

Mechanical Analysis for Engineering designs in Diamond Light Source Project

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The Diamond Light Source (DLS) is a medium energy synchrotron light source. DLS consists of a 100MeV Linac, 3.0GeV booster, and 3.0GeV storage ring with a target current of 300mA. The Phase One project also includes seven beamlines and experimental stations to be completed by 2007.

Many devices in the storage ring and beamlines directly managing the beam, are subject to the intense heat from the light source and the high pressure of cooling water. Furthermore, structures to guide the electron beam and synchrotron light, have to be positioned to very high accuracy despite all kinds of static and dynamic vibration load. To obtain the optimum design for critical components, Finite Element Analysis (FEA) is an essential tool for the project.

The electron beam in the Storage Ring is energised with 600kW of RF power which is then converted to X-rays by the Diamond machine. Although 600kW of X-rays are produced, only a tiny fraction (50-500W) is selected for use in each experimental station. Most of the unwanted heat has to be absorbed to avoid damage. Thermal stress analysis has been carried out for all absorbers and vessels in the storage ring and also for the monochromators, mirrors and beam windows in the beamline designs. For absorbers, both Oxygen-Free High Conductivity (OFHC) Copper and Glidcop are considered with elasto-plastic behaviour. In some cases, exact beam profiles have to be input in to the FE model with ANSYS Macro files developed at DLS. A new design criterion for such absorbers is suggested through the analysis.

In this work, the authors will present principles for thermal analysis in the design and construction process of the Diamond project. Some typical examples are depicted in the paper. In addition, vibration analysis including tests for girders and beamline devices are also conducted at DLS. Some vibration results are outlined in the paper.

The results of FE and Vibration analysis in DLS help engineers to predict the performance of individual parts and assemblies of the Diamond machine before manufacturing commences and thus ensure successful operation.