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The Interaction of a Turbulent Ship-Hull Boundary Layer and a Free Surface[1] N. MASNADI, N. WASHUTA, A. WANG, J.H. DUNCAN, University of Maryland — The free-surface deformation pattern caused by subsurface turbulent velocity fluctuations in the boundary layer at the mid-length of a naval ship is studied with a novel laboratory scale experimental technique. In this technique, the boundary layer is created in a large tank (13.4 m long, 1.3 m tall, and 2.4 m wide) with a surface-piercing meter-wide stainless steel belt that travels in a horizontal loop around two vertically oriented rollers whose axes are separated by 7.5 m. The device is enclosed in a dry box except for one of the two lengths between the rollers where a straight 6-meter-long section is exposed to the water and represents one side of the ship hull. The belt operates at full-scale ship speeds (up to 15 m/s) in order to match the Reynolds, Froude, and Weber numbers to those of naval ships, thus faithfully modeling the interaction of the turbulence with the free surface at laboratory scale. The water surface profile history midway between the rollers is recorded cinematically in a vertical plane normal to the belt using a Laser Induced Fluorescence (LIF) technique. This surface profile data is used to study the near-wall and far-field frequency content and propagation behavior of the surface ripples.

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