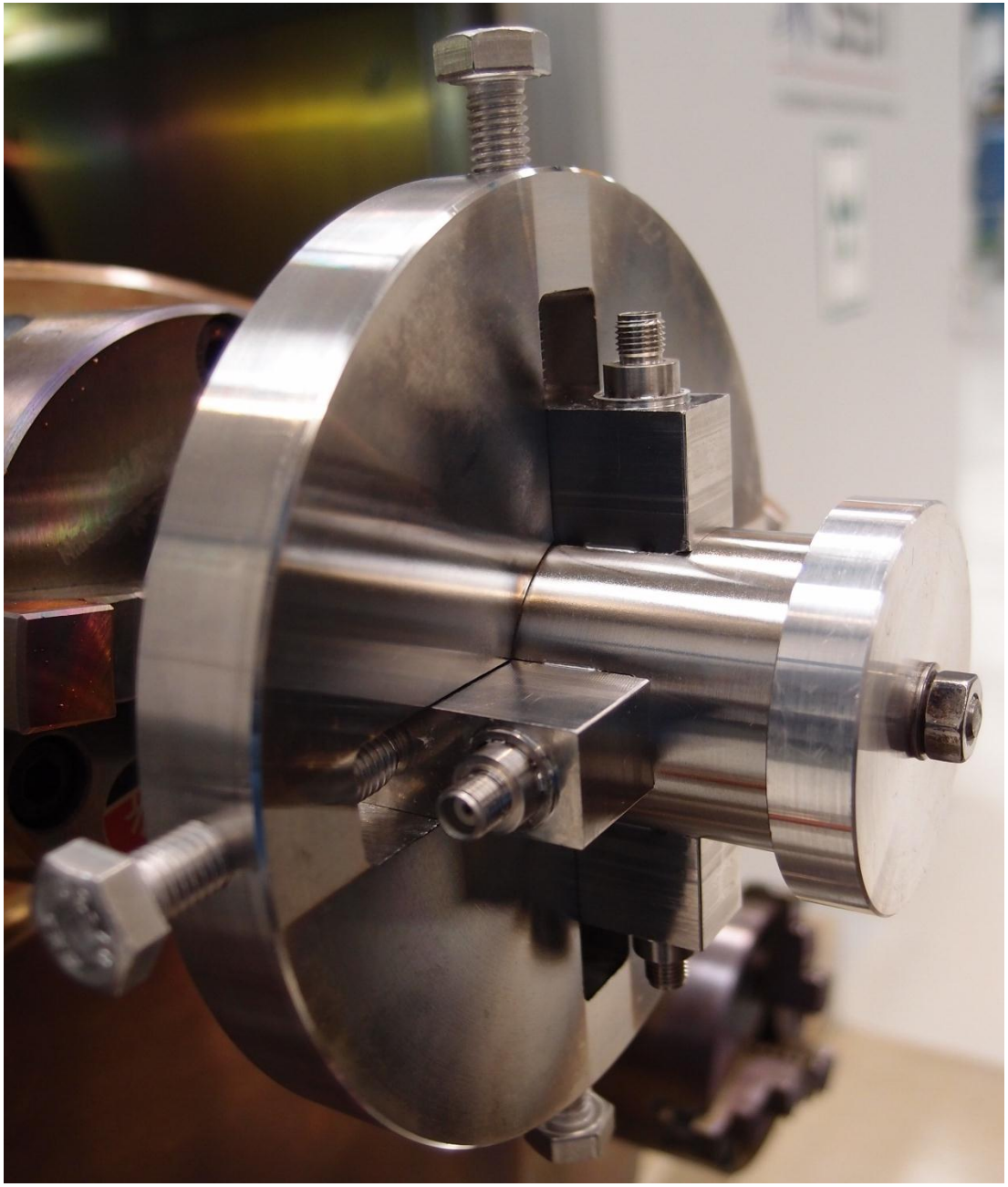
WELD #3: Stripline Box to Tube



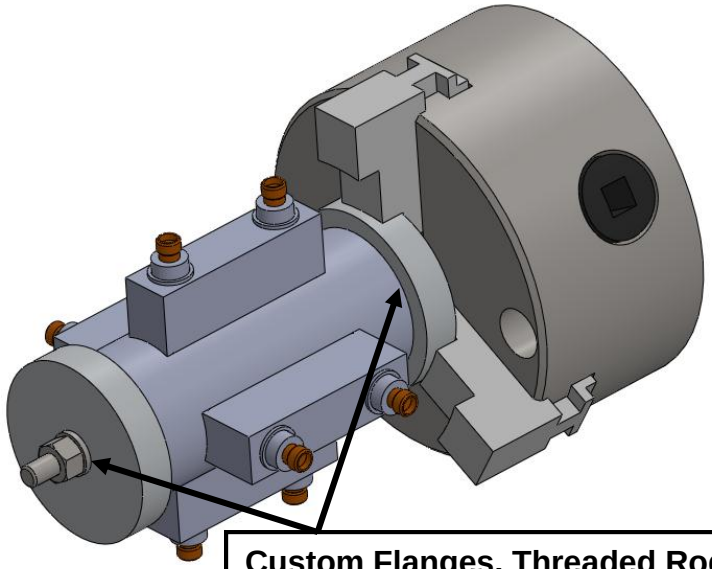
E-Beam Welding (IV)



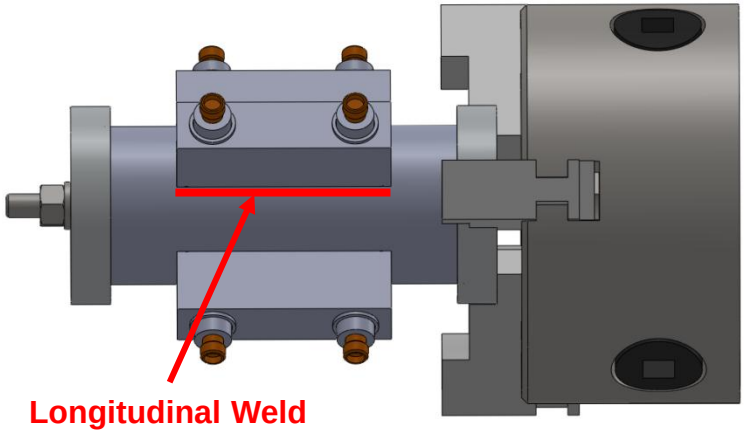




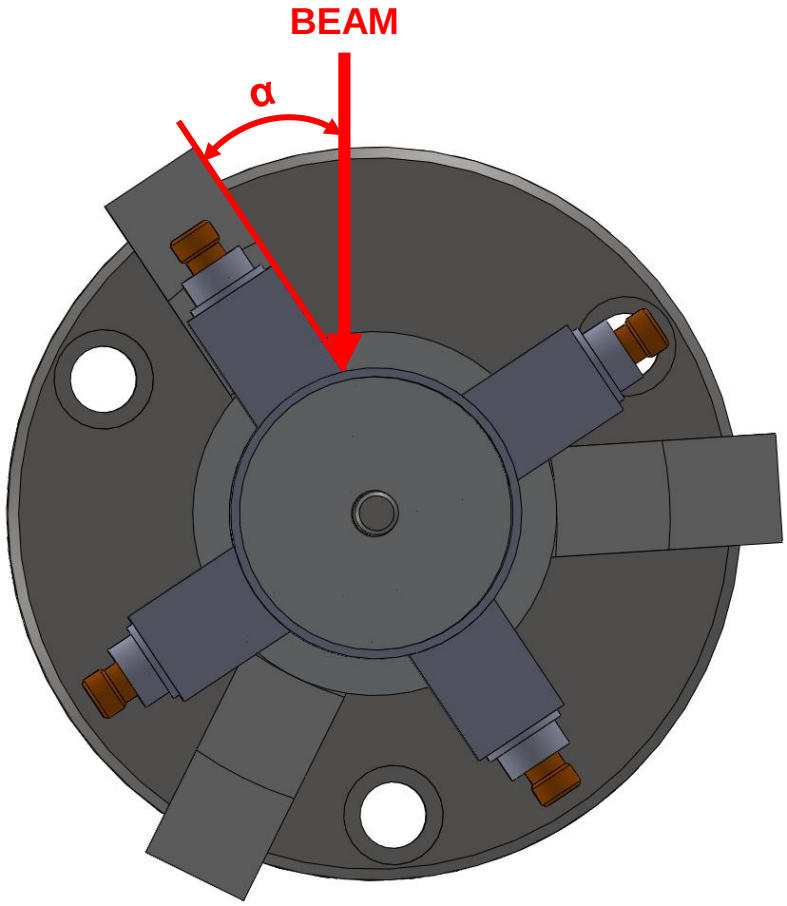
E-Beam Welding (V)



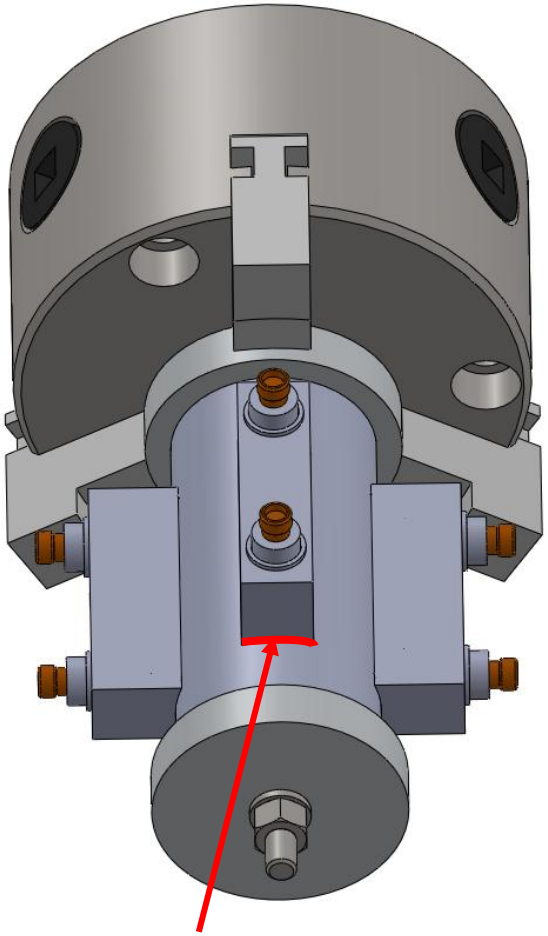
Custom Flanges, Threaded Rod, etc. to grab and rotate Assembly



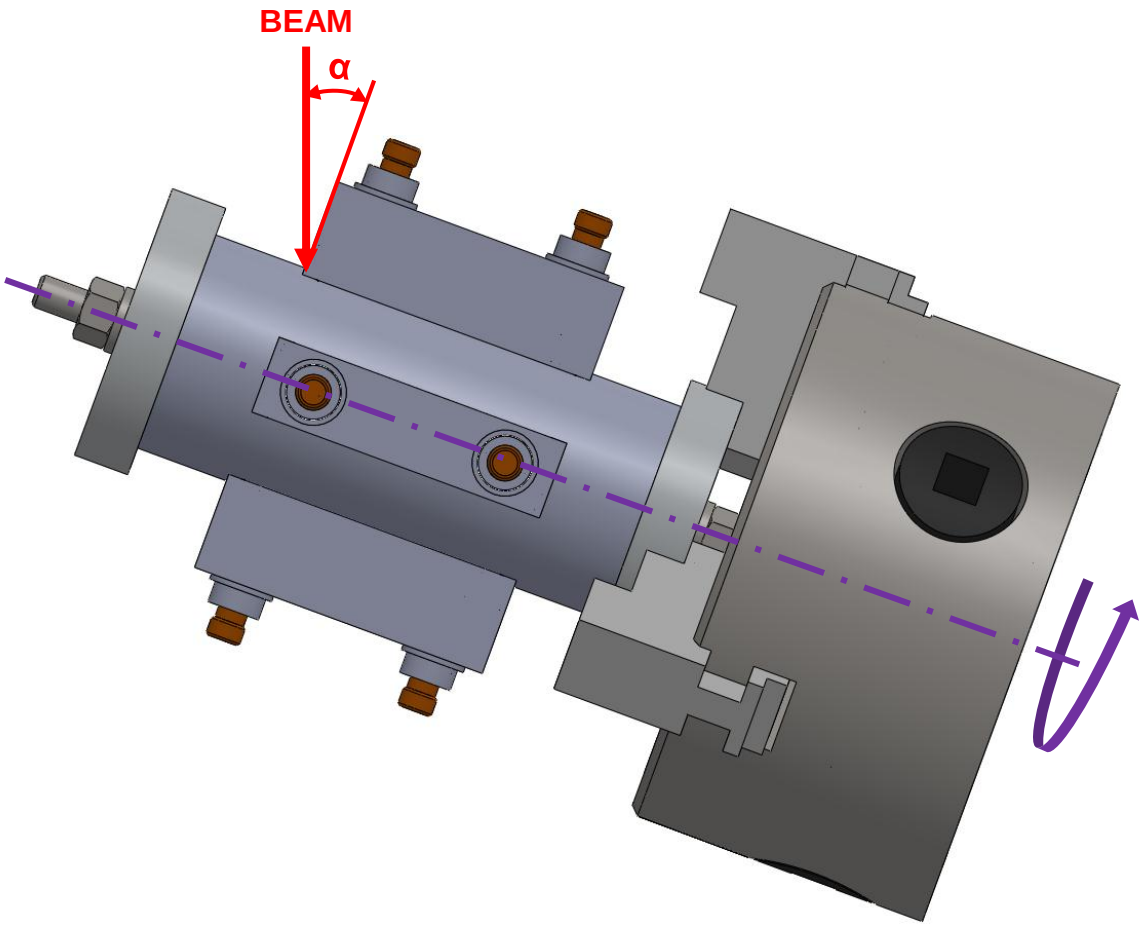
Longitudinal Weld



E-Beam Welding (VI)

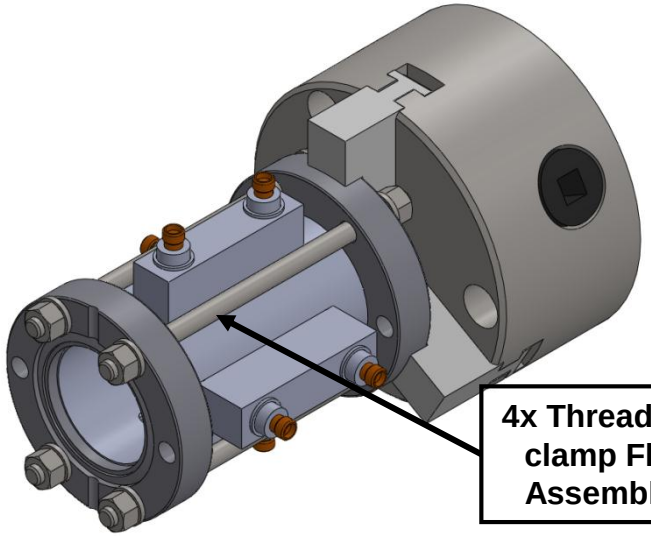


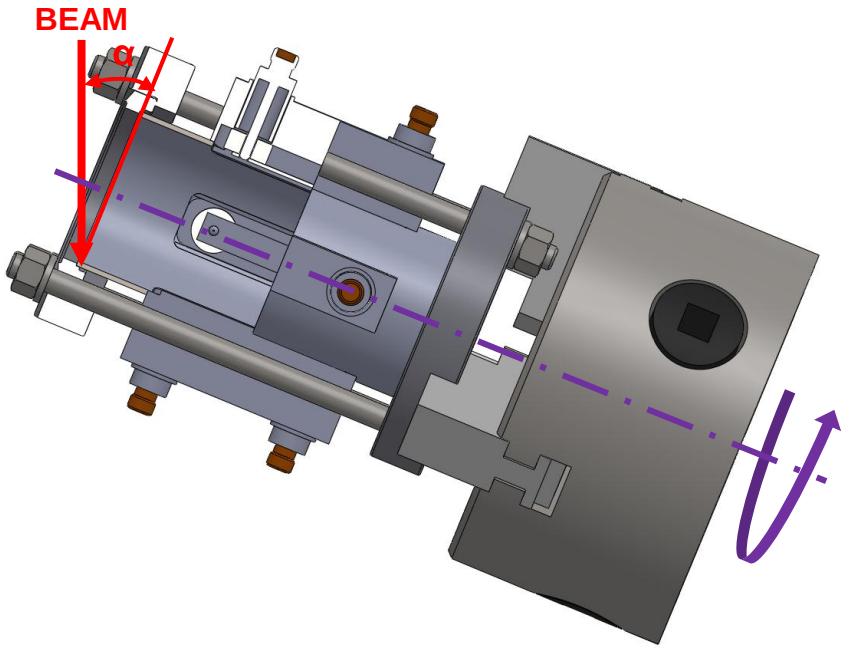
Transversal Weld

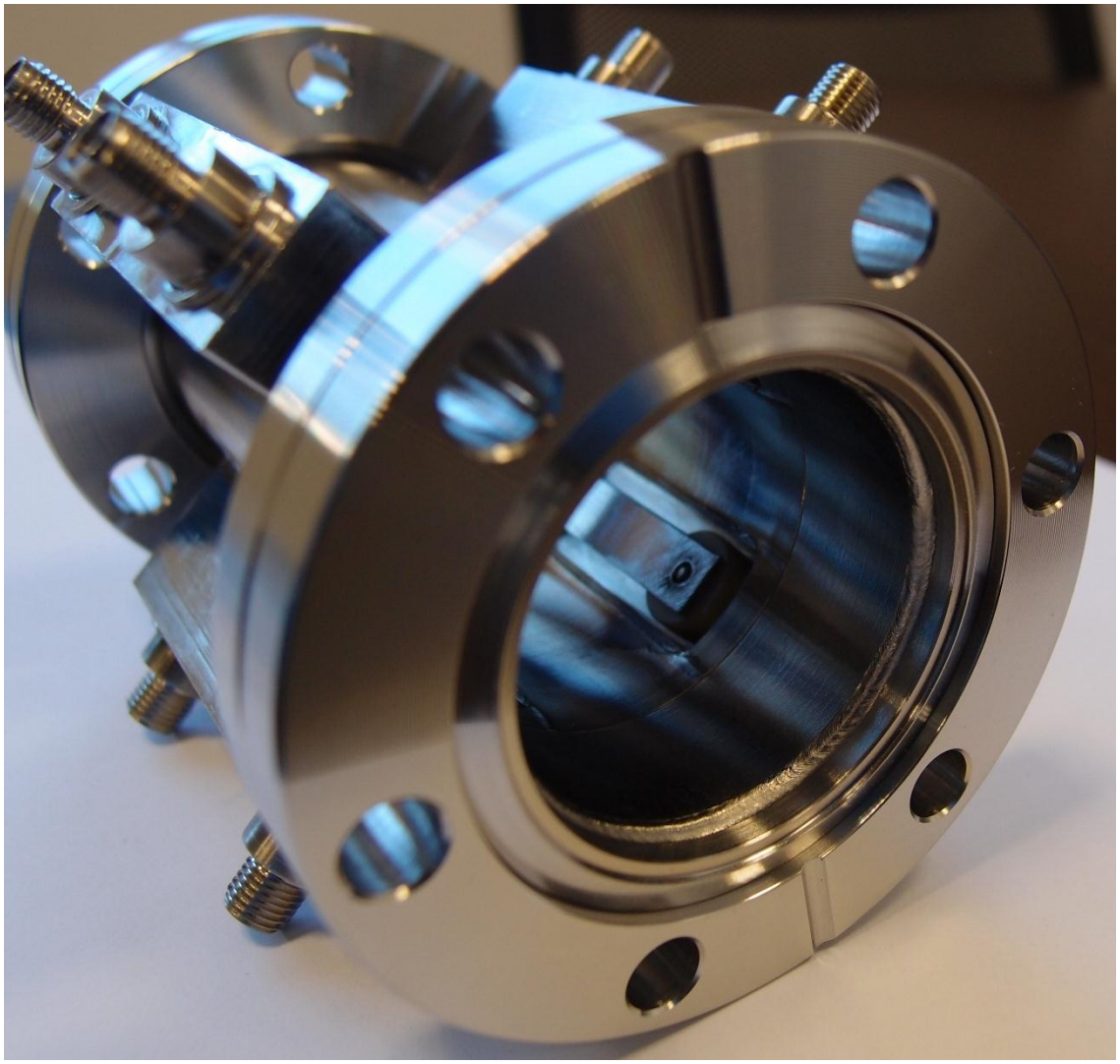


E-Beam Welding (VII)

WELD #4: Flanges to Tube Assembly

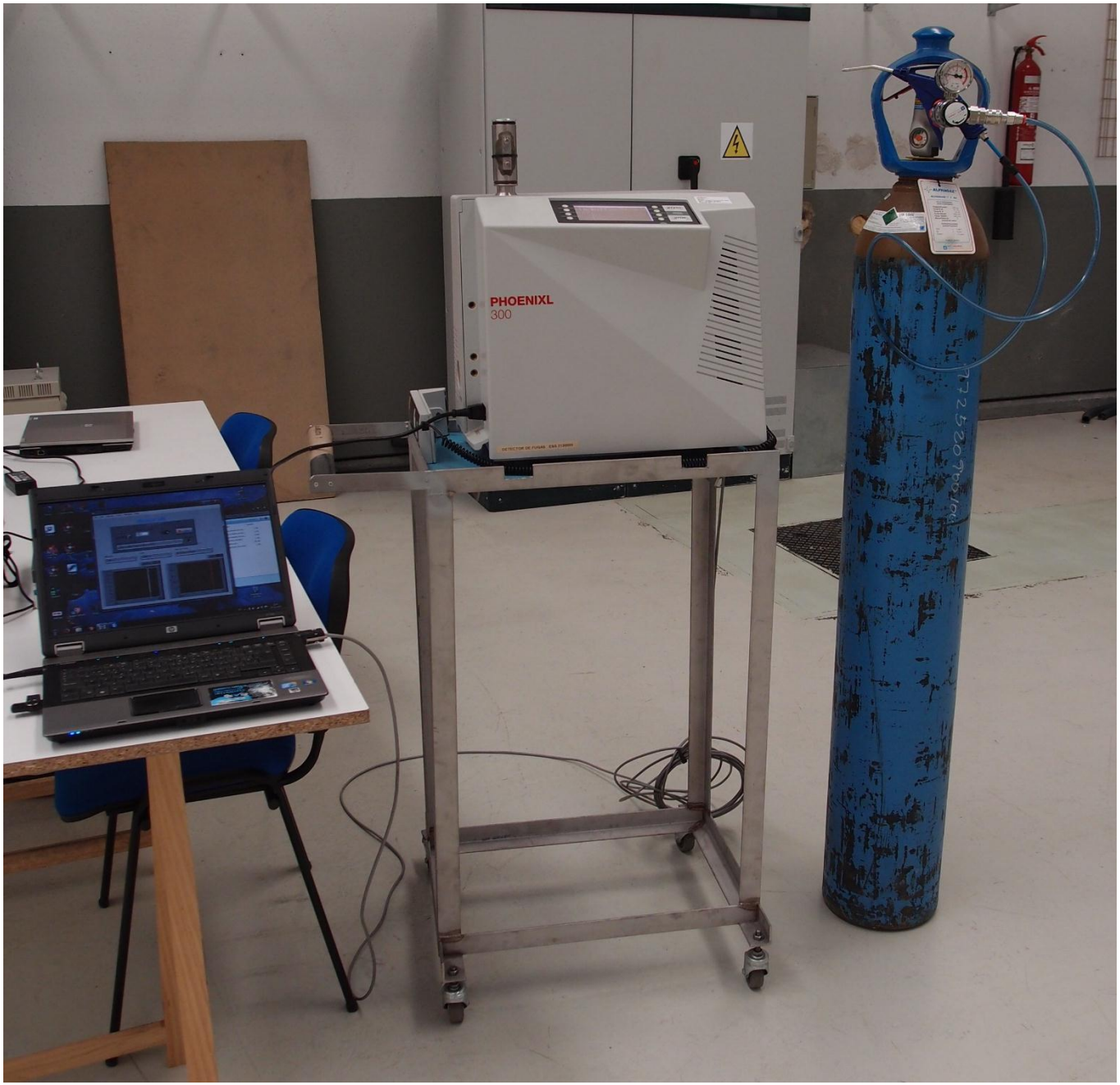




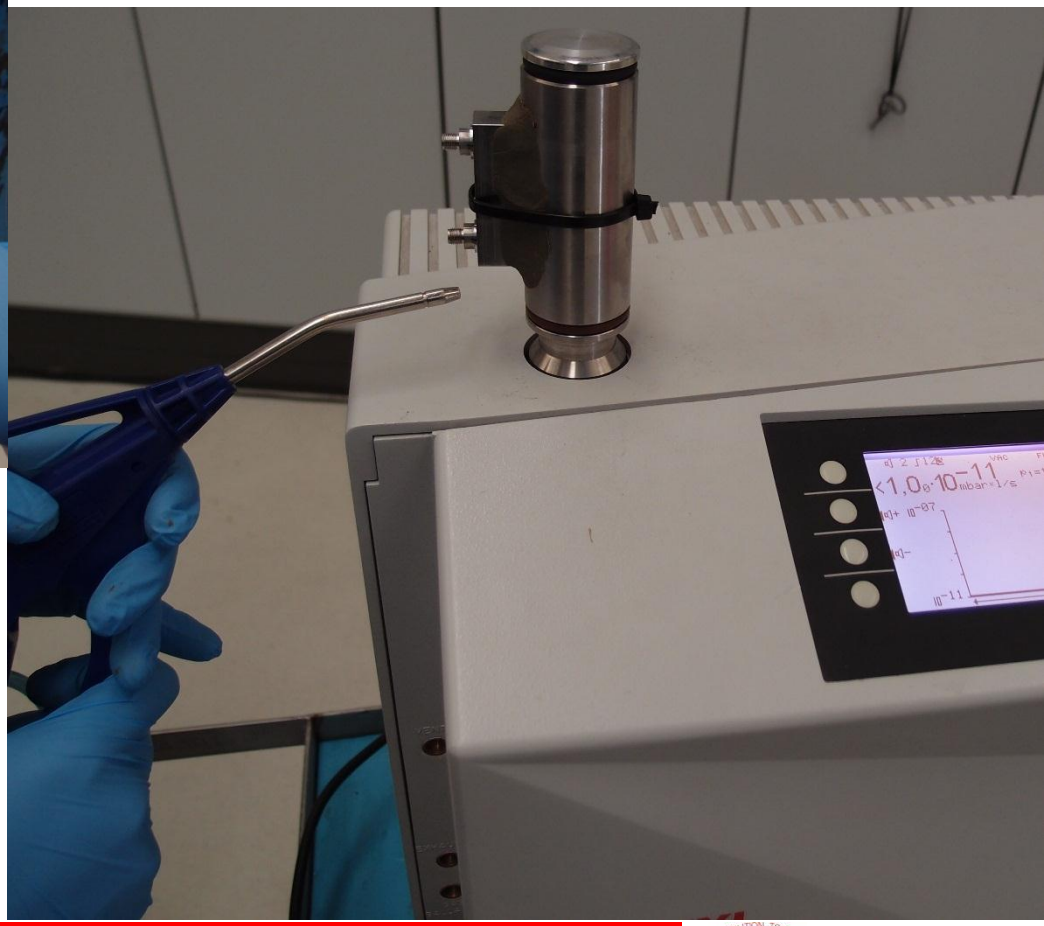


Vacuum Tests→ QA (I)

- ✓ Leak Detector
- ✓ Helium
- ✓ Laptop → Reports

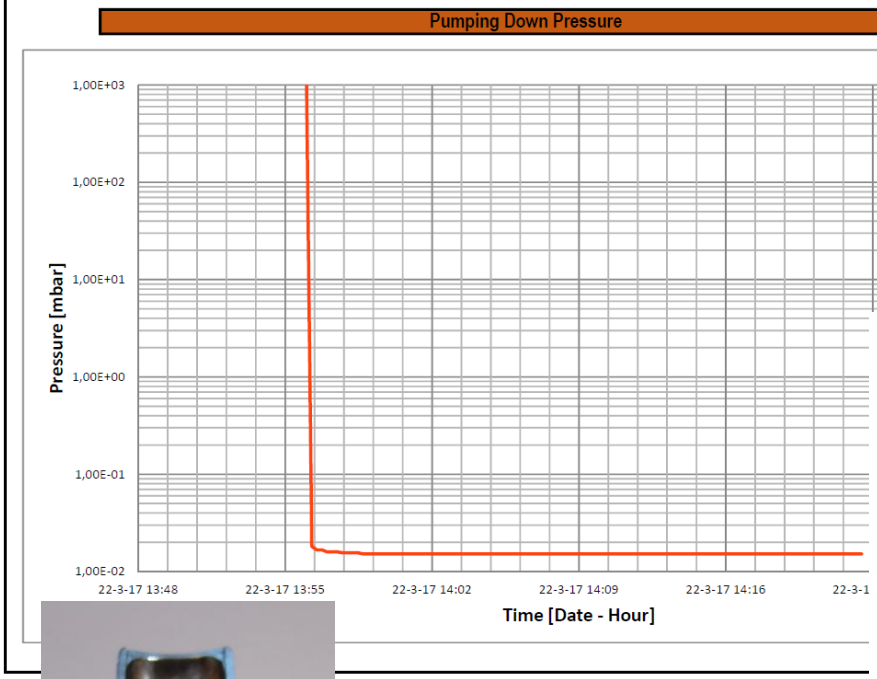


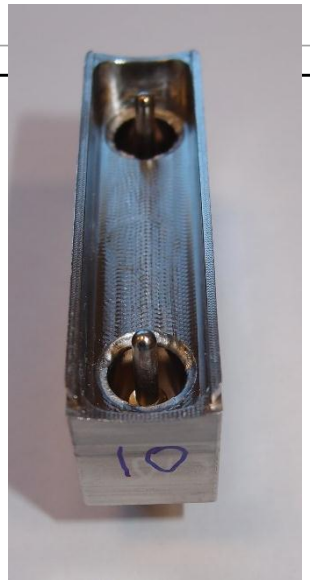
Vacuum Tests→ QA (II)



Vacuum Tests→ QA (III)

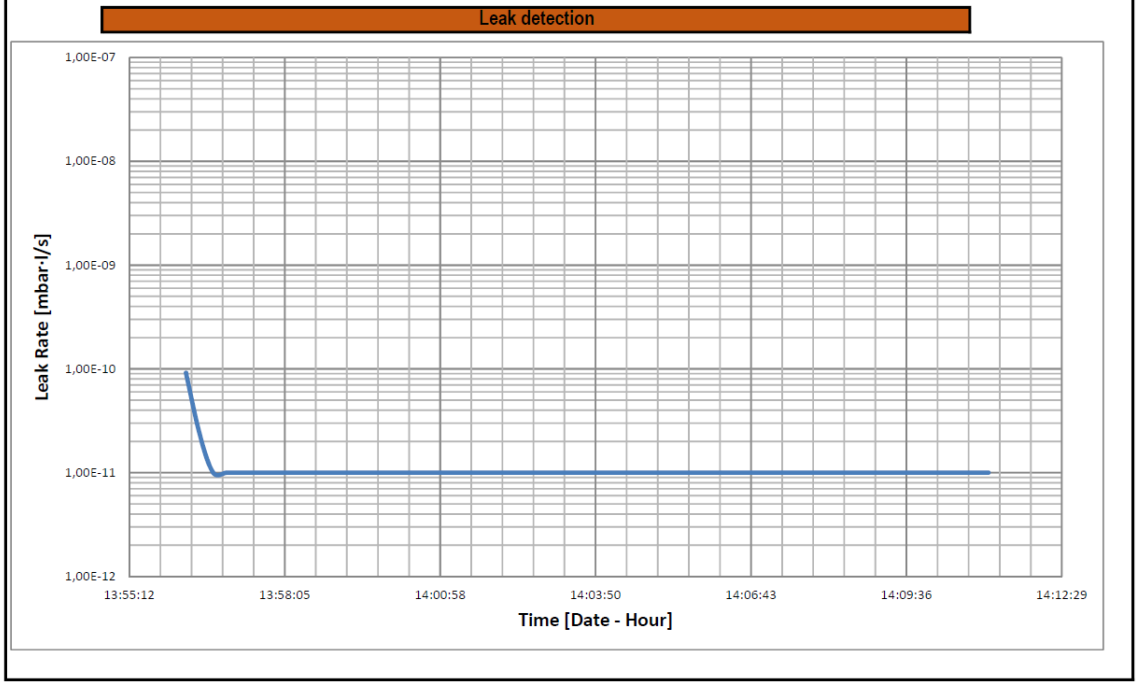
ESS bilbao	HELIUM LEAK TEST REPORT	BPM Prototype Leak Test 1 - 22/03/17
	ref. doc TVAC-VS-1101 REV.1	CHART 1/2





RF Connector Vacuum Sealing

ESS bilbao	HELIUM LEAK TEST REPORT	BPM Prototype Leak Test 1 - 22/03/17
	ref. doc TVAC-VS-1101 REV.1	CHART 2/2

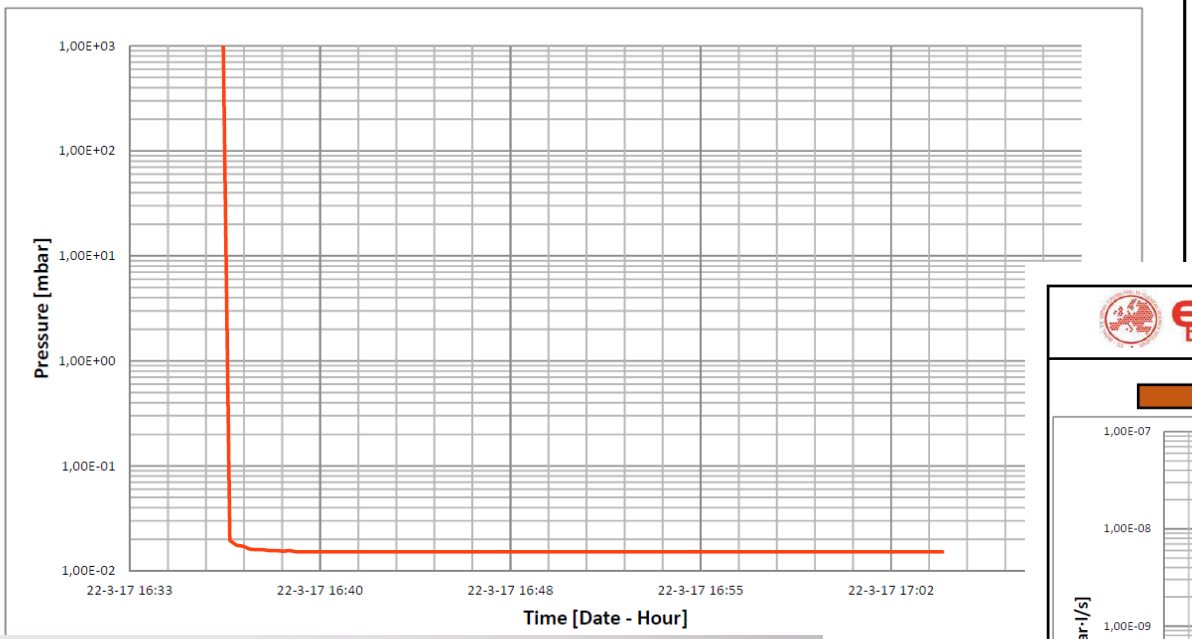


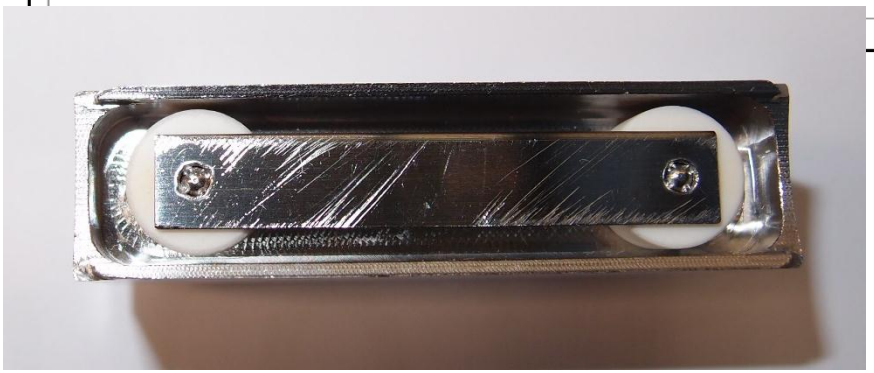
Vacuum Tests→ QA (IV)

Stripline Box Vacuum Sealing

ESS bilbao	HELIUM LEAK TEST REPORT	BPM Prototype Leak Test 2 - 22/03/17
	ref. doc TVAC-VS-1101 REV.1	CHART 1/2

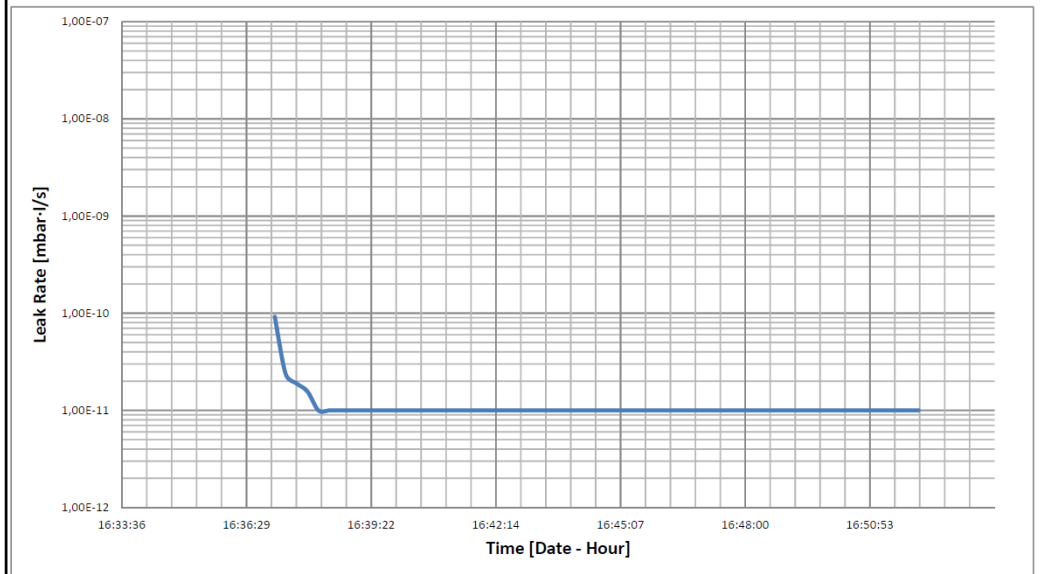
Pumping Down Pressure





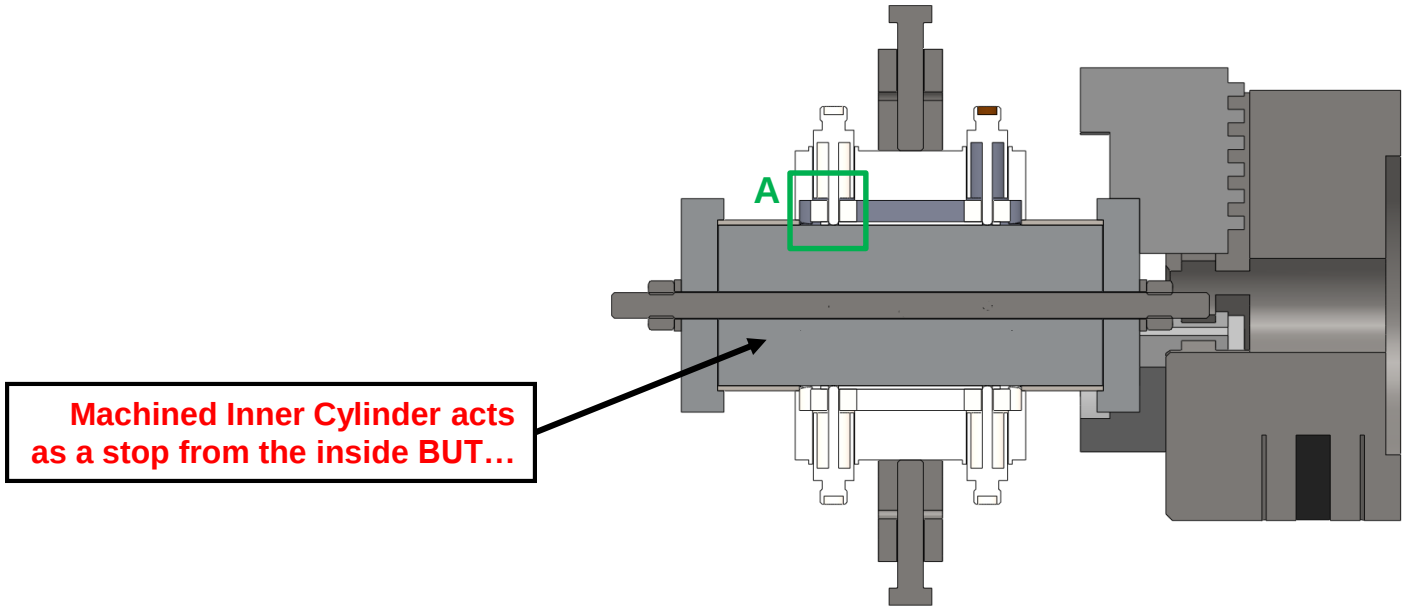
ESS bilbao	HELIUM LEAK TEST REPORT	BPM Prototype Leak Test 2 - 22/03/17
	ref. doc TVAC-VS-1101 REV.1	CHART 2/2

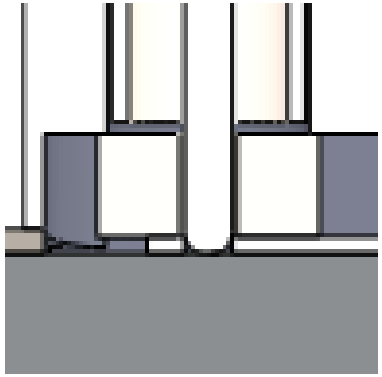
Leak detection



Troubleshooting (I)

➡ ISSUE #1: Fixturing Design Problem





Detail A

- **Connectors broken after Weld #3**
  - After Welds #1&2, connectors were OK (all vacuum tests were successful)
  - Weld #3 creates no stress to connectors (only box is welded, no constrains for connectors)
- **CAUSE: extraction of Inner Cylinder breaks connectors due to shear stresses:**
  - BPM Tube shrinks a bit during welding, leading to a tight grip between BPM Tube and Inner Cylinder
  - A smooth extraction of Inner Cylinder after Weld #3 does not prevent the Connectors from breaking

Troubleshooting (II)

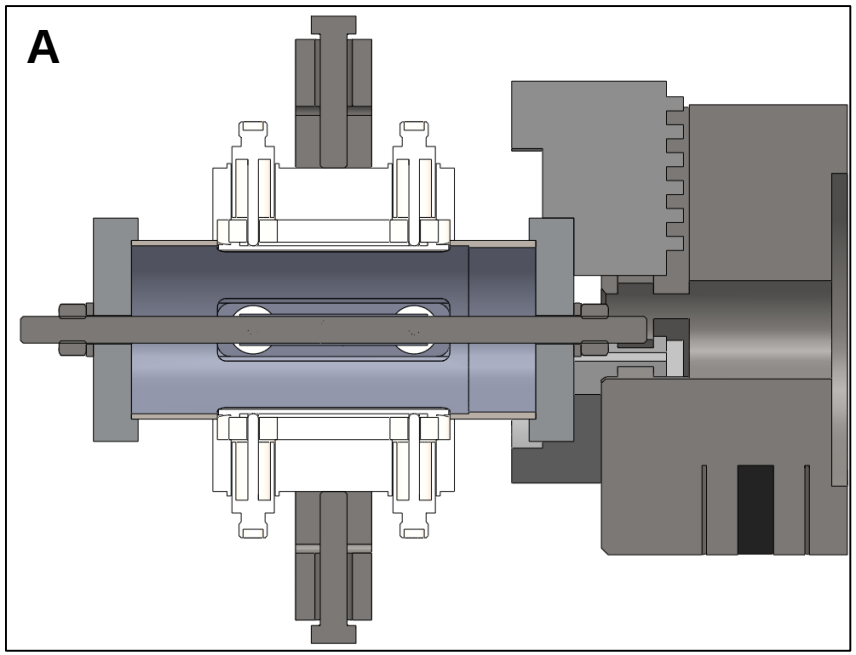
➡ SOLUTION #1: Fixturing Design Problem

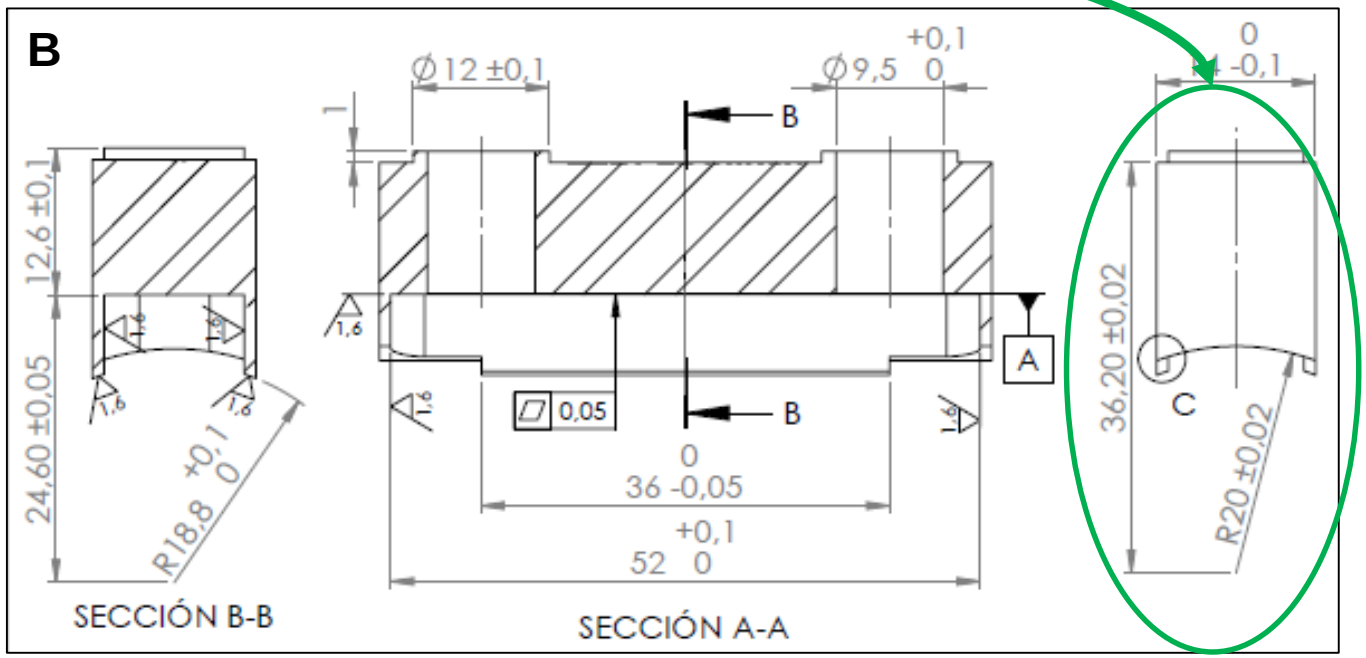
A. No Inner Cylinder

- Tube free to shrink
- No shear stresses to connectors

B. Much tighter dimensional tolerances:

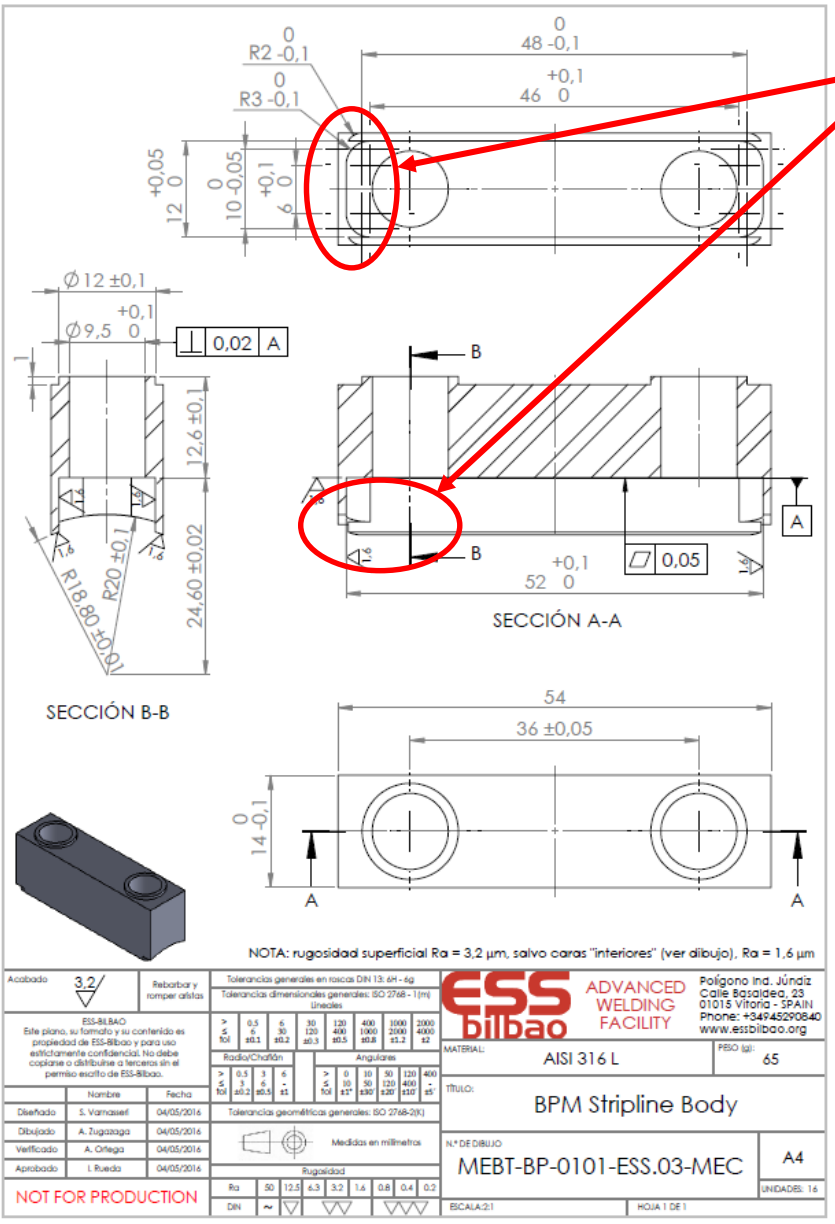
- Enough to assure relative positioning of striplines





Troubleshooting (III)

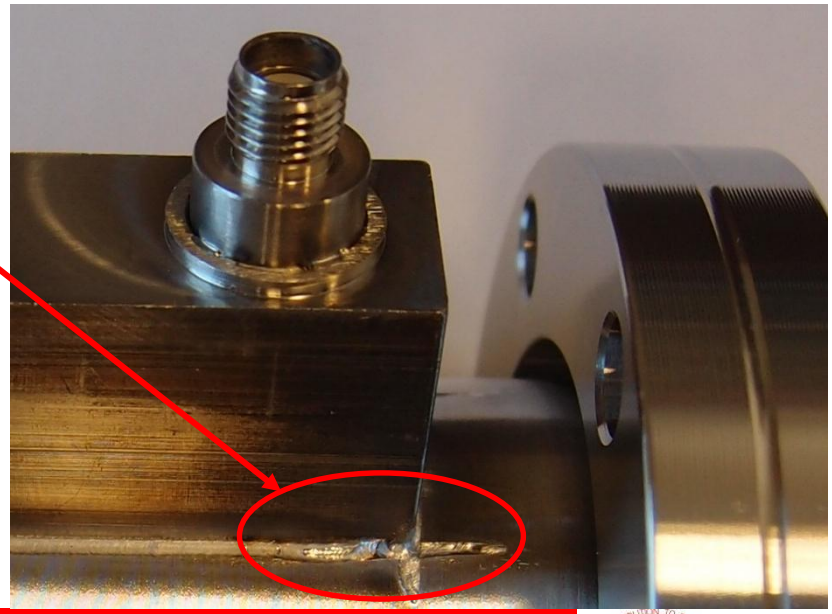
ISSUE #2: Part Design Problem



Tricky area to be machined

Manufacturer did not reproduce the area faithfully

Many welds needed to close the gap

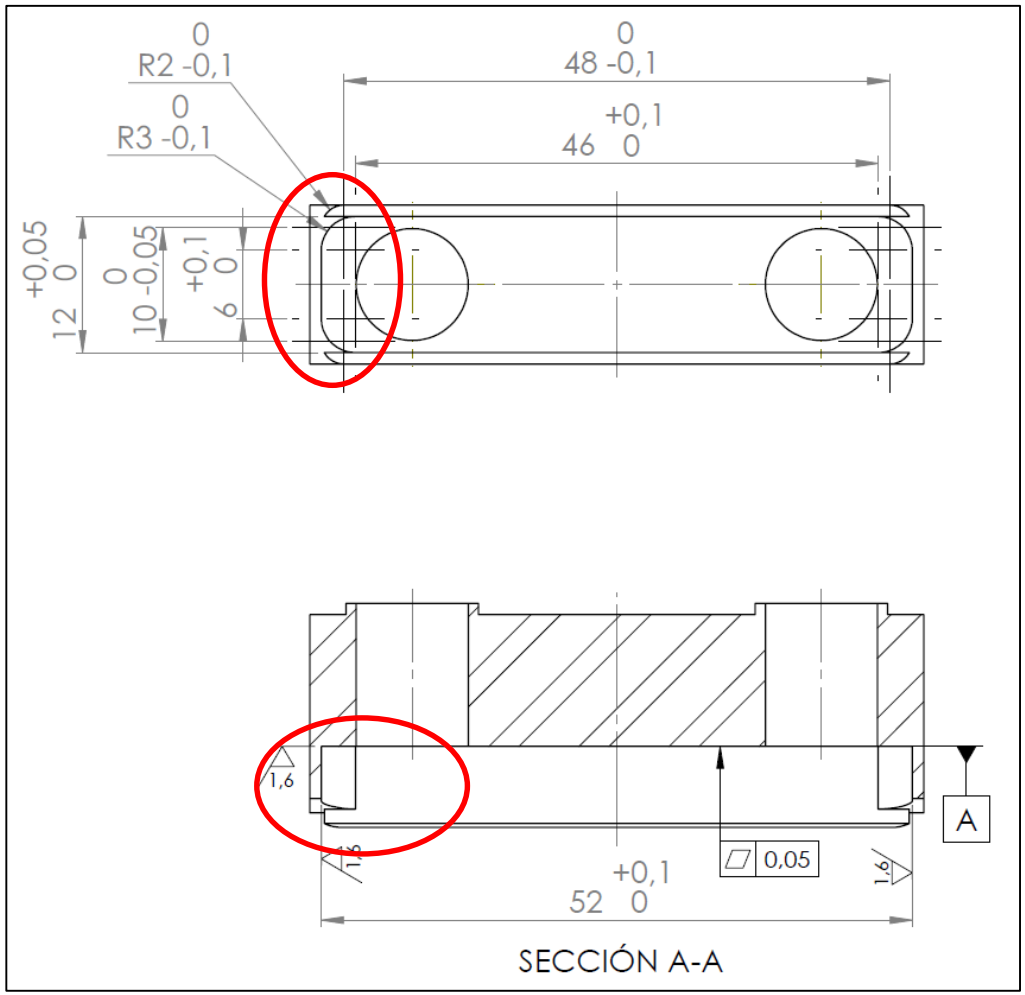


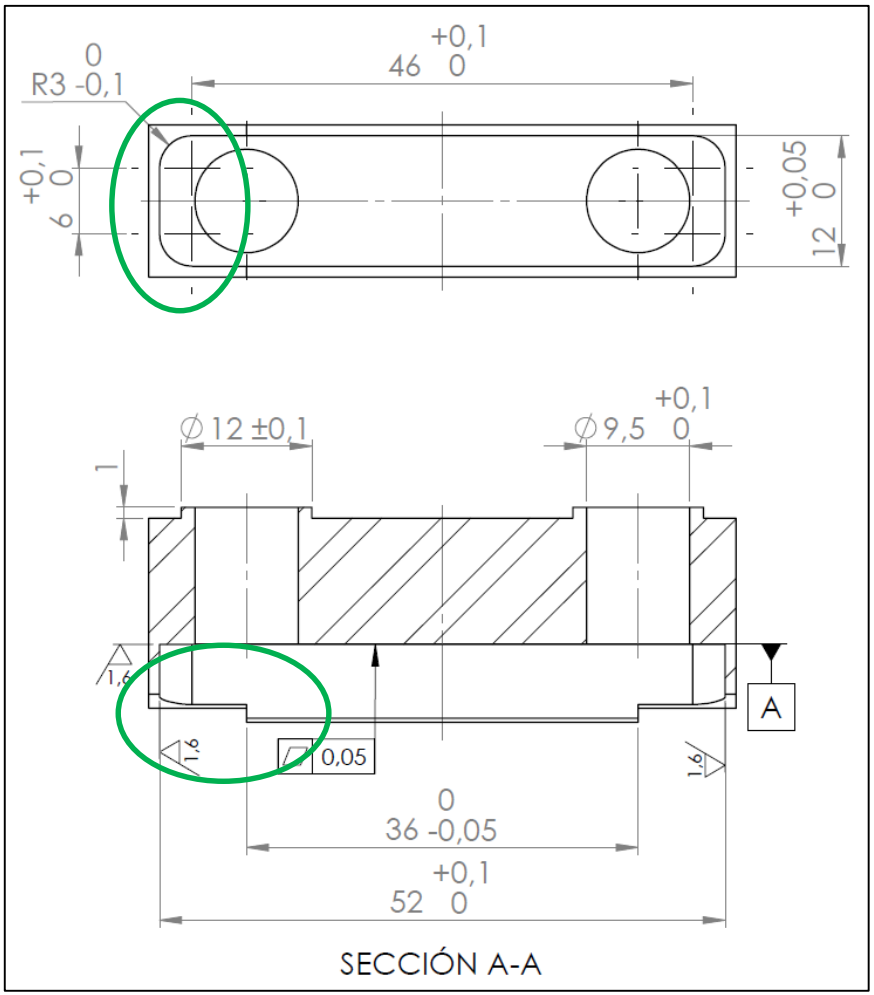
Big distortions in Final Part

Troubleshooting (IV)

SOLUTION #2: Part Design Problem

- **Design modified for BPM Stripline Body → end area 'relieved'**





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