

Cu cathode experience at FERMI and ozone cleaning

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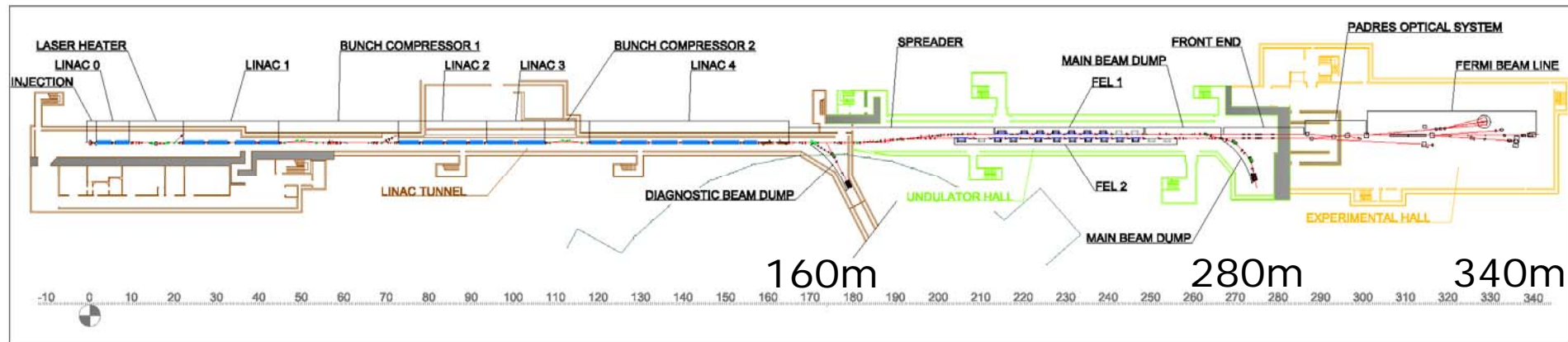
Workshop on Photocathodes for RF Guns

March 1-2, 2011

FERMI is a single-pass FEL user-facility covering the wavelength range from 60 nm (*initial*) to 3 nm (*final*)

Milestones

- Cu PC Gun (1.6 cell, S-band) acquisition and test at MAX-lab in 2008;
- Injection area installed in spring 2009 and first e-beam in August;
- Buildings complete in summer 2010;
- Full linac in operation at nominal energy in October 2010;
- First evidence of HG in December 2010;



2010 FERMI@Elettra Beam																															
Month	Gennaio January				Febbraio February				Marzo March				Aprile April				Maggio May				Giugno June				July	August	September	OCTOBER	NOVEMBER	DECEMBER	week end
date	date	date	date	date	date	date	date	date	date	date	date	date	date	date	date	date	date	date	date	date	date	date	date	date	date	date	date	date			
L																															
M																															
M																															
G																															
V																															
S	7																														
D	3																														
L	4	Install																													
M	5	LI																													
M	6	through																													
G	7	BC1																													
V	8	Spectro																													
S	9	-meter																													
D	10																														
L	11																														
M	12																														
M	13																														
G	14																														
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2010 second semester: three commissioning runs; two shutdowns

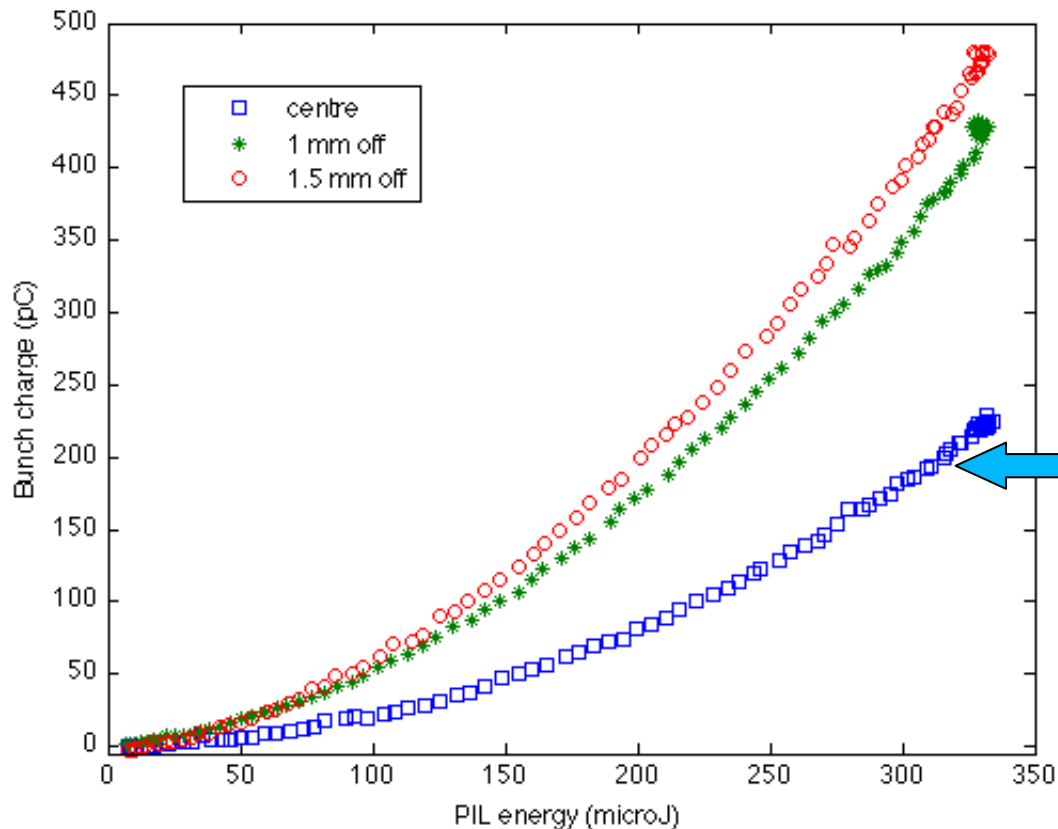
**RUN 3 start
18 June 2010**

LEGENDA: Shutdown periods: NO BEAM
 Commissioning from Gun to BC1: parallel installation downstream temporary wall
 Commissioning through MBD: parallel installation only in Experimental Hall
 Control Access System final test: June UH-EH modulators until KG12; 09.07 KG13-14

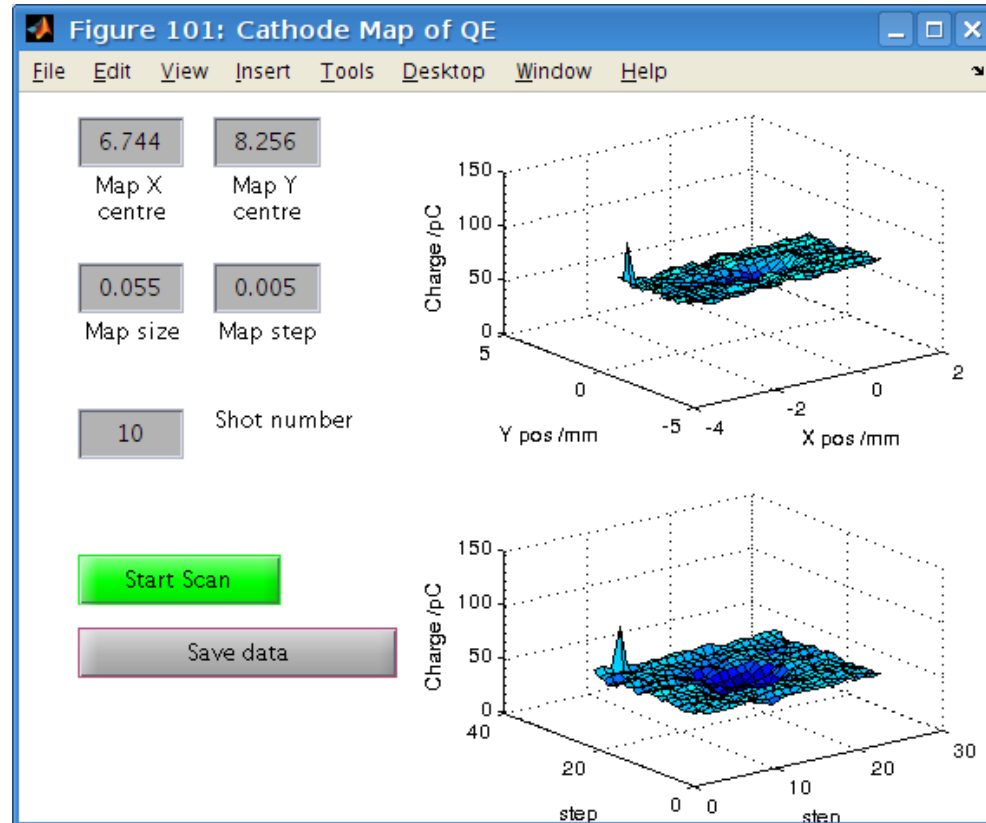
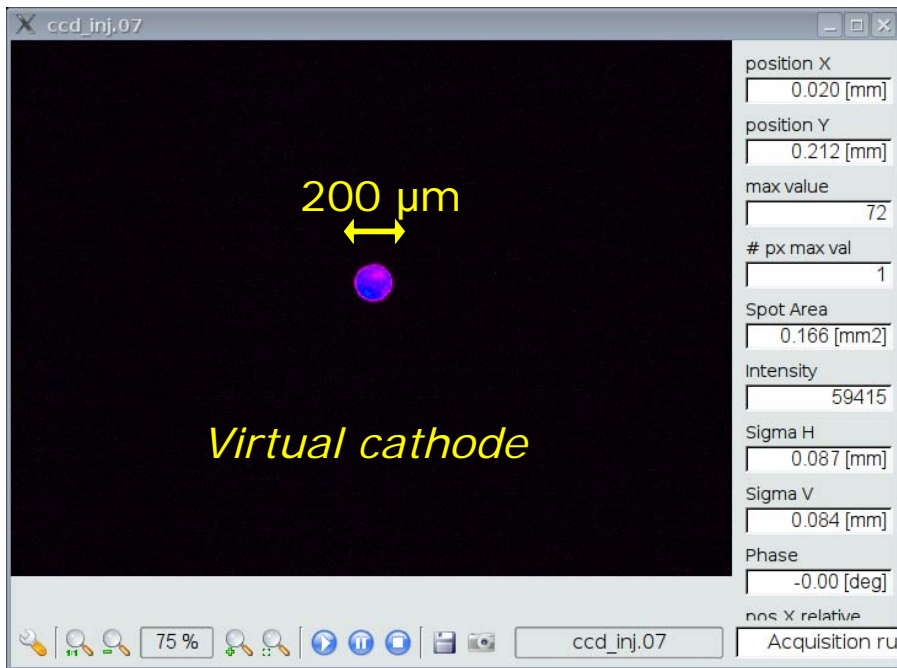
Milestones MAIN FERMI Yard (actual)
 Baseline Milestones MAIN FERMI Yard
 20.08: MAIN FERMI YARD conclusione lavori - data contrattuale
 29.08: consegna anticipata di parte del cantiere, passaggio a modalita' di accesso normali
 For details of installation and commissioning phases see FERMI MASTER PLAN

KW: Calendar Week
 M: Morning Shift, L: Late, N: Night

Bunch charge Vs laser pulse energy: **status at first run end**
 3 November 2009. After 2 operation months (and 600 MJ dose of
 RF energy)

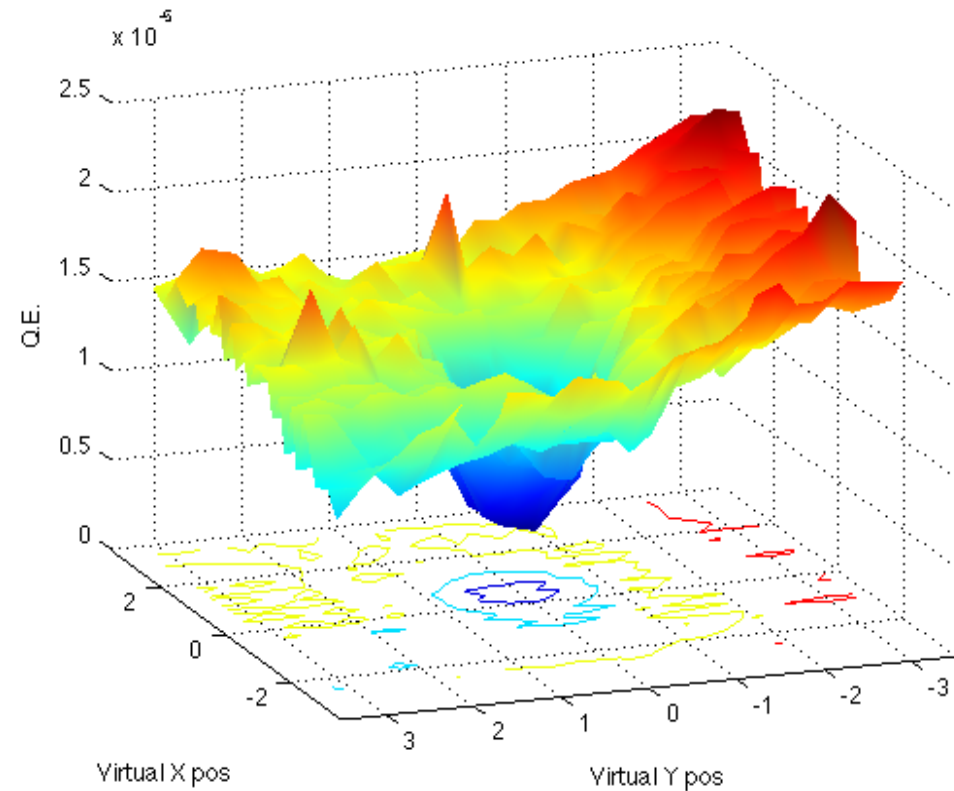
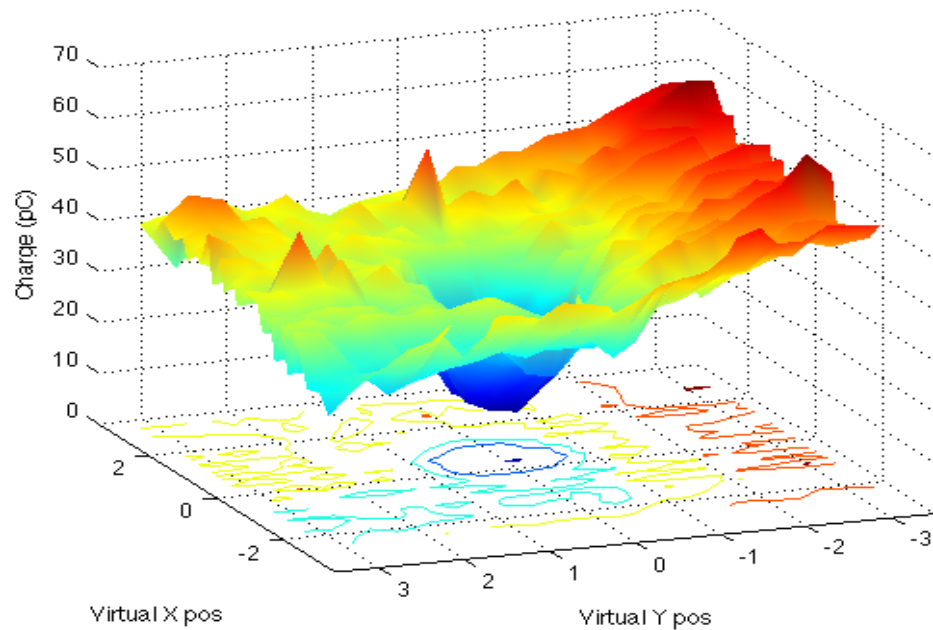


Q.E. $\approx 3 \text{ e-}6$



- With a small laser spot (about 200 μm FW);
- scan the surface by changing the laser pointing;
- detect the spot position on the virtual cathode;
- measure the emitted bunch charge with the first current monitor.

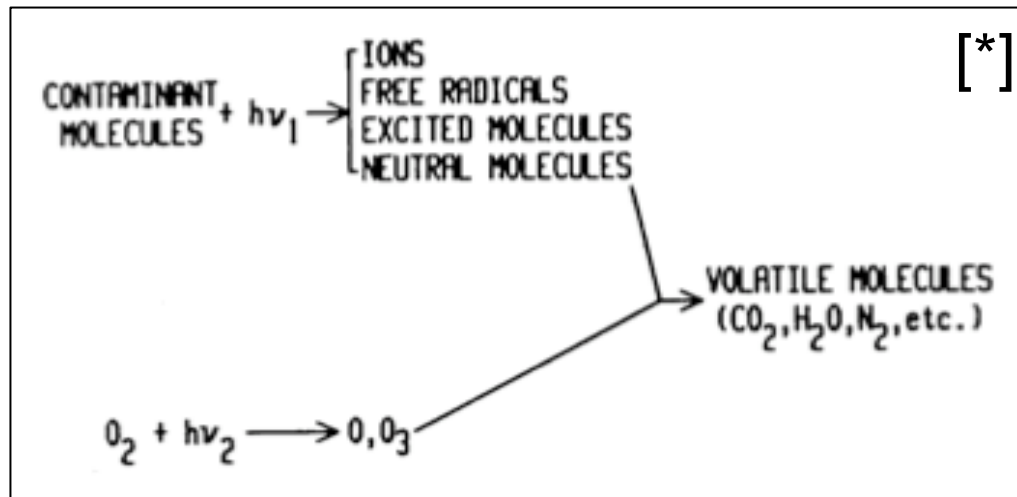
After the first run a Q.E. degradation was observed in the cathode centre.
 After 2 operation months the following cathode map was measured:



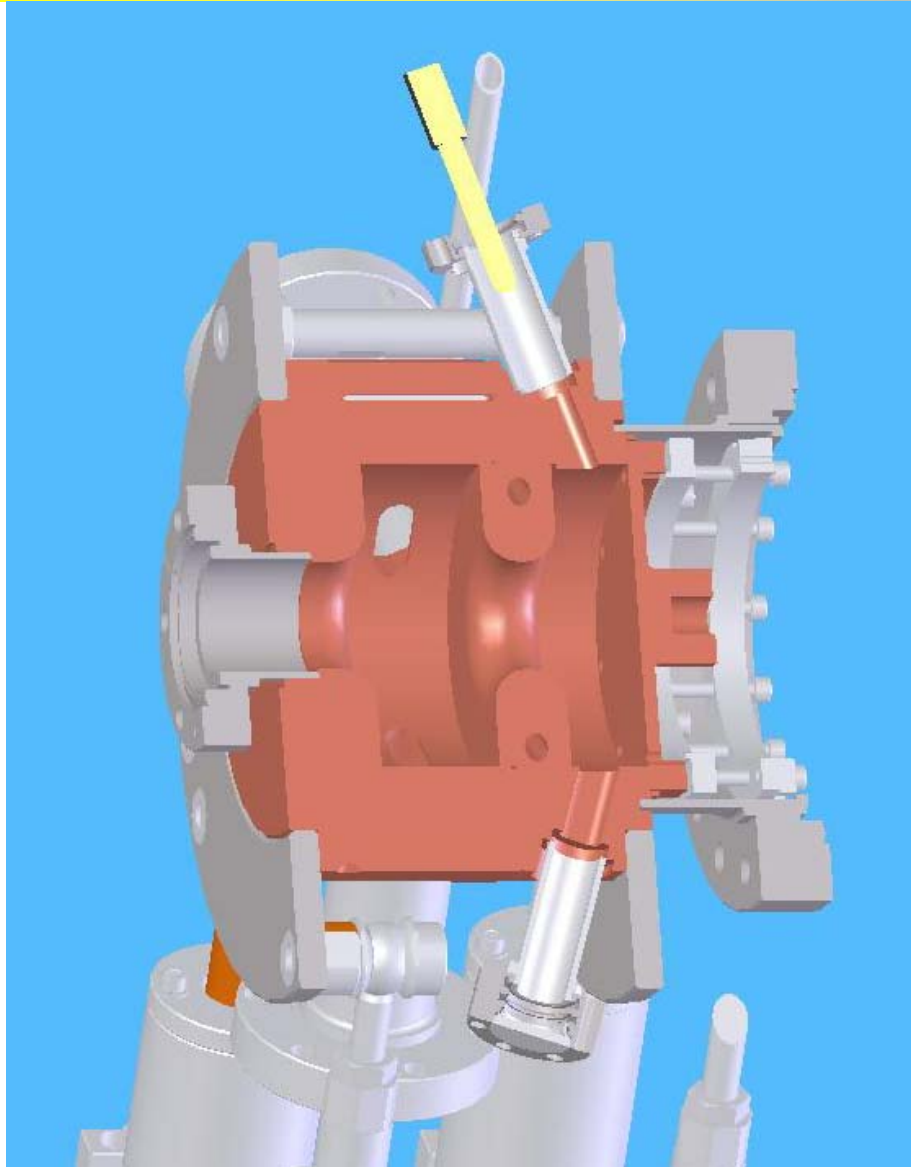
Cathode surface sampled by a 200 μm laser spot. and about 10 μl .

Gun problem: the cathode efficiency degradation

- Cathode exchange (*last choice*);
- Cathode restoration:
 - Laser Cleaning;
 - Surface sputtering;
 - UV/Ozone Cleaning (*from the beamline experience*);



[*] Kern, W. (1993). Handbook of Semiconductor Wafer Cleaning Technology - Science, Technology, and Applications. William Andrew Publishing/Noyes.

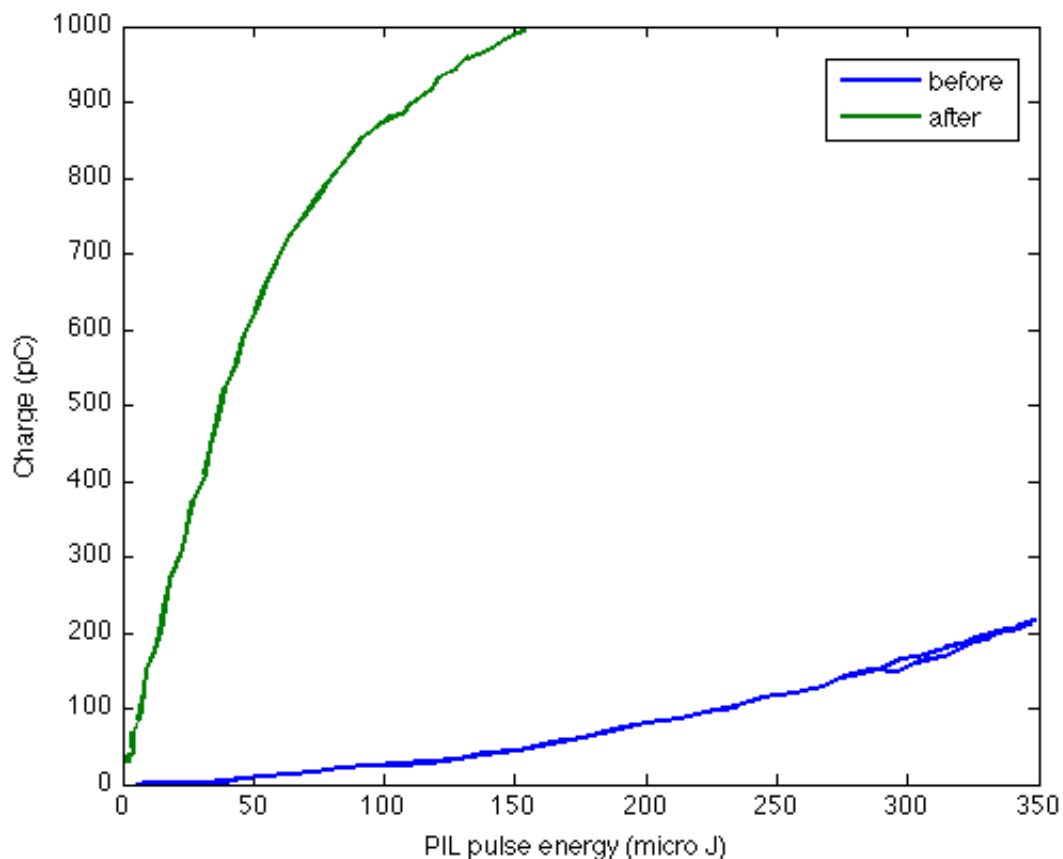


Pen-Ray® Mercury Lamps

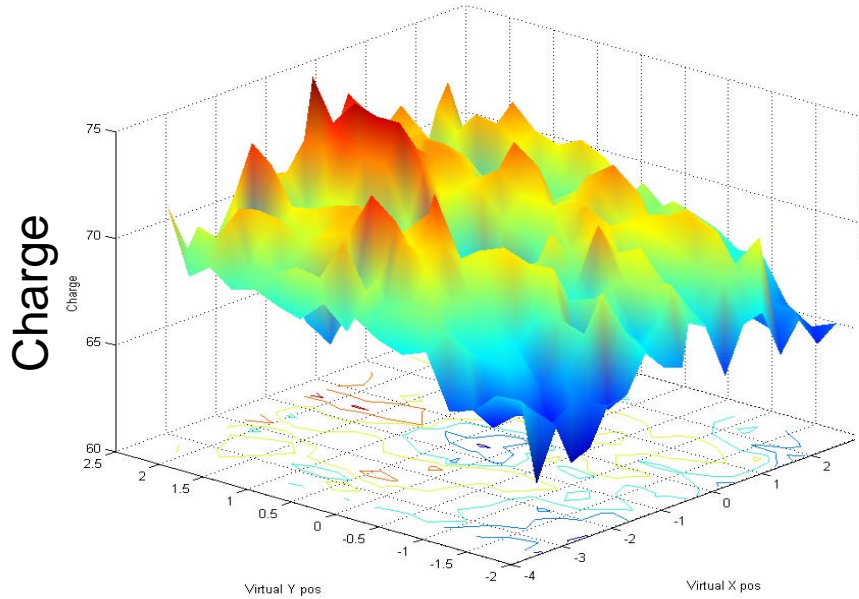


Oxygen

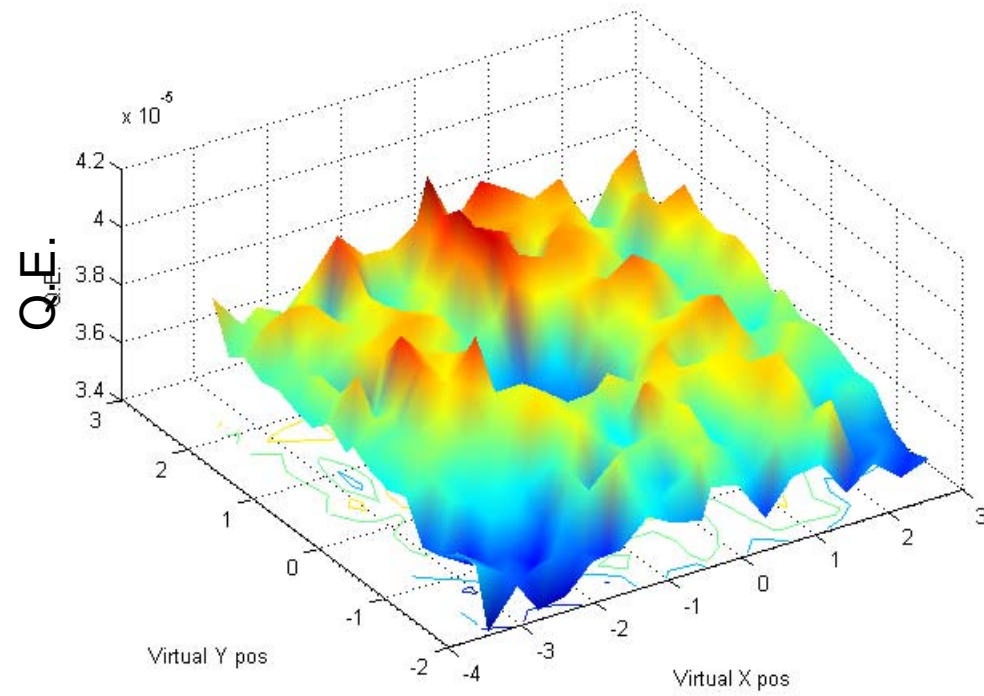
In December 2009 the Ozone cleaning was performed.
 On 23th January 2010 the beam was extracted again:



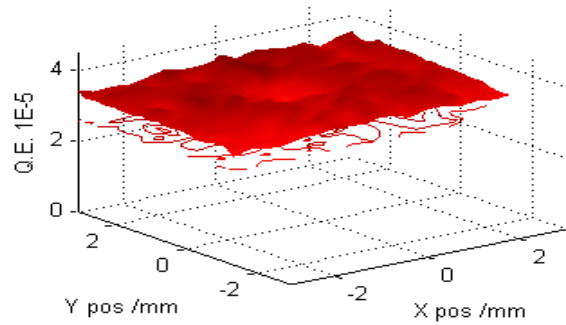
Bunch charge Vs PIL energy (phase set at 35 deg) **BEFORE** and **AFTER** cleaning



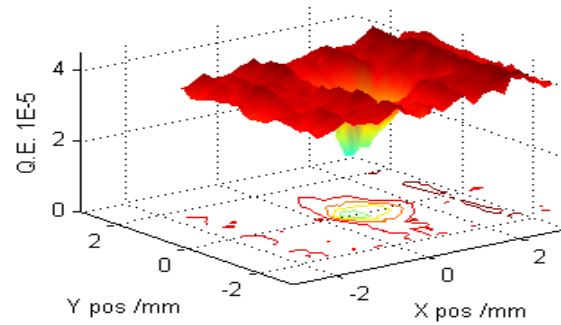
The cleaning restored
the surface uniformity (\cong)



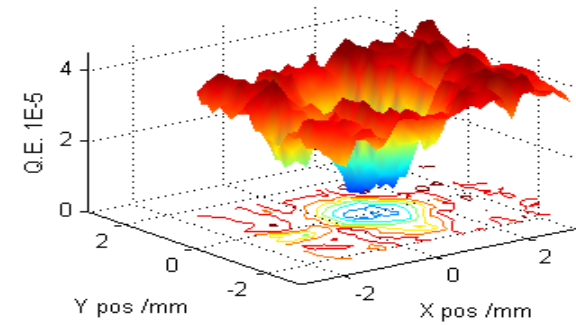
Mappa after cleaning



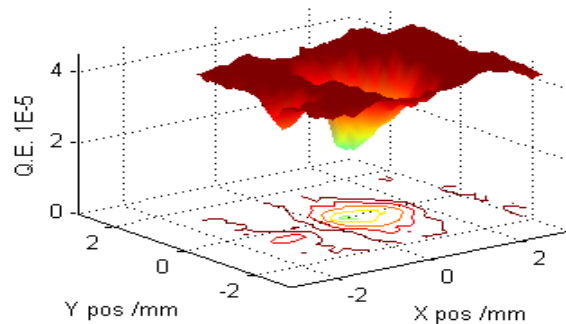
15/02/10



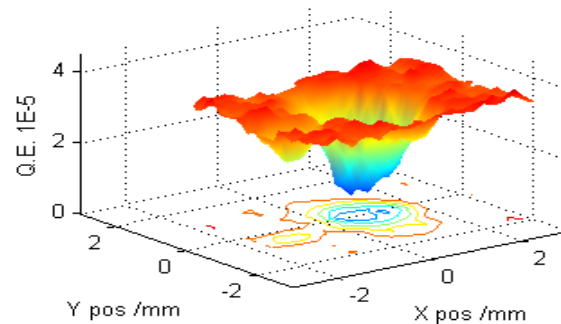
25/02/10



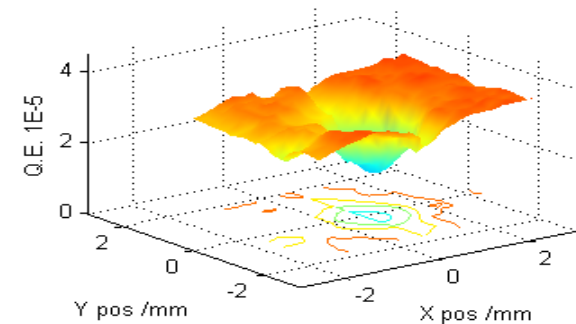
01/03/10



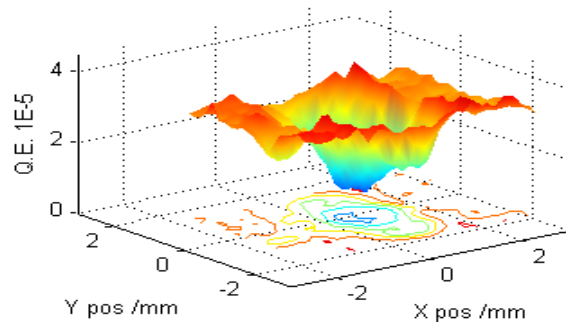
09/03/10



16/03/10

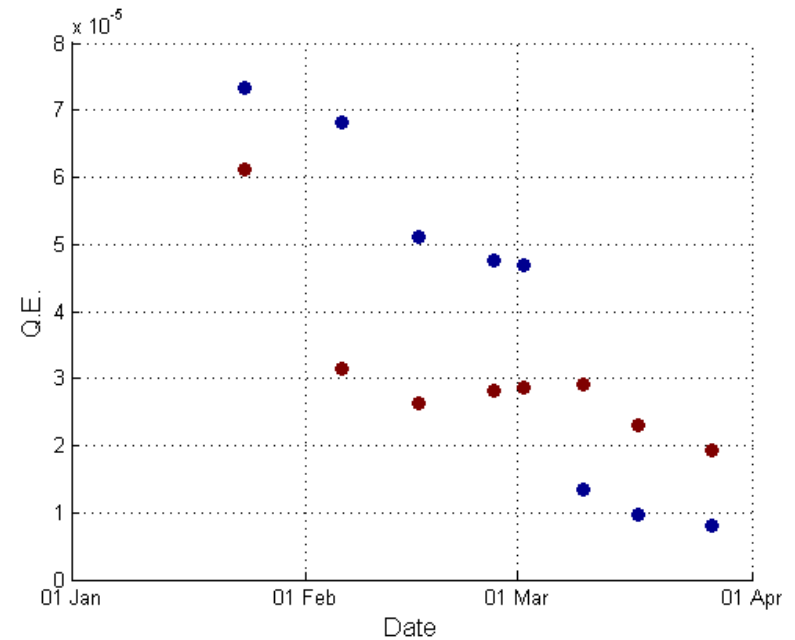
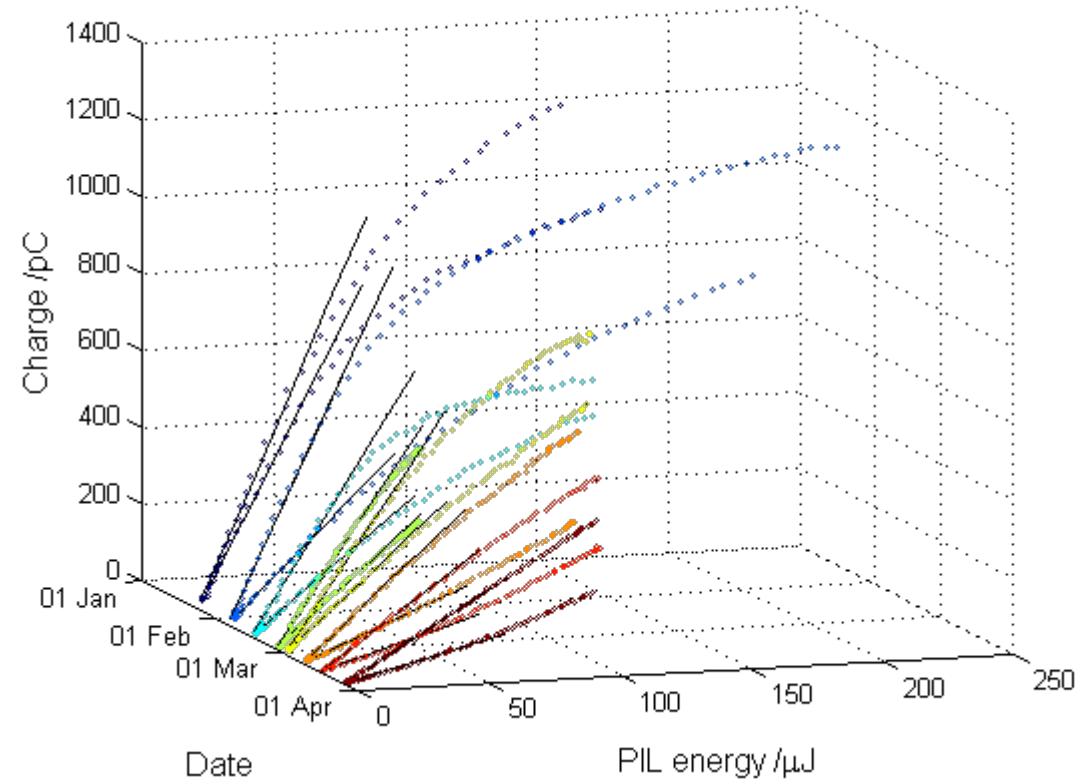


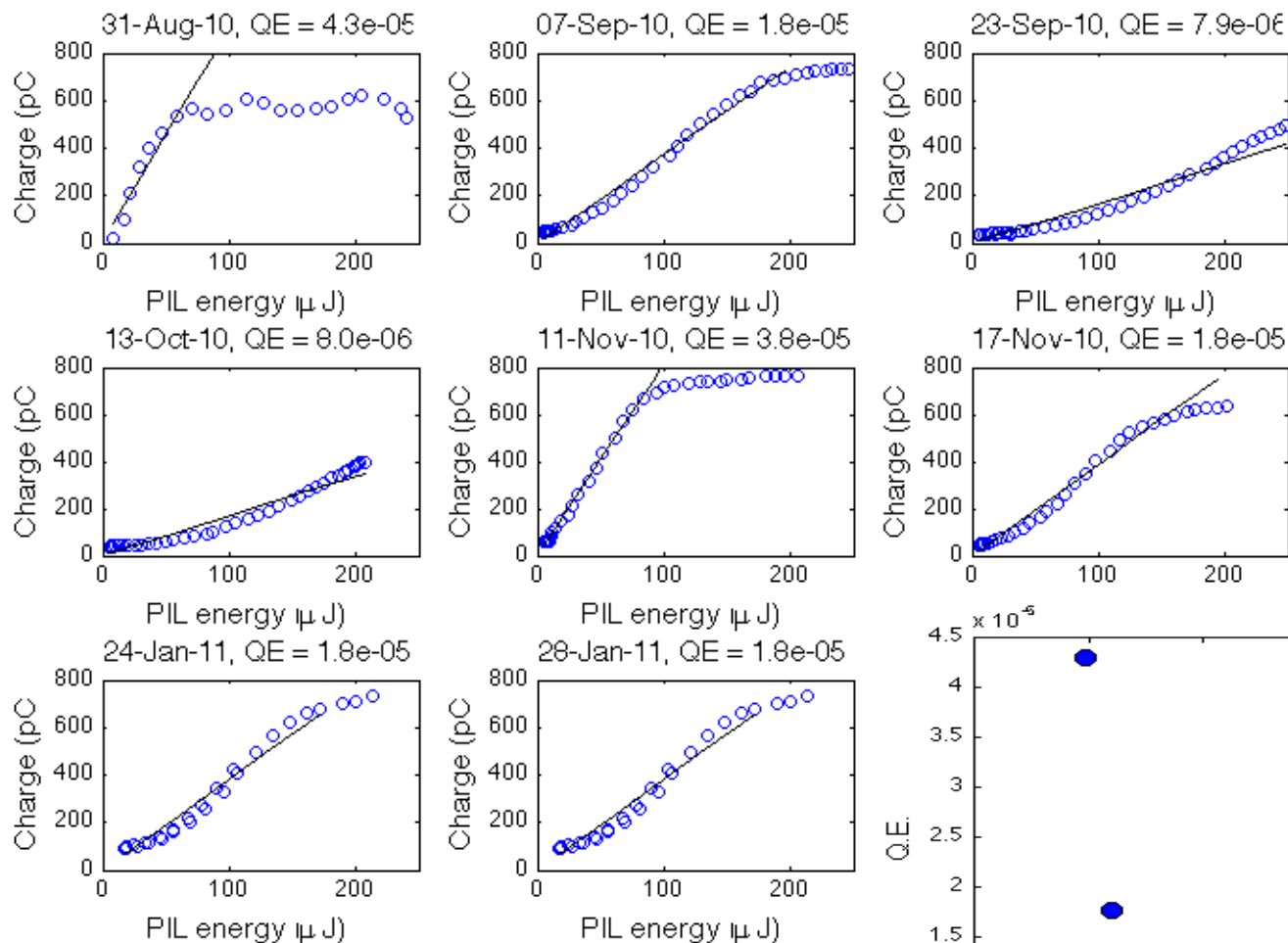
26/03/10



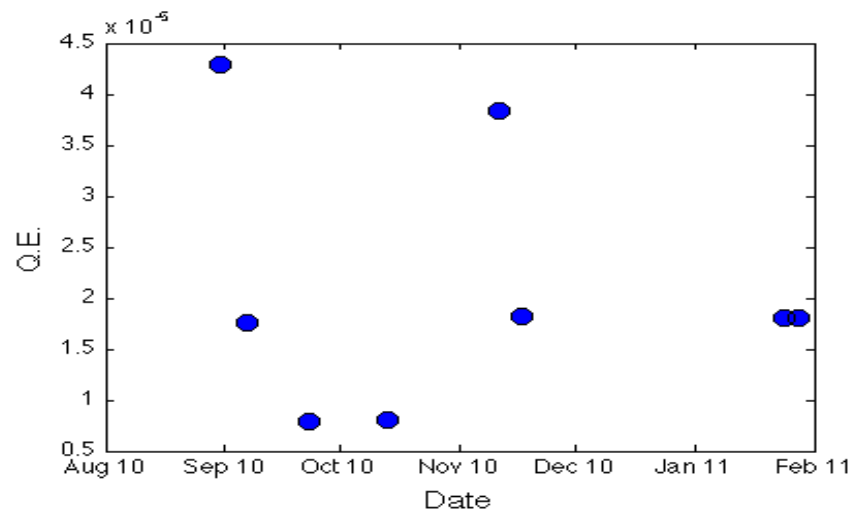
During the 2nd run several cathode map were collected.

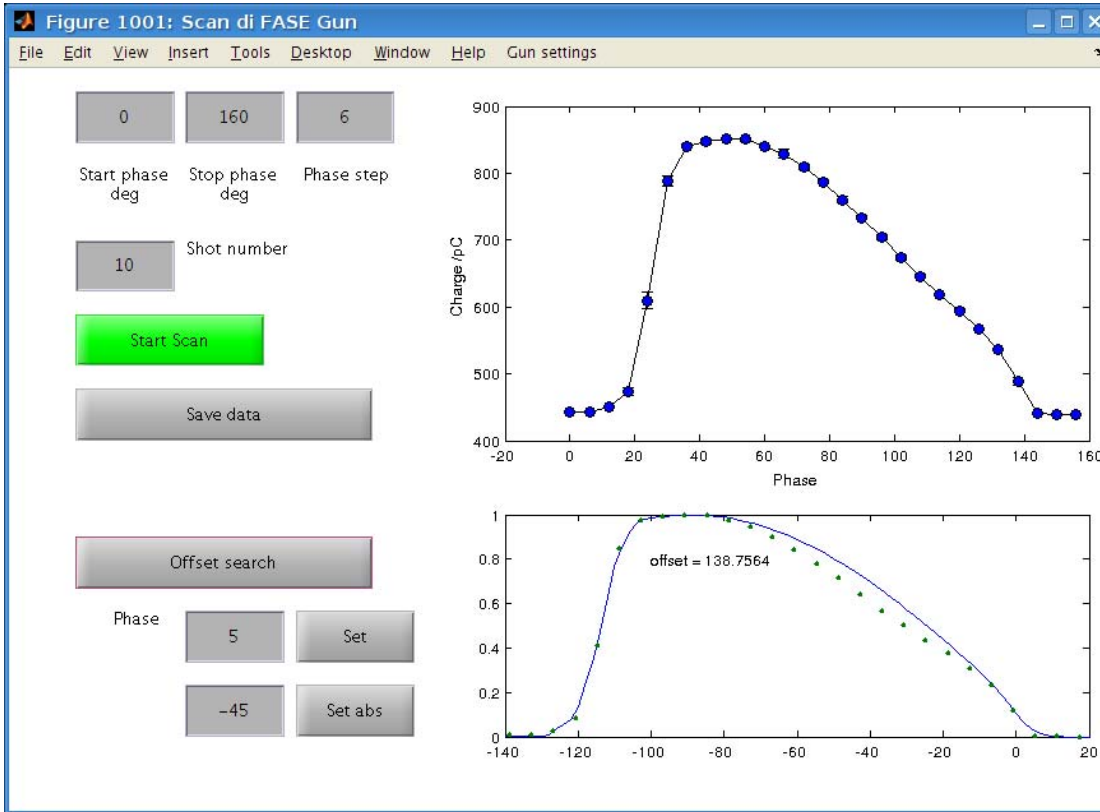
Charge scan vs laser energy trend





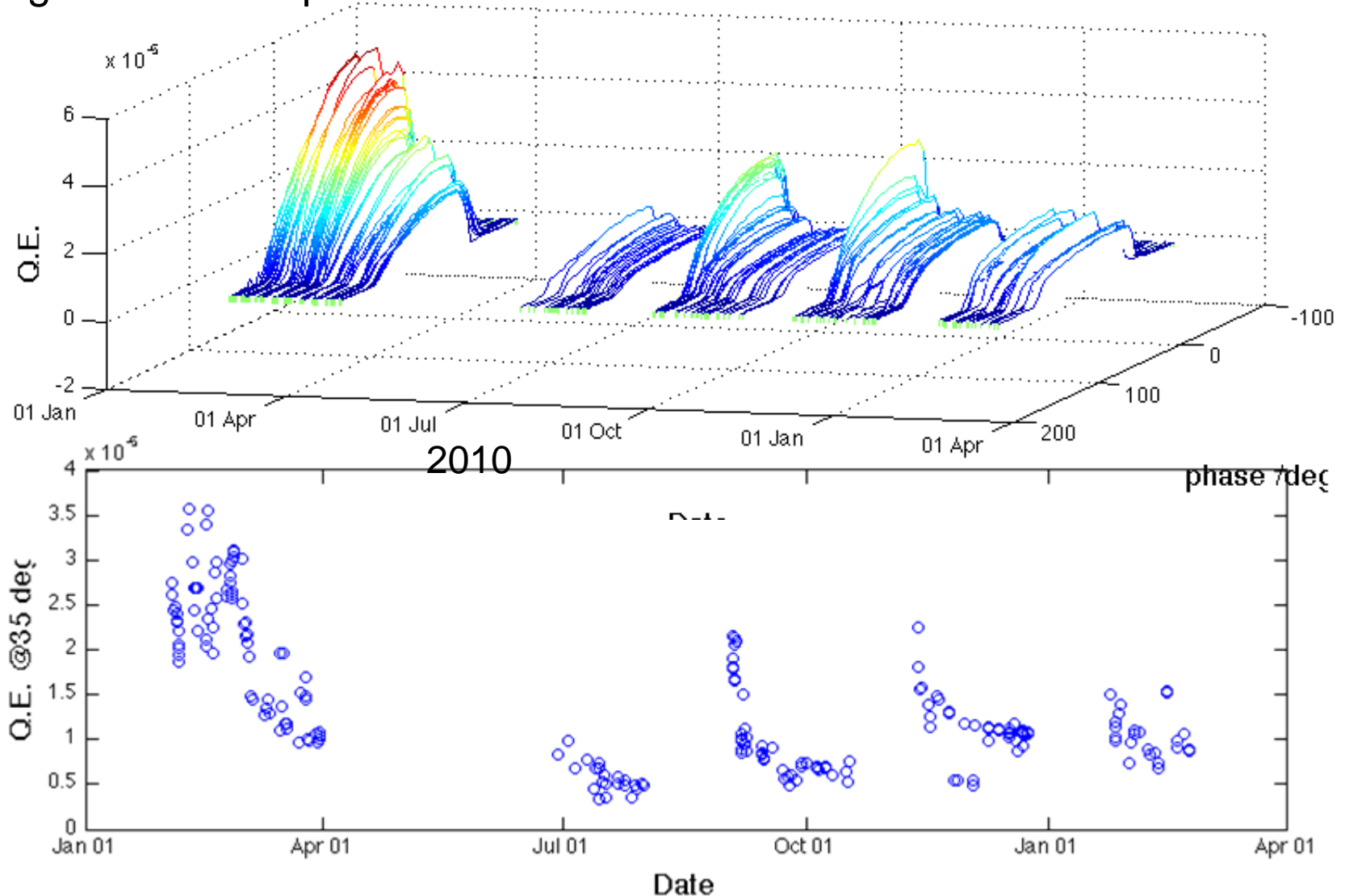
Charge scan
vs laser
energy trend





Phase scan matlab tool: changes the phase shifter and reads the first current monitor.

During the runs the phase scans were collected:



- The Ozone cleaning of the cathode was applied successfully;
- The restoration technique of the cathode Q.E. has been performed several times;
- The PC Gun cathode is under monitoring;