Minutes of LHC-CP Link Meeting 17

Subject	:	LHC Controls Project	
Date	:	9 October, 2001	
Place	:	865-1-D17	
Participating Groups	:	EST-ISS	no representative,
		LHC-ACR	Ph. Gayet,
		LHC-ECR	no representative,
		LHC-IAS	J. Brahy,
		LHC-ICP	F. Rodriguez-Mateos,
		LHC-MMS	no representative,
		LHC-MTA	apologies,
		LHC-VAC	R. Gavaggio,
		PS-CO	no representative,
		SL-AP	E. Wildner,
		SL-BI	no representative,
		SL-BT	E. Carlier,
		SL-CO	A. Bland,
		SL-HRF	Ed Ciapala,
		SL-MR	R. Billen,
		SL-MS	no representative,
		SL-OP	M. Lamont,
		SL-PO	Q. King,
		ST-MO	R. Bartholome replacing P. Solander.

Others : A. Butterworth (SL-HRF)
R. Lauckner (Chair),
M. Peryt (Logging Project)
B. Puccio (Machine Protection),
R. Schmidt (Machine Protection),
M. Tyrrell (Alarm Project),
M. Vanden Eynden (Core Team),
J. Wenninger (SL-OP)
M. Zerlauth (AC-TCP).

Distribution : Via LHC-CP website: **http://cern.ch/lhc-cp**
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Agenda :

1. Matters arising from Previous Meeting	
2. LHC-CP News	R. Lauckner
3. Components Work	P. Gayet
4. Machine Protection and Control	B. Puccio, R. Schmidt
5. Post Mortem System	J. Wenninger
6. AOB	

1. Matters arising from Previous Meeting

Discussions on the Controls Equipment Naming have continued. The ST requirement has been identified as Part Identification (LHC-PM-QA-206.00 rev 1.1). R Lauckner has proposed that families of system code C be designated following the needs of equipment in the tunnel. CI is proposed for Interlocks. Discussions are continuing with R, Saban and the TEWG.

2. LHC-CP News R. Lauckner

The project to prepare the Logging Database for LHC Operation has started, a copy of the mandate is attached to these minutes. M. Peryt and R. Billen have been asked to prepare a first operational version to support the Control Systems used during the QRL reception tests.

D. Myers of IT-CO reports that they are drafting the contract for the purchase of the PVSS licenses for the LHC Machine and Services after approval at the last Finance Committee.

The Alarm Survey has been sent out and M. Tyrrell reported that the first replies have already been received.

The schedule and main topics for the next LHC-CP meetings are:

23/10	Back Ends, Slow Timing	Charrue, Beetham
20/11	Future Front Ends, Middleware, Opertional Data	Vanden Eynden, Lauckner, Billen

3. Components Work P. Gayet

P. Gayet recalled the original objectives of the Components Working Group. These included:

> "Define common technical approaches across these systems particularly in areas such as PLC software and hardware architecture, usage of SCADA, fieldbus configuration and development methods"

Initial discussions had indicated that most groups were already committed to a variety of solutions in these areas and that the subsequent catalogue of support needs would be unrealistic. Consequently he has decided to concentrate on re-enforcing the definition of standards at CERN and elaborating a realistic set of support services.

CERN collaborations initiated by the Controls Board are currently active in the areas of fieldbuses and SCADAs. The Fieldbus Working Group has now prepared a new recommendation for cables and connectors. This is already a useful tool for experts and will be discussed at the next meeting of the Controls Board. At the recent CERN workshop on Field Networking the penetration of Ethernet into the lower layers of Control Systems had been explored. Clear trends are for Ethernet to become the communication bus down to and between PLCs. Modbus TCP is emerging as an important protocol for communicating with PLCs over Ethernet. However in the device layer the penetration is much weaker and fieldbuses have important advantages. At CERN the IT-CS group is becoming actively involved with defining the architecture and support services for Ethernet deployed in these applications.

Turning to SCADA systems he reported on two working groups that have been created to address activities involving PVSS at CERN. The SCADA Application Support Group, SASG, chaired by W. Slater of IT-CO has been set up to coordinate PVSS application development at CERN and brings together groups working actively with PVSS. P. Gayet explained that PVSS is programmable rather than configurable and that JCOP and UNICOS have both developed Frameworks to support common applications such as Alarms and Trending. The SASG is trying to homogenise this work.

A second group: the Industrial SCADA Application Group, (ISAG) brings together CERN Controls Groups and CERN Contractors who are planning PVSS component developments being carried out by the suppliers. Their essential aim is to avoid duplicate developments by different contractors.

Based on these initiatives and also the current commitments of the Controls Groups P. Gayet proposed a new approach to support based on solutions and services which are potentially valid for a large number of users. Support for PLC and Fieldbus activities would come from the LHC-IAS Group while SCADA support will come from the SASG and the ISAG.

He showed how support could be organised for the preparation, installation and maintenance phases of controls work. More refined proposals will be presented to the Components Working Group members in November leading to a schedule for introduction of services and other deliverables by the end of the year.

The LHC-IAS group is heavily committed to the Cryogenic Control System – UNICOS. This includes PLC software capable of supporting a wide range of applications for the LHC and a SCADA framework that is being considered by the SASG and ISAG. Groups working on controls at the LHC such as SL-MS, SL-HRF and LHC-VAC could certainly apply such components.

R. Billen asked where was the best place to request a bridge between PVSS and Oracle?P. Gayet replied that the SASG is collating such needs across CERN. At present project members on this working group are himself and M. Tyrrell.

R. Gavaggio pointed out that cables for fieldbuses have to be ordered by the end of this year and if such orders are to be funnelled this must be done quickly. P. Gayet said that he will urgently discuss this with users of fieldbuses.

ACTION P. GAYET

F. Rodriguez-Mateos pointed out that the work to identify the fieldbuses to be used by each group has already been done by the TEWG.

In response to a question from M. Tyrrell, P. Gayet said that LHC-IAS will use Razor and CVS for code management and MP5 for Asset Management in Industrial Control Systems.

R. Lauckner pointed out that standard ergonomics across PVSS displays used in the PCR is highly desirable, at least up to some level; certainly conventions for interacting with screen controls such as buttons and windows.

R. Gavaggio said that if an ergonomics framework is to be used for the new SPS Vacuum Application it has to be ready within a few weeks!

ACTION P. GAYET

4. Machine Protection System and Control R. Schmidt, B. Puccio

R. Schmidt and B. Puccio summarised the recent operational experience with Machine Interlock and Protection Systems at Sting 2 and associated Control Systems issues.

The machine protection for the LHC must prevent damage of equipment. Associated downtimes would be measured in months. A second goal is to improve operational efficiency by triggering beam dumps to avoid quenches. A post mortem system must be included to reach the first goal and to provide information to improve the understanding of how to operate safely.

He explained the separate facilities of power abort and beam abort. The power abort facility must be ready in 2004 for the commissioning of the first sector while beam abort is not required for the sector test but must be ready for 2006. The architecture of the power abort system is tightly coupled to the powering and quench protection systems. Each cryostat, or an assembly of several cryostats, is powered independently and there are one or two power interlock controllers per cryostat. The beam interlock controllers follow the LHC geometry, with controllers at each end of the sectors.

B. Puccio illustrated the functioning of the protection system for String 2 with the power permit condition enabling the powering of the magnets and the coordination of equipment protection after triggering from the quench detection system. He reviewed the hardware interfaces between the Interlock system and other devices and explained the split of responsibility between the interlock hardware matrix and the interlock PLC. The matrix handles the very critical fast power abort while the PLC implements the slow power abort and the power permit. The resulting service has proved very robust.

Experience with the PCVue supervision system had been satisfactory. Development had been co-ordinated by LHC-IAS, and most of the software has been written by Indian collaborators from BARC. The resulting displays and facilities had been well tuned to the needs.

B. Puccio showed that the clocks in the data acquisition and other systems are de-synchronised by over 1 minute. Since all relevant data is recorded with the DAQ system, a synchronisation of the systems of String 2 had never been considered. For String 2 this does not cause any problem, but for the machine synchronisation is mandatory.

R. Schmidt outlined of what he expects from the Controls Project:

1. Advice and support for SCADA and PLCs
2. Communication services between Interlock System and other control systems in particular cryogenics and quench detection
3. Data Acquisition System for the recording of state changes – could there be a general solution, possibly build on the systems that has been used for LEP?
4. Time of Day, beam energy and status, beam intensity information is required at the level of the equipment
5. Advice and support for communication services – fieldbus, network

6. Common time stamping across all devices involved with machine protection (beam monitors, quench protection, powering, interlocks, ….)
7. ORACLE available to download data to PLCs and SCADA to manage application data

Other issues that should be addressed, inside and outside the Controls Project:

8. Hardware commissioning of the sector needs to be performed with the people from the equipment groups working close to the electronics. Therefore underground, local "Control Rooms" (areas with a minimum infrastructure for placing terminals, etc.) during equipment tests are required

ACTION: R. Lauckner

M. Lamont asked how local control room service could be established given the extent of the arcs. F. Rodriguez and Q. King said recent experience commissioning String 2 had shown that it was very important to have the supervisory workstations close to the personnel besides the equipment. R. Lauckner pointed out that wireless networking will be available but R. Schmidt said that a portable PC was not sufficient.

5. POST MORTEM SYSTEM J. WENNINGER

Although it has been decided to limit the team working on this issue to a minimum progress has been slowed by holidays more than statistics would have predicted. Nevertheless analysis and experience from String 2 has identified 2 characteristic times for time stamping resolution – 10 μs and 1 ms. The former is needed to identify events within a turn of the machine. Analysis of LEP experience has shown that the post mortem system developed for the superconducting LEP RF could be very useful as a generic state change logger. This has already been incorporated into the proposal for Machine Interlock control reported above.

P. Gayet insisted that 1 ms was much less than the fastest logging cycles that are possible in the cryogenics controls system (500 ms). R. Schmidt commented that at String 1 the DAQ system has revealed interesting trends in cryogenic parameters as short as a few ms after an event.

6. AOB

There was no further business.

Long Term Actions	**People**
Attach leaves to EDMS tree	All, M. Vanden Eynden
Establish Post Mortem sub-project	R. Lauckner
Clarify Middleware Services to be used by LHC-CP	Core Team

Reported by R. Lauckner

Geneva, 4th October, 2001

LHC Controls Project

M E M O R A N D U M

A/To:	R. Billen, M. Peryt
De/From:	R. J. Lauckner 
Copie/Copy	P. Lebrun, S. Myers
Concerne/Subject:	Mandate for the LHC Controls Logging Project

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Introduction

The LHC-CP, launched in January 2000, has the mandate to establish the requirements for the LHC control system and to initiate and monitor engineering sub-projects. After discussion with the interested parties, the LHC-CP core team is launching an LHC-CP sub-project to address the analysis, design and procurement of the Logging Facilities for the future LHC control system.

The Purpose of this Project

The following points are seen as the main goals motivating this initiative:

- manage information required to improve the performance of the machine and individual systems;
- meet specific INB requirements to record beam history;
- make available long term operational statistics for management;
- avoid duplicate logging developments.

Scope

For this work no distinction is made between logging and archiving. Data logging is a synchronous process usually involving data reduction. Usage of the data is an asynchronous activity.
The following activities are associated with the project:

- analyse logging experience from accelerator operation, LHC string tests, cryogenics operation, technical services monitoring and alarm archiving analysis;
- investigate requirements from equipment engineers, operators, machine physicists, INB specialists and CERN managers;
- Identify a good balance between central logging, under the project's responsibility, and ad hoc systems which will remain the responsibility of the end user.

- design and implement first version to support QRL control systems – cryogenics, vacuum, alarms. Include suitable interface to technical services data;
- ensure scalability - the final system will cover the logging requirements of all LHC sub-systems;
- investigate requirements of the Post Mortem system as a user of the Logging System and design the interface.

Access to hardware is out of scope

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Objectives for the end of 2002

The logging facility must be ready for validation by QRL users at the end of 2002. The following are the main deliverables for that time:

- establish logging support for the operation of all systems involved with QRL control;
- a technical description of how the architecture will meet post mortem requirements;
- a strategy to develop system for LHC commissioning and operation.

After validation of the logging facilities by the QRL users a major project review will be held to re-examine this mandate.

Resources and Major Milestones

The project team is composed of R. Billen and M. Peryt. They will work together to provide the manpower for the early project phases. More manpower may be required when the architectural design phase is reached. It is anticipated that requirements and prototyping activities will be carried out at CERN. Wider collaboration may well be started later in the project. IT division will be asked to extend their support of operational databases and servers to include LHC Logging. External consultancy may be employed during this work. The associated costs will be attributed to the LHC Controls Project budget. Development activities can probably be based on current technical infrastructure.

Major milestones for the preparation for QRL reception tests are:

Dec 2001	Vacuum, Cryogenics and Alarm users present requirements
Mar 2002	Functional Specification for Logging System published
Jun 2002	Proposed basic architecture of Logging System documented
Sep 2002	User Interfaces Published
Dec 2002	System available for validation by QRL Users

Related Activities

The project team should remain aware of the following associated activities:

- The activities of the ORAPCR committee, including definition of the data required for operating the LHC accelerator
- The preparation of database facilities for on-line operational data
- The work of the LAWG

Components work

Is there anything happening??

Scope of activity

- Fieldbus Working group
- SCADA Working group SSAG, ISAG
- Component working group
- Next steps

Field bus working group/support

- Cabling & connection recommendation issued
- Ethernet,IP as field network workshop
  - Put together control people & network guys
  - No Ethernet-IP to sensor
  - No high level communication through TCP-IP
  - The new standard for PLC communication

Scada working group

- SSAG group has been set up to coordinate PVSS application Development At CERN.
  - LHC-IAS, ST-MO, SL-CO, IT-CO
  - Develop guidelines for developments
  - Study the framework Compatibility
  - Try to homogenize concepts
  - manage component repository
  - Monitor the activity of ISAG
    - same group with subcontractor (GTD,SPIE) & ETM
    - Plan PVSS components developments

Component group

- No activity since all users are too busy and the chairman not motivated by the first meeting.
- A new approach :
  - Do not try to merge heterogeneous solutions coming from different user
  - But offer solutions & services from control groups wich are potentially valid for a large number of users
  - Imply commitment & reorganization of the control groups

Methodology

- *Setup a frame of proposal within control group (IAS for PLC & Fieldbus) SSAG,ISAG for SCADA.*
  - *OCT 2001*
- *Present this frame to component group members to identify the direction and priority*
  - *Nov 2001*
- *Setup within control groups a Time schedule for deliveries.*
  - *Dec 2001*

UNICOS framework objectives

- Setup a Control framework Including PLC & SCADA
  - Develop an Object library for PLC
    - Object I/O
    - Field object (valves, motors, PID, etc)
    - Process Control Objects (frame for compound equip.)
  - Develop a SCADA Framework
    - PLC object interface for monitoring & control
    - Trending facilities
    - Alarm facilities
    - Standard interface to external systems
  - Develop a communication mechanism
- Preserve independence of hardware layers
- Develop homogeneous production rules for all user applications

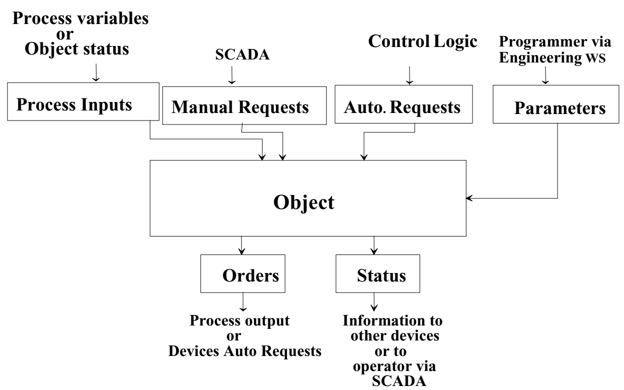
UNICOS Functions in PLC object

- Mode management
  - Manual, Auto, Forced, Local(can be extended)
- Acivity state
  - On/Open. Off/ close, position
- Interlock status
  - Full stop, Temp stop, Start interlock, acknowledged
- Warning status
  - Ioerror, auto/manual
- Output setting
- Internal ramp and bumpless evolution
- Specific logic block

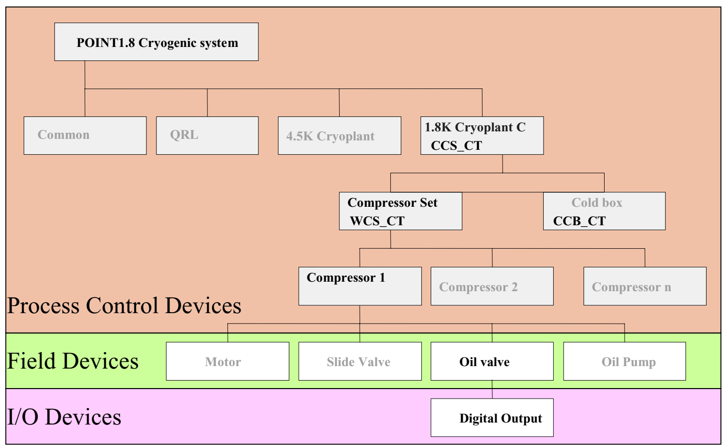
UNICOS SCADA Framework content

- Display types
  - Synoptics
  - Trends
    - Predefined
    - Configurable
  - Lists
    - Alarm list
    - Event list
    - Object list
  - Diagnostics
  - info
- Basic background design
- Display navigation facility
- Object presentation
  - Display element
  - Faceplate
  - Online trend
  - trend
  - Diagnostic screen
- Object driving
  - Manual order setting
  - selection
- Object selection mechanism
- Color code for static element
- Color code for dynamic element

UNICOS object Model



Object hierarchy

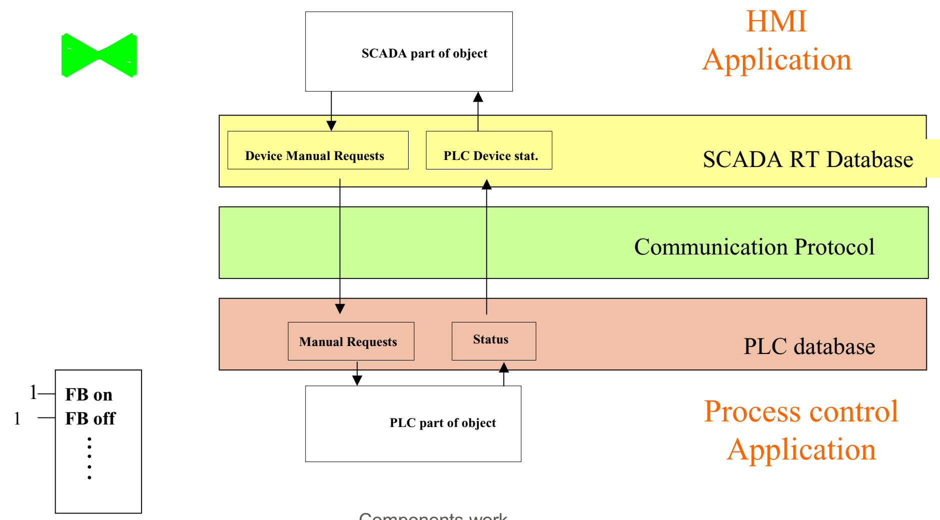


For each object type an adapted user interface is created & implemented in the supervision to allow monitoring & control

Independence between layers

Supervision Layer	HMI Application	Script SCADA
	Communication	
Control Layer	Process control Application	IEC 61131 Languages
Field Layer	Interface to process : Fieldbuses 4/20mA	Firmware from PLC or fieldbuses manufacturers

SCADA & PLC Objects Communication



Present Software implementation

- IN PLC Schneider use IEC languages with Concept (quantum), PL7(premium) Platforms
- SCADA Use PCView32 version 7
- PLC/ PLC & SCADA/PLC communication use an event driven protocol based on Modbus & developed by GTD
- Open toward other accelerator control system with OPC or ODBC (oracle)

What's next (1)

- Based on the first application being developed, establish the software production rules.
  - Template of specification documents compatible with cryoplants spec are tested
  - PLC source code templates of will be establish
  - Unique database & codes generation tools will be developed
  - Methodology of software production will be setup
  - Training course are planned

What's next (2)

- Evolution of Schneider PLC,
  - Unification of Premium & Quantum series using the same development platform mid 2002
- Study the portability Pcview > PVSSII
  - Pre-study august 2001
  - Framework "portage" december 2001
  - Study the complementarity with JCOP & ST FW
- Study the portability Schneider > Siemens
  - Pre-study december 2001
  - Library "portage" 2002

What's next (3)

- Integration within the LHC control system environment
  - Use an adapted version of the SCADA UNICOS framework on other system (vacuum,..) >>> PVSS II
    - Collaboration with LHC-Vac
  - Use the PLC object for gas control in Experiment
    - Collaboration with IT-CO
  - Use the PLC/PLC/SCADA protocol as base for a CERN wide standard for Schneider & Siemens
    - Collaboration with ST-MO, PS-CO, IT-CO
- Open the framework to new users or new needs (new devices, new operational concept)
  - SL-MS, SL-HRF

	besoin de 1à 5	échéance	foreseen delivery
Phase de Preparation			
Fieldbus			
Définition des recommandations d'usage			
Outil de development (choix et usage des logiciel de configuration réseaux field bus)			
avec PLC			févr.02
sans PLC			févr.02
Materiel (utilisation et choix)			
cable			existe
coupleur/link			févr.02
connecteurs			existe
chips (worldfip)			févr.02
passerelle (entre réseaux)			juin.02
Topologie			
Regles d'installations (Comment garantir dès la conception le bon fonctionnement du bus)			existe
Documentation layout (Choix d'un support pour décrire les implantations FB, à introduire dans EDMS)			sept.02

Phase de Preparation			
PLC			
Définition des recommandation d'usage			
o Modules recommandés (standardisation des modules de bases) fabricant retenus par le CERN et les périphériques			
o Connectique			
o Version soft firmware (choix de la bonne version firmware)			
o Topologies			
o Documentation type (Template) pour layout et configuration			
o Connexion vers le terrain (solution, réseaux)			
o Powering Comment faire un powering correct des PLC et des I/O			
o Mise a la terre			
Mise a disposition de composant de base			
o Communication protocole (entre PLC)			
Schneider to Schneider, Siemens to siemens, Siemens to schneider, (profibus,fipio,TCP-IP)			
o Communication protocole (PLC/SCADA)			
Siemens to PVSS (OPC,Unicos,…)			
Schneider to PVSS (Unicos,Push data,OPC)			
o Communication protocole (PLC/CMW)			
Programmation			
o Methodologies (style, naming convention, structure, language(comment les utiliser),organisation de l'application.			
o Communication/ Protocole(ou et comment implementer les comunications)			
o Outils de développement (mise a disposition de l'atelier logiciel, licences, version,…)			

Phase de Preparation			
SCADA			
PVSS integration			
o Guidelines for PVSS development			oct.01
o Supervision of control system (communication, PVSS process,PLC status			mars.02
o driver for event driven communication to PLC (unicos)			déc.01
o Unicos Framework			déc.01
o ST Framework			
o JCOP Framework			
o Communication to PLC (OPC)			
o Communication to CMW			
o interface to general controle service (loging, post mortem)			
o generic control tool configuration database			
Rules to develop application using the frameworks			

Phase de Preparation			
Systèmes (Field bus + PLC+ SCADA)			
Intégration PLC/fieldbus/SCADA			
o Definition d'architectures standard a adapter aux besoins des utilisateurs (unicos, Csam,…)			
o Preparation de specification Type pour developement a l'exterieur sur Standard			
o support au developpement d'application utilisant les standard (internes)			
o adpatation (partielle ou totale) des applications existantes aux standard			
Préparation de solution horizontale			
o Time stamping a la source			
o Synchronization			
o interface to general controle service (loging, post mortem)			
o generic control tool configuration database			
Preparation de la gestion des Assets			

Phase d'installation			
Fieldbus			
– Design et validation du layout (cablage/topologie)			
– Contrôle de l'installation			
– Mise en service du réseau			
– Qualification du réseau			
o Hardware			
o Soft (configuration, …)			
– Mise a jour des documentions			
o réseau Hard			
o Configuration (addresses, etc…)			
– Hot line CERN premier support			

Phase d'installation			
PLC			
– Mise a disposition des réseaux et services			
o Fieldbus			
o Ethernet			
o Powering			
o Raccordement des masses			
– Identification des composants			
o Integration dans une database unique pour la machine			
o Code barre			
o Asset management			
– Gestion des versions logiciel (software repository mise a disposition)			
– Mise a jour des documentions			
o réseau Hard			
o Configuration (addresses, etc…)			
– Hot line CERN premier support			
– Gestion des adresses IP,mac			

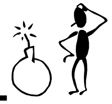
Phase de maintenance			
Fieldbus + PLC			
– Corrective			
o Diagnostique Identifier la cause du défaut (supervision des systeme de controle integré)			
o Reparation			
o Procédure de dépannage			
o Gestion de spare			
o Logbook des faults			
o Mise a jour asset management			
o Hot line cern Support			
o Mise à jour documentation			
o PIQUET			
– Preventive			
o Etablir, appliquer ou faire appliquer un plan de maintenance pour tous ce qui est consommable			
▪ Fan			
▪ Batterie			
▪ Alimentation			
▪ Calibration			
▪ Filtres			
▪ Composants en zone irradié			
– Evolutive			
o Upgrade des versions			
▪ Firmware			
▪ Conservation de l'homogeneité			
▪ Software applicatif			
▪ Solutions horizontales et standard			
o Extension modification des systemes			
o Hot line CERN Support			
o Mise à jour documentation			

Interlock and Protection Systems for the LHC

- The Risks
- The Challenge
- The LHC Layout
- The String 2 System => Bruno Puccio
- Extrapolation from String 2 to the Protection Systems in the LHC

(contributions from many colleagues !)

The Risks: Energy in Magnets and Beams



Energy in two LHC Beams: 700 MJ

– Two systems, one for each beam

Dump the beams in case of failure in less than, say, two turns (0.2 ms)

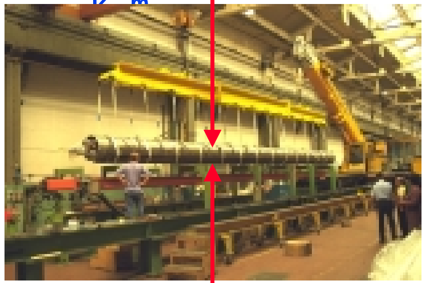
Energy in the magnet system (one sector): 1.2 GJ

– Eight systems in the LHC

– In each sector about 100 circuits

Extract the magnet energy if there is a failure in one of the circuits - time constant is between some 10 ms and some 100 seconds

Falling from 2 km



Falling from 28 km

LHC Machine Protection is to...

Prevent an uncontrolled release of stored energy, thus avoiding:

- damage of equipment (repair of a dipole magnet > 1 month)
- unnecessary down-time - example: BEAM DUMP to avoid quenches

and will include:

- tools for consistent error and fault tracing ……. POST MORTEM

Related topic:

– access and interlock system to protect people is separate system, however, there are links between the access system and the machine protection

LHC Machine Interlocks = Integration of systems

The interlocks deal with the **integration of systems** into the LHC MACHINE PROTECTION SYSTEM,……, **with the glue that links systems** such as:

- **BEAM DUMP SYSTEM**
- **BEAM LOSS MONITOR SYSTEM**
- **QUENCH PROTECTION and POWERING SYSTEM**
- **BEAM CLEANING SYSTEM (two long straight sections for collimators)**
- Access, RF, Vacuum, Collimators, Warm magnets, Experiments, ….

Separation of POWER ABORT and BEAM ABORT

With respect to POWERING: Energy stored in magnets of one cryostat

Fault detected => POWER ABORT, and most of the magnetic energy is dumped into ENERGY EXTRACATION RESISTORS

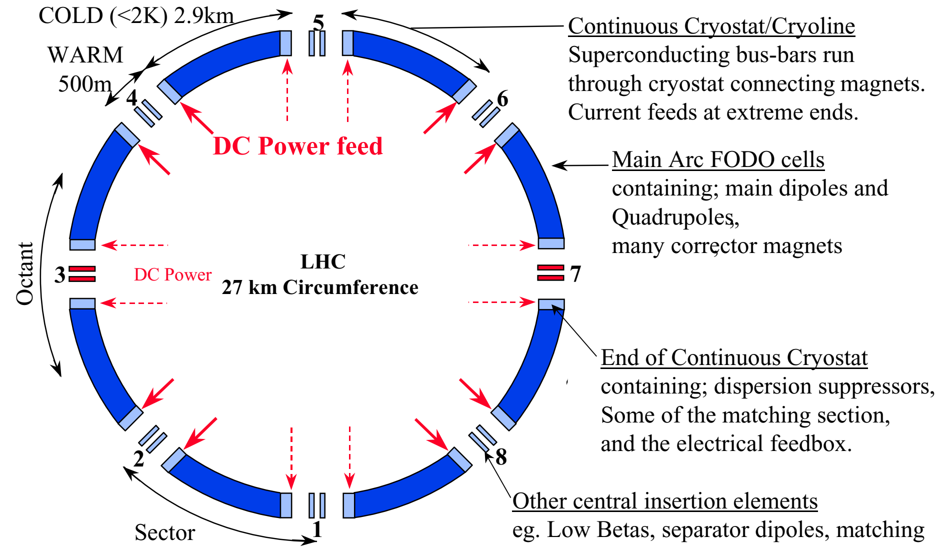
- four large such systems for each sector - 2 for MB, 1 for QF, 1 for QD (in total 32)
- some hundred smaller (600 A) systems around the LHC

Electrical circuits in one continuous cryostat independent from circuits in other cryostats
String II - Commissioning of Power and Magnet Interlock System under way

With respect to BEAM OPERATION: Energy stored in beams
Fault detected => BEAM ABORT, beam is directed into BEAM DUMP BLOCK

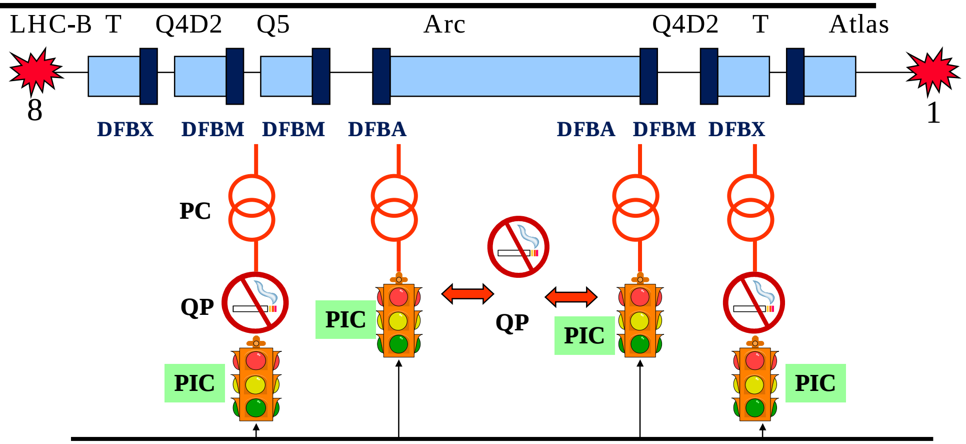
- Two systems - one BEAM DUMP SYSTEM for each beam
- Beam operation not before 2006

Powering: LHC is divided into 8 Sectors



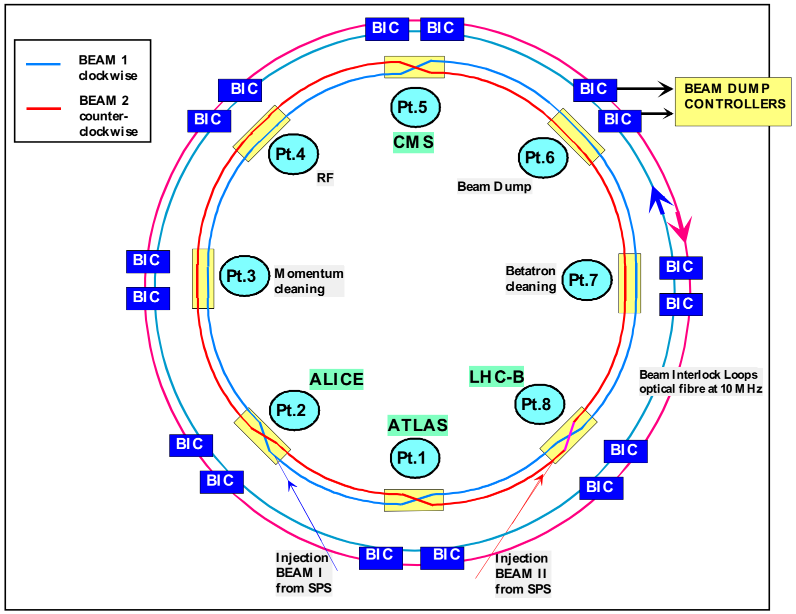
Slide from P.Proudlock

Electrical circuits are divided in Powering sub-sectors - one (two) Powering Interlock Controller per sub-sector



Commissioning of the powering systems from 2004-2006

Architecture of BEAM INTERLOCK SYSTEM in the LHC



Three-Fold Functionality

Give Permission: A system that allows to switch on (equipment interlock system)
- power converters
- beam injection enable
- other systems and commissioning modes - to be defined

this is in general not time critical and includes many systems

POWER ABORT
- fire quench protection heaters
- stop power converter
- open energy extraction switches

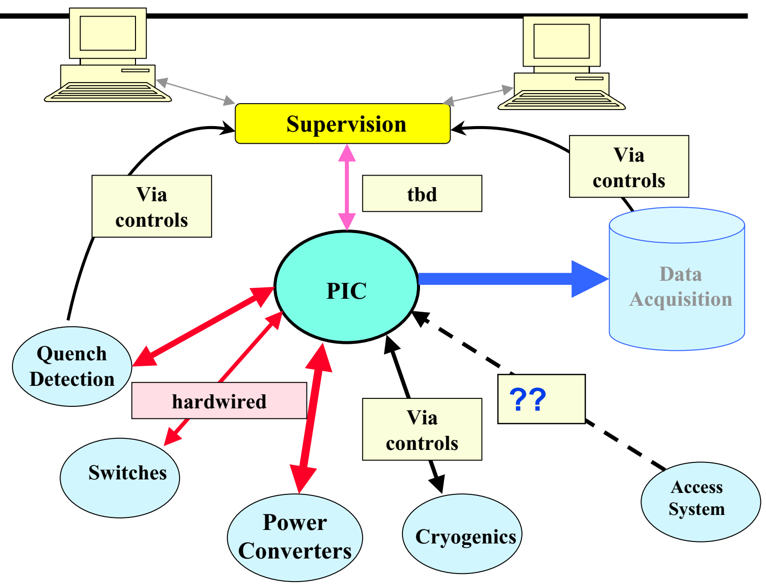
this is time critical and must be fail-safe

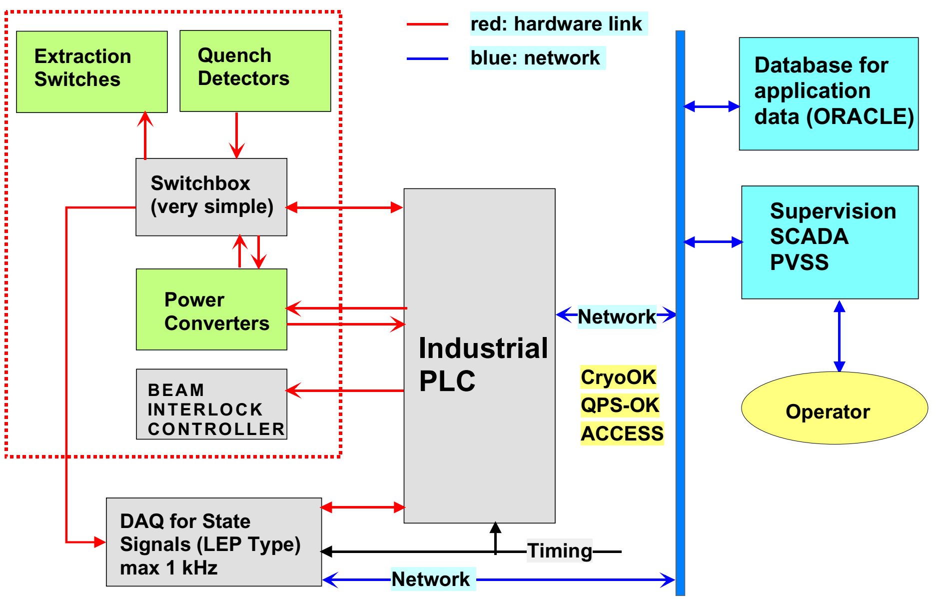
BEAM ABORT
- dump beams as fast as possible

this is VERY time critical and must be fail safe, and includes less systems

A system recording the data for post-mortem analysis of any ABORT
Clear diagnostics (example - get info quench in MQM circuit in sector 5)

Interfaces for Machine Powering Interlock Controller



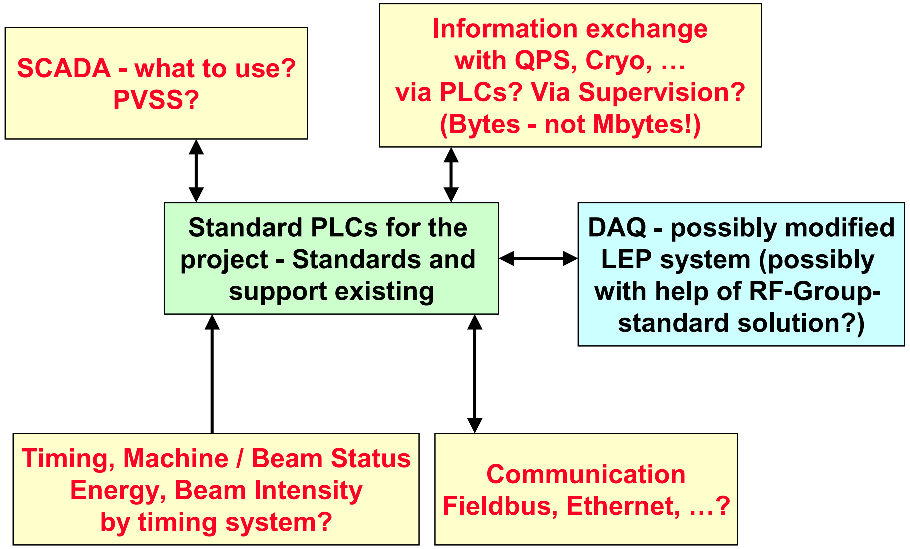


POWERING INTERLOCK CONTROLLER for one POWERING SUBSECTOR 10/10/2001

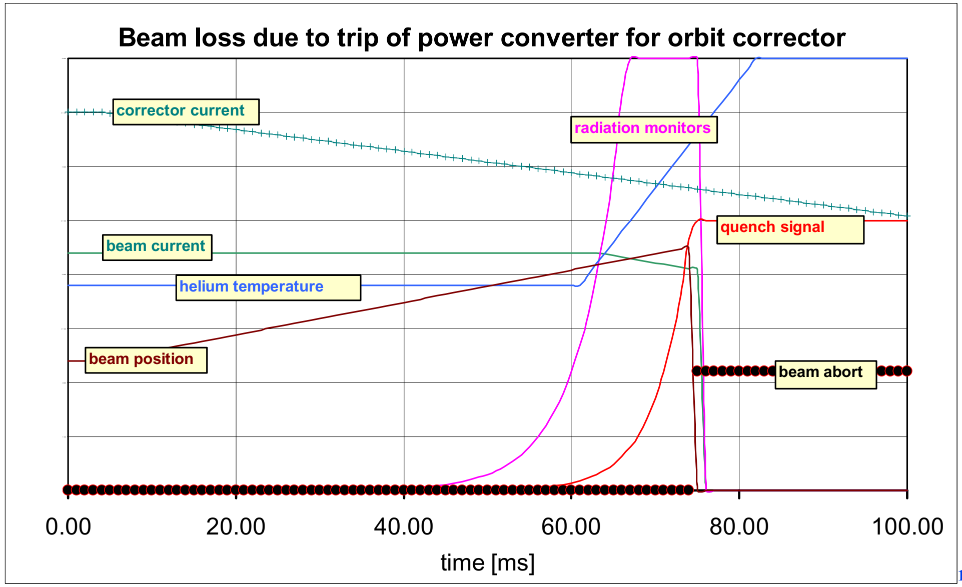
Outlook

- Require POWER INTERLOCK CONTROLLER for first sector (octant) test in 2004 (Prototype for end 2002)
- Require full functionality of BEAM PERMIT CONTROLLER for 2006 (or possibly at an earlier date if required by the SPS - renovation)
- POST MORTEM facilities essential - with common timing system
- Not to be forgotten, other issues than interlock system: Request for distribution of energy around the machine (Beam Loss Monitors, other systems….) - proposed as future topic

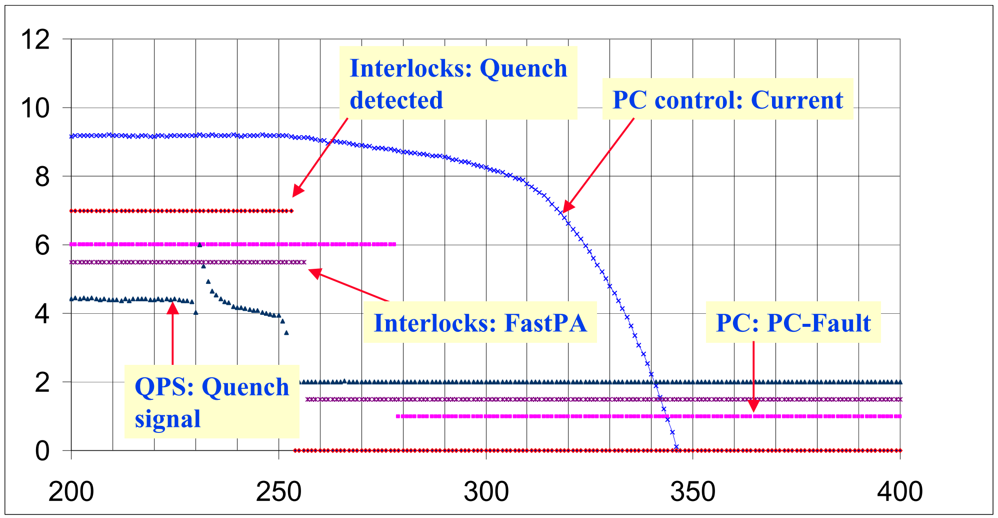
Questions to the controls project



Post Mortem Diagnostics MUST be a part of the system - Artist view of the requirement



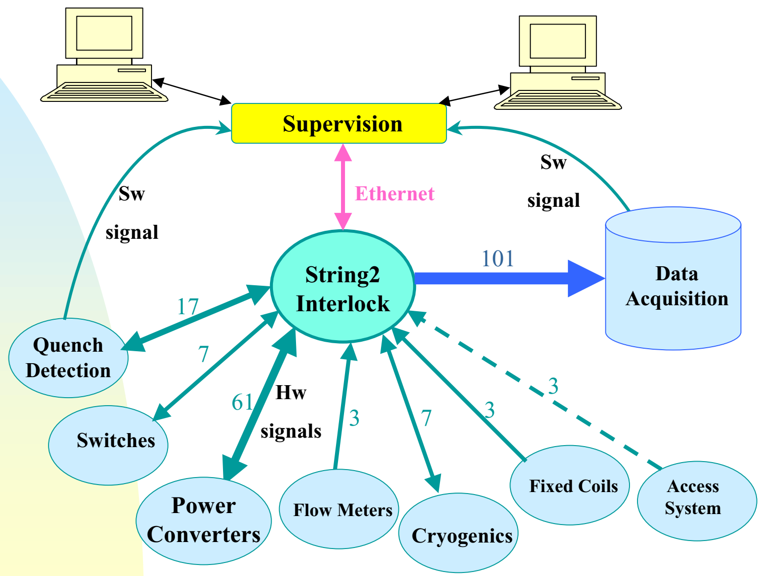
Post Mortem Diagnostics is a part of the system DAQ for String 2 Results



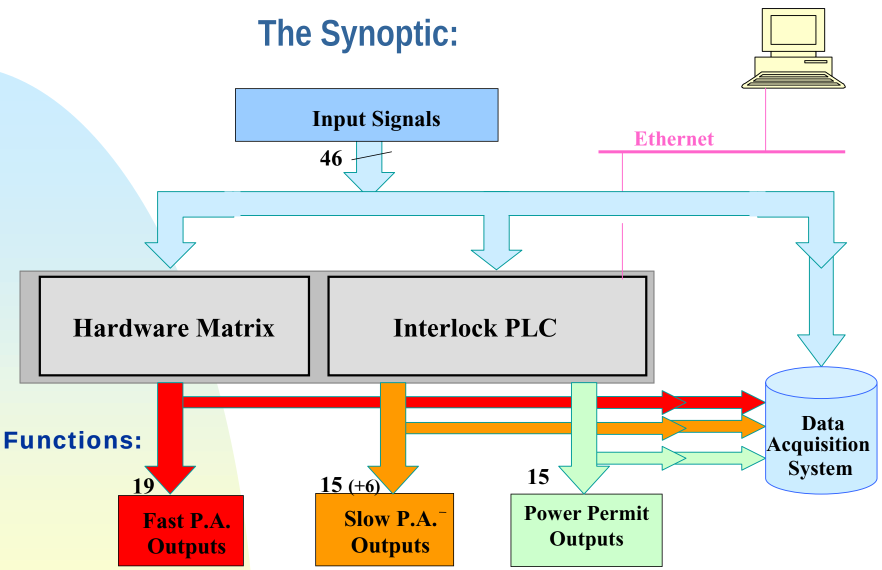
String2 Interlock

- Overview
- Commissioning
- Lessons for LHC

The Interfaces



The Synoptic:



3 Functions:

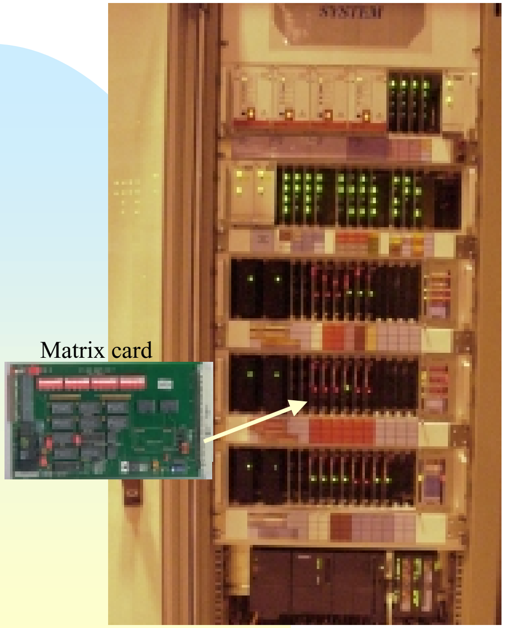
Fast Power Abort & Open Switches

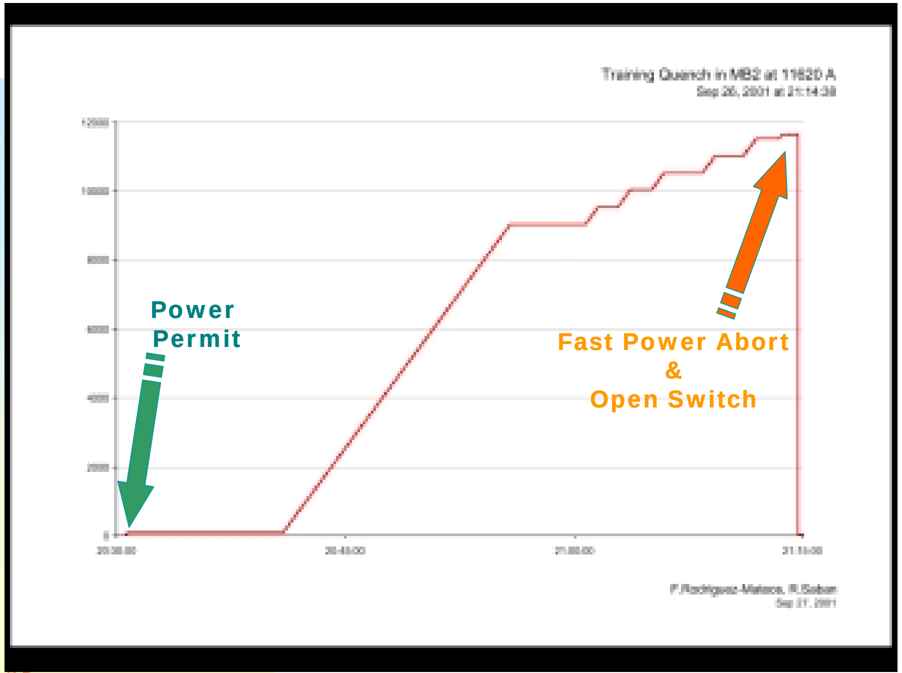
Slow Power Abort

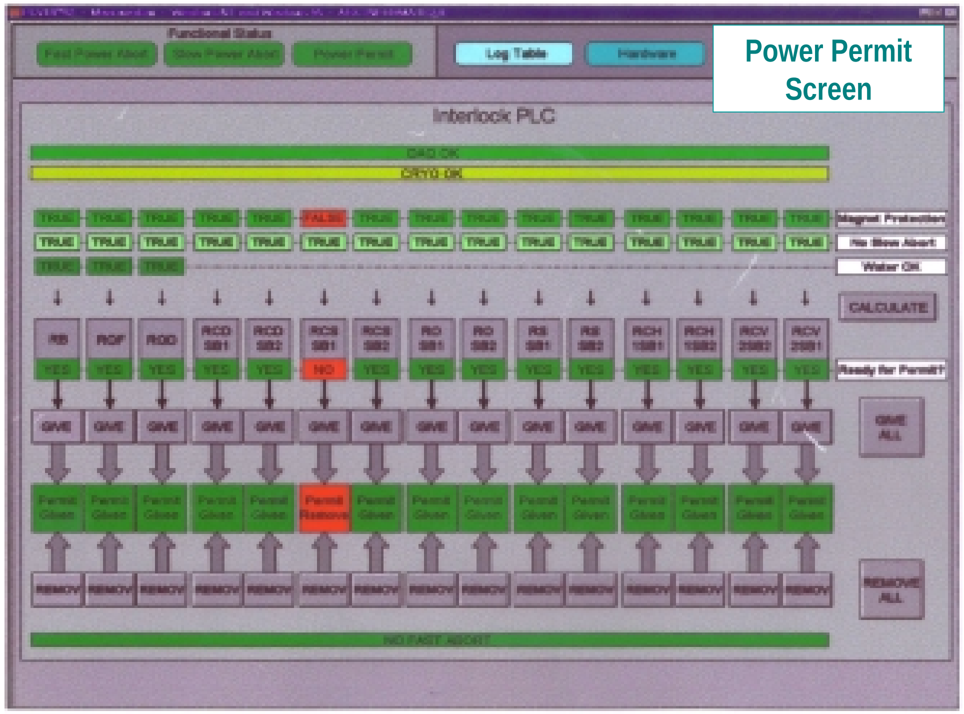
Power Permit

General View in SM18

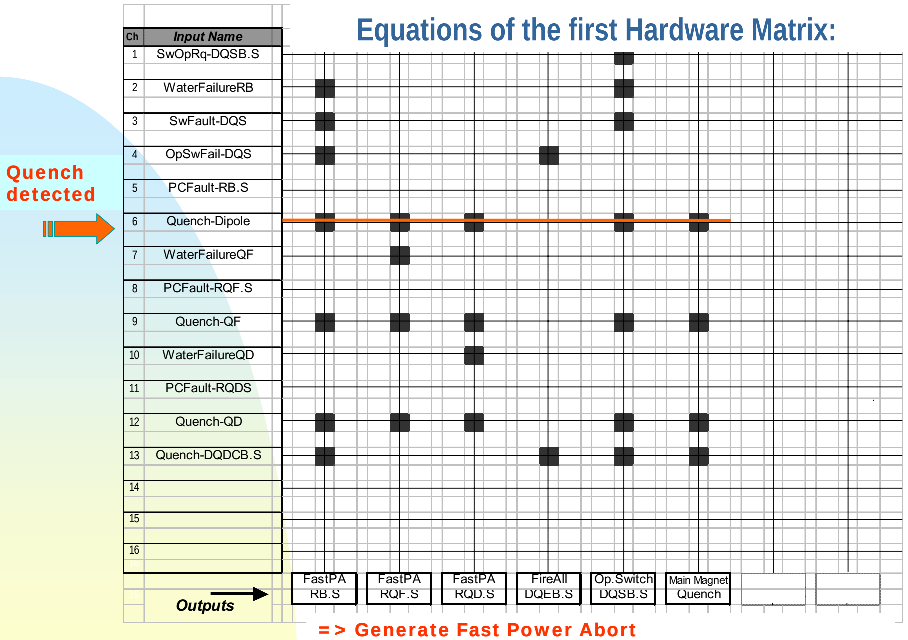
Front & rear views of the Rack :







Equations of the first Hardware Matrix:



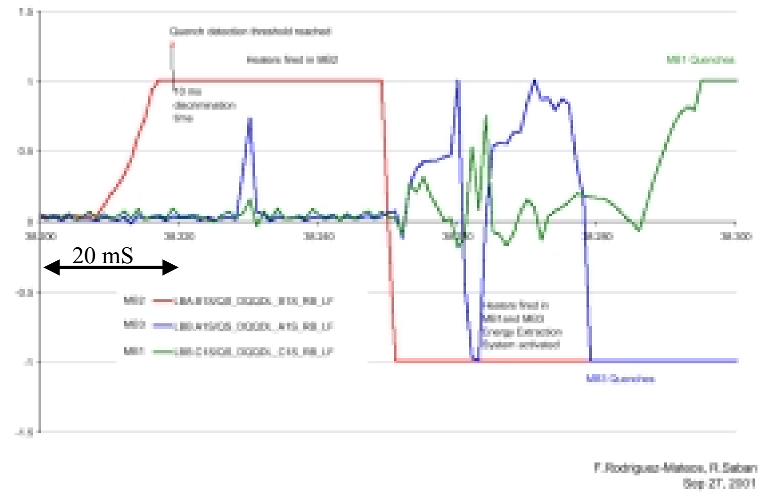
=> Generate Fast Power Abort
& Open Energy Extraction Switch

first Lessons learnt:

- Robustness of the solution "Matrix **+** PLC"
- Satisfied by the Supervision (Industrial product + Indian collaboration)
- Flexibility is mandatory during commissioning phases
- PLC becomes an evidence:
  - Well suited to perform "Matrix Tasks"
  - Easy to program and to control
  - CERN standardized and full supported
  - Helpful for monitoring and debugging
- Need of a common source for Time stamping !

Extracted from DACQ system:

Training Quench in MB2 at 11620 Amp.
Sep.26,2001 at 21:14:38



Data extracted from the PLC Log File:

Quench signal Received from the Dipole circuit

dd/mm/yy	hh:mm:ss.xxx	BitName	SET\CLR	LastValue	New Value	DB	Bit	I/O Field
26.09.2001	20-22-00.059	PPermit-RB.S	SET	00000000H	00000001H	17	2	Output2
26.09.2001	21-15-58.076	Quench-Dipole	CLR	1FFF1FFFH	0FFF1FDFH	15	2.5	Input1
26.09.2001	21-15-58.076	Fast PA-RB.S	CLR	0FF0FC3FH	00000010H	16	2	Input3
26.09.2001	21-15-58.076	Fast PA-RQF.S	CLR	0FF0FC3FH	00000010H	16	2.1	Input3
26.09.2001	21-15-58.076	Fast PA-RQD.S	CLR	0FF0FC3FH	00000010H	16	2.2	Input3
26.09.2001	21-15-58.076	OpSw-DQSB.S	CLR	0FF0FC3FH	00000010H	16	2.3	Input3
26.09.2001	21-15-58.076	Main Magnet Quench	CLR	0FF0FC3FH	00000010H	16	2.5	Input3
26.09.2001	21-15-58.076	Fast PA-RCD.SB1	CLR	0FF0FC3FH	00000010H	16	3.2	Input3
26.09.2001	21-15-58.076	Fast PA-RCD.SB2	CLR	0FF0FC3FH	00000010H	16	3.3	Input3
26.09.2001	21-15-58.076	Fast PA-RS.SB1	CLR	0FF0FC3FH	00000010H	16	3.4	Input3
26.09.2001	21-15-58.076	Fast PA-RS.SB2	CLR	0FF0FC3FH	00000010H	16	3.5	Input3
26.09.2001	21-15-58.076	Fast PA-RO.SB1	CLR	0FF0FC3FH	00000010H	16	3.6	Input3
26.09.2001	21-15-58.076	Fast PA-RO.SB2	CLR	0FF0FC3FH	00000010H	16	3.7	Input3
26.09.2001	21-15-58.076	Fast PA-RCS.SB1	CLR	0FF0FC3FH	00000010H	16	4.4	Input3
26.09.2001	21-15-58.076	Fast PA-RCS.SB2	CLR	0FF0FC3FH	00000010H	16	4.5	Input3
26.09.2001	21-15-58.076	OpSw-DQSCS.SB1	CLR	0FF0FC3FH	00000010H	16	4.6	Input3
26.09.2001	21-15-58.076	OpSw-DQSCS.SB2	CLR	0FF0FC3FH	00000010H	16	4.7	Input3
26.09.2001	21-15-58.076	Fast PA-RCH.1SB1	CLR	0FF0FC3FH	00000010H	16	5	Input3
26.09.2001	21-15-58.076	Fast PA-RCV.1SB2	CLR	0FF0FC3FH	00000010H	16	5.1	Input3
26.09.2001	21-15-58.076	Fast PA-RCH.2SB2	CLR	0FF0FC3FH	00000010H	16	5.2	Input3
26.09.2001	21-15-58.076	Fast PA-RCV.2SB1	CLR	0FF0FC3FH	00000010H	16	5.3	Input3
26.09.2001	21-15-58.077	Slow PA-RB.S	CLR	0000FFFFH	0000FFFEH	15	10	Output1
26.09.2001	21-15-58.077	DipoleQuench	CLR	0000003FH	0000003EH	15	12	Output3
26.09.2001	21-15-58.078	SwOpRq-DQSB.S	CLR	0FFF1FDFH	0FFF1FDEH	15	2	Input1
26.09.2001	21-15-58.078	Quench-DQDCB.S	CLR	0FFF1FDEH	0FFF0FDEH	15	3.4	Input1
26.09.2001	21-15-58.078	FireAll-DQEB.S	CLR	00000010H	00000000H	16	2.4	Input3
26.09.2001	21-15-58.078	Slow PA-RCS.SB1	CLR	0000FFFEH	0000FFFCH	15	10	Output1
26.09.2001	21-15-58.079	BusBarQuench	CLR	0000003EH	0000003AH	15	12	Output3
26.09.2001	21-15-58.079	PCFault-RB.S	CLR	0FFF0FDEH	0FFF0FCEH	15	2.4	Input1
26.09.2001	21-15-58.079	Slow PA-RCS.SB2	CLR	0000FFFCH	0000FFF8H	15	10	Output1
26.09.2001	21-15-58.081	Slow PA-RQF.S	CLR	0000FFF8H	0000FFF0H	15	10	Output1
		etc…						
26.09.2001	21-15-58.094	Slow PA-RCV.2SB1	CLR	0000C000H	00008000H	15	12	Output1
26.09.2001	21-15-59.013	CryoOK	CLR	007F3FFFH	007E3FFFH	15	8	Input2

Post-Mortem System

Since May :

Definition of a small team (E. Ciapala, F. Rodriguez Mateos, R. Schmidt and J. Wenninger) to study requirements & various aspects in more detail.

Then … a long summer break. We decided that it is not meaningful to work in sub-core teams !

Work is now resuming – we are starting to go through some groups. Still aiming for a "document" around the end of this year.

Timing & Synchronization

Progress

- in the analysis of the system
  &
- experience from STRING II

lead us to require that all systems should be synchronized to

- 10 µsec : fast systems (beam instr., RF, kickers,…)
- 1 msec : "others"

Logging of state changes

In one of our meetings we "reviewed" the post-mortem system developed for the SC LEP RF and in use for the last LEP run in 2000.

- Based on local acquisition units.
- A DSP with a local clock was used to check for <u>state changes</u>.
- It was synchronized at the beginning of each fill
  (i.e. every few hours) with a GPS system.

In the discussion we realized that this approach could be very useful to design of a "generic" state change "logger". The first client probably is the machine interlock system.