OPTIMIZATION AND ERROR STUDIES FOR THE USSR HMBA LATTICE

L.Hoummi, S.M.Liuzzo, N.Carmignani, L.R.Carver, T.Perron, S.M.White - ESRF, Grenoble, France
T.V.Kulevoy - National Research Center «Kurchatov Institute» also at ITEP, Moscow,Russia
I.A. Ashanin, S.M.Polozov - National Research Nuclear University MEPhI, Moscow, Russia

contact: lina.hoummi@esrf.fr

In accordance with resolution of government of Russian federation no.287 on approval of the Federal research and engineering programme fordevelopment of synchrotron and neutron studies and research infrastruc-ture for 2019-2027

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871072.

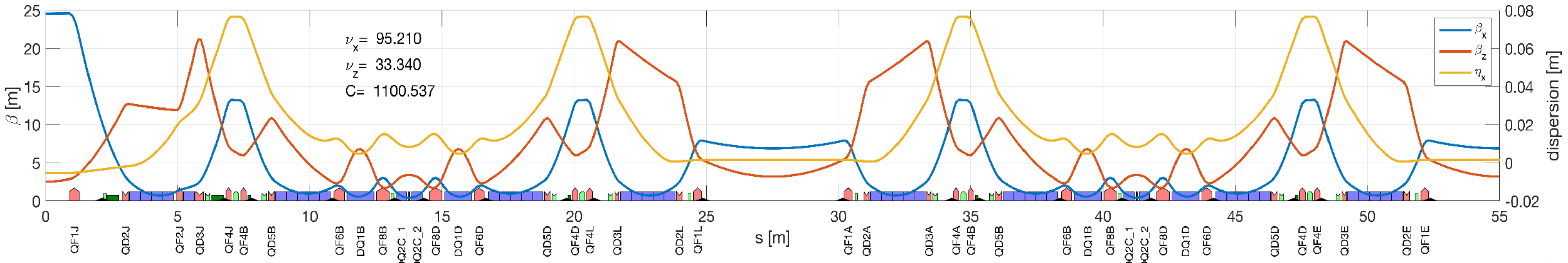
CREMLIN PLUS

Storage Ring light source to be built in Protvino (Moscow region):

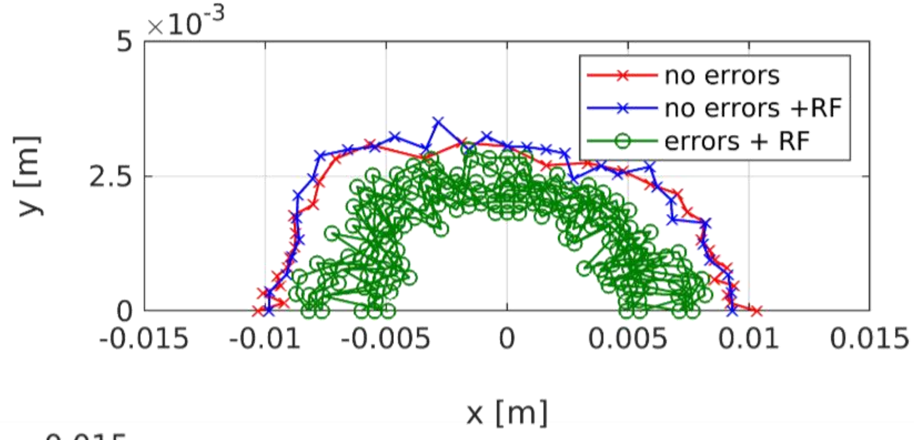
USSR – Ultimate Source of Synchrotron Radiation

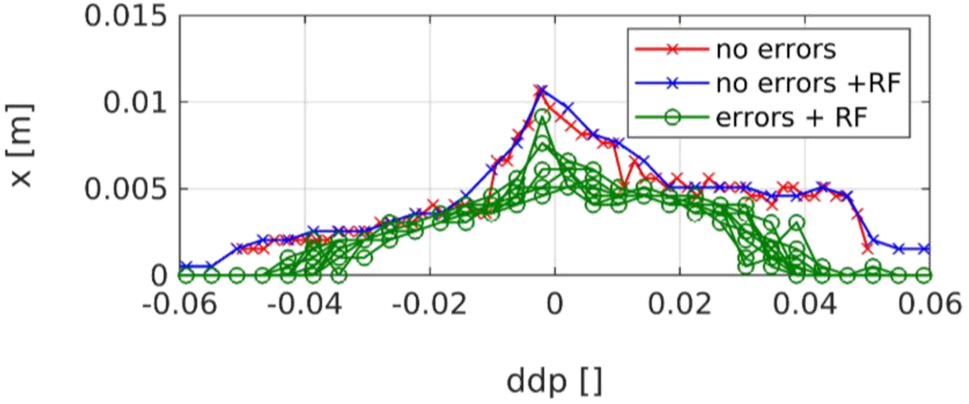
1100m
6GeV
HMBA lattice
70pm.rad
Off-axis injection
74 beamlines

6 GeV USSR	HMBA	HMBA +SB
Circumference	1055 m	1100 m
cells	40	40
beamlines	34 ID	34 ID + 40 BM
nat. hor. emittance	68 pm.rad	70 pm.rad
vertical emittance	5 pm.rad	5 pm.rad
energy spread	$0.85\ 10^{-3}$	$0.86\ 10^{-3}$
mom. comp. factor	$5\ 10^{-5}$	$6\ 10^{-5}$
bunch length (I=0)	2.7 mm	2.9 mm
tune	95.21, 33.34	95.21, 33.34
chromaticity	12,7.5	7,6
Energy loss / turn	2.1 MV	2.0 MV
RF voltage	5.0 MV	5.0 MV
RF frequency	352 MHz	352 MHz
harmonic number	1240[1]	1296[2]
Max. total current	200 mA	200 mA



The realistic performances of both lattices are simulated with the addition of errors of amplitude displayed in the top table. 10 seeds of errors were generated and for each set, a commissioning-like correction sequence was implemented: first turns, steering, optics, etc. The correction allowed recovery of the nominal single-particle dynamics.





Error amplitudes

element	Δx	Δy	Δϕ	ΔK/K
units	μm	μm	μrad	1e-4
Dipoles	50	50	90	10
Dipole-Quadrupoles	50	50	90	5
Quadrupoles	50	50	90	5
High grad. Quadrupoles	50	50	90	5
Sextupoles	50	50	90	35
Octupoles	50	50	90	40
Beam Position Monitors	50	50	0	0
Correctors	200	200	0	0

Single-particle dynamics characteristics of the lattices with errors

	Horizontal	Vertical
closed orbit	100 ± 10 μm	80 ± 10 μm
dispersion	0.4 ± 0.1 μm	0.4 ± 0.1 μm
tunes	0.0001	0.0001
β-beating	1.2 ± 0.2 %	1.1 ± 0.2 %
emittance	70 ± 1 pm	0.1 ± 0.01 pm
chromaticity	7.00 ± 0.01	6.00 ± 0.01
steerers	±300 μrad	±300 μrad
quadrupoles	$\pm 3\ 10^{-4}\ m^{-1}$	$\pm 3\ 10^{-4}\ m^{-1}$

ERROR STUDIES - INJECTION

The lattices with errors for both lattice candidates are tested for four different injectors and three operation modes. The expected lifetime, scaled to the ESRF-EBS, is 12.4 h in uniform filling. Similar performances are achieved for both lattices.

	HMBA	HMBA +SB
7/8 uniform	9.2 ± 1.5 h	12 ± 2 h
16 bunches	1.0 ± 0.2 h	0.9 ± 0.1 h
4 bunches	0.7 ± 0.1 h	0.6 ± 0.1 h

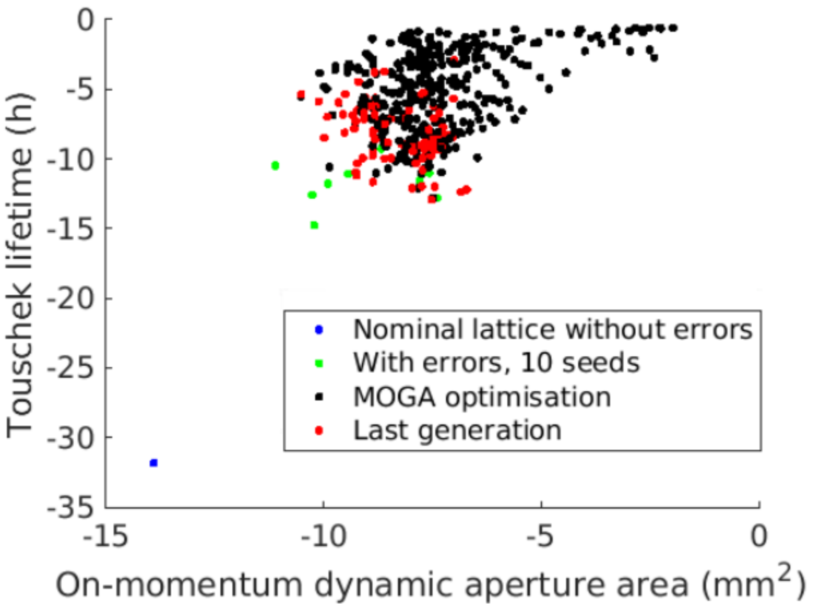
Four injectors were tested for off-axis injection. For both lattice candidates, the injection efficiency reaches almost 100%, with a large on-momentum dynamic aperture at injection.

	HMBA	HMBA +SB
max DA at injection	8.1 ± 0.4 mm	7.5 ± 1.0 mm
short booster	52 ± 15 %	-
long booster	95 ± 5 %	97 ± 2 %
Linac Thermo. gun	94 ± 7 %	95 ± 4 %
Linac Photo. gun	98 ± 2 %	98 ± 2 %

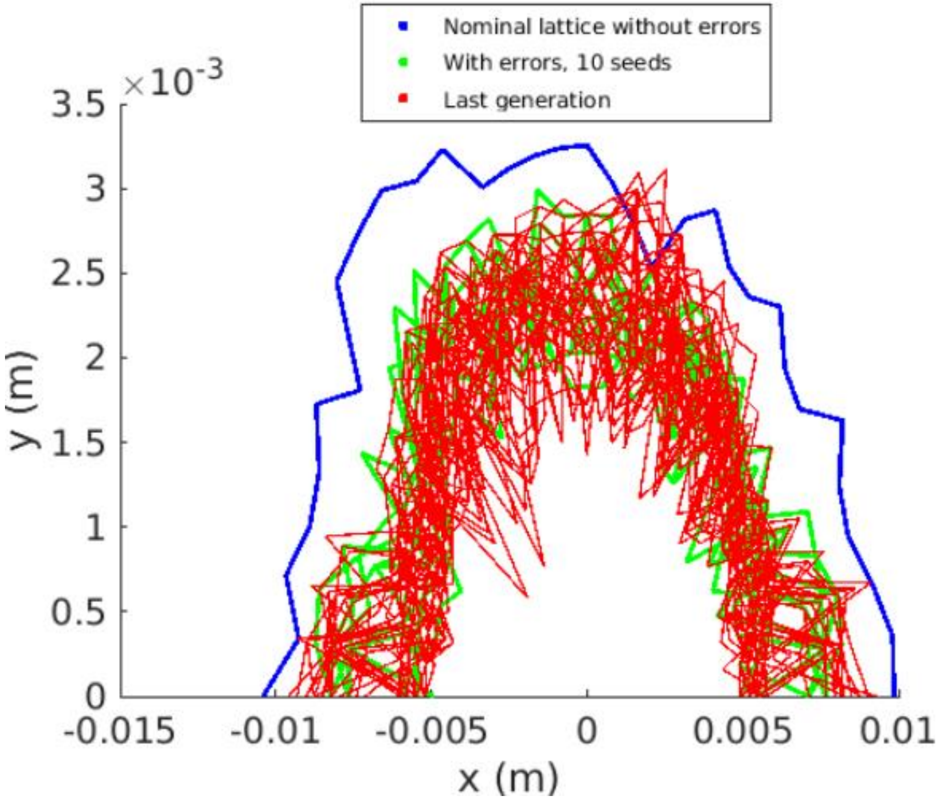
Optimization of the lattices with errors

- Optimization of the on-momentum dynamic aperture and the Touschek lifetime
- Chromaticities constant
- Variables: 6 sextupole families (3 in standard cells and 3 in injection cells) + 2 octupole families
- 20 generations of 20 individuals

Evolution of the MOGA objectives



Comparison of the on-momentum dynamic apertures



Results:

Achieved 13 h lifetime with equivalent on-momentum dynamic aperture. Optimizations ongoing to further approach the nominal performances.

REFERENCES AND OTHER POSTERS ON THIS PROJECT

See also:

T.V.Kulevoy et al, USSR – THE PROJECT OF THE ULTIMATE SYNCHROTRON RADIATION SOURCE IN RUSSIA

S.Liuzzo et al. USSR HMBA STORAGE RING LATTICE OPTIONS

S.Liuzzo et al. A LONG BOOSTER OPTION FOR THE USSR 6GEV STORAGE RING

S.White et al. A FLEXIBLE INJECTION SCHEME FOR THE ESRF-EBS