ESS MEBT PBI

Critical Design Review

MEBT Team

MEBT Team
Bilbao
12-13 July, 2017

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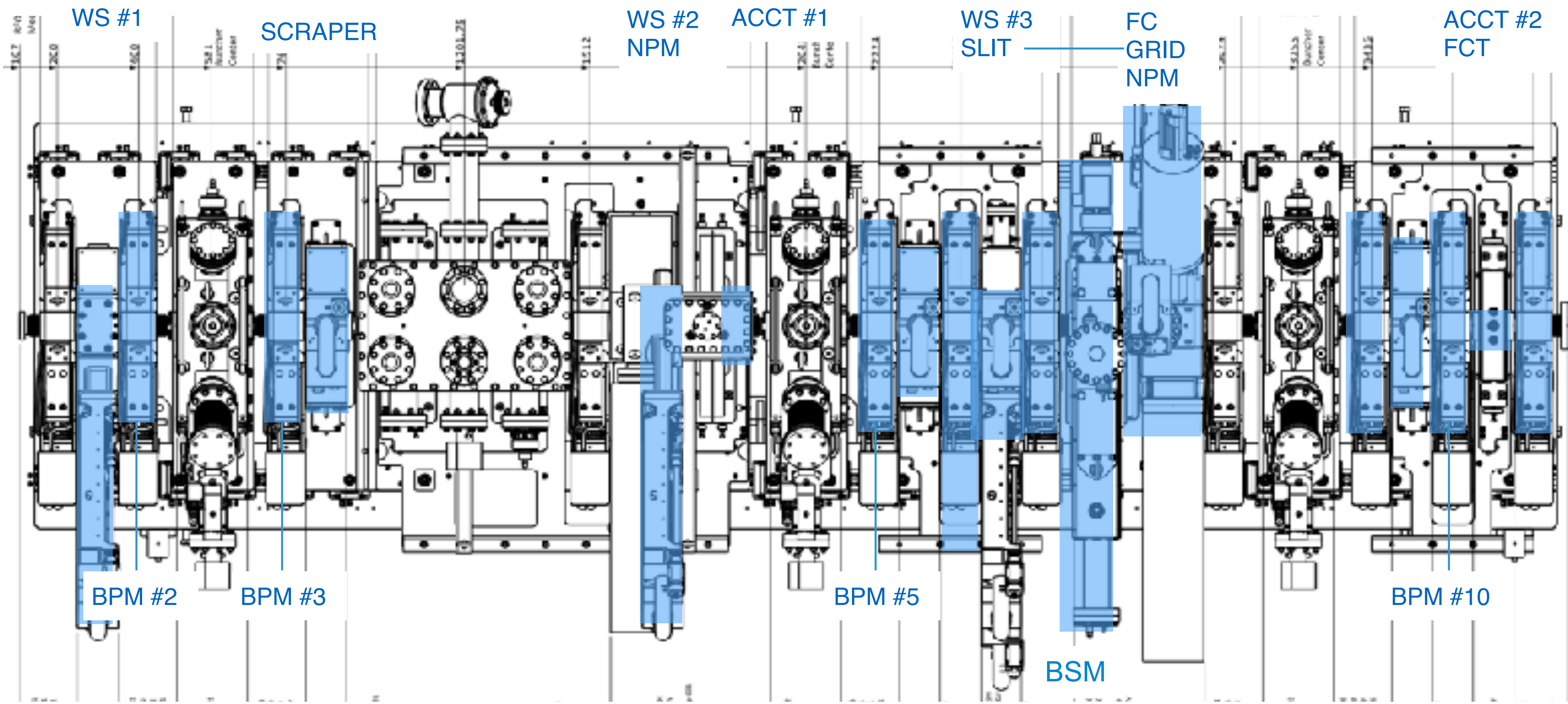
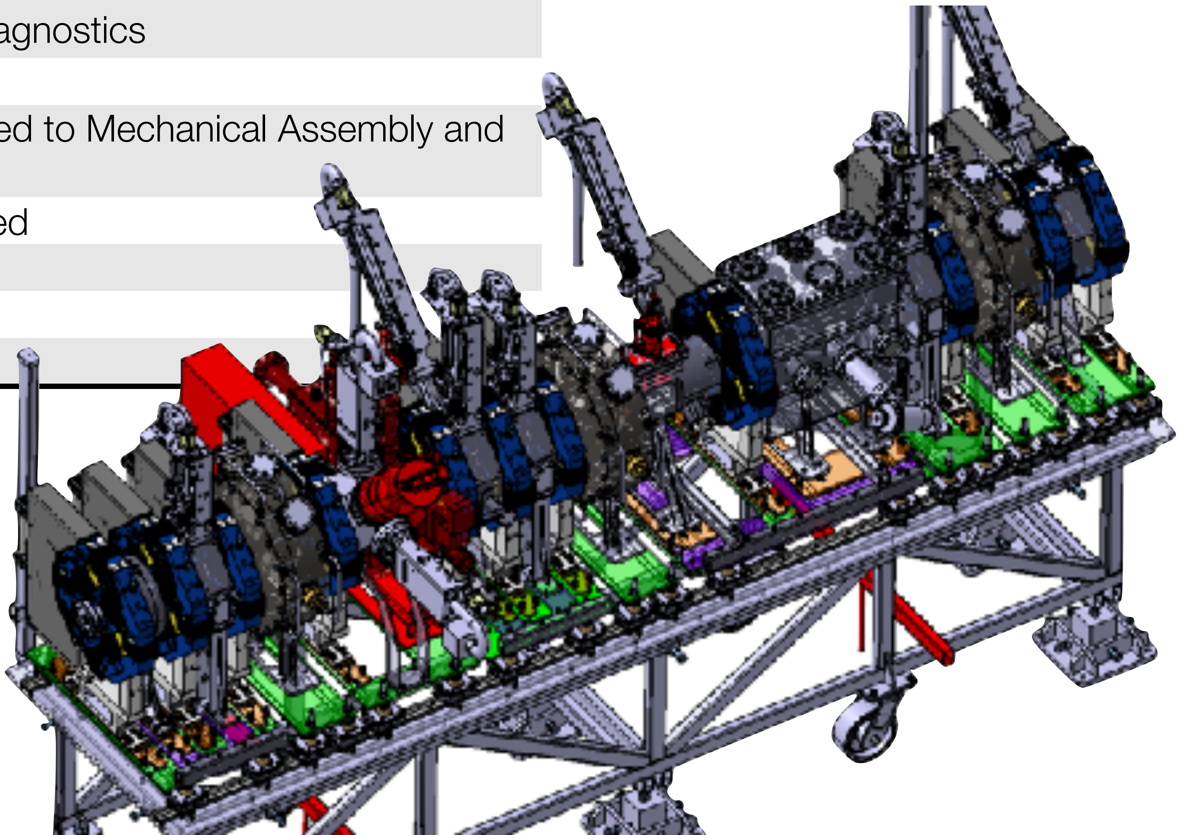
Beam Instrumentation

- Mech integration
- I (mA) x W(MeV) x pulse length (μs) x $\sigma_{(x,y)}$ (mm^2)



REVIEWS

Dates	Code	Description
Mar-14	HoA	HoA Agreed
Dec-14	HoA II	HoA Signed
Jan-15	CH-WS	Chopper workshop
Jun-15	MEC-WS	ESS MEBT Mechanical Layout Workshop
Feb-16	BIF I	ESS BIF (1)
Feb-16	**PDR I**	PDR for the MEBT Buncher and Magnets
Jul-16	**PDR II**	PDR for the MEBT Diagnostics
Oct-16	BIF II	ESS BIF (2)
Feb-17	**CDR I**	MEBT CDR1 Dedicated to Mechanical Assembly and Alignment System
May-17	TA	Technical Annex signed
May-17	**CDR II**	BPM CDR
May-17	**CDR III**	ICS CDR
Jul-17	**CDR IV**	PBI CDR



Codification

Project	Field	Component	Version
MEBT	BI	FC**90**	2

BI Components	
DBXX	Diagnostic Box
FCXX	Faraday cup
EMXX	EMU
SCXX	Scraper
WSXX	Wire scanner
BPXX	Beam position monitor
BCXX	Beam Current Transformer

MEBT Fields	
BI	Beam Instrumentation
QU	Quadrupole (includes Power supplies)
CH	Chopper (includes Beam Dump and Pulser)
BU	Buncher (includes coupler)

Reserved Names	
90	Manufacturing Specifications
91	Design Specifications
92	Interface Data Sheet / Interface Control Document
93	Acceptance Test Plan
94	Acceptance Test Measurement Report
95	Instruction Manual

ICS Reserved names	
80	Application Functionalities
81	Design Document
82	Development Document
83	Graphical User interface Description Document
84	Acceptance Plan
85	Acceptance Plan Results

Team in Bilbao

QUAD Team

JL Muñoz
D. Fernandez
G. Harper
I. Rueda
C. de la Cruz
A. Conde
J. Martin

BUNCHER Team

N Garmendia
A. Zugazaga
O. Gonzalez
I. Rueda
P. Gonzalez
A. Serrano
M. Huerta
G. Bakedano
L. Mugira
M. Alarcón

FC Team

A.R. Paramo
C. de la Cruz
Z. Izaola
A. Milla
I. Ortega
R. Vivanco
T. Mora

EMU Team

Z. Izaola
A.R. Paramo
C. de la Cruz
I. Mazkiaran
A. Vizcaíno
V. Toyos
A. Serrano
R. Vivanco
T. Mora

BPM Team

S.Varnasseri
I. Rueda
A. Ortega
A. Conde
J. Martin
J.L. Muñoz

CHOPPER Team

S.Varnasseri
C. de la Cruz
G. Harper
G. Mugika
A. Zugazaga
I. Rueda
R. Vivanco
T. Mora

BCT Team

S.Varnasseri
C. de la Cruz
A. Zugazaga
I. Rueda
A.R. Páramo
A. Conde
J. Martin
J.L. Muñoz

WS Team

A. Vizcaíno
A. Serrano
Z. Izaola
A.R. Páramo
A. Zugazaga

Assembly Team

I. Rueda
A. Zugazaga
A.Vizcaíno
J. Martin
A.R. Páramo

Installation Team

I. Rueda
A. Zugazaga
G. Mugika
G. Harper
I. Mazkiaran
J. Martin
A. Conde
A. Vizcaíno
N. Garmendia
…

Scraper Team

A.R. Páramo
I. Rueda
A. Zugazaga
A.Vizcaíno
C. de la Cruz
G. Bakedano
M. Magan

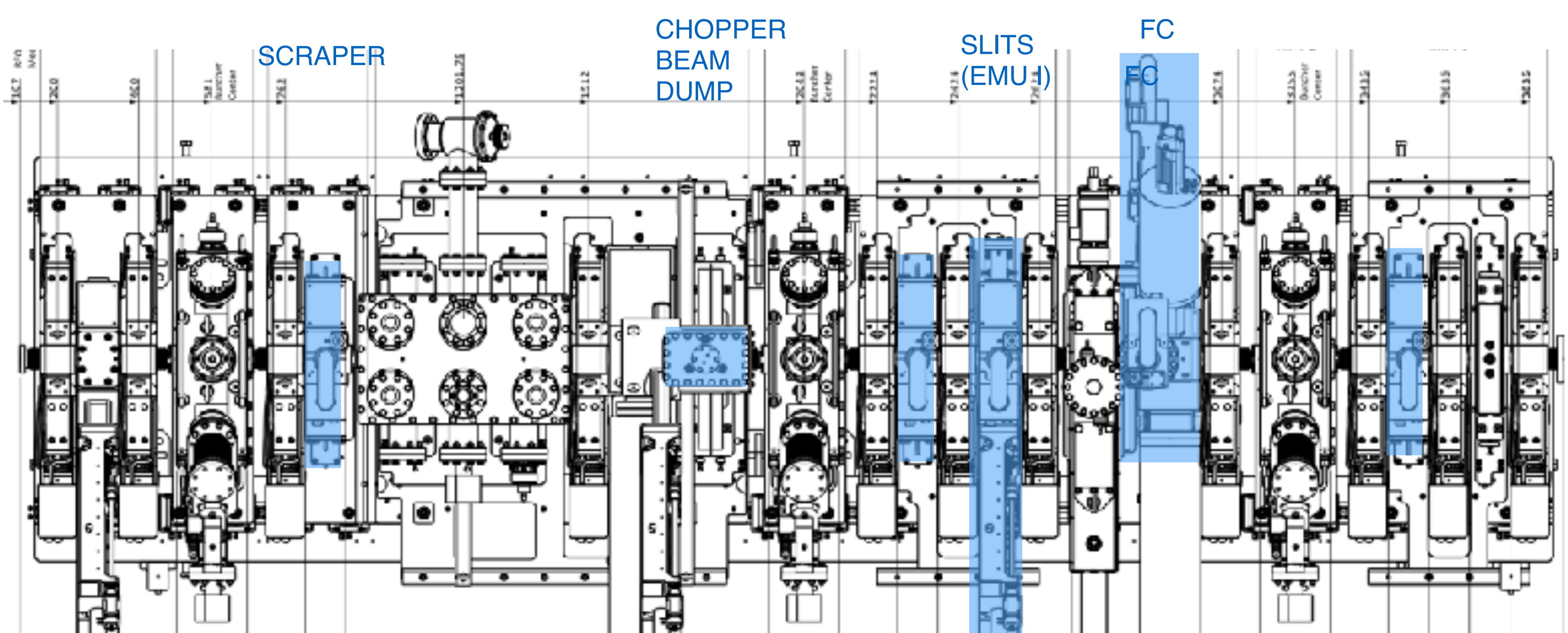
Control Team

L. Mugira
N. Garmendia
C. de la Cruz
A. Milla
I. Mazkiaran
G. Harper
J. Bilbao

Beam stoppers

Problem Description

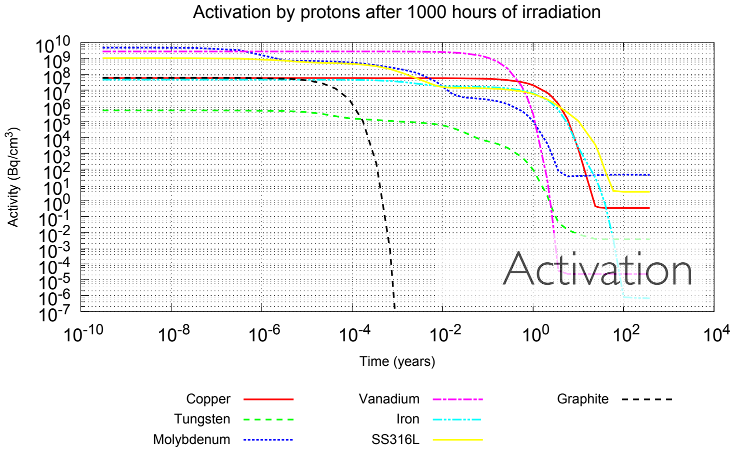
- From the **transient state** calculations, one can infer that this model has to be discarded given the combination of **high power** distributed in a **very concentrated** beam size and a **swallow deposition surface**.
- Please note that current and energy combination result in a **230 kW** peak power which exceeds other MEBTs, SNS peak power **130 kW**, LINAC4, RAL, JPARC (~**180 kW**).
- A limit of proton beam power density per unit of time and area allowed should be identified. This is crucial in order to ensure thermo-mechanical integrity of different interceptive devices along the MEBT.
- I (mA) x W(MeV) x pulse length (μs) x $\sigma_{(x,y)}$ (mm^2)

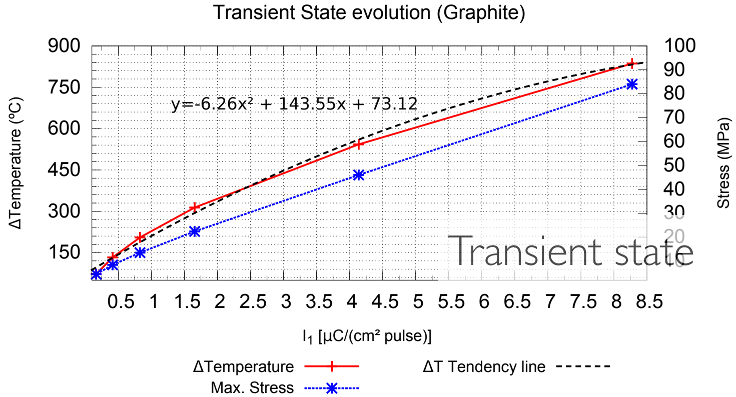


Beam stoppers

The proton beam has to fulfil the **Temperature** and **stress** criteria simultaneously to ensure the thermo-mechanic integrity of the Beam Stoppers.

- Tungsten has a limit of **0.6 μC/(cm²pulse)** and could work with **14Hz**, depending on the cooling conditions.
- Graphite has a limit of **6 μC/(cm²pulse)** and could work with **14Hz**, depending on the cooling conditions.
- Graphite is the best option as Beam Stopper material. The decision of choosing one material will also depend on other aspects:
    - Vacuum conditions and possible problems with the materials in a vacuum environment.
    - Fatigue process resistance.
    - Fabrication process, machining and assembly, etc.



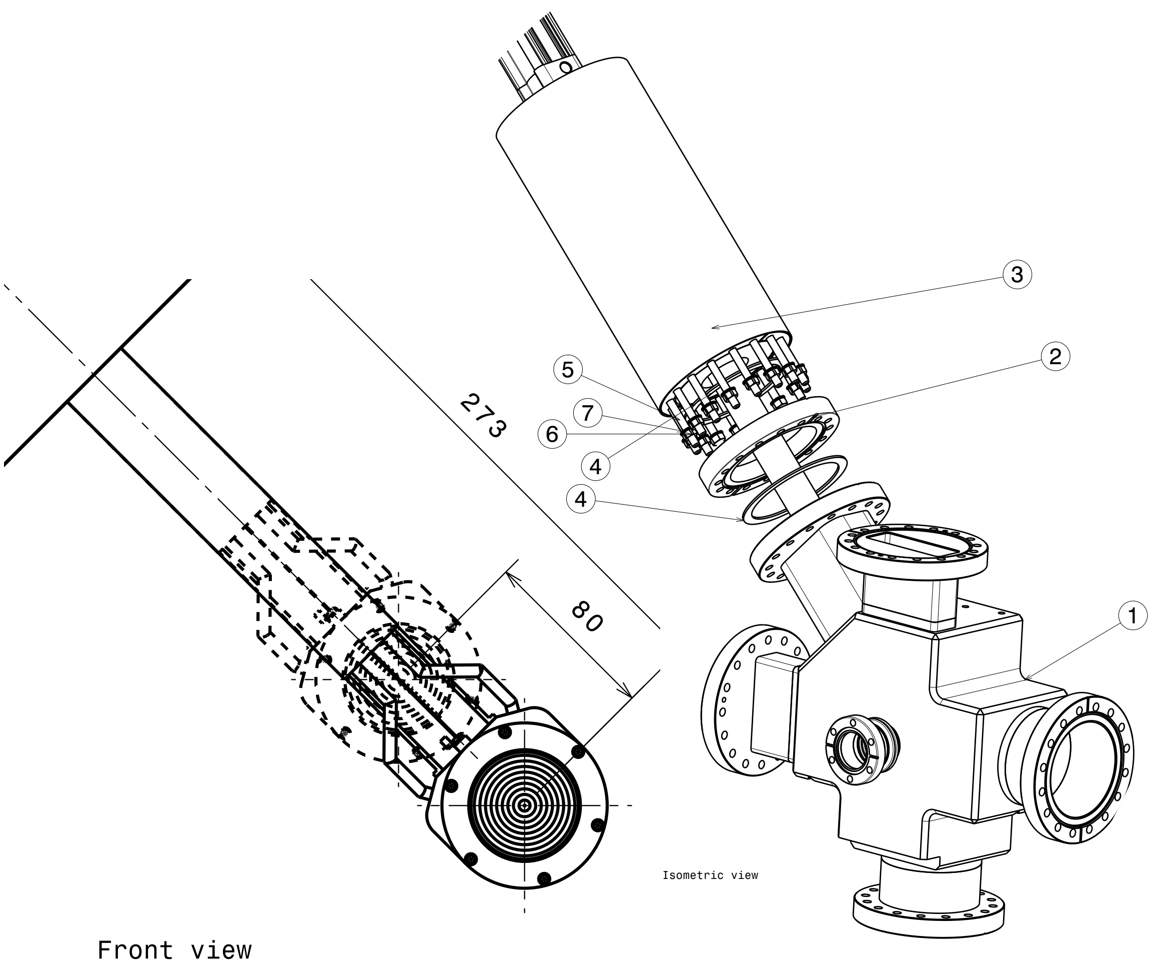


Peak current (mA)	Angle (º)	Beam size		I'' (μA/cm2)	Pulse Length MAX (μs)
		σ_x (mm)	σ_y (mm)		
65	90	2,5	1	4,14E+05	14,5
65	45	2,5	1	2,93E+05	20,5
65	30	2,5	1	2,07E+05	29,0
65	90	2,5	2,5	1,66E+05	36,2
65	45	2,5	2,5	1,17E+05	51,3
65	30	2,5	2,5	8,28E+04	72,5
65	90	5	2,5	8,28E+04	72,5
65	45	5	2,5	5,85E+04	102,5
65	30	5	2,5	4,14E+04	145,0
65	90	7,5	5	2,76E+04	217,5
65	45	7,5	5	1,95E+04	307,6
65	30	7,5	5	1,38E+04	435,0
65	90	7,5	7,5	1,84E+04	326,2
65	45	7,5	7,5	1,30E+04	461,4
65	30	7,5	7,5	9,20E+03	652,5

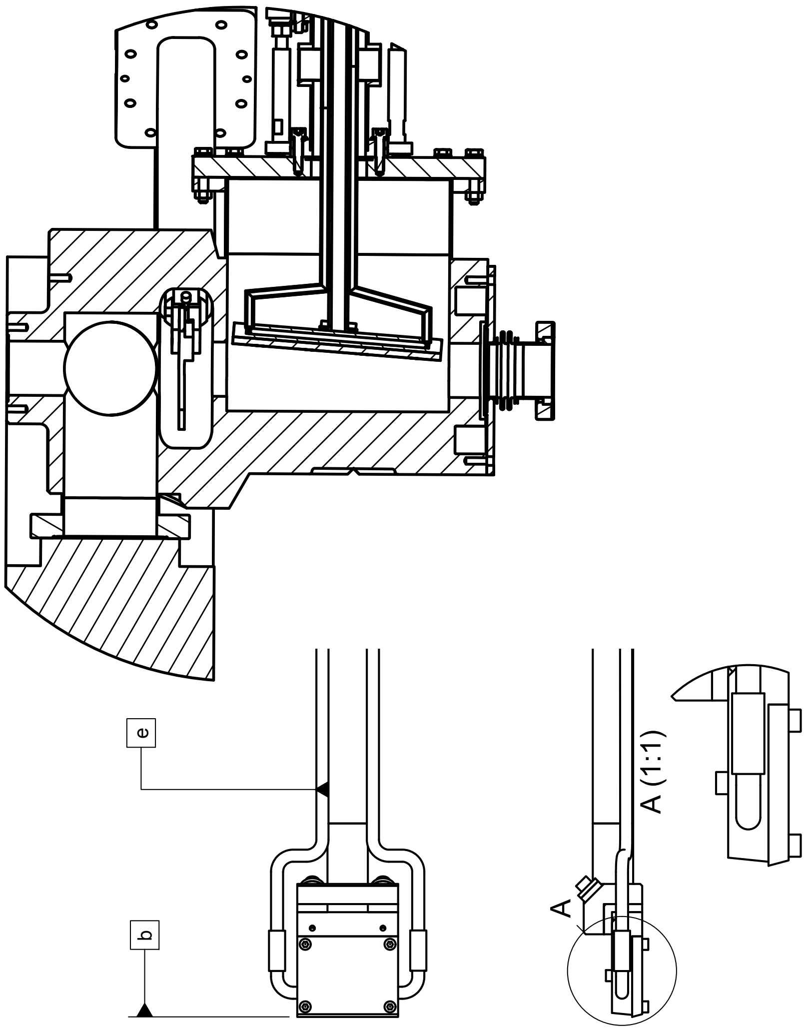
Exposure Limits

Beam stoppers: **two types**

FARADAY CUP
EMU SLIT
GRAPHITE

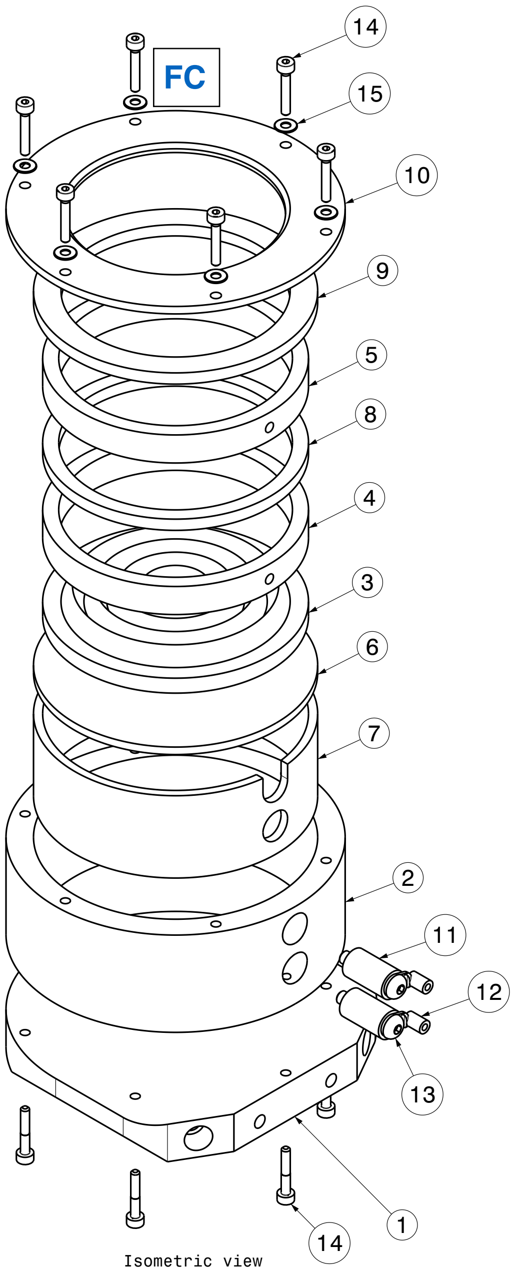


BEAM DUMP
SCRAPERS
TZM

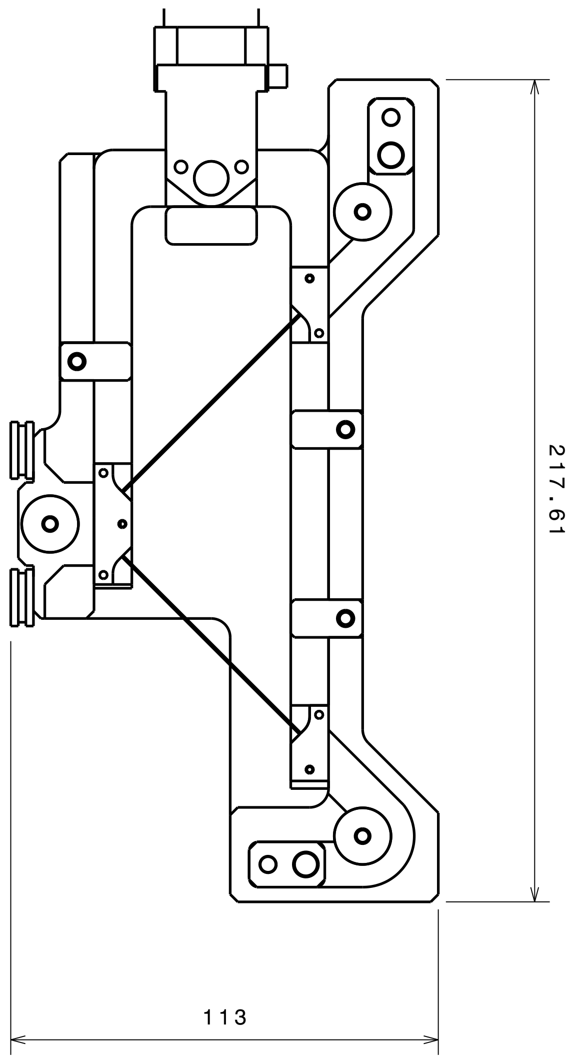


Interceptive devices: **replaceable parts**

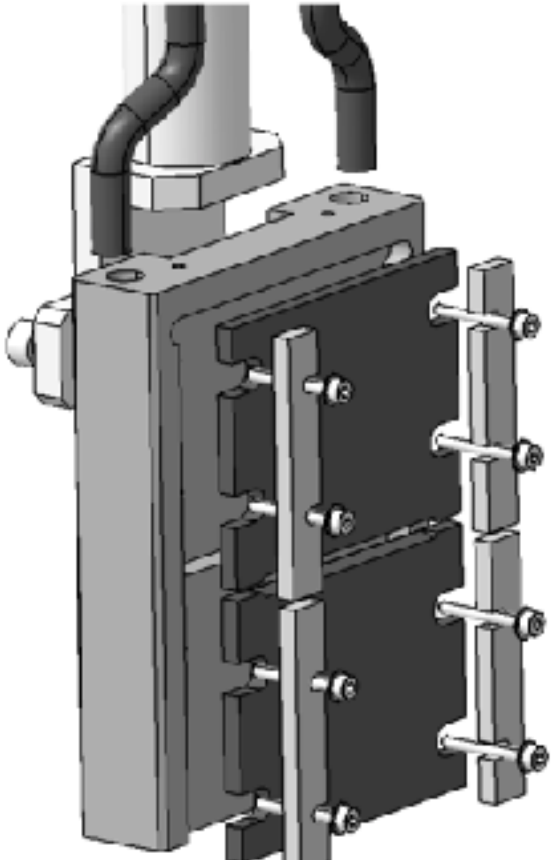
FC



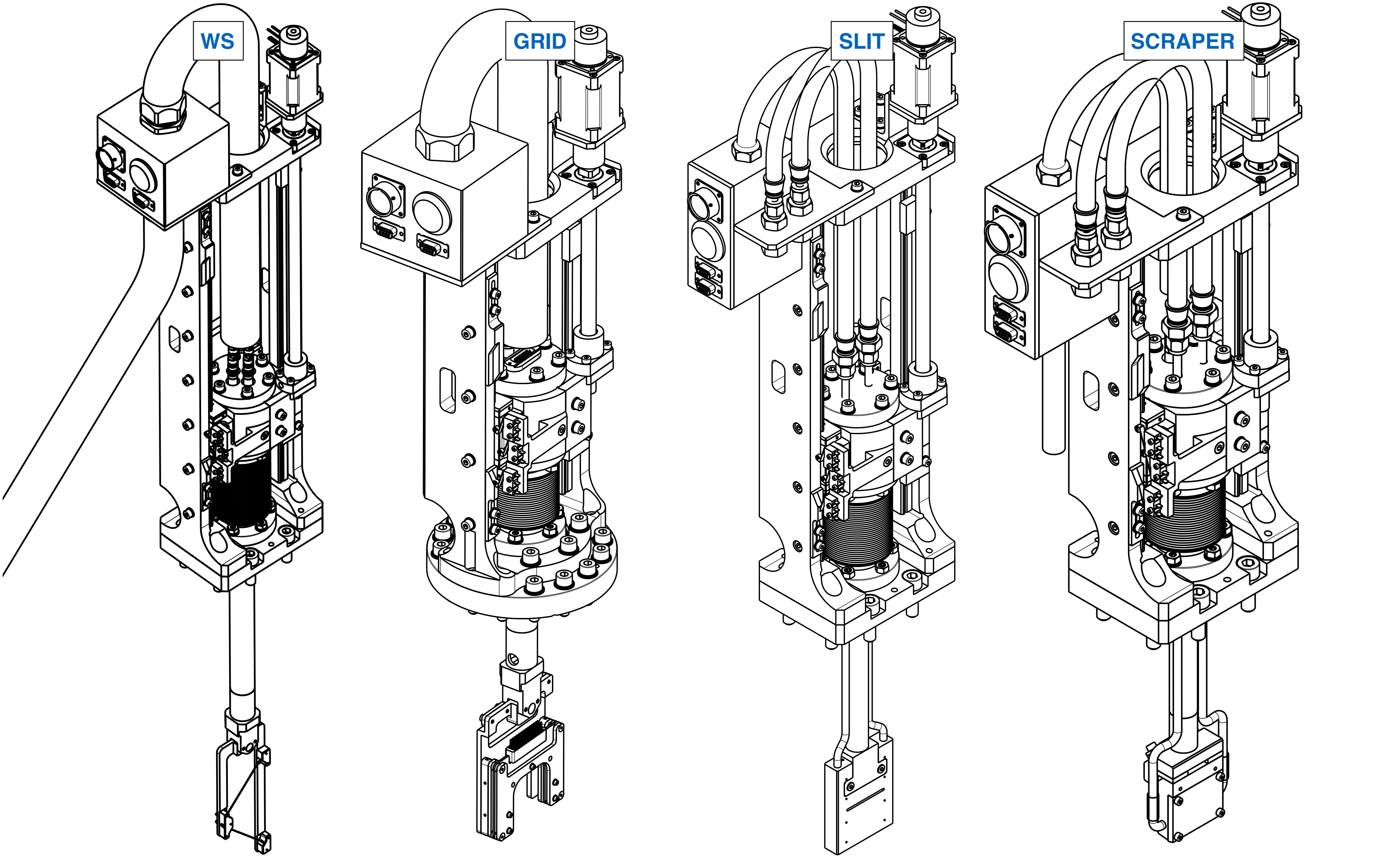
WS



EMU
SLIT



Actuators: **Standardisation**



Beam instrumentation

Finished

PDR held July 2016

FC

- Documentation delivered
- About to sign contract for manufacturing.
- Integration in available HW done (VME)
- GUI done

EMU

- Grid prototype done.
- Documentation delivered
- Integration in available HW done (VME)
- GUI done

WS

- kick off meeting done with manufacturing company.

BPM

- 1st prototype completed with many lessons learnt.
- CDR held in July 2016, to launch long delivery items.

BCM

- Design description document delivered.

In progress

EMU technical specification document under discussion with PBI.

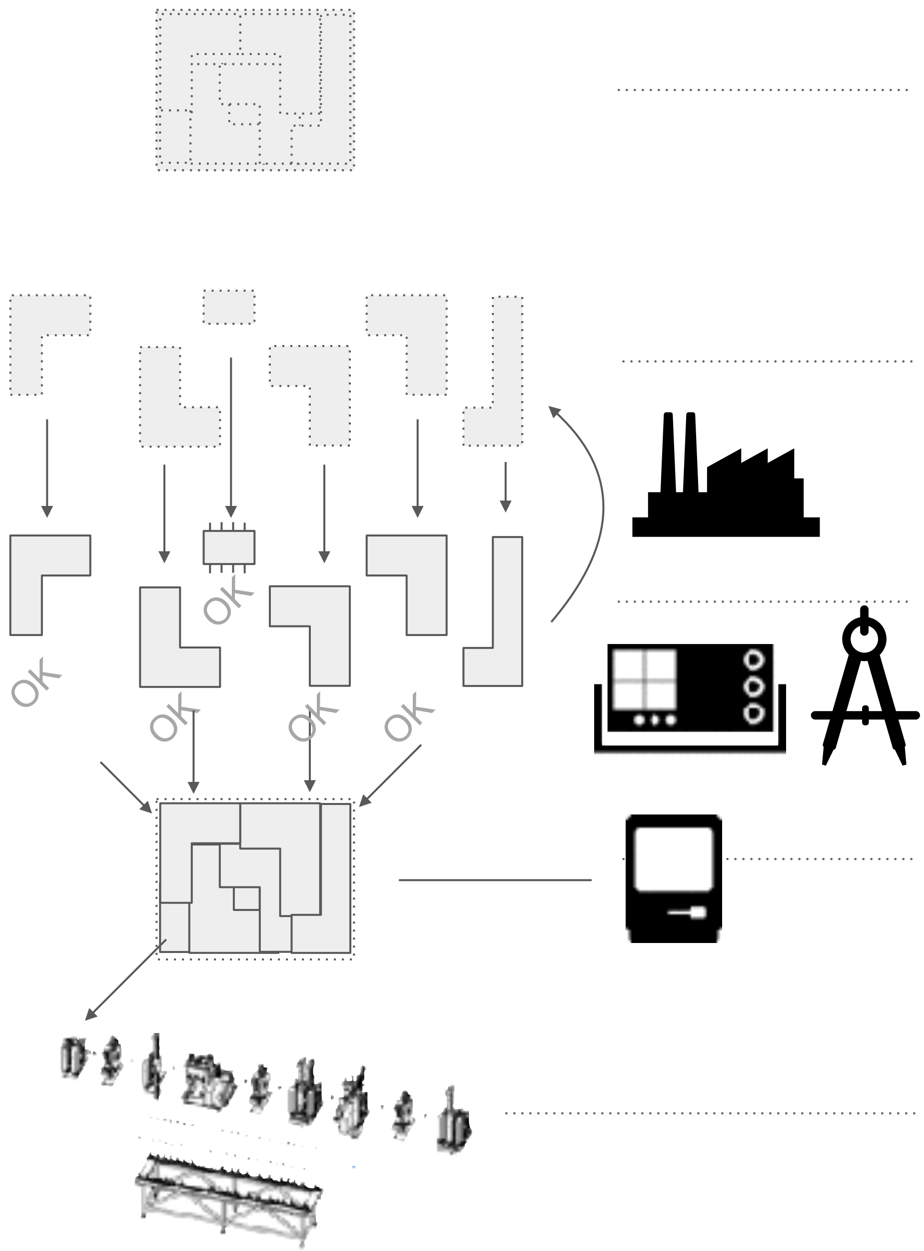
BCM procurement process.

BPM new ancillaries manufacturing

Future Steps

CDR for beam instrumentation 21-22 July 2017.

Step by Step **Acceptance**



Design Stage
Requirements
Design Reports

Production Stage

Drawings / 3D

Call 4 tenders

Acceptance tests

Verification Phase

Vertical test preparation and results

Assembly Phase

Assembly and Alignment procedure

Acceptance & Verification Tests

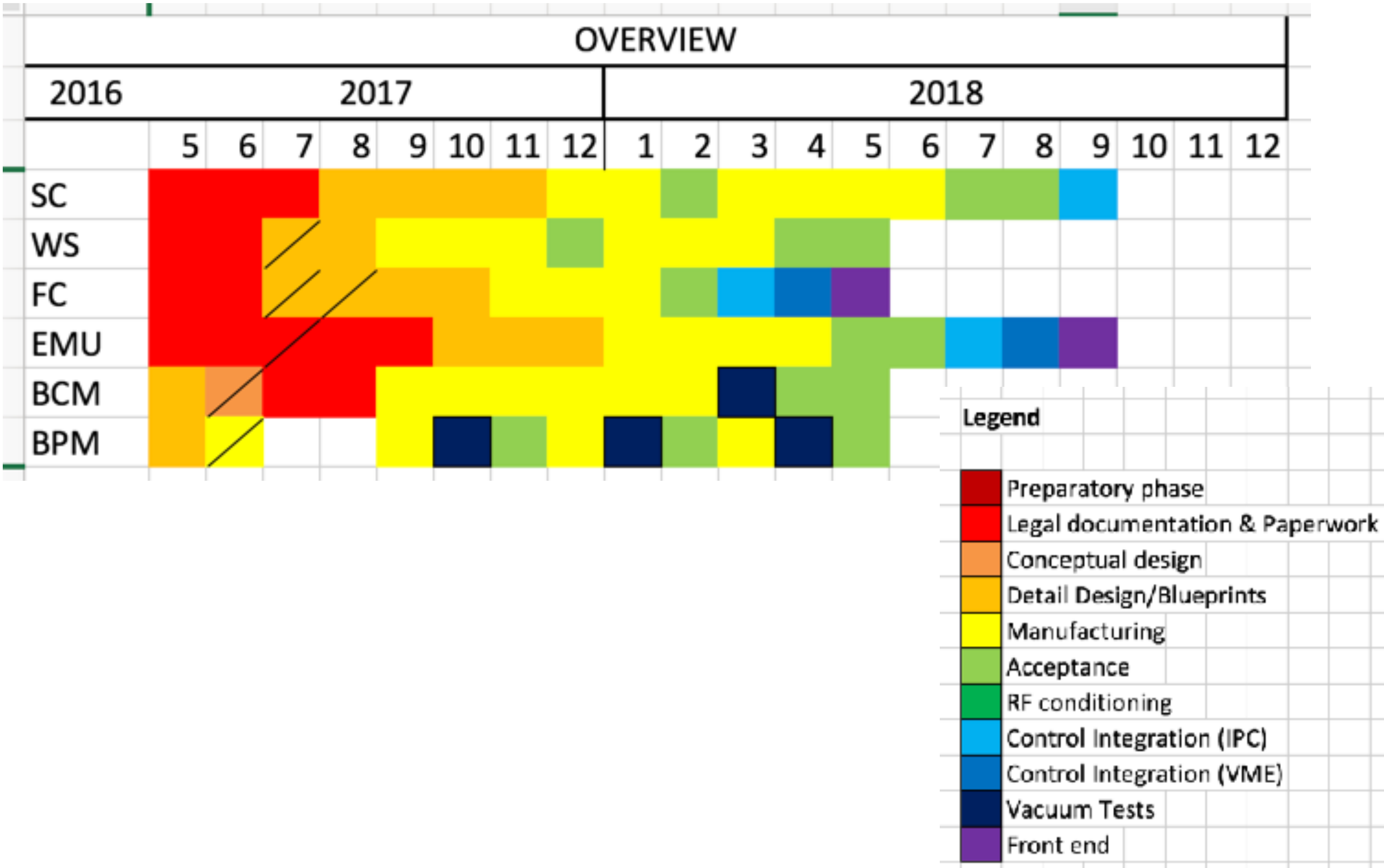
Project	Field	Component	Version
MEBT	BI	**EM90**	99
MEBT	BI	**EM94**	99
MEBT	BI	**EM85**	99

90	Manufacturing Specifications
94	Acceptance Test Measurement Report
85	Acceptance Plan Results (Control)

Acceptance Sequence	
✓	Factory Acceptance Tests
[ ]	Visual Inspection
[ ]	Vacuum tests (Leak & RGA)
[ ]	Electrical Tests
[ ]	Hydraulical Tests
[ ]	Metrology

Verification Sequence	
[ ]	Motion Control and Slow interlocks integration
[ ]	Motion Control, Slow interlocks and FPGA integration
[ ]	Grid and Slit Positioning
[ ]	Front end and FPGA integration

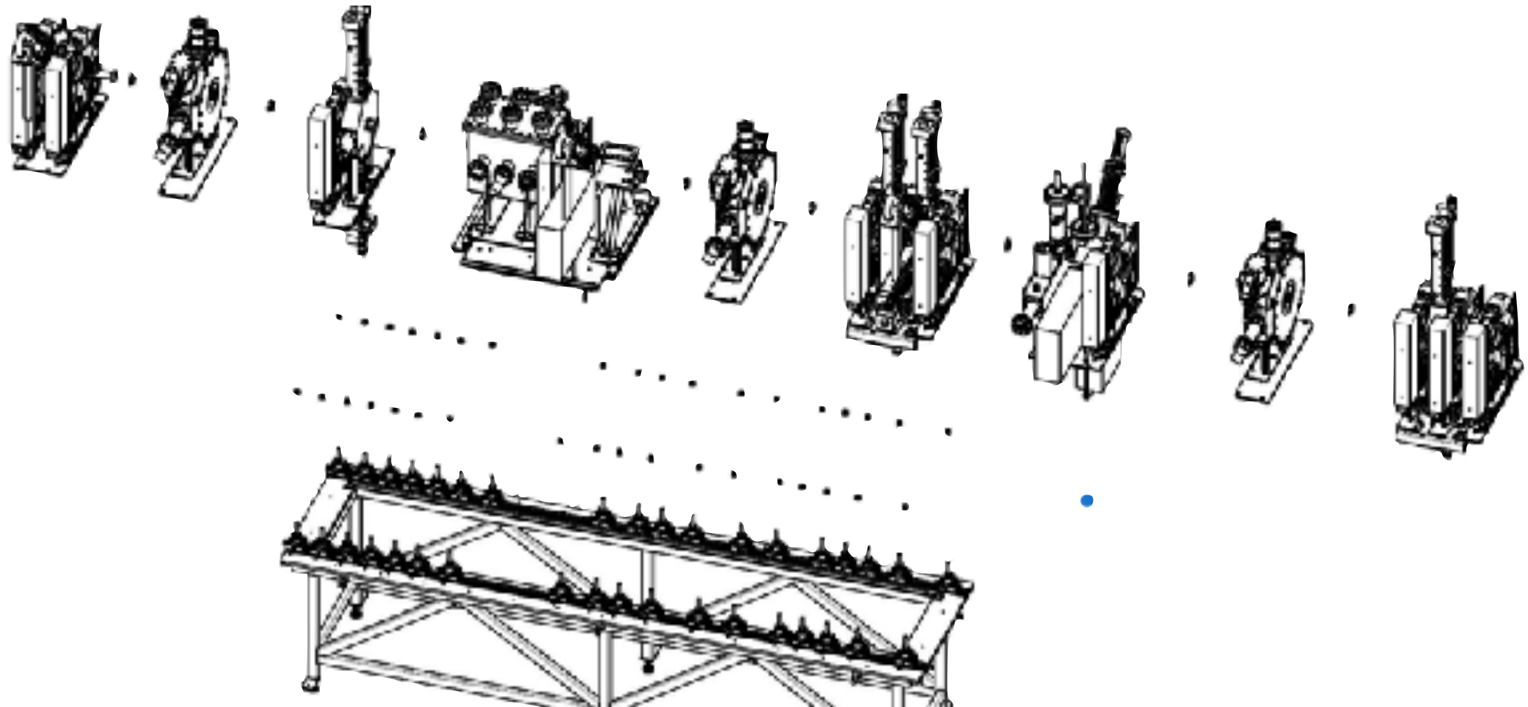
Acceptance, integration **times**



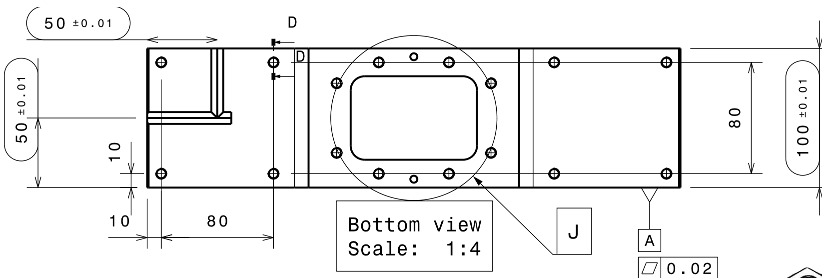
Assembly process

General remarks

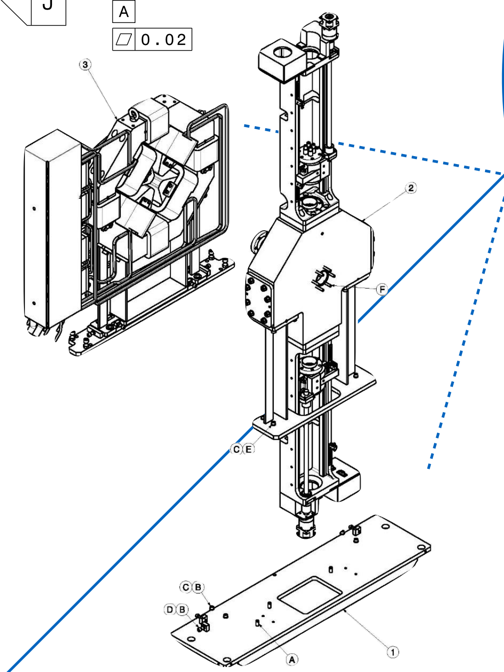
1. ALL MOUNTING MUST BE DONE IN A **CLEAN AREA** FREE OF DIRT, OIL AND GREASE
2. POWDER FREE **GLOVES** SHALL ALWAYS BE USED WHEN HANDLING CLEAN COMPONENTS
3. ALL **NON-SEALED OPENINGS** MUST BE PROTECTED WITH CLEAN METAL GASKETS AND NEW VACUUM USE ALUMINIUM FOIL
4. **FREE AREA** 3 TIMES BIGGER THAN THE AREA OCCUPIED BY MEBT WOULD BE NEEDED TO CARRY OUT MECHANICAL ASSEMBLY TASKS
5. **AUXILIAR WORK-BENCH** OR TABLE 3x1 MTRS FOR 2000 KG AND CLOSE TO MEBT FINAL LOCATION.
6. **CRANE** FOR 6500 KG AND LIFTING AVAILABLE HEIGHT OFF 4,5 MTRS FROM FLOOR.

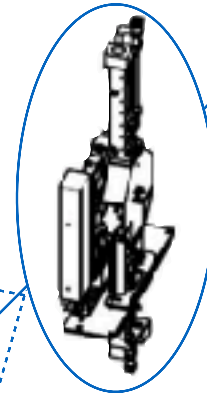


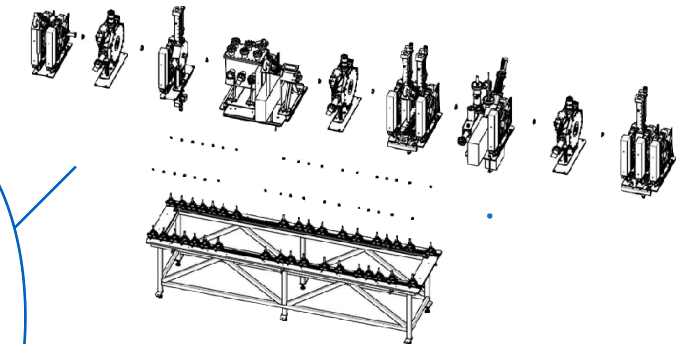
Traceability



BLUE PRINTS
MEBT-SC-2001-ESS.01



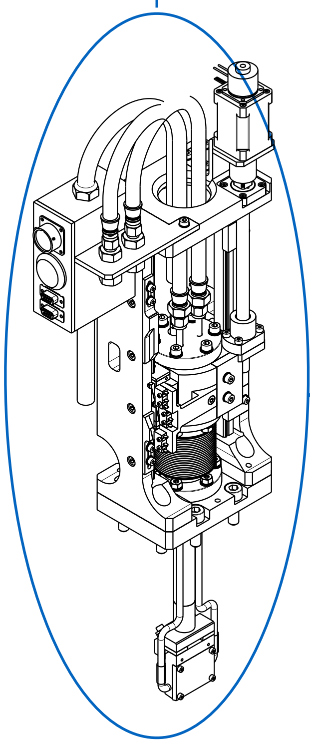




MEBT ASSEMBLY PROCEDURE
MEBT-00-0000-ESS_ASSY_PROC-REVX

HARDWARE				
F	6	SOCKET SCREW SILVER PLATED	ISO4026_M6x30_SS_A4_80_AG	
E	4	HEXAGON SOCKET HEAD CAP SCREW ZINC PLATED	ISO4762_M6x20_CS_8.8_Z	
D	3	ISO 4032 NUT STEEL GRADE A HEXAGON	ISO4032_M6_8_Z	
C	8	PLAIN WASHER 6 ZINC PLATED	ISO7089_6_200HV_Z	
B	7	HEXAGON SOCKET HEAD CAP SCREW ZINC PLATED	ISO4762_M6x30_CS_8.8_Z	
			ISO8735_8x24_CS	
			MEBT-QA-0000-ESS	
2	1	RAFT03 SCRAPPER	MEBT-00-0310-ESS	
1	1	RAFT03 – MAIN BASE	MEBT-00-0301-ESS	AISI 304L
N° ITEM	QUANTITY	DESCRIPTION	REFERENCE/CODE	MATERIAL

RAFT03 ASSEMBLY PROCEDURE
MEBT-00-0300-ESS_ASSY_PROC-REVX



SCRAPER TECHNICAL DOSSIER
MEBT-SC-1000-ESS.01

SHIP	STORAGE & TRANSPORT	100	-	ACC/ TVAC-VS-1102-ESS
TEST	VACUUM TEST	90	-	ACC/ TVAC-VS-1101-ESS & TVAC-VS-0102-ESS
TEST	DIMENSIONAL CONTROL	80	ISO 2768	GEOMETRIC TOLERANCES & 100% ROUNDED DIMENSIONS MEASURE INSTRUMENT CALIBRATION CERTIFICATE
TREAT	CLEANING	70	-	ACC/ TVAC-VS-1001-ESS
WELD	WELDS VISUAL INSPECTION	60	-	100% VISUAL INSPECTION
WELD	WELDING PROCEDURE SPEC. (WPS)	50	-	WELDING PROCEDURE QUAL. (WPQR) EN-ISO 15614 WELDERS QUAL. RECORDS EN 287-1
WELD	PRELIMINARY WELDING PROCEDURE (PWPS)	40	EN 15613	-
IDENT	P/N MARKING	30	-	ON ASIGNED AREA X
MACH	MACHINING	20	-	ACC/ ESS VACUUM HANDBOOK PART 3 SECTION 4 (FABRICATION)
MAT	AISI 304L	10	EN 10088 T2	CERTIFICATE 3.1
PROC.	DESCRIPTION	POS	SPECIF.	REMARKS

Acceptance, integration and assembly **areas**