**3D imaging with neutrons**

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**Abstract**

 Imaging techniques are the integral part of modern multidisciplinary research. They represent the family of methods used for the 2D or 3D quantitative visualization of inner structure of objects at different scales: from microscopy studies to seismic tomography. Neutron tomography has only recently become a widely used imaging method, which is now realized at dozens reactor facilities all over the world, including NRT station at IBR-2 reactor in Russia (Dubna, 2015), TITAN facility at WWR-K in Kazakhstan (Almaty, 2019) and imaging facility at the WWR-SM reactor in Uzbekistan (Tashkent, 2020). The use of neutrons as a radiation penetrating the object is shown to be advantageous in cases when other techniques fail or provide insufficient amount of structural information.

 Neutron tomography has been used in structural studies of meteorites and rocks, plants and food, cultural heritage and construction materials. A wide range of applications demonstrates the high potential of neutron imaging in various fields of research and therefore, it can be one of the methods that students will use in their current or future research. The presented course is focused on the basics of neutron tomography including the practical knowledge on the processing of experimental data and post-processing of the reconstructed data. In particularly, it has a crossover with our current work on the application of neutron tomography in petrophysics and rock mechanics.

**Tasks**

 Learn the basics of neutron tomography experiments; work with neutron data obtained on a rock sample (at the NRT station or at the TITAN facility); perform reconstruction of a 3D model; learn the basics of image analysis; application of image analysis methods to the reconstructed 3D model.

**Preliminary schedule by topics/talks**

 Weeks 1-3. Lectures, processing of experimental data. Weeks 2-5. Lectures, post-processing of the reconstructed data. Weeks 4-6. Prepare final report.

**Required skills**

 Obligatory: general physics and math.

 Desirably: computing skills, knowledge of Matlab or Python.

**Acquired skills and experience**

 Basic knowledge about neutron tomography experiments; understanding of neutron data processing; handling and analysis of 2D images and 3D image sets; programming skills improvement.

**Recommended literature**

 Podurets, K.M., Kichanov, S.E., Glazkov, V.P., et al.: 2021, Modern Methods of Neutron Radiography and Tomography in Studies of the Internal Structure of Objects. Crystallogr. Rep., 66, 254–266. DOI: 10.1134/S1063774521020115.

 Kozlenko, D.P., Kichanov, S.E., Lukin, E.V., et al.: 2016, Neutron radiography and tomography facility at IBR-2 reactor. Phys. Part. Nucl. Lett., 13, 3, 346–351. DOI: 10.1134/s1547477116030146.