CLIC issue: Drive Beam Power Production

1. **Short technical description and corresponding category(ies) of issues :**

Feasibility	Performance	Cost
X		X

2. **CLIC nominal parameter issues and comparison with state of the art (in text and/or table):**

Simulations

The simulation studies of the CLIC decelerator in an advanced state, and the items deemed most critical have been investigated by simulations, and a baseline design deemed satisfactory have been found.

The following main areas have been investigated by simulation:

- The focusing strategy have been established, and a first version of magnet specifications have consequently been developed.
- The PETS baseline design is integrated in PLACET simulations, including a simplified spectrum of harmful transverse dipole wake.
- Stability analysis of the decelerator lattice has been performed, showing good beam stability for nominal PETS design. However, scaling the PETS transverse Q-values with a factor 2 leads to unacceptable beam envelope growth due to the transverse wakes.
- it has been shown that advanced beam based correction is needed; advanced in the sense "better than 1-to-1 steering". It has been shown that dispersion free correction should perform very well with respect to minimising the beam envelope growth due to quadrupole misalignment. Techniques have been developed in order to perform dispersion free correction by delayed switching, implying very simple operation and no need to change the machine itself during steering. The correction strategy leads to BPM specifications of which a first version will soon be available.
- Based on beam dynamics requirements, limits have been determined for the acceptable transverse deflecting voltage in PETS RF breakdowns.

TBTS

First experimental results relevant for the decelerator (benchmarking of simulations) are available for experiments at the TBTS:

- First results from the Two-Beam test stands indicate agreement between theoretical and the measured power and energy loss at the level of better than 10%. For the transverse kicks further experimental data is needed in order to conclude.

TBL:

The first PETS is in place and the first BPMs and quadrupoles on movers are installed.

3. **R&D program presently set-up**:

TBTS

Further TBTS PETS tests will be performed with larger CLEX current, improved recirculation, and thus larger beam energy extraction and transverse kicks. The transverse dipole wake can be directly verified using antennae in the TBTS. These tests will benchmark further correspondence of theory and simulation, versus measurements, as started in this year.

TBL

The main testbed for the energy extraction and the test-bench for the decelerator is the TBL. It will provide possibilities for much larger energy extraction and one expects a significant effect of transverse kick combined with betatron motion. The current schedule is to have 8 PETS installed as well as a spectrometer dump for energy spectrum studies, toward the summer 2010. This will allow to verify transport of a beam with up to 30% of the energy extracted.

Simulations

Further refinements of PLACET simulations, including more studies of CLIC decelerator with recirculation, if this is still considered an option.

Losses due to beam halo and tail generation.

4. **What performances will realistically be achieved (Target Performances):**
   - **by end 2010**

Simulations:

- Lattice design including cost optimisation options.
- Study evidencing the decelerator stability with the current PETS.
- Studies supporting that beam.based alignment of the decelerator is effective.
- Some loss estimates for the decelerator

TBTS

- Improved measurements of power and energy loss. Transverse kick measurements.
- Measurements of dipole kicks.

TBL

The current schedule is to have 8 PETS installed as well as a spectrometer dump for energy spectrum studies, toward the summer 2010. This will allow to verify transport of a beam with up to 30% of the energy extracted.

- **by end 2012 (including FP7)**

TBL

It is foreseen to have 16 PETS installed in the TBL by 2011 and this will a allow to address a number of important issues relevant for the CLIC decelerator:

- Beam envelope increase due to dipole wake is predicted to be similar to the one for CLIC
- Decelerator alignment studies. Simulations show that even if TBL will not need advanced beam-based correction, the algorithms should still be effective. The TBL will therefore be a good testbed.
- Transport of a low energy beam (TBL space charge effects should be similar to CLIC, since the energy is lower by a factor 4 and the current is lower by a factor 3)
- Beam losses (halo generation)
- But limitations exist since even with 16 PETS we are limited to few betatron oscillations.
- Instrumentation and other hardware (movers) test-bed for the CLIC decelerator

Simulations

Further refinement of PLACET simulations. Items that are not estimated to be critical, should still be investigated before building large scale facilities. A non-exhaustive list is :

- Inclusion of real GdfidL wake function in the tracking simulations.
- Effects of of higher order wake fields, including dependence of the longitudinal mode on the transverse positions and effects of the quadrupole wakes.
- Effects of space charge.
- Effects of non-linear magnet multipole components.

5. **Comments on validation of CLIC parameters issues by comparison with Target Performances:**

6. **Optional: What additional R&D could be set-up to eventually reach the validation of nominal CLIC parameters (estimation of resources and schedule?)**