The critical zones around IP1 and IP5

4. For collimation we also need to change the DS in the continuous cryostat: 11T Nb$_3$Sn dipole

3. Need also to modify a large part of the matching section e.g. Crab Cavities & D1, D2 & corrector

2. Need also to change TAS and TAN passive absorbers and collimators → TAXS and TAXN

1. New triplet Nb$_3$Sn required due to:
   - Radiation damage
   - Need for more aperture

Changing the triplet region is not enough for reaching the HL-LHC goal!

- More than 1.2 km of LHC !
- Plus technical infrastructure (e.g. Cryo & Powering)
- Alignment and aperture are critical for HL-LHC performance reach!!!
New underground structures for the HL_LHC!
HL-LHC Insertion Regions around Experiments

**Insertion Layout:**

- D2
- D1
- Triplet

**Parallel to point focusing of triplet:**

- Offset of the triplet magnets generates transverse shift of the bunches at the IP equal to the triplet offset
  - \( \sigma = 7.5 \mu \text{m} \)
  - 4 \( \mu \text{m} \) triplet alignment error separates the beams at the IP

- Operation requires regular orbit correction along the Matching Section
- Requires sufficient aperture margins in the elements of the Matching Section or regular re-alignment campaigns
- HL-LHC proposes a fully remote alignment system to cope with the radiation environment and to allow regular alignment campaigns
Alignment of Active components Inside a Cryostat

Crab Cavities 
Superconducting magnets

Requires innovative solutions for high precision Internal Metrology!
Mandate of the review:
The main objective is to review the alignment solutions foreseen for HL-LHC, with a focus on the internal metrology, the monitoring of inner triplet cold masses and crab cavities inside their cryostat and full remote alignment systems.

Scope of the review:
The scope of this review is:
To examine the soundness of the proposed solutions individually and as a global system;
To verify that all requirements from equipment owners and machine operation are duly covered;
To check that the interfaces between WP15.4 and the other WPs are clear;
To check the readiness of the solutions proposed and evaluate the associated risk if any;
To evaluate the related test plan, acceptance criteria and the overall schedule;
To examine the procurement strategy, identifying possible risks;
To put in evidence possible integration issues and safety aspects.
Review of the HL-LHC Alignment and internal Metrology

Review Panel members:
Georg Gassner (SLAC, Chairman),
Johannes Prenting (DESY),
Jean-Philippe Tock (CERN) and
Jörg Wenninger (CERN)
Horst Friedsam (FNAL) via remote connection.

Secretarial support: Elodie Kurzen

Scientific secretary: Mark Jones

Review link persons: Hélène Mainaud Durand and Paolo Fessia.
**TAXNB** – absorber of neutrals - necessary for the LHCb upgrade
First hardware for HiLumi (installation Sept’19)

The new precise alignment tables for TANB.
The 2 TANB ready for installation

HiLumi WP8 – Collider-Experiment interface (EN-EA)