Summary of Workshop on Post Mortem

- Organisers: R.Lauckner, A. Rijllart, R.Schmidt
- http://indico.cern.ch/conferenceDisplay.py?confId=9340
- The main aims of the workshop were:
  - to verify readiness of hardware and software systems for imminent powering of the cold circuits
  - to develop the roadmap for beam operation in 2007 and beyond.
- Many groups have started to prepare their systems for the different phases of commissioning and operation. The workshop reviewed their activities, identify open issues and help to define the future roles and responsibilities.
- In case of a failure during the operation of the LHC, such as a beam loss and/or magnet quench, a coherent set of information from the various subsystems is required to diagnose the causes for the failure.
- Post Mortem must detect loss of redundancy in protection systems

LHC "Post Mortem" Workshop: Introduction

Initiative by Robin Lauckner, Adriaan Rijllart and myself, helped by many other colleagues

This is the first workshop on the **recording and analysis of data after an event** in the LHC, such as a **magnet quench or a beam dump - Post Mortem**. Data will come from transient recorders, from the logging systems, from alarms and probably other sources

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other accelerators: HERA at DESY

THE USAGE OF TRANSIENT RECORDERS IN THE DAILY HERA MACHINE OPERATION

R. Bacher, M. Clausen, P. Duval and L. Steffen, DESY, Hamburg, Germany

PAC 1997, HERA operating in the 7th year

Many parameters of HERA machine components such as RF systems or quench protection as well as important beam parameters are continuously measured using transient recorders. **In general, these recorders are not synchronized among one another and sample the data with very different rates ranging from 200 Hz to 50 MHz**. At present, **work is going on to integrate the different existing transient recorders into a global system**. The article reviews the transient recorder hardware in operation at HERA. In addition, the proposed trigger distribution based on the HERA Integrated Timing system as well as the software concept to archive, retrieve and display the data will be described.

not exactly a new concept…also not for LHC

Conclusion

- Equipment safety (equipment interlock and controls) not yet defined
  - Beam and power permit link to be considered
  - Beam abort link to be considered - must be very reliable
  - Power abort links to be considered - must be very reliable
  - BNL (RHIC) has beam abort and power abort link - some 100 modules
- Transient recorders should be available
  - for signals required to understand beam dumps and power aborts (beam monitors, radiation monitors, magnet protection, power converter, ...)
  - data coherence for different systems
  - synchronisation of measurements from transient recorders at the level of milliseconds - acquisition frequency depend on system
- For safety relevant systems - watch out for consequences of mains failure

simple and robust

SCADA day - RS 22/1/99

- What data is needed to understand failures during LHC operation? R.Lauckner (Chamonix 10, 2001)
- The LHC Post-Mortem System, E.Ciapala, F.Rodriguez Mateos, R. Schmidt, J. Wenninger (LHC Project Note 303, October 2002)
- What do we see in the control room? R.Lauckner (Chamonix 12, 2003)
- Machine Interlock Systems (LHC Design Report, 2004)

.....jump by several years

- Most systems have been made to allow recording transient data (Beam instruments, power converters, quench protection, ….)
- The systems use synchronised clocks for their recording
- Triggering is in two different ways
  - self triggered in case of a failure (e.g. QPS, PC)
  - external trigger (BLM, BPM, ...)
- Some systems record all state transitions (Powering Interlock System, Beam Interlock System) in the logging system, this is for systems with small data volumes and long periodes between state transitions

Aims of the PM system

Some questions that should be answered with the PM data :

1. What happened?
   A. Initiating event
   B. Event sequence leading to the dump
2. The beam is dead, but is the machine still okay?
   A. Powering & magnets ('abnormal' signals in QPS…)
   B. Beam Dumping System XPOC
3. Did the protection systems perform as expected?

The answers will arrive on a time scale ranging from minutes to months !

J.Wenninger

Analysis top priority

A beam just died, but life goes on…

Can we (OP) proceed and re-inject or do we stop ?

~10 Gbytes transformed into…

Prepare for more Higgses

Call experts !

on the time scale of ~ 1-15 minutes

J.Wenninger

Ingredients

- Every LHC equipment and diagnostics system must implement a circular PM buffer
- Data must be UTC Time-Stamped to ~ ms or µs depending on type
- Precise Naming Convention must be devised and supported
- The PM buffer must be frozen by an external PM Timing Event or by self-triggering
- Self Describing, tagged, data must be presented to the PM API
- Alarm and Logging information essential
- The PM data must be combined to form the Post Mortem Event data: size ~ few Gbytes
- The PM event must be automatically analyzed. 'Digested' information must be generated for operations
- The PM event must be Stored – the most relevant data must be stored for the lifetime of the LHC. Some of it may be important for INB

AB-LHC Review, Controls
18 – 20 November, 2003

R.Lauckner

What exists - PM System, Logging, Alarms (Adriaan Rijllart)

PM system architecture, front-ends, servers, triggering	**LAUCKNER, Robin**
PM Data Collection and Storage	**TROFIMOV, Nikolai**
SDDS to LabVIEW, the path from client data to viewing and analysis	**KHOMENKO, Boris**
Alarms in relation with Post Mortem	**SIGERUD, Katarina**
Logging data in relation with PM and archiving	**BILLEN, Ronny**

1. **Rüdiger: Main motivation** for PM comes from **machine protection**
2. **Robin: Time stamping** at the source and **coherent naming** are prerequisites
3. **Nikolai**: Data model for suppliers established, scalability tests underway, multiple PM servers for fault tolerance and load balancing to be done
4. **Boris**: **SDDS established** for analysis clients, data managed by **filing system**, data on exposed server and **user with insecure password**
5. **Katarina**: Alarms primarily for alerting operator, can be **packed in SDDS** and **exported for analysis clients**, alarms are archived for (only) 2 years
6. **Ronny**: Periodic **logging** of slow phenomena firmly **established**, coherent naming must extend across all LHC data repositories, **long term archiving** of information for retrieval required. **Measurement DB for higher frequency** data is required, data to be exported into PM system (only 7 days im MDB)

Cold circuits – data, analysis (Felix Rodriguez Mateos)

Powering of the SC circuits: procedures and strategies for circuit validation	**VERGARA, Antonio**
Present status of the individual systems analysis applications	**REYMOND, Hubert**
Analysis requirements for the SC magnet systems	**SIEMKO, Andrzej**
How do we tackle the extended requirements?	**RIJLLART, Adriaan**

1. **Antonio: Post Mortem data analysis vital tool** for cold circuit commissioning
2. **Andrzej**: Global Magnet Post Mortem Analysis includes **Individual System Analysis** (ISA), **Logical System Analysis** (LSA) and **Global System Analysis** (GSA). **Software trigger** for Analysis, **preventing to give Power Permit** if not ok. Analysis in modules.
3. **Hubert: Sequencer** conducts HC tests, **PMA** will **assess result**. Software is specified by system experts. Lot of software is existing.
4. **Adriaan:** Bottom up staged analysis strategy. Lab VIEW: **signal analysis tools**, **maths library, formula nodes**, **MATLAB scripts**, **import C code**.

Operation with beam - PM requirements (Jorg Wenninger)

Beam quality checks at injection	**KAIN, Verena**
Beam dump XPOC analysis	**GODDARD, Brennan**
Emergency dump Post Mortem	**WENNINGER, Jorg**
Post Mortem acquisition triggering	**LEWIS, Julian**

1. **Verena:** Shot-by-shot logging data is required for a "post mortem" of the injection quality check. Sequenced Data Acquisition (SDA), Fermilab contribution. Non-CERN standard data format and DB.
2. **Brennan:** PM trigger must be condition on Beam Dump Trigger. XPOC, based on LSA. Propose not to use PM data for XPOC. (This was the primary purpose of the PM system!!)
3. **Joerg:** Rapid accurate PM analysis a top priority for operation. System integrity analysis to be specified by system experts. Outline specification for Beam PM analysis and tagging. PMA and LSA approaches must be coherent.
4. **Julian:** Two separate timing events, one per beam. Does one need an additional "dump both beams" event? PM event suppression driven by application software **DONE**

Data providers, volume, type of analysis (Robin Lauckner)

Overview of providers	**LAUCKNER, Robin**
Beam Instrumentation	**BART PEDERSEN, Stephane**
Collimators and movable objects	**JONKER, Michel**
R.F.	**BUTTERWORTH, Andrew**
Kickers	**CARLIER, Etienne**

1. **Robin:** updated table of PM data providers, BLM 2 GB, PC 2 GB, RF 2 GB, others less. Gives ~100 GB/week during early beam commissioning
2. **Stéphane:** All BI systems provide standard metadata. Ready for scalability tests, 20 crates now, 100 crates June/July.
3. **Andy:** 3ms buffers frozen by BIS. PM and observation independent. PM triggers independent for Ring 1 and 2. Start analysis with simple signal plotting.
4. **Etienne:** PM data not sufficient for IPOC. Transient trigger from BIS. SbS and Transient contention. Alarm and logging data added to PM buffer. Injection SbS gives 6MB/shot. Reliability of total chain is an issue for the kickers.
5. **Michel:** Can PM system be used for non-PM data? Correlation of PM data with machine data (mode, energy, ramp-time, etc) is important. Does this come from logging? Demonstrate innocence of their system in case of incident.

Summary of PM workshop: Hardware commissioning 2

PM for superconducting elements – required for tests in parallel (… end of May) partially done

1. Semi-automatic analysis needed
2. Conclusion of PM analysis: where it happened, what is the result?
3. Soft inhibit of re-powering needed in case that analysis shows no-conform results or fails
4. Software trigger module for Logical System Test. When is it needed and how? **(Action: MPP/SACEC?)**

Others issues

1. MPWG to address issues of PM 1 or 2 PM triggers and contention between use of buffers for periodic and transient requirements.
2. Remark: Easier searching of data if **SDDS directory structure is in DB**?
3. Cross system signal browsing, saved signal sets, who specifies? (**SACEC?)**
4. Correlation of signals, how to specify, which file to load? DB?
5. SDDS enhancement to have more intelligence (X-Y info, etc). Task force on SDDS will be set-up with BI, PO and CO (**Action: J.J.Gras**).
6. Who is setting overall priorities? HW commissioning coordination for HC
7. Does CO/MA have enough resources to meet the HWC deadlines?
8. Remark: One person of AB-PO should be the contact person to the PM team

Beam PM, Technology: LabVIEW vs Java

1. Should Beam PM be done with the same technology as Magnet PM?
   - **Not necessarily**
2. What are the criteria to decide (expertise, resources)? What is the latest date to decide? Who?
3. Joerg asks if CO supports LabVIEW for the next 15 years?
4. If we use both technologies, how do they work together? (discuss with Mike, Eugenia?).

- **Data should be open to read from anything**

Some remarks for discussion

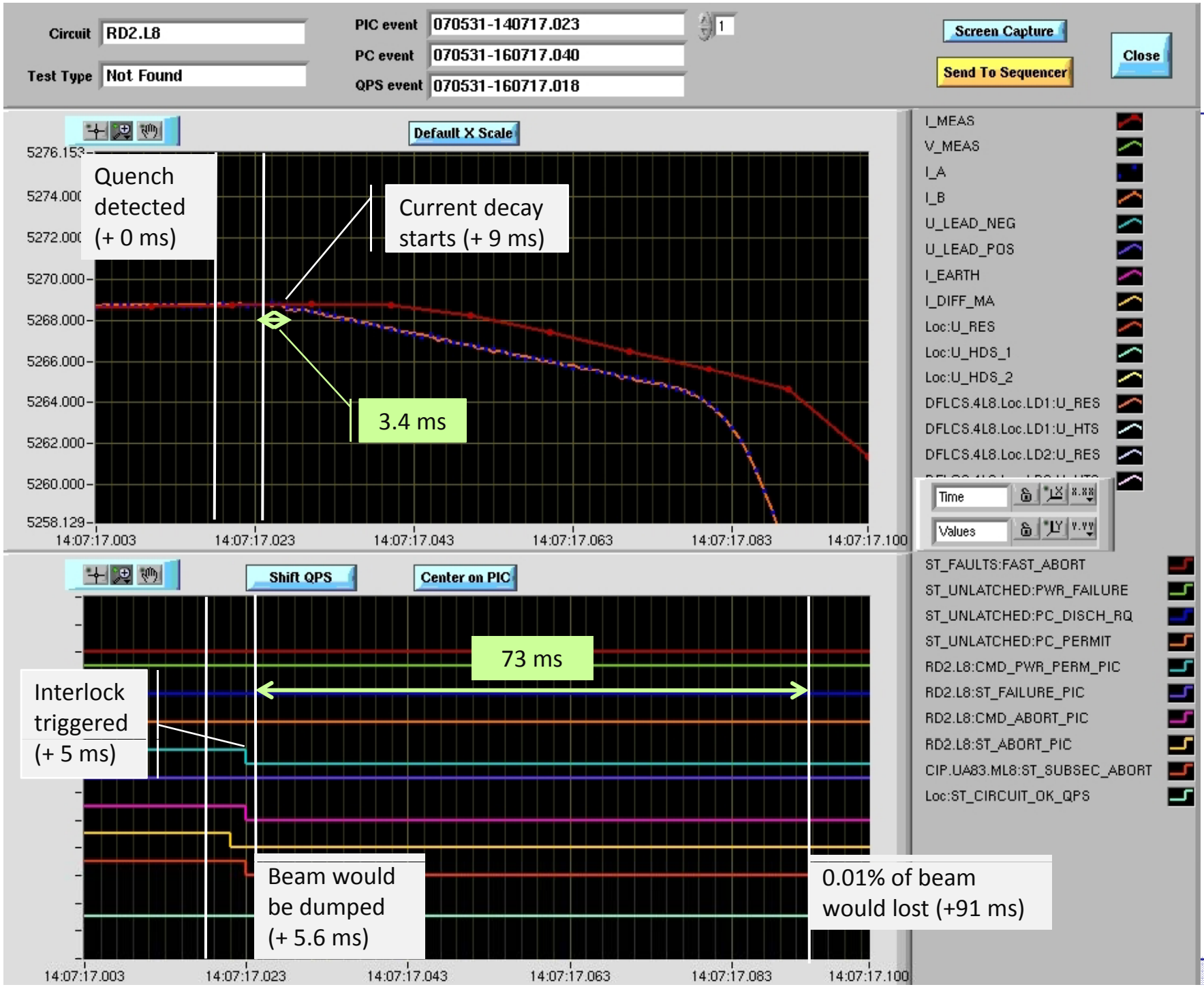
1. HWC PM should be done with **top down** thinking
   - simple global analysis, then more detailed aspects for global analysis and individual system analysis
2. **HC should steer powering PM**, and **OP should steer beam PM**, with a strong emphasis on minimum requirements
3. Because of the **wide scope of open issues** from this workshop a **PM team is essential** to follow up on open issues identified at the workshop **diverse team, computer scientist, hw people, operation, someone must drive the effort dynamic leader**
4. Groups must analyse their own data within a software framework defined by the PM team
5. PM team must be pro-active and concentrate on the global aspects of PM

The job of the PM team is to master the global perspective rather than write detailed analysis for equipment groups for which task they will never have adequate resources

Remarks: PM for Hardware Commissioning

- Heavy use of the PM system during Hardware commissioning from April to July
- PM system captured and recorded all important event
- Display of the data was ok
- Some analysis tools were available
- Data from Post Mortem used together with data from (continuous) Logging System (Timber)

- Many improvements for next Hardware commissioning period, starting mid November
  - analysis modules
  - introduction of “events”, grouping the relevant data files that are recorded after a quench, a powering abort, …. and allows to get data, for example, all quenches of one magnets, all quenches in one sector, …


Circuit
RD2.L8
Test Type
Not Found
PIC event
070531-140717.023
PC event
070531-160717.040
QPS event
070531-160717.018
1
Screen Capture
Send To Sequencer
Close
Default X Scale
Quench detected (+ 0 ms)
Current decay starts (+ 9 ms)
3.4 ms
5276.153
5274.000
5272.000
5270.000
5268.000
5266.000
5264.000
5262.000
5260.000
5258.129
14:07:17.003
14:07:17.023
14:07:17.043
14:07:17.063
14:07:17.083
14:07:17.100
I_MEAS
V_MEAS
I_A
I_B
U_LEAD_NEG
U_LEAD_POS
I_EARTH
I_DIFF_MA
Loc:U_RES
Loc:U_HDS_1
Loc:U_HDS_2
DFLCS.4L8.Loc.LD1:U_RES
DFLCS.4L8.Loc.LD1:U_HTS
DFLCS.4L8.Loc.LD2:U_RES
Time
Values
Shift QPS
Center on PIC
73 ms
Interlock triggered (+ 5 ms)
Beam would be dumped (+ 5.6 ms)
0.01% of beam would lost (+91 ms)
ST_FAULTS:FAST_ABORT
ST_UNLATCHED:PWR_FAILURE
ST_UNLATCHED:PC_DISCH_RQ
ST_UNLATCHED:PC_PERMIT
RD2.L8:CMD_PWR_PERM_PIC
RD2.L8:ST_FAILURE_PIC
RD2.L8:CMD_ABORT_PIC
RD2.L8:ST_ABORT_PIC
CIP.UA83.ML8:ST_SUBSEC_ABORT
Loc:ST_CIRCUIT_OK_QPS

- End