Development for proton detector NINJA at SAMURAI magnet gap with VME-EASIROC readout

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SAMURAI has various properties for nuclear spectroscopic studies. Up to now, experimental programs measuring heavy residual and neutrons in coincidence have been performed. On the other hand, projectile velocity protons have not been considered for coincidence measurement since they cannot go to the downstream of the magnet due to the strong focusing by the SAMURAI magnet. Therefore, a new proton detector array NINJA(Nimble detector array for Nucleons with JAck-knife like trajectory) have been constructed. The NINJA located inside the SAMURAI gap and can be operated under the strong magnetic field of SAMURAI. NINJA enables us to provide exotic decay channels such as *d*-bar (singlet s state on $p + n$ system) decay from excited states of nuclei. It is also expected to detect one of the protons from the (p,2p) reaction at forward angle combined with the SAMURAI-MINOS configuration.

Properties of NINJA are shown in Tab. 1. Geometry of NINJA was designed to be used on various experiment without interfering with other particle trajectories than that of protons.

Table 1. Specifications of NINJA

Structure of detector	1 X-layer, 1 Y-layer
Scintillator	EJ-200
Formation of Scintillator	X-layer (18 slats) 60×720 mm^2×10 mm^t Y-layer (12 slats) 60×1100 mm^2×10 mm^t
Readout structure	WLS,MPPC(double side)
Readout circuit	VME-EASIROC
Slide limit	800 mm
Cable length	Vacuum side：4.5 m Atmosphere side：0.5 m

The NINJA consists of plastic scintillator with optical readout by MPPC mounted at top and bottom side through wave length shift fiber (WLS) KURARAY YB-5. The WLS is mounted on backside ditch of the plastic scintillator. At both ends of the WLS, dedicated connectors[1], are attached so as to be connect MPPCs optically. The signals from MPPCs are read-out by the EASIROC circuit[2] implemented on VME bus. In parallel this readout, we separately prepared a hand-made single channel readout circuit to obtain the response of MPPC and their HV dependence of readout efficiency.

A supporting structure of the NINJA was designed to compose the array within 25 mm in depth. The size of the supporting structure is minimized to enlarge the active area of NINJA.

Readout cable layout were determined by estimating it on a CAD software. Low consumption cable at high frequency (S-02162-B) was chosen for vacuum side. The signals are transmitted through a vacuum feed through attached at the bottom side of the extension duct of the SAMURAI gap chamber. From the feed through to the read-out circuit, the LEMO-16 pair exchange cables with 50 cm length and 17 pair to 34 pair cables with 20 cm is used to minimize the length of the cables. The high voltages for each MPPCs are supplied via hand-made AC coupled circuit connected to the exchange cable.

The support structure of NINJA can be slid along a rail which is mounted inside the SAMURAI vacuum chamber as shown in Fig. 1. The position of the detector can be determined depending on trajectories of protons, which are given by the magnetic field and proton momenta in interest.

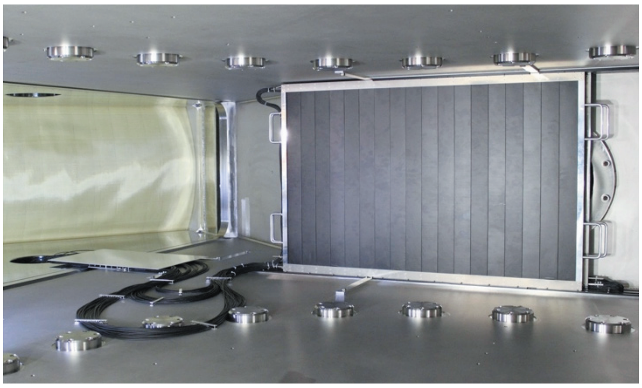

Fig. 1: NINJA inside the SAMURAI Gap.

In the last experiment[3),4)], the position is optimized for the 200 MeV protons with a 2.4T of SAMURAI magnetic field.

From this experiment, we found that noise reduction is necessary so as to use NINJA as a trigger source, while it works well as a parasitic detector. The NINJA will be used to every SAMURAI experiment with *n*-HI coincidence configuration.

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References

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