An RF System for the Proposed DIAMOND 3 GeV Light Source.

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Abstract

A preliminary design study has been carried out on a possible replacement for the Daresbury SRS, at present under consideration in the UK. The provisional design specification is for 300 mA at 3 GeV with good lifetime in a ring that contains many powerful multipole wigglers and superconducting bends. Various options for the necessary RF system have been evaluated and the conclusions on choice of frequency, cavity type and power source will be discussed.

1. INTRODUCTION

A review of the future requirements for synchrotron radiation in the UK. concluded that at some time in the future the SRS should be replaced by a medium energy X-ray source. Known as DIAMOND at Daresbury, the source would be third generation designed to produce a spectrum of radiation to complement that available at the ESRF.

2. GENERAL DESCRIPTION

The 3 GeV, 300 mA , low emittance (10 - 50 nm-rad) storage ring provides high brightens soft X-ray beams from 150 eV to 3 keV and high flux X-rays in the 3 - 30 keV photon range. It is a 16 cell design with twelve of the 3 m long straight being available for insertion devices. Two more are to be used for injection, with two being reserved for RF. structures. A possible lattice is the triple bend achromat (TBA) [1], with the three dipole magnets in each cell having equal bending radius. This allows the progressive replacement of the central 1.3 T dipoles by 4.5 T superconducting dipoles to provide the harder X-rays without using the straight sections. Table 1, below summarises the basic parameters neede for the R.F. design.

Energy	3 GeV
Current	300 mA
Storage ring circumference	~ 300 m
No of cells	16
No. of multipole wigglers	0 - 10
No. of superconducting dipoles	0 - 16
Energy loss/turn	1 -2 MeV
Momentum compaction	0.0015 -
RF frequency	500 MHz

Table 1. Basic Parameters for R.F. design

The RF system is to be modular, the number of modules increasing as the number of insertion devices and number of superconducting dipoles are increased.

3. R.F. DESIGN

For this paper only the design of the storage ring is considered, and full energy injection is assumed. Initial investigations indicate that based on a current of 300mA DIAMOND is not limited by beam instabilities but by the loading on the RF system due to the high power of the emitted synchrotron radiation. The additional load imposed by the multipole wigglers and superconducting dipoles is substantial , and consequently RF cavities and power sources will be provided in a small number of high power units.

A unit source power of between 350 and 400 kW was chosen as both 500MHz klystrons and inductive output tubes are available in this range. Each power source would feed either one 3 cell cavity or two single cell cavities.

Power Source.

Klystrons at power levels of 350 kW are available from at least three European and two overseas manufacturers. Efficiencies of between 60% - 70% are presently achievable with these tubes.

Inductive output tubes (IOT's) are now being developed by a number of manufacturers, and it is expected that 350 -400kW tubes with high efficiency will be available when DIAMOND is built.

It is likely that Daresbury will require a "turnkey" power source system.

Cavities

There has been no detailed design work on any cavity design, however two options have been considered.

A three cell cavity, as shown in figure 1, with a shunt impedance of 20 MΩ (linac-ohms) is achievable, but would require two input windows to take the full power from one source.

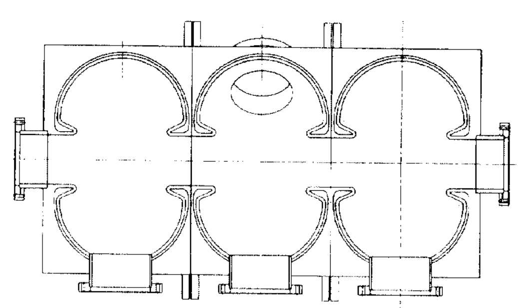

Figure 1 3 Cell RF Cavity

Careful examination of all possible higher order modes is now required to see if this design is desirable.

Two single cell cavities were also considered for the basic RF power unit. A shunt impedance of 8 MΩ for a single cell should be achievable, and the higher order mode spectra is potentially less of a problem.

Input coupling to the three cell cavity would more than likely use two loop couplers, as at the ESRF [2]. Again, coupling to the single cell cavity will probably be by a loop coupler, but investigations into feeding up to 200 kW via an aperture window will be considered.

Table 2 below summarises the options. For budgetary purposes the RF power unit was one 350 kW klystron feeding one three cell cavity and the option shaded was the configuration used.

4. CONCLUSIONS

The R.F. system for DIAMOND will be constructed from a small number of high power units. More units can be added as the storage ring is upgraded.

Number of multipole wigglers	Number of superconducting dipoles	Total radiation loss per turn	Number of klystrons	Number of cavities	Total RF power at cavities (kW)	RF power available for beam (kW)	Maximum beam current (mA)
0	0	1.0	1	2	330	220	220
0	0	1.0	2	2	660	440	440
10	0	1.3	2	2	660	440	340
4	4	1.3	2	2	660	440	340
10	4	1.5	2	2	660	440	300
4	8	1.5	2	2	660	440	300
8	8	1.6	2	2	660	440	275
10	16	2.0	3	3	990	660	330

Table 2 Maximum beam current for different number of multipole wigglers, superconducting dipoles, klystrons and cavities.

REFERENCES

[1] Prelininary Lattice Studies for the Proposed X-ray Source Diamond. J.A.Clarke et al These proceedings.

[2] ESRF Foundation Phase Report Feb. 1987.