HE-LHC optics overview

J. Abelleira, W. Bartmann, M. Crouch, E. Cruz, M. Giovannozzi, B. Goddard, M. Hofer, J. Keintzel, P. Mirave, Y. Nosochkov, L. van Riesen-Haupt, T. Risselada, R. Tomas, F. Zimmermann and D. Zhou

FCC week 2018
Amsterdam

http://cern.ch/fcc

*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

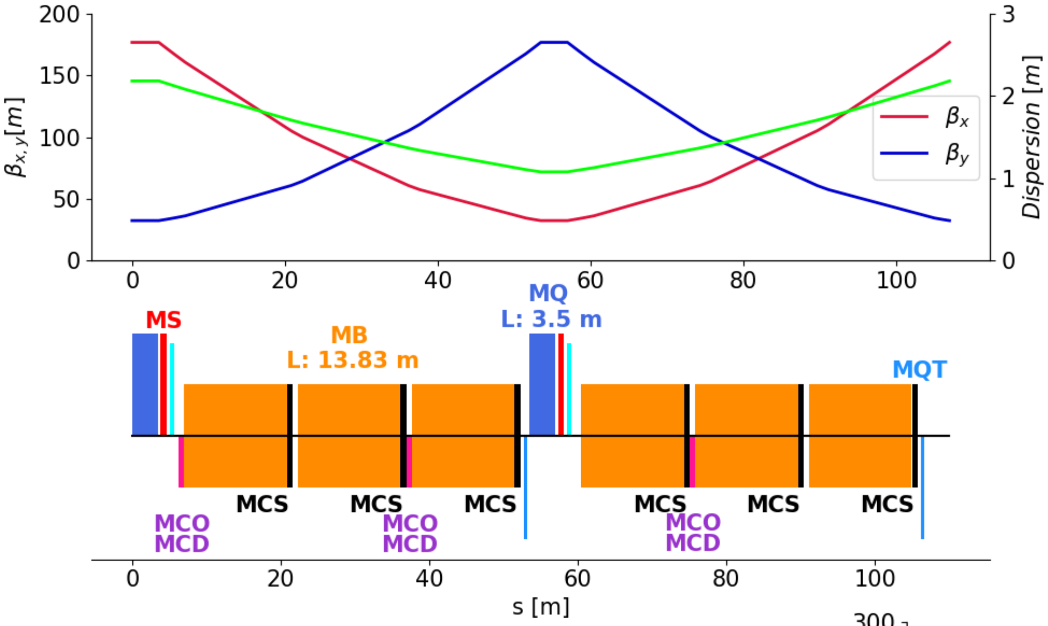
23 FODO cells per arc

- LHC like
- Better for aperture at 450GeV
- Lower energy reach (26 TeV)

18 FODO cells per arc

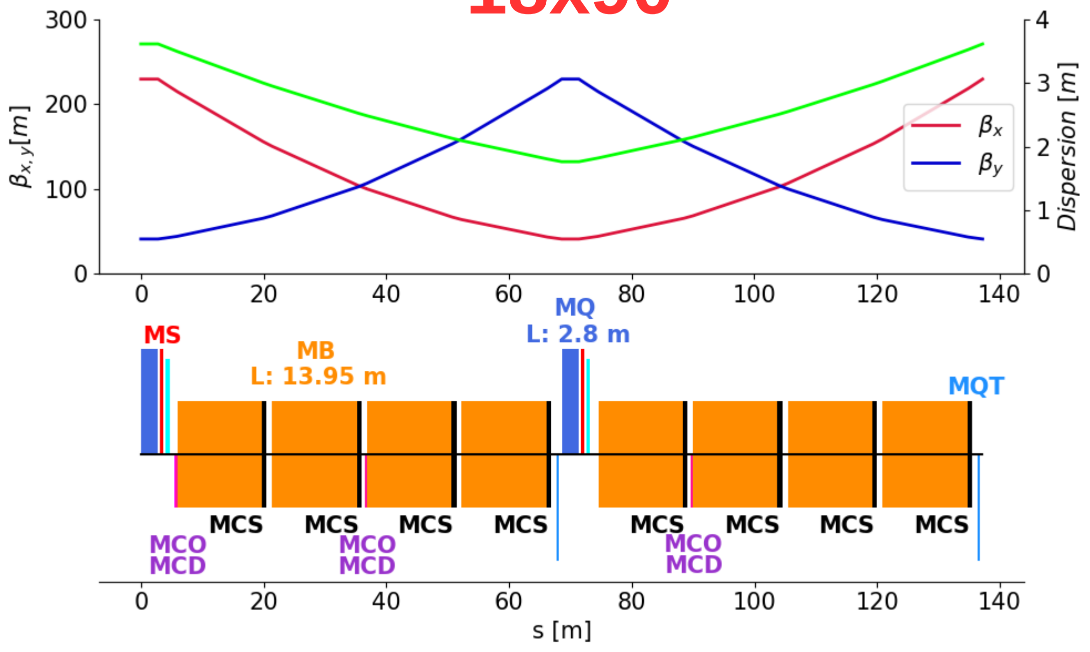
- Less focusing than LHC
- Larger Dx and betas so poorer aperture at 450GeV
- Better dipole filling factor
- Larger energy reach (27 TeV)

23 and 18 FODO cells: 90° phase ad.

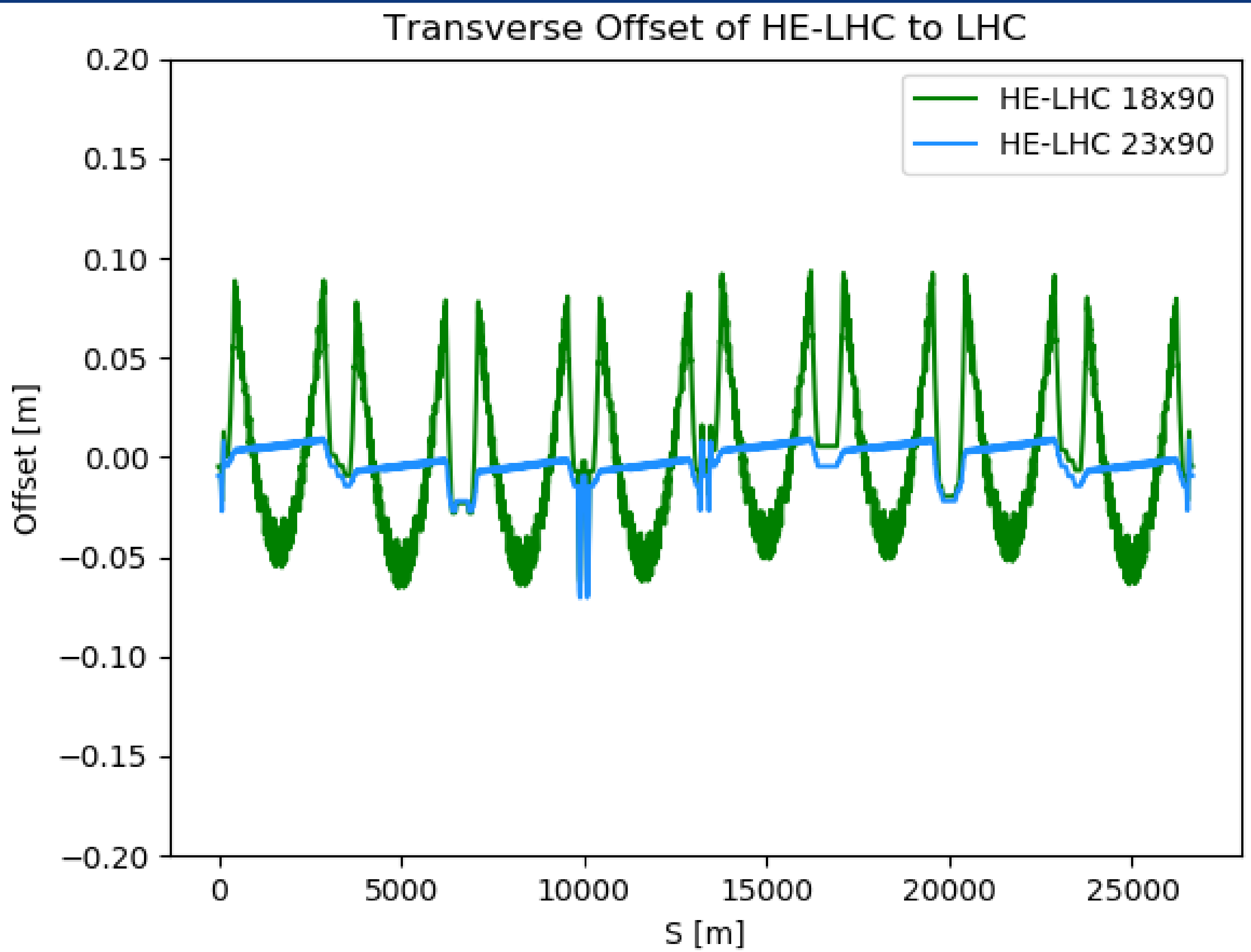


23x90

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?

New code for lattice generation

ALGEA: **A**utomatic **L**attice **GE**neration **A**pplication

See talk by J. Keintzel

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

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.

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

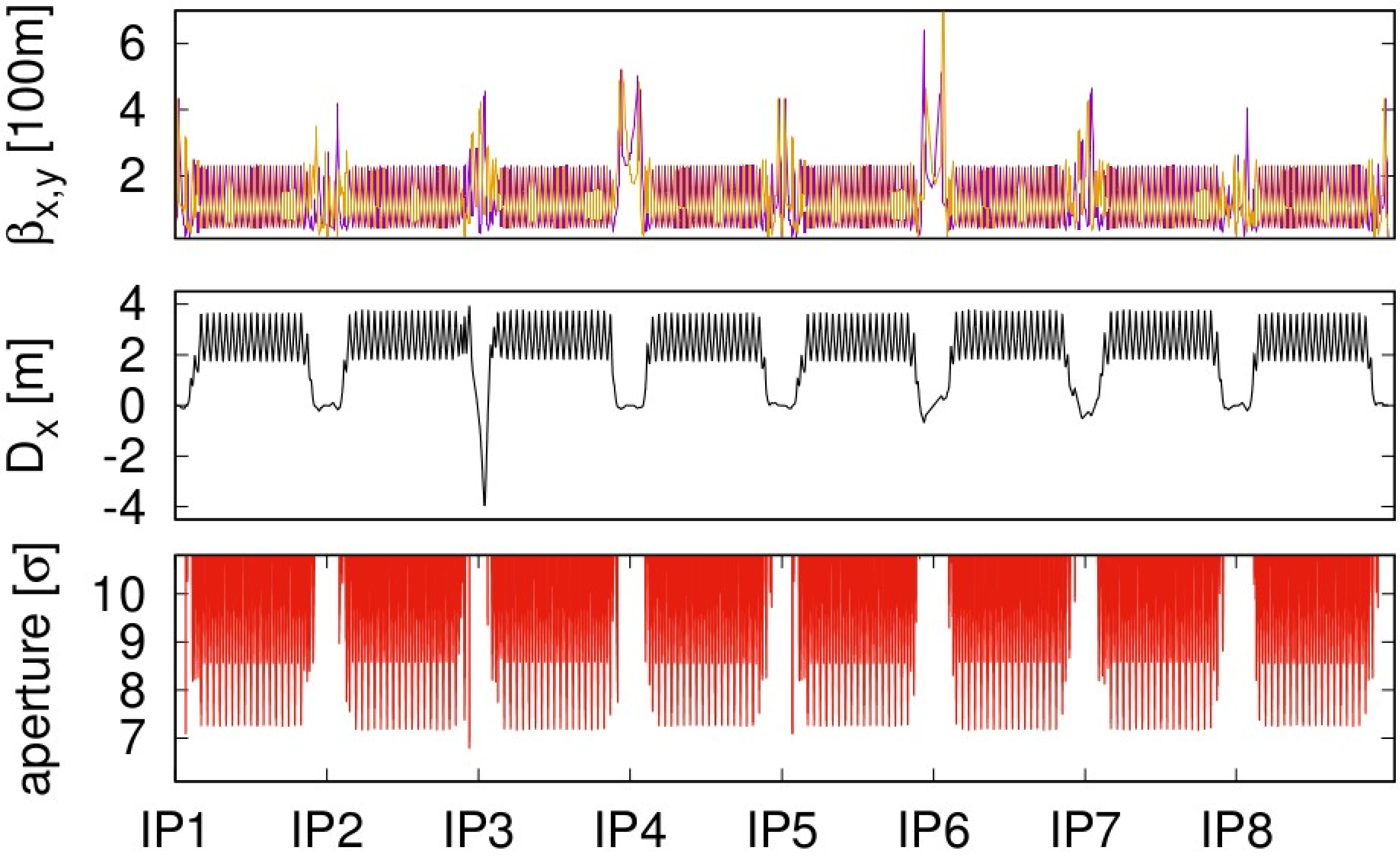
V0.3 (23x90 and 18x90)

- Respects magnet separations
- Collision optics could not be fully matched yet

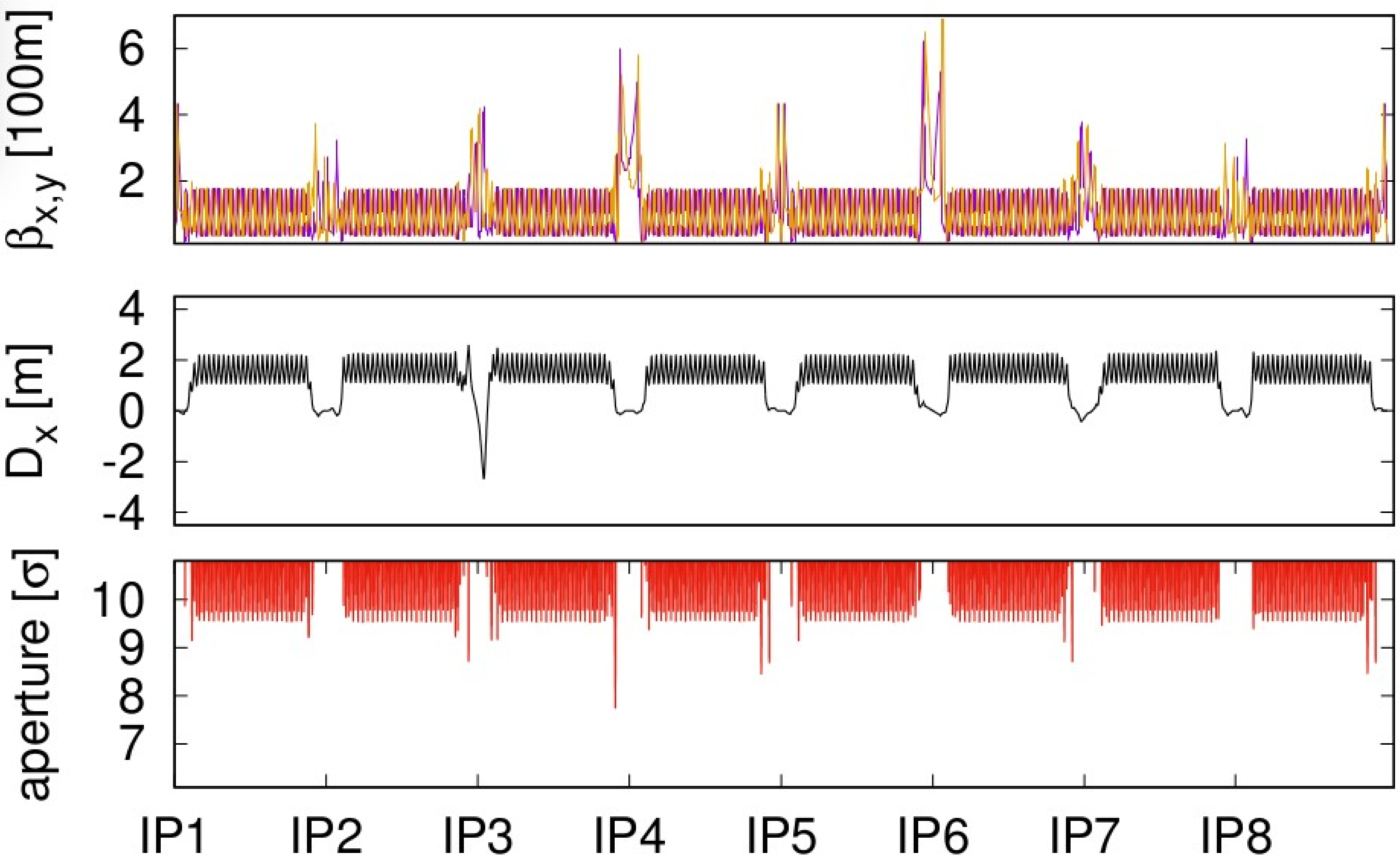
V0.4 (23x90 and 18x90)

- Dispersion suppressor optimized
- Under development

V0.4: 18x90 450 GeV



V0.4: 23x90 450 GeV



Physical aperture at 450GeV

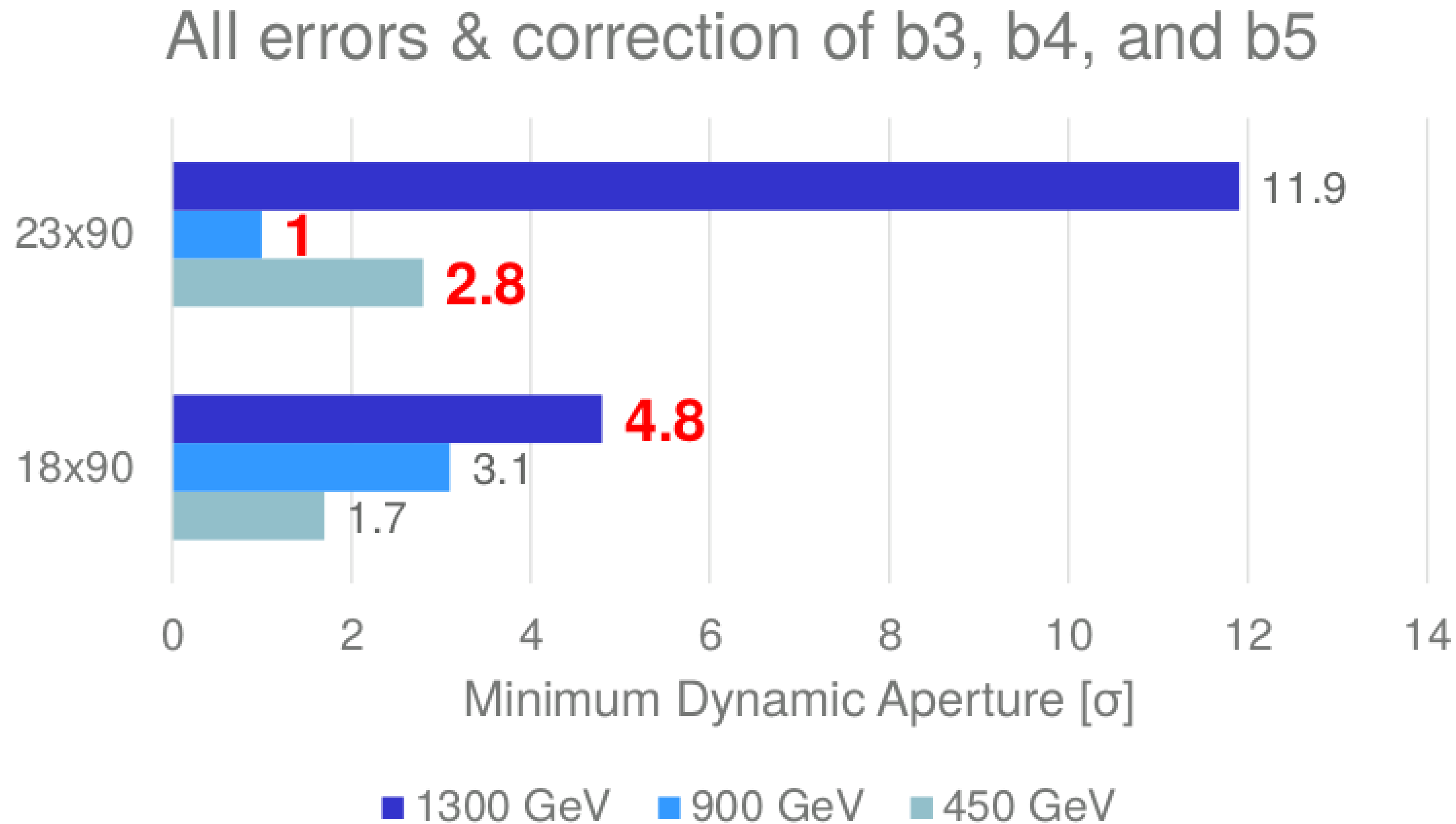
Continue optimizing dispersion suppressor → ALGEA

Beam stay-clear for collimation, is 10σ 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

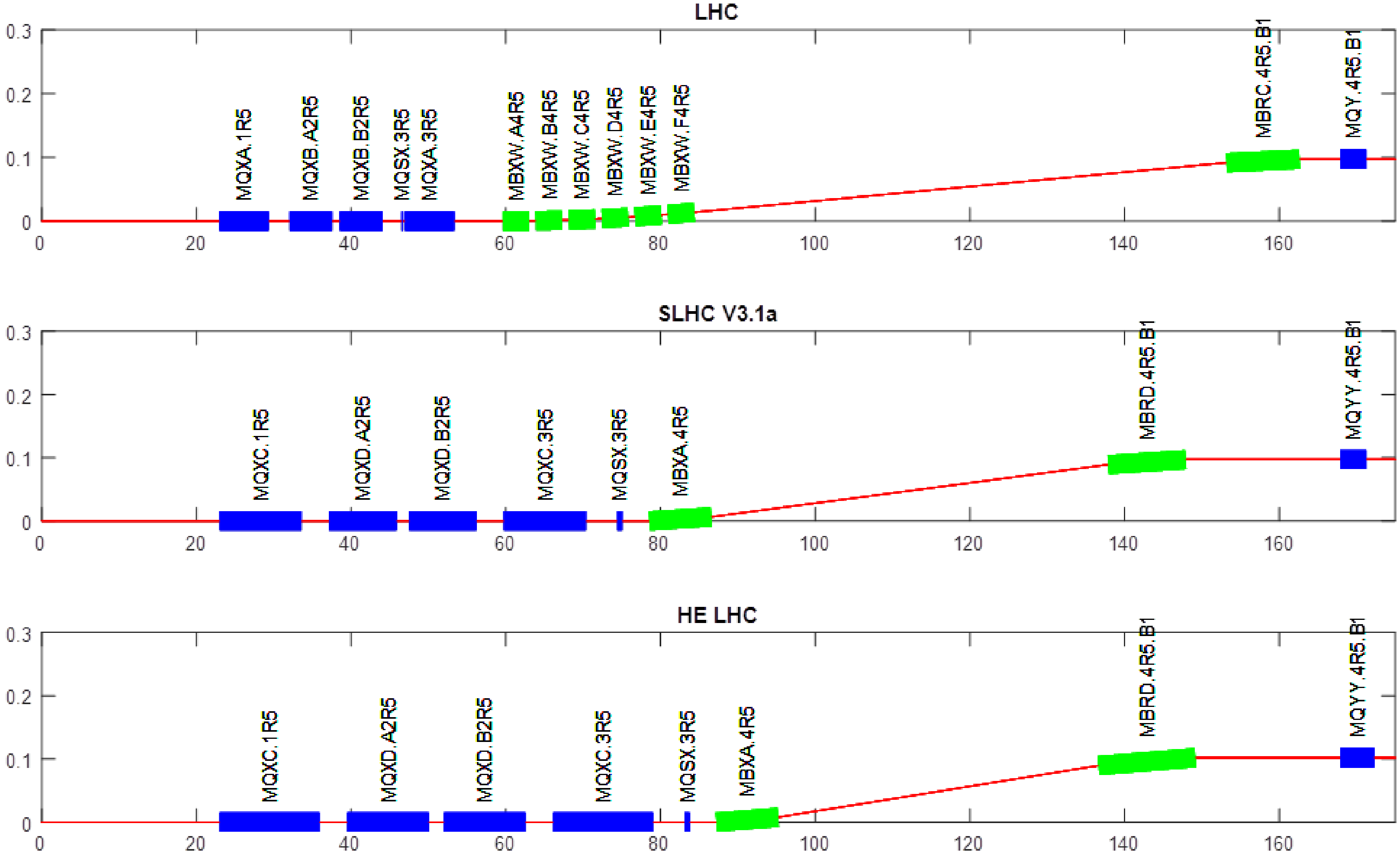


The larger magnetic errors below 1.3 TeV require new correction/sorting approaches!

Improved magnet design is being explored too.

See talks by M. Hofer and Y. Nosochkov

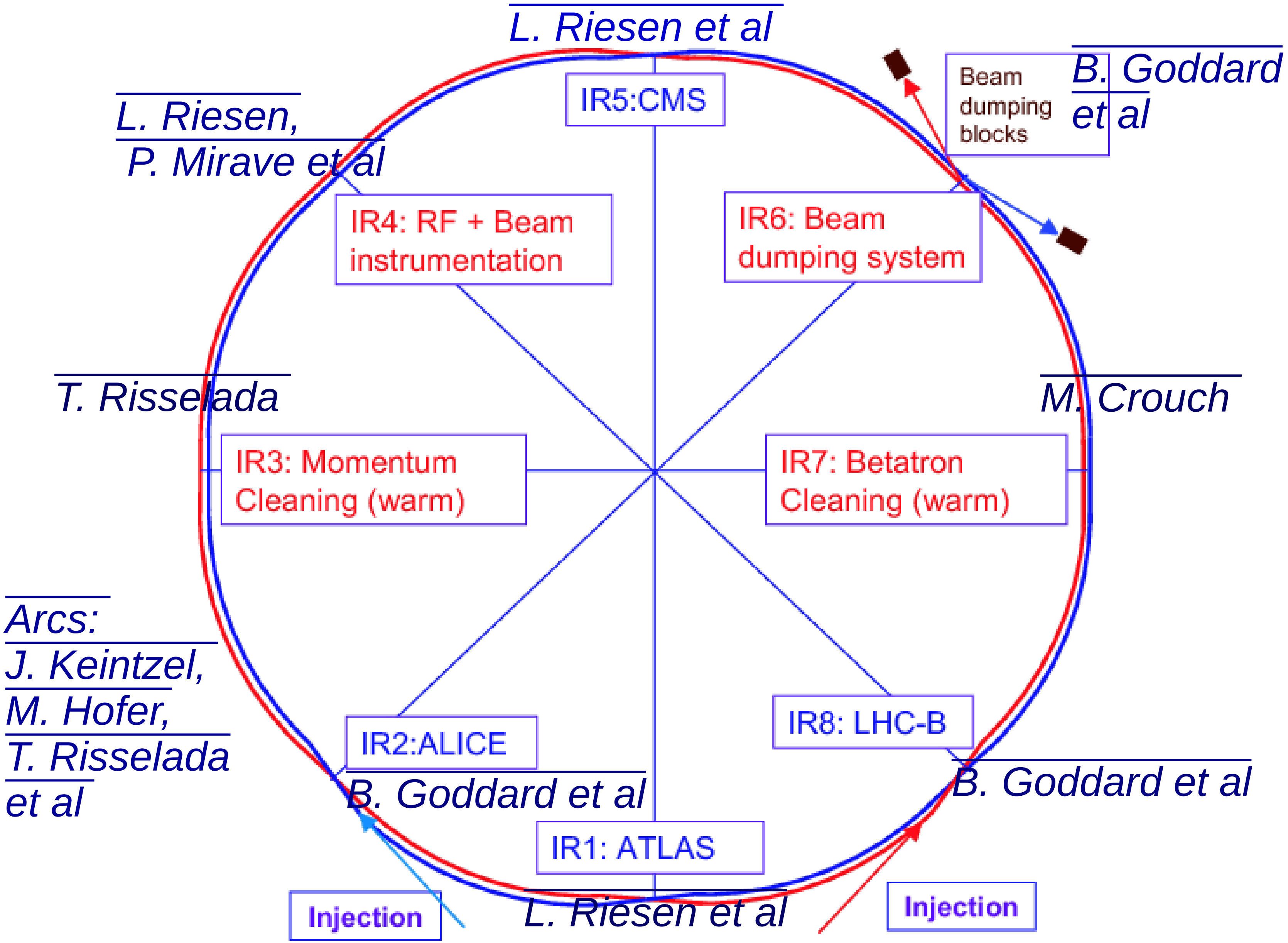
Interaction region design



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

See talk by L. van Riesen-Haupt

Insertion regions

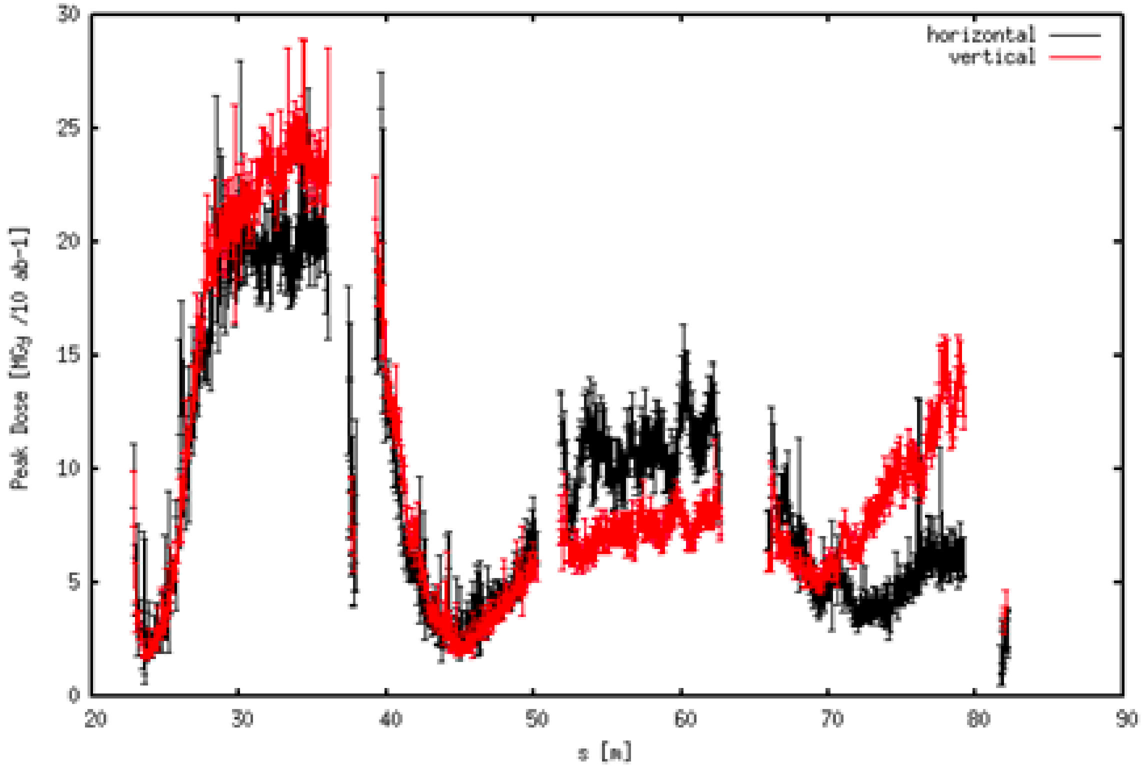


Alternative IR flat optics

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?

Summary

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