Minutes of LHC-CP Link Meeting 10

Subject	:	LHC Controls Project	
Date	:	20 February, 2001	
Place	:	Bat 936	
Participating Groups	:	EST-ISS	Apologies
		LHC-ACR	Apologies
		LHC-ECR	No representative
		LHC-IAS	Brahy, J
		LHC-ICP	Apologies
		LHC-MMS	No representative
		LHC-MTA	Walkiers, L
		LHC-VAC	Gavaggio, R.
		PS-CO	Di Maio, F.
		SL-AP	Brüning, O.
		SL-BI	No representative
		SL-BT	Carlier, E.
		SL-CO	Bland, A.
		SL-HRF	Ciapala, E.
		SL-MR	Billen, R.
		SL-MS	P.Dahlen
		SL-OP	Lamont, M.
		SL-PO	King, Q.
		ST-MO	Sollander, P
Sub-Project Leaders	:	Alarms	Tyrrell, M.
		LAWG	Lamont, M.
		Components	Apologies
Others	:	Lauckner, R. (chair)	
		Vanden Eynden, M. (Core Team, secretary)	
Distribution	:	Via LHC-CP website: **http://cern.ch/lhc-cp**	
		Notification via: **lhc-cp-info@cern.ch**	

Agenda	:	1. Minutes from previous meeting	
		2. LHC-CP News	R. Lauckner
		3. Controls during the Sector Test	M. Lamont
		4. The LHC Alarms Sub-project Status Report	M. Tyrrell
		5. AOB	

1. Minutes from Previous Meeting

R. Lauckner reminded that a first prototype of the LHC-CP EDMS system has been proposed and that all link persons are invited to give their feedback to M. Vanden Eynden.

ACTION: All link persons

2. LHC-CP News **R. Lauckner**

R. Lauckner reminded that the 2nd LHC-CP Workshop will take place on 5th and 6th of April. The program will contain a plenary session (morning of the 5th) covering the follow-up of the major issues raised during the last workshop (Middleware, String II, Real Time controls, etc). Three parallel sessions will be organised during the afternoon. A first session will cover Database aspects. A second one will be devoted to architecture and a third one will discuss hardware sharing opportunities. The morning of April, 6th will include summing ups of the three parallel sessions and presentations of two major CERN controls activities : the CERN Fieldbus working group and the CERN SCADA working group.

R. Lauckner said that the LHC-CP team is in the process of setting up the LHC Post Mortem working group. All parties interested in this new activity are invited to contact E. Ciapala and/or J.Wenninger.

A Database Workshop is being organised by T.Petterson. This workshop will be focussed on production Databases for machine operation. R.Billen will represent the LHC-CP project during this workshop.

The ST/MO group is currently in the process of evaluating PVSS as supervision platform for the LHC. A presentation of this activity will be organised in the scope of the LHC-CP meetings.

W.Salter is currently collecting CERN development and licensing requirements for the PVSS SCADA system.

The next LHC-CP meeting will take place on March 13th and will cover QRL planning and LAWG activities.

3. Controls during the LHC Sector Test **M.Lamont**

Mike presented the different scenarios which are currently discussed for the LHC sector test which will start in April 2004 (see attached slides). Two parts have to be considered : the systems tests which will take about 4 months (technical commissioning of the cryogenics, vacuum, machine protection and cold mass instrumentation) and the tests with beam for which 2 weeks will be allocated. The sector test is representative of the whole machine and the importance to get the control system as close a possible to its final design is essential.

In the discussion O. Brüning and R. Lauckner stressed the importance of making maximum use of the beam tests.

4. LHC Alarms Project Report **M.Tyrrell**

Mark first recalled what the main characteristics of an "alarm service" are (see attached slides). He then stressed the fact that the strategy they will use is to maintain the current Alarm system in parallel with the new developments until the new system offers the desired functionality and reliability. Mark outlines the strong collaborations between this project and the PS/SL Middleware project and the ST/MO group (for PVSS prototyping activities).

From a more technical aspect, he explained the technology used today (RPC, SystemV message queues, X-Window protocol) and outlined some preliminary ideas for the new system (publish/subscribe communication mechanism using a subject based organisation of the Alarm information). In terms of time scale, year 2001 will be used to survey requirements, gain experience with PVSS and Middleware technology and evaluate potential architectures. In 2002, the project will produce a functional specification of the system along with the architectural design. A prototype is foreseen by end 2002. In 2003, the new system will be operational for the QRL tests. In 2004 the final system will be operational for the sector test.

5. AOB

There was no further business.

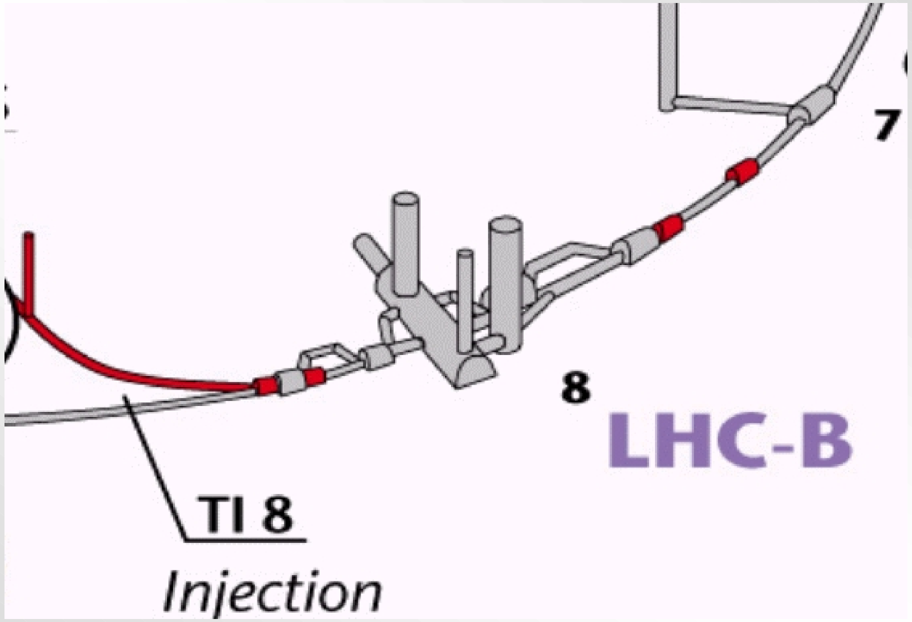
Actions	**People**
Establish Real-time sub-projects.	R Lauckner
Set up the LHC Controls Engineering data tree in EDMS	M. Vanden Eynden

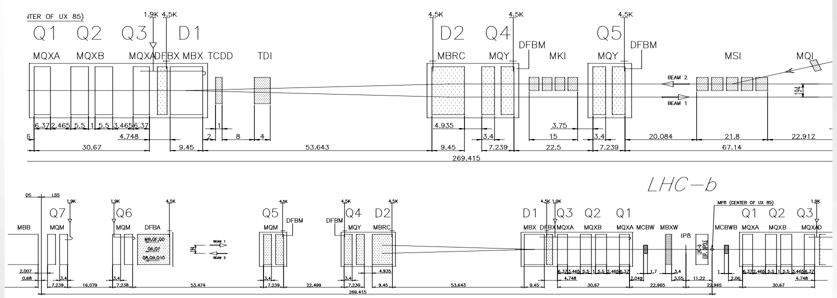
LHC sector test - preamble

- LHC is 8 essentially separate sectors, sector test therefore representative of the whole machine, as such aim for rigourous test of what will be reality
- Technical commissioning due to start April 2004
- Sector test versus injection test?
  - Systems test - a major objective, with the emphasis on the arc THESE TECHNICAL SYSTEM TESTS WILL TAKE AT LEAST 4 MONTHS..
  - Test with beam - a major objective, with the emphasis on the arc WITH A BIT OF LUCK WE MIGHT GET 2 WEEKS AT THE END

Basics

- Beam 2 will be injected from the right of IP8, through IP8 and into the continuous cryostat of sector 8-7, dump before IP7.
- Not a sector test but sector and a bit…
- Main emphasis for the tests should centre on the continuous cryostat of the arc.
- Around 7 months foreseen in latest version.
- Injection will be blocked at point 8 by LHCb installation from about November 2004 for around 18 months.





Layout: plan A - full scheme

- Injection into outer LHC ring right of point 8,
  - through Q5,Q4, D2, D1, triplet right,
  - non-existent LHCb,
  - triplet left, D1,D2, inner ring of Q4, Q5
  - dispersion suppressor
  - arc 7-8.
- Injection will take place after 81 is commissioned

• Installation and commissioning of cryogenics to the right of point 8 will be required. Major bugbear.

• Need to commission inner triplets.

However:

• Triplets will not have to be removed for LHCb installation

• Clearly extremely useful to system test them

• Not essential for tests with beam (vis a vis arc)

Layout: plan B - shortcut

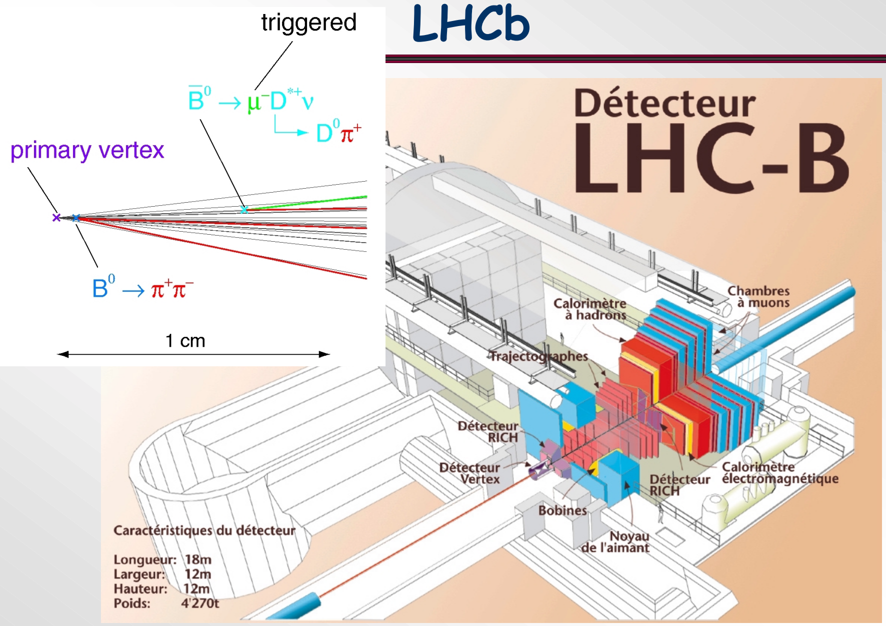
- 1. Skip both D1s, D2s + inner triplets. Install warm quadrupoles right of IP8:
  - temporary warm transfer line across the region
  - temporary vacuum system
  - beam would come in outer ring, traverse IR8 in large aperture beam pipe, and enter outer ring at Q4 to the left.
- Variations possible e.g. could replace D1/D2 with correctors

• much simpler than the complexity of a cold insertion

• LHCB magnets will not be available at time of test so special hardware necessary anyway

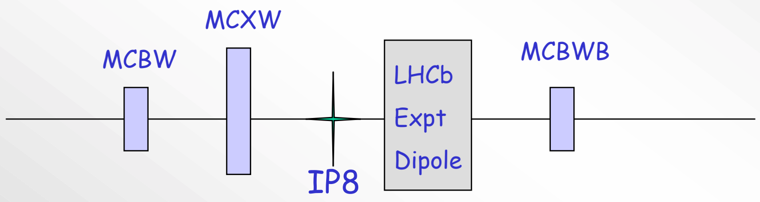
• don't get to commission and test insertion (cryogenics, vacuum, power, protection…)

LHCb



LHC-b

- Installation of magnet and compensating dipoles clearly take place after sector test.
- Installation will block beam tests (around Nov. 2004)
- but not system tests (NB)
- Inner triplets can stay if installed



Sector Commissioning ⇔ Circuits for injection tests

Circuit	Qty total	Qty for beam through arc	Qty for beam through LSS	Qty for injection test
13kA	3	3	NA	3
4 to 8 kA	26	5	12	17
600 A	61	11	4	15
60 to 120 A	148	56	4	60
Total	238	75	20	95

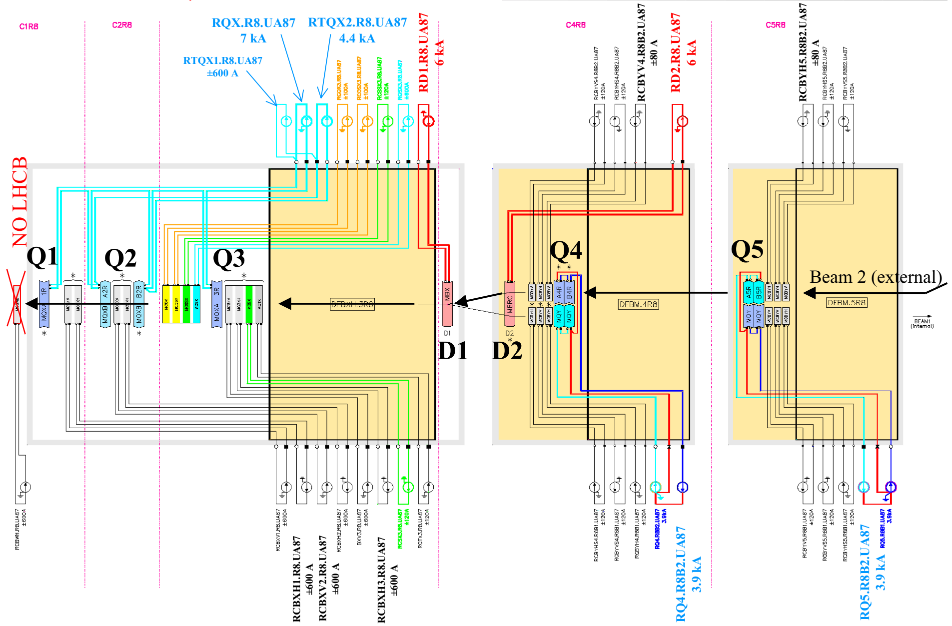
supplying 226 kA

Major hardware commissioning job.

Inner triplet commissioning : "It's not a trivial problem".

Experimental schedule needed with realistic resources (see String1, String2 and RHIC experience)

INSERTION, RIGHT OF POINT 8



Technical commissioning

- **Vacuum**. Leak and pressure tests: beam lines, He lines, external vacuum vessel. Subsectorisation. Full He pressure tests. Pump down. Alignment.
- **Cryogenics** Commissioning and debugging of the control system. System tests. Magnet temperature control. Screen cooling. Flow stability. cool down, final cool down, quench recovery tests. Warmup. Tuning of cryogenics distribution loops. Heat loads. Cryoplant dynamics. QRLs
- **Cold mass instrumentation** calibration of temperature sensors, voltage taps. DAQ.
- **Machine protection** system checks of quench protection, energy extraction, data acquisition, instrumentation, functional tests, recovery. Quench propagation. Helium discharge.
- **Powering**: Warm and cold DC low voltage test, electrical insulation tests power with short circuit, interlocks, extraction. Tracking studies.

Technical commissioning II

- This is for real. The technical services listed above will need the FINAL controls infrastructure in place to perform commissioning, tests and subsequent operation.
  - Vacuum
  - Cryogenics
  - Powering
  - Machine protection
  - Cold mass instrumentation
- This is NOT an exercise!
- So SCADA, PLC integration, data exchange, logging, DAQ, applications, you name it, it has to be in place.

Not to mention cooling, ventilation, access...

At the end of which...

- Beam pipes pumped down
- Magnets cold.
- Protection systems tested.
- Able to power magnets safely

Very cold checkout - what else is required?

Very cold checkout

- Full system shakedown
- Dry run operational cycle
- Equipment tests
  - Collimators } Not strictly necessary
  - TDI }
  - high current magnet & power converter tests
  - kickers
  - control system
- Fault recovery, quench recovery procedures

Transfer

- Extraction from SPS
  - extraction to be commissioned. Potential interference with TI8 installation
  - foreseen to go TED in TT40 for 2003 - good because it allows time for problem resolution
- TI8
  - to be commissioned in parallel with sector test

CONTROL SYSTEM MIGHT BE USEFUL...

Interlocks

- Power permit and abort will need to be in place to provide machine protection:
  - prevent damage to magnets, cables and current leads
- Transfer line interlocks will need to be in place.
- Low intensity pilots to be used. Not be able to quench a magnet.
- Clearly beam dump not required but beam permit system should be commissioned. Intensity transfer veto.

Power converters

- Full functionality of digital controllers
  - world FIP
  - gateways
  - network
- Standard high-level control functionality
  - cycle, ramp, set, trim, alarms, interlocks
- Acquisition: debugging, tracking studies...

• Many more circuits will be available which will not be necessary for the simple transfer of the beam.

• Beam experiments may require other circuits

• However it will be very useful to test and commission all circuits of the sector with or without beam.

Instrumentation

- Beam Position Monitors
- Beam Loss Monitors
- Beam Current Transformer (IBMS)
- Beam Synchronous Timing
- Beam sizes
- Screens
- For these:
  - hardware
  - front-ends, gateways, networks
  - data acquisition
  - applications

Controls I

- Basic architecture
  - front ends (principally power converters, beam instrumentation)
  - field buses, gateways
  - network
  - middleware
  - technical support for industrial systems (cryogenics, vacuum)
  - databases
- Transfer synchronization
- Sub-system
  - alarms
  - timing
  - post mortem
- Monitoring (vacuum, cryogenics in PCR)
- Logging & data exchange

Controls II

- Application software - a basic set
  - measurement acquisition,
    - trajectory: threading, correction etc. etc.
    - screens, beam size, BCT
  - injection steering (kicker control, knobs etc...)
  - settings generation
    - 450 GeV injection settings with or without triplets
    - baseline ramp
  - trim
    - orbit bumps, phase advance, energy, multipoles
  - hardware
    - power converters - set, trim, load ramp etc...
    - kickers

Beam - motivation

- Beam is important
  - a running start is essential, operations will depend crucially not just on technical system but also beam instrumentation, controls, accelerator understanding and it is important that we rattle these cages as hard as possible as soon as possible. In the LEP days…
  - constitutes an important part of the system tests, for example: mechanical aperture e.g. RF fingers in SSS (see pressure test/buckled bellows at RHIC)

HERA had a remarkably quick start up - sector test and full ring test with positrons… latter not possible here, must take full advantage of sector test.

With beam -transfer

- SPS
  - pulse to pulse variations, entry in line, beam sizes etc...
  - different bunch configurations
  - practice, practice, practice
- Transfer line
  - beam instrumentation
  - batch to batch stability
  - longer term stability, effect of temperature
  - steering, beam sizes, beam losses, interlock system etc...

With beam

1st thing, of course, is to get beam around the arc and have a drink

- Injection steering
- Trajectory acquisition and correction, threading
  - pick-up polarities...
- Optics measurements and comparison. Phase advance, twiss parameters (kick, trajectory difference)
- Dispersion, energy offset, variation with time
- Coupling
- Acceptance, mechanical aperture limit(s)
- Momentum aperture
- Effect of thermal cycling
- Multibunch injection

With beam II

- Magnet hysteresis study
- Magnet integral transfer function study
- Vary phase advance
- Field measurements
- Dynamic effects, persistent current decay, reproducibility, effects of ramping and re-cycling:
  - quads
  - bends
- Reference magnets
  - test model
  - reference magnets will not be available
- Commissioning of beam instrumentation
  - lots & lots to do

Conclusions

- Major challenge/opportunity to bring everything together: full-blown systems tests, highlight oversights, debug.
- On the control system side:
  - This is the first of eight sectors to be commissioned
  - WHAT IS IN PLACE WILL BE.
  - Commissioning of other sectors will continue afterwards without a break
  - Physical architecture will need to be finalised and in place
    - For technical services
    - & beam based systems like BI and Power converters
  - Limited suite of PCR application software for injection tests
  - Technical systems need final configuration
- Important for commissioning of completed machine (ambitious schedule just announced) that we make good progress in commissioning beam based instrumentation, equipment & associated control system during the sector test.

LHC 'Alarm Service' Progress Report.

M.W.Tyrrell.

CERN / SL / CO / AL

➨What is the Alarm Service ?

- ➨deals with 'problems'
- ➨range from 'alarms - warnings'
- ➨call these problems 'Fault States' (FS)
- ➨accept FS's from anywhere
- ➨offer general FS treatment facilities
- ➨results made available for 'display' and 'software'.

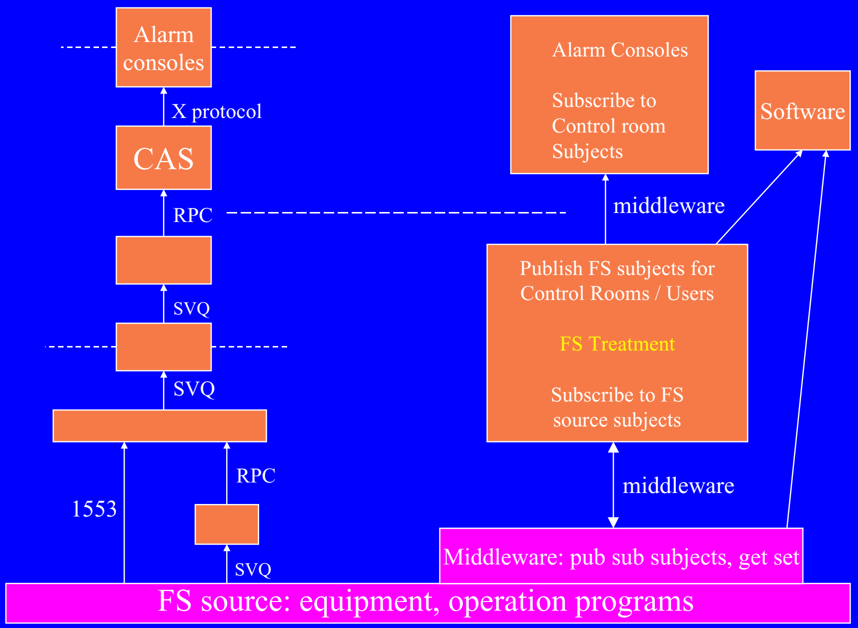
➨Current Situation

- ➨have an operational system
- ➨used for SPS, technical services and safety
- ➨must maintain this until the new system has been proven
- ➨strong collaboration with the; 'Middleware Project' - essential for alarm solution
- ➨made a prototype alarm facility for ST using PVSS - presented at ST Chamonix

➨Current Situation

- ➨anyone requiring alarm facilities NOW can be 'easily' connected to the present alarm system
- ➨this includes:
  - ➨FS display facilities + treatment facilities
  - ➨access to ALL the technical and safety information
- ➨in fact, ALL new FS's will be attached to this system until it is switched off

Architecture



Time Scales

- 2001:
  - user requirements - survey in preparation
  - gaining experience:
  - SCADA PVSS
  - C++ / Java / JMS solutions
  - web / alarm display
  - publish / subscribe interfaces
  - control interfaces - 'public' API, get / set
  - topology

Time Scales

- 2002
  - functional specification, architectural design
  - interfaces: equipment, operation software
  - topology
  - treatment facilities
  - FS naming, hierarchical name space
  - on-line maintenance of FS definitions
  - archiving / logging, use 'logging' service

Time Scales

- 2002:
  - display
  - filtering
  - archive interface / searching
  - statistical package
  - prototype end of 2002

➨Time Scales

- ➨2003:
  - ➨use prototype for QRL tests
  - ➨new and old systems running in parallel
  - ➨when satisfied , switch off old
- ➨2004:
  - ➨operational system used for 'Sector Tests'.

➨Solution Considerations

- ➨integrated approach:
  - ➨1 'source' of data for FS detection / diagnostics
  - ➨EL EFACEC, PVSS, SCADA:
    - ➨RT database - event manager connects:
      - ➨application / diagnostic programs
      - ➨alarm screen
  - ➨local or global alarm screen actions ?
- ➨passive or active ?
- ➨FS reduction

➨Current Connection Areas

- ➨EA - CESAR - Java
- ➨BI, LynxOS, C, C++, Java
- ➨PO, Server: HP / Linux / SUN, C, C++
- ➨Experiments, PVSS, OPC, Linux, NT
- ➨Cryogenics, (PC_View, OPC) -> PVSS ?
- ➨Vacuum ?, waiting for ST - TDS -> PVSS ?
- ➨LHC Front-ends, SPS 2001
- ➨1553

➨Conclusion

- ➨2001 clarification
- ➨2002 design, implementation
- ➨2003 testing
- ➨2004 final system