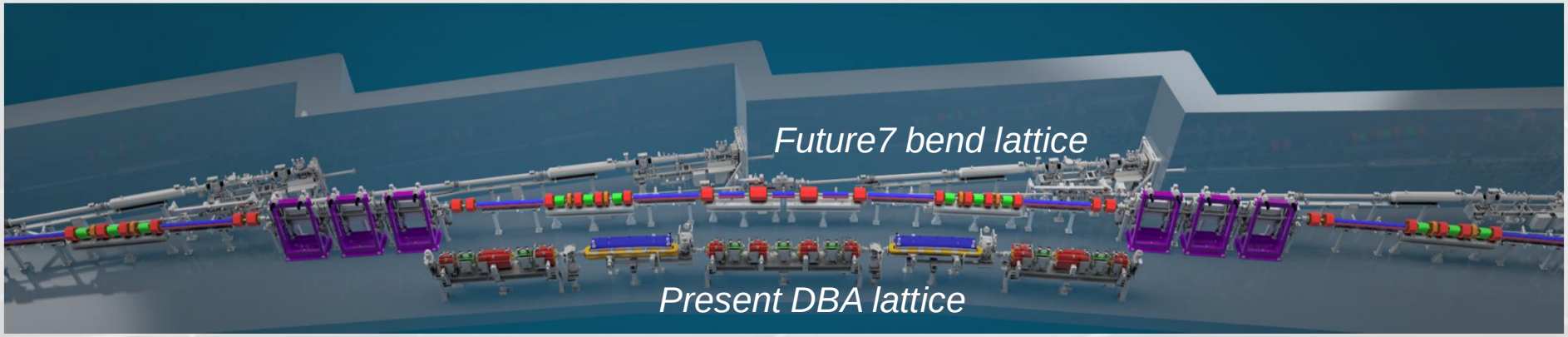
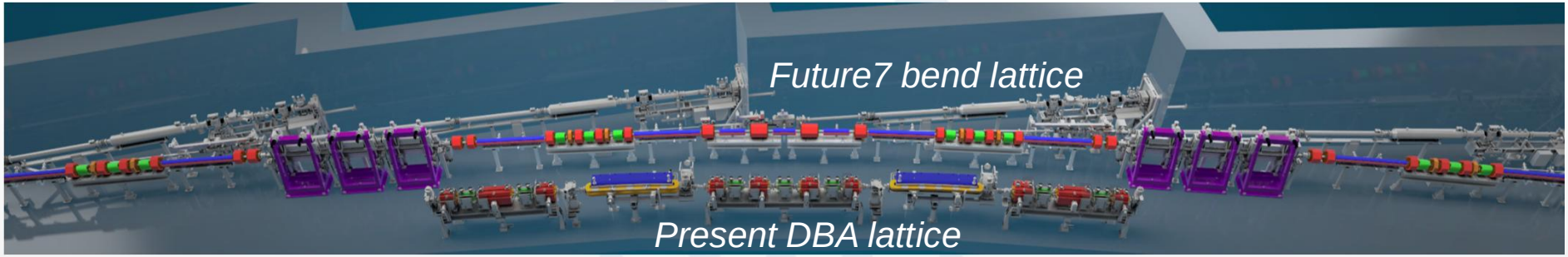


ESRF Upgrade Phase II Optics

P. Raimondi
On behalf of the
Accelerator & Source Division

SLAC November 9-11, 2013

Accelerator Upgrade Phase II



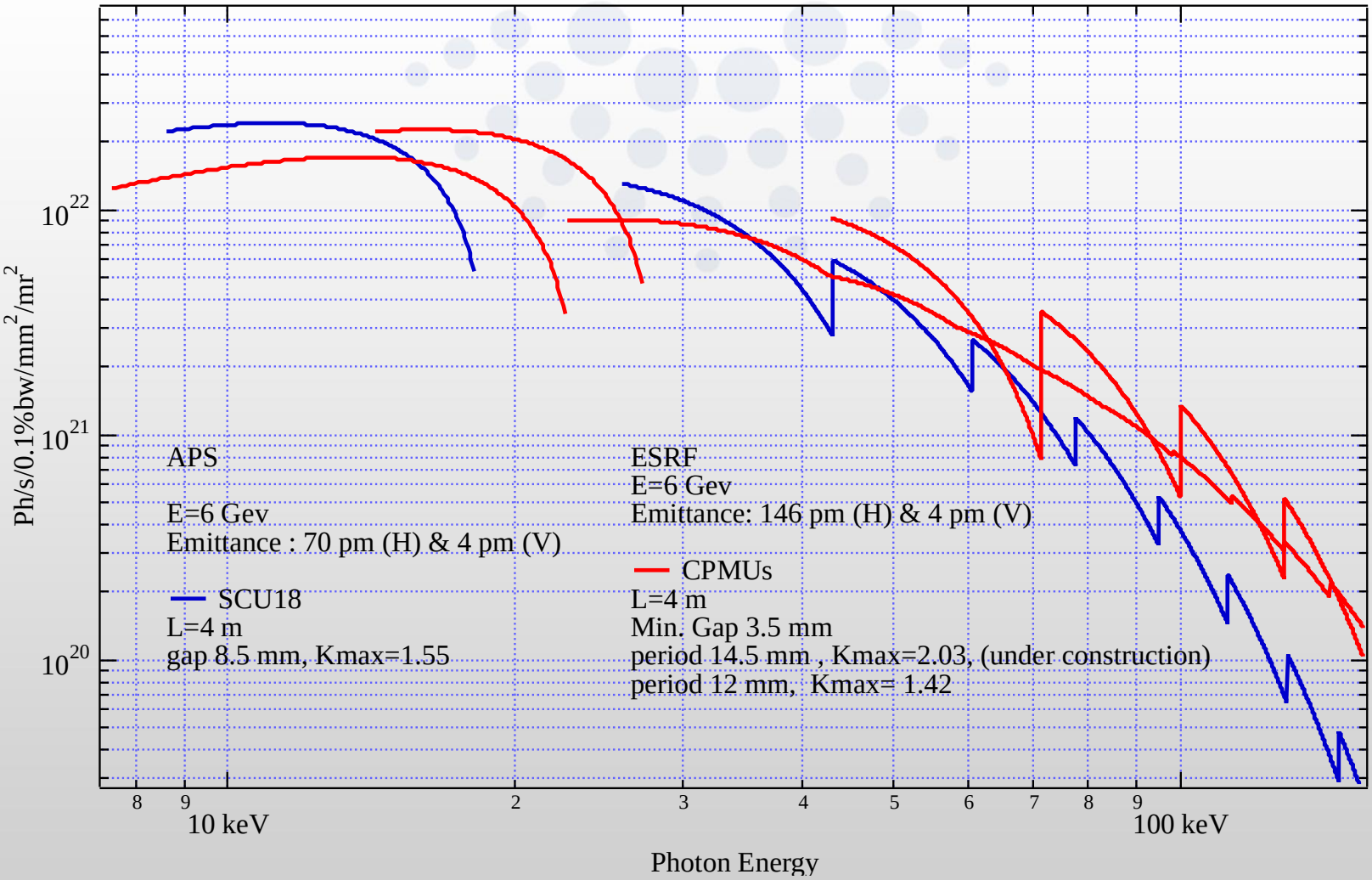
A recurrent request from ESRF beamlines is a **reduction of the horizontal emittance**

…..*with the strong constraint of re-using the same tunnel and infrastructure*

Thanks to the worldwide efforts made to develop an Ultimate Storage Ring, the ESRF is re-addressing the question, with the following requirements:

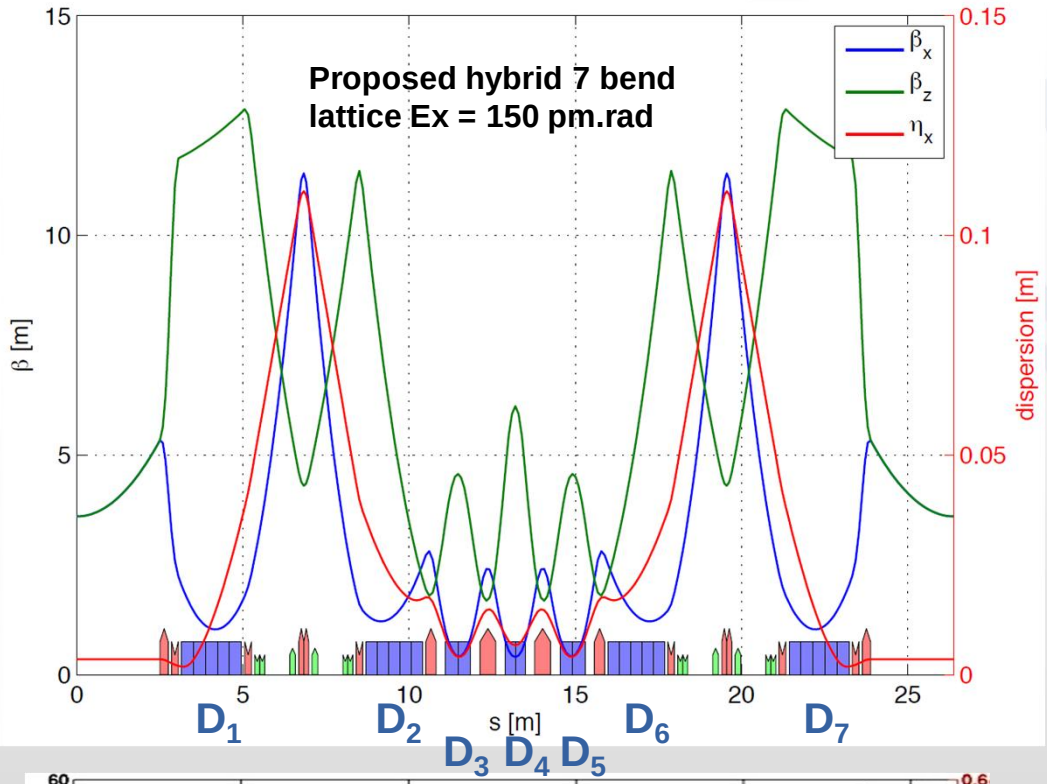
- Reduce the horizontal equilibrium emittance from 4 nm to less than 150 pm
- Maintain the existing ID straights and beamlines
- Maintain the existing bending magnet beamlines
- Preserve the time structure operation and a multibunch current of 200 mA
- Keep the present injector complex
- Reuse, as much as possible, existing hardware
- Minimize the energy lost in synchrotron radiation
- Minimize operation costs, mainly wall-plug power
- Limit the downtime for installation and commissioning to about one year.

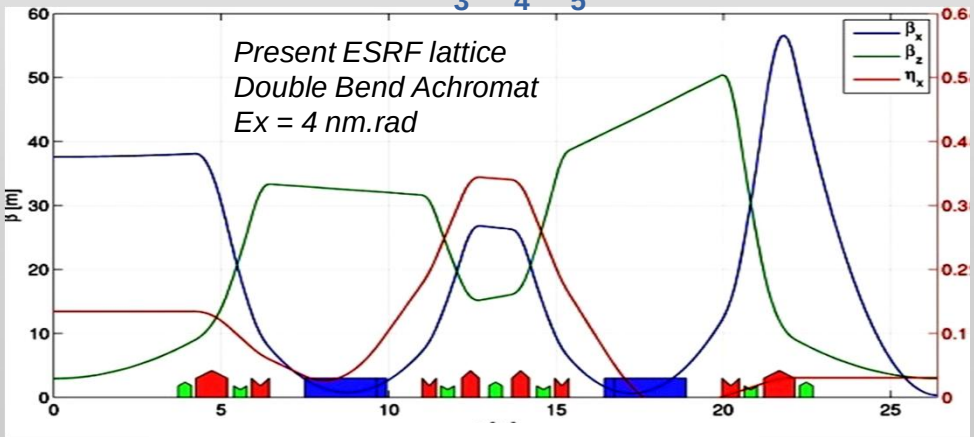
Short period undulators



The ESRF low emittance lattice

See: Poster MOPEA008





Bleu: Dipoles Red: Quadrupoles Green: sextupoles

@ 7 bending magnets D_{1to7}
➔ reduce the horizontal emittance

@ Space between D_1-D_2 and D_6-D_7
β-functions and dispersion allowed to grow
➔ chromaticity correction
with efficient sextupoles

@ Dipoles D_1, D_2, D_6, D_7
➔ longitudinally varying field to further reduce emittance

@ Central part alternating
➔combined dipole-quadrupoles$D_{3\text{-}4\text{-}5}$
➔high-gradient focusing quadrupoles
@ D_4 (0.34T) and D_5 (0.85T)
➔Source points for BM beamlines have same fields, positions and angles

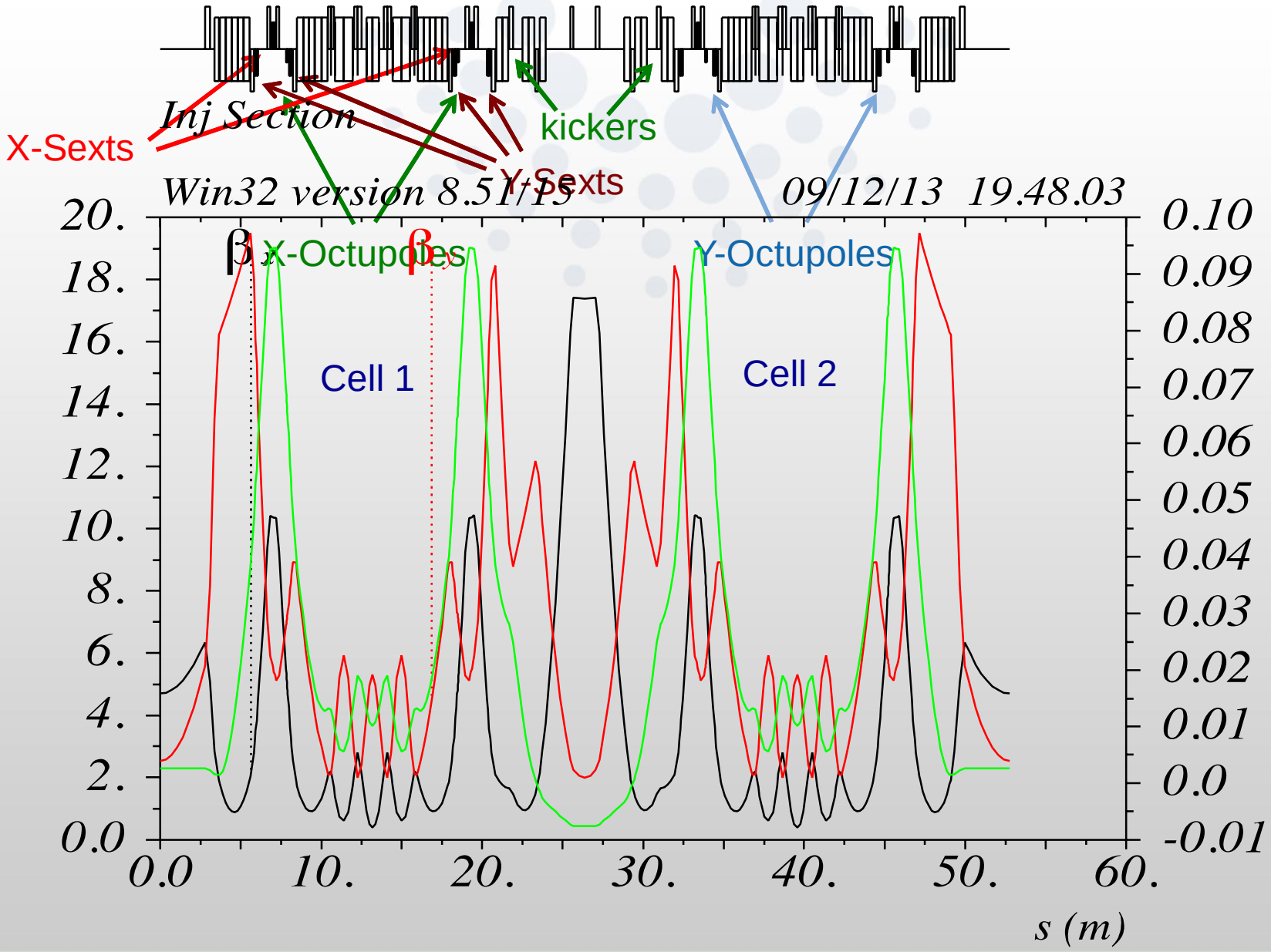
Transverse DA Optimization

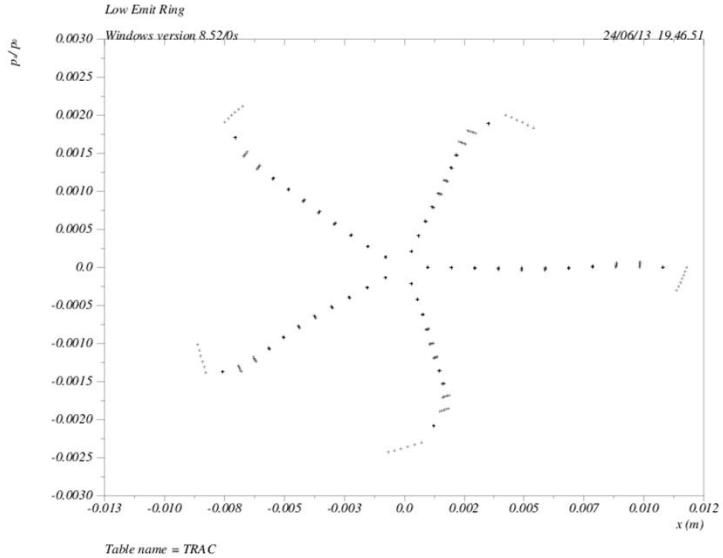
- Two sextupoles families (cells 1-2-1-2…) are used to zero the second order chromaticity
- Sextupoles are paired but interleaved, resulting in horizonal and vertical detuning with amplitude
- Tested **ALL** the possible octupoles and **ALL** their possible positions in the Chromatic Correction Section area, looking for symplicity and effectivness
- Best combination found by only one pair of octupoles per cell:
  - In the Cell with stronger y-sextupoles (and larger x-detuning contribution), they are X-like and inside the QF4 in the inner part of the cell.
  - In the Cell with stronger x-sextupoles (and smaller x-detuning contribution), they are y-like and just on the side of the SDs in the inner part of the cell.
- Their sum value cures the x-detuning.
- Their relative strength cures the fast x-detuning
- No other non-linear elements are needed.
- The y-detuning is zeroed by a proper value of alfa_y at the middle of the X-sextupoles
- The R12 and R34 between the x-sextupoles is about 0.5, reducing the overall octupoles strenght and the cross terms detuning => Positive impact on DA, apart distorting the x-phase space.

Injection Section Design

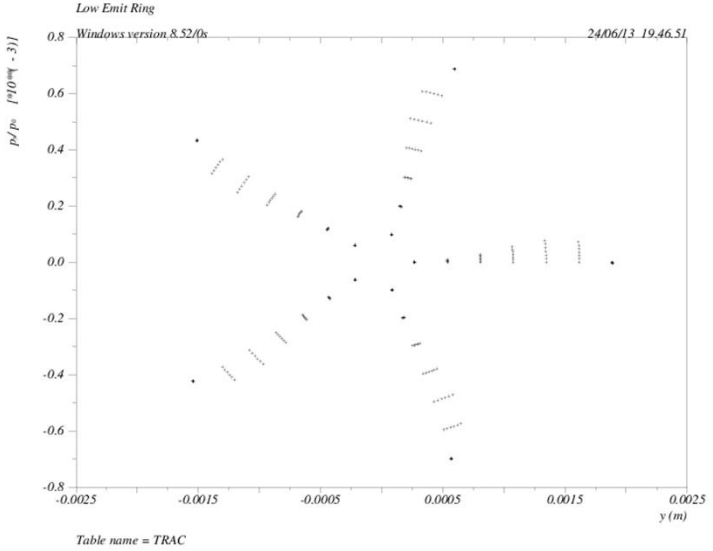
- The injection section has different dipoles and quadrupoles w.r.t. the standard straight, in order to:

- Increase the betax at the septum => increase injection efficiency
- Make space for the kickers in a sextupole free region => bump closed at all amplitudes
- Make PI phase advance between the kickers => only 2 kickers are needed.
- Preserve the overall cell phase advance => DA unperturbed

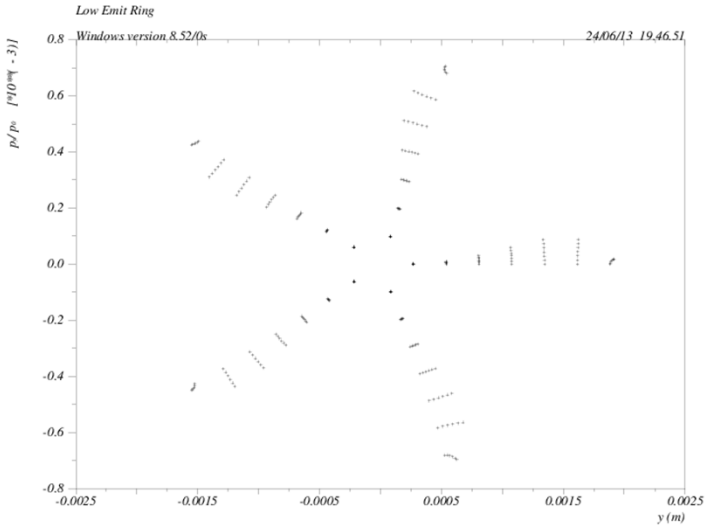

Inj Section
X-Sexts
kickers
Y-Sexts
Win32 version 8.51/15
09/12/13 19.48.03
X-Octupoles
Y-Octupoles
Cell 1
Cell 2
s (m)



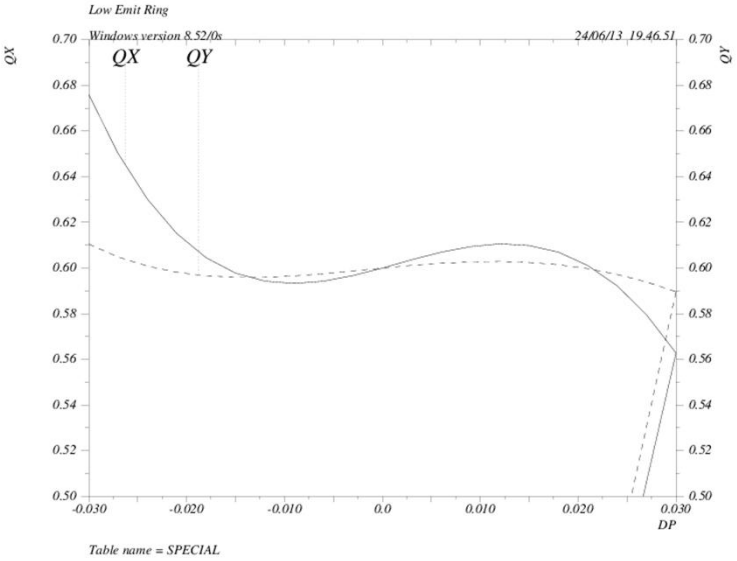
X Tracking, Qx=0.6



Y Tracking, Qy=0.6

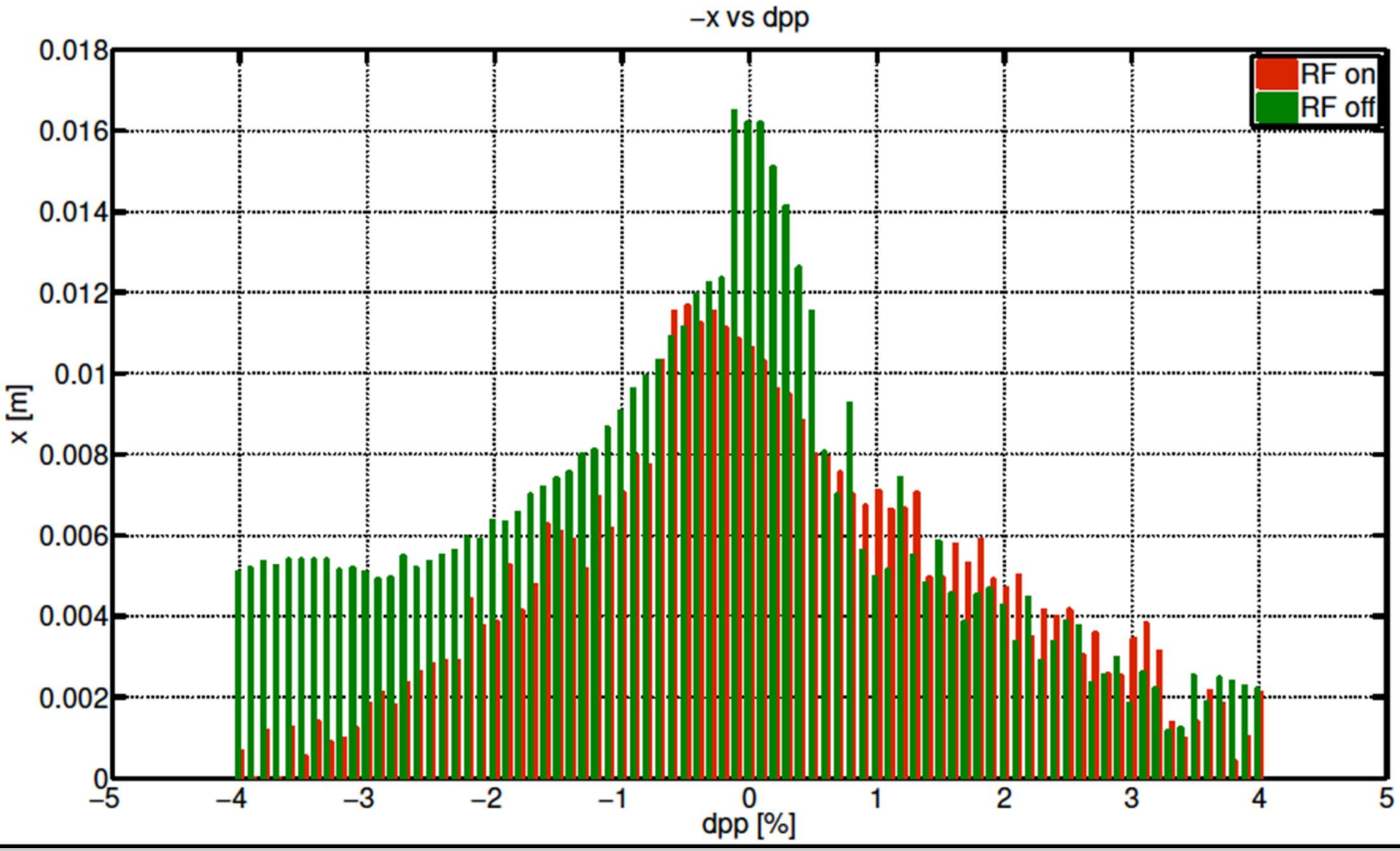


Y Tracking, with also initial x offset



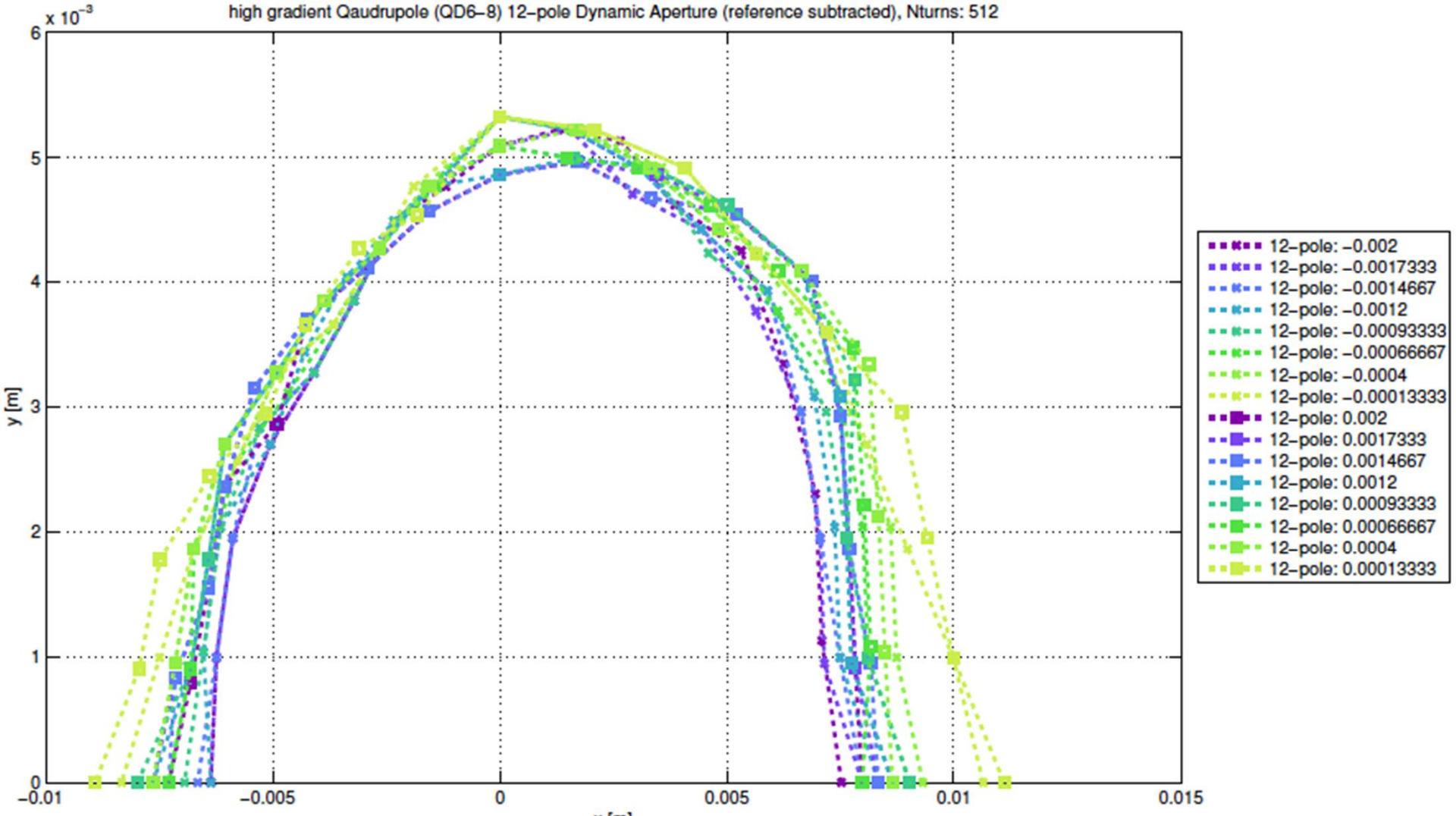
X & Y Chromaticity

Energy Acceptance



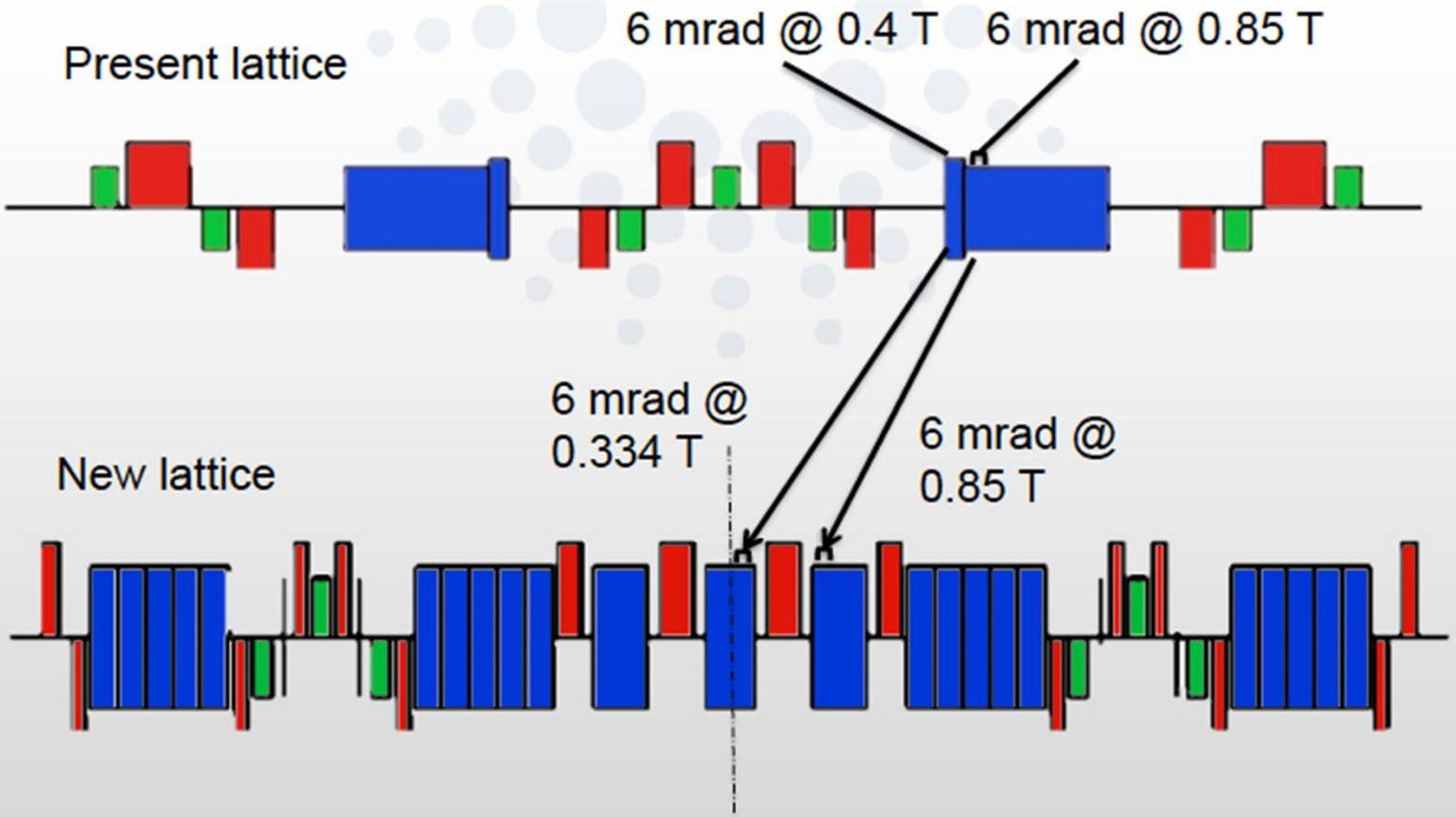
Strong path length dependence from x-amplitude, needs to be reduced

Multipole Errors Study



The multipoles errors requirements are different for each kind of magnets => their definition is under study

Bending magnet sources



New BM source: combined dipole/quadrupole magnets

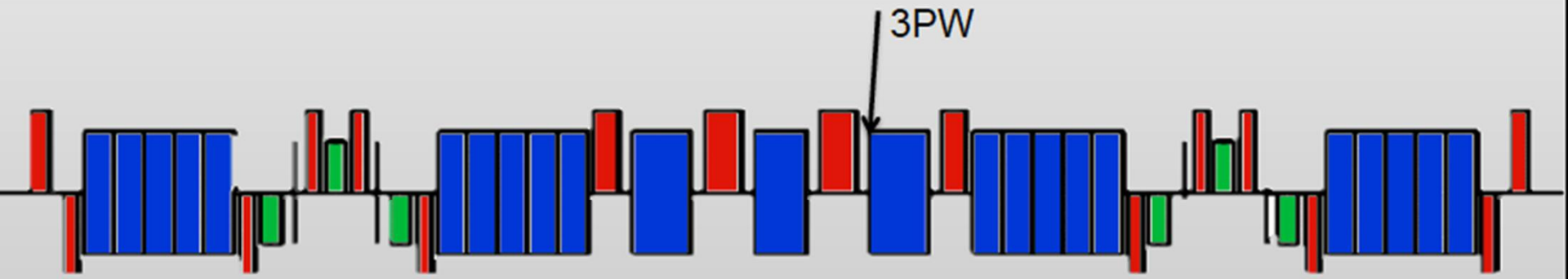
Potentially in focus

Change magnetic field characteristics for the two BM sources

- Easier engineering of combined dipole quadrupole
- Lower energy consumption

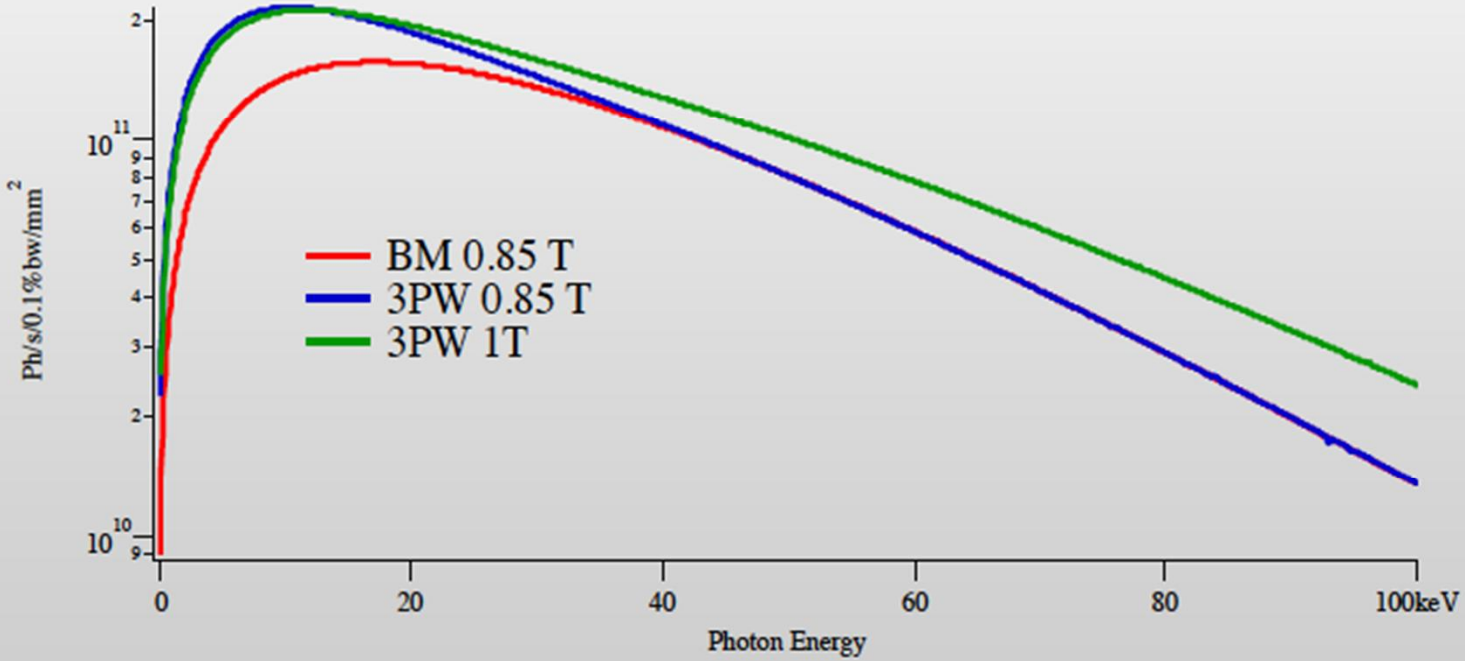
~ high field BM -> ~ 0.6 T
~ low field BM -> ~ 0.4-0.5 T

Possible use three poles wiggler as new source (preliminary)



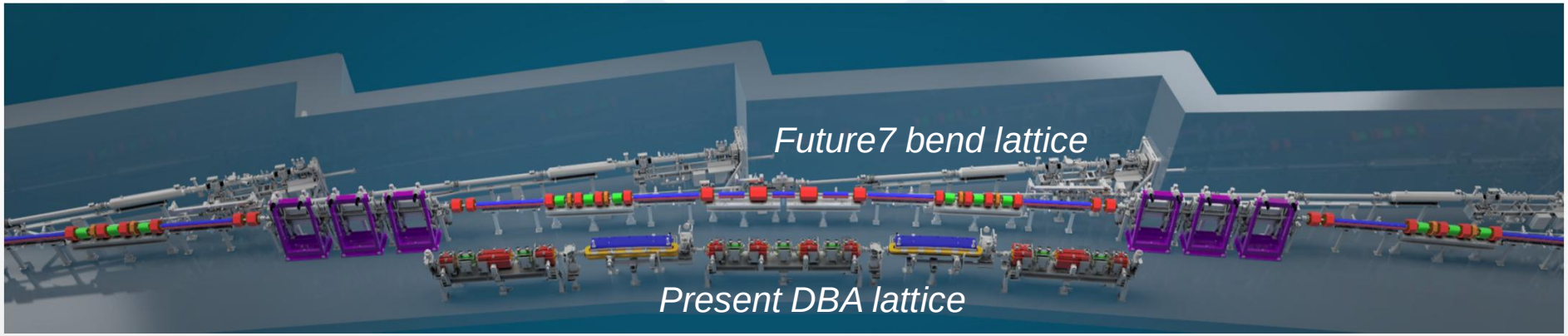
3PWs

- Radiated fan centered at -9 mrad (upstream dipole with larger angular deflection)
- Fan could have ~ 1- 2mrad opening
- Can be installed on demand
- Peak field adaptable (compatible with BL shielding)
- Magnetic length ≤ 150 mm
- Peak field up to 1 T easily feasible



"on axis" photon flux density @ 30 m

Conclusion



- ARC Cell design being finalized (Goal: June 2014 nearly frozen).
- Still space to optimize the Lattice Performances and DA
- Relaxed magnets requirements: High Quads Gradient ~96T/m
  Dipole-Quadrupole: 0.57T-35T/m
  Moderate Quads Gradient ~ 55T/m
  Long Gradient Dipoles: 0.54T Max
- Injection section design very promising.
- Bend lines source will be made by dedicated 3 (or more) poles wigglers
- More iterations with Vacuum System Design, Correctors and Diagnostic are needed.