

# Results from WG1 in Snowmass

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# Overview

- Second ILC workshop at Snowmass to prepare the BCD
  - First meeting of GDE
  - Baseline configuration document to be ready end of the year
  - GDE meeting Frascati to discuss BCD
  - Next year costing of the design
  - BCD should contain baseline and proposed R&D
- WG1 focused on beam dynamics
  - Conveners K. Kubo, P. Tenenbaum, D.S.

# Organisation

- First week ordinary workshop with presentations
- Second week concentrated on discussions and recommendations
  - A list of decisions which need recommendations from T. Himmel
  - Preparation of workplan
  - Actual simulations

# WG Goals at Snowmass

- Agreement on beam parameters with GG1
- Bunch compressor design
- Main linac configuration
- Agreement on model assumptions
- Agreement on necessary data standards
- Agreement on plan for coming 16 months
  - Definition of tolerances and specifications
  - Beam dynamics simulations / benchmarking

# Agreement on Beam Parameters with GG1

- Two main problems
  - Can a bunch compressor produce the short bunch length of 150um?
    - Yes
  - Can the luminosity target be met?
    - This is what we will try to answer in the coming year

# Generic Machine Layout

- We agreed on a generic beam line layout
  - Most lattices do not exist
  - But we agreed on what the lattice should provide
- Sub-systems are
  - DR to bunch compressor transport
  - Bunch compressors
  - Main linac
  - Beam delivery system (with WG4)
  - Spent beam line

# DR to BC Transport

- Matching region
- Emittance measurement station
  - Necessary to separate the systems
- Transverse collimation section
  - We are worried about halo from the damping ring
- Feed-forward measurement
  - Feed-forward and turn-around were felt necessary to ensure beam stability, each bunch is kicked individually
- Turn-around
- Spin rotator
- Feed-forward correction
- Emittance diagnostics and skew correction section

# Bunch Compressor

- It was felt that a two stage bunch compressor is required
  - One stage performance for 6mm to 300um is marginal
  - 150um demands two-stage
  - Sufficient margin should be provided
- Three designs were presented
  - A longer system by Peter Tenenbaum
  - A shorter system by Eun-San Kim
  - The longer was picked for BCD, since it is better investigated, will be revisited



# Bunch Compressor Components

- First RF section
- First chicane
- Collimators for longitudinal plane
- Longitudinal diagnostics
  - Phase, length, correlations
- Second RF section
- Second chicane

# Launch Region before Linac

- Collimators for longitudinal plane
- Longitudinal diagnostics
- Transverse diagnostics
- Transverse collimation/linac protection

# Main Linac

- Constant quadrupole spacing of about 24 cavities (GDE executive committee: 32)
  - 8 cavities per module from WG2
  - Increase of spacing at higher energies should help but no agreement yet
  - One emittance measurement station
- Different phase advance in both planes seems useful
  - Rotating wakefields can cause problems (R. Jones)
  - 60 degrees in x, 75 in y degrees

# Beam Delivery System and Post Collision Line

- Is designed by WG4
- Is an important ingredients in the integrated simulations
  - For luminosity estimates
    - E.g. banana effect
  - For understanding of diagnostics requirements
    - E.g. luminosity tuning

# Tunnel Configuration

- Three options
  - Laser straight
  - Following the earth curvature
  - Piece-wise straight
- First can be more expensive
  - But safest from beam dynamics point of view
- Simulations showed
  - The bends in piece-wise straight tunnel seem OK (P. Tenenbaum)
  - Following the earth curvature could be OK (N. Walker)
    - More detailed simulations confirm this (sofar) (A. Latina, K. Kubo, D.S.)

# Models for Imperfection

- A simple scattering model exists for prealignment
  - Based on ILC-TRC models
- A model (LICAS, A. Reichold, G. Grzelak) for the survey line is interfaced to one code (PLACET)
- Ground motion models exist (A. Seryi)
- Vibration model not satisfactory
- RF stability looks easier than for X-FEL
- A central documentation would be useful

# Bunch Compressor Alignment

- Some sensitivity studies have been done by Peter Tenenbaum
  - Full alignment and tuning study to be done
  - Dynamic effects need study
  - Bunch compressor is essential for integrated simulations, since it couples longitudinal and transverse planes

# Main Linac Alignment

- Several simulations of dispersion free steering in main linac (J. Smith, K. Kubo, K. Ranjan, N. Solyak, D.S.)
  - Differences in the simulations made comparison difficult
  - Basic concept is variation of gradient
  - Results seem comparable
  - Main Linac emittance growth too large
  - Particularly difficult is first section where energy difference is small



# Tuning Bump Performance

- Tuning bumps can reduce emittance growth to acceptable level
  - See Peder Eliasson's talk
- Need dispersion tuning at the beginning and end of main linac
  - Measurement is done at the end
- Wakefield bumps are also helpful
- Felt need of one station in linac
  - In first part uncorrelated energy spread dominates
  - In second wakefields and correlated energy spread

# Beam-Based Alignment of BDS

- Very important area but not well covered
- G. White showed first results of BPM to quadrupole alignment
- Tuning studies shown in BDS working group
- ATF2 will be perfect test bed

# Feedback Simulations

- Intra-pulse beam-beam feedback with realistic machine
  - This is a crucial ingredients of the ILC performance
  - Glen White showed encouraging results
  - More detailed understanding needed
- Pulse-to-pulse feedback is not sufficient
  - Linda Hendrickson, Andrea Latina
  - Linda made a very detailed study
    - Energy jitter can confuse feedback in dispersion points in BDS

# Interaction Point Tuning

- Some useful signal exist
  - Incoherent pairs, Beamstrahlung, Radiative Bhabhas (but need to be careful)
  - Bhabhas at small angles are too slow
- Tuning on the pairs (O. Napoly, D.S.) tested
  - Glen White used this signal for offset/angle optimisation
- Tuning on proper combinations of beamstrahlung can work
  - Peder Eliasson, D.S.
- Reconstruction of all beam parameters from beam signals seems very tough (G. White)

# Integrated Simulations

- Integrating all relevant sub-system into a simulation is required
  - Banana effect
  - Bunch compressor
- Integration different timescales is important
  - E.g. ground motion during beam-based tuning
  - Cross talk of feedback systems

# Code Development

- Need to develop integrated simulation packages
  - Components exist but integration and extension is required
  - BC (BMAD, LIAR, Lucretia, SAD, MERLIN)
  - ML (BMAD, LIAR, Lucretia, SLEPT, PLACET, MERLIN)
  - BDS (BMAD, LIAR, Lucretia, SAD, PLACET, MERLIN)
  - IP (CAIN, GUINEAPIG)

## Benchmarking is vital

- Want to have at least two codes for each area
  - Benchmarking with experiment (e.g. ATF2)
- Agreed on lattice format
  - XSIF for now, XML later
- Can we define better interface?

# Conclusion

- Quite a useful workshop
- Had some time for discussion