Transportation of laser beams for PALIS

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PArasitic RI-beam production by Laser Ion-Source (PALIS)[1] is under construction as a part of the slow RI-beam facility, SLOWRI, at RIBF. The PALIS is based on resonant photoionization of reaction products cached in a gas cell. According to the present plan, the gas cell will be installed in the vicinity of the slit at the F2 focal plane in BigRIPS. However, the laser system for PALIS is set up in a room on a different floor located at approximately 50 m in the horizontal and 10 m in the vertical direction from the F2 chamber of BigRIPS. Thus, to transport the laser beams across this long distance we designed an optics system.

The laser system newly installed for the PALIS consists of two dye lasers (Spectra-Physics Credo) pumped by a Nd:YAG laser (EdgeWave IS) at a repetition rate of 10 kHz. We will use a two-step two-color scheme or a three-step two- or three-color scheme for the resonant ionization of atoms. For example, in case of the three-color scheme, the Nd:YAG laser will be used in the third step from an intermediate state to the ionization continuum.

The planned optics system is shown in Fig. 1. Three sets of this system will be installed to transport three different-color laser beams independently. We prepared a few spares of each lens and mirror to exchange them according to the wavelength of laser. Three laser beams overlap each other at the PALIS gas cell. Because mirror M3 is close (~1 m) to the gas cell, it reflects all three laser beams; this is different from other optical components that are used for only one laser beam.

Because the beam size of the laser is small (0.8 mm horizontally and 2 mm vertically) at the exit of the dye laser,

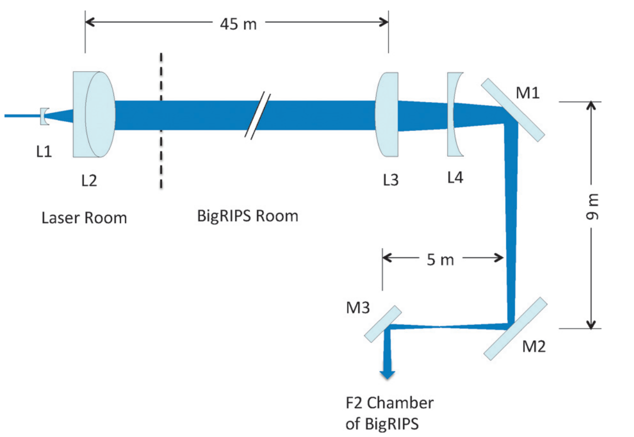

Fig. 1. Planned optics system for transportation of laser beams to PALIS.

it diverges after long distance transportation (with divergence of 1 mrad). Therefore, we expand the laser beam to approximately 7 mm x 17 mm using an expander consisting of a concave lens (L1) and an achromatic lens (L2). The estimated divergence of this beam is 0.1 mrad, and the beam size does not change significantly after a transportation distance of 45 m. Then the laser beam is focused with a long focal length using a combination of convex (L3) and concave (L4) lenses. Finally, the laser beam is injected into the PALIS gas cell in the F2 chamber of BigRIPS. The resonant photoionization occurs inside the SextuPole Ion Guide (SPIG) to which atoms move from the gas cell. We designed the optics system such that the beam size of laser changes to 3 mm x 3 mm along the 25-cm length of SPIG and the laser beam matches the 3-mm inside diameter of SPIG.

Regarding the intensity of the laser beam, outputs of the dye lasers are less than 15 W, or in case of using a second harmonic generator, they are less than 2 W. In many of the ionization schemes, the intensity of ions is not saturated with these laser powers. Therefore, higher transport efficiency of the laser beams is necessary to achieve higher intensity of ions. The designed optics system uses a minimum number of optical components, and the transport efficiency estimated from the transmission and reflectance of the optical components is approximately 50 % at a wavelength of 350 nm. If we use an optical fiber instead, the efficiency lowers to approximately 10 %.

The experimental room where BigRIPS is located cannot be entered when the RI beams are injected, although the laser room can be entered at any time. To handle the laser beams without entering the experimental room, we placed actuators to change the angles of 2-inch mirrors M1 and M2. These actuators can be controlled via Ethernet by a computer. Additionally, several CCD cameras will be installed to monitor the laser beam spots from a distance. We also plan to place a photo detector inside the gas cell to finally confirm that the laser beams pass through apertures of the PALIS.

Transportation of dye laser beam is currently being examined for attenuation of the intensity, spatial fluctuation of the beam spot, and so on. Besides the dye lasers, a narrow band-width injection-locked Ti/Sapphire laser[2] is being developed for the in-source laser spectroscopy. Transportation of this laser beam is also planned.

References
1) T. Sonoda et al: Nucl. Instr. Meth. B **295**, 1 (2013).
2) T. Takatsuka et al: Nucl. Instr. Meth. B **317**, 586 (2013).

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