# DYNAMIC MEASUREMENTS
# WITH STATIC COILS AND HALL PROBES

The purpose of the dynamic measurements is to estimate the effects during current ramp rates in the LHC dipoles and quadrupoles.

These effects come from the geometry of the superconducting cables. The main current is disturbed by coupling currents between the strands of the cables and also between the filaments of the strands. The interstrand currents depend on the resistive contact between the upper layer and the lower layer of the cable.

These currents induce :

- energy dissipation in the magnet (loss measurement),
- distorsion of the magnetic field (field advance measurement).

This field contribution is small but not negligeable and must be taken into account in the synchronisation of the power converters driving the LHC dipoles and quadrupoles.

The 2 effects depends linearly on the ramp rate and depends on the value of the resistive contact all along the magnet (few $\mu\Omega$). That is why measurements are done at different value of current ramp rate to deduce the loss factor and the field advance factor of the magnet. Then a modele is used to make an estimation of the resistive contact value.

It is difficult to control this value during the fabrication. It must stay between an interval ; not too high to allow an homogeneous thermal energy diffusion and avoid a local quench ; not to low to limit the loss and field advance effects.

**Loss measurement**

The current and the voltage on the magnet are measured with digital voltmeters to calculate the energy stored in the magnet.

The difference between the energy at the beginning and at the end corresponds to the energy dissipated in the magnet during the cycle. This measurement is repeated at different value of current ramp rate to deduce the loss factor.

**Field advance measurement**

The current and the voltage on the magnet are measured with digital voltmeters to calculate the field in the magnet.

The field in function with the current is linear but there is a little hysteresis. The field advance is the difference between the field during the ramp rate up and the ramp rate down at exactely the same value of current. This measurement is repeated at different value of current ramp rate to deduce the loss factor.

An other way to measure that is to use precision digital integrators to obtained directly the field without integrate the results by calculation. This method improves the resolution by a factor 10.

Using Hall probes gives also good results but it is a local value.