

# DEPTH OF BURIAL OF UXO IN ESTUARY ENVIRONMENTS

## MR23-C1-3855

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# Technical Background

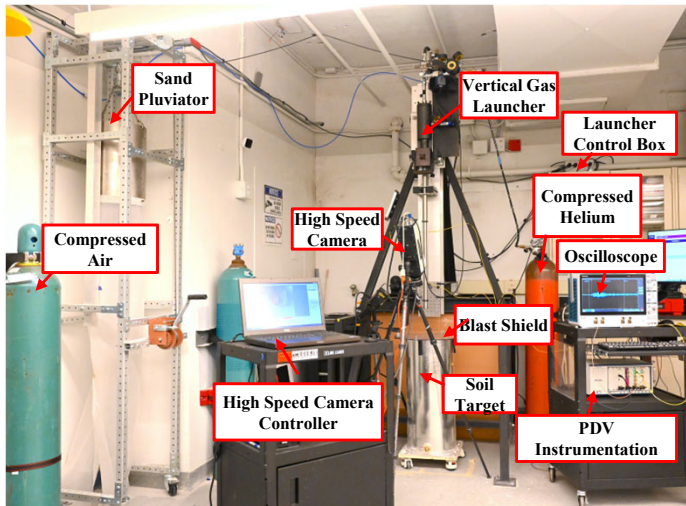
To develop methodology for predicting the Depth of Burial (DOB) of underwater UXOs using site specific geotechnical, hydrodynamic, and munition data.

- Soil: at NYU
- Water: at NPS

**MR23-C1-3855 combines water + Soil to develop a user-friendly methodology factoring in the effect of interfaces and projectile AoA and Obliquity**

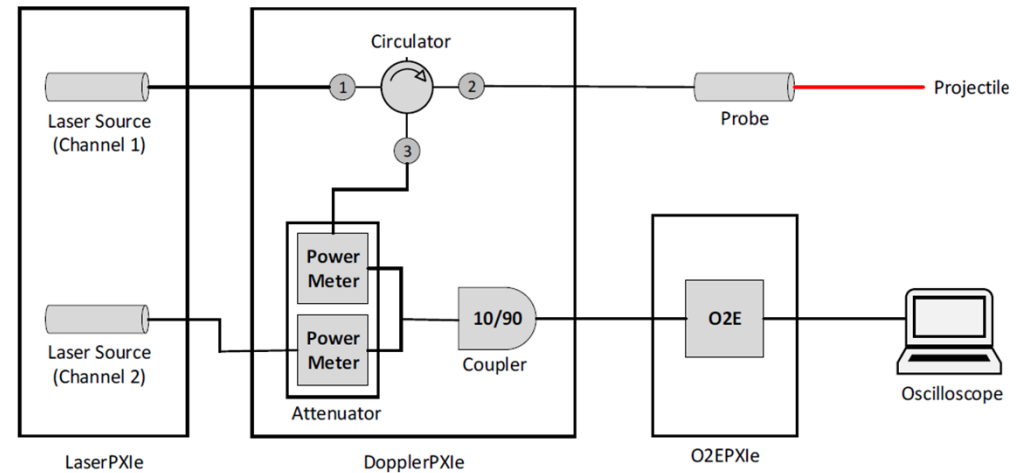
# New Facilities Have Been Put in Place

## Gravity-aligned impact range



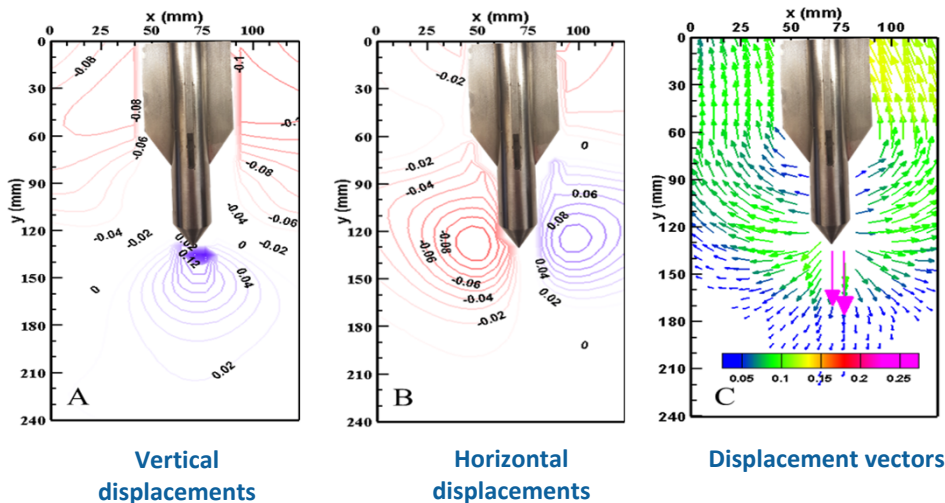
Impact range at MC

## Two-channel Photon Doppler Velocimeter

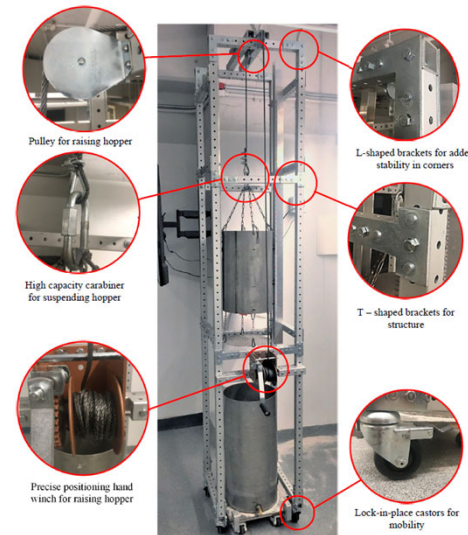


Direct measurement of penetration resistance.

## Transparent soils



## Precise target preparation techniques



Sand pluviator for preparing loose, dense samples under dry, wet conditions.

## DOF Code Upgrades

### UnUXO modifications

- Forces are now described by constant drag and lift coefficients.
- We will take out gravity and replace the drag and lift coefficients ( $f_{drag}$ ,  $f_{lift}$ ) with GeoPoncelet expressions that are derived from CPT measurements.

$$m \frac{d\mathbf{V}}{dt} = (\rho\Pi - m) g\mathbf{k} + f_{drag} \mathbf{e}_d + f_{lift} \mathbf{e}_l$$

$$\mathbf{I} \bullet \frac{d\boldsymbol{\Omega}}{dt} = \mathbf{r}_v \times \mathbf{f}_b + \mathbf{r}_f \times (\mathbf{f}_{drag} + \mathbf{f}_{lift}) + \mathbf{M}_r$$

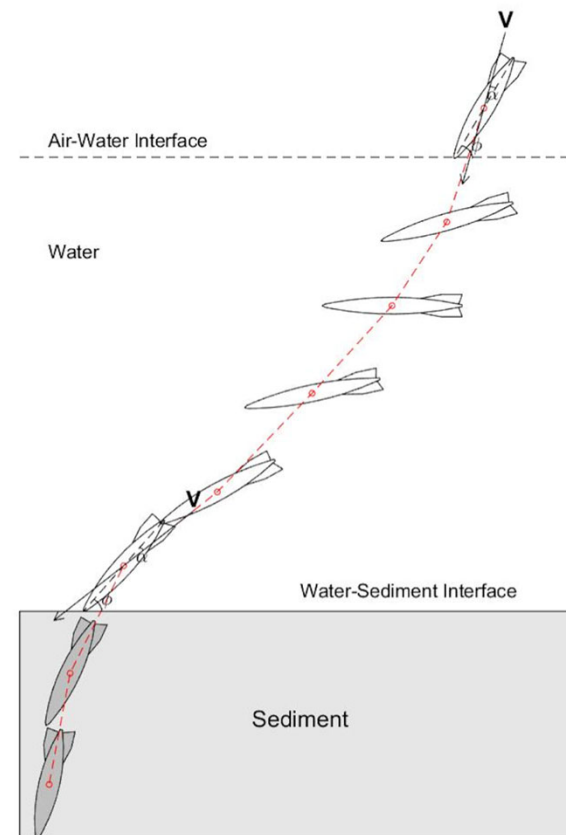
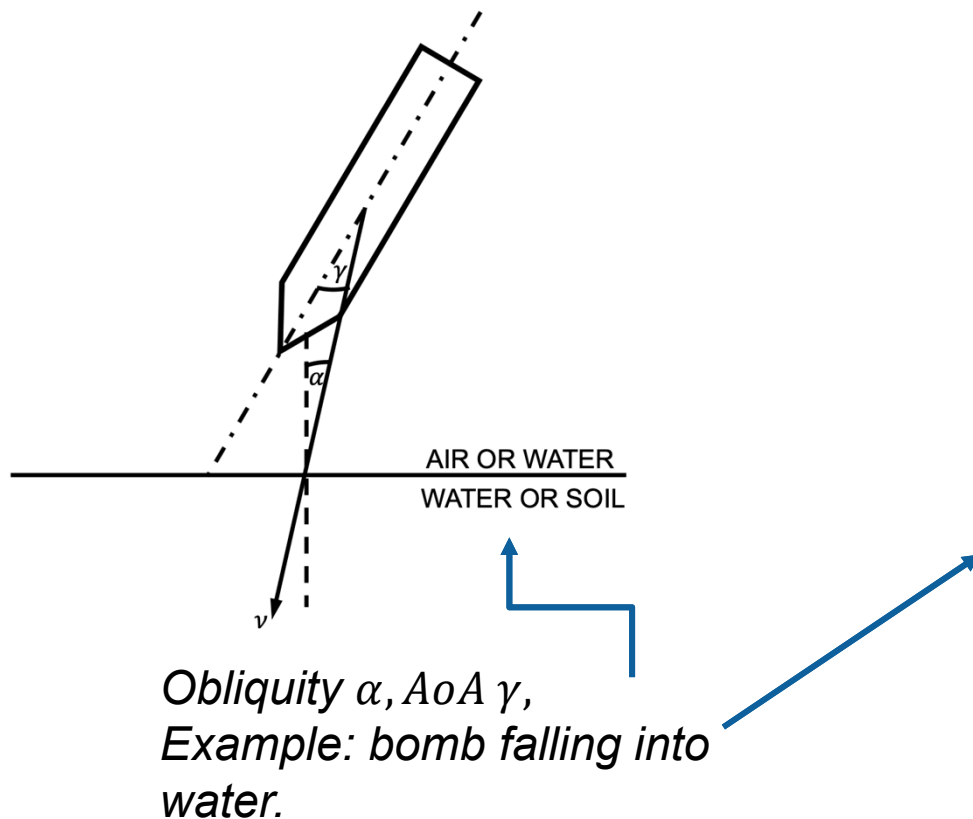
Equations describing translation  
and rotation

We can likely reduce number of degrees of freedom.

# Experiments in Soil and Water

Measure **drag** and **lift** coefficients.

- **Drag** comes from deceleration driven by penetration resistance.
- **Lift** results from transverse forces when AoA is not zero, which causes lateral motion and rotation. Experiments will be in water, sediment, and transparent soil



# Refine Model

