CCLRC Involvement In e^+e^- Linear Colliders

e^+e^- Panel January 2001

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CLRC

- Synchrotron Light Source
- Neutron Source
- Engineering
- Particle Physics
- Lasers …….

Content

- CLRC
- CLRC and Accelerators
- HEP Accelerator Studies
- Linear Colliders
- Daresbury Activities
- Daresbury LC Projects
- Future

CLRC and Accelerators (1)

- SRS
  - » 12 MeV Linac
  - » 600 MeV Booster
  - » 2.0 GeV Synchrotron Storage Ring
- ISIS
  - » Ion Source
  - » 70 MeV Linac
  - » 800 meV proton Synchrotron
  - » Target

CLRC and Accelerators (2)

- Oxford compact source
- DIAMOND
- ESS
- ATP
- Clatterbridge cyclotron
- EU Fel
- Neutrino Factory
- CLRC participates in a world community of accelerator labs

HEP Accelerator Studies

- Origins:
- 23 Oct 1998 meeting at RAL including PPD, ISIS, SRD, ED and universities.
- Support from the relevant funding bodies
  - » from April 1999 for three years
  - » £300k per year from PPARC
  - » £150k per year from CLRC
- Two panels set up to drive the activities:
  - » Internal Panel (IPARD) - CLRC reps & EPARD Chair
  - » External Panel (EPARD) both CLRC and university reps
  - » IPARD has met 9 times and EPARD 5 times

HEP Accelerator Studies

IPARD: P.Norton (RAL PPD - Chair), K.Peach (PPD), I.Gardner (ISIS), S.Smith (SRD), E.Baynham (ED), R.Edgecock (PPD), W.Murray (PPD), G.Myatt (Oxford)

EPARD: G.Myatt (Oxford - Chair), K.Peach (PPD), P.Norton (PPD), I.Gardner (ISIS), S.Smith (SRD), E.Baynham (ED), G.Blair (RHUL), P.Burrows (Oxford), C.Buttar (Sheffield), J.Dainton (Liverpool), C.Hawkes (Birmingham), K.Long (Imperial), A.Phelps (Strathclyde)

- Main Activities
  - » Electron-positron linear colliders
  - » Muon storage rings
  - » Generic technologies
- These areas were defined in Oct 1998

Linear Colliders Activity

- Beam delivery system (Andy Wolski) TESLA TDR, Adrian Bungau (Phd Student at Manchester)
- Damping rings for CLIC (Hywel Owen)
- Laser photoinjector for CLIC (Ian Ross - RAL CLF
- Generic Technology
  - » High power RF…. Faraday Proposal

Meetings and Discussions

- Support for both IPARD and EPARD
- Initial contact visits
  - » SLAC, DESY, CERN
- Workshops & Conferences
  - » LC 99, TESLA TDR, IOP Higgs, HEP Forum, EPAC2000, SC RF workshop
- Hosted BDIR2000 at Daresbury
- Informal Meetings
  - » UK LC Collaboration, klystrons, Superconducting RF, Tesla undulator etc.

Daresbury LC Projects

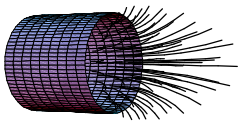
- Beam delivery
  - » Solenoidal Correction
  - » Error and feedback simulation
  - » Development of MERLIN code
- Damping rings
  - » Touschek lifetime modelling
  - » Analytic optimisation of design

Solenoid Compensation

- 4 Tesla field in latest IR design for TESLA
- Final Focus quadrupoles have to lie inside solenoid to deliver required spot size at interaction region
  - » gives rise to beam coupling
  - » much larger vertical beam size, much lower luminosity
  - » coupling needs to be compensated
- Compensate using skew quadrupoles close to Final Focus
  - » coupling from skew quadrupoles cancels coupling from solenoid field
- Compensation calculated analytically using *Mathematica*, numerically modelled using *DIMAD*

Kicks Within the Solenoid

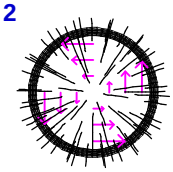
1



Fringe field at end of solenoid

Fringe field can be modelled as a thin radial field, with strength increasing linearly with radial distance from the beam axis.

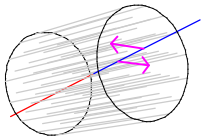
2



Kicks on particles from fringe field

The kicks result in coupling between horizontal and vertical motion. The size of the kick is proportional to the distance of the particle from the solenoid axis.

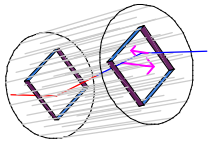
3



No focusing inside solenoid

The kick from the fringe field is cancelled out by the field within the main body of the solenoid...

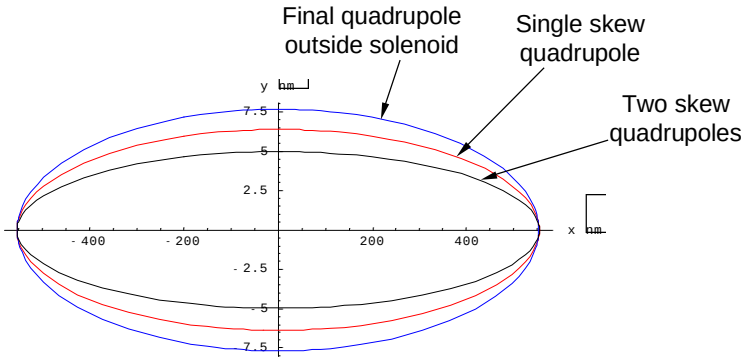
4



Quadrupole inside solenoid

...unless there is a focusing quadrupole. Small spot sizes require the final quadrupole close to the IP. In this case, the coupling kicks do not cancel, and skew quadrupoles are then needed to compensate the coupling forces.

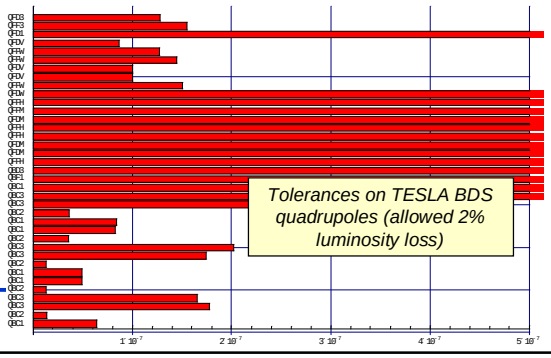
Effect on Beam Size at IR



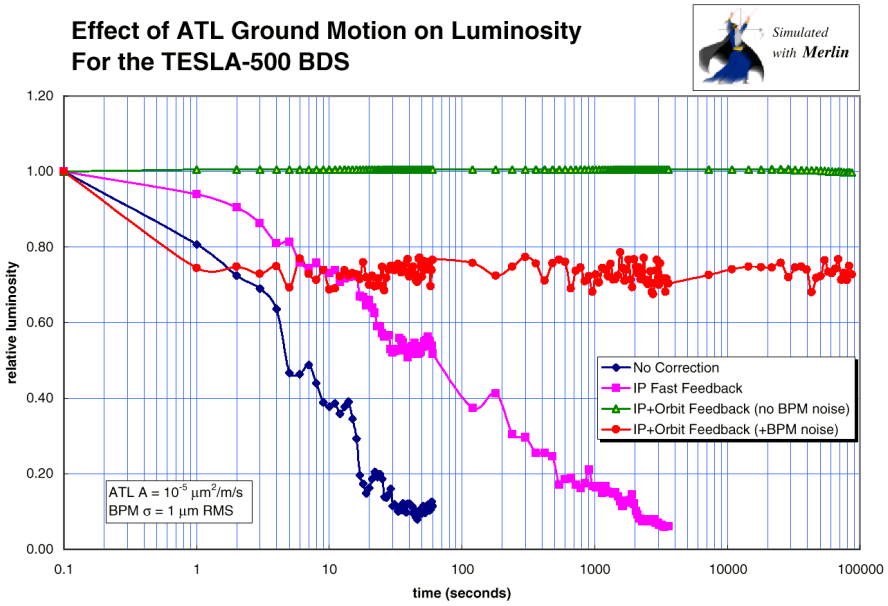
Two skew quadrupoles are required to restore the vertical beam size at the interaction point to the design value of 5 nm.

Beamline Modelling: Ground Motion Sensitivity

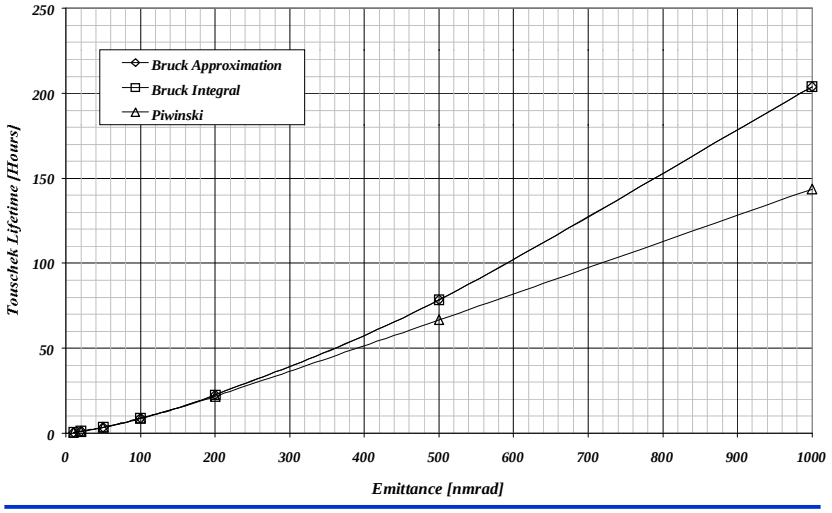
- **Luminosity and reliability rely crucially on understanding behaviour of all parts of the collider, from source to beam dump**
- **Powerful tools required to model behaviour of real machine, in commissioning and operational phases**
- **C++ class library (Merlin) in development**
  - » **'Process' concept allows user easily to add further effects**
  - » **'Frames' structure allows easy modelling of misalignments and ground motion**
  - » **Class library approach gives flexibility and allows customisation**



Effects of Ground Motion

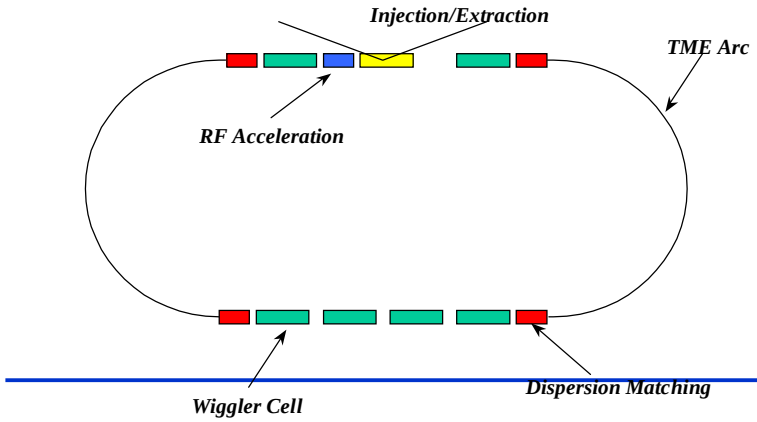


Damping Ring Touschek Lifetime



Damping Ring Design

- Analytic study is a multi-parameter optimisation.
- Many complex effects to study and parameterise
  - » IBS, Dynamic aperture, Damping wigglers……



Future

- **Continued support and participation in UK activities.**
- **Ideally placed to carry out full Physics & Engineering design of a major systems in collaboration with universities.**
  - » **Damping ring / Beam deliver**
- **Build and Deliver to Funded Project.**