ONR

OFFICE OF NAVAL RESEARCH S&T

Revolutionary Research . . . Relevant Results

Sharpening the Edge

Serving the Next Generation Warfighter . . . Now

Large UUV Technologies

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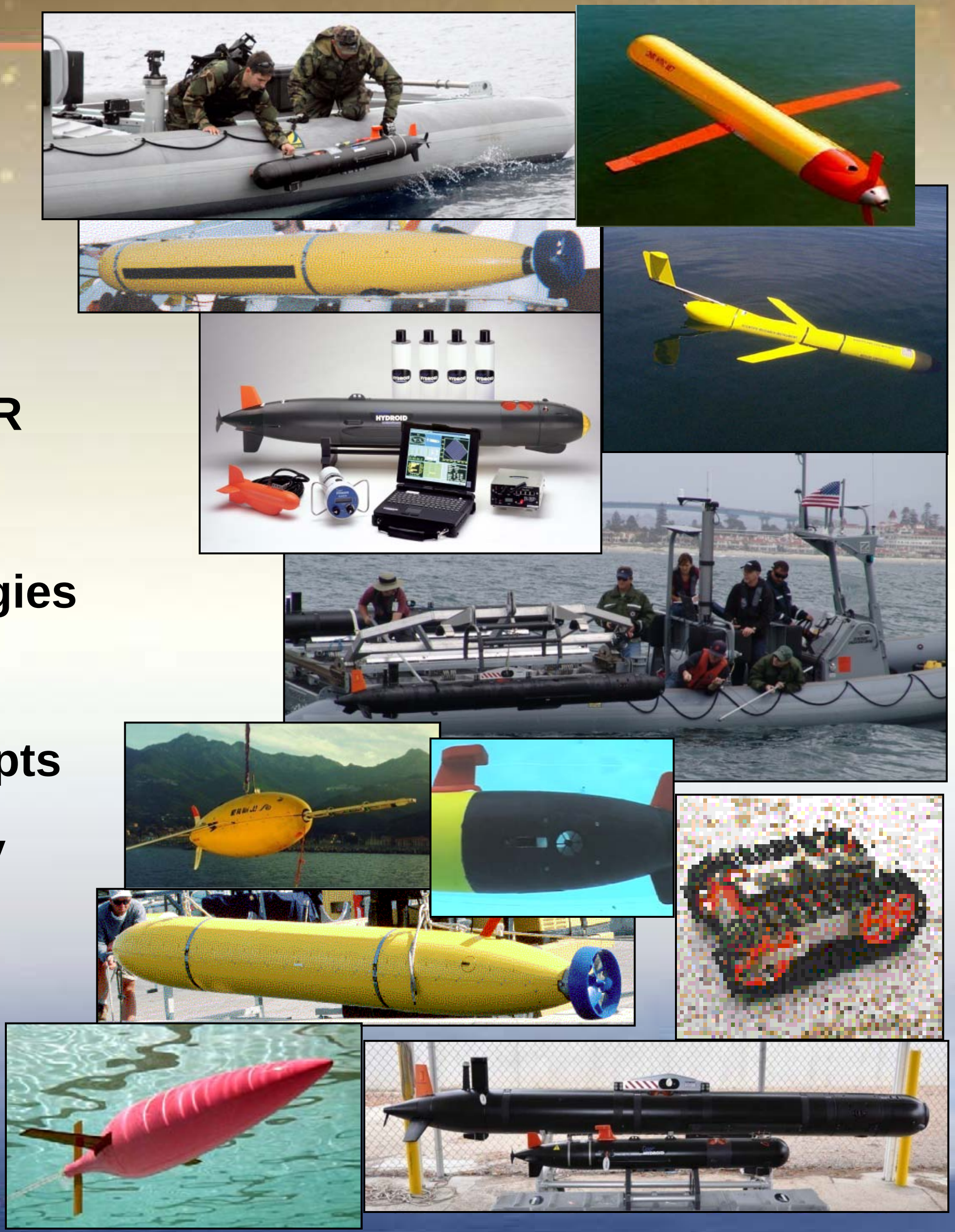
ONR Code 32

UUV Technology Strategy



Objectives:

- Multidisciplinary Research
  - New ideas, biomimetics, SBIR
- Basic & Applied Efforts
  - Mature component technologies
  - Autonomy
  - Feasibility of systems concepts
- Mission-Oriented Technology Demonstrations

Revolutionary Research . . . Relevant Results

Rapid Transition – Ocean Gliders

an example of S&T to Fleet use

Research and Development

ONR Investment history leading to ocean gliders
- Drifting ocean samplers 1950-1990 (SOFAR, RAFOS, ALACE)
- Vertically profiling drifting samplers 1990s (P-ALACE, ARGO)
- Powered vehicles matured in 1990s (AutoSub, REMUS, SAHRV)

Ocean Gliders developed in late 1990s
- Steerable through pitch, roll and buoyancy changes - vertically soaring
- Deployed globally – Labrador Sea, Gulf of Alaska, PAC, LANT, Cross Kuroshio, Gulf Stream
- Average mission time 3 - 4 months, max to date 7 months

Fleet Demonstration

Ocean Gliders demonstrated in RIMPAC 04, TASWEX 04, SMART SEARCH 05, TASWEX 05, RIMPAC 06, VALIANT SHIELD 07, RIMPAC 08
- T-AGS, small boat, contract vessel launch/recovery
- USS Buffalo (SSN 715) launch via DDS
- Progressively increasing complexity/numbers, sensors

Significant improvement in Battlespace characterization

Transition and Acquisition

OSD, ONR, SPAWAR TTI Funded to accelerate transition
- Navy Glider Consortium refining designs
- Providing CNMOC 6 hardened prototypes (3 FY07, 3 FY08)
- Signed TTA - OPNAV N84, ONR, SPAWAR PMW-180 and CNMOC
- CNMOC purchased 12 R&D variant Gliders for FY07-FY09
- Operator training, sampling strategies, C2, CONOPS refinement Oceanographer of the Navy N2/N6F5

Littoral Battlespace Sensing POR- purchase of 150 Gliders by FY12

S&T Developments in Man Portable and Light Weight UUVs Technology

Improved Navigation

- Low power INUs for UUVs
- USBL Navigation
- Robust DVL/ADCP
- Low Power Navigation
- FBN

Control & Autonomy

- UUV JAUS Standards
- ASTM F41 Architecture
- Hierarchy Autonomy
- Behavior Autonomy
- Obstacle Avoidance
- Onboard CAD/CAC
- Anti-Tamper
- CfN Mission Planning
- Precision Positioning

Launch & Recovery

- USV L&R
- Autonomous RHIB L&R
- Ship L&R
- Submerged L&R / Docking Station

Platform Improvements

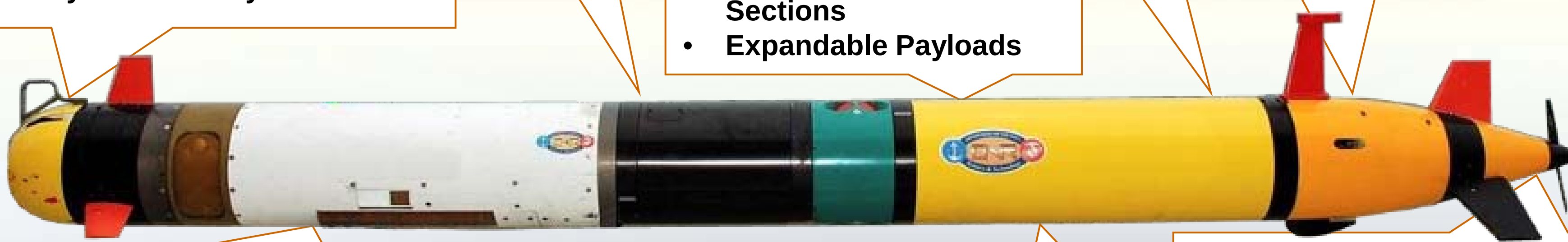
- Net Cutting
- Autonomous Recovery
- Forward Fin Module
- Hovering Module
- Anchor Module
- Ballast Module
- Payload Delivery Modules

Modularity

- Standard Interfaces
- Flooded or Dry Payload Sections
- Expandable Payloads

Communications

- Acoustic Comms
- Fast RF Comms



Sensors

- Marine Sonics DF Sidescan
- EdgeTech Sidescan
- SSAM DF
- RTG / LSG
- ASW
- ATLAS FLS
- LF sensors
- Video w/LED Bar
- Blazed Array Sensors
- Environmental Sensors
- Chemical Sensors
- BOSS

Propulsion

- Low Noise & Power Motors

Power Systems

- Li Ion Batteries
- Safe Pressure Tolerant Li Ion Batteries
- High Endurance Power Tow Module

Importance Of Large UUVs

The Chief of Naval Operations is planning a major push toward unmanned underwater vehicles with high stamina

Inside the Navy - 10/18/2010

Large UUVs

Class	Diameter (inches)	Displacement (lbs.)	Endurance High Hotel Load (hours)	Endurance Low Hotel Load (hours)	Payload (ft^3)
Man-Portable	3 - 9	< 100	< 10	10 - 20	< 0.25
LWV	12.75	~ 500	10 - 20	20 - 40	1 - 3
HWV	21	< 3,000	20 - 50	40 - 80	4 - 6
Large	> 36	~ 20,000	100 - 300	>> 400	15 - 30 + External Stores

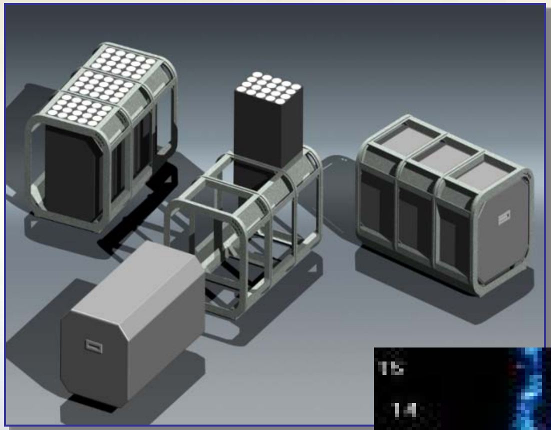
Missions:
- Persistent ISR
- ASW Hold at Risk
- Long Range Oceanography (future)
- Payload Delivery (MIW, ASW, SOF, EOD, TCS)

UUV Master Plan 2004

Large Diameter Unmanned Undersea Vehicle
Naval Strategic Priority

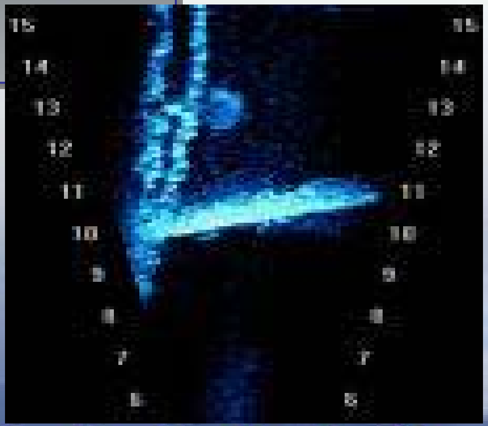
Product Description:
- Reliable Long Endurance UUV capable of 60+ days of operation in the Littorals
- Program will develop the needed Autonomy, Energy, and Core UUV systems to operate in complex ocean environment near harbors, shore, and high surface traffic locations

Key Program Goals
- 5x – 10x Current UUV Energy Density
- Autonomous in the Littorals:
- Open Architecture
- Open Ocean/Over the Horizon Operations



Open Architecture Modular Payloads

Warfighting Payoff:
- Enables realization of fully autonomous UUVs operating in complex near shore environments to increase capability
- Cost effectively closes war fighter capability and capacity gaps in critical mission areas
- Extends and multiplies the reach of the platform into denied areas and reduces platform vulnerability

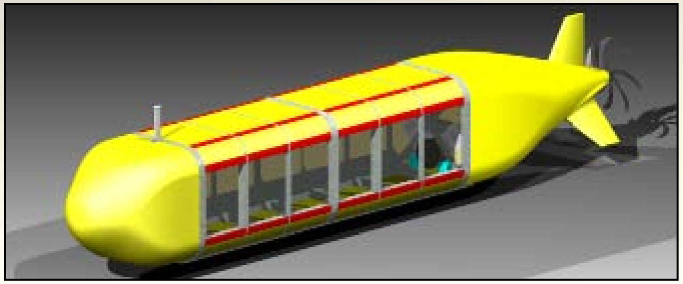


Autonomous Operation

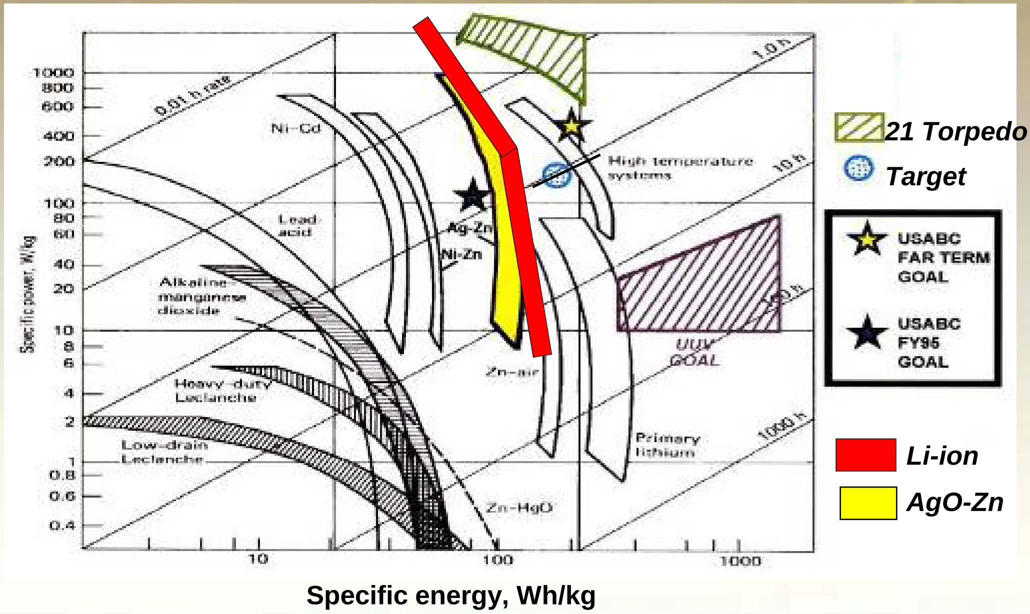
LD UUV Science and Technology Areas

Develop leap ahead capability in UUV Technologies in:

- **Energy Systems**
- **Autonomy (operate in the Littorals)**
- **Endurance Technologies**



Energy Systems



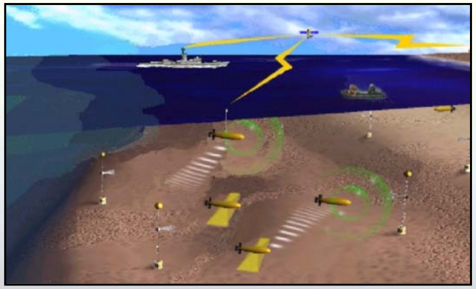
Significant unique S&T challenges to meeting UV power source requirements include:

- air-independent operation (have to carry oxidizer)
- long endurance (40+ hours up to 30 days)
- rapid, safe refuelability
- maintain stealth (low/no signature)
- environmentally friendly (fuels and oxidizers)
- weight/volume constraints
- buoyancy
- quick start-up
- cost effective

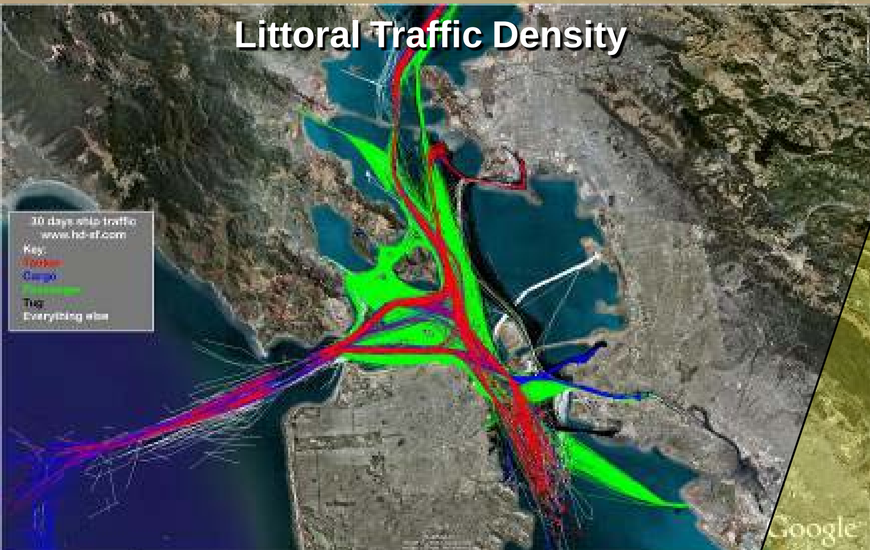
- **UUVs will need more power than current batteries technology can provide**
- **New technologies (fuel cells and combustors) offer additional energy density over batteries**
- **Goal of 1000 Whrs/liter**

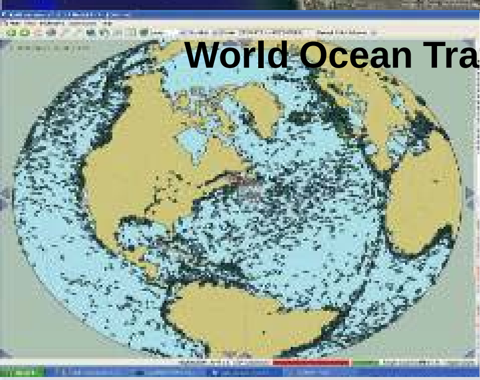
Autonomy Challenges

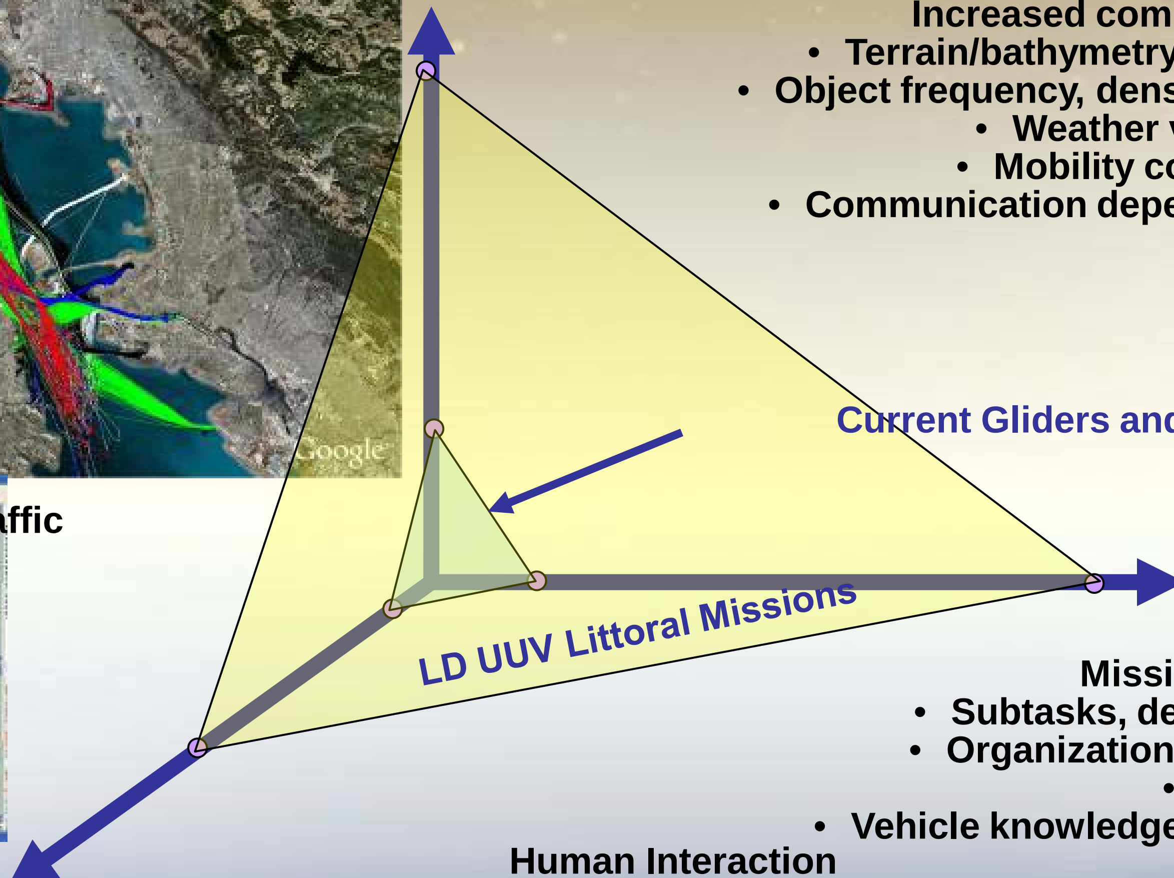
- **Operations in complex diverse littoral environments**
- **Limited communication connectivity with UUV**
- **Navigation with long undersea operation**
- **Complex missions with requires increased autonomy**
- **Manned platform/unmanned system interactions**



Why is this a Hard Problem?







Environmental Complexity
Increased complexity in:
- Terrain/bathymetry variation
- Object frequency, density, intent
- Weather variations
- Mobility constraints
- Communication dependencies

Mission Complexity
- Subtasks, decision making
- Organization, collaboration
- Performance
- Vehicle knowledge requirements

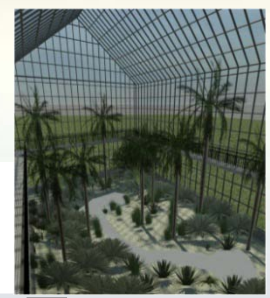
Human Interaction
- Type of operators/users (workload, skill levels, etc.)
- Frequency, duration, robot initiated interactions
- Decreased level of situational awareness

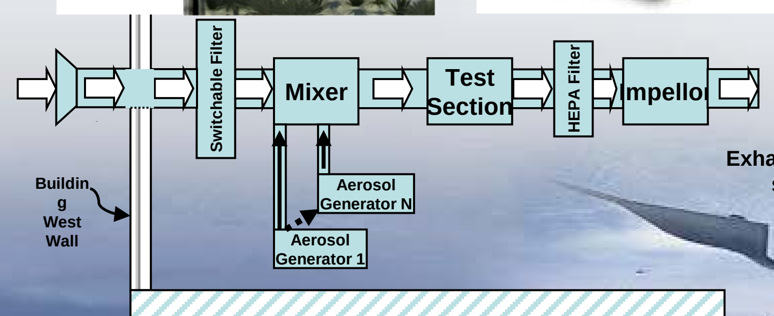
New laboratory for Autonomy Research

NRL's Autonomous Systems Research Laboratory

Conduct multidisciplinary S&T research and integrate S&T components into research prototype systems to address critical autonomy needs for DON and DOD

- Human-Systems Interaction Labs
- Power and Energy Lab
- Machine and electrical shops
- Sensor Research Lab
  - Reconfigurable Prototyping High Bay
  - Desert High Bay
  - Littoral & Hydrodynamics High Bay
  - Tropical High Bay
  - Upland Forest





Aerosol Flow facility

Technology Challenges

- Power & Energy
- System Reliability
- Autonomy
- C4I / IA
- Navigation without GPS

The Challenge: *Speed to Fleet*

"I never, ever, want to see a Sailor or a Marine in a fair fight! … We have to get technology to the Fleet faster."

- Adm. Gary Roughead, Chief of Naval Operations

Revolutionary Research . . . Relevant Results

The Future

- **Accelerate development of unmanned systems to:**
  - **Close warfighter capacity gaps cost effectively**
  - **Improve operational speed and efficiency**
  - **Increase access and maritime presence**
  - ***Seize the advantage***

- **Future DoN unmanned systems, are "game changers" and must:**
  - **Operate "From the Sea"**
  - **Be interoperable with legacy fleet assets through:**
    - **Launch and recovery from "at sea" platforms, as well as land**
    - **Command and control**

- **Key priorities include:**
  - **Power, power, power**
  - **Networking of unmanned systems with legacy fleet assets**
  - **Rapidly deployable and employable systems**

Questions

Revolutionary Research . . . Relevant Results

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