ESRF	**Experiment title:** High resolution X-ray scattering from sliding CDWs, in $NbSe_3$.	**Experiment number:** HS 961
Beamline: ID10 A	**Date of experiment:** from: 26 aug. 1999 to: 29 aug. 1999	**Date of report:** 20 feb. 2000
Shifts: 12 (partial)	**Local contact(s):** G. Detlefs	*Received at ESRF:* 1 - MAR 2000

Names and affiliations of applicants (* indicates experimentalists):
P. Monceau (1)*, H. Requardt (2)*
F.Ya Nad(1,3)*, R. Currat(4),
J.E. Lorenzo (5)*, D. Rideau (1,4)*.
(1) CRTBT/CNRS, Grenoble,
(2) Max-Planck-Institut für Metallforschung, Stuttgart,
(3) Institute of Radioengineering and Electronics, Moscow,
(4) ILL, Grenoble,
(5) Laboratoire de Cristallographie/CNRS, Grenoble.

Report:

The quasi-one-dimensional metal $NbSe_3$ undergoes a Peierls phase transition at T_p=145K. Below T_p the system is characterised by an electronic charge density wave (CDW) together with a modulation of the lattice ionic positions. The application of an electric field above a finite threshold gives rise to *collective* electron transport. The velocity of the sliding condensate is limited by the rate of conversion between normal and condensed carriers near the contact electrodes. This conversion is mediated by phase slip processes which play a similar role as vortices in type II superconductors or superfluids. Experimentally one observes a stretching (compression) of the CDW periodicity near the injection (extraction) contact (ie. a shift, of the position in reciprocal space of the CDW satellite peak).

The purpose of this experiment was twofold:
- *to extend the results obtained in Exp. HS 633, on the deformation profile of a sliding CDW in $NbSe_3$, especially* beneath *the contacts, where the CDW is pinned to the lattice or in the vicinity of localised defects, commonly present in such a material.*

- *to explore the time-resolved relaxation of the CDW satellite upon switching off the driving current, for different temperatures and positions along the sample.*

Measurements of satellite positions were performed on ID10 A, at 90K, 86K, 82K, 75K and 65K, using a 30 μm-wide X-ray spot (sample cross-section: 15 μm x 5 μm). Fig. 1 shows the intensity map $I(x, Q)$ of the CDW satellite peak as a function of the beam position, x, along the sample and the longitudinal coordinate, Q, in reciprocal space; in the pinned state (a), for I=0mA; in the sliding state, for I=3.5 mA (I/I_T=3) before (b) and after (c, see after) irradiation ; T = 90K. The vertical lines show the contact boundaries; a wide electrode (dashed area) and a narrow (15 μm) electrode have been evaporated, leaving an uncovered section of 3 mm between electrodes plus an uncovered section of 1 mm after the narrow electrode. At zero current (Fig. 1 a), one sees two localised anomalies on the CDW satellite intensity, at $x \approx 1.5$ mm and $x \approx 2.7$ mm. Measurements, along the sample, of the (0,2,0) Bragg peak position show that the zero-current anomalies are due to two small structural defects, acting as strong pinning center. The application of a DC current reveals, indeed, that the satellite peak position changes its value abruptly at these positions, indicating the occurrence of phase slippage.

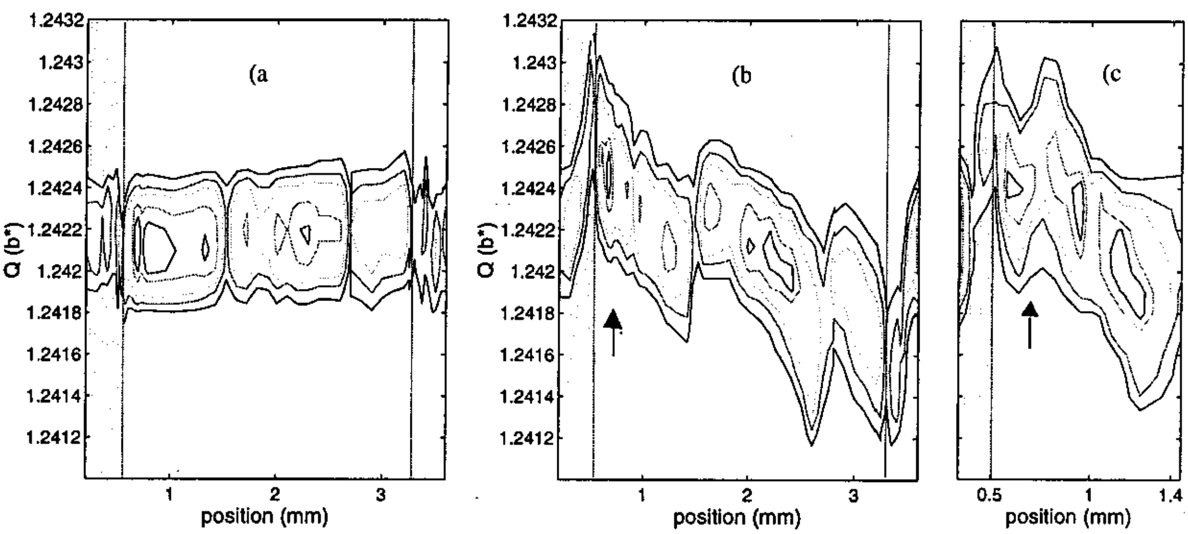

FIG. 1 Intensity maps $I(Q, x)$ (normalised units) of the CDW satellite peak as a function of the position, x, and the longitudinal coordinate, Q: in the pinned state (a), for I=0 mA, in the sliding state, for I=3.5 mA (I/I_T=3), before (b) and after (c) exposure to X-ray radiation (arrow). Beam width: 30 μm, T=90K, $NbSe_3$.

A further experiment was performed by exposing, the first block of the sample to X-ray radiation (arrow), over a long period of time, in order to create a locally damaged region. After the irradiation, the CDW satellite position changes its value abruptly at the position of the irradiating beam (fig. 1 c)). Accurate measurements of the CDW satellite position beneath the two electrodes reveal that the distortions of the CDW extend over an appreciable distance under the large electrode, but also beyond the thin electrode, in the region where the CDW is pinned.

Results reported here confirm and extend the results of Exp. 633: the CDW distortion profile exhibits maxima in the vicinity of localised defects as well as at contact boundaries.

Only half of the allocated beamtime could be used. Time-resolved measurements had to be rescheluded due to instrument failure.