Using the ALTA II Handheld Reflectance Spectrometer

The ALTA II spectrometer is an active spectrometer, which means that it emits energy and measures how much of that energy is reflected back. The instrument actually measures the amount of energy (in mV) that is reflected back and with some simple math, we can determine what the percent reflectance is. The ALTA II spectrometer measures seven bands in the visible portion of the spectrum and four bands in the infrared portion of the spectrum. In the bottom of the machine is a circular hole through which the light passes. If you look carefully you will see a circle of light bulbs inside. There are buttons on the front of the instrument that correspond to each of the bands. Each of the buttons also corresponds to one of the bulbs on the back of the instrument. When a button is pressed, the corresponding bulb will light up. When any of the seven visible band buttons are pressed, you will be able to see the bulb light up for that color. When one of the infrared buttons is pressed, you will not see that bulb light up. Don't become worried and think that the bulb has burned out. It is emitting energy, but can't be seen because our eyes are not able to see that type of energy. It will be important to record how much energy the infrared portion of the spectrum is reflecting because it can tell us a great deal about the health of the sample.

The LED screen on the front of the instrument gives number values at all times. When you set the instrument over a sample, it will give a reading, even without a button being pressed. This value is called the dark current. It is essentially the "noise" or random energy that is getting into the sensor. This value will have to be subtracted from future values. When taking a measurement, you must first record this value before pressing a button. If the value for dark current equals "1" it means that the instrument is being saturated with stray light. If your dark current is 1 you will need to re adjust your sample or reduce the lights in the room around where you are working. After recording the dark current value, hold down on one of the band buttons that correspond to a color and a wavelength value. Each button will give a unique number value for that sample. The values that it gives are millivolts (mV) of energy that is being reflected back at the sensor. These values will vary depending on the properties of the object being scanned. Usually you will be able to guess what colors will give you higher values. A red object will give higher values in red and crimson because we see it as red and therefore it is reflecting energy in that portion of the spectrum while absorbing other colors.

In order to get a value of percent reflectance from the mV values that are given by the instrument, you must do a little bit of math and another measurement. Getting a measurement of percent requires that we know how much energy would be reflected at 100% reflectance. To estimate this, you can use a small stack of plain white paper. The white paper should reflect almost all of the energy back to the instrument and give us a reference value. If we assume that this is reflecting all of the energy back at the instrument, we can then use this to estimate what percentage of energy is being reflecting from the sample. To do this you would record three values: 1) Dark current value (mV), 2) Reference value (mV) - value given when band button is pressed over the white paper, and 3) Sample value (mV) - value given when band button is pressed over the sample. In order to get the percent reflectance for each of the bands for a given sample you would calculate it as follows:

% Reflectance = (Sample Reflectance - Dark Current) / (Reference Value - Dark Current) * 100

Record the values on the datasheet provided for each of your white pine sample collections. These can be compared to the VIRIS measurements for those samples.

Caution:
Please make sure that you do not touch any of the bulbs because it could affect the measurements and damage the instrument.
Please handle the instruments with care because they are very fragile.

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ALTA II Spectrometer vs. VIRIS

The GER 2600 instrument (VIRIS) is similar to the ALTA II spectrometer in the respect that they both provide information about spectral properties of a sample in the same units (% reflectance). However, there are some fundamental differences between the two instruments. The VIRIS is a scientific grade instrument and gives much more precise and accurate measurements. The resolution of the VIRIS is approximately two nanometers (nm) while the ALTA II resolution is about 20 nm. The VIRIS measures a much broader range of the electromagnetic spectrum (350 nm - 2500 nm). The ALTA II measures from 470 nm - 940 nm in discrete bands, much like Landsat TM. The VIRIS is a passive instrument, which means that it does not emit any energy. It only measures the amount of energy that comes in to the sensor. The ALTA II instrument is an active instrument because it emits energy and measures the amount that is reflected back to the sensor. This is easy to see because when a visible band button is pressed you can see the bulb light up with that color.

Although the two instruments measure with differing accuracy and differing ranges, they both measure parts of the spectrum that are very important in Forest Watch. Two key areas that can be compared in each data set are the red portion of the visible spectrum and the near infrared portion of the spectrum. The visible portion tells us a great deal about the general health of the vegetation. Healthy foliage that is photosynthetically active will absorb a great deal of blue and red light and reflect green light. The ALTA II spectrometer measures seven separate bands within the visible portion of the spectrum and can pick out differences in reflectance within each of these three colors. The VIRIS also measures within this range and when the results from each instrument are graphed, they should be comparable. Although the ALTA II does not give enough information to calculate a specific REIP value, it does measure four bands in the infrared portion, which can be compared to the NIR portions of the VIRIS spectrum. Healthy vegetation will absorb greatly in the red portion and reflect large amounts in the NIR portion. You may compare the differences exhibited between the two regions and see how that compares to the REIP and TM 4/3 values from the VIRIS measurements.

In general the two instruments work in a very similar manner. They also work much like many of the satellite remote sensors that we have in space to monitor our planet. The great advantage to having students use the ALTA II spectrometer is that they can use the instrument in the classroom to measure the needle samples and know that this is a similar technology that UNH scientists are using in the laboratory.

We hope to develop regression equations, which would allow you to use the ALTA II data to predict the REIP values. Please send copies of data that you collect to us so that we may gain insight into the success of these instruments in the classroom and do some comparison of our own.

Scanning Your White Pine Samples

- *The following protocol should be followed to fill in the ALTA data sheet with values for the white pine samples collected from your plots from the north and south sides of each tree.*
- *Please collect enough sample so that you have a sufficient amount to send to UNH.*

1) Stack three pieces of clean white paper for each spectrometer that is used. You may split the paper into quarters and make stacks, as long as the paper is large enough to cover the field-of-view of the instrument and each stack is thick enough to keep any background light out.
2) Insert the 9-volt battery into the back of the instrument and close the battery cover.
3) Turn on the spectrometer by flipping the power switch on the right side of the instrument.
4) Test the instrument by pressing each button for several seconds to see that the bulbs are working for the visible bands. You will be able to see that they are working by looking inside the circular opening on the back of the instrument. This is also a good demonstration for the students.
5) On the data sheet record your school information and tree numbers.
6) With one of the white stacks of paper, press the instrument down on the stack so that no light can get in. (Make sure the paper covers the entire field of view). Record the number on the screen in the cell labeled "Dark Current". This is the stray light or "noise".
7) Then press one of the buttons and hold it down for several seconds. When it gives a consistent value, this is the amount of energy being reflected back at the receiver. Record the value for each of the bands in the row labeled "Reference".
8) Remove several tufts of 1st -year needles from each of your sample collections and group them together so that no light is coming through them.
9) Press the instrument down over the needles so that the field-of-view is completely covered by needles. Press each of the band buttons for several seconds and record the values for each color.
10) Repeat this process for all of you samples and record the values for each band with the corresponding sample number.
11) The values are now in energy (mV) and need to be converted to percent reflectance. In the next column you will enter the percent reflectance for each band and for each sample using the following formula:

% Reflectance = (Sample Reflectance - Dark Current) / (Reference Value - Dark Current) * 100

12) Calculate the average percent reflectance in the bottom row.
13) The ALTA graph gives you a way to graphically illustrate your data and compare your trees to each other. Plot each percent reflectance value (y-axis) against each wavelength value (x-axis).
14) Discuss with students why reflectance values are lower in the blue and red portions of the spectrum and discuss what that means in terms of plant utilization of energy.
15) Remove the batteries from the ALTA spectrometer and replace it in the protective packaging.

Caution:

- ***Please make sure that you do not touch any of the bulbs because it could affect the measurements and damage the instrument.***
- ***Please handle the instruments with care because they are very fragile.***
- ***Please be sure to remove the battery before returning.***

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ALTA II Data Sheet

Forest Watch Needle Sample Measurements

School Name: _____ NeedleYear: _____ Date: _____

Teacher: _____ Student(s): _____

% Refl. = ([Sample Refl. - DC] / [Reference Value - DC]) *100

	Dark Current (DC) (mV):																			
Tree #	Blue **470**		Cyan **525**		Green **560**		Yellow **585**		Orange **600**		Red **645**		Deep Red **700**		Infrared 1 **735**		Infrared 2 **810**		Infrared 3 **880**		Infrared 4 **940**	
	(mV)	% Refl	(mV)	% Refl	(mV)	% Refl	(mV)	% Refl	(mV)	% Refl	(mV)	% Refl	(mV)	% Refl	(mV)	% Refl	(mV)	% Refl	(mV)	% Refl	(mV)	% Refl
Reference (Ref.)		X		X		X		X		X		X		X		X		X		X		X
1																						
2																						
3																						
4																						
5																						
6																						
7																						
8																						
9																						
10																						
Average	X		X		X		X		X		X		X		X		X		X		X	

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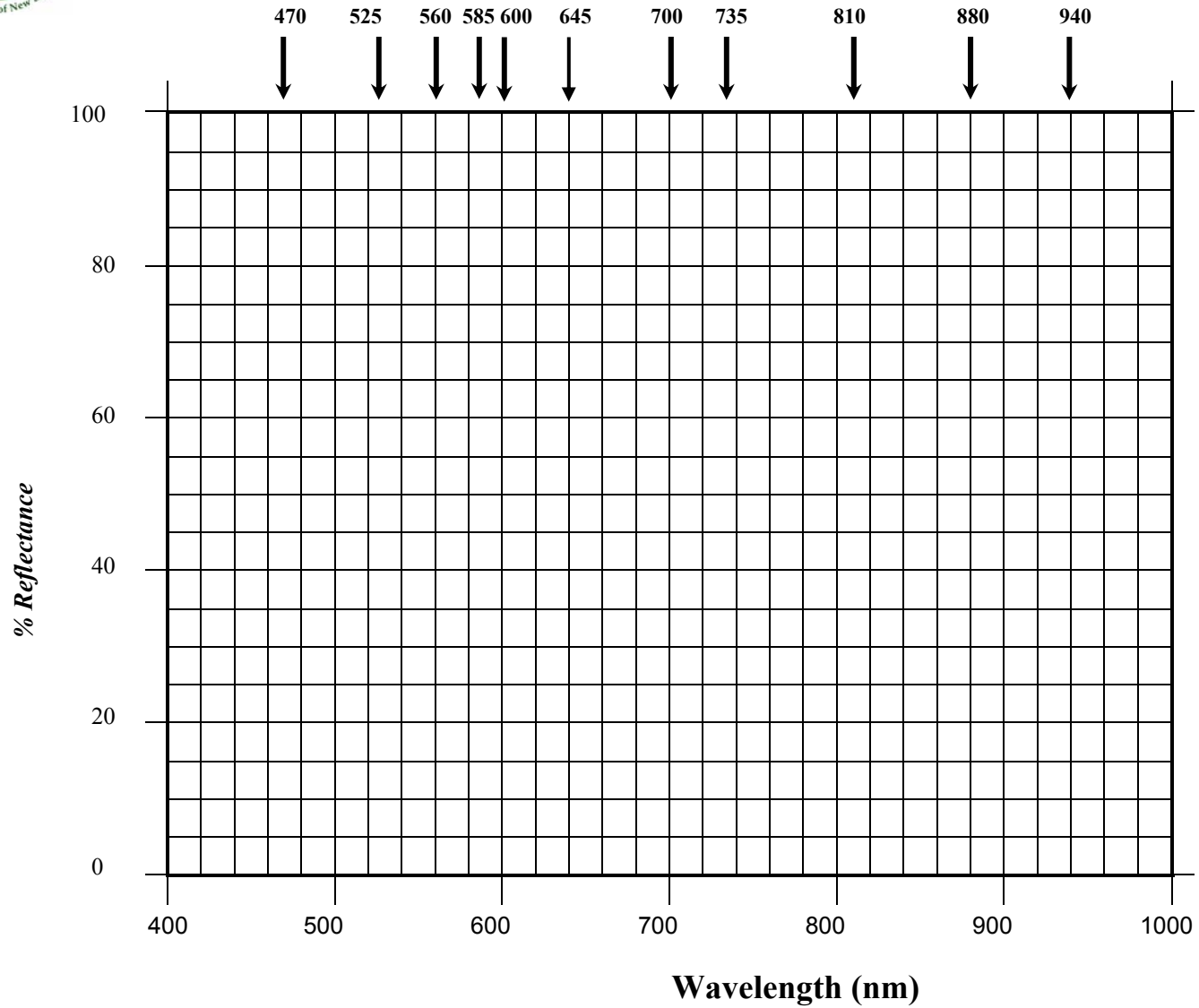
Forest Watch – Alta II Spectrometer - Graph Template



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