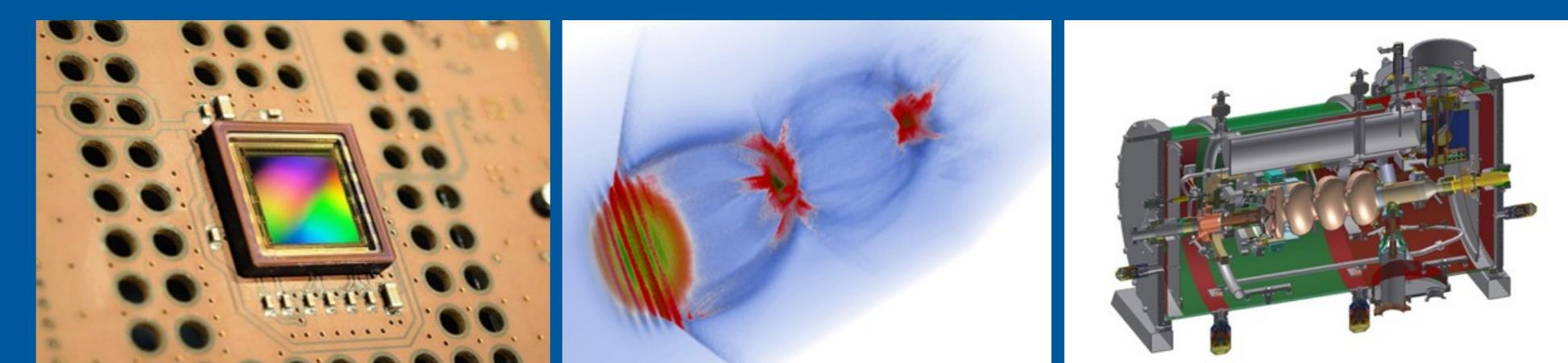
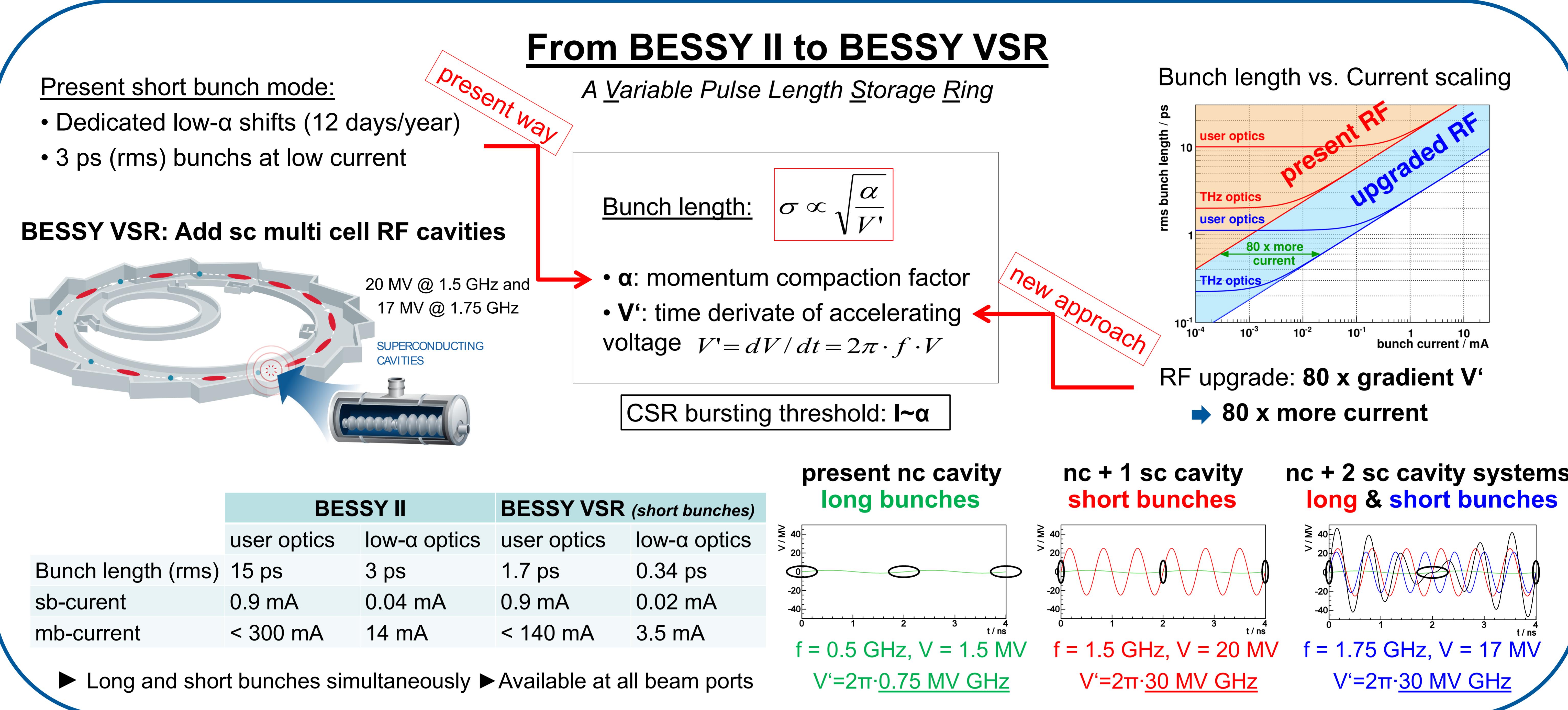


Beam dynamics of short bunch operation of BESSY VSR with sc rf systems

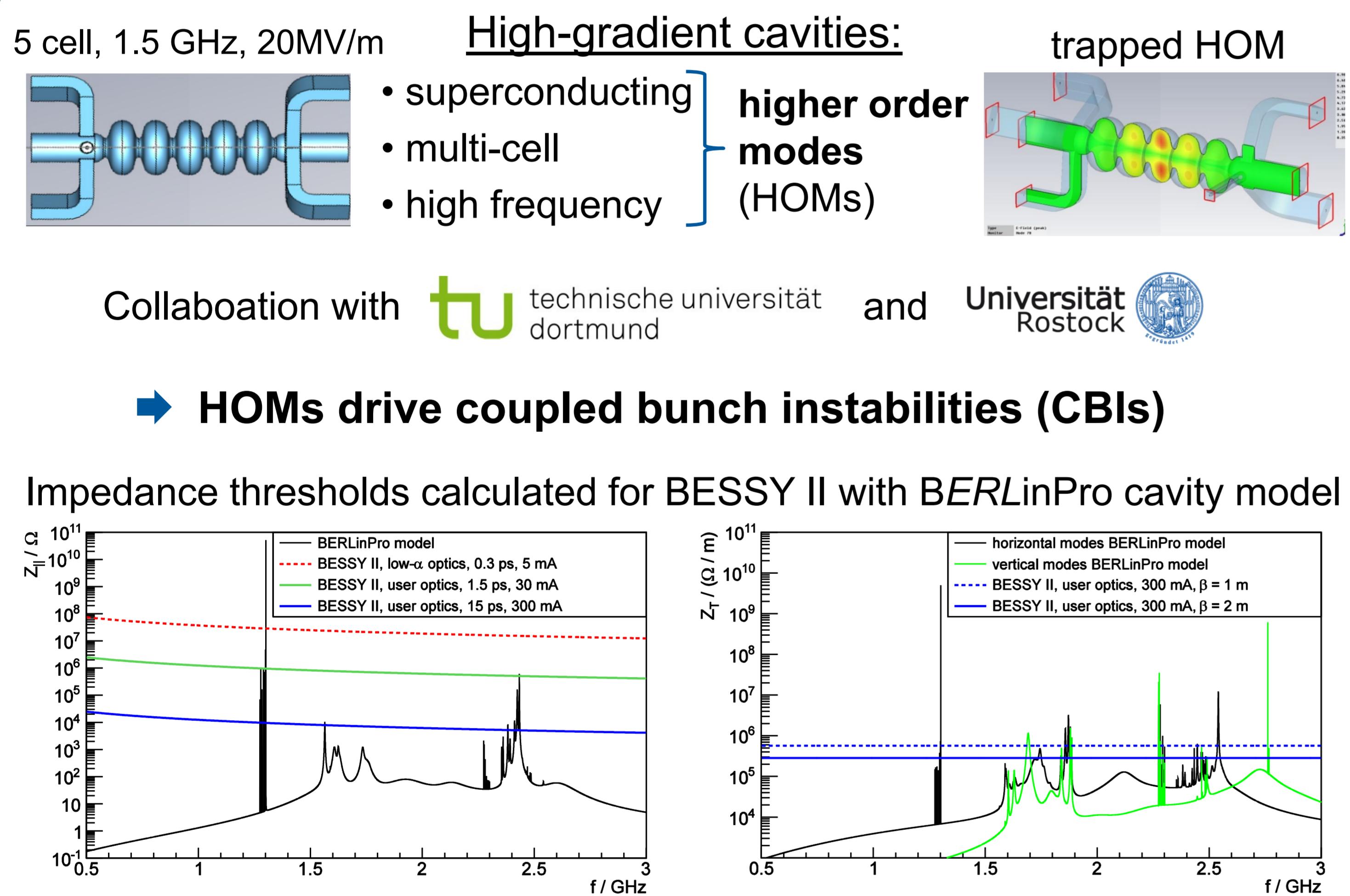


ARD-ST3 Picosecond and Femtosecond Electron and Photon Beams

Martin Ruprecht, HZB



HOMs and coupled bunch instabilities

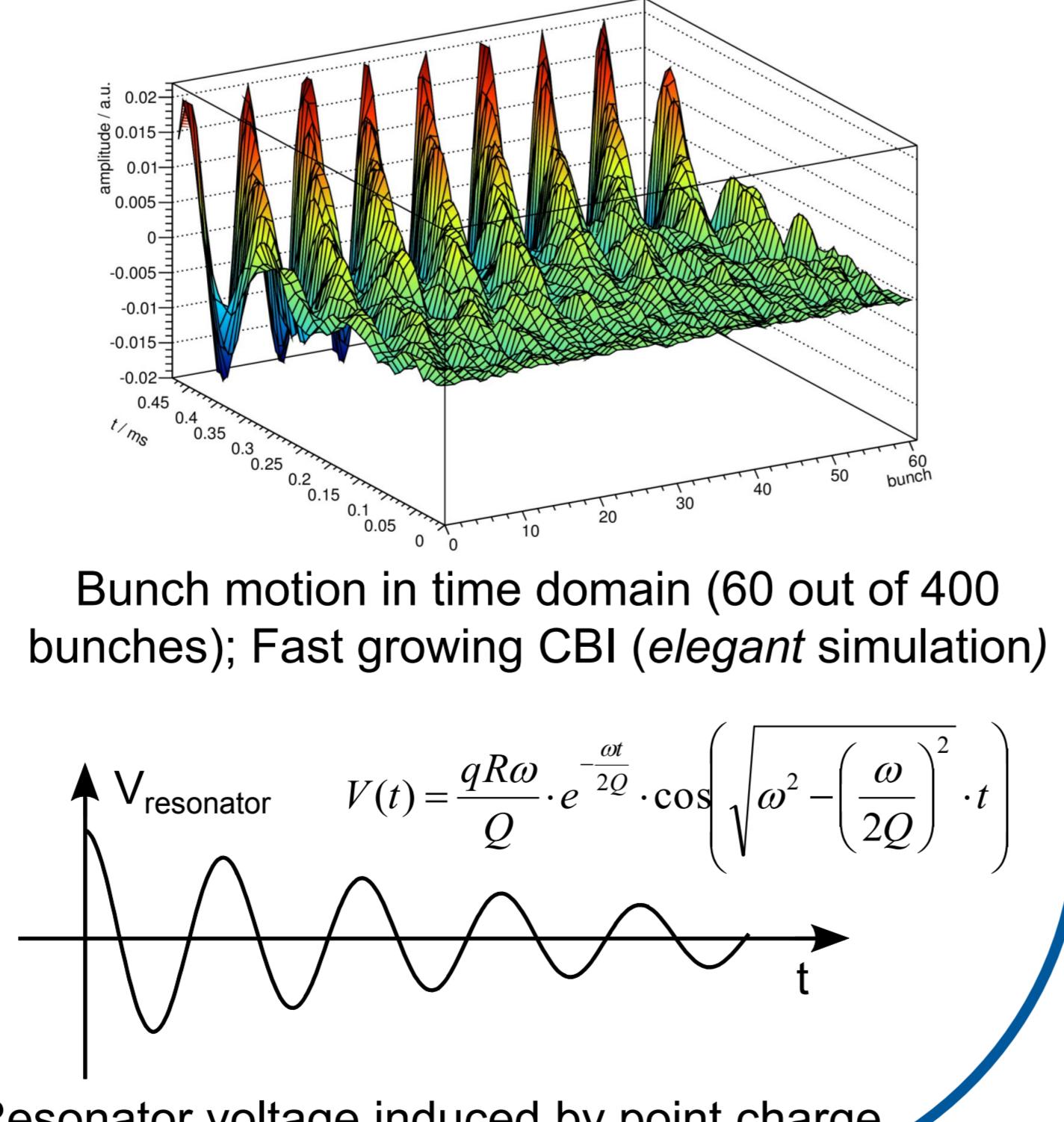


Counter measures:

- Adjust optics parameters (limited!)
- Landau damping
- Chromaticity
- Feedback

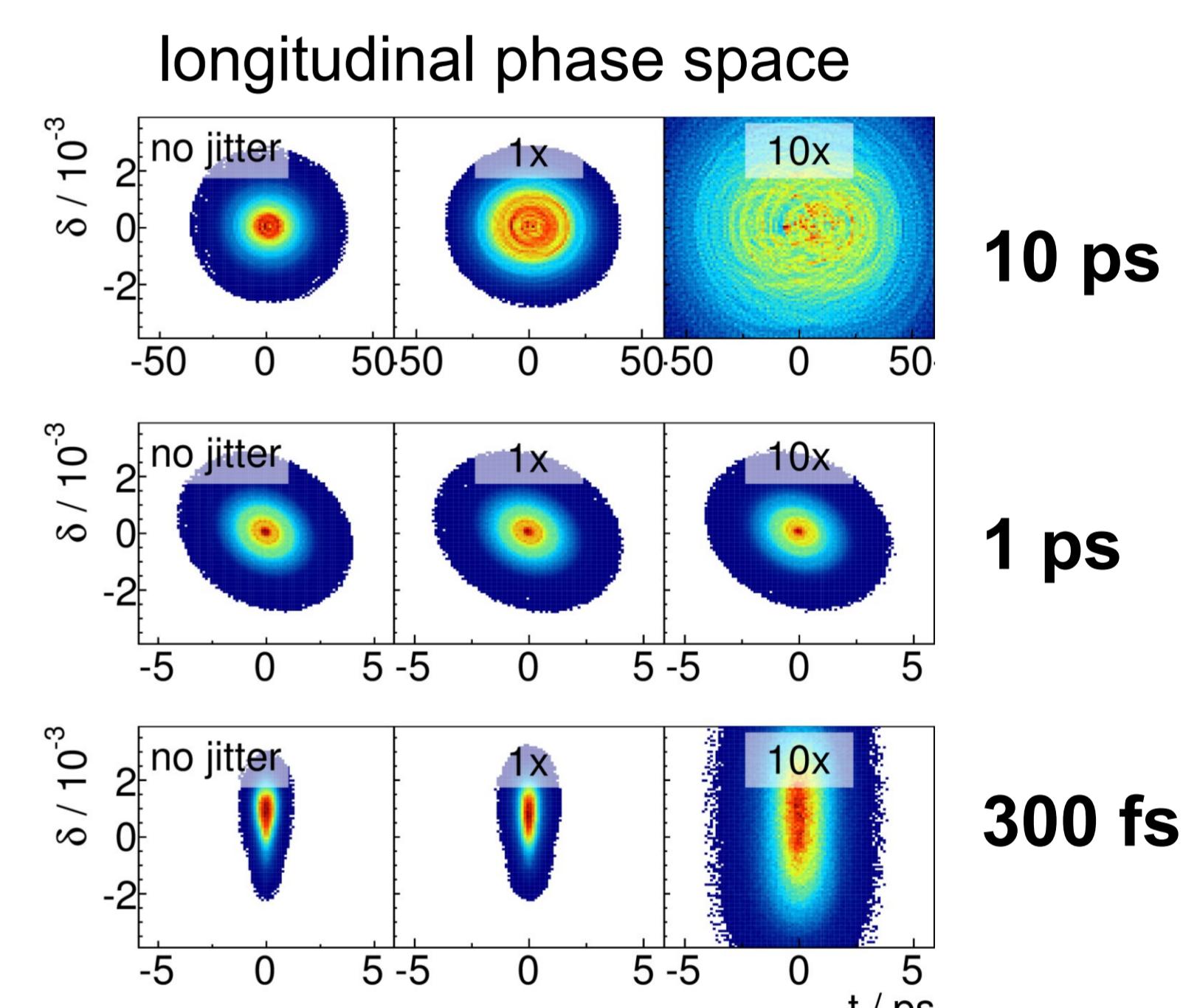
Development of tracking software:

- Particle-impedance interaction in 6D tracking (phasor scheme)
- Nonlinearities
- Many particles per bunch
- Transient beam loading



Influence of RF jitter on bunch size

- Realistic noise spectrum of CW operation (A. Neumann et al., SRF 2011, p.262):
 - Amplitude jitter $< 1.0 \cdot 10^{-4}$
 - Phase jitter < 0.02 deg
 - Measured spectrum applied in *elegant* simulation
 - Estimate limits: 10 x jitter
 - Applied on 1.75 GHz cavity



noise spectrum	300 fs bunch		1 ps bunch		10 ps bunch	
	σ_t	σ_δ	σ_t	σ_δ	σ_t	σ_δ
none	0.33 ps	$8.5 \cdot 10^{-4}$	1.0 ps	$7.1 \cdot 10^{-4}$	9.8 ps	$6.9 \cdot 10^{-4}$
x 1	0.34 ps	$8.0 \cdot 10^{-4}$	1.0 ps	$7.0 \cdot 10^{-4}$	13 ps	$9.3 \cdot 10^{-4}$
x 10	1.0 ps	$19 \cdot 10^{-4}$	1.0 ps	$7.0 \cdot 10^{-4}$	31 ps	$26 \cdot 10^{-4}$

► Expected jitter not critical!

M. Ruprecht et al., IPAC 2013, Shanghai, China

Discussion and perspective

- BESSY VSR: New domain for short pulses in storage rings; scheme also in discussion with **SLAC** NATIONAL ACCELERATOR LABORATORY
- Study of beam dynamics is ongoing, cooperation with **SOLEIL** SYNCHROTRON
- HOM driven coupled bunch instabilities need to be evaluated
 - Study of beam dynamics ↔ cavity design
 - Countermeasures (Landau damping, feedback) need to be evaluated → simulations and measurements planned

Key publications:

- Proceedings of the BESSY VSR - Workshop "The Variable pulse length Synchrotron Radiation source" 14.10. - 15.10. 2013, Berlin.
- G. Wüstefeld et al., 'Simultaneous Long and Short Electron Bunches in the BESSY II Storage Ring', IPAC 2011, San Sebastian, Spain, 2011.
- M. Ruprecht et al., talk 'Single Particle Tracking for Simultaneous Long and Short Electron Bunches', IPAC 2013, Shanghai, China, 2013.

