



ATMOSPHERIC & SPACE TECHNOLOGY RESEARCH ASSOCIATES

SCIENCE + TECHNOLOGY + APPLICATIONS // *Bringing it all together*

# Using LIDAR for Resource Management

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**ASTRA, LLC.**  
**Boulder, CO**

5<sup>th</sup> Forest Technology Conference  
November 18-19, 2015  
Portland, OR



# Shallow Water Situations

❖ Science  
❖ Technology  
❖ Applications  
*Bringing It All Together*





# Shallow Water Techniques

❖ Science

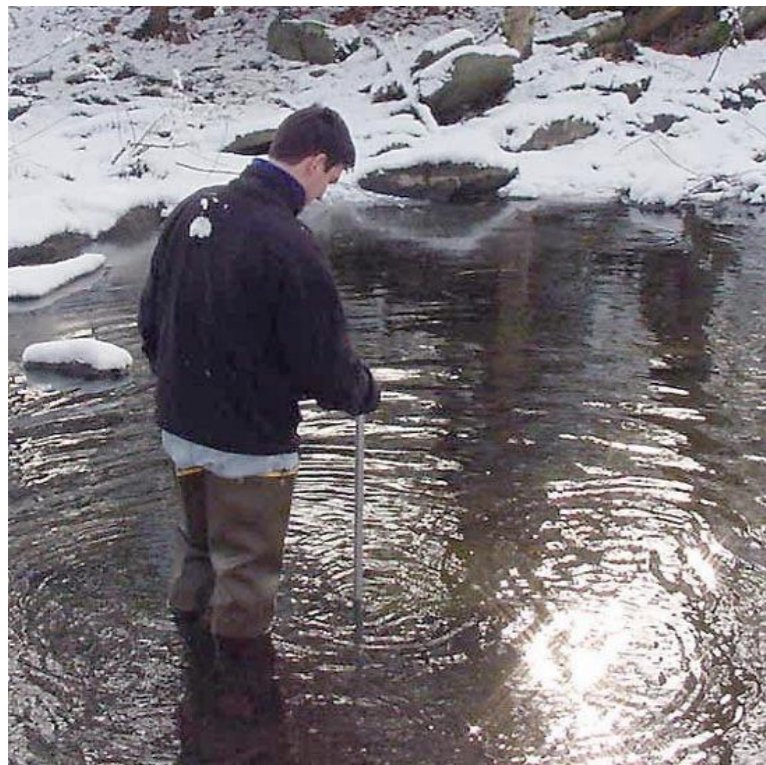
❖ Technology

❖ Applications

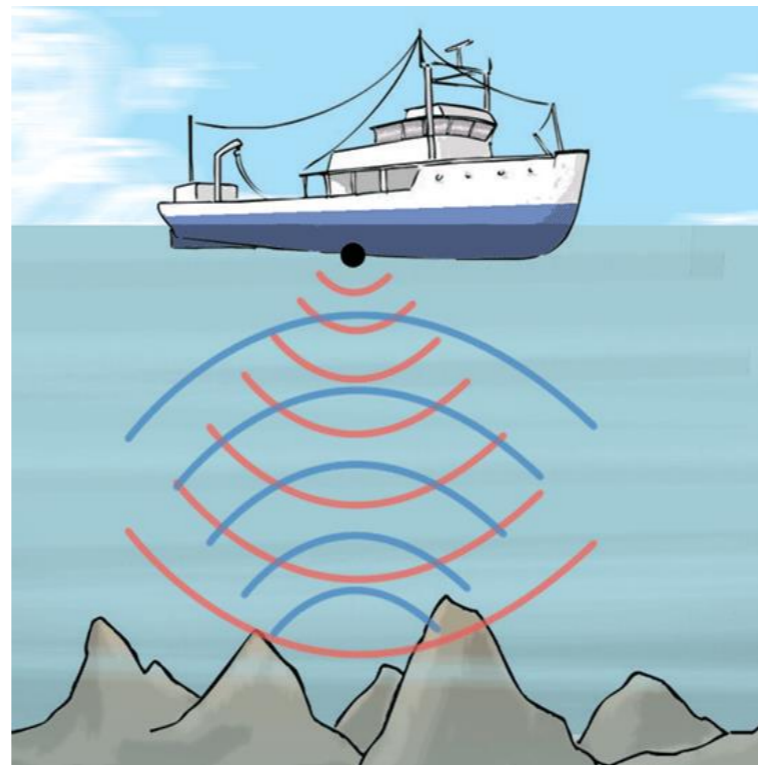
*Bringing It All Together*



- Measuring water depth with a stick is precise but is local and slow
- Impossible in fast moving water



- Sonar can be precise but must be in contact with water
- Impossible in shallow water
- Large surveys are slow



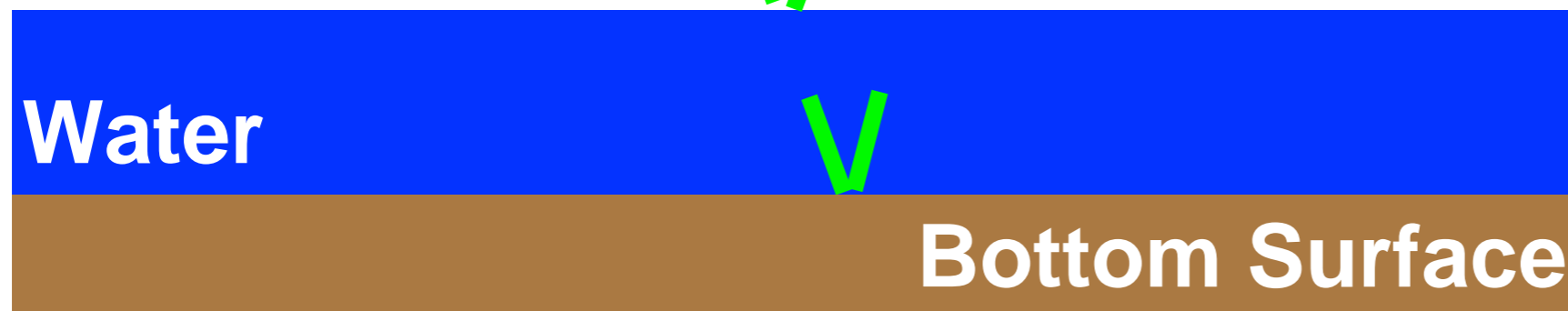
- Airborne Lidar permits fast surveys
- Existing technology has low precision (~30 cm)
- Shallow water presents difficulties



# Current Lidar Bathymetry



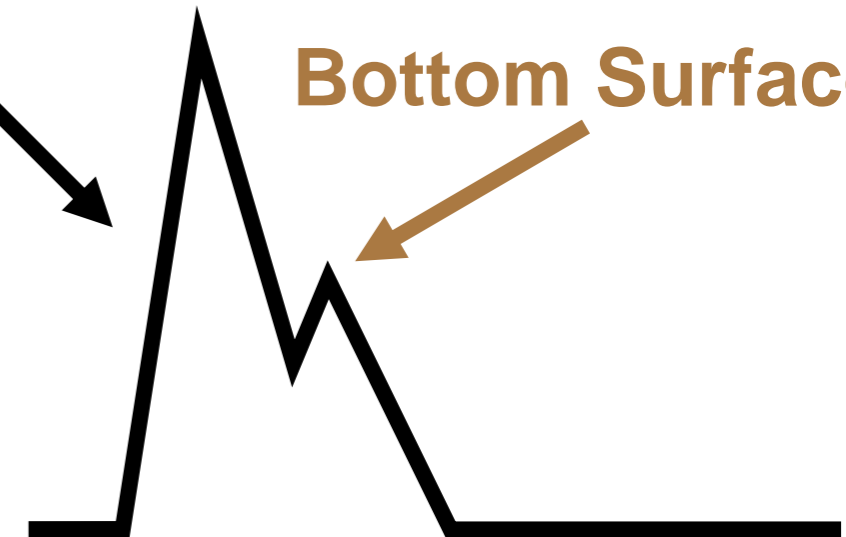
**Time of flight of  
laser pulses  
gives range**



**Signal**

**Bottom Surface**

**Water Surface**





# ASTRA Lidar System

❖ Science

❖ Technology

❖ Applications

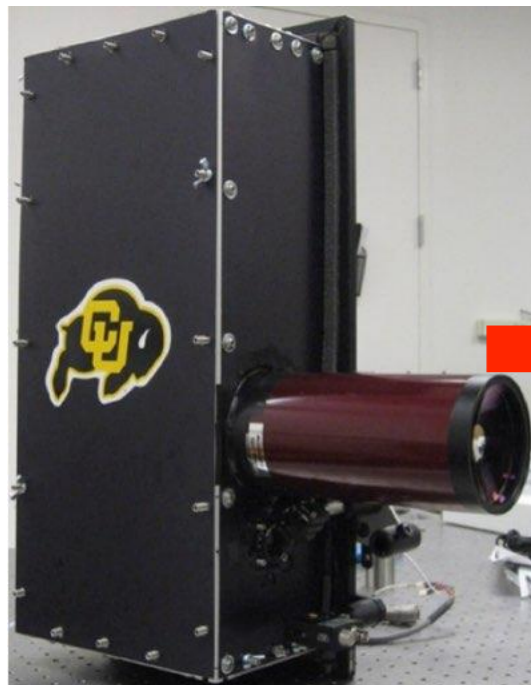
*Bringing It All Together*



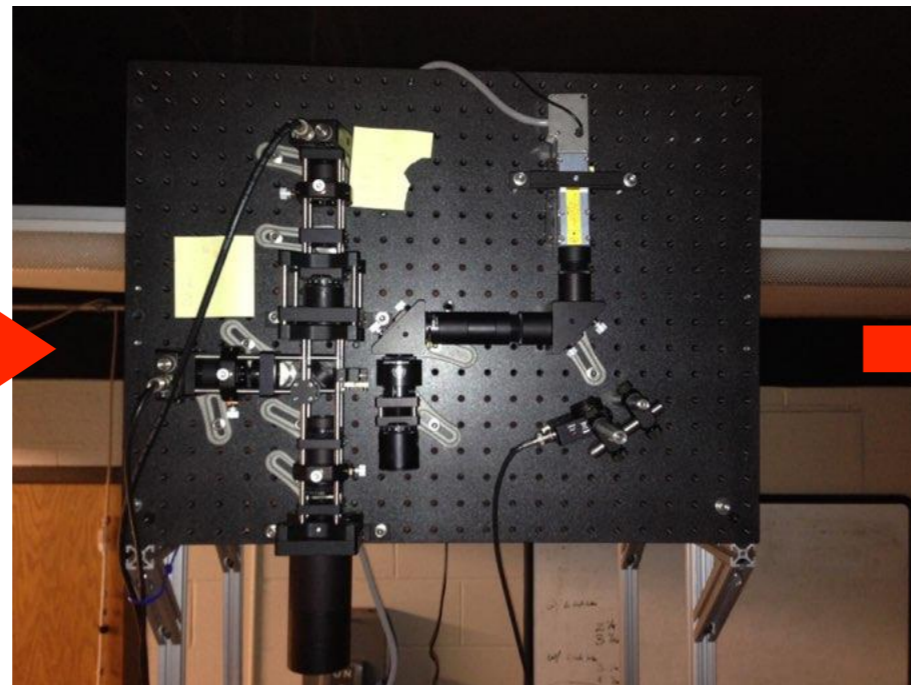
- ❖ Jointly developed with University of Colorado
  - Similar systems used for atmospheric research
- ❖ Designed with shallow water in mind
- ❖ Versatile
  - Scalable from large to small systems



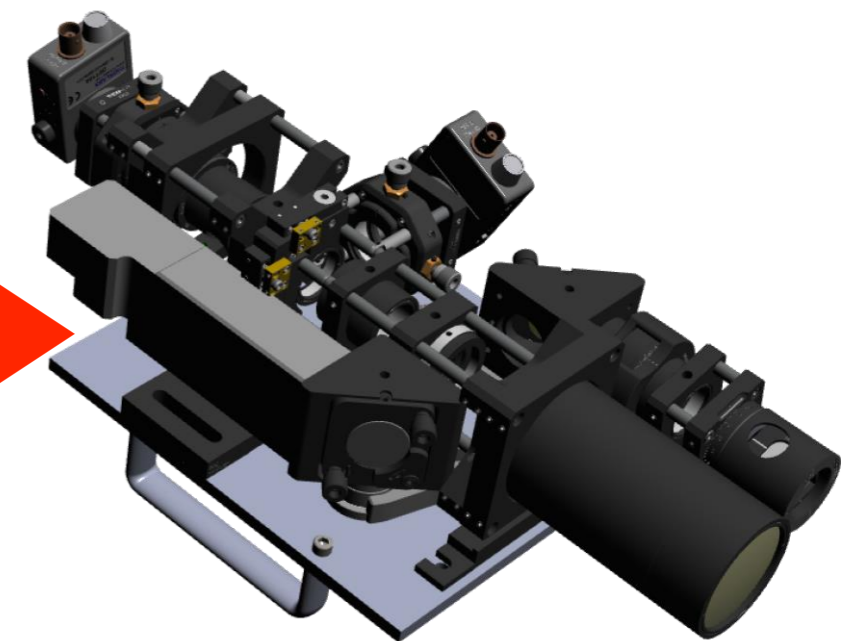
**50 lb  
Checked Bag**



**35 lb**



**7 lb  
Personal Item**



## 1. High resolution

- Depth resolution of 1 cm vs 20+ cm

## 2. Continuous land to shallow to deep water measurement

## 3. Real - time measurements

- Removes lengthy post-processing

## 4. Lightweight

## 5. Reduced complexity

## 6. Relaxed demand on laser specifications

## 7. Scales from handheld to airborne systems

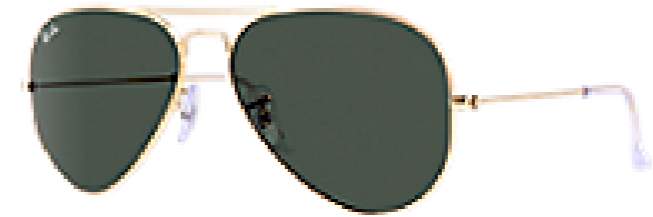
- Potential for UAV-mountable system



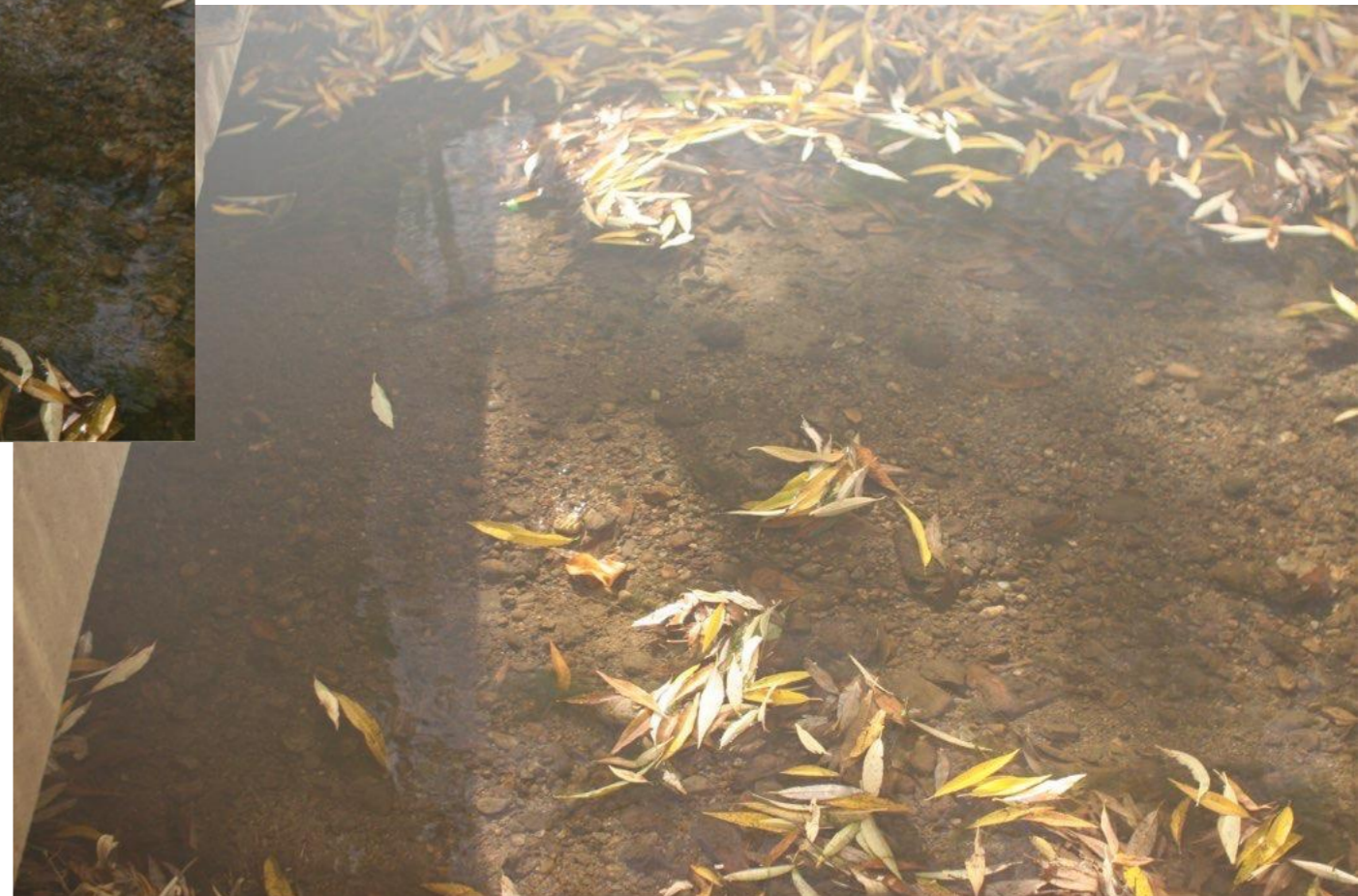
## Polarizer Allows for Different Views of Water



**Accept Surface Glare**



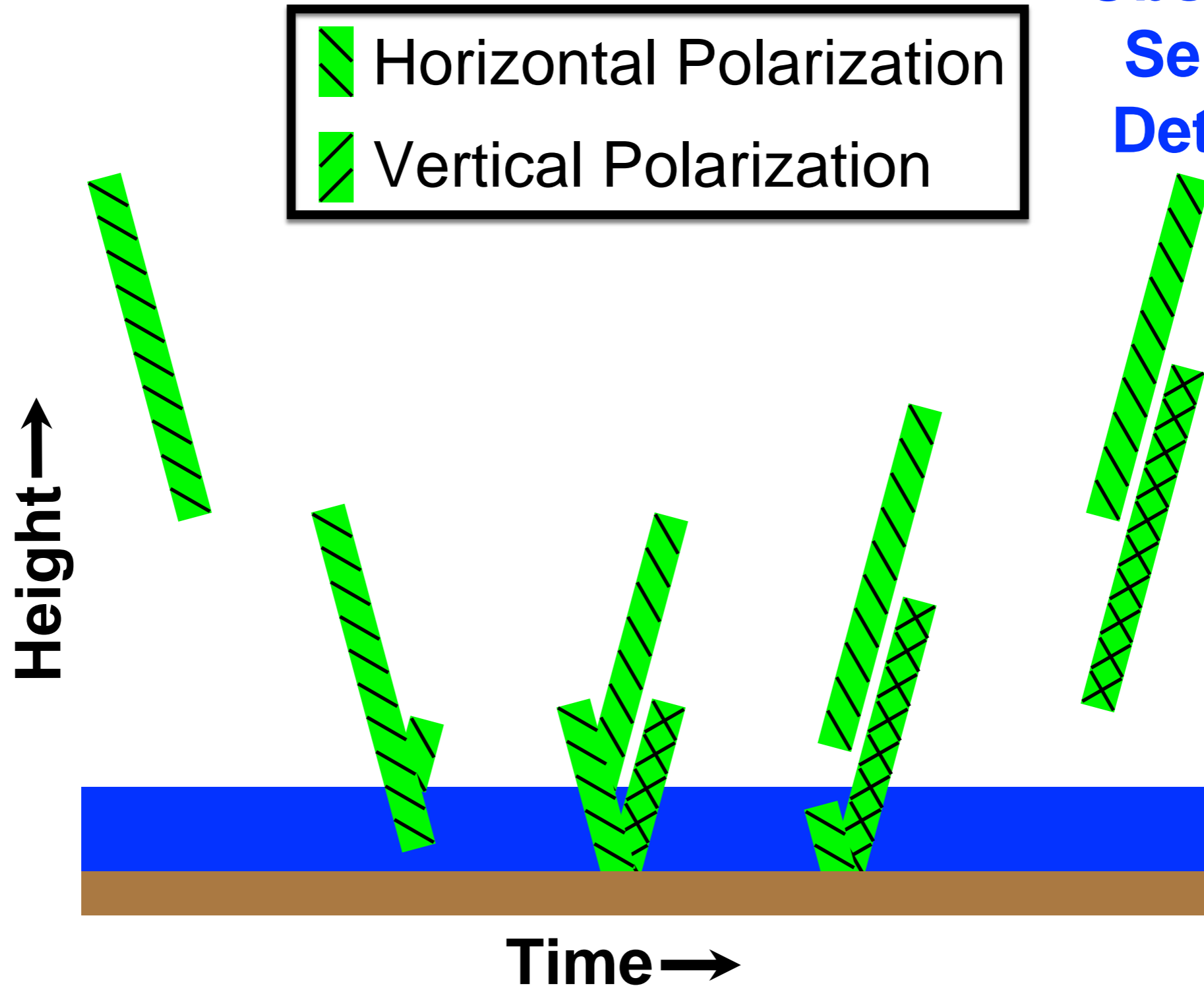
**Reject Surface Glare**





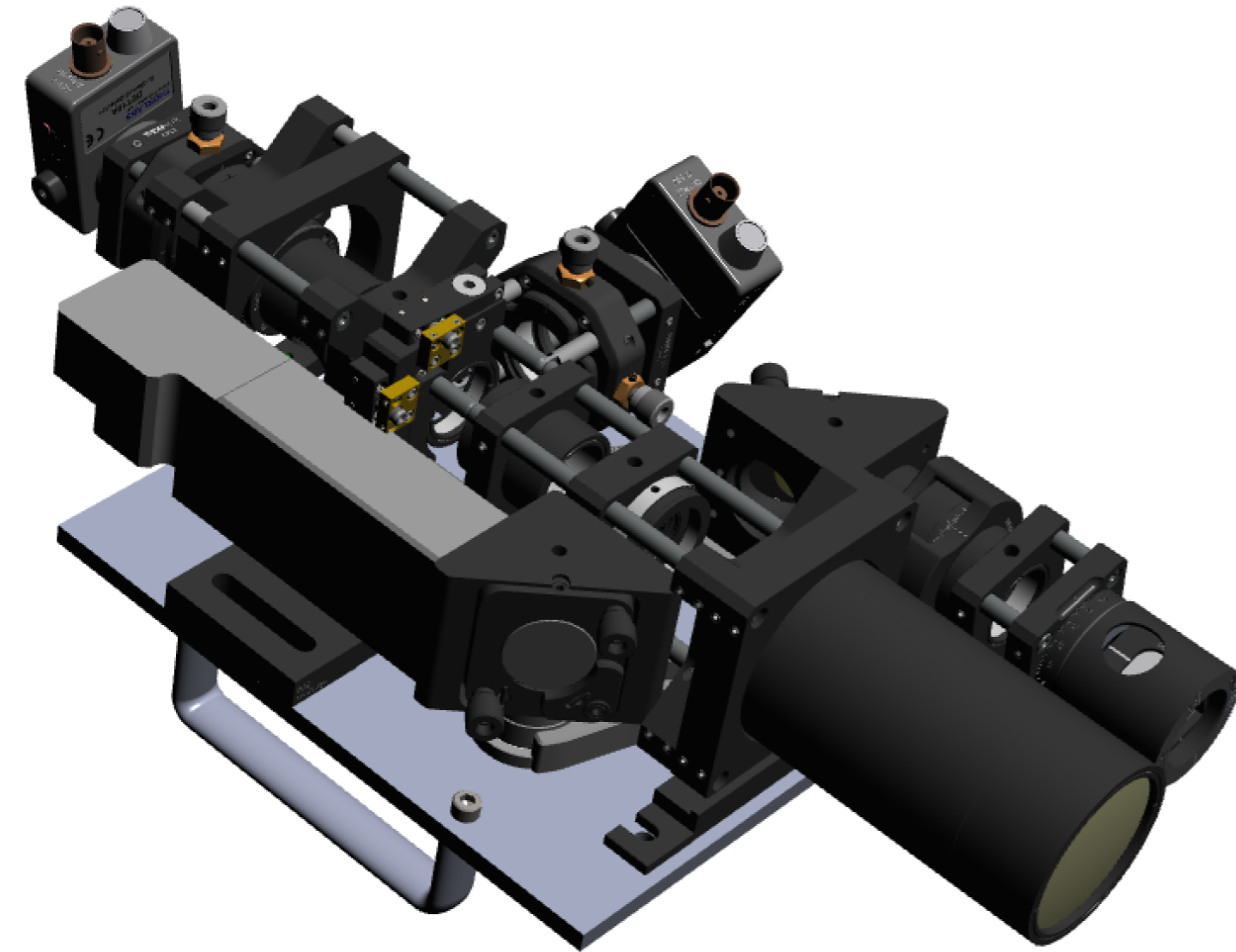
## INtrapulse PHAse Modification Induced by Scattering

Observe on  
Separate  
Detectors





## Demonstration Device



**Small size, weight and power allows use on UAVs and small aircraft**

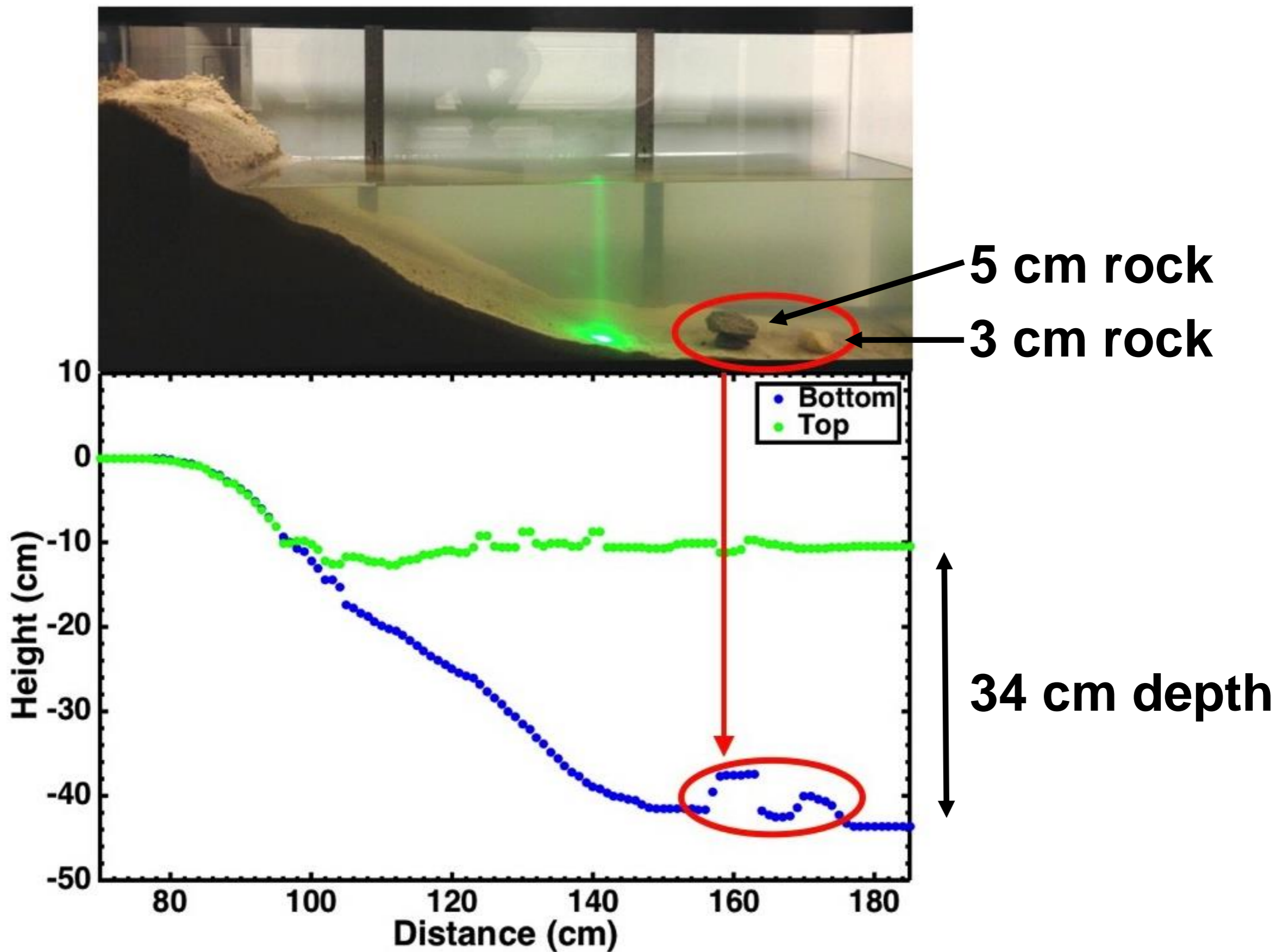
# Laboratory Data - Object Detection

Science

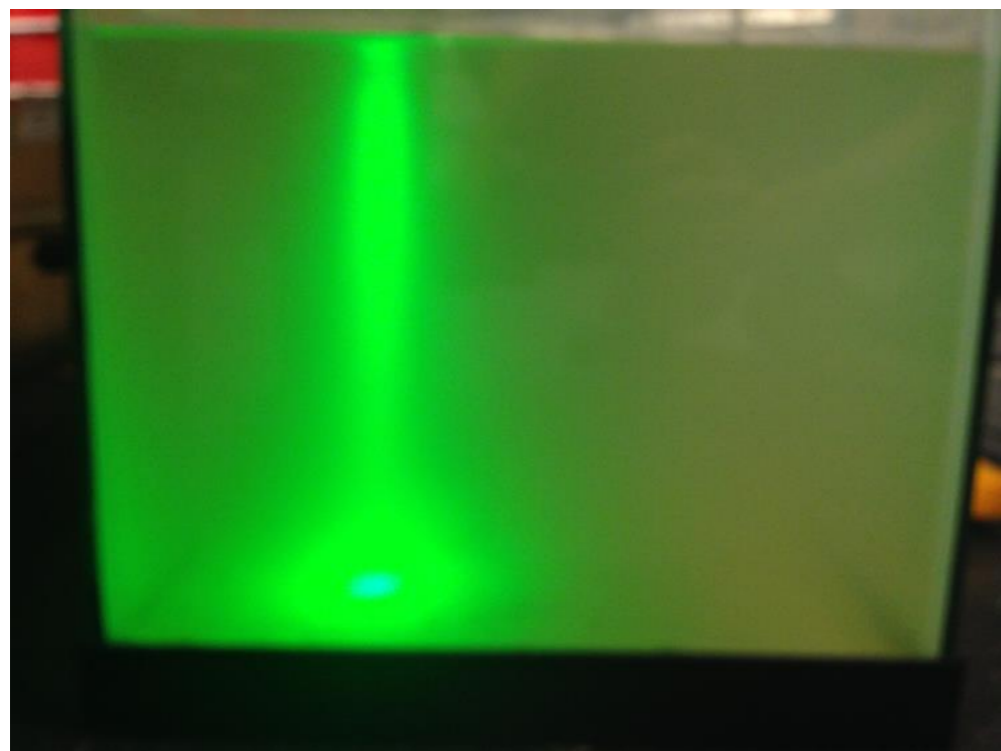
Technology

Applications

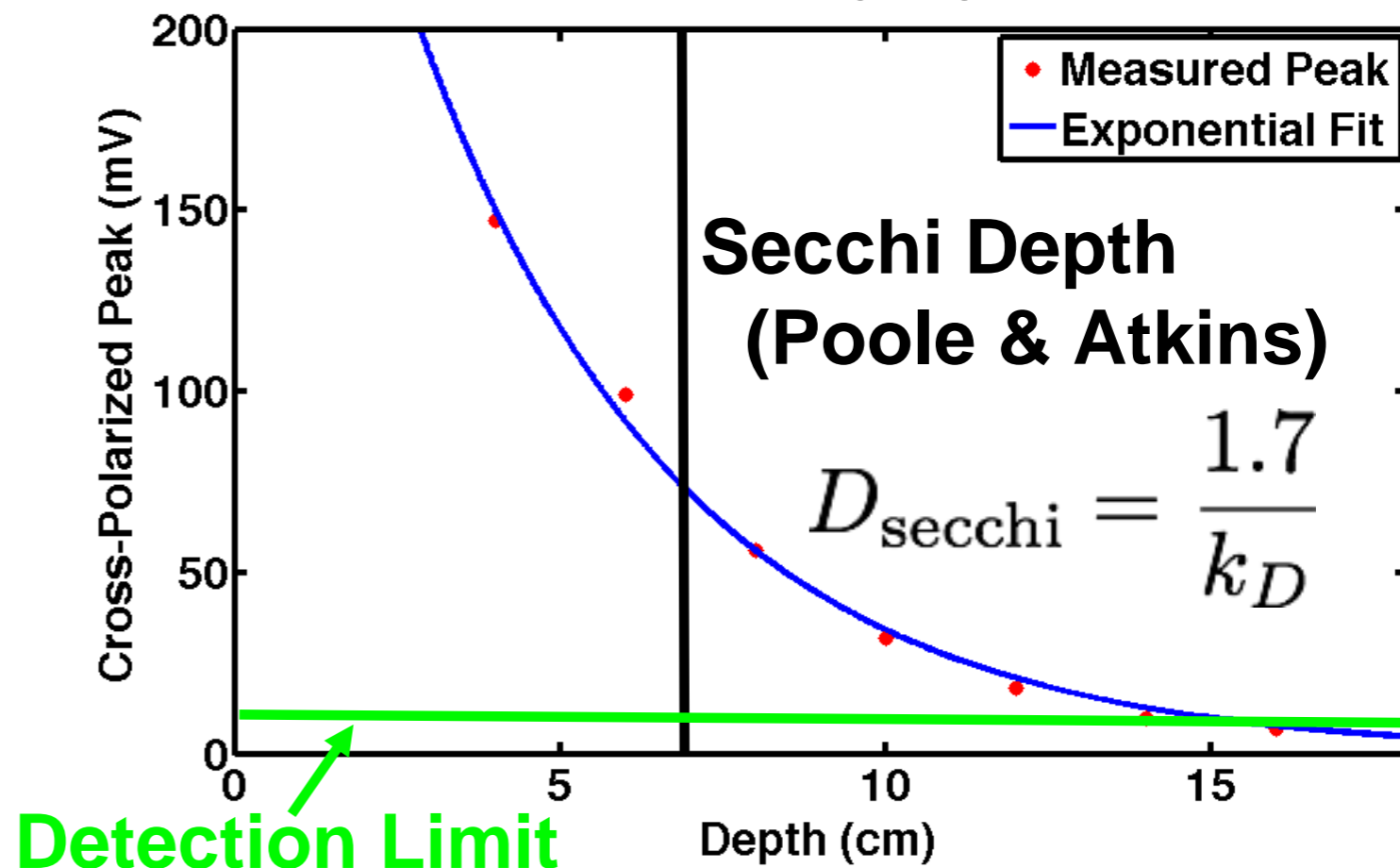
Bringing It All Together







Extinction:  $0.25 \text{ cm}^{-1}$



- Stirred up sand in aquarium
- Non-uniform particle size
- Roughly uniform spatial distribution
- Secchi Depth is how deep you can visually see an 8 in. diameter disk lowered into the water

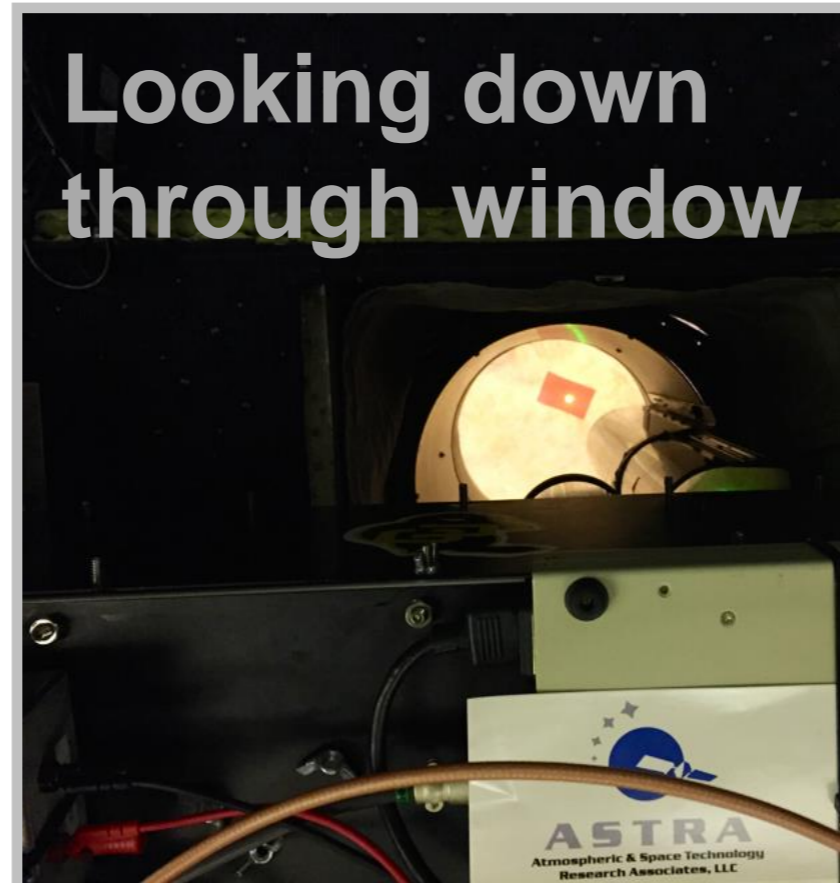
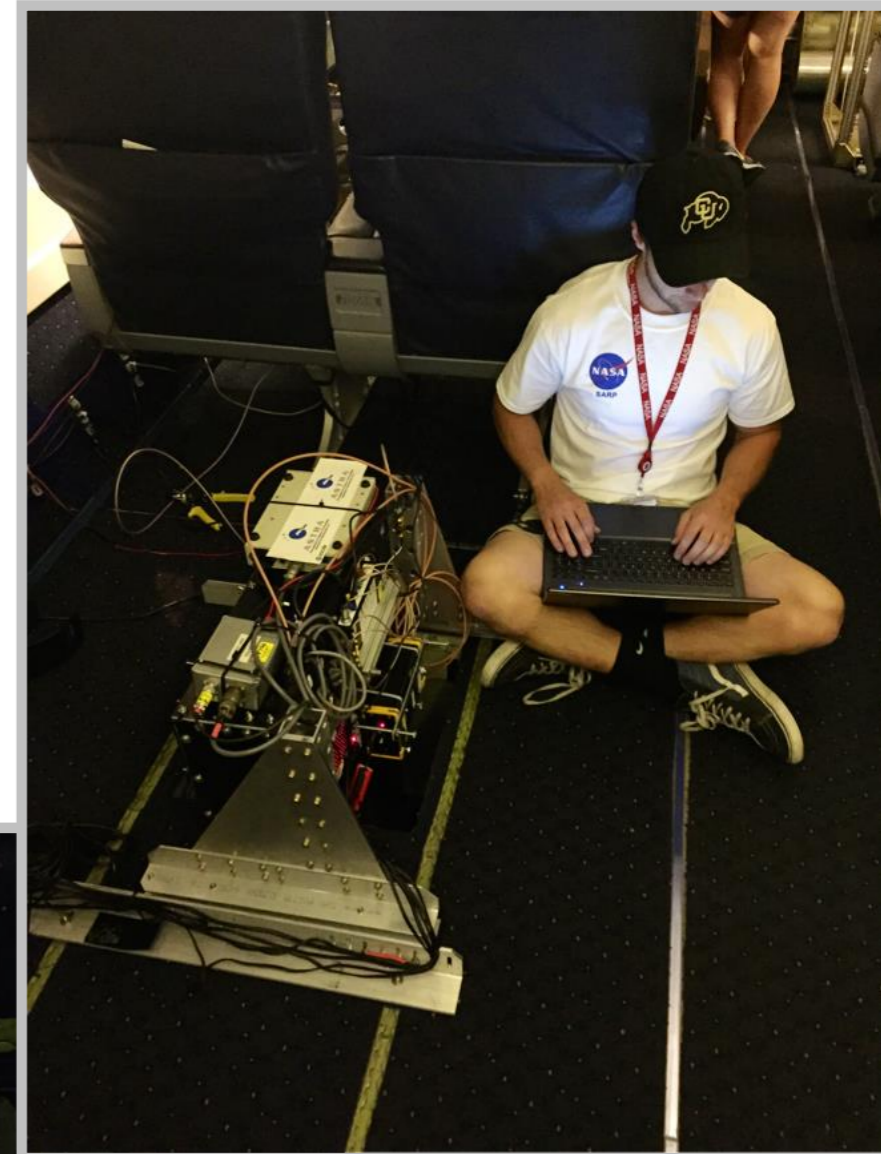
Can see to  $> 2x$   
Secchi Depth

# NASA-SARP Flight

✦ Science  
✦ Technology  
✦ Applications  
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**More Flights Planned**

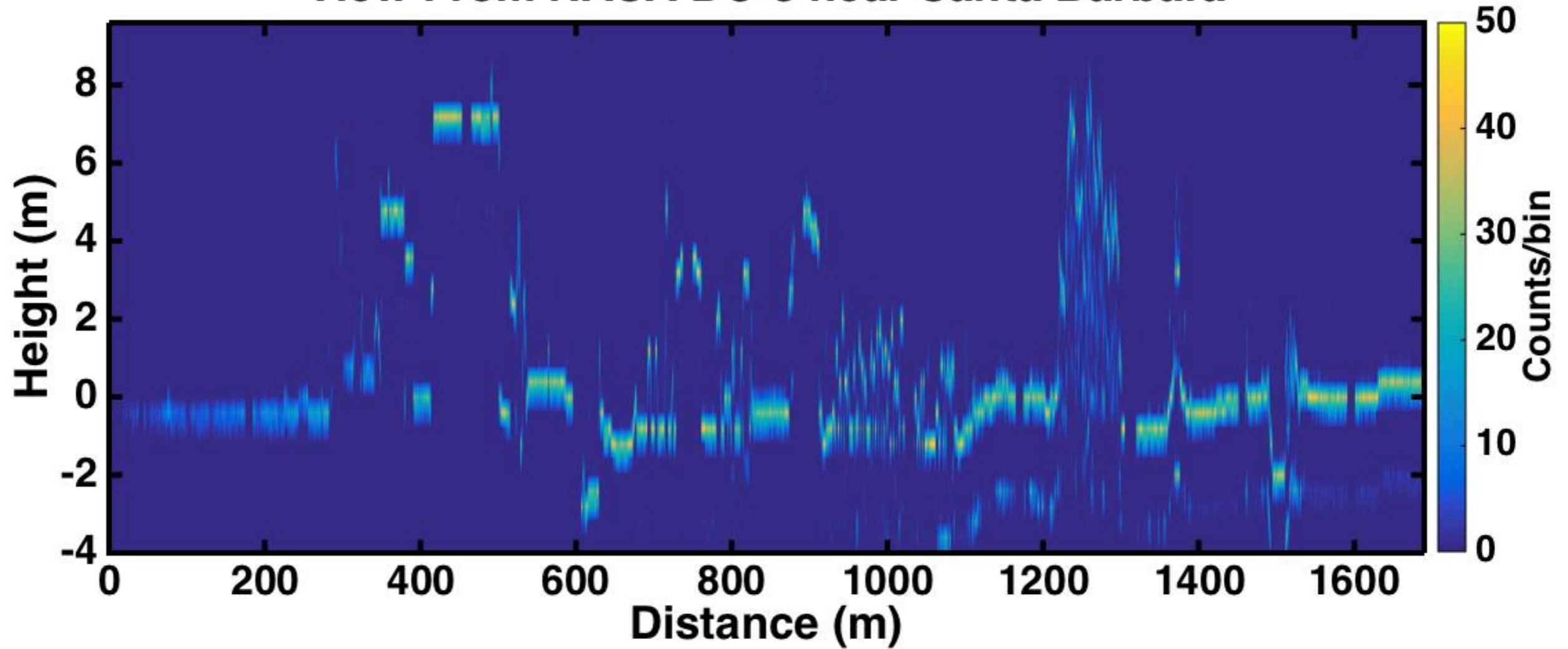


**Looking down through window**



# NASA-SARP Lidar Data

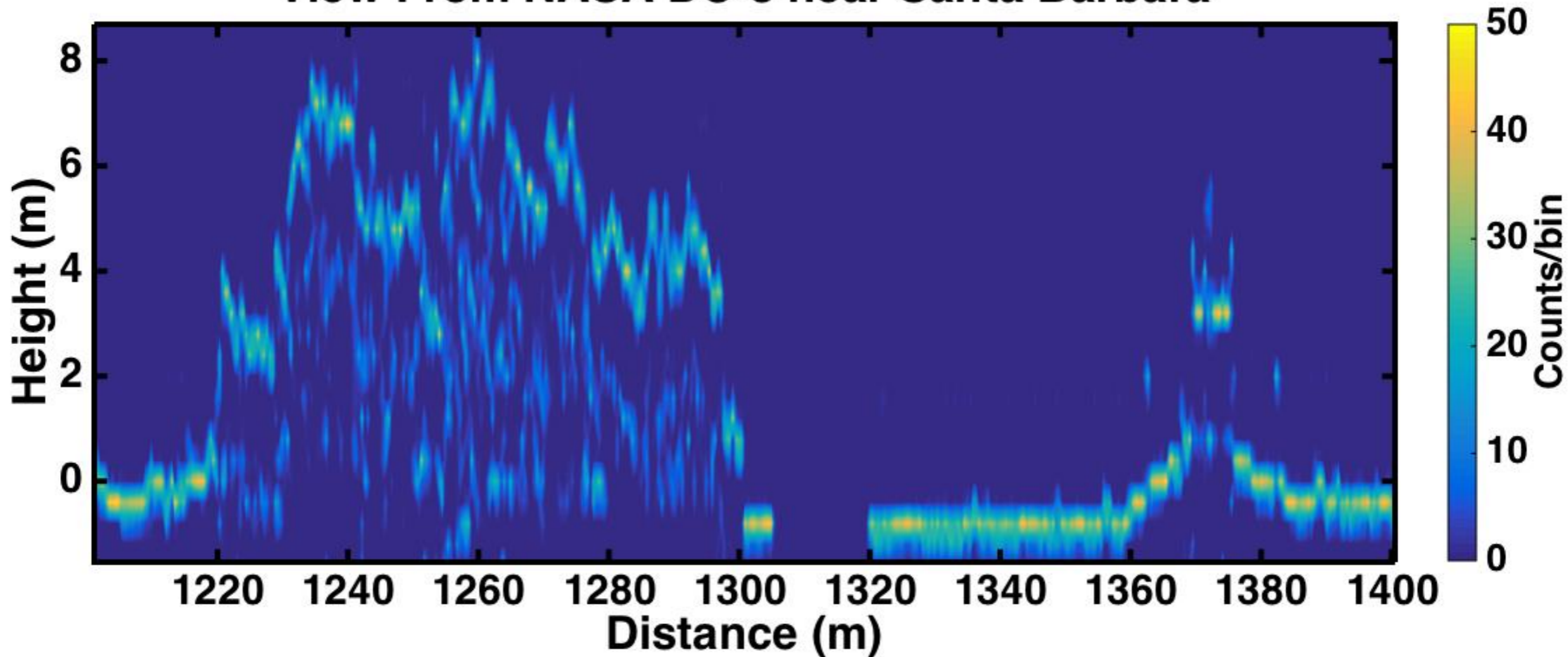
## View From NASA DC-8 near Santa Barbara





# NASA-SARP Lidar Data

## View From NASA DC-8 near Santa Barbara





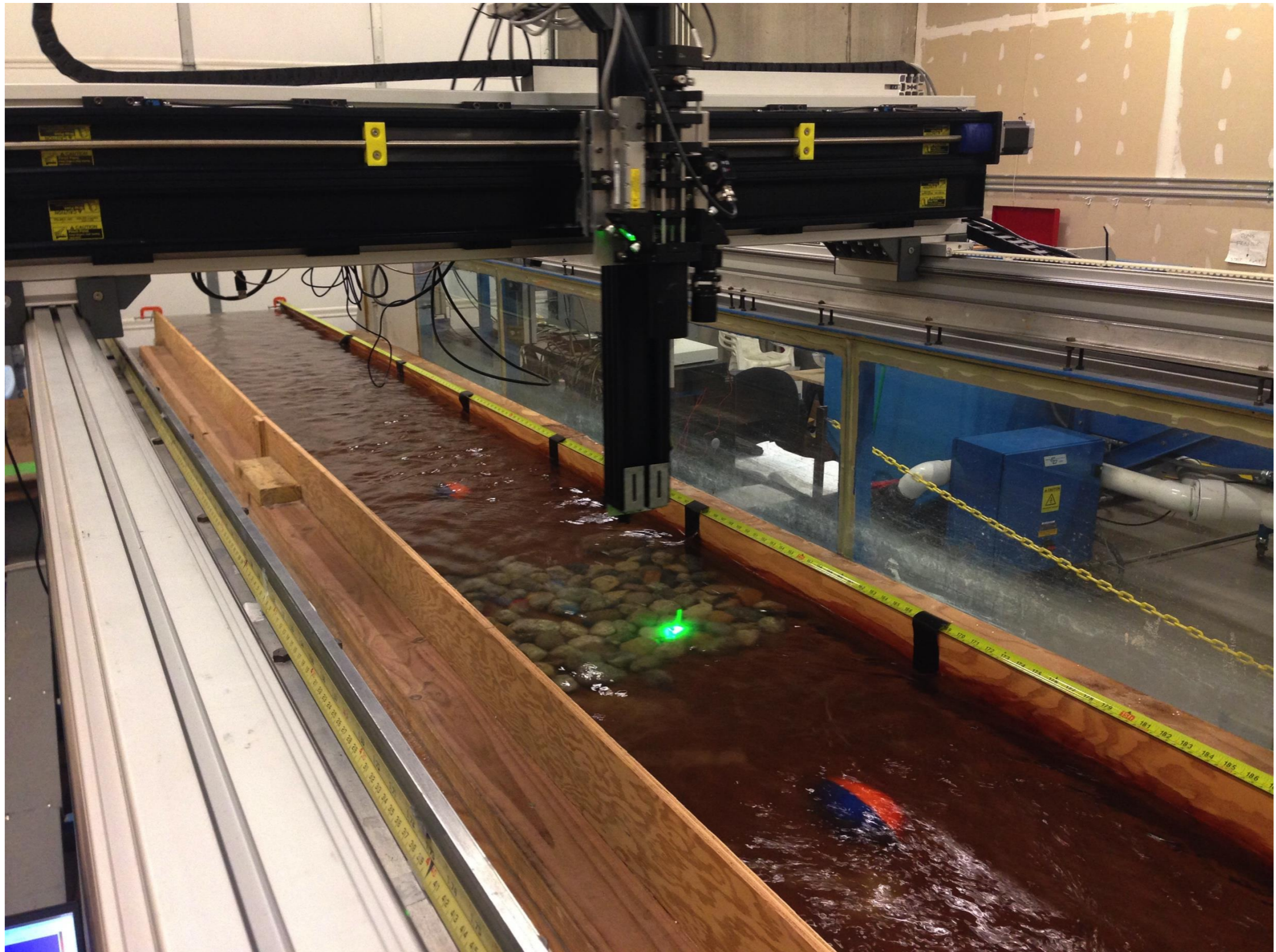
# USGS Flume Experiment

❖ Science

❖ Technology

❖ Applications

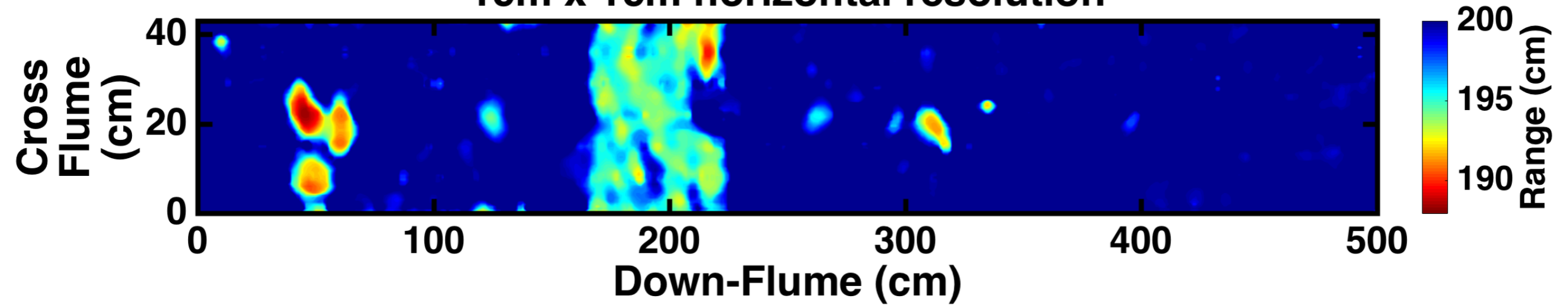
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# Indoor River Mapping

**Bottom Surface Under Water**  
1cm x 1cm horizontal resolution

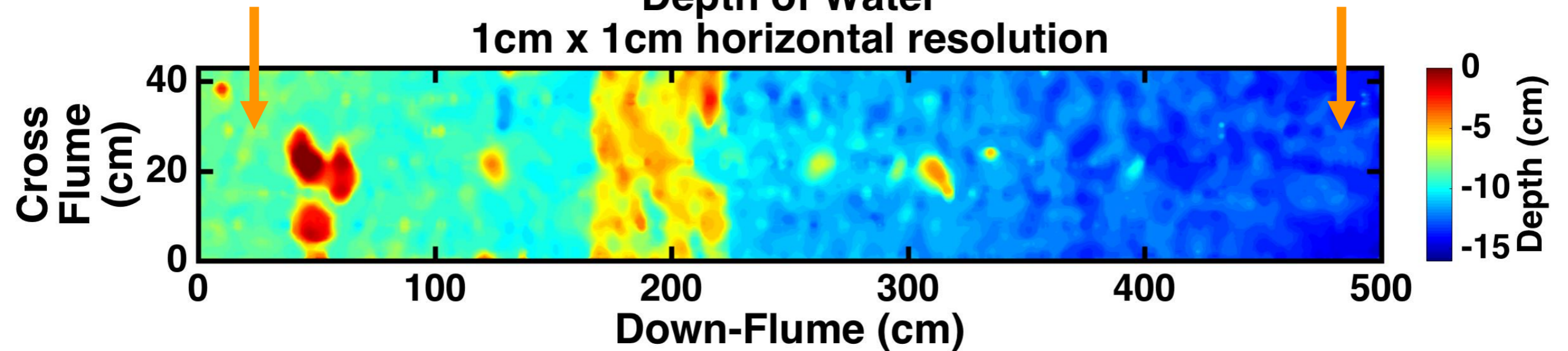


**Water Flow**

9 cm depth

**Depth of Water**  
1cm x 1cm horizontal resolution

13 cm depth





# Indoor River Object Detection

✦ Science

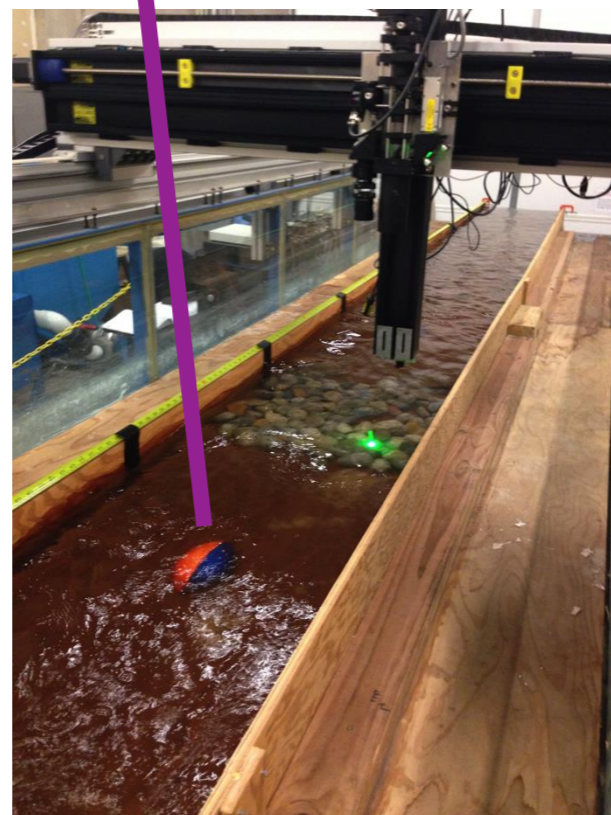
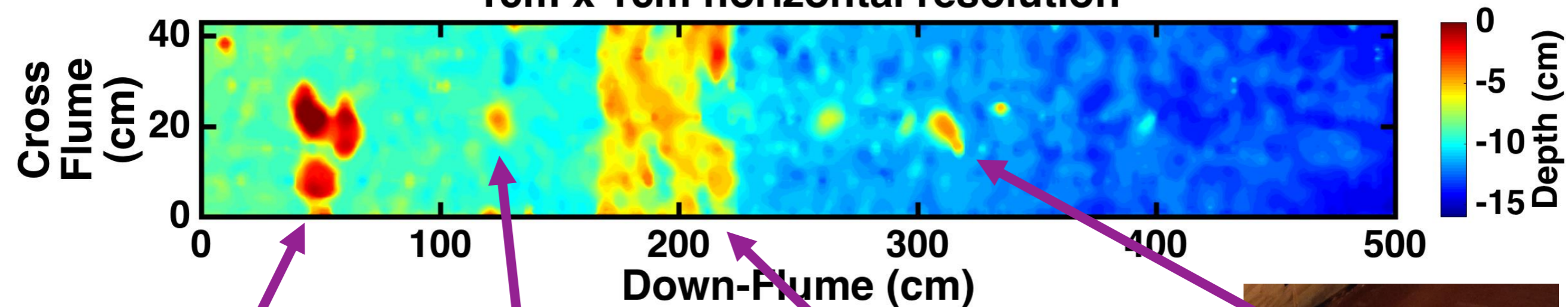
✦ Technology

✦ Applications

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Depth of Water  
1cm x 1cm horizontal resolution





# Questions?

❖ Science

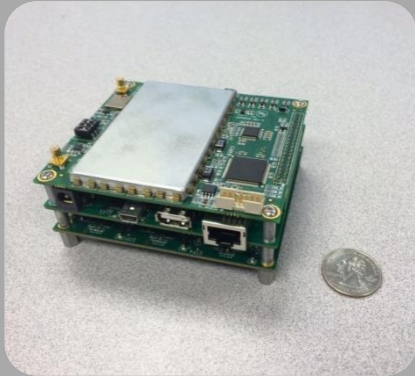
❖ Technology

❖ Applications

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## Experienced Team

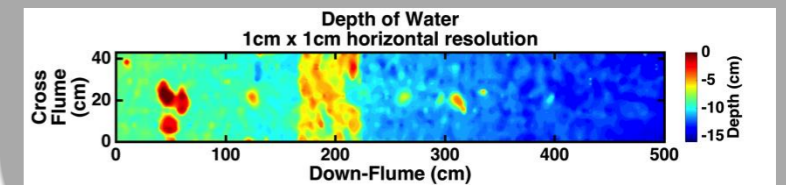
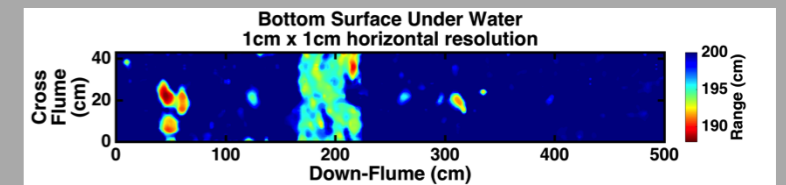


## Miniaturizing Technology



## Handheld, 7.5 lbs

## High Resolution Stream Mapping

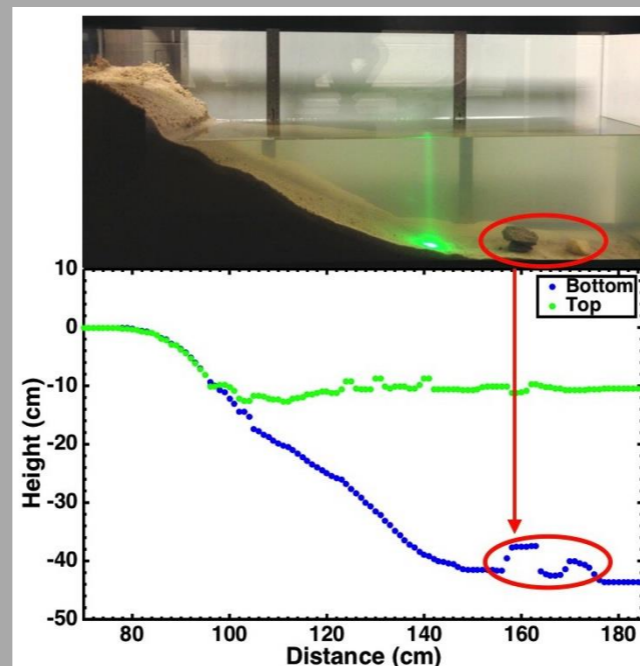


## New Technique



## 100x better resolution

## Resolution <1cm



## Currently Testing Onboard Aircraft