70-m laser beam transport for the RIBF-PALIS experiment

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Laser beam transport is essential part of the operation of PALIS.[1,2] Figure 1 shows a stereoscopic view of the PALIS laser beam transport line. Because of the strong radiation in the beam line area, one cannot access to PALIS when BigRIPS is in operation. Therefore, the laser light source, which needs appropriate tuning during the experiment, was placed in the human-accessible area. As a result, the laser light source and the ionization area for PALIS are on different floors and different building foundations, which leads to a total laser beam path of up to 70 m. Hence even small beam fluctuations can cause the laser beam to miss the distant downstream optics.

We designed and implemented a simple optical system consisting of several mirrors equipped with compact stepping motor actuators, lenses, beam spot screens, and network cameras. The system enables multistep resonant laser ionization in a gas cell and gas jet with a collinear overlap of a few millimeters diameter between the laser photons and atomic beam at 70 m away from the laser light source.

The optical components used for the long laser beam transportation are only four mirrors and one lens to simplify the whole system. The mirrors are vapour-deposited aluminum flat mirrors that were designed for high reflectivity at any incident angle. To avoid divergence due to the long distance, the beam size has to be sufficiently large. The beam size at the exit of the dye laser is approximately 0.8 mm horizontally and 2 mm vertically. Then it expands to 7 mm × 17 mm using a telescope consisting of a concave lens and an achromatic lens. The laser beam size is finally collimated to 3 mmϕ by a concave lens to irradiate the resonance photoionization volume. In order to control the mirror angle remotely, each mirror has an actuator equipped with a high-performance compact stepping motor for both the horizontal axis and vertical axis. The single-pulse travel of the stepping motor is 1 μ m. All stepping motors can be remotely controlled by a PC with an automation program written in LabVIEW. The remote control interface is integrated with the LAN platform, so that control is possible from any place where a LAN connection is available. Using a dichroic mirror and polarizing cube beam splitter, laser beams with different wavelengths are combined at the starting location in the laser laboratory and transported to the ionization volume.

We have achieved a transmission efficiency of 53 % from B1F laser laboratory to BigRIPS F2 room, for which the total flight path corresponds to about 66 m. We also confirmed that the position stability of the laser beam stays within a permissible range for a dedicated resonant ionization experiment. The system will be finalized in several on-line experiments for robust and efficient handling operations.

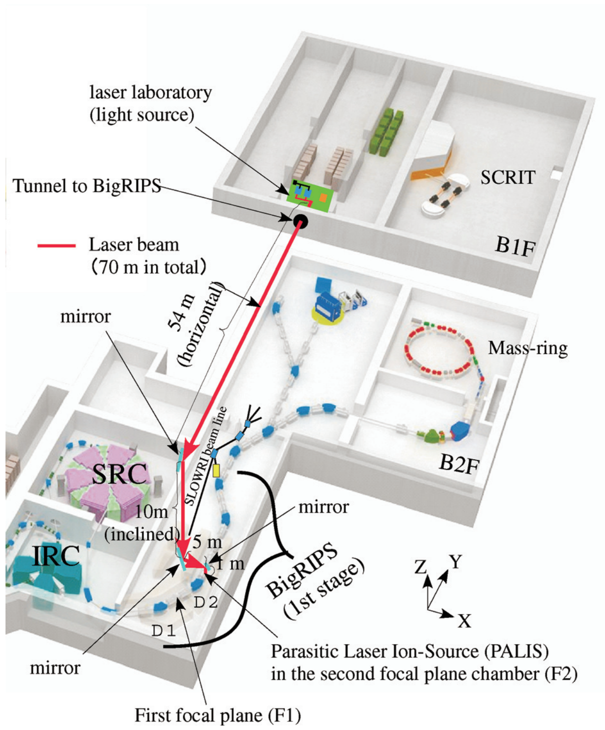

Fig. 1. Stereoscopic view of the 70-m laser beam transport line on the RIBF experimental floors. Multi-color laser beams are sent from the PALIS laser laboratory (B1F) to the PALIS located in the second focal plane chamber in the fragment separator BigRIPS (B2F-F2).

References
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2) T. Sonoda et al., Nucl. Instr. and Meth. B**295** 1(2013).

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