

BACHELOR PROJECT ASSIGNMENT

Student: Petr Mánek

Study programme: Open Informatics

Specialisation: Computer and Information Science

Title of Bachelor Project: Interactive Visualization System for Hybrid Active Pixel Detectors Within the ATLAS Experiment at CERN

Guidelines:

The goal of the thesis is to design and implement a system to improve acquisition, long-term storage and evaluation, and to establish an interactive visualization of data collected by Timepix detectors placed within the ATLAS experiment at CERN.

Timepix detectors were originally developed for X-ray imaging. With their frame-based readout, Timepix detectors produce output similar to camera pictures. In particular, the measurements can be interpreted as square pixel matrix containing tracks which correspond to trajectories of individual subatomic particles passing through the semiconductor layer. These tracking properties were utilized in previous-generation Medipix detectors for the purpose of particle detection by pattern recognition.

In the past, 16 Medipix detectors were installed at various positions within the ATLAS machine and used to collect relevant information about the radiation fields and the machine luminosity. During the last shutdown, these detectors were upgraded to the Timepix technology, enabling energy and time measurements in each pixel. To further improve particle discrimination, a two layer set-up was developed. With a manual data acquisition scheme already in place, it is important to develop a system to automate periodic transfer from detectors to permanent storage. Here the data will be visualized and evaluated.

The main objectives of the thesis are:

- To implement a server application capable of maintaining and managing extensive file system structure for long-term storage of data. It is preferred that such a structure is compatible with the ROOT file format which has proven efficient in similar applications, and is a standard tool in particle physics.
- To define a communication protocol allowing for frame-based data retrieval from the server. The protocol will also be used to facilitate data addition and other input/output operations.
- To create interactive web-based visualization, capable of displaying and evaluating the stored data online. This includes browsing through individual frames in a given time period and changing display parameters and options.

Bibliography/Sources:

- [1] Z. Vykydal et al., The Medipix2-based network for measurement of spectral characteristics and composition of radiation in ATLAS detector, Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, Volume 607, Issue 1, 1 August 2009, Pages 35-37, ISSN 0168-9002, <http://dx.doi.org/10.1016/j.nima.2009.03.104>.
- [2] D. Tureček et al., Remote control of ATLAS-MPX Network and Data Visualization, Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, Volume 633, Supplement 1, May 2011, Pages S45-S47, ISSN 0168-9002, <http://dx.doi.org/10.1016/j.nima.2010.06.117>.
- [3] D. Tureček et al., Pixelman: a multi-platform data acquisition and processing software package for Medipix2, Timepix and Medipix3 detectors, Journal of Instrumentation 6 C01046, doi: 10.1088/1748-0221/6/01/C01046 (2011).
- [4] Erik H.M. Heijne et al., Measuring radiation environment in LHC or anywhere else, on your computer screen with Medipix, Nuclear Instruments and Methods in Physics Research Section A: Accelerators, Spectrometers, Detectors and Associated Equipment, Volume 699, 21 January 2013, Pages 198-204, ISSN 0168-9002, <http://dx.doi.org/10.1016/j.nima.2012.05.023>.

Bachelor Project Supervisor: Ing. Stanislav Pospíšil, DrSc.

Valid until: the end of the summer semester of academic year 2016/2017

L.S.

prof. Dr. Ing. Jan Kybic
Head of Department

prof. Ing. Pavel Ripka, CSc.
Dean

Prague, December 11, 2015