Current status of SAMURAI-TPC†

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Understanding the equation of state (EOS) for dense asymmetric neutron-rich matter has been identified as an important scientific objective in the Nuclear Science in the past decade. In order to extend constraints on the symmetric matter ($\rho_n \approx \rho_p$) EOS at supra-saturation densities, obtained from central nucleus-nucleus collisions, to the essential frontier of neutron-rich matter, a construction of SAMURAI-TPC for pion production and flow measurements at the RIBF was proposed to the U.S. DOE in the summer of 2008 as one of U.S.-Japan Collaborative Researches. Soon after an approval of the proposal in the fall of 2010 we started a R&D of the TPC based upon the design of EOS-TPC at LBL and now we are at a final stage of the construction. This report describes the current status of TPC construction.

The SAMURAI-TPC was designed to fit within the pole gap of the SAMURAI dipole magnet. In Fig. 1 an exploded view of the TPC is shown. The TPC consists of several main components, namely a front end electronics mounted on, a rigid top plate, a pad plane and three wire planes, a field cage, a voltage step-down, a thin-walled enclosure, a calibration laser optics, a target mechanism, rails, and so on. Details about a electronics for the SAMURAI-TPC including front end electronics are described in a separated report[1)].

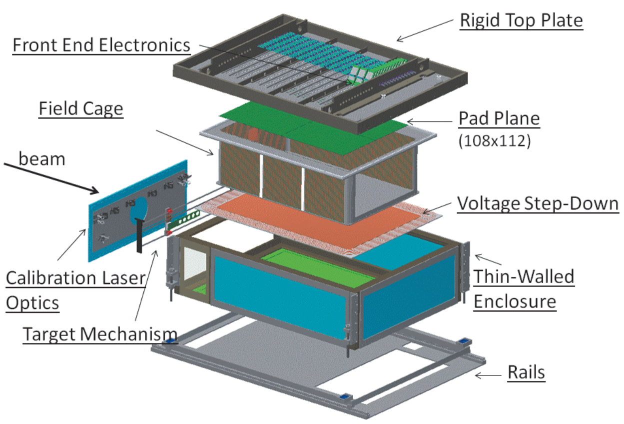

Fig. 1. Exploded view of SAMURAI-TPC.

The rigid top plate is a primary structural member of the TPC and reinforced with several ribs to hold a pad plane and three wire planes. Laser level measurements confirmed that the top plate was flat to within about 125 μm. The pad plane which consists of 108×112 pads of 12×8 mm^2 in size is mounted on bottom of the top plate. Each pad has capacitances of 12 pF to the ground and of 5 pF to adjacent pads. Cross talks between adjacent pads and non-adjacent pads are measured to be about 0.2% and less than 0.1%, respectively. Because of its large size the pad plane was fabricated in four pieces and glued to the top plane to form a single plane of 1.34×0.86 m^2 in size.

Wires for anode wire plane were wound on a frame in the detector lab of the NSCL/MSU and epoxied and soldered on a circuit board. Plans have been made to wind the ground plane and gating grid plane by the end of February. The field cage is mainly made of thin two layer PCB's so that reaction ejectiles could exit through it. Front window will be 12 μm PPTA and back window will be 125 μm Kapton, with evaporated aluminum electrodes. The cage is designed to be gas tight for separating detection gas volume from insulation gas outside the field cage.

In order to prevent sparking from cathode (20 kV) to ground the voltage step-down is situated about 6 mm below the cathode and glued to the bottom plate of the enclosure. The voltage step-down has 8 concentric copper rings which step the voltage down from cathode HV to ground. The thin-walled enclosure has a skeleton-structure of aluminum angle bars welded and polished for sealing. Its sides and down stream walls are made of framed aluminum sheet to minimize neutron scattering. The upstream plate will be modified to couple to the up stream beam-line. A motion chassis and hoist beams can be attached to the enclosure for lifting and/or rotating the entire TPC safely. We still need to work on the calibration laser optics, the target mechanism, and the rails, but those should be ready by the end of 2013. We plan to ship the TPC from MSU to RIBF in December of 2013.

References

1) T. Isobe et al.: RIKEN Accel. Prog. Rep. 46, in this report (2013).

† Supported in part by U.S. DOE
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