



SNAPSCAN SWIR

HYPERSPECTRAL IMAGING CAMERA

SYSTEM USER MANUAL



Snapscan SWIR range Hyperspectral Imaging Camera System User Manual

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Contents

1. Introduction	7
1.1 snapscan HSI sensor features	9
1.1.1 High resolution and fast sensor with 100 spectral filters between 1100-1700nm	9
1.1.2 Stepped filter layout	10
1.2 snapscan camera unit features	11
1.2.1 Sensors and on-board electronics housing	11
1.2.2 Onboard cooling	11
1.2.3 Integrated software controlled mechanical shutter	12
1.2.4 High resolution (spatial and spectral) data acquisition while keeping both the object and the camera stationary	12
1.2.5 Multiple mounting options	12
1.2.6 Lens selection guidance	13
1.3 snapscan software features	15
1.3.1 Extensive data acquisition customization features	15
1.3.2 Built-in white balancing	15
1.3.3 Multiple file format options for data export options	15
1.3.4 Integrated classifier	16
1.3.5 Support for 3 rd party HSI analysis software	16
1.3.6 Multiple data visualization options	16
1.3.7 Support for multiple languages	16
1.4 snapscan API features	16
2. Working principle	19
2.1 Linescan hyperspectral camera systems	19
2.1.1 Imecc hyperspectral linescan vs Traditional hyperspectral linescan	19
2.1.2 Imecc hyperspectral linescan vs snapscan	19
2.1.3 Imecc hyperspectral camera selection guide	21
2.2 Imecc snapscan hyperspectral camera	22
2.2.1 Image acquisition	22
2.2.2 Integrated translation platform	22
2.2.3 Acquisition modes	22
2.2.4 Acquisition features for higher data quality	23
2.2.5 Image post processing	26
2.3 Illumination	28
3. Evaluation System Assembly Manual	30
3.1 Assembly steps	30
3.1.1 Step 1 - Unpack and crosscheck the contents	31
3.1.2 Step 2 - Assemble the base plate	33
3.1.3 Step 3 - Assemble the camera holder posts and tripod mount	35
3.1.4 Step 4 - Assemble the lamp holder posts and mount the lamps	40
3.1.5 Step 5 - Connect the lamps to the power supply	45
3.1.6 Step 6 - Unpack and crosscheck the contents of box 1	48
3.1.7 Step 7 - Mount the snapscan camera	49
3.2 Identify the camera unit	55



3.3	Secure the camera for transportation	56
3.4	Troubleshooting	57
4.	Hardware manual	60
4.1	Mechanical specifications	60
4.1.1	Camera dimensions	60
4.1.2	Flange focal distance	61
4.1.3	Camera mounting options	61
4.2	Electrical specifications for snapscan GPIO interface	63
4.3	Operating conditions	63
4.4	Storage conditions	64
4.5	Maintenance tips	64
4.5.1	Preventive maintenance	64
4.5.2	Regular maintenance	64
4.5.3	Corrective maintenance	64
5.	Software Installation Manual	66
5.1	System requirements for the PC	66
5.2	Software installation	67
5.2.1	perClass Mira installation	68
5.3	Software configuration	69
5.4	Troubleshooting	71
6.	Software User Manual	75
6.1	General	75
6.2	Cube acquisition mode	76
6.2.1	Connect step	76
6.2.2	Configure step	77
6.2.3	Acquire step	82
6.3	Cube display mode	88
6.3.1	View step	92
6.3.2	Export step	107
6.4	Tutorial	110
6.4.1	Basic configuration	110
6.4.2	Tuning focus, aperture and acquisition parameters	111
6.4.3	Typical acquisition scenarios and recommended parameter settings	111
6.5	Support for 3 rd party software	114
6.5.1	perClass Mira	114
6.6	Troubleshooting	115
7.	Appendix	118
7.1	Abbreviations	118
7.2	Software Changelog	118
7.2.1	Snapscan v1.4.1.0	118
7.2.2	Snapscan v1.4.0.0	118



7.2.3	<i>Snapscan v1.3.0.9</i>	118
7.2.4	<i>Snapscan v1.2.4</i>	118
7.2.5	<i>Snapscan v1.2.3</i>	119
7.2.6	<i>Snapscan v1.2.2</i>	119
7.2.7	<i>Snapscan v1.2.1</i>	119
7.2.8	<i>snapscan v1.2.0</i>	119
7.2.9	<i>snapscan v1.1.2</i>	120





Chapter I

Introduction

I. Introduction

Congratulations on your purchase of imec's snapscan SWIR system. Imec's snapscan system is a breakthrough for hyperspectral imaging application research. Within as little as a seconds, high quality hypercube datasets can be created with unmatched signal-to-noise ratio and spatial and spectral resolution. The snapscan evaluation-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 0.77Mpx) & spectral (100 bands) resolutions possible for snapshot-based SWIR 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



Figure I: Snapscan SWIR hyperspectral imaging system



The contents of the snapscan evaluation system are shown in Table 1 and the product specifications are shown in Table 2.

Table 1 Contents of the snapscan evaluation system

snapscan camera system	<ul style="list-style-type: none"> ▪ snapscan camera with integrated sensor ▪ SWIR lens (optional) ▪ USB3.0 cable and power supply ▪ case for storage
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

Table 2 Product specifications of the snapscan system

Spatial resolution	up to 1206 x 640 pixels (0.77Mpx RAW per band)
Spectral resolution	100 bands
Spectral range	1100-1700nm
FWHM	~10-15nm (collimated)
Acquisition speed	~100ms – 20 seconds, depending on acquisition parameters, lighting and object (without including pre- and post-processing time)
SNR	>up to 600:1
Software scanning modes	Software TDI (x4 stages max) Digital binning (2x2, 3x3, 4x4) Spectral Region of Interest Spatial Region of Interest
Dynamic range	13 bit
Optics	Several options available
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), 5 - 50°C (transport)
Mechanical	Integrated mechanical shutter for automatic dark counts, Tripod mount (1/4"-20) + mounting M5 holes
Dimensions (WxDxH)	9 x 9 x 15 cm
Weight	895g (camera without optics)
Input voltage	24V DC 2.7A (external controller)

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



1.1 snapscan HSI sensor features

1.1.1 High resolution and fast sensor with 100 spectral filters between 1100-1700nm

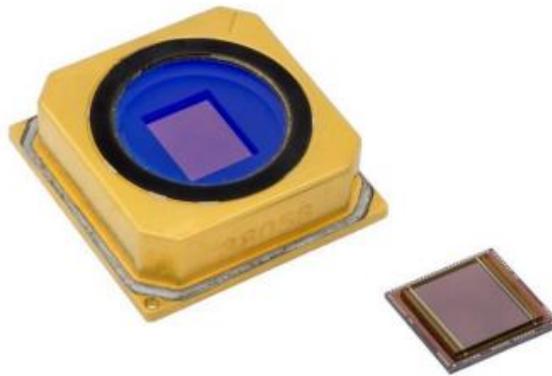


Figure 2 InGaAs sensors

The snapscan SWIR camera integrates a linescan HSI sensor based on a Cardinal 640 640x512 15um pixel pitch InGaAs Detector with digital SNIR ROIC image sensor. The key specifications of this HSI sensor are shown in the table below.

Spatial resolution – sensor	512(H) x 640(W) pixels
Spectral range	1100-1700nm
Spectral resolution	100 bands
Spatial resolution per band	up to 1206(H) x 640 (W) pixels (up to 0.77Mpx RAW per band)
Sensor frame rate	up to 350 fps (full sensor frame)
Bit depth	13bit
FWHM	~10-15nm (collimated)



1.1.2 Stepped filter layout

Physically there are 128 spectral bands on the HSI sensor. However, due to manufacturing variations, some bands can overlapping others or can be unusable. We guarantee at least 100 usable spectral bands between 1100-1700nm. There can be few extra spectral bands available which can vary across the HSI sensors.

- *Central wavelengths (CWL), FWHMs and absolute QE values indicated in Figure 3 & Figure 4 are for illustration purpose only. The actual CWL, FWHMS and peak QEs of the spectral bands are determined based on individual sensor calibration. This information can be found in the sensor calibration file provided with the camera and on the imec HSI support site.*

Specifications for the spectral bands are as follows:

Spatial resolution	4(H) x 640(W) pixels
Layout	Filters are arranged adjacent to each other in increasing order of their central wavelength

Thus, each spectral band is 4 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 1.2).

- Step sizes between 1 and 4 (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.
- 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

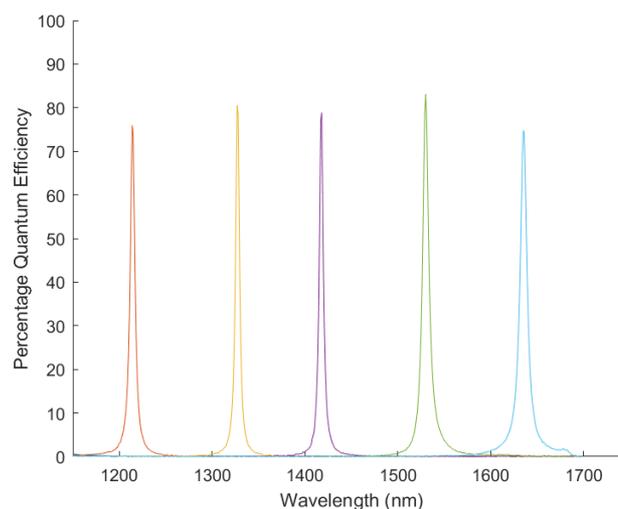


Figure 3 Subset of the spectral bands



Each of the 100 spectral filter is a narrow band filter with FWHM between ~ 10 - 15 nm. Figure 3 shows a subset of the spectral bands. Figure 4 shows the spectral response for all the filters.

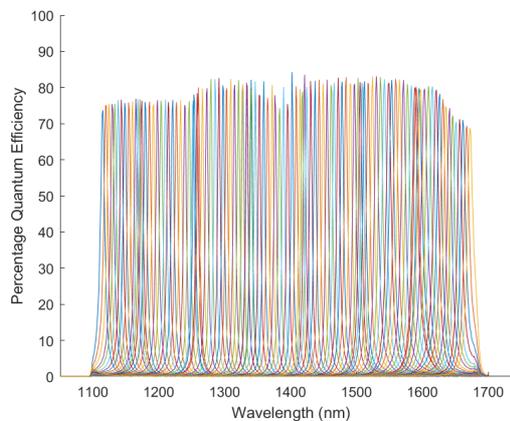


Figure 4 Spectral response for all the filters

1.2 snapscan camera unit features

1.2.1 Sensors and on-board electronics housing



Figure 5 Snapscan SWIR hyperspectral camera

The image sensor and all the on-board electronics in the snapscan camera is housed in a dust-proof chamber. The air through the air vents on the left side of the camera body is filtered.

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

1.2.2 Onboard cooling

The SWIR snapscan integrates a cooling fans, a heat sink and a thermoelectric cooler (TEC). The TEC and heat sink 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. It maintains the operating temperature of the sensor between 35°C to 45°C.

1.2.3 Integrated software controlled mechanical shutter

The SWIR 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.

1.2.4 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 is spatially translated internally during the data acquisition.

1.2.5 Multiple mounting options

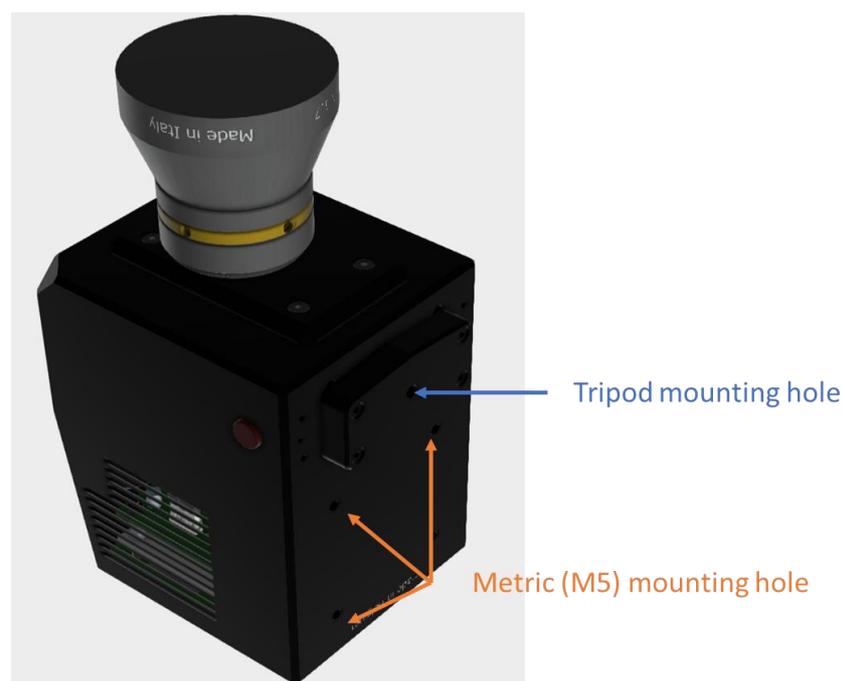


Figure 6 Mounting options 1x 1/4"-20 Tripod mount + 4x M5

snapscan camera provides two options for mounting the camera in a setup:

- Female Tripod mounting hole 1/4"-20 on the adapter plate.
- Mounting holes M5 (x6) on the bottom part of the housing (remove adapter plate for access to the last 2 M5 mounting holes).
- The Tripod mounting hole have a different thread size than the Metric mounting holes, they cannot be interchanged.



1.2.6 Lens selection guidance

The SWIR snapscan is mechanically designed to accommodate C-mount lenses with a maximum protrusion depth of 5mm. The lenses used should be designed for the 1100-1700nm spectral range.

To allow for high performance image acquisition when using the full scan range of the camera (1206 x 640 pixels) a lens with a minimum image circle diameter of 18mm should be used. If using the full scan range of the camera, a lens designed for a 4/3" sensor format is therefore recommended. When using only the central scan region, a lens with a smaller image circle (e.g. a lens designed for a 1" sensor format) may be used.

The SWIR snapscan camera houses a long pass filter between the lens and the image sensor (see Figure 8) to reject light outside the spectral range of the sensor. Due to the inclusion of a long pass filter in the optical path, the image plane is shifted by approximately 0.7mm away from sensor plane (see Figure 7). To accommodate the shift in the image plane, the use of a lens with a large depth of focus is recommended.

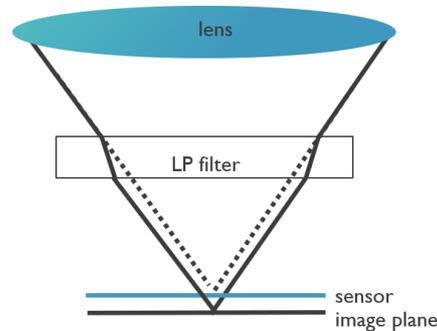


Figure 7 Shift of the image plane due to insertion of the bandpass filter.

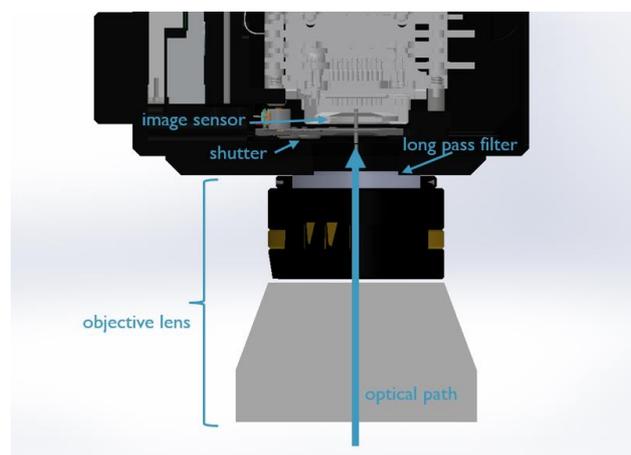


Figure 8 Optical path



If a lens with a limited depth of focus is used, the shift of the image plane can instead be compensated by including a spacer ring between the camera and the lens. The images below illustrate how a spacer ring may be inserted between the lens and the camera body. Follow these steps:

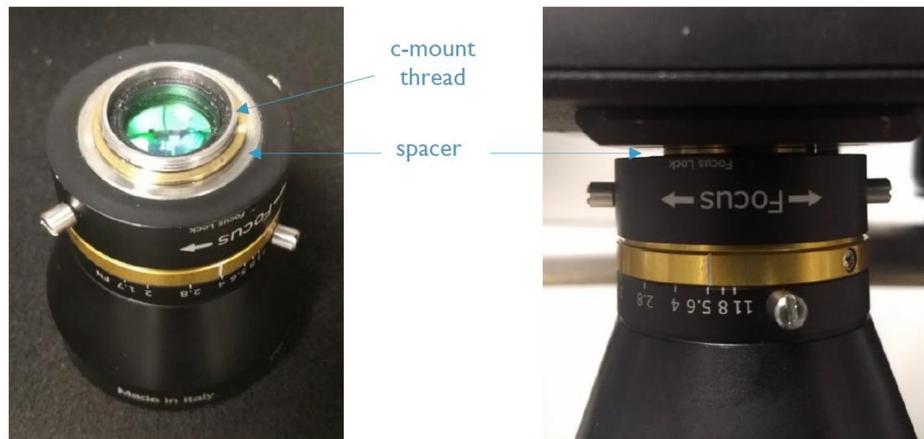


Figure 9 Inserting a space to compensate for the shift in the image plane

Step 1 - Unmount lens.

Step 2 - Put the spacer over the C-mount thread.

Step 3 - Mount the lens again.

1.3 snapscan software features

The snapscan 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.

1.3.1 Extensive data acquisition customization features

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

Parameters	Description
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.
Gain Mode	The camera can be operated in low or high gain mode.
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 passes	Each frame can be acquired up to 100 times and averaged across the multiple passes to improve the image quality.
Multiple file output modes	Output data can be assembled in a cube and stored in a single file, or the acquired frames are stored in separate files.

1.3.2 Built-in white balancing

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. snapscan automatically acquires the dark reference image using the built-in mechanical shutter and can carry out the white balancing.

1.3.3 Multiple file format options for data export options

The 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.3.4 Integrated classifier

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

I.3.5 Support for 3rd party HSI analysis software

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

I.3.6 Multiple data visualization options

The 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
- 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.3.7 Support for multiple languages

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

I.4 snapscan API features

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







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
 - *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
 - *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 10. 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 10 and Figure 11. These illustrations assume a hypothetical linescan sensor with three spectral bands.



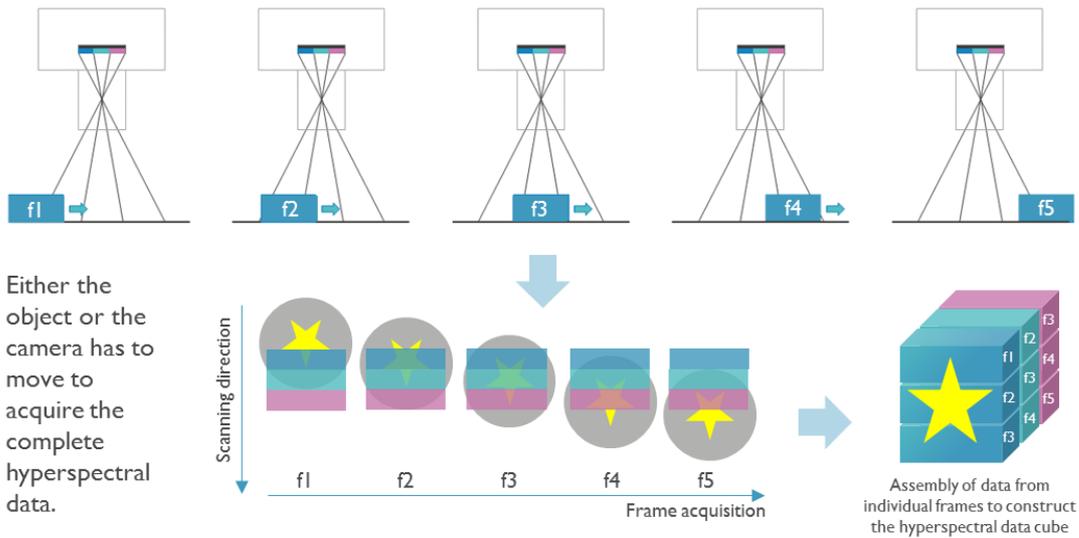


Figure 10 Working principle for imec hyperspectral linescan sensors

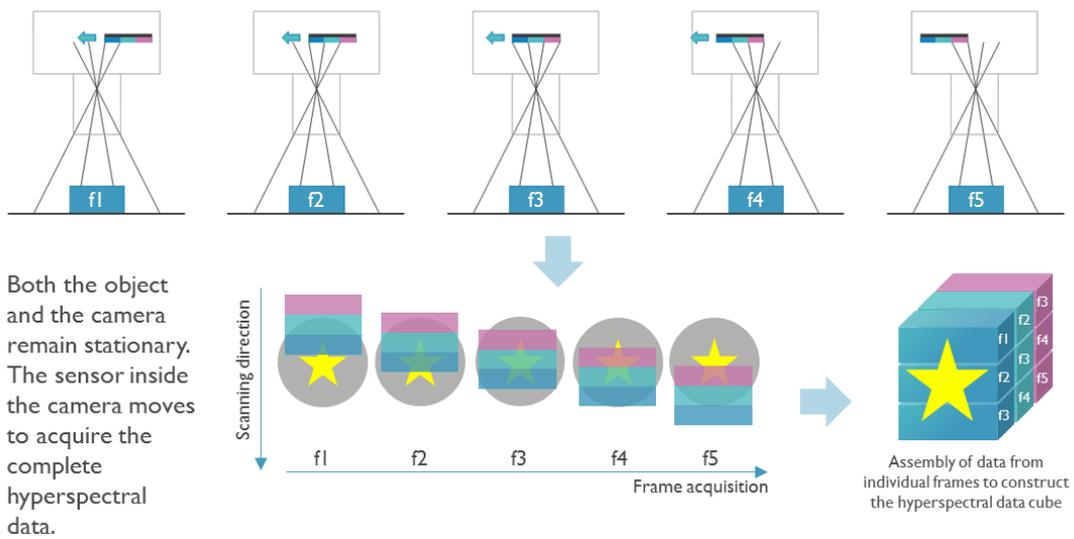
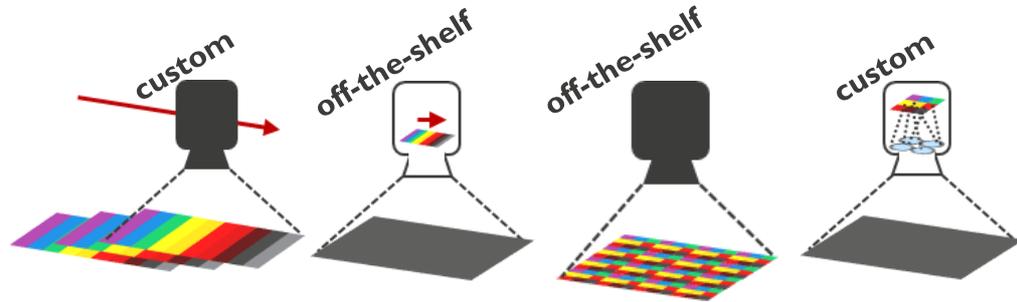


Figure 11 Working principle of imec hyperspectral snapscan camera



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 our current off-the-shelf and custom systems.



	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	Low spectral resolution	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.imec-int.com/en/hyperspectral-imaging>



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 11 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.

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 acquired in each position multiplied by their exposure time.

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. Some of 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 $N \times N$ 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 the width of one spectral band (typically 4 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 12, 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.

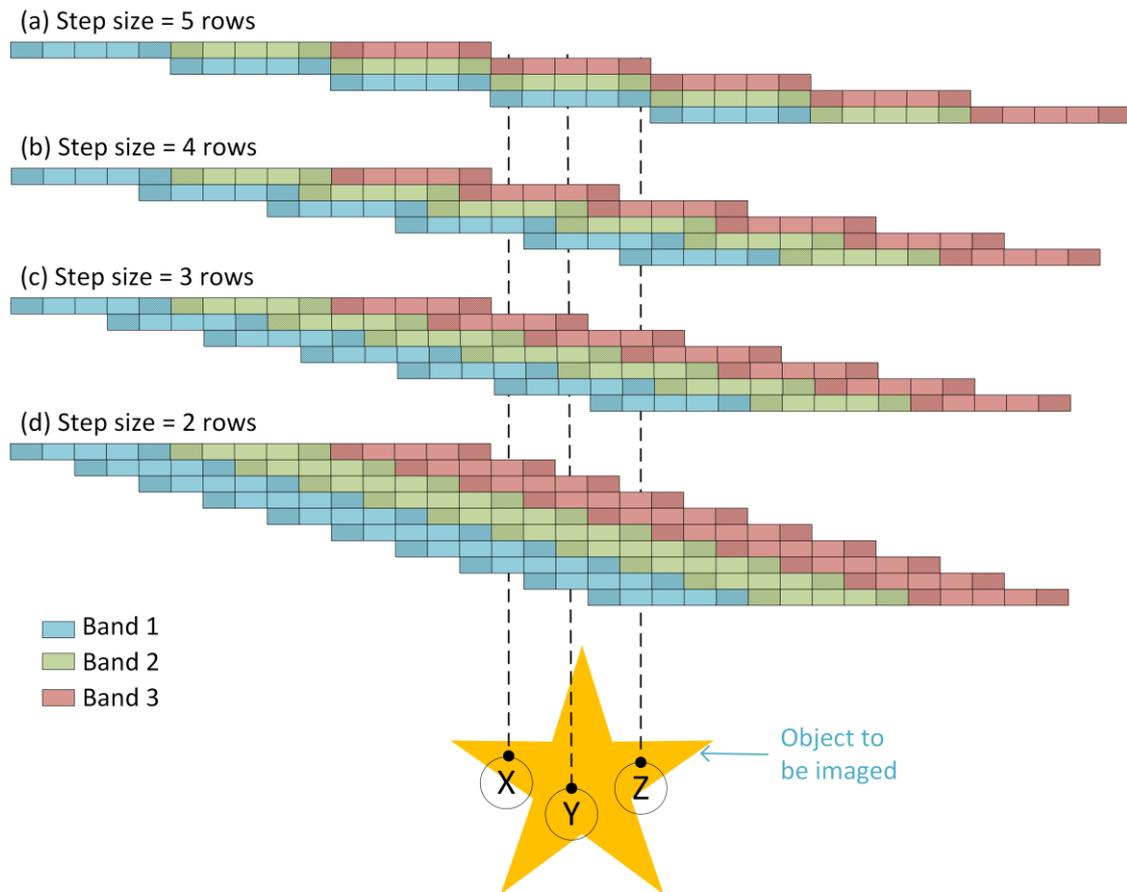


Figure 12 Illustration for pixel row skipping to remove cross talk

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 13 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.

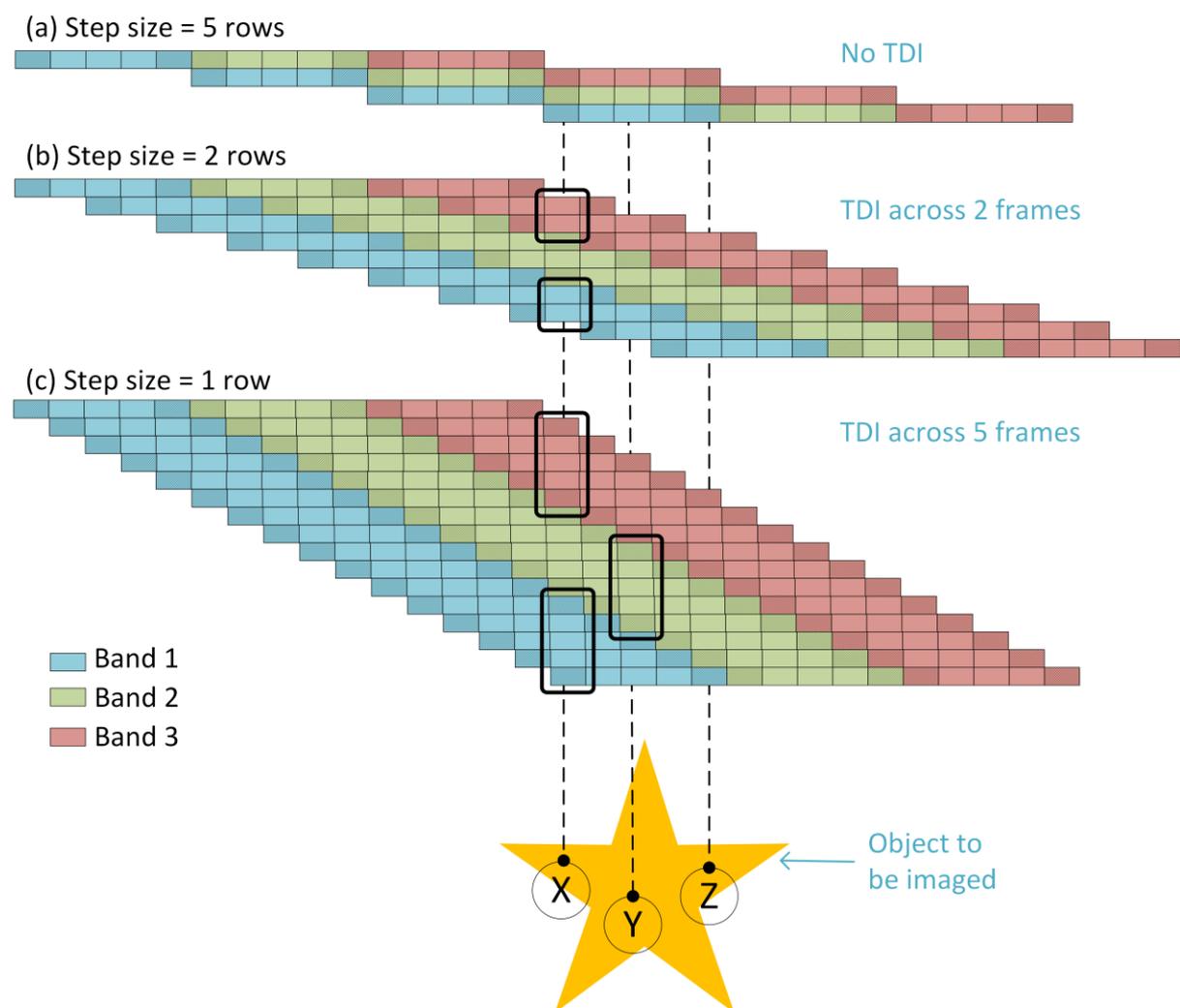


Figure 13: Illustration for software time delay integration



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

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 system and the imaging environment. The system related effects include, for example:

- 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
- the sensor characteristics (QE, FWHs...)

To measure the true surface reflectance/material absorption, one needs to correct for system related spectral effects; this may be done by measuring/providing the spectra of a known target. After correcting for system related effects, comparison of spectral responses across measurements and with available datasets is possible.

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 by use of a reference target. The



purpose is to minimize the influence of system related effects on the hyperspectral representation of an object.

White balancing is done by placing a reflectance target in the scene. In principle any reflectance target with known spectrum can be used to extract the reflectance spectra relative to the target. 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 of the reflectance target. 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
- $\text{dark ref}(\text{tint}_{\text{object}})$ is a dark reference image taken with the integration time of the object of interest
- $\text{dark ref}(\text{tint}_{\text{white ref}})$ 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 (as done in our evaluation system)
 - 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, and the choice of illumination will significantly impact the overall spectral response of the imaging system since the combined response of the illumination and the sensor needs to be considered (see Fig. 4). As seen for the LED illumination illustrated in Fig. 4, lower SNR will be achieved in spectral bands for which limited light is available.

Ideally, the user should strive towards using illumination which yields an equivalent number of photons per spectral band after sampling by the camera i.e. the illumination should take into account the spectral reflectance of the target and the variable QE response of the spectral filter bands. The evaluation kit includes halogen lamps as a standard configuration. However, to optimize system performance further, the illumination can be modified to compensate for spectral variations in the scene reflectance and/or the spectral response of the sensor.

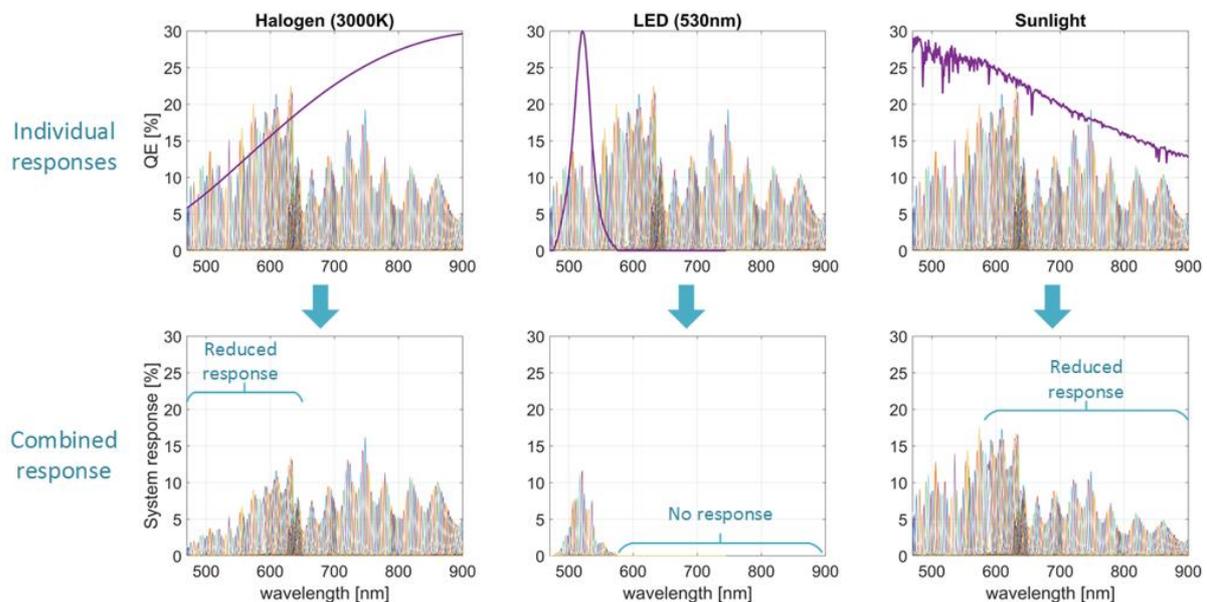


Figure 14 Combined response for different illuminations

Figure 14 shows the system response of the hyperspectral imaging system taking into account the effect of the illumination (purple) and the individual spectral filter band responses. Note that the importance of selecting the correct illumination is here illustrated using the band responses of the imec VNIR snapscan. Whilst the band responses differ for the snapscan SWIR, the principles for selecting appropriate illumination holds.





Chapter 3

Evaluation System Assembly Manual

3. Evaluation System Assembly Manual

This chapter will guide you through the assembly of the evaluation system. It provides an overview of all components in the evaluation system and instructions to assemble the evaluation system (as shown in Figure 15). Afterwards the assembly of the camera is instructed.



Figure 15 Final setup of the evaluation system

3.1 Assembly steps

Follow the steps below to assemble the evaluation system:

- Step 4* - Unpack the packages (cardboard box) and cross check the contents of the kit received with the list of components provided in the manual
- Step 5* - Assemble the base plate
- Step 6* - Assemble the camera holder post and mount the tripod head
- Step 7* - Assemble the lamp holder posts and mount the lamps
- Step 8* - Connect the lamps to the power supply



3.1.1 Step 1 - Unpack and crosscheck the contents

Step 1.1 Unpack and crosscheck the contents

The system is delivered in two main packages (as shown in Figure 16):

- Box 1 black explorer case
 - This is the camera box
 - The content depends on the camera ordered.
 - Box 2 containing (see Figure 17 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 20) and reflectance standard (item 21) are optical materials. Do not touch their surface in any way and store in dark conditions.*

Table 3 provides a list of all the components and the quantity for each component included in the evaluation system.



Figure 16: Main packages delivered with the evaluation system. Box 1 (left) contains the camera and cables and Box 2 (right) contains all evaluation system parts.





Figure 17 Contents of the Box 2

- Actual contents of the two boxes may vary depending on the options selected by you in the hyperspectral camera selection form during order placement.
- Item 20: Color checkerboard card is delivered in purpose of a VNIR camera system. The spectral response in the SWIR range of the checkerboard is flat.



Table 3: List of components and quantities in the evaluation system

Ref. No	Components	Quantity	Packaged
01	Base breadboard 300x300	1	Box 2
02	Scanning backgrounds	1	Box 2
03	Feet Ø27mm, female M6	4	Box 2
04	Threaded studs M6, black	4 (2 used)	Box 2
05	Threaded studs M6, metal	1	Box 2
06	Hex cap screw M6, 16mm, black	4	Box 2
07	Hex cap screw M6, 40mm, Metal	1	Box 2
08	Ø25.0 mm Post Clamp	1	Box 2
09	Right-Angle Ø25.0 mm to Ø1/2" Post Clamp	2	Box 2
10	Right angle post clamp	2	Box 2
11	Post 300x Ø25.0 mm	1	Box 2
12	Post 300x Ø12.7mm	4	Box 2
13	Post 150x Ø12.7mm	2	Box 2
14	Tripod ball head with 3/8" to 1/4" adapter	1	Box 2
15	Tunable stabilized DC power supply	1	Box 2
16	Tunable stabilized DC power supply power cable	1	Box 2
17	Halogen lamp 20W GU5.3 cool-fit	4	Box 2
18	Diffuser (Thorlabs DG20-120)	4	Box 2
19	Assembled lamp holder, wire, post end clamp and banana plug connectors	4	Box 2
20	Color checkerboard card, only delivered for a VNIR camera system	1	Box 2
21	Reflectance standard 95% 200x200mm	1	Box 2
22	Assembly tools	1	Box 2

- Actual contents of the two boxes may vary depending on the options selected by you in the hyperspectral camera selection form during order placement.
- Small parts may be in other part boxes

3.1.2 Step 2 - Assemble the base plate

Required items (Figure 18a)

Ref. No	Components	Quantity	Packaged
01	Base breadboard 300x300	1	Box 2
03	Feet Ø27mm, female M6	4	Box 2
06	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.

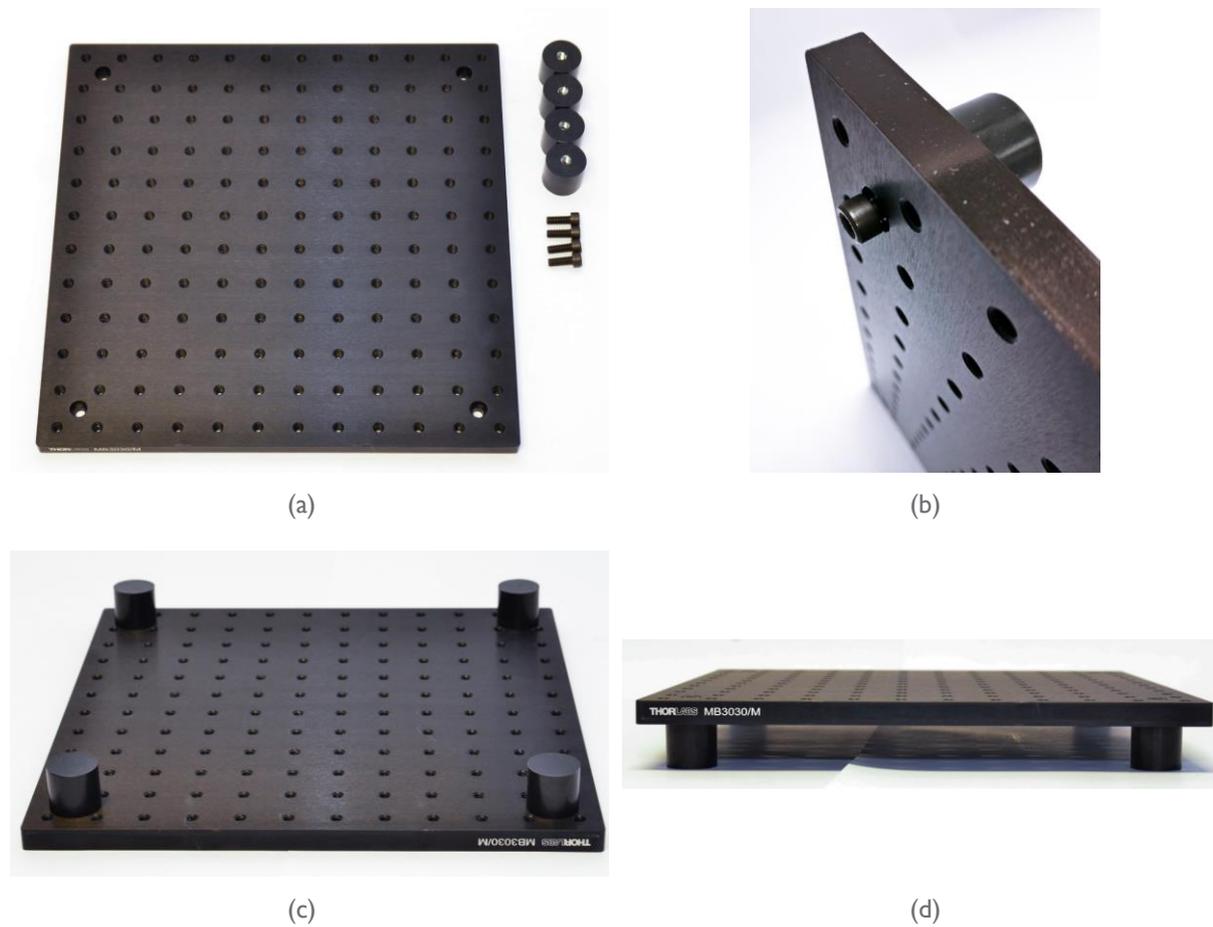


Figure 18: Assembly of the base plate



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

Required items

Ref. No	Components	Quantity	Packaged
11	Post 300x25.0mm	1	Box 2
12	Post 300x12.7mm	2	Box 2
13	Post 150x12.7mm	2	Box 2
14	Tripod ball head with 3/8" to 1/4" adapter	1	Box 2
04	Threaded studs M6 black	2	Box 2
08	Ø25.0 mm Post Clamp	1	Box 2
09	Right-Angle Ø25.0 mm to Ø1/2" Post Clamp	2	Box 2
10	Right angle post clamp	2	Box 2
16	Post end clamp 0.5"	1	Box 2
7	Hex cap screw M6, 16mm, Metal	1	Box 2
22	Assembly tools	1	Box 2

Procedure

Follow the steps below to assemble the camera holder posts and tripod mount, as shown in Figure 19.



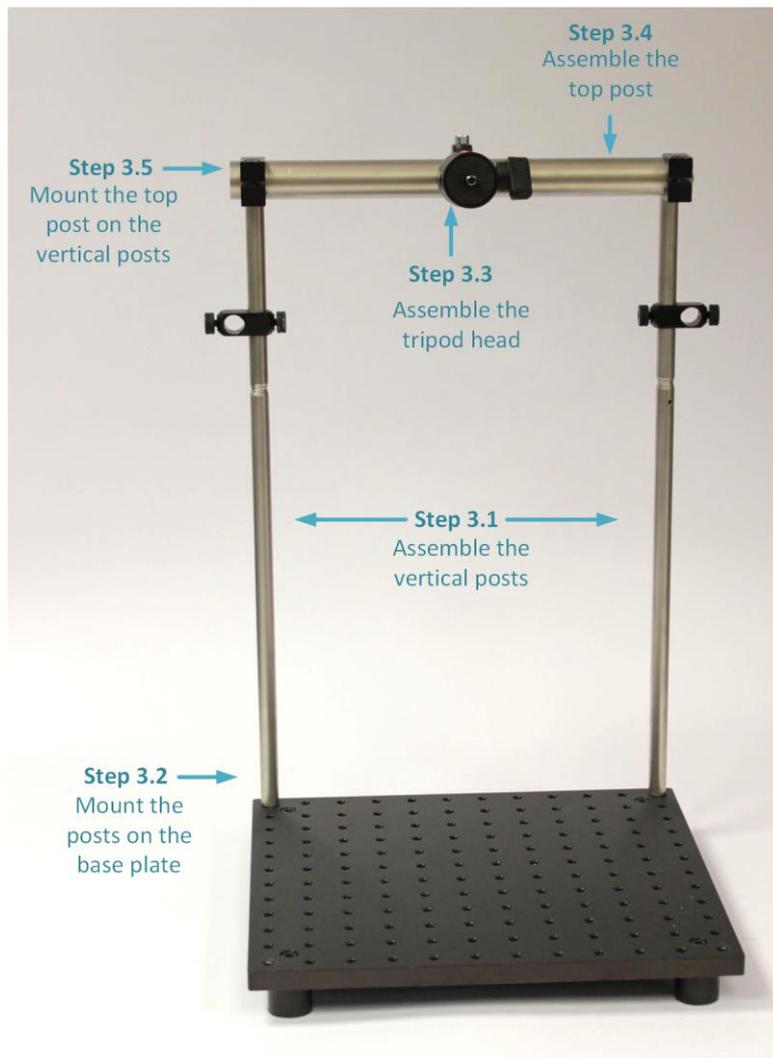


Figure 19 Mounting camera on the assembled on the base plate (Step 3)

Step 3.1 Assemble the vertical camera holder posts (Figure 20)

- Insert and screw the black threaded stud, with its conical end, in the bottom end of the long post.
- 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.
- Slide the right-angle post clamp on to the assembled post and screw it.
- Follow steps a-c to prepare two posts.
 - The position of right angle post clamp can be changed later to adjust the height of the lamps with respect to the base plate.*



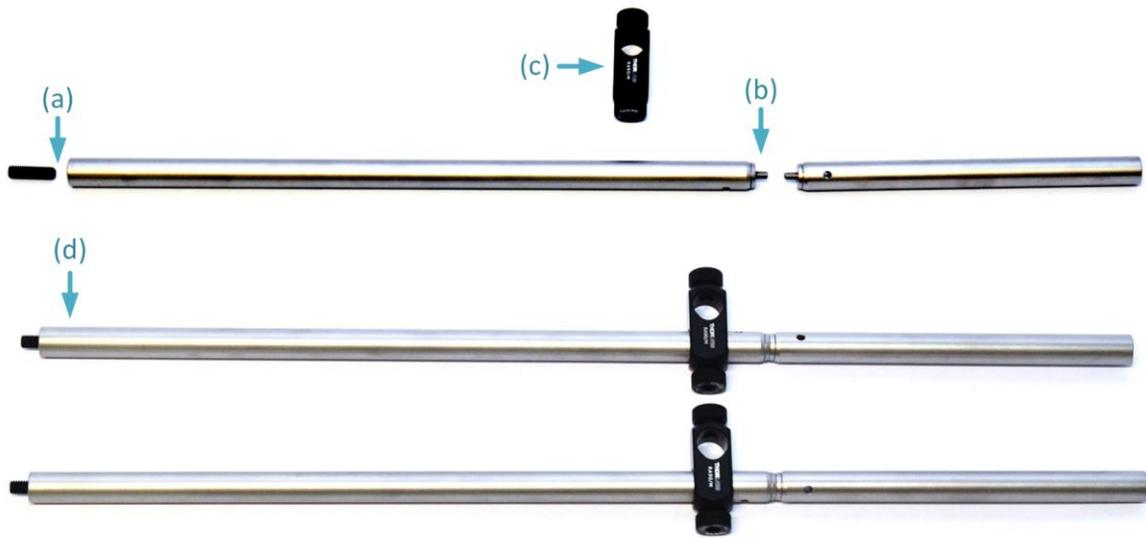
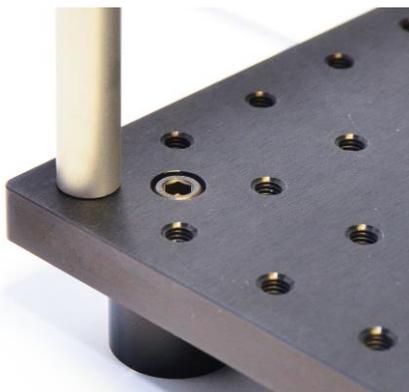


Figure 20 Assembly of the vertical camera holder posts (Step 3.1)

Step 3.2 Mount the camera holder posts on the base plate (Figure 21)

- a. Mount the post on the base plate such that the end of the post with the black threaded stud is screwed into the base plate. Use the first hole in the corner as shown in Figure 21a.
- b. Mount the two posts in opposite corners along the same edge of the base plate, as shown in Figure 21b with the right-angle post clamps to the outside.



(a)



(b)

Figure 21 Mounting of the vertical camera holder posts on the base plate (Step 3.2)



Step 3.3 Assemble the tripod head (Figure 22)

- Remove the stainless-steel ring from the top of the tripod ball head (adapter), revealing the black thread on top.
- Mount this removed stainless-steel adapter piece into the bottom of the tripod ball head.
- Screw the M6 metal stud into the bottom of the tripod ball head.
- Screw the Ø25.0 mm post end clamp onto the metal stud.



Figure 22 Assembly of tripod mount (Step 3.3)

Step 3.4 Assemble the top road with tripod head (Figure 23)

- Slide the 2x Right-Angle Ø25.0 mm to Ø1/2" Post Clamp onto both ends of the 300x25.0mm post and tighten the screw.
- Place the assembled tripod mount over the post in the middle, align the hole of the tripod mount with the hole of the post and tighten the hex screw with the allen key.
- Slide the M6 screw in the hole to prevent unwanted tilting under camera's weight.



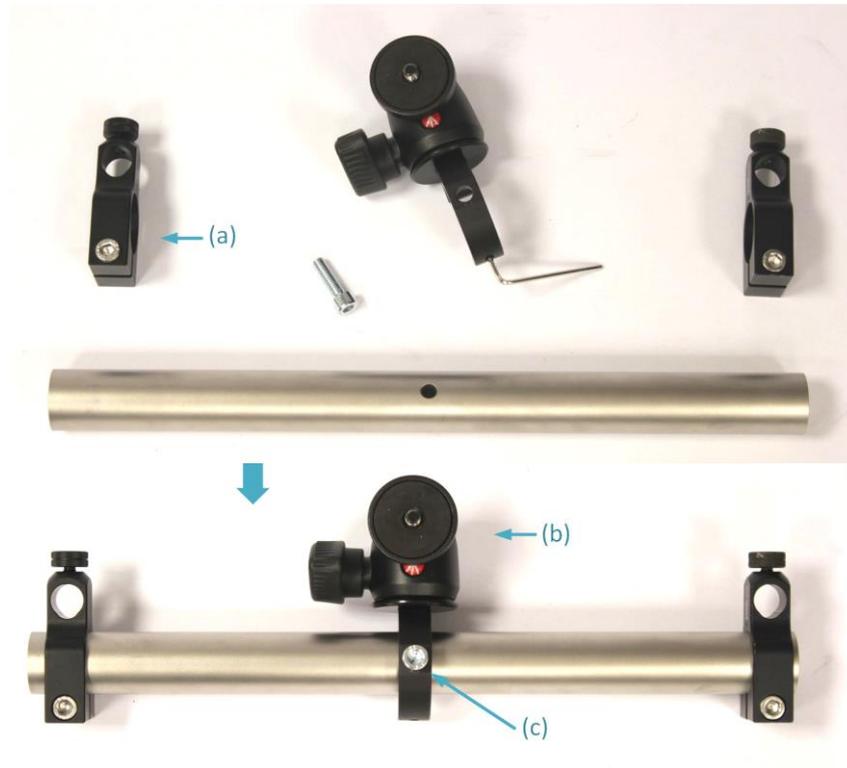


Figure 23 Assembly of the top post for camera mount

Step 3.5 Mount the top post on the vertical posts (Figure 24)

- a. Slide the assembled top post (from prev. step) on to the vertical posts and fix them on the top edge, as shown in Figure 24.



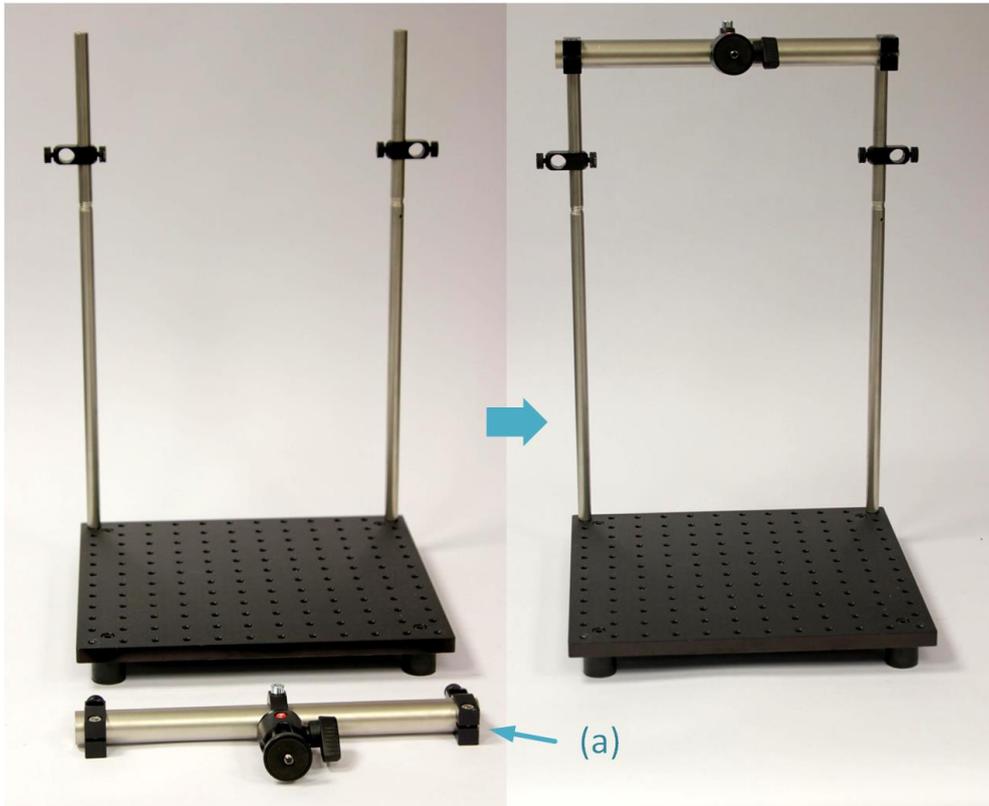


Figure 24 Assembly of top post with tripod head on the vertical posts (Step 3.5)

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

Required items

Ref. No	Components	Quantity	Packaged
19	Assembled lamp holder, wire, post end clamp and banana plug connectors	4	Box 2
12	Post 300x12.7mm	2	Box 2
17	Halogen lamp 20W GU5.3 cool-fit	4	Box 2
18	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 25.



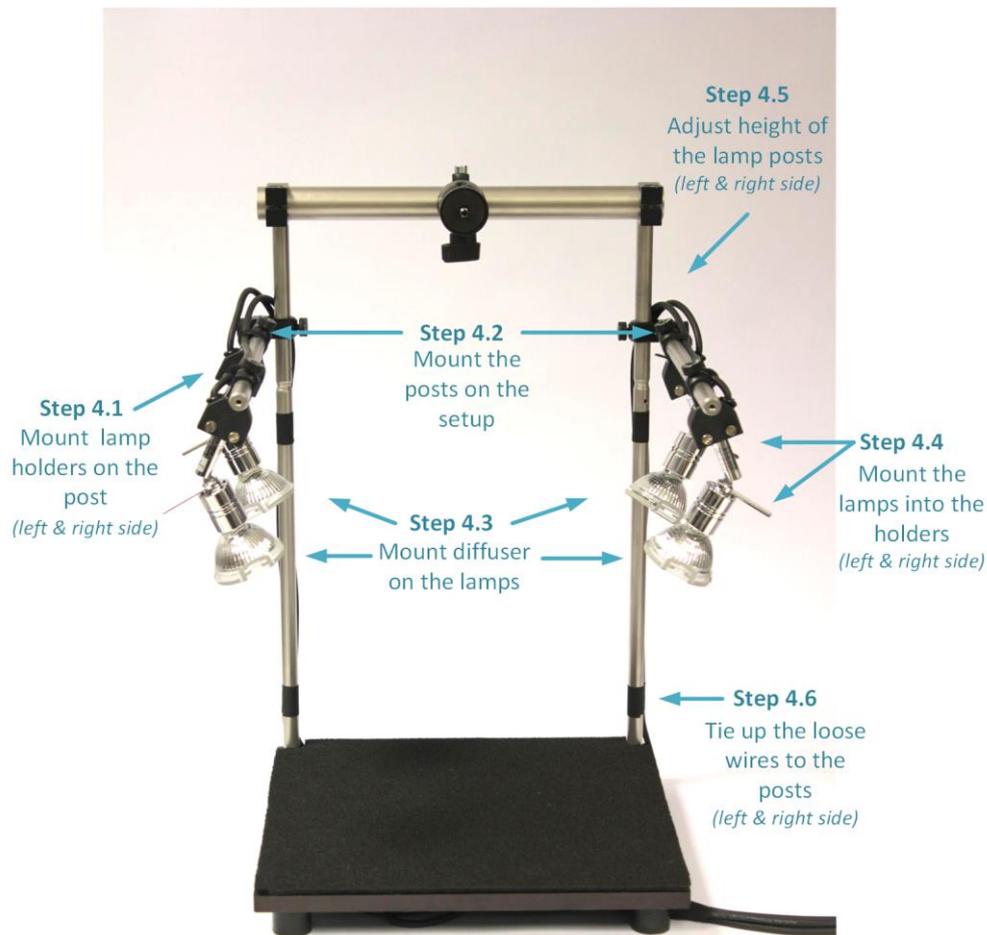


Figure 25 Assembly of lamp holder posts and mounting of lamps (Step 4)

Step 4.1 Mount the lamp holders on the post (Figure 26)

- a. 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).
- b. Slide two lamp holders on the post and fix them by tightening the screw on the post end clamp, as shown in Figure 26. Repeat this step to assemble the remaining two lamp holders on the second post.



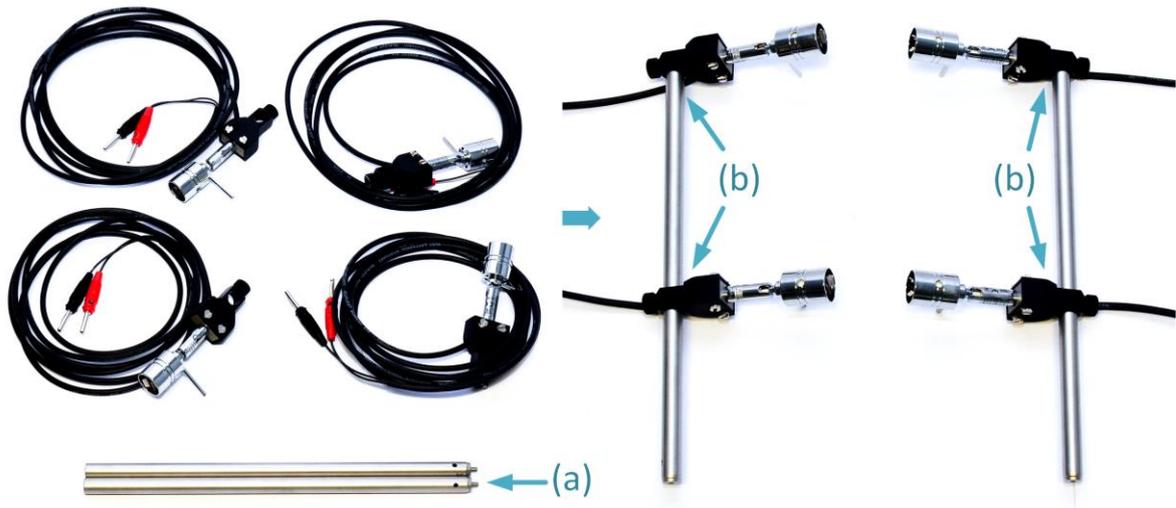


Figure 26 Assembly of lamp holders on the posts (Step 4.1)

Step 4.2 Mount the posts on to the setup (Figure 27)

- a. 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.

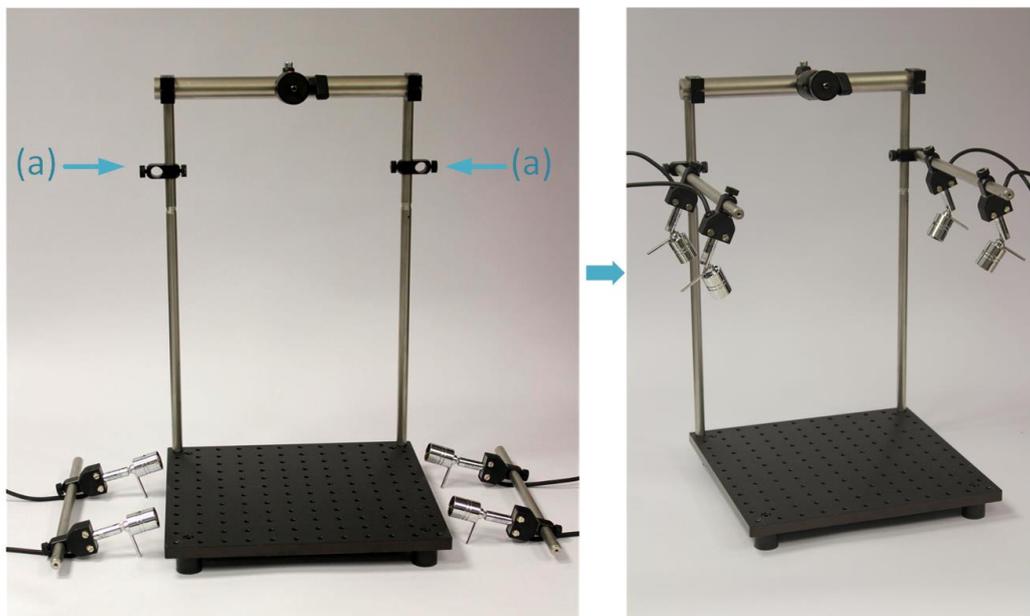


Figure 27 Mounting of lamp holders on to the setup

Step 4.3 Mount diffusers on the lamps

- a. Unpack the diffuser and the lamps, as shown in Figure 28.
 - 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 28 Unpacking of diffuser and lamp (Step 4.3a)

- b. Press and bend inwards the clips on the diffuser, as shown in Figure 29. This is needed for good fit of the diffuser on the lamps.



Figure 29 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 30.
- *Ensure that there is gap between the diffuser and the lamp*



Figure 30 Mounting diffuser on the lamp (Step 4.3c)

- d. Follow steps a-c to prepare a set of 4 lamps, as shown in Figure 31.





Figure 31 Set of 4 lamps with diffuser mounted on them

Step 4.4 Mount the lamps into the holders (Figure 32)

- 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.

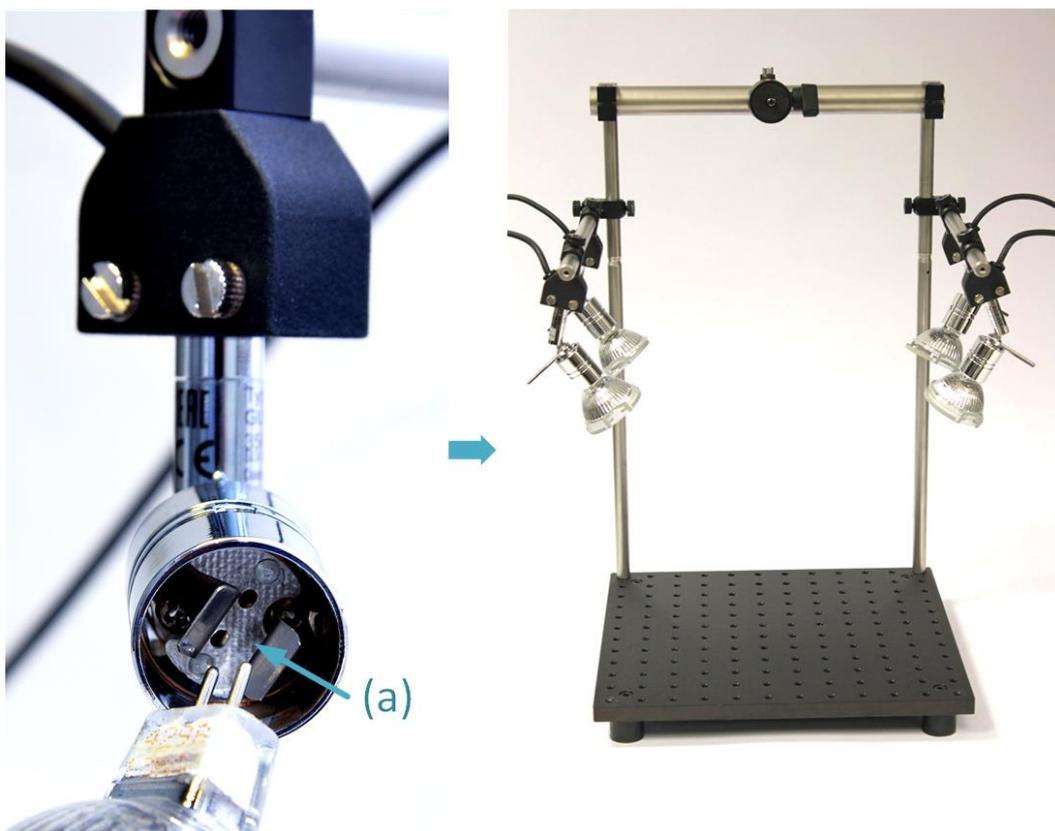


Figure 32 Mounting the lamps into the holders (Step 4.4)

Step 4.5 Adjust the height of the lamp posts (Figure 33)



- 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 33)
 - *The recommended height is shown in Figure 33. You can choose a suitable height depending on your application needs.*

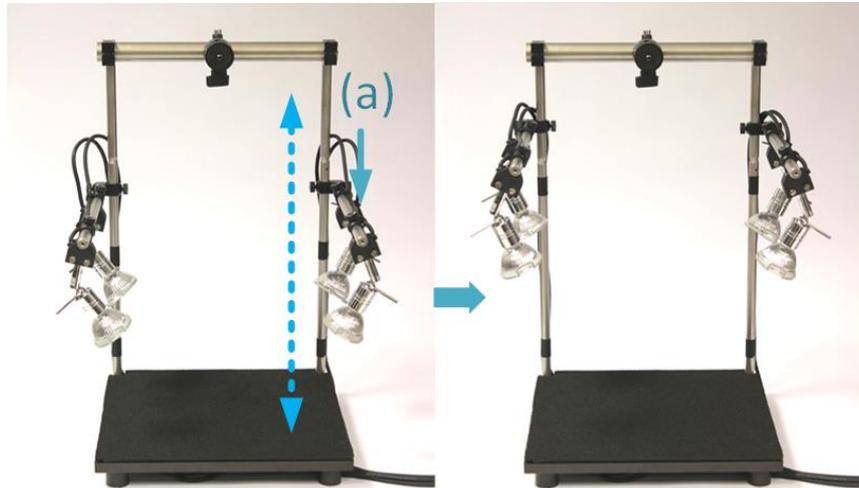


Figure 33 Adjust height of lamps depending on application needs

Step 4.6 Tie up the loose wires to the post (Figure 34)

- a. We recommend users to tie up the loose wires to the mounting posts, as shown by the blue arrows in Figure 34.



Figure 34 Tying up the loose wires to the mounting posts (Step 4.6)

3.1.5 Step 5 - Connect the lamps to the power supply

Required items



Serial No	Components	Quantity	Packaged
14	Tunable stabilized DC power supply	1	Box 2
15	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 35.

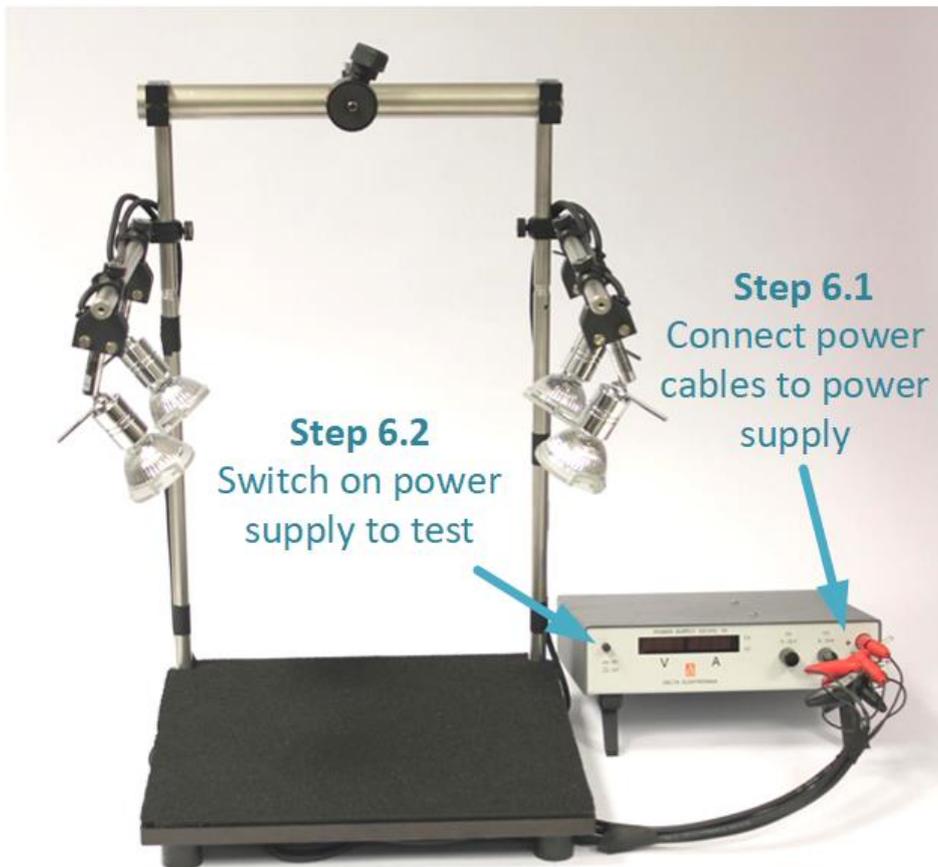


Figure 35 Connecting lamps to power supply and testing (Step 6)

Step 5.1 Connect power cables to power supply (Figure 36)

- 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 36.





Figure 36 Connecting lamps to the power supply (Step 6.1)

Step 5.2 Test the connection (Figure 37)

- 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.
 - You can switch off the power supply once the test is done.
 - 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 37 Test the power connection for the lamps



3.1.6 Step 6 - Unpack and crosscheck the contents of box I

Step 6.1 Unpack and crosscheck the contents

The Snapscan SWIR camera is packed in the black explorer case.



Figure 38 Contents of the Box I

- Actual contents of the box may vary depending on the options selected by you in the hyperspectral camera selection form during order placement.

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

Ref. No	Components	Quantity	Packaged
01	Snapscan SWIR Camera	1	Box I
02	Lens (OPTIONAL) (may be packed in a different box and different type than that shown in the picture)	1	Box I
03	Extension ring	1	Box I
04	Power supply	1	Box I
05	Power cord	1	Box I
06	USB cable	1	Box I
07	Holder for the locking keys	1	Box I

3.1.7 Step 7 - Mount the snapscan camera

Required items

Ref. No	Components	Quantity	Packaged
01	Snapscan SWIR camera	1	Box 1
02	Lens (OPTIONAL) (may be packed in a different box and different type than that shown in the picture)	1	Box 1
03	Extension ring	1	Box 1

Procedure

Follow the steps below to mount the snapscan camera on to the setup, as shown in Figure 39.

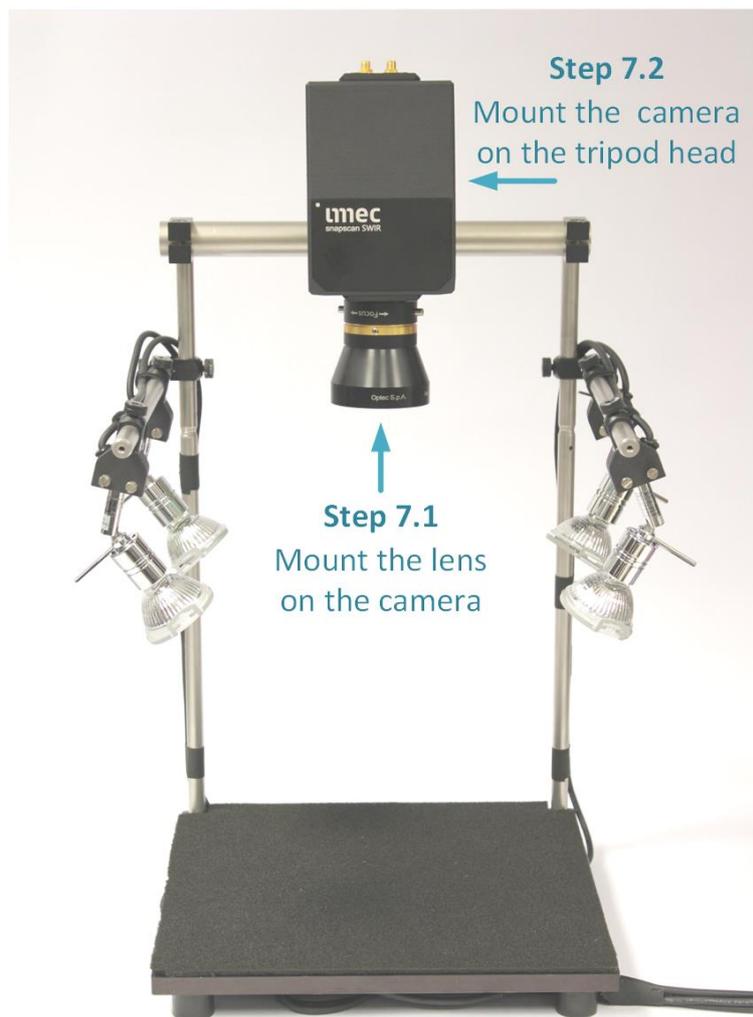


Figure 39 Mounting the snapscan camera on to the setup (Step 7)



Step 7.1 Mount the lens on the snapscan SWIR camera (Figure 40, Figure 41)

- *The lens is an optional component. If it is available in the delivery and the type depends on the order placed.*
 - 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. If applicable, place the extension ring over the c-mount tread of the lens.
 - d. 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.
- *It is recommended to leave the front cap on the lens until the system is fully assembled.*
 - *Do not forget to remove the front cap of the lens when using the system.*
 - *It is strongly recommended to put back the front cap on the lens when the system is not in use.*

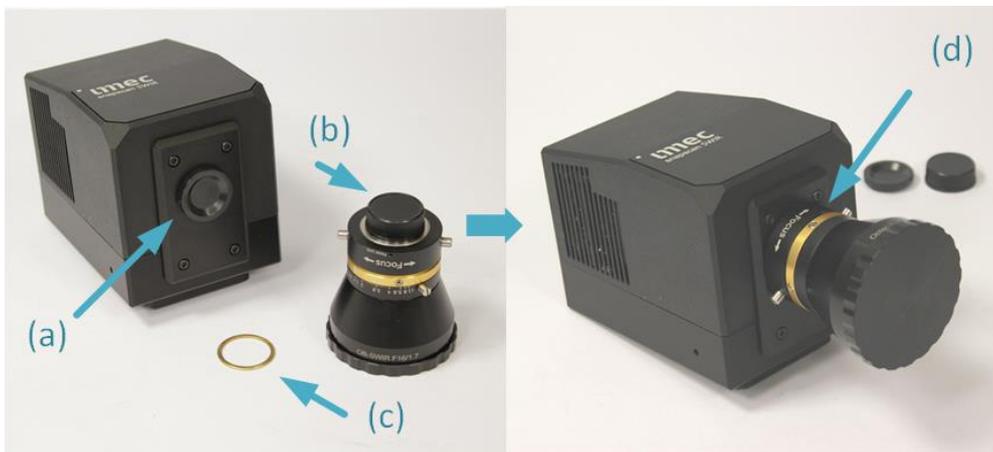


Figure 40 Mounting lens on the snapscan camera (Step 5.1)

- e. Unlock the screw, turn the aperture ring to set the lens aperture and lock the screw.
- f. Unlock the screw, turn the focus ring to set the lens focus and lock the screw.



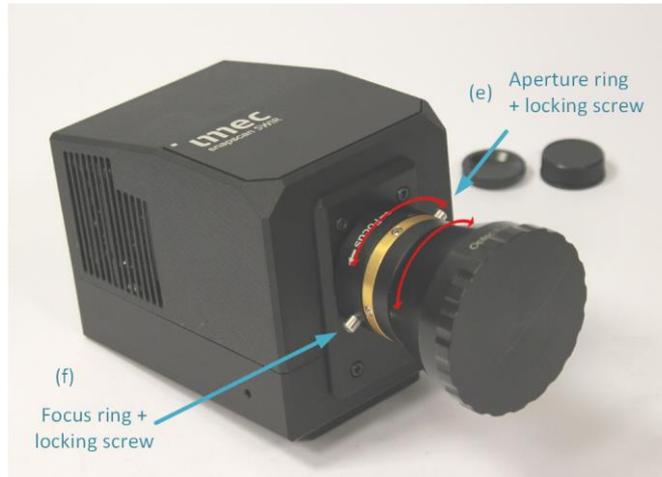


Figure 41 Focusing and setting the aperture of the lens

Step 7.2 Mount the snapscan camera on the tripod head (Figure 42)

- a. The tripod adapter plate on the bottom of the snapscan SWIR 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.
- b. Rotate the tripod screw to tighten the screw to affix the camera to the tripod head. You may lock the ball head and rotate the camera to tighten strong.
- c. Unlock the ball head to adjust the tripod head such that the camera body is parallel to the base plate and lock it again.

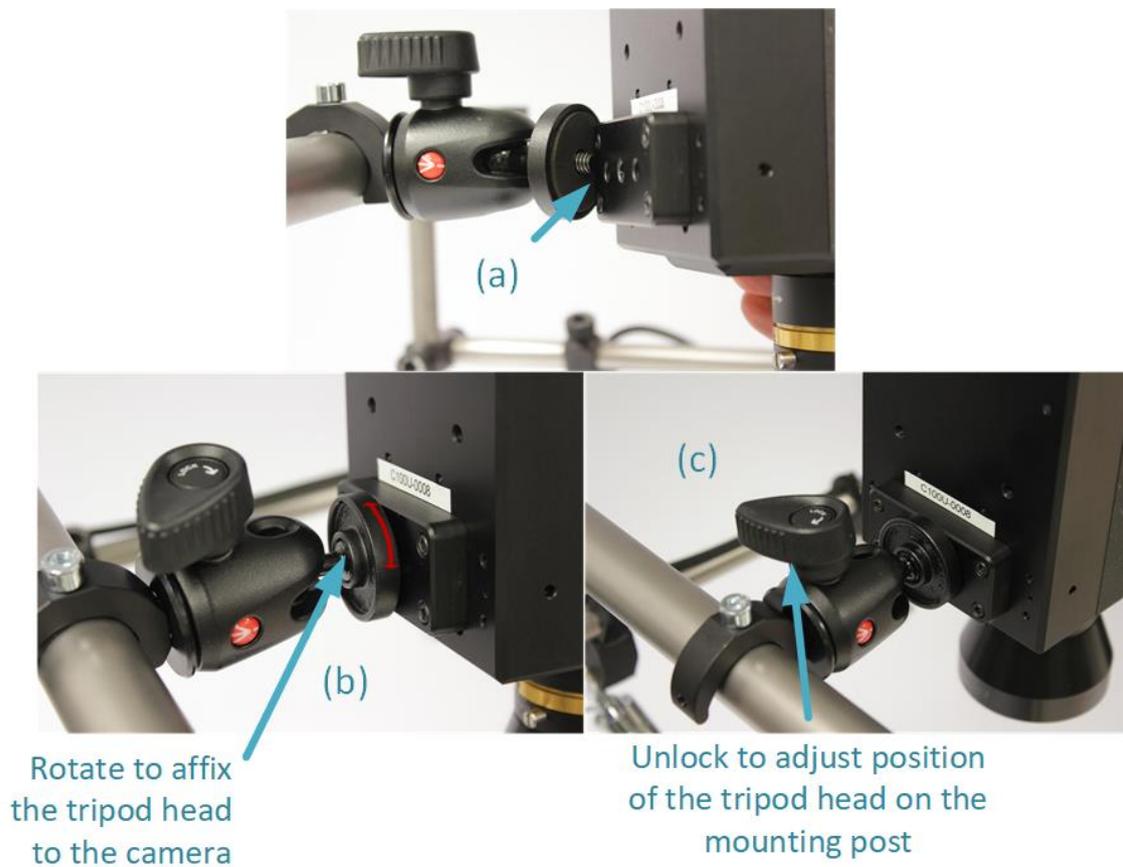


Figure 42 Mounting of snapscan camera on to the tripod head



Step 7.3 Removal of the locking pins

- a. Remove the 2 pink locking pins on the side of the camera
- b. Store them in the holding case for later use.



Figure 43 Removal of the locking pin

- *These locking pins are required to keep the camera's moving parts in a fixed position during transportation to prevent system damage. Read section 3.3 for instruction to put the locking pins in place.*

Step 7.4 Connect the snapscan camera to the PC (Figure 44)

- *The USB should be connected and powered before the power supply is connected. Not doing this may damage the camera.*
- a. USB 3.0 cable is used to connect the spanscan SWIR 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 44a.
 - b. Push the USB 3.0 micro-B connector into the camera's USB port (Figure 44b)
 - c. Lock the USB connector by turning the threaded rings (Figure 44c)





Figure 44 Connecting snapscan camera to the PC

Step 7.5 Connect the power adapter to the snapscan SWIR camera

- *The USB should be connected and powered before the power supply is connected. Not doing this may damage the camera.*
- a. Assemble the power adapter by affixing the power cable into the adapter, as shown in Figure 45.

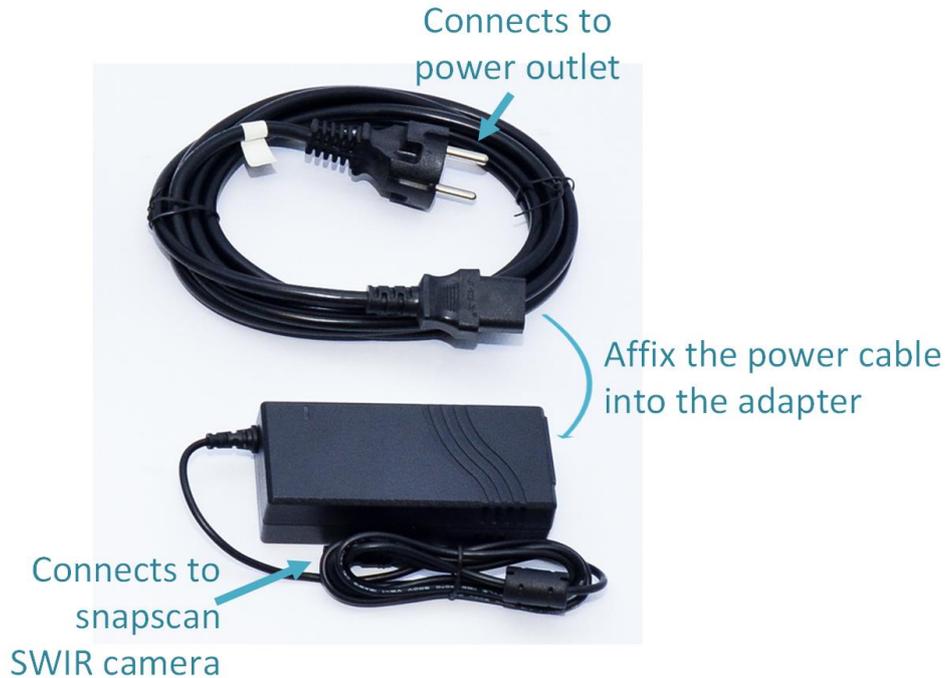


Figure 45 Assembling the power adapter for the snapscan controller

- b. Connect the power cord to the camera.





Figure 46 Connection of the Power cord

- c. The power LED should be on.

Step 7.5 Test the connection

- a. Verify that all the connections are complete, as shown in Figure 47.

The connections between the snapscan camera and the PC should be as shown in

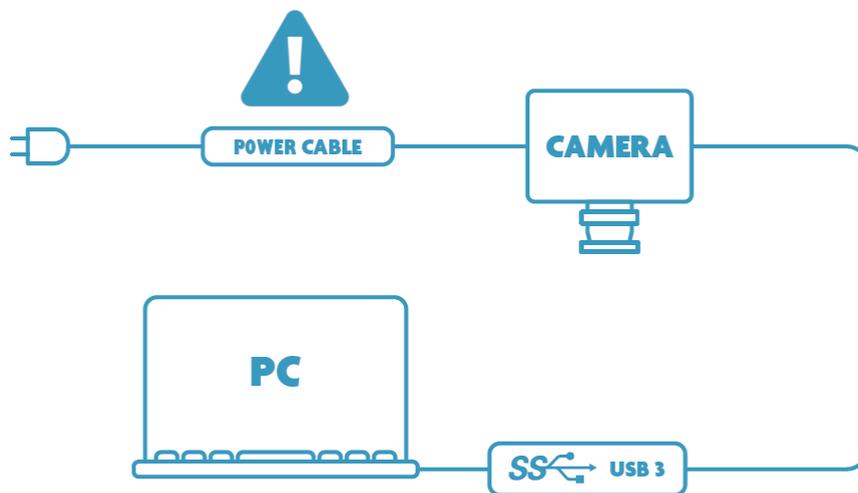


Figure 47 Connections between snapscan camera and PC

Power the system by first connect the USB to the computer and afterwards plug in the power cable.

- *The USB should be connected and powered before the power supply is connected. Not doing this may damage the camera.*

3.2 Identify the camera unit

Each camera unit is assigned a unique serial number, as shown in Figure 48. The description of the serial number is given in Table 5.





Figure 48 Serial number for camera units

Table 5 Description of the serial number

Label	Description	Values
①	Model identifier	A: model A (VNIR) B: model B (VNIR) C: model C (SWIR) X: model X
②	Sensor Identifier	100: Hyperspectral NIR sensor (600-1000nm) 150: Hyperspectral VNIR sensor (470-920nm)
③	Translation stage identifier	Q: Q-motion stage U: Ultrasonic stage
④	Device number	4 digit serial number starting from 0001

3.3 Secure the camera for transportation

To prevent internal damage of the camera during transportation the pink locking pins should be placed according to the following steps:

- a. Place the magnetic pin into the small hole on the bottom of the camera.
- b. Place the pink locking pin into the hole on the side of the camera.
- c. Pull the magnetic pin out of the camera.
- d. Repeat this step on the other side of the camera. Make sure the pin is not removed by accident.



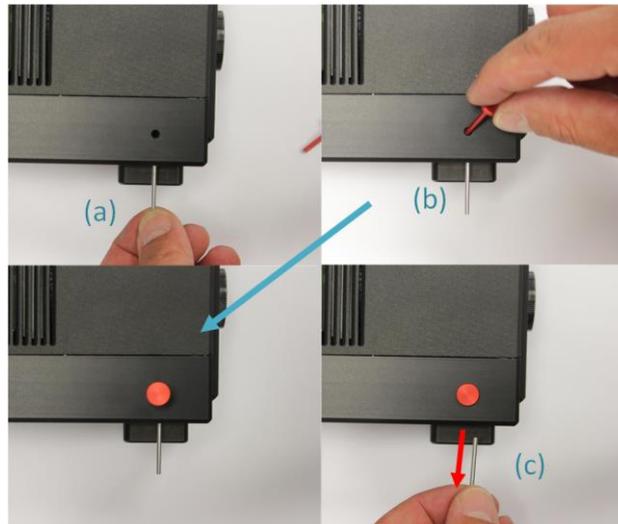


Figure 49 Secure the internal stage of the camera for transportation

3.4 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.

Check 3: If the cables attached to the lamp holders are connected to the power supply in the correct way.

Check 4: If the voltage and current is set correctly

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
- USB ports of the PC are functioning properly
- Power cord is connected correctly.

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.

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 Camera dimensions

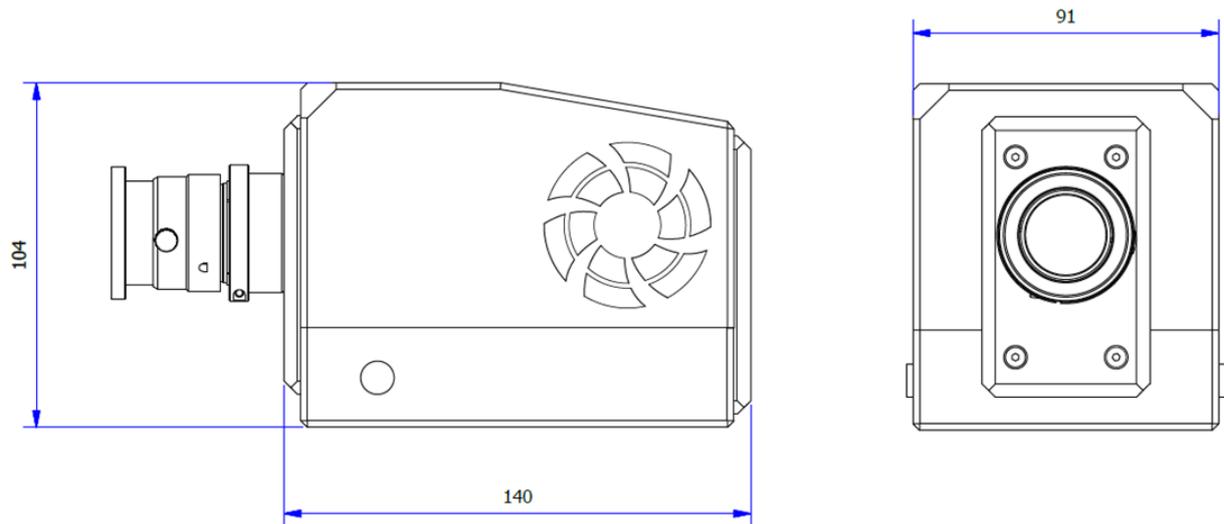


Figure 50 External dimensions of the camera body (all dimensions are in millimeter)



4.1.2 Flange focal distance

The flange focal distance is the distance from the mounting flange to the image sensor plane. It is a standard C-mount distance of 17.526 mm.

The flange focal distance is also known as flange-to-film distance, flange focal depth, flange back distance (FBD), flange focal length (FFL) in different applications.

4.1.3 Camera mounting options

4.1.3.1 Tripod adapter plate

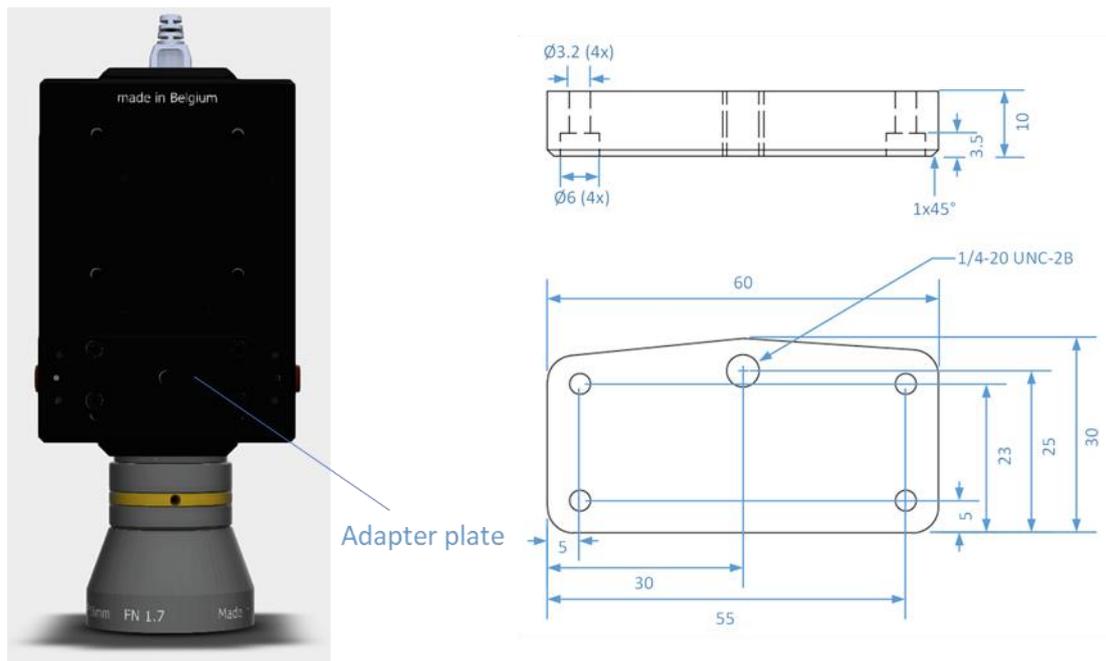


Figure 51: Top and side views of the tripod adapter plate along with its dimensions (all dimensions are in millimeter)

4.1.3.2 Mounting holes on the bottom of the camera





Figure 52 Bottom view of the snapscan camera showing the 4 mounting holes (all dimensions are in millimeter)

4.2 Electrical specifications for snapscan GPIO interface

Table 6 Overview of output parameters for the controller

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

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

- Always plug USB first
- 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.
- 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 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.
- 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.

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.





Chapter 5

Software Installation Manual

5. Software Installation Manual

This chapter will guide you through software installation and configuration.

5.1 System requirements for the PC

For successful operation of the software it is required that the computer conforms at least to the minimum system requirements as given in Table 8 and has a compatible USB3.0 adapter as specified in Table 9. It is highly recommended to reserve the use of the computer to the snapscan system.

- *Do not connect the snapscan system to the PC until after the installation.*
- *On computers with Windows 7 it's recommended to install dedicated USB3.0 drivers for your hardware instead of using the default generic drivers. Check your computer vendor's support site to download these drivers.*

Table 8: Minimum and recommended system requirements for the PC

Parameters	Minimum configuration	Recommended configuration
Operating System	Microsoft Windows 10, 64 bits	
Processor	Intel i5	Intel i7
Hard disk type	Solid State Drive (SSD)	
Free hard disk space	10GB	Usage dependent
RAM	16 GB	32 GB
USB for camera	1x USB 3.0	

Table 9: List of compatible driver version for different USB3.0 adapters

Adapter type	Compatible driver version
Fresco Logic FLI 100	3.5.24.0
Renesas D720202	3.0.12.0
Intel QM77, Z77, Z87, Z97	Latest
Intel Broadwell	Latest
ASMedia ASI042	Not compatible
Etron EJ168A	Not compatible
Via Labs VL800-Q8	Not compatible



5.2 Software installation

Follow the steps below to install the software:

- Download the latest version *HSI Snapscan.exe* from the imec hyperspectral support site: <http://hsisupport.imec.be>. Double click the installer to start the installation wizard.
- Follow the steps as guided by the installation wizard.
- The following software components are included in the installer:

Software components	Description	Disk space required
Imec HSI Snapscan	Mandatory. Required to control the snapscan system.	288.2 MB
Imec HSI studio	Optional. Can be used to view the data acquired with the snapscan acquisition software (data is in ENVI format). <ul style="list-style-type: none"> • <i>Currently, there is no separate documentation available. We refer users to Chapter 6 (Software user manual) of this manual.</i> 	0.2 MB
perClass Mira	Optional. perClass Mira is a spectral imaging software from perClass BV. perClass Mira can be used for viewing and analyzing the acquired hyperspectral image data. A 14 day limited functionality demo license is included with snapscan software. <ul style="list-style-type: none"> • <i>Documentation and user manual can be found online at http://doc.perclass.com/perClass_Mira/Introduction.html</i> 	2.3 GB

- If needed, the wizard will start the installers of the third-party software/drivers that is required to communicate with the snapscan hardware. Follow the instructions to complete the installation or update.

Driver type	Description	Disk space required
FTDI	Interface snapscan controller with PC	500 MB
PI	Internal stage control	
Ximea / eBus Pleora	Camera control	
MSVC redistributable	Run-time components for snapscan software	



5.2.1 perClass Mira installation

Following are the system requirements for perClass Mira

Parameters	Minimum configuration
Operating System	Microsoft Windows 7 (or higher), 64 bits
RAM ²	8 GB
GPU	NVIDIA GPU supporting CUDA 9.0 library (needs to be installed separately)
GPU memory	4GB

- Please refer to perClass' website for the latest system requirements - http://doc.perclass.com/perClass_Mira/Systemrequirements.html

Follow the steps below to install and activate perClass Mira:

- perClass Mira can be installed with an installer bundled in IMEC software
- 14-day limited functionality demo license is provided with the snapscan purchase. Follow the steps shown here to activate the license (http://doc.perclass.com/perClass_Mira/Firststart.html)
 - *Once a demo is activated, scanned images can be loaded in perClass Mira*
 - *classification solution can be created*
 - *decisions on more images can be tested from within perClass Mira*
 - *the solution can be exported in a file, loaded in IMEC software and applied to new images*
 - *perClass offers a 1-hour remote training using TeamViewer to help users to get started*
 - *Demo does not allow saving project files or exporting data. Please contact perClass for licensing options for full functionalities*



5.3 Software configuration

Follow the steps below to configure the software and complete the installation:

- Ensure that the system is connected, as shown in Figure 53. Please make sure USB cable is plugged before the power cable as mentioned above.

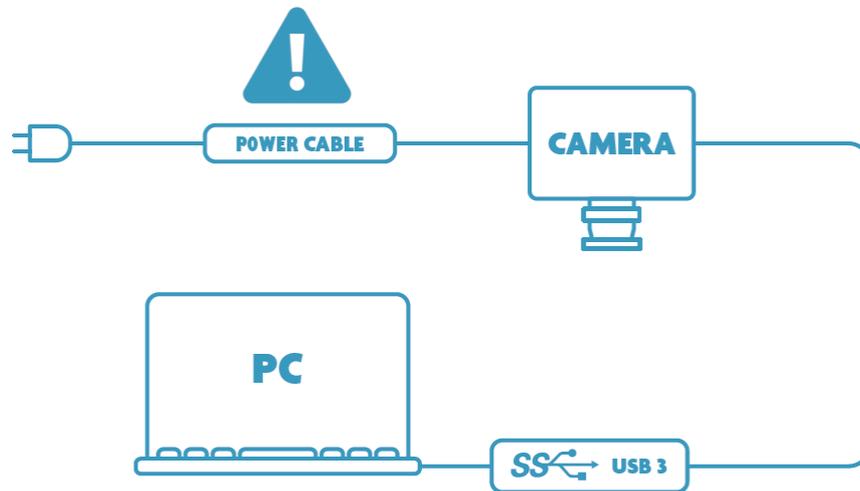


Figure 53: Connection diagram showing the connections between all components of the snapscan system.
Warning: make sure the USB cable is always plugged when powering the camera.

- *The USB should be connected and powered before the power supply is connected. Not doing this may damage the camera.*
- Configure the software by selecting the *system file* that has been delivered with the camera unit. The software will prompt to select this file when it is launched after the installation, as shown in Figure 54.

Each camera unit comes with two unique files: *system description file* and *sensor calibration file*. Both the files should be kept together in the same folder. It is advised not to modify these files to ensure proper functioning of the camera unit and the controller.

The *system description file* identifies the system and its different components. This information is used by the acquisition software to connect to the system and to correctly produce spectral measurements, It has the extension *.xml* and has the same name as the serial Nr of the camera.

The *sensor calibration file* contains the full calibration report for the hyperspectral image sensor integrated in the camera unit. It has the extension *.xml*.



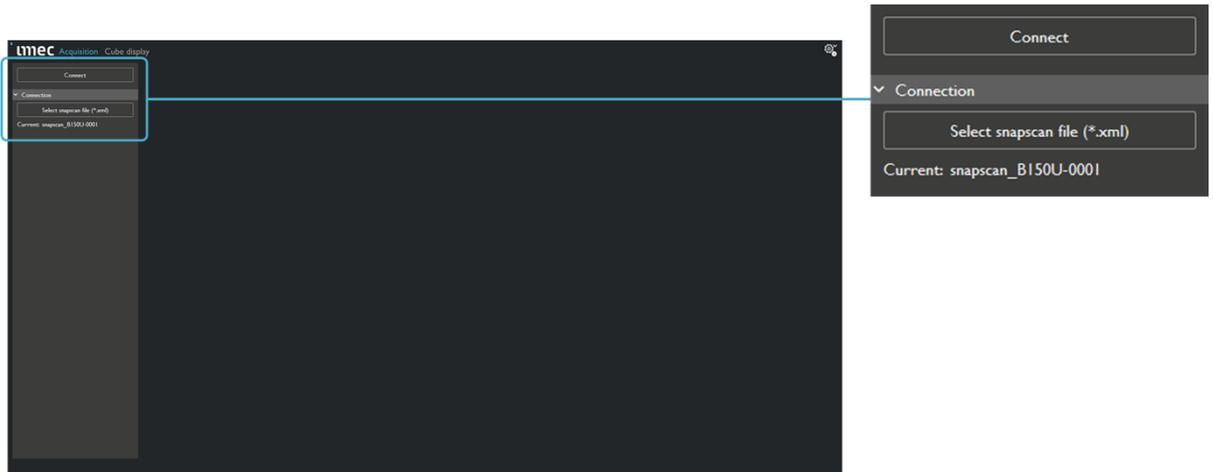


Figure 54 Configure system information file specific to the camera unit

- *Refer to the troubleshooting section in case of problems.*
- *Contact HSI support if the problems persist.*

5.4 Troubleshooting

The installation process didn't complete successfully

Locate the installation directory and verify if it exists and contains a shortcut to launch the software. If not, then launch the installer and run through the wizard again. Contact support in case of repeated failure.

The PC cannot find the correct drivers for the hardware

Make sure to first install the snapscan acquisition software. During installation all required device drivers will be installed on the PC.

The software cannot connect to the snapscan camera

Check 1: Correct system file is loaded and try connecting again.

Check 2: snapscan system is connected correctly to the computer:

- (Re-)Connect the snapscan camera's USB cable to a USB3.0 port.
- Try connecting the software again.
- Try with a shorter cable

Check 3: snapscan camera is detected in the device manager.

- Verify that the computer's USB ports are powered. This might not be the case when working on battery or in a power optimization mode.
- Try using a different USB3.0 port.
- Ensure that you are using the USB3.0 cable supplied with the system.

Check 4: There are no unknown devices in the device manager. If there are unknown devices:

- Disconnect the snapscan system by removing all connections to the computer.
- Open the directory resources\installers in the installation directory.
- Run the installer (XIMEA_API_Installer_Beta.exe) with at least the "Drivers" option checked and make sure it completes successfully.
- Connect the snapscan system. The operating system should now detect the device and install the correct driver.
- Try connecting again.

Check 5: USB3.0 drivers for the machine are installed correctly.

The default Windows 7 USB3.0 drivers might not be suited, especially on laptops. Navigate to the support site of your computer to download and install the dedicated USB3.0 drivers for your computer.



The software cannot connect to the snapscan controller

Check 1: The correct system file is loaded and try connecting again.

Check 2: Power cycle the snapscan controller and try connecting again.

Check 3: snapscan controller is connected correctly to the computer:

- (Re-)Connect the snapscan controller's USB cable to any USB port.
- Try connecting the software again.

Check 4: All devices are detected in the device manager. If either of the USB 2.0 hub, USB serial converter or PI controller are not detected then check the following -

- Controller is connected to mains power and is switched on.
- Computer's USB ports are powered. This might not be the case when working on battery or in a power optimization mode.
- Try using a different USB port.

Check 5: There are no unknown devices in the device manager. If there are:

- Disconnect the snapscan system by removing all connections to the computer.
- Open the directory resources\installers in the installation directory.
- Run the installers for the USB serial converter (CDM21226_Setup.exe) and PI USB driver (PI_USB_Driver_Setup_64Bit.exe) individually and make sure they complete successfully.
- Connect the snapscan system. The operating system should now detect the device and install the correct driver.
- Try connecting again.

Check 6: When working on a laptop, the laptop's USB port may not provide sufficient power. In this case,

- Try connecting the controller through an external USB hub.
- Put the laptop in a docking station and try using a docking station's USB port.
- Try using a shorter USB cable with micro USB connector.

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

Email: hsisupport@imec.be

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







Chapter 6

Software User Manual

6. Software User Manual

This chapter explains how HSI Snapscan can be used to configure the snapscan system, acquire hyperspectral data cubes and finally view and export the data.

First, an overview is given of the workflow and user interface layout, after which each view is explained in more detail.

6.1 General

HSI Snapscan provides the following two key functionalities:

1. Cube acquisition (see Section 6.2)
2. Cube display (see Section 6.3)

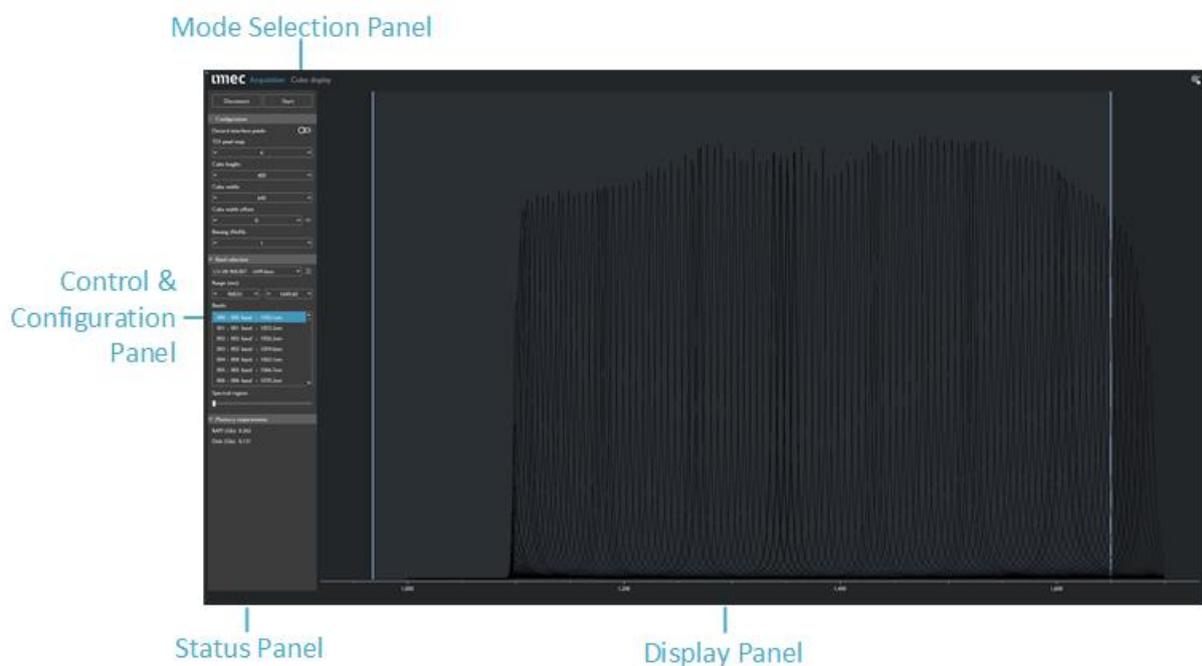


Figure 55 shows the different elements in the user interface of the software:

- **Mode selection panel** – Provides separate tabs to select cube acquisition or cube display mode.
- **Control & configuration panel** – This panel is specific to the selected mode. It provides control and configuration options to the user.
- **Display panel** – This panel is also specific to the selected mode. In acquisition mode, the panel displays live view from the sensor, whereas in cube display mode it shows a previously acquired cube as selected by the user.
- **Status panel** – Provides camera related information. For example, sensor temperature.
- *Cube acquisition tab is selected by default when the software starts.*

Figure 56 shows the typical workflow that a user must follow while using the software. Details of each step in the workflow are provided in the upcoming sections.



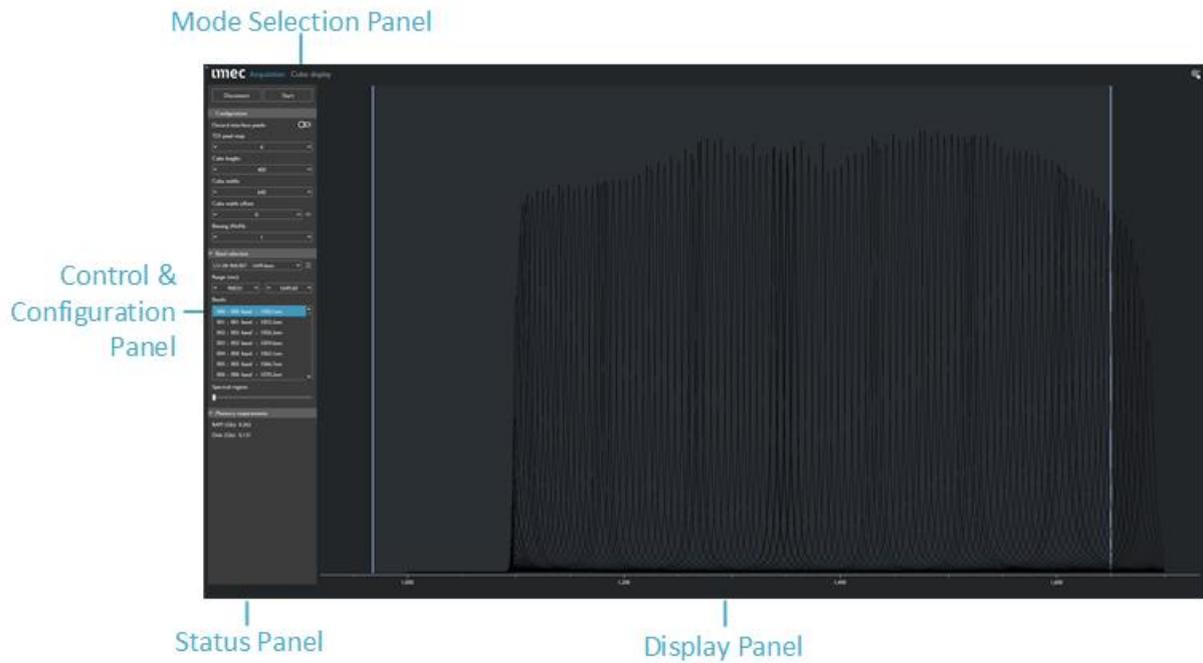


Figure 55: Annotation of the main elements in the snapscan software’s user interface

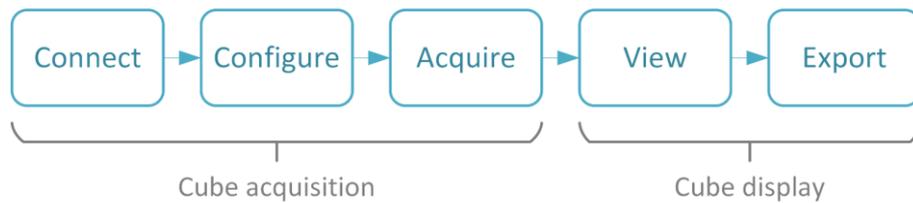


Figure 56: Illustration of the workflow of HSI Snapscan. This workflow guides the user from connecting to the snapscan system to exporting hyperspectral data.

6.2 Cube acquisition mode

Cube is acquired from the snapscan camera by following the first three steps in the workflow shown in Figure 56.

Connect step – select your snapscan system and establish connection

Configure step – configure the acquisition properties

Acquire step – control the system and acquire data

Each of these steps are discussed in detail in the upcoming sections.

6.2.1 Connect step

Follow the steps below to connect to the snapscan camera system:

- Step 1** - Click the “*Select SnapScan file*” button to load the *system description file* specific to your snapscan camera unit.



This file contains information on how to connect to the hardware as well as which *sensor calibration file* to use to interpret the data. When the file is loaded, the name of the file is shown and the connect button becomes available.

- *The software keeps track of the last used snapscan system description file. When restarting the software, reconnecting is possible without having to select the system file again.*

Step 2 - Click the *Connect* button

This will establish a connection to the snapscan system, initialize the hardware and switch the user interface to the configuration step. If needed, refer to Section 5.4 for troubleshooting instructions.

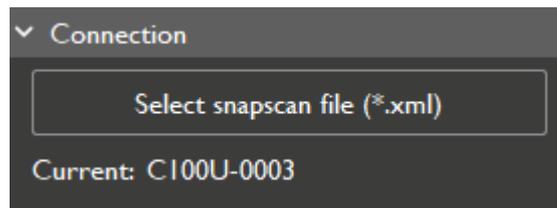


Figure 57: Controls available to connect to the snapscan system.

6.2.2 Configure step

Follow the steps below to configure the snapscan camera system for the cube acquisition:

- Step 1 -** Set the camera parameters by following the instructions in Section 6.2.2.1
- Step 2 -** Select the spectral bands by following the instructions in Section 6.2.2.2
- Step 3 -** Click the *Start* button to switch to acquisition interface (discussed in detail in Section 6.2.3)

6.2.2.1 Configuration parameters

The configuration parameters available are shown in Figure 58 and their description is provided in Table 10. These parameters determine the memory requirements, output data size, quality, and maximum acquisition speed.

- *An estimation of the memory requirements and data size is displayed below the settings and are updated when the user changes a configuration parameter.*



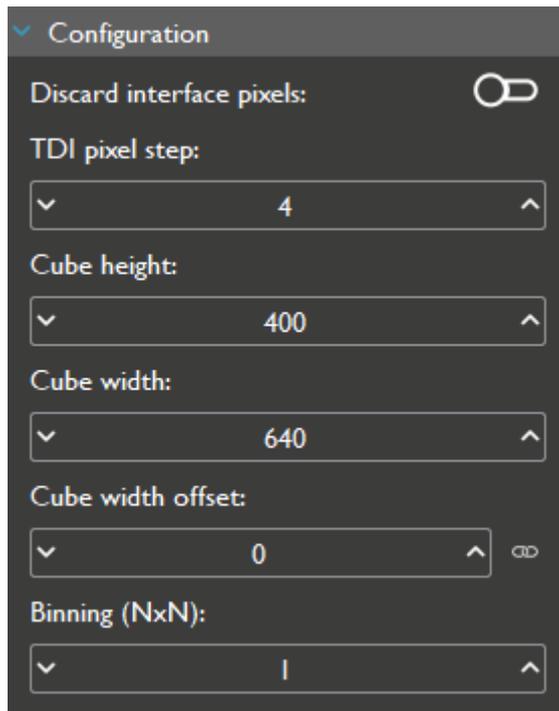


Figure 58: Controls available to configure the snapscan output data. The output data properties define the memory requirements, output data size, quality, and maximum acquisition speed.

Table 10: Overview of the parameters available to configure the snapscan system.

Parameters	Values	Description
Discard interface pixels	On / Off Default: Off	On: Pixel rows at the edges of spectral bands are ignored. This will reduce the crosstalk between the spectral bands. Off: All the pixels rows of a spectral bands are used. <i>Note:</i> The TDI pixel step must be minimum 2 less than the maximum.
TDI pixel step	1 to 4 (number of pixel rows per spectral band) Default: 4	Sets the travel range between two consecutive images. <i>Tip:</i> Smaller values avoid band to band crosstalk, enable software TDI, reduce noise, increase number of frames needed, increase acquisition duration.
Cube height	1 to 1206 (number of pixel rows in the sensor) Default: 512	Sets the number of rows in the output data. <i>Tip:</i> Higher values will increase the vertical spatial resolution, but it will also increase the required memory and the size of output file.
Cube width	1 to 640 (number of pixel columns in the sensor) Default: 640	Sets the number of columns in the output data. <i>Tip:</i> Higher values will increase the horizontal spatial resolution, but it will also increase the required memory and the size of output file.
Cube offset x	0 to 640 (number of pixel columns in the sensor) Default: 0	Sets the offset from top edge in live view in case the selected cube width is lower than 640. <i>Tip:</i> Use cube height, width and offset to acquire selected region in the field of view.
Binning (NxN)	1 to N (2, 3, ... ,20) Default: 1	Pixels within a NxN neighborhood are merged by averaging. <i>Tip:</i> Binning increases the SNR but decreases the spatial resolution and the size of output file.

6.2.2.2 Spectral bands selection

In Section 2.2.4.4, we have introduced the principle and benefits of band selections. In this section, we will guide you on how to select bands using graphical visualization and configuration panel.

The default band selection is configured during the in-factory system calibration, which selects all the bands in the full spectral range of the camera.

Band selection can be carried out using the graphical visualization in the Display panel where the spectral response of all the bands are shown. The selected bands can be edited either using the graphical visualization or using the Control & Configuration panel.

- *When using band selection, the software will automatically compute a correction matrix to compute the true spectral signal from the selected bands.*



- The actual index of the band on the sensor is stored in the band's name when exporting the data without correction.

Using graphical visualization

Follow the steps below to add, remove and modify SROIs:

Add	Left click on the plot to add a SROI. A faint blue overlay, bordered by two blue lines (handles), indicates the added SROI. The response of all selected bands is shown in the color corresponding to the wavelength.
Remove	Right click on a SROI to remove it
Modify	Hold and drag the left or right handles on the overlay to include or exclude additional bands.
Reset	Left click and drag over the full spectral range displayed

Figure 59 shows an example of band selection with two SROIs.



Figure 59: Example of a band selection with two spectral regions of interest. The user can interact with the visualization to modify the band selection. By default, after connection, the full sensor is read out.



Using configuration panel

The band selection can also be modified using the configuration panel, as shown in Figure 58. The lower part of the panel provides controls for band selection, as shown in Figure 60. These controls are described in Table 11.

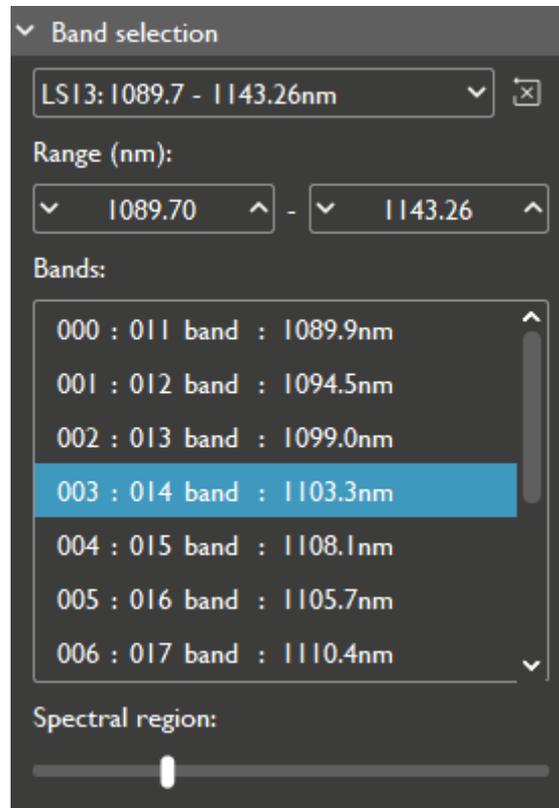


Figure 60. Band selection tool is complementary to the right side and can be used to fine-tune the range or highlight a given band by clicking on it or moving the slider.

Table 11 Description of controls for band selection in the configuration panel

Range (nm)	<p>The central wavelength of the first and last spectral band in the selected SROI is displayed here. The spectral range of the selected SROI can be edited by changing the beginning and the end wavelengths.</p> <p>All the SROIs selected using the graphical visualization are listed in the pulldown menu and it can be used to select a specific SROI.</p>
Bands	<p>Displays the list of bands in the selected SROI. Specific band can be highlighted by clicking it in the band list or using the slider below.</p> <p><i>Tip:</i> Some bands on the sensor have been disabled during the in-factory system calibration to optimize the system's spectral response. When these bands fall in a spectral region, they are greyed out in the region's band list. The band data will be recorded in the data but will not be used for spectral correction.</p>
Spectral region	<p>The slider can be used to scroll through the bands displayed for the selected SROI.</p>



6.2.3 Acquire step

The user interface for the acquisition mode is shown in Figure 61, where

1. The Control & Configuration panel can be used to set the image acquisition parameters, such as integration time, gain and scanning mode.
2. The Display panel shows the live view from the snapscan camera.
 - The live view provides a sight on the scene as seen by the snapscan camera. The outer border is displaying the maximum possible size while the inner one indicates the region that will be scanned as specified in the configure step.
 - When a preview image has been captured it is displayed as a background of the view.
 - An overlay is masking the unselected bands of the sensor.
 - In the top-right corner, controls are provided to rotate/flip the view. Saturated pixels are shown in red.

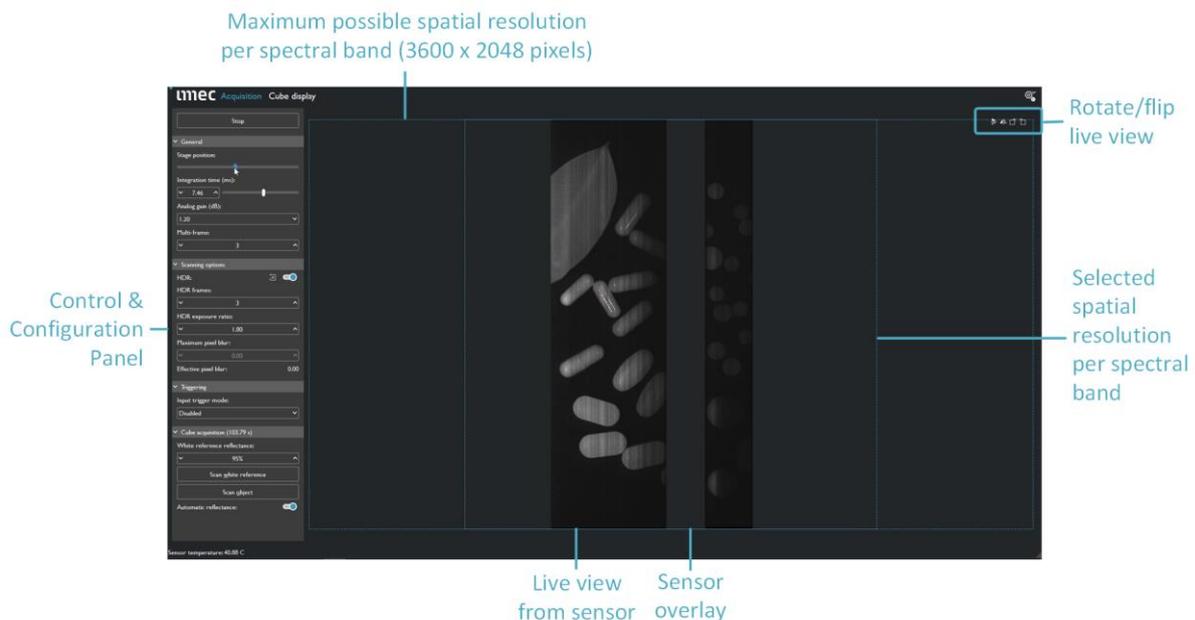


Figure 61: User interface and live view display for the acquisition mode after the camera has been connected and configured with default SROI settings, i.e. all spectral bands are selected.





Figure 62: User interface and live view for the acquisition mode after the camera has been connected and configured with specific bands selected. The semi-transparent colored overlay indicates bands that fall outside of the band selection. Note: HDR and multi-frame features are currently unavailable.

Follow the steps below to configure the acquisition parameters and acquire images from the snapscan camera

- Step 1** - Set the image acquisition parameters by following instructions in Section 6.2.3.1.
- Step 2** - Acquire reference data for white balancing and image data for the object under scanning by following instructions in Section 0.
- Step 3** - Go to *Cube Display* tab for viewing the acquired data and for further processing or click *Disconnect* button to go back to configuration mode.

Figure 63 shows the different elements available in the Control & Configuration panel.



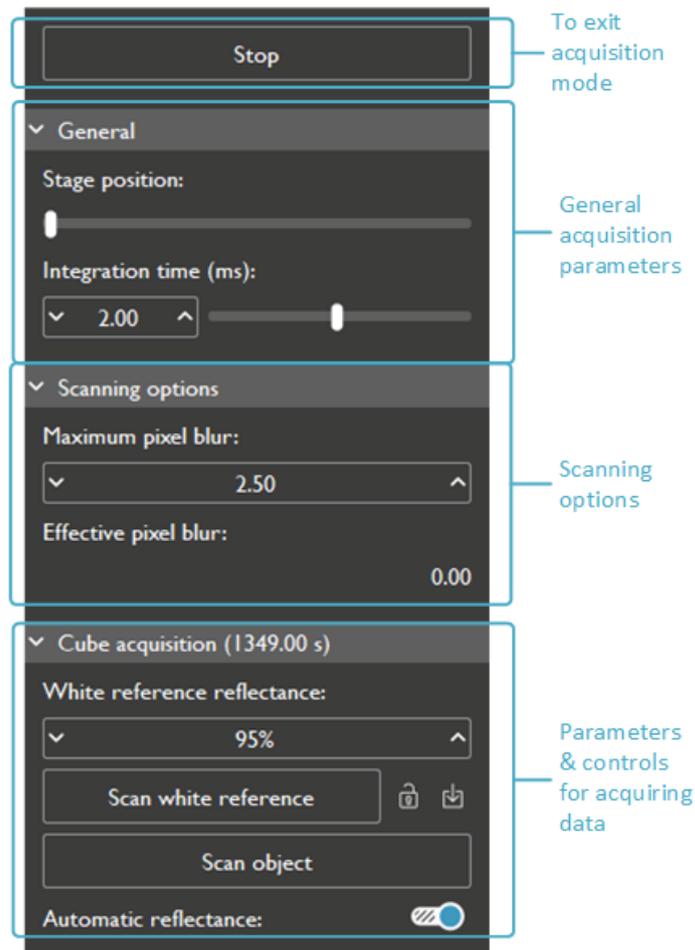


Figure 63 Control and configuration panel in the acquisition mode

6.2.3.1 Image acquisition parameters

There are the following categories of image acquisition parameters:

- General
- Pixel blur control
- External triggering control
- *Modifying the cube size and TDI settings requires returning to the configuration mode by stopping the acquisition. This is done by clicking the stop button.*

General acquisition parameters

The general acquisition parameters, as shown in Figure 64, let the user set the integration time and analog gain for the acquisition as well as the number of times a single frame should be acquired and averaged. An overview of these parameters is given in Table 12.



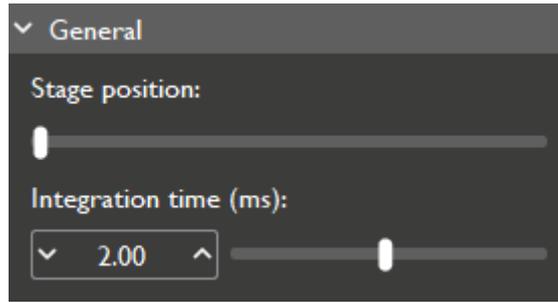


Figure 64: The general acquisition parameters allow setting integration time.

Table 12: Overview of the general parameters available to configure the acquisition with the snapscan system.

Parameter	Values	Description
Stage position	N.A	Drag the slider left or right to move the sensor live view across the field-of-view of the camera.
Integration time	0.01 – 90ms	Set the time period during which photons are collected by the sensor to capture a single frame. <i>Tip:</i> Lower values enable faster acquisition but may decrease the SNR.

Pixel blur control parameters

Pixel blur refers to the distance travelled by the sensor while sensor exposure is in progress. The traveled distance is measured in terms of pixels. The snapscan camera can operate in one of the following two modes:

1. Continuous: Data is acquired in-motion. The frame acquisition is synchronized to the motion by a hardware signal. The motion during the acquisition causes motion-blur in the data which can be controlled using the pixel blur control parameter.
2. Stop motion: Data is acquired in standstill. The sensor is moved by the pixel step (defined in the configuration view) and brought to standstill before acquiring the next frame. Hence, the pixel blur control parameter is not applicable in this mode.

The software automatically select the most appropriate mode given a set of parameters. Meanwhile, setting *Pixel Blur* to 0 will force Stop motion.

Follow the steps below to configure pixel blur control parameter (see Figure 65 and Table 13):

- Step 1 -** Check the *Effective pixel blur* value. This value is automatically calculated by the software based on the achievable frame rate, TDI steps and selected integration time. The achievable frame rate is displayed in the Configuration panel and is dependent on the bit-depth and number of spectral regions-of-interest (SROI).
- Step 2 -** Estimate the required resolution in terms of minimum number of pixels required to cover the targeted feature size. Count the number of pixels covering the feature size in the live view of the sensor.



Step 3 - Verify if the *Effective pixel blur* value is acceptable or not based on the table below.

Feature size (in pixels) [as seen in sensor live view]	Recommended maximum pixel blur
≥ 7	≤ 5
6	≤ 4
5	≤ 3
4	≤ 2
3	≤ 1
2	0

Step 4 - If the *Effective pixel blur* value is higher than the recommended maximum allowable pixel blur, set *Maximum pixel blur* parameter to a value lower or equal to the recommended value.

Step 5 - If the system does not accept the specified value, then change the configuration and acquisition parameters mentioned in Step 1. If the *Effective pixel blur* is still higher than the recommended value and it is not acceptable then you may have to change the optics and/or working distance such that the targeted feature size (in terms of pixels) and as seen in sensor live view increases.

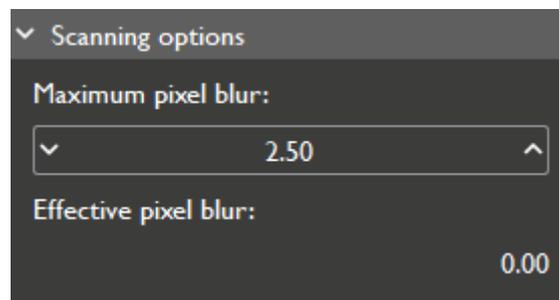


Figure 65: Scanning options available in the continuous scanning mode. Motion blur is controlled by limiting the distance traveled during the exposure time.

Table 13: Overview of the parameters available to configure the pixel blur controls

Parameter	Range	Description
Effective pixel blur	0 - 5	Distance traveled by sensor (in terms of pixels) during the exposure time. Tip: Smaller values indicate lower blurring and hence sharper images.
Maximum pixel blur	0 - 5	Threshold specified by user on the pixel blur.



6.2.3.2 Acquiring data

The actual data acquisition typically consists of two acquisitions:

1. A scan of the object
 2. A scan of a white reference (used in the software to normalize or white balance the object data into raw reflectance or raw transmittance)
- *These acquisitions can be done in any order.*
 - *Multiple object scans can be acquired with the same white reference. The software temporarily stores internally the white reference after it is acquired. This temporary copy is maintained until the user exits acquisition mode by clicking “Stop” (see Figure 63) or a new white reference is acquired.*

Figure 66 shows the controls for acquiring the data. The estimated time required for an acquisition is displayed above the controls.

- *Scans are always stored in memory until exported. Creating a new object or white reference scan replaces in memory the previously acquired object or reference scan respectively.*

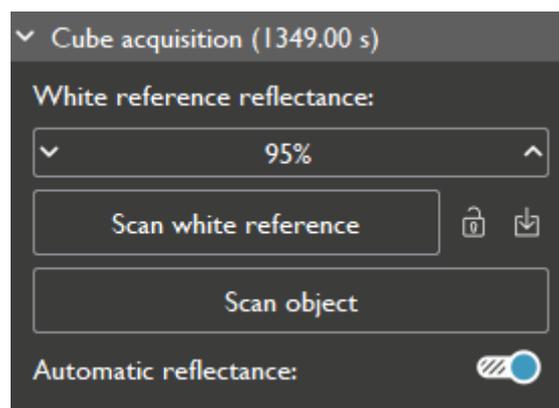


Figure 66: Cube acquisition controls. An estimate of the acquisition time given the current parameters is displayed on top of the section.

Acquiring white reference image

Follow the steps below to acquire white reference scan:

- Step 1** - Place a white reference under the camera.
- Step 2** - Set *White reference reflectance* parameter. The default value is 95%. If you are using the white reference target provided with the snapscan system, then leave this value at 95%. In case you are using a different white reference target then set this value accordingly.
- Step 3** - Ensure that the white reference is covering the whole region of interest.
- Step 4** - Set the acquisition parameters as needed. Ensure that there is neither over nor under exposure for any of the spectral band(s) and parts of the scene.



Step 5 - Click *Scan white reference*.

- i. The system will start acquiring the image and wait until it is over.
- ii. The snapscan camera has an integrated software-controlled mechanical shutter (see Section 1.2.3). The software will automatically acquire the dark reference image by closing the shutter.

Acquiring object image

Follow the steps below to acquire object scan:

Step 1 - Place the object under the camera.

Step 2 - Ensure the scene to be within the white referenced region.

Step 3 - Set the acquisition parameters as needed. Ensure that there is neither over nor under exposure for any of the spectral band(s) and parts of the scene.

Step 4 - Click *Scan object*.

- i. The system will start acquiring the image and wait until it is over.
- ii. snapscan has an integrated software-controlled mechanical shutter (see Section 1.2.3). The software will automatically acquire the dark reference image by closing the shutter.

Step 5 - If *Automatic reflectance* is enabled (default setting) and both object and white reference images are available, then the software will automatically carry out the reflectance correction (see Section 2.2.5) and prompt the user to go to *Cube display* mode.

To avoid losing data by pressing the wrong button, the white reference will be locked and must be manually unlocked to intentionally redo the reference.

A previously acquired reference can be imported. Be careful that your light setup must be strictly equivalent to be meaningful. Using an unmatching reference will yield wrong data.

6.3 Cube display mode

The acquired cube is visualized, analyzed and saved by following the last two steps in the workflow shown in Figure 67 (see Section 6.2 for the first three steps).

View step – process, visualize and analyze the acquired data

Export step – export to save the acquired data and reference data

Each of these steps are discussed in detail in the upcoming sections.



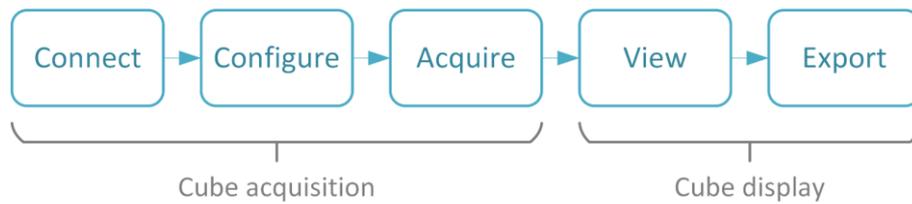


Figure 67: Illustration of the workflow of the snapscan software. This workflow guides the user from connecting to the snapscan system to exporting hyperspectral data.

The user interface for the cube display mode is shown in Figure 68, where

- Control & Analysis panel can be used select, export and render the acquired images. This panel also provides controls to display spectral information of selected regions on the image as well as carry out classification.
- Image Display panel shows the rendered image. This panel can also display the classified image.
- Data Visualization panel can be used to view the metadata of the acquired cube, spectral and pixel responses of regions selected in the control & analysis panel, as well as ground truth and class image for classification.

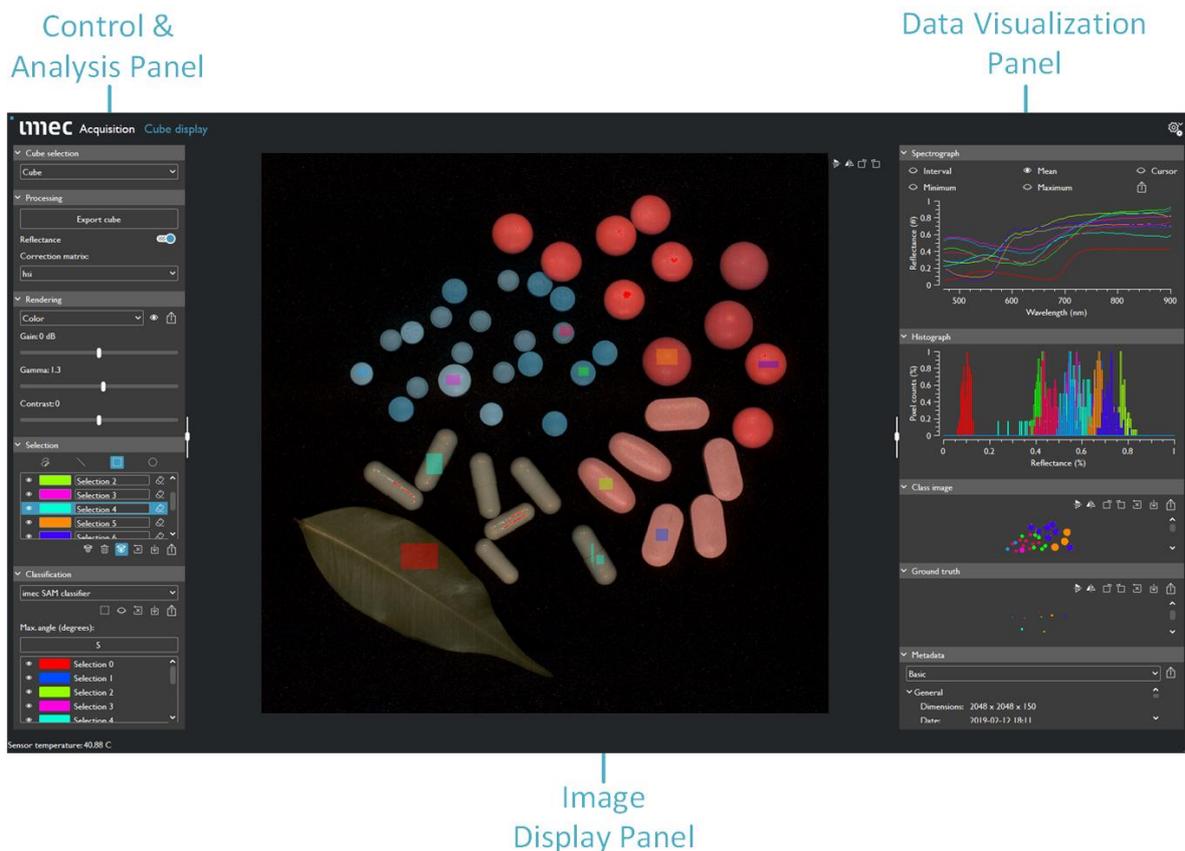


Figure 68: GUI of the Cube display mode



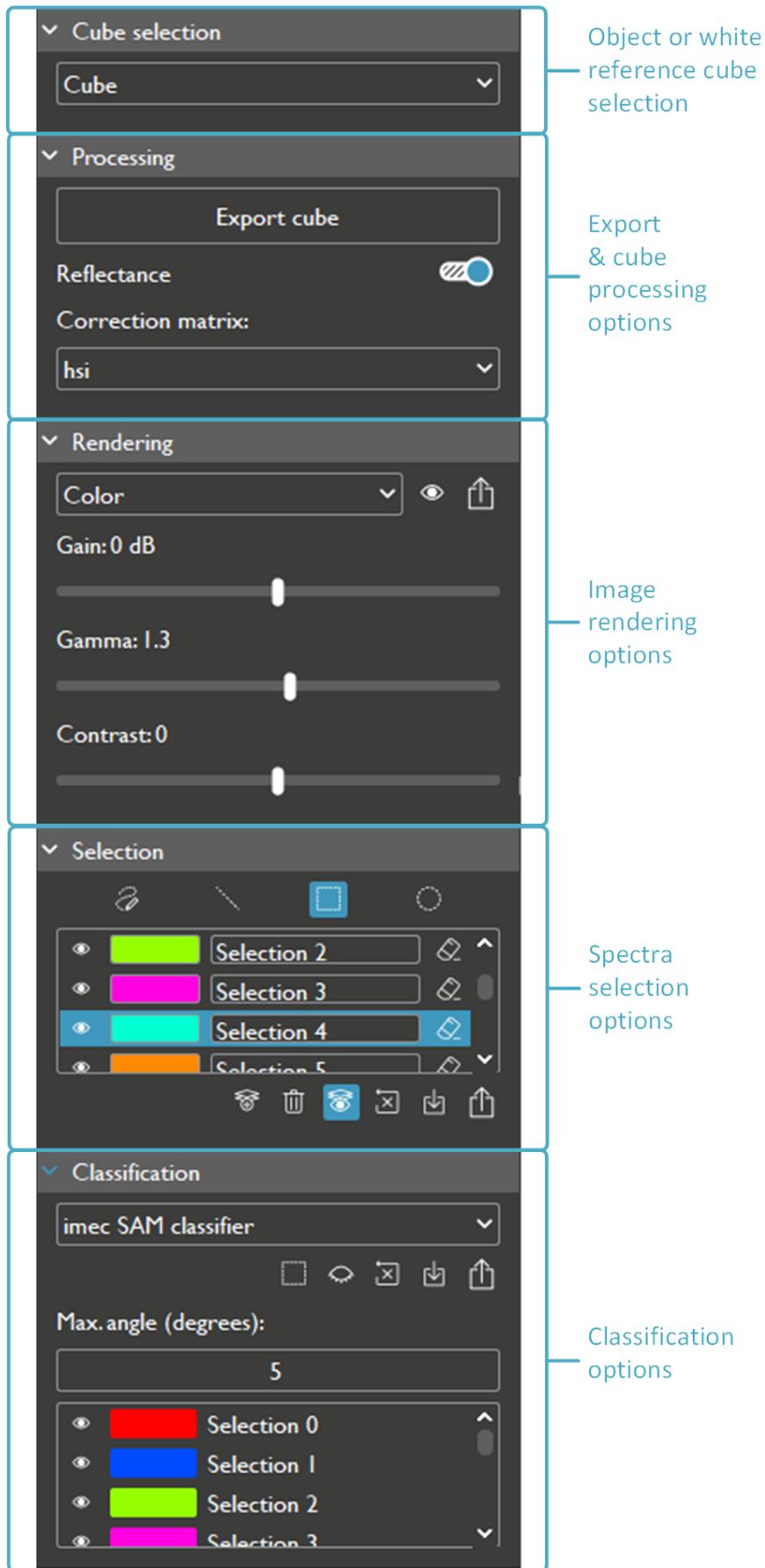


Figure 69 View of the “Control & Analysis Panel” (see Figure 68).



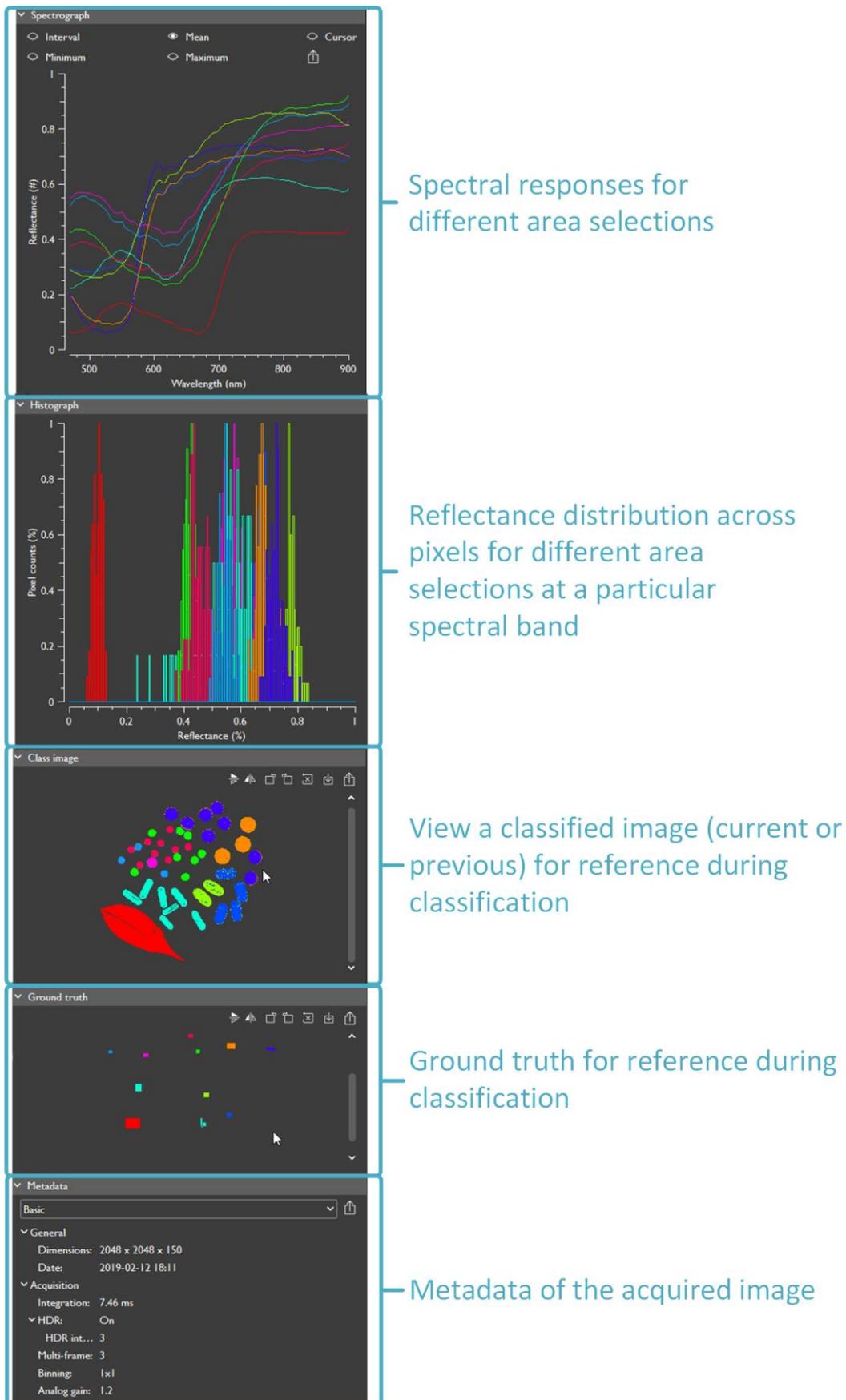


Figure 70 View of the "Data visualization" panel (see Figure 68)



6.3.1 View step

Follow the steps below to view the acquired cube:

- Step 1 -** Select the object or the white reference cube using the *Cube selection* control. The object cube will be selected and displayed by default after switching to cube display mode.



Figure 71. Cube selection. Switches between cube and white reference.

- Step 2 -** Select/de-select the post-processing to be applied on the cube. By default, the software applies reflectance correction (when both object and white reference cubes are available) and spectral correction to the acquired cube. User can select/de-select one or both post-processing to visualize the cube. (see Section 6.3.1.1 for details)
- *This step is applicable only to the object cube.*
- Step 3 -** Select the rendering type for visualization. HSI Snapscan offers multiple rendering types. (see Section 6.3.1.2 for details)
- Step 4 -** Analyze the spectral quality of the acquired image by selecting different areas on the image and plotting the spectral response for these different areas. (see Section 6.3.1.3 for details)
- Step 5 -** Carry out classification (if needed). (see Section 6.3.1.4 for details)

6.3.1.1 Processing

HSI Snapscan offers following post-processing options prior to visualization:

- **Export cube:** see Section 6.3.2.
- **Reflectance:** software will automatically carry out reflectance correction when both object and white reference images are available. It is possible to disable reflectance to view the irradiance cube.
- **Correction matrix:** software will automatically carry out spectral correction if reflectance is enabled. It is possible to disable spectral correction by selecting *None* in the pull-down menu.

Figure 72 shows the configuration parameters for the processing section.



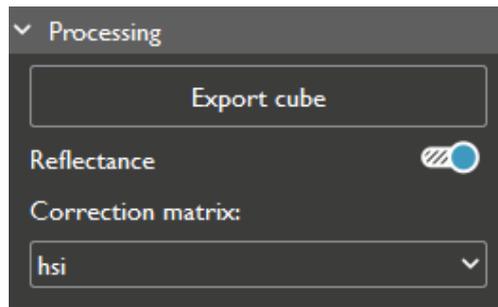


Figure 72. The processing section lets the user switch between irradiance and reflectance data and choose which correction matrix to apply to the reflectance data. The Export cube button gives access to the data export dialog.

6.3.1.2 Rendering

The snapscan software provides the following three rendering options to view the selected cube:

- Color
- Single band
- False color

The rendering type can be selected using the pull-down menu (see Figure 73) and each rendering type is discussed further in this section.

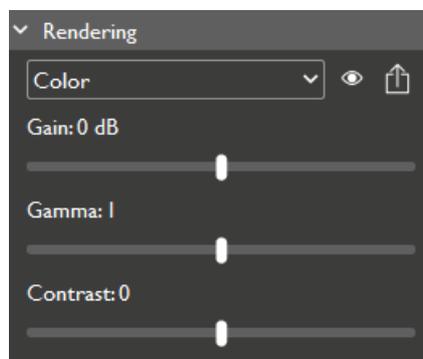


Figure 73 Rendering type selection

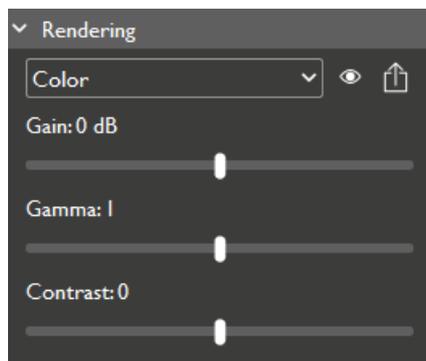
Color rendering

The software put the CIE 1931 curve in a different range to generate a pseudo color rendering of the image.



Following controls are available to adjust the rendering (see Figure 74):

Parameter	Range	Description
Gain (in dB)	-40 to 40 Default: 0	Adjust brightness of the image by increasing or decreasing the gain.
Gamma	0.17 – 6 Default: 1	Adjusts both brightness and contrast of the image. Different pixels in the images are impacted differently depending on their original intensity levels.
Contrast	-128 to 128 Default: 0	Adjust the distinction between the lighter and darker areas in the image by increasing or decreasing the contrast value.



(a)

(b)

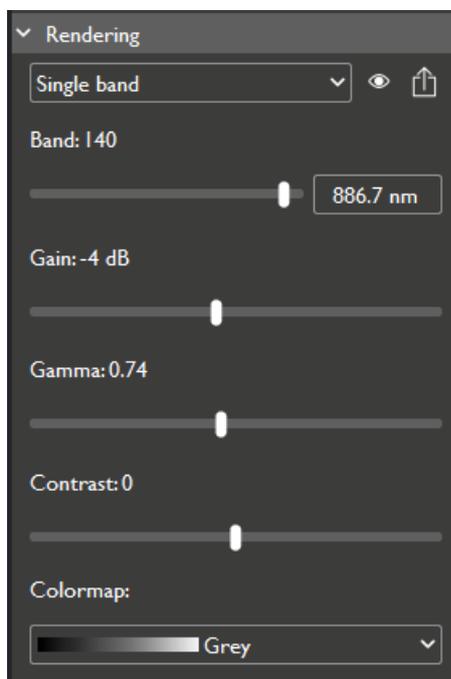
Figure 74 (a) Color rendering controls, (b) Rendered image



Single band rendering

The single band rendering generates an image from a single spectral band in the data cube. Following controls are available to adjust the rendering (see Figure 75):

Parameter	Range	Description
Band	0 to N Default: NA	Move the slider left or right to scroll through the images corresponding to different spectral bands. The bands are ordered from left to right in increasing order of their central wavelengths, i.e. moving slider to the left will select bands with decreasing central wavelengths and vice versa when slider is moved to the right.
Gain (in dB)	-40 to 40 Default: 0	Adjust brightness of the image by increasing or decreasing the gain.
Gamma	0.17 – 6 Default: 1	Adjusts both brightness and contrast of the image. Different pixels in the images are impacted differently depending on their original intensity levels.
Contrast	-128 to 128 Default: 0	Adjust the distinction between the lighter and darker areas in the image by increasing or decreasing the contrast value.
Colormap	Grey Grey inverted Inferno Viridis Default: Grey	4 different color maps are available. Switching between color maps helps enhancing the visualization contrast. The colormaps have been selected to maximize the contrast sensitivity to the human eye.



(a)



(b)

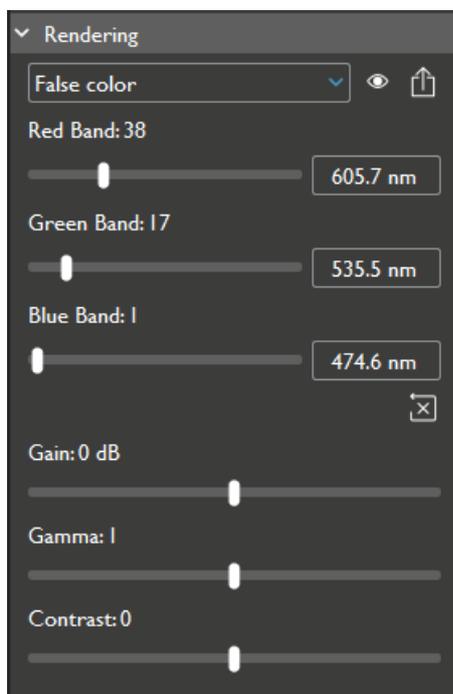
Figure 75. (a) Single band rendering controls, (b) Rendered image of spectral band with central wavelength at 747nm



False color rendering

The false color rendering generates an RGB image using three spectral bands in the data cube. This enable the user to define his own coloring system to highlight pixels based on spectral features. Following controls are available to adjust the rendering (see Figure 76):

Parameter	Range	Description
Red/ Green/ Blue Band	0 to 150 Default: Computed by software	By default, red, green and blue bands are selected such that the color rendering is close as possible to the true color rendering. User can change the band selection for red, green or blue channels by moving the respective sliders.
Gain (in dB)	-40 to 40 Default: 0	Adjust brightness of the image by increasing or decreasing the gain.
Gamma	0.17 – 6 Default: 1	Adjusts both brightness and contrast of the image. Different pixels in the images are impacted differently depending on their original intensity levels.
Contrast	-128 to 128 Default: 0	Adjust the distinction between the lighter and darker areas in the image by increasing or decreasing the contrast value.



(a)



(b)

Figure 76 (a) False color rendering controls, (b) Image rendered in false color



6.3.1.3 Spectral analysis

The selection panel allows user to select specific areas on the rendered image and display the spectral response of the pixels in the selected area in the spectrograph. This helps the user to quickly analyze the spectral quality of the acquired data.

Figure 77 shows an example where a single area is selected on the image (marked in red) and the corresponding mean and interval spectra are displayed in the spectrograph.

Figure 78 shows an example where multiple areas are selected on the image (marked in different colors) and the corresponding mean and interval spectra for each area is displayed in the spectrograph.

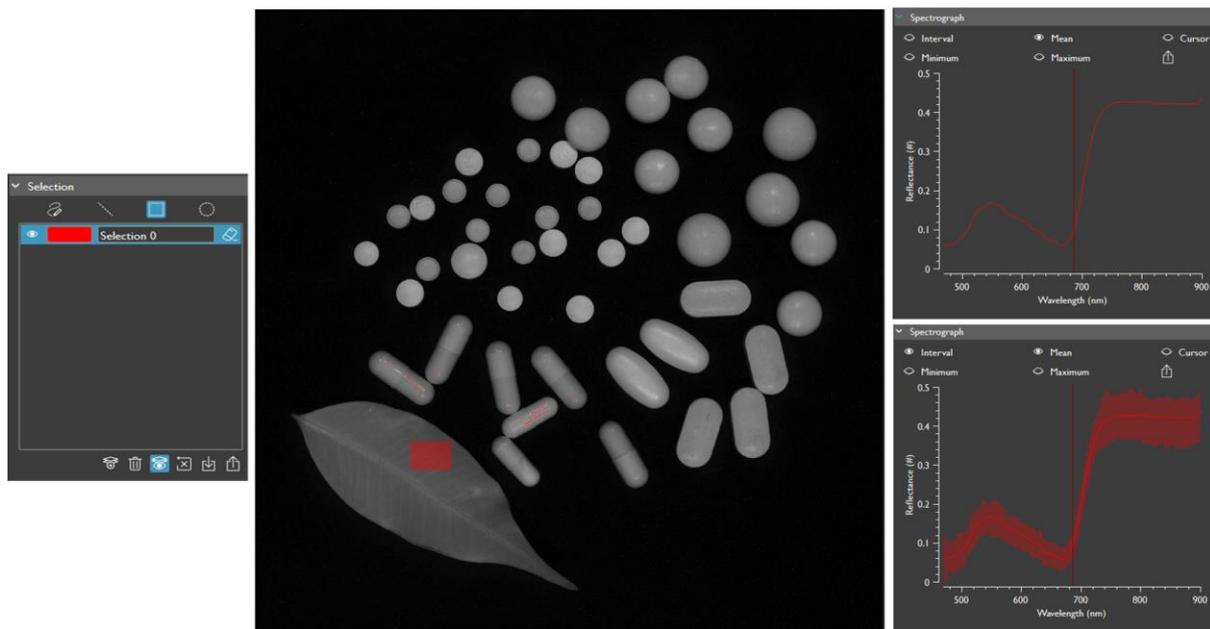


Figure 77 Illustration of the selection of single area on the rendered image and displaying in the spectrograph, the mean & interval spectra across all the pixels



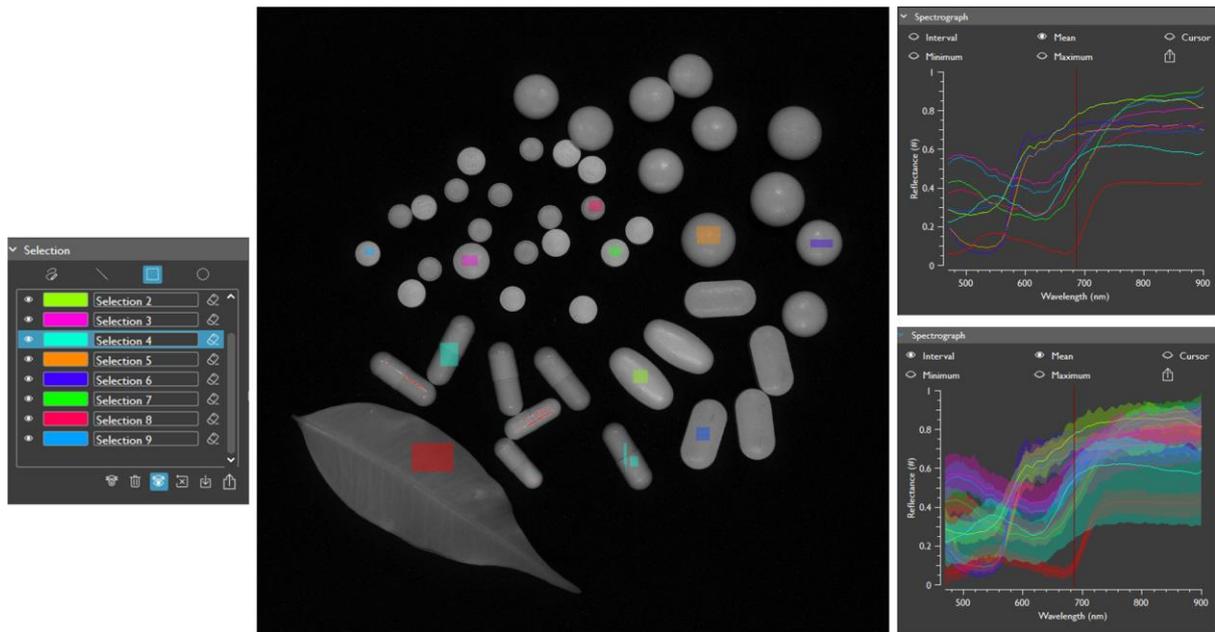


Figure 78 Illustration of the selection of multiple areas on the rendered image and displaying in the spectrograph, the mean and interval spectra across all the pixels for each of the selected area

Follow the steps below for carrying out spectral analysis:

- Step 1** - Add a new selection by clicking on the  icon. Provide a suitable name and select a suitable color for the selection (if needed).
- Step 2** - Select a suitable drawing tool  and mark the area(s) on the image to be included in this selection.
- Step 3** - Repeat steps 1 and 2 until all desired selections are created and areas for each selection are marked on the image, as shown in Figure 78.
- Step 4** - Analyze the spectral responses using the spectrograph.
- Step 5** - Edit the selections (if needed) by using the icons provided on the panel and as described in Table I4 and Table I5.
- Step 6** - If needed, export and save the selections as well as the spectrograph.

A description of different controls in the selection panel is given in Table I4 and those for spectrograph is given in Table I5.



Table 14 Description of controls in the selection panel

Icon	Description
	Free hand drawing tool to select regions on the image. Pixels under the drawn curve are selected.
	Straight line drawing tool to select regions on the image. Pixels under the drawn line are selected.
	Rectangle drawing tool to select regions on the image. All the pixels within the drawn rectangle are selected.
	Circle drawing tool to select regions on the image. All the pixels within the drawn circle are selected.
	Add new selection
	Delete an the currently active selection.
	Toggle On/Off visibility of all selections.
	Reset the whole selection model.
	Import a pre-saved selection model.
	Export and save the current selection model.
	Toggle visibility of a selection.
	Software will automatically assign a color when a new selection is added. This color will be used to mark the selected area on the image as well as for plotting the spectra in the spectrograph. User can change the color by double clicking on this icon and selecting a new color.
	Software will automatically assign name to each selection. User can edit the assigned name by double clicking on the text box.
	Clear the pixels associated to a selection.



Table 15 Description of controls in the spectrograph

Icon	Description
 Interval	Toggle the interval view, displaying the span between the minimum and maximum value for each wavelength. This will affect plots for all the selections.
 Mean	Click on this icon to toggle on/off the display of mean spectra. This will affect the plots for all the selections.
 Cursor	Click on this icon to toggle on/off the display of spectra under the cursor.
 Minimum	Click on this icon to toggle on/off the display of lower limit in the spread of spectra across all the pixels included in the selection(s). This will affect plots for all the selections.
 Maximum	Click on this icon to toggle on/off the display of upper limit in the spread of spectra across all the pixels included in the selection(s). This will affect plots for all the selections.
	Export the spectra.

Histogram

The histogram visualizes the data variability and distribution of a selection in a specific spectral band. To enable comparison of different selections the distributions are normalized to the number of pixels in a selection. A screenshot of the histogram is given in Figure 79.

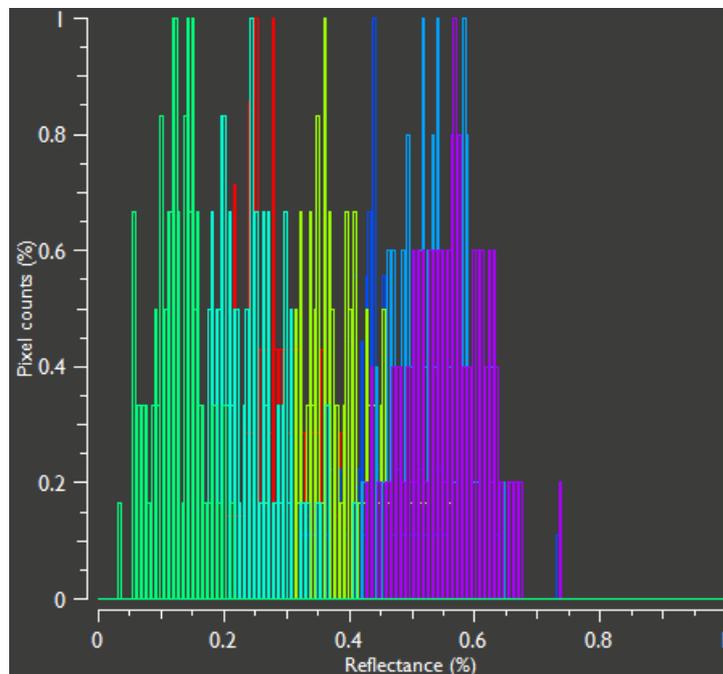


Figure 79. Distribution of three different selections in a specific spectral band.



6.3.1.4 Classification

HSI Snapscan provides the following two options for classification:

- In-built imec Spectral Angle Mapper (SAM) classifier
- Integration with 3rd party industry leading HSI analysis software [perClass Mira](#)

Imec Spectral Angle Mapper (SAM) classifier

Follow the steps below to use SAM classifier:

Step 1 - Generate the training set by creating one or more selections and marking areas per selection on the image (see Section 6.3.1.3 for instructions on how to create the selections).

This supervised technique will use marked pixels as labels and selections as target classes.

Step 2 - Select “*imec SAM classifier*” using the pull-down menu (see Figure 80).

Step 3 - If needed, adjust the classifier parameter “*Max. angle degrees*” (see Figure 80). The default value for this parameter is 5.

Step 4 - Train the classifier by turning the switch on. This will also automatically apply the trained model on the whole data cube and display the classified image (see Figure 81).

Clicking on  icon will toggle on/off the display of classified image. When toggled off, the classified image can still be seen in the class image panel on the right-hand side (see Figure 70).

All the selections used for training the classifier will also be listed in the classification panel (see Figure 80).

Step 5 - Repeat steps 1 to 4 if needed to get the desired classification results.

Step 6 - The classifier model can be exported and saved by clicking on  icon.

Step 7 - A pre-saved classifier model can be loaded and applied by clicking on  icon. Use this option to apply the same classification model on more than one images. Repeat steps 1 to 4 if needed. Export and save the edited classification model if needed.

A description of different controls in the classification panel is given in Table 16.



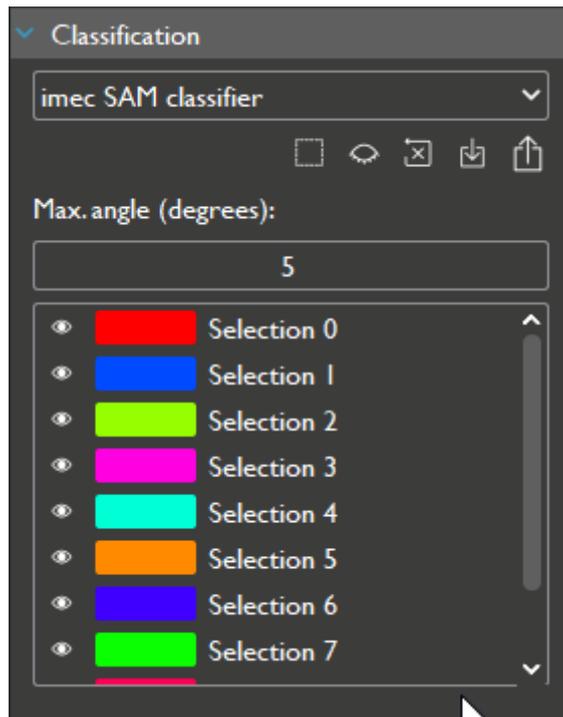


Figure 80. View of the classification panel when “imec SAM classifier” is selected. Note: this screenshot is outdated.

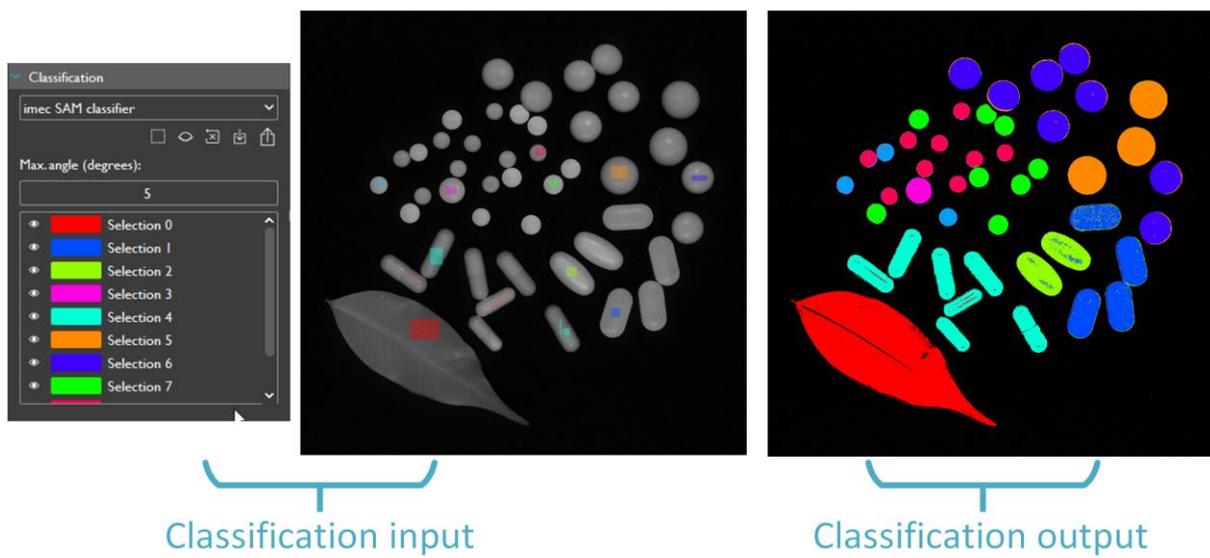
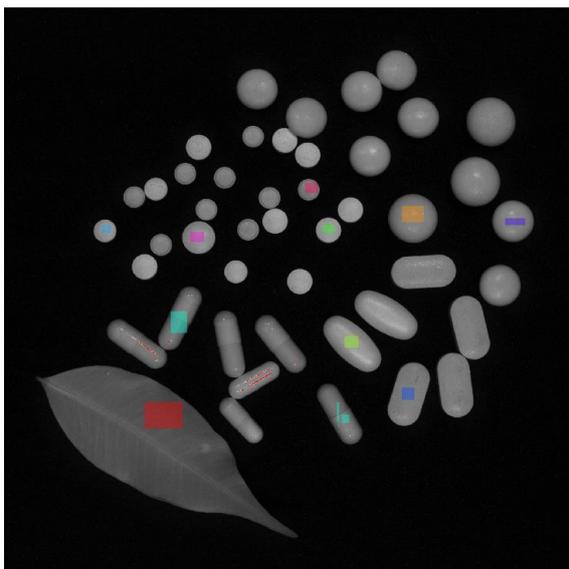


Figure 81 Illustration of the input and output of classification using imec SAM classifier

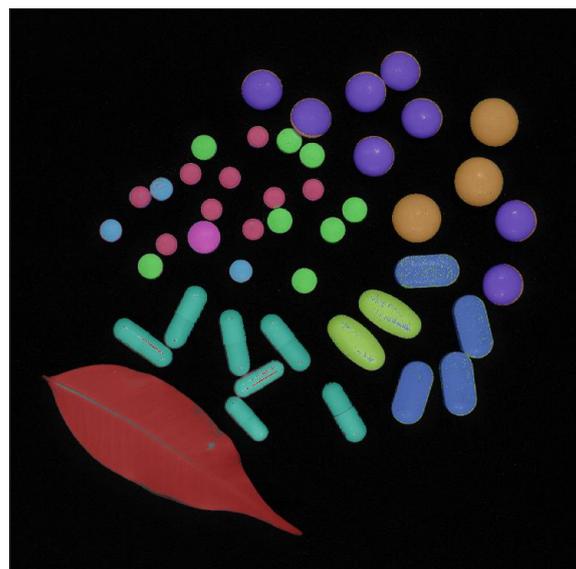


Table 16 Description of controls in the classification panel when imec SAM classifier is selected

Icon	Description
	The SAM mapper will assign different pixels to different selections while carrying out the classification. By clicking this icon, the original selection is replaced with the output of the classification, i.e. the areas classified by SAM as belonging to a particular class will be assigned to the corresponding selection. (see Figure 82)
	Reset the classifier model. These will delete the existing classes and the trained model.
	Import a file with pre-saved classification model. Use this option to apply the same classification model on more than one images.
	Export and save the current classification model.
Max angle	Sets the tolerance on the spectral angle from a spectrum to a centroid. Value range: 0 to 180 Default value: 5
	Toggle on/off the display of classification of a class. By default, the classification for all the classes are displayed.



(a)



(b)

Figure 82 Example of impact of  “Convert to Selection” icon. (a) Original selection, (b) Updated selection after clicking on  icon.



perClass Mira classifier

[perClass Mira](#) is a spectral imaging software from perClass BV which can be used for viewing and analyzing the acquired hyperspectral image data. A 14-day limited functionality demo license is included with snapscan software.

See Section 5.2.1 for instructions on how to install and activate perClass Mira.

Follow the steps below to use perClass Mira classifier:

- Step 1** - Select “*perClass classifier*” using the pull-down menu (see Figure 83).
- Step 2** - Click on “*perClass Mira*” button to open the perClass Mira software (see Figure 83).
- Step 3** - A new project dialog box will open. Select “*IMEC*” as the project type and select an appropriate path to store the data (see Figure 84).
- Step 4** - The cube will open in the perClass Mira software (see Figure 85). Please refer to http://doc.perclass.com/perClass_Mira/Introduction.html for full documentation and user manual on how to use perClass MIRA software to analyze the cube.

You may also refer to the video on the following link to see the workflow for using perClass Mira with the snapscan software - <http://perclass.com/applications/separating-dark-textiles>.

- Step 5** - A pre-saved classifier model created in perClass Mira can be loaded and applied by clicking on  icon. Use this option to apply the same classification model on more than one images.

A description of different controls in the classification panel is given in Table 17.

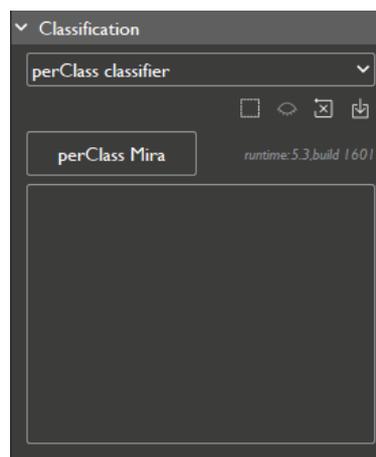


Figure 83 View of the classification panel when “*perClass classifier*” is selected



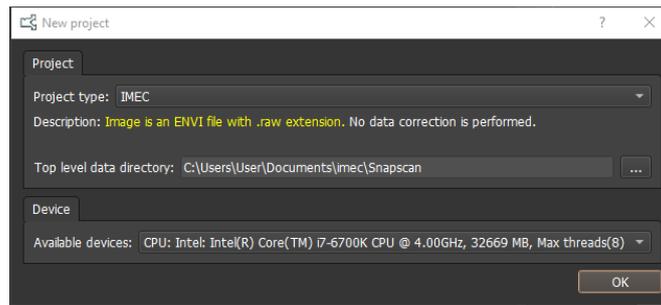


Figure 84 New project dialog box when the cube is opened in perClass Mira software. Select “IMEC” as the project type and select an appropriate path to store the data.

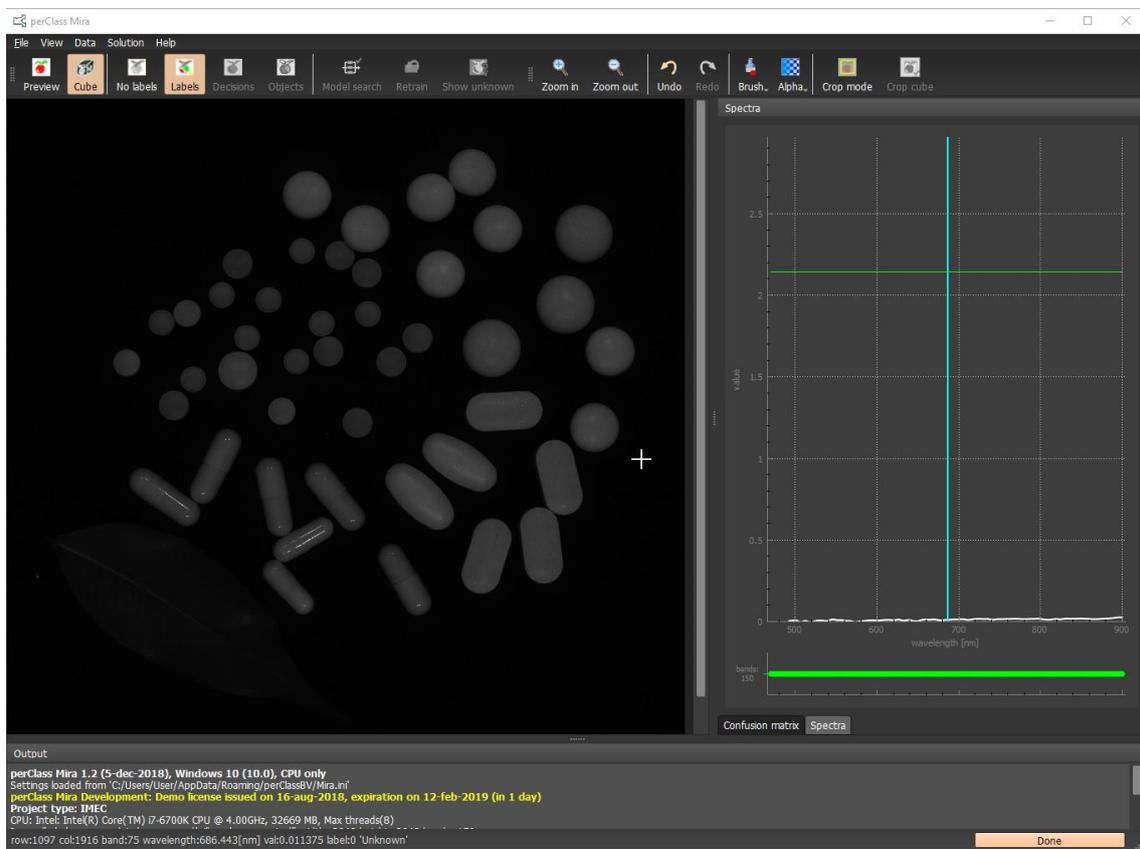


Figure 85 GUI of perClass Mira software

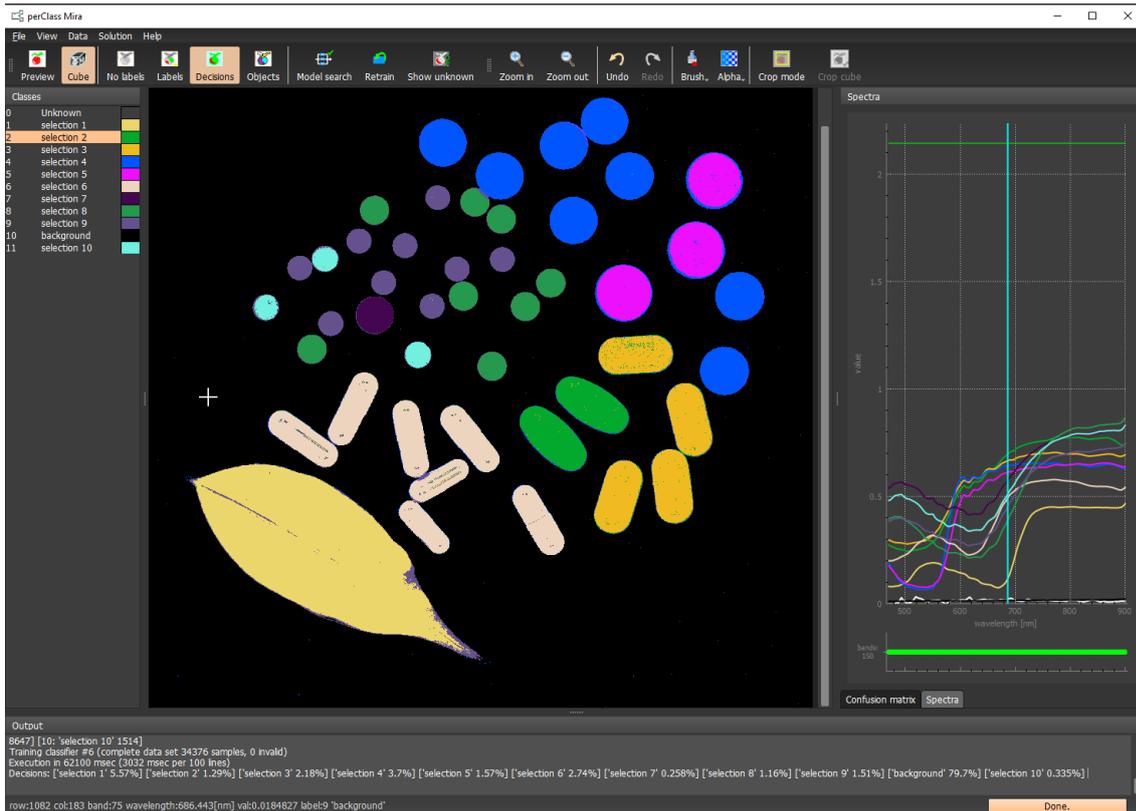


Figure 86 An example of classification carried out in perClass Mira software

Table 17 Description of controls in the classification panel when “perClass classifier” is selected

Icon	Description
	The perClass classifier will assign different pixels to different selections while carrying out the classification. By clicking this icon, the original selection is replaced with the output of the classification, i.e. the areas classified as belonging to a particular class will be assigned to the corresponding selection. (see Figure 82)
	Toggle on/off the display of classification of a class. By default, the classification for all the classes are displayed.
	Reset the classifier model. These will delete the existing classes and the trained model.
	Import a file with pre-saved classification model. Use this option to apply the same classification model on more than one images.



6.3.2 Export step

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

Follow the steps below to export the acquired hyperspectral data:

- Step 1** - Click “Export cube” button on the left-hand side panel (see Figure 87).
- Step 2** - An “Export Setting” dialog box will open (see Figure 88). Follow the sub-steps below:

- a. Select the destination folder and provide the filename
- b. Select the file format. The snapscan software can export file in ENVI, PNG, PGM and TIFF formats.

ENVI is the default file format¹ in which the hyperspectral data is exported. In cases of PNG, PGM and TIFF file formats, each spectral band is saved as a separate image file and the metadata is stored in an accompanying XML file.

An overview of the non-standard metadata stored in the ENVI file header or in the XML file is given in Table 18.

- c. Select the references to be exported along with the object cube. The snapscan software does not exports the references by default.
 - *It is important to export the references if you plan to re-process the data cubes later using a different software pipeline. In this case, the irradiance data cube should also be exported (see the next step).*
 - *Dark references are always exported as RAW and white references are always exported in ENVI file format.*
 - *White Reference and White Dark Reference are only available if a white reference was acquired.*
 - *Cube Dark Reference is only available if an object was acquired.*
- d. Select the data cubes to be exported.
 - *Irradiance* – data cube with dark noise removed but no white balancing (see Section 2.2.5.1).
 - *Reflectance* – Irradiance cube with balancing applied (see Section 2.2.5.1).
 - *Corrected* – Reflectance cube with spectral correction applied. The available correction matrices are listed in the dropdown menu, which is enabled if the “Corrected” option is checked.
 - *Reflectance and Corrected are only available if a white reference was acquired.*

¹ See the following link for the ENVI file format specification:
<http://www.harrisgeospatial.com/docs/ENVIHeaderFiles.html>



- The snapscan software exports only the corrected cube by default (if white reference was acquired).

Step 3 - Click “OK” to start exporting the data and close the dialog box.

- Applying reflectance and spectral correction to the object cube requires processing of the acquired data. This operation may take up to a couple of minutes depending on the resolution of the cube and the computing power of the system.

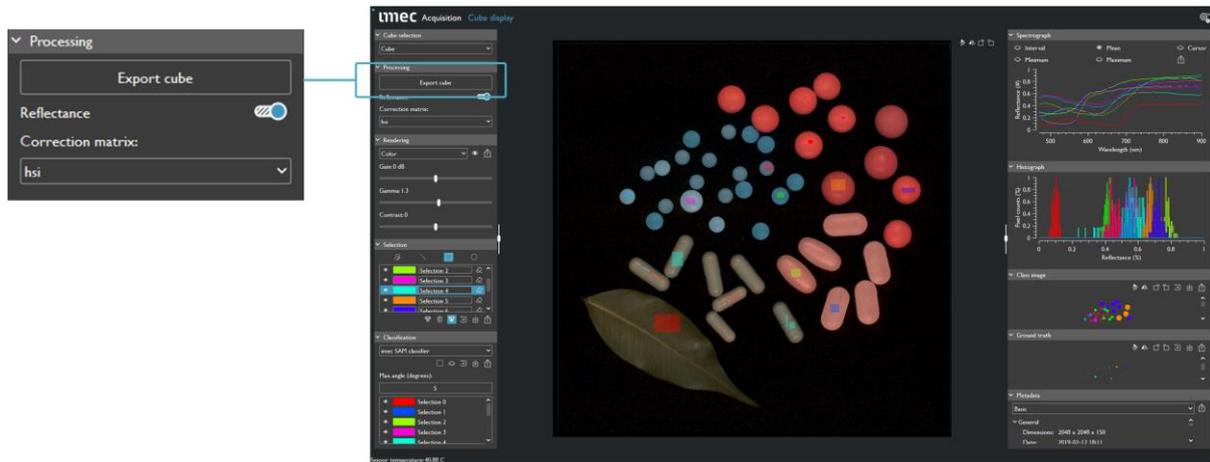


Figure 87 “Export Cube” selection button in the “Cube display” GUI.

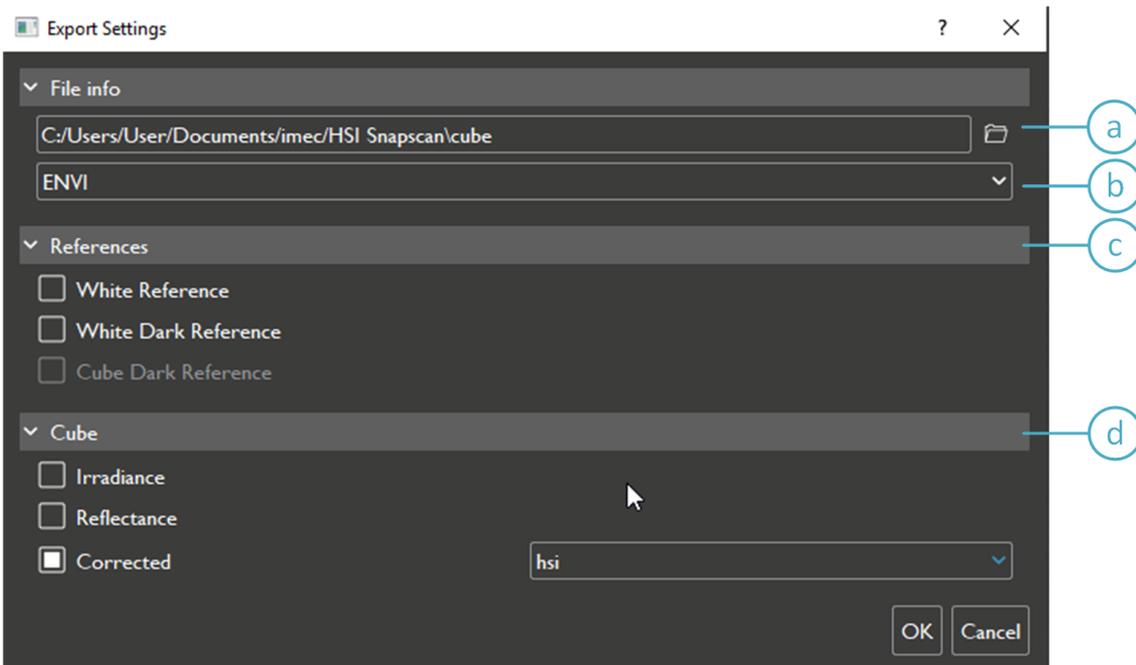


Figure 88 Screenshot of the export settings dialog box which allows the user to choose the location, name and format of the file. It also allows user to select the references and cubes to be exported.



Table 18: Overview of all metadata fields stored in the ENVI file header or XML metadata file.

Parameter	Description
Binning columns	The binning applied on the columns during the acquisition.
Binning rows	The binning applied on the rows during the acquisition.
Integration time	The integration time (in milliseconds) used to create the scan.
Analog gain	The sensor analog gain used to create the scan.
Scanning mode	The scanning mode used to create the scan.
Scanning direction	Direction of motion of the sensor during the scan. Either right to left or vice-versa.
Scanning velocity	The velocity of the sensor during the scan, in millimeters per second.
Pixel step	The step size between any two positions in number of pixels.
Pixel blur	The effective pixel blur incurred due to motion during integration.
HDR flag enabled	Flags if HDR was enabled (1) to acquire the data for the scan or not (0).
HDR flag scaling	Flags if the HDR frames are rescaled by their exposure time factor (1) or not (0). This flag is meaningless if HDR is not enabled.
Number of averaged frames	The number of frames that are averaged to acquire one frame. This value is equal to the multi-pass setting.
Number of frames	The total number of frames acquired to create the scan.
Frame positions	Vector with the position of each frame that was acquired during the scan, in millimeters.
Frame temperatures	Vector with the sensor temperature for each frame that was acquired during the scan, in degrees Celsius.
Frame timestamps	Vector with the time of acquisition of each frame that was acquired during the scan, relative to the first acquired frame, in seconds.
Output mode	Depicts if the data contains a stitched cube (Datacube) or a stack of unstitched frames (Framestack).
Max value	The maximum data value.
Saturation value	The data value marking saturation. All values in the data equal or larger than this value are considered saturated. This value is always less or equal to the maximum data value.
No data value	The value marking data points with “no value”, e.g., due to defect pixels.
Corrected data	Flags if a correction matrix was applied to the data (1) or not (0).
Reflectance data	Flags if the data has been white balanced and hence can be interpreted as reflectance percentage (1) or not (0).
Data source	The software name and version that generated the data.
Sensor bit depth	The bit-depth of the ADC on the sensor converting electrons to digital number.
Sensor id	The four-number unique sensor identifier.
Sensor pixel pitch	The size of one pixel, in millimeters.
Sensor type	The sensor’s hyperspectral filter layout type.



6.4 Tutorial

This chapter provides step by step tutorials to easily learn making good acquisitions with the snapscan system.

6.4.1 Basic configuration

This tutorial will guide the user to easily acquire, analyze and export hyperspectral data cubes.

1. Connect your snapscan system to the PC.
2. Open HSI Snapscan.
3. Select your snapscan system file.
4. Click “Connect”.
5. Keep the default configuration settings.
6. Click “Start”
7. Put your object in the field of view.
8. Set the lens parameters.
 - Set the aperture to F/2.8.
 - The optimal focus is found such that all spatial features appear sharp in the image.
9. Find the optimal integration time as the largest possible value at which only very few or no pixels are saturated.
10. Verify your integration time setting.
 - Moving the sensor left and right will show if the integration time is valid to capture spectral data for all spatial points. Reduce the integration time if pixels saturate when moving the sensor left and right.
11. Click “Scan object” in the “Cube acquisition” section.
12. Remove the object and put the reflectance target in the field of view.
13. Tune the integration time. Verification is not needed in case of uniform illumination.
14. Click “Scan white reference” in the “Cube acquisition” section.
15. Go to the “Cube display” tab to show the data.
16. Inspect the spatial data in the image view.
 - Scroll through the bands using the slider in the rendering group.
 - Adjust the digital gain using the slider in the rendering group.
 - Zoom and pan using the mouse.
17. Select pixels within the view.
 - Press and hold the left mouse button. Move the mouse keeping the left mouse button pressed to drag. Then release the left mouse button to complete the selection.



18. Optional: click  icon in the “Selection” panel or by using the right click context menu and select other pixels. Click the switch icon of the “Classification” panel to show a classified image on top of the rendering.
19. Open the data export dialog by clicking “Export cube” button.
20. Select a destination folder and filename prefix.
21. Disable all options except “Corrected”. This will export the hyperspectral data reflectance data, corrected for the system model.
22. Click “Ok” to export the data.
23. The last step concluded the acquisition. The software can now be closed or go back to the “Acquisition” tab to acquire more data.

6.4.2 Tuning focus, aperture and acquisition parameters

There is an interplay between the integration time, the lens’ aperture and the focus. Opening the lens’ aperture allows more light in the system, allowing shorter integration time, but reducing the depth of field. It is also recommended to limit the aperture to a maximum opening of F/2.8 as the Fabry-Perot filters have an angular dependency. This tutorial provides guidelines to find the optimal configuration of these parameters.

1. The aperture should be set to the largest value possible yielding the required depth of field. For a given focal length and distance to the subject, the f-stop can be computed with the following tool: <http://www.dofmaster.com/dofjs.html>
 - Limit the maximum aperture opening to F/2.8.
2. Choose an integration time such that the image is optimally exposed, while keeping the scan duration within acceptable limits.
 - The optimal integration time is found as the large possible value at which no pixels are saturated.
3. Focus the lens on the subject such that all features are clearly in focus.
 - On surfaces with disparity, the sharpest focus must be achieved halfway the total depth of the analyte.
 - Different wavelengths have a different focal error, hence focusing for one wavelength may bring the image out of focus in different wavelengths. Optimize the focus for the wavelengths of interest for your application.

As the available parameters are all connected, there might not be an optimal solution within the constraints of the application. In this case a tradeoff must be made, or the illumination intensity must be increased.

6.4.3 Typical acquisition scenarios and recommended parameter settings

The snapscan camera system provides flexibility to optimize the acquisition parameters depending on the application requirements. In this section, we use three typical scenarios as example to show the trade-off between these scenarios and recommended parameter settings.



The three typical scenarios are:

- High speed acquisition – scenarios where acquisition time is critical. E.g. in-line sorting applications or applications where target objects can be stationary only for limited duration.
- High quality acquisition – scenarios where image quality is critical. E.g. microscopy and art restoration.
- Speed-quality balanced acquisition – scenarios where both acquisition time and image quality are equally critical and needs to be balanced. E.g. skin oximetry.

The performance trade-offs across these scenarios are shown in Figure 89 and the recommended settings for configuration and acquisition parameters are shown in Table 19. It is assumed that the spatial dimensions of the acquired cube are same in all the scenarios.

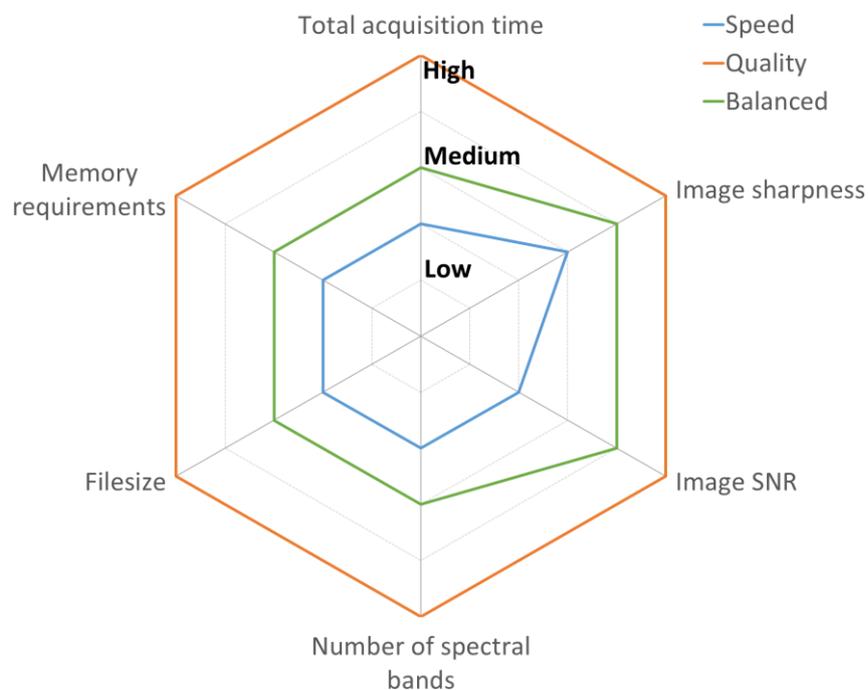
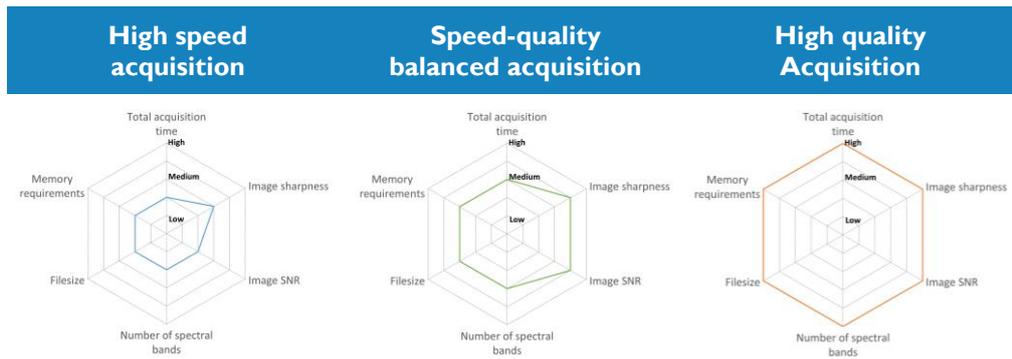


Figure 89 Performance trade-offs across the three acquisition scenarios – high speed, high quality and speed-quality balanced. It is assumed that the spatial dimensions of the acquired cube are same in all the scenarios.



Table 19 Recommended configuration and acquisition parameter settings for the three acquisition scenarios



	High speed acquisition	Speed-quality balanced acquisition	High quality Acquisition
Discard interface	NO	YES	YES
TDI pixel steps	4	3	1
Cube height	Minimum required to cover the field-of-view		
Cube width	Minimum required to cover the field-of-view		
Binning	2x2 to 4x4 (to improve SNR while trading-off some spatial resolution)	Up to 2x2 (improve SNR while minimizing loss in spatial resolution)	NO
Spectral band selection	Select minimum required spectral bands	Select almost all key spectral ranges of interest	Use all spectral bands
Integration time	Minimum possible without underexposing	Set it between minimum & maximum values based on overall acquisition time targeted	Maximum possible without saturating
Multi-frame	1	2-3	> 3
HDR	NO	YES Smaller HDR steps (2-3)	YES Larger HDR steps (4-6)



6.5 Support for 3rd party software

6.5.1 perClass Mira

perClass Mira is a spectral imaging software from perClass BV which can be used for viewing and analyzing the acquired hyperspectral image data. A 14-day limited functionality demo license is included with snapscan software.

Full documentation and user manual can be found online at http://doc.perclass.com/perClass_Mira/Introduction.html. Please refer to Section 5.2.1 for instructions on installing and activating perClass Mira.

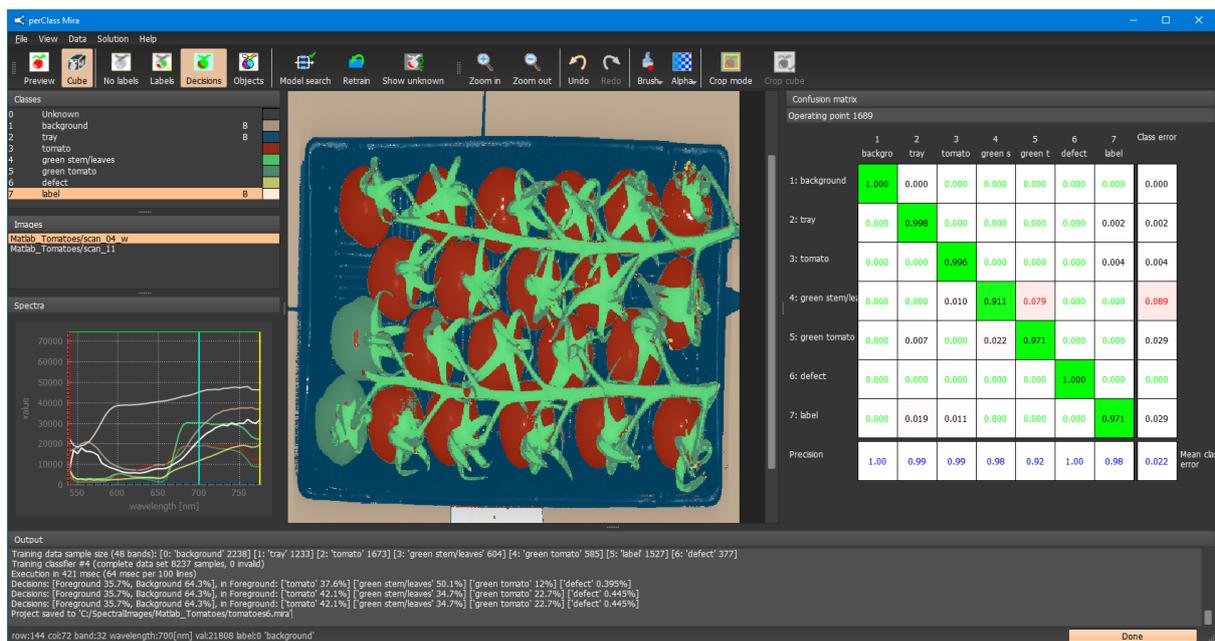


Figure 90 Screenshot of perClass Mira GUI (source: http://doc.perclass.com/perClass_Mira/Introduction.html)



6.6 Troubleshooting

There is no live image after starting the snapscan system

Check if there is enough memory available to allocate all data. If not, then stop the snapscan system and free up memory by closing other software.

- *All required memory is allocated when starting the snapscan system. To not compromise the performance of the system, the camera driver will not work when the system is swapping memory to disk.*

Data acquisition is very slow and the software is unable to acquire cube

Check 1: Camera is plugged in a USB3.0 port.

Check 2: No other devices are connected to the same USB hub.

Check 3: When working on a mobile system, ensure it is on mains power and the system is set to high performance mode.

Check 4: The CPU not to be fully used; close other software to reduce load.

Check 4: Try forcing pixel blur to 0. Underdesigned CPU may not be able to cope with continuous acquisition mode.

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.

The software does not respond when exporting a cube

Check 1: There is sufficient disk space.

- *Exporting data can appear slow as filesize of a cube can reach up to 5.4Gb. When disks run full, the export speed may further slow down due to fragmentation of free disk space.*

Check 2: System has enough RAM available.

- *The system will swap RAM to disk in case more memory is needed than available. This is very slow and seriously affects system performance.*

Check 3: Please wait.

- *Computing spectral correction on the exported data may appear slow as it involves up to 2.6 trillion operations. Depending on the computer's processor speed and the size of the data cube, this operation may take up to one full hour.*



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

Email: hsisupport@imec.be

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





Chapter 7

Appendices

7. Appendix

7.1 Abbreviations

API	Application Program Interface
FWHM	Full Width Half Maximum
GPIO	General Purpose Input / Output
HDR	High Dynamic Range
HSI	Hyperspectral Imaging
QE	Quantum Efficiency
SAM	Spectral Angle Mapper (See section 6.3)
SNR	Signal to Noise Ratio
SROI	Spectral Region of Interest (See section 2.2)
SWIR	Short Wave Infrared
TDI	Time Delay Integration (See section 2.2)
TEC	Thermoelectric Cooler
VNIR	Visible and Near Infrared Range

7.2 Software Changelog

7.2.1 Snapscan v1.4.1.0

7.2.2 Snapscan v1.4.0.0

7.2.3 Snapscan v1.3.0.9

7.2.4 Snapscan v1.2.4

- Caching moved to Suite default
- Default values:
 - Bit depth : 10
 - Analog gain: 2.8
 - Digital gain: 1.2
 - Integration time: 1.0
- Bit depth, Analog gain are no longer GUI based
- Dark ref is faster



- Continuous mode triggers more easily

7.2.5 Snapscan v1.2.3

- bug fix related to cube width/height

7.2.6 Snapscan v1.2.2

- Hotfix in PI stage driver to support different speeds in stop motion. This was required to support all snapscan HW revisions.
- Added alignment tool to the project to create released version.

7.2.7 Snapscan v1.2.1

- New feature :
 - Reset band selection
 - Lock white ref
 - Load white ref
 - Korean language
 - Export path is now persistent
 - Shutter is now closed when not needed
 - Export system now default the last used correction matrix
 - Cubes smaller than the sensor are now centered by default
 - Metadata now states the used correction matrix if any
- Bugfixes :
 - Flip and rotate button conflict solved
 - A150Q issue related to the speed in stop motion
 - Caching irradiance on full storage
 - Few others

7.2.8 snapscan v1.2.0

- Following enhancements have been made to the user interface
 - Tooltips have been added to icons and buttons
 - New icons have been added
 - Toolbar has been extended by adding support, about and languages in the tool button
 - Support for following languages have been added – Japanese and Chinese
 - Abort and progress bar have been added in spinner dialog
- Configuration parameter “Cube Offset X” have been added which sets the offset from top edge in live view in case the selected cube width is lower than 2048.
- Stop Motion and Continuous camera modes are automatically selected by the software and is no longer a user setting
- Support for snapscan SWIR range hyperspectral camera added to the software
- Following widgets added to cube display - class image, ground truth and metadata
- Import/ export options added to different widgets in cube display mode (for example, rendering, spectrograph, selection, classification, etc.)
- Default location for file I/O is moved to Documents\imec\- Internal file management is moved to AppData\Roaming\imec\



7.2.9 snapscan v1.1.2

- Added support for perClass Mira
- Selection model is no longer reset on loading classifier
- Class model is now separated from selection model
- Class label layer is now split into multiple layers that can be hidden/shown individually
- Background image can be hidden to focus on classes
- Gaussian smoothing on spectrums added
- Default export reworked: unchecked by default but the most processed available cube
- There is now a visual feedback when modification of a parameter is not yet taken into account. Enter or focusOut to validate entry.
- Storing to cache is now only applied when required to fasten up the visualization of irradiance.
- Color match rendering is now default



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