

OPERATION OF THE RCNP CYCLOTRON

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Summary of the performance of the AVF cyclotron and the Ring cyclotron in 2003 is given in Table. 1. About 90 % of beam time was carried out with using the Ring cyclotron. The beam time for the WS course was over 2500 hours, which corresponds to ~90 % of all beam time using Ring cyclotron.

We had ~70 hours of unscheduled shutdown in 2003, which is mainly due to the following severe machine troubles;

- 1) a breakdown of an intermediate Rf vacuum tube for a cavity #2 of the Ring cyclotron by heat. Parasitic resonance may occur.
- 2) a breakdown of a main Rf vacuum tube for a cavity #1 of the Ring cyclotron. Operating time was over 50,000 hours.
- 3) a breakdown of 19 transistors at once in the power supply for the #13 trim coil of the AVF cyclotron.
- 4) inundation of an AVF Rf amplifier by water leakage of an ion source upstairs. The amplifier was dismantled to dry during ~ half a day.
- 5) a breakdown of a cryogenic vacuum pump settled the Ring cyclotron.
- 6) some hardware(computer board, cable and connector etc.) troubles of the control system for the RCNP cyclotron complex.

Table 1:A summary of operational statistics

Beam time	Beam time for experiments	G 249h10min
		I 92h35min
		WS 2563h45min
		WSS 45h00min
		N0 135h55min
		ESS 53h10min
		Total 3139h35min
		Tuning of beam for experiments 505h45min
	Preparation for Acceleration and Developments 1408h50min	
	Total 5054h10min	
Maintenance		1601h20min
Shutdown	Scheduled shutdown and holidays	2032h00min
	Unscheduled shutdown	72h30min
Total		8760h00min

The beam usage of the cyclotrons is summarized in Table 2. In 2003, about 94 % of the beam time was carried out for the light ions.

In RCNP, high-quality beams have been strongly required. It had been already found that beam quality strongly depends on condition of the injector, the AVF cyclotron[1]. A fixed internal phase probe was tested in 2002 and improved and installed in 2003. It is found that isochronous magnetic field was not realized for some ions. Thus, trim coil currents of the AVF cyclotron were newly calculated. The Rf voltages of the AVF cyclotron were also increased and a position of the phase defining slit in the central region was changed. As a result, quasi-single-turn beam extraction, which had been already reported for helium-3 beam[2], was realized for all light ions[3]. The best energy resolutions in our laboratory were obtained for some ions in this year. For example, 39 keV of the energy resolutions were obtained for 200 MeV proton beams, 79 keV were obtained for 200 MeV deuteron beams, 75 keV and 110 keV were obtained for 420 MeV and 450 MeV helium-3 beams and 74 keV were obtained for 400 MeV helium-4 beams, respectively.

Table 2: A summary of the beam usage of the RCNP cyclotrons

Particles	
Proton	946 ^h 40 ^{min}
Pol. Proton	1371 ^h 30 ^{min}
Deuteron	15 ^h 00 ^{min}
Pol. Deuteron	769 ^h 10 ^{min}
³ He	679 ^h 50 ^{min}
Alpha	955 ^h 40 ^{min}
⁷ Li	72 ^h 00 ^{min}
¹¹ B	244 ^h 20 ^{min}
Total	5054^h10^{min}

For 786 MeV ¹¹B⁵⁺ beam, the obtained beam intensity was much increased, up to 30 nA at target, in 2003, because the vacuum level in the NEOMAFIOS ECR ion source became better by upgrading a TMP vacuum pump.

The operation statistics from 1977 are shown in fig. 1. Until 2002, statistics in the FISCAL YEAR are shown and statistics in the CALENDAR YEAR are shown for 2003. The unscheduled shutdown in 2003 slightly decreased as compared with that in 2002.

References

- [1] e.g., S. Ninomiya *et. al.*, RCNP Annual Report 2001 p.148
- [2] S. Ninomiya *et. al.*, RCNP Annual Report 2002 p.152
- [3] S. Ninomiya *et. al.*, elsewhere in this report.

