STATUS OF HIMAC

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Abstract

HIMAC, Heavy Ion Medical Accelerator in Chiba, has been used for cancer therapy, physics and biology experiments since 1994. The present status and typical improvements are described.

INTRODUCTION

More than 1,700 patients have been treated at HIMAC since 1994 (Table 1). Therapeutic use requires a well-reproduced, stable beam supply over the period of treatment, while the condition of the beam, such as energy, varies from patient to patient.

As described in the previous reports[1], HIMAC is an accelerator complex that has three ion sources, injector LINAC, two synchrotron rings, and three treatment rooms, together with four experiment rooms.

OPERATION

Schedule

Therapy is performed during the daytime of Tuesday through Friday. Physics and biological experiments are performed night and weekend. We devote to work maintenance and machine study on Monday by turns.

Month-long shut down in August and March serve for periodic maintenance and major installation of new device/system.

Staff

Accelerator Engineering Corporation, AEC, has been carrying out operation and maintenance of HIMAC under the auspices of NIRS. There are 29 staffs in its accelerator operation group, 3 of whom are supervisors, that are charged with HIMAC operation, maintenance, and R&D activities. Their average age is 31.5 years old, and about 5.2 years are their average experience in HIMAC. The other 3 staffs of the group work at the neighboring cyclotron operation.[2] For clinical and basic research irradiation at HIMAC, AEC's respective groups are assigned with about the same number of staffs. It is to be noted that the corresponding department of NIRS has less than ten people who are involved in the entire HIMAC operations.

HIMAC accelerator operation is done in two half-day shifts; Day, or "11", shift from 8:30 to 20:30, Night one from 20:00 to 9:00. Six (6) operation teams are formed with typically 3 staffs/team. Each team has, usually, one day-shift and one night-shift (followed by an "off" on the day) during a week in this order. The rest of the week is for maintenance on a regular 8-hour/day working. In Table 2, breakdown of the staffs for various maintenance area is shown.

Beams

Annual operation hours for various ions except C is shown in Fig. 1.

Table 1: Patient Statistics of Carbon Ion Cancer Therapy at HIMAC (***Preliminary***, as of March 2004)

Part	94-5		FY96		FY97		FY98		FY99		FY2000		FY01		FY02		FY03		Total		AT	Remarks
Head&Neck	19		19		31		22	+1	38		29		39		40	+1	35		272	+2	(9)	
Cent. Nerve	14		10		6		9		7		15		10		6		5		82	+0		
Lung	17		27	+1	17		28		33	+1	45		51		55	+1	47		320	+3	(3)	NSCLC
Liver	12		13	+1	19		25	+2	17	+1	22	+1	28		18	+3	22		176	+8		HCC
Prostate	9		18		10		30		30		31		44		47		77		296	+0	(23)	(hormone)
Uterus	9		13		11		10		11		13		5		10		7		89	+0		
Bone & Soft T.			9		13	+1	19	+6	18		25		23	+2	32	+6	43	+2	182	+17	(8)	
Esophagus			1		16		4				2								23	+0		
Rectum													10		13		15	+1	38	+1		(post-op.)
Skull Base					6		4		2		2		4		8		3		29	+0		
Pancreas											3		7		12		18		40	+0		(pre.op)
Eye											0		8		16		18		42	+0		
TearGland															5		3		8	+0		
General	24		16	+1	30		17	+3	32	+4	14	+7	12	+4	14	+11	40	+7	199	+37	(13)	
TOTAL	104	0	126	+3	159	+1	168	+12	188	+6	201	+8	241	+6	276	+22	333	+10	1796	+68	(56)	

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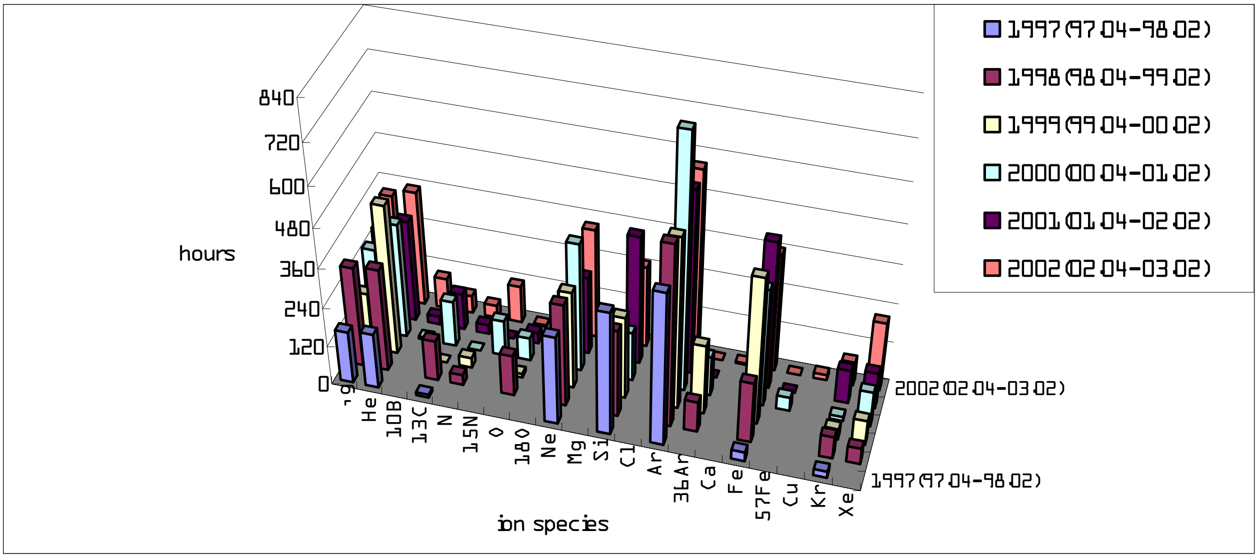

Figure1: Annual operation hours for various ions except C (C is about 4000hours every year)

Table 2: Maintenance work in accelerator operation group

Work area	Number of staff
Ion source	4
RF system	2
Beam monitor	4(1)*
Vacuum	3
Control system	6
R&D of small ring	2
Power supply & Magnet	2(2)*
Electron Cooling	(1)*
Cooling	1
other	5

*concurrent activity

Ar, Fe, and Xe are among frequently accelerated beams other than C.

Trouble Incidences

Annual occurrence of beam-supply failure of 30 minutes or longer grouped by successful recovery action is shown below. in Fig. 2. It is seen that the replacement trouble has become major cause of the delay in beam recovery.

IMPROVEMENTS OF OPERATION

TSA improvement

Time Sharing Acceleration, TSA, has been used since 1997.3. However, several limitation, such as charge state selection and Debuncher tuning, caused operational errors. Introduction of new scheme selector and memory structure solved the problem and the Day-time parameter for therapy carbon bean can be stored in reserved "mode" and recovered with only a cell push on touch panel. See Figs. 3 and 4 for the scheme and the new selector.

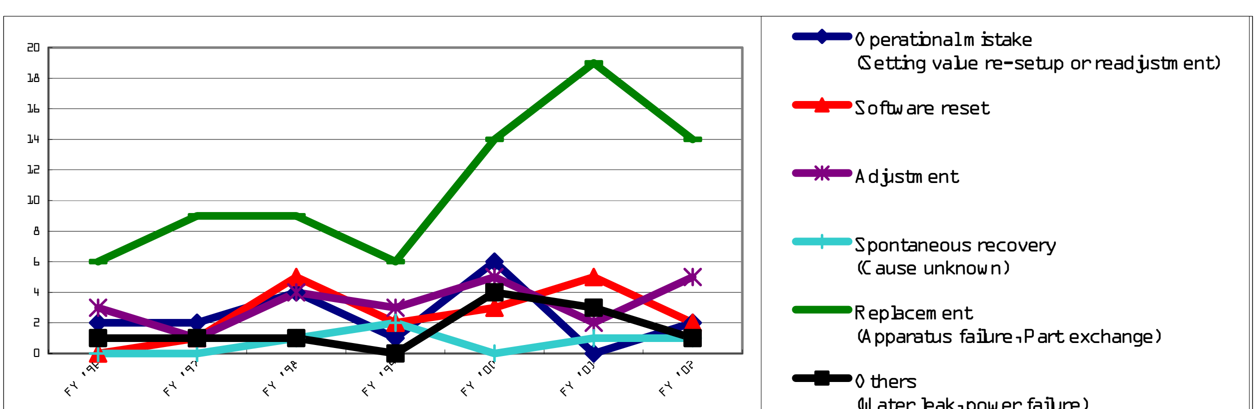

Figure 2: Annual occurrence of beam-supply failure of 30 minutes or longer grouped by successful recovery action

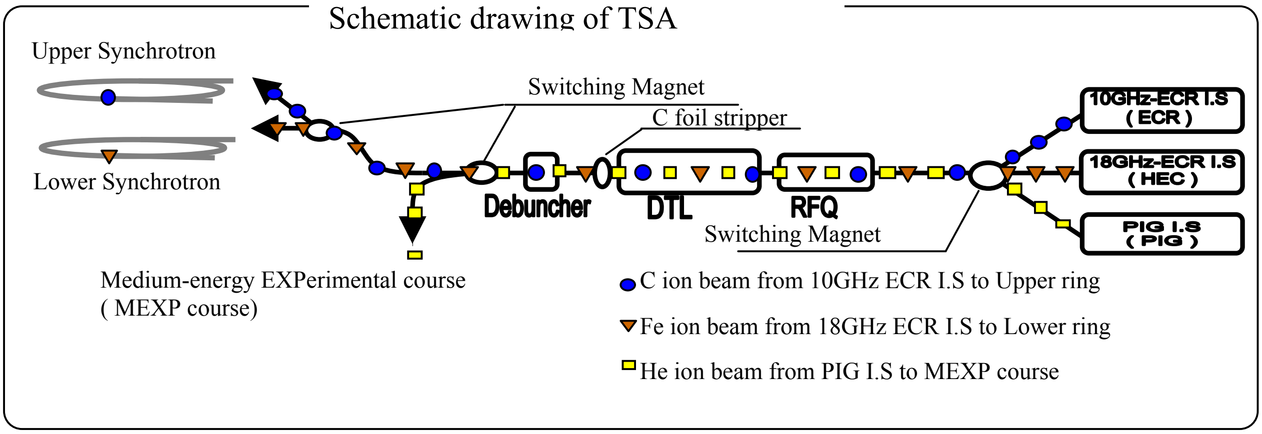

Figure 3: Shematic drawing of TSA

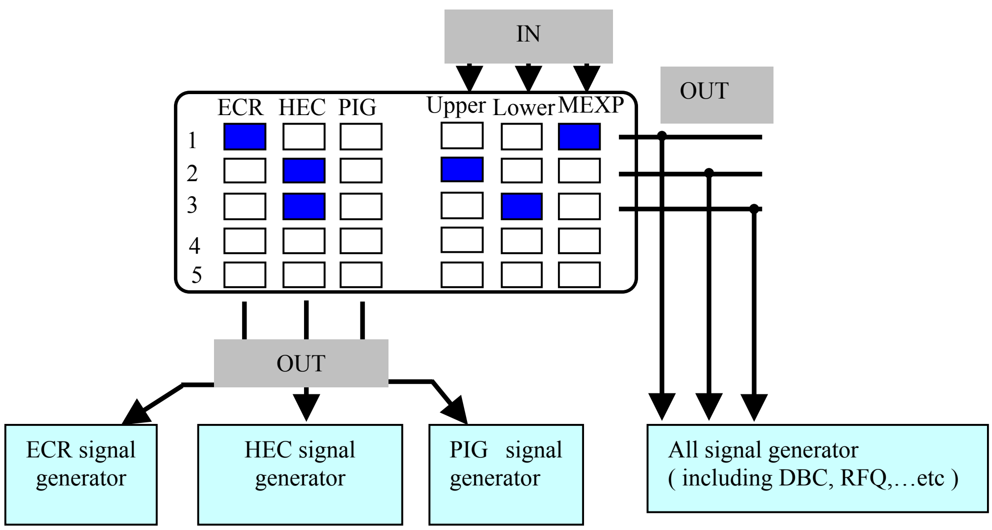

Figure 4: New timing selector

Verification of the Patient Positioning System --Development of "Triple Exposure" Method--

X-ray TV images at right angle eavh other are used for the patient positioning in HIMAC. The following is what "triple exposure" means. An x-ray film attached on the holder is set on the treatment couch. The film is exposed by the x-ray in the beam's eye view, and the cross-wires on the beam nozzle is projected on the film. The multi-leaf collimator is set to rectangle (100*85mm), and the same film is exposed by carbon-beams. The patient collimator with square aperture (60*60mm) is set into the collimator holder, and the film is exposed by carbon-beam, again.

The triple exposure is an easy, quick and yet comprehensive method of cordinate verification. It can promote QA programs for cancer radiotherapy. Results and preliminary analyses were presented in WAO2003.

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