Update on the Lifetime of Cs_2Te Cathodes Operated at the FLASH Facility

FLASH – The Free-Electron Laser at DESY, Hamburg, Germany *flash.desy.de*

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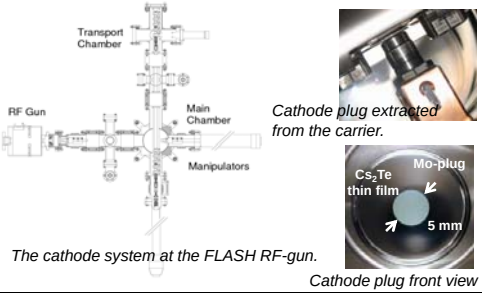
- Since 2005, FLASH is operating as a user facility: ~8000 h per year
- Superconducting technology: able to produce thousands of bunches per second
- The photoinjector of FLASH uses high QE Cs_2Te photocathodes
- Cathodes are prepared at LASA (INFN Milano) and DESY (numbers 6xx)
- Since 2013, we had only two cathodes in use: 618.3 and 73.3
- Cathode 618.3 has been operated for 439 days with an average QE of 3 % and a total charge of 3.2 C extracted
- **Cathode 73.3 is in use for a record of 933 days by the time of the conference with a QE of 8.8 % in average and a total charge of 18 C extracted**

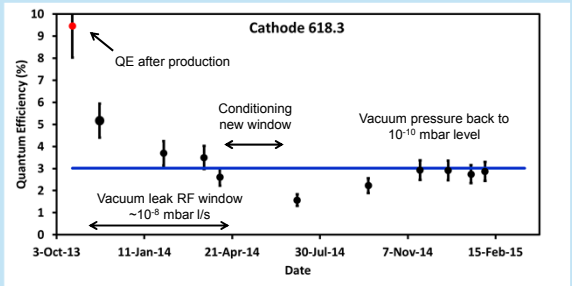


The cathode system at the FLASH RF-gun.

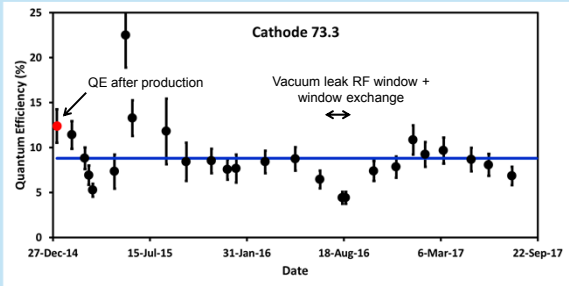
Cathode plug extracted from the carrier.

Cathode plug front view

Lifetime



Operational lifetime of Cs_2Te cathode 618.3 at FLASH.

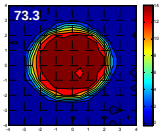


Operational lifetime of Cs_2Te cathode 73.3 at FLASH.

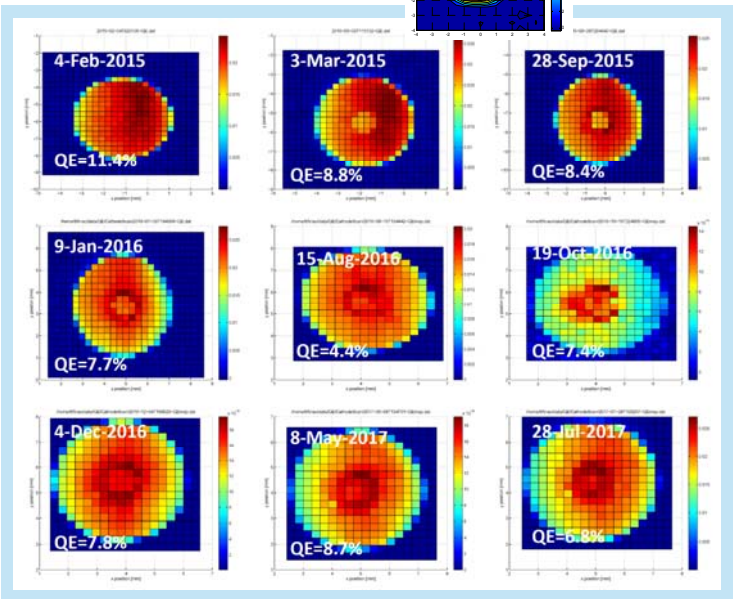
- Cathode 618.3 produced in May 2013, in use 21-Nov-2013 to 4-Feb-2015
- 439 days of FLASH operation (with ~8000 h beam per year)
- Total charge extracted: 3.2 C
- QE dropped to an average of 3 % due to a small vacuum leak at the RF window discovered late. New window installed April 2014.
- Further QE drop probably due to conditioning of the new RF window to <2%
- Recovered later to 3% when vacuum condition became excellent again (<10^{-10} mbar)

- Cathode 73.3 produced in June 2013, in use since 4-Feb-2015 up to now
- 933 days of operation (with ~8000 h beam per year)
- Total charge extracted so far: 18 C
- QE stable at an average of 8.8%
- QE drops due to leaks in the vacuum system near the RF-gun (RF window and beamline)
- QE recovered since leaks have been fixed in a timely manner

QE map evolution of 73.3



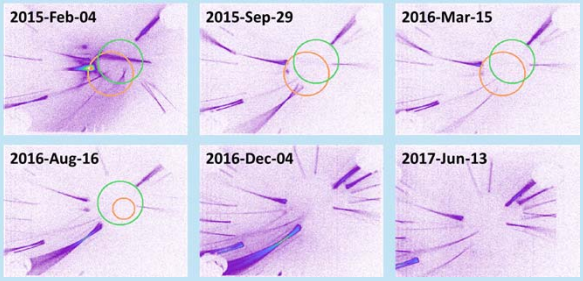
Initial cw QE map after production



- QE map: laser spot scanned linear horizontally and vertically
- Spot size σ = 25 µm, step size 85 µm
- Charge is color-coded in nC

- Laser spot size during operation 1.2 mm (flat hat)
- Initial fast QE degradation at the laser spot position
- Overall QE degrades slower
- QE recovers and stabilizes due to UV cleaning effects

Darkcurrent



Darkcurrent emitted with cathode 73.3 from Feb 2015 to June 2017. The images are taken using a Ce:YAG powder screen, 1.6 m downstream of the cathode. The green circle indicates the position of the Cs_2Te film.

- The RF-gun is dry ice cleaned which reduces the darkcurrent from the gun backplane by an order of magnitude
- All darkcurrent images are taken with the same standard operation conditions: RF power 5 MW, 600 µs RF pulse length, solenoid field 180 mT
- A strong emitter of the fresh cathode could be conditioned away
- Some emitters appear and disappear from time to time
- Darkcurrent is reasonable small and stable over time with an average of 5 µA (±20%)
- The darkcurrent transmitted through the linac is reduced by a kicker/collimator combination at the gun exit
- Darkcurrent from the gun is the main source of activation of beamline components and also heating of the cryogenic system

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