FERMI@Elettra Photoinjector has started its commissioning!

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A collaboration contract with the MAX-lab, Lund (Sweden), has been signed to progress significantly with the activities on the FERMI@Elettra electron source till the FERMI building extension is completed.
The project aim is to perform the acceptance test of the FERMI Gun delivered by UCLA and to start its commissioning using the existing S-band 25 MW klystron and the existing photoinjector UV laser (262 nm, 10 ps duration and 500 J pulse energy available).
The crucial elements of the FERMI photoinjector (RF cavity, magnets, laser beam diagnostics and transport and electron beam diagnostics) have been installed in the injector tunnel of MAX-lab, as shown in Figure 1, during Easter shutdown.

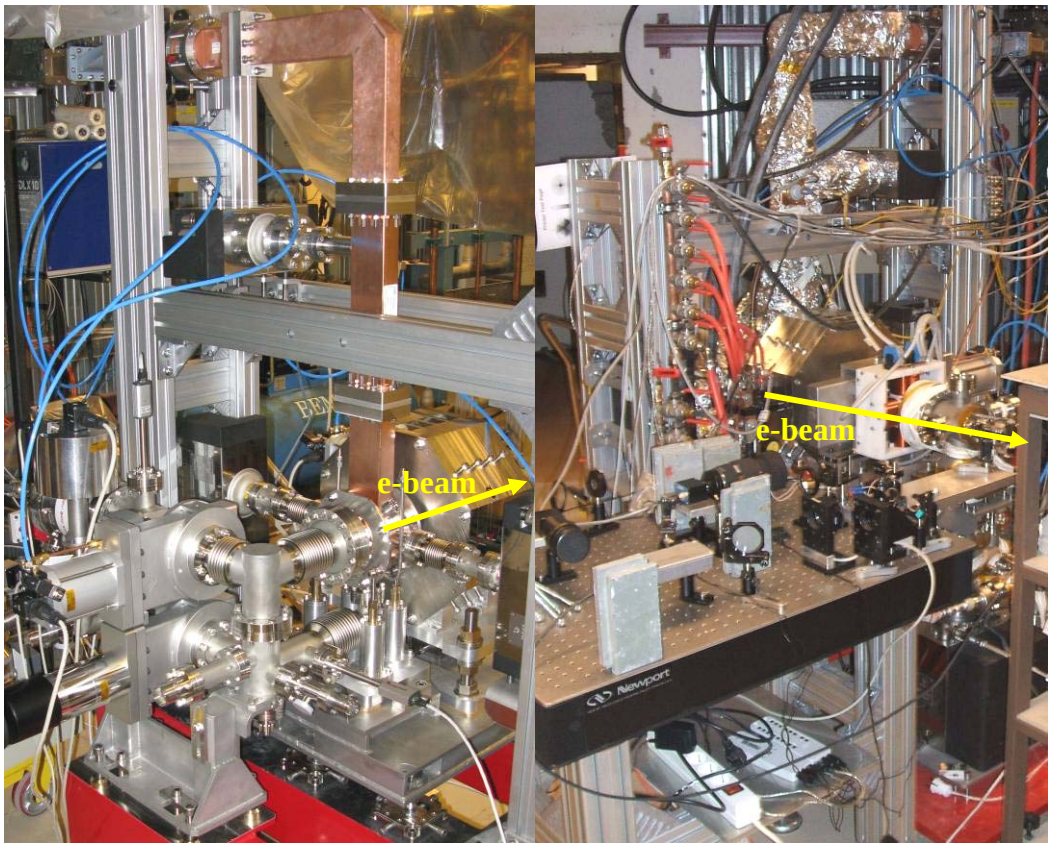

Figure 1: FERMI photoinjector in the MAX-lab tunnel. Left: FERMI gun back-view with RF waveguide and cavity and pumping system. Right: FERMI gun front view with corrector, laser tank, laser transport, laser and e-beam diagnostics.

During the allocated beam time of week 21, the RF gun was conditioned to full specifications, achieving, in four nights, the nominal values of 10 MW input peak power (corresponding to the maximum gradient at the photocathode of about 120 MV/m), 3 μs pulse duration and 10 Hz repetition rate.

On the night of May 28, the RF gun's copper cathode was illuminated by a UV laser operating at 262 nm delivering 50 μJoules per pulse and the first FERMI photolectrons were clearly detected on both the

integrating current transformer (ICT) and YAG:Ce scintillation screen. Figure 2 shows the time behaviour of the RF power at the gun input measured by means of a directional coupler, the laser time arrival measured with a photodiode signal and the electron beam current signal measured with the ICT. The photo-electron peak, superimposed on the dark current background, is clearly visible on the ICT trace in correspondence of the laser shot. The photoelectron beam charge was measured equal to 180 pC, corresponding to a quantum efficiency QE = $1.7 \cdot 10^{-5}$.

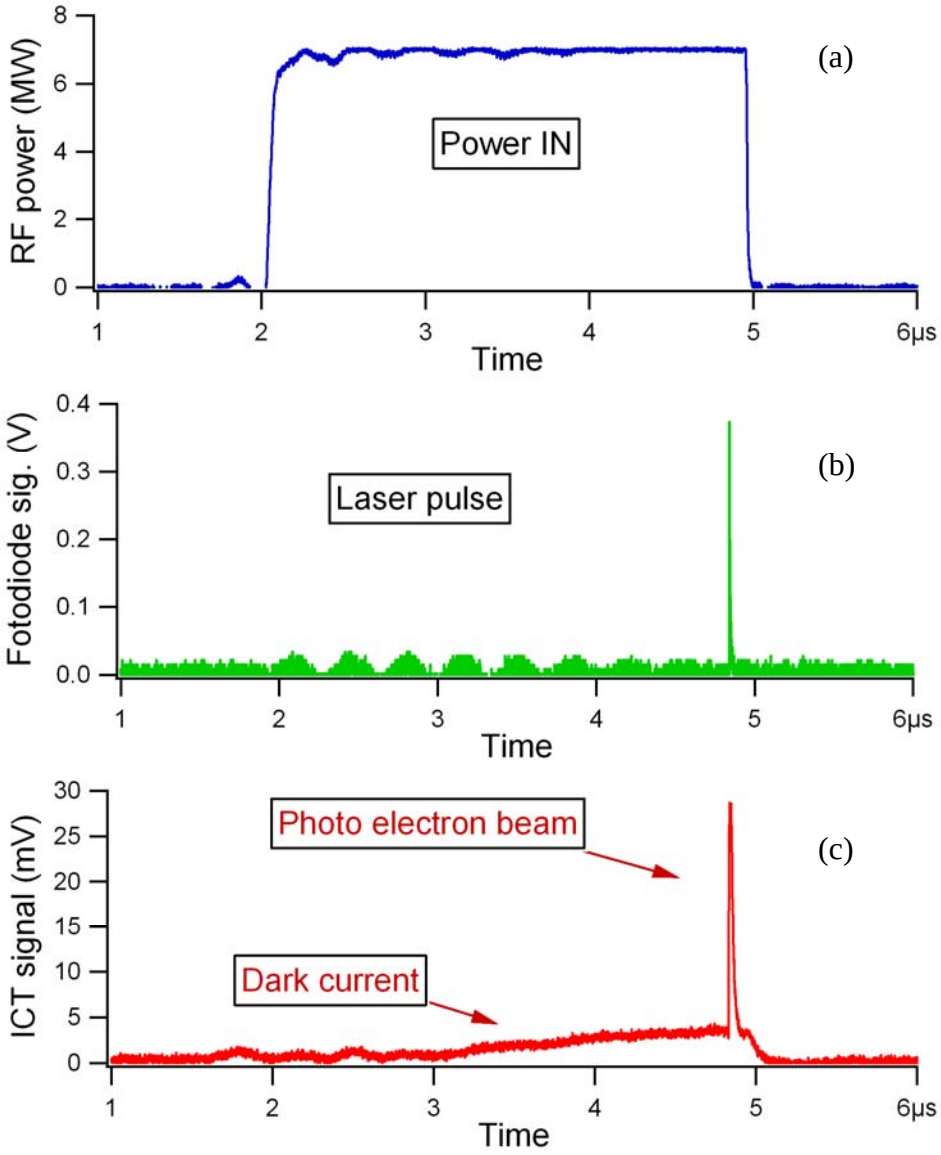

Figure 2: Time behaviour of the RF power at the input of the gun (a), of the photodiode signal of the laser (b) and of the ICT signal (c).

During the third allocated beam time of weeks 27 and 28, the Gun commissioning has advanced with new crucial results. Figure 3 shows a typical e-beam image on the YAG screen focused by the solenoid. The horizontal and vertical rms beam size measured are respectively 1.5 and 1.0 mm. A characteristic phase scan measurement is shown in Figure 4: the extracted bunch charge is represented as a function of the relative phase of the laser with respect to the RF cavity field. Many toroid signals, as that represented in Figure 2 (c), are plotted at different values of the phase; at the correct phase values, the photoelectron peak is superimposed on the dark current background, which is independent from the phase.

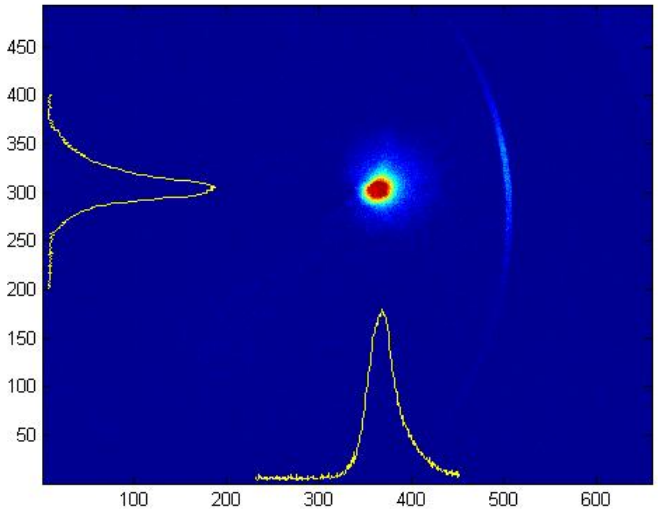

Figure 3: Electron beam on the YAG screen with 80 MV/m RF gradient and $I_{solenoid}$ = 110 A (the horizontal and vertical scales represent the number of the CCD pixel).

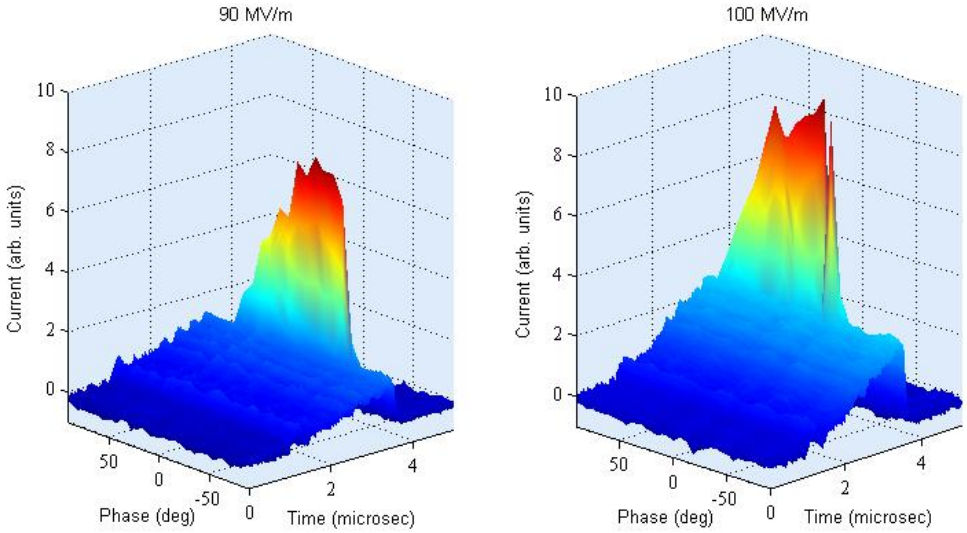

Figure 4: Two measurements of bunch charge extracted vs the relative phase of the laser with respect to the RF cavity field, acquired at different RF field gradient.

In conclusion, the FERMI photo-cathode gun commissioning has been successful started in the MAX-lab tunnel with encouraging results: the cavity conditioning went on smoothly, the first photoelectrons were extracted and measured, the first quantum efficiency measurement indicates a good cathode surface cleanness and, more in general, the system behaves according to specification.

Further activities are planned at MAX-lab to continue the characterization of the FERMI gun e-beam. The system will be moved back to Trieste as soon as the FERMI site will be completed.

[1] Mauro Trovò et al., “Status of the FERMI@Elettra Photoinjector”, EPAC 08, Genova, June 2008, MOPC080 pg 247.