The European Synchrotron

EBS optics adjustments to accommodate: Short Bend, 2-pole wigglers and canted beamlines

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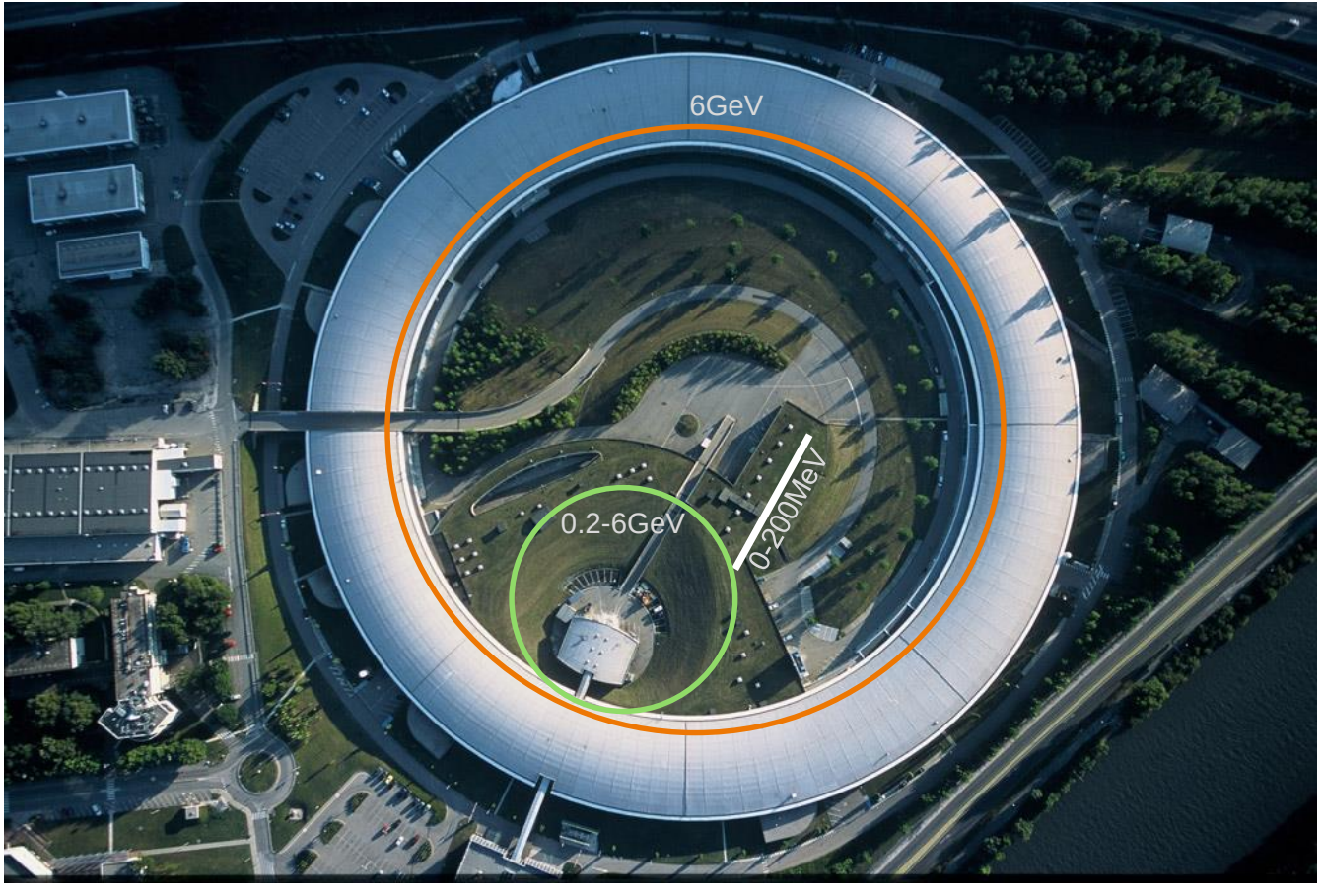
CURRENT ESRF, ACCELERATOR CHAIN LAYOUT AND MAIN PARAMETERS

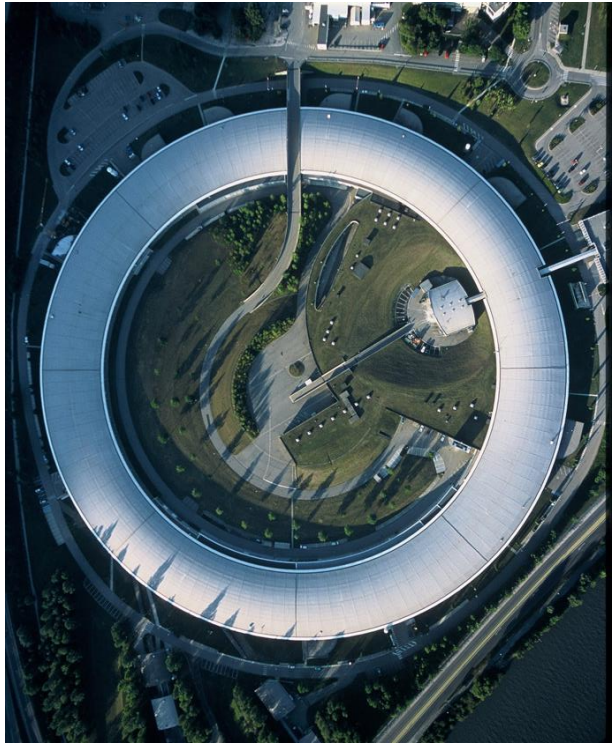
ERSF-EBS
Storage ring

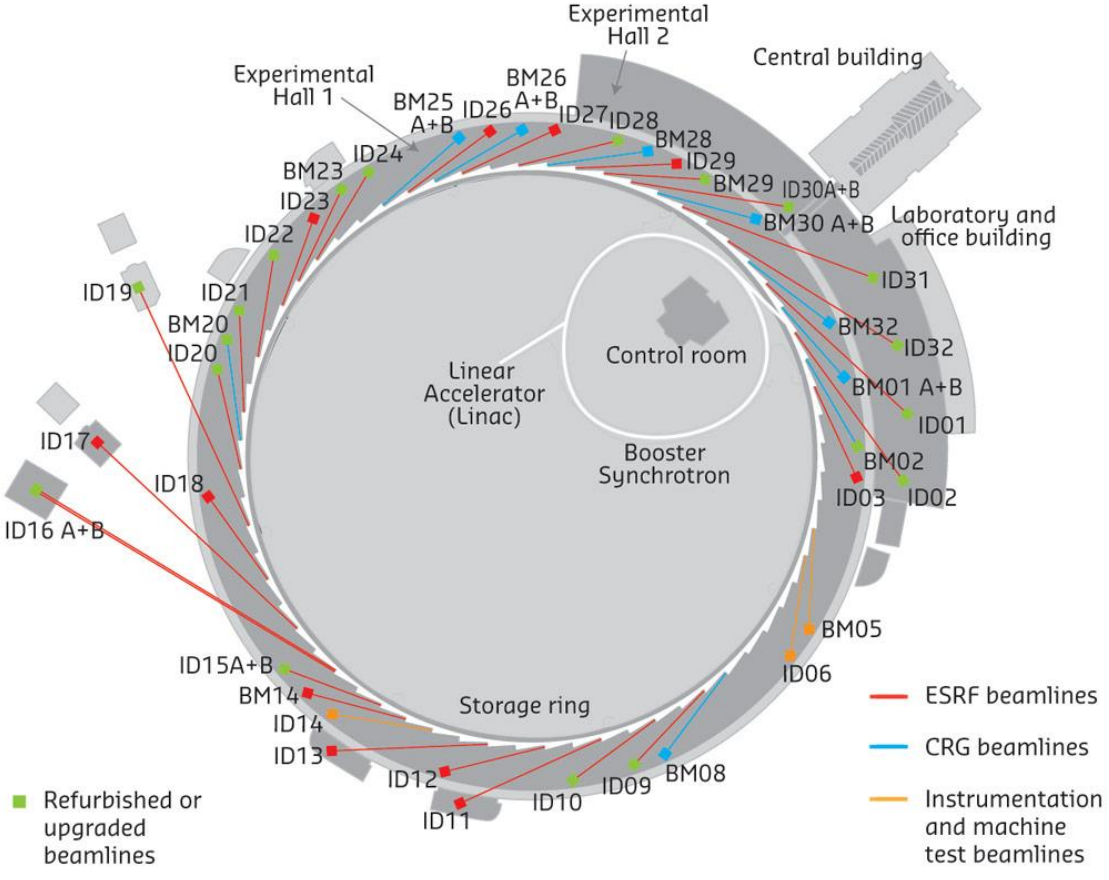
C=844 m
E=6 GeV
τ= 0.5-20 h *
V_{RF}= 6.5 MV
ε_x=132 pm rad
ε_y= 5 pm rad
I = 40-200 mA *

(*) according to filling mode



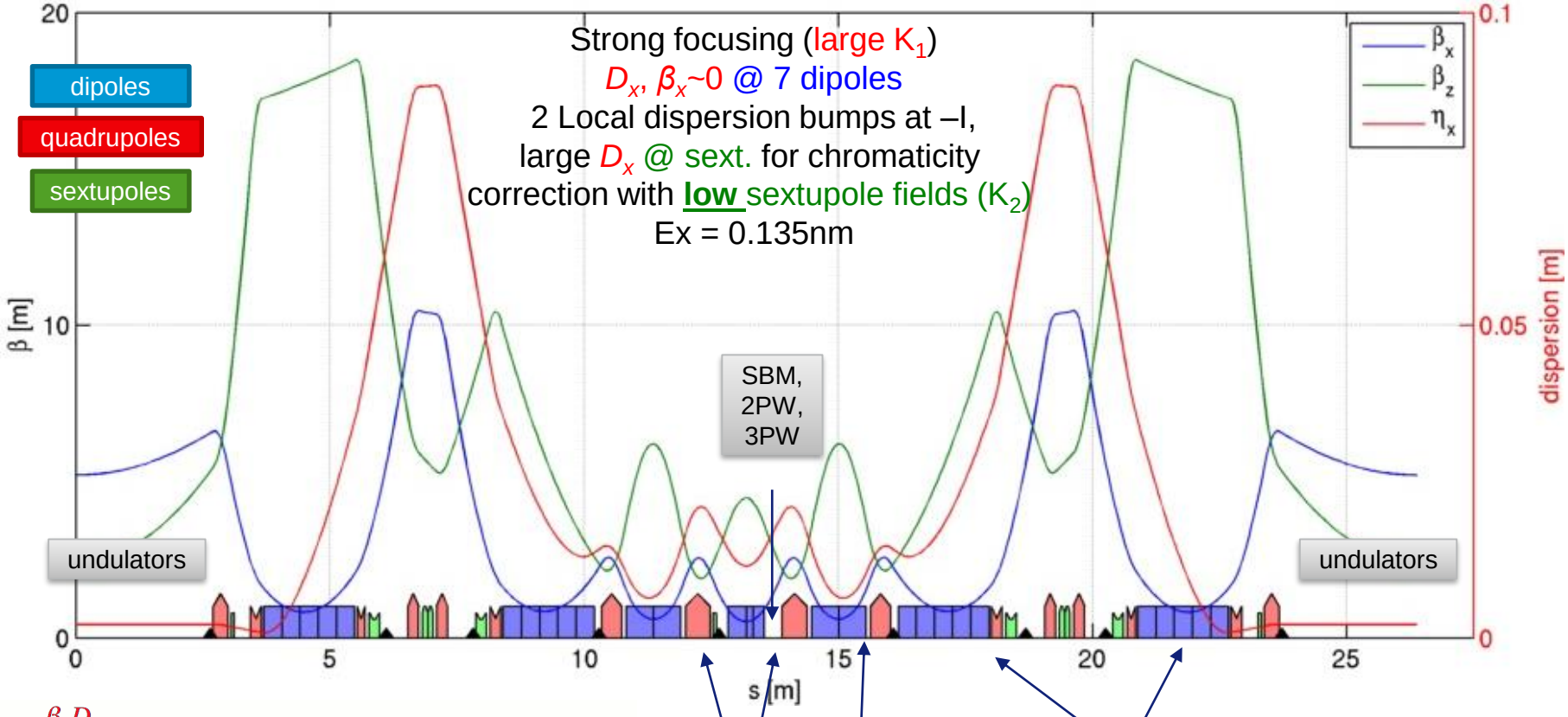
ABOUT ESRF: EUROPEAN SYNCHROTRON RADIATION FACILITY





Cell 4 Injection,
Cell 5, 7, 25 RF

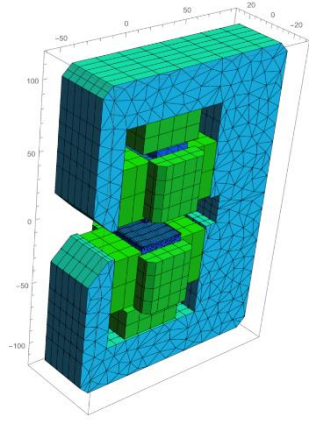
PROPOSED LATTICE LAYOUT FOR THE UPGRADE IN 2020: HYBRID MULTI BEND ACHROMAT

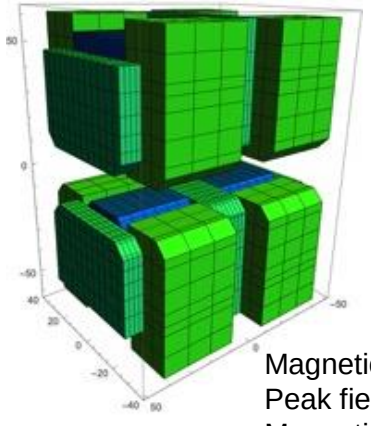


$$E_x \propto \frac{\beta_x D_x}{\rho} \quad (@\,dipoles)$$

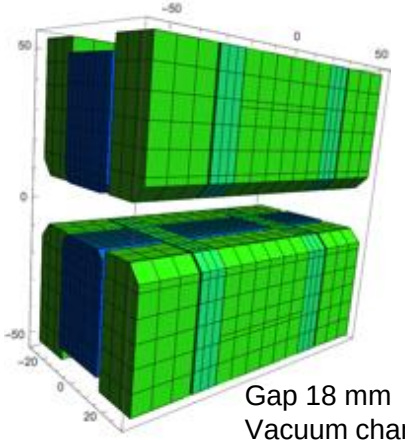
$$Chromaticity\ [>0] \propto -\beta_x K_1\ (@\,quads) + D_x K_2\ (@\,sext.)$$

SHORT BEND, 2POLES WIGGLER, 3POLES WIGGLER

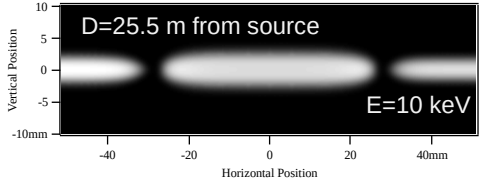


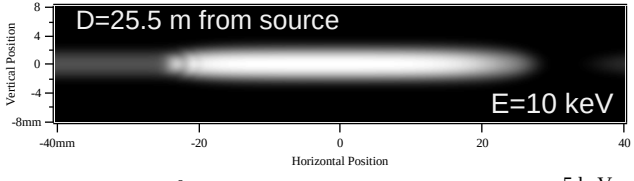


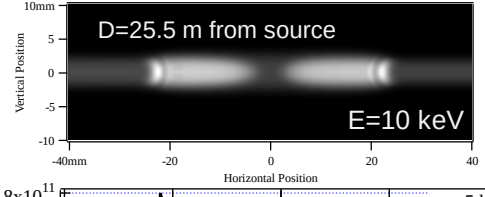
Magnetic gap 18 mm
Peak field: 0.86 T
Magnetic length: 99.1 mm

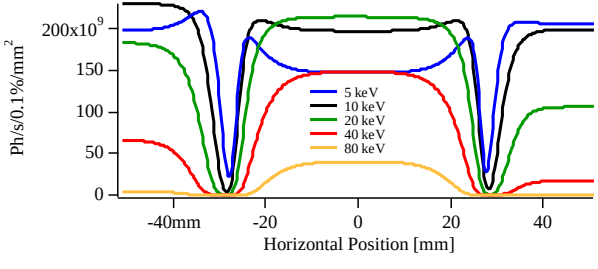


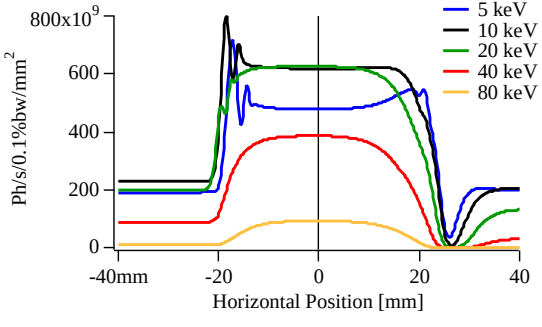
Gap 18 mm
Vacuum chamber: 16 mm
Magnetic length 110 mm

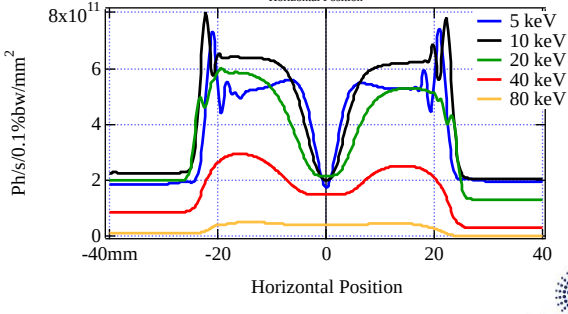




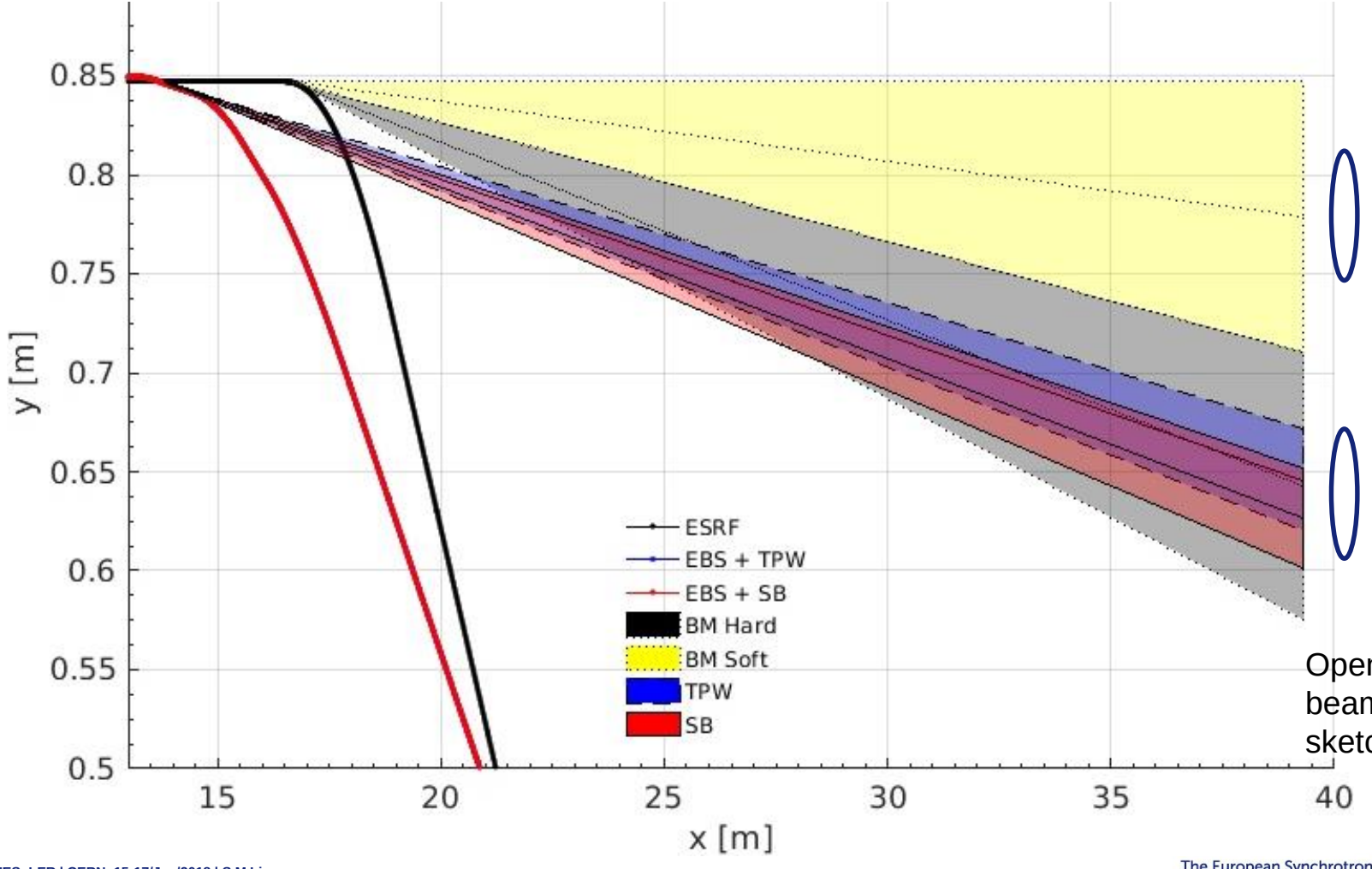








RADIATION FANS FROM DIFFERENT BM SOURCES COMPARED TO PRESENT



Opening at beamlines sketch

LIST OF SPECIFICITY FOR EACH CELL

CELL	BM type	ID type
1	2PW A	
2	SBM	
3		injection
4		injection
5	2PW A	
6		
7	2PW A	
8	SBM	
9		
10		
11		
12		
13		
14	2PW B	2.0 mrad
15		2.0 & 2.7 mrad
16	SBM	2.7 mrad
17		
18	3PW 18	
19		
20	SBM	
21		
22		
23	3PW	
24		
25	2PW A	
26	SBM	
27		
28	SBM	
29	2PW B	2.2 mrad
30	SBM	2.2 mrad
31	2PW A	
32	SBM	

Non standard cells out of 32

+ 2 3PW,

- 2 3PW (no impact on cell)

+ 7 2PWA, 2PWB

+ 8 SBM

+ 2 injection cells

+ 6 canting

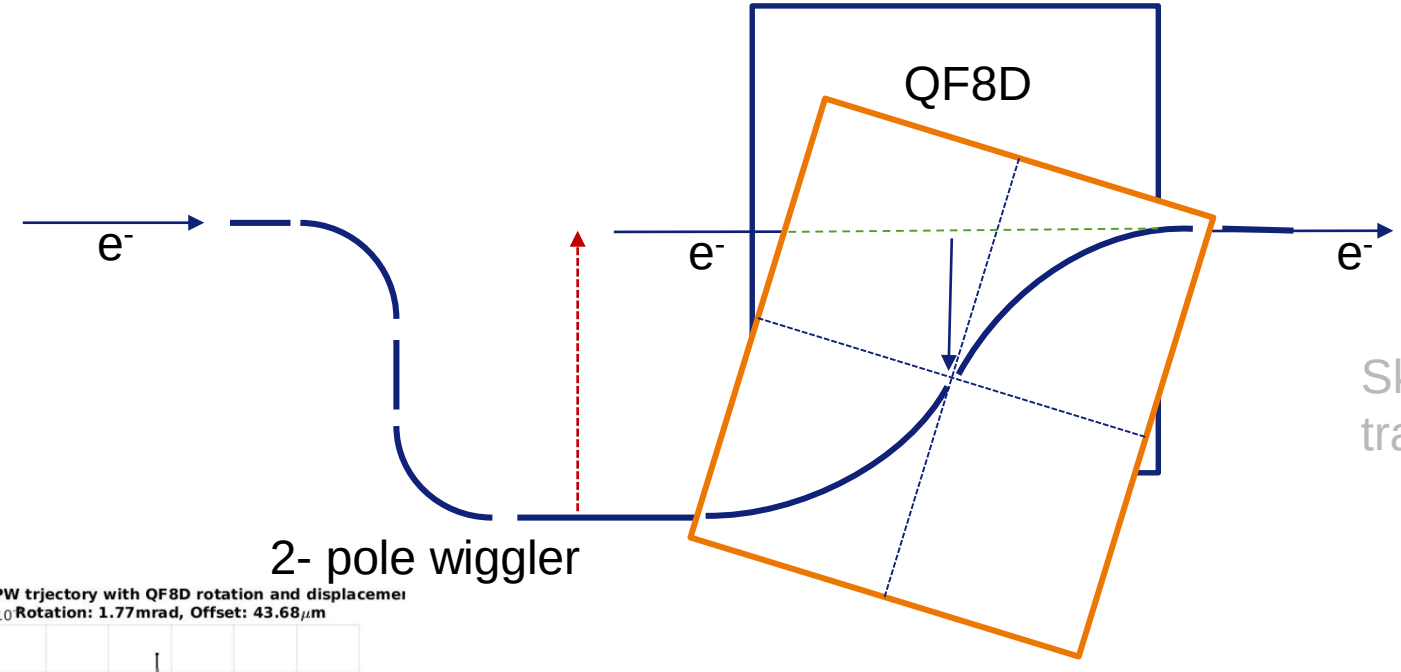
- 5 (canting + canting/2PW/SBM)

= 18 non standard cells over 32

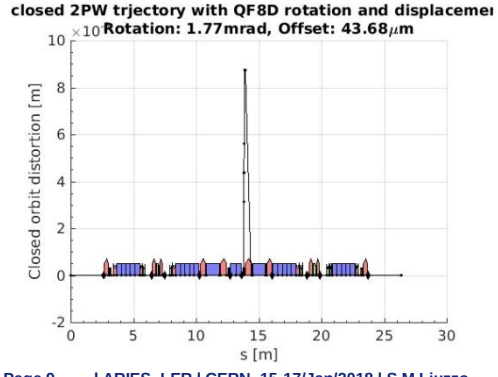
THREE POLES WIGGLERS

Like an ID, nothing to do, but only two beamlines can make use of the photons produced.

TWO POLES WIGGLER CORRECTION USING ROTATION OF QF8D

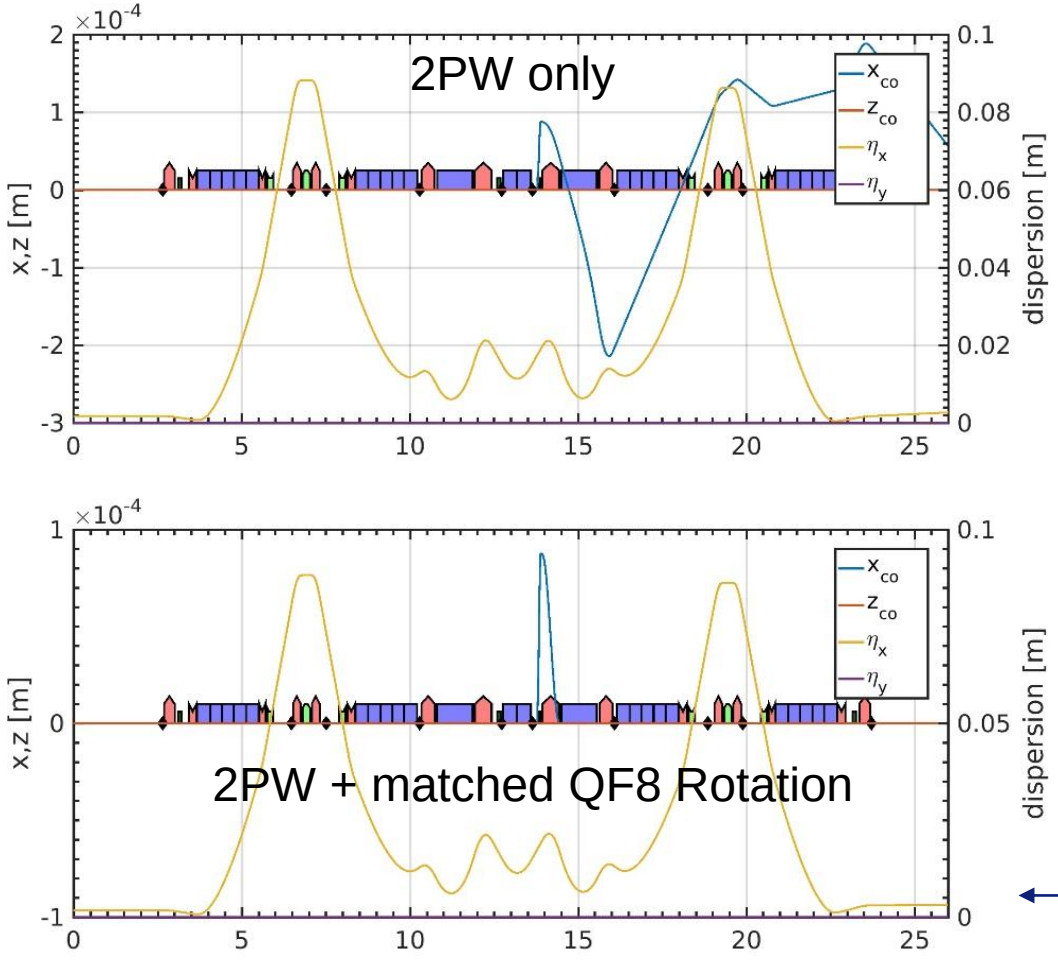


Skatch not real trajectories!!!



- Translation of half the trajectory change
- Rotation fitted to close the bump

2PW MATCHING (2PWA)



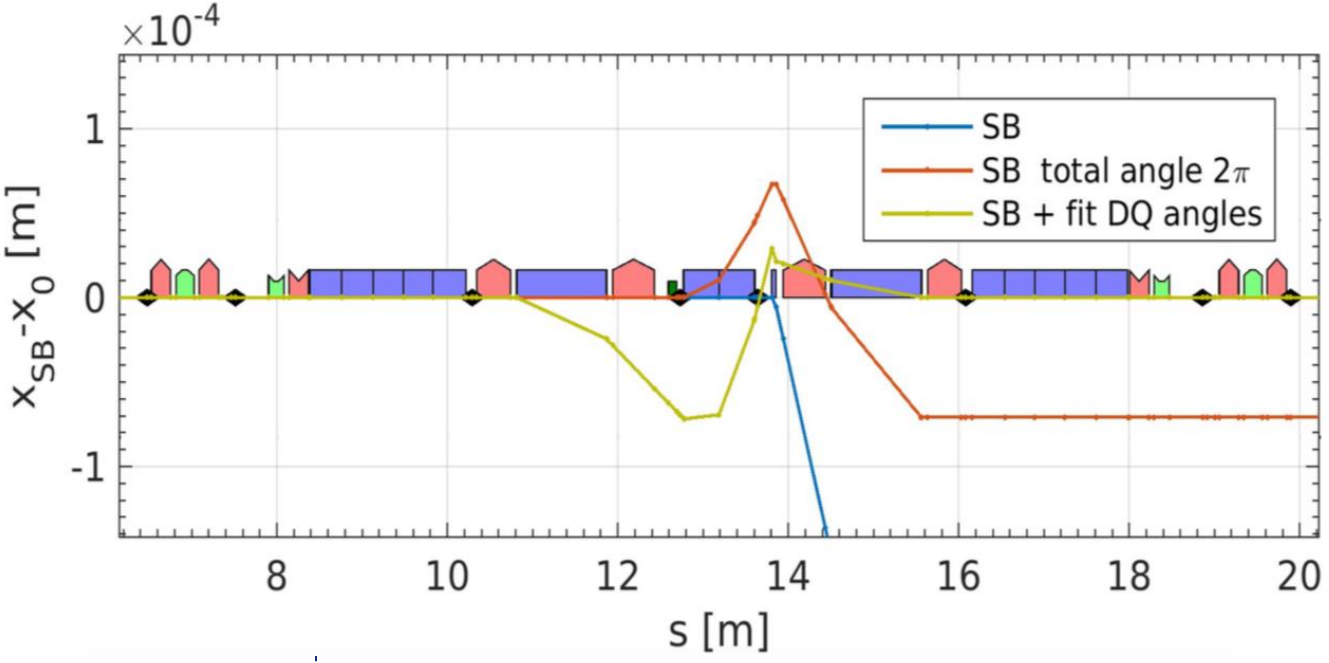
Two models available:
Multipole Kicks or Dipoles (QF8).

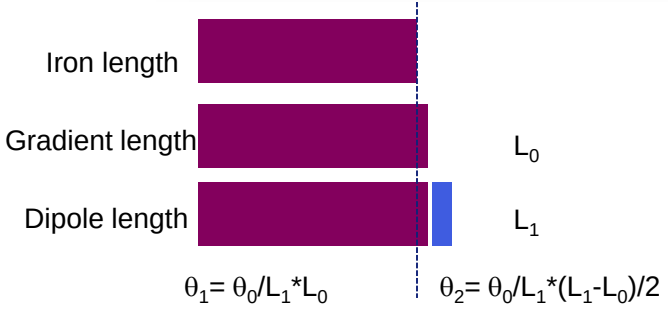
QF8 rotation can be set such that the c.o.d. bump is closed or such that the survey of the lattice is closed.

In any case some dispersion mismatch is still present and is tuned using the cell quadrupoles.

← Dispersion not matched

SHORT BENDING MAGNETS



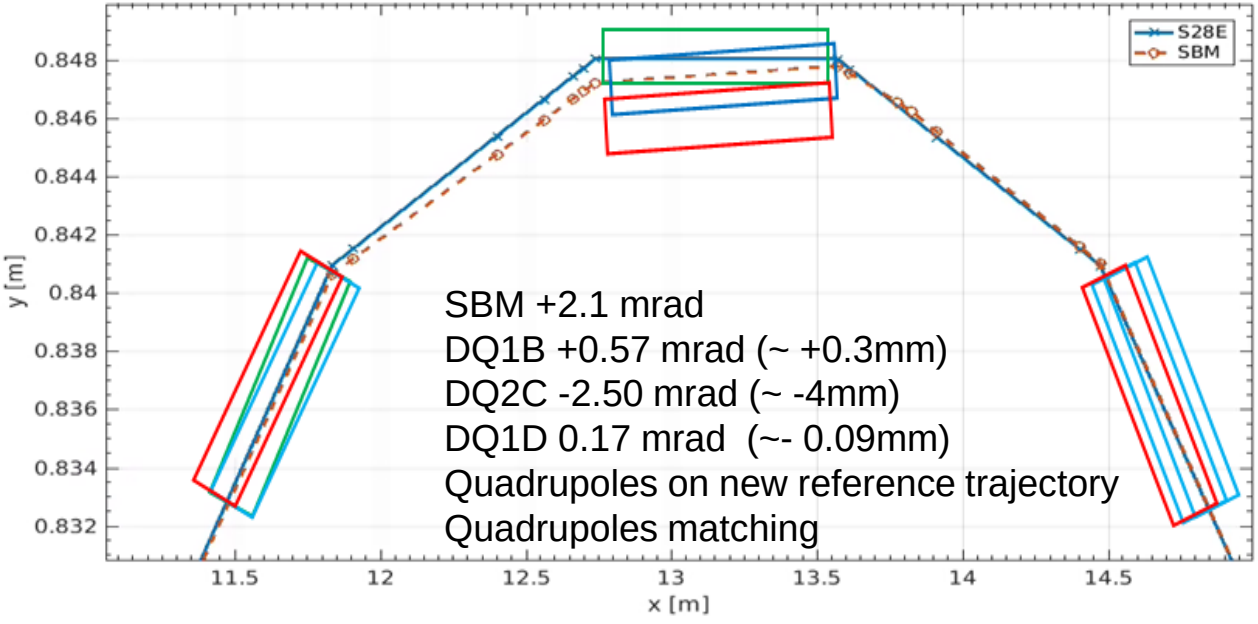


To fit the required DQs angles:

- Match survey positions (+DR25)
- Modify also dipole magnetic lengths
- Modify entrance and exit angles

The values found depend on the DQ model used.

SB DIPOLE MODEL

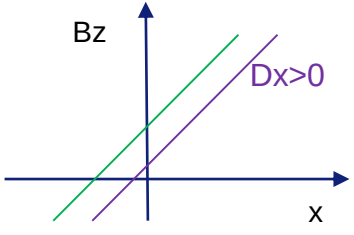


DQ2/QF8 on reference

DQ2 on final position for correct bending angle

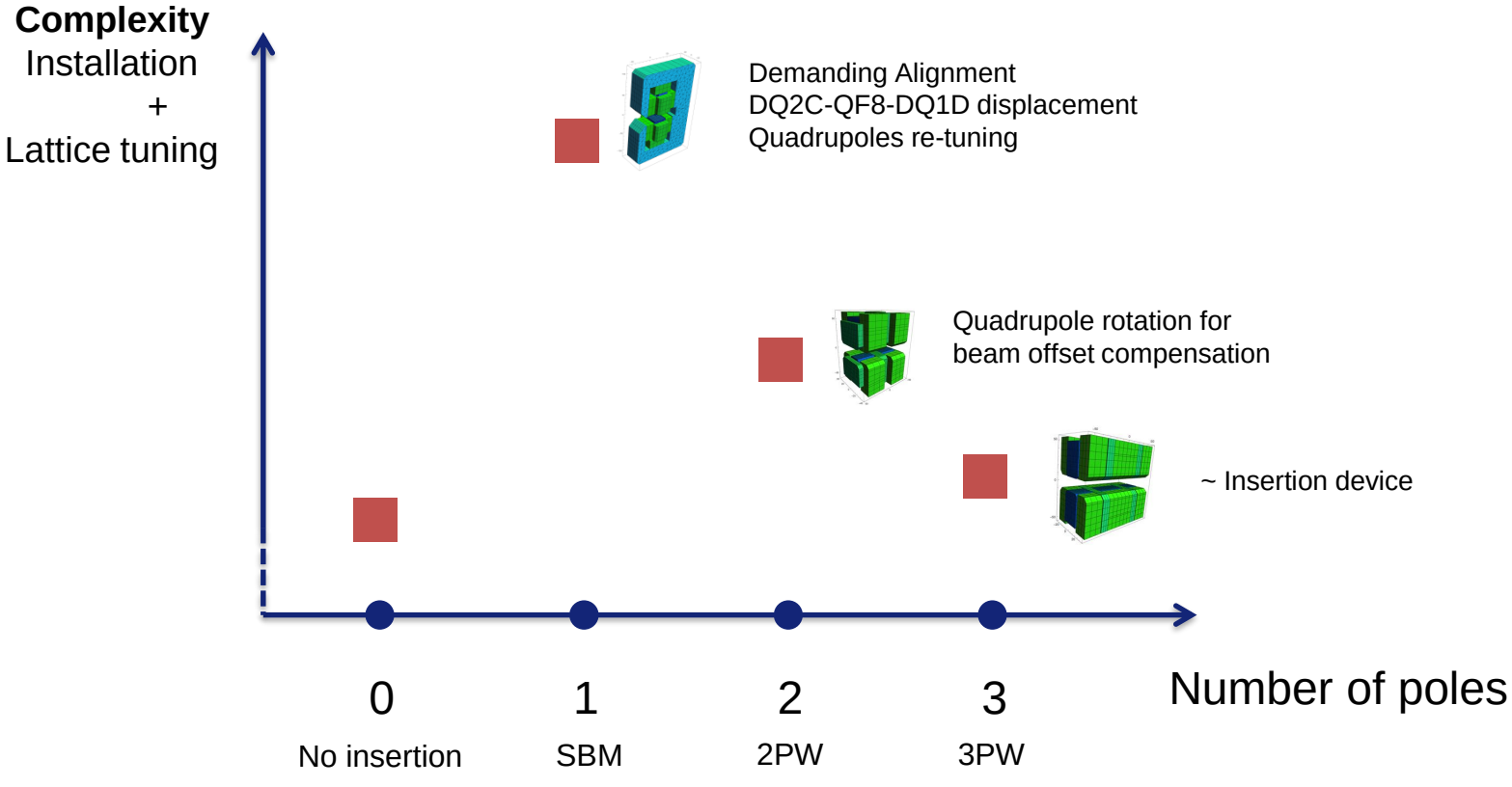
DQ2 / QF8 standard cell

New trajectory for region between DQ1B and DQ1D. All magnets realigned, DQ1 and DQ2 make a different angle. Magnetic center measurement will be performed also for this different angles (2 angles for each DQ, the standard cell angle and the SB cell angle)



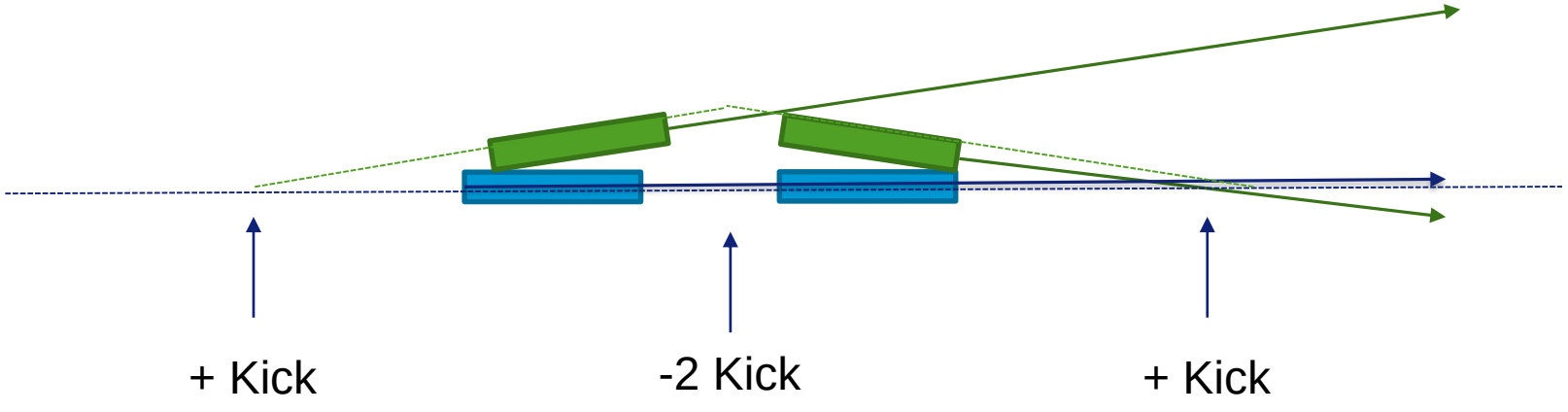
SUMMARY

- Several alternative to conventional BM visited



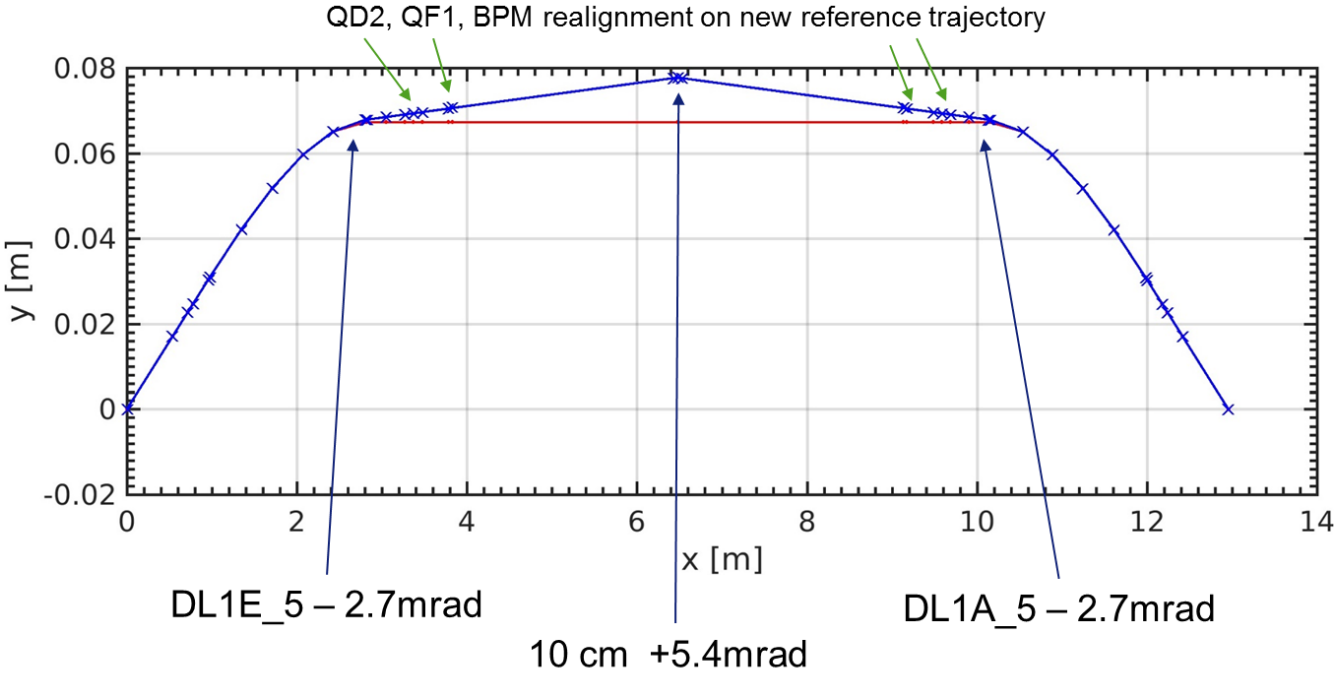
CANTED BEAMLINE

Canted beamlines allow to have 2 different photon beamlines in the same straight section.
Usually the insertion is done with 3 bending magnets in the straight section.



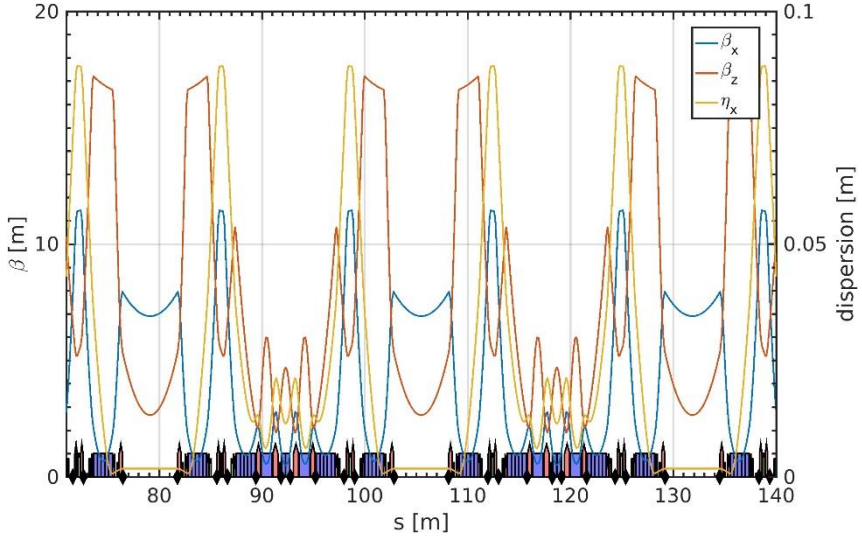
If all the kicks are in the straight section this is transparent to the lattice optics.

CANTED BEAMLINES

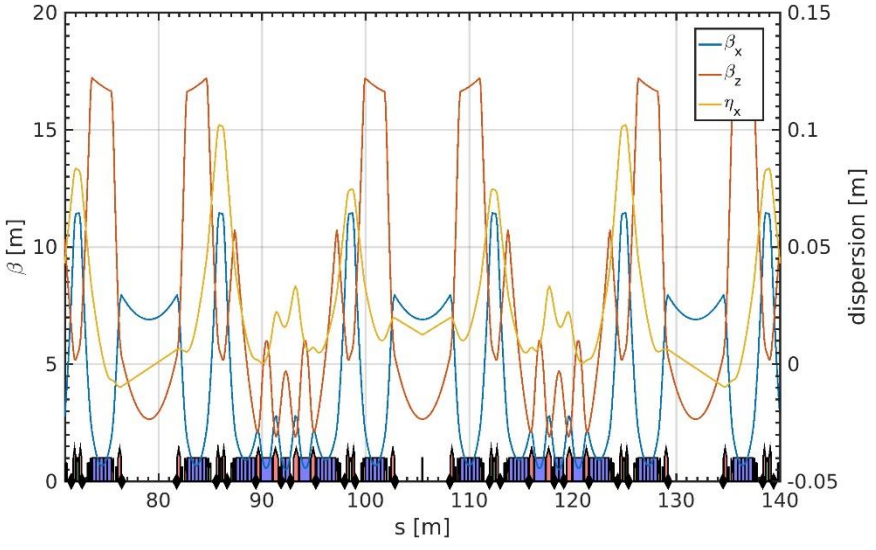


For EBS, due to space reason, the field of the lattice dipoles has to be reduced to create the required angle.

OPTICS WITH ONE CANTED BEAMLINES



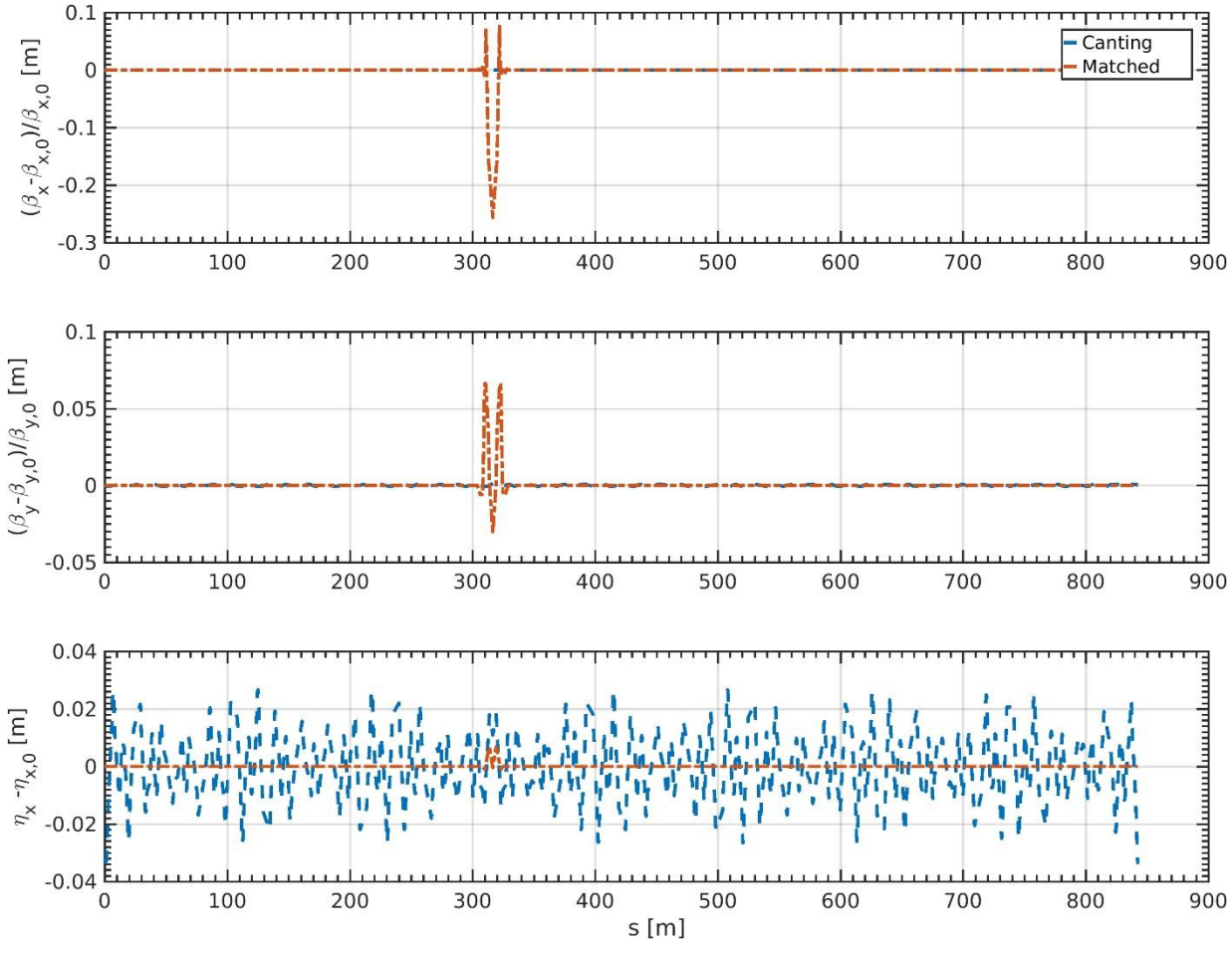
Nominal optics, no canting



Canted beamline without matching

About 20mm horizontal dispersion distortion.

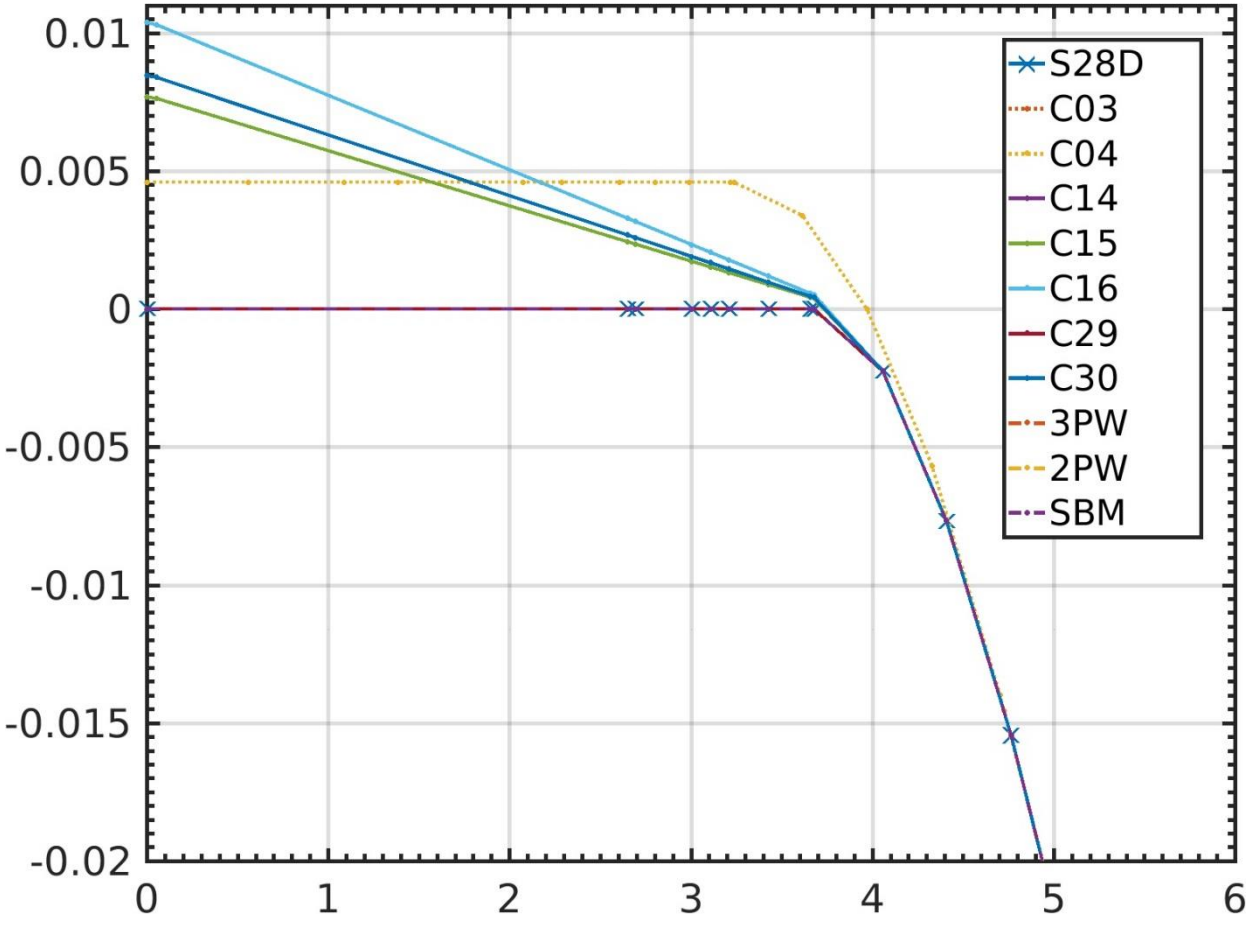
CANTED BEAMLINES OPTICS MATCHING



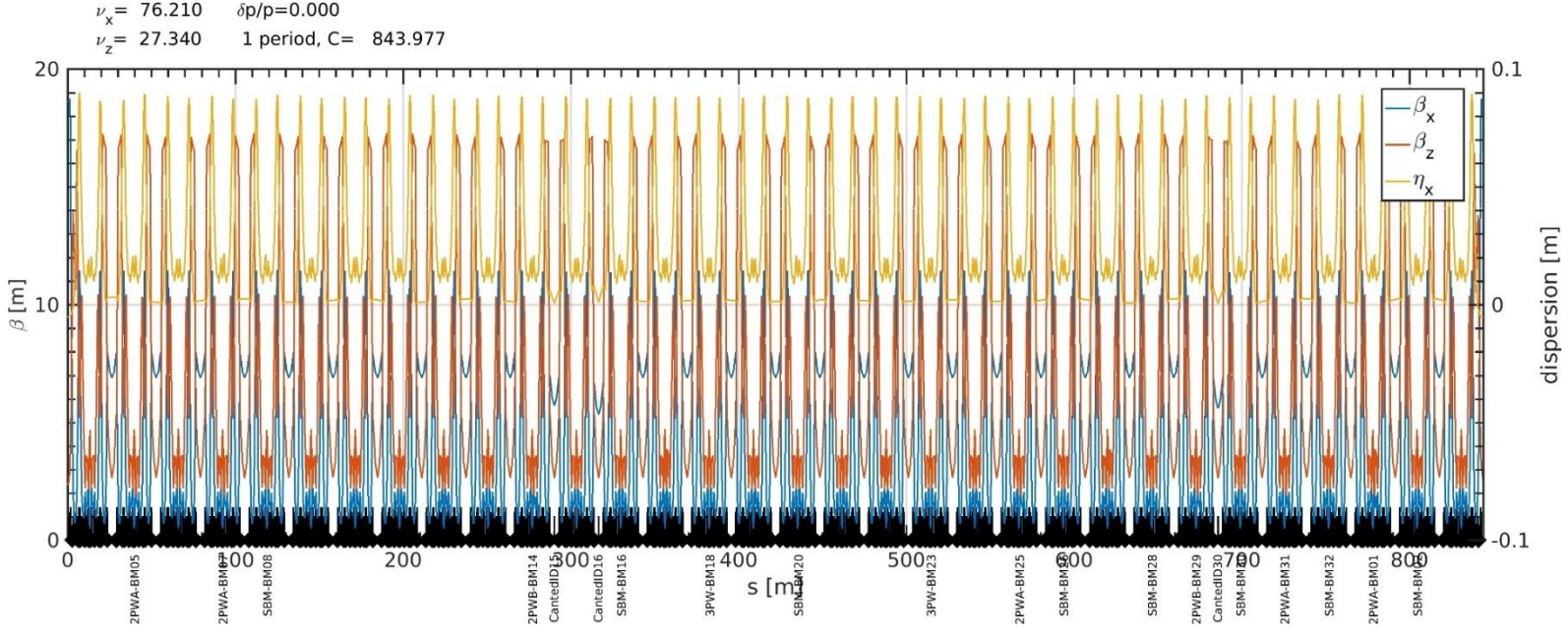
QF1E	2.53946	2.63668	0.0972169
QF1A	2.53946	2.63668	0.0972169
QD2E	-2.67203	-2.69479	-0.0227639
QD2A	-2.67203	-2.69479	-0.0227639
QD3E	-2.40427	-2.4419	-0.0376296
QD3A	-2.40427	-2.4419	-0.0376296
QF4E	2.42999	2.32915	-0.100833
QF4A	2.42999	2.32915	-0.100833
QF4D	2.42999	2.45164	0.0216504
QF4B	2.42999	2.45164	0.0216504
QD5D	-2.7045	-2.64879	0.0557082
QD5B	-2.7045	-2.64879	0.0557082
QF6D	4.46454	4.4655	0.000961386
QF6B	4.46454	4.4655	0.000961386
QF8D	4.42547	4.41868	-0.00678815
QF8B	4.42547	4.41868	-0.00678815

Individual magnets in the concerned cells.

ID SURVEY POSITIONS



2020 LATTICE



5 cells with combined features

ID14: Canted cell + 2PW

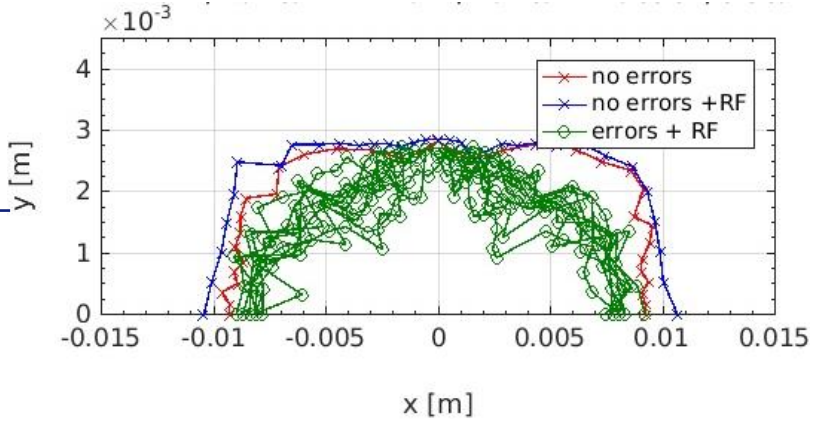
ID15: Canting 2.0 and 2.7 mrad

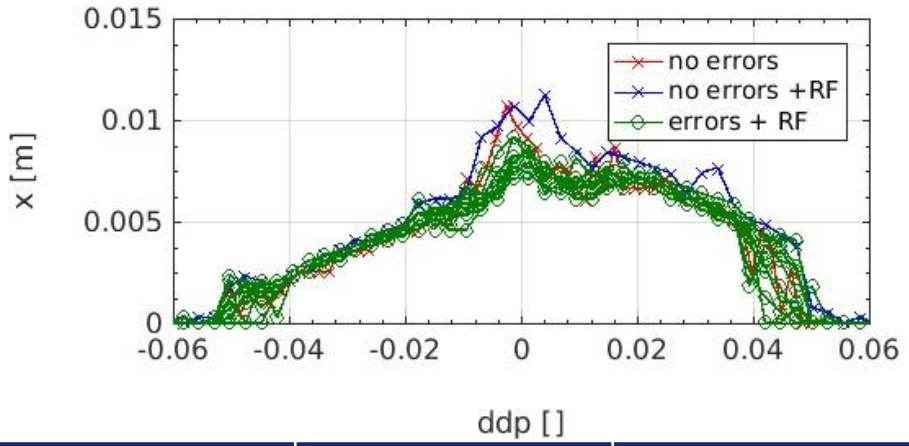
ID16: Canted cell + SBM

ID29: Canted cell + 2PW

ID30: Canted cell + SBM

DYNAMIC APERTURES





	DA	TLT	IE	DA [mm]	TLT [h]	I.E. [%]
	No errors			10 seeds average		
S28D	-11.5	27.4	97.7	-8.3±0.4	21.5±1.3	88.4±4.8
+Canting	-10.2	22.2	97.5	-8.4±0.4	20.2±1.0	85.6±5.3
+2PW	-10.3	22.7	97.4	-8.5±0.2	19.7±0.8	86.7±5.2
+3PW	-10.3	22.9	97.4	-8.5±0.5	19.7±0.7	86.6±5.3
+SBM	-10.4	22.1	97.2	-8.5±0.4	19.1±0.6	85.9±5.8

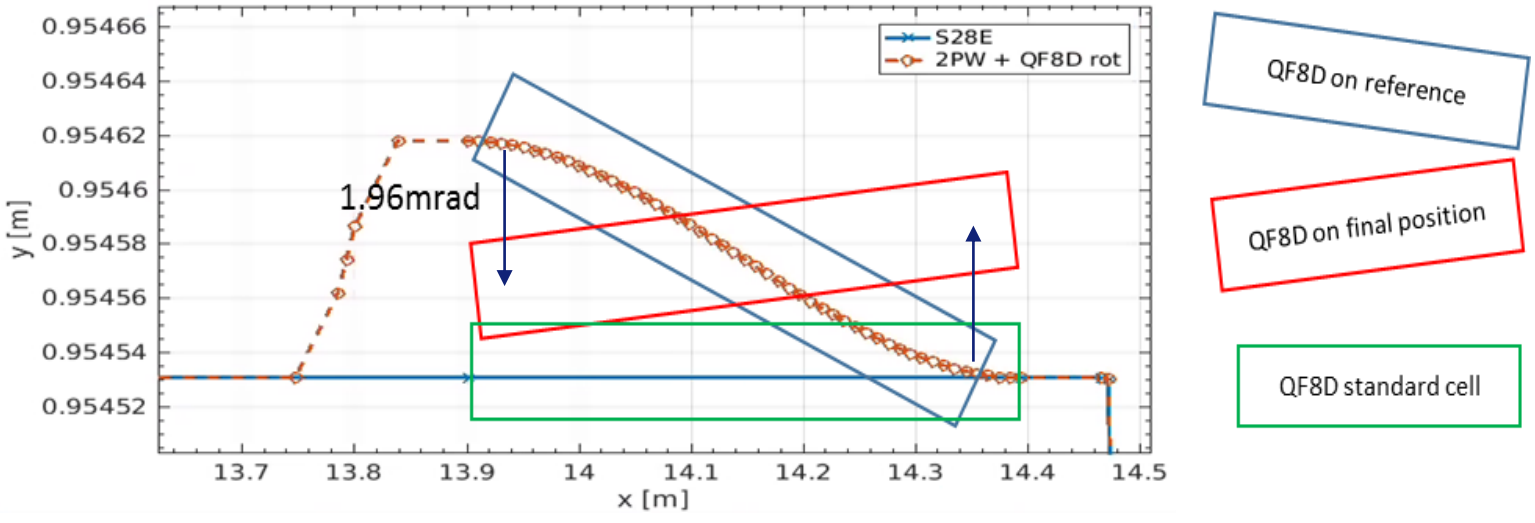
Physical Apertures are set in all simulations

CONCLUSIONS

The S28D lattice has been modified to include all future modifications.

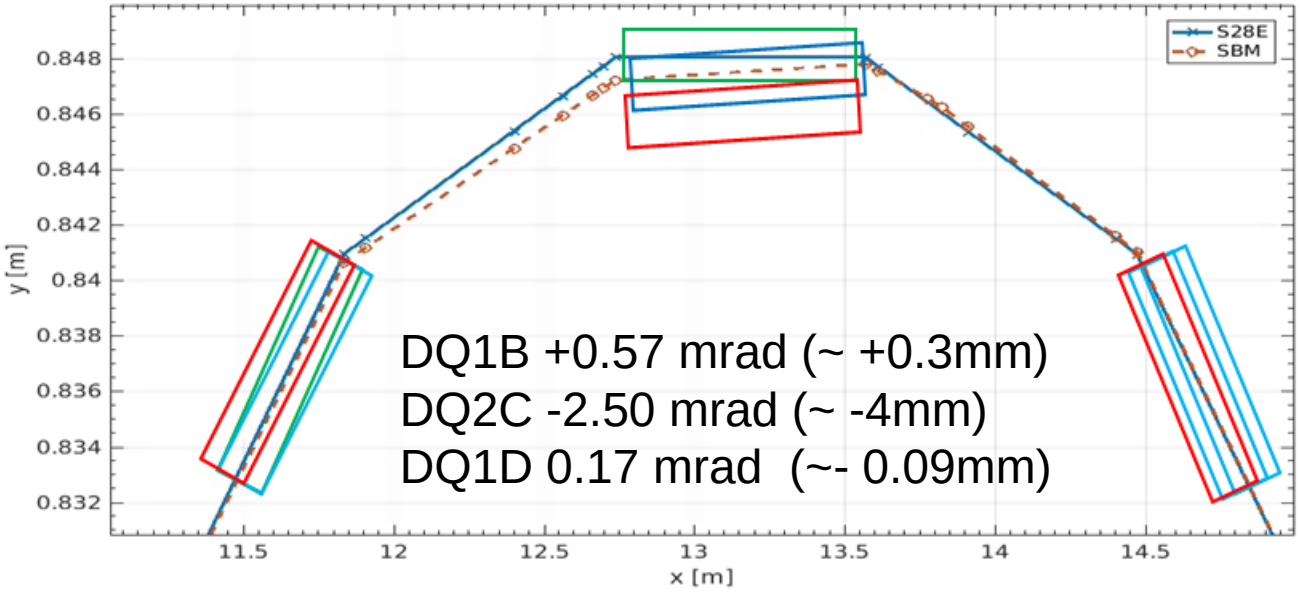
- **Single cell all independent quadrupoles matching (also for optics tuning! P.R.)**
- **2PW local quadruple matching implemented instead of global correction**
- **SBM matching fixed to include magnetic lengths of DQ and entrance exit angles.**
- **2PW and SBM can be inserted in any cell, also in Canted cells (asymmetric)**
- **Chromaticity corrected and RM12 RM34 not far from optimal in every cell.**
- **Produce Survey file for Drafting Office**
- **More tuning/optimization work for Canted beamlines and SBM tuning**

DIPOLE FOR 2PW MODEL



Cell quadrupoles modified to recover dispersion an keep optics knobs unchanged
Matching is more difficult in cells with Canting.
QF8D sliced in 50 slices for convergence (1.95mrad)

SB DIPOLE MODEL

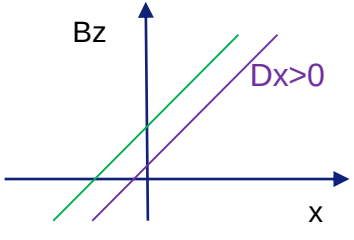


DQ2/QF8 on reference

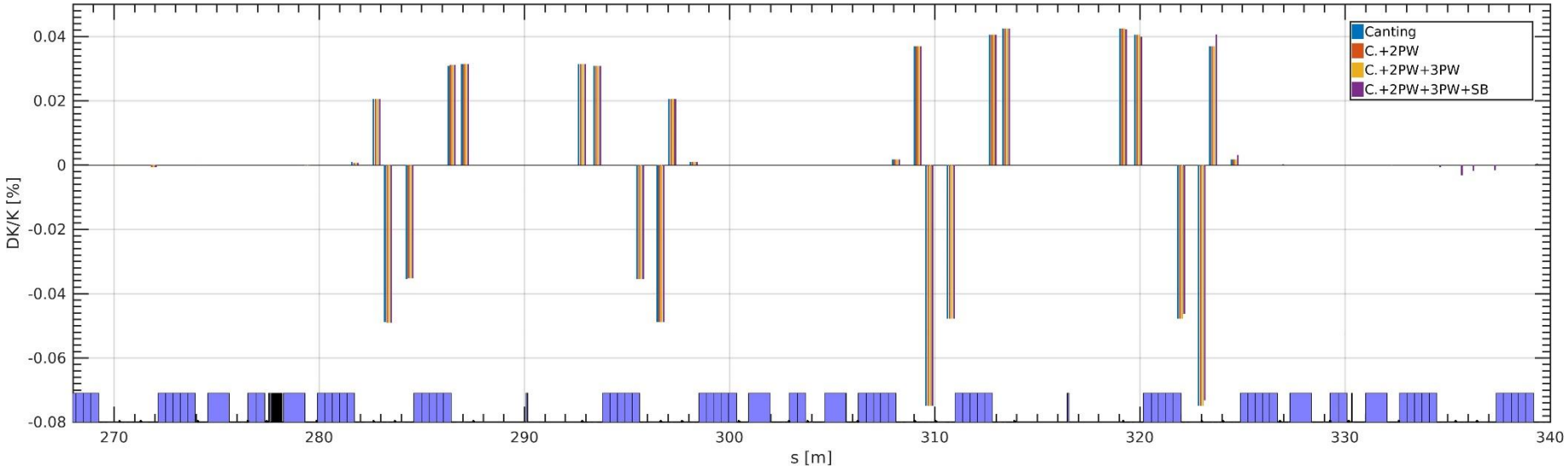
DQ2 on final position for correct bending angle

DQ2 / QF8 standard cell

New trajectory for region between DQ1B and DQ1D. All magnets realigned, DQ1 and DQ2 make a different angle. Magnets wire position should be measured also for this different angle (2 angles for each DQ, the standard cell angle and the SB cell angle)

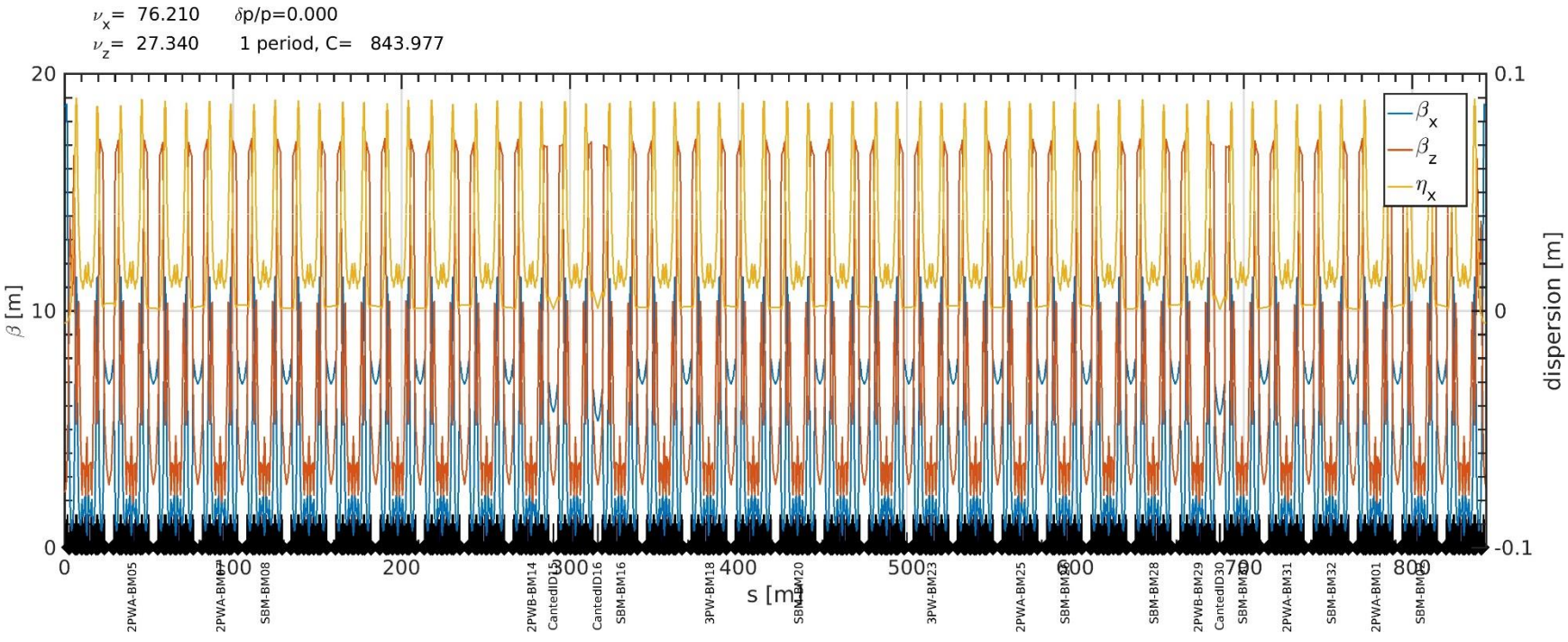


DK FOR CANTING AND BM INSERTIONS



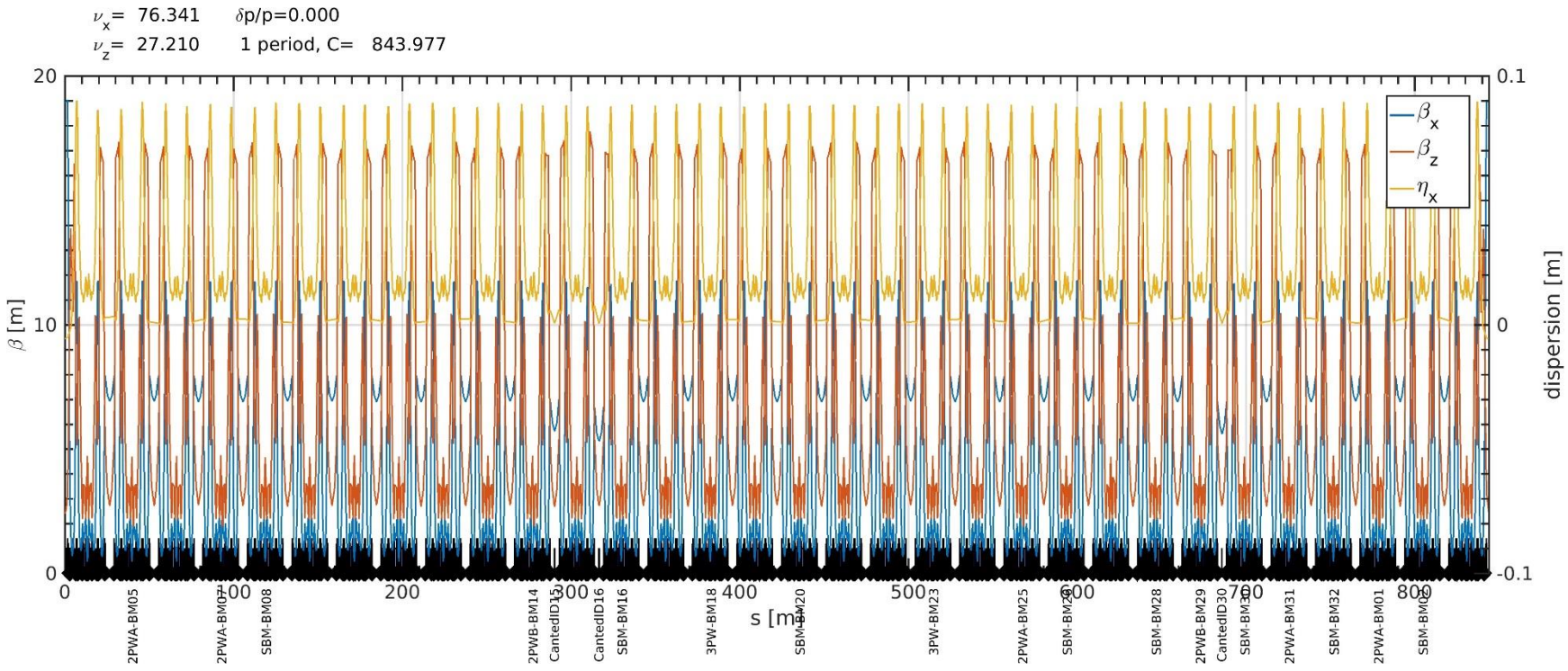
Canting is the main source of rematch. SB and 2PW are small modifications.

LATTICE OPTICS



SB dipole model
2PW dipole model
Canting corrected using QF6 to QF1

TUNE CHANGE ON LATTICE WITH ALL BM INSERTIONS



Tunes swapped .21 .34 to .34 .21 using ebs.opticsmatching
The standard cell, injection and canted cells are matched.
SB and 2PW cell are not adjusted, thus the 0.001 error in Qx.