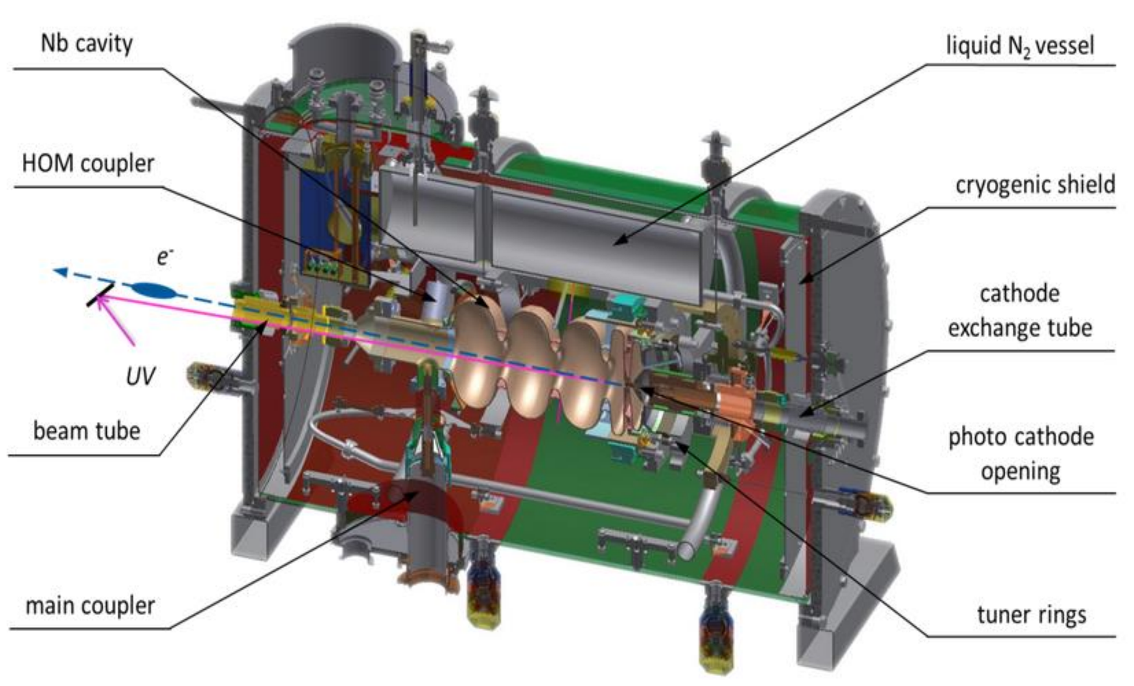
Preliminary geometry optimization of a 3.5-cell SRF gun cavity at ELBE based on beam dynamics

K. Zhou*[1,2], P. Li[1], A. Arnold[2], J. Teichert[2], J. Schaber[2], R. Xiang[2], S. Ma[2].

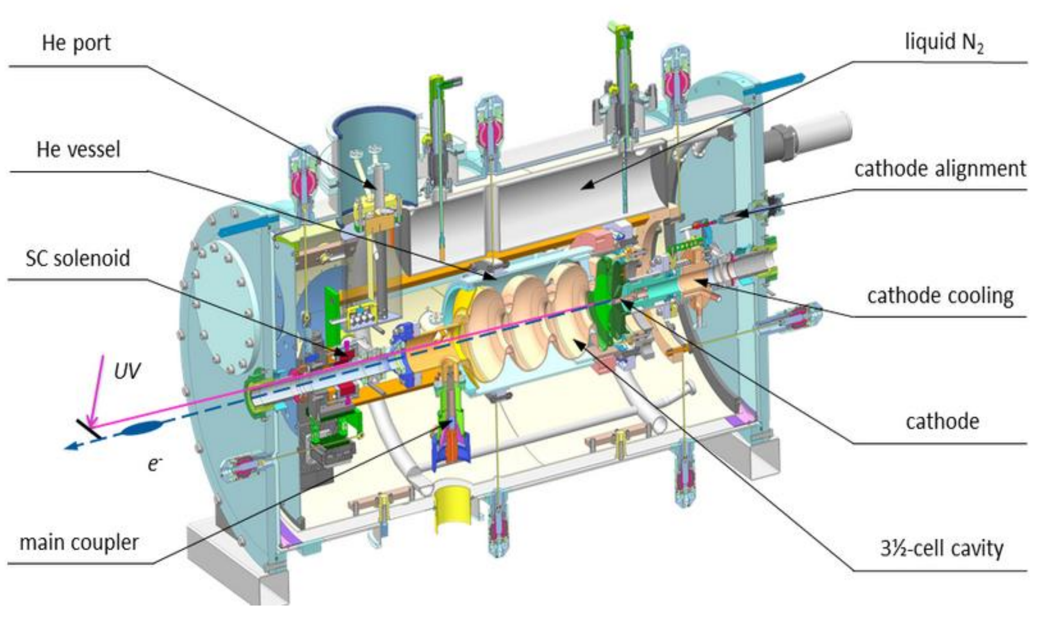
[1] Institute of Applied Electronics, China Academy of Engineering Physics (CAEP), 621900 Mianyang, P.R. China.
[2] Institute of Radiation Physics, Helmholtz-Zentrum Dresden-Rossendorf (HZDR), 01314 Dresden, Germany.

HZDR
HELMHOLTZ ZENTRUM DRESDEN ROSSENDORF

Background



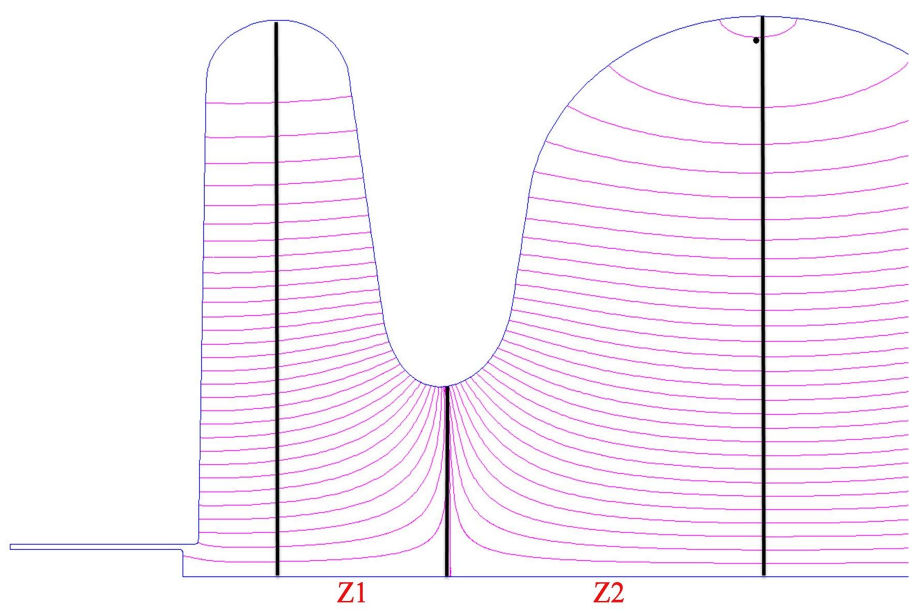
SRF GUN I (2007-2014)



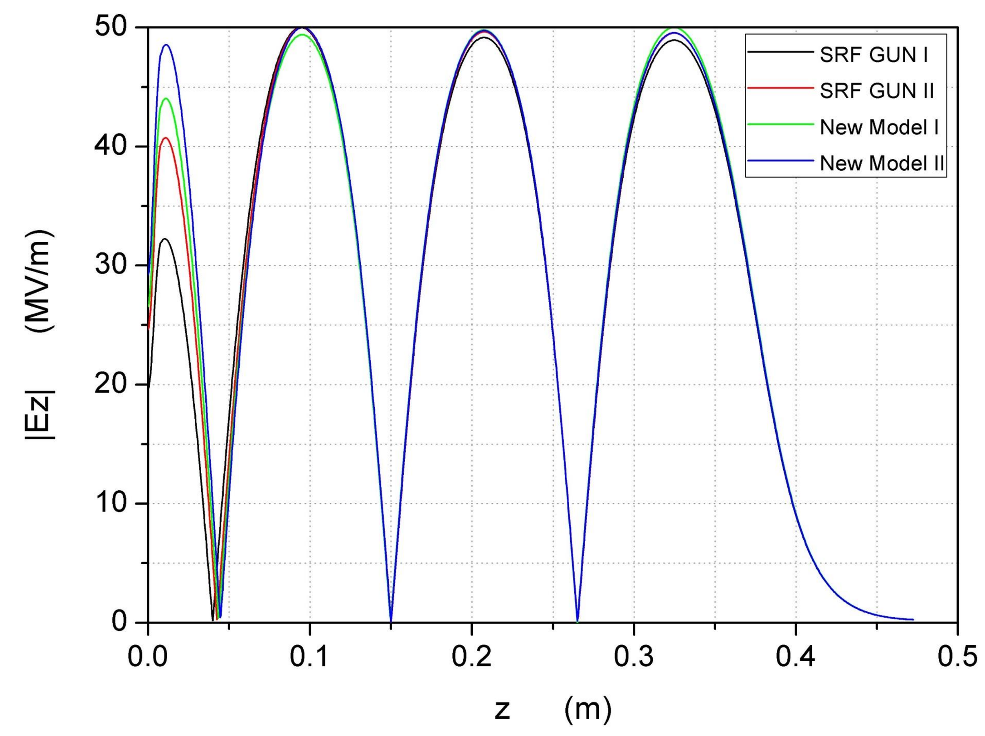
SRF GUN II (2014-Today)

- SRF GUN III was initiated with the same niobium cavity of SRF GUN I refurnished at DESY and a new built cryomodule with a superconducting solenoid.
- At present, HZDR is also optimizing the SRF cavity for the next generation ELBE SRF GUN.

New Models



The changing areas of the cavity models



On-axis field profiles of these cavity models normalized to E_{peak} = 50 MV/m

Geometry changes of the new models comparing to SRF GUN I and SRF GUN II. (Unit: mm)

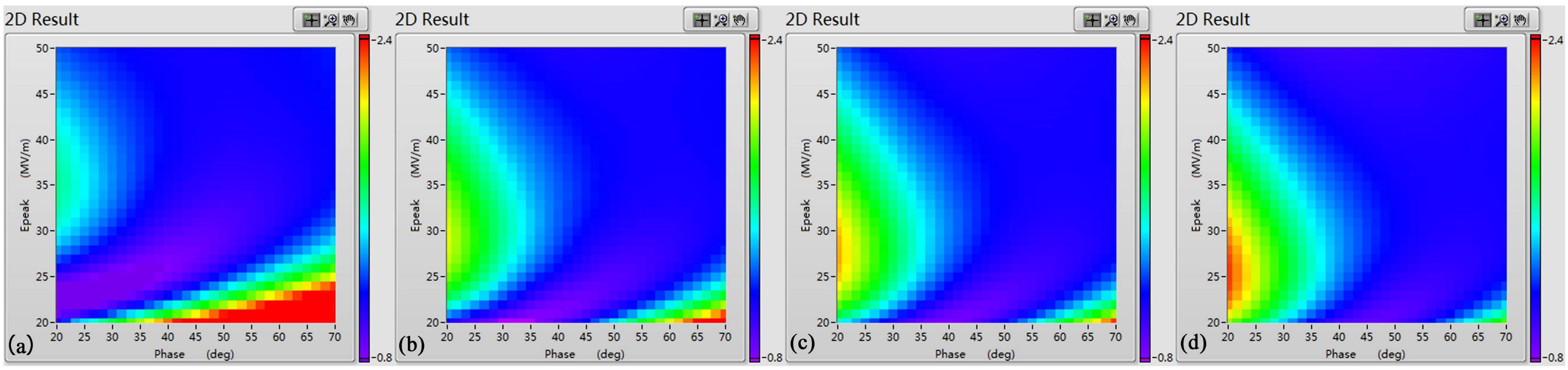
Models	SRF GUN I	SRF GUN II	New Model I	New Model II
Z1	25	25.6	25.8	26
Z2	51.89	51.3	51.0	50.8

Physical Parameters of new models comparing to SRF GUN I and SRF GUN II.

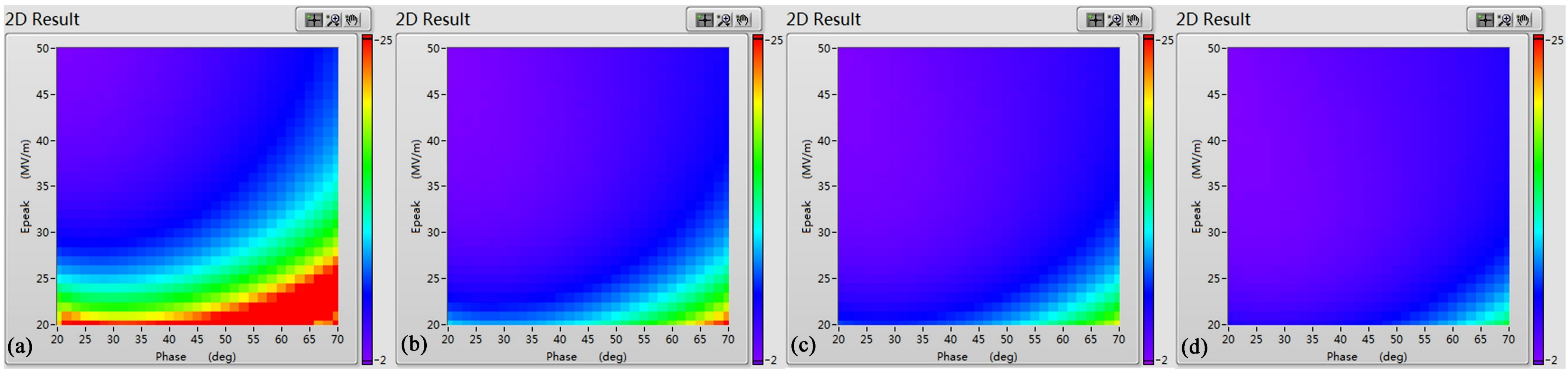
Models	Freq. (MHz)	E_{peak1}/E_{peak}	E_{max}/E_0	B_{max}/E_0 mT/(MV/m)	Field Flatness	r/Q
SRF GUN I	1297.67693	64.5%	2.174	4.285	97.8%	336.8
SRF GUN II	1297.66094	81.5%	2.661	5.060	99.0%	330.5
New Model I	1297.62255	88.0%	2.848	5.353	98.8%	327.3
New Model II	1297.67210	97.1%	3.104	5.771	99.1%	323.0

E_0 is the average electric field gradient along the central axis; E_{peak1} is the maximum electric field gradient in the first half cell; E_{peak} is the maximum electric field gradient along the central axis; E_{max} is the maximum electric field of the whole cavity; B_{max} is the maximum magnetic field of the whole cavity.

Simulation results



Output **transverse emittance** (pi mm mrad) of (a) SRF GUN I, (b) SRF GUN II, (c) New Model I and (d) New Model II.



Output **longitudinal emittance** (pi keV mm) of (a) SRF GUN I, (b) SRF GUN II, (c) New Model I and (d) New Model II.

Parameters setting:

Parameters	Value	Unit
Bunch Charge	100	pC
Laser Pulse	3	ps
Initial rms Radius	0.5	mm
Initial Transverse Emittance	0.05	mm mrad
Observation point	1	m

- With the increase of the electric field strength, the RF phase corresponding to the minimum transverse emittance also increase.
- The region of the minimum transverse emittance moves to higher RF phases and lower electric fields from SRF GUN I to New Model II.
- New Model I and New Model II offer smaller output longitudinal emittances than SRF GUN I and SRF GUN II, especially at low electric fields.

Acknowledgement

We would like to thank the whole ELBE team for their great help with this project. The work was supported by State Administration of Foreign Experts Affairs P.R. China and Institute of Applied Electronics, China Academy of Engineering Physics (CAEP).

* Contact: Dr. Kui Zhou • Institute of Applied Electronics, China Academy of Engineering Physics • Email: zhoudakui@163.com

39th International Free-Electron Laser Conference, August 26th – 30th , Hamburg.