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RF Workshop Conclusions

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Conclusions and outcomes of the HOM workshop held in ESS on 22nd & 23rd September, 2011.

1 Conclusions

Multipactor (MP) in HOM couplers The geometry of any reasonable HOM coupler design may be sufficiently refined to achieve an acceptable MP performance, thus the decision on the optimal HOM coupler should be based on other specifications.

HOM-based diagnostics If it is decided to install HOM couplers, then they should be instrumented in such a way as to allow for their use as beam & cavity diagnostic devices.

Chopping scheme Any reasonable chopping scheme for ESS is unlikely to be fast enough to have any appreciable influence on the charge spectrum observed by the HOMs, and so considerations of this can be put to one side for the moment.

Bunch length The very short bunch length planned in the SC section (∼20 ps) implies that the bunch spectrum will extend to very high frequencies. Lengthening of the bunch within reasonable limits (set by the acceptance of the linac and HEBT) can be expected to have very little impact on the excitation of HOMs, and so no requests will be made for alterations to the longitudinal phase space.

Installation of couplers There was a broad, but not unanimous, consensus that HOM couplers should be installed. This was formed by a bias towards limiting the risk to the beam of the HOM power, as well as limited the load on the cryogenics, the desire to maintain upgradeability, and by the conclusion that MP risks could be minimised by optimising the design of the coupler. The disagreement with this conclusion was related to a desire to minimise the complexity of the machine.

Cryoload It was stated that the increased cryogenic power required due to the HOM power may be a greater consideration than the HOM's influence on the beam dynamics.

Number of couplers If it is decided to install HOM couplers, then two are necessary to ensure that no modes are "missed" by these dampers. This also allows their use as diagnostic devices.

Specification of damping requirements After suitable studies have been performed, it should be possible to specify the damping requirements of the HOMs. This should not take the form of a maximum quality factor for all modes, but should be specified for each mode seperately. The product of R/Q and Q_{ex} is more useful than simply stating the quality factor, and there should be difference specifications depending on how close particular modes are to machine lines.

Maximum Q_{ex} The maximum $Q_{ex} < 10^8$ is defined by the repetition rate of the macro pulses.

Halo Halo studies were not considered to be useful since there would be a substantial amount of difficulty in defining the input beam parameters (i.e. the density and shape of the halo), and in trying to draw definitive conclusions from any set of expected results.

2 Simulation studies required

Beam dynamics "Marcel Schuh style" studies need to be performed using full details of the ESS lattice, and the expected R/Q spectrum from each cavity–type. These studies, expected to take approximately 6 months, need to be completed before any decision can be made on the installation of HOM couplers.

Damping of HOMs by the FPC The fundamental power coupler (FPC) can be expected to provide some damping of the excited HOMs, and so should be taken into account when determining the expected quality factor of each mode. Care must be taken with the interpretation of these results, as assumptions about the broadband response of the FPC boundary condition may cause the damping behaviour of this to be over-estimated.

Comparison of coupler designs Each proposed coupler design needs to be compared on the basis of its EM and mechanical parameters. e.g. scattering matrix, sensitivity to errors, etc. It should also be investigated whether it is possible to reduce some of the demands on the coupler by moving it further from the cavity (and thus reducing the amount of fundamental mode power it will observe).

Field emission It was concluded that these studies are not a major priority at the moment, but that they may give insights into the sorting of cavities prior to installation. That is, they may allow the effect of cavities with large field emission to be installed in locations where the negative effects of this are minimised.

Inter-cavity transition region This is a region of considerable complexity, and requires several studies to determine how best to design it. As well as the inter-cavity distance, it is also necessary to investigate the effects of the existence of a taper, & bellows, in order to quantify their effect on the beam and the dissipation of the HOM power. The optimal location of the HOM coupler should also be studied.

3 Test-stand measurements

It should be emphasised that the primary purpose of the planned test-stands is for validation and development of high power RF, and not for HOM coupler R&D. Nevertheless, some studies were identified that could take place at such test-stands.

Electron beam to test HOM-BPMs This should not be a priority, however a low-energy electron beam facility could be constructed with a view to testing HOM-BPM schemes.

MP studies & coupler processing HOM couplers could be instrumented in such a way that allows MP to be observed during high power testing. This would allow benchmarking of the simulation codes, as well as measurements of the processing times of the prototype couplers.