**Title:** Optical tracking detector

**Time Frame:** Long

**Physics Justification:** Very large tracking chambers such as liquid argon TPCs are recently becoming the detectors of choice for neutrino detectors because of their high density compared to gas TPCs, their accurate tracking capabilities, and the relatively low cost of Argon as a TPC tracking medium. Disadvantages of LAr TPCs are the need for cryogenics, the use of high voltages and high voltage feedthrus, and the potential safety hazards if the liquid rapidly converts to a gas. Optical tracking chambers, using water based liquid scintillator, may be a competitive alternative to LAr TPCs if large area, fine grained, picosecond time resolution optical detectors can be produced at relatively low cost. Because of the reduced hazard of producing large volumes of suffocating gas, these detectors could be installed deep underground where the low backgrounds would enable them to carry out a variety of experiments such as a search for proton decay, and a study of cosmic neutrino interactions as well as looking at interactions from accelerator produced neutrinos.

**Technical Capabilities:** Optical tracking detectors would use both Cerenkov and scintillation light to do tracking and particle identification. Track position resolutions should be the order of mm, possibly 100s of microns. Water is cheap, very large underground water Cerenkov detectors have been built and used for physics studies for years, and water based liquid scintillator which has been recently developed at BNL by Minfang Yeh and collaborators uses chemicals which are inexpensive and biodegradable. Safety considerations should be restricted to assuring the integrity of the water container. Also, high voltage is not a consideration. Finally, because the light detection is on the outside surface of the container, construction and maintenance costs should be relatively low compared to other types of tracking detectors.

**Technical Requirements:** Large area inexpensive optical detectors are needed with mm spatial resolution and picosecond or subpicosecond timing capability. There is currently a Large Area Picosecond Photo Detector (LAPPD) funded project underway to develop detectors of this type. Inexpensive, water based liquid scintillator has been recently developed at BNL. Computer algorithms for doing tracking and particle identification based on the position and arrival time of Cerenkov and scintillation light from charged particles moving in the detector need to be developed and optimized, although some work has been done by the LAPPD collaboration. A detector of the order of 1-2 m3 would need to be constructed and tracking and performance studies of this detector carried out in a suitable test beam.

**Industrial Involvement:** Large Area Photodetectors will ultimately have to be produced by Industry at a reasonable price.

**Key Motivations for this Detector R&D:**

* Increases physics capabilities of very large detectors.
* Decreases cost of very large detectors.
* Provides increased safety for very large detectors.