

Lifetime of Cs₂Te Cathodes Operated at the FLASH Facility

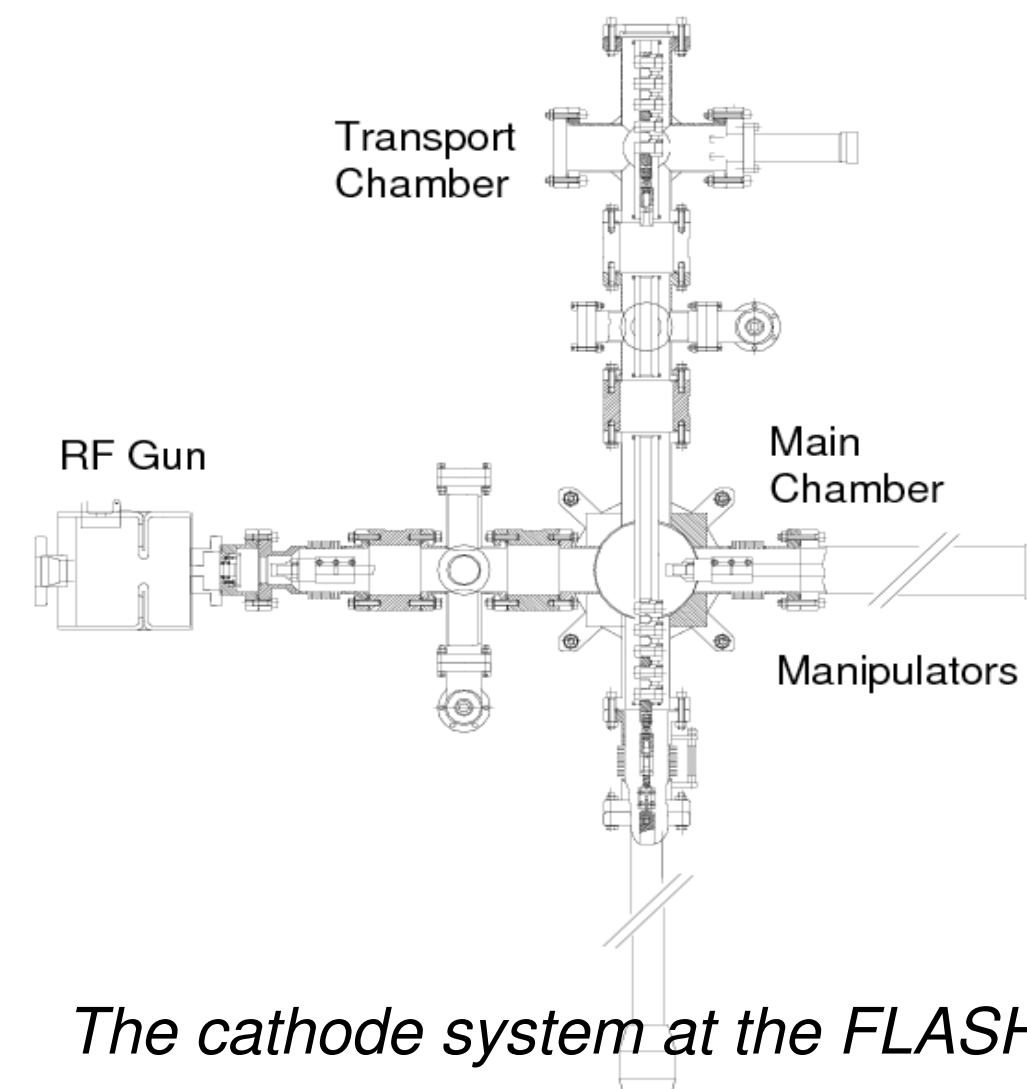
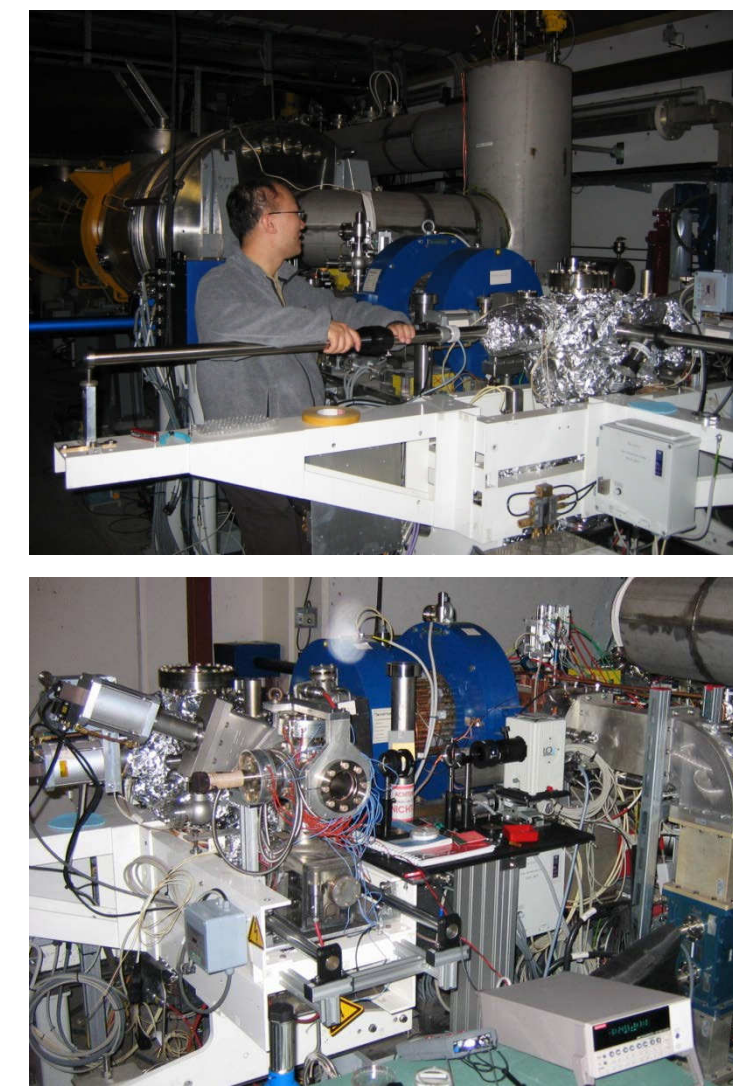


FLASH
Free-Electron Laser
in Hamburg

FLASH – The Free-Electron Laser at DESY, Hamburg, Germany
flash.desy.de
S. Schreiber, S. Lederer, Deutsches Elektronen-Synchrotron

Summary

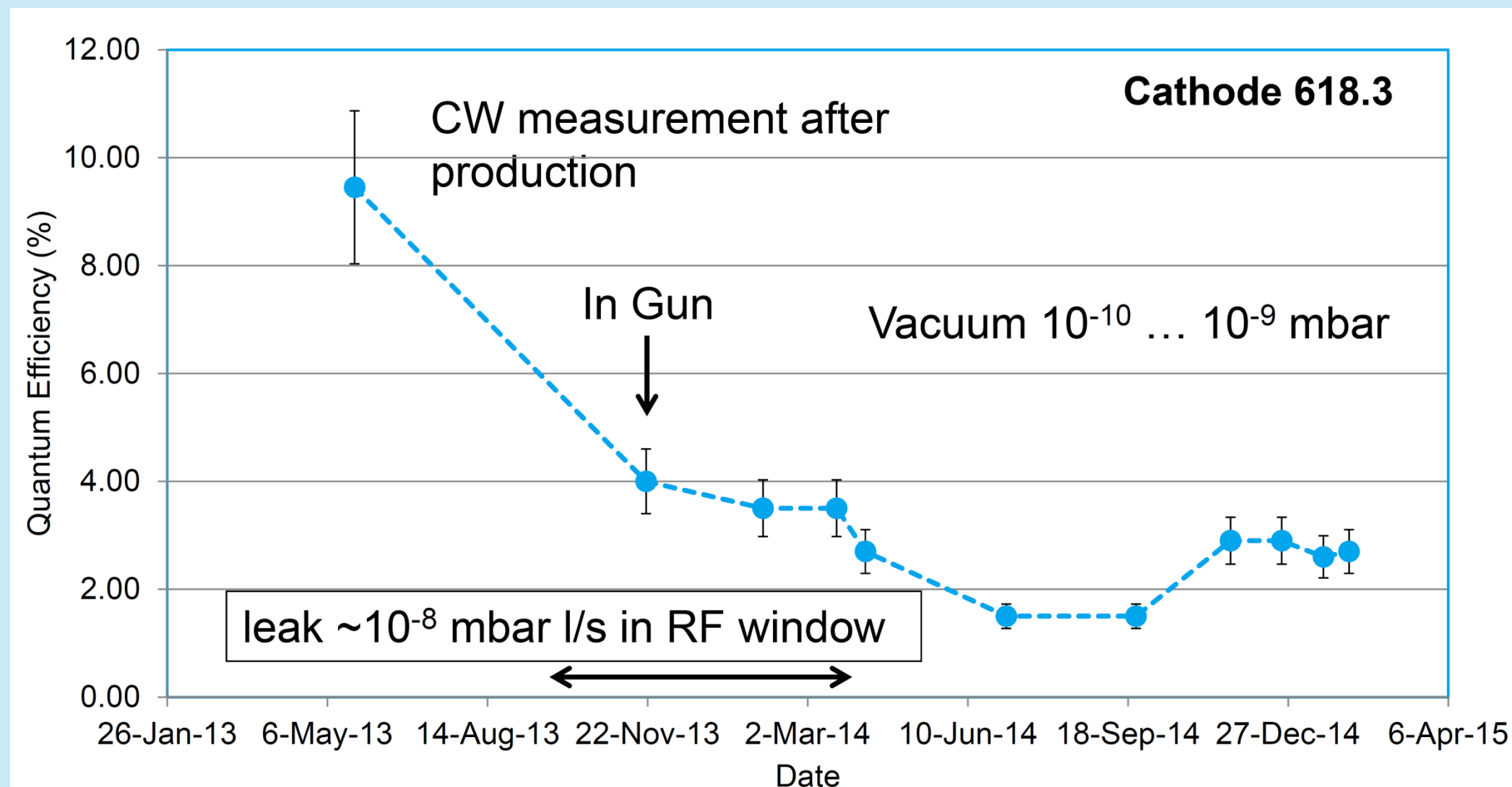
- > The photoinjector of FLASH uses Cs₂Te photocathodes.
- > Since 2005, FLASH is operating as a user facility (>7500 h per year)
- > Cathodes are prepared at LASA, Milano, Italy and DESY (DESY cathode numbers start with 6xx)
- > Recently, cathode 618.3 has been used during regular FLASH operation for a **record of 439 days at a good QE of ~3 %** with a total charge of 3.2 C extracted
- > The present cathode 73.3 is in for 6 months now



Cathode plug extracted from the carrier.

The cathode system at the FLASH RF-gun.

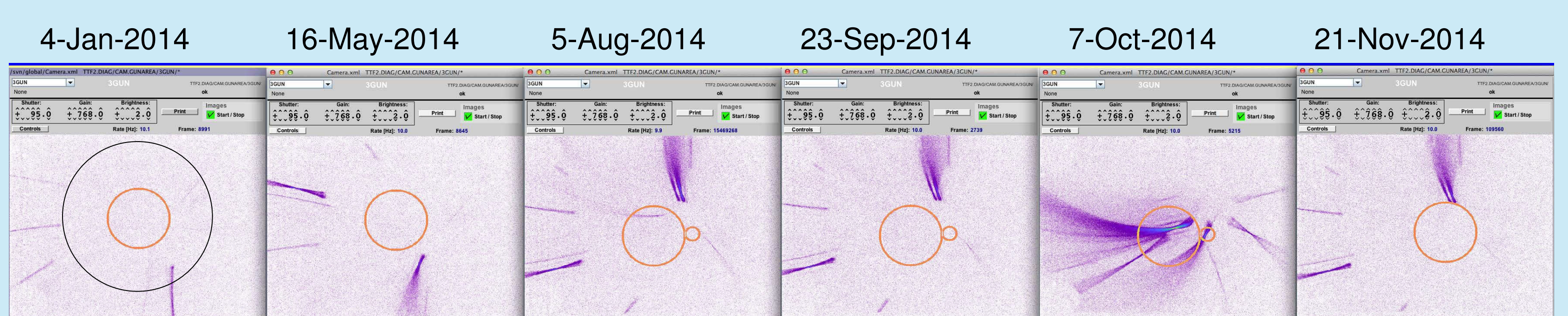
Lifetime



Operational lifetime of Cs₂Te cathode 618.3 at FLASH.

- > Cathode 618.3: in use at FLASH 21-Nov-2013 to 4-Feb-2015
- > These are 439 days of FLASH operation (>7500 h per year)
- > Total charge extracted: 3.2 C
- > QE dropped to 3 % due to a small vacuum leak at the RF window discovered and repaired April 2014
- > Further 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)

Darkcurrent

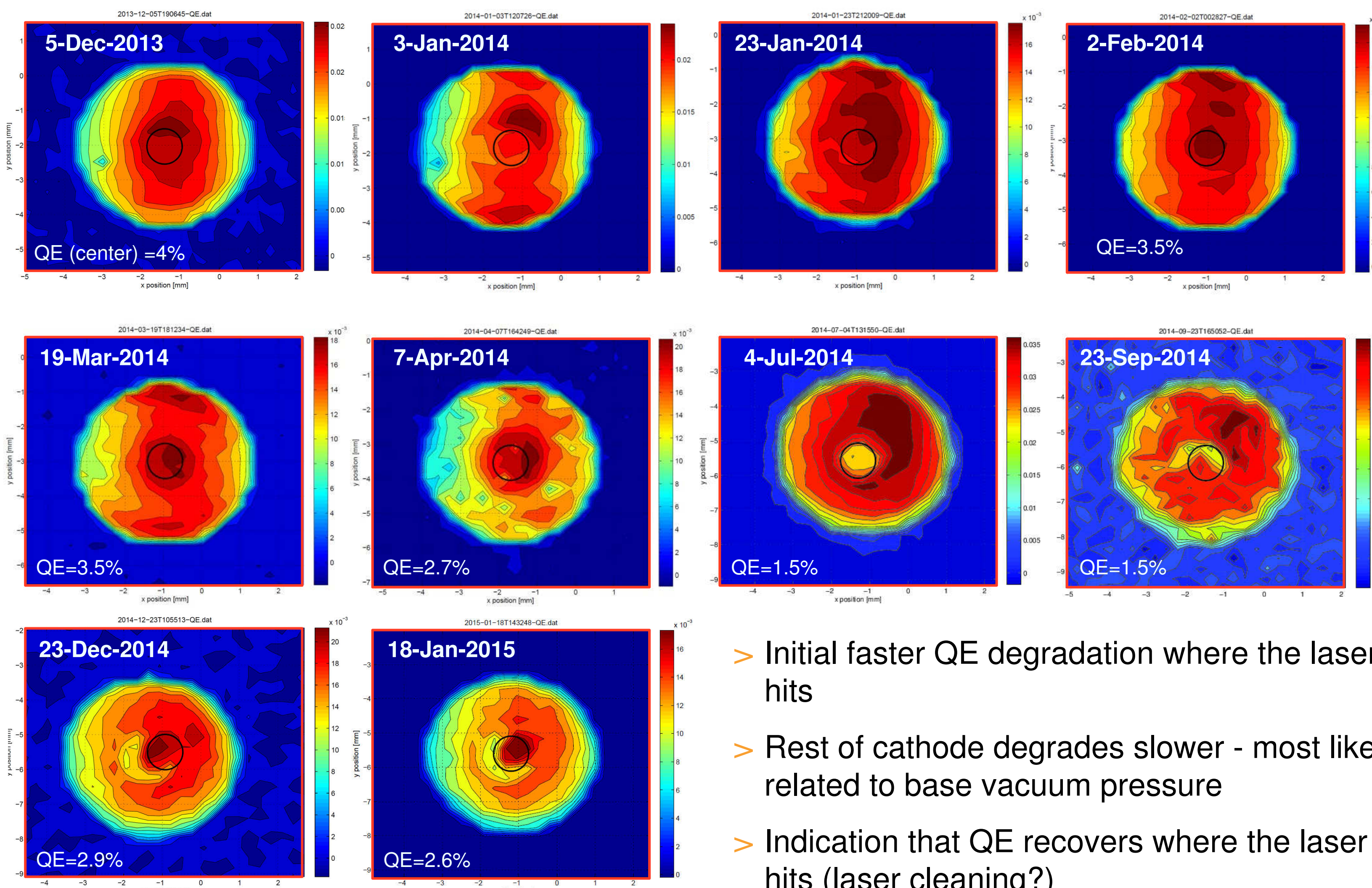
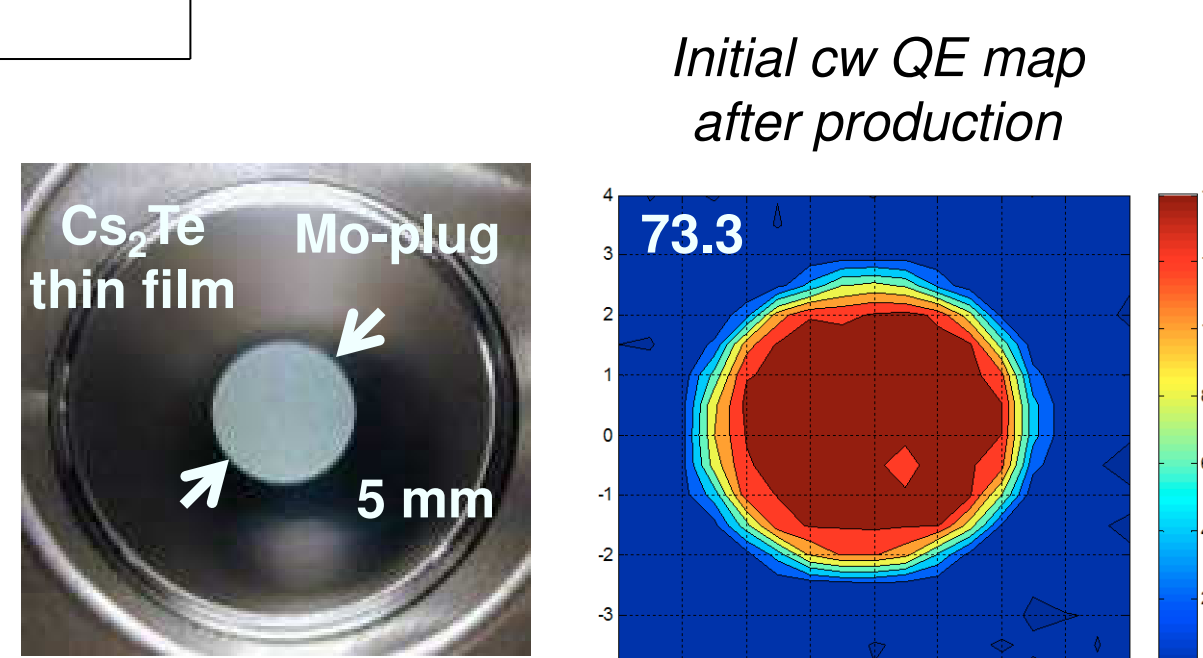


Darkcurrent with cathode 618.3 measured with a Ce:YAG powder screen 1.6 m downstream the cathode. The image from Oct. 2014 is with cathode 619.3. The red circle indicates the position of the Cs₂Te film, the black circle the rim of the cathode. Some emitters disappear, other show up.

- > L-band RF gun (1.3 GHz), dry ice cleaned, vacuum pressure < 10⁻¹⁰ mbar
- > Fwd power 4.8 MW, 500 μs RF pulse length → max. gradient at cathode 52 MV/m, beam momentum 5.6 MeV/c
- > Cathode 618.3: very small darkcurrent of 5 μA, measured at gun exit
- > To reduce activation of beamline components and also the cryogenic load, a darkcurrent kicker close to the gun dumps most of the darkcurrent into a collimator
- > Emitters appear partly at the rim of the thin film, partly at the rim of the plug or gun backplane
- > Darkcurrent is constant with time, with one exception of a stronger emitter appearing and shortly disappearing again

QE map evolution

- > Cathode 618.3
- > QE map with laser spot size 100 μm diam., step size 85 μm

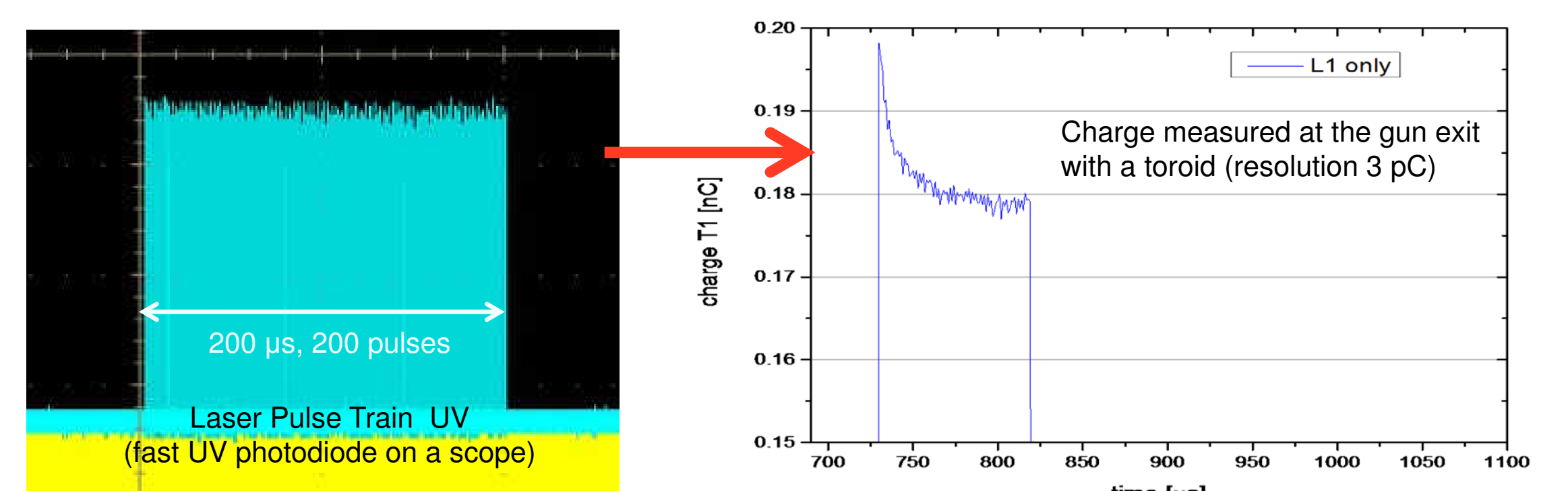


Note: the color code does not show absolute QE's, see scale

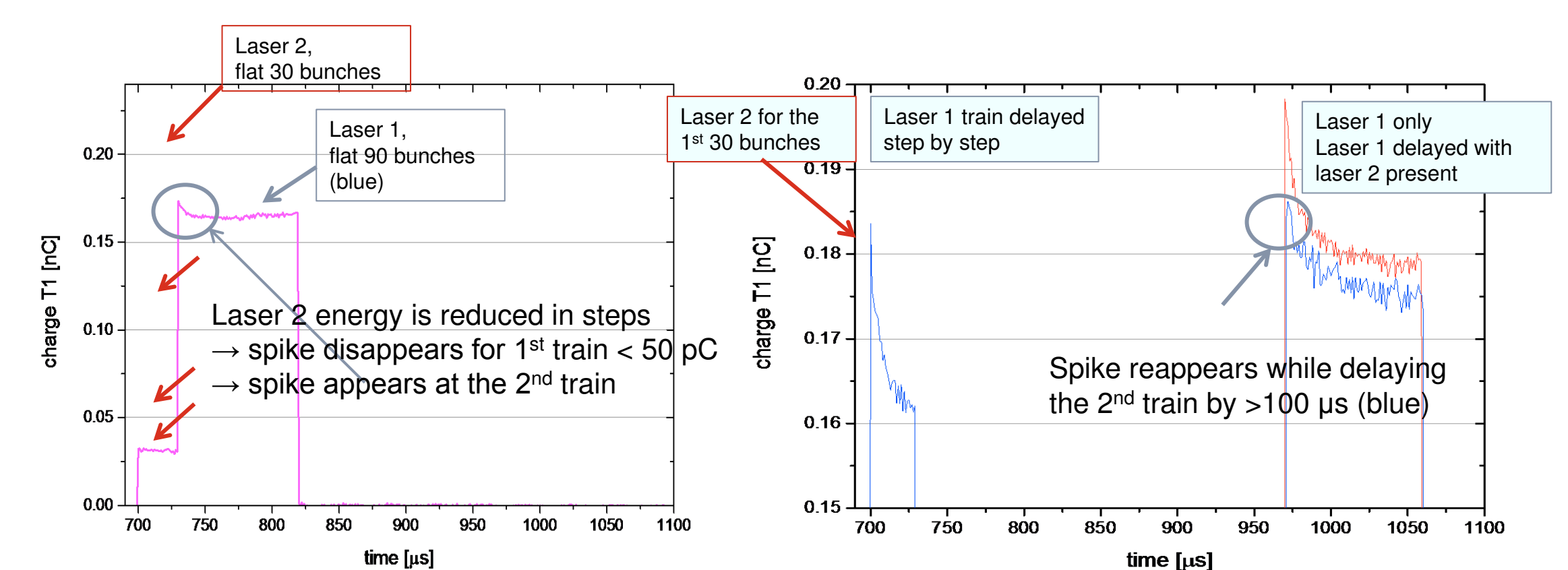
- > Initial faster QE degradation where the laser hits
- > Rest of cathode degrades slower - most likely related to base vacuum pressure
- > Indication that QE recovers where the laser hits (laser cleaning?)

Emission issue of fresh cathode 73.3

- > QE after preparation 12.4%
- > Fresh in the gun 4-Feb-2015 QE=10%



- > A flat energy distribution of the laser pulse train produces a 'spike' at the head of the electron bunch train emitted from a fresh cathode – that's not what one wants to have



- > The spike is not produced by a spike in the laser train
- > It originates from the cathode, for a field of >20 MV/m
- > The decay time is ~30 μs, recovery time ~250 μs
- > Spike strength depends on laser energy density and accelerating field on cathode
- > The decay time decreases slowly with time over weeks

TUP042