

ZHAW – Institute of Applied Mathematics and Physics

IAMP_ESS_FBIS

FBIS-SRS

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Table of Contents

1	Introduction	10
2	Scope	10
3	Driving Requirements	11
3.1	Minimal Latency	11
3.2	Support Staged Commissioning	11
3.3	Scalable Number of Inputs	11
3.4	Support ESS Lifetime	11
3.5	Seamless integration into ESS System Landscape	11
3.6	Compatible with IEC 61508 SIL2	12
3.7	Maximal Availability	12
4	Functional System Requirements	13
4.1	Interfaces	13
4.1.1	LPSID Interface	13
4.1.2	LPSVAC Interface	13
4.1.3	LPSMAG Interface	13
4.1.4	ACCT Digital Processing Board Interface	13
4.1.5	RF Fast Interlock Module Interface	13
4.1.6	Fast Gate Valve Interface	14
4.1.7	ESS Timing System Interface	14
4.1.8	LEBT Chopper Interface	14
4.1.9	MEBT Chopper Interface	14
4.1.10	Ion Source Interface	14
4.1.11	Control System Interface	15
4.2	Input Signal Pre-Processing	15
4.2.1	Sensor System Inputs	15
4.2.1.1	LPSID Inputs	15
4.2.1.1.1	LPSID Beam Permit Input	15
4.2.1.1.2	LPSID Beam Permit	15
4.2.1.1.3	LPSID Beam Permit State	15
4.2.1.1.4	LPSID Beam Permit Errors	16
4.2.1.1.5	LPSID Proton Beam Destination Input	16
4.2.1.1.6	LPSID Proton Beam Destination	16
4.2.1.1.7	LPSID Proton Beam Destination State	16
4.2.1.1.8	LPSID Proton Beam Destination Errors	17
4.2.1.1.9	LPSID Proton Beam Mode Input	17
4.2.1.1.10	LPSID Proton Beam Mode	17
4.2.1.1.11	LPSID Proton Beam Mode State	17
4.2.1.1.12	LPSID Proton Beam Mode Errors	18
4.2.1.1.13	LPSID ID Positions Input	18
4.2.1.1.14	LPSID ID Positions	18
4.2.1.1.15	LPSID ID Positions State	18
4.2.1.1.16	LPSID ID Positions Errors	19
4.2.1.2	LPSVAC Inputs	19
4.2.1.2.1	LPSVAC Beam Permit Input	19

4.2.1.2.2	LPSVAC Beam Permit.....	19
4.2.1.2.3	LPSVAC Beam Permit State	19
4.2.1.2.4	LPSVAC Beam Permit Errors.....	20
4.2.1.2.5	LPSVAC Proton Beam Destination Input	20
4.2.1.2.6	LPSVAC Proton Beam Destination	20
4.2.1.2.7	LPSVAC Proton Beam Destination State	20
4.2.1.2.8	LPSVAC Proton Beam Destination Errors	21
4.2.1.2.9	LPSVAC Proton Beam Mode Input	21
4.2.1.2.10	LPSVAC Proton Beam Mode	21
4.2.1.2.11	LPSVAC Proton Beam Mode State	21
4.2.1.2.12	LPSVAC Proton Beam Mode Errors	22
4.2.1.3	LPSMAG Inputs.....	22
4.2.1.3.1	LPSMAG Beam Permit Input.....	22
4.2.1.3.2	LPSMAG Beam Permit.....	22
4.2.1.3.3	LPSMAG Beam Permit State	22
4.2.1.3.4	LPSMAG Beam Permit Errors	23
4.2.1.3.5	LPSMAG Proton Beam Destination Input	23
4.2.1.3.6	LPSMAG Proton Beam Destination.....	23
4.2.1.3.7	LPSMAG Proton Beam Destination State	23
4.2.1.3.8	LPSMAG Proton Beam Destination Errors.....	24
4.2.1.3.9	LPSMAG Proton Beam Mode Input.....	24
4.2.1.3.10	LPSMAG Proton Beam Mode.....	24
4.2.1.3.11	LPSMAG Proton Beam Mode State	24
4.2.1.3.12	LPSMAG Proton Beam Mode Errors.....	25
4.2.1.4	ACCT Inputs.....	25
4.2.1.4.1	ACCT_x Beam Permit Input	25
4.2.1.4.2	ACCT_x Beam Permit	25
4.2.1.4.3	ACCT_x Beam Permit State.....	25
4.2.1.4.4	ACCT_x Beam Permit Errors	26
4.2.1.4.5	ACCT_x_ Proton Beam Destination Input.....	26
4.2.1.4.6	ACCT_x Proton Beam Destination	26
4.2.1.4.7	ACCT_x Proton Beam Destination State	27
4.2.1.4.8	ACCT_x_ Proton Beam Destination Errors	27
4.2.1.4.9	ACCT_x_ Proton Beam Mode Input.....	27
4.2.1.4.10	ACCT_x Proton Beam Mode	27
4.2.1.4.11	ACCT_x Proton Beam Mode State	27
4.2.1.4.12	ACCT_x_ Proton Beam Mode Errors	28
4.2.1.5	RF Inputs.....	28
4.2.1.5.1	RF-FIM_x Beam Permit Input.....	28
4.2.1.5.2	RF-FIM_x Beam Permit.....	28
4.2.1.5.3	RF-FIM_x Beam Permit State	29
4.2.1.5.4	RF-FIM_x Beam Permit Errors.....	29

4.2.1.6	Fast Gate Valve Inputs.....	29
4.2.1.6.1	FGV Spokes Beam Permit Input	29
4.2.1.6.2	FGV Spokes Beam Permit	29
4.2.1.6.3	FGV Spokes Beam Permit State	29
4.2.1.6.4	FGV Spokes Beam Permit Errors.....	29
4.2.1.6.5	FGV HEBT Beam Permit Input.....	30
4.2.1.6.6	FGV HEBT Beam Permit.....	30
4.2.1.6.7	FGV HEBT Beam Permit State	30
4.2.1.6.8	FGV HEBT Beam Permit Errors.....	30
4.2.1.6.9	FGV Dump Line Beam Permit Input.....	30
4.2.1.6.10	FGV Dump Line Beam Permit.....	30
4.2.1.6.11	FGV Dump Line Beam Permit State	31
4.2.1.6.12	FGV Dump Line Beam Permit Errors	31
4.2.2	Actuation System Inputs	31
4.2.2.1	ESS Timing System Inputs	31
4.2.2.1.1	ESS Timing System Beam Inhibit Status	31
4.2.2.1.2	ESS Timing System Requested Proton Beam Destination.....	31
4.2.2.1.3	ESS Timing System Requested Proton Beam Destination	32
4.2.2.1.4	ESS Timing System Requested Proton Beam Destination State	32
4.2.2.1.5	ESS Timing System Requested Proton Beam Destination Errors	32
4.2.2.1.6	ESS Timing System Requested Proton Beam Mode Input.....	32
4.2.2.1.7	ESS Timing System Requested Proton Beam Mode	33
4.2.2.1.8	ESS Timing System Requested Proton Beam Mode Errors	33
4.2.2.1.9	ESS Timing System Requested Proton Beam Mode State	33
4.2.2.1.10	ESS Timing System Timestamp.....	33
4.2.2.1.11	ESS Timing System Beam Pulse On Trigger.....	34
4.2.2.1.12	ESS Timing System Beam Pulse Off Trigger.....	34
4.2.2.2	LEBT Chopper Input Signals.....	34
4.2.2.2.1	LEBT Chopper Status Input.....	34
4.2.2.2.2	LEBT Chopper Status.....	34
4.2.2.2.3	LEBT Chopper Status State	34
4.2.2.2.4	LEBT Chopper Status Errors.....	35
4.2.2.2.5	LEBT Chopper LPS Beam Permit Input	35
4.2.2.2.6	LEBT Chopper LPS Beam Permit	35
4.2.2.2.7	LEBT Chopper LPS Beam Permit State.....	35
4.2.2.2.8	LEBT Chopper LPS Beam Permit Errors	36
4.2.2.2.9	LEBT Chopper Fast Alarm Input	36
4.2.2.2.10	LEBT Chopper Fast Alarm	36
4.2.2.2.11	LEBT Chopper Fast Alarm State	36
4.2.2.2.12	LEBT Chopper Fast Alarm Errors.....	36
4.2.2.3	MEBT Chopper Input Signals.....	37
4.2.2.3.1	MEBT Chopper Status Input.....	37

4.2.2.3.2	MEBT Chopper Status.....	37
4.2.2.3.3	MEBT Chopper Status State	37
4.2.2.3.4	MEBT Chopper Status Errors.....	37
4.2.2.3.5	MEBT Chopper LPS Beam Permit Input	38
4.2.2.3.6	MEBT Chopper LPS Beam Permit	38
4.2.2.3.7	MEBT Chopper LPS Beam Permit State.....	38
4.2.2.3.8	MEBT Chopper LPS Beam Permit Errors	39
4.2.2.3.9	MEBT Chopper Health Input	39
4.2.2.3.10	MEBT Chopper Health	39
4.2.2.3.11	MEBT Chopper Health State	39
4.2.2.3.12	MEBT Chopper Health Errors.....	40
4.2.2.4	Ion Source Input Signals	40
4.2.2.4.1	Ion Source Status Input	40
4.2.2.4.2	Ion Source Status	40
4.2.2.4.3	Ion Source Status State.....	40
4.2.3	Latching of Erroneous Input Signals	41
4.2.4	Input Signal Control System Readout.....	41
4.2.5	Logging of Erroneous Input Signals	41
4.2.6	Logging of Input Signal State Changes.....	41
4.2.7	Variables Control System Readout.....	42
4.2.8	Logging of Variables State Changes.....	42
4.2.9	Masking.....	42
4.2.9.1	Generic Masking Requirements.....	42
4.2.9.1.1	Masking Feature (OK/NOK Signals).....	42
4.2.9.1.2	Masking Feature (Beam Destination).....	43
4.2.9.1.3	Masking Feature (Proton Beam Modes)	43
4.2.9.1.4	Default Masking.....	43
4.2.9.1.5	Control System Masking Readout.....	44
4.2.9.1.6	Logging of Masking Changes	44
4.2.9.1.7	Clear Mask.....	45
4.2.9.1.8	Masking of Redundant Signals.....	45
4.2.9.2	Masking Conditions	45
4.2.9.2.1	Masking of Sensor System Input Signals	45
4.2.9.2.1.1	Mask to NOK.....	45
4.2.9.2.1.2	LPSID Beam Permit Mask to OK.....	46
4.2.9.2.1.3	LPSVAC Beam Permit Mask to OK	46
4.2.9.2.1.4	LPSVAC Proton Beam Destination Masking	46
4.2.9.2.1.5	LPSVAC Proton Beam Mode Masking	46
4.2.9.2.1.6	LPSMAG Beam Permit Mask to OK	46
4.2.9.2.1.7	LPSMAG Proton Beam Destination Masking	47
4.2.9.2.1.8	LPSMAG Proton Beam Mode Masking	47
4.2.9.2.1.9	ACCTx Beam Permit Mask to OK.....	47
4.2.9.2.1.10	ACCTx Proton Beam Destination Masking.....	47

4.2.9.2.1.11	ACCTx Proton Beam Mode Masking.....	48
4.2.9.2.1.12	ACCTx No Beam Mask to OK.....	48
4.2.9.2.1.13	RF-FIMx Beam Permit Mask to OK.....	48
4.2.9.2.2	Masking of Actuation System Input Signal Reading.....	48
4.2.9.2.2.1	MEBT Chopper Controller Health Mask to OK.....	48
4.2.9.2.2.2	LEBT Chopper LPS Beam Permit Mask to OK.....	49
4.3	Decision Logic Computation.....	49
4.3.1	State Evaluation.....	49
4.3.1.1	Beam Permit States Evaluation.....	49
4.3.1.1.1	LPSID Beam Permit Evaluation.....	49
4.3.1.1.2	LPSVAC Beam Permit Evaluation.....	49
4.3.1.1.3	LPSMAG Beam Permit Evaluation.....	50
4.3.1.1.4	ACCT_1 Beam Permit Evaluation.....	50
4.3.1.1.5	ACCT_2 Beam Permit Evaluation.....	50
4.3.1.1.6	ACCT_3 Beam Permit Evaluation.....	51
4.3.1.1.7	ACCT_4 Beam Permit Evaluation.....	51
4.3.1.1.8	ACCT_5 Beam Permit Evaluation.....	52
4.3.1.1.9	ACCT_6 Beam Permit Evaluation.....	52
4.3.1.1.10	ACCT_7 Beam Permit Evaluation.....	52
4.3.1.1.11	MEBT Chopper LPS Beam Permit Evaluation.....	53
4.3.1.1.12	MEBT Chopper Health Evaluation.....	53
4.3.1.1.13	RF-FIM_1..4 Beam Permit Evaluation.....	54
4.3.1.1.14	RF-FIM_5..9 Beam Permit Evaluation.....	54
4.3.1.1.15	RF-FIM10..35 Beam Permit Evaluation.....	55
4.3.1.1.16	RF-FIM36..71 Beam Permit Evaluation.....	55
4.3.1.1.17	RF-FIM72..155 Beam Permit Evaluation.....	55
4.3.1.1.18	Fast Gate Valve SPK Beam Permit Evaluation.....	56
4.3.1.1.19	Fast Gate Valve HEBT Beam Permit Evaluation.....	56
4.3.1.1.20	Fast Gate Valve DMPL Beam Permit Evaluation.....	57
4.3.1.2	No Beam States Evaluation.....	57
4.3.1.2.1	Beam Inhibit No Beam Supervision.....	57
4.3.1.2.2	Regular Beam Interlock No Beam Supervision.....	58
4.3.1.2.3	LEBT Beam Destination No Beam Supervision.....	58
4.3.1.2.4	MEBT Beam Destination No Beam Supervision.....	58
4.3.1.2.5	DTL1 Beam Destination No Beam Supervision.....	58
4.3.1.2.6	DTL2 Beam Destination No Beam Supervision.....	59
4.3.1.2.7	Spokes1 Beam Destination No Beam Supervision.....	59
4.3.1.2.8	Spokes2 Beam Destination No Beam Supervision.....	59
4.3.1.2.9	MBL Beam Destination No Beam Supervision.....	60
4.3.1.2.10	Tuning Dump Beam Destination No Beam to Target Supervision.....	60
4.3.1.2.11	Target Beam Destination No Beam to Tuning Dump Supervision.....	60
4.3.1.3	Switch-Off Status Evaluation.....	61

4.3.1.3.1	ESS Timing System Status Supervision	61
4.3.1.3.2	LEBT Chopper Status Supervision.....	61
4.3.1.3.3	MEBT Chopper Status Supervision.....	61
4.3.1.3.4	Ion Source Status Supervision	62
4.3.1.4	TBD	62
4.3.1.4.1	Regular Beam Interlock when Global Beam Permit reflects NOK	62
4.3.2	Mode Enforcement.....	63
4.3.2.1	Enforced Proton Beam Destination.....	63
4.3.2.2	Enforced Proton Beam Destination Computation	63
4.3.2.3	Default Proton Beam Destination State	63
4.3.2.4	Proton Beam Destination Mismatch.....	63
4.3.2.5	Logging of Enforced Proton Beam Destination Changes	64
4.3.2.6	Enforced Proton Beam Destination Control System Readout	64
4.3.2.7	Enforced Proton Beam Mode.....	64
4.3.2.8	Enforced Proton Beam Mode Computation	64
4.3.2.9	Default Proton Beam Mode	65
4.3.2.10	Proton Beam Mode Mismatch.....	65
4.3.2.11	Logging of Enforced Proton Beam Mode Changes	65
4.3.2.12	Enforced Proton Beam Mode Control System Readout	65
4.3.3	Global Beam Permit Generation	66
4.3.3.1	Global Beam Permit Possible States	66
4.3.3.2	Global Beam Permit	66
4.3.3.3	Default Global Beam Permit State	66
4.3.3.4	Setting Global Beam Permit to NOK via Control System.....	67
4.3.3.5	Setting Global Beam Permit to OK via Control System	67
4.3.3.6	Control System Readout	67
4.3.3.7	Logging.....	67
4.3.4	Beam Pulse Phase Detection	68
4.3.4.1	Beam Pulse Phase.....	68
4.3.4.2	ESS Timing System Beam Pulse On Triggers.....	68
4.3.4.3	ESS Timing System Beam Pulse Off Triggers.....	68
4.3.4.4	Default Beam Pulse Phase State.....	69
4.3.4.5	Multiple Beam Pulse On Triggers	69
4.3.4.6	Control System Readout	69
4.3.4.7	Logging.....	70
4.3.5	Regular Beam Interlock Generation.....	70
4.3.5.1	Regular Beam Interlock Possible States.....	70
4.3.5.2	Regular Beam Interlock.....	70
4.3.5.3	Default Regular Beam Interlock State.....	70
4.3.5.4	Global Beam Permit NOK due to Regular Beam Interlock	71
4.3.5.5	Control System Readout	71
4.3.5.6	Logging.....	71
4.3.6	Emergency Beam Interlock Generation	72
4.3.6.1	Emergency Beam Interlock Possible States	72
4.3.6.2	Emergency Beam Interlock	72
4.3.6.3	Default Emergency Beam Interlock State	72
4.3.6.4	Global Beam Permit NOK due to Emergency Beam Interlock.....	72

4.3.6.5	Regular Beam Permit NOK due to Emergency Beam Interlock	73
4.3.6.6	Control System Readout	73
4.3.6.7	Logging.....	73
4.3.7	Latching.....	74
4.3.7.1	Generic Latching Requirements.....	74
4.3.7.1.1	Latching Feature.....	74
4.3.7.1.2	Latching Feature Configuration	74
4.3.7.1.3	Default Latching Configuration	74
4.3.7.1.4	Control System Latching Configuration Readout	74
4.3.7.1.5	Logging of Latching Configuration Changes	75
4.3.7.2	Mandatory Latching.....	75
4.3.7.2.1	Regular Beam Interlock Latching	75
4.3.7.2.2	Emergency Beam Interlock Latching.....	75
4.3.7.3	External Reset Feature	75
4.3.7.4	External Reset Logging.....	76
4.4	Output Signal Generation	76
4.4.1	Sensor System Output Signals	76
4.4.2	Actuation System Output Signal Generation	76
4.4.2.1	ESS Timing System Output Signals.....	76
4.4.2.1.1	ESS Timing System Beam Permit Out.....	76
4.4.2.1.2	ESS Timing System Beam Permit Out State	76
4.4.2.1.3	FBIS Beam Permit Out	77
4.4.2.1.4	FBIS Beam Permit Out Latched	77
4.4.2.2	LEBT Chopper Output Signals.....	77
4.4.2.2.1	LEBT Chopper Beam Permit Out	77
4.4.2.2.2	LEBT Chopper Beam Permit Out State.....	77
4.4.2.2.3	FBIS Beam Permit Out	78
4.4.2.3	MEBT Chopper Output Signals.....	78
4.4.2.3.1	MEBT Chopper Beam Permit Out	78
4.4.2.3.2	MEBT Chopper Beam Permit Out State.....	78
4.4.2.3.3	FBIS Beam Stop Positive Pulser	79
4.4.2.3.4	FBIS Beam Stop Negative Pulser	79
4.4.2.4	Ion Source Output Signals	79
4.4.2.4.1	Ion Source Beam Permit Out.....	79
4.4.2.4.2	Ion Source Beam Permit Out State	79
4.4.2.4.3	FBIS Beam Stop	80
4.4.2.4.4	Ion Source Emergency Beam Interlock.....	80
4.4.2.4.5	Ion Source Emergency Beam Interlock State	80
4.4.2.4.6	FBIS Magnetron PS Off.....	80
4.4.2.4.7	FBIS HV Platform Off	81
4.4.3	Output Signal Control System Readout	81
4.4.4	Logging of Output Signal State Changes.....	81
4.4.5	Logging of Variables State Changes.....	82
4.5	Event Logging.....	82

4.5.1	Timestamp.....	82
4.5.2	Timestamp Resolution.....	82
4.5.3	Log Events Control System Readout.....	83
4.5.4	Log Events Persistence	83
4.6	Startup and Shutdown	83
4.6.1	Power-On Behaviour	83
4.6.2	Power-On Self Test.....	84
4.6.3	Shutdown Sequence	84
4.7	Processing Latency	84
4.7.1	Beam Permit Processing Latency.....	84
4.8	Diagnostic Interface	85
4.8.1	Diagnostic Interface.....	85
4.8.2	On-Site Information	85
4.9	Firmware Updates	85
4.9.1	Firmware Update.....	85
4.9.2	Firmware Acceptance.....	85
4.9.3	Firmware Configuration Identification.....	86
5	Non-Functional System Requirements.....	86
5.1	Mechanical.....	86
5.1.1	Rack Mountable	86
5.1.2	Height Units.....	86
5.1.3	Weight	87
5.1.4	Identification	87
5.2	Temperature	87
5.2.1	Operating Temperature Range	87
5.2.2	Storage Temperature Range	87
5.3	MTBF and Lifetime	88
5.3.1	Lifetime.....	88
5.3.2	MTBF.....	88
5.4	Electrical	88
5.4.1	Power Supply	88
5.4.2	EMI	88
5.4.3	ESD	89
5.5	Maintenance	89
5.5.1	Physical Unit Replacement	89
5.5.2	Maintenance during Runtime	89

1 Introduction

The FBIS Verification Cross Reference Matrix provides a list of verification ideas and verification methods for all functional and non-functional requirements for the Fast Beam Interlock System (FBIS) on system level.

The FBIS will be realized by ZHAW and will be part of the Machine Protection System (MPS) for the European Spallation Source in Lund, Sweden. The document shall serve as a starting point for detailed test plans.

2 Sope

The Verification Cross Reference Matrix (VCRM) is a ZHAW document and is based on System Requirement Specification (SRS).

DRAFT

3 Driving Requirements

3.1 Minimal Latency

[#\[ISSUE:63253\]](#)

Requirement	Minimal Latency
Verification Technique	Demonstration
Verification Idea	Timing Measurement Acceptance Criteria: <ul style="list-style-type: none"> • Not specified

3.2 Support Staged Commissioning

[#\[ISSUE:63254\]](#)

Requirement	Support Staged Commissioning
Verification Technique	Review
Verification Idea	Critical Design Review Method: <ul style="list-style-type: none"> • Expert judgement Acceptance Criteria: <ul style="list-style-type: none"> • Design supports staged commissioning

3.3 Scalable Number of Inputs

[#\[ISSUE:63270\]](#)

Requirement	Scalable Number of Inputs
Verification Technique	Review
Verification Idea	Critical Design Review Method: <ul style="list-style-type: none"> • Expert judgement Acceptance Criteria: <ul style="list-style-type: none"> • Design supports scalable number of inputs

3.4 Support ESS Lifetime

[#\[ISSUE:63271\]](#)

Requirement	Support ESS Lifetime
Verification Technique	Review
Verification Idea	Critical Design Review Method: <ul style="list-style-type: none"> • Expert judgement Acceptance Criteria: <ul style="list-style-type: none"> • Design supports intended ESS lifetime

3.5 Seamless integration into ESS System Landscape

[#\[ISSUE:63272\]](#)

Requirement	Seamless integration into ESS System Landscape
Verification Technique	Review

Verification Idea	<p>Critical Design Review Method:</p> <ul style="list-style-type: none"> • Expert judgement <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • Design supports seamless integration
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3.6 Compatible with IEC 61508 SIL2

[#\[ISSUE:63273\]](#)

Requirement	Compatible with IEC 61508 SIL2
Verification Technique	Analysis
Verification Idea	<p>Analysis Methods:</p> <ul style="list-style-type: none"> • RBD • FMEDA <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • PFH is suitable for SIL2

3.7 Maximal Availability

[#\[ISSUE:63280\]](#)

Requirement	Maximal Availability
Verification Technique	Analysis
Verification Idea	<p>Analysis Method:</p> <ul style="list-style-type: none"> • RBD • FMEDA <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • MTBF > TBD • MTTR < TBD

4 Functional System Requirements

4.1 Interfaces

4.1.1 LPSID Interface

[#\[ISSUE:62882\]](#)

Requirement	LPSID Interface
Verification Technique	Review
Verification Idea	Design Review Acceptance Criteria: <ul style="list-style-type: none"> Interface is realized as specified

4.1.2 LPSVAC Interface

[#\[ISSUE:63711\]](#)

Requirement	LPSVAC Interface
Verification Technique	Review
Verification Idea	Design Review Acceptance Criteria: <ul style="list-style-type: none"> Interface is realized as specified

4.1.3 LPSMAG Interface

[#\[ISSUE:63819\]](#)

Requirement	LPSMAG Interface
Verification Technique	Review
Verification Idea	Design Review Acceptance Criteria: <ul style="list-style-type: none"> Interface is realized as specified

4.1.4 ACCT Digital Processing Board Interface

[#\[ISSUE:63619\]](#)

Requirement	ACCT Digital Processing Board Interface
Verification Technique	Review
Verification Idea	Design Review Acceptance Criteria: <ul style="list-style-type: none"> Interface is realized as specified

4.1.5 RF Fast Interlock Module Interface

[#\[ISSUE:63828\]](#)

Requirement	RF Fast Interlock Module Interface
Verification Technique	Review
Verification Idea	Design Review

	Acceptance Criteria: <ul style="list-style-type: none"> • Interface is realized as specified
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4.1.6 Fast Gate Valve Interface

[#\[ISSUE:63846\]](#)

Requirement	Fast Gate Valve Interface
Verification Technique	Review
Verification Idea	Design Review Acceptance Criteria: <ul style="list-style-type: none"> • Interface is realized as specified

4.1.7 ESS Timing System Interface

[#\[ISSUE:63276\]](#)

Requirement	ESS Timing System Interface
Verification Technique	Review
Verification Idea	Design Review Acceptance Criteria: <ul style="list-style-type: none"> • Interface is realized as specified

4.1.8 LEBT Chopper Interface

[#\[ISSUE:62904\]](#)

Requirement	LEBT Chopper Interface
Verification Technique	Review
Verification Idea	Design Review Acceptance Criteria: <ul style="list-style-type: none"> • Interface is realized as specified

4.1.9 MEBT Chopper Interface

[#\[ISSUE:62905\]](#)

Requirement	MEBT Chopper Interface
Verification Technique	Review
Verification Idea	Design Review Acceptance Criteria: <ul style="list-style-type: none"> • Interface is realized as specified

4.1.10 Ion Source Interface

[#\[ISSUE:62906\]](#)

Requirement	Ion Source Interface
Verification Technique	Review
Verification Idea	Design Review Acceptance Criteria:

	<ul style="list-style-type: none"> Interface is realized as specified
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4.1.11 Control System Interface

[#\[ISSUE:63429\]](#)

Requirement	Control System Interface
Verification Technique	Review
Verification Idea	Design Review Acceptance Criteria: <ul style="list-style-type: none"> Interface is realized as specified

4.2 Input Signal Pre-Processing

4.2.1 Sensor System Inputs

4.2.1.1 LPSID Inputs

4.2.1.1.1 LPSID Beam Permit Input

[#\[ISSUE:64447\]](#)

Requirement	LPSID Beam Permit Input
Verification Technique	Test
Verification Idea	Covered by testing of related requirements <ul style="list-style-type: none"> LPSID Beam Permit State LPSID Beam Permit Errors

4.2.1.1.2 LPSID Beam Permit

[#\[ISSUE:65039\]](#)

Requirement	LPSID Beam Permit
Verification Technique	Test
Verification Idea	Covered by testing of related requirements <ul style="list-style-type: none"> LPSID Beam Permit State LPSID Beam Permit Errors

4.2.1.1.3 LPSID Beam Permit State

[#\[ISSUE:64021\]](#)

Requirement	LPSID Beam Permit State
Verification Technique	Test
Verification Idea	Simulate LPSID using HIL-Simulator Required Interfaces: <ul style="list-style-type: none"> Serial Datalink Discrete Preconditions: <ul style="list-style-type: none"> LPSID_BEAM_PERMIT is "NOK" Procedure: <ul style="list-style-type: none"> Set "LPSID Beam Permit A" to "High" Set "LPSID Beam Permit B" to "Low"

	<ul style="list-style-type: none"> Set data field "LPSID Beam Permit" to "OK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> LPSID_BEAM_PERMIT is set to "OK"
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4.2.1.1.4 LPSID Beam Permit Errors

[#\[ISSUE:64022\]](#)

Requirement	LPSID Beam Permit Errors
Verification Technique	Test
Verification Idea	<p>Simulate LPSID using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Discrete Serial Datalink <p>Precondition:</p> <ul style="list-style-type: none"> LPSID_BEAM_PERMIT is "OK" <p>Procedure:</p> <ul style="list-style-type: none"> Send messages using HIL-Simulator Change message datafields and discrete signals to simulate error conditions <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> LPSID_BEAM_PERMIT is set to "NOK" for error conditions

4.2.1.1.5 LPSID Proton Beam Destination Input

[#\[ISSUE:63214\]](#)

Requirement	LPSID Proton Beam Destination Input
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirements</p> <ul style="list-style-type: none"> LPSID Proton Beam Destination State LPSID Proton Beam Destination Errors

4.2.1.1.6 LPSID Proton Beam Destination

[#\[ISSUE:65139\]](#)

Requirement	LPSID Proton Beam Destination
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirements</p> <ul style="list-style-type: none"> LPSID Proton Beam Destination State LPSID Proton Beam Destination Errors

4.2.1.1.7 LPSID Proton Beam Destination State

[#\[ISSUE:65142\]](#)

Requirement	LPSID Proton Beam Destination State
Verification Technique	Test
Verification Idea	<p>Simulate LPSID using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Serial Datalink <p>Precondition:</p> <ul style="list-style-type: none"> n/a <p>Procedure:</p>

	<ul style="list-style-type: none"> • Send cyclic messages over serial datalink • Change message datafields for "LPSID Proton Beam Destination" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • LPSID_PROTON_BEAM_DESTINATION is set according to message datafields
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4.2.1.1.8 LPSID Proton Beam Destination Errors

[#\[ISSUE:64024\]](#)

Requirement	LPSID Proton Beam Destination Errors
Verification Technique	Test
Verification Idea	<p>Simulate LPSID using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Serial Datalink <p>Preconditions:</p> <ul style="list-style-type: none"> • LPSID_PROTON_BEAM_DESTINATION is set to "Target" <p>Procedure:</p> <ul style="list-style-type: none"> • Send messages using HIL-Simulator • Change message datafields to simulate error conditions <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • LPSID_PROTON_BEAM_DESTINATION is set to "None" for error conditions

4.2.1.1.9 LPSID Proton Beam Mode Input

[#\[ISSUE:63274\]](#)

Requirement	LPSID Proton Beam Mode Input
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirements</p> <ul style="list-style-type: none"> • LPSID Proton Beam Mode State • LPSID Proton Beam Mode Errors

4.2.1.1.10 LPSID Proton Beam Mode

[#\[ISSUE:65143\]](#)

Requirement	LPSID Proton Beam Mode
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirements</p> <ul style="list-style-type: none"> • LPSID Proton Beam Mode State • LPSID Proton Beam Mode Errors

4.2.1.1.11 LPSID Proton Beam Mode State

[#\[ISSUE:65144\]](#)

Requirement	LPSID Proton Beam Mode State
Verification Technique	Test
Verification Idea	<p>Simulate LPSID using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Serial Datalink <p>Precondition:</p> <ul style="list-style-type: none"> • n/a <p>Procedure:</p>

	<ul style="list-style-type: none"> • Send cyclic messages over serial datalink • Change message datafields for "LPSID Proton Beam Mode" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • LPSID_PROTON_BEAM_MODE is set according to message datafields
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4.2.1.1.12 LPSID Proton Beam Mode Errors

[#\[ISSUE:64026\]](#)

Requirement	LPSID Proton Beam Mode Errors
Verification Technique	Test
Verification Idea	<p>Simulate LPSID using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Serial Datalink <p>Preconditions:</p> <ul style="list-style-type: none"> • LPSID_PROTON_BEAM_MODE is set to "Production" <p>Procedure:</p> <ul style="list-style-type: none"> • Send cyclic messages using HIL-Simulator over serial datalink • Change message datafields to simulate error conditions <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • LPSID_PROTON_BEAM_MODE is set to "None" for error conditions

4.2.1.1.13 LPSID ID Positions Input

[#\[ISSUE:63596\]](#)

Requirement	LPSID ID Positions Input
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirements</p> <ul style="list-style-type: none"> • LPSID ID Positions State • LPSID ID Positions Errors

4.2.1.1.14 LPSID ID Positions

[#\[ISSUE:65146\]](#)

Requirement	LPSID ID Positions
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirements</p> <ul style="list-style-type: none"> • LPSID ID Positions State • LPSID ID Positions Errors

4.2.1.1.15 LPSID ID Positions State

[#\[ISSUE:65147\]](#)

Requirement	LPSID ID Positions State
Verification Technique	Test
Verification Idea	<p>Simulate LPSID using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Serial Datalink <p>Preconditions:</p> <ul style="list-style-type: none"> • LPSID_ID_POSITIONS are set to "unknown" <p>Procedure:</p>

	<ul style="list-style-type: none"> • Send cyclic messages using HIL-Simulator over serial datalink • Change message datafields to simulate valid and invalid ID positions <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • LPSID_ID_POSITIONS are set according to message datafields
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4.2.1.1.16 LPSID ID Positions Errors

[#\[ISSUE:65148\]](#)

Requirement	LPSID ID Positions Errors
Verification Technique	Test
Verification Idea	<p>Simulate LPSID using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Serial Datalink <p>Preconditions:</p> <ul style="list-style-type: none"> • LPSID_PROTON_BEAM_MODE is set to "Production" <p>Procedure:</p> <ul style="list-style-type: none"> • Send cyclic messages using HIL-Simulator over serial datalink • Change message datafields to simulate error conditions <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • LPSID_PROTON_BEAM_MODE is set to "None" for error conditions

4.2.1.2 LPSVAC Inputs

4.2.1.2.1 LPSVAC Beam Permit Input

[#\[ISSUE:63712\]](#)

Requirement	LPSVAC Beam Permit Input
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirements</p> <ul style="list-style-type: none"> • LPSVAC Beam Permit State • LPSVAC Beam Permit Errors

4.2.1.2.2 LPSVAC Beam Permit

[#\[ISSUE:65051\]](#)

Requirement	LPSVAC Beam Permit
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirements</p> <ul style="list-style-type: none"> • LPSVAC Beam Permit State • LPSVAC Beam Permit Errors

4.2.1.2.3 LPSVAC Beam Permit State

[#\[ISSUE:64084\]](#)

Requirement	LPSVAC Beam Permit State
Verification Technique	Test
Verification Idea	<p>Simulate LPSVAC using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Serial Datalink • Discrete

	<p>Preconditions:</p> <ul style="list-style-type: none"> • LPSID_BEAM_PERMIT is "NOK" <p>Procedure:</p> <ul style="list-style-type: none"> • Set "LPSVAC Beam Permit A" to "High" • Set "LPSVAC Beam Permit B" to "Low" • Set data field "LPSVAC Beam Permit" to "OK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • LPSVAC_BEAM_PERMIT is set to "OK"
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4.2.1.2.4 LPSVAC Beam Permit Errors

[#\[ISSUE:64086\]](#)

Requirement	LPSVAC Beam Permit Errors
Verification Technique	Test
Verification Idea	<p>Simulate LPSVAC using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete • Serial Datalink <p>Precondition:</p> <ul style="list-style-type: none"> • LPSVAC_BEAM_PERMIT is "OK" <p>Procedure:</p> <ul style="list-style-type: none"> • Send messages using HIL-Simulator • Change message datafields and discrete signals to simulate error conditions <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • LPSVAC_BEAM_PERMIT is set to "NOK" for error conditions

4.2.1.2.5 LPSVAC Proton Beam Destination Input

[#\[ISSUE:63713\]](#)

Requirement	LPSVAC Proton Beam Destination Input
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirements</p> <ul style="list-style-type: none"> • LPSVAC Proton Beam Destination State • LPSVAC Proton Beam Destination Errors

4.2.1.2.6 LPSVAC Proton Beam Destination

[#\[ISSUE:65150\]](#)

Requirement	LPSVAC Proton Beam Destination
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirements</p> <ul style="list-style-type: none"> • LPSVAC Proton Beam Destination State • LPSVAC Proton Beam Destination Errors

4.2.1.2.7 LPSVAC Proton Beam Destination State

[#\[ISSUE:65151\]](#)

Requirement	LPSVAC Proton Beam Destination State
Verification Technique	Test
Verification Idea	Simulate LPSVAC using HIL-Simulator

	<p>Required Interfaces:</p> <ul style="list-style-type: none"> Serial Datalink <p>Precondition:</p> <ul style="list-style-type: none"> n/a <p>Procedure:</p> <ul style="list-style-type: none"> Send cyclic messages over serial datalink Change message datafields for "LPSVAC Proton Beam Mode" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> LPSVAC_PROTON_BEAM_DESTINATION is set according to message datafields
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4.2.1.2.8 LPSVAC Proton Beam Destination Errors

[#\[ISSUE:64088\]](#)

Requirement	LPSVAC Proton Beam Destination Errors
Verification Technique	Test
Verification Idea	<p>Simulate LPSVAC using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Serial Datalink <p>Preconditions:</p> <ul style="list-style-type: none"> LPSVAC_PROTON_BEAM_DESTINATION is set to "Target" <p>Procedure:</p> <ul style="list-style-type: none"> Send messages using HIL-Simulator Change message datafields to simulate error conditions <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> LPSVAC_PROTON_BEAM_DESTINATION is set to "None" for error conditions

4.2.1.2.9 LPSVAC Proton Beam Mode Input

[#\[ISSUE:63714\]](#)

Requirement	LPSVAC Proton Beam Mode Input
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirements</p> <ul style="list-style-type: none"> LPSVAC Proton Beam Mode State LPSVAC Proton Beam Mode Errors

4.2.1.2.10 LPSVAC Proton Beam Mode

[#\[ISSUE:65149\]](#)

Requirement	LPSVAC Proton Beam Mode
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirements</p> <ul style="list-style-type: none"> LPSVAC Proton Beam Mode State LPSVAC Proton Beam Mode Errors

4.2.1.2.11 LPSVAC Proton Beam Mode State

[#\[ISSUE:65152\]](#)

Requirement	LPSVAC Proton Beam Mode State
Verification Technique	Test
Verification Idea	Simulate LPSVAC using HIL-Simulator

	<p>Required Interfaces:</p> <ul style="list-style-type: none"> Serial Datalink <p>Precondition:</p> <ul style="list-style-type: none"> n/a <p>Procedure:</p> <ul style="list-style-type: none"> Send cyclic messages over serial datalink Change message datafields for "LPSVAC Proton Beam Mode" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> LPSVAC_PROTON_BEAM_MODE is set according to message datafields
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4.2.1.2.12 LPSVAC Proton Beam Mode Errors

[#\[ISSUE:64090\]](#)

Requirement	LPSVAC Proton Beam Mode Errors
Verification Technique	Test
Verification Idea	<p>Simulate LPSVAC using HIL-Simulator</p> <p>Required:</p> <ul style="list-style-type: none"> Serial Datalink <p>Preconditions:</p> <ul style="list-style-type: none"> LPSVAC_PROTON_BEAM_MODE is set to "Production" <p>Procedure:</p> <ul style="list-style-type: none"> Send cyclic messages using HIL-Simulator over serial datalink Change message datafields to simulate error conditions <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> LPSVAC_PROTON_BEAM_MODE is set to "None" for error conditions

4.2.1.3 LPSMAG Inputs

4.2.1.3.1 LPSMAG Beam Permit Input

[#\[ISSUE:63821\]](#)

Requirement	LPSMAG Beam Permit Input
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirements</p> <ul style="list-style-type: none"> LPSMAG Beam Permit State LPSMAG Beam Permit Errors

4.2.1.3.2 LPSMAG Beam Permit

[#\[ISSUE:65052\]](#)

Requirement	LPSMAG Beam Permit
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirements</p> <ul style="list-style-type: none"> LPSMAG Beam Permit State LPSMAG Beam Permit Errors

4.2.1.3.3 LPSMAG Beam Permit State

[#\[ISSUE:64085\]](#)

Requirement	LPSMAG Beam Permit State
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Verification Technique	Test
Verification Idea	<p>Simulate LPSMAG using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Serial Datalink • Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> • LPSMAG_BEAM_PERMIT is "NOK" <p>Procedure:</p> <ul style="list-style-type: none"> • Set "LPSMAG Beam Permit A" to "High" • Set "LPSMAG Beam Permit B" to "Low" • Set data field "LPSMAG Beam Permit" to "OK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • LPSMAG_BEAM_PERMIT is set to "OK"

4.2.1.3.4 LPSMAG Beam Permit Errors

[#\[ISSUE:64087\]](#)

Requirement	LPSMAG Beam Permit Errors
Verification Technique	Test
Verification Idea	<p>Simulate LPSMAG using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete • Serial Datalink <p>Precondition:</p> <ul style="list-style-type: none"> • LPSMAG_BEAM_PERMIT is "OK" <p>Procedure:</p> <ul style="list-style-type: none"> • Send messages using HIL-Simulator • Change message datafields and physical signals to simulate error conditions <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • LPSMAG_BEAM_PERMIT is set to "NOK" for error conditions

4.2.1.3.5 LPSMAG Proton Beam Destination Input

[#\[ISSUE:63822\]](#)

Requirement	LPSMAG Proton Beam Destination Input
Verification Technique	Test
Verification Idea	

4.2.1.3.6 LPSMAG Proton Beam Destination

[#\[ISSUE:65153\]](#)

Requirement	LPSMAG Proton Beam Destination
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirements</p> <ul style="list-style-type: none"> • LPSMAG Proton Beam Destination State • LPSMAG Proton Beam Destination Errors

4.2.1.3.7 LPSMAG Proton Beam Destination State

[#\[ISSUE:65154\]](#)

Requirement	LPSMAG Proton Beam Destination State
Verification Technique	Test
Verification Idea	<p>Simulate LPSMAG using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Serial Datalink <p>Precondition:</p> <ul style="list-style-type: none"> n/a <p>Procedure:</p> <ul style="list-style-type: none"> Send cyclic messages over serial datalink Change message datafields for "LPSMAG Proton Beam Destination" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> LPSMAG_PROTON_BEAM_DESTINATION is set according to message datafields

4.2.1.3.8 LPSMAG Proton Beam Destination Errors

[#\[ISSUE:64089\]](#)

Requirement	LPSMAG Proton Beam Destination Errors
Verification Technique	Test
Verification Idea	<p>Simulate LPSMAG using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Serial Datalink <p>Preconditions:</p> <ul style="list-style-type: none"> LPSMAG_PROTON_BEAM_DESTINATIO is set to "Target" <p>Procedure:</p> <ul style="list-style-type: none"> Send messages using HIL-Simulator Change message datafields to simulate error conditions <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> LPSMAG_PROTON_BEAM_DESTINATIO is set to "None" for error conditions

4.2.1.3.9 LPSMAG Proton Beam Mode Input

[#\[ISSUE:63823\]](#)

Requirement	LPSMAG Proton Beam Mode Input
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirements</p> <ul style="list-style-type: none"> LPSMAG Proton Beam Mode State LPSMAG Proton Beam Mode Errors

4.2.1.3.10 LPSMAG Proton Beam Mode

[#\[ISSUE:65155\]](#)

Requirement	LPSMAG Proton Beam Mode
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirements</p> <ul style="list-style-type: none"> LPSMAG Proton Beam Mode State LPSMAG Proton Beam Mode Errors

4.2.1.3.11 LPSMAG Proton Beam Mode State

[#\[ISSUE:65156\]](#)

Requirement	LPSMAG Proton Beam Mode State
Verification Technique	Test
Verification Idea	<p>Simulate LPSMAG using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Serial Datalink <p>Precondition:</p> <ul style="list-style-type: none"> n/a <p>Procedure:</p> <ul style="list-style-type: none"> Send cyclic messages over serial datalink Change message datafields for "LPSMAG Proton Beam Mode" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> LPSMAG_PROTON_BEAM_MODE is set according to message datafields

4.2.1.3.12 LPSMAG Proton Beam Mode Errors

[#\[ISSUE:64091\]](#)

Requirement	LPSMAG Proton Beam Mode Errors
Verification Technique	Test
Verification Idea	<p>Simulate LPSMAG using HIL-Simulator</p> <p>Required:</p> <ul style="list-style-type: none"> Serial Datalink <p>Preconditions:</p> <ul style="list-style-type: none"> LPSMAG_PROTON_BEAM_MODE is set to "Production" <p>Procedure:</p> <ul style="list-style-type: none"> Send cyclic messages using HIL-Simulator over serial datalink Change message datafields to simulate error conditions <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> LPSMAG_PROTON_BEAM_MODE is set to "None" for error conditions

4.2.1.4 ACCT Inputs

4.2.1.4.1 ACCT_x Beam Permit Input

[#\[ISSUE:63621\]](#)

Requirement	ACCT_x Beam Permit Input
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirements</p> <ul style="list-style-type: none"> ACCT_x Beam Permit State ACCT_x Beam Permit Errors

4.2.1.4.2 ACCT_x Beam Permit

[#\[ISSUE:65162\]](#)

Requirement	ACCT_x Beam Permit
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirements</p> <ul style="list-style-type: none"> ACCT_x Beam Permit State ACCT_x Beam Permit Errors

4.2.1.4.3 ACCT_x Beam Permit State

[#\[ISSUE:64092\]](#)

Requirement	ACCT_x Beam Permit State
Verification Technique	Test
Verification Idea	<p>Simulate ACCT digital processing board using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Serial Datalink • Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> • ACCT_x_BEAM_PERMIT is "NOK" <p>Procedure:</p> <ul style="list-style-type: none"> • Set "Alarm x" to "High" • Set data field "Alarm x" to "OK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • ACCT_x_BEAM_PERMIT is set to "OK"

4.2.1.4.4 ACCT_x Beam Permit Errors

[#\[ISSUE:64093\]](#)

Requirement	ACCT_x Beam Permit Errors
Verification Technique	Test
Verification Idea	<p>Simulate ACCT Digital Processing Board using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete • Serial Datalink <p>Precondition:</p> <ul style="list-style-type: none"> • ACCT_x_BEAM_PERMIT is "OK" <p>Procedure:</p> <ul style="list-style-type: none"> • Send messages using HIL-Simulator • Change message datafields and discrete signals to simulate error conditions <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • ACCT_x_BEAM_PERMIT is set to "NOK" for error conditions

4.2.1.4.5 ACCT_x Proton Beam Destination Input

[#\[ISSUE:63654\]](#)

Requirement	ACCT_x Proton Beam Destination Input
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirements</p> <ul style="list-style-type: none"> • ACCT_x Proton Beam Destination State • ACCT_x Proton Beam Destination Errors

4.2.1.4.6 ACCT_x Proton Beam Destination

[#\[ISSUE:65163\]](#)

Requirement	ACCT_x Proton Beam Destination
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirements</p> <ul style="list-style-type: none"> • ACCT_x Proton Beam Destination State • ACCT_x Proton Beam Destination Errors

4.2.1.4.7 ACCT_x Proton Beam Destination State

[#\[ISSUE:65159\]](#)

Requirement	ACCT_x Proton Beam Destination State
Verification Technique	Test
Verification Idea	<p>Simulate ACCT digital processing board using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Serial Datalink <p>Precondition:</p> <ul style="list-style-type: none"> n/a <p>Procedure:</p> <ul style="list-style-type: none"> Send cyclic messages over serial datalink Change message datafields for "ACCT Proton Beam Destination" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> ACCT_x_PROTON_BEAM_DESTINATION is set according to message datafields

4.2.1.4.8 ACCT_x Proton Beam Destination Errors

[#\[ISSUE:64096\]](#)

Requirement	ACCT_x Proton Beam Destination Errors
Verification Technique	Test
Verification Idea	<p>Simulate ACCT Digital Processing Board using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Serial Datalink <p>Preconditions:</p> <ul style="list-style-type: none"> ACCT_x_PROTON_BEAM_DESTINATION is set to "OK" <p>Procedure:</p> <ul style="list-style-type: none"> Send messages using HIL-Simulator Change message datafields to simulate error conditions <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> ACCT_x_PROTON_BEAM_DESTINATION is set to "None" for error conditions

4.2.1.4.9 ACCT_x Proton Beam Mode Input

[#\[ISSUE:63652\]](#)

Requirement	ACCT_x Proton Beam Mode Input
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirements</p> <ul style="list-style-type: none"> ACCT_x Proton Beam Mode State ACCT_x Proton Beam Mode Errors

4.2.1.4.10 ACCT_x Proton Beam Mode

[#\[ISSUE:65160\]](#)

Requirement	ACCT_x Proton Beam Mode
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirements</p> <ul style="list-style-type: none"> ACCT_x Proton Beam Mode State ACCT_x Proton Beam Mode Errors

4.2.1.4.11 ACCT_x Proton Beam Mode State

[#\[ISSUE:65157\]](#)

Requirement	ACCT_x Proton Beam Mode State
Verification Technique	Test
Verification Idea	<p>Simulate ACCT digital processing board using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Serial Datalink <p>Precondition:</p> <ul style="list-style-type: none"> n/a <p>Procedure:</p> <ul style="list-style-type: none"> Send cyclic messages over serial datalink Change message datafields for "ACCT Proton Beam Mode" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> ACCT_x_PROTON_BEAM_MODE is set according to message datafields

4.2.1.4.12 ACCT_x Proton Beam Mode Errors

[#\[ISSUE:64097\]](#)

Requirement	ACCT_x Proton Beam Mode Errors
Verification Technique	Test
Verification Idea	<p>Simulate ACCT Digital Processing Board using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Serial Datalink <p>Preconditions:</p> <ul style="list-style-type: none"> ACCT_x_PROTON_BEAM_MODE is set to "Production" <p>Procedure:</p> <ul style="list-style-type: none"> Send messages using HIL-Simulator Change message datafields to simulate error conditions <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> ACCT_PROTON_BEAM_MODE is set to "None" for error conditions

4.2.1.5 RF Inputs

4.2.1.5.1 RF-FIM_x Beam Permit Input

[#\[ISSUE:63830\]](#)

Requirement	RF-FIM_x Beam Permit Input
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirements:</p> <ul style="list-style-type: none"> RF-FIM_x Beam Permit State RF-FIM_x Beam Permit Errors

4.2.1.5.2 RF-FIM_x Beam Permit

[#\[ISSUE:65053\]](#)

Requirement	RF-FIM_x Beam Permit
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirements:</p> <ul style="list-style-type: none"> RF-FIM_x Beam Permit State RF-FIM_x Beam Permit Errors

4.2.1.5.3 RF-FIM_x Beam Permit State

[#\[ISSUE:64126\]](#)

Requirement	RF-FIM_x Beam Permit State
Verification Technique	Test
Verification Idea	TBD

4.2.1.5.4 RF-FIM_x Beam Permit Errors

[#\[ISSUE:64127\]](#)

Requirement	RF-FIM_x Beam Permit Errors
Verification Technique	Test
Verification Idea	TBD

4.2.1.6 Fast Gate Valve Inputs

4.2.1.6.1 FGV Spokes Beam Permit Input

[#\[ISSUE:65048\]](#)

Requirement	FGV Spokes Beam Permit Input
Verification Technique	Test
Verification Idea	Covered by testing of related requirements: <ul style="list-style-type: none"> • FGV Spokes Beam Permit State • FGV Spokes Beam Permit Errors

4.2.1.6.2 FGV Spokes Beam Permit

[#\[ISSUE:63848\]](#)

Requirement	FGV Spokes Beam Permit
Verification Technique	Test
Verification Idea	Covered by testing of related requirements: <ul style="list-style-type: none"> • FGV Spokes Beam Permit State • FGV Spokes Beam Permit Errors

4.2.1.6.3 FGV Spokes Beam Permit State

[#\[ISSUE:64128\]](#)

Requirement	FGV Spokes Beam Permit State
Verification Technique	Test
Verification Idea	TBD

4.2.1.6.4 FGV Spokes Beam Permit Errors

[#\[ISSUE:64131\]](#)

Requirement	FGV Spokes Beam Permit Errors
Verification Technique	Test
Verification Idea	TBD

4.2.1.6.5 FGV HEBT Beam Permit Input

[#\[ISSUE:65049\]](#)

Requirement	FGV HEBT Beam Permit Input
Verification Technique	Test
Verification Idea	Covered by testing of related requirements: <ul style="list-style-type: none"> • FGV HEBT Beam Permit State • FGV HEBT Beam Permit Errors

4.2.1.6.6 FGV HEBT Beam Permit

[#\[ISSUE:63849\]](#)

Requirement	FGV HEBT Beam Permit
Verification Technique	Test
Verification Idea	Covered by testing of related requirements: <ul style="list-style-type: none"> • FGV HEBT Beam Permit State • FGV HEBT Beam Permit Errors

4.2.1.6.7 FGV HEBT Beam Permit State

[#\[ISSUE:64129\]](#)

Requirement	FGV HEBT Beam Permit State
Verification Technique	Test
Verification Idea	TBD

4.2.1.6.8 FGV HEBT Beam Permit Errors

[#\[ISSUE:64132\]](#)

Requirement	FGV HEBT Beam Permit Errors
Verification Technique	Test
Verification Idea	TBD

4.2.1.6.9 FGV Dump Line Beam Permit Input

[#\[ISSUE:65050\]](#)

Requirement	FGV Dump Line Beam Permit Input
Verification Technique	Test
Verification Idea	Covered by testing of related requirements: <ul style="list-style-type: none"> • FGV Dump Line Beam Permit State • FGV Dump Line Beam Permit Errors

4.2.1.6.10 FGV Dump Line Beam Permit

[#\[ISSUE:63850\]](#)

Requirement	FGV Dump Line Beam Permit
Verification Technique	Test

Verification Idea	TBD
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4.2.1.6.11 FGV Dump Line Beam Permit State

[#\[ISSUE:64130\]](#)

Requirement	FGV Dump Line Beam Permit State
Verification Technique	Test
Verification Idea	TBD

4.2.1.6.12 FGV Dump Line Beam Permit Errors

[#\[ISSUE:64133\]](#)

Requirement	FGV Dump Line Beam Permit Errors
Verification Technique	Test
Verification Idea	TBD

4.2.2 Actuation System Inputs

4.2.2.1 ESS Timing System Inputs

4.2.2.1.1 ESS Timing System Beam Inhibit Status

[#\[ISSUE:63226\]](#)

Requirement	ESS Timing System Beam Inhibit Status
Verification Technique	Test
Verification Idea	<p>Simulate ESS Timing System using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> • None <p>Procedure:</p> <ul style="list-style-type: none"> • Set "TS Ready" states corresponding to IDD <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • TS_READY corresponds "TS Ready"

4.2.2.1.2 ESS Timing System Requested Proton Beam Destination Input

[#\[ISSUE:63551\]](#)

Requirement	ESS Timing System Requested Proton Beam Destination Input
Verification Technique	Test
Verification Idea	<p>Control Timing System using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Timing System Control <p>Procedure:</p> <ul style="list-style-type: none"> • Set "Requested Proton Beam Destination" to possible states <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • REQUESTED_PROTON_BEAM_DESTINATION corresponds "Requested Proton Beam Destination" <p>Remark:</p> <ul style="list-style-type: none"> • It is assumed that the Timing System can be controlled by the HIL-Simulator

4.2.2.1.3 ESS Timing System Requested Proton Beam Destination

[#\[ISSUE:65166\]](#)

Requirement	ESS Timing System Requested Proton Beam Destination
Verification Technique	Test
Verification Idea	Covered by testing of related requirements <ul style="list-style-type: none"> • LPSID Proton Beam Destination State • LPSID Proton Beam Destination Errors

4.2.2.1.4 ESS Timing System Requested Proton Beam Destination State

[#\[ISSUE:65168\]](#)

Requirement	ESS Timing System Requested Proton Beam Destination State
Verification Technique	Test
Verification Idea	Control Timing System using HIL-Simulator Required Interfaces: <ul style="list-style-type: none"> • Timing System Control Procedure: <ul style="list-style-type: none"> • Set "Requested Proton Beam Destination" to possible states Acceptance Criteria: <ul style="list-style-type: none"> • REQUESTED_PROTON_BEAM_DESTINATION corresponds "Requested Proton Beam Destination" Remark: <ul style="list-style-type: none"> • It is assumed that the Timing System can be controlled by the HIL-Simulator

4.2.2.1.5 ESS Timing System Requested Proton Beam Destination Errors

[#\[ISSUE:65170\]](#)

Requirement	ESS Timing System Requested Proton Beam Destination Errors
Verification Technique	Test
Verification Idea	Control Timing System using HIL-Simulator Required Interfaces: <ul style="list-style-type: none"> • Timing System Control Procedure: <ul style="list-style-type: none"> • Set "Requested Proton Beam Destination" to erroneous states Acceptance Criteria: <ul style="list-style-type: none"> • REQUESTED_PROTON_BEAM_DESTINATION is "None" Remark: <ul style="list-style-type: none"> • It is assumed that the Timing System can be controlled by the HIL-Simulator

4.2.2.1.6 ESS Timing System Requested Proton Beam Mode Input

[#\[ISSUE:63550\]](#)

Requirement	ESS Timing System Requested Proton Beam Mode Input
Verification Technique	Test
Verification Idea	Control Timing System using HIL-Simulator Required Interfaces: <ul style="list-style-type: none"> • Timing System Control Procedure: <ul style="list-style-type: none"> • Set "Requested Proton Beam Mode" Acceptance Criteria:

	<ul style="list-style-type: none"> • REQUESTED_PROTON_BEAM_MODE corresponds to "Requested Proton Beam Mode" <p>Remark:</p> <ul style="list-style-type: none"> • It is assumed that the Timing System can be controlled by the HIL-Simulator
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4.2.2.1.7 ESS Timing System Requested Proton Beam Mode

[#\[ISSUE:65167\]](#)

Requirement	ESS Timing System Requested Proton Beam Mode
Verification Technique	Test
Verification Idea	Covered by testing of related requirements <ul style="list-style-type: none"> • LPSID Proton Beam Mode State • LPSID Proton Beam Mode Errors

4.2.2.1.8 ESS Timing System Requested Proton Beam Mode Errors

[#\[ISSUE:65171\]](#)

Requirement	ESS Timing System Requested Proton Beam Mode Errors
Verification Technique	Test
Verification Idea	Control Timing System using HIL-Simulator Required Interfaces: <ul style="list-style-type: none"> • Timing System Control Procedure: <ul style="list-style-type: none"> • Set "Requested Proton Beam Mode" to erroneous states Acceptance Criteria: <ul style="list-style-type: none"> • REQUESTED_PROTON_BEAM_MODE is "None" Remark: <ul style="list-style-type: none"> • It is assumed that the Timing System can be controlled by the HIL-Simulator

4.2.2.1.9 ESS Timing System Requested Proton Beam Mode State

[#\[ISSUE:65169\]](#)

Requirement	ESS Timing System Requested Proton Beam Mode State
Verification Technique	Test
Verification Idea	Control Timing System using HIL-Simulator Required Interfaces: <ul style="list-style-type: none"> • Timing System Control Procedure: <ul style="list-style-type: none"> • Set "Requested Proton Beam Mode" to all possible states Acceptance Criteria: <ul style="list-style-type: none"> • REQUESTED_PROTON_BEAM_MODE corresponds to "Requested Proton Beam Mode" Remark: <ul style="list-style-type: none"> • It is assumed that the Timing System can be controlled by the HIL-Simulator

4.2.2.1.10 ESS Timing System Timestamp

[#\[ISSUE:63552\]](#)

Requirement	ESS Timing System Timestamp
Verification Technique	Test
Verification Idea	Covered by testing of related requirements <ul style="list-style-type: none"> • Timestamp

4.2.2.1.11 ESS Timing System Beam Pulse On Trigger

[#\[ISSUE:63553\]](#)

Requirement	ESS Timing System Beam Pulse On Trigger
Verification Technique	Test
Verification Idea	Covered by testing of related requirements <ul style="list-style-type: none"> • ESS Timing System Beam Pulse On Triggers

4.2.2.1.12 ESS Timing System Beam Pulse Off Trigger

[#\[ISSUE:63554\]](#)

Requirement	ESS Timing System Beam Pulse Off Trigger
Verification Technique	Test
Verification Idea	Covered by testing of related requirements <ul style="list-style-type: none"> • ESS Timing System Beam Pulse Off Triggers

4.2.2.2 LEBT Chopper Input Signals

4.2.2.2.1 LEBT Chopper Status Input

[#\[ISSUE:63534\]](#)

Requirement	LEBT Chopper Status Input
Verification Technique	Test
Verification Idea	Covered by testing of related requirements <ul style="list-style-type: none"> • LEBT Chopper Status State • LEBT Chopper Status Errors

4.2.2.2.2 LEBT Chopper Status

[#\[ISSUE:65119\]](#)

Requirement	LEBT Chopper Status
Verification Technique	Test
Verification Idea	Covered by testing of related requirements <ul style="list-style-type: none"> • LEBT Chopper Status State • LEBT Chopper Status Errors

4.2.2.2.3 LEBT Chopper Status State

[#\[ISSUE:64872\]](#)

Requirement	LEBT Chopper Status State
Verification Technique	Test
Verification Idea	Simulate LEBT Chopper using HIL-Simulator Preconditions: <ul style="list-style-type: none"> • n/a Required Interfaces: <ul style="list-style-type: none"> • Discrete Procedure: <ul style="list-style-type: none"> • Set "LC Status" to possible states

	Acceptance Criteria: <ul style="list-style-type: none"> • LC_STATUS corresponds to "LC Status"
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4.2.2.2.4 LEBT Chopper Status Errors

[#\[ISSUE:64873\]](#)

Requirement	LEBT Chopper Status Errors
Verification Technique	Test
Verification Idea	Simulate LEBT Chopper using HIL-Simulator Preconditions: <ul style="list-style-type: none"> • n/a Required Interfaces: <ul style="list-style-type: none"> • Discrete Procedure: <ul style="list-style-type: none"> • Set "LC Status" to invalid states Acceptance Criteria: <ul style="list-style-type: none"> • LC_STATUS corresponds to "not deflecting"

4.2.2.2.5 LEBT Chopper LPS Beam Permit Input

[#\[ISSUE:64874\]](#)

Requirement	LEBT Chopper LPS Beam Permit Input
Verification Technique	Test
Verification Idea	Covered by testing of related requirements <ul style="list-style-type: none"> • LEBT Chopper LPS Beam Permit State • LEBT Chopper LPS Beam Permit Errors

4.2.2.2.6 LEBT Chopper LPS Beam Permit

[#\[ISSUE:65120\]](#)

Requirement	LEBT Chopper LPS Beam Permit
Verification Technique	Test
Verification Idea	Covered by testing of related requirements <ul style="list-style-type: none"> • LEBT Chopper LPS Beam Permit State • LEBT Chopper LPS Beam Permit Errors

4.2.2.2.7 LEBT Chopper LPS Beam Permit State

[#\[ISSUE:64875\]](#)

Requirement	LEBT Chopper LPS Beam Permit State
Verification Technique	Test
Verification Idea	Simulate LEBT Chopper using HIL-Simulator Preconditions: <ul style="list-style-type: none"> • n/a Required Interfaces: <ul style="list-style-type: none"> • Discrete Procedure: <ul style="list-style-type: none"> • Set "LC LPS Beam Permit" to possible states Acceptance Criteria: <ul style="list-style-type: none"> • LC_LPS_BEAM_PERMIT corresponds to "LC LPS Beam Permit"

4.2.2.2.8 LEBT Chopper LPS Beam Permit Errors

[#\[ISSUE:64877\]](#)

Requirement	LEBT Chopper LPS Beam Permit Errors
Verification Technique	Test
Verification Idea	<p>Simulate LEBT Chopper using HIL-Simulator</p> <p>Preconditions:</p> <ul style="list-style-type: none"> • n/a <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Procedure:</p> <ul style="list-style-type: none"> • Set "LC LPS Beam Permit" to invalid states <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • LC_LPS_BEAM_PERMIT corresponds to "TBD"

4.2.2.2.9 LEBT Chopper Fast Alarm Input

[#\[ISSUE:65121\]](#)

Requirement	LEBT Chopper Fast Alarm Input
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirements</p> <ul style="list-style-type: none"> • LEBT Chopper Fast Alarm State • LEBT Chopper Fast Alarm Errors

4.2.2.2.10 LEBT Chopper Fast Alarm

[#\[ISSUE:65123\]](#)

Requirement	LEBT Chopper Fast Alarm
Verification Technique	
Verification Idea	<p>Covered by testing of related requirements</p> <ul style="list-style-type: none"> • LEBT Chopper Fast Alarm State • LEBT Chopper Fast Alarm Errors

4.2.2.2.11 LEBT Chopper Fast Alarm State

[#\[ISSUE:64878\]](#)

Requirement	LEBT Chopper Fast Alarm State
Verification Technique	Test
Verification Idea	<p>Simulate LEBT Chopper using HIL-Simulator</p> <p>Preconditions:</p> <ul style="list-style-type: none"> • n/a <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Procedure:</p> <ul style="list-style-type: none"> • TBD <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • LC_FAST_ALARM is "TBD"

4.2.2.2.12 LEBT Chopper Fast Alarm Errors

[#\[ISSUE:64879\]](#)

Requirement	LEBT Chopper Fast Alarm Errors
Verification Technique	Test
Verification Idea	<p>Simulate LEBT Chopper using HIL-Simulator</p> <p>Preconditions:</p> <ul style="list-style-type: none"> • n/a <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Procedure:</p> <ul style="list-style-type: none"> • TBD <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • LC_FAST_ALARM is "TBD"

4.2.2.3 MEBT Chopper Input Signals

4.2.2.3.1 MEBT Chopper Status Input

[#\[ISSUE:63569\]](#)

Requirement	MEBT Chopper Status Input
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirement</p> <ul style="list-style-type: none"> • MEBT Chopper Status State • MEBT Chopper Status Errors

4.2.2.3.2 MEBT Chopper Status

[#\[ISSUE:65124\]](#)

Requirement	MEBT Chopper Status
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirement</p> <ul style="list-style-type: none"> • MEBT Chopper Status State • MEBT Chopper Status Errors

4.2.2.3.3 MEBT Chopper Status State

[#\[ISSUE:64866\]](#)

Requirement	MEBT Chopper Status State
Verification Technique	Test
Verification Idea	<p>Simulate MEBT Chopper using HIL-Simulator</p> <p>Preconditions:</p> <ul style="list-style-type: none"> • n/a <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Procedure:</p> <ul style="list-style-type: none"> • Set "MC Status" to possible states <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • MC_STATUS is "TBD"

4.2.2.3.4 MEBT Chopper Status Errors

[#\[ISSUE:64869\]](#)

Requirement	MEBT Chopper Status Errors
Verification Technique	Test
Verification Idea	<p>Simulate LEBT Chopper using HIL-Simulator</p> <p>Preconditions:</p> <ul style="list-style-type: none"> • n/a <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Procedure:</p> <ul style="list-style-type: none"> • Set "MC Status" to invalid states <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • MC_STATUS corresponds to "not deflecting"

4.2.2.3.5 MEBT Chopper LPS Beam Permit Input

[#\[ISSUE:63567\]](#)

Requirement	MEBT Chopper LPS Beam Permit Input
Verification Technique	Test
Verification Idea	<p>Simulate MEBT Chopper using HIL-Simulator</p> <p>Preconditions:</p> <ul style="list-style-type: none"> • n/a <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Procedure:</p> <ul style="list-style-type: none"> • Set "MC LPS Beam Permit" to possible states <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • MC_LPS_BEAM_PERMIT corresponds to "MC LPS Beam Permit"

4.2.2.3.6 MEBT Chopper LPS Beam Permit

[#\[ISSUE:65054\]](#)

Requirement	MEBT Chopper LPS Beam Permit
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirement:</p> <ul style="list-style-type: none"> • MEBT Chopper LPS Beam Permit State

4.2.2.3.7 MEBT Chopper LPS Beam Permit State

[#\[ISSUE:64806\]](#)

Requirement	MEBT Chopper LPS Beam Permit State
Verification Technique	Test
Verification Idea	<p>Simulate MEBT Chopper using HIL-Simulator</p> <p>Preconditions:</p> <ul style="list-style-type: none"> • n/a <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Procedure:</p> <ul style="list-style-type: none"> • Set "MC LPS Beam Permit" to "TBD" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • MC_LPS_BEAM_PERMIT is "OK"

4.2.2.3.8 MEBT Chopper LPS Beam Permit Errors

[#\[ISSUE:64876\]](#)

Requirement	MEBT Chopper LPS Beam Permit Errors
Verification Technique	Test
Verification Idea	<p>Simulate MEBT Chopper using HIL-Simulator</p> <p>Preconditions:</p> <ul style="list-style-type: none"> • n/a <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Procedure:</p> <ul style="list-style-type: none"> • Set "MC LPS Beam Permit" to invalid states <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • MC_LPS_BEAM_PERMIT is "TBD"

4.2.2.3.9 MEBT Chopper Health Input

[#\[ISSUE:63568\]](#)

Requirement	MEBT Chopper Health Input
Verification Technique	Test
Verification Idea	<p>Simulate MEBT Chopper using HIL-Simulator</p> <p>Preconditions:</p> <ul style="list-style-type: none"> • n/a <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Procedure:</p> <ul style="list-style-type: none"> • Set "MC Health" to possible states <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • MC_HEALTH corresponds to "MC Health"

4.2.2.3.10 MEBT Chopper Health

[#\[ISSUE:65125\]](#)

Requirement	MEBT Chopper Health
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirements</p> <ul style="list-style-type: none"> • MEBT Chopper Health State • MEBT Chopper Health Errors

4.2.2.3.11 MEBT Chopper Health State

[#\[ISSUE:64808\]](#)

Requirement	MEBT Chopper Health State
Verification Technique	Test
Verification Idea	<p>Simulate MEBT Chopper using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> • n/a <p>Procedure:</p> <ul style="list-style-type: none"> • Set "MC Health" to "TBD" <p>Acceptance Criteria:</p>

	<ul style="list-style-type: none"> MC_HEALTH is "TBD"
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4.2.2.3.12 MEBT Chopper Health Errors

[#\[ISSUE:64809\]](#)

Requirement	MEBT Chopper Health Errors
Verification Technique	Test
Verification Idea	Simulate MEBT Chopper using HIL-Simulator Required Interfaces: <ul style="list-style-type: none"> Discrete Preconditions: <ul style="list-style-type: none"> n/a Procedure: <ul style="list-style-type: none"> Set "MC Health" to invalid states Acceptance Criteria: <ul style="list-style-type: none"> MC_HEALTH is "TBD"

4.2.2.4 Ion Source Input Signals

4.2.2.4.1 Ion Source Status Input

[#\[ISSUE:63599\]](#)

Requirement	Ion Source Status Input
Verification Technique	Test
Verification Idea	Covered by testing of related requirements <ul style="list-style-type: none"> Ion Source Status Ion Source Status State

4.2.2.4.2 Ion Source Status

[#\[ISSUE:65126\]](#)

Requirement	Ion Source Status
Verification Technique	Test
Verification Idea	Covered by testing of related requirement <ul style="list-style-type: none"> Ion Source Status State

4.2.2.4.3 Ion Source Status State

[#\[ISSUE:65127\]](#)

Requirement	Ion Source Status State
Verification Technique	Test
Verification Idea	Simulate Ion Source using HIL-Simulator Preconditions: <ul style="list-style-type: none"> n/a Required Interfaces: <ul style="list-style-type: none"> Discrete Procedure: <ul style="list-style-type: none"> Set "TBD" to "TBD" Acceptance Criteria: <ul style="list-style-type: none"> IS_STATUS is "TBD"

4.2.3 Latching of Erroneous Input Signals

[#\[ISSUE:63589\]](#)

Requirement	Latching of Erroneous Input Signals
Verification Technique	Demonstration
Verification Idea	<p>Simulation of erroneous input signals using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Selected Input Signals Control System <p>Procedure:</p> <ul style="list-style-type: none"> Simulate input signals using definitions in IDD <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> Error states are latched

4.2.4 Input Signal Control System Readout

[#\[ISSUE:62890\]](#)

Requirement	Input Signal Control System Readout
Verification Technique	Inspection
Verification Idea	<p>Inspection of Control System Input Signal Values</p> <p>Preconditions:</p> <ul style="list-style-type: none"> FBIS is integrated with Control System Input Signal tests passed <p>Required Interfaces:</p> <ul style="list-style-type: none"> Control System Interface <p>Procedure:</p> <ul style="list-style-type: none"> Simulate input signals using HIL-Simulator Inspect Control System values for input signals <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> Control System values for input signals corresponds to input signals

4.2.5 Logging of Erroneous Input Signals

[#\[ISSUE:63590\]](#)

Requirement	Logging of Erroneous Input Signals
Verification Technique	Demonstration
Verification Idea	<p>Simulation of erroneous input signals using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Input Signals as defined in increment Logging <p>Procedure:</p> <ul style="list-style-type: none"> Simulate valid and invalid input signals using definitions in IDD <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> Error states for erroneous input signals are logged

4.2.6 Logging of Input Signal State Changes

[#\[ISSUE:64027\]](#)

Requirement	Logging of Input Signal State Changes
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Verification Technique	Demonstration
Verification Idea	Simulation of state changes of input signals using HIL-Simulator Required Interfaces: <ul style="list-style-type: none"> • Input Signals as defined in increment • Logging Procedure: <ul style="list-style-type: none"> • Simulate state changes of input signals Acceptance Criteria: <ul style="list-style-type: none"> • State changes for input signals are logged

4.2.7 Variables Control System Readout

[#\[ISSUE:64028\]](#)

Requirement	Variables Control System Readout
Verification Technique	Inspection
Verification Idea	Inspection of Control System Decision Logic Variables Preconditions: <ul style="list-style-type: none"> • FBIS is integrated with Control System Required Interfaces: <ul style="list-style-type: none"> • Control System Interface Procedure: <ul style="list-style-type: none"> • Simulate states of decision logic variables • Inspect Control System states for decision logic variables Acceptance Criteria: <ul style="list-style-type: none"> • Control System states for decision logic variables corresponds to decision logic variables

4.2.8 Logging of Variables State Changes

[#\[ISSUE:64029\]](#)

Requirement	Logging of Variables State Changes
Verification Technique	Demonstration
Verification Idea	Simulation of state changes of decision logic variables using HIL-Simulator Required Interfaces: <ul style="list-style-type: none"> • Decision Logic Variables as defined in increment • Logging Procedure: <ul style="list-style-type: none"> • Simulate state changes of decision logic variables Acceptance Criteria: <ul style="list-style-type: none"> • State changes for decision logic variables are logged

4.2.9 Masking

4.2.9.1 Generic Masking Requirements

4.2.9.1.1 Masking Feature (OK/NOK Signals)

[#\[ISSUE:63016\]](#)

Requirement	Masking Feature (OK/NOK Signals)
Verification Technique	Demonstration
Verification Idea	Demonstrate Masking Feature

	<p>Required Interfaces:</p> <ul style="list-style-type: none"> Control System Interface <p>Preconditions:</p> <ul style="list-style-type: none"> Masking of all inputs is set to "No Masking" <p>Procedure:</p> <ul style="list-style-type: none"> a) Use Control System Interface to set "Mask to OK" b) Use Control System Interface to set "Mask to NOK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> a) Masking is set to "Mask to NOK" for signal inputs where masking criteria have been met b) Masking is set to "Mask to OK" for signal inputs where masking criteria have been met c) Masking is set to "No Masking" when masking criteria have not been met
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4.2.9.1.2 Masking Feature (Beam Destination)

[#\[ISSUE:63715\]](#)

Requirement	Masking Feature (Beam Destination)
Verification Technique	Demonstration
Verification Idea	<p>Demonstrate Masking Feature</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Control System Interface <p>Preconditions:</p> <ul style="list-style-type: none"> Masking of all inputs is set to "No Masking" <p>Procedure:</p> <ul style="list-style-type: none"> a) Use Control System Interface to set "Mask to OK" b) Use Control System Interface to set "Mask to NOK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> a) Masking is set to "Mask to NOK" for signal inputs where masking criteria have been met b) Masking is set to "Mask to OK" for signal inputs where masking criteria have been met c) Masking is set to "No Masking" when masking criteria have not been met

4.2.9.1.3 Masking Feature (Proton Beam Modes)

[#\[ISSUE:63718\]](#)

Requirement	Masking Feature (Proton Beam Modes)
Verification Technique	Demonstration
Verification Idea	<p>Demonstrate Masking Feature</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Control System Interface <p>Preconditions:</p> <ul style="list-style-type: none"> Masking of all inputs is set to "No Masking" <p>Procedure:</p> <ul style="list-style-type: none"> a) Use Control System Interface to set "Mask to OK" b) Use Control System Interface to set "Mask to NOK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> a) Masking is set to "Mask to NOK" for signal inputs where masking criteria have been met b) Masking is set to "Mask to OK" for signal inputs where masking criteria have been met c) Masking is set to "No Masking" when masking criteria have not been met

4.2.9.1.4 Default Masking

[#\[ISSUE:62925\]](#)

Requirement	Default Masking
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Verification Technique	Demonstration
Verification Idea	<p>Demonstrate Masking Feature</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Control System Interface <p>Preconditions:</p> <ul style="list-style-type: none"> Masking of all inputs is set to "No Masking" <p>Procedure:</p> <ul style="list-style-type: none"> a) Use Control System Interface to set "Mask to OK" b) Use Control System Interface to set "Mask to NOK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> a) Masking is set to "Mask to NOK" for signal inputs where masking criteria have been met b) Masking is set to "Mask to OK" for signal inputs where masking criteria have been met c) Masking is set to "No Masking" when masking criteria have not been met

4.2.9.1.5 Control System Masking Readout

[#\[ISSUE:62926\]](#)

Requirement	Control System Masking Readout
Verification Technique	Inspection
Verification Idea	<p>Inspect Mask Settings via Control System</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Control System Interface Logging <p>Preconditions:</p> <ul style="list-style-type: none"> Masking Feature (OK/NOK Signals) Masking Feature (Beam Destination) Masking Feature (Proton Beam Modes) Default Masking <p>Procedure:</p> <ul style="list-style-type: none"> Inspect Mask settings via Control System <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> Mask setting values shown via Control System Interface corresponds to logged mask settings

4.2.9.1.6 Logging of Masking Changes

[#\[ISSUE:62927\]](#)

Requirement	Logging of Masking Changes
Verification Technique	Inspection
Verification Idea	<p>Inspect Mask Settings via Control System</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Control System Interface Logging <p>Preconditions:</p> <ul style="list-style-type: none"> Masking Feature (OK/NOK Signals) Masking Feature (Beam Destination) Masking Feature (Proton Beam Modes) Default Masking <p>Procedure:</p> <ul style="list-style-type: none"> Inspect Mask settings Inspect Mask Settings via Control System <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> Mask setting values shown via Control System Interface corresponds to logged mask settings

4.2.9.1.7 Clear Mask

[#\[ISSUE:63194\]](#)

Requirement	Clear Mask
Verification Technique	Demonstration
Verification Idea	<p>Demonstrate Masking Feature</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Control System Interface <p>Preconditions:</p> <ul style="list-style-type: none"> Masking of all inputs is set to "No Masking" <p>Procedure:</p> <ul style="list-style-type: none"> a) Use Control System Interface to set "Mask to OK" b) Use Control System Interface to set "Mask to NOK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> a) Masking is set to "Mask to NOK" for signal inputs where masking criteria have been met b) Masking is set to "Mask to OK" for signal inputs where masking criteria have been met c) Masking is set to "No Masking" when masking criteria have not been met

4.2.9.1.8 Masking of Redundant Signals

[#\[ISSUE:63189\]](#)

Requirement	Masking of Redundant Signals
Verification Technique	Demonstration
Verification Idea	<p>Demonstrate Masking Feature</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Control System Interface <p>Preconditions:</p> <ul style="list-style-type: none"> Masking of all inputs is set to "No Masking" <p>Procedure:</p> <ul style="list-style-type: none"> a) Use Control System Interface to set "Mask to OK" b) Use Control System Interface to set "Mask to NOK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> a) Masking is set to "Mask to NOK" for signal inputs where masking criteria have been met b) Masking is set to "Mask to OK" for signal inputs where masking criteria have been met c) Masking is set to "No Masking" when masking criteria have not been met

4.2.9.2 Masking Conditions

4.2.9.2.1 Masking of Sensor System Input Signals

4.2.9.2.1.1 Mask to NOK

[#\[ISSUE:63192\]](#)

Requirement	Mask to NOK
Verification Technique	Demonstration
Verification Idea	<p>Covered by demonstration for</p> <ul style="list-style-type: none"> Masking Feature (OK/NOK Signals) Masking Feature (Beam Destination) Masking Feature (Proton Beam Modes) Clear Mask Masking of Redundant Signals

4.2.9.2.1.2 LPSID Beam Permit Mask to OK

[#\[ISSUE:62929\]](#)

Requirement	LPSID Beam Permit Mask to OK
Verification Technique	Demonstration
Verification Idea	Covered by demonstration for <ul style="list-style-type: none"> • Masking Feature (OK/NOK Signals) • Masking Feature (Beam Destination) • Masking Feature (Proton Beam Modes) • Clear Mask • Masking of Redundant Signals

4.2.9.2.1.3 LPSVAC Beam Permit Mask to OK

[#\[ISSUE:63658\]](#)

Requirement	LPSVAC Beam Permit Mask to OK
Verification Technique	Demonstration
Verification Idea	Covered by demonstration for <ul style="list-style-type: none"> • Masking Feature (OK/NOK Signals) • Masking Feature (Beam Destination) • Masking Feature (Proton Beam Modes) • Clear Mask • Masking of Redundant Signals

4.2.9.2.1.4 LPSVAC Proton Beam Destination Masking

[#\[ISSUE:63720\]](#)

Requirement	LPSVAC Proton Beam Destination Masking
Verification Technique	Demonstration
Verification Idea	Covered by demonstration for <ul style="list-style-type: none"> • Masking Feature (OK/NOK Signals) • Masking Feature (Beam Destination) • Masking Feature (Proton Beam Modes) • Clear Mask • Masking of Redundant Signals

4.2.9.2.1.5 LPSVAC Proton Beam Mode Masking

[#\[ISSUE:63721\]](#)

Requirement	LPSVAC Proton Beam Mode Masking
Verification Technique	Demonstration
Verification Idea	Covered by demonstration for <ul style="list-style-type: none"> • Masking Feature (OK/NOK Signals) • Masking Feature (Beam Destination) • Masking Feature (Proton Beam Modes) • Clear Mask • Masking of Redundant Signals

4.2.9.2.1.6 LPSMAG Beam Permit Mask to OK

[#\[ISSUE:63824\]](#)

Requirement	LPSMAG Beam Permit Mask to OK
Verification Technique	Demonstration
Verification Idea	Covered by demonstration for <ul style="list-style-type: none"> • Masking Feature (OK/NOK Signals) • Masking Feature (Beam Destination) • Masking Feature (Proton Beam Modes) • Clear Mask • Masking of Redundant Signals

4.2.9.2.1.7 LPSMAG Proton Beam Destination Masking

[#\[ISSUE:63825\]](#)

Requirement	LPSMAG Proton Beam Destination Masking
Verification Technique	Demonstration
Verification Idea	Covered by demonstration for <ul style="list-style-type: none"> • Masking Feature (OK/NOK Signals) • Masking Feature (Beam Destination) • Masking Feature (Proton Beam Modes) • Clear Mask • Masking of Redundant Signals

4.2.9.2.1.8 LPSMAG Proton Beam Mode Masking

[#\[ISSUE:63826\]](#)

Requirement	LPSMAG Proton Beam Mode Masking
Verification Technique	Demonstration
Verification Idea	Covered by demonstration for <ul style="list-style-type: none"> • Masking Feature (OK/NOK Signals) • Masking Feature (Beam Destination) • Masking Feature (Proton Beam Modes) • Clear Mask • Masking of Redundant Signals

4.2.9.2.1.9 ACCTx Beam Permit Mask to OK

[#\[ISSUE:63656\]](#)

Requirement	ACCTx Beam Permit Mask to OK
Verification Technique	Demonstration
Verification Idea	Covered by demonstration for <ul style="list-style-type: none"> • Masking Feature (OK/NOK Signals) • Masking Feature (Beam Destination) • Masking Feature (Proton Beam Modes) • Clear Mask • Masking of Redundant Signals

4.2.9.2.1.10 ACCTx Proton Beam Destination Masking

[#\[ISSUE:63659\]](#)

Requirement	ACCTx Proton Beam Destination Masking
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Verification Technique	Demonstration
Verification Idea	Covered by demonstration for <ul style="list-style-type: none"> • Masking Feature (OK/NOK Signals) • Masking Feature (Beam Destination) • Masking Feature (Proton Beam Modes) • Clear Mask • Masking of Redundant Signals

4.2.9.2.1.11 ACCTx Proton Beam Mode Masking

[#\[ISSUE:63719\]](#)

Requirement	ACCTx Proton Beam Mode Masking
Verification Technique	Demonstration
Verification Idea	Covered by demonstration for <ul style="list-style-type: none"> • Masking Feature (OK/NOK Signals) • Masking Feature (Beam Destination) • Masking Feature (Proton Beam Modes) • Clear Mask • Masking of Redundant Signals

4.2.9.2.1.12 ACCTx No Beam Mask to OK

[#\[ISSUE:63660\]](#)

Requirement	ACCTx No Beam Mask to OK
Verification Technique	Demonstration
Verification Idea	Covered by demonstration for <ul style="list-style-type: none"> • Masking Feature (OK/NOK Signals) • Masking Feature (Beam Destination) • Masking Feature (Proton Beam Modes) • Clear Mask • Masking of Redundant Signals

4.2.9.2.1.13 RF-FIMx Beam Permit Mask to OK

[#\[ISSUE:63831\]](#)

Requirement	RF-FIMx Beam Permit Mask to OK
Verification Technique	Demonstration
Verification Idea	Covered by demonstration for <ul style="list-style-type: none"> • Masking Feature (OK/NOK Signals) • Masking Feature (Beam Destination) • Masking Feature (Proton Beam Modes) • Clear Mask • Masking of Redundant Signals

4.2.9.2.2 Masking of Actuation System Input Signal Reading

4.2.9.2.2.1 MEBT Chopper Controller Health Mask to OK

[#\[ISSUE:63537\]](#)

Requirement	MEBT Chopper Controller Health Mask to OK
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Verification Technique	Demonstration
Verification Idea	Covered by demonstration for <ul style="list-style-type: none"> • Masking Feature (OK/NOK Signals) • Masking Feature (Beam Destination) • Masking Feature (Proton Beam Modes) • Clear Mask • Masking of Redundant Signals

4.2.9.2.2.2 LEBT Chopper LPS Beam Permit Mask to OK

[#\[ISSUE:63536\]](#)

Requirement	LEBT Chopper LPS Beam Permit Mask to OK
Verification Technique	Demonstration
Verification Idea	Covered by demonstration for <ul style="list-style-type: none"> • Masking Feature (OK/NOK Signals) • Masking Feature (Beam Destination) • Masking Feature (Proton Beam Modes) • Clear Mask • Masking of Redundant Signals

4.3 Decision Logic Computation

4.3.1 State Evaluation

4.3.1.1 Beam Permit States Evaluation

4.3.1.1.1 LPSID Beam Permit Evaluation

[#\[ISSUE:62932\]](#)

Requirement	LPSID Beam Permit Evaluation
Verification Technique	Test
Verification Idea	Simulate LPSID using HIL-Simulator Required Interfaces: <ul style="list-style-type: none"> • Discrete Preconditions: <ul style="list-style-type: none"> • LPSID_BEAM_PERMIT is "OK" • Input is configured to "No Masking" Procedure: <ul style="list-style-type: none"> • Set LPSID_BEAM_PERMIT to "NOK" Acceptance Criteria: <ul style="list-style-type: none"> • GLOBAL_BEAM_PERMIT_k is set to "NOK" • GLOBAL_BEAM_PERMIT is set to "NOK"

4.3.1.1.2 LPSVAC Beam Permit Evaluation

[#\[ISSUE:63722\]](#)

Requirement	LPSVAC Beam Permit Evaluation
Verification Technique	Test
Verification Idea	Simulate LPSVAC using HIL-Simulator Required Interfaces:

	<ul style="list-style-type: none"> • Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> • LPSID_BEAM_PERMIT is "OK" • Input is configured to "No Masking" <p>Procedure:</p> <ul style="list-style-type: none"> • Set LPSVAC_BEAM_PERMIT to "NOK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • GLOBAL_BEAM_PERMIT_k is set to "NOK" • GLOBAL_BEAM_PERMIT is set to "NOK"
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4.3.1.1.3 LPSMAG Beam Permit Evaluation

[#\[ISSUE:63827\]](#)

Requirement	LPSMAG Beam Permit Evaluation
Verification Technique	Test
Verification Idea	<p>Simulate LPSMAG using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> • Input is configured to "No Masking" <p>Procedure:</p> <ul style="list-style-type: none"> • Set LPSMAG_BEAM_PERMIT to "OK" • Set LPSMAG_BEAM_PERMIT to "NOK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • GLOBAL_BEAM_PERMIT_k is set to "OK" • GLOBAL_BEAM_PERMIT_k is set to "NOK"

4.3.1.1.4 ACCT_1 Beam Permit Evaluation

[#\[ISSUE:63197\]](#)

Requirement	ACCT_1 Beam Permit Evaluation
Verification Technique	Test
Verification Idea	<p>Simulate ACCT_1_BEAM_PERMIT using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> • ACCT_1_BEAM_PERMIT is "OK" • Input is configured to "No Masking" <p>Procedure:</p> <ul style="list-style-type: none"> • Set ACCT_1_BEAM_PERMIT to "NOK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • GLOBAL_BEAM_PERMIT_k is set to "NOK" • GLOBAL_BEAM_PERMIT is set to "NOK"

4.3.1.1.5 ACCT_2 Beam Permit Evaluation

[#\[ISSUE:63622\]](#)

Requirement	ACCT_2 Beam Permit Evaluation
Verification Technique	Test
Verification Idea	<p>Simulate ACCT_2_BEAM_PERMIT using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete

	<p>Preconditions:</p> <ul style="list-style-type: none"> • Input is configured to "No Masking" <p>Procedure:</p> <ul style="list-style-type: none"> • For each proton beam destination do: • Reset • Set ACCT_2_BEAM_PERMIT to "OK" • Wait • Set ENFORCED_PROTON_BEAM_DESTINATION to new proton beam destination • Set ACCT_2_BEAM_PERMIT to "NOK" • Reset • Loop <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • GLOBAL_BEAM_PERMIT_k is set according table.
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4.3.1.1.6 ACCT_3 Beam Permit Evaluation

[#\[ISSUE:63623\]](#)

Requirement	ACCT_3 Beam Permit Evaluation
Verification Technique	Test
Verification Idea	<p>Simulate ACCT_3_BEAM_PERMIT using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> • Input is configured to "No Masking" <p>Procedure:</p> <ul style="list-style-type: none"> • For each proton beam destination do: • Reset • Set ACCT_3_BEAM_PERMIT to "OK" • Wait • Set ENFORCED_PROTON_BEAM_DESTINATION to new proton beam destination • Set ACCT_3_BEAM_PERMIT to "NOK" • Reset • Loop <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • GLOBAL_BEAM_PERMIT_k is set according table.

4.3.1.1.7 ACCT_4 Beam Permit Evaluation

[#\[ISSUE:63624\]](#)

Requirement	ACCT_4 Beam Permit Evaluation
Verification Technique	Test
Verification Idea	<p>Simulate ACCT_4_BEAM_PERMIT using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> • Input is configured to "No Masking" <p>Procedure:</p> <ul style="list-style-type: none"> • For each proton beam destination do: • Reset • Set ACCT_4_BEAM_PERMIT to "OK" • Wait • Set ENFORCED_PROTON_BEAM_DESTINATION to new proton beam destination • Set ACCT_4_BEAM_PERMIT to "NOK" • Reset

	<ul style="list-style-type: none"> • Loop <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • GLOBAL_BEAM_PERMIT_k is set according table.
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4.3.1.1.8 ACCT_5 Beam Permit Evaluation

[#\[ISSUE:63625\]](#)

Requirement	ACCT_5 Beam Permit Evaluation
Verification Technique	Test
Verification Idea	<p>Simulate ACCT_5_BEAM_PERMIT using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> • Input is configured to "No Masking" <p>Procedure:</p> <ul style="list-style-type: none"> • For each proton beam destination do: • Reset • Set ACCT_5_BEAM_PERMIT to "OK" • Wait • Set ENFORCED_PROTON_BEAM_DESTINATION to new proton beam destination • Set ACCT_5_BEAM_PERMIT to "NOK" • Reset • Loop <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • GLOBAL_BEAM_PERMIT_k is set according table.

4.3.1.1.9 ACCT_6 Beam Permit Evaluation

[#\[ISSUE:63626\]](#)

Requirement	ACCT_6 Beam Permit Evaluation
Verification Technique	Test
Verification Idea	<p>Simulate ACCT_6_BEAM_PERMIT using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> • Input is configured to "No Masking" <p>Procedure:</p> <ul style="list-style-type: none"> • For each proton beam destination do: • Reset • Set ACCT_6_BEAM_PERMIT to "OK" • Wait • Set ENFORCED_PROTON_BEAM_DESTINATION to new proton beam destination • Set ACCT_6_BEAM_PERMIT to "NOK" • Reset • Loop <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • GLOBAL_BEAM_PERMIT_k is set according table.

4.3.1.1.10 ACCT_7 Beam Permit Evaluation

[#\[ISSUE:63627\]](#)

Requirement	ACCT_7 Beam Permit Evaluation
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Verification Technique	Test
Verification Idea	<p>Simulate ACCT_7_BEAM_PERMIT using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> Input is configured to "No Masking" <p>Procedure:</p> <ul style="list-style-type: none"> For each proton beam destination do: Reset Set ACCT_7_BEAM_PERMIT to "OK" Wait Set ENFORCED_PROTON_BEAM_DESTINATION to new proton beam destination Set ACCT_7_BEAM_PERMIT to "NOK" Reset Loop <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> GLOBAL_BEAM_PERMIT_k is set according table.

4.3.1.1.11 MEBT Chopper LPS Beam Permit Evaluation

[#\[ISSUE:63611\]](#)

Requirement	MEBT Chopper LPS Beam Permit Evaluation
Verification Technique	Test
Verification Idea	<p>Simulate MC_LPS_BEAM_PERMIT using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> Input is configured to "No Masking" <p>Procedure:</p> <ul style="list-style-type: none"> For each proton beam destination do: Reset Set MC_LPS_BEAM_PERMIT to "OK" Wait Set ENFORCED_PROTON_BEAM_DESTINATION to new proton beam destination Set MC_LPS_BEAM_PERMIT to "NOK" Reset Loop <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> GLOBAL_BEAM_PERMIT_k is set according table.

4.3.1.1.12 MEBT Chopper Health Evaluation

[#\[ISSUE:63818\]](#)

Requirement	MEBT Chopper Health Evaluation
Verification Technique	Test
Verification Idea	<p>Simulate MEBT Chopper using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> Input is configured to "No Masking" <p>Procedure:</p> <ul style="list-style-type: none"> For each proton beam destination do: Reset

	<ul style="list-style-type: none"> • Set MC_HEALTH to "OK" • Wait • Set ENFORCED_PROTON_BEAM_DESTINATION to new proton beam destination • Set MC_HEALTH to "NOK" • Reset • Loop <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • GLOBAL_BEAM_PERMIT_k is set according table.
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4.3.1.1.13 RF-FIM_1..4 Beam Permit Evaluation

[#\[ISSUE:63837\]](#)

Requirement	RF-FIM_1..4 Beam Permit Evaluation
Verification Technique	Test
Verification Idea	<p>Simulate RF-FIM_x_BEAM_PERMIT using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> • Input is configured to "No Masking" <p>Procedure:</p> <ul style="list-style-type: none"> • For x = 1..4 • For each proton beam destination do: • Reset • Set RF-FIM_x_BEAM_PERMIT to "OK" • Wait • Set ENFORCED_PROTON_BEAM_DESTINATION to new proton beam destination • Set RF-FIM_x_BEAM_PERMIT to "NOK" • Reset • Next • Next <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • GLOBAL_BEAM_PERMIT_k is set according table.

4.3.1.1.14 RF-FIM_5..9 Beam Permit Evaluation

[#\[ISSUE:63838\]](#)

Requirement	RF-FIM_5..9 Beam Permit Evaluation
Verification Technique	Test
Verification Idea	<p>Simulate RF-FIM_x_BEAM_PERMIT using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> • Input is configured to "No Masking" <p>Procedure:</p> <ul style="list-style-type: none"> • For x = 5..9 • For each proton beam destination do: • Reset • Set RF-FIM_x_BEAM_PERMIT to "OK" • Wait • Set ENFORCED_PROTON_BEAM_DESTINATION to new proton beam destination • Set RF-FIM_x_BEAM_PERMIT to "NOK" • Reset • Next • Next

	Acceptance Criteria: <ul style="list-style-type: none"> GLOBAL_BEAM_PERMIT_k is set according table.
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4.3.1.1.15 RF-FIM10..35 Beam Permit Evaluation

[#\[ISSUE:63843\]](#)

Requirement	RF-FIM10..35 Beam Permit Evaluation
Verification Technique	Test
Verification Idea	Simulate RF-FIM_x_BEAM_PERMIT using HIL-Simulator Required Interfaces: <ul style="list-style-type: none"> Discrete Preconditions: <ul style="list-style-type: none"> Input is configured to "No Masking" Procedure: <ul style="list-style-type: none"> For x = 10..35 For each proton beam destination do: <ul style="list-style-type: none"> Reset Set RF-FIM_x_BEAM_PERMIT to "OK" Wait Set ENFORCED_PROTON_BEAM_DESTINATION to new proton beam destination Set RF-FIM_x_BEAM_PERMIT to "NOK" Reset Next Next Acceptance Criteria: <ul style="list-style-type: none"> GLOBAL_BEAM_PERMIT_k is set according table.

4.3.1.1.16 RF-FIM36..71 Beam Permit Evaluation

[#\[ISSUE:63845\]](#)

Requirement	RF-FIM36..71 Beam Permit Evaluation
Verification Technique	Test
Verification Idea	Simulate RF-FIM_x_BEAM_PERMIT using HIL-Simulator Required Interfaces: <ul style="list-style-type: none"> Discrete Preconditions: <ul style="list-style-type: none"> Input is configured to "No Masking" Procedure: <ul style="list-style-type: none"> For x = 36..71 For each proton beam destination do: <ul style="list-style-type: none"> Reset Set RF-FIM_x_BEAM_PERMIT to "OK" Wait Set ENFORCED_PROTON_BEAM_DESTINATION to new proton beam destination Set RF-FIM_x_BEAM_PERMIT to "NOK" Reset Next Next Acceptance Criteria: <ul style="list-style-type: none"> GLOBAL_BEAM_PERMIT_k is set according table.

4.3.1.1.17 RF-FIM72..155 Beam Permit Evaluation

[#\[ISSUE:63844\]](#)

Requirement	RF-FIM72..155 Beam Permit Evaluation
Verification Technique	Test
Verification Idea	<p>Simulate RF-FIM_x_BEAM_PERMIT using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> Input is configured to "No Masking" <p>Procedure:</p> <ul style="list-style-type: none"> For x = 36..72 For each proton beam destination do: Reset Set RF-FIM_x_BEAM_PERMIT to "OK" Wait Set ENFORCED_PROTON_BEAM_DESTINATION to new proton beam destination Set RF-FIM_x_BEAM_PERMIT to "NOK" Reset Next Next <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> GLOBAL_BEAM_PERMIT_k is set according table.

4.3.1.1.18 Fast Gate Valve SPK Beam Permit Evaluation

[#\[ISSUE:63851\]](#)

Requirement	Fast Gate Valve SPK Beam Permit Evaluation
Verification Technique	Test
Verification Idea	<p>Simulate FGV_SPK_BEAM_PERMIT using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> Input is configured to "No Masking" <p>Procedure:</p> <ul style="list-style-type: none"> For each proton beam destination do: Reset Set FGV_SPK_BEAM_PERMIT to "OK" Wait Set ENFORCED_PROTON_BEAM_DESTINATION to new proton beam destination Set FGV_SPK_BEAM_PERMIT to "NOK" Reset Next Next <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> GLOBAL_BEAM_PERMIT_k is set according table.

4.3.1.1.19 Fast Gate Valve HEBT Beam Permit Evaluation

[#\[ISSUE:63852\]](#)

Requirement	Fast Gate Valve HEBT Beam Permit Evaluation
Verification Technique	Test
Verification Idea	<p>Simulate FGV_HEBT_BEAM_PERMIT using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> Input is configured to "No Masking"

	<p>Procedure:</p> <ul style="list-style-type: none"> • For each proton beam destination do: • Reset • Set FGV_HEBT_BEAM_PERMIT to "OK" • Wait • Set ENFORCED_PROTON_BEAM_DESTINATION to new proton beam destination • Set FGV_HEBT_BEAM_PERMIT to "NOK" • Reset • Next <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • GLOBAL_BEAM_PERMIT_k is set according table.
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4.3.1.1.20 Fast Gate Valve DMPL Beam Permit Evaluation

[#\[ISSUE:63853\]](#)

Requirement	Fast Gate Valve DMPL Beam Permit Evaluation
Verification Technique	Test
Verification Idea	<p>Simulate FGV_DMPL_BEAM_PERMIT using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> • Input is configured to "No Masking" <p>Procedure:</p> <ul style="list-style-type: none"> • For each proton beam destination do: • Reset • Set FGV_DMPL_BEAM_PERMIT to "OK" • Wait • Set ENFORCED_PROTON_BEAM_DESTINATION to new proton beam destination • Set FGV_DMPL_BEAM_PERMIT to "NOK" • Reset • Next <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • GLOBAL_BEAM_PERMIT_k is set according table.

4.3.1.2 No Beam States Evaluation

4.3.1.2.1 Beam Inhibit No Beam Supervision

[#\[ISSUE:62937\]](#)

Requirement	Beam Inhibit No Beam Supervision
Verification Technique	Test
Verification Idea	<p>Simulate Beam Presence using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> • ACCT1_NO_BEAM is "OK" <p>Procedure:</p> <ul style="list-style-type: none"> • Set GLOBAL_BEAM_PERMIT to "NOK" • Set ACCT1_NO_BEAM to "NOK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • REGULAR_BEAM_INTERLOCK_k is set to "NOK"

4.3.1.2.2 Regular Beam Interlock No Beam Supervision

[#\[ISSUE:62993\]](#)

Requirement	Regular Beam Interlock No Beam Supervision
Verification Technique	Test
Verification Idea	<p>Simulate Beam Presence using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> ACCT1_NO_BEAM is "OK" <p>Procedure:</p> <ul style="list-style-type: none"> Set REGULAR_BEAM_INTERLOCK to "NOK" Set ACCT1_NO_BEAM to "NOK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> EMERGENCY_BEAM_INTERLOCK_k is set to "NOK"

4.3.1.2.3 LEBT Beam Destination No Beam Supervision

[#\[ISSUE:62938\]](#)

Requirement	LEBT Beam Destination No Beam Supervision
Verification Technique	Test
Verification Idea	<p>Simulate Beam Presence using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> ENFORCED_PROTON_BEAM_DESTINATION is "MEBT" ACCT1_NO_BEAM is "OK" <p>Procedure:</p> <ul style="list-style-type: none"> Set ENFORCED_PROTON_BEAM_DESTINATION to "LEBT" Set ACCT1_NO_BEAM to "NOK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> REGULAR_BEAM_INTERLOCK_k is set to "NOK"

4.3.1.2.4 MEBT Beam Destination No Beam Supervision

[#\[ISSUE:63673\]](#)

Requirement	MEBT Beam Destination No Beam Supervision
Verification Technique	Test
Verification Idea	<p>Simulate Beam Presence using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> ENFORCED_PROTON_BEAM_DESTINATION is "LEBT" ACCT1_NO_BEAM is "OK" <p>Procedure:</p> <ul style="list-style-type: none"> Set ENFORCED_PROTON_BEAM_DESTINATION to "MEBT" Set ACCT1_NO_BEAM to "NOK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> REGULAR_BEAM_INTERLOCK_k is set to "NOK"

4.3.1.2.5 DTL1 Beam Destination No Beam Supervision

[#\[ISSUE:63672\]](#)

Requirement	DTL1 Beam Destination No Beam Supervision
Verification Technique	Test
Verification Idea	<p>Simulate Beam Presence using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> ENFORCED_PROTON_BEAM_DESTINATION is "LEBT" ACCT1_NO_BEAM is "OK" <p>Procedure:</p> <ul style="list-style-type: none"> Set ENFORCED_PROTON_BEAM_DESTINATION to "DTL1" Set ACCT1_NO_BEAM to "NOK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> REGULAR_BEAM_INTERLOCK_k is set to "NOK"

4.3.1.2.6 DTL2 Beam Destination No Beam Supervision

[#\[ISSUE:63674\]](#)

Requirement	DTL2 Beam Destination No Beam Supervision
Verification Technique	Test
Verification Idea	<p>Simulate Beam Presence using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> ENFORCED_PROTON_BEAM_DESTINATION is "MEBT" ACCT2_NO_BEAM is "OK" <p>Procedure:</p> <ul style="list-style-type: none"> Set ENFORCED_PROTON_BEAM_DESTINATION to "DTL2" Set ACCT2_NO_BEAM to "NOK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> REGULAR_BEAM_INTERLOCK_k is set to "NOK"

4.3.1.2.7 Spokes1 Beam Destination No Beam Supervision

[#\[ISSUE:63675\]](#)

Requirement	Spokes1 Beam Destination No Beam Supervision
Verification Technique	Test
Verification Idea	<p>Simulate Beam Presence using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> ENFORCED_PROTON_BEAM_DESTINATION is "LEBT" ACCT3_NO_BEAM is "OK" <p>Procedure:</p> <ul style="list-style-type: none"> Set ENFORCED_PROTON_BEAM_DESTINATION to "Spokes1" Set ACCT3_NO_BEAM to "NOK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> REGULAR_BEAM_INTERLOCK_k is set to "NOK"

4.3.1.2.8 Spokes2 Beam Destination No Beam Supervision

[#\[ISSUE:63676\]](#)

Requirement	Spokes2 Beam Destination No Beam Supervision
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Verification Technique	Test
Verification Idea	<p>Simulate Beam Presence using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> ENFORCED_PROTON_BEAM_DESTINATION is "LEBT" ACCT3_NO_BEAM is "OK" <p>Procedure:</p> <ul style="list-style-type: none"> Set ENFORCED_PROTON_BEAM_DESTINATION to "Spokes2" Set ACCT3_NO_BEAM to "NOK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> REGULAR_BEAM_INTERLOCK_k is set to "NOK"

4.3.1.2.9 MBL Beam Destination No Beam Supervision

[#\[ISSUE:63677\]](#)

Requirement	MBL Beam Destination No Beam Supervision
Verification Technique	Test
Verification Idea	<p>Simulate Beam Presence using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> ENFORCED_PROTON_BEAM_DESTINATION is "LEBT" ACCT4_NO_BEAM is "OK" <p>Procedure:</p> <ul style="list-style-type: none"> Set ENFORCED_PROTON_BEAM_DESTINATION to "MBL" Set ACCT4_NO_BEAM to "NOK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> REGULAR_BEAM_INTERLOCK_k is set to "NOK"

4.3.1.2.10 Tuning Dump Beam Destination No Beam to Target Supervision

[#\[ISSUE:63678\]](#)

Requirement	Tuning Dump Beam Destination No Beam to Target Supervision
Verification Technique	Test
Verification Idea	<p>Simulate Beam Presence using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> ENFORCED_PROTON_BEAM_DESTINATION is "LEBT" ACCT6_NO_BEAM is "OK" <p>Procedure:</p> <ul style="list-style-type: none"> Set ENFORCED_PROTON_BEAM_DESTINATION to "MBL" Set ACCT6_NO_BEAM to "NOK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> REGULAR_BEAM_INTERLOCK_k is set to "NOK"

4.3.1.2.11 Target Beam Destination No Beam to Tuning Dump Supervision

[#\[ISSUE:63679\]](#)

Requirement	Target Beam Destination No Beam to Tuning Dump Supervision
Verification Technique	Test

Verification Idea	<p>Simulate Beam Presence using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> • ENFORCED_PROTON_BEAM_DESTINATION is "LEBT" • ACCT6_NO_BEAM is "OK" <p>Procedure:</p> <ul style="list-style-type: none"> • Set ENFORCED_PROTON_BEAM_DESTINATION to "Tuning Dump" • Set ACCT6_NO_BEAM to "NOK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • REGULAR_BEAM_INTERLOCK_k is set to "NOK"
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4.3.1.3 Switch-Off Status Evaluation

4.3.1.3.1 ESS Timing System Status Supervision

[#\[ISSUE:62895\]](#)

Requirement	ESS Timing System Status Supervision
Verification Technique	Test
Verification Idea	<p>Simulate Switch-Off Failure using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> • GLOBAL_BEAM_PERMIT is "OK" • TS_STATUS is "OK" <p>Procedure:</p> <ul style="list-style-type: none"> • Set GLOBAL_BEAM_PERMIT to "NOK" • Set TS_STATUS to "NOK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • REGULAR_BEAM_INTERLOCK_k is set to "NOK"

4.3.1.3.2 LEBT Chopper Status Supervision

[#\[ISSUE:63541\]](#)

Requirement	LEBT Chopper Status Supervision
Verification Technique	Test
Verification Idea	<p>Simulate Switch-Off Failure using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> • GLOBAL_BEAM_PERMIT is "OK" • LC_STATUS is "OK" <p>Procedure:</p> <ul style="list-style-type: none"> • Set GLOBAL_BEAM_PERMIT to "NOK" • Set LC_STATUS to "NOK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • REGULAR_BEAM_INTERLOCK_k is set to "NOK"

4.3.1.3.3 MEBT Chopper Status Supervision

[#\[ISSUE:63548\]](#)

Requirement	MEBT Chopper Status Supervision
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Verification Technique	Test
Verification Idea	<p>Simulate Switch-Off Failure using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> • GLOBAL_BEAM_PERMIT is "OK" • MC_STATUS is "OK" • ENFORCED_PROTON_BEAM_DESTINATION is "MEBT" <p>Procedure:</p> <ul style="list-style-type: none"> • Set ENFORCED_PROTON_BEAM_DESTINATION to "LEBT" • Set GLOBAL_BEAM_PERMIT to "NOK" • Set MC_STATUS to "NOK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • REGULAR_BEAM_INTERLOCK_k is set to "NOK"

4.3.1.3.4 Ion Source Status Supervision

[#\[ISSUE:63600\]](#)

Requirement	Ion Source Status Supervision
Verification Technique	Test
Verification Idea	<p>Simulate Switch-Off Failure using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> • IS_STATUS is "OK" • REGULAR_BEAM_INTERLOCK is "OK" <p>Procedure:</p> <ul style="list-style-type: none"> • Set IS_STATUS to "NOK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • EMERGENCY_BEAM_INTERLOCK_k is "NOK"

4.3.1.4 TBD

4.3.1.4.1 Regular Beam Interlock when Global Beam Permit reflects NOK

[#\[ISSUE:62991\]](#)

Requirement	Regular Beam Interlock when Global Beam Permit reflects NOK
Verification Technique	Test
Verification Idea	<p>Test Regular Beam Interlock using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete • ESS Timing System <p>Preconditions:</p> <ul style="list-style-type: none"> • GLOBAL_BEAM_PERMIT is "OK" • BEAM_PULSE_PHASE is "Inter Pulse" <p>Procedure:</p> <ul style="list-style-type: none"> • Set GLOBAL_BEAM_PERMIT to "NOK" • Set BEAM_PULSE_PHASE to "Intra Pulse" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • REGULAR_BEAM_INTERLOCK_k is "NOK" <p>Procedure:</p>

4.3.2 Mode Enforcement

4.3.2.1 Enforced Proton Beam Destination

[#\[ISSUE:63612\]](#)

Requirement	Enforced Proton Beam Destination
Verification Technique	Simulation and Modelling
Verification Idea	Covered by simulation of related requirement <ul style="list-style-type: none"> • Enforced Proton Beam Destination Computation

4.3.2.2 Enforced Proton Beam Destination Computation

[#\[ISSUE:62942\]](#)

Requirement	Enforced Proton Beam Destination Computation
Verification Technique	Simulation and Modelling
Verification Idea	Simulation of Proton Beam Destination Computation Required Interfaces: <ul style="list-style-type: none"> • None Preconditions: <ul style="list-style-type: none"> • None Procedure: <ul style="list-style-type: none"> • Logic will be modelled and simulated with MATLAB/Simulink Acceptance Criteria: <ul style="list-style-type: none"> • ENFORCED_BEAM_DESTINATION is computed as specified in table

4.3.2.3 Default Proton Beam Destination State

[#\[ISSUE:63613\]](#)

Requirement	Default Proton Beam Destination State
Verification Technique	Simulation and Modelling
Verification Idea	Covered by simulation of related requirement <ul style="list-style-type: none"> • Enforced Proton Beam Destination Computation

4.3.2.4 Proton Beam Destination Mismatch

[#\[ISSUE:62943\]](#)

Requirement	Proton Beam Destination Mismatch
Verification Technique	Test
Verification Idea	Compare Simulink Model with FBIS using HIL-Simulator Required Interfaces: <ul style="list-style-type: none"> • Discrete • Serial • Debug Preconditions: <ul style="list-style-type: none"> • Simulation for Enforced Proton Beam Destination Computation passed Procedure: <ul style="list-style-type: none"> • Use simulation data to generate test cases • Compare simulation results with FBIS response Acceptance Criteria: <ul style="list-style-type: none"> • Simulation and FBIS response is identical

4.3.2.5 Logging of Enforced Proton Beam Destination Changes

[#\[ISSUE:62944\]](#)

Requirement	Logging of Enforced Proton Beam Destination Changes
Verification Technique	Inspection
Verification Idea	<p>Inspection of ENFORCED_PROTON_BEAM_DESTINATION log entries</p> <p>Preconditions:</p> <ul style="list-style-type: none"> • Event logging is working • Test Proton Beam Destination Mismatch passed <p>Procedure:</p> <ul style="list-style-type: none"> • Inspect log entries if state changes for ENFORCED_PROTON_BEAM_DESTINATION have been created <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • Log entries exist • State changes are consistent with test

4.3.2.6 Enforced Proton Beam Destination Control System Readout

[#\[ISSUE:63618\]](#)

Requirement	Enforced Proton Beam Destination Control System Readout
Verification Technique	Inspection
Verification Idea	<p>Inspection of Control System access to ENFORCED_PROTON_BEAM_DESTINATION state</p> <p>Preconditions:</p> <ul style="list-style-type: none"> • FBIS is integrated with Control System <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Control System Interface <p>Procedure:</p> <ul style="list-style-type: none"> • Inspect Control System for ENFORCED_PROTON_BEAM_DESTINATION state <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • Control System ENFORCED_PROTON_BEAM_DESTINATION value corresponds to the ENFORCED_PROTON_BEAM_DESTINATION state

4.3.2.7 Enforced Proton Beam Mode

[#\[ISSUE:62951\]](#)

Requirement	Enforced Proton Beam Mode
Verification Technique	Simulation and Modelling
Verification Idea	<p>Covered by simulation for related requirement</p> <ul style="list-style-type: none"> • Enforced Proton Beam Mode Computation

4.3.2.8 Enforced Proton Beam Mode Computation

[#\[ISSUE:63615\]](#)

Requirement	Enforced Proton Beam Mode Computation
Verification Technique	Simulation and Modelling
Verification Idea	<p>Simulation of Enforced Proton Beam Mode Computation</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • None <p>Preconditions:</p>

	<ul style="list-style-type: none"> • None <p>Procedure:</p> <ul style="list-style-type: none"> • Logic will be modelled and simulated with MATLAB/Simulink <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • ENFORCED_PROTON_BEAM_MODE is computed as specified in table
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4.3.2.9 Default Proton Beam Mode

[#\[ISSUE:63616\]](#)

Requirement	Default Proton Beam Mode
Verification Technique	Simulation and Modelling
Verification Idea	<p>Covered by simulation of related requirement:</p> <ul style="list-style-type: none"> • Enforced Proton Beam Mode Computation

4.3.2.10 Proton Beam Mode Mismatch

[#\[ISSUE:62918\]](#)

Requirement	Proton Beam Mode Mismatch
Verification Technique	Test
Verification Idea	<p>Compare Simulink Model with FBIS using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete • Serial • Debug <p>Preconditions:</p> <ul style="list-style-type: none"> • Simulation for Enforced Proton Beam Mode Computation passed <p>Procedure:</p> <ul style="list-style-type: none"> • Use simulation data to generate test cases • Compare simulation results with FBIS response <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • Simulation and FBIS response is identical

4.3.2.11 Logging of Enforced Proton Beam Mode Changes

[#\[ISSUE:63617\]](#)

Requirement	Logging of Enforced Proton Beam Mode Changes
Verification Technique	Inspection
Verification Idea	<p>Inspection of ENFORCED_PROTON_BEAM_MODE log entries</p> <p>Preconditions:</p> <ul style="list-style-type: none"> • Event logging is working • Test Default Proton Beam Mode passed <p>Procedure:</p> <ul style="list-style-type: none"> • Inspect log entries if state changes for ENFORCED_PROTON_BEAM_MODE have been created <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • Log entries exist • State changes are consistent with tests

4.3.2.12 Enforced Proton Beam Mode Control System Readout

[#\[ISSUE:62945\]](#)

Requirement	Enforced Proton Beam Mode Control System Readout
Verification Technique	Inspection
Verification Idea	<p>Inspection of Control System access to ENFORCED_PROTON_BEAM_MODE state</p> <p>Preconditions:</p> <ul style="list-style-type: none"> • FBIS is integrated with Control System • Enforced Proton Beam Mode passed • Enforced Proton Beam Mode Computation passed • Default Proton Beam Mode passed <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Control System Interface <p>Procedure:</p> <ul style="list-style-type: none"> • Inspect Control System for ENFORCED_PROTON_BEAM_MODE state <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • Control System ENFORCED_PROTON_BEAM_MODE state value corresponds to the ENFORCED_PROTON_BEAM_MODE state

4.3.3 Global Beam Permit Generation

4.3.3.1 Global Beam Permit Possible States

[#\[ISSUE:65102\]](#)

Requirement	Global Beam Permit Possible States
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirement</p> <ul style="list-style-type: none"> • Global Beam Permit

4.3.3.2 Global Beam Permit

[#\[ISSUE:62818\]](#)

Requirement	Global Beam Permit
Verification Technique	Test
Verification Idea	<p>Simulate GLOBAL_BEAM_PERMIT_k</p> <p>Preconditions:</p> <ul style="list-style-type: none"> • GLOBAL_BEAM_PERMIT is "NOK" <p>Procedure:</p> <ul style="list-style-type: none"> • Stimulate GLOBAL_BEAM_PERMIT_k <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • GLOBAL_BEAM_PERMIT is "OK" when all GLOAB_BEAM_PERMIT_k are "OK"

4.3.3.3 Default Global Beam Permit State

[#\[ISSUE:62828\]](#)

Requirement	Default Global Beam Permit State
Verification Technique	Inspection
Verification Idea	<p>Inspect GLOBAL_BEAM_PERMIT state</p> <p>Precondition:</p> <ul style="list-style-type: none"> • System is down <p>Procedure:</p> <ul style="list-style-type: none"> • Inspect GLOBAL_BEAM_PERMIT during startup <p>Acceptance Criteria:</p>

	<ul style="list-style-type: none"> • GLOBAL_BEAM_PERMIT is "NOK" <p>Remark:</p> <ul style="list-style-type: none"> • A user feedback is required to signal that all GLOABL_BEAM_PERMIT_k have been evaluated
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4.3.3.4 Setting Global Beam Permit to NOK via Control System

[#\[ISSUE:62831\]](#)

Requirement	Setting Global Beam Permit to NOK via Control System
Verification Technique	Demonstration
Verification Idea	<p>Demonstration</p> <p>Precondition:</p> <ul style="list-style-type: none"> • GLOBAL_BEAM_PERMIT is "OK" <p>Procedure:</p> <ul style="list-style-type: none"> • Set GLOBAL_GLOABL_PERMIT to "NOK" using Control System Interface <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • GLOBAL_BEAM_PERMIT is "NOK"

4.3.3.5 Setting Global Beam Permit to OK via Control System

[#\[ISSUE:63434\]](#)

Requirement	Setting Global Beam Permit to OK via Control System
Verification Technique	Demonstration
Verification Idea	<p>Demonstration</p> <p>Precondition:</p> <ul style="list-style-type: none"> • GLOBAL_BEAM_PERMIT is "NOK" <p>Procedure:</p> <ul style="list-style-type: none"> • Set GLOBAL_GLOBAL_PERMIT to "OK" using Control System Interface <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • GLOBAL_BEAM_PERMIT is "NOK"

4.3.3.6 Control System Readout

[#\[ISSUE:62857\]](#)

Requirement	Control System Readout
Verification Technique	Inspection
Verification Idea	<p>Inspect GLOBAL_BEAM_PERMIT value</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Control System Interface <p>Preconditions:</p> <ul style="list-style-type: none"> • a) GLOBAL_BEAM_PERMIT is "NOK" • b) GLOBAL_BEAM_PERMIT is "OK" <p>Procedure:</p> <ul style="list-style-type: none"> • Inspect GLOBAL_BEAM_PERMIT values shown in Control System <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • a) GLOBAL_BEAM_PERMIT value is "OK" • b) GLOBAL_BEAM_PERMIT value is "NOK"

4.3.3.7 Logging

[#\[ISSUE:62858\]](#)

Requirement	Logging
Verification Technique	Inspection
Verification Idea	<p>Inspection of GLOBAL_BEAM_PERMIT log entries</p> <p>Preconditions:</p> <ul style="list-style-type: none"> • Event logging is working • Test Global Beam Permit passed <p>Procedure:</p> <ul style="list-style-type: none"> • Inspect log entries if state changes for GLOBAL_BEAM_PERMIT have been created <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • Log entries exist • State changes are consistent with test

4.3.4 Beam Pulse Phase Detection

4.3.4.1 Beam Pulse Phase

[#\[ISSUE:62966\]](#)

Requirement	Beam Pulse Phase
Verification Technique	Test
Verification Idea	<p>Covered by testing related requirements</p> <ul style="list-style-type: none"> • ESS Timing System Beam Pulse On Triggers • ESS Timing System Beam Pulse Off Triggers • Multiple Beam Pulse On Triggers

4.3.4.2 ESS Timing System Beam Pulse On Triggers

[#\[ISSUE:63275\]](#)

Requirement	ESS Timing System Beam Pulse On Triggers
Verification Technique	Test
Verification Idea	<p>Simulate ESS Timing System using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Timing System • Control System or Diagnostic Interface <p>Preconditions:</p> <ul style="list-style-type: none"> • BEAM_PULSE_PHASE is "Unknown" "Inter Pulse" <p>Procedure</p> <ul style="list-style-type: none"> • Send "Beam Pulse On Trigger" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • BEAM_PULSE_PHASE is "Intra Pulse"

4.3.4.3 ESS Timing System Beam Pulse Off Triggers

[#\[ISSUE:63277\]](#)

Requirement	ESS Timing System Beam Pulse Off Triggers
Verification Technique	Test
Verification Idea	<p>Simulate ESS Timing System using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Timing System • Control System or Diagnostic Interface <p>Preconditions:</p>

	<ul style="list-style-type: none"> • BEAM_PULSE_PHASE is not "Inter Pulse" <p>Procedure</p> <ul style="list-style-type: none"> • Send "Beam Pulse Off Trigger" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • BEAM_PULSE_PHASE is "Inter Pulse"
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4.3.4.4 Default Beam Pulse Phase State

[#\[ISSUE:62967\]](#)

Requirement	Default Beam Pulse Phase State
Verification Technique	Inspection
Verification Idea	<p>Inspect Beam Pulse Phase state during startup</p> <p>Preconditions:</p> <ul style="list-style-type: none"> • Power is switched off <p>Procedure:</p> <ul style="list-style-type: none"> • Switch power on • Inspect Beam Pulse Phase value <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • Beam Pulse Phase is unknown

4.3.4.5 Multiple Beam Pulse On Triggers

[#\[ISSUE:63278\]](#)

Requirement	Multiple Beam Pulse On Triggers
Verification Technique	Test
Verification Idea	<p>Simulate ESS Timing System</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Timing System • Control System or Diagnostic Interface <p>Preconditions:</p> <ul style="list-style-type: none"> • BEAM_PULSE_PHASE is "Intra Pulse" <p>Procedure:</p> <ul style="list-style-type: none"> • Send "Beam Pulse On Trigger" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • REGULAR_BEAM_INTERLOCK_k is "NOK"

4.3.4.6 Control System Readout

[#\[ISSUE:62968\]](#)

Requirement	Control System Readout
Verification Technique	Inspection
Verification Idea	<p>Inspect BEAM_PULSE_PHASE values shown by Control System</p> <p>Precondition:</p> <ul style="list-style-type: none"> • Test for ESS Timing System Beam Pulse On Triggers passed • Test for ESS Timing System Beam Pulse Off Triggers passed • Test for Multiple Beam Pulse On Triggers passed <p>Procedure:</p> <ul style="list-style-type: none"> • Inspect values shown via Control System <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • Values via Control System for BEAM_PULSE_PHASE are consistent to tests

4.3.4.7 Logging

[#\[ISSUE:62969\]](#)

Requirement	Logging
Verification Technique	Inspection
Verification Idea	<p>Inspect BEAM_PULSE_PHASE log entries</p> <p>Precondition:</p> <ul style="list-style-type: none"> • Event Logging is working • Test for ESS Timing System Beam Pulse On Triggers passed • Test for ESS Timing System Beam Pulse Off Triggers passed • Test for Multiple Beam Pulse On Triggers passed <p>Procedure:</p> <ul style="list-style-type: none"> • Inspect Event Logging entries <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • Event logging has log entries for each state changes

4.3.5 Regular Beam Interlock Generation

4.3.5.1 Regular Beam Interlock Possible States

[#\[ISSUE:65100\]](#)

Requirement	Regular Beam Interlock Possible States
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirement</p> <ul style="list-style-type: none"> • Regular Beam Interlock

4.3.5.2 Regular Beam Interlock

[#\[ISSUE:62997\]](#)

Requirement	Regular Beam Interlock
Verification Technique	Test
Verification Idea	<p>Simulate REGULAR_BEAM_INTERLOCK_k</p> <p>Preconditions:</p> <ul style="list-style-type: none"> • REGULAR_BEAM_INTERLOCK is "NOK" <p>Procedure:</p> <ul style="list-style-type: none"> • Stimulate REGULAR_BEAM_INTERLOCK_k <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • REGULAR_BEAM_INTERLOCK is "OK" when all REGULAR_BEAM_INTERLOCK_k are "OK"

4.3.5.3 Default Regular Beam Interlock State

[#\[ISSUE:62998\]](#)

Requirement	Default Regular Beam Interlock State
Verification Technique	Inspection
Verification Idea	<p>Inspect REGULAR_BEAM_INTERLOCK state</p> <p>Precondition:</p> <ul style="list-style-type: none"> • System is down <p>Procedure:</p> <ul style="list-style-type: none"> • Inspect REGULAR_BEAM_INTERLOCK state during startup <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • REGULAR_BEAM_INTERLOCK is "NOK"

	Remark: <ul style="list-style-type: none"> A user feedback is required to signal that all REGULAR_BEAM_INTERLOCK_k have been evaluated
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4.3.5.4 Global Beam Permit NOK due to Regular Beam Interlock

[#\[ISSUE:63555\]](#)

Requirement	Global Beam Permit NOK due to Regular Beam Interlock
Verification Technique	Test
Verification Idea	Simulate Escalation Strategy using HIL-Simulator Required Interfaces: <ul style="list-style-type: none"> Discrete Preconditions: <ul style="list-style-type: none"> REGULAR_BEAM_INTERLOCK is "OK" GLOBAL_BEAM_PERMIT_k is "OK" Procedure: <ul style="list-style-type: none"> Set REGULAR_BEAM_INTERLOCK to "NOK" Acceptance Criteria: <ul style="list-style-type: none"> GLOBAL_BEAM_PERMIT_k is set to "NOK"

4.3.5.5 Control System Readout

[#\[ISSUE:62999\]](#)

Requirement	Control System Readout
Verification Technique	Inspection
Verification Idea	Inspect REGULAR_BEAM_INTERLOCK value Required Interfaces: <ul style="list-style-type: none"> Control System Interface Preconditions: <ul style="list-style-type: none"> a) REGULAR_BEAM_INTERLOCK is "NOK" b) REGULAR_BEAM_INTERLOCK is "OK" Procedure: <ul style="list-style-type: none"> Inspect REGULAR_BEAM_INTERLOCK values shown in Control System Acceptance Criteria: <ul style="list-style-type: none"> a) REGULAR_BEAM_INTERLOCK value is "OK" b) REGULAR_BEAM_INTERLOCK value is "NOK"

4.3.5.6 Logging

[#\[ISSUE:63000\]](#)

Requirement	Logging
Verification Technique	Inspection
Verification Idea	Inspection of REGULAR_BEAM_INTERLOCK log entries Preconditions: <ul style="list-style-type: none"> Test Regular Beam Interlock passed Procedure: <ul style="list-style-type: none"> Inspect log entries if state changes for REGULAR_BEAM_INTERLOCK have been created Acceptance Criteria: <ul style="list-style-type: none"> Log entries exist State changes are consistent with test

4.3.6 Emergency Beam Interlock Generation

4.3.6.1 Emergency Beam Interlock Possible States

[#\[ISSUE:65101\]](#)

Requirement	Emergency Beam Interlock Possible States
Verification Technique	Test
Verification Idea	Covered by testing of related requirement <ul style="list-style-type: none"> • Emergency Beam Interlock

4.3.6.2 Emergency Beam Interlock

[#\[ISSUE:63003\]](#)

Requirement	Emergency Beam Interlock
Verification Technique	Test
Verification Idea	<p>Simulate EMERGENCY_BEAM_INTERLOCK_k</p> <p>Preconditions:</p> <ul style="list-style-type: none"> • EMERGENCY_BEAM_INTERLOCK is "NOK" <p>Procedure:</p> <ul style="list-style-type: none"> • Stimulate EMERGENCY_BEAM_INTERLOCK_k <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • EMERGENCY_BEAM_INTERLOCK is "OK" when all EMERGENCY_BEAM_INTERLOCK_k are "OK"

4.3.6.3 Default Emergency Beam Interlock State

[#\[ISSUE:63004\]](#)

Requirement	Default Emergency Beam Interlock State
Verification Technique	Inspection
Verification Idea	<p>Inspect EMERGENCY_BEAM_INTERLOCK state</p> <p>Precondition:</p> <ul style="list-style-type: none"> • System is down <p>Procedure:</p> <ul style="list-style-type: none"> • Inspect EMERGENCY_BEAM_INTERLOCK state during startup <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • EMERGENCY_BEAM_INTERLOCK is "NOK" <p>Remark:</p> <ul style="list-style-type: none"> • A user feedback is required to signal that all EMERGENCY_BEAM_INTERLOCK_k have been evaluated

4.3.6.4 Global Beam Permit NOK due to Emergency Beam Interlock

[#\[ISSUE:63557\]](#)

Requirement	Global Beam Permit NOK due to Emergency Beam Interlock
Verification Technique	Test
Verification Idea	<p>Simulate Escalation Strategy using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> • EMERGENCY_BEAM_INTERLOCK is "OK" • GLOBAL_BEAM_PERMIT_k is "OK" <p>Procedure:</p>

	<ul style="list-style-type: none"> • Set EMERGENCY_BEAM_INTERLOCK to "NOK" Acceptance Criteria: <ul style="list-style-type: none"> • GLOBAL_BEAM_PERMIT_k is set to "NOK"
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4.3.6.5 Regular Beam Permit NOK due to Emergency Beam Interlock

[#\[ISSUE:63556\]](#)

Requirement	Regular Beam Permit NOK due to Emergency Beam Interlock
Verification Technique	Test
Verification Idea	Simulate Escalation Strategy using HIL-Simulator Required Interfaces: <ul style="list-style-type: none"> • Discrete Preconditions: <ul style="list-style-type: none"> • REGULAR_BEAM_INTERLOCK_k is "OK" • EMERGENCY_BEAM_INTERLOCK is "OK" Procedure: <ul style="list-style-type: none"> • Set EMERGENCY_BEAM_INTERLOCK to "NOK" Acceptance Criteria: <ul style="list-style-type: none"> • REGULAR_BEAM_INTERLOCK_k is set to "NOK"

4.3.6.6 Control System Readout

[#\[ISSUE:63005\]](#)

Requirement	Control System Readout
Verification Technique	Inspection
Verification Idea	Inspect EMERGENCY_BEAM_INTERLOCK value Required Interfaces: <ul style="list-style-type: none"> • Control System Interface Preconditions: <ul style="list-style-type: none"> • a) EMERGENCY_BEAM_INTERLOCK is "NOK" • b) EMERGENCY_BEAM_INTERLOCK is "OK" Procedure: <ul style="list-style-type: none"> • Inspect EMERGENCY_BEAM_INTERLOCK values shown in Control System Acceptance Criteria: <ul style="list-style-type: none"> • a) EMERGENCY_BEAM_INTERLOCK value is "OK" • b) EMERGENCY_BEAM_INTERLOCK value is "NOK"

4.3.6.7 Logging

[#\[ISSUE:63006\]](#)

Requirement	Logging
Verification Technique	Inspection
Verification Idea	Inspection of EMERGENCY_BEAM_INTERLOCK log entries Preconditions: <ul style="list-style-type: none"> • Test Emergency Beam Interlock passed Procedure: <ul style="list-style-type: none"> • Inspect log entries if state changes for EMERGENCY_BEAM_INTERLOCK have been created Acceptance Criteria: <ul style="list-style-type: none"> • Log entries exist • State changes are consistent with test

4.3.7 Latching

4.3.7.1 Generic Latching Requirements

4.3.7.1.1 Latching Feature

[#\[ISSUE:63017\]](#)

Requirement	Latching Feature
Verification Technique	Demonstration
Verification Idea	<p>Latching and influence on computation logic of FBIS using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete • Control System <p>Procedure:</p> <ul style="list-style-type: none"> • Latch individual FBIS Decision Logic States <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • Influence computation logic as described

4.3.7.1.2 Latching Feature Configuration

[#\[ISSUE:63009\]](#)

Requirement	Latching Feature Configuration
Verification Technique	Demonstration
Verification Idea	<p>Change the latching configuration of FBIS Decision Logic States using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete • Control System <p>Procedure:</p> <ul style="list-style-type: none"> • Change the latching of individual FBIS Decision Logic States <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • Latching of individual FBIS Decision Logic States can be changed to "No Latching" or "Latch NOK"

4.3.7.1.3 Default Latching Configuration

[#\[ISSUE:63010\]](#)

Requirement	Default Latching Configuration
Verification Technique	Demonstration
Verification Idea	<p>Default latching configuration of FBIS Decision Logic States using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Procedure:</p> <ul style="list-style-type: none"> • Check default latching configuration of FBIS Decision Logic states <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • Latching of individual FBIS Decision Logic States are per default set to "No Latching" unless latching for the respective condition is explicitly stated

4.3.7.1.4 Control System Latching Configuration Readout

[#\[ISSUE:63011\]](#)

Requirement	Control System Latching Configuration Readout
Verification Technique	Demonstration

Verification Idea	Read latching configuration of FBIS Decision Logic States using HIL-Simulator Required Interfaces: <ul style="list-style-type: none"> • Discrete • Control System Procedure: <ul style="list-style-type: none"> • Check latching configuration of FBIS Decision Logic states via Control System Acceptance Criteria: <ul style="list-style-type: none"> • Control System is able to read latching configuration of FBIS Decision Logic states at all times
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4.3.7.1.5 Logging of Latching Configuration Changes

[#\[ISSUE:63012\]](#)

Requirement	Logging of Latching Configuration Changes
Verification Technique	Inspection
Verification Idea	Inspection of Event Logging entries Required Interfaces: <ul style="list-style-type: none"> • Discrete • Logging Procedure: <ul style="list-style-type: none"> • Simulate writing changes to the latching configuration of decision states Acceptance Criteria: <ul style="list-style-type: none"> • Latching configuration changes are logged with a timestamp

4.3.7.2 Mandatory Latching

4.3.7.2.1 Regular Beam Interlock Latching

[#\[ISSUE:63014\]](#)

Requirement	Regular Beam Interlock Latching
Verification Technique	Inspection
Verification Idea	Inspect REGULAR_BEAM_INTERLOCK Latching Configuration via Control System Acceptance Criteria: <ul style="list-style-type: none"> • REGULAR_BEAM_INTERLOCK is configured to "Latch NOK"

4.3.7.2.2 Emergency Beam Interlock Latching

[#\[ISSUE:63018\]](#)

Requirement	Emergency Beam Interlock Latching
Verification Technique	Inspection
Verification Idea	Inspect EMERGENCY_BEAM_INTERLOCK Latching Configuration via Control System Acceptance Criteria: <ul style="list-style-type: none"> • EMERGENCY_BEAM_INTERLOCK is configured to "Latch NOK"

4.3.7.3 External Reset Feature

[#\[ISSUE:63115\]](#)

Requirement	External Reset Feature
Verification Technique	Demonstration
Verification Idea	Reset latched FBIS Decision logic states using HIL-Simulator Required Interfaces:

	<ul style="list-style-type: none"> • Discrete • Control System <p>Procedure:</p> <ul style="list-style-type: none"> • Send external reset command <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • All latched FBIS Decision logic states are reset
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4.3.7.4 External Reset Logging

[#\[ISSUE:63116\]](#)

Requirement	External Reset Logging
Verification Technique	Demonstration
Verification Idea	<p>External reset command reception logging using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete • Logging <p>Procedure:</p> <ul style="list-style-type: none"> • Send external reset command <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • External reset command is logged with a timestamp

4.4 Output Signal Generation

4.4.1 Sensor System Output Signals

4.4.2 Actuation System Output Signal Generation

4.4.2.1 ESS Timing System Output Signals

4.4.2.1.1 ESS Timing System Beam Permit Out

[#\[ISSUE:65106\]](#)

Requirement	ESS Timing System Beam Permit Out
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirement:</p> <ul style="list-style-type: none"> • ESS Timing System Beam Permit Out State

4.4.2.1.2 ESS Timing System Beam Permit Out State

[#\[ISSUE:62959\]](#)

Requirement	ESS Timing System Beam Permit Out State
Verification Technique	Test
Verification Idea	<p>Simulate GLOBAL_BEAM_PERMIT using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> • GLOBAL_BEAM_PERMIT is "OK" • TS_BEAM_PERMIT_OUT is "OK" • FBIS Beam Permit Out is "High" <p>Procedure:</p>

	<ul style="list-style-type: none"> • Set "GLOBAL_BEAM_PERMIT" to "NOK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • TS_BEAM_PERMIT_OUT is "NOK" • FBIS Beam Permit Out is "Low"
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4.4.2.1.3 FBIS Beam Permit Out

[#\[ISSUE:65130\]](#)

Requirement	FBIS Beam Permit Out
Verification Technique	Test
Verification Idea	<p>Simulate ESS Timing System using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> • TS_BEAM_PERMIT_OUT is "NOK" <p>Procedure:</p> <ul style="list-style-type: none"> • Set TS_BEAM_PERMIT_OUT to "OK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • "FBIS Beam Permit Out" is "TBD"

4.4.2.1.4 FBIS Beam Permit Out Latched

[#\[ISSUE:63602\]](#)

Requirement	FBIS Beam Permit Out Latched
Verification Technique	Test
Verification Idea	<p>Simulate ESS Timing System using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> • GLOBAL_BEAM_PERMIT is "OK" • REGULAR_BEAM_INTERLOCK is "OK" • EMERGENCY_BEAM_INTERLOCK is "OK" <p>Procedure:</p> <ul style="list-style-type: none"> • Set REGULAR_BEAM_INTERLOCK to "NOK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • "FBIS Beam Permit Latched" is "TBD"

4.4.2.2 LEBT Chopper Output Signals

4.4.2.2.1 LEBT Chopper Beam Permit Out

[#\[ISSUE:64966\]](#)

Requirement	LEBT Chopper Beam Permit Out
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirement</p> <ul style="list-style-type: none"> • LEBT Chopper Beam Permit Out State

4.4.2.2.2 LEBT Chopper Beam Permit Out State

[#\[ISSUE:64880\]](#)

Requirement	LEBT Chopper Beam Permit Out State
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Verification Technique	Test
Verification Idea	<p>Simulate GLOBAL_BEAM_PERMIT using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> GLOBAL_BEAM_PERMIT is "NOK" <p>Procedure:</p> <ul style="list-style-type: none"> Set "GLOBAL_BEAM_PERMIT" to "OK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> LC_BEAM_PERMIT_OUT is "OK"

4.4.2.2.3 FBIS Beam Permit Out

[#\[ISSUE:64882\]](#)

Requirement	FBIS Beam Permit Out
Verification Technique	Test
Verification Idea	<p>Simulate LC_BEAM_PERMIT_OUT using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> LC_BEAM_PERMIT_OUT is "NOK" <p>Procedure:</p> <ul style="list-style-type: none"> Set "LC_BEAM_PERMIT_OUT" to "OK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> FBIS Beam Permit Out is "OK"

4.4.2.3 MEBT Chopper Output Signals

4.4.2.3.1 MEBT Chopper Beam Permit Out

[#\[ISSUE:64967\]](#)

Requirement	MEBT Chopper Beam Permit Out
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirement</p> <ul style="list-style-type: none"> MEBT Chopper Beam Permit Out State

4.4.2.3.2 MEBT Chopper Beam Permit Out State

[#\[ISSUE:64799\]](#)

Requirement	MEBT Chopper Beam Permit Out State
Verification Technique	Test
Verification Idea	<p>Simulate interlock conditions using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> GLOBAL_BEAM_PERMIT is "NOK" REGULAR_BEAM_INTERLOCK is "NOK" EMERGENCY_BEAM_INTERLOCK is "NOK" <p>Procedure:</p> <ul style="list-style-type: none"> Set "GLOBAL_BEAM_PERMIT" to "OK" Set REGULAR_BEAM_INTERLOCK to "OK"

	<ul style="list-style-type: none"> • Set EMERGENCY_BEAM_INTERLOCK to "OK" Acceptance Criteria: <ul style="list-style-type: none"> • MC_BEAM_PERMIT_OUT is "OK"
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4.4.2.3.3 FBIS Beam Stop Positive Pulser

[#\[ISSUE:63538\]](#)

Requirement	FBIS Beam Stop Positive Pulser
Verification Technique	Test
Verification Idea	Simulate interlock conditions using HIL-Simulator Required Interfaces: <ul style="list-style-type: none"> • Discrete Preconditions: <ul style="list-style-type: none"> • MC_BEAM_PERMIT_OUT is "NOK" Procedure: <ul style="list-style-type: none"> • Set MC_BEAM_PERMIT_OUT to "OK" Acceptance Criteria: <ul style="list-style-type: none"> • "FBIS Beam Stop Positive Pulser" is "OK"

4.4.2.3.4 FBIS Beam Stop Negative Pulser

[#\[ISSUE:64800\]](#)

Requirement	FBIS Beam Stop Negative Pulser
Verification Technique	Test
Verification Idea	Simulate interlock conditions using HIL-Simulator Required Interfaces: <ul style="list-style-type: none"> • Discrete Preconditions: <ul style="list-style-type: none"> • MC_BEAM_PERMIT_OUT is "NOK" Procedure: <ul style="list-style-type: none"> • Set MC_BEAM_PERMIT_OUT to "OK" Acceptance Criteria: <ul style="list-style-type: none"> • "FBIS Beam Stop Negative Pulser" is "OK"

4.4.2.4 Ion Source Output Signals

4.4.2.4.1 Ion Source Beam Permit Out

[#\[ISSUE:65134\]](#)

Requirement	Ion Source Beam Permit Out
Verification Technique	Test
Verification Idea	Covered by testing of related requirement <ul style="list-style-type: none"> • Ion Source Beam Permit Out State

4.4.2.4.2 Ion Source Beam Permit Out State

[#\[ISSUE:63603\]](#)

Requirement	Ion Source Beam Permit Out State
Verification Technique	Test
Verification Idea	Simulate Ion Source with HIL-Simulator

	<p>Required Interfaces:</p> <ul style="list-style-type: none"> Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> GLOBAL_BEAM_PERMIT is "NOK" REGULAR_BEAM_PERMIT is "NOK" EMERGENCY_BEAM_PERMIT is "NOK" <p>Procedure:</p> <ul style="list-style-type: none"> Set GLOBAL_BEAM_PERMIT to "NOK" Set REGULAR_BEAM_PERMIT to "NOK" Set EMERGENCY_BEAM_PERMIT to "NOK" <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> IS_BEAM_PERMIT_OUT is "OK"
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4.4.2.4.3 FBIS Beam Stop

[#\[ISSUE:65135\]](#)

Requirement	FBIS Beam Stop
Verification Technique	Test
Verification Idea	<p>Simulate Ion Source with HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> IS_BEAM_PERMIT_OUT is "NOK" <p>Procedure: Set IS_BEAM_PERMIT_OUT to "OK"</p> <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> "FBIS Beam Stop" is "TBD"

4.4.2.4.4 Ion Source Emergency Beam Interlock

[#\[ISSUE:65137\]](#)

Requirement	Ion Source Emergency Beam Interlock
Verification Technique	Test
Verification Idea	<p>Covered by testing of related requirement</p> <ul style="list-style-type: none"> Ion Source Emergency Beam Interlock State

4.4.2.4.5 Ion Source Emergency Beam Interlock State

[#\[ISSUE:65138\]](#)

Requirement	Ion Source Emergency Beam Interlock State
Verification Technique	Test
Verification Idea	<p>Simulate Ion Source with HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> EMERGENCY_BEAM_PERMIT is "NOK" <p>Procedure: Set EMERGENCY_BEAM_PERMIT to "OK"</p> <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> IS_EMERGENCY_BEAM_INTERLOCK is "OK"

4.4.2.4.6 FBIS Magnetron PS Off

[#\[ISSUE:63604\]](#)

Requirement	FBIS Magnetron PS Off
Verification Technique	Test
Verification Idea	<p>Simulate Ion Source with HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> IS_EMERGENCY_BEAM_INTERLOCK is "NOK" <p>Procedure: Set IS_EMERGENCY_BEAM_INTERLOCK to "OK"</p> <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> "FBIS Magnetron PS Off" is "OK"

4.4.2.4.7 FBIS HV Platform Off

[#\[ISSUE:65136\]](#)

Requirement	FBIS HV Platform Off
Verification Technique	Test
Verification Idea	<p>Simulate Ion Source with HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Discrete <p>Preconditions:</p> <ul style="list-style-type: none"> IS_EMERGENCY_BEAM_INTERLOCK is "NOK" <p>Procedure: Set IS_EMERGENCY_BEAM_INTERLOCK to "OK"</p> <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> "FBIS HV Platform Off" is "OK"

4.4.3 Output Signal Control System Readout

[#\[ISSUE:62963\]](#)

Requirement	Output Signal Control System Readout
Verification Technique	Inspection
Verification Idea	<p>Inspection of Control System Output Signal States</p> <p>Preconditions:</p> <ul style="list-style-type: none"> FBIS is integrated with Control System Output Signal tests passed <p>Required Interfaces:</p> <ul style="list-style-type: none"> Control System Interface <p>Procedure:</p> <ul style="list-style-type: none"> Simulate output signals using HIL-Simulator Inspect Control System values for output signals <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> Control System values for output signals corresponds to output signals

4.4.4 Logging of Output Signal State Changes

[#\[ISSUE:65132\]](#)

Requirement	Logging of Output Signal State Changes
Verification Technique	Demonstration
Verification Idea	<p>Simulation of state changes of output signals using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> Discrete

	<ul style="list-style-type: none"> • Logging <p>Procedure:</p> <ul style="list-style-type: none"> • Simulate state changes of output signals <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • State changes for output signals are logged
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4.4.5 Logging of Variables State Changes

[#ISSUE:65133](#)

Requirement	Logging of Variables State Changes
Verification Technique	Demonstration
Verification Idea	<p>Simulation of state changes of decision logic variables using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Decision Logic Variables as defined in increment • Logging <p>Procedure:</p> <ul style="list-style-type: none"> • Simulate state changes of decision logic variables <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • State changes for decision logic variables are logged

4.5 Event Logging

4.5.1 Timestamp

[#ISSUE:63279](#)

Requirement	Timestamp
Verification Technique	Demonstration
Verification Idea	<p>Triggering of Logging Events using HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Discrete • ESS Timing System Interface <p>Procedure:</p> <ul style="list-style-type: none"> • Trigger Log Events using HIL-Simulator <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • Log Events have Timestamp

4.5.2 Timestamp Resolution

[#ISSUE:63193](#)

Requirement	Timestamp Resolution
Verification Technique	Test
Verification Idea	<p>Inspect timestamp resolution</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • ESS Timing System Interface • Logging <p>Preconditions:</p> <ul style="list-style-type: none"> • Log Events received <p>Procedure:</p> <ul style="list-style-type: none"> • Inspect Event Logging Timestamps <p>Acceptance Criteria:</p>

- Event Logging Timestamps have an resolution better than <1us

4.5.3 Log Events Control System Readout

[#\[ISSUE:62863\]](#)

Requirement	Log Events Control System Readout
Verification Technique	Demonstration
Verification Idea	<p>Demonstration of Control System access to Event Logging</p> <p>Preconditions:</p> <ul style="list-style-type: none"> • FBIS is integrated with Control System • Timestamp passed • Timestamp Resolution passed <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Control System Interface • ESS Timing System Interface <p>Procedure:</p> <ul style="list-style-type: none"> • Trigger Event Loggings using HIL-Simulator • Inspect Control System for Event Loggings <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • Control System Event Loggings corresponds to the Event Loggings from the ESS Timing System Interface

4.5.4 Log Events Persistence

[#\[ISSUE:63605\]](#)

Requirement	Log Events Persistence
Verification Technique	Inspection
Verification Idea	<p>Inspection of Control Event Logging persistence</p> <p>Preconditions:</p> <ul style="list-style-type: none"> • FBIS is integrated with Control System • Timestamp passed • Timestamp Resolution passed <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Control System Interface • ESS Timing System Interface <p>Procedure:</p> <ul style="list-style-type: none"> • Stimulate Log Events using HIL-Simulator <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • Control System Log Events corresponds to the Log Events of the last 5 minutes

4.6 Startup and Shutdown

4.6.1 Power-On Behaviour

[#\[ISSUE:63631\]](#)

Requirement	Power-On Behaviour
Verification Technique	Test
Verification Idea	<p>Test with HIL-Simulator</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • OPL • Discrete

	Precondition: <ul style="list-style-type: none"> • FBIS is not powered Procedure: <ul style="list-style-type: none"> • FBIS is powered Acceptance Criteria: <ul style="list-style-type: none"> • Actuation system outputs correspond to Regular Beam Interlock.
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4.6.2 Power-On Self Test

[#\[ISSUE:63632\]](#)

Requirement	Power-On Self Test
Verification Technique	Test
Verification Idea	Test Power-On Self Test Preconditions: <ul style="list-style-type: none"> • TBD Required Interfaces: <ul style="list-style-type: none"> • TBD Procedure: <ul style="list-style-type: none"> • TBD Remark: <ul style="list-style-type: none"> • Detailed requirements can be specified after a FMEDA has been done for the hardware design

4.6.3 Shutdown Sequence

[#\[ISSUE:63633\]](#)

Requirement	Shutdown Sequence
Verification Technique	Demonstration
Verification Idea	Demonstrate Shutdown Required Interfaces: <ul style="list-style-type: none"> • OPL • Discrete Preconditions: <ul style="list-style-type: none"> • FBIS is powered • GLOBAL_BEAM_PERMIT is "OK" Procedure: <ul style="list-style-type: none"> • Shutdown FBIS Acceptance Criteria: <ul style="list-style-type: none"> • Actuation System Outputs correspond to Regular Beam Interlock

4.7 Processing Latency

4.7.1 Beam Permit Processing Latency

[#\[ISSUE:63471\]](#)

Requirement	Beam Permit Processing Latency
Verification Technique	Test
Verification Idea	Performance Test using HIL-Simulator Required Interfaces: <ul style="list-style-type: none"> • Discrete Preconditions:

	<ul style="list-style-type: none"> • GLOBAL_BEAM_PERMIT is "OK" <p>Procedure:</p> <ul style="list-style-type: none"> • Set GLOBAL_BEAM_PERMIT to "NOK" • Measure Time <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • Measured latency is < 5us.
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4.8 Diagnostic Interface

4.8.1 Diagnostic Interface

[#\[ISSUE:63045\]](#)

Requirement	Diagnostic Interface
Verification Technique	Demonstration
Verification Idea	TBD

4.8.2 On-Site Information

[#\[ISSUE:63046\]](#)

Requirement	On-Site Information
Verification Technique	Inspection
Verification Idea	TBD

4.9 Firmware Updates

4.9.1 Firmware Update

[#\[ISSUE:64267\]](#)

Requirement	Firmware Update
Verification Technique	Demonstration
Verification Idea	<p>Manual Testing</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • n/a <p>Preconditions:</p> <ul style="list-style-type: none"> • n/a <p>Procedure</p> <ul style="list-style-type: none"> • Download new firmware <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • New firmware is loaded

4.9.2 Firmware Acceptance

[#\[ISSUE:64271\]](#)

Requirement	Firmware Acceptance
Verification Technique	Demonstration
Verification Idea	<p>Manual Testing</p> <p>Required Interfaces:</p> <ul style="list-style-type: none"> • Firmware Update

	Preconditions: <ul style="list-style-type: none"> • n/a Procedure <ul style="list-style-type: none"> • Download invalid firmware Acceptance Criteria: <ul style="list-style-type: none"> • Invalid firmware is rejected
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4.9.3 Firmware Configuration Identification

[#\[ISSUE:64270\]](#)

Requirement	Firmware Configuration Identification
Verification Technique	Inspection
Verification Idea	Inspection of Firmware Configuration Identification Acceptance Criteria: <ul style="list-style-type: none"> • Firmware identification is according specification

5 Non-Functional System Requirements

5.1 Mechanical

5.1.1 Rack Mountable

[#\[ISSUE:62994\]](#)

Requirement	Rack Mountable
Verification Technique	Inspection
Verification Idea	Inspection of physical assemblies of the FBIS Precondition: <ul style="list-style-type: none"> • All physical assemblies are available Procedure: <ul style="list-style-type: none"> • Take measurements of the physical assemblies Acceptance Criteria: <ul style="list-style-type: none"> • Physical assemblies fit into a 19" rack

5.1.2 Height Units

[#\[ISSUE:63040\]](#)

Requirement	Height Units
Verification Technique	Inspection
Verification Idea	Inspection of physical assemblies of the FBIS Precondition: <ul style="list-style-type: none"> • All physical assemblies are available Procedure: <ul style="list-style-type: none"> • Check height unit occupation of the physical assemblies Acceptance Criteria: <ul style="list-style-type: none"> • Each physical assembly does not occupy more than 12 height units

5.1.3 Weight

[#\[ISSUE:63053\]](#)

Requirement	Weight
Verification Technique	Inspection
Verification Idea	<p>Inspection of physical assemblies of the FBIS</p> <p>Precondition:</p> <ul style="list-style-type: none"> All physical assemblies are available <p>Procedure:</p> <ul style="list-style-type: none"> Measure weight of the physical assemblies <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> None of the physical assemblies exceed the weight limit of 20kg

5.1.4 Identification

[#\[ISSUE:63041\]](#)

Requirement	Identification
Verification Technique	Inspection
Verification Idea	<p>Inspection of physical assemblies of the FBIS</p> <p>Precondition:</p> <ul style="list-style-type: none"> All physical parts are available <p>Procedure:</p> <ul style="list-style-type: none"> Check identification of the physical parts <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> Each physical part can be clearly identified as a part of the FBIS

5.2 Temperature

5.2.1 Operating Temperature Range

[#\[ISSUE:63048\]](#)

Requirement	Operating Temperature Range
Verification Technique	Demonstration
Verification Idea	<p>Demonstrate operation within temperature limits</p> <p>Procedure:</p> <ul style="list-style-type: none"> See FBIS Environmental Qualification Test Plan <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> See FBIS Environmental Qualification Test Plan

5.2.2 Storage Temperature Range

[#\[ISSUE:63049\]](#)

Requirement	Storage Temperature Range
Verification Technique	Demonstration
Verification Idea	<p>Demonstrate storage temperature range within temperature limits</p> <p>Procedure:</p> <ul style="list-style-type: none"> See FBIS Environmental Qualification Test Plan <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> See FBIS Environmental Qualification Test Plan

5.3 MTBF and Lifetime

5.3.1 Lifetime

[#\[ISSUE:63051\]](#)

Requirement	Lifetime
Verification Technique	Analysis
Verification Idea	<p>Calculate MTBF and Lifetime Procedure:</p> <ul style="list-style-type: none"> Reliability Prediction / FMEDA / RBD <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> TBD

5.3.2 MTBF

[#\[ISSUE:65103\]](#)

Requirement	MTBF
Verification Technique	Analysis
Verification Idea	<p>Calculate MTBF and Lifetime Procedure:</p> <ul style="list-style-type: none"> Reliability Prediction / FMEDA / RBD <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> TBD

5.4 Electrical

5.4.1 Power Supply

[#\[ISSUE:63055\]](#)

Requirement	Power Supply
Verification Technique	Inspection
Verification Idea	<p>Inspection of FBIS design Acceptance Criteria:</p> <ul style="list-style-type: none"> Power supply is including according to requirements text

5.4.2 EMI

[#\[ISSUE:63056\]](#)

Requirement	EMI
Verification Technique	Demonstration
Verification Idea	<p>Demonstrate operation within specified limits Procedure:</p> <ul style="list-style-type: none"> See FBIS Environmental Qualification Test Plan <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> See FBIS Environmental Qualification Test Plan

5.4.3 ESD

[#\[ISSUE:63057\]](#)

Requirement	ESD
Verification Technique	Demonstration
Verification Idea	<p>Demonstrate operation after ESD tests</p> <p>Procedure:</p> <ul style="list-style-type: none"> • See FBIS Environmental Qualification Test Plan <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • See FBIS Environmental Qualification Test Plan

5.5 Maintenance

5.5.1 Physical Unit Replacement

[#\[ISSUE:63629\]](#)

Requirement	Physical Unit Replacement
Verification Technique	Demonstration
Verification Idea	<p>Demonstrate exchange within 1h</p> <p>Procedure:</p> <ul style="list-style-type: none"> • Replace Line Items several times • Stop time per replacement <p>Acceptance Criteria:</p> <ul style="list-style-type: none"> • The average time for replacement is < 1h

5.5.2 Maintenance during Runtime

[#\[ISSUE:63630\]](#)

Requirement	Maintenance during Runtime
Verification Technique	
Verification Idea	n/a