Grazing Incidence Pumped Zr X-Ray Laser at PHELIX

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A **g**razing **i**ncidence **p**umped (GRIP) Zr **x**-ray **l**aser (XRL) was experimentally demonstrated at the PHELIX laser. Two lasing lines are observed, the strongest one in saturation. Analysis of the keV emission of the plasma is performed and the results are compared with the experiments performed at 45° incidence on target.

GRIP XRL using Zr as active medium is reported for the first time. An extensive optimization of the laser output was performed. In the strong pumping regime used in the experiments, the peak-to-peak delay was found to influence the XRL output over large variations of the order of a few hundreds of ps only slightly. This is in contrast to the results of [1] where the delay of 50 ps was critical for obtaining lasing in the weak pumping regime.

Extended analysis of these results in comparison with earlier experiments under 45o incidence on target [2] and similar conditions was performed. This way the understanding of the effect of the incidence angle was deepened. The optimum main pulse duration was found to be 0.5 ps (see fig. 1), considerably different from the result with normal incidence **t**ransient **c**ollisionally **e**xcited (TCE) XRL [3], where the optimum main pulse duration was 3 to 6 ps. A reduction of he plasma absorption was measured for shorter main pulse duration at constant pump energy (see fig. 2) which agrees qualitatively with the computations performed.

Gain curves were obtained for both lasing lines of the Ni-like GRIP Zr XRL. The small-gain signal is similar for the two lasing lines. Saturation of the main lasing line (22.02 nm) is inferred from the curve shape while for the second lasing line this is not seen, suggesting the possibility of enhanced lasing output at the second lasing line for a longer active medium.

An interesting result was obtained using the spatially resolved keV emission registered with the pinhole camera. Two side lobes in the emission showing increased temperature along the focal line of the main pulse were observed. The result correlates well with previous interference measurements of the plasma density profile and with near-field imaging of the TCE Ag XRL experiments at LULI [4].

The GRIP scheme will lead to a better performance of the XRL source for spectroscopy of Li-like ions. For this purpose, the laser will be transferred to the reinjection channel between ESR and SIS.

Another attractive perspective is the pumping efficiency in higher Z Ni-like lasers. Using the PHELIX laser, experiments employing pump energies of up to 150 J are planned.

This should allow to create XRL output at several 100 eV photon energy, possibly reaching the water window.

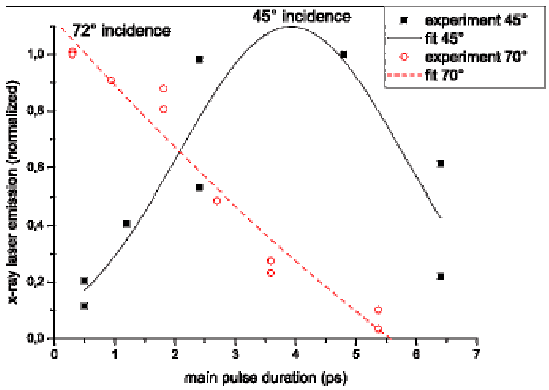

Figure 1: XRL emission versus main pulse duration at incidence angles of 45o and 72°.

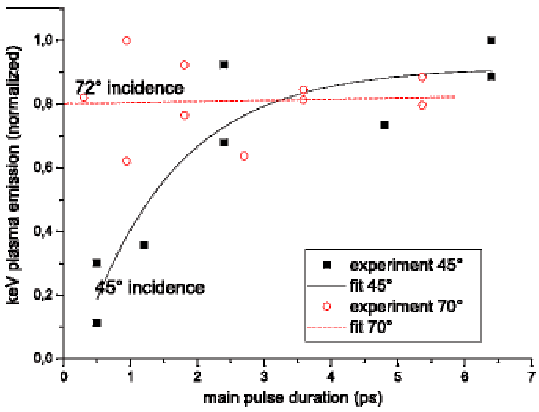

Figure 2: Plasma emission in the keV range versus main pulse duration at incidence angles of 45o and 72°.

References

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