IRFU : Institut de recherche sur les lois fondamentales de l'univers

Saclay

Contribution à la conception et à l'implémentation d'un système embarqué pour le système SIRIUS

Spécialité Électronique embarquée

Niveau d'étude Bac+5

Formation Master 2

Unité d'accueil

Candidature avant le 15/09/2018

Durée 6 mois

Poursuite possible en thèse non

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Résumé

Sujet détaillé

L'acquisition de données pour l'expérience SIRIUS est cours de conception avec tous les membres de la collaboration (IRFU, CNRS, GANIL). Une contribution majeure de l'IRFU à l'instrument est la conception et la fourniture du circuit spécifique FPCSA pour Floating Point Charge Sensitive Amplifier. Ce circuit est opérationnel pour la mesure d'une large bande d'énergie avec une très bonne résolution et un temps mort très petit.
Le projet proposé est de contribuer à la chaîne d'acquisition de données qui collecte et formate les données de 16 cartes de conversion Analogique-Digital pour les envoyer sur le réseau local et stocker les données sous le contrôle d'un logiciel de supervision. Les cartes Numexo2 conçues au GANIL offrent les ressources nécessaires (logique programmable, mémoire, processeur embarqué) pour implémenter la fonction requise. Un circuit XILINX Virtex-6 est en charge de la collection des données des ADCs et un Virtex-5 et son processeur intégré PowerPC sont en charge de l'interface au réseau, du contrôle et de la synchronisation des données. Un logiciel et un firmware générique conçus par le GANIL tourne déjà mais des adaptations sont requises pour répondent aux spécifications de SIRIUS.
Le principal objectif du stage est de fournir un système d'acquisition (DAQ) opérationnel en s'appuyant sur le logiciel et le firmware du GANIL. Une fois le DAQ validé avec un générateur d'impulsions, une campagne de mesures sur un détecteur sera menée. L'étudiant sera membre d'une équipe de physiciens, d'électroniciens et de développeurs de logiciels et devra fortement interagir avec l'équipe.

Mots clés

Logiciel embarqué, FPGA, acquisition de données

Compétences

Conception numérique, Simulation VHDL

Logiciels

VHDL, C/C++, Java, Xilinx Development Tools, Linux

Contribution to the design and implementation of an embedded data acquisition system for SIRIUS

Summary

The main objective of the proposed project is to deliver an operational data acquisition system (DAQ) based on the GANIL framework. The student will be integrated in a physicist, hardware and software team and will have to interact with all the members to achieve its project.

Full description

Background:
The CEA/IRFU has a long history of performing fundamental physics research of the infinitely small (particle and nucleus) and in developing related technological instruments. Within IRFU as part of the CEA missions, the Nuclear Physics Division (DPhN) is leading experimental and theoretical fundamental research in nuclear physics. The “nuclear structure group”, inside the DPhN, is focused on the exploration of nuclei at the boundaries of nuclear existence; exotic nuclei, heavy/superheavy nuclei, nuclei with large deformations are studied in all the available heavy ion accelerators. Using the high intensity ion beam from the future Linear driver Accelerator (Linac) SPIRAL2 under construction at GANIL (http://www.ganil-spiral2.eu/) coupled with the S3 spectrometer and its dedicated state of the art detection (SIRIUS) and data acquisition system there will be unique opportunities in 2018 for exciting experimental studies of the heaviest man-made elements.
S3 is composed of a target able to withstand very intense beams, a separator stage to reject the primary beam and a spectrometer stage to identify the reaction products. Ions of potential interest produced by the beam interacting with a specific target are transmitted through S3 and fanned out according to their mass over charge ratio. But these heavy nuclei are unstable and their decay through different reactions produces numerous secondary particles. Their identification relies on multiple measurements, coherent in space and time, provided by a complex multistage detection unit comprising Gaseous ion tracking devices, double-sided silicon strip detectors (DSSD), Germanium X and gamma ray detectors, etc. and the associated data acquisition system. Further down the line, an identification of the initial heavy ion is sought through intensive data processing and decay model inversion algorithms.

Project:
The data acquisition system for the Sirius experiment is currently being designed with contribution from all members of the collaboration (IRFU, CNRS, GANIL). A major contribution of IRFU to the instrument lies on the very front end of the data acquisition chain with the design and implementation of a dedicated floating point charge sensitive amplifier (FPCSA) for wide range energy measurements with good resolution and extremely short dead time. Analog to digital converter (ADC) boards are being designed at CSNSM (http://www.csnsm.in2p3.fr/).

The proposed project is to contribute to another element along the data acquisition chain where the collected digital data from 16 ADC boards needs to be formatted and sent over the local network for remote storage under the supervision of a master data acquisition software system. The Numexo2 boards designed at GANIL provide the necessary resources in terms of programmable logic (FPGA), processor, memory and more to implement the required functionality. A Xilinx Virtex 6 FPGA is in charge of data collection from the ADCs and a Virtex 5 FPGA with embedded PowerPC processor is foreseen for networking, control and synchronization. A generic software and firmware framework provided by GANIL is up and running but still need to be adapted to the SIRIUS specification.

The main objective of the proposed project is to deliver an operational data acquisition system (DAQ) based on the GANIL framework. Once the DAQ validated with a pulse generator, a campaign of measurements on an operational detector will be setup and done. The student will be integrated in a physicist, hardware and software team and will have to interact with all the members to achieve its project.

Keywords

Skills

Numerical design, VHDL simulation

Softwares

VHDL, C/C++, Java, Xilinx Development Tools, Linux