# Simultations with diff. numbers of Rf stations

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International
MUON Collider
Collaboration

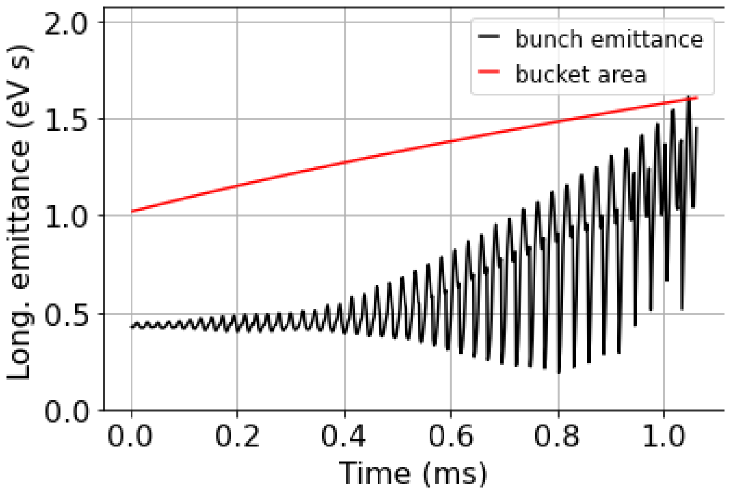
# The number of RF stations $n_{RF}$ …

- Reminder: $n_{RF} >> 1$ because of the high synchrotron tune of ≈ 0.3-1.5
- The higher $n_{RF}$, the smaller the quadrupole-like oscillations because of the discreet energy steps and resulting mismatching
- A higher $n_{RF}$ might result in higher construction and powering costs, even though the total number of cavities is constant and defined by the energy gain per turn

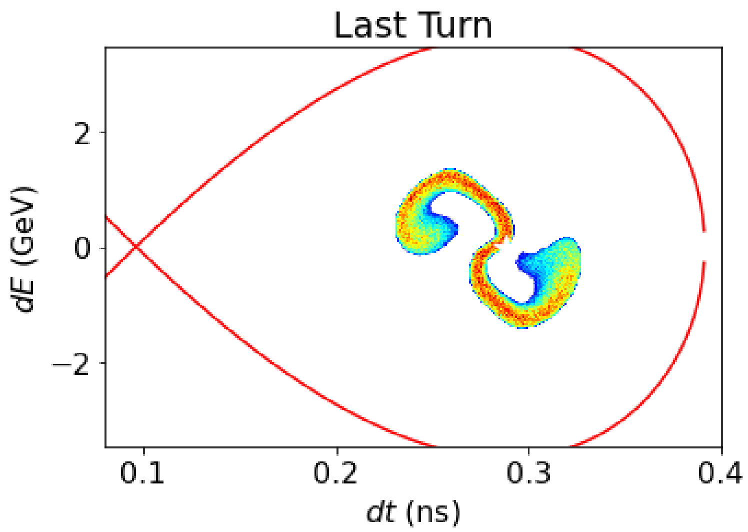
-> investigate this with EN-EL or CV

**<u>Today:</u>** Determine emittance growth as a function of $n_{RF}$ as main criteria for beam quality for each RCS

- Obtain emittance from simulation, i.e. $4\pi\sigma_t\sigma_E$, along cycle and determine increase in emittance with respect to its end



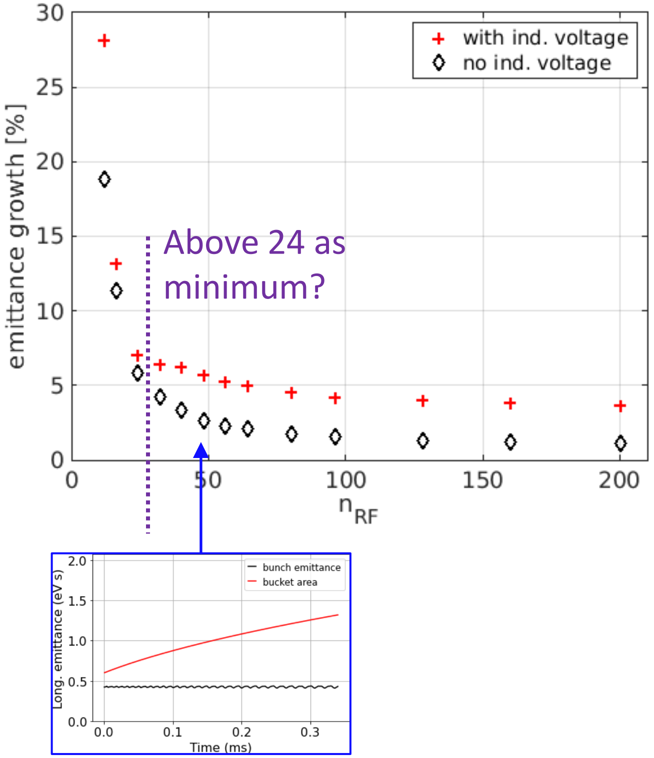

Simulation for RCS2,
$n_{RF} = 12$



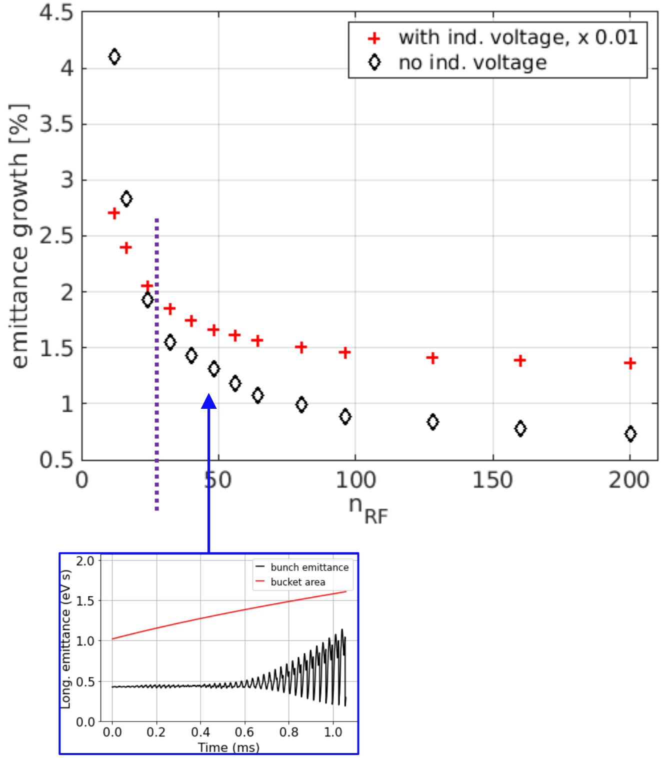
# Emittance growth vs. $n_{RF}$

- For each RCS and with and without induced voltage

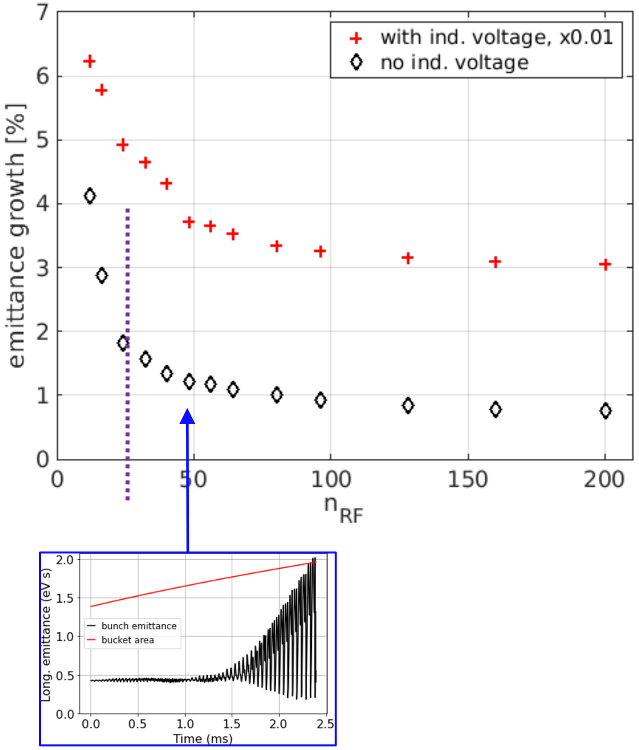
RCS1




RCS2




RCS3




- No significant improvement of the emittance for $n_{RF}$ >48
- $n_{RF}$ > 24 as minimum number of stations

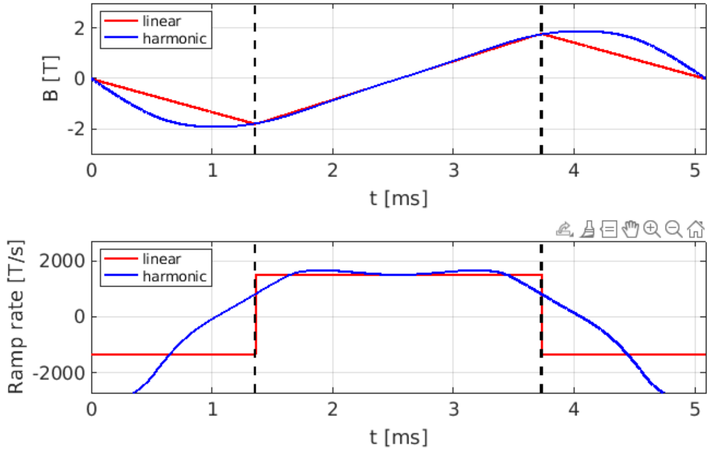
# Summary

- The comparison of the emittance growth vs. number of RF stations for otherwise equal parameter is already an effective tool to determine a range for $n_{RF}$
- $24 < n_{RF} < 48$ seems a reasonable choice
- No different in trend caused by wakefields, as expected for the synchrotron tune

# Additional slides

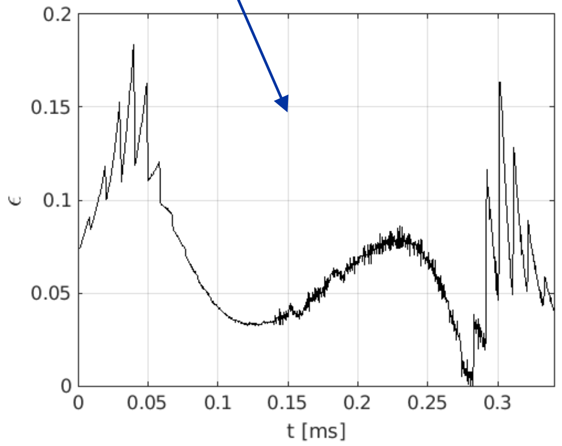
# Adiabaticity factor

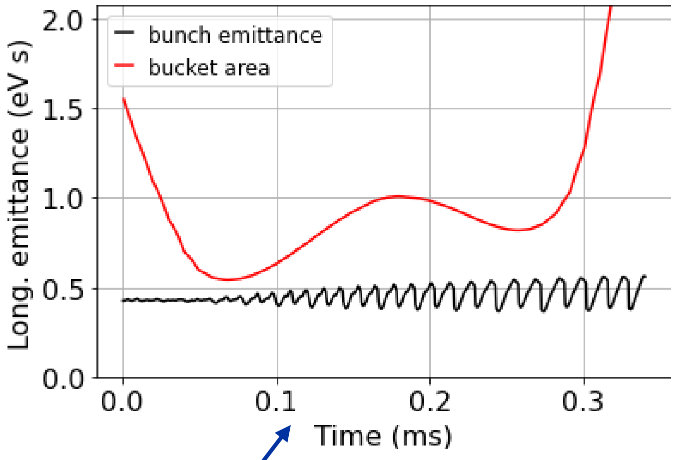
- Linear vs. harmonic ramping function as trade-off between magnet powering and RF requirements acc. gradient. Determined adiabaticity factor and bucket area restrictions based on the ramp rates and during simulations

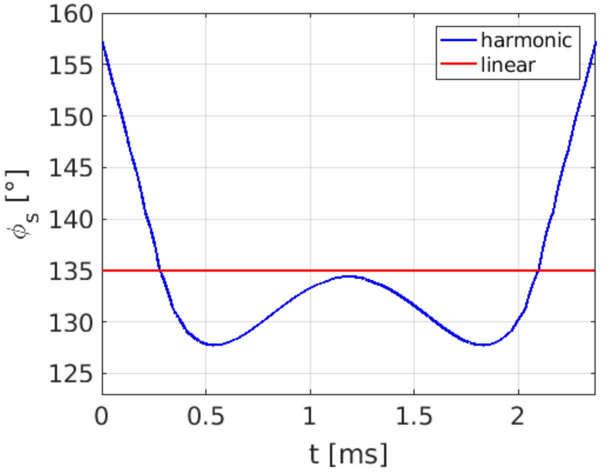



$$\varepsilon = \frac{1}{\omega_s^2}\left|\frac{\mathrm{d}\omega_s}{\mathrm{d}t}\right| \ll 1 \ .$$

$$\varepsilon(t) = \frac{1}{2\omega_s}\left|\frac{\dot{B}_{harm}}{B_{harm}} + \frac{\tan(\phi_s)}{\cos(\phi_s)} \cdot \frac{\ddot{B}_{harm}}{\dot{B}_{lin}} \cdot \sin(\phi_{s,0})\right| \ll 1$$




Beam not properly matched with non-linear ramp and multiple RF stations, tbi

higher gradients can be obtained by sweeping synchron. phase

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