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

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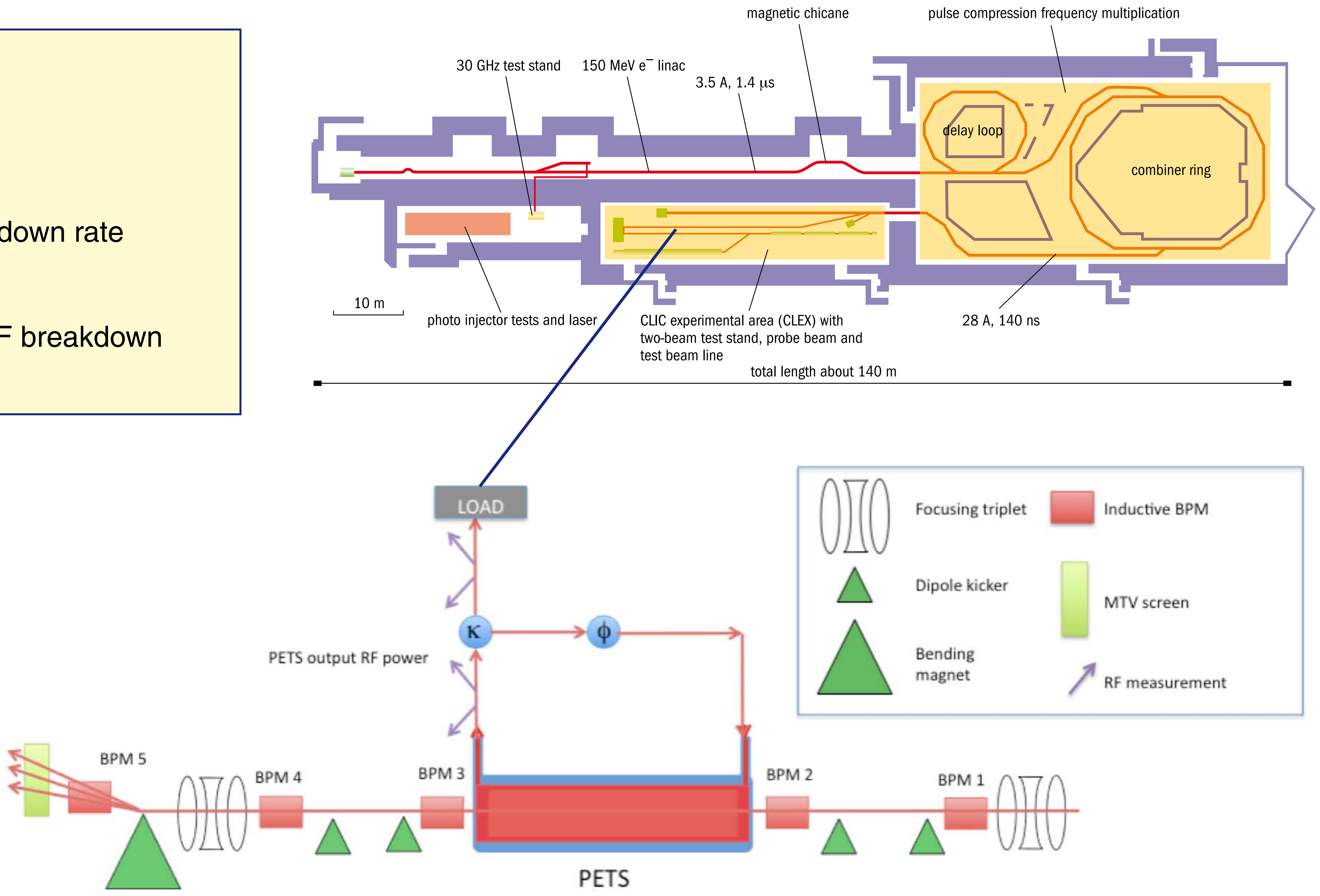
THE TWO-BEAM TEST-STAND

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 BPM's 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.

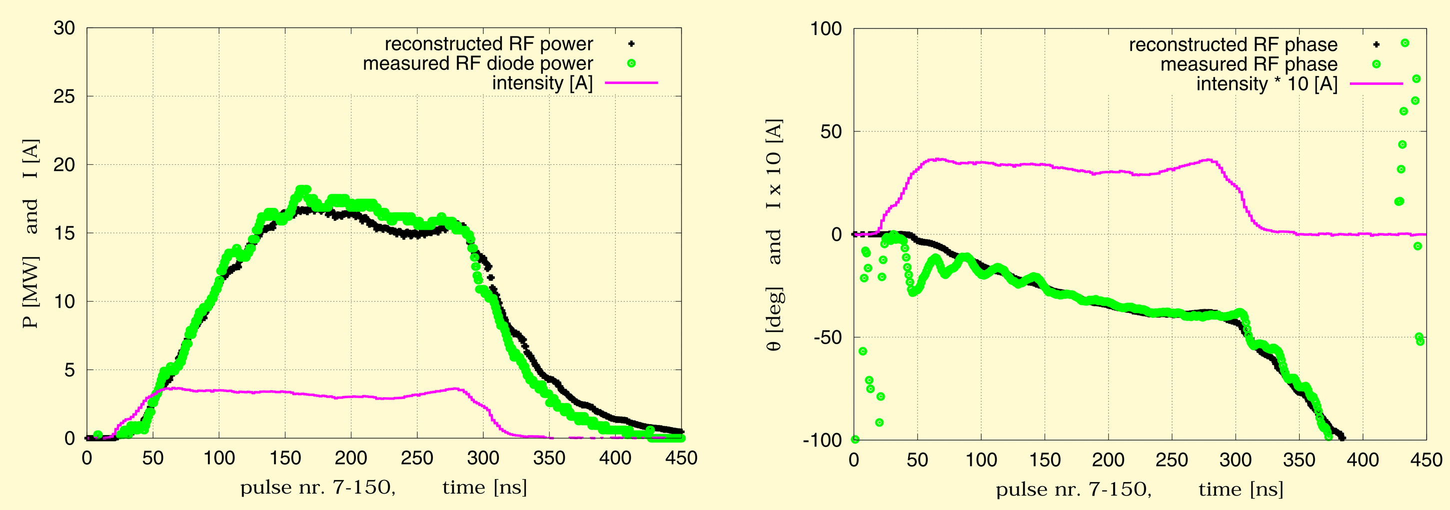
RECIRCULATION AND RECONSTRUCTION

Recirculation
- factor g = splitter ratio κ times ohmic losses
- phase shift φ

Field after M cycles: $E_M = E_{beam} \sum_{m=0}^{M} g e^{j\phi}$

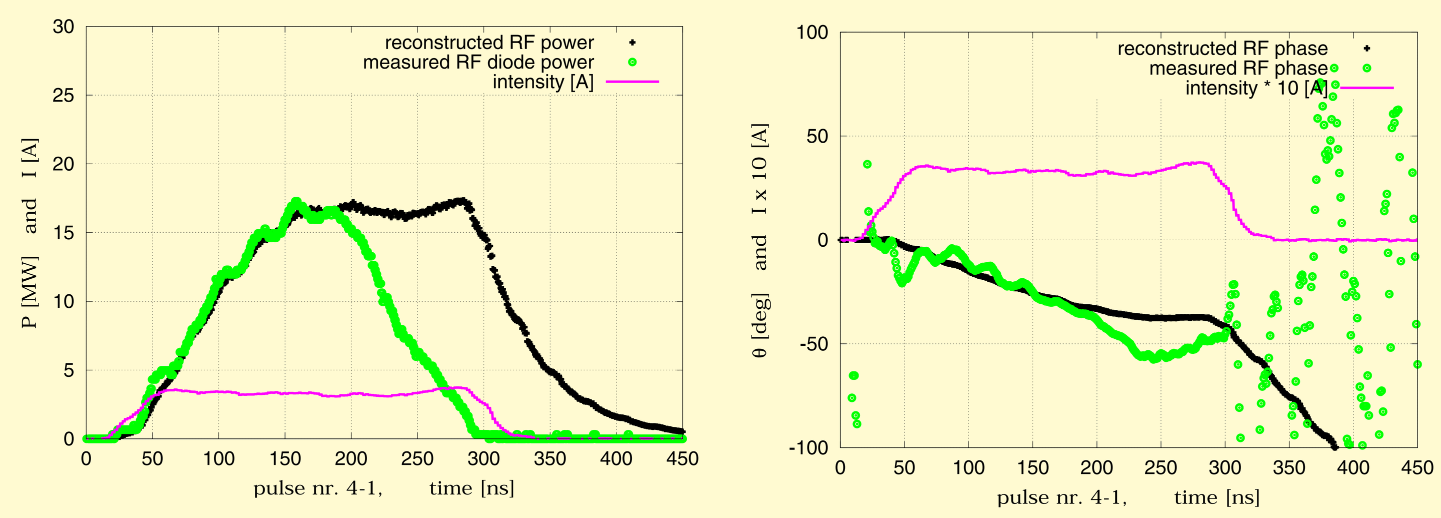
Reconstruction
Use BPM2 intensity measurement to calculate output power and phase, compare to measured (12 GHz diode, I&Q demodulator).

Comparison yields g = 0.75, φ = -18°.



PULSE SHORTENING

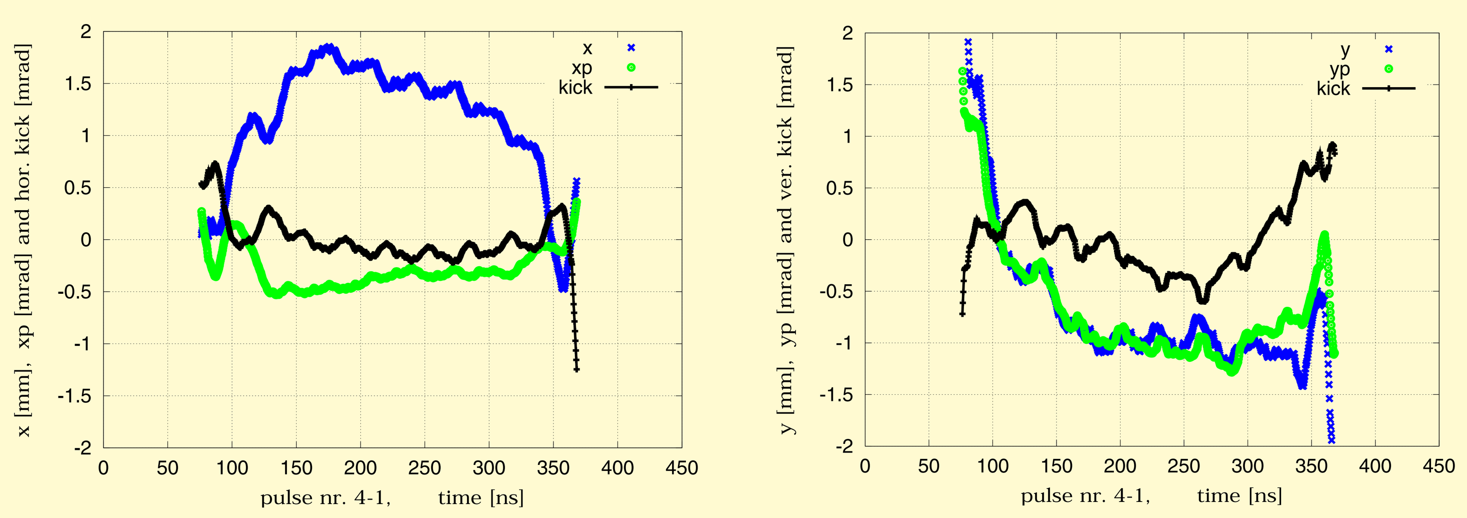
Conditioning: increased beam intensity --> increased RF power.
Some pulses: output power shorter than reconstructed power.
In model:
- vary gain g and phase φ
- or vary bunch arrival phase



KICK MEASUREMENTS

Significant beam kicks have been observed
- for 1 mm off-axis: expectation <100 µrad due to dipole wake
- for RF breakdown: unknown

Use 5 BPM's to estimate offset (X), angle (Xp) at centre PETS and the relative kick angle.

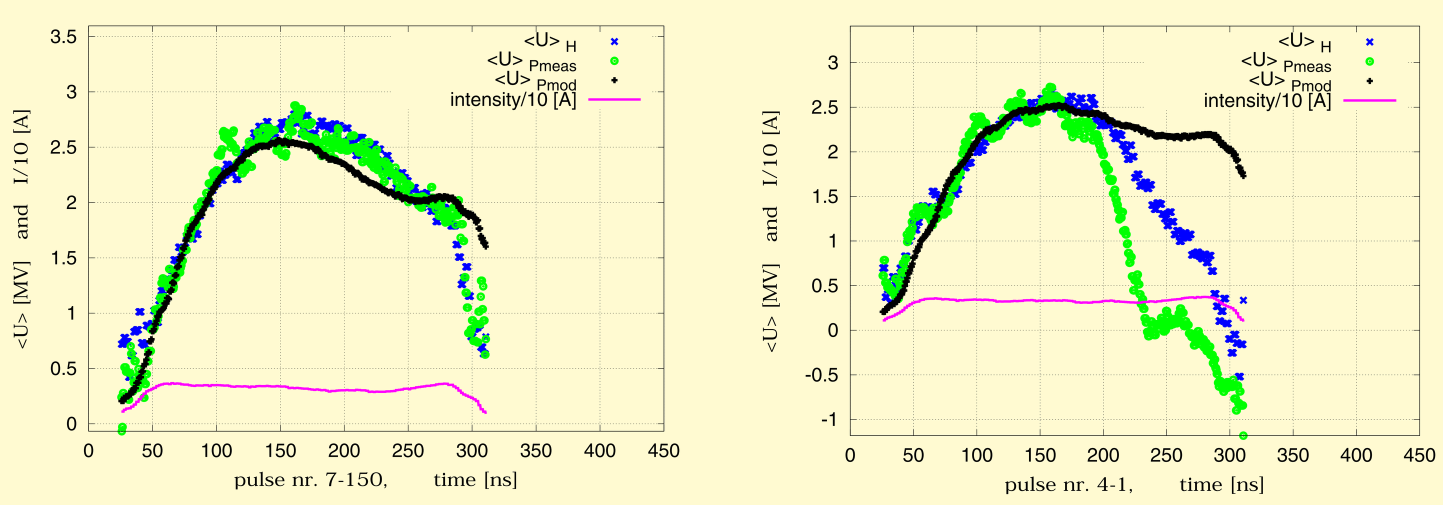


ENERGY LOSS MEASUREMENTS

Methods
- BPM5 in the spectrometer line: $\langle U\rangle_H$
- power and beam intensity measurement: $\langle U\rangle_{Pmeas}$
- beam intensity measurement and recirculation reconstruction:

$$\langle U_M \rangle = \Re(E_M) LF(\lambda) - \frac{1}{2} E_{beam} LF(\lambda)$$

RMS difference <20% for ~75% of pulses



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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