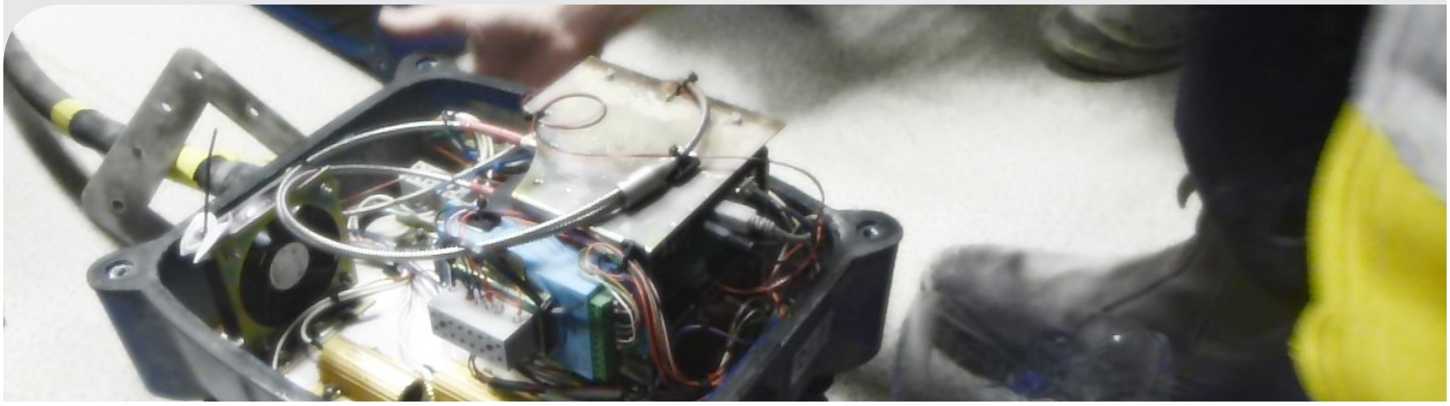


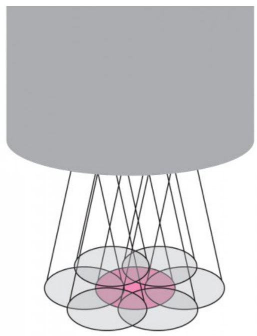
BLUE CUBE QUARTERLY.

2017 | Second Edition

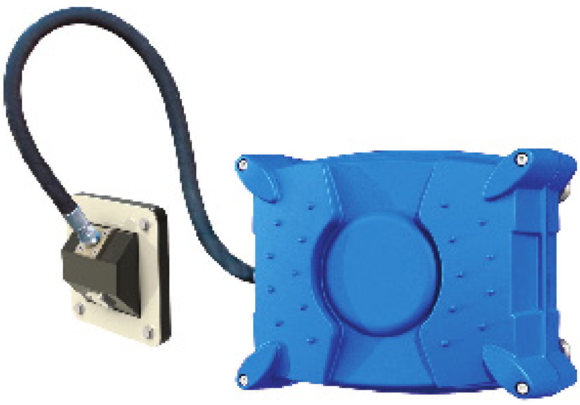
Reflection Probes

The operation of a Blue Cube analyser is based on diffuse reflectance spectroscopy (DRS). This entails that the passing slurry or dry stream is illuminated by a halogen light and the reflected light is interpreted by a spectrometer (see article on Spectrometer and spectra basics).

The optical components of the analyser are mounted in a blue IP67 casing covered with a stainless steel additional cover (see article on temperature control). This is called the optical processor and it is connected to the scan head, through a reflection probe that is housed in a robust hydraulic hose. Due to the hydraulic hose having a larger bend radius than that of the reflective probe, the latter is protected.



Source: Ocean Optics



The type of reflection probe used in the Blue Cube analyser collects light at the same angle as it illuminates and is made of six illumination fibers around a single read fiber. This results in a 25° full angle field of view. Each illumination fiber projects a cone of light from the source and then all of them overlap at the sample in the center from where it is seen by the fiber that observes the reflected light. The six illumination fibers are therefore connected to the light source inside the optical processor and the single fibre is connected to the spectrometer.

Cladding is also used around the fibers to prevent the emitted and reflected light from escaping. This is established through the cladding having a lower reflective index than the fibers which then causes a total internal reflection of the light.

BLUECUBE® measurement for control

Content by: Karen Keet | kk@bluecubesystems.com

Spectrometer and spectra basics

Contributions by Ruan Botma | rb@bluecubesystems.com

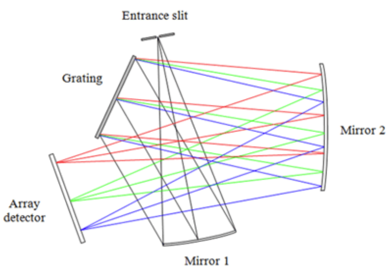
The Blue Cube analyser uses a spectrometer to split reflected light into its spectral components to measure differences in light intensity in real time. The analogue signal measured in the optical processor is digitised as a function of wavelength and interpreted by a computer located in the data processor.

This process entails that the reflected light is shone into the spectrometer via the reflection probe through a narrow aperture called the slit. The light is collimated (made parallel) by a first mirror and directed onto a diffraction grating. The grating then disperses the spectral components at slightly varying angles from where a second mirror then focuses the spectral components onto the detector.

The detector converts the photons into electrons. The result is then digitised using an analogue to digital converter. The computer then reads the digital value. The software interpolates the signal based on the number of pixels in the detector. At this point the data can be plotted as a function of wavelength and can be used in many different ways.

Blue Cube Systems uses a range of different spectrometers for specific applications. For the typical Blue Cube analyser a spectrometer is used that is compatible with detection within the visible and near-infrared (VIS-NIR) wavelength range.

It should be noted that within this wavelength range identification of minerals and elements are not done and libraries are not used. In the infra-red (IR) range, spectra share information on fundamental molecular vibrations but in the NIR range, only the overtones and combinations of IR can be detected. The digitised spectra is therefore regularly calibrated against samples with known analysis using multivariate calibration models.

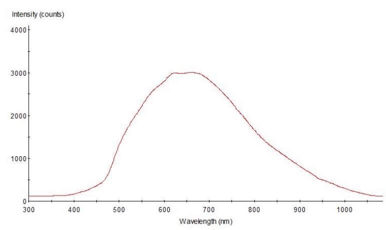


Light dispersion

Source: Ocean Optics

Typical spectrometer

Source: Ocean Optics



Digitized Spectrum

Temperature control

The optical processor is controlled at a set temperature of approximately 55 degrees Celsius. The reason why temperature control is important is because the spectrometer relies on a temperature stable environment for reliable measurement.

As Ocean Optics explains, ambient temperature change is a potential source of wavelength and baseline drift, peak distortion and change in detector sensitivity. All these factors can have an effect on the accuracy of the measurements if the ambient temperature in the optical processor, where the spectrometer is located, is not controlled.

Three resistors inside the optical processor

>> continue on page 3

>> continue from page 2

The Blue Cube analyser controls the temperature inside the optical processor using three resistors which increases the inside temperature when switched on.

The actual temperature is not measured inside the optical processor but the spectrometer offset is used as it has an almost linear relationship to temperature. During the manufacturing process a calibration curve is set up to define the relationship between spectrometer offset and temperature. The offset of the spectrometer which correlates with approximately 55 degrees Celsius is then determined and used thereafter as the set point in the configuration of a particular Blue Cube analyser.

Blue Cube optical processor temperature cover

The reason why specifically 55 degrees Celsius is used as a set point is because it is generally believed to be higher than the hottest summer anywhere in the world (as the control mechanism is only to heat up, not to cool down) but low enough not to cause significant damage to the electronic components inside the optical processor.

A stainless steel box (also referred to as the 'temperature box') is mounted over the optical processor to prevent direct wind or sunlight from affecting the temperature control.

Analyser maintenance

Bulb replacement simplified

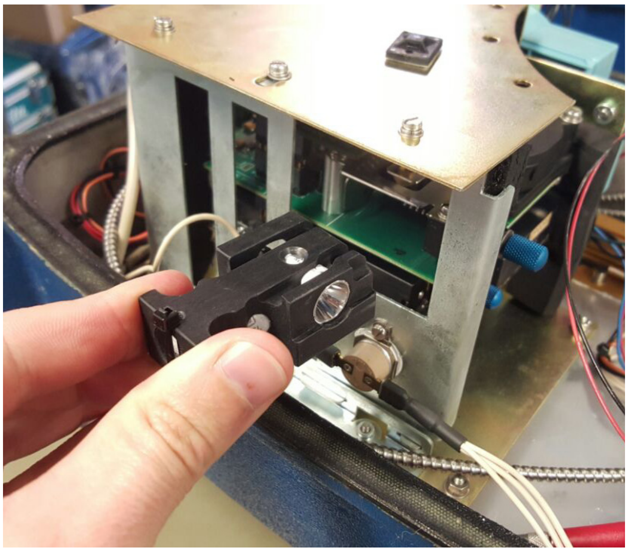
Blue Cube Systems has recently introduced a new configuration of the original halogen bulb used in the optical processor.

The initial procedure is still the same where the optical processor (with hydraulic hose and scan head) is removed from the process and taken to a dust free and dry workshop. Once the optical processor has been opened, the replacement of the bulb is now a lot easier.

The original halogen bulb is now mounted in an enclosure (referred to as a 'saddle') which can be inserted and removed in a similar way as one would replace the ink cartridges of your home printer.

This functionality is available on all new Blue Cube analysers. If you have an older model on site, the light board will also need to be replaced before the new saddle type of bulbs can be used.

The power supply to the halogen bulbs in the past has been fixed at 5V. With the new light boards, it is possible to adjust the power supplied to the bulb through a software configuration setting. With the new bulbs the optimal voltage supply has been found to be around 95% of its maximum. Theoretically



the lifetime of the bulb would be longer when run at a lower voltage, but there is a minimum voltage required which is determined by the halogen cycle. At a lower voltage the bulb temperature can become too low for the halogen cycle to be sustained.

When the bulbs are assembled into the saddles, a small permeable bag of silica gel is also included. This bag is similar to the ones found with capsules in small plastic medicine containers. The purpose is to absorb excess moisture.

BLUE CANVAS

Kazakahkstan

Phanus Bekker from the Blue Cube Support team visited Altay Terekty in Kazahkstan. Here with him on the photo left is Vassiliy Olishevets (KPA), Ulan Anuarbek (KPA) and Alexander Borisov (Altay). Below Phanus is with Elena Slavitskaya (Metso) and in the photo on the right is Dastan Kurmanalin (KPA).

Chile

Albertus Heydenrych represented Blue Cube Systems at the Exponor exhibition in Antafogasta, Chile. On the photo below is Rafaela Dellarossa who is the agent for Blue Cube products in Chile, together with Mia Gous from BHPBilliton.

Australia

Karen Keet attended the 8th World Conference on Sampling and Blending (WCSB8) in Perth. On the right is Abel Arkenhout and Francis Pitard. Below is Karen with Stepan Orlov, Adrian Paine and Daniel van der Spuy from Process IQ, distributors of Blue Cube products in Australia.

BLUE CANVAS

Zambia

Karen Keet visited the Kansanshi and Kalumbila teams in Zambia. The Kalumbila team on the left is Daniel Fernandez Segovia and Clare Malama, both from Metallurgy. The Kansanshi team from top right is Cobus Venter (Instrumentation) and bottom right is Wakunoli Munalula (Process Control) and Kankung'a Kankinza (Metallurgy).

West Coast

Commissioning engineer Ruan Botma recently installed Blue Cube analysers on eight process streams at Elandsfontein Phosphate Mine on the West Coast of South Africa. On this photo is Jonathan Munnik in front of one of the Blue Cube analysers.

Limpopo

Site metallurgist Mosima Mathibe spent some time with Jafta Mashele and his team at Thorncliff Mine to provide training on the Blue Cube calibration procedure.

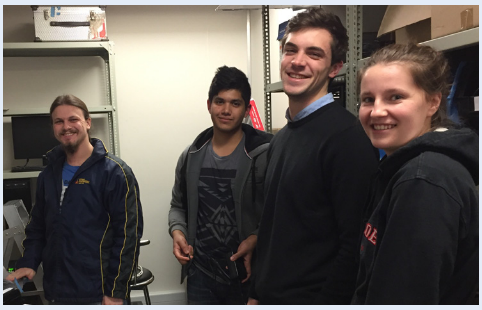
AT THE OFFICE

Warm welcome

Two new faces at the Blue Cube office are Stuart Cullum who is responsible for technical sales and Liza du Plessis who joined the calibration team.

Goodbye

We are saying goodbye to Lize Cillié who was part of the calibration team for almost three years. She will be pursuing further studies.



Blue Cube Systems recently had a few students at the office for vacation work. From left to right is Albert Nothnagel, Zhunaid Mohamed, Luke van der Stokker and Michele Louw.