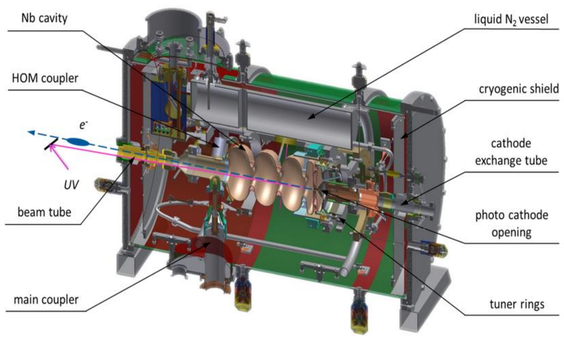
Geometry dependent beam dynamics of a 3.5-cell SRF gun cavity at ELBE

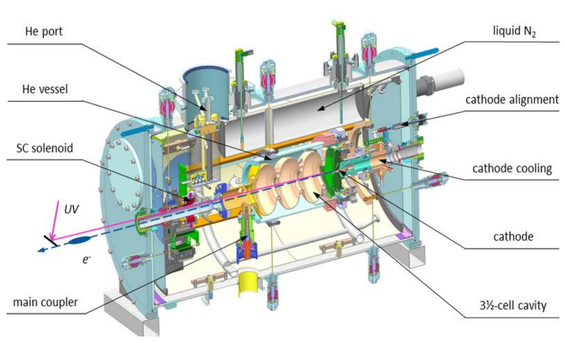
K. Zhou*[1,2], A. Arnold[1] , J. Teichert[1], J. Schaber[1], R. Xiang[1], S. Ma[1].

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

Background



SRF GUN I (2007-2014)

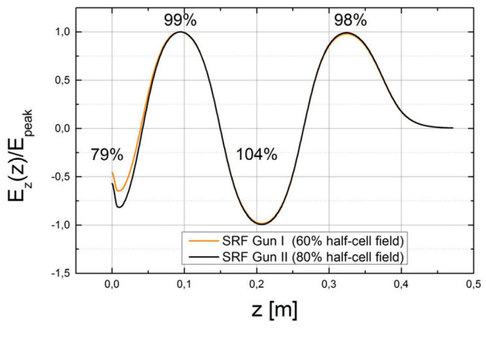


SRF GUN II (2014-Today)

Cavity Status of SRF GUN II:

	CW RF measured 2014	with CW beam at present
Acceleration field	10 MV/m	8 MV/m
Peak field on axis	25.6 MV/m	20.5 MV/m
Cathode field	15.4 MV/m	14.4 MV/m
Kinetic energy		4 MeV

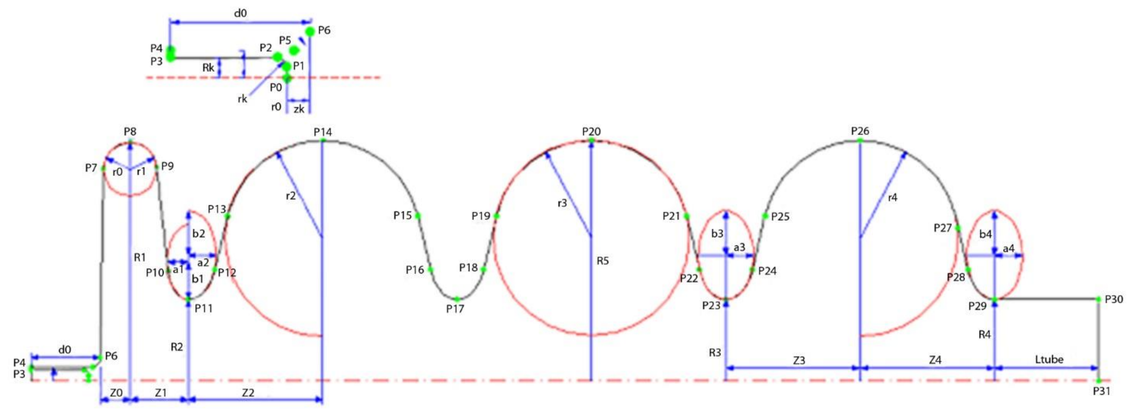
*To **optimize the next generation SRF gun**, the impact on beam dynamics from the **SRF cavity geometry** needs to be investigated.*

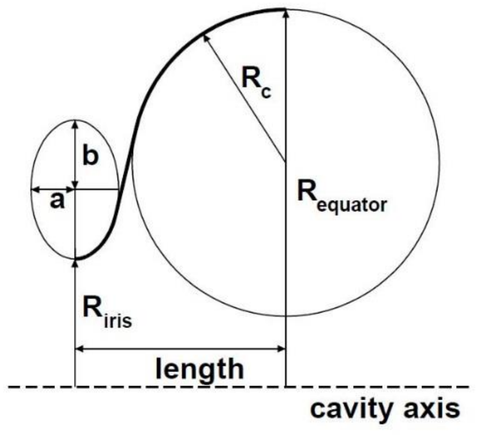


On-axis field profiles of SRF GUN I and SRF GUN II[1]

[1] A. Arnold et al. LINAC2014, Geneva, Switzerland, p578-580.

Cavity geometry





Contour of a half-cell

Cavity Parameters (in mm)

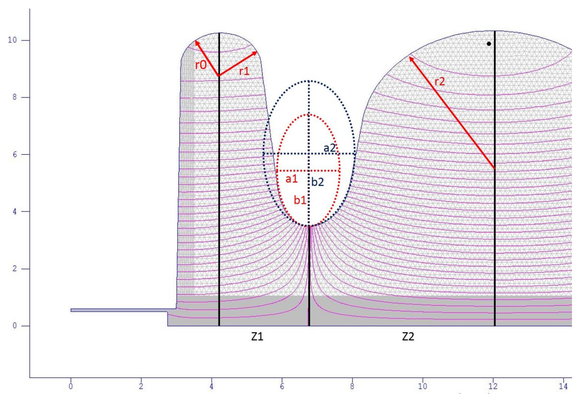
Z0	12.65	Z2	51.8872	Z4	57
Z1	25	a2	12	R4	39
R1	102.5777	b2	19	a4	9
R2	35	r2	37.1032	b4	12.8
a1	9	Z3	57.65	r4	43.0613
b1	16	R3	35	LTube	100
r0	11.396	R5	103.3	Rk	5
r1	11.396	a3	12	Zk	2.5
	6	b3	19	rk	0.5
d0	30	r3	42.8565	rw	0.5
Sr	0				

Geometry parameters of SRF GUN I

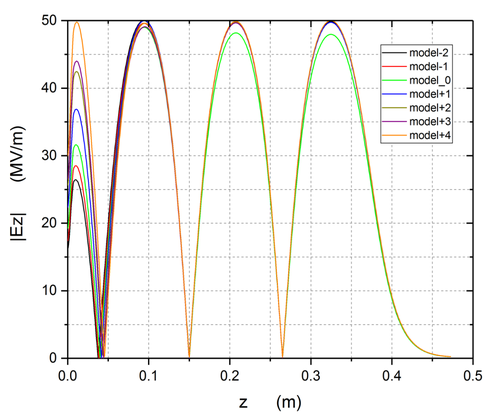
Cavity models

Seven cavity models with different changes of the half cell and first TESLA cell

models	Z1 (mm)	a1 (mm)	b1 (mm)	r0&r1 (mm)	Z2 (mm)	a2 (mm)	b2 (mm)	r2 (mm)
model-2	-2	-2	-1.5	0	+2	+2	+2	+0.4
model-1	-1	-1	-1	0	+1	+1	+1	+0.2
model_0	0	0	0	0	0	0	0	0
model+1	+1	+1	+1	0	-1	-1	-1	0
model+2	+2	+2	+2	0	-2	-2	-2.5	0
model+3	+3	+3	+3	+0.1	-3	-3	-3	-0.1
model+4	+4	+4	+4	+0.15	-4	-4	-4	-0.1



The changing places of these models



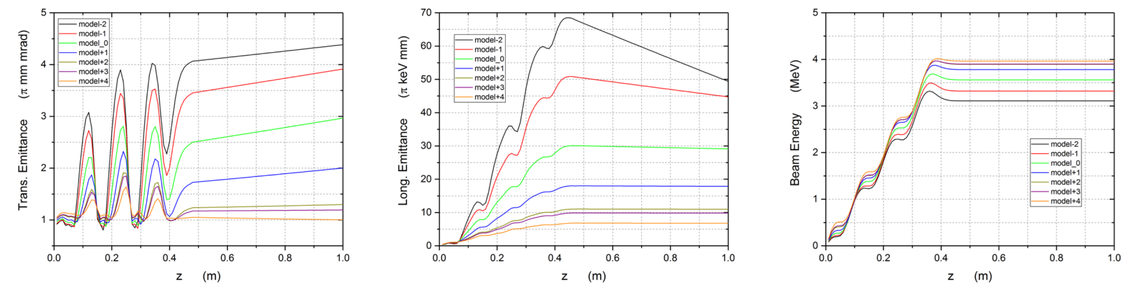
On-axis field profiles @ Epeak = 50 MV/m

Physical parameters of these seven models calculated with Superfish

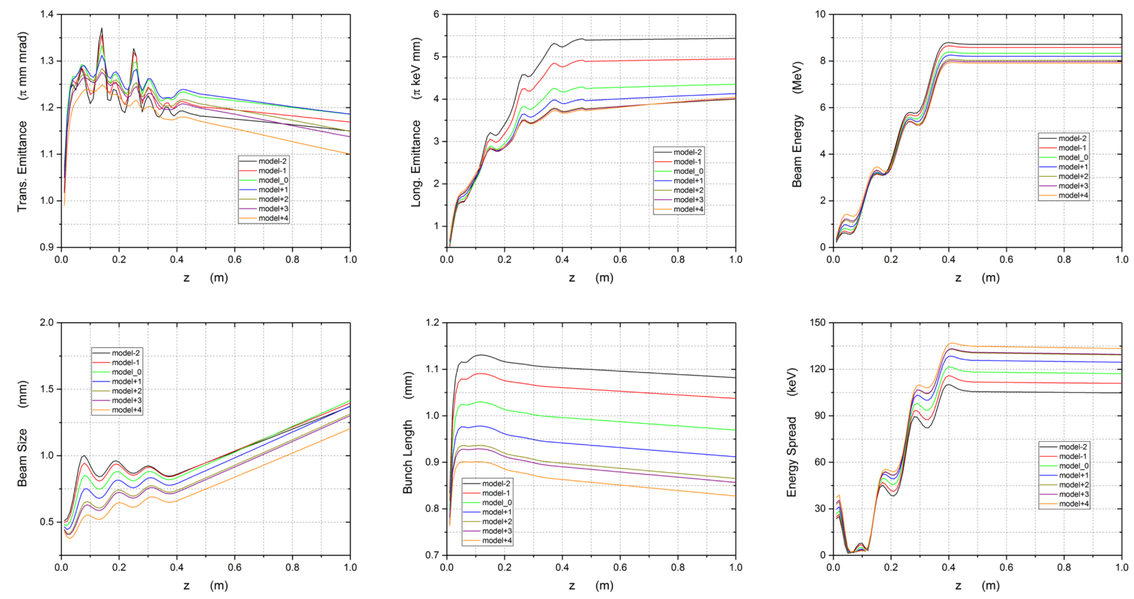
models	Freq. (MHz)	E0 (MV/m)	Epeak1 (MV/m)	Epeak (MV/m)	Epeak1/ Epeak	Emax/E0	Bmax/E0 mT/(MV/m)	Field Flatness	r/Q
model-2	1297.631	10	9.59	18.1	52.9%	2.052	4.142	99.4%	340.5
model-1	1297.61	10	10.3	18.1	57.0%	2.024	4.112	99.2%	339.4
model_0	1297.677	10	11.7	18.2	64.5%	2.174	4.285	97.8%	336.8
model+1	1297.646	10	13.1	17.8	73.8%	2.431	4.713	99.5%	333.6
model+2	1297.624	10	15.0	17.6	84.9%	2.755	5.254	99.2%	328.7
model+3	1297.605	10	15.5	17.6	88.0%	2.856	5.396	98.2%	327.1
model+4	1297.632	10	17.3	17.3	99.6%	3.170	5.916	99.2%	321.5

***E0** is the average electric field gradient along the central axis; **Epeak1** is the maximum electric field gradient in the first half cell; **Epeak** is the maximum electric field gradient along the central axis; **Emax** is the maximum electric field of the whole cavity; **Bmax** is the maximum magnetic field of the whole cavity.*

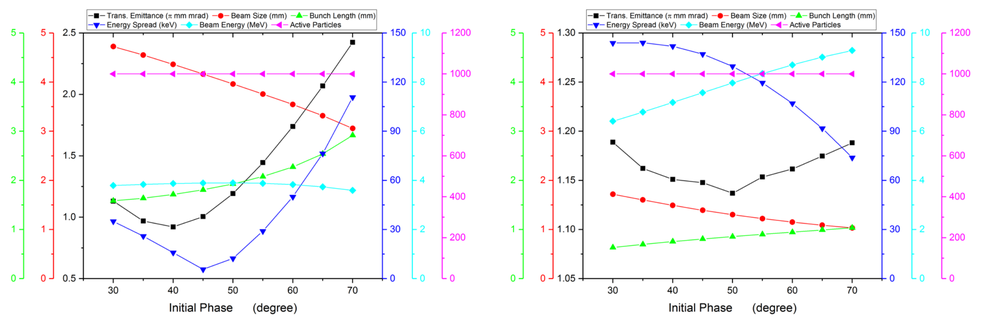
Simulation results



Simulation results @ Qbunch = 100 pC, Epeak = 20 MV/m, phase = 50 deg.



Simulation results @ Qbunch = 100 pC, Epeak = 50 MV/m, phase = 50 deg.



Phase scan of model+3 @ Epeak = 20 MV/m (left) and 50 MV/m (right)

Acknowledgement

We would like to thank the whole ELBE team for their 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: Kui Zhou • Institute of Radiation Physics, Radiation Source ELBE • Email: zhoudakui@163.com • www.hzdr.de

GEFÖRDERT VOM Bundesministerium für Bildung und Forschung
DRESDEN concept