Experiences & Insights from Introducing Terrestrial Laser Scanning (TLS) to Geology Field Courses

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NSF

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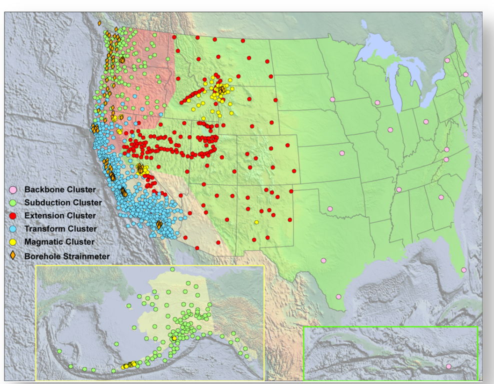
2013 Geological Society of America meeting

UNAVCO is a non-profit, membership governed consortium of universities that facilitates geoscience research and education using geodesy.

UNAVCO supports GPS, InSAR and LiDAR data acquisition, data archiving, equipment, development & testing, training.

UNAVCO operates and maintains the **Plate Boundary Observatory** network of instruments.

UNAVCO Education & Community Engagement works to promote a broader understanding of Earth science.



GEODETIC IMAGING AT UNAVCO

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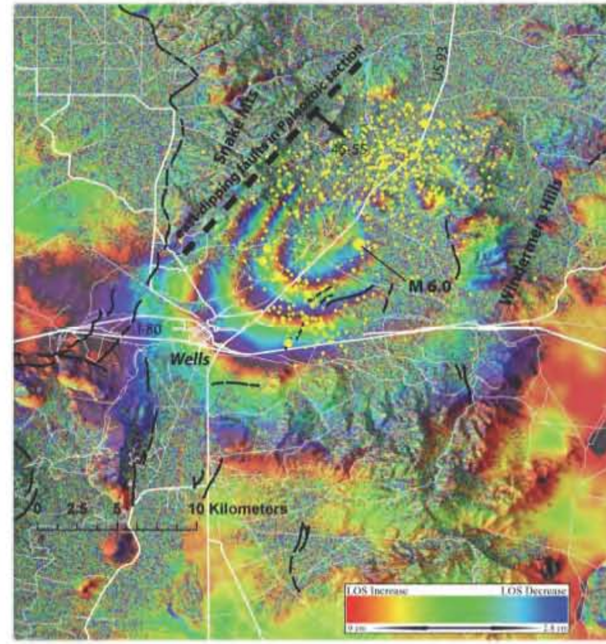
Terrestrial LiDAR

Airborne/ Spaceborne InSAR



Airborne/ Spaceborne LiDAR

Terrestrial Radar

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TLS Community Support

Support Resources

- Instrumentation (6 scanners)
- Field engineering
- Data processing
- Training
- Data archiving & dissemination

Community Building

- Workshops
- Inter-Agency collaborations & partnerships

Education and Outreach

- Training courses
- Field camps (~90 students in 2013)

Scanners funded by the National Science Foundation

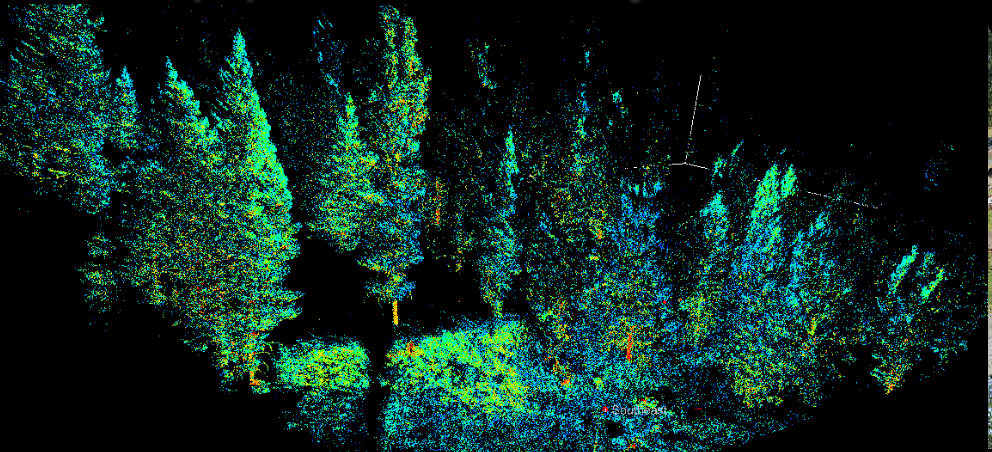
	 **Riegl VZ-1000**	 **Riegl VZ-400**	 **Riegl Z620**	 **Leica C10**
Laser Wavelength	1550 nm (near IR)	1550 nm (near IR)	1550 nm (near IR)	532 nm (green)
Effective Range (max)	1400 m	500 m	2000 m	150 m
High-speed meas. rate	122,000 points/sec	125,000 points/sec	11,000 points/sec	50,000 points/sec
Precision	5 mm	5 mm	10 mm	4 mm
Accuracy	8 mm	5 mm	10 mm	6 mm
Field of View	100° x 360°	100° x 360°	80° x 360°	270° x 360°
Dimensions	308mm x 180mm	308mm x 180mm	463mm x 210mm	238mm x 395mm
Weight	9.8kg	9.8kg	16kg	13 kg

TLS field camp overview

- Initiated in 2009 at Indiana University Geologic Field Station as part of G429 course (geophysics elective).
- 2013 = Indiana, U. Houston, U. Michigan, UC Santa Cruz

Program:

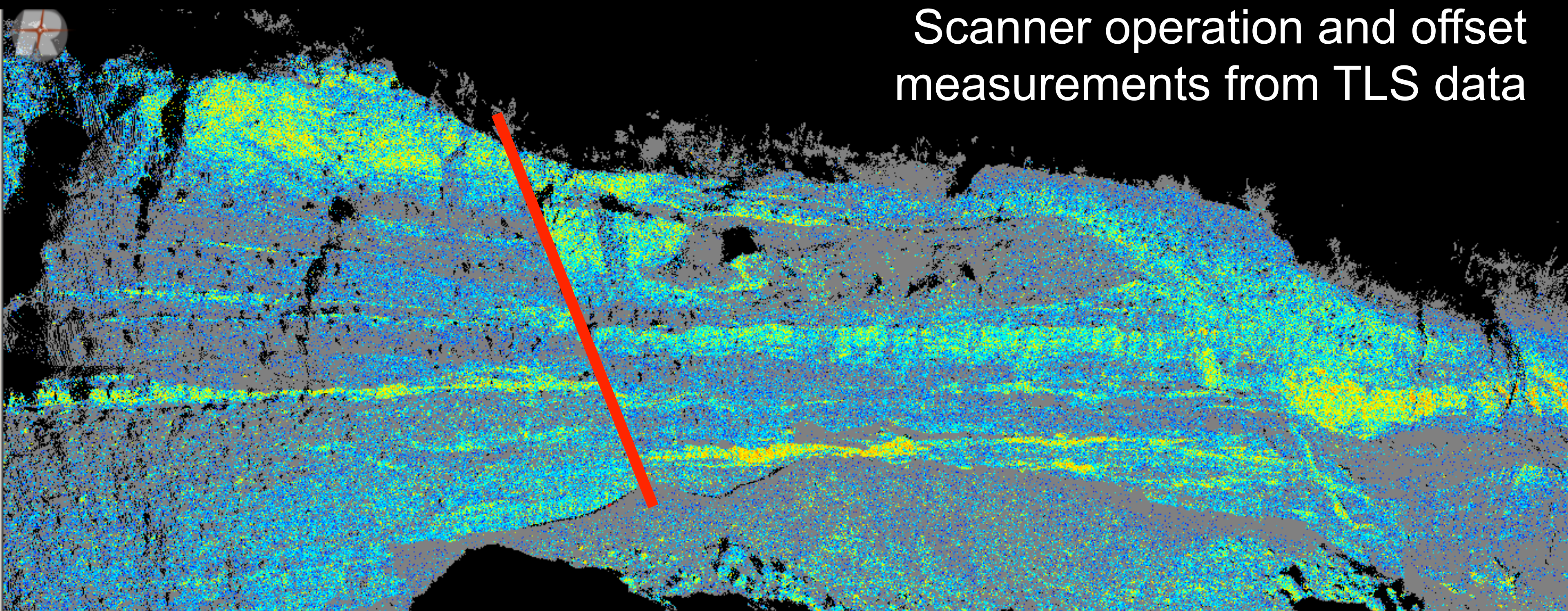
- 5 day elective within or at end of camp program
- UNAVCO provides staff, TLS and GPS instruments. Faculty define exercises, study sites, curriculum.
- Emphasis = TLS technology, survey design, hands-on operation of equipment, and analysis of data.



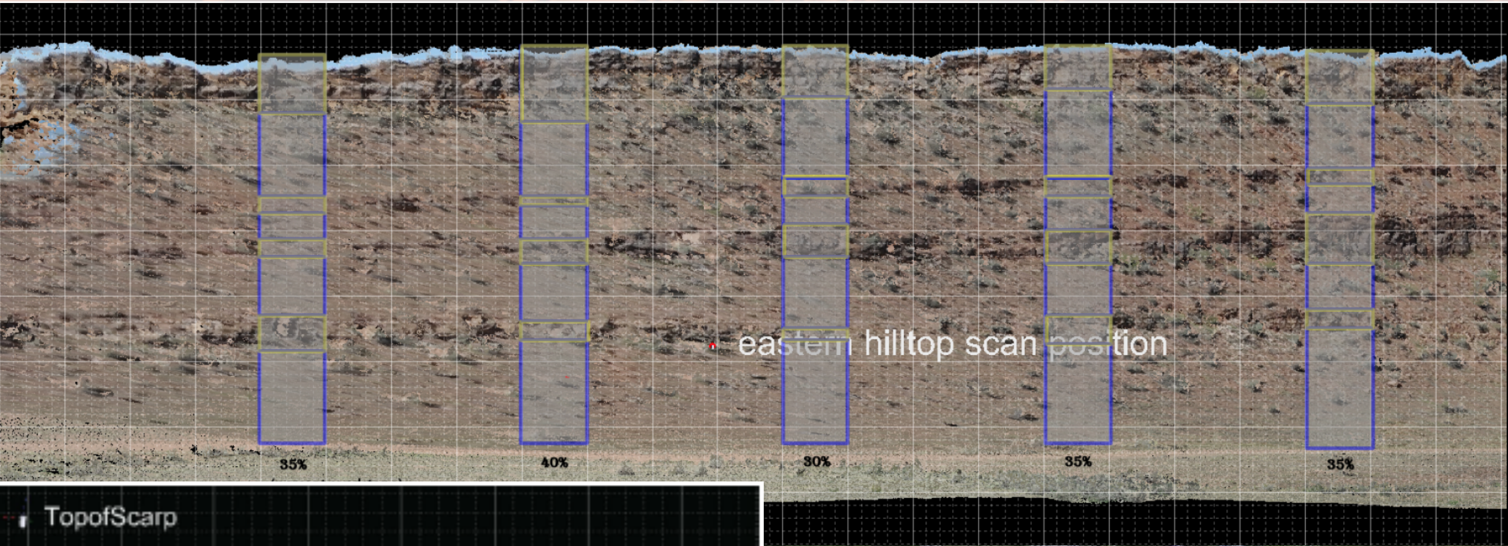
TLS at IUGFS

- New scan site each day – increasing complexity and independence
- Emphasis placed on project metadata and documentation
  - Instrument set up and data processing flow charts
  - Equipment lists, site maps, and tables of scan parameters.

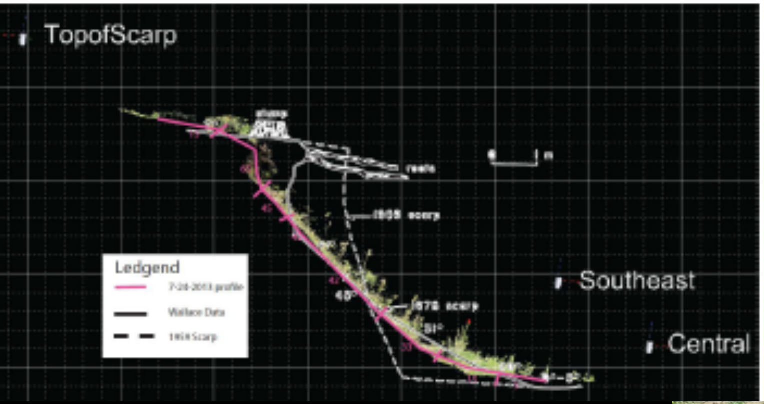
Day 1: Harrison borrow pit site w/ fault.
Scanner operation and offset
measurements from TLS data



TLS at IUGFS



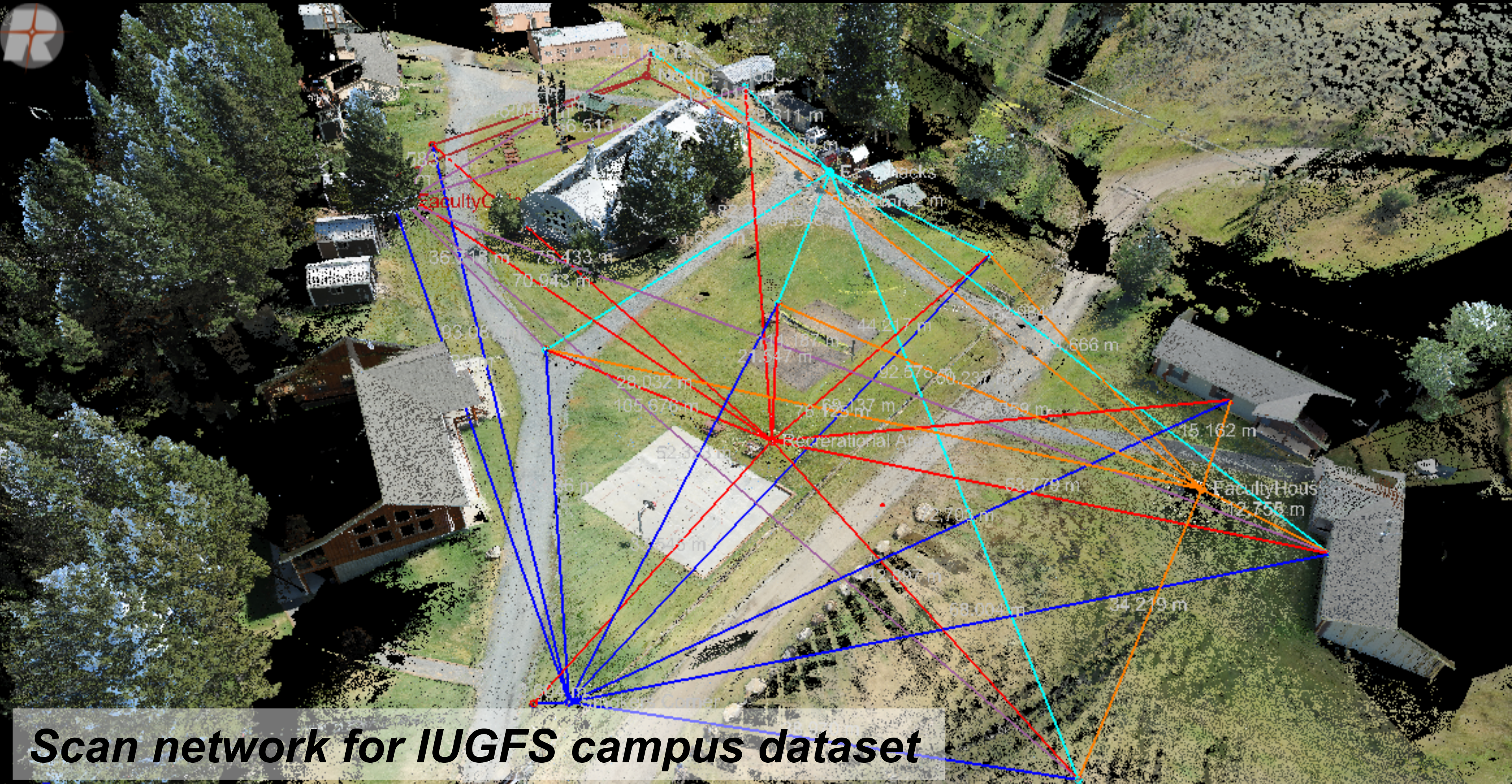
Sand/mud ratios for an interval of the Kootenai Fm at Sandy Hollow. [*Matt Booth, Whitman College*]



Comparison of 1959 fault scarp observations with TLS scan data to evaluate scarp degradation. [*Elizabeth Horne, Utah State*]

TLS at IUGFS

Final Project: Independently design & propose a survey, deploy the instruments, collect and analyze data.

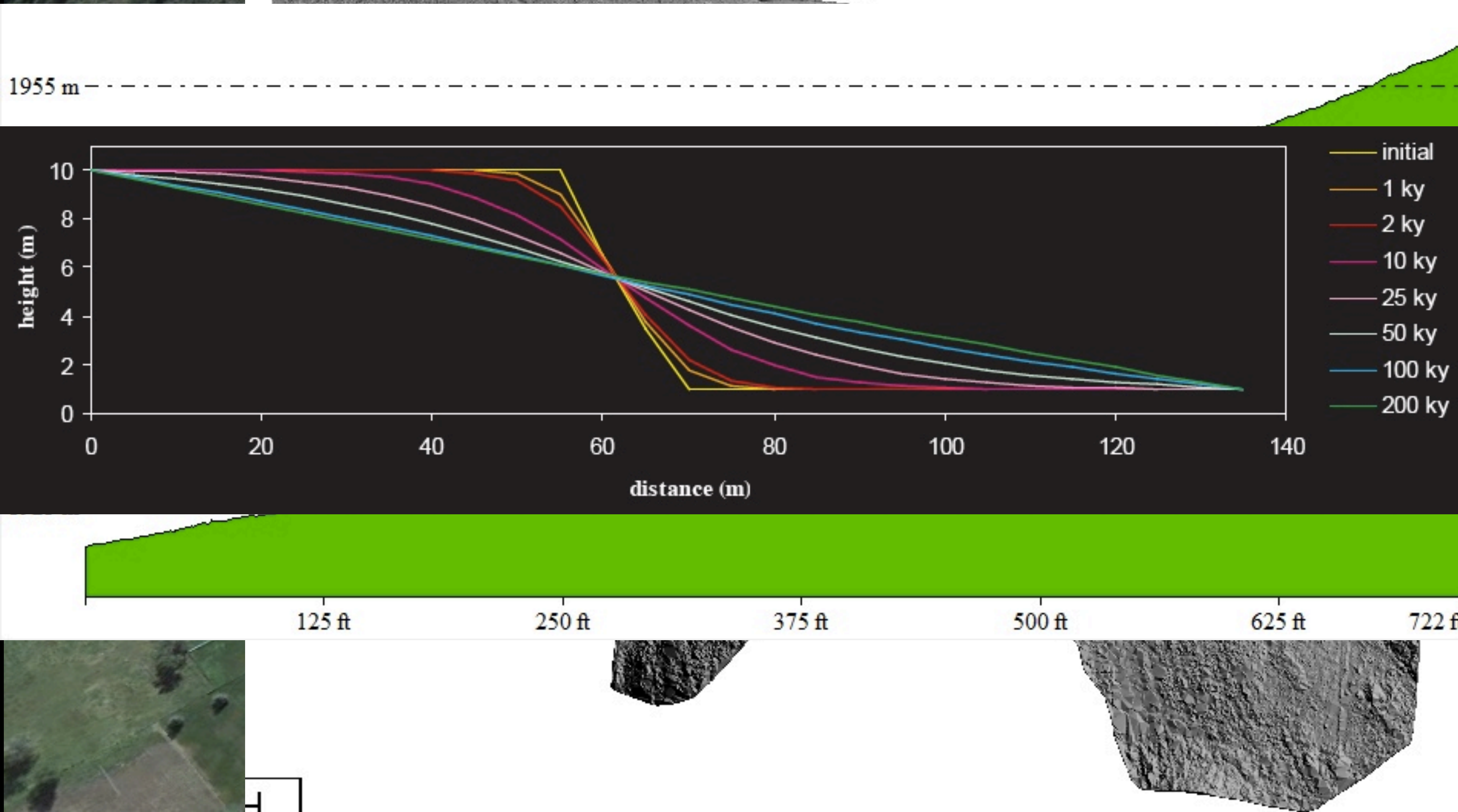


Scan network for IUGFS campus dataset

TLS at U. Michigan

Morphologi dating of Star Valley fau

10 cm bare earth DEM



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Curriculum Materials

TLS field camp manual

- Developed for use at IUGFS
- TLS introduction
- TLS theory

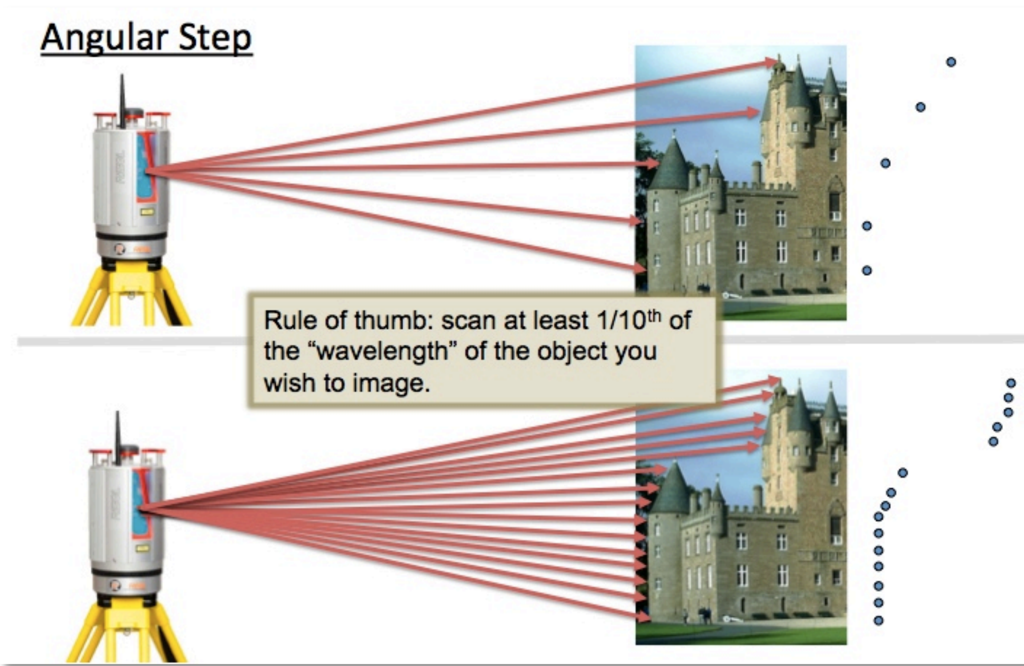
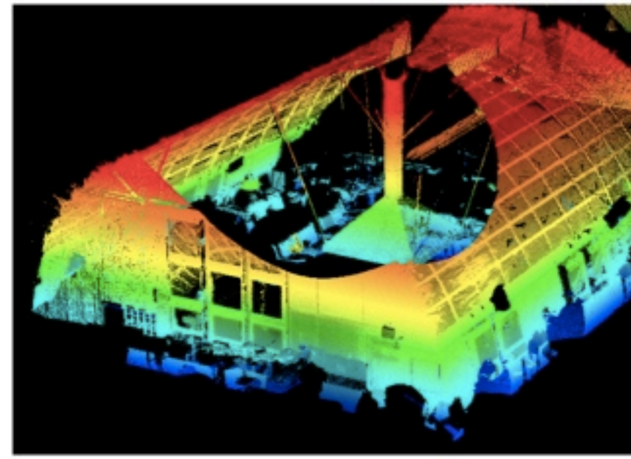


Illustration of the impact of angular step size on scan resolution



G429g

Geophysical and Tectonic Applications to Field Investigation in the Northern Rocky Mountains 2013

Compiled by:
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With contributions from:
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Indiana University Geologic Field Station
1949-2013

TLS field camp manual

- Exercises & worksheets

Using basic trigonometry, calculate various parameters to determine scan resolution, time, etc.

Scan Resolution Parameter Worksheet

Use this worksheet to determine the optimal and realistic scan times based on desired scan resolution.

Beam diameter at instrument: ________m (ReiglZ620=0.014; ReiglVZ400=0.007)

Beam divergence: __________radians (ReiglZ620=0.00015; ReiglVZ400=0.0003)

Constants for a given scanner

Table 1. Scan spacing

Scan site and scan number	Distance to target (m)	Spot size (m) [Dist*Diverg]+ Diameter	Angle of Incidence to target	Ellipse max diameter (m) Spotsize/sine[Angle]	Optimal measurement spacing (m)	**Actual spacing used (m)**	**Comments**
	Min						
	Max						
	Mean						
	Min						
	Max						
	Mean						
	Min						
	Max						
	Mean						
	Min						
	Max						
	Mean						

Table 2. Scan time

Scan site and scan number	Horiz scan dist (m)	Optimal # horiz measurements	Vert scan dist (m)	Optimal # vert measurements	Time for optimal scan [#horiz * #vert * time/measurement]	**Time for actual scan**

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Practical Considerations I

Group size & time management:

- Small groups, downtime
- Keep students working on activities, outcrop orientations, site maps
- Interleave TLS w/ mapping?

- Data processing takes time. Leave processing to UNAVCO staff(?). Advanced products not feasible overnight.
- TLS data analysis = less field time

Practical Considerations II

Site selection:

- Compact sites with limited vegetation preferable.
- Ease of access important
- Outcrops, fault scarps, fluvial terrace risers & cut banks, recently burned slopes.

Computing Resources:

- Analysis of data requires computer access.
- Pre-install TLS and GIS software.
- Budget time to distribute data

TLS field camp conclusions

- 90+ geoscience students Introduced to TLS technology and data analysis in 2013.
- Cutting-edge technology is complimentary to traditional field geology program, esp. when project areas/topics are tied into course curriculum.

- Students engaged. Demand increasing. Sponsor enthusiastic.
- Planning is essential – site selection, time management, computing resources necessary to streamline operations and keep students engaged.

Thanks!

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2012 U. Houston Geophysics Field Camp, Red Lodge, MT