First Beam Tests of the CLIC Power Extraction Structure in the Two-beam Test Stand

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THE TWO-BEAM TEST-STAND
Demonstrate two-beam acceleration
- test RF components
- power production in PETS
- high gradient acceleration with low RF breakdown rate
Concentrate on
- beam stability & dynamics limitations from RF breakdown
- physics of RF breakdown

DESIGN
- upstream quadrupole triplet to adjust to a small beam size.
- PETS with external recirculation.
- two steerer dipoles and two BPMs before and after the test area to control and monitor incident angle and beam position.
- downstream quadrupole triplet provides a small beam size for energy measurements in the spectrometer line.

RECCIRCULATION AND RECONSTRUCTION
Recirculation
- factor \( g \) = splitter ratio \( \times \) times ohmic losses
- phase shift \( \varphi \)
Field after \( M \) cycles:
\[
E_{M} = E_{beam} \sum_{m=0}^{\infty} g^m e^{i\varphi}
\]
Reconstruction
Use BPM2 intensity measurement to calculate output power and phase, compare to measured (12 GHz diode, I&Q demodulator).
Comparison yields \( g = 0.75 \), \( \varphi = -18^\circ \).

PULSE SHORTENING
Conditioning: increased beam intensity \( \rightarrow \) increased RF power.
Some pulses: output power shorter than reconstructed power.
In model:
- vary gain \( g \) and phase \( \varphi \)
- or vary bunch arrival phase

ENERGY LOSS MEASUREMENTS
Methods
- BPMs in the spectrometer line: \( <U_H> \)
- power and beam intensity measurement: \( <U_p> \)
- beam intensity measurement and recirculation reconstruction:
\[
<U_{M}> = \Re(E_{M}) L F(\lambda) - \frac{1}{2} E_{beam} L F(\lambda)
\]
RMS difference <20% for ~75% of pulses

KICK MEASUREMENTS
Significant beam kicks have been observed
- for 1 mm off-axis: expectation <100 \( \mu \)rad due to dipole wake
- for RF breakdown: unknown
Use 5 BPMs to estimate offset (X), angle (Xp) at centre PETS and the relative kick angle.

CONCLUSIONS
- extensive possibilities to correlate beam and RF measurements.
- simple constant parameter model gives a good agreement between estimations and measurements of the RF power production and beam energy loss.
- ongoing work to improve the quality of the modelling and measurements and extend their scope.

First results demonstrate that the TBTS is an excellent tool for studying the PETS dynamics.

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