**Overview**

Two injectors (protons, positrons, and deuterons), a 5m-long RFQ, a medium energy beam line, a 30m-long LINAC (26 superconducting accelerating cavities) and high energy beam lines supplying two experimental halls.

**SPIRAL2**

Superconducting linear accelerator and experimental areas

The main geometric constraint for SPIRAL2 beam axes position was that they had to be linked with GANIL historical beam lines coordinates system. Another main constraint was that due to seismic risk area, SPIRAL2 consists of 5 different civil engineering blocks (with 10m expansion gap) and no shafts authorised from the ground floor.

A surface geodetic network was built in 2011. Then, the primary axis was set out from surface network pillars on the site (10 reference points), on 50m long, at 10m underground.

The underground network was thus constructed along this primary axis.

**TOPOMETRIC NETWORK**

The superconducting linear accelerator of SPIRAL 2 is composed of two types of QSR cavities (low beta 0.07 and high beta 0.12) operating at 88.05 MHz, with intermediate warm sections, housing quadrupole doublets and diagnostics.

There are 12 low beta type cryomodules (housing 1 cavity each), 7 high beta type (housing 2 cavities each) and 20 warm modules, that is 28 modules. Cryomodules have been built and assembled in two different laboratories, away from France-GANIL.

**LINAC ALIGNMENT**

The maximum tolerated static errors for the global alignment are:

- Cables: ±0.0 mm
- Magnets: ±0.0 mm
- Rotation [X, Y, Z]: ±0.3 deg
- Translation (X, Y, Z): ±0.02 mm

**Alignment requirement**

- Beam axis are transferred outside the cavities on target bolting.
- Modules (cryo and warm) are assembled on their support and aligned (optically) on benches in their respective laboratory. These benches are true copies of the future LINAC frame.
- LINAC mechanical frame consists in two aligned halve guide and support.
- Modules are finally installed on the LINAC frame with no need of adjustment (only in distance along the beam line).
- For high beta cryomodules, the wire targets of the cavities are visible and measurable from outside. The position of the cavities may even be adjusted.

**Alignment problems encountered**

- Geometric stability of the alignment benches along time.
- Consequences: misalignment of cavities not rigid enough thus assembly and adjustment repeated operations had deformation effects.
- Consequences: at their delivery at GANIL, all the cryomodules have been re-measured on a real line copy of the LINAC frame.

The initial principle (5 years ago) was based only on optical measurements (micro alignment telescope). In the meantime, 3D portable CMM with high precision arrived at GANIL: laser tracker and portable arm.

With the problem encountered above, the need of 3D full measurement of the LINAC modules was really felt. A whole 3D measurement of LINAC modules on site has also been undertaken.

- But, mixing optical and 3D measurements from different benches and on site is being an intricate job.