“New accelerators” project report

Theme: ***02-0-1127-2016/2018, Advanced Studies on Systems of New Generation Accelerators and Colliders for Fundamental and Applied Research.***
Theme leader: ***G.D. Shirkov****, deputies:* ***Yu.A. Budagov, G.V. Trubnikov.***

Project: ***Design, construction and test of prototype elements for new generation accelerators and colliders for fundamental and applied purposes.***
Project leaders: ***G.D. Shirkov, G.V. Trubnikov.***

1. Linac-200 2nd accelerating station (E = 60 MeV) was commissioned. Magenta channel at Fig. 1 is klystron current, orange – beam current (about 1 mA), blue – klystron voltage, green – accelerating section field envelope.

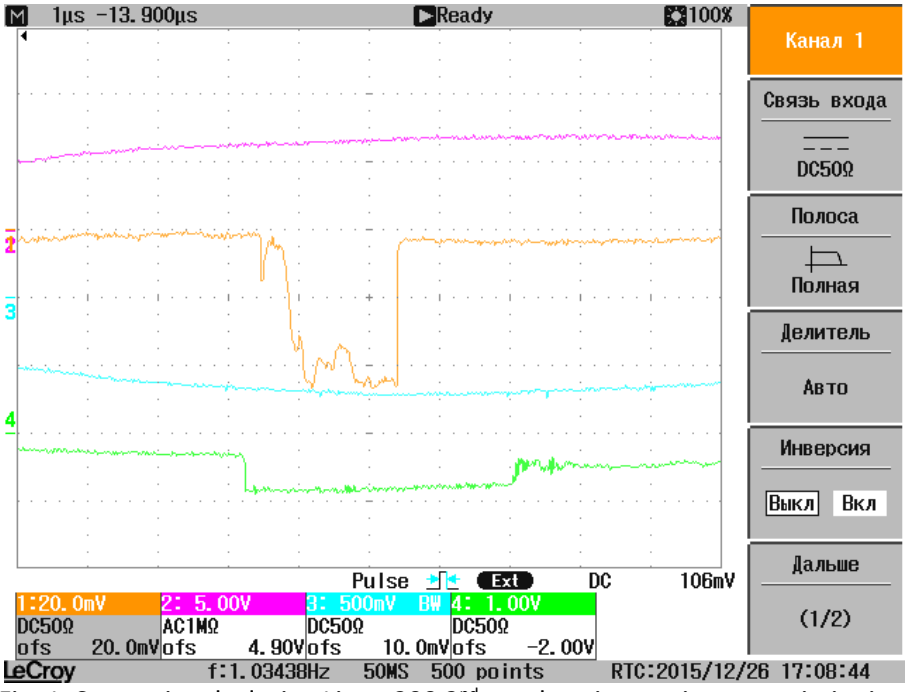


Fig. 1. Scope signals during Linac-200 2nd accelerating station commissioning.

2. Preparation works at 3rd and 4th accelerating stations of the Linac-200 are finished. Beam test is planned before the end of 2016.
3. Users’ experiments at Linac-200:
    a. Beam tests of crystal scintillators for Mu2e experiment using extremely low intensity electron beam.
    b. Study of radiation hardness of GaAs and Si pad detectors. The study is a part of R&D of forward calorimeter for the experiments at the future electron-positron colliders in the frame of the FCAL international collaboration. Remarkably, the accelerator successfully

operated at 10 Hz repetition rate for 5–8 hours almost every day during 1,5 months during this beam test, which is the first run of such a duration since the delivery from NIKHEF.

4. Experimental estimation of the transverse emittance based on multi-wire sensors data was conducted at the photogun bench. Estimated emittance vs bunch charge is shown at Fig. 2.

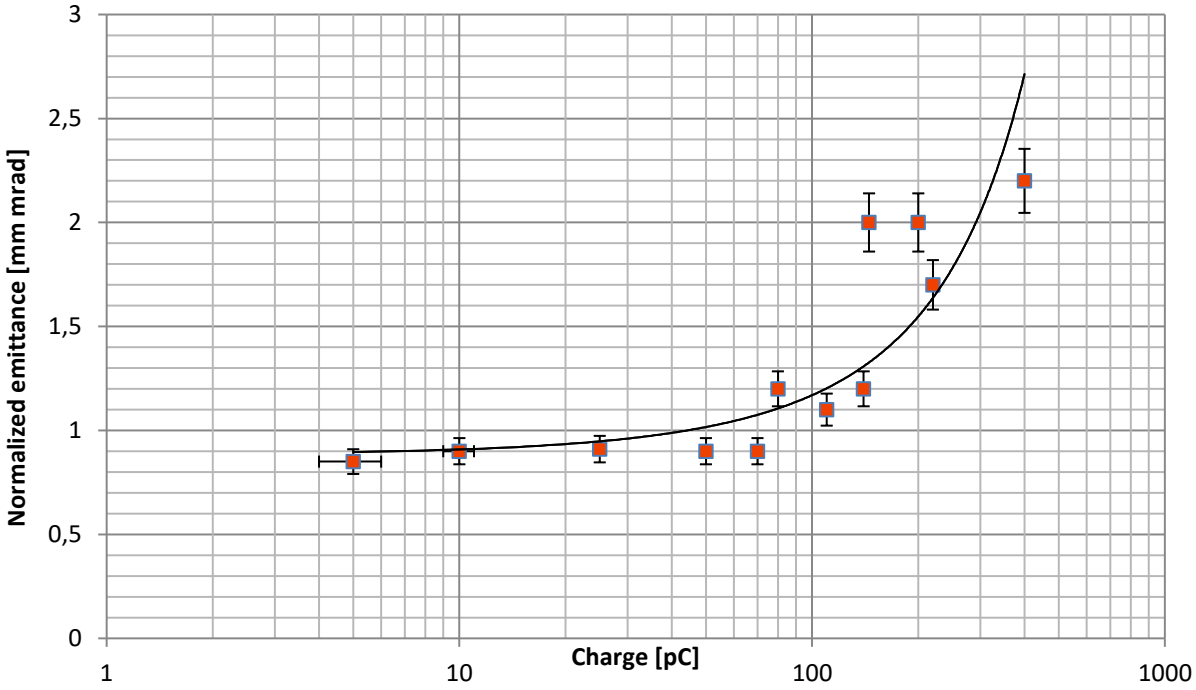


Fig. 2. Experimental estimation of the transverse emittance vs bunch charge.

5. Laser driver beam to photocathode transportation line was mounted at the photoinjector bench (Fig. 3). Beamline transports image of the round aperture with 5 mm diameter to photocathode with 1:5 scale.

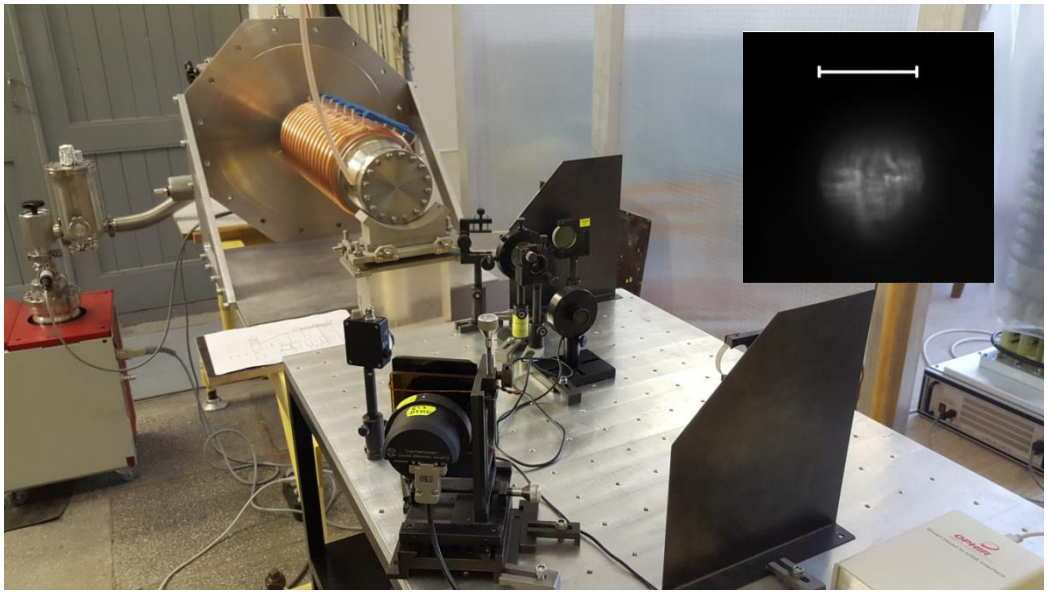
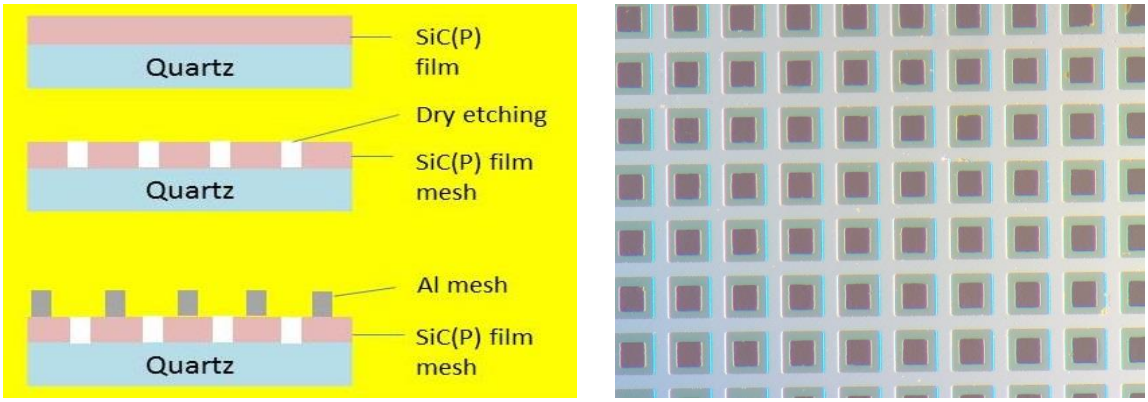


Fig. 3. Photoinjector with mounted laser optical transportation beamline. Transported aperture image is also shown (white segment length is 1 mm).

6. Main photoinjector systems (vacuum, diagnostics, HV) were mounted and commissioned. Photoinjector beamline was assembled and passed vacuum tests. The designed residual gas pressure of $3 \cdot 10^{-8}$ torr was reached.
7. New transmission-type photocathode with phosphorus doped SiC film mesh was prepared in collaboration with IEE SAS (Slovakia). P doped SiC film was deposited by PECVD technology. Dry etching was used for SiC mesh preparation on quartz glass using Al mask prepared by photolitography and lift off technique. Main technological steps and photo of prepared cathode are shown at Fig. 4. Photocathode quantum efficiency testing was performed at photogun test bench. Calculated QE rose up with the concentration of P in the films, maximum QE of $5.8 \cdot 10^{-4}$ % was reached (see Fig. 5).



(a) (b)

Fig. 4. Main technological steps (a) and picture of SiC mesh with contact Al mesh (b) of prepared transmission photocathode.

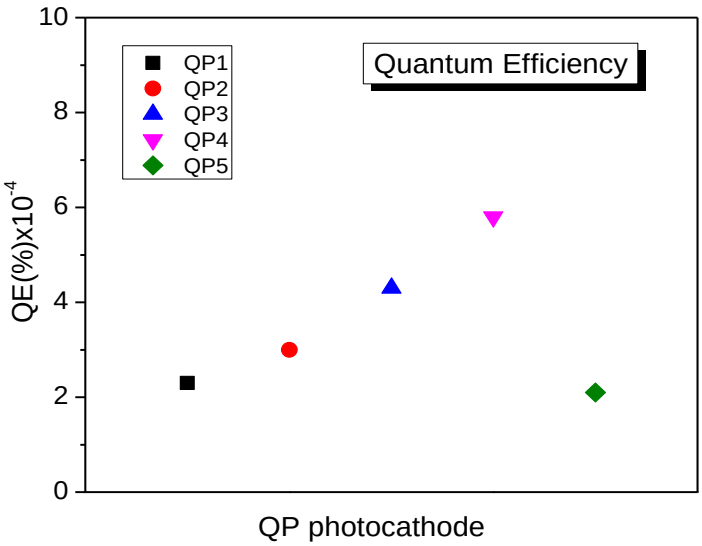


Fig. 5. Quantum efficiency of the P doped SiC transmission photocathode

8. The new beam imaging setup was tested for laser beam visualization at the photogun bench (including virtual cathode setup) and electron beam visualization at Linac-200 bench. The setup is based at the high-sensitivity CCD camera Prosilica GC1380, DESY developed AVINE software suite is used for imaging. The laser beam image at the virtual cathode is shown at Fig. 6, the Linac-200 beam image — at Fig. 7.

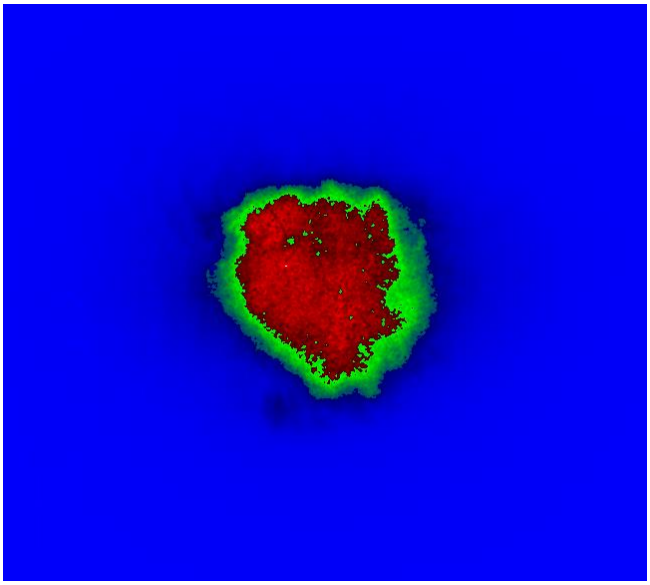


Fig. 6. LS-2134 laser beam at the virtual cathode.

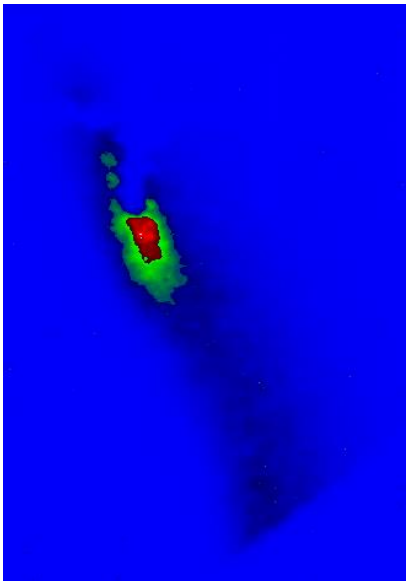


Fig. 7. Linac-200 beam.

9. Mounting of the first stage of the Linac-200 training beamline is completed. (Fig. 8).

Fig. 8. Overview of the Linac-200 training beamline.

Publications

[1] N.I. Balalykin, V.F. Minashkin, M.A. Nozdrin, G.V. Trubnikov, G. D.Shirkov (JINR, Dubna, Russia), E.I. Gacheva, E.V. Katin, E.A. Khazanov, G.A. Luchinin, A.K. Poteomkin, V.V. Zelenogorskii (IAP RAS, Nizhny Novgorod, Russia), and J. Huran (IEE SAS, Bratislava, Slovakia). JINR LHEP Photoinjector Prototype. Physics of Particles and Nuclei Letters, vol. 13, no. 7, 2016.

[2] N.I. Balalykin, M.A. Nozdrin, A.A. Feshchenko, A.P. Kobzev (JINR, Dubna, Russia), J. Huran, J. Arbet (IEE SAS, Bratislava, Slovakia). Transmission photocathodes based on stainless steel mesh and quartz glass coated with N-doped DLC thin films prepared by reactive magnetron sputtering. Journal of Physics: Conference Series 700 (2016) 012050.

[3] M.A. Nozdrin, N.I. Balalykin, V.F. Minashkin, G.D. Shirkov (JINR, Dubna, Russia), S. Weisse (DESY, Zeuthen, Germany). Diagnostics at JINR LHEP Photogun Bench. Proceedings of the 11th International Workshop on Personal Computers and Particle Accelerator Controls (PCaPAC'16).

[4] М.А. Ноздрин, Н.И. Балалыкин, В.Ф. Минашкин, Г.Д. Ширков. Диагностика на стенде фотопушки ЛФВЭ ОИЯИ. Сообщения ОИЯИ Р9-2016-6.