

Machine Timing

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- Disclaimer
- SPS Timing
- LHC Timing

Disclaimer

- The content of this presentation reflects mostly my personal view on timing requirements for the SPS and the LHC, even if I think they are shared to a some extent by my OP colleagues.
- For the PS they are no special requirements. R. Steerenberg will make comments on 'Exploitation'.
- Some equipment groups may have needs that I do not cover. For a complete overview of timing needs, please refer to the deceased LHC Timing WG (I was never a member of that WG) or to various other sources.

I had neither the time nor the wish to hunt for a complete list of requirements.

SPS Timing - general

- In the future the SPS must be able to provide more operational beams than in the past and perform much more complex cycles.
- A high performance timing system is crucial to achieve this goal since it is orchestrating the CERN accelerator complex. **It is essential to extend the capabilities of the PS-timing system to the entire complex for future optimization** (0.9 seconds, cycle optimization...).
- Obviously the CPS complex has already achieved the SPS goals – it seems therefore ‘natural’ to apply the PS recipe to the SPS (and LHC).
- Question :
 - Is it possible to apply the PS-model in a straightforward way ?
 - Is there anything that must be adapted ?

The SPS timing big-bang

- At the SPS startup in 2004, the old SPS MTG was disconnected (RIP!) and the PS timing system took control over SPS timing distribution.
- Needless to say, on the SPS side we noticed the difference !
- The first weeks were a bit 'difficult', since the complexity of the PS-timing system application SW is >>>> higher than what we were used to.
- **Past the initial learning phase operation was rather smooth**, with occasional problems due to lack of experience and to poor communication MCR-PCR, which should vastly improve with the CCC.

SPS Timing - economy

- Since pulsing the SPS is costly, the concept of 'economy' cycle was introduced at the SPS :
 - When no beam is available or a fault condition that prevents beam operation is detected, the magnet are NOT or only PARTIALLY pulsed (magnetic history).
 - The OLD SPS MTG was able to react within a given cycle and switch to economy if no beam was sent down the line from the PS.
- In 2004 switching to economy at the SPS did not work as well as in the past, due to a variety of reasons.
- If nothing is done, the situation will become even more difficult in the future, mostly because of limitations in the communication between the SPS SW Interlock System and the MTG, and due to the presence of SPS legacy SW.

SPS Timing - economy

Actions :

- The run in 2006 will be a transition year with mixtures of new and old SW in the SPS and the limitation from the SW interlock still present – a minimal solution (in terms of manpower) should be implement. We are working on it.
- OP and CO must work out a long term solution for 2007 and beyond, when legacy SW should be dying out. Some constructive discussions have already started...
- A major ingredient of the solution is the new SPS software interlock system. Its design requires in depth discussions with the CO timing section. At the same time the issues of SPS beam inhibit in the injectors will be also be addressed.

CTIM-LTIM

- CPS and SPS have a fundamentally different way of handling timing events:
 - SPS : **organized around many CENTRAL timing events** (generated by the MTG). Control of TG8... timing modules is in hands of equipment groups.
Exception : SPS RF system.
 - PS : **very few central events, many events LOCAL** to each TG8... module, controlled by OP → OP is 'responsible' for eqp timing (at least has access to...)
- The timing team wants to import the CPS model into the SPS:
 - change may be crucial for successful & efficient multi-user OP.
 - implies an important change in how the SPS timing is operated.
→ advantages or disadvantages – depends on the viewpoint !

Actions :

- Although I am practically converted (at least have no more objections to a transition), discussions are needed inside OP and with equipment groups.

SPS as LHC injector

- The efficient sequencing of the CERN complex for LHC injection is clearly one of the critical timing issues that have to be addressed in the next years.
- The exact sequence of events required to fill the LHC is not finalized (alternate rings...), and we must maintain sufficient flexibility until we have practical experience with the LHC → **timing system flexibility is clearly fundamental.**
- At the same time, **450 GeV LHC beams are very dangerous**, and safety must also be considered → **timing system can play an important role.**

Actions :

- Discussions have started with the timing team and others on various SPS cycling options for LHC filling. The discussions must be pursued.
- For 2006 we must be ready to perform tests of some cycling options using the SPS extraction systems and actual beam !

SPS timing - details

Things that may have to be adapted for the SPS ...

- The PS-style timing system uses the concept of the **NEXT** user.
 - PS eqp use this information to prepare for the following cycle.
 - SPS eqp are not using this concept.
 - The strict use of this concept at the SPS implies that decisions on cycles are taken a long time ahead, which is a priori not necessary and constraints the flexibility.
 - I propose to adapt this concept for the SPS.
- The SPS super-cycle counter should be maintained. This simple information makes life ∞ -tely easier for people like Gianluigi, me & others when it comes to data analysis. Timestamps are 'nice' but much more complicated to handle....
- ...

LHC timing

- From the point of view of the distribution of timing events, the MTG of the LHC has very little to do – as was the case for LEP !
 - During long periods the LHC disconnects from the injector chain.
 - Only occasional events must be send out to start ramping, synchronized settings..
 - **A critical issue concerns the distribution of the post-mortem event which is important to freeze post-mortem buffers that will enable us to analyze the cause of beam dumps. It is important to realize that although the PM event is critical, it is not SAFETY critical → only used to PM diagnostics !**
- On the other hand, the timing system has an important role for the distribution of information :
 - LHC mode, energy, beam intensity,... are required by many users.
 - Accurate timestamps : logging & post-mortem.
 - Possibly Safe LHC Parameters – under discussion.

LHC timing system availability

- As far as I know, the LHC experiments will perform cosmic ray calibration runs, data acquisition tests... during machine shutdown periods. They rely (via the TTC system) on the LHC timing system for the distribution of the accurate timestamps.
- interruptions of the LHC MTG, for maintenance and other reasons, may have to be carefully scheduled !

I strongly recommend to investigate such issues !

Final remarks

- The definition of the timing systems for SPS and LHC seems to me to be on track. I personally had many lively & long, but eventually fruitful and constructive discussions with J. Lewis & J.C. Bau.
- I see the following managerial issues :
 - Who is entitled to take decisions on timing issues for SPS and LHC ?
 - For the SPS many timing issues are 'passed on' to me. In some cases I cannot take decisions without consulting many people and even then ...
→ a working group seems to me an overkill – but maybe a small group of concerned people that are entitled to take decisions ?