Status report on survey and alignment activities at

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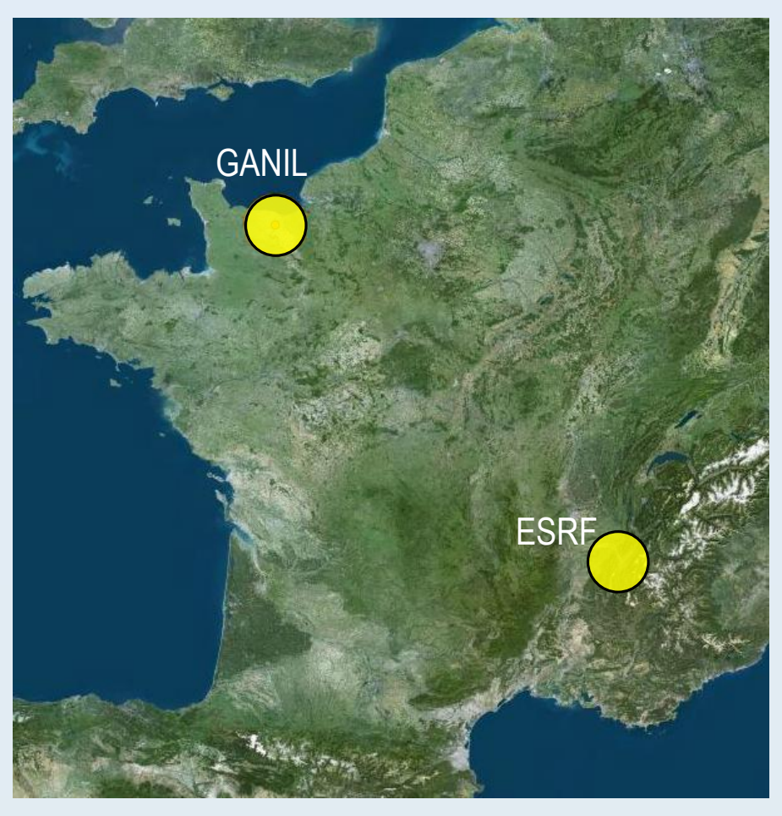
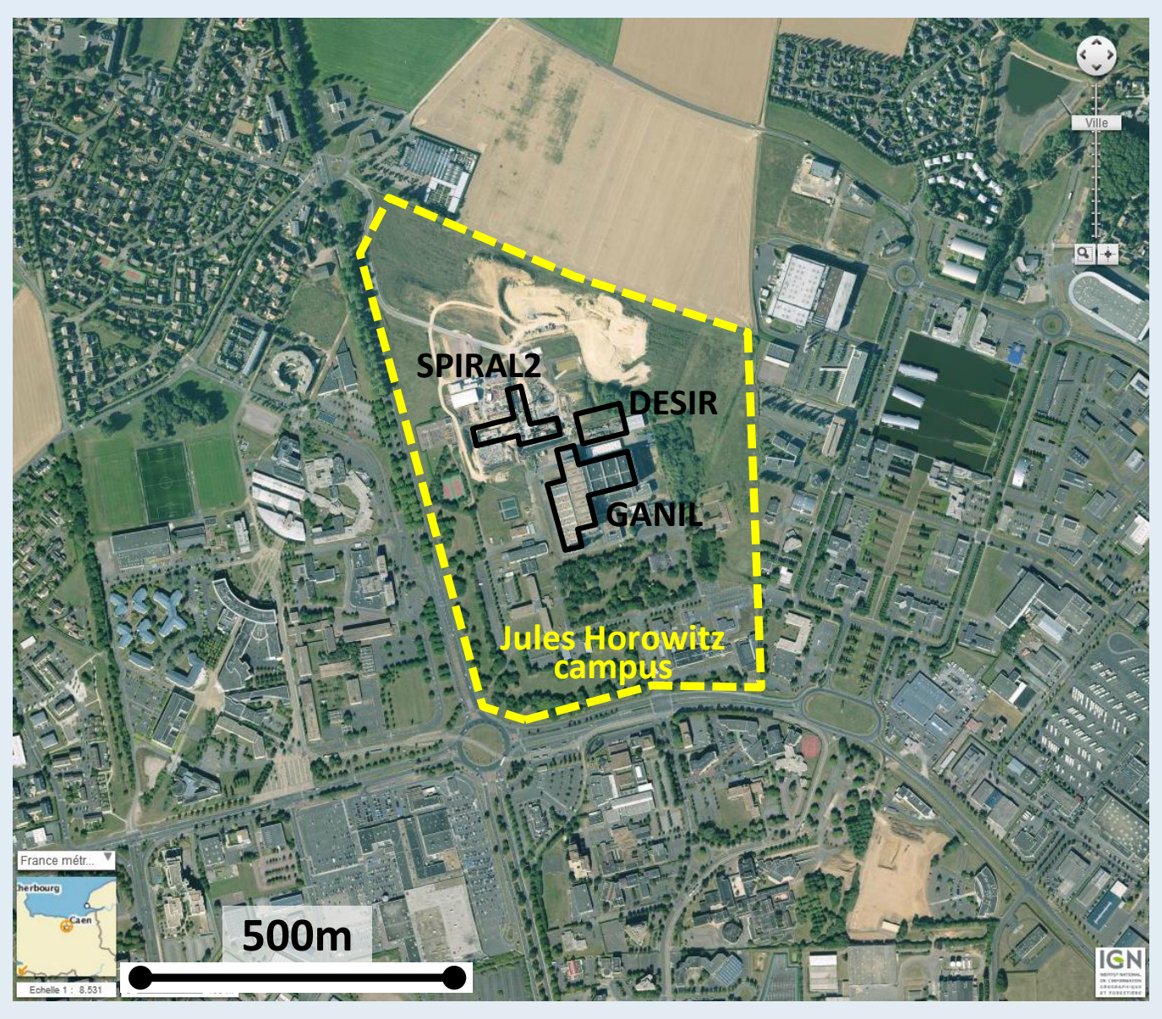
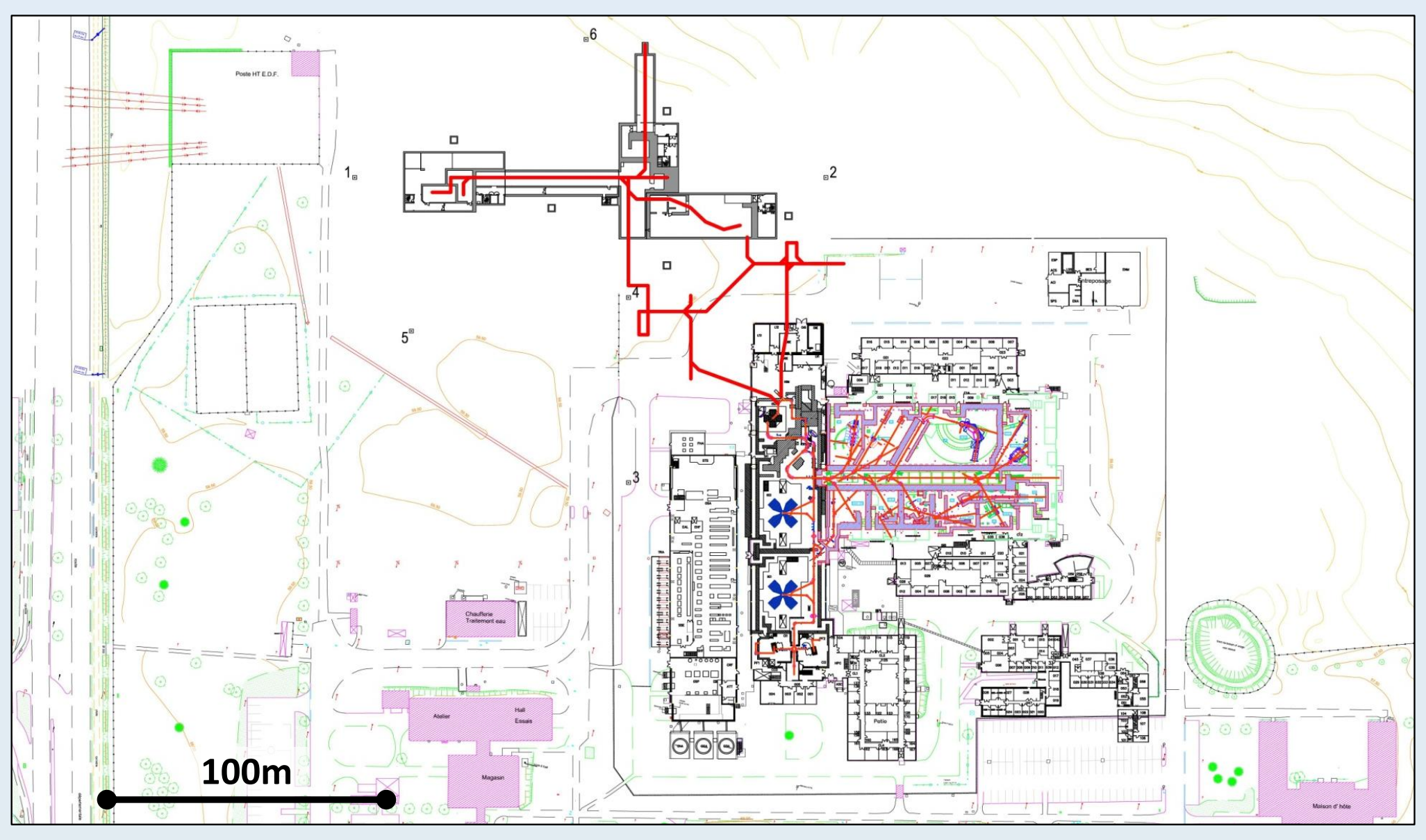
Thanks to all members of GANIL and other laboratories involved in these projects.

laboratoire commun CEA/DRF CNRS/IN2P3

Overview







AGATA@GANIL
(2014-2018)

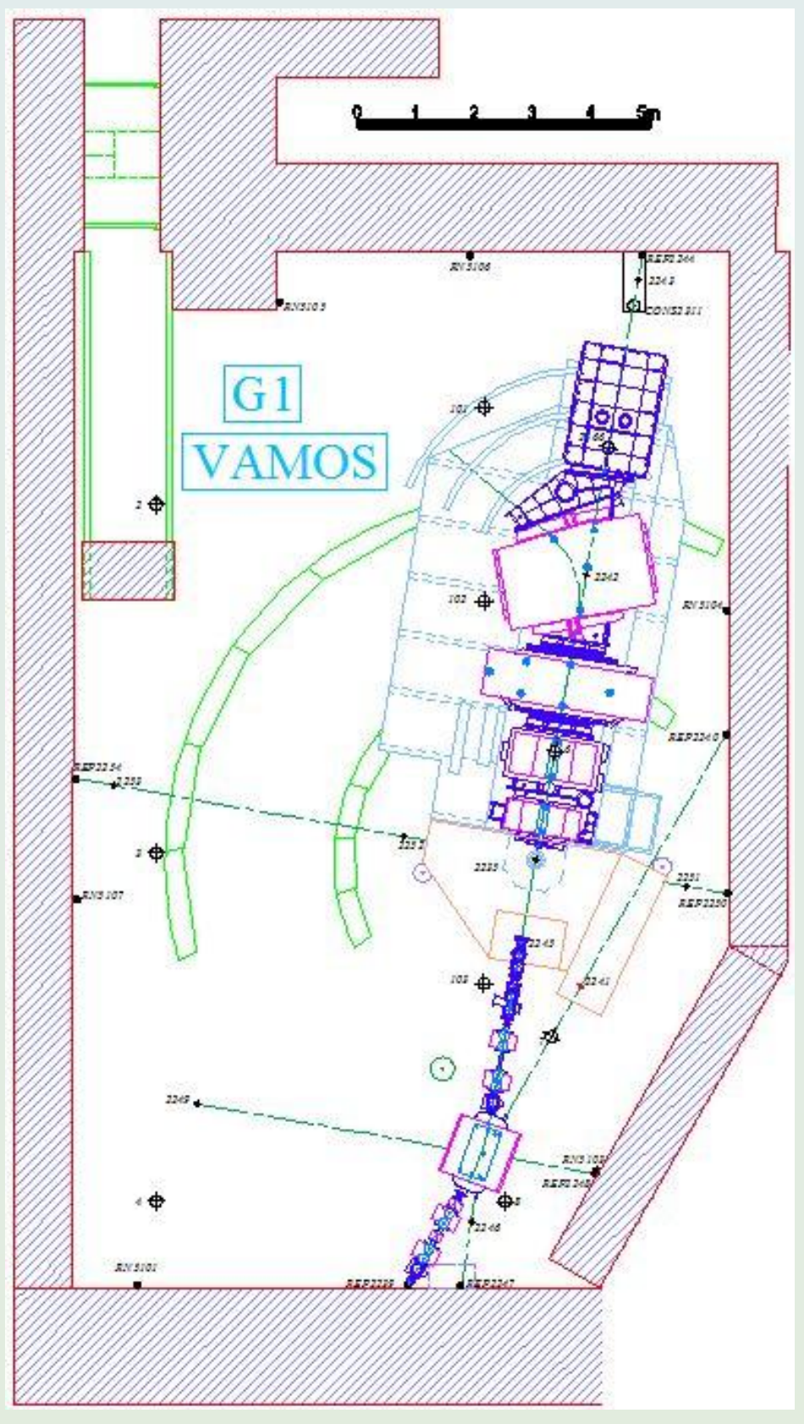
*Advanced **GA**mma **T**racking **A**rray*
π gamma-ray detector (¼ of a sphere)

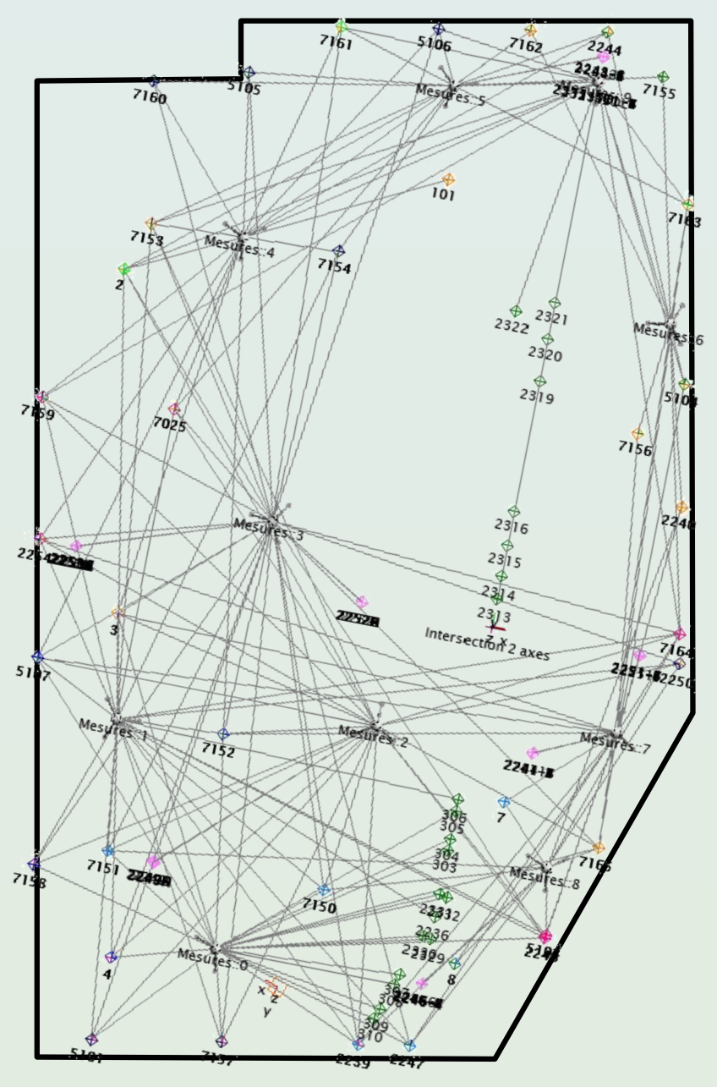
Environment adaptation

G1, the cave chosen to host AGATA campaign depends on the historical part of GANIL facility (30 years old). Reference network consisted in adjustable engraved cross marks materializing theoretical beam axis, a few network points and some wall bench marks. XY points were not known in Z and Z points were not known in XY. That was a kind of 2D+Z network.

So we had to create a 3D network based on the original one.

Additionally, we measured the existing platform that would receive AGATA in order to adapt interfaces.






Measuring engraved cross mark

Offline alignment operations

- ✓Honeycomb convergence control after receipt at Ganil ①
- ✓Adjustment of the ring in the frame ②
- ✓Adjustment of the honeycomb on the ring ③
- ✓Fiducialisation of the whole detector (fiducials on the frame, the ring and the honeycomb)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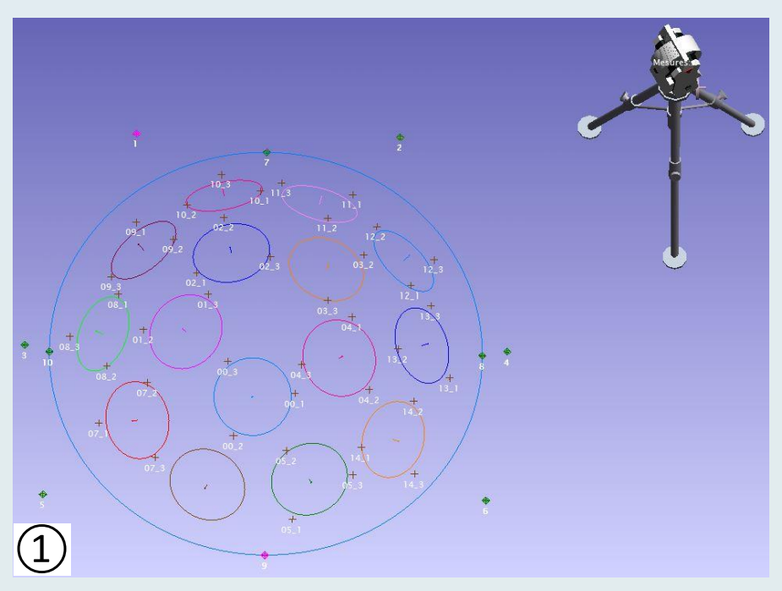
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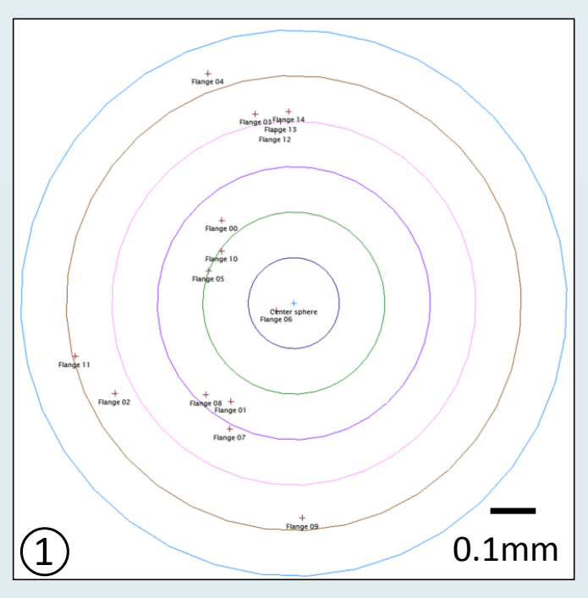
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Result of the 15 normals to flanges intersecting a specific plane positioned at the center of the sphere (honeycomb radius is 900 mm).


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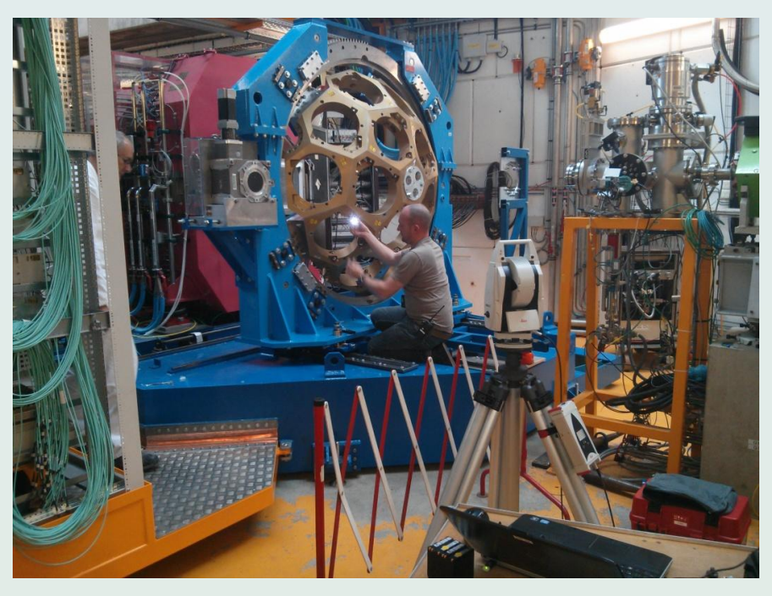
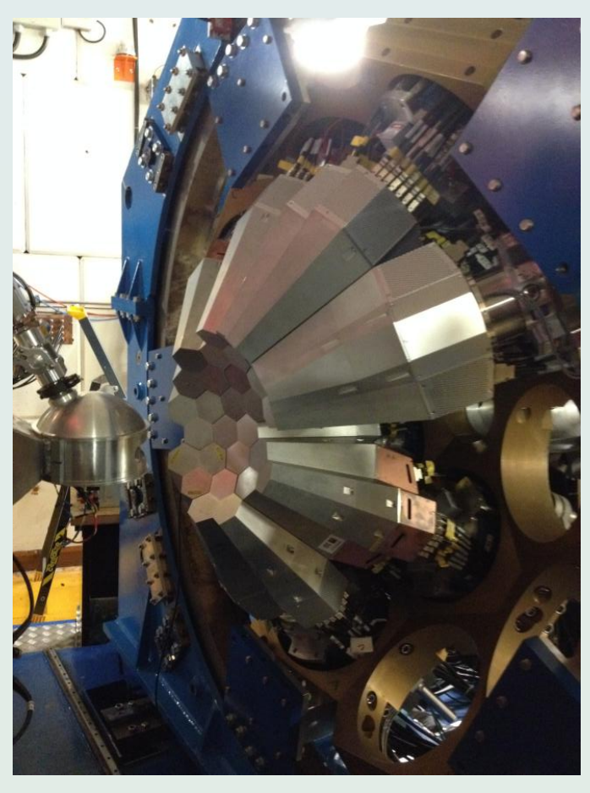
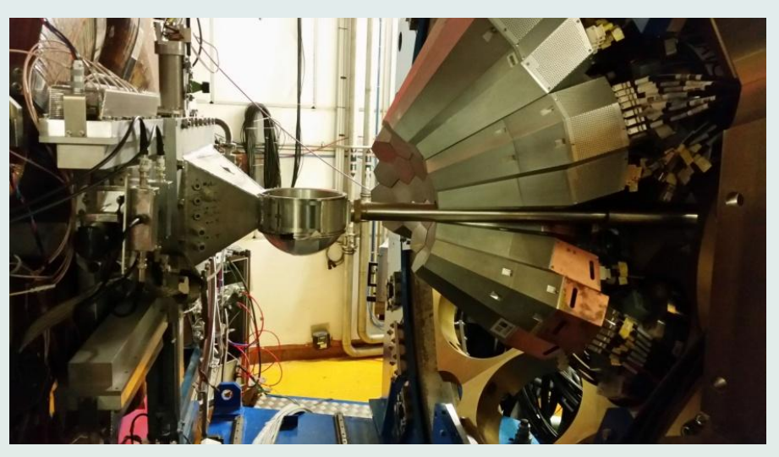
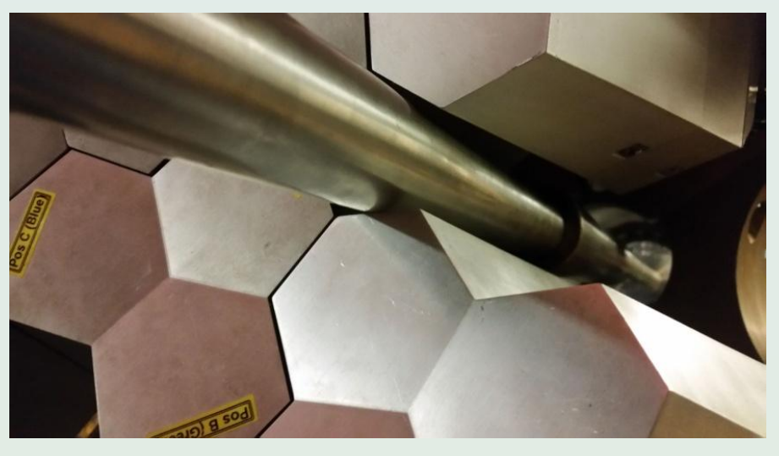
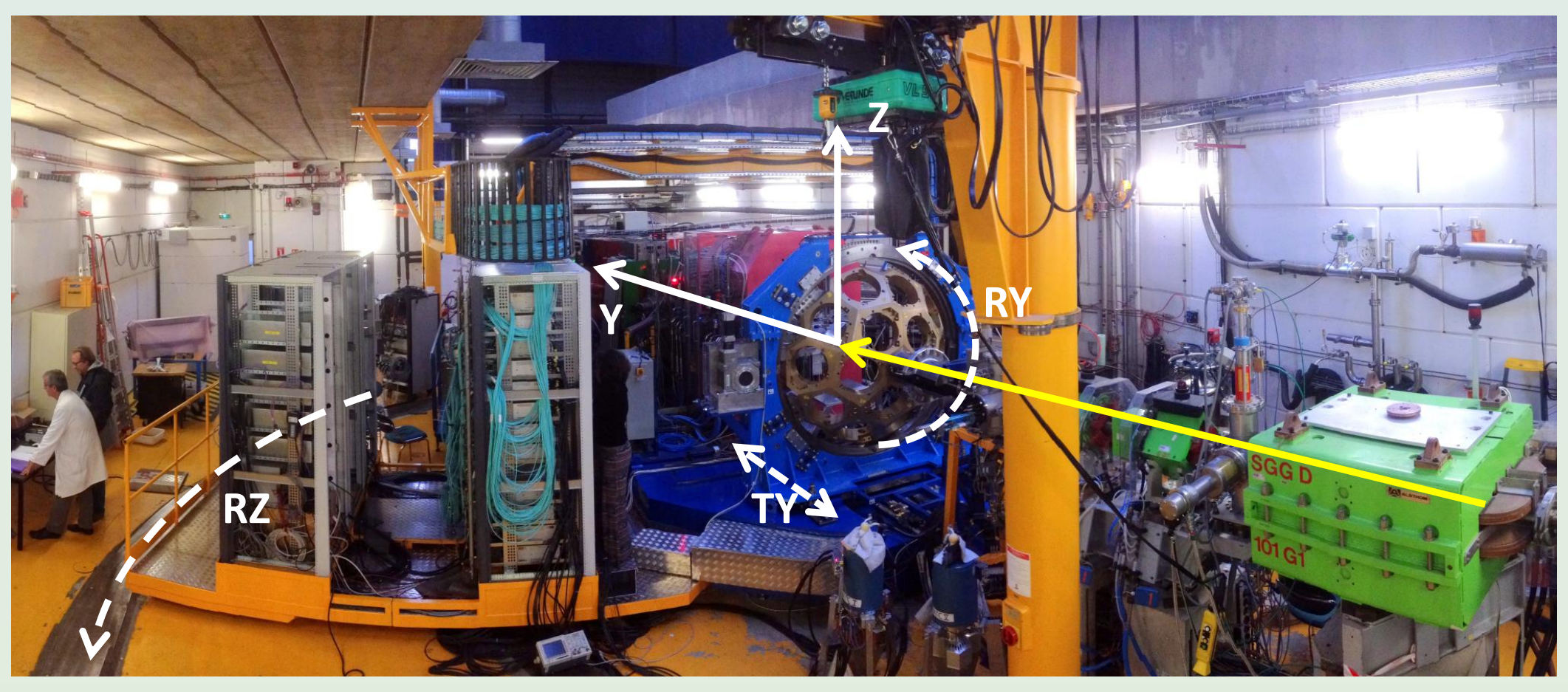
Alignment on the beam axis, at the beam target point











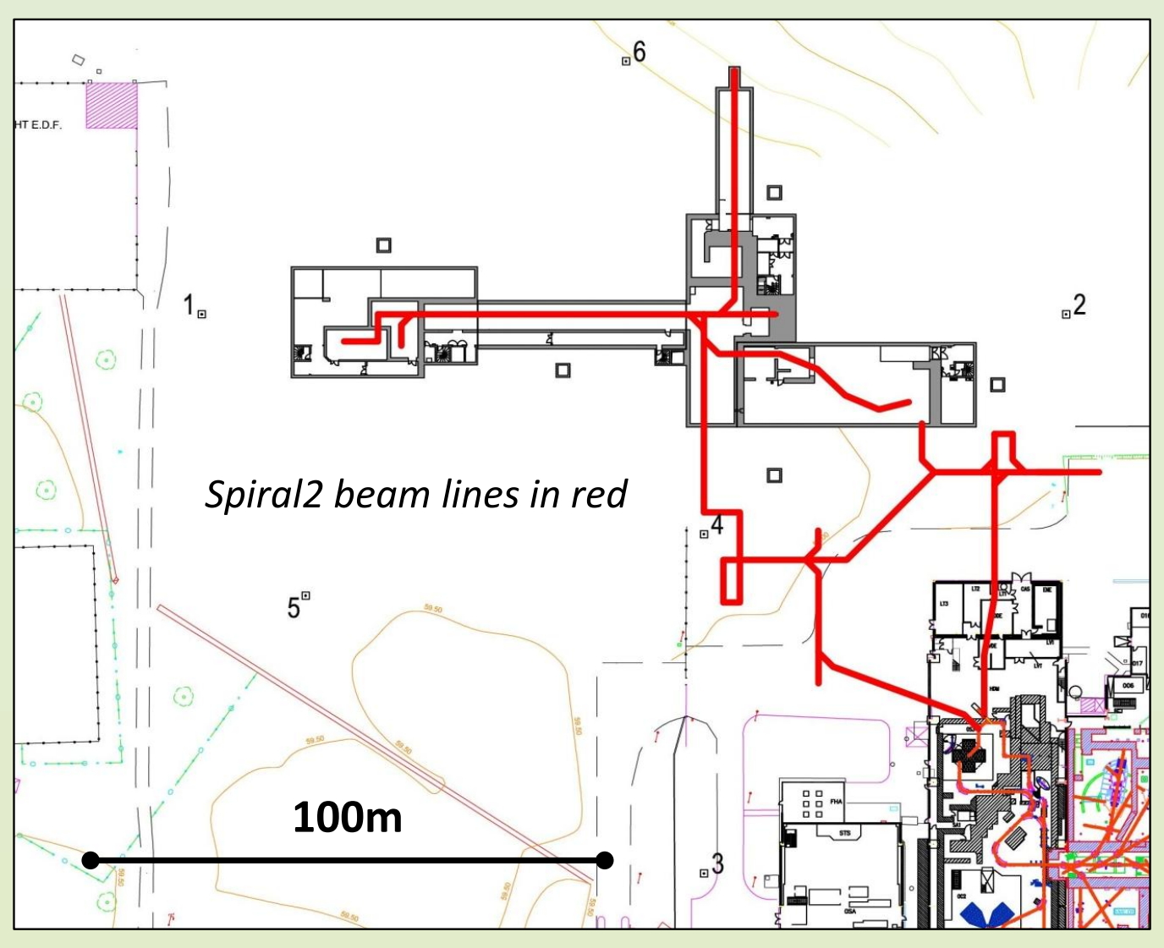
AGATA experiments campaign

AGATA is actually coupled with VAMOS (an 8m long and 80 tons spectrometer) which can rotate until 45° (RZ).
The blue frame can translate (TY). And the honeycomb can rotate (RY).
Thus AGATA has 3 degrees of freedom that have to be determined for each experiment in order to calculate Rho/Theta/Phi of each cluster seen from the target point (rotation center of the spectrometer).

SPIRAL2 *Superconducting linear accelerator and experimental areas*

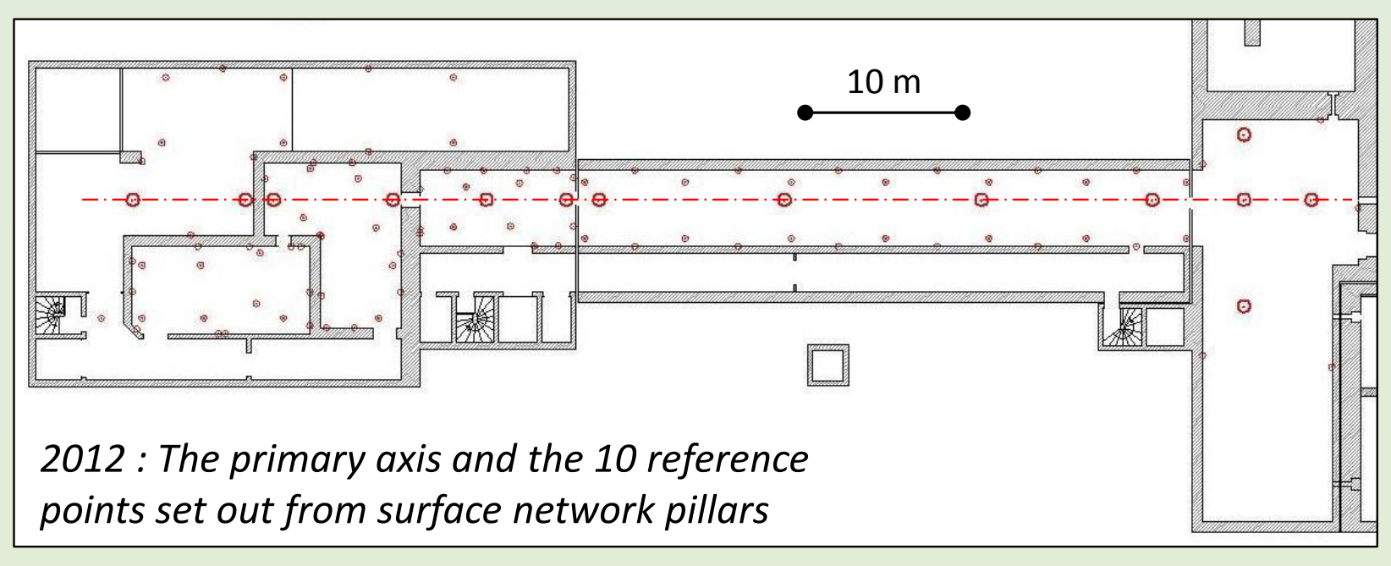
Two injectors (producing ions, protons and deutons), a 5m long RFQ, a medium energy beam line, a 30m long LINAC (26 supraconducting accelerating cavities) and high energy beam lines supplying two experimental halls

TOPOMETRIC NETWORK

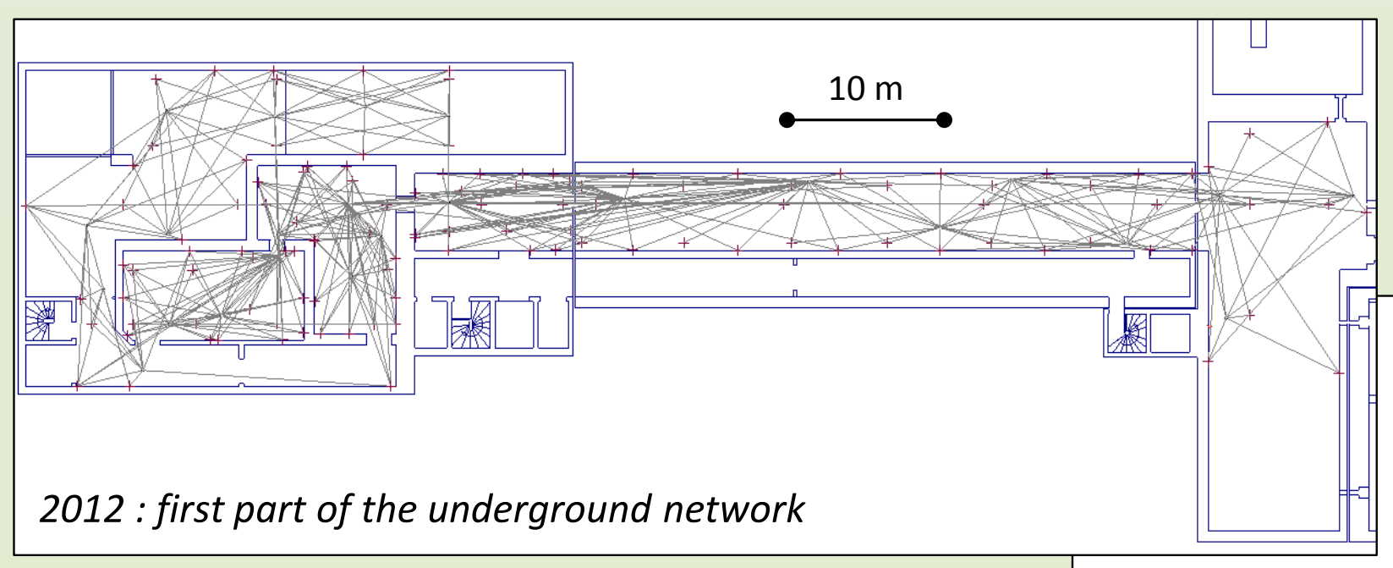


The main geometric constraint for Spiral2 beam axis position was that they had to be linked with GANIL historical beam lines coordinates system.
Another main constraint was that due to seismic risk area, SPIRAL2 consists of 5 different civil engineering blocks (with 10 cm expansion gap) and no shafts authorized 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 slabs (10 reference points , on 90m long, at 10m underground).
The underground network was thus constructed along this primary axis.



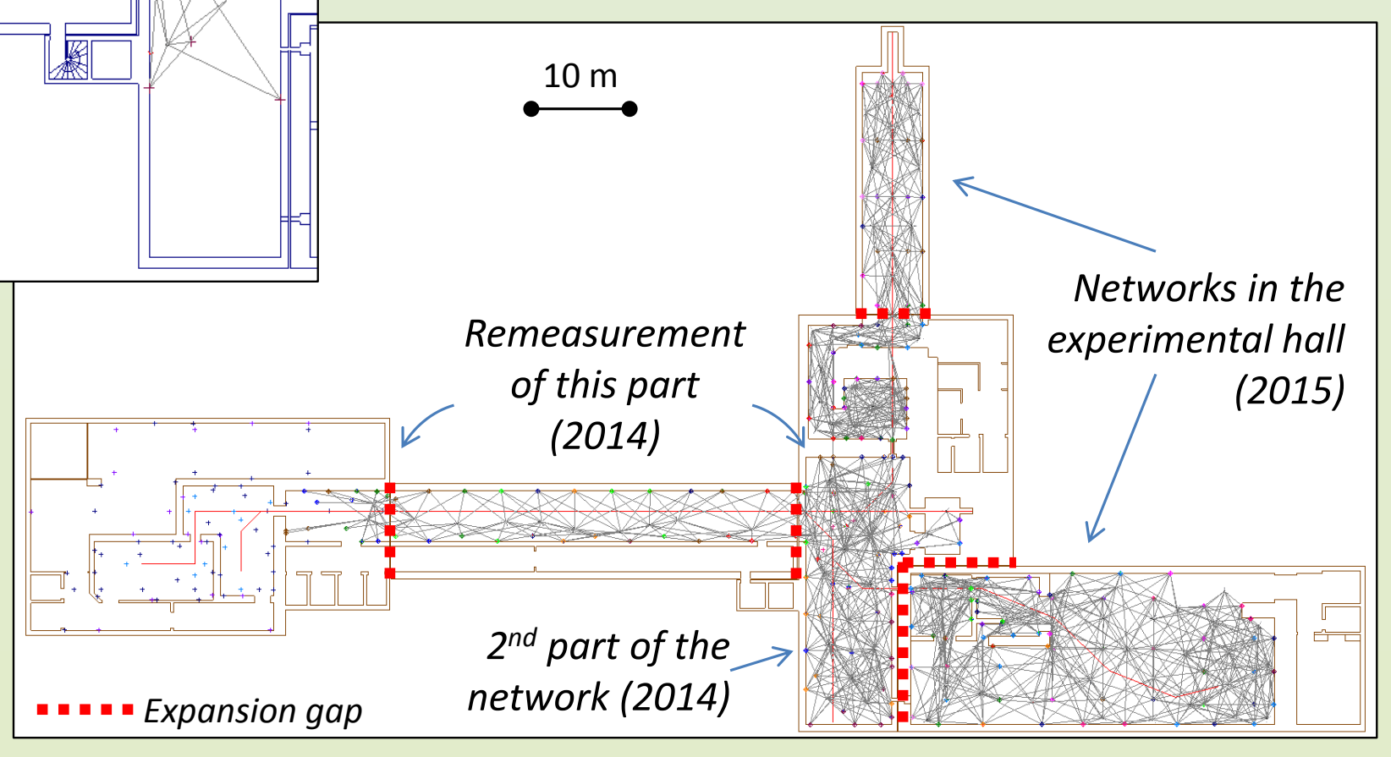
2012 : The primary axis and the 10 reference points set out from surface network pillars

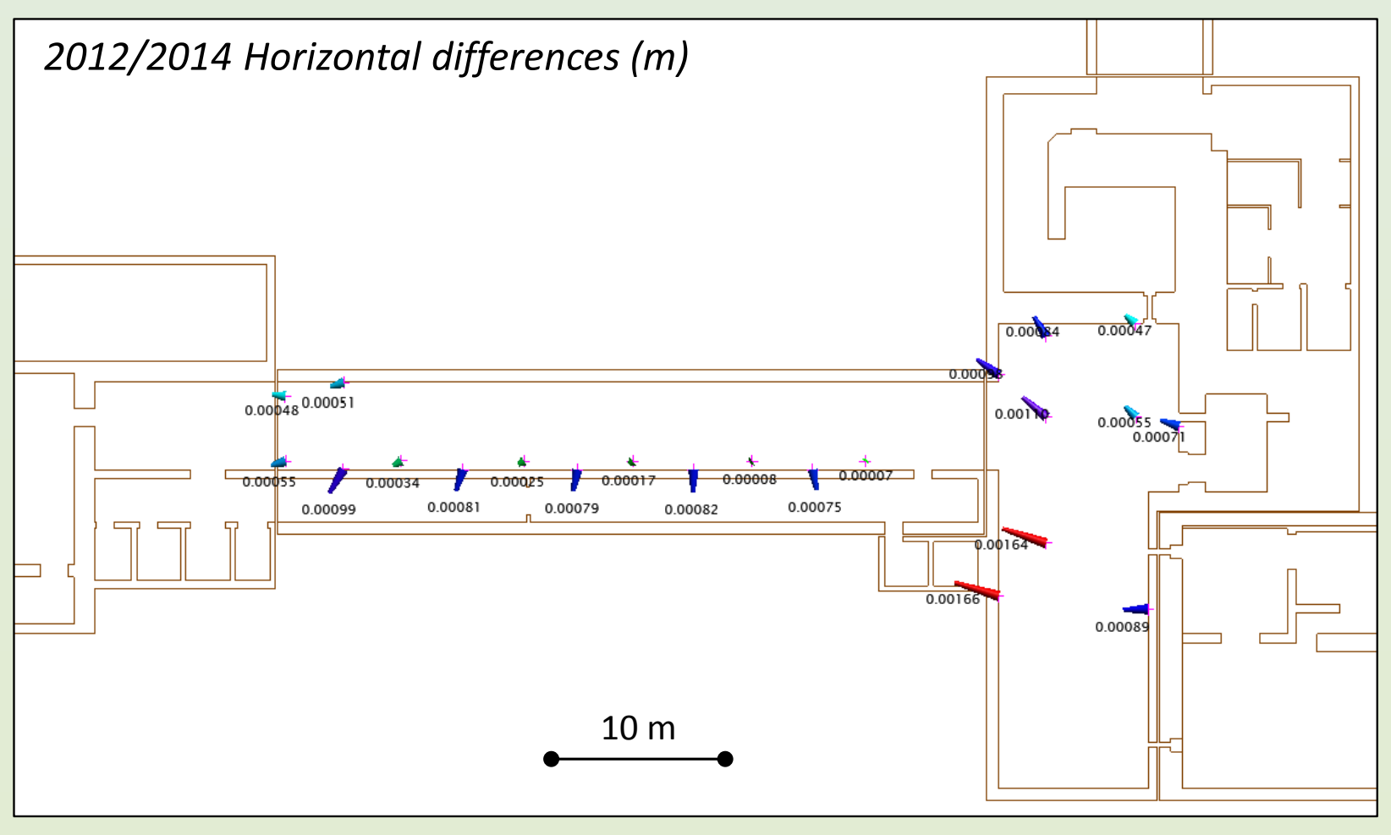


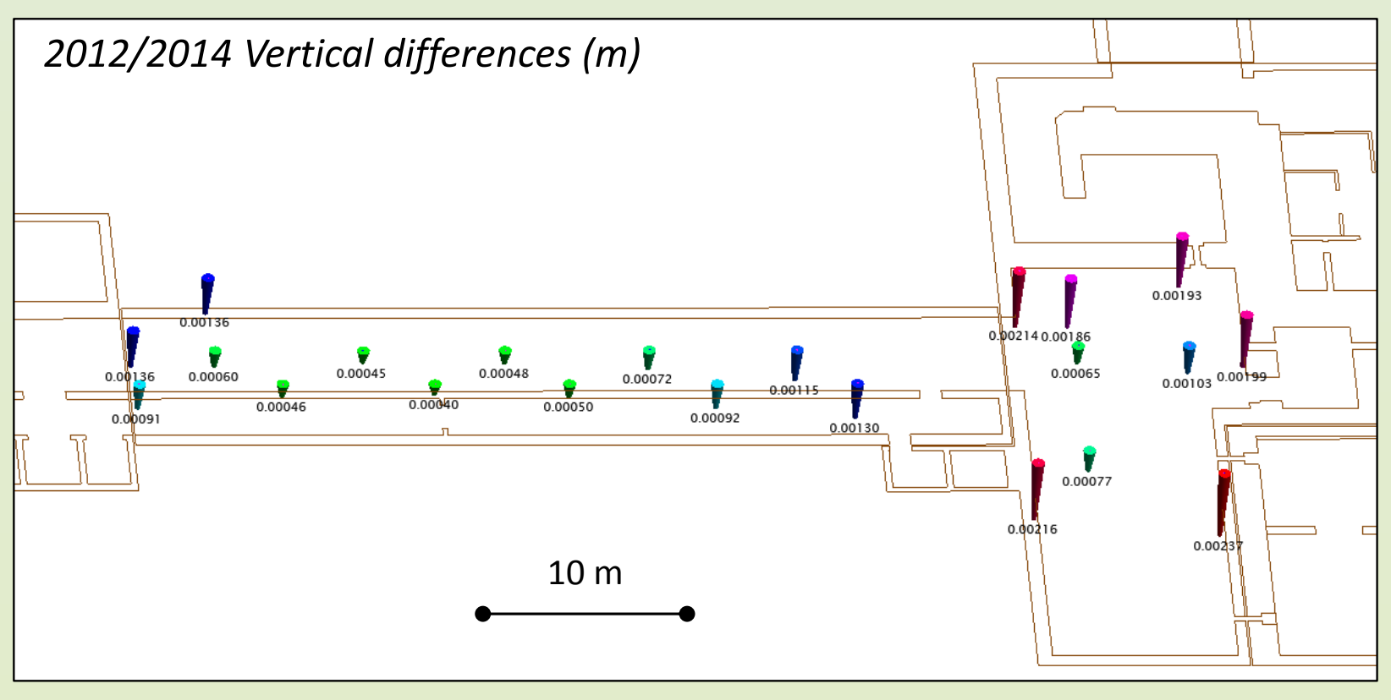
2012 : first part of the underground network

First part of the network dates back to 2012 (civil engineering just finished!). Then, in 2014 we had to re-measure the part of the network over the blocks 1-2-3 because of relative movements between blocks.
Differences observed are shown on the right.

In 2015, we continued the network in the experimental halls after waiting the longest we could regarding the need of the first alignments, hoping civil engineering blocks have reached stability. We will see …




2012/2014 Horizontal differences (m)


2012/2014 Vertical differences (m)

LINAC ALIGNMENT

The superconducting linear accelerator of SPIRAL 2 is composed of two types of QWR 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 39 modules.
Cryomodules have been built and assembled in two different laboratories, away in France from GANIL.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Alignment requirement

The maximum tolerated static errors for the global alignment are :

	cavities	magnets
displacement	± 1.0 mm	± 0.1 mm
rotations (X, Y)	± 0.3 deg	± 0.03 deg
rotations (Z)	-	± 0.2 deg

Alignment principle

- ✓Beam axis are transferred outside the cavities on target holders ①
- ✓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. ②
- ✓LINAC mechanic frame consists in two aligned rails (guide and support) ③
- ✓Modules are finally installed on the Linac frame with no need of adjustment (only in distance along the beam line) ④
- ✓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 @4K ⑤


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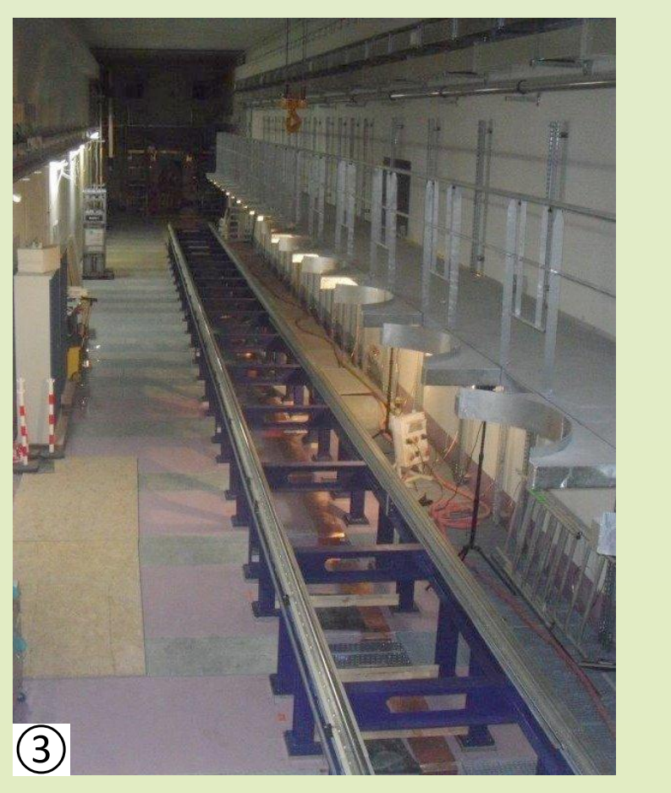
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Alignment problems encountered

Geometric stability of the alignment benches along time
- ➢causes : conception of the benches 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 true copy of the LINAC frame

The initial principle (10 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 fiducialisation of the LINAC modules was really felt. A whole T0 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.


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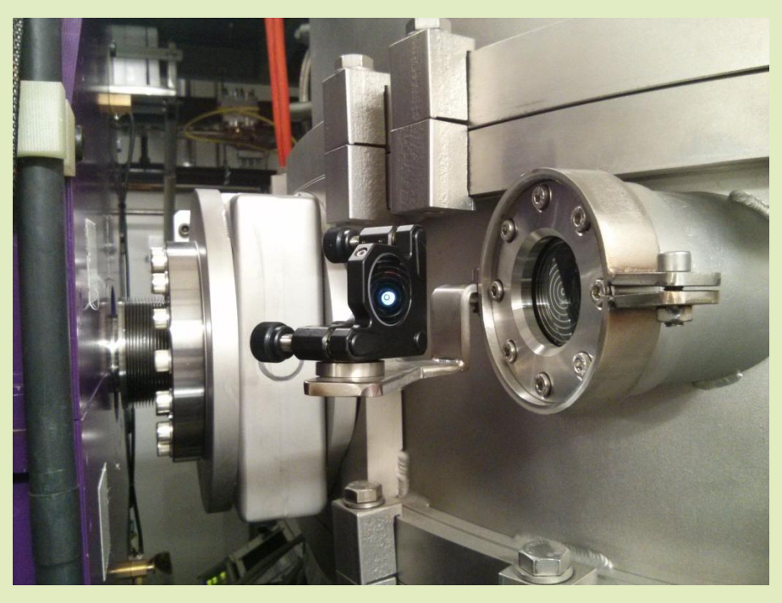
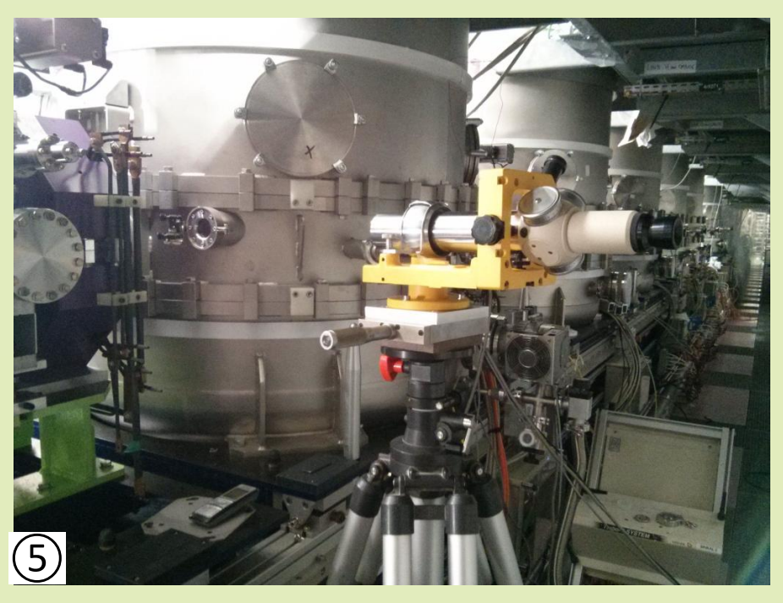
Summer 2016, first partial cooling of the LINAC : control of the position of a high beta cavity at 4K

Each high beta cavity is provided with 3 wire targets.
Combining the 3D position of the cryomodule and the relative position of the wire targets compared to the cryomodule, the position of the cavity can be determined.

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IWAA 2016
14th International Workshop on Accelerator Alignment
3-7 October 2016 – E.S.R.F., GRENOBLE, FRANCE