1 Most Significant Contributions to Research and/or Practical Applications

Top and Higgs Physics at D0

The Tevatron is the world's highest energy particle accelerator. Recent upgrades in centre of mass energy (to 2 TeV) and luminosity will greatly expand the physics reach of the two general-purpose Tevatron experiments: CDF and D0. The accelerator advances have been accompanied by major upgrades to both experiments. The scientific programme which drives the upgrade is dominated by the search for new phenomena, the search for the Higgs boson and the study of top physics. The revamped accelerator and detectors began taking data in March 2001. The intention is to collect approximately 100 times more integrated luminosity during this data taking period (commonly referred to as RunII) than was acquired during previous Tevatron runs in the early 1990s. This, coupled with the substantial cross-section enhancements provided by the energy upgrade, means that the top quark event sample and Higgs search reach of the experiments are substantially improved.

Within the D0 collaboration the Higgs and top physics groups were combined until July 2001. I had been a member of this combined group for approximately 1.5 years and since the groups split I have been a member of the top physics group. I have taken an active role in these groups since I first joined D0. In particular, for more than a year I have convened a group to study triggers for Higgs and top physics. This effort involves bi-weekly meetings of 10-15 physicists to present studies of trigger efficiencies and rates for signals and backgrounds relevant to top or Higgs physics. I have also been the top physics group representative to the D0 trigger board. The trigger board is the body which approves all trigger configurations to be run online and which allocates bandwidth among physics groups. It has been my responsibility to present the needs of the top physics group to the trigger board and to defend top trigger bandwidth.

In addition to trigger-related responsibilities to the top and Higgs efforts, I have also been working closely with a Michigan State University graduate student to measure W helicity from $t\bar{t}$ decays. This study is ongoing. Also, I have been involved in single top studies by presenting a new MC generator written by Michigan State University theorists and by helping to incorporate it into the D0 software framework.

Computing

Over the past three years I have made significant contributions to offline computing for the D0 collaboration. I am one of the two founding members and primary administrators of a linux-based desktop PC cluster which has grown from 2 machines to approximately 220 machines. The importance of the cluster lies in its transparent support of a D0 code development environment and batch system which allows all nodes to be used to process D0 data on all desktop machines at the experiment. This linux cluster is now used as a model for collaborators at remote institutions. I provide support for remote institutions which attempt to emulate our computing model.

The D0 linux cluster has been a testbed for a prototype datagrid (SAM). I am the manager of the SAM station which delivers data from our central storage facility to the desktop processor farm at D0. I will build on this experience at Simon Fraser by making use of local compute farms to deliver and process large quantities of data and simulation files from both D0 and ATLAS.

I am a member of the D0 computing policy board. This group determines the computing policies and priorities for the experiment and allocates the computing budget.

I am one of the authors of the D0 5 year computing plan. My contribution was to write the sections which refer to desktop and analysis computing for the experiment. I was also involved in the networking and central analysis facilities planning sections of the document. This document was produced for the experiment and was used as part of a formal Fermilab review of computing at the two Tevatron experiments. The D0 plan was favourably received.

I am a member of the D0 Offsite Analysis Taskforce. This taskforce acts as a point of contact for offsite computing issues for collaborators. It is also charged with setting up offsite regional analysis centres for storing and processing D0 data.

Trigger and Data Acquisition

The D0 detector has been significantly upgraded since the last data run in 1995. One of the most significant upgrades has been to the trigger system. Trigger hardware needed to be redesigned to cope with the higher rate environment provided by the upgraded Tevatron and the software needed to be completely re-written. This opportunity was used to migrate from procedural software written in Fortran and C to an object-oriented design implemented in C++.

Since joining D0 I have been heavily involved in the design and implementation of both online and offline trigger software. Beginning in September 2000 I have been responsible for all D0 trigger simulation software. This involves managing a software project consisting of over 100 separate packages produced by approximately 20 code developers. My responsibilities include the design of the simulator, coordination and verification of code releases, documentation and representation of trigger software needs at various managerial meetings (eg. D0 Computing Policy Board). D0 has a three level trigger in which level 1 is hardware and firmware-based, while levels 2 and 3 algorithms are purely software run on either custom-built or commercial processors. Since two of the trigger levels are software, we are able to run the exact same code in the trigger simulator as is run online. For this reason the trigger simulator is more than simply a tool to simulate trigger conditions for physics studies, it is the primary platform for debugging and verifying online trigger code.

In addition to managing the overall trigger simulation effort, I am the subsystem coordinator for the level 1 and level 2 software. The primary duty of a subsystem coordinator is to ensure that all of the software in the subsystem remains mutually compatible. Any wide release of level 1 or level 2 software must be approved by me. This requires understanding in detail the levels 1 and 2 simulation and online software and data formats. I have assisted in unpacking trigger raw data and ensuring that tools are in place to examine trigger output as various systems come online. I am also responsible for implementing the level 2 online-only code which allows various processors in the system to communicate with each other over a custom backplane.

Top Physics at the LHC

The Large Hadron Collider (LHC) is a 7 TeV on 7 TeV proton-proton collider being constructed at CERN, Geneva, Switzerland. At LHC energies, the cross-section for top quark production is very high, leading to the claim that it will be the world's first "top factory".

My interest in top physics at the LHC has focused primarily on sources of top production via the electroweak interaction. These processes are often collectively referred to as "single top" since they result in the production of one top quark, in contrast to strong production which results in a $t\bar{t}$ pair. Single top production has yet to be observed, but promises to provide new opportunities to test the Standard Model and search for new physics. The single top cross-section is related to the CKM matrix element V_{tb}, which has never been directly measured. The measurement of this cross-section is the only known way to perform this measurement at a hadron collider.

In the Standard Model there are three primary types of diagrams which result in single top production; these are referred to as t-channel production, s-channel production and associated production. These three sources of single top are, in principle, experimentally separable and provide three independent measures of V_{tb}. Prior to my studies it was widely believed that these signatures could not be separated in the LHC environment. However, I showed that it should be possible to measure these channels independently at an LHC experiment.

Electroweak top quark production results in the production of highly polarized top quarks. Since the top quark decays before it can hadronize, the polarization information is propagated to its decay products. This provides the first opportunity to study the polarization of a bare quark. Using angular distributions I have shown that it is feasible to measure this polarization to within less than 2% after one year of data-taking at the LHC.

Hadronic Calorimetry

Hadronic calorimetry is essential in performing many of the physics studies envisioned for ATLAS, one of the two general-purpose experiments being built for the Large Hadron Collider (LHC). The primary functions of hadronic calorimetry in ATLAS are to perform jet reconstruction and E_t^{miss} measurement. The Hadronic Endcap Calorimeter (HEC) must perform these tasks in the challenging radiation environment which will be present in the forward regions of the ATLAS detector.

In 1998 the first production modules of the ATLAS Hadronic Endcap Calorimeter were tested in electron and pion beams at CERN. At this time I was the primary maintainer of the testbeam offline software as well the online display code. I was also responsible for data archiving. I migrated the beam tests from custom-written tape archiving software (which I had written and maintained) to a CERN central data storage system. In addition to these specific responsibilities I acted as a shift leader during data-taking runs.

The data taken during the 1998 run was very valuable in assessing the performance of the Hadronic Endcap Calorimeter. My colleagues and I at the University of Victoria performed a detailed analysis of this data. We studied the detector response and resolution for electrons over an energy range from 20 to 120 GeV. More importantly, we measured the energy resolution and response for pions over an energy range from 20 to 180 GeV and made the first measurement of the intrinsic ratio of the electromagnetic to hadronic response of the calorimeter (e/h).

Split of Time Between D0 and ATLAS

My intention is to split my research time between D0 and ATLAS with 75% of my time allocated to D0 and 25% allocated to ATLAS. However, the main service-work con-

tribution to each experiment will involve the use of the WestGrid facilities to process and store large volumes of data and MC. I expect there to be significant overlap between these two projects. D0 is a leader in the development and deployment of Grid technologies. It should provide an excellent training ground for ATLAS-style analyses.

2 Research Contributions and Practical Applications

Selected Refereed Publications

1. D. O'Neil, B. González Piñeiro and M. Lefebvre *Prospects for Measuring $V_{\rm tb}$ via s-channel Single Top at ATLAS*, Accepted: Journal of Physics G, August 2002.

2. B. Dowler et al., *Performance of the ATLAS Hadronic End-Cap Calorimeter in Beam Tests*, Nucl.Instrum.Meth.A482:94-124,2002

3. D0 Collaboration (V.M. Abazov et al.) *t anti-t Production Cross-Section in p anti-p Collisions at $\sqrt{s}$ = 1.8-TeV*. May 2002. 62pp. Submitted to Phys.Rev.D e-Print Archive: hep-ex/0205019

4. D0 Collaboration (V.M. Abazov et al.) *A Search for the Scalar Top Quark in P Anti-P Collisions at $\sqrt{s}$ = 1.8-TEV*. FERMILAB-PUB-01-233-E, Aug 2001. 7pp. Submitted to Phys.Rev.Lett. e-Print Archive: hep-ex/0108018

5. D0 Collaboration (V.M. Abazov et al.) *Search for Single Top Quark Production at D0 Using Neural Networks*. FERMILAB-PUB-01-102-E, Jun 2001. 16pp. Published in Phys.Lett.B517:282-294,2001 e-Print Archive: hep-ex/0106059

Plus 10 more articles published with the D0 collaboration

Non-Refereed Publications

1. O'Neil, D, *Top Physics at D0*, Proceedings of the 2002 Lake Louise Winter Institute.

2. Altarelli, G (ed.); Mangano, M L (ed.)*1999 CERN Workshop on Standard Model Physics (and more) at the LHC*, CERN Yellow Report. 529 p - CERN-2000-004.

3. M. Beneke et al., *Top Quark Physics*, March 2000. 111p - hep-ph/0003033.

4. B. González Piñeiro, R. Brock, D. O'Neil and M. Lefebvre, *Top and W polarization in EW Top Production at LHC*, ATL-PHYS-2000-017.

5. M. Dobbs, M. Lefebvre, D. O'Neil, *Hadronic Endcap Modules Zero Pion and Electron Energy Scan Analysis from April 1998 Testbeam Data* , ATLAS-LARG-99-001.

Plus 3 more publications

Presentations at Conferences or Institutions

1. *Lake Louise Winter Institute*, Lake Louise, Alberta, Canada., February 2002. "Top Physics at D0" (contributed).

2. *American Physical Society Meeting*, Washington, D.C., USA, May 2001. "Top Physics at the ATLAS Detector" (contributed).

3. *High Energy Physics Seminar*, Michigan State University, East Lansing, Michigan, April 24, 2001. "Studies of Electroweak Top Quark Production at ATLAS"(invited).

4. *Thinkshop 2: Top Quark Physics for RunII and Beyond*, Fermilab, Batavia, Illinois, November 11, 2000. "Single Top at the LHC" (invited).

5. *Thinkshop 2: Top Quark Physics for RunII and Beyond*, Fermilab, Batavia, Illinois, November 11, 2000. "Single Top Sensitivity to New Physics in RunII and (mostly) Beyond" (invited).

6. *Plenary Session: Standard Model Physics (and more) at the LHC*, CERN, Geneva, Switzerland. October 1999. "Single Top Production and Top Polarization" (invited).

3 Contributions to the Training of Highly Qualified Personnel

I have not yet held a position which would allow me to formally supervise or co-supervise the training of personnel. I will be able to take these responsibilities in my position at Simon Fraser University. As a research associate I have worked closely with graduate students in an advisory role. I have also acted as a dean of the "University of the Tevatron" which is an organization which brings lectures to graduate students resident at Fermilab.

4 Delays in Research Activity

For the last three years the bulk of my research time has been devoted to the D0 experiment at Fermilab. The research was done in the context of the current RunII data period. The data being acquired as part of this period is expected to yield many significant publications over the next 10 years. However, no refereed publications have yet been produced based on this data.