

EVALUATION OF LHeC RING-RING INSTALLATION ISSUES

Discussions with:

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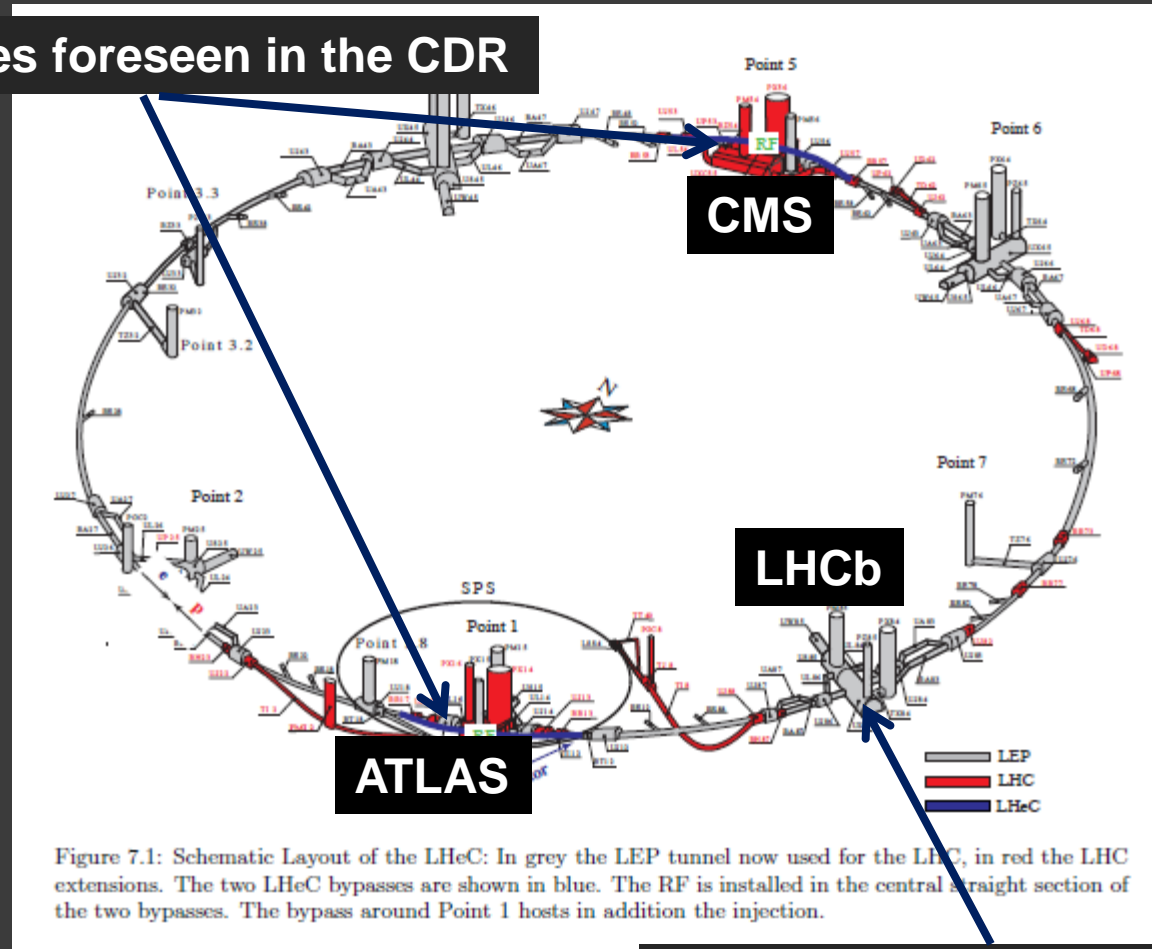
Many thanks to all

Overview

- ⦿ **Ring-Ring Geometry**
- ⦿ **Junction of the e-ring by-passes with LHC tunnel**
- ⦿ **Integration challenges**
- ⦿ **Machine protection**
- ⦿ **Installation schedule**

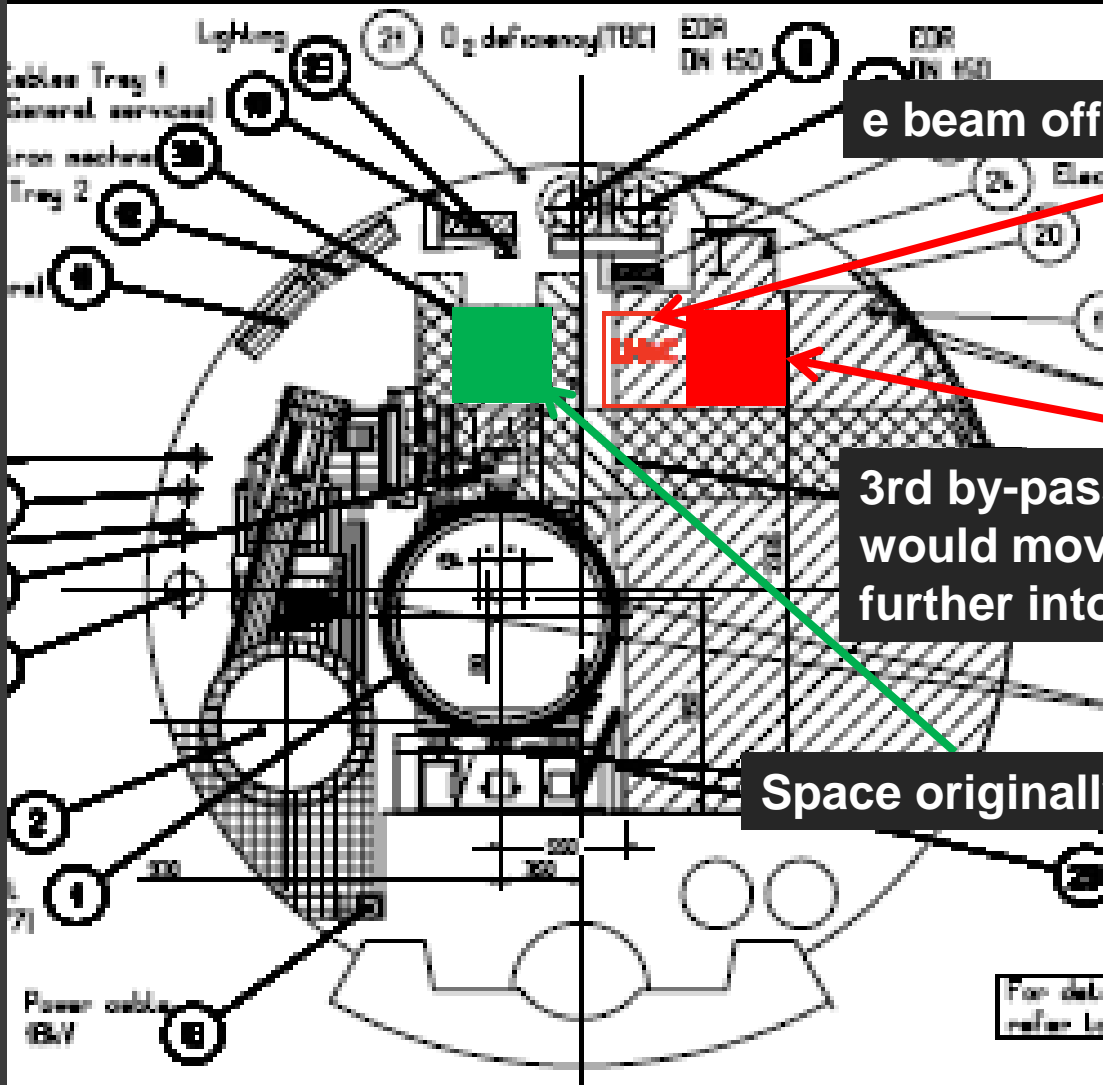
Geometry of the LHeC Ring-Ring option

Two by-passes foreseen in the CDR



Need to consider a 3rd by-pass

compensation for additional by-pass lengths



e beam offset of 61cm / LHC mean axis

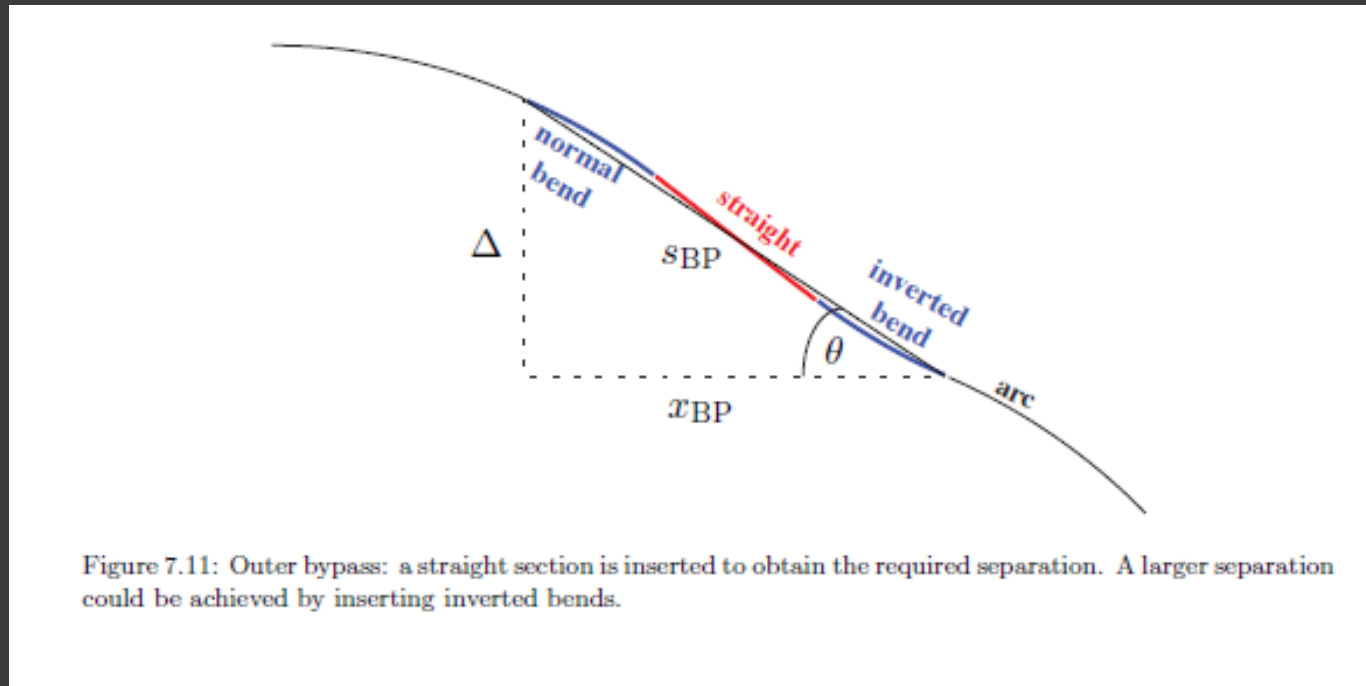
**3rd by-pass length compensation
would move the beam ~30cm
further into the transport reserved area**

Space originally allocated to a future e ring

Geometry of the LHeC Ring-Ring option

- ⦿ Compensation of the by-passes lengths brings the e-ring into the LHC transport area;
 - ⦿ Sliding supports required to move out the e-ring will be very delicate (precision, stability);
 - ⦿ Integration in the existing installation has to cope with all intermediate positions;
 - ⦿ Need to separate elements or synchronize movements along un-interrupted sections.
- ➔ **There is a strong incentive to review the requirement of equal lengths of the proton and electron rings**

Junction of the e-ring by-passes with LHC tunnel

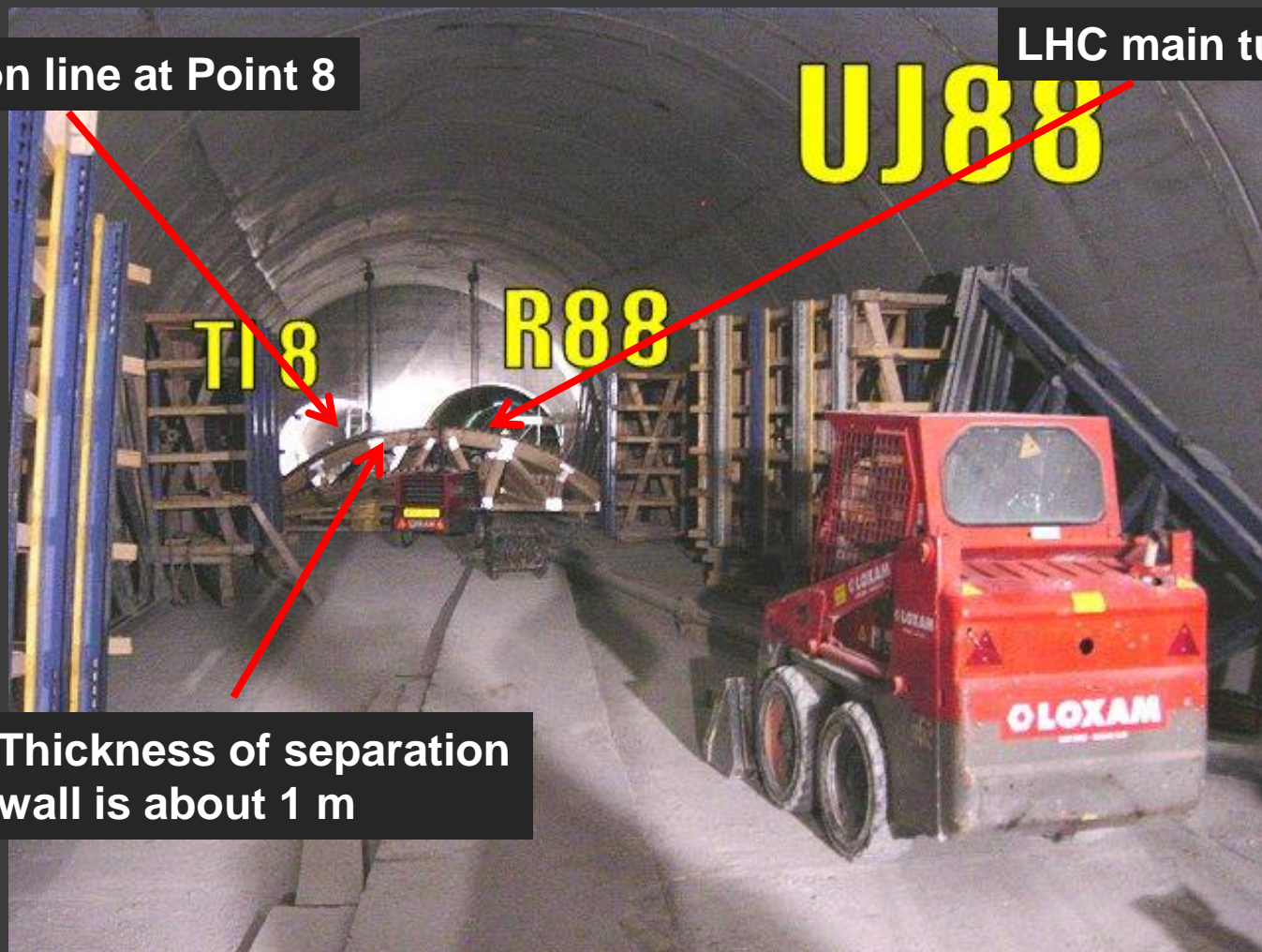


The bending radius of the LHC dipoles is 2804 m
→ an electron beam going straight needs 75 m to move 1 m sideways from the proton trajectory

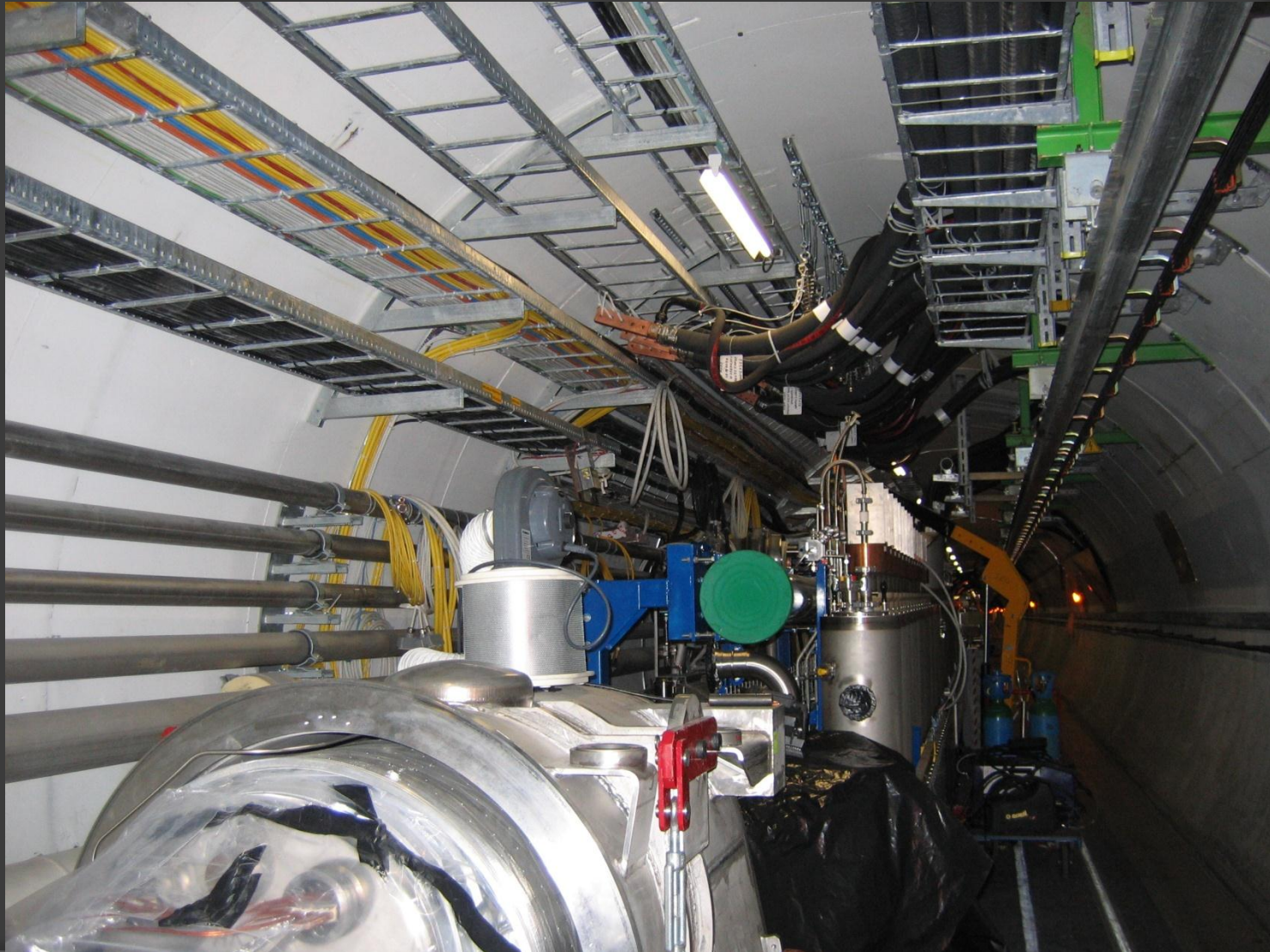
Junction of the e-ring by-passes with LHC tunnel

Injection line at Point 8

LHC main tunnel



Integration challenges



Integration challenges and Machine protection

- ⦿ Access to equipment for maintenance and repair has to be maintained;
- ⦿ Many areas will be highly activated as LHC luminosity increase:
 - ➔ Interventions need to be optimized to keep workers expositions below acceptable threshold;
- ⦿ LHC beam loss monitors will be sensitive to synchrotron radiation from the e-beam:
 - ➔ Shielding of monitors means extra space, extra material activated and also extra difficulties/time for interventions.

Installation schedule:

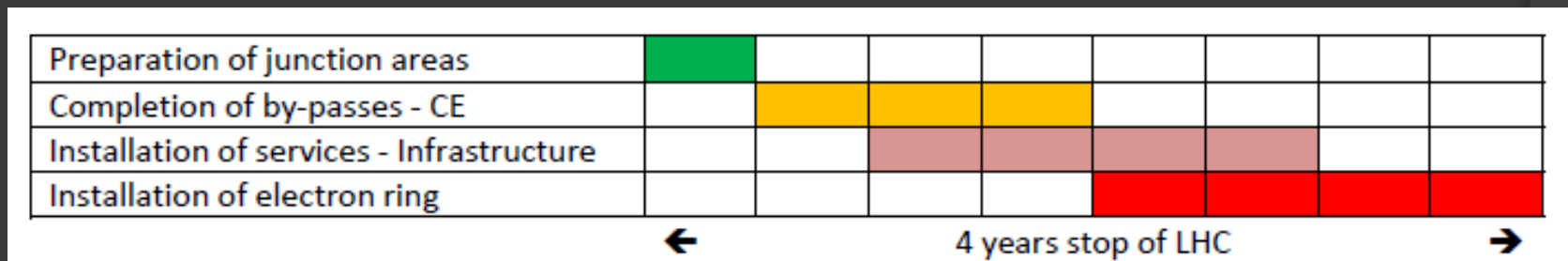
Interference with LHC operation

- ⦿ CE for new shafts and klystron galleries can probably proceed while LHC is running;
- ⦿ However, it is not the case of the by-passes:
 - ➔ we need 7m of earth to shield a working area from an accidental LHC beam loss;
- ⦿ Need to dismount LHC in the junction areas to be digged:
 - The cryo-magnets would be disconnected and stored on surface,
 - The cryo-line would also be dismounted,
 - All services have to be removed,
 - The CE work-site has to be sealed for dust, but ventilation must be maintained in the LHC to control temperature/dew point.
 - ➔ Assume **~6 months** before CE can start in the junction areas

Installation schedule:

Interference with LHC operation

- CE to complete the first junction areas (digging, water-proofing, concreting) would take **~6 months**;
- The completion of the 3 by-passes (1km each) and of the 6 junction areas would take another year (see John Osborne)
- The installation of services for the e-ring can be evaluated to last **2 years** (LEP and LHC experience), out of which 1 year overlaps with civil engineering;
- The installation of the e-ring elements would also take 2 years, out of which half could overlap with the services:
 - **~1 year** of installation on the critical path
 - the re-installation and commissioning of LHC could occur in // (managing of co-activities will be challenging)



Summary

- ⦿ The LHeC CDR is very complete and addresses most of the issues presented
- ⦿ The complete integration study will be challenging:
 - Number of by-passes must be reviewed
 - Constraints on e-ring circumferences must be clarified
 - Interventions must be optimized in light of RP requirements
- ⦿ The installation of the e-ring in the LHC tunnel will have a strong impact on the LHC operation