Report from LEADE

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LHC Programme Committee
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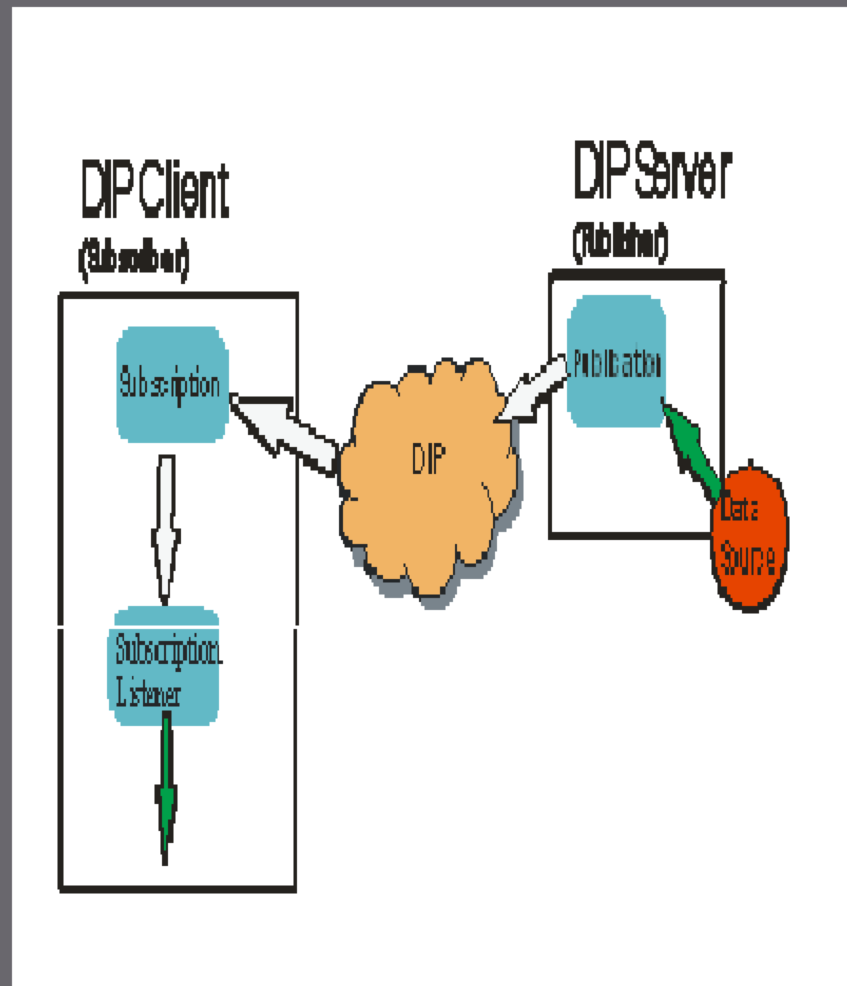
DIP - Introduction

- Single data exchange mechanism between all systems involved in LHC operations.
  - Allows for relatively small amounts of real-time data in summary form to be exchanged between very loosely-coupled heterogeneous systems.
- Simple and robust publish/subscribe system which supports an on-change data exchange.
- Negotiated contract between client & provider.
  - Client is expected to know the name of the data item.
  - Providers expected to update their data.



DIP - Status

- DIP has been running for some time and available for data exchange.
  - There are two DIP DNSs implemented in a redundant configuration on the GPN.
  - The DNSs establish the link between the DIP data publishers and subscribers and maintain list of available publications.
- List of domains and status flag for publishers available through API.

DIP – Support & Maintenance

- Support and maintenance provided by IT/CO
  - Maintenance of DIP API and documentation.
  - Bug fixing and upgrading of new OS versions.
  - Implementation of agreed new functionalities (through LDIWG).
  - Consultancy to domains on integration
  - First line of support via **ITControls.Support@cern.ch**
  - Maintenance of DIP infrastructure (DNS)

http://itcofe.web.cern.ch/itcofe/Services/DIP/welcome.html

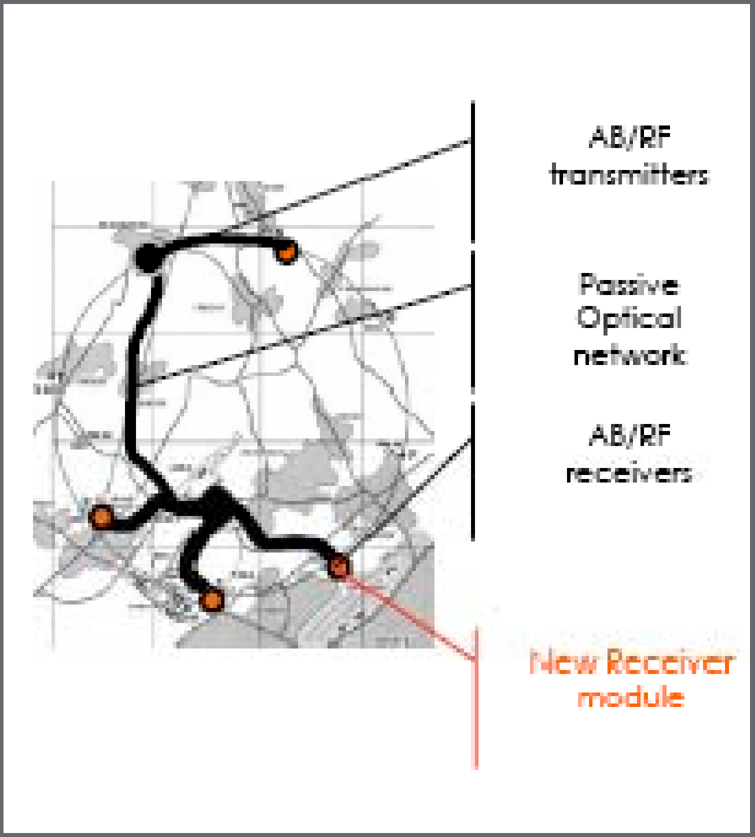
(includes information on status of DIP Name Servers)

DIP - Future Plans

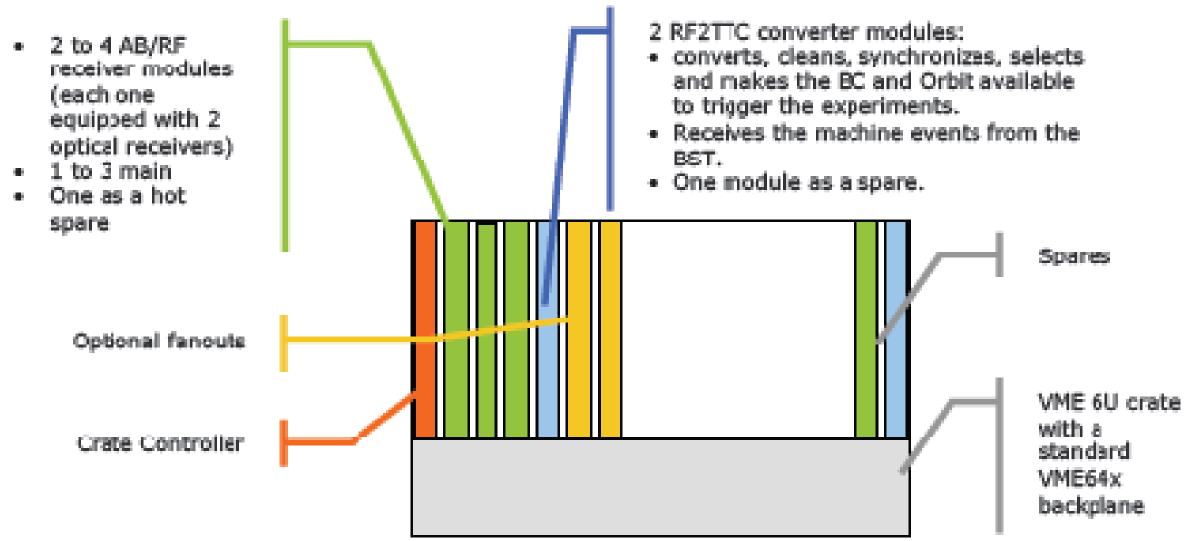
- Near-term improvements
  - The DIP DNSs will be moved onto the TN.
    - Installed in managed virtual servers.
    - Move to be completed by end June 2008.
      - All users to be informed well in advance of the date for the move.
      - This will mitigate unstable DIP running conditions observed recently.
  - DIP monitoring capabilities will be improved at the same time.
- Piquet service is not foreseen at present.

TTC - Introduction

- TTC system objectives:
  - Transmit the machine timing signals from SR4 (where the RF is generated) up to the experiments and the machine instrumentation.
  - Integrate the trigger and control signals with the timing signals at the level of each experiment.
    - Distribution to the detector electronics.



TTC - Implementation



The equipment to be installed in each experiment consists of:

- One 6U VME crate;
- One crate controller;
- 2 to 4 AB/RF receiver 6U VME modules (1 to 3 main and one spare);
- 2 TTC2RF interface boards (one main and one spare).

TTC - Responsibilities

Equipment	Qty/exp (minimum configuration)	Provided by	Paid by	Delivery/ Installation	On call support during runs	Support/ maintenance	Spares
AB/RF dual transmitter VME module, installed in CCC/SR4	• 3 modules for [ALICE, ATLAS, LHCb and the TTC lab] in CCC • 3 modules for CMS in SR4	AB/RF	Experiments[1]	AB/RF	piquet service provided by AB/RF	AB/RF	The spares for the TTC will be included in the pool of 15% spares stored and maintained by AB/RF for their own use.
AB/RF dual receiver VME module	2 receiver modules (one main and one spare). This is the minimum scheme. For full signals monitoring, 4 modules are recommended.	AB/RF	Experiments[1]	AB/RF	piquet service provided by AB/RF for the experiments (not for the TTC lab)	AB/RF	• One hot spare is required per experiment • The other spares for the TTC will be included in the pool of 10% spares stored and maintained by AB/RF for their own use.
6U VME 64x crate	1	PH/ESS	PH/ESS	PH/ESS/ Experiments	-	Experiments	Experiments
Crate controller	1 (Ex: SBC VP110)	PH/ESS	PH/ESS	PH/ESS/ Experiments	-	Experiments	Experiments
RF2TTC	2 (one main and one spare)	PH/ESS	Experiments	PH/ESS – Autumn 2006	-	PH/ESS	8 spares to be maintained by PH/ESS.
TTC Fibres	6 (3 for the BCs, 2 for the Frev, and 1 as a spare)	TS/EL	TS/EL	TS/EL – Autumn 2005	-	TS/EL	1 spare fibre
BST master	1 Transmitter (type TTCex) at CCC to broadcast the BST signals to all the experiments.	AB/CO	AB/CO	AB/CO	AB/CO-BDI during runs (they need this system for the machine instrumentation)	AB/BDI-AB/CO	Managed by AB/BDI-CO
BST fibre	2	TS/EL	TS/EL	TS/EL – Autumn 2005	-	TS/EL	One fibre per ring
Control software	1	PH/ESS	PH/ESS	PH/ESS – Summer 2006	-	PH/ESS	

TTC – Status

- TTC system already running stably
  - Experiments have choice between timing signals provided by the RF equipment in SR4 or internal signals provided locally by TTC equipment.
- Outstanding tasks
  - Installation of 400 MHz generator modules in SR4
    - Complete end June 2008
  - RF electrical splitters installed in CCR RF crate
    - Complete end May 2008
  - BST system installed in the CCR and transmitting to experiments synchronously to the RF clock.
    - Complete end June 2008
  - Piquet
    - Available end June 2008

TTC – Future Plans

- Installation of remotely-monitored oscilloscope CCR TTC support crate.
  - Monitor quality of received system.
- Web page with access to monitored results
- Firmware upgrade on experiment requested

BST - Introduction

- Beam Synchronous Timing (BST) system primary use is to synchronise LHC beam instrumentation.
  - LHC data and GPS timing signals available to be added to experiment event records and DCS.
- BST profits from TTC's ability to transmit data by inserting BST message broadcasted to all client instrumentation crates through-out TTC distribution networks.
- The Beam Observation (BOBR) system is installed in each client instrument crates - recovers BST messages and provides all timing signals required to synchronise instruments.

Byte	Description	Beam	Data format	Update Rate	Info
0, 1, 2, 3, 4, 5, 6, 7	GPS Absolute Time	1 OR 2	64 bits : UTC Format [Number of microseconds since 01/01/1970]	Turn	Automatic Update by BST Master Every Turn
8, 9, 10, 11	Turn Count Number	1 OR 2	0 .. 4294967294 (106 hours - reset on first injection)	Turn	Automatic Update by BST Master Every Turn
12, 13, 14, 15	LHC Fill Number	1 • 2	32 bits : Integer or Absolute Time with second resolution	On Change	BI Main Task
16, 17, 18, 19	Total Intensity	1	4 Bytes : Integer * 10E8 charges	10Hz	BI Main Task
20, 21, 22, 23	Total Intensity	2	4 Bytes : Integer * 10E8 charges	10Hz	BI Main Task
24, 25	Beam Momentum	1 • 2	2 bytes in GEV/c	10Hz	BI Main Task
26	BST Master Status Register	1 OR 2	Bit Enumeration: Ring 1 or 2 or SPS, Master Running Flags, Test Bits...	Turn	BI Main Task
27	Machine Mode	1 • 2	Enumerated type: No beam, filling, ramping, physics,...	On Change	BI Main Task
28	Particle Type	1	Enumerated type: proton, Pb, Sn, Kr, Ar, O, ..	On Change	BI Main Task
29	Particle Type	2	Enumerated type: proton, Pb, Sn, Kr, Ar, O, ..	On Change	BI Main Task
30-39	Spare				
40-63	Used exclusively by AB/BI				

BST - Status

- BST is in operation with simulated RF signals
  - Currently commissioning work advancing with simulated clocks.
- Signals from SR4 under preparation
  - RF (FRev, 40 MHz and pre-pulses) synchronisation signals and corresponding adaptors at SR4 → mid-June (cabling in progress).

BST – Future Plans

- Maintenance and Operation
  - Fibres between BST Master transmitter crate and experiments under responsibility of PH/ESE.
  - Each experiment responsible for integration of own specific BST module.
- Modified message structure is being agreed.
  - Changes to the experiment firmware would need to be done in order to decode the new structure.
  - To be released for approval soon.
- No further new developments expected at this stage.

GMT - Introduction

- General Machine Timing (GMT) signals encode precise time of day (UTC) and machine timing events.
  - 40.000 MHz locked to GPS UTC 1 PPS
  - UTC - time jitter < 10 ns and < 1ns resolution
  - All key LHC and SPS timings available
  - Telegrammes for all CERN accelerators distributed each 1.2 s.
  - Machine mode
  - Safe beam flags
  - Post Mortem information
  - User information as requested

GMT - Status

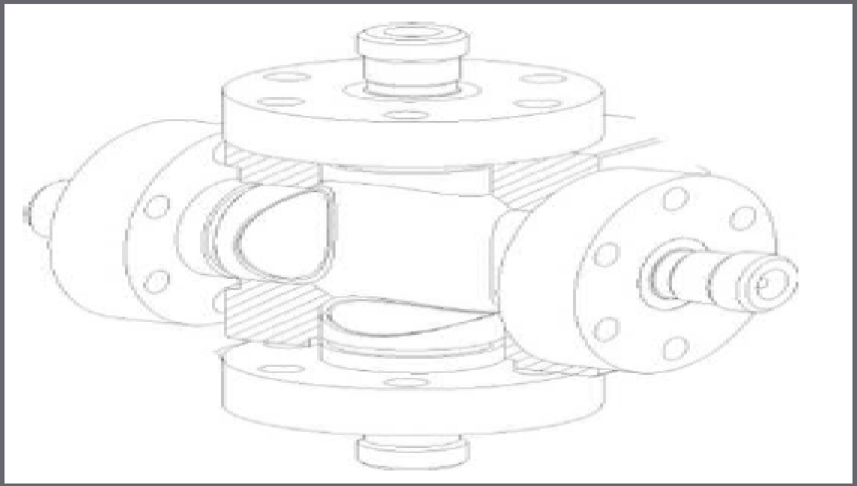
- Most of the hardware is installed
  - 3 VME crates, GPS, clock generation, and timing distribution racks.
  - LHC Central Timing is ready and in operation.
  - Installation of Safe Machine Parameter SMPV module remains outstanding (loop not complete)
- Presently continuing to run reliability checks.
- Issues – installation of hardware at experiment end in progress but follow-up needed to ensure completion by end June 2008.

GMT – Future Plans

- Implementation of logging and monitoring of timing events.
  - Under discussion with AB/OP

BPTX - Introduction

- Out of a total of 1166 BPMs at the LHC, one experiment BPM (called the BPTX) is installed per incoming beam at each of the 4 experiment interaction points.
- Each BPTX consists of 4 button electrodes arranged around the beam at a radius of 30.5 mm.
- BPTX essentially pick-up signals from each LHC bunch.



BPTX - Applications

- Use as direct time reference from the LHC bunches.
- Check for satellite bunches between RF buckets.
- Monitor intensity of each bunch.
- Identify location of gaps in the LHC bunch train.
- Check whether the TTC system is synchronised with the actual arrival of the bunch.

These measurements will be particularly useful during the setting-up phase of the experiments.

BPTX - Status

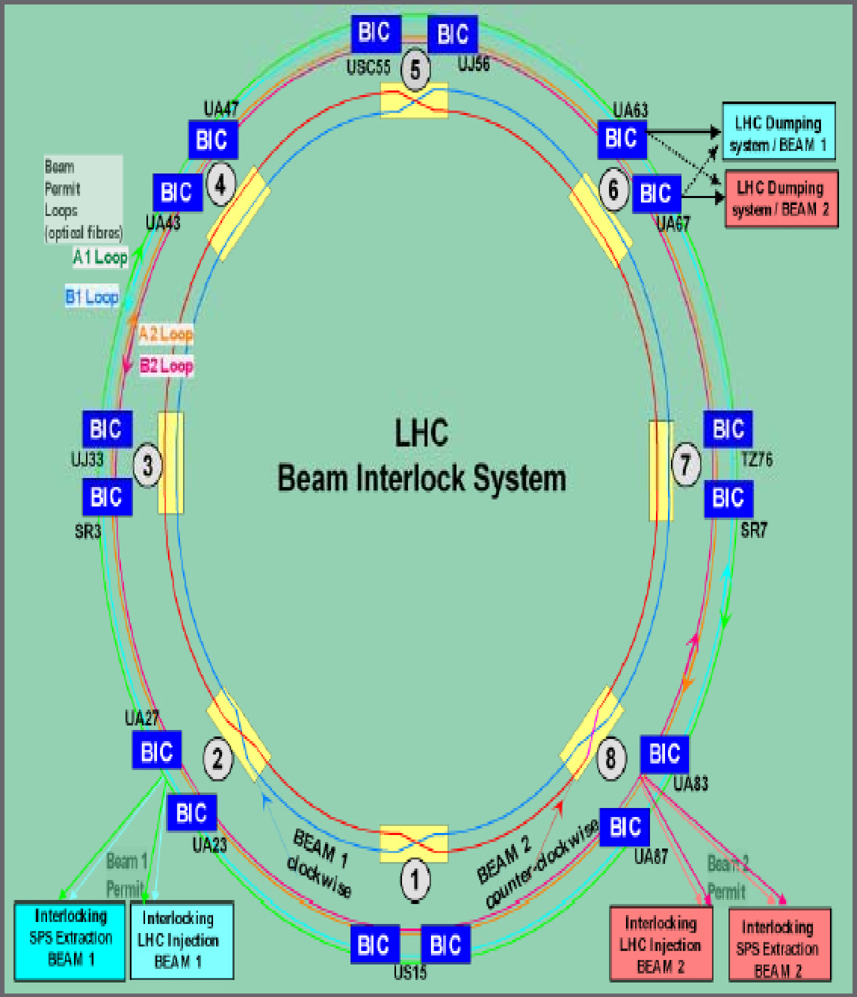
- Status per experiment
  - ATLAS – all systems tested and operational; ATLAS taken ownership; fast scope read-out
  - CMS – all systems installed; TDR check of long cables to be completed; fast scope read-out.
  - ALICE – all systems installed; connection of cables to combiners to be completed; Beam Phase Intensity Monitor (BPIM) read-out.
  - LHCb – all systems installed; TDR check of long cables to be completed; Beam Phase Intensity Monitor (BPIM) read-out.
- Schedule
  - All remaining work to be completed within next two weeks.
  - All systems operational by end June 2008.

BPTX – Future Plans

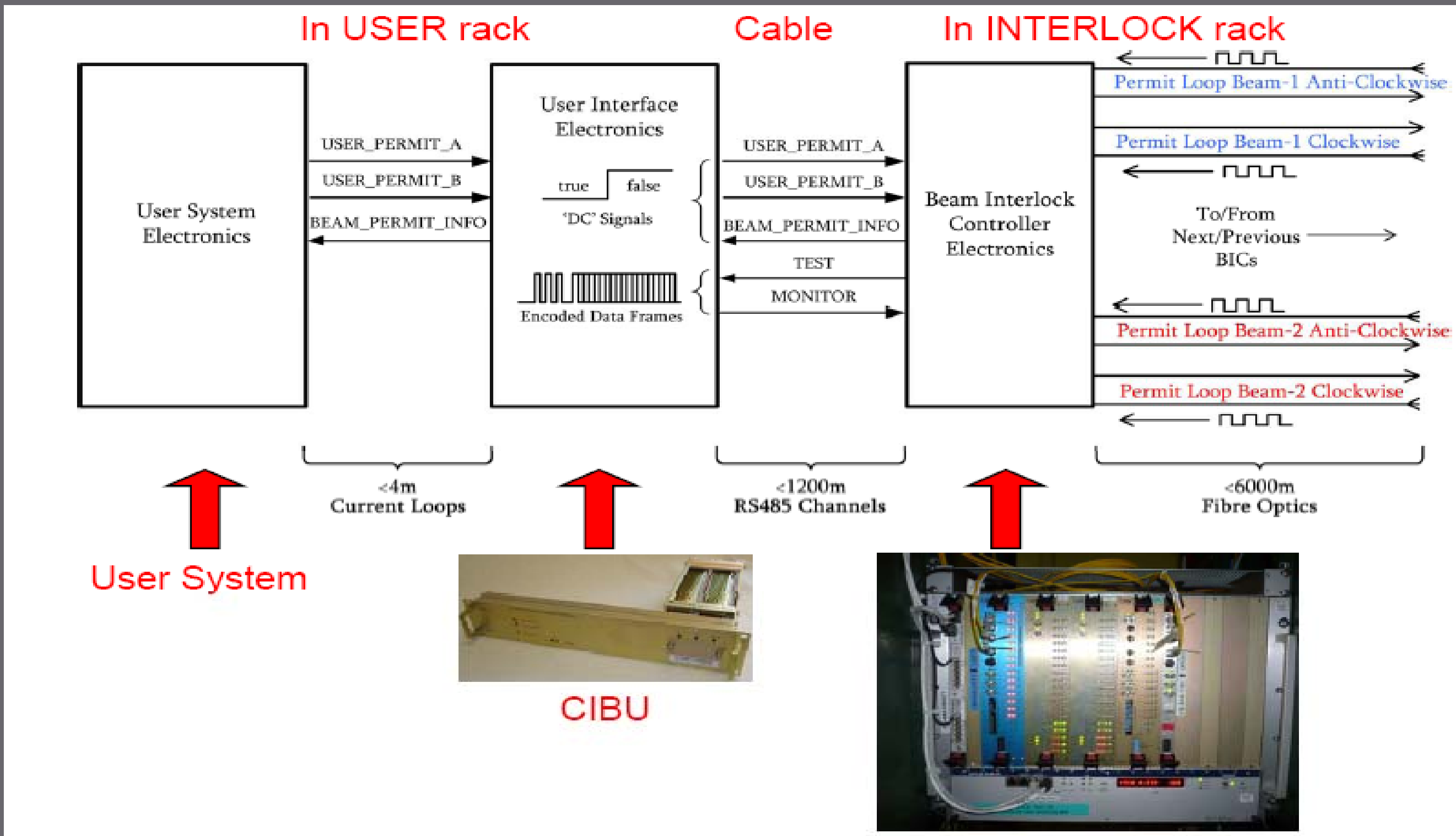
- No changes are foreseen for the BPTX in the near future.
  - Unless specific modifications/upgrades from experiments are requested following LHC running.
- Once all BPTX systems are installed and commissioned by AB/BI, ownership passes over to the individual experiments.

Experiment Interlocks - Introduction

- Several beam hardware interlock signals will be provided by the experiments.
  - Beam abort requests
  - Injection inhibits
  - Spectrometer magnet interlock systems
  - Interlocking of experiment moveable devices
- Individual users, e.g. experiment systems, provide a USER_PERMIT signal for BEAM1 and/or BEAM2 that are collected by the Beam Interlock System (BIS) through the Beam Interlock Controller (BIC).



Experiment Interlocks - Introduction



Experiment Interlock - Status

LHCb (Detector)	Interface Commissioned
LHCb (Experiment Magnet)	Interface Commissioned
LHCb-Velo	Interface Commissioned
ALICE (Detector)	Interface Commissioned
ALICE (Experiment Magnet)	Interface Commissioned
CMS (Detector)	scheduled on week#24
CMS (Experiment Magnet)	" "
Totem Detector	" "
ATLAS (Detector)	scheduled on week#25
ATLAS (Experiment Magnet)	" "
LHCF Detector	" "

Both beam connections - CIBUS

Totem Movable Device	scheduled on week#24
ATLAS Movable Device	scheduled on week#25

Moved to end June 2008

Individual beam connections - CIBUD

Experiment Interlocks - Status

Injection BIS

LHCb (beam-1 Injection Inhibit)	Interface partly commissioned	f.o. link not present
LHCb (beam-2 Injection Inhibit)	Interface partly commissioned	Cupper cable not present
ALICE (beam-1 Injection Inhibit)	Interface partly commissioned	Cupper cable not present
ALICE (beam-2 Injection Inhibit)	Interface partly commissioned	f.o. link not present
ALICE-ZDC (beam-1 Injection Inhibit)	Interface fully commissioned	Cupper cable already installed
CMS (beam-1 Injection Inhibit)	Will be partly commissioned on week#24	f.o. link not present
CMS (beam-2 Injection Inhibit)	" "	" "
TOTEM (beam-1 Injection Inhibit)	" "	" "
TOTEM (beam-2 Injection Inhibit)	" "	" "
ATLAS (beam-1 Injection Inhibit)	Will be partly commissioned on week#25	f.o. link not present
ATLAS (beam-2 Injection Inhibit)	" "	" "

Issues - fibre optics not yet installed; no fixed date yet
As soon as fibres are installed, the BISUs will be contacted in order to carry out the commissioning of the connections.

BEAM_PERMIT – to be supplied by experiments; in consultation with Machine Cold-check-out Co-ordinator

Experiment Interlocks – Future Plans

- Automation of tests between the various EXPT links.
  - These tests are to be done before beam injection fill every fill to check whether all BIC systems functioning properly (e.g. masks)
  - Ability to provoke remotely the change of the USER_PERMIT signal (`A' or `B' signal) from TRUE to FALSE without need to interact with experiments.
  - To be ready for 2009 LHC start-up.

Post Mortem - Introduction

- In case of failure during LHC operation, e.g. beam loss or magnet quench, a coherent set of information from various sub-systems is required to diagnose causes for the failure.
- Post Mortem will provide recording and analysis of data after event of failure at the LHC.
- Data will come from transient recorders, logging systems, alarms, etc.

Post Mortem - Description

- Most LHC systems allow for recording of transient data – beam instrumentation, power converters, quench protection, interlocks etc.)
- Systems use synchronised clocks (UTC time-stamped) for their recording.

Post Mortem – Status I

- All relevant LHC equipment systems are prepared for transient recording.
- Versions of the Post Mortem are already available for the LHC Hardware Commissioning.
  - Systems involved in powering tests provide required Post Mortem data during pre-defined test sequences.
  - Data is collected and stored in Post Mortem system
  - First version of event analyser has been developed
    - Able to identify source of powering failures in fully-automated way.
    - Several tools exist to view and analyse the Post Mortem data.

Post Mortem – Status II

- Final Post Mortem system for LHC beam operation is under development.
  - Tests with additional clients, e.g. BLM, have been completed.
  - Further tests on the complete systems are in progress and are scheduled to be completed in the coming weeks.
- Closer interaction between the experiments and machine should be organised in order to get the experiment Post Mortem data into the system

Contacts

System	Linkpersons
DIP	W. Salter
TTC	S. Baron, P. Baudrenghien
BST	J.-J. Gras, R. Jones
GMT	J. Lewis, J. Serrano
BPTX	R. Jones
Experiment Interlocks	B. Puccio
Post Mortem	R. Schmidt, M. Zerlauth

Experiment	Linkpersons
ALICE	A. Di Mauro, D. Evans
ATLAS	T. Pauly, S. Wenig
CMS	J. Spalding, J. Troska
LHCb	R. Jacobsson
LHCf	A.-L. Perrot
TOTEM	W. Snoeys

Conclusions & Outlook

- The realisation of all data exchange systems has made excellent progress.
  - Installation and commissioning is being completed and all systems are scheduled to be fully operational by the end of June 2008.
- A reasonable plan for future work has been put forth for individual systems.
  - More may result from the initial LHC running period.
- Would need continued good collaboration during LHC beam commissioning phase to ensure correct functionality with real LHC events.

Conclusions & Outlook

- Future organisation
  - LEADE will follow up on the future work to the systems, including ensuring that the new specifications are compatible across requirements coming from machine and experiments.
  - Dedicated mini task forces will follow up on issues resulting from LHC beam commissioning and first run.
    - An organisation based on mini task forces is already in place will be asked to continue to handle issues arising from the upcoming beam commissioning phase
  - Monitoring and reporting, should be done through the LPC contact persons of each experiment
    - Include in report to the weekly LPC meeting.