LEO BELLANTONI

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Education:

Ph.D., May 1995, University of Wisconsin at Madison
Thesis: "The Production of Excited Charm Mesons in Semileptonic B Meson Decay"
Sau Lan Wu, Fermi Professor of Physics

Peace Corps Volunteer, Morogoro Tanzania 1985-1987

S.B. in Physics, May 1981, Massachusetts Institute of Technology
Thesis: "A Longitudinal Drift Particle Ionization Detector and Data Gathering System"
Professor Steve Steadman

Experience:

Staff Scientist II, Fermi National Accelerator Lab	2009-present
Staff Scientist I, Fermi National Accelerator Lab	2003-2009
Robert Wilson Fellow, Fermi National Accelerator Lab	1999-2003
Leon Lederman Fellow, Fermi National Accelerator Lab	1995-1999
Research Assistant, (ALEPH) University of Wisconsin	1988-1995
Teaching Assistant, University of Wisconsin	1987-1988
Engineer, Varian Associates, Gloucester, Massachusetts	1984-1985
Engineer, Control Data Corp., Lexington Massachusetts	1981-1984

Selected Publications:

Particle phenomenology

L.Bellantoni, J.Erler, J.J.Heckman and E.Ramirez-Homs, "Masses of a Fourth Generation with Two Higgs Doublets", *Phys. Rev.* **D86** (2012) 034022.

L.Bellantoni, "Inferred limits on lepton flavor violating decays of the K_s", *Phys. Rev.* **D73** (2006) 014002.

Particle experimental results

V. Abazov *et.al.*, "Search for associated Higgs boson production using like charge dilepton events in $p\bar{p}$ collisions at $\sqrt{s}$ = 1.96 TeV", *Phys. Rev.* **D84** (2011) 092002.

A. Alavi-Harati *et.al.*, "Search for the Rare Decays $K_L \to \pi^0\pi^0\mu^+\mu^-$ and $K_L \to \pi^0\pi^0 X \to \pi^0\pi^0\mu^+\mu^-$", *Phys. Rev. Lett.* **107** (2011) 201803.

A. Alavi-Harati *et.al.*, "Search for the Rare Decay $K_L \to \pi^0 e^+ e^-$", *Phys. Rev. Lett.* **93** (2004) 021805.

A. Alavi-Harati *et.al.*, "Search for $K_L \to \pi^0 e^+ e^-$", *Phys. Rev. Lett.* **86** (2001) 397-401.

A. Alavi-Harati *et.al.*, "Search for $K_L \to \pi^0 \mu^+ \mu^-$", *Phys. Rev. Lett.* **84** (2000) 5279-82.

D. Buskulic *et.al.*, "A Study of $D^{*+}\pi^-$ Production in Semileptonic B Decay", *Phys. Lett. B.* **345** (1995) 103-114.

D. Buskulic *et.al.*, "Heavy Flavor Production and Decay with Prompt Leptons in the ALEPH Detector", *Z. Phys.* **C62** (1994) 179-98.

D. Decamp *et.al.*, "A Search for pair-produced Charged Higgs Bosons in Z Decays", *Phys. Lett.* **B241** (1990) 623-34.

Particle experimental techniques

D. Buskulic *et.al.*, "Heavy Quark Tagging with Leptons in the ALEPH Detector", *Nucl. Inst. Meth.* **A346** (1994) 461-75.

L. Bellantoni, J.S. Conway, J.E. Jacobsen, Y.B.Pan, S.L. Wu, "Using Neural Networks with Jet Shapes to Identify *b* Jets in e^+e^- Interactions", *Nucl. Inst. Meth.* **A310** (1991) 618-22.

W.Atwood *et.al.*, "Performance of the ALEPH Time Projection Chamber", *Nucl. Inst. Meth.* **A306** (1991) 446-58.

Particle accelerator techniques

T.M.Austin, J.Cary, G. Werner, L. Bellantoni, *Comp. Sci. and Discovery*, **4** (2011) 015004.

T. Koeth, L. Bellantoni, H.T.Edwards, R.PFliller, A.H.Lumpkin, J.Ruan “Emittance Exchange at the Fermilab A0 Injector”, EPAC08-THPC020, Jun 26, 2008.

L.Bellantoni, H.Edwards, R.Wanzenberg, “Calculation of Asymptotic and RMS Kicks due to Higher Order Modes in the 3.9GHz cavity”, FERMILAB-TM-2404-AD-APC-TD, March 2008.

C.Adolphsen *et.al.*, “Design of the ILC Crab Cavity System”, EuroTeV Report 2007-010.

L.Bellantoni, G.Burt, “Wakefield Calculation for Superconducting TM_{110} Cavity Without Azimuthal Symmetry”, FERMILAB TM-2356-AD-E-TD, August 2006.

G.Burt, A.Dexter, L.Bellantoni, P.Goudket, C.Beard, A.Kalinin, L.Ma, “Crab Cavity System for the ILC”, *2005 ILC Physics and Detector Workshop and 2nd ILC Accelerator Workshop*, August 14-27, 2005, Snowmass Colorado.

L.Bellantoni, H.Edwards, T.Khabibouline and A.Rowe, "Field Flatness Tuning of TM_{110} Mode Cavities with Closely Spaced Modes", *11th Workshop on RF Superconductivity*, September 8-12 2003, Travemunde, Germany.

R.Wanzenberg, L.Bellantoni, H.Edwards, M.McAshan, "Design and Measurement of a Deflecting Mode Cavity for an RF Separator", and M.Champion, L.Bellantoni, T.Berenc, C.Diebele, H.Edwards, M.Foley, J.Fuerst, M.Kuchnir, A.Rowe, "Engineering Design and Prototype Tests of a 3.9GHz Transverse Mode Superconducting Cavity for a

Radiofrequency Separated Kaon Beam", *Particle Accelerator Conference*, June 18-22 2001, Chicago Illinois.

Recent invited talks:

"SUSY Results from the Tevatron", SUSY 2011, Fermilab, Aug 2011.

"Beyond Standard Model Physics", FNAL Users Meeting, June 2010.

"Searches for Beyond-Standard Model Physics", APS-DPF Plenary, Detroit, July 2009.

"Search for $K_L \to \pi^0\pi^0\mu^+\mu^-$" at KTeV", APS-DPF Parallel Session, Detroit, July 2009.

"ILC Crab Cavity Wakefields Analysis", ICFA Mini-Workshop on Deflecting/Crabbing Cavity Applications in Accelerators, Shanghai, China, April 2008; Chair Working Group 1 at the same conference.

"Recent Results from KTeV", 40th Moriond Conference on Electroweak Interactions and Unified Theories, La Thuile Italy, March 2005.

"Fermilab SRF Cavity R&D and Infrastructure", presentation to ITRP at DESY, April 2004.

Recent Committees/Panels:

Fermilab Committee on Scientific Appointments, 2010-12

Director's Review of LBNE Program, 2009.

Scientific Committee, ICFA Min-Workshop on Deflecting/Crabbing Cavities, Shanghai China, April 2008.

Argonne APS Short pulse X-ray Deflecting Cavity RF Design Review. Aug. 2007.

DOE SBIR program reviewer, 2007 onwards.

IMSA Admissions Committee, 2004 onwards.

Operational Readiness Clearance Review Committee Chair, 2008 onwards.

Summary of Phenomenological Research

Used sampling techniques to predict the masses of a possible 4th generation of standard model fermions in several different electroweak symmetry breaking scenarios, and found that to a great extend the Higgs sector has little impact on what the masses would be, should a 4th generation exist. The resulting publication also emphasized that existing experimental methods do have a shortcoming in their assumptions about final states and that remedies for this are on hand.

Published a model independent derivation of the branching ratio limits for lepton flavor violation in the K_S system, both in 2 and 3 body decays, based on recent experimental limits on lepton flavor violation in K_L and K^+ decays. The resulting limits imply that larger data samples than are likely to exist without a dedicated experiment would be needed to provided an interesting level of sensitivity.

Summary of Research with the DØ Collaboration

Hardware/Detector

Performed the prototype bench tests and production mass-testing of the TRIP-t chip, which is the custom ASIC that provides amplified amplitude, time-of-arrival, and trigger signals for the AFEII boards. Devised testing procedure in the DØ Combined Test Stand for the assembled boards and supervised a group of 3-4 students to test all the boards prior to their installation.

Algorithms/Analysis

Co-convened the DØ Calorimeter Algorithms group, with oversight of EM object, τ, and jet identification subgroups, as well as calorimeter calibration and missing E_T subgroups. Collectively these groups

- Provided and maintained tools for the identification of and analysis with electrons, photons, hadronic taus, jets, and missing E_T.
- Developed a new electron ID suite with better performance and lower maintenance costs.
- Developed, released and supported the first photon ID suite to be used in a standard way across the collaboration.
- Developed a τ ID which incorporated several significant improvements, including the use of impact parameter information from the silicon vertex detector.
- Developed a more efficient alternate algorithm to verify that an identified jet originated from the hard-scatter high p_T interaction rather than from one of the (many!) secondary interactions in the beam crossing.
- Developed a systematic new treatment of jets to accommodate declining gains in the Inter-Cryostat Detector.
- Recalibrated the calorimeter after the 2009 and 2010 TeVatron shutdowns.
- Were, in conjunction with the calorimeter operations group, responsible for maintaining calorimeter data integrity.
- Developed better parameterizations of unclustered energy for use in the computation of the significance of missing E_T.
- Implemented and validated better electron identification and calorimeter calibrations for the reprocessing of a key subset of the DØ data; validated also those particle identifications that were affected by, if not improved for, the reprocessing.

With other DØ physicists, searched for and set a limit on the production of a neutral scalar Higgs in association with a W^+ with leptonic decay modes. The result, based on an integrated luminosity of 5.3fb^{-1}, has been published in *Phys. Rev.* **D** and preliminary versions were available for conferences in the spring of 2009 and again in the summer of 2010. We set 95% C.L. upper limits on $\sigma(WH)$ x $Br(H\rightarrow WW^*)$ as low as 6.7x the standard model rate for a Higgs masses of 135 GeV. The search method is sensitive to both fermiphobic and standard model Higgs.

Summary of Research with the KTeV Collaboration

Hardware/Detector

Coordinated the commissioning of the Transition Radiation Detectors (TRDs); designed & installed the preamplifier cable plant; created monitoring software and was responsible for the performance of this detector for the 1996-7 run.

Commissioned FERA ADC system; designed and assembled a system from off-the-shelf hardware and real-time software to synchronize the data acquisition, TRD and drift chamber HV, trigger system, and ADC monitoring software to the TeVatron beam spill time structure. Was responsible for the performance of these electronics and software for the 1996-7 run.

Run coordinator during 1999 run.

Analysis/Calibration

Motivated by the anomalous HyperCP result on $\Sigma^+\rightarrow p\mu^+\mu^-$, searched for $K_L\rightarrow\pi^0\pi^0\mu^+\mu^-$ and showed my result to the collaboration. Using the 1997 dataset, I obtained $Br(K_L\rightarrow\pi^0\pi^0\mu^+\mu^-) \leq 3 \times 10^{-10}$. This work has been followed through on by a U.Va student, David Phillips, who presented the final negative result, based on the full dataset, $Br(K_L\rightarrow\pi^0\pi^0\mu^+\mu^-) \leq 9.2 \times 10^{-11}$, and $Br(K_L\rightarrow\pi^0\pi^0X\rightarrow\pi^0\pi^0\mu^+\mu^-) \leq 1.0 \times 10^{-10}$.

Searched for $K_L\rightarrow\pi^0e^+e^-$ and set a 90% C.L. limit of $Br(K_L\rightarrow\pi^0e^+e^-) \leq 5.6 \times 10^{-10}$; this preliminary result was shown at the 1999 Moriond conference. The final result on the full dataset, 2.8 x 10^{-10}, uses the same analysis methods as the preliminary result, and I played a large role in getting the final number out.

Introduced a second algorithm for particle identification with the TRDs, which became the more commonly used algorithm. The substantial improvement – 250::1 rejection factor, as compared to 150::1 in the prototypes – was due mostly to simple technical craftsmanship rather than any fundamental improvement of the algorithm.

Analyzed the kinematics of the $K_L\rightarrow\pi^0\mu^+\mu^-$ mode and discovered that the phase space fiducial requirements essential to the $\pi^0e^+e^-$ mode are of little use in this mode. I developed the final set of numbers for release, concluded that $Br(K_L\rightarrow\pi^0\mu^+\mu^-) \leq 6.9 \times 10^{-10}$, and published the result in Physical Review Letters.

Summary of Research with the ALEPH Collaboration

Hardware/Detector

Designed tests for the FASTBUS interface to the ADC modules of the ALEPH Time Projection Chamber; helped install and commission these modules; lead a small group that kept these electronics working and calibrated, repaired faulty test pulse generation circuits. Between 1990 and 1994, assumed TPC coordinator responsibilities.

Analysis/Calibration

Did a search for charged Higgs bosons in the early LEP-I data, taken in 1989. I set and published a limit for the minimum possible mass of $H^{\pm} \rightarrow \tau^{+}\tau$- close to the $M_Z/2$ kinematic bound.

Searched for $B \rightarrow D^{**} \ell \nu$ and found $Br(B^{\pm} \rightarrow D^{**0}(2420)\ \ell \nu X) = (0.48 \pm 0.21)\%$. There was no observable $D^{**}(2460)$ component. This result identified about 20% of the then-missing semileptonic branching ratio.

Measured the inclusive semileptonic branching ratio, $Br(B \rightarrow X\ \ell \nu)$, and, with a small group of collaborators, published this result, the lepton ID methods, and the purity and efficiency tests of the lepton ID methods.

Developed feed-forward neural networks using back propagation for b jet identification in Higgs decays; this work required code optimization on a CRAY X-MP vector processing system.

Summary of Research with Particle Accelerator Physics and Technology

I was a lead developer of superconducting cavities that operate at 3.9GHz in the deflecting TM_{110} mode. These cavities were originally planned for installation (a) in the K^+ RF separated beamline and (b) in the A0 photoinjector as a beamslice diagnostic. At this time they are the planned "crab" cavities for the ILC. I was the assistant project manager for the R&D work before the cancellation of the CKM experiment; this work had the intended side effect of providing the initial SRF technology base at Fermilab. I continued to work on this device towards its application as a beam slice diagnostic and as an ILC crab cavity.

Direct effort:

- Did a complete analysis of both long-range and short-range wakefields of this cavity in its 13-cell version.
- Applied the results of the formalism developed for this wakefield analysis to thoroughly analyze the HOM coupler requirments for the 3rd Harmonic cavities in the FLASH beamline.
- Worked with Rutgers graduate student Tim Koeth as he built, assembled, tuned and tested in a beamline a 5-cell Cu version of the 3.9GHz deflecting mode cavity for an emittance exchange experiment.
- Provided support for cold tests of cavities in A0; pursuant to this, measured and developed and effective remedy to (large) floor vibrations, mysterious or inadequate refrigeration system behavior, and a variety of RF measurement errors.
- Extended the two-chain lumped equivalent element model of Bane & Gluckstern, and McAshan to handle finite power dissipation, and with that model predicted that the desired (π) mode of the 13 cell prototype cavity would be very hard to distinguish from the nearest neighboring mode, the (π-1) mode.
- With T. Khabibouline, developed two methods for tuning cavities with overlapping modes

for field flatness The 13 cell prototype was tuned to ±6%, with the polarization controlled to ±4°. The tuning was carried out on a second-generation tuning device which I worked with A.Rowe to develop.
- Developed a heat flow model that supported going to thicker walls for the cavities in order to stiffen the structure mechanically..
- Took, analyzed, and modeled data describing the cooling of a niobium piece in a vacuum vessel after electron beam welding. To first order, the cool down time depends only on the width of the melted area.
- Created a procedure to use RF measurements on intermediate sized fragments of an entire cavity to improve the mechanical tolerances of cavities as they roll off the assembly line.

As a leader:
- Organized a workshop at FNAL in May 2006 on computational studies of 3.9GHz / crab cavities, and used this to help coalesce a group of people interested in working on this device. WIth that group, developed a beamline proposal and test sequence for the ILC Crab cavity R&D project in the MuMuon/ILCTA facility.
- Put together cost estimate for the crab cavity subsystem of the ILC, and provided draft for the RDR sections on this subsystem.
- Investigated and fixed a range of quality control and manufacturing issues, including initial frequency variations at intermediate manufacturing stages, as well as issues involving welding, clean handling and acid etching techniques.
- Validated the basic design of the cavity by reaching field strengths 50% over specification in a 3 cell thick wall prototype; the surface resistance also met spec, although we think we ought to be able to better.

As a result of my visibility in this field, I was asked to serve on a technical external review for the short-pulse X-ray source crab cavity design at ANL's APS in August 2007, and to review SBIR proposals from 2007.

Summary of Research in Industry

I worked with Varian Associates and Control Data Corporation in the early 1980s to develop second generation electron beam microlithography machines for the VLSI industry. I studied the distortions in the beam deflection fields, and concluded that a major impediment was the buildup of thin insulating layers on the surface of the deflecting electrodes. Consequently, I did the first research in this sector into the idea of cleaning the electron optics of these machines by creating an oxygen rich plasma inside the vacuum chamber.

Highlights of Teaching Experience

For two years I taught A-level physics and mathematics to about 40 students at Kilakala Secondary School in Morogoro, Tanzania, while I was in the Peace Corps. It was an extremely rewarding experience.

I helped launch the Phriendly Physics program, which helps elementary school teachers overcome their physics-phobias and upgrade the science content of their curricula. The program was so successful at the pilot stage that the administrator for that school district insisted in reserving all the available seats in the next year's program!

I have participated in a number of other lab-related outreach programs, including the Ask-A-Scientist program, and have been regularly involved in IMSA's applicant review process.

I introduced both high school students and their teachers to hands-on science in the DOE Honors and Topics in Modern Physics programs. Participants in these programs design and carry out their own research programs, studying cosmic rays, with a little help from a nearby physicist.