Título puesto: LLRF control loop stability
Curso: 2023-24
División: Aceleradores

Descripción del proyecto:

- Radiofrequency system is used at ALBA to keep the energy of the electrons constant as they emit synchrotron radiation. An electric field parallel to the direction of the particles is generated into a resonant cavity with an external high-power source for that purpose. A control loop is implemented to keep the voltage and the phase inside the cavity constant and synchronized with the electron beam.
- Low Level Radiofrequency is an FPGA based system that continuously measures the voltage inside the cavity and generates the appropriate drive signal to the amplifiers that is finally sent back to the cavity, thus implementing a PID control loop. Amplitude and phase of the voltage is demodulated into IQ components so that two loops are actually implemented in the LLRF.
- Since the voltage inside the cavity is generated not only by the external high-power generator, but also by the beam itself, the IQ components are not independent and they are coupled through the beam. Also, the beam owns some natural frequencies that might interact with the control loop.
- Here the candidate will study the basics of the radiofrequency system, specifically how the voltage is induced in the cavity and will also study the LLRF control loop system. As main contribution, an analytic and exhaustive analysis of the system "Cavity + LLRF control loop" must be studied, in particular, the stability criteria under different working conditions of beam loading, synchronous phase and external perturbations. Also, a comparison between the IQ loop and polar loop (amplitude and phase) must be carried out. Finally, results must be validated in a machine study day.they will analyze the obtained results.

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Perfil del estudiante:

Student profile: Physics student or similar engineering education.

Requirements:

- Knowledge of control theory.
- Experience with programming languages like MATLAB or Python.
- Good level of spoken and written English.

Program:

- Introduction to RF for accelerators.
- Theoretical model of “Cavity + LLRF control loop” system definition and stability analysis for both rectangular (IQ) and polar (amplitude and phase) loop.
- Theoretical results validation using machine day studies.
- Documentation of the project.

Tutor: Pol Solans

Responsable División: Francis Perez

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