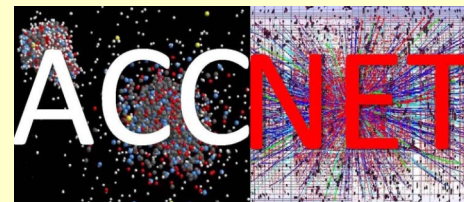


Polarized Beam Possibility in LEP3

U. Wienands, SLAC

Acknowledgment of support
by AccNet and EuCARD



Radiative Polarization

- Sokolov-Ternov self polarization due to sync. rad.
 - slightly different spin-flip rate for SllB and S antill B
 - ultimate polarization is 92.4%

– time scale is

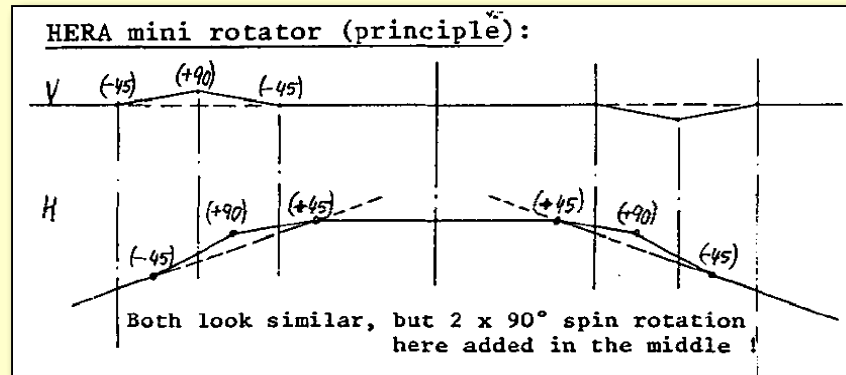
$$\tau_{st}^{-1} = \frac{5\sqrt{3}}{8} \frac{r_e \gamma^5 \hbar}{m_e |\rho|^3} = \frac{2\pi}{99} \frac{E^5}{C \rho^2}$$

- at $E = 45$ GeV, $\rho = 2625$ m, $C=26700$ m
 $\tau_{ST} \approx 4.4$ h.
 - *only* parameters to vary is ρ

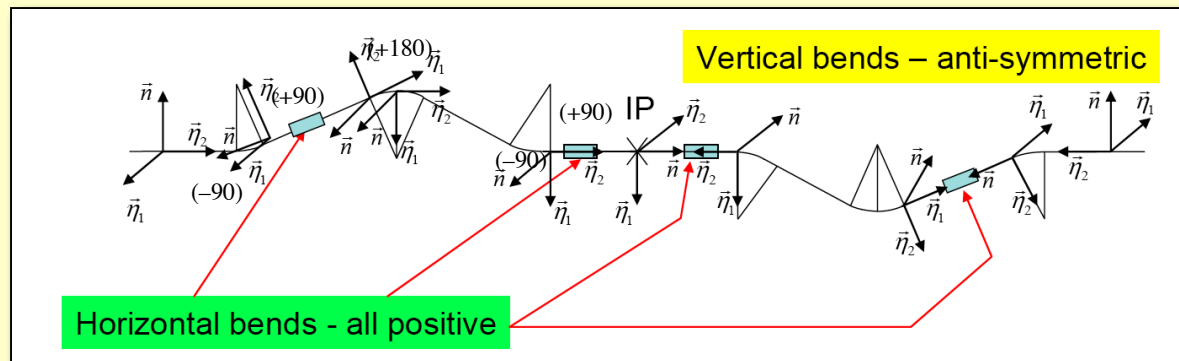
- At 45 GeV U_0 is about 10% of U_0 at 120 GeV
 - > can reduce ρ by e.g. a factor 5.
 - > $t_{pol} \approx 10$ min
 - Would run 25 MW/beam at 45 GeV, 7.2 mA
 - possibly limits luminosity achievable @ Z

Spin Rotators

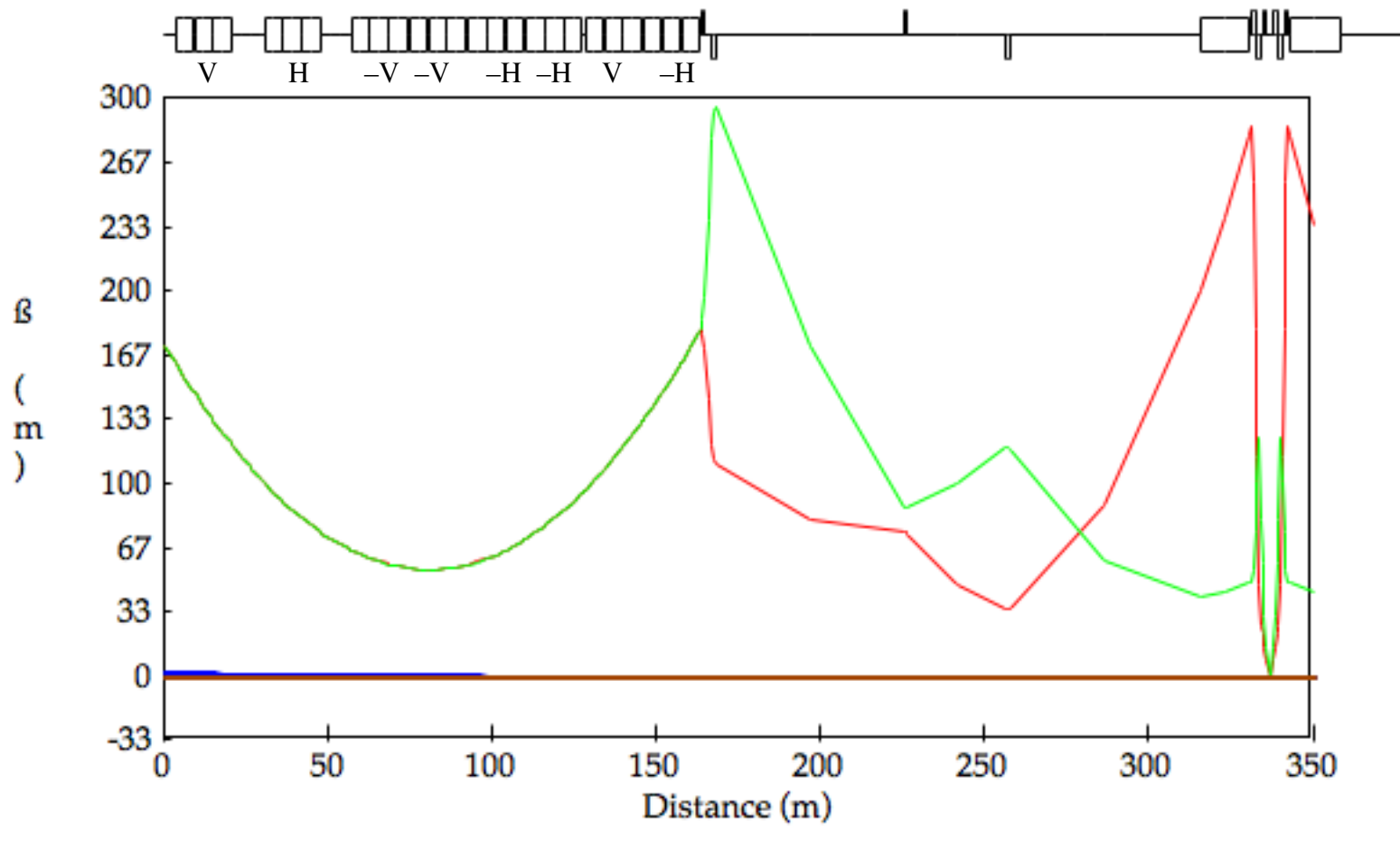
- HERA spin rotator at DESY:



- I. Koop's Rotator proposed for SuperB:



HERA Rotator for LHeC (1st att.)



Depolarization

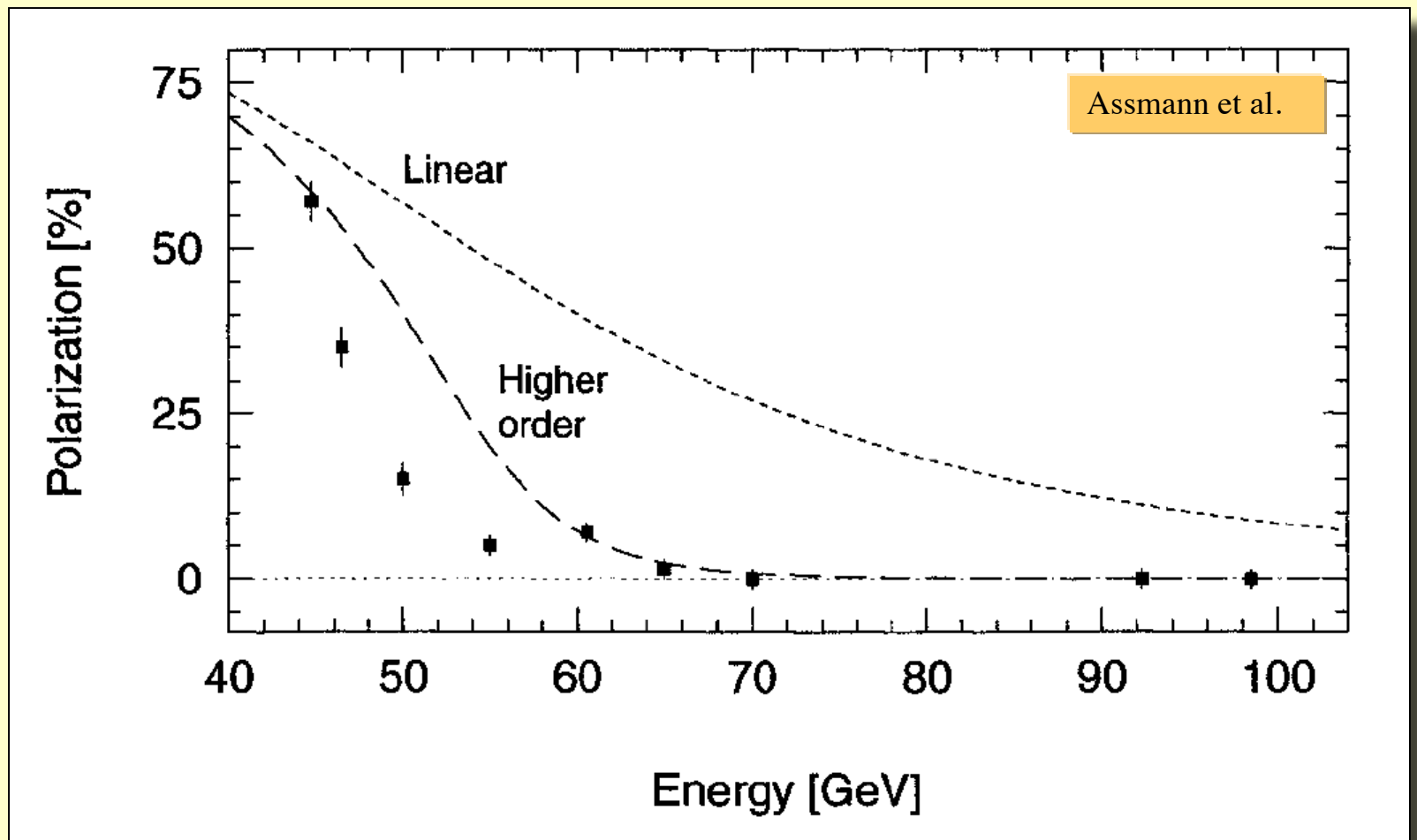
- Depolarizing effects due to spin diffusion:
 - $d\hat{n}/d\delta \neq 0$, esp. near spin-orbit resonances
 - $\gamma G = n \pm mQ_s \pm lQ_y \pm oQ_x$; n, m, l, o : integer
 - Driven by spin-mismatch
 - spin rotators, lattice peculiarities, misalignment/c.o.
- Characteristic depolarization rate:

$$\tau_{DK}^{-1} = \frac{5\sqrt{3}}{8} \frac{\lambda_e}{2\pi} r_e c \gamma^5 \left\langle \frac{1 - \frac{2}{9}(\hat{n} \cdot \vec{s}) + \frac{11}{18} \vec{d}^2}{\rho^3} \right\rangle$$

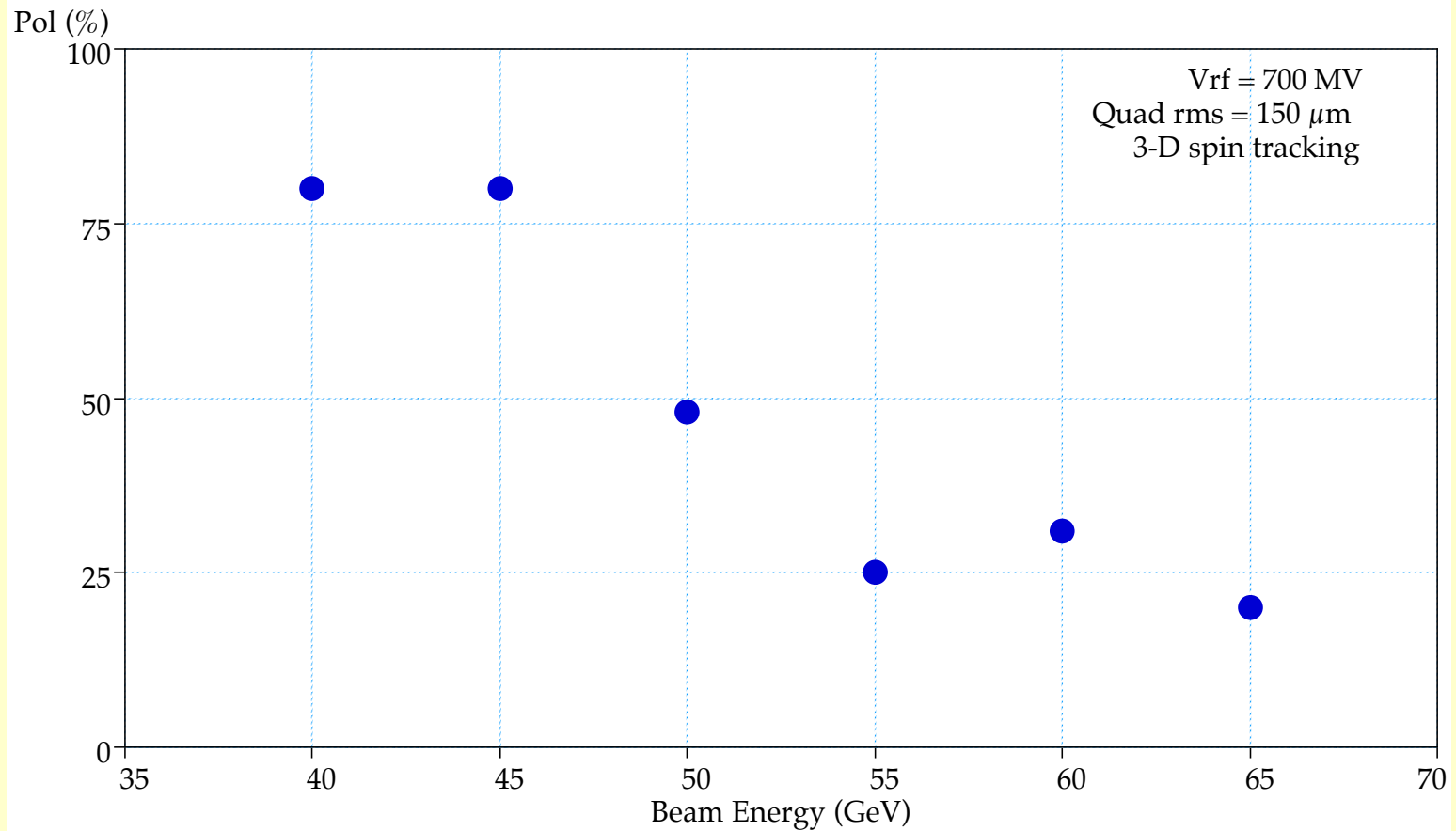
- Eq. polarization becomes

$$P_\infty \approx P_{ST} \frac{1}{1 + \frac{\tau_{ST}}{\tau_{DK}}}$$

LEP Results



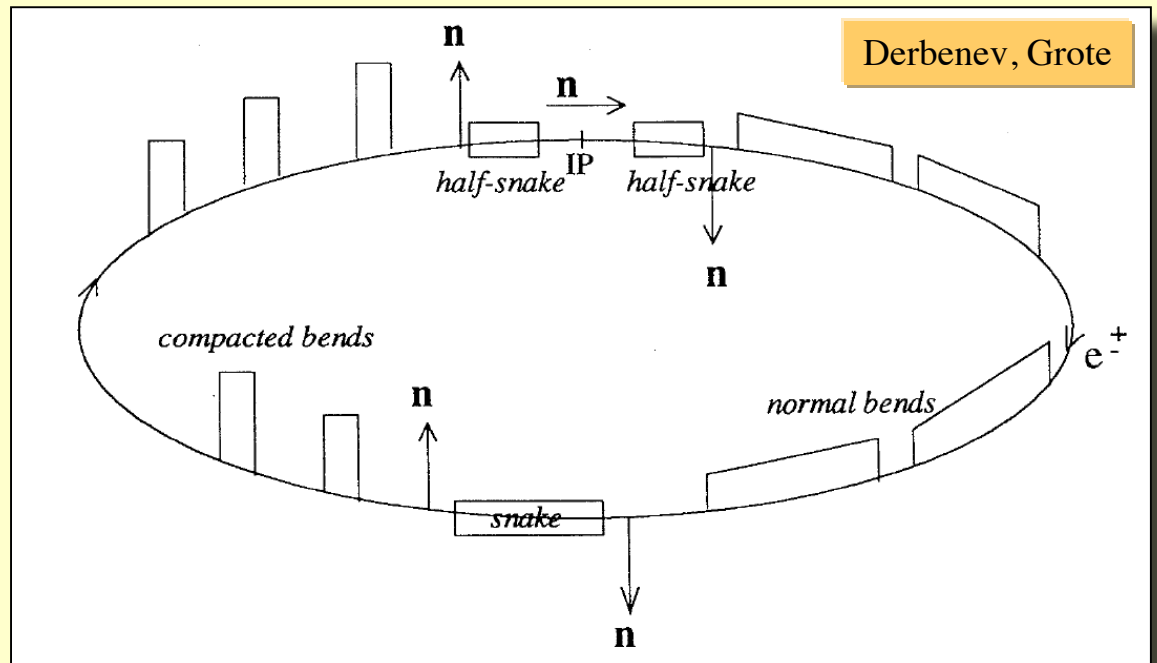
Polarization vs Energy (LHeC)



Alternative: Snakes

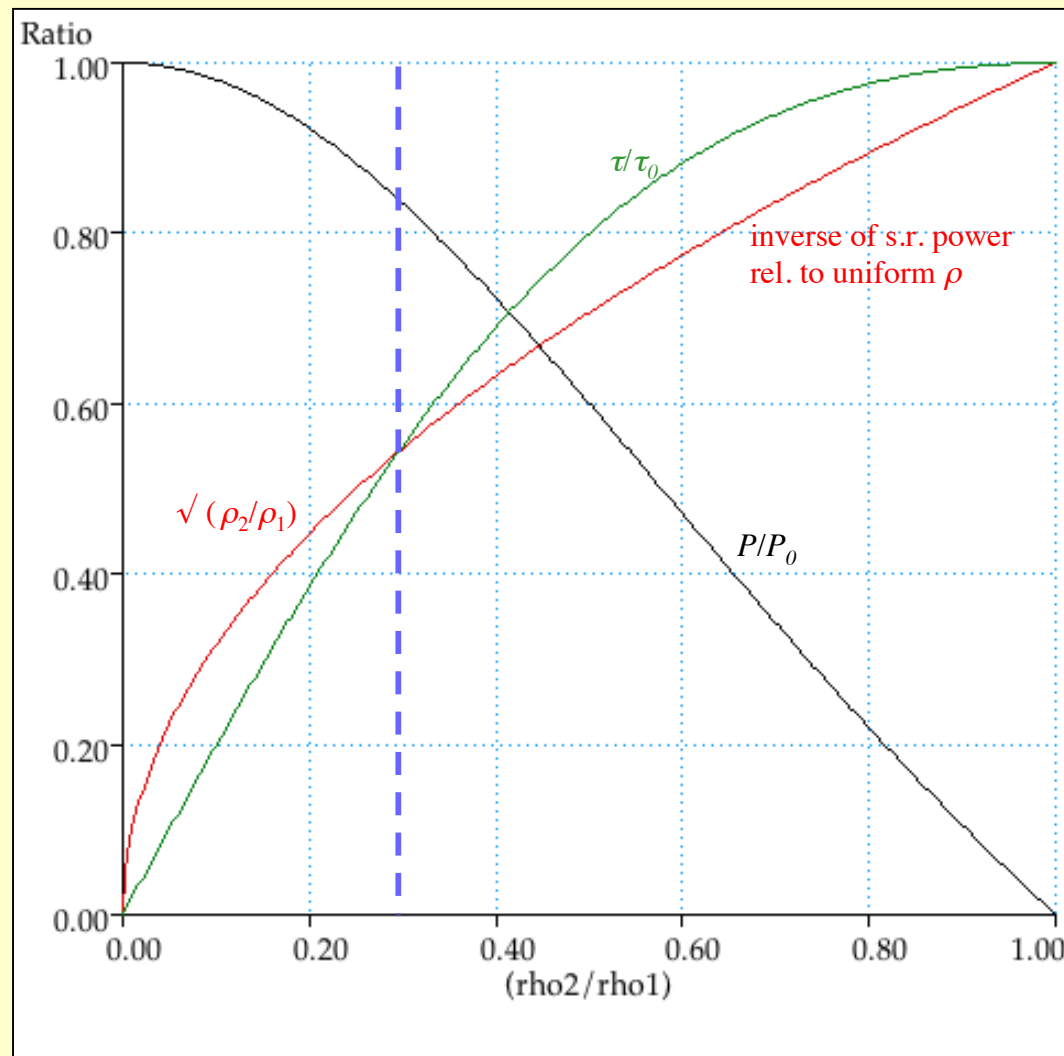
- Type-2 snake (IR) & type-1 snake (opposite region)
 - type-2 snake about s , type-1 snake about x .
 - $n(s)$ up in one half, down in the other half or the ring
 - type-2 snake integrated w/ spin rotators (& vert. dogleg)
- Polarization from balance of the arcs

$$\tau_{ST} = \frac{2\pi}{99} \frac{E^5}{C\rho^2}$$



Estimate for Asymmetric Ring

$1/\rho^2$ scaling

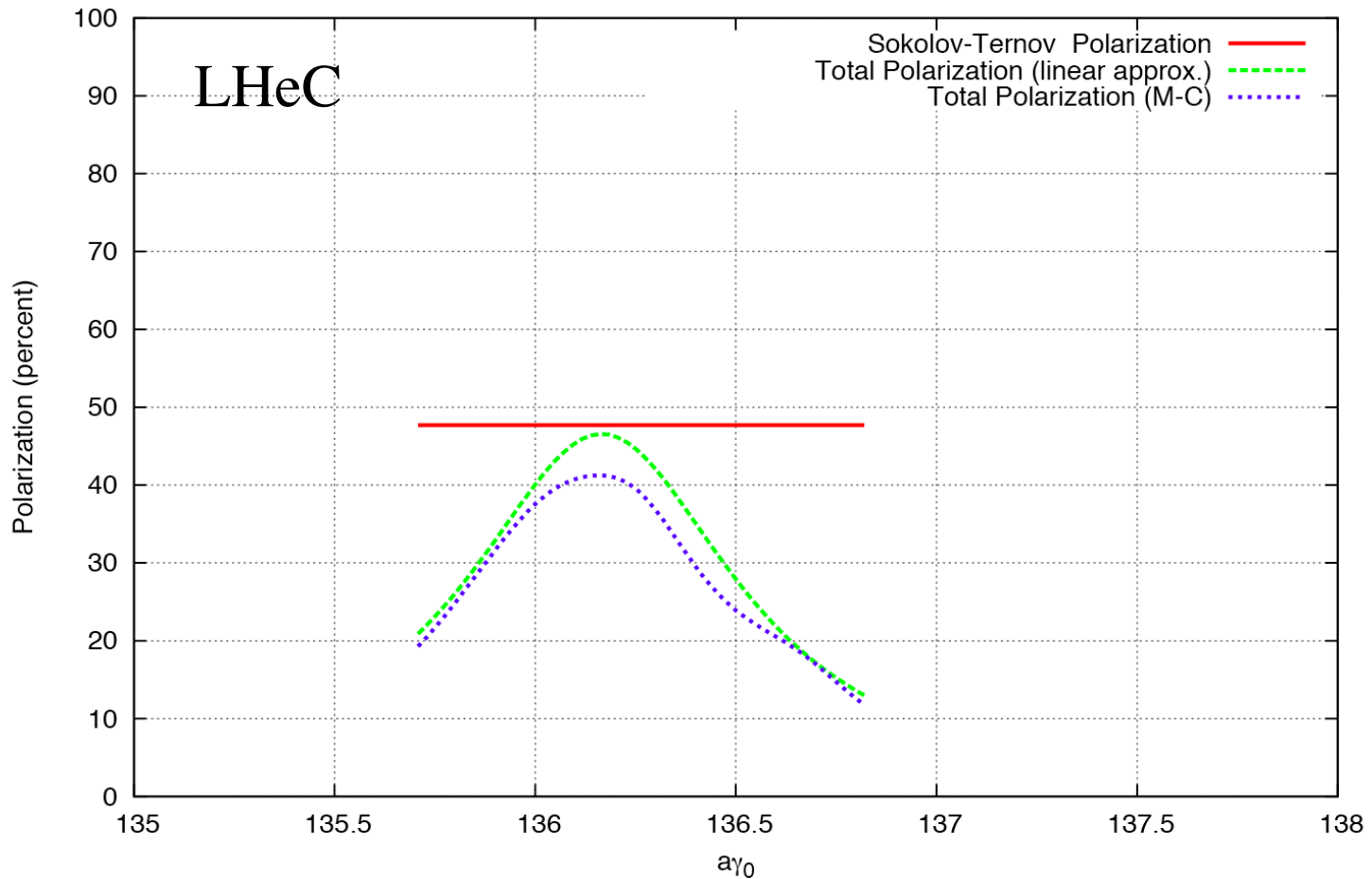


LEP3 Parameters for D-G

- Make ρ avg 1/3 of nominal $\Rightarrow \tau_{ST}$ becomes 1/2 h
- 1/3 ratio of $\rho \Rightarrow \tau_{ST}$ becomes 15 min;
 - 80% of max. polarization
 - highest energy loss/dipole still $\sqrt{3}$ less than 120 GeV case for same I

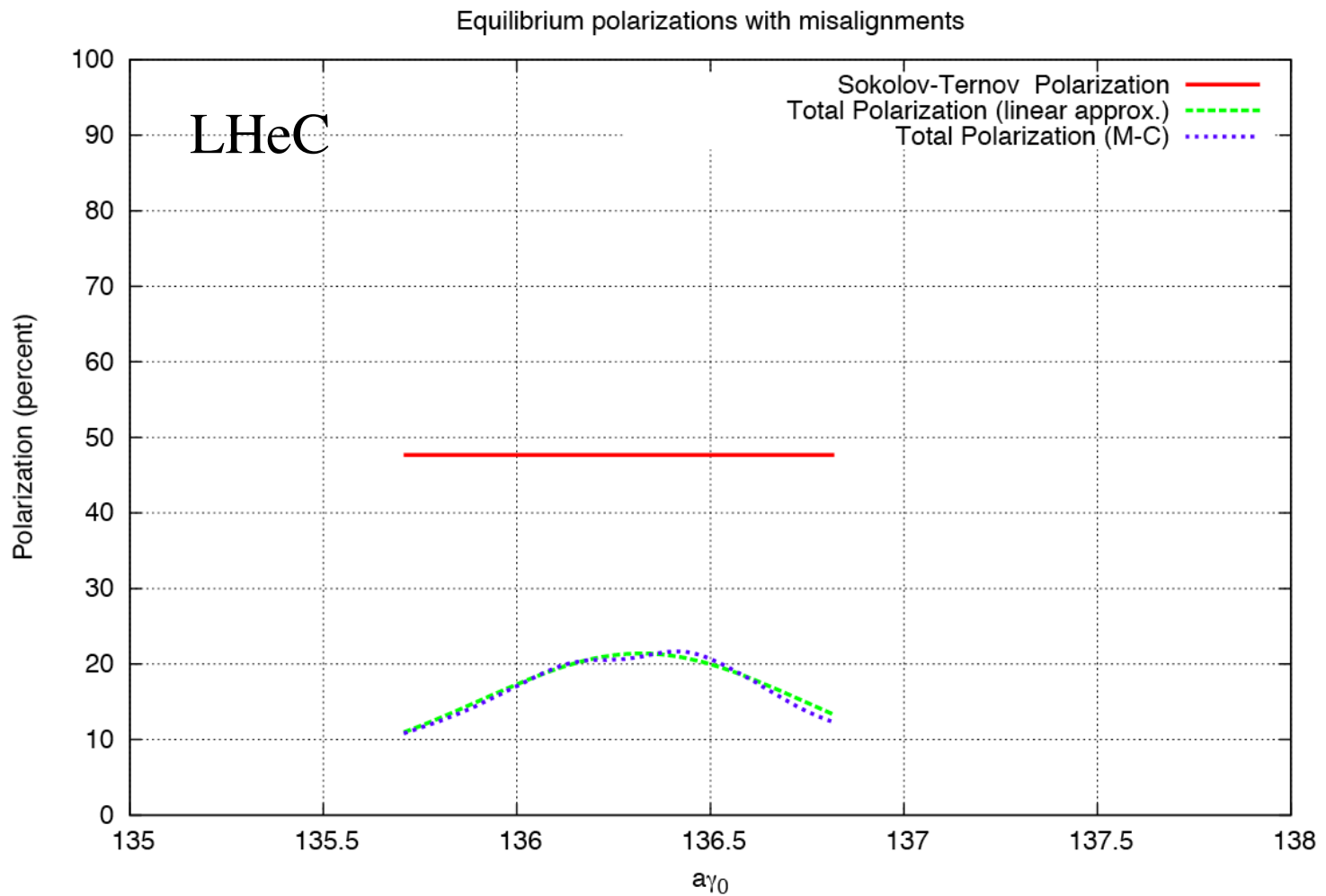
SLICKTRACK, no Misalignment

forced spin
match in IR
by zeroing
out G-matrix
elements



SLICKTRACK with Misalignment

forced spin
match by
zeroing out
G-matrix
elements,
 $\nu_s=0.067$



Summary

- ≈ 4 h polarization time for a LEP3 HF running at 45 GeV
 - > reduce bending radius by \approx factor 5 for O(10 min)
- Need to keep Q_s down to avoid depolarization.
 - > preferably below 0.05 (?)
- If energy spread turns out to be too large; a snake scheme a la Derbenev-Grote may work.
- If all else fails: *accelerate polarized electrons!*



End of Presentation