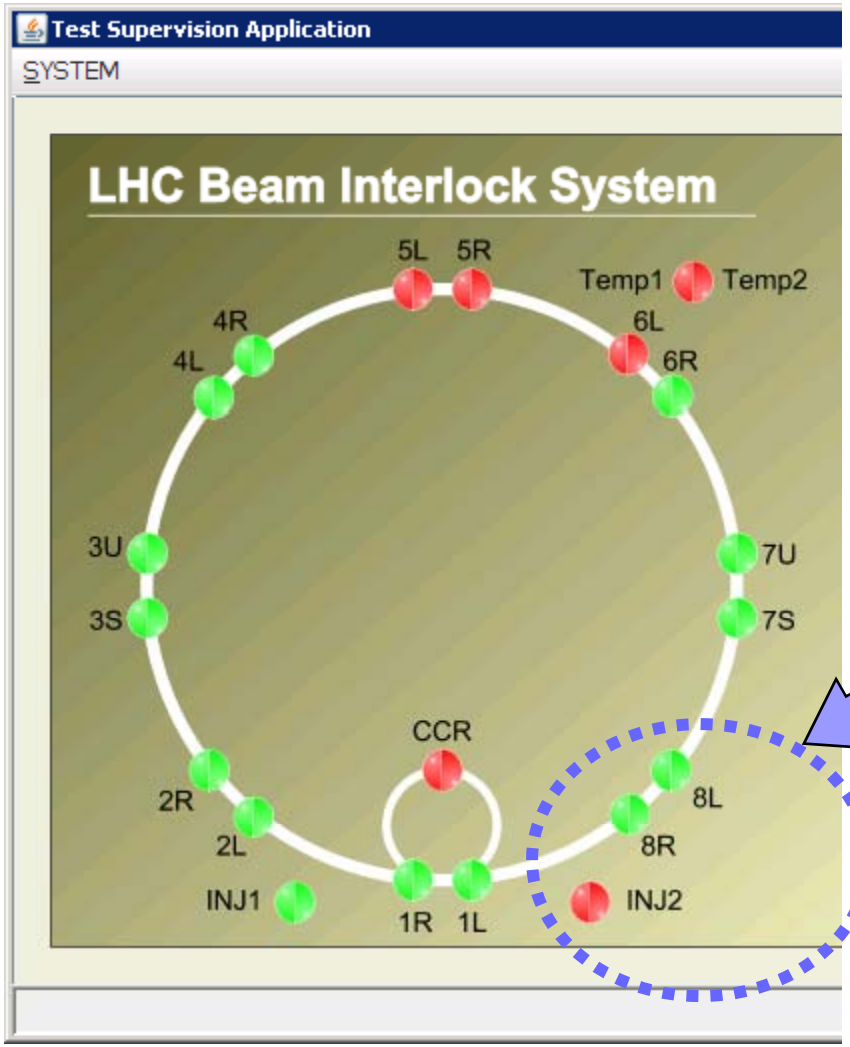


BIS Commissioning in Point 8

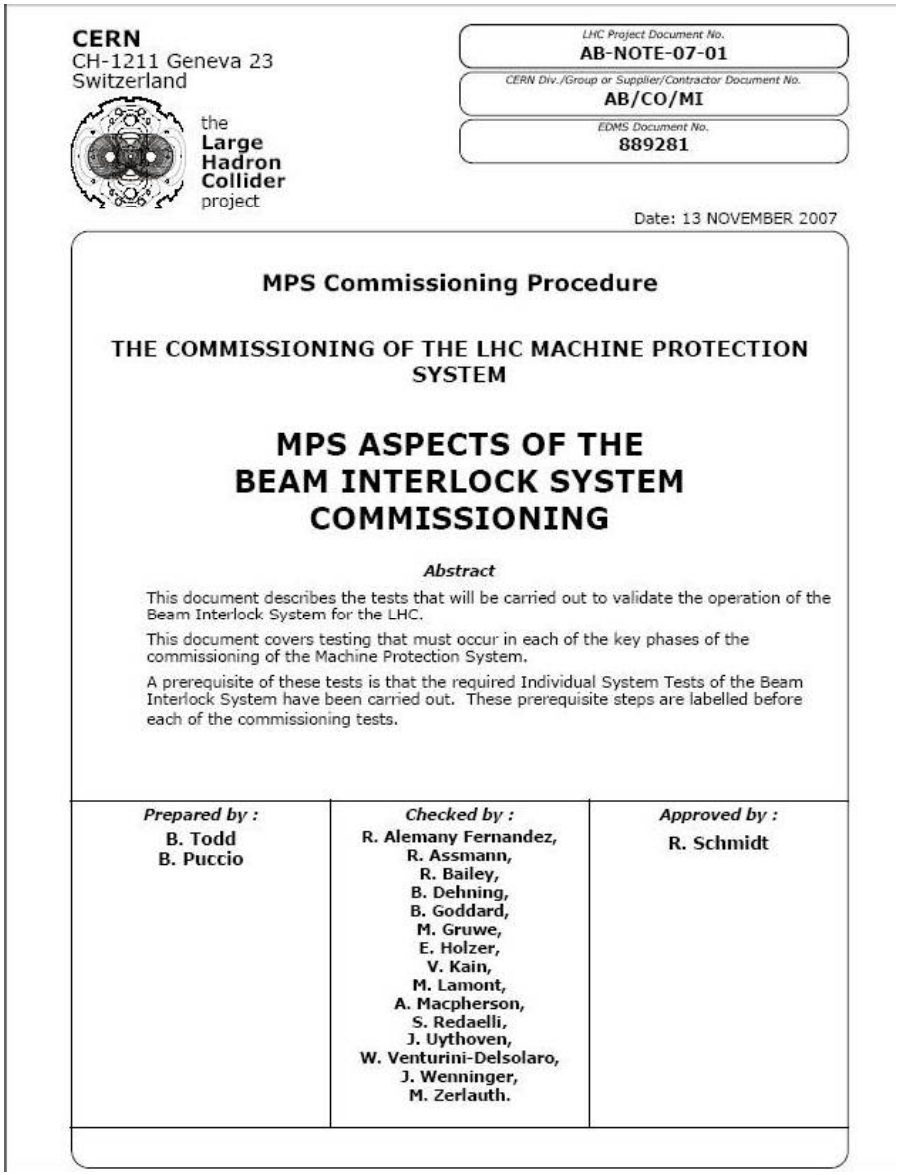
on week#17

(21st-> 25th April 08)

2 Controllers for LHC-ring BIS:
26 links in total

1 Controller for LHC-ring BIS:
7 available links

Commissioning Procedure



CERN
CH-1211 Geneva 23
Switzerland
the **Large Hadron Collider** project

LHC Project Document No.
AB-NOTE-07-01
CERN Div./Group or Supplier/Contractor Document No.
AB/CO/MI
EDMS Document No.
889281

Date: 13 NOVEMBER 2007

MPS Commissioning Procedure

THE COMMISSIONING OF THE LHC MACHINE PROTECTION SYSTEM

MPS ASPECTS OF THE BEAM INTERLOCK SYSTEM COMMISSIONING

Abstract

This document describes the tests that will be carried out to validate the operation of the Beam Interlock System for the LHC.

This document covers testing that must occur in each of the key phases of the commissioning of the Machine Protection System.

A prerequisite of these tests is that the required Individual System Tests of the Beam Interlock System have been carried out. These prerequisite steps are labelled before each of the commissioning tests.

Prepared by :	*Checked by :*	*Approved by :*
B. Todd B. Puccio	R. Alemany Fernandez, R. Assmann, R. Bailey, B. Dehning, B. Goddard, M. Gruwe, E. Holzer, V. Kain, M. Lamont, A. Macpherson, S. Redaelli, J. Uythoven, W. Venturini-Delsolaro, J. Wenninger, M. Zerlauth.	R. Schmidt

CIBU Documentation

CERN AB DEPARTMENT
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CERN Div./Group or Supplier/Contractor Document No
AB/CO/MI
EDMS Document No.
636589
Date: 16 OCTOBER 2006

TECHNICAL NOTE

USER INTERFACE TO THE BEAM INTERLOCK SYSTEM

Abstract

This note describes the functionality and the requirements of any User System's connection to the Beam Interlock System via the User Interface; this connection is critical for machine safety and must be implemented in a very specific manner to provide safe and reliable interlocking. The same unit is provided for all of the different applications of the Beam Interlock System; LHC ring, LHC injection, SPS ring and SPS Extraction & Transfer Lines.

Written by :
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A. Dinius AB/PO
B. Puccio AB/CO

4.3 PINOLOGY OF CIBU SOCKETS

The socket on the *User Interface* (*CIBU*) for the connection from/to the *User System* is a **Burndy 8-Pin UT07**. The pinology of the socket is shown in the table directly below, with the schematic on the right:

PIN	Schematic Name	Function
1	GND	EMC improvement by ground proximity
2	GND	EMC improvement by ground proximity
3	User.Permit.A+	Current Loop + for USER_PERMIT 'A'
4	User.Permit.A-	Current Loop – for USER_PERMIT 'A'
5	User.Permit.B+	Current Loop + for USER_PERMIT 'B'
6	User.Permit.B-	Current Loop – for USER_PERMIT 'B'
7	Beam.Info.+	BEAM_INFO + collector
8	Beam.Info.-	BEAM_INFO - emitter
Shield	GND	EMC improvement by enclosure

Table 10: Pinology of CIBU User Connection

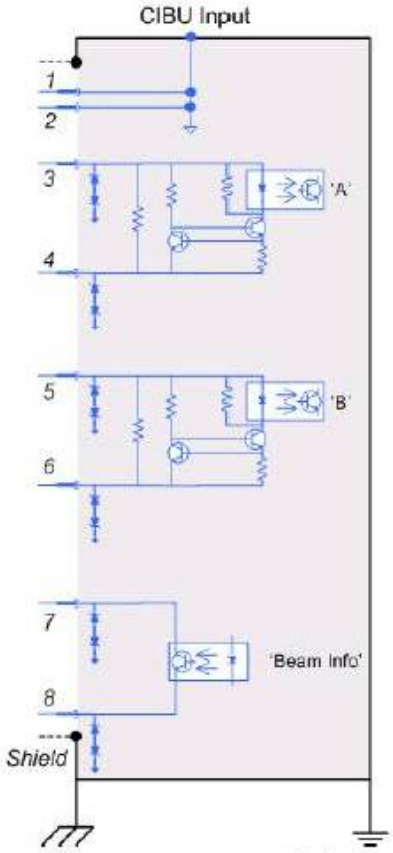


Figure 11: CIBU Input Circuit Schematic

Input current limits

4. ELECTRONIC INTERFACE REQUIRED WITH THE USER SYSTEMS

4.1 GIVING USER_PERMIT

As the safety and reliability requirements of the BIS are strict, there are many rules to follow concerning the interface to the User System. The redundant USER_PERMIT signals **'A'** and **'B'** are generated by two separate current loops from the User System, for each of the two current loops the following applies:

Input Loop Current *(mA)*	USER_PERMIT *(Boolean)*
< 1	FALSE (user **DOES NOT** give permission for beam)
≥ 9	TRUE (user gives permission for beam)

Table 6: Function of the Input Current Loops for USER_PERMIT

Note that between the values of 1 and 9 milliamps, the value of USER_PERMIT is either TRUE or FALSE, depending on the age of the installed equipment. A newer optocoupler will react to lower levels of current, whereas an ageing device will have a higher threshold of current.

Essentially USER_PERMIT is guaranteed FALSE when the current is less than one milliamp, it is guaranteed TRUE when the current is greater than nine milliamps.

CIBU Input Specifications

4.4 USER SYTEM TO BIS INPUT/OUTPUT SPECIFICATIONS

The circuit on the previous page shows the complete interface, care must be taken not to exceed the specification of any of the components used, in particular the optocouplers for the user permit signals.

4.4.1 GUARANTEED INPUT SPECIFICATIONS

Name	Description	Value
V_{ins} (max)	Maximum voltage allowed on a single USER.PERMIT.+ or .- line	33 V
V_{in} (max)	Maximum Voltage allowed from USER.PERMIT.+ to USER.PERMIT.-	~25V
V_{in} (min)	Minimum voltage needed across circuit for USER_PERMIT = TRUE	~3 V
V_{in} (rev)	Maximum negative Voltage allowed from USER.PERMIT.+ to USER.PERMIT.-	5V
dV_{in}/dt (max)	Maximum rate of change of V_{in} with respect to time	5000 V/µs
I_{intrue} (min)	Minimum current from USER.PERMIT.+ to .- for USER_PERMIT = TRUE	9 mA
I_{intrue} (max)	Maximum current from USER.PERMIT.+ to .- for USER_PERMIT = TRUE	~15mA
$I_{infalse}$ (max)	Maximum current from USER.PERMIT.+ to .- for USER_PERMIT = FALSE	1mA
I_{in} (reverse)	Maximum negative current from USER.PERMIT.+ to .-	10 $\mu A^{(*)}$
Δt (min)	Minimum signal length to change USER_PERMIT from TRUE to FALSE	2 µs
SAFETY	Combined Safety of USER_PERMIT 'A' and 'B'	SIL 3

Table 11: CIBU Input Specifications

The current in the input stage is internally regulated by the CIBU; the guaranteed values of current are shown in the table above. Note that a digital filter is applied to the USER_PERMIT signal, removing 2µs of state change from TRUE to FALSE.

A Note for PLC Users:

1. The dV/dt maximum means the use of mechanical relays for driving the input circuits should be avoided.

2. Applying a reverse voltage of 24V to the input circuit (for example swapping pins 3 and 4 by accident) will damage the CIBU

EMC Compliance of interconnection

5.4 EMC COMPLIANCE OF INTERCONNECTION

In order to avoid EMC problems, the connection from CIBU to User System must be correctly implemented. The connection is to be realised as follows:

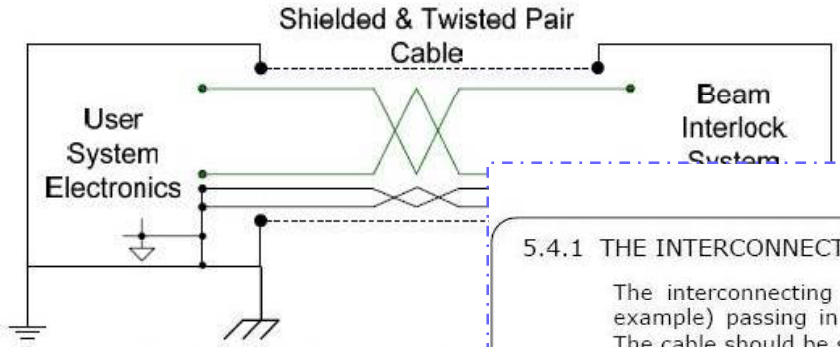


Figure 12: Principle of Interconnection f

5.4.1 THE INTERCONNECTING CABLE

The interconnecting cable needs to be a **shielded-twisted-pair** (NE 8 is a good example) passing in a sensible route from User System to Beam Interlock System. The cable should be stowed in cable-racks if the distance to travel exceeds around 1m. As a rule of thumb it should be no longer than **4m** as the CIBU should be as close as practically possible to the User System. Care should be taken **not to allow the cable to run in parallel to power cables**, as they will interfere. It should also be noted that the cable should **not run in parallel to conductors carrying very low voltage signals**, as the cable can be a source of interference, as well as a receptor.

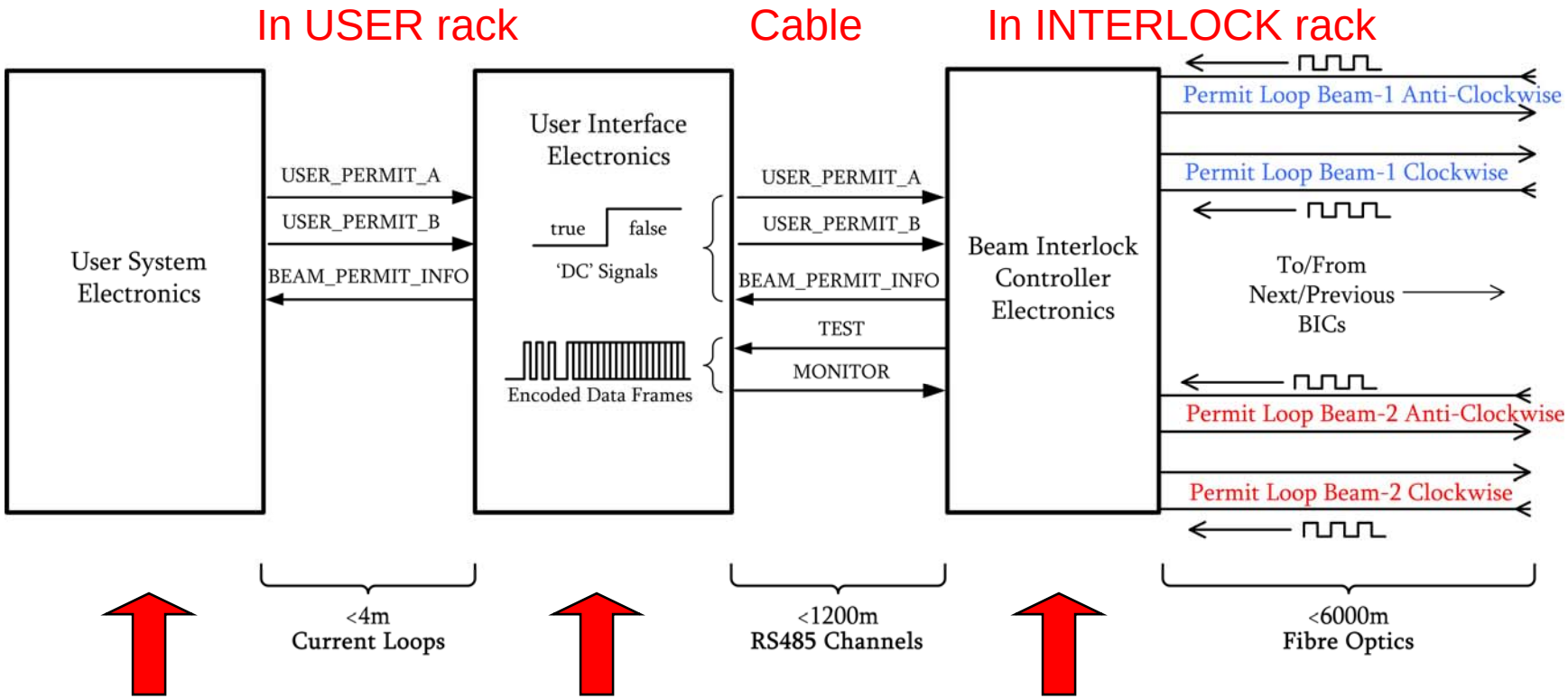
5.4.2 THE CONNECTORS

Conductive **metal connectors** are needed, which should mate with an electrically conductive chassis **without anodisation**. Whereevr possible a treatment such as alodine should be applied to make the metalwork more conductive. Note that standard front panels are NOT conductive. The shield of the cable should be connected **360°** around the connector, surrounding all the signal wires completely; **pig-tail connections for the shield are expressly forbidden**.

5.4.3 THE EARTHING

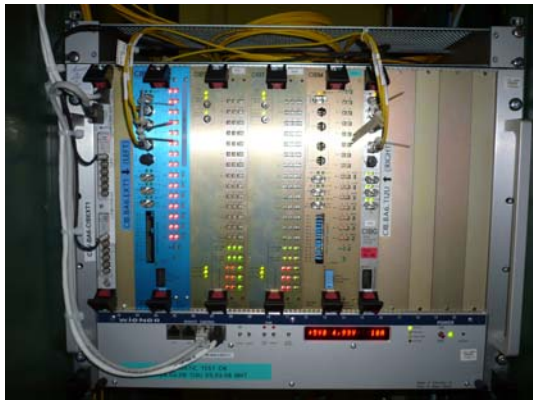
The shield of the cable should be electrically connected to the chassis, which itself should form a protective box around the user equipment. The chassis should be connected to Earth with the shortest stubs possible, and in many places. The electronic ground of the User System should also be joined to Earth in many places, with short stubs. Internal connections are provided that link the ground of the Beam Interlock System with the User System. **The electrical grounds of the Beam Interlock System and the User System should be connected together in all circumstances.**

Electrical Architecture

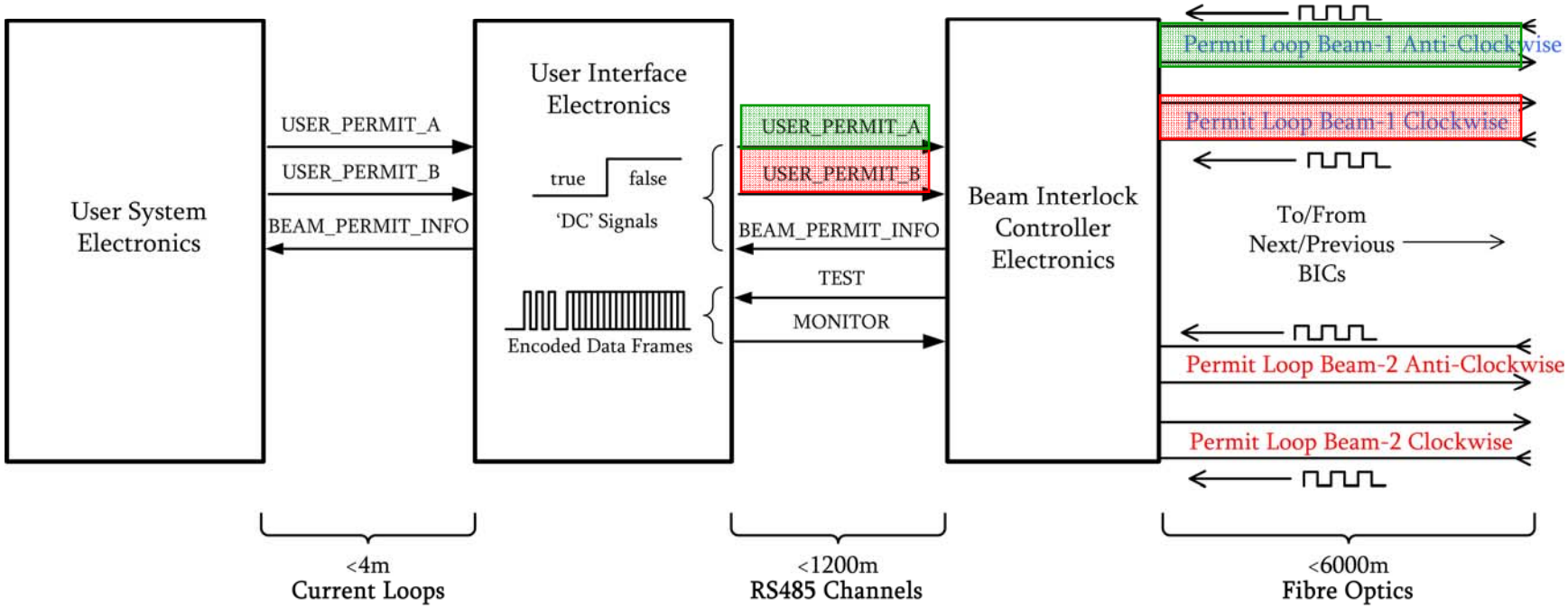


User System

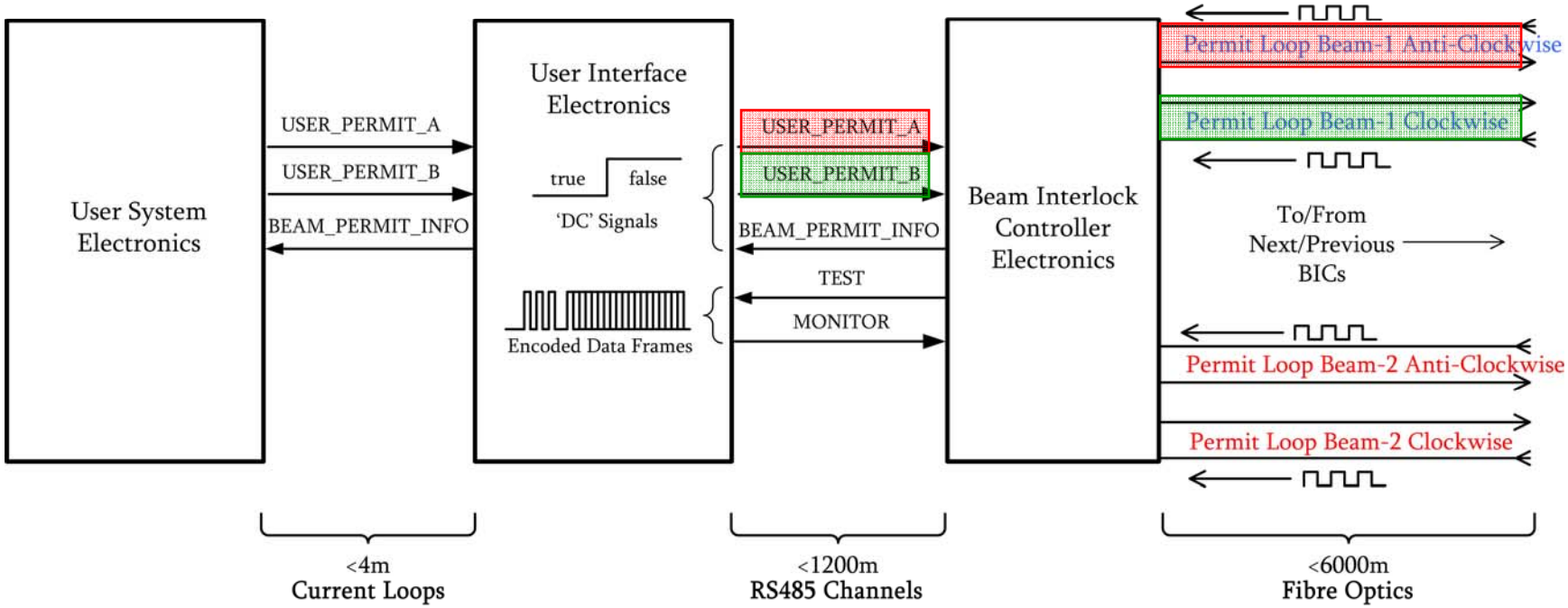
CIBU



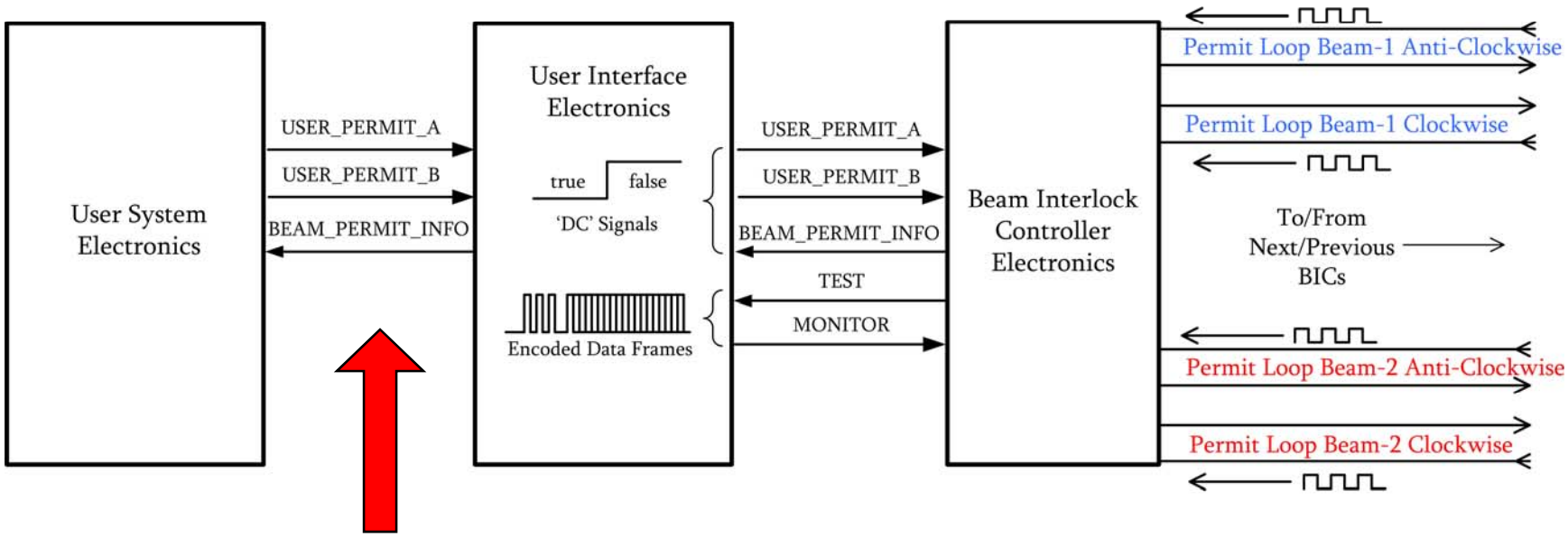
Testing with ‘A’ and ‘B’



Testing with ‘A’ and ‘B’



Testing with ‘A’ and ‘B’



User System to User Interface
TEST in the same way

BIS Commissioning: MTF steps (summary)

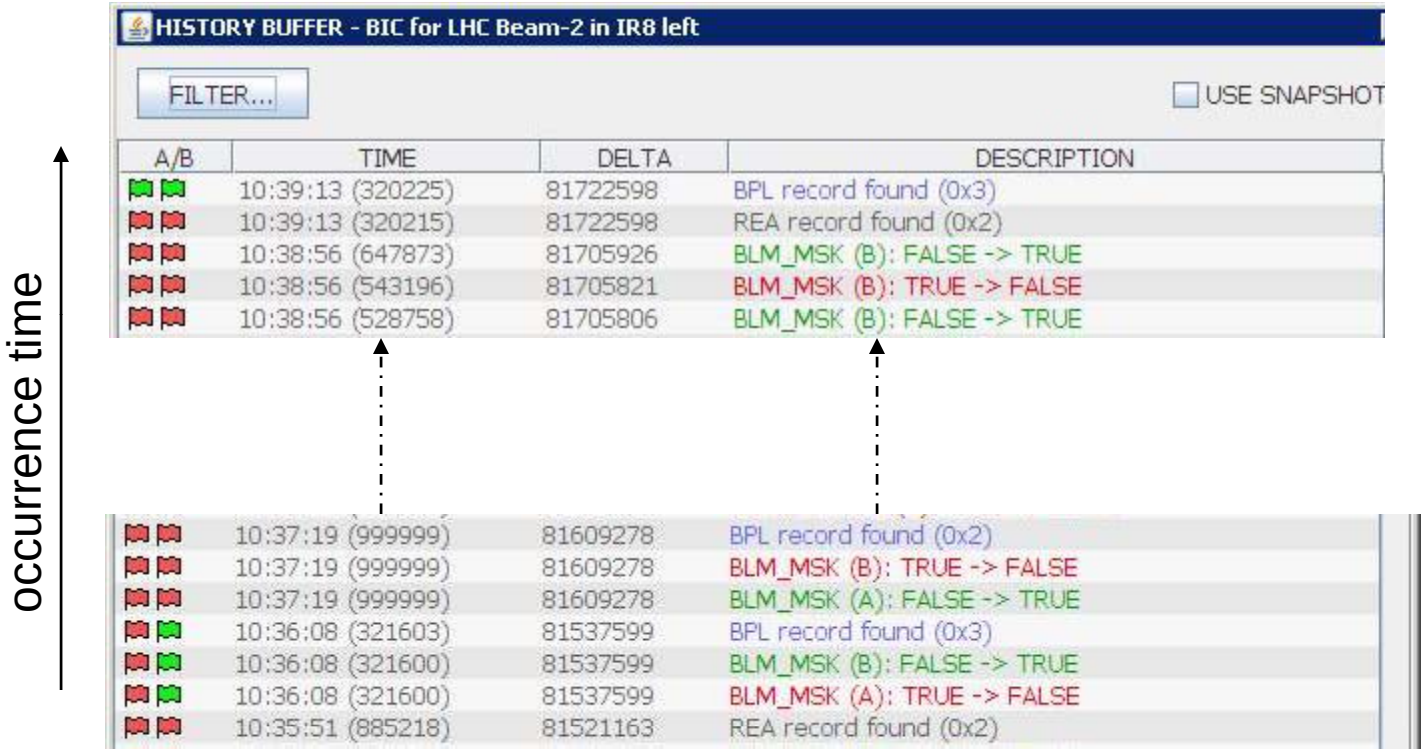
1. System (controller level) has completed IST
2-1. Reception of USER SYSTEM Inputs: Beam 1 (IST)
2-2. Reception of USER SYSTEM Inputs: Beam 2 (IST)
3-1. Verification of USER_PERMIT and CIBU functional response: Beam 1
3-2. Verification of USER_PERMIT and CIBU functional response: Beam 2
4-1. BIC BEAM_PERMIT (BP) response to USER_PERMITs (UPs): Beam 1
4-2. BIC BEAM_PERMIT (BP) response to USER_PERMITs (UPs): Beam 2
5-1. Transmission of BEAM_PERMIT_INFO(BPI) to User System: Beam 1
5-2. Transmission of BEAM_PERMIT_INFO(BPI) to User System: Beam 2

BIS Commissioning: MTF steps 3 & 4 (details)

Step	Value	Units	Comments
CIBU_V for A: A=T & B=F	4>x <30	**V**	**Verify cable voltage at input-A (CIBU): USER_PERMIT_A = TRUE & USER_PERMIT_B = FALSE**
CIBU_I for A: A=T & B=F	>9	**mA**	**Verify current at input-A (CIBU): USER_PERMIT_A = TRUE & USER_PERMIT_B = FALSE**
CIBU_V for B: A=T & B=F	<1	**V**	**Verify cable voltage at input-B (CIBU): USER_PERMIT_A = TRUE & USER_PERMIT_B = FALSE**
CIBU_I for B: A=T & B=F	<1	**mA**	**Verify current at input-B (CIBU): USER_PERMIT_A = TRUE & USER_PERMIT_B = FALSE**
Glitch Counter: A=T & B=F	**OK / Not OK**		**Verify Glitch Counter for both input-A & input-B: USER_PERMIT_A = TRUE & USER_PERMIT_B = FALSE**
BIC response: A=T & B=F	**OK / Not OK**		**Verify BIC response for both input-A & input-B: USER_PERMIT_A = TRUE & USER_PERMIT_B = FALSE**
History Buffer: A=T & B=F	**OK / Not OK**		**Verify History buffer should show a trouble-free transition: USER_PERMIT_A = TRUE & USER_PERMIT_B = FALSE**

Re-do the above sequence with USER_PERMIT_A = FALSE & USER_PERMIT_B = TRUE

Verification in the BIC's History buffer



Measured values for A Input (when A=True)

CIBUS.UA83.L8	WIC	23.60 Volts	13.95 mA
CIBUS.UA83.L8	Vacuum b1b2	23.33	13.70
CIBUS.UA87.R8	Vacuum b1b2	23.30	13.96
CIBUS.UA87.R8	LHCb_DET	4.20	11.00
CIBUS.UA87.R8	LHCb_Mov	23.90	14.23
CIBUS.UA87.R8	LHCb_Mag	3.17	10.00
CIBUS.UA83.L8	PICL_MSK	10.91	11.86
CIBUS.UA83.L8	PICL_UNM	10.82	11.86
CIBUS.UA87.R8	PICR_MSK	10.81	11.85
CIBUS.UA87.R8	PICR_UNM	10.84	11.85
CIBUS.UA83.L8	BLM_MSK	4.15	10.39
CIBUS.UA83.L8	BLM_UNM	4.15	10.48
CIBUD.UA87.R8	BTV-b2	4.66	10.97
CIBUS.SR8.INJ2	COLL_MOT-b2	22.84	13.46
CIBUS.SR8.INJ2	COLL_ENV-b2	23.80	13.94
CIBUS.SR8.INJ2	Vacuum b2	23.60	14.17
CIBUS.SR8.INJ2	LHCb Injection Inhibit	4.20	10.95
CIBUS.SR8.INJ2	MKI8	23.68	10.15
CIB.UA83.L8.B1.B2	COLL_MOT-b1-b2	23.09	13.45
CIB.UA87.R8.B1.B2	COLL_MOT-b1-b2	23.00	13.40
CIB.UA83.L8.B1.B2	COLL_ENV-b1-b2	23.90	13.85
CIB.UA87.R8.B1.B2	COLL_ENV-b1-b2	23.80	13.95
CIB.UA83.L8.B1.B2	Vacuum b1-b2	23.32	13.60
CIB.UA87.R8.B1.B2	Vacuum b1-b2	23.80	14.09

summing up

- Fruitful collaboration BIS ⇔ User Systems
- Most of the links (LHC-ring BIS) have been validated
  - LHCb Detector & Velo: both OK
  - LHCb Magnet signal out of limits => test postponed
- Links for Injection Inhibit partially done:
  - CIBU for Beam-2 Inhibit: input signals OK
  - CIBF for Beam-1 Inhibit: input signals OK
  - Tests are going to continued when cable and F.O. will be in place.