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Trieste

Copper photocathodes experience at FERMI and the recent yttrium photocathode test

M. Trovò

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Outline

- ✓ FERMI & its photocathode guns
- ✓ QE ‘life’ & restoration issue
- ✓ Yttrium test
- ✓ Summary

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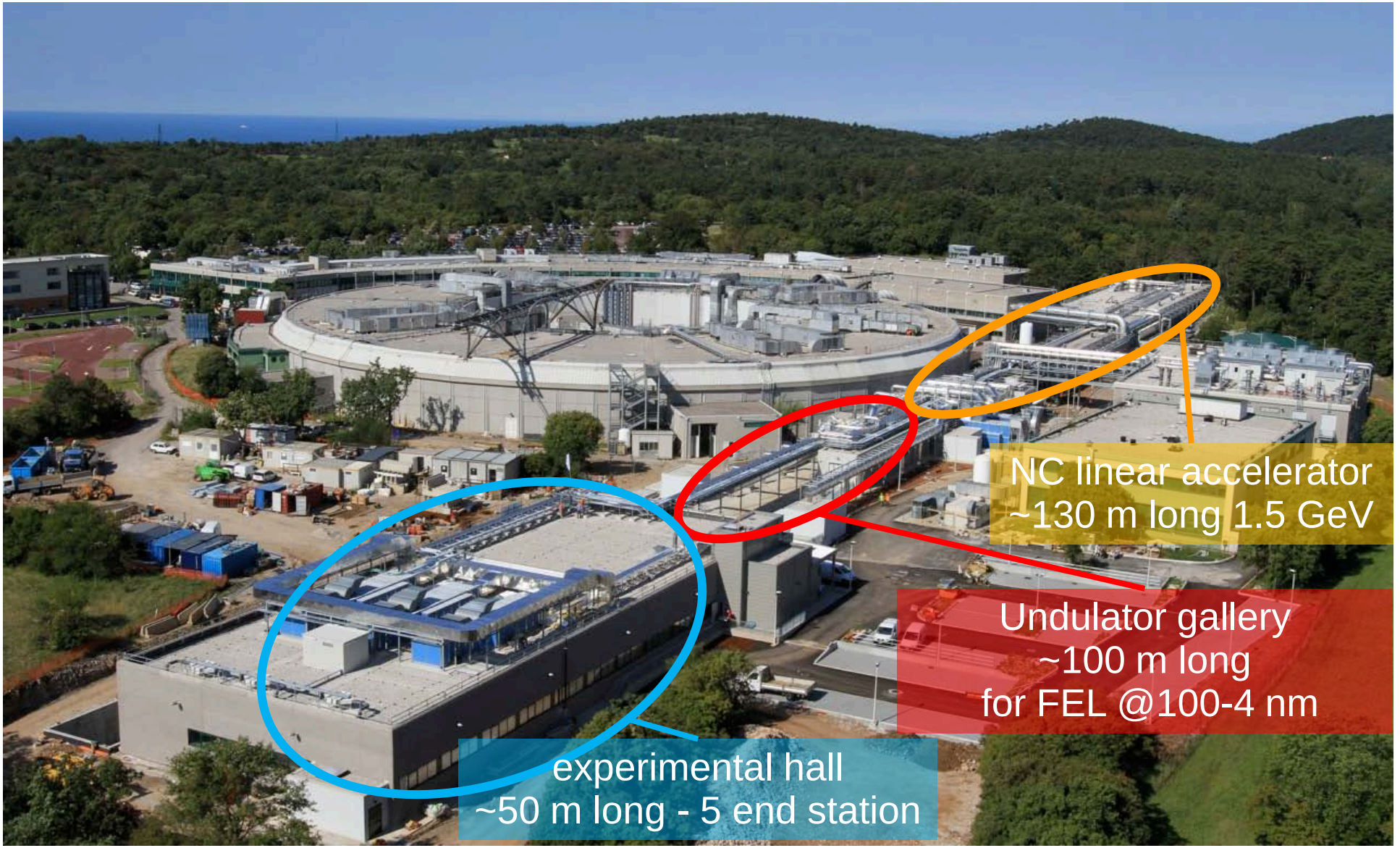
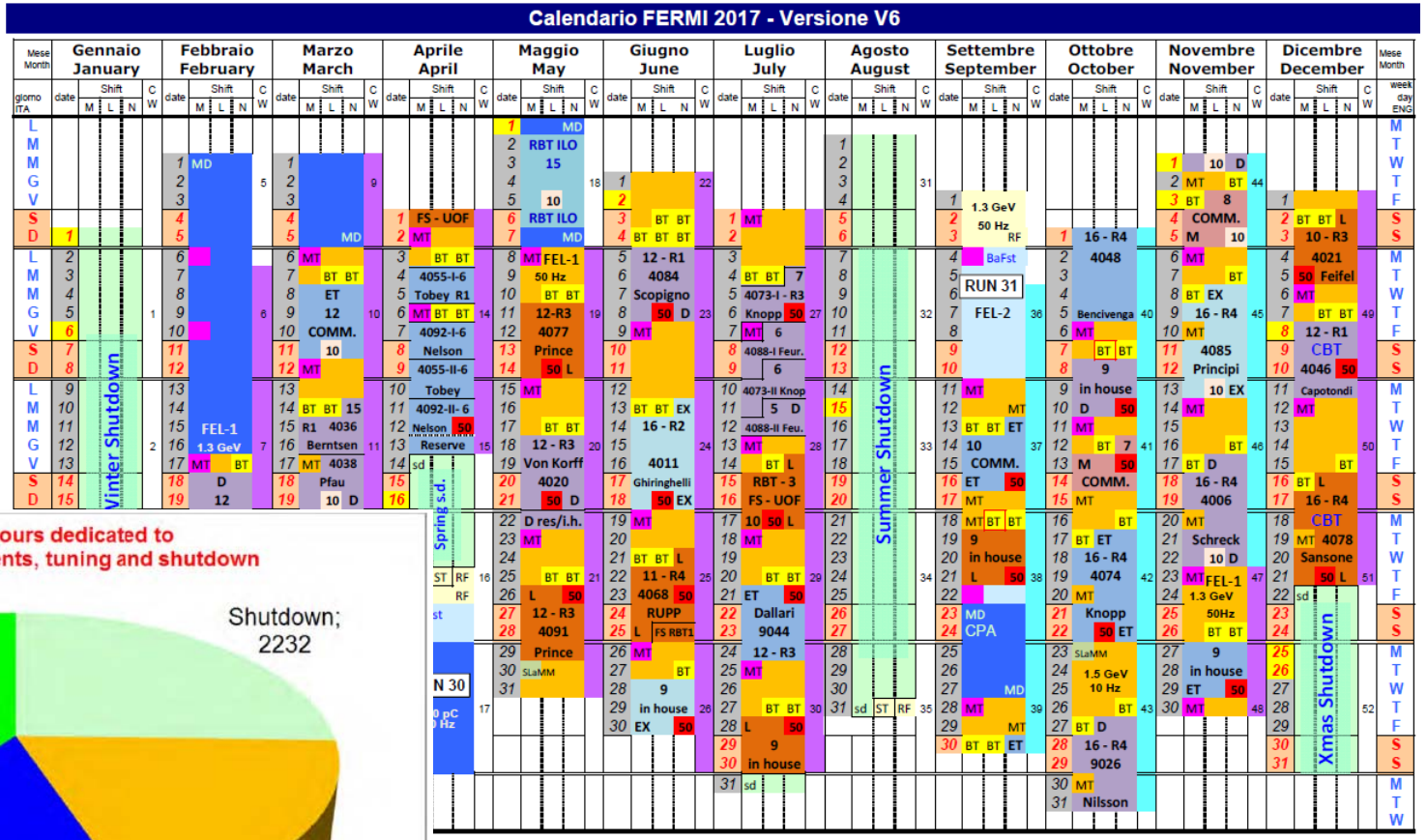
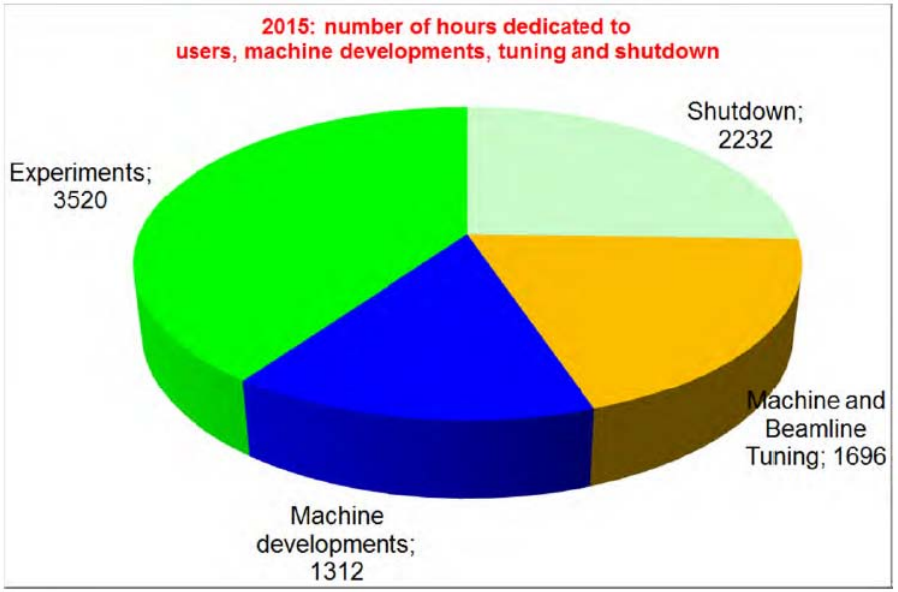
The FERMI machine



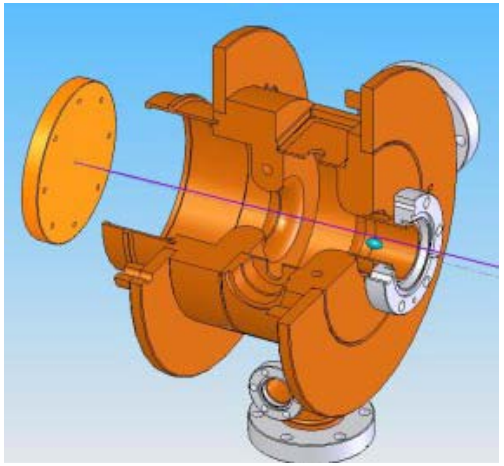
FERMI: FEL user facility



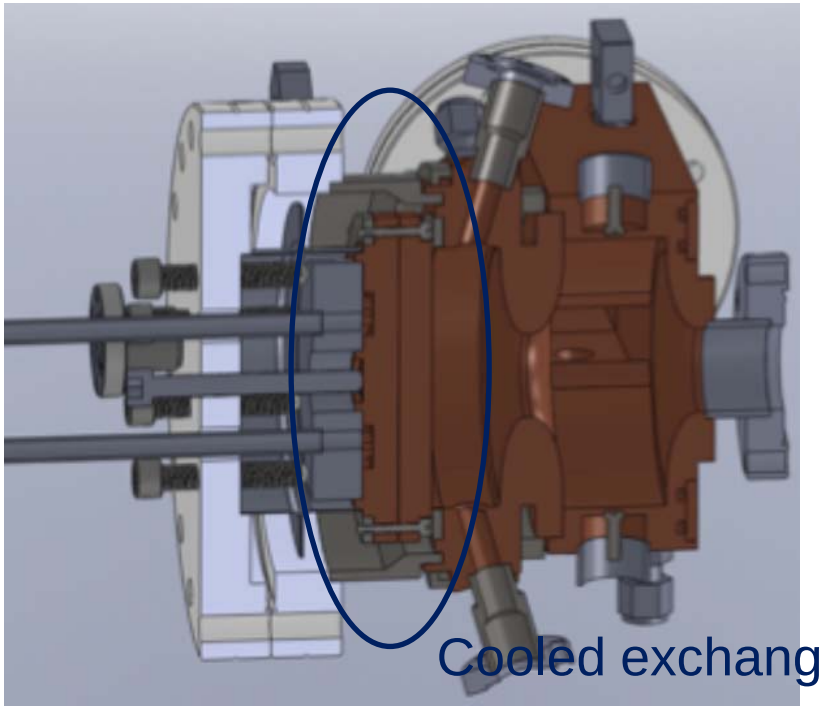


PC-Gun has to garatee the e-beam for operation of 6500 hours/year!

FERMI photocathode guns



1.6 cell Gun 1 cavity (by UCLA)



1.6 cell Gun 2 cavity (by Radia Beam)

Picture of Gun 1 cavity and solenoid

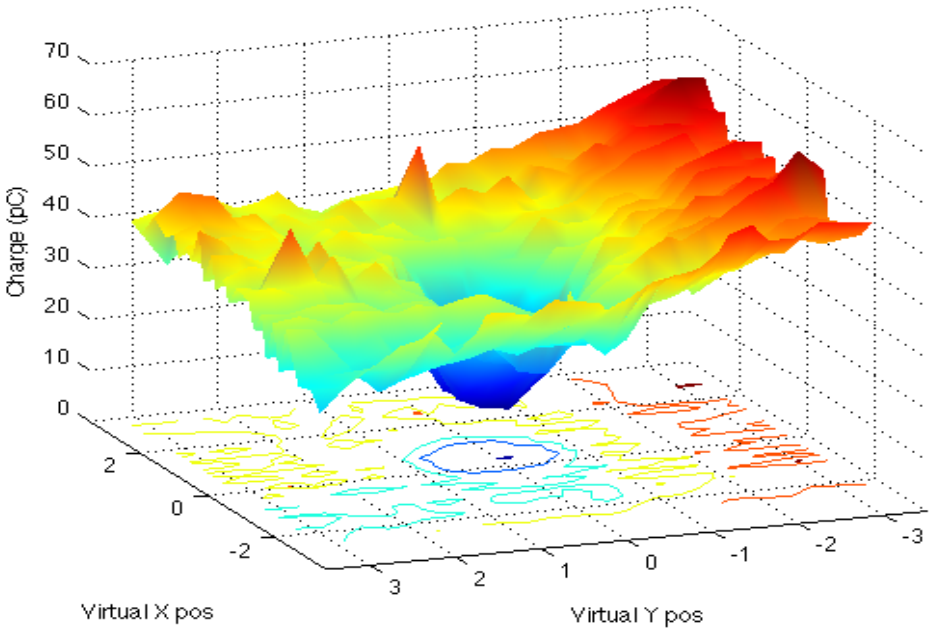
The photo-cathode gun 1 is based on the proven 1.6 cell electron gun developed at BNL/SLAC/UCLA and it was delivered by UCLA in the 2008. The PC-Gun has been used as FERMI photo-injector during the operation from 2009 till 2013.

Gun 2 for 50 Hz operation was delivered by Radia Beam technologies in the end of 2012 and it replaced the old one in May 2013.

QE – localized degradation

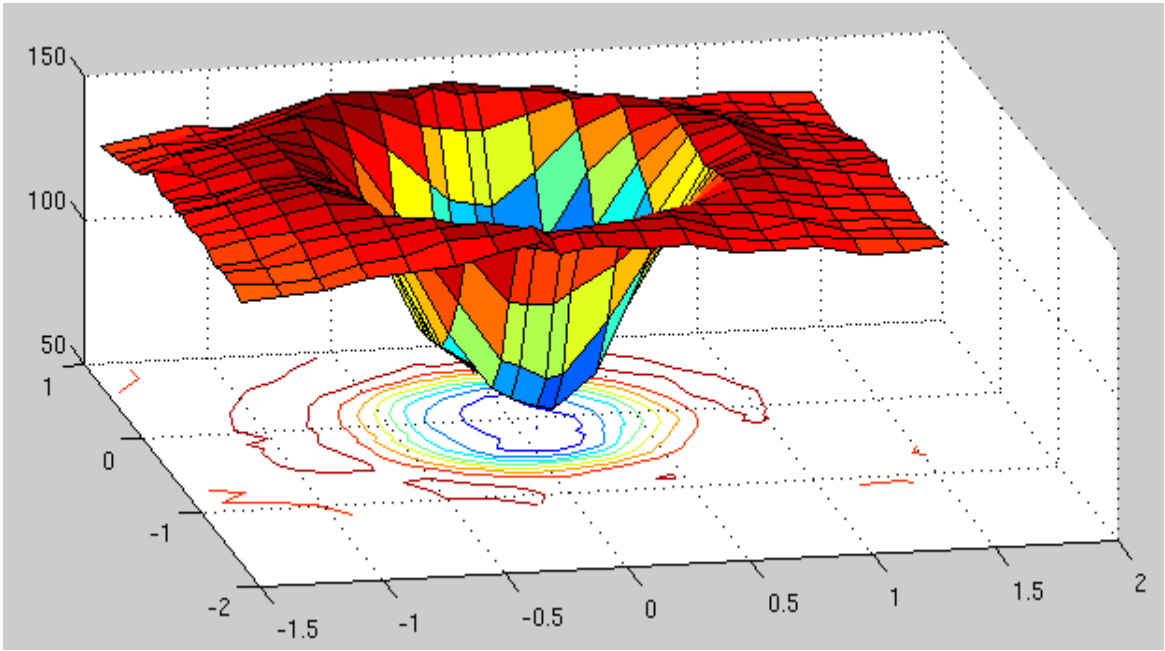
After the first run a Q.E. degradation was observed in the cathode centre.
After 2 operation months (and 600 MJ of dose) the following cathode map was measured:

Gun 1 - 2009



Cathode surface sampled by a 100 µm laser spot. and about 10 µJ.

Gun 2 - 2017



Something from the residual gas on the surface!

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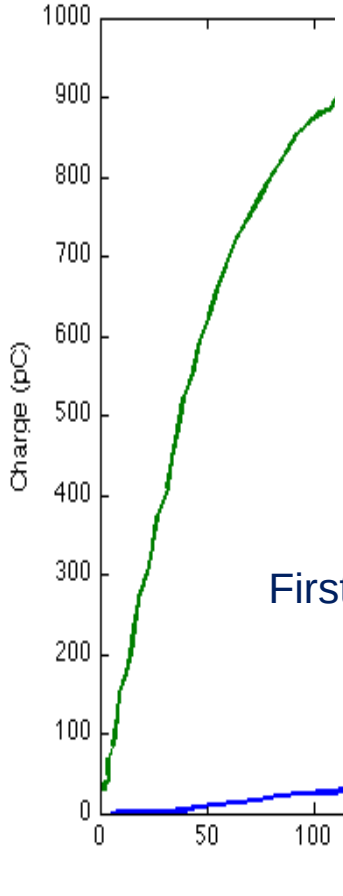
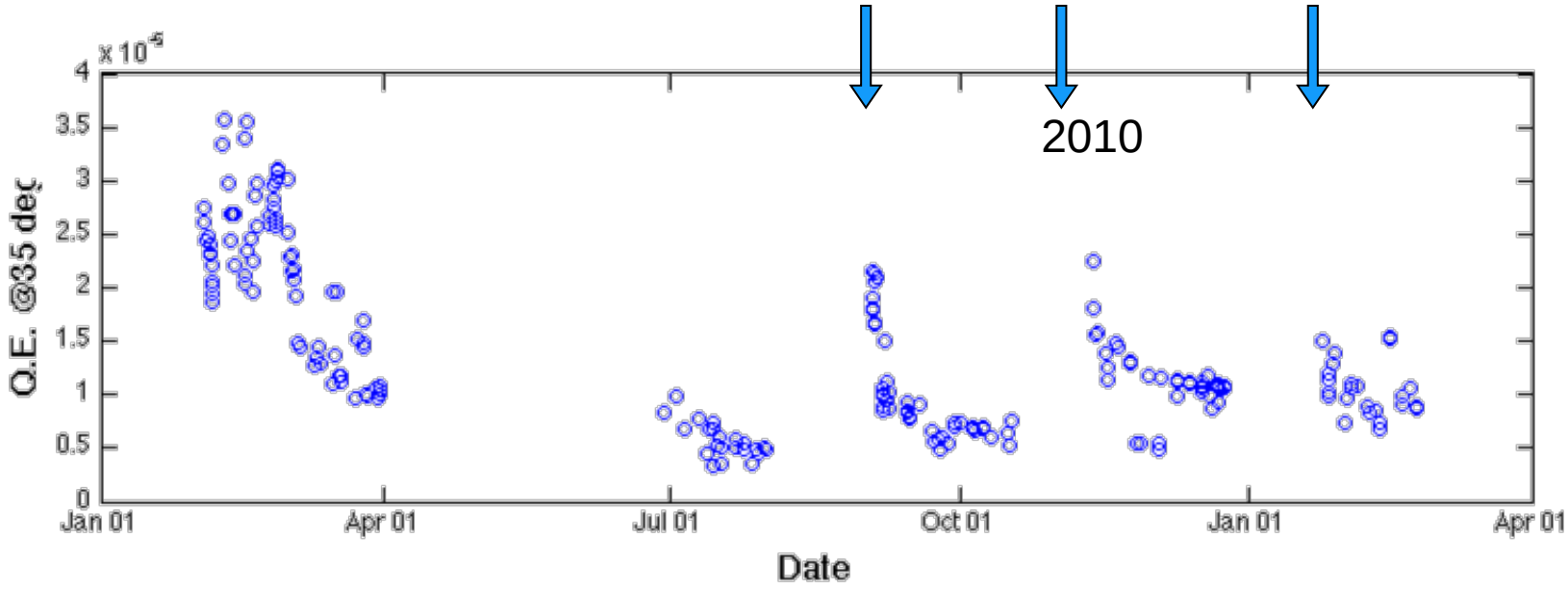
UV/Ozone Cleaning

UV/Ozone Cleaning procedure normally used at the beamline to remove carbons from mirror surfaces.





First application – Dec. 09

Drowback:
Few day activity!

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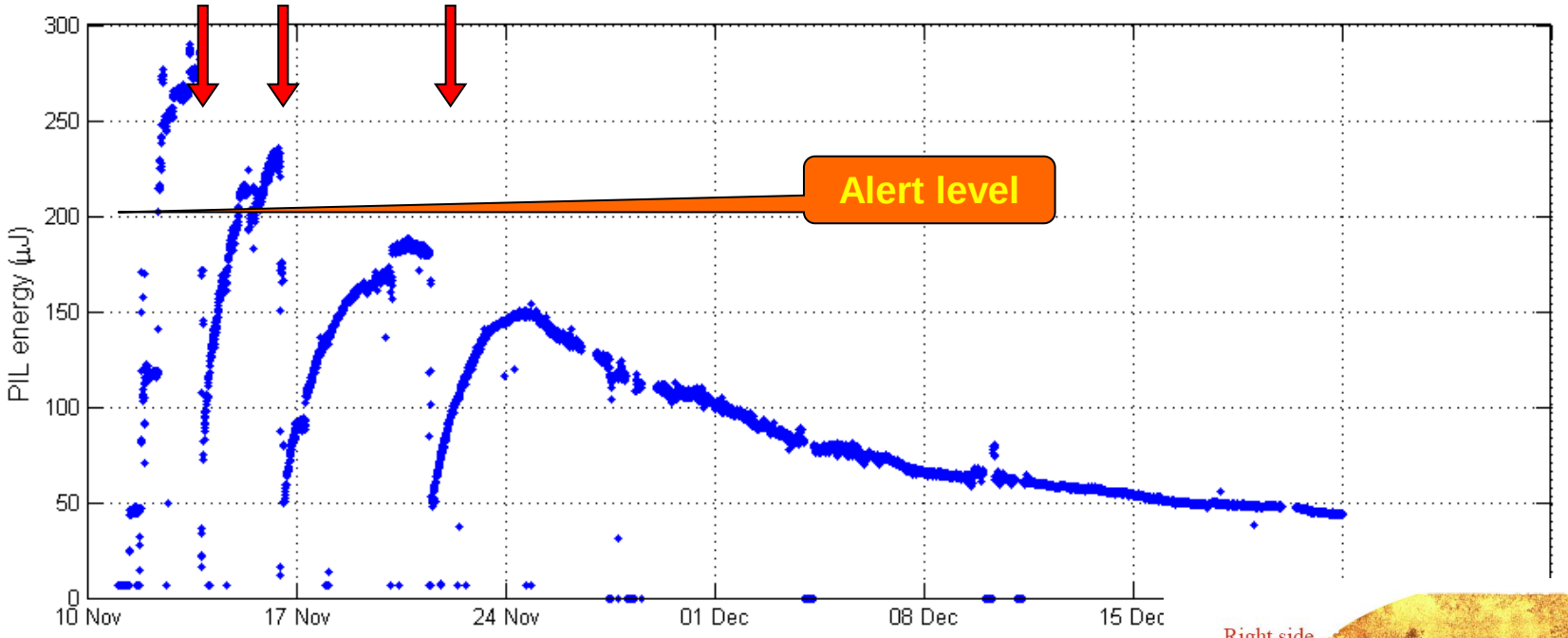
NEW Gun - cathode 1

RUN 18 - 2013: Laser cleaning experience



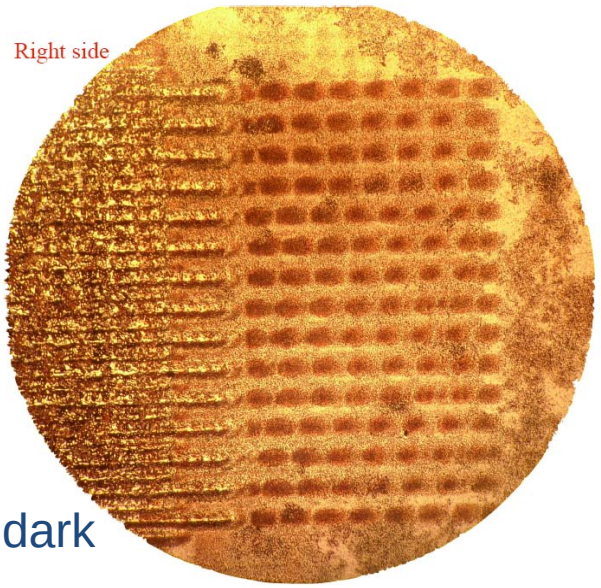
PIL pulse energy required for 500pC bunch charge

Laser cleaning application

according to LCLS recipe: small UV laser spot moved around the surface.

In some conditions the cathode surface was damaged

with an emittance degradation (up to 3 mm mrad!) and dark current up to 1.8nC!



Cathode 2 preparation

In house machined *plus* polishing by external company, Casimir *(Vilnius, Lithuania)*

Surface quality: 60-40 Scratch-Dig
Surface Accurasy (Flatness): 2
lambda@632nm
Roughness: 5nm

Intallation preparation:

- Cleaning in ultrasonic bath
- baking separatly @ 200deg

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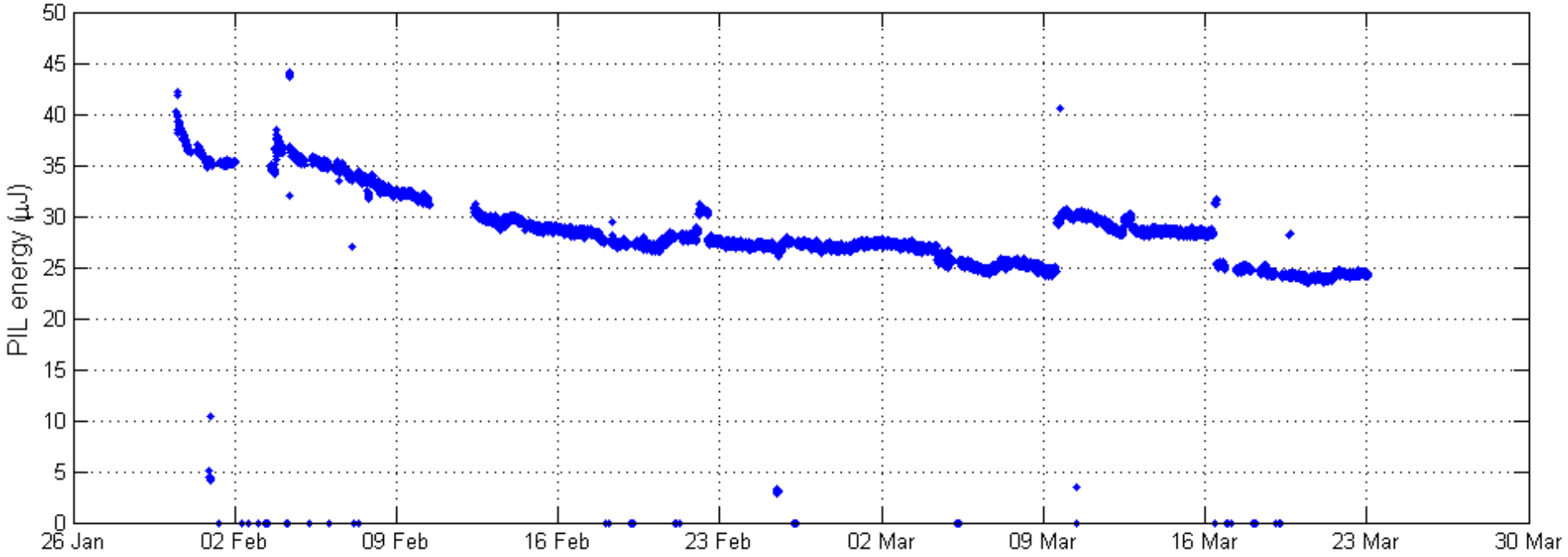
RUN 19 - 2014: New cathode

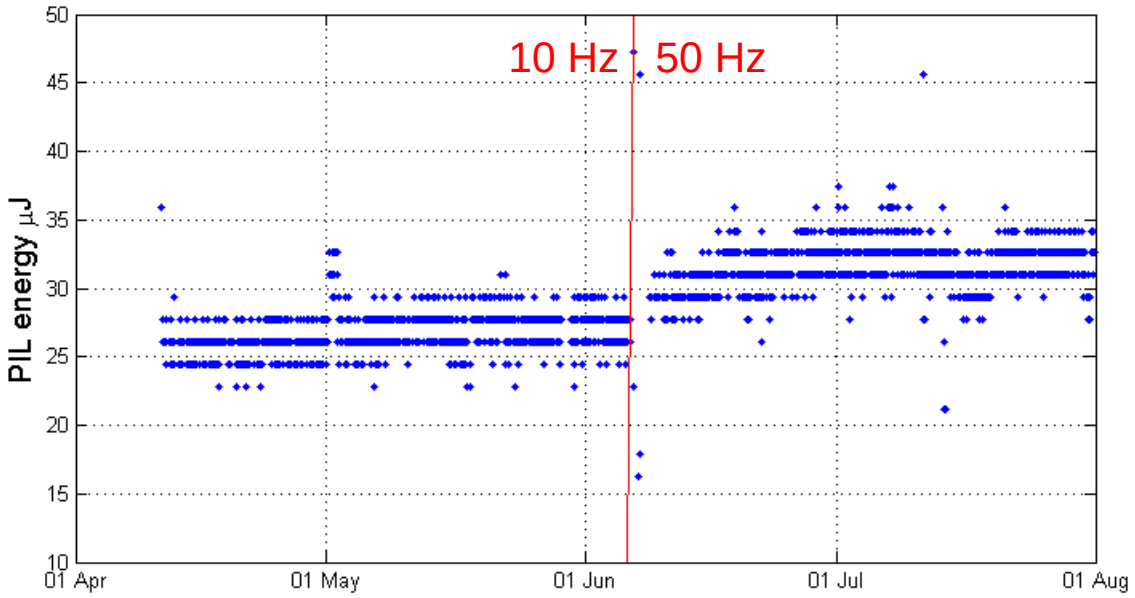


PIL pulse energy required for 500pC bunch charge (feedback regulation)

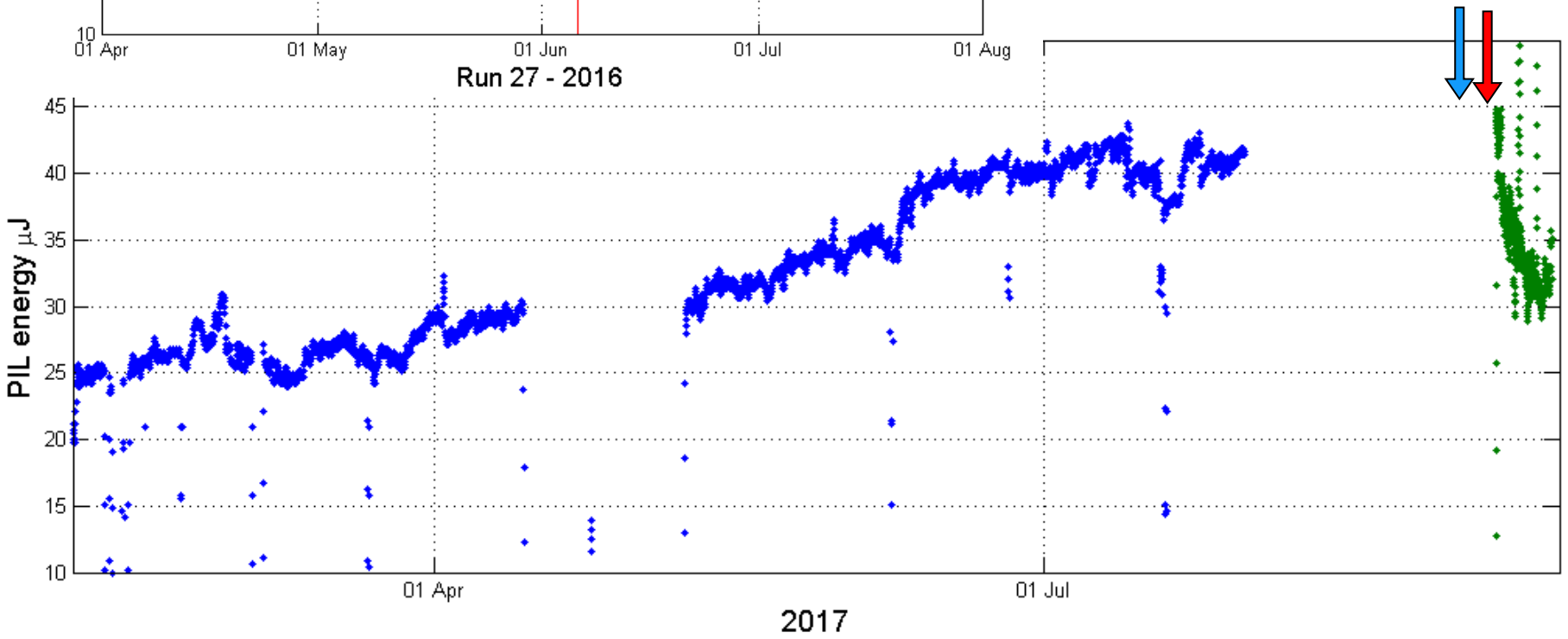
Q.E. is now about 0.01% (PIL quite relaxed);

Emittance < 1 mm mrad in LH@100MeV;

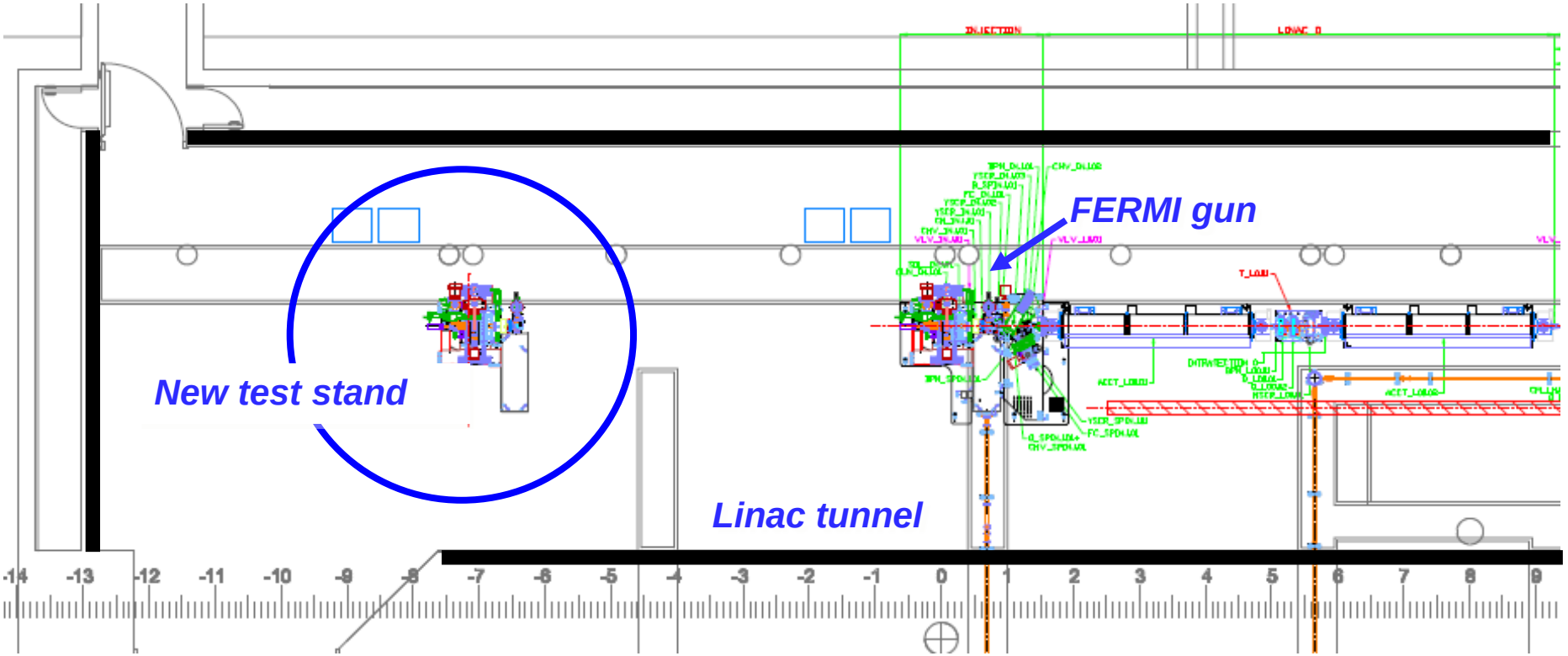
QE trend



PIL pulse energy required for 700pC bunch charge



CTF: a test stand



We will make use of the room left free in the Fermi tunnel just below the Spare klystron,

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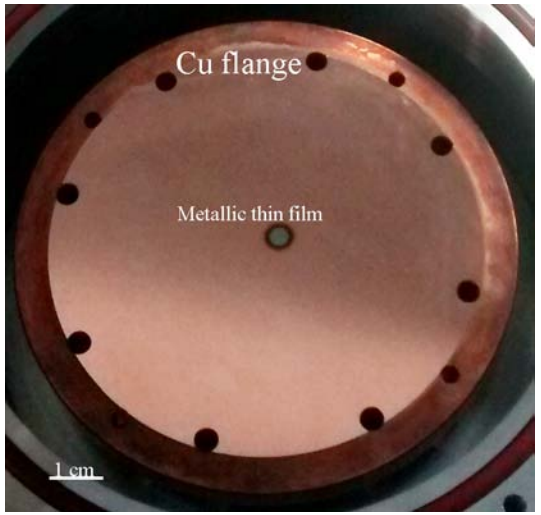
Metallic film over cupper



PULSED LASER DEPOSITION OF Y ON CU

- FILMS HIGHLY ADHERENT;
- HIGH QUALITY FILMS;

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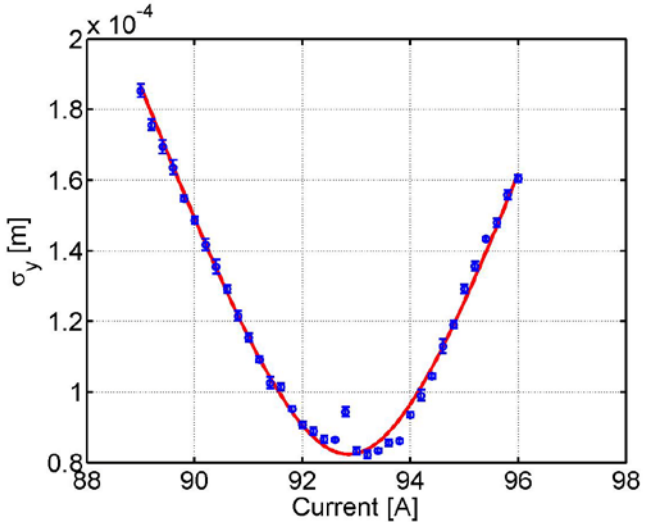
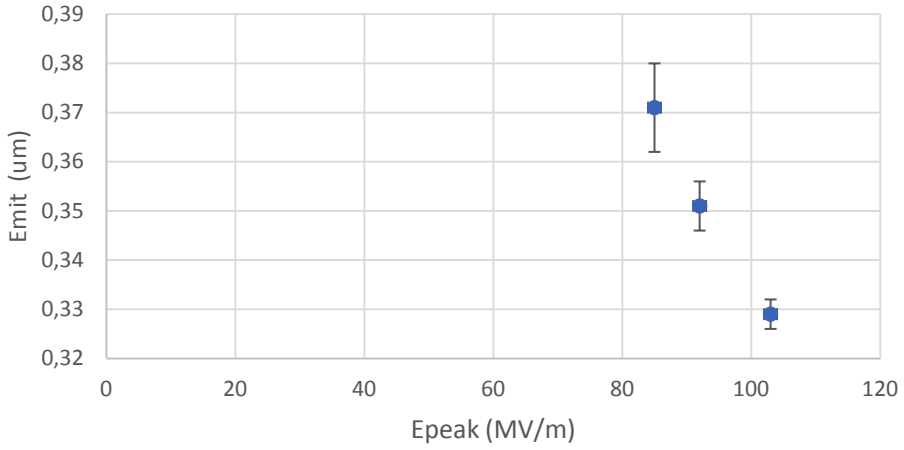
E-beam measurement 8-12 May 17

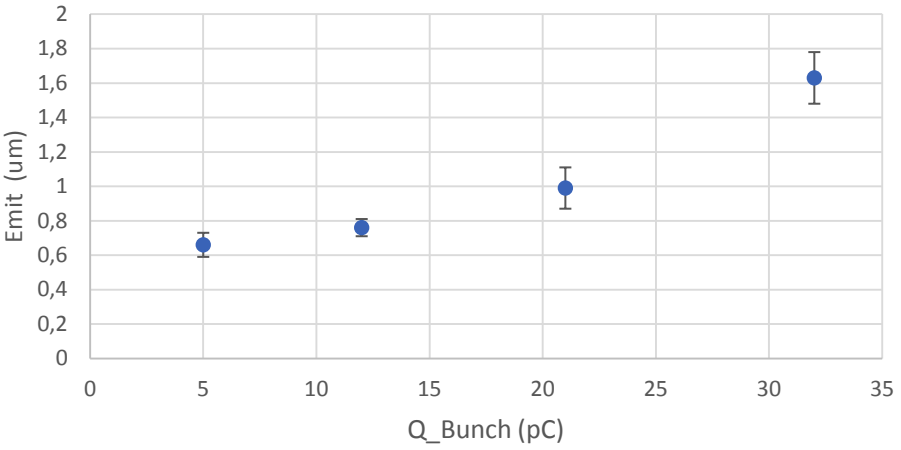


Emittanace measurement with the solenoid scan method

Emit. versus E_{peak}



Emit versus Q_{bunch}



Courtesy of J. Scifo

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Summary

- ✓ An user facility requires reliable injector that garanties e-beam for ‘planned’ operations;
- ✓ We have discussed actions to counteract the local QE degradation;
- ✓ another interesting option, Yttrium, has been tested;

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Thank you!