



AOTF-NIR Solutions



NEAR-INFRARED SPECTROSCOPY

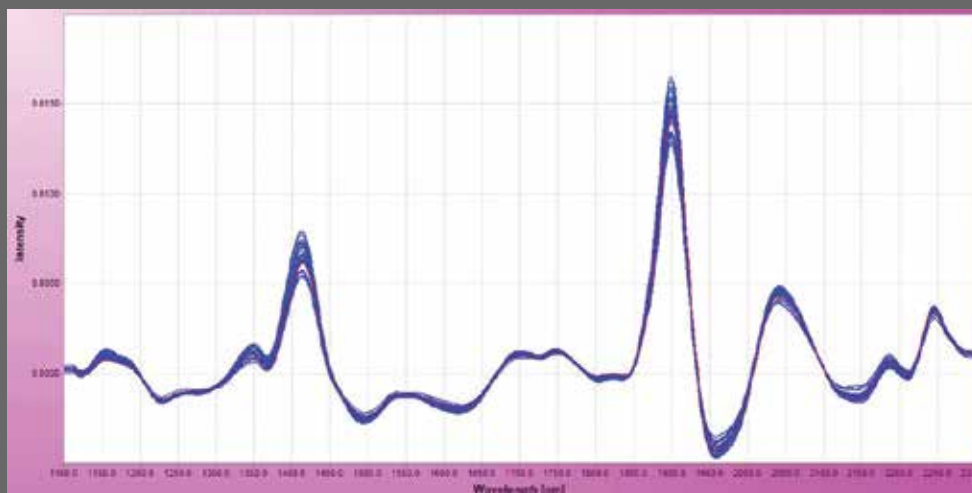
INTRODUCTION TO NIR

The near-infrared (NIR) region can be defined as the wavelength region from 700 to 2500 nm. It was discovered that different chemical bonds (like O-H, C-H, and N-H) vary in strength and energy with respect to their vibrations and can be seen in the spectrum as a series of absorptions at different wavelengths. Identifying these “peaks” at particular wavelengths provides the opportunity to measure the amount of a particular molecule that is present in the sample.

However, interpreting NIR spectra can be very difficult without the use of data processing and chemometric software.

THERE ARE TYPICALLY FOUR PHASES OF ANALYSIS

- 1. Data Collection** – sample spectra and measurements are taken with a chosen spectrometer and method (i.e. transmission, reflectance, transreflectance)
- 2. Data Processing** – includes signal processing to prepare the sample for chemometrics
- 3. Calibration** – chemometrics, which uses a variety of methods to build a “model” used for analysis
- 4. Prediction** – use of the chemometrics model to accurately predict an unknown sample

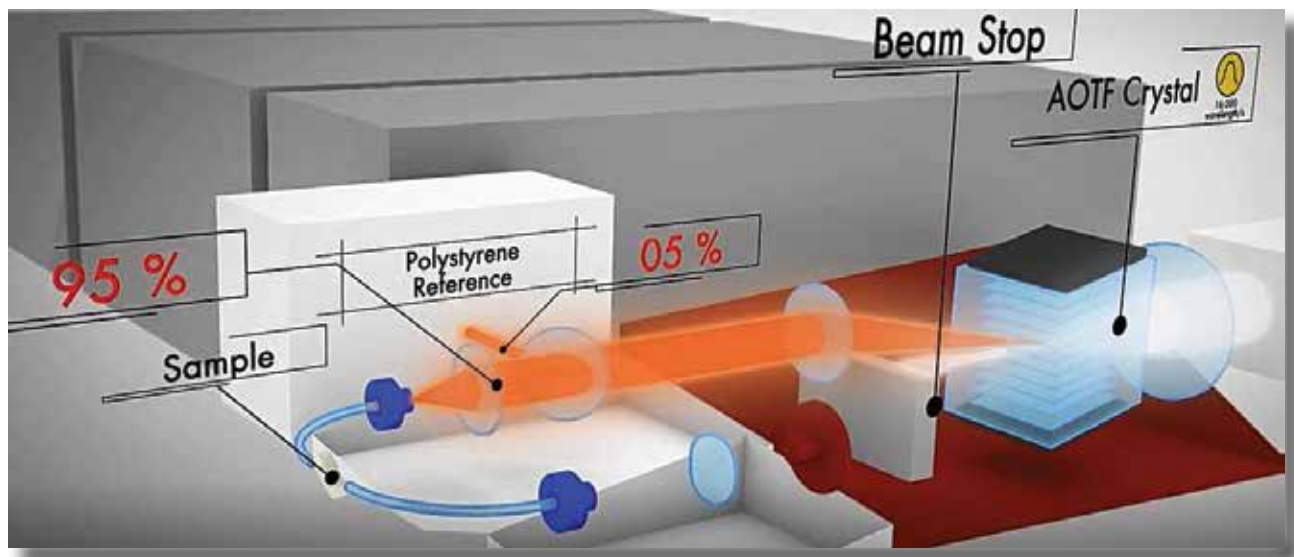


NIR Spectra of Moisture Peak

BRIMROSE AOTF-NIR

ROBUST — RELIABLE — ACCURATE

The Brimrose AOTF-NIR spectrometers use a Telerium-Dioxide (TeO_2) crystal in combination with an RF generator. A white light source (Tungsten) is supplied to the crystal. The RF generates acoustic waves that propagate through the crystal and allow the crystal to diffract one wavelength of light. Changing the frequency of the RF easily and quickly allows different wavelengths to pass very rapidly. The individual wavelengths are then split into 2 beams of light. The “reference” channel includes 5% of the light and is diverted to a polystyrene reference detector. The remainder of the light is the “sample” channel and passes to the sample and returns to an InGaAs detector. The reflected (or transmitted) light from the sample is divided by the reference to create a true spectrum for analysis that doesn’t require operator interaction.



AOTF-NIR Representation

ADVANTAGES OVER OTHER NIR TECHNIQUES

- **Solid State** – no moving parts, therefore it is immune to ambient vibration
- **Faster** – capable to scan up to 16,000 wavelengths per second, therefore can get up to 30 scans per second across the whole wavelength range (1100-2300 nm)
- **Sensitive** – higher resolution with excellent signal-to-noise ratio
- **Immune to Ambient Light** – no need to block ambient light from the sample
- **Real-Time Dual Beam Reference** – no drifting, excellent wavelength repeatability, no need to recalibrate the device

AOTF-NIR APPLICATIONS

PROCESS – LABORATORY – FIELD

NIR spectroscopy is a technique that has gained widespread acceptance as a powerful diagnostic tool, particularly for quality assurance and process analytical control (PAT) purposes in pharmaceutical, food/agricultural, and chemical industries.

NIR has been in use in the pharmaceutical industry even before the PAT initiative was introduced in the early 2000's. The initial use for NIR was for raw material identification to reduce the costs and time of laboratory testing. Since its early adoption in the mid 1980's for raw material identification, NIR use has expanded for in-line and at-line testing.

A VARIETY OF NIR PROCESS APPLICATIONS

Pharmaceutical

- Blending Uniformity
- Fluid Bed Drying
- Raw Materials Identification
- Tablet Analysis
- Lyophilization

Food/Agriculture

- Moisture
- Fats
- Proteins/Acids
- Ash
- Brix
- Volatile Oils

NIR
Process

Petrochemical

- Gas Analysis
- Gas Blending
- Moisture
- Feedstock
- Ethanol
- Biodiesel

Chemical/Polymer

- Catalyst Identification
- Solvent Recovery Monitoring
- Reaction Monitoring
- Paper/Pulp/Wood

MAIN INDUSTRIES

Pharmaceutical

Brimrose integrates non-destructive and Process Analytical Technology (PAT) to improve quality and safety. AOTF-NIR helps ensure the quality and integrity of pharmaceutical products for the public.



Food/Agriculture

Measure moisture levels simultaneously with other items such as fats, proteins, ash, and acids. Measure potency and determine the right time for harvesting. We want your customers to have the best ingredients, the best quality, and the best meal.



Chemical/Polymer

Accurately measure and analyze during powder drying, monitoring solvents production, density measurement in polyethylene powder, mechanical property monitoring, etc.



Petrochemical

AOTF-NIR spectrometers are excellent tools for measurement of fuel properties. Good results for gasoline, diesel, kerosene, and gas-oil as well as BTX components in fuels in vapor analyzers can be used in the refinery.



STANDARD AOTF-NIR SPECTROMETERS

IN-LINE / AT-LINE

Brimrose designs and builds ruggedized AOTF-NIR Spectrometers to meet customer individual needs and environmental constraints to improve production, quality, and consistency. We specialize in At-Line, In-Line, and Multi-Purpose near infrared spectrometers that are adaptable and flexible to meet your ever-changing needs.

LUMINAR 4030

The Brimrose Luminar 4030 AOTF-NIR Free Space Process Spectrometer is designed and built for in-line or at-line measurement in a production facility. The 4030 has a stainless-steel housing and can be configured for use in the following:

- **Free Space** – with the use of a mounting plate
- **Fiber-Optic** – uses a probe or flow cell mounted in-line



Tobacco Measurement



In-Line Food Processing

The free space configuration is mounted to a blender, pipe, or over a conveyor at a fixed distance from the product so that the transmitted light reflects back from the sample for optimal analysis. The fiber-optic configuration uses a fiber-optic cable to transmit the light from the spectrometer to a probe or flow cell that is mounted in position. The light returns through the fiber from the attachments for analysis. The length of the fiber-optic cable can be up to 300 m with almost no signal degradation.



STANDARD AOTF-NIR SPECTROMETERS

IN-LINE / AT-LINE

LUMINAR 7030

The Brimrose Luminar 7030 AOTF-NIR Free Space Spectrometer is designed for in-line measurement in a production facility. The spectrometer has two enclosures. One enclosure contains the optics and is placed at the location of the product being analyzed. The 2nd enclosure contains the electronics and is connected with a 1-meter cable. The small enclosures allow for in-line mounting of the spectrometer in small spaces where the Luminar 4030 model might not fit well. The performance is the same.

The design and implementation is indicative of the innovative thinking of Brimrose engineers when tasked to provide flexibility for multiple customer scenarios and challenges.

In addition to the original design, Brimrose has continuously used the 7030 platform to innovate solutions for companies that need the flexibility of a hand-held unit like the 5030 but also need more robust enclosures and cooling systems.



Blending Uniformity



Optical Module (left) and Electronic Controller Unit (right) with IP55 Water Tight - Dust Tight Enclosure

STANDARD AOTF-NIR SPECTROMETERS

IN-LINE / MULTI-PURPOSE



LUMINAR 5030

The Brimrose Luminar 5030 AOTF-NIR Spectrometer is our most flexible unit. The 5030 has an aluminum housing and can be used in the following ways:

- **Hand-Held**
- **Laboratory** – with the use of a lab stand
- **Mounted** – with the use of a mounting plate; when stainless steel not required

Designed with flexibility in mind, the Luminar 5030 has the widest range of customer applications including: Blending Uniformity, Fluid Bed Dryers, Material Identification, Peanut and Soybean Sorting, Hay and Alfalfa, Olives, Brix, etc.



Monitoring a Fluid Bed Dryer



Lab Stand - Alfalfa Measurement

STANDARD AOTF-NIR SPECTROMETERS

AT-LINE MEASUREMENT



Liquid Probe / Flow Cell Application

LUMINAR 3060

The Brimrose Luminar 3060 AOTF-NIR Multiplexer Spectrometer is designed for at-line measurement in a production facility with up to 16 active channels. Each channel is connected to a probe or flow cell with fiber-optic cable. A single spectrometer is multiplexed by rapidly switching the light source from each channel into the detector. All 16 channels can be sequentially analyzed in less than 1 minute.

The 3060 can be a cost-effective option when needing multiple test points and not wanting to purchase multiple 4030's (or another Brimrose AOTF-NIR model). Choosing between a 4030 and 3060 depends upon the number of test points required and the location of each test point due to the length of fiber-optics required to be run.

STANDARD AOTF-NIR SPECTROMETERS

STANDARD FEATURES/OPTIONS

STANDARD OPTIONS

Each Brimrose AOTF-NIR Spectrometer may have one or more of the following standard options:

- **Physical** – Battery-Ready, Lab Stand, Trigger, Mounting Plate, Communication
- **Software** – Snap32!, Chemometrics

CUSTOM OPTIONS

INSTALLATION

Enclosures	Nema 4X	Nema 12X	IP55	IP65	
Cooling	None	Fan-Cooled	Vortex-Cooled	Vortex Heat Exchanger	A/C Heat Exchanger
Power	12-Volt DC converted from 110-Volt AC, 60 Hz	12-Volt DC converted from 220-Volt AC, 50 Hz	24-Volt DC converted from 110-Volt AC, 60 Hz	24-Volt DC converted from 220-Volt AC, 50 Hz	Battery (optional)
Mounting	Tri-Clamp	Plate w/ Window	Plate w/o Window	Lab Stand	Wall Brackets

OPERATION

Communication	Modbus TCP/Serial	Fieldbus	Wireless Ethernet	OPC UA	I/O Capability, 4-20 mA Adapter
Triggering	Gravity Switch (common)		Proximity Switch		

OPTICS

Optics	Diffuse Reflectance	Transflection	Transmission	Working Distance/Spot Size options: (see chart below)	
Light Source	5-Watt	10-Watt	20-Watt	35-Watt	

CERTIFICATIONS

ATEX: Zone 0,1,2,20,21,22	UL: Class I Division I and II, Class II Division I and II
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WORKING DISTANCE / SPOT SIZE OPTIONS

Model	Minimum (Standard)	Maximum
4030	45 mm / 6 mm	65 mm / 10 mm
5030	40 mm / 6 mm	20 mm / 3 mm
7030	45 mm / 6 mm	65 mm / 10 mm

* Other custom distances and spot sizes can be configured.

CUSTOM-BUILT AOTF-NIR

BUILT FOR PURPOSE

Brimrose is capable to design and manufacture products that are solutions to problems that no other company wants to tackle. As a result, Brimrose has custom-built many different models of spectrometers that would meet the needs of individual applications of our customers.

LUMINAR 3076 SEEDMEISTER

The Brimrose Luminar 3076 SeedMeister AOTF-NIR Analyzer is a system specifically developed for non-destructive analyzing and sorting 100% of seeds.

- **Properties** – oil, protein, moisture, starch, oleic, linoleic, sugar, etc.
- **Major Hybrid Seeds** – corn, soybeans, coffee, watermelon, peanuts, sunflower and much more.

One of our customers was able to salvage an entire year's worth of seeds. The Seedmeister was used initially to help identify and sort watermelon seeds that would breed seedless watermelons. However, in one particular year, the customer was getting seeds where there were too many mixed lots and disease infected seeds. Product loss would have been catastrophic due to losses in customer sales and relationships. Nearly 3 million seeds were salvaged from being destroyed. Customer confidence was restored and even improved.



The SEEDMEISTER Mark IIIx



The latest Seedmeister has several modifications for the measurement of nuts and seeds of irregular shape and size. The Luminar 3076 Seedmeister Mark IIIx is the perfect turnkey solution for breeders who need consistent and accurate results when sorting. The Mark IIIx has proved very effective at measuring the oleic – linoleic ratio in peanuts so that breeders can grow healthier products.

CUSTOM-BUILT AOTF-NIR

BUILT FOR PURPOSE

LUMINAR 4020

The Luminar 4020 AOTF-NIR Thin-Film Analyzer was designed to measure multiple layers of thin films individually and to eliminate the need to measure thickness of substrate for accurate coating weight. Coating weight of adhesive and residual solvent are routinely measured with this high-speed on-line analyzer, which can either be mounted on a traveler and scan across the web or measures statically.



Thin Film Analyzer

LUMINAR 3070



Flour Measurement

When thinking of AOTF-NIR advantages, most typically think of in-line or at-line advantages. However, the Luminar 3070 Benchtop Analyzer also has advantages because it is an AOTF-NIR instrument, namely:

- **Dry Measurements** – reflectance with a rotating dish for powders and granules with almost zero preparation. Single tablets in reflectance are possible. Speed is 5 to 8 seconds per sample.
- **Liquid Measurements** – flow cell with pouring the sample into a funnel, allowing good representation of large sample volume, enabling less homogeneous liquids. Speed is 5 to 8 seconds per sample.
- **Transmission Arm with Detector** – for single tablets in transmission. Also, seeds in transmission.
- **Immunity to Ambient Light** – no need to shield the sample, making it easier to operate.

SOME CUSTOMER TESTIMONIALS

WHAT OUR CUSTOMERS SAY



"We've interfaced our first unit via PID loop to thermal bake technologies in an effort to optimize the moisture content of our product. Our application is a 'real-time iterative approach that not only optimizes the desired output, but has eliminated product rejections due to over and under drying.' Our pilot application has returned well over six figures in the first 8 months of continuous operation. We expect similar returns with the installation and commissioning of four additional units in like processes across the Americas Regions..."

-- Kerry Ingredient

"Ackley Machine Corporation integrates the Brimrose AOTF-NIR spectrometers to their VIP Laser Drill (trademark) to simplify osmotic drug delivery by verifying the integrity of a tablet's outer membrane prior to laser drilling and vision inspection. This precision laser pharmaceutical tablet drilling machine drills and inspects up to 60,000 products per hour and is a Class I Laser Product."

-- Ackley Machine Corporation



Photo courtesy of Ackley Machine Corp



*The Brimrose NIR Spectrometer wakes up to great views.
Where is your NIR located?*

Brimrose Goes to The Moon in Search of Water



The AOTF-NIR Spectrometer has been selected to be a part of several NASA missions to determine the nature of the Hydrogen it encounters, whether water (H₂O) or hydroxyl (OH). Both can be a useful resource for NASA in tasks, including making fuel for space exploration. Additionally, the custom-designed and built spectrometer will help identify different types of minerals and ices present - frozen carbon dioxide, ammonia, and methane.

This novel spectrometer was specifically designed with respect to the applications and chose for ruggedization and immunity to ambient light. The range of analysis spans from NIR to MIR, specifically 1300-4000nm. NASA selected the Brimrose AOTF-NIR as part of it's Lunar Payload Development Program, a subdivision of the Commercial Lunar Payload Services (CLPS) initiative and the Near Infrared Volatiles Spectrometer System (NIRVSS). So far, four missions have been selected to include the Brimrose AOTF-NIR Spectrometer on the payloads.

Path to Success

***Partnerships &
Operational Excellence***



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