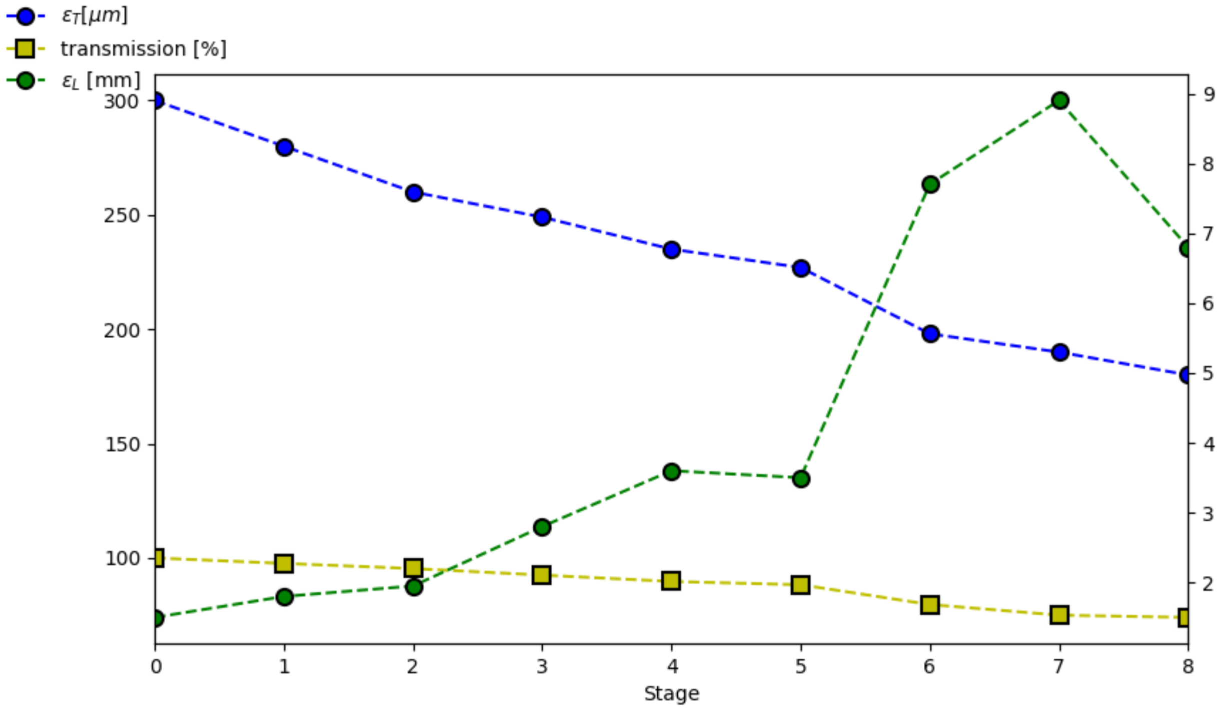
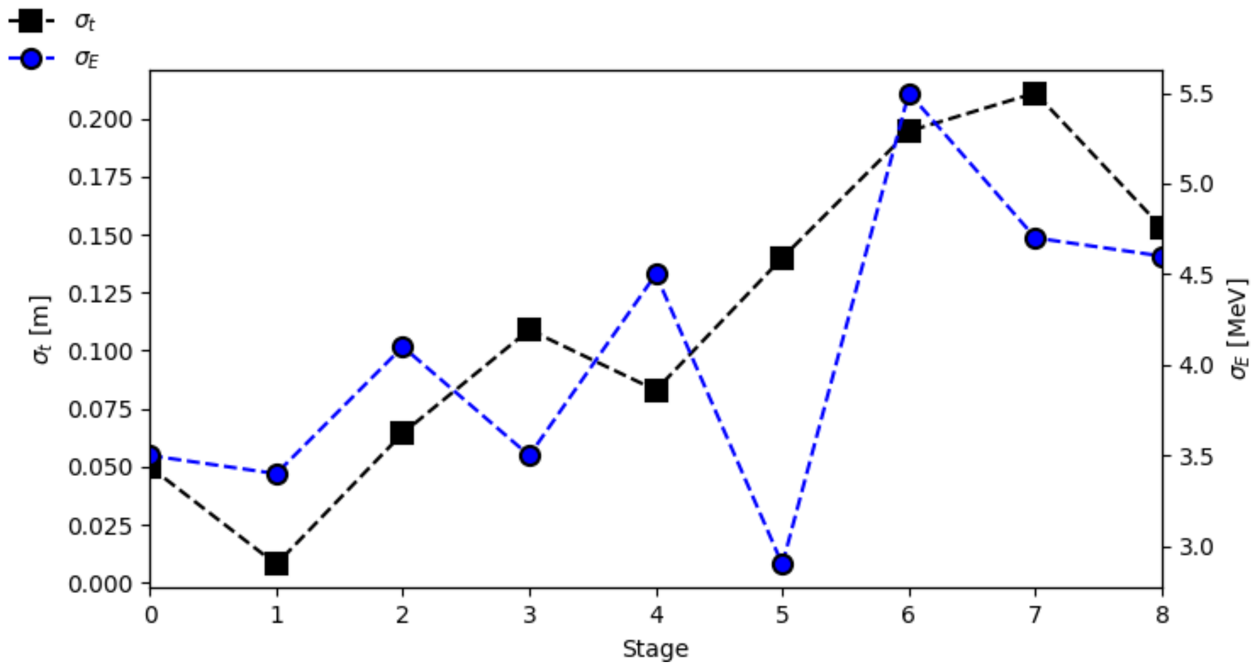
Updates on final cooling channel optimisation

International MUON Collider Collaboration

40 T, Liquid hydrogen absorber, initial beam: $P_z = 135MeV/c, \epsilon_\perp = 300\mu m, \epsilon_\| = 1.5mm, \sigma_t = 50mm$
Free parameters: solenoid length, absorber length, drift, RF frequency, voltage, phases (2 cavities with different phases)

Objective function:
Given different weights: min -> difference to a given target $P_z, \epsilon_\perp, \sigma E/\Delta N, \sigma_t$
8 cells: $\epsilon_\perp = 300\mu m \rightarrow \epsilon_\perp = 175\mu m$





Agreement between RF-Track and cooling equations

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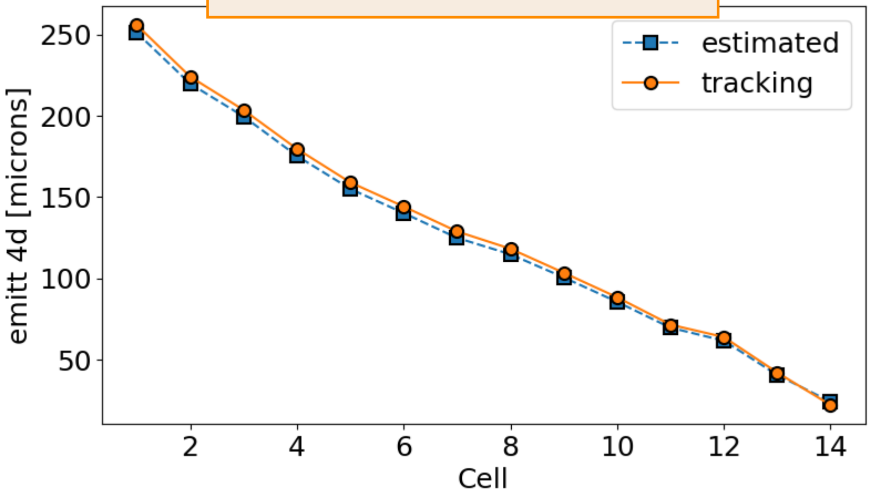
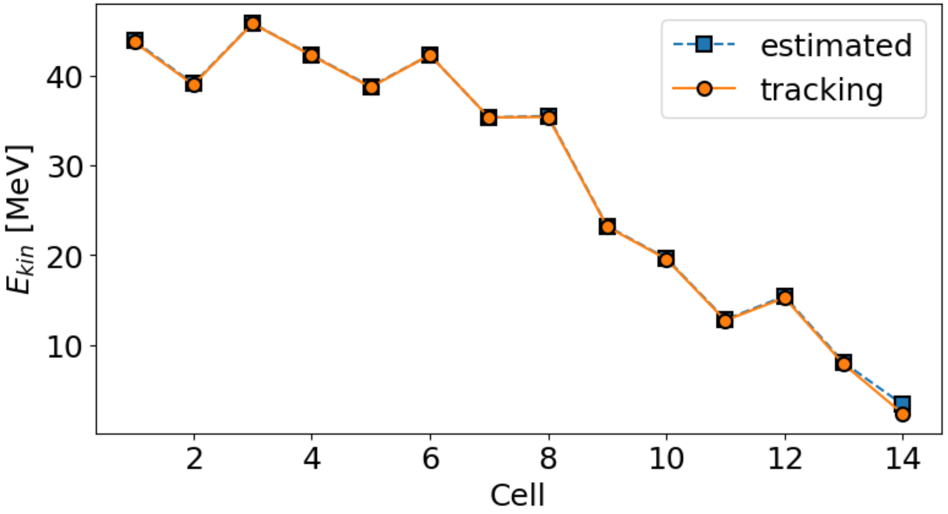
$$\frac{d\epsilon_\perp}{ds} = -\frac{\epsilon_\perp}{\beta^2 E}\frac{dE}{ds} + \frac{\beta_\perp E_s^2}{2\beta^3 mc^2 L_R E}$$

$$\frac{dE}{ds} = 4\pi N_A \rho r_e^2 m_e c^2 \frac{Z}{A}\left[\frac{1}{\beta^2}\ln\left(\frac{2m_e c^2\gamma^2\beta^2}{I(Z)}\right) - 1 - \frac{\delta}{2\beta^2}\right]$$

- 40 T (static field), Liquid hydrogen absorber, initial beam: $P_z = 135MeV/c, \epsilon_\perp = 300\mu m, \epsilon_\parallel = 0mm$

No Longitudinal Spread considered





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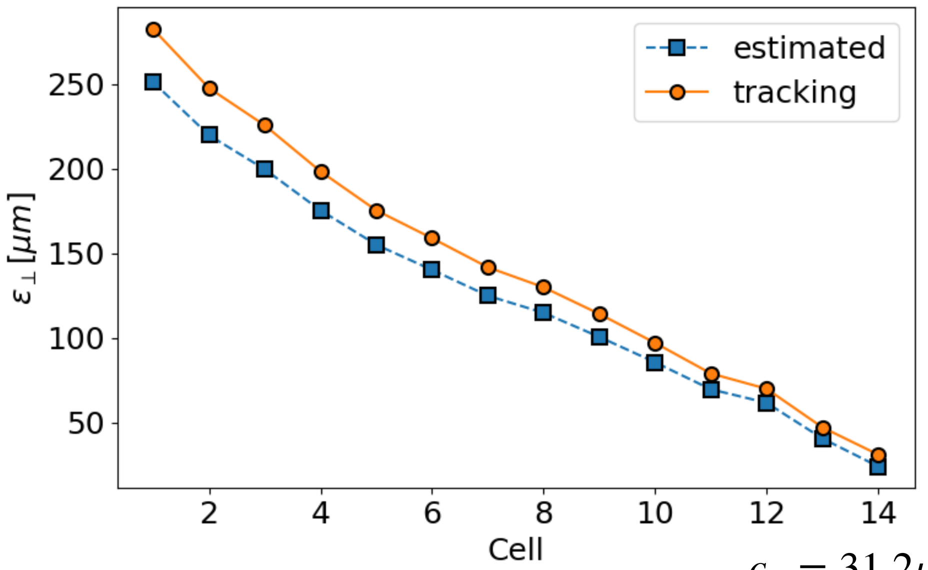
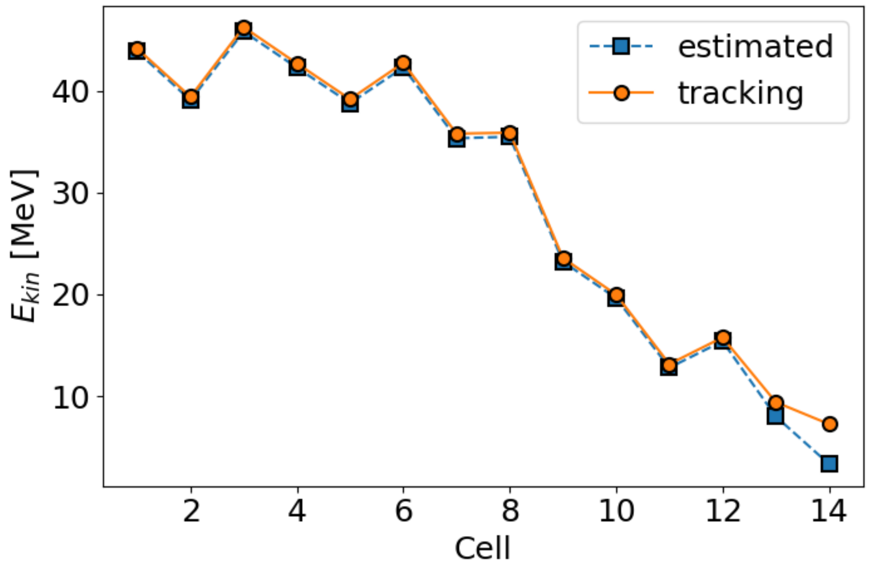
- 40 T (static field), Liquid hydrogen absorber, initial beam: $P_z = 135MeV/c, \epsilon_\perp = 300\mu m, \epsilon_{||} = 50mm, \sigma t = 50mm, \sigma E = 3.2MeV$



$\epsilon_\perp = 31.2\mu m$

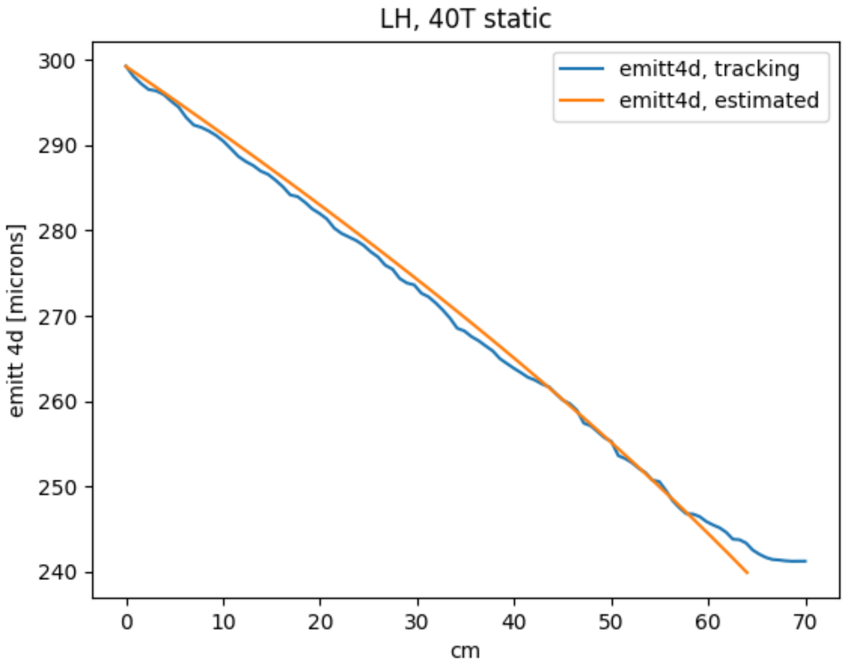


Longitudinal spread included
Note: *same longitudinal emittance and bunch length in every cell*
-> real effect will be larger

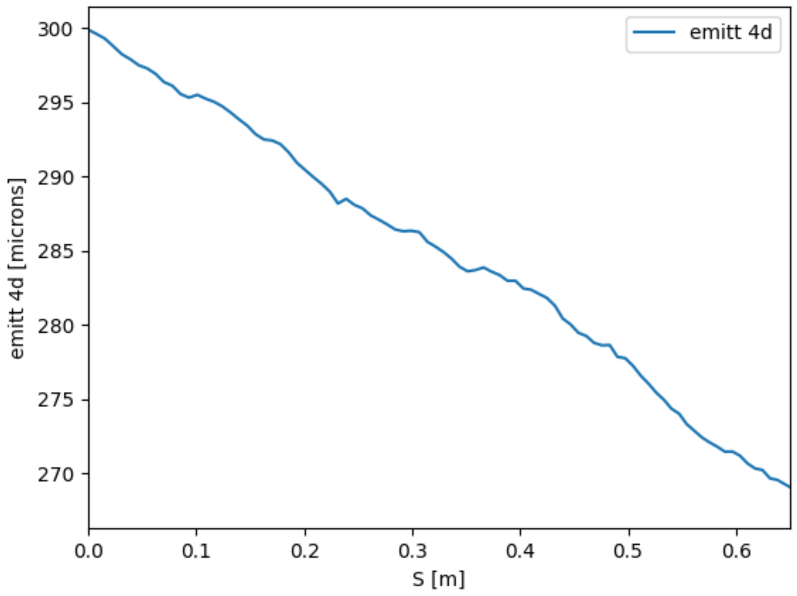
Bunch length and transverse emittance

- 40 T (static field), Liquid hydrogen absorber,
- initial beam: $P_z = 135 MeV/c, \epsilon_\perp = 300 \mu m$

$\sigma t = 0mm$



$\sigma t = 50mm$



➡ Slice the beam longitudinally and compare the emittance

Bunch length and transverse emittance

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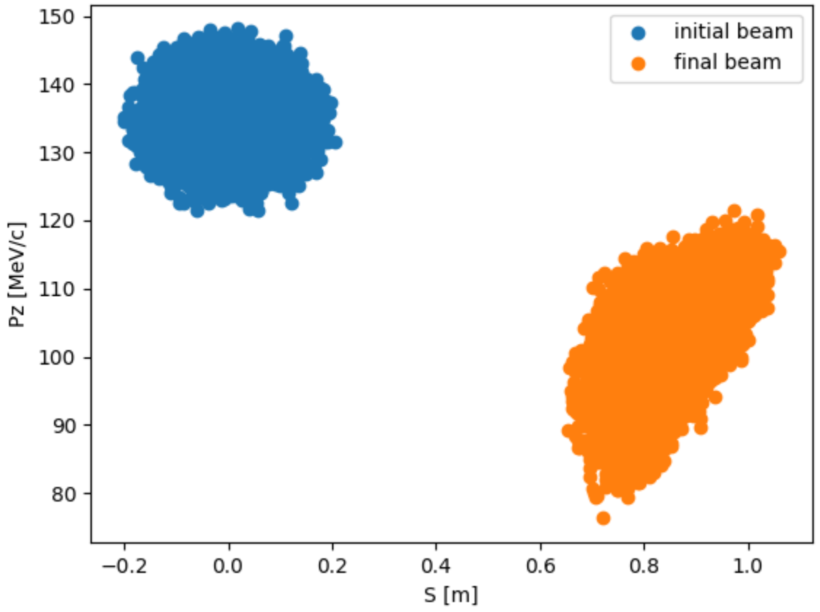

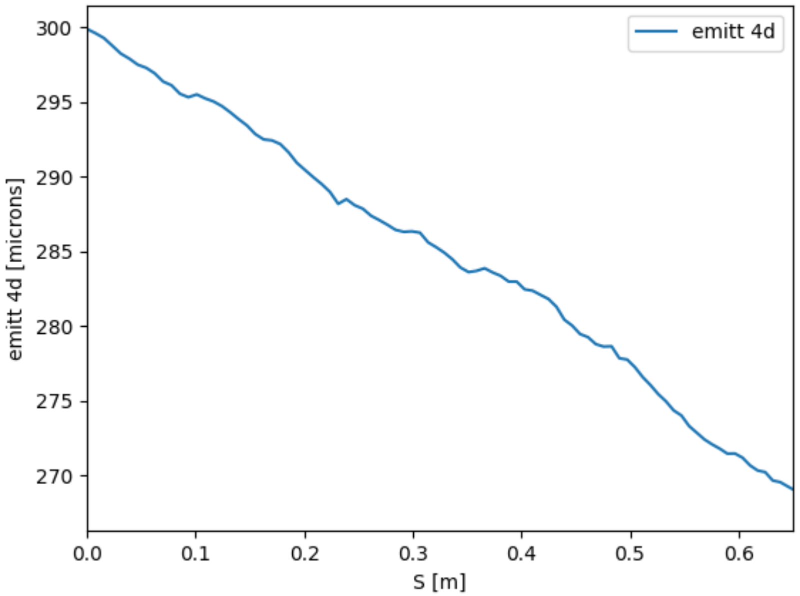

➡ Slice the beam longitudinally and compare the emittance

➡ Full bunch: 272 micron

➡ Bunch slices range from 258 to 298 micron: $\epsilon_{\perp} = 272 \pm 10.56 \mu m$