SRF Gun and SRF Linac Driven THz at ELBE Successfully in User Operation

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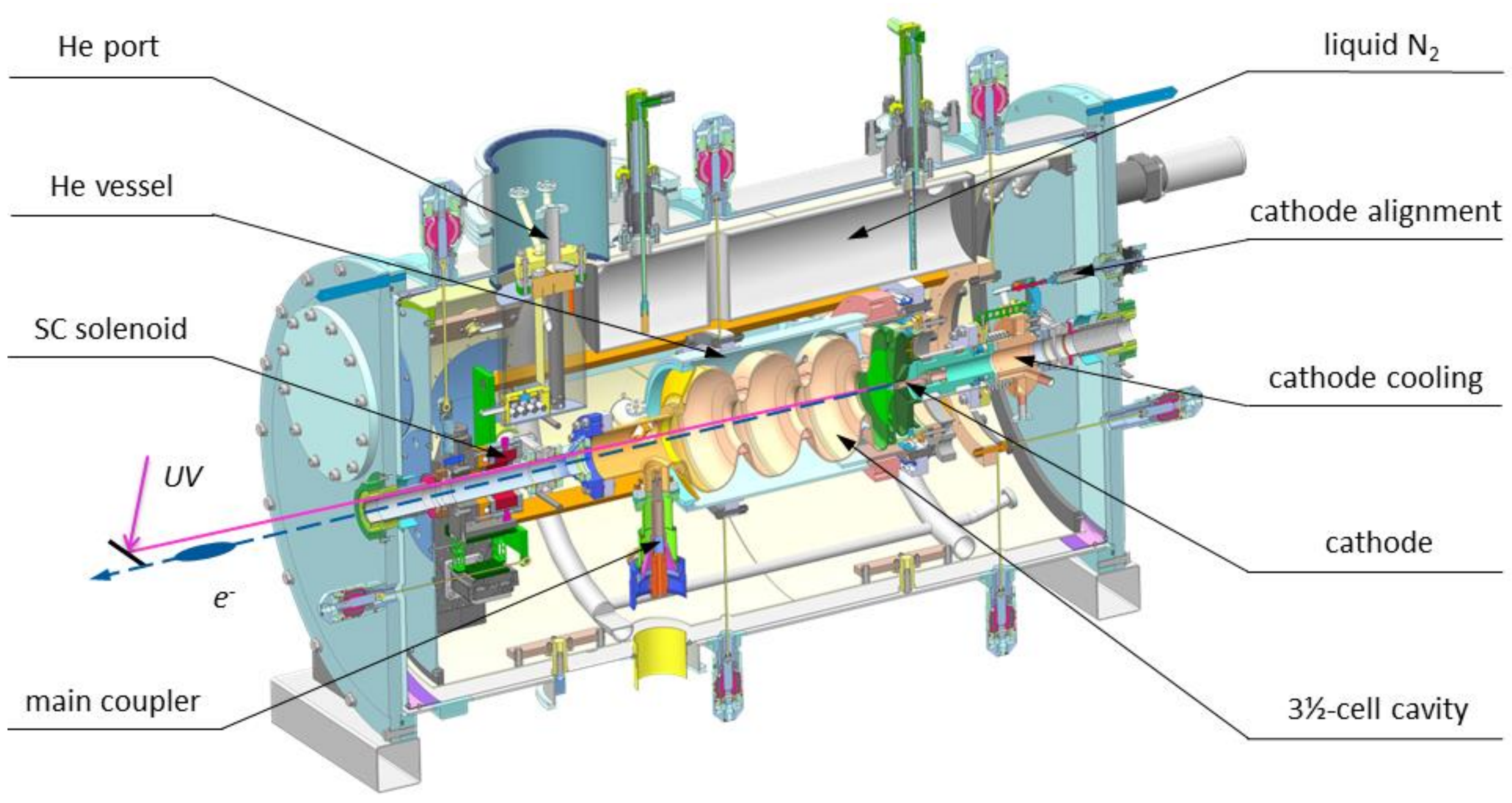
Introduction

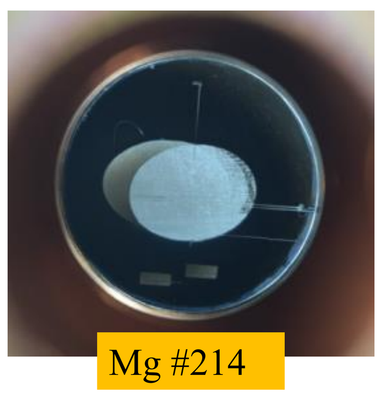
The first all-SRF accelerator driven THz source has been operated as a user facility since 2018 at ELBE radiation center.

The CW electron beam is extracted from SRF gun II, accelerated to relativistic energies and compressed to sub-ps length in the ELBE SRF linac with a chicane. THz pulses are produced by passing the short electron bunches through a diffraction radiator (CDR) and an undulator. The coherent THz power increases quadratically with bunch charge. Pulse energy up to 10µJ at 0.3 THz with 100kHz has been generated.

SRF Gun II

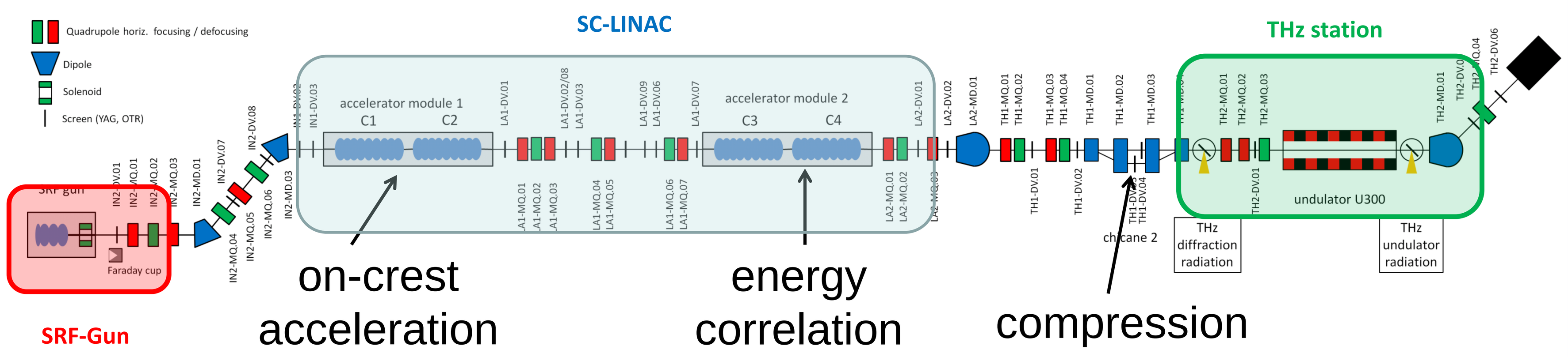


- 1.3 GHz 3+½ cell Nb cavity, SC solenoid
- DC bias on NC cathode
- Mg photocathodes QE = 0.1% ~ 0.3%
- laser: 258 nm, 100 kHz, Gaussian
- ~10 Coulomb charges are extracted in ~ 200 h beam time.



Parameter	Values
SRF gun gradient / peak field	8 MVm^{-1} / 20 MVm^{-1}
Gun beam energy E_{kin}	4 MeV
Bunch charge	100 – 200 pC
Pulse repetition rate	100 kHz CW
Beam Current	10 - 20 µA
Dark current	33 nA
Photo cathode / QE	Mg / 0.2 -0.3 %
Laser pulse diameter at PC	4 mm
Laser pulse length (rms)	2.6 ps

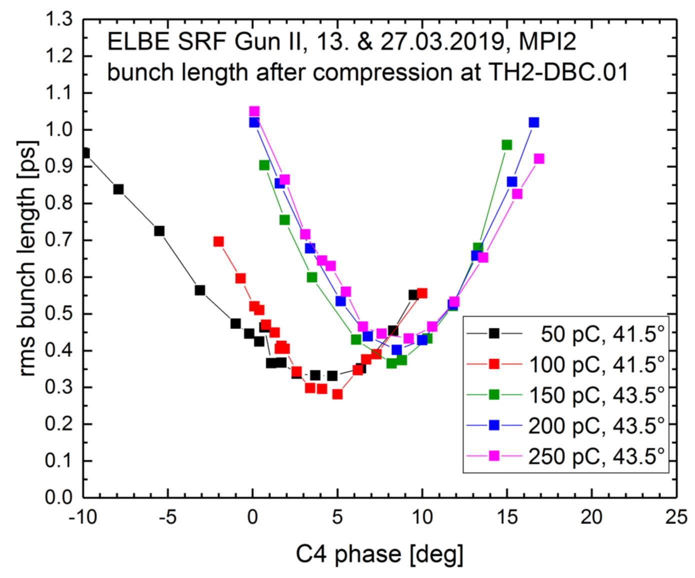
SRF Linac and Bunch Compression



Beam Parameters for THz experiment

- E_{ELBE} = 26.5 MeV
- Linac 1 (2x Tesla 9-cell) on-crest
- Linac 2 (2x Tesla 9-cell) off-crest
- Bunch length after compression:

200 – 400 fs measured with Martin-Puplett Interferometer



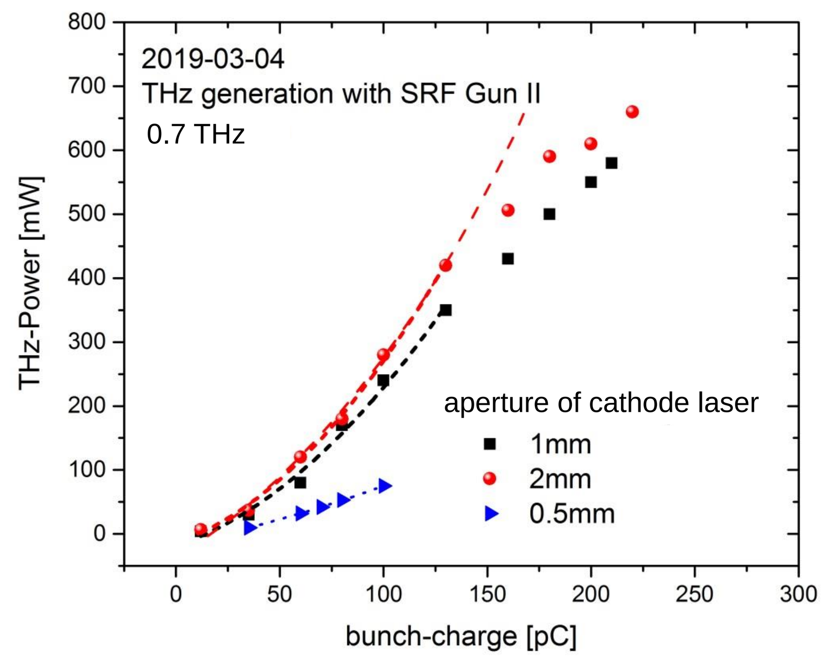
High Power THz Radiation for Users

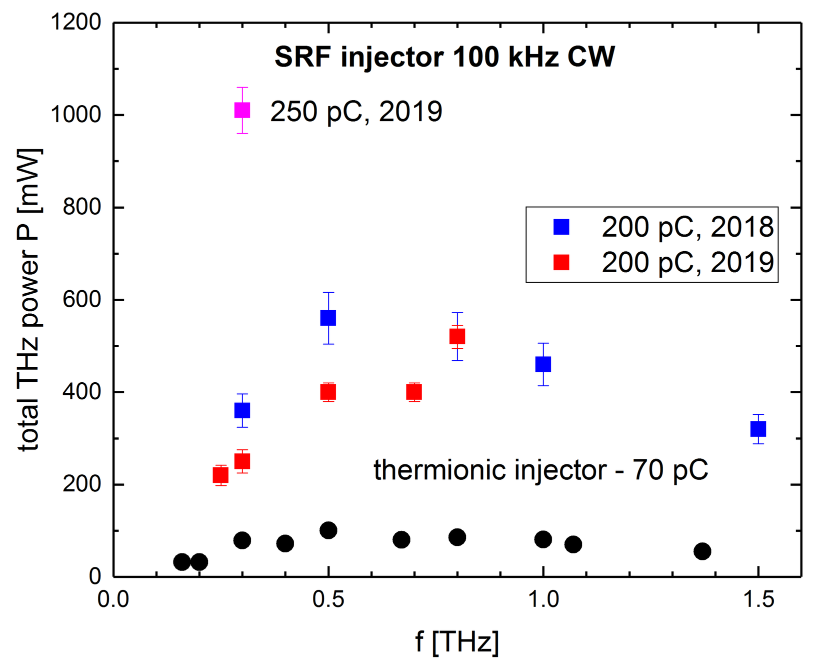
Now SRF gun II is the standard injector for THz production at ELBE

31 ELBE shifts with SRF gun in Run I/2019

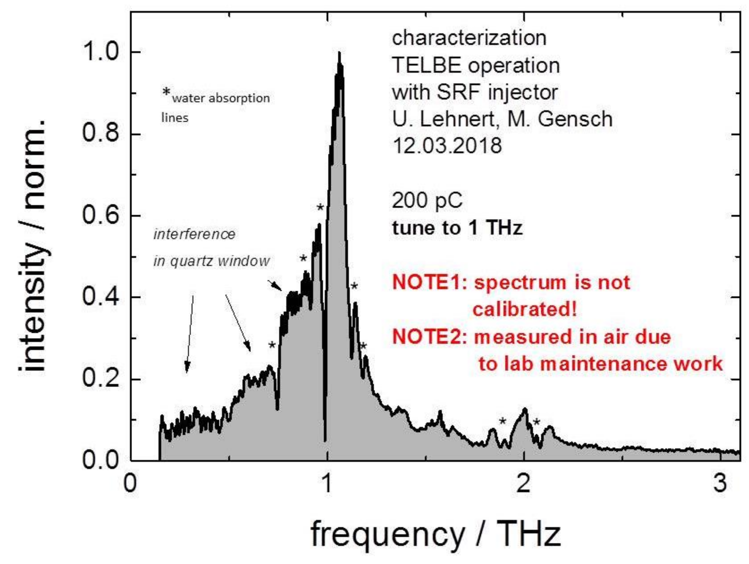
17 THz+MD shifts with SRF gun in Run II/2019

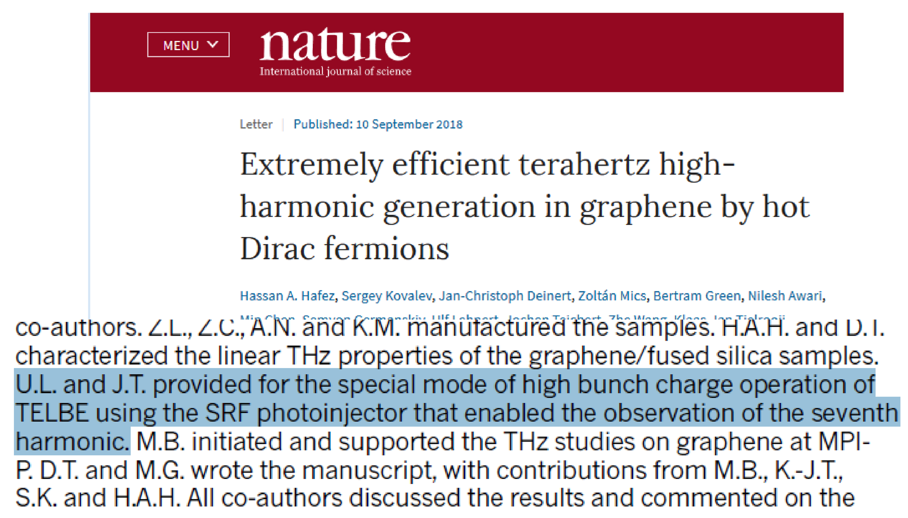
THz production with 250 pC demonstrated: 1 W / 10 µJ @ 100 kHz CW





Convincing results for THz production:
Stable high power THz radiation for new scientific cases




nature

Extremely efficient terahertz high-harmonic generation in graphene by hot Dirac fermions

co-authors. Z.L., Z.C., A.N. and K.M. manufactured the samples. H.A.H. and D.T. characterized the linear THz properties of the graphene/fused silica samples. U.L. and J.T. provided for the special mode of high bunch charge operation of TELBE using the SRF photoinjector that enabled the observation of the seventh harmonic. M.B. initiated and supported the THz studies on graphene at MPI-P. D.T. and M.G. wrote the manuscript, with contributions from M.B., K.-J.T., S.K. and H.A.H. All co-authors discussed the results and commented on the

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