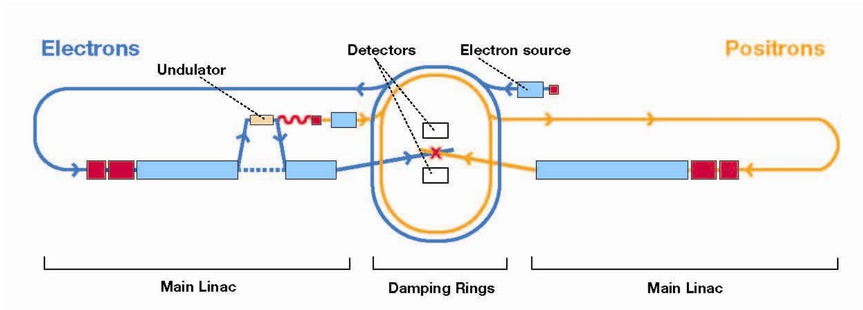
heLiCal collaboration: Polarised positron source for the ILC

The positron source for the International Linear Collider (ILC) is a helical undulator-based design, which can generate unprecedented quantities of polarised positrons.

The heLiCal collaboration takes responsibility for the design and prototyping of the superconducting helical undulator and is producing a prototype rotating target wheel.

The layout of the ILC



Physics motivation

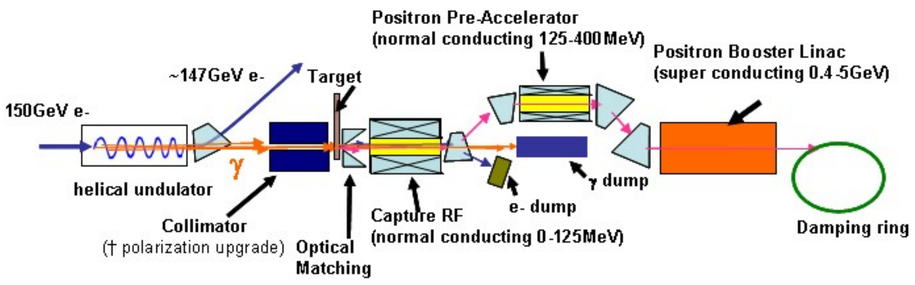
The helical undulator design has the strong advantage of producing the positrons in a longitudinally polarized state.

Having both the electron and positron beams polarized is essential for maximising the physics reach of the ILC; an example of the role of polarized positrons for determining the quantum numbers of supersymmetric particles is shown below. More details of the physics case for polarized positrons and all aspects of the positron source can be found at: *http://www.ippp.dur.ac.uk/~gudrid/source/*

The ILC positron source will have to produce of order 10^{14} positrons per second.

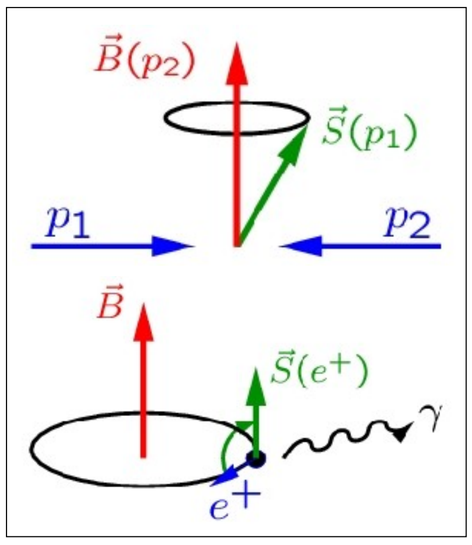
In the current design the ILC electron beam is passed through a helical undulator of length approximately 200m producing synchrotron radiation which interacts with a target where polarized positrons and electrons are produced.

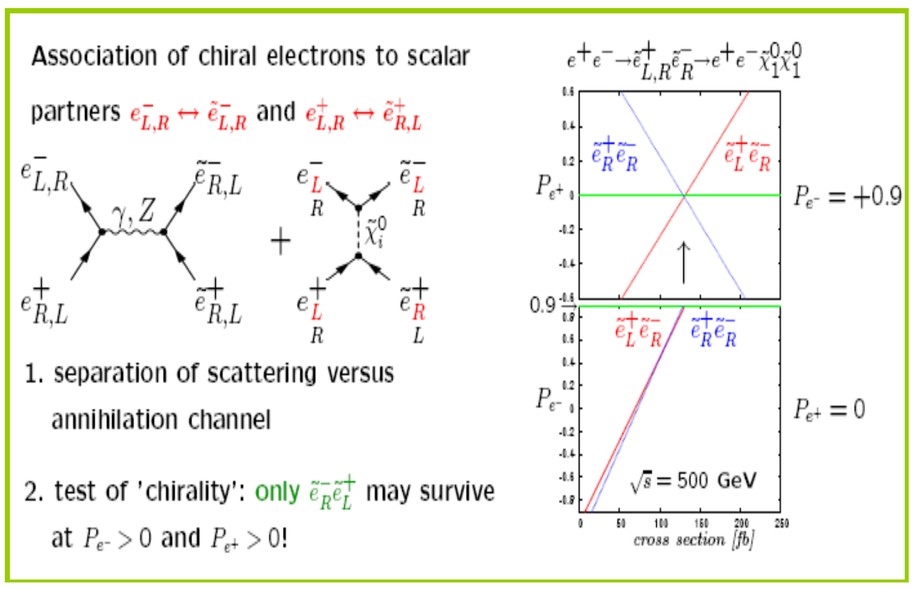
Layout of the ILC positron source



Spin Tracking

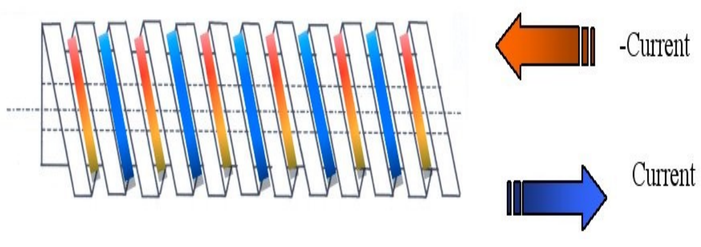
All possible depolarization effects from the source up to the interaction point have to precisely studied. Involved theoretical calculations are required and precise experimental simulations are performed.



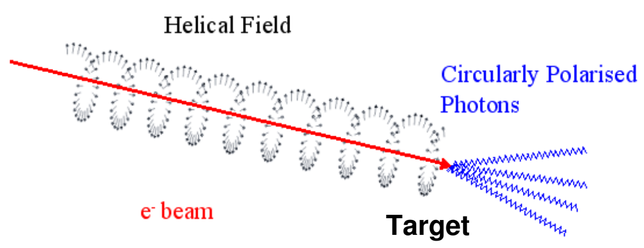


Helical Undulator Insertion Device

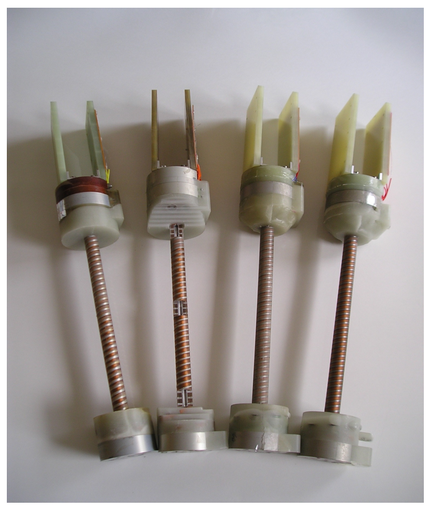
Left: structure of undulator windings



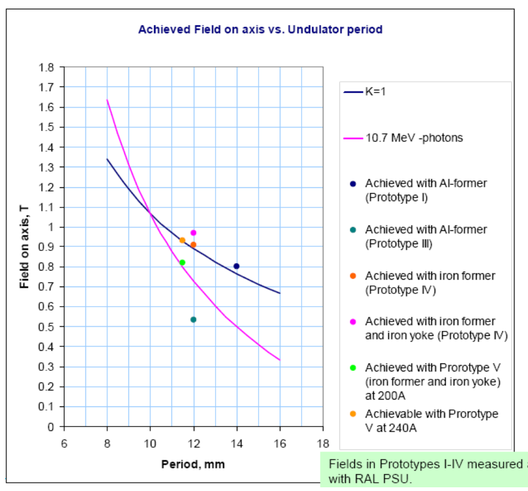
Right: Generation of circularly polarised photons in a helical field



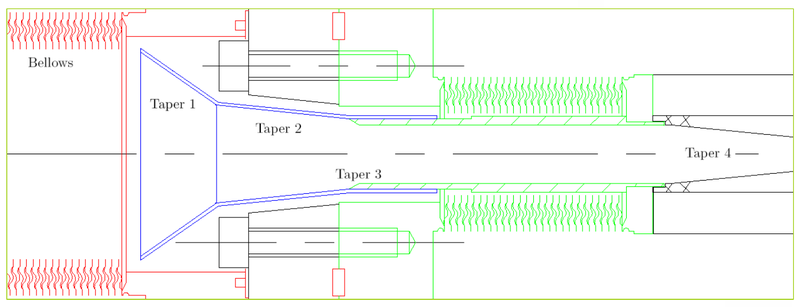
4 short undulator prototypes



- Magnets or current elements are used to generate a spatially rotating magnetic dipole field along the major axis of the undulator.
- Charged particles entering the undulator describe helical trajectories in the field.
- Superconducting technology has been selected for the ILC positron source as it offers high field quality and easily tunable field strength.
- Five short superconducting undulator prototypes with a length of 300mm have already been built and successfully tested.
- Full scale prototype will have a 4m cryostat containing two ~2m undulators.
- Bellows will be used to join the warm and cold regions between undulator sections.



Fields in Prototypes I-IV measured at 200A with RAL PSU.

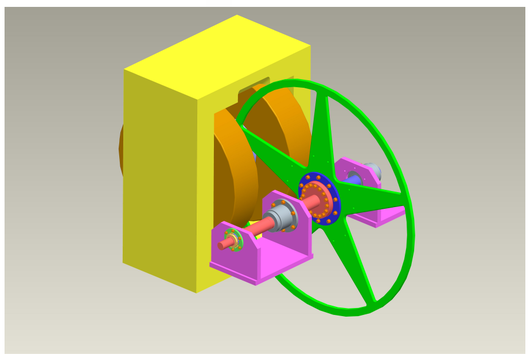


Above: Unshielded bellows design.

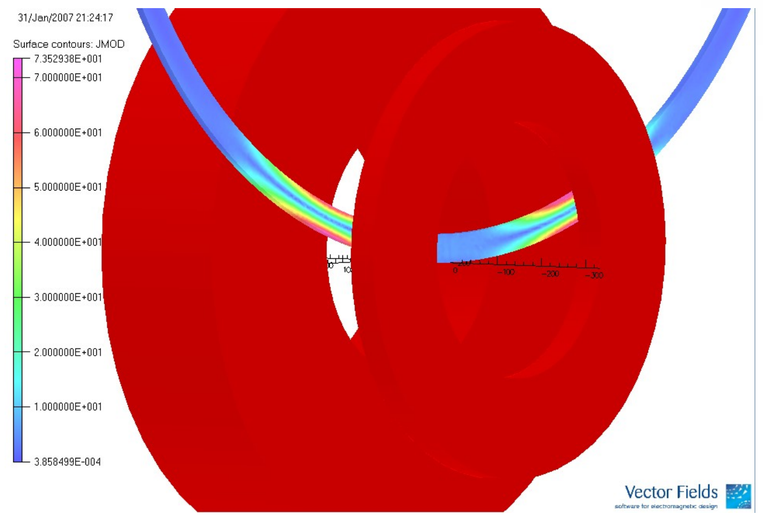
Left: Results of undulator prototypes: A period of 10mm and field of 1.05T is desirable

Target Prototype

- A rotating titanium target design has been adopted to reduce the photon beam power density. The rate at which the target can be cooled determines the required angular velocity at the target rim.
- Target prototype will be rotated in amagnetic field at Daresbury Lab to validate simulations.

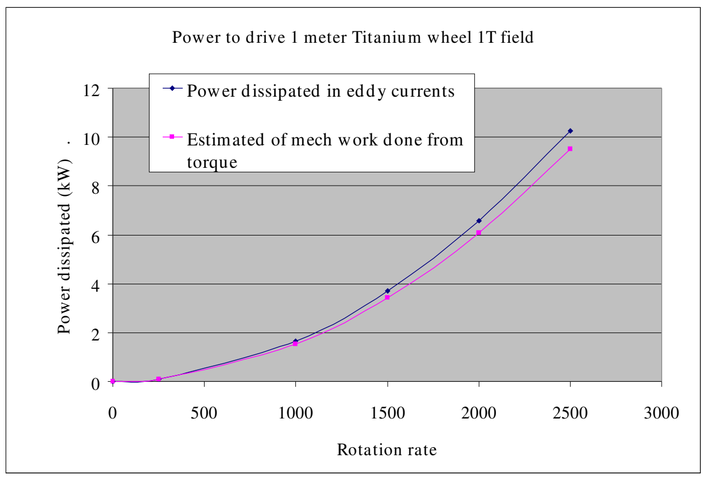


Left drawing: ILC target wheel



Above: Simulation of the eddy currents induced in the wheel by B-field

Below: Power dissipated in eddy currents and torque



The heLiCal collaboration

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The heLiCal collaboration is making an active contribution to the ILC undulator-based positron source design: design and prototyping of the helical undulator itself, assessing its impact on the main electron beam, as well as studying and simulating depolarisation effects from start to end.