Upgrade of the PHELIX Target Area*

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In 2013, the upgrade of the PHELIX high-energy target area, dedicated to laser-only experiments in the PHELIX Laser Hall (PLH), has been completed. Due to this effort, the experimental possibilities could be broadened, experiment setup became simpler and radiation protection has been optimized. In April, the new chamber was commissioned by an internal beam-time testing the radiation shielding. Since then, eight experimental beam-times have been realized [1].

Experimental aspects

The most important improvement compared to the previous target chamber is that now, the full-aperture (25 cm) PHELIX beam can be transported into the target chamber which in itself allows for a doubling of the available energy. Together with the new, $22.5°$ incidence angle off-axis focusing parabolic mirror with an effective focal length of 400 mm, intensities of up to $1.1 \cdot 10^{22}$ W/cm^2 are attainable. However, due to aberrations caused by the beam transport and the parabolic mirror, low-energy measurements give an estimate of $2 \cdot 10^{21}$ W/cm^2 while diagnostics data taken during the shots show additional aberrations resulting in more realistic intensities of about $5 \cdot 10^{20}$ W/cm^2. These issues are to be addressed in the coming year with adaptive optics and the acquisition of a new glass paraboic mirror.

Furthermore, two idendical beam entrances through which the laser coming from the PW compressor can enter the chamber allow for a high degree of flexibility with multiple beams on multiple targets. Especially, the last turning mirror before the chamber lets through a leakage about 1% of the full beam energy which offers a versatile beam for pump/probe, shadowgraphy or interferometry setups with a temporal resolution of a few picoseconds [2].

From the practical point of view, the new chamber can now be accessed from three sides via specially developed sliding doors, allowing users to operate the target chamber without the use of a heavy-duty crane. The target manipulator system can be easily reconfigured for all allowed target positions. This year's experiments have shown that the electrical shielding of the manipulator stages is sufficient, however, additional shielding measures for the motor controllers and control PCs in the target area were necessary. The vacuum system has also been upgraded with a 450 m^3/h screw pump as well as an overall turbo pumping speed of 2800 l/s, allowing for a pump-down time of about 30 min from air pressure to $5 \cdot 10^{-5}$ mbar which is the upper limit for the operation of the optical compressor.

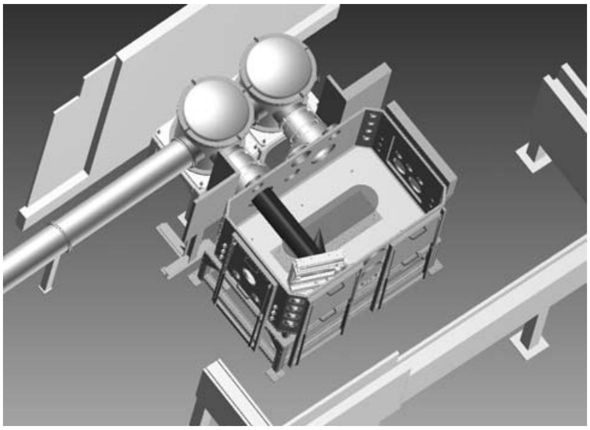

Figure 1: View of the experimental area in the PHELIX laserbay with the additional shielding around the target chamber; red: laser beam path via new parabola; green: permitted target position area

Radiation protection

Before the upgrade, the necessary radiation shielding was assured by means of metal bricks which had to be piled around the target in the vacuum chamber. This seriously limited the use of diagnostics and it was also labor intensive as the shielding material had to be removed after nearly every shot to exchange targets or read out diagnostics. Now, metal shielding panels were installed outside the new target chamber. The design reflects the building wall shape and material in order to minimize the amount of additional shielding material. Important parts are hidden behind the clean-room wall, others directly mounted at or close to the chamber as can be seen in fig. 1. If the target is mounted within a volume of ± 17.5x59x1 cm, the laser can irradiate the target from any direction without further shielding. The relevant documents like the radiation protection directive of PHELIX have been updated. Finally, the responsible authority has allowed GSI to operate PHELIX with laser intensities of up to $7 \cdot 10^{22}$ W/cm^2.

References

[1] S. Götte et al., this report

[2] F. Wagner et al., this report

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