Hyperspectral Detection of Stressed Asphalt

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Agenda

- Overview of the Penn State Asphalt Laboratory
- Phenomenology
- Measuring asphalt spectra
- Laboratory findings
- Detection of asphalt targets in AVIRIS imagery
- Conclusion

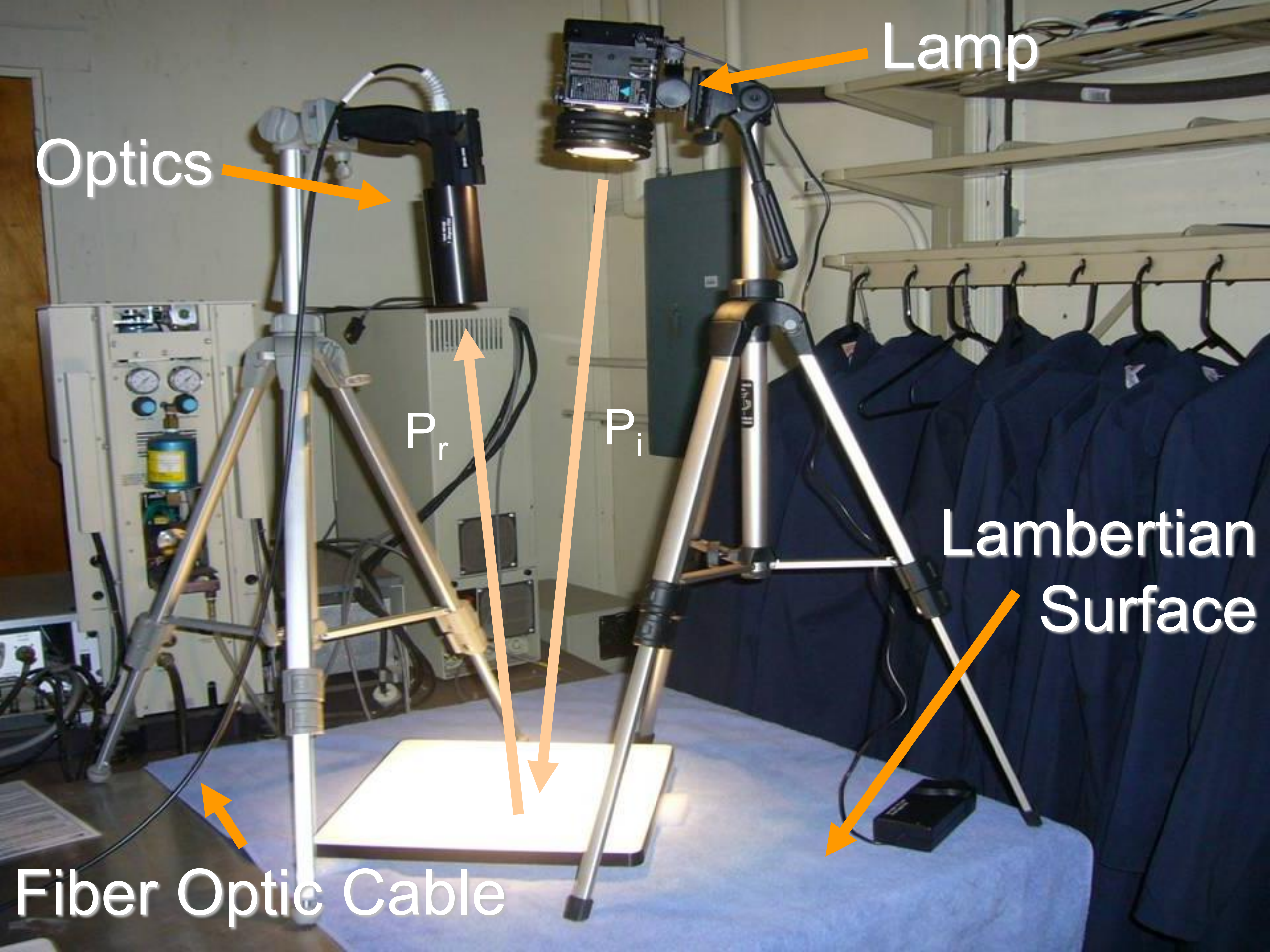

C-102
NECEPT
Superpave
TRAINING
LABORATORY
Laboratory Information

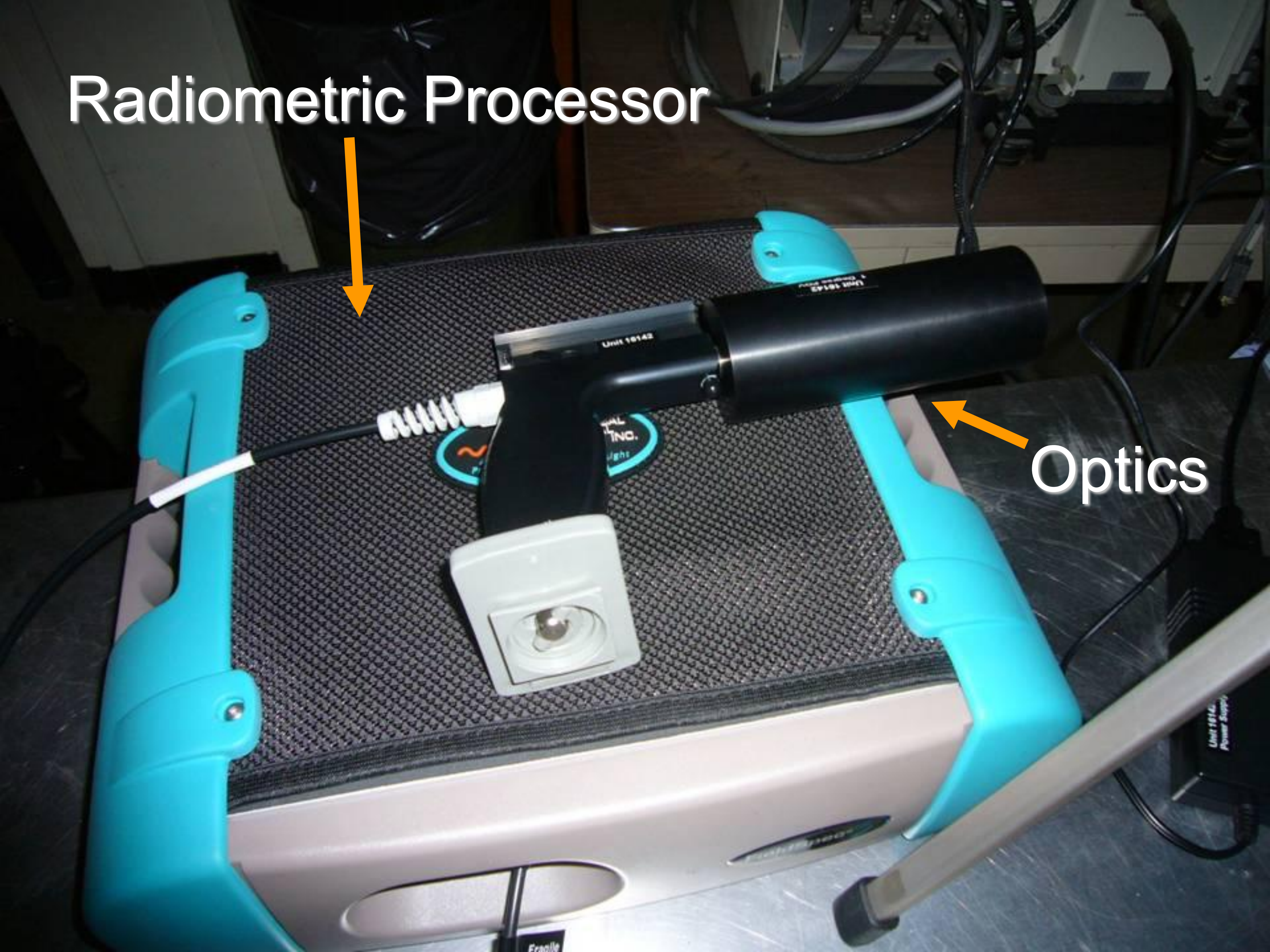
Sample Asphalt Cores

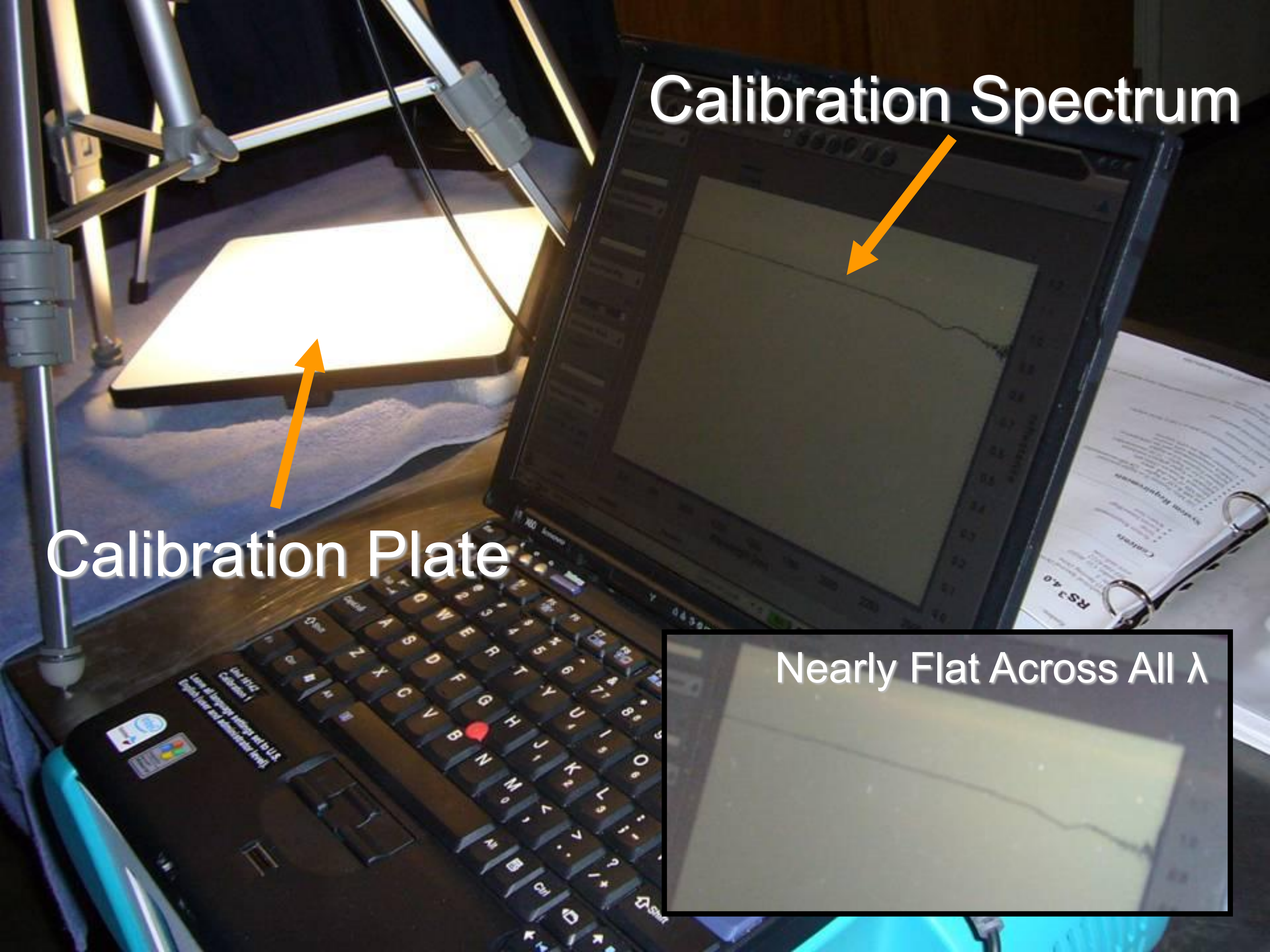
Aggregates

Binders

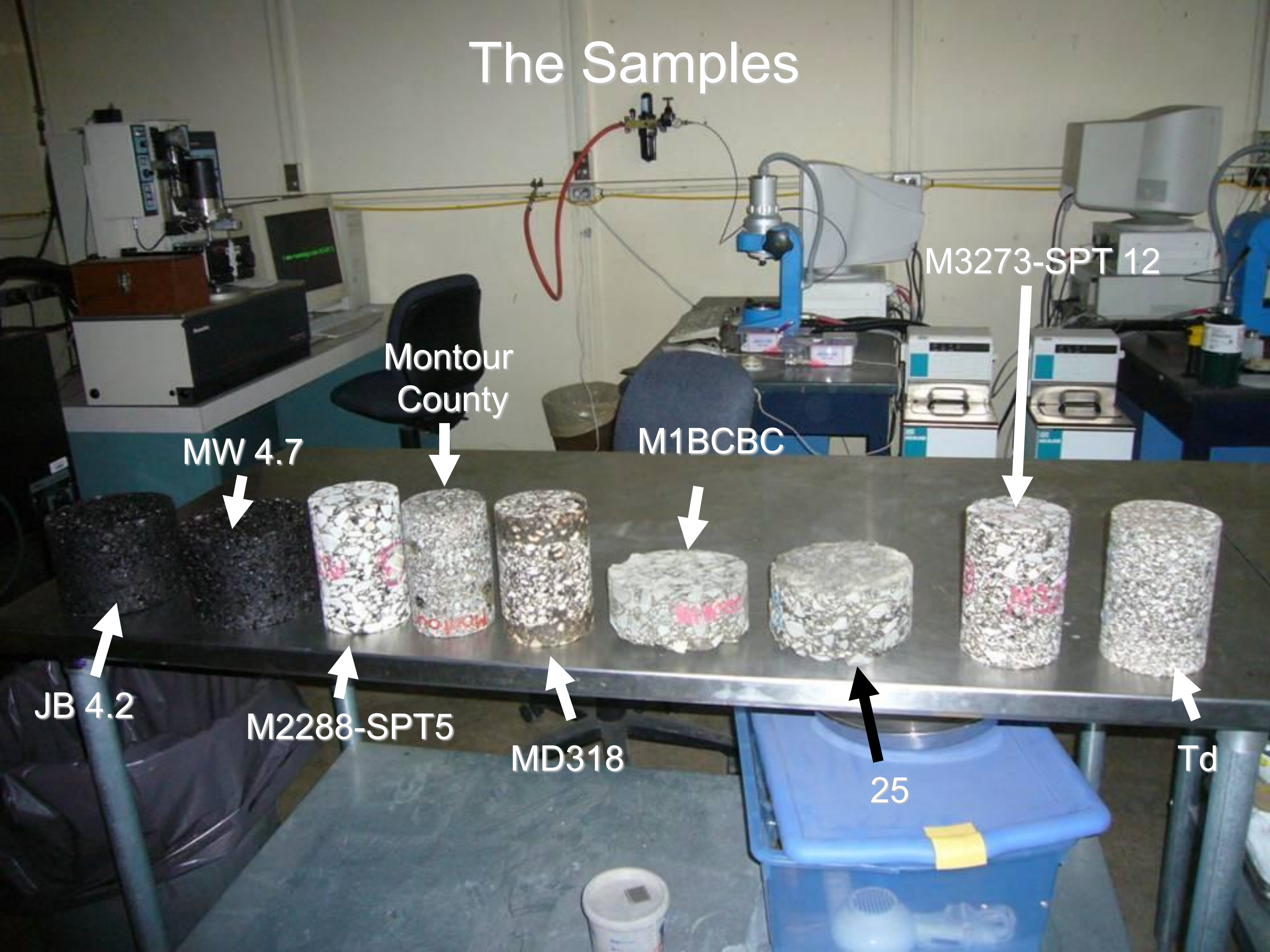

"Baking" Pans
Ovens
05-29-02
B2149


Lamp
Optics
P_r
P_i
Lambertian Surface
Fiber Optic Cable

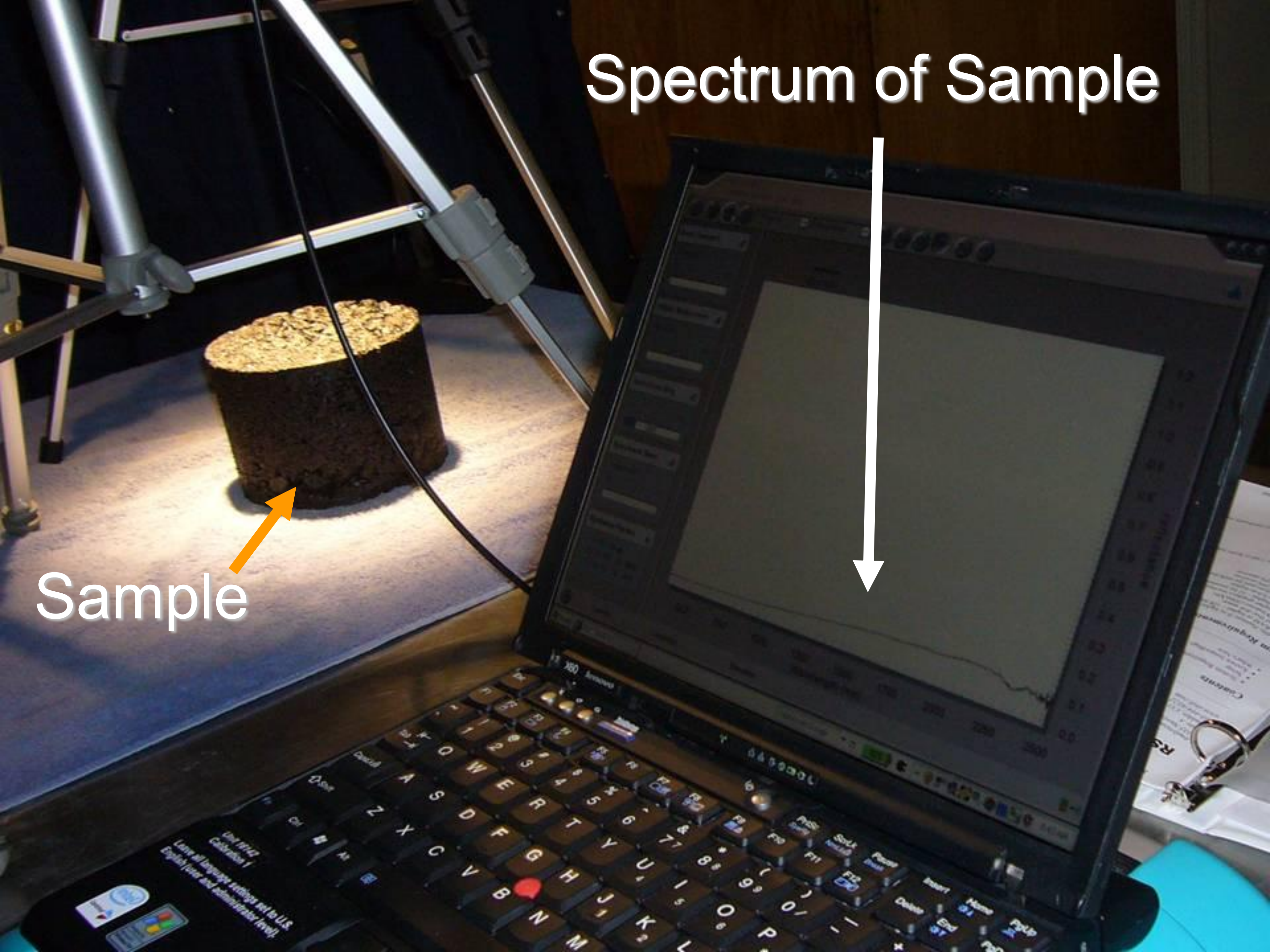

Radiometric Processor
Optics


Calibration Spectrum
Calibration Plate
Nearly Flat Across All λ

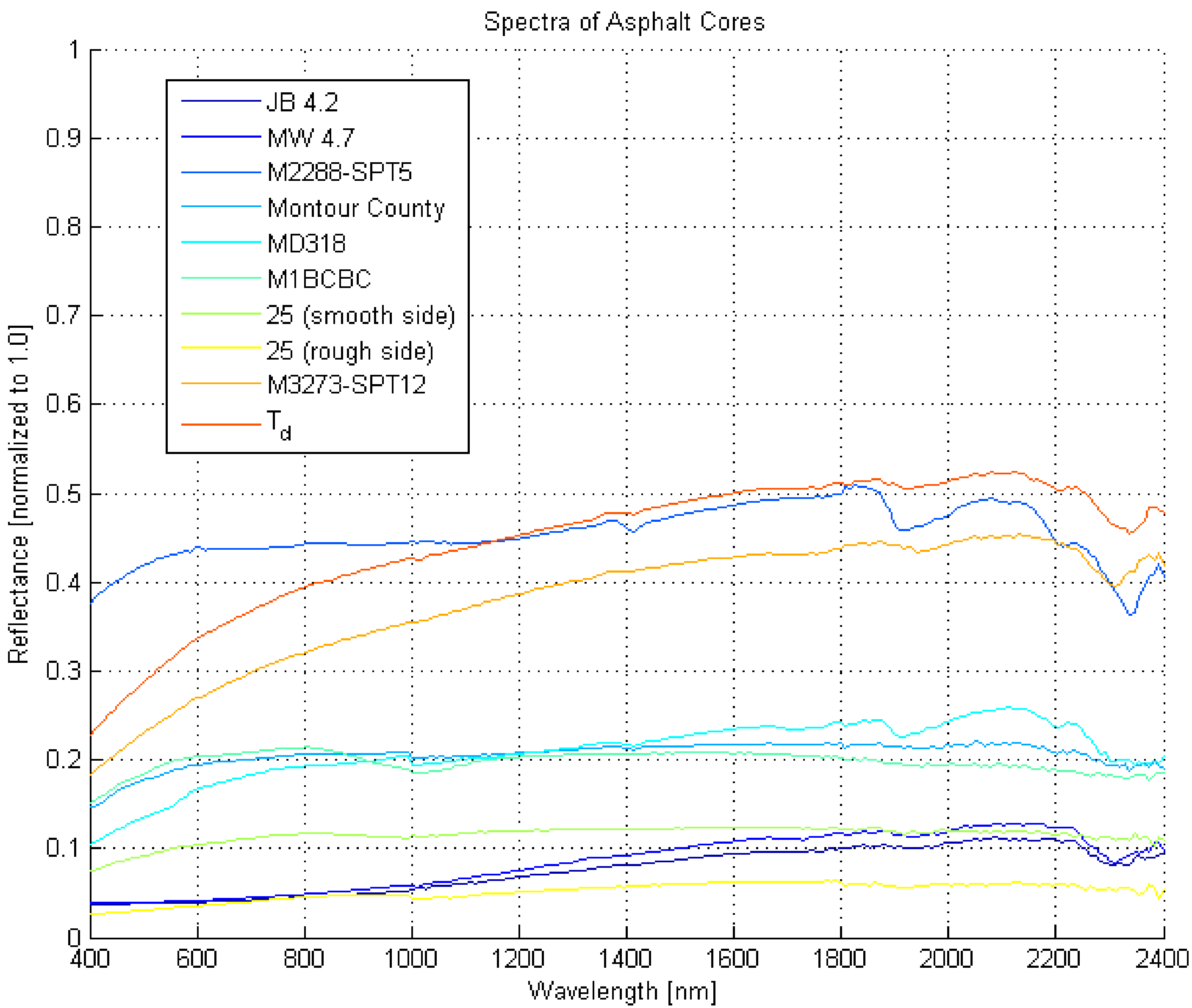
The Samples


Montour
County
MW 4.7
M1BCBC
M3273-SPT 12
JB 4.2
M2288-SPT5
MD318
25
Td

Samples Up Close

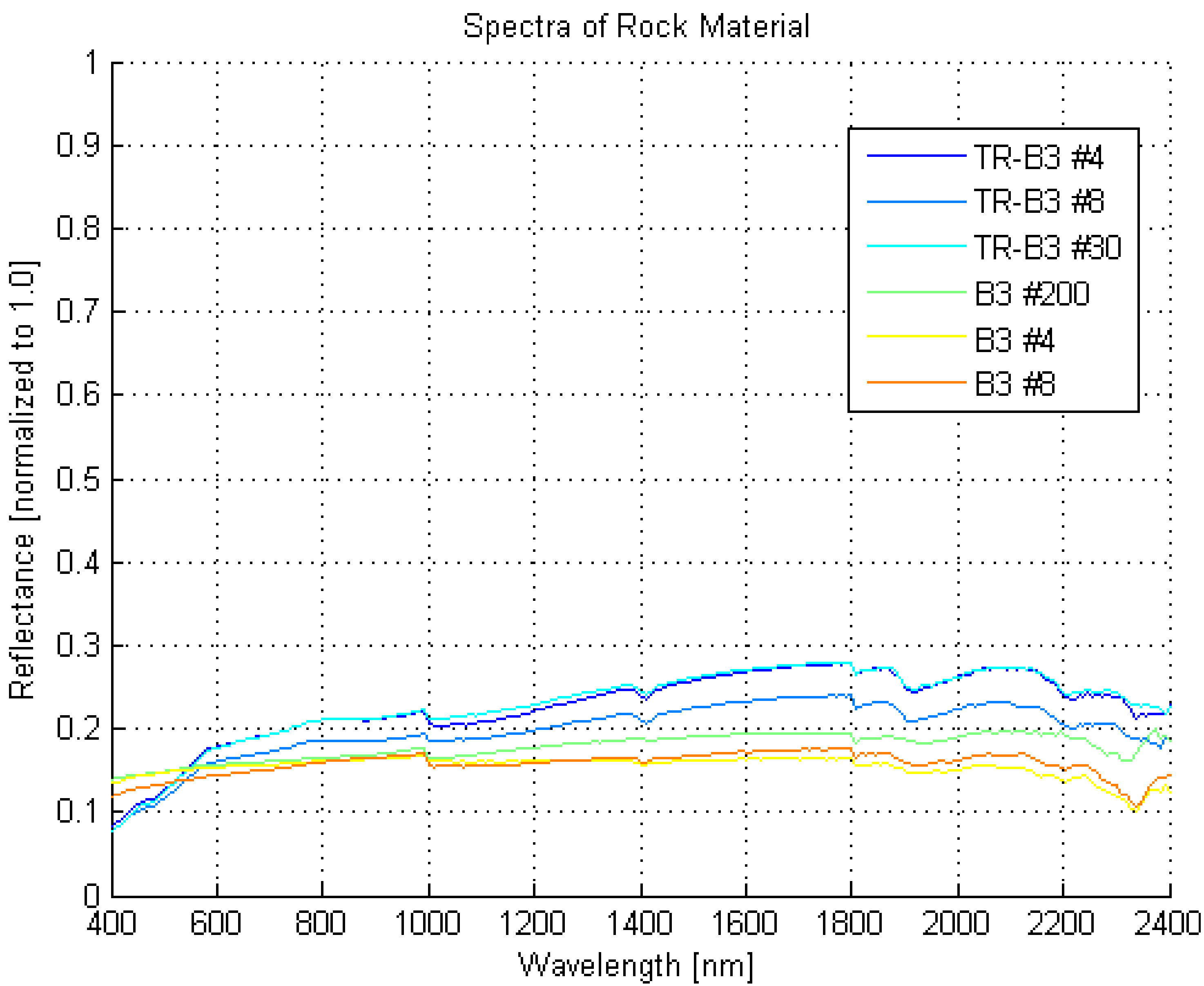

Spectrum of Sample
Sample

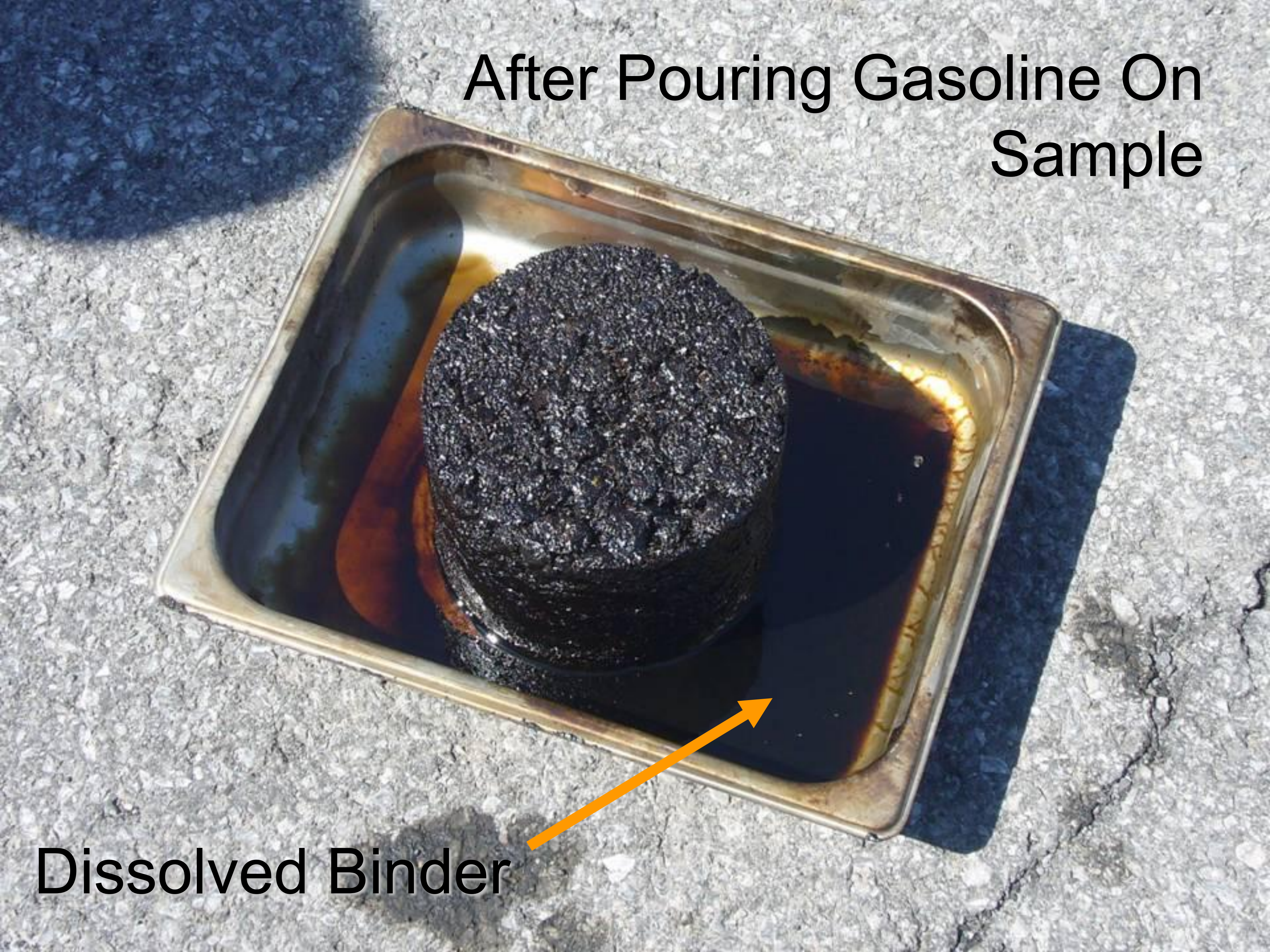
Spectra of Asphalt Cores



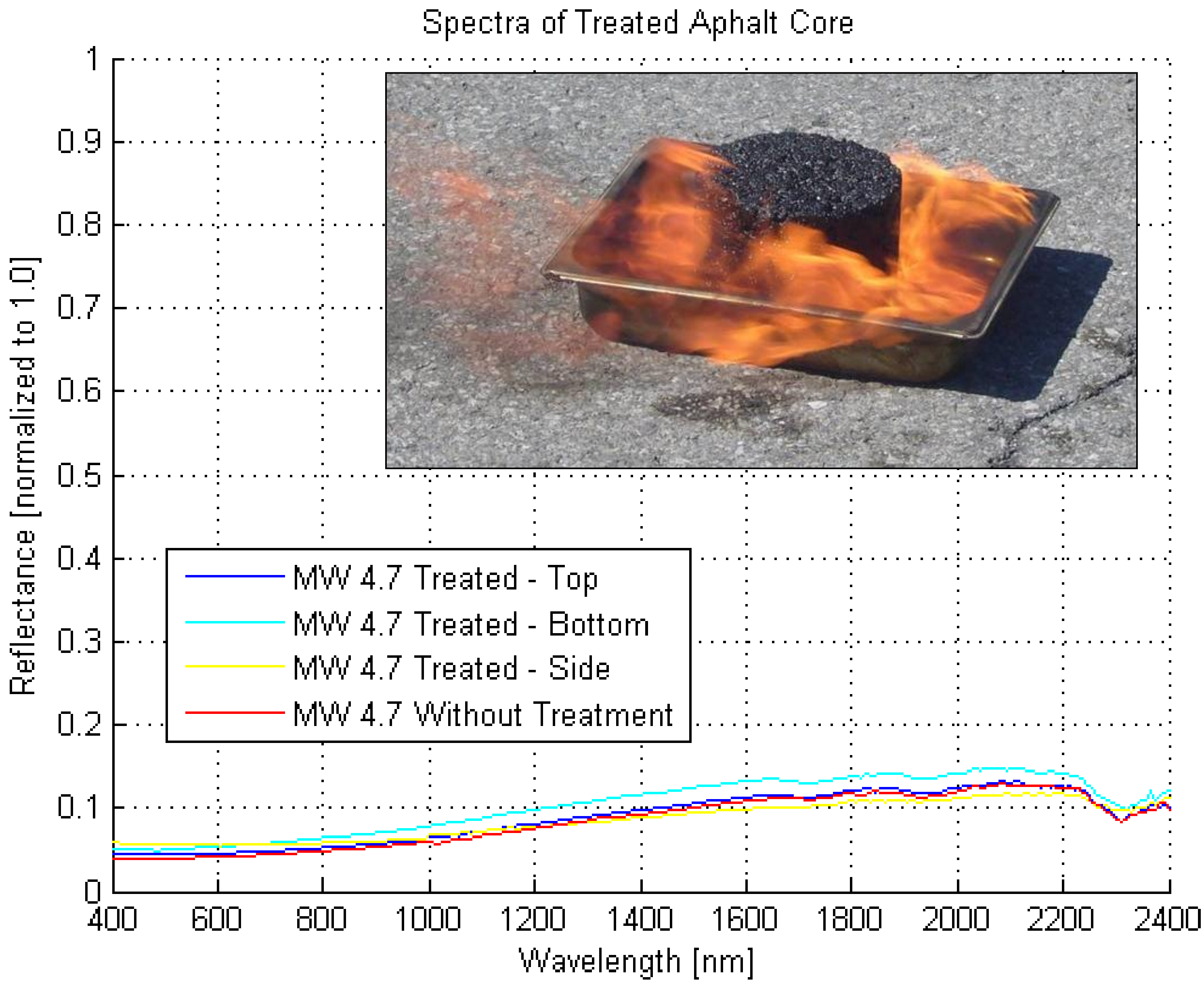

Aggregate

Spectra of Aggregates

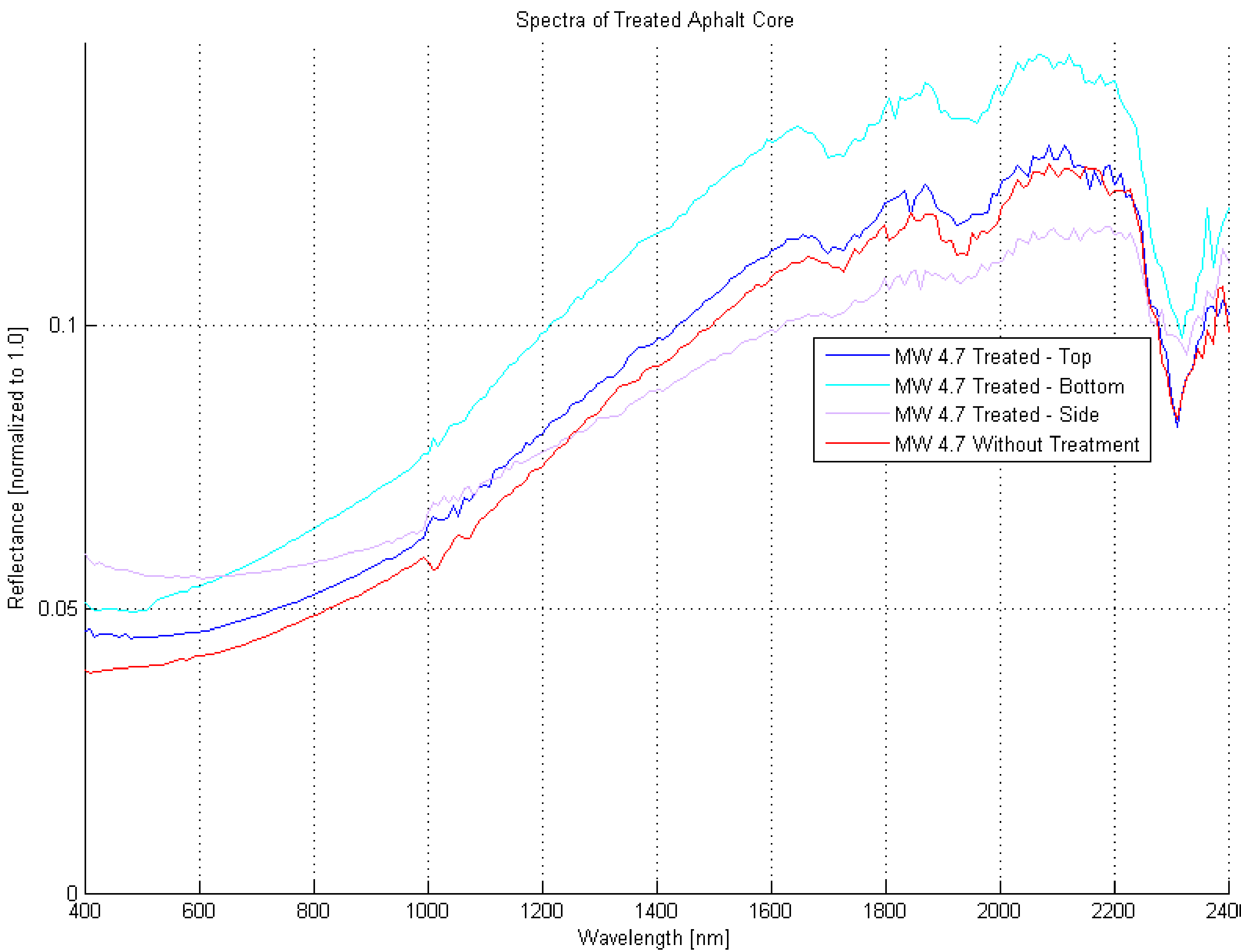



After Pouring Gasoline On Sample
Dissolved Binder

Spectra of Treated Asphalt Core



Spectra of Treated Asphalt Core - Zoom



Laboratory Findings

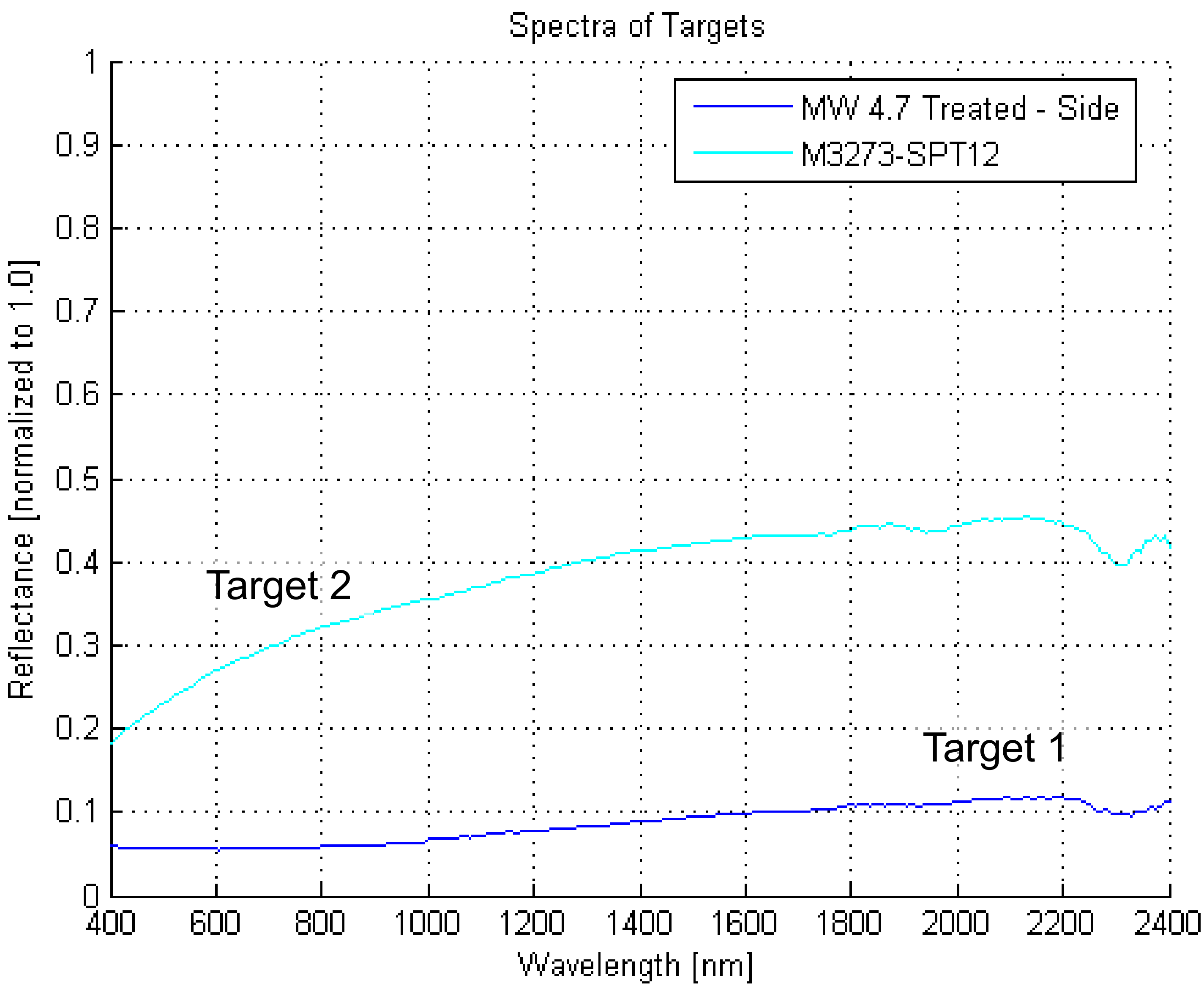
- Fair amount of variability between the different asphalt cores we sampled
  - Not much variability between the *treated* cores
  - Very difficult to discriminate much less quantify
- Asphalt should be burned longer
  - Burned for only 10-15 seconds
  - Didn't notice any softening
  - Gasoline ran off top of sample and into pan
  - Need for experimentation in more realistic setting

Modified data analysis to distinguish between *types* of asphalt

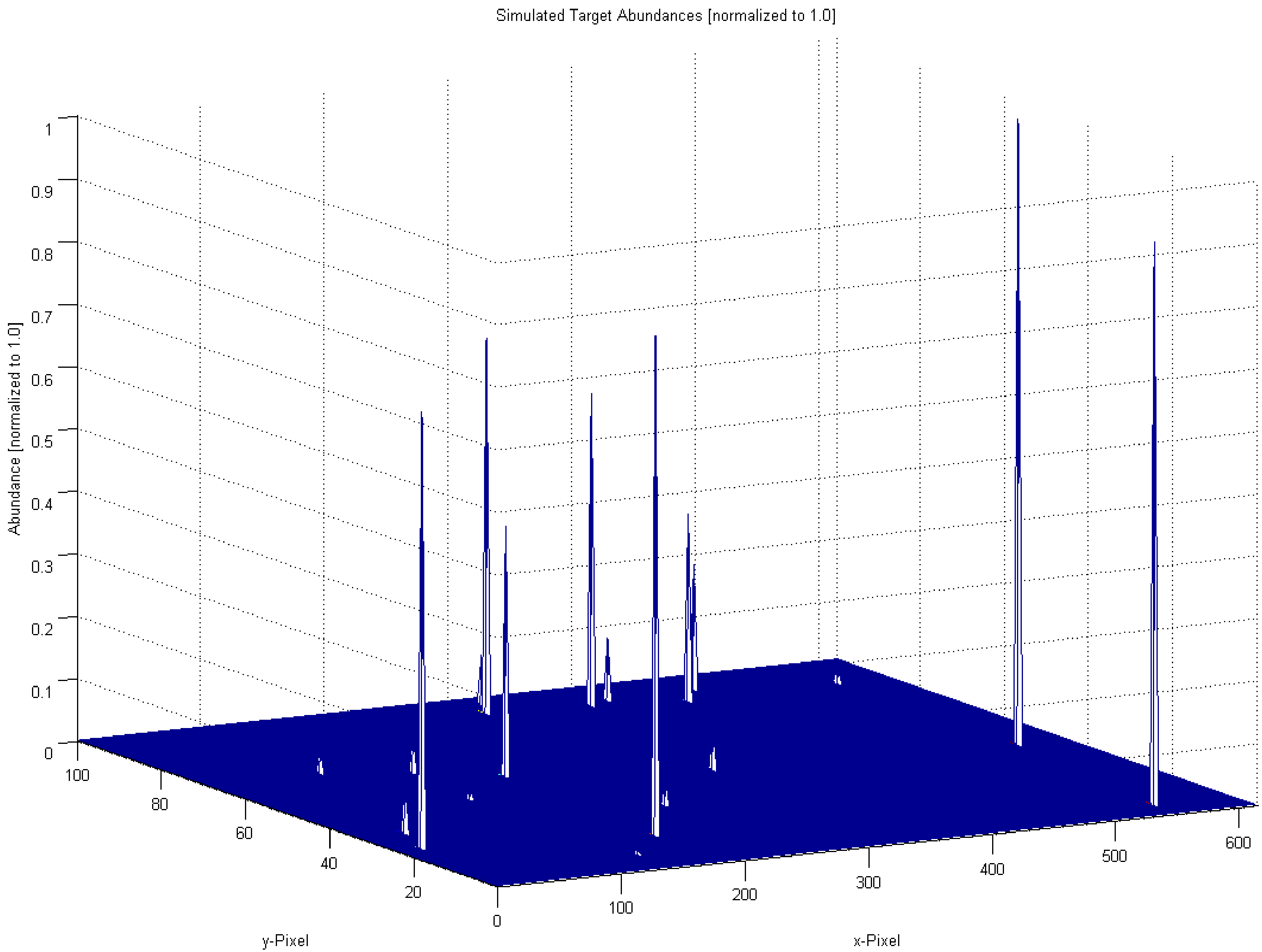
Detection Experiment

- **Hypothesis:** It is possible to detect different asphalt types using hyperspectral imagery (HSI)?
- **Experiment**
  1. Measure spectra of different asphalt types in 400-2400nm range
  2. Choose two target asphalt types to distinguish
  3. Embed, at random pixel locations, several abundance amounts of target spectra into AVIRIS imagery using the 2005 AVIRIS noise model. Abundances used: [0.01:0.01:0.09 0.1:0.1:1.0]
  4. Unmix image to recover endmembers
  5. Use least squares techniques to measure abundance quantification
  6. Repeat steps three to five 1000 times
  7. Average results

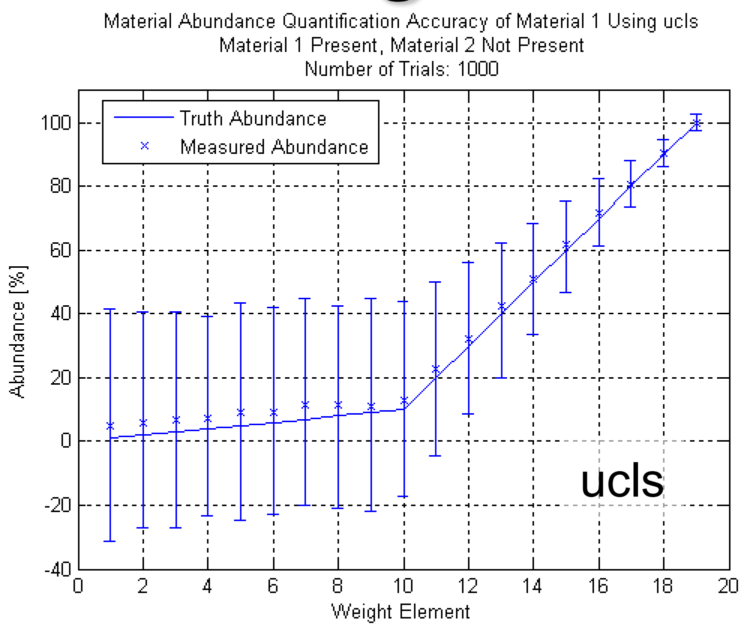
Spectra of Targets

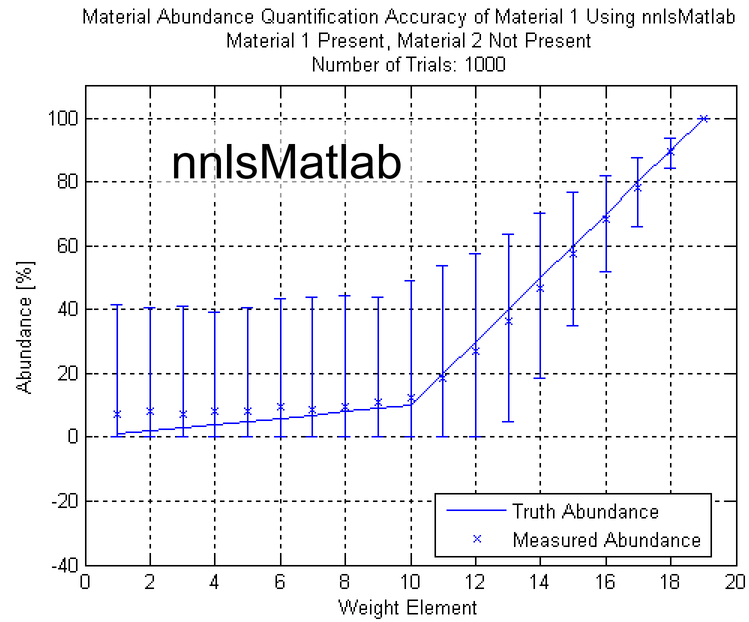


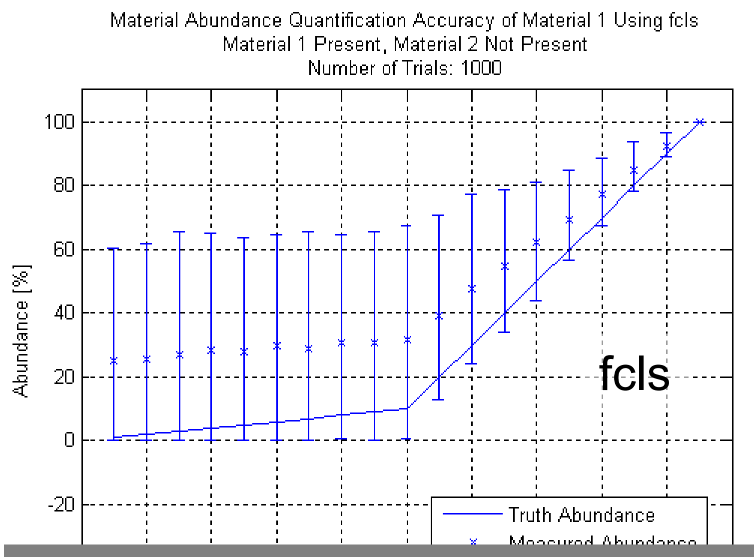
Embedded Targets Into AVIRIS Imagery

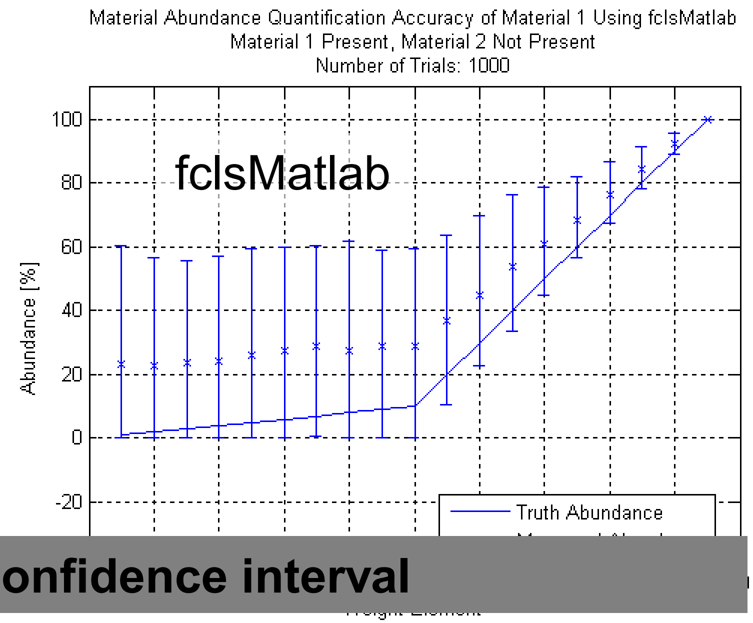


Target 1 Detection Results



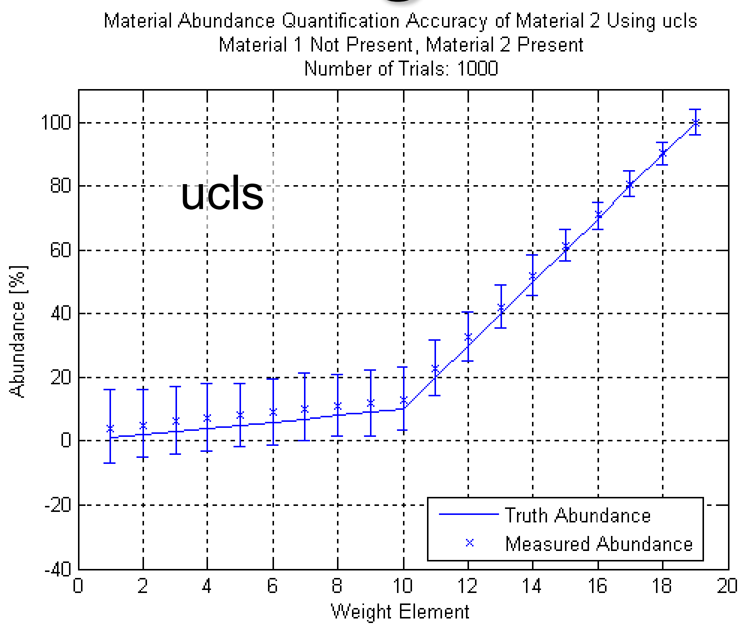


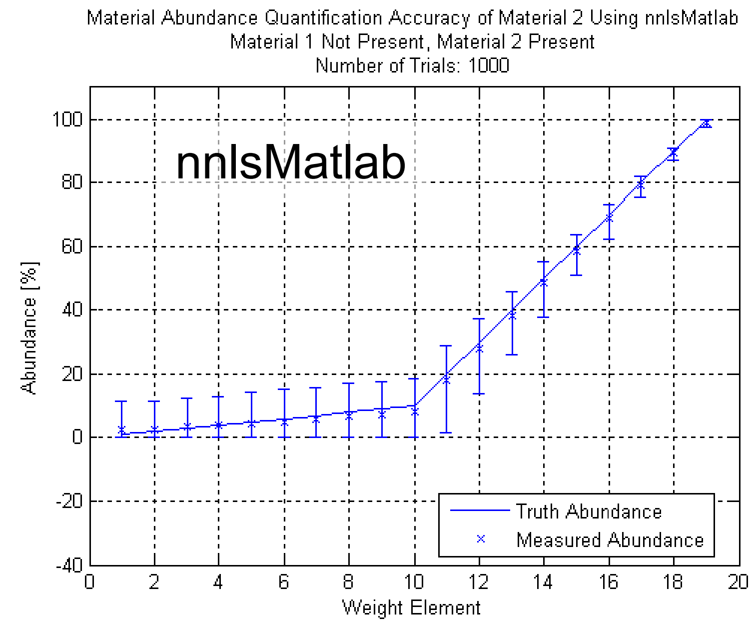


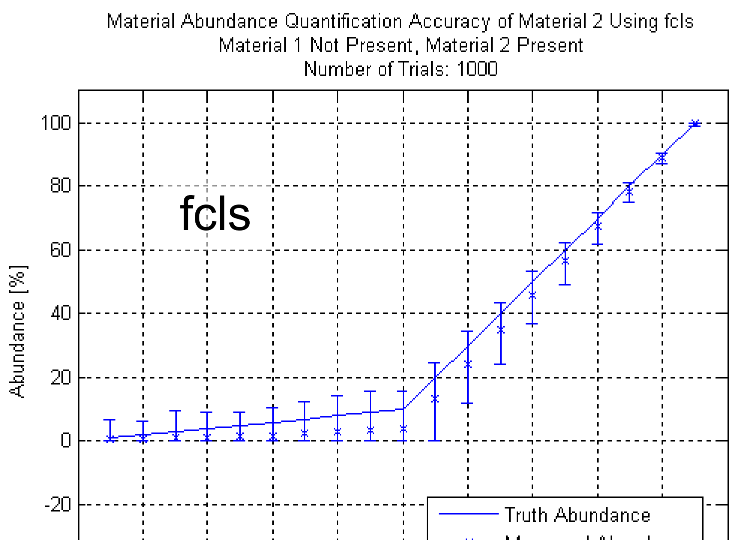


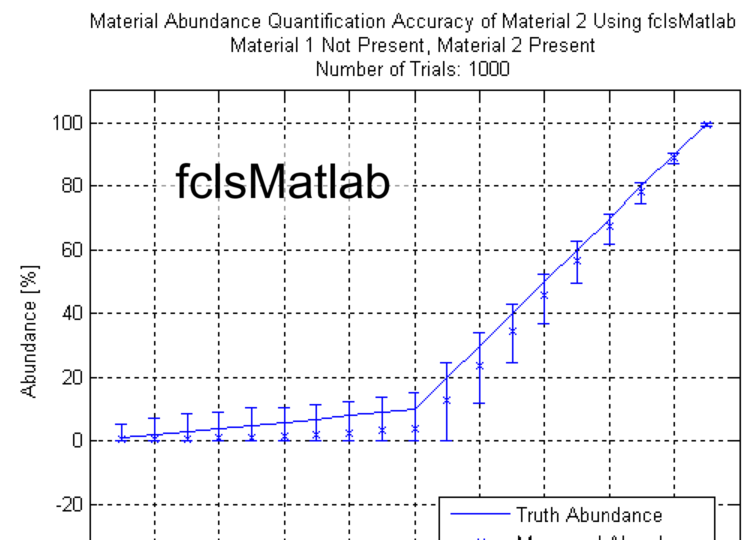
Error bars represent 95% confidence interval

Target 2 Detection Results



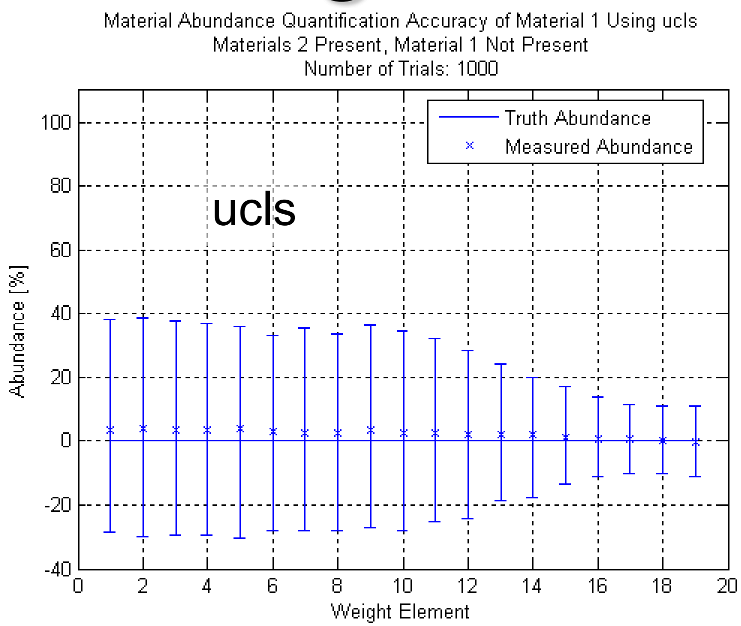


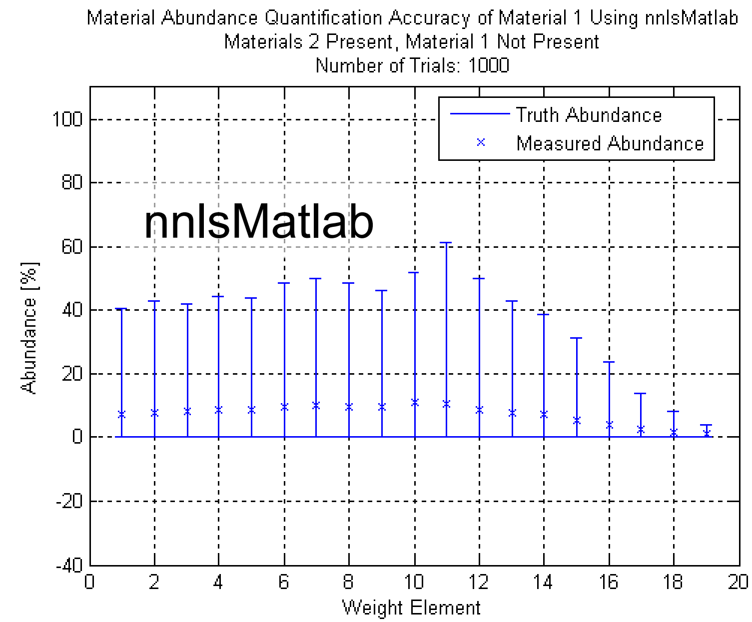


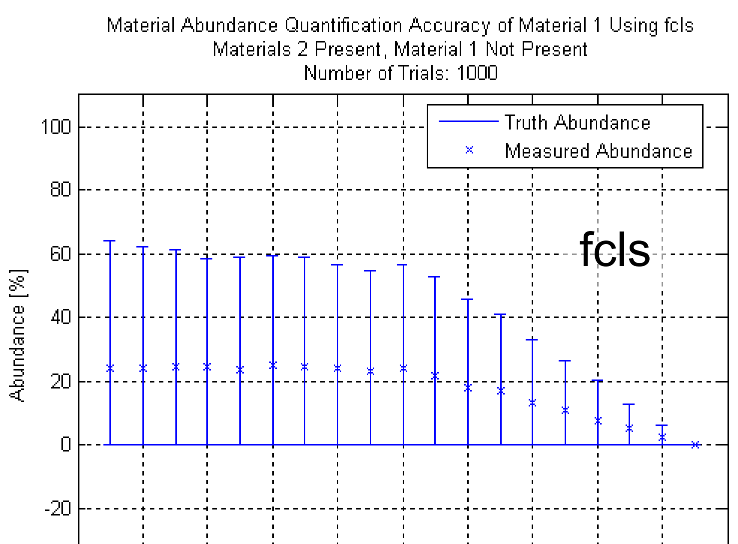


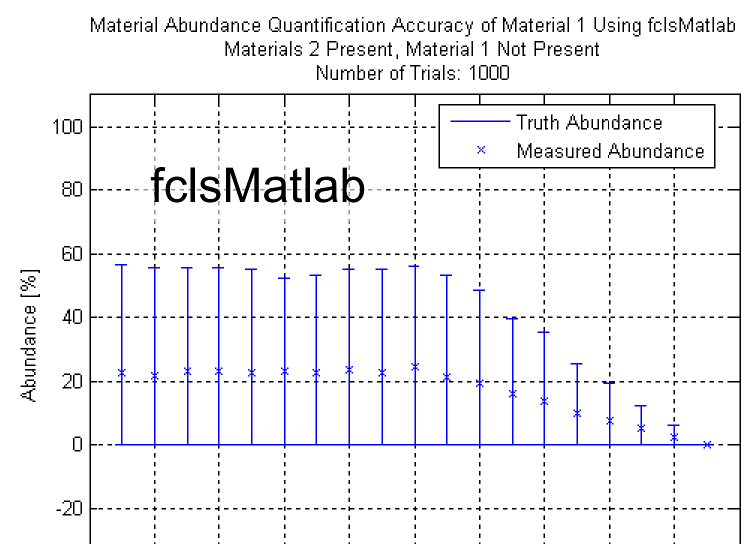
Error bars represent 95% confidence interval

Target 1 False Alarm Results



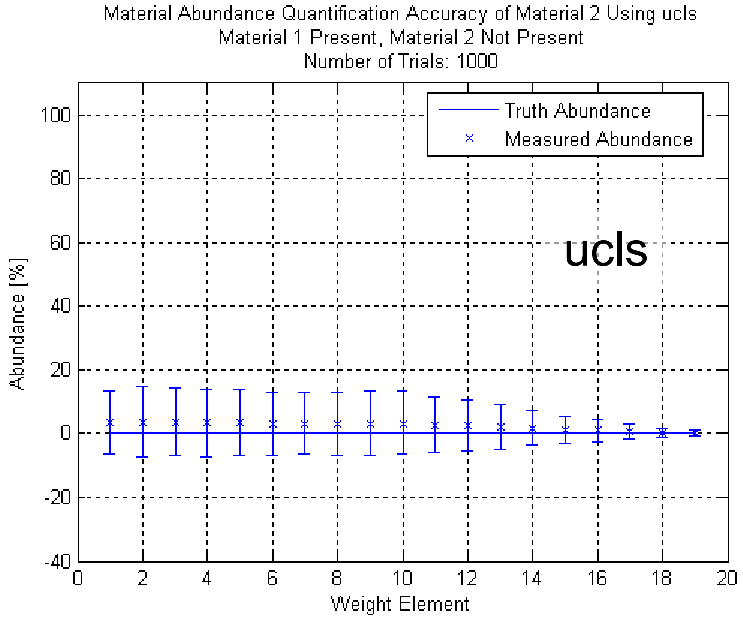


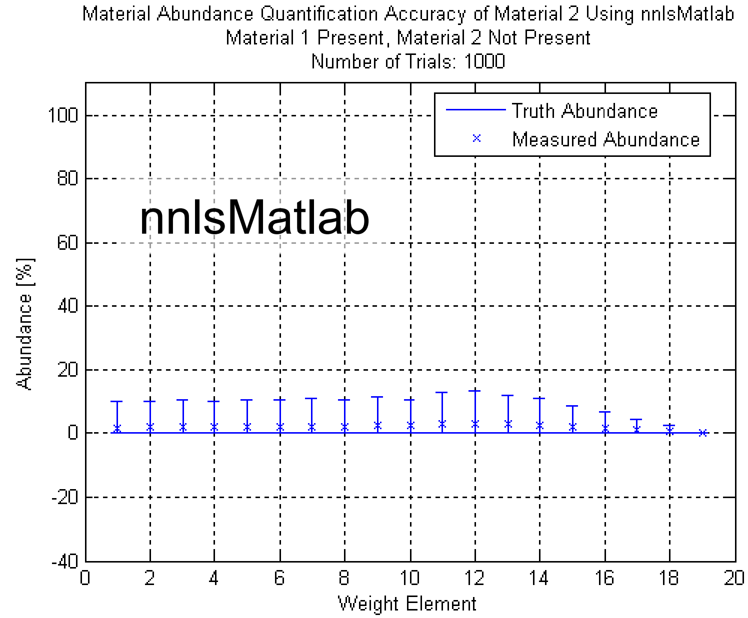


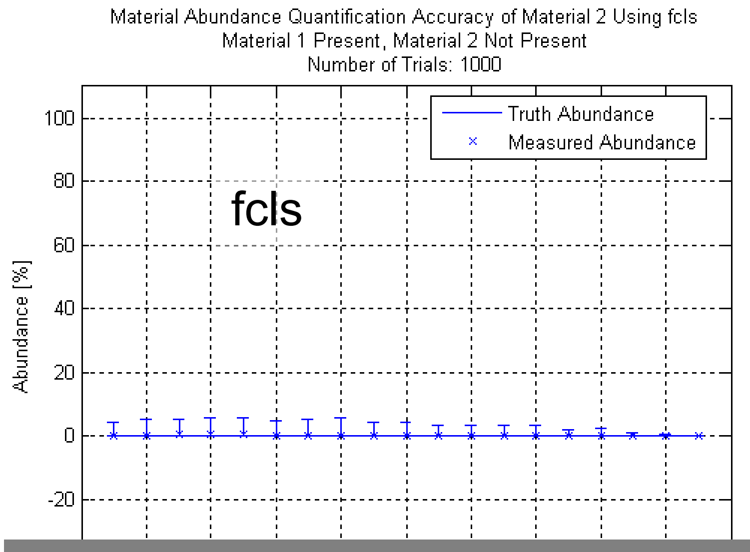


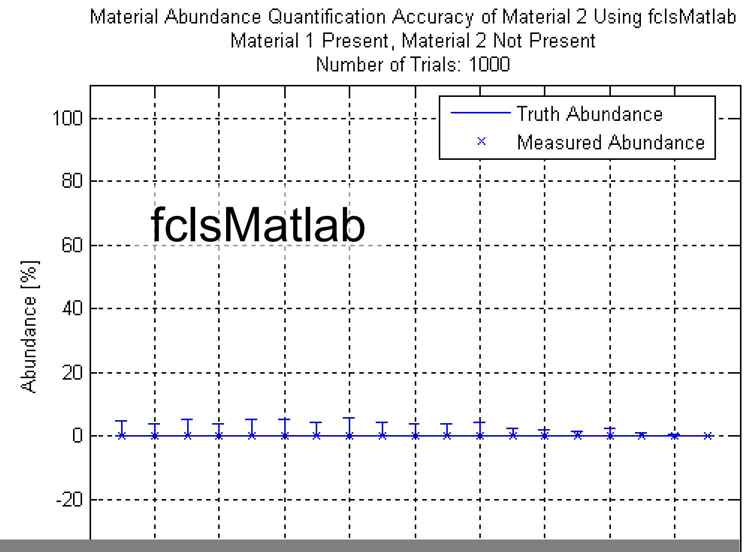
Target 1 detected when target 2 present

Target 2 False Alarm Results









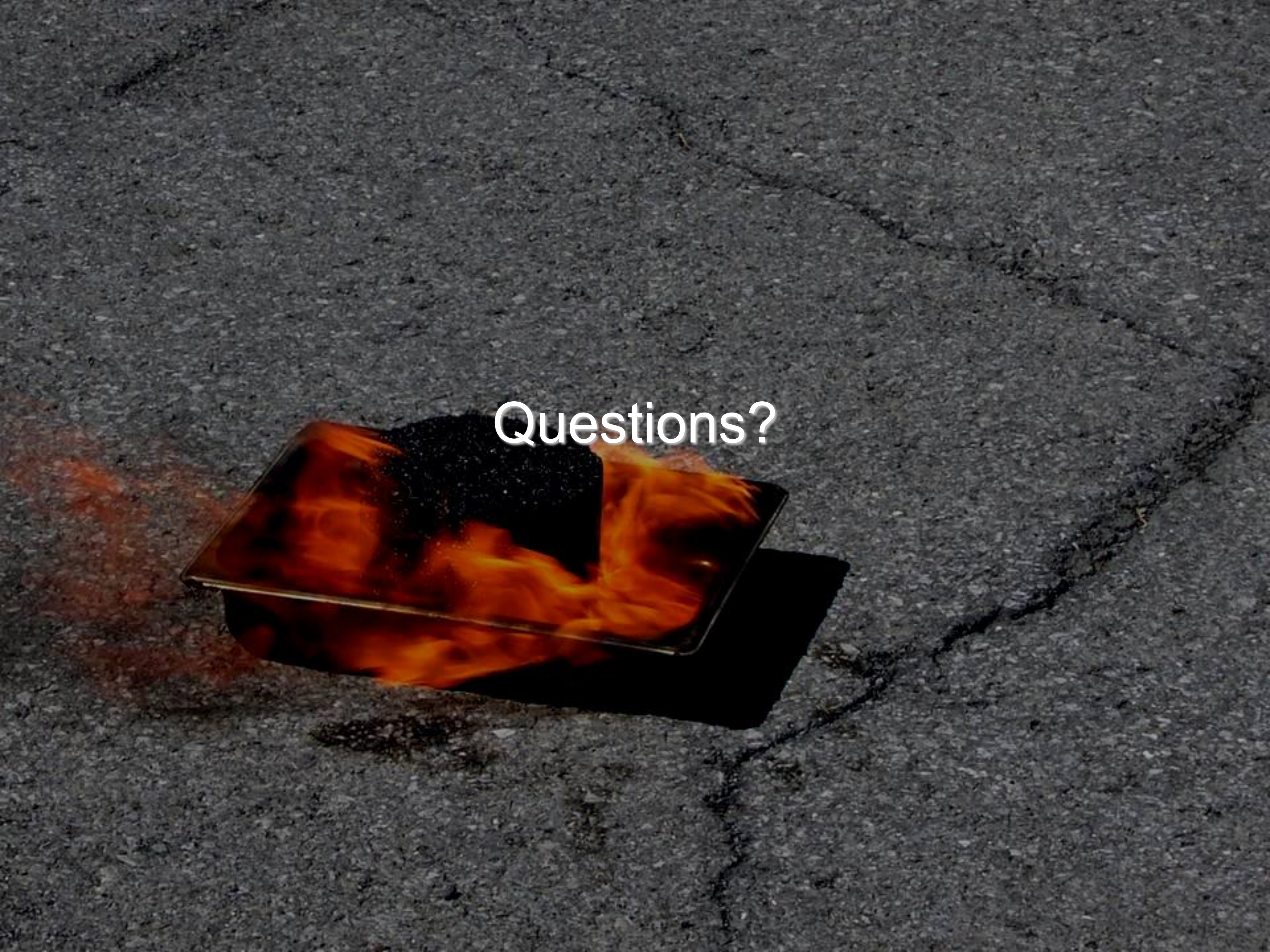
Target 2 detected when target 1 present

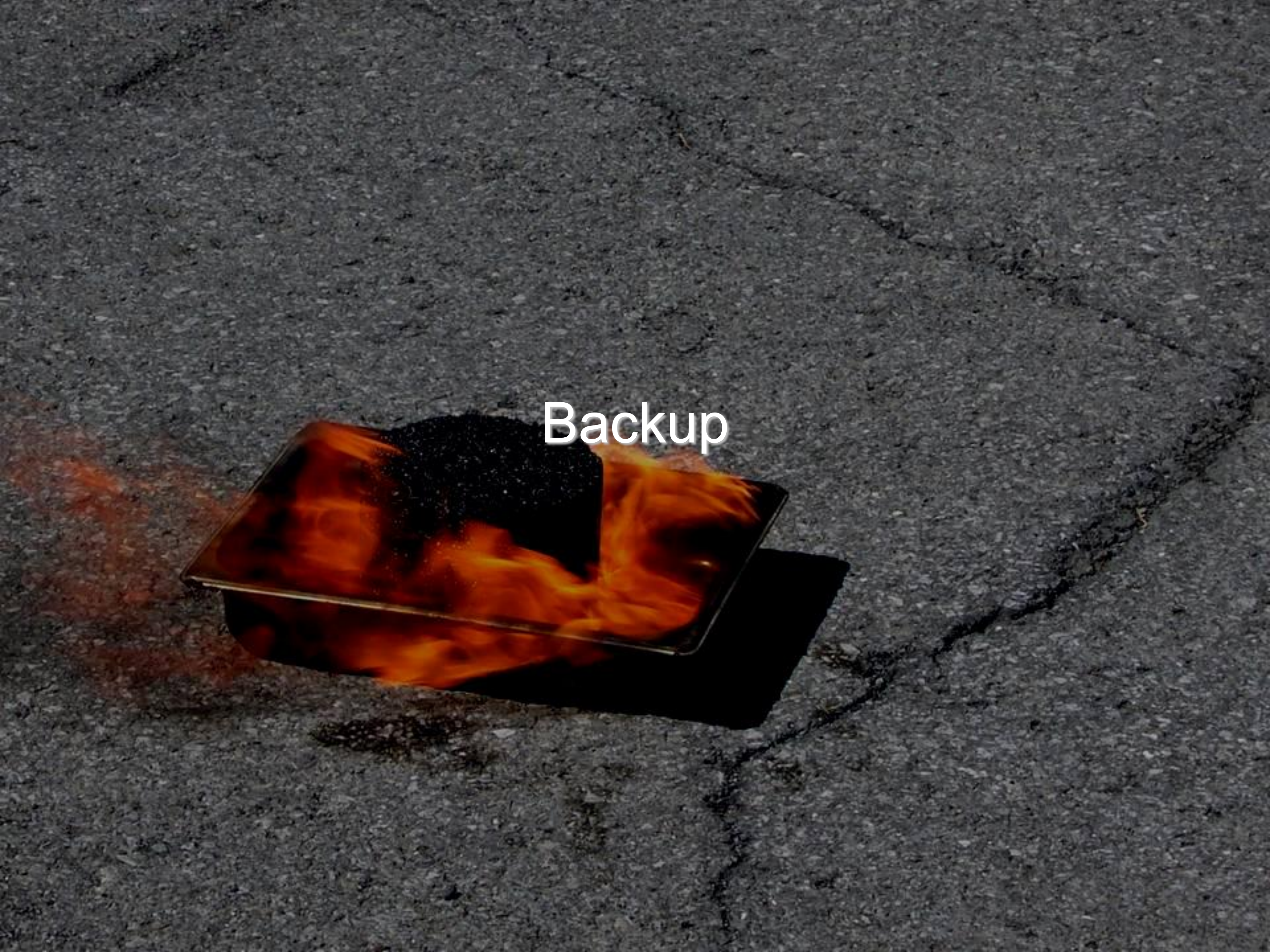
Conclusions

- Need to reevaluate experiment using more realistic conditions
- Asphalt types are difficult to distinguish at pixel abundances less than 90%
- Nonnegative least squares (NNLS) performed the best at abundance quantification when the target was actually present in the pixel
- All of the constrained least squares methods outperformed the unconstrained least squares (UCLS) method regarding false detections (false alarms)

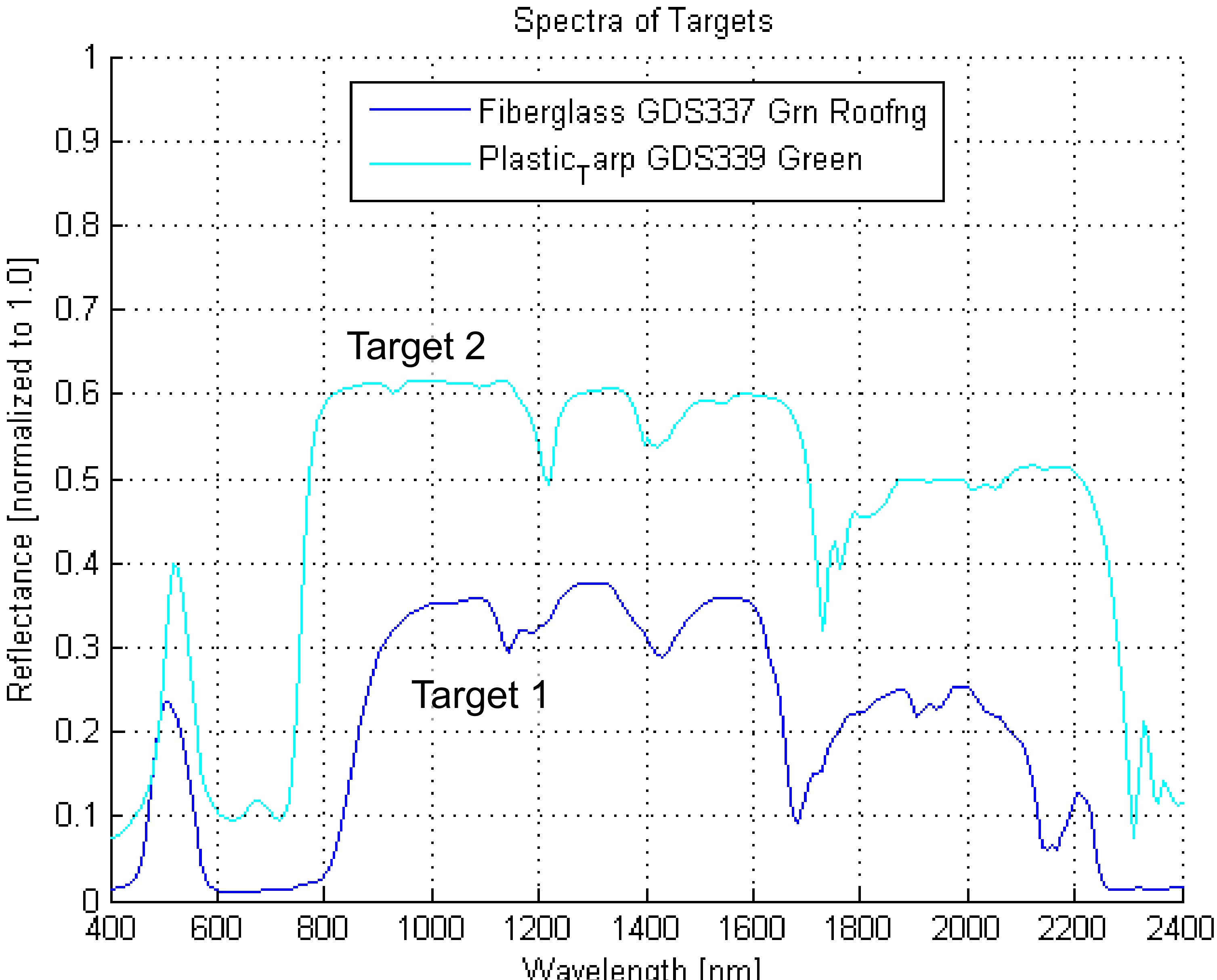
Thank You

- Penn State Asphalt Laboratory
  - Dr. Solaimanian
  - Scott Milander
- Dr. Lampkin
  - Provided portable radiometer
- Dr. Kane
- Dr. Fantle

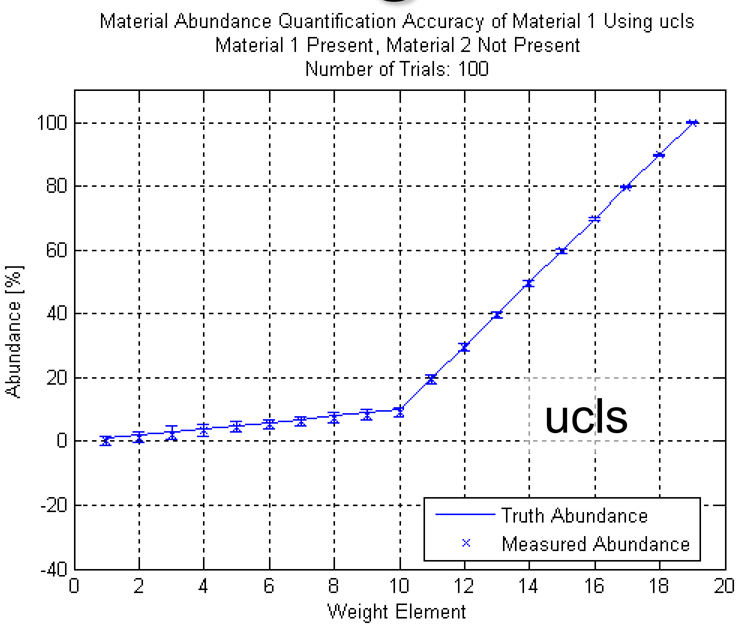

Questions?

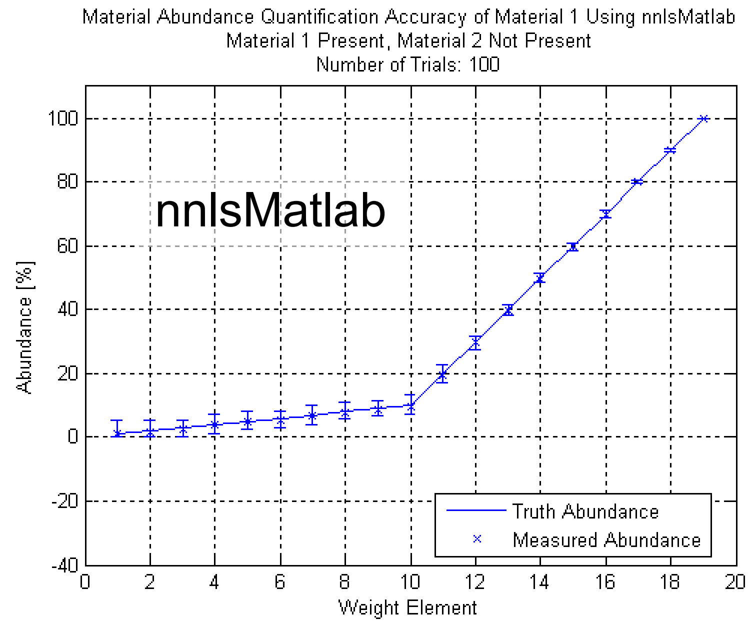

Backup

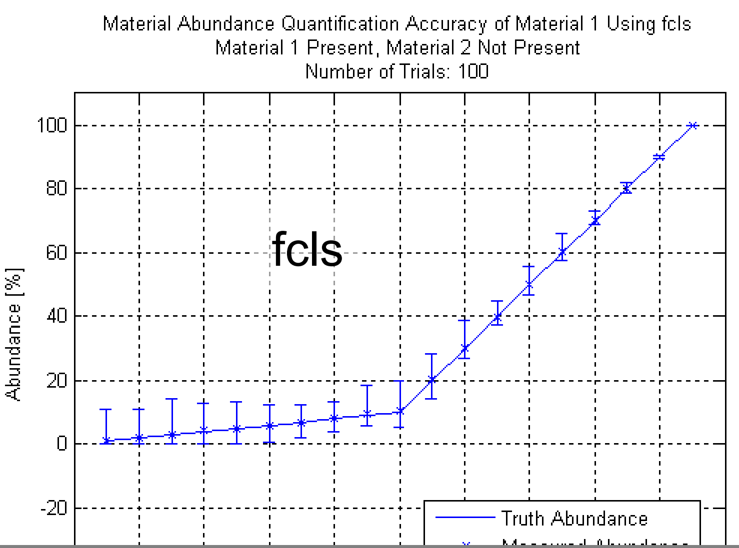
Spectra of Targets

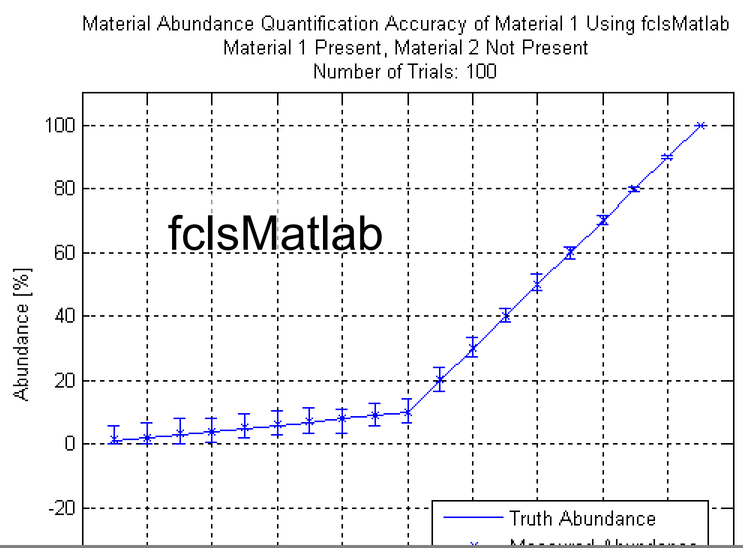


Target 1 Detection Results



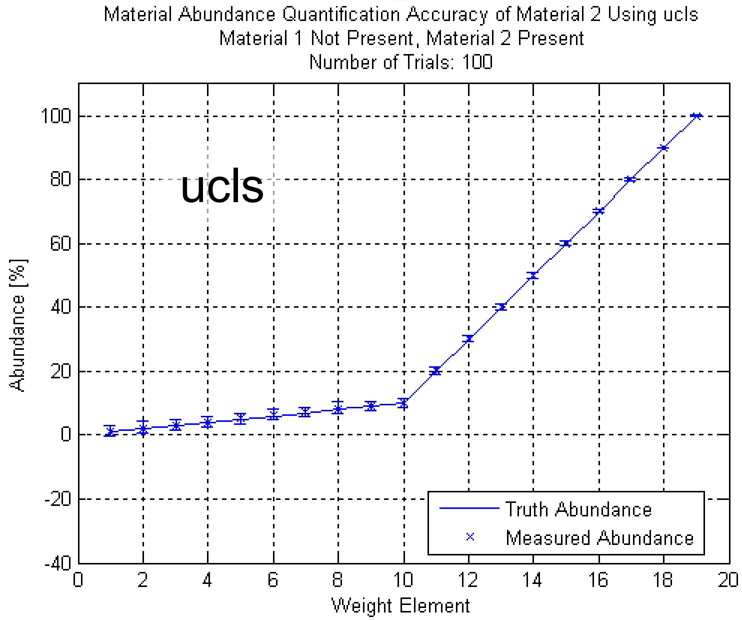


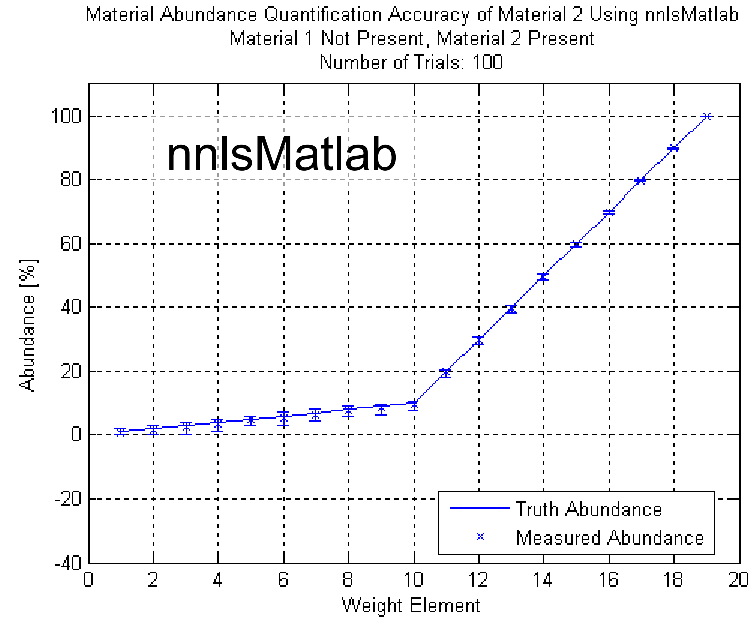


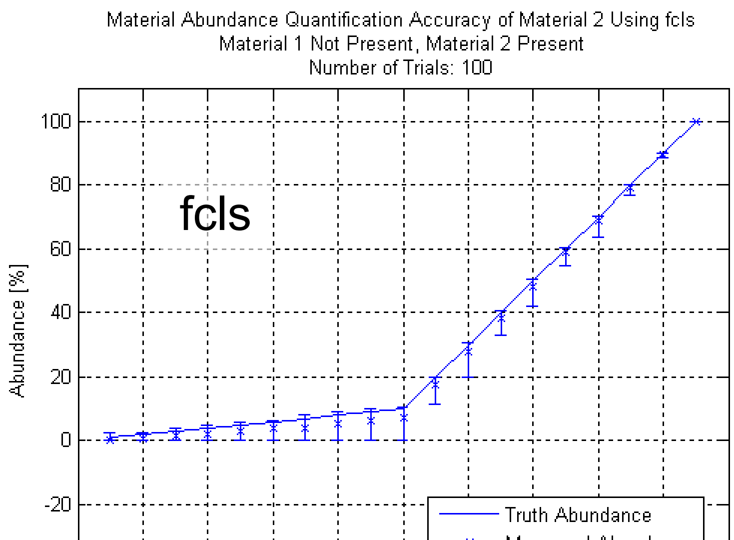


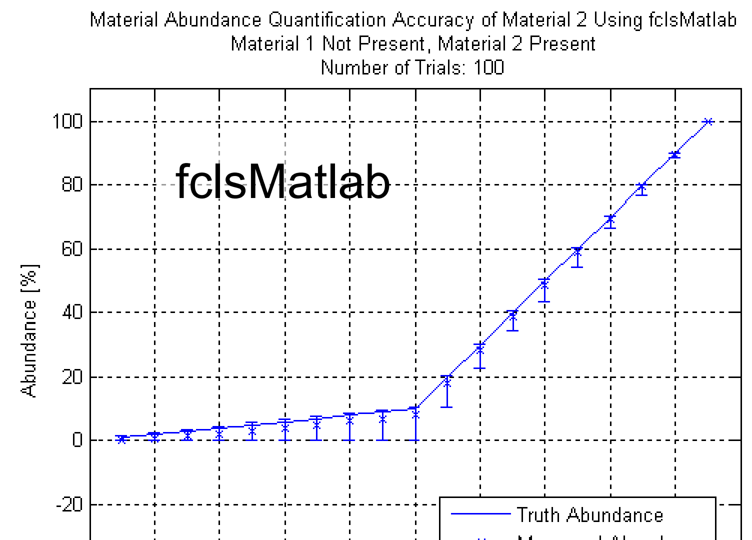
Only 100 trials conducted for these simulations

Target 2 Detection Results



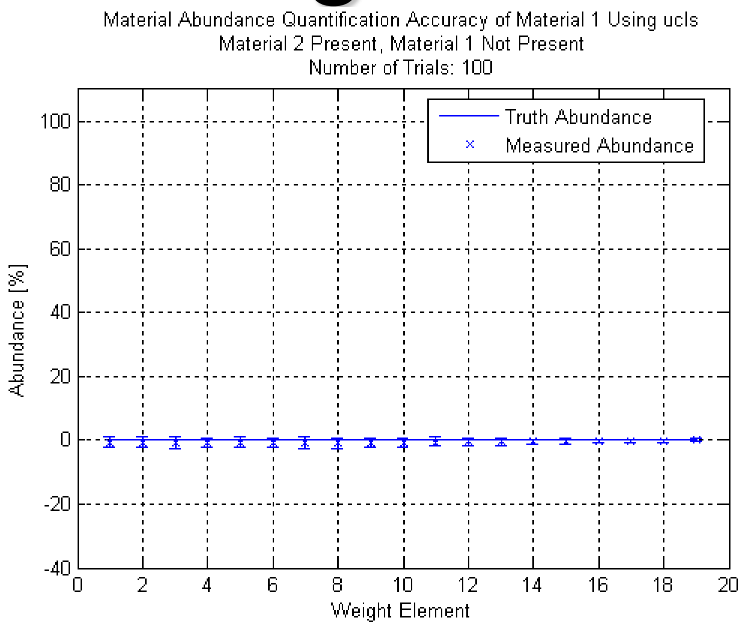


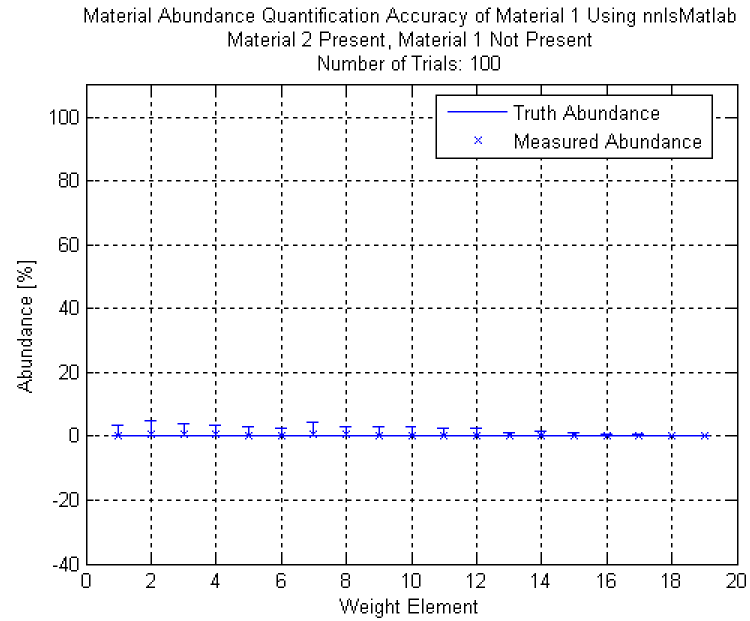


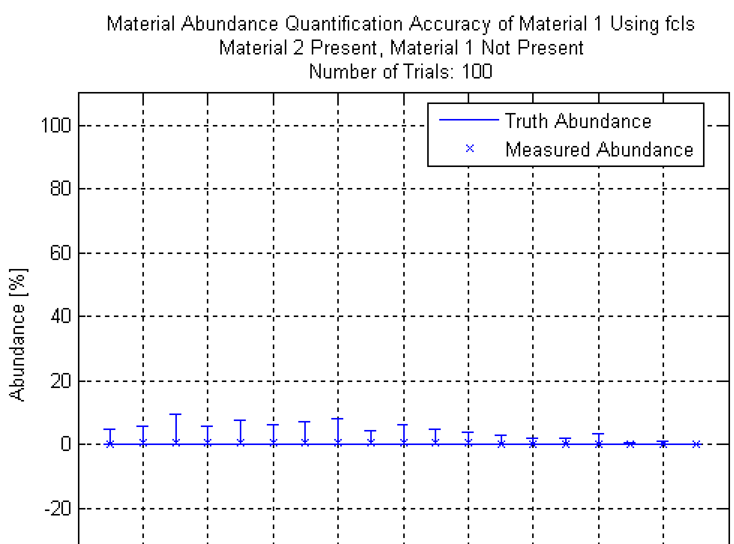


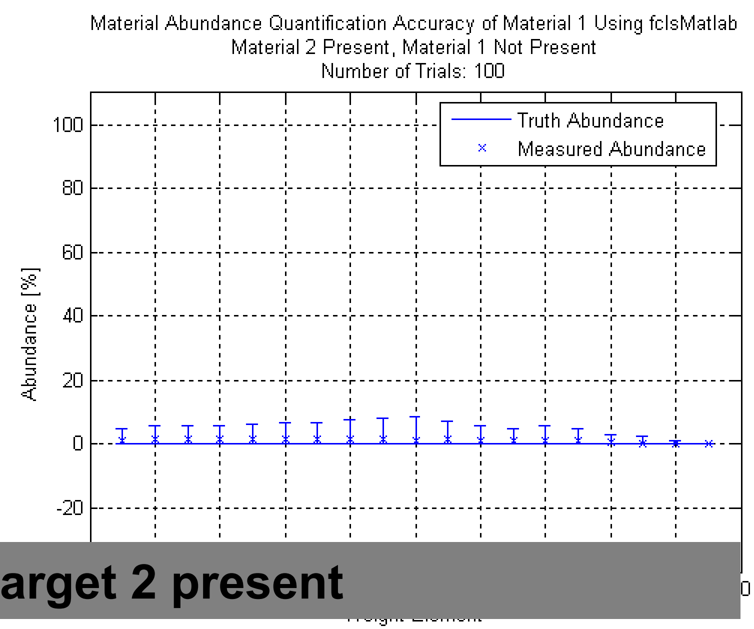
Error bars represent 95% confidence interval

Target 1 False Alarm Results



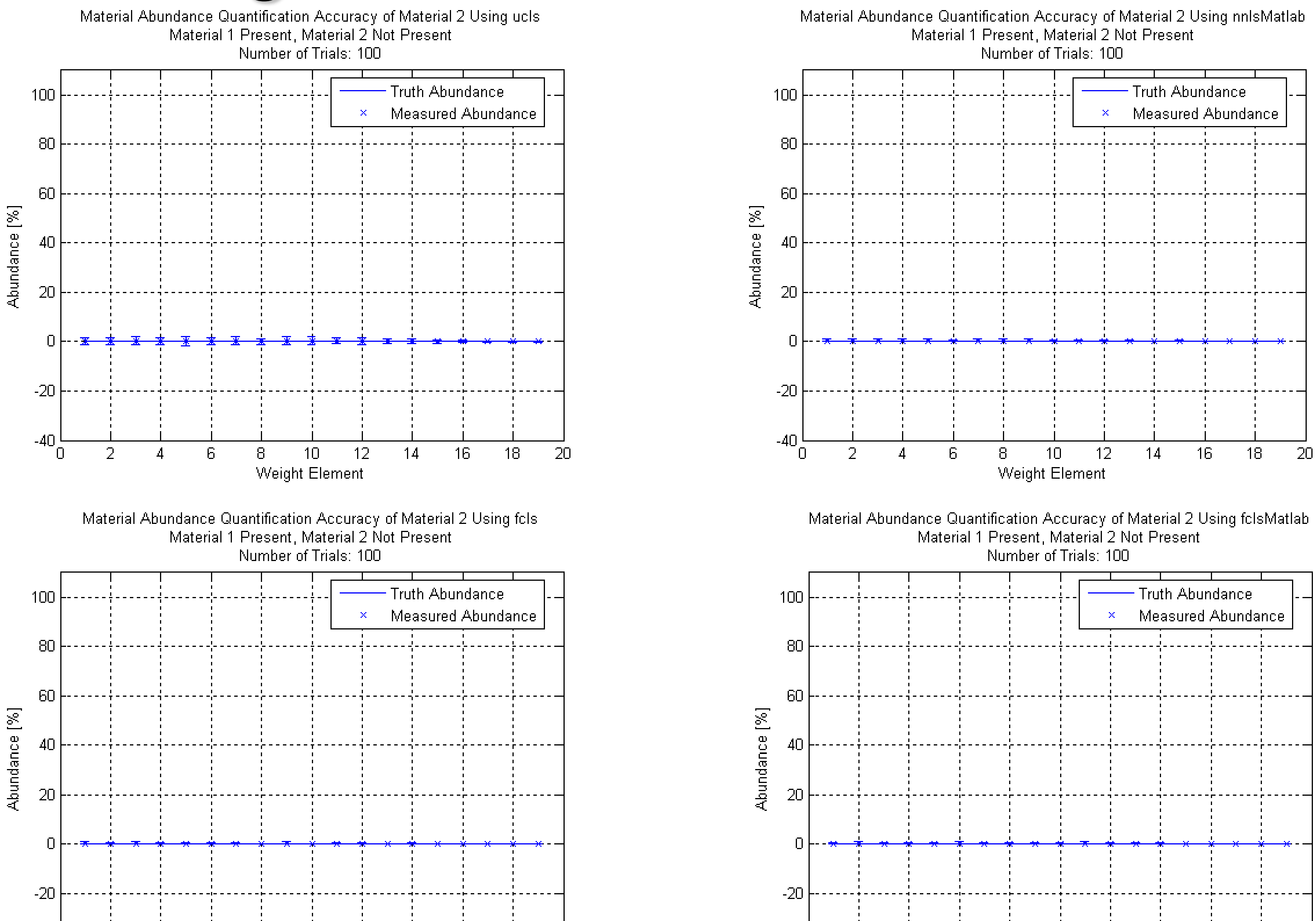






Target 1 detected when target 2 present

Target 2 False Alarm Results



Target 2 detected when target 1 present