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

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ERSF-EBS
Storage ring

\[ C = 844 \text{ m} \]
\[ E = 6 \text{ GeV} \]
\[ \tau = 0.5-20 \text{ h} \]
\[ V_{\text{RF}} = 6.5 \text{ MV} \]
\[ \varepsilon_x = 132 \text{ pm rad} \]
\[ \varepsilon_y = 5 \text{ pm rad} \]
\[ I = 40-200 \text{ mA} \]

(*) according to filling mode
ABOUT ESRF: EUROPEAN SYNCHROTRON RADIATION FACILITY

Cell 4 Injection, Cell 5, 7, 25 RF
Strong focusing (large $K_1$)

$D_x, \beta_x \sim 0$ @ 7 dipoles

2 Local dispersion bumps at $-\lambda$, large $D_x$ @ sext. for chromaticity correction with **low** sextupole fields ($K_2$) Ex = 0.135nm

$E_x \propto \frac{\beta_x D_x}{\rho}$ (@ 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

D=25.5 m from source
E=10 keV

D=25.5 m from source
E=10 keV

D=25.5 m from source
E=10 keV
RADIATION FANS FROM DIFFERENT BM SOURCES COMPARED TO PRESENT

Opening at beamlines sketch
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
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

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

QF8D

2- pole wiggler

Skatch not real trajectories!!!
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.
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.
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)
• Several alternative to conventional BM visited

<table>
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<th>Complexity</th>
<th>Installation + Lattice tuning</th>
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<tr>
<td>0</td>
<td>No insertion</td>
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<tr>
<td>1</td>
<td>SBM</td>
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<tr>
<td>2</td>
<td>2PW</td>
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<td>3</td>
<td>3PW</td>
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Demanding Alignment
DQ2C-QF8-DQ1D displacement
Quadrupoles re-tuning

Quadrupole rotation for beam offset compensation

~ Insertion device
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.
For EBS, due to space reason, the field of the lattice dipoles has to be reduced to create the required angle.
Canted beamline without matching

About 20mm horizontal dispersion distortion.

Nominal optics, no canting
Individual magnets in the concerned cells.
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

Physical Apertures are set in all simulations

<table>
<thead>
<tr>
<th></th>
<th>DA</th>
<th>TLT</th>
<th>IE</th>
<th>DA [mm]</th>
<th>TLT [h]</th>
<th>I.E. [%]</th>
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<td></td>
<td></td>
<td></td>
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<td>10 seeds average</td>
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<td>No errors</td>
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<td>S28D</td>
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<td>-8.3±0.4</td>
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<td>22.2</td>
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<td>20.2±1.0</td>
<td>85.6±5.3</td>
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<tr>
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<td>86.7±5.2</td>
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<tr>
<td>+SBM</td>
<td>-10.4</td>
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<td>97.2</td>
<td>-8.5±0.4</td>
<td>19.1±0.6</td>
<td>85.9±5.8</td>
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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
Cell quadrupoles modified to recover dispersion and keep optics knobs unchanged.
Matching is more difficult in cells with Canting.
QF8D sliced in 50 slices for convergence (1.95 mrad)
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).

DQ1B +0.57 mrad (~ +0.3mm)
DQ2C -2.50 mrad (~ -4mm)
DQ1D 0.17 mrad (~- 0.09mm)
Canting is the main source of rematch. SB and 2PW are small modifications.
SB dipole model
2PW dipole model
Canting corrected using QF6 to QF1
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.