FROM RESEARCH TO INDUSTRY

cea

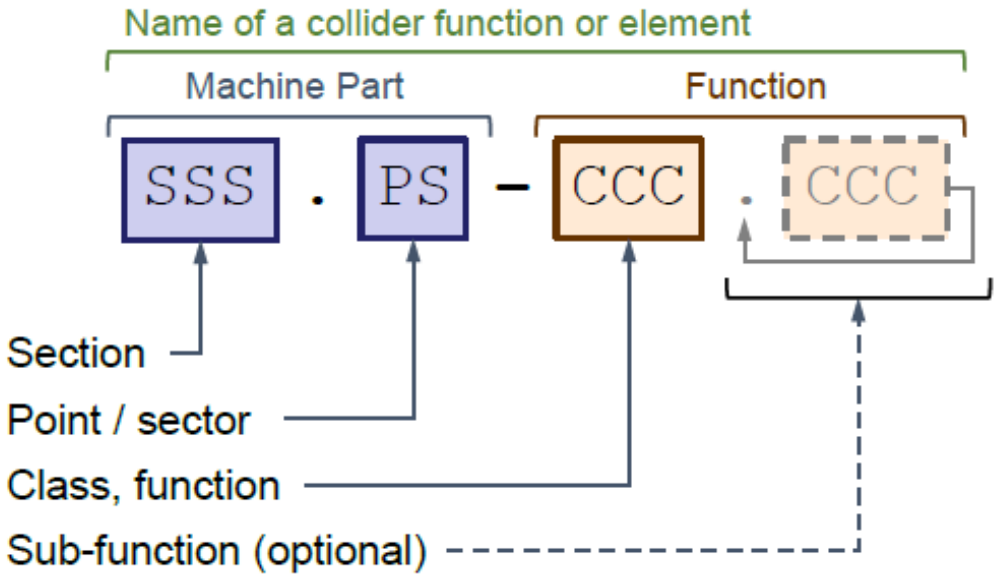
EuroCirCol

www.cea.fr

ARC LATTICE INTEGRATION

EuroCirCol kick-off meeting 3-4 June 2015 | Antoine CHANCE

NAMING CONVENTION
EDMS NO. 1434552



SSS	Description
LSS	Long straight section
ESS	Extended straight section
TSS	Technical straight section
DIS	Dispersion suppressor
SAR	Short arc
LAR	Long arc

PS	Description
P*n*	Point *n*, where *n* ∈ {A..L} is a singularity on the perimeter. A point is named by a letter, clockwise in alphabetical order.
AB, BC, CD, DE, EF, FG, GH, HI, IJ, JK, KL, LA	Sector is a span between two Points. Each sector is named by two letters, indicating the start and termination point, clockwise. Sectors have different lengths.

DOM	Domain Description
LAY	Layout
LAT	Optics and lattice
POW	Power
EXP	Experiments
ACC	Acceleration and RF
BDI	Beam diagnostics & instr.

CCC	Layout class or function
EXP	Experiment
INJ	Injection
EXT	Extraction
COL	Collimation
FRB	Feed / Return Box
RFS	Radiofrequency system

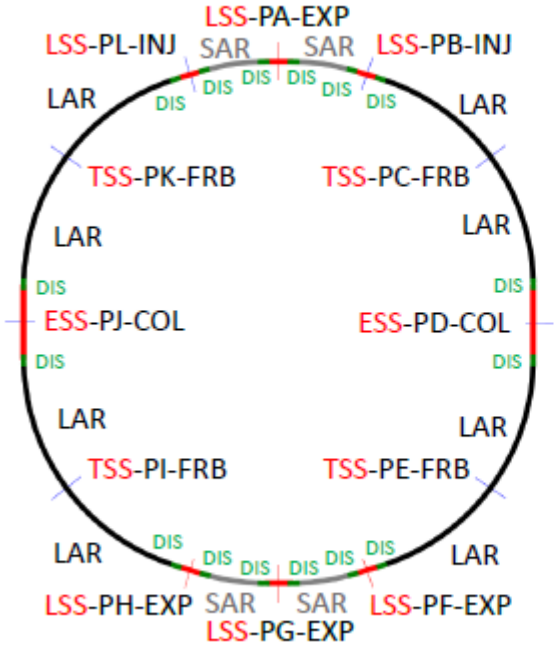
Functions and classes are associated to domains. These are not reflected in the naming convention. The tables below outline examples for domains, functions and element classes. The list of FCC endorsed domains, functions and classes is recorded on the FCC Web site (http://cern.ch/fcc).

Examples:

LSS-PA-EXP _____ Experiment at 12 o'clock
LSS-PDF-COL.EXT _____ Collimation and extraction region at 3:00 o'clock
LSS-PG-ERF _____ Experiment and RF region at 6 o'clock

LAYOUT AND FUNCTIONAL SECTIONS

FCC-hh Allocated Sections and Functions

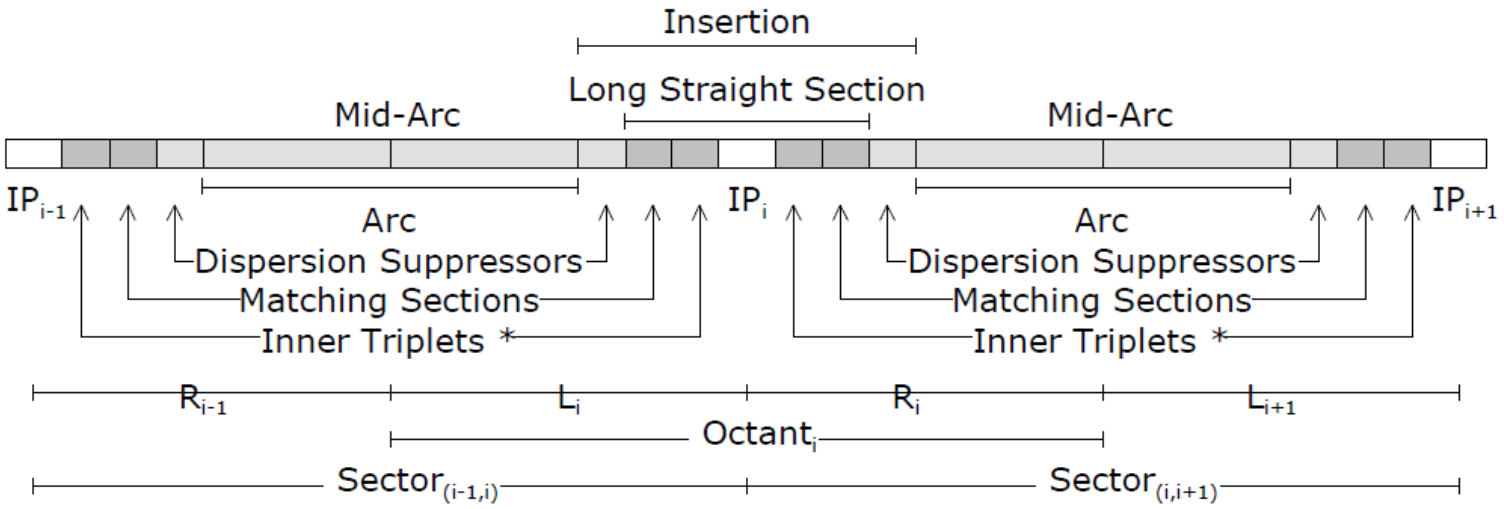


LSS-PA-EXP	First general purpose experiment
LSS-PB-INJ	1st Injection region
LSS-PF-EXP	First special purpose experiment
LSS-PG-EXP	Second general purpose experiment
LSS-PH-EXP	Second special purpose experiment
ESS-PD-COL ESS-PD-EXT	1st collimation & extraction region
ESS-PJ-COL ESS-PJ-EXT	2nd collimation & extraction region
TSS-PC-FRB	Feed and return 1
TSS-PE-FRB	Feed and return 2
TSS-PI-FRB	Feed and return 3
TSS-PK-FRB	Feed and return 4
LSS-PL-INJ	2nd Injection region

- Still a few questions remain:
  - Name of the dispersion suppressors: DIS-AB1 and DIS-AB2

ELEMENT NAMING CONVENTION

- Numbering of the elements in the cells is the same as LHC (see EDMS 103369):



with i = A, i-1=L, i+1=B

- Please use the naming convention (from WP1):
  - For the optics integration (macros are based on these names)
  - To make your work easier in the following (anyways, you will have to do it…)
  - Send your remarks as soon as possible to improve this convention. There is still some work to do.

ARC CELL GENERATION

Abbreviation	Generic name	Number	Length [km]
LSS	Long straight section	6	1.4
ESS	Extended straight section	2	4.2
TSS	Technical straight section	4	ε
DIS	Dispersion suppressor	16	0.4
SAR	Short arc	4	3.2
LAR	Long arc	8	depends on total length

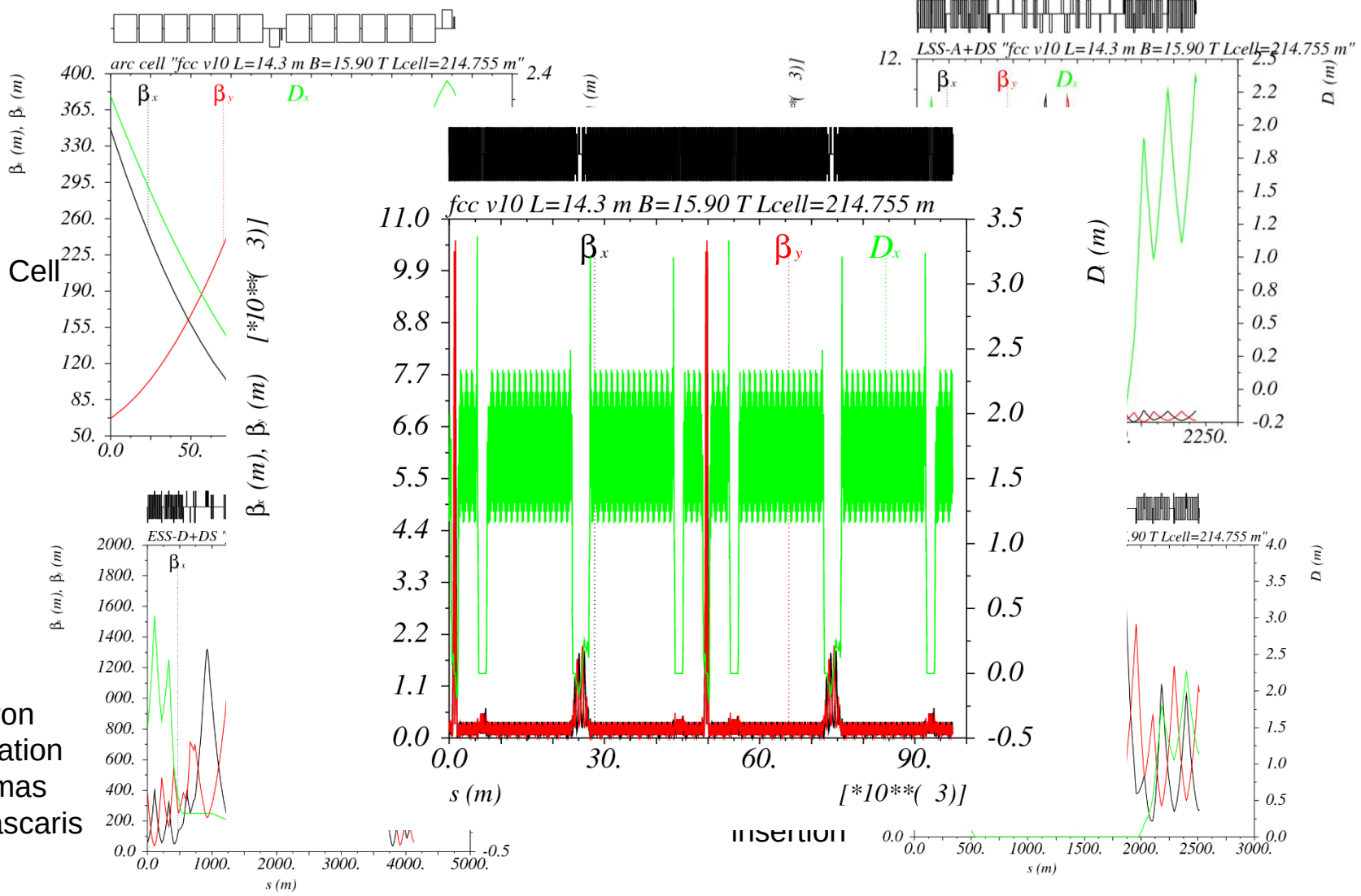
See Barbara's presentation et the FCC week 2015

Generation of the arc cell with input parameters like:

- Minimum space between dipoles (e. g. 1.36 m)
- Dipole maximum field (e.g. 16 T)
- Dipole length (e.g. 14.3 m)
- Minimum space between quadrupole and dipoles (e.g. 3.67 m)
- Maximum gradient of the quadrupole (e.g. 370 T/m)
- E.g. ∅ = 50 mm, beam screen radius 20 mm
- Sextupole length e. g. 0.5 m
- Space between quadrupole and sextupole e. g. 1.0 m
- Phase advance per cell 90° x/y
- Circumference e.g. 3.75 × LHC ~100 km

LATTICE INTEGRATION

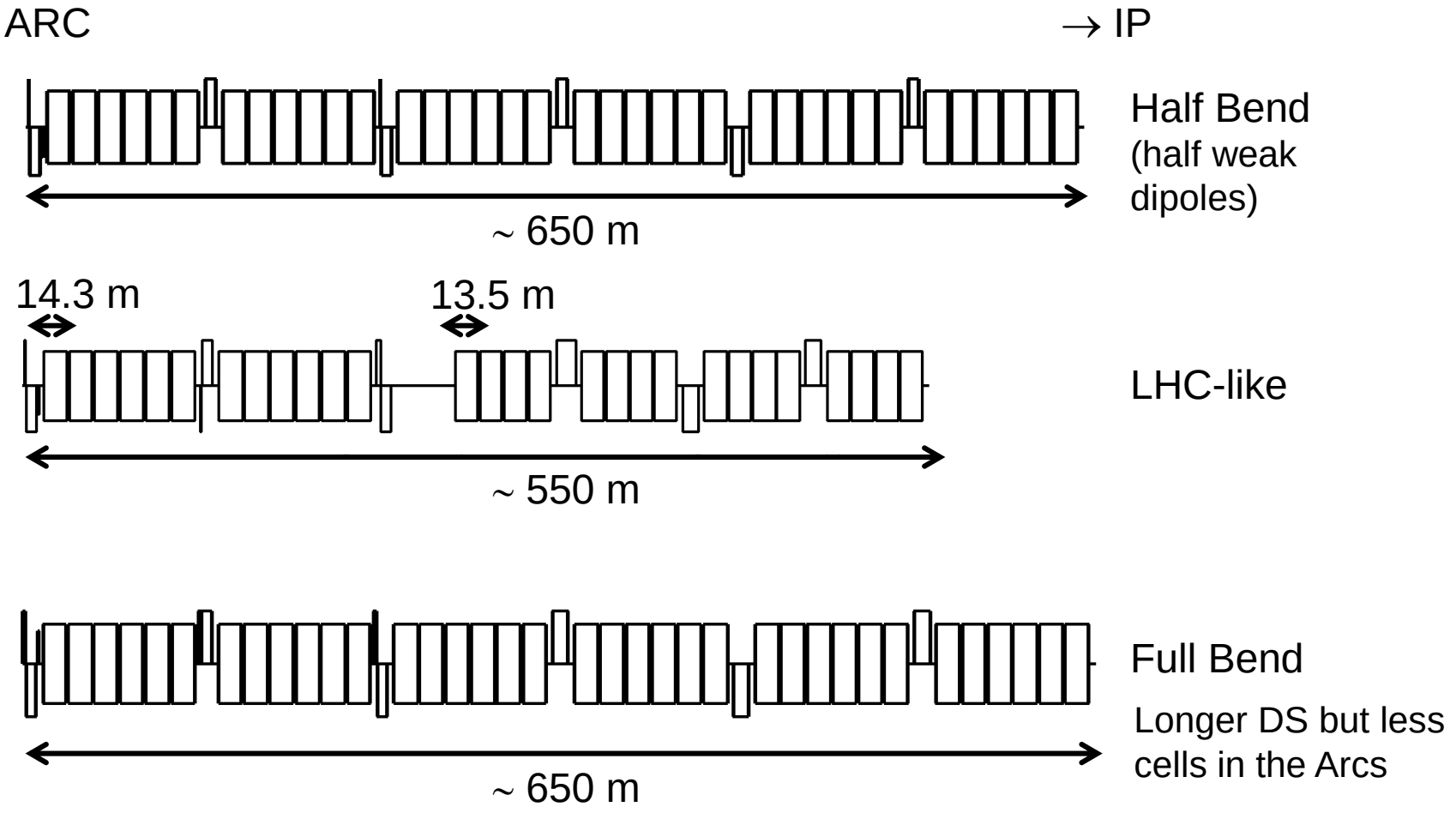
Arc Cell



Betatron collimation
R. Tomas
M. Fiascaris

Insertion

DISPERSION SUPPRESSOR (DIS) TYPES



Half Bend (half weak dipoles)

LHC-like

Full Bend

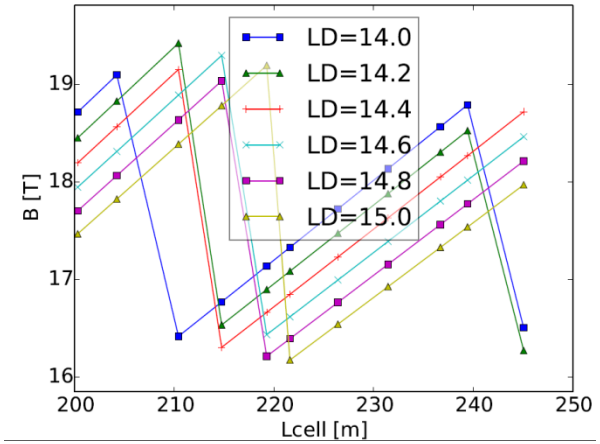
Longer DS but less cells in the Arcs

DISPERSION SUPPRESSOR AND DIPOLE FIELD

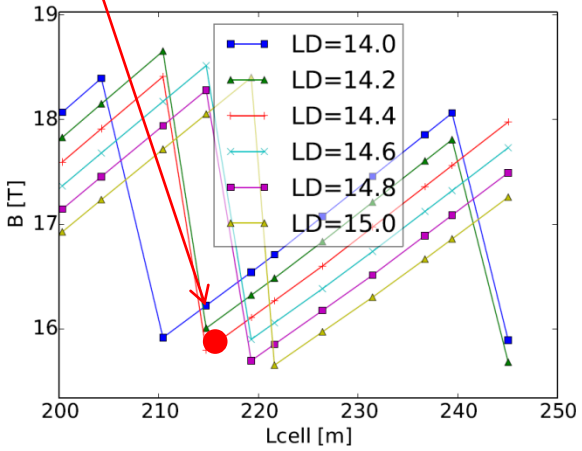
- madx files are in:
  http://fccr.web.cern.ch/FCCr/hh/LATTICE_V4/Baseline

Circumference = 100.12 km

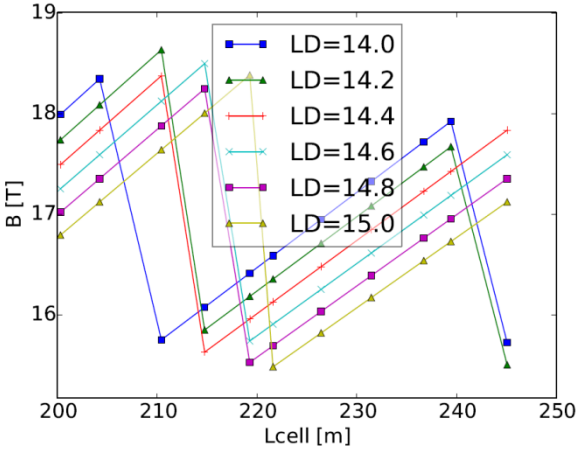
Half Bend



baseline LHC-like



Full Bend



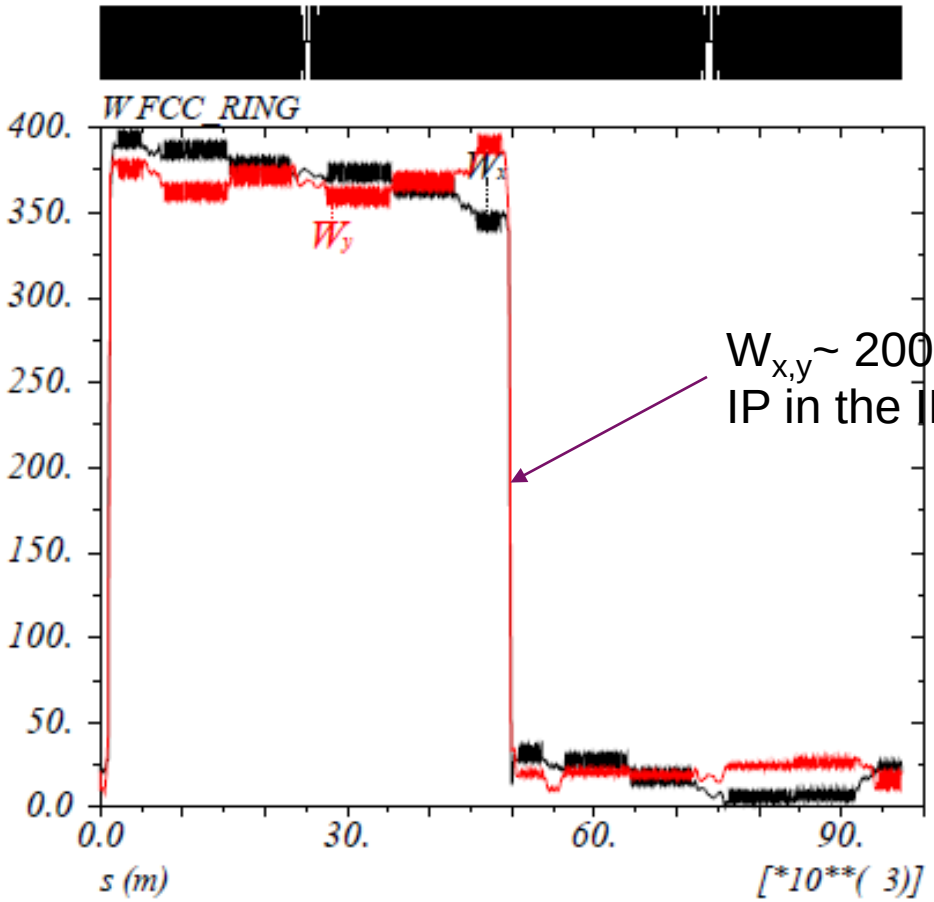
⇒ Full Bend DS: ~1% lower dipole field with respect to LHC-like DS

⇒ Half Bend DS: no solution below 16 T

CHROMATICITY CORRECTION SCHEME

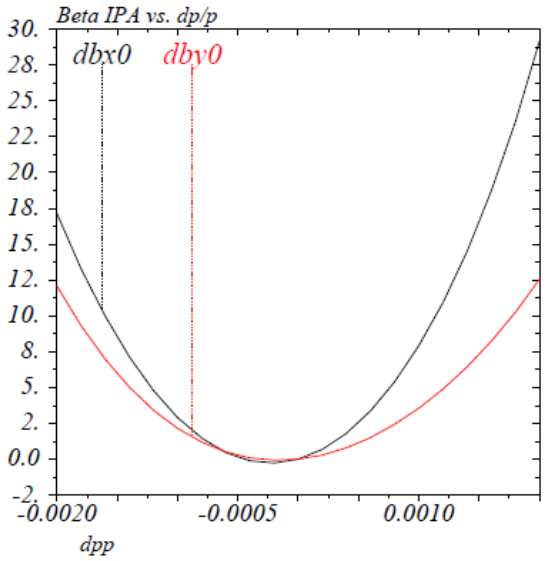
- Several chromaticity correction schemes are under study:
  - **« Naive » solution**: xe use one family per plane to correct the chromaticity.
  - We adapt **Fartoukh's ATS scheme** to FCC-hh by using pairs of sextupoles to correct the chromaticity (phase advance of pi between each sextupole of the same family). The aim of this method is to minimize the Montague functions (can be seen as the derivatives of the Twiss functions with the energy)
  - **Home solution**. We start from the previous solution and we minimize the minimum and maximum of the variation of the betatron functions at the Ips A, D, G and J on a omentum range.
- In the 2 last cases, a lot of matcing must be done (to have the right phase advances between the Ips, to compensate step by step the Montague functions and so on).
- For comparison, in all cases, the global tune is the same.
- Chromaticity after correction: 2 in both planes

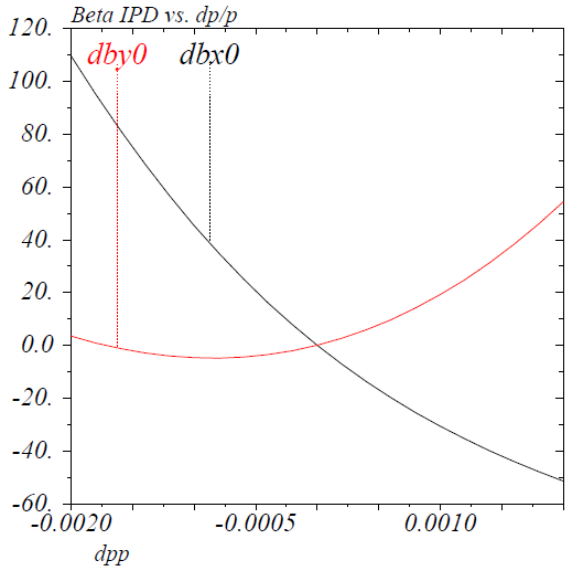
NAIVE SOLUTION
MONTAGUE FUNCTION

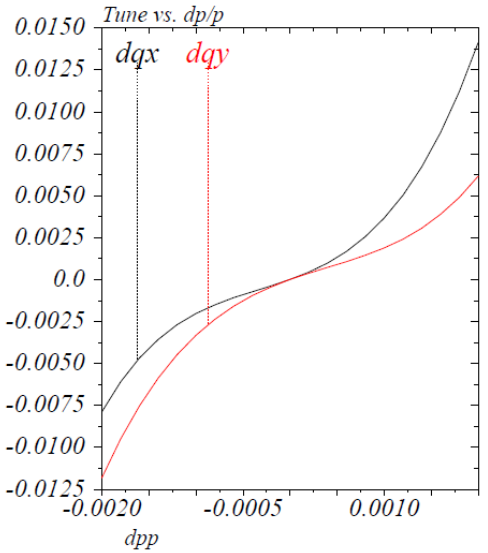


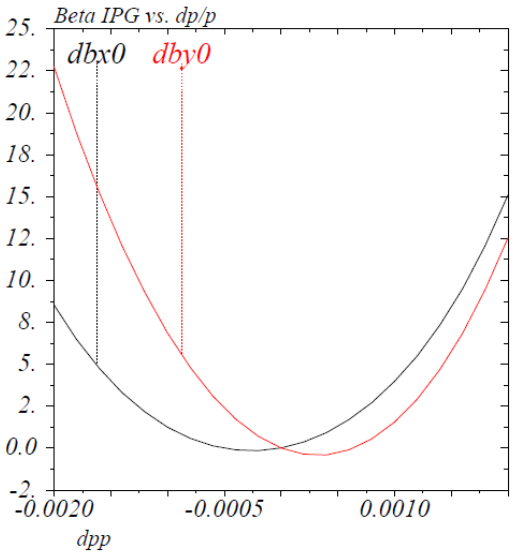
$W_{x,y}$~ 200 at the IP in the IR

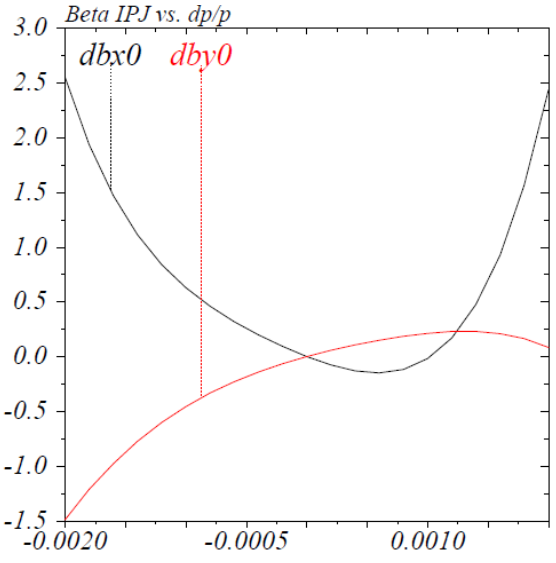
NAIVE SOLUTION
VARIATION OF BETA AT THE IPS (IN %)



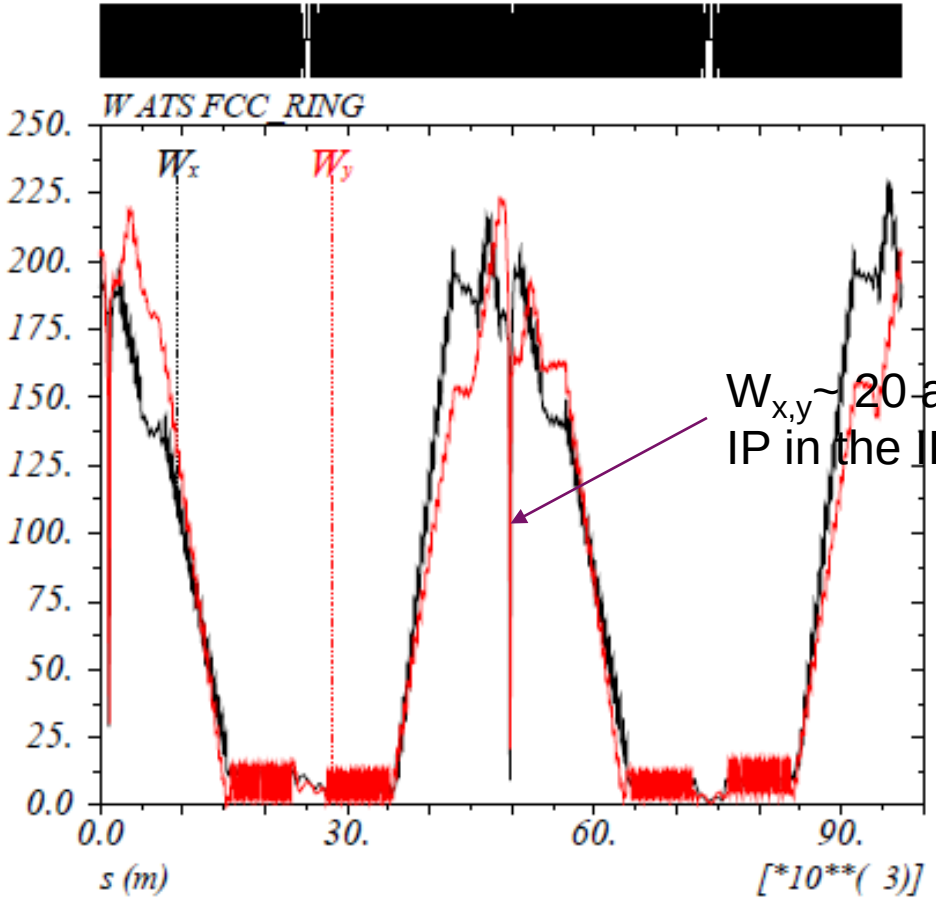






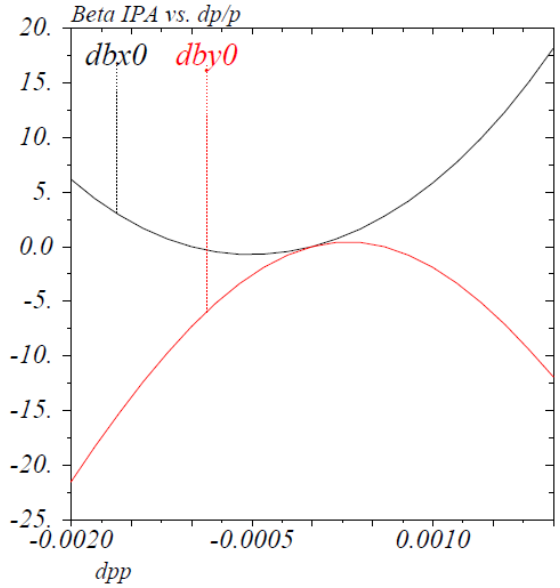


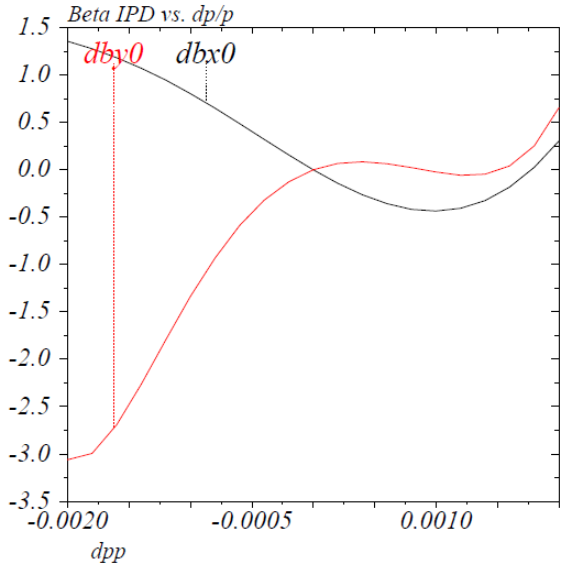
ATS SOLUTION
MONTAGUE FUNCTION

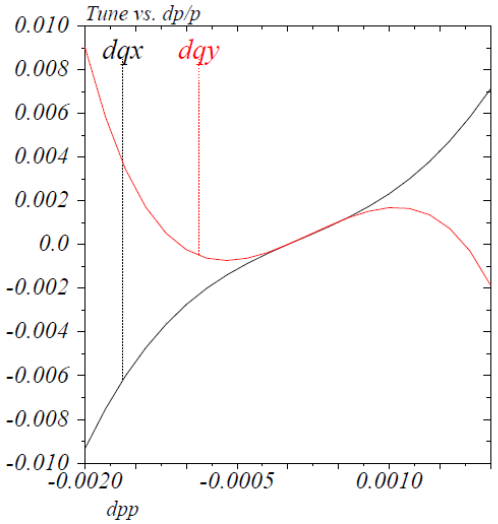


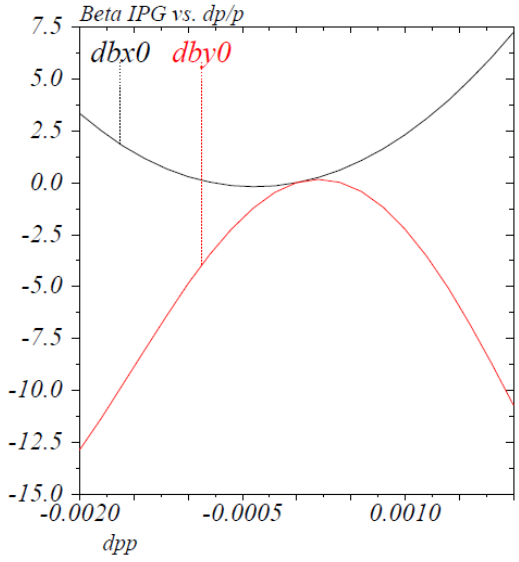
$W_{x,y}$~ 20 at the IP in the IR

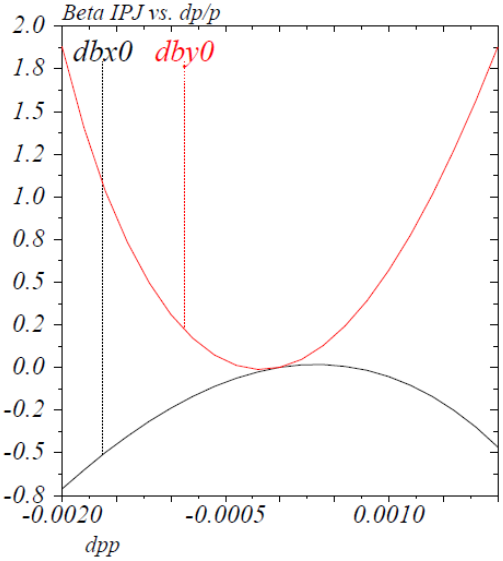
ATS SOLUTION
VARIATION OF BETA AT THE IPS (IN %)



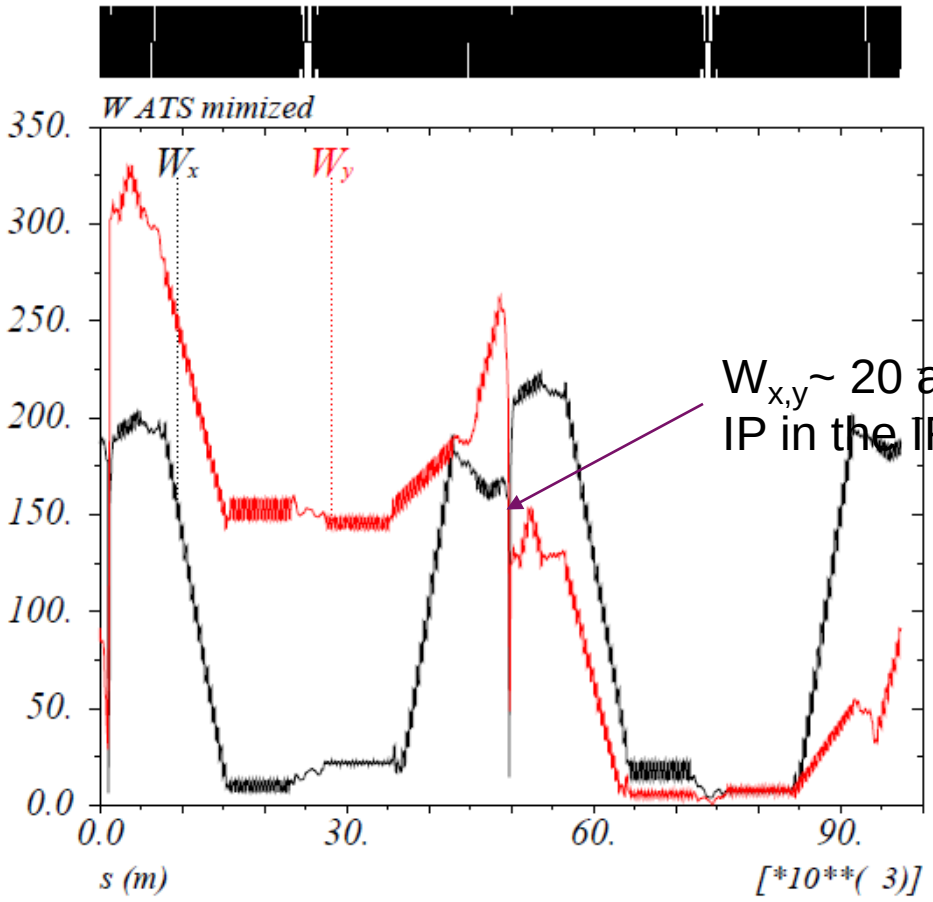






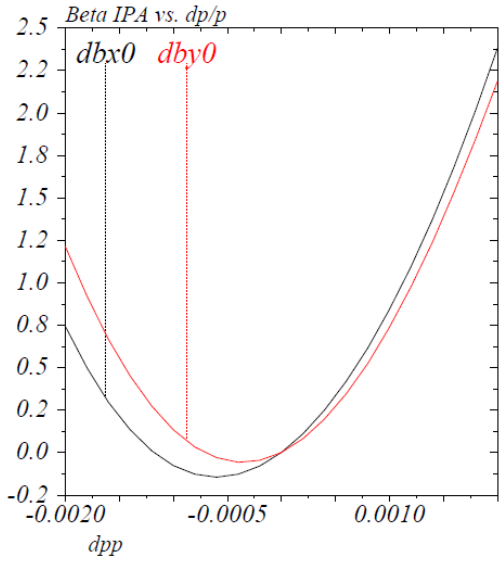


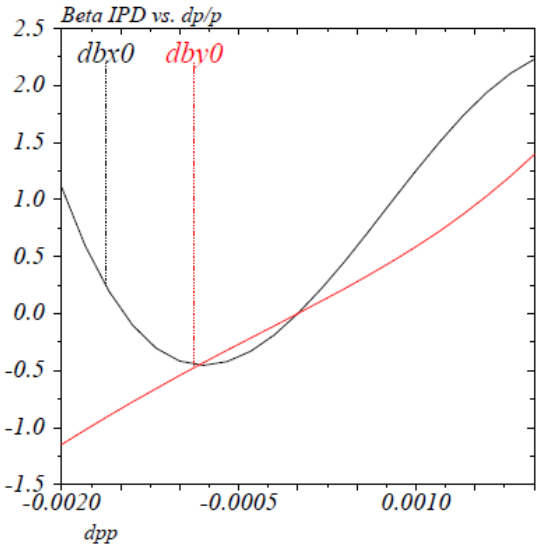
ATS MIN SOLUTION
MONTAGUE FUNCTION

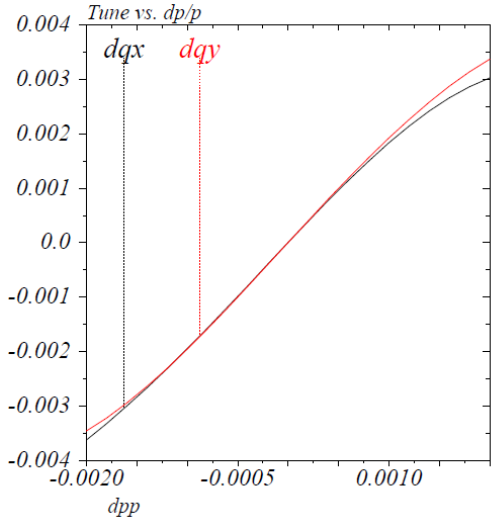


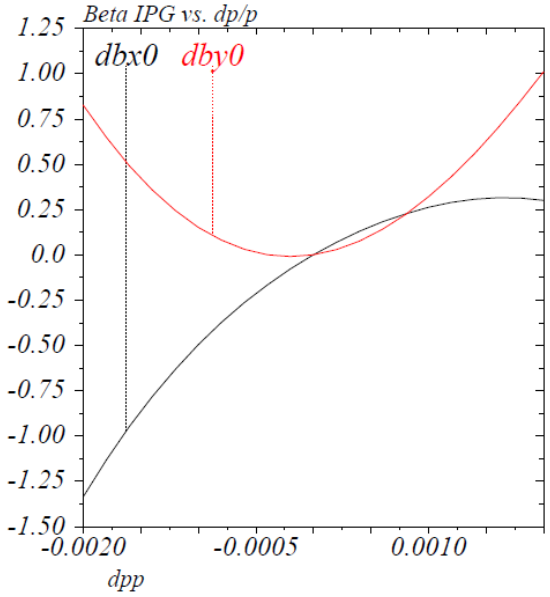
$W_{x,y}$~ 20 at the IP in the IR

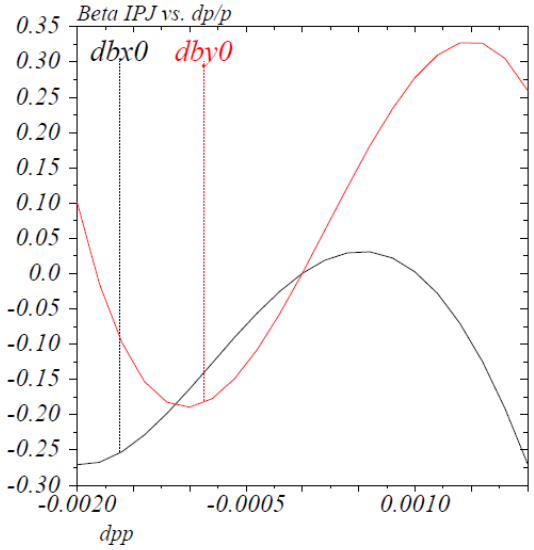
ATS MIN SOLUTION
VARIATION OF BETA AT THE IPS (IN %)











SEXTUPOLE STRENGTH NEEDED

CORRECTION SCHEME	MIN STRENGTH M^{-3}	MAX STRENGTH M^{-3}
NAIVE	-0.045	0.022
ATS	-0.076	0.050
ATS MIN	-0.070	0.052

STATUS

- Lattice integration similar to what was presented in FCC week 2015
  - Realisation of the arc cells with some input parameters.
  - Realisation of the optics of the whole machine with the existing lattice files.
  - The naming convention is under application.
- Some second order schemes are under tudy to correct the chromaticity.
  - The first results are promising with small variation of the betatron functions with momentum.
  - More investigation is needed.

WORKING PLAN

- For September 2015:
  - Checking that the element names are conform to the naming convention.
  - Adding the dipole and multipole correctors (setupole and decapole to correct. the b3 and b5 components in the dipoles) in the lattice.
  - Adding some methods to adjust the global tune.
    - Matching the Qpoles of the arcs.
    - Using a dedicated section.
- For December 2015:
  - Integrating the collimation lattice files (momentum collimation).
  - Integrating a first aperture model (MAD-X model).
  - Making the first calculations for obit correction.
  - Refining the chromaticity correction scheme.


EuroCirCol