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NUCLEAR INSTRUMENTS & METHODS IN PHYSICS RESEARCH
Section A

Status of the commissioning of the SC linac LISA for "SURF" FEL experiment

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The construction of the superconducting linac LISA and the transport line to the 25 MeV spectrometer has been completed in July. The commissioning of the whole machine will be carried on starting in September. The installation of the 25 MeV arc to the undulator will be completed by December.

Up to now successfully rf power tests and conditioning of 3 out of 4 modules composing the superconducting accelerator have been accomplished. Conditioning is to be continued also the improve the present results (~ 4 MV/m at 25% duty cycle) limited by intense X-ray emission.

A technique to measure the quality factor Q_0 by on-line LHe level measurement has been devised [1], taking into account the complex behaviour of LHe in the loop-controlled cryogenic system. The peculiarity of this behaviour is the onset of coupled pressure, temperature and density oscillations which make the LHe evaporated mass evaluation a very indirect measurement.

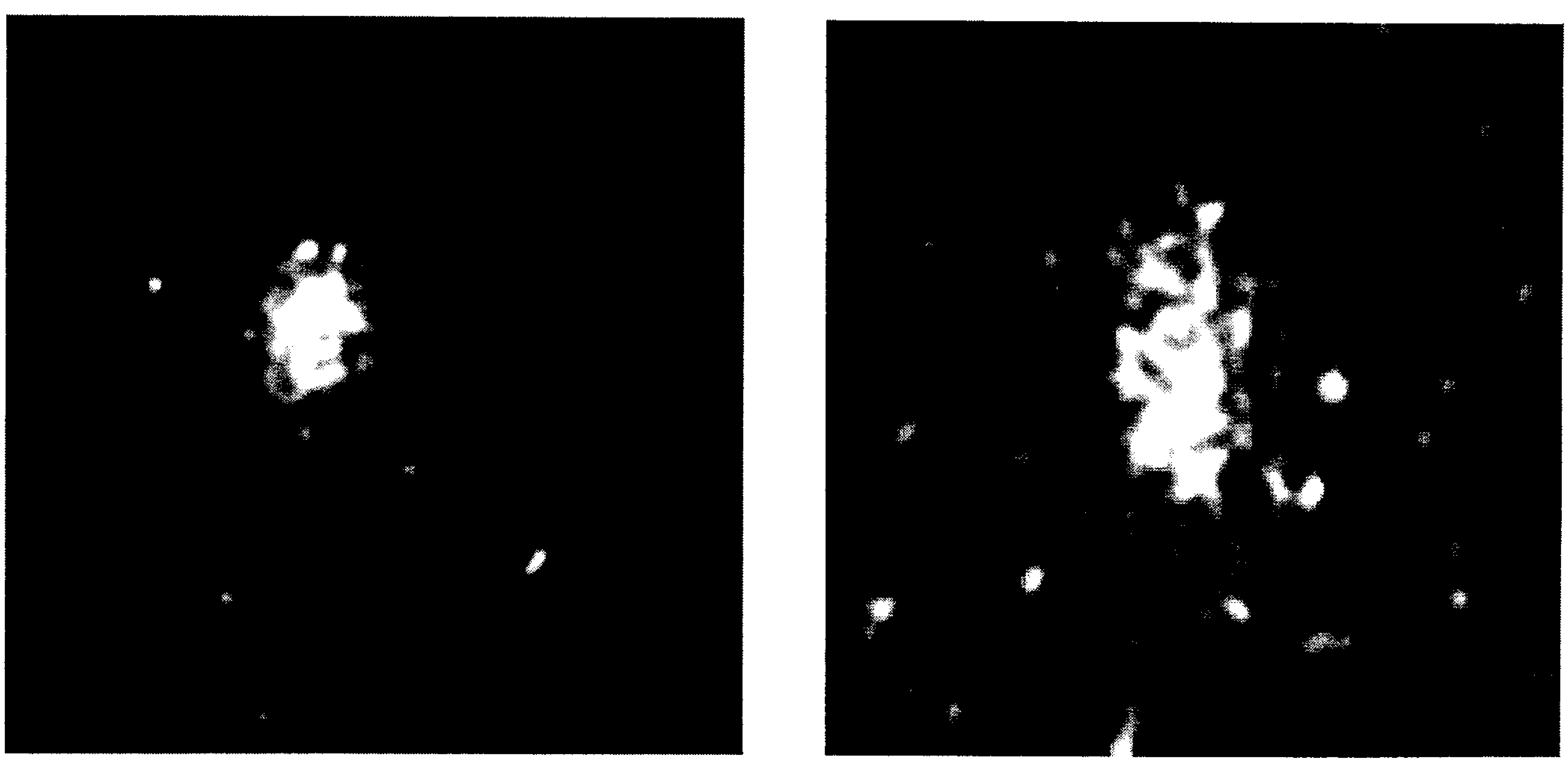

Fig. 1. Two OTR spots obtained with a 500 μA pulse 1 ms long at 1.1 MeV. The left picture shows a well focused beam; the right one shows a vertically defocused beam due to a current variation in the upstream quadrupole.

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Extensive gun tests have been carried out at various anode voltages and beam currents in the pulsed regime at ~ 1 Hz, aiming at improving the gun performances and carefully measuring emittance with the fixed screen–variable focusing method. Although some discrepancies have been observed between the measured parameters and the Hermannfeldt's code predictions, the performances are largely satisfactory for the injector operation [2].

The diagnostics for trajectory optimization in the injector is based on a few fluorescent screens all along the line, and also on a set of stripline beam position monitors (BPM) after the 1 MeV preaccelerator. Optical Transition Radiation (OTR) has been observed at 1 MeV, with an intensity suitable for future diagnostics.

Two kinds of fluorescent screen are used. Anodized Al screens are used in the 100 keV line, where sometimes the high current beam broke the Cr-doped ceramic; although fluorescence from the former is much less intense than from Cr-doped ceramic, it provides clear pictures of the beam spot. Another shortcoming of ceramic screens at 100 keV is electrostatic charging, that defocuses the incoming beam after a few shots. Beam perturbations have been observed also when a screen out of the electron trajectory can be hit by stray electrons. Al plates do not cause this problem [3].

Stripline BPMs provide a sensitivity to beam displacement of 200 μV/(mm mA); further signal processing gives a current independent sensitivity of ~ 100 mV/mm. The acquisition system, based on simultaneous sampling of the displacement signal from the processing modules, will provide a snapshot of the whole orbit.

OTR emitted by a 400 μA, 1 ms pulse has been observed at 1.1 MeV using a high sensitivity CCD camera. The wide angle of peak emission ($\theta_{max} \sim 1/\gamma$), and its low intensity, demanded a peculiar optical setup, with the optical axis aligned along the maximum emission angle, limiting at present extensive measurements of the angular distribution.

Two pictures of the beam spot, at different values of the upstream quadrupole, are shown in Fig. 1.

The undulator [4] has been delivered in March, after a careful trimming of the field. The in-vacuum mirror holder of the optical cavity has been assembled and tested. The vacuum pipe to be placed inside the undulator is under construction. In the final design it was decided to use titanium instead of stainless steel both to avoid magnetic field distortions due to susceptibility in the soldered joints and to lighten the structure. Inside the pipe three retractable holders will be housed in order to insert metallic mirrors for trajectory and beam size measurements exploiting OTR emission. Mirrors allow simple tracking of the electron trajectory overlapping an external laser with the OTR source points.

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