How and what did we do in 1999.

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Abstract

For the first time over the last years, some of the requests of machine development (MD) time in the SPS could not be satisfied because of the insufficient number of hours dedicated to machine studies. A survey of the subjects and of the use of the allocated time is presented. The problems encountered in programming and running machine developments sessions will be also discussed.

1 STUDIES IN 1999

We had 4 different kinds of MD sessions:

- **Long MD** of 24 hrs. instead of 48 in 98 in order not to have too long period without being able to fill LEP.
- **Wednesday MD** of 8 hrs. long.
- **Parallel MD** on Monday, Wednesday and Friday from 8:00 to 18:00.
- **No Beam MD** during the CPS MD time.

The subjects can be classified into 5 categories, shown in table 1.

Table 1: Major MD subjects in 1999

SPS as LHC Injector	Acceleration & Synchronisation., Feedback & Feed-forward, Multi-bunch instability, Damper, Injection matching, Emittance blow-up, Intra-beam Scattering, Impedance meas, Transverse instability
SPS as LHC 'Testbed'	Electron cloud build-up in LHC & SPS, Resonance studies, Ions 'desorption', Q-loop commissioning.
High Intensity (CNGS)	2 µsec. batch acceleration & stability, Barrier bucket test, µ-wave instabilities, Fast extracted beam trajectory stability.
Operation	Injection line optics measurements, Physical aperture measurements.
Other Subjects	SPS as a multi-cycling machine, Energy loss of protons.

The distribution of these subjects into the different types of sessions was made on request, but also in taking account of technical and human constraints as beam characteristics, number of participants, need of access, …

2 HOW DID WE SPEND THE TIME IN 1999

First of all, 220 hrs., only 6% have been devoted to the dedicated MD (Long + Wednesday), versus 3415 hrs. performed on Physics. Fortunately, we could work in parallel on the MD segment at injection energy without affecting Physics. If we add the 700 hrs. of this segment plus the 70 hrs. of the No Beam MD, to the above 220 hrs., we notice that we spent an amount of 990 hrs. for these MD studies.

The operation team performed about 130 hrs. (12%) to set-up the particular MD beams.

Table 2 shows the breakdown of MD time in the SPS by category.

Table 2: Distribution of MD time by category

	Requested	**Scheduled**	**Performed**
Long	172 h	156 h	148 h
Weds.	154 h	64 h	73 h
Parallel	570 h	560 h	700 h
No Beam	50 h	80 h	70 h

- 8 hrs. of Long MD have been lost in the benefit of the FT Physics and to allow the filling of LEP.
- About 150 extra hours could be performed due to the availability of the beam from CPS, during the Wednesday and Parallel MD.
- The requested and performed time was variable throughout the year, due to the encountered problems and emerging ideas.
- We could observe many transfers from Long & Wednesday MD to Parallel MD. The latter was very important and useful due to its flexibility and free time possibility. But sometimes, the beam conditions were inadequate.

Table 3 shows the breakdown of MD time by subject.

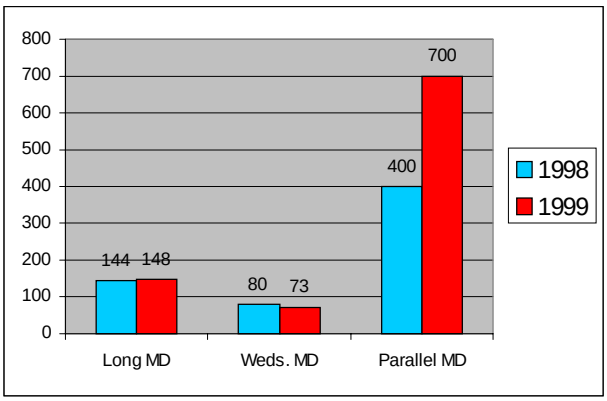
Table 3: Distribution of MD time by subject

	Requested	**Performed**
SPS as LHC Injector	480 h	580 h
SPS as LHC Testbed	90 h	120 h
SPS High Intensity	170 h	130 h
Operation	150 h	140 h
Other Subjects	50 h	20 h
total	**940 h**	**990 h**

As can be seen from Table 3, most of the MD time was dedicated to the preparation of the SPS as LHC Injector. Some unexpected problems like the beam induced electron cloud formation and its impact on the behaviour of some equipment as the Damper, demanded long investigations in order to evaluate the required hardware upgrades. For that reason, some studies could not be performed (*longitudinal feedback, energy loss of protons, resonance studies, fast extracted beam trajectory, main magnet remanent field effects*).

Figure 1 shows that the last performance is about the same as the previous year, except for the time spent during parallel MD sessions, witch has been increased by 75%.

Figure 1: Performance (hrs.) comparison 98–99



3 THE PERFORMANCES OF THE OPERATION TEAMS

- 7 different kinds of beam that we used, were prepared by the **CPS** with specific parameters as *momentum, batch length , bunch number, bunch spacing, bunch length, longitudinal & transverse emittance, delta p/p, intensity [1].*
- Table 4 presents 7 different super-cycles built for **SPS** in order to accelerate the LHC beam or to allow the FT Physics (protons or ions) and the fill of LEP, in parallel with the MD segment at different energies.

Table 4: SPS operation's performance

	Proton 1	**Lead**	**Lepton**	**Proton 2**
SC 360	-	Phys.13	Phys.22	MD 26
SC 361	-	Phys.13	Phys.22	MD 26
SC 529	MDlhc 26-1inj	-	Phys.22	-
SC 536	MDlhc 26-3inj	-	-	-
SC 917	Phys.14	-	Phys.22	MD 14
SC 924	Phys.14	-	Phys.22	MD 14
SC 928	Phys.14	-	Phys.22	MD 26

4 SOME PROBLEMS WE ENCOUNTERED

- A dedicated MD session is always seen as perturbing. It breaks the routine, we have in Physics mode. The temptation is great to use that time for an access or to compensate a machine stop due to a hardware problem or a critical period.
- Providing leptons during long sessions is quite inefficient for MD. The couplings required for the RF supra-conducting cavities for leptons acceleration and for high intensity LHC beam MD are quite different and 2 hrs. were required to switch from one mode to the other and back.
- We had to fight against hardware limitations as *Beam Dump, Damper, 200Mhz RF cavities, Bct's, …*
- There were also software lacuna *like 'manual' super cycles changes, no individual or general saving system of parameters and a lack of diagnostics [2].*
- The publication of reports did not cover all the studies.
- The reduction of Long MD duration from 48 to 24 hrs. induced more setting-ups, less Wednesday sessions and a greater difficulty to distribute the subjects. On the other hand, it allowed more flexibility for program changes and there was less likelihood to fall in a period of 'a big hardware problem on the machine'.

5 CONCLUSIONS

5.1 What could be efficient for Machine Development?

- We should give priority to MD during MD sessions!
- We must have a total remote control in PCR.
- We could develop a saving system for all the different super-cycles.
- We should encourage descriptions of the performed studies, of their results and of the encountered problems.

5.2 It is useful to recall that, not with standing the large amount of time (990 hrs.) spent for MD, some of the subjects had to be studied on the parallel segment under conditions witch did not match the requests and above all, many demands were unsatisfied!

5.3 We could hope that all the actors *(operators, called specialists, physicists, management, participants*) would achieve a greater awareness of the importance of the Machine Development.

6 REFERENCES

[1] D.Manglunki, "The CPS status and prospects for next year", these proceedings.
[2] D.Jacquet, "Multi-cycling, what is still going wrong today?", these proceedings.