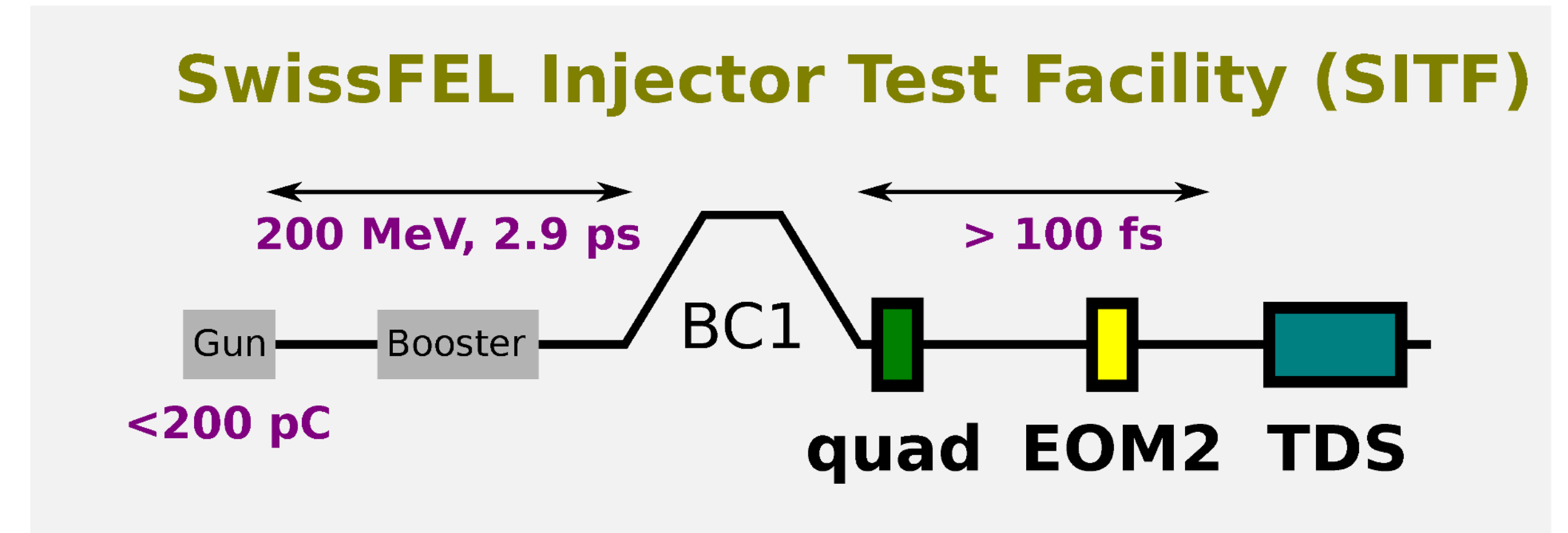




ABSTRACT

SwissFEL is an electron LINAC based X-ray source under construction at Paul Scherrer Institute (PSI) in Switzerland. Electro-optic monitors (EOM) will be available for bunch temporal profile measurements before and after the first compression stage. The profile reconstruction is based upon spectral decoding technique. This diagnostic method is non-invasive, compact and cost effective. It does not have high resolution and wide dynamic range of an RF transverse deflecting structure (TDS), but it is free of transverse beam size influence, what makes it a perfect tool for fast compression tuning. Now we present results of measurements with compressed bunches of a few hundred femtoseconds. EOM has demonstrated the dynamic range of interest for the SwissFEL first compression stage (300-600 fs). Corresponding TDS results are presented for reference.

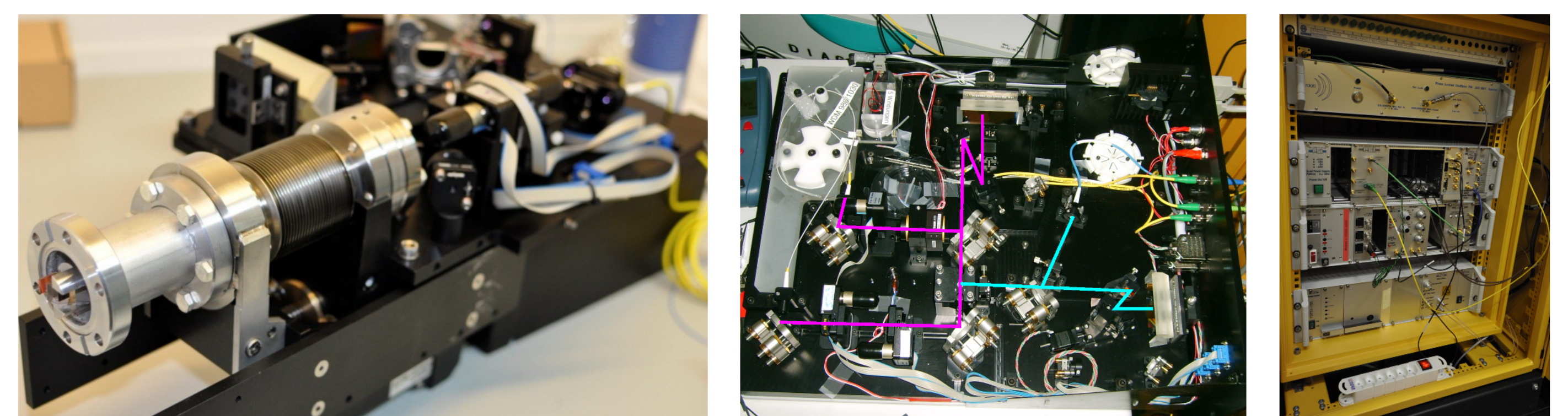
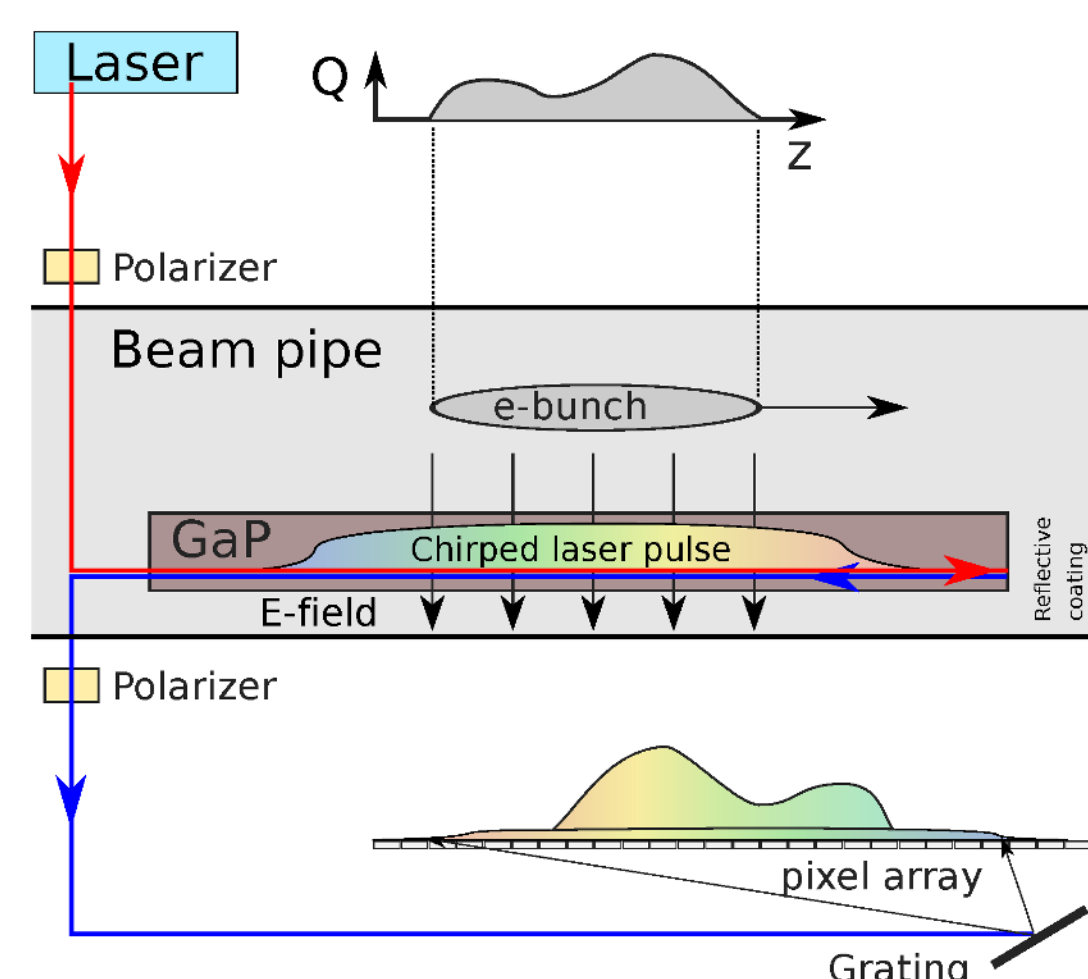


ELECTRO-OPTIC SPECTRAL DECODING (EOSD) SETUP

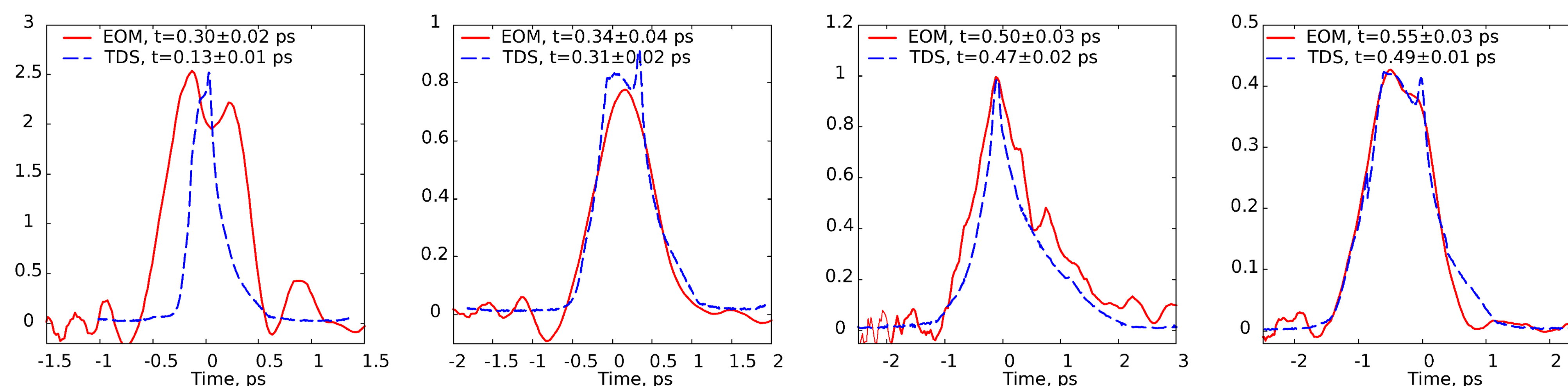
The laser generates 5-10 nJ pulses at 1030 nm with fundamental frequency of 1 MHz at the output. A 2 mm thick GaP crystal is installed in the beam pipe.

Linearly polarized laser beam is almost blocked by nearly crossed polarizers without external electric fields. Once a laser pulse and an electron bunch are overlapped in time, a polarization modulation proportional to the electric field is induced along the laser pulse. It is converted into an intensity modulation after the second polarizer. An optical spectrometer is used to record the modulated laser spectrum.

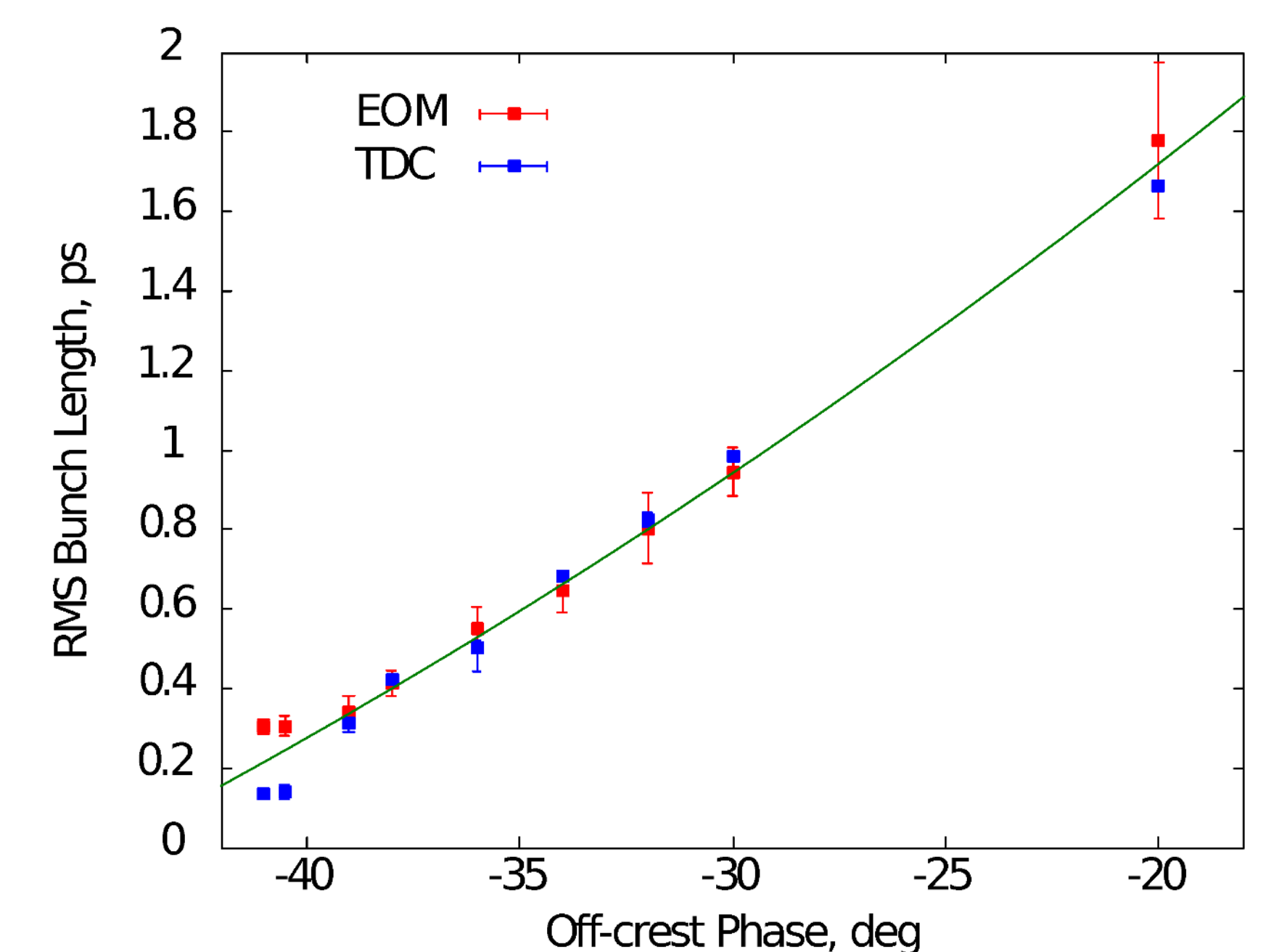
Synchronous propagation of the laser pulse and electron bunch is of critical importance for high resolution and large modulation amplitude.



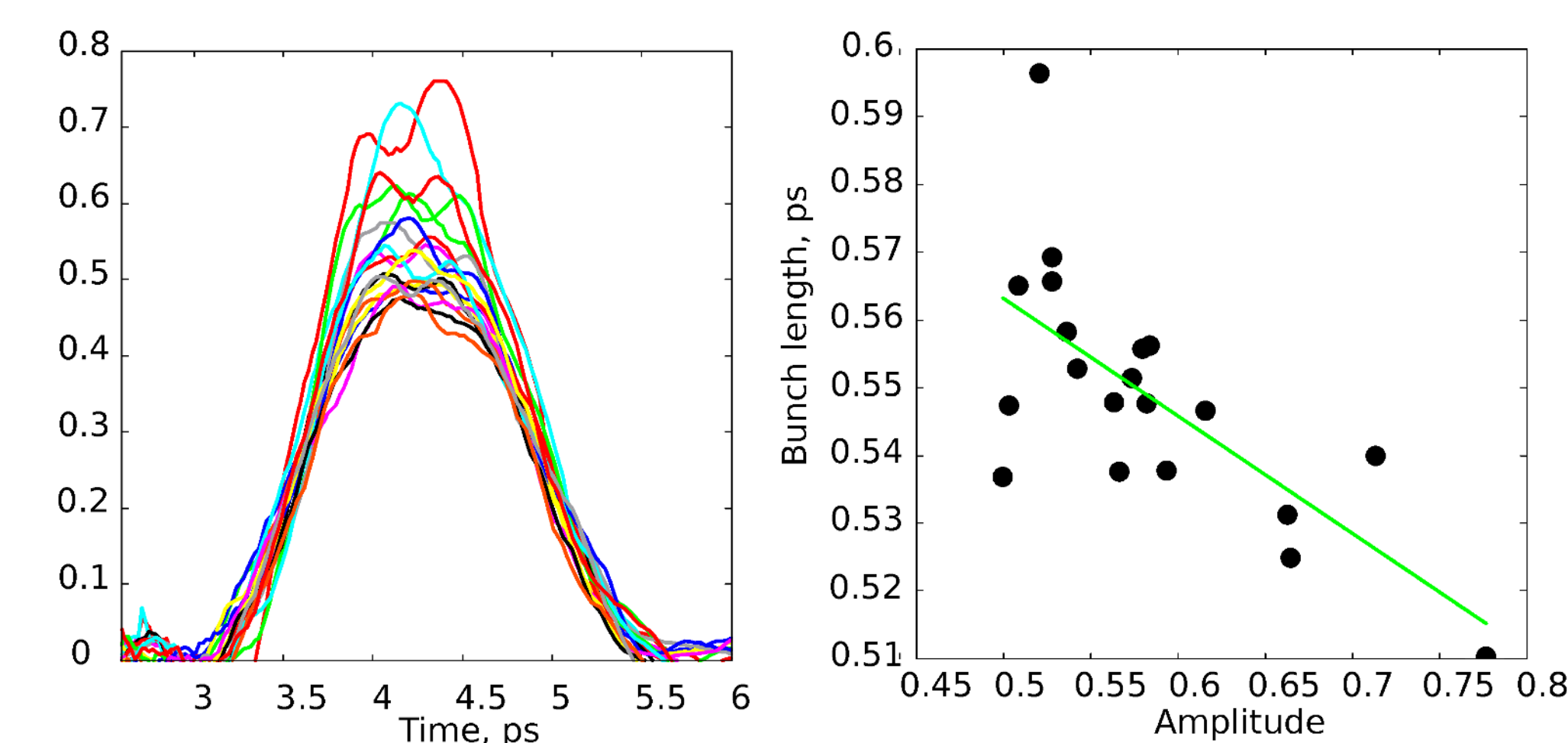
EXPERIMENTAL RESULTS



All bunch duration values are **root mean square (RMS) values of a fitted gaussian distribution**. Error bars indicate statistical error of 10 trials for TDS and 100 for EOM both at 2-3 Hz repetition rate. Bunch charge was kept at **100 pC** during the entire period of measurements. Profile plots are showing the amplitude of the relative laser pulse modulation of EOM, the TDS signal is normalized for convenience of the data collation. EOM and TDS do not have synchronous readout and the corresponding measurements are done in sequence one after the other.

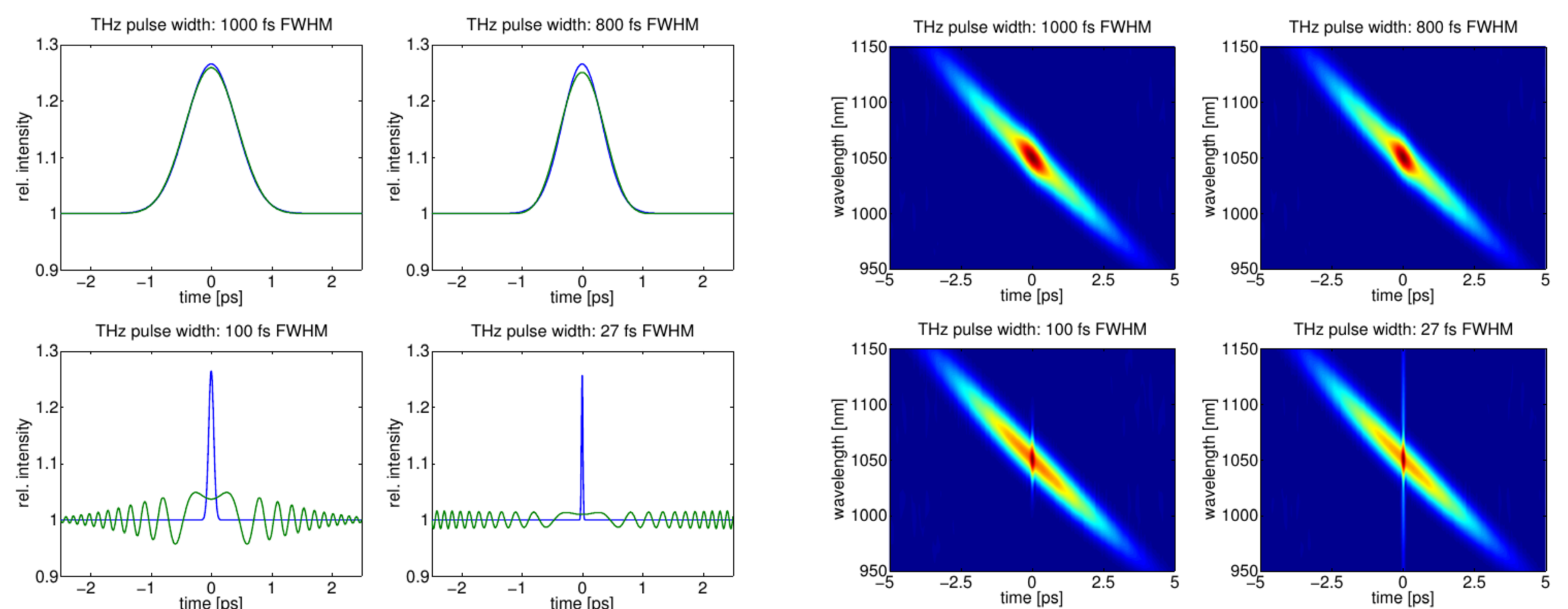


BUNCH PROFILE STABILITY

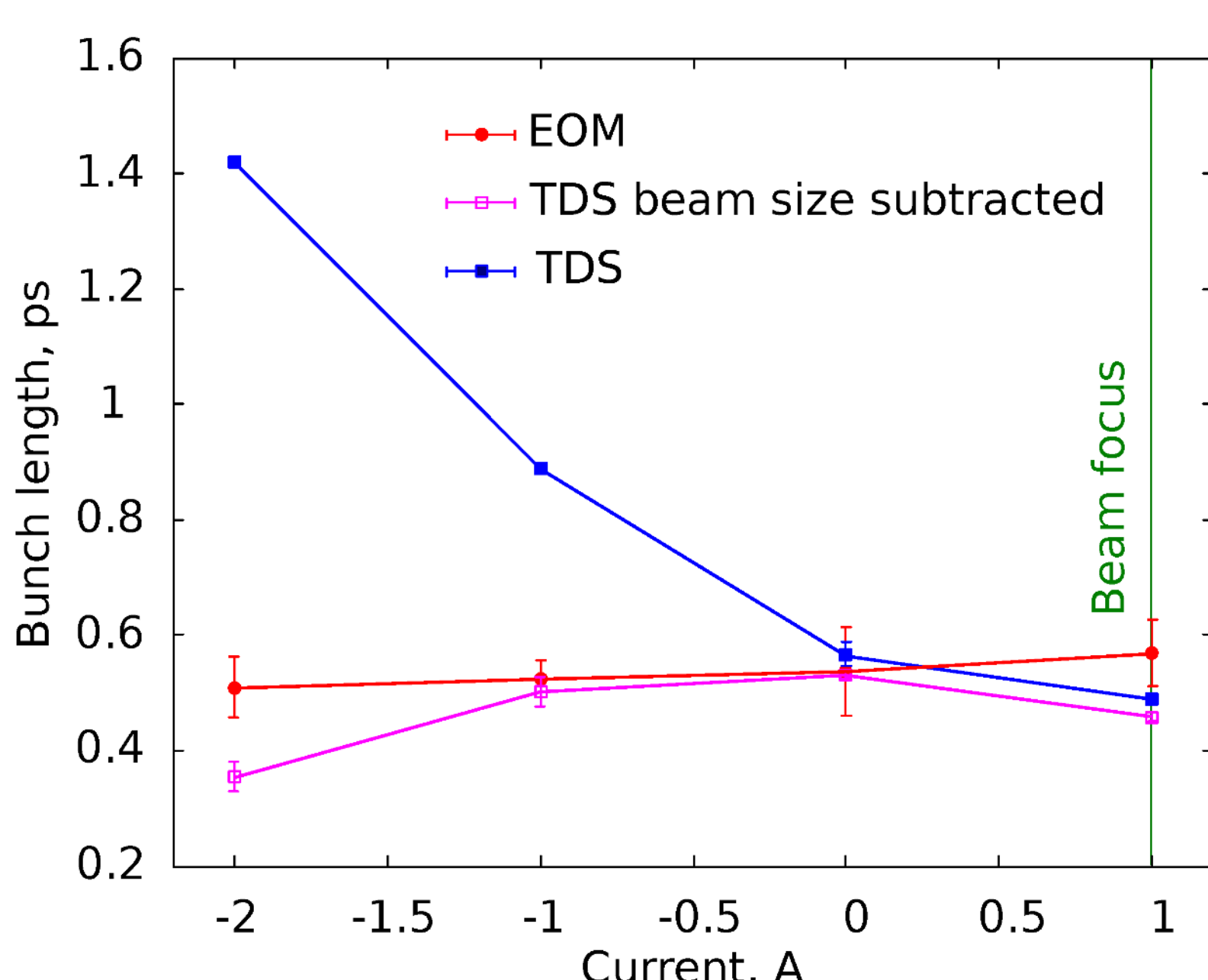


A set of 15 measured profiles. Charge RMS fluctuation 1%, bunch length 3%, modulation amplitude 12%

FREQUENCY MIXING (Courtesy of F. Müller)



TRANSVERSE SIZE EFFECT



EOM and TDS response is represented as a function of a quadrupole magnet current which changes the bunch size at the detectors. TDS bunch size subtraction procedure is applied

CONCLUSIONS

Good agreement with transverse deflector results in a wide dynamic range. Profile amplitude fluctuates stronger than the relevant beam parameters. No significant dependence on transverse size observed. EOM resolution is limited by frequency mixing.

Advantages

- + measurements of bunch temporal profile
- + no transverse size influence
- + absolute calibration
- + non-invasive

Disadvantage

- limited resolution of spectral decoding