Executive Summary

The next generation of particle physics experiments at the Large Hadron Collider (LHC) near Geneva, Switzerland, will produce enormous and complex data sets that will be analyzed in a world-wide computing system. Canada has played a critical role in the construction of the LHC and the ATLAS experiment, and exploitation of this investment requires that Canada deploy an integrated set of computing resources that will enable Canadians to lead the analysis of the ATLAS data and the extraction of some of the most significant scientific results in history. The computing and analysis facilities will need to process several Petabytes (10^{15} bytes) of complex data several times per year. The global ATLAS collaboration will have nearly 2000 physicists, including about 100 researchers in Canada alone. ATLAS Canada is a microcosm of ATLAS as a whole, including researchers from nine different Canadian universities and the TRIUMF laboratory with interests in widely differing areas of particle physics.

The ATLAS computing and analysis model has been developed by an international team of computing and physics experts. The model matches the sequential analysis pattern of particle physics experiments, where raw detector signals are first processed into "objects" that represent primary physics quantities (*e.g.*, electrons with a given energy and direction produced in an interaction), and then the objects are analyzed both for measurements of known processes and for searches for new physics (*e.g.* is there an anomalous peak in the distribution of the invariant mass of electron pairs?). These different steps in the analysis lead naturally to a set of "tiered" centres in the international computing system. The initial processing of the data, called "reconstruction", is a continuous operation running 24 hours/day 7 days/week and requires facilities dedicated only to the ATLAS experiment, while the later detailed physics analyses are best performed on shared facilities. We know from our experience with large experiments that the resource needs of physics analysis have many "peaks" and "valleys" making shared-use facilities ideal. These experiments, including CDF and D0 at Fermilab near Chicago and Babar at SLAC near San Francisco, have already demonstrated successful use of existing shared CFI facilities. All users benefit from the resource sharing, since they have access to resource peaks above their average allocation.

The ATLAS Canada computing model is designed to give Canadians the ability to lead the many different ATLAS scientific analyses in which Canadians have interest. It includes a "Tier-1" centre dedicated to ATLAS and a distributed "Tier-2" computing federation utilizing shared facilities. The use of grid tools will allow the computing resources to function effectively together. Particle physicists, led by members of ATLAS Canada, pioneered the use of a Canadian computational grid, GridX1, for distributed analysis. GridX1 has already been used successfully for ATLAS data simulation exercises. Funding for the dedicated Tier-1 centre is being requested from the Canadian Foundation of Innovation (CFI) Exceptional Opportunities Fund, while the Tier-2 centres are being requested as part of the shared-use facilities in the CFI National Platforms Fund request.

The ATLAS experiment is our next step in the understanding of the basic building blocks of matter and the interactions among them. The analysis of the ATLAS data will be a daunting task, and Canadians are well positioned to lead the way. Both computing and human resources are critical to its success. This document describes the ATLAS Canada computing and analysis model.