Progress on the PTC Standalone Model of the LHC

- ➢ **Features of the model**
- ➢ **Transfer Lines**
- ➢ **Additional Tools**
- ➢ **Outlook**

Features 1/2

➤ Full **3D** placement of all elements of the **2-in-1** structure. In fact, it is **truly one structure** of both beams.

➤ Dangling from it we have the **Tl2** and **Tl8** injection lines which are therefore also a part of a **single structure**.

➤ The magnets are considered as **thick** elements.

➤ All known **harmonics** are added to these thick elements.

➤ Misalignment of both **single magnets** and **assemblies** have been added. There is also the additional option to "glue" elements within assemblies.

➤ The **aperture** is considered including shifts of the **mechanical** axis.

➤ Presently, all this **cannot** be achieved in **MAD-X PTC compatibility mode**.

➤ Etienne has provided us with a **graphical environment** (Windows only) which allows to study the structure graphically.

➤ Essential is that this structure is **trackable**.

Features 2/2

- The first step is to provide the LHC optics files. This can now easily obtained due to 2 features:
  - The MAD-X extract command (HG) is used to split the machines into common and arc pieces for both beams.
  - PTC is then run **within MAD-X to create flat files** of these pieces to be dealt with in PTC standalone.
- These flat files are then connected to **one structure** and this structure is then located in **global coordinates** via **Survey** data. In fact, the tilt of the machine is represented using 3 point **triangulation**.
- Using Per Hagen's **misalignment** files assemblies are located and both assemblies and the elements within them are misaligned separately.
- *Comments*:
  - The **end-arc regions** were particularly nasty to set up and needed several iteration before completion. In particular, to avoid artificial large effect of harmonics in the separation dipoles!
  - In general, **Survey data** are required to **high precision** for the beam to circulate like in the real world!
  - Unfortunately, differences in the various files due to **data base consistencies** required a lot of effort to sort out!

Transfer Lines

➢ **Both transfer lines are attached to their proper ring in the 2-in-1 LHC structure.**

➢ **They are oriented in 3D virtual space by 3 point triangulation as well.**

➢ **Apparently, there is a small (~0.2mm) Survey mismatch between the LHC and these lines. We hoped more for 1μm and the kicker are better matched than this Survey slip.**

➢ **Still, one can nicely track particles from the transfer lines into the LHC.**

➢ **In parallel maps are tracked through the structures for calculation of TWISS parameters.**

Additional Tools

➢ **PTC offers an elaborate toolkit for re-splitting the elements into number of slices and higher order splitting techniques according to their magnetic strength:**

➔ **One can start with a small number of slices and later re-split to achieve the required quality of lattice parameters.**

➢ **The elements can now be "visited" such that one can determine TWISS parameters inside the element.**

➢ **More relevantly this allows to treat (examples have been prepared):**

- ➢ **Radiation**
- ➢ **Beam-Beam**
- ➢ **Space Charge**
- ➢ **AC-dipole**

Outlook

➢ **The PTC standalone model of the LHC and the transfer lines has been prepared with all required features.**

➢ **The provided software still needs considerable cleaning up from our side.**

➢ **Very relevant new features will also be implemented in MAD-X proper.**

➡ *Ready for the LHC commisioning in particular for the injection studies.*