Title: S-Band electron LINAC for ThomX

Abstract in English

ThomX is a back scattering source that aims to provide an average photon flux of about 10^{12}-10^{13} ph/s in the hard X-ray range (40-90) keV. The framework of my thesis focuses on the design study of the S-band ThomX linacs, namely the RF gun and the travelling wave accelerating structures.

First, the thesis highlights the physics of Inverse Compton Scattering with a description of the kinematics of the photon and electron collisions. In addition, it gives a general explanation of the Compton photon flux and the brightness. The main possible applications of the ThomX machine are briefly discussed.

Moreover, the thesis describes in detail the high power radio-frequency (RF) source used for the ThomX machine, namely the ScandiNova modulator K2-2 and the Toshiba Klystron E 37310 including the acceptance test results. As well as, it includes the development of the network components, such as the power divider, power circulator, phase shifters and attenuators performing the RF low power tests of these components.

Additionally, the dissertation also provides the electromagnetic characteristics of the ThomX linac, namely the LEP injector linac (LIL) quasi-gradient structure and the RF gun, and solenoid configuration using CST Studio Suite®. Moreover, it introduces the cooling system characteristics of the ThomX linac, the thermal analysis and the vacuum system tests.

The commissioning of the ThomX linac is performed including the RF conditioning and the first beam commissioning. During the beam commissioning, the charge measurement using an integrated current transformer (ICT), and the energy measurements using steerer magnets are described. Furthermore, analytical approximation models for the energy and the energy spread, in standing and travelling wave structures, are proposed and fitted with measurements. In addition, an experimental work carried out at the PHIL photoinjector is introduced for the beam energy and energy spread measurements, using a dipole magnet for a purpose of acquiring practical skills before the ThomX commissioning.

The dissertation also demonstrates the electromagnetic simulation and analysis of the dual feed constant gradient (CG) structure, which will be installed as a replacement of the LIL structure. The fabrication process of this structure such as machining, brazing, alignment and backing out, which are performed in collaboration with research instruments (RI) company in Germany, are explained in detail. Finally, the tuning and the low power test are performed using the bead-pull technique, and the results are compared with simulation data and with the technical specifications.