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Experimental Capabilities of the PHELIX facility

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PHELIX is a dual front-end high-energy short-pulse laser capable of generating shaped nanosecond and sub-picosecond laser pulses, which has been in operation since 2008 at GSI Helmholtzzentrum für Schwerionenforschung GmbH [1].

Summary

The general layout of the laser is depicted in the figure below. The short sub-picosecond pulses are generated in the front-end that comprises a commercial mode-locked oscillator, an ultrafast parametric amplifier boosting the short-pulse energy to 100 ⊠J for temporal contrast enhancement [2], the pulse stretcher and two stages of regenerative amplification up to 30 mJ. The shaped nanosecond pulses are generated in a separate fiber-based front-end and subsequently amplified in a regenerative amplifier to 20 mJ. Both front-end are fully synchronized and can be used to seed simultaneously or independently the pre- and main amplifiers.
The pre-amplifier section deals at first with the beam-shaping stage, where several apodizer types can be exploited to shape the beam to various shapes depending on the experimental requirements. After this stage, the beam profile is image-relayed throughout the rest of the amplifier. The amplification is provided by two glass rods with a diameter of 19 and 45 mm used in double pass for stress-induced birefringence compensation. In addition, adaptive optics techniques are employed to compensate for the on-shot aberration of both the pre-amplifier and main amplifier.
The main amplifier provides a gain of about 50 at a maximum operation fluence of 1 J/cm2 that ensures a low B-integral in the system. Following the main-amplifier sensor that provides the main point of characterization of the laser, the beam is either sent to the UNILAC experimental hall or the petawatt target area (PTA) for experiments.
Experiments at PHELIX can be conducted in short-pulse mode with an energy up to 200 J on target and intensities in excess of 1020 W/cm2. In the near future while FAIR is being built, we plan to upgrade the PTA with a deformable mirror to ensure tighter focusing and reaching even higher intensities. Until the APPA cave is commissioned, the beamline with the 100 TW branch and the nanosecond 2⊠ branch should also remain in operation at Z6. A review of the planned upgrades and current developments will be shown during the meeting.

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