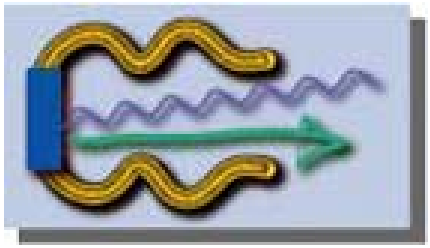
RUNNING EXPERIENCE OF FZD SRF PHOTOINJECTOR

Rong Xiang
On behalf of the BESSY-DESY-FZD-MBI collaboration and the ELBE team

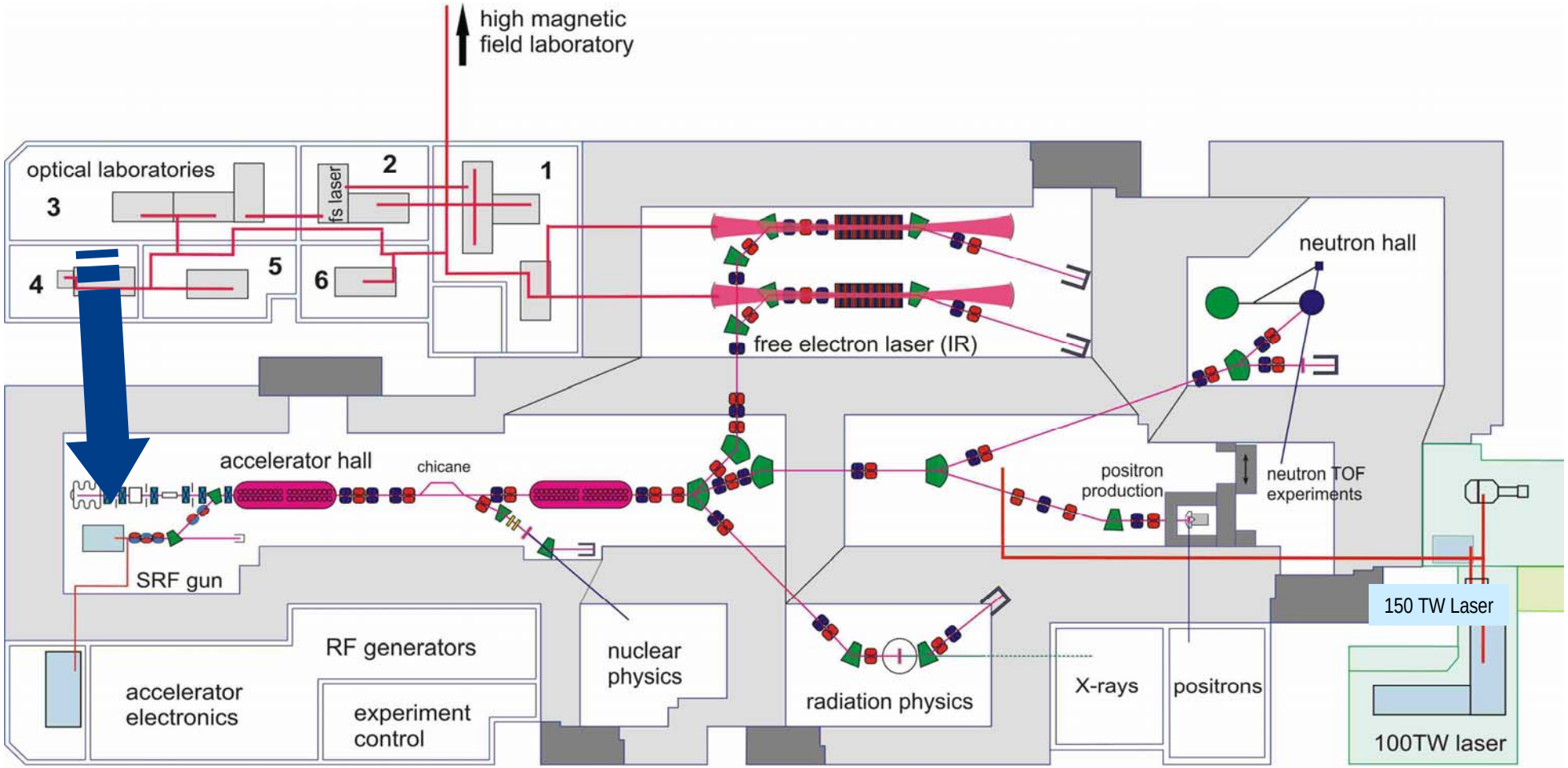


Bundesministerium
für Bildung
und Forschung

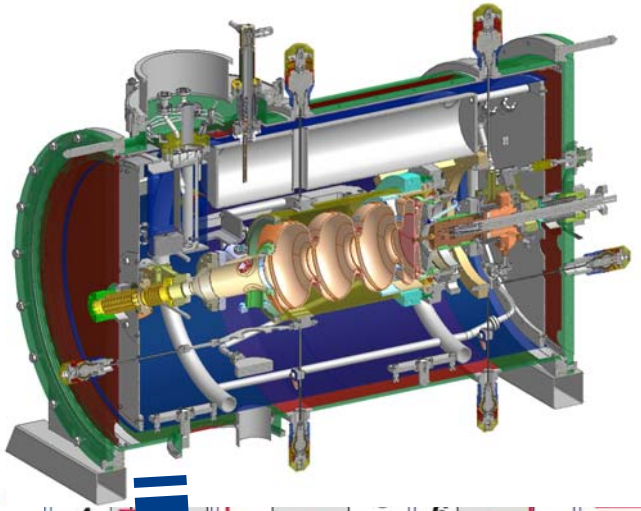
FEL 2009, Liverpool, United Kingdom, August 23 ~ 28, 2009

Outline

- Introduction
- RF measurement on SC cavity
- Operation experience on photocathode
- Beam diagnostic
- Summary

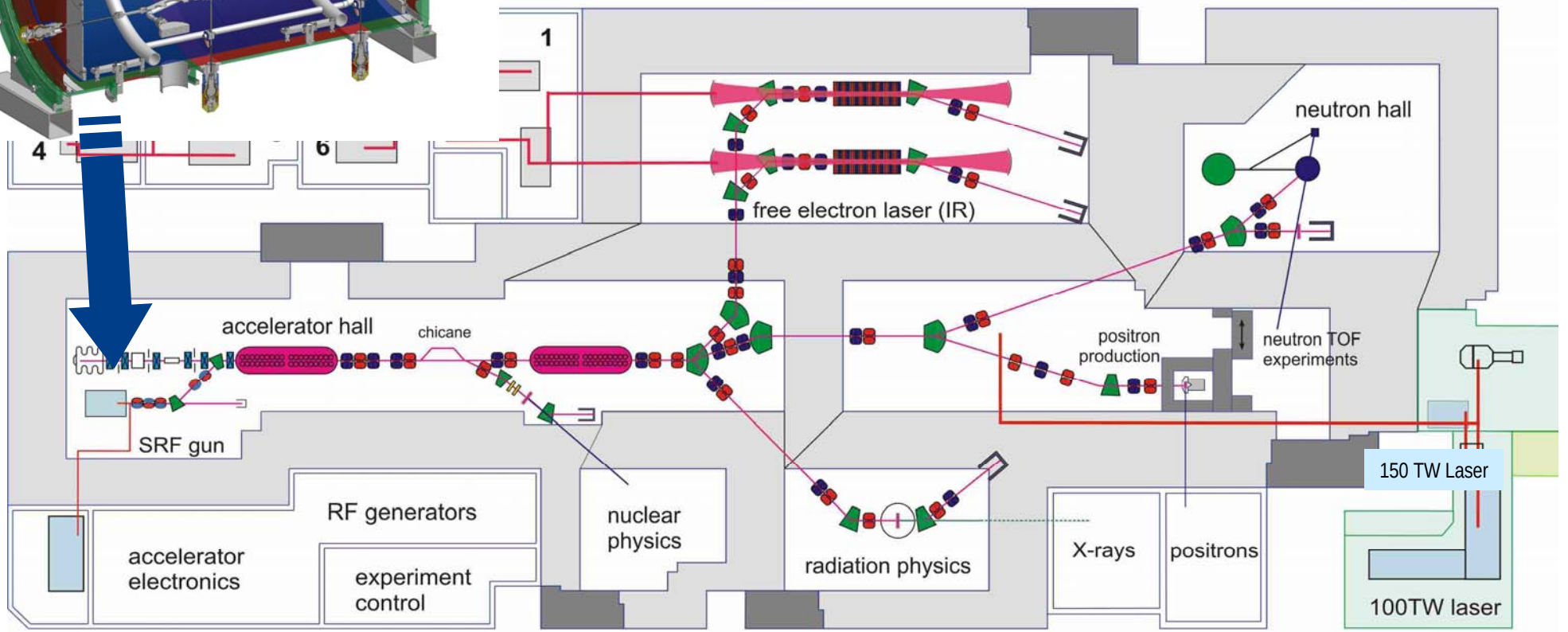


ELBE user facility in FZD



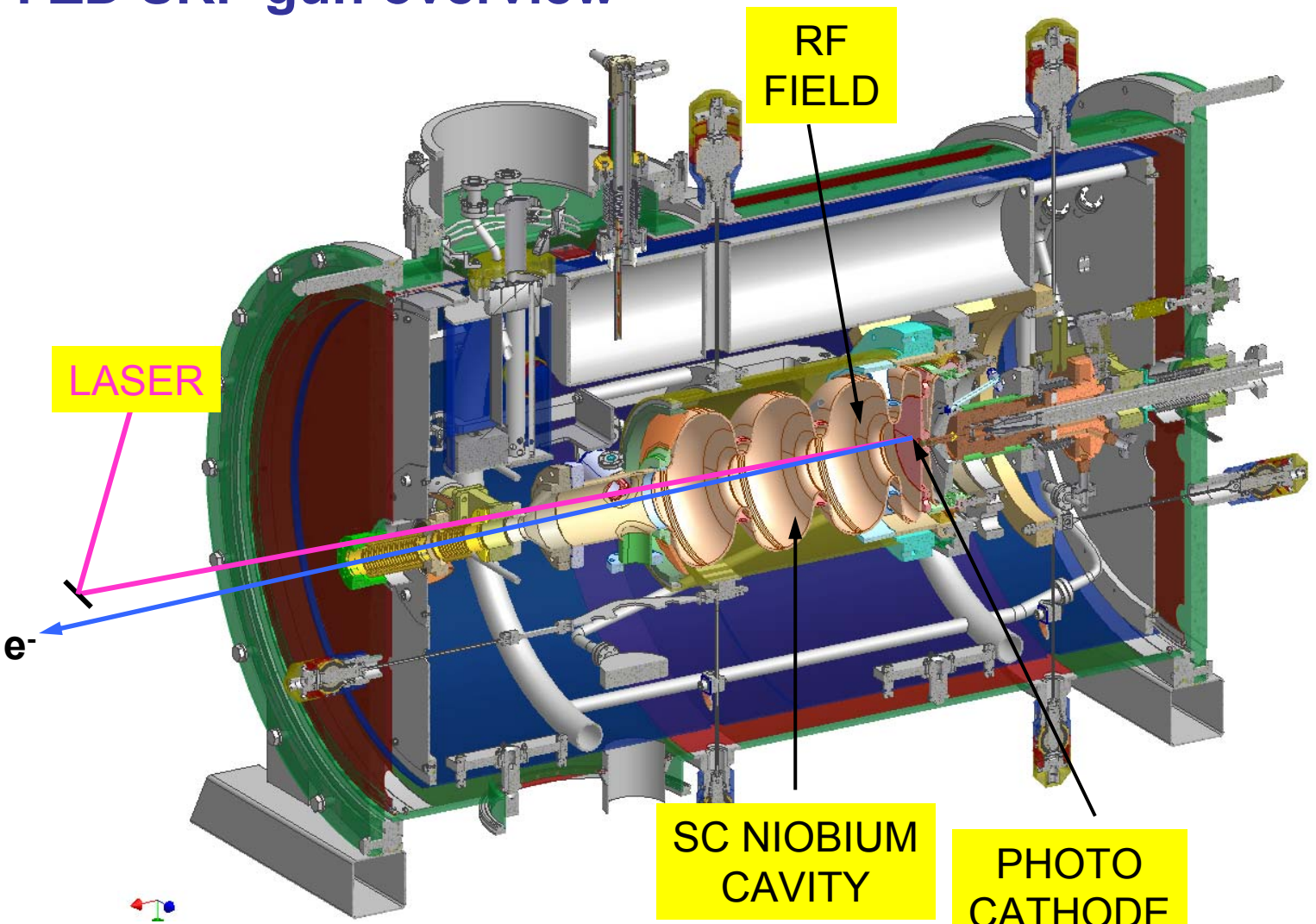
- New Injector for the ELBE SC Linac
- Test Bench for SRF Gun R&D

gh magnetic
eld laboratory



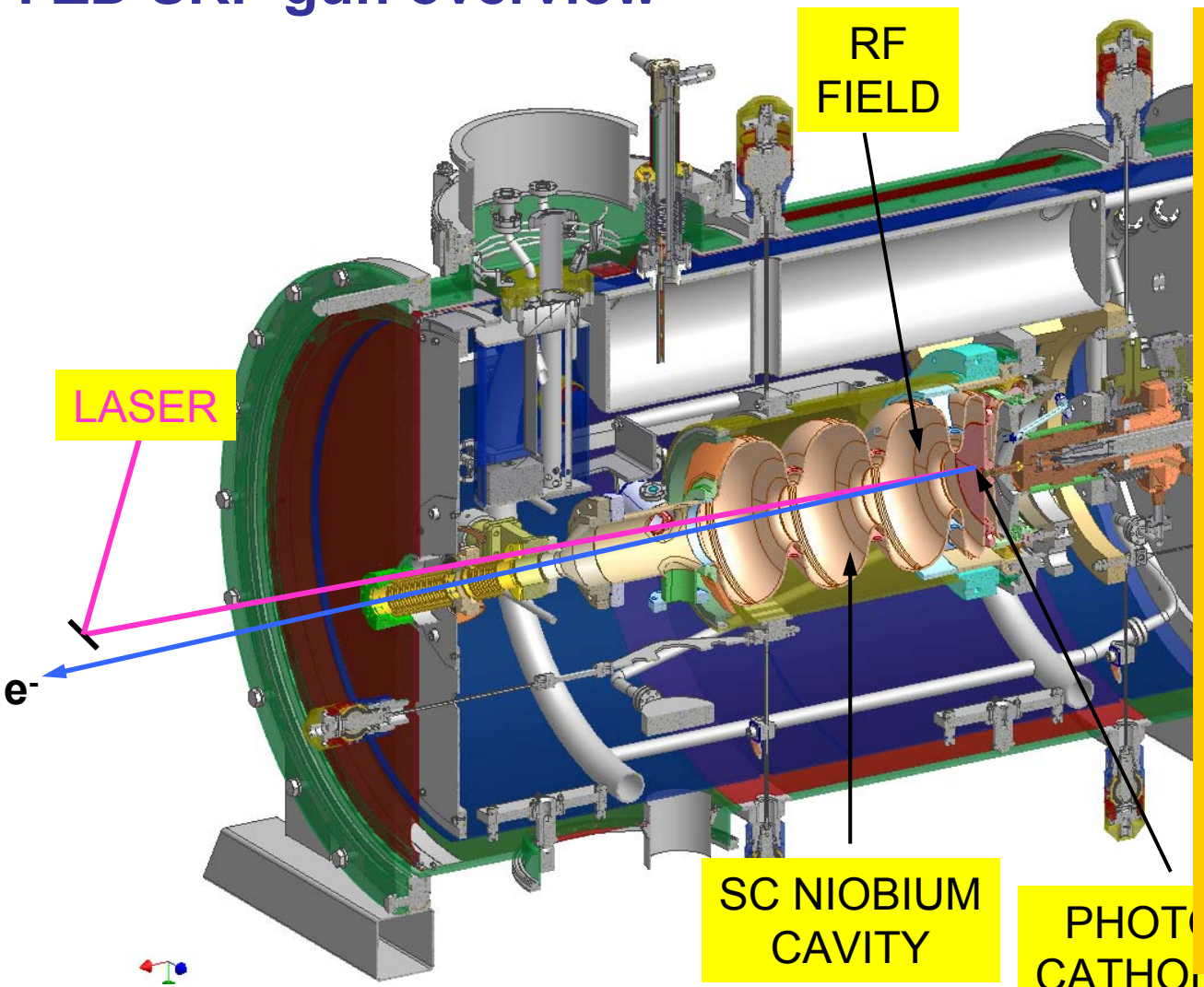
ELBE user facility in FZD

FZD SRF gun overview



A. Arnold, et al., NIM A 577, 440 (2007)

FZD SRF gun overview



1. **direct production of short pulses:**

laser & photo cathode

2. **high acceleration field at cathode:**

radio frequency field

3. **CW operation for high average current:**

superconducting cavity

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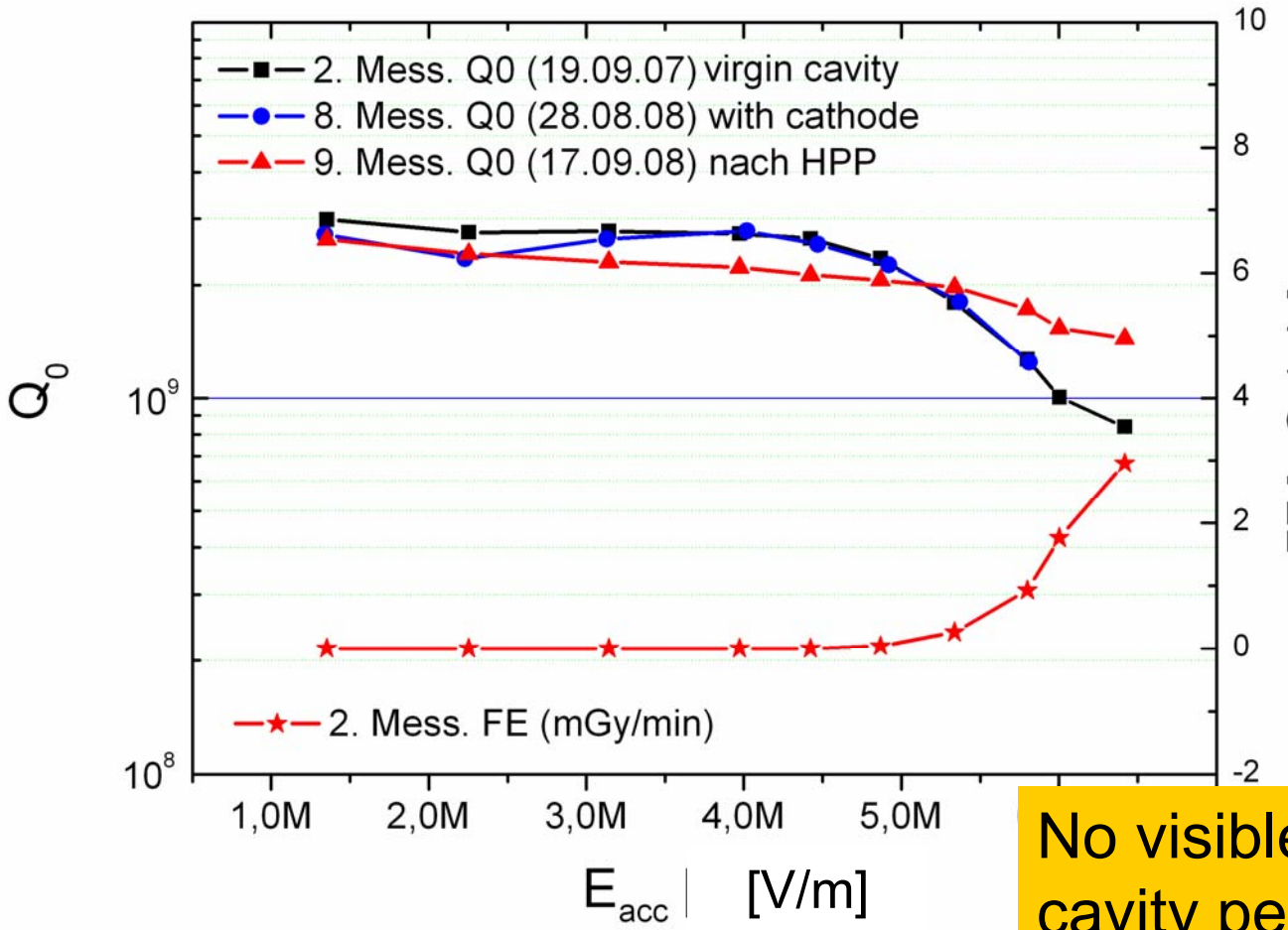
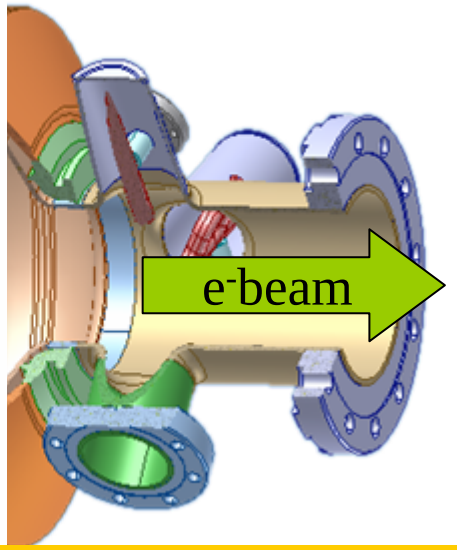
SRF PHOTO INJECTOR

A. Arnold, et al., NIM A 577, 440 (2007)

Supercondcuting cavity

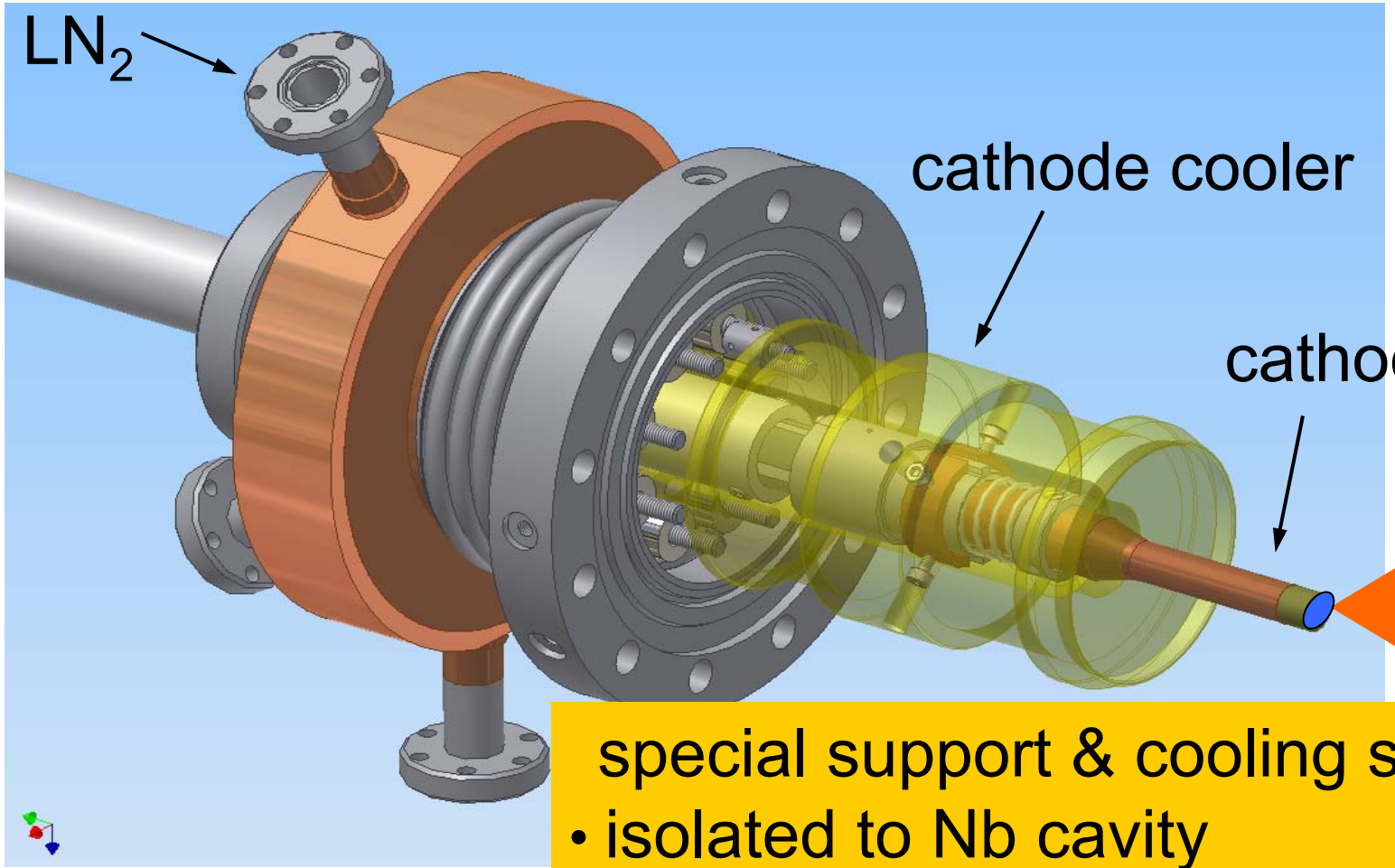




No visible degradation of the cavity performance after two years operation and with Cs_2Te cathode inside.

A. Arnold, et al., PESP2008, Newport News

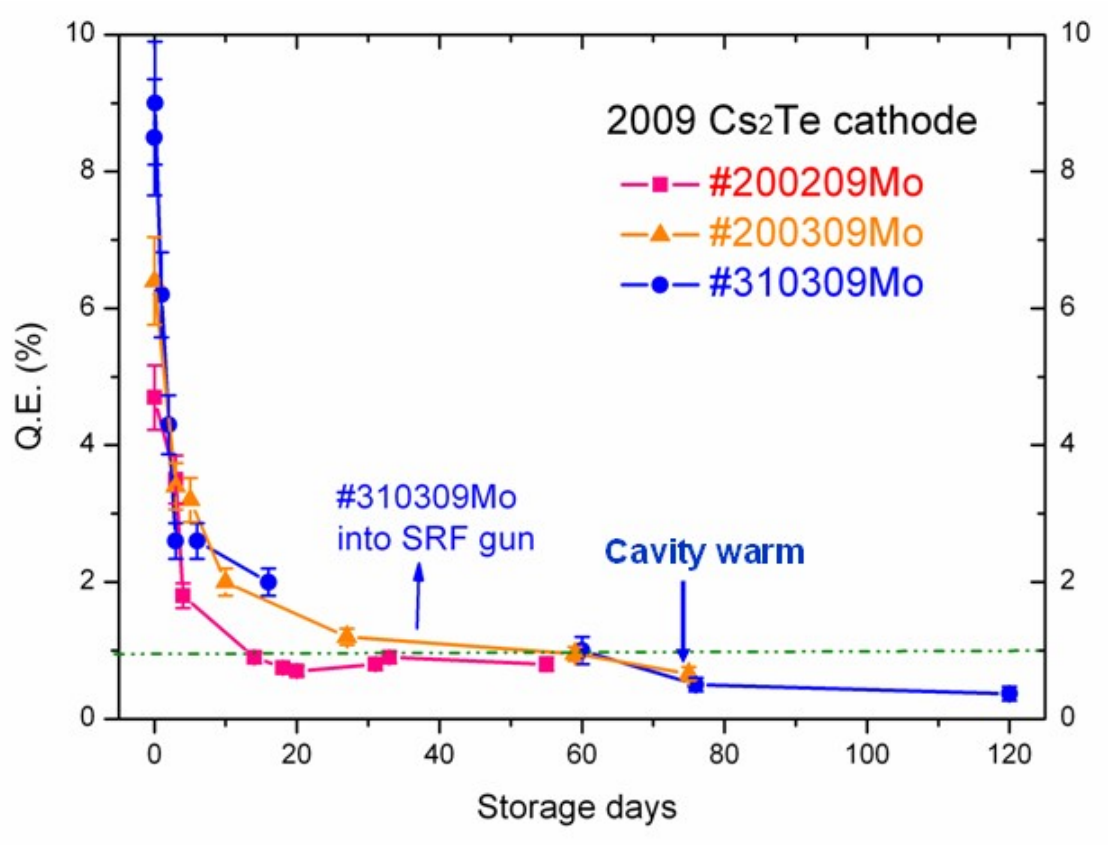
NC Photocathode in the SC cavity ?

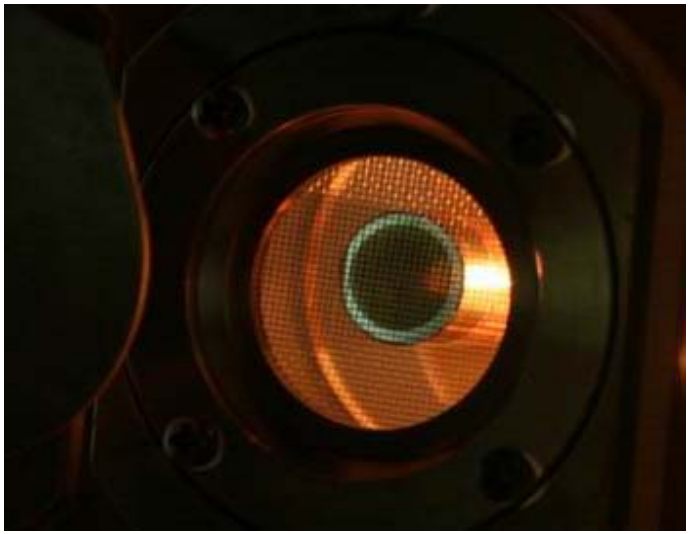


special support & cooling system
- isolated to Nb cavity
- cool with liquid nitrogen (77 K)

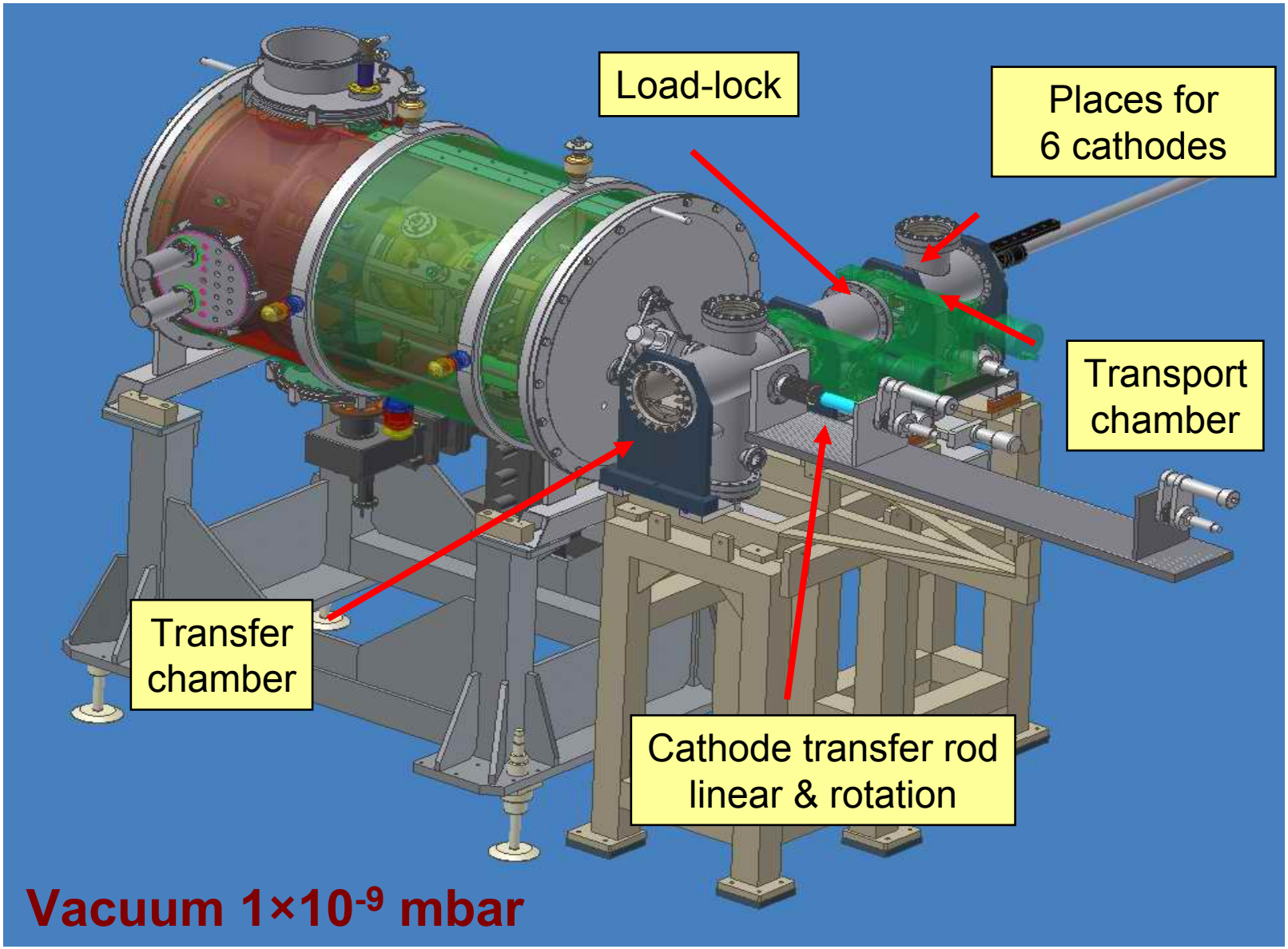
F. Staufenbiel, SRF2005, Beijing

SRF Gun requires QE≥1%

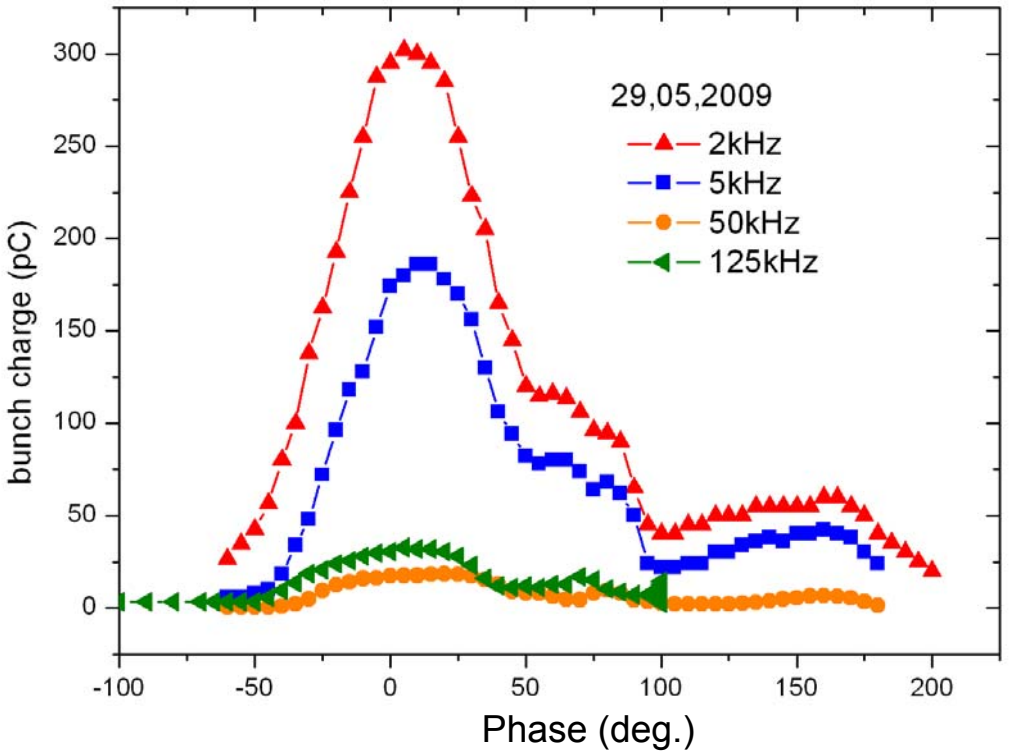


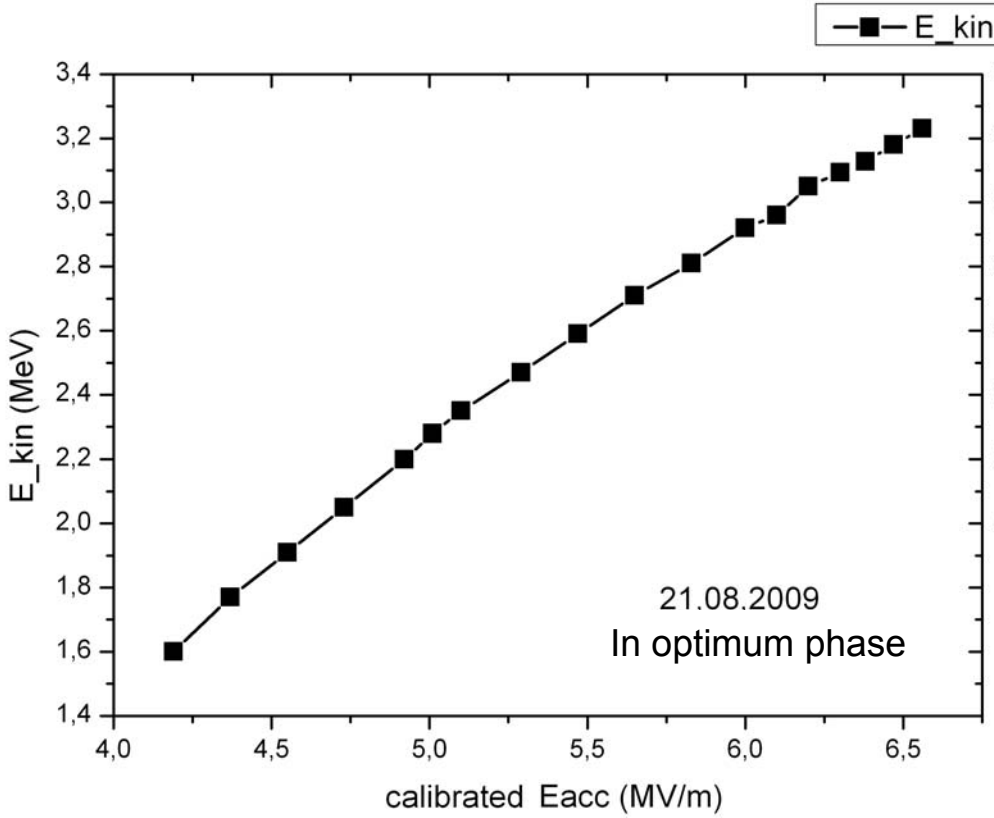


Cathode	Serving time	Q.E. in gun
#090508Mo	2008-5-23 to 2008-6-23	0.05%
#070708Mo	2008-7-21 to 2008-9-19	0.1%
#310309Mo	2009-5-8 till now	1.1%


Load-lock
Places for
6 cathodes
Transport
chamber
Transfer
chamber
Cathode transfer rod
linear & rotation
Vacuum 1×10-9 mbar

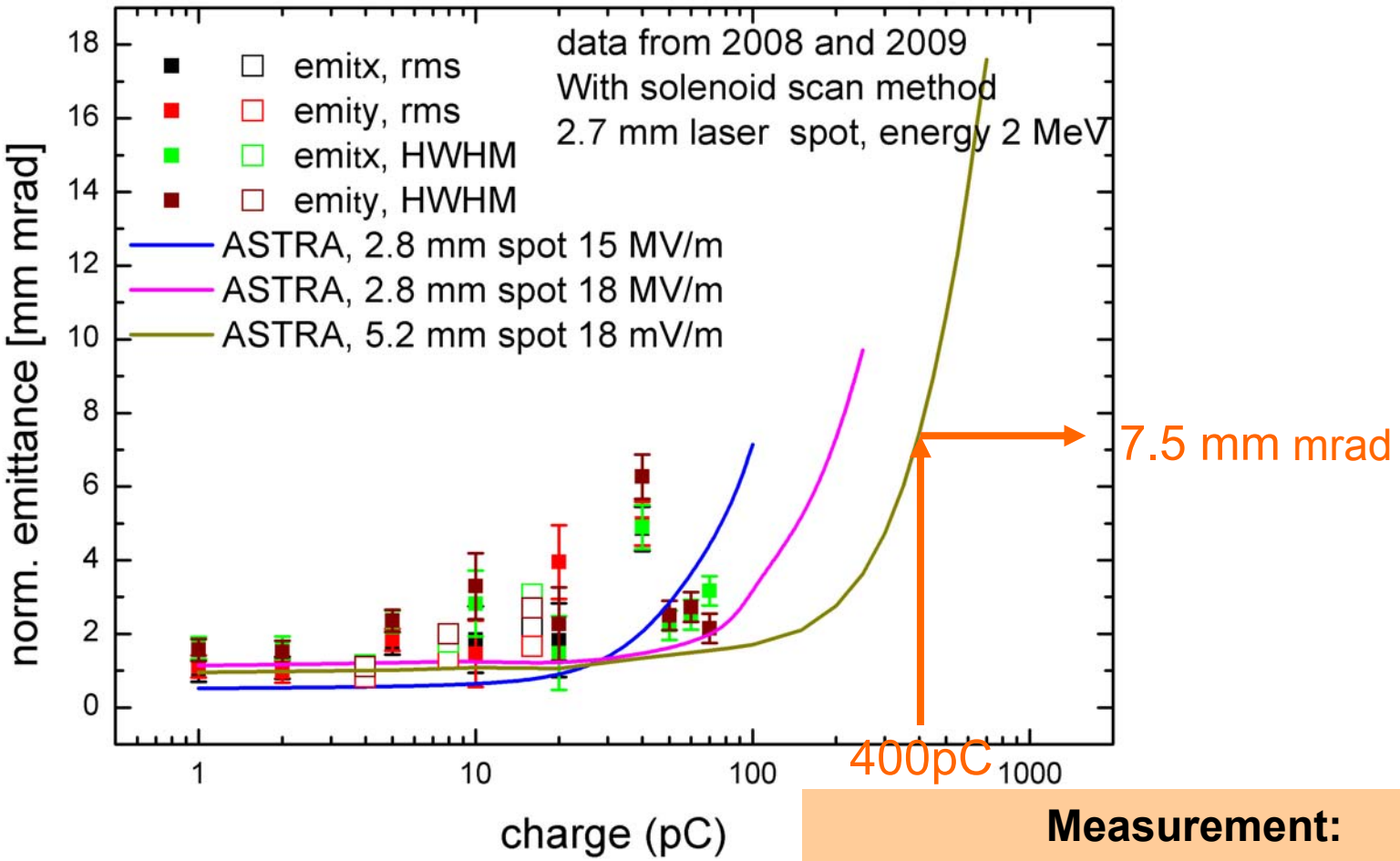
Bunch charge & energy





T. Kamps, et al., Rev. Sci. Instr. 79, 093301 (2008)

Transverse Emittance



Measurement:

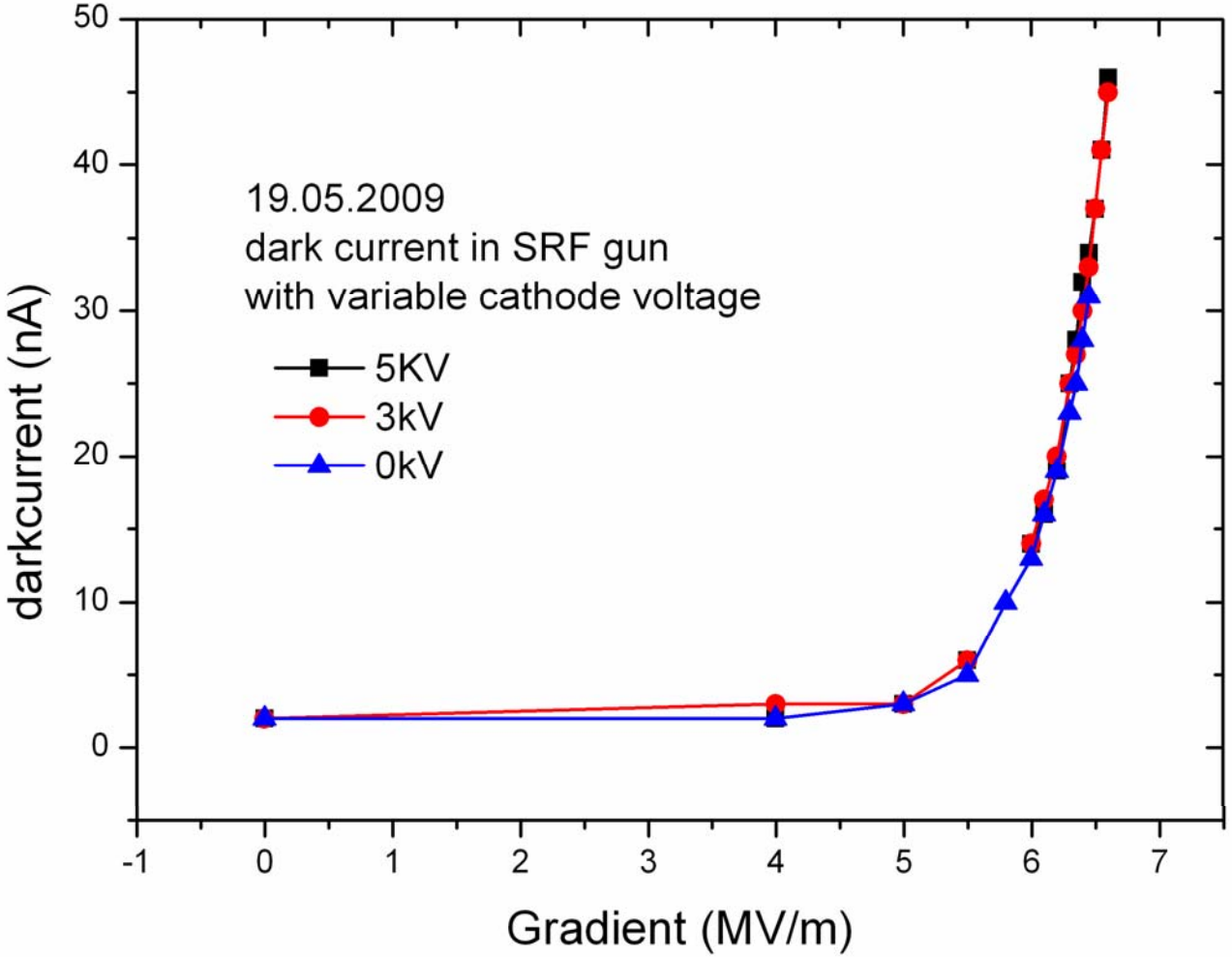
2 MeV energy

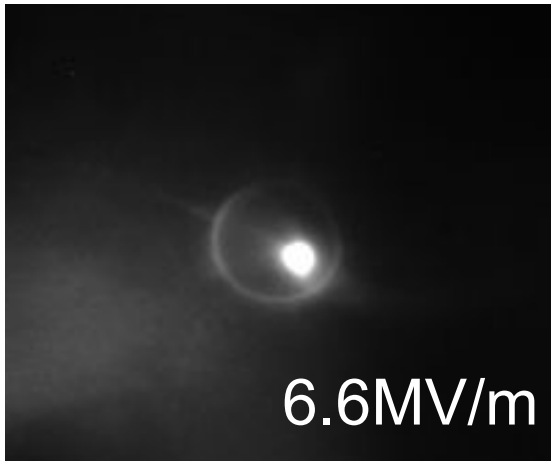
laser: temporal:15 ps FWHM Gaussian

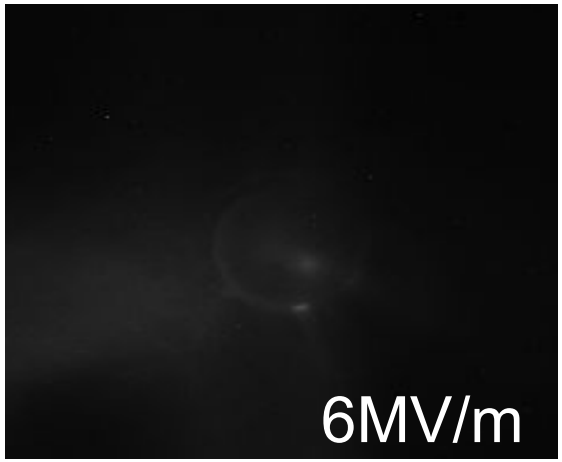
lateral: 2.7 mm diam. sharp edge

J. Teichert, ERL2009, Ithaca, New York

Dark current







Fact of SRF Gun operation:

Cavity operation for > 1000 hours
beam time for > 100 hours

basic principle works well
Ready for ELBE, 2009

Problems:

low gradient
high space charge effect
Dark current

New cavities
with higher gradient

Future:

- Routine source for ELBE
- Test bench for R&D of FZD type SRF gun
  Emittance compensation methods
  GaAs photocathode

EuCARD

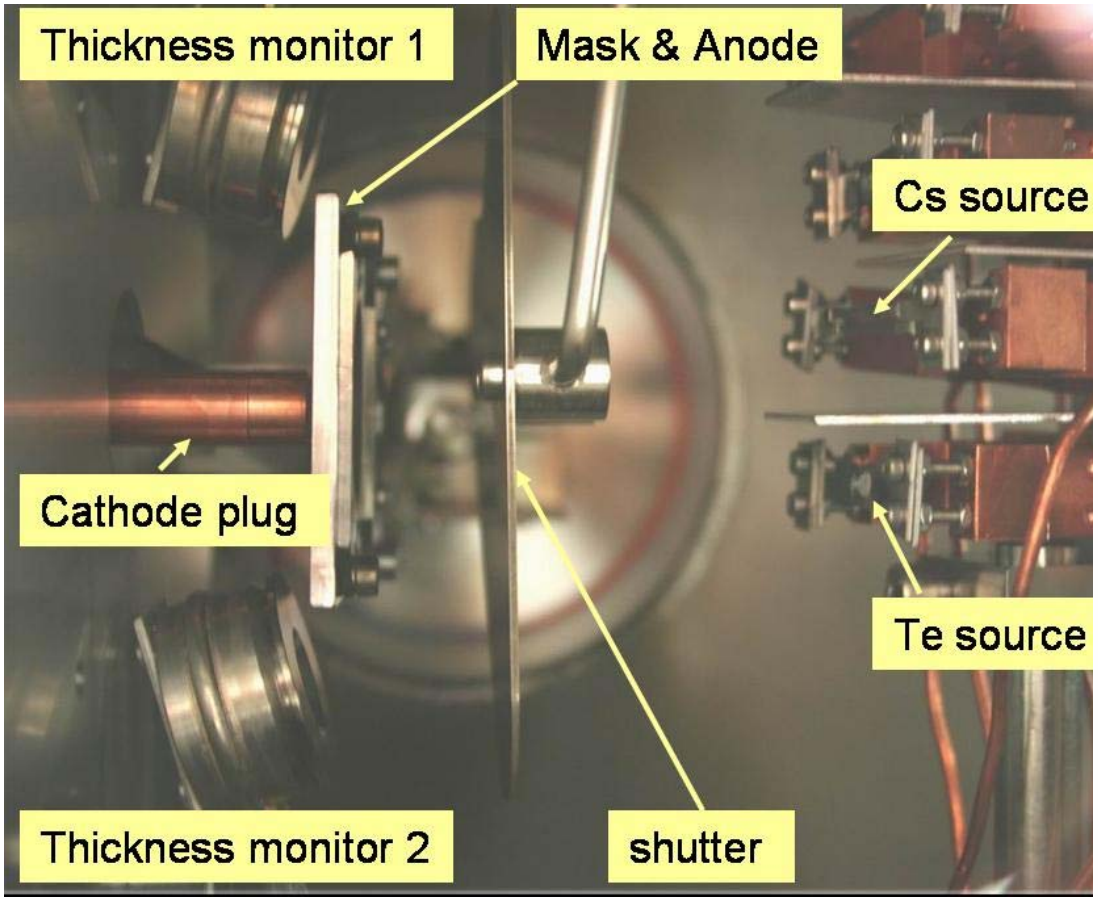
Thank you!

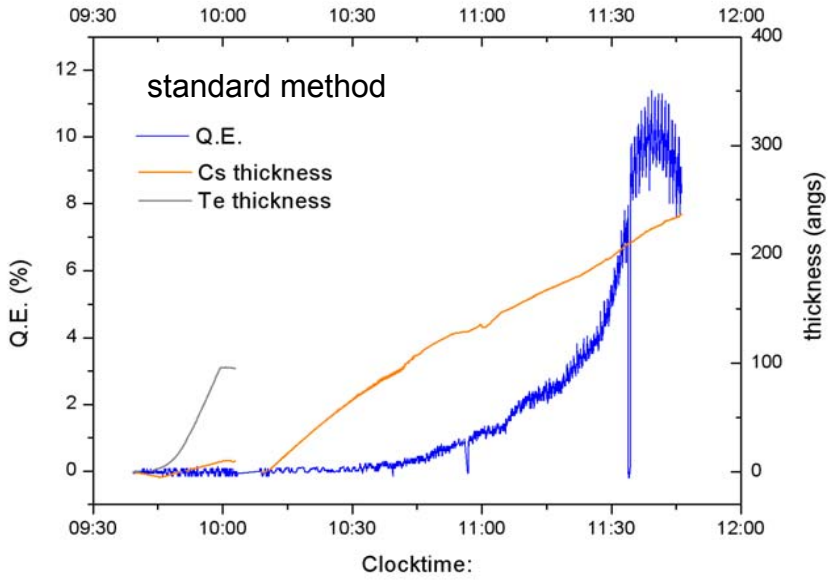
Thanks to the ELBE crews,
the colleagues of BESSY, DESY and MBI,
ACCEL and all the others supporting and
encouraging this project

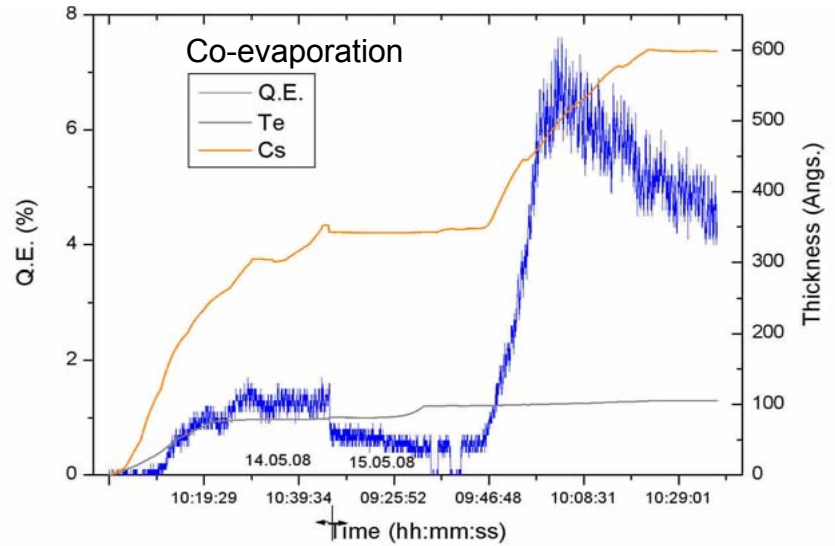
SRF Gun Parameters

parameter	present cavity			new "high gradient cavity"	
	measured	ELBE	high charge	ELBE	high charge
final electron energy	3 MeV	3 MeV		≤9.5 MeV	
peak field	17.6MV/m	18 MV/m		50 MV/m	
laser rep. rate	1 – 125 kHz	13 MHz	2 – 250 kHz	13 MHz	≤500 kHz
laser pulse length (FWHM)	15 ps	4 ps	15 ps	4 ps	15 ps
laser spot size	1~6 mm	5.2 mm	5.2 mm	2 mm	5 mm
bunch charge	≤ 300 pC	77 pC	400 pC	77 pC	1 nC
max. aver. Current	16 µA	1 mA	100 µA	1 mA	0.5 mA
peak current	20 A	20 A	26 A	20 A	67 A
transverse. norm. emittance (rms)	3±1 mm mrad @ 80 pC	2 mm mrad	7.5 mm mrad	1 mm mrad	2.5 mm mrad

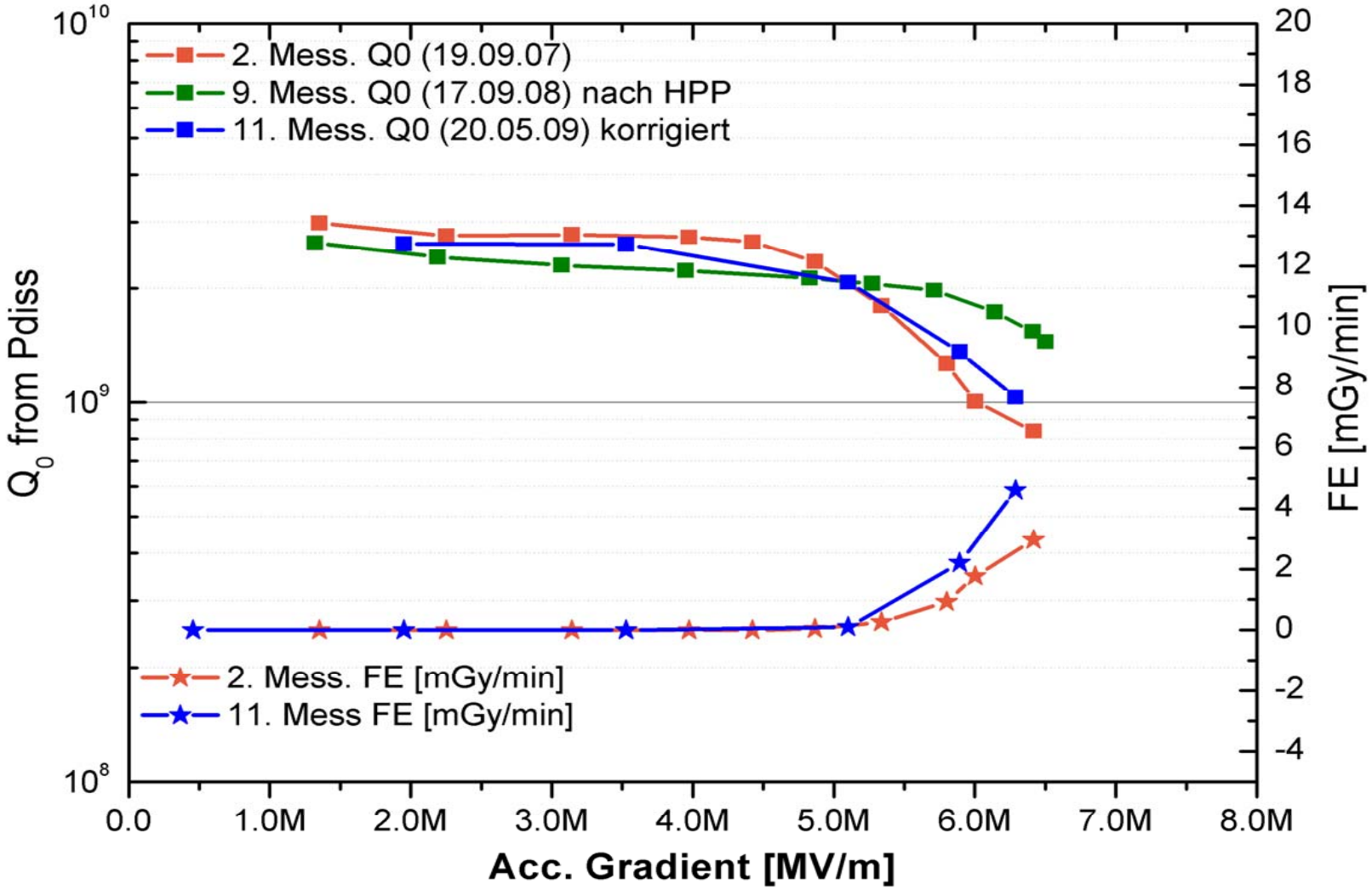
Cs_2Te PHOTOCATHODES



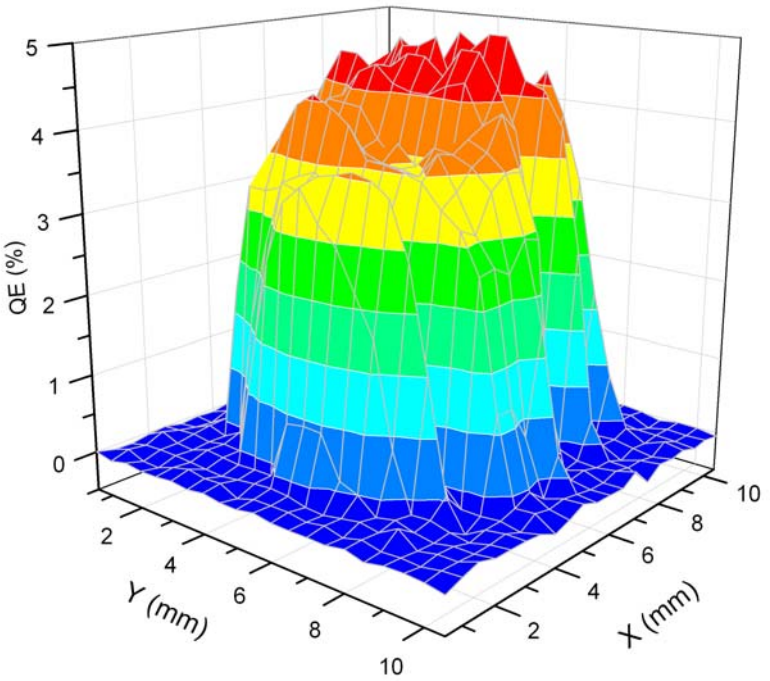




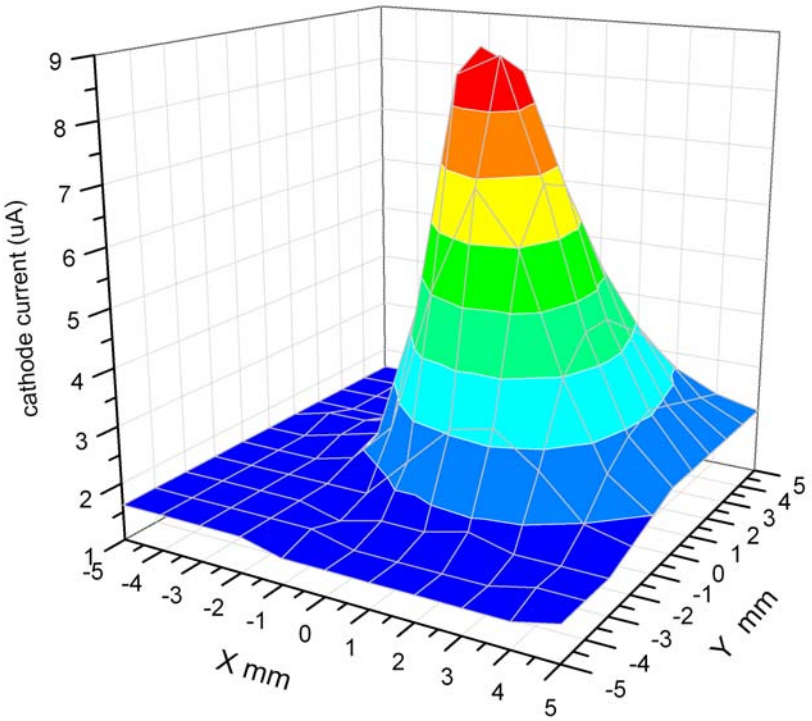
Supercondcuting cavity



QE distribution

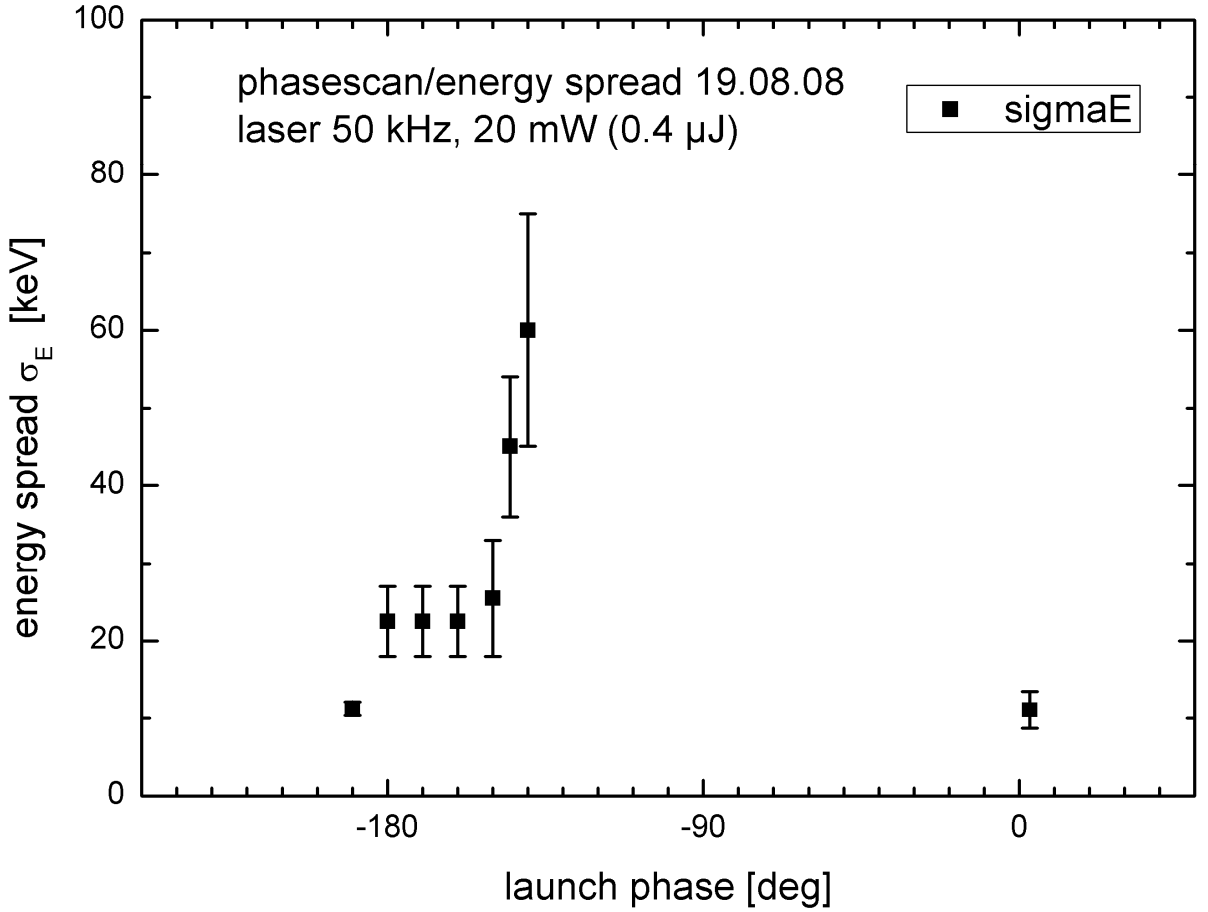


in prep. Chamber
Laser spot ø 0.5 mm
Laser power 0.4 mW
Q.E. max = 5%



- 15.05.09 in SRF gun
- Laser spot ø 3 mm
- Q.E. max ~ 1%

Energy spread



Second electron emission