Commissioning and first RF results of the second 3.5 cell Rossendorf SRF gun

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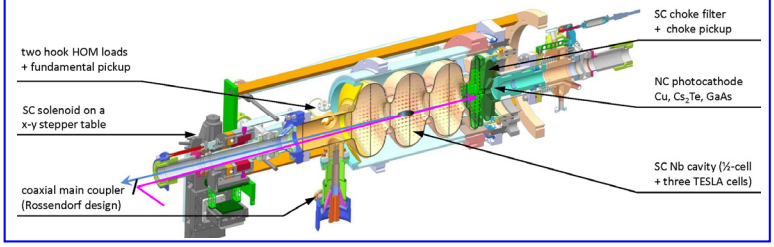
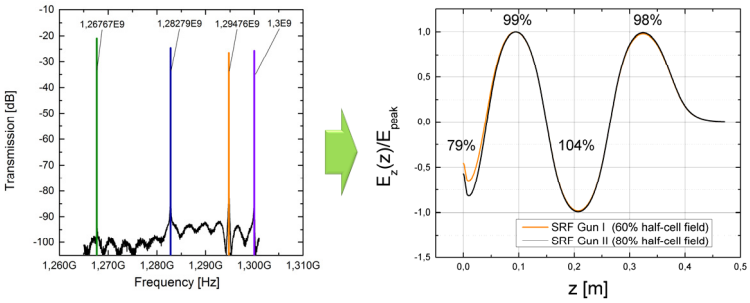
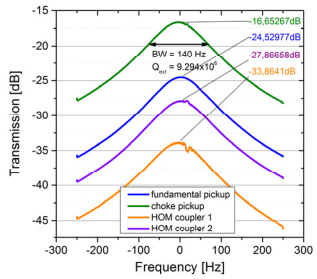
Introduction

After successful operation of the first 3.5 cell SRF gun at the superconducting linear accelerator ELBE, a second and slightly improved gun was recently commissioned. Its main goal is to achieve high average current (1 mA) and low emittance (1 mm mrad @ 77 pC) as well as to test new semiconductor cathodes.



Passband, field distribution and external Q

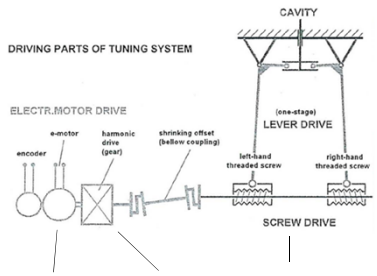


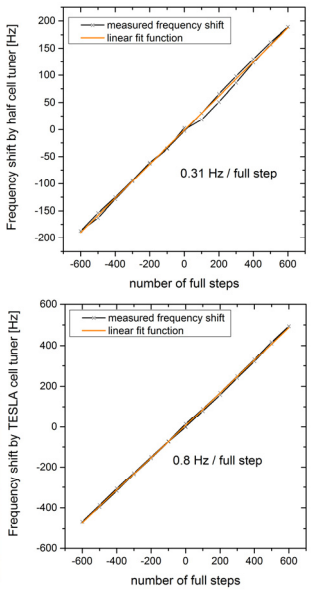


- field distribution is calculated from passband frequencies
- Q_{ext}

FPC:	9.3×10^{06}
F-Pickup:	2.7×10^{11}
Choke:	4.3×10^{10}
HOM1:	2.3×10^{12}
HOM2:	5.8×10^{11}

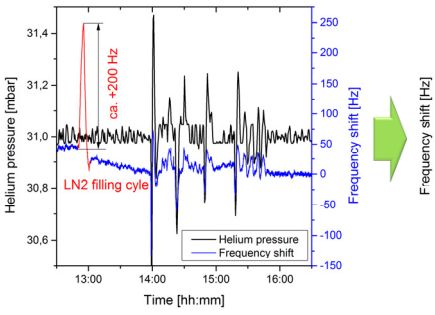
Tuning system



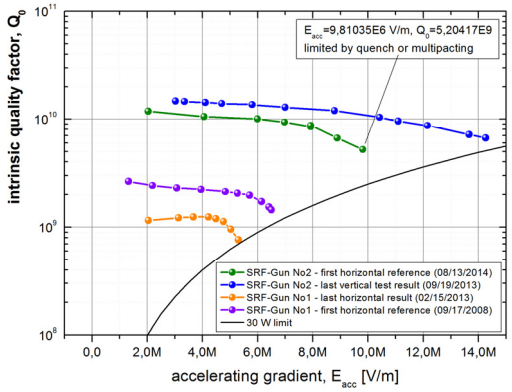


tuner parameter	unit	cold test	
		half cell	full cells
force path	mm	±15	
load path	mm	±0.30	±0.30
frequency const.	kHz/mm	257	650
tuning range	kHz	±77	±195
mech. resolution	nm/step	1.25	1.25
frequ. resolution	Hz/step	0.31	0.80

Pressure sensitivity



Q_0 vs. E_{acc}



Formulas:

$$E_{acc} = \frac{1}{L}\sqrt{2rsQtP_t}$$

$$Q_0 = \frac{Q_t P_t}{P_{diss}}$$

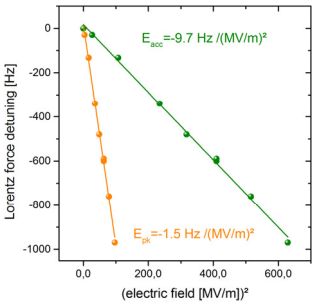
Constants:

$r_s = 167.5\ \Omega$

$Q_t = 2.68e11$

$L = 0.5\ m$

Lorentz force detuning

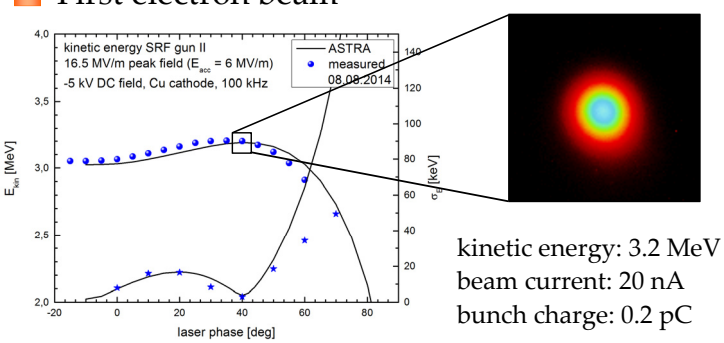


comparison with	SRF gun I	TESLA cavity
k_{acc} / Hz/(MV/m)²	5	1
k_{pk} / Hz/(MV/m)²	0.69	0.25

$$\Delta f = -k_{acc} \cdot E_{acc}^2 = -k_{peak} \cdot E_{peak}^2$$

$$k_{peak} = k_{acc}\left(\frac{E_{peak}}{E_{acc}}\right)^2 \qquad \frac{E_{pk}}{E_{acc}} = 2.56$$

First electron beam



kinetic energy: 3.2 MeV
beam current: 20 nA
bunch charge: 0.2 pC

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