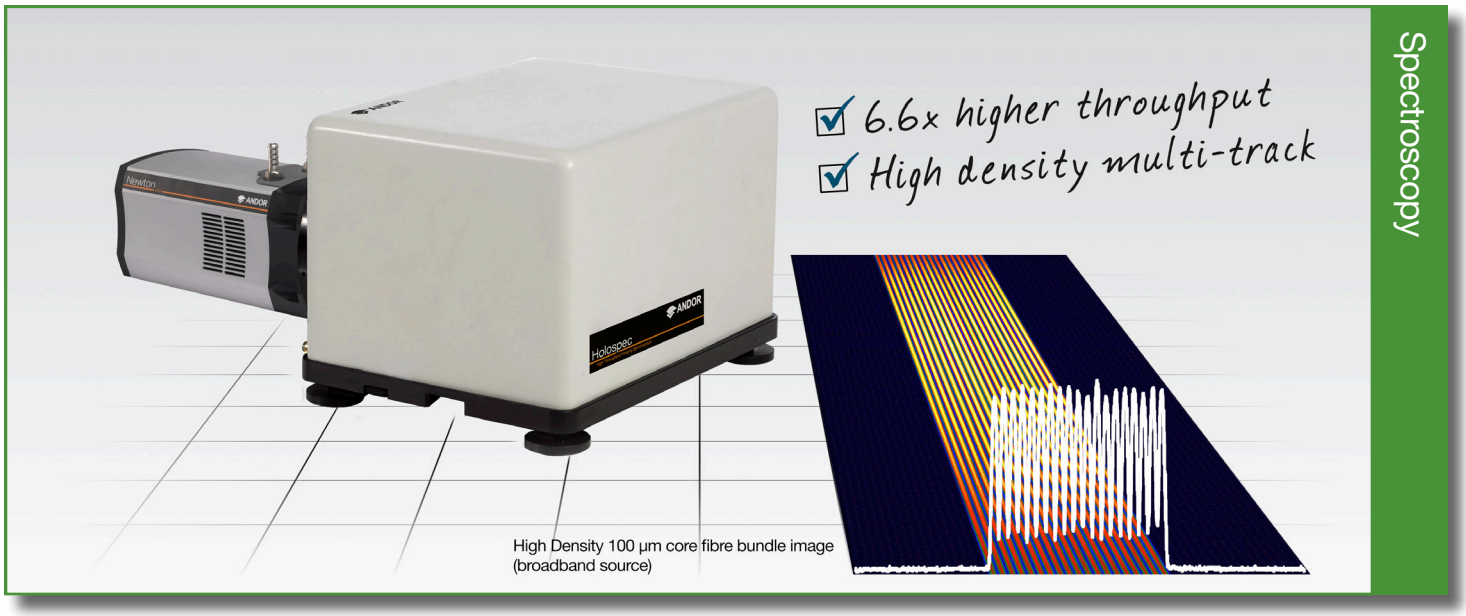
Andor HoloSpec

On-axis high throughput imaging spectrograph

ANDOR
an Oxford Instruments company



Features and Benefits

- **High collection efficiency ultrafast F/1.8 aperture**
  Up to 6.5 times better light collection efficiency than traditional 1/3rd m Czerny-Turner designs

  100 % light collection from NA=0.22 fibre optics
- **On-axis imaging-corrected design**
  Superb optical aberration correction across a large focal plane for superior spatial resolution and high density, low crosstalk multi-track (multi-fibre) acquisitions

  Gather more photons per pixel- increased signal-to-noise ratio
- **High throughput optical design**
  High transmission volume phase holographic (VPH) gratings with state-of-the art optics - maximum optical efficiency for visible or near-infrared range
- **Low scattered light**
  'Smooth' sinusoidal refractive index VPH gratings profile greatly reduces stray light - maximizes detection dynamic range and signal-to-noise
- **Compact and rugged design**
  Pre-aligned and pre-calibrated, out-of-the-box operation, excellent thermal stability and easily transportable
- **Easily interchangeable accessories**
  'Snap-in' accessories, including precision slits and pre-aligned grating assemblies
- **Specialized Raman grating options**
  Optimized for Stokes/Anti-Stokes, low-frequency or high-frequency Stokes operation, 514.5 to 830 nm laser options
- **Optional integrated Rayleigh filtering unit**
  Fully-enclosed SuperNotch Plus Kaiser filter compartment with user-friendly external adjustment
- **Seamless integration with Andor's world class Spectroscopy detectors**
  Combine high optical throughput and ultra-sensitive CCD, ICCD and EMCCDs cameras for maximum photon collection

Gathering more photons... at pace!

Working with challenging photon fluxes? Need results in milliseconds, not minutes?

The superb light collection efficiency capabilities of the superfast F/1.8 Andor HoloSpec spectrograph platform provides a perfect match to Andor's ultra-sensitive CCD, EMCCD and ICCDs detectors, offering the most sensitive and versatile detection solution on the market for Visible or Near-Infrared spectroscopy.

The Andor HoloSpec is the ideal solution for collecting more light and achieving better signal-to-noise ratio faster, which is critical for applications such as micro-Raman mapping, microfluidics, real-time medical diagnosis (point-of-care analyzers) or stand-off bacteriological agents or explosives detection.

The HoloSpec also offers aberration-corrected optics for excellent multi-track capabilities, with high density fibre optics to enable simultaneous acquisitions with extremely low crosstalk, even on narrow spectroscopy sensors.

Its rugged and compact design makes it an ideal tool for challenging industrial or in-the-field applications, while still offering research-grade performance suitable for academic research.

Application focus

- ✓ **Chemical mapping – micro-Raman (e.g. SERS or TERS-based) or micro-fluorescence mapping**
- ✓ **Microfluidics – e.g. spectral flow cytometry**
- ✓ ***In-vivo* medical diagnosis**
- ✓ **Stand-off gated Raman or LIBS**
- ✓ **Process control**

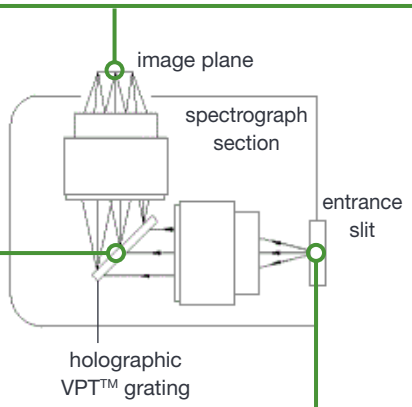
Superior detection capabilities- 4 reasons to make every photon count

2 Superb multi-track capabilities

Imaging-corrected optical system for superior, high density multi-channel spectroscopy (See page 3 for details).

3 Low stray light gratings- higher dynamic range

The 'smooth' refractive index structure of volume phase holographic (VPH) gratings scatters less unwanted light than the typical surface relief structure of conventional 'ruled' gratings.



4 Choose the most sensitive detectors on the market

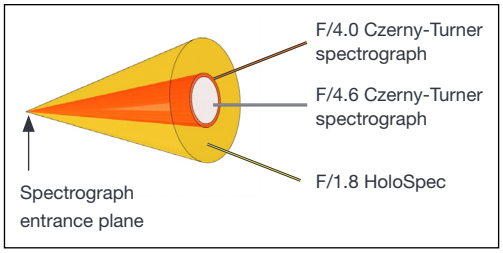
iDus 416 'low-dark current deep-depletion' CCD- superior near-IR detection with up to 95% QE at 800 nm.

Newton EMCCD- unmatched sensitivity in the UV-visible range, superfast kHz acquisition capabilities, single photon sensitive.

iStar ICCD- nanosecond-gated detector for recording fast transient phenomena.

iDus 416 | Newton EMCCD | iStar ICCD

1 Superior light gathering power- when every photon counts



Light collection varies with $1/(F/\#)^2$- the lower the F/# the higher the accepted light cone angle into the system, therefore the higher the collection power (see figure above).

	HoloSpec	300 mm CZT spectrograph	320 mm CZT spectrograph
F/#	1.8	4.0	4.6
Numerical aperture (NA)	0.27	0.12	0.11
Cone angle (air)	30.1	14.3	12.4
Light gathering power comparison	-	HoloSpec is 4.9x better	HoloSpec is 6.5x better

See technical note *Andor HoloSpec- the high throughput spectrograph*

AND

HoloSpec gathers 100% of light from traditional silica-silica F/2.22 (NA=0.22) fibre optics

Spectroscopy applications where throughput matters:

✓ **Intrinsically photon-starved experiments...**
e.g. Quantum dot photoluminescence, micro-Raman of biosamples, micro-photoluminescence of carbon nanostructures, plasmonics spectroscopy of light harvesting complex or organic light-emitting diode (OLEDs), cathodoluminescence, stand-off chemical detection.

✓ **When acquisition time is a constraint...**
Gather enough photons in short periods of time while accessing meaningful signal-to-noise ratio.
e.g. micro-spectroscopy chemical mapping, micro-fluidics such as spectrally-resolved flow cytometry, on-line process control.

✓ **Minimizing photodamage of photo-sensitive samples...**
Protect samples from photodegradation and phototoxicity – achieve meaningful signal-to-noise ratio in shorter timescales to minimize over-exposure to excitation sources e.g. biomaterials such as live cells or luminescent biotags.

Exceptional high-density multi-track capabilities- for superior photon collection

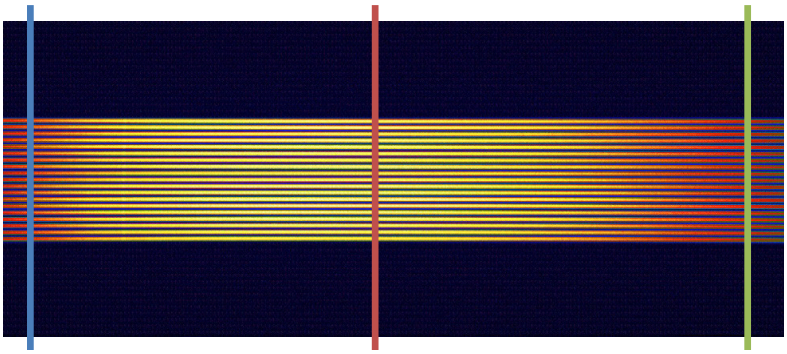


Figure 1: Image of a very high density 19 x 100 µm core (125 µm inc. cladding) fibre optic bundle at the output focal plane of a HoloSpec. Broadband source captured from 532 - 609 nm with a Newton EMCCD DU971P-BV.

High-density multi-track AND high throughput

The HoloSpec advanced imaging corrected optics allow clear separation of individual channel images from densely packed fibre optics bundles.

Up to 32 x 100 µm core fibre channels can be individually resolved over a 4 mm high sensor with low crosstalk despite the high density fibre bundle configuration. Crosstalk can be further reduced by:

- Reading the sensor in multi-track mode with narrow track height
- Using fibre bundle with alternating 'Live' and 'Dead' channels to offer ***zero*** crosstalk between consecutive tracks

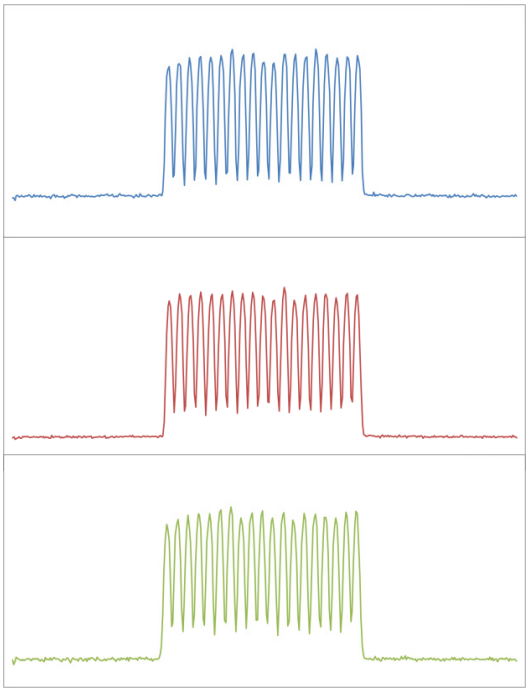


Figure 2: Vertical intensity profile cross section of image in figure 1 at centre and edges of the focal plane.

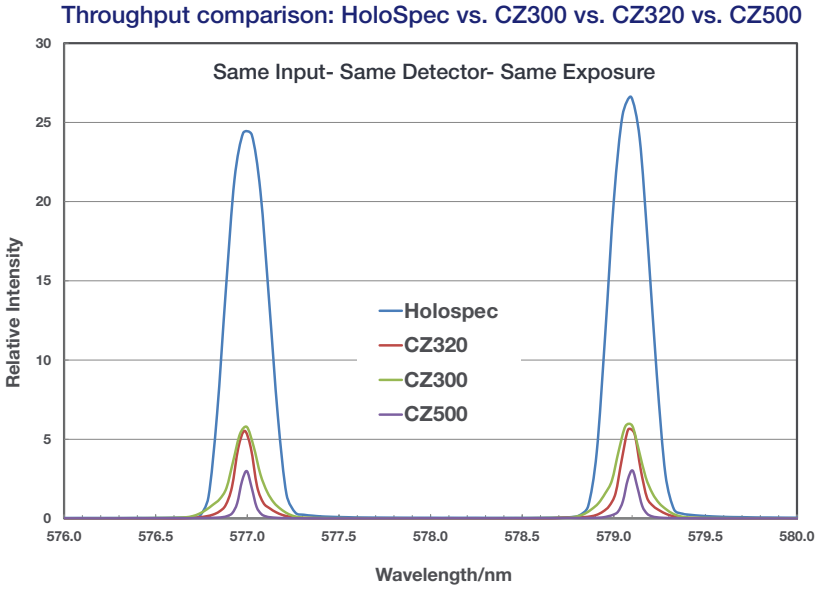


Figure 3: Direct comparison of HoloSpec throughput with Czerny Turner (CZT) systems. Each with 1200 g/mm gratings optimized for the 500-600 nm region. Numbers refer to focal lengths (mm).

Holospec in action

Advantages of full spectrum flow cytometry, C. K. Sanders *et al*, *J. Biomed. Opt*. 18(3), 037004 (Mar 11, 2013). doi:10.1117/1.JBO.18.3.037004 [2013]

Fundamentals of stand-off Raman scattering spectroscopy for explosive fingerprinting, J. Moros *et al*, *J. Raman Spectrosc*., 44: 121–130. doi: 10.1002/jrs.4138 [2013]

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Wrapping and dispersion of multiwalled carbon nanotubes improves electrical conductivity of protein–nanotube composite biomaterials, C. M. Voge *et al*, *Journal of Biomedical Materials Research* Part A, 101A(1) 231–238. doi: 10.1002/jbm.a.34310 [2013]

In situ Raman spectroscopy for the evaluation of solubility in supercritical carbon dioxide mixtures, I. Rodriguez-Meizoso *et al*, *The Journal of Supercritical Fluids*, 65: 87-92. doi: 10.1016/j.supflu.2012.03.002 [2012]

Synthesis of graphene-CoS electro-catalytic electrodes for dye sensitized solar cells, Santanu Das *et al, Carbon*, 50(13): 4815–4821. doi: 10.1016/j.carbon.2012.06.006 [2012]

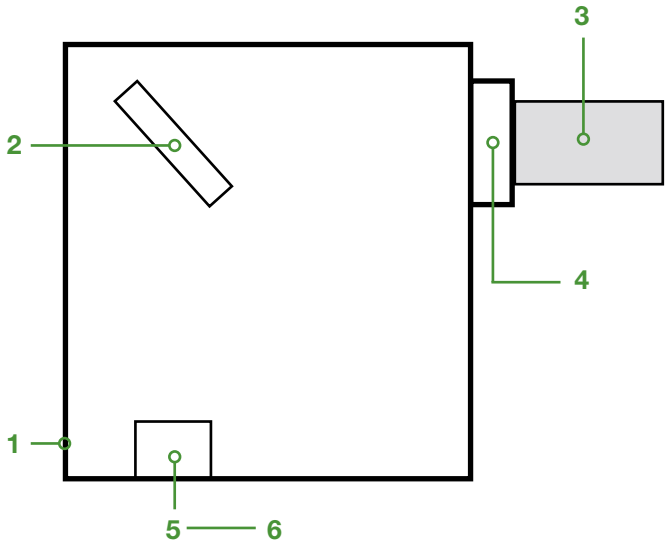
Have you found what you are looking for?

Need a higher spectral resolution? Andor's motorised, research grade Shamrock Czerny-Turner spectrographs offer 500 & 750 mm focal lengths.

Need to work in the SWIR regions? Andor's Kymera and Shamrock series can be configured with silver-coated optics for enhanced collection efficiency in the NIR-SWIR with Andor iDus InGaAs detectors.

HoloSpec F/1.8- ideal for general broadband Spectroscopy

Parameter	HOLOSPEC-F/1.8-VIS	HOLOSPEC-F/1.8-NIR
Optimized operation wavelength (nm)	450-730	800-1,060
F/# aperture	F/1.8 (across entire plane)	F/1.4 @ centre F/1.8 @ edges
Focal length (output/input, mm)	85/75	85/75
Magnification	1.13	1.13



Dimensions L x W x H mm [inches]	250 x 190 x 170 [10 x 7.5 x 6.7]
Weight kg [lbs]	5 [11]

Key

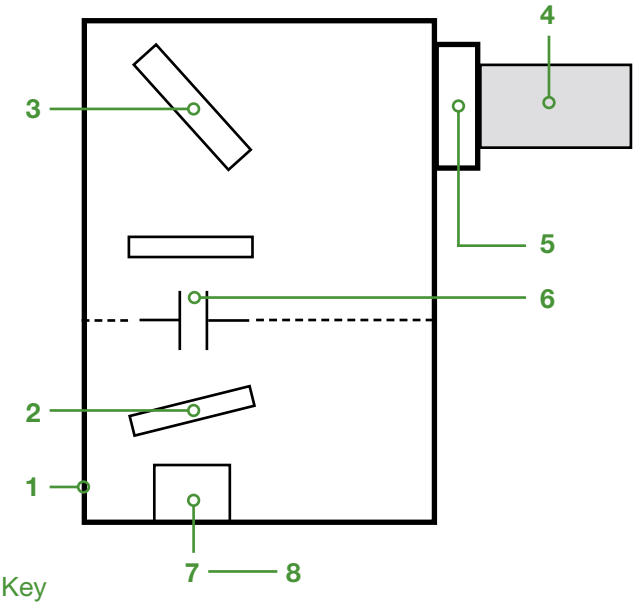
1	Base unit	**HOLOSPEC-F/1.8-VIS** – Visible range **HOLOSPEC-F/1.8-NIR** – Near IR range
2	Gratings	**HS-H**-***** - See *'Broadband' volume phase holographic gratings* table on page 6 for Broadband or Raman-specific options
3	Detector	Please refer to the iDus CCD, Newton CCD & EMCCD and iStar ICCD specification sheets to select the best detector for your wavelength range and desired resolution
4	Detector flange	**HS-FLG-CCD** – For Spectroscopy CCD, EMCCD and ICCD detectors **HS-SHT-9005** - Ø35 mm shutter with flange assembly for Spectroscopy CCD, EMCCD and ICCD detectors (shutter driver **ACC-SD-VED24** must be ordered separately)
5	Input accessories	**HS-EXSLIT-INAD**– Entrance slit mount for input slit (one required per system with a slit input configuration) **HS-SLT-INPUT-******** – Entrance slits, (require one **HS-EXSLIT-INAD** to be ordered per system), See *Inputs & Intermediate* Slits table on page 6 for available options **HS-FOI-FC** - FC fibre adapter **HS-FOI-SMA** - SMA fibre adapter **HS-ASM-8081** - Ø11 mm fibre ferrule X-Y adjuster (cannot be used in conjunction with input slit) **HS-ASM-0101** - 30 mm cage adapter input Ferrule multi-track fibre adapters•1
6	Additional input accessories	Integrated Raman probes•1

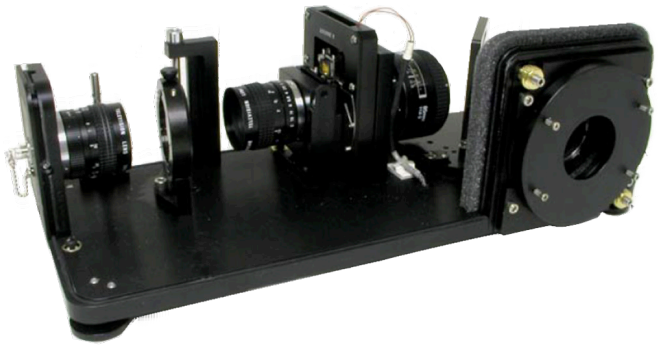
Detector Specification sheets
andor.com/spectroscopy

Resolution calculator
andor.com/calculators

HoloSpec F/1.8i- ideal for Raman applications

Parameter	HOLOSPEC-F/1.8i-VIS	HOLOSPEC-F/1.8i-NIR
Optimized operation wavelength (nm)	450-730	800-1,060
Integrated Notch filter chamber	Yes	
F/# aperture	F/1.8 (across entire plane)	F/1.4 @ centre F/1.8 @ edges
Focal length (output/input, mm)	85/75	85/75
Magnification	1.20	1.20





Dimensions L x W x H mm [inches]	440 x 190 x 170 [17.3 x 7.5 x 6.7]
Weight kg [lbs]	8.2 [18]

Key

1	Base unit	**HOLOSPEC-F/1.8i-VIS** – Visible range **HOLOSPEC-F/1.8i-NIR** – Near IR range
2	Notch filters	**HS-HSPF-***** - See *Notch Filters* table on page 6 for specific laser wavelength options
3	Gratings	**HS-H**-***** - See *'Raman' volume phase holographic gratings* table on page 7 for Raman-specific options
4	Detector	Please refer to the iDus CCD, Newton CCD & EMCCD and iStar ICCD specification sheets to select the best detector for your wavelength range and desired resolution
5	Detector flange	**HS-FLG-CCD** – For Spectroscopy CCD, EMCCD and ICCD detectors **HS-SHT-9005** - Ø35 mm shutter with flange assembly for Spectroscopy CCD, EMCCD and ICCD detectors (shutter driver **ACC-SD-VED24** must be ordered separately)
6	Intermediate accessories	**HS-SLT-INTER -****** – Intermediate slits, See *Input & intermediate slits* table on page 6 for available options
7	Input accessories	**HS-EXSLIT-INAD**– Entrance slit mount for input slit (one required per system with a slit input configuration) **HS-SLT-INPUT-****** – Entrance slits, (require one **HS-EXSLIT-INAD** to be ordered per system), See *Input & intermediate slits* table on page 6 for available options **HS-FOI-FC** - FC fibre adapter, **HS-FOI-SMA** - SMA fibre adapter **HS-ASM-0101** - 30 mm cage adapter input Ferrule multi-track fibre adapters•1
8	Additional input accessories	Integrated Raman probes•1

Detector Specification sheets
andor.com/spectroscopy

Resolution calculator
andor.com/calculators

Input & intermediate slits

Slit size (W x H) •2, 3	Input slit part number	Intermediate slit part number ('i' models only with Rayleigh filtering compartment)
25 µm x 8 mm	HS-SLT-INPUT-0025	HS-SLT-INTER-0025
50 µm x 8 mm	HS-SLT-INPUT-0050	HS-SLT-INTER-0050
100 µm x 8 mm	HS-SLT-INPUT-0100	HS-SLT-INTER-0100
250 µm x 8 mm	HS-SLT-INPUT-0250	HS-SLT-INTER-0250
500 µm x 8 mm	HS-SLT-INPUT-0500	HS-SLT-INTER-0500
1000 µm x 8 mm	HS-SLT-INPUT-1000	HS-SLT-INTER-1000
2000 µm x 8 mm	HS-SLT-INPUT-2000	HS-SLT-INTER-2000
4000 µm x 8 mm	HS-SLT-INPUT-4000	HS-SLT-INTER-4000

Notch filters

Laser wavelength (nm) •3	Diameter	Optical Density at laser wavelength	Spectral bandwidth (cm^{-1})	Andor part number
514.5	Ø 50 mm (2")	> 6	< 350	HS-HSPF-514.5
532				HS-HSPF-532.0
632.8				HS-HSPF-632.8
785				HS-HSPF-785.0

'Broadband' volume phase holographic gratings*

Central wavelength (nm)•3	Nominal dispersion (nm/mm)	Nominal Bandpass (nm) [λ min, λ max]•6,	Resolution at centre (nm)•7,8	Andor part number	Recommended Holospec model
590	15.78	372 to 808 nm•4	0.95	HS-HVG-590	VIS
600	11.15	446 to 754 nm	0.67	HS-HFG-600	VIS
650	11.92	485 to 815 nm	0.72	HS-HFG-650	VIS
730.8	13.46	545 to 917 nm	0.81	HS-HFG-730.8	VIS
750	13.85	559 to 942 nm	0.83	HS-HFG-750	NIR
800	21.54	502 to 1098 nm•5	1.29	HS-HVG-800	NIR
850	15.77	632 to 1068 nm•5	0.95	HS-HFG-850	NIR

* values shown for a 50 µm x 4 mm (W x H) slit

‘Raman’ volume phase holographic gratings*

Laser wavelength (nm) •3	Specific coverage	Average reciprocal dispersion (cm^{-1}/mm)	Nominal dispersion (nm/mm)	Nominal Bandpass (cm^{-1}) [shift min, shift max] •6	Nominal Bandpass (nm) [λ min, λ max]•6	Average resolution (cm^{-1})•7,8	Resolution at centre (nm)•7,8	Andor part number	Recommended Holospec model
514.5	Stokes Anti-Stokes	101.0	2.76	-1160 to 1634 cm^{-1}	487 to 566 nm	6.06	0.17	HS-HSG-514.5-SA	VIS
514.5	Low-frequency	96.9	2.87	-312 to 2367 cm^{-1}	507 to 590 nm	5.81	0.17	HS-HSG-514.5-LF	VIS
514.5	High-frequency	84.6	3.29	2201 to 4539 cm^{-1}	583 to 675 nm	5.07	0.20	HS-HSG-514.5-HF	VIS
532	Stokes Anti-Stokes	97.5	2.86	-1082 to 1614 cm^{-1}	503 to 582 nm	5.85	0.17	HS-HSG-532-SA	VIS
532	Stokes Anti-Stokes (high dispersion)	40.7	1.14	-673 to 453 cm^{-1}	514 to 545 nm	2.44	0.07	HS-HDG-532	VIS
532	Low-frequency	91.9	2.97	-111 to 2430 cm^{-1}	529 to 611 nm	5.51	0.18	HS-HSG-532-LF	VIS
532	High-frequency	81.5	3.42	2178 to 4432 cm^{-1}	602 to 696 nm	4.89	0.21	HS-HSG-532-HF	VIS
632.8	Stokes Anti-Stokes	83.6	3.33	-1240 to 1072 cm^{-1}	587 to 679 nm	5.02	0.20	HS-HSG-632.8-SA	VIS
632.8	Low-frequency	77.9	3.57	-84 to 2071 cm^{-1}	630 to 728 nm	4.68	0.21	HS-HSG-632.8-LF	VIS
632.8	High-frequency	68.3	4.08	1882 to 3770 cm^{-1}	718 to 831 nm	4.10	0.25	HS-HSG-632.8-HF	NIR
647	Stokes Anti-Stokes	81.1	3.43	-1070 to 1171 cm^{-1}	605 to 700 nm	4.86	0.21	HS-HSG-647-SA	VIS
647	Low-frequency	76.4	3.65	-115 to 1997 cm^{-1}	642 to 743 nm	4.58	0.22	HS-HSG-647-LF	VIS
647	High-frequency	67.0	4.16	1805 to 3656 cm^{-1}	733 to 848 nm	4.02	0.25	HS-HSG-647-HF	NIR
752	Stokes Anti-Stokes	69.7	3.99	-915 to 1012 cm^{-1}	704 to 814 nm	4.18	0.24	HS-HSG-752-SA	NIR
752	Low-frequency	65.3	4.29	24.7 to 1830 cm^{-1}	753 to 872 nm	3.92	0.26	HS-HSG-752-LF	NIR
752	High-frequency	62.3	5.58	1835 to 3558 cm^{-1}	872 to 1027 nm	3.74	0.34	HS-HSG-752-HF	NIR
785	Stokes Anti-Stokes	67.1	4.16	-919 to 936 cm^{-1}	732 to 847 nm	4.03	0.25	HS-HSG-785-SA	NIR
785	Stokes Anti-Stokes (high dispersion)	27.7	1.69	-460 to 307 cm^{-1}	758 to 804 nm	1.66	0.10	HS-HDG-785	NIR
785	Low-frequency	75.4	5.36	-207 to 1877 cm^{-1}	773 to 921 nm	4.52	0.32	HS-HSG-785-LF	NIR
785	High-frequency	60.5	5.87	1718 to 3390 cm^{-1}	908 to 1070 nm•5	3.63	0.35	HS-HSG-785-HF	NIR
830	Stokes Anti-Stokes	74.7	5.11	-1117 to 947 cm^{-1}	760 to 901 nm	4.48	0.31	HS-HSG-830-SA	NIR
830	Low-frequency	66.5	5.34	-67.9 to 1771 cm^{-1}	825 to 973 nm	3.99	0.32	HS-HSG-830-LF	NIR
830	High-frequency	56.9	6.24	1685 to 3257 cm^{-1}	965 to 1138 nm•5	3.41	0.37	HS-HSG-830-HF	NIR

* values shown for a 50 µm x 4 mm (W x H) slit

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Phone +1 (860) 290 9211
Fax +1 (860) 290 9566

China
Beijing
Phone +86 (10) 8271 9066
Fax +86 (10) 8271 9055

Items shipped with your Spectrograph

1x Spectrograph base unit (with integrated Notch compartment for 'i' models), including set of 4 clamping feet
1x Grating fitted as selected at time of ordering
1x Input accessory (slit or fibre-optics connector) fitted as selected at time of ordering
1x Detector flange fitted as selected at time of ordering
1x User guide and Quick Start Guide (on CD)
1x Individual performance sheet

Footnotes: Specifications are subject to change without notice

1. Please contact your Andor representative to discuss available options
2. For alternative slit height options, please contact your local Andor representative
3. Special designs are available on request - please contact your local Andor representative
4. The HoloSpec transmission decreases rapidly below 400 nm, so the full wavelength range displayed may not be achievable
5. Silicon-based detectors are sensitive to around 1,050 nm, so the full wavelength range displayed will not be achievable
6. Typical values quoted for a 27.6 mm wide sensor, e.g. Newton DU940
7. Typical values quoted for a 50 µm x 4 mm (W x H) slit and a 13.5 µm pixel sensor, e.g. Newton DU940
8. For F/1.8i models, typical resolution should be multiplied by 1.2 due to the optical magnification of the system.

OXFORD INSTRUMENTS
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Operating & Storage Conditions

- Operating Temperature: 10°C to 40°C ambient
- Relative Humidity: < 80% (non-condensing)
- Ingress Protection: IP20
- Storage Temperature: -20°C to 70°C