MEBT BPMs: Status Update

3-4 October 2016

S. Varnasseri

2nd BI Forum, Bilbao

Outlines

- Design specifications
- Bilbao responsibilities
- BPM locations
- Bunch charge spectrum
- Displacement sensitivity
- Assembly
- Update on prototype progress
- Planning

Design Specifications

BPM related beam parameters of MEBT

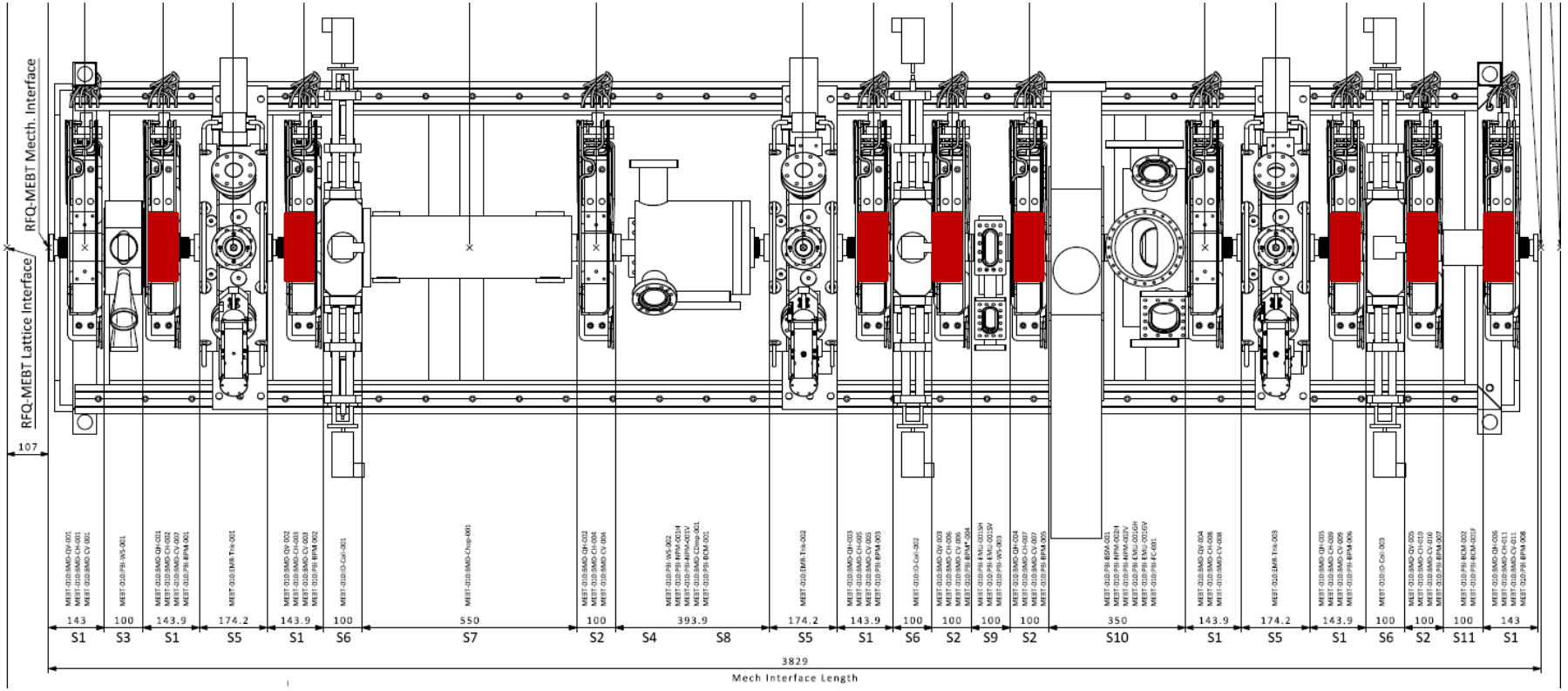
Parameter	Value	Unit
Beam energy	3.62	MeV
Beam current (avg.)	62.5	mA
Particles/bunch	1.1e9	
Readout frequency	704	MHz
RF frequency	352	MHz
Bunch length	60-180	ps
Pulse length (max.)	~2.8	ms

Bilbao Responsibilities

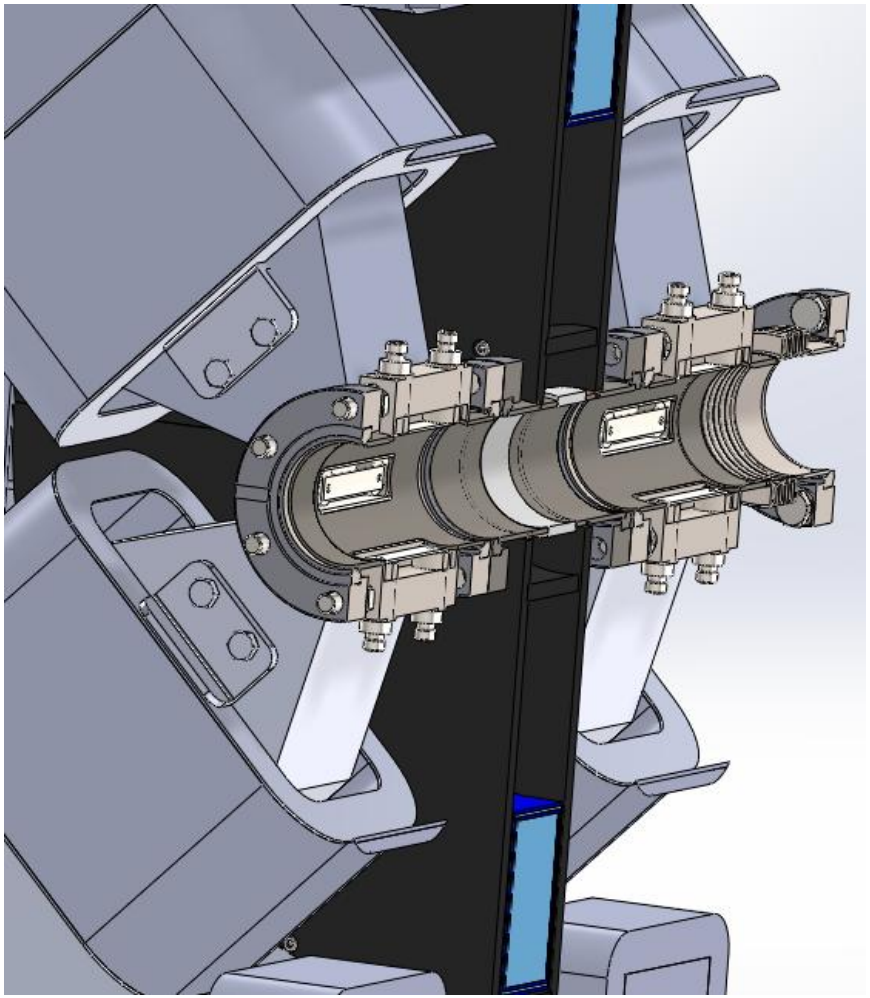
Bilbao			ESS ERIC		
Category	**Issue**	**Quantity**	**Category**	**Issue**	**Quantity**
Mechanical	Mechanical design, manufacturing and assembly	8	**Electrical**	Electronics (×4 ch) and acquisition	8
	Internal alignement with Quad	8		Cables from patch panel to Electronics	32
	Integration	8			
	Vacuum/mechanical test	8	**ICS**	Control and EPICS integration.	8
Electrical	EM design	8			
	Short cable from BPM to Patch panel (~1m)	32			
	Patch panel SMA (female)-N (female)	8		FPGA programming	8 (7+1)
	Electrical tests	8			

Locations of BPMs

7 BPMs are used for beam position monitoring system (position, phase) and one for timing characteristics of beam.

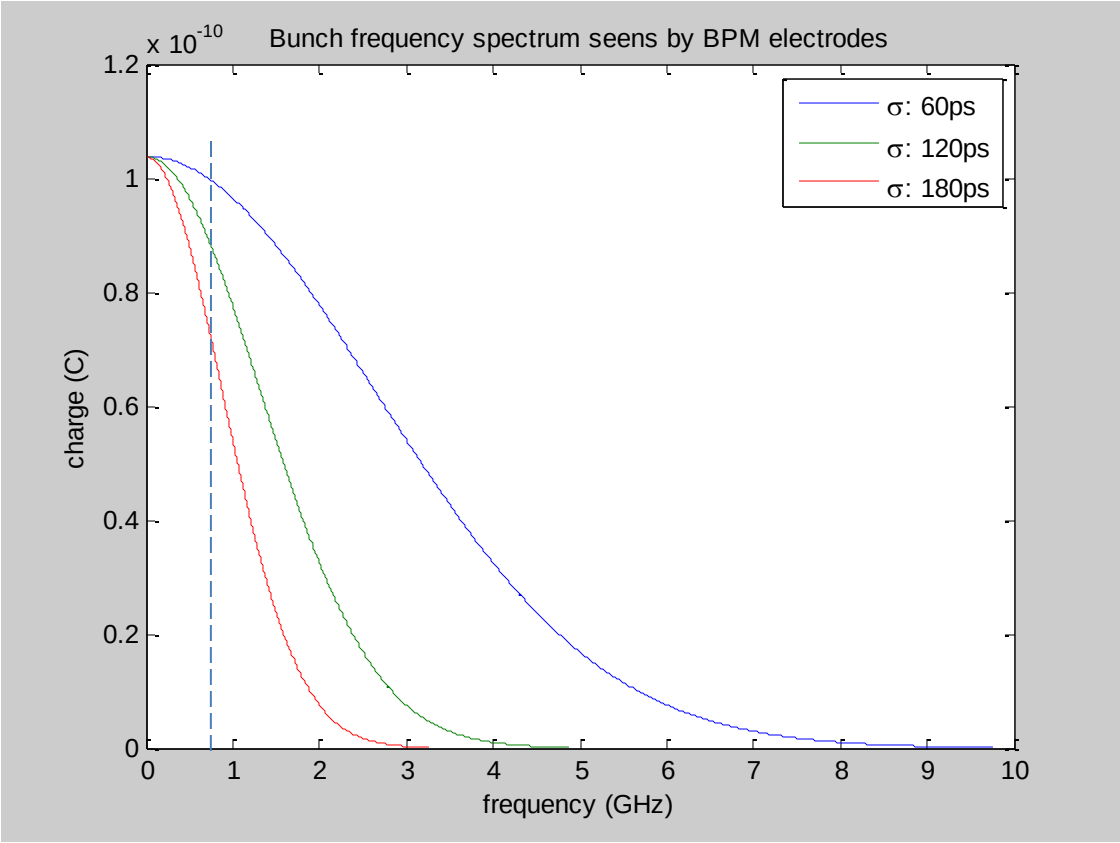


The BPM Striplines are placed inside quadrupole magnets, therefore their outer dimensions are bound by the magnet yokes. The maximum length should be 100 mm (flange to flange) due to mechanical integration.



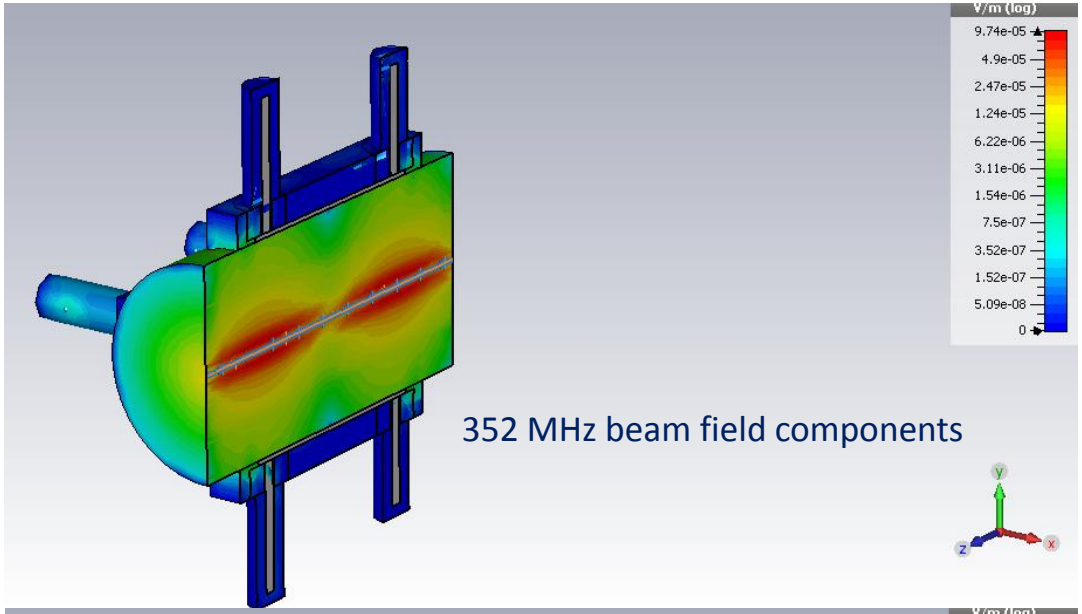
Beam bunch charge spectrums

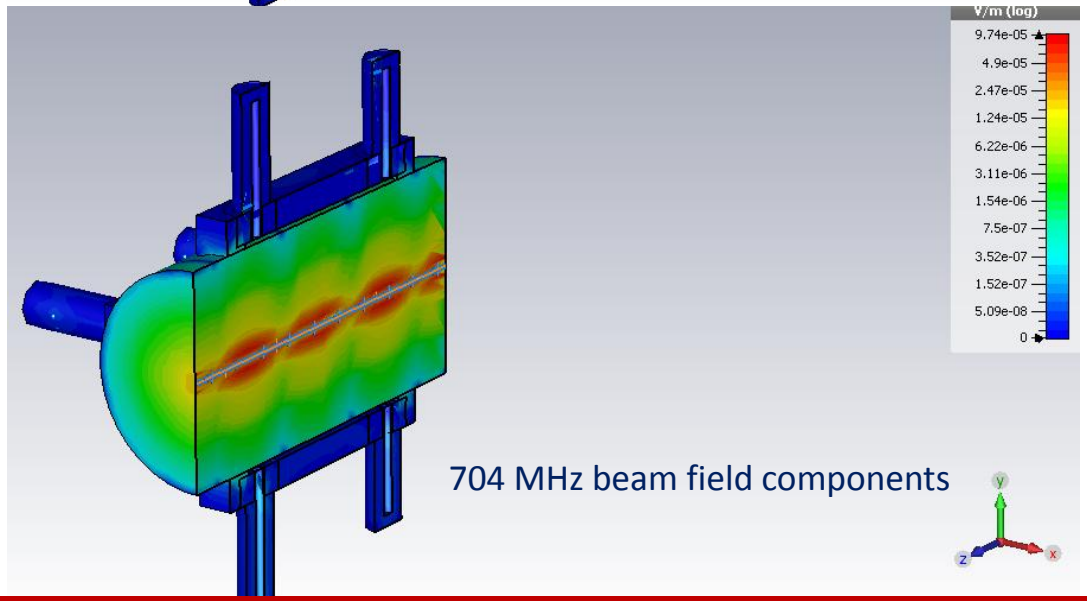
The beam charge component which is seen by electrods in MEBT (β=0.088) with various bunch lengths.



At 704 MHz

Beam field frequency components



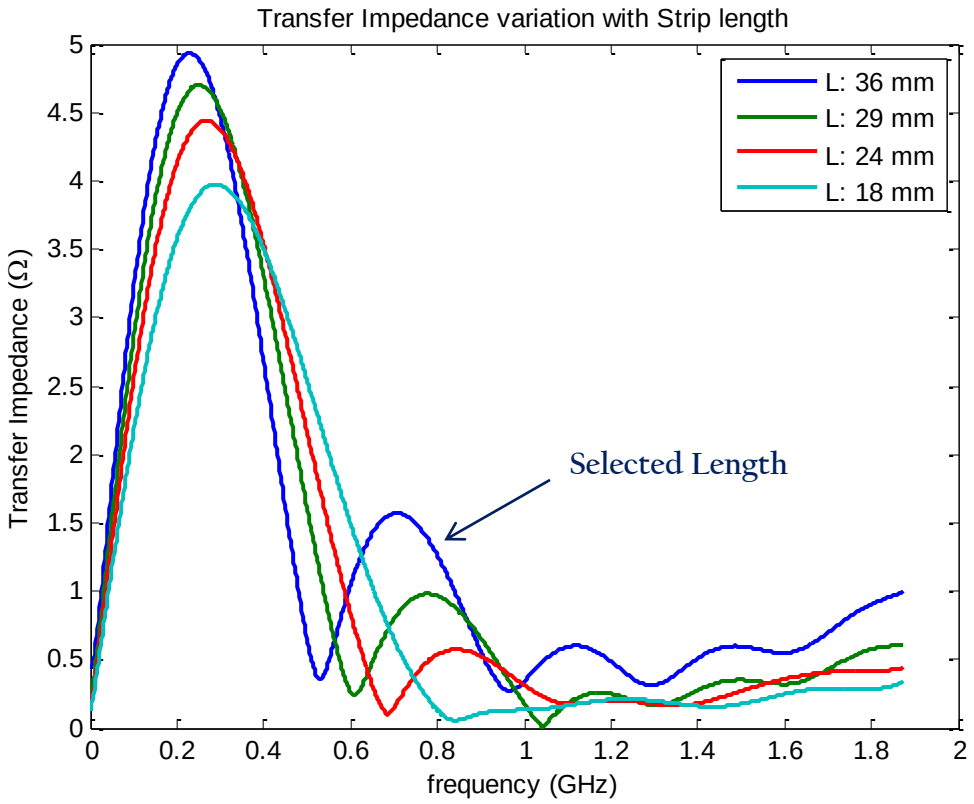


Specification: The 704.42 MHz (2nd harmonic) of the electrode signal shall be used for BPM signal processing. The 352.21 MHz (RF frequency) may be used as well at later stages to improve the BPM performance.

BPM Transfer Impedance Variation due to Various Strip Lengths

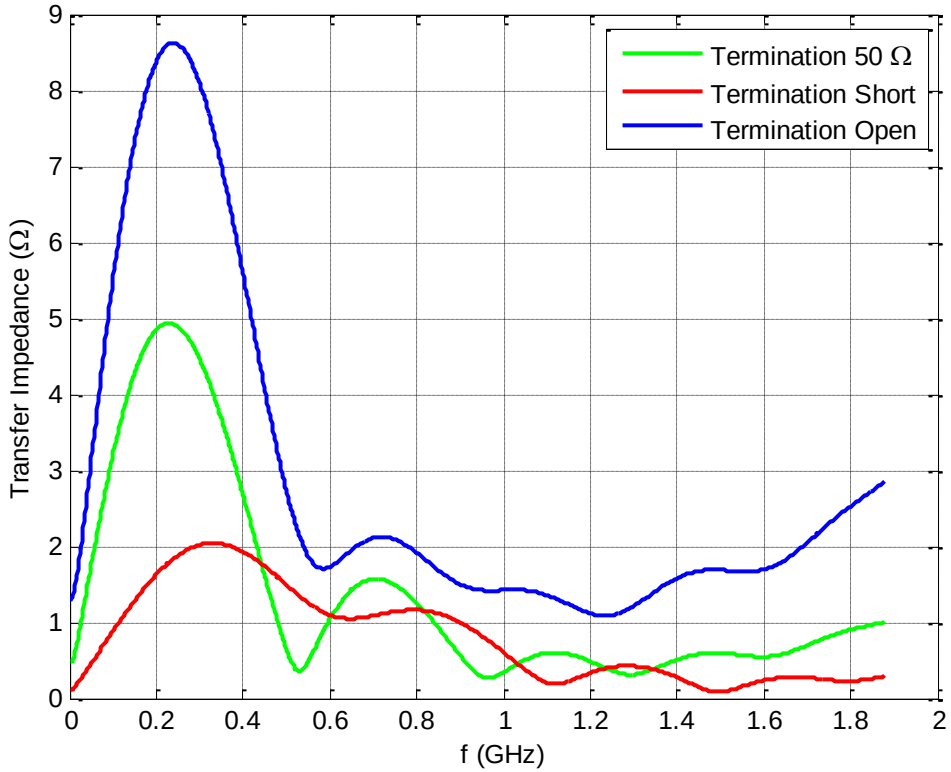
Simulations show the variation of transfer impedance due to Strip length sweep at frequency span of 1.8 GHz.

$$Z_t(f) = \frac{V_{pu}(f)}{I_{beam}(f)}$$



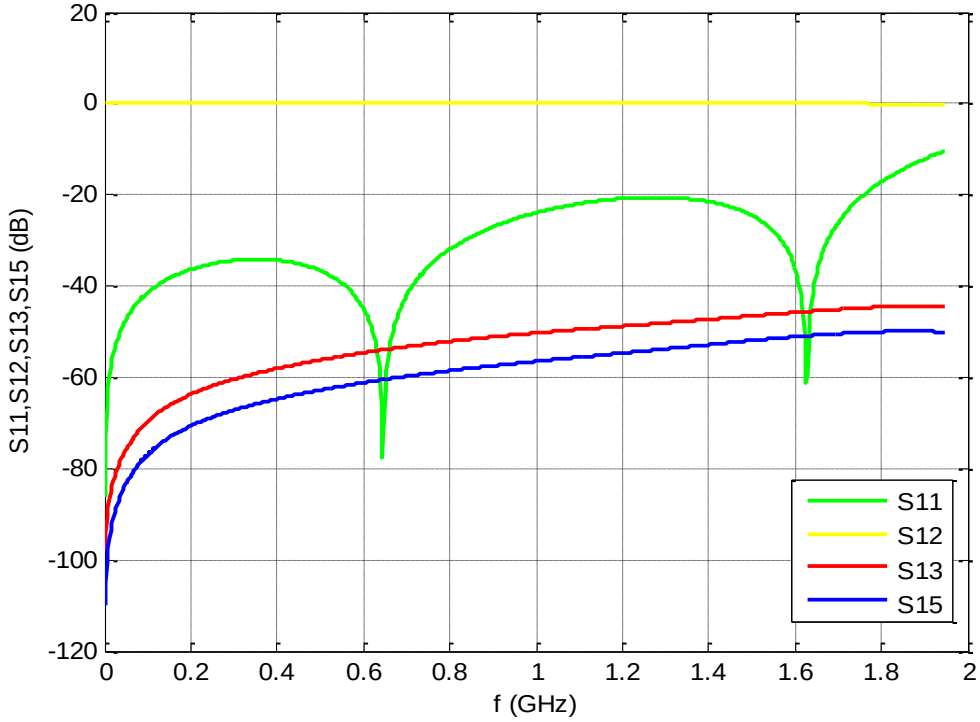
BPM Transfer Impedance for Different Terminations

Type of downstream termination has considerable effect on the voltage amplitude of the signal port and therefore BPM accuracy.



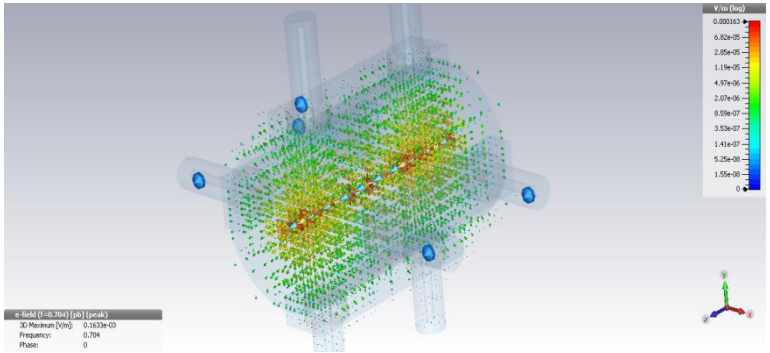
S - Parameters

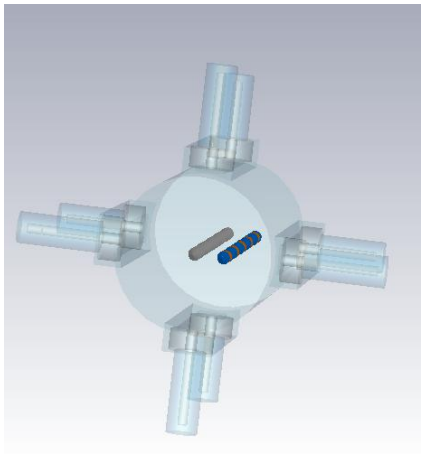
The transmission and reflection parameters and coupling of one electrode in relation to the adjacent electrode (S13) and in-front electrode (S15) is plotted.
The electrode reflection response around the interested frequency is expected to be better than -35 dB.

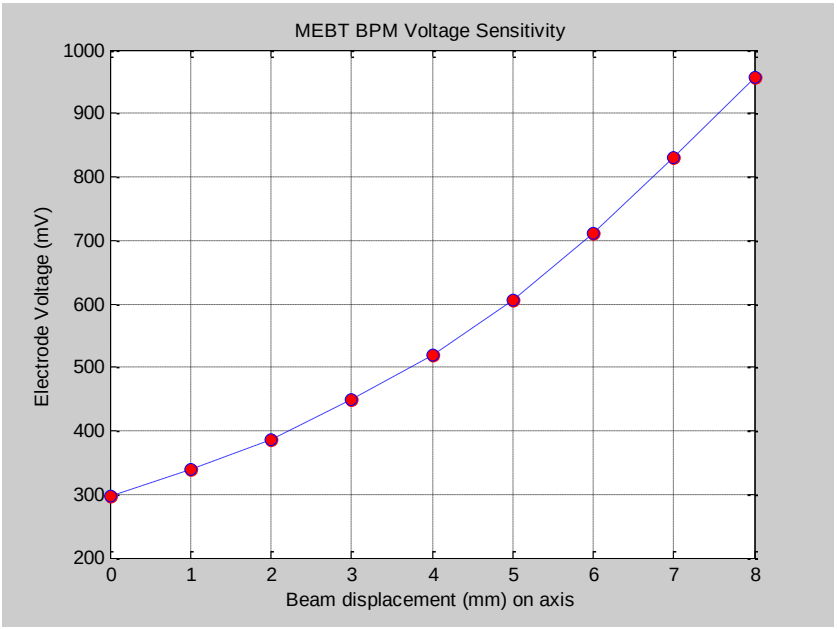


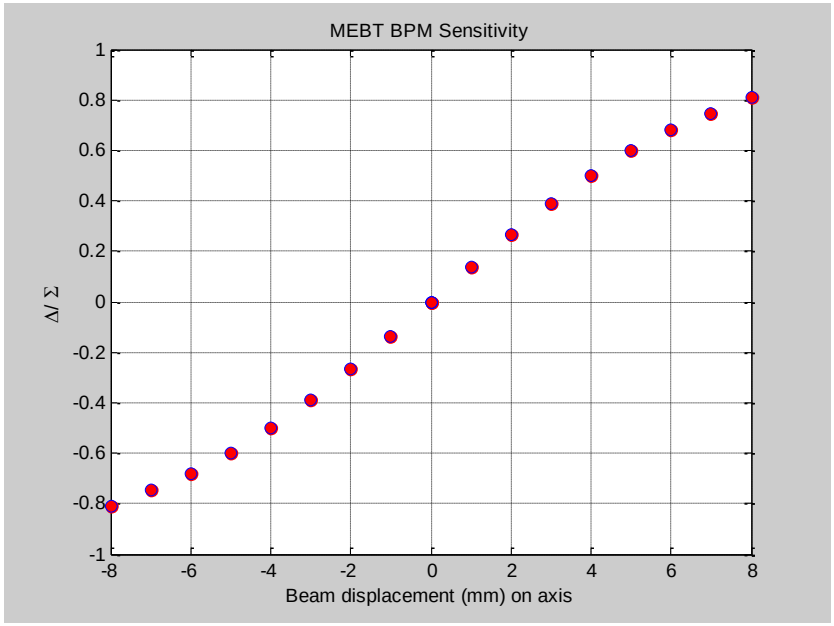
BPM Sensitivity to Displacement

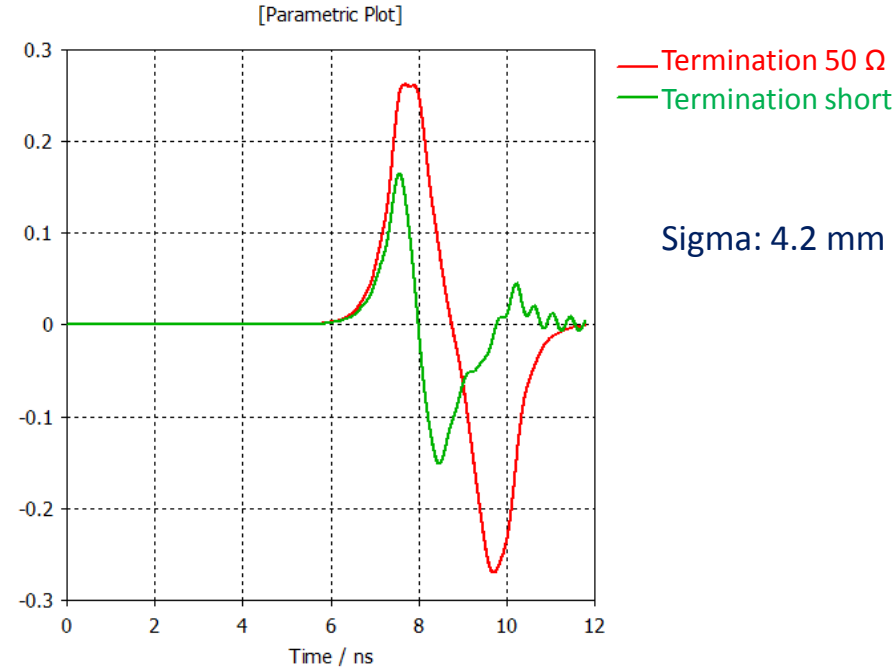
Voltage sensitivity to displacement (Oscop mode) is 45 [mV/mm] for 50Ω termination. Delta over sigma sensitivity is 0.13 [1/mm].



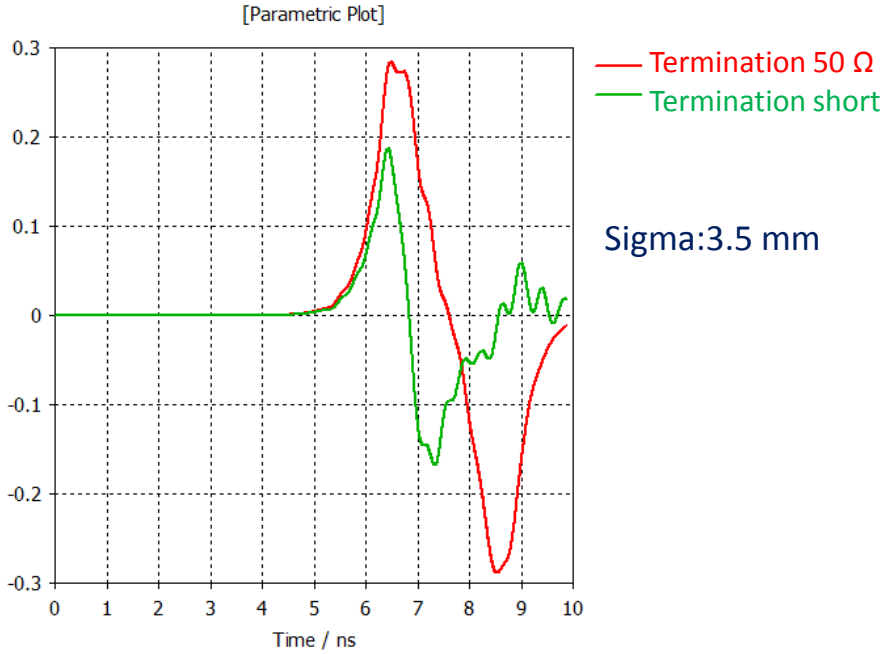




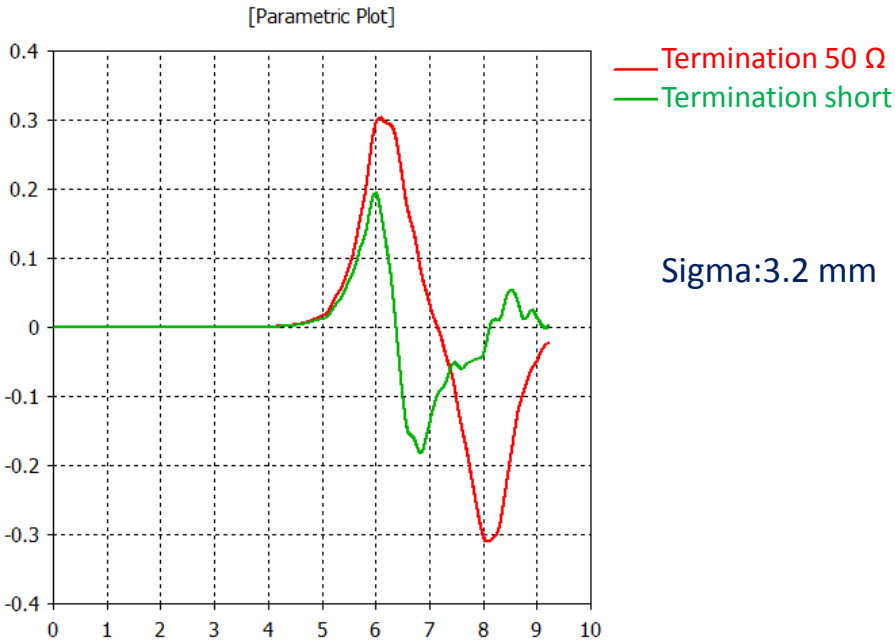




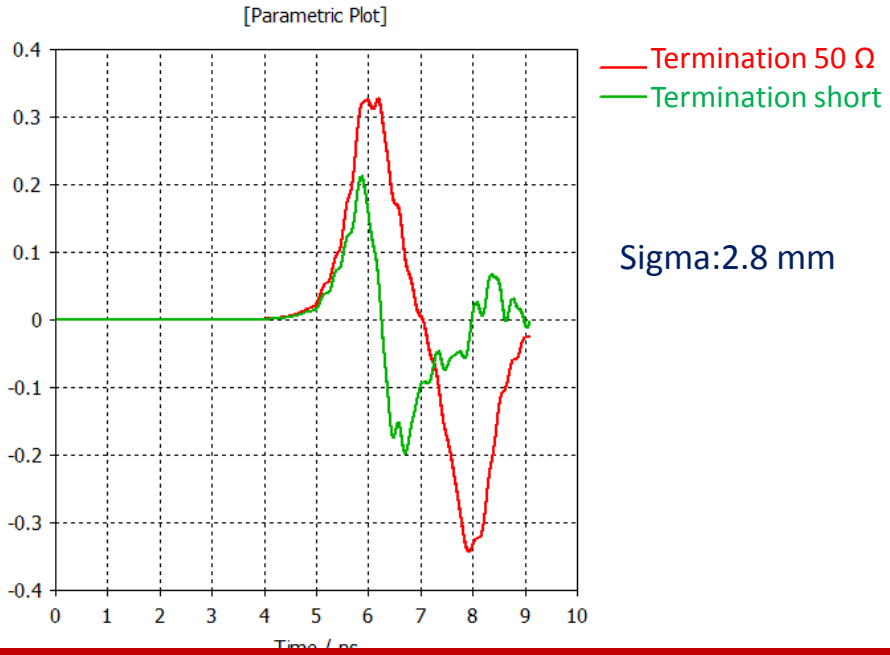
Sigma: 4.2 mm



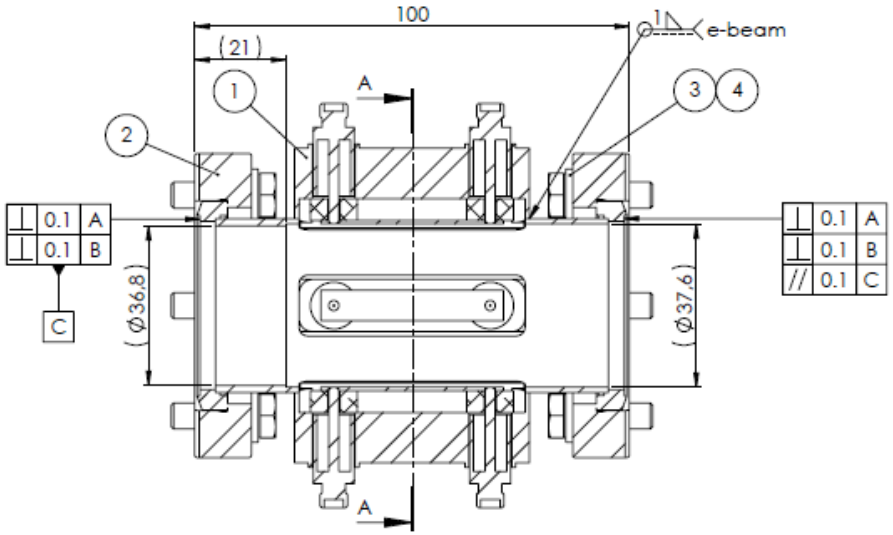
Sigma:3.5 mm

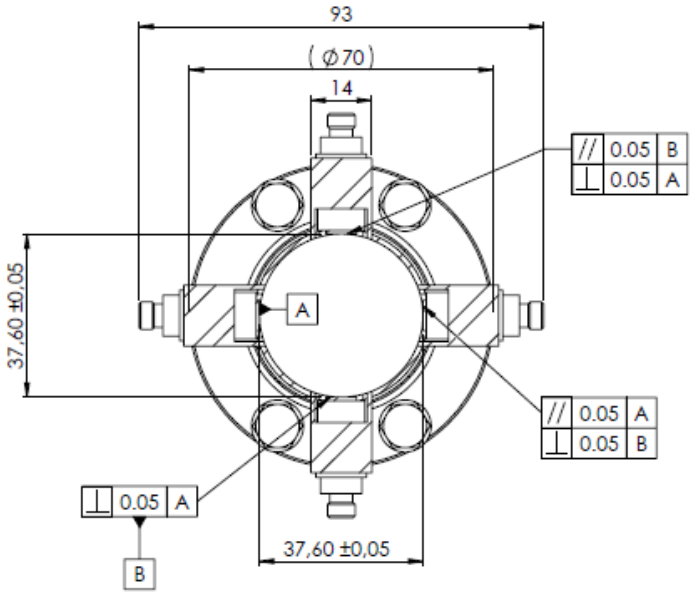


Sigma:3.2 mm



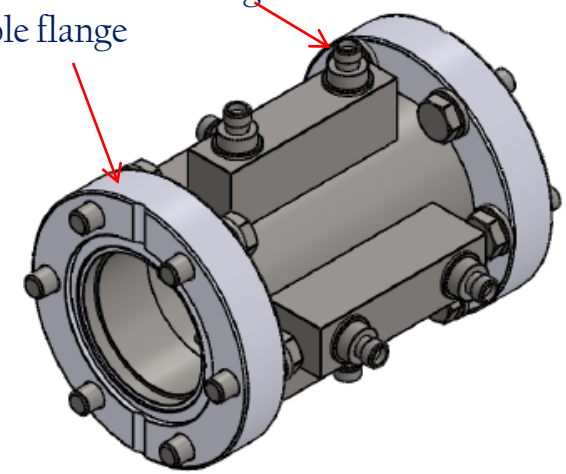
Sigma:2.8 mm





SECCIÓN A-A

Welded SMA feedthrough
Rotatable flange



N.º DE ELEMENTO	N.º DE PIEZA	Material	CANTIDAD
1	MEBT-BP-0100-ESS.00-PCK	AISI 316L	4
2	MEBT-BP-1100-ESS.01-PCK	AISI 316L	1
3	Washer ISO 7089 - 6	AISI 316	12
4	ISO 4017 - M6 x 20-N	AISI 316	12

Acabado: rebarbar y romper aristas

Tolerancias generales en roscas DIN 13: 6H - 6g

Tolerancias dimensionales generales: ISO 2768 - 1[m] Lineales

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

	Nombre	Fecha
Diseñado	S. Varnasset	16/09/2015
Dibujado	A. Zugasaga	26/10/2015
Verificado	I. Rueda	
Aprobado		

NOT FOR PRODUCTION

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
P.T. Zamudio
c/ Laida Bidea 201, Pab 4
48170 ZAMUDIO (Bizkaia)
tel: 946076855
www.essbilbao.org

MATERIAL:

PESO (g): 477.09

TÍTULO: Section 2 - BPM

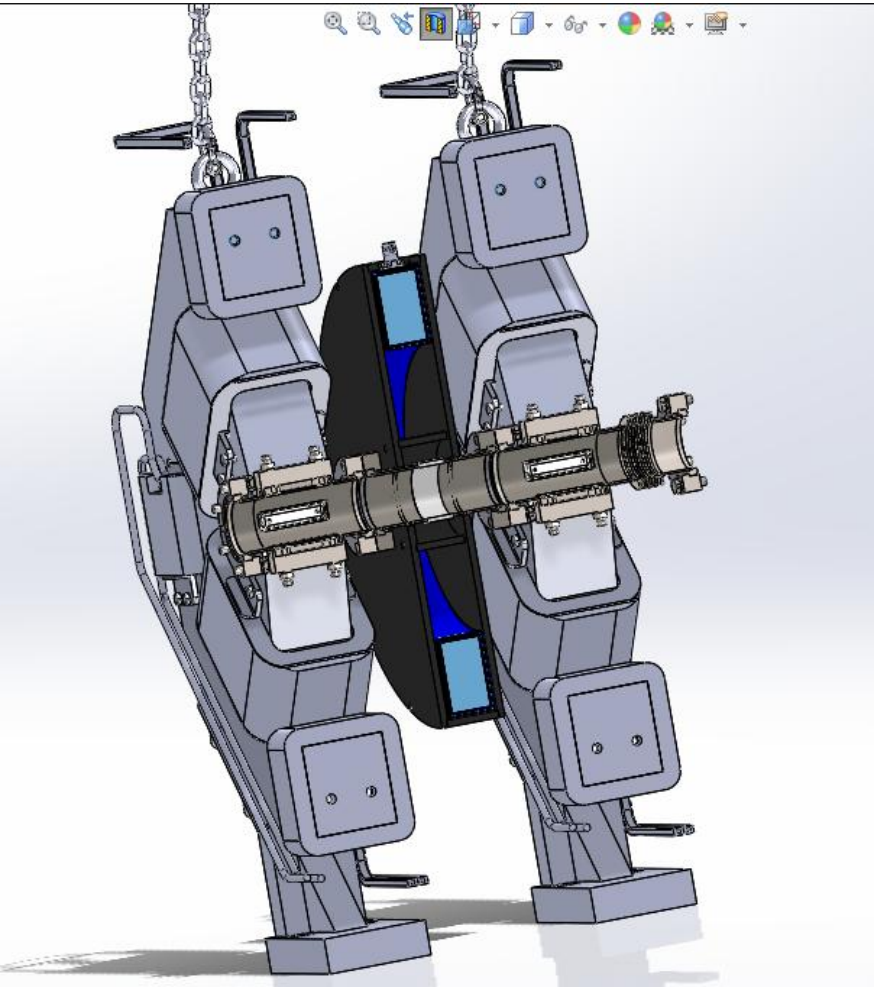
Nº DE DIBUJO: MEBT-BP-1000-ESS.01-PCK

A3

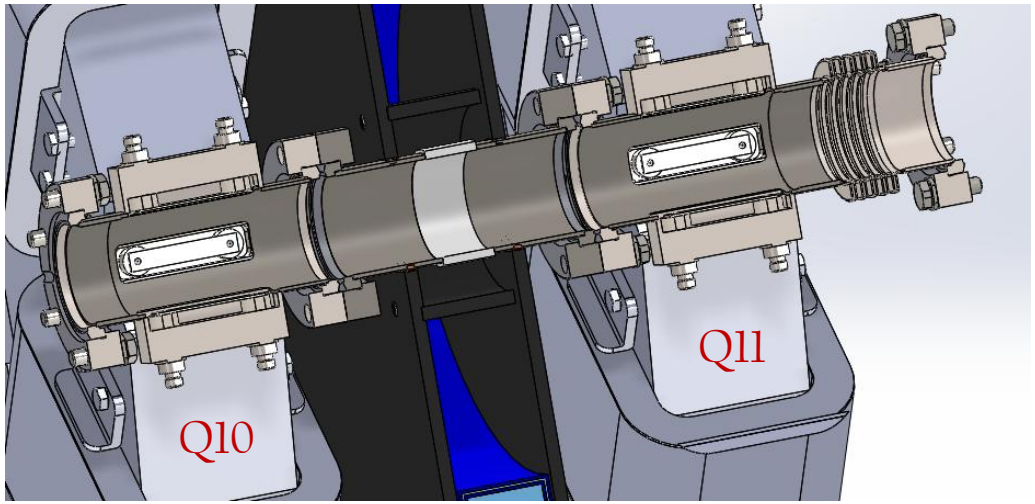
ESCALA: 1:1

HOJA 1 DE 1

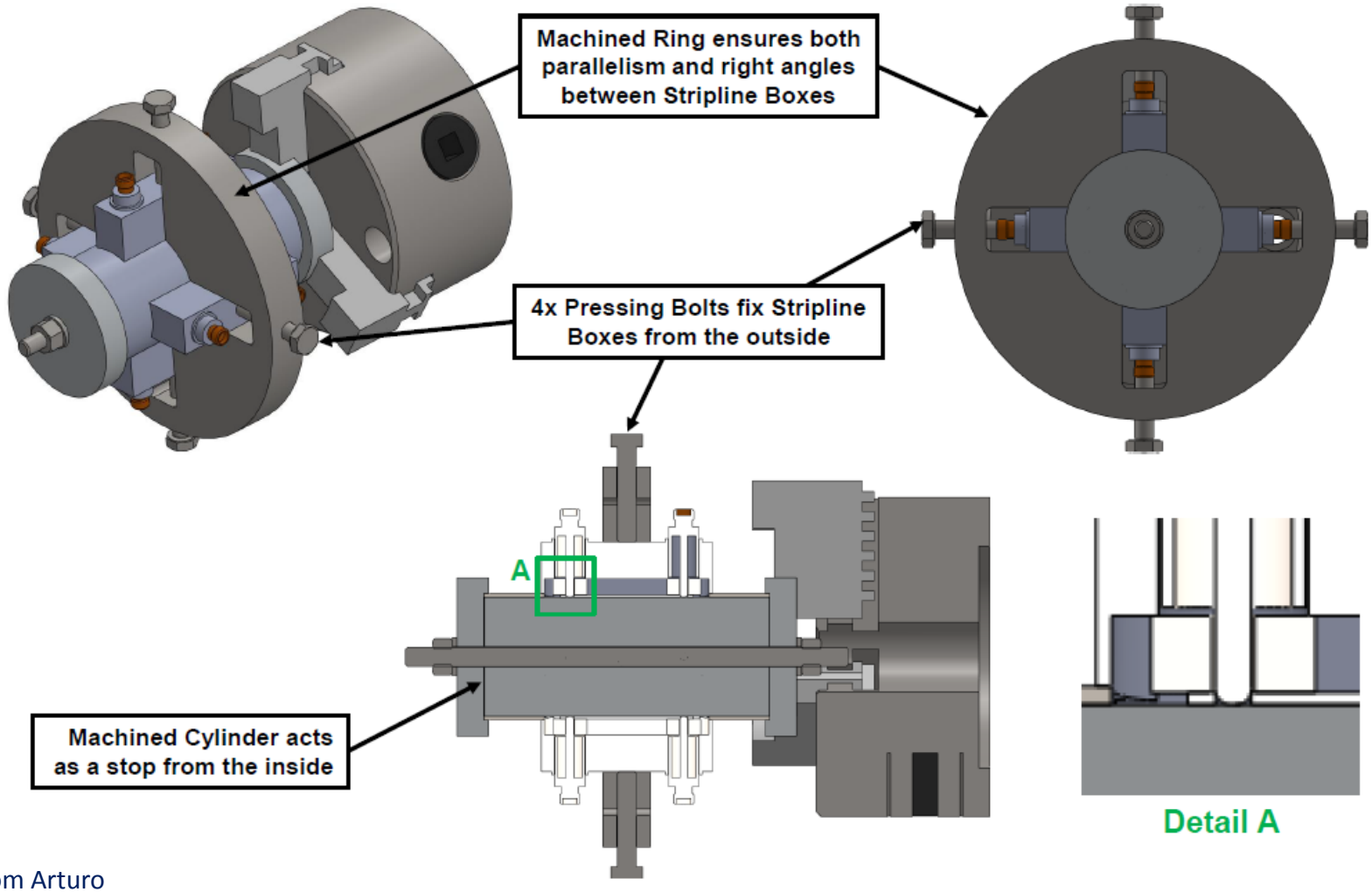
Assembly and location between quadrupoles (Q10, Q11)



There are two versions of BPMs, with and without bellows within MEBT. The BPMs are mechanically supported by Quadrupole yokes , put in between thin magnetic transparent sheets.



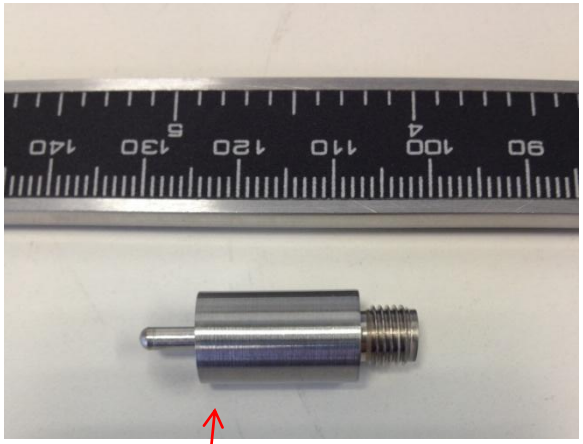
Prototype assembly tools



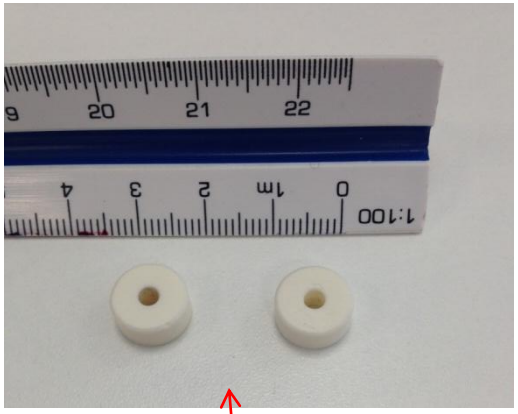
Slide from Arturo

Prototype progress and experiences(1)

All prototype components are delivered to Bilbao end of June. They have been quality measured and in the first production or second production found Ok.
The BPM feedthroughs were measured for magnetic permeability, mechanical tolerances, and vacuum leakage (Ok).
Welding prototypes started in August/September.

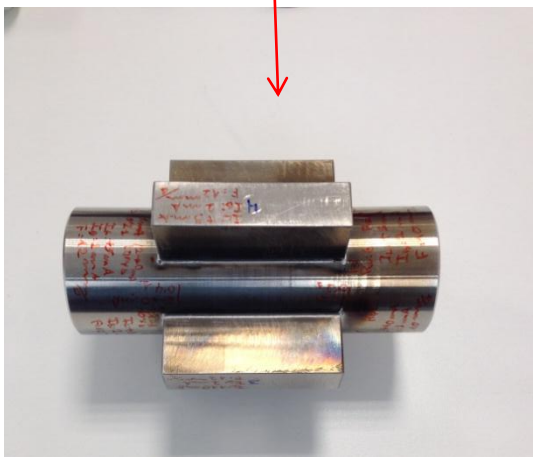


Non-magnetic weldable vacuum feedthroughs (toleranace min 10um)



Ceramic Al2O3 cermiac spacers (tolerances min 5 um).

Various e-beam welding currents trials



Prototype progress and experiences(2)

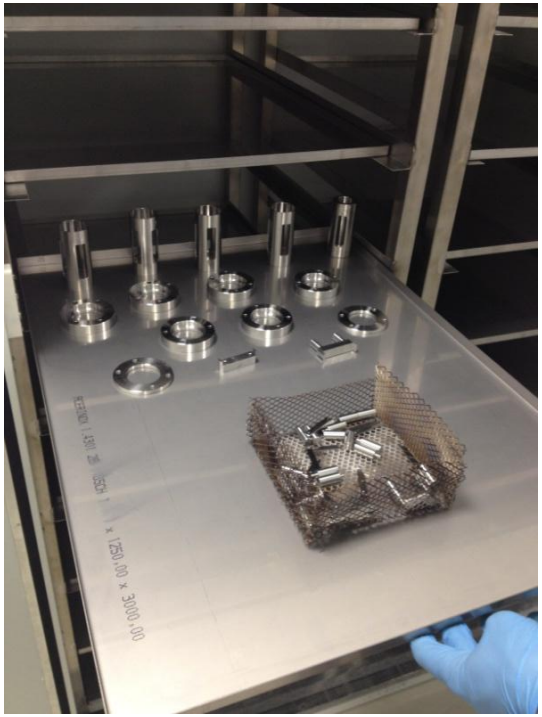
In order to be sure of the components before and after welding, particularly for the feedthrough, the magnetic permeability and vacuum leakage test were performed before welding. We plan to repeat the tests also for the whole setup after welding.

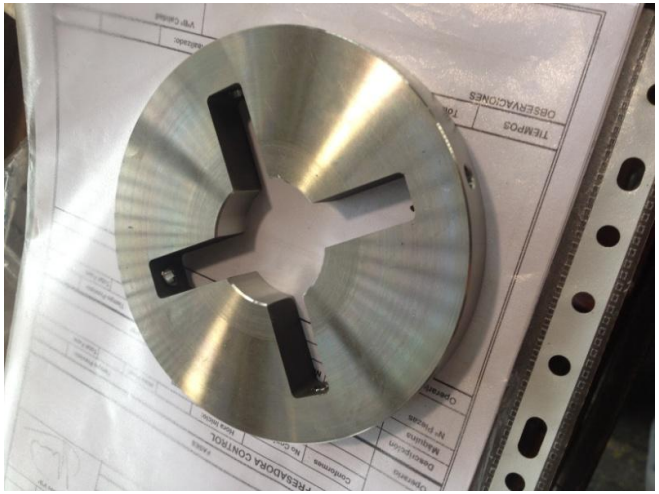
Vacuum leakage test (Ok)

The standard CF40 rotatable flange has been slightly customized to allow for BPM tube welding insert

the pieces of the prototypes

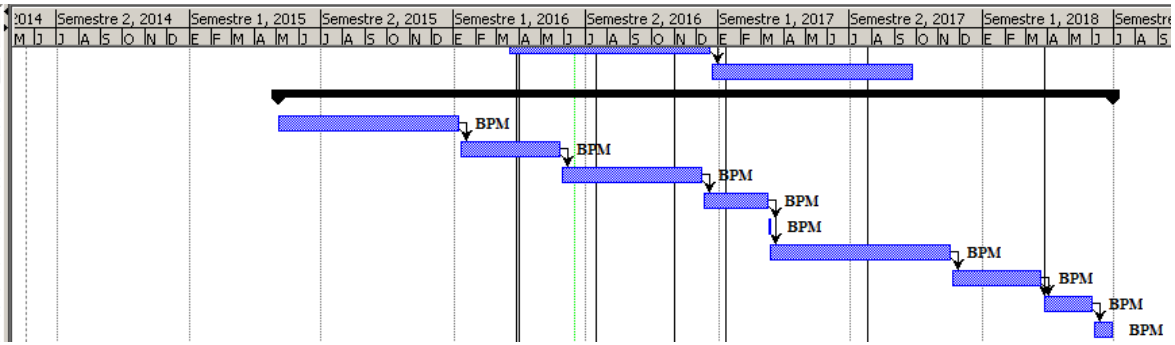
Prototype progress (3)





Planning

	Nombre	Inicio	Duracion	Ter
96	Diagnostic Boxes Fabrication	22/12/16...	200 days?	27/09/17
97	**BPM**	**4/05/15...**	**825 days?**	**29/06/1**
98	BPM: Stripline for MEBT - EM Design	4/05/15 ...	180 days	8/01/16 1
99	BPM: Mechanical Design	11/01/16...	100 days	27/05/16
100	BPM: Prototype	30/05/16...	140 days	9/12/16 1
101	BPM: Electrical and Vacuum tests	12/12/16...	65 days?	10/03/17
102	BPM: CDR	13/03/17...	1 day?	13/03/17
103	BPM: Fabrication of 8	13/03/17...	180 days	17/11/17
104	BPM: Electrical and vacuum tests	20/11/17...	90 days?	23/03/18
105	BPM: Integration	26/03/18...	50 days?	1/06/18 1
106	BPM: Delivery	4/06/18 ...	20 days	29/06/18



Milestones:

- Design Started (March 2015)
- Design preview (November 2015)
- Prototype start (March 2016)
- Prototype finish (expected): November 2016
- Prototype Electrical/mechanical/vacuum measurements (finish expected): March 2017

DESIGN OF STRIPLINE BEAM POSITION MONITORS FOR THE ESS MEBT

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R.A. Baron, H. Hassanzadegan, A. Jansson, T. Shea, ESS- ERIC, Lund, Sweden

Abstract

There will be overall 8 Beam Position Monitors (BPM) installed in the ESS MEBT. Seven of them will be used for the measurement of beam position, phase and intensity. One BPM will be used for the fast timing characterization of the chopped beam. The design is based on shortened stripline to accommodate the signal level for low velocity proton beam within MEBT. Due to mechanical space limits, all the BPMs are embedded inside quadrupoles; which requires special care on the magnetic properties of the materials within BPM sets and in particular the feedthroughs. The prototype electromagnetic and mechanical design is finished and its manufacturing is underway. This paper gives an overview of the electromagnetic and mechanical design and related analysis voltage amplitude reaching to electronics has to be compatible with margin to input level of electronics. The design of stripline monitors is based on transmission line with 50 Ω characteristics impedance. Furthermore the bunch length is not fixed during the passage within MEBT, so the voltage amplitude on electrodes slightly varies depending on the physical location of BPMs. In the following sections, the electromagnetic design, characteristics and mechanical realization of the first prototype is described.

Article on design details: IBIC 2016