Introduction of KARA Storage Ring

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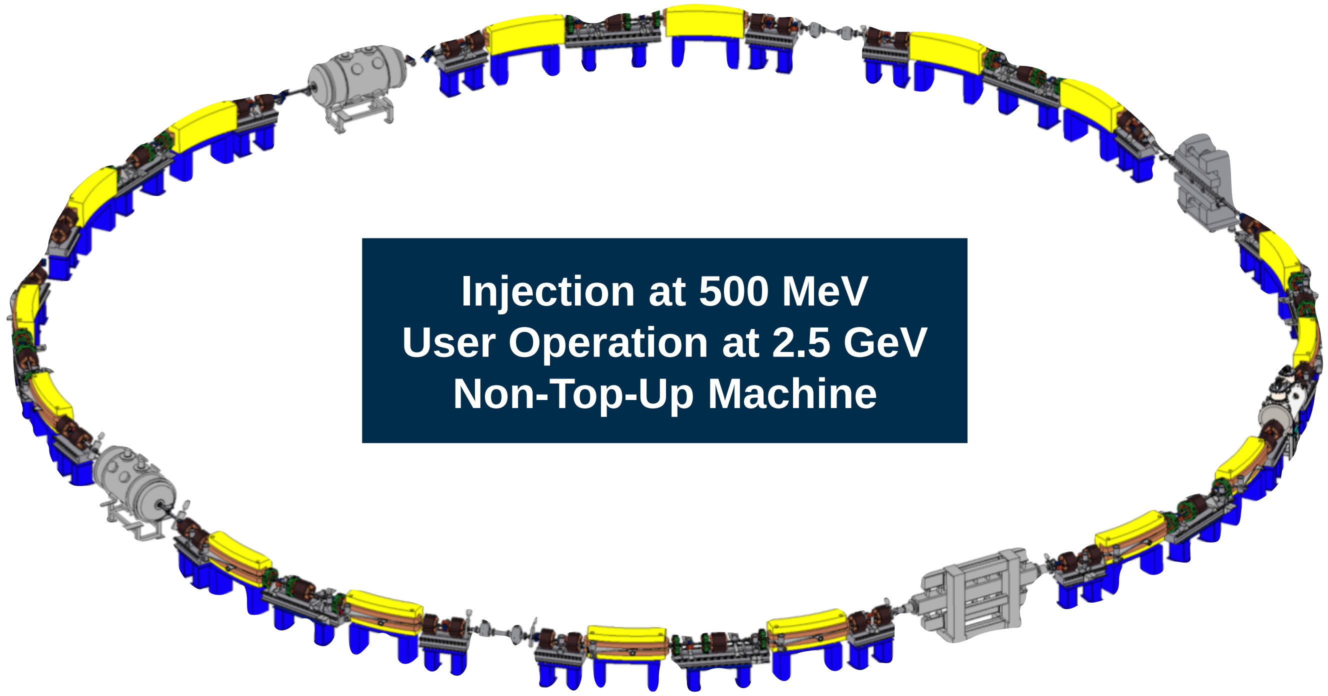
Karlsruhe Research Accelerator (KARA)

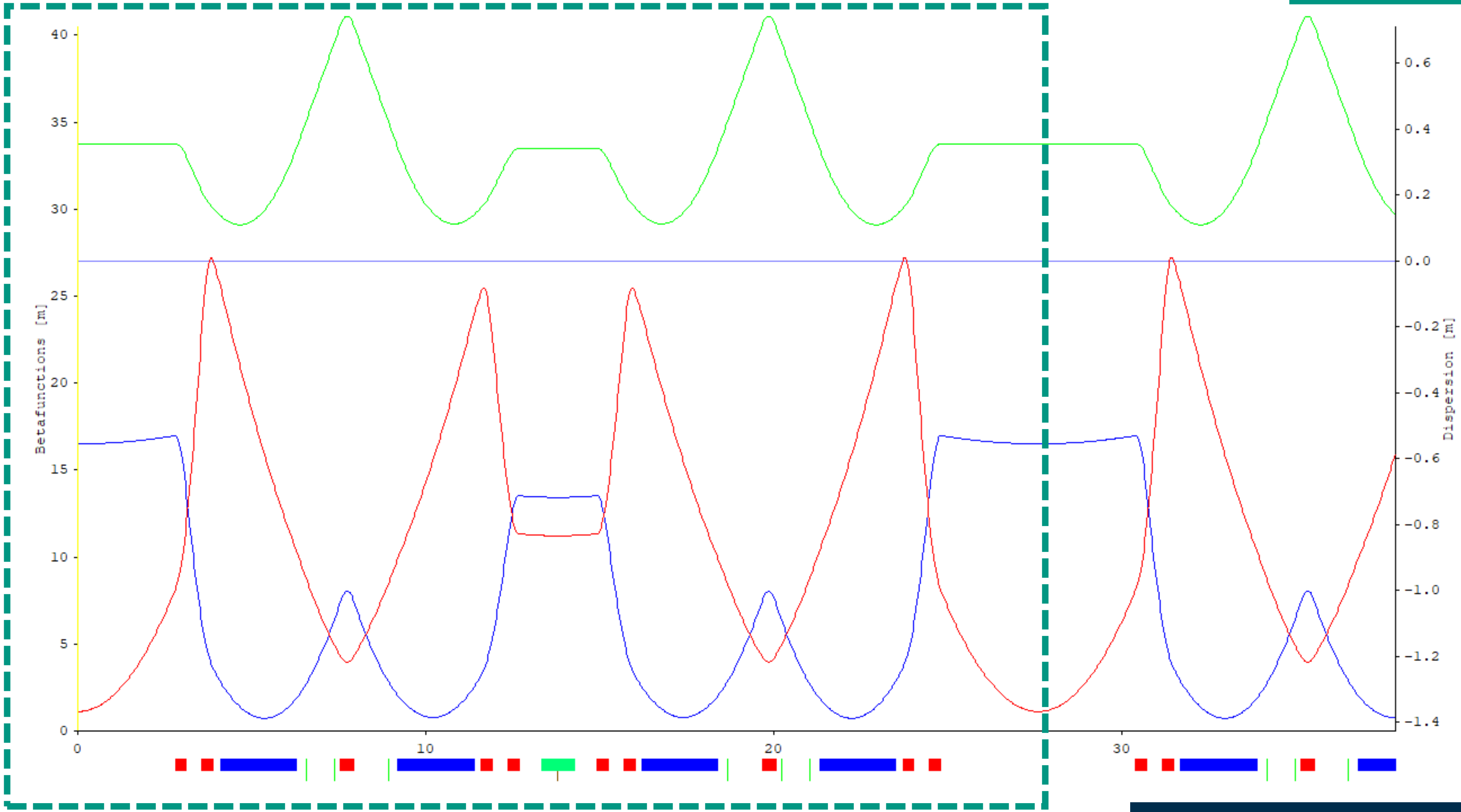
KIT synchrotron light source & accelerator test facility

Parameters	Values
Circumference	110.4 m
Energy range	0.5 – 2.5 GeV
RF frequency	499.7 MHz
Revolution frequency	2.715 MHz
Harmonic number	184
Beam current	up to 200 mA
r.m.s. bunch length	45 ps (2.5 GeV) a few ps (1.3 GeV, low-alpha)
Lattice structure	DBA



Lattice Functions at KARA

Results by OPA



Periods		1
Length	[m]	110.416
Angle	[deg]	360.000
AbsAngle	[deg]	360.000
TuneX		6.73663
TuneY		2.80165
ChromX		-12.330
ChromY		-11.602
Alpha	[xE-3]	9.701
Jx		0.96933
Energy	[GeV]	2.500
EmitXo	[nm rd]	58.770
dE/turn	[keV]	621.6
Espread	[xE-3]	0.901
TauX	[ms]	3.056
TauY	[ms]	2.963
TauE	[ms]	1.459
EmitYo	[pm rd]	0.276
Location		START
Position	m	0.000
BetaX	m	16.510
AlphaX		0.0000
BetaY	m	1.121
AlphaY		0.0000
Disp.	m	0.3550
dD/ds	rad	0.0000
PhiX/2pi		0.0000
PhiY/2pi		0.0000
curly H	m	0.007631
OrbitX	mm	0.0000
OrbitX'	mrad	0.0000

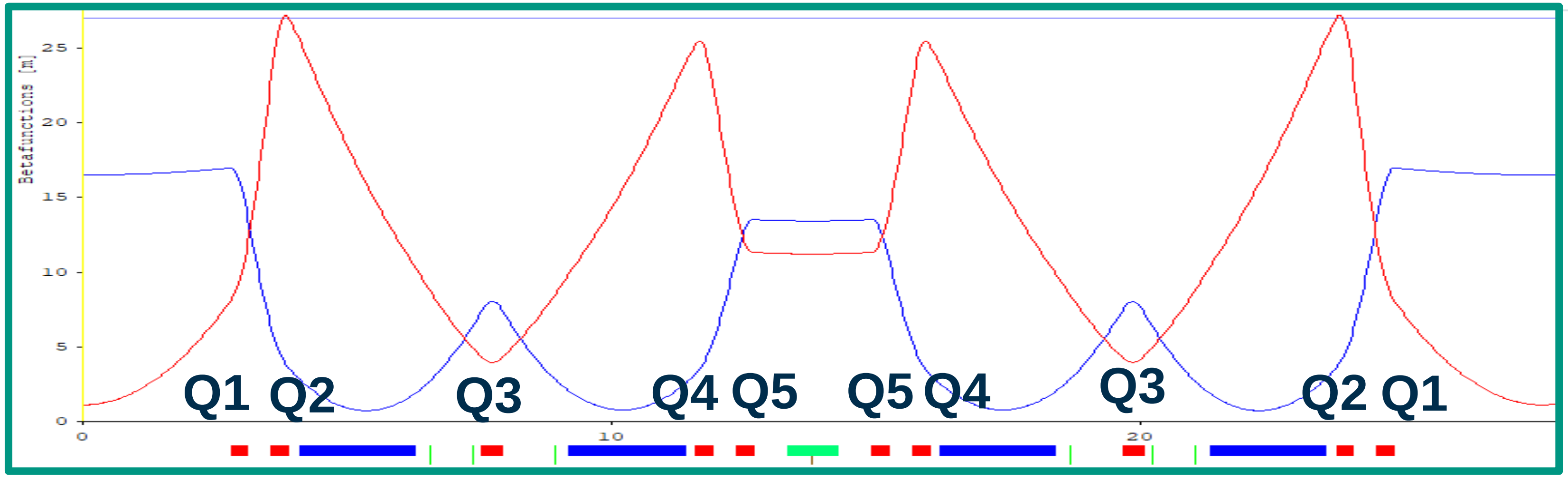
- One superperiod = 1 long straight + 1 short straight + 2 gaps of separated bends

KARA … four-folded structure

Quadupole Families at KARA

Quadrupoles: Five-Family Configuration

Family name	Main function	Location and total number
Q1	Horizontal-quads	The first-Q at long straight: 8
Q2	Vertical-quads	The second-Q at long straight: 8 (up- and downstream of the first bend)
Q3	Horizontal-quads, dispersion control	In the gap of separated bends: 8
Q4	Vertical-quads	The first-Q at short straight: 8 (up- and downstream of the second bend)
Q5	Horizontal-quads	The second-Q at short straight. 8



BPMs at KARA

Basic configuration … located at

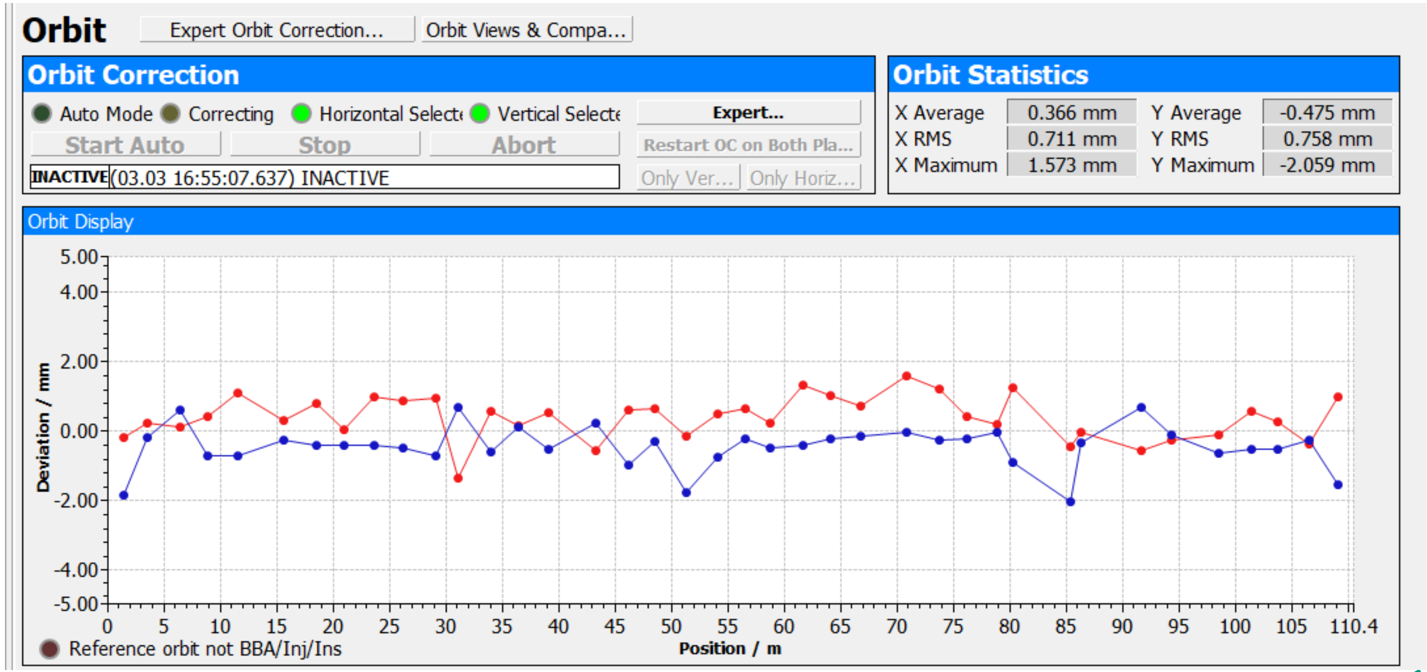
- up- and downstream of every separated bend
- upstream of the Q1-Q2 doublet in the long straights

39 of 40 are integrated into the closed orbit measurement system now.

(1 BPM at the downstream of the second bend in sector-4 is not in operation)

BPM modules:

- Libera Brilliance (i-Tech)



Corrector (Steering) Magnets at KARA

Location and total number: horizontal correctors

- One upstream of the Q1-Q2 doublet
- Two in one gap of the separated bends
- One in the short straight

In total … **28** horizontal correctors

Location and total number: vertical correctors

- One between the Q1-Q2 doublet
- Two in the short straight

In total … **16** vertical correctors

Available Operation Energy at KARA

Available operation energy range: 0.5 – 2.5 GeV

- Several typical operation beam energies:
  - 0.5 GeV for injection
  - 1.3 GeV for low-alpha & short bunch experiment (for CSR generation, etc.)
  - 2.2 and 2.3 GeV for power-saving operation
  - 2.5 GeV for normal user operation

- Power-saving operation at 2.2 and 2.3 GeV

... One of two RF stations (klystrons) can be switched off.

*Two RF stations are needed for the 2.5 GeV operation.

Magnets at Energy-Saving Operation

Output current for each power supply of quadrupole families and bending magnet

Magnets	2.2 GeV (A)	2.3 GeV (A)	2.5 GeV (A)
Q1	295	311	343
Q2	298	323	374
Q3	256	267	288
Q4	278	285	309
Q5	283	296	330
Bend	551	583	664

A fascinating point:

Can the spatial offset of quadrupole magnets change in different operating energy modes?

Experiment 1: Beam-Based Alignment (BBA)

The purposes:

To measure special offsets of quadrupole magnets in different machine operation energy

Ideas (Christian will present them in detail)

- BBA at 2.5 GeV operation in different beam currents (two klystrons)
- BBA at 2.2 and 2.3 GeV (one klystron)
- Measurement of lattice functions under the experimental conditions

- BBA at 2.5 GeV by changing the temperature of cooling water (technically possible?)
- Touch, disconnect and reconnect the BPM cables to see the effect on the measured beam position.
- BBA by deactivation of sextupole magnets
- BBA by change of the magnet-cycling procedure (ex. the number of cycling, warming-up time)

Experiment 2: System identification of the corrector magnets system

The purposes:

To measure the time response of the entire corrector magnet system (power supply, magnet, vacuum chamber, control system). **This is relevant for FOFB (fast orbit feedback system).**

Ideas (Günther will explain them in detail)

- Kick the beam with a chosen corrector magnet using a step-function change
- Observe the stored beam response using a fast (> 10 k Samples/sec) BPM.
- Synchronization between the corrector kick and the beam orbit recording is relevant

(The synchronisation system is not yet ready for KARA, so this time we can only do some basic tests)