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GENERAL ASPECTS OF THE ISIS UPGRADE

T A Broome, I S K Gardner and G H Rees.
Rutherford Appleton Laboratory,U.K.

ABSTRACT
Current and proposed work on the ISIS accelerator and target station are described.

1. INTRODUCTION

The planned ISIS upgrade programme for the accelerator and target station is described. This programme aims to increase the synchrotron energy from 750 MeV to 800 MeV, and to increase the intensity from 100uA towards 200uA and also to continue the improvement in the reliability of the facility. In addition some longer term possible developments are mentioned.

As the upgrade programme for the accelerator and the target station are detailed in two other papers [1,2] for this conference only brief outlines of the work will be given here.

2. PRESENT STATUS

A comparison of the yearly operation from 1987 is shown in Table 1 with data for 1990 up to the end of September. The main effort in the last two years has been directed at improving the accelerator reliability and reducing the frequency of beam trips which are thought to shorten the lifetime of the Uranium target. The uAhrs between trips has risen by a factor of nine since 1987. The target performance is summarised in Table 2.

The fith Uranium target was installed in July this year. The investigation into the failure of Uranium target number 2 was reported at the last ICANS meeting. Since then two more Uranium targets have failed. The failure of target 3 followed a very similar pattern to targets 1 and 2 with a progressive blockage in the cooling channels at the front of the target to the point that the temperature of the Uranium plates became unacceptable and the target was changed. The behaviour of target 4 was somewhat different from the other targets in that during its operational life there were significant and abrupt, changes in the flow and pressure drop characteristics of the front cooling channels with no effect on the target plate temperatures. These changes are not understood. Finally, as with the other targets, the monitoring indicated a partial blockage and a small quantity of Uranium fission products was detected in the cooling water, indicating a cladding failure, so the target was changed.

	1987	1988	1989	1990 (So far)
Total Scheduled User Time(Days)	176	182	178	119
Total Lost Time(Days)	48	50	47	24
Total Time on Target(Days)	128	132	131	95
Percentage of time on Target	73%	72%	73%	80%
Total Integrated Current(mAhrs)	120	230	288	218
Average Current during scheduled time(uA)	28	53	67	77
Average Current with beam on(uA)	39	72	91	96
Peak Current averaged over 24 hrs(uA)	70	97	107	102
uAhrs per trip	6	18	31	53
Number of cycles for science	7	6	7	4

Table 1

Target	Gross Thermal Cycles	Integrated Current mAhr
U#1	Not measured	92.4
U#2	> 38624	53.1
U#3	10389	174.9
U#4	4147	138.8
Ta#1	18124	327.5
U#5	1657	104.1

Table 2

Some difficulties with the production of Uranium targets, which have now been resolved, resulted in extended running using the backup Tantalum target.

3 REQUIRED PERFORMANCE

It is now anticipated that the trapping efficiency in the synchrotron, at high intensity, will be about 60% and not 50% as originally envisaged. Allowing for 2% beam absorption in the thick Muon target the required and achieved performance figures for the accelerator are listed in Table 3.

	Required	Achieved
Beam on Target	2.50 E 13 ppp	1.60 E 13 ppp
Accelerated Beam	2.55 E 13 "	1.60 E 13 "
Trapped Beam	2.58 E 13 "	1.60 E 13 "
Accepted Beam (70 MeV)	4.30 E 13 "	3.30 E 13 "
Injector Beam (70 MeV)	4.39 E 13 "	4.00 E 13 "
Pre-injector Beam (650 KeV)	7.98 E 13 "	8.75 E 13 "

Table 3

With the present limit of 350 us pulse length on the linac RF system these figures indicate a current from the linac of 20 mA and a pre-injector current of 36.5 mA. Pre-injector H- currents of 50 mA have now been reached and 40 mA currents have been maintained for days with resulting 70 MeV beams of about 18 mA.

4 THE KFK/RAL IMPROVEMENT PROGRAMME

This improvement programme is outlined in Fig 1. It started this year following the completion of a KFK/RAL supplementary agreement. It is expected that all the hardware will be completed and installed by April 1993. Equipment installation will take place during each of the long shut-downs which last from January to at least April each year. The equipment required to raise the synchrotron energy to 800 MeV will be installed in the shut-down of 1991. The additional synchrotron magnets (octupoles and sextupoles) required for higher intensity operation will be installed in 1992. The Target Station modifications for 200 uA beams will be completed by 1992.

5 OTHER DEVELOPMENT AREAS

Installation of a collimator after the Muon target in the 800 MeV beam transport line has greatly reduced the radiation problems in this beam line but the levels on the beam line components at the end near the main target still make maintenance in this area difficult. A development plan to address this problem is now being investigated.

KFK/RAL ISIS UPGRADE PROGRAMME

Year ->	1990	1991	1992	1993
Planned Beam Energy				
750 MeV	XXXXXXXXXXX			
800 MeV Trials	X			
800 MeV		XXXXXXXXX	XXXXXXXXXXX	XXXXXXXXXXX
Planned Linac Beam Intensity				
10 - 15 mA	XXXXXXXXXXX	XXXXXXXXXXX	XXX	
15 - 20 mA			XXXXXXXXX	XXXXXXXXXXX
Planned Synchrotron Beam Intensity				
100 - 130 uA	XXXXXXXXXXX	XXXXXXXXXXX	XXX	
130 - 200 uA			XXXXXXXXX	XXXXXXXXXXX
Ion Source and Pre-injector complete	XXXXXXXXXXX	XXXXXXXXXXX	XXX	
70 MeV transfer line power supplies complete	XXXXXXXXXXX	XXXXXXXXXXX	XXX	
Linac debuncher complete	XXXXXXXXXXX	XXXXXXXXXXX		
Octupoles, sextupoles & dipoles installed	XXXXXXXXXXX	XXXXXXXXXXX	XXX	
Synchrotron RF high power amplifier complete	XXXXXXXXXXX	XXX		
Extraction kickers upgrade complete	XXXXXXXXXXX	XXX		
800 MeV beam line power supplies complete	XXXXXXXXXXX	XXXXXXXXXXX	XXXXXXXXXXX	
Target station complete for 200 uA	XXXXXXXXXXX	XXXXXXXXXXX	XXX	
Beam diagnostics design & installation	XXXXXXXXXXX	XXXXXXXXXXX	XXXXXXXXXXX	XXX
Installed Equipment Reliability Improvement	XXXXXXXXXXX	XXXXXXXXXXX	XXXXXXXXXXX	XXX

Fig 1

6 TARGET STATION DEVELOPMENT

There are several possibilities for Uranium target development which will improve the lifetime of the Uranium targets. The main thrust of this development work is to provide targets with better resistance to thermal cycling damage. This can be achieved a number of ways: by altering the details of the heat treatment of the target plates in manufacture, by changing the design of the cladding and support frame for the plates and by the use of a Uranium Molybdenum alloy as the basic target material. Details of this work are being given in another paper at this conference [2].

A new backup target is being designed and will be built using Tungsten. This will give a significantly greater neutron yield than the existing Tantalum backup target.

A major upgrade of the cryogenic plant for the methane moderator will be installed early in 1991. This will allow online replacement of the liquid methane. Radiation damage to the methane during operation produces higher hydrocarbons and hydrogen with the result that the neutron fluxes from the moderator are reduced by as much as 30% during the four week run at a mean current of 100 uA. Also many of the hydrocarbons formed are solid at the operating teperature, 100 K, with the consequent risk of blockage. It is clear that without this upgrade it will not be practical to operate at beam currents as high as 200 uA.

7 LONGER TERM DEVELOPMENTS

Some consideration is now being given to the design of a second Target Station for ISIS. Initial thoughts suggest a pulse repetition rate of about 12.5 Hz.

A facility for the production of radioactive beams in the mass range 9 to 240 with energies up to 40.6 MeV/nucleon at A=238, 123.4 MeV/nucleon at A=79 and 183.5MeV/nucleon at A=9 is also under consideration. A fraction of the ISIS 800 MeV proton beam would be used to produce these exotic nuclei by the bombardment of suitable targets. The new nuclei would be selected by an isotope seperator and then accelerated.

The future development programme will also cover the compatability of both the above facilities with the possible upgrade of ISIS to 1.6 mA beam current by changing to an 800 MeV storage ring mode of operation.

References

1 I.S.K. Gardner and G.H. Rees, Accelerator Aspects of the ISIS Upgrade, this conference.

2 T.A. Broome and M. Holding, The Status of the ISIS Targets.

Q(N.Watanabe): Do you need additional shield on the target station?

A(I.Gardner): Additional shielding will be required. It will be achieved by replacing some of the concrete on top of the target station by iron.

Q(R.Pynn): What is the projected cost of the ISIS upgrade to 200μA.

A(I.Gardner): The projected cost of the ISIS upgrade to 200μA is £3.4M plus 100 man years of effort.