



\vec{e}^- in SuperB: Update

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Recap on Spin Motion in Rings

- Central to spin dynamics in rings is the “stable spin direction” n_0 .
 - Equivalent to closed orbit for transverse motion.
 - P vector \parallel to n_0 will remain stationary turn after turn.
 - Components \perp to n_0 precess about n_0 with tune γG
 - $n_0 \approx \parallel$ guide field unless $gG \approx$ integer or spin rotators present
- In the presence of synchrotron radiation:
 - Diffusion of P vectors away from n_0 when n_0 changes with energy (equivalent to emittance growth from s.r.)
 - the magnitude of $dn_0/d\delta$ in the dipole magnets quantifies this.
 - Sokolov-Ternov polarization



Spin Motion in SuperB

- In SuperB, Sokolov-Ternov polarization build-up \approx hours
 - outflanked by diffusion by $O(10)$
 - $>$ inject fully polarized e^- with $P \parallel n_0$
- To get longitudinal polarization, use spin rotators on either side of the IP
 - $> 90^\circ$ in spin about radial axis using combination solenoid (90° about s) & dipoles
 - $>$ for technical reasons, the dipoles rotate spin by 270° about y .
- For layout reasons, the rotator dipoles have to be symmetric about the IP
 - $>$ match only on energy, $dn_0/d\delta$ is large \Rightarrow strong diffusion

$$\bar{P} = P_{inj} \frac{\tau_{pol}}{\tau_{pol} + \tau_{beam}} + P_{eq} \frac{\tau_{beam}}{\tau_{pol} + \tau_{beam}}$$

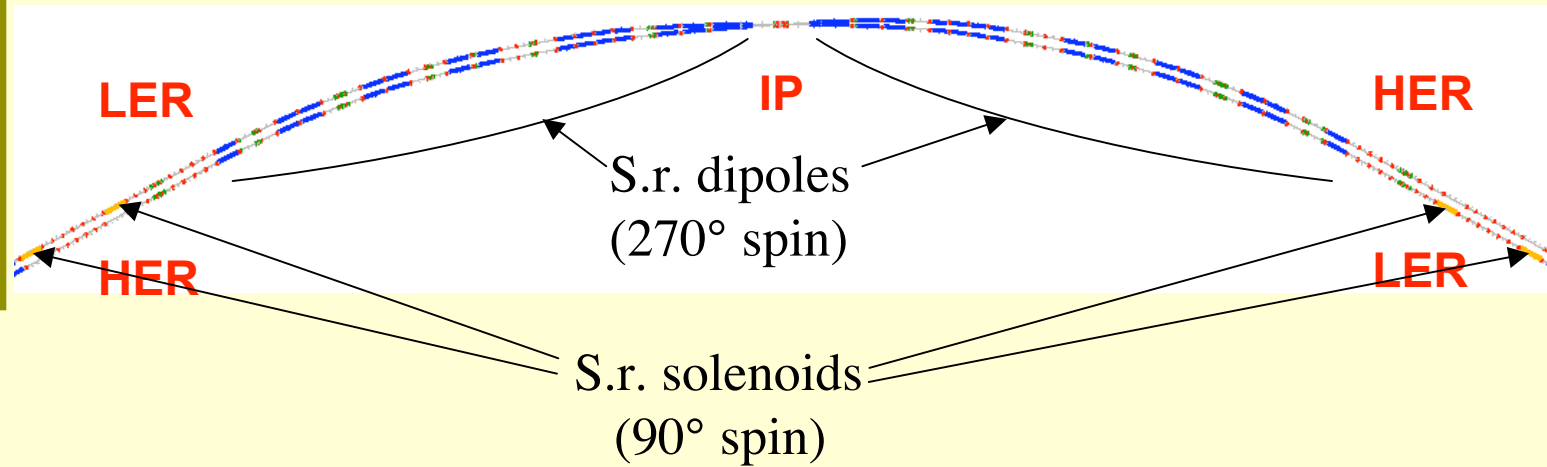


Since SLAC WS in October

- UW made 2nd visit to DESY
 - Mostly worked on spin tracking
- New lattices
- A lot more work on polarimetry
 - > Ken Moffett talk
- In the following, SLICKTRACK results are for the LER SB418 lattice of late July 09
 - “technical difficulties” in converting newer lattice
- My own code results are for new “V9 mod” lattice
 - in essence Sinyatkin’s with some mods by Y.N.



Latest IR Lattices (Yuri et al.)



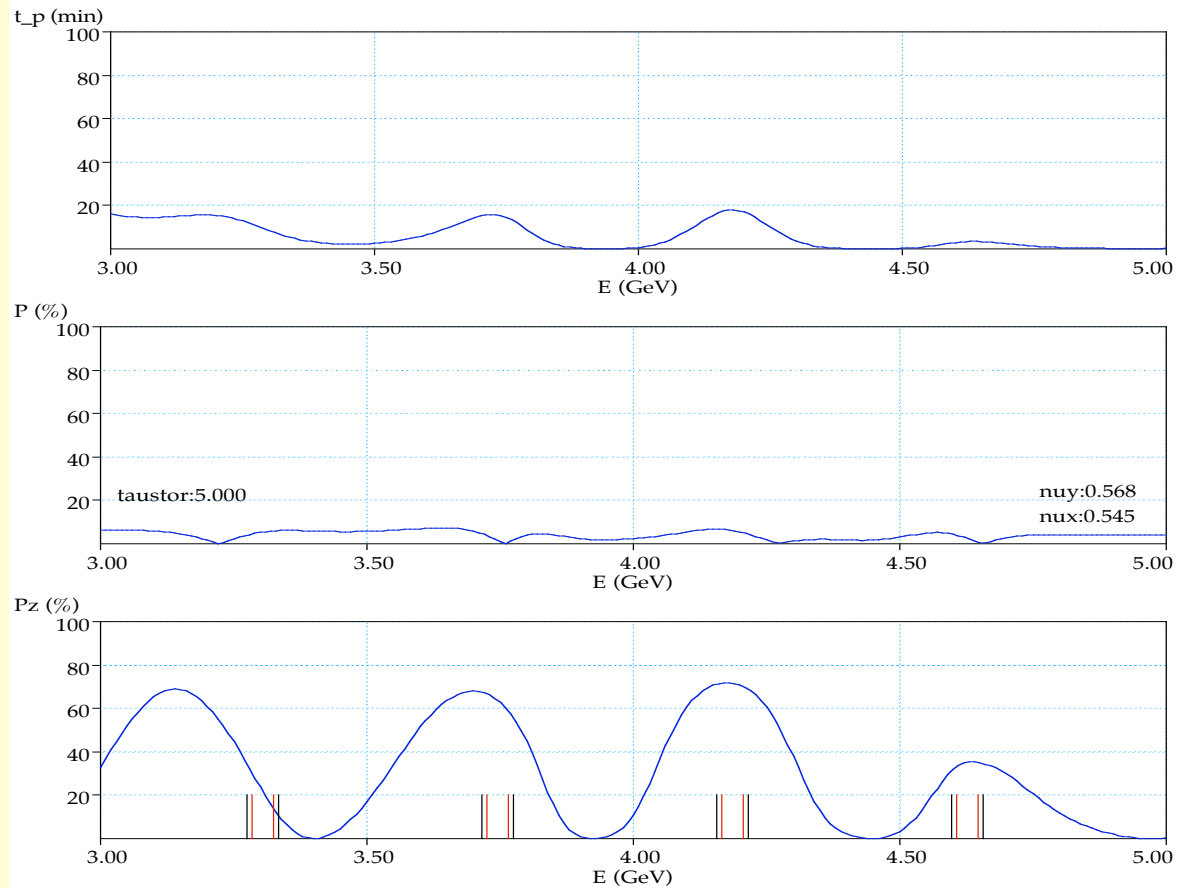


LER (V9 mod) lattice

Polarization, LER, symmetric 3*90° rotator

30-Nov-09

Analytic est.
of $d\gamma/d\delta$



Lattice close to Yuri's latest



SLICKTRACK MC

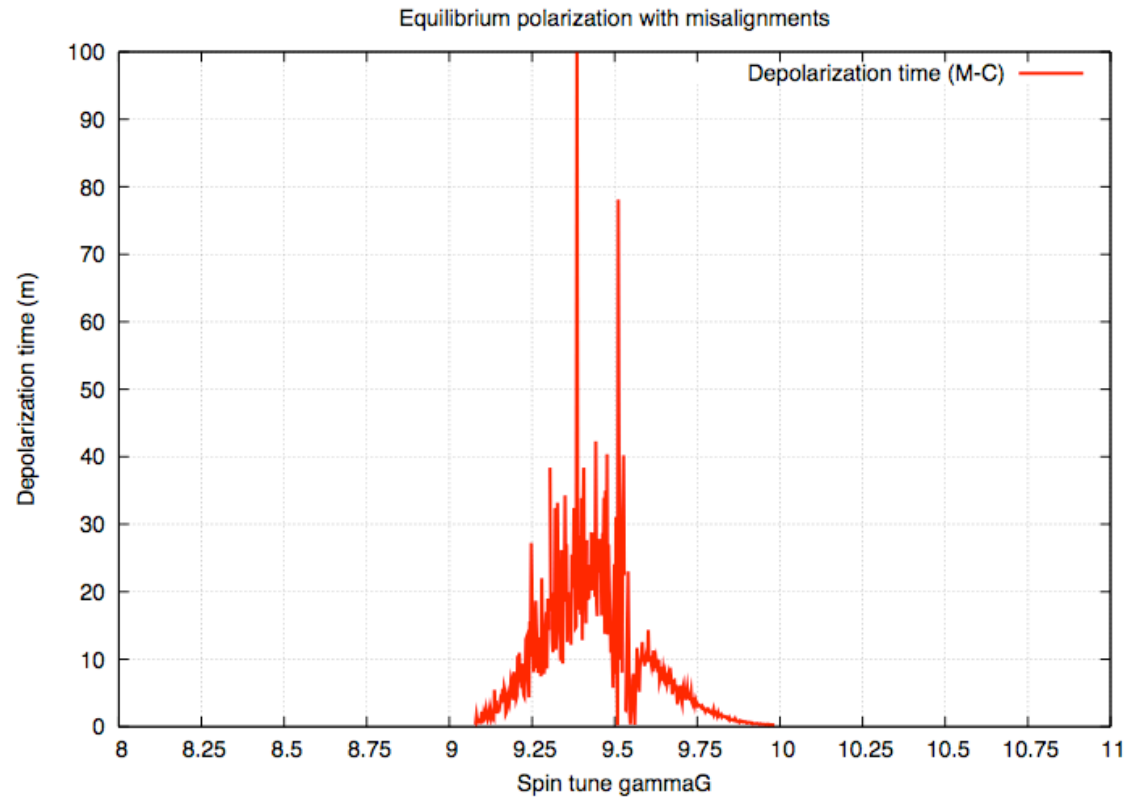
10 particles

120 damping times

1 MeV resolution

misalignment & orbit corr. (partial)

nonlinear spin



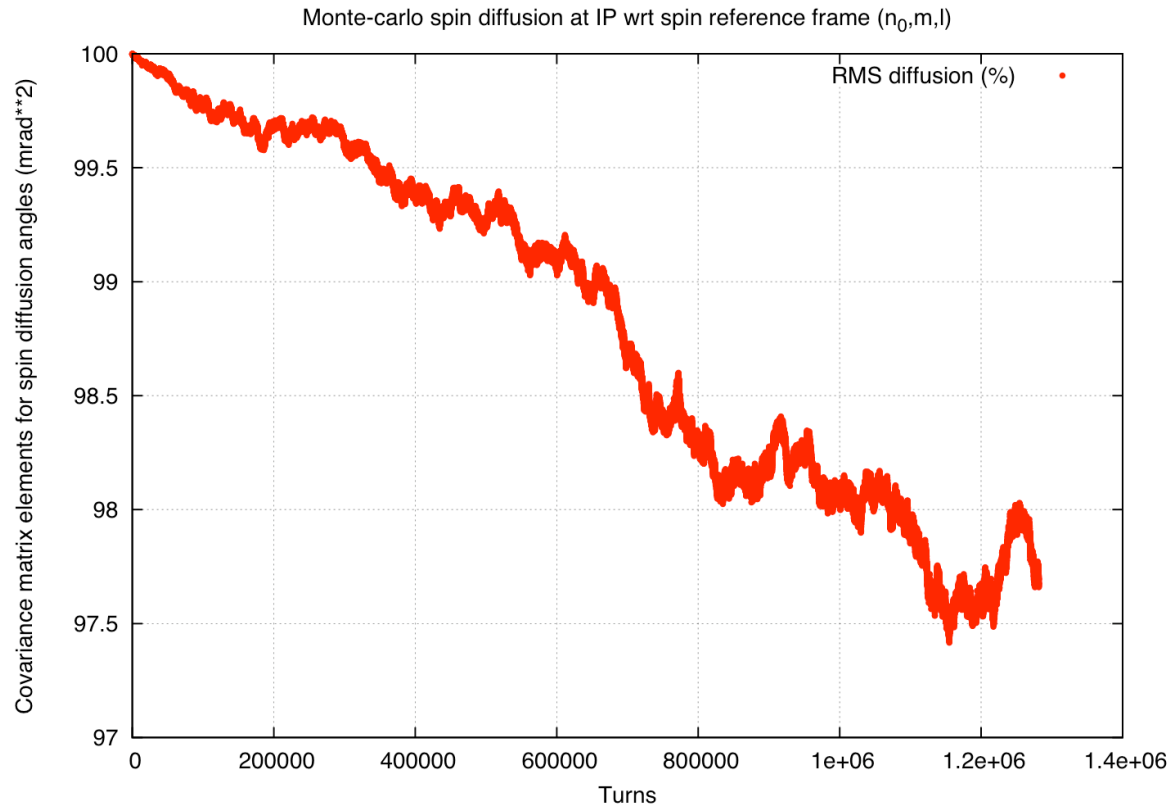
The apparent shift of the maximum in spin tune away from 9.5 is not fully understood (it is already present to a lesser degree in the undistorted lattice)

The dips are betatron resonances. The sharp spikes are single channels => likely statistics



Spin Diffusion

10 particles
4.18 GeV
1.2 mio turns
(≥ 5 seconds)
misalignment
& orbit corr.
(partial)
nonlinear
spin



The low-frequency wiggles are possibly an artefact of the random-number generator
Long-term tracking results not always consistent with (naive) expectation



More long-term tracking...

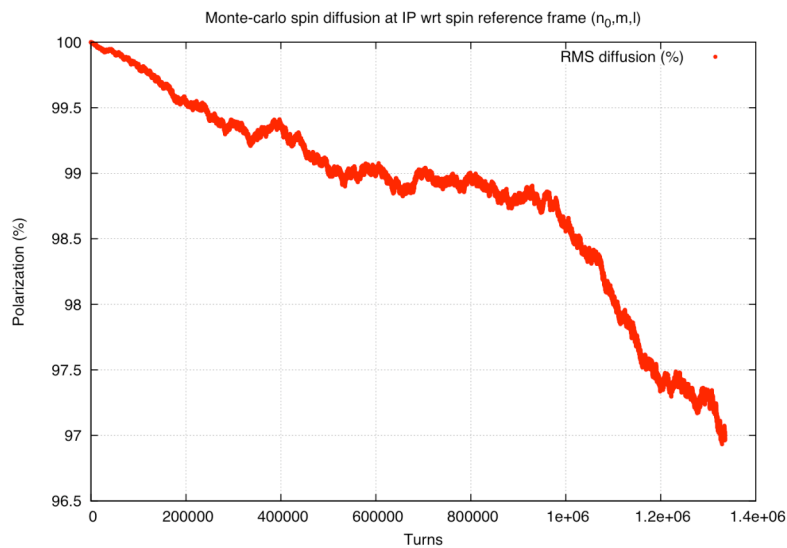
4.123 GeV

1.2 mio turns
(≥5 seconds)

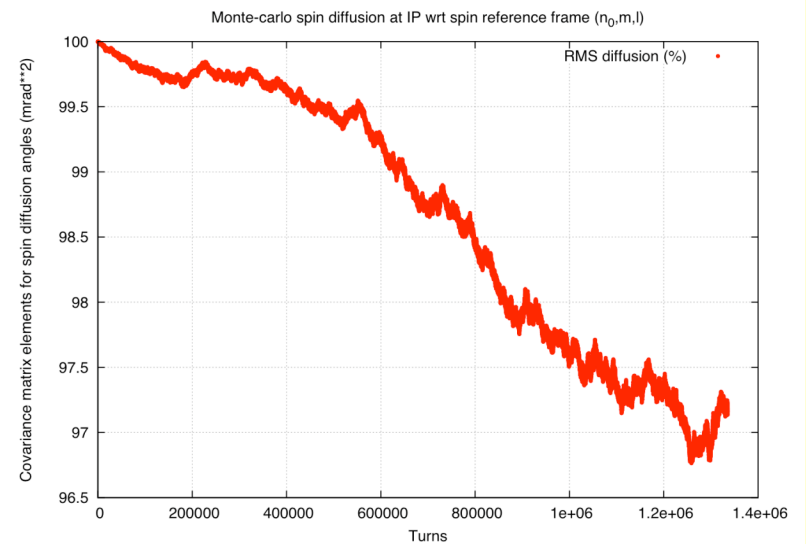
misalignment
& orbit corr.
(partial)

nonlinear
spin

20 particles



10 particles



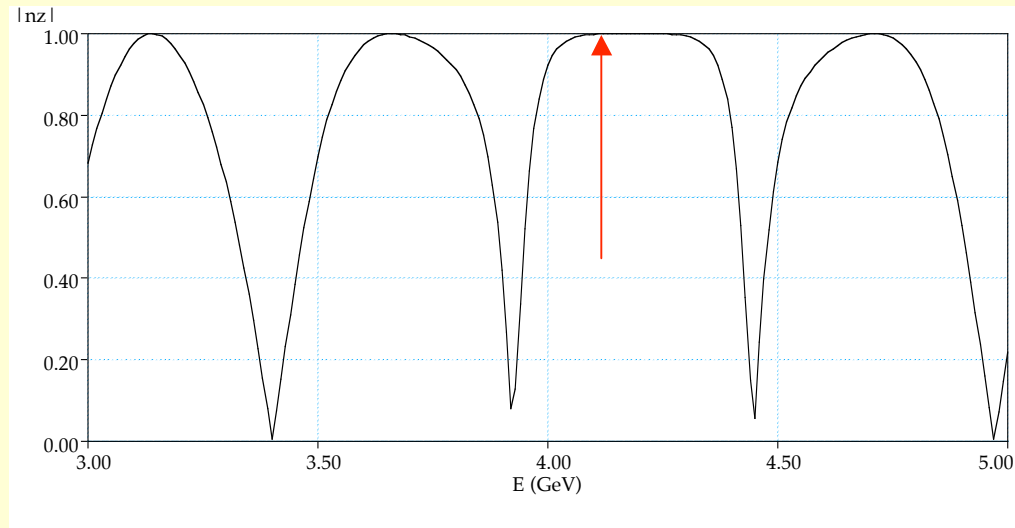


Some Questions

- Accuracy of spin-precession angles in rotators?
 - > need to evaluate effect on n_0
- Variation of n_0 with particle (not ring-) energy?
 - > $\sigma E/E \approx 5E-4$; variation of n_0 across a few $\sigma E/E$ is very small (negligible).
- Variation of n_0 with ring energy?
 - > next slide



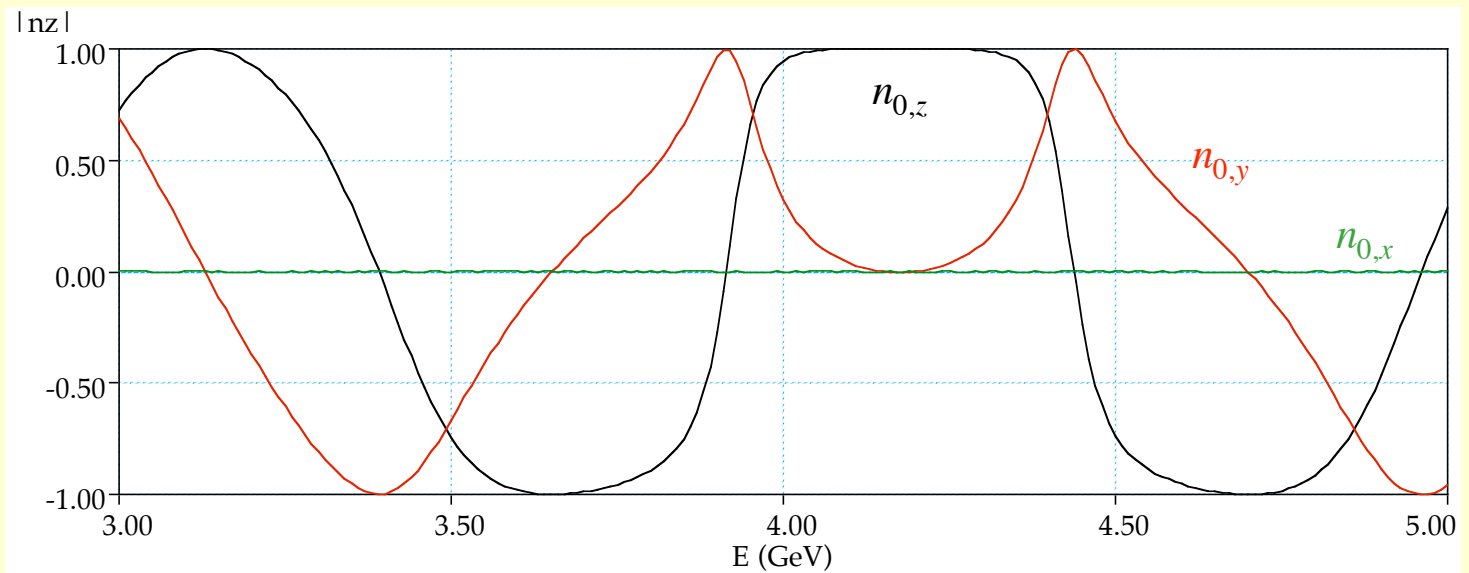
Variation of Polarization Axis



- $n_{0,z}$ vs energy, solenoid = 90° fixed
 - wide operating band in energy, not a limit



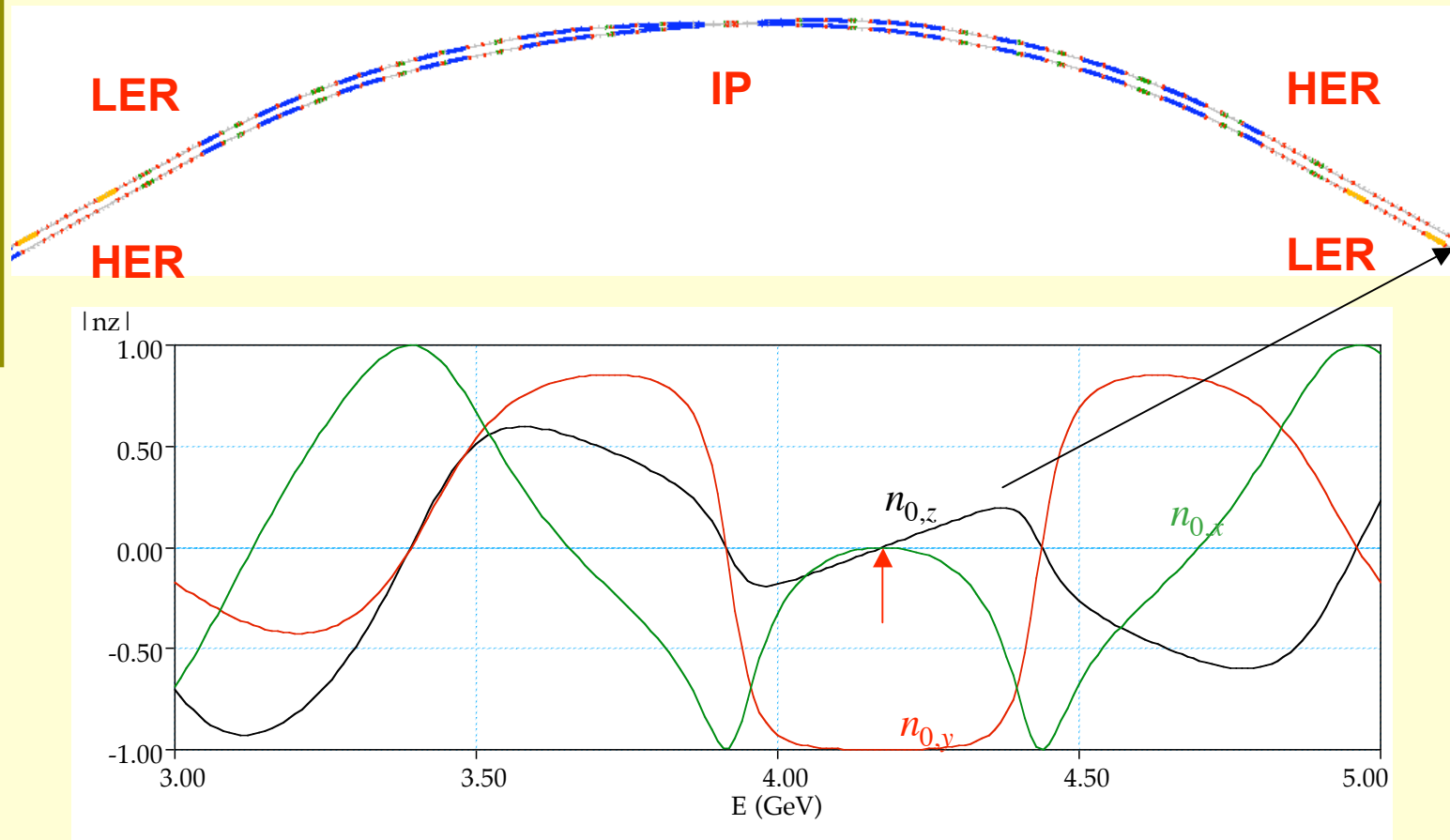
A Little more Detailed...



- At energies off the “golden” energy, a *vertical* component develops
 - at first sight unexpected (solenoids always at 90° !)
 - ???

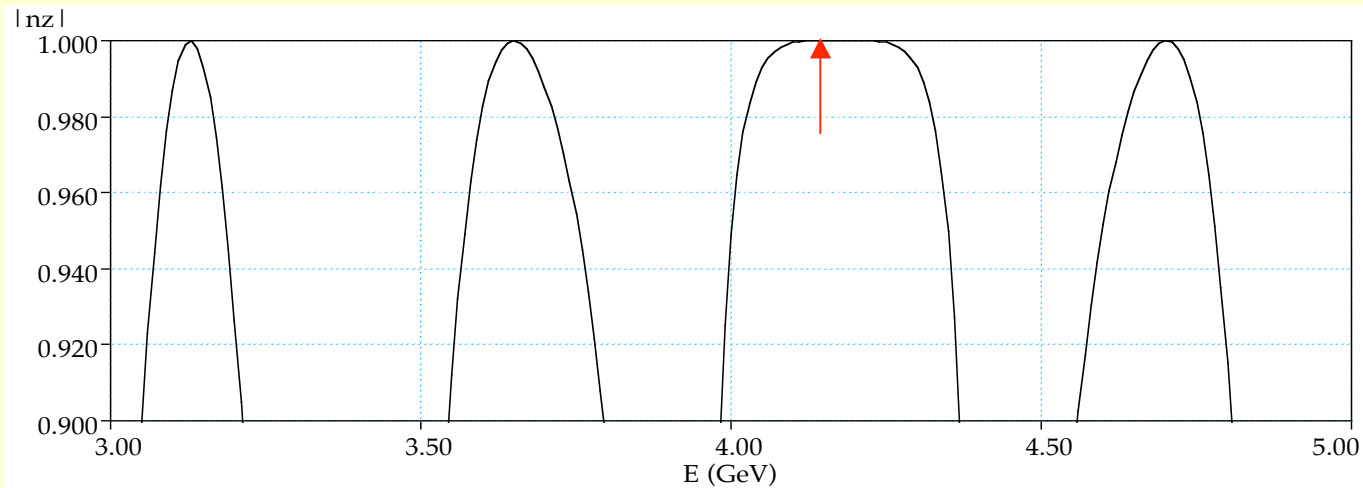


n_0 Axis at Entrance of 1st Solenoid





Solenoid Tolerances



- -1% off for solenoid-group on one side
 - P longitudinal about $(1-10^{-4})$
 - up to 1% vertical component develops, $\approx 0.2\%$ horiz. depending on exact energy.
- -1% off both sides (i.e. symmetric)
 - twice the effect but purely vertical component
- No discernible effect on time constant



Summary

- Depolarization (diffusion-) time ≈ 20 min by own code and SLICKTRACK tracking
 - mismatch of spin rotator dominates effect from orbit excursions.
 - higher order effects seem to be not significant
- Polarization @ full lumi expected to be 70%
 - newer lattice revs tend to have shorter depolarization time.
- Diffusion-dominated, \Rightarrow likely similar depolarization time for both signs of polarization
 - $>$ alternating or randomized bunch polarizations appear feasible
 - SLICKTRACK in principle can track this but need to modify code to provide possibility of input.
- Imperfections (solenoid settings, energy) cause mostly vertical polarization component
 - $>$ Measuring vertical component @ IP would be useful tuning tool.
- Long-term tracking results need to be understood