

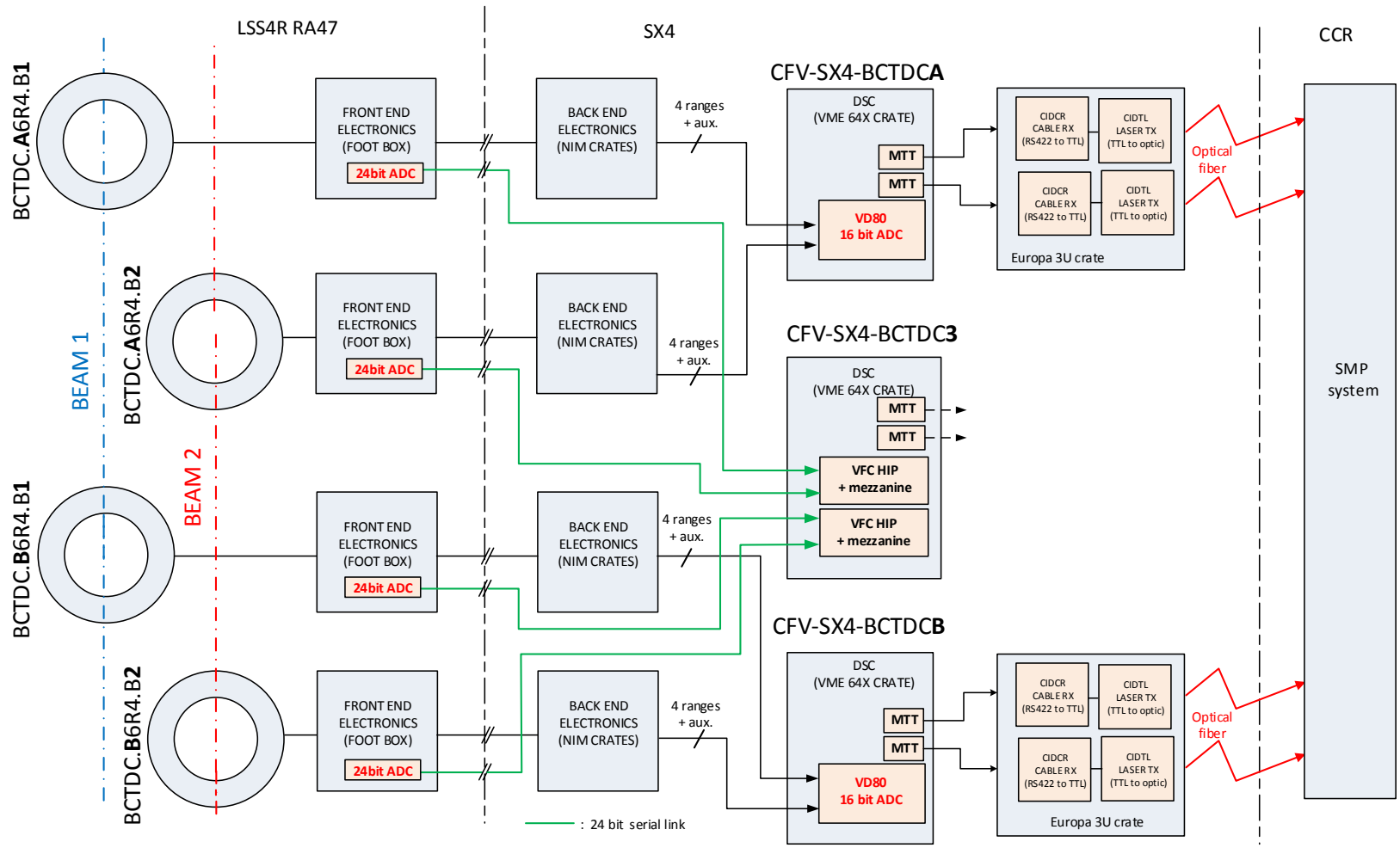
# **SMP: Summary of changes and re- commissioning after EYETS 2016-17**

**I. Romera, S. Gabourin**

# Summary of changes - LHC

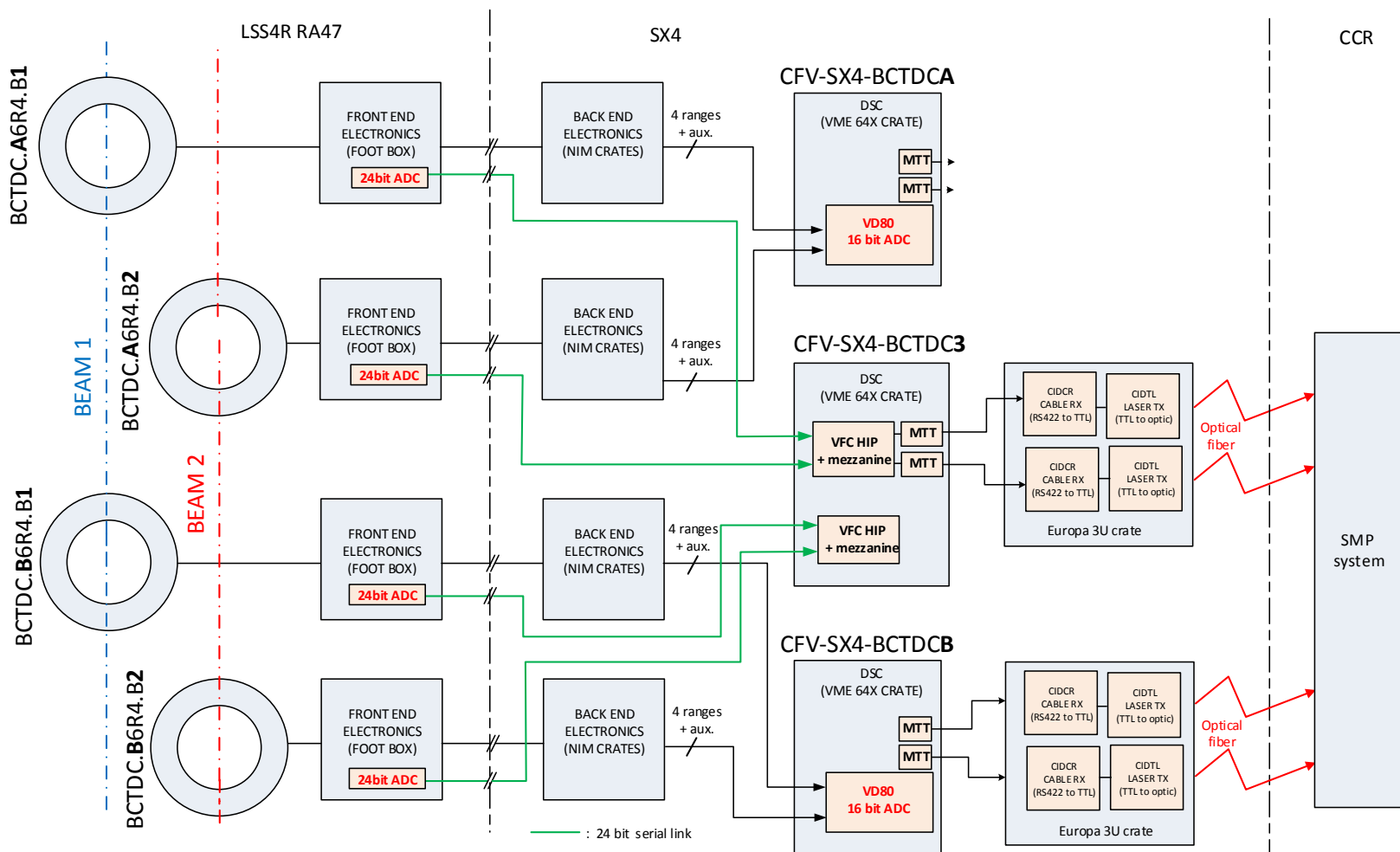
- **Timeout for Setup Beam Flag equations** => From 4.5h to 12h
- **Squeezing Factor window limits** => From  $\beta^* = 10\text{m}$  to 30m between max and min limits that can be set by LHC-OP
- **New intensity link from 24-bit BCTDC module** located close to monitors (see [P. Odier – 141<sup>st</sup> MPP](#))
  - 2 new optical links to SMP, **successfully tested in 2016 TS3**
  - **No change required on the SMP** (intensities have the same format and units)

# LHC BCTDC links to SMP in 2016



P. Odier

# LHC BCTDC links to SMP in 2017

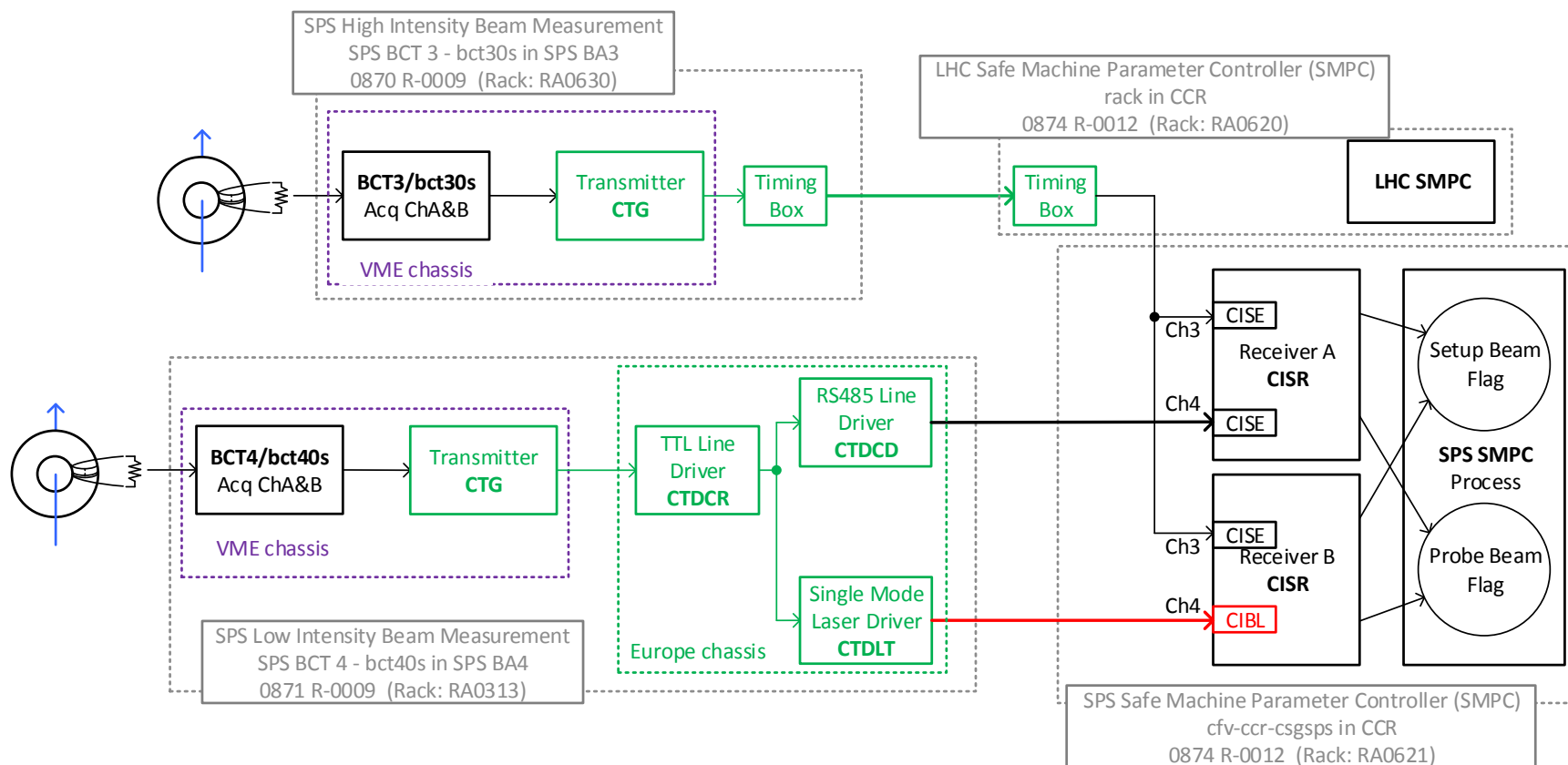


P. Odier

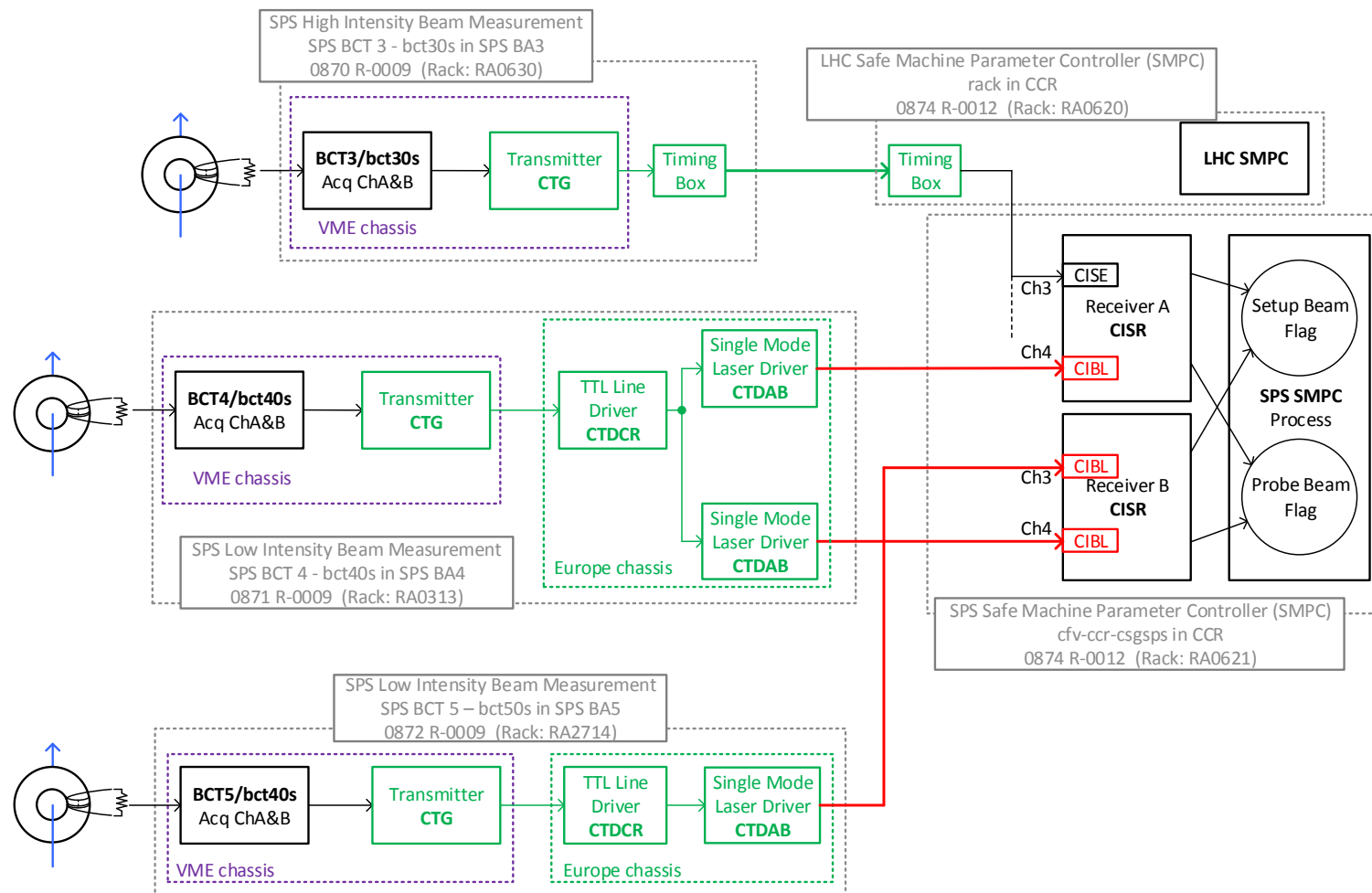
# Summary of changes - SPS

- **No changes on firmware/hardware**
- **New link from BCT5 in BA5 for high intensity beam measurements (protons), 16 bit, 100Samples/s, rms noise ~ 1.5E9 charges (see P. Odier – 141<sup>st</sup> MPP)**
- **Copper link from BCT4 has been replaced by optical link (CTDAB and CIBL)**

# SPS BCTDC links to SMP in 2016



# SPS BCTDC links to SMP in 2017



# Machine checkout

- Commissioning steps defined on **MPS document** ([EDMS 1112187](#))
- **LHC**
  - Verification of **intensity reception** (especially from new 24-bit BCTDC during/after calibration)
  - Verification of **energy reception** with a ramp from injection to physics (no circulating beam) **and flags generation and transmission**
  - Verification of **SFs and broadcast to GMT**
- **SPS**
  - Verification of **intensity reception** (especially from new BCT5 and new BCT4 optical channel), **flags generation** (SBF and PBF) **and transmission** to EXT BICs and SPS Timing
  - Verification of **energy reception, flags generation** (E\_LHC\_FLAG, E\_AWAKE\_FLAG, E\_HIRADMAT\_FLAG) **and transmission** to extraction BICs and LHC timing



# Commissioning with beam

- **LHC**

- **Verification of BPF** reception and transmission for both beams
- **Verification of SBF equations** (NORMAL, RESTRICTED, BEAM\_SETUP & IONS) for different intensities and energies, and SBF transmission
- **Verification of Moveable Devices and Stable Beam flag** generation and transmission
- **Cross checker** validation

- **SPS**

- **Verify correct flag generation (PBF and SBF) and transmission to EXT BICs and GMT (for  $I < 1E11$  p+,  $> 1e11$  p+,  $> 5E11$  p+)**

# SPARE SLIDES

# SPS PBF, SBF, ENERGY

Safe Machine Parameters in CCC : Detailed Overview

**Device Tree**

- SMPC
  - SPS
    - RA
    - RB
    - GA
    - GB
    - A
  - LHC
    - RA
    - RB
    - GA
    - GB
    - A
    - C
- CISV
  - BIC
  - CCR.CIB.1

**Board Info**

Board Name : CISX  
 Variant Name : GS  
 Slot Number : 6

**Monitor FPGA Info**

Version : 1.2  
 Revision : 2.0  
 ISE Version : 13.1.0  
 Percent used : 73%  
 UTC : 07-12-11 16:26:53

**Control FPGA Info**

Version : 1.3  
 ISE Version : 9.1.3  
 Percent used : 41%  
 UTC : 07-12-10 19:17:41

**Subscription State**

UPDATE :

**From Sources**

BCT4/40S Intensity A 0.0E0 [p]  
 BCT4/40S Intensity B 0.0E0 [p]

BCT3/30S Intensity A 1.0E10 [p]  
 BCT3/30S Intensity B 1.0E10 [p]

BEM4 Energy Link A 0.000 GeV  
 BEM4 Energy Link B 0.032 GeV  
 BEM6 Energy Link A 0.000 GeV  
 BEM6 Energy Link B 0.000 GeV

**Generation**

1 out of 2 : Select A then B → BCT4/40S Intensity 1.6777215E15 [p] ≤ 1.0E11 [p] = **Probe Beam Limit**

Operator Probe Beam Limit 1.5E10 [p] →

1 out of 2 : Select A then B → BCT3/30S Intensity 6.5535E14 [p] ≤ 5.0E11 [p] = **Setup Beam Limit**

1 out of 4 : Select BEM4 A then BEM4 B then BEM6 A then BEM6 B →

**AWAKE** Lower Limit 397.440 GeV ≤ **Machine Energy** ≤ 402.600 GeV **Upper Limit**  
**HiRadMat** 437.400 GeV ≤ 0.000 GeV ≤ 442.560 GeV  
**LHC** 448.440 GeV ≤ 0.000 GeV ≤ 453.600 GeV

**To Arbiter & Extraction BIS**

SPS Probe Beam Flag FALSE

SPS Setup Beam Flag FALSE

Energy AWAKE FALSE

Energy HiRadMat FALSE

Energy LHC FALSE

# LHC SBF

Safe Machine Parameters in CCC : Detailed Overview

**Device Tree**

- SMPC
  - SPS
    - RA
    - RB
    - GA
    - GB
  - LHC
    - RA
    - RB
    - GA
    - GB
    - A
    - C
  - CISV
    - BIC
    - CCR.CIB.1

**Data Sources**

Slow BCT Beam-1 A	0.0E0 [p]
Slow BCT Beam-1 B	5.0E9 [p]
Slow BCT Beam-2 A	1.2E9 [p]
Slow BCT Beam-2 B	4.6E9 [p]
BETS1 Reference RA	450.00 GeV
BETS2 Reference RB	450.00 GeV
BETS1 Interlock RA	450.00 GeV
BETS2 Interlock RB	450.00 GeV

Beam Mode: NO\_BEAM

Squeezing Factor IR1	8.25 m
Squeezing Factor IR2	8.25 m
Squeezing Factor IR5	8.25 m
Squeezing Factor IR8	8.25 m

BPF (BPM) 1A	Horizontal Beam Position	F
BPF (BPM) 1C	Vertical Beam Position	F
BPF 1E	Fast Intensity Measurement	F
BPF (BPM) 2A	Horizontal Beam Position	F
BPF (BPM) 2C	Vertical Beam Position	F
BPF 2E	Fast Intensity Measurement	F

Optics ID Ti2	0
Optics ID Ti8	0

**Setup Beam Flag Generation**

```

    graph TD
      subgraph Intensity
        I1[2 out of 2 Select Highest] --> B1I[Beam-1 Intensity: 5.0E9 [p]]
        I2[2 out of 2 Select Highest] --> B2I[Beam-2 Intensity: 4.6E9 [p]]
      end
      B1I --> S4[2 out of 4 Select Highest]
      B2I --> S4
      S4 --> ME[Machine Energy: 450.00 GeV]
      ME --> CS[Calculate SBF Limit]
      CS --> SBL[Set-up Beam Limit: 5.0E11 [p]]
      SBL --> C1[Calculate]
      SBL --> C2[Calculate]
      C1 --> ASBF2[Actual SBF 2: FALSE]
      C2 --> ASBF1[Actual SBF 1: FALSE]
      ASBF2 --> F1[Force]
      ASBF1 --> F1
      F1 --> F2[Force]
      F2 --> ASBF1
      F2 --> ASBF2
      F2 --> SBF1[Setup Beam Flag]
      F2 --> SBF2[Setup Beam Flag]
      F2 --> PBF1[Beam Presence Flag]
      F2 --> PBF2[Beam Presence Flag]
      F2 --> OI2[OpID_Ti2]
      F2 --> OI8[OpID_Ti8]
      
```

**To Arbiter**

Beam-1 Intensity	0.0E0 [p]
Beam-2 Intensity	0.0E0 [p]
Machine Energy	450.00 GeV
Moveable Devices Allowed In	FALSE
Stable Beams	FALSE
Beta* IR1	8.25 m
Beta* IR2	8.25 m
Beta* IR5	8.25 m
Beta* IR8	8.25 m
Setup Beam Flag	Beam-1: FALSE, Beam-2: FALSE
Beam Presence Flag	Beam-1: FALSE, Beam-2: FALSE
OpID_Ti2	0
OpID_Ti8	0

**To Extraction BIS**

Setup Beam Flag	Beam-1: FALSE, Beam-2: FALSE
Beam Presence Flag	Beam-1: FALSE, Beam-2: FALSE

**Board Info**

Board Name: CISX  
 Variant Name: GL  
 Slot Number: 6

**Monitor FPGA Info**

Version: 2.3  
 Revision: 2.0  
 ISE Version: 13.1.0  
 Percent used: 100%  
 UTC: 19-03-15 13:00:00

**Control FPGA Info**

Version: 0.8  
 ISE Version: 10.1.0  
 Percent used: 92%  
 UTC: 19-03-15 13:00:00

**Subscription State**

UPDATE:

# LHC STB & Moveable devices

Safe Machine Parameters in CCC : Detailed Overview

**Device Tree**

- SMPC
  - SPS
    - RA
    - RB
    - GA
    - GB
  - LHC
    - RA
    - RB
    - GA
    - GB
    - A
    - C
  - CISV
    - BIC
    - CCR.CIB.1

**Data Sources**

Slow BCT Beam-1 A	0.0E0 [p]
Slow BCT Beam-1 B	3.9E9 [p]
Slow BCT Beam-2 A	1.2E9 [p]
Slow BCT Beam-2 B	3.1E9 [p]
BETS1 Reference RA	450.00 GeV
BETS2 Reference RB	450.00 GeV
BETS1 Interlock RA	450.00 GeV
BETS2 Interlock RB	450.00 GeV

Beam Mode:

Squeezing Factor IR1	9.40 m
Squeezing Factor IR2	9.40 m
Squeezing Factor IR5	9.40 m
Squeezing Factor IR8	9.40 m

BPF (BPM) 1A Horizontal Beam Position	F
BPF (BPM) 1C Vertical Beam Position	F
BPF 1E Fast Intensity Measurement	F
BPF (BPM) 2A Horizontal Beam Position	F
BPF (BPM) 2C Vertical Beam Position	F
BPF 2E Fast Intensity Measurement	F

Optics ID Ti2	0
Optics ID Ti8	0

**Moveable Devices Allowed In / Stable Beams Generation**

**Physics Energy Calculation:**

Lower limit	Current	Upper limit	Physics Energy
3994.68 GeV	450.00 GeV	4002.24 GeV	FALSE

2 out of 4 Select Highest

**Beam Squeezed Calculation:**

Lower limit	Current	Upper limit	Beam Squeezed
IR1: 10.92 m	9.40 m	11.01 m	FALSE
IR2: 1.96 m	9.40 m	2.05 m	FALSE
IR5: 10.96 m	9.40 m	11.05 m	FALSE
IR8: 9.96 m	9.40 m	10.05 m	FALSE

Calculate MDI/STB

**To Arbiter**

Beam-1 Intensity	0.0E0 [p]
Beam-2 Intensity	0.0E0 [p]
Machine Energy	450.00 GeV
Moveable Devices Allowed In	FALSE
Stable Beams	FALSE
Beta* IR1	9.40 m
Beta* IR2	9.40 m
Beta* IR5	9.40 m
Beta* IR8	9.40 m
Setup Beam Flag	
Beam-1	FALSE
Beam-2	FALSE
Beam Presence Flag	
Beam-1	FALSE
Beam-2	FALSE
OpID_Ti2	0
OpID_Ti8	0

**To Extraction BIS**

Setup Beam Flag	
Beam-1	FALSE
Beam-2	FALSE
Beam Presence Flag	
Beam-1	FALSE
Beam-2	FALSE