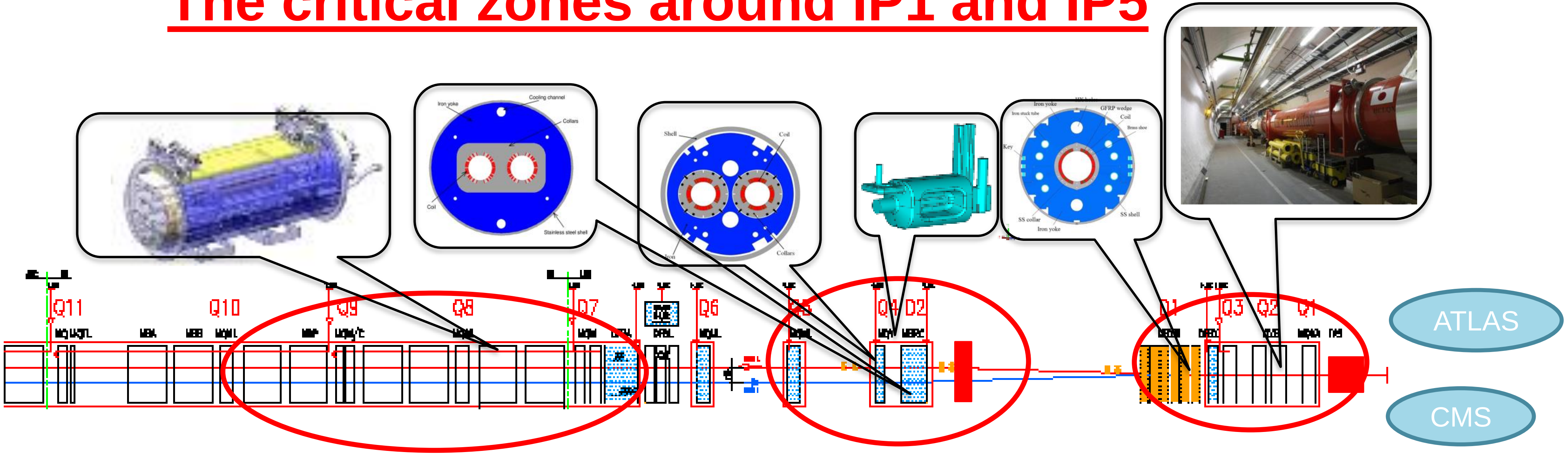
The critical zones around IP1 and IP5



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

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

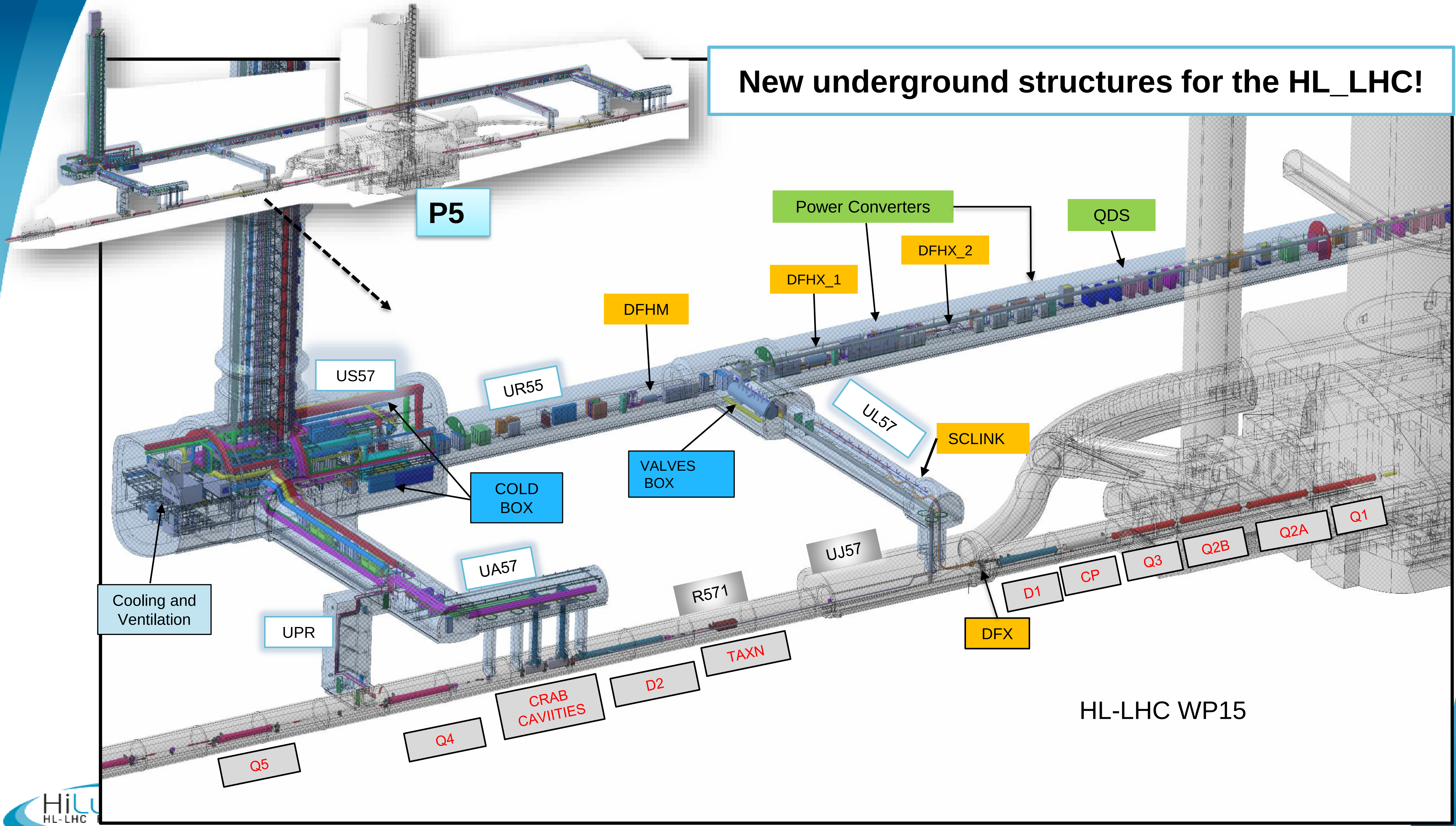
2. Need also to change TAS and TAN passive absorbers and collimators ➔ TAXS and TAXN

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!

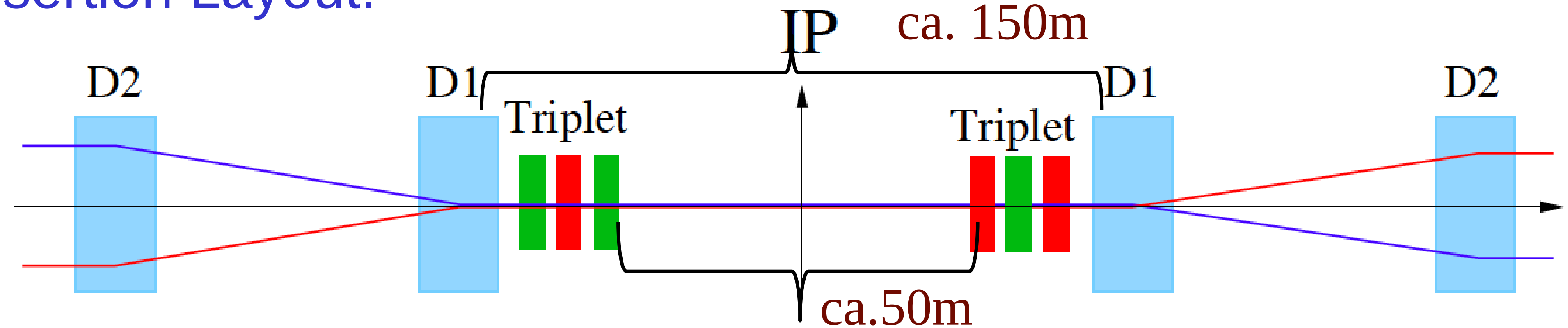
- ➔ **More than 1.2 km of LHC !!**
- ➔ **Plus technical infrastructure (e.g. Cryo & Powering)**
- ➔ **Alignment and aperture are critical for HL-LHC performance reach!!!**

New underground structures for the HL_LHC!



HL-LHC Insertion Regions around Experiments

🟩 Insertion Layout:



🟩 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

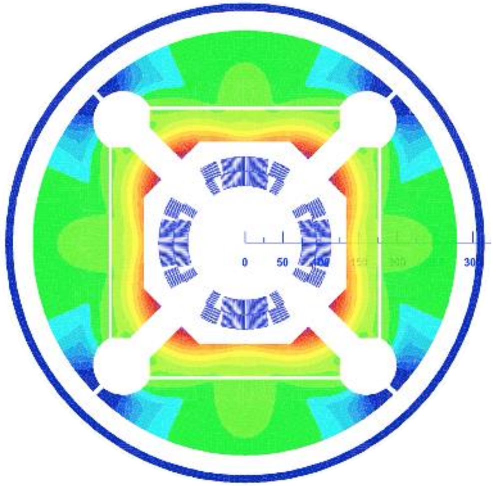
➔ σ = 7.5μm ➔ 4μm triplet alignment error separates the beams at the IP

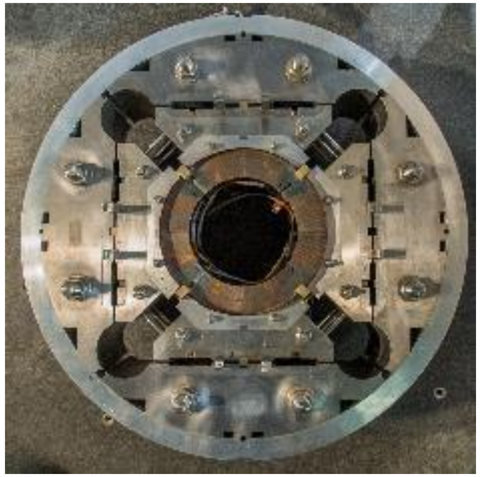
- ➔ Operation requires regular orbit correction along the Matching Section
- ➔ Requires sufficient aperture margins in the elements of the Matching Section or regular re-alignment campaigns
- ➔ HL-LHC proposes a fully remote alignment system to cope with the radiation environment and to allow regular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

Alignment of Active components Inside a Cryostat

Crab Cavities

Superconducting magnets





Requires innovative solutions for high precision Internal Metrology!

Review of the HL-LHC Alignment and 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)

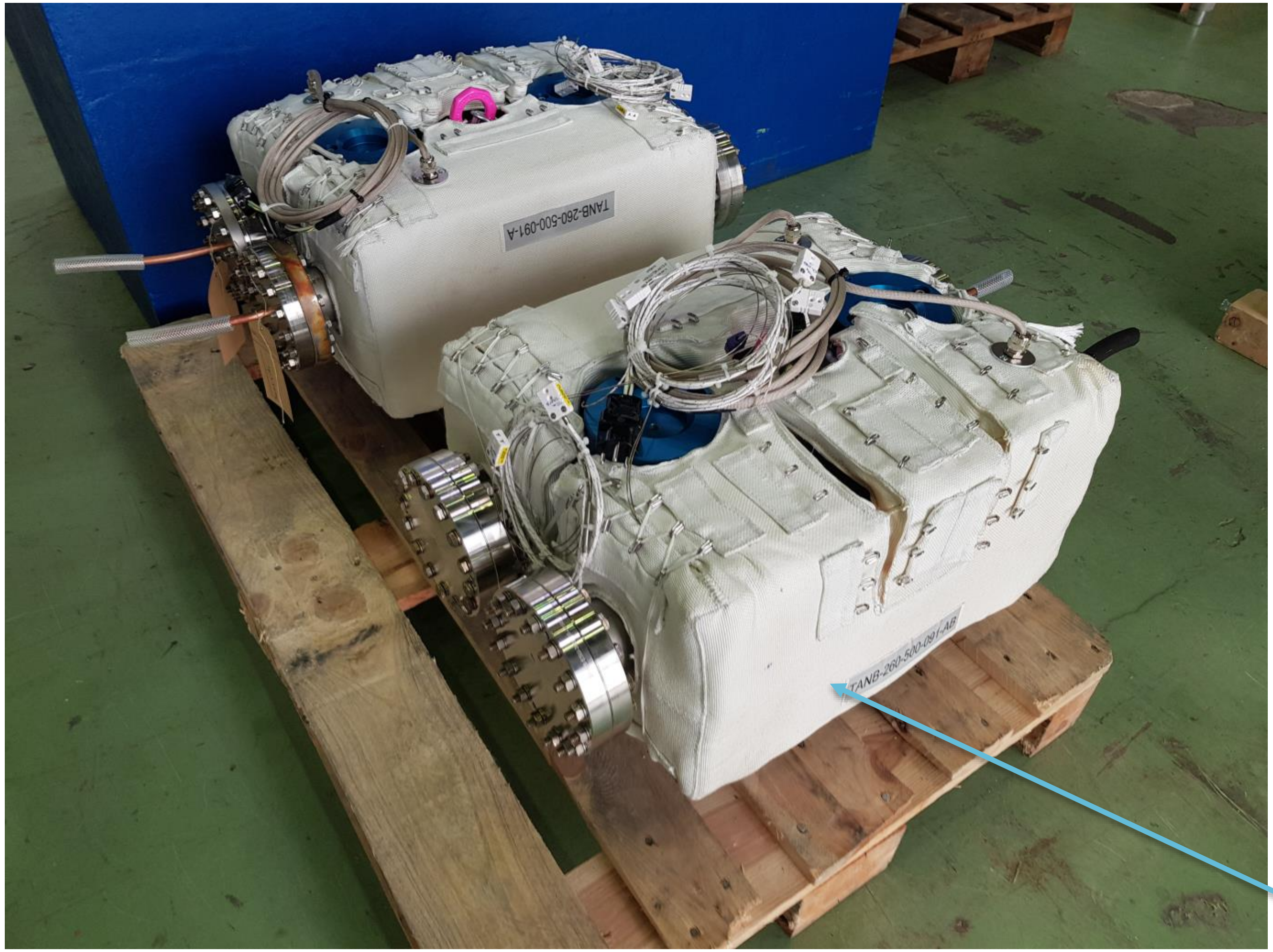
Horst Friedsam (FNAL) via remote connection.

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 harware for HiLumi (installation Sept'19)



The new precise alignement tables for TANB.

The 2 TANB ready for installation

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