METROLAB Instruments SA

NMR MAGNETIC MEASUREMENT SYSTEM IN GANIL ACCELERATOR

This Application Note describes a typical system using NMR magnetic measurements elements from METROLAB as building blocks allowing a complete survey of magnets parameters in the specific site of GANIL in France.

BRIEF GANIL SITE DESCRIPTION

GANIL[1], built between 1975 & 1982, is located In Normandy near Caen and realizes research projects using accelerated "heavy" nuclei, for french CEA[2] & CNRS[3].

Principal sorts of nuclei used are defined as "hot", corresponding to high temperature levels (T≤5MeV), or "exotic" meaning they do not exist in a stable form.

It iis composed of two ion insertion sources (see "CO" in fig.1) with their cyclotron unit, two cascaded accelerators, also cyclotron type ("CSS1" & "CSS2") and a High resolution a spectrometer at the output of CSS2.

The beam is then directed to their various experiment rooms ("D1" to "D6" & "G1" to "G4").

Two sorts of beams are available :

- High energy beam, delivered by the whole accelerator system; these beams may serve two experiments in a time-sharing mode, by switching the beam with a pulsed magnet.
- Medium energy beams, extracted from CSS1 and continuously directed to the room D1.

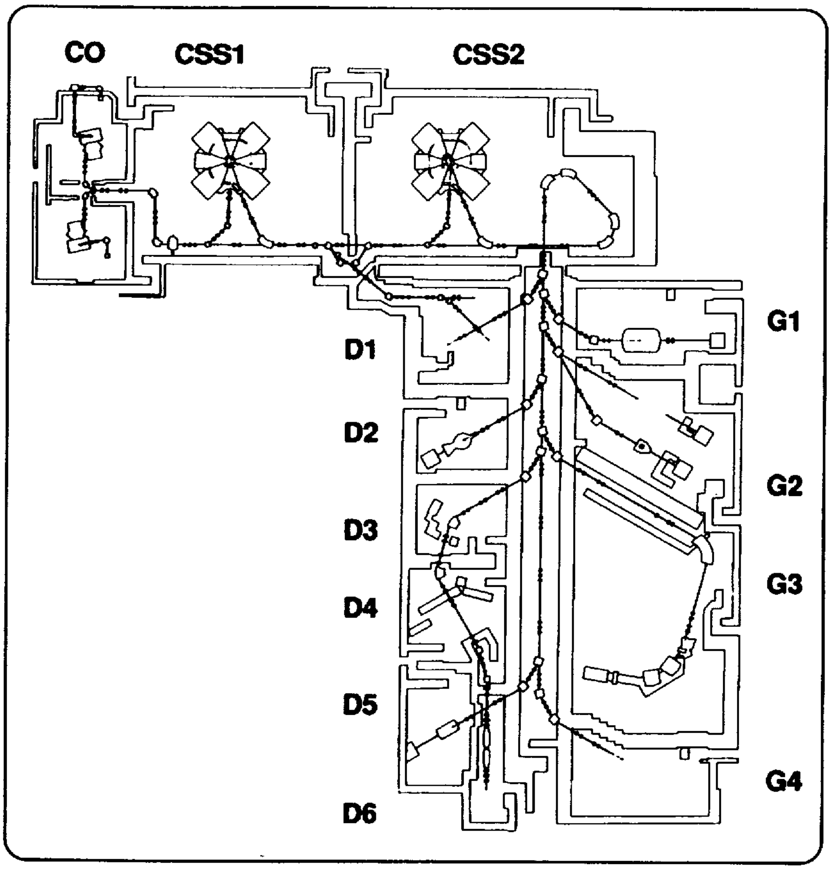

Fig. 1 : Plan of the various particles paths in GANIL

In order to produce "exotic" nuclei GANIL is presently building a new cyclotron, fed by the system above described, and named SPIRAL[4], specialized in radioactive nuclei acceleration. The photography beside shows the SPIRAL cyclotron during final tests before first use.

Fig.2 : View of SPIRAL accelerator during setting up

1- GANIL : The French " Grand Accélérateur National d'Ions Lourds
2- CEA : French "Commissariat à l'Energie Atomique"
3- CNRS : "Centre National de la Recherche Scientifique"
4- SPIRAL : "Système de Production d'Ions Radioactifs Accélérés en Ligne"

MAGNETIC MEASUREMENT DESCRIPTION

Central Magnetic Measurement Laboratory

All magnetic measurements depend on a unique internal laboratory, which makes all the different types of magnetic measures for the GANIL:

- Reception of new magnets. All new magnets are tested by the laboratory for their principal parameters, such as : B / I coefficient, field homogeneity, magnetic length and absence of any anomaly.
- Control of magnetic properties of magnet core material (permeability and saturation).
- Magnetic measurements with Hall techniques.
- Installation and maintenance of NMR magnetic measurement system on all the parts of the accelerator.

General magnetic measurement specifications

Globally, magnetic measurements are done in the range 0,3 / 2 T.

In that range, the precision required is 0.01 mT which can be expressed as a 5 x 10-6 accuracy.

For deflection magnets ranging in the whole span of magnetic field, it is necessary to put 3 different probes together at a measuring point, in order to cover the complete range of field values.

Measurement organization

For magnetic measurements, the principal machine is controlled by one PT 2025 magnetometer system (see fig.3), according to the diagram reported in fig.5 and with a total amount of 49 probes, choosen among types 2 to 5, for measuring magnetic fields ranging from 90mT to 1.85T.

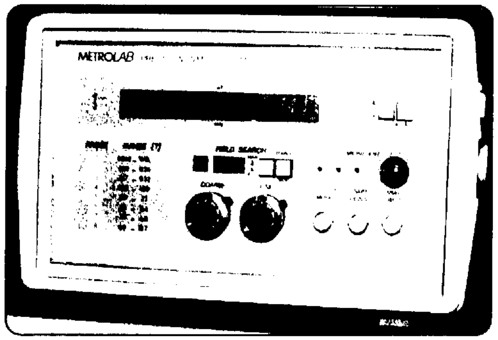

Fig. 3 : The 2025 Magnetometer cabinet centralizing all measures

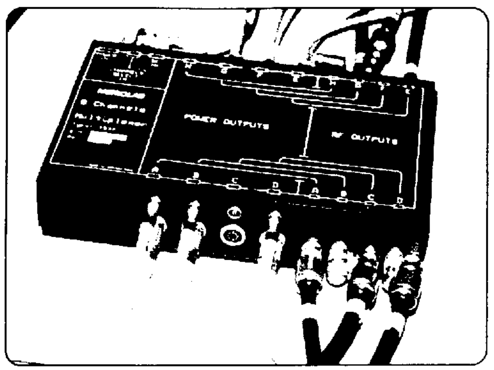

Fig. 4 : The primary multiplexer type MUX 2032

The SPIRAL machine is controlled by another system, identical to the former, but smaller in the number of probes (10) and measuring magnetic fields ranging from 53 mT to 2.1T. This second system is now ibeing built, during the final tests of this new machine.

In the schematic diagram, describing the principal machine system, the second rank 8 channels multiplexers are of 2 kinds :

- MUX 2031 directly connected to the 1060 type probes. This configuration allows cable length between 3 and 20 meters.
- MUX 2030, associated with individual 1030 amplifiers for each 1060 probe. This configuration allows cable length up to 100 meters.

The first rank multiplexer, type MUX 2032 (see fig.4)can be connected to the formers with 100 meters cables. This cable arrangement allows to cover the long distances of some magnets to the main unit PT 2025.

For SPIRAL system, only MUX 2031 will be used in the second rank 8 channels multiplexers, since the machine is very compact and so, no long cables are necessary (see fig.5).

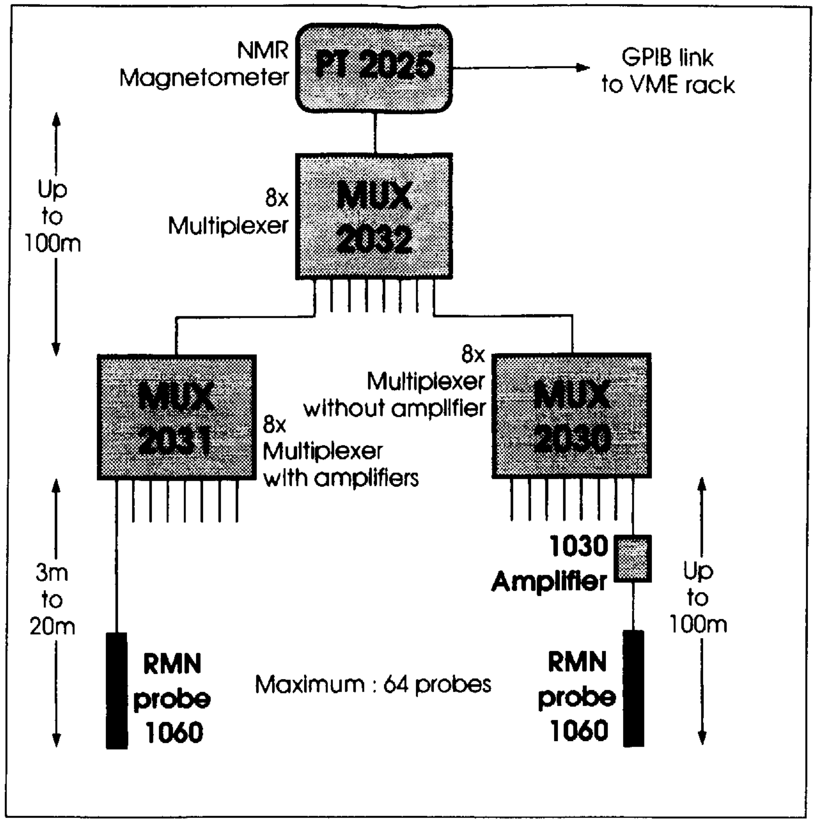

Fig. 5 : General diagram of the field measurementsystem in Ganil accelerator

For both systems, measures from PT 2025 units are transmitted via a GPIB link to a VME bus rack (see fig.6), achieving connection to the main control room. The field measuring signal is then used to control the whole accelerator system.

Complementary equipment

The central magnetic measurement laboratory is equipped with another magnetometer unit PT 2025 for laboratory uses only, such as described above; especially for new magnet reception tests.

Another PT 2025 is used as a maintenance unit in case of system failure on either of the two instruments.

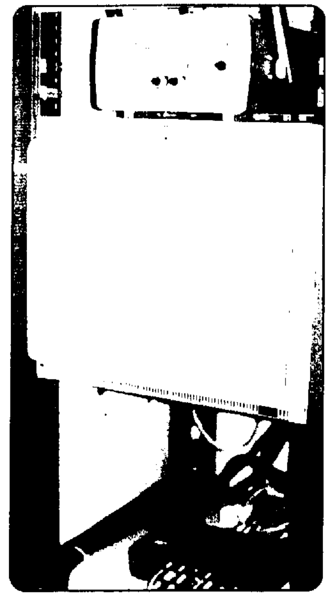

Fig. 6 : The 2025 and VME communication rack

Fig. 7 : Installation of a single 1060 probe in a magnet

CENTRAL SURVEY OF THE ACCELERATOR

The accelerator system is driven from a central room, fully equipped with computers, collecting all the data from the different sensors on the path of particles, and controlling the total amount of physical parameters (about 5000) necessary to make the accelerator run correctly.

One of the important parameters is the precise value of the magnetic field generated in the gap of the many magnets (deflection or focusing magnets) situated on the path of particles.

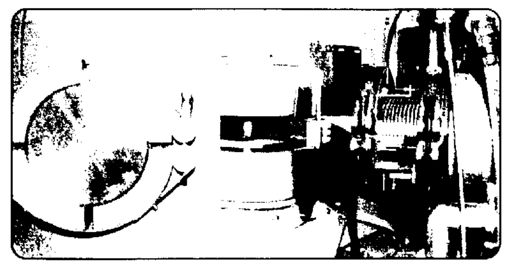

Fig. 8 : Installation of 3 1060 probes in a wide field range magnet

Magnetic field measuring policy

Historically, first magnetic measuriements have been performed with NMR magnetometers of various origins, including, since 1995, Metrolab equipments. More and more then, for reliability reasons and maintenance facilities, Metrolab equipment has been preferred and became, finally, the unique origin chosen for new installation and replacement of old ones.

Now, all the magnetic measures in Ganil are planned to be achieved with Metrolab equipment in a short delay, in order to unify measuring and maintenance routines.

The measurement system schematic diagram is shown, realized by a double stage multiplexer operated selection of probes (with a total capacity of 64, presently used with 50 probes), converging to only one PT 2025 magnetometer unit.

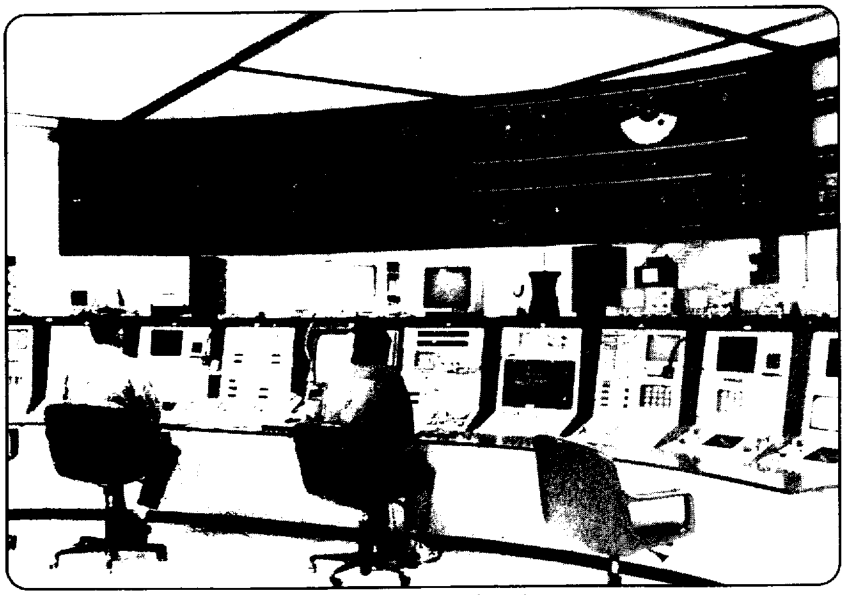

Fig. 9 : Main control room of the accelerator

Setting of the beam for an experiment

The setting up of an experiment consists in a routine of beam trajectory progressive adjustment, step by step, from one magnet to the following.

This explains the solution chosen for the system which needs only one measurement at a time and thus may function with a unique magnetometer unit. Beam trajectory is monitored by profilers injected in the path of particles of different principles (thread type (horizontal or vertical), and now gas type which present less interference with the beam).

CONCLUSIONS

The above description of this realization in Ganil accelerator is a good example of the utilization of only standard parts proposed in the Metrolab catalog in order to create a complete dedicated magnetic field measuring system.

The good choice of elements allows to adapt only the cable length in order to make measurement on the whole extended site of the accelerator.

The same approach may be used for any implementationof magnetic field measurement system, including non static measurements, with the complementary utilization of the Metrolab PDI integrator type 5025 or 5035. Mixing the 2 technologies yelds high speed in measuring and NMR calibration of measures[5].

5- Di Cesare P., Reymond C., Rottstock H., Sommer P., "SPS magnetic field cycle measurement system", CERN SPS/PCO/Note 89-9

Please contact us for a technical advice, a quotation or the adress of your local distributor

METROLAB Instruments SA
110, Ch. du Pont du Centenaire
CH-1228 PLAN LES OUATES
Geneva - Switzerland
Tel. +41 (22) 884 33 11
Fax +41 (22) 884 33 10
E-mail : contact@metrolab.ch - Internet :http://www.metrolab.ch