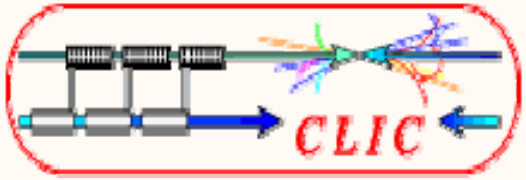
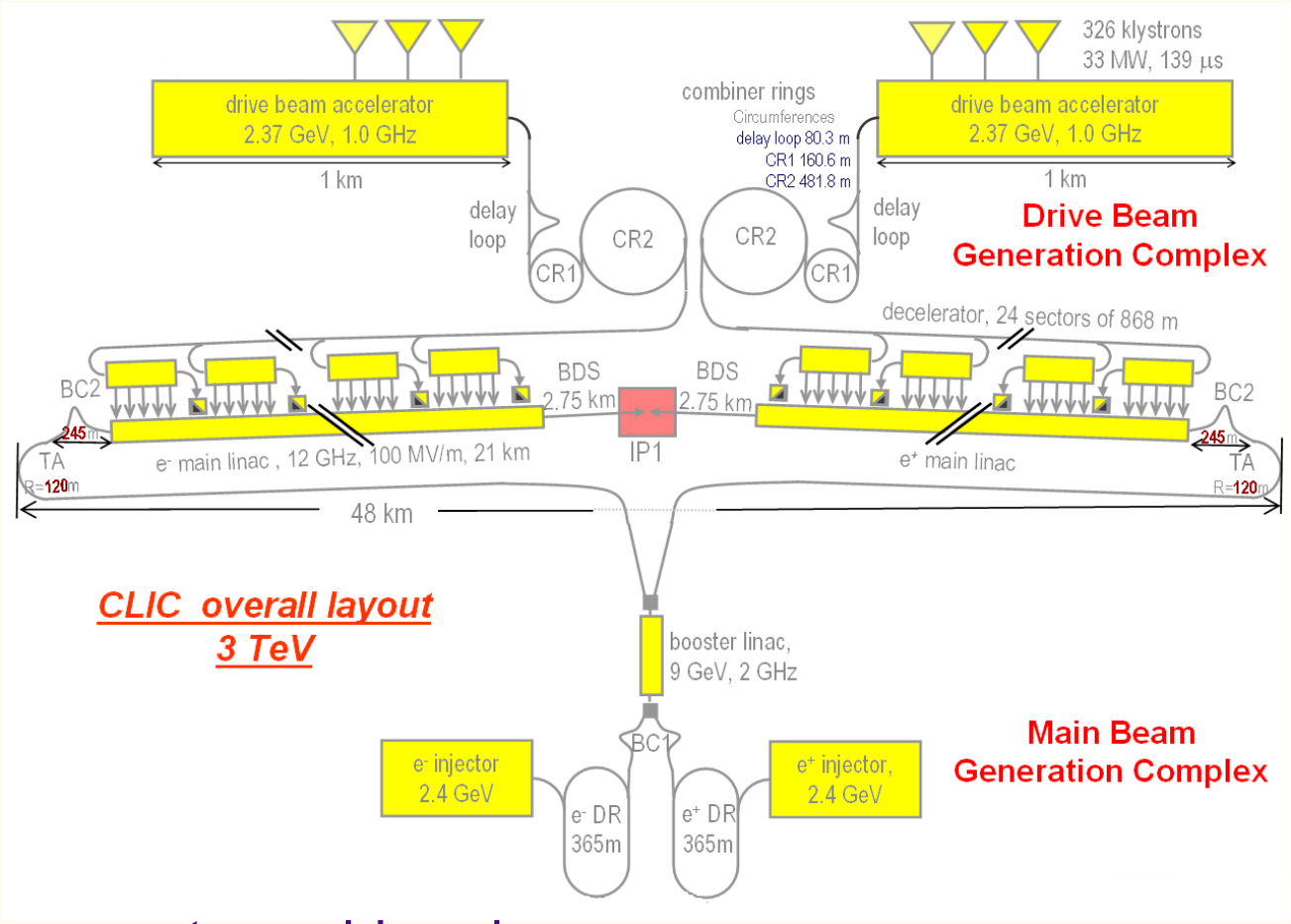


The global concept

- Our objectives and strategy
- Our experience
- The issues
- Organization of the studies

Jean-Pierre Quesnel

Comparison with ILC as far as the alignment is concerned



- Injectors are not considered
- Survey and pre-alignment is an issue for the CLIC main beam and drive beam linacs
- Survey and pre-alignment is an issue for CLIC and ILC beam delivery systems / final focus

Our Objective

- Accuracy of alignment to be improved by a factor ~30 compared to our “traditional” accuracy for the existing accelerators
- Our objective is to demonstrate the feasibility of the alignment for the CLIC linacs elements by 2010 (same schedule as ILC) and *to propose a cost evaluated and integrated solution*.
- The strategy applied is to use existing technologies, even if we know that these technologies will improve a lot in a close future.
- Many issues have still to be studied in the frame of our baseline. We will review them and they will be highlighted by my colleagues in their presentations
- After 2010, a program of consolidation of the studies will be set up, and ILC as well as other projects will take benefit of these studies.
- Comparisons between existing sensors around the world would be very useful for the validation our hypotheses and for improving them.

The next presentations

- The principle of the alignment of the CLIC, by H. Mainaud-Durand.
- The tests done on our HLS and WPS at CERN (calibrations, radiation tests…), by A. Herty,
- The optical WPS under development with “Open Source Instruments Inc.” , by F. Lackner
- Our facilities (TT1, TT83, calibration facility…) where tests are ongoing, by T. Touzé.

The baseline

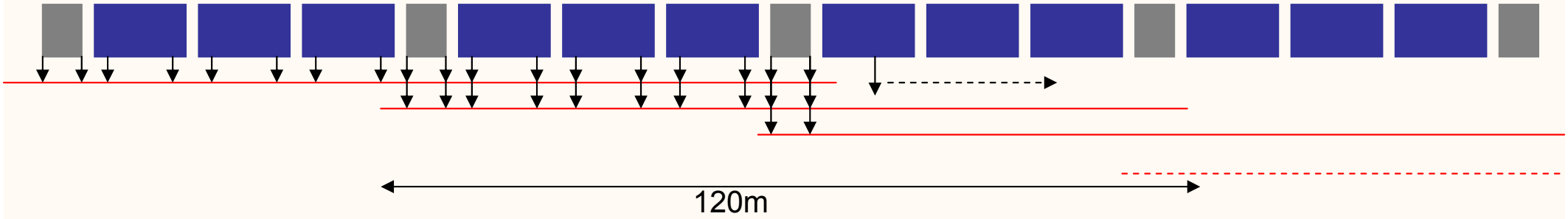
- The propagation of the straight line is based on the use of stretched wires, for the horizontal and the vertical as well.
- HLS are used to control the vertical sag of the wires
- The machine elements are aligned directly from the wires or thanks to a proximity network. (see Hélène)
- This technology exists and is already in production (LHC inner triplets)
- Well known technology at CERN, even if a lot of work still to be done. This gives confidence that it can be used.
- A back up solution with an optical method in vacuum is under investigation (NIKHEF)
- Today, the wire is considered cheaper than an optical solution

The stretched wire

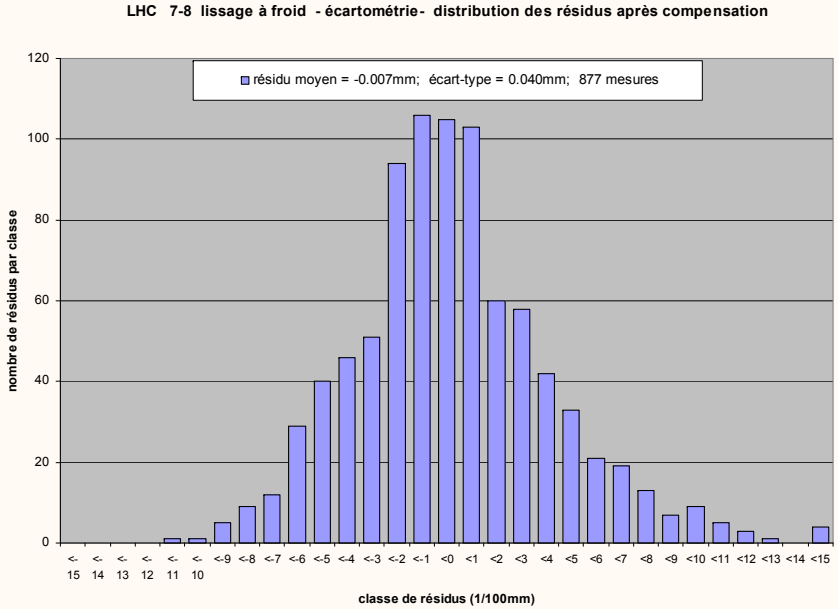
- The sensors at CERN
  - capacitive WPS (“FOGALE nanotech”)
  - optical WPS (“Open source Instr.”)
  - “Sylvac” adapted manual sensors

- The wires at CERN
  - Carbon peek for capacitive sensors
  - Other fibers for optical sensors (Dyneema, Vectran, others…)
  - Length of the wires stretched up to 500 m
  - We have developed a system for stretching long wires

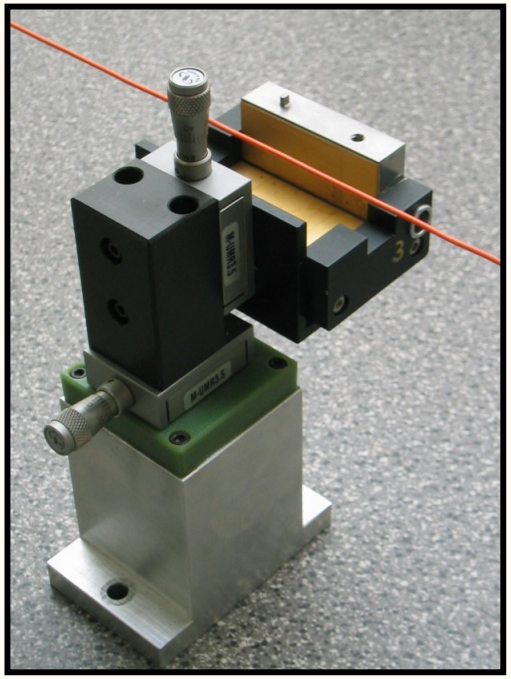
Classical wire offset measurements in the LHC



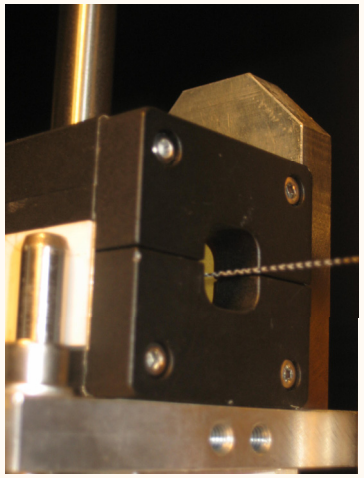
Redundancy = 2
Length of the wires ~120 m
18 measurements per wire
Sigma of the residuals: 40 microns



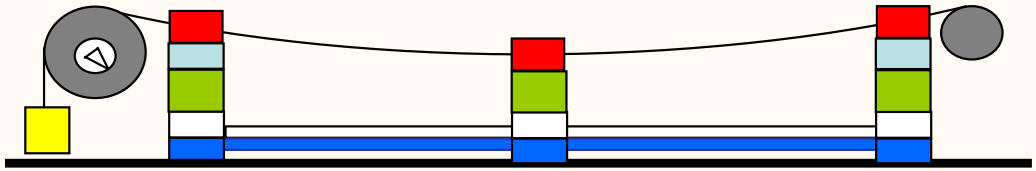
WPS



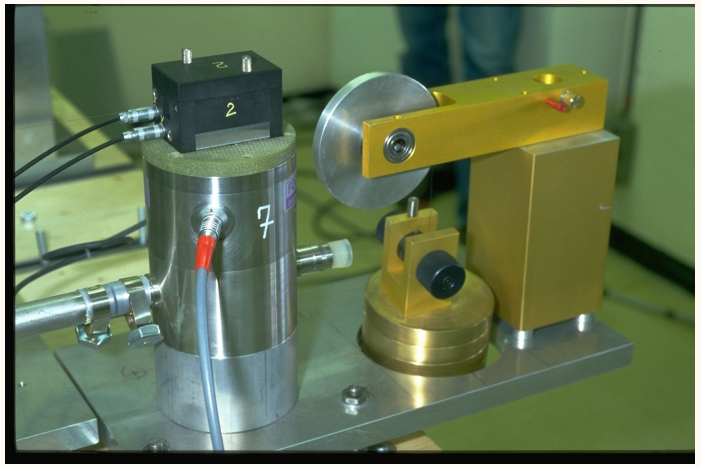
Résolution: 0.2 μm
Range: 10 x 10 mm
Repetability: 1 μm
Aquisition frequency up to 10 Hz



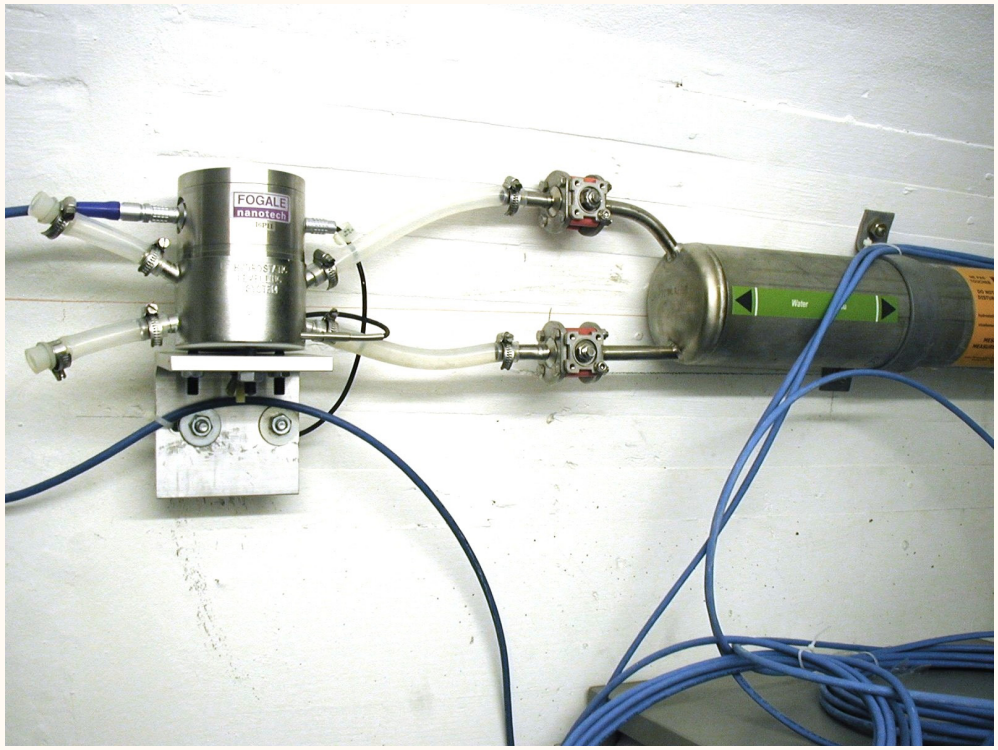
- ✓ In the horizontal plane : the wire is the straight line
- ✓ In the vertical plane : the wire = catenary

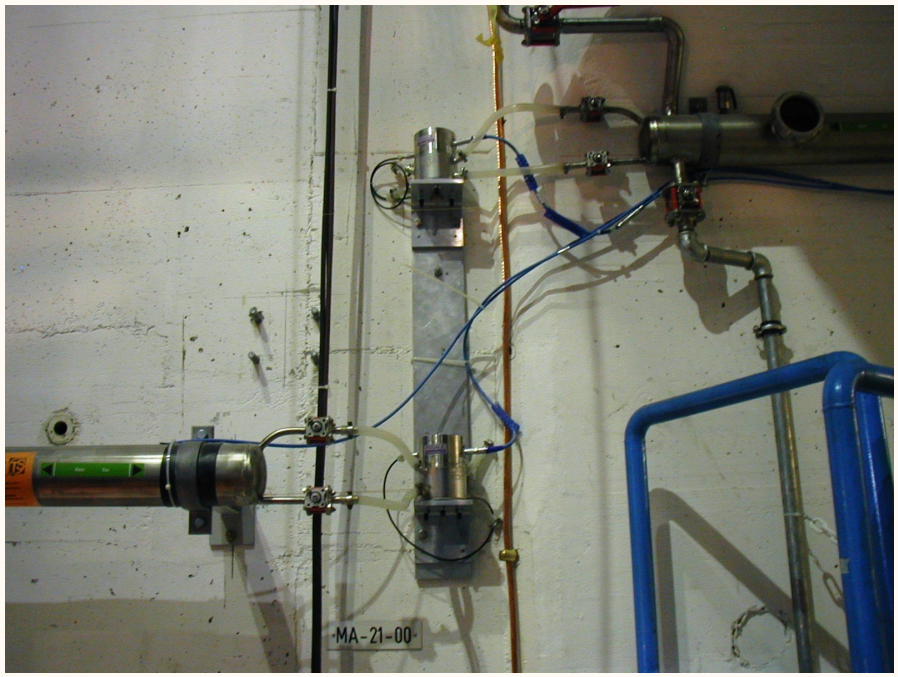


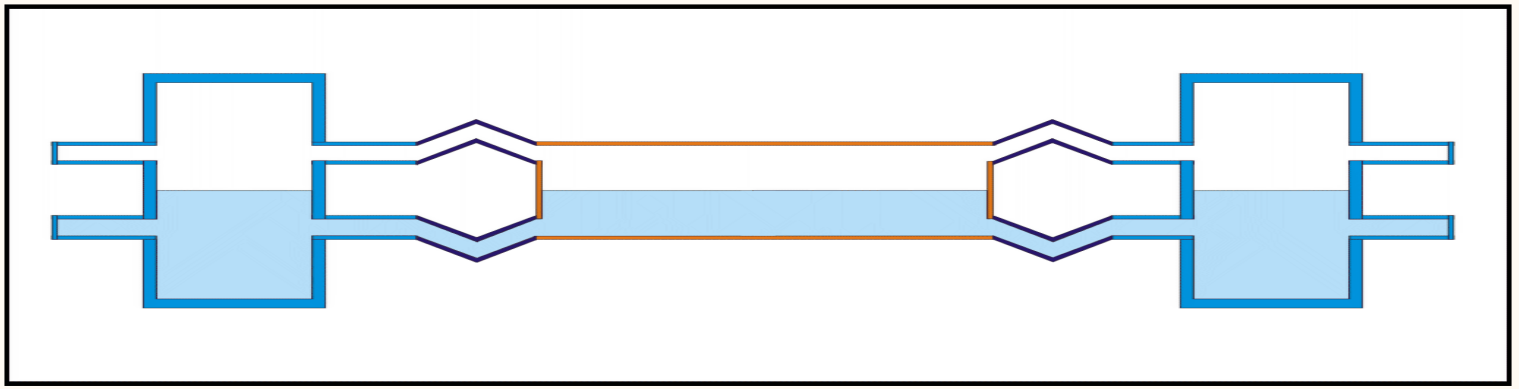
Wire used: carbon peek



The capacitive HLS (from FOGALE nanotech)





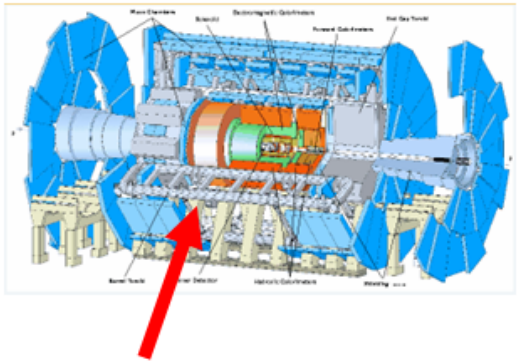


Our experience from LHC inner triplets

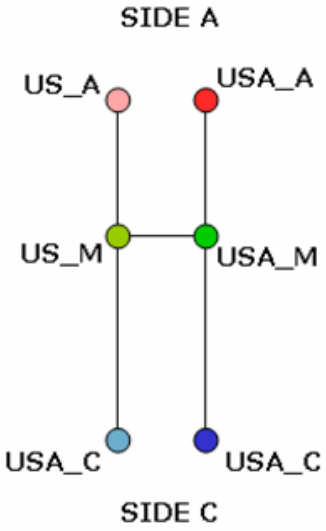
- The 4 experiment are equipped with the sensors
- over 120 m long wires
- It is a real situation
- In production
- 3 sorts of sensors (HLS, WPS, DOMS)
- Radiation environment
- Magnetic fields
- Quite complex
- Experience gained for installation, communication, control, protection of the equipment.
- We can observe many phenomena

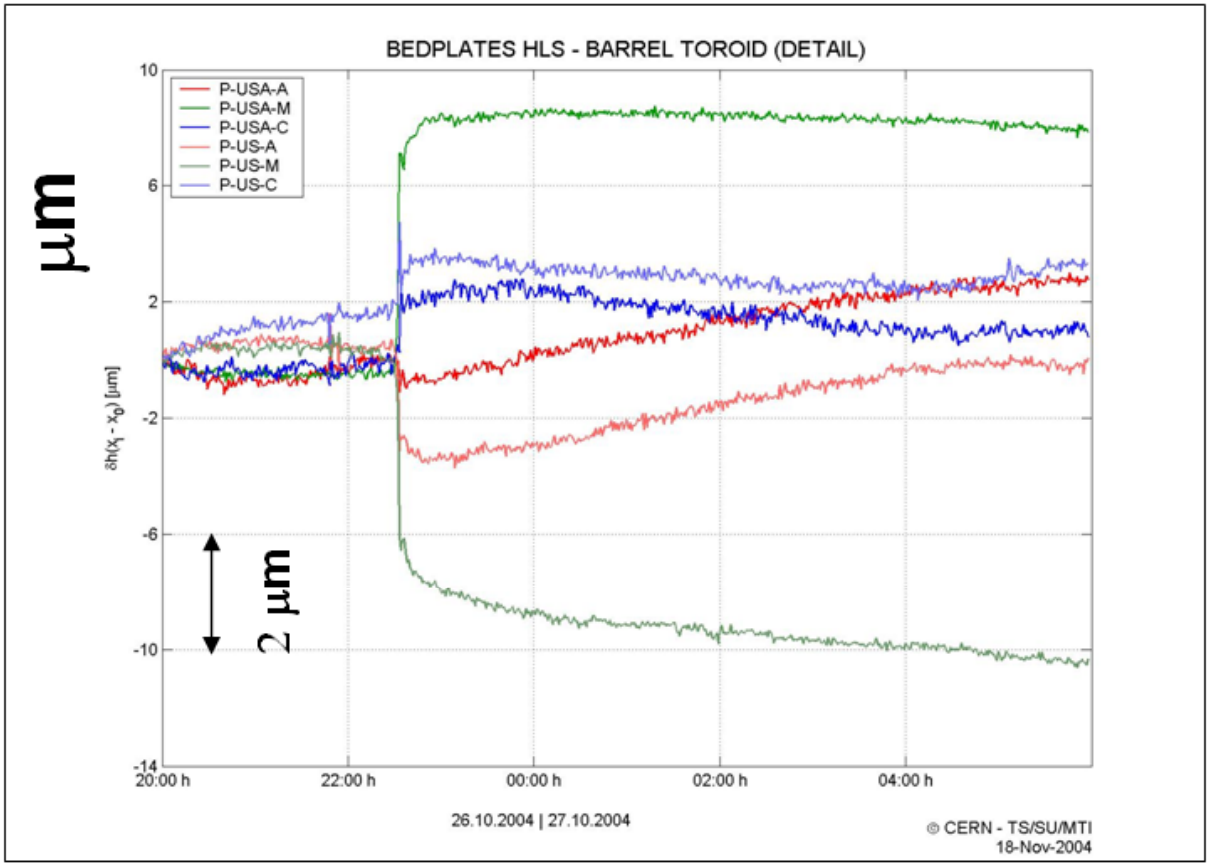
- Tracking the microns in such an environment is very challenging

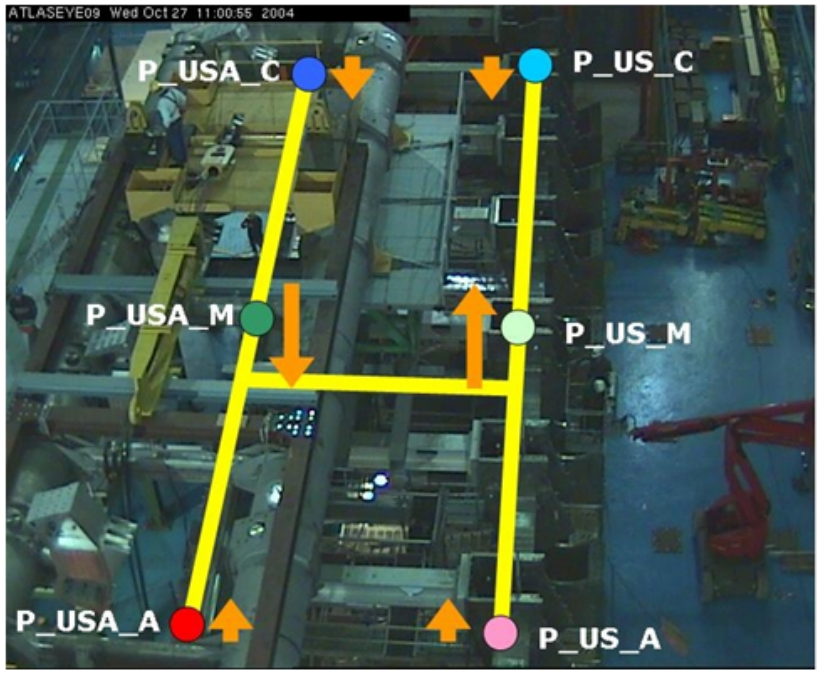
HLS MEASUREMENT – BARREL TOROID COILS INSTALLATION



One of the 8 BT coils





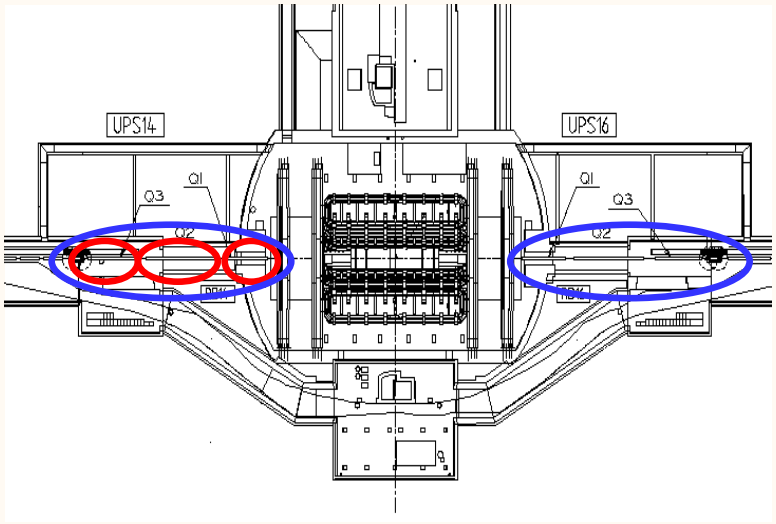


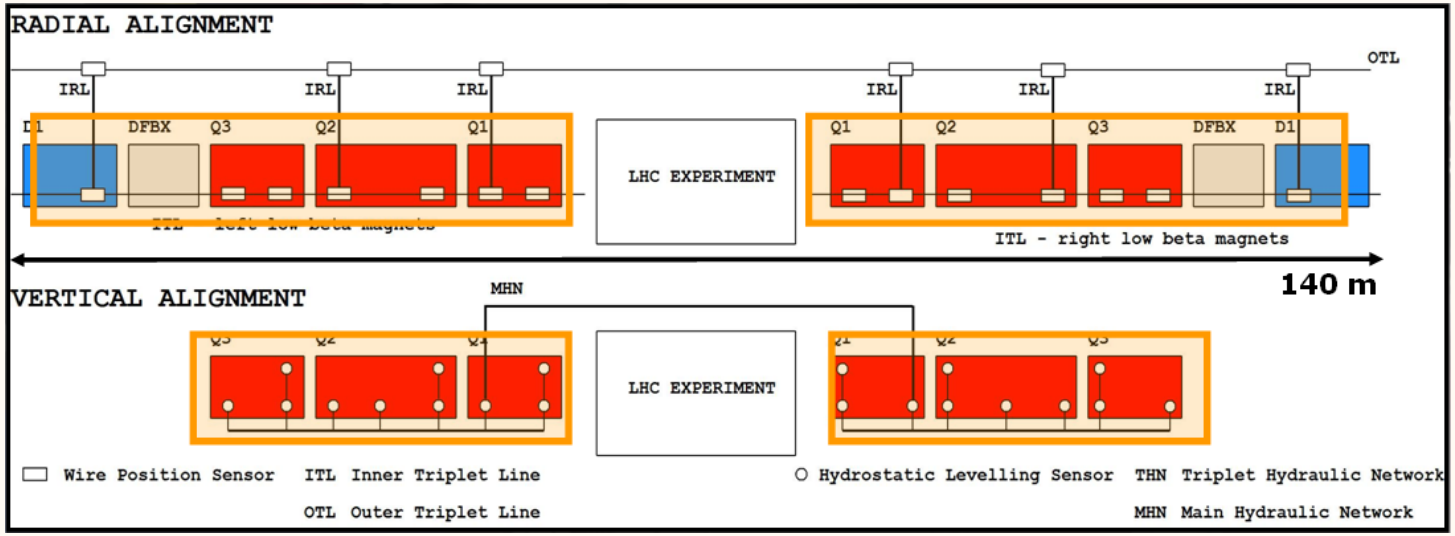
Installation of one BT coil (24m long, 100t)

...

effect on the Bedplates measured with the HLS

HLS and WPS on the inner triplets



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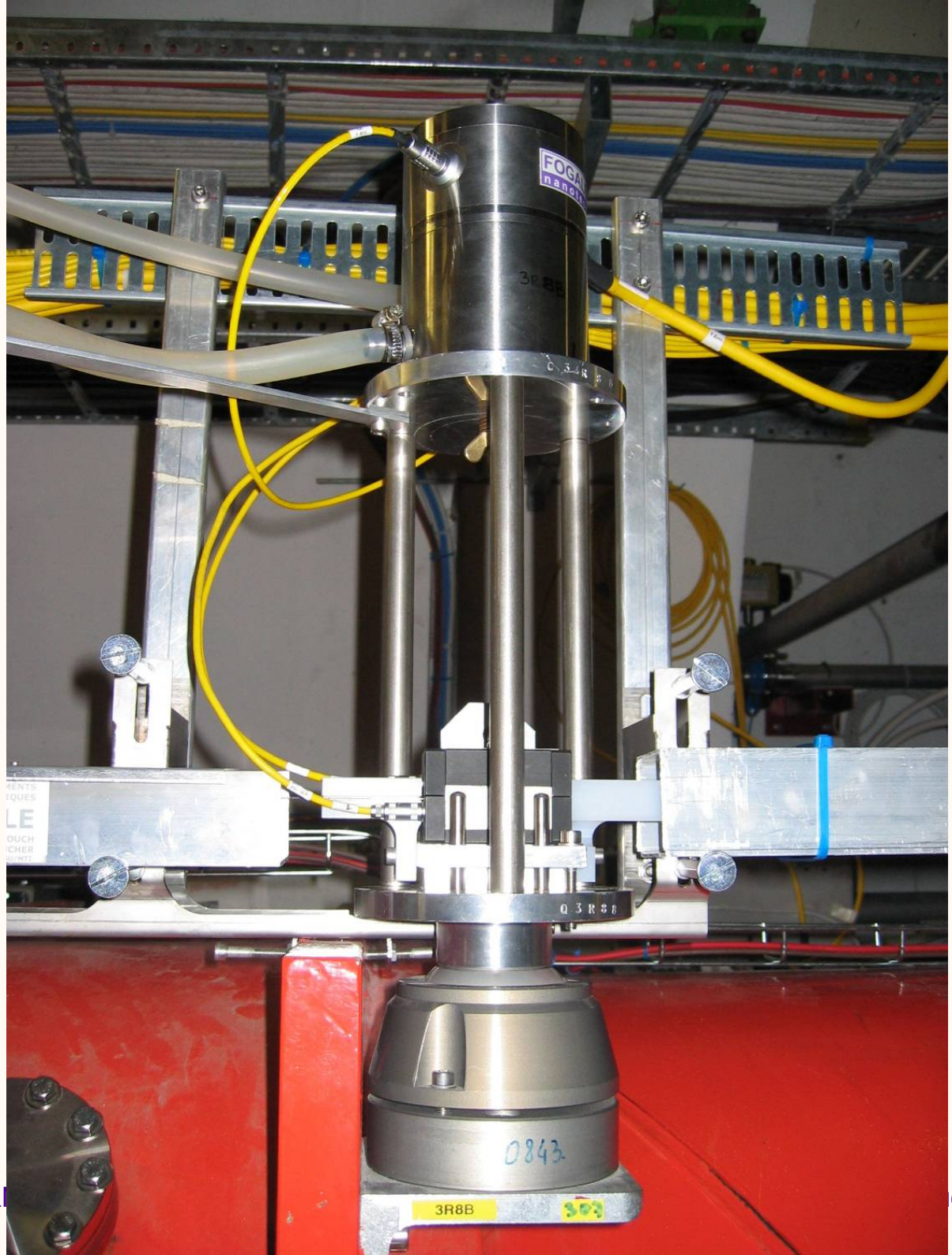
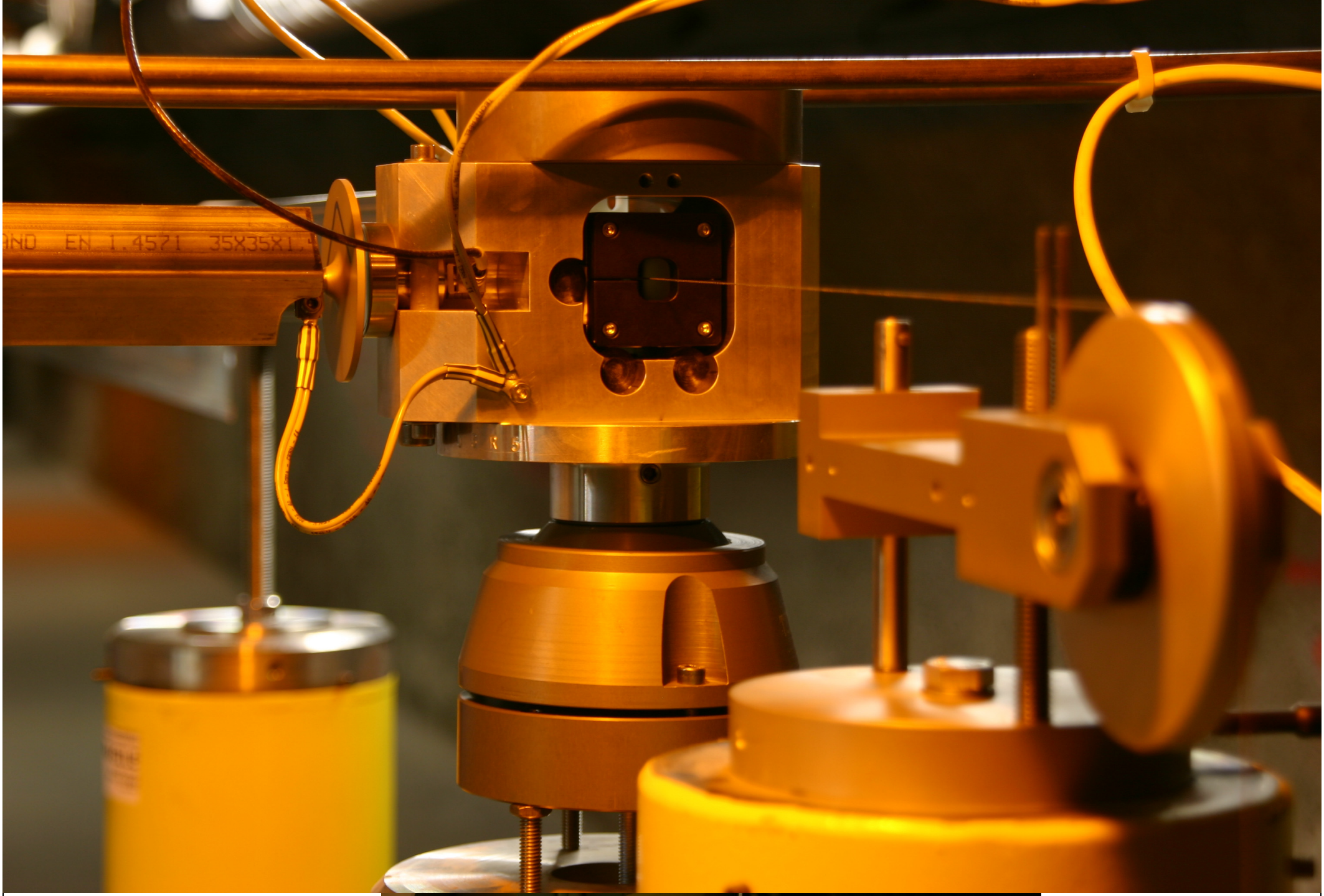
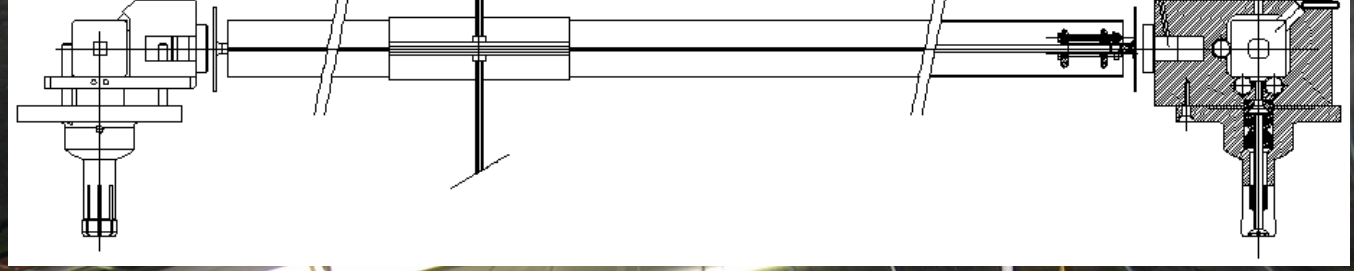
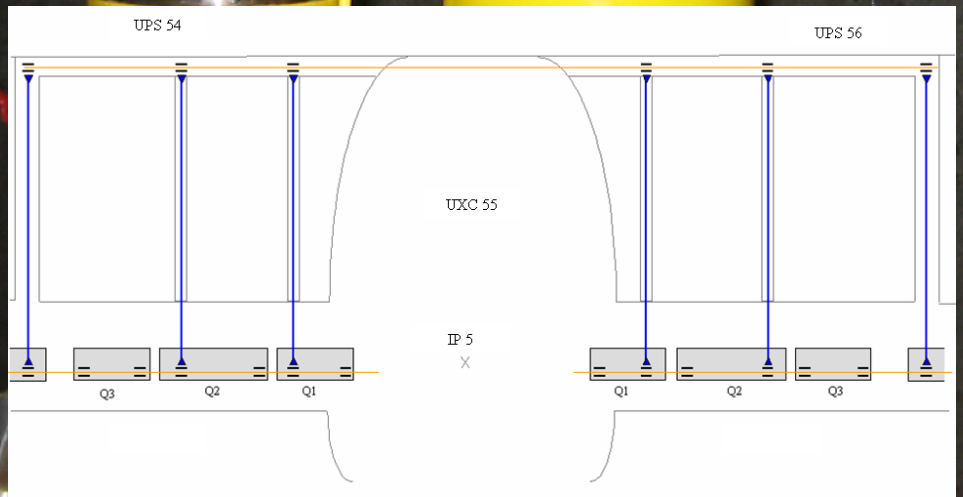

FOGALE
nanotech
3R8B
0843

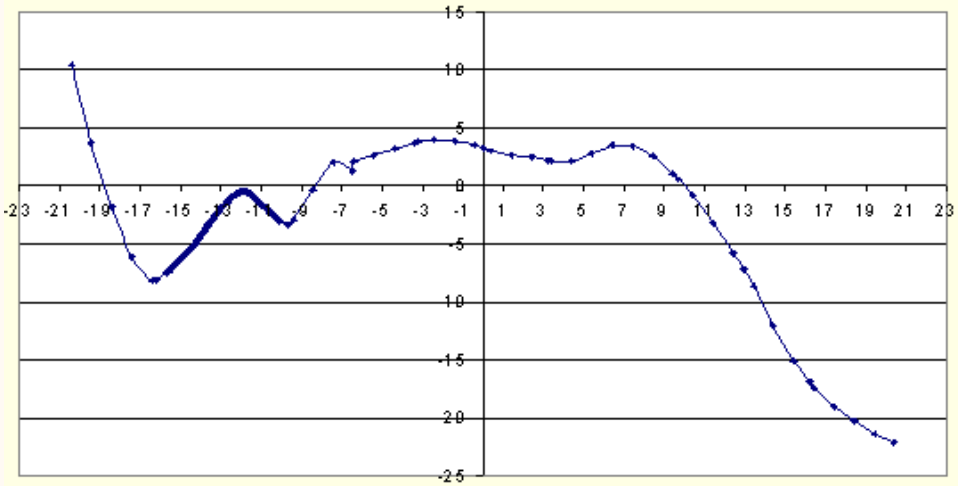

EN 1.4571 35X35X1



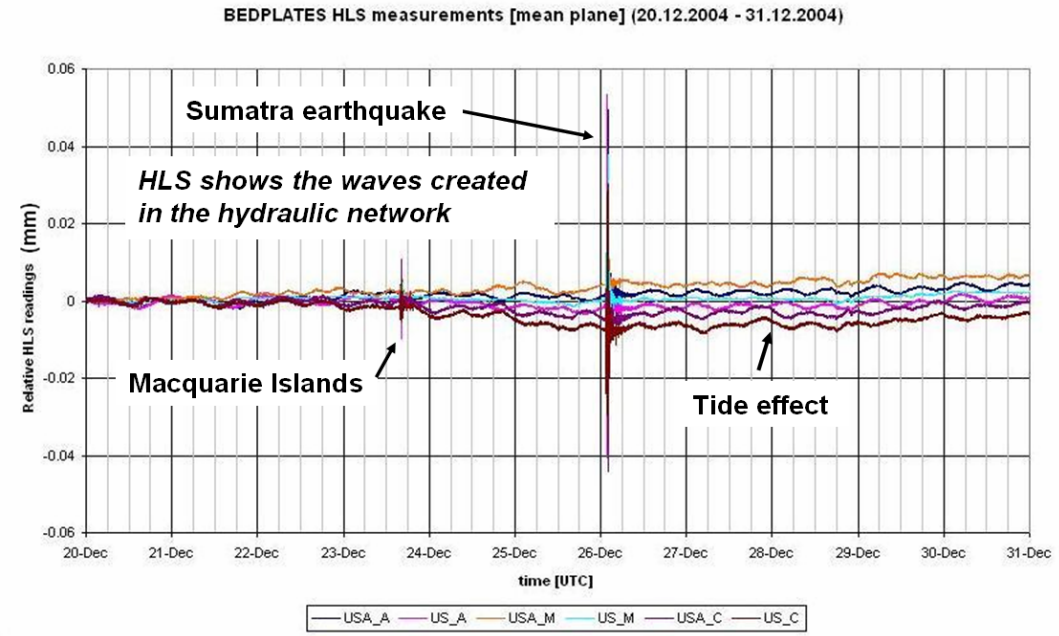

UPS 54
UPS 56
UXC 55
IP 5
Q3
Q2
Q1
Q1
Q2
Q3

Geodetic issues

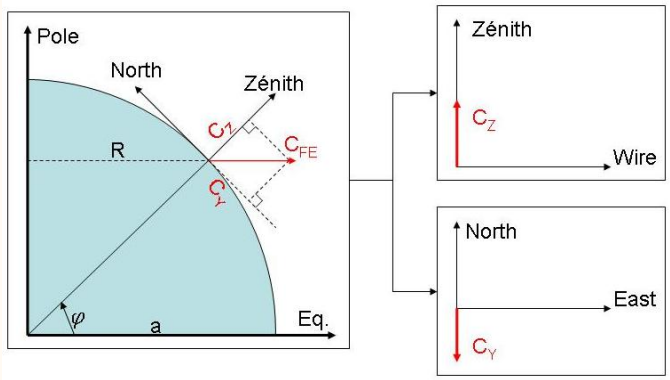
The effect of the gravity on the water and the wires
The effect of the tides on the HLS
The effect of the inertial forces

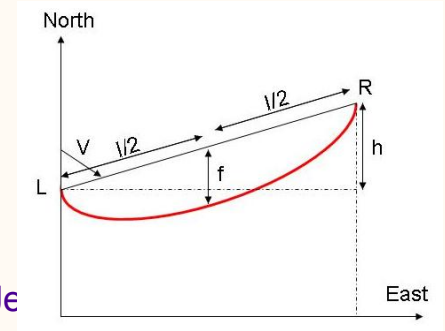


HLS – EXTRA PHENOMENA RECORDING – EARTHQUAKES



~70 earthquakes seen from Dec 2005 with the HLS installed at CERN





The issues for the sensors

- The absolute calibration of the sensors
  - Mechanical aspects
  - CMM to be used
  - Can we skip the problem?

- The behavior of the wires and the sensors
  - Drifts and real accuracy
  - Radiation environment
  - Magnetic fields
  - Electro-magnetic environment, cables for electronics
  - Atmospheric parameters
  - Integration, installation, access for repair, compatibility with stabilization…
  - The maximum length of the wires (today, preliminary tests done over 500m)
  - New fibers ?

- Wireless sensors ?...

Comparisons to be done in strictly similar conditions

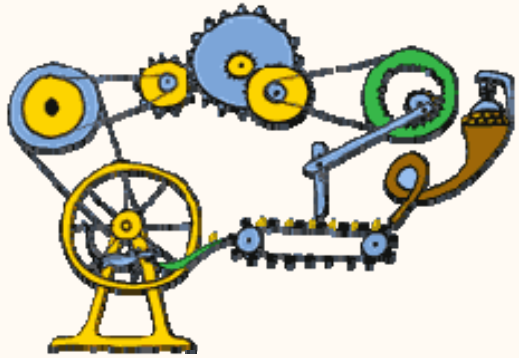
Our facilities

- The LHC inner triplet areas (over ~120 m)
  - Not easy to access
    - Limitation of space
    - Control access
    - Constraints for cabling
    - training
  - High radiation level
  - In production
  - Not adapted for short term tests
  - Well adapted for testing in radiation environment

Our facilities *(see Thomas presentation)*

- TT1 (140 m)
- TT83 for long wires (500 m)
  - But access is limited
  - Radiation
  - Slope (1%)
- Calibration base (50 m)
- TZ32 tunnel (800 m)
  - For geodesy studies (geoid, gravimetry, deviation of the vertical)
  - Access limited
  - Slope

CONCLUSION



"The Micron World, in which steel acts like butter and in which temperature excursions are like Gulliver's Travels, has been tamed and industrialized on the laboratory scale. I do not believe the problems that we are going to encounter in the design of future linear colliders on a kilometer scale will turn out to be fundamental. Rather, the challenge will be to be innovative enough to find sound engineering solutions that we can afford. Further, we should involve the alignment community in all aspects of the design decision making process at the earliest moment."

From G.E. Fischer, SLAC, 1989