BINP involvement in the CLIC DR project

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Areas

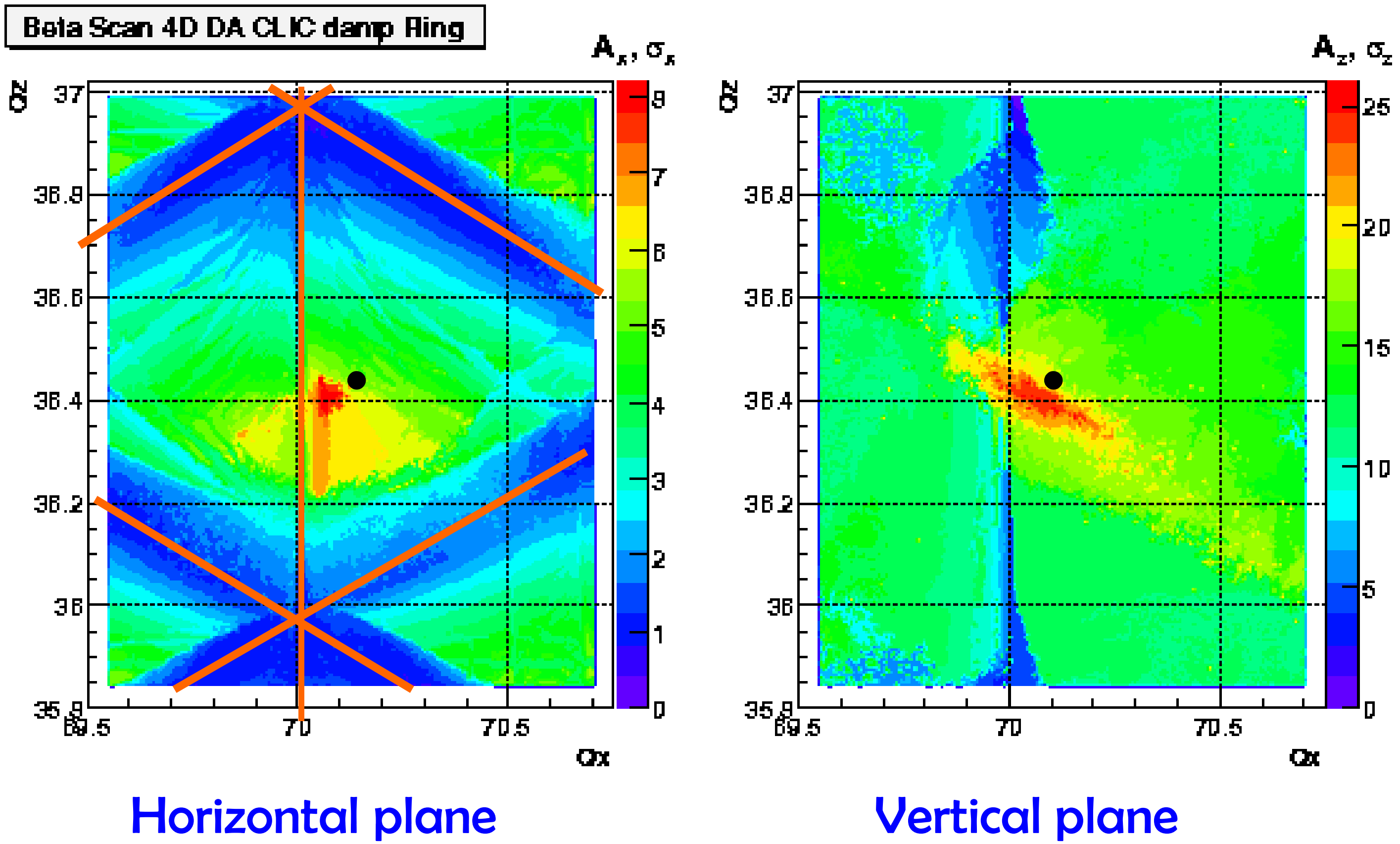
- Dynamic aperture study
- SC wiggler design and production
- Wiggler section design
- Accelerator components design and production
- Test work at the BINP accelerators
- Physical and technical expertise

DA simulation

Symplectic DA tracking including:

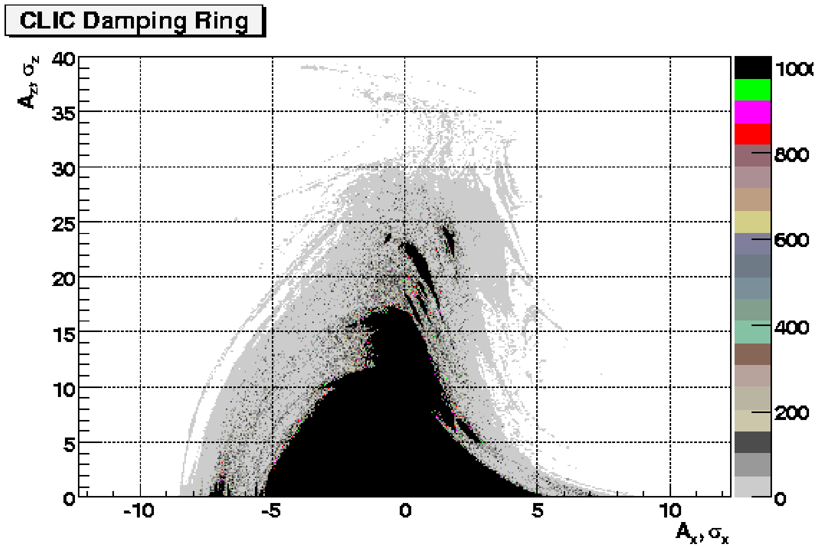
- On- and off-energy
- Phase space trajectories
- DA tune scan
- Fourier analysis
- Nonlinear detuning analysis
- Multipole field errors
- Coupling and COD
- Wigglers
- Etc

CLIC DR betatron tunes scan

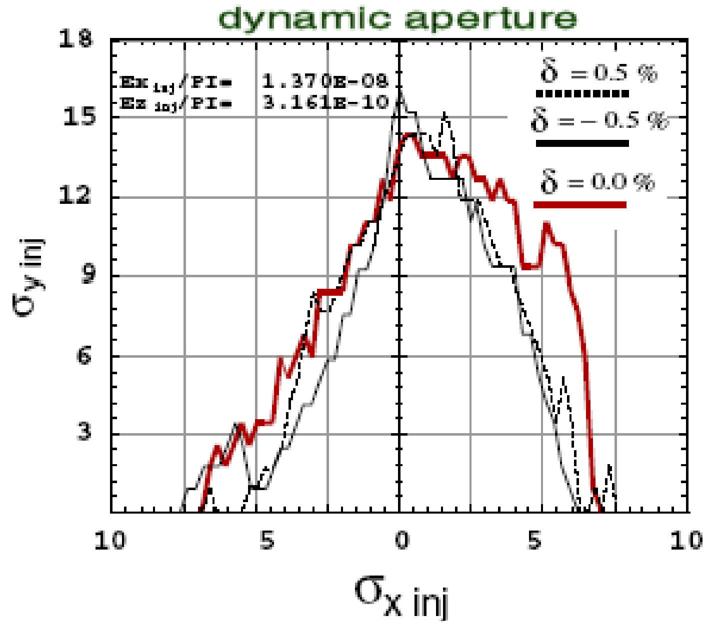


DA scan over the betatron tune plane allows to optimize the working point

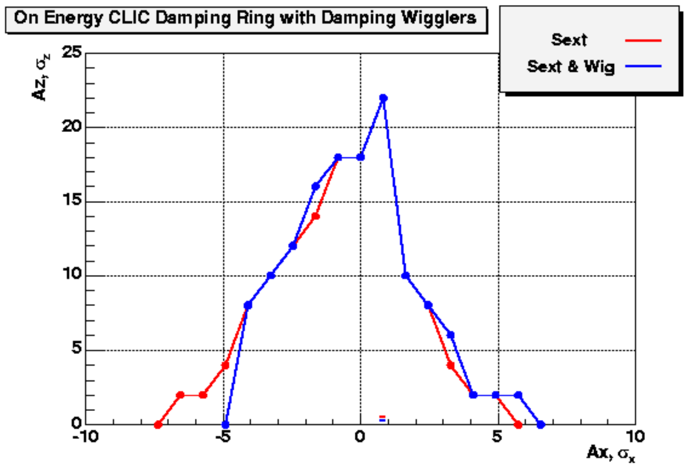
Dynamic aperture simulation



Levichev, Piminov (2005)



Zimmermann, Korostelev (2007)

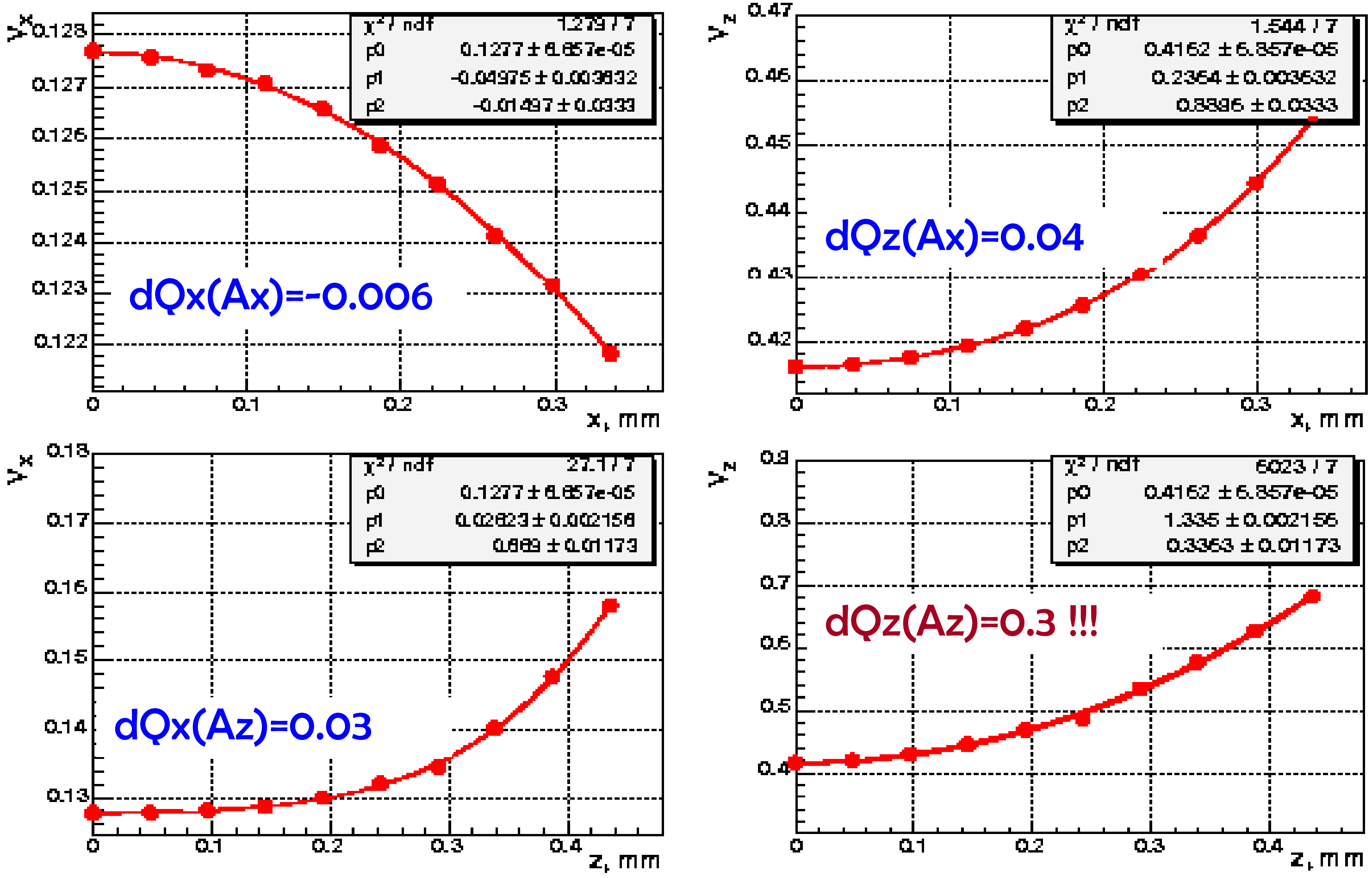


← LP (2005)

DR DA with and without damping wigglers

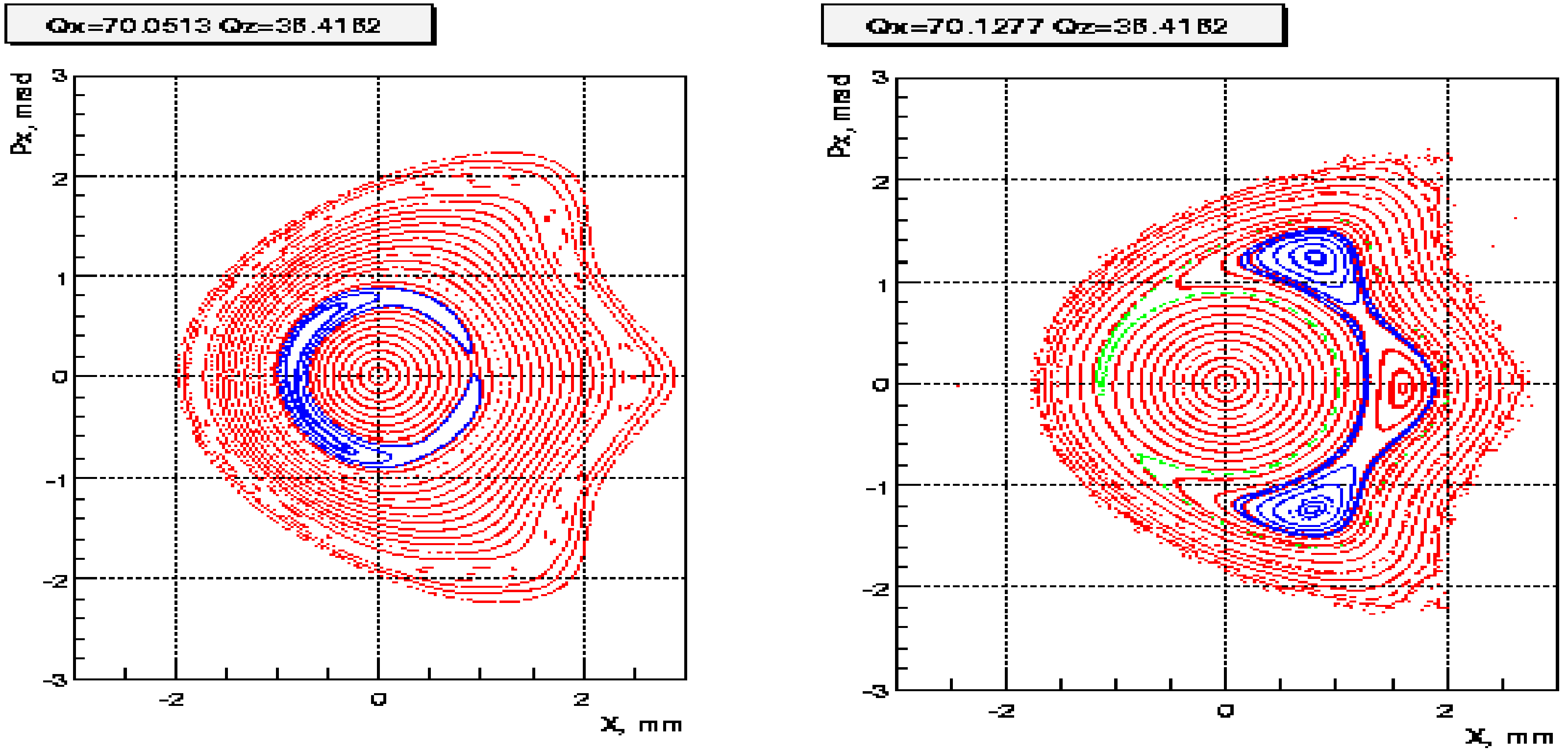
Conclusion: essential effect is due to the strong chromatic sextupoles. Wigglers do not influence the dynamic aperture

Nonlinear detuning



With amplitude increases the betatron tunes may cross many resonances

Phase space study



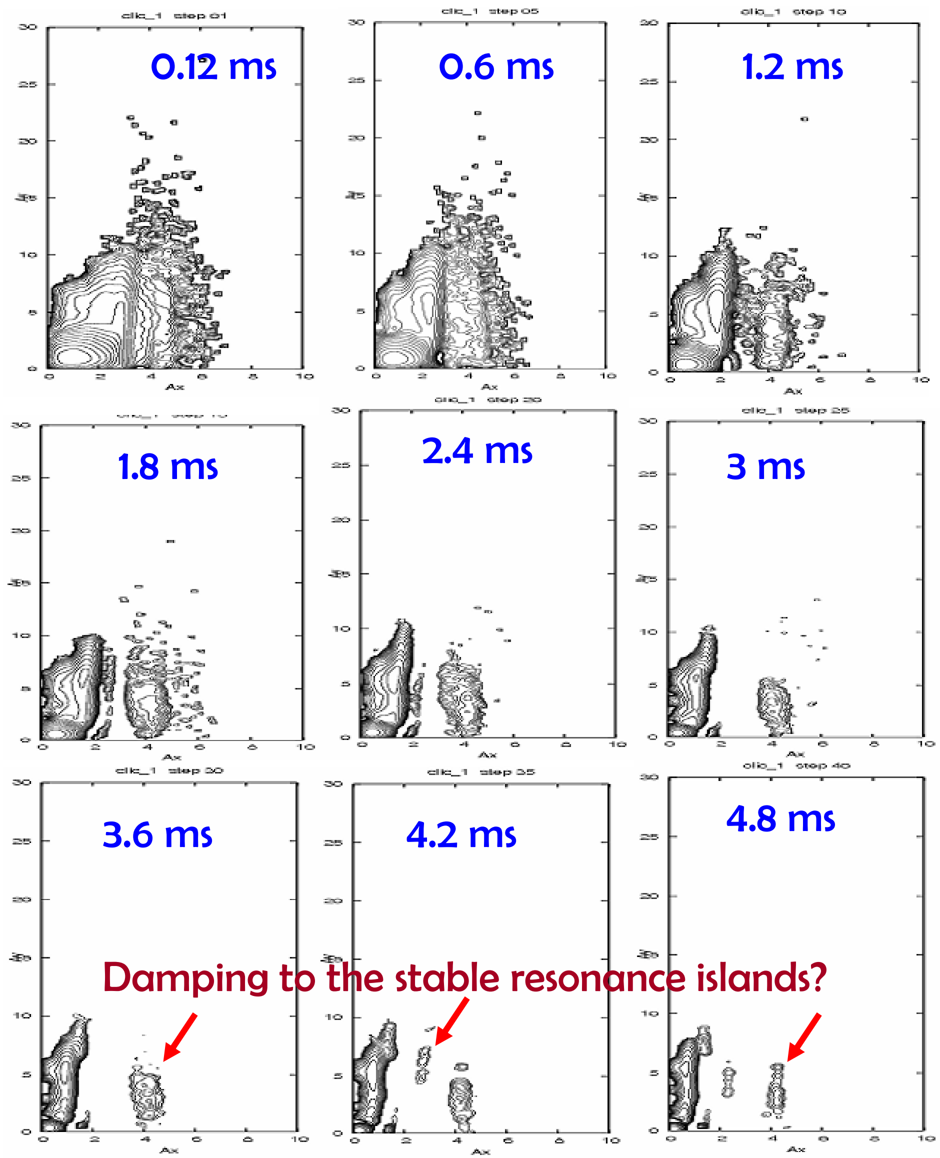
Stable resonance islands exist inside the CLIC DR dynamic aperture

Damping DA simulation

A new computer code was developed recently in BINP.
This software provides:

- Correct including of radiation damping/excitation
- Beam contour distribution plots
- Beam loss simulation
- Possible including of IBS and other heating mechanisms

CLIC DR beam loss during damping (2007)



For ideal DR lattice 130 particles from 20000 were lost during the beam damping (0.65%)

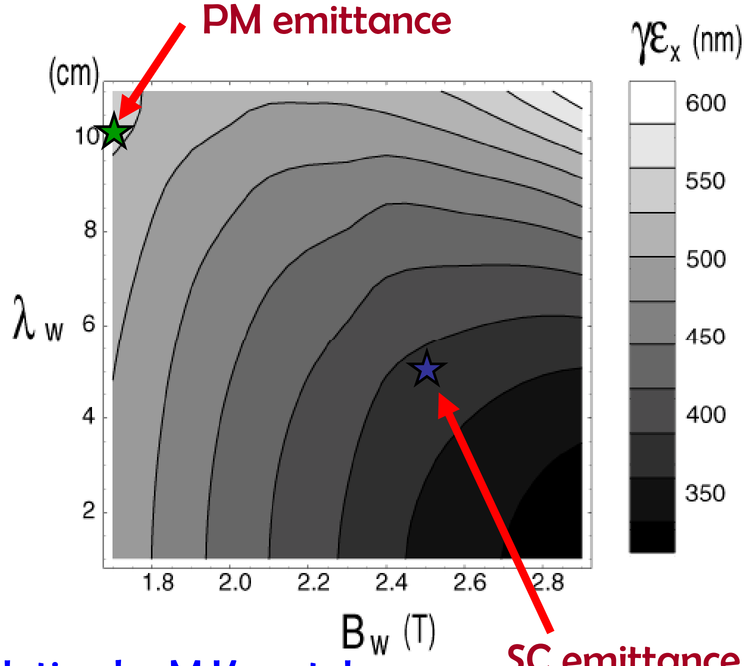
Including of errors and misalignment as well as IBS seems reasonable

Particles damped away from the beam core should be studied additionally

Damping wiggler development

- Wiggler parameter selection
- Wiggler conceptual design
- Short wiggler prototype production and test
- Full length wiggler production and test

PM technology vs. SC technology



Simulation by M.Korostelev

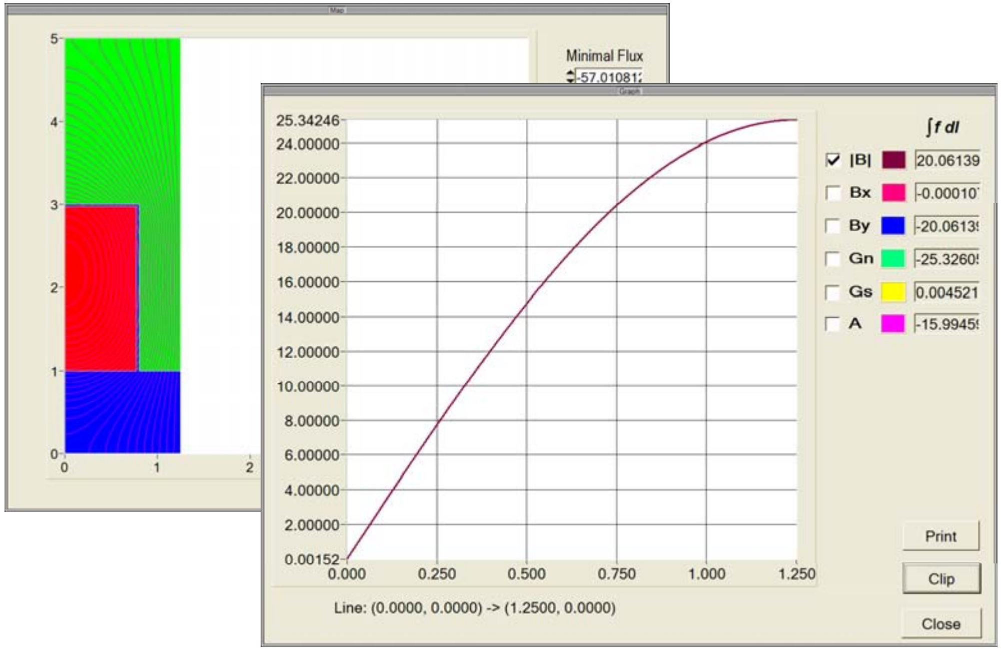
PM damping wiggler for PETRA III

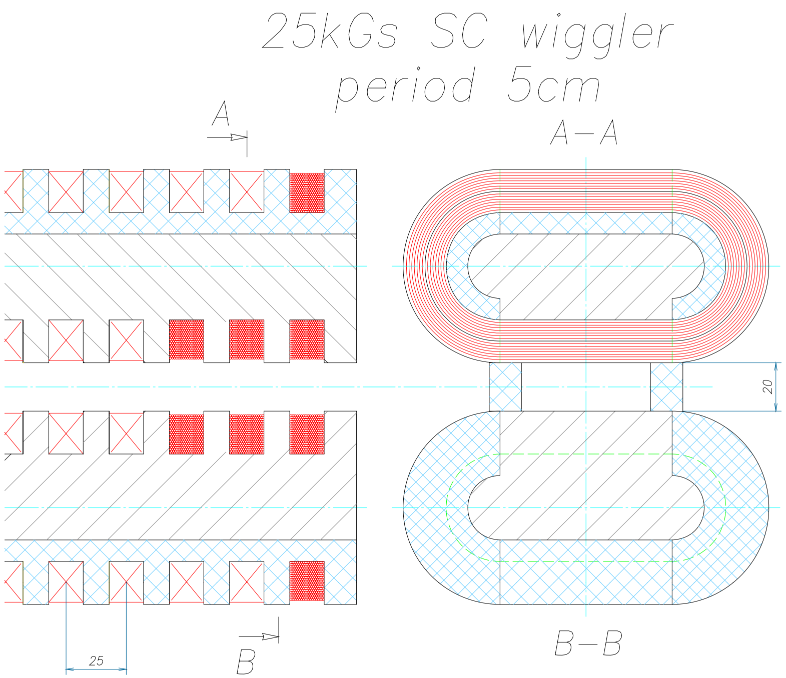
		PM	SC (NbTi)
Period length	cm	10	5
Aperture	mm	12	12
Peak field	T	1.7	2.5
W. length	m	2	2
Temperature	K	Room	4.2 K

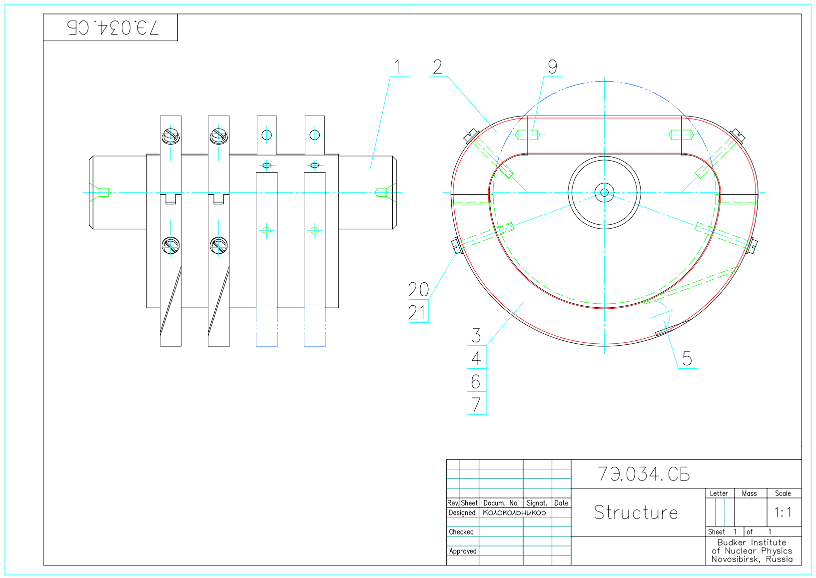
SC Wiggler (short prototype)

Period length	5.0 cm
Vertical pole gap	2 cm
Beam aperture	1.4 cm
Peak field	2.5 T
Prototype length	50 cm

Design by Pavel Vobly







Short prototype schedule

17.03.07 – 01.10.07: the wiggler design and starting the production of the coiler unit to test the winding technology

01.10.07 – 01.02.08: finalizing of the winding technology and starting of production of the wiggler prototype

15.11.07 – Status report including: magnetic field calculation, winding technology description, drawings of the wiggler prototype and winding tooling, description of the quench protection system

01.02.08 – 01.05.08: yoke and tooling production

01.05.08 – 15.06.08: coils production

15.06.08 – 01.07.08: wiggler installation in the cryostat

01.07.08 – 01.10.08: wiggler test and magnetic measurement

Wiggler section design

	PM	SC
Beam current (mA)	150	
Beam energy (GeV)	2.424	
SR critical energy (keV)	6.54	9.62
Deflection parameter *K*	15.88	11.67
Vert opening angle (mrad)	0.21	0.21
Hor opening angle (mrad)	6.7	4.9
Power from one wiggler (kW)	3.22	6.97
Power from 38 wigglers (kW)	**122.5**	**265**

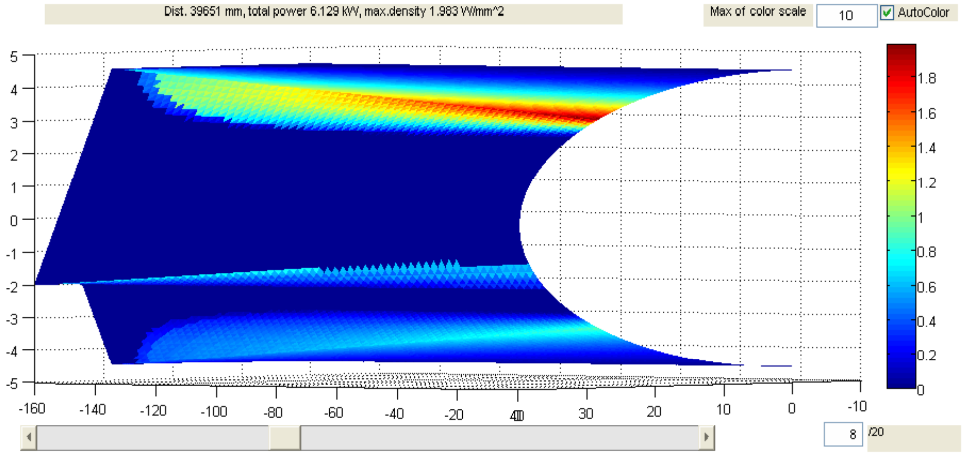
- Almost 300 kW of radiation power should be safely removed from the vacuum chamber
- Around 5% of the power is reflected isotropically from absorber surface
- SC wiggler inner surface is very sensitive even to the very small heating power

3D SR power distribution

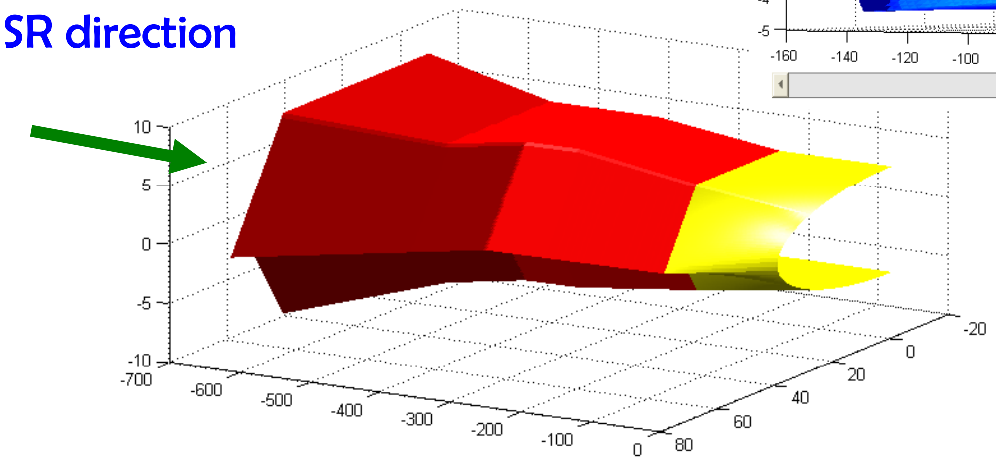
For the PETRA III project a special software simulated the 3D SR power distribution over the vacuum chamber components and the absorber structure has been developed.

A COD and components misalignment are included

Power density distribution for the worst trajectory →

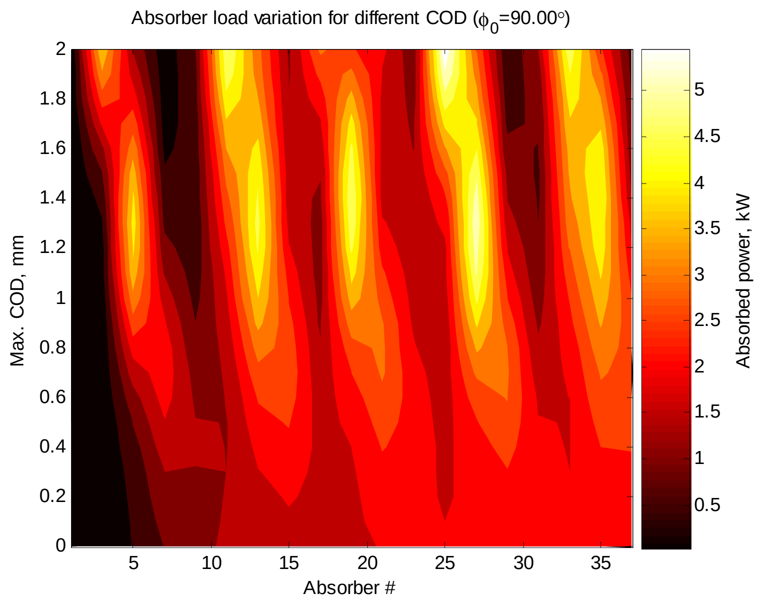


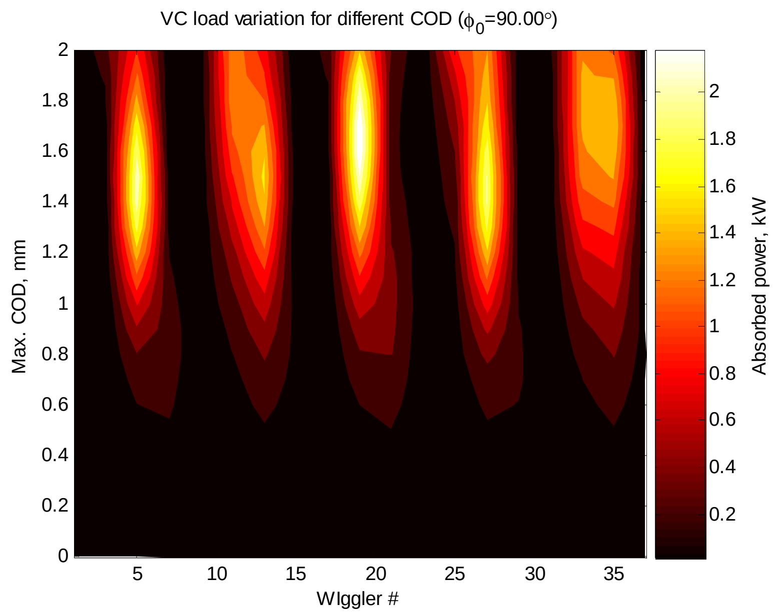
SR direction



CLIC DR preliminary results

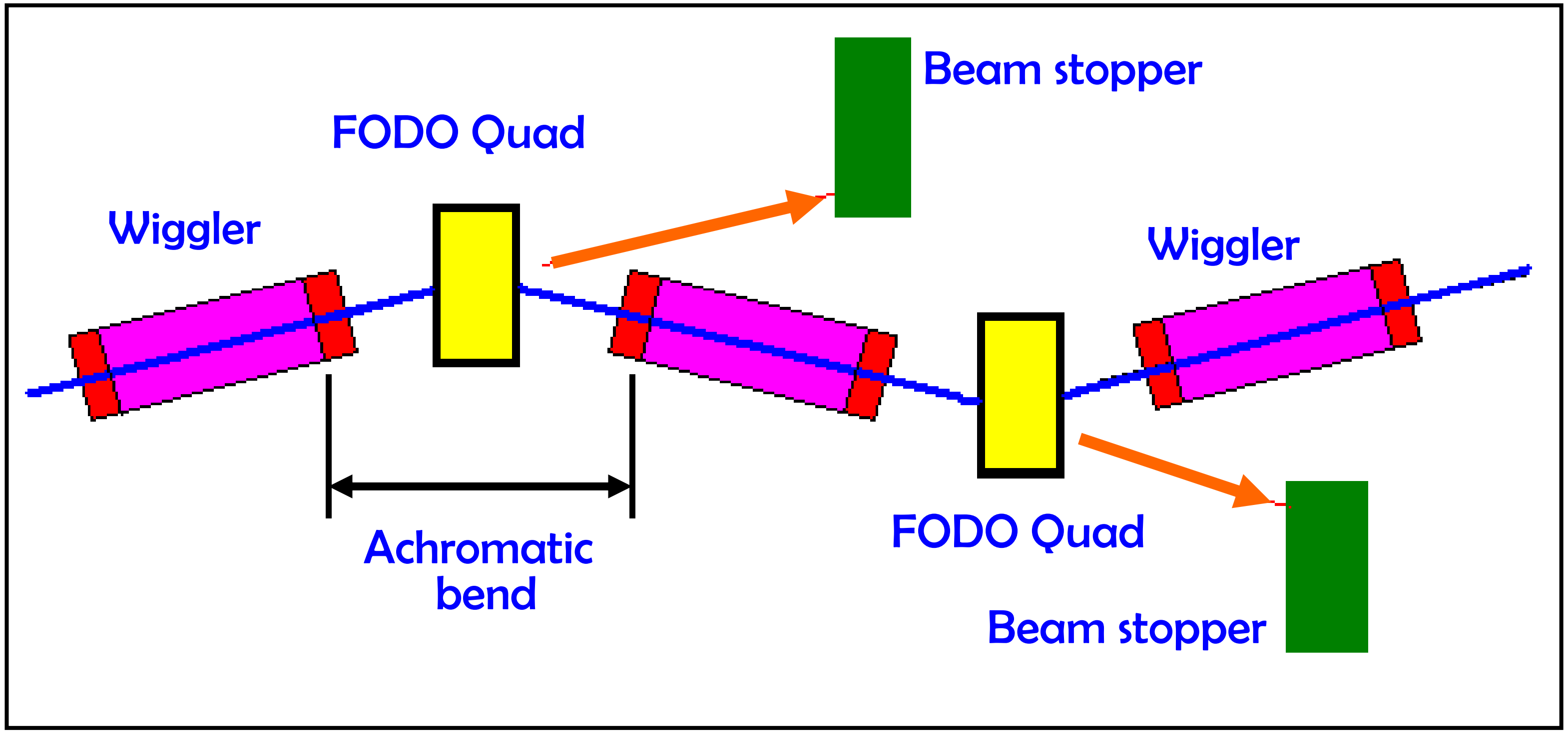
- For the CLIC DR a very preliminary calculation for the permanent magnet wiggler has been performed
- No realistic apertures, elements sizes, etc. were taken into account
- No special schemes of the radiation evacuation were considered





Optimization results for the PM wiggler allow to get the maximum power at absorber ~4÷5 kW and that at the vacuum chamber walls ~50÷60 W for the COD level less than 0.8 mm.

SR evacuation with achromatic bends

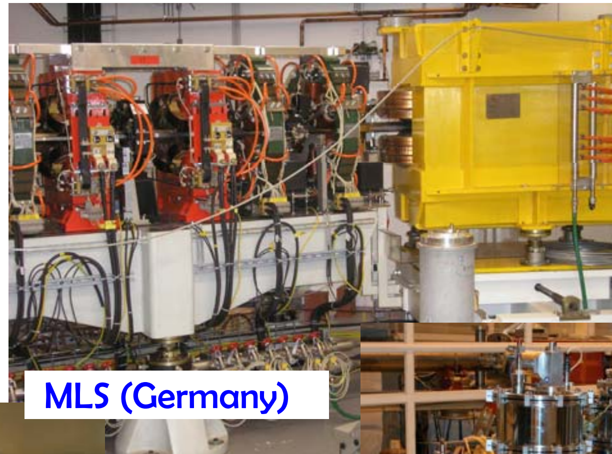


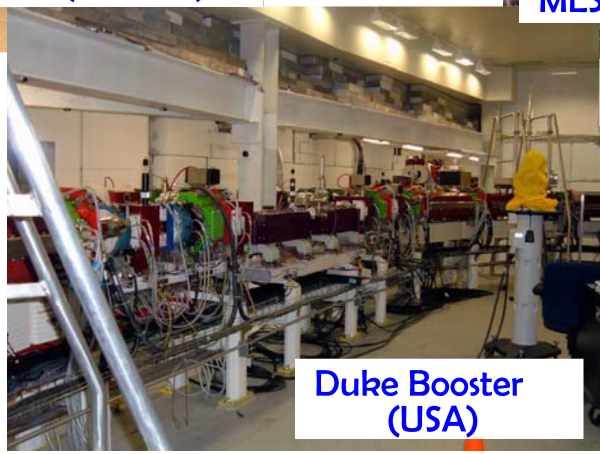
- Achromatic bend is constructed by the two wiggler end poles and the regular FODO cell quadrupoles
- For 5 mrad bend the resulting emittance increases for 2% only

Physical and technical expertise

- BINP has experience in production of variety of accelerator components (magnets, vacuum parts, RF, wigglers, etc.).
- BINP has experience in "turn-key" systems, their operation and maintenance.


Siberia-2 (Moscow)


MLS (Germany)


Duke Booster (USA)


SC Wiggler (Italy)

Summary: possible BINP involvement in the CLIC DR project

- Lattice, beam dynamics and optimization
- Polarization study
- Wiggler design, production, measurement, etc.
- Technical consideration of the DR elements (magnets, vacuum components, SR absorption system, etc.)
- Wiggler section design for the SC wiggler solution