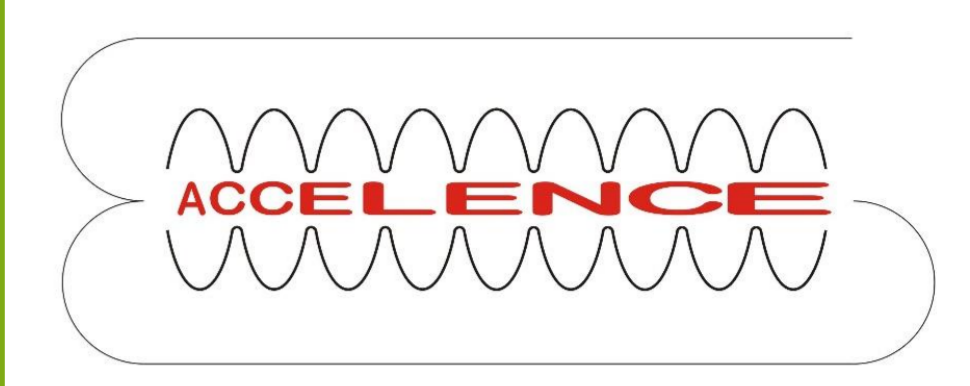


Once Recirculating Energy Recovery Linac Operation of S-DALINAC*



TECHNISCHE
UNIVERSITÄT
DARMSTADT



M. Arnold^{1,#}, J. Birkhan¹, F. Hug², J. Pforr¹, N. Pietralla¹, F. Schließmann¹, M. Steinhorst¹

¹Technische Universität Darmstadt, Germany; ²Johannes Gutenberg-Universität Mainz, Germany

*Work supported by DFG through GRK 2128

Abstract

The S-DALINAC is a thrice recirculating superconducting electron accelerator which can be either used in conventional accelerating operation or, since a major upgrade in 2015/2016 was installed, as an energy recovery linac (ERL) alternatively. A once or twice recirculating ERL operation is possible due to the layout of the accelerator. For both setups beam dynamics calculations have been performed or are under investigation at the moment. The once recirculating ERL mode was proven successfully in August 2017, which set the first German ERL into operation. The results will be discussed more in detail in this contribution.

S-DALINAC

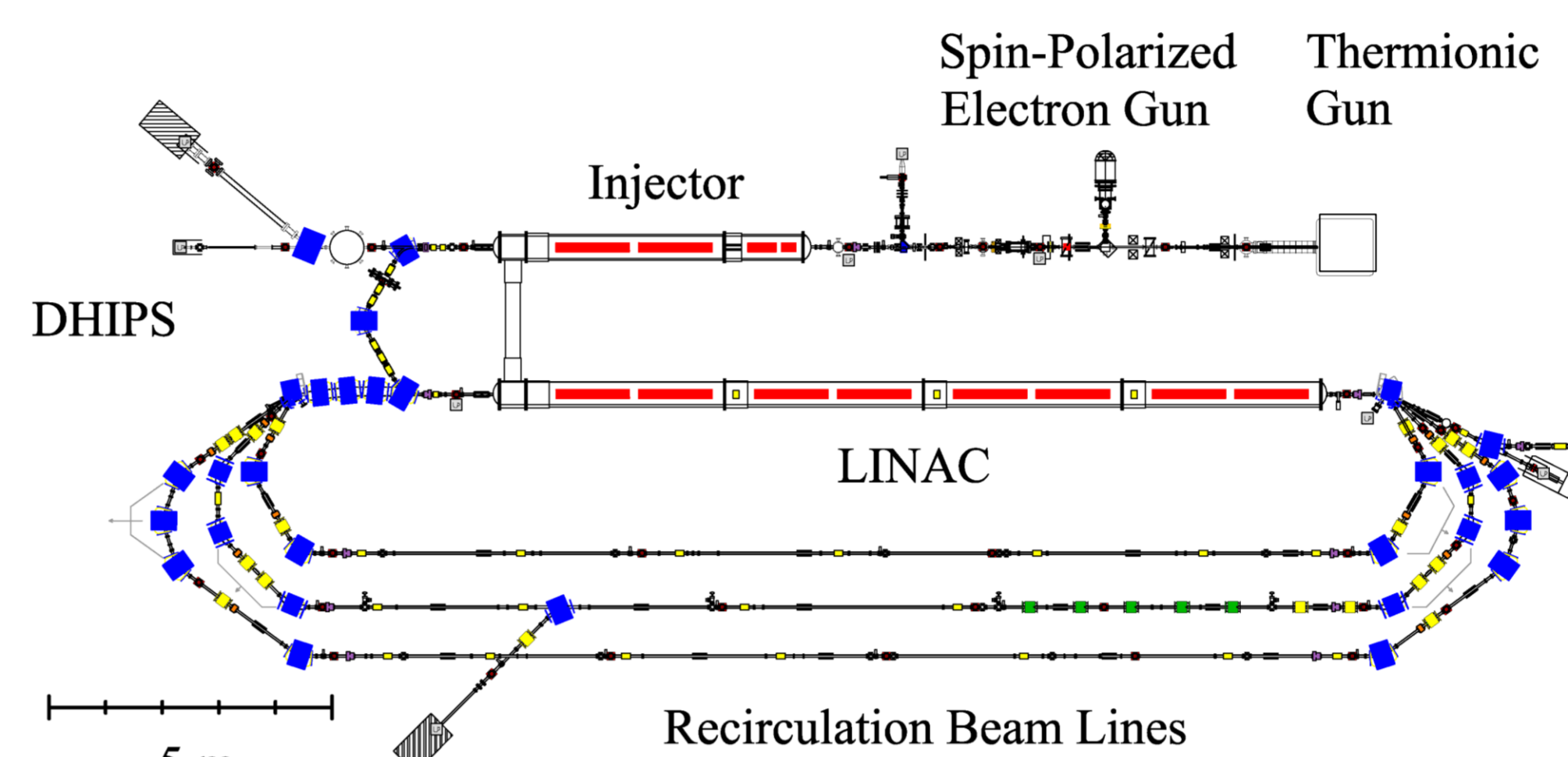


Figure 1: Floorplan of the S-DALINAC.

Design energy: 130 MeV
Beam current at 130 MeV: 20 μ A
Frequency: 2.997 GHz
Duty cycle: cw
Particles: Polarized or unpolarized electrons
Temperature: 2 K

ERL Mode

- Once recirculating ERL mode
- Energy ratio injector to main linac: 1:8
- Twice recirculating ERL mode
- Energy ratio injector to main linac: 1:4

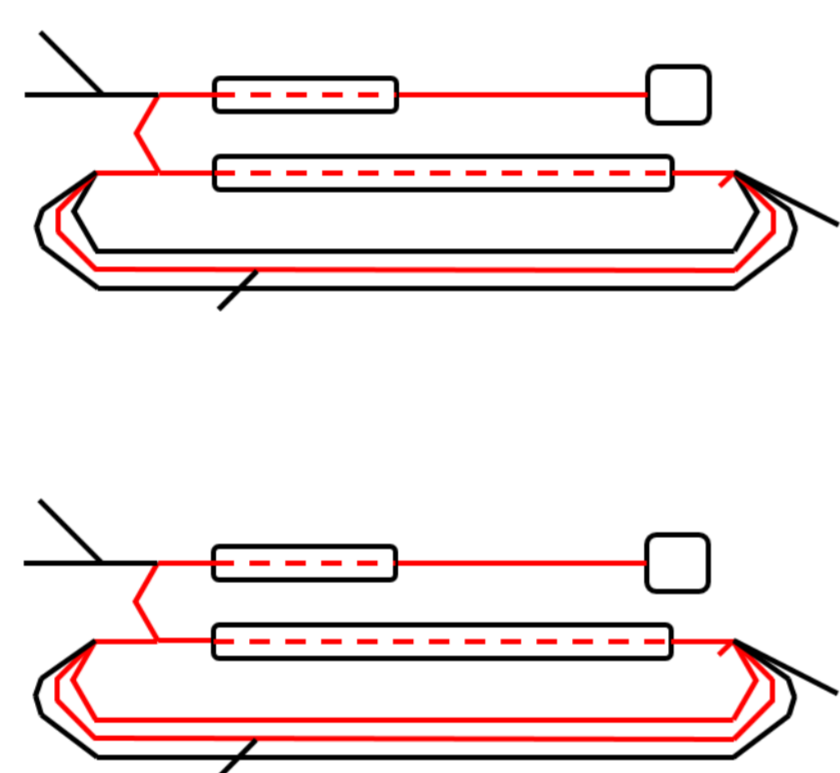


Figure 2: Scheme of once and twice recirculating ERL mode.

Beam Dynamics Simulation

- Once recirculating ERL – see Figure 3
- Twice recirculating ERL under investigation
- Done with *elegant*

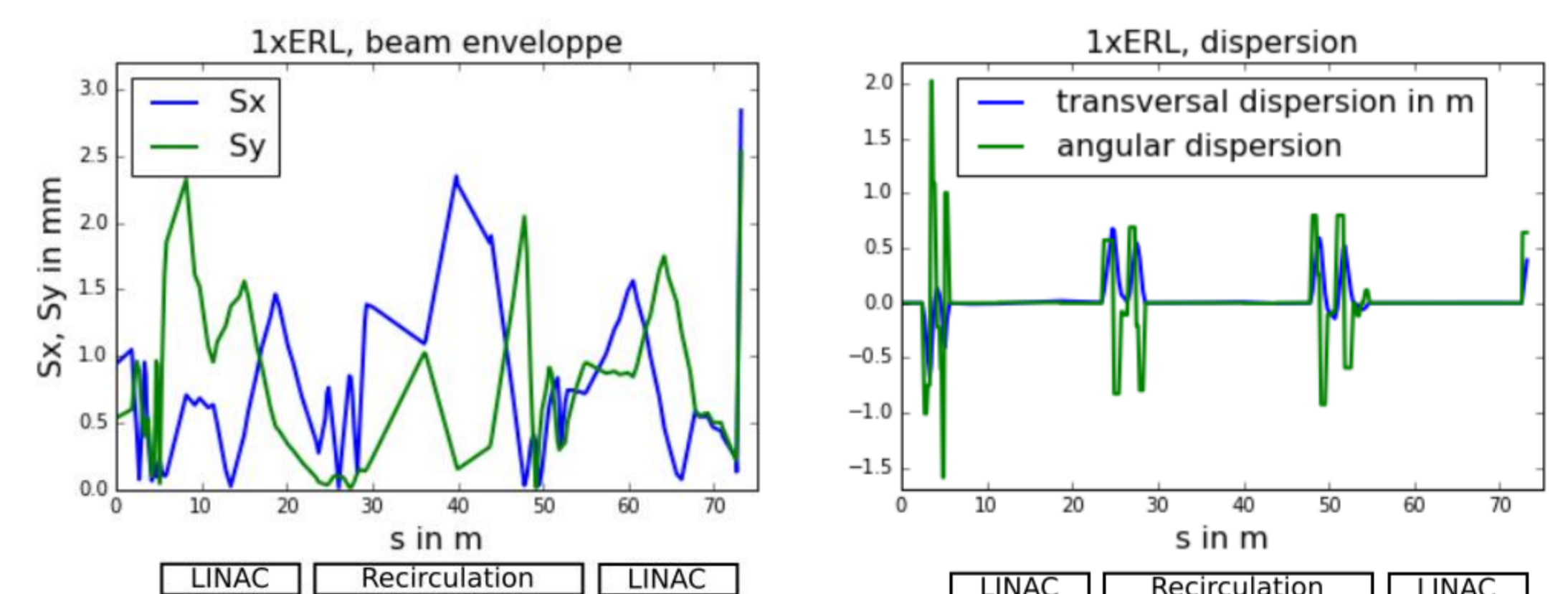


Figure 3: Envelope and dispersion curves along the beam line for the once recirculating ERL mode.

First Energy Recovery Linac Operation

- In August 2017 first run in once recirculating ERL mode
- First running ERL in Germany
- Efficiency of 88.7^{+9.3}_{-5.1}% achieved

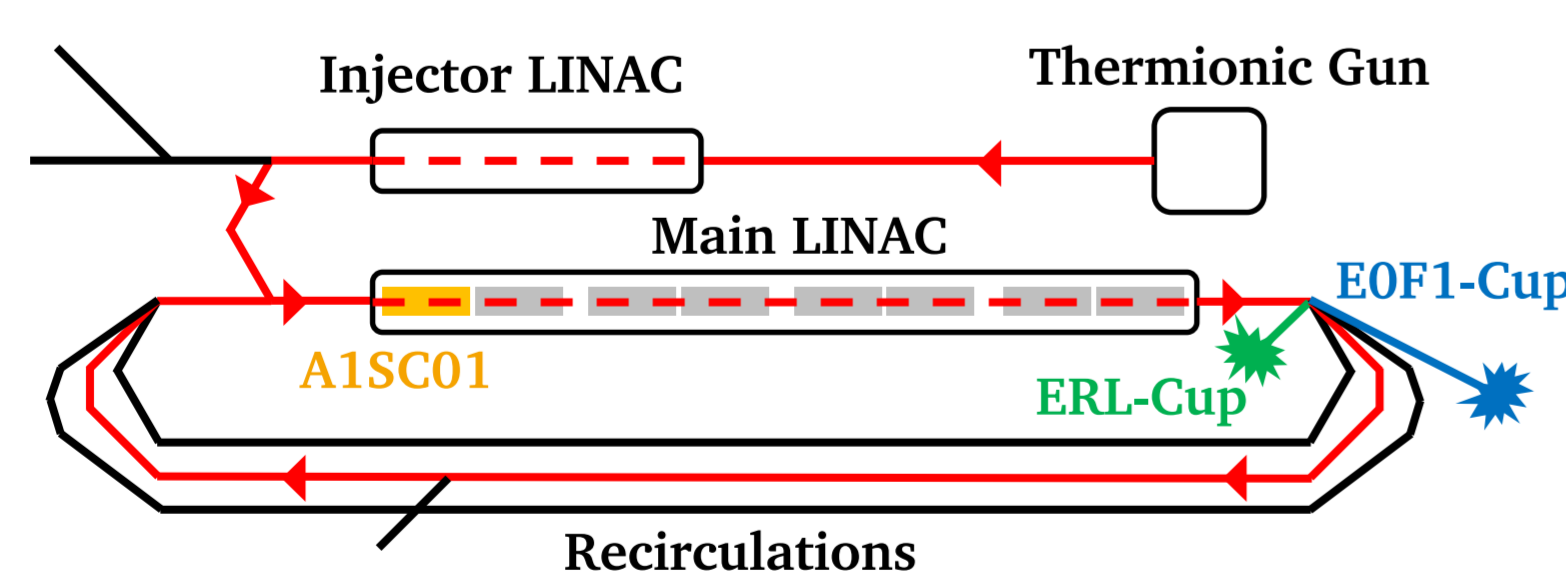


Figure 4: The beam path of the once recirculating ERL mode is shown in red. Parameters observed during the measurement are the powers of A1SC01 as well as the beam currents for ERL mode (ERL-Cup) and normal, accelerating operation (EOF1-Cup).

Table 1: Overview of parameter settings for once-recirculating ERL operation.

Parameter	Value
Energy gain injector	2.5 MeV
Energy gain linac	20.0 MeV
Current (before injector)	1.2 μ A

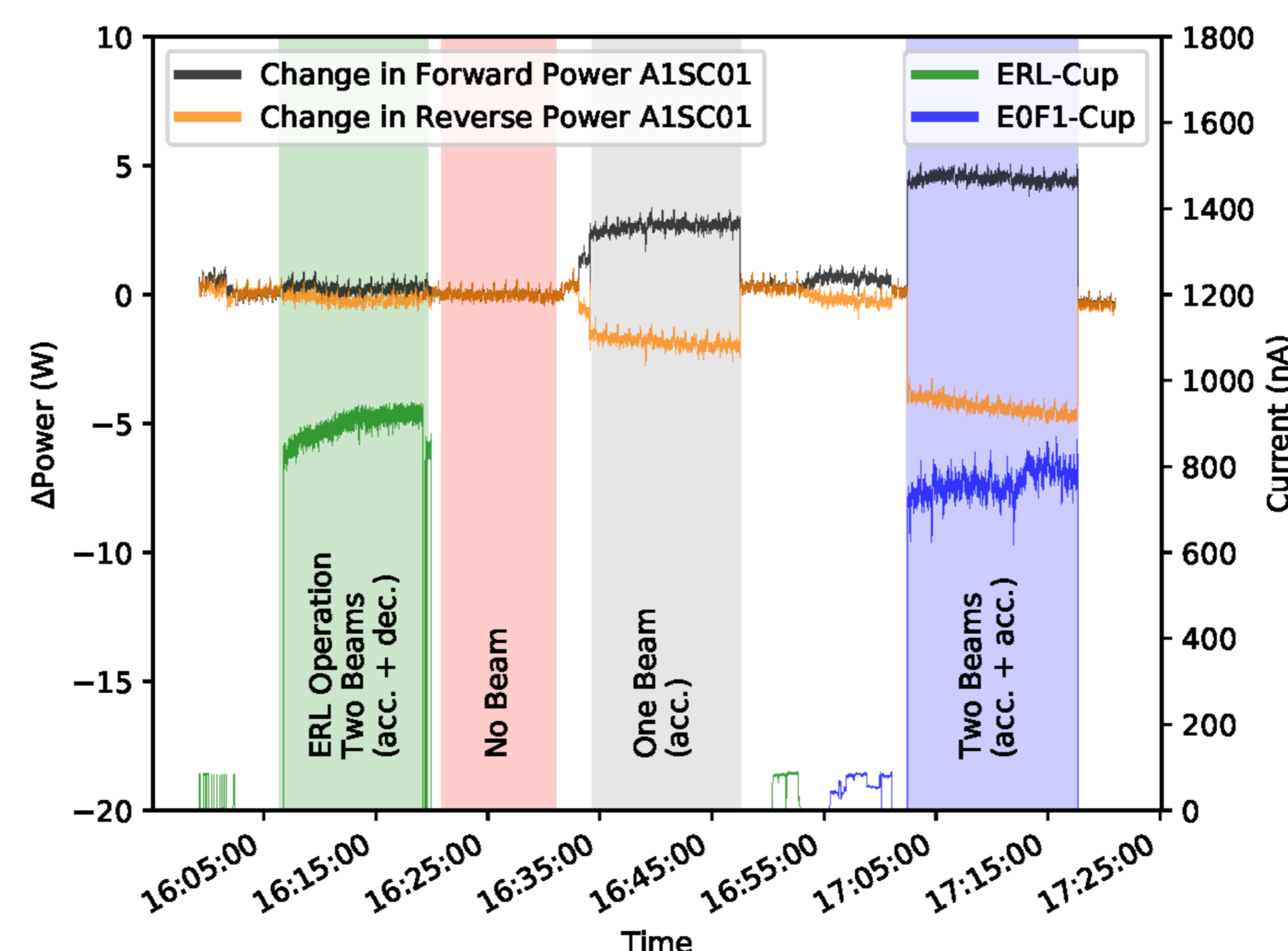


Figure 5: Four different measurements have been conducted: ERL operation (green), no beam in the main accelerator (red), one (grey) or two (blue) accelerated beams in the main accelerator. During all measurements the forward and reverse power of A1SC01 have been measured as well as the beam currents in the for each operation corresponding beam dumps (ERL: ERL-Cup; normal, accelerating operation: EOF1-Cup).

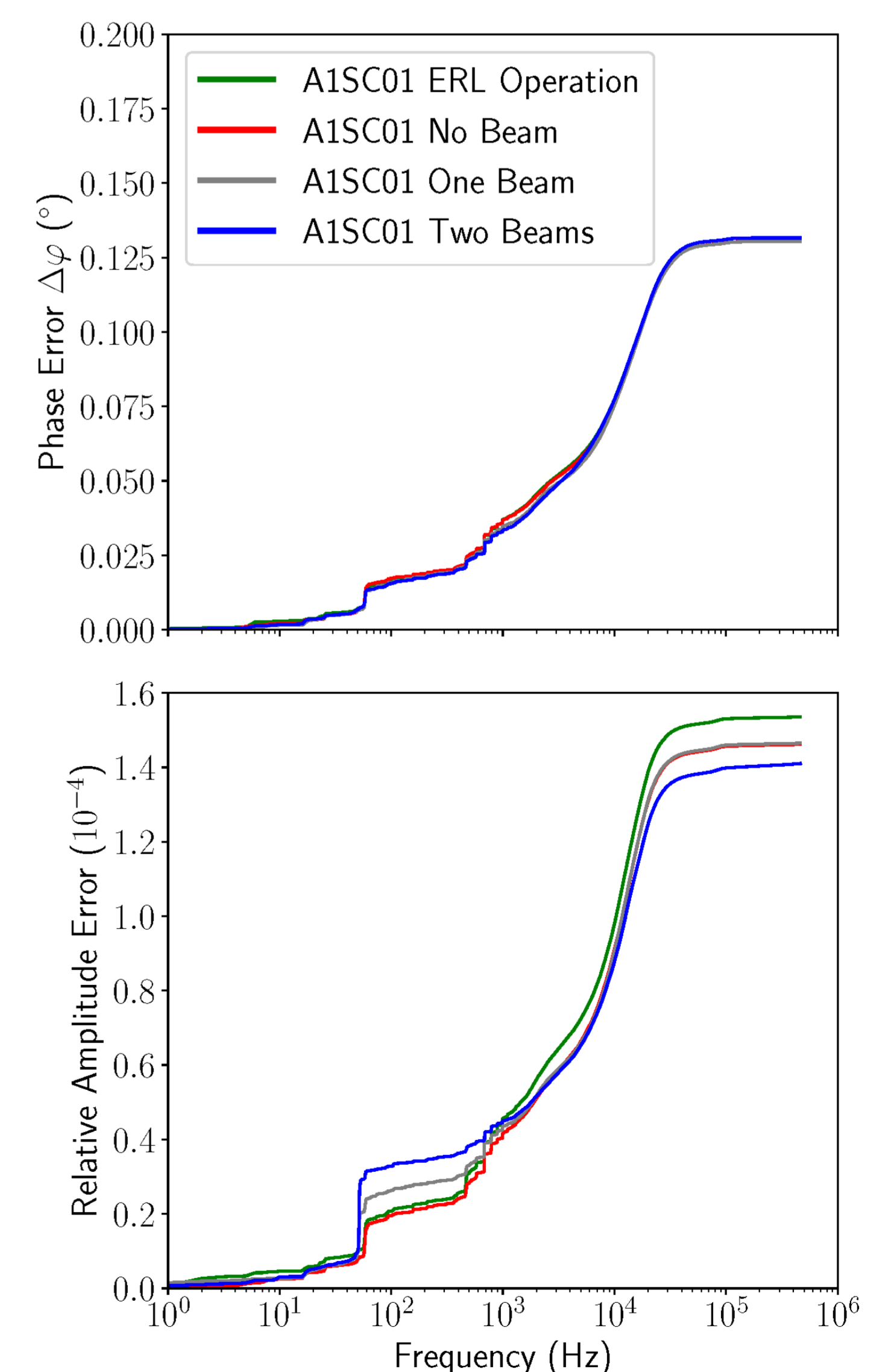


Figure 6: Phase and relative amplitude errors of A1SC01 have been measured during the four different beam modes. The data was transformed to frequency domain and integrated.