

# Longitudinal dynamics in low-alpha mode (*SLS performance upgrade*)

A.Sargsyan, G. Amatuni

# Low-alpha mode

$$\frac{\Delta L}{L} = \alpha \frac{\Delta p}{p}, \quad \alpha - \text{momentum compaction factor}$$

$$\text{bunch length} \sim \sqrt{|\alpha|}$$

$$\alpha = \alpha_1 + \alpha_2 \frac{\Delta p}{p} + \dots$$

$$\alpha_1 = \frac{1}{L} \int_0^L \frac{D_0(s)}{\rho(s)} ds$$

$$\alpha_2 = \frac{1}{L} \int_0^L ds \left[ \frac{(D'_0(s))^2}{2} + \frac{D_1(s)}{\rho(s)} \right]$$

For SLS

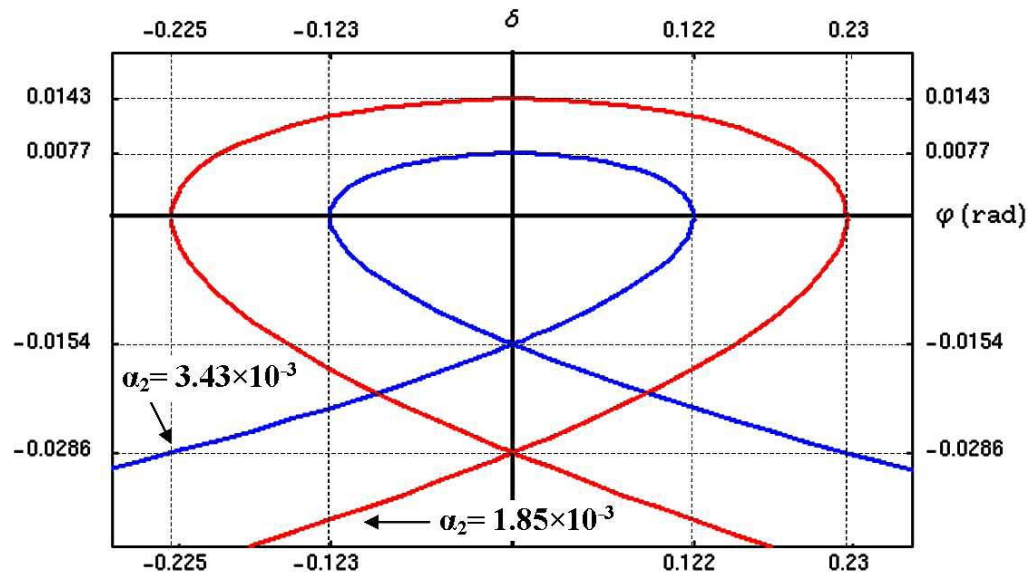


$\alpha_1 = 6 * 10^{-4}$  normal operation mode

$\alpha_1 = 5.3 * 10^{-5}$  low-alpha mode

# Longitudinal dynamics in low-alpha mode for SLS

- An analysis of the longitudinal dynamics at low alpha mode (studies of bucket shapes, fixpoints, energy acceptance and phase acceptance as a function of  $\alpha_1$  and  $\alpha_2$ ) was done.

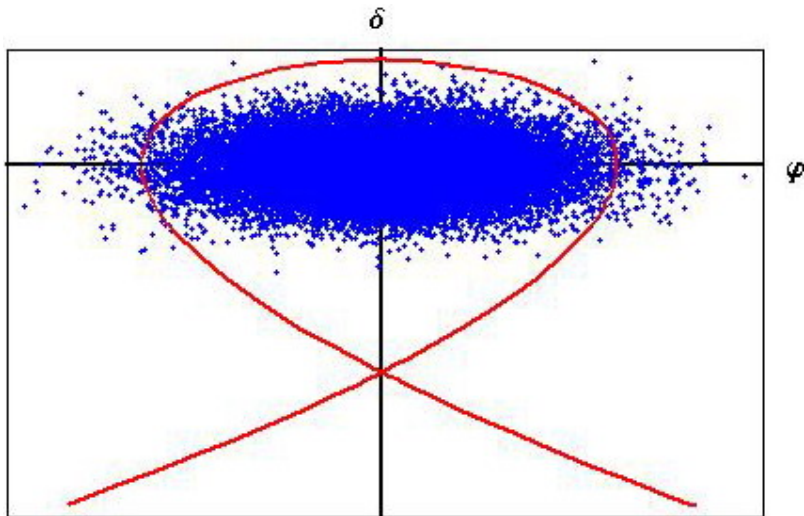


**Figure 1:** Alpha-buckets for  $\alpha_1 = 5.3 \times 10^{-5}$  and two values of  $\alpha_2$ . Parameters of the SLS storage ring:

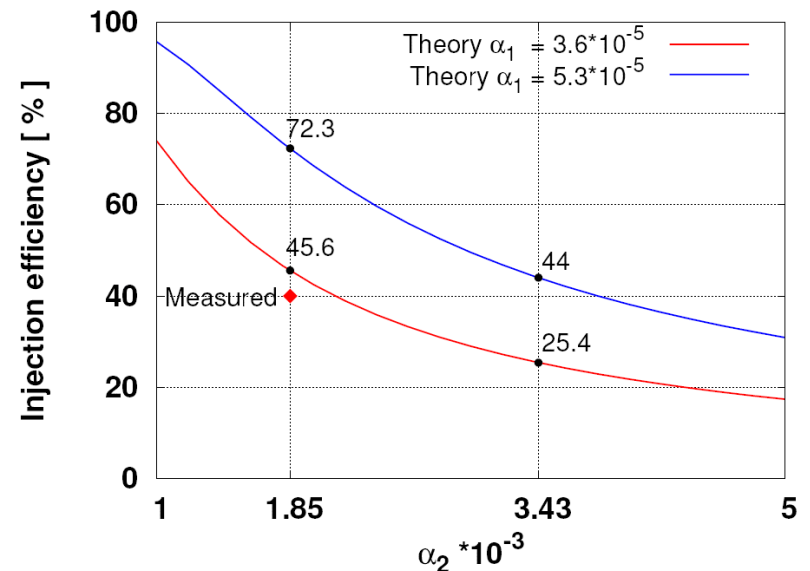
$$E_0 = 2.4 \text{ GeV}, h = 480, V_{rf} = 2.1 \text{ MeV}, \phi_s = 165^\circ.$$

# Injection efficiency

- The injection process (mismatch of booster bunch to low-alpha bucket) was studied and maximum injection rate was estimated.
- Theoretical results were compared with TRACY simulation results (tracking 25000 particles over 1500 turns). As an example, for the case of injecting a bunch of 22 mm rms in the  $\alpha_1 = 5.3 \times 10^{-5}$ ,  $\alpha_2 = 3.4 \times 10^{-3}$  lattice, the tracking result of 39.5% confirmed the theoretical value of 40.0%.



**Figure 2:** Mismatch of booster bunch to low-alpha-bucket.



**Figure 3:** Theoretical injection efficiency as a function of  $\alpha_2$  for design (blue) and measured (red) value of  $\alpha_1$ .