

SRF Gun Development at DESY

Electron beams for CW FELs



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HELMHOLTZ RESEARCH FOR
GRAND CHALLENGES



Electron Beams for Continuous Wave (CW) FELs

photocathode gun technology providing high brightness beams

design beam parameters	CW SRF Gun for XFEL	APEX-1 CW Gun for LCLS II (NC)	pulsed NC XFEL Gun
bunch train duty cycle [%]	100	100	0.6
beam current [μA]	up to 25	up to 60	up to 27
bunch repetition rate [kHz]	1 000 to 100	620 to 100	up to 4 500
bunch charge [pC]	20 to 250	10 to 300	20 to 1 000
transverse emittance [μm]	0.4 to 0.8	0.2 to 0.6	0.2 to 1.0
beam energy at gun exit [MeV]	3	0.75	6.1
RF parameters			
operation frequency	1.3 GHz	186 MHz	1.3 GHz
accelerating gradient [MV/m]	21	19.5	31
electric peak (cathode) field [MV/m]	40	19.5	60
RF input power	750 W	~ 100 kW	~ 42 kW

The parameters of normal conducting (NC) pulsed guns can be met by superconducting (SC) guns operating continuous wave (CW).

All Superconducting Gun

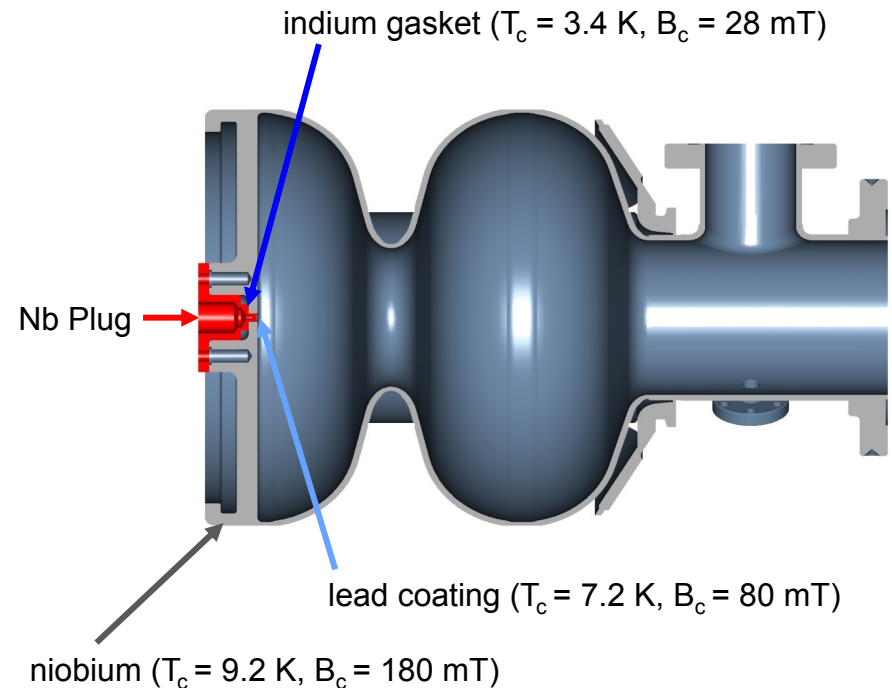
for optimal integration of cathodes in an ultra-clean SC cavity

existing cathode insertion systems still face challenges

- w.r.t. **multipacting**, **field emission**, **cathode heating**, **cathode lifetime**, etc.
- R&D still required and ongoing
- e.g. performed at HZDR and HZB

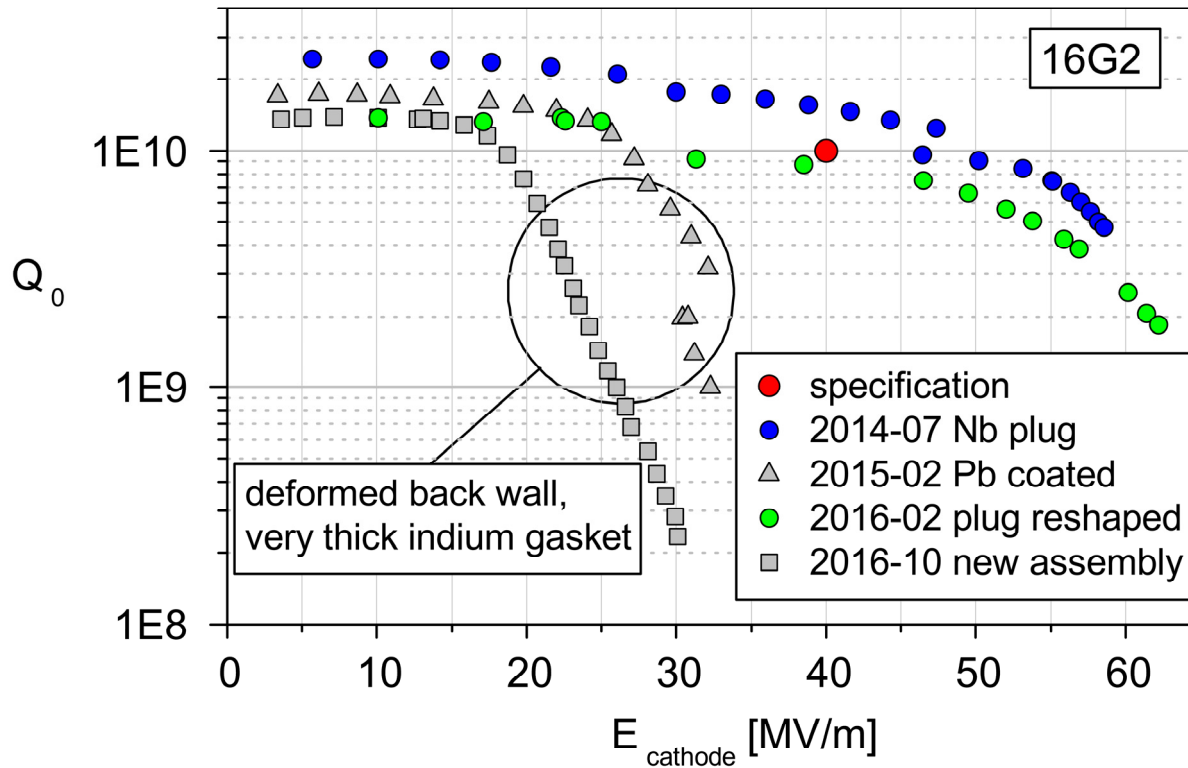
DESY approach: **superconducting (sc) cathode attached to the cavity backside**

- 😊 **cleaning after cathode insertion** in a clean room
- 😊 cathode particles (lead) should not heat and quench the cavity
- 😞 exchanging the cathode
- ⇒ only **reasonable** with **cathode lifetimes above 100 days**



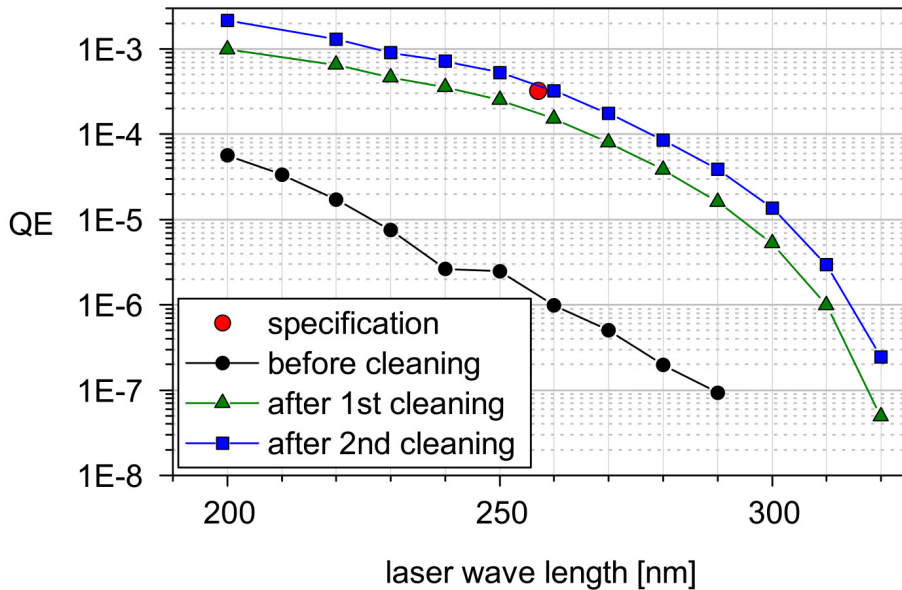
We Achieve the Required Gradients

results from cavity '16G2'



Quantum Efficiency (QE) and Cathode Lifetimes

the QE of the lead cathodes



Laser cleaning (at 248nm):

- 1st 1000 shots with 0.06 mJ/mm²
- 2nd 10000 shots with 0.06 mJ/mm²

lifetime of the lead cathodes

long time test

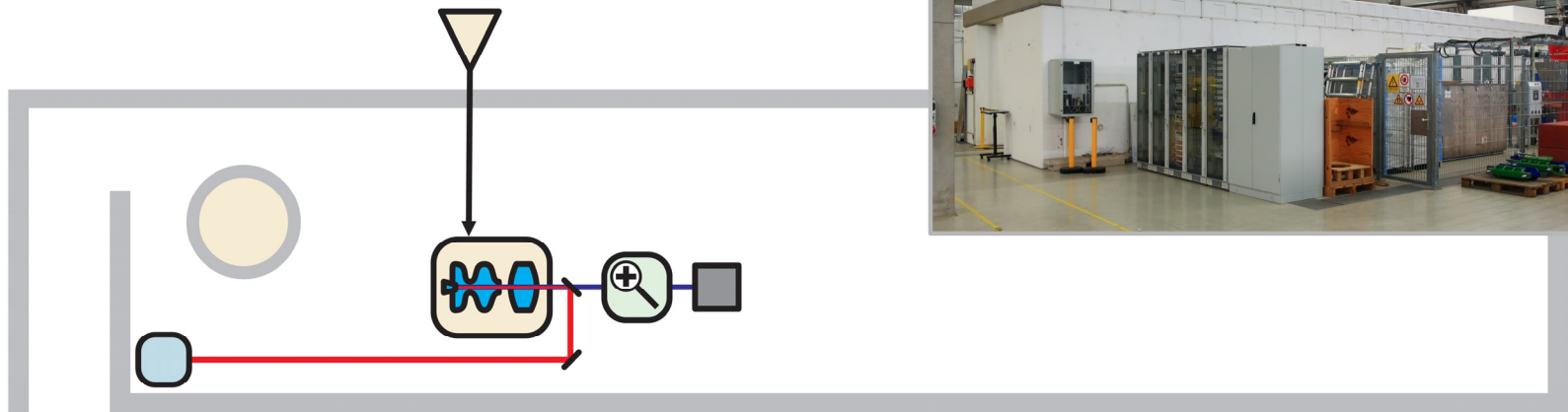
- 550 hours of irradiation
- ⇒ only small QE variations







Quantum Efficiency (QE)

- ⇒ sufficient for the specified bunch charge using an industry built laser
- ⇒ so far no degradation over time

Next Step: Putting It All Together

Goal: Demonstration of a sufficiently long lifetime of the cathode irradiated with a laser in a cavity operating at the design gradient and generating electron bunches with charge up to 250 pC.



- | | | | |
|---|--|---|---|
|  cathode laser |  cryomodule |  RF power amplifier |  beam dump |
|  1.6 cell gun cavity |  beam diagnostics |  focusing magnet |  cryogenic valve box |

please come to our poster!

MOP0037

A banner for LINAC2018 featuring a traditional Chinese building with a red roof and a pond in the foreground. The text "LINAC2018" is written in a large, blue, stylized font with a white outline, and "Beijing 16-21 September 2018" is written in a smaller, white, serif font below it.

LINAC2018

Beijing 16-21 September 2018