DEVELOPMENTS ON SHORT AND LONG PULSED PROTON INJECTOR FOR THE 100 MeV PROTON LINAC AT KOMAC

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The Korea Multi-purpose Accelerator Complex (KOMAC) has been operated to provide 100 MeV proton beams for beam users from various fields such as bio/medicine, material science, industrial applications and semiconductor researches. Beside a stable operation of a 100 MeV proton linac, we have been working on its upgrades and expanding target rooms. One of the projects in progress is to develop a new combined injector of a 100 MeV proton linac for both long (> 1 ms) and short(< 1 μs) pulsed proton beams. The current injector is a microwave ion source, generating 2 ms proton beams. We plan to install an additional ion source, i.e. a superconducting electron beam ion. This unique combination will provide both long and short proton beams at 100 MeV at different time shares. Further, our plan extends to development of a pulsed neutron source, and finally to construct a utilization facility for secondary particles at KOMAC. In this paper, we present an initial part of the grand plan, i.e. the installation of an injector for both long and short pulsed proton beams.

I. INTRODUCTION

A 100-MeV proton linac at KOMAC currently operated with a proton injector based on a microwave ion source, a radio frequency quadrupole and a drift tube linac. The microwave ion source has been stably operated for long (> 1 ms) pulsed proton beams. In order to expand proton beam- utilization fields and, as a part of a development plan for a pulsed neutron source, a superconducting electron beam ion source for short (< 1 μs) pulsed proton beams will be installed. In the following section, we describe the current status of the microwave ion source, plans for a superconducting ion source and comparison between them.

II. MICROWAVE ION SOURCE FOR LONG (> 1 ms) PULSED PROTON BEAMS

A 100-MeV proton linac at KOMAC consists of a 50-keV proton injector based on 2.45-GHz microwave ion source which was developed and completely home-built. It gives a proton beam of max. 20mA with a pulse width of 2 ms. Due to difficulty in fast switching of high voltage, the same technique cannot be applied to generate short (< 1 μs) pulsed proton beams. Fig. 1 shows a picture of microwave ion source installed as an injector (a) and a capture of an extracted proton pulse from the microwave ion source (b).

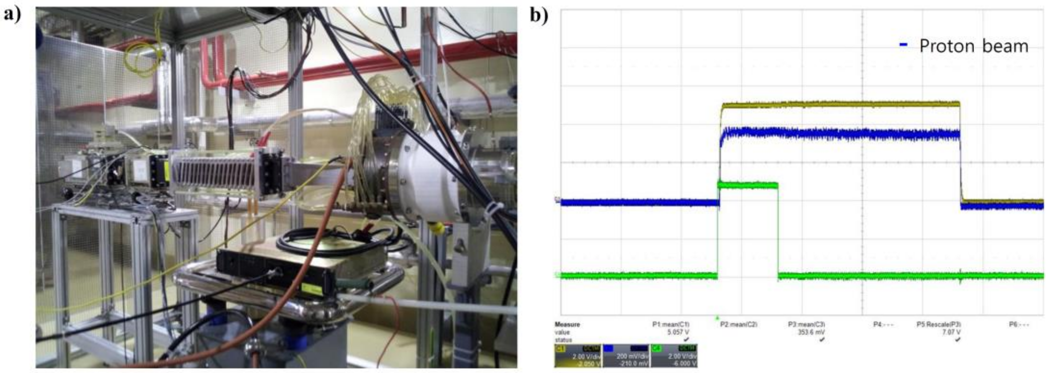

Fig.1. Microwave ion source installation as an injector of the 100 MeV proton linac (a) and a capture of a 2 ms proton pulse extracted from the microwave ion source (b)

III. SUPERCONDUCTING ELECTRON BEAM ION SOURCE FOR SHORT (< 1 μs) PULSED PROTON BEAMS

A superconducting electron beam ion source consists of an electron gun, a 6 T superconducting solenoid, drift tubes and several electrostatic optics. It is commercially available from Dreebit GmbH. An electron beam gets compressed by the superconducting solenoid and ionizes hydrogen gas to generate proton pulses. It also has an assembly for generating short, variable pulses of less than 1 μs. It produces a short proton pulse of 610 pC at 50 keV. We will complete the installation by end of 2017. Below is TABLE I which compares between the microwave ion source and the superconducting electron beam ion source.

TABLE I. Comparison between the microwave ion source and the superconducting electron beam ion source

	Microwave ion source	Superconducting electron beam ion source
Working principle	Ionization of hydrogen gas by the plasma generation using the microwave energy	Ionization of hydrogen gas by a high density of the electron beam formed by a 6 T superconducting solenoid
Proton beam current	20 mA	610 pC/pulse
Proton beam pulse width	About 2 ms	Less than 1 μs
Proton beam energy	50 keV	50 keV

IV. FUTURE SCOPE

Development of a tungsten target for 1 kW pulse neutron generation is parallel in progress. Combination of a 100 MeV proton linac with a new injector and a tungsten target will set a base to generate neutron pulses of 100 MeV energy and < 1 μs pulse width.

IV. CONCLUSIONS

We describe an overview of the microwave ion source currently used as an injector (> 1 ms proton beams) of a 100 MeV proton linac. In order to develop a new injector which can provide both long (> 1 ms) and short (<1 μs) pulsed proton beams, we will additionally install a superconducting electron beam ion source. Features and plans on the superconducting electron beam ion are briefly discussed.

ACKNOWLEDGMENTS

This work has been supported through KOMAC (Korea of Multi-purpose Accelerator Complex) operation fund of KAERI by MSIP (Ministry of Science, ICT and Future Planning).