Beam Dynamics Studies in Europe

D. Schulte

Goals

- Reliably predict luminosity performance
- Ensure that predicted luminosity is acceptable
- Reliably predict background conditions
- Ensure that predicted levels are acceptable

$\Rightarrow$ Need to develop codes and benchmark them

$\Rightarrow$ Need to develop tuning strategies with acceptable performance and define tolerances on imperfections

Driving Design Decisions

- The GDE requests to identify design issues as soon as possible and to address them in a hurry
- Since most resources are integrated in EU or UK co-funded research, want to address issues respecting commitments
- Address a number of issues as detailed below
- But driving decisions is only part of the game

Scientific Community Support

- Parallel studies of beam dynamics issues are essential
  - to verify results
  - to help making sure nothing is forgotten
  - to improve performance by competition
- For the LHC studies at many other colliders are very important
- ILC is more lonesome

  $\Rightarrow$ other linear accelerators are important

  $\Rightarrow$ CLIC is scientifically important

  $\Rightarrow$ need to ensure parallelism in different ways
- Exchange of beam dynamics experts with other experts essential
- Interface standards help to ease information exchange

Overview

- Beam dynamics studies are to a large extent organised in
  - EUROTeV: a design study in which resources are available to hire people

    $\Rightarrow$ beam dynamics mainly in the ILPS (integrated luminosity performance studies) work package
  - ELAN: a network to allow efficient information exchange

    $\Rightarrow$ has a beam dynamics work package
  - other contributions
- EUROTeV and ELAN also contain non-ILC work

  $\Rightarrow$ will concentrate on ILC here

Beam Dynamics Issues

- Design of the different lattices (overlap with other working groups)

  bunch compressor(s), main linac, collimation system, diagnostics system(s), final focus system, post collision line

- Beam-based alignment and tuning of these systems
- Feeedback systems
- Measurement of beam collision parameters in post collision line
- Collimation and background affecting luminosity

Bunch Compressor Design

M. Pedrozzi

- Significant effort in the US

  $\Rightarrow$ reduced effort in Europe

- Simulate US design for benchmarking purposes

- Multi-TeV option

  $\Rightarrow$ can learn something for ILC

Integrated Luminosity Performance Studies

Ph. Burrows, D. Schulte, N. Walker, G. White

- Study the alignment, feedback and tuning of ILC
- A part of the effort is for CLIC, but even that will be made useful for ILC
- Main emphasis on beam delivery system, main linac and luminosity optimisation
- Fully integrated study
- Need agreement on diagnostics tolerances, imperfections, wakefield modelling, standard interfaces, benchmarking

Main Linac

- Studied TESLA main linac (TRC)
- Recent results (PAC) differed from previous ones

  $\Rightarrow$ maybe problem has been found but shows importance of comparisons
- Update simulations for the ILC
- Improve the level of detail in the simulations
- Evaluate tuning strategies based on emittance/luminosity measurements
- Design issues: lattice, tunnel, diagnostics, beam position measurements in cavities

Beam Delivery System

- Benchmarking of MAD, SAD, PLACET
- Design of ILC BDS beam-based feedback system including component specifications and locations
- Develop BDS beam-based alignment strategy
- Develop BDS beam-based feedback and tuning strategy
- Incorporate BDS into global feedback and tuning strategy
- Participation to ATF2 for benchmarking/real life application
- Non-linear collimation system could become interesting for ILC

Beam-Beam Simulations

Ph. Bambade, D. Schulte

- Further development of beam-beam code GUINEA-PIG
  - benchmarking with CAIN and physics generators
  - include Bhabha scattering
  - improve hadronic event generation
  - improve usebility, e.g. automatic grid choice
  - include depolarisation

Post Collision Line Studies

V. Ziemann, Ph. Bambade

- Beamstrahlung studies including comparison of e^+e^- and e^-e^-
- Comparison of BDSIM and DIMAD for post collision line (large energy spread)
- Tracking code for arbitrary fields
- Evaluation of losses in the post collision line
- Upgrade of neutron simulation in BDSIM
- Optimisation of parameters for e^-e^- collision
- Study of background levels (photons, electrons and neutrons) in detectors due to losses in post collision line
- Comparison of 2mrad and 20mrad crossing angle

Further Post Collision Line Studies

- Extrapolation of sub-TeV post collision line to higher energies and luminosities
- Identification of shortcomings of extrapolation and adapted design for multi-TeV energies

  $\Rightarrow$ helps to solve problem with ILC high luminosity 1TeV design
- Inclusion of diagnostics: beamstrahlung, coherent pairs, polarisation

Halo and Tail Generation

H. Burkhardt

- A large uncertainty exists about the level of halo that needs to be collimated
- Will try to review the different processes
  - make comprehensive list of relevant processes
  - address most important ones
  - make analytical models where appropriate
  - develop codes where appropriate
  - identify benchmark potential
- Develop a code module that provides a tail model that can be used in different collimation system studies

Collimation System Studies

G. Blair, R. Barlow, A. Faus-Golfe, D. Schulte, N. Walker

- Close collaboration with BDS working group
- Further development of BDSIM, MERLIN and PLACET
- Efficiency studies
- Collimator survival
- Neutrons, implementation into BDSIM and studies
- Muons, evaluation of BDS with respect to muons

Study of Failure Modes

N. Walker, D. Schulte

- Derive list of critical failures
- Agree globally on prioritisation
- Develop software
- Study failures

Code Development

- MERLIN: a beam transport code mainly developed at DESY (N. Walker)
- PLACET: a beam transport code developed at CERN (D. Schulte)
- GUINEA-PIG: a beam-beam simulation code originally from DESY, later CERN and now also LAL (Ph. Bambade, D. Schulte)
- BDSIM: a collimation simulation code from RHUL (G. Blair)
- Integrated packages based on the above codes, e.g. QMUL (G. White)
- A main issue is to benchmark the different codes, which is vital to ensure the correctness of the predictions

Conclusion

- A wide programme for beam dynamics exist in Europe
- It is largely based on new people

$\Rightarrow$ Will need some time to get going at full speed