Tuesday Morning, October 21, 2008

IPF 2008 Frontiers in Imaging: from Cosmos to Nano
Room: 312 - Session IPF-TuM

Marine/Terrestrial Imaging
Moderator: D. Zawada, USGS, Florida ISC

8:00am **IPF-TuM1 Imaging in the Underwater Environment: Current Status and Future Trends**, ***S.G. Ackleson***, Office of Naval Research **INVITED**

Natural waters are largely opaque to electromagnetic energy except for a narrow wavelength range between 400 and 700 nm - the visible light spectrum. If the water body, the ocean for example, contained only pure water, it would be possible to view objects through several hundred meters of path length. Unfortunately, natural waters are never pure, but contain large concentrations of suspended and dissolved matter that act to scatter and absorb light energy. The combined attenuation effects of scatter and absorption greatly reduce imaging range. The useful imaging range of conventional camera and flood light combinations is limited to between 1 and 2 optical attenuation lengths, translating to a few tens of meters in clear ocean water, but < 5 m in most coastal and estuarine environments. The development, over the last two decades, of laser-based systems employing synchronous scan and range-gated approaches have increased imaging range to 4 - 5 attenuation lengths and recent improvements in pulsed laser beam form and efficiency and signal processing techniques can potentially increase imaging range another 2 attenuation lengths. However, future improvements in underwater imaging will likely not be driven by better light sources and detectors or sensor architecture, but by how such systems are deployed. Advances in autonomous underwater platforms are allowing imaging researchers to think beyond traditional co-located source and detector approaches to scenarios where the imaging components are distributed within underwater sensing networks. Such approaches could potentially overcome limitations due to imaging range by using knowledge of local environmental variability and may provide opportunities to image across much greater ranges.

8:40am **IPF-TuM3 Coral Fluorescence Imaging**, ***C.H. Mazel***, Physical Sciences Inc. **INVITED**

Fluorescence in corals is optical alchemy, a magical transformation of ultraviolet or blue light to a rainbow of intense hues. Many marine organisms exhibit vivid fluorescence effects, a marvel of physics in action. Photography of coral fluorescence produces images of striking beauty that are also of great value for science. The biological function of the proteins that are the source of the fluorescence is not yet known, although there is no shortage of hypotheses – an aid for photosynthesis of the symbiotic algae, a sunscreen to protect against excessive ambient light levels, a way to preserve and intensify color in the wavelength-limited underwater environment, a beacon for prey. Photographs taken on the reef provide valuable clues that contribute to the scientific sleuthing. Whatever the function of fluorescence for the corals themselves, the phenomenon is a boon for reef science. Juvenile corals are very small (on the order of 1 mm) and are next to impossible to find in the complex surroundings of a reef. By diving at night with the right equipment many of these small corals can be excited to glow brightly, making them easy to find against the darker background. But not even reef scientists want to do all their work at night, and techniques have been developed to find and photograph fluorescing corals in the daytime without special shading. Corals are not the only marine organisms that fluoresce. The more scientists look, the more examples they find over a wide taxonomic range. In some cases the fluorescence signatures are distinct, and work has been done to perform computer classification of seafloor scenes based on the RGB representations of the fluorescence. Imaging is playing an important role in understanding the significance of fluorescence in the marine environment, and in putting the phenomenon to practical scientific use.

9:20am **IPF-TuM5 Deep Sea Bioluminescence**, ***E.A. Widder***, Ocean Research & Conservation Association **INVITED**

Bioluminescence occurs throughout the depth and breadth of the ocean. Organisms use light to find food, attract mates and avoid predators. An overview of bioluminescence will be provided along with an historical synopsis of methods of measurement. Emphasis will be placed on light producers most likely to impact underwater neutrino telescopes.

10:40am **IPF-TuM9 LIDAR in the Coastal Environment**, ***J. Wozencraft***, US Army LIDAR Bathymetry Technical COE **INVITED**

11:20am **IPF-TuM11 Streak-Tube Imaging and the Virtual Periscope**, ***B.E. Hubbard***, Areté Associates **INVITED**

This presentation will survey two distinct types of underwater imaging technology that have been developed in recent years for use by the military community. Areté Associates has developed and patented an innovative LIDAR technology that exploits the high spatial-temporal resolution of a streak-tube to generate extremely high-resolution 3-D images of scenes from a remote platform. This unique approach to 3-D imaging LIDAR enabled unrivaled object detection and classification in turbid media. Since then, Areté has developed several LIDAR systems for the mine countermeasures community that utilizes STIL technology to detect sea mines from air and underwater-borne platforms. Areté Associates' patented Virtual Periscope system enables underwater vehicles to image scenes from below the ocean surface without the need to raise a periscope. This technology improves stealth and mobility of the vehicle and reduces the risk of collisions with surface objects. The Virtual Periscope system uses a compact set of sensors and algorithms to measure and unwrap the image distortions caused by the wavy ocean surface.

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