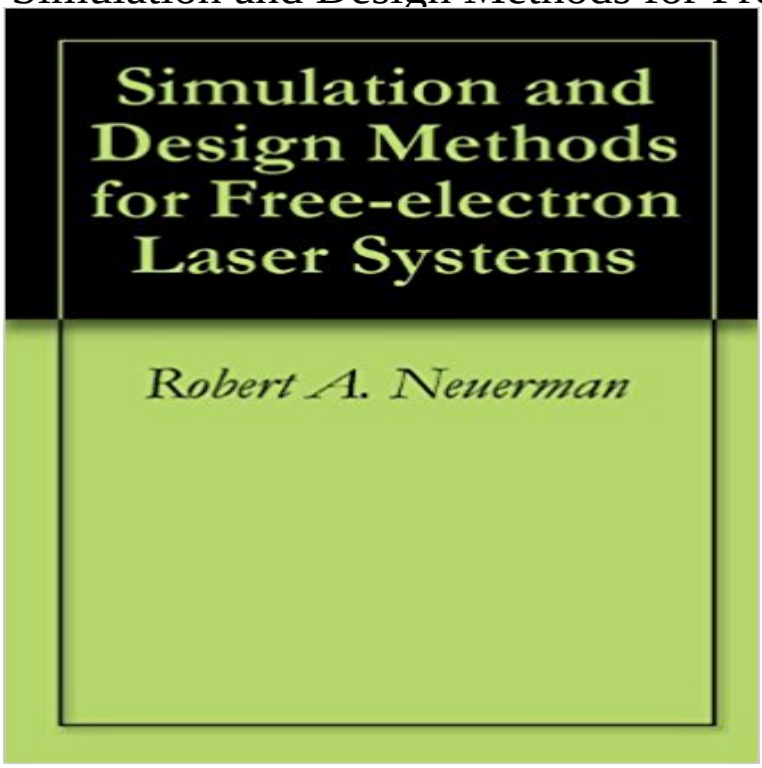
Simulation and Design Methods for Free-electron Laser Systems



Modeling and simulation have proven invaluable to the design of various systems and planning of many experiments since the free-electron laser was invented in the 1970s. This thesis illustrates methods used for these tasks and for the validation and development of further theory. FEL systems and their components are described, briefly discussing how they fit into design considerations. Basic theory of FEL operation is reviewed, including the resonance condition, FEL wave and pendulum equations, and the concepts of undulator taper, extraction and beam quality. Two computer programs used for FEL simulation (FEL3D/FEL4D, developed at the Naval Postgraduate School, and Ginger, developed at Lawrence Berkeley National Laboratory) are discussed and compared, then applied to specific FEL cases. The cases studied serve to evaluate key performance characteristics of FELs. The final case study directly compares output from the two programs. In addition to this type of physics simulation, computer tools are also vital for component design. Relevant methods are illustrated using the example of an electrostatic cathode test cell and drawings made using the Los Alamos National Laboratories design tool, Poisson Superfish. After reviewing the principles involved and system constraints, a new test cell is designed for use with future NPS experiments. The effects of anode-cathode spacing and anode aperture size are examined for two different anode configurations and recommendations are made for future design iterations.

Figure 18 from Simulation and design methods for free-electron Figure 15. Ceramic Insulator with Conflat Flanges - Simulation and design methods for free-electron laser systems **Simulation and design methods for free-electron laser systems** Modeling and simulation have proven invaluable to the design of various systems and planning of many experiments since the free-electron laser was invented **Simulation and Design Methods for Free-electron Laser Systems** Figure 21. Baseline Design - Simulation and design methods for free-electron laser systems **Table 3 from**

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