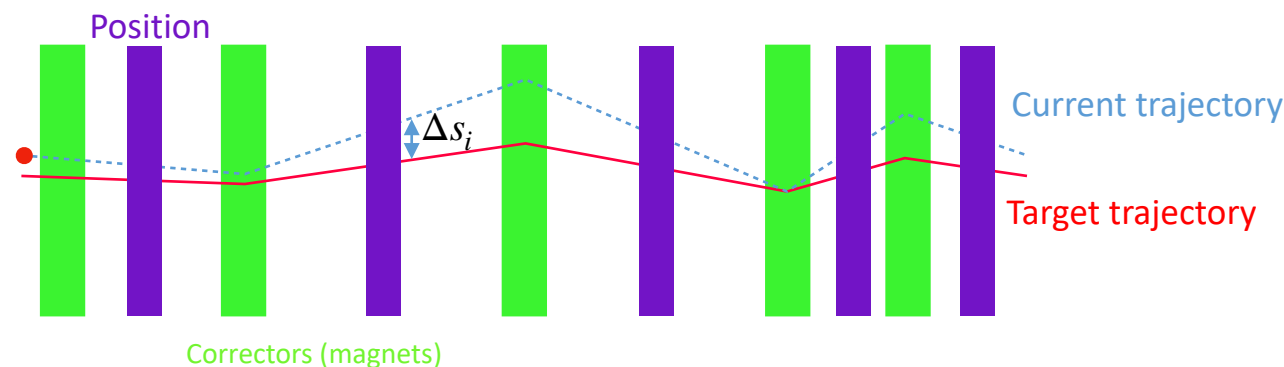


CERN AWAKE steering problem

- Well studied in several papers/thesis
- Linear Dynamics with 10 degrees of freedom in actions and states
- Non-trivial due to action limitations
- Analytical solution for the optimal policy
- Easy to understand, focus on the RL problem not the MDP
- The simulation corresponds exactly to the real system (measured optics)
- All our algorithms were tested on the real machine

CERN AWAKE steering problem

Markov decision process: $(S, A, R, P, \rho_0, \gamma)$



- 10 continuous states S and actions $A \in [-1, 1]$ (**actions are bounded/constraints**) (10 DoF problem - observation is state)
- Rewards R negative of RMS of states $r_i \propto -\sqrt{\sum \Delta s_i^2}$
- Actions are done in $s_{t+1} = \mathbf{R}a_t + s_t$
- Episodic training
- Initial criteria: Initial distribution ρ_0 is away from low RMS - to make problem a bit challenging
- Termination criteria:
 - Maximal number of interactions (truncation)
 - RMS below measurement uncertainty (successful termination)
 - States $s_i >$ beam pipe (termination or clipping)
- Transitions P are deterministic or stochastic, $\gamma=1$
- If we speak about different tasks i (MPDs) we mean different matrices \mathbf{R}_i