HL-LHC Beam Dynamics with Hollow Electron Lenses

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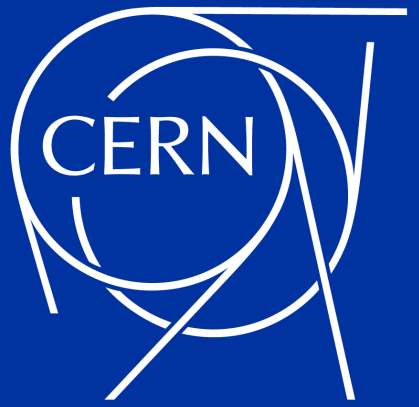


Poster Session HB 2021

Introduction

- Beam halo in LHC can contain up to 5% of the stored beam energy
- HL-LHC: failure scenarios can induce sudden orbit changes

  → Energy stored in transverse halo can damage collimation system
- Hollow Electron Lens:
  active halo removal via hollow shaped electron beam
- Creates clearance between beam and collimator

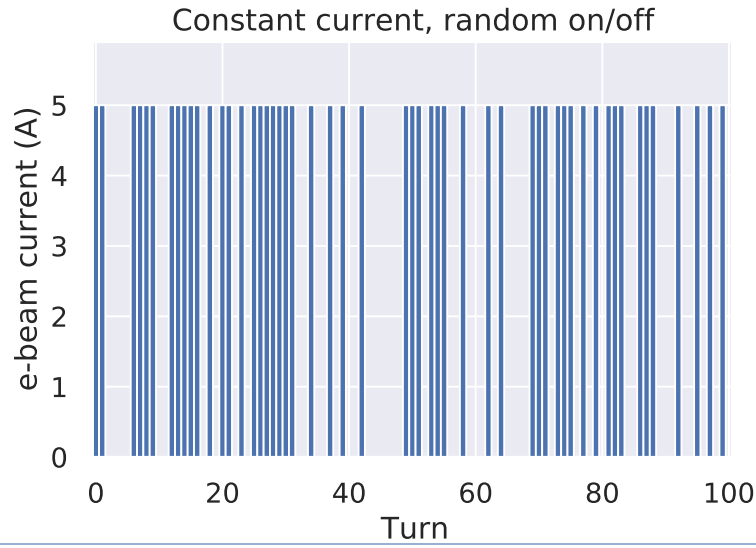
Ideal case:

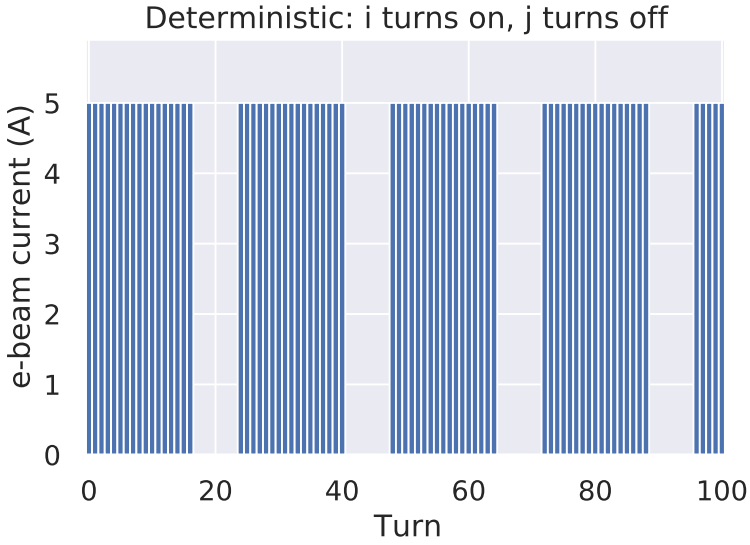
- Efficient depletion → highest possible halo depletion fraction
- Small disturbance of beam core from residual fields:
  smallest possible emittance growth

Operational Schemes (Selection)

RND mode

Randomly switch on/off HEL at constant current with probability 50% per turn





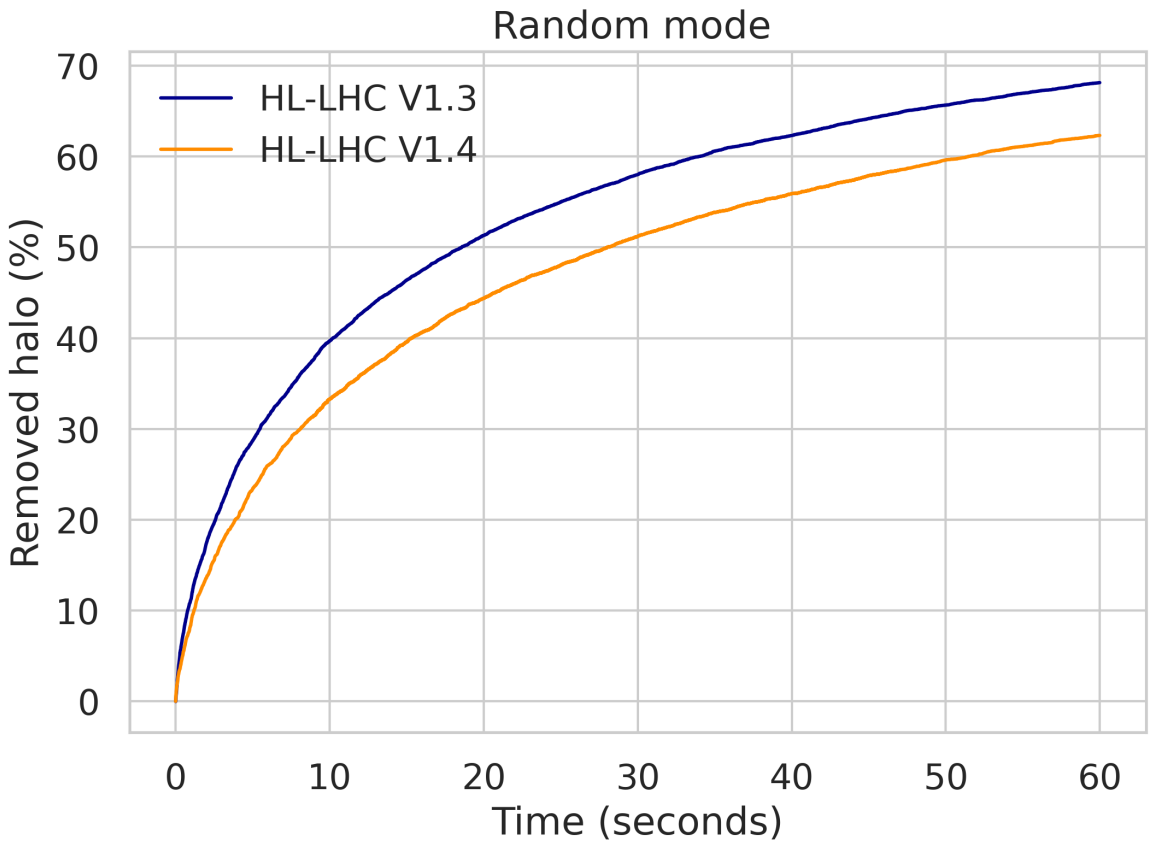
Pij mode

Periodically keep the e-beam on at constant current for *i* turns and off for *j* subsequent turns

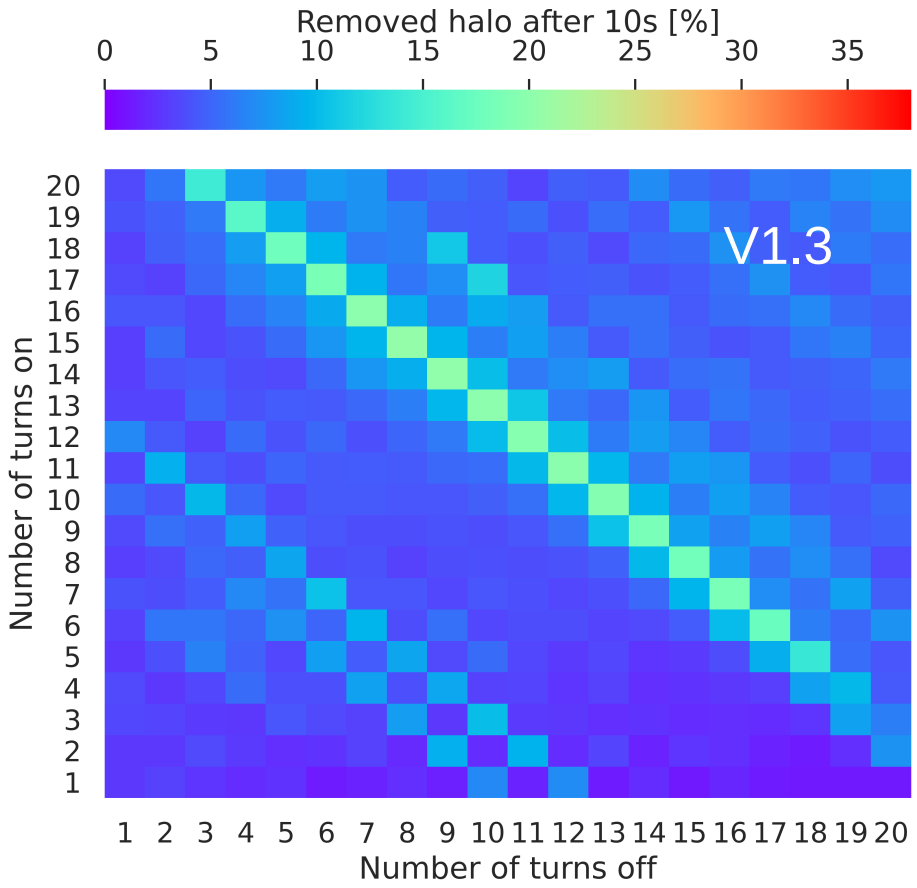
Optics update

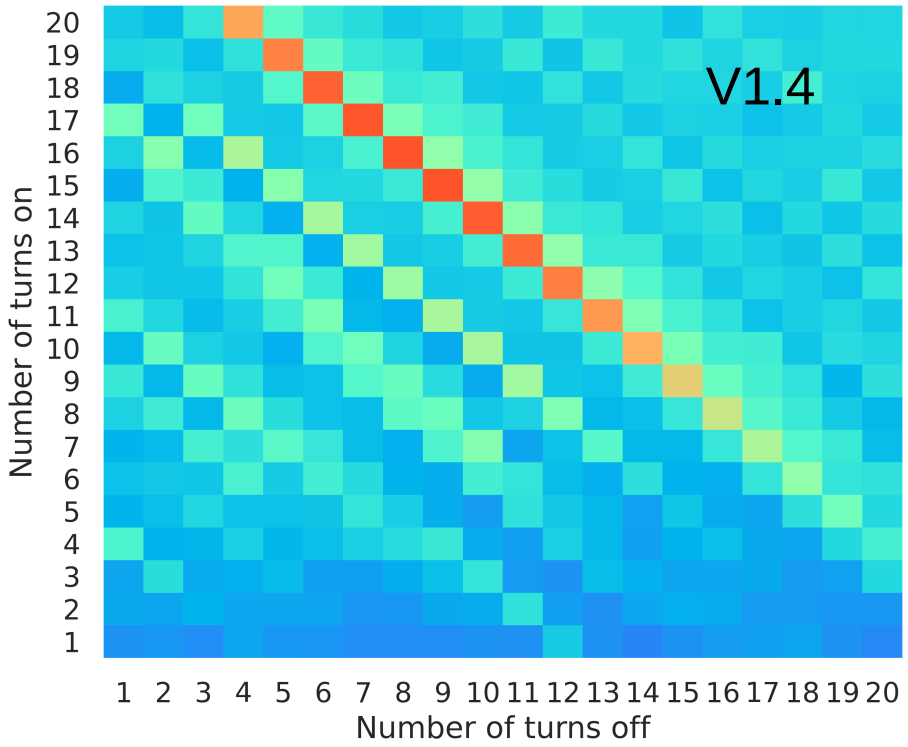
- Updated HL-LHC optics optimized with larger proton beams at HEL
  - Can use larger electron beams → improved stability
- Compare depletion fraction and emittance growth in previous (V1.3) and updated optics (V1.4)

Depletion efficiency

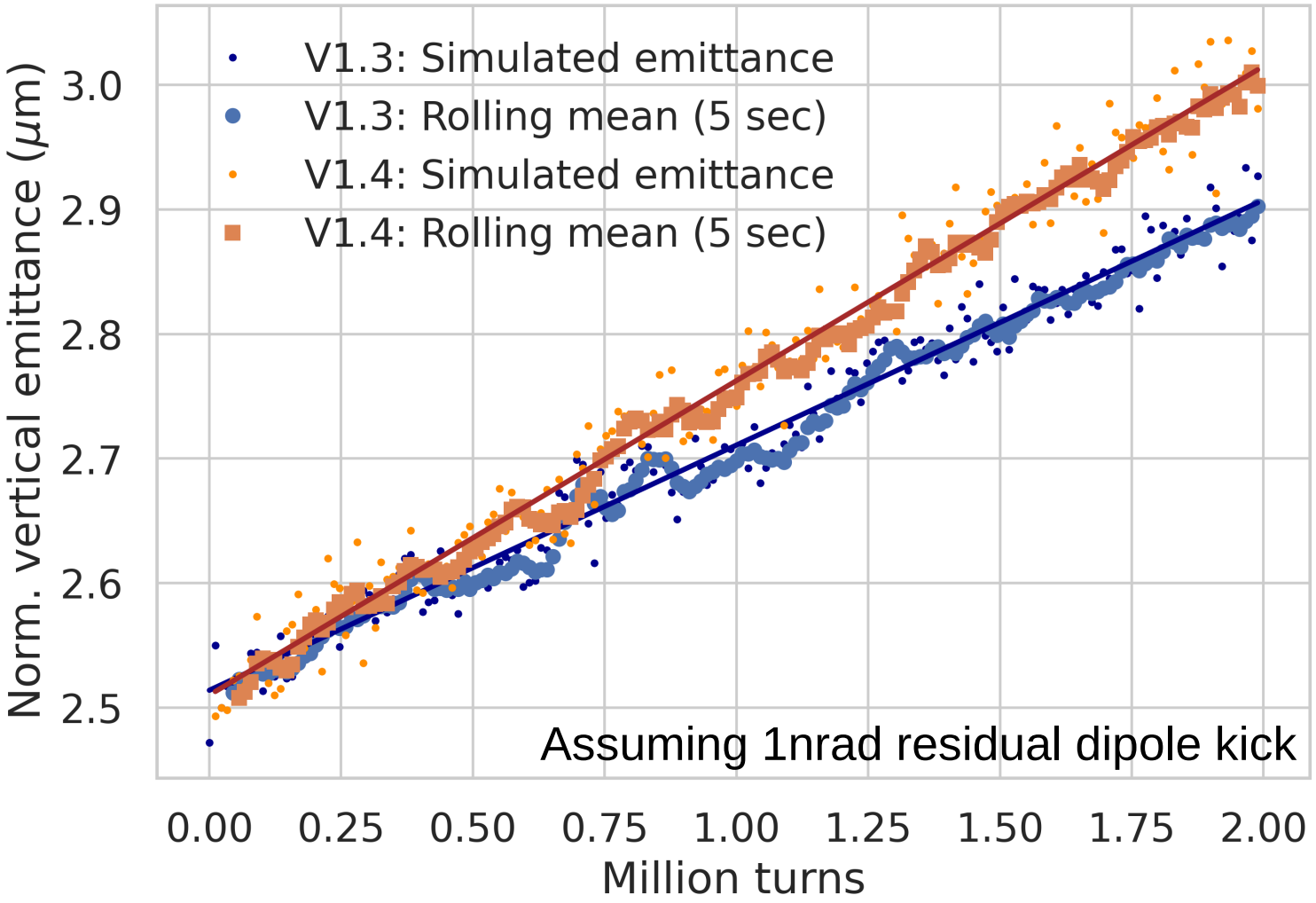


Depletion efficiency





Emittance growth in random mode



Conclusions

- New optics with better electron beam stability: depletion efficiency in same order of magnitude
- Emittance growth with larger beams at HEL slightly increased in random mode
- Outcome of previous studies → emittance growth can likely be compensated

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