HE-LHC optics overview


FCC week 2018
Amsterdam

Work supported by the European Commission under the HORIZON 2020 projects EuroCirCol, grant agreement 654305, and ARIES, grant agreement 730871.
HE-LHC optics challenges

- Physical aperture at 450 GeV
- Dynamic aperture at 450 GeV
- Layout fitting existing tunnel
- IR collision optics at 13.5 TeV
HE-LHC optics choice: #cells/arc

23 FODO cells per arc
- LHC like
- Better for aperture at 450GeV
- Lower energy reach (26 TeV)

18 FODO cells per arc
- Less focusing than LHC
- Larger Dx and betas so poorer aperture at 450GeV
- Better dipole filling factor
- Larger energy reach (27 TeV)
23 and 18 FODO cells: 90° phase ad.

23x90

18x90
HE-LHC: The layout challenge

Tolerances on layout deviations from current LHC are still being defined but are in the order of some cm. Is current 18x90 OK?
ALGEA: Automatic Lattice GEneration Application

ALGEA parametrizes full ring lattice (#cells/arc, etc.), optimizes layout, respects minimum magnet separation, follows naming convention, installs corrector circuits, etc., and outputs a MADX model.

“The Algea were the spirits of pain and suffering of both the mind and body.”

See talk by J. Keintzel
HE-LHC current optics versions

**V0.2** (only 18 cells/arc option)
- Does not respect minimum magnet separations
- Has a matched collision optics for 18x90

**V0.3** (23x90 and 18x90)
- Respects magnet separations
- Collision optics could not be fully matched yet

**V0.4** (23x90 and 18x90)
- Dispersion suppressor optimized
- Under development
V0.4: 18x90 450 GeV
Physical aperture at 450GeV

Continue optimizing dispersion suppressor $\rightarrow$ ALGEA

Beam stay-clear for collimation, is $10\sigma$ ok? Even lower?

Is the beam screen optimal for HE-LHC?

If all fails, how much should we increase magnet apertures? Impact on Energy reach? Cost?
Dynamic aperture at injection

The larger magnetic errors below 1.3 TeV require new correction/sorting approaches!

Improved magnet design is being explored too.

See talks by M. Hofer and Y. Nosochkov
Interaction region design

Successful design in V0.2.
More challenging in V0.3/0.4

See talk by L. van Riesen-Haupt
Insertion regions

L. Riesen, P. Mirave et al

L. Riesen et al

IR5: CMS

IR4: RF + Beam instrumentation

IR3: Momentum Cleaning (warm)

IR2: ALICE

IR1: ATLAS

Injection

IR6: Beam dumping system

IR7: Betatron Cleaning (warm)

IR8: LHC-B

Beam dumping blocks

B. Goddard et al

Arcs:
J. Keintzel, M. Hofer, T. Risselada et al

M. Crouch

L. Riesen et al
Similarly to HL-LHC an alternative flat optics is being studied, which could avoid using crab cavities.

Quite advanced, already with energy deposition studies.

See talk by J. Abelleira.
More exotic...

Combined function dipoles to increase focusing and improve beam-stay clear at injection?

Longer dipoles, e.g. 14→20m, for increased filling factor?

Shorter L* to alleviate the collision optics challenge?
HE-LHC is full of exciting challenges for linear and non-linear optics design

Impressive progress of the team in last few months!
spare slides
Optics V0.3 Versus V0.4

HE-LHC 23x90 V0.3

HE-LHC 23x90 V0.4