Adaptation of 2D Multiwire Detector System to AMOR

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In order to be able to measure efficiently structure and magnetic roughness parallel to sample surface or interface and to study in-plane periodicities in patterned surface systems the time-of-flight neutron reflectometer AMOR is equipped with a large 2D multiwire detector system. The 2D detector system requires fast read-out electronics and dedicated software to analyse and visualize measured data, which has been made available and tested.

Off-specular neutron reflectometry has developed into an extremely helpful method to study in-plane structure in patterned thin films and interfaces. Measurements are performed on such different systems as magnetic multilayers, polymers layers, phospholipid model membranes, polymer gratings or magnetic dot arrays. The incident beam scatters along wavevector q_x, q_y and q_z, with z perpendicular to the sample surface and x in the direction of the incident beam. The specular reflectivity from the sample surface is given when the angle of incident beam α_i and of reflected beam α_f are equal while at α_i not equal α_f off-specular reflectivity is detected (Fig. 1). The wavevector is given by $q_z = 2\pi/\lambda\,(\sin\alpha_f + \sin\alpha_i)$ and $q_x = 2\pi/\lambda\,(\cos\alpha_f - \cos\alpha_i)$. q_y is not resolved due to the very relaxed collimation in the y direction in our experiments. With a 2D detector system the scattered off-specular intensity can be measured simultaneously with the scattered specular intensity.

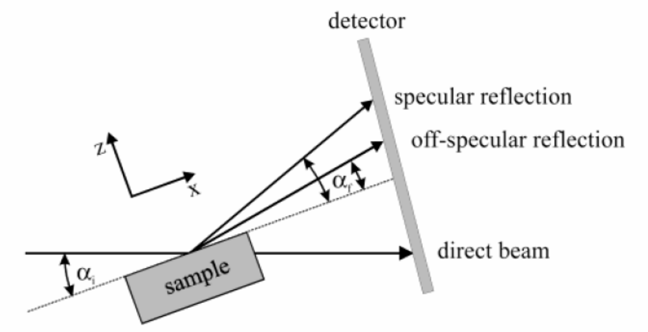

Figure 1: Scattering geometry for specular and off-specular reflectivity.

At the reflectometer AMOR the 2D multiwire detector system consists of 128 vertical and 128 horizontal wires covering an area of 190 x 190 mm^2. Thus, the detector area has a nominal resolution of 1.48 mm. The detector electronics transforms this array into a hv-matrix of 4096 x 4096 individual channels, which is read-out according to the time binning of the histograming memory, e.g. 200 time channels with 150 µsec width of each channel. The hv-matrix is re-duced to a smaller size to improve counting statistics of the individual time channels, e.g. 256 x 128. The time channels are the third dimension of the matrix. This final 3D matrix is stored in the NeXus data file of the specific measurement. A view of the hv-matrix projected along all time channels (t-direction) is shown in Fig. 2. It displays the intensity distri-bution of the direct beam as given on the detector array. The v-direction is related to q_x, the h-direction to q_y, the t-direction to q_z. Projection along the h-direction and transfor-mation of the time channels into λ produces a vλ-matrix as shown in Fig. 3, which can be transformed directly into a q_x,q_z presentation of the specular and off-specular reflectivi-ties. Subsequent measurements at different incident angles map-out large off-specular regions.

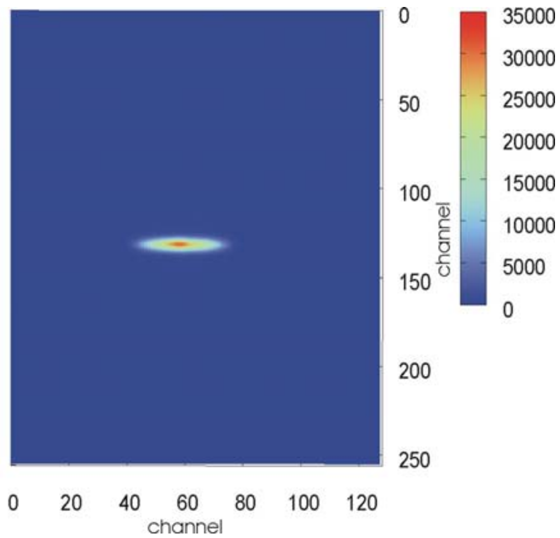

Figure 2: Intensity distribution in h- and v-direction on the 2D detector at AMOR integrated over all time channels.

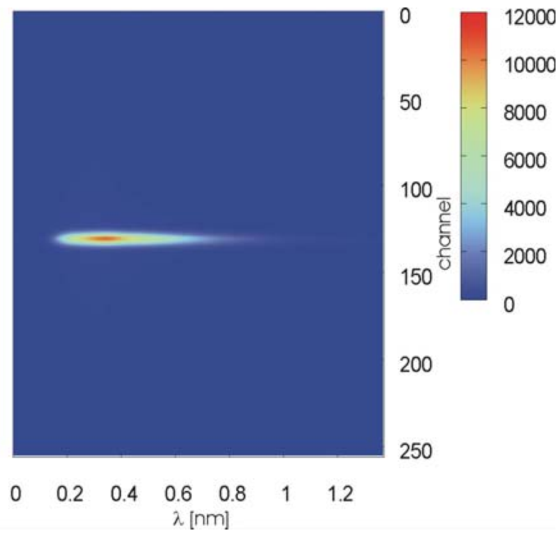

Figure 3: Intensity distribution along v- and λ-direction as transformed of data shown in Fig. 1.

Instrument: AMOR
Work fully performed at SINQ