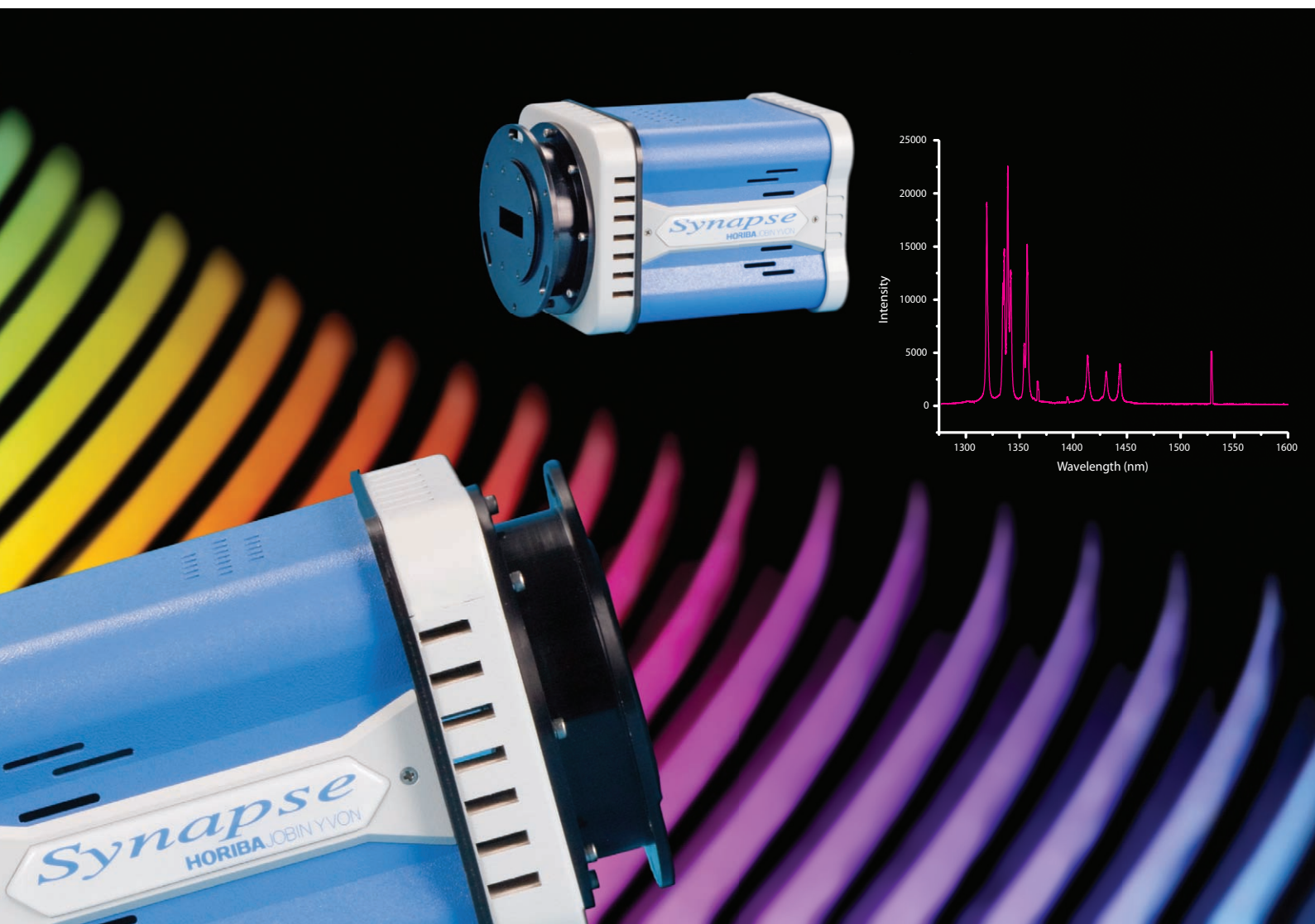


HORIBA JOBIN YVON

Multichannel Detectors



CCDs & InGaAs Arrays for Spectroscopy
from HORIBA Jobin Yvon



Synapse™

Compact High-Performance
Multichannel Detector
with Thermoelectric Cooling

The Synapse CCD is a compact, easy-to-use high performance detector for your spectroscopic system. A Hi-speed USB (USB 2.0) interface allows for a fast, simple computer connection. It quickly connects to our powerful SynerJY® software for easy detector and spectrometer control and data acquisition. The Synapse comes standard with input and output triggers for experimental interactions, a built-in shutter driver, and an auxiliary signal input.

The Synapse uses multistage thermoelectric (TE) cooling with guaranteed performance to $-70\text{ }^{\circ}\text{C}$, which reduces dark current levels to less than 0.005 electrons/pixel/second, without the use of liquid nitrogen, any external liquid cooling systems or booster power supplies. The CCD sensor is placed in a lifetime hermetically sealed vacuum chamber with a single, anti-reflective coated window for maximum cooling performance and maintenance free operation.

Symphony®

The Ultimate High-Performance Multichannel
Detector with Cryogenic Cooling

The Symphony CCD achieves its superior sensitivity by reducing dark current to negligible levels. Liquid nitrogen cools the CCD sensor to a typical operating temperature of $-133\text{ }^{\circ}\text{C}$. This reduces the Dark Signal of a CCD to less than 1 electron/pixel/hour. With liquid nitrogen cooling, integration times can stretch into hours with no appreciable Dark Signal.

The sensor is placed in a single window vacuum chamber for maximum cooling performance. Our vacuum chamber does not require routine pumping to maintain vacuum and cooling performance.

The Symphony system comes with a choice of Dewars that can provide either 24 or 36 hours of operation without refilling. The Symphony's easy-fill Dewar has an extra large opening to allow simple transfer of liquid nitrogen into the system.



For more than 185 years, HORIBA Jobin Yvon has been providing high quality optical instruments for the analysis of light. Our latest Multichannel Detectors are the complete solution for modern spectroscopic measurements from simple absorbance to the most difficult Raman or photoluminescence (PL) measurements. These high performance detectors are designed to interface with all HORIBA Jobin Yvon spectrometers and provide highly sensitive detection for any experiment.

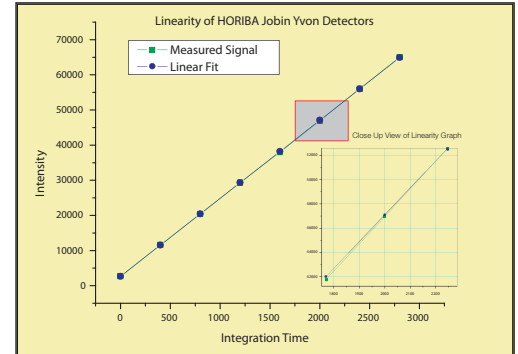


High Sensitivity & Low Noise

HORIBA Jobin Yvon's CCDs are the next generation in detection systems, offering unparalleled sensitivity and extremely low noise. Our systems are specifically designed for low noise spectroscopic detection. The low-noise amplifiers are located close to the CCD sensor to minimize any noise contribution from the external environment.

Signal Linearity

HORIBA Jobin Yvon's electronics are specifically designed to provide excellent signal linearity over the entire dynamic range. This allows for more accurate data and better results over a wide variety of signal levels. To ensure such high performance, each system is tested for linearity, full well capacity and read noise specifications.



Built-In Shutter Driver

As a spectroscopic full-frame Multichannel Detector, a shutter is used to control exposure time and to perform dark subtraction for correct spectral acquisitions. Unlike other Multichannel Detectors that require an extra module, HORIBA Jobin Yvon's Multichannel Detectors have a shutter drive circuit built-in for quick connection to the shutter.

Flexible Triggers

A HORIBA Jobin Yvon Multichannel Detector will become an invaluable tool for your experiments. Each Detector has a set of programmable TTL edge triggers for experimental interactions. The input trigger is used to start an acquisition while the output trigger is programmable to act as an exposure monitor or a readout monitor.

Powerful Software

All HORIBA Jobin Yvon Multichannel Detectors come with our SynerJY® software for data acquisition and advanced data analysis and are compatible with our additional data acquisition packages, such as LabSPEC or FluorESSENCE™. For more customized experiments, our Multichannel detectors can also be used with our Software Development Kit (SDK) or LabVIEW® VIs to provide full control over every aspect of the detector and measurements.

Auxiliary Signal Input

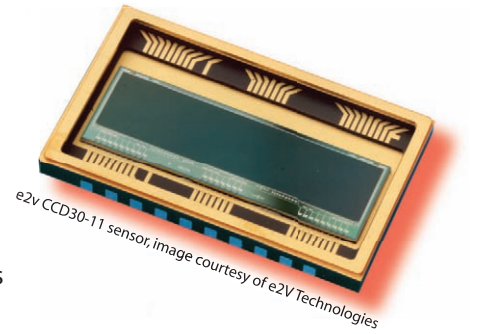
HORIBA Jobin Yvon's Multichannel Detectors bring the flexibility of spectroscopic data acquisition to the next level by providing an input for a separate voltage or current signal, such as a PMT, silicon photodiode, or InGaAs solid state detector. This additional input can be used for a multitude of purposes including as an automatic reference detector for a reference power correction or to extend the wavelength range of your spectrometer by using an InGaAs or Germanium photodiode.

In the reference mode, the auxiliary input records data at the same time as the detector exposure. As a separate data acquisition channel, this input can be used to scan the spectrometer past the usable wavelength range of silicon into the NIR. Only HORIBA Jobin Yvon offers this additional capability standard on all Synapse and Symphony Multichannel Detectors.

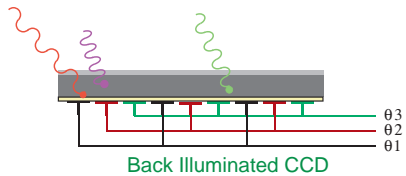
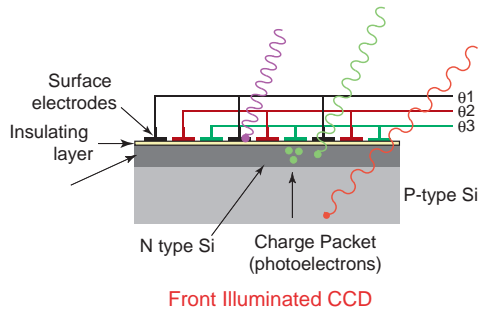


CCD Detectors for Every Application

The heart of Synapse and Symphony Multichannel Detectors is the CCD sensor. Most high end spectroscopic CCD sensors are two dimensional with rows and columns of pixels. Sensors used in spectroscopy are typically between 25 mm and 28 mm long and between 3 mm and 12.5 mm high, corresponding closely with the size of the focal planes of modern spectrographs. The fabrication methods employed can be modified to optimize sensitivity in the UV, VIS or NIR regions of the spectrum.



HORIBA Jobin Yvon offers a wide variety of sensors providing several alternatives in balancing wavelength response, sensitivity and price. There are two main categories of CCD sensors: Front Illuminated and Back Illuminated.



Front Illuminated CCDs are designed so that the light is incident on the CCD, but must pass through the CCDs silicon gate before reaching the optically active silicon. Standard front illuminated CCDs (FIVS) are best used for applications where reduced UV response and high full well potential (dynamic range) are desirable.

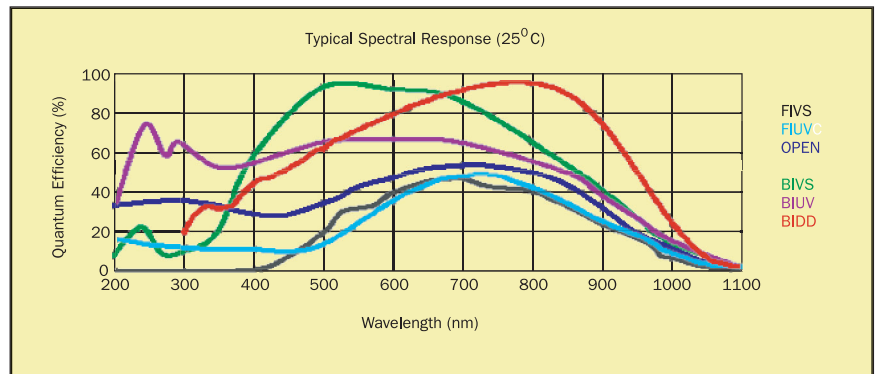
Deep UV response of a front illuminated chip is enhanced by either adding a lumogen coating to the CCD (FIUV) or by etching a small opening on the electrodes to allow UV light to pass to the silicon. The latter type is known as an Open Electrode (OPEN) CCD. Front illuminated chips are free from etaloning effects due to their thickened substrate.¹

Back Illuminated CCDs are physically thinned so that the capture zone is closer to the surface which improves the UV quantum efficiency. Optimized anti-reflection coatings also help in improving the photo conversion and therefore, the quantum efficiency of the sensor. (Choose BIVS for Visible optimized CCDs and BIUV for UV optimized CCDs.)

For Visible to NIR measurements (600 nm to 1000 nm), Back-Illuminated Deep Depletion (BIDD) CCDs have been created to increase NIR response over standard Back Illuminated CCDs and to reduce etaloning effects.

Each chip type has its own quantum efficiency and noise characteristics. The graph shows the typical QE curves for each type of CCD chip. When selecting a CCD remember that the signal to noise ratio increases as a square root of the increase in the quantum efficiency. For example, selecting a CCD with 4 times the QE will increase the signal-to-noise by a factor of 2.

Sensor selection should be based upon image size on the entrance slit of the spectrograph, whether the sensor is responsive in the spectral region of study, and if it is sensitive enough to distinguish the signal from the accumulated noise, within any temporal constraints of the measurement. Quantum efficiency becomes an issue only when the light level approaches the lowest limits of detectability.



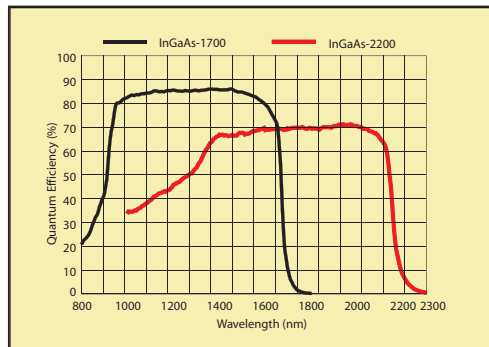
¹ Etaloning effects are variations in signal due to interference between the reflection of light between the surfaces of the CCD structure in the NIR. Please see our Technical Note on Etaloning for more details.

Symphony InGaAs Arrays

For work in the NIR (800 nm to 2200 nm), InGaAs linear arrays are the preferred multichannel detector choice. InGaAs linear arrays have a different structure than a CCD and are composed of a set of individual photodiodes linked together into a linear array of pixels. Each pixel is rectangular in shape and is defined by its pixel width and height. Pixel widths come in 25 μm and 50 μm options. InGaAs arrays with 25 μm wide pixels are better for experiments that require the highest resolution available, while InGaAs arrays with 50 μm wide pixels will have better signal-to-noise ratios for the same signal level based on the larger signal collected on each pixel. Pixel heights are 250 μm or 500 μm depending on the InGaAs sensors wavelength range of interest.

| InGaAs Array Format | Pixel Width | Wavelength Range | Dimensions |
|---------------------|------------------|--------------------|-----------------------------|
| 512 x 1 | 50 μm | 800 nm to 1700 nm | 25.6 mm x 500 μm |
| | | 1100 nm to 2200 nm | 25.6 mm x 250 μm |
| 512 x 1 | 25 μm | 800 nm to 1700 nm | 12.8 mm x 500 μm |
| | | 1100 nm to 2200 nm | 12.8 mm x 250 μm |
| 1024 x 1 | 25 μm | 800 nm to 1700 nm | 25.6 mm x 500 μm |
| | | 1100 nm to 2200 nm | 25.6 mm x 250 μm |

Please refer to specific InGaAs Array datasheets for more detailed information.



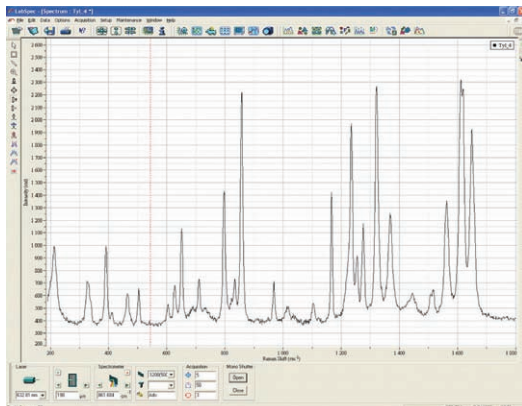
InGaAs arrays are available with two operating wavelength ranges, 800 nm to 1700 nm (InGaAs - 1700) and 1100 nm to 2200 nm (InGaAs - 2200). The InGaAs - 1700 will have lower noise than the InGaAs - 2200.

HORIBA Jobin Yvon is proud to offer its InGaAs detectors in both the thermoelectric cooled and liquid nitrogen cooled Symphony detector systems. The wavelength response of InGaAs is more sensitive to temperature changes than silicon based CCDs. As a result, the upper wavelength (red) edge of the detector response will shift lower based on operating temperature. Symphony InGaAs detectors can adjust the operating temperature to allow measurement of signal at the edge of the wavelength response, if required.

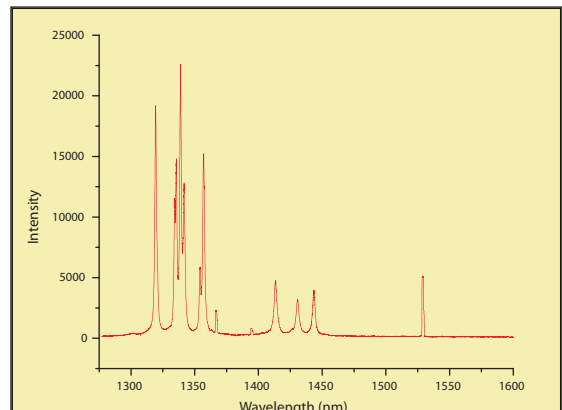
Superior Performance

HORIBA Jobin Yvon CCDs and InGaAs Arrays provide quality data in the most demanding applications. Our detectors are widely used in full spectroscopic systems for applications like **Raman**, **Photoluminescence**, **Fluorescence**, and **Emission** spectroscopy where high sensitivity is key for successful measurements. In addition, they are used in applications such as **ICP** and **Absorption & Transmission** spectroscopy where high dynamic range is also required.

When high quality data is required, nothing beats a HORIBA Jobin Yvon CCD or InGaAs Array!



Raman Spectrum of Tylenol taken with iHR320 and 1024x256 OPEN Synapse CCD



Erbium Oxide Luminescence taken with Symphony STE InGaAs Array

CCD Sensor Specifications

| CCD Format | Pixel Size | Dimensions | FIVS | FIUV | OPEN | BIVS | BIUV | BIDD |
|------------|-------------------|-------------------|------|------|------|------|------|------|
| 1024 x 256 | 26 µm x 26 µm | 26.7 mm x 6.7 mm | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| 1024 x 128 | 26 µm x 26 µm | 26.7 mm x 3.3 mm | ✓ | ✓ | | ✓ | ✓ | |
| 2048 x 512 | 13.5 µm x 13.5 µm | 27.6 mm x 6.9 mm | ✓ | ✓ | | ✓ | ✓ | |
| 512 x 512 | 24 µm x 24 µm | 12.3 mm x 12.3 mm | ✓ | | | ✓ | ✓ | |

Multichannel Detector System Features

| Feature | Synapse | | Symphony | |
|------------------------------------|------------------------------------------------------------|------------------------------------------------------|------------------------------------------------------------|-----------------------------------------------------------------------------------------|
| CCD Grade ¹ | Scientific Grade 1 | | | |
| ADC Resolution | 16 bit | | | |
| ADC Readout Speeds | 20 kHz & 1 MHz | | 20 kHz to 1 MHz | |
| Typical Read Noise ² | 2.5 - 5 electrons r.m.s. | | | |
| Number of Gains | 3 | High Sensitivity Best Dynamic Range High Light | 5 | High Sensitivity, Best Dynamic Range, High Light, plus two intermediate levels |
| Nonlinearity | < 0.4% @ 20 kHz < 1 % @ 1 MHz | | < 0.4% @ 20 kHz < 1 % @ All Other Speeds | |
| Typical Dark Current ² | < 0.005 electrons/pixel/s | | < 1 electron/pixel/hour | |
| Typical Operating Temperature | -70 °C | | -133 °C | |
| Single Element Fused Silica Window | Anti-reflective (A/R) Coated MgF ₂ Available | | Anti-reflective (A/R) Coated MgF ₂ Available | |
| Computer Interface | Hi-Speed USB (USB 2.0) | | Fast Ethernet | |
| Input Triggers, User Programmable | 1 | | 1 | |
| Output Triggers, User Programmable | 1 | | 2 | |
| Auxiliary Signal Input, (I or V) | ✓ | | ✓ | |
| I ² C Interface | ✓ | | ✓ | |
| Software Development Kit | ✓ | | ✓ | |
| LabVIEW® VIs | ✓ | | ✓ | |

All specifications are subject to change without notice.

1 For more information about CCD Grades, please refer to our technical discussion, *CCD Sensor Blemish Specifications*.

2 Specifications are CCD sensor dependent. Please see specific data sheets for exact values.

www.jobinyvon.com

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