

THE MACHINE INSTALLATION AT SOLEIL

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Abstract

SOLEIL is a third generation Synchrotron radiation Source, under construction in France near Paris. The 357 m circumference storage ring is mainly composed of (32 +1) dipoles, 160 quadrupoles, 120 sextupoles, 2 RF cryomodules, ~ 200 vacuum chambers, 6 injection equipment, 12 beamline front-ends and 4 insertion devices (initially). The 157 m circumference Booster comprises 36 dipoles, 44 quadrupoles, 28 sextupoles, 1 RF cavity and 8 injection/extraction equipment. Before the beginning of the Process installation, a general planning was established detailing the various stages of the equipment installation and their assembly protocols before their on-site installation. In reality, many unknown factors, delays on the buildings, delays on the equipment deliveries, technical problems encountered during the construction, have constrained us to significantly and frequently amend and adapt this initial planning. Due to the various delays, it was also necessary to manage the cohabitation with the various building trades. However, the work made on the initial planning paid off as without its detailed protocols, we could not have carried out the Process installation within correct deadline.

ORGANIZATION OF THE WORK

Planning

The initial planning was to install simultaneously pairs of cells in order to answer the constraints of the roof beams handling. The handling time to open and close a pair of cells being of 40h; this duration partly conditioned the rhythm of the arcs and front-ends installation. The planning envisaged the straight sections once the totality of the arcs and front-ends were settled and connected (29 days). To optimize the intervention times, the baking of the arcs, TDL and the straight-sections of the same pair of cells was envisaged at the same time (40 days). Final alignment was to be carried out in the last (39 days).

Before the installation in the tunnel, the assembly of the magnets (quadrupoles and sextupoles) and their vacuum chambers should have been settled on the girders in the pre assembly area. It took 2 days in average to assemble a girder and 56 days in total with 2 teams (2 mechanics, 2 vacuum technicians, 1 store keeper and 1 crane operator).

Then, the installation of a pair of cells (without the straight section) was planned as follows:

- 1st week: installation of the Arcs and the BL Front ends, roof beams opened (girders, dipoles, pre alignment, dipole VC, equipment and Front end transportation)

- 2nd week: installation of the Arcs and the BL Front ends, roof beams closed (vacuum equipment, Front End setting, Vacuum tests, Alignment)
- 3rd week : fluids connection
- 4th week : magnet cabling
- 5th week: equipment cabling.

Team

To carry these operations through a successful conclusion, a team dedicated to installation was set up, including 3 people of the Operation group (the group leader, his assistant and 1 operator), as well as 1 mechanic and the person responsible for Planning/Project methods. Throughout the installation, this team relied on technical skills of the various SOLEIL groups, the first of which being the Mechanical, Vacuum, Alignment, and Building groups (especially the crane operators).

Meetings were also systematically organised to follow the installation: an “evening review” was daily made to account for the operations advance; the coordination between all the building trades was made during the meeting “Interfaces Machine Installation” on each Monday. The installation constraints were discussed with the project leader and the persons in charge for programmes, in particular for the experimental program on each Friday.

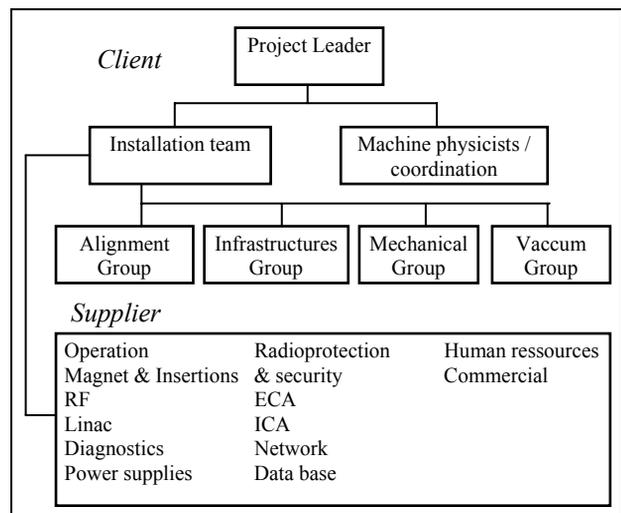


Figure 1: Installation Team Organization.

CONSTRAINTS ON THE INSTALLATION PROCESS

The real task sequencing was different than scheduled because of a certain number of constraints.

The 8 month delay of the beneficial occupancy (July 4th and 8th) obliged the teams to organize differently the work in the assembly area.

Many factors explain that the planning had to be altered regularly:

- the delay in the equipment deliveries (quadrupoles vacuum chambers, BPM's, baking films)
- the defects in quad. Vacuum chambers (leaks, NEG peeling)
- the required mechanical corrections (supports, flatness defect of the slab)
- the difficulties to store the roof beams
- the access limitation linked to the Booster beam tests
- the sharing of the cranes with the Experiment and Building programs
- the interaction with the installation of the 1st beamline hutches.

The result of that was an overlapping of many activities: installation of the girders, civil engineering operations on the heads of the tunnel walls (resurfacing and painting), cabling, and fluids connecting. And the duration of each phase appeared to be longer than expected, for example, 2 weeks instead of 1 to assemble one cell and 13 days instead of 9 to install a pair of cells in the tunnel.

ALIGNMENT

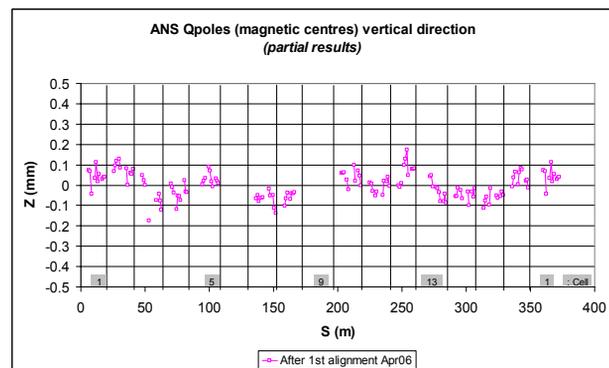
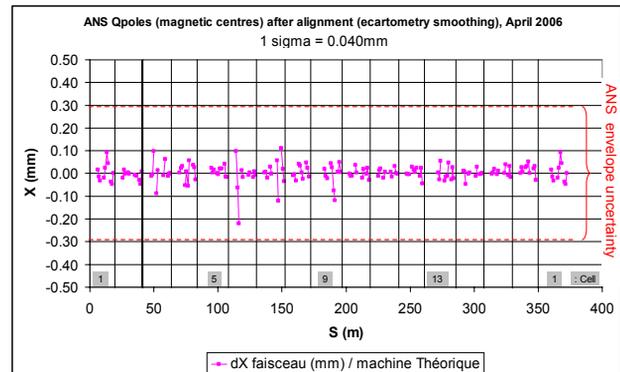
The preliminary work on the detailed tasks and protocols definition, especially for the alignment, allowed carrying out successfully the installation planning.

The 160 Quadrupoles, the 120 Sextupoles and the straight section components were all aligned during the SR phase mounting. A relative accuracy closed to the 50 μ m required by the Machine Physics has been achieved for the Quadrupoles magnetic centres (MC) that define the machine reference axis of the SR.

All the magnets were aligned on girders with a mixed mechanic/magnetic method. The checking measurements including a "magnet comparator" specially designed at SOLEIL and the Micro-Control STR500 sensor enabled to reach standard deviations of the Quadrupoles MC alignment equal to 15 μ m in X and 11 μ m in Z. They show the excellent work of both, girder machining and magnetic measurements directed by other SOLEIL teams (Engineering and Magnetic and Insertion Devices groups).

The 56 girders supporting the SR magnets were finally positioned to define the machine reference axis in X direction, by means of a TDA5005 theodolite for the

envelope and a wire ecartometer for the local smoothing. The achieved results are excellent with 0.040mm rms in smoothing and 0.30mm rms for the SR diameter. The Z profile presents a rms within 0.10mm, as measured with a N3 optical level. The Hydrostatic Levelling System (HLS) set up on the SR girders is not yet fully operational but will allow the improvement of that value in the next few months.



Such results could not be achieved in so short a delay regarding the size of the Alignment/Metrology (AMG) Group (5+1 persons) without the help of the SOLEIL mechanical team who has pre-aligned the whole SR equipment in the mm accuracy, thus favouring the fine alignment of the girders by the AMG. In the future, we intend to achieve a full realignment of the SR in the frame of the maintenance within 2 weeks for a 2-men team.

INSTALLATION ASSESSMENT

Several steps had been defined in order to elaborate the planning and set up the installation: definition of an exhaustive list for the available equipment, of a flow-process grid and associated protocols for the girders, settling of the installation tasks sequencing.

Intrinsically, the duration of each task was respected.

Because of the contingencies, many activities overlapped and the resources had to adapt to all the constraints in order to reach the deadlines.

Despite the delay with respect to the initial planning, the whole preparation revealed to be crucial to achieve successfully the installation.

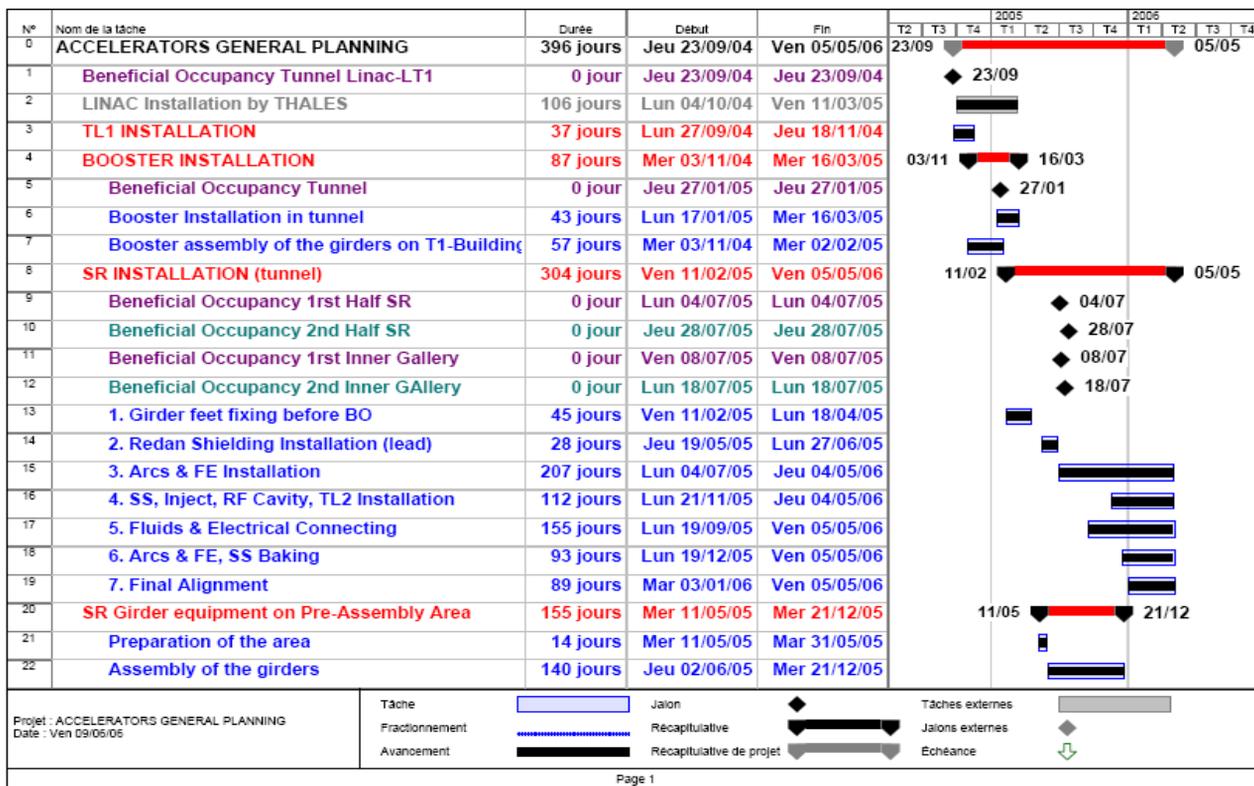


Figure 2: Accelerators Main Planning.

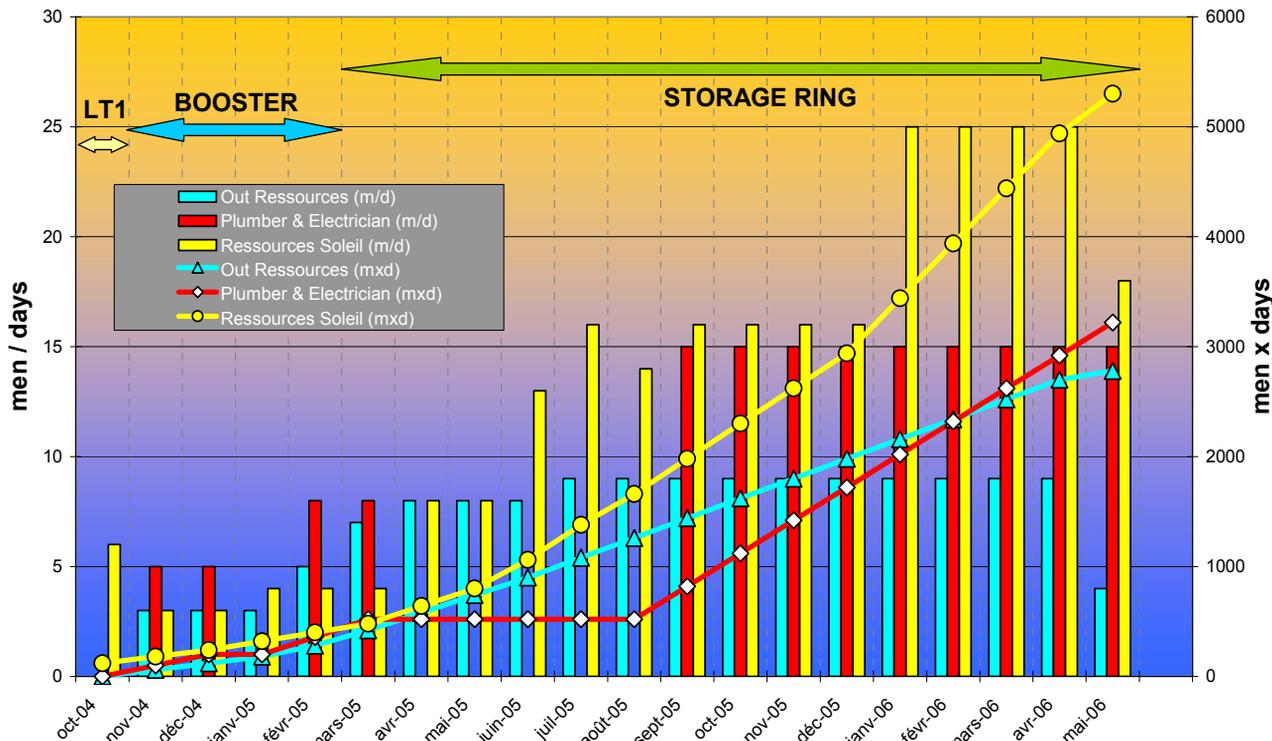


Figure 3: Total Manpower Installation.