Lawrence R. Sulak - Research

For 45 years Sulak has explored particle physics using novel calorimetric detectors he has developed for neutrinos at Fermilab, Brookhaven, IMB, Super-K and Antares, for the g-2 muon measurement at Brookhaven, and for the Higgs and supersymmetry searches at CMS.

After working at Brookhaven with Val Fitch (measuring the mass difference to 1/2%) and at CERN on kaon physics, with Cline, Mann and Rubbia he initiated the first experiment at Fermilab, measuring pions to predict neutrino production with the C0 internal jet target.

With Rubbia, he designed, built the first massive liquid scintillator calorimeter (100 T) and large area drift chambers (15 m^2), and performed the analysis that discovered neutral weak currents (muonless events) using neutrino beams (E1A) in 1974. At Brookhaven Lab, using another calorimeter and electronics of his design, he and collaborators were the first to observe neutrino and antineutrino elastic scattering, and to search for neutrino oscillations. This work was the first to demonstrate that two of the four forces, the weak and the electromagnetic, are unified.

Inspired by his work on Dumand, Sulak proposed, designed and prototyped a massive ring-imaging Cherenkov detector to search for the predicted signal of Grand Unification (proton decay) and for neutrino oscillations. He formed a collaboration (IMB) with Reines to build the world's first massive water calorimeter (10,000 tons, 20 *m* on a side). In the early 80's, IMB disproved the SU(5), reported evidence for neutrino oscillation, and observed the first neutrino outburst from a stellar collapse.

In the 1990's Sulak's group moved elements of the IMB calorimeter to Japan, to form the Super-K collaboration. This proved that neutrinos have mass and oscillate from one form to another. In high-energy physics, only the recent Higgs discovery has garnered more citations.

Sulak was co-initiator and/or co-principle investigator of other larger detectors. These include the astrophysical MACRO observatory deep in the Gran Sasso tunnel of Italy, the detectors for the superconducting storage ring *g-2* experiment at Brookhaven (now moved to FNAL), the K2K experiment (the first to shoot neutrinos a long distance from an accelerator to a detector), confirming the atmospheric oscillation results with accelerator neutrinos, and the Antares astrophysical neutrino detector at the bottom of the Mediterranean.

In the Superconducting Super Collider era, Sulak was co-spokesman of the proposal for the TeXas Detector. Upon the advent of the LHC, in 1994 Sulak took the quartz fiber Cherenkov calorimeter he had developed for the SSC and adapted it to the CMS experiment. This sub detector has been critical in tagging the forward jets formed when the Higgs particle is produced and for severely limiting the phase space for a supersymmetric particle to exist.

In 2009 he established the BU/CERN/University of Geneva program, the only one in the world to send junior physics majors (15) each year for an 8-month CERN internship.

Before the recent prodigious output of papers from CMS, Sulak co-authored some 200 journal articles receiving more than 7000 citations. He was honored early-on with the Outstanding Young Scientist Award by *Science Digest* and Fellowship in the APS, and the Marseille Research Prize. He and his collaborators were awarded the Asahi Prize and for the observation of supernova neutrinos the Bruno Rossi Prize of American Astronomical Society. The detectors that his pioneering IMB work spawned, Super-K and SNO, were honored by two awards in 2015, the Nobel Prize in Physics and the Physics Breakthrough Prize in Fundamental Physics.

Sulak is the Myers Distinguished Professor of Physics at Boston University.