Underwater Bomb Trajectory Prediction

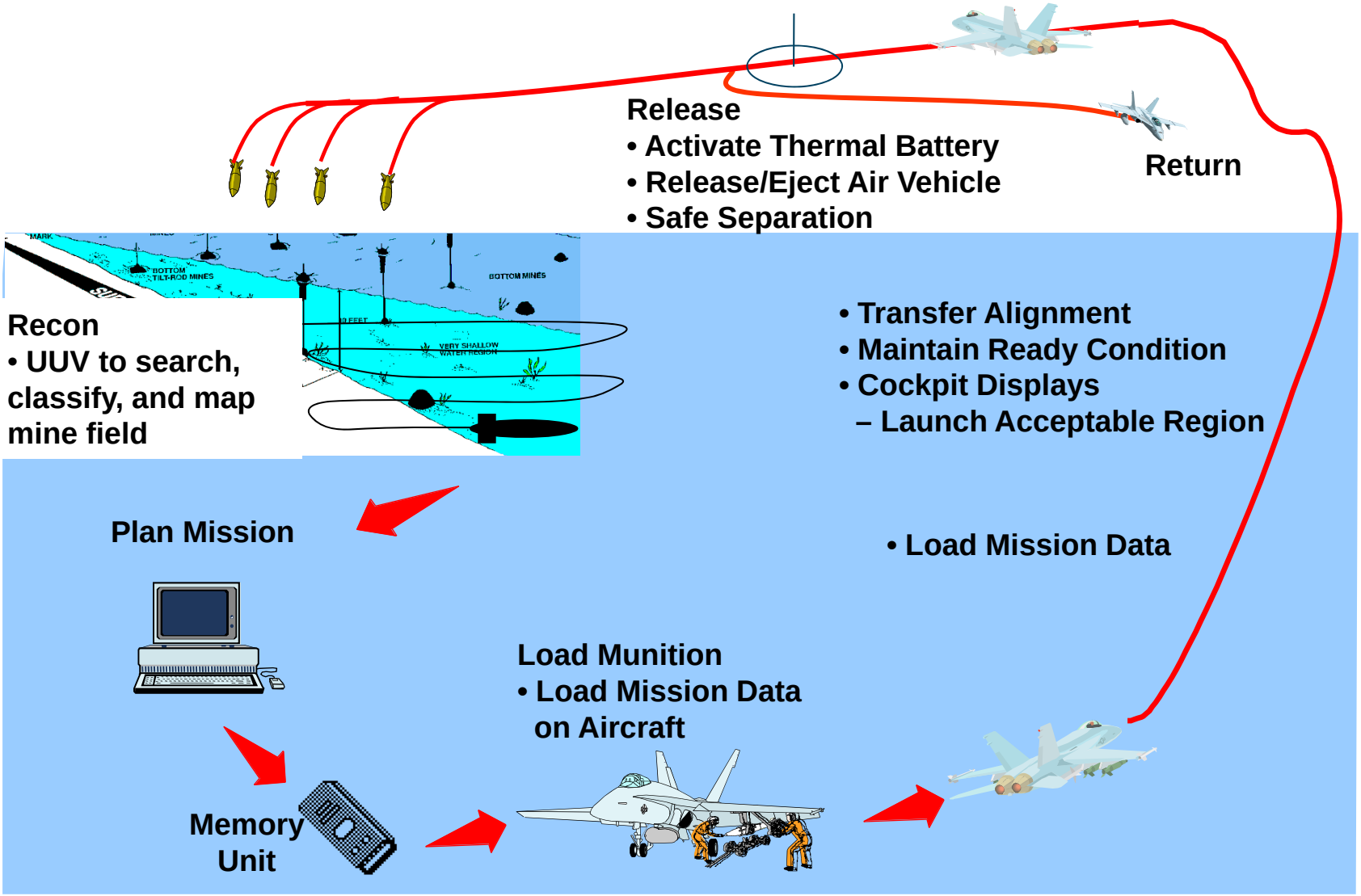
Peter C. Chu
Naval Ocean Analysis and Prediction (NOAP) Laboratory
Naval Postgraduate School

Sponsored by
Office of Naval Research
(Program Manager: Brian Almquist)

Collaborators & Contributors

- Ronald Betsch, Naval Oceanographic Office, Stennis Space Center, Mississippi
- Jack Goeller, ATR Corp
- Jim Markarski, Boeing
- Paul Gefken, SRI International, USA
- LCDR Charles Allen, Naval Postgraduate School
- LCDR Greg Ray, Naval Postgraduate School
- C.W. Fan, Naval Postgraduate School

Mission Execution CONOPS



Organic Mine Warfare

Because of a lack of immediately available mine counter measures in any large quantities, the Navy is evaluating the JDAM for its capability in countermine and assault breaching. The JDAM accuracy, repeatability (guaranteed delivery patterns for multiple deliveries), and fusing options make it a prime contender for an interim capability.

- Brian Almquist, ONR, 2008

Joint Direct Attack Munition (JDAM) Assault Breaching System (JABS)

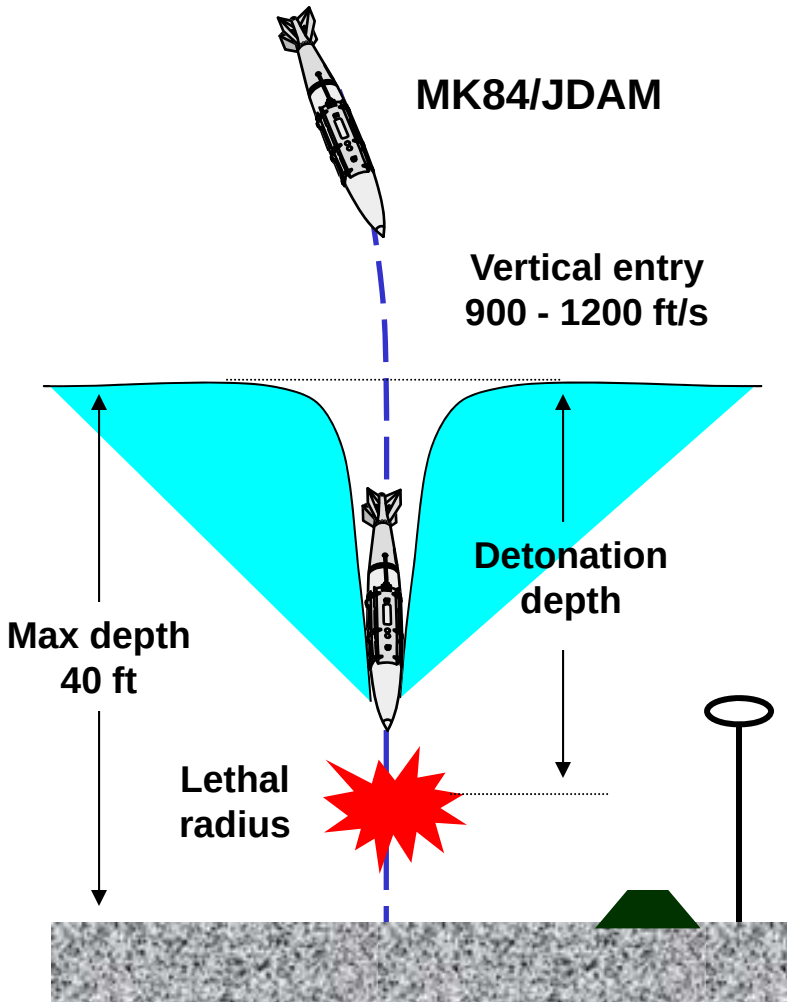
Standoff Delivery Platform

SZ & BZ Countermine & Counterobstacle

- **Current capability to clear SZ/BZ mines and light obstacles on the beach**
- **USN and/or USAF Delivered, Signed MOA between USN & USAF for Assault Breaching Munitions Delivery**
  - **B1, B2, B52, F/A18, JSF**
- **New mission for an existing weapon system**

We know JABS performs well to water depths of 10 ft. Can it go deeper?

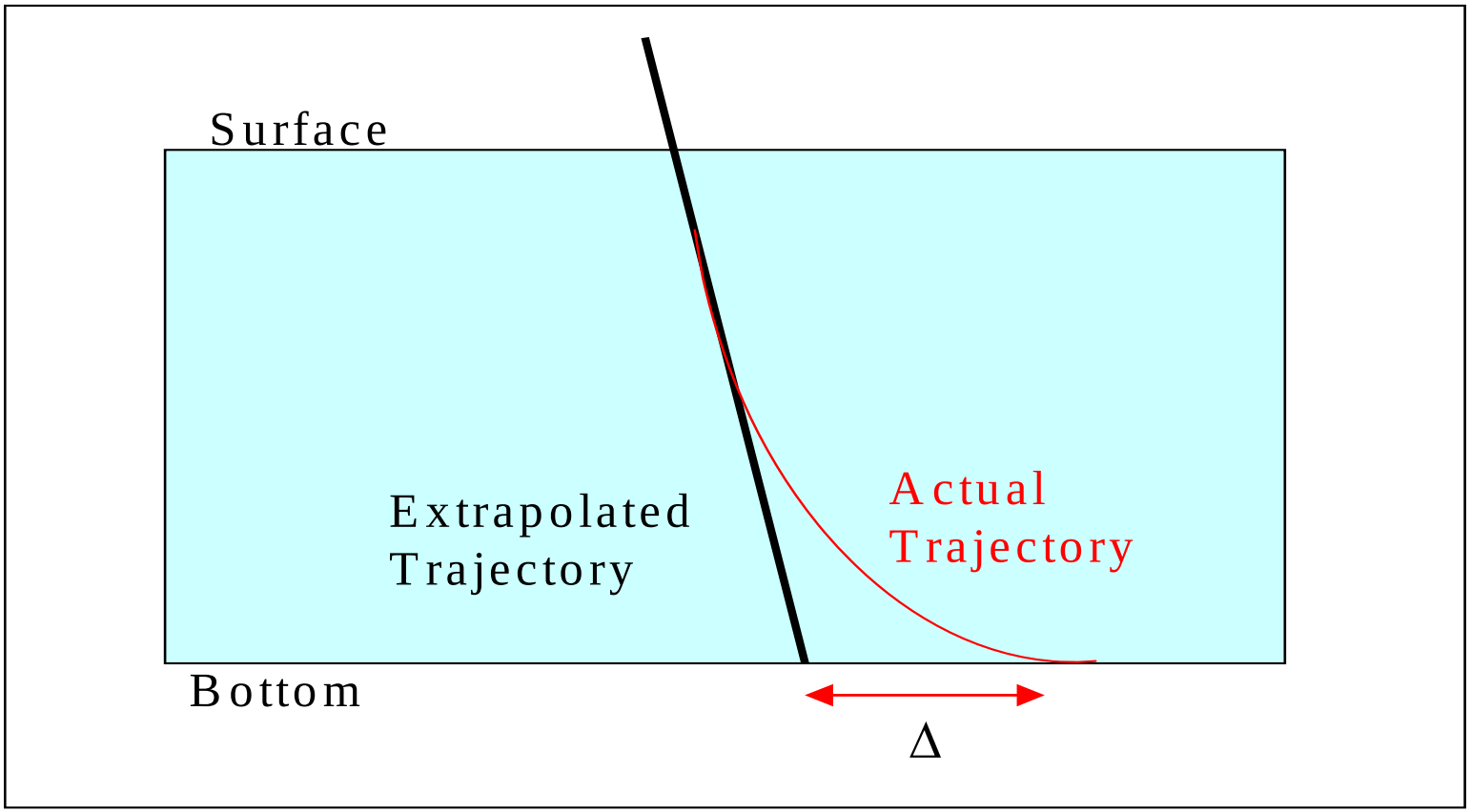
Mine Neutralization by MK84/JDAM



Objective

- Investigate lethality of precision guided bombs against mines in 10-40 ft water depths (VSW).

- Investigate bomb stability after water impact, lethal radius, and optimum detonation depth for fuse design.



For effective mine clearance

$\Delta < 7$ ft (2.1 m)

References

- Chu, P.C., and C.W. Fan, 2011: Probability density function of underwater bomb trajectory deviation due to stochastic ocean surface slope. *Journal of Dynamic Systems, Measurement and Control*, American Society of Mechanical Engineers, **133**, 031002 (13 pages)
- Chu, P.C., J.M. Bushnell, C.W. Fan, and K.P. Watson, 2011: Modeling of underwater bomb trajectory for mine clearance. *Journal of Defense Modeling and Simulation, The Society for Modeling and Simulation International*, ***8*** *(1), 25-36*
- Chu, P.C., C.W. Fan, and P. R. Gefken, 2010: Diagnostic-photographic determination of drag/lift/torque coefficients of high speed rigid body in water column. *Journal of Applied Mechanics*, American Society of Mechanical Engineers, **77**, 011015-1