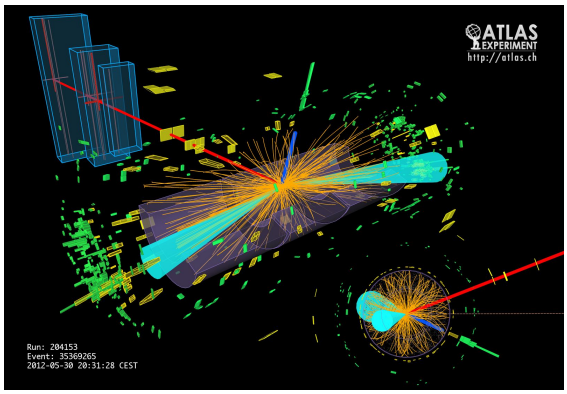
Internship/Master's thesis proposal:

# Visualization and Interactive Analysis of Collision Tracts




Modern high-energy particle physics experiments such as the ones conducted at CERN on the Large Hadron Collider produce large datasets of particle collision events and the traces of subsequently generated decay products. Physicists analyze traditionally this data using different algorithms and by comparing real events to those generated by simulations based on their standard model. This task is becoming more and more complex due to the increase in luminosity causing an increase in the event complexity: up to 10.000 trajectories in the same event are expected. To better support the physicists in integrating the results of these comparisons and understanding both their simulations and specific real events, the goal of this internship is to create an interactive visualization and data exploration tool based on the interaction data of the particles with the different layers of the detectors, as they originate from collisions along a linear trajectory of the original particle path.

In a collaboration between the Linear Accelerator Laboratory (Laboratoire de l'Accélérateur Linéaire, LAL) and the AVIZ research team at Inria, this project will investigate the interactive visualization of the 3D dataset based on the specific properties of the particle collision data. In particular, the challenges of this project are as follows:

- The physicists need both global and local views of the dataset, requiring both spatial and scale-dependent navigation.
- The data is largely of linear character, meaning that several interactions of one particle with different layers of the detector need to be integrated into a single path with well-defined characteristics.
- The decay particles are generated by several (up to 200) initial proton collisions which are arranged along a linear path. Some of the collisions generate more decay particles than others, yet is should be easy to determine, mark, and visualize the particle tracts based on their original collision event.
- Several collision events lead to bundles of decay particles. A challenge is to treat the bundles as such and explore abstraction techniques such as bundling and clustering for the visualization.
- The interactions of the (simulated) particles with the detectors are associated with certainty data, so the visualization should include this uncertainty information.
- In addition to navigation in the 3D space, the interactive exploration should also support selection operations of the linear bundles based on their origin (originating collision, with a tolerance), by the type of particle involved, and by other data characteristics. An input of a linear selection specification should be possible.

A Kaggle challenge on developing track finding algorithms on such datasets will run during the spring 2018; a variety of algorithms will hence be available for comparison through visual tools.

This internship will take place at the AVIZ team of Inria Saclay (minimum duration of 12 weeks), with a short stay at CERN in Switzerland. The prerequisites is a very good fluency in computer programming, preferably in Unix and using a programming environment/language that is familiar to the domain experts (e.g., Python), as well as modern graphics programming (shader-based OpenGL) and visualisation libraries such as VTK. We also expect the candidate to be able to fluently communicate in English both in written and in spoken form.


Contacts: David Rousseau <rousseau@lal.in2p3.fr>
Tobias Isenberg <tobias.isenberg@inria.fr>
http://tobias.isenberg.cc/

Groups: Laboratoire de l'Accélérateur Linéaire, LAL
https://www.lal.in2p3.fr/

AVIZ team, Inria Saclay
http://www.aviz.fr/