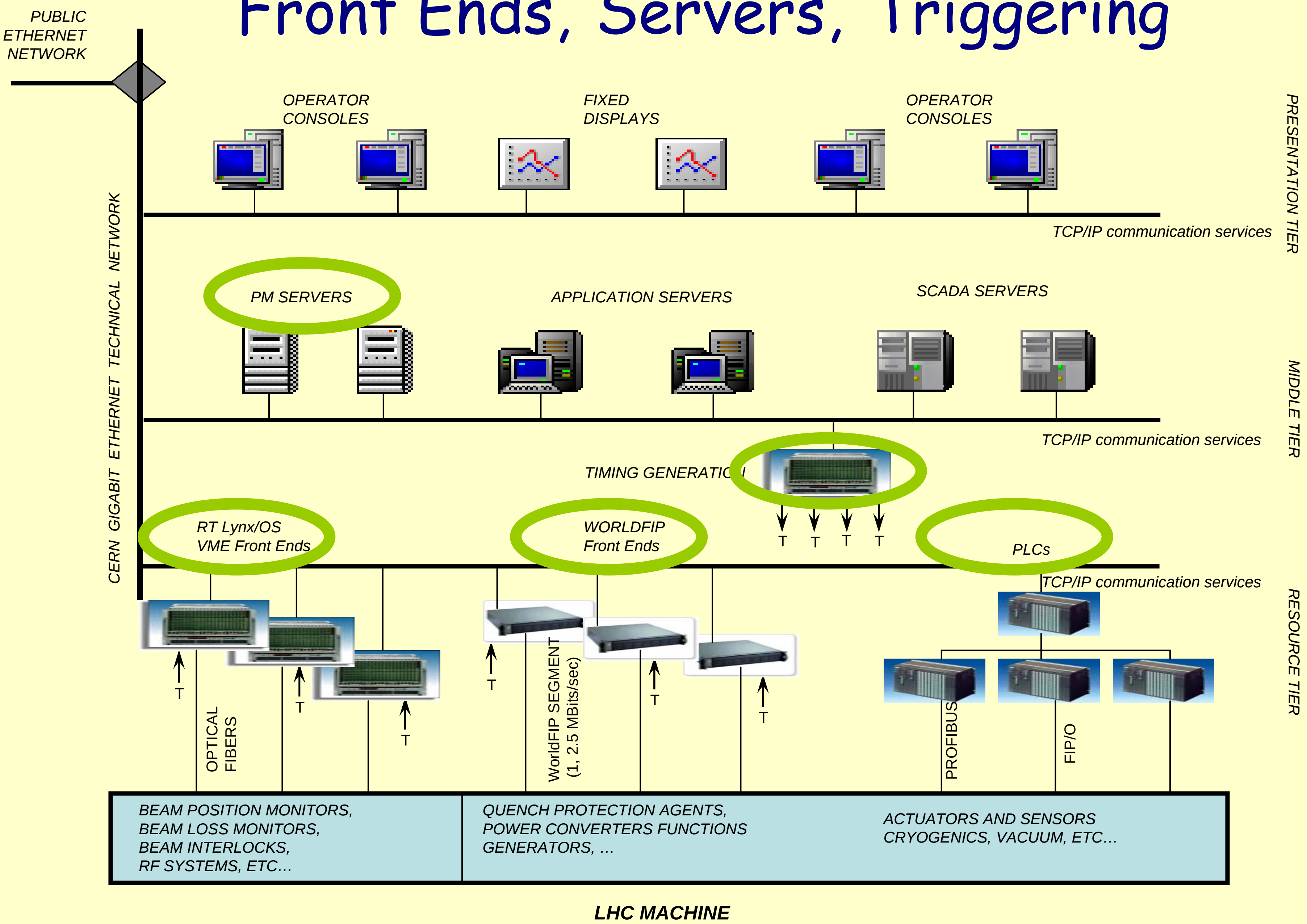
PM System Architecture Ingredients

Workshop on LHC Post Mortem

Session 1 – What exists - PM System, Logging, Alarms

Robin Lauckner

Front Ends, Servers, Triggering



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

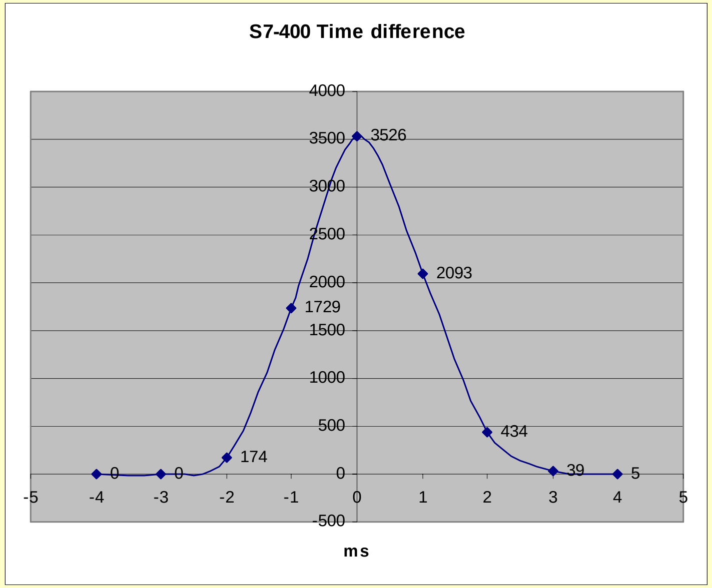
Timestamps

Data must be UTC time-stamped – close to the source. CTG is a precise source of UTC time but will not be unique, NTP is used by PLCs and will also compare data from experiments, technical services and beyond.

Currently Logging and Alarm Archive contain UTC, PC transients also UTC. CCC clocks and displays are mixed.

System	Timestamp accuracy
Beam dump	< 0.05 ms
Beam instrumentation	
Radio frequency	
Injection (kickers…)	
General machine timing	
Machine interlocks	1 ms or better
Quench protection	
Power converter	
Feedbacks (orbit, tune…)	1-10 ms
Cryogenics	
Vacuum	
All other systems	

LHC-Project Note 333, Ciapala et al, Oct 2002



NTP Time-stamping on PLCs - From J.BRAHY & R. BRUN (AB/CO/IS, May 2005

Naming Convention

"Precise Naming Convention must be devised and supported" (AB-LTC Nov 2003)

LHC-C-QA-0002 "NAMING OF LHC ENTITIES …" Billen, Lauckner

Semantics **<LHC parameter>**

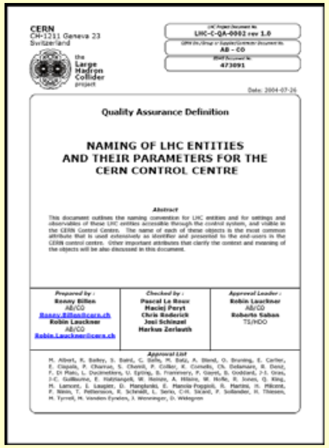
<LHC entity>:<quantity code>

Semantics **<LHC entity>**

<LHC entity code>.<location>.<function>

Semantics **<Quantity Code>**

<Physical Quantity>_<Differentiator>_<Qualifier>


Quality Assurance Definition

NAMING OF LHC ENTITIES
AND THEIR PARAMETERS FOR THE
CERN CONTROL CENTRE

LHC Complexity leads to unfamiliar names MB.A20L3:U_HDS_4– over 152'000 are documented in the Naming Database

Some of the names are impractical – RPTE.UA23.RB.A12 :I_MEAS but this probably means RB.A12:I_MEAS

Using of naming db to explore MB.A20L3

Entities and Signals
NAMING DATABASE

Home | Signal Simple Extraction | Signal Experts Interface | LHC Equipment Codes | SPS Equipment Codes | PS Equipment Codes | Print | Help

Accelerator: LHC
System: ALL

SIGNAL (PARAMETER) NAME

	Entity Code	Occurence	Location	Function	Quantity Code
	MB	A	20L3		
Starting wildcard	No	No	No	No	No
Ending wildcard	Yes	Yes	Yes	Yes	Yes

Customize Search Output

- Signal Description: Hide
- Accelerator: Hide
- System: Hide
- Entity Code: Hide
- Occurence: Hide
- Location: Hide
- Function: Hide
- Quantity Code: Hide
- Location Class: Display
- Unit: Display
- Data Type: Display
- LHC Layout DB: Display

Search: Go

File Output: XML | CSV

SIGNALS

1 - 12

Parameter Name	Parameter Description	Accelerator	System	Entity Code	Occurence	Location ▲	Function	Quantity Code
MB.A20L3:ST_MAGNET_OK	(NQD0 and NQD1) or (NQD2 and NQD3) of MB.A20L3	LHC	QPS	MB	A	20L3		ST_MAGNET_OK
MB.A20L3:ST_NQD0	Quench detected (1st comparator) of MB.A20L3	LHC	QPS	MB	A	20L3		ST_NQD0
MB.A20L3:ST_PWR_PERM	ST_COHER and (U_QS0<20mV) and (ST_MAGNET_OK) of MB.A20L3	LHC	QPS	MB	A	20L3		ST_PWR_PERM
MB.A20L3:TIMESTAMP_ACQ	Timestamp at which data were acquired of MB.A20L3	LHC	QPS	MB	A	20L3		TIMESTAMP_ACQ
MB.A20L3:TS_MAGNET_NOK	Timestamp of the magnet quench of MB.A20L3 (ms precision)	LHC	QPS	MB	A	20L3		TS_MAGNET_NOK
MB.A20L3:U_1	Voltage across magnet first aperture of MB.A20L3	LHC	QPS	MB	A	20L3		U_1
MB.A20L3:U_2	Voltage across magnet second aperture of MB.A20L3	LHC	QPS	MB	A	20L3		U_2
MB.A20L3:U_HDS_1	1st Heater power supply voltage (capacitor voltage) of MB.A20L3	LHC	QPS	MB	A	20L3		U_HDS_1
MB.A20L3:U_HDS_2	2nd Heater power supply voltage (capacitor voltage) of MB.A20L3	LHC	QPS	MB	A	20L3		U_HDS_2
MB.A20L3:U_HDS_3	3rd Heater power supply voltage (capacitor voltage) of MB.A20L3	LHC	QPS	MB	A	20L3		U_HDS_3
MB.A20L3:U_HDS_4	4th Heater power supply voltage (capacitor voltage) of MB.A20L3	LHC	QPS	MB	A	20L3		U_HDS_4
MB.A20L3:U_QS0	Analogue output of the bridge (1st comparator) of MB.A20L3	LHC	QPS	MB	A	20L3		U_QS0

Triggering!

- Systems are internally and / or externally triggered
  - QPS only internal trigger
  - PCs internal and external trigger
- Timing event is not used for circuit commissioning
- After an unexpected beam dump the loss of Beam Permit will cause a Timing Event that will freeze buffers across machine
- Very fast systems – RF with 3ms buffers, will trigger off the BIC to reduce delays
- Before injection the LHC is 28 independent cryostats a general Timing Event inappropriate
- Shot by shot timing event trigger to capture injection data
- During inject and dump must avoid 10 GB/min

Self-Describing-Data-Sets: SDDS

An important challenge for LHC Post Mortem will be to enable discovery of data in the system and then to allow programmers and programs to access the information contained in the data. Alarms and Logging have their own schemes to deal with the 2nd problem but it has been decided to adopt SDDS for data on the PM Servers.

Michael Borland from ANL is the father of SDDS – he writes
…true self−describing data can in principle be read equally by any number of programs, including programs written by the user. No particular program "owns" the self−describing file in the way that a spreadsheet program owns a spreadsheet file or a wordprocessing program owns a document …
When accessing data from a self− describing file, a program … will be able to determine whether the desired data actually exists, what its data type is (e.g., floating point or character string), as well as optional information such as units, description, and dimensions.

Alarms and Logging

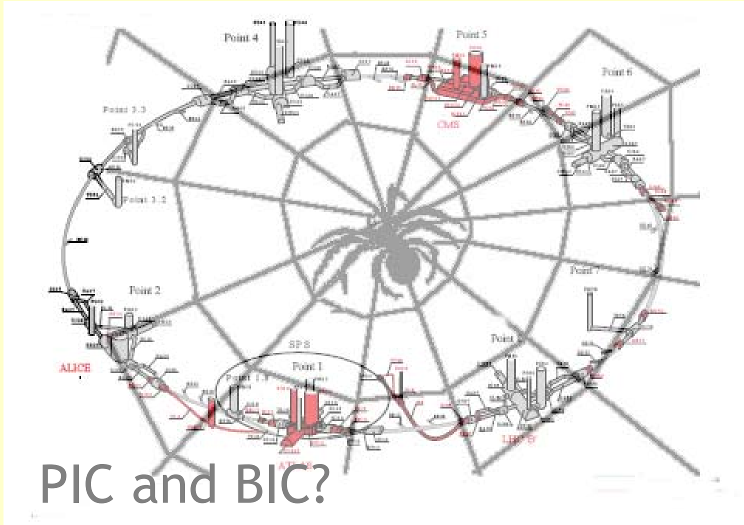
Alarm and Logging information essential (AB-LTC Nov 2003)

- LHC power converters are logged and alarmed
- PIC: buffers are logged, faults alarmed
- QPS alarms not yet there, logging?
- Quench analysis tools extract data from logging and alarms

Post Mortem Event

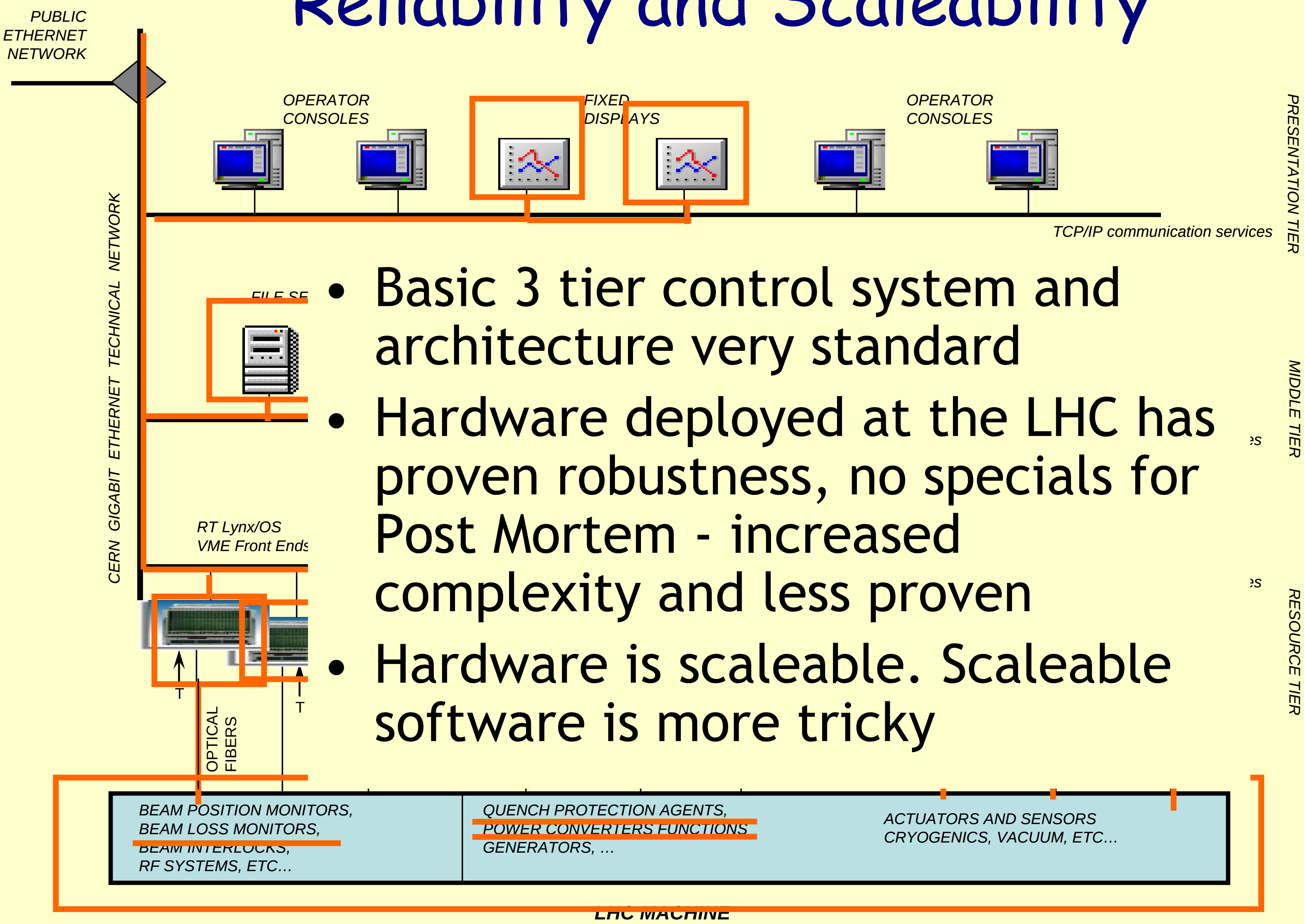
The PM data must be combined to form the Post Mortem Event data: size ~ few Gbytes

- PM Analysis is currently at the individual system level
- More global treatment of circuits on the way
- The more general problem of monitoring data arrival in central servers, identifying and associating data from varied sources is a future challenge



Cataloguing and storing events is also for the future

Reliability and Scaleability

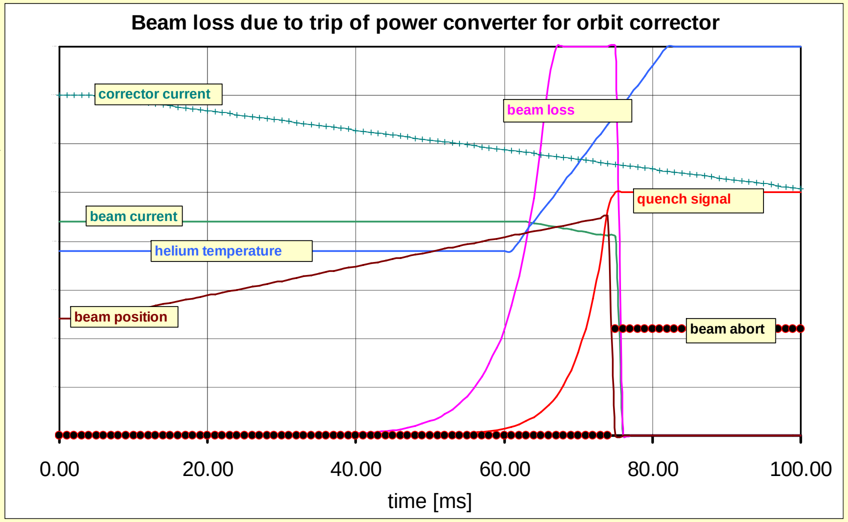


- Basic 3 tier control system and architecture very standard
- Hardware deployed at the LHC has proven robustness, no specials for Post Mortem - increased complexity and less proven
- Hardware is scaleable. Scaleable software is more tricky

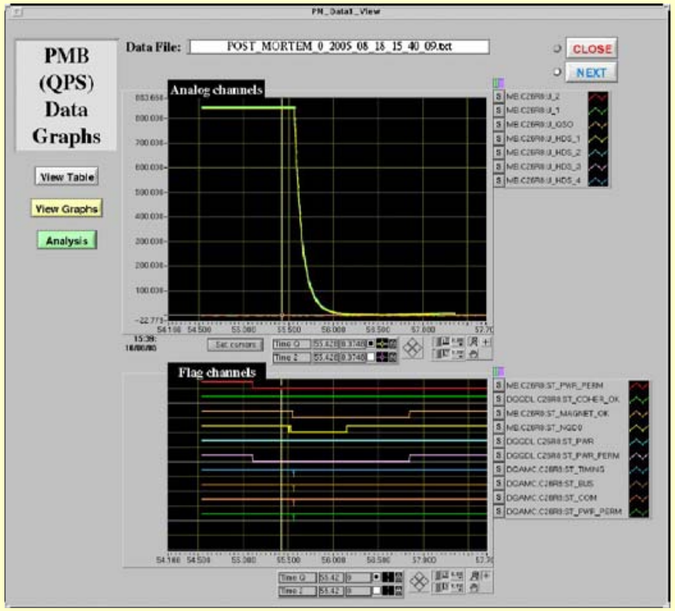
Analysis

- Generic Analysis
- External Analysis
- Specific Analysis

Rüdiger plot - Different systems and sources



Developed for LHC h/w



Existing investment of AP s/w

Final Points

- Some key ingredients of architecture in place
  - Naming, Timestamping, SDDS for integration of data from different systems
  - Logging and measurement, alarms and PM servers operational and robust
  - Specific analysis for quench data well advanced
- Post Mortem is being implemented in the existing robust and scaleable control system
- Event building and long term data management are challenging tasks for the future
- Simple approach while understanding grows