Design work for PALIS system

T. Sonoda,[*1] M. Wada,[*1] I. Katayama,[*1] N. Fukuda,[*1] H. Iimura,[*2] N. Inabe,[*1] T. Kubo,[*1] K. Kusaka,[*1] H. Takeda,[*1] H. Suzuki,[*1] M. Wakasugi,[*1] K. Yoshida[*1] and SLOWRI collaboration

In FY2013, the construction budget for a low-energy RI-beam facility SLOWRI was finally founded. The design drawing for the PArasitic slow RI-beam production by Laser Ion Source (PALIS)[1)] was finalized.

We will restore unused RI-beams for producing slow RI-beam by installing a gas catcher in the vicinity of the second focal plane (F2) of the fragment separator BigRIPS. This will enable the use of parasitic slow RI-beams for various precision experiments whenever BigRIPS experiments are in operation.

In order to realize the reasonable performance under various constrained conditions, there are a lot of novel methods taken into the PALIS design. In particular, the following three worthwhile items were resolved as to avoid any interference to the BigRIPS main beam experiments. The first item is the position of the gas cell, which should be able to move horizontally on the x-axis perpendicular to the BigRIPS beam direction. At F2, RI-beams with slightly different isotones are focused on alongside the x-axis. By applying an overhead beam extraction, the PALIS gas cell collects such the isotone beams neighboring a BigRIPS main beam at both the neutron-rich and neutron-deficient sides, respectively. The extracted RI-beams from the gas cell are transported along the y-axis to the height of 70 cm from the BigRIPS beam, where it bends by 90 degrees in another beam line comprising several bellow combinations. Using a stepping motor, the PALIS gas cell can be moved -60 mm away from the central axis of the BigRIPS beam, and is also pulled by +160 mm toward the evacuation site.

The second item is the differential pumping system for realizing the gas cell pressure for Ar/He up to 10^5 Pa under the totally separated vacuum condition between the PALIS beam line and the BigRIPS F2 chamber. So far, we have developed a novel implementation of differential pumping, in combination with a sextupole ion beam guide (SPIG), which allows a pressure difference from 10^5 to 10^{-3} Pa within a drastically miniaturized geometry compared to conventional systems[2)]. This system can utilize a large exit hole for fast evacuation times, minimizing the decay loss for short-lived nuclei during the extraction from a gas cell, while a sufficient gas cell pressure is maintained for stopping high-energy RI-beams. By following this method, the gas evacuation lines become compact NW-based flanges, resulting in the complete separation of the PALIS vacuum from the BigRIPS beam line.

The third issue is the preparation of the high-voltage platform for ion acceleration, which is necessary for the electrical isolation between the PALIS gas cell, following the beam extraction system including the evacuation lines of differential pumping, and the grounded beam lines. The low-energy RI-beam from PALIS should be transported to the SLOWRI experimental room via 50 m long low-energy beam line. Therefore, ion acceleration is indispensable, while any problem induced from high voltage breakdown should be avoided for the protection of BigRIPS beam profile detectors placed in the F2 chamber. For the first phase, we will adopt the pulsed cavity method[3)] located at the outside of the F2 chamber. The extracted low-energy RI-beam transported via SPIG and QMS first enters a linear ion cooler-buncher, and then, the produced pulsed beam is accelerated toward a cavity at the potential of about 1 kV. When the ion pulse reached the field-free region inside the cavity, the fast switch applies a high voltage potential about 30 kV, the latter is switched again to ground potential for ion acceleration. This pulsed cavity consists of MRTOF[4)] in expectation of future isobar purification. By this way, the electrical isolation is no longer necessary.

The PALIS design work has been almost finalized, as shown in Fig. 1. The off-line and on-line commissioning test for PALIS will be started from June 2014.

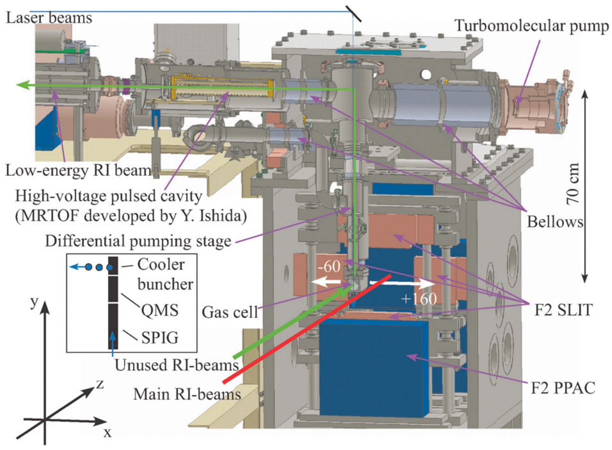

Fig. 1. BigRIPS F2 chamber implemented with PALIS.

References
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*1 RIKEN Nishina Center
*2 Japan Atomic Energy Agency