Local bump depolarizer. Different options.

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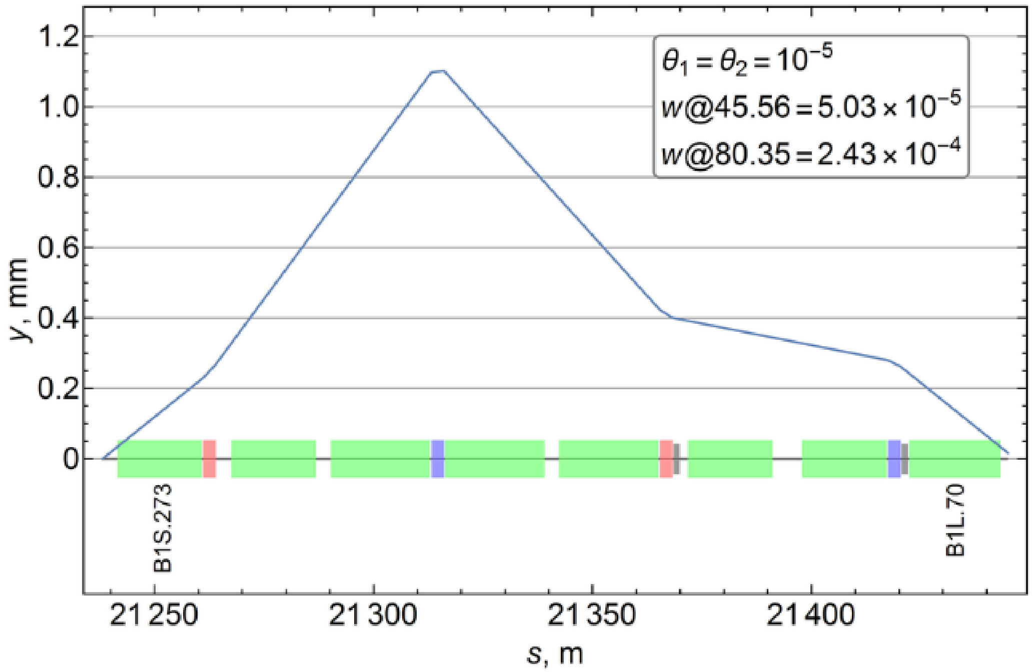
Outline

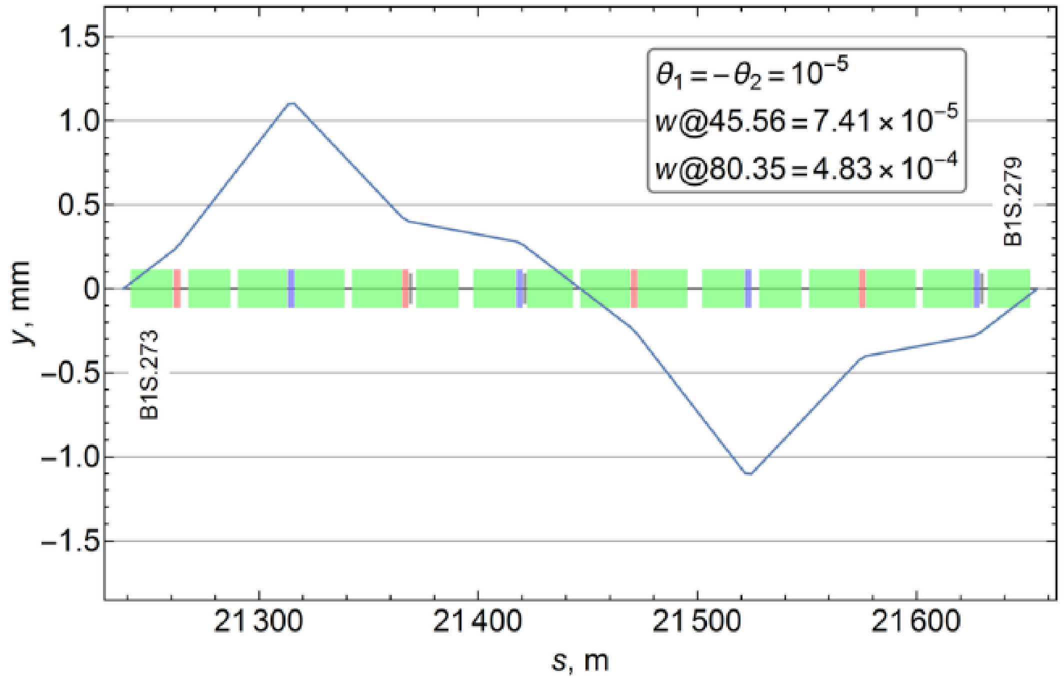
Local bumps created by two identical transverse RF-kickers

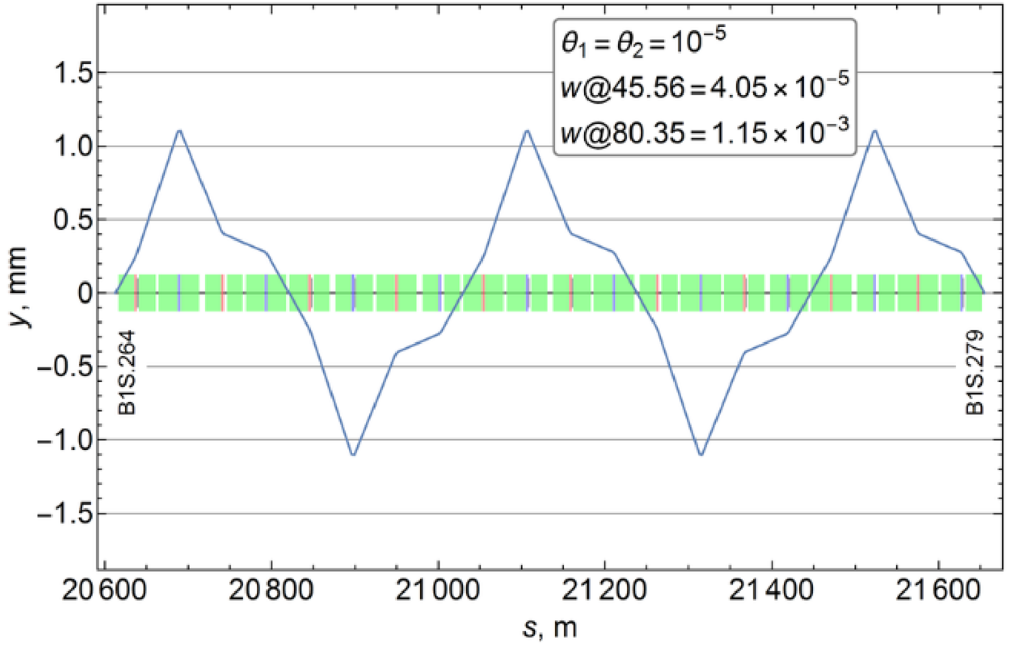
Harmonic strength evaluation at Z and at W beam energies

Discussion of results

Local vertical orbit bumps in FCC-ee arc







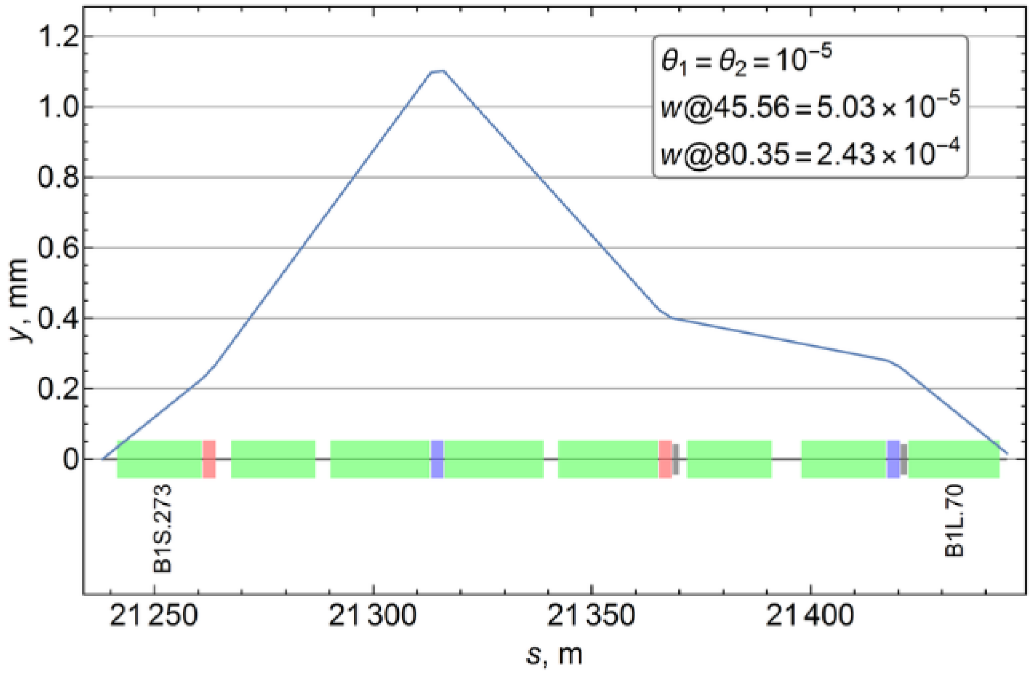
At 45 GeV a full-wave orbit bump is about 27% more effective (w=0.000175) than a half-wave one (w=0.0001377).

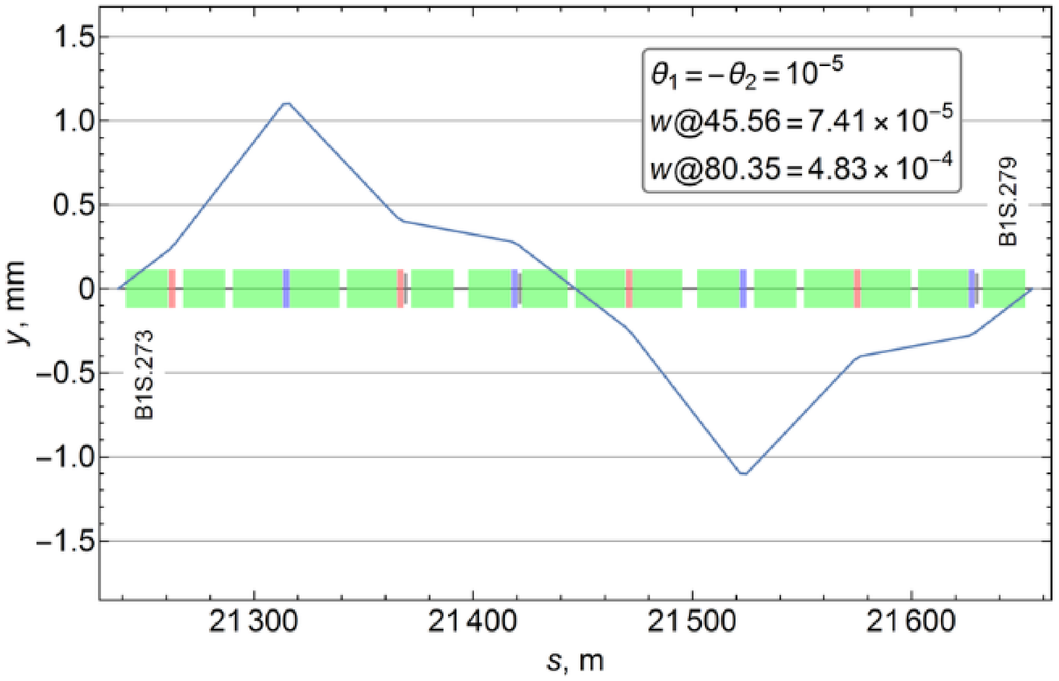
But at 80 GeV a short half-wave bump works much better (w=0.014) than a full-wave setup (w=0.001037).

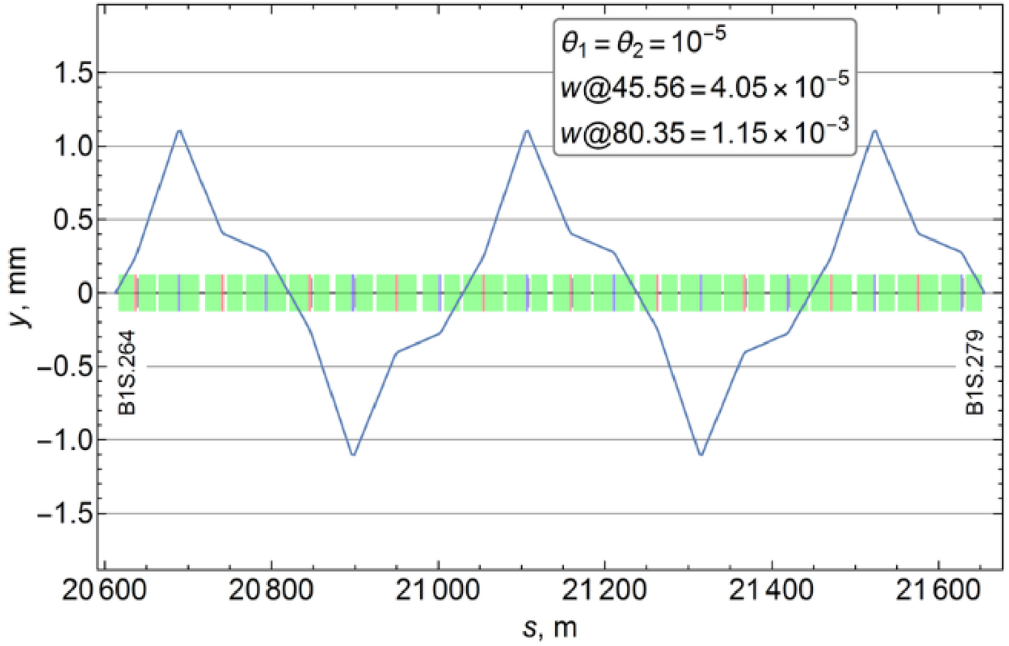
Longer bumps (1.5, 2.0, 2.5 waves) are not advantages.

With the same kick angles $\theta_{1,2}$ a half-wave spin rotator is about 45 times more effective at 80 GeV than at 45 GeV. This is thanks to about 2 times larger spin rotation by the RF-kicks itself and by the horizontal bends.

Local vertical orbit bumps in FCC-ee arc





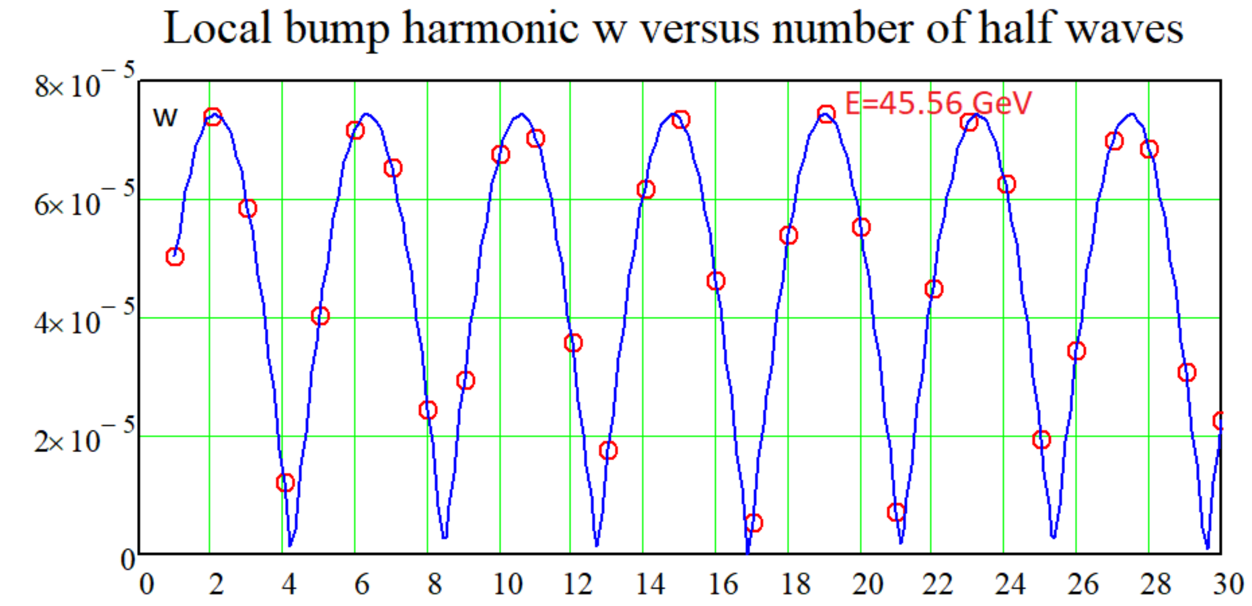


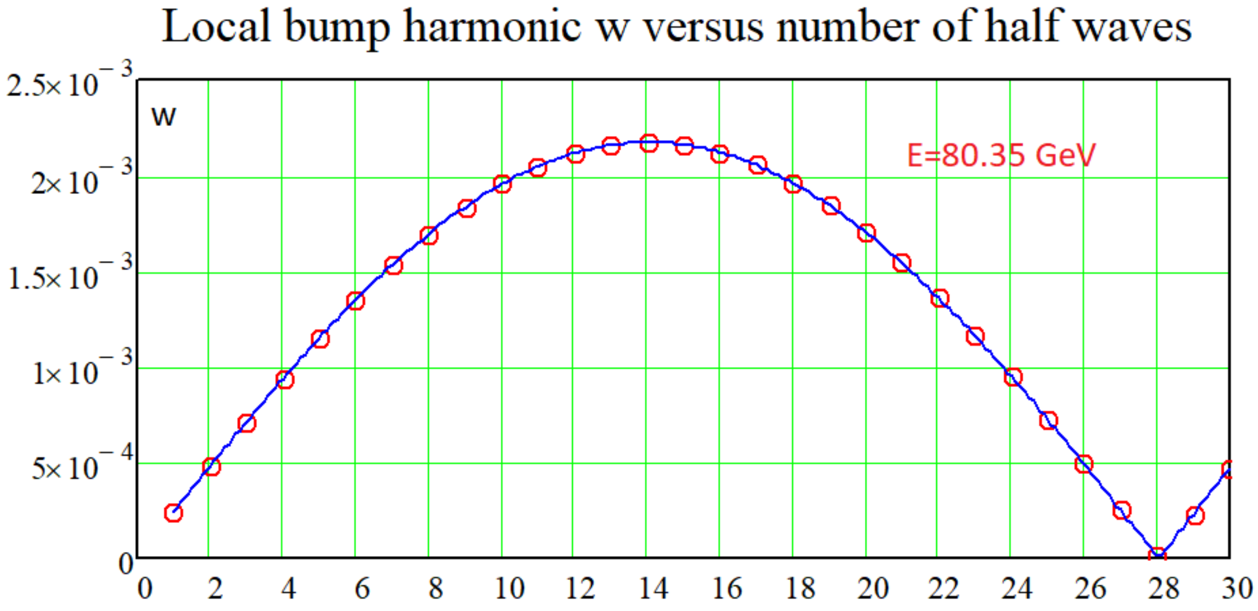
Harmonic value *w* of a local bump depolarizer is just a sum of spin rotations by the *M* kickers/quads $(1+\nu)\alpha_m$ around the *x*-axis. Each kick is weighted by a complex factor $\eta_m = e^{i\nu\varphi_m}$:

$$w = \frac{1}{4\pi}\sum_{m=1}^{M}(1+\nu)\alpha_m \cdot \eta_m$$

where ν is a spin tune, and φ_m is the horizontal bend angle starting from the first kick.

Harmonic value at Z and at W versus number of half waves





A half wave bump is a shortest one. Longer bumps comprised from *N* pi-bumps could provide larger depolarizer harmonic value. Their strength can be calculated as an geometric progression:

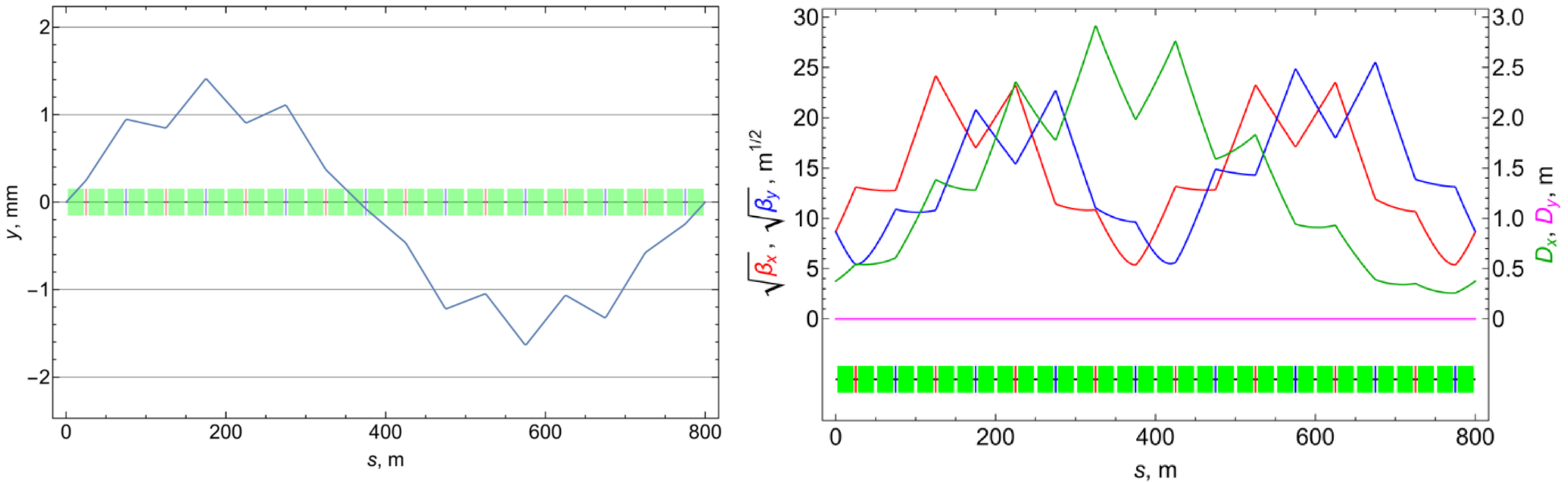
$$w_N = w_1 \left| \frac{1-(-e^{i\nu\varphi_M})^N}{1+e^{i\nu\varphi_M}} \right|$$

At *Z* the spin phase advance $\nu\varphi_M = 1.655$ per one half wave arc section is small and increase of *N* is not too much effective.

In contrast, at *W* the spin phase advance $\nu\varphi_M = 2.918$ per one half wave arc section is close to its optimal value π, and w grows almost linearly with increase of *N*!

How can we make w larger at Z?

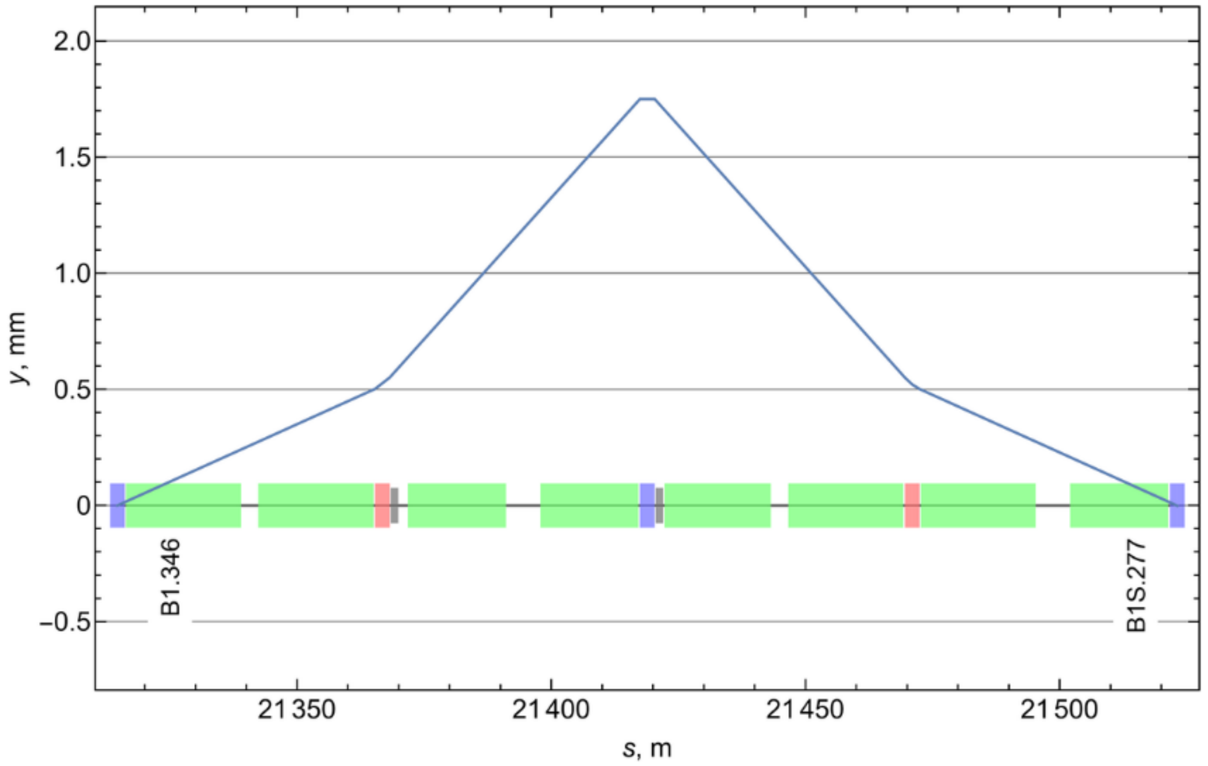
One can organize a 1-wave local bump which replaces the normal 2-wave piece of an arc. Then spin rotation by dipoles per a betatron phase will become larger and the total spin deflection will increase substantially. For 45.56 GeV $w = 2.88 \cdot 10^{-4}$. The gain is about 5.8.

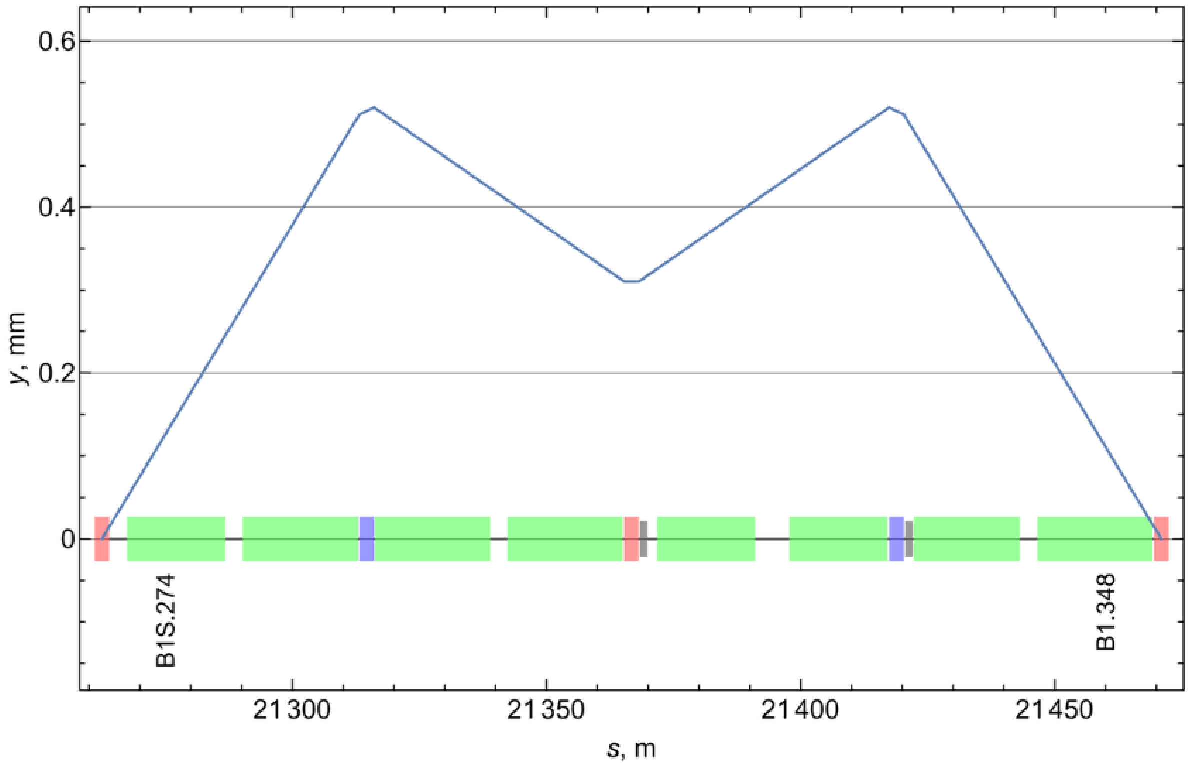


Drawbacks: larger the dispersion and beta-functions and some difficulties to match with a regular lattice.
Probably will find better solutions!

Alternative bumps for a depolarizer at Z

Can insert strip-lines into a vacuum chamber in D or F quads. Then the harmonic values differ from the option shown in page 4: at 45.56 GeV w=7.35e-5 for the bump with the end points in D-lenses and w=3.39e-5 for the ends in F-lenses. Both cases are not attractive…





Discussion of results

For W energy region a long local bump comprised from 8-12 half waves works very well, while at Z we do not find such a good solution up to now.

Will continue our efforts!