Pulsed Multipole Injection for the MAX IV Storage Rings

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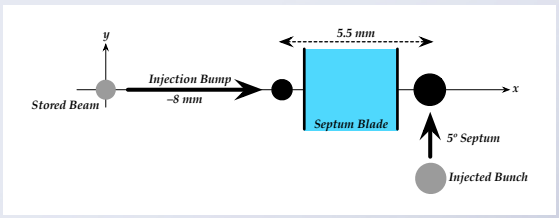
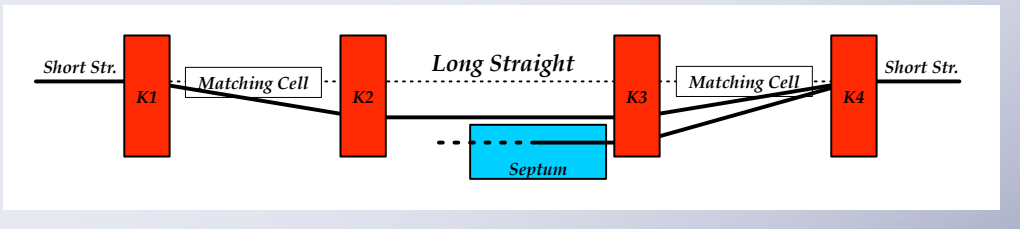
Conventional Injection with a Four-Kicker Bump

- Four dipole kickers & pulsers need to be perfectly matched, synchronized, and aligned to close local bump
- If local injection bump not fully closed
  ➜ coherent betatron oscillation of stored beam
  ➜ degrades photon beam at experiments
- Need space for four strong dipole kickers and septum
  ➜ injection may take up space otherwise reserved for IDs
- If sextupoles and/or octupoles in injection bump
  ➜ cannot perfectly close bump for all particles in stored beam

➜ ***Less favorable for new ultralow-emittance rings***





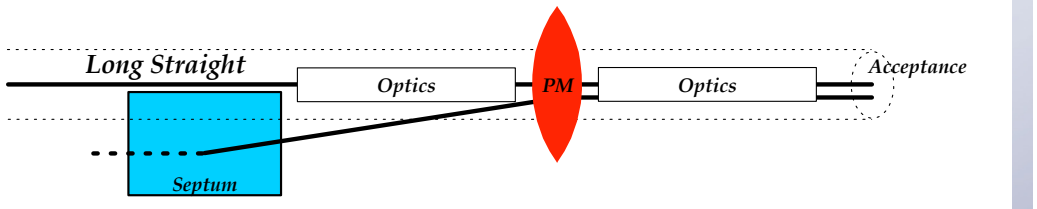
Advantages of Pulsed Multipole Injection

- Injected bunch kicked into ring acceptance by a single pulsed multipole magnet
- Stored beam passes multipole magnet center ➜ no perturbation
- Pulse shape not crucial (but keep fall time short)
- PMI demonstrated at KEK ➜ unprecedented beam stability during injection

➜ Potential to make continuous top-up operation transparent to users

➜ Synchronization and alignment of only a single magnet (complexity & space!)

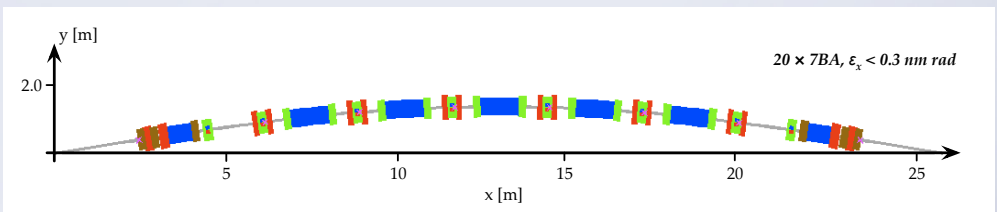
➜ ***Both MAX IV storage rings will use pulsed sextupole injection***

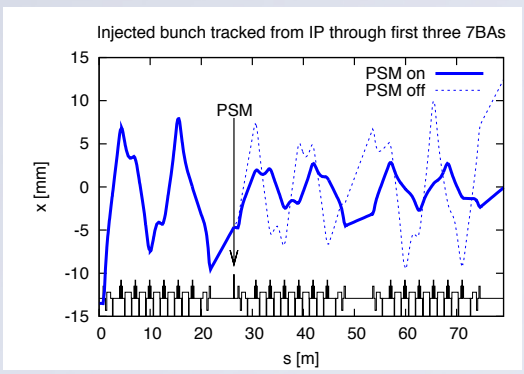


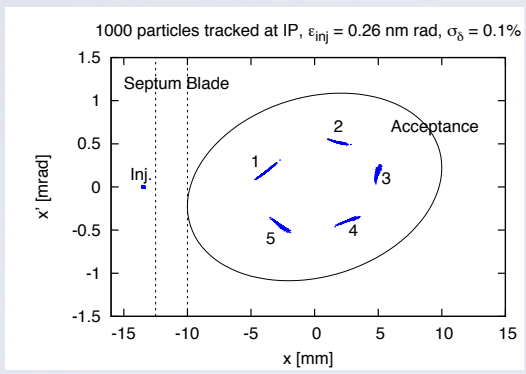
Pulsed Sextupole Injection in the MAX IV 3 GeV Storage Ring

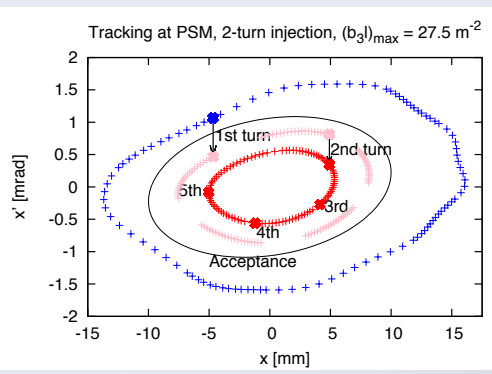
- Inject at –13.5 mm, PSM in second long straight, hor. ring acceptance 10.6 mm mrad
- Single-turn injection: $b_3 l = 54\ m^{-2}$, $\tau = 3.5\,\mu s$ ➜ injection to 2.3 mm mrad
- Two-turn injection: $b_3 l = 28\ m^{-2}$, $\tau = 7\,\mu s$ ➜ injection to 3.1 mm mrad
- PSM does not perturb stored beam (alignment!)

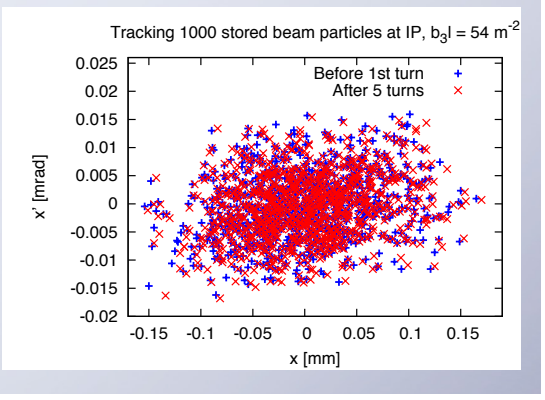
➜ Pulse length relaxed, magnet strength manageable







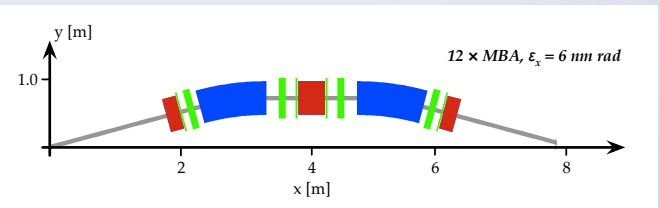


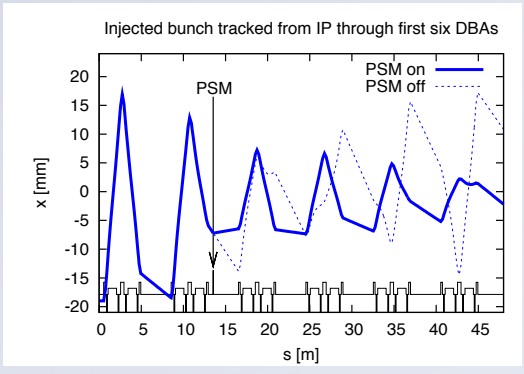


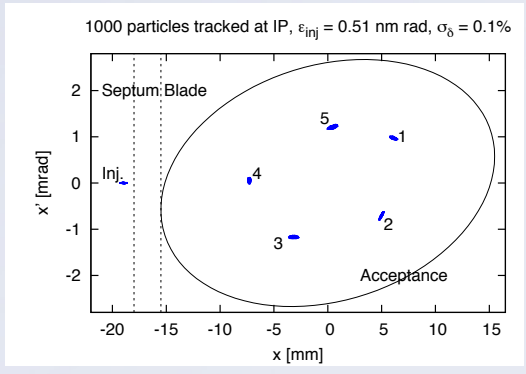
Pulsed Sextupole Injection in the MAX IV 1.5 GeV Storage Ring

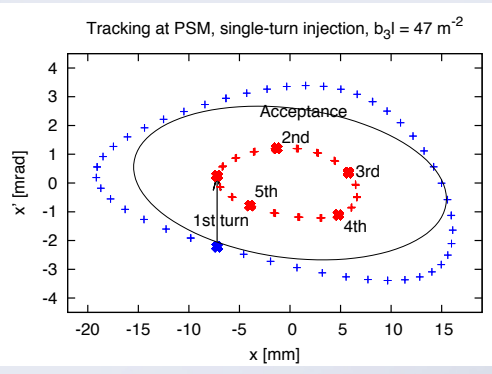
- Inject at –19 mm, PSM in third straight, hor. ring acceptance 40.5 mm mrad
- Single-turn injection: $b_3 l = 47\ m^{-2}$, $\tau = 0.6\,\mu s$ ➜ injection to 8.8 mm mrad
- Two-turn injection: $b_3 l = 47\ m^{-2}$ (or as low as $32\ m^{-2}$), $\tau = 1.3\,\mu s$ ➜ injection to 9.1 mm mrad
- PSM does not perturb stored beam (alignment!)

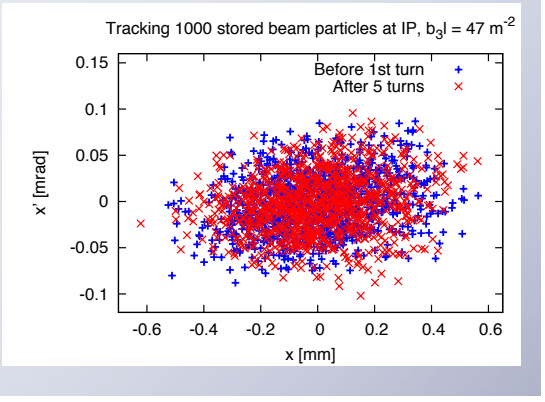
➜ Pulse length and magnet strength demanding











MAX IV Project → http://www.maxlab.lu.se/maxlab/max4

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