INSTITUTION: Princeton University
NSF PROGRAM: UNDERGROUND PHYSICS
PROPOSAL TITLE: Collaborative Research: MAX - Multi-ton Argon and Xenon TPCs

PANEL SUMMARY:
Panel Summary

Collaborative Research: Max - Multi-ton Argon and Xenon TPCs.

Intellectual Merit

This is a proposal to develop, in a collaborative fashion, two phase TPC's for liquid Xenon and liquid Argon dark matter detectors. Dark matter would be detected through scattering of nuclei within the cryogenic liquid. The position detection goal for the scattering event is in the mm range for the three coordinates using signals detected separately from the scintillation light generated in the liquid and the subsequently detected ionization yield. The signal characteristics and localization of the event are used to reject backgrounds of various types. Prototype detectors for both Xenon and Argon at roughly the 100 kg mass scale are being commissioned and will have results in the coming year. The goal for these is a cross section limit of approximately 10-45 cm2. Demonstrated results from these detectors are crucial for having confidence in the next step, proposed for DUSEL.

In the case of Argon the availability of sufficient low activity Argon is crucial. Work on an appropriate source is underway. The large atomic number, high density, and potential for spin dependent cross section sensitivity, as well as high degree of self shielding, make Xenon very attractive as a detection medium. The MAX S4 goal is to have designs for large Argon and Xenon dark matter detectors with fiducial volumes of approximately 2.5 tons. These would yield limits for dark matter detection of approximately 10-47 cm2. The development of a novel photodetector, called the qupid, which uses a photocathode and avalanche photodiode to generate the electrical signal and that would generate very little background because it uses a minimal amount of components, is an attractive development project. The detectors would require a water shield to limit backgrounds, which also has to be designed.

External reviews were two excellent and three very good, which helped inform the deliberations of the panel.

Broader Impacts

The question to be addressed by MAX, the nature of Dark Matter, has captured the imagination of the public at large as well as students studying science. The technologies and methods to be refined by MAX will advance the application of noble liquids as imaging detectors, with potential applications in national security. The MAX proposal would also enhance collaboration with groups in Europe and Japan and with National Labs in the U.S.

The proposed activity would advance the scientific and educational mission of Dusel through activities for

high school students. They have expanded the participation in a summer school for Italian students at Princeton to include in 2008 students from South Dakota, to be expanded more broadly to include more American students in 2009.

Recommendation:

The search for dark matter is a very important part of the initial DUSEL physics program and this proposal should be funded. The collaboration is very strong and experienced. We note, however, that we have two proposals with similar techniques for a liquid Xenon detector, although the groups have a few different technical solutions they are examining, that are worthy of exploration. Eventually only one such detector might be approved and achieving a successful experiment will be a large and challenging task. It would be optimal if the different groups would now choose to collaborate toward a final detector plan.

PANEL RECOMMENDATION:
PANEL RECOMMENDATION KEY:
DNF:Do Not Fund, FIP:Fund If Possible, F:Must Fund