NIRLine InGaAs linear image sensors (AvaSpec-NIR256/512)

The InGaAs linear image sensors deliver high-sensitivity in the NIR wavelength range. The detector consists of a charge-amplifier array with CMOS transistors, a shift-register and timing generator. For InGaAs detectors the dynamic range is limited by the dark noise. For ranges up to 1.75 µm no cooling is required and these detectors are available in both 256 and 512 pixels. Detectors for the extended range -2.5 µm all have 2- stage TE-cooling to reduce dark noise and are available in 256 and 512 pixel versions.

6 versions of detectors are available:

- 256/512 pixel non-cooled InGaAs detector for the 900-1750 nm range
- 256/512 pixel cooled InGaAs detector for the 900-1750 nm range
- 256/512 pixel 2-stage cooled Extended InGaAs detector for the 1000-2500 nm range

Sensitivity

The sensitivity of a detector pixel at a certain wavelength is defined as the detector electrical output per unit of radiation energy (photons) incident to that pixel. With a given A/D converter this can be expressed as the number of counts per mJ of incident radiation.

The relation between light energy entering the optical bench and the amount hitting a single detector pixel depends on the optical bench configuration. The efficiency curve of the grating used, the size of the input fiber or slit, the mirror performance and the use of a Detector Collection Lens are the main parameters. With a given set-up it is possible to do measurements over about 6-7 decades of irradiance levels. Some standard detector specifications can be found in Table 4 detector specifications. Optionally, a cylindrical detector collection lens (DCL) can be mounted directly on the detector array. The quartz lens (DCL-UV/VIS for AvaSpec-ULS2048) will increase the system sensitivity by a factor of 3-5, depending on the fiber diameter used. The DCL-UV/VIS-200 can be used for our spectrometers with larger pixel heights to have a better vertical distribution of light focusing on the detector and is primarily for fiber diameters larger than 200 µm and round- to-linear assemblies.
Our SensLine has the most sensitive detectors out of all of our instrument lines, as it includes back-thinned and thermoelectrically cooled detectors.

In Table 4 the UV/VIS detectors are depicted with their specifications, please find below some additional information on how those specifications are determined.

Pixel Well Depth (electrons)

This value is specified by the detector supplier and defines how many electrons can fit in a pixel well before it is saturated, this value determines the best reachable Signal to Noise (=√(Pixel well depth)).

Sensitivity in Photons/count @ 600 nm

The number of Photons of 600 nm that are needed to generate one count of signal on a 16-bit AD converter, the lower this number is, the better is the sensitivity of the detector.

The calculation of the number of Photons/count is (Pixel Well depth in electrons)/16-bit AD/Quantum Efficiency @ 600 nm.

Sensitivity in counts/µW per ms integration time

Sensitivity here is for the detector types currently used in the UV/VIS AvaSpec spectrometers as output in counts per ms integration time for a 16-bit AD converter. To compare the different detector arrays we have them all built up with an optical bench with UA 300 lines/mm grating covering 200-1100 nm, DCL if applicable, and 50 µm slit.

The measurement setup for 350-1100 nm has a 600 µm fiber connected to an AvaSpere-50-LS-HAL, equivalent to an optical power of 1.14 µW.
For the UV/VIS measurement at 220-1100

AVANTES enlightening spectroscopy

Detector Specifications
NIRLine

NIRLine Detectors

Detector Specifications (NIR)

	NIRLine					
Detector	HAM-256-1.7	HAM-512-1.7	SU-256-1.7	SU-512-1.7	HAM-256-2.5	HAM-512-2.5
Type	Linear InGaAs array	Linear InGaAs array	Linear InGaAs array with 1-stage TE cooling	Linear InGaAs array with 1-stage TE cooling	Linear InGaAs array with 2-stage TE cooling	Linear InGaAs array with 2-stage TE cooling
# Pixels, pitch	256, 50 µm	512, 25 µm	256, 50 µm	512, 25 µm	256, 50 µm	512, 25 µm
pixel width x height (µm)	50 x 500	25 x 500	50 x 500	25 x 500	50 x 250	25 x 250
Sensitivity HS in counts/µW per ms	8,200,000 (integral 1000 - 1750 nm)	3,880,000 (integral 1000 - 170 nm)	4,800,000 (integral 1000 - 1750 nm)	2,500,000 (integral 1000 - 1750 nm)	990,000 (integral 1000 - 2500 nm)	480,000 (integral 1000 - 2500 nm)
Signal/Noise (HS)	1900:1	1900:1	5000:1	5000:1	1800:1	1900:1
Dark noise HS (counts RMS)	16	16	16	16	16	15
Dynamic Range HS	6000	6000	4900	4900	3500	4300
Sensitivity LN in counts/µW per ms	469,000 (integral 1000 - 1750 nm)	222,000 (integral 1000 - 1750 nm)	160,000 (integral 1000 - 1750 nm)	83,000 (integral 1000 - 1750 nm)	55,000 (integral 1000 - 2500 nm)	26,600 (integral 1000 - 2500 nm)
Signal/Noise (LN)	5000:1	5000:1	5000:1	5000:1	4000:1	3700:1
Dark noise LN (counts RMS)	12	12	12	12	12	13
Dynamic Range LN	9000	9000	7600	7600	4500	5100
Peak wavelength	1550 nm	1550 nm	1500 nm	1500 nm	2300 nm	2300 nm
QE (%) @ peak	90%	90%	70%	70%	65%	65%
Photo-responsive non-uniformity	± 5%	± 5%	10%	10%	± 5%	± 5%
Defective pixels (max)	0	0	0	0	12	26
Wavelength range (nm)	900 - 1750	900 - 1750	900 - 1750	900 - 1750	1000 - 2500	1000 - 2500
Frequency	500 kHz	500 kHz	1.2 MHz	1.2 MHz	500 kHz	500 kHz

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