Low Emittance Transport Simulations

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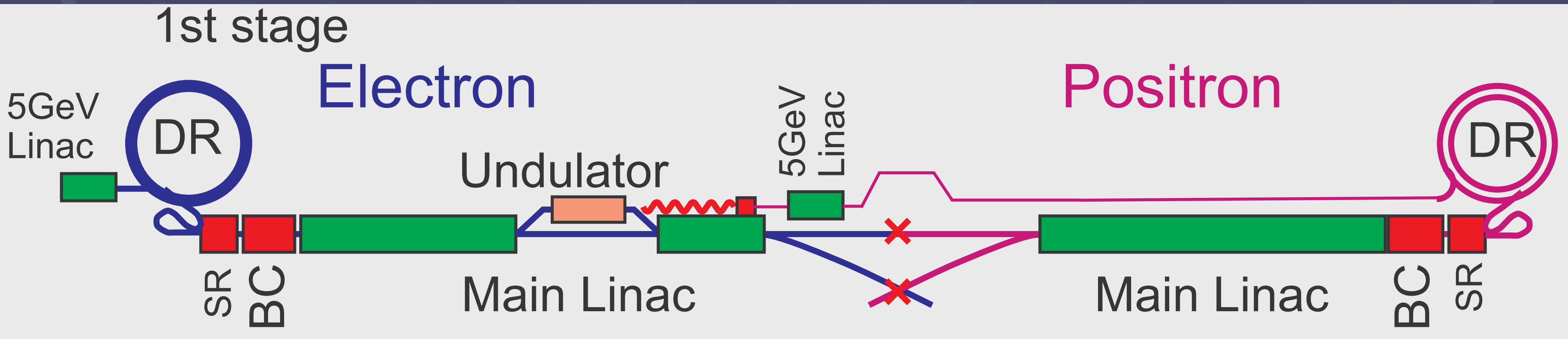
Intro

- Goal Luminosity 2×10^{34} cm^{-2}s^{-1}
  - Four-orders of magnitude more than SLC/LEP
  - Luminosity performance of machine can only be predicted by simulation
- What do the simulators need to specify (deliverables)
  - alignment tolerances
  - specifications for diagnostics (i.e. BPM resolution)
  - tuning magnet configurations
  - tuning algorithms
  - location and number of beam-based feedback systems
  - ….
- Our models have become more sophisticated (realistic) over the last 10 years, but there is still much to do.

What is the LET?



Extraction from damping ring
turn-around
spin rotator
bunch compressor

} Ring To Main Linac (RTML)

main linac
beam delivery system
IR (IP)
(extraction to dump)

Need to preserve bunch quality through ~15 km of accelerator

$$\gamma\epsilon_x = 8 \times 10^{-6} m$$

$$\gamma\epsilon_y = 2 \times 10^{-8} m$$

Static Tuning

- Dealing with the static (as given) alignment errors (i.e. installation errors)
- Aligning all the components to give the minimum emittance growth along the machine <u>using the beam</u>
- Beam Based Alignment Methods
  - quadrupole shunting
  - dispersion free steering (DFS)
  - emittance tuning using closed orbit bumps
  - novel methods…?

Dynamic Stabilisation

- Once we have performed beam-based alignment and tuning, the machine ‘moves’
- Slow moving (diffusive) like ground motion slowly walks the machine away; this must be counteracted
- Fast vibration (>0.2 Hz) causes ‘beam jitter’
  - charge centroid
  - transverse beam size (emittance)
- Must compensate using
  - fast beam-based feedbacks
  - direct mechanical stabilisation techniques
  - combination of both

The 'Gray Area'

- static
- dynamic

two extremes of same spectrum

- Since static tuning requires a finite amount of time, there can be influence of the dynamic effects on the static tuning
  - static tuning algorithms must be fast enough to align things before they move.
  - fast jitter can cause problems for tuning algorithms

Need models that simulate static tuning algorithms in the presence of dynamic effects

Workshop CERN 8-11/2/05

- Lattices (design)
  - are all the ‘bits’ in place?
- Main linac tuning techniques (BBA)
  - comparison of different simulations
  - where are the differences?
  - can we agree on required specifications/tolerances
- RTML tuning approach
  - not well studied or defined
- BDS tuning
  - again BBA, and ‘luminosity tuning knobs’
- Ground motion and feedback systems
  - location and number
  - how they have been modelled etc…
- Spin transport
  - what’s been done, what’s been overlooked?
- Future plans and (global) organisation towards ILC RDR

The Holy Grail

- Start to End LET simulation including
  - entire LET model
  - complete and realistic simulation of static tuning algorithms (including finite time scales)
  - models of beam based feedback systems etc.
  - time-dependent ‘environmental effects’
    - e.g. ground motion
  - realistic beam-beam collisions for luminosity estimation (GUINEA-PIG)

We have the right tools, but software engineering to bolt the pieces together is still needed

DESY (EUROTeV) contribution

- Contractually obliged to participate
  - but we want to anyway ☺
- DESY:
  - LETSTAT:
    Studies of the static tuning algorithms for the Ring-to-Linac beamline, which includes the spin-rotator and bunch compressor sections
    18 person-months
  - LETILPS:
    Integration of codes and further code development towards a sophisticated model of Low Energy Transport system. Participation in simulations of luminosity performance.
    27 person-months
  - FMSIM:
    Participation in Failure Mode studies; development of simulation software; participation in the evaluation of FM.
    27 person months
  - LETFDBK:
    Participation in the development of simulation codes for the study of fast orbit correction (feedback). Studies of feedback performance.
    27 person months
  - HOLCOLSIM:
    Participation in studies of collimator efficiency (halo collimation); effect of luminosity tuning on (machine-based) backgrounds; general background tuning algorithms.
    27 person months

total: 126 man-months (10.5 man-years)