# National Coastal Mapping Strategy - Bathymetric Lidar Quality Levels Introduction and Discussion

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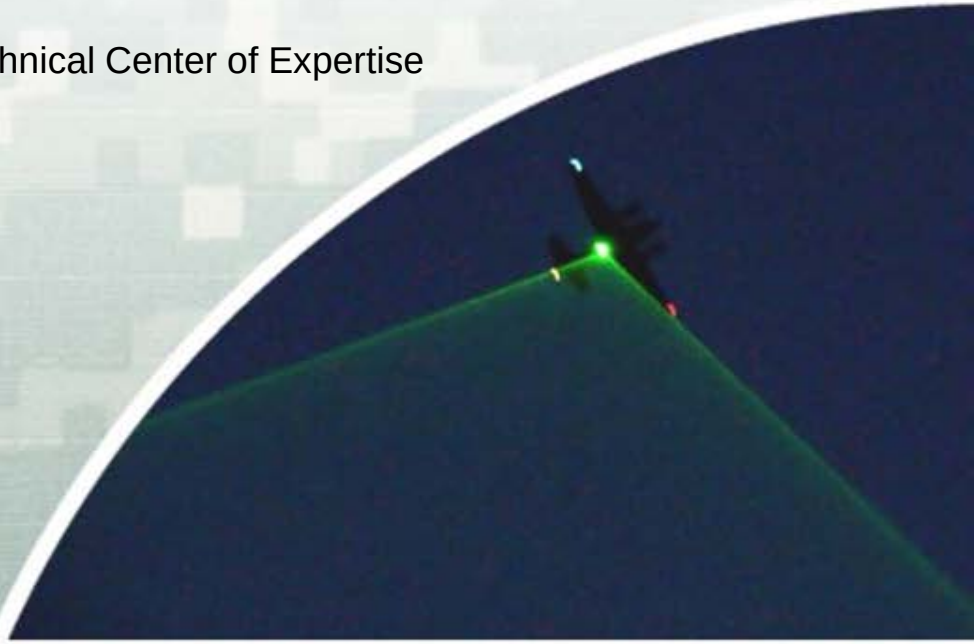
Outline

- QL Introduction and Intent
- QL Currently Defined
- QL Considerations
- NCMS Coverage
- QL Use and Maintenance
- Workshop Discussion



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# QL Introduction and Intent

National Coastal Mapping Strategy (NCMS) by Interagency Working Group on Ocean and Coastal Mapping (IWG-OCM)

- Component 1 - Aspirational Strategy and Agency Responsibilities
- Component 2 - Annual Coordinated Planning of Coastal Mapping Activities
- **Component 3 - Establishing Common Standards for U.S. Coastal Mapping**
- Component 4 -Establishing Cooperative Data Management
- Component 5 - Research and Development to Improve U.S. Coastal Mapping

# QL Introduction and Intent

## Component 3 - Establishing Common Standards for U.S. Coastal Mapping

“ Having QLs defined consistently by all agencies facilitates comparing specifications across agencies, coordinating acquisition to meet cross-agency needs,and determining whether data collected for one purpose will meet requirements for other uses.”

## Approach to defining Bathy QLs considered:

- 3DEP Quality Levels for topographic lidar
- (IHO) hydrographic vertical uncertainty
- Existing agency specifications

# QL Currently Defined

IHO order - Special

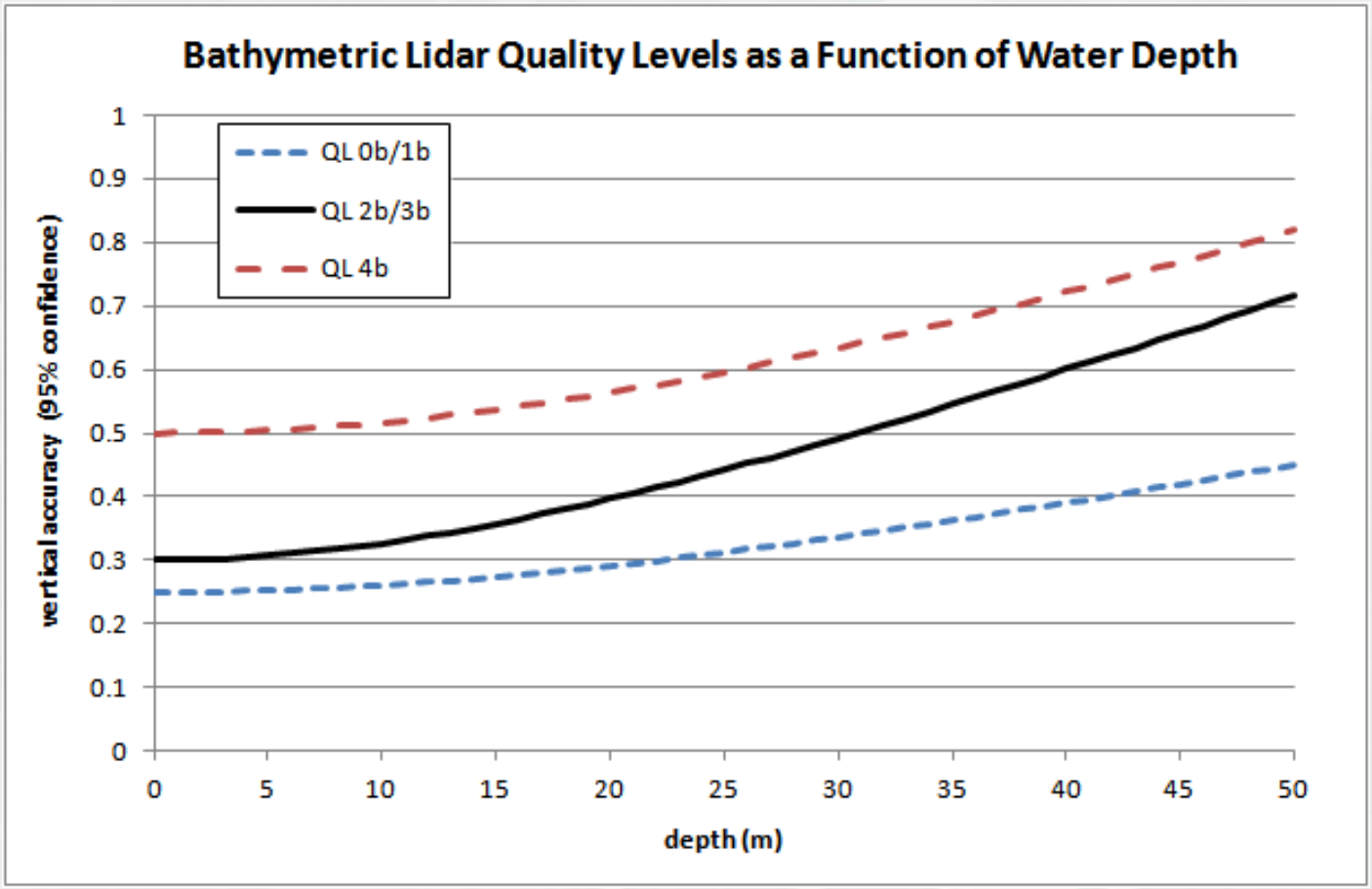
3DEP QL2

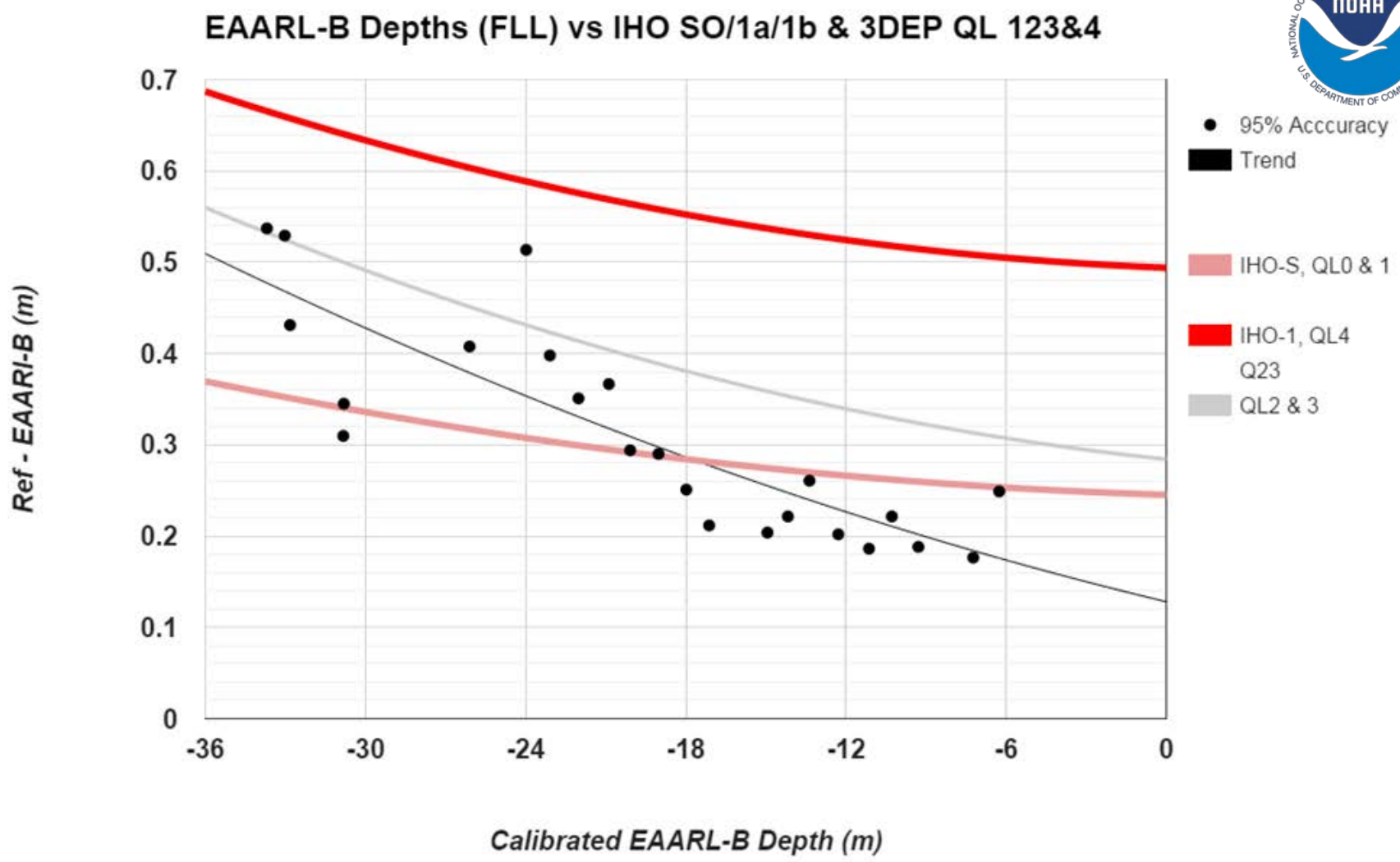
IHO order - 1

| Bathy Lidar Quality Level | Vertical accuracy coefficients a,b as in sqrt(a^2+(b*d)^2)) (m) | Nominal Pulse Spacing (m) | Point Density (pt/m$^2$) | Example Applications |
|---|---|---|---|---|
| $QL0_B$ | 0.25, 0.0075 | ≤0.7 | ≥2.0 | Detailed site surveys requiring the highest accuracy and highest resolution seafloor definition; dredging and inshore engineering surveys; high-resolution surveys of ports and harbors |
| $QL1_B$ | 0.25, 0.0075 | ≤2.0 | ≥0.25 | |
| $QL2_B$ | 0.30, 0.0130 | ≤0.7 | ≥2.0 | Charting surveys; regional sediment management General bathymetric mapping; coastal science and management applications Change analysis; deepwater surveys, environmental analysis |
| $QL3_B$ | 0.30, 0.0130 | ≤2.0 | ≥0.25 | |
| $QL4_B$ | 0.50, 0.0130 | ≤5.0 | ≥0.04 | Recon/planning; all general applications not requiring higher resolution and accuracy |

★ uncertainty vs accuracy - given dynamic coast and “control” confidence

# QL Currently Defined



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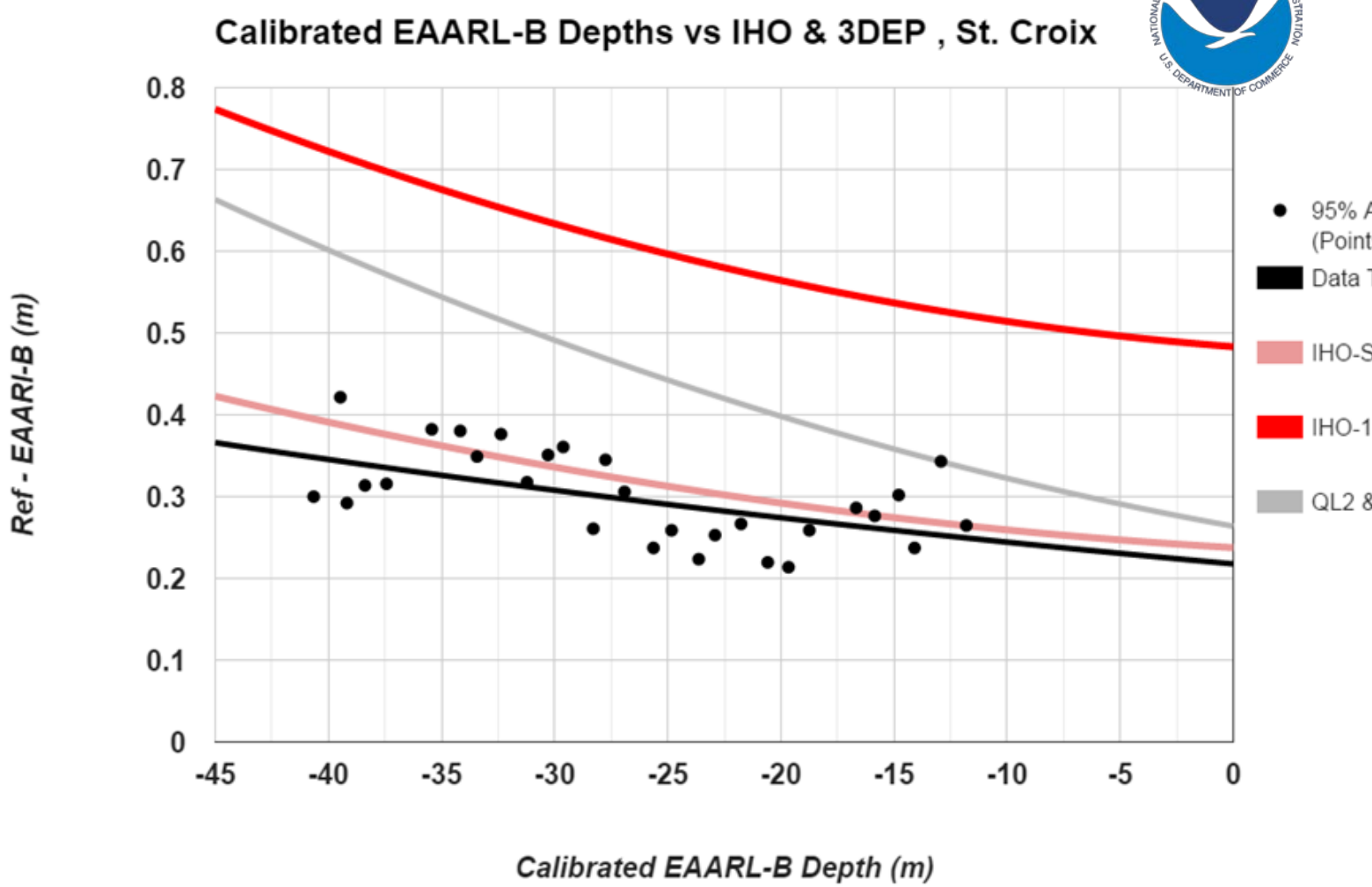
Calibrated EAARL-B Depths vs IHO & 3DEP , St. Croix
Ref - EAARl-B (m)
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
-45
-40
-35
-30
-25
-20
-15
-10
-5
0
Calibrated EAARL-B Depth (m)
95% A
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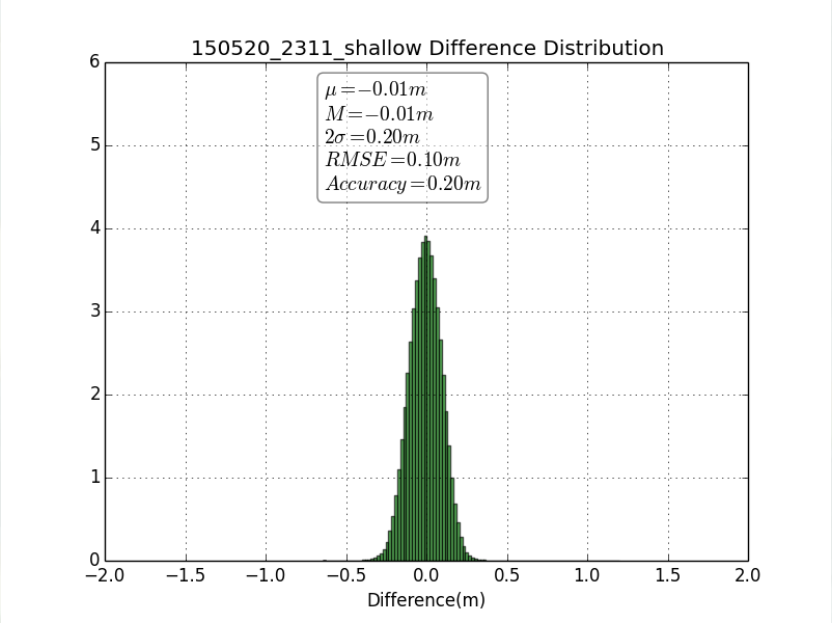
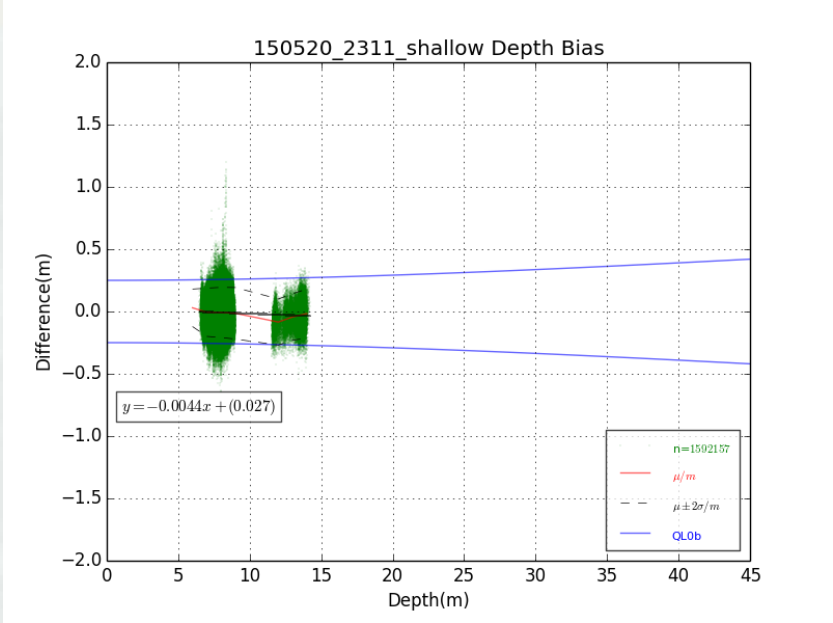
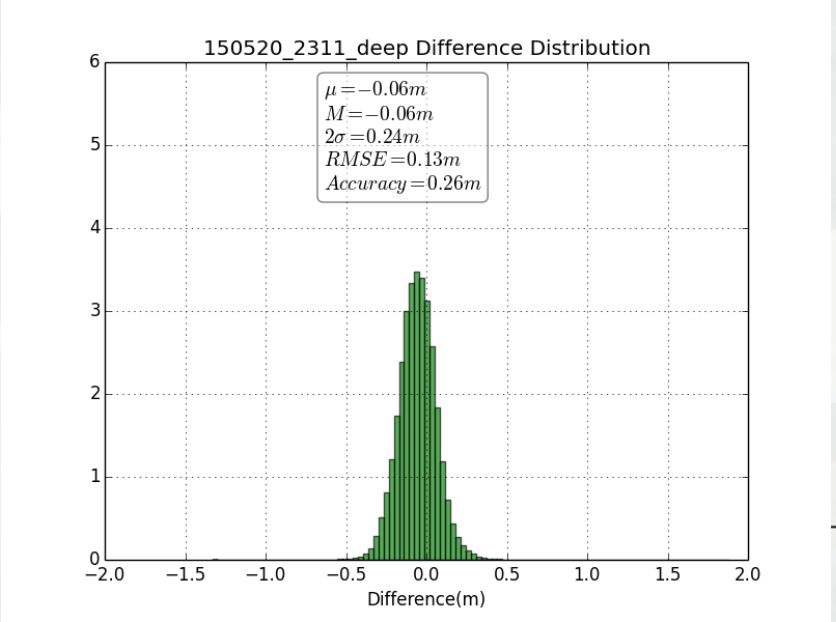
IHO-S
IHO-1
QL2 &

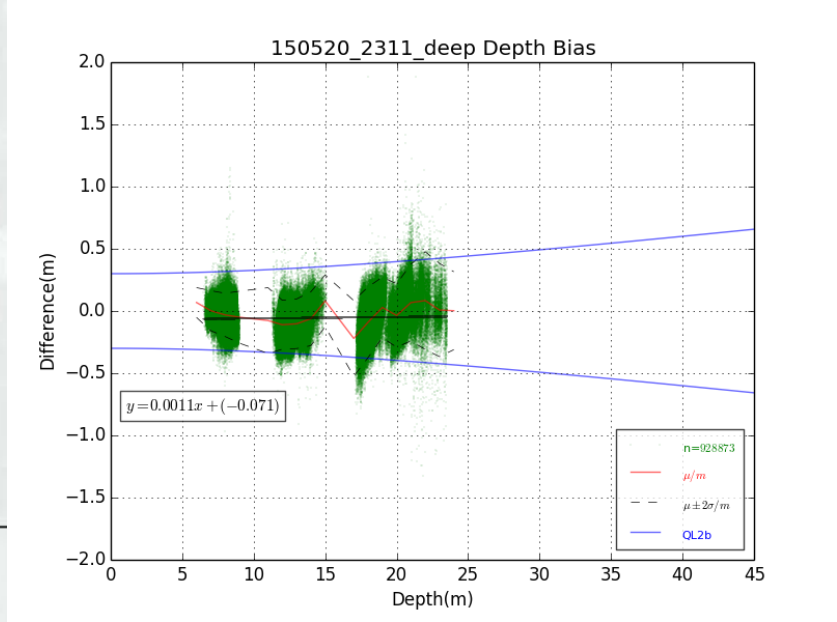
# QL Considerations

- RMSE vs depth dependent uncertainty / 3DEP vs IHO



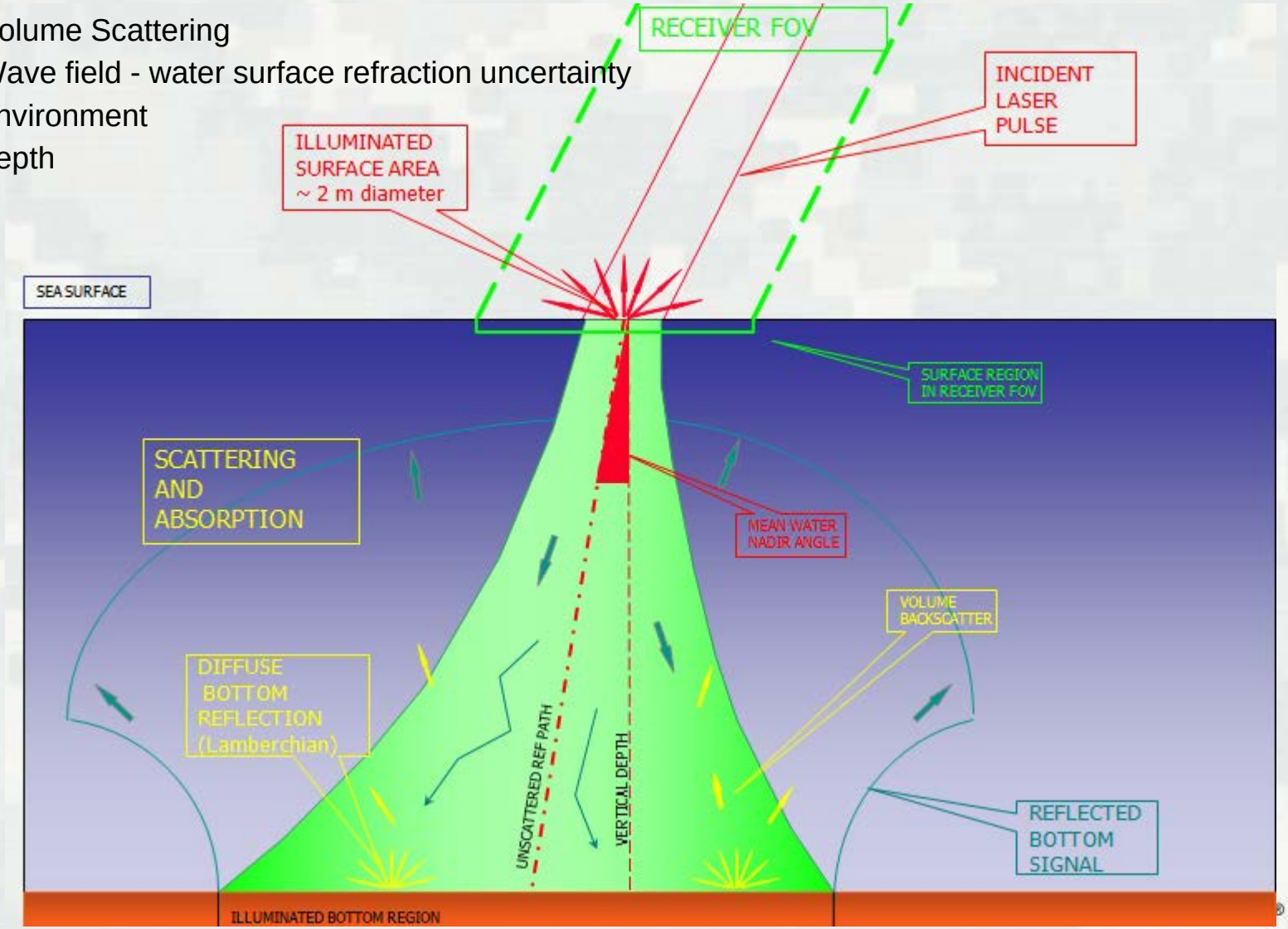



# QL Considerations

- What About Horizontal Accuracy? THU?
  - Beam diameter/receiver FOV - return location?
  - Volume Scattering
  - Wave field - water surface refraction uncertainty
  - environment
  - depth
- TVU?



# QL Considerations

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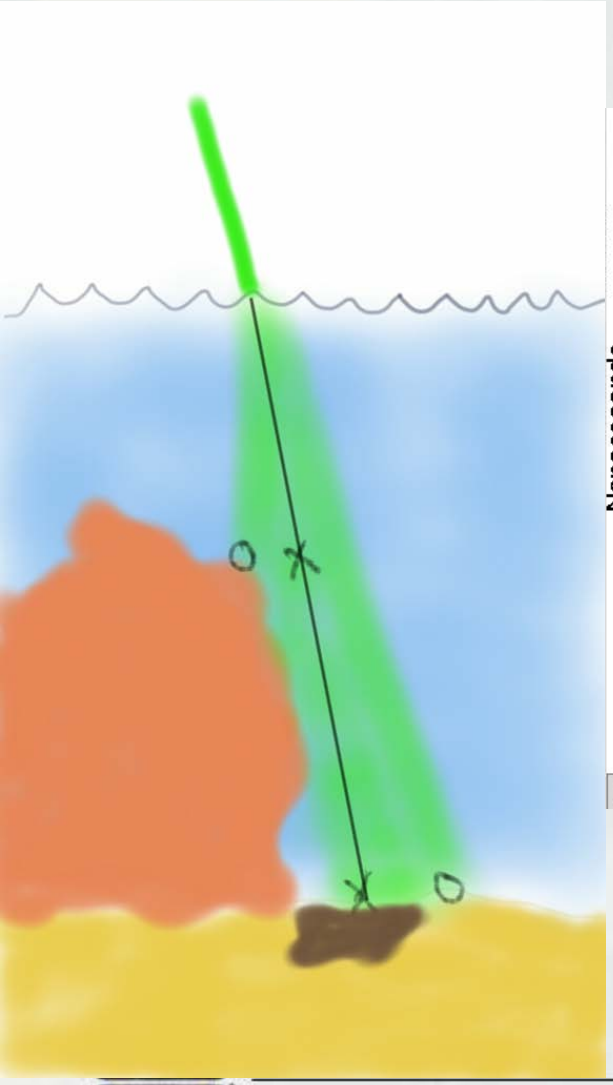
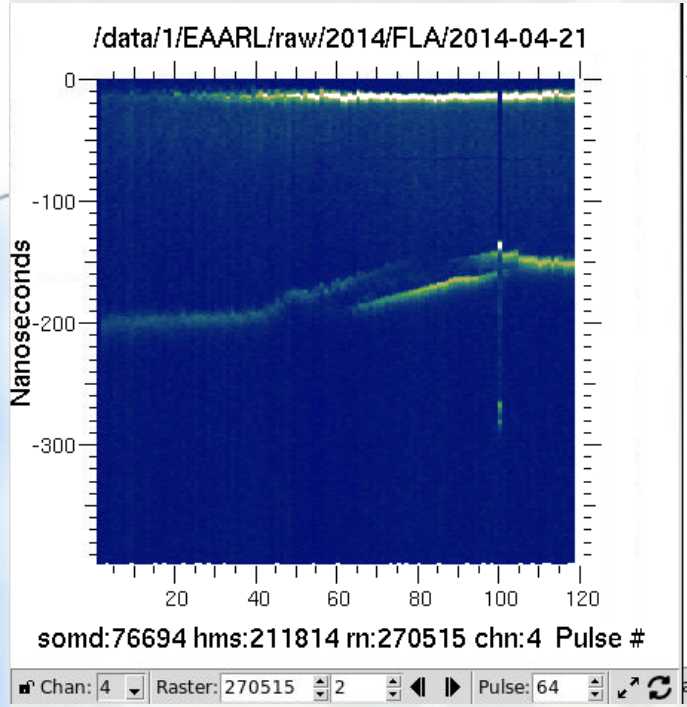
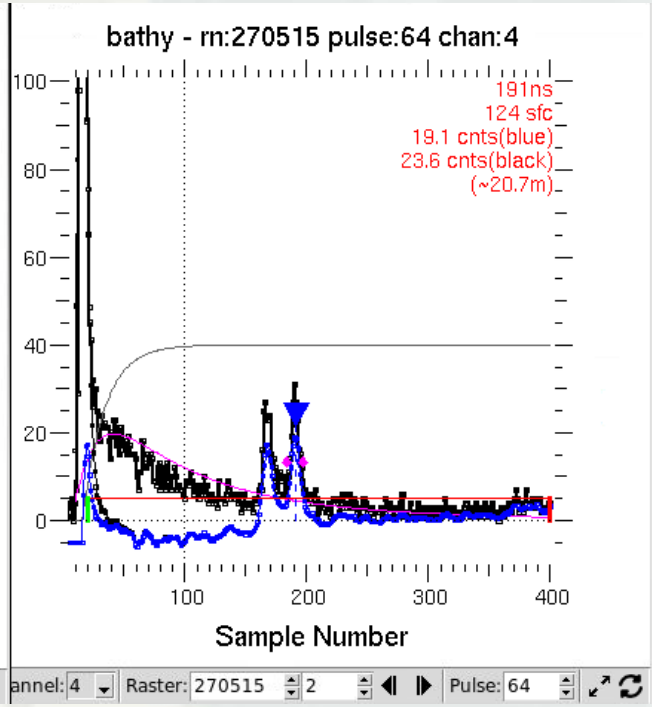




# QL Considerations

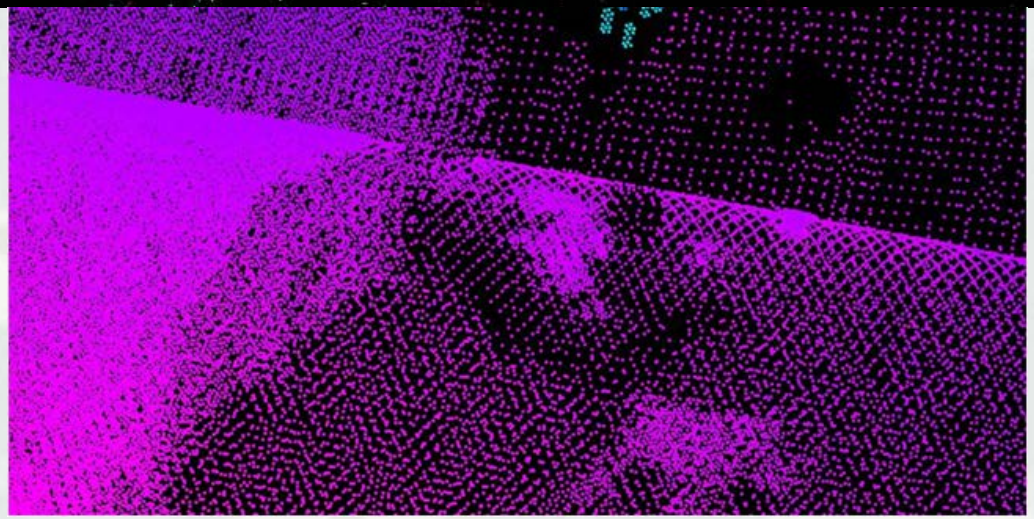
- Include smooth surface repeatability and swath overlap difference? How often do you have or need recent nearshore bathymetric GT?

| Quality Level (QL) | Aggregate nominal pulse spacing (ANPS) (m) | Aggregate nominal pulse density (ANPD) (pls/m$^2$) | Smooth surface repeatability (cm) | Swath overlap difference, $RMSD_z$ (cm) | Swath overlap difference, maximum (cm) | $RMSE_z$ (nonvegetated) (cm) | NVA at 95-percent confidence level (cm) |
|---|---|---|---|---|---|---|---|
| QL0 | ≤0.35 | ≥8.0 | ≤3 | ≤4 | ±8 | ≤5.0 | ≤9.8 |
| QL1 | ≤0.35 | ≥8.0 | ≤6 | ≤8 | ±16 | ≤10.0 | ≤19.6 |
| QL2 | ≤0.71 | ≥2.0 | ≤6 | ≤8 | ±16 | ≤10.0 | ≤19.6 |
| QL3 | ≤1.41 | ≥0.5 | ≤12 | ≤16 | ±32 | ≤20.0 | ≤39.2 |

| Bathy Lidar Quality Level | Vertical accuracy coefficients a,b as in sqrt(a^2+(b*d)^2)) | Smooth surface repeatability (m) | Swath overlap difference, RMSDz (m) |
|---|---|---|---|
| $QL0_B$ | 0.25, 0.0075 | ≤0.075, 0.0075 | ≤0.10, 0.0075 |
| $QL1_B$ | 0.25, 0.0075 | ≤0.075, 0.0075 | ≤0.10, 0.0075 |
| $QL2_B$ | 0.30, 0.0130 | ≤0.09, 0.0130 | ≤0.12, 0.0130 |
| $QL3_B$ | 0.30, 0.0130 | ≤0.09, 0.0130 | ≤0.12, 0.0130 |
| $QL4_B$ | 0.50, 0.0130 | ≤0.15, 0.0130 | ≤0.20, 0.0130 |

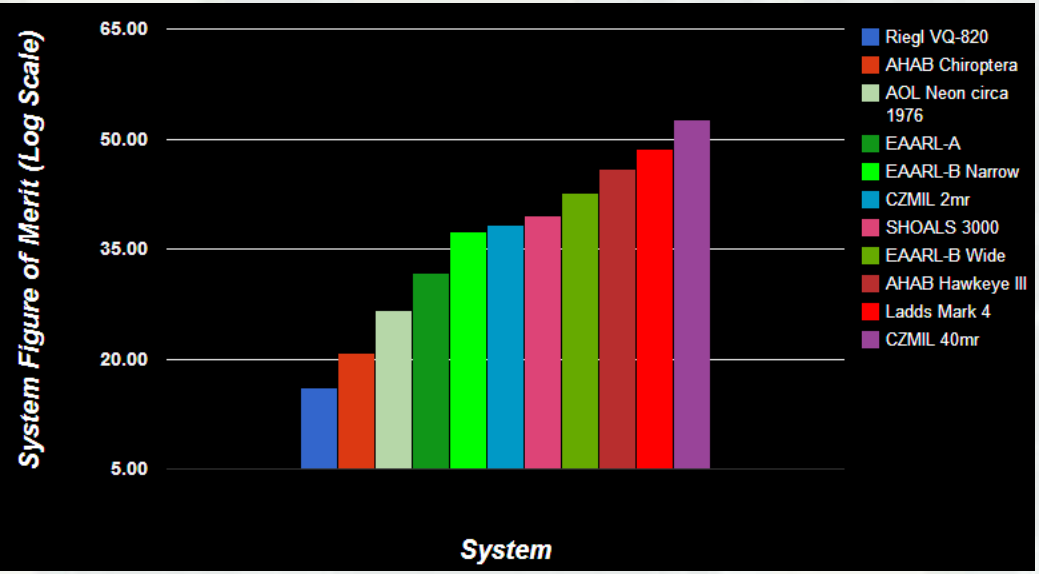
# QL Considerations

- NPS, point density, and bottom return point density are not the same
  - varying coverage with depth, surface, and water conditions



# QL Considerations

- Depth performance? System Power-Receiver Area. Factor to give user some idea of expected depth for a project as current industry uses a broad design spectrum of bathy lidar sensors.




$$S = \frac{[\log(A * W) - 4]}{0.1}$$

*Where:*

A = Area of Receiver in $cm^2$

W = Peak Pulse Power (Watts)

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# NCMS Coverage

- Overarching goal of NCMS is the achievement of continuous, gap-free coverage across the intertidal zone.
  - NOAA's NGS requires tide coordinated collects around high and low tide
  - Some bathymetric lidar systems acquire topo and bathy data separately, and the use of either at optimal tidal times is used for maximum coverage
  - Depending on environment, some systems can acquire seamless coverage in a single pass

❖ Gap-free consideration

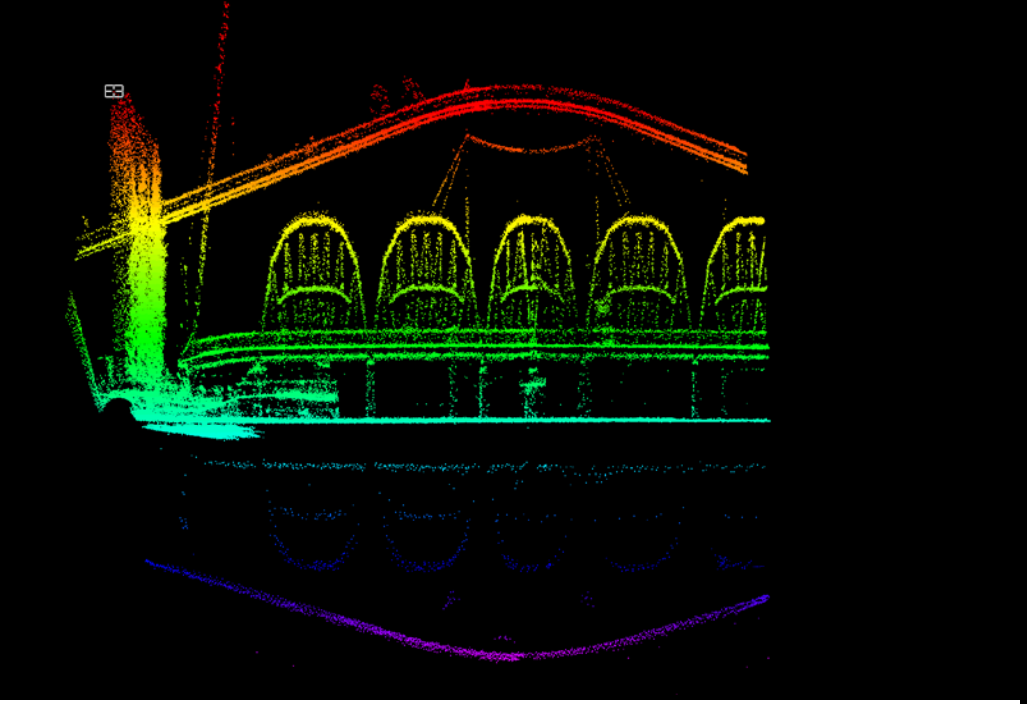
- ➢ Environment may make acquisition difficult to manage for a gap-free intertidal zone, regardless of working around tidal windows (contractor management)
  - ■ HI,WA,OR coast with large, continuous surf zones or turbid nearshore zones
- ➢ Operating programs like NCMP attempt gap-free coverage but management of that zone on large scale projects is not feasible

# QL Use and Maintenance

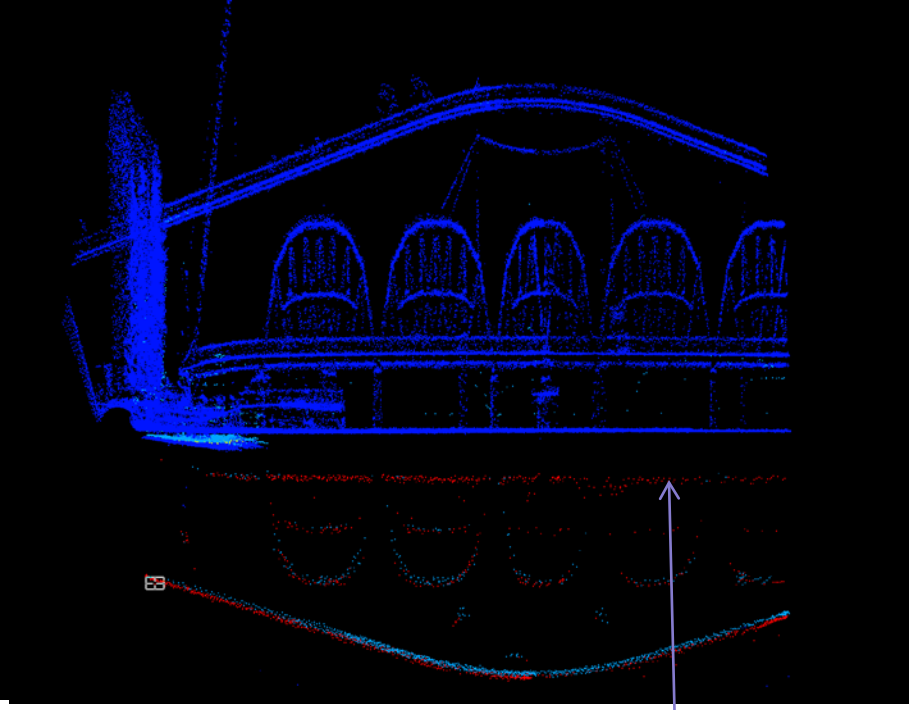
- Federal mapping agencies update their specifications to reference the bathy QLs
  - QLs closely built on existing specifications and neighboring field's requirement to prevent major future modifications
  - Example. Agencies meeting at NCMS Summit identify a geographic area of mutual interest but with different QL requirements. Agency with lower QL requirements could acquire the data for both agencies use.

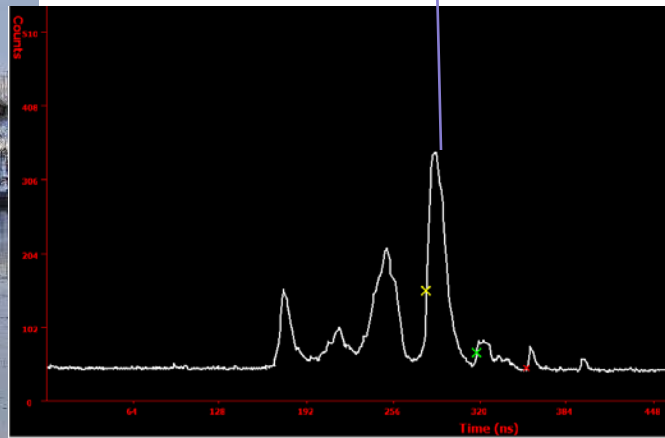
# Workshop Discussion

- RMSE vs depth dependent “accuracy” / 3DEP vs IHO
- THU and TVU?
- Including intra and inter swath allowances? How often do you have or need recent nearshore bathymetric GT?
- NPS, point density, and bottom return point density are not the same
- Depth performance? System Power-Receiver Area. Factor to give user some idea of expected depth for a project as current industry uses a broad design spectrum of bathy lidar sensors.



Color by depth



Color by classification. Dark blue topo and rest is bathy

Richmond-Dresden Bridge