Beam dynamics issues in Beam Delivery System

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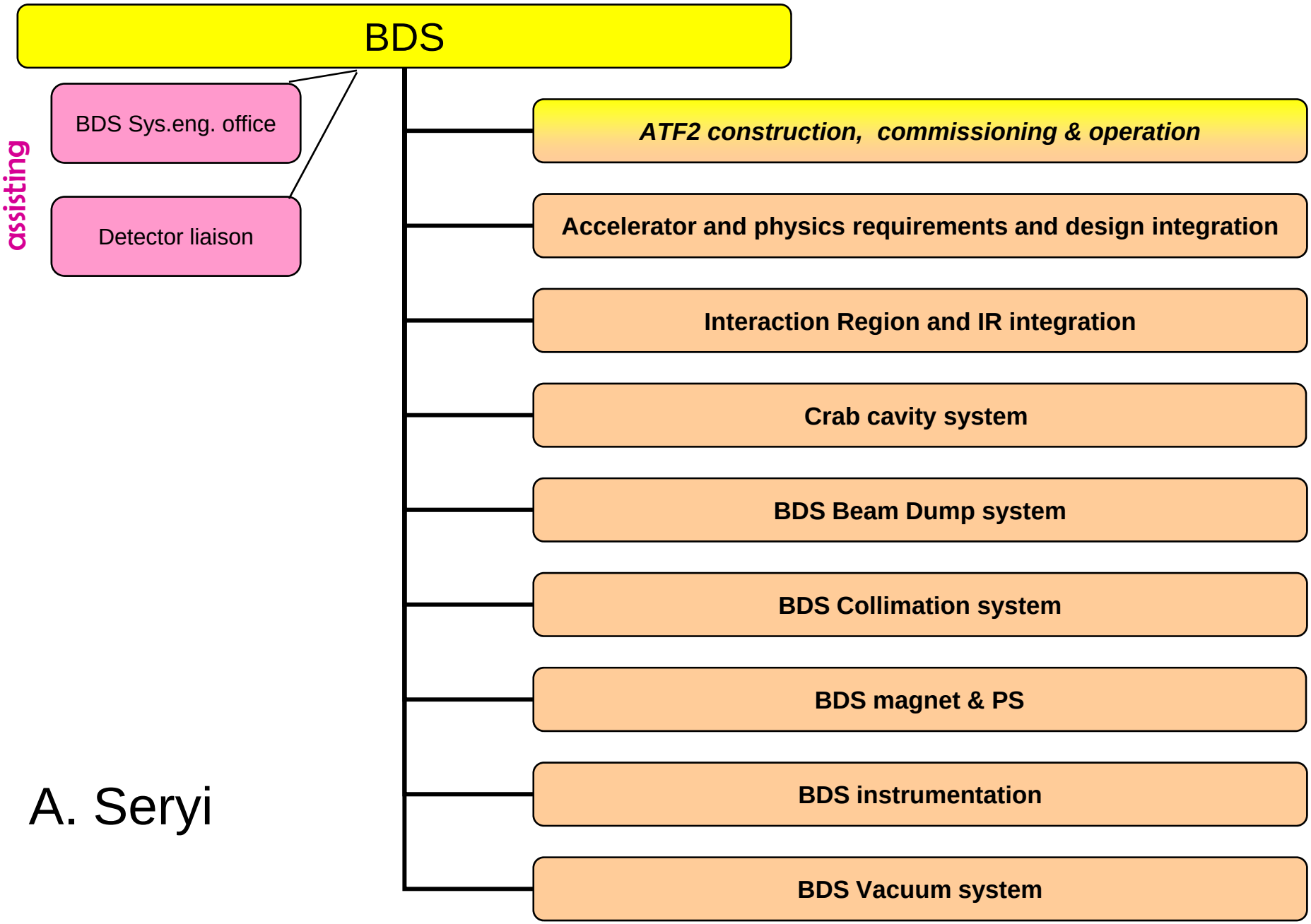
BDS
BDS Sys.eng. office
Detector liaison
assisting
ATF2 construction, commissioning & operation
Accelerator and physics requirements and design integration
Interaction Region and IR integration
Crab cavity system
BDS Beam Dump system
BDS Collimation system
BDS magnet & PS
BDS instrumentation
BDS Vacuum system

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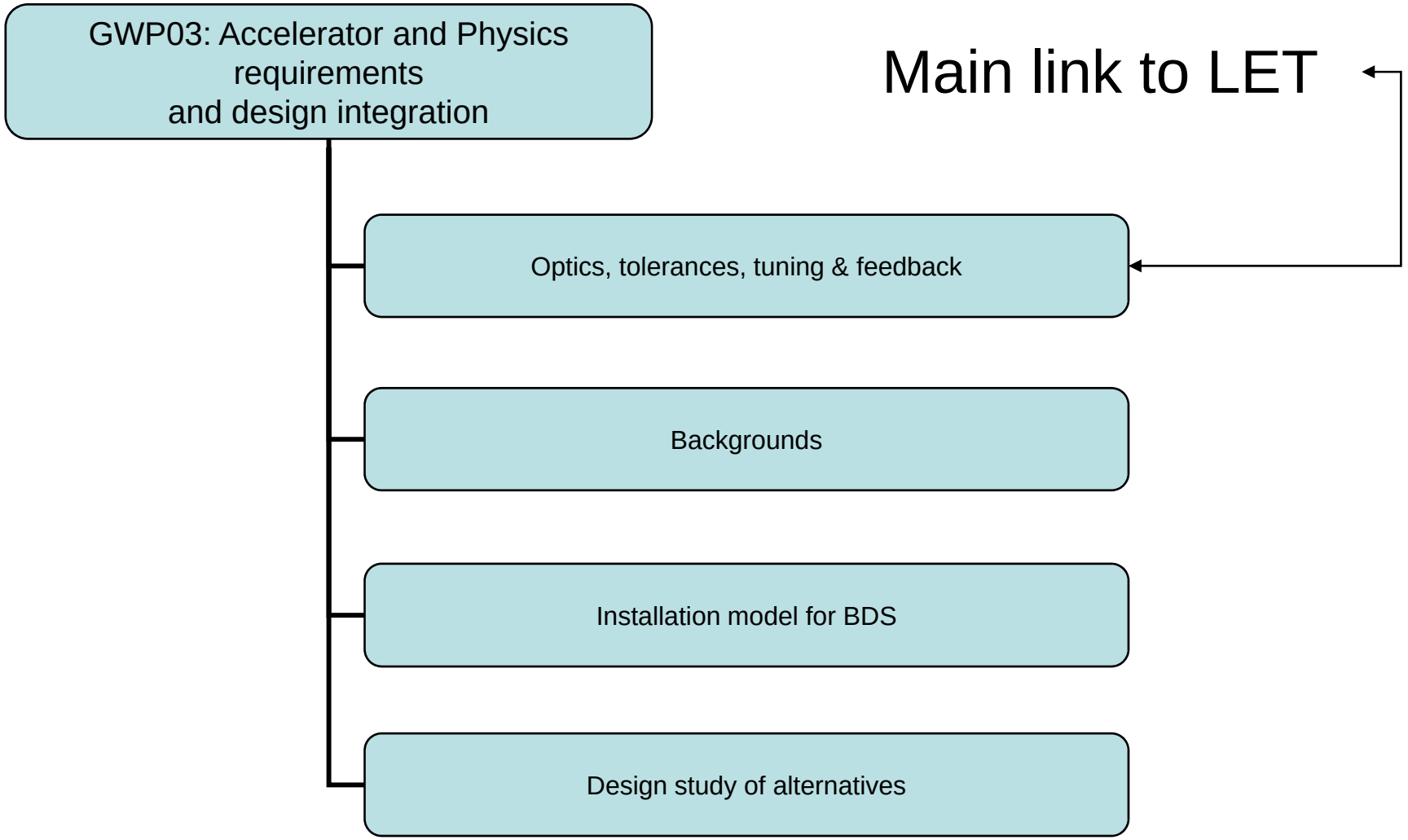
GWP03: Accelerator and Physics requirements and design integration
Main link to LET
Optics, tolerances, tuning & feedback
Backgrounds
Installation model for BDS
Design study of alternatives

Optics, tolerances, tuning and feedback

- Document performance driven specs
- Study performance vs. optics length
- Study optics for magnet types standardization
- Study optics for aperture standardization
- Study High Lumi upgrade path
- Study 1TeV upgrade path for FD, PS, magnets
- Study commissioning needs (other FD, its support, shielding)
- Determine field, stability and other tolerances
- Different L* optics performance & tunability
- Study abnormal optics & MPS issues
- Study Z, 200-350, 500, 1000 GeV CM performance
- Document site specific design features

BDS RDR design

- RDR (ILC2006e) lattice design
  - Hybrid system upgrade to 1 TeV CM without geometry changes
  - Emittance budget dictated by operation @1TeV CM
- Discussions after KOM
  - Study possible reductions in the lattice length by allowing higher emittance growth and degradation of luminosity near boundary of high energy

Upstream Polarimeter Chicane

- RDR design combines functionality of polarimeter chicane (which needs to be operated at constant integrated strength) with detection of laser wire photons and includes detection of off-energy beam (MPS collimator + BPM)
- Many issues for this design

Discussion of issues related to this design :

GWP09 meeting to review Emittance meas (28th Nov)
http://ilcagenda.linearcollider.org/conferenceDisplay.py?confId=2380

GWP03 meeting to discuss the requirements of the upstream polarimeter (29th Nov):
http://ilcagenda.linearcollider.org/conferenceDisplay.py?confId=2399

Collimation Performance Improvement

- RDR collimation performance optimisation - use flexibility of adjusting the phase advances (& to obtain better bandwidth for better collimation efficiency) including the energy spectrometer (F. Jackson, PAC07)
- Full tracking simulations (STRUCT) including absorbers are required to ensure that the spoiler and absorber openings can indeed be relaxed
- Option to use matching quadrupoles before the betatron section to cover entire parameter space will be explored. Need to ensure that the beam sizes on the spoilers guarantee their survival over the entire parameter range.

BDS Collimator Wakefields

- Spoilers (2 β-tron, 1 energy) are smallest apertures in BDS (<1mm)
  - **~10 Absorbers @ 2mm gaps**
- Prediction of wakefield effects has been well established since 'ILC Technical Review Committee' of NLC, TESLA, CLIC (2003)
- Estimation of wakefield kicks (Stupakov theory) → jitter amplification → emittance growth

$$\frac{\Delta\varepsilon}{\varepsilon} = (0.4nA)^2, \qquad A \sim \kappa\beta$$

Stupakov kick factor

incoming jitter

Total jitter amplification factor for BDS

- For current set of spoiler apertures, vertical emittance growth is ~4% for 0.5σ vertical jitter
  - **Should be mitigated by octupole tail folding and lattice optimisation**
- How reliable is emittance growth calculation? – currently under investigation with PLACET (full simulation with Stupakov wakefield implementation)

Magnetic field requirements in the IR

- Magnetic field requirements in the IR

  Magnetic field along the detector axis or along the beamline cause Y shift of the IP position and beam size growth via coupling and other terms

- The coupling effect should be compared with desired tuning stability time (S. Seletskiy, IRENG07)

What level of field “leakage” can we expect to have in the IR?

The limits can be set only on variation of the field in time, not on static value (which may need to be limited by safety or other consideration).

Vibration Tolerances

- Luminosity loss due to jitter of final doublet cryomodules (>5% @ ~200nm RMS).
  - Needs to be convolved with ‘background’ environment of GM and other jitter sources.
- Small effect due to kicker distance from SD0, becomes more pronounced in cases with larger RMS jitter.
- Simulations of BDS tuning show something like ~10% overhead in luminosity after initial tuning. All dynamic lumi-reducing effects should total less than this.
  - Remaining luminosity overhead dictates how long ILC can run before some (online) re-tuning required (~ 3 days with current assumptions).

IRENG07-G.White

Stability Issues

- RDR assumptions of beam jitter entering the BDS :
  - No Intra-train feedback in the beginning of BDS and train to train jitter coming to the BDS is 0.5sigma, which contributes to the jitter amplification factor
  - Bunch to bunch jitter in the train is 0.1 sigma
- What is initial misalignment of trains and how long feedback convergence would last?
  - This defines the losses at collimation and radiation burst
- Alignment, stability and audible noise requirements
  - Impact on detector designs
  - Design and location of facilities
    - Presence of service cavern
  - Effect on location and design of feedback hardware

Stability Issues

- FD stability – relative motion of QF1 and QD0 is more important for push-pull, with these magnets being on different supports
- Detector positioning accuracy
  - Study the correcting methods for detector positioning accuracy
  - Can we compensate by some correcting elements (dipole coils in FD or anti-solenoid?)
- Shallow site issues
  - Stability requirements
    - Vibration
    - Slow settlement

BDS tasks related to LET (1)

- BDS has the most different styles of magnets; standardize the magnets and reduce the styles
- Magnets on strings
  - Additional correctors/PSs
  - How will it affect the tuning + beam based alignment
  - How will it affect the performance after push-pull
- Temperature requirements in the tunnel and its effect on beam stability
- Stability requirements for push-pull
- Angle feedback and integration of other feedbacks?
- Effect of wakes from pumping ports, vacuum chamber misalignments, resistive wall, IR wakes, HOM heating, wake fields from crab, spoilers, other transitions….

BDS tasks related to LET (2)

Laser wire

- Define requirements on emittance measurement (absolute/relative) of train (or bunch) every ? second? → beam tuning procedure
- The present design of laser wire assumes 300 scans per train, which drives the requirements of the laser
- Do we need any beam spotsize diagnostics between collimation region and IP (somewhere in the final focus?)

Crab system

- To understand and verify requirements on the crab cavity mode damping from beam dynamics point of view. e.g. 10E+4 for SOM is difficult from RF design, but may be relaxed with intra-train feedback?
- The alignment of crab cavity and effects of the orbit offset in sextupoles may be perhaps fixed with some small vertical crab cavity nearby the main one.

Beam parameters for 200-350 GeV

- The detector, theory and other groups need input for 200 and 350 GeV CM parameters, which would then cover all the endpoint and middle point of the baseline energy range where the luminosity will be delivered, as specified in the ILC Parameter Document.
- There is also a need to identify IP parameters for 90GeV CM, which is beyond the baseline range, but could be used for calibration.
- ILC operating parameters study will be led by ILC Integration group.
- Andrei has generated first draft set of parameters for 90-200-350 GeV CM. More detailed study will include dependence on L* and will be produced by Sendai.

Timescale and planning for the EDR

- The detailed EDR plan for GWP03 at task level is being developed.
- There is a need to freeze the lattice design as early as possible in order to pass the information to other groups. However, to understand the implications of reducing the tunnel length with the decisions related to the maximum energy range, reviews of physics driven measurements etc it seems unlikely to be achieved by Sendai. Our goal is to freeze the lattice design by autumn 2008.
- In addition to the existing BDS links to LET on start-to-end simulations and tuning, we need to define links of various GWP03 tasks to LET.