

ASD Malvern PANalytical Presentation

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ASD, a Malvern Panalytical brand

Our history and impact



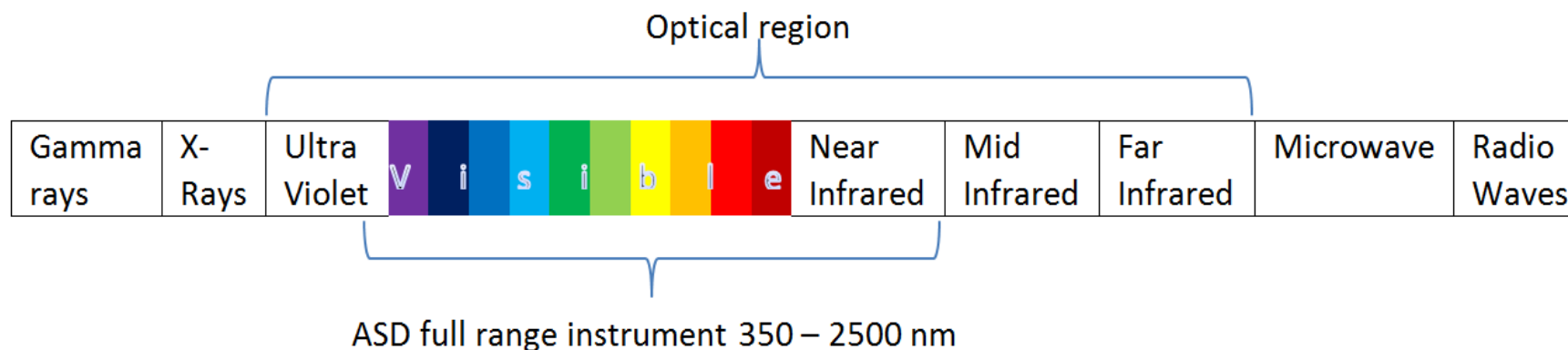
- Founded in 1990 by University of Colorado Professors
- Located in Colorado, USA
- Created to address need for field portable, robust, high-speed instruments
- Purchased by PANalytical in 2012 and now, part of Malvern Panalytical (2017) – not located in Malvern; UK
- Industry leader in Remote Sensing (non-contact) and Mining

**Providing unique Portable solutions to
Industrial/Agriculture/Mining/Environmental**



Wavelength Range (Spectral Range)

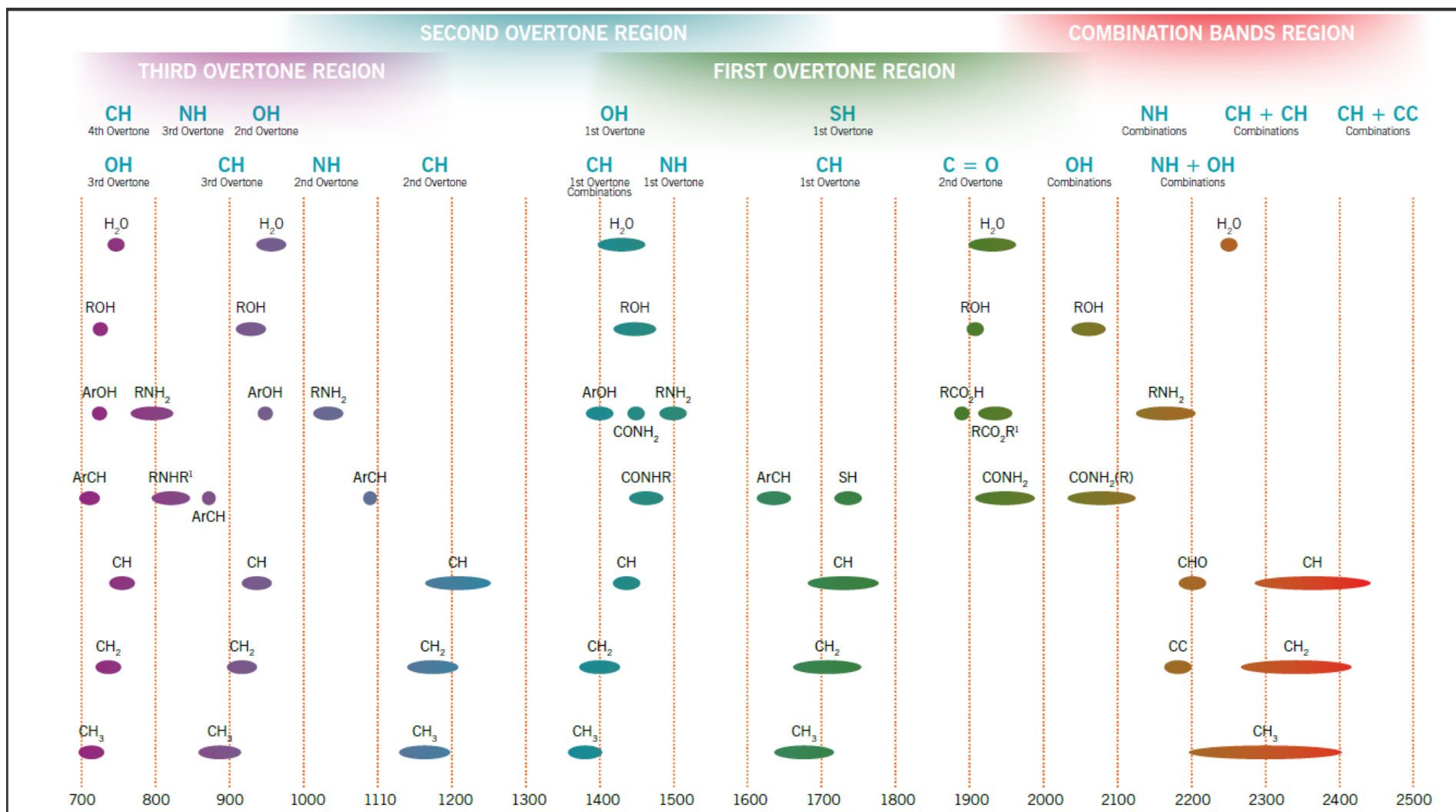
What are we measuring?



- The optical region is just one form of Electromagnetic Radiation and is the form that can be controlled by optical means such as lenses, mirrors, prisms, and fiber optics.
- The wavelength range utilized by ASD spectrometers spans from 350 to 2500 nanometers (nm). This includes a little of the Ultraviolet (UV), the Visible (VIS) as well as the Near Infrared (NIR) also called Short Wave Infrared (SWIR).
- One of the positive aspects of using this range is that it is non-hazardous, so no special safety training or certification is needed to use this technology. It uses regular white light, like that emitted from the sun or a light bulb. Of course, the brightness of the light source should always be considered to avoid damage to the eyes (to be on the safe side, avoid looking into light sources).

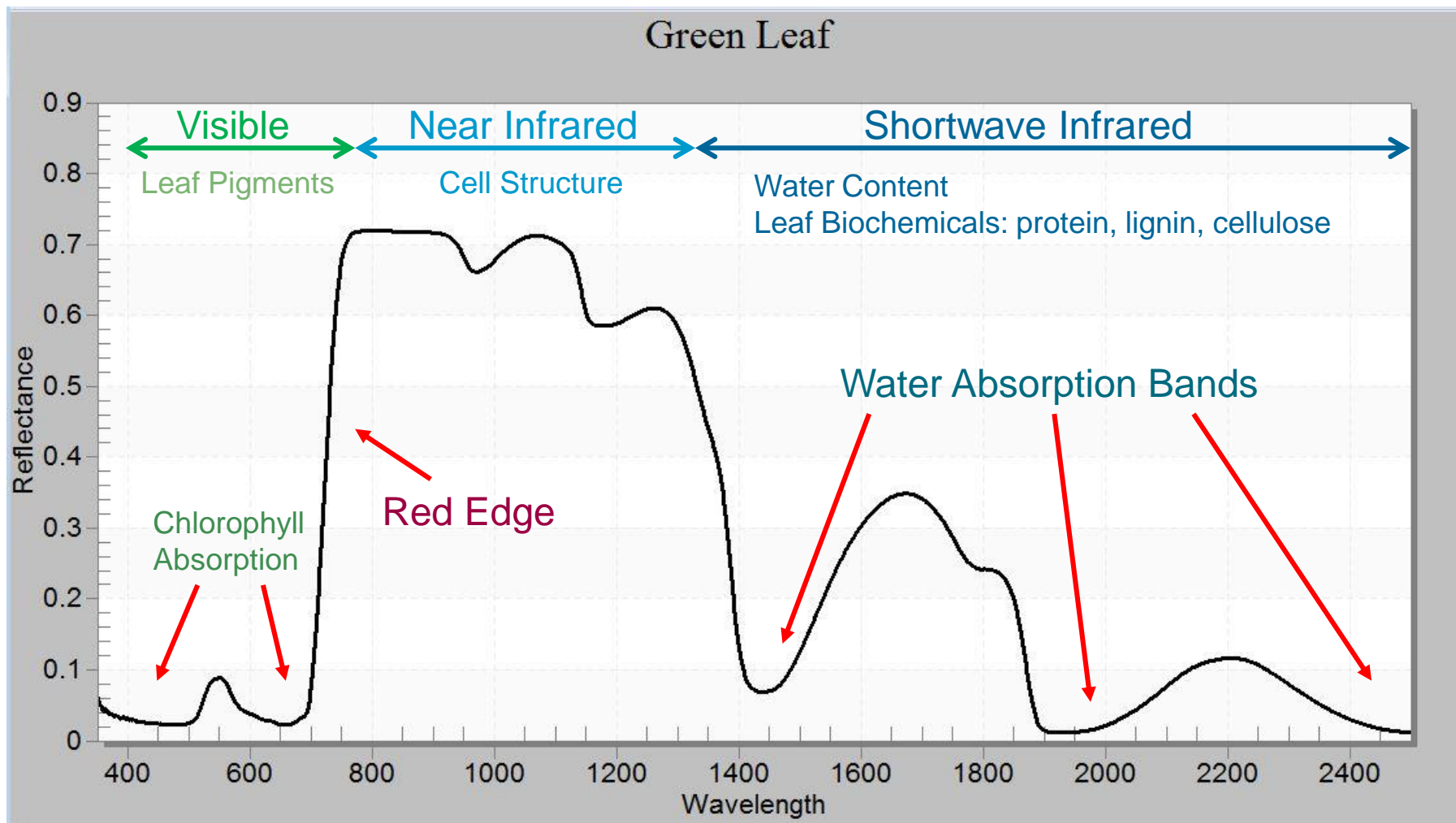
Spectral Considerations

What are we measuring?



Example of a Full Range Spectrum

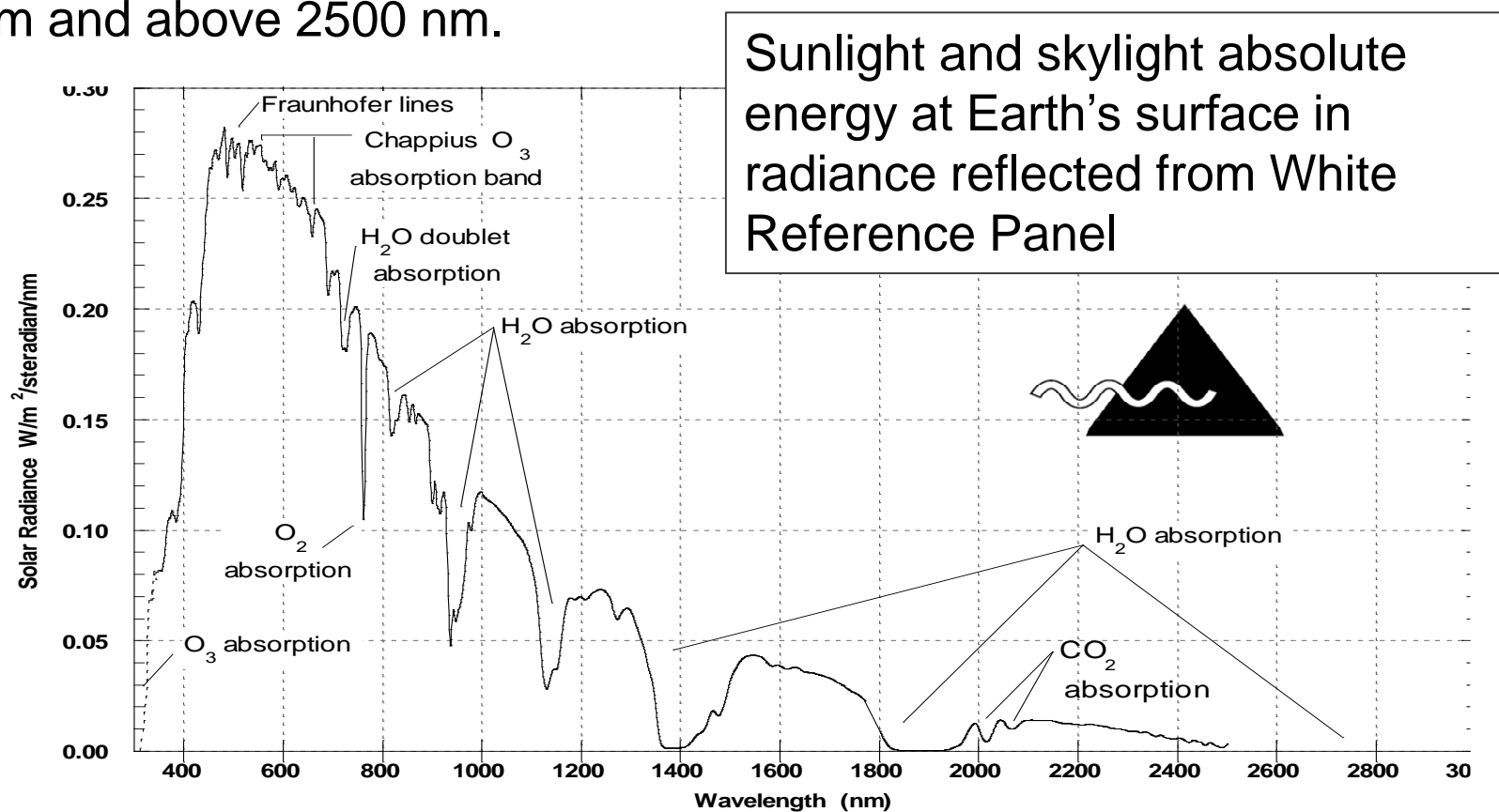
VIS-NIR Spectrum in Vegetation



Measurement Types

Radiance and Irradiance

- Water, oxygen, and carbon dioxide in the Earth's atmosphere absorb the energy from sunlight and skylight at certain wavelengths. Water is especially absorbing at 1400 nm, 1900 nm and above 2500 nm.



Applications

Providing academic and industrial solutions for 30+ years

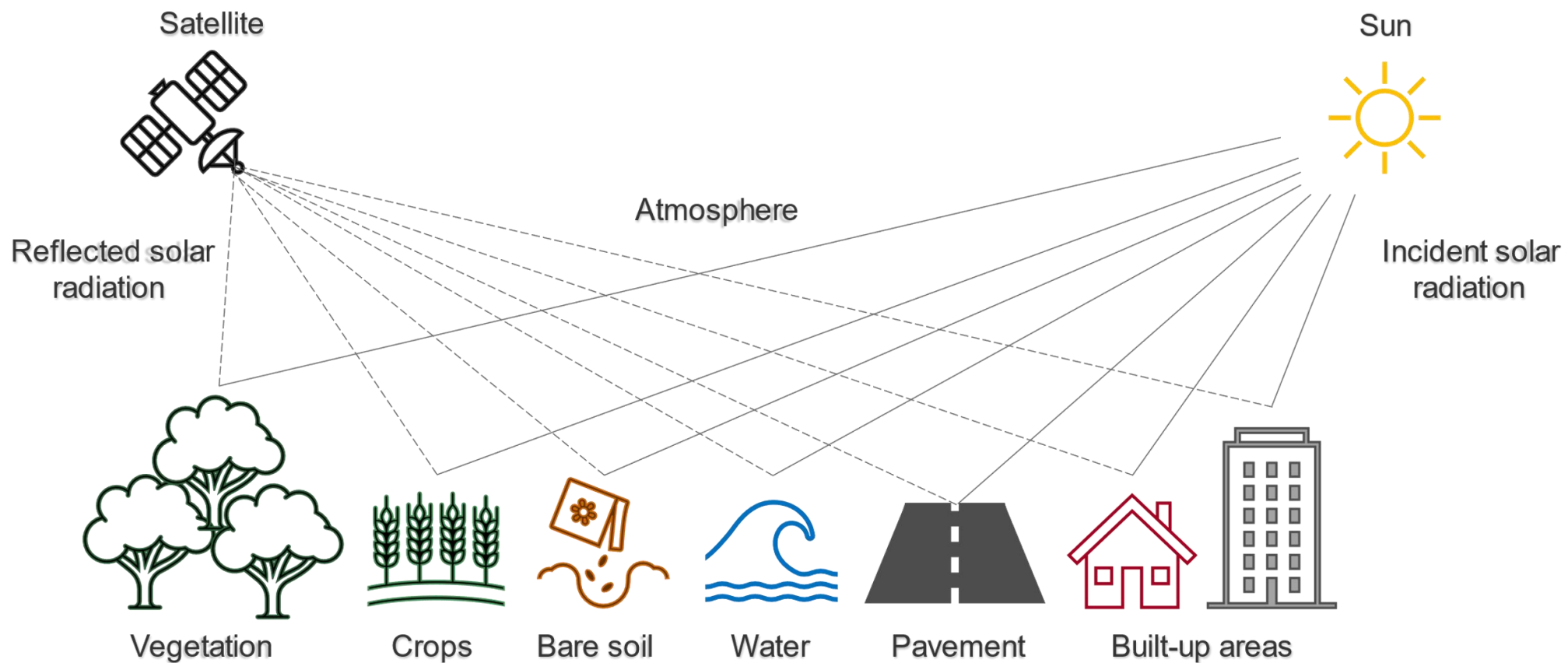


- Remote sensing (typically outside using natural light)
 - Imaging, environmental, forestry, agriculture (leaf, soil analysis)
 - Groundtruthing
- Mining / Geology (portable, handheld and at line)
 - Mining Exploration - Mineral identification
 - Mining Production - Quantification of moisture, alteration minerals, clays
 - Mine Reclamation – Re-vegetation, mine stabilization (clays)
- Material analysis (portable, handheld and in-process at line)
 - Specific component analysis of food, nutraceutical, or other material
 - Brix, pH, fat, protein, carbohydrates, moisture
 - Incoming raw material inspection, QA/QC
 - Art restoration, Archeology, Culture Heritage



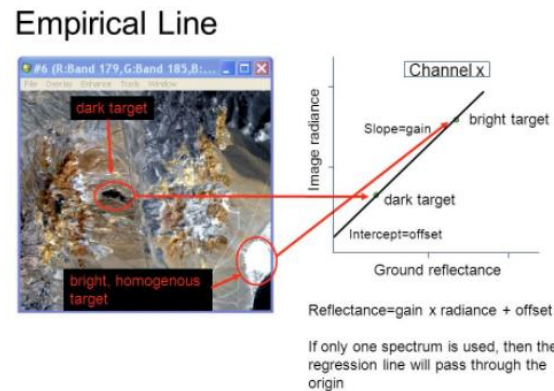
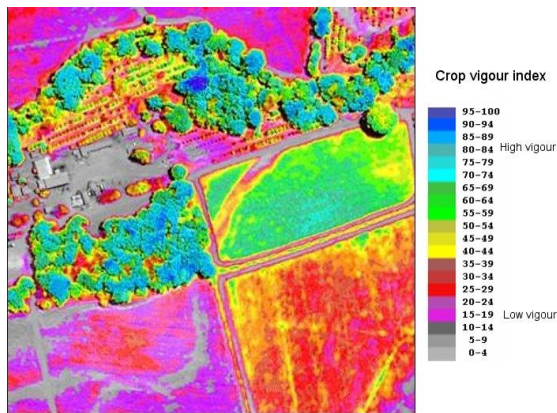
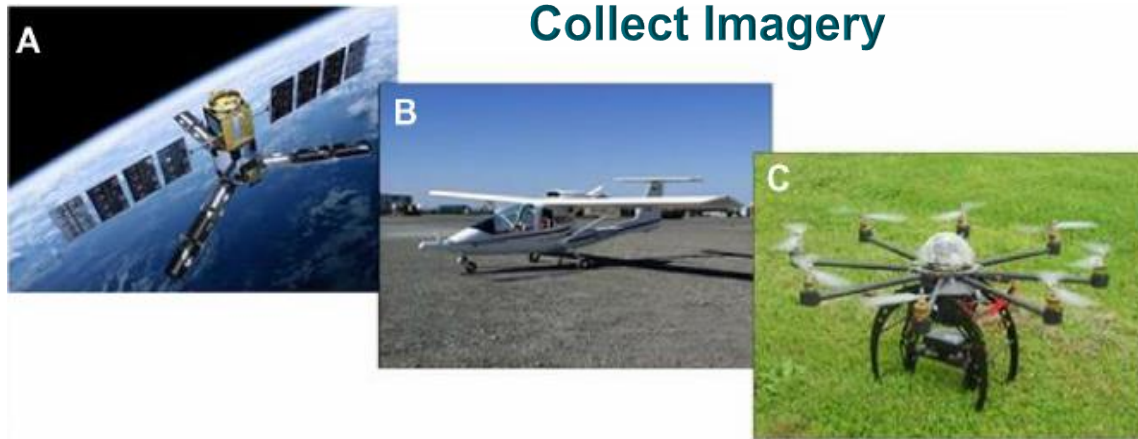
What is Remote Sensing?

“The science of obtaining and interpreting information from a distance, using sensors that are not in physical contact with the object being observed”



Remote Sensing Image Analysis Workflow

VIS-NIR Spectroscopy



Calibrate imagery with field spectra (normalize)

Remote Sensing Market Overview



- Groundtruthing of imaging sensors
 - Calibration
 - Feature characterization and identification
- Agriculture
 - Quantitative vegetation analysis (Total Nitrogen, pests, health)
 - Soil analysis
- Environmental Monitoring
 - Climate Change analysis
 - Snow/Ice studies
- Water Quality
 - Contamination of water column
 - Algae
 - Coral Reefs



ASD range

Spectrometers



FIELDSPEC 4

Field exploration, and remote sensing, but also atmospheric research

- Full range: 350-2500 nm
- Detectors:
 - VNIR: 512 element silicon array
 - SWIR 1 & 2: graded index InGaAs Photodiode, two stage TE cooled
- Spectral resolution: 3 nm @ 700 nm.
6 nm, 8nm & 10 nm @ 1400nm/2100 nm
- **Pre-installed permanent foreoptics cable**



TERRASPEC 4

Mineral and mining applications

- Full range: 350-2500 nm
- Detectors:
 - VNIR: 512 element silicon array
 - SWIR 1 & 2: graded index InGaAs Photodiode, two stage TE cooled
- Spectral resolution: 3 nm @ 700 nm.
6 nm & 10 nm @ 1400nm/2100 nm
- **Jumpered foreoptics cable**



LABSPEC 4

Lab-based studies

- Full range: 350-2500 nm
- Detectors:
 - VNIR: 512 element silicon array
 - SWIR 1 & 2: graded index InGaAs Photodiode, two stage TE cooled
- Spectral resolution: 3 nm @ 700 nm.
6 nm & 10 nm @ 1400nm/2100 nm
- **Optional integrated light source**
- **Jumpered foreoptics cable**
 - **bi-furcated probe accessories**

Accessories Overview

Facilitating field and laboratory measurements

ASD brand proprietary contact probes, fiberoptic jumper cables, in-air and underwater foreoptics, and integrating spheres. Allows for optimal flexibility and convenience in measurement approaches and field portable measurements.

