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RF SYSTEM CHANGES ASSOCIATED WITH THE SRS UPGRADE

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Abstract

One of the two insertion devices proposed to be installed during the planned SRS upgrade [1] will occupy one of the straights at present occupied by an RF cavity. To ensure a sensible, reliable and easily maintained system all four cavities will move to new locations. Consequently the high power klystron and associated feeder system will need to be reconfigured. Advantage of the upgrade is taken to replace the klystron high voltage power supply with a crowbarless power converter and to provide an updated control system.

1 INTRODUCTION

The UK's synchrotron radiation source (SRS) sited at Daresbury has now been operational for 15 years. As the world's first dedicated x-ray synchrotron source most beamlines used the radiation from the dipole magnets, although a 5 T superconducting wavelength shifter has been operational since 1982, and a 6 T superconducting wavelength shifter has been operated in the storage ring since 1993. A permanent magnet undulator became operational in 1984.

The SRS is planned to be upgraded by installing two 2 T multipole wigglers. The SRS was not designed to accommodate insertion devices, and consequently most of the machine straight sections are filled with essential accelerator components, such as injection magnets and RF cavities. The optimum straights for the multipole wigglers have been identified, and at present one is occupied by an RF cavity.

This paper describes changes to the RF system and each machine straight that give a solution which is sensible, reliable, cost effective, with an easily maintained RF system. To enhance the machine operating efficiency it is proposed to replace the obsolete and inefficient high voltage power supply for the RF klystron by the Daresbury designed crowbarless power converter [2] and a modern control system.

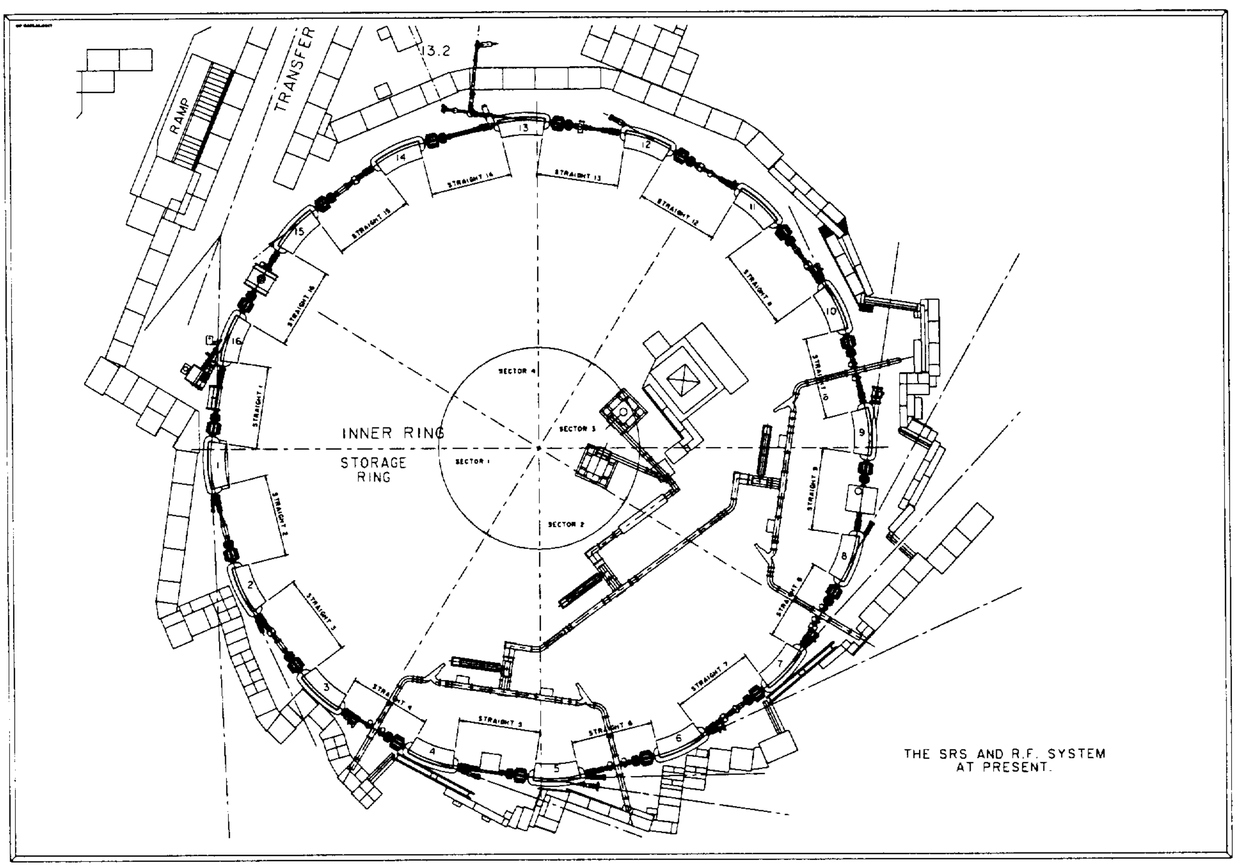

Figure 1. Present RF System and Machine Layout.

2 THE SRS RF SYSTEM

The SRS RF system was designed 20 years ago, and had to provide an accelerating voltage of 2.1 MV, with sufficient power to make up synchrotron radiation losses of 275 keV per turn with a 400 mA electron beam. The High Brightness Lattice (HBL) upgrade in 1986 reduced the required accelerating voltage to 1.2 MV, because of the reduction in the momentum compaction factor.

The present RF system consists of one 250 kW klystron feeding four accelerating cavities via a waveguide feeder system. The klystron is matched by a ferrite waveguide isolator, and the waveguide is split using magic tees to isolate the cavities from each other at the fundamental frequency of 500 MHz. Further isolation and limited higher order mode (HOM) damping is provided by waveguide filters. Figure 1 shows the present layout.

Table 1 presents the changes in the RF parameters due to the proposed upgrade.

Table 1. RF Parameter Upgrade Changes

		Present	Upgrade
Beam Current	mA	250	250
RF Frequency	MHz	499.710	499.710
Loss/Turn	keV	302	322
Overvoltage,		4.0	4.0
Total Cavity Power	kW	50.6	57.6
Beam Power	kW	75.5	80.5
Source Power	kW	138.6	152

As can be seen the two multipole wigglers together cause an extra 20 keV loss per turn, about 2.5 kW each in power for a 250 mA beam. Keeping the overvoltage, constant requires the accelerating voltage to increase to 1.29 MV, which also requires an extra 5 kW from the RF system. This means an increase in power from the RF system, including losses from all sources, of 11.4 kW. As the RF system is designed to deliver up to 220 kW, no extra components are required.

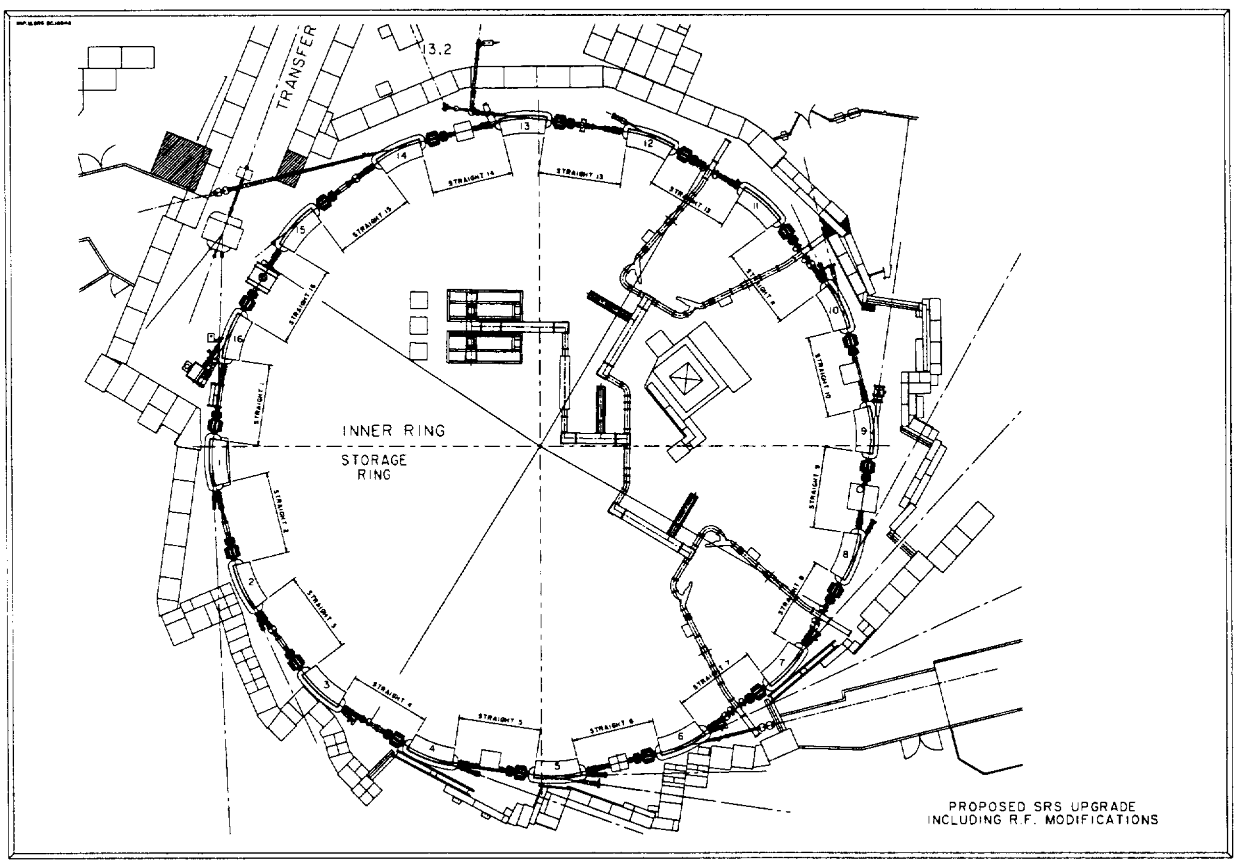

Figure 2. Upgrade RF System and Machine layout

3 MACHINE STRAIGHTS

The SRS has 16 straight sections. In each straight there is a D-quadrupole magnet, a vertical steering magnet, a combined F-sextupole/multipole magnet, and an F-quadrupole magnet. There are other accelerator components in particular straights as detailed in table 2. The injection magnets and the present insertion devices cannot be moved, and four straights are required for the cavities.

Table 2. Present Straight Allocation

Str.	Device	Str.	Device
1	**Septum**	9	**S/c Wiggler 1**
2	**Kicker 1**	10	Cavity
3	**Kicker 2**	11	Diagnostic Strip
4	Cavity 1	12	Octupole
5	**Undulator**	13	Collimator
6	Cavity 2	14	Tune Measuring
7	Current Monitor	15	**Kicker 3**
8	Cavity 3/Octupole	16	**S/c Wiggler 2**

Items in **bold** cannot be moved

The SRS is already a well utilised machine, and the area for the extra beamlines and stations is limited. One multipole wiggler can be installed in straight 14, using a free area in the experimental hall. The second multipole wiggler can be installed in straight 6, with part of the present beamline 6 demolished to provide room for the new beamline.

Table3. Upgrade Straight Allocation.

Str	Device	Str	Device
1	**Septum**	9	**S/c Wiggler 1**
2	**Kicker 1**	10	Free
3	**Kicker 2**	11	Cavity 3
4	TCM/Diag Strip	12	Cavity 4
5	**Undulator**	13	Collimator/Tune Meas.
6	Multipole wiggler	14	Multipole wiggler
7	Cavity 1	15	**Kicker 3**
8	Cavity 2	16	**S/c Wiggler 2**

Items in **bold** cannot be moved

The changes to the straights are detailed in table 3. From table 3, it is obvious that cavity 2 has to move. To keep the RF system symmetrical, providing good isolation for the cavities and ensuring safe and reliable operation, the RF system can be re-configured as in figure 2.

This upgrade involves many other consequences [1] including the following RF related ones that are included in figure 2:

- the new waveguide layout and the s/c wiggler cold box clash
- the straight services have to be modified, and
- the cavity control racks have to be moved.

Figure 2 includes these changes.

4 KLYSTRON HIGH VOLTAGE POWER SUPPLY

The klystron high voltage power supply was designed in the early 1970's, and not with computer control in mind.

The power supply is a nominal 50 kV 12 A supply, it has a conventional six phase rectifier with a roller regulator - so it is slow to respond. It requires a 16 μF smoothing capacitor, and as a consequence has a stored energy of 20 kJ. To protect the klystron under certain fault conditions the power has to be removed in a few μs, so a crowbar system is used. The mains disturbance due to the crowbar operating, causes other parameters to give erroneous fault indication. The high voltage power supply control system is a manual system that has been converted to operate with a computer control system.

Advantage of the upgrade shutdown and the necessity to re-configure the RF system is being taken to replace this obsolete and inefficient power supply with a computer controlled crowbarless power converter. It will consist of a number of resonant power supply modules operating at 25 - 40 kHz, combined in such a way to require no smoothing capacitor. There will be only 20 J of stored energy in the HT cables. The power can be removed in less than 5 μs.

5 SUMMARY

The SRS upgrade will enhance the performance of the SRS, providing increased photon flux, especially in the x-ray region. This will extend the life of the SRS, and the consequent changes to the RF system will make the system more reliable, easier to maintain and therefore have an higher operational efficiency.

REFERENCES

[1] 'Upgrading the Daresbury SRS with Additional Insertion Devices and its Implications for the Storage Ring Layout', J.A.CLARKE and M.W.POOLE, these Proceedings.

[2] 'A Crowbarless High Voltage Power Converter for RF Klystrons', D.E.Poole et al, these Proceedings