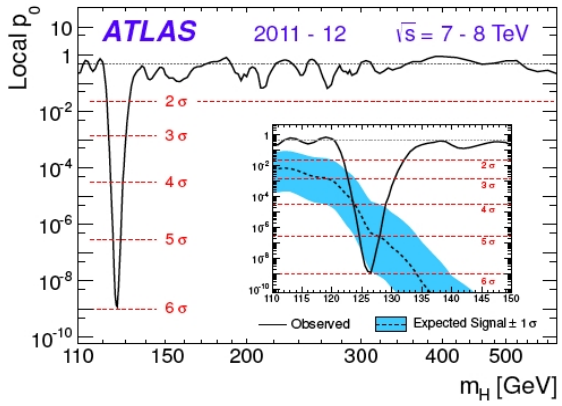
Undergraduate Student Research Positions with the ATLAS Toronto Group in 2020

The University of Toronto ATLAS group has several summer student positions open to USRA recipients and other students for summer 2020. The group comprises seven faculty members (Ilic, Krieger, Orr, Savard, Sinervo, Teuscher and Trischuk), four postdoctoral fellows and over 20 graduate students.

The ATLAS experiment at the Large Hadron Collider (LHC) at CERN, in Geneva Switzerland, is studying the very highest collision energies ever observed in the lab. The most exciting discovery to date has been the observation of a new particle at 125 GeV, with properties so consistent with the Standard Model Higgs boson that we claim it has been discovered! We will be studying the full dataset collected between 2015 and 2018 and analyzing it for it for insights and discoveries, and will be working on building the next generation of instrumentation for ATLAS. Summer students will be working with us in projects involving data analysis and advanced instrumentation development. Perhaps something un-expected will emerge from the data-taking while you're looking!

Project topics and potential supervisors include:

- **Physics Studies for ATLAS:**



  Simulation of physics events in the ATLAS detector and development of data selection and analysis techniques for specific physics channels. The LHC has been colliding protons at 13 TeV since 2015 and the group is involved in analysis of channels including multiple W and Z bosons, top quarks and Higgs bosons. There will be opportunities to look at some of the very newest data. Who knows, perhaps we will make a discovery this summer!

  Contact: Bob Orr, Pierre Savard, Pekka Sinervo, Richard Teuscher

- **ITk sensor, module, readout production and quality assurance R&D:**

The ATLAS experiment is replacing its inner detector with a new Inner Tracker (ITk), with the new device in place by 2026. The collision intensity and radiation background will mean that both the particle sensors and their associated readout electronics must be more radiation-tolerant and run at much higher data transfer speeds. In Toronto we are producing silicon modules that will be installed in the ITk at CERN, in association with Celestica, a company specializing in the fabrication of high-density electronics. All of these modules will be tested in our cleanroom on the UofT campus, undergoing a series of quality assurance tests, graded and the best shipped to be mounted on the tracker support mechanics. We are currently outfitting our cleanroom and preparing all the tools and test stations for this production that will continue for the four years. In addition to module building we will also be testing and characterising miniature silicon sensors that have been irradiated in a reactor. This is to simulate how the real sensors will behave after being exposed to radiation from the LHC beams. We use a probe station, a Strontium-90 source, and a laser system at low temperature to study the sensors. One, or more, students involved with this project will help to modify our sensor testing setup, take data with the miniature sensors, and help to understand the interesting physics of these devices.

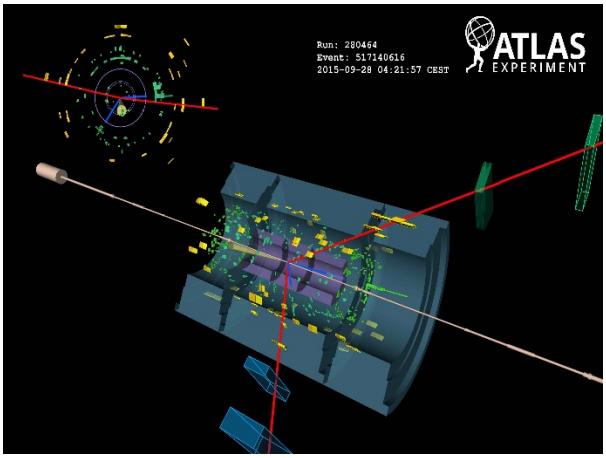
There is plenty of scope for electronics, hardware, software and most of all, thinking, all in the environment of a small self-contained experiment. An additional project will involve the integration of the ITk readout and the FELIX data acquisition system. The picture opposite shows one of our first complete silicon sensor modules, with its associated readout chips.

Contact: Nikolina Ilic, Bob Orr or William Trischuk

At CERN a student with, for example, an IPP summer fellowship or participating in the project through the Woodsworth Science Abroad program, will be able to join our efforts in understanding how the prototype ITk readout electronics responds to neutron and ionizing radiation dosage. This work will use intense radioactive sources. We will be focusing on tests of the ``production" versions of the readout chip, the so-called ABCStar.

Contact: Richard Teuscher or Pekka Sinervo

- **ATLAS Detector Simulation:**



Upgrades to the ATLAS detector for the High-Luminosity LHC era, starting in 2026, also include the design and construction of a new readout system for the existing liquid argon calorimeter. The ATLAS Toronto group is involved in a number of ways, including the development of the signal processing techniques that will be used to extract the energy and timing of calorimeter signals, using digital filtering techniques. This position involves simulation work related to these studies. Some prior knowledge of electronics and signal processing techniques would be advantageous.

Contact: Peter Krieger

The ATLAS Toronto group is also involved in the development of a simulation of the ITk detector, studies of its performance and the use of machine-learning techniques. The ITk will have to function in an environment where the LHC beams will create up to 200 collisions at one time. We will be working to better understand and improve the simulation software the ATLAS collaboration has developed to model and predict the performance of the tracking system. We are also studying the use of machine-learning techniques to understand whether their potential for unravelling complex event topologies.

Contact: Pekka Sinervo

We will consider applications from students not holding a USRA award, but USRA recipients are given priority. There may be some opportunity for some of these students to spend at least part of the summer at CERN, but that will depend on funding and the nature of the project.

For more information, contact the people listed above for each position.