Controls for LTI & CNGS

- SPS2001:towards a common control system? Mike Lamont
- Installation & commissioning plans: Volker Mertens
- Controls requirements: Axel Daneels
- Interlocks: Jörg Wenniger
- Application Software: Veronique Paris
- General Controls infrastructure: Pierre Charrue
- Analog Acquisition: Ed Ciapala
- Timing: Gary Beetham
- Time stamping: Aliaster Bland
- Middleware: Vito Baggiolini

SPS2001 1/3

- Motivation for common solutions obvious
- Use SPS as test bed for:
  - Object Oriented Development
  - Attempt to come up with solutions that are re-usable by the transfer lines and the LHC (where possible).

SPS2001 Conclusions 2/3

- Clear that as we move into the LHC era we don't have the resources to support multiple solutions to similar technical problems.
- WORK IN PROGRESS
- Analysis and design approach:
  - USDP, UML, Rational Rose etc.
- Development environment:
  - JAVA, IDE, ORACLE, GUIs
  - Persistence layer
  - Version control etc.
  - Components: dataviewer, fixed displays…
  - Use of EJBs, application servers or whatever…

SPS2001 Conclusions 3/3

- Common Middleware
- Common Front-end Framework
- Explore novel requirements of LHC such as real-time
- Operational tools
  - Sequencer, Logbook, Console manager…
- Services
  - Alarms, Logging, Post mortem, Interlocks…
- Plus, with a bit of luck, some application software…

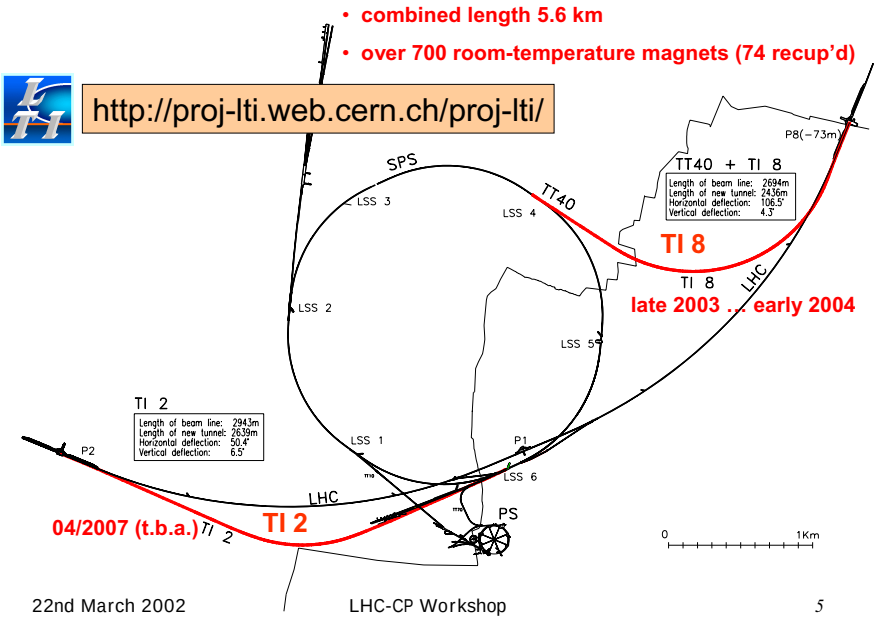
We're trying to come up with acceptable solutions appropriate for the transfer lines and the LHC…

and before promising the earth we have to prove that it works… watch this space.

Installation & Commissioning – Volker

- combined length 5.6 km
- over 700 room-temperature magnets (74 recup'd)

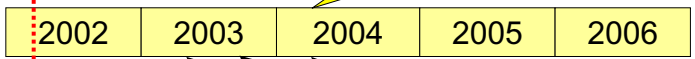
http://proj-lti.web.cern.ch/proj-lti/



Schedule

"Old":

Sector test using warm line @ IP8



Injection test early 2004

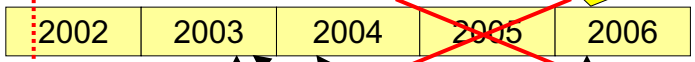
TI 8 test late 2003

LSS4 extraction test early 2003

New:

SPS stop

Sector test

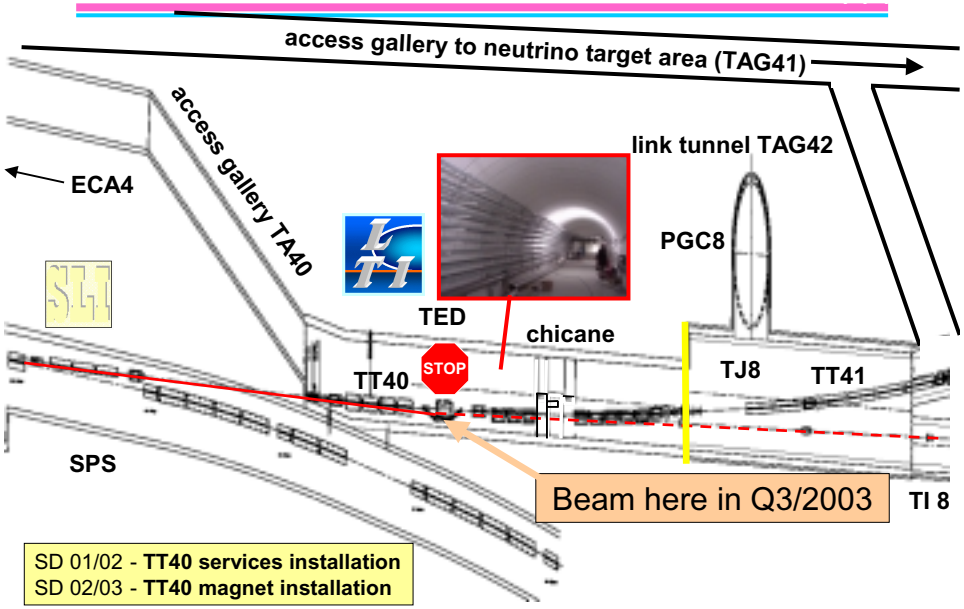


LSS4 extraction test Q3/2003

TI 8 test late 2003 or early 2004

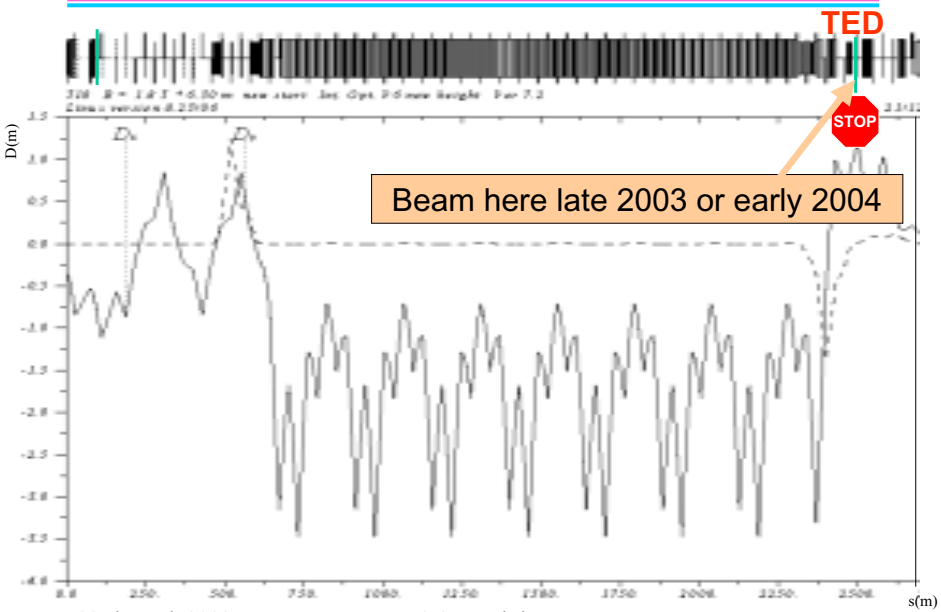
Injection test early 2006

Installation & Commissioning



SD 01/02 - **TT40 services installation**
SD 02/03 - **TT40 magnet installation**

Installation & Commissioning



LTI Overview 4/4

- Installation and commissioning (with beam) in 3 phases:
  - **SPS extraction / TT40:** Q3/2003
  - **TI 8:** late 2003 or early 2004
  - **injection elements:** 04/2006
- Planning looks feasible, but not yet "granted" (e.g. extraction kickers very tight).
- Progress + constraints to be closely monitored (equipment + controls HW/SW).
- Interlock solution/planning to be clarified/decided.
- Access requirements/safety chains to be finalized.
- Software requirements to be worked out/agreed.
- A suggestion: try to use TI 8 test as testbed for "final" software.
- SW tools should be ready for equipment tests i.e. several months before the beam tests (pls no "on-line debugging" during MD time).

Controls requirements – Alex Daneels

- Axel has put together an encyclopaedic survey of the Equipment groups requiring controls facilities
- He has established who, what and when…
- Results need to be published & verified by the groups concerned.

Equipment Groups requesting Control Facilities

Vacuum (R.Gavaggio)
Warm Magnet Surveillance(G.Mugnai, P.Dahlen)
Powering (MUGEF) (J-D.Hundzinger / Q.King)
Beam Instrumentation (J-J Gras)
SPS Extraction – Transfer Line Dumps (E.Carlier)
Radiation Monitoring (D.Perrin)
Interlocks (R.Schmidt, B. Puccio, R. Giachino, J.Wenninger)
PCR Application Software (V.Mertens, G.Arduini)
Fire Detection (Fl.Bonthond)

- Currently no requests for Fire Detection in the LHC tunnel, and thus also not in TT40 and TI8. Fire detection in BA4, ECA4, BA7, SR8, UA87 is already in place.

Overview of Equipment Groups' Requirements (1)

- Controls 'Infrastructure" H/W and associated S/W
  - Racks + VME Crates
    - in BA4, ECA4, HCA4, BA7, SR8, UA87
  - Control cables
  - Ethernet
  - Fieldbus (WorldFIP, Profibus, also MIL1553)
  - FEC in VME crates
    - Front-End CPU with RTOS (LynxOS), drivers, libraries, SOFNET-S7
    - Machine Timing
    - Remote Reboot
    - Remote Terminal
  - PLC (S7/400, S7/300) with synchronisation
  - GSM Communication: in construction in TT40, planned for TI8

Overview of Equipment Groups' Requirements (2)

- **Software**
  - **Oracle database infrastructure**
    - Configuration, calibration, measurement
  - **Timing**
    - Machine Timing, Time stamping, Beam Description, Pre-pulse, Revolution freq., 40 MHz (BST)
  - **Middleware**
    - In particular API to equipment Control, S/W Interlocks, Error handling
  - **Logging**
  - **Alarms**
  - **Interlock**
    - Fast Extraction Interlock, Access Interlock
  - **Analog signals**
  - **Post-Mortem (to be discussed)**
  - **Back ends / Operational Platforms in Equipment Buildings (BA4, ECA4, HCA421, SR8, UA87)**

Overview of Equipment Groups' Requirements (3)

- **When:**
  - **Controls 'Infrastructure" H/W and associated S/W**
    - **Vacuum: Dec 2002 (TT40); Apr 2003 (TI8)**
    - **Warm Magnet Surveillance: Dec 2002 (TT40); Apr 2003 (TI8)**
    - **Powering: Dec 2002 (TT40 and TI8)**
    - **Beam Instrumentation: Dec 2002 (TT40); Apr 2003 (TI8)**
    - **SPS Extraction Transfer Line Dumps: Dec 2002 (TT40); Apr 2003 (TI8)**
    - **Radiation Monitoring: beginning of SPS/SD 2002-2003**
    - **Interlocks: if prototype of new system, then: Dec 2002**
  - **Software**
    - **Most all: Dec 2002 (TT40); Apr 2003 (TI8)**
    - **PCR Application Software: cold check out 2003**

Interlocks - Jörg

- **Distinguished between Hardware and Software Interlocks**
  - **Hardware interlocks under consideration**
  - **Software interlocks responsibility of SPS2001**

- In the LHC & CNGS era, the hardware interlock system
  - § must support fast cycle changes.
  - § requires additional inputs : beam quality, LHC inputs…
  - § must handle fast extractions !
  - § Not full-filled by the existing system !

§ Main (Sub-)Components :
  - § The SPS emergency beam dump.
  - § The extraction interlocks for **CNGS, LHC and FT beams.**

§ **collaboration** was started between SPS & LHC

Interlocks 2/3

For the future

§ The present emergency beam dump system could **"survive"** into the multi-cycling area, but :
  - o spare parts are rare.
  - o not much room for new inputs.

§ A new system must be put in place in the coming years

§ The interlock situation has been reviewed with the "actors" that are involved today (BI, BT, PO, CO) to identify
  - § Present limitations.
  - § Future developments.
  - § Critical issues :

Some ideas have emerged, but more work is required before a solution emerges

Interlocks 3/3

- 2002 : proposal for a conceptual design.
- Summer/fall 2003 : extraction tests TT40 / TI8.
  - § Ideally : test of a 'meaningful' prototype.
  - § It is not clear if a prototype can be build within that timescale !
- Most urgent problems / decisions :
  - § NO manpower is presently available to build the SPS system.
  - § A proposal to form a single interlock section for all machines has been made, but the 'home-group' and manpower resources of this section are not finalized…

Application software – Vero 1/2

For transfer line tests…

- **Existing TZ software**
  - **Extensions for new lines straight-forward**
  - **Some additional nice-to-have features to be added**
  - **Rapid S/C changes might be possible with hardware modifications**
  - **Limitations: limited number of cycles, trim functionality, cycle dependent interlocks**
- **New software**
  - **SPS2001**
    - Kickers and some other BT equipment in 2002
    - Cycle dependent SW Interlock later
  - **CMW middleware**
    - New BI equipment
  - **SSIS modified**
    - SW interlocks for 2003

Application software 2/2

- **2003 tests: combination of:**
  - **TZ (principally)**
  - **SPS2001 for equipment control**
- **Foresee migration to SPS2001 (providing rapid supercycle changes, cycle dependent interlocks etc) in the following 2 years in time for the sector test with beam.**

Controls' infrastructure - Pierre

- **Reminder of controls infrastructure**
- **Workstations:**
  - **Archiectual split: GUIs running on W2K, business layer on UNIX**
  - **Status of HELIX awaiting restructuring**
- **Front-ends**
  - **VME, PowerPC, Lynx as standard**
  - **Integration of PLCs and cPCI under study**
  - **Set of standard services offered**
- **Field buses**
  - **1553 still much in use**
  - **WorldFIP in coming, supoort offered (together with LHC/IAS)**
  - **PLCs incoming but little expertise within SL, waiting on restructuring.**

Controls' infrastructure 2/2

- Network
  - IT/CS's responsibility, SL to define requirements (is anyone coordinating this?), part of Service Level agreement
- Operating system
  - HP/UX 10.2 for file servers etc, upgrade waiting on restructuring
  - LynxOS for front-ends
  - W2K for consoles – little support
  - LINUX? Restructuring?
- Alarms
  - LHC-CP initiative for the LHC Alarm Package launched early 2001
  - PVSS and in-house development were studied
  - Decision has been taken to build the LHC-Alarm system using in-house development
  - Old and New system will be put in place in parallel. First prototype for the QRL tests

Analog Acquisition – Ed Ciapala 1/4

- General Purpose Analog Signal Observation in LHC
- Signal Types and Numbers - RF & BT
- LHC Era – Common solutions across equipment, PS SPS and LHC
- - Analog signal transmission equipment (Fibres)
- - Acquisition systems : Summary of discussions:
  - Existing nAos system
  - Requirements
  - hardware,
  - Software
  - Timing
  - Post mortem
- SPS Extraction (TT40) Requirements (E. Carlier)
- How to proceed?

Analog acquisition – Hardware 2/4

- Acquisition Modules
  - Slow systems: Many suppliers
  - Fast systems: Acquiris, (Widely used at CERN) PS-BD, SL-RF, SL-BT
  - GaGe – recent presentation of future products

- Platforms
  - VME Widely used at CERN– very long term commercial future ?
  - VXI (Becoming) Extinct – Main problem for nAos
  - PCI Most widely used, size & connectivity are problems ?
  - CPCI Good size (3U/6U) & connectics, software compatible with PCI
  - PXI NI (LabVIEW) CPCI with extensions
  - (3U height only but fits in 6U CPCI)

! General agreement that CPCI is the best choice !

LHC Analog Signals – Software 3/4

- Custom =>
  - Still Using COTS Solutions (Commercial/CERN) as far as possible
- 3 Layers:
  - Local acquisition server
    - LabVIEW, 'C', Windows ...
  - Remote clients (Data Presentation)
    - LabVIEW
    - Own GUI & Dataviewer
  - Communication / Middleware
    - CMW OPC

- Choice of OS =>
  - Windows – better COTS support ?
  - Linux – CERN expertise stronger ?

! General agreement more difficult to reach !

AA: How to proceed ? 4/4

- Close collaboration on urgent projects

1. PS LEIR acquisition system
2. SPS RF Fast Mountain Range Display
3. SPS extraction (EA and LHC) - TT40

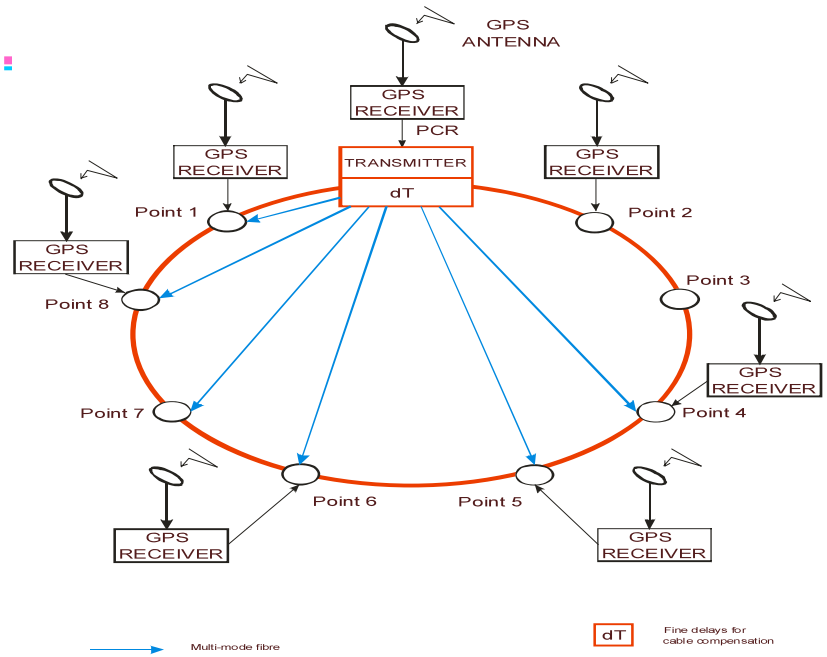
⇒ Coordination of software developments

⇒ => common solutions

- Analysis of individual systems
  - Observation, control, post mortem, acquisition points
- Agreement on standard acquisition hardware modules/multiplexers

Timing

- The Present SPS Timing System will be Extended. This includes:
  - GMT
  - Pre-Pulses
  - Revolution Frequency
- New technology: NONE
  - Will re-use the existing SPS equipment. This includes optical transmitters/receivers using multi-mode fibres. Local copper distribution and TG8 timing modules



LHC DATE TRANSMISSION TEST

Timestamping – Alastair 1/2

Very Comprehensive Overview of…

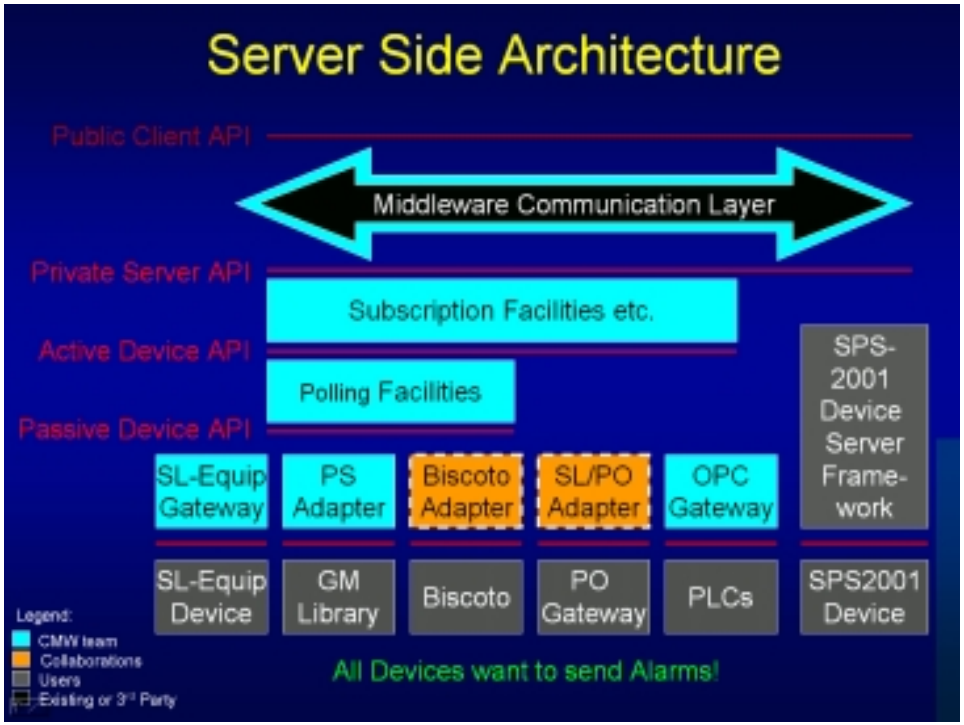
- Typical uses for time stamps
  - Alarms
  - Logging
  - Post Mortem
- GPS
- Formats for time (text, Unix and Windows, Java, Oracle)
- How Computers keep time
- Network Time Protocol
- PLCs
- Conclusions

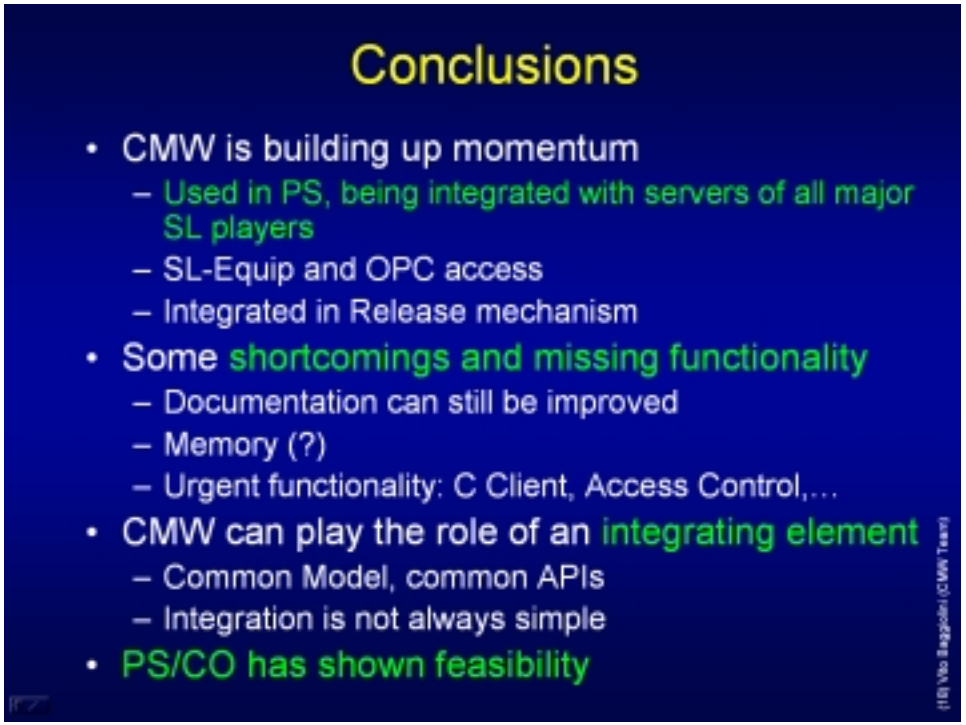
Timestamping – Conclusions 2/2

- **A coherent use of time throughout the CERN Control Systems will allow better applications and diagnostics to be made for our Operators and Equipment Specialists.**
- **One GPS source (with spare) can be used as the reference. Other GPS receivers must be used to check distribution through the Control System.**
- **The recommendation here is to use:**
  - **Hardware pulses or Machine Timing for precision finer than a millisecond**
  - **NTP for general computer synchronization**
- **An obvious choice of format looking from the middle layers of the Control System is time in seconds since the 1st of January 1970. However some may disagree and say that for example PLCs should send data directly in Oracle string date format! This has the disadvantage that only Oracle can easily perform calculations on these strings …**

Middleware - Vito

- **One solution, which is CMW, if…**





Conclusions 1/2

- **Installation and commissioning (with beam) in 3 phases:**
  - **SPS extraction / TT40:** Q3/2003
  - **TI 8:** late 2003 or early 2004
  - **injection elements:** 04/2006
- **Controls' requirements clearly established**
- **Hardware Interlocks – problem understood but manpower urgently needed if meaningful prototype to be tested in 2003**
- **Applications: TZ can do the job, eventual migration to SPS2001 before sector test.**
- **Controls infrastructure:**
  - **situation fluid in some areas – waiting on restructuring**
  - **Support for incoming technology such as PLCS ill-defined (for the moment)**

Conclusion 2/2

- **Timing: In good hands, no worries for the lines**
- **Timestamping: important we have agreement, Alastair's suggestions need to be formalised**
- **Middleware: Clear that we need one solution**
  - **We go with CMW, but…**
    - Work in progress
    - Problems to be resolved, functionality to be provided
    - It is now being deployed in PS and SL and must prove itself capable of meeting requirements
    - Integration with SPS2001 framework to be pursued
  - **A formal review is required.**

Coordination and follow-up required