Structure from Motion

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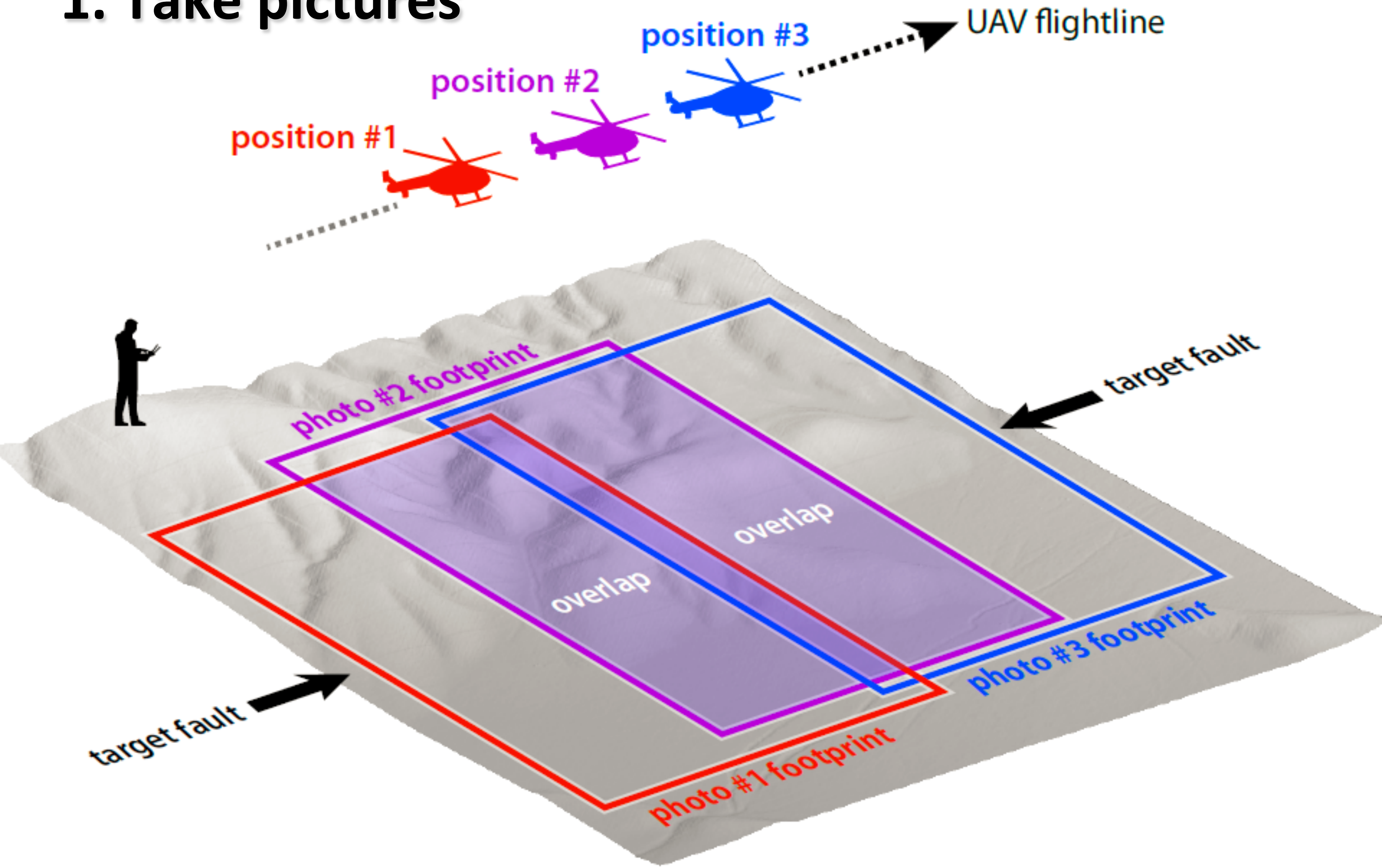
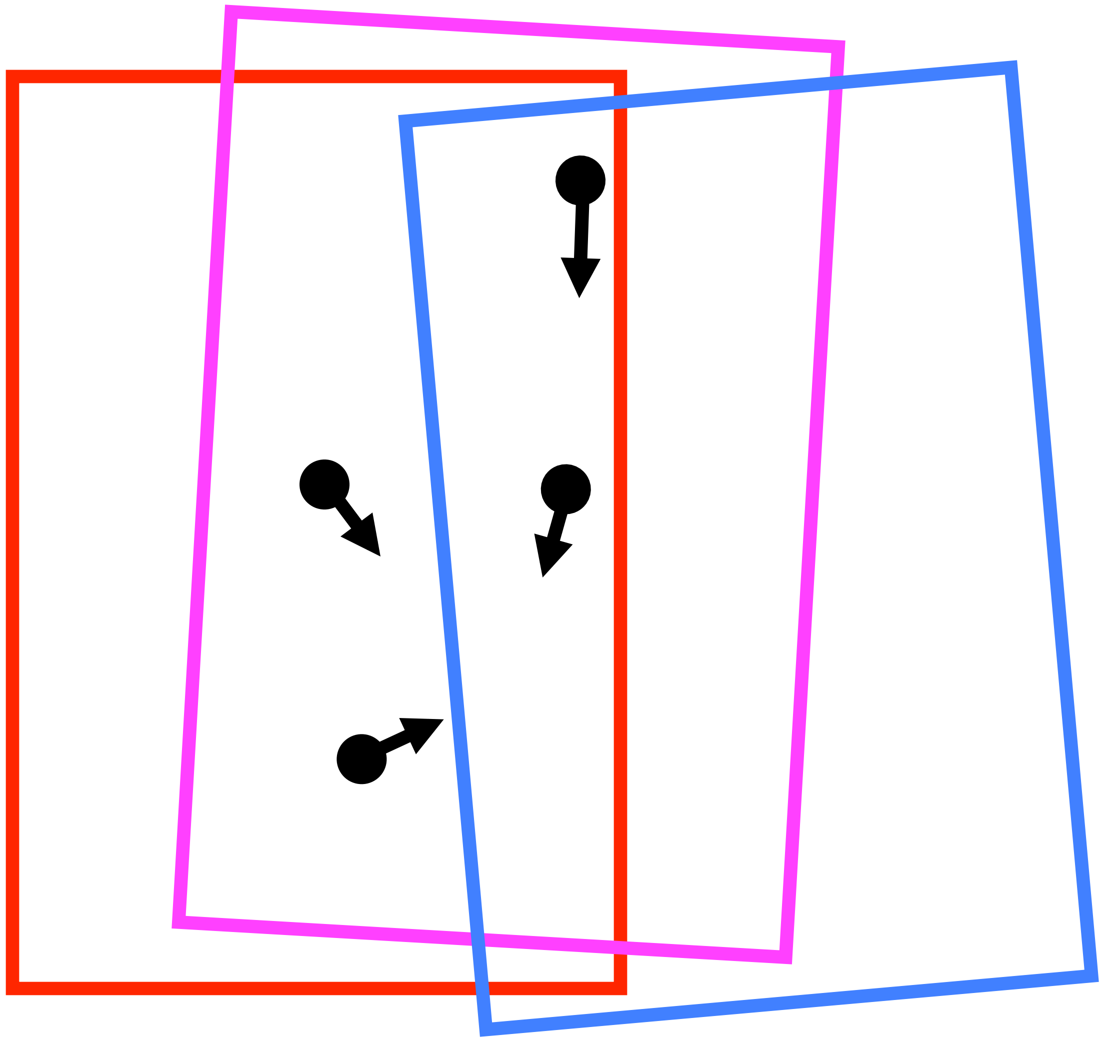
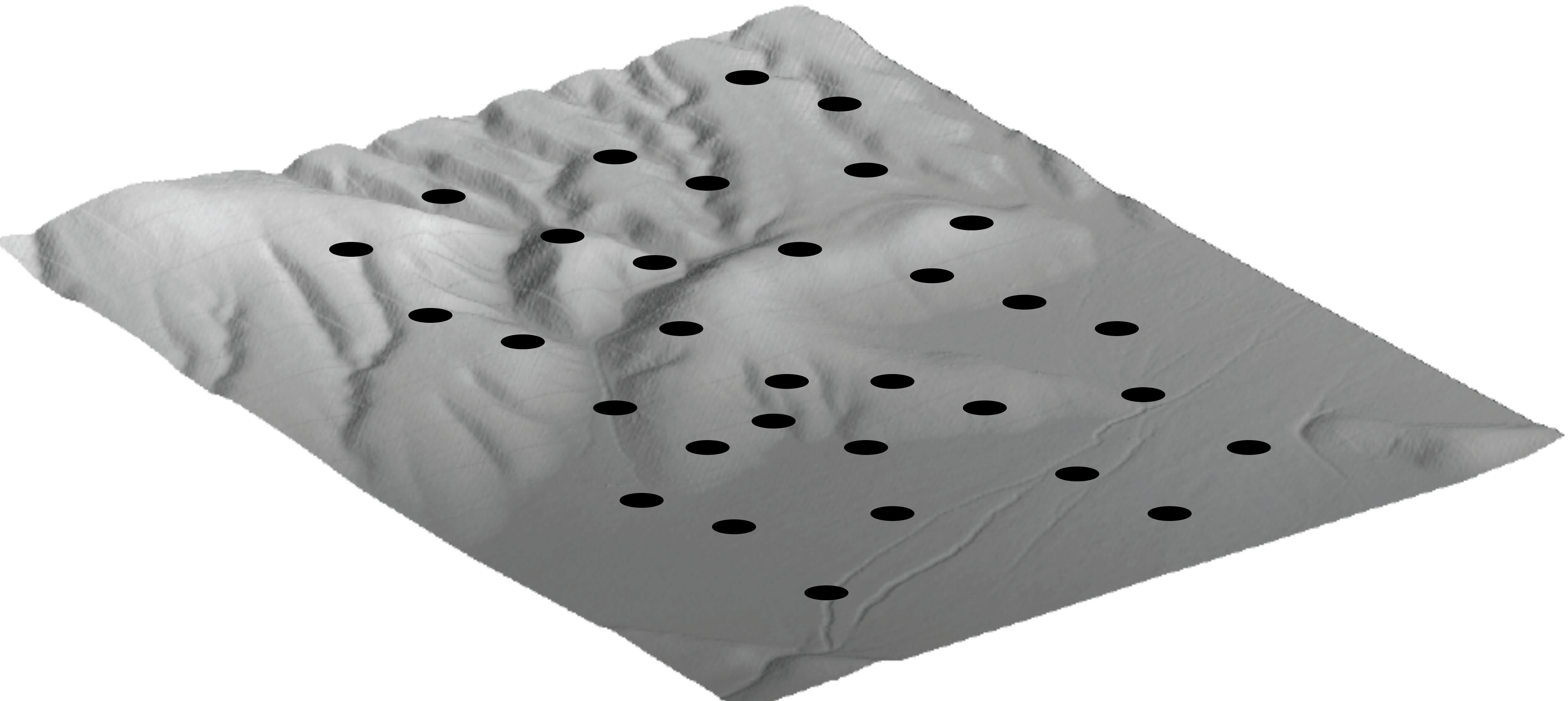
1. Take pictures



1. Identify points which are the same and see how they have moved in the picture overlap

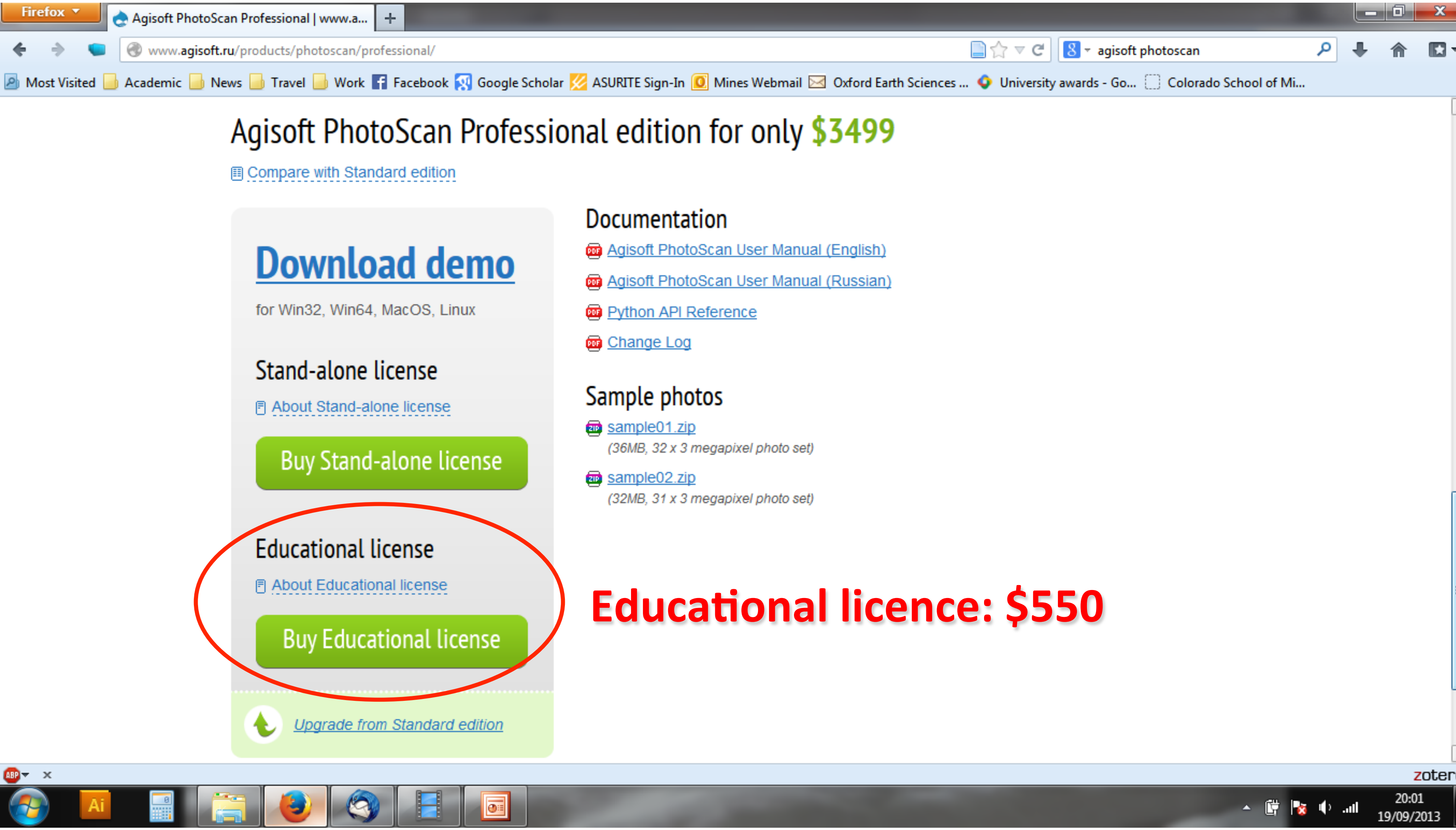


1. Generate 3D point cloud and DEM



Structure from Motion

- Take pictures which have some overlap
- Find points which are same in both images
- Determine how these points have changed between images
- Create a **Digital Surface Model** and 'drape' the images over the model (**Texture Map**)
- Software = AGISOFT PHOTOSCAN



Educational licence: $550

Choice of camera

The camera should have two key features:

- time lapse setting – remotely takes photo every *x* seconds

- Internal or external GPS tagging (not absolutely essential but helps speed up processing in Agisoft Photoscan)

Nikon D5100 – costs about $1000 incl. lens and geotag

Excellent photos but quite heavy (~ 1 kg) so cannot be carried by small UAVs.

Canon Powershot – costs about $200

Has internal GPS. SD card needs to be programmed to do time lapse. Light enough (~400 g) to be carried by most small UAVs.

For: once in the air can follow pre-set flight path. Robust in high wind and can take off and land anywhere.

Against: needs trained pilot to take off and land. Initial costs are high and helicopter needs careful maintenance.

Helicopter ($15,000)

For: easy to self- launch and to pilot. Can cope in moderately windy conditions.

Against: can only carry small cameras and is susceptible to damage during landing.

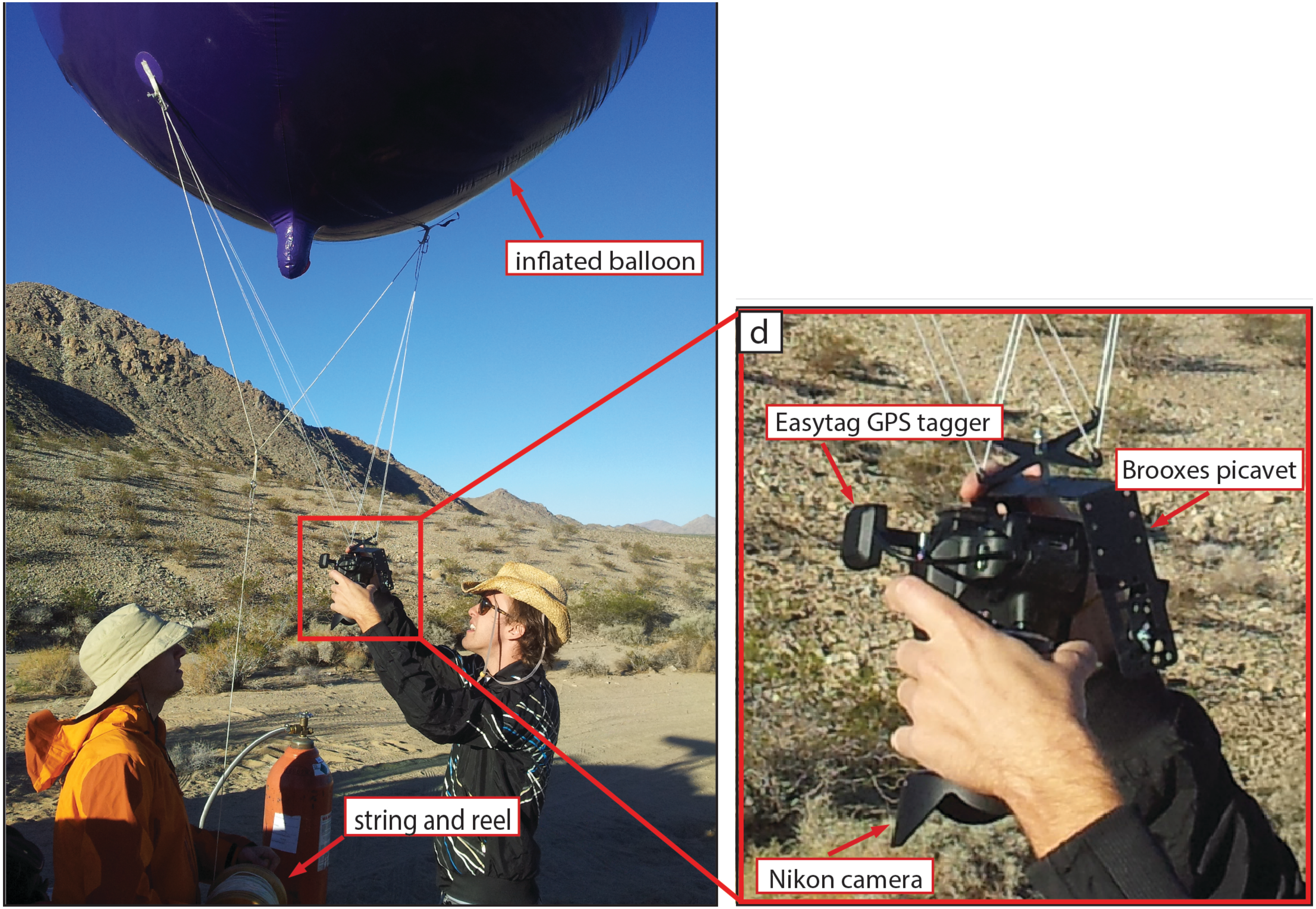
http://robotics.asu.edu/projects/autokite/

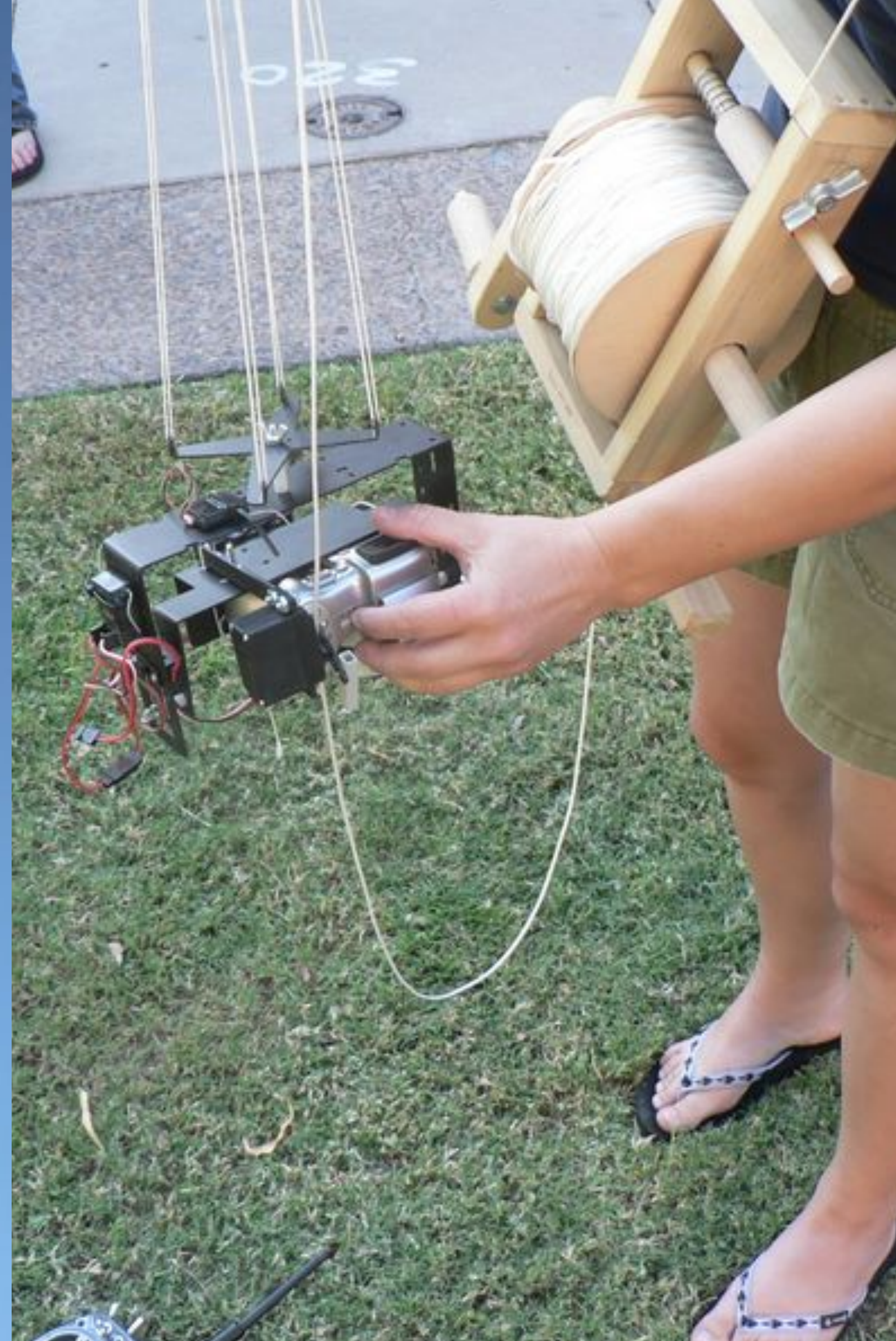
For: can be deployed at a greater height (up to 300m) providing a much wider field of view. Can simply be dragged along the target fault.

Against: difficult to control even in light breezes and impossible in windy conditions.

Biggest cost is helium. One 300 cubic ft. tank costs $100 in the US and fills the balloon twice => $50 per flight

Buy from industrial gas company (Airgas, Praxair, Air Liquide)

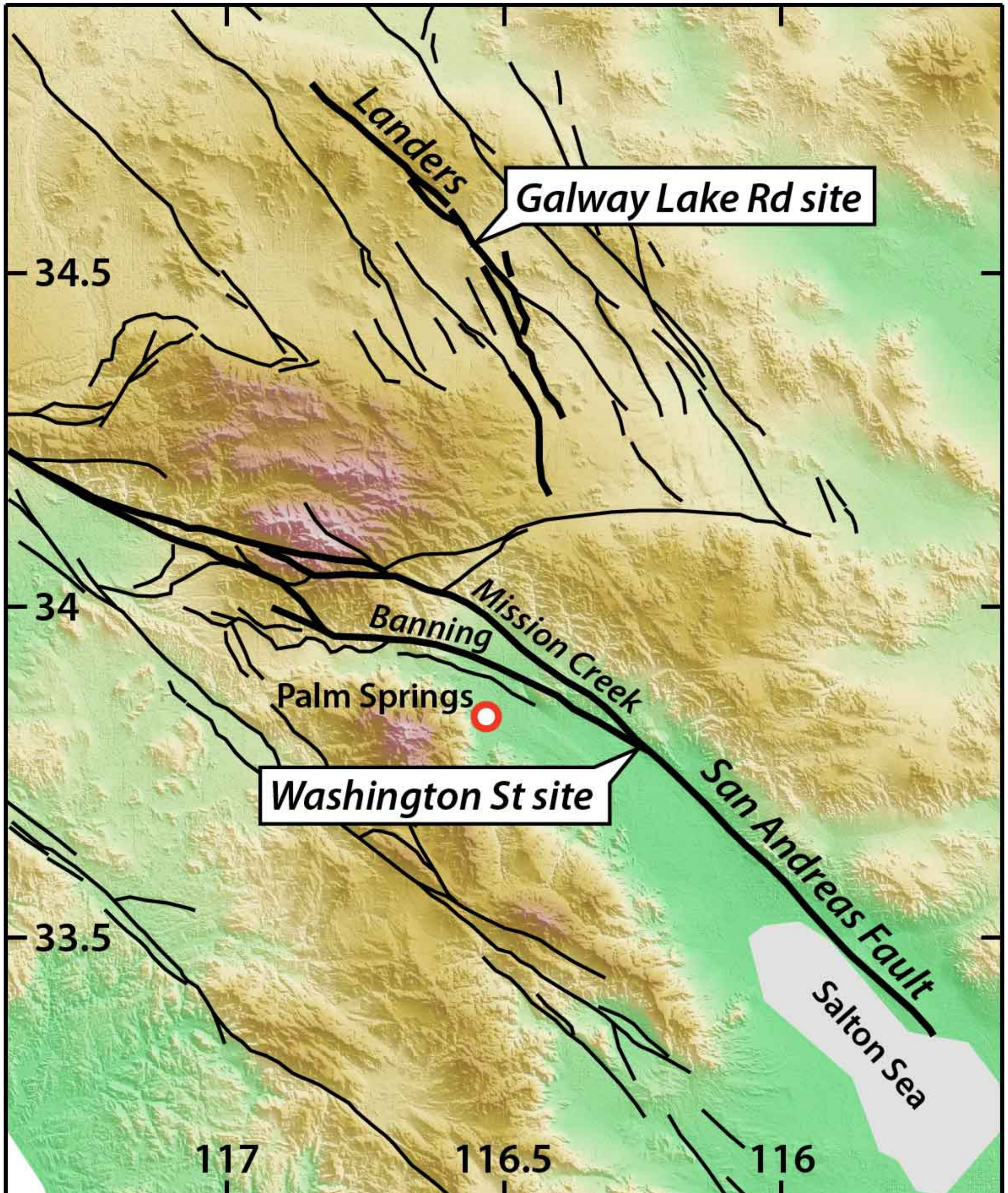

inflated balloon
string and reel
d
Easytag GPS tagger
Brooxes picavet
Nikon camera

Typically we try to fly at about 50-150 m above ground level (AGL). We then drag the balloon around the area of interest.

At higher heights you get increased photograph footprint but a slightly lower ground resolution.

However at 150 m we still get 100s of points/m^2. So in general the higher up the better.



Galway Lake Rd site

Covers part of the 1992 Landers earthquake rutpure.

Here we are testing SfM's potential as a rapid response mapping tool (e.g. aftermath of an earthquake).

Existing TLS dataset

Washington St site

Argument over which of two SAF strands is active.

Small meter-scale streams offsets >> slip in last event

Larger alluvial fan offsets >> long term slip rates

Existing airborne LiDAR data

230 photos taken in about one hour

Orthophoto

Photo coverage plot

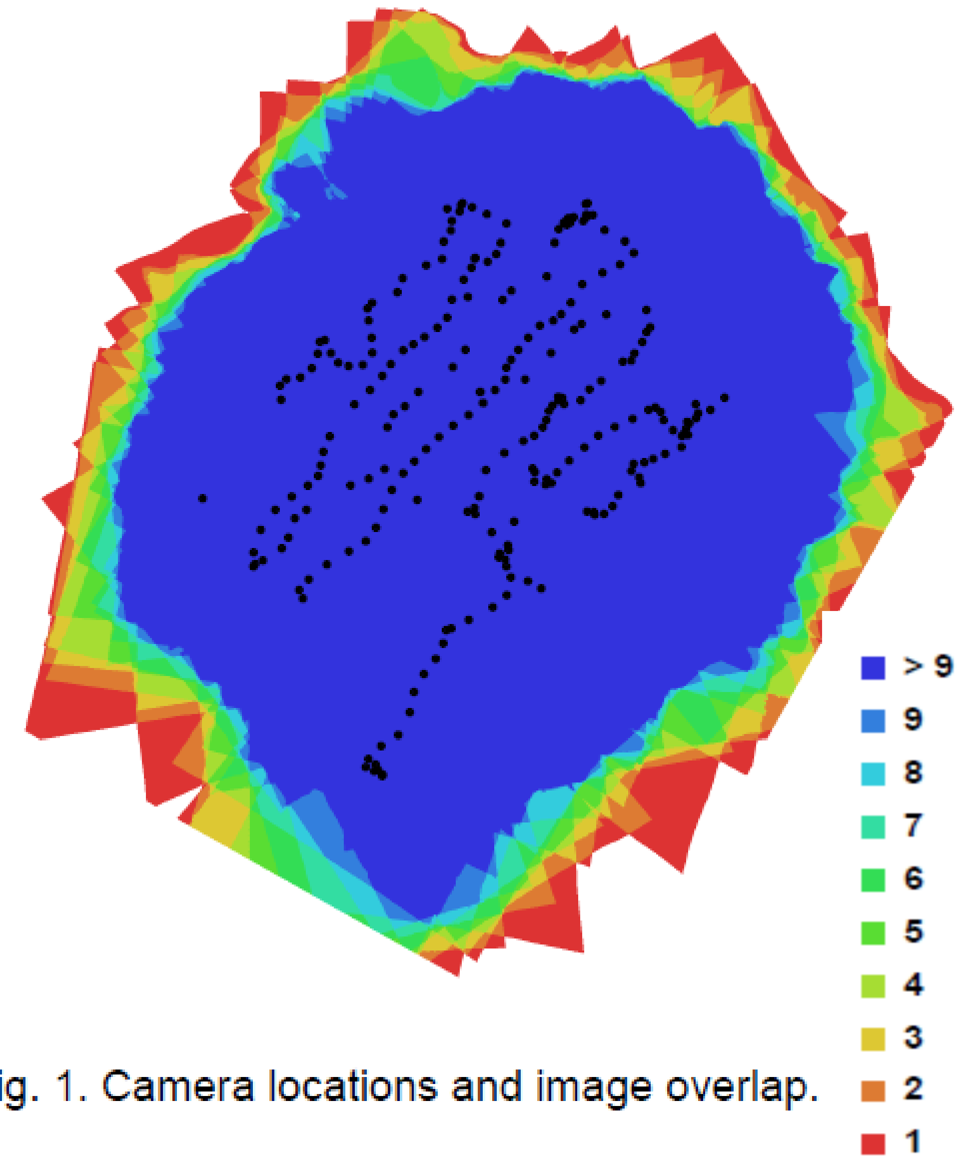


Fig. 1. Camera locations and image overlap.

Camera position errors

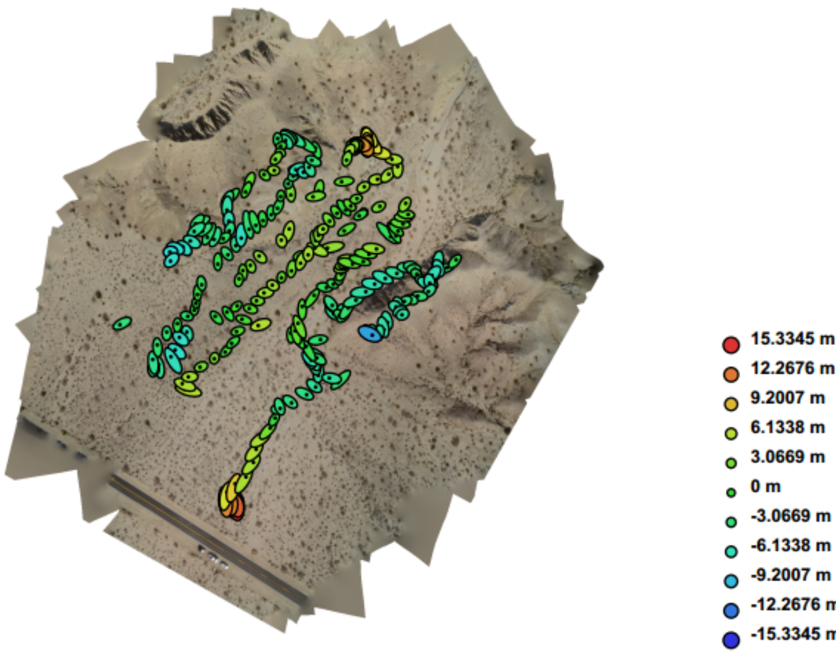


Fig. 2. Camera locations and error estimates.
Z error is represented by ellipse color. X,Y errors are represented by ellipse shape.
Estimated camera locations are marked with a black dot.

X error (m)	Y error (m)	Z error (m)	Total error (m)
1.673308	1.897283	4.716075	5.351730

Table. 2. Average camera location error.

Digital Elevation Model

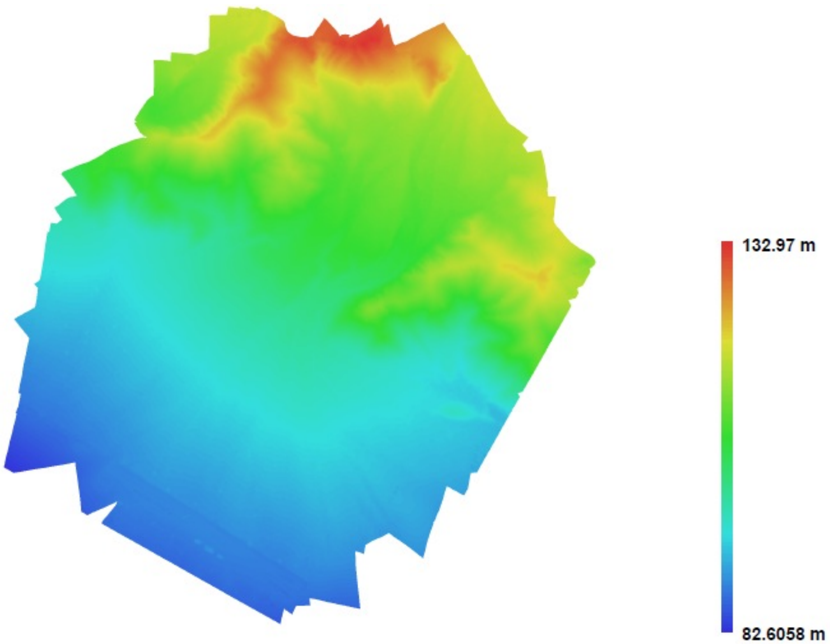
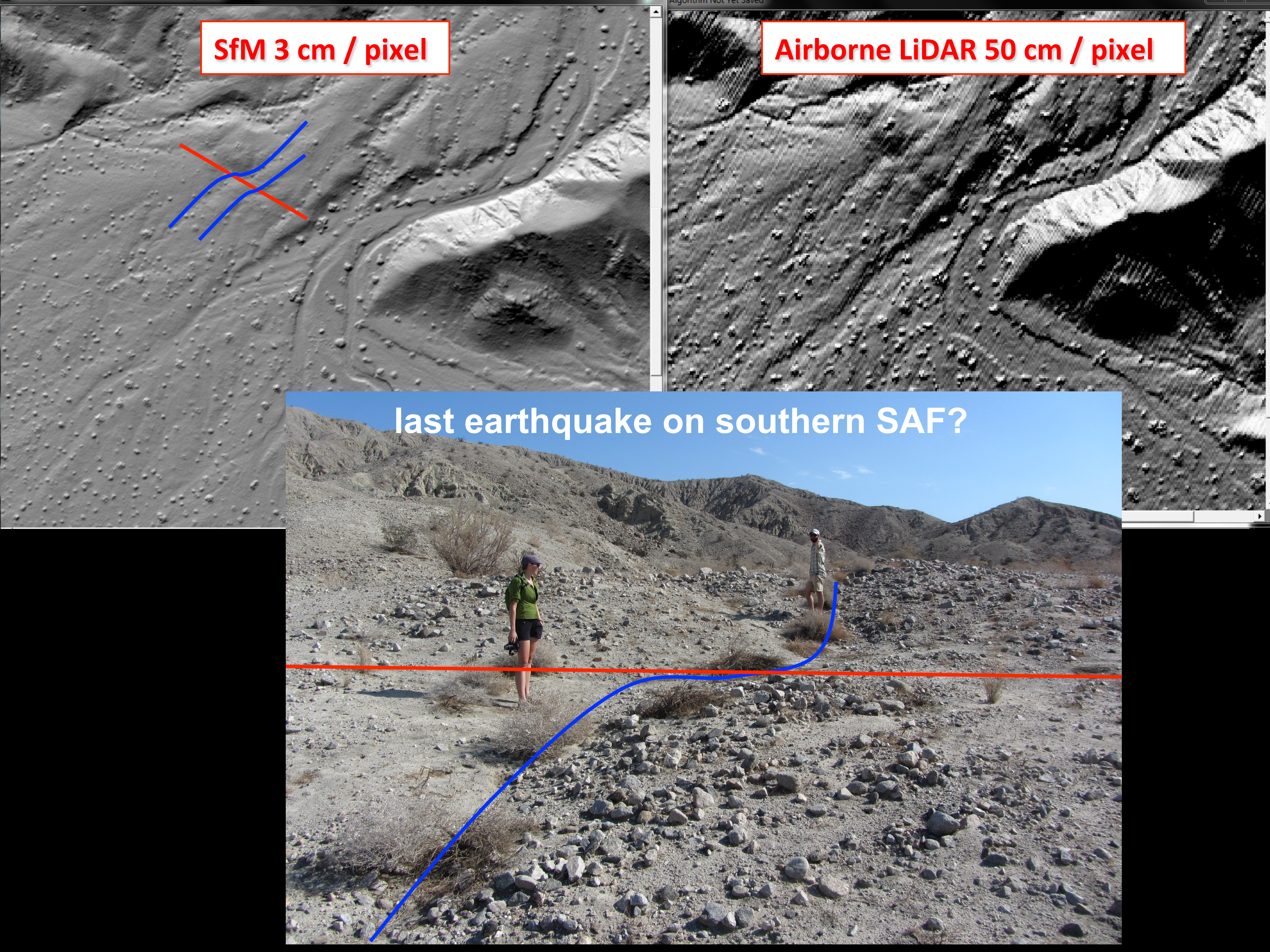
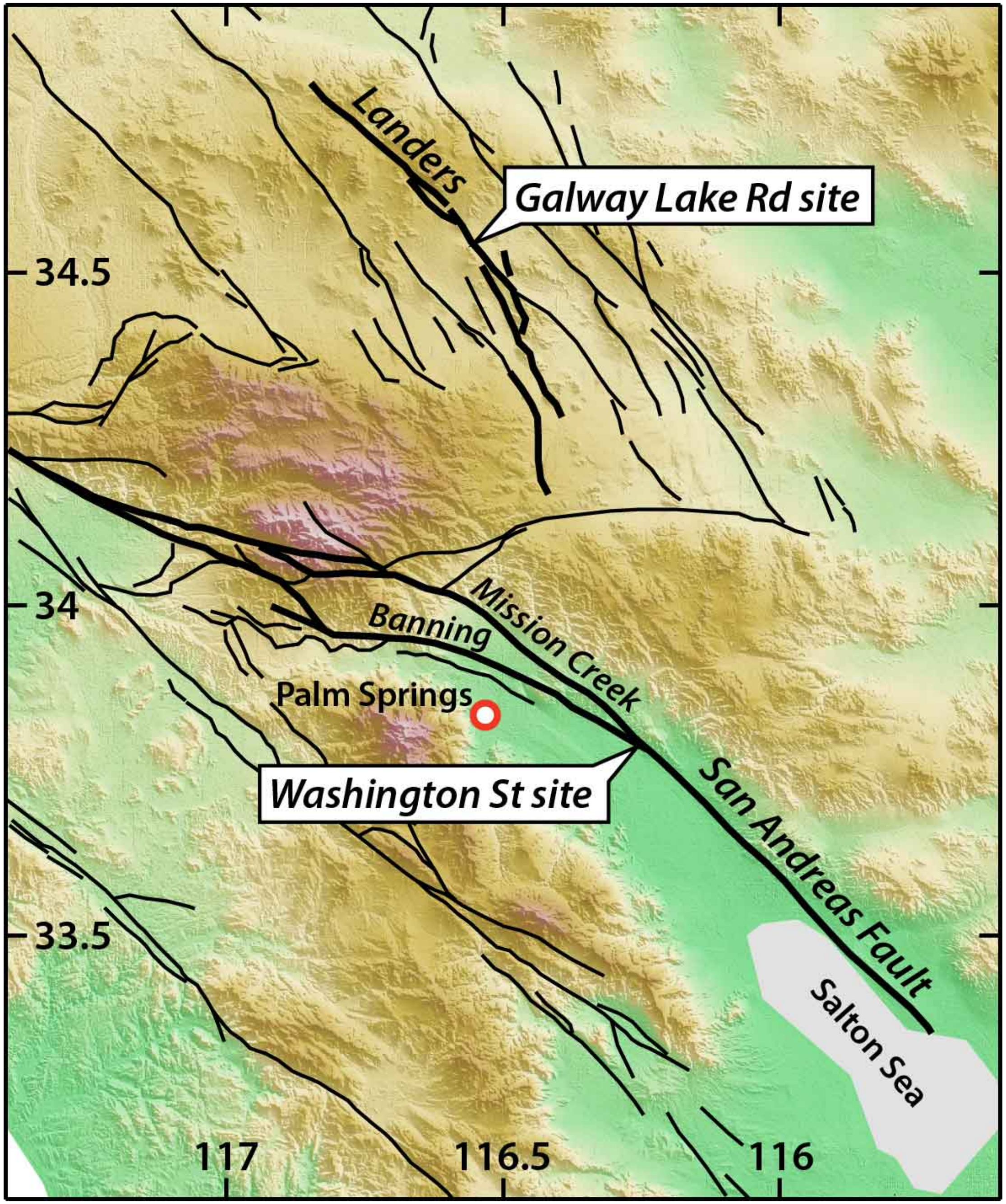


Fig. 3. Reconstructed digital elevation model.

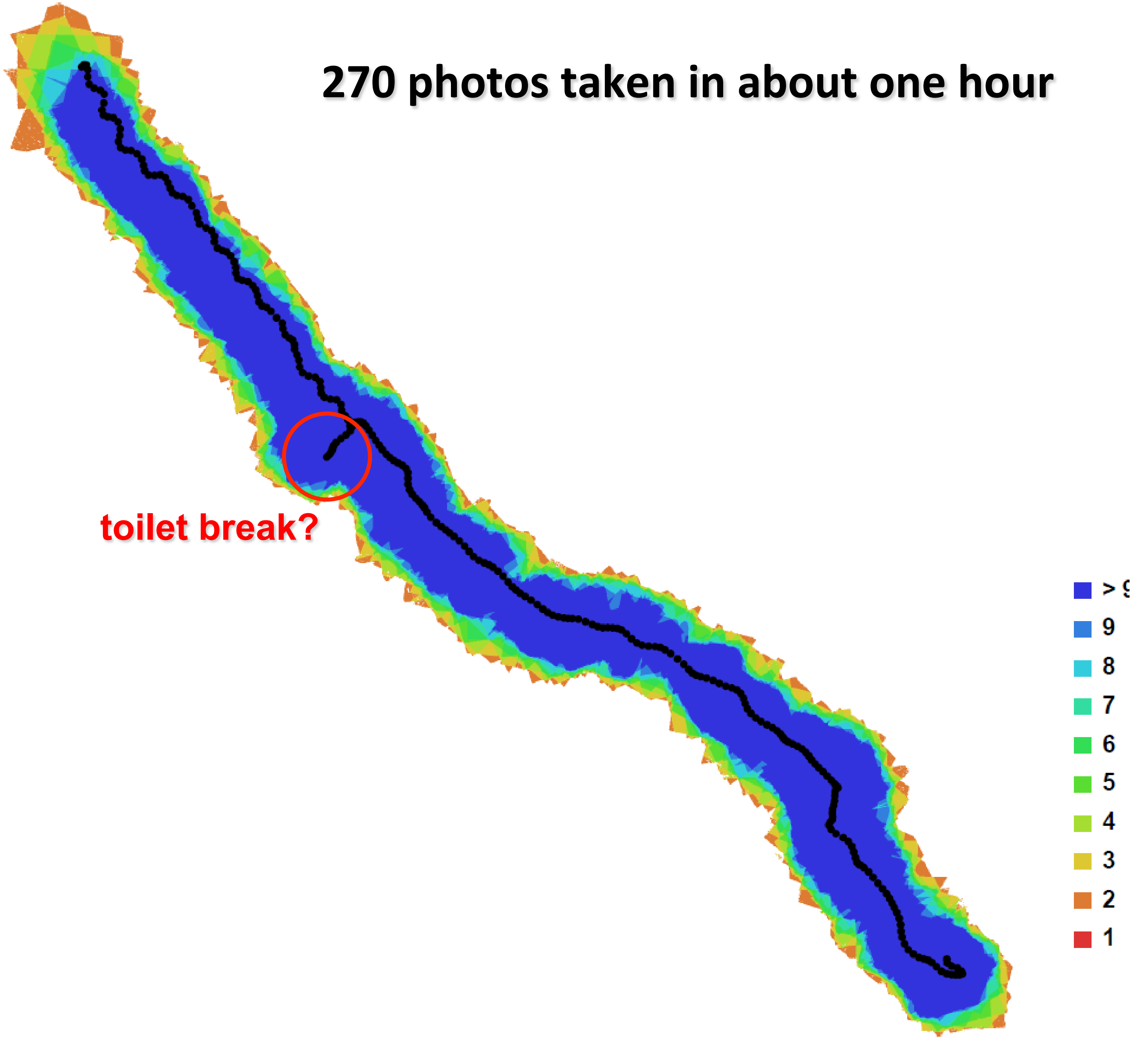
Resolution:	0.026356 m/pix
Point density:	719.038 points per sq m


SfM 3 cm / pixel
Airborne LiDAR 50 cm / pixel
last earthquake on southern SAF?



Landers
Galway Lake Rd site
34.5
Mission Creek
34
Banning
Palm Springs
Washington St site
San Andreas Fault
33.5
Salton Sea
117
116.5
116

270 photos taken in about one hour



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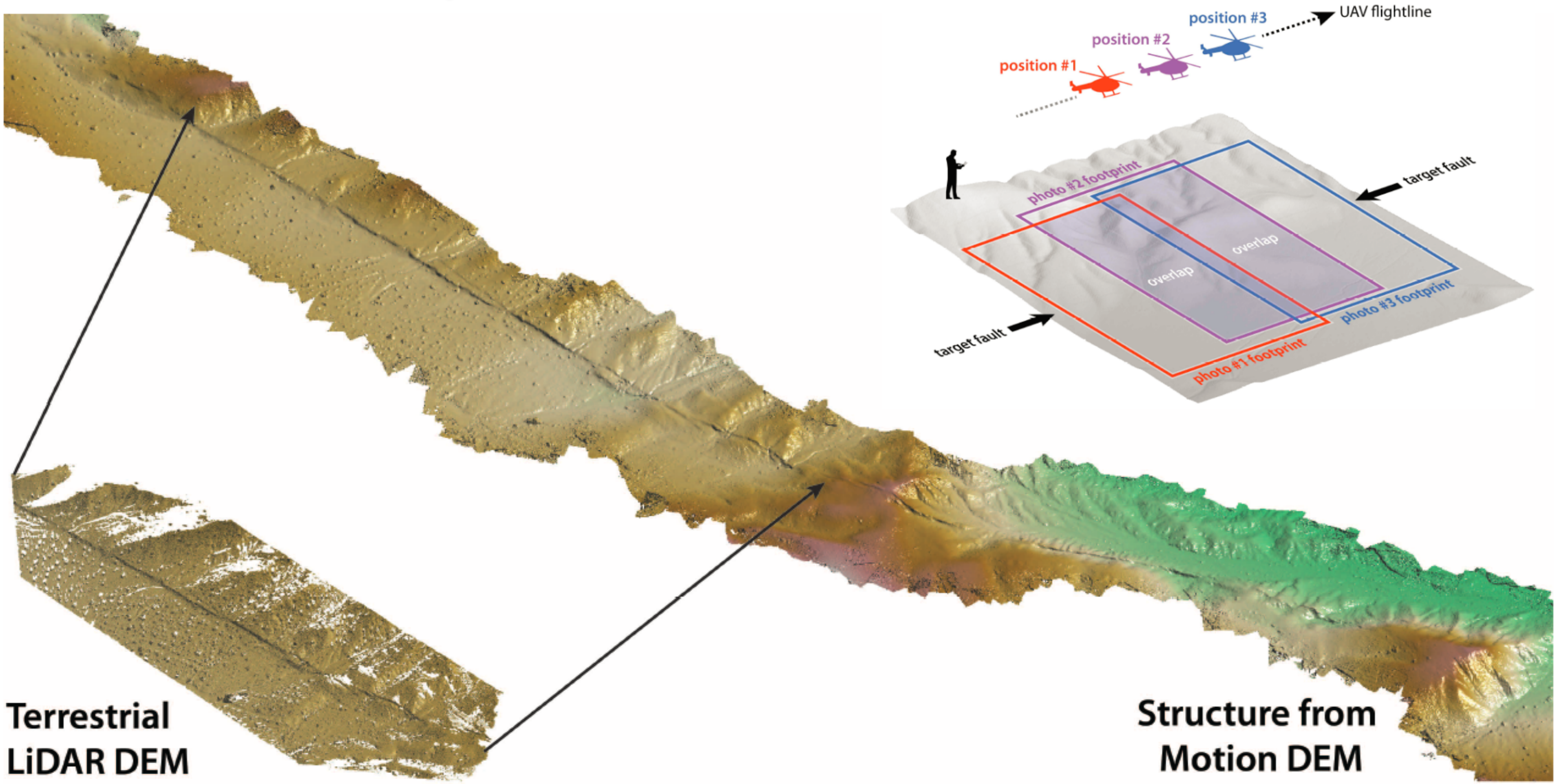

TLS data took two days to collect