Dark Matter Search - During the period of performance, our group continued the search for dark matter in the form of weakly interacting massive particles or WIMPs. As a key member of the CDMS (Cryogenic Dark Matter Search) collaboration, we completed the CDMS II experiment which led the field in sensitivity for more than five years. We fabricated all detectors, and participated in detector testing and verification. In addition, we participated in the construction and operation of the facility at the Soudan Underground Laboratory and played key roles in the data acquisition and analysis.

Towards the end of the performance period, we began operating the SuperCDMS Soudan experiment, which consists of 15 advanced Ge (9 kg) detectors. The advanced detector design called iZIP grew out of our earlier DOE Particle Detector R&D program which demonstrated the rejection of surface electrons to levels where they are no longer the dominant source of background. Our group invented this advanced design and these larger detectors were fabricated on the Stanford campus in collaboration with the SLAC CDMS group and the Santa Clara University group. The sensitivity reach is expected to be up to 5 times better than CDMS II after two years of operation. We will check the new limits on WIMPs set by XENON100, and we expect improved sensitivity for light mass WIMPs beyond that of any other existing experiment.

Our group includes the Spokesperson for SuperCDMS and continues to make important contributions to improvements in the detector technology which are enabling the very low trigger thresholds used to explore the low mass WIMP region. We are making detailed measurements of the charge transport and trapping within Ge crystals, measuring the diffusive trapping distance of the quasiparticle excitations within the Al phonon collector fins on the detector surface, and we are contributing to the development of much improved detector Monte Carlos which are essential to guide the detector design and optimize the analysis.

Neutrino Physics - In the period of performance the neutrino group successfully completed the construction of EXO-200 and commissioned the detector. Science data taking started on Jun 1, 2011. With the discovery of the 2-neutrino double-beta decay in 136-Xe and the first measurement of the 0-neutrino mode resulting in the most stringent limit of Majorana masses, our group continues to be a leading innovator in the field of neutrino physics which is central to DOE-HEP Intensity Frontier program.

The phenomenon of neutrino oscillations, in part elucidated by our earlier efforts with the Palo Verde and KamLAND experiments, provides the crucial information that neutrino masses are non-zero and, yet, it contains no information on the value of the neutrino mass scale. In recent times our group has therefore shifted its focus to a high sensitivity 0-neutrino double beta decay program, EXO. The 0-neutrino double beta decay provides the best chance of extending the sensitivity to the neutrino mass scale below 10 meV but, maybe more importantly, it tests the nature of the neutrino wave function, providing the most sensitive probe for Majorana particles and lepton number violation. The EXO program, formulated by our group several years ago, plans to use up to tonnes of the isotope 136-Xe to study the 0-neutrino double beta decay mode. The EXO-200 detector is the first step in this program and it represents the only large US-led and based experiment taking data. The EXO-200 isotope enrichment program broke new grounds for the enterprise of double beta decay. The detector design and material selection program paid off, resulting in a background that is among the very best in the field. The “first light" of EXO-200 was very exciting with the discovery -in the first month of data- of the rarest 2-neutrino double beta decay mode ever observed. The lower limit on the 0-neutrino double beta decay half-life, published in Phys. Rev. Lett. and based on the first 120 days of data is the second best but, when translated into a Majorana mass scale, it is one of the most stringent constraint we have on neutrino masses. Indeed, such a limit was the first result to contradict a claim of discovery in 76-Ge for most nuclear matrix elements calculations. As we continue data taking and plan some modest upgrades to EXO-200 our group is also very active in the design of nEXO, a 5 tonne detector based on the technology demonstrated by EXO-200.

Over the years we have made it a tradition to explore the frontier and not to be shy about looking in new directions and re-inventing ourselves to best take advantage of the precious few opportunities provided by Nature. We have also cultivated a number of young people at all levels and, by now, many of the undergraduates, graduate students and postdocs educated by this group have leading positions in academia and industry around the world.