

Subsea LiDAR Metrology



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SUT

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Company Overview



Based in the technology hub of Boulder, Colorado, 3D at Depth is **dedicated to the development of underwater laser measurement sensors and software**

- Patented subsea LiDAR technology
- SL1 subsea LiDAR system launched in March 2013
- Track record; completed 10+ projects
- Recently completed second generation subsea LiDAR development; SL2
- Seeking partners who can bring the technology to the field

Agenda

Metrology workflows using Subsea LiDAR

- Instrument
- Collection Planning
- Operations
- Data Processing and Deliverables

Subsea LiDAR Metrology

INSTRUMENT OVERVIEW

SL1 and SL2 Subsea LiDAR Scanners



Time of flight (ToF) 532nm (green) LiDAR system built to offshore Oil and Gas requirements

Performance and accuracy are comparable to topside scanners

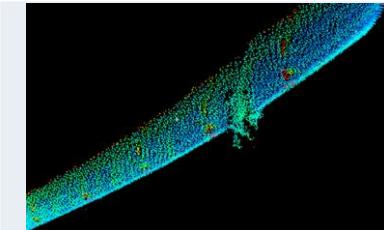
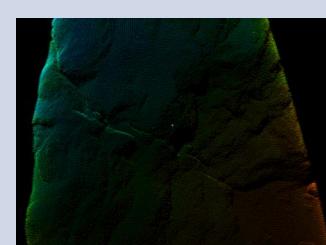
6mm single shot and 4mm positional accuracy in a single scene

SL1 Single canister, 3000m depth rating integrated pan

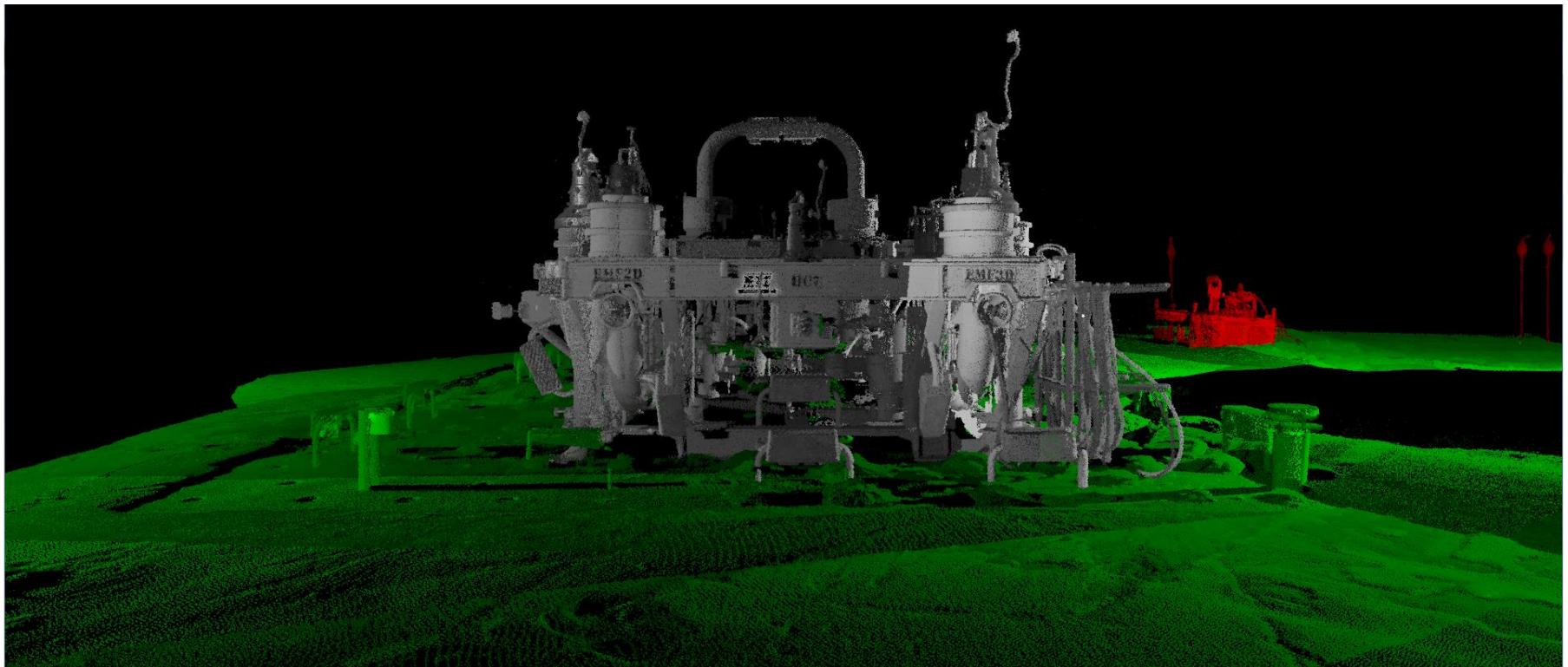
SL2 Dual canister, 1500m depth rating integrated pan and tilt

Offered as a service or lease

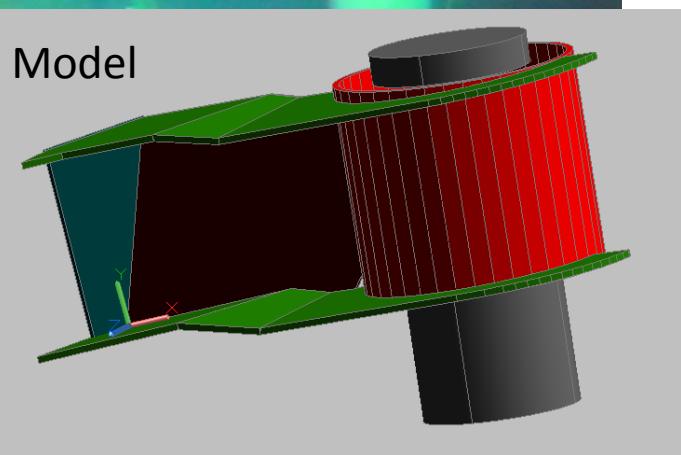
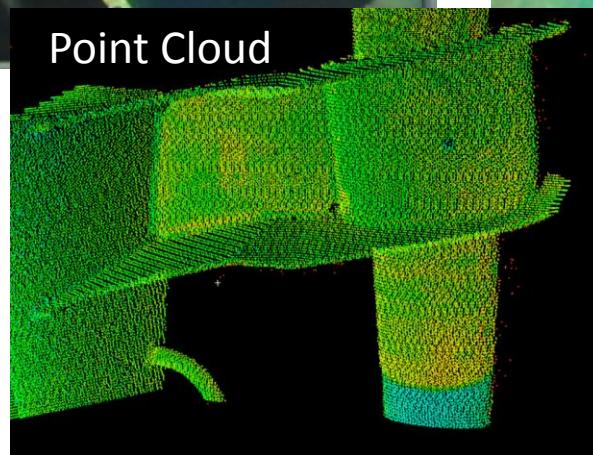
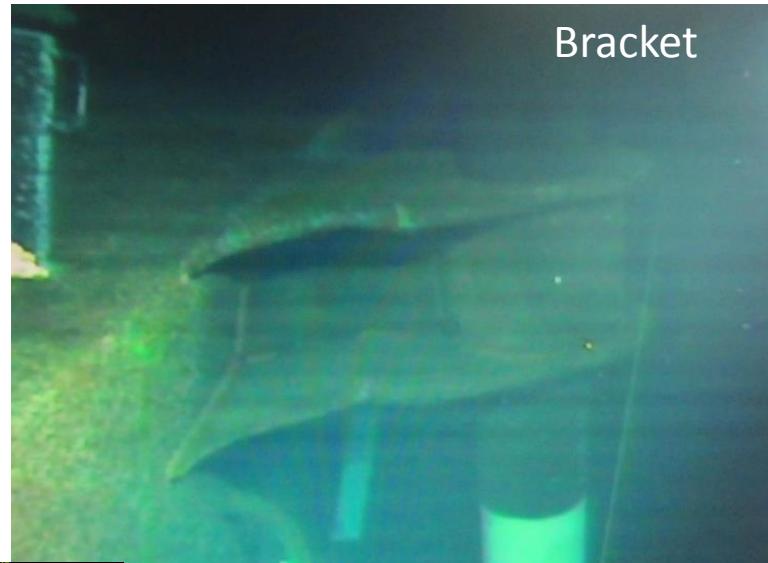
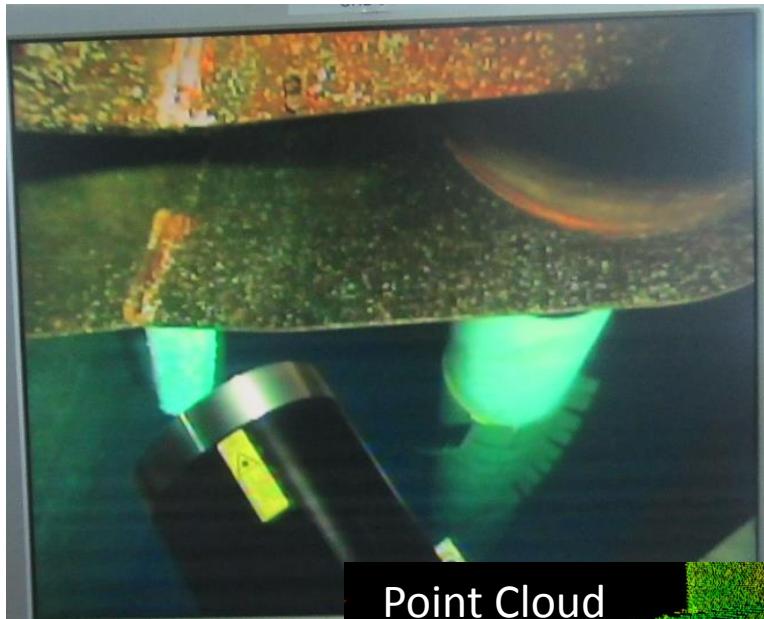
Scanning Modes

Mode	Description	Parameters	
Survey	Sensor is placed in a stationary location and moved into several scan positions for large areas.	<ul style="list-style-type: none">• High resolution• 3-5 minutes per scan• Registration of multiple scan through targets	
Fast	Steady platform but not stationary; mid water ROV	<ul style="list-style-type: none">• Lower resolution• 1-2 seconds per scan• Snapshots	
Mobile	Sensor integrated with a moving ROV, AUV or boat and integrated with an INS for motion compensation	<ul style="list-style-type: none">• Single axis scanning• Line scan or bowtie pattern• Time stamped to INS feed	

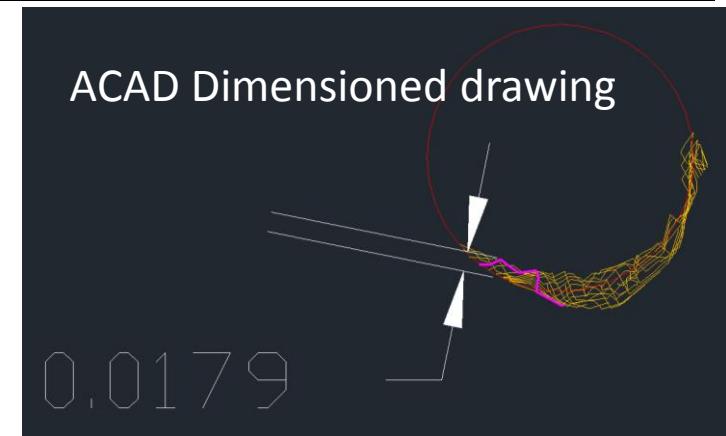
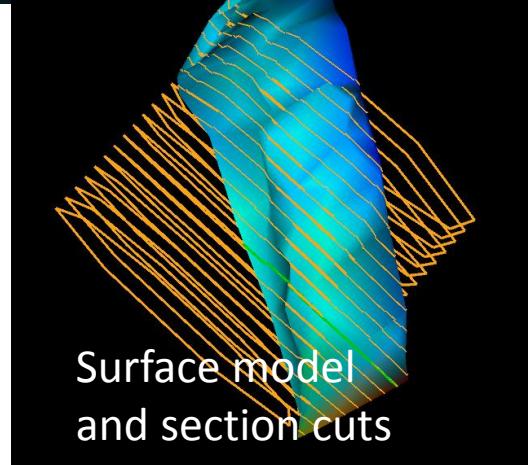
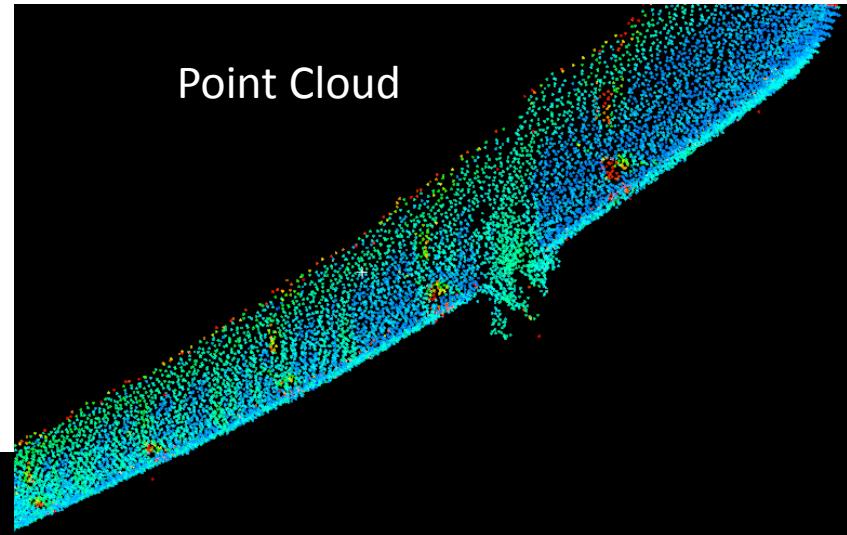
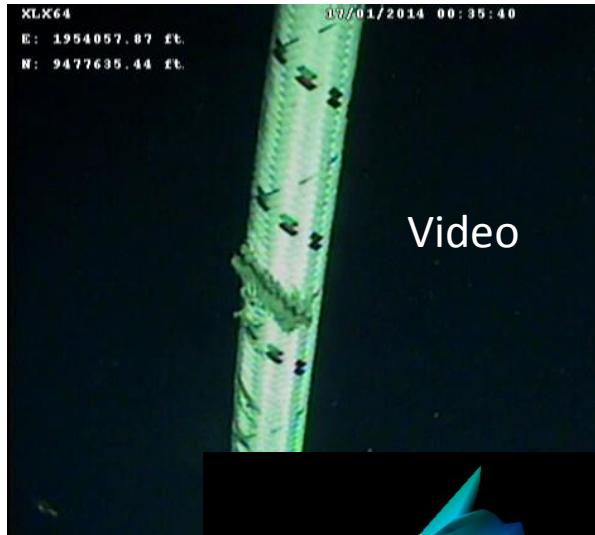
Survey Mode



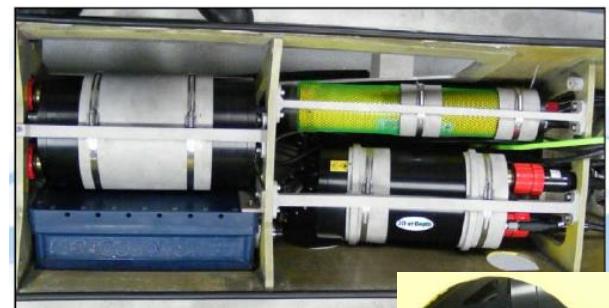
Fast Scan



Fast Scan



Mobile Scanning

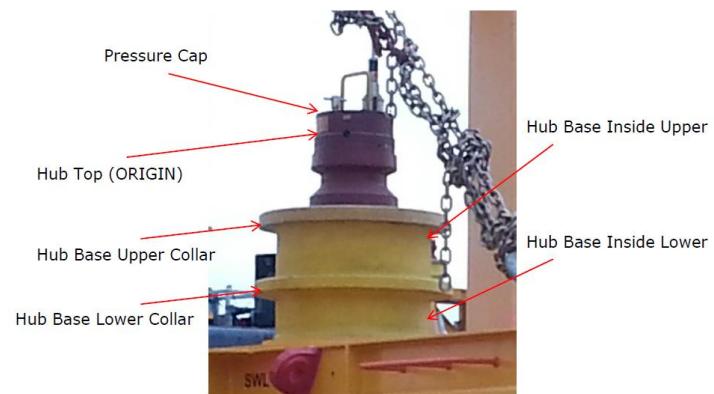
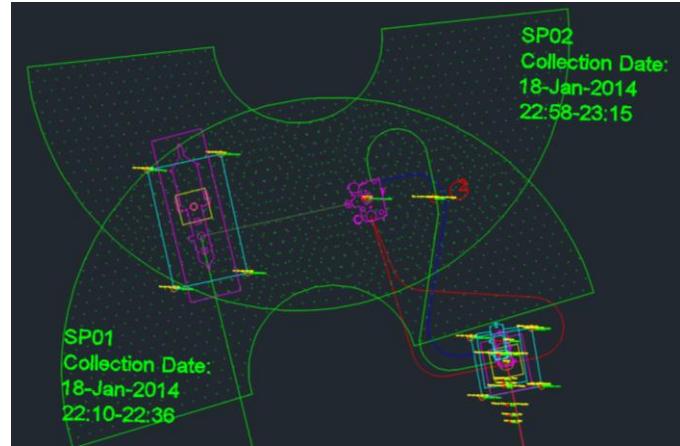


Subsea LiDAR Metrology

COLLECTION PLANNING/DESIGN

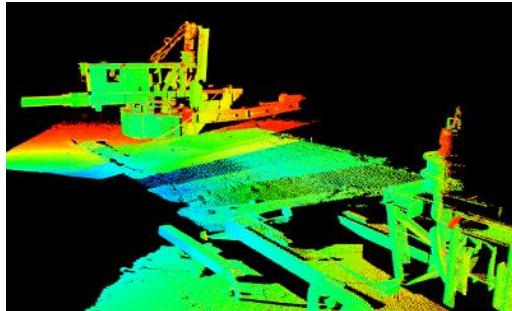
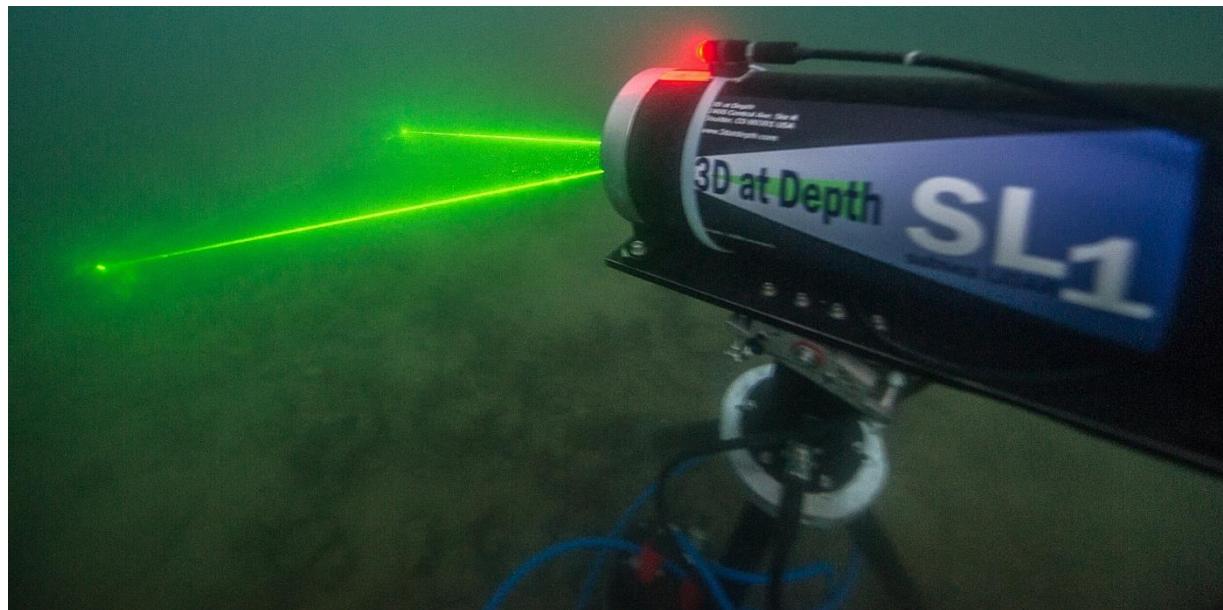
Planning Parameters

- Accuracy/tolerances
- DC and field drawings
- Range
- Line of sight
- Height of platform
- Scan locations
- Currents
- Seabed

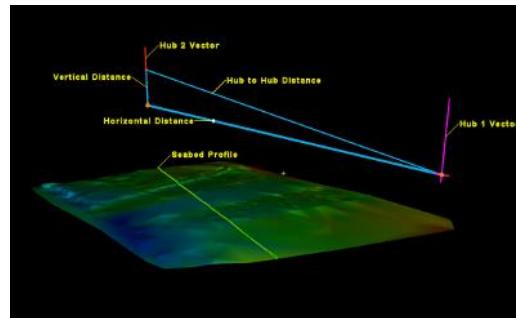


Subsea LiDAR Metrology Workflow

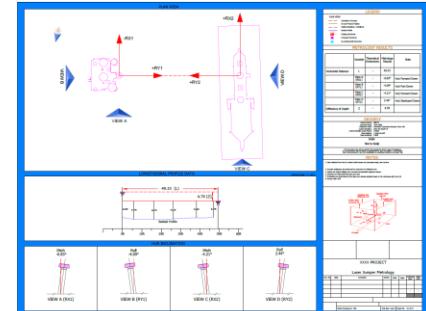
1. Place tripods and targets if needed
2. Sensor placed into position
ROV or Tripod
3. Run test scans
Range
Gain
Line of sight
4. Scan scene
5. QC data
6. Move to next position
7. Repeat workflow



7. Data preprocessed into point clouds

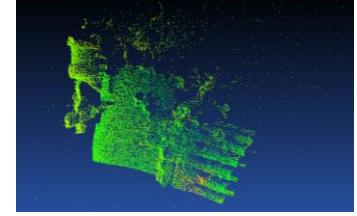
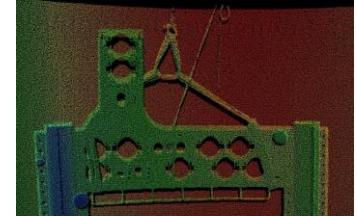
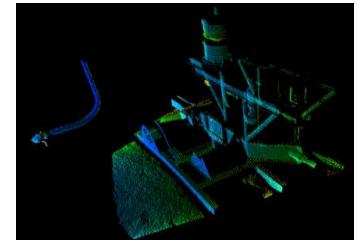
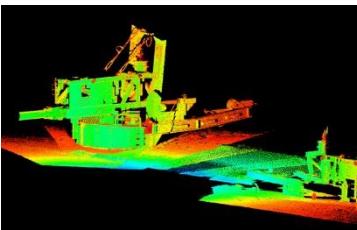


8. CAD elements extracted from point cloud (modeling)



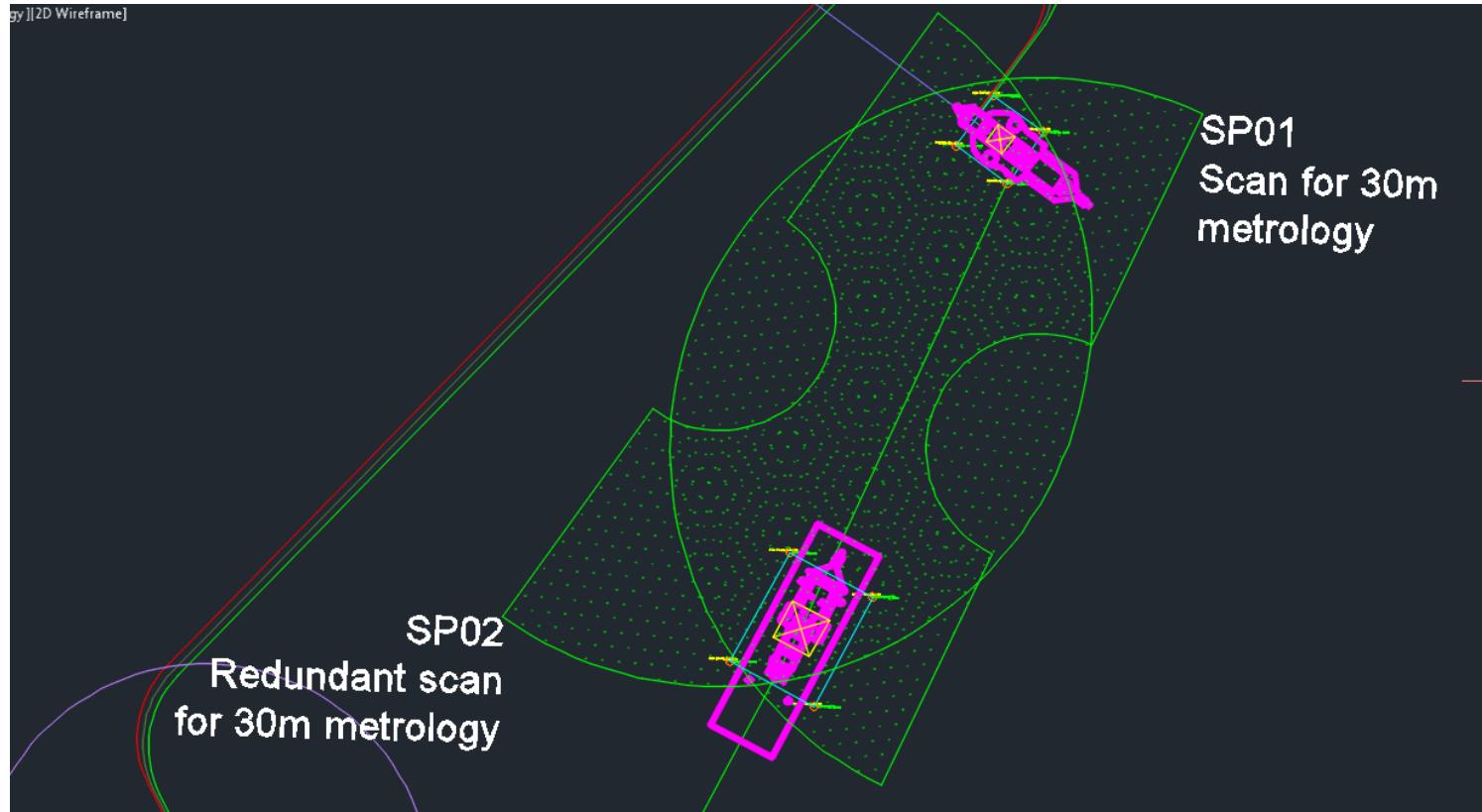
9. Data QC'd and the deliverable is developed

Range determines workflow

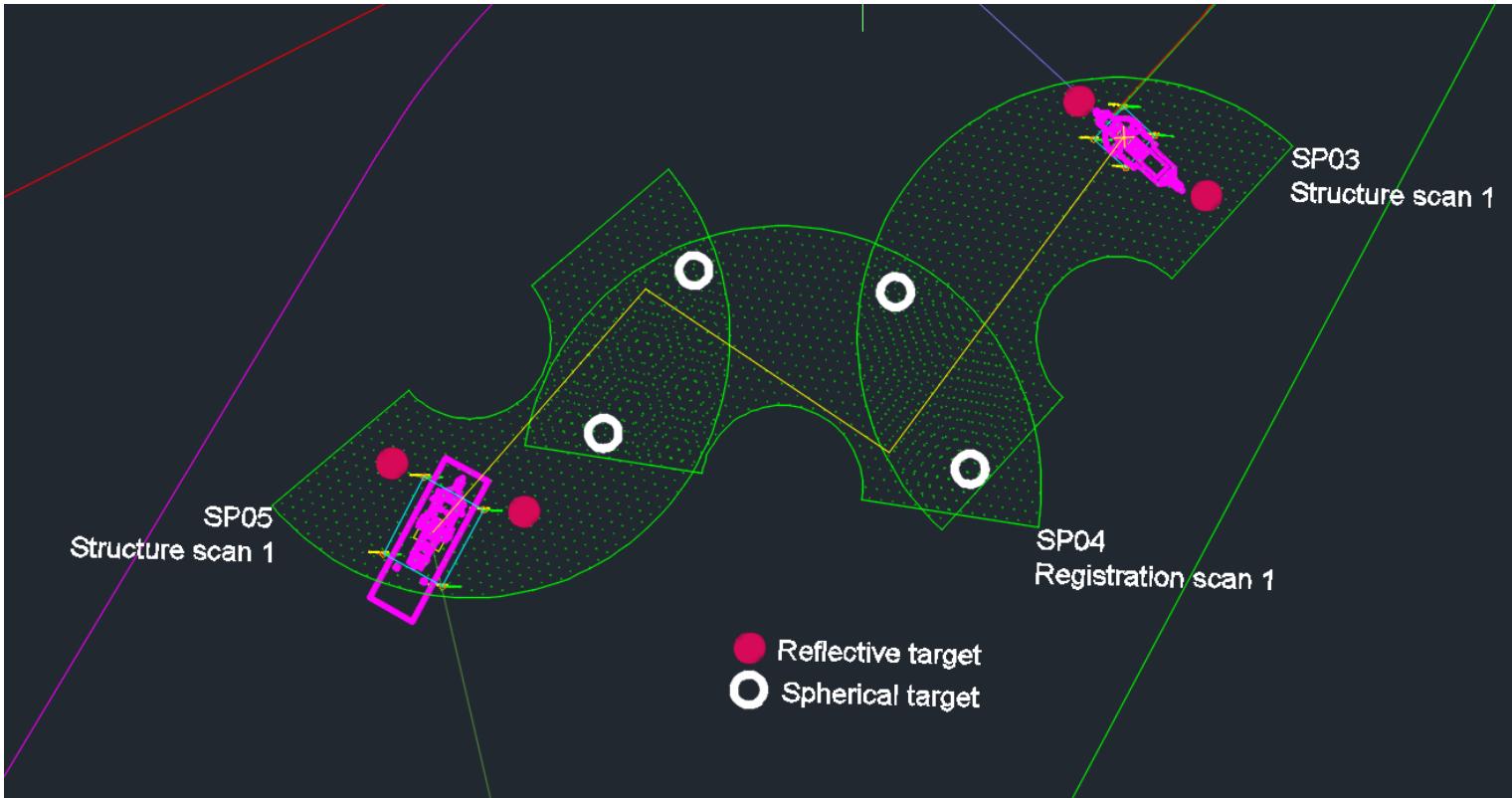
Visibility	Range	Data collection		
Poor	2-4 meters	Small areas of interest from close range Difficult to register together Mobile an option		
Fair	5-10 meters	> 2 scan positions: accuracy ≈ 8-10 mm per registration		
Good	10-25 meters	2 scan positions: accuracy ≈ 8-10 mm*		
Very good	25-45 meters	Single setup: Accuracy ≈ 4-7 mm*		

*measuring a point to point distance at 35 meters

Single Scan Position (with redundancy)



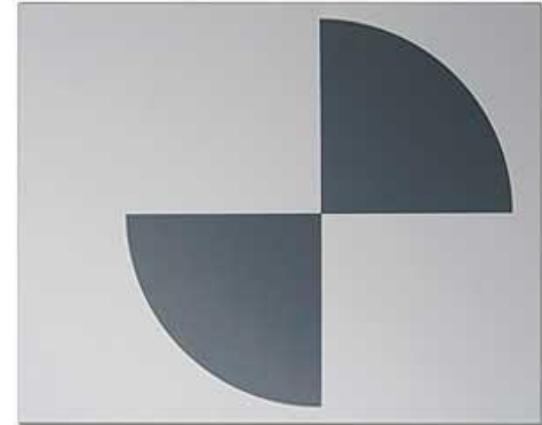
Multiple Scan Positions



Registration Targets



Spheres

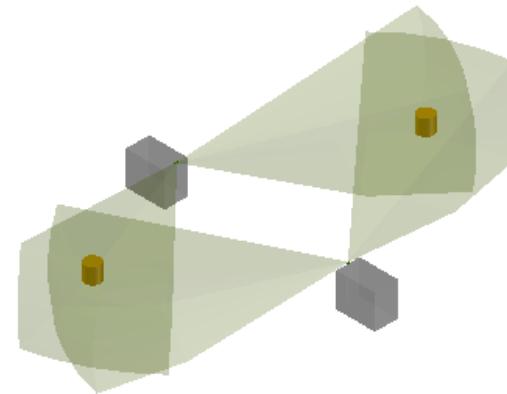
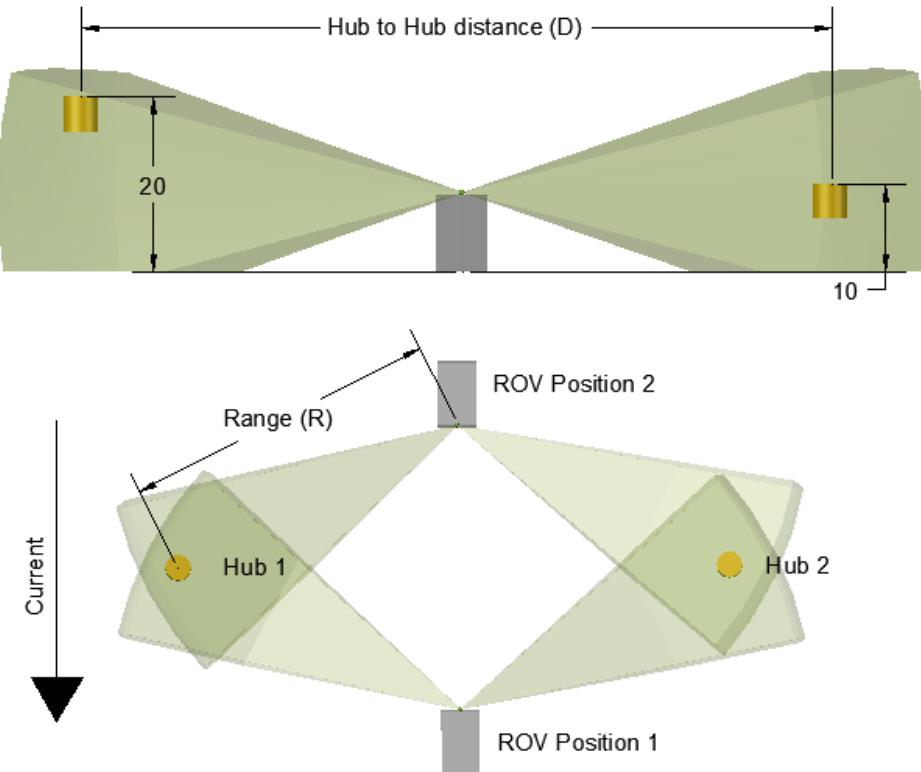


B/W Survey



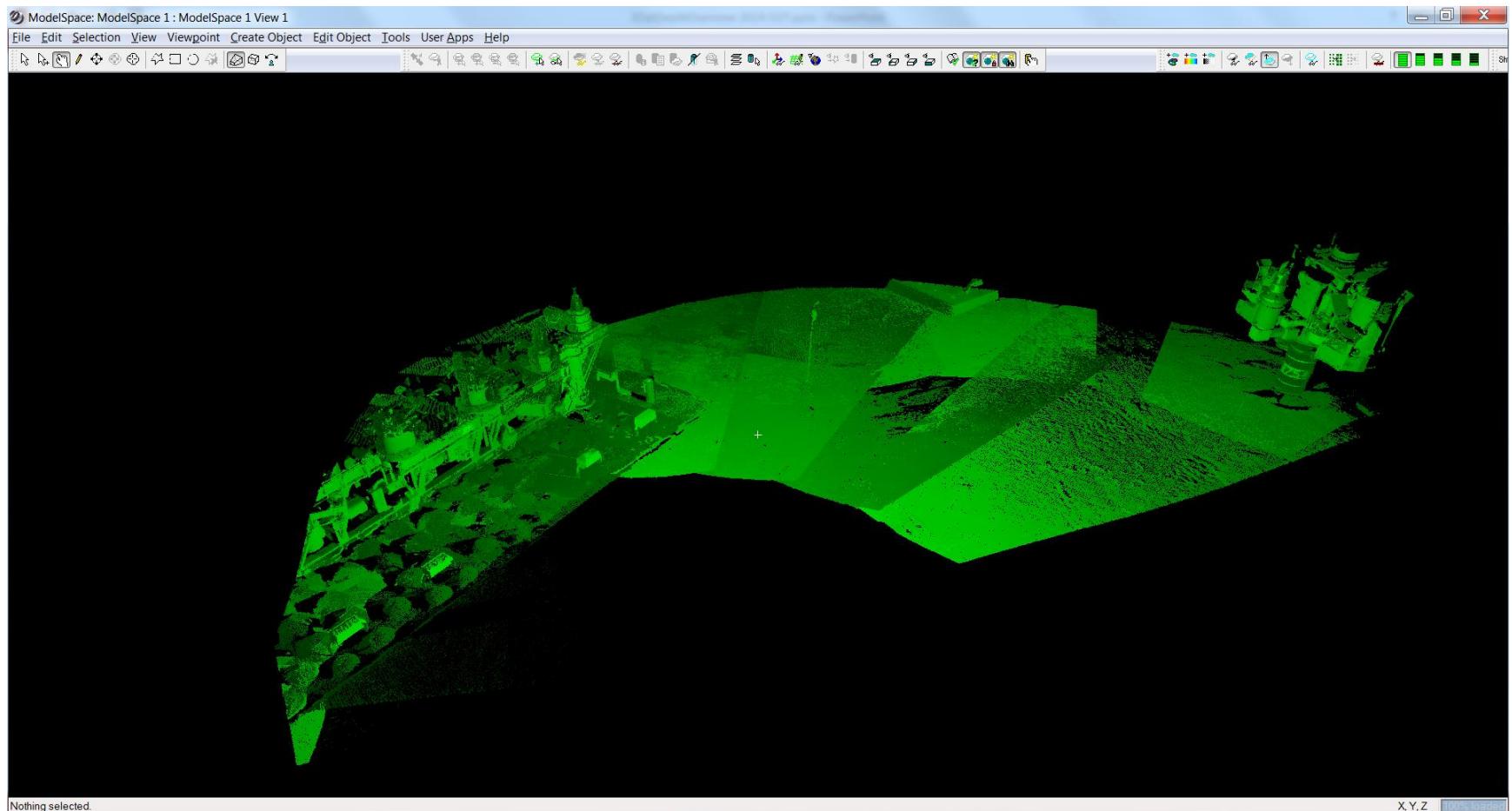
Reflective

Line of Sight

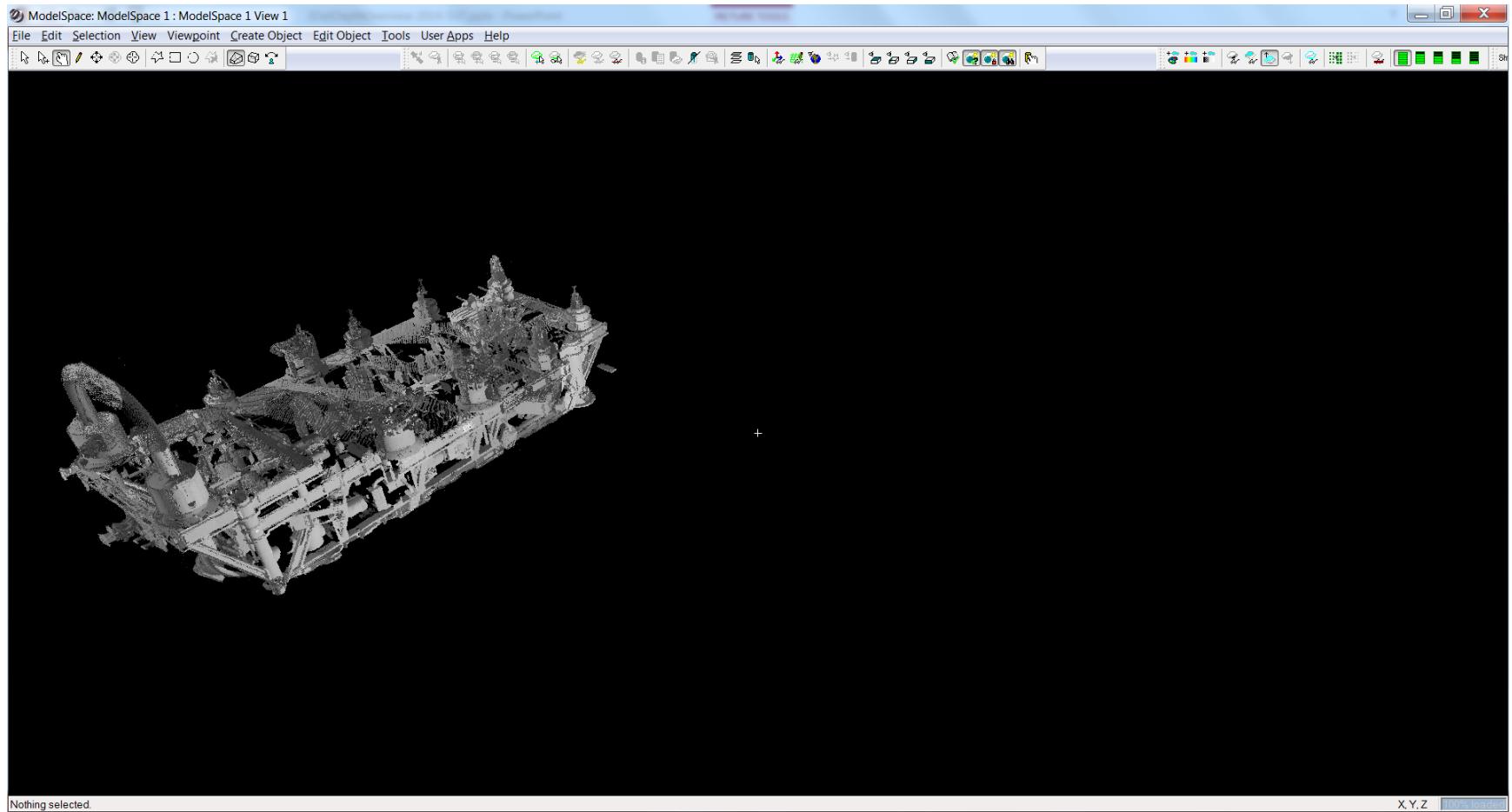


By scanning the structures topside, the point clouds can be used as part of the data solution – snapped into the subsea scanned scene which mitigates the line of sight issue thus further reducing the collection time and complexity

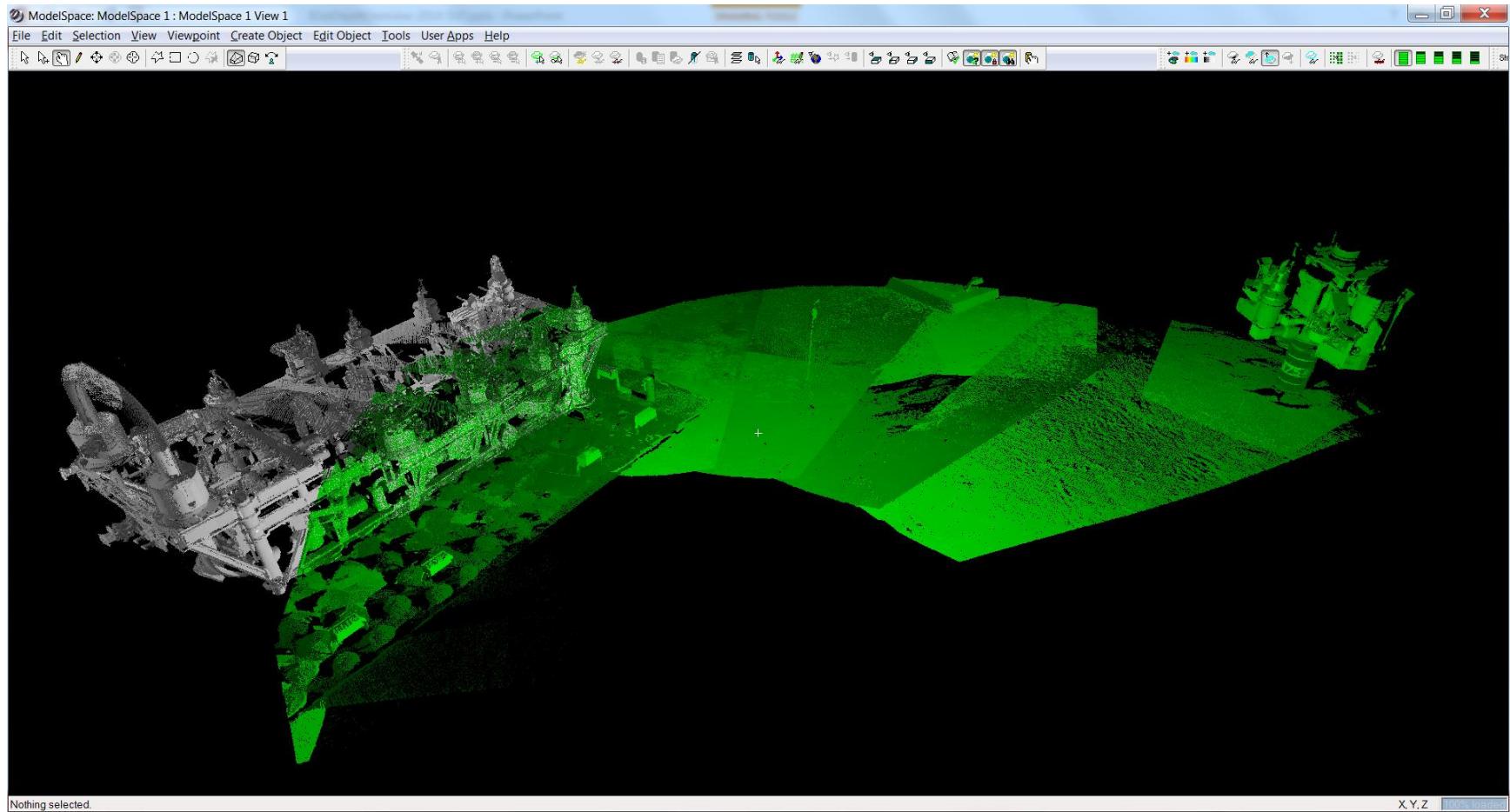
Single Scan Result



Top Side Scan



Register Topside into Subsea Model



Subsea LiDAR Metrology

OPERATIONAL CONSIDERATIONS

Deployment Options



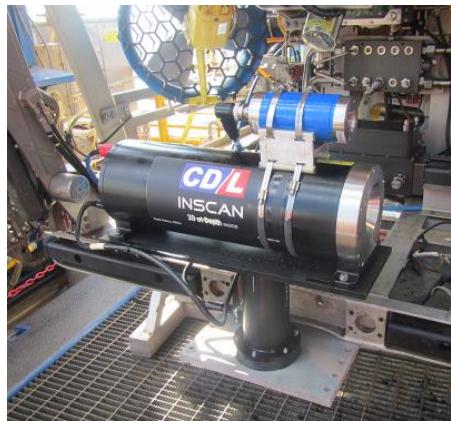
SL1 TOP ROV Mounted



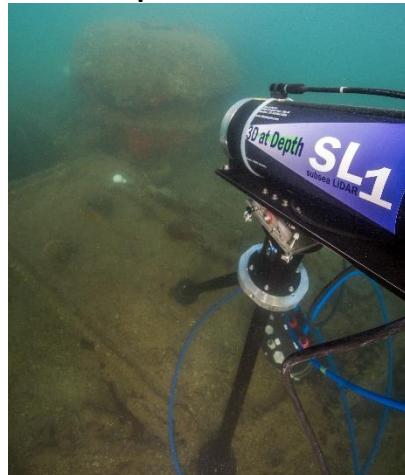
SL1 Tripod Mounted



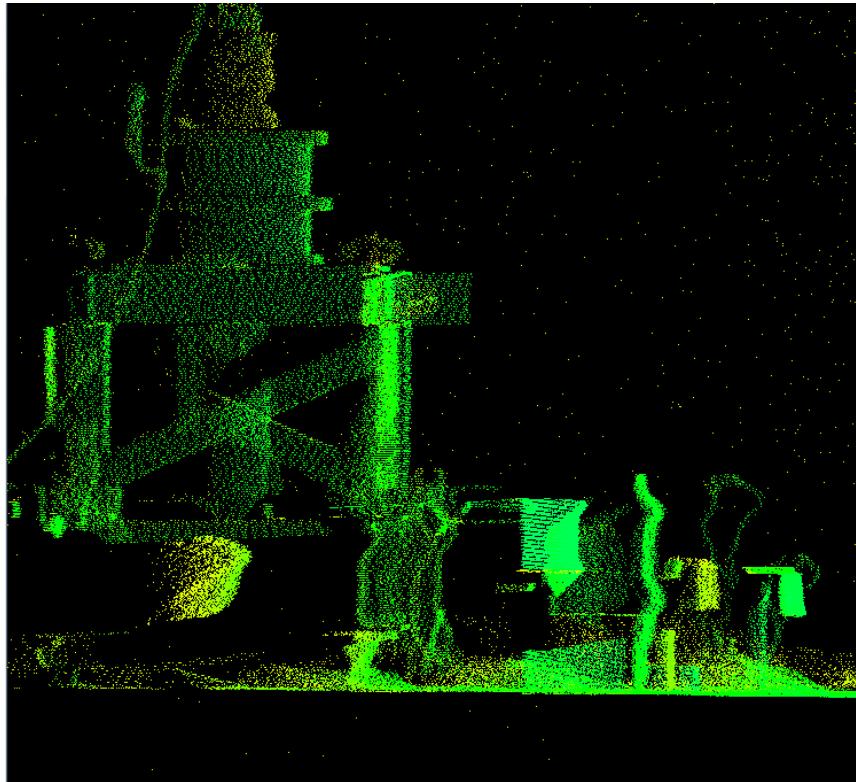
SL2 AUV Mounted



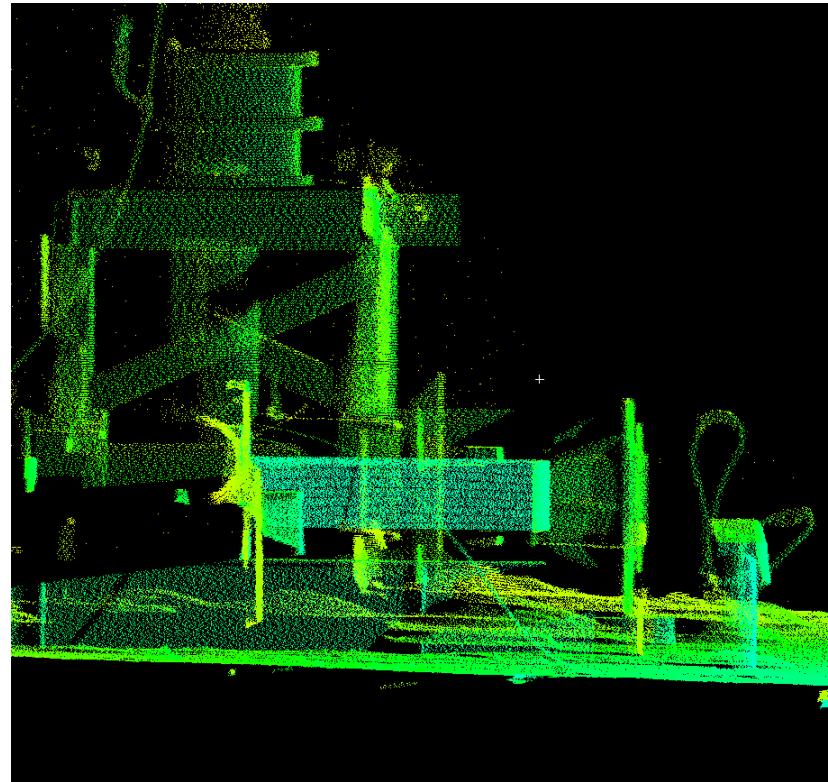
SL1 DECK ROV Mounted



Platform Stability

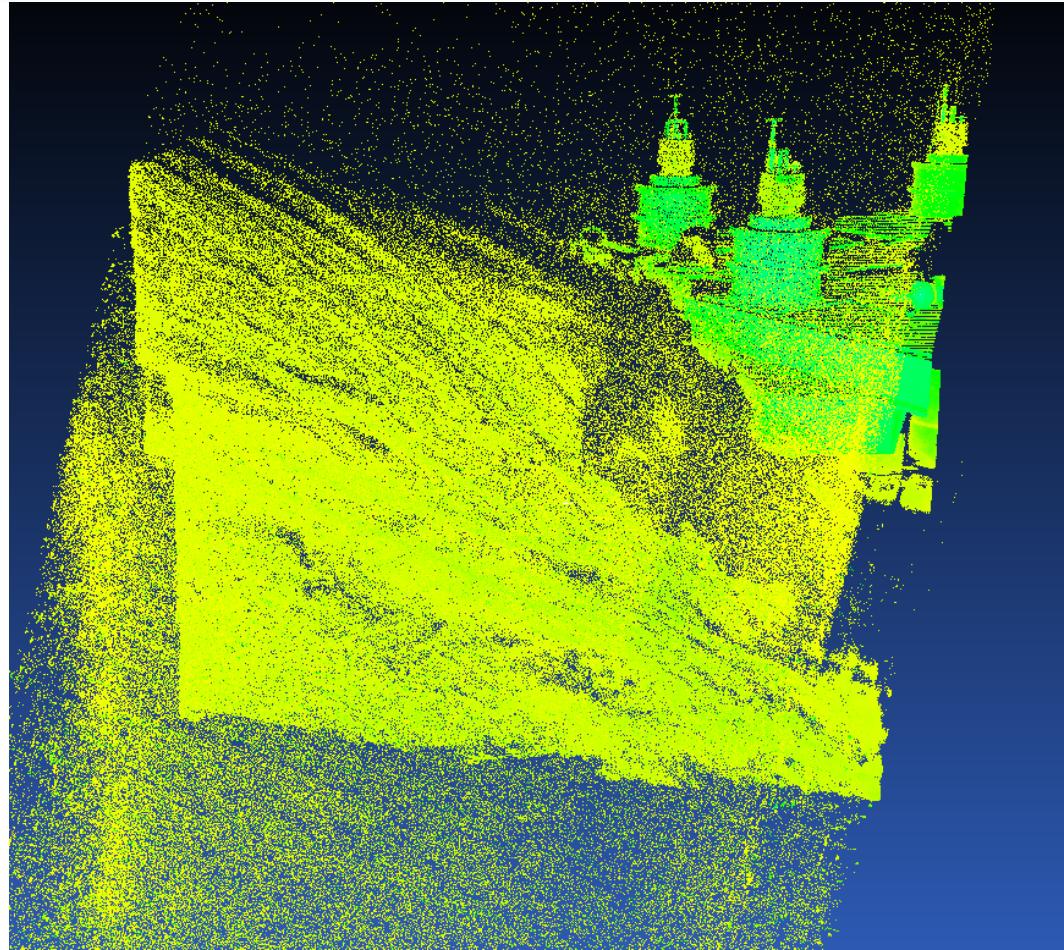


Non stable ROV

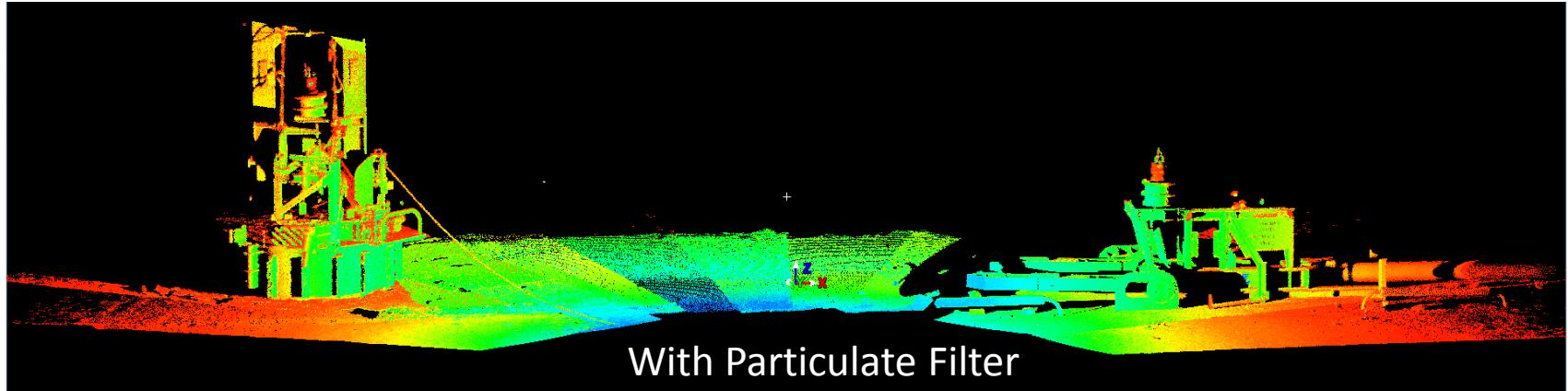
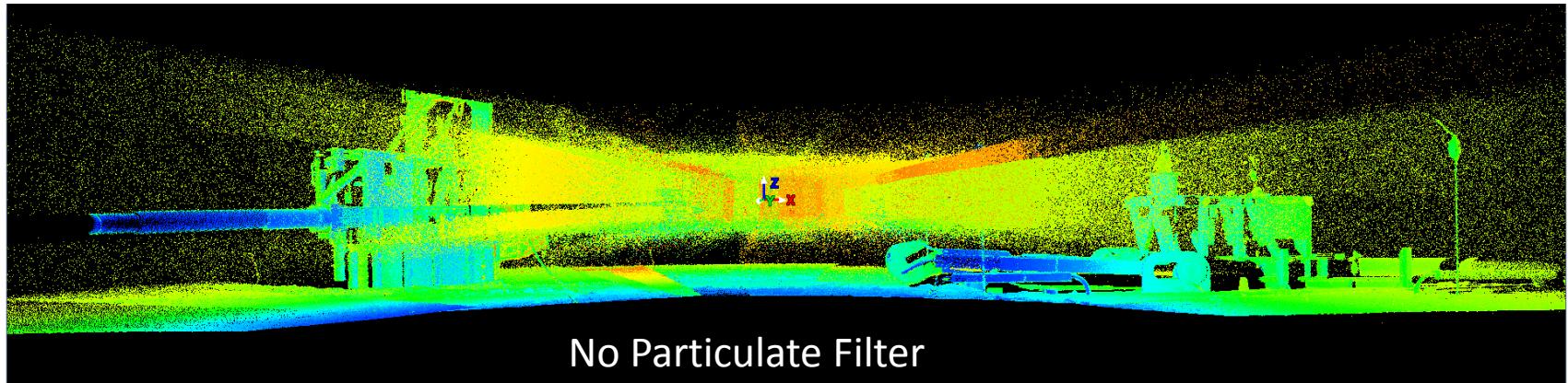


Stable ROV

Particulates



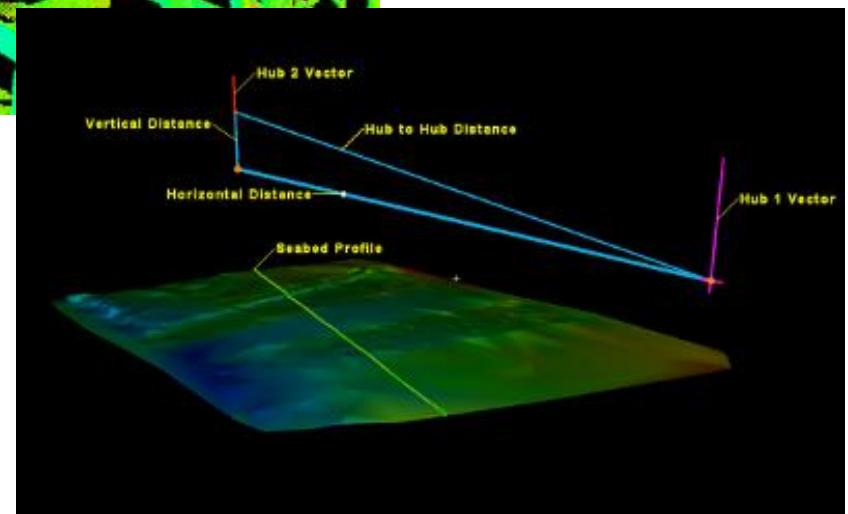
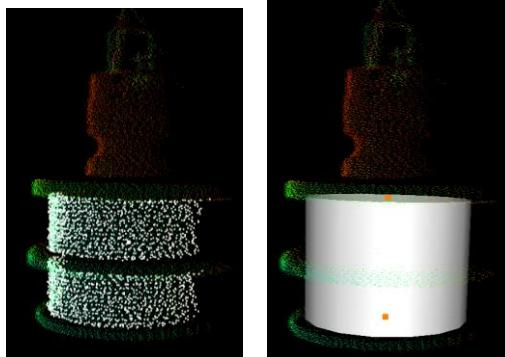
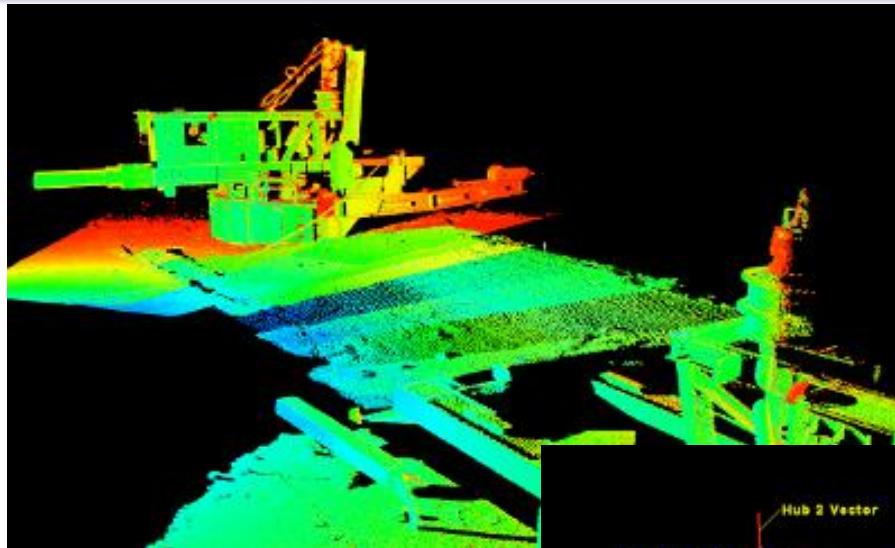
Particulate Filter



Underwater LiDAR Best Practices

POST PROCESSING

Deriving Vectors



Summary

- 3D at Depth have developed a subsea LiDAR *platform*
- End users have several options for deployment and collection
- Topside software and best practices can be used for subsea workflows
- We have developed some base applications and hope the community can define many more
- Building a business case to invest in the North Sea and support the region