IBIC 2019 Paper: WEPP014

A REPORT ON DEVELOPMENTS OF THE BCM AND BPM PICKUPS OF THE ESS MEBT

S. Varnasseri, I. Bustinduy, A. Ortega, I. Rueda, A. Zugazaga, A. Conde, J. Martin, **ESS-Bilbao, Bilbao, Spain**
R.A. Baron, H. Hassanzadegan, T. Shea, **European Spallation Source- ERIC, Lund, Sweden**

ESS MEBT (Medium Energy Beam Transport) with energy of 3.62 *MeV* is part of the European Spallation Source (ESS) which is delivered recently and to be operational at Lund, Sweden early 2020. In order to monitor and characterize the beam parameters, various beam diagnostics instruments including the position, phase and intensity measurement devices have been incorporated in the MEBT. There are overall 8 Beam Position Monitors (BPM), Two ACCT and one FCT installed in the MEBT of ESS. Seven of BPMs will be used for the measurement of beam position, phase and intensity. One BPM and the FCT will be used for the fast timing characterization of the chopped beam. The BPM design is based on 50Ω shortened stripline to accommodate the space restrictions and signal level for low velocity proton beam of MEBT.

BPM DESIGN

Table 1: MEBT BPM related beam parameters

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 (σ_z)	60-180	ps
Pulse length (max.)	2.86	ms
Repetition rate	14	Hz

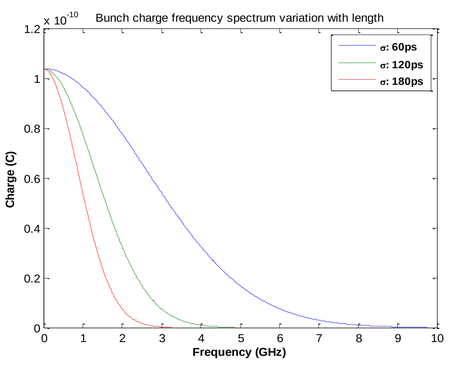


Fig. 1: Bunches frequency spectrum.

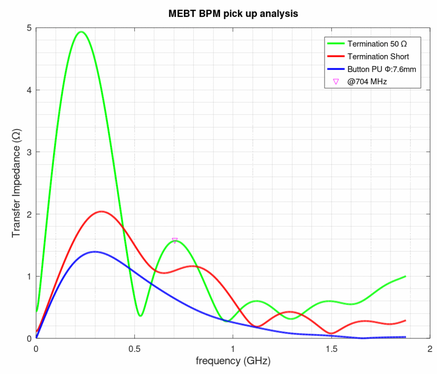


Fig. 2: BPM pick-ups transfer impedance comparison.

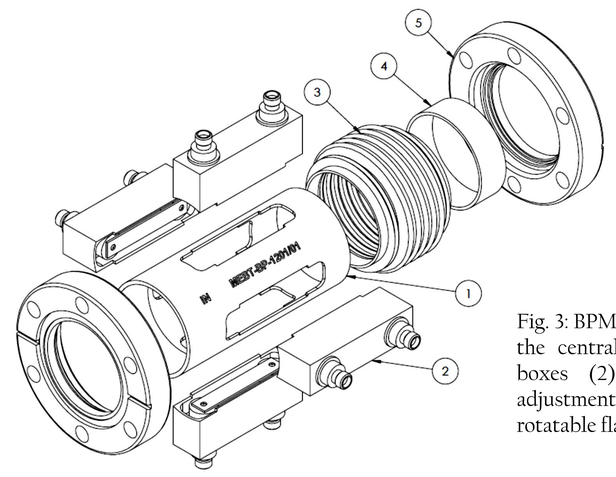


Fig. 3: BPM type 1 showing the central tube (1), RF boxes (2), Bellow (3), adjustment tube (4), rotatable flange (5)

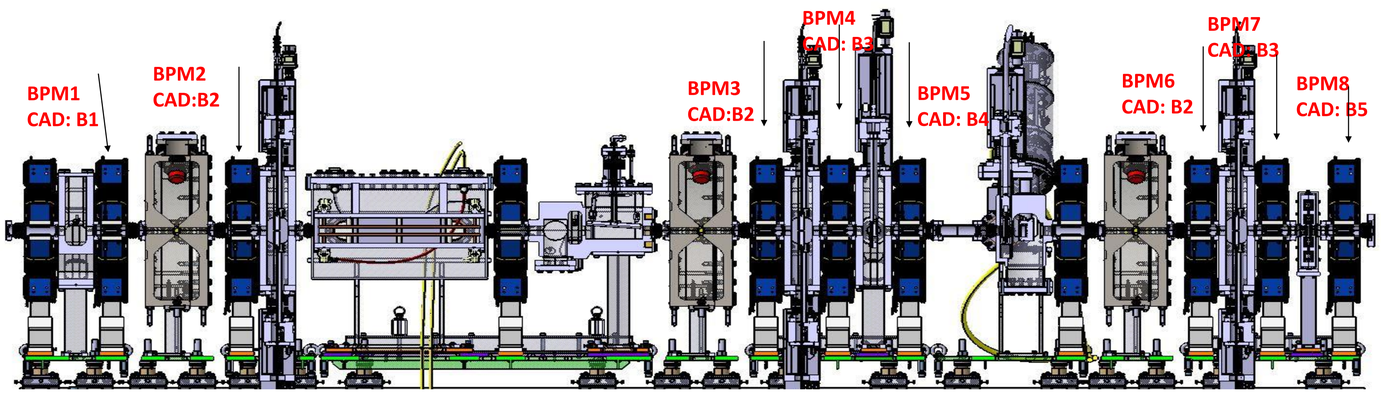


Fig. 4: BPMs distribution in the MEBT.

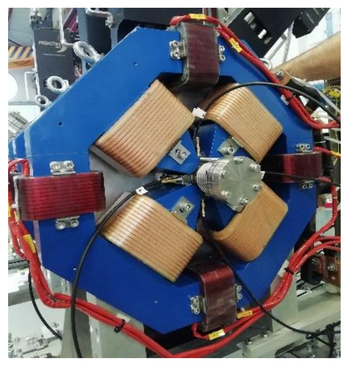


Fig. 5: BPM2-1 installed in the quadrupole magnet.

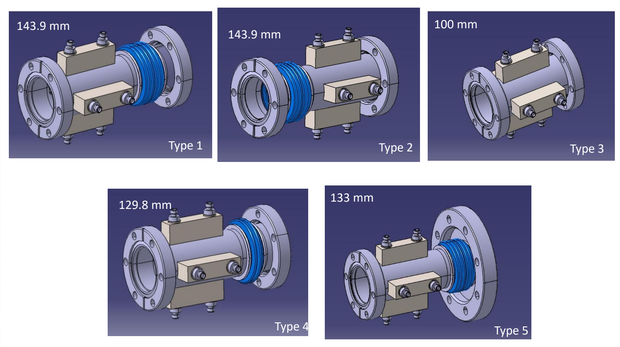


Fig. 6: Various types of BPMs of MEBT.

BPM MEASUREMENTS

During the process of welding and fabrication of the BPMs, several checks including the vacuum leakage, RF, electrical and metrology checks were carried out. The final RF and vacuum checks have been realized just before installation of the BPMs inside quadrupoles and after installation in the MEBT. The measurements show a return loss of less than -21 dB and coupling of around -50 dB for adjacent strip pick-ups (e.g up and left) for all the BPMs at the frequency of 704 MHz. The coupling of opposite strip pick-ups (e.g up and down) is around -58 dB at frequency of 704 MHz. The measured bandwidth (3dB) of the BPMs is ~3 GHz.

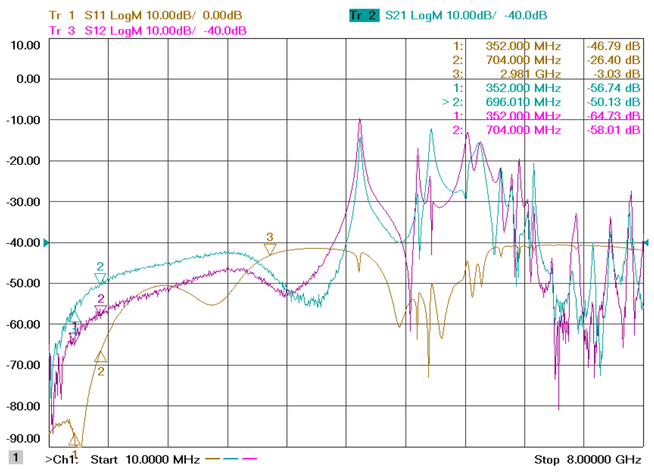


Fig. 7: BPM measured return loss and couplings

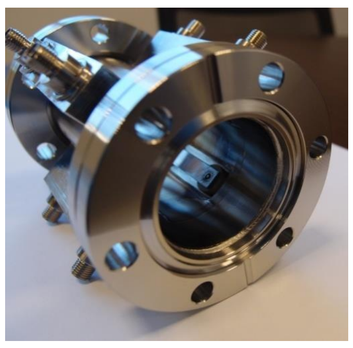


Fig. 8: BPM type3 before installation.

Due to mechanical space limits, all the BPMs are embedded inside quadrupoles. The BPM electromagnetic design and mechanical drawings has been performed at ESS-Bilbao, the pieces are machined in various local companies, and the final weldings and manufacturing was performed at ESS-Bilbao e-Beam welding facility. The vacuum leakage tests, RF tests and metrology of BPMs and COMBO tests were performed before installation within MEBT.

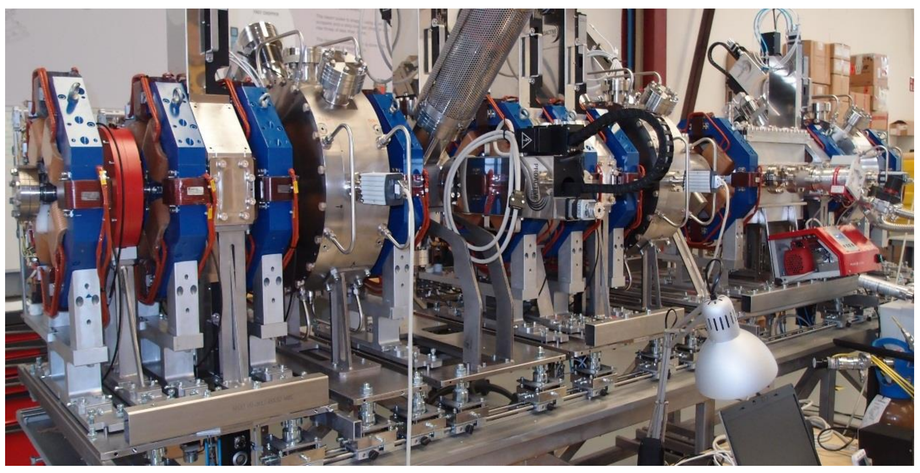


Fig. 9: A view of the MEBT during pre-installation in ESS-Bilbao

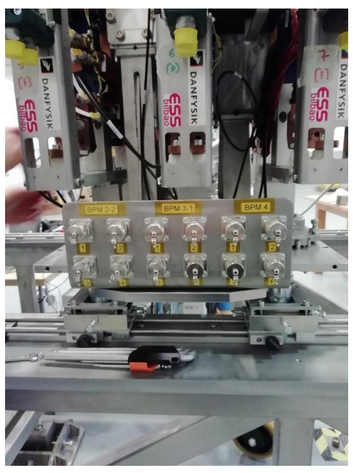


Fig. 10: A Patch panel for three BPMs.

Combo design is based on the Bergoz® in-flange CTs, which the two toroids of ACCT and FCT are surrounding its vacuum pipe. The 6 mm electrical gap is realized with the Al2O3 brazed with Kovar to the vacuum pipe in both sides. For the integration purposes, the flanges on both sides of the Combo are DN40 CF which are connected to the adjacent BPMs in MEBT. The outer diameter of the Combo is 271 mm and the flange-flange length is 100 mm.

CURRENT TRANSFORMERS

For the purpose of beam current measurement (BCM) in terms of f slow and fast time resolution, two ACCTs and one FCT are placed in two locations of the MEBT.

Tabl.e 2: BCMs specifications

Parameter	Value
ACCT 1,2 Bandwidth (3dB)	1 MHz
FCT bandwidth (3dB)	620 MHz
ACCT1,2 rise time	‹ 346 ns
FCT rise time	‹ 550 ps
ACCT 1,2 Droop	‹ 1.16 %/ms
FCT Droop	4.3 %/µs
Electronics full scale range	±10 V
Full scale current (ACCT 1,2)	±80 mA

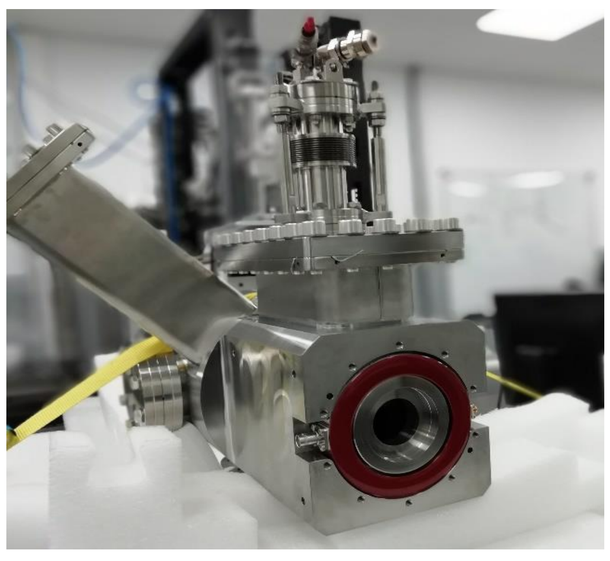
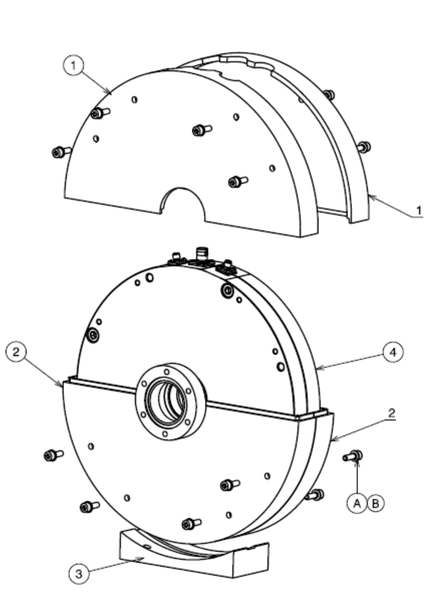


Fig. 11: ACCT1 installed in the Groove of beam dump.



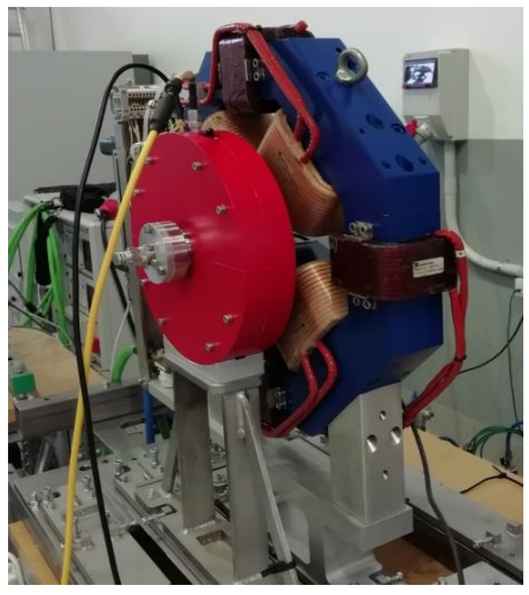


Fig. 12: COMBO layer and installation with Quadrupole for magnetic shielding checks.