

# **BIS: Summary of changes and re-commissioning after YETS 2017-18**

I. Romera, C. Martin, R. Secondo, J. Uythoven

# Summary of changes

- **LHC BIS**

- No hardware/firmware modifications
- No new user connections
- We have put in place the local loop in P6 on 12.01.2018
  - Procedure EDMS <https://edms.cern.ch/document/1739915/1>

- **SPS BIS**

- New connection on BA6 SPS ring BIC
  - Crab cavity ring, input 5, non-maskable

- **SPS Extraction BIS**

- New connection on TT60A BIC
  - Crab cavity LSS6, input 7, non-maskable

# Key dates

- **22.03** => Operational configuration re-established (remove local loops)
- **30.03-02.04 (Easter weekend)** => Best effort support for BIS operation
  - Pilot beams at injection energy only
- **03.04-04.04** => BIS MPS tests with loop closed
  - Including ABT, dedicated machine tests for 4 – 8 hours

# HWC and Machine checkout

- MPS commissioning procedure ([EDMS 889281](#))
- **HWC**
  - Test links from User Systems to BIS
  - Test links from SIS to BIS
  - Test Setup Beam Flag transmission through GMT
  - Test links from BIS to LBDS
  - Test links from LHC-BIS to Injection-BIS
- **Machine checkout**
  - Run pre-operational checks with no errors
  - Provoke beam dump and check BIS IPOC => result ok

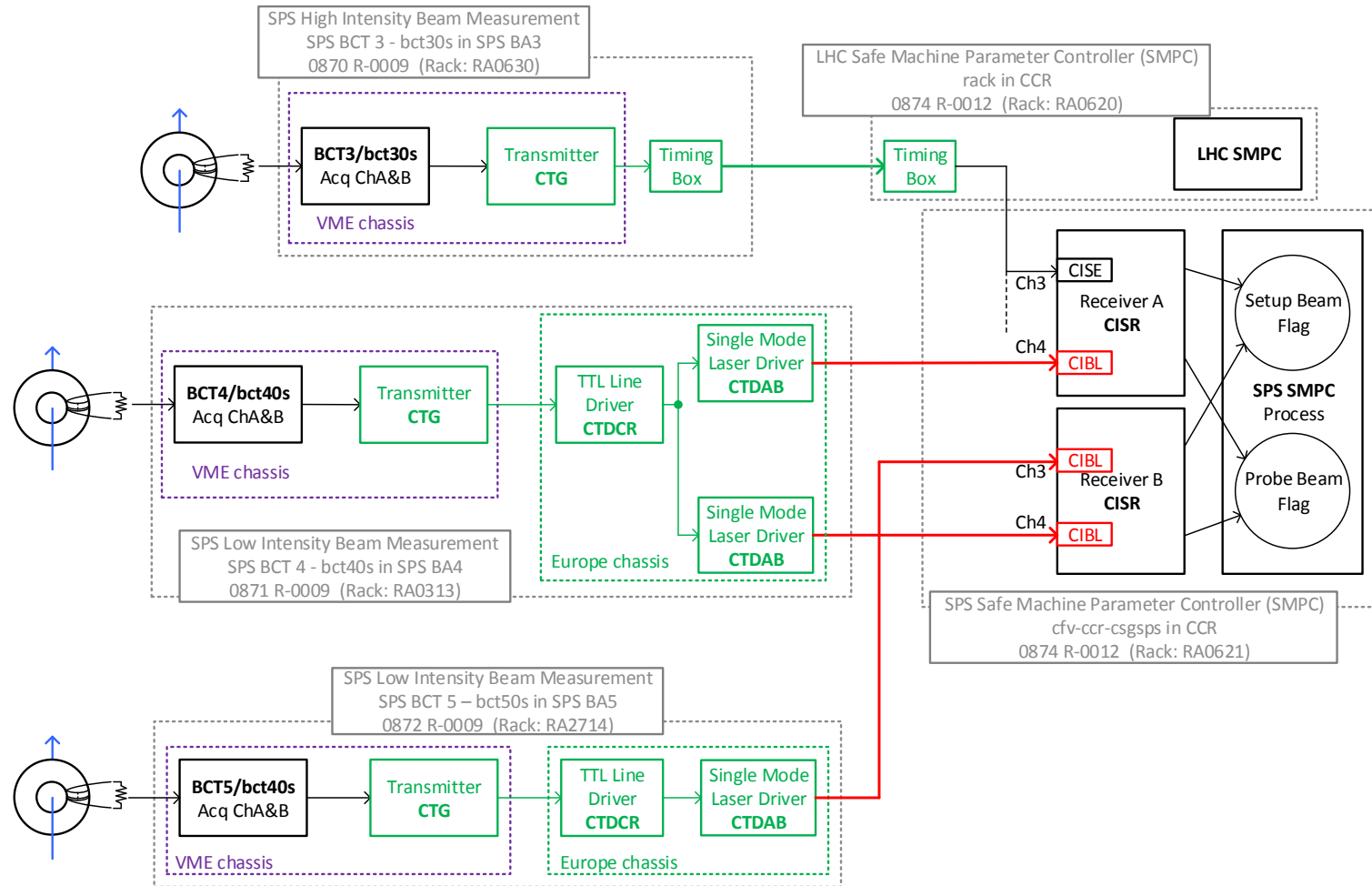
# **SMP: Summary of changes and re-commissioning after YETS 2017-18**

I. Romera, C. Martin, R. Secondo, J. Uythoven

# Summary of changes

- **LHC:**
  - No changes on hardware/firmware
  - SMP to GMT cable replaced by spare (due to PLL errors on the timing receiver CTR)
- **SPS:**
  - **Hardware:**
    - 2x receiver boards (CISR) were replaced to accommodate changes on BCT headers
  - **Firmware:**
    - New format encoding of BCT headers
    - New header values for BCT 4/5

# SPS BCTDC links to SMP



# SPS BCTDC headers format

	2017		2018	
Header Bit	Bit Name	BCT Valid Header (1/0)	Bit Name	BCT Valid Header (1/0)
7	0	always '0'	Not applicable	always '0'
6	I10/I8	'1' when the payload is from BCT3 ( $n \times 10^{10}$ ) '0' when the payload is from BCT4 ( $n \times 10^8$ )	I10/I8	'1' when the payload is from BCT3 OR BCT5 ( $n \times 10^{10}$ ) '0' when the payload is from BCT4 ( $n \times 10^8$ )
5	0	always zero	Redundant/Single source	'1' when the source is redundant (connected to both CISR A and B) '0' when the source is single (connected to only one CISR receiver)
4	0	always zero	Not applicable	always '0'
3	Operational / NOT Operational	'1' when the BCT is operational '0' when the BCT is not operational	Operational / NOT Operational	'1' when the BCT is operational '0' when the BCT is not operational
2	Simulation/ Real	'1' when the payload is simulation data '0' when the payload is real data	BA bit 2	'011' = BA 3 '100' = BA 4 '101' = BA 5
1	OK/ Fault	'1' when the BCT is OK '0' when the BCT is in a faulty state	BA bit 1	
0	Calibrated/ NOT Calibrated	'1' when the BCT is calibrated '0' when the BCT is not calibrated	BA bit 0	



# SPS BCTDC header values

SPS.BCTDC.31832 - BA3		
Header Bit	Bit Name	BCT3 Valid Header <b>4B</b>
7	Not applicable	0
6	<b>I10/I8</b>	1
5	<b>Redundant/Single source</b>	0
4	Not applicable	0
3	<b>Operational / NOT Operational</b>	1
2	BA bit 2	0
1	BA bit 1	1
0	BA bit 0	1

SPS.BCTDC.41435 - BA4		
Header Bit	Bit Name	BCT4 Valid Header <b>2C</b>
7	Not applicable	0
6	<b>I10/I8</b>	0
5	<b>Redundant/Single source</b>	1
4	Not applicable	0
3	<b>Operational / NOT Operational</b>	1
2	BA bit 2	1
1	BA bit 1	0
0	BA bit 0	0

SPS.BCTDC.51895 - BA5		
Header Bit	Bit Name	BCT5 Valid Header <b>4D</b>
7	Not applicable	0
6	<b>I10/I8</b>	1
5	<b>Redundant/Single source</b>	0
4	Not applicable	0
3	<b>Operational / NOT Operational</b>	1
2	BA bit 2	1
1	BA bit 1	0
0	BA bit 0	1

# New headers validated with BE-BI

**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 : R  
Slot Number : 5

**Monitor FPGA Info**

Version : 5.2  
Revision : 2.0  
ISE Version : 11.1.0  
Percent used : 95%  
UTC : 03-09-12 11:07:50

**Control FPGA Info**

Version : 0.3  
ISE Version : 0.0.0  
Percent used : 41%  
UTC : never received

**Subscription State**

UPDATE :           

**Reset Receiver Counters Panel**

Reset All RX error counters | Reset All TX error counters

**SOURCE 1 - SPS/BEM4/Operational**

Value received : 0x820000DD at time : 07-03-18 15:11:38  
Polarity : INVERTED Ms received : FALSE  
Source Alive : TRUE  
Error received : no error at time : never received  
Error Count : 0  
Value transmitted : 0x7B000000 decoded : 0.000 GeV  
Mon. Error transmitted : no error at time : never received  
Ctrl. Error transmitted : no error at time : never received  
Error Count : 0

**SOURCE 2 - SPS/BEM6/Operational**

Value received : 0x8A00008C at time : 07-03-18 15:11:38  
Polarity : INVERTED Ms received : FALSE  
Source Alive : TRUE  
Error received : no error at time : never received  
Error Count : 0  
Value transmitted : 0x6B000000 decoded : 0.000 GeV  
Mon. Error transmitted : no error at time : never received  
Ctrl. Error transmitted : no error at time : never received  
Error Count : 0

**SOURCE 3 - SPS/BCT5**

Value received : 0x4D000000 at time : 07-03-18 15:11:37  
Polarity : NORMAL Ms received : TRUE  
Source Alive : TRUE  
Error received : no error at time : never received  
Error Count : 0  
Value transmitted : 0x8B000000 decoded : 0.0E0 [p]  
Mon. Error transmitted : no error at time : never received  
Ctrl. Error transmitted : no error at time : never received  
Error Count : 0

**SOURCE 4 - SPS/BCT4**

Value received : 0x2C000006 at time : 07-03-18 15:11:37  
Polarity : NORMAL Ms received : TRUE  
Source Alive : TRUE  
Error received : no error at time : never received  
Error Count : 0  
Value transmitted : 0x9B000006 decoded : 6.0E8 [p]  
Mon. Error transmitted : no error at time : never received  
Ctrl. Error transmitted : no error at time : never received  
Error Count : 0

# Machine checkout

- Commissioning steps defined on **MPS document** ([EDMS 1112187](#))
- **LHC**
  - Validation of **intensity reception – DONE with calibration patterns**
  - Validation of **energy reception** with a ramp from injection to physics (no circulating beam) **and flags generation and transmission**
  - Validation of **SFs and broadcast to GMT**
- **SPS**
  - Validation of **intensity reception, flags generation** (SBF and PBF) **and transmission** to EXT BICs and SPS Timing – **DONE with calibration patterns**
  - Validation of **energy reception, flags generation** (E\_LHC\_FLAG, E\_AWAKE\_FLAG, E\_HIRADMAT\_FLAG) **and transmission** to extraction BICs and **GMT**

# 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 Beams** 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

**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 7.0E8 [p]

BCT4/40S Intensity B 7.0E8 [p]

BCT3/30S Intensity A 2.0E10 [p]

BCT5/50S Intensity B 0.0E0 [p]

BEM4 Energy Link A 0.000 GeV

BEM4 Energy Link B 0.008 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] ≤ **Probe Beam Limit** 1.0E11 [p] =

**Operator Probe Beam Limit**  
1.0E11 [p]

1 out of 2 : Select A then B → BCT3/BCT5 Intens... 6.5535E14 [p] ≤ **Setup Beam Limit** 5.0E11 [p] =

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

	Lower Limit		Upper Limit
AWAKE	397.440 GeV	≤	402.600 GeV
HiRadMat	437.400 GeV	≤	442.560 GeV
LHC	448.440 GeV	≤	453.600 GeV
<b>Machine Energy</b>		≤	0.000 GeV

**To Arbiter & Extraction BIS**

SPS Probe Beam Flag FALSE

SPS Setup Beam Flag FALSE

Energy AWAKE FALSE

Energy HiRadMat FALSE

Energy LHC FALSE

SMP recommissioning EYETS 2017-18

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# LHC SBF

**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 : 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 : 0.9  
 ISE Version : 10.1.0  
 Percent used : 92%

UTC : 13-04-17 09:57:10

**Subscription State**

UPDATE :

**Data Sources**

Slow BCT Beam-1 A: 3.7E9 [p]  
 Slow BCT Beam-1 B: 0.0E0 [p]  
 Slow BCT Beam-2 A: 0.0E0 [p]  
 Slow BCT Beam-2 B: 0.0E0 [p]

BETS1 Reference RA: 6500.28 GeV  
 BETS2 Reference RB: 6500.28 GeV  
 BETS1 Interlock RA: 6500.28 GeV  
 BETS2 Interlock RB: 6500.28 GeV

Beam Mode: NO\_BEAM

Squeezing Factor IR1: 0.00 m  
 Squeezing Factor IR2: 0.00 m  
 Squeezing Factor IR5: 0.00 m  
 Squeezing Factor IR8: 0.00 m

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

Optics ID Ti2: 0  
 Optics ID Ti8: 0

**Setup Beam Flag Generation**

2 out of 2 Select Highest → Beam-1 Intensity: 3.7E9 [p]  
 2 out of 2 Select Highest → Beam-2 Intensity: 0.0E0 [p]

2 out of 4 Select Highest → Machine Energy: 6500.28 GeV

Calculate SBF Limit → Set-up Beam Limit: 1.21E10 [p]

Equation Type: NORMAL  
 Timeout: 0 s

Calculate → Actual SBF 2: TRUE  
 Calculate → Actual SBF 1: TRUE

Force SBF 2 to False: NOT FORCED  
 Force SBF 1 to False: NOT FORCED

Force → Force

**To Arbitrator**

Beam-1 Intensity: 0.0E0 [p]  
 Beam-2 Intensity: 0.0E0 [p]  
 Machine Energy: 6500.16 GeV

Moveable Devices Allowed In: FALSE  
 Stable Beams: FALSE

Beta\* IR1: 0.00 m  
 Beta\* IR2: 0.00 m  
 Beta\* IR5: 0.00 m  
 Beta\* IR8: 0.00 m

Setup Beam Flag  
 Beam-1: TRUE  
 Beam-2: TRUE

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

OpID\_Ti2: 0  
 OpID\_Ti8: 0

**To Extraction BIS**

Setup Beam Flag  
 Beam-1: TRUE  
 Beam-2: TRUE

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

# LHC STB & Moveable devices

**Device Tree**

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

**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 : 0.9  
 ISE Version : 10.1.0  
 Percent used : 92%

UTC : 13-04-17 09:57:10

**Subscription State**

UPDATE :

**Data Sources**

Slow BCT Beam-1 A: 3.4E9 [p]  
 Slow BCT Beam-1 B: 0.0E0 [p]  
 Slow BCT Beam-2 A: 0.0E0 [p]  
 Slow BCT Beam-2 B: 0.0E0 [p]

BETS1 Reference RA: 6500.28 GeV  
 BETS2 Reference RB: 6500.28 GeV  
 BETS1 Interlock RA: 6500.28 GeV  
 BETS2 Interlock RB: 6500.28 GeV

Beam Mode: NO\_BEAM

Squeezing Factor IR1: 0.00 m  
 Squeezing Factor IR2: 0.00 m  
 Squeezing Factor IR5: 0.00 m  
 Squeezing Factor IR8: 0.00 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: 6492.60 GeV ≤ Current: 6500.28 GeV ≤ Upper limit: 6504.00 GeV = TRUE

2 out of 4 Select Highest

**Beam Squeezed Calculation:**

IR	Lower limit	Current	Upper limit	Result
IR1	0.28 m	0.00 m	19.80 m	<span style="background-color: red; color: black;">FALSE</span>
IR2	9.50 m	0.00 m	20.00 m	<span style="background-color: red; color: black;">FALSE</span>
IR5	0.28 m	0.00 m	19.80 m	<span style="background-color: red; color: black;">FALSE</span>
IR8	2.90 m	0.00 m	25.00 m	<span style="background-color: red; color: black;">FALSE</span>

Beam Squeezed: FALSE

**To Arbitrer**

Beam-1 Intensity: 0.0E0 [p]  
 Beam-2 Intensity: 0.0E0 [p]

Machine Energy: 6500.28 GeV

Moveable Devices Allowed In: FALSE  
 Stable Beams: FALSE

Beta\* IR1: 0.00 m  
 Beta\* IR2: 0.00 m  
 Beta\* IR5: 0.00 m  
 Beta\* IR8: 0.00 m

Setup Beam Flag  
 Beam-1: TRUE  
 Beam-2: TRUE

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

OpID\_Ti2: 0  
 OpID\_Ti8: 0

**To Extraction BIS**

Setup Beam Flag  
 Beam-1: TRUE  
 Beam-2: TRUE

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