Quasi-isochronous conditions and high order terms of momentum compaction factor at the compact storage ring

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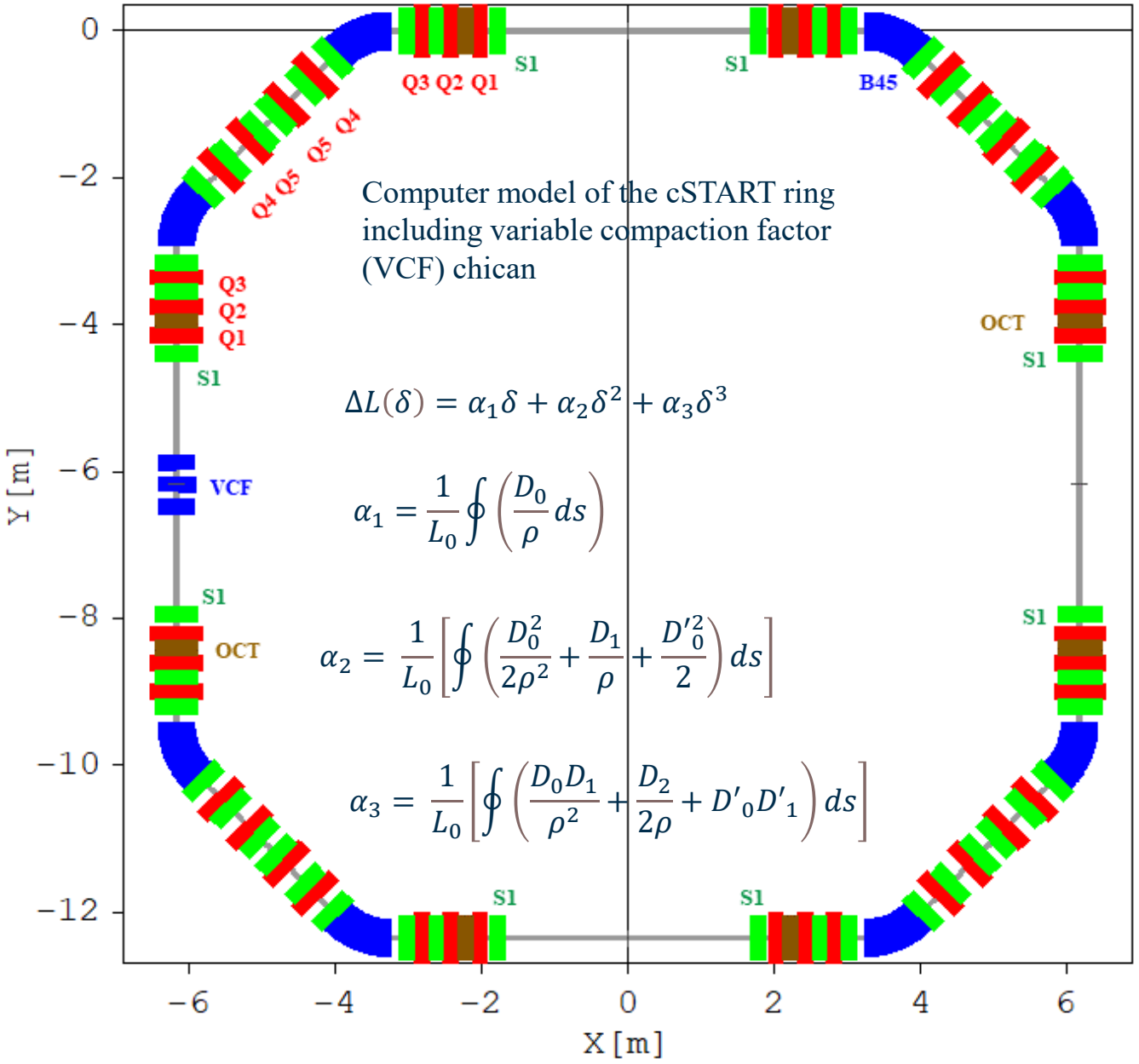
- The **compact** storage ring project for accelerator research and technology (**cSTART**) is realized at the Institute for Beam Physics and Technology (**IBPT**) of the Karlsruhe Institute of Technology (KIT)
- **Flexible** lattice of a ring benefits variety of **operation modes**. Different physical experiments including **direct injection** and circulation of **Laser Plasma Accelerator** (LPA) electrons are planned at cSTART
- Deep **variation** of **momentum compaction factor** with simultaneous **control** of **high order terms** of alpha would demonstrate the capture and **storage** of **ultra-short bunches** of electrons in a circular accelerator
- Computer studies of linear and non-linear beam dynamics were performed with an objective to estimate arrangement and performance of dedicated **three pole chican** magnets to provide **quasi-isochronous** conditions for electrons
- Additonal families of so called "**longitudinal" sextupoles** and **octupoles** are included into a ring lattice to control **slope** and **curvature** of momentum compaction factor as function of energy offset of particles in a bunch.



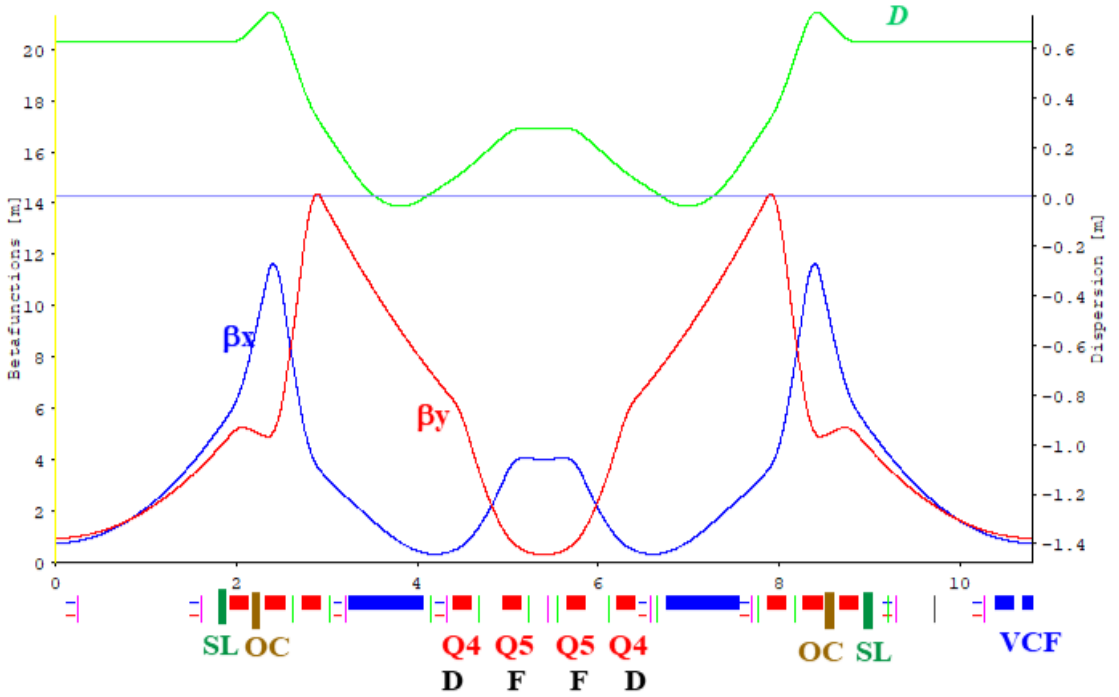
Computer model of the cSTART ring including variable compaction factor (VCF) chican

$$\Delta L(\delta) = \alpha_1 \delta + \alpha_2 \delta^2 + \alpha_3 \delta^3$$

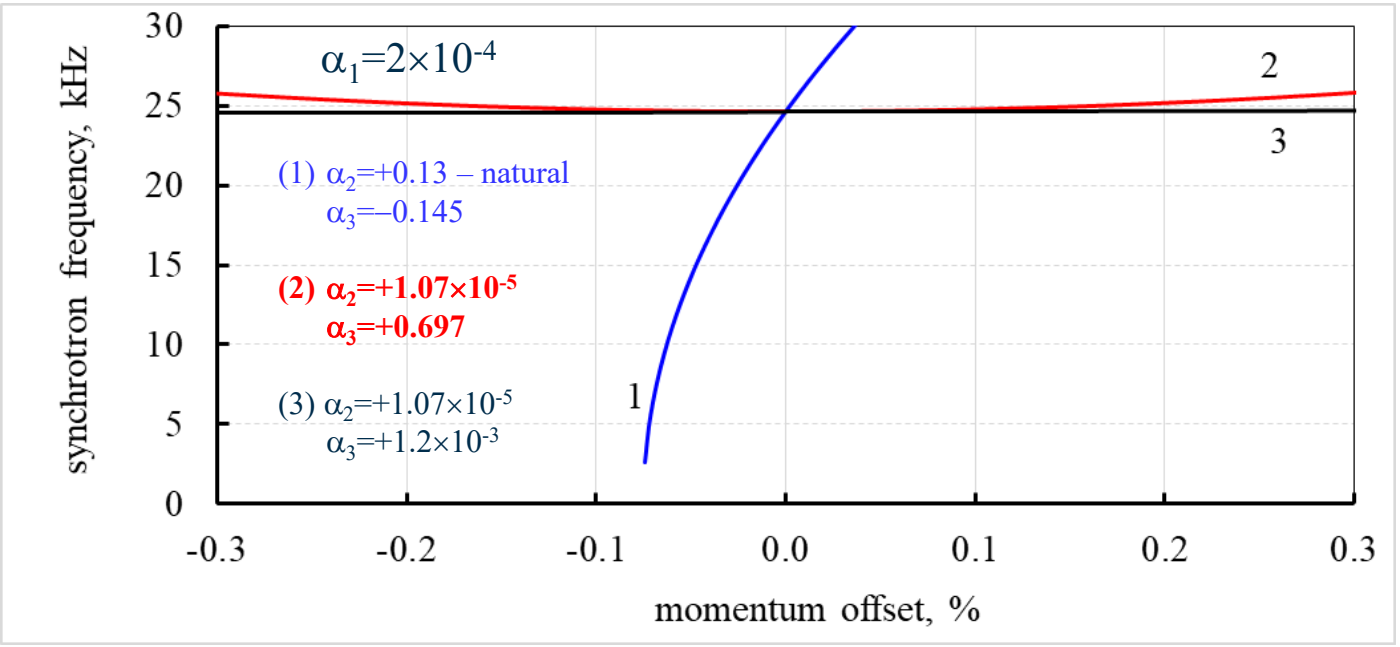
$$\alpha_1 = \frac{1}{L_0} \oint \left(\frac{D_0}{\rho} ds \right)$$

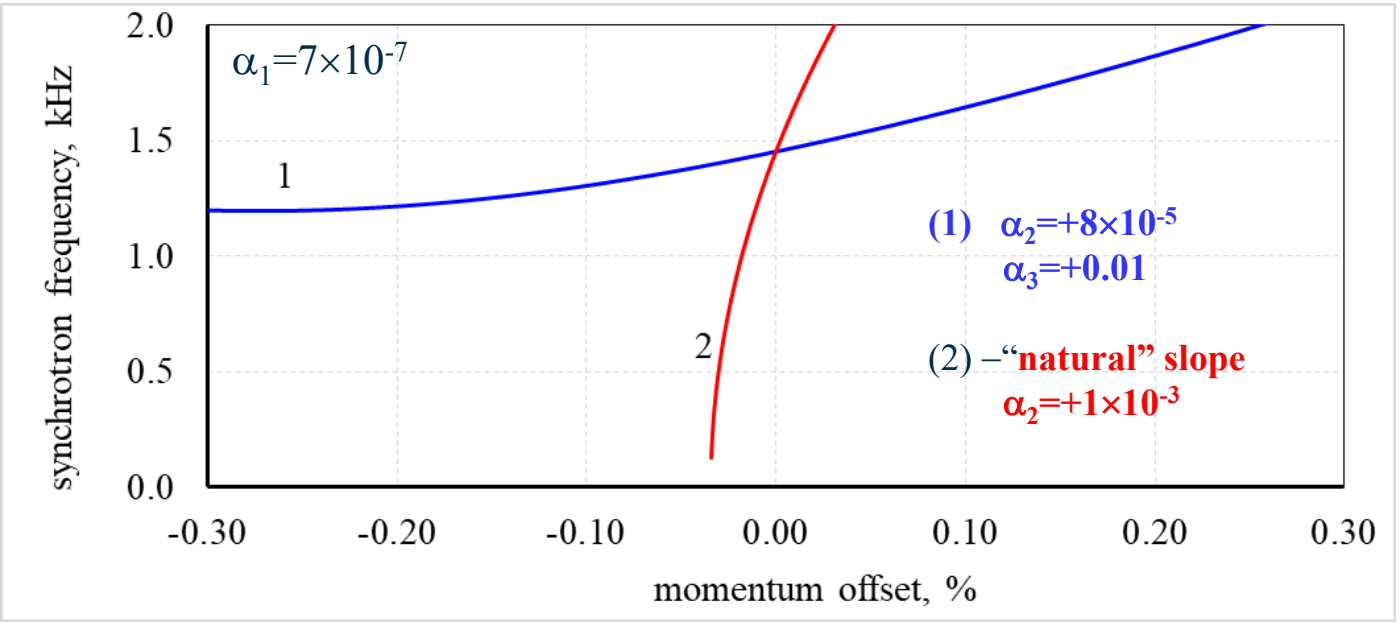
$$\alpha_2 = \frac{1}{L_0} \left[\oint \left(\frac{D_0^2}{2\rho^2} + \frac{D_1}{\rho} + \frac{D'^2_0}{2} \right) ds \right]$$

$$\alpha_3 = \frac{1}{L_0} \left[\oint \left(\frac{D_0 D_1}{\rho^2} + \frac{D_2}{2\rho} + D'_0 D'_1 \right) ds \right]$$

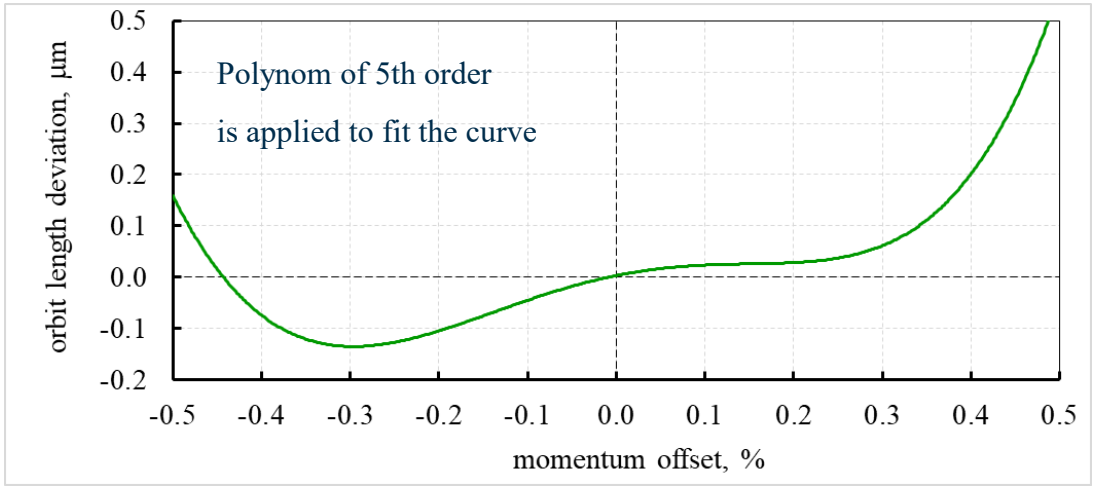


- Recent experiments with additional longitudinal sextupole at KARA ring provide “prove of principles” of dedicated set up with variable compaction factor chican at cSTART ring
- Ultrashort bunches of about 900 fs “zero current” bunch length (rms) have been received at KARA
- Flexible lattice with VCF chican at cSTART will benefit research program with ultrashort bunches





- Orbit length deviation for off-momentum particles at ultralow–α optics with $\alpha_1=7\cdot10^{-7}$
- High order terms are suppressed to minimize bunch length and provide sufficient momentum acceptance



Bunch elongation is less than 0.2 μm (0.7 fs) for particles at periphery of energy distribution $\delta_E=\pm0.3\%$ ($\delta_p=0.1\%$ rms)