Towards an optics baseline for HE-LHC

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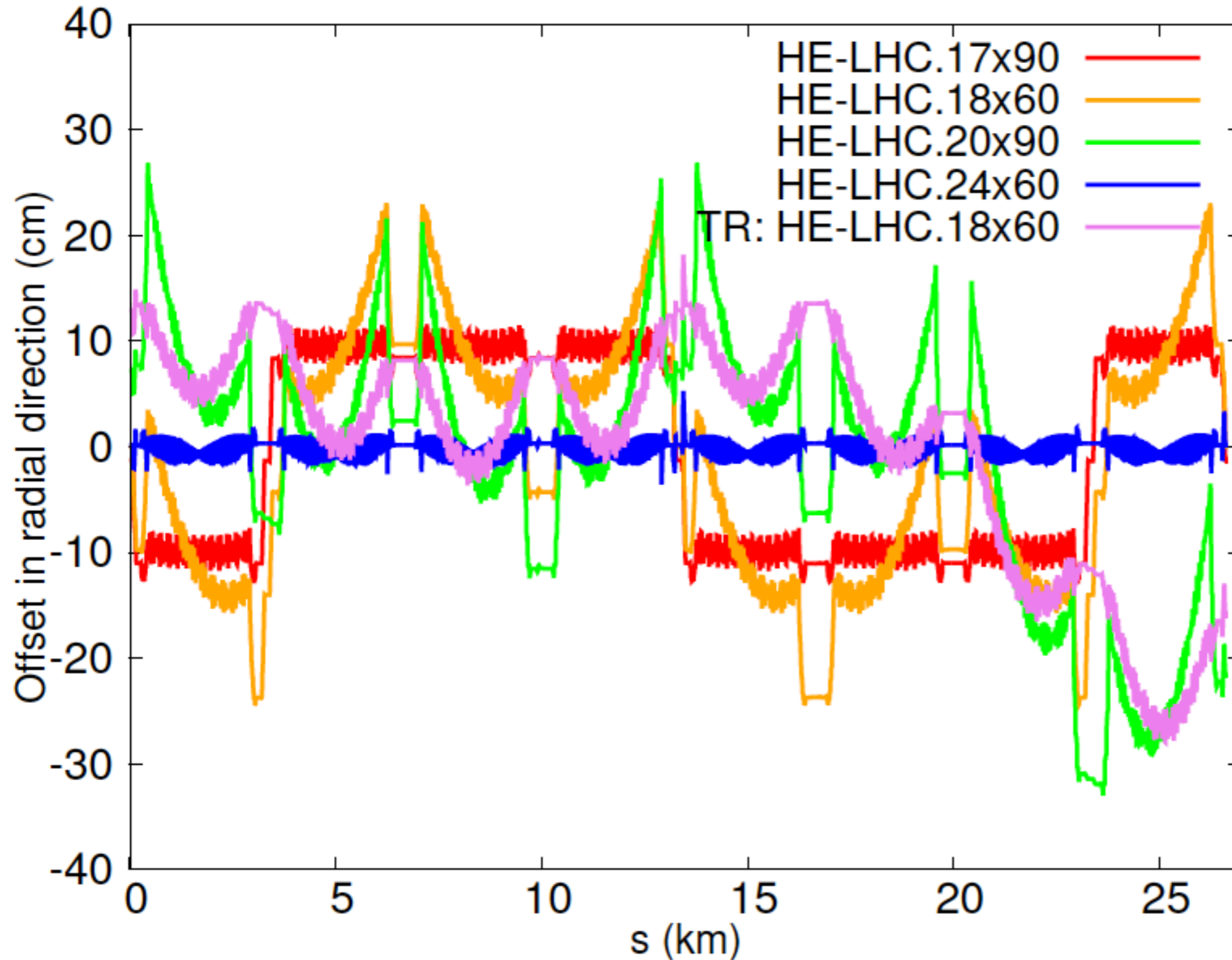5th HE-LHC optics meeting, CERN, Sep. 26, 2017

Outline

➤ **MADX files for HE-LHC optics**

- **Survey**
- **Messages from Thys and J. Jowett**

➤ **Summary and Future plan**

1. MADX files for HE-LHC optics
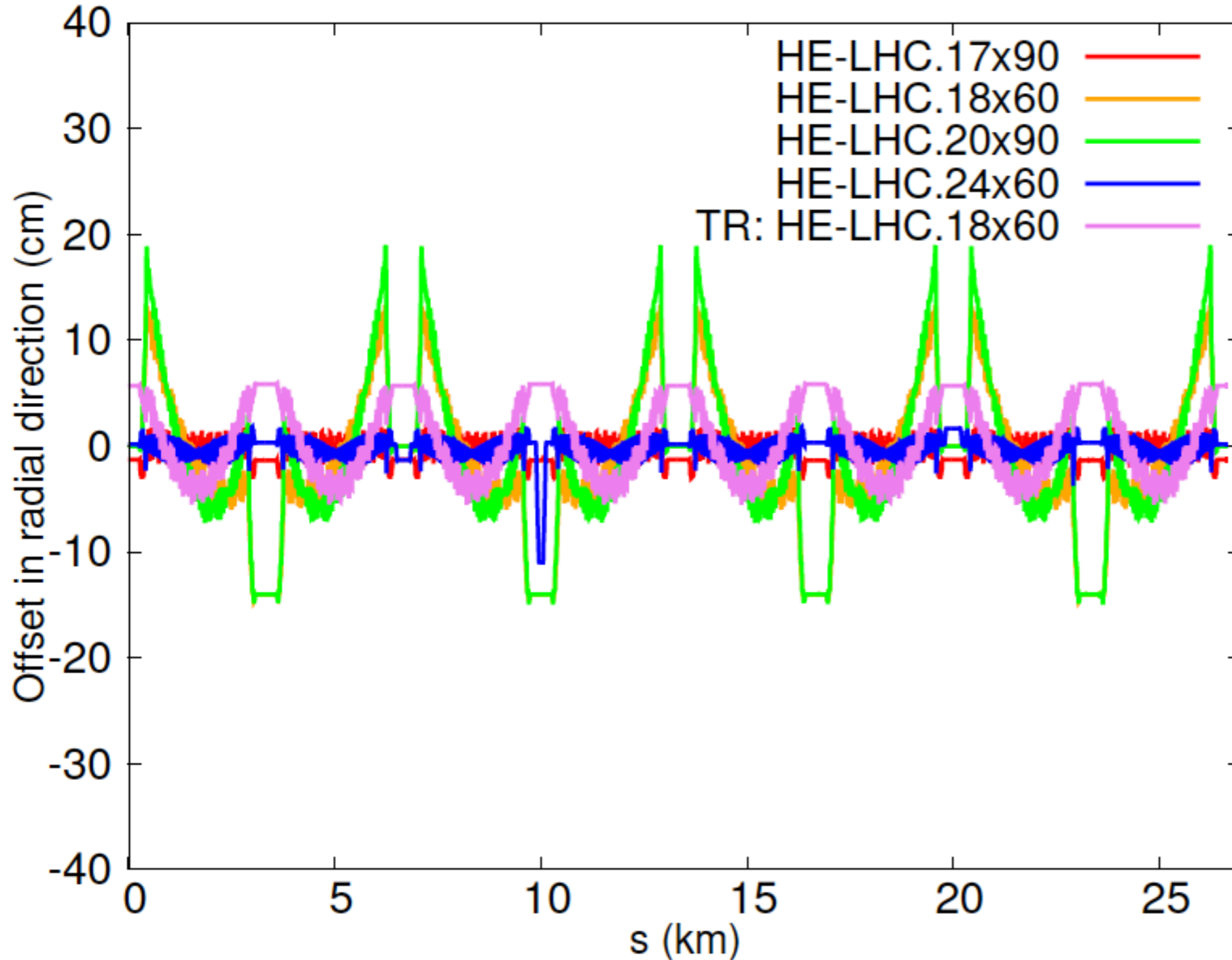
➤ Ring survey

- **Comparison with LHC V6.503**

Ring separation:
LHC V6.503: 194 mm
17x90: 204 mm
18x60: 204 mm
20x90: 204 mm
24x60: 194 mm

1. MADX files for HE-LHC optics

➤ **Ring survey**

- **Comparison with LHC V6.503 with zero beam separation**

Consistent with Thys's calculations:

sequence file name	p.to.p
merged_HE-LHC.seq	4 cm
merged_HE-LHC.18x60_tr.seq	11 cm
merged_HE-LHC.18x60_v102.seq	27 cm
merged_HE-LHC.20x90_v200_5657.seq	17 cm
merged_HE-LHC.17x90_tr.seq	4 cm
merged_HE-LHC.20x90_v201.seq	33 cm

1. MADX files for HE-LHC optics

➤ **Messages from Thys**

    ● **DS: inner-outer path length differences in main bends**

       The geometry of the two beams is organized as follows in the LHC sequence files. A parameter "DS" indicates the half path length difference in each main bend between the inner and outer aperture. Its value is used to adjust the longitudinal position ("s" value) of each element in the sequence. Without this correction the geometry error after one turn is about 30 cm.

       DS was implemented in the first lattice (24x60), but not for the following lattices (18x60/90, 20x90, 17x90).

    ● **R0: "ring 0", or the "average beam".**

       It is an imaginary trajectory running half-way between the two beams.

       Currently we use the "average beam" of LHC as a reference to define the geometry of HE-LHC. But it is not enough!

   ● **LEP survey: The ideal reference for HE-LHC geometry.**

       The LHC orbit has an offset of **8 cm** w.r.t. the LEP orbit (and presumably the LEP tunnel, see LHC design report) in the region of the dispersion suppressors.

       Need to contact CERN Survey Group for LEP survey data. Has contacted John Jowett and got positive response: MAD8 file is available, but needs to be translated to MADX tfs format.

    ● **Improvement of HE-LHC geometry is doable, but mostly by hand: NO automatic definitions => Need narrow down choices of lattices!**

1. MADX files for HE-LHC optics

➤ Ring survey
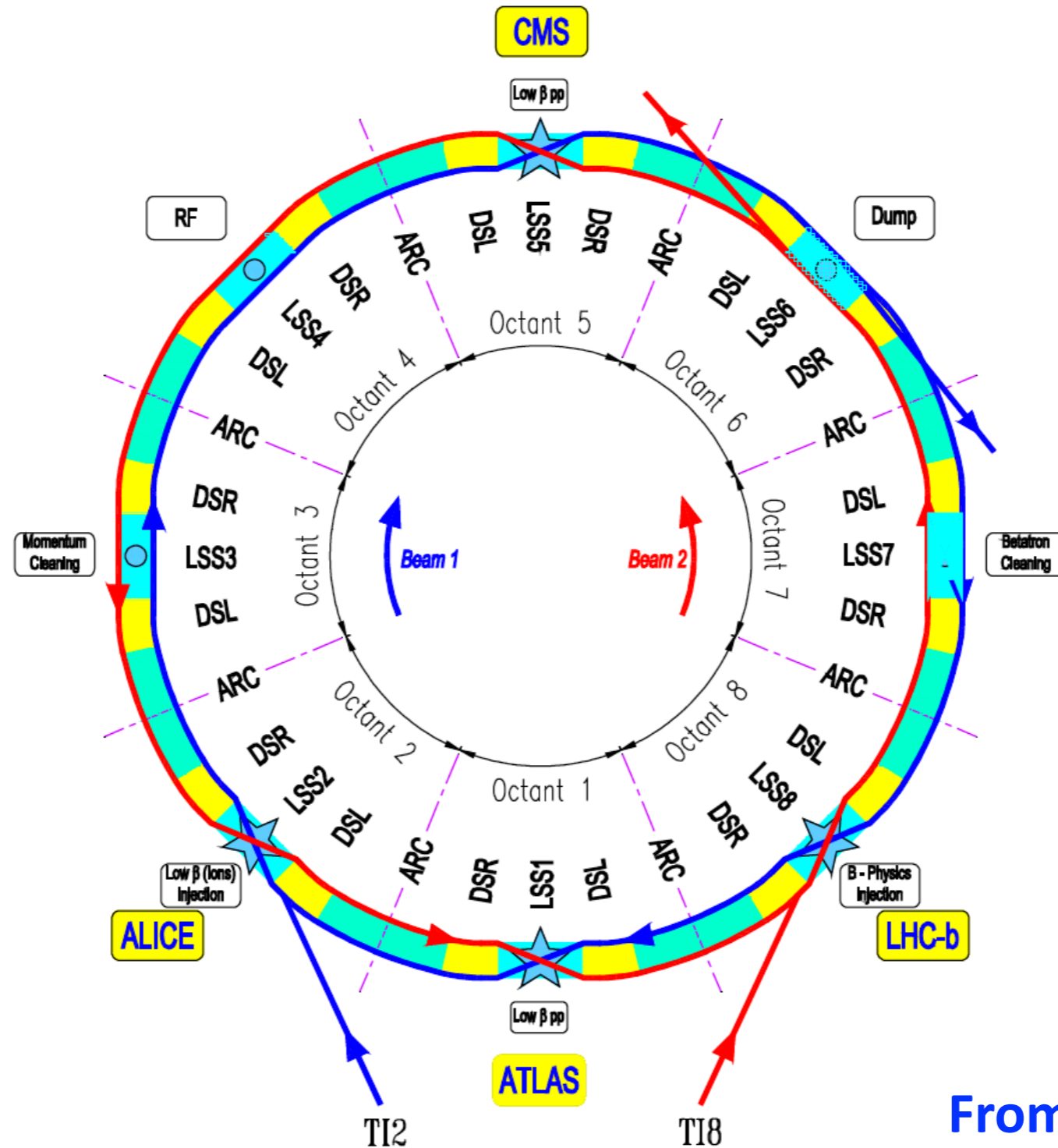
Figure 3.2: Schematic layout of the LHC. Beam 1 circulates clockwise and Beam 2 counter-clockwise.

From LHC design report

1. MADX files for HE-LHC optics

➤ **Current strategy/plan**

- **60 deg arcs (18x60 and 24x60) rolled out?**
  Thys: poor tunability
  Yuri: worse DA (Need further study)
- **18x90 as the current baseline (geometry same as 18x60)**
  * **merged_HE-LHC.18x60_tr.seq: Good geometry but "DS" not implemented?**
  * **merged_HE-LHC.18x60_v102.seq: Geometry not good and no "DS"**
- **17x90 and 20x90 as optional candidates**
  * **merged_HE-LHC.17x90_tr.seq: Good geometry but n1 in arcs not large enough?**
  * **merged_HE-LHC.20x90_v201.seq: Poor geometry but possibly to be improved (?). If good geometry found, it would be the strongest candidate for HE-LHC?**

1. MADX files for HE-LHC optics

➤ **On 20x90 lattice**

- **Acceptable magnet strengths in arcs (?)**
- **Good n1 in arcs (?)**
- $t_x = (2+1)$ mm, $f_{arc} = 0.14$, $\delta_p = 8.6*10^{-4}$, $\varepsilon_x = 2.5$ μm, $k_\beta = 1.05$, $E_{inj} = 450$ GeV
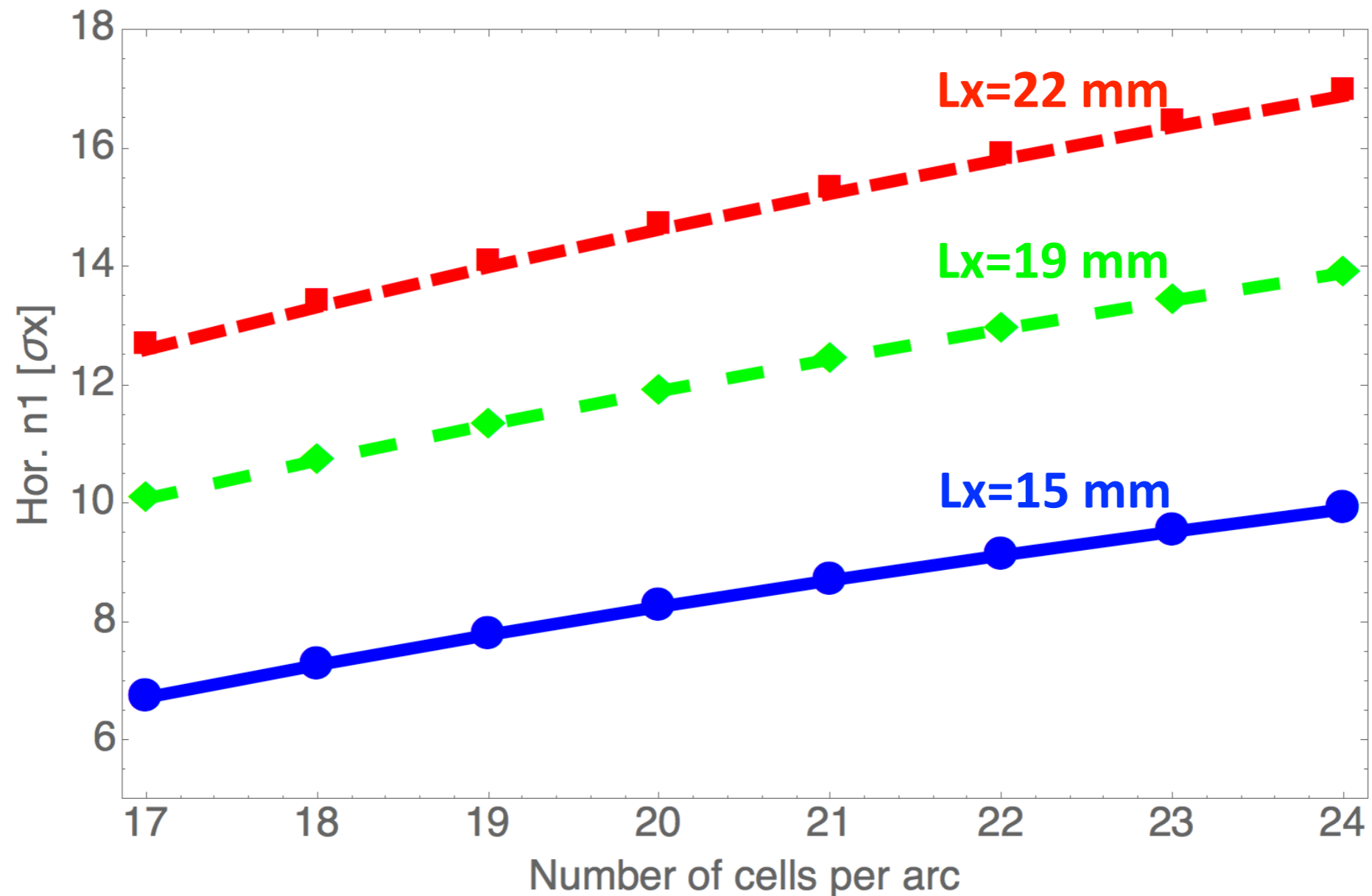
2. Summary and future plan

➤ HE-LHC geometry

- **To be improved [communication with Thys].**
- **LEP survey data needed [communication with Thys].**

➤ Future plan

- **Improvement of HE-LHC geometry**
- **Periodical annulments of HE-LHC to collaborators**
- **Detailed DA simulations and optimizations with errors**