BI Technical Board
December 2014

LHC BLM SYSTEM:
STATUS OF CHANGES DURING LS1+

Christos Zamantzas on behalf of the BLM team.

Overview

- Hardware Changes
  - Tunnel installation & Acquisition electronics
  - Surface installation & Processing electronics
- Firmware/Server Changes
  - BLETC and BLECF
- Application Changes
  - Updates, additions and wishlist
- Verification & Commissioning
  - RSM, Dry-Runs, Checkout, Beam Commissioning
- Injection Interlock Inhibit
  - Solution agreed and planning

Listing main actions to be performed or developed in the system

LHC BLM SYSTEM:
HARDWARE CHANGES

Modifications in the tunnel installation

ECRs in preparation

- ✓ Dismantle all detectors in the ARC and DS (~2500) and
- ✓ Dismantle 70% of the detectors in LSS (~1000)
  - in order to allow intervention in the interconnections

- ✓ Exchange 40 multiwire cables with the NES18 type
  - Reduce noise on 240 detectors
  - ➢ Continuation of campaign to exchange all noisy installations

- ✓ Relocate 816 detectors
  - New supports, cable extensions, cable trays needed
  - ➢ Improve protection
  - ➢ see Eduardo Nebot Del Busto's presentation for the reasons

New locations of the detectors

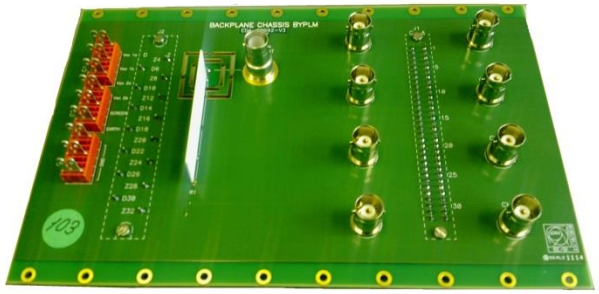
Modifications in the tunnel installation

- ✓ Exchange 360 acquisition crate **backplanes**
  - Improve stability, add features
- ✓ Modify 309 **signal** distribution boxes
  - Allow reset of the complete sector
- ✓ Installation/Connection to WorldFIP
  - Straight Section needs additional electronics
  - Allow remote access per card
- ✓ Add everywhere High Voltage divider boxes
  - Increase accuracy

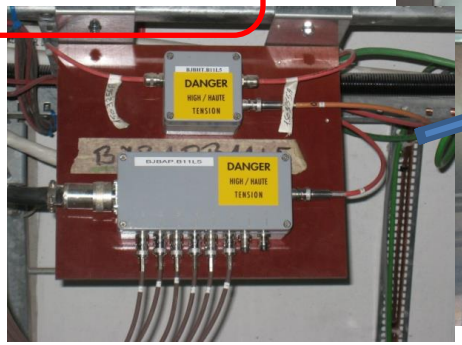
to do

- Modify 40 High Voltage distribution boxes
  - Add suppressor diodes and resistors
  - Only in areas with high losses

ECR in preparation



Improved backplane



➢ For more info see Ewald Effinger's presentation in 73th MPP

Modifications in the ACQ electronics

- Modify all BLECF modules (~700)
  - Change limit for the HV level detection flag
    - currently too restrictive for proper use by the SIS.
    - change detection level from 1370V to 950V

✓

cancelled

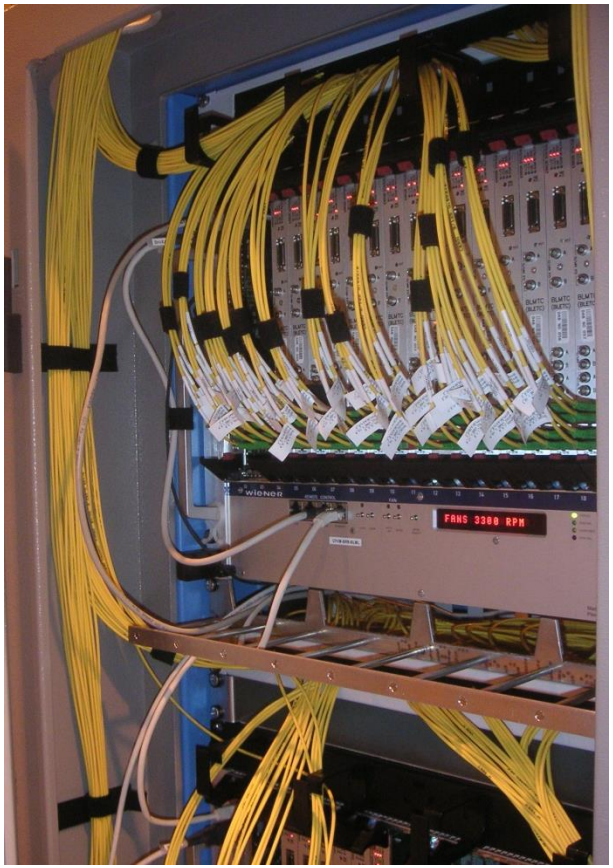
- Change laser settings of the GOH
  - increase transmission power to give more margin of attenuation
  - add ~ 30% more power

Modifications in the surface installation

- Replacement of all racks
  - Add temperature regulated racks
  - ✓ Remove and disconnect **complete installation** (crates, cables, power etc)
  - Reconnection/replacement of all fibre patchcords (~1600 fibres)

- Modifications for apt interventions
  - ✓ Replacement of all rear connection cables
  - Allow direct access to power supplies and rear rack connections

- Add two new crates for possible future **Injection Interlock Inhibit** implementation:
  - ✓ Install additional racks in P2 and P8
  - Separate problematic monitors for injection
  - ➢ see also Wolfgang Bartmann's presentation



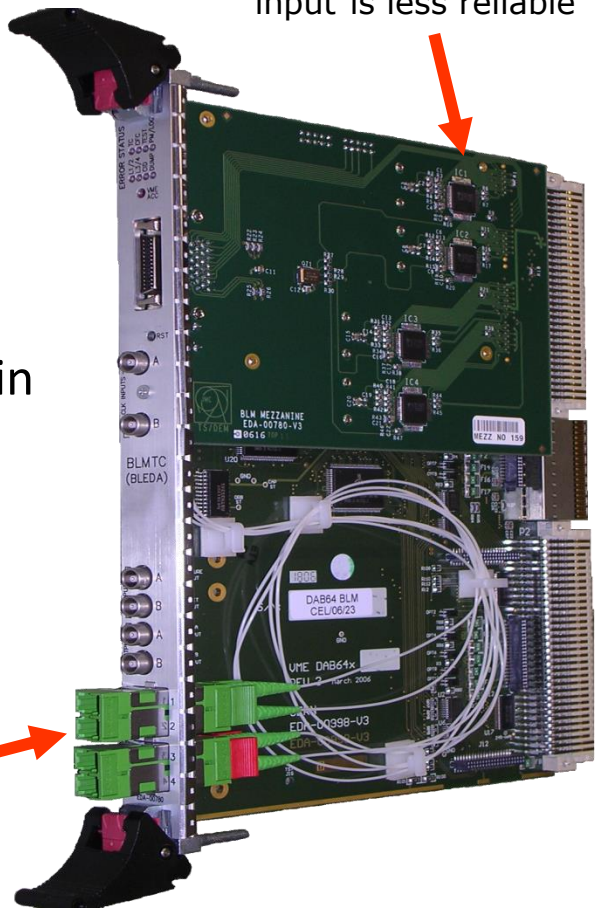
Modifications in the TC electronics

- Maintenance of all processing modules (~400)
  - Fix or Replace ~ 20% of mezzanines ✓
  - Clean-up of the optical adaptors and connectors

- Shuffle optical links
  - Expect to improve availability by removing common mode failure ✓
  - 80% of optical link errors and failures were in LK: 1-2

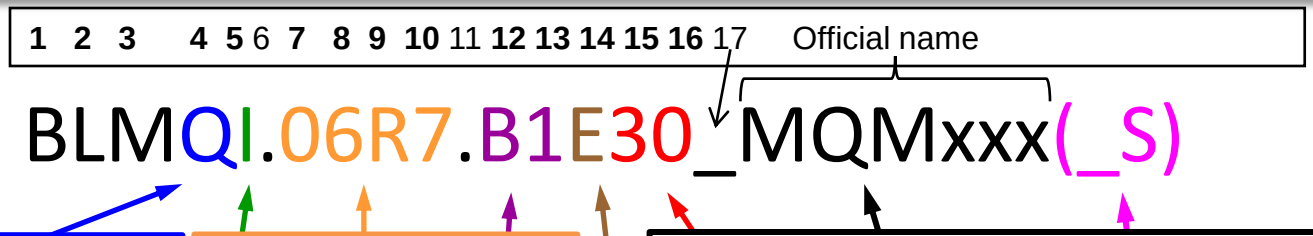
Accumulation of dust on the connectors

Optical Link 1
input is less reliable



E2000-APC
input connections to four optical fibres.

Expert Name Convention Change



BLM location or feature:
- Q – Quadrupole
- B – Dipole (Bending)
- T – Collimator (Target)
- E – Extra
- D – Dump Line
- P – Direct Dump (Protection)
- C – Cryo
- I – Injection lines (*TI2,TI8,TT41)**
- X – eXperiments
- 2 – Coupled detectors
- M – Mobile detectors

Position:
- 01-34 - number of cell
- L or R - side from IP
- 1-8 - IP
- xxxx - distance from beginning of TD [dm]

Observed elements:
- Up to two elements (e.g. MQ, MQXA or MBA.A-MBB)
- Function (batt, hv)
- Distance from IP6 [m] _ Change of TD diameter [mm]
- Distance from beginning of Dump Core [m]

Beam relation:
- B1 – Beam 1
- B2 – Beam 2
- B0 – Centre

Position on the element:
for B1/2 from beam direction:
- 10+i at the entrance
- 20+i at the middle
- 30+i at exit

for B0 from IP:
- 10 – first
- 20 – second

Detector type:
- I – IC
- S – SEM
- L – LIC
- F – FIC
- D – Diamond
- S – Silicon
- B – ACEM (Bunch meas.)
- C – Channel Check

Transverse position:
- E external
- I internal
- C central
- T top
- B bottom
- L left to beam direction
- R right to beam direction

Optional:
- _S – second coupled monitor (counting from beam direction)
- _T – vertical slice test monitor
- _DUMP – inside beam dump

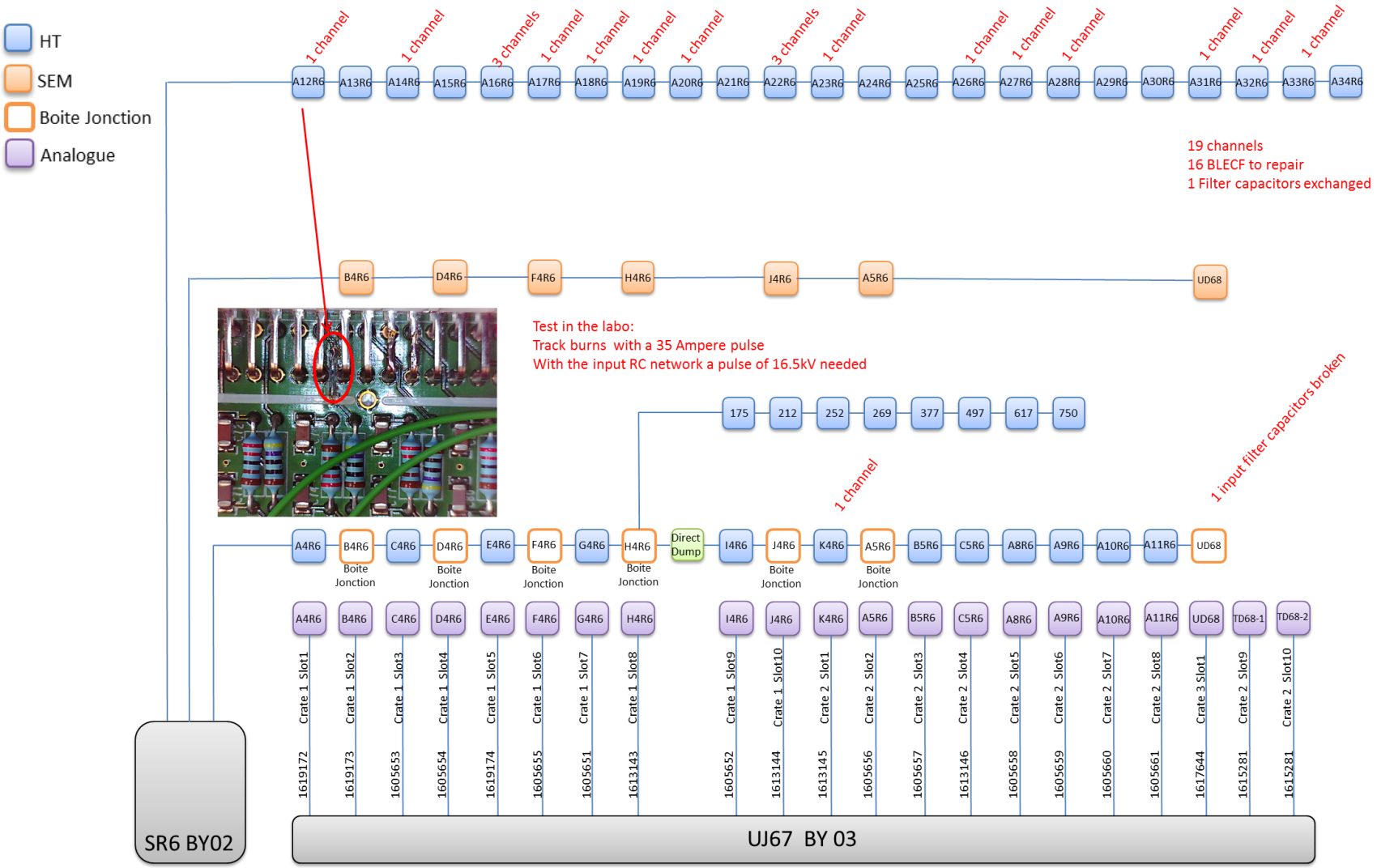
Database Updates

- Completed:
  - 900 channels have been updated in MTF, LAYOUT and LSA
  - 21,000 new Logging variables created
  - 2,000 Logging variables renamed

- On-going actions:
  - Data on 300 channels to be updated
  - Slots for 30 new channels to be added
  - Rename of 10,000 Logging variables

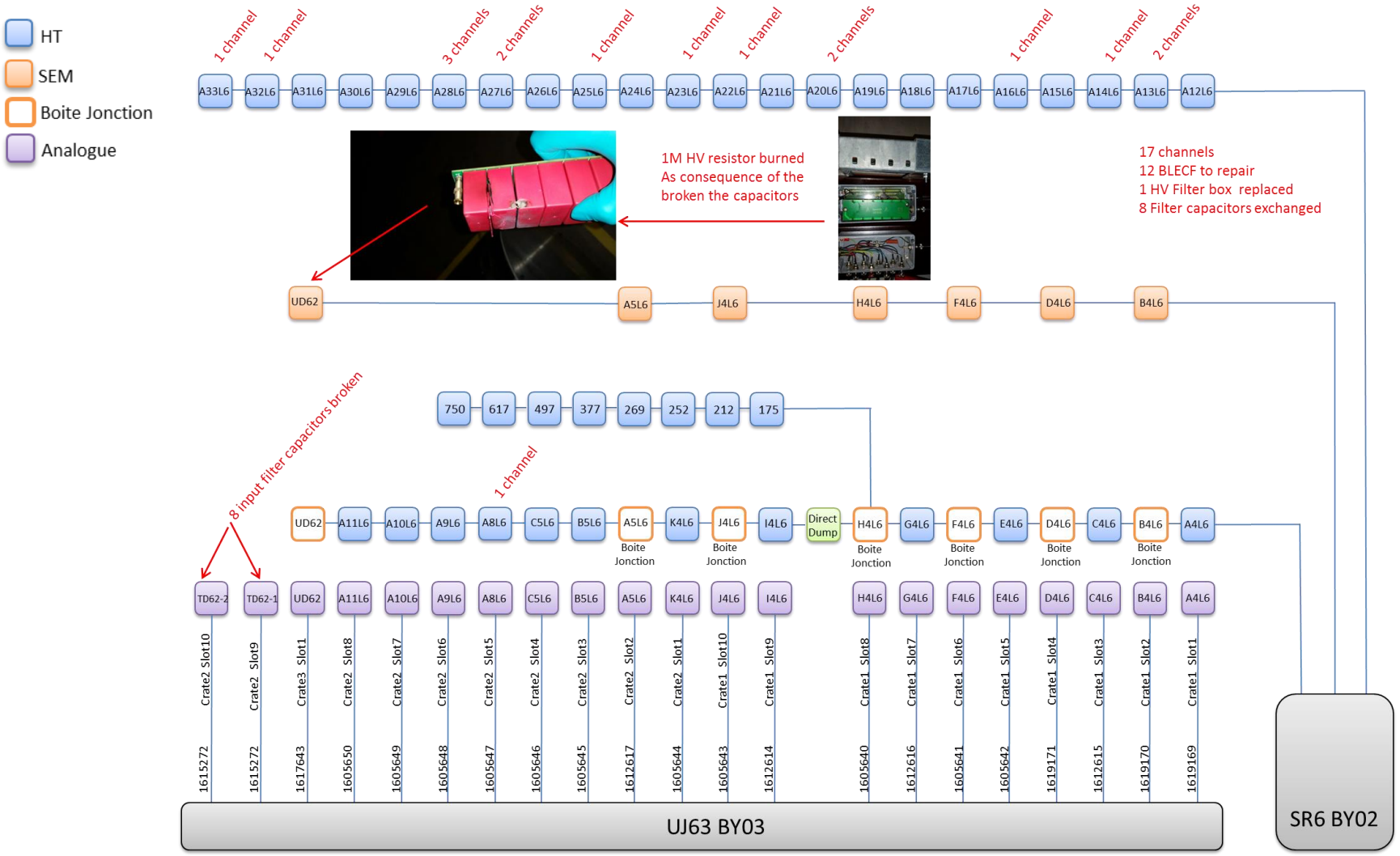
Incident in IP6: 6R

Ewald



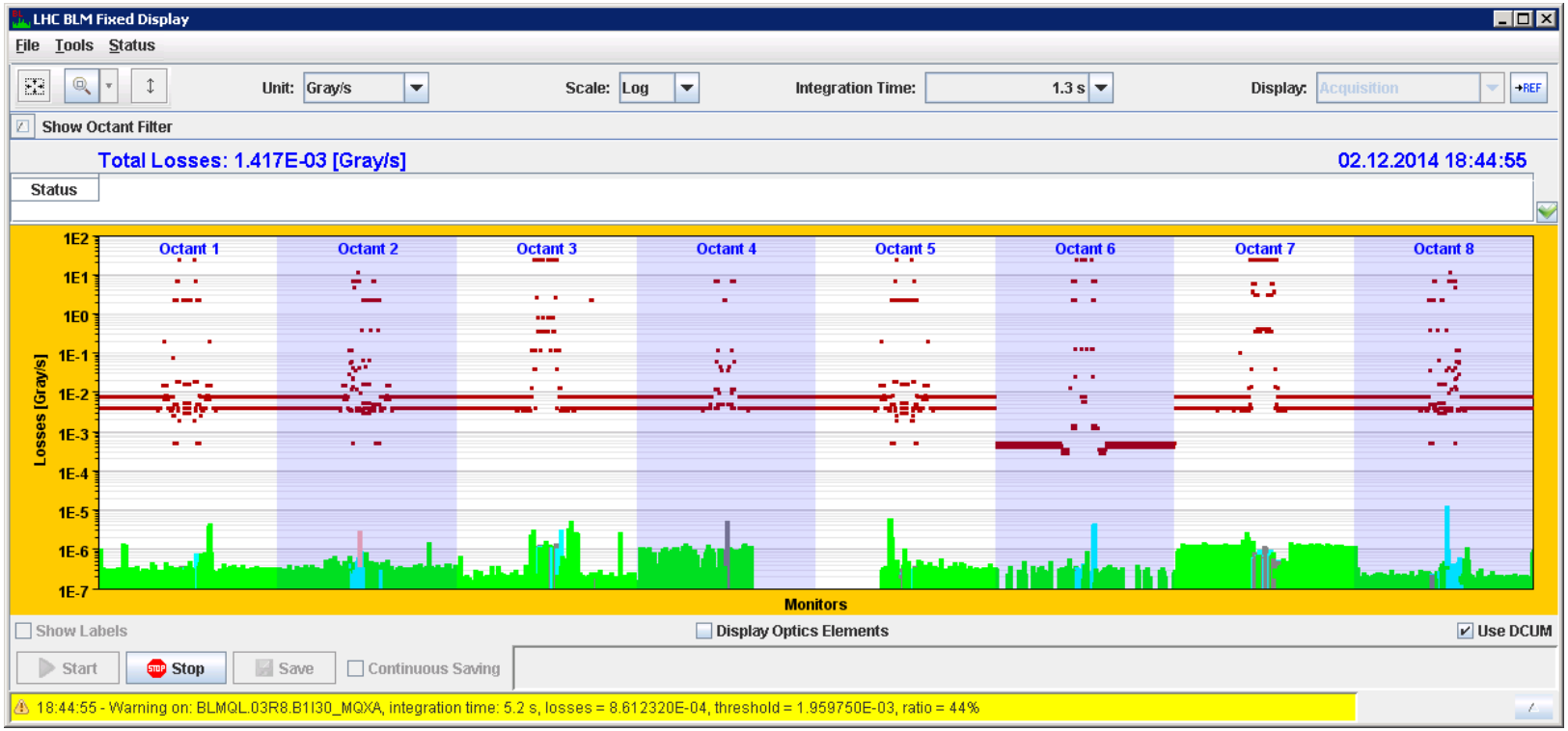
Incident in IP6: 6L

Ewald



2014/12/02: Status of the installation

- All crates operational
- 3,216 channels complete, 687 channels with issue
  - 280 ch. from S45 (cards not yet installed)
  - 95 ch. from IP6 (cards in repair)



LHC BLM SYSTEM:
FIRMWARE & SERVER CHANGES

Current State of Firmware/FESA

- All functionality present in Run 1 is again operational with the new CPU for both BLETC and BLECS modules.
- Tested:
  - Logging (measurements and statuses), XPOC, PM, IQC
  - Read/write of threshold values and system parameters
  - Online MCS check
  - Sanity Checks

Modification of the BLECS firmware

- Combiner and Survey firmware additional modifications:

Higher priority:

- Improve regular automatic system checks
  - block increase of input offset
  - add timeout for check completion
- Improve connectivity check
  - Increase range of values allowed
- Improve Energy value reception and logging
  - fast changes of energy values are propagated to the BLETC modules but not logged

Lower priority:

- Add better compatibility with new CPUs
  - new VMEbus core with MBLT mode
  - new memory map optimized for block transfers
- Preparation for the "Injection Interlock Inhibit" feature

Modification of the BLETC firmware

- Processing Module firmware additional modifications:

  Higher priority:
  - Add better compatibility with new CPUs
    - new VMEbus core with MBLT mode
    - new memory map optimized for block transfers
  - Improve PM and UFO Buster buffers
    - increase size to 43,690 samples per channel
  - Improve XPOC buffer
    - split data and triggers per beam

  Lower priority:
  - Improve data for Collimation Beam Based Alignment
    - increase data rate (now at 12.5 Hz)

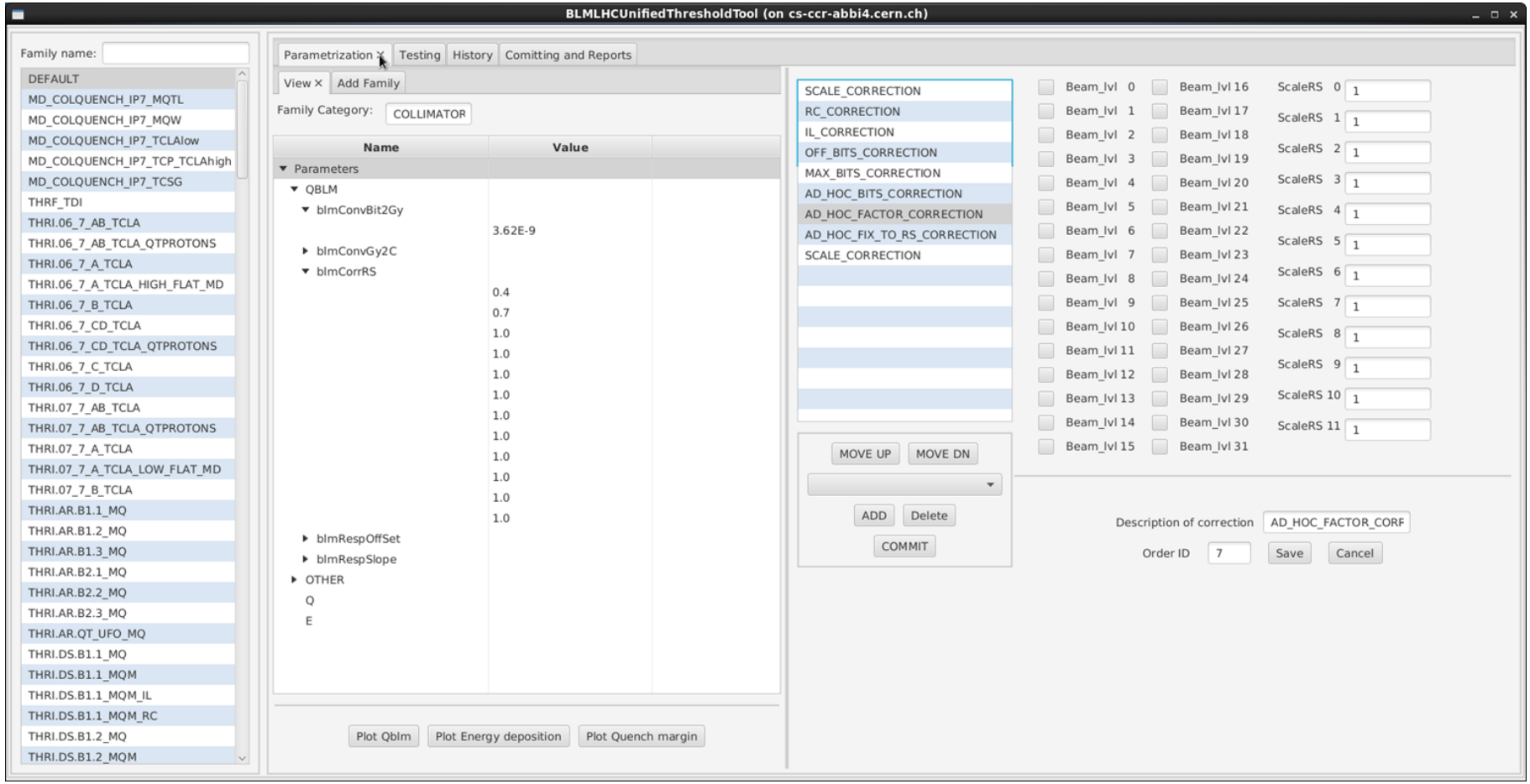
- FESA server will need to be updated accordingly

LHC BLM SYSTEM:
SOFTWARE CHANGES

Threshold Management Application

Blazej & Stephen

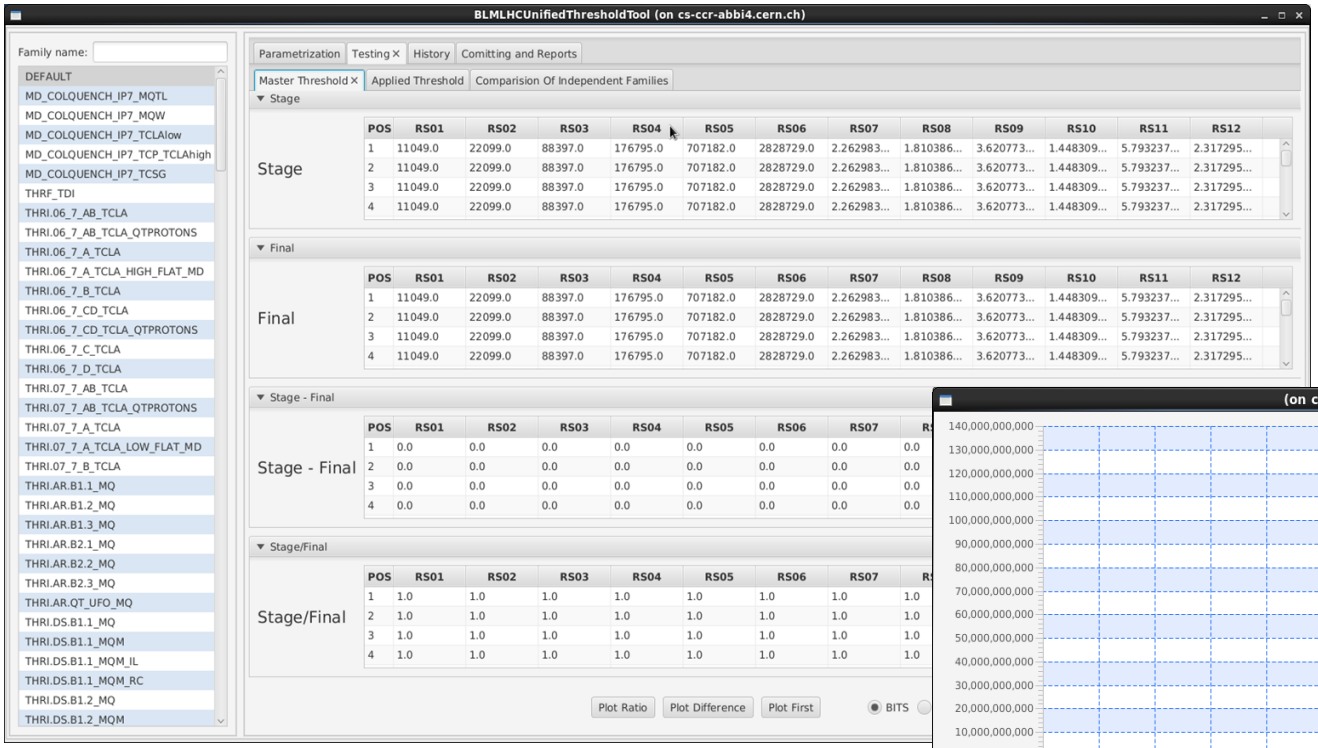
- View on parameterization and correction functions

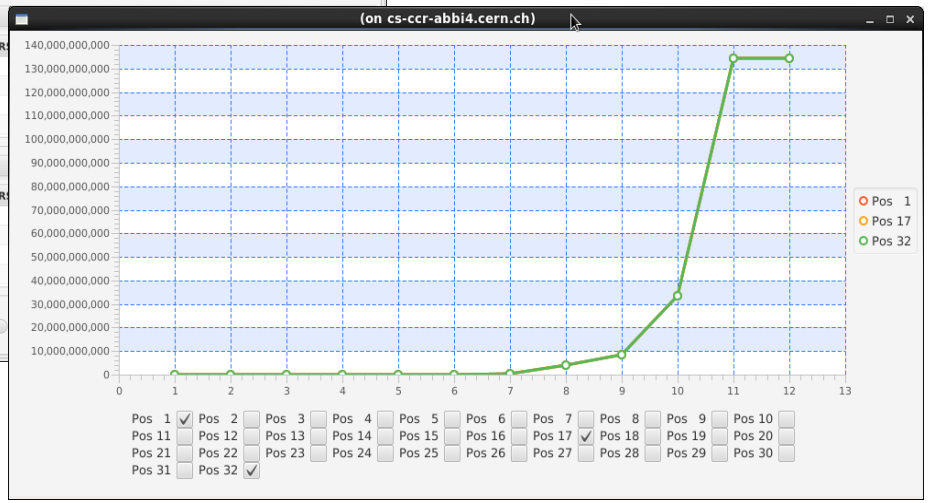


Threshold Management Application

Blazej & Stephen

- View and Plotting of Threshold values

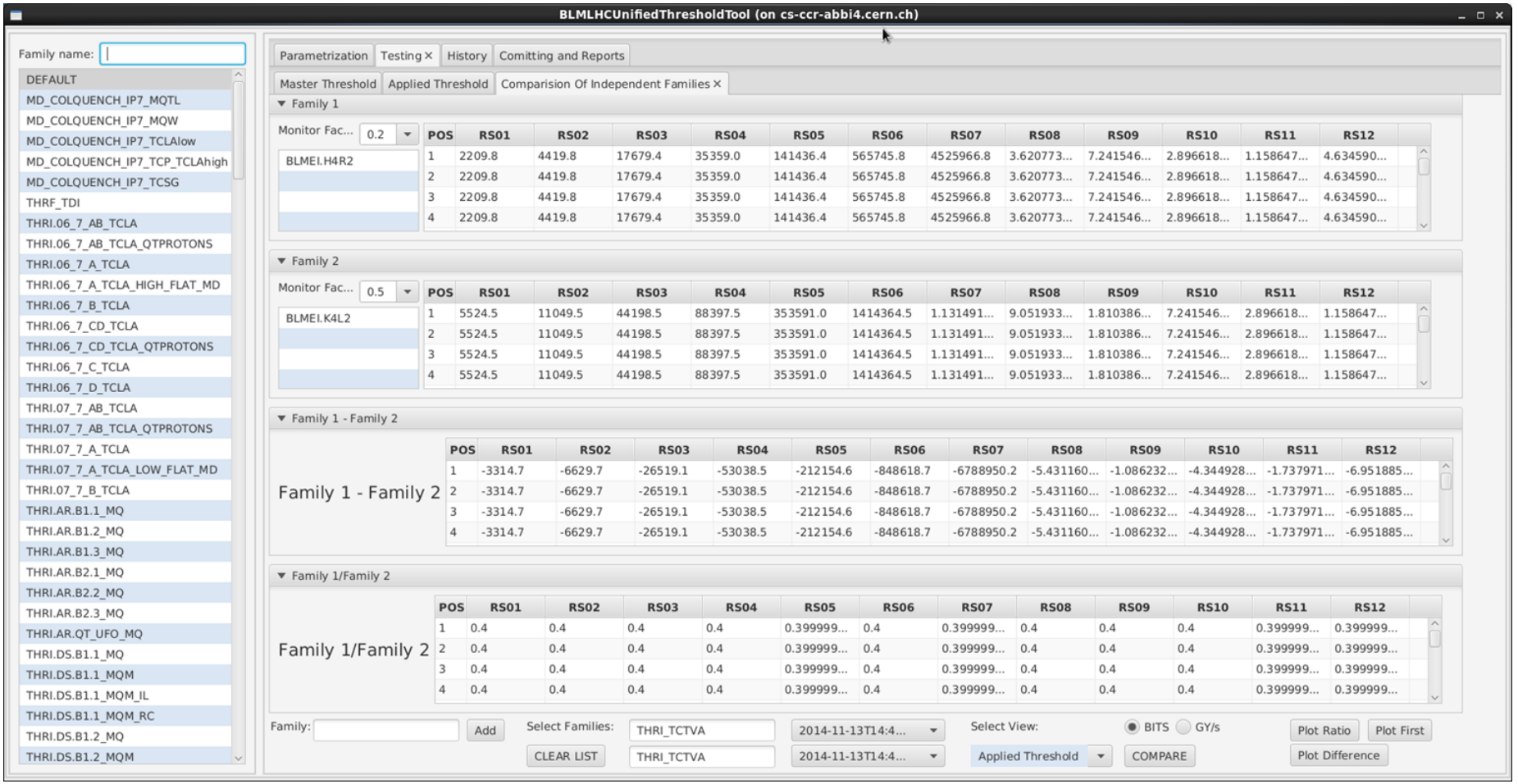




Threshold Management Application

Blazej & Stephen

- Comparison of thresholds for different families and different dates



Threshold Management Application

Blazej & Stephen

- ✓ Application ready wrt specifications
  - GUI implemented
  - DB middle-tier connection

- To Do:
  - Improve plots (SW)
  - Fixing bugs and data in DB (CO)
  - Computation algorithms missing (BL & CO)
  - Extensive testing of the application and DB logic of threshold values calculation (BL & SW)

Other Applications

Blazej & Stephen

- ✓ Moved to Maven and some corrections:
  - System Parameters application
  - Threshold Values application modifications
  - Connectivity Check results viewer
  - Master table viewer
- ✓ Expert Applications are all operational
  - Next year to be moved also to Maven
- ■ To correct:
  - System Status application (via Concentrator)
  - Mobile Monitor Setup application

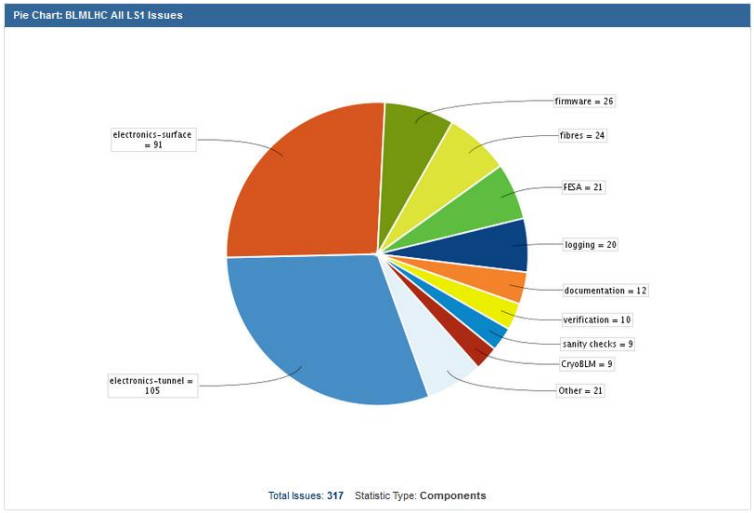
Application Improvement wishlist

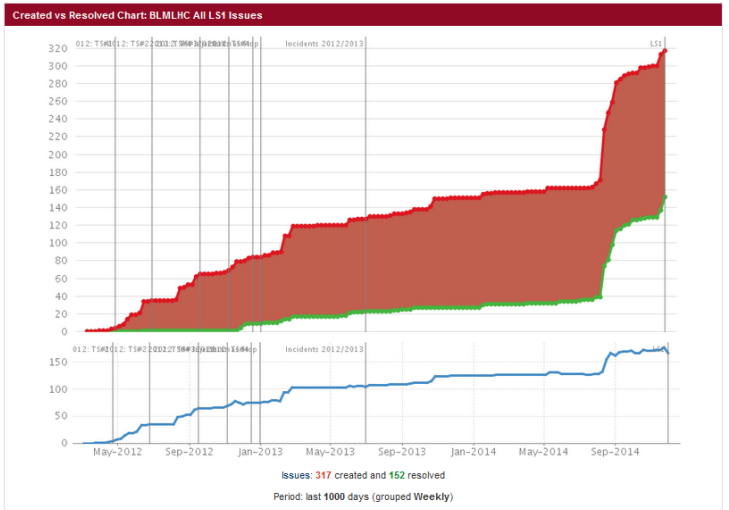
- **System Parameters** application (BE/SW)
  - automatic fill of serials when a card is exchanged
  - step increase of connectivity check limits
- **System Status** application additions (BE/OP)
  - give global overview
  - provide system error cause
- **System Management** application (BE/OP and BE/CO)
  - Generate new monitors/parameters, Drive settings to electronics, Initiate/Abort checks
  - ➢ provide a clear procedure for actions to be taken
  - ➢ avoid errors due to complexity of the generic applications (generation, trim etc)
- **Monitor Factor** application (BE/OP)
  - show history
  - compare two points in time
  - roll back of changes (very useful for MDs, etc.)

LHC BLM SYSTEM:
VERIFICATION & COMMISSIONING

Issue Tracking

- On-going actions:
  - Check all optical connections
  - Check behaviour of each card
  - Check behaviour of each channel
  - Check all interlock connections
- To start in 2015:
  - Update all serial numbers
  - Calculate new Connectivity check limits



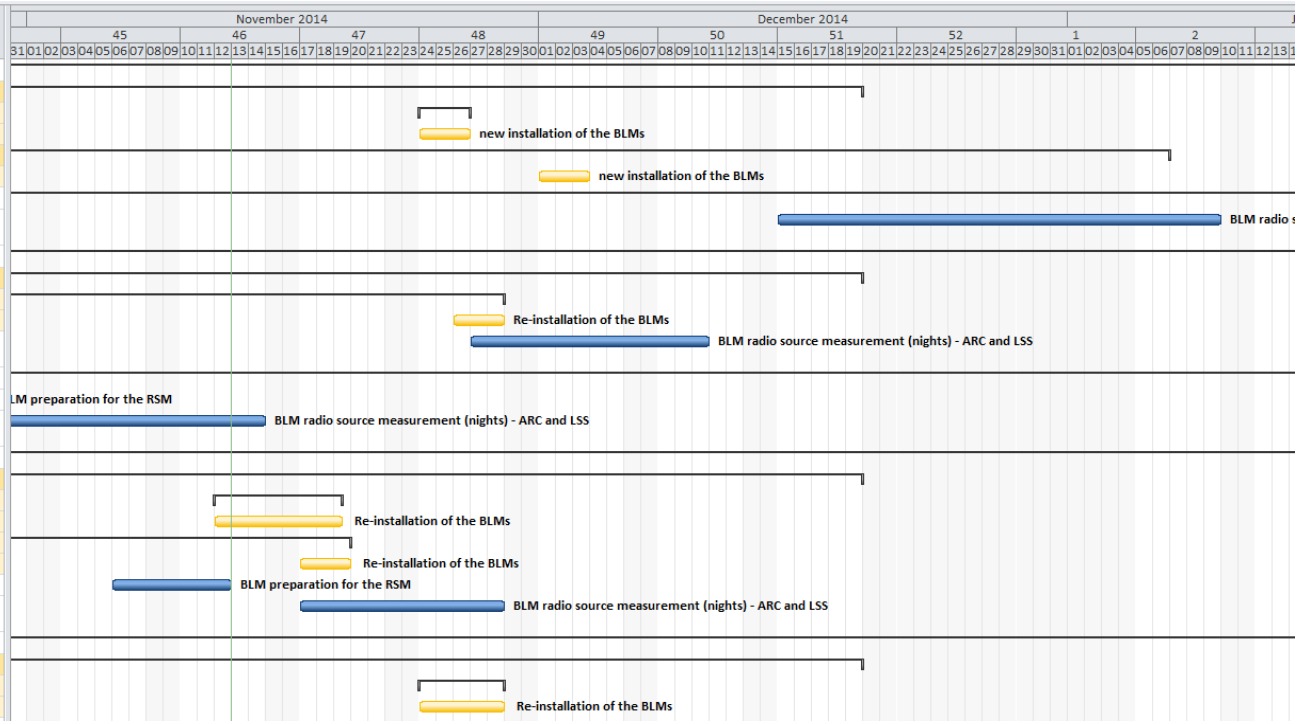


Radiation Source Measurements

Slava

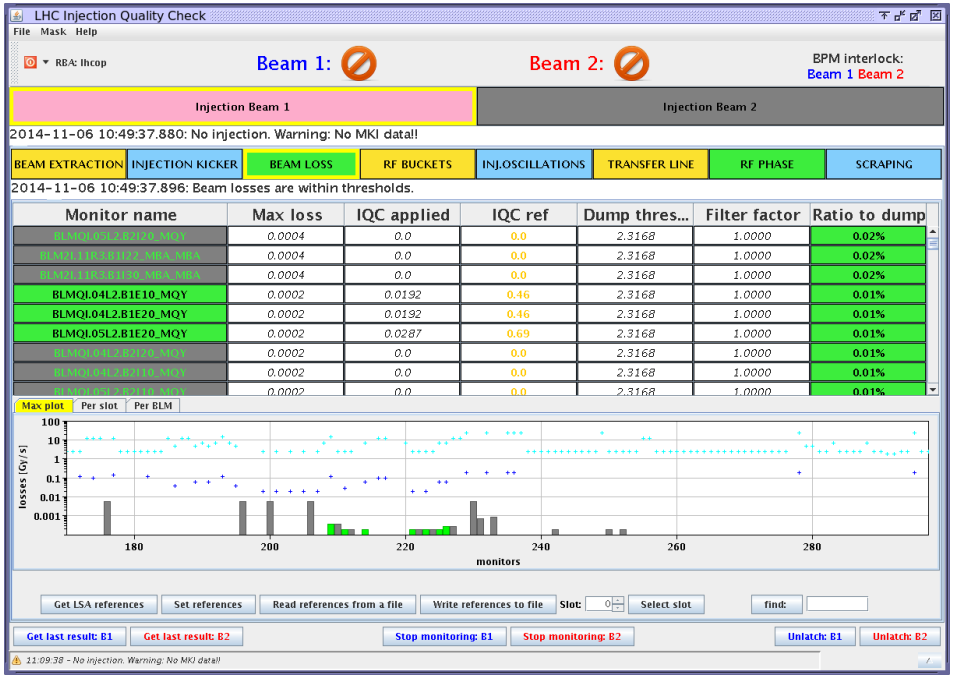
- Last two sectors pending:
  - S45: W49 installation, W50 measurements
  - S34: W51 measurements
- In 2015, selective measurements in areas with many issues

Task Name	Duration	Start	Finish
Sector 12	496 days?	21/02/13	27/02/15
LSS 1R	74 days	08/09/14	19/12/14
A6R1	3 days	24/11/14	26/11/14
new installation of the BLMs	3 days	24/11/14	26/11/14
LSS 2L	42 days	27/10/14	06/01/15
new installation of the BLMs	3 days	01/12/14	03/12/14
Sector 34	554 days?	19/11/12	27/02/15
BLM radio source measurement (nights) - ARC and LSS	10 days	15/12/14	09/01/15
Sector 45	554 days?	19/11/12	27/02/15
LSS 5L	40 days?	27/10/14	19/12/14
A6L5	25 days	27/10/14	28/11/14
Re-installation of the BLMs	3 days	26/11/14	28/11/14
BLM radio source measurement (nights) - ARC and LSS	10 days	27/11/14	10/12/14
Sector 56	499 days?	16/02/13	27/02/15
BLM preparation for the RSM	3 days	27/10/14	29/10/14
BLM radio source measurement (nights) - ARC and LSS	13 days	29/10/14	14/11/14
Sector 78	489 days?	18/02/13	13/02/15
LSS 8L	54 days?	07/10/14	19/12/14
A6L8	5.5 days	12/11/14	19/11/14
Re-installation of the BLMs	5.5 days	12/11/14	19/11/14
A4L8	23 days	20/10/14	19/11/14
Re-installation of the BLMs	3 days	17/11/14	19/11/14
BLM preparation for the RSM	5 days	06/11/14	12/11/14
BLM radio source measurement (nights) - ARC and LSS	10 days	17/11/14	28/11/14
Sector 81	544 days?	19/11/12	13/02/15
LSS 8R	52 days?	09/10/14	19/12/14
MKI areas	5 days	24/11/14	28/11/14
Re-installation of the BLMs	5 days	24/11/14	28/11/14



Dry-Runs

- ✓ Completed already 3; several issues identified and corrected
- ■ W50 dry-run (last) to verify:
  - triggered acquisitions (IQC, XPOC, PM) fixed displays,
  - acquisition of continuous data not blocked when trigger arrives



IQC display during Dry-Run, November 6-7 2014

System Checkout

When the installation is complete and all operational: 2 major and time consuming checks

- Exhaustive threshold triggering
  - automatic test in all the LHC crates
  - 30-50 hours
- Large scale HV modulation tests
  - each test consists of 200 x modulation checks to verify the integrity of the monitors and connections,
  - Results are used to calculate accurate detection limits
  - 3-5 nights

Commissioning with Beam

Tests to perform with beam:

- Test transmission time USER_PERMIT
  - Measure system latency between beam loss and interlock
- MPS functionality of the BLM
  - All crates and channels can provoke an interlock
- Interface of direct BLMs with the LBDS
  - Verify the system can provoke an interlock

Performed together with FMCM by OP:

- Threshold and reaction time at 450GeV
- Threshold and reaction time at physics energy

Details on the modifications planned and the new functionality

LHC BLM SYSTEM:
INJECTION INTERLOCK INHIBIT

Modifications: Installation

- Move relevant detectors to separate acquisition cards
  - See ECR for injection BLMs for the list of monitors involved.
  - Re-cabling of signal and power distribution is necessary for some.

  - Note: we asked initially the current grouping of monitors to **not** be broken. This was later agreed to be an unrealistic demand.

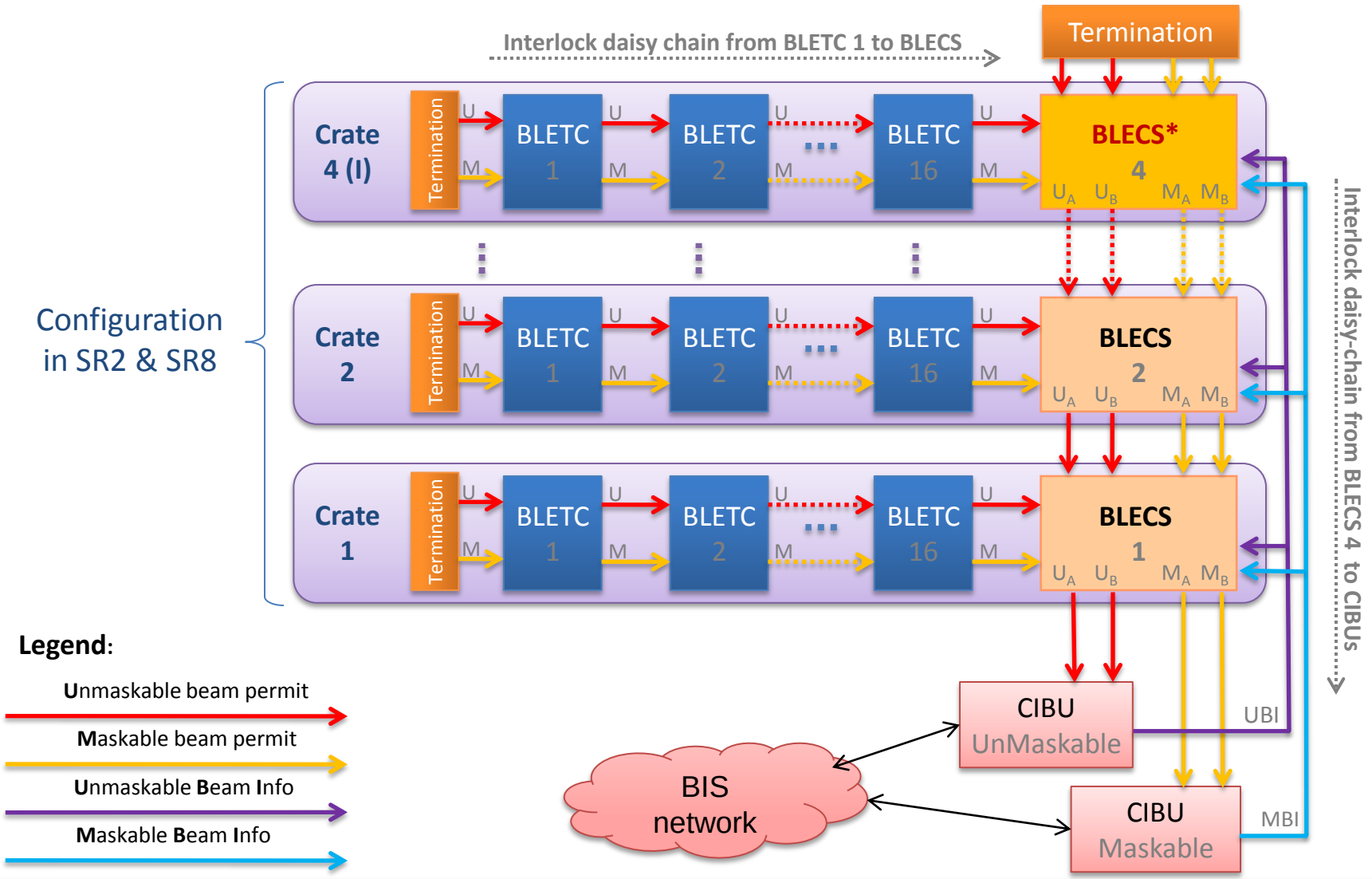
✓ Add two new processing crates
  - Connect to the standard interlock daisy chain between crates
  - Will be the last in the chain to avoid inhibiting other crates' interlocks

- Add new processing modules and connect fibres.

- Update the MTF, LAYOUT and LSA databases with this configuration.

All to be completed during LS1

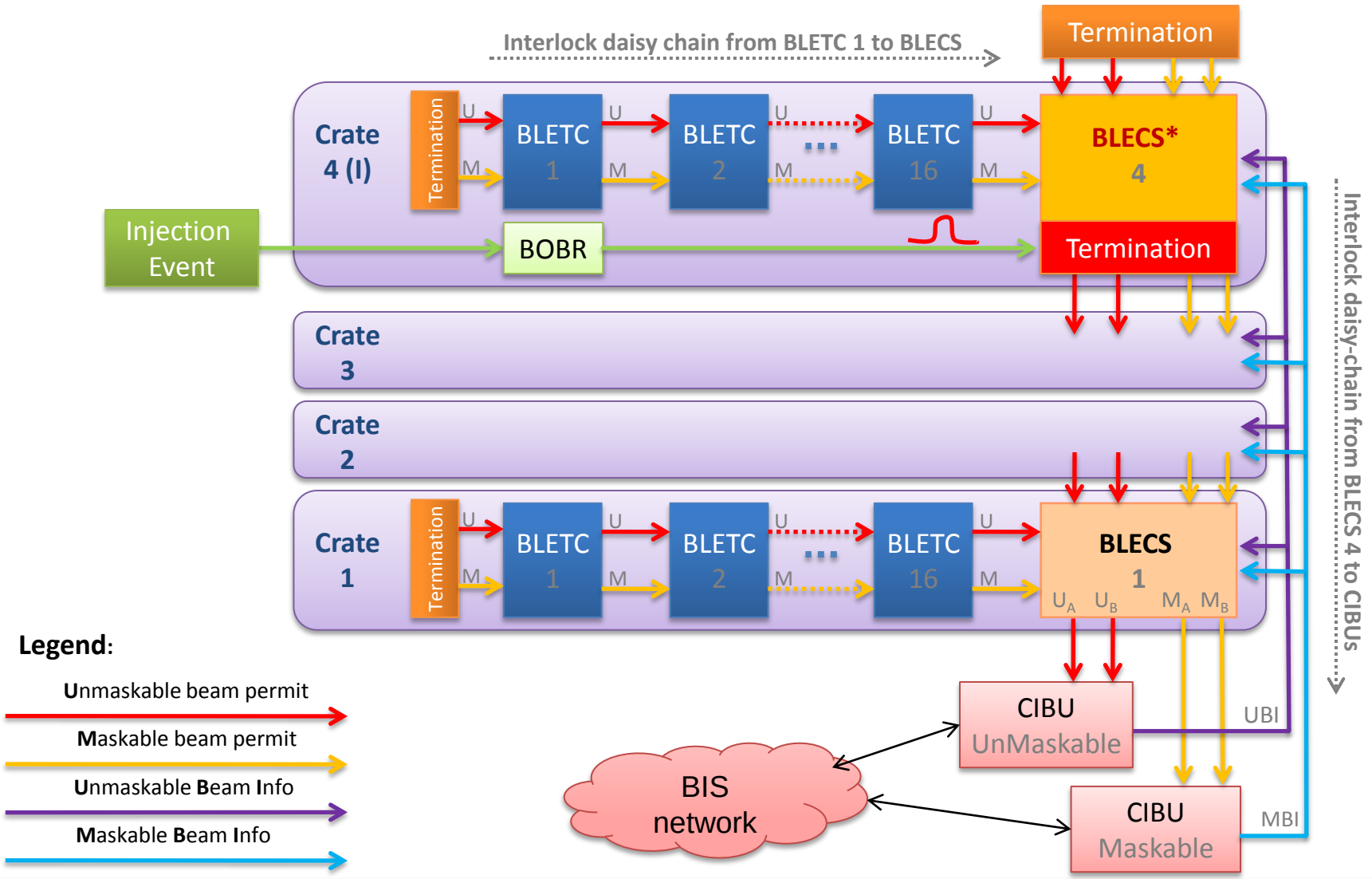
Configuration in SR2 & SR8



Modifications : Hardware

- Modify the BOBM (BST master) configuration to forward a timing event related to the injection
  - There are several to choose from,
    e.g. HIX.FW-CT, HIX.W100-CT, HIX.W20-CT, HIX.AMC-CT.
- Modify the BOBR (BST receiver) configuration to distribute the timing event in the backplane of the crate.
  - A pulse is broadcasted to all cards through a dedicated line of the VME64x P0 connection whenever the event is received
- Modify the BLECS firmware to force the Beam Permit line for a fixed period of time when it receives the injection signal and certain other conditions are satisfied.
  - Persistent FESA settings per crate will (in the future can become part of the MCS parameters):
    - Activate/Disactivate the inhibit functionality.
    - Define the time the beam permit is forced to TRUE
  - Inhibit of the output will happen only under certain conditions:
    - during injection,
    - energy is 450 GeV,
    - …

Interlock Inhibit Functionality



Additional information

- The modified firmware, at this time, cannot affect the total reliability of the system but it can affect its availability, i.e. false dumps.
- Measurement or threshold values will not be modified at any time, i.e. no blinding.
- Interlocks by channels over threshold values will always be logged.
  - For all channels and all integration periods at 1 Hz
  - Though, it will be not possible to know when exactly or how many times inside the 1 s the interlock occurred.

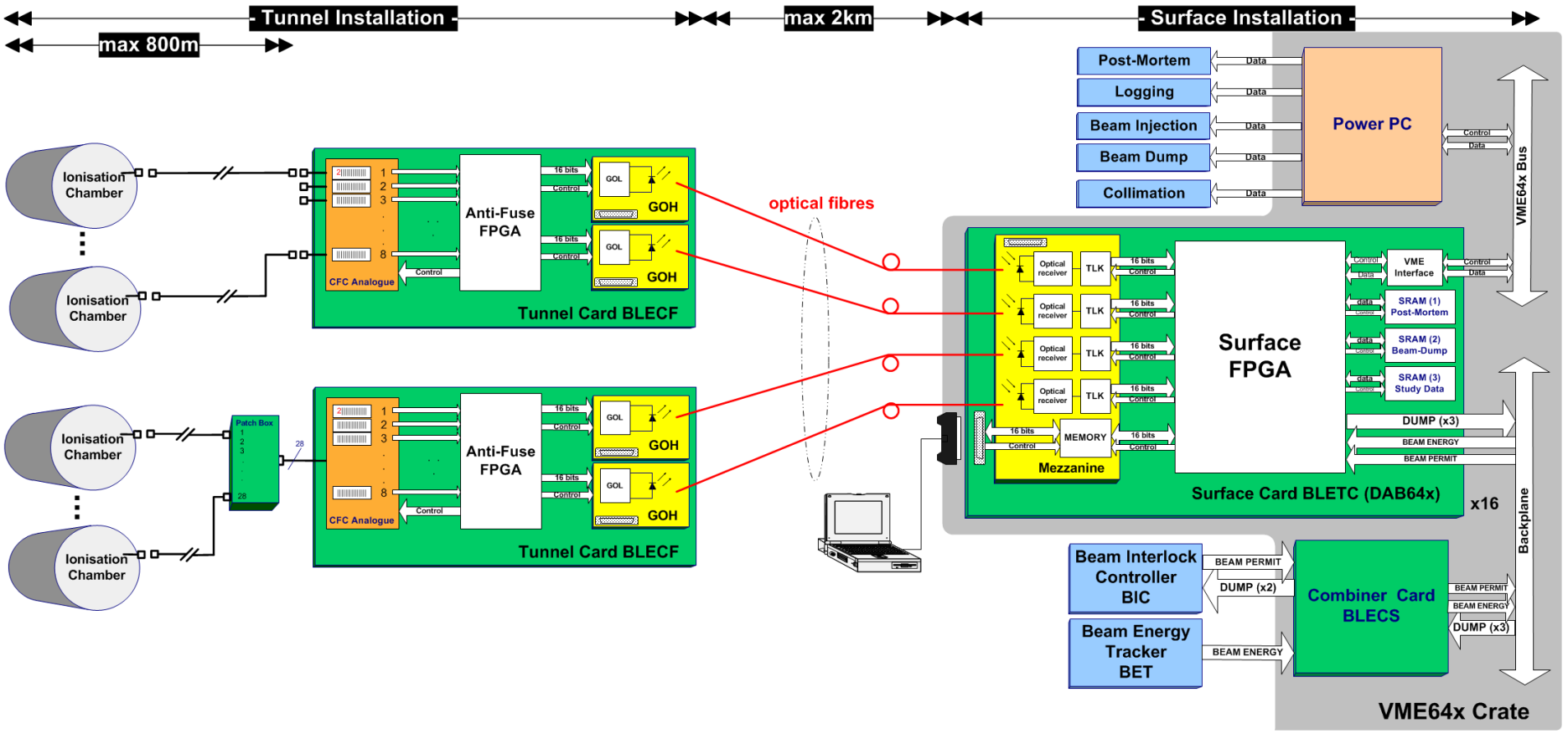
Deployment Plan

- At TS1 deploy special BLECS firmware on new crates
  - separate crates have been installed
  - detector distribution (+use of LICs) has been done
  - new functionality only on the two new injection crates
  - injection signal via the BOBR (via backplane)
- During 2015 maintain two BLECS firmware
  - evaluate the need of the inhibit functionality
  - discover the optimal settings and safeguards required (deadtime, max. repeat, checks etc.)
  - modify further firmware and deploy as necessary (MPP has accepted reduced reliability for these two crates)
- At WTS 2015, depending on outcomes,
  - decide if functionality is needed
  - deploy common firmware to all BLECS modules
  - move FESA settings to DB parameters with MCS

Summary

- Most of the system has been completely re-installed
- All system modules have been modified and underwent maintenance
- Primarily the changes aim to reduce failures and errors
  - Optical links
  - HV power supply
  - Sanity checks
- Additional changes aim to improve
  - Remote control of cards and crates
  - Data collection and distribution
  - Improve ability to maintain the installation
- Complete re-commission will be necessary
  - Rad-source measurements
  - MPS checklist

Thank you

THANK YOU

LHC BLM System Overview