



# Introduction and Scope

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Cockcroft Institute / Lancaster University

3-4 March 2009

Advanced QED Methods for Future Accelerators

# Practicalities

- Wireless network access
  - Connect to 'STFC-guest' network
  - Start web browser
  - You should be prompted for a username and password
  - Username and password available from reception
- Transport
  - Prepaid taxis to and from the Holiday Inn Runcorn will be available at the following times
    - Tuesday 18:00
    - Wednesday 08:45
  - We can assist with booking taxis to other destinations (airport, etc)
  - If you have any queries about transport please contact reception or Sue Waller
    - office: S01
    - Email: [s.waller@stfc.ac.uk](mailto:s.waller@stfc.ac.uk)
    - Tel: 01925 603212
- Workshop dinner
  - Halton Roon, Holiday Inn Runcorn at 19:00

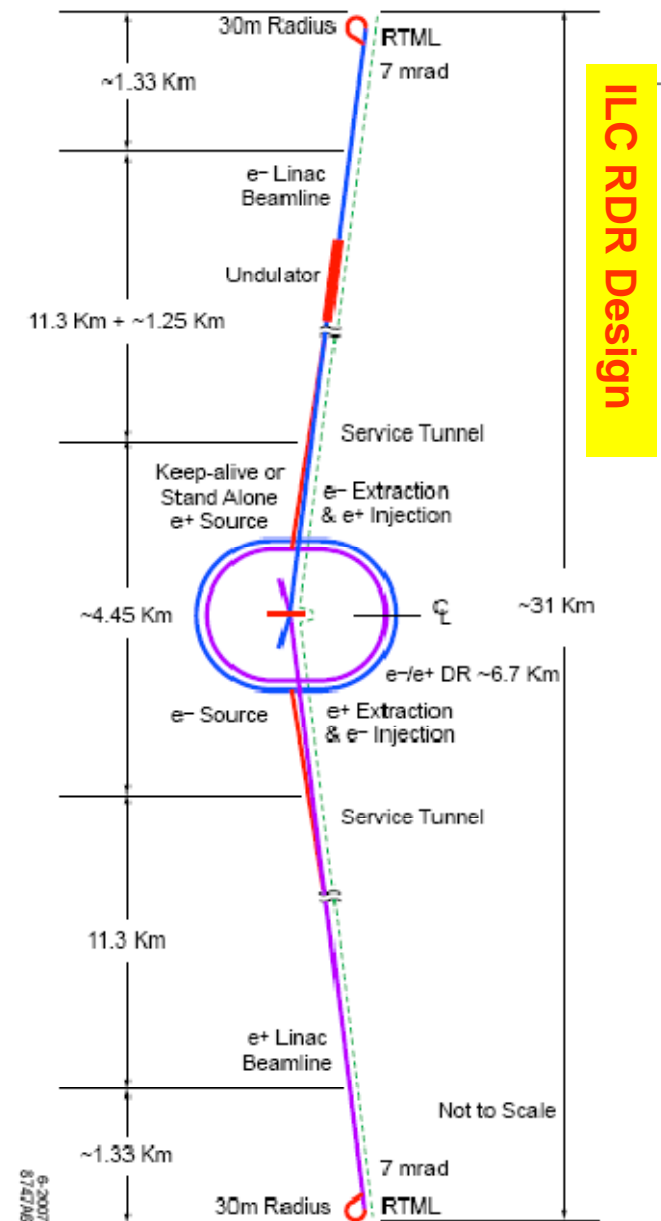
# Origin and aims of Workshop

- This workshop follows on from a small workshop on “Models of Depolarisation in Linear Colliders” held at the CI last year
- The goal of that workshop was to evaluate models of depolarisation at the interaction point of future linear colliders and identify any further theoretical work required.
- The aim of this workshop is to gain a firmer understanding of the QED techniques available and applicable to processes in the intense fields expected at future accelerators.

# ILC / CLIC

	ILC	CLIC
Center of mass energy (GeV)	500	3000
Luminosity ( $10^{34} \text{ cm}^{-2}\text{s}^{-1}$ )	2	6
Particles per bunch ( $10^9$ )	20	3.72
Bunches per pulse	2625	312
Bunch separation (ns)	369	0.5
Bunch train length (ns)	969,000	156
Pulses per second	5	50
Beam power (MW)	10	14
Horizontal beam spread at IP (nm)	639	40
Vertical beam spread at IP (nm)	5.7	1

**Next generation  $e^+e^-$  colliders require  $\sim 10^{14}$   $e^+/s$**



# Spin Dynamics

Generally most interesting spin dynamics effects occur in rings...

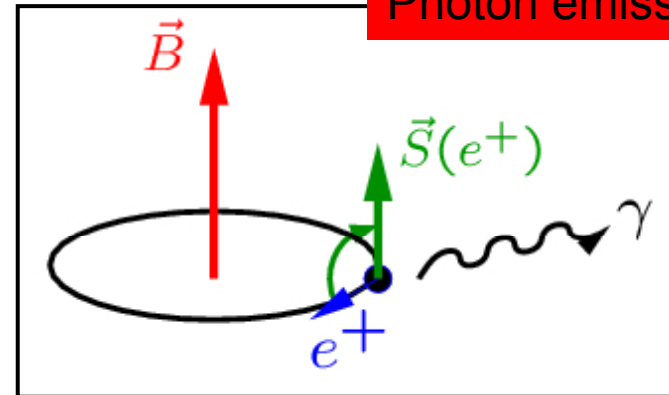
However, even in a linear collider, both stochastic spin diffusion through photon emission and classical spin precession in *inhomogeneous* magnetic fields can lead to depolarisation.

$$\delta\theta_{spin} \propto \frac{(g-2)}{2} \gamma \delta\theta_{orbit}$$

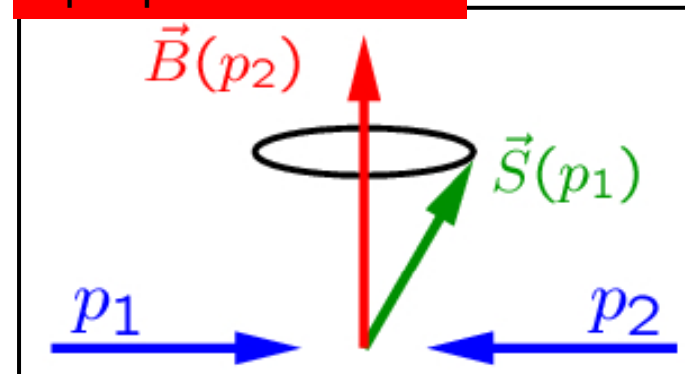
1 mrad orbital deflection  $\Rightarrow$  30° spin precession at 250GeV.

Largest depolarisation effects at ILC / CLIC are expected at the Interaction Points.

## Photon emission



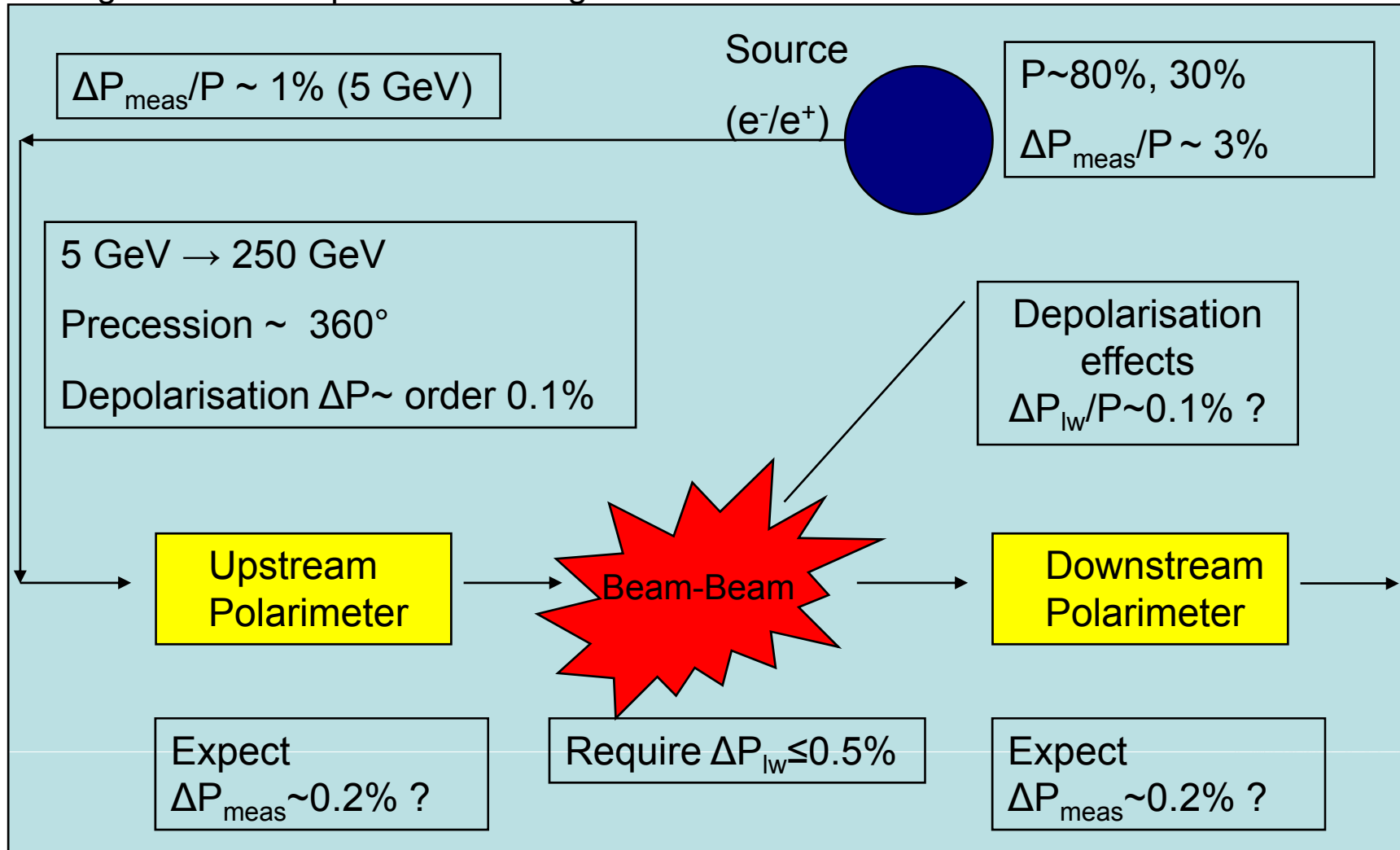
## Spin precession



HeLiCal collaboration is developing software tools to study evolution of polarisation from source to interaction point in linear colliders and elsewhere.

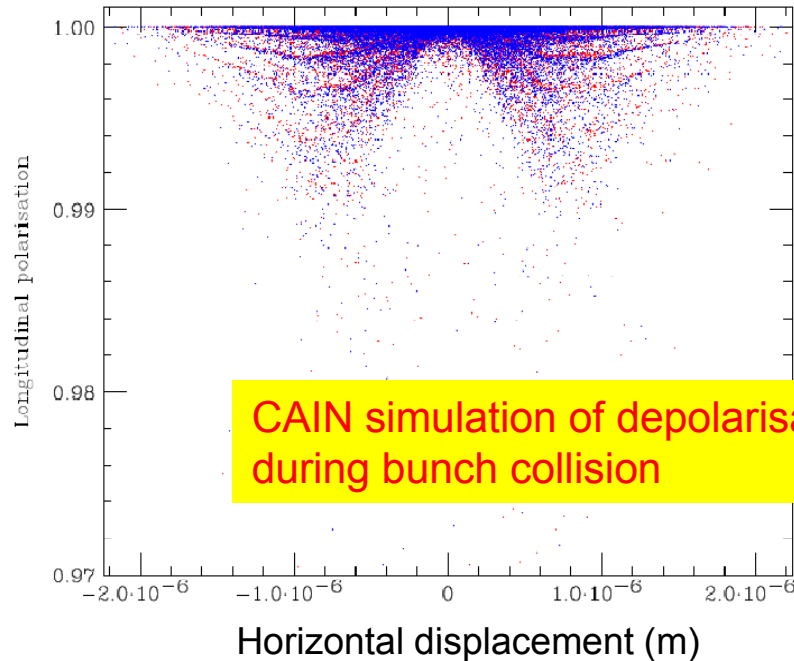
# Depolarisation at the ILC / CLIC

Modelling evolution of spin states through the ILC.





# Beam-Beam depolarisation



Parameter set	Depolarization $\Delta P_{lw}$		
	ILC 100/100	ILC 80/30	CLIC-G
T-BMT	0.17%	0.14%	0.10%
S-T	0.05%	0.03%	3.4%
incoherent	0.00%	0.00%	0.06%
coherent	0.00%	0.00%	1.3%
total	0.22%	0.17%	4.8%

$$\Delta P_{lw}^- = \left| P^- \right|_{t=0} - \left| P_{lw}^- \right| \approx 2\Delta f_{r.h.}^-$$

Uncertainties in depolarisation model grow with centre-of-mass energy.

$$\frac{d\vec{S}}{dt} = -\frac{e}{m\gamma} \left[ (\gamma a + 1) \vec{B}_T + (a + 1) \vec{B}_L - \gamma \left( a + \frac{1}{\gamma + 1} \right) \frac{1}{c^2} \vec{v} \times \vec{E} \right] \times \vec{S}$$

T-BMT equation. Anomalous magnetic moment subject to radiative corrections because of strong bunch field  $\Rightarrow$  theoretical uncertainty...

# Timetable Tuesday 3<sup>rd</sup> March

## Introduction and scope of workshop.

time	title	presenter
11:00	Workshop welcome and Overview	Prof. DANTON, John
11:45	Scope of the Workshop	Dr. BAILEY, Ian
12:15	The Furry Representation	MOORTGAT-PICK, Gudrid

## Session 1: Intense Field QED (IFQED) methods - Walton Room C (14:30-16:00)

time	title	presenter
14:30	Recent development of operator quasiclassical method	Prof. BAIER, Vladimir
15:30	The method of Nikishov and Ritus	Dr. HARTIN, Anthony

## Tea and Coffee - Walton Room C (16:00-16:20)

## Session 2: IFQED calculations - Walton Room C (16:20-18:00)

time	title	presenter
16:20	Vacuum polarization effects in intense laser fields	Dr. DI PLAZZA, Antonino
16:55	Compton Scattering at High Intensities	Dr. HEINZL, Tom
17:30	Manifestation of Quantum Effects in Advanced Accelerators	Dr. MIKHAILICHENKO, Alexander

## Workshop Dinner - Holiday Inn (19:00-22:00)





## Wednesday 04 March 2009

### **Session 3: Simulation of IFQED processes in colliders - Walton Room C (09:00-10:30)**

time	title	presenter
09:00	Guinea-Pig++ Update	Dr. RIMBAULT, Cecile
09:30	Spin Depolarization expected at CLIC	Dr. BAILEY, Ian
10.00	IFQED processes in CAIN	HARTIN, Anthony

### **Session 4: IFQED Applications - Walton Room C (11:00-13:00)**

time	title	presenter
11:00	Strong fields and recycled accelerator parts as a laboratory for fundamental physics	Dr. JAECKEL, Joerg
11:30	Lepton pair creation in strong laser fields	Dr. HATSAGORTSYAN, Karen
12:00	Experiments on strong field QED in crystals	Dr. UGGERHOEJ, Ulrik
12:30	Geometric and Ultrarelativistic methods for accelerator physics	Dr. GRATUS, Jonathon

### **Discussion and Summary - Walton Room C (14:30-16:00)**

time	title	presenter
15:30	Workshop Summary	Dr. HESSELBACH, Stefan

