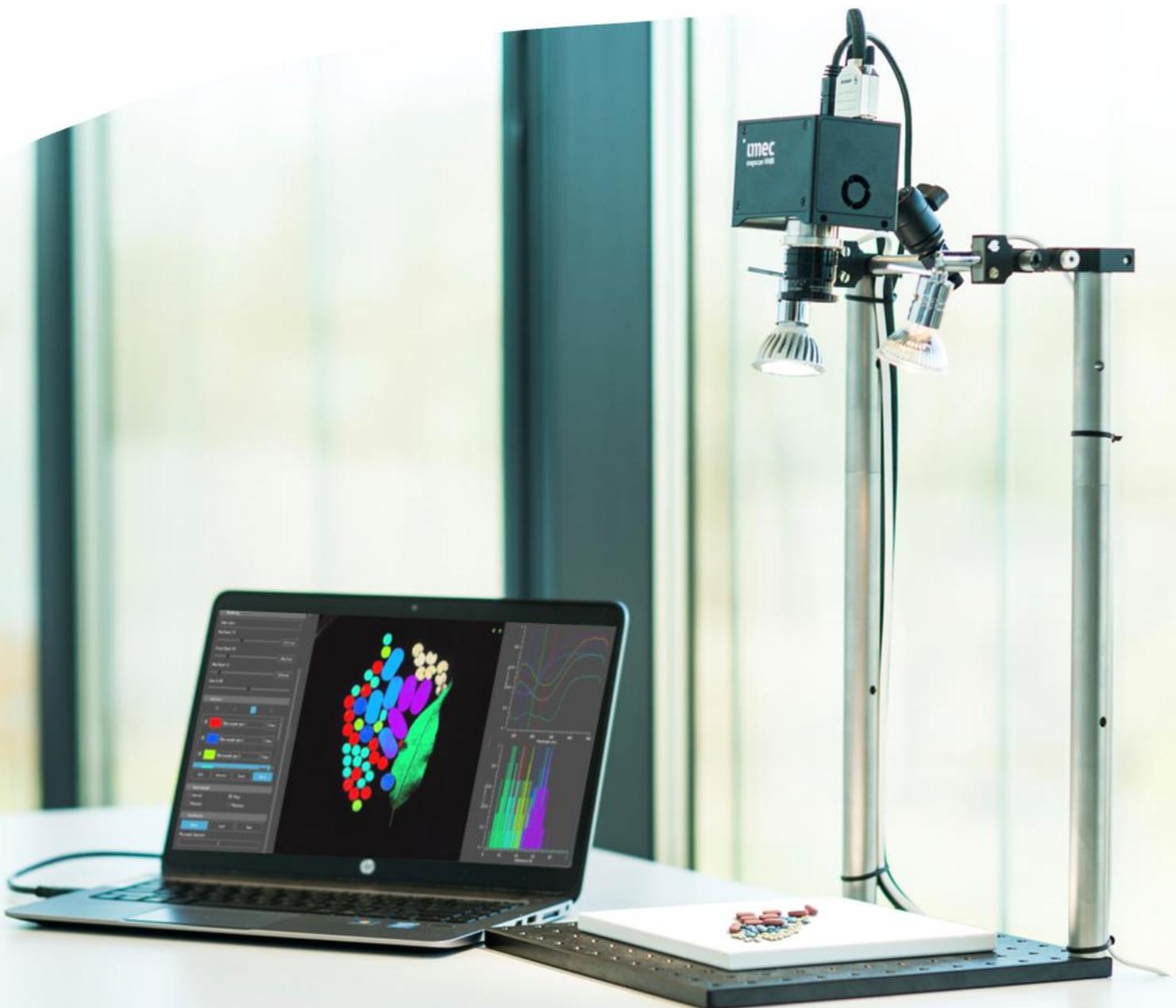




SNAPSCAN VNIR

HYPERSPECTRAL IMAGING CAMERA

SYSTEM USER MANUAL



Snapscan VNIR range Hyperspectral Imaging Camera System User Manual

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Chapter I

Introduction

I. Introduction

Congratulations on your purchase of imec's snapscan evaluation system. Imec's snapscan system is a major breakthrough for hyperspectral imaging application research. Within as little as a few hundreds of milliseconds, high quality hypercube data-sets can be created with unmatched signal-to-noise ratio and spatial and spectral resolution. The snapscan demo-kit enables application research of the highest quality, while still being user-friendly. It integrates all key components required: the spectral image sensor, camera, optics, piezo scanning, active cooling system, lighting, tripod mounts, and snapscan software (an advanced hyperspectral imaging software developed by the imec team).

The key benefits of Imec's snapscan hyperspectral imaging system are:

- Snapshot acquisition made easy and user-friendly with integrated ultrasonic scanning mechanism directly inside the camera to reach sub-second acquisition times
- Highest spatial (up to 7Mpx) & spectral (150+bands) resolutions possible for snapshot-based hyperspectral imaging in a compact, lightweight and mass-manufacturable design
- Highest SNR ever reached with imec on-chip filter technology thanks to active cooling and advanced software features for cube reconstruction and spectral correction



The contents of the snapscan evaluation system are shown in Table 2 and the product specifications are shown in Table 3. Each camera unit is assigned a unique serial number, as shown in Figure 14. The description of the serial number is given in Table 5.





Serial number for camera units

Table I Description of the serial number

Description	Values
Model identifier	B: model B
Sensor Identifier	150: Hyperspectral VNIR sensor (470-920nm)
Translation stage identifier	U: Ultrasonic stage
Device number	4 digit serial number starting from 0001

Each controller is assigned a unique controller box and its label is in the form as shown in Figure 15 Back side of the control box with serial number.





Back side of the control box with serial number.

Description	Values
Model identifier	921-0005-01
Device number	4 digit serial number starting from 0001



Table 2 Contents of the snapscan evaluation system

snapscan camera system	<ul style="list-style-type: none"> ▪ snapscan camera with integrated sensor (Type B150U) ▪ controller box (Type 912-0005-01) ▪ USB3.0 cable, custom 16 pin cable and power supply ▪ case for storage ▪ Optional: Schneider Kreuznach lens
Components for illumination setup	<ul style="list-style-type: none"> ▪ mounting setup with vibration dampening ▪ halogen lighting solution with diffusers ▪ tunable stabilized DC power supply
Targets for calibration	<ul style="list-style-type: none"> ▪ reflectance tile 95%, 200 x 200 mm ▪ color checkerboard card

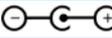
Table 3 Product specifications of the snapscan system (B150U / 912-0005-01)

Spatial resolution	up to 3650 x 2048 pixels (7Mpx RAW per band)
Spectral resolution	100+ bands (NIR version), 150+ bands (VNIR version)
Spectral range	600-970nm (NIR version), 470-900nm (VNIR version)
FWHM	~10-15nm (collimated)
Acquisition speed	~200ms – 20 seconds, depending on acquisition parameters, lighting and object (without including pre- and post-processing time)
SNR	>100-200, flat SNR over spectral range
Software scanning modes	Software TDI (x5-8 stages max) Multi-exposure HDR (high dynamic range) Digital binning (2x2, 3x3, 4x4) Spectral Region of Interest (1 to 8 regions maximum) Spatial Region of Interest (2048 x custom scanning length)
Dynamic range	8/10 bit
Optics	Schneider Kreuznach Apo-Xenoplan lens, f2.0, C-mount Focal length options: 20/24/35/50 mm lenses
Smile & keystone	Software corrected
Interface	USB3.0 + GPIO + I/O for triggering
Cooling	Passive & active cooling (fan based + TEC)
Cooling range (sensor)	35 - 45°C
Temperature	10 - 40°C (operation), 20 - 40°C (non operational)
Mechanical	Integrated mechanical shutter for automatic dark counts, Tripod mount (1/4"-20) + side mounting M5 holes + M6 mounting holes
Dimensions (WxDxH)	10x7x8 cm (camera), 13x10.7x4.7 cm (external controller)
Dimensions (integrated rejection filter)	Diameter - 25.4mm, Maximum thickness - 3.44mm
Weight (in grams)	642g (camera without optics), 715g (camera with supplied optics), 545g (external controller)
Input voltage	24VDC 4A (external controller) 24VDC 2,2A / 5VDC 0,5A USB (camera)



Housing	Fireproof by Fire Enclosure
Environmental	Maximum relative humidity 60 % for temperatures up to 31 °C decreasing linearly to 50 % relative humidity at 40 °C, non condensing, Pollution degree 2.

Table 3 Product specification external power supply (XP Power VET36US240C2-JA)

Input voltage	100~240 Vac 50/60Hz 0,8A
Output voltage	24VDC +/-5% 1,5A
Output connector	 2,5/5,5mm center positive
Protection class	Class II
Power cable	1,830 mm ±50



General warning



CE marking*



Do not waste (WEEE logo)



Caution, possibility of electric shock

* Only cameras of product version 2.0 and higher delivered to customer after 2022-05-02 are compliant to the CE-certification.

1.1.1 WARNINGS

- Read carefully this manual before the installation.
- An unqualified person must not proceed to any intervention on the electrical installation.
- Refer to the manual's Intervention Instruction section for the installation.
- Under no circumstances should the unit be opened or repaired. In case of any problem, contact imec technical support.
- Should the equipment be used in other manners than those specified, protection could be impaired.
-  Internal components use high voltage. Do not open the unit!
- Power to the sensor is not cut when the power switch is off. The sensor is powered directly by USB.
- Do not use liquids to clean the unit. Only clean using a dry cloth.

1.1.2 Delivery content

The camera is delivered with these components:

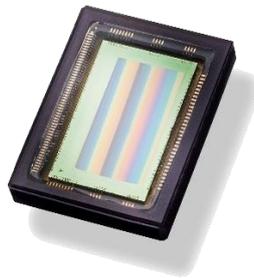


- Camera B150U
- Controller 912-0005-01
- Hirose cable
- USB 2.0 cable
- USB 3.0 cable
- External power supply XP Power VET36US240C2-JA
- Optional:
 - 2mm allen wrench key
 - 1.3" 35mm lens (APO- Xenoplan 2.0/35)

This manual will help you get started and guide you through system assembly and the usage of hardware. We begin by giving you a quick overview of salient features of the snapscan image sensor, camera system and software.

1.2 snapscan HSI sensor features

1.2.1 High resolution and fast sensor with 150+ spectral filters between 470-900nm



snapscan camera integrates linescan HSI sensor based on CMOSIS CMV2000¹ image sensor. The key specifications of this HSI sensor are shown in the table below.

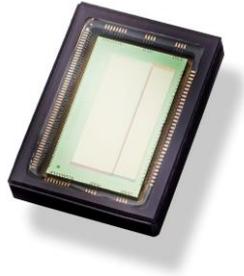
Spatial resolution – sensor	1088 (H) x 2048 (V) pixels
Spectral range	470-900nm
Spectral resolution	150+ bands
Spatial resolution per band	up to 3650 (H) x 2048 (V) pixels (up to 7Mpx RAW per band)
Sensor frame rate	up to 340 fps (full sensor frame)

¹ <https://ams.com/cm2000>



Bit depth	8/10 bit
FWHM	~10-15nm (collimated)

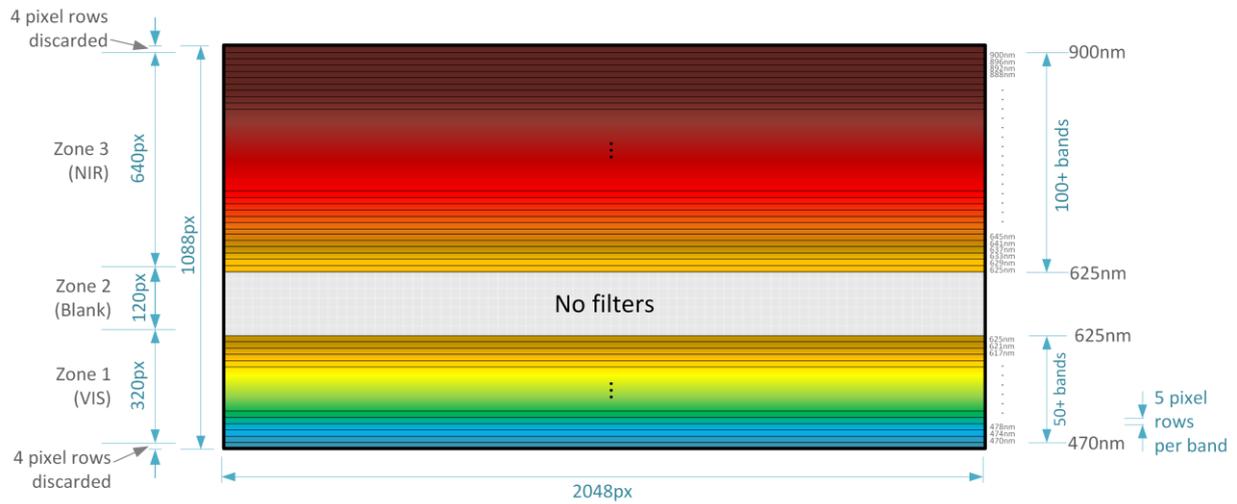
1.2.2 Integrated cut-off filters



The cut-off filters are integrated on the sensor directly which simplifies the usage of the camera.



1.2.3 Stepped filter layout (VNIR)



The pixel array of the VNIR HSI sensor is divided into following 3 zones:

Zone 1 (VIS)	Pixels with spectral filters between 470-625nm
Zone 2 (Blank)	Pixels in this zone do not have any filters. This zone is provided to allow tolerance in the alignment of cut-off filters for the VIS and NIR zones. Pixels in this zone are discarded in the final hyperspectral data cube reconstruction.
Zone 3 (NIR)	Pixels with spectral filters between 625-900nm

Physically there are more than 150 spectral bands on the HSI sensor. However, due to manufacturing variations, several spectral bands on the lower and upper ends of the zones can be unusable. Thus, we guarantee at least 150 usable spectral bands between 470-900nm. There can be few extra spectral bands available which can vary across the HSI sensors.

i Central wavelengths (CWL) indicated in the figure above are for illustration purpose only. The actual CWL of spectral bands are determined based on individual sensor calibration. This information is provided in the sensor calibration file provided with the camera.

Specifications for a spectral band in the VIS and NIR zones are as follows:

Spatial resolution	5(H) × 2048(W) pixels
Layout	Filters are arranged adjacent to each other in increasing order of their central wavelength

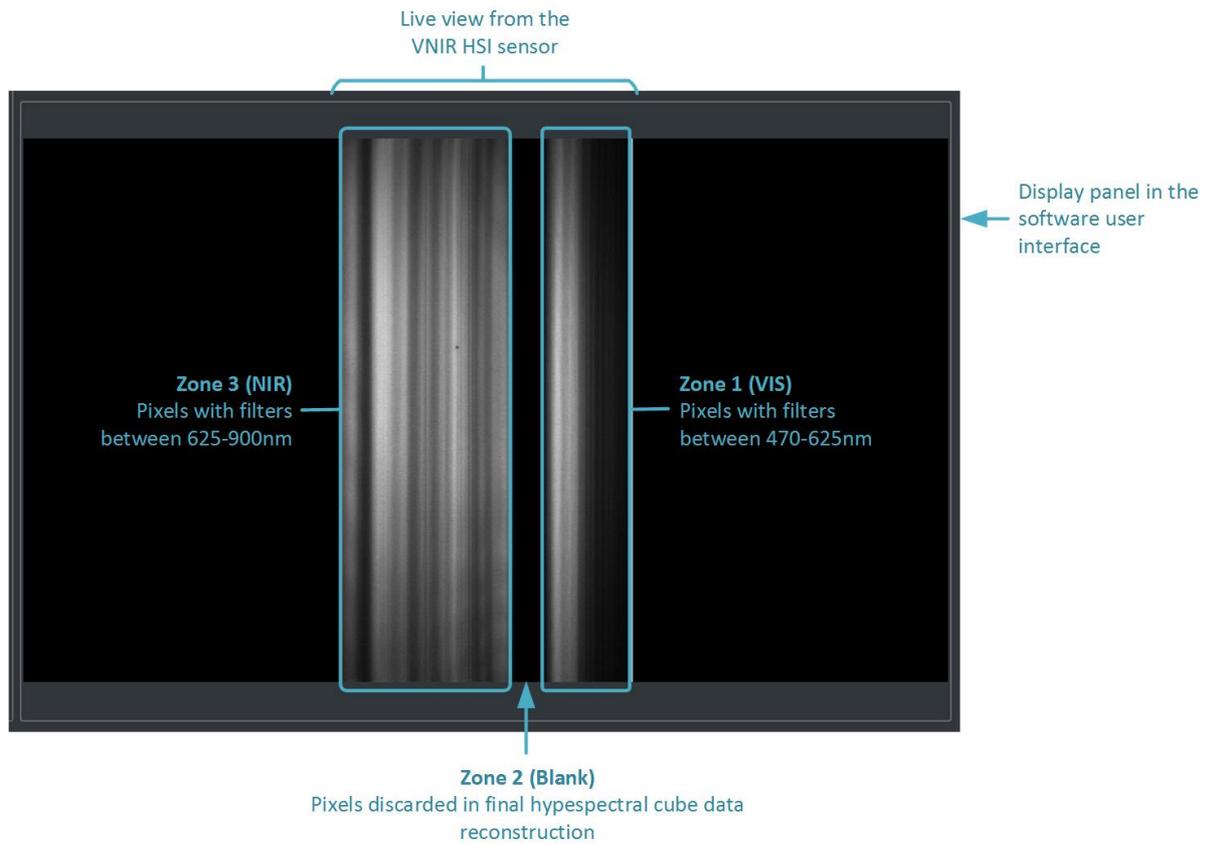
Thus, each spectral band is 5 pixel-rows high. We refer to it as the “stepped” filter design which provides the flexibility to select the step size (in terms of pixel rows) for the translation of the HSI sensor inside the camera body (see Section 1.3).

- Step sizes between 1 and 5 (height of a spectral band) can be selected
- Larger step sizes enable faster image acquisition whereas smaller step sizes can be used to improve the data quality.

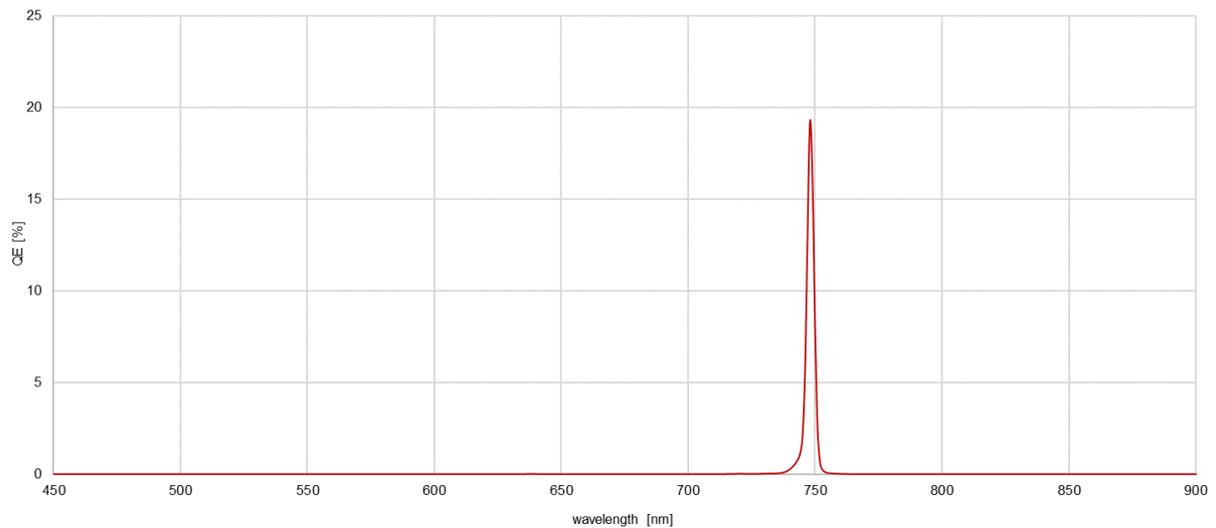
i See Section 2.2.4 “Acquisition features for higher data quality” for explanation on features such as cross talk removal by pixel row skipping and software time delay integration



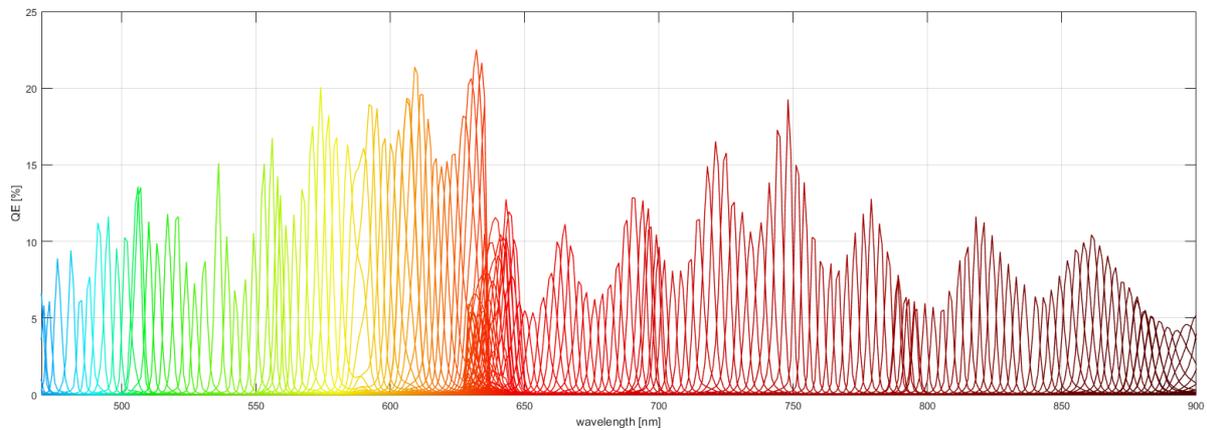
The live view from the VNIR HSI sensor is shown in the figure below. The three zones can be seen in the live view.



1.2.4 Narrow band spectral filters



Each of the 150+ spectral filter is a narrow band filter with FWHM between 2-10nm. The figure above shows the spectral response of a filter with central wavelength at 748nm and FWHM of 4.9nm. The figure below shows spectral response for all the filters.



1.3 snapscan camera unit features

1.3.1 Sensors and on-board electronics are housed in sealed dustproof chamber

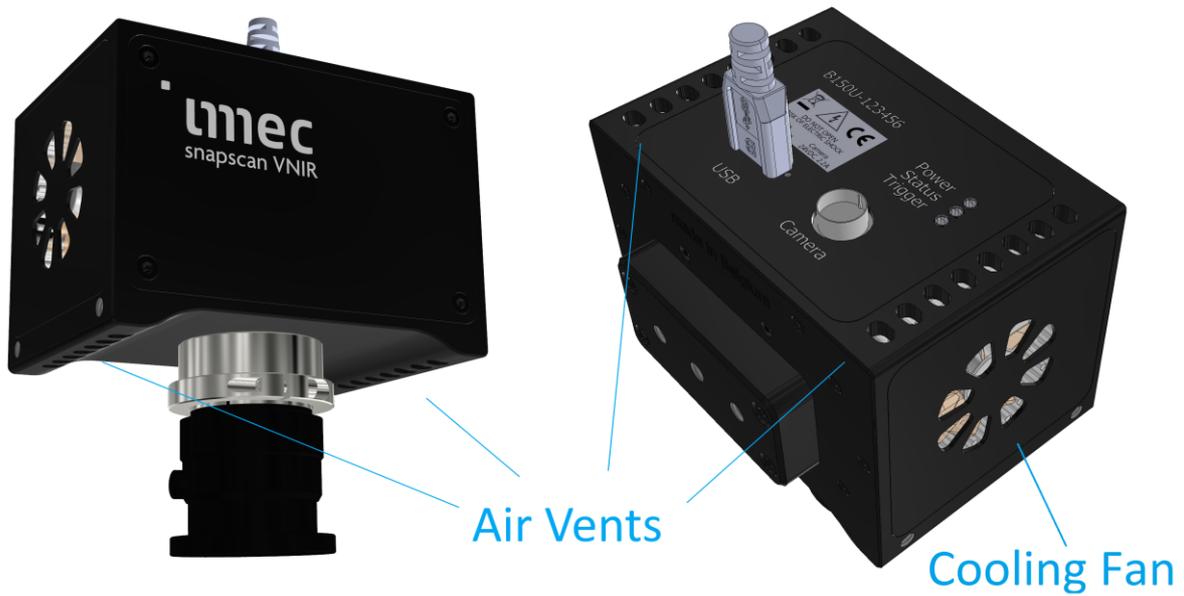


The image sensor and all the on-board electronics in the snapscan camera is housed in a sealed chamber making it dustproof. The air through the air vents on the left and right sides of the camera body does not enter the chamber.

i Currently not IP rated. Camera internals are sealed from exterior when lens is mounted.



I.3.2 Onboard cooling maintains operating temperature between 35°C to 45°C

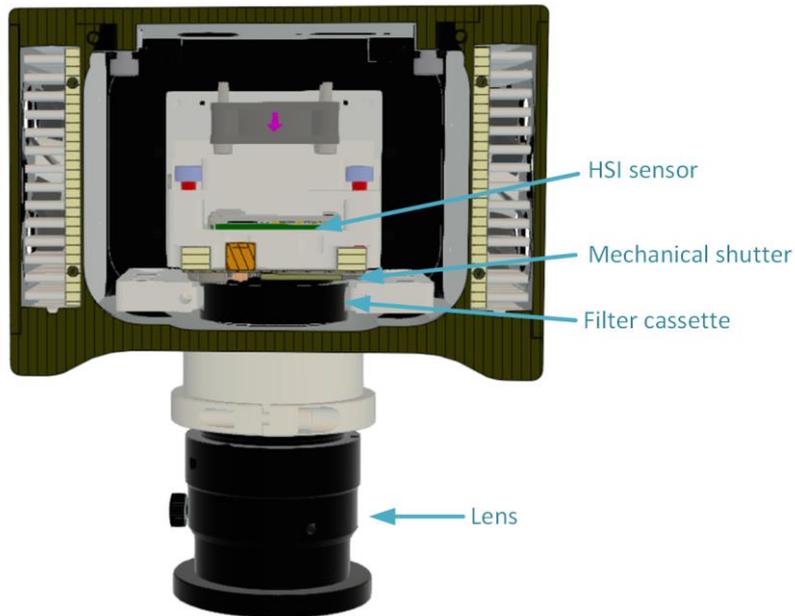


Snapscan integrates 3 cooling fans, 3 heat sinks and a thermoelectric cooler (TEC). There is a set of cooling fan and a heat sink on both the left and the right sides of the camera. The third cooling fan and the heat sink, and the TEC is directly behind the HSI sensor inside the chamber housing the HSI sensor, integrated translation stage and on-board electronics.

The TEC, heat sink and the cooling fan helps in cooling the HSI sensor board and evacuate the heat from the camera chamber. In future, software control of TEC will be enabled which will help in better local cooling of the hotspots of the HSI sensor board. The heat sinks and the cooling fans on the sides help in evacuating the heat from the camera body by generating an air flow as shown in the figure below.

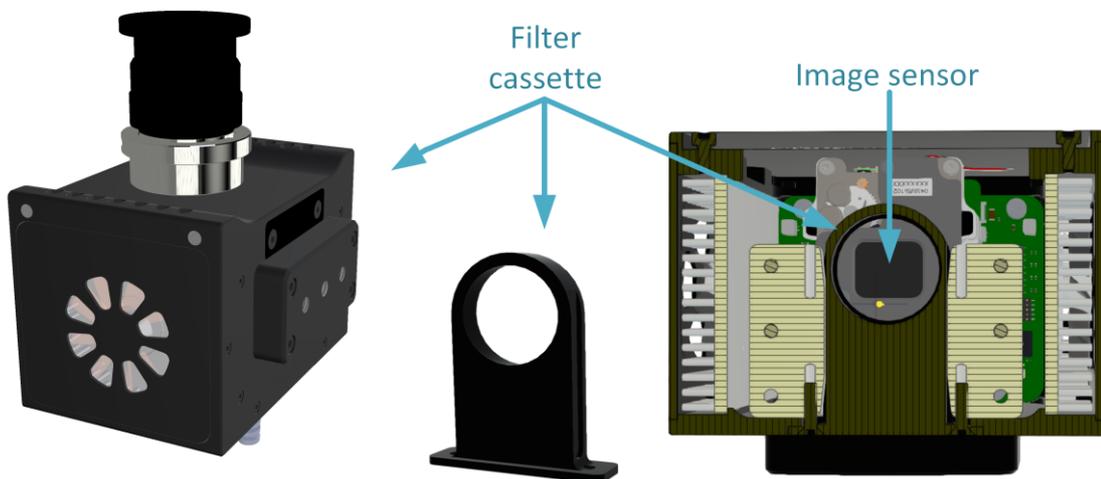


1.3.3 Integrated software controlled mechanical shutter



Snapscan integrates a software controlled mechanical shutter which is placed in front of the HSI sensor. The shutter is closed to obtain dark images to automatically calculate the dark counts in the software during image acquisition.

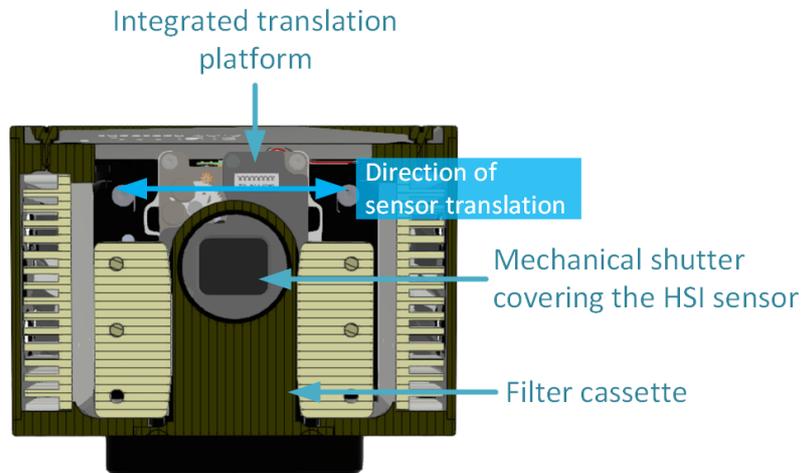
1.3.4 Flexibility to select specific spectral range using inter-changeable filters



Snapscan has a built-in filter cassette. Users can select specific spectral ranges by inserting suitable filters in this cassette. The filter is placed between the lens and the image sensor when the cassette is inserted into the camera body.

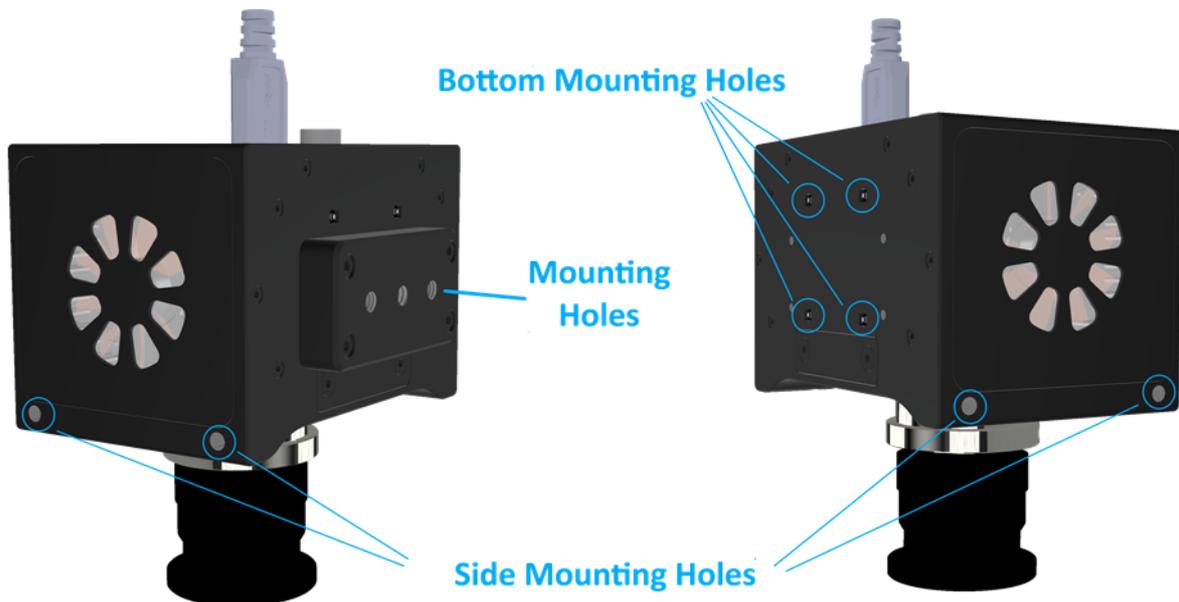


1.3.5 High resolution (spatial and spectral) data acquisition while keeping both the object and the camera stationary



Snapscan integrates a linescan hyperspectral image sensor which enables acquisition of high resolution (spatial and spectral) data. This sensor is mounted on a translation platform which is integrated inside the camera body. As a result, the camera and the object can remain stationary, as the sensor translates internally during the data acquisition.

1.3.6 Multiple mounting options



Snapscan camera provides multiple options for mounting the camera in a setup:

- Tripod adapter plate with mounting holes. It has two M6 holes and a 1/4 20UNC. The adapter plate is affixed by default but can be removed.
- Mounting holes on the bottom (need to remove the tripod adapter plate to expose them)
- M5 mounting holes on the sides.



1.4 HSI snapscan software features

HSI snapscan GUI software enables acquisition and display of hyperspectral image data. The software offers user the flexibility to configure a wide range of acquisition parameters to tailor the data acquisition as per their needs and help them acquire good quality data. It also provides several useful visualization tools and a built-in classifier to quickly visualize and analyze the acquired data. The software also offers integration with 3rd party hyperspectral analysis software, such as [perClass Mira](#), for more advanced analysis. It also allows the acquired data to be exported to standard ENVI format so that users can use their own analysis flow on the acquired data.

1.4.1 Extensive data acquisition customization features

HSI snapscan software provides a wide range of parameters to configure the snapscan system and customize the data acquisition.

Parameters	Description
Bit Depth	The sensor bit depth can be set to 8 or 10.
Cube dimensions	The number of rows and columns in the output data can be specified so that the size of the output file and data acquisition throughput can be customized.
Spatial binning	Pixels within a NxN neighborhood are merged by averaging. snapscan software allows following binning options - 1x1, 2x2, 3x3 up to 20x20.
Spectral bands selection	By default, data is acquired for all the spectral bands supported by the HSI sensor. Users can select up to 8 sets of bands to selectively skip the remaining bands while acquiring the data.
Selectively discard pixels	Pixel row at the edge of every spectral band can be discarded. This helps in reducing the impact of crosstalk across the spectral bands.
Software TDI	Time Delay Integration (TDI) can be enabled during data acquisition to achieve higher throughput and/or higher data quality. snapscan allows user to configure the number of TDI stages.
Multiple file output modes	Output data can be assembled in a cube and stored in a single file, or the individual bands are stored in separate files.

1.4.2 Built-in white balancing

HSI snapscan software can carry out white-balancing as a post-processing step on the acquired hyperspectral data. Users are required to scan the object and a white reference target. HSI snapscan automatically acquires the dark reference image using the built-in mechanical shutter and can carry out the white balancing.

1.4.3 Multiple file format options for data export options

HSI snapscan software enables user to export the acquired hyperspectral data in the following file formats – ENVI, PNG, PGM and TIFF.

In cases of PNG, PGM and TIFF file formats, each spectral band is saved as a separate image file. In each case, detailed metadata of the acquisition parameters is saved along with the exported file.



I.4.4 Integrated classifier

HSI snapscan software allows user to quickly analyze the acquired data using the integrated Spectral Angle Mapper based classifier.

I.4.5 Support for 3rd party HSI analysis software

HSI snapscan software currently provides user to obtain 14-day trial license for industry leading HSI analysis software [perClass MIRA](#).

I.4.6 Multiple data visualization options

HSI snapscan software provides following options for visualization of the acquired data

- Individual frame corresponding to a specific spectral band can be viewed
- Frames for all the spectral bands can be quickly stepped through and viewed
- A false color RGB image can be rendered and the users can adjust the bands selected for red, green and blue color channels. The software also provides “Color Match” feature which automatically renders a true color RGB image using information from multiple bands for the red, green and blue color channels.
- Spectral profile of one or more selected regions on the acquired data can be viewed using the integrated Spectrograph toolbox. The toolbox can be customized to display mean, minimum and maximum spectra for each selection.

I.4.7 Support for multiple languages

HSI snapscan software currently supports English, Chinese and Japanese. More languages can be supported in future based on customer requests.

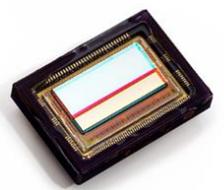
I.5 snapscan API features

Snapscan APIs are available in C and Python for data acquisition and visualization as supported in the snapscan GUI software. Please contact HSI Support for further details regarding the APIs.





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snapscan VNIR





Chapter 2

Working Principle

2. Working principle

We begin by explaining the working principle of the snapscan camera system. We explain the differences in the working of traditional linescan, imec's linescan and imec's snapscan hyperspectral camera systems. We then discuss the working and features of snapscan camera system in further details.

2.1 Linescan hyperspectral camera systems

Linescan camera systems require a relative translational movement between the object and the camera. In traditional linescan hyperspectral camera systems, this is typically realized by moving either the object relatively to the camera or the camera relatively to the object. For example, in industrial inspection and sorting applications the object is moved on a conveyor belt, whereas in remote sensing applications, the camera is flown with a drone or satellite to scan the earth surface.

2.1.1 Imec hyperspectral linescan vs Traditional hyperspectral linescan

Traditional hyperspectral linescan camera

- Acquires the hyperspectral image of an object line by line
 - Captures immediately the complete spectral information for each point in the spatial line
- i** *Light incident on the camera from each scanline is dispersed into different wavelengths using an optical system and projected on to an image sensor that records intensity at different wavelengths.*

Imec hyperspectral linescan camera

- Acquires the hyperspectral image of an object frame by frame
 - Captures the complete spectral information for a point across multiple frames
- i** *The camera's lens projects an entire area image on the imec hyperspectral linescan sensor. Different filters are deposited on the sensor, stretching over the full width of the sensor and varying along the sensor's height. The light is thus filtered depending on the row position of the image on the sensor, yielding images as shown in Figure 1. This greatly simplifies the system's optical system and on top makes focusing and setting exposure times easier.*

2.1.2 Imec hyperspectral linescan vs snapscan

In imec's snapscan system, both the object and the camera remain stationary. The image sensor inside the camera and behind the lens, moves linearly to scan the projection of the object on the image circle while both the object and the camera are kept still.

The difference between imec's hyperspectral linescan and snapscan is illustrated in Figure 1 and Figure 2. These illustrations assume a hypothetical linescan sensor with three spectral bands.



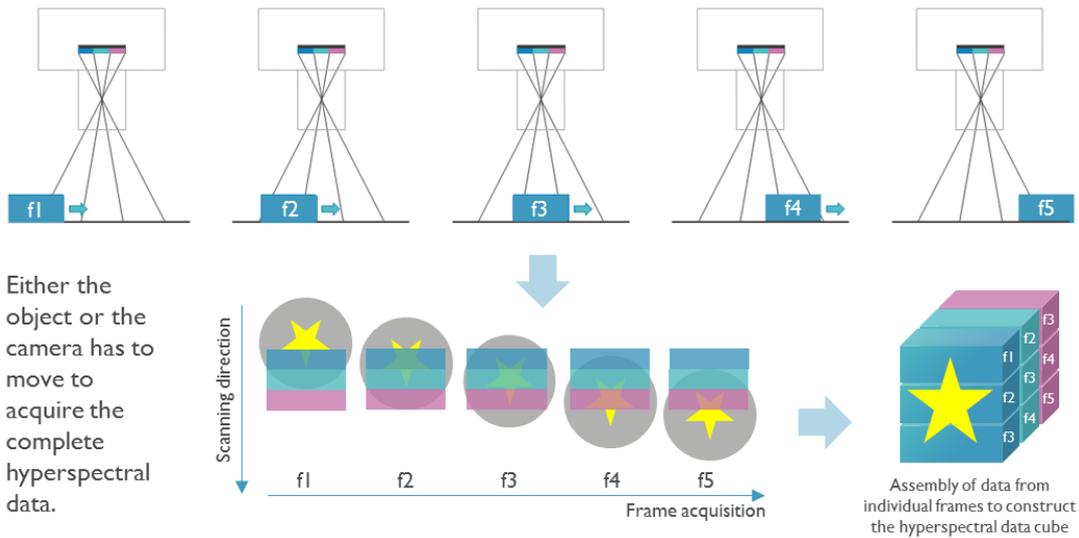


Figure 1 Working principle for imec hyperspectral linescan sensors

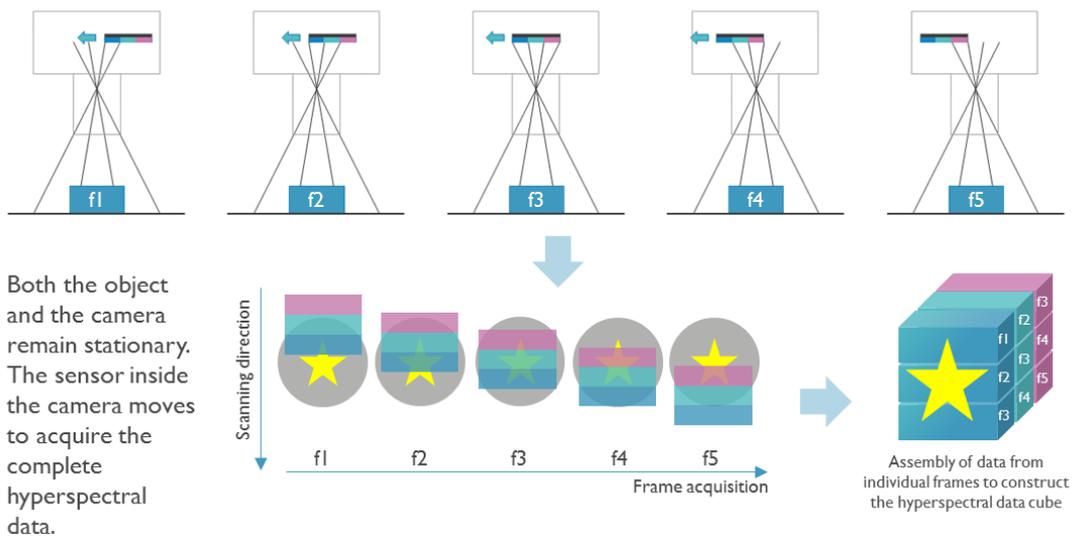
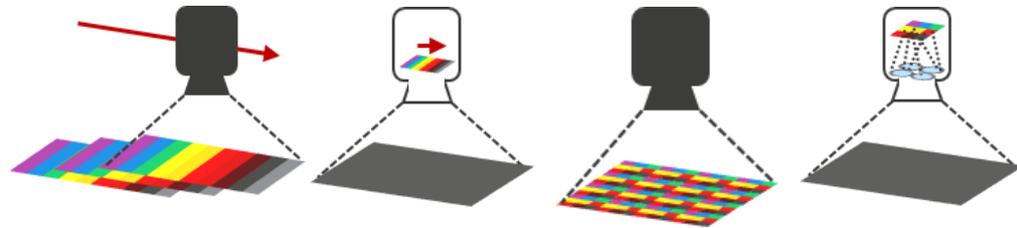


Figure 2 Working principle of imec hyperspectral snapscan camera



2.1.3 Imec hyperspectral camera selection guide

Imec has multiple camera offerings based on different sensor types (linescan, mosaic and tiled). The table below provides a high-level comparison of the different camera offerings based on the current state of our technology and offerings.



	Linescan	snapscan	Snapshot Mosaic	Snapshot Tiled
Acquisition speed	-	+	+++	+++
Video-rate	---	-	+++	+++
Maximum spatial resolution	++	+++	+	-
Spatial quality	+++	+++	+	-
Spectral resolution	+++	+++	+	+
Spectral range	+++	+++	-	++
Spectral quality	++	+++	-	++
SNR	++	+++	+	-
Key advantages	High spectral and spatial resolution	Highest quality cubes being 'snapshot', no 3D topography issue	True snapshot at video-rate	True snapshot with high quality spectra
Key limitations	Need scanning movement, issues with 3D topographies	Video-rate not in reach	Software corrections needed for cross talk	Spatial vignetting, duplicator alignment challenges
Key applications	Remote sensing (UAV, airborne, satellite), food sorting, machine vision	R&D, microscopy, medical skin & wounds healing, agriculture robotics	Industrial sorting & food quality grading, medical endoscopy, UAV inspection	Medical surgery, security surveillance

Visit our website or contact us for further details on our offerings and latest technology developments: <https://www.imechyperspectral.com/>



2.2 Imec snapscan hyperspectral camera

2.2.1 Image acquisition

It has been mentioned in Section 2.1.2 that the snapscan camera system acquires the hyperspectral image by the movement of the sensor inside the camera body. Figure 3 illustrates the process of image acquisition. In this figure, we assume a hypothetical sensor with 3 spectral bands. The object to be imaged is the yellow star and the lens of the camera system projects the image circle (indicated in gray). The sensor moves across the image circle and acquires 5 frames in total such that the complete star is acquired for all the spectral bands. The sensor moves from top to bottom in steps equal to the height of one filter on the sensor. These frames are assembled to form a hyperspectral image cube. The frame assembly takes into account the filters layout on the sensor and the motion during the scan. Each band image is composed of parts of multiple images, acquired at different positions.

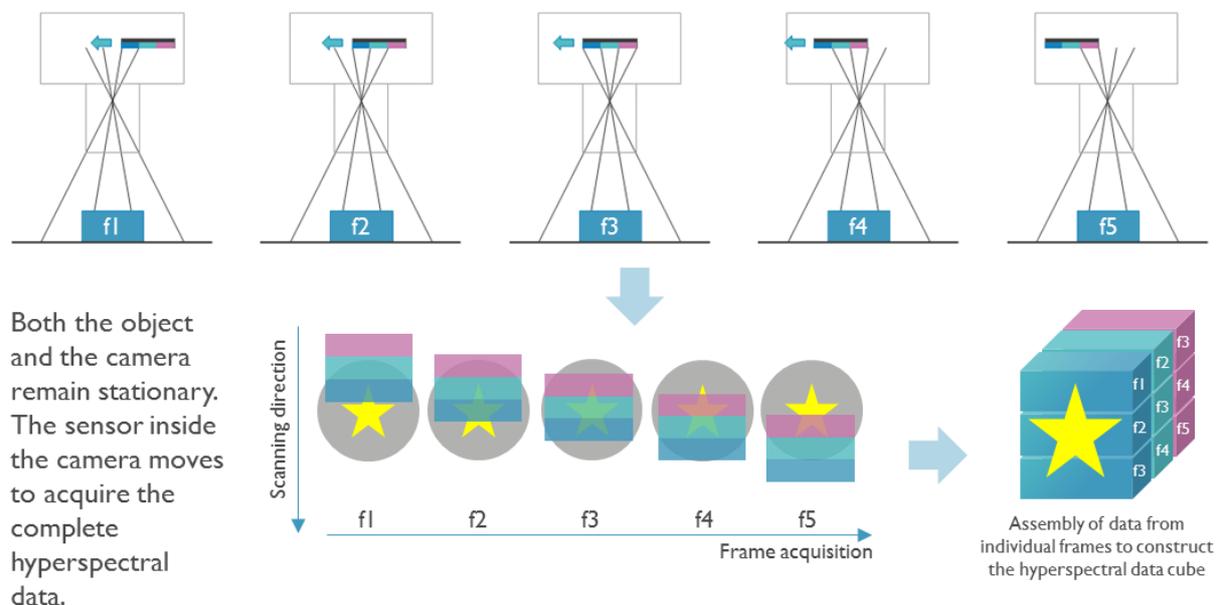


Figure 3 Working principle of image acquisition using the snapscan camera system

2.2.2 Integrated translation platform

In typical linescan setups the quality of the acquisition largely depends on (1) the alignment of the direction of motion to the camera and (2) on the synchronization between the movement and sensor readout speed. The snapscan system integrates both the sensor and the translation platform, making the system behave as a snapshot camera.

Integrating a miniaturized translation platform with the camera enables higher degree of accuracy for motion direction and control.

1. The alignment of the **direction of motion** to the sensor orientation is carried out and fixed in factory to sub-pixel accuracy.



2. The **precise motion** control enables the synchronization between the sensor translation and image acquisition to be controlled to sub-pixel precision, either by software or hardware feedback loop.

Typically, the synchronization of the motion to the sensor readout is done such that the object's projection on the sensor shifts one band between any two images.

The precise motion control in the snapscan system also enables more advanced acquisition modes, which can significantly increase the signal-to-noise ratio in the acquired data (please see Section 2.2.4.4).

2.2.3 Acquisition modes

The snapscan camera can operate in either continuous or stop motion acquisition modes. The software automatically selects the mode depending on the selected acquisition parameters.

1. **Continuous mode** - Sensor movement and sensor exposure happen simultaneously.

The translation platform's internal encoder is used to trigger the sensor at the correct position. The movement is fluent and there is no delay in acceleration and deceleration before taking an image. The movement speed is limited by the sensor's exposure time and the maximum allowable motion blur or distance moved during one exposure time.

2. **Stop motion mode** - Sensor movement and sensor exposure are alternated.

The sensor is repeatedly stopped at a selected step size to acquire the image and then move to next position. This completely avoids motion blur and allows taking multiple images at a given position. Evidently this acquisition mode is slower than the continuous mode. The total duration of the acquisition depends on the travel distance, the step size and the number of images times their exposure time acquired in each position.

2.2.4 Acquisition features for higher data quality

The snapscan camera provides several configurable parameters which can help in improving the quality of the acquired image data. These parameters are discussed further in this section.

2.2.4.1 Pixel binning

Pixel binning is a well-known concept in imaging where information from adjacent pixels are combined and reported out as a single pixel. The snapscan camera system can be configured to implement a NxN binning where $N = 1, 2, 3 \dots 20$ (default is 1).

2.2.4.2 Cross talk removal by pixel row skipping

The precise control of the integrated sensor translation platform allows the sensor to be moved in step sizes between one pixel row and height of one spectral band (typically 5 pixel rows). Hence, it is possible to skip collecting data from the pixel rows at the interfaces of two spectral bands. Skipping the interface rows avoids recording cross-talk between different bands and hence improve the system's spectral response.



In Figure 4, we assume that the sensor has 3 spectral bands and each spectral band has 5-pixel rows. The shaded pixels are at the interface of two spectral bands and hence susceptible to cross talk. We show illustration for 4 cases having different step sizes while scanning the object. Let us further consider three points (X, Y and Z) on the object.

In case of point X, let us discuss the data collection for the different step sizes:

- 5 rows – Data for all the 3 bands are collected from interface pixels only. Thus, all the acquired data may have been affected by cross talk.
- 4 rows – Data for all the 3 bands are collected from non-interface pixels. Thus, the data is least susceptible to cross talk.
- 3 rows – Data for all the 3 bands can be collected both from interface and non-interface pixels across different frames. To minimize the susceptibility to cross talk, the interface pixels can be ignored.
- 2 rows – Same as above.

If we consider all the three points (X, Y and Z) then we see that step sizes of 2 and 3 ensures that data can be collected from non-interface pixels for all the three bands, thus ensuring a higher data quality.

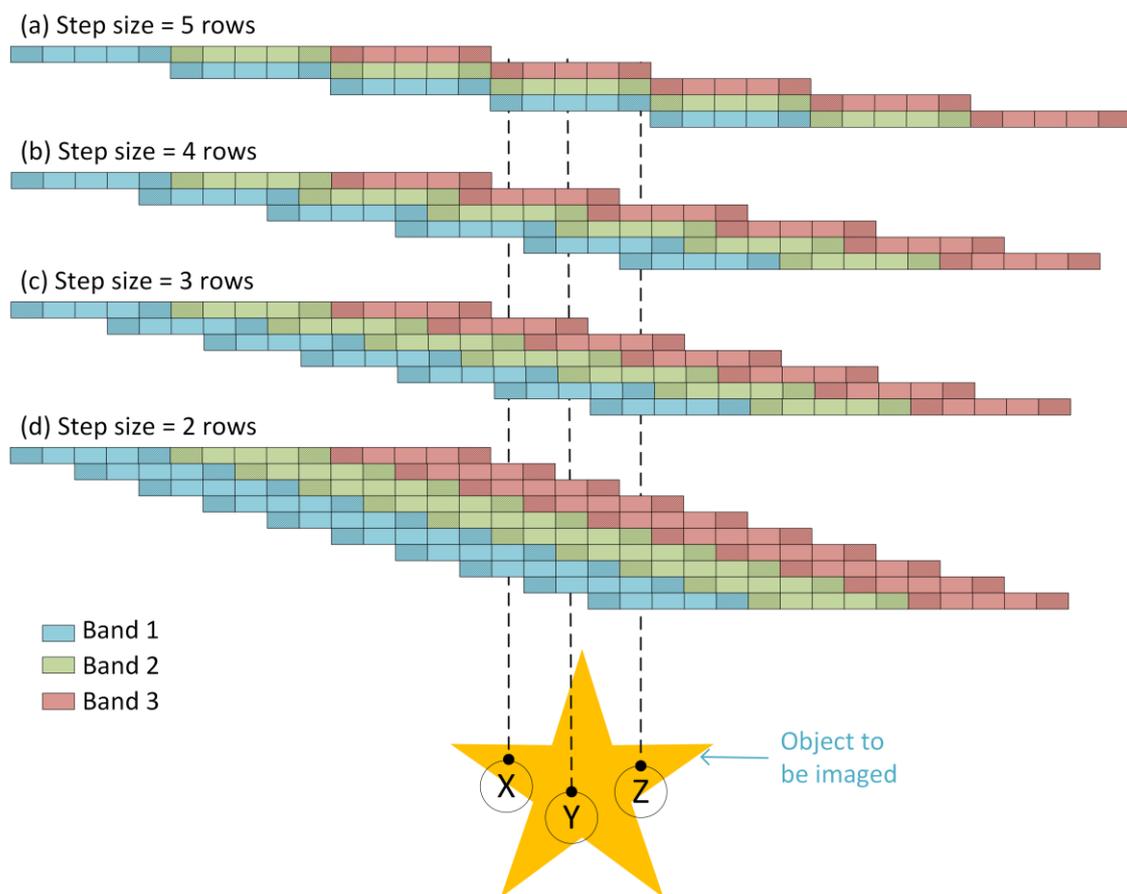


Figure 4 Illustration for pixel row skipping to remove cross talk



2.2.4.3 Software Time Delay Integration (softTDI)

Time delay integration (TDI) is a known concept in imaging where multiple frames (shifted in time and position) of the same object (with relative motion between the object and the camera) are acquired and information is combined across these frames (in hardware) to achieve high throughput and/or high quality imaging in low light conditions.

TDI is typically implemented in hardware. However, the snapscan camera enables TDI in software and provides flexibility to configure the step size at which multiple frames are acquired. The precise control of the integrated sensor translation platform allows the sensor to be moved in step sizes between one pixel row and height of one spectral band (typically 5 pixel rows).

To enable softTDI, the sensor needs to be translated at step sizes smaller than the height of one spectral band. This allows capturing images of an object such that multiple pixels across multiple frames will capture data for the same spectral band.

Figure 5 shows an illustration, where we assume that the sensor has 3 spectral bands and each spectral band has 5 pixel rows. Thus, the sensor can be translated at step sizes between 1 and 5 pixel rows. We consider 3 different step sizes in our illustration and discuss below the impact on softTDI:

- 5 rows (height of spectral band): Allows no softTDI
- 2 rows: Each point in the object is imaged at least in 2 frames for the same spectral band. SoftTDI can be implemented by averaging data collected from pixels across the 2 frames.
- 1 row: Each point in the object is imaged at least in 5 frames for the same spectral band. SoftTDI can be implemented, as discussed above.



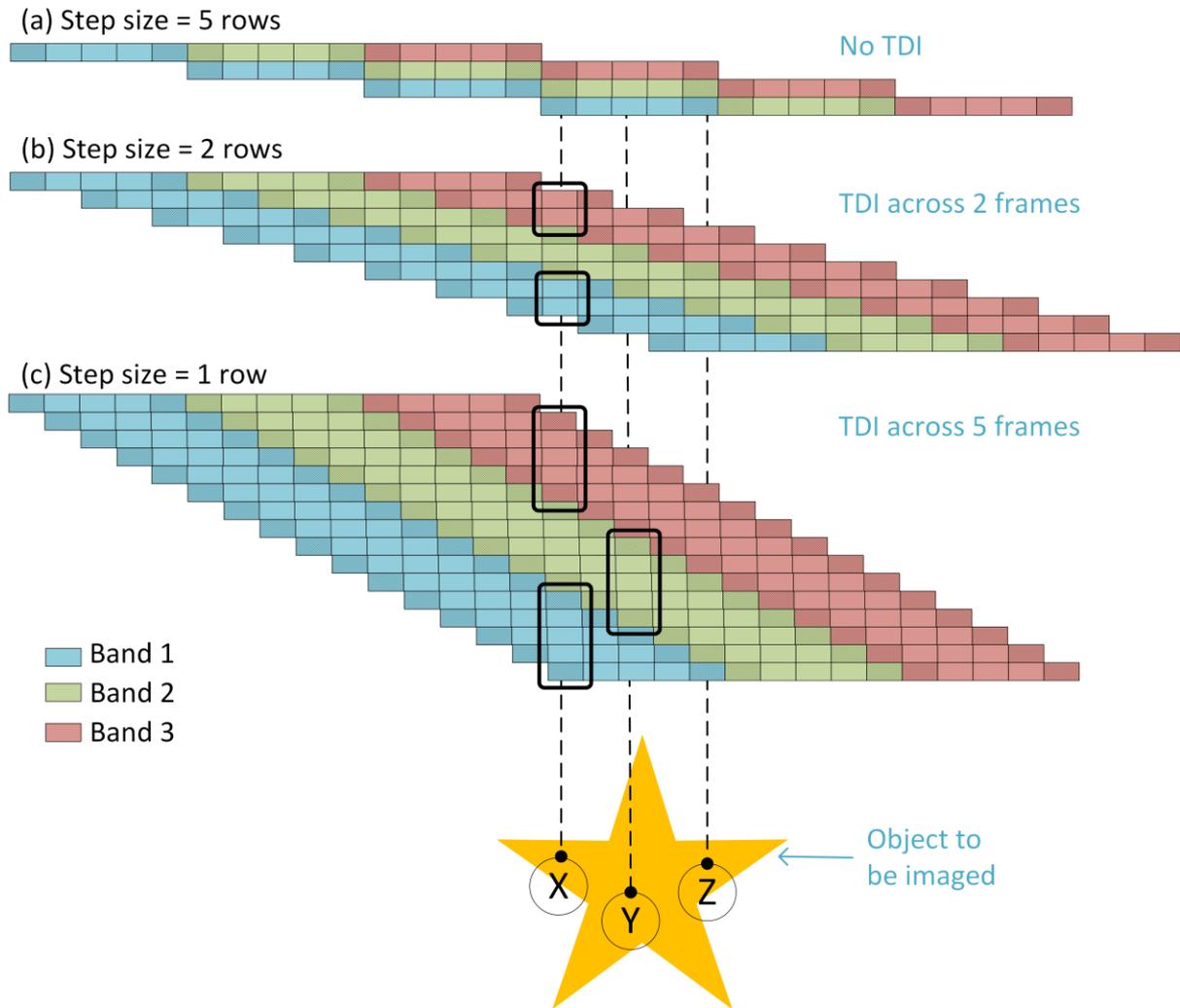


Figure 5: Illustration for software time delay integration

2.2.4.4 Spectral bands/ Regions of Interest selection

By default, the snapscan camera system acquires data for all the spectral bands supported in the integrated sensor. However, the snapscan provides the feature of band selection which allows the user to specify one or more spectral ranges that are of interest for the acquisition. The acquired data will then only contain the bands corresponding to the selected spectral ranges. Bands that fall outside the selected regions will not be acquired.

Each selected spectral range is referred to as **Spectral Region of Interest (SROI)**. The snapscan camera system allows up to 8 SROIs (default is 2).

The band selection is done directly on the sensor. As a result, the amount of readout data from the sensor can be reduced. This leads to following benefits:

- Less data is transferred from the sensor. It allows higher framerates and hence shorter acquisition times.



- Size of output data and the file is reduced. It reduces the amounts of data to be processed and stored, easing the requirements of the PC used for the acquisition and improving processing times.

2.2.4.5 Multi-pass acquisition

The snapscan camera system ensures that image acquisitions are repeatable because of the high accuracy of the motion control of the integrated translation platform. This allows further increasing the signal to noise ratio (SNR) of the acquired image data by averaging across data acquired in multiple acquisitions across multiple passes.

2.2.5 Image post processing

The key purpose of a spectral imaging system is to measure the true surface reflectance (or true material absorbance in case of measurements in transmittance mode) of the object to be imaged. However, the image acquisition is subjected to interference and non-idealities of the imaging systems and its components, and the imaging environment. White balancing needs to be applied on the acquired data to obtain true reflectance/ absorbance where all the system related effects are normalized:

2.2.5.1 White balancing

White balancing, also referred to as reflectance calculation, is the process of extracting the reflectance signal from the captured radiance of an object. The purpose is to remove the influence of the following on the hyperspectral representation of an object.

- the light source emission spectrum
- spatial non-uniformities in the illumination
- the impact of the medium through which the light travels
- vignetting of the lens system
- the spectral deformation caused by the lens system
- and small differences between the system model and reality
- sensor characteristics (QE, ...)

White balancing also enables the comparison of spectral responses across measurements and with available databases.

The white balancing is done by placing a white diffuse reflectance target in the scene. In principle any reflectance target with known spectrum can be used. In practice it is simpler to use a reflectance target with an as flat as possible reflectance spectrum and scaling up the measurement to 100% by dividing the measurement by the reflectance value. For example, the reflectance target delivered with the snapscan system has a flat diffuse reflectance spectrum of 95%.

The following formula illustrates the calculation of the reflectance, using one white reference image and two dark reference images



$$\text{object}_{\text{reflectance}} = \frac{\text{object}_{\text{radiance}} - \text{dark ref} (\text{tint}_{\text{object}})}{\text{white ref} - \text{dark ref} (\text{tint}_{\text{white ref}})} \times \frac{\text{tint}_{\text{white ref}}}{\text{tint}_{\text{object}}}$$

where

- $\text{object}_{\text{radiance}}$ is the radiance of the object of interest
- white ref is the radiance of a white reflectance tile
- dark ref ($\text{tint}_{\text{object}}$) is a dark reference image taken with the integration time of the object of interest
- dark ref ($\text{tint}_{\text{white ref}}$) is a dark reference image taken with the integration time of the white reflectance tile
- $\text{tint}_{\text{white ref}}$ is the integration time used to capture the white reference image
- $\text{tint}_{\text{object}}$ is the integration time used to capture the object image

The object, white and dark reference images are the raw output from the sensor, resulting in a set of four 2D arrays. The above-mentioned formula should be applied on the digital numbers of the corresponding pixel locations of the four images.

Reflectance vs transmittance mode imaging

There are two key differences between the two modes of imaging:

- **Placement of object, light source and camera system**
 - Reflectance mode - the light source and the camera system are on the same side of the object,
 - Transmittance mode - the object is placed in between the light source and the camera system.
- **White reference measurement**
 - Reflectance mode – carried out using a reflectance tile with known spectrum
 - Transmittance mode – carried out by using a measurement in absence of the object and without using any reference object. Note that when the object is placed on a transparent substrate, the substrate must be kept in place when doing the white reference measurement.

2.3 Illumination

Illumination is a critical factor in hyperspectral imaging. Different sources of illumination have different intensity levels at different wavelengths, as shown in Figure 6. The choice of illumination will significantly impact the overall spectral response of the imaging system. Figure 7 shows the spectral response of different spectral bands in the HSI sensor. These responses have been obtained under ideal lab condition illumination. Figure 8 illustrates the impact of three different illumination sources (halogen, LED and sunlight). It can be seen that the spectral response of the illumination source influences the overall spectral response of the HSI sensor. Thus, it is important to take into account the spectral property of illumination used in the system based on application requirements.



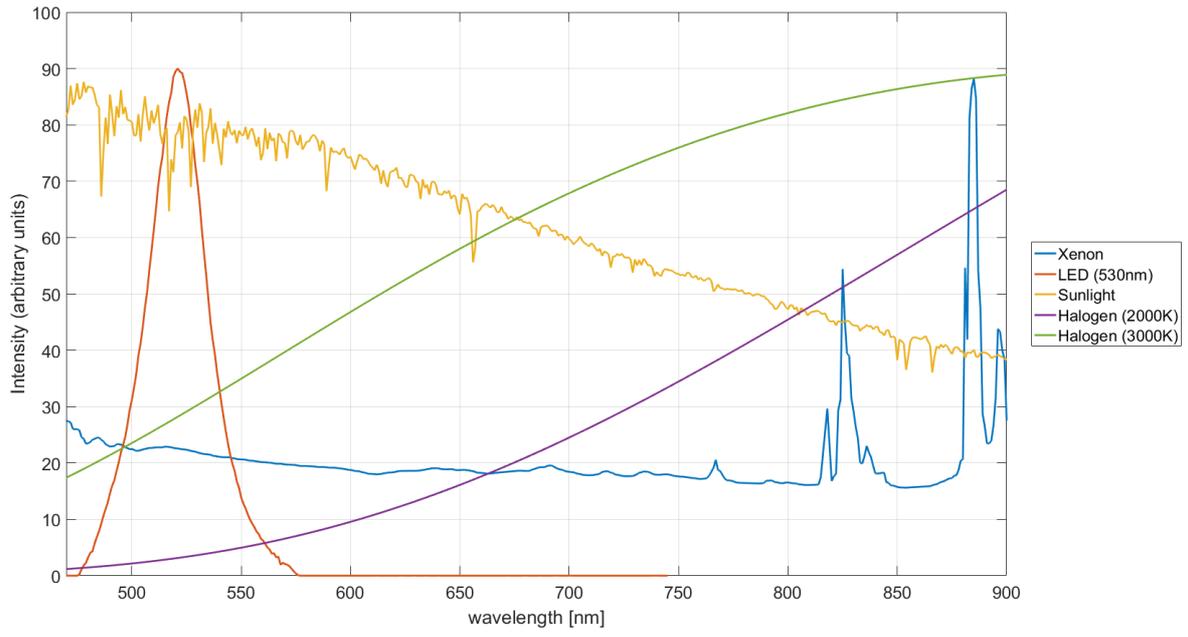


Figure 6 Spectral content of different light sources



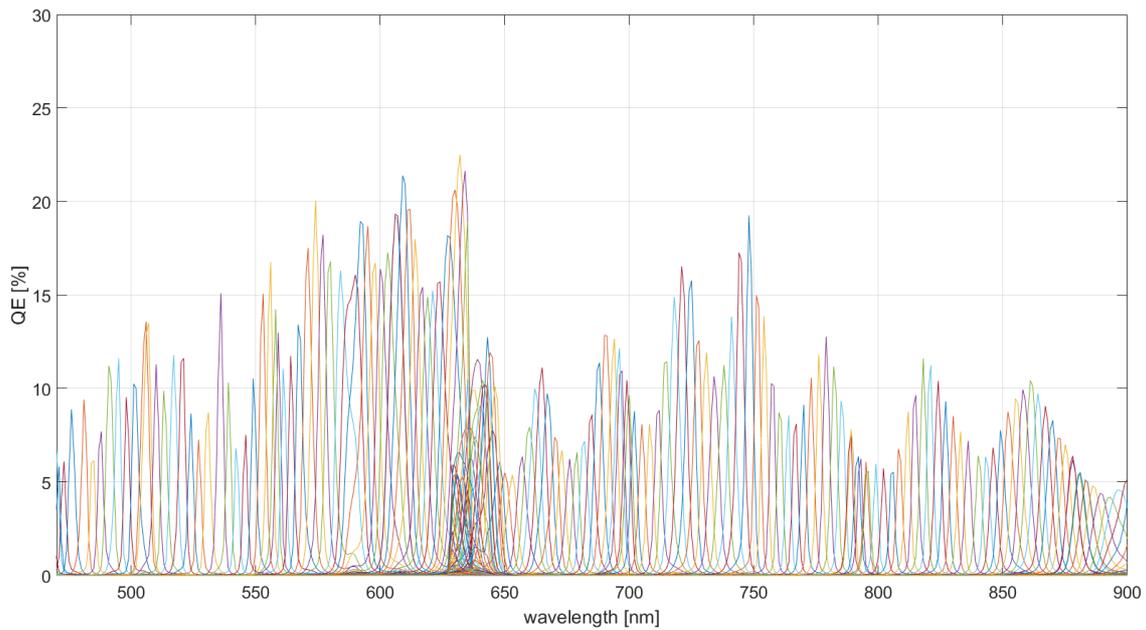


Figure 7 Responses of different spectral bands of the HSI sensor obtained under ideal illumination conditions

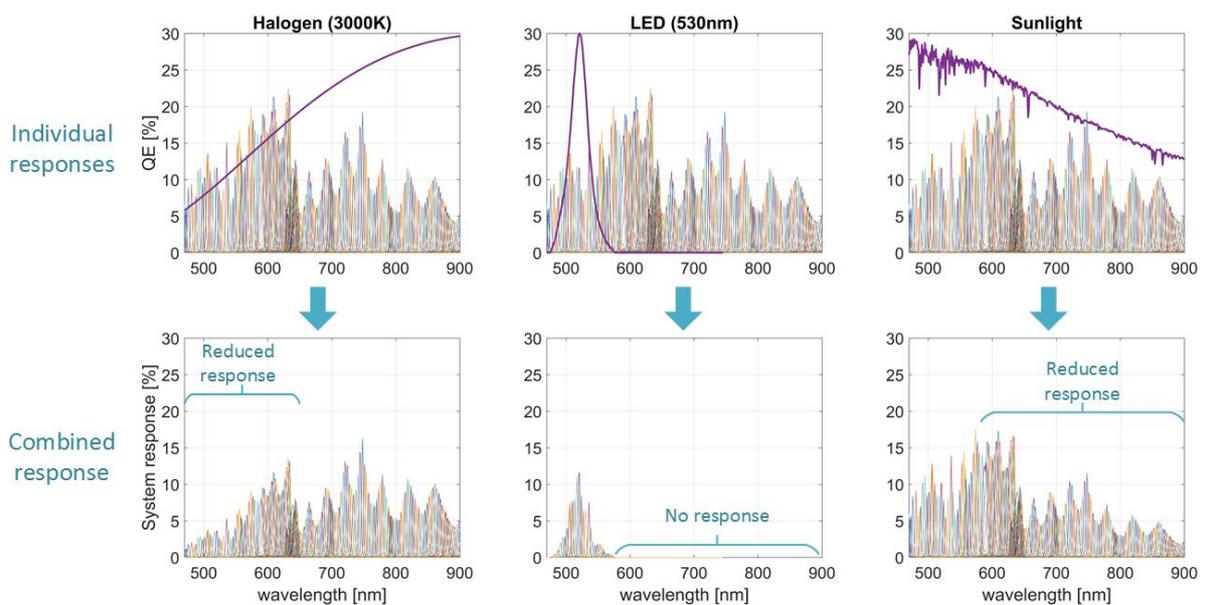


Figure 8 Illustration of impact of different illumination sources on overall spectral response of the system

- ❶ The evaluation kit includes halogen lamps as a standard configuration. It can be seen from Figure 8 that halogen based illumination has lower SNR in the blue color range. Thus, if your application requires higher SNR in the blue color range then we recommend you to contact Imec HSI support to help you with illumination customizations.
- ❶ We are currently qualifying multi LED based illumination solution which gives the user the ability to tune the spectral content of the illumination specific to application needs. Please contact imec HSI support for further information.







Chapter 3

Evaluation System Assembly Manual

3. Evaluation System Assembly Manual

This chapter will guide you through the assembly of the snapscan evaluation system. It provides an overview of all components in the snapscan evaluation system and instructions to assemble the snapscan evaluation system (as shown in Figure 9).



Figure 9 Final setup of the snapscan evaluation system

3.1 Assembly steps

Follow the steps below to assemble the evaluation system:

- Step 1* - Unpack the packages (black explorer case and cardboard box) and cross check the contents of the kit received with the list of components provided in the manual
- Step 2* - Assemble the base plate
- Step 3* - Assemble the camera holder post and mount the tripod head
- Step 4* - Assemble the lamp holder posts and mount the lamps
- Step 5* - Mount the snapscan camera
- Step 6* - Connect the lamps to the power supply
- Step 7* - Connect the camera to controller and PC



The above steps are discussed in detail further in this chapter. The interconnection between the different components is shown in Figure 10.

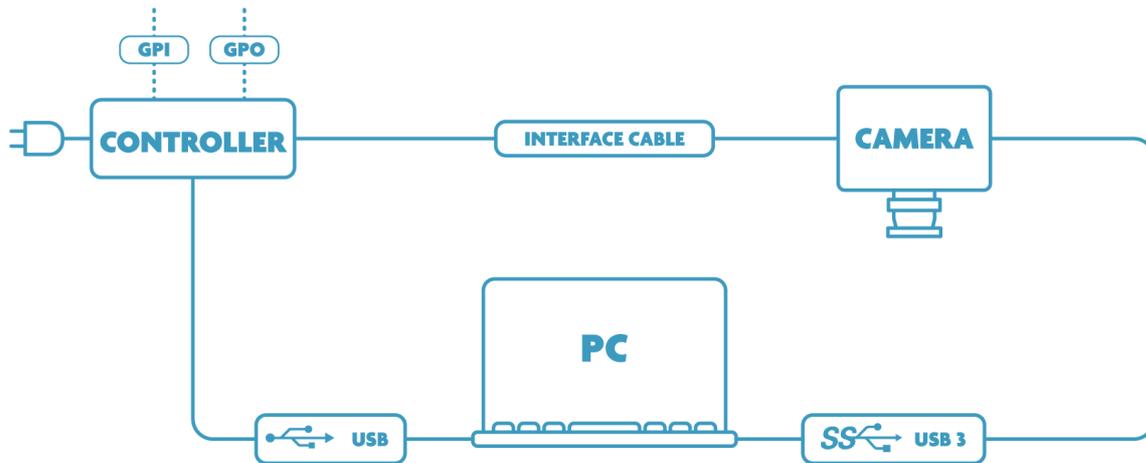


Figure 10 Interconnection between different components in the final setup

3.1.1 Step 1 - Unpack and crosscheck the contents

Step 1.1 Unpack and crosscheck the contents

The snapscan evaluation system is delivered in two main packages (as shown in Figure 11):

- Box 1 containing (see Figure 13 for contents)
 - snapscan camera with integrated sensor
 - controller box
 - Schneider Kreuznach lens
 - USB3.0 cable, custom 16 pin cable and power supply

- Box 2 containing (see Figure 13 for contents)
 - Components to build a setup with illumination
 - mounting setup with vibration dampening
 - halogen lighting solution with diffusers
 - tunable stabilized DC power supply
 - Reflectance targets for calibration
 - reflectance tile 95%, 200 x 200 mm
 - color checkerboard card

⚠ *The color checkerboard (item 23) and reflectance standard (item 24) are optical materials. Do not touch their surface in any way and store in dark conditions.*

Table 4 provides a list of all the components and the quantity for each component included in the evaluation system.





Figure 11: Main packages delivered with the snapscan evaluation system. Box 1 (left) contains the snapscan system and cables and Box 2 (right) contains all evaluation system parts.



Figure 12 Contents of the Box 1





Figure 13 Contents of the Box 2

i Actual contents of the two boxes may vary depending on the options selected by you in the snapscan hyperspectral camera selection form during order placement.



Table 4: List of components and quantities in the snapscan evaluation system

Ref. No	Components	Quantity	Packaged
01	snapscan camera B150U	1	Box 1
02	snapscan controller 912-0005-01	1	Box 1
03	Schneider-Kreuznach lens	1	Box 1
04	USB 3.0 cable 3m	1	Box 1
05	snapscan 16-pin cable	1	Box 1
06	USB 2.0 cable	1	Box 1
07	snapscan controller adapter	1	Box 1
08	snapscan controller adapter power cable	1	Box 1
09	Base breadboard 300x300	1	Box 2
10	Feet Ø27mm, female M6	4	Box 2
11	Hex cap screw M6, 16mm, black	4	Box 2
12	Threaded studs M6 black	2	Box 2
13	Post 300x12.7mm	5	Box 2
14	Post 150x12.7mm	2	Box 2
15	Right angle post clamp	4	Box 2
16	Post end clamp 0.5"	1	Box 2
17	Tripod ball head with 3/8" to 1/4" adapter	1	Box 2
18	Tunable stabilized DC power supply	1	Box 2
19	Tunable stabilized DC power supply power cable	1	Box 2
20	Halogen lamp 20W GU5.3 cool-fit	4	Box 2
21	Diffuser (Thorlabs DG20-120)	4	Box 2
22	Assembled lamp holder, wire, post end clamp and banana plug connectors	4	Box 2
23	Color checkerboard card	1	Box 2
24	Reflectance standard 95% 200x200mm	1	Box 2
25	Allen key 3mm	1	Box 2
26	Scanning background ²	1	Box 2

i Actual contents of the two boxes may vary depending on the options selected by you in the snapscan hyperspectral camera selection form during order placement.

² Not shown in Figure 13



Step 1.2 Identify the camera unit and the controller box

Each camera unit is assigned a unique serial number, as shown in Figure 14. The description of the serial number is given in Table 5.



Figure 14 Serial number for camera units

Table 5 Description of the serial number

Description	Values
Model identifier	B: model B
Sensor Identifier	I50: Hyperspectral VNRI sensor (470-920nm)
Translation stage identifier	U: Ultrasonic stage
Device number	4 digit serial number starting from 0001

Each controller is assigned a unique controller box and its label is in the form as shown in Figure 15 Back side of the control box with serial number..





Figure 15 Back side of the control box with serial number.

Description	Values
Model identifier	921-0005-01
Device number	4 digit serial number starting from 0001



3.1.2 Step 2 - Assemble the base plate

Required items (Figure 16a)

Ref. No	Components	Quantity	Packaged
09	Base breadboard 300x300	1	Box 2
10	Feet $\varnothing 27\text{mm}$, female M6	4	Box 2
11	Hex cap screw M6, 16mm, black	4	Box 2

Procedure:

Attach the 4 feet to the breadboard, through the holes, offset from the array. The screw should sink completely in the hole, creating a flat surface. Tighten well.

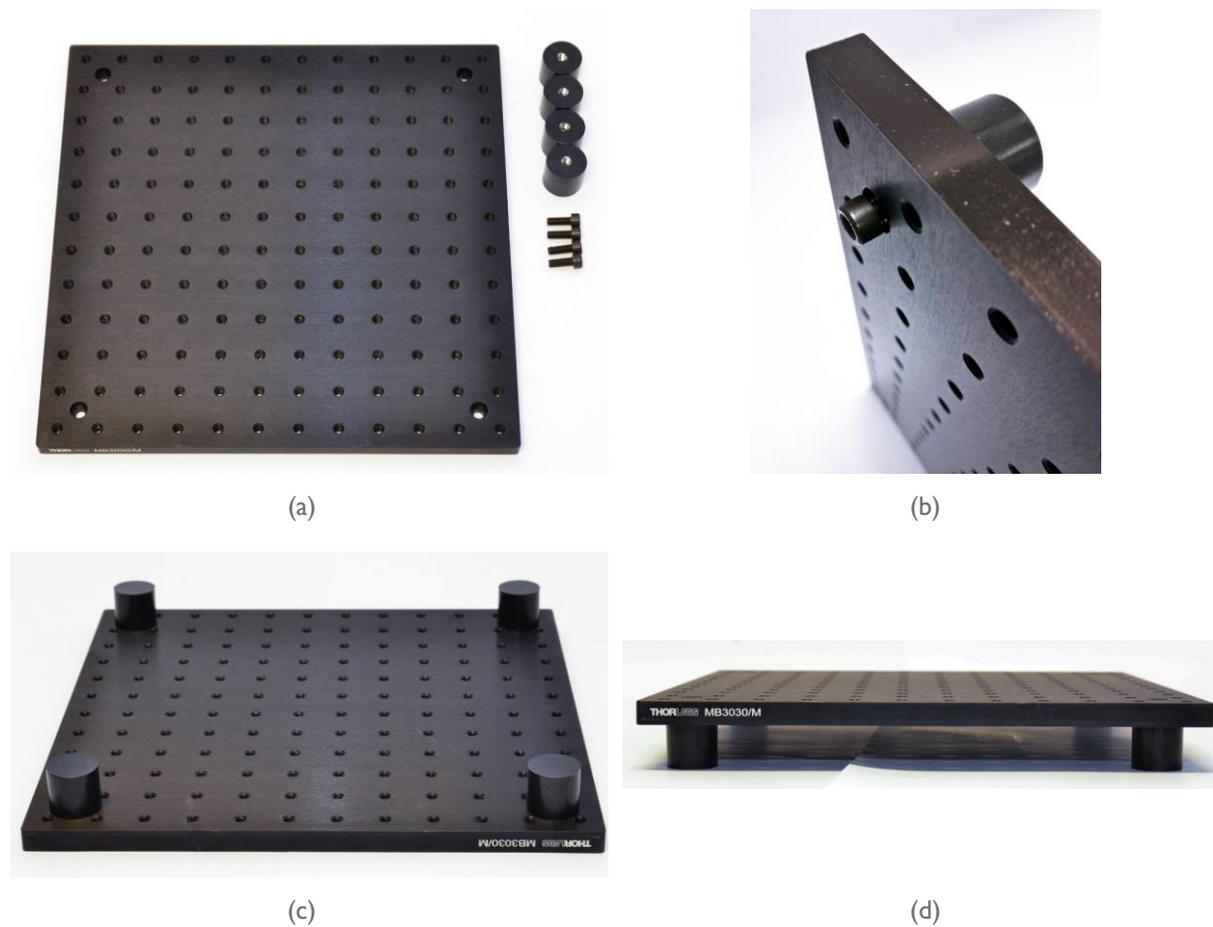


Figure 16: Assembly of the base plate (Step 2)



3.1.3 Step 3 - Assemble the camera holder posts and tripod mount

Required items

Ref. No	Components	Quantity	Packaged
17	Tripod ball head with 3/8" to 1/4" adapter	1	Box 2
13	Post 300x12.7mm	3	Box 2
14	Post 150x12.7mm	2	Box 2
12	Threaded studs M6 black	2	Box 2
15	Right angle post clamp	4	Box 2
16	Post end clamp 0.5"	1	Box 2

Procedure

Follow the steps below to assemble the camera holder posts and tripod mount, as shown in Figure 17.

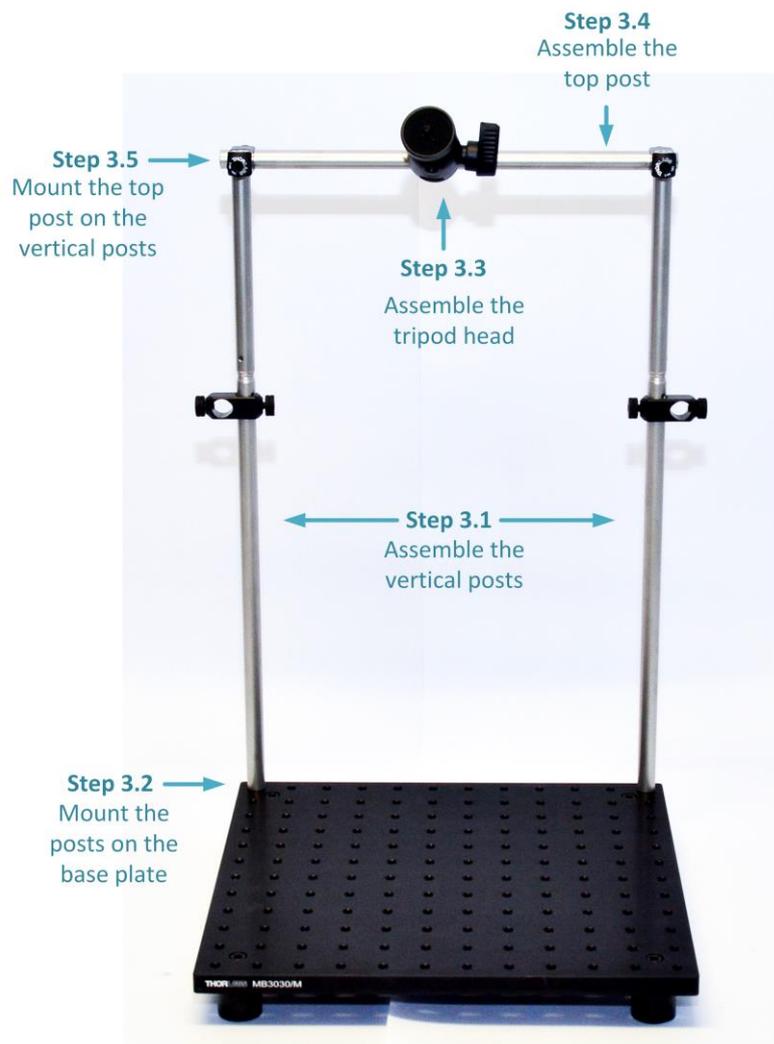


Figure 17 Mounting camera on the assembled on the base plate (Step 3)



Step 3.1 Assemble the vertical camera holder posts (Figure 18)

- a. Insert and screw the black threaded stud, with its conical end, in the bottom end of the long post.
- b. Unscrew the stainless-steel setscrew from the top of the long post (these are not required for this build, use an Allen key size 2 if necessary). Screw the top of short post onto the top of the long post, connecting them with a stainless-steel setscrew.
- c. Slide the right angle post clamp on to the assembled post and screw it.
- d. Follow steps a-c to prepare two posts.

i *The position of right angle post clamp can be changed later to adjust the height of the lamps with respect to the base plate.*

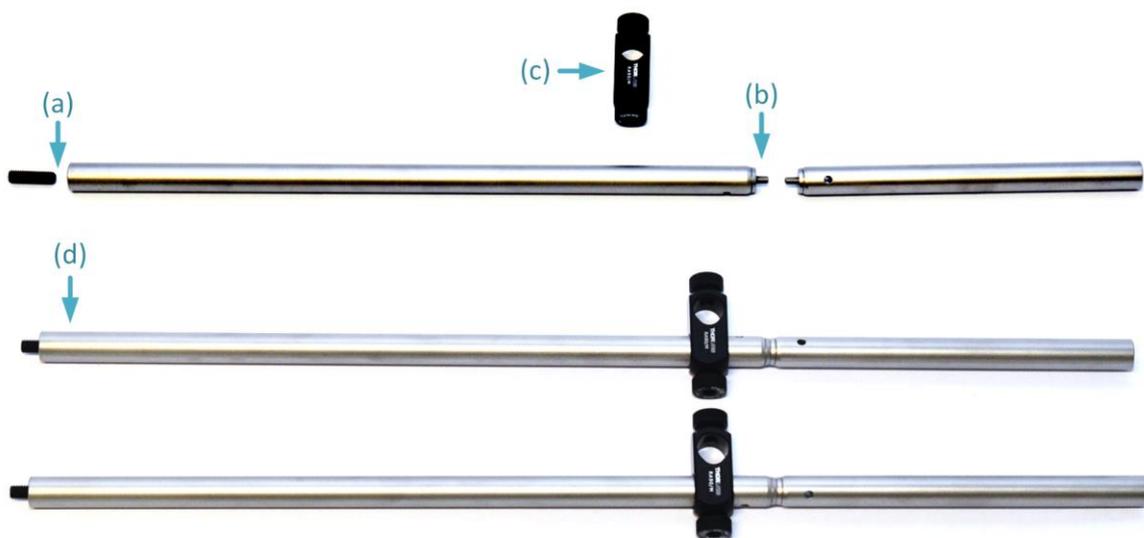
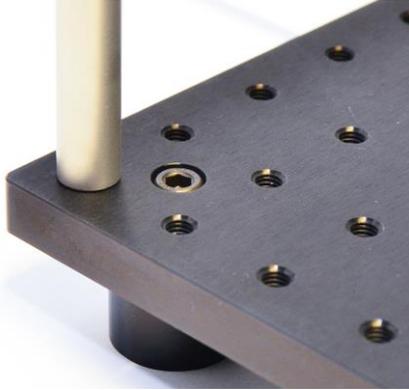


Figure 18 Assembly of the vertical camera holder posts (Step 3.1)

Step 3.2 Mount the camera holder posts on the base plate (Figure 19)

- a. Mount the post on the base plate such that the end of the post with the black threaded stud is screwed in to the base plate. Use the first hole in the corner as shown in Figure 19a.
- b. Mount the two posts in opposite corners along the same edge of the base plate, as shown in Figure 19b.





(a)



(b)

Figure 19 Mounting of the vertical camera holder posts on the base plate (Step 3.2)

Step 3.3 Assemble the tripod head (Figure 20)

- a. Unscrew the stainless-steel ring from the top of the tripod ball head (adapter), revealing the black thread on top.
- b. Screw this stainless-steel adapter piece into the bottom hole.
- c. Screw the post end clamp into the bottom hole of the tripod ball head.





Figure 20 Assembly of tripod mount (Step 3.3)

Step 3.4 Assemble the top road with tripod head (Figure 21)

- Unscrew the stainless-steel setscrew from the top of the post (these are not required for this build, use an Allen key size 2 if necessary).
- Slide the ball head assembly onto the long post and screw it in the middle of the post.
- Slide the 2x right angle post clamps onto both ends and tighten the screw.

⚠ Ensure that the screw is properly tightened once the camera is mounted to avoid the tripod head changing orientation under camera's weight.



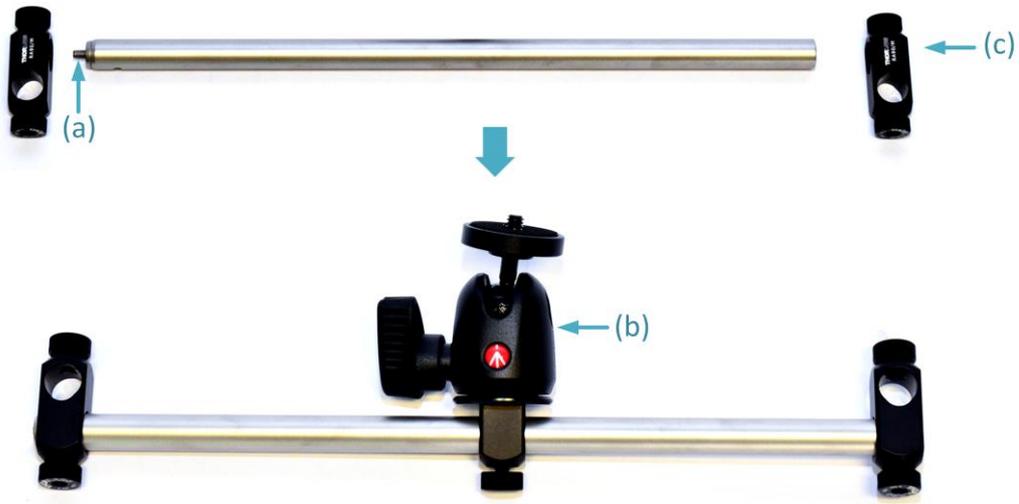


Figure 21 Assembly of the top post for camera mount (Step 3.4)

Step 3.5 Mount the top post on the vertical posts (Figure 22)

- a. Slide the assembled top post (from Step 3.4) on to the vertical posts and fix them on the top edge, as shown in Figure 22.

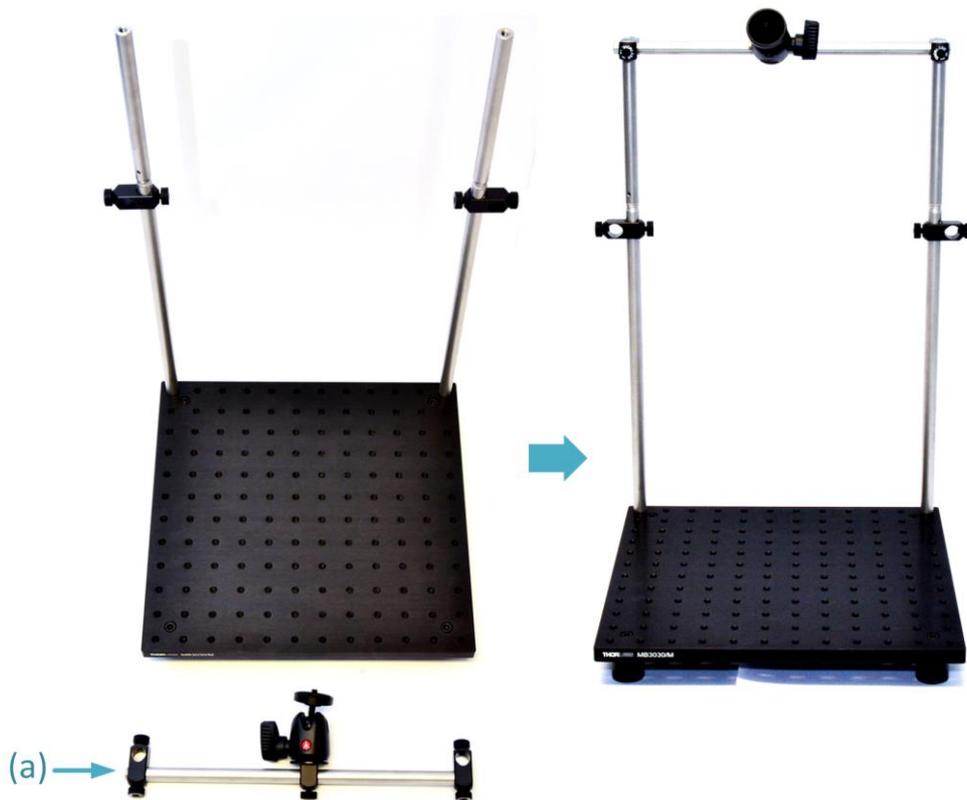


Figure 22 Assembly of top post with tripod head on the vertical posts (Step 3.5)



3.1.4 Step 4 - Assemble the lamp holder posts and mount the lamps

Required items

Ref. No	Components	Quantity	Packaged
22	Assembled lamp holder, wire, post end clamp and banana plug connectors	4	Box 2
13	Post 300x12.7mm	2	Box 2
20	Halogen lamp 20W GU5.3 cool-fit	4	Box 2
21	Diffuser (Thorlabs DG20-120)	4	Box 2

Procedure

Follow the steps below to assemble the lamps and mount them on to the setup, as shown in Figure 23.

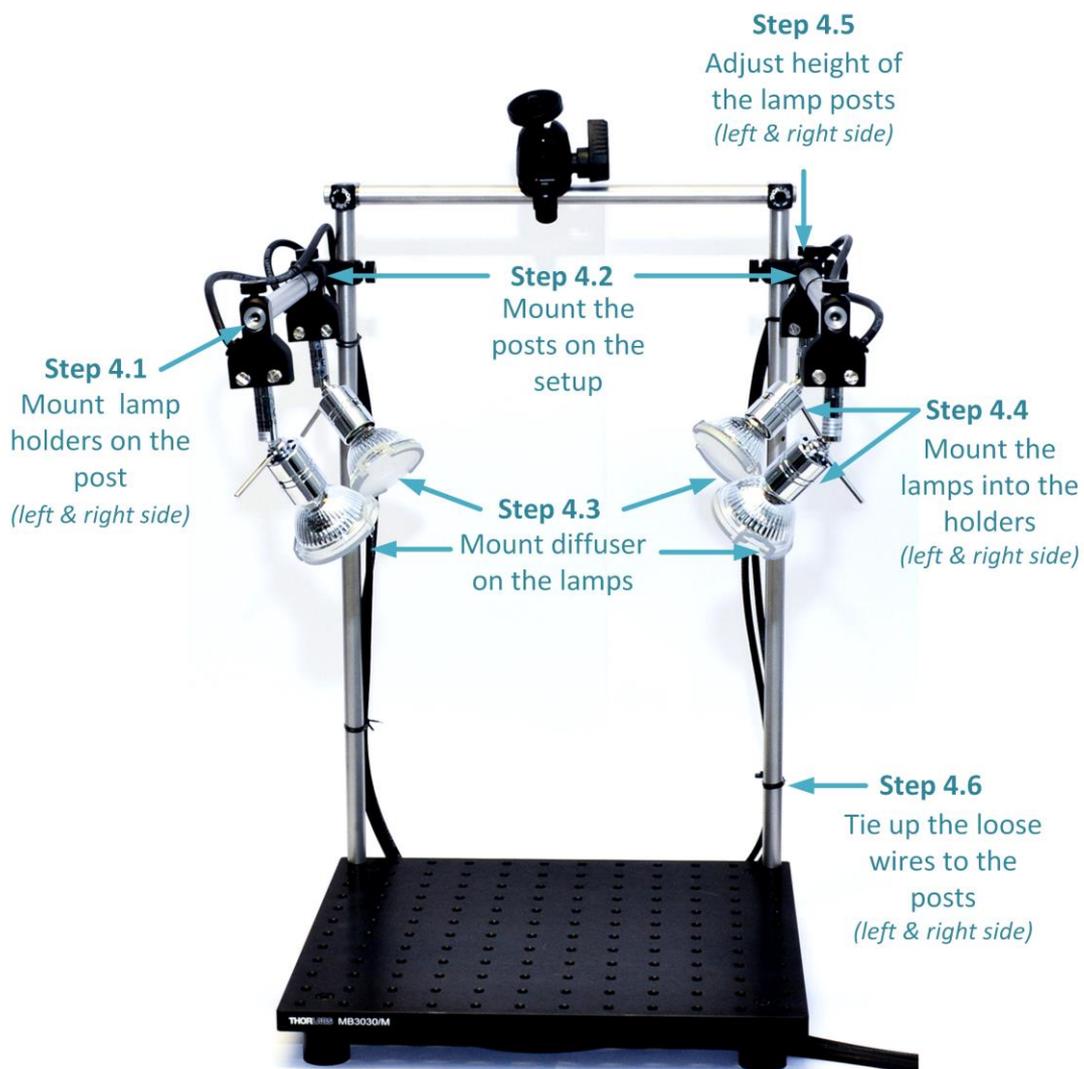


Figure 23 Assembly of lamp holder posts and mounting of lamps (Step 4)



Step 4.1 Mount the lamp holders on the post (Figure 24)

- Unscrew the stainless-steel setscrew from the top of the post (these are not required for this build, use an Allen key size 2 if necessary).
- Slide two lamp holders on the post and fix them by tightening the screw on the post end clamp, as shown in Figure 24. Repeat this step to assemble the remaining two lamp holders on the second post.

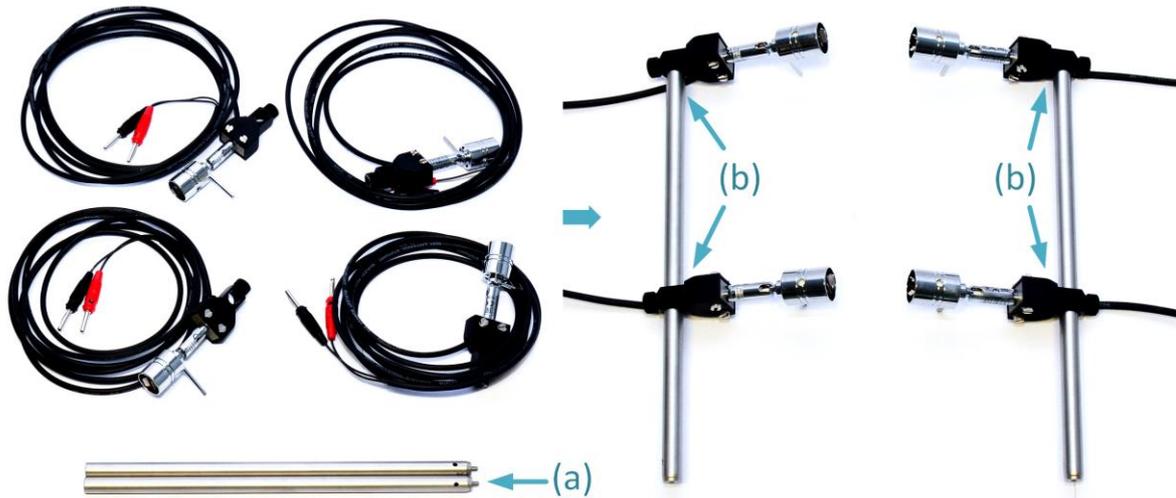


Figure 24 Assembly of lamp holders on the posts (Step 4.1)

Step 4.2 Mount the posts on to the setup (Figure 25)

- Slide the assembled post (from Step 4.1) into the right-angle post clamp fixed on the vertical post. Repeat this step for other assembled post.

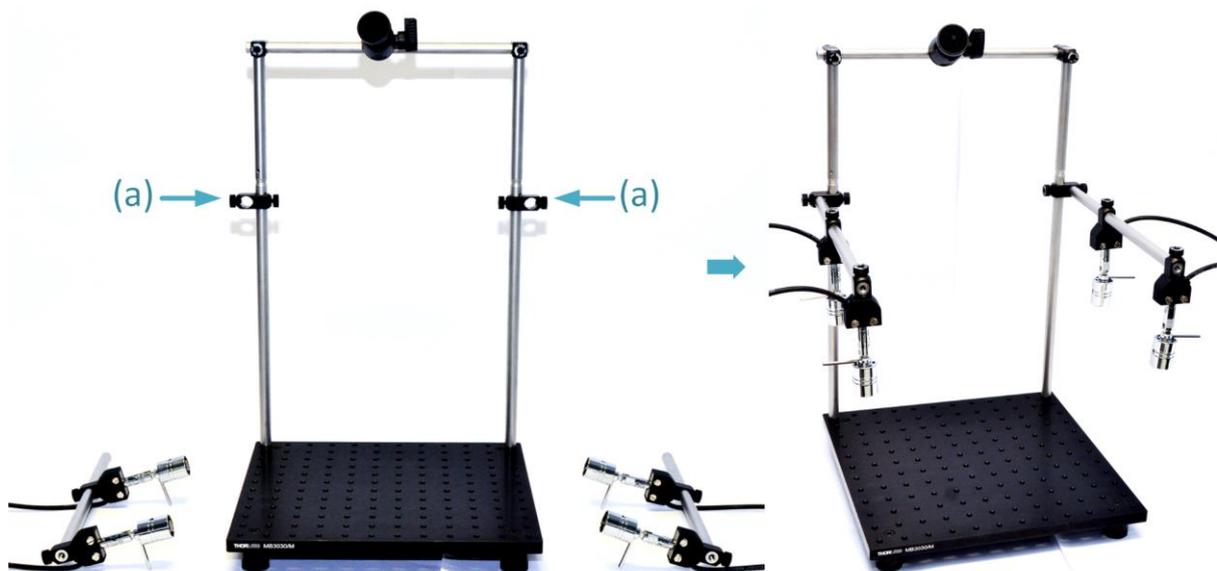


Figure 25 Mounting of lamp holders on to the setup (Step 4.2)



Step 4.3 Mount diffusers on the lamps

- a. Unpack the diffuser and the lamps, as shown in Figure 26.

i Depending on your application, using different types of lamps and/or light shaping filters can improve the SNR of the acquired data. It is strongly recommended to experiment with different types of lamps to tune the total system response. Refer to the manual *Hyperspectral Sensors* for more information.



Figure 26 Unpacking of diffuser and lamp (Step 4.3a)

- b. Press and bend inwards the clips on the diffuser, as shown in Figure 27. This is needed for good fit of the diffuser on the lamps.



Figure 27 Bending the clips of diffuser for mounting on the lamps (Step 4.3b)

- c. Press the diffuser on to the lamp such that the top edge of the lamp gets locked in to the clip of the diffuser, as shown in Figure 28.

⚠ Ensure that there is gap between the diffuser and the lamp

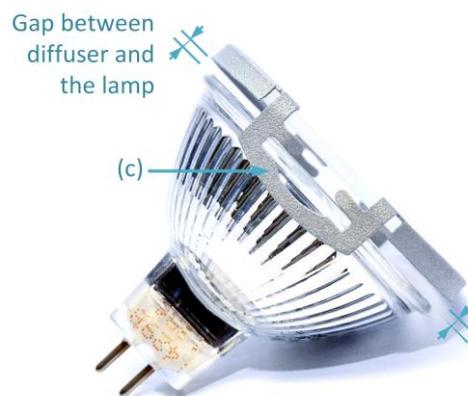


Figure 28 Mounting diffuser on the lamp (Step 4.3c)



d. Follow steps a-c to prepare a set of 4 lamps, as shown in Figure 29.



Figure 29 Set of 4 lamps with diffuser mounted on them (Step 4.3d)

Step 4.4 Mount the lamps into the holders (Figure 30)

- a. Align the pins of the lamp to the holes in the socket and push the lamp into the holder. Repeat this step for all the four lamps.

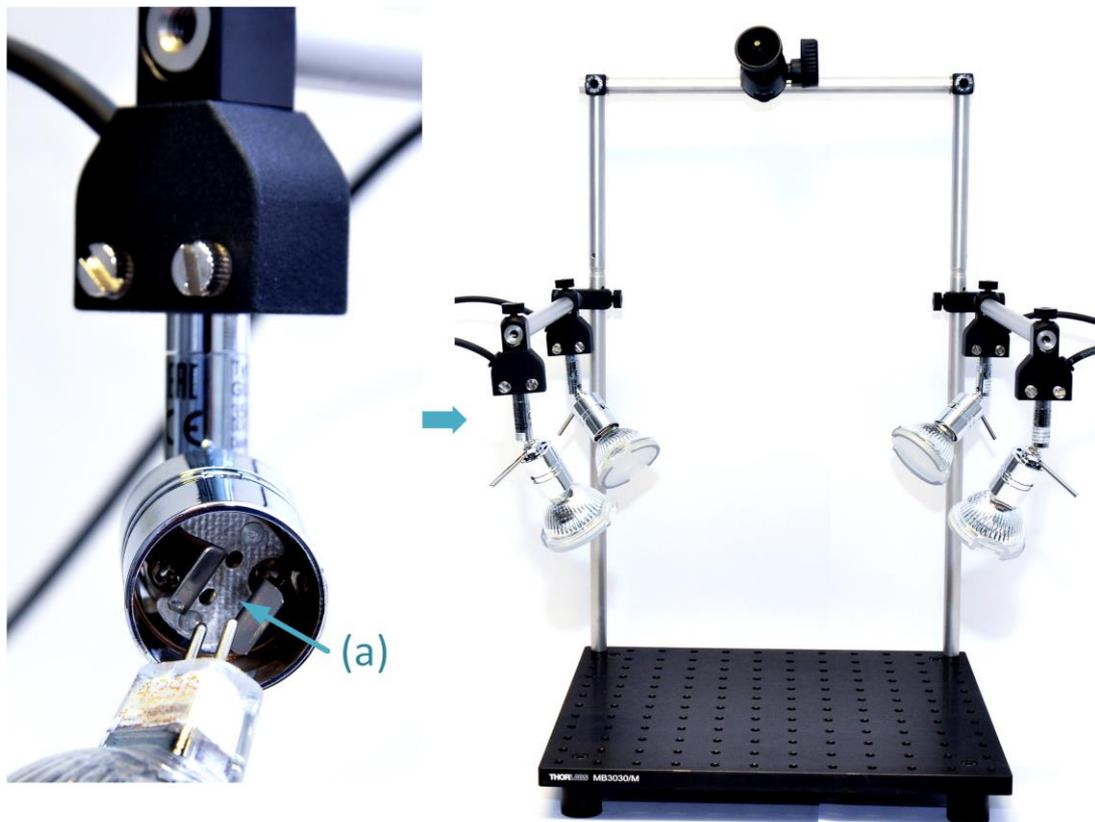


Figure 30 Mounting the lamps into the holders (Step 4.4)



Step 4.5 Adjust the height of the lamp posts (Figure 31)

- a. The height of the lamps can be adjusted by moving the lamp holding posts up and down along the vertical posts (as indicated by red arrow in Figure 31)

 The recommended height is shown in Figure 31. You can choose a suitable height depending on your application needs.

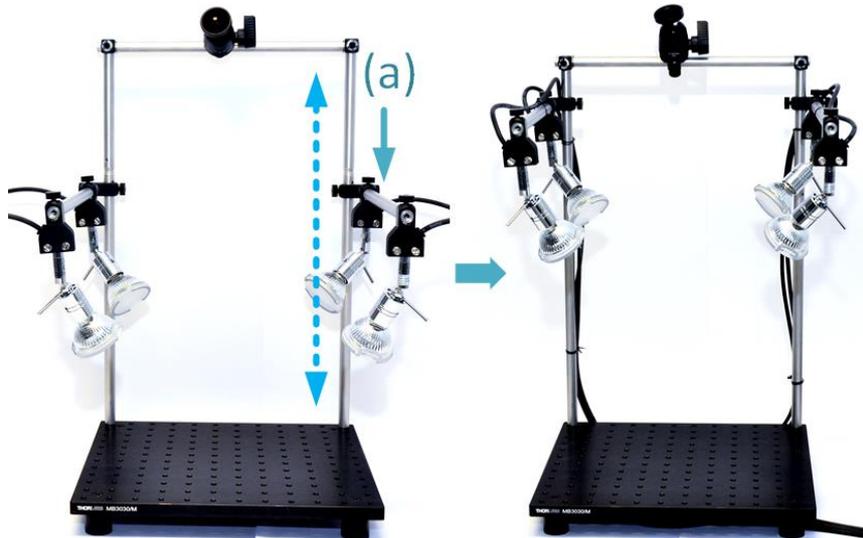


Figure 31 Adjust height of lamps depending on application needs (Step 4.5)

Step 4.6 Tie up the loose wires to the post (Figure 32)

- a. We recommend users to tie up the loose wires to the mounting posts, as shown by the blue arrows in Figure 32.



Figure 32 Tying up the loose wires to the mounting posts (Step 4.6)



3.1.5 Step 5 - Mount the snapscan camera

Required items

Ref. No	Components	Quantity	Packaged
01	snapscan camera	1	Box 1
03	Schneider-Kreuznach lens	1	Box 1

Procedure

Follow the steps below to mount the snapscan camera on to the setup, as shown in Figure 33.

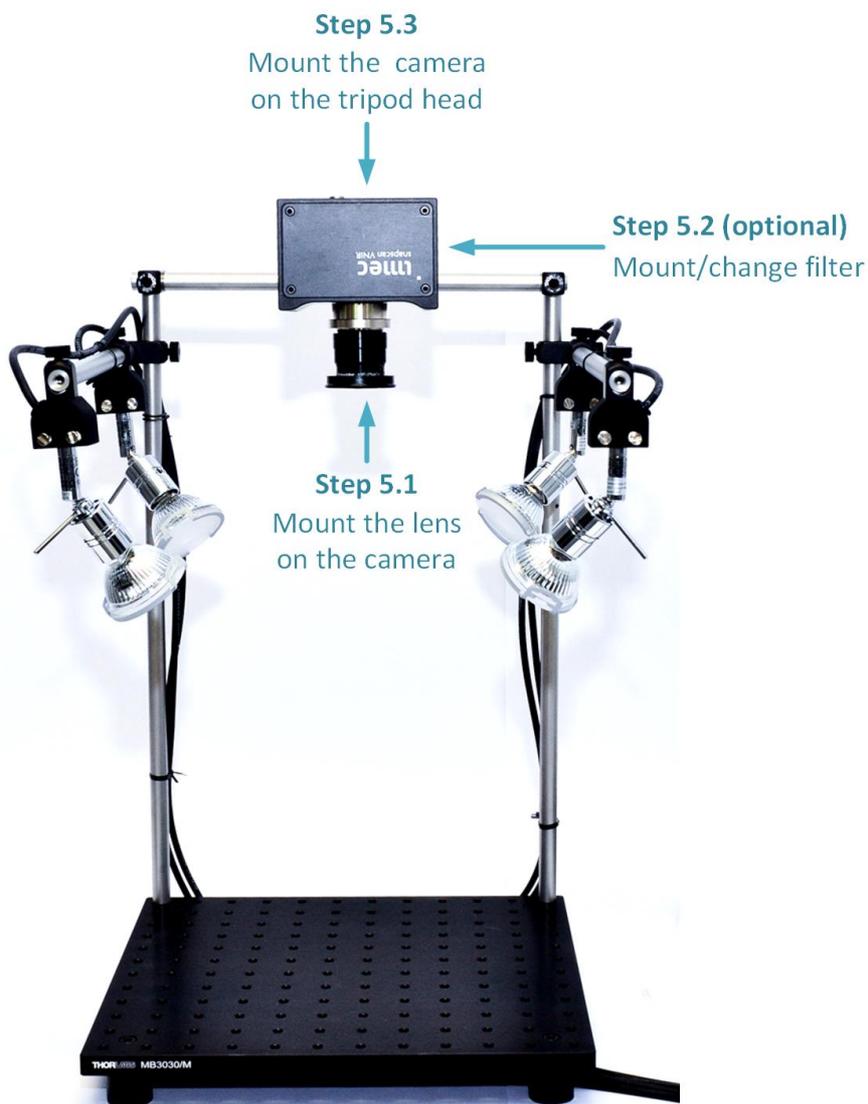


Figure 33 Mounting the snapscan camera on to the setup (Step 5)



Step 5.1 Mount a lens on the snapscan camera (Figure 34, Figure 35)

- a. Place the snapscan camera on a horizontal flat surface and remove the body cap of the camera
- b. Remove the rear cap of the lens
- c. Insert the rear of the lens into the c-mount of the camera and turn it clockwise to secure the lens on the camera body.

- i** It is recommended to leave the front cap on the lens until the system is fully assembled.
- i** Do not forget to remove the front cap of the lens when using the system.
- i** It is strongly recommended to put back the front cap on the lens when the system is not in use.



Figure 34 Mounting lens on the snapscan camera (Step 5.1)

- d. If the lens has an aperture locking screw, unlock the screw, turn the aperture ring to set the lens aperture and lock the screw.
- e. If the lens has a locking ring, unlock the locking ring with a hex key. Rotate the lens in or out until the correct focus is achieved. It is important to make sure that the lens remains fixed in the C-mount and only the lens body is rotated. Lock the locking ring with a hex key.

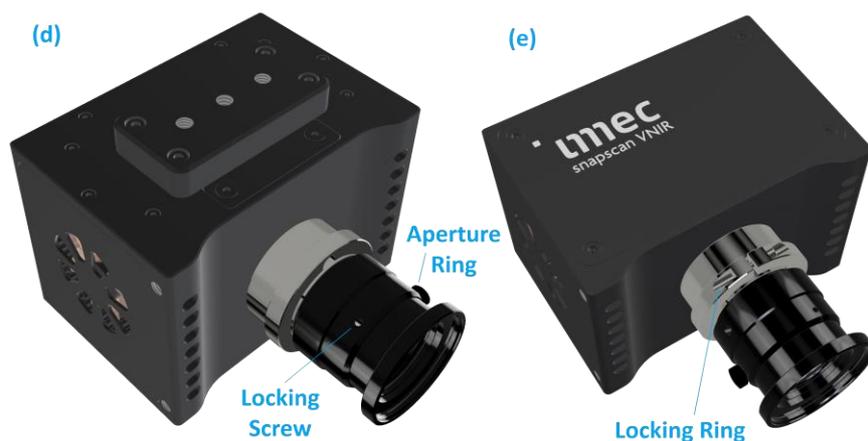


Figure 35 Focusing and setting the aperture of the lens



Step 5.2 Mount the snapscan camera on the tripod head (Figure 36)

- The tripod adapter plate on the bottom of the snapscan camera provides a threaded hole to which the tripod head can be affixed. Align the hole on the camera to the screw on the tripod head.
- Rotate the tripod screw to tighten the screw to affix the camera to the tripod head. You may use the lock/unlock level on the tripod head to adjust the position of the ball head.
- Unlock the post clamp screw to adjust the tripod head on the mounting post such that the camera body is parallel to the base plate and lock it again. Make sure to tighten the screw properly to avoid tripod head rotating down due to camera's weight.

⚠ You will require imperial allen key size 3/16" for the post clamp screw

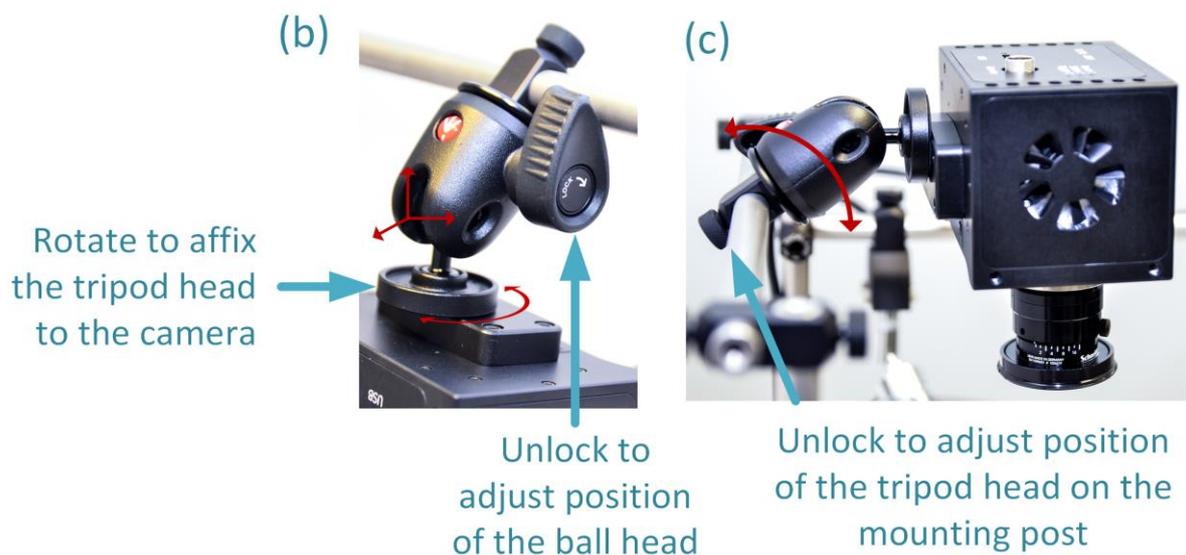


Figure 36 Mounting of snapscan camera on to the tripod head (Step 5.2)



3.1.6 Step 6 - Connect the lamps to the power supply

Required items

Serial No	Components	Quantity	Packaged
18	Tunable stabilized DC power supply	1	Box 2
19	Tunable stabilized DC power supply power cable	1	Box 2

Procedure

Follow the steps below to connect the lamps to the power supply and test, as shown in Figure 37.

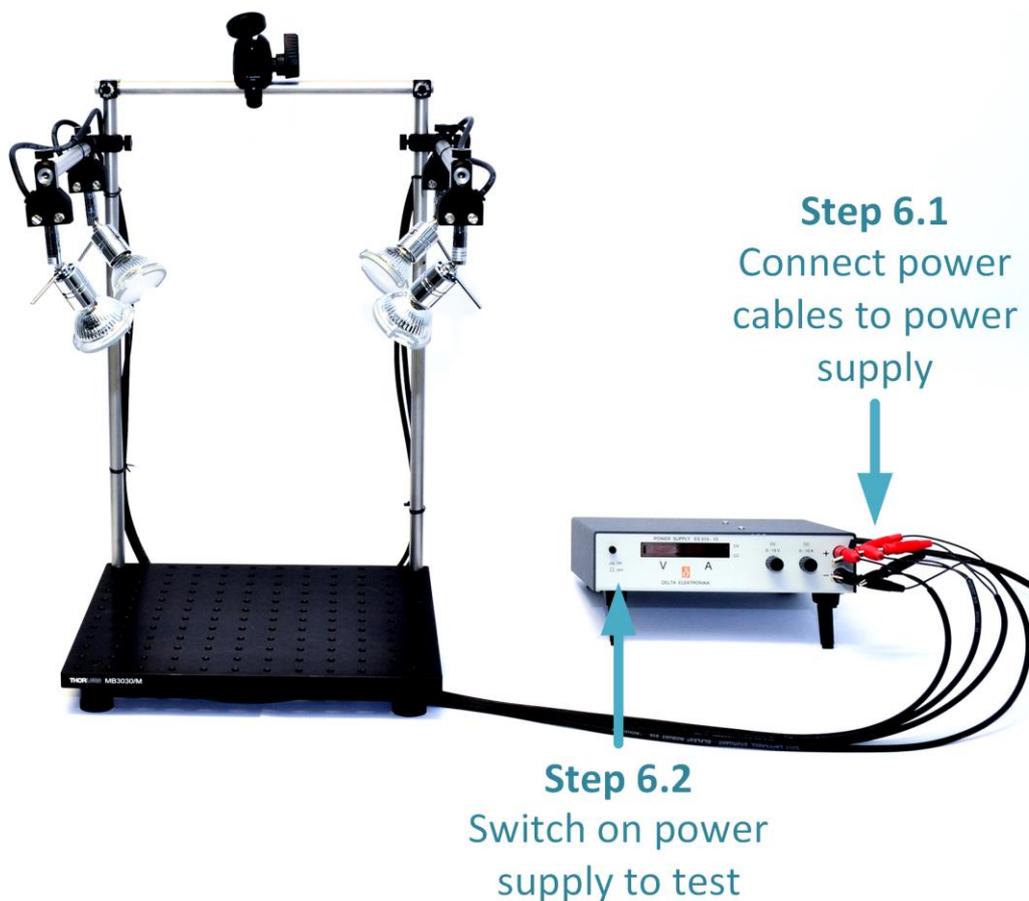


Figure 37 Connecting lamps to power supply and testing (Step 6)

Step 6.1 Connect power cables to power supply (Figure 38)

- Connect the 4 pairs of red and black connectors corresponding to the 4 lamps to the output of the power supply, as shown in the Figure 38.





Figure 38 Connecting lamps to the power supply (Step 6.1)

Step 6.2 Test the connection (Figure 39)

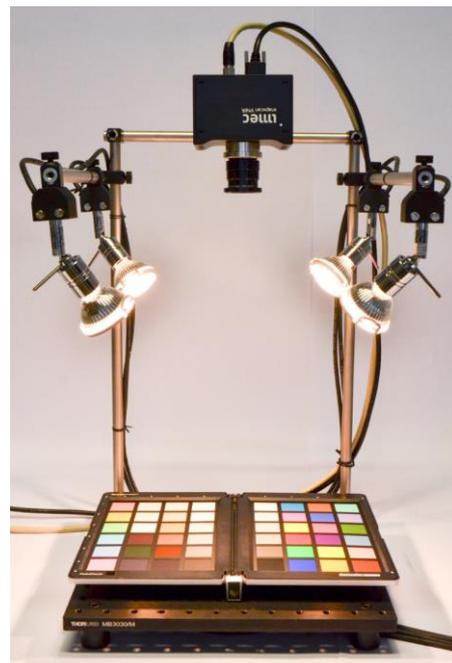
- a. Switch on the power supply and set the output voltage at 12V.
- b. If all the connections have been correctly done, all 4 lamps should illuminate.

i You can switch off the power supply once the test is done.

i While using the system for acquiring data, the lamps need to be switched on for at least 15 minutes to allow them to warm up and stabilize.



(a)



(b)

Figure 39 Test the power connection for the lamps (Step 6.2)



3.1.7 Step 7 - Connect the camera to the controller and PC

Required items

Serial No	Components	Quantity	Packaged
02	snapscan controller	1	Box 1
07	snapscan controller adapter	1	Box 1
08	snapscan controller adapter power cable	1	Box 1
05	snapscan 16-pin cable	1	Box 1
04	USB 3.0 cable (3m)	1	Box 1
06	USB 2.0 cable	1	Box 1

Procedure

Follow the steps below to connect the snapscan camera to the controller and the PC, as shown in Figure 40.

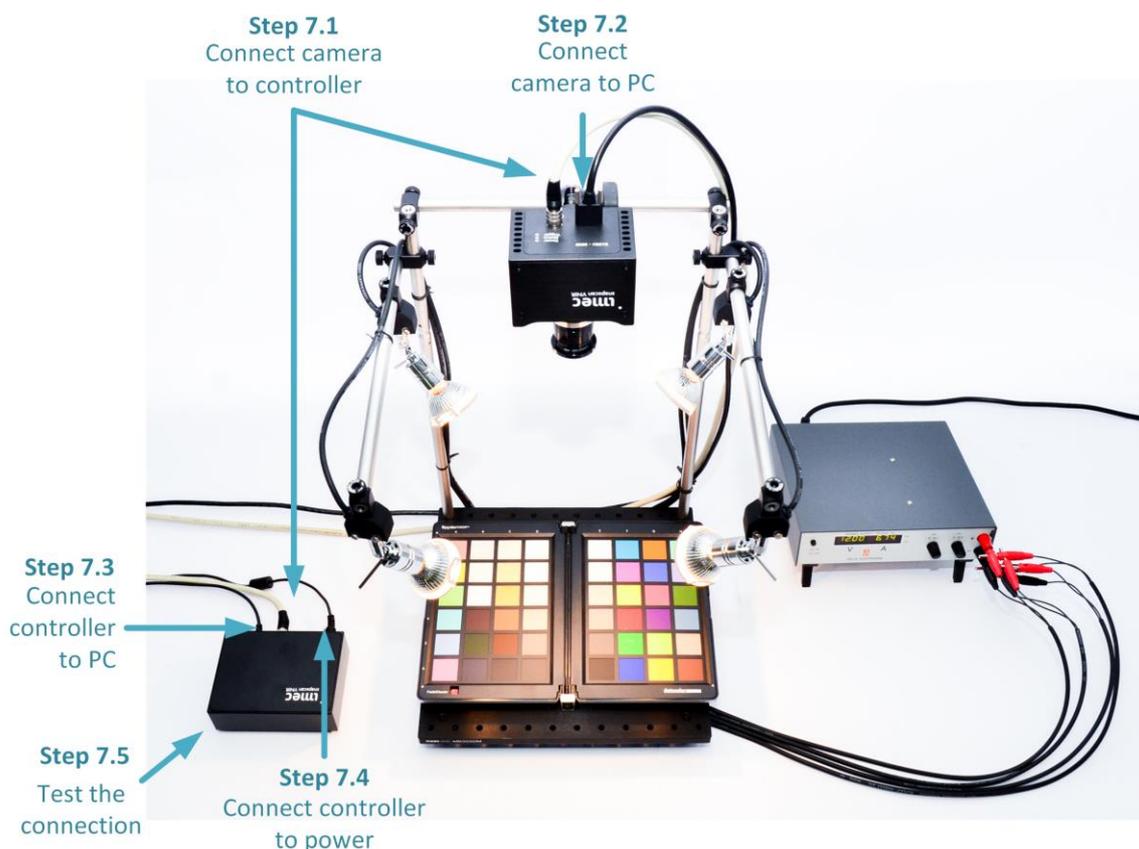


Figure 40 Connecting camera to controller and PC (Step 7)



Step 7.1 Connect camera to controller

- a. The 16 pin scapscan cable has male and female connectors on the two ends. Connect the female side to the camera, as shown in Figure 41.



Figure 41 Connecting the 16pin scapscan cable to the camera (Step 7.1a)

- b. Align the notch in the connector of the cable to the notch in the connector of the camera (as shown in Figure 42) and push the cable in place.



Figure 42 Align the notch on the cable connector to the notch in the camera connector (Step 7.1b)



- c. Lock the connector by turning the threaded ring, as shown in Figure 43.



Figure 43 Locking the snapscan controller cable in the camera's connector (Step 7.1c)

- d. Align the notch in the connector of the cable to the notch in the connector of the controller, as shown in Figure 44.



Figure 44 Align the notch on the cable connector to the notch in the controller connector (Step 7.1d)



- e. Push the cable connector into the controller connector and lock the connector by turning the threaded ring, as shown in Figure 45.



Figure 45 Connecting the snapscan 16 pin cable to the snapscan controller (Step 7.1e)

Step 7.2 Connect the snapscan camera to PC (Figure 46)

- a. USB 3.0 cable is used to connect the spanscan camera to the PC. The USB 3.0A connector is the PC side and USB 3.0 micro-B connector is the camera side. Align the USB 3.0 micro-B connector to the port on the back of the snapscan camera, as shown in Figure 46a.
- b. Push the USB 3.0 micro-B connector into the camera's USB port (Figure 46b)
- c. Lock the USB connector by turning the threaded rings (Figure 46c)



Figure 46 Connecting snapscan camera to the PC (Step 7.2)



Step 7.3 Connect the snapscan controller to PC (Figure 47)

- a. USB 2.0 cable is used to connect the snapscan controller to the PC. The USB 2.0A connector is the PC side and USB 2.0 mini-B connector is the controller side. Align the USB 2.0 mini-B connector to the port on the back of the snapscan controller (as shown in Figure 47), and push it into the port.



Figure 47 Connecting the snapscan controller to the PC (Step 7.3)

Step 7.4 Connect the power adapter to the snapscan controller

- a. Assemble the power adapter by affixing the power cable into the adapter, as shown in Figure 48.



Figure 48 Assembling the power adapter for the snapscan controller (Step 7.4a)

- b. Connect the barrel connector to the power input port on the backside of the snapscan controller, as shown in Figure 49.





Figure 49 Connecting power adapter to the snapscan controller (Step 7.4b)

Step 7.5 Test the connection

- a. Verify that all the connections are complete, as shown in Figure 50.



Figure 50 All the connections for the snapscan camera and controller (Step 7.5a)

- b. The connections between the snapscan camera, the snapscan controller and the PC should be as shown in Figure 51.



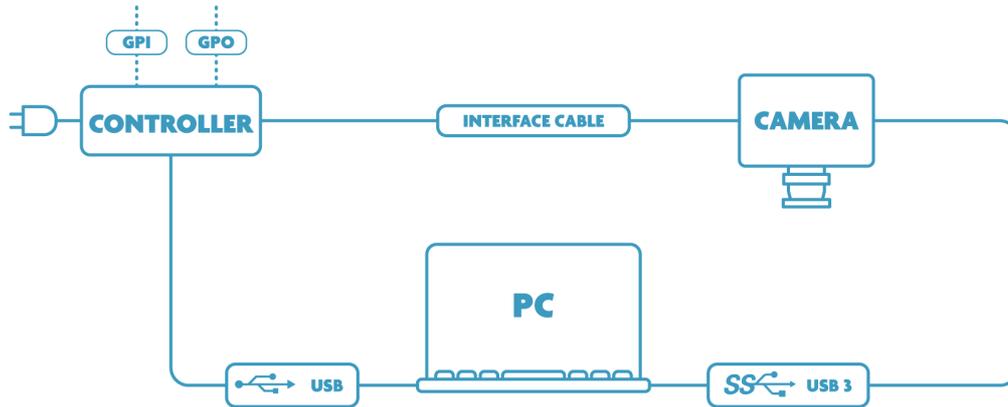


Figure 51 Connections between snapscan camera, snapscan controller and PC (Step 7.5b)

- c. Power the system by switching on the controller using the “Power” button on its rear panel (see Figure 50). If all the connections are setup correctly then the fans and the lights of the camera unit will switch on.



3.2 Troubleshooting

The lamps do not work

Carry out following checks:

Check 1: Is power supply working? If not, then check if-

- power cord is plugged in
- power supply is turned on

Check 2: Are the lamps properly inserted in the sockets? If not, then press the lamps deeper into the sockets. (see step 4.4)

Check 3: If the cables attached to the lamp holders are connected to the power supply in the correct way (see step 6.1)

Check 4: If the voltage and current is set correctly (see Step 6.2)

The controller does not work

Check if the red power LED of the controller is lit or not. If not, then check if

- the power supply is plugged in
- the controller is turned on

The camera does not work

Check if the power and status LED on the back of the camera are lit or not. If not, then check the following:

- USB3.0 cable is connected to the camera and a PC
- custom 16-pin cable is connected to the camera and the controller
- controller is connected to a PC via the USB2.0 cable
- USB ports of the PC are functioning properly
- controller is turned on

The diffuser is attached loosely to the halogen lamp

Remove the diffuser and holder from the lamp, press the holder's handles further inward to ensure a better fit and clip back on the lamp.

When handling the camera body it sounds like something is loose inside the camera

Check if the filters in the filter cassette are locked in place.



The camera makes a clicking sound after it is connected and during scanning

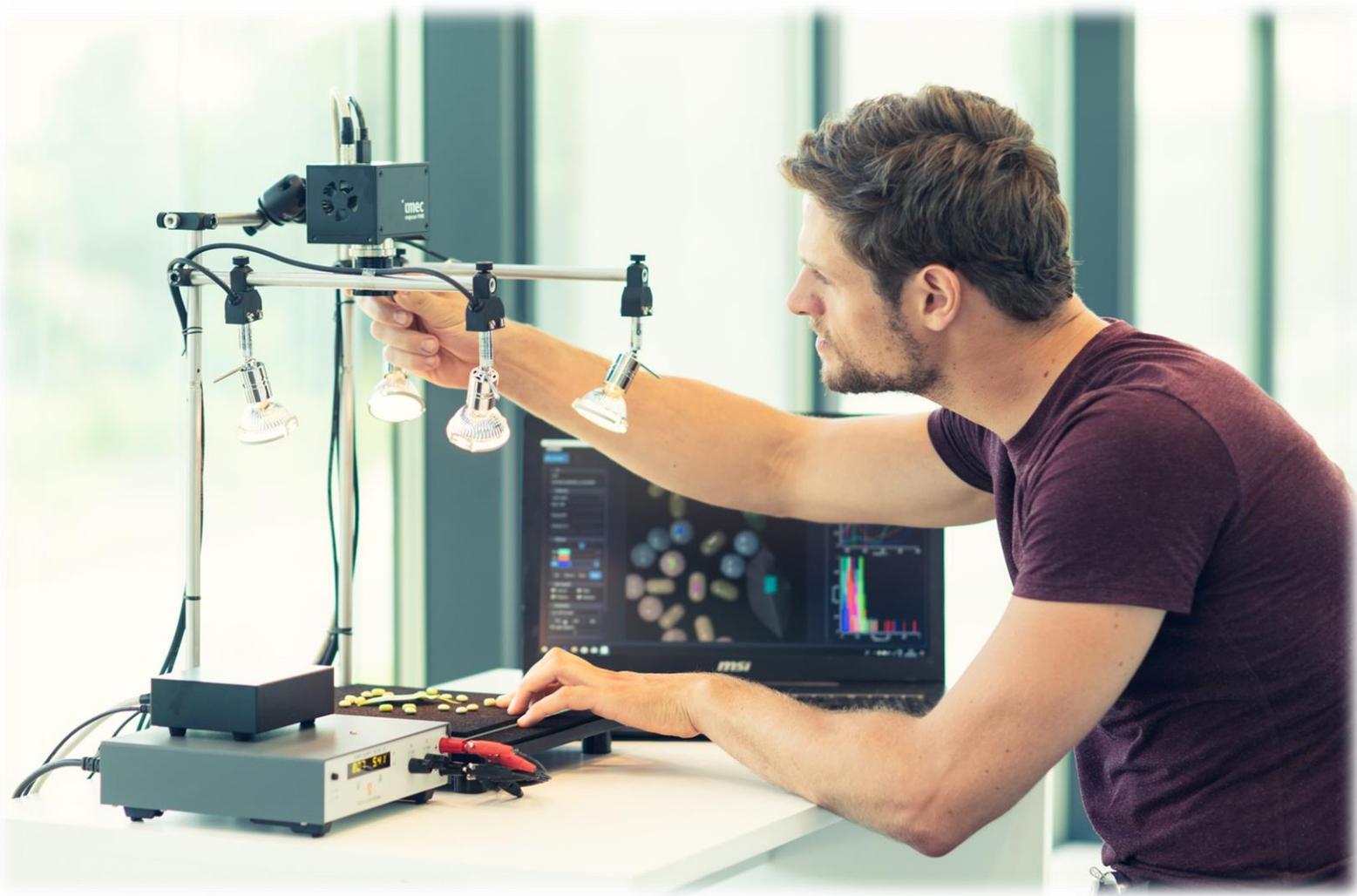
This is normal. The camera shutter will cycle after connection and before starting a scan. During a scan the translation stage is moved internally, which can also lead to audible clicking.

Contact imec HSI support if the problem persists or for any other problems:

Email: hsisupport@imec.be

Website: <http://hsisupport.imec.be>







Chapter 4

Hardware Manual

4. Hardware manual

4.1 Mechanical specifications

4.1.1 External controller dimensions

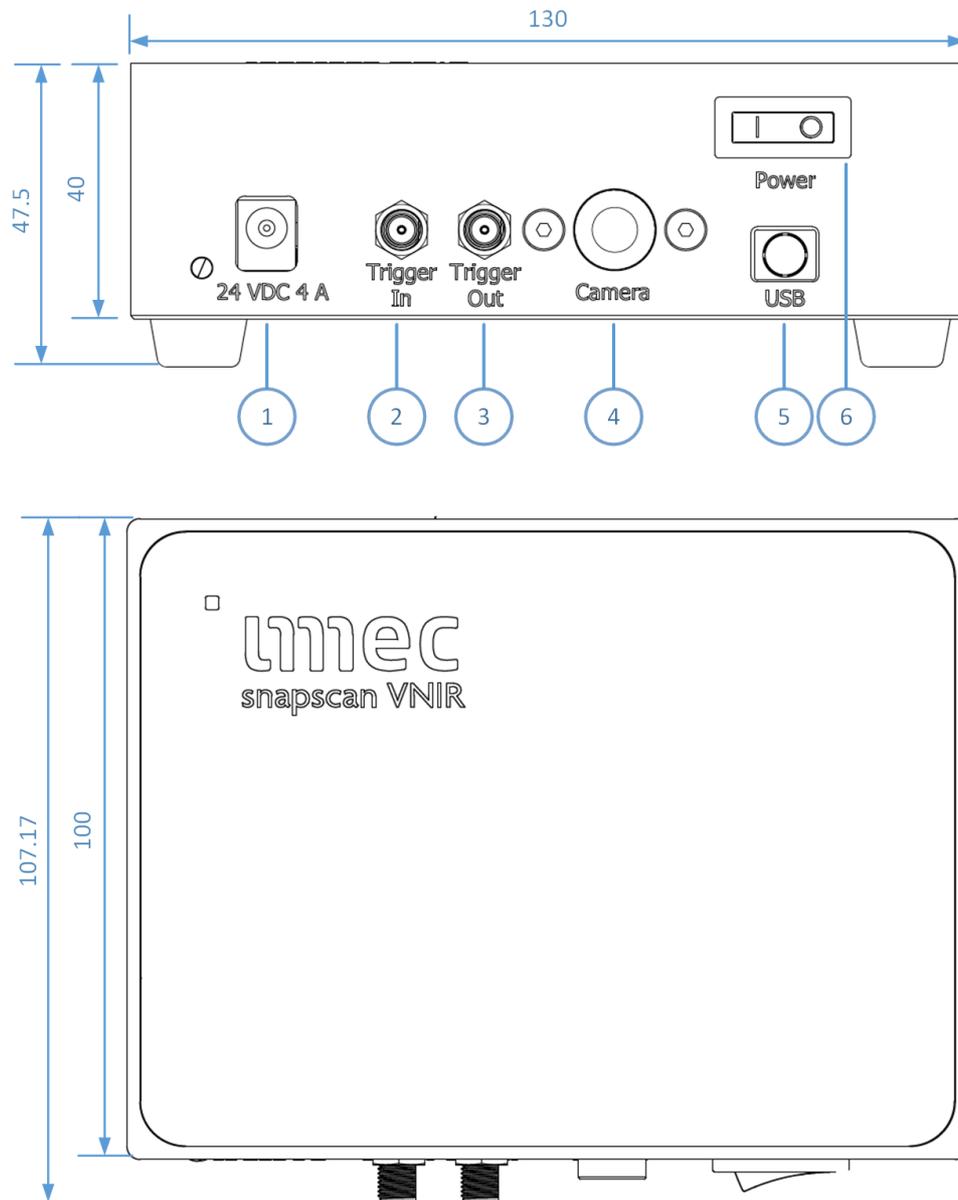


Figure 52: External dimensions of the snapscan controller and I/O in the back panel (all dimensions are in millimeter)

1	24 VDC 2.7A power input	4	Camera port (16-pin Hirose female)
2	Trigger In (female SMA)	5	USB 2 interface (Mini-B)
3	Trigger Out (female SMA)	6	Power switch



4.1.2 Camera dimensions

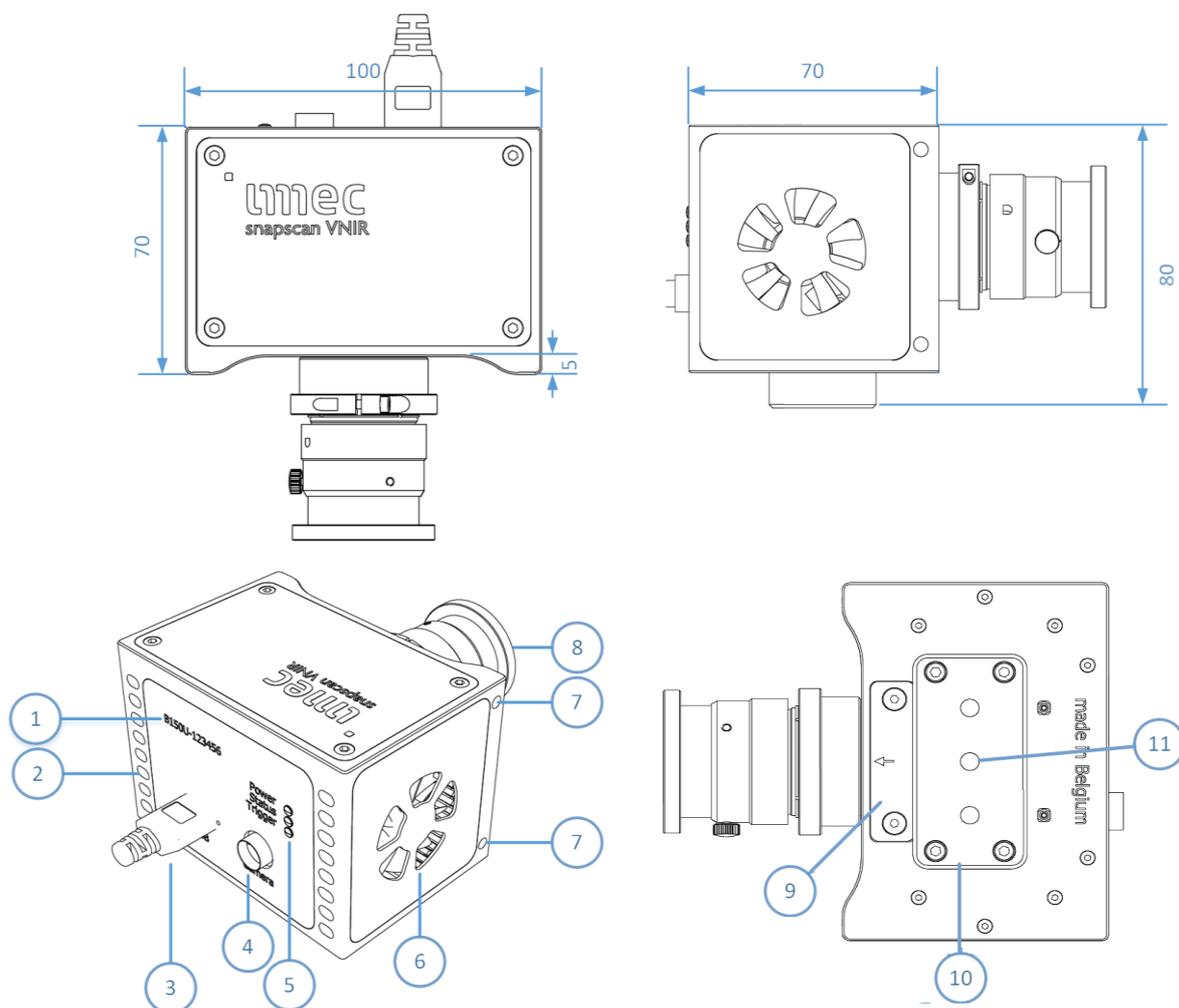


Figure 53 External dimensions of the camera body (all dimensions are in millimeter)

1	Camera serial number	7	Mounting holes
2	Air vents	8	Lens
3	USB 3 connector	9	Filter cassette
4	Camera port (16-pin Hirose female)	10	Tripod adapter plate
5	Indicator LEDs	11	Tripod mounting hole
6	Cooling fan		



4.1.3 Flange focal distance

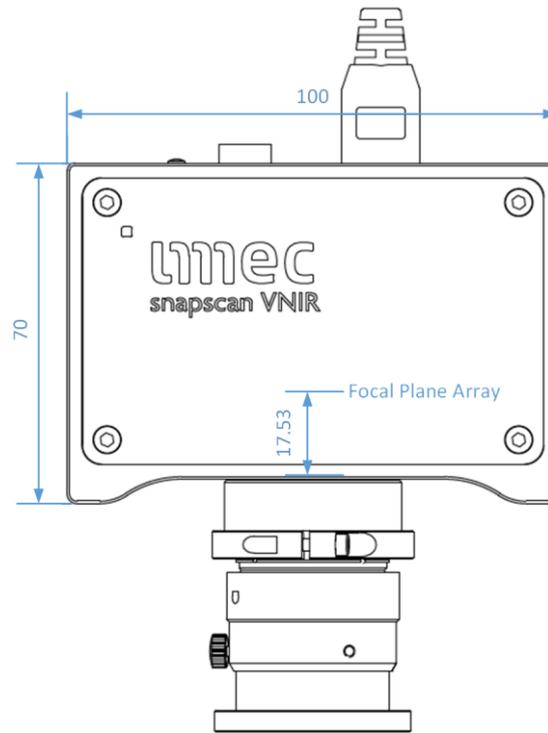


Figure 54 Flange focal distance, i.e. distance between the image sensor and the lens mount (all dimensions are in millimeter)

4.1.4 Camera mounting options

4.1.4.1 Tripod adapter plate

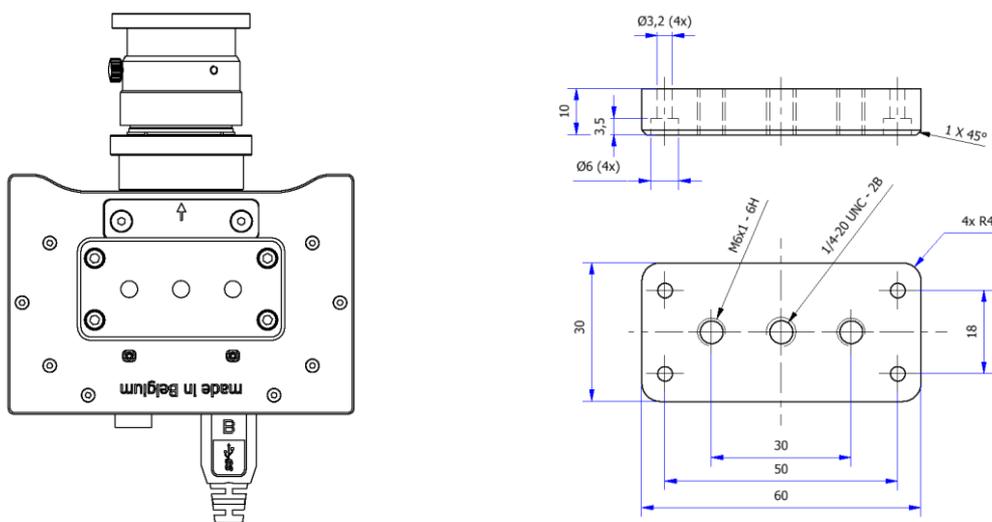


Figure 55: Top and side views of the tripod adapter plate along with its dimensions (all dimensions are in millimeter)

4.1.4.2 Mounting holes on the bottom of the camera

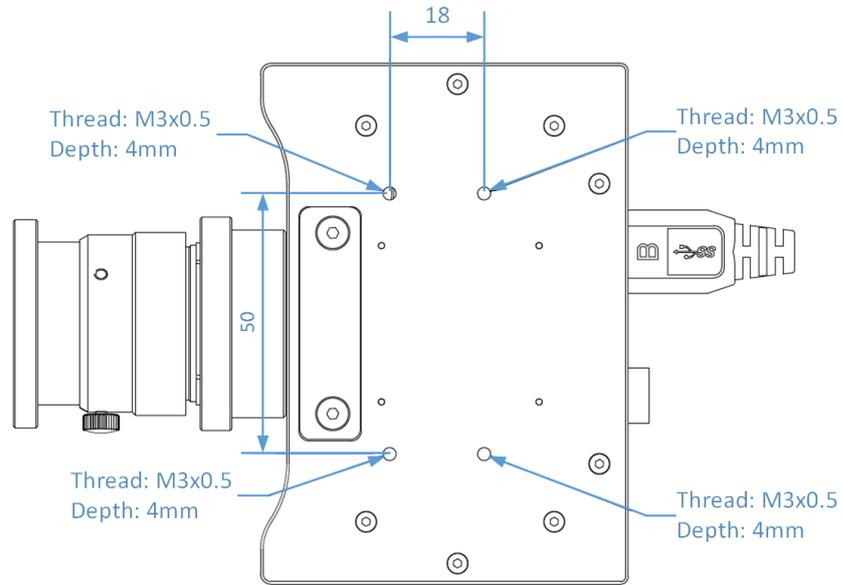


Figure 56 Bottom view of the snapscan camera showing the 4 mounting holes (all dimensions are in millimeter)

⚠ The mounting screws should not go deeper than 4mm in the holes. It can damage the internals of the camera.



4.1.4.3 Mounting holes on the sides of the camera

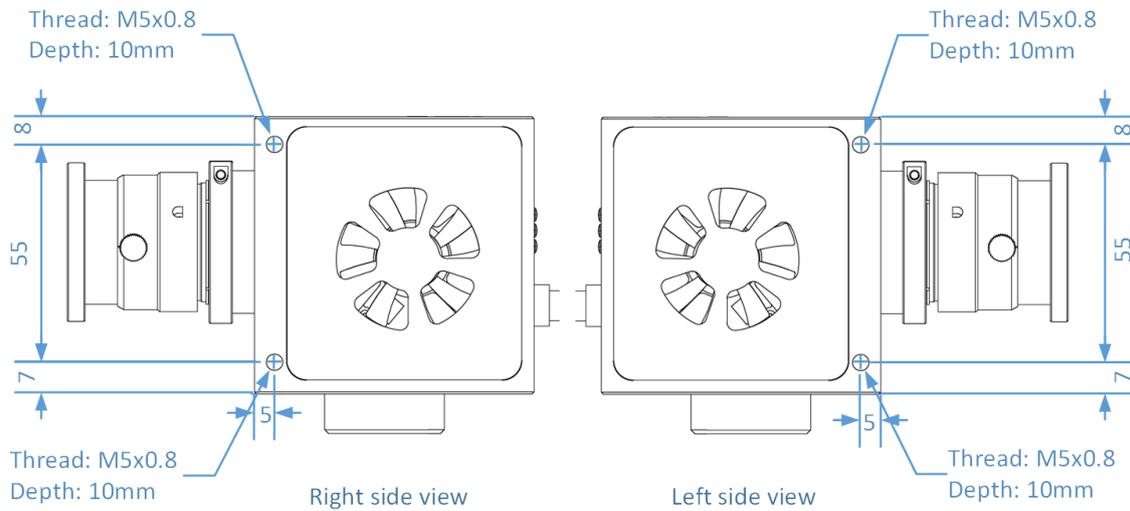


Figure 57: Side views of the snapscan camera along with dimensions and the available mounting holes (all dimensions are in millimeter)

4.1.5 Filter cassette dimensions

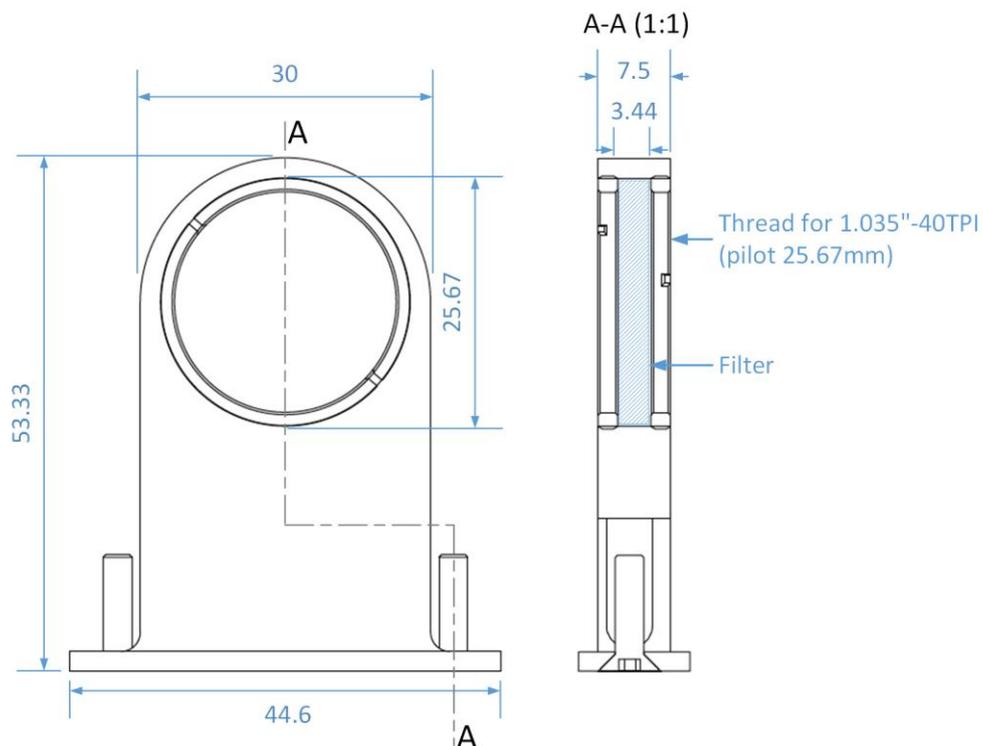


Figure 58: Front and side views of the filter holder along with its dimensions (all dimensions are in millimeter). The optical filter will be placed between two retaining rings, as indicated. The filter diameter is 25.4mm and maximum thickness is 3.44mm.



4.2 Electrical specifications for snapscan controller's GPIO interface

Table 6 Overview of output parameters for the controller (Trigger output)

Output parameters	Values
Frequency	Synchronized with camera frame acquisition
Output pulse	50 ns in continuous scanning mode 10 ms in discontinuous scanning mode
Max output frequency	1700 Hz
Voltage levels	0-5 V TTL
Opto-coupled	Yes
Fuse	No
Max. current	10 mA
Logic	Pull down
Visual indication	Trigger LED flashes red

Table 7 Overview of input parameters for the controller (Trigger input)

Input parameters	Values
Function	Can be used to start the acquisition
Minimum duration of input pulse	50 ms
Voltage levels	0-5 V TTL
Opto-coupled	Yes
Fuse	No
Max. current	10 mA
Logic	Pull down

⚠ High voltage 71V DC. When removing the interface cable between controller and camera, actuators inside the camera can stay charged for several hours. Temperature changes can also induce charges on the internal actuators.

4.3 Operating conditions

- The snapscan system is intended to be used in a lab environment.
- Always ensure that the camera is connected and mounted correctly before operation.
- Never operate the camera without lens or without filter cassette.
- Only use the power supply and cables provided with the system.
- Respect the electrical specification when connecting to the GPIO ports.



4.4 Storage conditions

The snapscan system is delivered in a ruggedized plastic case. The camera should be stored in this case when not in use. Please ensure that you always place the camera, lens, controller box and its main cables back in this case for safe storage. Use the provided lens, C-mount and connector caps when storing the system.

⚠ Please note that, while this plastic storage case is highly resistant to vibrations, impact due to falls, high and low temperatures, the camera and the components are not. Subjecting the camera unit or any of the included components to excessive vibrations, impact due to falls or extreme temperature outside the specified ranges might cause a damage even when they are inside the storage case.

4.5 Maintenance tips

4.5.1 Preventive maintenance

- Do not use the camera when the filter cassette or lens is removed
- Do not leave the camera lens mount uncovered after the lens is removed. Immediately cover it with the provided C-mount cap.
- When removing the filter cassette, take following steps to avoid the dust from entering the system
 - Cover the filter cassette slit
 - Rest the camera with the filter cassette slit facing down
- Take special care not to damage the connectors
- Secure the USB connector on camera by tightening the screws
- Protect the camera system from water and excess humidity
- Protect the camera system from vibrations, while in operation and during storage
- Do not touch the filters, sensor and shutter.
- Always use the camera with the controller it was delivered with. Using a different controller may irreversibly damage the camera.

4.5.2 Regular maintenance

- Clean the lens input port on a regular basis with a clean micro tissue.
- Remove dust from fans with a camera dust blower.
 - Do not use a vacuum cleaner or apply air forcefully.

4.5.3 Corrective maintenance

- Contact imec HSI support for case specific support.
- Specialty maintenance at imec is available upon request.
- In case of particle contamination in the optical system:
 - Sensor cleaning should not be performed by the user.
 - Clean the lens output port with a clean cotton swab.
 - Clean filter in the filter cassette with a clean cotton swab.

⚠ Opening the camera or controller voids the warranty. Special precautions have been taken to make this noticeable.







Chapter 5

Applications

5. Applications

We provide here a few examples of applications for which our customers and partners are using the snapscan camera system. Besides these applications, snapscan can be used in a wide range of other applications such as forensics, agriculture, quality control in industrial processes, waste sorting, food & feed analysis, etc.

5.1 Microscopy

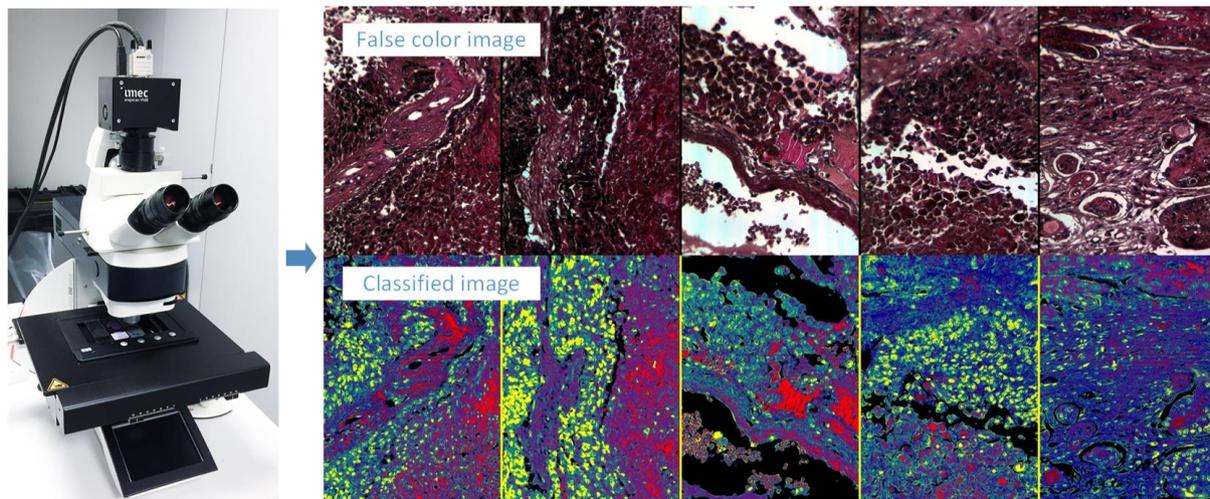


Figure 59 snapscan camera mounted on a Leica microscope and example of histopathology samples for H&E stained lung cancer (image courtesy: Hyperspectral Intelligence Inc³)

The snapscan camera can be mounted on microscope, as shown in Figure 59. This enables high spectral and spatial resolution hyperspectral imaging of samples examined under microscopes. Figure 59 shows an example of histopathology samples for H&E stained lung cancer for which hyperspectral images were obtained at more than 150 spectral bands and the spatial resolution for each band is 7Mpx.

Snapscan makes it easy to setup hyperspectral imaging for microscopy and acquire high quality at a fast acquisition speed. Care must be taken to select the right components (illumination and optical lenses) and also to carry out system calibration and white balancing correctly. Please contact [imec HSI support](#) for further details.

5.2 Fundus imaging

The snapscan camera can also be integrated with fundus cameras. In a manner similar to microscopy, snapscan enables high spectral and spatial resolution hyperspectral imaging of retina. Please contact [imec HSI support](#) for further details.

³ <https://www.hyperspectral-intelligence.com/>



5.3 Skin/ wound imaging

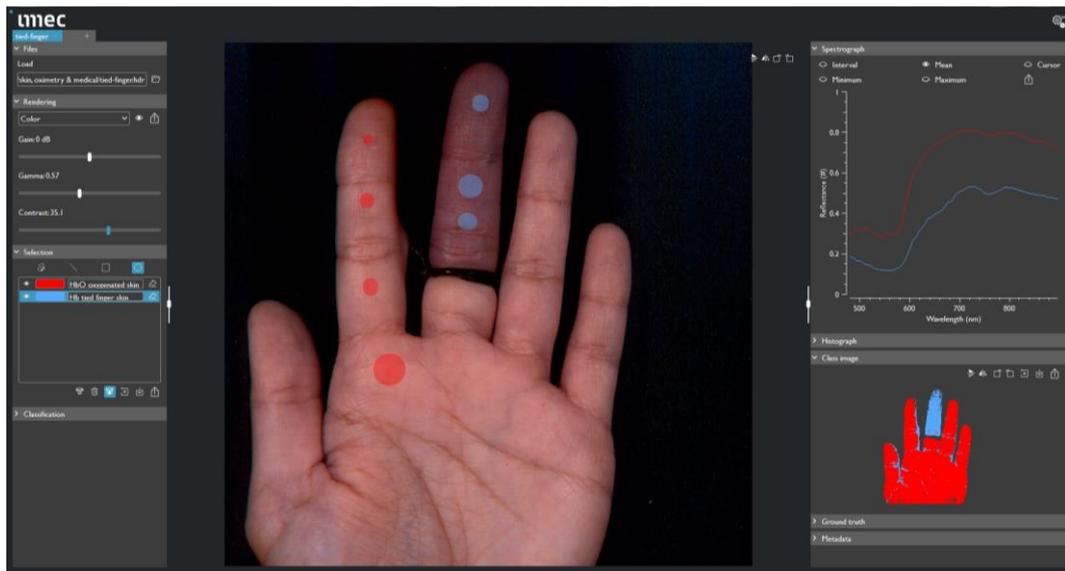


Figure 60 Example of skin oximetry. The blood flow to the upper part of the middle finger is restricted by tying the finger. The difference in oxygenation levels in the index finger and the tied finger results in differences in their respective spectral responses. This can be used to generate oxygenation maps, as shown in the classified image on the right-hand side.

The snapscan camera system can be used for health and medical applications, such as skin imaging, wound imaging, etc. The spectral range of snapscan covers several important skin/tissue biomarkers such as oxygenated/ de-oxygenated hemoglobin, hemoglobin, fat, hydration, etc. Please contact [imec HSI support](#) for further details.



5.4 Outdoor imaging

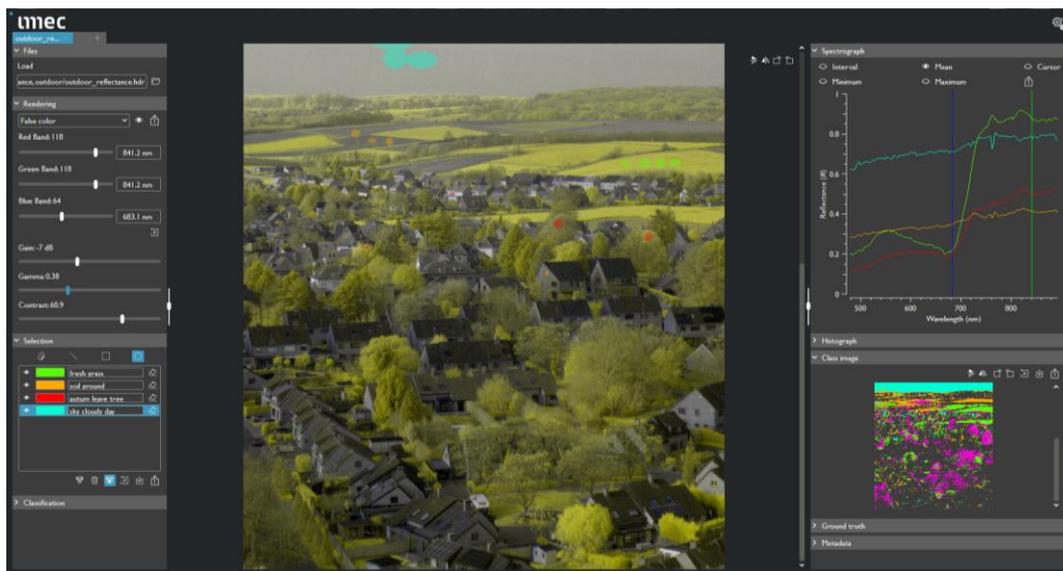


Figure 61 Example of pseudo NDVI image of an outdoor scene

The snapscan camera system can be used for outdoor imaging where natural light is used as the illumination. Care must be taken to correctly carry out system calibration and white balancing. Please contact [imec HSI support](#) for further details.

5.5 Art & antiquities conservation

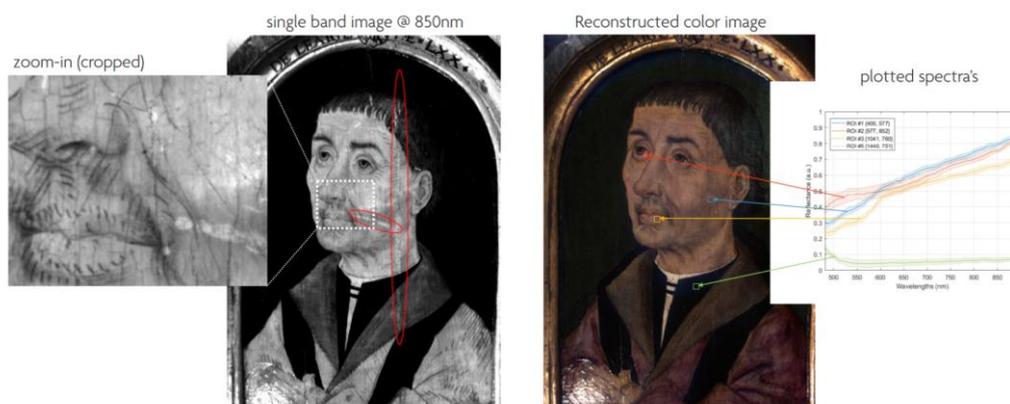


Figure 62 Digitize artwork to generate preliminary study information on exact color and pigment information used by the original painter. Courtesy Prof. dr. Maximilian Martens, Dept. Art History, Musicology and Theatre Studies, Ghent University. Painting – portrait of Jean Wouters, collection of Jan Muller.

Combined VIS-NIR spectral range, high spatial and spectral resolution of the snapscan camera system allows art and antiquities conservators to extract exact color and pigment information. Please contact [imec HSI support](#) for further details.



5.6 Mineralogy



Figure 63 Spectral analysis of iron ore to determine the iron content as well as distribution for grading the ore.

Combined VIS-NIR spectral range, high spatial and spectral resolution, dust-proof and robust construction and on-board cooling of the snapscan camera system also makes it suitable for use in outdoor and dusty environments, such as ore extraction mines or ore analysis labs. Please contact [imec HSI support](#) for further details.

5.7 Pharmaceuticals

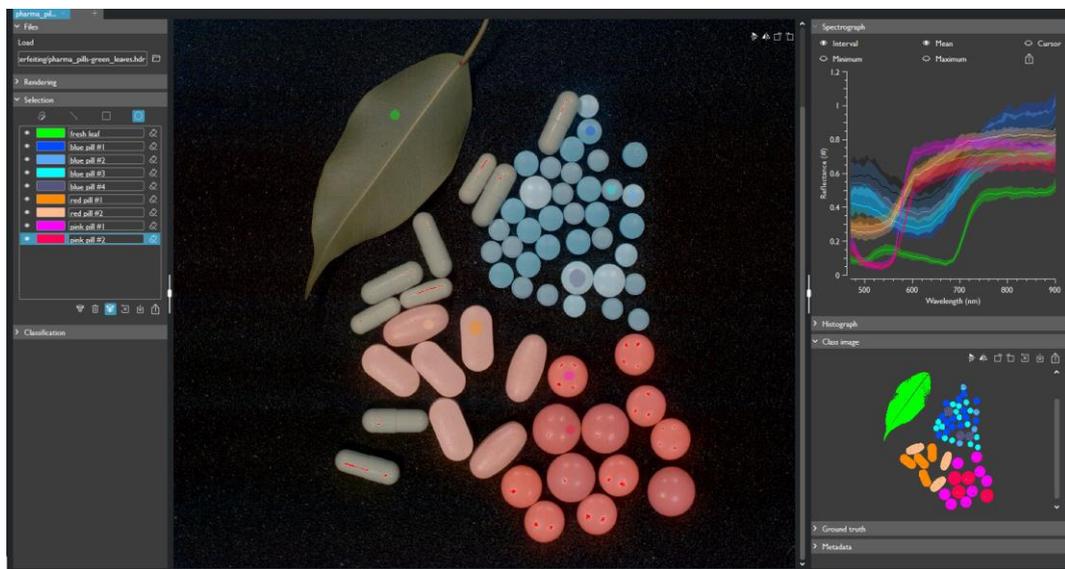


Figure 64 Example of differentiating similar looking pharmaceutical pills.

Combined VIS-NIR spectral range and ability to optimize spatial and spectral resolution along with scanning speed of the snapscan camera system enables non-destructive inspection of the pharmaceutical products for quality control, composition analysis as well as differentiating



similar looking products. Snapscan camera system can also be used to identify counterfeit drugs. Please contact [imec HSI support](#) for further details.

5.8 Food quality grading and sorting

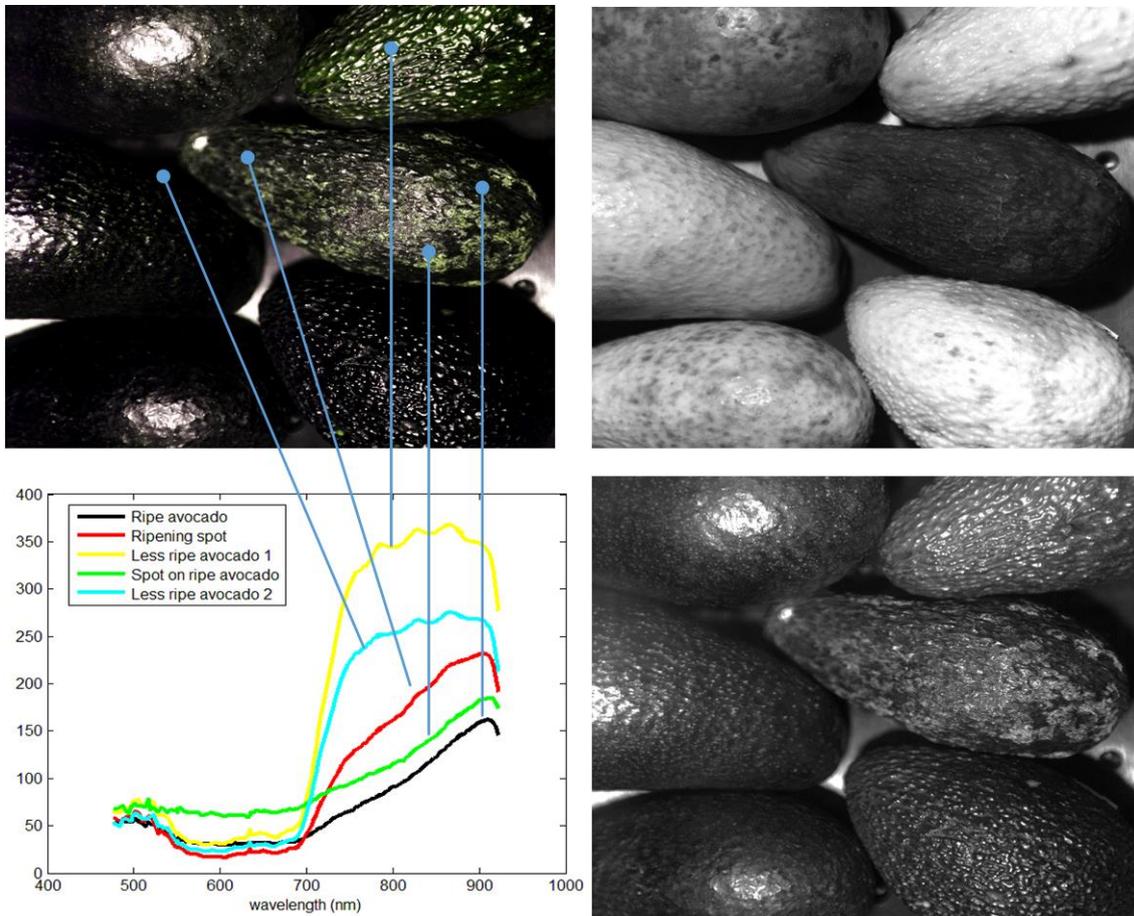


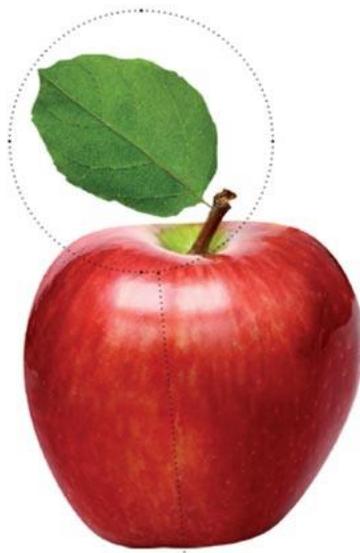
Figure 65 Detection of ripeness of avocados

The snapscan camera system enables high spatial and spectral hyperspectral imaging for food quality grading and sorting. For example, fruit growers can use it for detection of ripeness, bruises and diseases for fruits like apples, lemons, cherries, kiwis, peaches, avocados, etc. Please contact [imec HSI support](#) for further details.

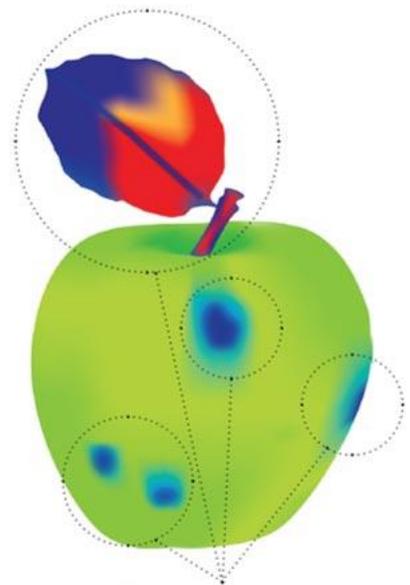




MONOCHROME IMAGING



COLOR IMAGING



CHEMICAL COLOR IMAGING



Chapter 6

Appendices

6. Appendix – Glossary and Shortcuts

6.1 Glossary

Parameter	Description
Analog gain	Gain applied when converting photons to electrons.
Cross talk	Signal in a pixel generated by electrons leaking in from neighboring pixels.
Digital gain	Gain applied when converting electrons to digital number.
Exposure / Integration time	Time during which the sensor is exposed to photons.
HDR	High Dynamic Range
SAM classifier	Spectral Angle Mapper classifier
SNR	Signal to Noise Ratio
TDI	Time Delayed Integration



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