

## Mechanical Performance of Large Format Underwater Photo-multiplier

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Large, deep, well shielded liquid detectors have become an important technology for the detection of neutrinos over a wide dynamic range of a few MeV to TeV. The critical component of this technology is the large format semi-hemispherical photo-multiplier tube with diameters in the range of 25 to 50cm. The survival of an assembled array of these photo-multiplier tubes under high hydrostatic pressure is the subject of this study. These are the results from an R&D program which is intended to understand the PMT performance under hydrostatic pressure and the modes of failure when a photo-multiplier tube implodes under hydrostatic pressure. Our tests include detailed measurements of the shock wave which results from the implosion of a photo-multiplier tube with different installation enclosure configuration. And we also include a comparison of the test data to modern hydrodynamic simulation codes. Using these results we can extrapolate to other tube geometries and make recommendation on deployment of the photo-multiplier tubes in deep water detectors with a focus on risk mitigation from a tube implosion shock wave causing a chain reaction loss of multiple tubes.

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