

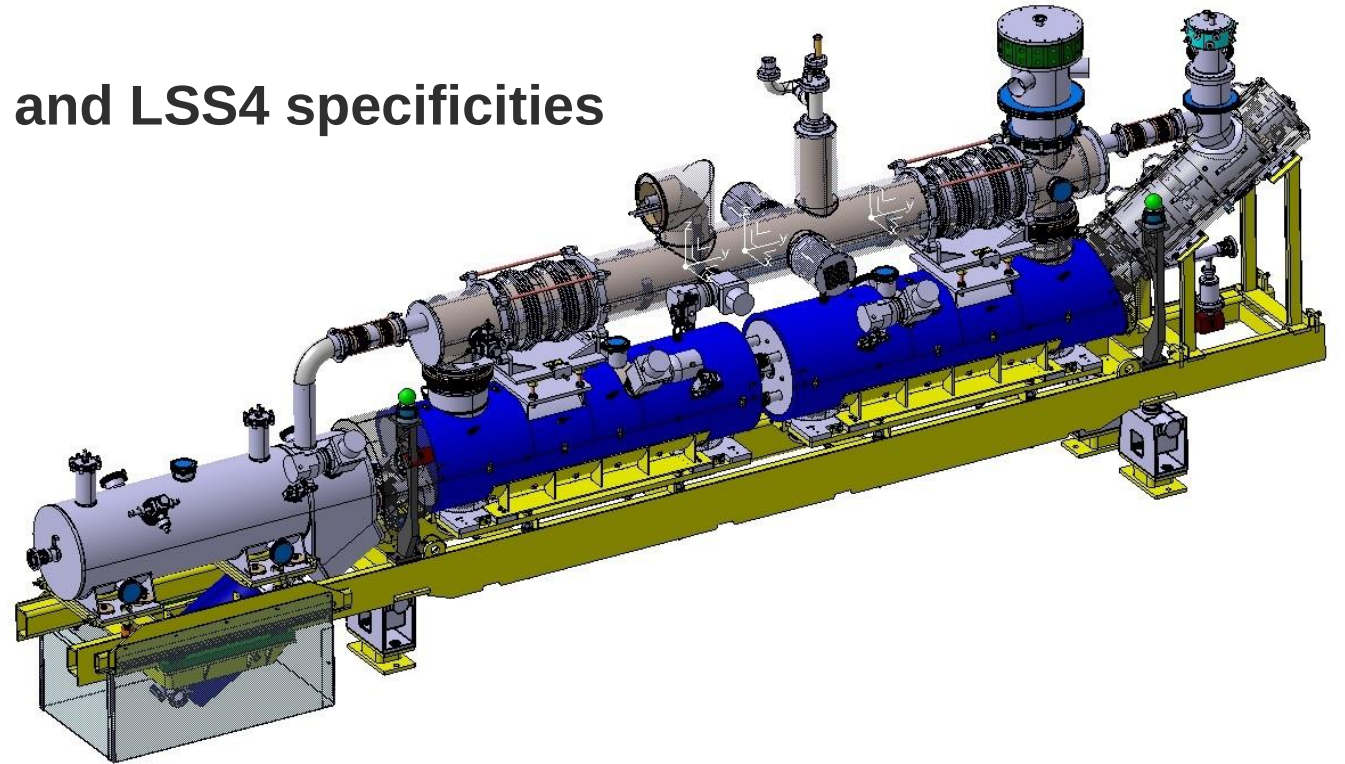
HEL metrology assembly activities and alignment in IR4

Jean-Frederic FUCHS

13.04.21

AGENDA

- Survey Requirements
- Metrology assembly activities
- Tunnel activities : Alignment process and LSS4 specificities
- Conclusion



Survey Requirements

Guidelines and requirements for an alignment of a new component

- The document will be published on EDMS in few weeks

The standard tolerance for an alignment of a component, sometimes weighing several tons, is about two tenth of millimeter. Such an accurate challenge cannot be guarantee without many steps following the survey requirements.

The document will present all the survey specifications from the initial design to the installation and alignment of a new component on a beam line at CERN.

This document should be read carefully and taken in account by the Equipment Owner and the integration / design team

[GUIDELINES]

Guidelines and requirements for an alignment of a new component on a beam line at CERN

Accelerators Survey & Geodesy (BE-GM-ASG)

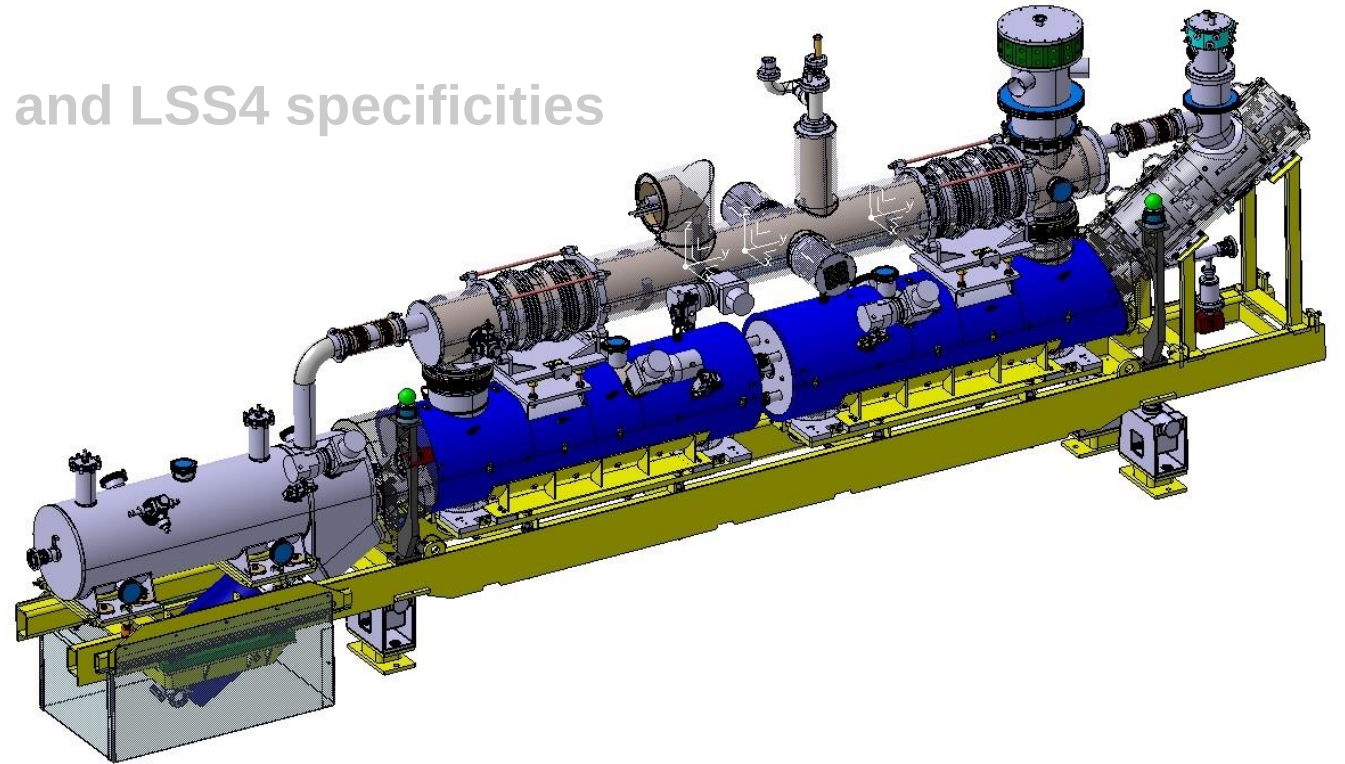
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Jean-Frederic FUCHS

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Metrology assembly activities

The **BE-GM-ASG** section has an expertise in laser tracker measurements

Metrology assembly activity will be a **key point** of the HEL project

BE-GM-ASG shall be associated to all owner requests for the activities related to geometrical validation or/and during assembly phases.

In collaboration with BE-GM-ASG:

- The **assembly strategy** shall be **clarified** by the equipment owner,
- The **workflow and tolerances** shall be **documented**,
- Interaction and assembly activities with BINP shall be **clarified**,
- **Responsibilities** shall be **clarified**,



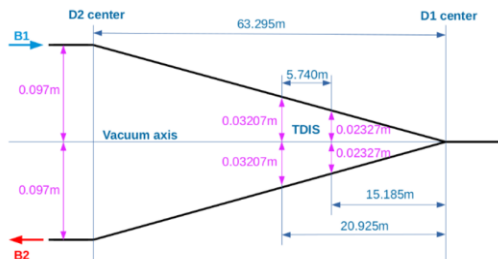
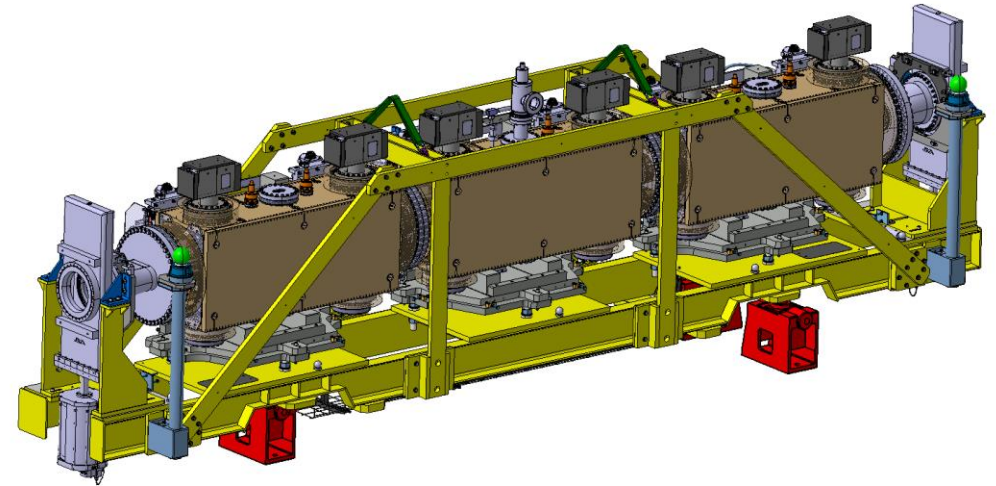
Metrology assembly activities

The both TDIS installed during LS2 can be considered as “similar component” :

- **The TDIS team feedback will be fruitful for HEL project**
- **Some survey feedback and lessons learnt for HEL project :**

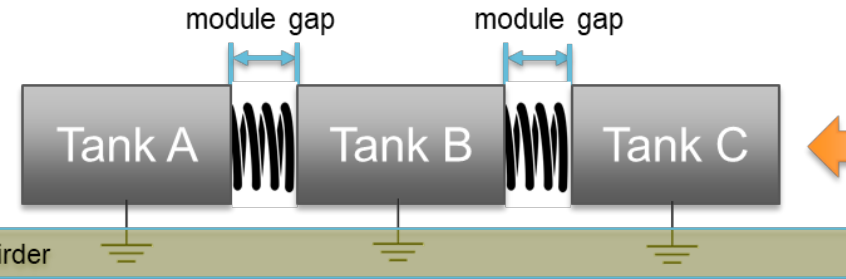
- ✓ The Layout DB is based on the “average beam” while the Survey DB considers the circulating beam (B1 / B2) since ~ 2009
- ✓ Nominal data / position are given by the beam points (MADx, LDB). The orbit bumps are not involved as SU nominal data (please consider that : bump can be added following beam base alignment request)
- ✓ The drawings should be prepared by the Equipment Owner and approved before the survey activities. Survey should be part of the approval process.
 - ✓ The component drawings should clarify the component axis w.r.t. the beam axis defined by the beam points.
 - ✓ The installation drawings should take in account the “tunnel configuration” (slope, roll, beam,).
- ✓ Survey will not execute any marking out or tracing activity without an approved drawing (slope, roll, ..) and request clarification
- ✓ Survey brings support following equipment owner request : meeting are needed for a better communication and survey report should be analyzed by the equipment owner
- ✓ Survey should be included in the first discussion and the equipment owner should follow the survey recommendations
- ✓ For the TDIS : an additional “fiducialisation” is needed after transportation as the girder is not stable enough (exceptional situation),
- ✓ For the TDIS : a second alignment after vacuum is needed as the TDIS modules are not stable enough (exceptional situation),

TDIS-specific alignment procedure is under preparation by Survey, EN-STI will be in the approval process ([EDMS 2433171](#))



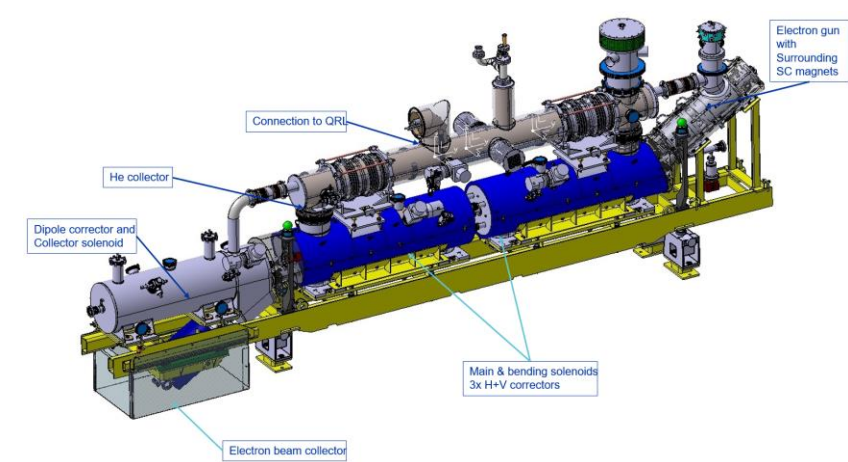
Trajectories used by survey team for alignment

F = 1.4 tons



F = 1.4 tons

Metrology assembly activities

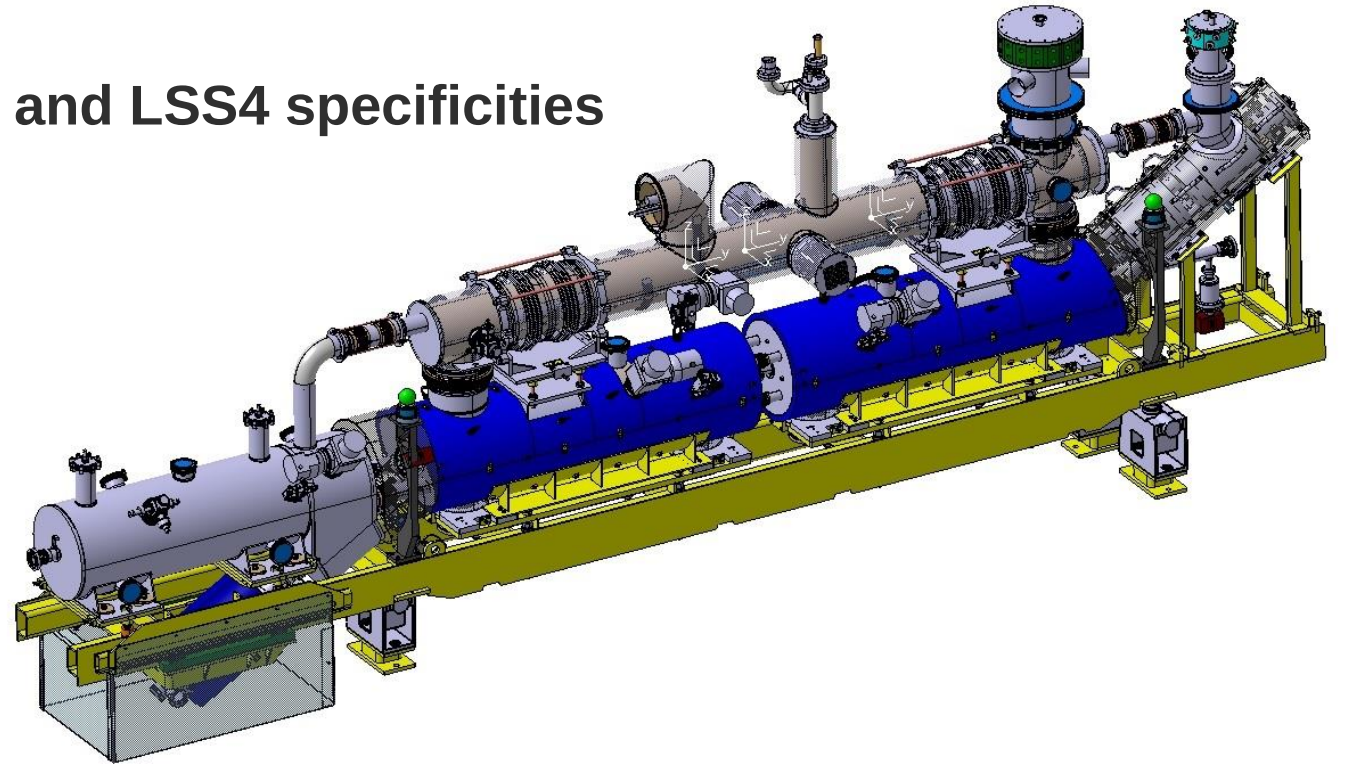


HEL project will be challenging :

- This complex module assembly will need a **well-defined survey strategy** with additional reference points on the girder / components (to be discussed),
- **Metrology assembly activities will be shared with BINP** : efficient communication will be needed combined with a Knowledge Transfer (including documentation, visit and measurements in Russia),
- **The design** of the components and **associated alignment supports shall integrate survey requirements** :
 - The **girder rigidity** will be **critical** and should be taken into account in the design (load test is needed),
 - The **connection between components** should not affect the adjacent alignment,
 - The **“connection QRL components” installation** must not affect the alignment (!),
 - **Transport** should not affect the component stability and alignment (fiducialisation parameters),
- **Important additional workload for survey** considering the 3 assemblies (HEL-0, HEL-1, HEL-2).

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Alignment process

HiLumi
HL-LHC Integration meeting in June 2017
<https://indico.cern.ch/event/574329/>

LSS4 alignment & HEL integration

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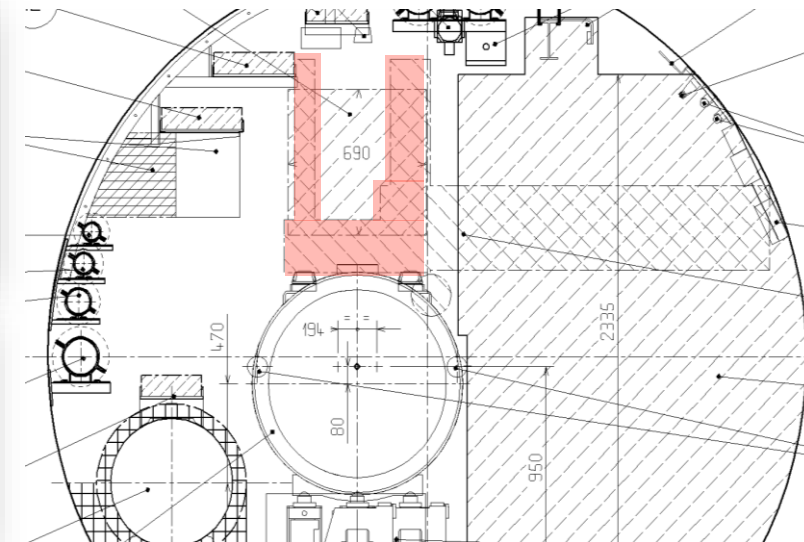
HL-LHC integration meeting - 30/06/2017

LSS Survey smoothing process (LHC)

1. Main magnet alignment (vertical / radial)
2. Secondary component alignment (vertical / radial) using the main magnet as references

Survey constraints

- Line of sight dedicated for survey measurements : **HEL will be installed inside the survey reservation !**



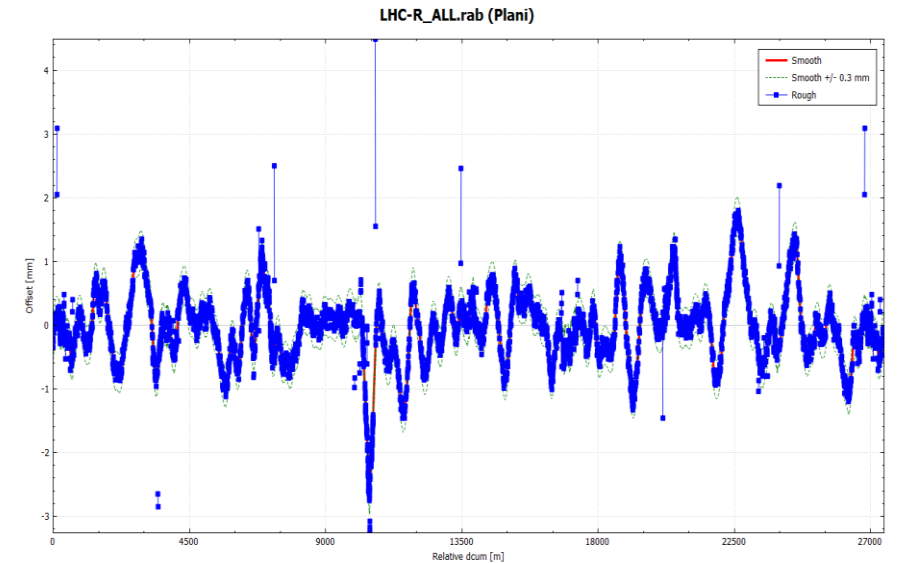
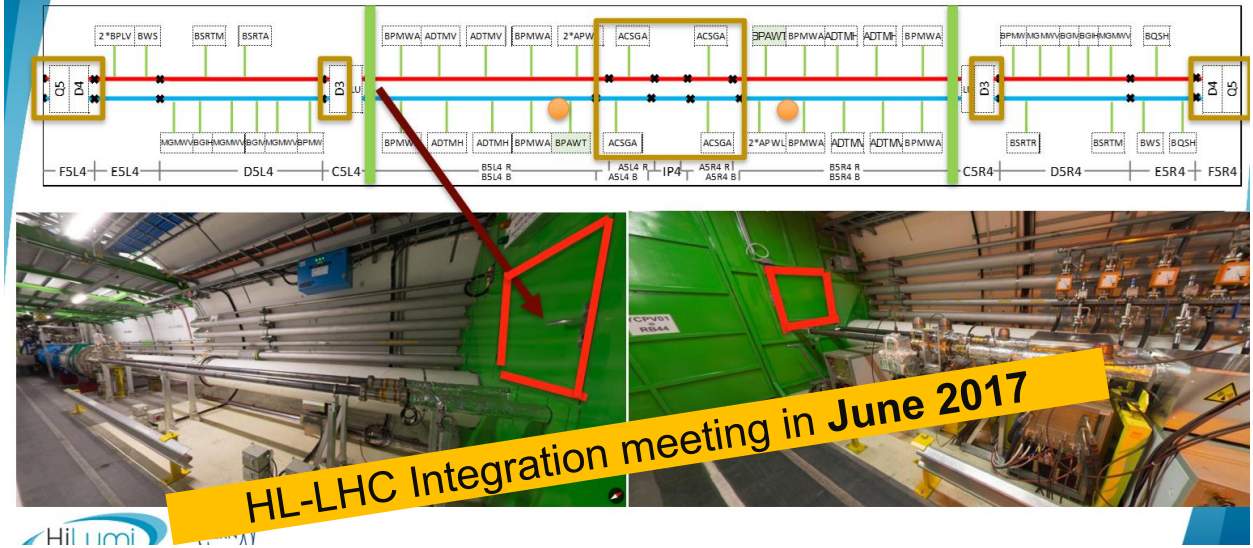
LSS4

LSS4 is a specific and complex area

- Lack of main magnets
- RF cavities in the IR4 center
- Green doors between D3 ☑ survey use the windows
- Many secondary components
- The “duct protection” cannot be used (rails / LSS axis) ☑ Airflow perturbation during wire measurements
- LS1 feedback ☑ LS2 consolidation with a new strategy

The LSS4 is the most complex area in LHC
The HEL will be a major obstacle for the survey process by blocking the survey volume

LSS4 from Q5 to Q5

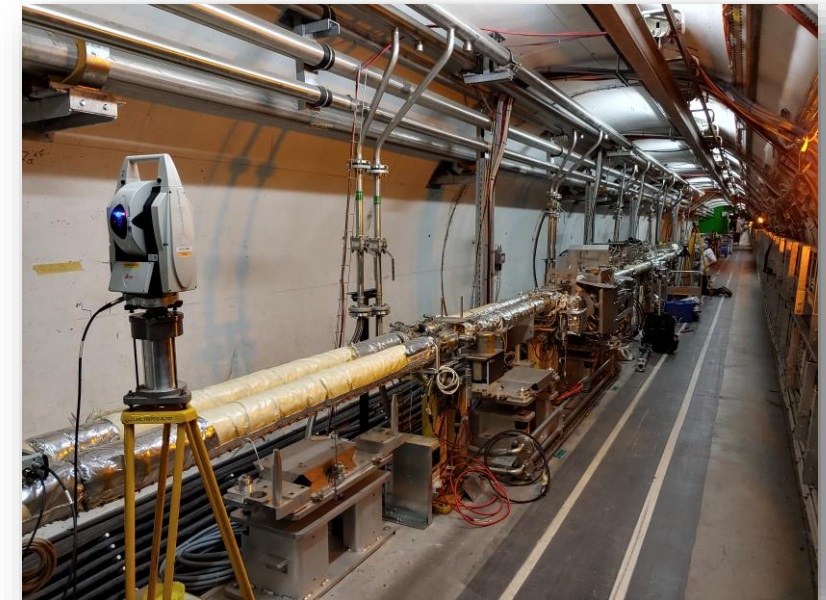
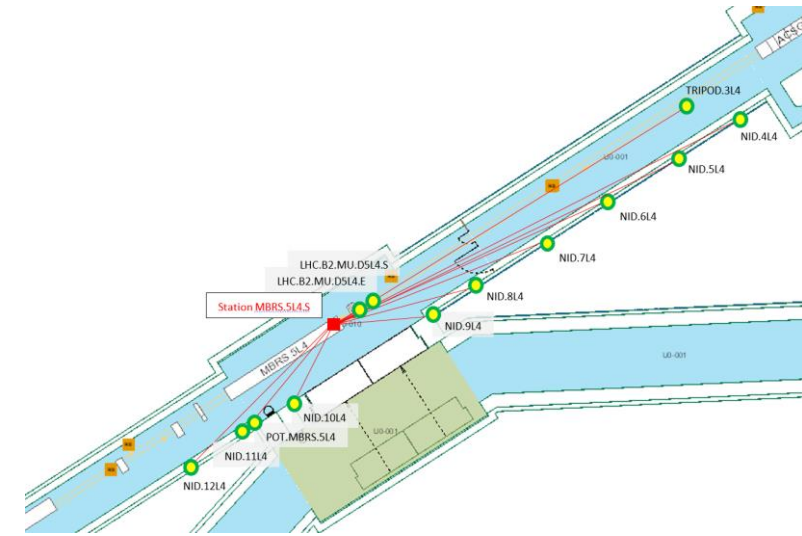


LSS4 strategy and HEL alignment

A new challenging survey strategy shall be defined for LSS4

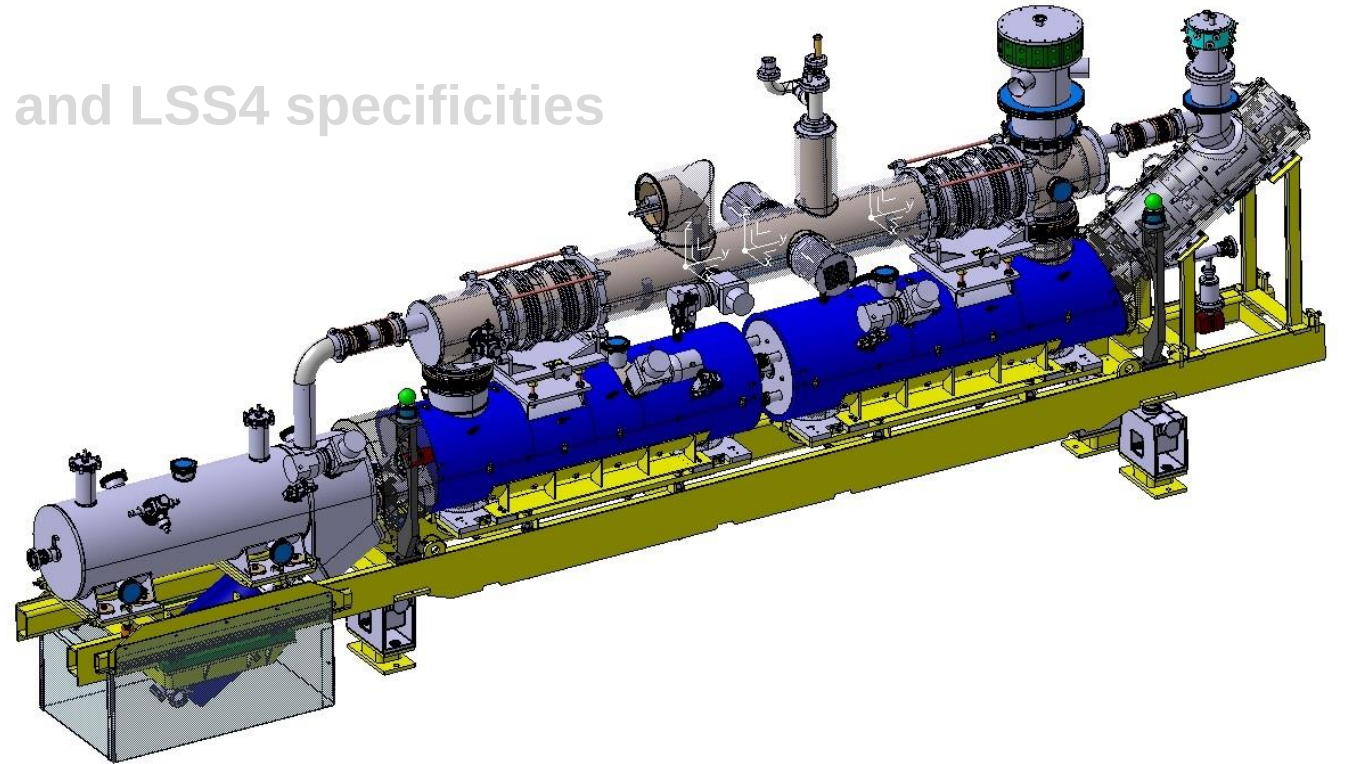
- New network configuration,
- Software simulations,
- New measurements methods will be implemented,
- Global LSS4 measurement during a YETS,
- **Validation of the new strategy before LS3.**

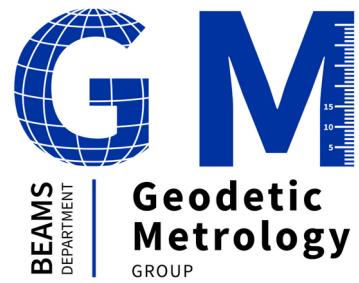
The HEL installation will have a **major and long term effect** for all the LSS4 smoothing campaign as a not standard process will need to be applied.



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