Survey for SPL

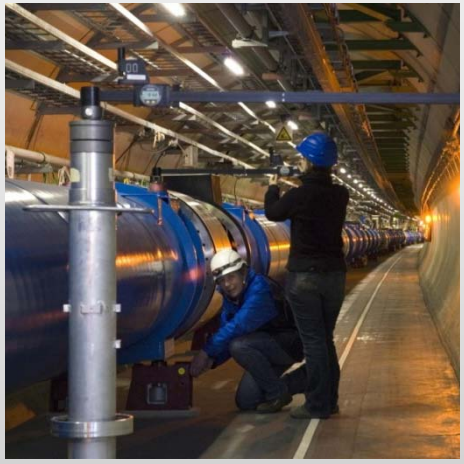
Dominique Missiaen BE-ABP/SU

Outline

- Scope & Main Parameters
- Technical Description
  - Metrological mechanical controls
  - Alignment activities
  - Complementary activity
- Conclusion

Scope of the Work Package

- Large Scale Metrology Work
  - Metrology of Linac Modules
  - Survey and Alignment Work
    - Linac



Main Parameters

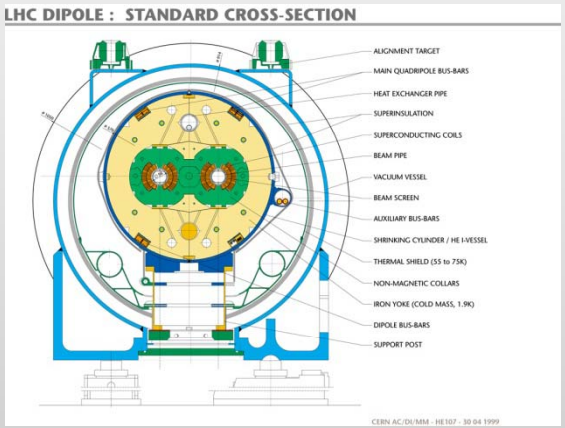
- Tunnel Alignment Precisions (Linac Beam Dynamics WP)
  - Linac
    - 0.5 mm for the cryomodules at 1 sigma
    - 0.3 mm for the quadrupoles at 1 sigma
- Tunnel floor (Civil Engineering WP)
  - Tolerance: +0 / -5 mm
  - Smoothness: < 2 mm over 2 m
  - Stability: movements up to 5 mm during first few years
- Number of elements and modules to measure or align
  - ~30 cryomodules
  - Warm components ?

Technical Description

- Linac cryomodules
  - Fiducialisation of Modules w.r.t to a reference axis
- Accelerator Alignment Activities
  - Spatial Data Controls
  - Metrology
  - Install and determine geodetic reference networks
  - Mark-out beam line and supports
  - First alignment of beam line elements
  - Final alignment / Smoothing
- Complementary Activities
  - Civil Engineering Controls
  - As-built Measurements

General Work Conditions I

- All objects to be measured MUST be equipped with survey reference targets and a tilt reference
  - Same precise position for all elements of same type and design



General Work Conditions II

- All objects to be positioned / aligned MUST be equipped with a precise positioning system appropriate to the alignment precisions and time constraints imposed by the project
  - Standardisation of systems for elements and modules

General Work Conditions III

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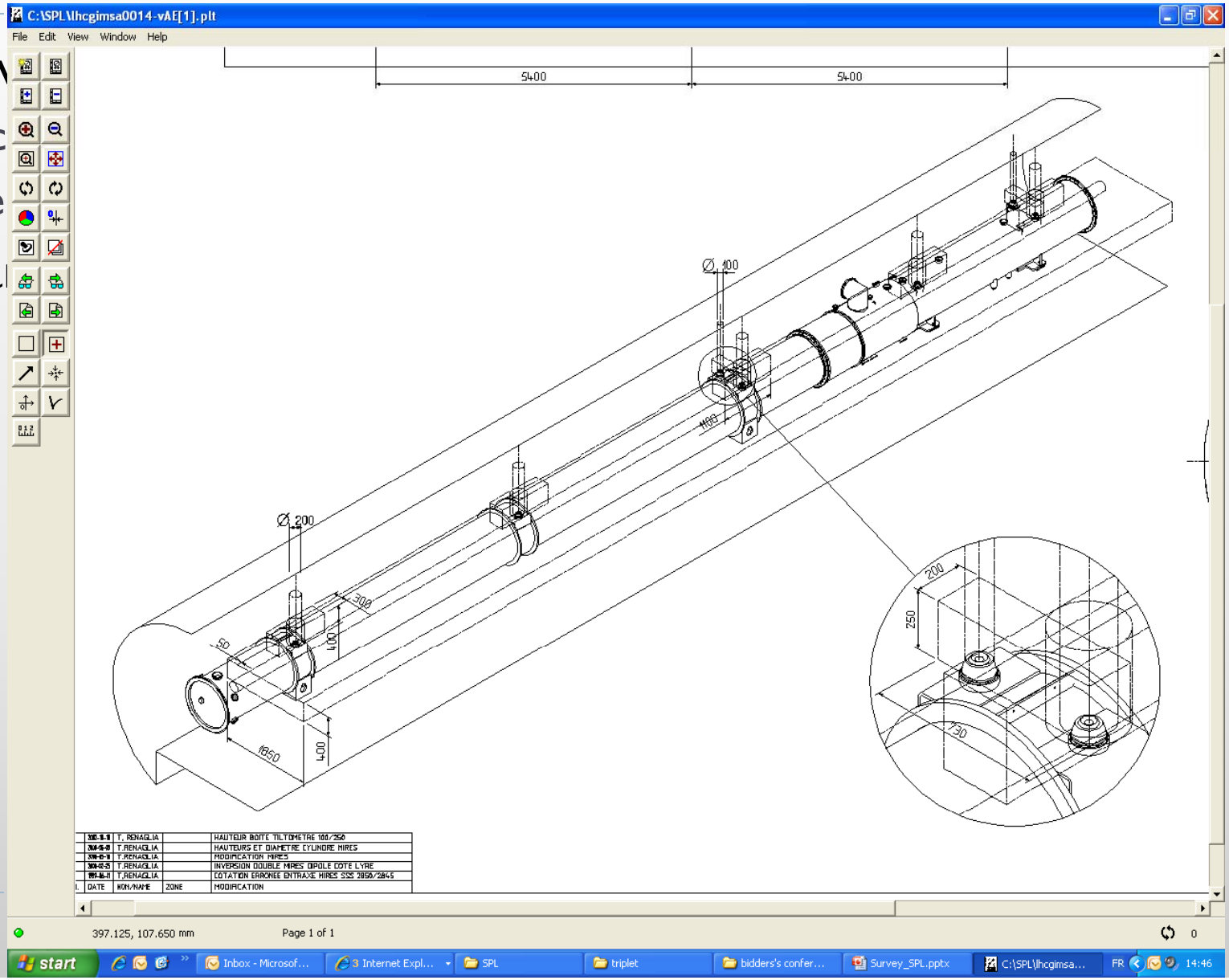
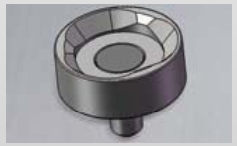


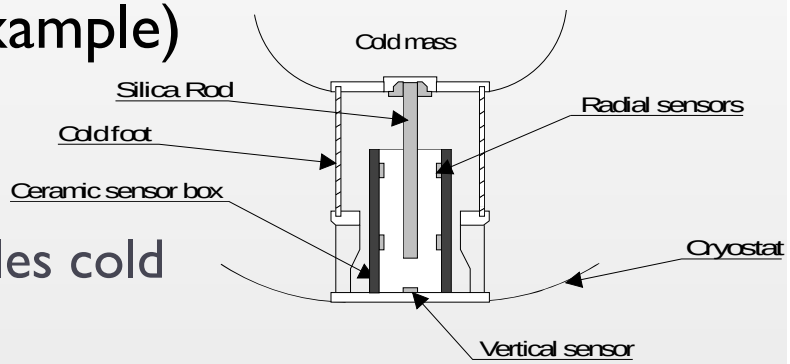
Mechanical Control Measurements

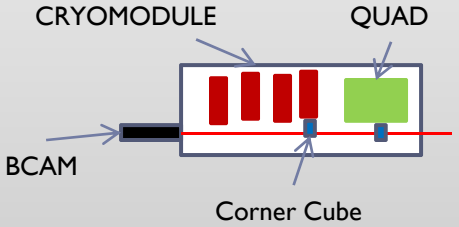
- Determination of the reference axis
  - Alignment of the string of cavities and quadrupoles with respect to a reference beam axis
- Determination of the position of the alignment fiducials w.r.t a reference axis
  - Measurement or adjustment of fiducials ?
- Could be done with a laser tracker
  - Same size of objects as the LHC dipoles => accuracy in the range of 0.07 mm at 1 sigma



Stability of the reference axis

- During the prototyping stage there is a need to verify the internal position of the components (axis of the quads for example) w.r.t fiducials
- SU Experience in this domain
  - Capacitive sensors inside the LHC dipoles cold foot
  - SMARTEC system
    - Interferometry with two laser fibers used on some prototypes of LHC dipoles cryostats
    - Still available at CERN
  - BCAM system as proposed for HIE-Isolde
    - CCD camera, lens and a corner cube (or another BCAM)
    - Never tested in cold conditions



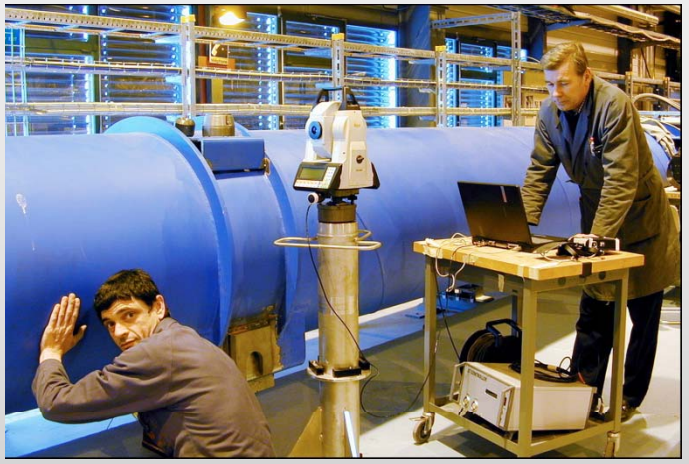


Geodetic Reference Networks

- Tunnel Geodetic Reference Network
  - Established as soon as the tunnel is accessible
  - Pillar based or points in the floor
  - Reference network for accelerator alignment activities
  - Network tied to existing machines (Linac4 and SPS if possible)
    - Transferred direct from the existing machines
    - If the link not available possibility that we need a shaft (to surface in the PS2 area or to TI2)
    - And Gyroscopic measurements also needed

Initial Positioning

- Constraints
  - After the geodetic reference network is established
  - The beam line MAD File inserted in the SURVEY database
  - Metrology work completed and element/module data available and inserted in the SURVEY database
  - Clear space must be maintained for Survey activities
    - Instruments
    - Survey reference targets
    - Positioning Systems
    - Measurement lines-of-sight



Initial Positioning (II)

- Carried out with a total station, nylon offsets, direct levelling, inclinometer
- Linac Modules and Elements
  - Alignment from geodetic reference network
- Line-of-sight holes used to ensure alignment from Linac4

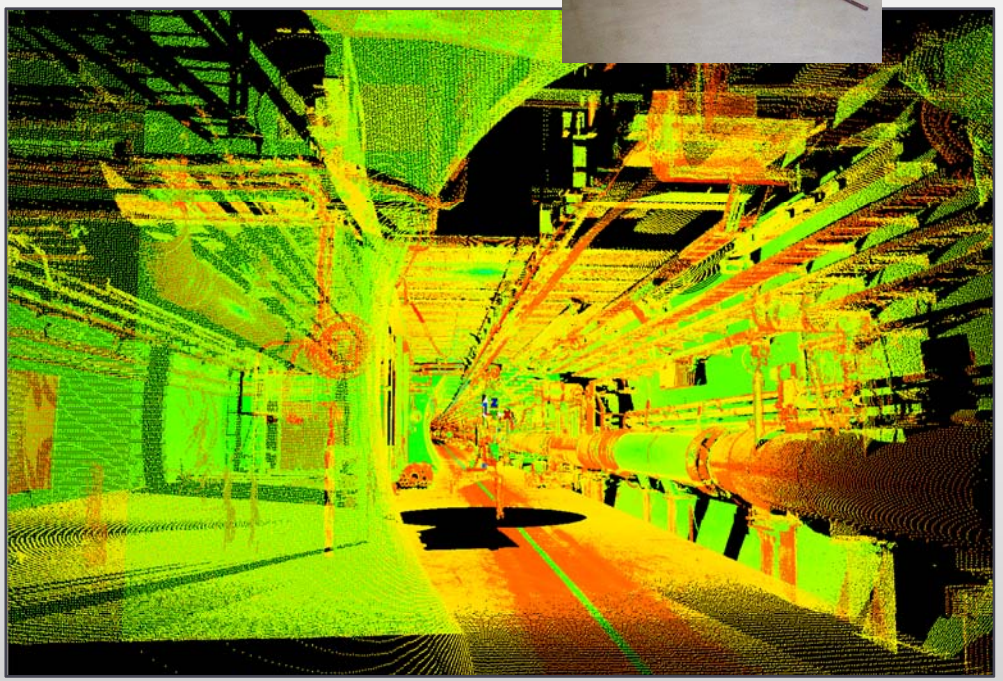
Final Alignment / Smoothing

- Constraints
  - After interconnection of elements, prior to commissioning
- Control tilts, vertical and horizontal positions
- Measurement directly on the beam line elements
  - Inclinometer, direct levelling, distances and nylon wire offsets
  - Installation of flexible plastic ducting for wire offset measurements

- Link to be done with adjacent lines (L4, SPS ?)

As-built Measurements

- Laser Scanner measurements
  - Provides 3D documentation
  - Saves time by indentifying potential conflicts
  - Civil engineering
  - Installed infrastructure
  - Machine
- Locations
  - Linac tunnel



Conclusions

- The alignment of the SPL is not really challenging
  - The alignment tolerances are not too tight
  - Problem could come from the late possibility to connect with a metrology SPL to the SPS => perhaps necessity to have a shaft to surface or a link to Ti2
  - Internal metrology will be more challenging
    - In particular monitoring of the cavities and quads with respect to external fiducials on the cryostat.

Thank you for your attention