

# Operation of the RCNP Cyclotron

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A summary of the performance of the AVF and the Ring cyclotron in 2005 is given in Table 1. The main topics in 2005 is the installation of equipments related to the upgrade project of the AVF cyclotron facility [1]. The accelerator operation was stopped in the middle of December resumed on May 18 in 2005. Most subjects were completed during the shutdown, although some of them were appended during the summer maintenance period in August and September. They are summarized as follows.

1. The RF power supply was fully replaced. The new final amplifier is operated with a tetrode RS2042SK by Siemens instead of RCA4648. The operational characteristics are improved due to the high power of 400 kW. It becomes much easier to overcome multi-pactoring.
2. A dee electrode with a slot was installed. The full voltage was successfully applied after conditioning for a short period.
3. A beamline was installed and commissioned to diagnose beam characteristics from the AVF cyclotron as well as to directly transport low energy beams from the AVF to experimental halls.
4. A new irradiation apparatus was constructed to produce many kinds of radioisotopes for such studies as nuclear chemistry, earth and space science, solid state science, and so on. The system consists of an irradiation chamber with a pneumatic tube for the rapid transportation of the target and a gas-jet coupled chamber by which the reaction products recoiled from the target are transported to the radioisotope laboratory within several seconds through the long capillaries (70 m).
5. Nineteen power supplies were fabricated for trim coils, dipole and quadrupole magnets. Their stability was measured to be better than design specifications. They were controlled by programmable logic controllers (PLCs). PLCs were damaged by thermal neutrons and were moved out of the cyclotron vault.
6. The main frame of the accelerator control system was completely replaced by a cluster of personal computers connected by a net work. The new system was commissioned to control several thousands devices without serious problems.
7. A flat-top accelerating system was newly introduced to the AVF cyclotron and the basic performance was proved. The optimization of the parameters is being performed with various beams now.

Table 1: A summary of operational statistics

Beam time	Beam time for experiments	K	66 <sup>h</sup> 25 <sup>m</sup>
		WS	903 <sup>h</sup> 44 <sup>m</sup>
		WSS	54 <sup>h</sup> 10 <sup>m</sup>
		WN	100 <sup>h</sup> 50 <sup>m</sup>
		N0	420 <sup>h</sup> 20 <sup>m</sup>
		EN	213 <sup>h</sup> 15 <sup>m</sup>
		Total	1758 <sup>h</sup> 44 <sup>m</sup>
		Tuning of beam for experiments	
	Developments		1674 <sup>h</sup> 08 <sup>m</sup>
	Total		3658 <sup>h</sup> 18 <sup>m</sup>
Scheduled maintenance and set up for experiments			1007 <sup>h</sup> 55 <sup>m</sup>
Shutdown	Scheduled shutdown and holidays		3911 <sup>h</sup> 20 <sup>m</sup>
	Unscheduled shutdown		182 <sup>h</sup> 27 <sup>m</sup>
	Total		4093 <sup>h</sup> 47 <sup>m</sup>
Total			8760 <sup>h</sup> 00 <sup>m</sup>

8. An 18 GHz ECR ion source was assembled including superconducting mirror coils, a sextupole magnet made of NdBFe permanent magnets, a plasma chamber, extractin electrodes and an analyzing magnet. A gas supply system is under fabrication and the first plasma ignition is planned eraly spring of 2006.

The bem time for experiments is about a half of that in the previous year, since we had a long shutdown to upgrade the AVF cyclotron and to make developments. The beam quality was found to be almost same as before the shutdown without the flat-top operation.

The beam usage of the cyclotron is summarized in Table2. About 65 % of the beam time was carried out with protons. 200 MeV  $^{40}\text{Ar}^{8+}$  beam was used to study isomeric states produced by fusion reactions, which was directly transported from the AVF cyclotron to the EN course through the new beam line.

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

Particles	
Proton	1728 <sup>h</sup> 48 <sup>m</sup>
Pol. Proton	660 <sup>h</sup> 30 <sup>m</sup>
$^4\text{He}$	962 <sup>h</sup> 30 <sup>m</sup>
$^{12}\text{C}$	33 <sup>h</sup> 30 <sup>m</sup>
$^{16}\text{O}$	4 <sup>h</sup> 20 <sup>m</sup>
$^{18}\text{O}$	5 <sup>h</sup> 20 <sup>m</sup>
$^{40}\text{Ar}$	263 <sup>h</sup> 20 <sup>m</sup>
Total	3658 <sup>h</sup> 18 <sup>m</sup>

The operation statistics from 1977 are shown in Fig. 1. Until 2002, statistics in the FISCAL YEAR are shown and those in the CALENDER YEAR are shown later than 2003.

## References

- [1] K. Hatanaka *et al.*, RCNP Annual Report 2004, t1.

Fig.1 Operation statistics

