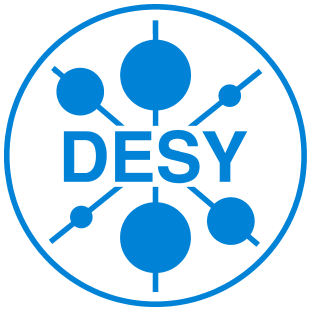
Spin Rotation Schemes at the ILC for Two Interaction Regions and Positron Polarisation with both Helicities

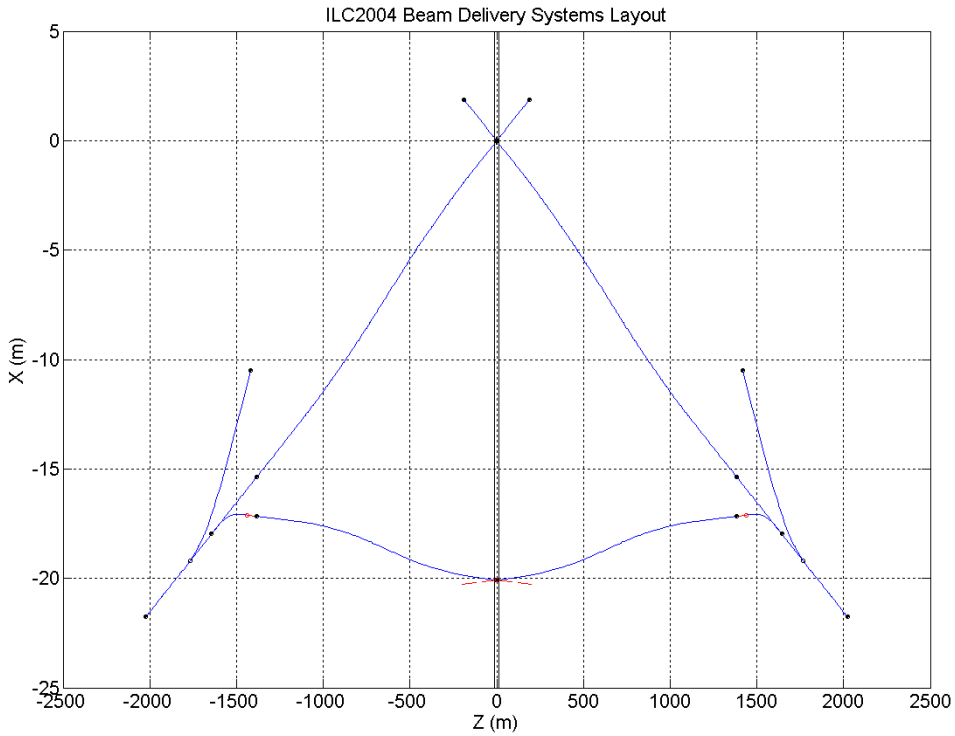
Klaus Mönig



Based on K. Moffeit, M. Woods, P. Schüler, K. M., P. Bambade, SLAC-TN-05-045

Introduction

- Electron polarisation is a must at ILC, positron polarisation is very desirable.
- The ILC should have two interaction regions with identical physics potential (at least for e^+e^-).
- It has some advantages if the two IRs can run simultaneously, e.g. alternating each train



- The beams in the two IRs are not parallel
- The spin rotates by

$$\theta_{\rm spin} = \gamma\frac{g-2}{2}\theta_{\rm bend} = \frac{E(\,{\rm GeV})}{0.44065}\theta_{\rm bend}$$

- For identical spin orientation in the linac the spins are parallel in the IPs for $E_b = n \cdot 125.85\,\mathrm{GeV}$ (assuming 11 mrad between IRs)
- However we need parallel spins for all energies
- Need a system that steers the beam individually for each IR
- If polarised positrons are produced with a helical undulator they have always the same polarisation at the source
- Need a system that provides both helicities at the IP
- Possible use for $\gamma\gamma$:
  - may want to do something in 2nd IP (e^-e^-?) while $\gamma\gamma$ is running in the first
  - are there reasons (CP violation) to run $e^+\gamma$ instead of $e^-\gamma$?

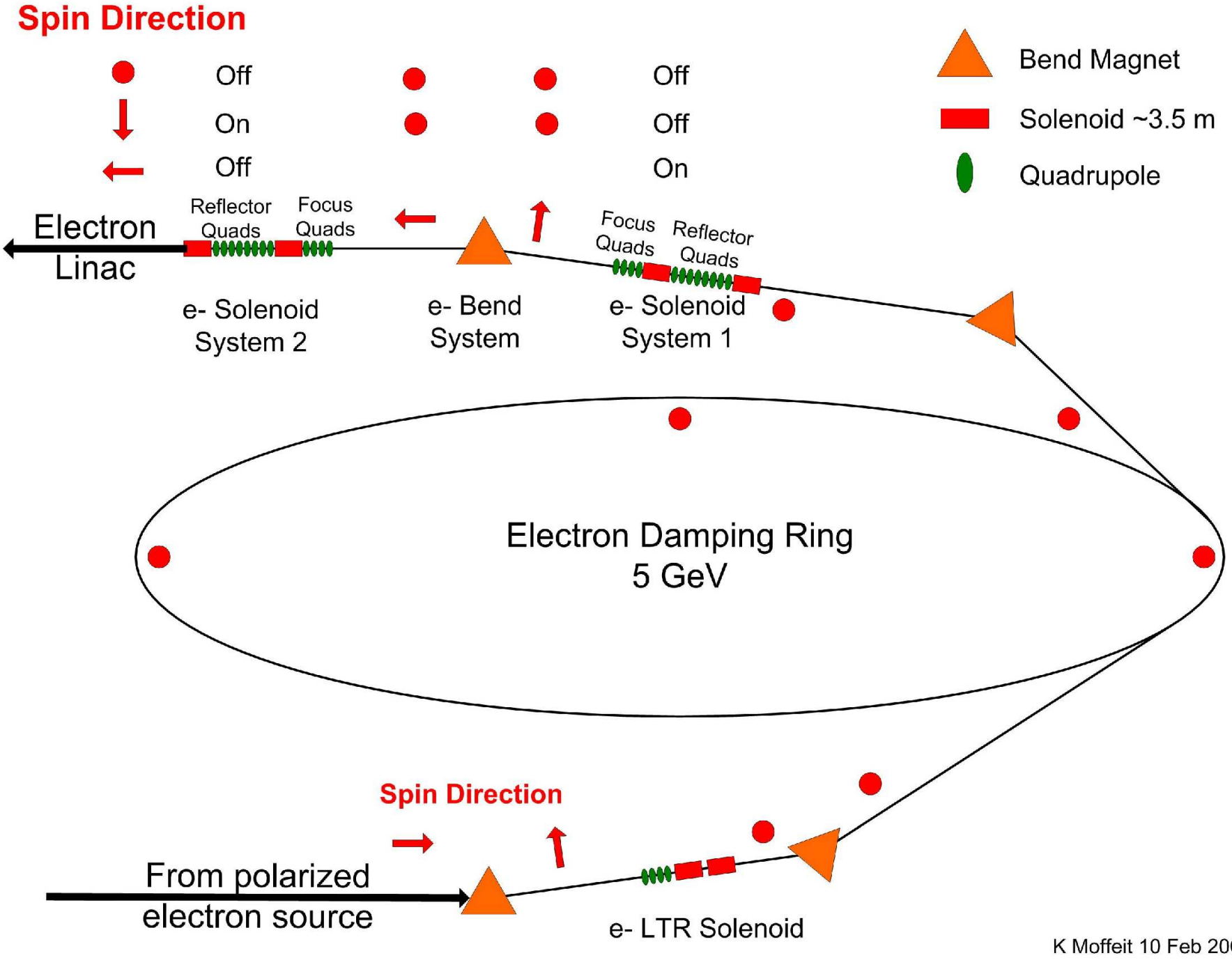
The Electron System for one IR

- Electrons are produced longitudinally polarised P. Emma, NLC Note 7 (1994)
- Have to rotate them transversally before the damping ring
- After the damping ring one has to rotate them such that they arrive longitudinally polarised at the IP
- Use solenoids for spin rotation

$$\varphi_s = \left[1 - \frac{g-2}{2}\right] \frac{B_z L_s}{(B_0\rho)} \approx \frac{B_z L_s}{(B_0\rho)} = 2\varphi_b$$

($B_0\rho$ =magnetic rigidity, φ_b =roll angle of the beam)

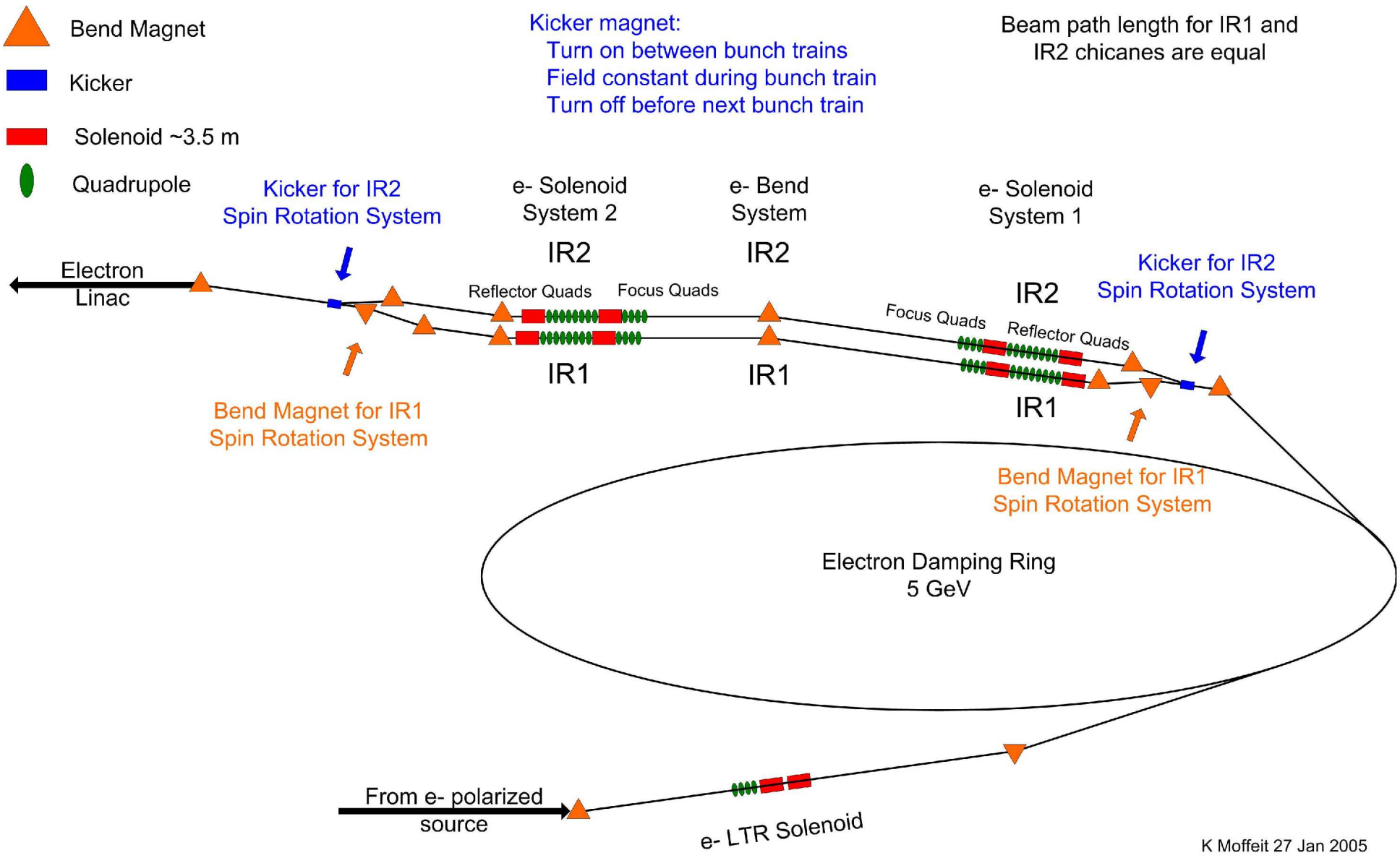
- With two identical solenoids with a deflector in between can achieve spin rotation without beam-roll
- Damping ring entrance: need one rotator after a bend
- Damping exit: need two rotators with a bend in between to achieve arbitrary spin rotation


Spin Direction
Off
On
Off
Off
Off
On
Bend Magnet
Solenoid ~3.5 m
Quadrupole
Electron
Linac
Reflector
Quads
Focus
Quads
Focus
Quads
Reflector
Quads
e- Solenoid
System 2
e- Bend
System
e- Solenoid
System 1
Electron Damping Ring
5 GeV
Spin Direction
From polarized
electron source
e- LTR Solenoid
K Moffeit 10 Feb 2005

The Electron System for two IRs

- Unless the two IRs are exactly parallel the spin orientation in the linac must be different
- The time constants in the solenoids are too long to change the field between trains
- The only way to have different spin orientations for the two IRs is to have parallel rotators with kickers selecting between the two
- All bends can be in the horizontal plane not to increase the emmitance in the vertical
- The path length in both rotators has to be identical within the electron bunch length

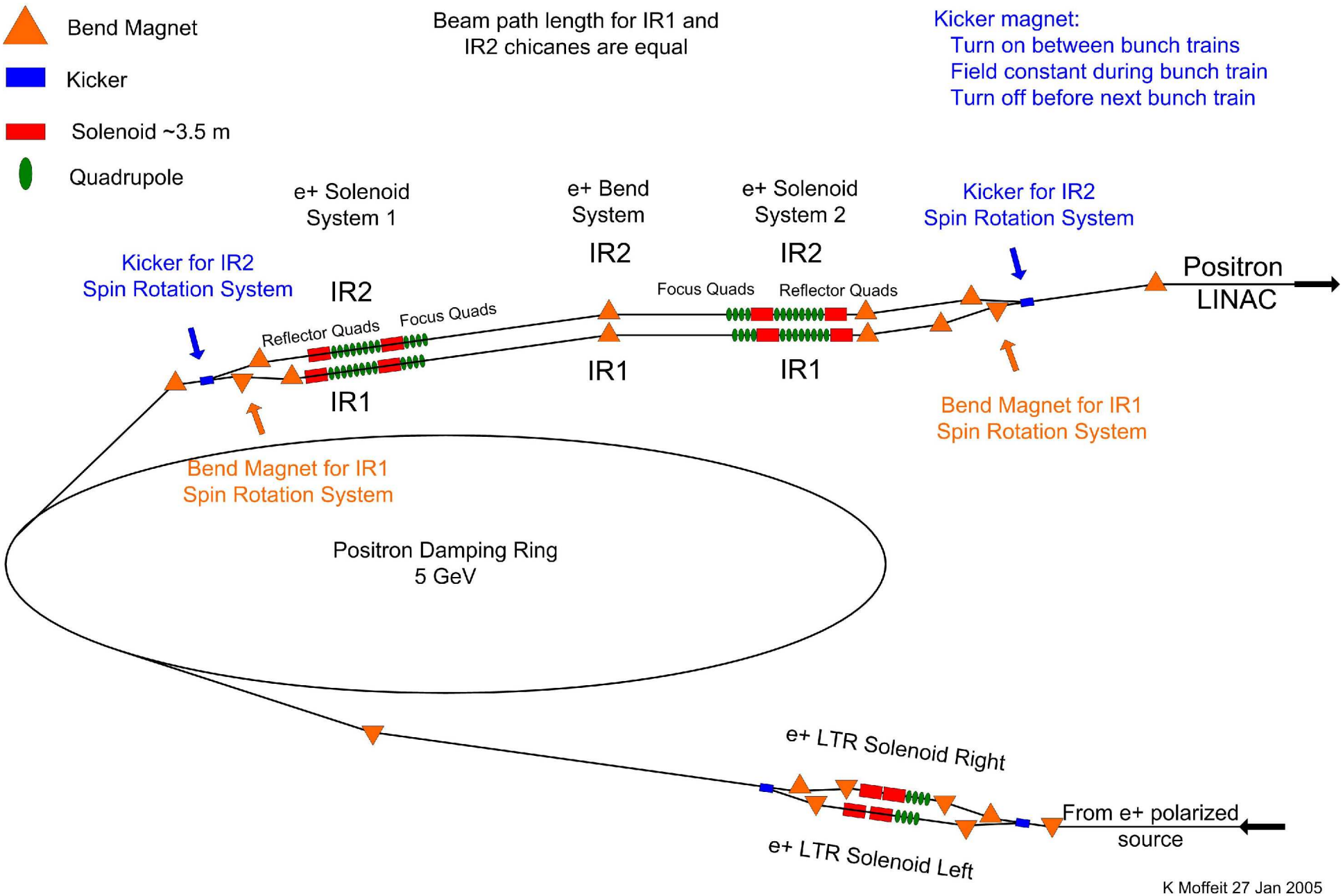
The Electron Rotation System



The System for Polarised Positrons

- If polarised positrons are produced with an undulator only one helicity is possible
- (This is not necessarily the case for a Compton source)
- Physics requires both helicities at the IP
- This problem can be solved with two parallel rotators at the damping entrance:
  - one rotator rotates the spin pointing upwards
  - the other rotator rotates the spin pointing downwards
- the rotators at the exit transform these orientations into positive and negative helicities.

The Positron Rotation System



Conclusions

- It is possible to have a spin rotator system that allows
  - to run in two IRs simultaneously with full flexibility in the spin orientation
  - to have polarised positrons with both helicities

- The system requires at most three more spin rotators and a few kickers

- At the moment the design in on the CDR level, a detailed design is needed for the TDR