



Compact Probe for In-Situ Optical Snow Grain Size Stratigraphy

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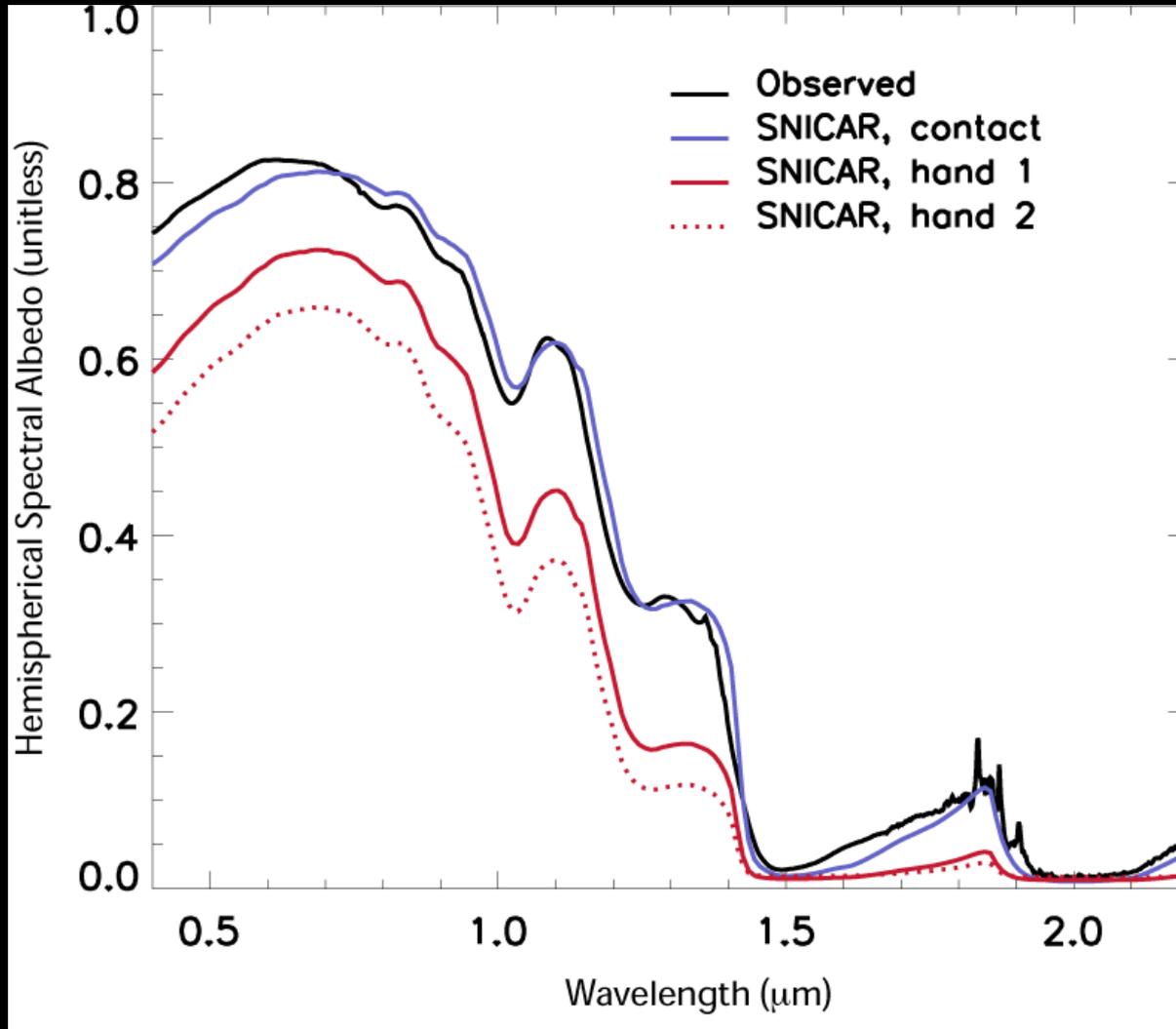


Traditional Grain Size Measurement

- Hand lens grain size estimation

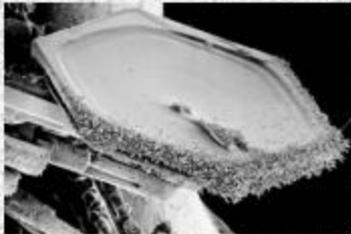


Radiative transfer from hand lens



Traditional Grain Size Measurement

Snow Grain Shapes



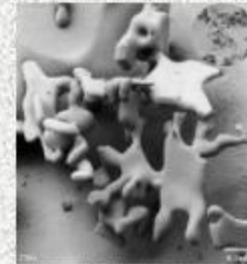
Rime on Plate Crystal



Early Rounding



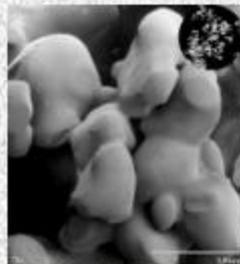
Faceted Growth



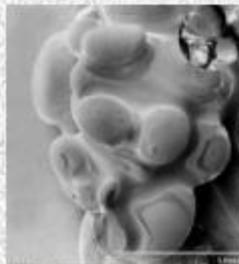
Early Sintering (Bonding)



Wind-Blown Grains



Melt-Freeze with
No Liquid Water



Melt-Freeze with
Liquid Water



Faceted Layer Growth



Hollow, Faceted Grain
(Depth Hoar)

Contact Spectroscopy

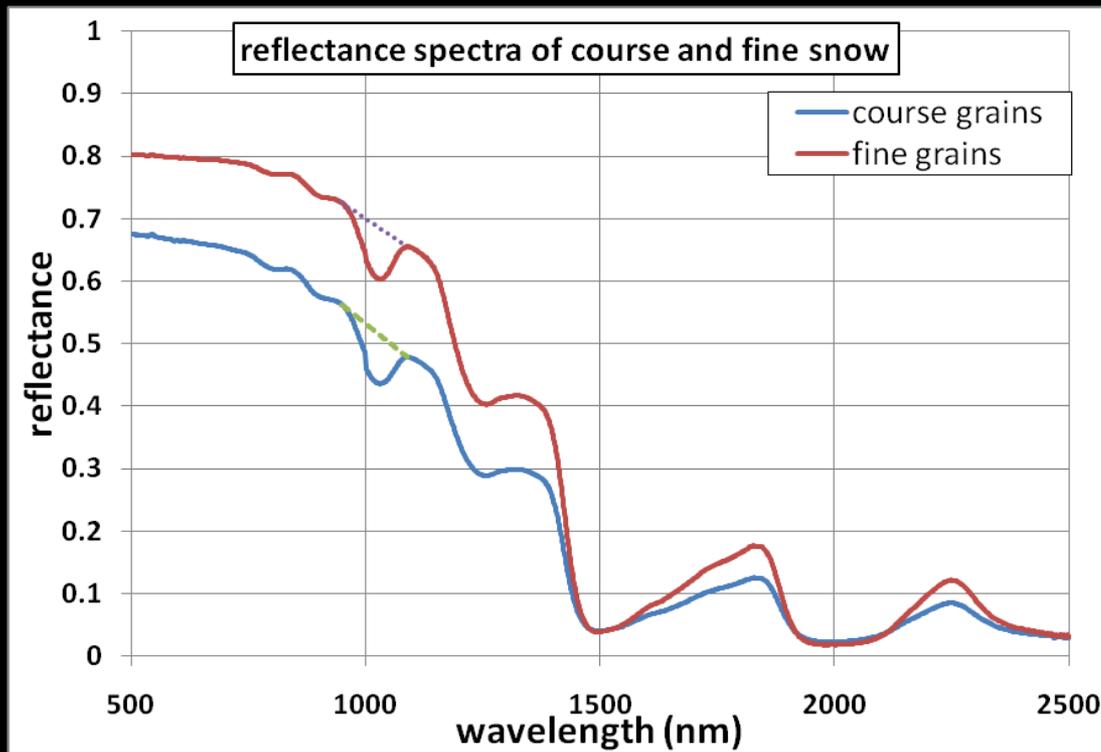


- Advantages
 - Less subjective
 - Repeatable
 - Faster
 - Data applicable to remote sensing

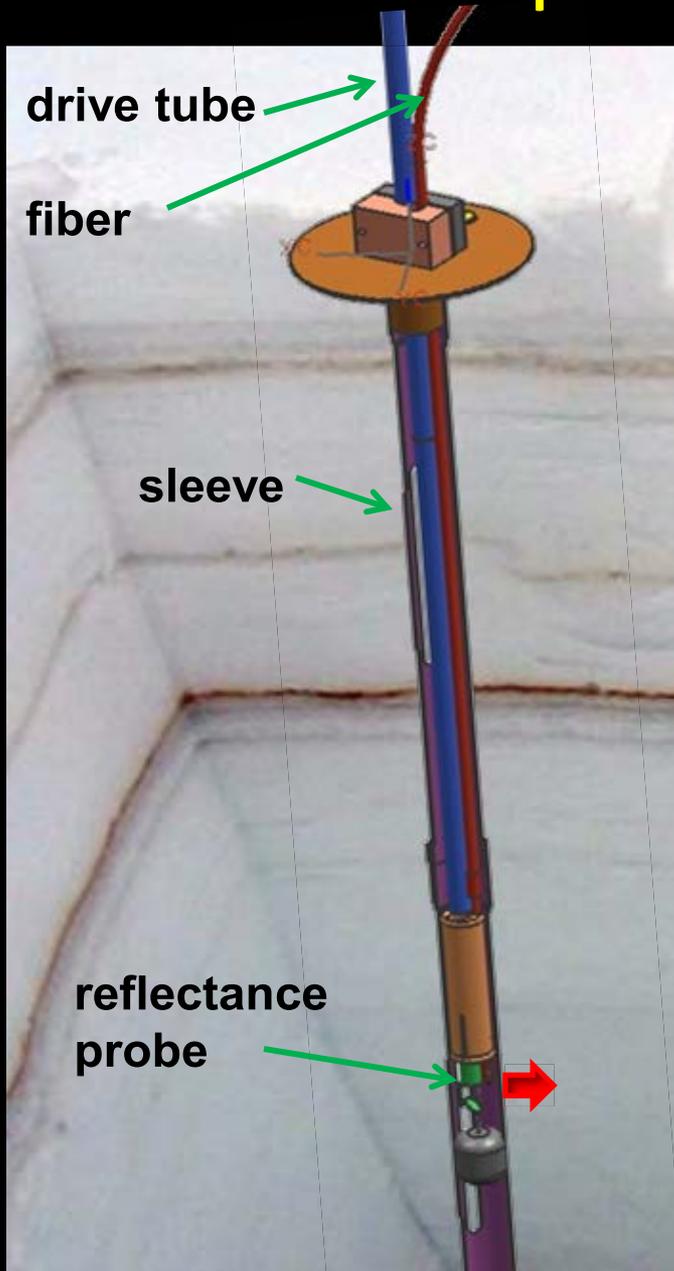
Painter et al., *Journal of Glaciology*
2007

Contact Spectroscopy

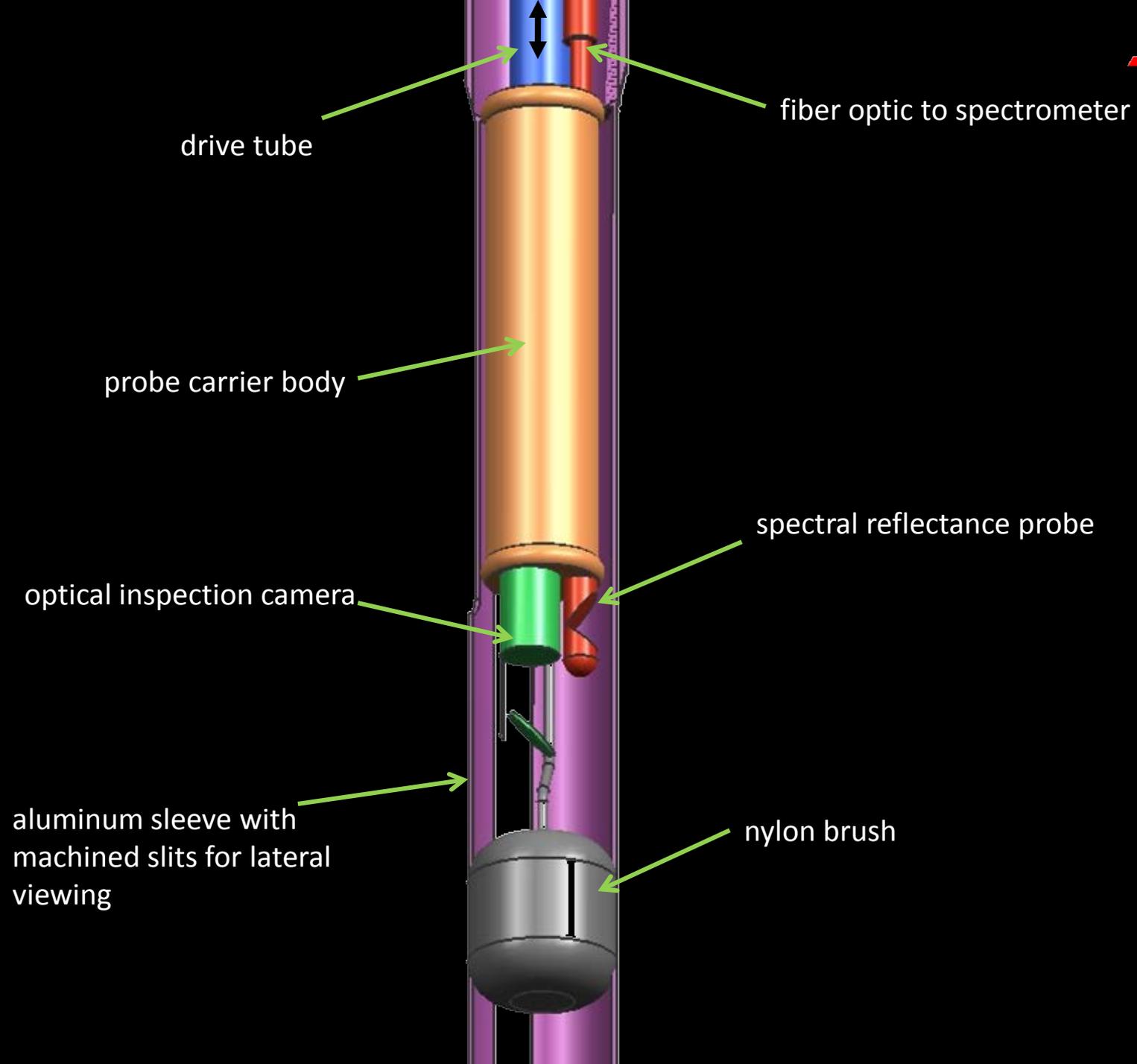
- optical equivalent grain size
- obtained by integrating absorption feature and comparing to RT model
- Painter et al., 2007; Nolin and Dozier, 2000.

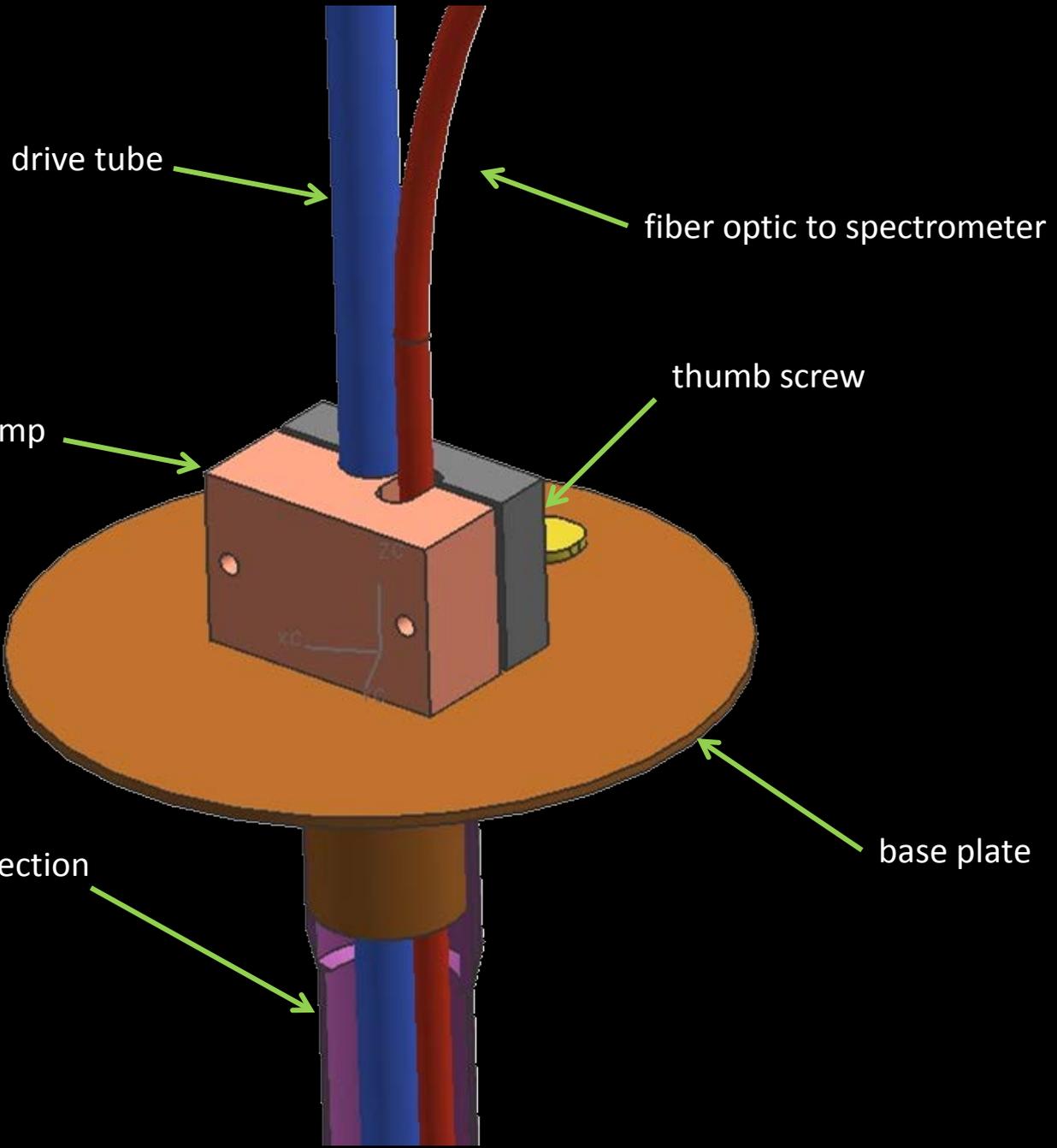


Spectral Profiler Probe



- Send optics down bore hole
- Lateral reflectance spectra
- Fiber optic sends signal to surface
- No snowpit!





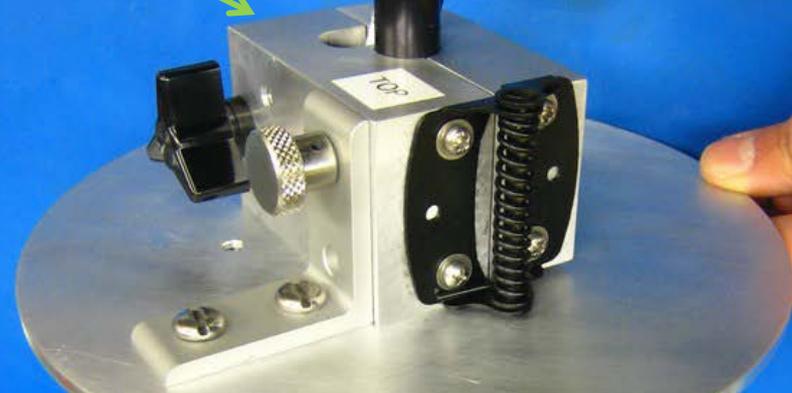


Spectral Profiler Probe Hardware

drive tube

fiber optic to spectrometer

clamp



base plate

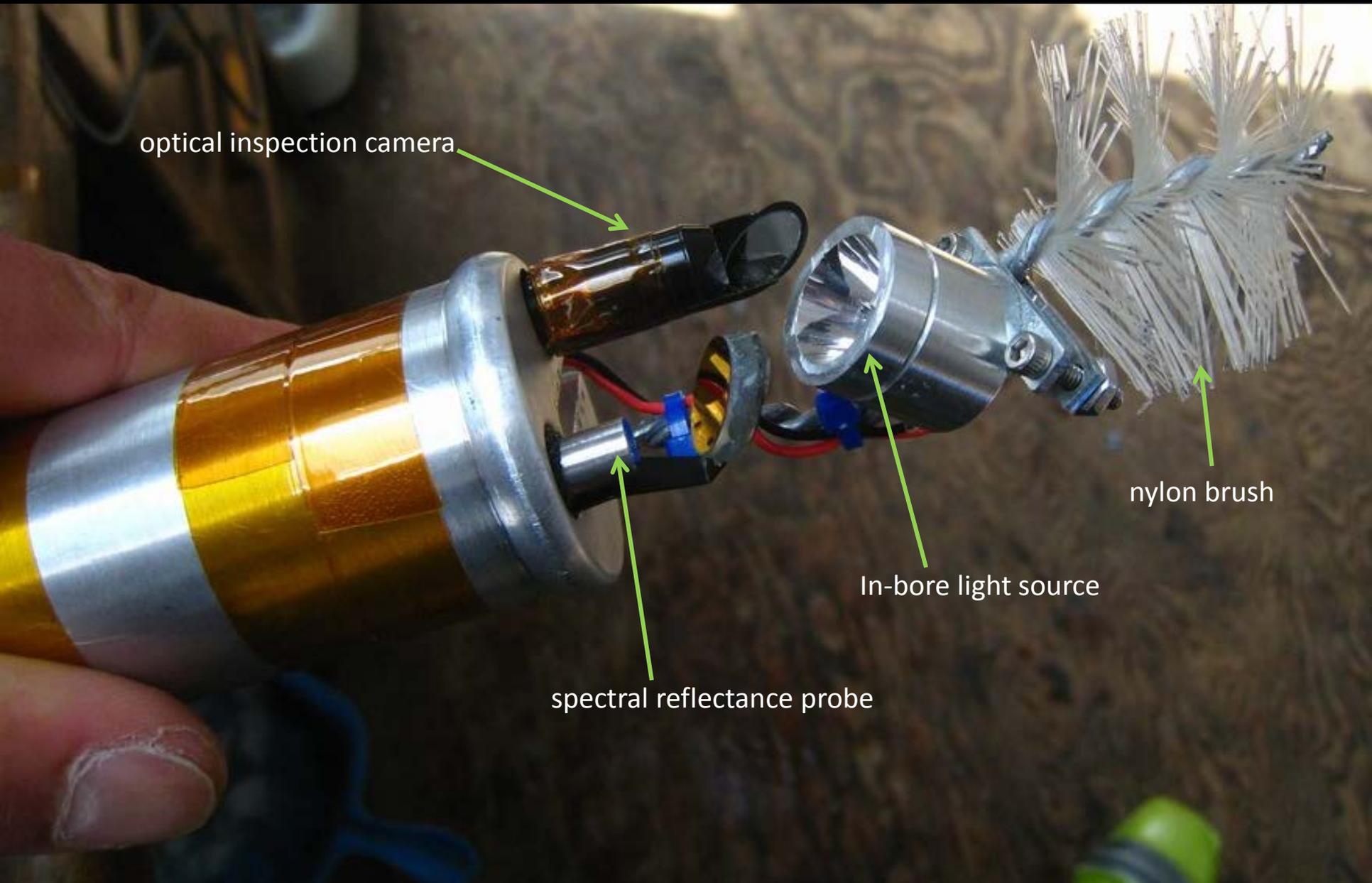
aluminum sleeve

reflectance probe





Spectral Profiler Probe Hardware



optical inspection camera

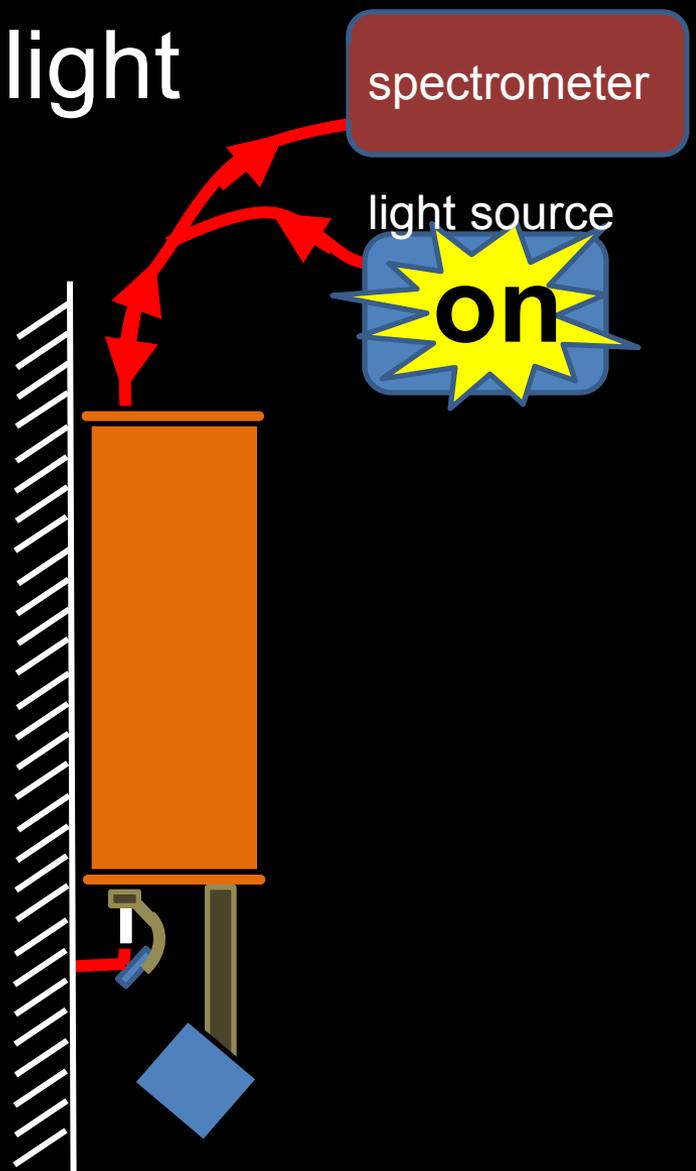
spectral reflectance probe

In-bore light source

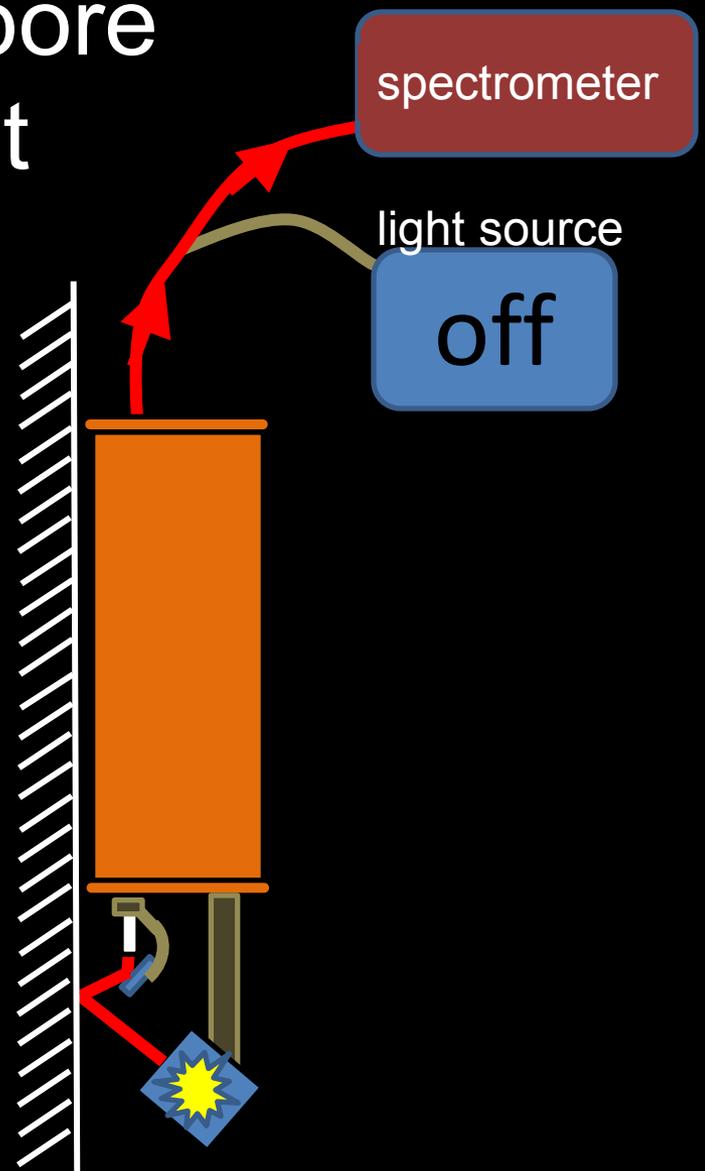
nylon brush

2 configurations

fiber light



In-bore light



Probe stowed
for transport

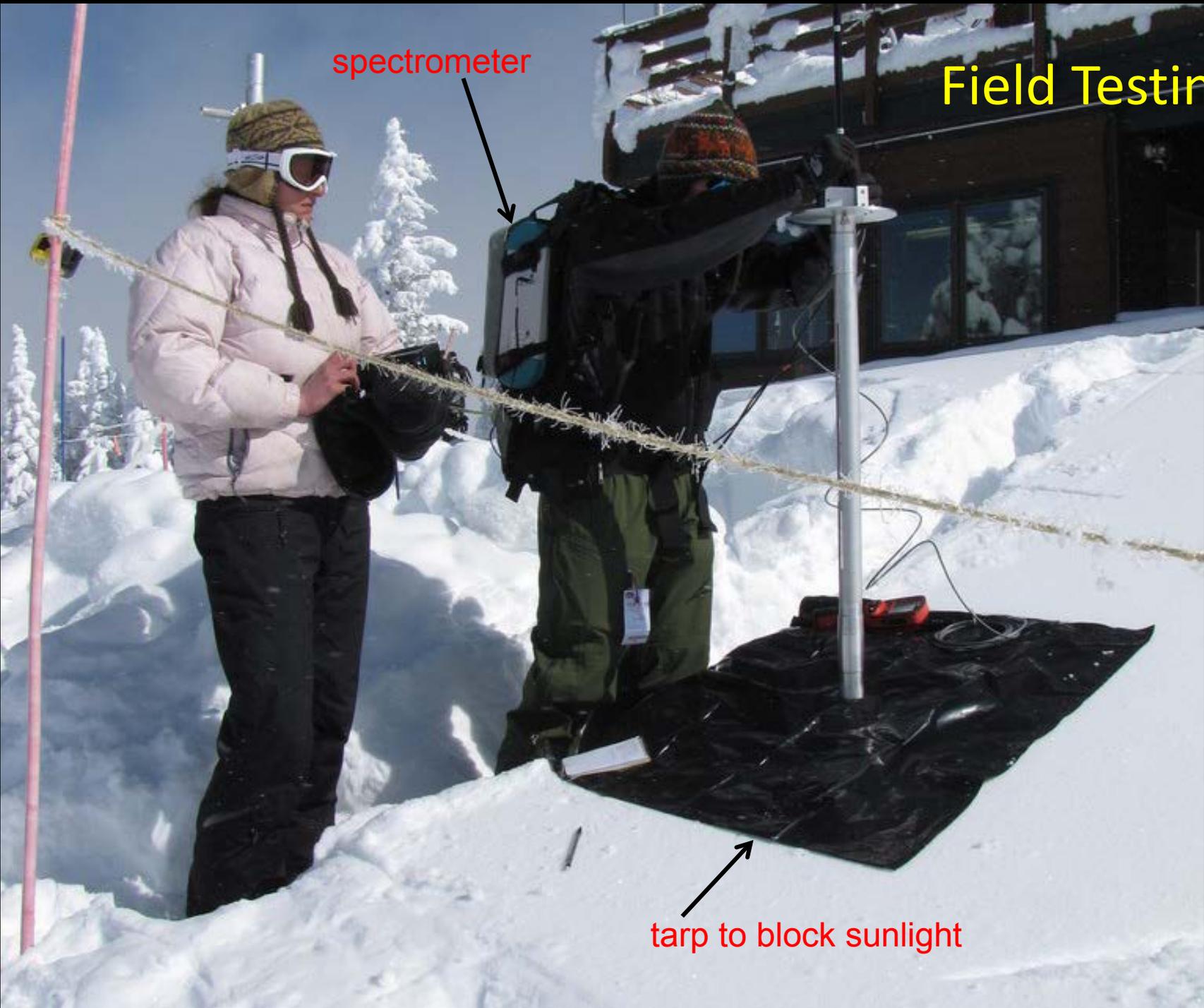


Field Testing

spectrometer



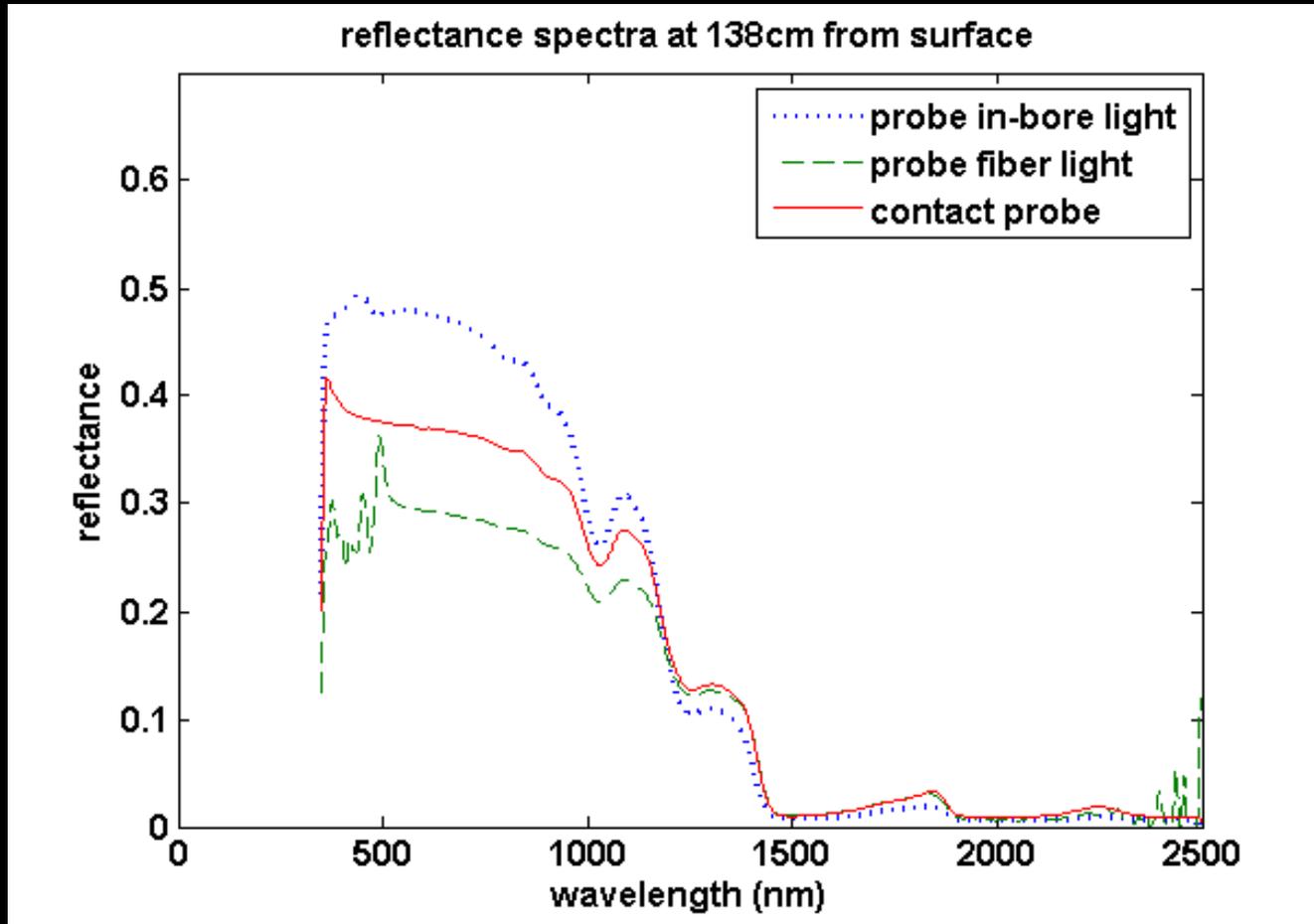
tarp to block sunlight



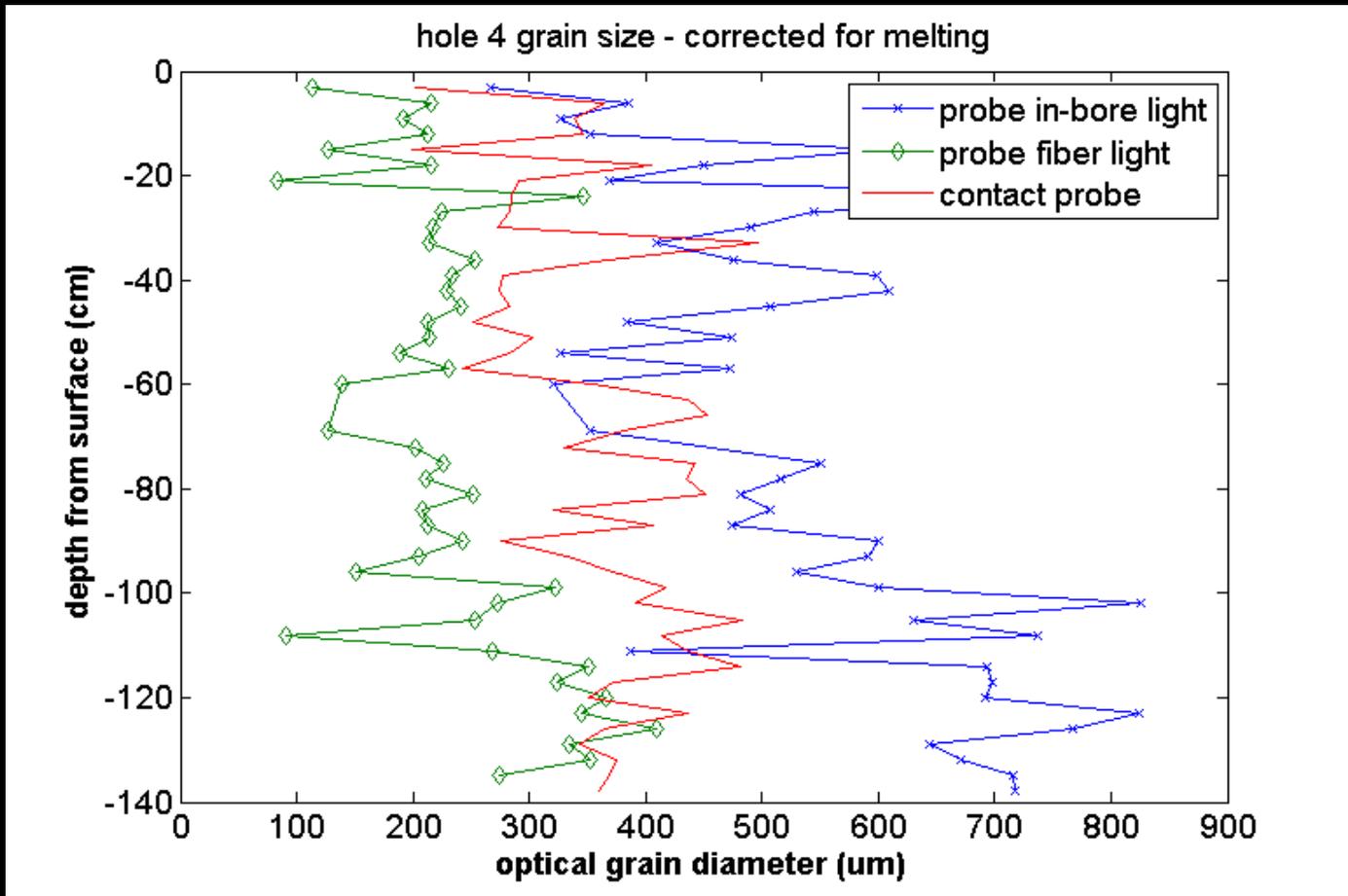
Field testing



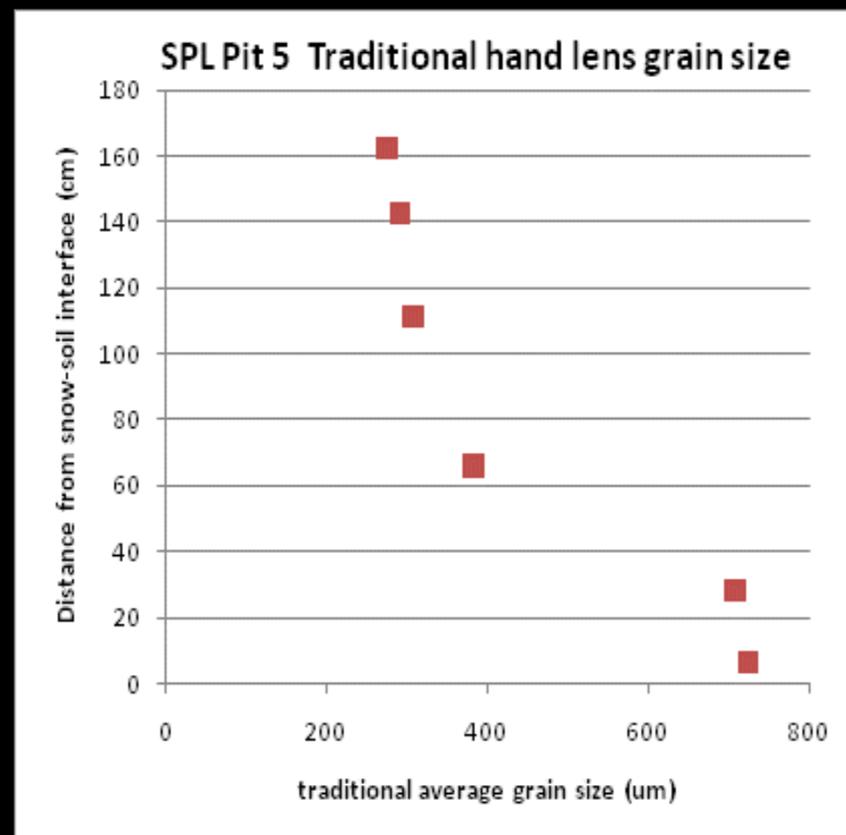
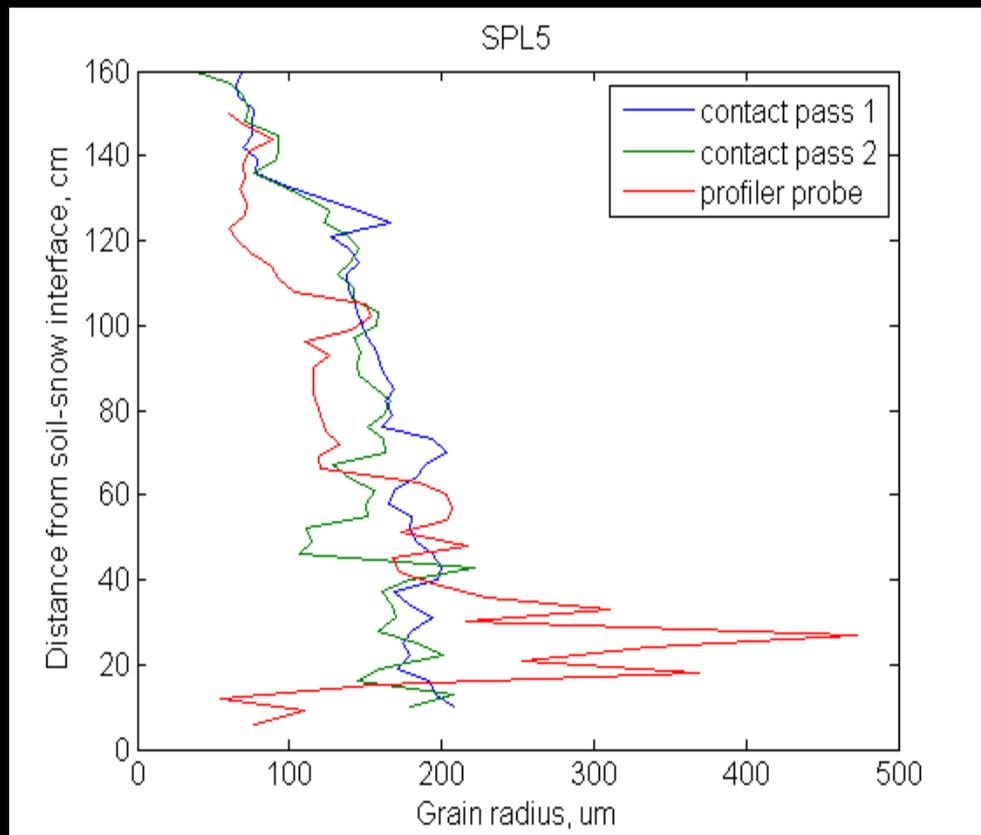
Niwot Ridge April 2010 results



Niwot Ridge April 2010 results



Storm Peak Lab Feb 2010 results





Future Work

- miniaturize probe
- add density measurement
- algorithm for on-site grain size retrieval
- take measurements over large geographic area



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supplemental

