Research Activities – Prof. Wesley H. Smith

Prof. Smith designed and developed the tracking detectors and readout electronics that transformed the famous CCFR neutrino experiment in order to use the Fermilab new high-energy neutrino beam in extremely short but intense bursts and record all the information on every interaction. As spokesman over a decade he led groundbreaking physics analyses that measured such fundamental quantities as the charges of the quarks in the proton, the number of strange and charmed quarks in the proton and the fraction of the proton composed of gluons. These results are now part of standard particle physics textbooks.

Prof. Smith led the US group on the ZEUS experiment at the HERA ep collider located at the DESY laboratory in Hamburg Germany. Prof. Smith led the international team that built the ZEUS trigger system that became the basis for all subsequent particle physics collider detectors and developed at UW the revolutionary Calorimeter First Level Trigger. This system uses more than a thousand high-speed electronics boards analyzing 14 kbits of data at an input rate of 10 MHz beam crossings to select a few hundred Hz of events for further analysis. ZEUS has been one of the most productive and important of the major particle physics experiments, publishing more than 170 articles in refereed journals including 31 physics publications that have more than 100 citations each. These results on the strong force of Quantum ChromoDynamics that binds the quarks and gluons in the proton have dramatically changed the understanding of QCD and the gluons that are the production mechanisms for new physics expected in the next generation of particle physics experiments. 19 UW Ph.D. students completed their thesis work on ZEUS with Prof. Smith. Prof. Smith was recognized internationally by being invited to Chair and host the leading particle physics conference (DIS2005) in Madison in April with about 280 attendees.

Prof. Smith is a leader of the CMS experiment being built for the LHC at CERN in Geneva, Switzerland, serving on the Steering Committee of 15 physicists that guides this more than 2000 member global (40 country) collaboration. The LHC will operate at 7 times the energy and 100 times the luminosity of the present highest energy and luminosity collider at Fermilab and will search for the mechanism of particle mass generation, supersymmetry that links mass particles with force particles, the dark matter making up most of the universe and extra dimensions. The CMS experiment is a 15 m high, 24 m long fully instrumented billion-dollar complex of particle physics detectors viewed by over 10 million electronics channels.

As the CMS trigger project manager, Prof. Smith led the design of yet another revolutionary system reducing the input rate of 10^9 interactions every second by a factor of at least 10^7 to 100 Hz, by processing data from all over the CMS detector in scores of racks of high speed electronics. The most challenging part is the calorimeter trigger system built at UW under Prof. Smith's leadership. This $6M DOE project of more than a thousand high speed electronics boards is a major step forward in particle physics technology, processing 50 terabits/sec from 1 GHz of physics collisions to select 50 kHz of good physics candidates. This system has now been produced, is under test and being installed CERN.

In early 2007, the CMS Collaboration Board approved Prof. Smith to serve as CMS Trigger Coordinator, one of six coordinators serving on the Executive Board of this 2500-collaborator

experiment. In this new role, he is responsible for the data taken by the detector and kept for offline analysis.

Recognizing the extraordinary challenge of analyzing petabytes of LHC physics data per year, Prof. Smith and Prof. Dasu worked with Prof. Miron Livny and the Condor group at the UW Computer Science department to build a UW campus grid of more than 2000 computers forming the NSF-funded Grid Laboratory of Wisconsin (GLOW) that serves researchers in the fields of Computer Science, Genomics, High Energy Physics, Material Science, Neutrino Astrophysics and Medical Physics. Prof. Smith's research group was recently funded by the NSF and the CMS Computing project to create the Data Intensive Science University Network (DISUN), a grid-based facility comprising computing, network, middleware and personnel resources from, Caltech, U.C. San Diego, U. Florida and UW that will form the bulwark of the US CMS University computing. GLOW and other UW-based resources have been one of the highest producer of CMS simulated events, integrating 11 M CPU hours since October 2005, more than any single CMS institution worldwide.

Prof. Smith is one of the leaders of a new initiative to increase the luminosity of the LHC by an order of magnitude, called the Super LHC (SLHC), further extending the reach of the energy frontier to even more new physics. This involves more revolutionary innovations in detector technology that Prof. Smith is proposing and developing. This new initiative will shape the course of the field of particle physics over the next decade.

Prof. Smith is now the Task Manager of the UW DOE particle physics grant, the second largest in the US. Prof. Smith's has chaired, served as spokesperson, or otherwise strongly influenced a large number of important high-level advisory panels, including the DOE High Energy Physics Advisory Panel (HEPAP). In 2007 He served as the vice-chair of the DOE/NSF HEPAP University Grants Program Subpanel. He started a new course, Physics Today, for UW undergraduate physics majors to introduce them to the broad scope of physics research areas. This highly appreciated course has become a staple of the Physics Department curriculum and is taught by Prof. Smith in addition to his regular teaching load. Prof. Smith has also pioneered new teaching methods in the Physics Department introductory undergraduate courses.

Prof. Smith has been a National Science foundation Presidential Young Investigator and a Department of Energy Outstanding Junior Investigator. He is a Fellow of the American Physical Society and in 2006 was named the University of Wisconsin Bjorn Wiik Professor of Physics.