DAMAGE SITUATION OF THE 12UD PELLETRON TANDEM ACCELERATOR AT THE UNIVERSITY OF TSUKUBA BY THE GREAT EAST JAPAN EARTHQUAKE

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Abstract

The 12UD Pelletron tandem accelerator at the University of Tsukuba suffered serious damage from the Great East Japan Earthquake on 11 March 2011. On the day, the 12UD Pelletron tandem accelerator was in operation at 8 MV. A main tank of the 12 UD Pelletron tandem accelerator located from downstairs 4th floor to 7th floor was strongly shaken by the shock of the earthquake. All high voltage accelerating columns fell down in the accelerator tank. A situation of the damage and a post-quake reconstruction project of the Tandem Accelerator Facility at the University of Tsukuba are reported.

INTRODUCTION

The 12 UD Pelletron tandem accelerator was manufactured by National Electrostatic Corp. (NEC), USA and was installed at the University of Tsukuba, Tandem Accelerator Complex (UTTAC) in 1975 [1]. A maximum terminal voltage of 12 MV is available for various ion beam applications [2]. By the Great East Japan Earthquake on 11 March 2011, the 12UD Pelletron tandem accelerator suffered serious damages. The 9.0-magnitude earthquake hit the east Japan area. Many accelerator facilities were damaged by this earthquake [3]. A maximum acceleration was 371.7 cm/s^2 (gal) with the duration time of 300 s that registered by the Kyoshin-Net (NIED) [4] at the site of the University of Tsukuba. On the day, 12UD Pelletron tandem accelerator was in operation at 8 MV for ^{41}Ca trial measurements by AMS. The electricity supply went out during the earthquake. The blackout lasted for 4 days, and we had to continuously stop the electric power for 2 days for hazard avoidance. We could not access our facility for the first week because of many aftershocks. Fortunately, there were no casualties by this earthquake in the facility. The 1 MV Tandetron accelerator at the facility did not have any serious damage because of its T type hard structure and it has worked properly after the earthquake.

DAMAGE OF THE 12UD PELLETRON TANDEM ACCELERATOR

Fig.1 shows a cross-section drawing of the 12UD Pelletron tandem accelerator facility which is a vertical type. A main tank of the 12 UD Pelletron tandem accelerator is located from downstairs 4th floor to 7th floor in the accelerator tower. Fig. 2 shows a plane view of the 1st floor with two experimental rooms.

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Accelerator Tank

The accelerator tank was strongly shaken by the shock of the earthquake. Three shock prevention devices for the accelerator tank at the 7th floor were pushed out with breaking anchor bolts of 1 inch in diameter as shown in Fig. 3. Weight supports and jacks at the 4th floor were moved as nearly taken off as shown in Fig. 4. All high voltage accelerating columns fell down in the accelerator tank. Fig. 5 shows the downed accelerating column in the tank at the bottom. Structures of the terminal shell and columns inside the tank were completely collapsed.

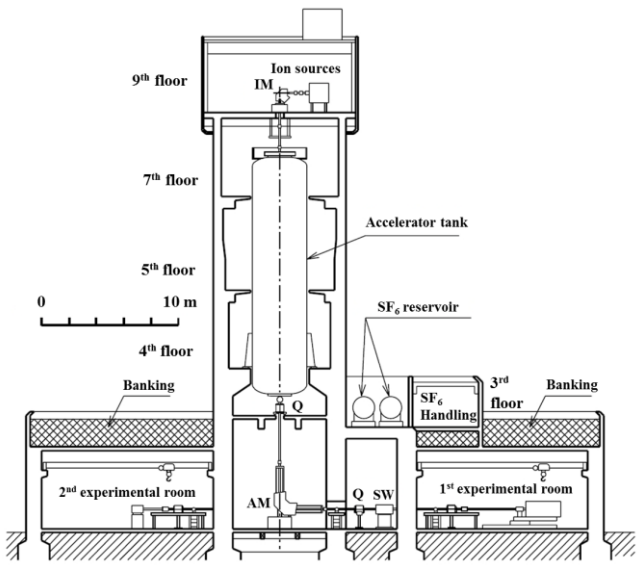

Figure 1: Layout of the 12UD Pelletron tandem accelerator facility at the University of Tsukuba.

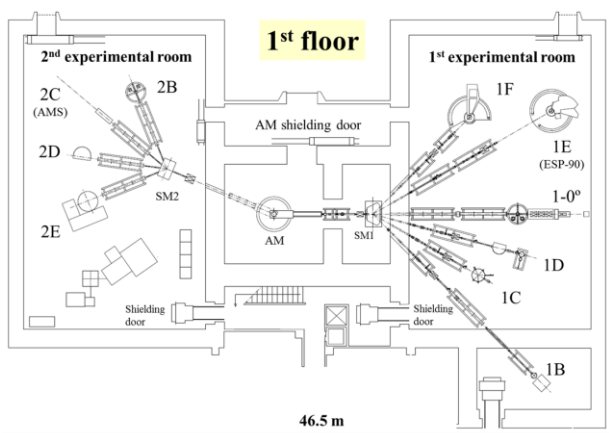

Figure 2: A plane view of the 1st floor at the facility.

Figure 3: Broken shock prevention device for the accelerator tank at the 7th floor. Anchor bolts of 1 inch in diameter for the shock prevention device were severed by the shock of the earthquake.

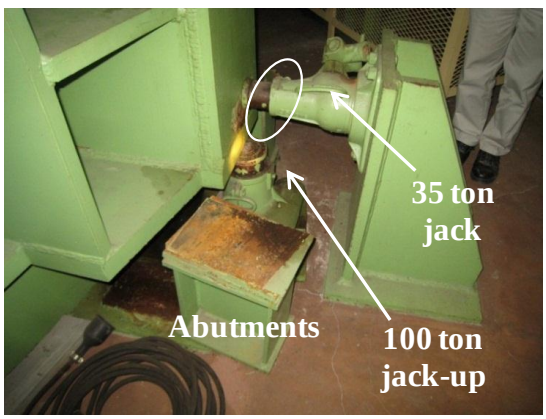

Figure 4: Moved weight supports and jacks at the 4th floor by the shock of the earthquake.

Figure 5: Collapsed accelerating column and terminal (the view from the 7th floor).

Ion Sources at the 9th Floor

Two of three ion sources at the 9th floor were also seriously damaged by the earthquake. The anchor bolts of the Wien filter for the polarized ion source were destroyed by the earthquake. Finally, the Wien filter was moved 1 m from the beam line by the earthquake and aftershocks for a month as shown in Fig. 6. Almost piping bellows between connected heavy loads were broken by shaking at the 9th floor. Ceramic columns of the AMS ion source were also broken. Water pressure gauges of the cooling water system were shaken and broken off by its root on the plumbing. A water spurt came out the polarized ion source. The inflection magnet weight of 4 tons at the 9th floor was moved 5 cm on the mount by the earthquake as shown in Fig. 7.

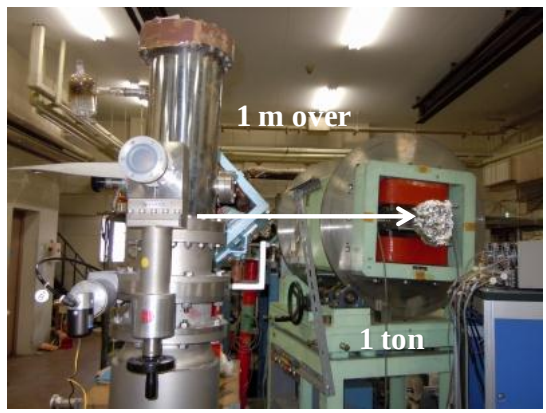

Figure 6: Broken Wien filter for the polarized ion source. The Wien filter was moved 1 m from the beam line after the earthquake and aftershocks.

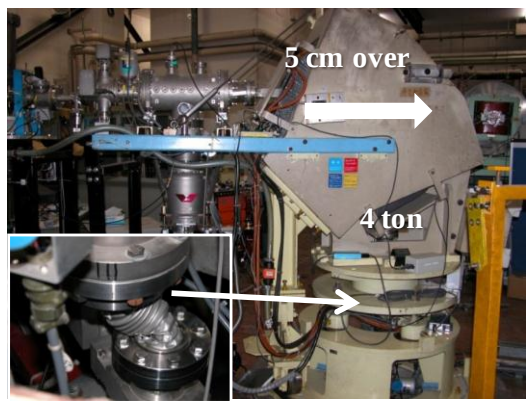

Figure 7: Moved inflection magnet at the 9th floor.

Experimental Rooms at the First Floor

At the 1st floor, a β-NMR experimental magnet weight of 800 kg at the 1-F beam course was dropped from heights of 1.75 m with breaking a stepladder as shown in Fig. 8. Several tool racks also fell down in the facility (Fig. 9). Many magnets were moved and a number of joint bellows were broken as shown in Fig. 10. Many vacuum apparatuses such as turbo-molecular pumps and ion pumps were damaged at points around broken joint bellows. A shielding door motor was broken by the shock of the earthquake at the analyzer magnet room. Therefore, we could not access immediately in the analyzer magnet

room after the earthquake. Shielding concrete blocks at the analyzer magnet room came down to the floor.

Figure 8: Dropped β-NMR experimental magnet at the 1-F beam course of the 1st floor.

Figure 9: Fallen shelf at the 1-0° beam course.

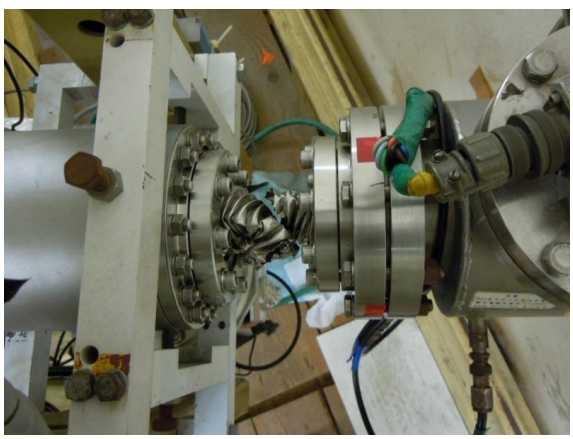

Figure 10: Broken joint bellows after the analyzer magnet of the 1st floor.

EARTHQUAKE DISASTER RECONSTRUCTION PROJECT

We decided to shut down the 12UD Pelletron tandem accelerator in 2011. At present, we are planning to install a new middle-sized tandem accelerator at the 2nd experimental room instead of the broken 12UD Pelletron tandem accelerator since it is difficult to repair the previous one due to some boundaries in the building construction. A new accelerator system will consist of a horizontal type 6 MV Pelletron tandem accelerator, new 3 ion sources and the polarized ion source which will be moved from the 9th floor to a new experimental booth at the ground, an accelerator mass spectrometry system and an ion beam analysis system. High energy beam transport line will be connected from the 2nd experimental room to the present experimental facilities at the 1st experimental room. The new AMS system will be capable of measuring environmental levels of long-lived radioisotopes of ^{10}Be, ^{14}C, ^{26}Al, ^{36}Cl, ^{41}Ca and ^{129}I. The new IBA system will be equipped with a high-precision five-axis goniometer. The construction of the new accelerator system is scheduled in the spring of 2014.

SUMMARY

The 12UD Pelletron tandem accelerator with a history of over 35 years at the University of Tsukuba was destroyed by the Great East Japan Earthquake in 2011. We decided to update the 12UD Pelletron tandem accelerator to the new 6 MV tandem accelerator. We have mapped out a strategy for reconstruction project. The 6 MV tandem accelerator will mainly be applied for AMS, IBA, beam irradiation research and nuclear physics. The beam delivery will start on September 2014.

ACKNOWLEDGMENT

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[3] *Science*, Vol. 333, 8 July 2011, 154.
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