#### **Distributed BI Systems**

#### BLM, BPM, BTV and BRAN

Laurette Ponce & Fabio Follin

#### Production & Installation & Tests

- BI will produce and install the beam instrumentation on time with respect to the general machine schedule
- Except for BLM followed by the MPWG, the procedures for the beam instrument commissioning with beam will be defined by BI for the different instruments.

#### MTF



#### BI individual system tests

Main 🔪 Slot data	a) Installation & C	ommissioning Operation Documents History				
tions :						
Job Id	R/E  Status  Res	5. Description	Show Last Repeated Started  Ended  NC			
<u>14234704</u>	Done Ok	10-BLM channel check (leakage, bias current)	2007-03-01 2007-03-01			
.4234705	Done Ok	20-BLM Acquisition Chain Desription	2007-03-01 2007-03-01			
4234706	Pending	30-BLM Acquisition Chain Test via test signal				
4234707	Pending	40-BLM HV modulation Test				
4387494	Pending	50-BLM Acquisition Chain Test via RA Source	Main Slot data Installation & Consissioning Operation Documents History Actions : Back to list			
4390118	Pending	60-BLM Interlock Test	Installation Job Data Job Id 14234704			
44445 CEH Sw	ERN I-1211 Geneva 23 vitzerland the Large Hadron Collider project	LHC Project Document No. LHC-B-TP-0002,00 rev0.3 CERN Div /Group or Supplier/Contractor Document No. AB-BI EDMS Document No. 751016	Phase Installation Job Data Responsible Job Id 14234705 Executed by 9 <sup>rl</sup> Parent Job Scheduling Responsible Povided by Actual Start Date 20 Comments Scheduling Actual Start Date 2007-03-01 Results Non Conformity Comments Sub Jobs Scheduling Actual End Date 2007-03-01 Scheduling Actual End Date			
<b></b>		Date: 2000-09-12	Job Id  R/E  Status  Re Results Non Conformity			
		Test Procedure	Yielded Properties Property Monitor Type Monitor Type Job 10  R/E  Statue  Res.  Description  Started  Description			
	THE COMMISS	IONING OF THE HARDWARE IN THE LHC SECTORS	HV Patch         Yielded Properties         Naminal Value         Values         Uators           BDBAP Input         Preserver         10179         10179         10179           Tunnel Mini Rock Id.         AnalogEF.ac, cr, CF, CI         104378         104378           LC(diffsct) Wroble&M-r         BLECF Identificator         HCBLEFORL-CRODO45           Bilgon Ivis source w/cable         Opt Link AFE:Cr, CFC, CI         VA83=8105_2_7_5           Audit         OI- Patch Tunnel:Ra, Pa, In         VA83=8105_D_10           Created on         OI-Patch Tunnel:Ra, Pa, In         VA83=8105_D_10           Last modified on         OI-Datch Starl, Pa, In         SR8=8105_2_2_6_3_10           Mite BLET CI         OID Acq:Ra, VME 51_DAB_In         SR8=8105_2_2_6_3_158=8105_2_6_3_10			
	INDIVID DIFFER	UAL SYSTEM TESTS OF THE ENT BEAM INSTRUMENTS	VME control de control			
	The tests are meant to <b>instrumentation.</b> This instrumentation. The pu the monitor up to the fr the beam instrumentati qualify our instrumentat	Abstract validate the correct functioning of the LHC beam phase of commissioning follows installation campaign of BI rpose of these tests is to assess the entire acquisition chain from ont end computers. Upon termination of this commissioning phase, on will be ready for the final tests with beam necessary to fully tion. These final test procedures are not covered by this document.	VME Fantray Hostname     CFVM-SR8-BLMC       DAB card Id.     Mezzanine card Id.       CIRU Id.     FPCA firmware vers(BLECC)       FPCA firmware vers(BLECS)       Audit       Created on     2000-01-01       Last modified on     2007-06-17			

#### BLM

- Some 4000 BLMs : 3600 IC and 400 SEM for higher loss intensities
- Part of Machine Protection:
  - The only system to protect LHC from fast losses and to prevent quench
  - All BLMs are interlocked and send a beam dump request via the BIS if signal over threshold or one of the tests failed
- 12 time windows (from 40 us to 83.88 s) and 32 different energy levels to cover the different loss duration and the beam energy => ~1'500'000 thresholds values



• Each monitor is declared as maskable/unmaskable, Channels are connected/NOT connected at the HW level

## **BLM for quench prevention**



- At each Quad, 3 monitors per beam checking the 2 aperture limitations and the middle + at cold dipoles in LSS
- positions as much standardized as possible, but integration problems :
  - To define families of monitors (about 250!!)
- Beam dump threshold set to 30 % of the quench level (to be discussed)
- Thresholds derived mainly from simulations : several source of uncertainty

### **BLM for machine protection**



- BLM in LSS :at collimators, warm magnets, MSI, MSD, MKD, MKB, all the masks...
- Beam dump threshold set to 10 % of equipment damage level (need equipments experts to set the correct values)

## Layout DB

			FUNCTIONAL POS	ITION IDENTIFICATION				
Parent Hierarchy		\LBBRP.11L8						
Туре		BLMEI (Type ID : 13255	52, Quality Assurance Plan : HC)					
Description		Extra (ie not on quadru	oole) Beam Loss Monitors consisting of a	an Ionization Chamber				
Official Name		BLMEI.A11L8 (ID : 1637	001)					
Expert Name		BLMEI.11L8.B2I21_MBB						
AT/VAC Name		BLMEI.62.11L8						
AT/ACR Name								
Function								
Equipment (MTF PART ID)								
Classes								
Related Electrical object								
Functional Position History	v							
			DIME	NSIONS				
Length		0.60 m						
Width		0 m						
Height		0 m						
			LOCA	LISATION				
Location		HALF-CELL MACHINE -	11L8 (CIVIL WORK : R82)					
		Coordinates	(S/U/V)			Rotations		
S Middle	Idle 22932.2680 m (-383.0348 m from IP 8)					0 *		
U Start	0.4990 m				В	0 *		
U End V Stort	0.4990 m				c	0.0		
V End	Om				C	0		
			OTHER F	PROPERTIES				
Status	An equipment is installed in this slot							
Phase	Slot required from phase 1 to 2							
Responsible		B. DEHNING (AB-BI)						
Comment								
Pins List								
			FUNCTIONAL POSIT	ION TYPE PROPERTIES				
			LOGICAL CONNECTIONS TO	OTHER FUNCTIONAL POSITIONS				
Name		Direction	Туре	Label	Ca	Cable Humber Pins Map.		
BLETC	BLETC.05SR8.BLMC		UNKNOWN	2_7_A1/Opt Link 3		? Pins Map		
BLETC.05SR8.BLMC		UP	UNKNOWN	2_7_A2/Opt Link 4		?	Pins Map	
			MEMBER O	F THE SYSTEM				
	SYSTEM		CATEGORY			ABCAM		
	SIGNALS							
Link to signals related to BLM	EI.11L8.B2I21_MBB in the naming d	atabase						
			LAYO	DUT DB				

samedi, 3. novembre 2007 04:01:00

## Naming convention

- Official name (i.e the layout one) : refer to the location in the cell, no indication of the beam, need to be change if one monitor in added, and BLMQI.A7L8 is attached to Q6!!
- The expert name to identify the location:



### **BLM acquisition modes**

- Max Losses
  - The highest loss observed at the monitor since the last update (at 1Hz) for the time periods < 1.3s and the value of the RS for time periods > 1.3s.
- Study Data
  - Triggered as and when required, the granularity of this data will be per channel 1 data point every 40 us covering the last 1.3 s.
- XPOC Data
  - Triggered every beam dump, will return for each channel 1 data point every 40 us covering the last 100ms (to be defined by the user) before the dump and the following 40ms.
- Post Mortem Buffers
  - Will be sent on PM events via the CO PM channel.
- Collimation Data
  - Feed loss data into the collimation control system to ensure that losses don't exceed set limits during motion. This data will be sent through a dedicated UDP layer and be triggered by the collimation system.

## BLM

- Hardware & Front-End
  - All monitors at CERN, installation following the interconnection closure
  - electronics and front end software will be ready for the start-up
- Software
  - Thresholds (and connectivity) generation and handling
    - Expert version available (tested on SPS), to be converted in OP usable version ?
    - Tables existing in LSA DB
  - Concentrator (LSA-CMW)
    - Exist and already used by the Collimator application
  - Fixed Display & Applications
    - Prototype of the Fixed Display in place
    - HIGH LEVEL OPERATIONAL REQUIREMENTS document
    - detailed application to be implemented

#### **BLM tests**

- The whole procedure test is followed by the Machine Protection System Commissioning WG: <u>EDMS document</u> under preparation
- Results of the tests are stored in MTF for all the phases, as for HWC
- Functional tests are done after reception of chambers, after installation and during operation
- System tests during the machine checkout : the integral system should be tested from the CCC.
  - Conditions required to perform tests
    - Successful completion of the individual tests of BLM system sector by sector.
    - Logging system available (measurement and logging)
    - Setting data base (LSA) available
    - BIS operational
    - LBDS operational
    - Beam energy distribution operational
  - Description of the tests
    - Test of beam permit by disabling of signal initiated by MPS for each octant
    - Test of the test sequence by the sequencer (time allocated, integrity test of data...)
    - Test the change of the threshold value with the beam energy signal
    - Test of the trigger of threshold comparison (periodicity and after a change...)

#### **BLM tests**

- Functional test of full acquisition chain with Radioactive Source
  - The procedure for this test will be described in a dedicated document made in collaboration with TIS. The purpose is to create a signal on the chamber with the RA source and check its presence in the corresponding DAB card channels.
  - Time estimation : 0.5 to 1 hour per front-end station (8 BLMs)
  - This test is foreseen to be done with the OP participation ???

#### BPM

#### 1000 BPM

– 66 Crates x 18 monitors



- 3 FESA classes defined:
  - Ring Beam Position Monitors
  - Interlocked Beam Position Monitors (Point 6)
  - Dump Line Beam Position Monitors

## **BPM acquisition modes**

- Threading
  - For the first injections even without RF capture.
  - Asynchronous acquisition for a few turns.
- Orbit
  - Latest orbit acquisition published at 1 Hz.
  - Orbit is acquired faster for RT.
- Capture
  - On request, acquires the beam position for selected bunches over a selected number of consecutive turns.
- XPOC
  - The position for the last turns prior to every beam-dump event will be available for XPOC
- Post Mortem Buffers
  - Will be sent on PM events via the CO PM channel.

### BPM

- Hardware & Front-End
  - Monitors, electronics and front end software will be ready for the start-up
  - Functionality tested with the "ping-pong" ball
- Software
  - Concentrators
    - LSA (LSA-CMW)
    - RT (BI-UDP)
  - Applications
    - YASP
    - 1000 Tours
    - RT Feed Back

#### **BPM tests without beam**

- Concentrators
  - LSA-CMW concentrator
  - BI-UDP Feed Back (orbit) concentrator
- Applications
  - YASP
  - Feed Back
  - 1000 Tours
- Calibration Setting
  - Gains (electronics)
- Timing (BST)
- BPM auto-triggering in asynchronous mode must be commissioned for receiving pre-pulses and telegrams
- Acquisition modes
  - the single pass trajectory (beam positions versus machine azimuths)
  - the beam oscillation sampled at one or several azimuths (beam positions versus time)
  - the closed orbit (average beam positions versus machine azimuths)
  - intensity measurement mode (sum signal) usefull for first-turn threading (for finding aperture restrictions)

#### **BPM tests with beam**

- Signals combination (detailed in phase A.1 procedure)
  - Beam 1 / Beam 2
  - Plane H / V
  - Sign Up-Down / Left-Right
- As soon as beam is captured
  - Fine delays tuning (versus BST)
- Between Pilot and Nominal Intensity
  - Trigger sensitivity swapping: necessary but slow process

#### BTV

- Same Front End Software than for existing BTV (TT10, TI2, TI8, ...)
  - 13 cameras in the ring
  - 6 cameras in the dump line

#### **BTV** tests

- Calibration
- Settings
  - Camera Switch
  - Screens and Filters movement
  - Lamps
  - Windows Origins and Sizes
  - Fit Thresholds and Offsets
- Interlocks
  - BIC (screens in or moving, ...)
    - Can be IN only if 'Safe Beam Flag' = TRUE
  - SIS (single tours cameras) ???



#### **BRAN (Luminosity Monitors)**

 Monitor the collisions rate by detecting the flux of forward neutral particles generated in the interactions



 The challenge of these detectors is to be sufficiently radiation hard to survive 20 years of LHC operation (this means several Giga Gray of integrated dose) and to be sufficiently fast and sensitive to allow the bunch by bunch measurement for luminosities in the range 10<sup>28</sup> 10<sup>34</sup>

#### BRAN (Luminosity Monitors)

Two different types

- Gas Luminosity Monitors (IP1 and IP5)
  - LBNL (Lawrence Berkeley National Laboratory) is committed to develop and install the fast ionization chambers
  - Designed for ATLAS and CMS where the collision rate should be as high as possible
- CdTe Luminosity Monitors (IP2 and IP8)
  - CERN will install solid state CdTe detectors produced by CSA-LETI
  - Designed for ALICE and LHC-b where the rate should be set and kept at optimal levels

### **BRAN (Luminosity Monitors)**

#### Status

- Installation (hardware + electronics) expected for January or February
- FESA classes existing (only acquisition and with fake data)
- OP Fixed Display (no yet existing)
  - Average luminosity
  - Bunch by bunch luminosity
  - Cross angle
- Experiments data exchange using DIP (Data Interchange Protocol)

# Summary

- Individual system tests well documented and in MTF
- CCC software functionality to be checked during the Check-out
- Some pending questions :
  - Remote changing of BLM thresholds (and status)?
  - Definition of the OP BLM families