# Ground-Based LiDAR


Dr. Robert Kayen
U.S. Geological Survey
Menlo Park, CA

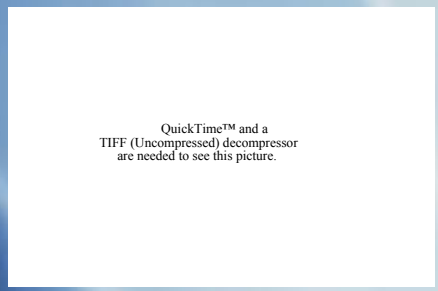
# The Reconnaissance Problem:

We want to collect and archive highly detailed, accurate spatial measurements of damaged ground and structures, and do this rapidly, with limited budget?

Solution: Tripod-mounted LiDAR

# Ground-Based LiDAR

- LiDAR (Light Detection And Ranging)




**Distance = (Speed of Light x Time of Flight) / 2**

- Portable & light tripod-mounted systems
- Fixed or Rotating laser-line scanner systems
- Produces 3-D target positions at up to 500k positions/minute
- Range: Up To 1 kilometer around Tripod under optimal atmospheric conditions

# LiDAR & GEER: Bringing damage ground and structural morphologies back to the lab for analysis, and as a permanent record of event effects.

- Rapid data collection of damaged terrain.
- Ultra-high accuracy terrain models for deformation calculations and change detection .
- Archive-quality spatial models of damage.
- 3-D spatial visuals and fly-through videos for engineering analysis and public outreach.


USGS-GD Unit:
Riegl z210i


USGS-WRD Unit:
Optech ILRIS-3D

# LiDAR Systems at the USGS


**Riegl z210i**
General Purpose Mapper:

- **700m+ Range**
- Max. X,Y,Z Accuracy 0.9 cm
- Targets: 5.6M in 11 minutes
- Scan window: 80° by 336°

*USGS-Geologic Division System*

**OpTech ILRIS-3D**
Narrow window High-Res Mapper

- **300m+ Range**
- Max. X,Y,Z Accuracy 0.3-0.4 cm
- Targets: 1.8M in 15 minutes
- Fixed window: 40° by 40°

*USGS-Water Resources Division System*


Denali Fault offset at

Trans Alaska Pipeline, 7/2004:

Single Riegl z210i Scan range 580m

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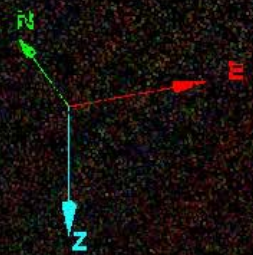
*USGS-WRD System*


# Point Resolution
# Spacing : ~2mm
# near tripod
# with 9mm 3-D resolution

Fissure

~30 cm



Sub-cm 3-D spatial deformation measurements of minor or significant damage at distances up to 700-1000m

Minor Fissures

Parkfield 10/4/2004

# LiDAR Data Processing


**Riegl z210i**

Single or Multiple scans.

Merge point cloud data with I-Site3D

Triangulated surface (TIN) for measurement and change detection using I-Site3D

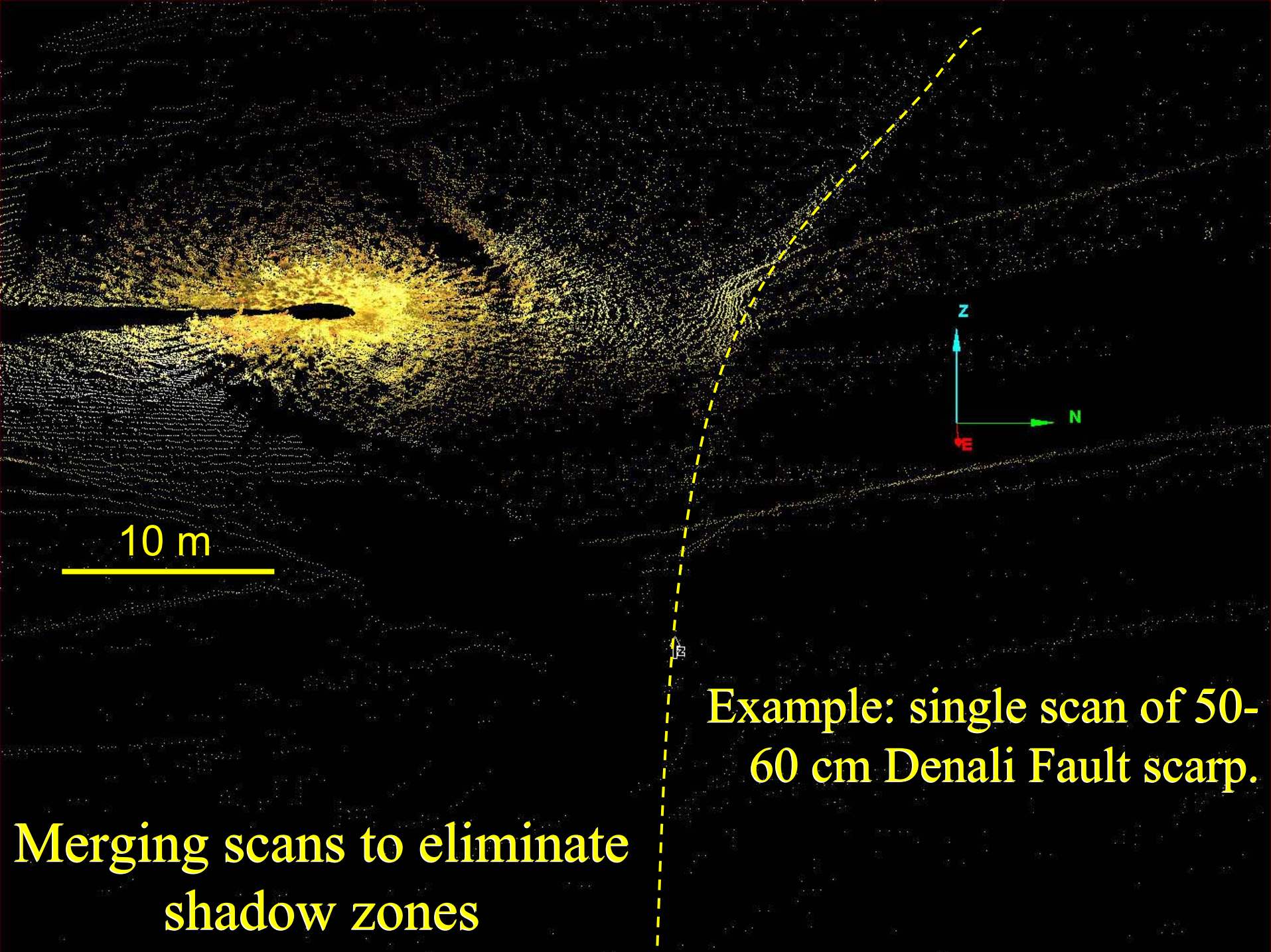
*USGS-GD System*

**OpTech ILRIS-3D**

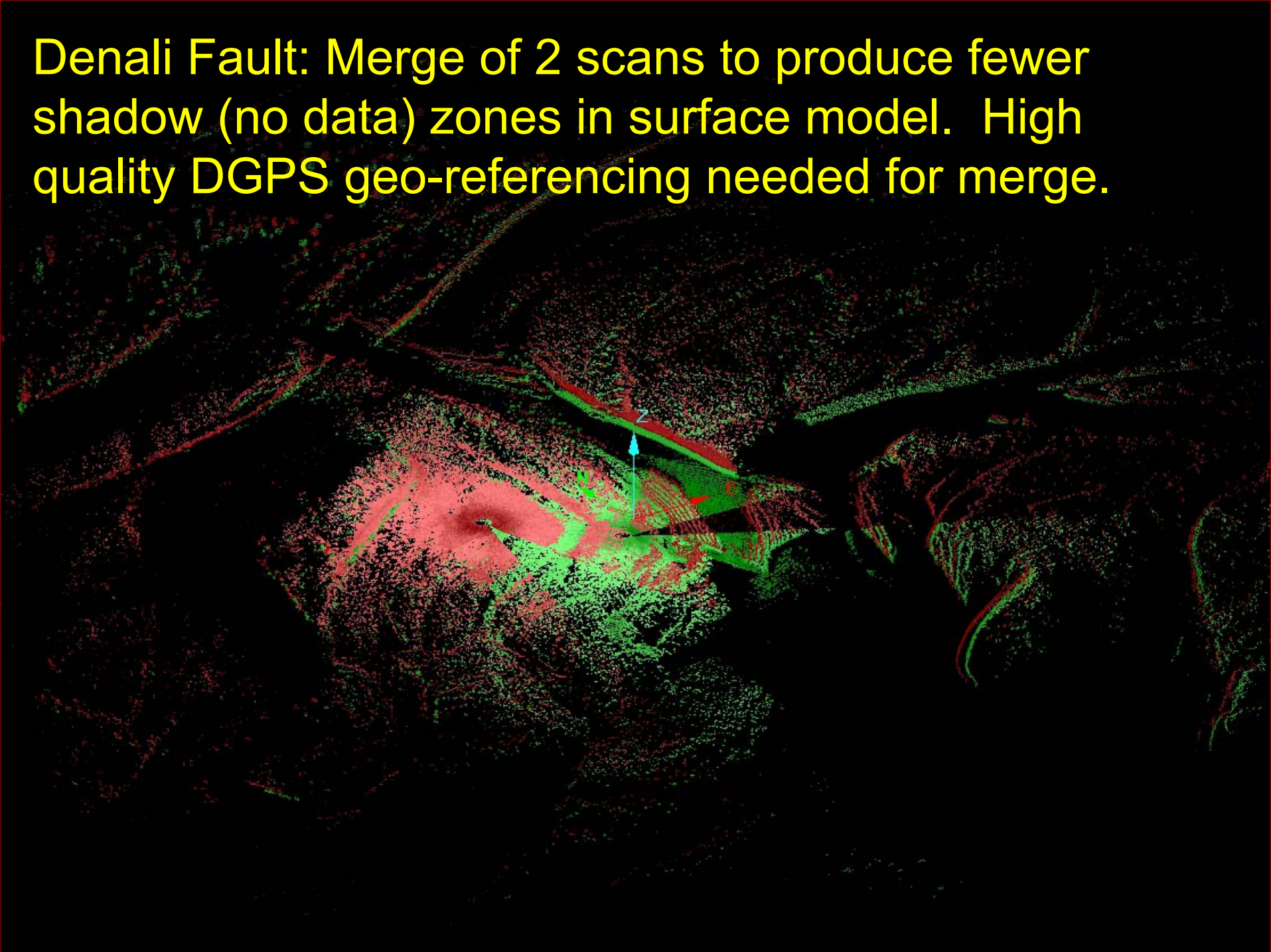
Multiple scans to expand scan window & eliminate shadow zones.

Merge point cloud data, produce triangulated surface (TIN) with PolyWorks.

*USGS-WRD System*

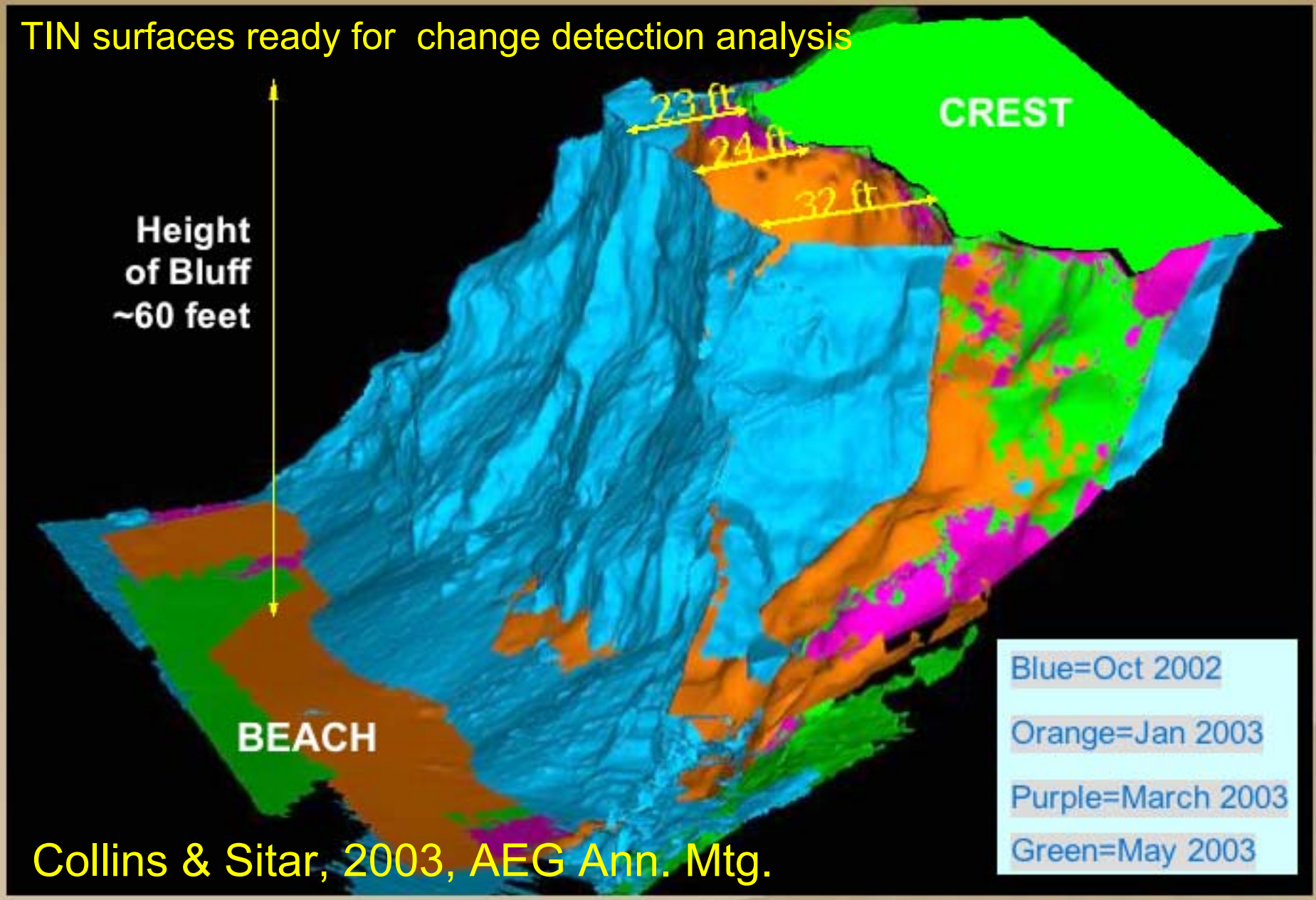

Z
N
E
10 m
Example: single scan of 50-60 cm Denali Fault scarp.
Merging scans to eliminate shadow zones

Denali Fault: Merge of 2 scans to produce fewer shadow (no data) zones in surface model. High quality DGPS geo-referencing needed for merge.



# Denali Fault: Merging of 8 scans to produce a largely shadow free surface model of rupture

# Digital Terrain Model Generation




Collins & Sitar, 2003, AEG Ann. Mtg.

# Summary

- GEER-EERI-USGS can utilize ground-based LiDAR to collect damage morphology data at speeds, accuracies, and range that was previously unimaginable in earthquake reconnaissance.
- These permanently archived terrain models will vastly improve controls on empirical deformation studies and allow researchers decades later to virtually-revisit damage sites.

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