# Minutes of LHC-CP Link Meeting 13

**Subject** : LHC Controls Project

**Date** : 29th May, 2001

**Place** : 936-Conference Room

**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 | no representative, |
| LHC-VAC | R. Gavaggio, |
| PS-CO | F. Di Maio, |
| SL-AP | E. Wildner, |
| SL-BI | J-J. Gras, |
| SL-BT | E. Carlier, |
| SL-CO | A. Bland, |
| SL-HRF | E. Ciapala, |
| SL-MR | R. Billen, |
| SL-MS | G. Mugnai, |
| SL-OP | M. Lamont, |
| SL-PO | Q. King, |
| ST-MO | P. Solander. |

**Others** :
G. Beetham (Timing)
R. Brun (LHC-IAS)
A. Butterworth (SL-HRF)
P. Dahlen (SL-MS)
A. Daneels (Project Planning)
R. Lauckner (Chair),
I. Laugier (LHC-VAC)
R. Schmidt (Machine Protection)
M. Tyrrell (Alarm Sub-Project).
M. Vanden Eynden (Core Team),
J. Wenninger (Post Mortem)

**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 — R. Lauckner
3. Slow Timing and Time Stamping for the LHC — G. Beetham
4. Post Mortem, where do we go from here? — J. Wenninger
5. Planning for the QRL Controls — A. Daneels
6. AOB

## 1. Matters arising from previous meeting

M. Vanden Eynden reported that nothing has been done to clarify the distinction between documentation stored in the EDMS system under the LHC Baseline and that under the LHC-CP Documentation tree.

R. Lauckner and P. Gayet have discussed extending the survey of Front End architectures to cover all systems with P. Ribeiro. This subject will be presented at a project meeting in July.

M. Tyrrell reported that there have been no objections raised to the new planning for the Alarm Sub-Project. R. Lauckner will update the mandate.

The core team has discussed the requested clarification of Middleware services to be used in the project. The subject is complex and has been added to the list of long term actions.

Q. King said that he was preparing information concerning planning for the sector test requested by A. Daneels. He asked for the collaboration of G. Beetham in this matter.

## 2. LHC-CP News R. Lauckner

Conclusions from the April workshop have been presented to MARIC and a summary was the subject of an SL seminar. There has been little reaction.

The Controls Board has agreed a cost-sharing model for the implementation of the SCADA recommendation. A meeting is scheduled with J. May next week to launch the purchasing exercise. The board is also considering a re-launch of the LHC Data Interchange Working Group. The focus will probably be exchange of data between PVSS users. Interested groups should contact R. Lauckner.

Requests for mobile communication in the tunnel have been received from Vacuum group and the installation team (P. Proudlock). R. Lauckner will follow up with P. Anderssen. (ComIn).

E. Ciapala has establish a Webpage http://cern.ch/lhc-cp-hardware-sharing/ and a mailing list for the hardware sharing community. Groups are encouraged to provide feedback.

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

| | | | |
|---|---|---|---|
| 12/6? | Database, QRL Planning | Billen, Daneels | ? |
| 3/7? | TCR Operation, Front End architectures | Ninin, Gayet, Ribeiro | ? |

## 3. Slow Timing and Time Stamping for the LHC G. Beetham

G. Beetham presented the progress towards building the slow timing system to synchronise control actions across the machine and the time of day distribution system for time stamping.

A classic slow timing system will be provided using the same 4 byte event frame as the SPS. This will avoid the development of a timing generator (MTG) specifically for the LHC. It is proposed to use one byte for machine mode information.

The detectors have still not decided if they require the slow timing but G. Beetham anticipates that this will be required based on the LEP experience where this was not provided. He showed the geographic requirements for timing signals which continues to evolve, the most recent changes following the BI decision to remove their electronics to the surface buildings.

A project has been launched to test the suitability of using the SNTP protocol on Ethernet to provide time of day information to PLCs. G. Beetham has set up an SNTP server in the PCR deriving daytime from a GPS receiver. R. Brun and J. Brahy explained how this information will be used to set the clock in Siemens and Schneider PLCs and then compared with a local GPS receiver in order to assess the overall accuracy of such a system. Results depend on the availability of SNTP support from manufacturers but are expected by December. A. Bland showed the operational performance of the clocks in 190 LynxOS systems where jitters in the region of 10 msecs were measured.

A. Bland pointed out that the network topology being used for the time of day tests with PLCs was not going to give the best results.

G. Beetham went on to describe prototyping work on timing receiver modules which has been done by his students. All cards have been based on VHDL technologies and the results were a good demonstration of the advantages of using this technology. Projects have included:

1. A G64 card to decode IRIG B with slow timing freeze trigger
2. A G64 card to decode slow timing events
3. A stand alone module to decode slow timing events
4. A Compact PCI card to decode slow timing events

G. Beetham outlined the major goals for 2001 which include the freezing of all hardware and software interfaces for the slow timing and time of day systems. Work is continuing based on the TIM Working Group. A functional specification will be produced.

*R. Lauckner said that specifications for the timing receiver hardware should be the responsibility of the TIM working group.*

*J-J Gras and R. Schmidt both expressed concern over the use of UTC for time of day services. R. Lauckner said that it has been decided that the timing team will always deliver time of day expressed as UTC. Conversion to local time for display purposes will be done downstream. J-J Gras requested that this be centralised.*

**4. Post Mortem, where do we go from here? J. Wenninger**

J. Wenninger stated that the answer was the Sector Test. Expanding this statement he explained that the major systems involved in 2004 will be machine protection, powering and quench protection.

He went on to propose different categories of PM data systems and also suggestions to standardise buffer depths and sampling intervals. Looking at the different data categories he pointed out that it is not reasonable to insist on standard rates and depth for systems as varying as turn by turn beam instrumentation and services where logging techniques are perhaps more appropriate.

*There was a discussion concerning the respective roles of the logging and post mortem techniques, J. Wenninger pointed out that a major distinction was the continuous nature of logging cf. the snapshot nature of post mortem.*

A series of meetings had taken place at the end of 2000 to profit from experience with PM at HERA and the CERN String1. One of the recommendations from these experts was to express all post mortem information as self-describing ASCII data.

He proposed that each group should be responsible for the local acquisition and preparation of the data. However it is not clear if the data should be pushed to the centre or information should be collected from the centre.

*Discussion on this point led to questions about avoiding data loss in the event of major incidents such as a 400kV power drop, These will certainly occur and if damage or very long recovery times ensue it will be important to analyse the event.*

Other tricky issues concern data filtering. Should we collect and record the data from all magnets that did not quench! Should filtering be done at the equipment level or centrally?

*R. Lauckner suggested that all systems should be required to demonstrate that they had functioned correctly.*

Concerning analysis software J. Wenninger said that he expected techniques to develop as operational needs were understood. Additionally expert equipment analysis software would be necessary and this should recognise data in PM format.

Finally he underlined the importance of being able to relate data from different systems. One important facility to do this will be a good naming convention.

*Many points were discussed. E. Ciapala mentioned the importance of the PM system for LEP RF. This had contributed to the operational performance of the RF and LEP. It seems that nobody has any proposal for how PM data acquisition will be frozen in PLCs. A. Bland suggested that the local clocks in all PM systems should be checked before injecting beam. M. Vanden Eynden suggested that Use Case techniques should be applied to address the many open issues.*

In summary R. Lauckner said that he and J. Wenniger will produce a framework to tackle these issues.

## 5. Planning for the QRL Controls A. Daneels

This topic was postponed because of lack of time. However the information is available on the project website at http://cern.ch/lhc-cp/Planning/planning.html. Feedback to A. Daneels would be useful.

## 6. AOB

There was no further business.

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

Reported by R. Lauckner

# Slow Timing and Time Stamping for the LHC

- **Slow Timing**
  - Current situation
- **Time Stamping**
  - Siemens
  - Schneider + Gespac
  - TrueTime NTS-100
- **User Interface Modules**
  - IRIG-B G64
  - TX3 G64
  - Stand alone TX3
  - Time stamping Module



# Conclusions

- **The existing classic deterministic timing system will work for LHC and will be compatible with PS and SPS. I.e. we have a solution now.**
- **Must freeze the user interface, i.e. output pulses and data formats, by 2001.**
- **Final decision on long distance transport mechanism early 2002.**



## SPS Events, a reminder

| Reserved | Event | Cycle Type | Cycle Type |
|---|---|---|---|
| SPS | Extraction | Proton | 1 |
| SPS | Transition | Proton | 2 |

## LHC Events, a proposal

| Ring | Event | Mode | Batch |
|---|---|---|---|
| Ring 1 | Set Bunch Clock | Filling | 3 |
| Ring 2 | Dump | Adjusting | - |
| LHC | Start Ramp | Ramping | - |
| LHC | Post Mortem | Physics | - |

## And what about?

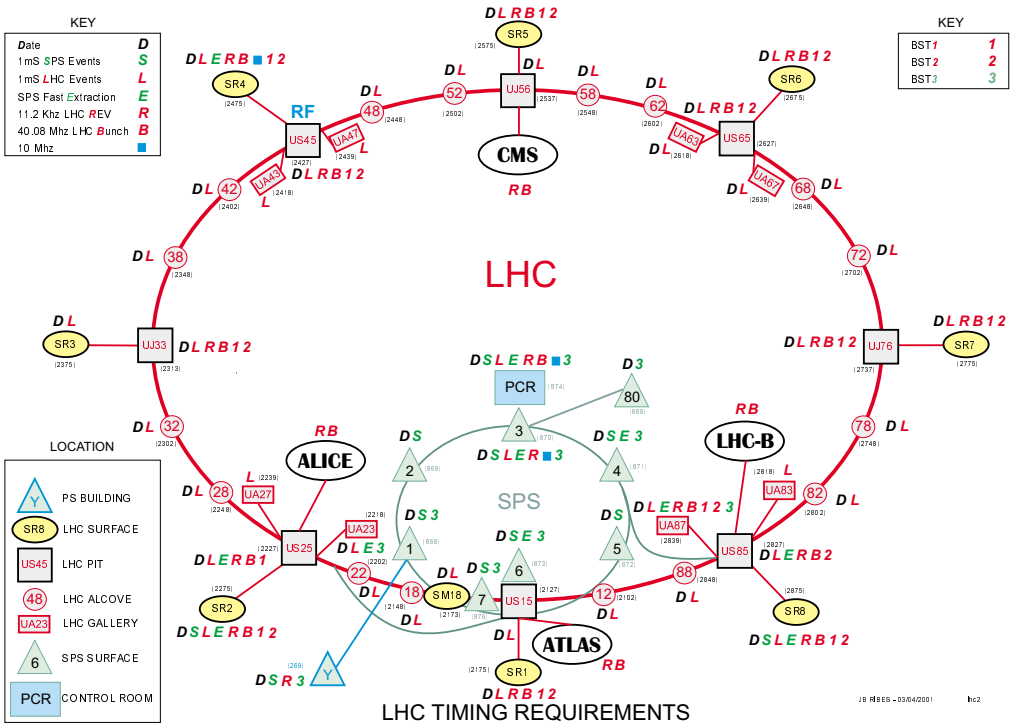
| | | | |
|---|---|---|---|
| SPS | Start TI2 Mugef | Proton | 1 |

Gary, 5/6 April 2001 2nd. LHC-CP Workshop 12

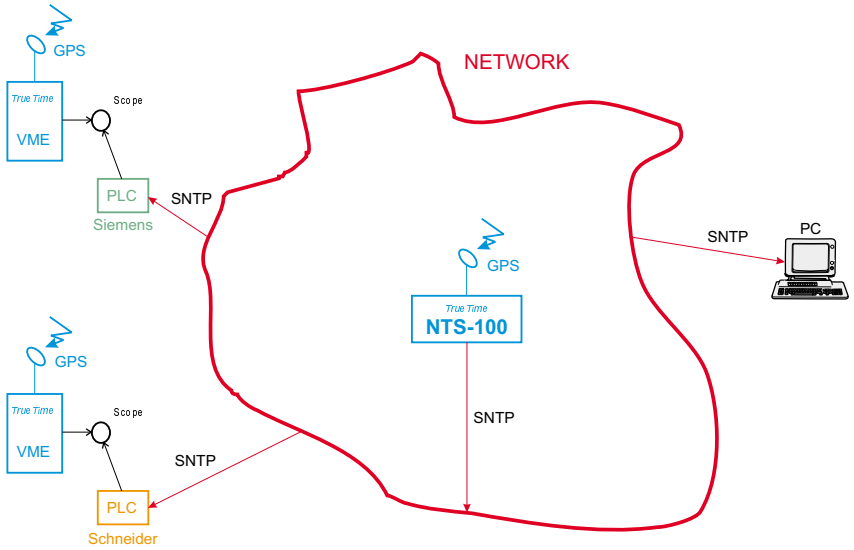


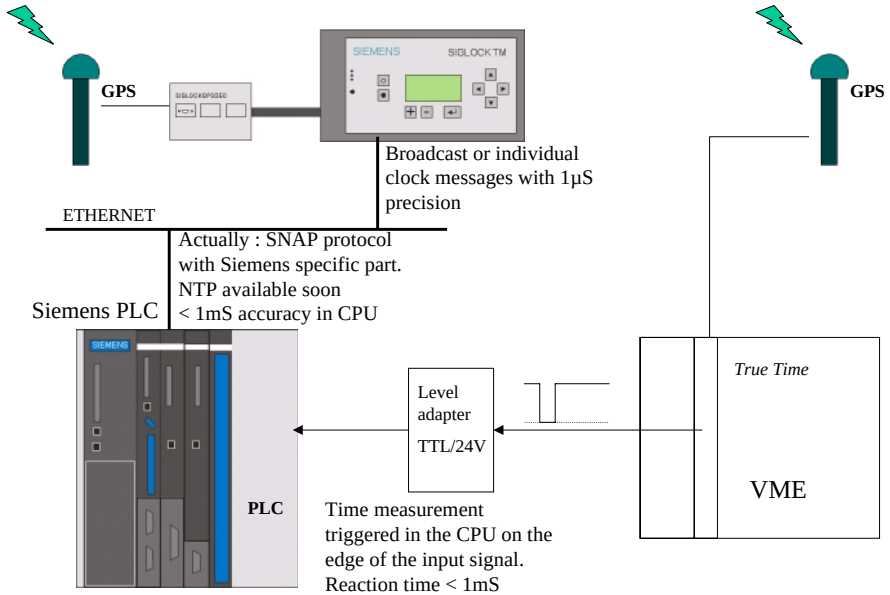
LHC TIMING REQUIREMENTS

| 4/3/01 | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| LHC | Date | SPS Ev | LHC Ev | sps Extr | REV | Bunch | 10MHz | bst1 | bst2 | bst3 |
| RE 12 | D | | L | | | | | | | |
| US 15 | D | | L | | | | | | | |
| SR 1 | D | | L | | R | B | | 1 | 2 | |
| SM 18 | D | | L | | | | | | | |
| RE 18 | D | | L | | | | | | | |
| RE 22 | D | | L | | | | | | | |
| UA 23 | D | | L | E | | | | | | 3 |
| US 25 | D | | L | E | R | B | | 1 | | |
| SR 2 | D | S | L | E | R | B | | 1 | 2 | |
| UA 27 | | | L | | | | | | | |
| RE 28 | D | | L | | | | | | | |
| RE 32 | D | | L | | | | | | | |
| UJ 33 | D | | L | | R | B | | 1 | 2 | |
| SR 3 | D | | L | | | | | | | |
| RE38 | D | | L | | | | | | | |
| RE 42 | D | | L | | | | | | | |
| UA 43 | | | L | | | | | | | |
| US 45 | D | | L | | R | B | | 1 | 2 | |
| SR 4 | D | | L | E | R | B | | 1 | 2 | |
| UA 47 | | | L | | | | | | | |
| RE 48 | D | | L | | | | | | | |
| RE 52 | D | | L | | | | | | | |
| UJ 56 | D | | L | | | | | | | |
| SR 5 | D | | L | | R | B | | 1 | 2 | |
| RE 58 | D | | L | | | | | | | |
| RE 62 | D | | L | | | | | | | |
| UA 63 | D | | L | | | | | | | |
| US 65 | D | | L | | R | B | | 1 | 2 | |
| SR 6 | D | | L | | R | B | | 1 | 2 | |
| UA 67 | D | | L | | | | | | | |
| RE 68 | D | | L | | | | | | | |
| RE 72 | D | | L | | | | | | | |
| UJ 76 | D | | L | | R | B | | 1 | 2 | |
| SR 7 | D | | L | | R | B | | 1 | 2 | |
| RE 78 | D | | L | | | | | | | |
| RE 82 | D | | L | | | | | | | |
| UA 83 | | | L | | | | | | | |
| US 85 | D | | L | E | R | B | | | 2 | |
| SR 8 | D | S | L | E | R | B | | 1 | 2 | |
| UA 87 | D | | L | E | R | B | | 1 | 2 | 3 |
| RE 88 | D | | L | | | | | | | |
| SM 18 | D | | L | | | | | | | |
| ATLAS | | | ? | | R | B | | | | |
| ALICE | | | ? | | R | B | | | | |
| CMS | | | ? | | R | B | | | | |
| LHC-B | | | ? | | R | B | | | | |




LHC TIMING REQUIREMENTS



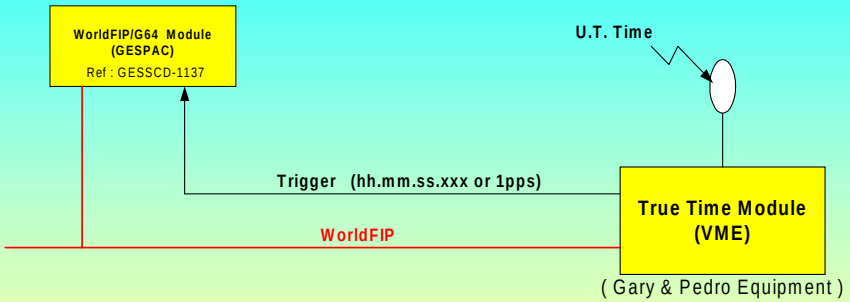




J. Brahy - C.Dehavay / LHC-IAS

*TIMESTAMPING*
*With SCHNEIDER & GESPAC*

# *TIMESTAMPING With SCHNEIDER PLC & GESPAC Module*

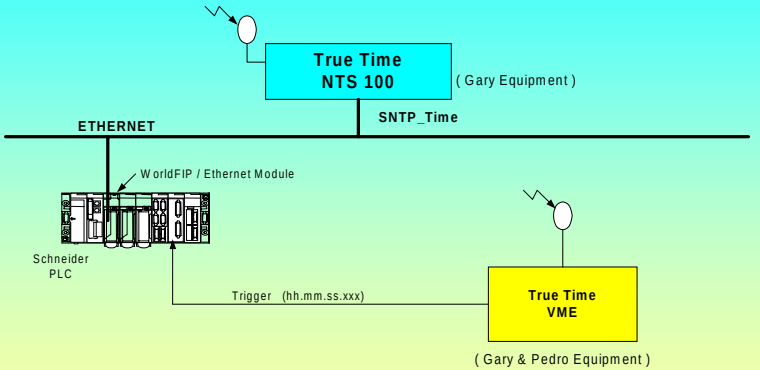
# TIMESTAMPING
## With GESPAC & TRUETIME VME Modules




**TIMESTAMPING with "True-Time" VME & Gespac WorldFIP Module**



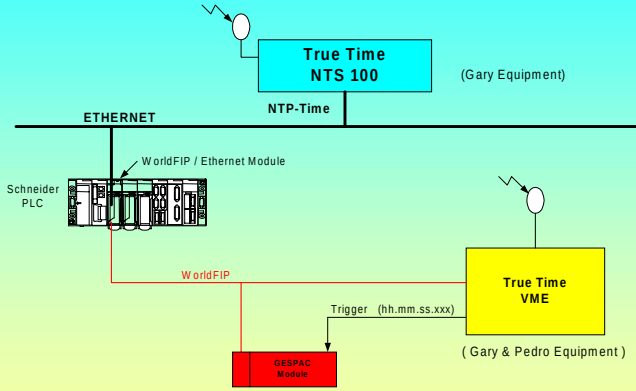
# TIMESTAMPING
## With SCHNEIDER PLC




**TIMESTAMPING Test on Ethernet/NTP Network with SCHNEIDER PLC**

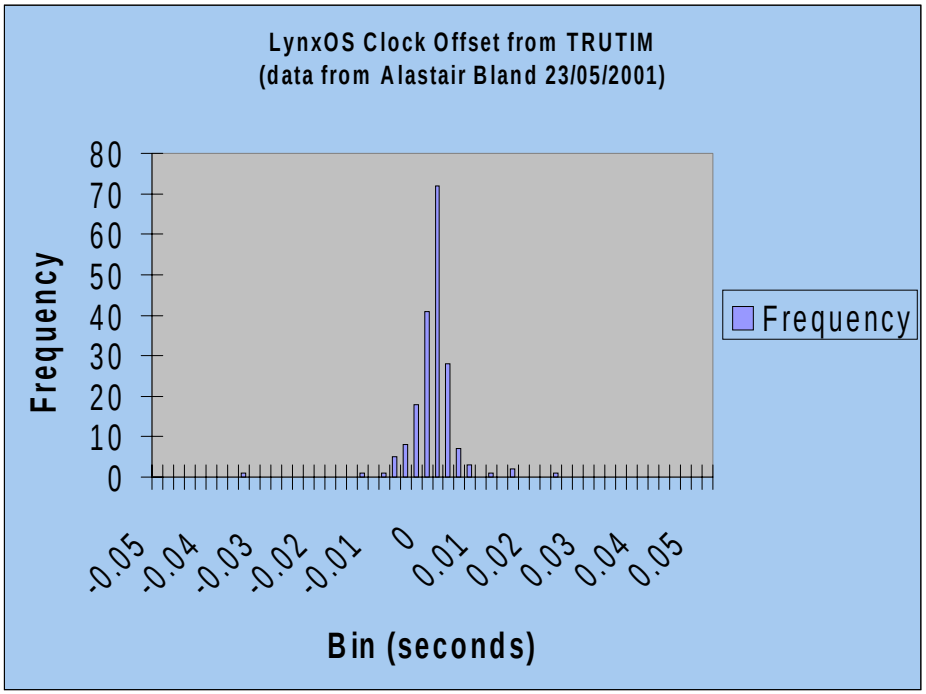


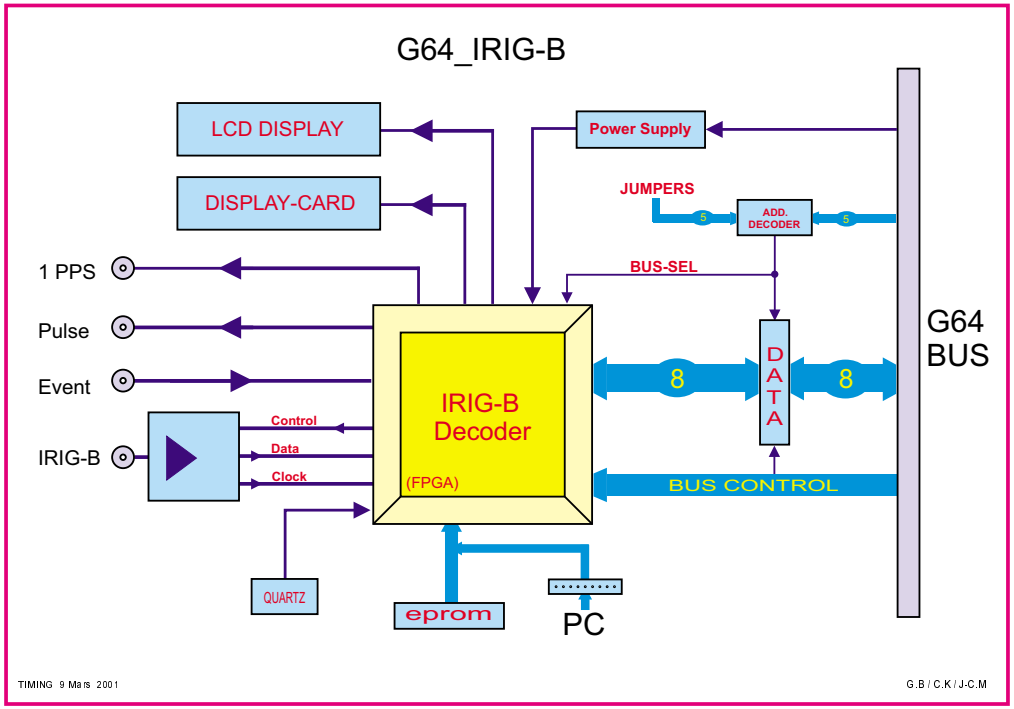
# TIMESTAMPING
## With SCHNEIDER PLC & GESPAC Module

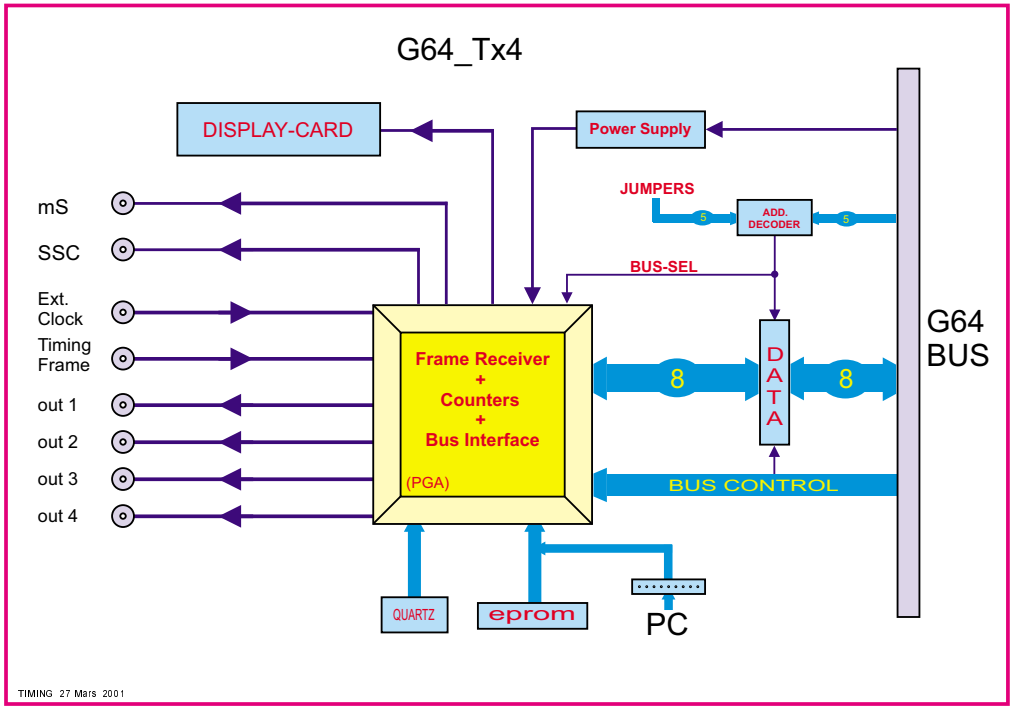



**TIMESTAMPING Test on Ethernet/NTP Network with SCHNEIDER & GESPAC Modules**





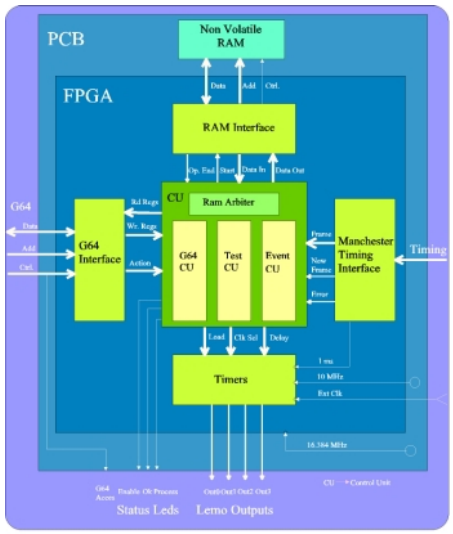


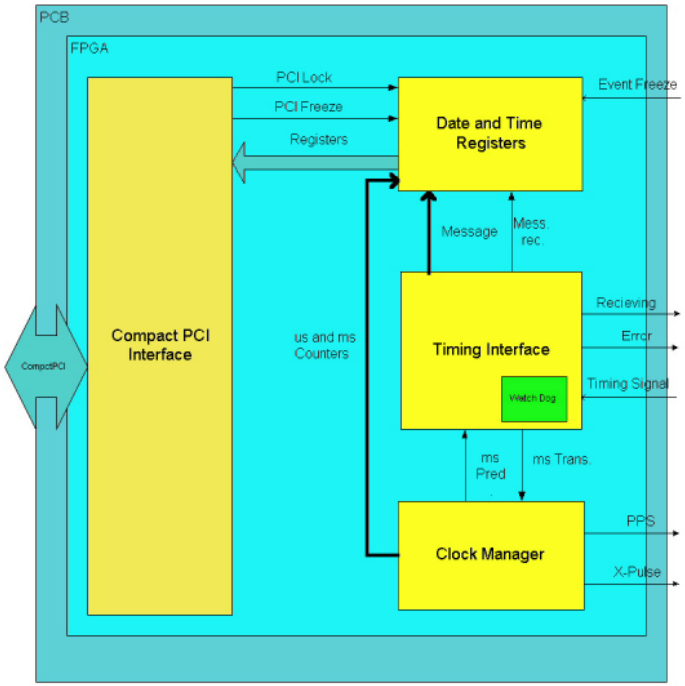




# Stand Alone TX3

Modular design:

- Control Unit.
- Timers.
- G64 interface.
- Timing interface.
- RAM interface.



# Post-Mortem System

## Where do we go from here?



# ...to the Sector Test !

In 2004 we want a PM system for the sector commissioning

"Primary" systems that will be involved :

- Machine Protection
- Powering
- Quench protection

but also :

- Vacuum (?)
- Beam instrumentation (interest increases if beam is available...)



# Data Catagories

Data/system categories :

- Machine protection system (beam & power permit controllers)
- Beam instrumentation (positions, sizes, currents, losses,..)
- Magnets & protection (power converters, quench protection, dump, kickers)
- Beam tuners (feedbacks, operators)
- Beam interception (vacuum, collimators)
- Alarms
- Services (access, cooling, cryogenics, electricity)



# Rates & depths

I suggest to define a standard buffer depth $\tau$ for the PM data :

$\tau \sim$ cover the last 20-60 seconds before dump

This depth should be the same for all systems unless there is evidence that it is "meaningless" or "impossible to realize", possible exceptions :

- Quench detection, energy extraction
- Kickers
- …

Unless a signal exhibits "very slow" changes, the sampling interval should be $\leq$ 10-20 ms close to the dump, with the possibility of becoming coarser at earlier times - depends a lot on the data category.

# Signal/Data Definition I

Machine protection system :
- The primary source of information for causes of beam/power aborts & for the *machine state.*
- All state data for ~ ± (?) τ around dump. Sampling rate ??

Beam instrumentation :
- Turn-by-turn for *N* turns before dump.
- Average data for an interval τ before dump, "some" data after dump.
- General philosophy ~ clear, the actual numbers need to be defined.

Beam Tuners :
- Record every action & copy trim archive for depth τ.
- Is this realistic for transverse dampers and other very fast systems ?



# Signal Definition II

Magnets & Protection :
- Record all data required to diagnose a possible "fault".
- The system experts should propose useful information & rate.
  <--> internal diagnostics

Beam Interception :
- Record movements with depth τ (collimators).
- PM acquisition of *transients* for vacuum valves ?

Alarms :
- Grab & copy "every" alarm for a depth ± τ around dump.

Services :
- Rely on logging (what about cryogenics ?).



# Data Formats

In the initial brain-storming meetings we suggested to use :

- ASCII format (can always be zipped)
- For each instrument (channel), sequences of :
  - Data descriptor (name, units, time, …)
  - Data bloc

*Simple, uniform & self-describing !*

- *But potentially inefficient for large amounts of IO…*
- Easy to extend to new parameters, instruments...
- (Requests for) exceptions should be carefully studied.
- Overall : the advantages >> disadvantages…



# Data Acquisition I

Local acquisition & data preparation :

- Up to each group to implement & organize.
- The PM must be integrated into the acquisition (rolling buffers…).

Data transfer philosophies :

- Every system delivers the data to some central place.
- A central *PM service* collects the data.

Who is responsible for "delivery" ?
The PM system or the equipment groups ?

# Data Acquisition II

Data filtering & reduction :

-> could be applied to large hardware systems like power converters, quench recorders, vacuum valves,... where an "OK-state" is "clearly" defined.

- But we should be able to collect EVERYTHING !
- To filter data, there are two simple strategies :
  - @ source : get only what is considered useful
    --> equipment responsibility to make a good filter !
  - purge after analysis ⟷ SAFER !

Initially we should probably avoid any filtering, but it should be consider in the design of the system.



# Data storage

Storage medium :
- Large amount of DISK space (count in units of 100 Gbytes) .
- A "tape-type" medium for long term storage with an efficient way of retrieving selected information.

Storage organization :
- (dedicated) DB.
- Flat files in some directory tree structure.
- Mixed : flat files + references/pointers in a DB.
- A DB solution should fit into the general "LHC DB strategy".
- Each PM acquisition should be considered one EVENT.

The way we store the data will also have some impacts on analysis SW (dedicated PM or adapted expert programs).



# Analysis SW

Control room/operation level:
- Diagnostics of machine state :
  what's wrong - what do we do next - who needs to be called...
- Some information on what happened :
  this will go through some learning curve ...

This SW would be dedicated to PM

Expert/Detailed analysis level :
- Re(use) expert programs for equipment and beam data analysis.
  --> PM data format must be accepted by such SW



# Related issues

The analysis of the data requires an excellent machine description to relate associated signals from various equipment.

This can be significantly simplified with a good NAMING CONVENTION for all instruments.

--> proposal under development by R. Saban & R. Schmidt

# So ...

What I propose to do next :

- First iteration of a detailed list of signals & sampling rates :
  - For beam instrumentation I can make a wish-list.
    --> followed by a review of the SL/BI boards.
  - For most equipment groups : call for proposal (if possible).
    --> wait for String II experience ?
  - Clarify some uncertain areas (dampers, vacuum valves…)

- A (more) detailed proposal for a data format + “collect” reactions !

- Expert “analysis” software : who plans to write/buy/… what ?
  <--> is this coordinated by LHC-CP ? Identify missing items.

- Think about the data transfer & storage.