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PHD thesis 2018
Master 2 intership
Accelerator department of LAL
Orsay, France

Beam Dynamics in the ThomX electron storage ring

CONTEXT :

The thesis is part of the ThomX project, which aims at developing an intense and compact X- ray source for use in a medical environment or art history. ThomX is an equipement of excellence funded by the French National Research Agency, CNRS, IN2P3 and Université Paris Sud. This project brings together institutional partners and French industrialists; it brings centers of excellence in the field of accelerators, power lasers and X-ray detection. The candidate will be part of the Accelerator department and of the THOMX team of scientists, engineers and technicians. The building phase of the project is ending and the accelerator will start during 2018.

Description of the thesis subject:

The thesis will be experimental and theoretical, with an unique experience during an accelerator commisioning. Main research program is:

- Impedance measurement with the RF test bench
- Transverse impedance budget evaluation with electromagnetic simulations
- Simulation of the impact of collectives effects on the electron beam dynamics
- Participation to the ThomX commissioning phase
- Experimental measurement of the impedance effects on the electron beam

Nowadays, there are more demanding performances concerning the charge density in accelerators. Modelisations, which describe only single particle dynamics are not sufficient. Mutual interactions of the particles and with their environment such as vacuum chamber, ions of residual vacuum should be taken into account in order to preserve the electron beam stability. These effects called collective effects take an important part on accelerator studies for machines as LHC or for smallest accelerator as ThomX. Particularly, interactions of the charged beam circulating inside the vacuum pipe generates a wakefield, which will itself interacts with the electron bunch and modify its characteristic, or create instabilities.

These interactions can be modelised with an impedance, which can be longitudinal or transverse. First approach consists in evaluating through electromagnetic simulations, the impedance of the accelerator devices. Confirmations of these modelisations are required by means of RF measurement, which consists in measuring induced current in the accelerator devices. At the end, the experiment done with the electron beam enables to refine the modelisation and then improves experience/simulation reconciliation. Impedance studies take a major importance in the dynamics of charged particle beams, but can also be an approach to manipulate the phase space of the electron beam or for diagnostics.

The proposed thesis in the context of ThomX will be mainly dedicated on transverse impedance and collective effects of the electron storage ring. Simulations and RF longitudinal impedance measurements have been already done on the main device of the ring. Modelisation and the RF test bench already exist. Nevertheless, transverse impedance measurement needs adaptations. The difficulty lies in low noise measurements with small mechanical elements. In addition, the starting of ThomX commissioning being during the 2018 year, an important part of the work will be done to characterize the instabilities. A comparison between simulations and experimental results will be done to identify additional sources of instabilities and improve modelisation. Transverse impedance should be implemented in the used tracking code for ThomX to evaluate the damage on the electron beam. Other sources of instabilities such as ion cloud, coherent synchrotron radiation or intrabeam scattering will be also treated.

EXPECTED PROFILE

Applicants are expected to hold a Master 2 degree in physics or in a related field.
The candidate should have a strong attraction for experimentation and numerical tools.
Good programming and computational skills would be an added value.
The eligible candidate should be able to communicate at a scientific level in English. Knowledge of French can also be useful.

CONTACT / deadline:

This subject is classified as a priority for the laboratory and is funded subject to a sufficient level of the student. Interested student are encouraged to contact bruni@lal.in2p3fr as soon as possible.
Applications should be sent no latter than march/april. A first evaluation of the application student will be done during January for the first wave of ED PHENIICS Thesis Scholarship Award.