Minutes of LHC-CP Link Meeting 27

Subject	:	LHC Controls Project	
Date	:	16th July, 2002	
Place	:	864-2-B14	
Participating Groups	:	LHC-ACR	P. Gomes,
		LHC-ECR	no representative,
		LHC-IAS	H. Milcent C-H Sicard,
		LHC-ICP	apologies
		LHC-MMS	no representative,
		LHC-MTA	no representative,
		LHC-VAC	no representative,
		PS-CO	no representative,
		SL-AP	no representative,
		SL-BI	no representative,
		SL-BT	apologies,
		SL-CO	K. Kostro,
		SL-HRF	A. Butterworth, E. Ciapala,
		SL-MR	apologies,
		SL-MS	no representative,
		SL-OP	no representative,
		SL-PO	no representative,
		ST-MA	P. Sollander.
Others	:	A. Daneels (Planning) R. Lauckner (Chair), M. Tyrrell (Alarm Sub-Project), M. Vanden Eynden (Core Team).	
Distribution	:	Via LHC-CP website: **http://cern.ch/lhc-cp** Notification via: **lhc-cp-info@cern.ch**	
Agenda	:	1. Matters arising from Previous Meeting	
		2. LHC-CP News	
		3. Experience from the RF test stands	L. Arnaudon
		4. QRL Baseline	A. Daneels
		5. AOB	

1. Matters arising from Previous Meeting

P. Sollander reported on a discussion that had taken place with D. Blanc and R. Billen to explore the connectivity of the LHC Cooling and Ventilation control system towards the machine control system. He presented an overview of the SCADA-PLC architecture that is in use. Information from all of the installations is gathered by the TCR Data Server (TDS). Exporting information from the TDS would satisfy LHC machine requirements and if new data are required standard tools are in place to extend the coverage of the TDS.

There are plans to migrate the old LEP G64 based systems into this architecture.

2. LHC-CP News

R. Lauckner reported on various discussions that have taken place concerning the introduction of the Earned Value Management system for the LHC project. A meeting had taken place with P. Bonal to clarify the approach, The LHC-CP project activities are to be broken down into work units with better than 3 month granularity. Work units will be assigned resources both materials and labour and the value of the work units will be the sum of these resources. A discussion has also taken place with the accelerator sector Controls Group Leaders. Major issues concern the framework and tools for this work, defining the WBS beyond the current definitions used for LHC budget control, and defining controls activities throughout the period up to LHC beam operation.

There are no further LHC-CP meetings planned before the summer period. The high-level software preparation for the future SPS east extraction and transfer through TI8 will be a priority subject in September.

3. Experience from the RF Test Stands. L. Arnaudon

L. Arnaudon reported on recent work to renew the control system for the RF test stands in building 112. The objectives were to replace obsolete equipment from the LEP era and to get first hand experience with and validate solutions being considered for the control of the RF in the LHC machine. The project was launched in June 2001 and the new controls facilities were in service from May 2002 for Klystron testing. Major choices to be validated were PLCs, industrial COTS, FIPIO and Ethernet, PC servers, CMW and use of Java for applications.

All hardware devices are connected to a Schneider PLC using Ethernet, FIPIO and direct analogue connections. Interlock crates were assembled from COTS solutions, modules use the I2C bus to communicate with a Micro controller that is a general-purpose gateway to Modbus/TCP.

Water flows, temperatures and voltages are also measured with COTS devices, in some cases these were modified for special tasks such as measuring high voltages. Values are acquired with remote ADCs communicating to the PLC via FIPIO. Data was obtained in the PLC memory with "a few configuration clicks!"

The use of micro controllers and FIPIO gave a large reduction in the amount of cabling needed to bring all this information to the control room.

The Schneider Premium range was selected for the PLC, mainly because of the large range of PLCs available and because of the excellent software development environment – PL7Pro. The PLC program is organised in independent blocks that reflect the real hardware devices. This structure can be exported through a PC based OPC server and via the CMW to the high level Java environment.

A local Ethernet switch was set up to provide the connections to the PLCs, micro controllers and the outside world via a PC running the Schneider OPC server. This is the architecture recommended by Schneider. While the local networking was easy to handle experience showed that in a larger application support for the remote management of Windows PC server machines would be required – configuration, monitoring and reboot.

High-level synoptic views were developed in Java. Communication towards the equipment used the CMW, which allows integration of the PLC/OPC world into the Java based application world. The RF team really appreciated being able to map their physical devices into the Java environment using the device property model. However developing the Java code was a large investment for the non-specialists in the RF group and modified Swing components with built in CMW capability would have been very useful.

More specialised low level interfaces to the equipment were made using the PLC Web servers. Low-level debugging tools were successfully implemented and it was convenient to have access to these and on-line equipment documentation. Nevertheless the performance of the Web server is a limitation today although future PLCs should have enough processing capacity to overcome this difficulty.

He concluded that this project had allowed the RF team to successfully integrate industrial offerings. Major open issues were the future architecture and support for communication down to the PLCs, the support of Windows servers in the control system and the responsibilities for developing high-level programs for equipment specialists.

R. Lauckner commented that a suitable alternative for building the high level synoptic views would be the PVSS SCADA tool. L. Arnaudon said that this had not been tested because it was decided that CMW was a more open solution that will solve the requirement to integrate industrial and custom VME or cPCI based equipment.

Marc Vanden Eynden said that SL-CO were considering the issue of supporting Windows servers – being able to offer services such as installation, process management and reboot.

Claude-Henri explained that UNICOS had moved away from use of FIPIO and adopted Ethernet to communicate with small PLCs. However such an evolution was transparent to the application.

4. QRL Planning Baseline A. Daneels

Axel Daneels introduced the new planning baseline for the QRL control systems. The previous baseline has been updated to follow the revised (delayed) LHC project planning issued in March 2002 The milestones have been placed "as late as possible" as no indication of activity duration is shown. Some simplification had also been introduced as it was now clear that VME front ends were not required for the systems involved and the database support required for the calibration data for the cryogenic instruments was not within the scope of LHC controls.

The QRL activity is divided into 3 phases, pre-commissioning, commissioning and reception testing. Two major systems: cryogenics and vacuum and the underlying infrastructure will be progressively required. It is planned to introduce first versions of the machine logging and alarm systems during the commissioning phase. A. Daneels also showed major milestones for the infrastructure – mainly communications.

He concluded by reporting that most of the preparation work seems well in hand. However certain areas require attention or clarification: support for configuration data, analogue signal requirements and procurement of optical fibres.

In the ensuing discussion it became clear that there was a general interest in more detailed reporting of the progress of the work. R. Lauckner proposed that a more complete review should be carried out after the summer holiday period.

ACTION: A. Daneels

After the meeting A. Daneels confirmed with the cryogenics team that analogue signals would be visualised within the UNICOS system and there was no requirement for digital oscilloscope facilities.

5. AOB

There was no further business.

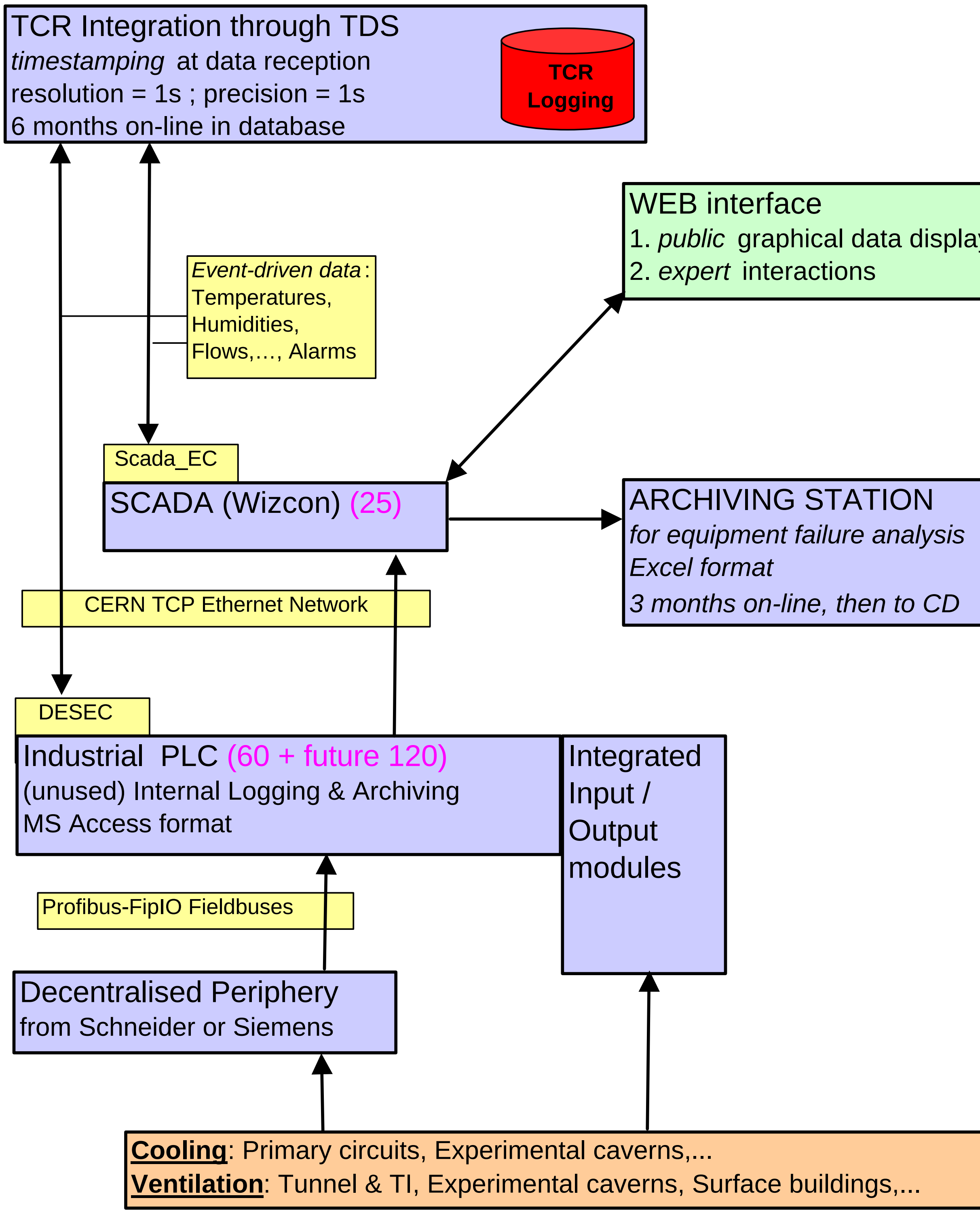
Long-Term Actions	**People**
Common power circuit database requirements	R. Schmidt
Underground Control Rooms requested	R. Lauckner
Establish Post-mortem sub-project	R. Lauckner
Clarify Middleware Services to be used by LHC-CP	Core Team

Reported by R. Lauckner

From discussion with:
Didier BLANC
Peter SOLLANDER

R. BILLEN
9 July 2002

Context: *Monitoring & Control of the LHC cooling and ventilation processes in a SCADA-PLC architecture.*
Note: *LEP Ventilation process is still in operation (G64-ECA, Mil1553- PCA) which can no longer be supported*



A new Klystron Test Stand

The story of :

"How to fill the control room and get ready to test the first LHC Klystron"

Covered items

- Timescale, planning & people (when-how-who)
- Background and motivation
- The new test stand structure (Global diagram)
- Hardware details (Infrastructure & Equipments)
- Equipment software (PLC & µC)
- Communication choices (FIPIO, Ethernet, OPC ,CMW)
- Human interface software (Web & Java)
- Some real examples (Pictures & Screen Shots)
- Can we draw some conclusions and more..

Timescale, planning & people (when-how-who)

People involved :

O.Brunner, B.Lambert, G.Pecheur, M.Disdier, P.Martinez, J.Pradier, Ch.Nicou,D.Landre,Ph.Lachavanne, H.Frischholz, L.Arnaudon

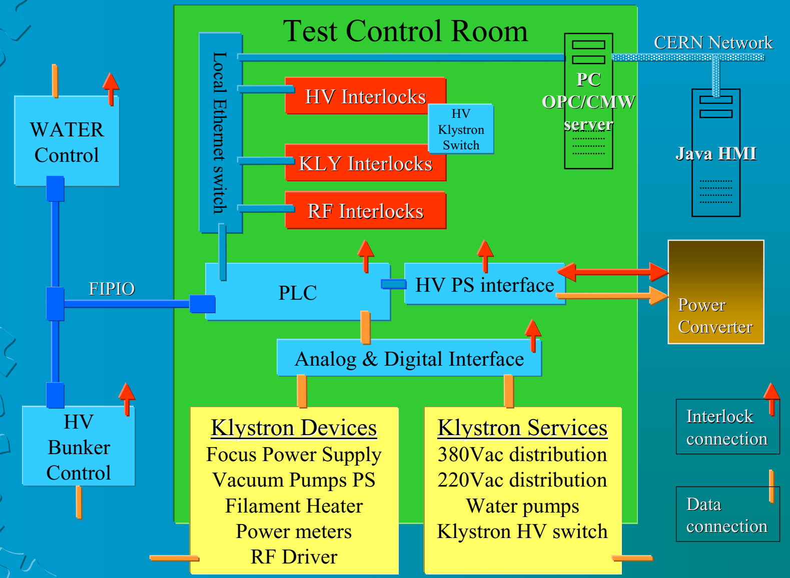
H112 control room

Background and motivation

- H112 infrastructures in bad state
- No spare parts for special equipments
- Old LEP type control equipments
- Communication weakness (no remote control and hang-ups)
- Many Hw. problems

- Test and validate the HW/SW choices for LHC (PLC, Industrial COTS, FIPIO & Ethernet, PC's)
- Reorganize the Water distribution system (noise, measurements)
- Test new Interlock system
- Test distributed control architecture
- Implement the Middleware 'OO' concept

The new test stand structure (Global diagram)



Hardware details (Infrastructure & Equipments) 1

The first priority was to review the LEP hardware and localize the weak points.

We found the following :

RF Drive, Interlocks,Filament Heater, 220/380 distribution

We decided to reuse some LEP elements (RF Drive, Focus PS and Filament Heater)

All the devices were modified, tested and integrated in the new structure.

The interlock system was redesigned (see later)

The Water distribution control was redesigned (see later)

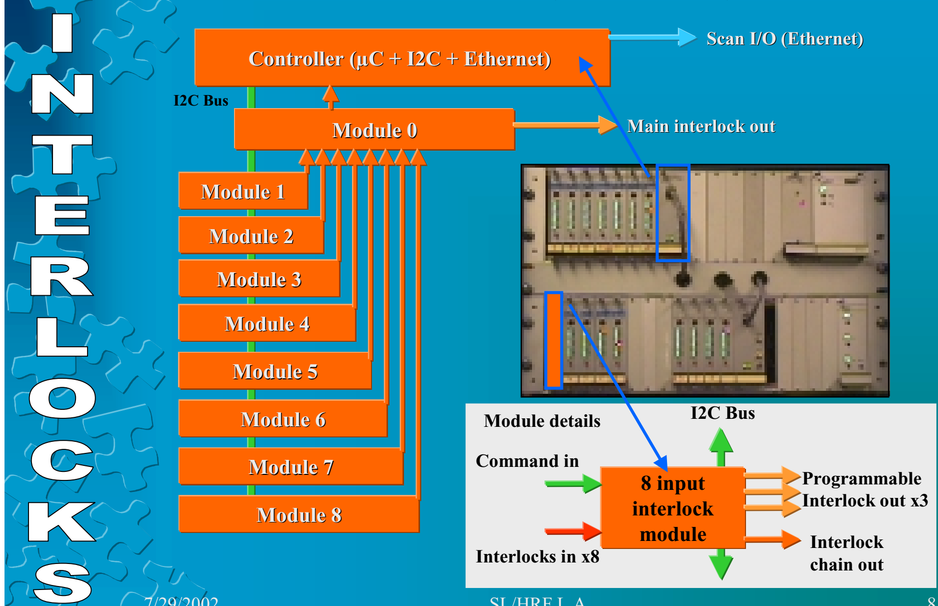
The HV bunker control was redesigned (see later)

And finally..

The PS interface was redefined.

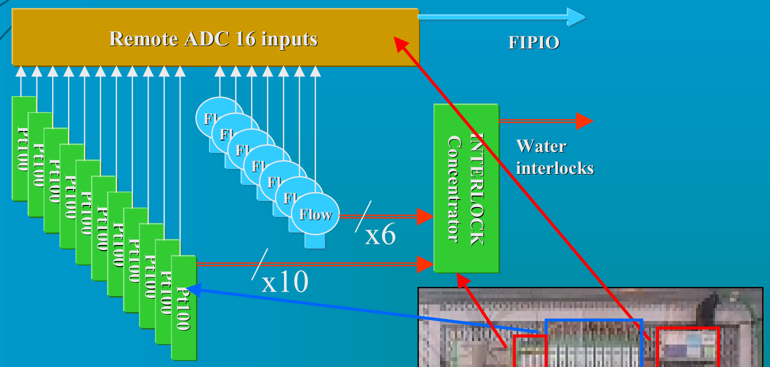
The aim was to use, as far as possible, industrial components and integrate them in the a "LHC type" control structure.The exercise was done keeping in mind the LHC operation constrains. (Access, Reliability, remote specialist access and ….

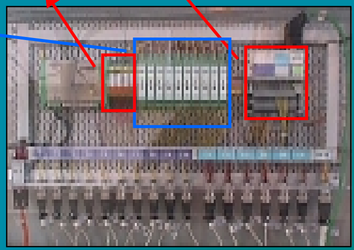
Hardware details (Interlocks) 2



WATER CIRCUITS

Hardware details (Water circuits) 3

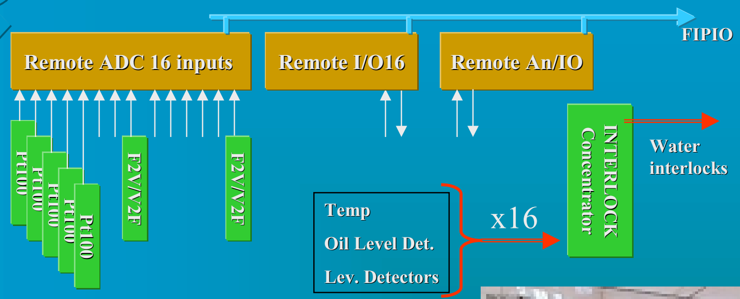


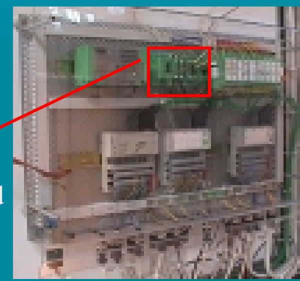


Temperature and Flows are measured locally and transmitted to the PLC via FIPIO. Each conditioner generates an interlock.

HV Bunker

Hardware details (HV bunker) 4





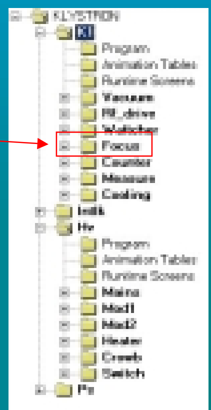
Again all the HV Bunker analog signals are measured locally and transmitted to the PLC via FIPIO as well as the digital controls.
Each conditioner generates an interlock.
Some high voltage detectors were redesigned (Ex.V2F-F2V converter)

PLC

Equipment software (PLC) 1

We have selected the Schneider PREMIUM PLC range for the following reasons:
Wide range of CPU, well defined product road map, unique IDE (PL7Pro) for the whole product range with very good documentation tools,CERN standard and good CERN and Schneider support.

The PLC program is organized in independent Functional Blocks reflecting real devices.
(Ex. Focus PS, Heater, Modulator, …)
From the PL7 code we can export an image of the variables and easily produce a configuration file for both the OPC server and the CMW database.
The PLC operates in cyclic mode and in this case the cycle takes an average of 4mS.
In this set-up one PLC is controlling one Klystron, the HV Bunker and the Power Converter.



µC

Equipment software (µC) 2

We have designed (M.D.) a series of general purpose µC based modules.
All the modules are programmed with the same IDE.
The Field bus interface is a general purpose "gateway" between I2C and Modbus/TCP

Device	µC	Functions and description
Interlock modules	C51	Detection of first fault and I2C communication with the Field bus interface
Field bus interface (PHYTEC and Modbus/TCP Anybus modules)	Phytec module	Detection of first faulty module , I2C comm. and Anybus module
	Anybus module	DPRam interface with Phytec module Modbus/TCP communication with the PLC (Scan I/o)
RF Power Meters interface	ADµC812	Calculate RF power value, calibration, interlock generation and I2C comm. with the Field bus interface
Two channels Temperature conditioner	ADµC812	Calculate temperature (C,K), generate interlock and faulty probe detection

Communication choices (FIPIO) 1

FIPIO is a Schneider Field bus derived from WorlfFip.
Main parameters :
speed 1Mbit/sec, 128 nodes max, periodic variables and messages
Easy configuration and fault reports

Schneider has a wide range of FIPIO modules (Analog, Digital , Mixed and specialized nodes)

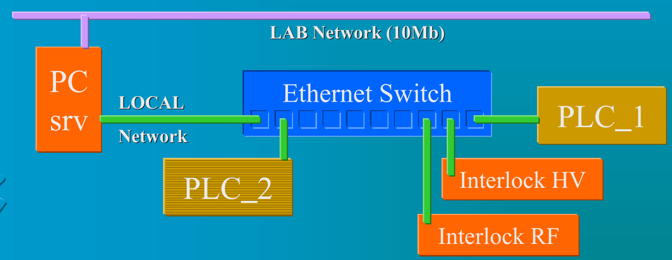
Only a few configuration clicks are needed to set-up the network and get the data in the PLC memory.

We have installed the following modules:
two 16 channels Analog input
one 16/16 Digital Input/output
one mixed Analog in/out Digital in/out modules.

We found FIPIO a very reliable and flexible solution.

Communication choices (Ethernet) 2

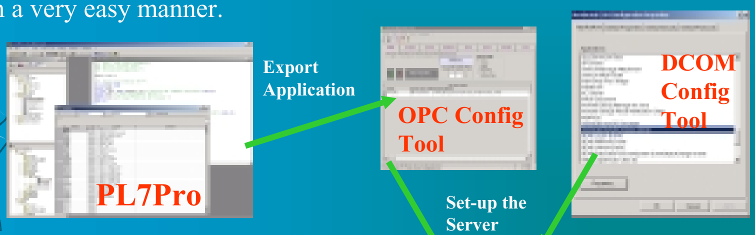
We have set-up a switched 100Mb private Ethernet network between the Server (PC with two Ethernet boards), PLC and the interlock systems. This solution gives a collision free and good bandwidth network.



We had no major problems installing and setting-up this small network.
But
With a larger number of machines we will need specialists to support, install and monitor this kind of local networks in LHC.

Communication choices (OPC) 3

We decided to use OPC as the standard interface between HMI, control programs and the PLC's. OPC is an industry standard for communication, *(unfortunately)* based on COM/DCOM and Windows.
During all our tests we did non get any major problems due to OPC
(Info at http://www.opcfoundation.org/)
Schneider provides an OPC server, for the PREMIUM PLC, configurable in a very easy manner.

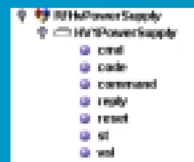


Although we did not use all the OPC functions and settings the results were satisfactory

Communication choices (CMW) 4

We (O.B. L.A.) worked with the **Controls MiddleWare Project** team (K.K.) in order to integrate the PLC/OPC world in the CMW communication model.

The CMW team produced an OPC Gateway and gave us guidelines, code examples and long fruitful discussions.



We mapped real devices to the device/property model of CMW by extending the OPC configuration file.

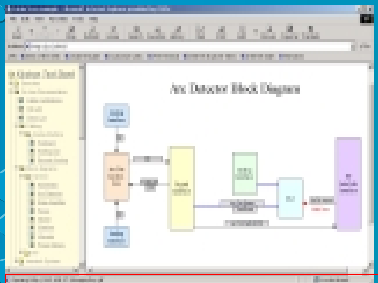
The first test was presented by K.K. in a previous meeting (Focus PS)

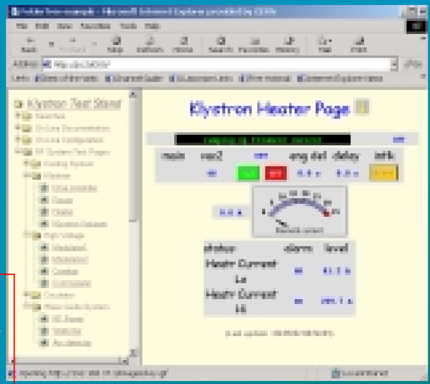
By using the provided tools (CmwExplorer) we could extensively test and validate the concept.

We think that CMW is a very good (open) solution and collaboration will bring the product to maturity.

Human interface software (Web) 1

The new PLC Ethernet interfaces can host Web pages (8Mb). We successfully tried to implement low level debugging tools and online documentation using this facility.





Specialists can access the system at the lowest level from anywhere with updated online documentation.

Great isn't it ?

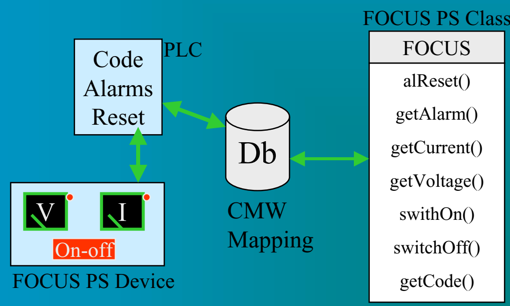
Human interface software (Java) 2

The main motivation of using Java was the possibility of reusing the code namely the classes we (O.B.) implemented for the test stand needs.

We have created a class for all the physical devices with methods for all the real properties and for some virtual ones.

Java code Example :

```
foc1        = new Focus("K1");
foc1.alReset();
foc1.switchOn();
foc1.getAlarm();
…
```



Human interface software (Java cont..) 3

The PLC will generate some virtual properties (Code, Alarm, Status) for every physical devices.

Code : an integer representing the actual device condition

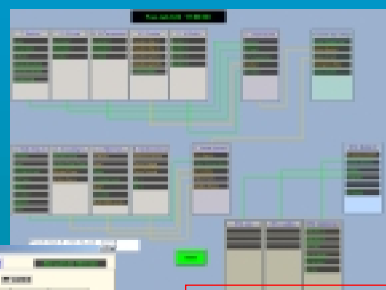
Some Ex : 100 = focus switch ON command received
102 = Power Supply busy
103 = Focus OFF - no 380V
108 = Focus OFF - 380V ON/ready to switch ON
208 = Heater delay - waiting I fil < 27A
303 = Drive OFF Temperature Fault
…

The same idea applies to the interlock system but the 8 channel are mapped to the low byte of an integer and decoded in the application.

Ex :

```
if ((code & 1)!=1
{st=" Tstamp.now() : HV INTLK :  Circulator Load Temp Interlock\n";}
```


Some real examples 1

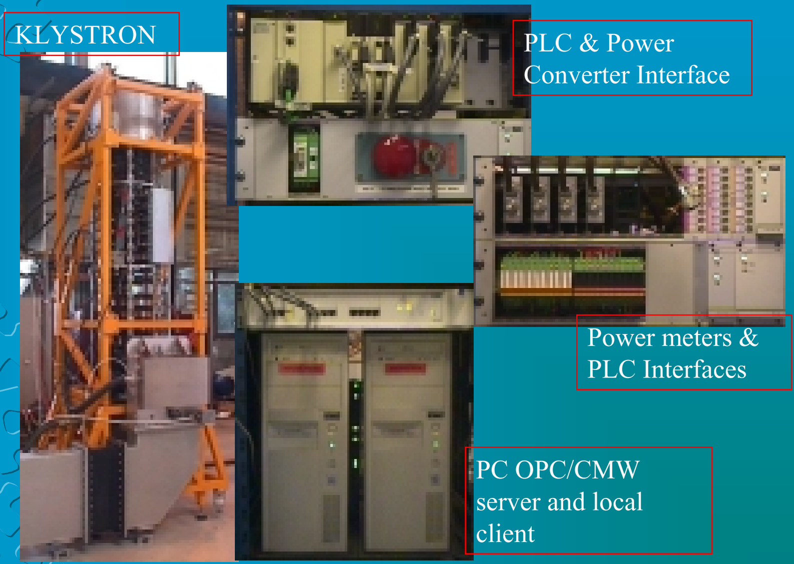


Main Fix Display

Interlock Control

Main Control panel & Alarms and commands displays

Some real examples 2



Can we draw some conclusions and more 1

YES WE CAN !
We have successfully integrated industrial equipments.
PLC's are a good choice for controls
We can use a lot of the industrial controls element and build special equipments based on industry standards (µC)

We will extend the remote I/O and distributed structure during the next test stand project ADT (Master / Salve PLC's)

We are convinced that the 'OO' approach is the good one, we have seen this during the setting-up, **a modular system is easier to debug**

Embedded Web pages are a fantastic tool for specialist they can access the devices at the lowest level

We had good collaboration with the CO team during the CMW-Java implementation (and we will continue ..)

AND ….

Can we draw some conclusions and more 2

We had to face some problems :

Web pages on actual PLC's are slow so we had to keep them small
Ł we hope more and faster tools in the near future

Private network installation was not transparent (PC with 2 Eth. boards)
Ł we need more than a confidential help from some friends

The Power Converter control is not yet the LHC version
Ł we contacted PO for test in the near future

Writing good Java code can be a full time job for non specialists ..
Ł it would have been nice to have modified Swing components with CMW communication capability

AND ….

Can we draw some conclusions and more 3

Now some open questions

Can we base the future on OPC CMW
or else
how can we integrate the PLC industrial world directly in CMW ?

Are we going to see Windows PC in the control chain
or else
are we moving to Linux or to some 'SuperOs' and how this is going to be supported ?

We wrote a specialist (Java) programs for the test stand
who will do this for the next test stand (ADT) and the LHC ?

List of key words :
Distributed Architecture PLC FIPIO ETHERNET OPC CMW JAVA

Controls for QRL Commissioning & Reception (Sector 7-8): New Baseline

Axel Daneels (SL/DI)

What's New to the Planning?

New Dates for QRL (+ recap of Control Requirements)

Simplification but New (?) Requirements

New Milestones

Questions / Problems / Conclusion

New Dates for QRL (1)

- **Preamble:**
  - **New dates are based on:**
    - LHC Construction & Installation, General Co-ordination Schedule (LHC-PM-MS-0005-rev 1.3 Draft; AC/TCP)
    - G.Riddone (Wed 27-03-02)

New Dates for QRL (2)

- **QRL Installation (Mechanical elements, alcoves, local cables, et tutti quanti):**
  - **16-June-03 to 07-Nov-03 (= 21 weeks)**
- **QRL Pre-commissioning:**
  - **14-Jul-03 to 07-Nov-03 (= 17 weeks) : 1 year from now!**
  - **Recap of Requirements (cf. meeting 2 Feb 2001)**
    - **Control Functionality**
      - Manipulation of sensors / actuators and operation phases (Cool-down, Stand-by, Warm-up)
      - Monitoring
    - **Required Infrastructure**
      - Fieldbus along sector
      - Supervision system in local (CRYO) and central control rooms (PCR, TCR)
      - Uploading / downloading calibration data from / to Oracle database
      - Analog signal observation
      - Vacuum interlocks

New Dates for QRL (3)

- **QRL Commissioning:**
  - **07-Nov-03 to 01-Dec-03 (3 weeks)**
  - **Recap of Requirements (cf. meeting 2 Feb 2001)**
    - **Control Functionality**
      - Manipulation of sensors / actuators and operation phases (Cool-down, Stand-by, Warm-up)
      - Monitoring
      - Logging
      - Alarms
    - **Required Infrastructure**
      - Vacuum fully operational
      - CRYO controls and adjacent refrigeration machinery fully operational
      - Local and central (PCR, TCR) control rooms

New Dates for QRL (4)

- QRL Reception:
  - 01-Dec-03 to 05-Mar-04 (12 weeks) (05-Mar-04 = Acceptance!)
  - Recap of Requirements (cf. meeting 2 Feb 2001)
    - Control Functionality
      - Manipulation of sensors / actuators and operation phases (Cool-down, Stand-by, Warm-up)
      - Monitoring
      - Logging
      - Alarms
      - TCR and stand-by personnel on call
    - Required Infrastructure
      - Vacuum fully operational
      - CRYO controls and adjacent refrigeration machinery fully operational
      - Local and central (PCR, TCR) control rooms
      - *General services*
      - *Safety (Oxygen deficiency risk)*

Simplification but New (?) Requirements

- Exit:
  - Front-End:
    - all industrial PLC: none of M. Vanden Eynden's business
  - Database_Calib:
    - = responsibility of the equipment specialists
- New:
  - Analog signals for QRL Cryo
    - Requested by: G.Riddone, Ph. Gayet
    - Needed at "Pre-commissioning" : 14 Jul. 03.
    - E. Ciapala informed by e-mail (4/07/2002)
- Note:
  - planning from “end date”
  - milestones = “as late as possible”

New Major Milestones

ID	SYSTEM	MAJOR MILESTONE	DATE	WHO
0	QRL Controls : New Baseline	QRL Controls: New Baseline	28.01.02	
1	Alarms	Decide on Alarm Technology	28-01-02	Tyrrell
2	Alarms	Alarm System: Functional + Architect. Specs available	28-02-02	Tyrrell
3	Logging	Logging Architectural Design Document	25-07-02	Billen
4		Logging Interfaces Published	18.10.02	Billen
5	Alarms	Alarm System: Operational Prototype available	06.01.03	Tyrrell
6	Timing	Synchronisation of PLC	27-01-03	Beau
7	Communications Infrastructure	Voice Communication: 900 MHz leaky Feeder installed	28-03-03	Andersson
8		Technical network on the LHC surface sites installed	28-03-03	Andersson
9		Network Optical Fibres in underground areas (7-8) installed	28.03.03	Andersson
10	General Services (WorldFIP, etc)	WorldFIP installed for QRL Pre-Commissioning	16.06.03	Guillaume
11	Timing	Timestamping (1 - 4 msec resolution)	14-07-03	Beetham
12	Analog Signals	Analog Signals Systems ready for QRL VAC	14-07-03	E.Ciapala
13	Control Rooms	CRYO Control room ready for QRL	14-07-03	Gayet
14	General Services (WorldFIP, etc)	Cables for analog signals (CRYO)	14-07-03	Guillaume
15	Control Rooms	PCR ready for QRL Commissioning	07.11.03	Chauss
16		TCR Ready for QRL Commissioning	07.11.03	Haas
17	Alarms	Alarm System available for QRL Commissioning	07-11-03	Tyrrell
18	Logging	Logging available for QRL VAC & CRYO	07-11-03	Billen
19	QRL_VAC	QRL Vacuum Control Ready for QRL Commissioning	07-11-03	Gavaggio
20	QRL_CRYO	CRYO Control System Ready for QRL Commissioning	07.11.03	Gayet

Questions / Problems / Conclusion

- Database for configuration data:
  - something is being / will be set-up: is QRL concerned (?)
- Analog Signals:
  - to be planned (E.Ciapala)
- Installation of Network optical cables during SD 2002-2003 in:
    - LSS4 & TT40 = O.K.
    - TI8 & Sector7- 8: may be a problem (late Tender: FC 12/02 or 03/03!)
  - L-K de Jonge will investigate
- Nonetheless, and as a conclusion:
  - Except for previous points, … everything seems on schedule!!!