Machine Protection Panel Workshop, March 2013

LHC BLM SYSTEM:
HARDWARE CHANGES DURING LS1

Christos Zamantzas for the BLM team.

Overview

- 2012 Performance summary
  - Main changes introduced
  - Interlocks and Faults analysis
- LS1 foreseen changes
  - Tunnel installation & Acquisition electronics
  - Surface installation & Processing electronics
  - Firmware modifications
  - Application additions
  - Commissioning

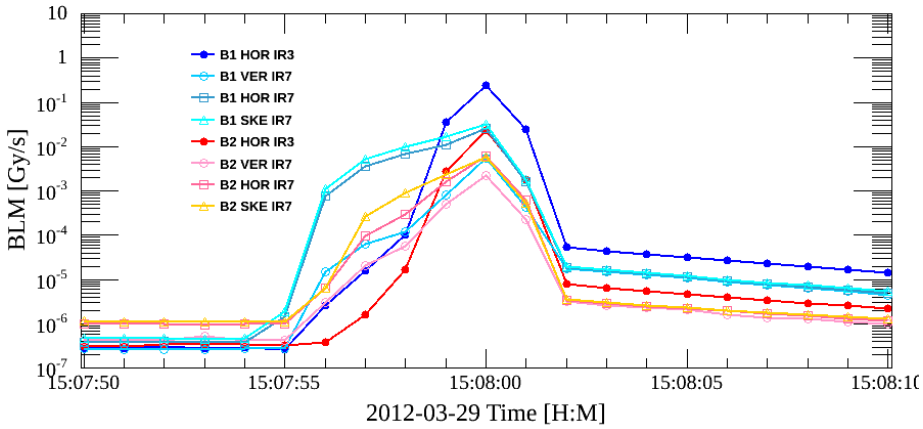
Listing main performance changes in 2012 run and fault statistics

LHC BLM SYSTEM:
2012 PERFORMANCE SUMMARY

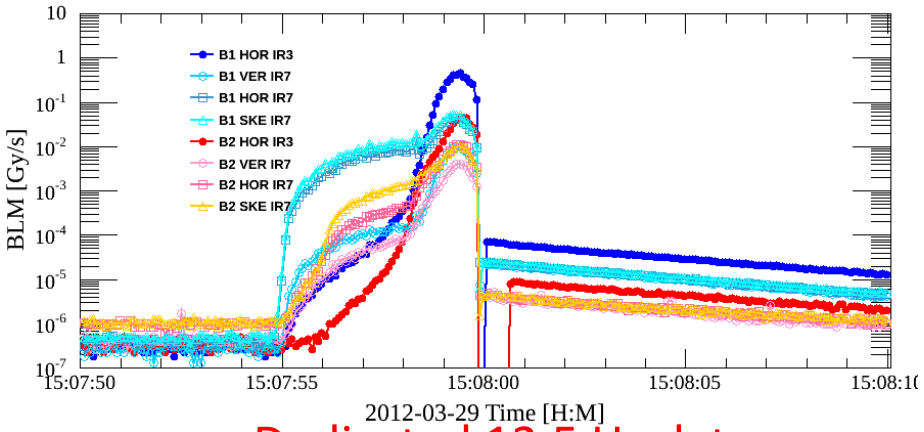
11/03/2013

Automatic/fast Collimator BBA

- New dedicated buffer for automatic and faster Collimator Beam Based Alignment
  - continuous transmission to collimation client
  - UDP packets at 12.5 Hz
  - deliver from each BLM detector a 82 ms integral
- Excellent diagnostic tool. Has been also used successfully to study :
  - the time evolution of the losses in IR7 and IR3 during the loss maps
  - halo diffusion and population



Standard 1 Hz data



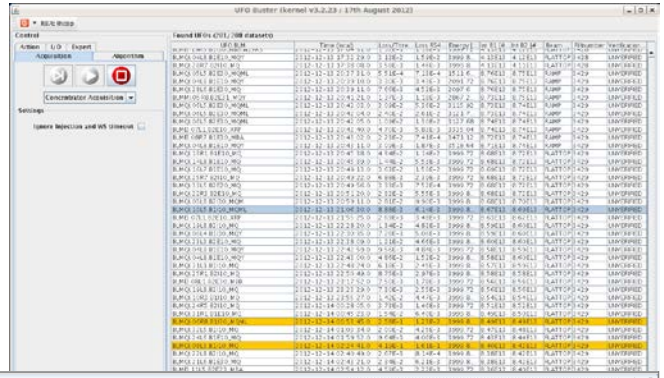
Dedicated 12.5 Hz data

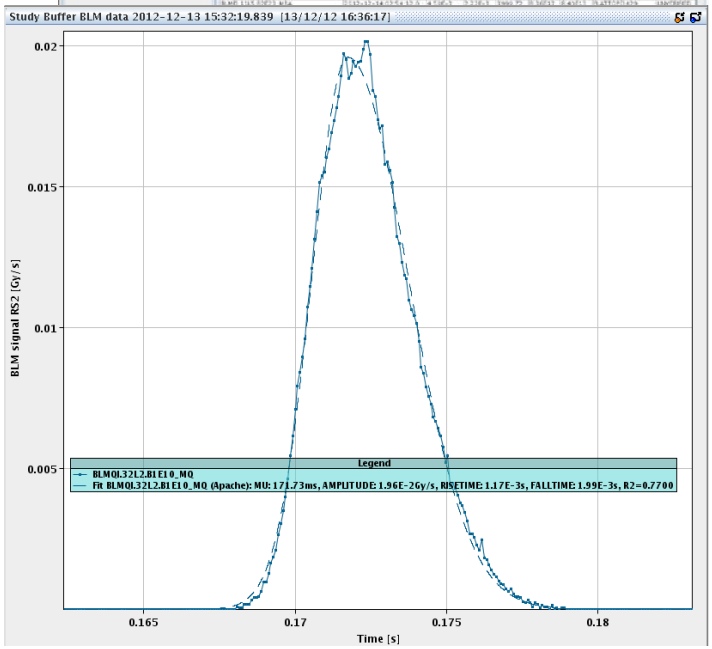
Plots courtesy of Belen Maria Salvachua Ferrando, Gianluca Valentino and Stefano Redaelli

UFO Buster

Unidentified falling objects (UFOs) are potentially a major luminosity limitation for nominal LHC operation.

- New dedicated Capture buffer
  - Dynamic selection of the recording length and type of data
    - 40 µs integral with 512 samples/channel or
    - 80 µs integral with 4396 samples/channel
- New client: UFO buster
  - Allow detection of abnormal losses in real time
  - Triggers collection of high frequency data





Plots courtesy of Tobias Baer

LIC detectors development

- Development of the LIC detectors
  - Cover region between IC and SEM detectors
  - Part of strategy for the mitigation of the injection losses

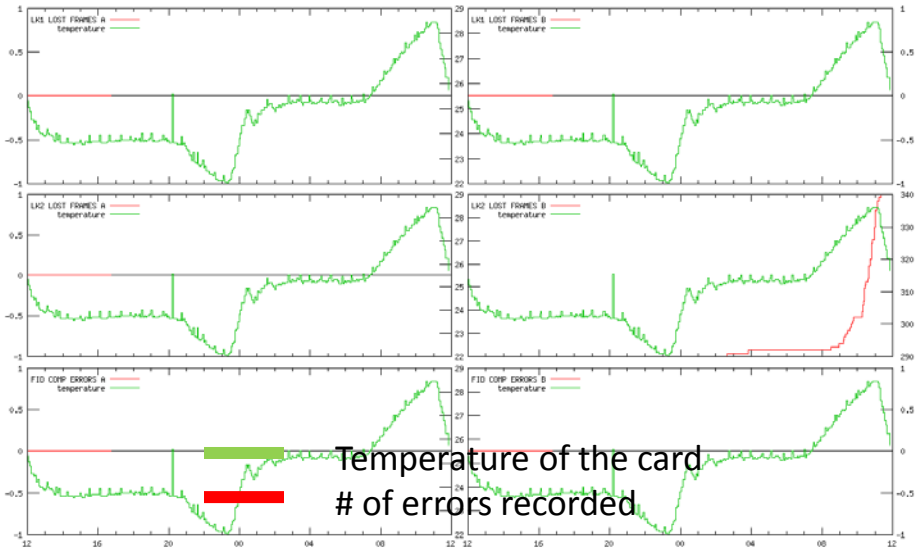
1. Started with a first set of monitors for both beams
   - Investigate behaviour (and reliability)
   - Check correctness of the LIC's conversion factor
   - Check correctness of the calculated thresholds
2. Additional monitors added during the consecutive Technical Stops
   - Direct comparison with IC detectors

- Many issues with first batches
  - Several changes in the production and design parameters

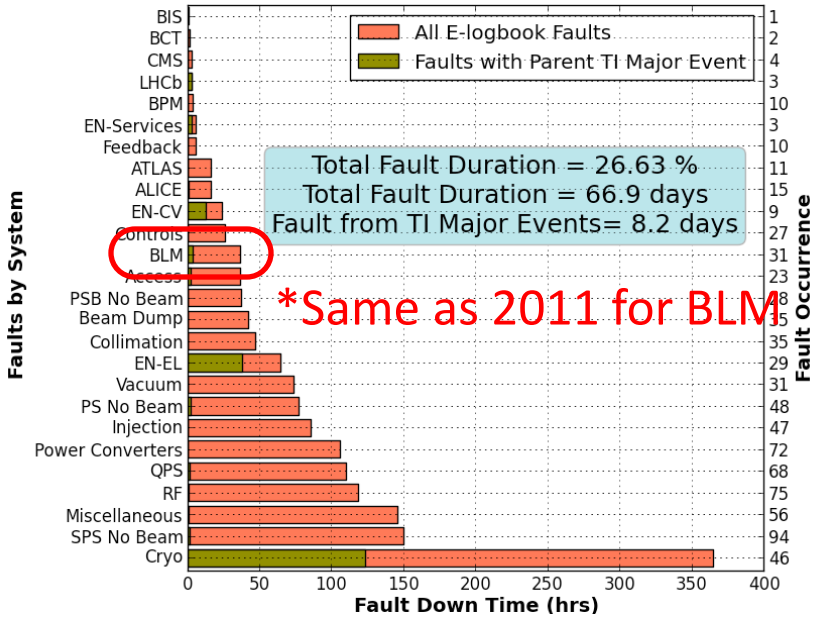
➢ See Eduardo Nebot Del Busto's presentation in Evian 2012

Preventive system fault analysis

- Daily **automatic** analysis of the systems performance
  - Unavailability due to errors from optical link failures **increased**.
  - **Prototype** detector types were installed
    - Many **cards**, **detectors** and **cabling** have been exchanged in the shadow before affecting LHC availability.



Example of the daily optical link report

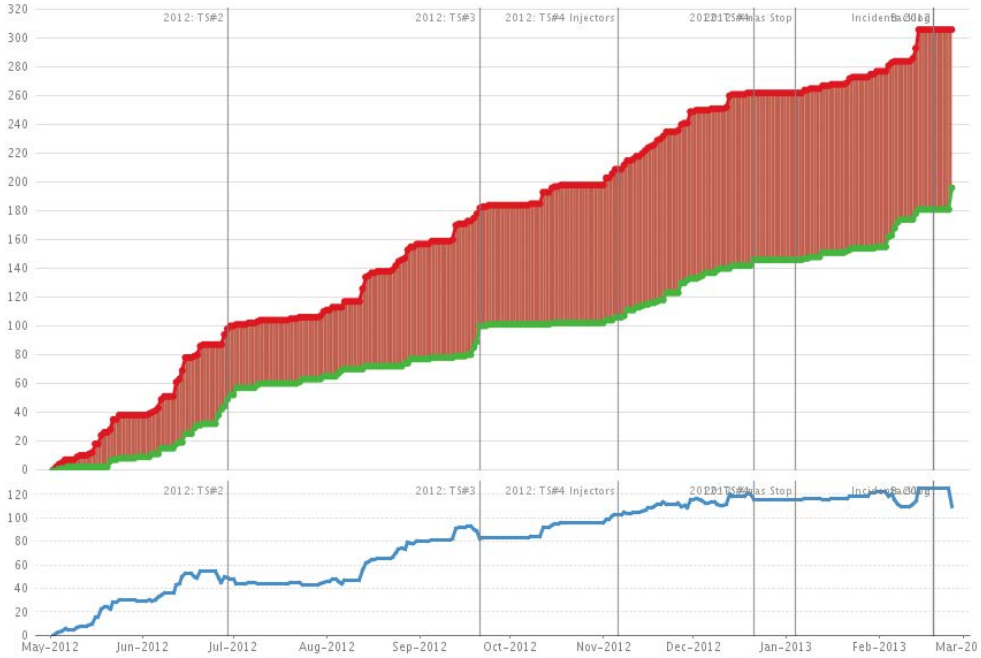


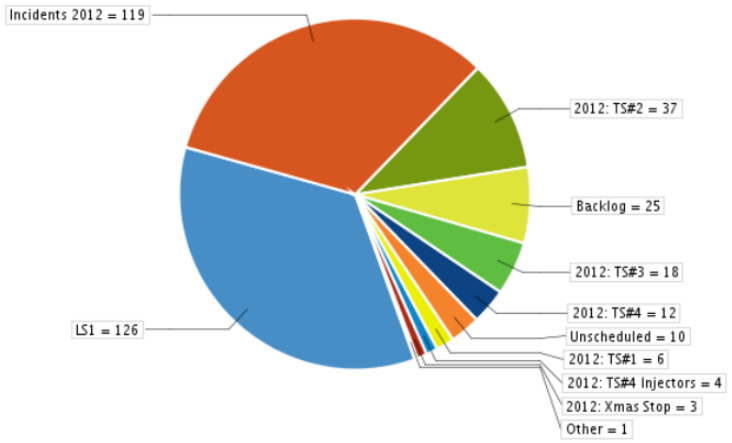
LHC Beam Operation Workshop 2012

courtesy A. Macpherson

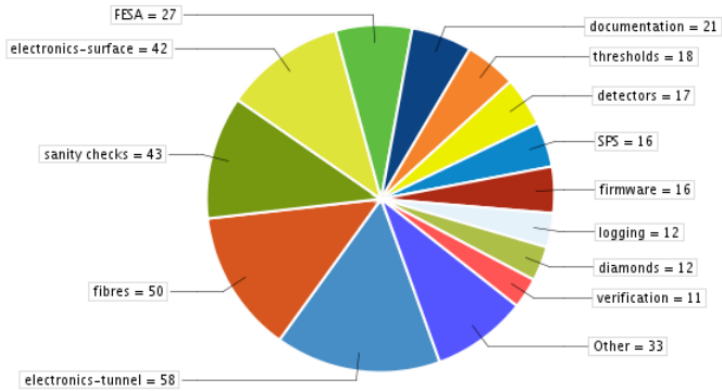
Issue and Task Tracking

- Addition of JIRA project tracker
- Extensive use in 2012
  - register all issues occurred
  - track tasks for the Technical Stops and Shutdowns





Total Issues: **361** Statistic Type: **Fix For Versions (all)**

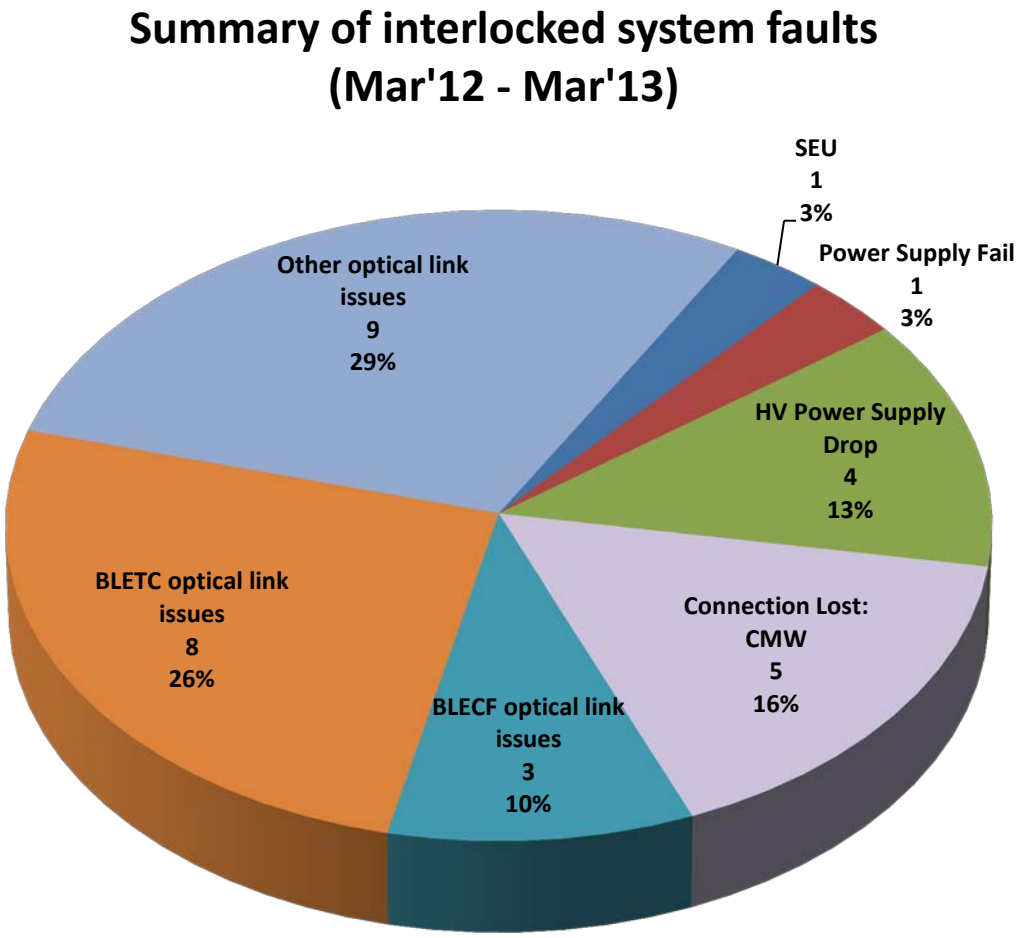


Total Issues: **376** Statistic Type: **Components**

Many thanks to BE/CO for providing the tool and support

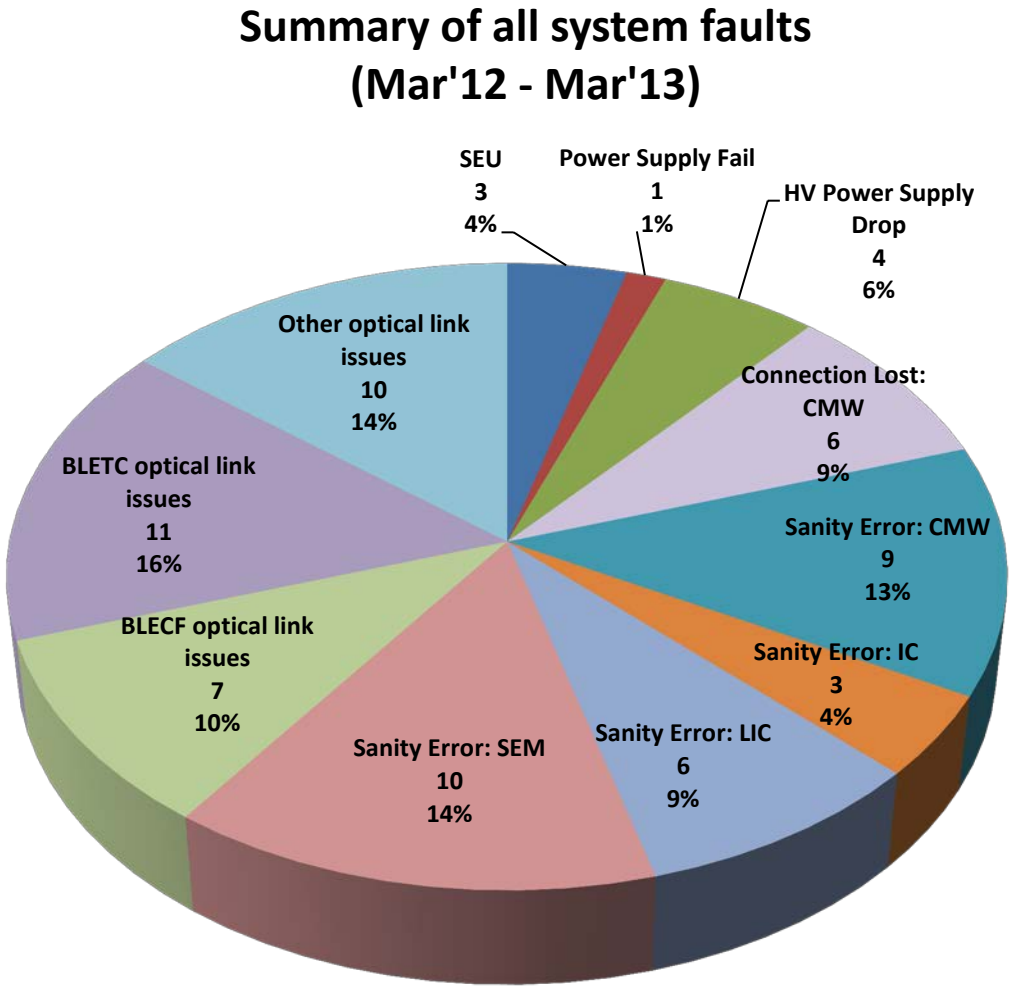
Interlocked system faults

Summary of interlocked system faults (Mar'12 - Mar'13)		
Type	#	%
SEU (surface)	1	3.23%
Power Supply Fail	1	3.23%
HV Power Supply Drop	4	12.90%
Connection Lost: CMW	5	16.13%
BLECF optical link issues	3	9.68%
BLETC optical link issues	8	25.81%
Other optical link issues	9	29.03%
Total	31	



All types of system faults

Summary of all system faults (Mar'12 - Mar'13)		
Type	#	%
SEU (surface)	3	4.29%
Power Supply Fail	1	1.43%
HV Power Supply Drop	4	5.71%
Connection Lost: CMW	6	8.57%
Sanity Error: CMW	9	12.86%
Sanity Error: IC	3	4.29%
Sanity Error: LIC	6	8.57%
Sanity Error: SEM	10	14.29%
BLECF optical link issues	7	10.00%
BLETC optical link issues	11	15.71%
Other optical link issues	10	14.29%
Total	70	



Listing main actions to be performed or developed in the system

LHC BLM SYSTEM:
LS1 FORESEEN 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

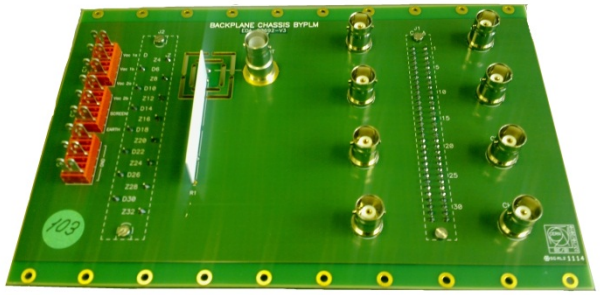
- Relocate 816 detectors
  - New supports, cable extensions, cable trays needed
  - ➢ Improve protection
  - ➢ see Eduardo Nebot Del Busto's presentation for the reasons

New locations of the detectors

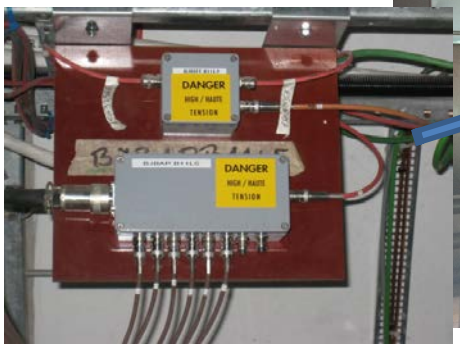
Modifications in the tunnel installation

ECR in preparation

- 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
- Modify 20 High Voltage distribution boxes
  - Add suppressor diodes and resistors
  - Only in areas with high losses



Improved backplane



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

Modifications in the ACQ electronics

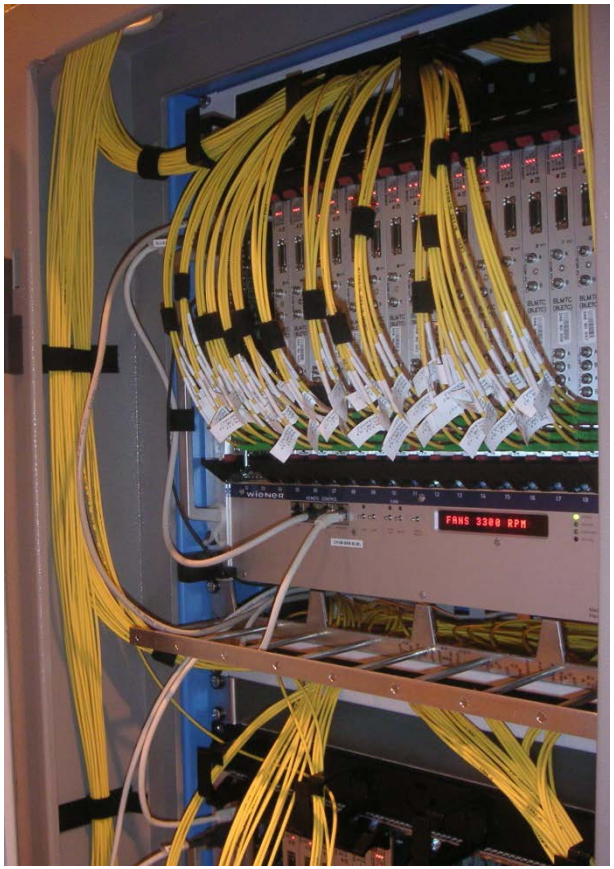
- Modify all BLECF modules (~700)
  - Change limit for the HV level detection flag
    - currently too restrictive for proper use by the SIS.
    - change detection level from 1370V to 950V
  - Change laser settings of the GOH
    - increase transmission power to give more margin of attenuation
    - 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

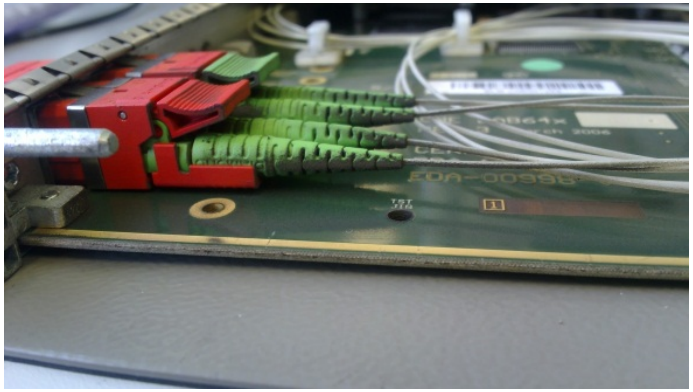
- Add two new crates for possible future **Injection Inhibit** implementation
  - Install additional racks in P2 and P8
  - Separate problematic monitors for injection
  - ➢ see also Wolfgang Bartmann's presentation



Modifications in the TC electronics

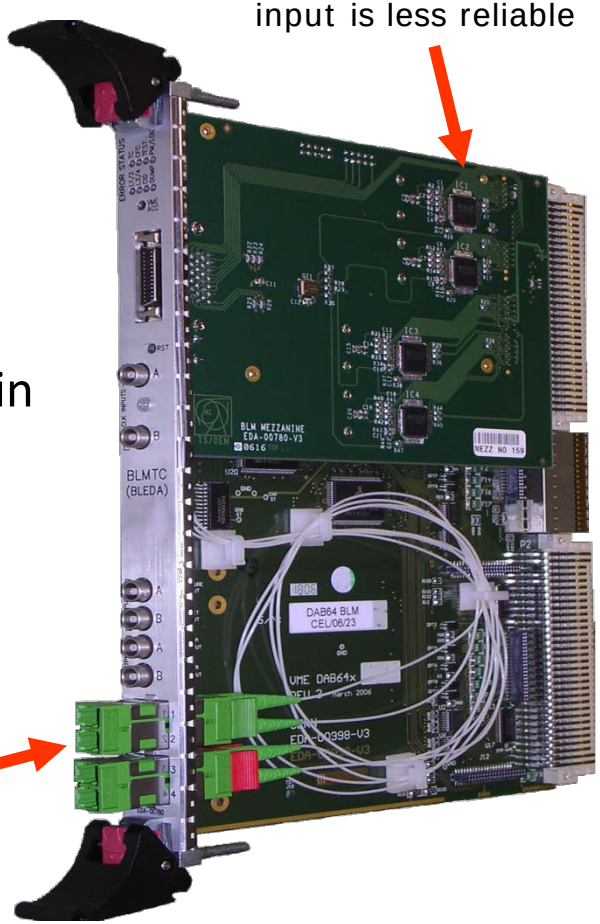
- Maintenance of all processing modules (~400)
  - Fix or Replace ~ 20% of mezzanines
  - Clean-up of the optical adaptors and connectors

- 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.

Modification of the BLECS firmware

- Combiner and Survey firmware modifications:
  - 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
  - Add compatibility with new CPUs
    - new VMEbus core with MBLT mode
    - new memory map optimized for block transfers
  - Preparation for the “Injection Inhibit” feature

Modification of the BLETC firmware

- Processing Module firmware modifications:
  - Improve PM and UFO Buster buffers
    - increase size to 43,690 samples per channel
  - Improve XPOC buffer
    - split data and triggers per beam (not sure yet if possible)
  - Improve data for Collimation Beam Based Alignment
    - increase data rate (not sure yet if possible)
  - Add compatibility with new CPUs
    - new VMEbus core with MBLT mode
    - New memory map optimized for block transfers

Application Improvement wishlist

- **Internal 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.)

Commissioning after LS1

- In short, equal to LHC start-up
  - Check all optical connections
  - Update all serial numbers
  - Check behaviour of each card
  - Calculate new Connectivity check limits
  - Radiation Source measurements
    - First sector to be available already in Nov'13 !!
  - Complete MPS checklist

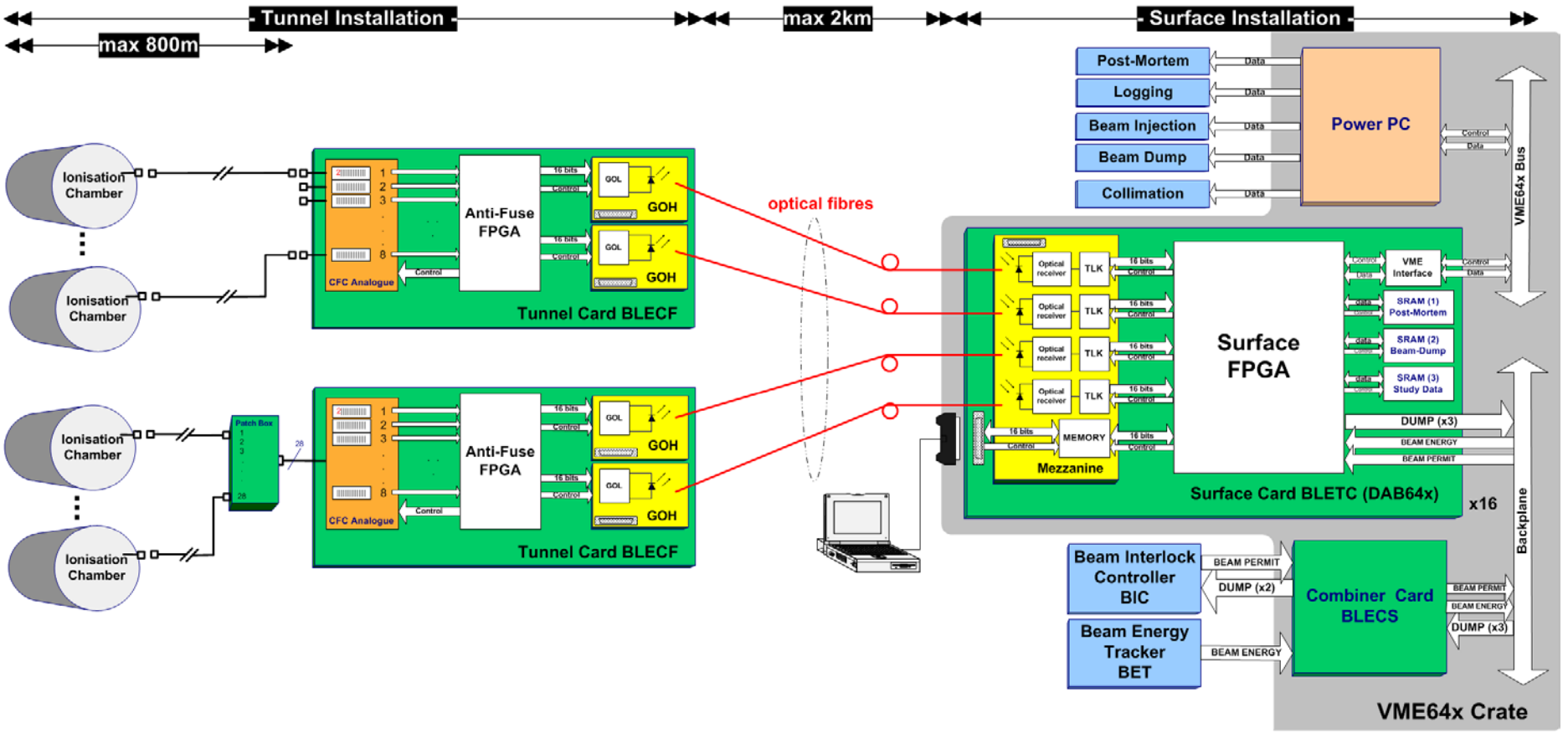
Summary

- Most of the system will be completely re-installed
- All system modules will be modified and undergo 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



Modifications on additional systems

- New design of the BLM Direct Dump system
  - Follow changes in the LHC Beam Dump system
- Deployment of new acquisition system for the Diamond detectors