CLIC Solenoid Simulations

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Thanks to: Michele Modena, Antonio Bartalesi

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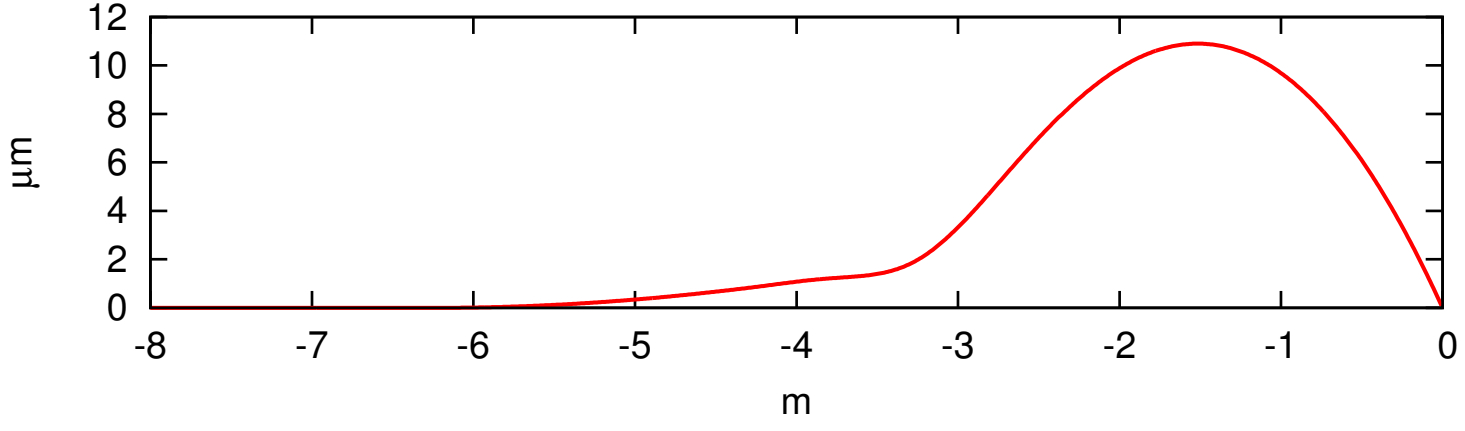
Introduction

- Motivation
- Deterministic Simulation Procedure
- Anti-Solenoid Effects
- Tuning Simulations

Detector Solenoid for lepton colliders

- Large (horizontal) crossing angle -> strong (horizontal) magnetic field on beam -> strong (vertical) orbit deflection
- Solenoid field/orbit deflection produces:
  - Dispersion at IP.
  - Coupling at IP (mainly y-x').
  - Incoherent synchrotron radiation -> emittance increase (not recoverable).



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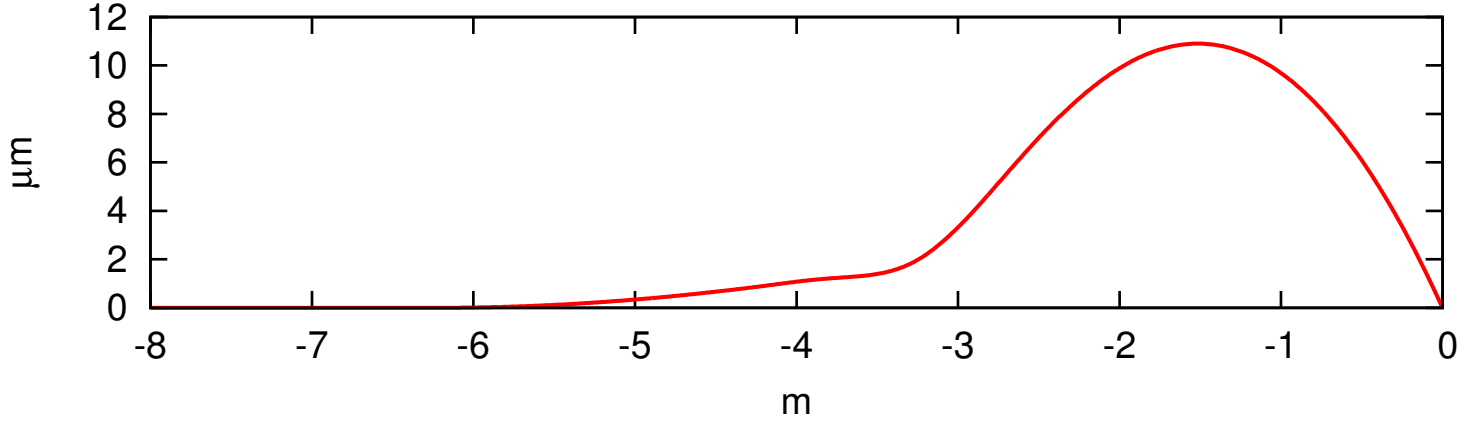

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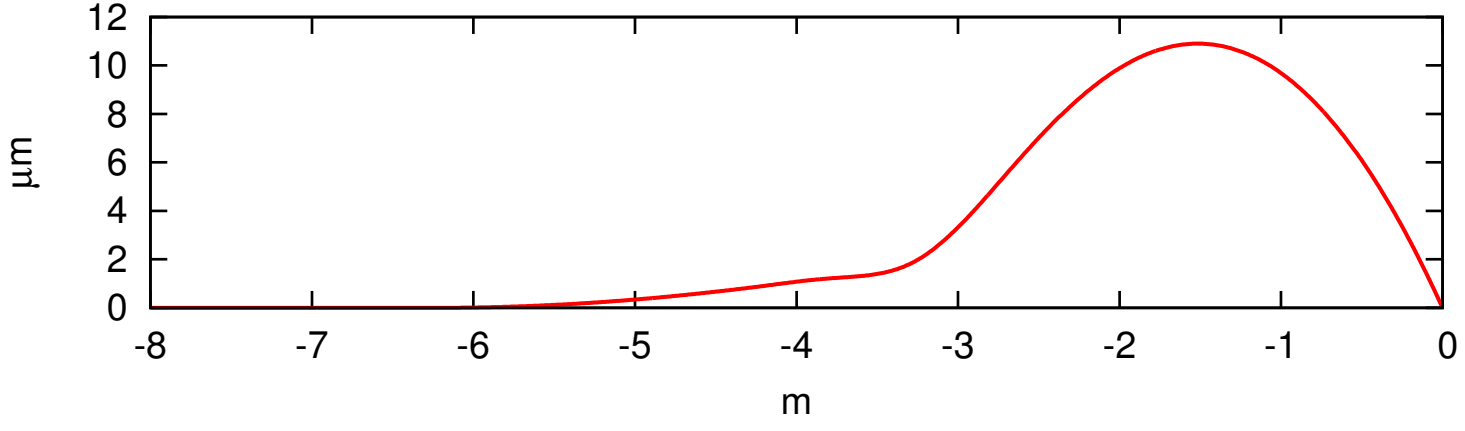

"Deterministic" Simulation Procedure

- Basic idea: Start with an ideal distribution at IP, track backwards through beamline without synchrotron radiation, finally track forward with synchrotron radiation.
- Obtains: The luminosity loss due to ISR from the solenoid field alone, excluded of losses due to optics distortions (since beam is already corrected).

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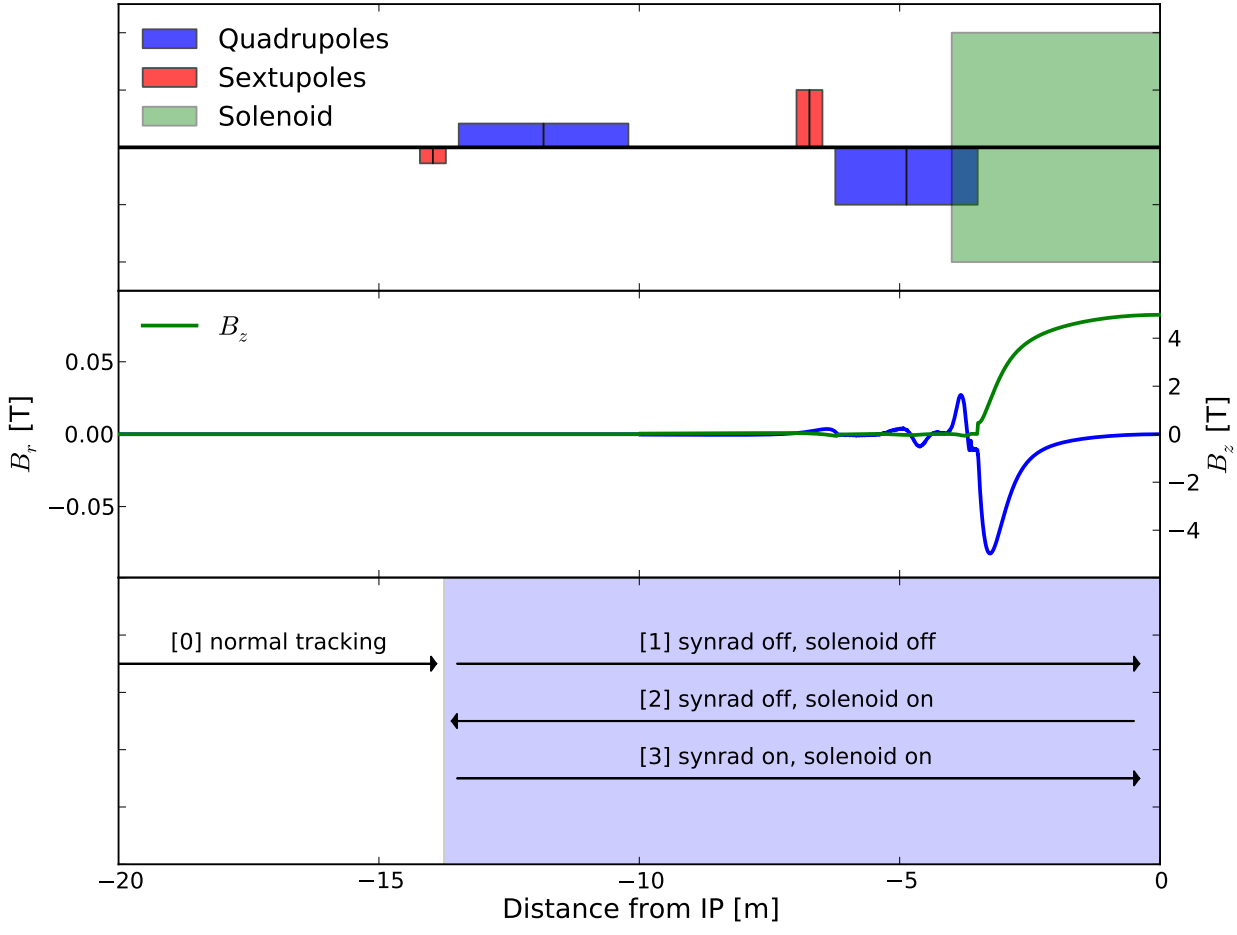

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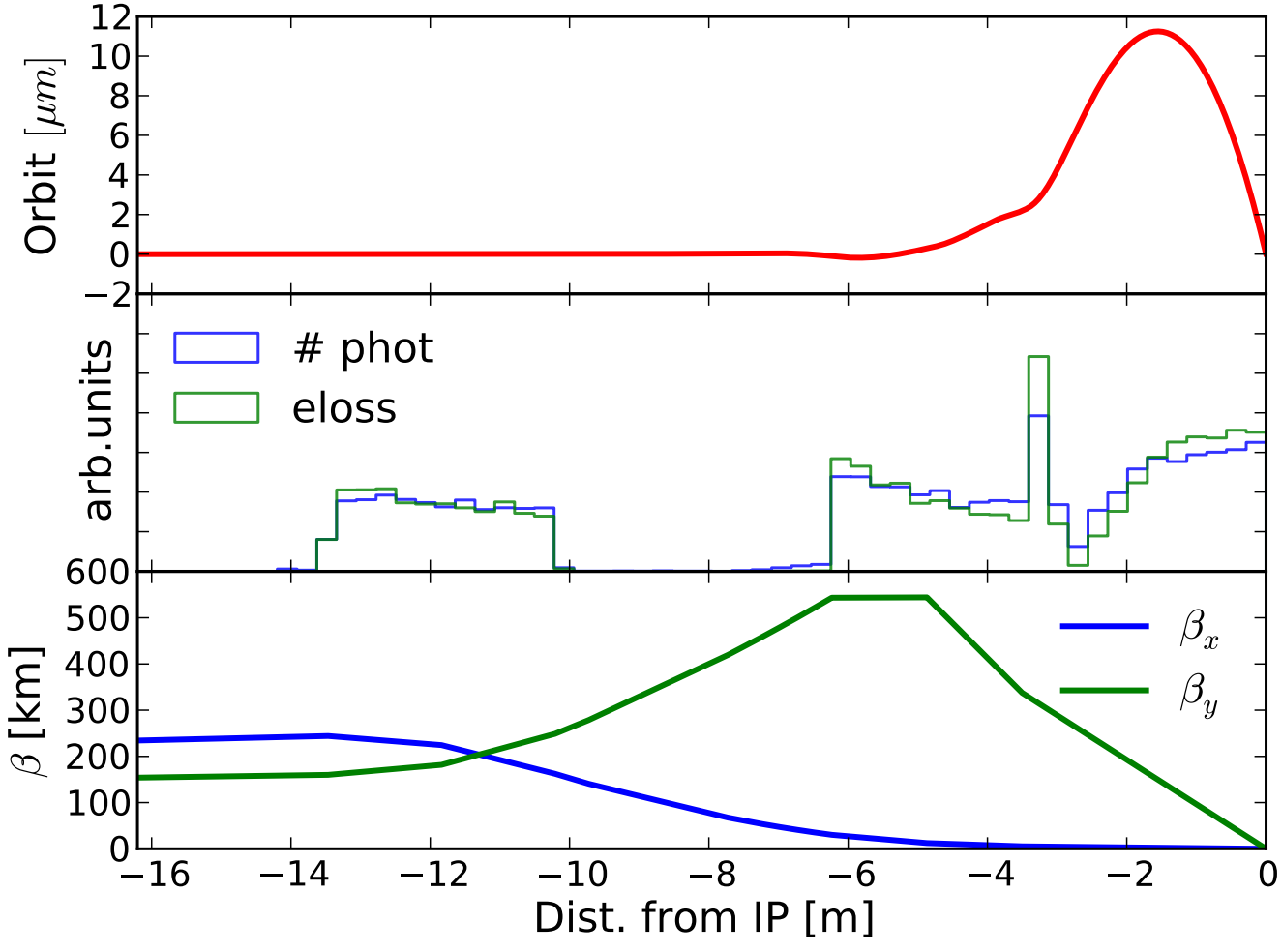
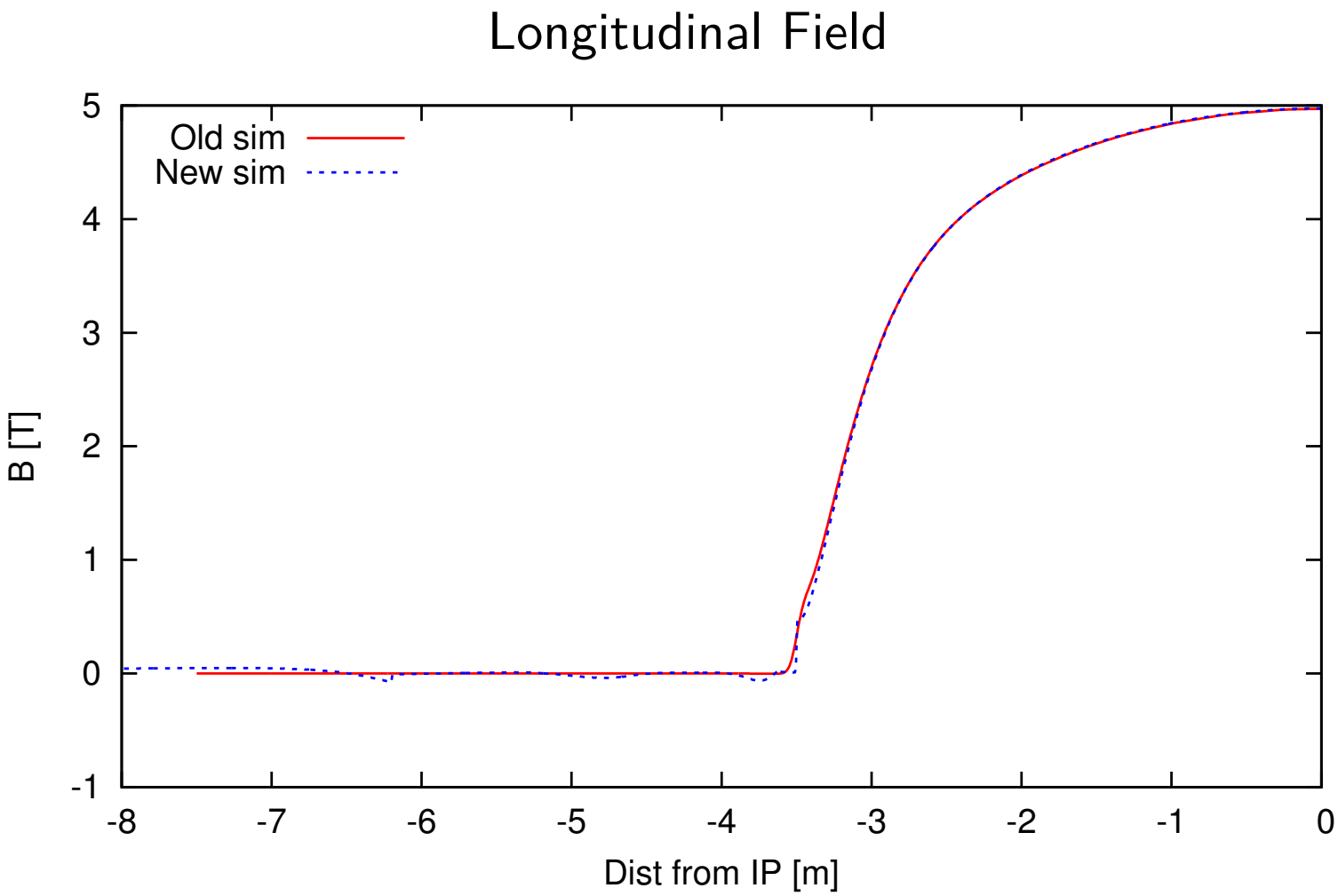


New Solenoid+Anti-Solenoid Field Simulation



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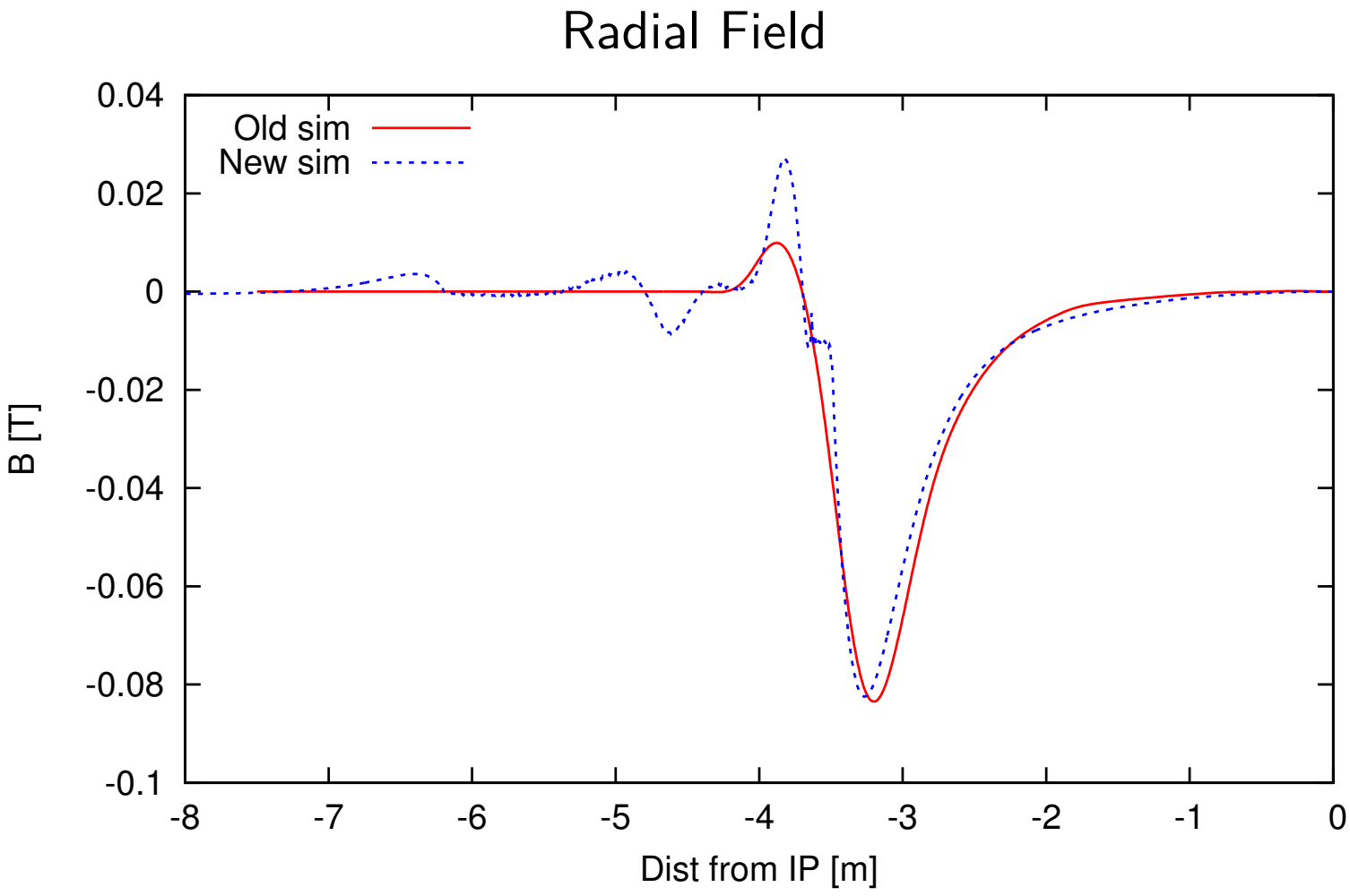

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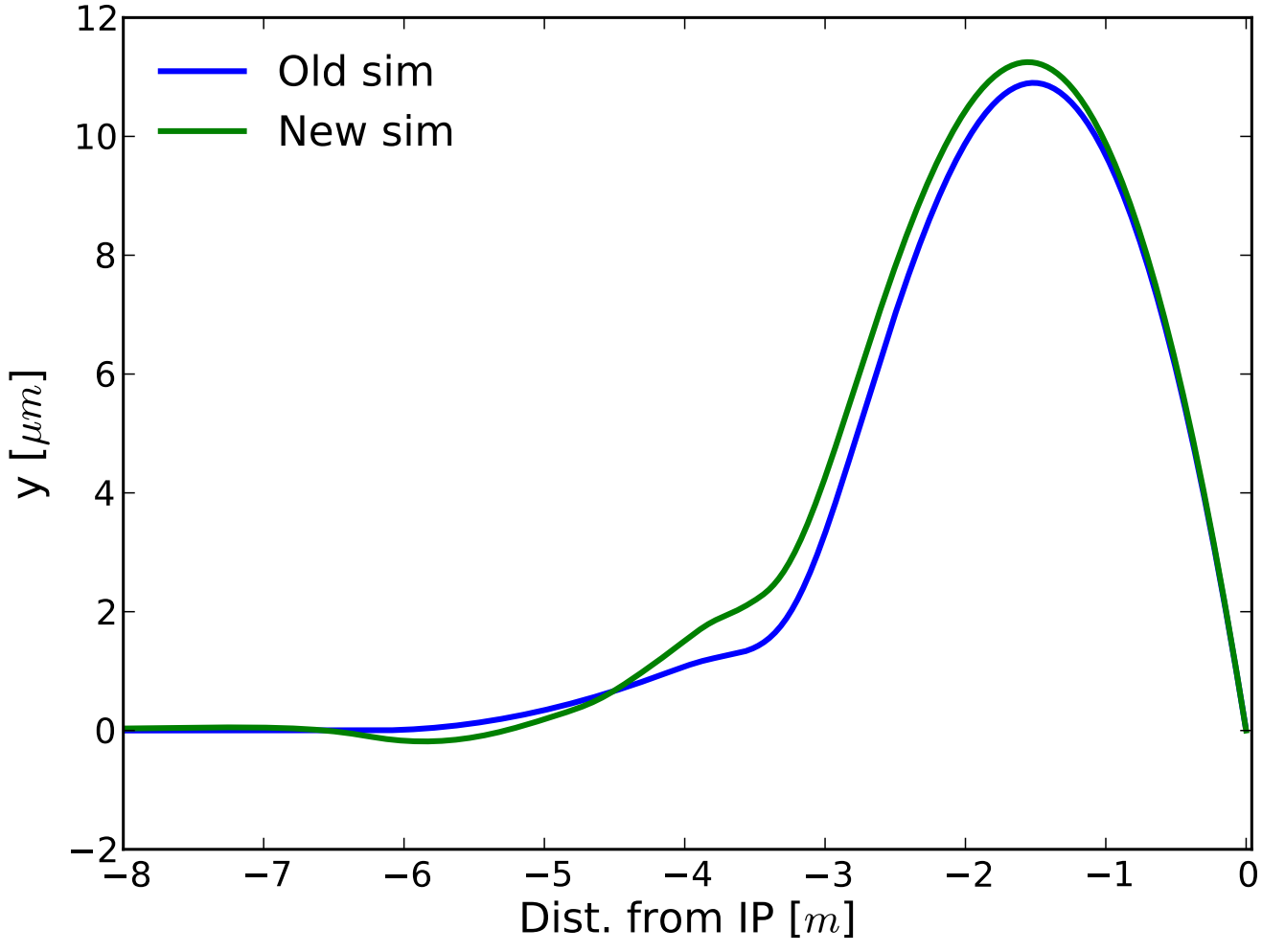
Deterministic Simulation: Orbit Deflection

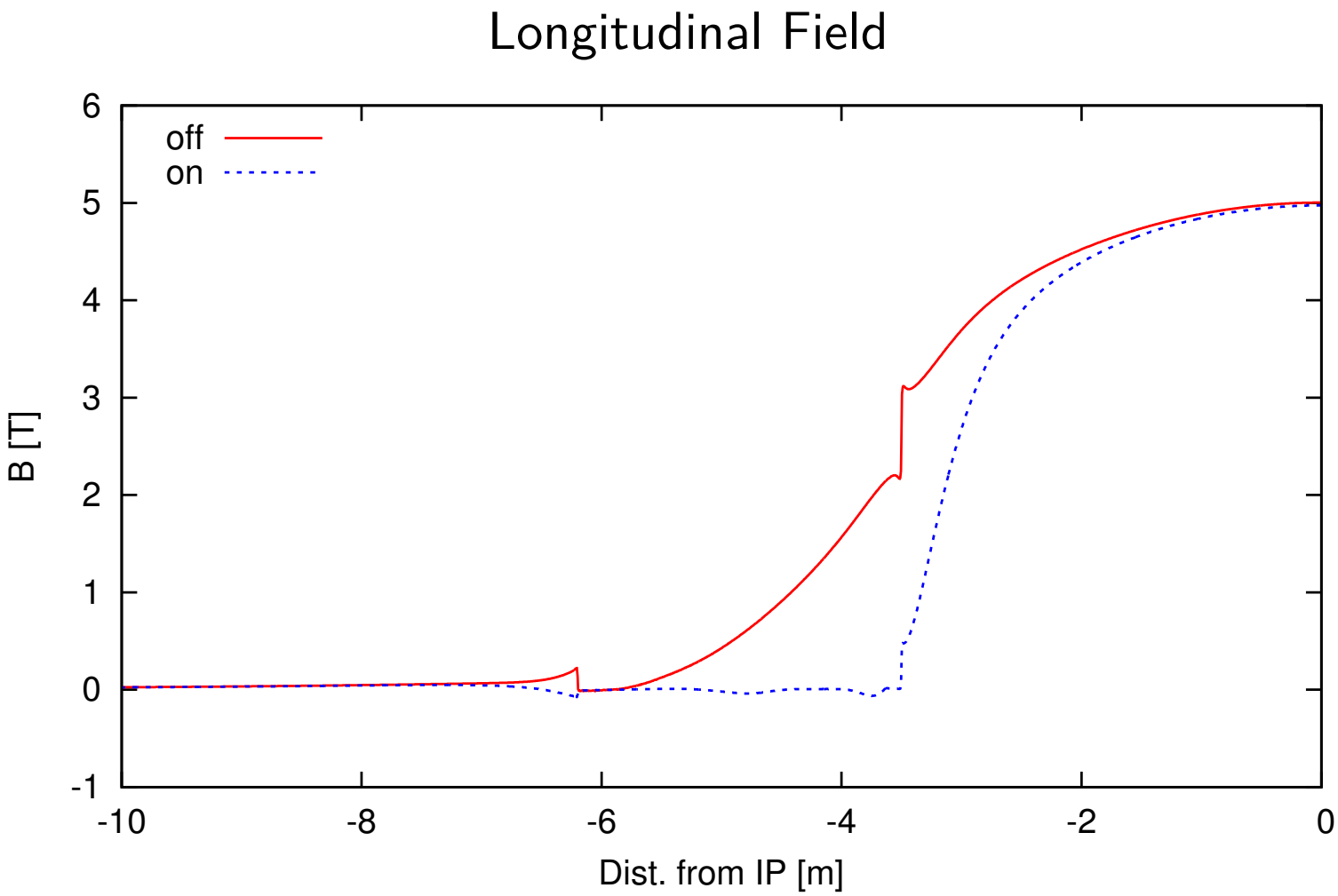


Deterministic Simulation: Luminosity Loss

	Old Simulation [%]	New Simulation [%]
Relative loss	3.5	4.1 ± 0.2

(statistical error from multiple simulations)

Effect of the Anti-Solenoid



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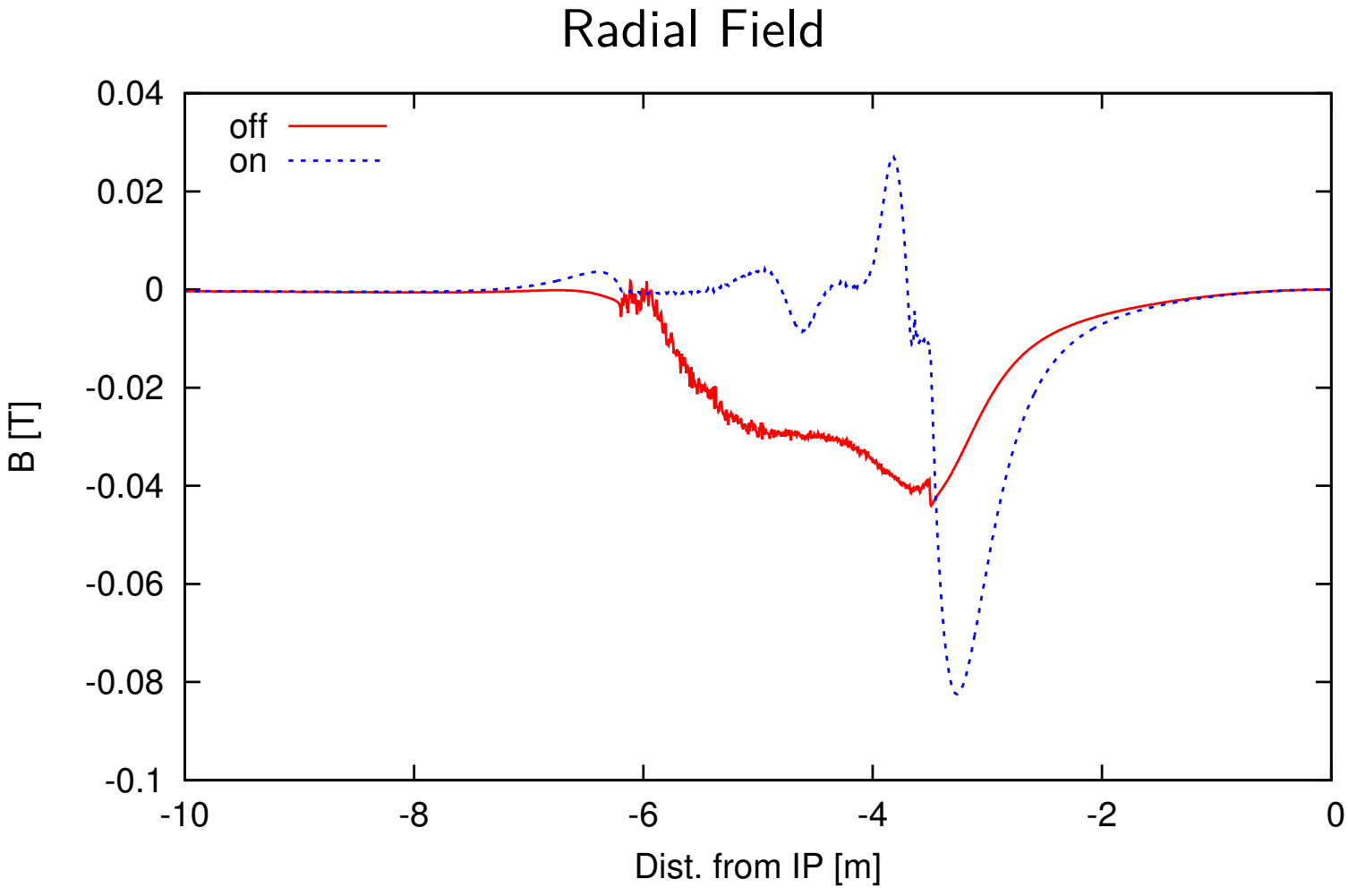

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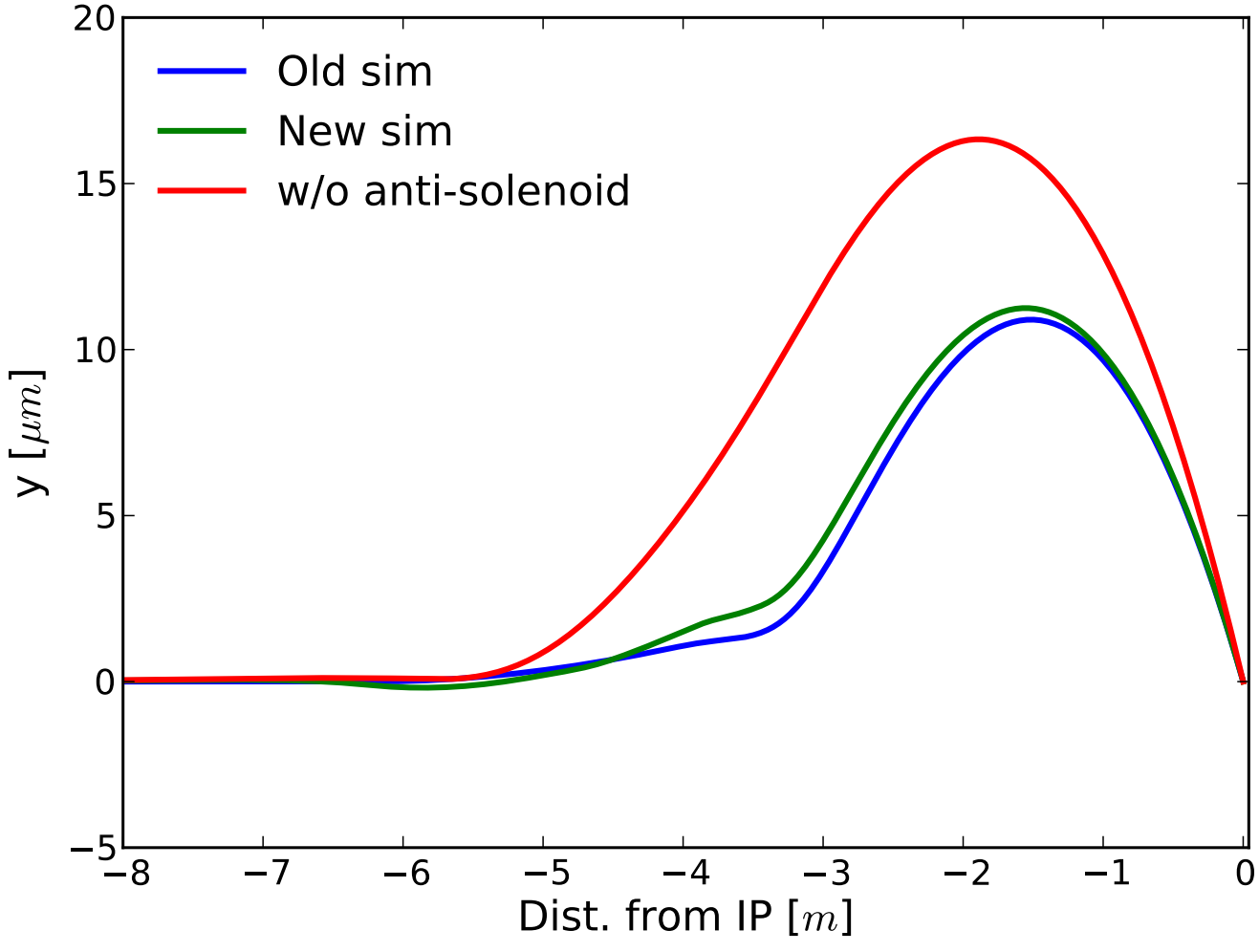

Deterministic Simulation: Luminosity Loss

	w/o anti-solenoid [%]	w anti-solenoid [%]
Relative loss	5.0	4.1

The main purpose of the anti-solenoid is to protect the permanent magnet.

Tuning Simulations

Should be able to end up with **same luminosity loss** as "forward-backward-forward" simulations if we find the ideal correction?

- 5 sextupoles in BDS -> 5 horizontal and 5 vertical knobs.
- QD0 vertical displacement provide one additional knob.
- See e.g. PRSTAB 15, 051006 for details about these knobs.
- Algorithm: Iterate over knobs and do a parabola fit for each.

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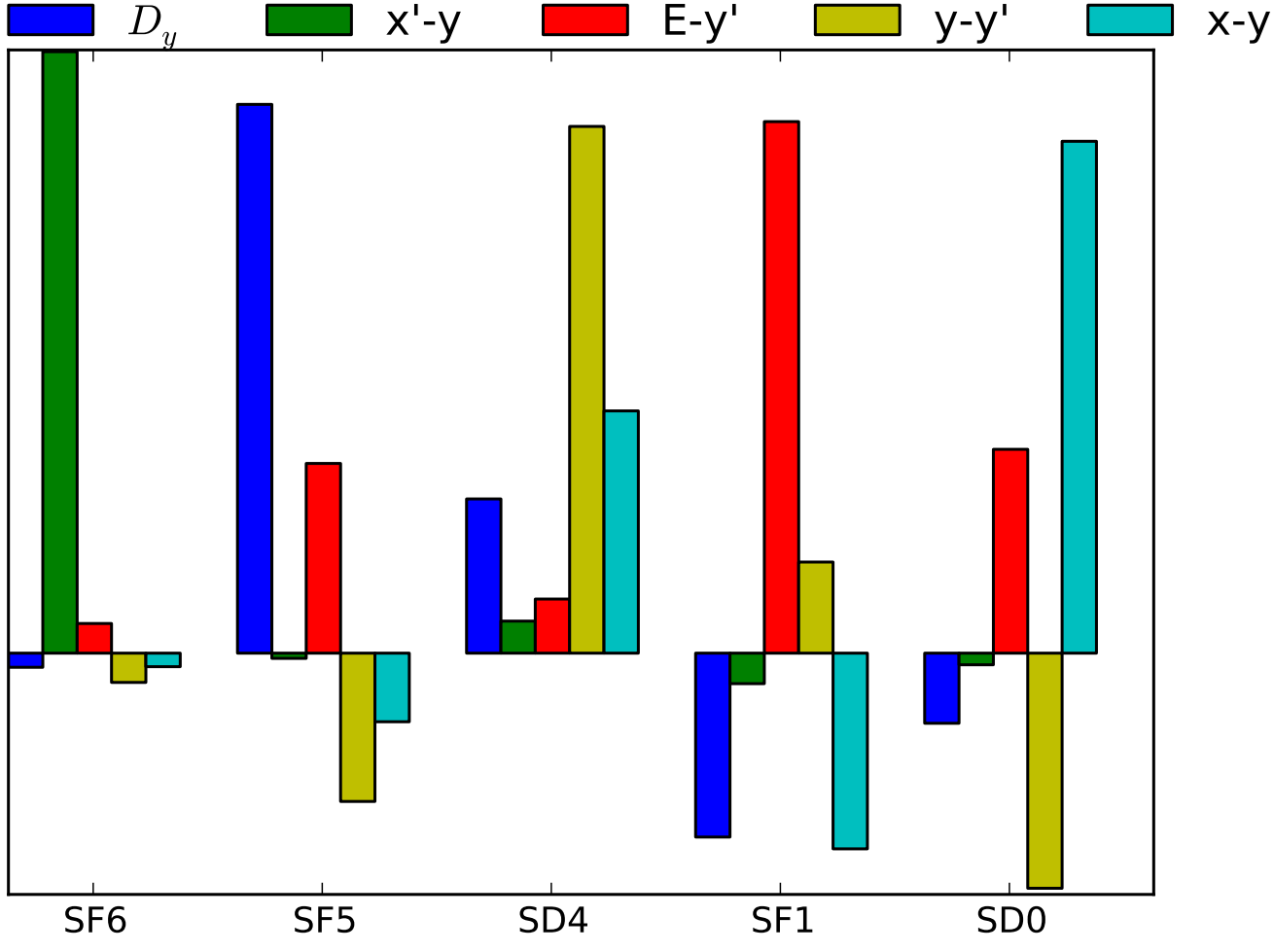
Vertical sextupole knobs in the FFS



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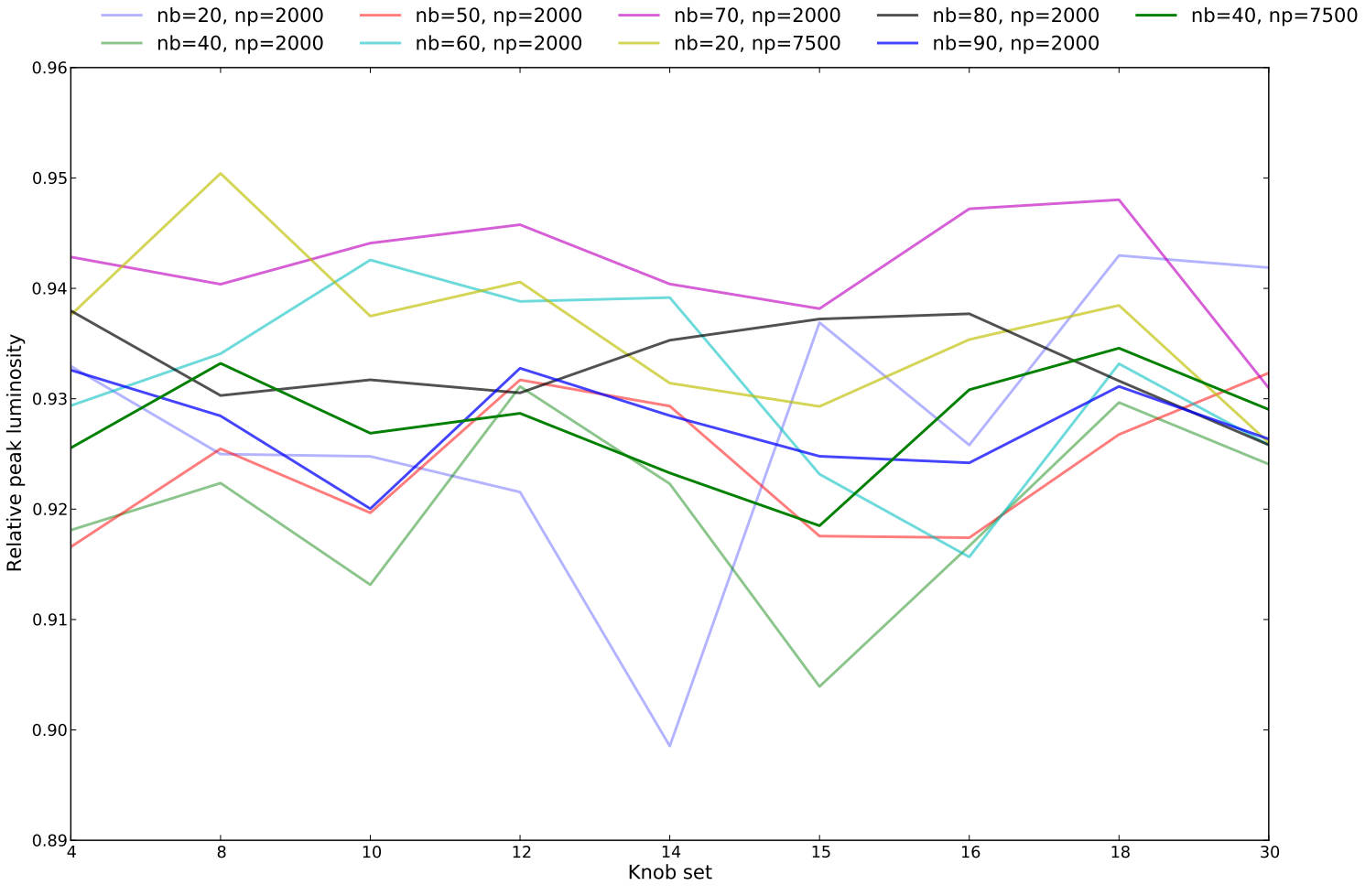

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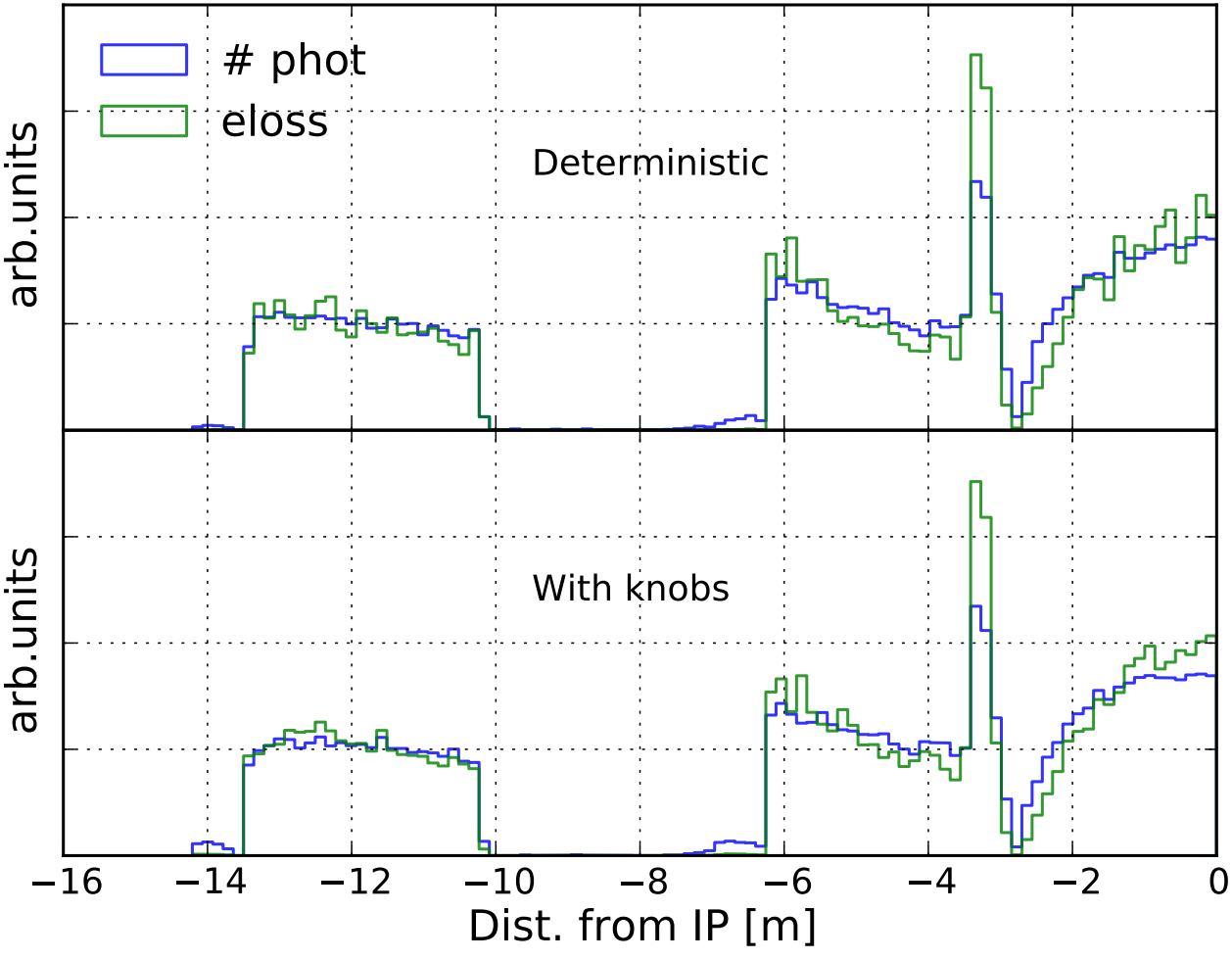

Summary

- We get about 4% luminosity loss with the latest SiD field map.
  - And about 5% luminosity loss with the anti-solenoid off.
- Tuning studies so far show $\sim 7\%$ luminosity loss or less.
  - Using SiD + anti-solenoid.
  - Studies are ongoing.
  - Fluctuating results makes these studies time-consuming and difficult to analyze.
- Improved solenoid field map give similar results as before.

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