



## **Nanostructures irradiated by fs and ns laser pulses: latest advances on X-ray sources and high energy density plasmas**

O. Rosmej<sup>1</sup>, N. Andreev<sup>2</sup>, O. Kostenko<sup>2</sup>, A. Ovchinnikov<sup>2</sup>, O. Chefonov<sup>2</sup>,  
N. Zhidkov<sup>3</sup>, N. Suslov<sup>3</sup>, A. Kunin<sup>3</sup>, D. Schäfer<sup>4</sup>, Th. Nisius<sup>4</sup>, N. Borisenko<sup>5</sup>,  
G. Vergunova<sup>5</sup>, Y. Zhao<sup>6</sup>, J. Duan<sup>6</sup>, J. Liu<sup>6</sup>, Th. Wilhein<sup>4</sup>, M. Agranat<sup>2</sup>

<sup>1</sup> GSI Helmholtzzentrum für Schwerionenforschung, Darmstadt, Germany

<sup>2</sup> Joint Institute for High Temperatures of RAS, Russian Academy of Sciences, Moscow, Russia,

<sup>3</sup> VNIIEF, Sarov, Russia,

<sup>4</sup> Rhein-Ahr-Campus Remagen, University of Applied Sciences, Germany;

<sup>5</sup> Lebedev Physical Institute, Moscow, Russia,

<sup>6</sup> Institute of Modern Physics, Lanzhou, China

[o.rosmej@gsi.de](mailto:o.rosmej@gsi.de), <http://www.gsi.de>

### **a. Optimization of the X-ray yield of $K_{\alpha}$ sources using nano-structured targets**

Spectrally resolved X-ray scattering allows diagnosing fundamental plasma parameters. Probing of plasmas with short  $K_{\alpha}$  sources will allow for spectrally-resolved X-ray scattering measurements with picosecond resolution. This accuracy is required to determine, for example, parameters of dense transient plasmas or to investigate ultrafast phase transitions in solids. Still the conversion efficiency of  $K_{\alpha}$  production, when plane solids and foils are irradiated by sub-picosecond laser pulses does not exceed  $3 \times 10^{-4}$  in  $4\pi$  sr. We propose to use targets with nanostructured surface layers for a many-fold increase of the laser energy conversion efficiency into to the narrowband  $K_{\alpha}$  -radiation. The envisaged x-ray beams will be used for backlighting and spectroscopy of high energy density (HED) matter states produced by heavy ion beams at GSI-Darmstadt. In pilot experiments at the JIHT Laser Centre it was recently shown that nano-structured high-Z surfaces can lead to an effective increase of a hot electron production and hence an increased  $K_{\alpha}$  yield. In particular, at the same laser intensity of  $1 \div 5 \times 10^{17}$  W/cm<sup>2</sup> a five-fold increase of the  $K_{\alpha}$  yield by irradiation of Cu-nanostructured targets with 40 fs laser pulse of 10 TW Ti:Sapphire laser system was achieved.

### **b. Indirect heating of low Z nano-structured targets in experiments with ns laser pulses**

For combined experiments on the interaction of heavy ion beams with ionized matter (GSI) a high density plasma target with homogeneous in time (over 5 ns) and space plasma parameters are required. For these purposes we develop the combined target which consists on the hohlraum and low Z foam target heated by the converter radiation before probed by an ion bunch. Foam targets are rather promising due to their slow hydrodynamic response and effective conversion of the deposited radiation energy into internal plasma energy. Direct irradiation of the gold converter walls with nanosecond pulses delivered by the PHELIX-laser system (GSI) leads to hohlraum radiation spectra in the photon energy range of 50-500 eV. Expected temperatures of the foam targets heated by this radiation amount to 20-30 eV at electron densities of  $10^{21}$  cm<sup>-3</sup>. First experimental results will be reported.