EUROPEAN SPALLATION SOURCE

Meeting Minutes
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# ESS MEBT Mechanical Layout Workshops, 2-5 June 2015

**Meeting Dates**
2 – 5 June 2015

**Location**
ESS Bilbao, Spain

**Joint-Chairmen**
Ibon Bustinduy, Matthew Conlon

**Secretary**
Matthew Conlon

## 1. Purpose

To jointly confirm the requirements and to develop the conceptual design (mechanical layout) for MEBT including for quadrupoles, beam instrumentation, bunchers and to the degree possible, chopper and beam dump.

## 2. Participants

| Name | | Partner Org | Specialty |
|---|---|---|---|
| Aitor Zugazaga | AZ | Bilbao | vacuum systems |
| Aurélien Ponton | AP | ESS | accelerator systems |
| Carlos de la Cruz | CC | Bilbao | Control |
| David Fernandez | DF | Bilbao | electro magnetic |
| Fabien Rey | FR | ESS | alignment systems. Participated via Skype, 2 June. |
| Giles Harper | GH | Bilbao | electric systems |
| Ibon Bustinduy | IB | Bilbao | MEBT WU Leader, accelerator systems |
| Igor Rueda | IR | Bilbao | mechanical design |
| Juan-Luis Muñoz | JM | Bilbao | electro magnetic |
| Marcelo Ferreira | MF | ESS | vacuum systems |
| Matthew Conlon | MC | ESS | MEBT WU liaison |
| Pedro Gronzález | PG | Bilbao | Technical Director |
| Ryoichi Miyamoto | RM | ESS | beam physics |
| Seadat Varnassari | SV | Bilbao | beam physics and instrumentation |
| Tom Shea | TS | ESS | beam instrumentation |
| Zvonko Lazic | ZL | ESS | mechanical design |
| Carlos Martinez de Marigorta | CM | Bilbao | Alignment systems. Participated via Skype, 2 June. |
| Idoia Mazkiaran | IM | Bilbao | Control |
| Jon Bilbao | JB | Bilbao | Electric systems |

## 3. Agenda, presentations and supporting information

*See Indico site:* https://indico.esss.lu.se/indico/event/351/

## 4. Minutes of Meeting

| Date / Time | Agenda item and Discussion | Lead participants |
|---|---|---|
| **2 June** | | |
| 15:00-16:00 | Alignment requirements and design input for stands/support<br>*See the Indico site for FR's presentation and report for this workshop conducted via Skype.* | IB, FR, IR, CM |
| **3 June** | | |
| afternoon | Vacuum requirements and design<br>*See the Indico site for MF's presentation and report for this workshop.* | MF, AZ, IM, GH, JB |
| **4 June** | | |
| 09:00-09:30 | Introduction<br>IB welcomed the visitors. MC and IB described the purpose of the workshops, adjusted the agenda items, and summarized the outcomes from workshops, which occurred 2-3 June. | MC, IB |
| 09:30-10:30 | Confirm MEBT Level 3 (L3) requirements<br>IB presented the L3 requirements from DOORS and discussed these with AP and the participants:<br>• explaining ESS Bilbao's understanding of each requirement<br>• identifying missing references and missing values or parameters in the requirements, shown as 'XXX',<br>• proposing values or parameters where they were missing<br>• proposing additions, deletions and other changes<br><br>See actions nr. 1 to nr. 9, inclusive. | AP, IB |
| 10:30-12:30 | Beam physics lattice design - MEBT 2015.v0c<br>*See Indico site for RM's presentation.*<br>RM's presentation included specific comments to ESS Bilbao's spreadsheets MEBT_2015_v3_integrated.xlsx of approximate date 150520.<br><br>ESS and Bilbao agreed the lattice MEBT 2015.v0c as presented by RM.<br><br>To avoid confusion, the spreadsheets MEBT_2015_v3_integrated.xlsx has not been included in the Indico site, since ESS and Bilbao agreed to adopt the new lattice MEBT 2015.v0c and the | RM, AP, IB |

| Date / Time | Agenda item and Discussion | Lead participants |
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| | resulting locations presented by RM. The centre locations in the mechanical layout (ESS-34690) presented later in the agenda by ZL, fully complies with MEBT 2015.v0c.<br><br>See actions nr. 10 to nr. 12, inclusive. | |
| 12:30-13:00 | Confirm L4 Beam Magnets and Deflectors (BMD) requirements - Chopper pulser<br>Bilbao has been in discussions with three potential suppliers for the chopper pulser – Kentech Instruments (UK) and FID (Germany), IXYS Colorado (USA). GH presented the L4 BMD requirements for the chopper's pulser and discussed these with AP and the participants:<br>• explaining ESS Bilbao's understanding of each requirement<br>• identifying missing references and missing values or parameters in the requirements, shown as 'XXX',<br>• proposing values or parameters where they were missing<br>• proposing additions, deletions and other changes<br><br>See actions nr. 13 to nr. 18 inclusive. | GH, AP, SV, CC |
| 14:00-15:30 | Mechanical Layout including RFQ-MEBT and MEBT-DTL interfaces L3 interfaces<br>ZL presented layout schematics ESS-003490 which conformed to 'optical' centre locations from lattice configuration MEBT 2015.v0c, without flanges or bellows. ESS-003490 includes proposed interface design for RFQ-MEBT and MEBT-DTL not yet agreed between Bilbao and INFN.<br>Given the constraints presented by RM (slide 7) Bilbao (IB, IR) considered solution a), where BSM, NPM, GRID and FC are located between Q7 and Q8 as best alternative. To be studied the required actual length of this section and for WS and SLIT device between Q6 and Q7. this section is agreed to use as a basis for MEBT 3D model going forward.<br><br>First ACCT belongs to RFQ, therefore between Q1 and Q2 a single WS is required. Both end vacuum valves belong to RFQ and DTL respectively.<br><br>See actions nr. 19 to nr. 20 inclusive. | ZL, AP, IR |
| 15:30-16:00 | Confirm L4 Electro-Magnetic Resonator (EMR) requirements<br>PG presented the L4 EMR requirements for buncher cavities and discussed these with AP and other participants:<br>• explaining ESS Bilbao's understanding of each requirement<br>• identifying missing references and missing values or parameters in the requirements, shown as 'XXX',<br>• proposing values or parameters where they were missing | IB, AP, PG |

| Date / Time | Agenda item and Discussion | Lead participants |
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| | • proposing additions, deletions and other changes<br><br>See actions nr. 21 to nr. 23 inclusive. | |
| 16:00-16:30 | Confirm L4 Radio Frequency (RF) requirements<br>See actions nr. 19 to nr. 21 inclusive. | IB, AP |
| 16:30-17:30 | Review the design drawings for MEBT bunchers<br>ZL and MF made a preliminary review of the CAD drawings for the proposed prototype / first production buncher procurement. The assessment was that the design was not yet sufficiently mature for procurement.<br>See actions nr. 24 to nr. 25 inclusive. | IR, ZL, MF |
| 17:30-18:00 | Review of draft L4 Proton Beam Instrumentation (PBI) requirements<br>ESS and Bilbao had discussed PBI requirements and specifications for MEBT before, but ESS had not provided a list of L4 requirements for PBI before. AP presented a first draft proposed list of requirements with the aim. When agreed by both parties, these L4 MEBT PBI together with specifications for some specific instruments, such as the Emittance Measurement Unit (EMU) would be included with the IKC Agreement technical annex (Schedule).<br>See actions nr. 26 to nr. 34 inclusive. | AP, IB, SV |
| **5 June** | | |
| 09:00-10:00 | Confirm remaining L4 Beam Magnets and Deflectors (BMD) requirements<br>IB presented the remaining L4 BMD requirements and discussed these with AP and other participants:<br>• explaining ESS Bilbao's understanding of each requirement<br>• identifying missing references, missing values or parameters in the requirements, shown as 'XXX', and undefined terms / definitions<br>• proposing values or parameters where they were missing<br>• proposing additions, deletions and other changes<br><br>See actions nr. 35 to nr. 48 inclusive. | IB, AP, MF, TS, JM, DF |
| 11:00-12:00 | General discussions on mechanical layout design<br>Including integration of quadrupoles and instruments, and design for vacuum<br>See actions nr. 19, 20 and 49 | ZL, IR, MF, TS, RM, TS, AP, IB, MC |
| 12:00-12:30 | Conclusions<br>See summarising actions:<br>• action nr 25 (date for CDR Buncher in Bilbao) and<br>• action nr 46 (review meeting 30 June/01 July in Lund) | all |

## 5. Actions

| Nr | Action | Who | Due |
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| 1 | Clarify ESS Bilbao's MEBT-related scope and responsibilities in regards to L2 Accelerator and L3 MEBT (section) requirements<br>Statements are to be included in the IKC Agreement Schedule (technical Annex) for MEBT to describe ESS Bilbao's scope and responsibilities in regards to achieving L2 and L3 requirements included in the IKC Agreement. Where necessary, the description and clarification statements of particular L2 and L3 requirements included in the IKC Agreement, should specifically define ESS Bilbao's scope and responsibility in regards to that requirement for MEBT. | MC, AP | 150630 |
| 2 | L3 MEBT SyR-11 Beam Transmission<br>Unclear requirement. Amend the description to clarify the requirement. | AP (TS,RM) | 150619 |
| 3 | L3 MEBT SyR-16 Beam current range<br>Unclear requirement. Reword the description and/ or add clarification text. Possibly remove the 'maximum step size' phrase. | AP | 150619 |
| 4 | L3 MEBT SyR-17 Operating vacuum pressure<br>Unclear requirement. Reword the description and/ or add clarification text. | MF (AP) | 150619 |
| 5 | L3 MEBT SyR-18, 19, 20, 21 Pulse length parameters<br>Unclear responsibilities between ESS and Bilbao in regards to controlling these parameters and being able to achieve these requirements in MEBT. Reword the description and/ or add clarification text to better clarify responsibilities. | AP (TS) | 150619 |
| 6 | L3 MEBT SyR-23 Ambient air temperature<br>L3 MEBT SyR-24 Humidity level<br>These are not 'requirements' for MEBT to achieve but provide operating conditions for MEBT. Consider moving these to L2, or otherwise identify these as guidance rather than requirements to be achieved. | AP (IB) | 150619 |
| 7 | Missing L2 or L3 requirements for MEBT operating modes.<br>ESS (AP) to consider whether to provide requirements for MEBT operating modes, states and conditions. The outcomes of ESS internal discussions on this subject should be communicated to Bilbao by the due date. | AP (TS) | 150630 |
| 8 | Missing L2 or L3 requirements for Reliability.<br>ESS (AP) to consider providing requirements for required MEBT reliability. The outcomes of ESS internal discussions on this subject should be communicated to Bilbao by the due date . | AP (TS) | 150630 |
| 9 | Missing L2 or L3 requirements for Maintainability<br>ESS (AP) to consider providing requirements for required MEBT maintainability. The outcomes of ESS internal discussions on this subject should be communicated to Bilbao by the due date | AP (TS) | 150630 |
| 10 | Register the lattice design MEBT 2015.v0c in CHESS and ensure that LegoLinac (David McGinnis responsible) and Accelerator integrated model (Nick Gazis responsible) is updated accordingly. | RM, MC | 150612 |
| 11 | Beam-line length allocated for Emittance Measurement Unit (EMU).<br>Lattice design MEBT 2015.v0c allocates a beam-line length of 350mm | AP (RM, | 150630 |

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| | between Quadrupole (Q) 7 and Q8, for EMU. RM's modelling shows that a length at least of approximately 400mm and perhaps even 450mm, may be acceptable. AP to investigate with Accelerator's Integration Group (AIG) to determine if 350mm is a maximum allowable length for EMU for MEBT in regards to tunnel systems integration, and whether an increase of up to 50mm may be allowable. | TS, IB) | |
| 12 | Add identifiers and notes to the MEBT layout drawing:<br>• add lattice version identification 'MEBT 2015.v0c'<br>• add identification for beam instruments<br>• add numbering for quadrupoles and buncher cavities e.g. QV 1, CAV 2 | ZL | 150630 |
| 13 | Pulser manufacturers have a standard for pulser triggers, and Bilbao (GH) suggests that there should not be a requirement for pulser triggering. AP to discuss with ESS ICS Machine Protection Group (Annika Nordt). | AP | 150630 |
| 14 | L4 MEBT.BMD-77 Chopper Nominal Beam Deflection Angle<br>ESS to confirm the value of 4,0 KV in the clarification comments. | AP | 150630 |
| 15 | L4 MEBT.BMD-80 Chopping Efficiency<br>ESS to consider moving this requirement to L3, and rewording or providing clarifying comments to define ESS and Bilbao responsibilities. | AP | 150630 |
| 16 | Not used | - | - |
| 17 | L4 MEBT.BMD-83 Chopper Voltage Operating Micro-Pulse Length<br>L4 MEBT.BMD-84 Chopper Voltage Maximum Micro-Pulse Length<br>Bilbao (GH) consider the range of values in requirements BMD-83 and BMD-84 may be unachievable using a single, standard pulser, and hence may be unacceptable technical risk and potential cost and schedule risk. AP to review the requirement, and discuss with ESS ICS Machine Protection Group (Annika Nordt). AP to advise Bilbao of the outcomes. | AP | 150630 |
| 18 | L4 MEBT.BMD-89 Chopper Micro-Pulse Voltage Flat-Top Jitter<br>L4 MEBT.BMD-90 Chopper Post-Pulse Noise<br>ESS to review the requirement values of +/-0.001 of the nominal voltage. Bilbao proposes removing this requirement from L4. | AP | 150630 |
| 19 | ESS (ZL) will update ESS-0034690 in accordance with Action 12 and other comments noted during the meeting, confirm data exchange locations and formats with ESS' Accelerator integrator (Nick Grazis) and provide ESS-0034690 CAD data to Bilbao for use in Bilbao's MEBT 3D model (Catia v5). | ZL | 150630 |
| 20 | Bilbao (IR) will update the 3D model with input from ESS-0034690, and other inputs as a result of these workshops and on-going design work for quadruoples, beam instruments, chopper, dump and bunchers, and provide this to ESS. | IR | 150626 |
| 21 | L4 MEBT.EMR-SyR-41 Number of RF pick-up probes<br>ESS to review the number of pick-up probes, and consider tagging this as an interface requirement. | AP | 150612 |
| 22 | L4 MEBT.RF- 60, 70, 80, 90, 100, 110, 120 LLRF<br>ESS (AP) to review these with WP 8, Anders Johansson. | AP | 150630 |
| 23 | L4 MEBT.RF-130<br>Define cavity frequency tuning range | AP | 150630 |

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| 24 | CAD drawings for MEBT buncher<br>ESS (MF, ZL) will review the buncher drawings from vacuum and general mechanical design point-of-view and provide written comments to Bilbao (IR, IB). | ZL, MF | 150610 |
| 25 | Date for Critical Design Review (CDR) for MEBT Buncher<br>ESS (MC) recommended that a CDR was necessary so that all ESS interfacing work packages could review the buncher design and procurement specification prior to Bilbao going to procurement. MC requested that Bilbao (PG, IB) review the current schedule for procurement and testing of bunchers to determine an earliest date for CDR in Q3 2015. | PG, IB | 150630 |
| 26 | ESS to generally review all draft L4 PBI requirements.<br>Some requirements might be moved to L3. For others, the description may need to be amended or clarification comments included to better define ESS' and Bilbao's respective responsibilities in achieving each requirement. | AP | 150630 |
| 27 | MEBT-L4-PBI-010, 020, 030, 040 Beam diagnostic device operating domain<br>ESS to rewrite these requirements to align with descriptions for beam modes as proposed by TS. | AP (TS) | 150630 |
| 28 | MEBT-L4-PBI-060 Beam current measurement: accuracy<br>Express this value as ± 1mA. | AP | 150630 |
| 29 | MEBT-L4-PBI-070 Beam current measurement: resolution<br>Delete resolution insert precision. Amend the description to clarify ESS' need with this requirement. | AP | 150630 |
| 30 | MEBT-L4-PBI-110, 120 Transverse phase space measurement<br>AP to discuss with Benjamin Cheymol to clarify these requirements. It may be appropriate to incorporate these into L5 specifications, rather than as L5 requirements. | AP | 150630 |
| 31 | MEBT-L4-PBI-200 Transverse beam position measurement: number of measurements<br>Reword this requirement to take into account the agreed configuration of steerers and connected BPM in MEBT. | AP | 150630 |
| 32 | MEBT-L4-PBI-200 Number of BPMs<br>Number of BPMs and their electronics should be consistent. Confirm the number of BPMs required. | AP, RM | 150630 |
| 33 | MEBT-L4-PBI-210 accuracy<br>Question from Bilbao (SV): Should we clarify the required performance of BPMs in this or another requirement? (Single ended now?) | AP, TS | 150630 |
| 34 | MEBT-L4-PBI-XXX NPM<br>Bilbao requests a requirement to clarify the minimum number of ports required for NPM. | AP, TS | 150630 |
| 35 | Definitions document<br>ESS to create a definitions document, with ESS-00xxx reference number, to be used as a reference for terminology used in L4 BMD and potentially other sets of requirements, to avoid ambiguity in requirement titles and descriptions and to reduce the need to define terms in the clarifying text for each requirement | AP | 150630 |
| 36 | MEBT-L4-BMD-15 Nominal Effective Magnetic Field Length – Quadrupole | AP | 150630 |

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| | MEBT-L4-BMD- 29 Steering Direction-Corrector<br>Consider removing these requirements, or reword descriptions or include clarifying comments to make these requirements clearer.<br>Also, it is necessary to define Magnetic field length. See action 32. | | |
| 37 | MEBT-L4-BMD-20 Integrated Magnetic Field Gradient Uniformity – Quadrupole<br>Bilbao (IB) proposes removing '±XX% and inserting ±1%<br>Terms also need definition. See action 32. | AP | 150630 |
| 38 | MEBT-L4-BMD- 21 Harmonic Content - Quadrupole<br>Bilbao (IB) proposes removing '±XX% and inserting:<br>± < 100 units per 1e4, or ±1% equivalent<br>Terms also need definition. See action 32.<br>AP to consider including in the description or in clarifying comments the request from MF that verification of this requirement must be done with chamber i.e. under vacuum. IB remarked that magnetic characterization is standard in-air procedure, and this should be untied from magnetic design/manufacturing process. | AP | 150630 |
| 39 | MEBT-L4-BMD- 25 Fringe Field Magnitude<br>MEBT-L4-BMD- 26 Remnant Magnitude Field<br>ESS to reword these requirements and potentially tagging these as interface requirements.<br>Comment from TS that these requirements need to be traced to L4 BPI requirements.<br>For -25 Fringe Field Magnitude Bilbao (IB) proposes removing '…less than XXX gauss' and inserting ±1%<br>Terms also need definition. See action 32. | AP | 150630 |
| 40 | MEBT-L4-BMD- 27 Full Aperture<br>Amend the requirement description to words similar to '1 mm free gap between chamber and magnet' | AP (MF) | 150630 |
| 41 | MEBT-L4-BMD- 28 Vacuum Chamber Inner Diameter<br>Reword the requirement description to clarify that ESS Bilbao shall select a standard pipe diameter should be used, larger than 36.8 mm | AP, MF, IR | 150630 |
| 42 | MEBT-L4-BMD- 32 Nominal Magnetic Field Integral - Corrector<br>MEBT-L4-BMD- 33 Operating Range - Corrector<br>MEBT-L4-BMD- 34 Maximum Magnetic Field Integral - Corrector<br>Consider removing BMD-32 (or make the nominal value '0')<br>Consider rewording BMD-33 and -34. Ensure terms are defined. See action 32. | AP | 150630 |
| 43 | MEBT-L4-BMD- 35 Magnetic Field Integral Uniformity - Corrector<br>Ensure terms are defined. See action 32.<br>Bilbao (IB) proposes removing 'better than XX%' and rewording to 'less than 20%' | AP | 150630 |
| 44 | MEBT-L4-BMD- 36 Harmonic Content - Corrector<br>Bilbao (IB) proposes removing 'XX-pole' and inserting '10-pole'<br>Bilbao (IB) proposes removing 'lower than xxx%' and inserting 'lower than 50%' | AP | 150630 |
| 45 | Add new MEBT-L4 requirement<br>Consider adding a new requirement to address sextapole field. | AP | 150630 |

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| 46 | MEBT-L4-BMD- 37 Radiation Hardness<br>Reword this requirement to better describe the risk and radiation dose to protect against from neutron radiation. | AP | 150630 |
| 47 | MEBT-L4-BMD- 38 Fire Resistance<br>MEBT-L4-BMD- 39 Magnetic Life Time<br>MEBT-L4-BMD- 40 Electrical Safety<br>Reword these requirements to better clarify these requirements more specifically for the MEBT and its quadrupoles. | AP | 150630 |
| 48 | Add new MEBT-L4-BMD(?) requirement(s)<br>Consider adding a new requirements for movable beam dump for MEBT chopper. | AP | 150630 |
| 49 | IKC Agreement MEBT Technical Annex review meeting, 30 June or 01 July, Lund.<br>It was proposed to meet to review the technical content for an IKC Agreement Schedule (technical annex). This Schedule would include updated versions of requirements and mechanical layout resulting from the actions from the workshops 2-5 June and any subsequent agreements. This review meeting is proposed at ESS Lund for 30 June or 01 July. ESS (MC) and ESS Bilbao (IB) to confirm the date. | IB, MC | 150612 |