OXFORD INSTRUMENTS | ANDOR

Shamrock 750

High Resolution Performance Czerny-Turner Spectograph

Key Specifications

- ✓ 750 mm focal length
- ✓ F/9.7 aperture
- ✓ Resolution down to 0.02 nm
- ✓ Dual input & dual output configurations
- ✓ Interchangeable triple grating turret
- ✓ 10 pm wavelength repeatability
- ✓ USB 2.0 connectivity

Key Applications

- ✓ Raman & Luminescence/PL
- ✓ Absorption/Transmission
- ✓ LIBS/OES
- ✓ SFG/SHG
- ✓ Material Science
- ✓ Plasma Science
- ✓ Chemistry & Catalysis

andor.oxinst.com

Introducing Shamrock 750

The Shamrock 750 offers the highest resolution of the Shamrock family, but is also well suited for applications requiring multi-track capabilities. This rugged platform features a comprehensive range of light coupling accessories and gratings, and combines ideally with Andor's market leading CCD, Electron Multiplying CCDs, InGaAs and Intensified CCDs.

Specifications Summary

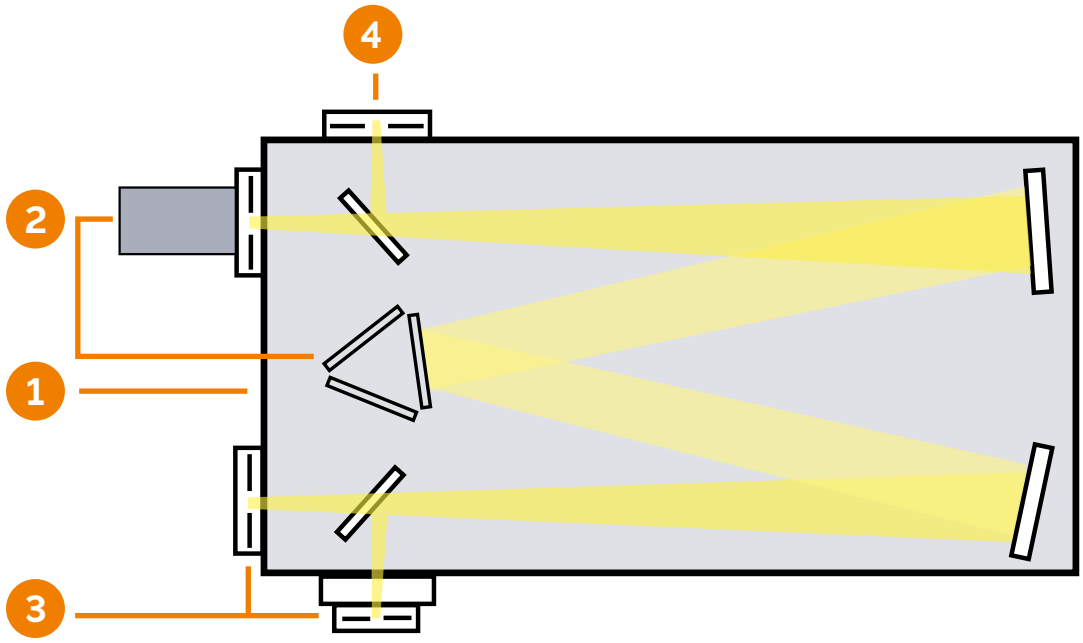
Resolution with Newton DU940 CCD 1200 l/mm @ 500 nm 2400 l/mm @ 300 nm	 0.04 nm 0.02 nm
Aperture	F/9.7
Focal length	750 mm
Magnification (Vertical @ centre of CCD)	1
Gratings	Interchangeable indexed triple turret
Slit widths range (input/output)	Manual or motorized 10 µm to 2.5 mm
Communication	USB 2.0
Wavelength accuracy	0.03 nm
Wavelength repeatability	10 pm

Features and Benefits

Feature	Benefit
Pre-aligned, pre-calibrated detector & spectrograph	Motorized, individually factory-calibrated systems – out-of-the-box operation and seamless integration to experimental set-ups
USB 2.0 interface	Plug and play connectivity, ideal for laptop operation alongside Andor USB cameras
Motorized, indexed triple grating turret	Easily upgradable in-the-field
Dual detector outputs	For extended wavelength coverage when combining Andor UV-Visible CCD and InGaAs cameras Compatible with Andor's range of CCD, ICCD & EMCCD cameras
Multi-track enhanced option	Optimizes system performance for low cross-talk, high density multi-leg fibre signal acquisition
Wide range of accessories available	The ultimate in modular set-up including: Motorized slits & filter wheel, Microscope interfaces, Shutters, Fibre-optic & lens couplers, Multi-way fibre-optic bundles, Light sources and optics.
Monochromator capabilities	Extract best optical resolution while allowing use of single point detectors with sensitivity up to 12 µm
Silver-protected coated optics options	Most efficient for Near-Infrared detection when used in conjunction with Andor InGaAs cameras and single point detectors InGaAs, PbS, InSb & MCT
Integrated in EPICS •[23]	Supported by EPICS control software

Step-by-Step System Configuration

How to customize the Shamrock 750:



1 Chassis configuration

a) Select combination of input and output ports (see page 3 for available options).
b) Select type of optics coating required (aluminium + MgF_2 is standard, protected silver coated optics available on request for NIR detection).
c) Select purge port option (for improved detection down to 180 nm), and shutter for background acquisition and detectors protection.

2 Resolution & band-pass

a) Select the appropriate Shamrock spectrograph platform, giving due consideration to bandpass and spectral range requirement.
b) Select gratings and detector to fulfil resolution requirements.
c) Select gratings for suitable wavelength coverage.

3 Input light coupling interface

Refer to accessory tree for available configurations (direct coupling, fibre coupling or third party hardware connectivity).

4 2nd exit port configuration

Refer to accessory tree for available configurations, including camera flanges.

5 Software interface

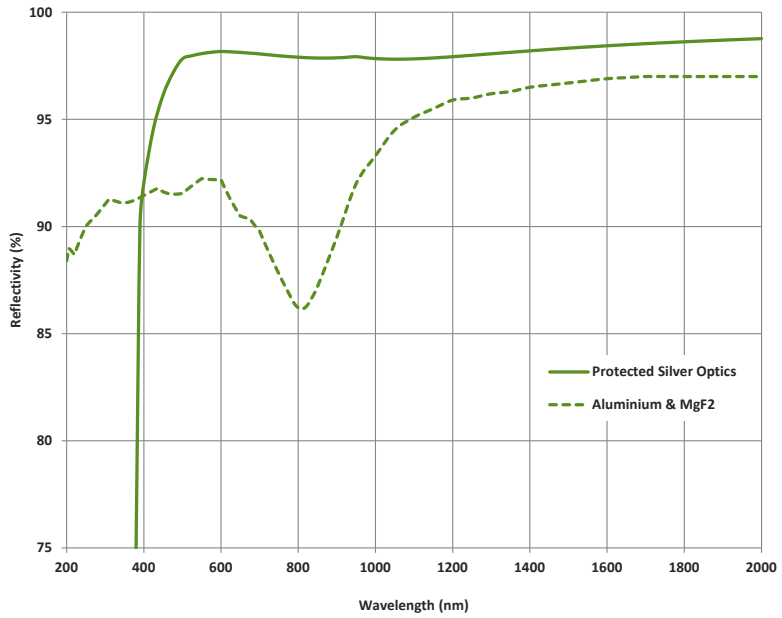
Select either state-of-the-art Solis software or Software Development Kit (SDK) option – please refer to appropriate section for further information.

Step 1 - Chassis Configuration

Ordering Information

Model	Side input port	Direct input port	Direct output port	Side output port	Motorized flipper mirror
SR-750-A	Manual slit	-	Camera	-	-
SR-750-B1	Manual slit	-	Camera	Manual slit	✓
SR-750-B2	Manual slit	-	Camera	Camera	✓
SR-750-C	Manual slit	Manual slit	Camera	-	✓
SR-750-D1	Manual slit	Manual slit	Camera	Manual slit	✓
SR-750-D2	Manual slit	Manual slit	Camera	Camera	✓
SR-750-X-SIL	Protected silver coated optics options for models shown above (replace X with relevant model number)				

Optics Coatings Reflectivity Graph

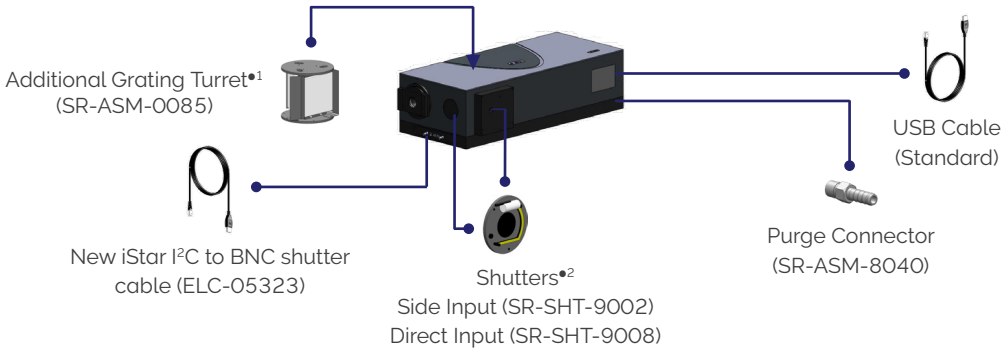


The graph shows the standard Al + MgF_2 optics coatings reflection efficiency versus wavelengths.

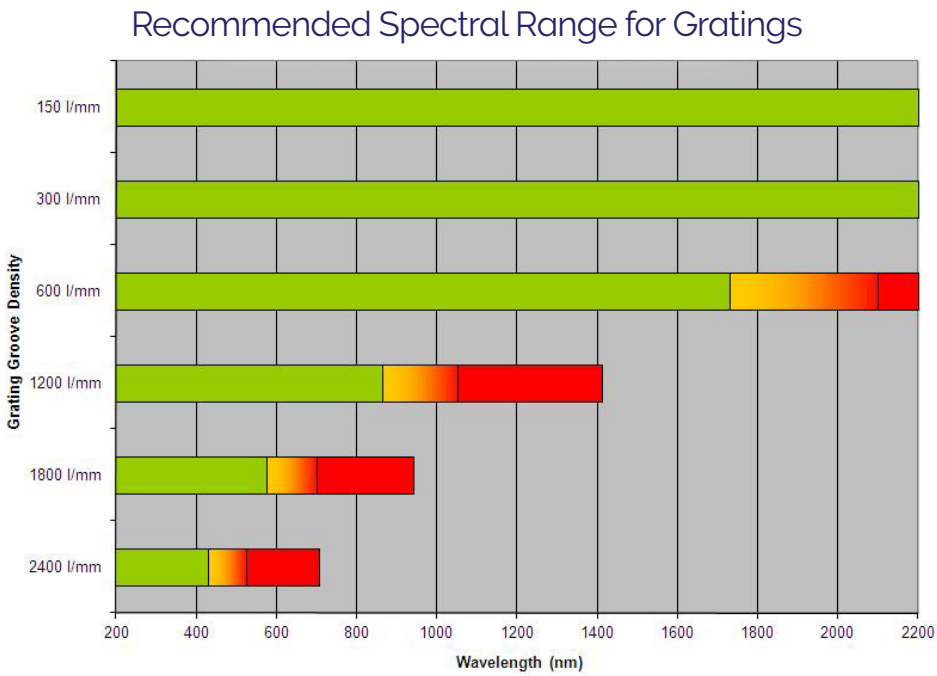
Protected silver coated optics option is also available on request for maximum efficiency in the NIR region and is recommended for working with Andor iDus InGaAs detectors or IR single-point detectors, such as MCT, PbS and InSb.

When choosing protected silver coatings, it is strongly recommended to also order **protected silver coated gratings** for maximum efficiency throughout the system.

Chassis Accessories



Step 2a - Choosing The Right Platform vs Dispersion Requirements



Resolution calculator
andor.com/calculators

Green
Aberration-free region
Orange
Possible impact on system resolution
Red
Likely impact on system resolution

Czerny-Turner spectrographs are designed to provide the best optical performance for a range of grating angles as reflected on the green parts of the graph above. Outside this range, the spectral lines may exhibit a degree of optical aberration (such as coma), which will become more prominent at the steeper angles. These configurations are reflected by the orange to red scales on the graph. In these regions, consideration should be given to higher spectrograph focal length models with lower groove density gratings to achieve the desired resolution.

	Grating (l/mm)					
	150	300	600	1200	1800 (Holo)	2400 (Holo)
Kymera 193i						
Bandpass (nm)•3,•5	902	445	215	98	56	46•6
Resolution (nm)•4,•5	1.96	0.96	0.47	0.21	0.12	0.10•6
Kymera 328i						
Bandpass (nm)•3,•5	600	297	144	67	39	32•6
Resolution (nm)•4,•5	0.88	0.43	0.21	0.10	0.06	0.05•6
Shamrock 500i						
Bandpass (nm)•3,•5	357	177	86	40	26	19•6
Resolution (nm)•4,•5	0.52	0.26	0.13	0.06	0.04	0.03•6
Shamrock 750						
Bandpass (nm)•3,•5	242	120	59	28	18	14•6
Resolution (nm)•4,•5	0.35	0.18	0.09	0.04	0.03	0.02•6

Where aberration is a concern for a particular experimental set-up, the table above shows resolution and band-pass performance for a variety of alternative configurations. This should be used in conjunction with the graph above to assist in selecting the most appropriate Kymera or Shamrock spectrograph platform to meet resolution and band-pass needs, whilst minimising the risk of potential aberration.

Step 2b - Choosing The Right Grating vs Resolution and Band-pass

The Shamrock 750 features an innovative triple grating turret, designed to offer flexibility and control over your choice and interchange of gratings. The triple grating turret can be easily and speedily removed, and replaced by an alternative turret with new gratings. The intelligent design of the 750 means that only a simple offset adjustment is required once the new turret and gratings are added. The 750 is shipped with the grating turret already in place, ensuring your system is ready for use straight out of the box. Additional grating turrets are available with up to three pre-installed gratings (see below for details). If the grating you require is not on the list, please contact Andor for further details. Additional grating turrets (part number SR-ASM-0085) can also be supplied on request.

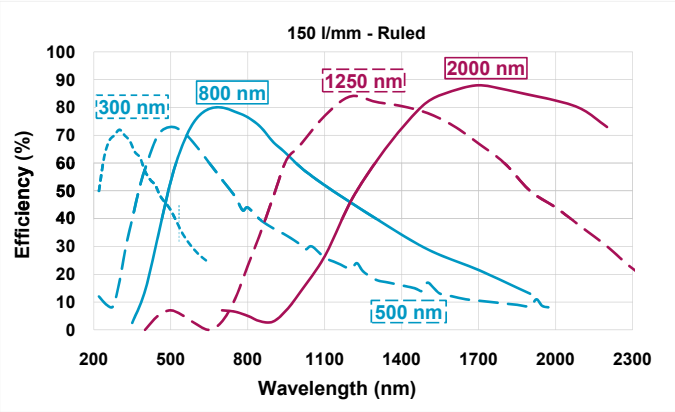
Lines/ mm	Blaze (nm)	Nominal dispersion (nm/mm)•7	Bandpass (nm)•3,•7	Resolution (nm)•4,•7,•10	Peak efficiency (%)	Andor part number	Maximum recommended wavelength (nm)	Maximum attainable wavelength (nm)
150	300	8.78	243	0.36	72	SR5-GRT-0150-0300	6995	11440
150	500	8.76	242	0.35	73	SR5-GRT-0150-0500		
150	800	8.72	241	0.35	80	SR5-GRT-0150-0800		
150	1250	8.66	240	0.35	84	SR5-GRT-0150-1250		
150	2000	8.53	236	0.35	88	SR5-GRT-0150-2000		
300	300	4.38	121	0.18	88	SR5-GRT-0300-0300	3500	5720
300	500	4.35	120	0.18	81	SR5-GRT-0300-0500		
300	1000	4.27	118	0.17	72	SR5-GRT-0300-1000		
300	1200	4.23	117	0.17	92	SR5-GRT-0300-1200		
300	1700	4.11	114	0.17	89	SR5-GRT-0300-1700		
600	300	2.17	60	0.09	84	SR5-GRT-0600-0300	1750	2860
600	500	2.13	59	0.09	72	SR5-GRT-0600-0500		
600	1000	2.01	56	0.08	72	SR5-GRT-0600-1000		
600	1200	1.95	54	0.08	88	SR5-GRT-0600-1200		
600	1900	1.64	45	0.07•9	88	SR5-GRT-0600-1900		
	(@1600)•8	1.79	49	0.07				
1200	300	1.06	29	0.04	72	SR5-GRT-1200-0300	875	1430
1200	500	1.01	28	0.04	81	SR5-GRT-1200-0500		
1200	1000	0.79	22	0.03•9	69	SR5-GRT-1200-1000		
	(@ 800)•8	0.89	25	0.04	69			
1200	Holographic (500 nm peak)	1.00	28	0.04•9	81	SR5-GRT-1200-EH*		
1800	Holographic (250 nm peak)	0.69	19	0.03	62	SR5-GRT-1800-DH	585	955
1800	Holographic (380 nm peak)	0.66	18	0.03	70	SR5-GRT-1800-FH		
2400	300	0.49	13	0.02	68	SR5-GRT-2400-0300	435	715
2400	Holographic (220 nm peak)	0.51	14	0.02	68	SR5-GRT-2400-BH		
2400	Holographic (400 nm peak)	0.45	12	0.02	73	SR5-GRT-2400-GH		
Mirror	UV-VIS	-		-	-	SR5-GRT-MR-AL+MGF2	-	-
Mirror	VIS-NIR	-		-	-	SR5-GRT-MR-SILVER		

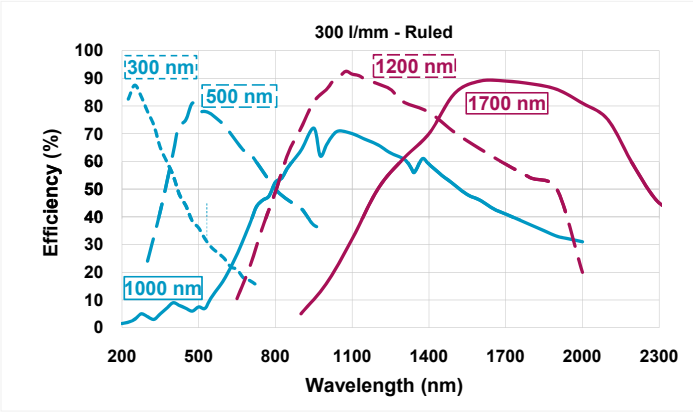
*Option for minimized scattered light.

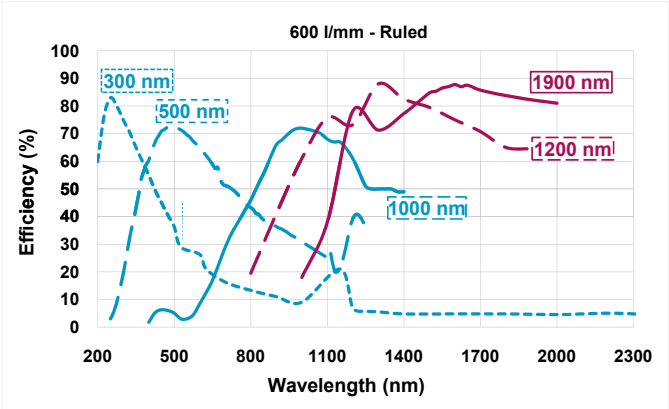
Need to have maximum collection efficiency in the NIR/SWIR? All gratings are also available with protected silver coating. Please contact your local representative for further information.

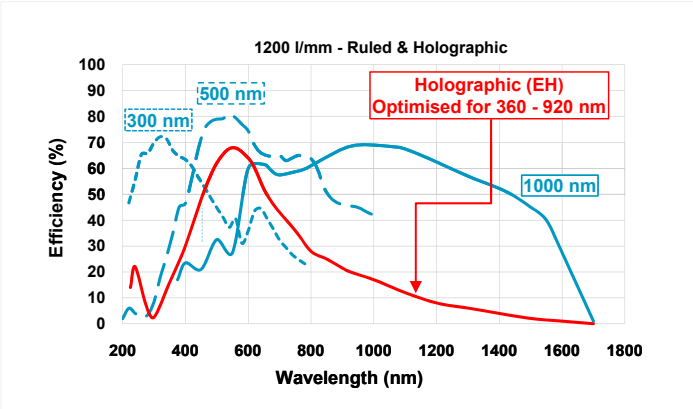
Step 2c - Selecting The Correct Grating Efficiency Option

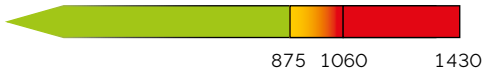
All graphs shown below represent efficiency for 45˚ polarisation

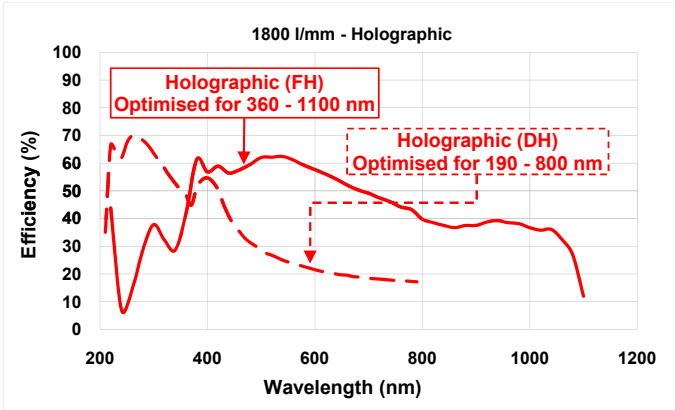


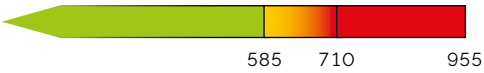


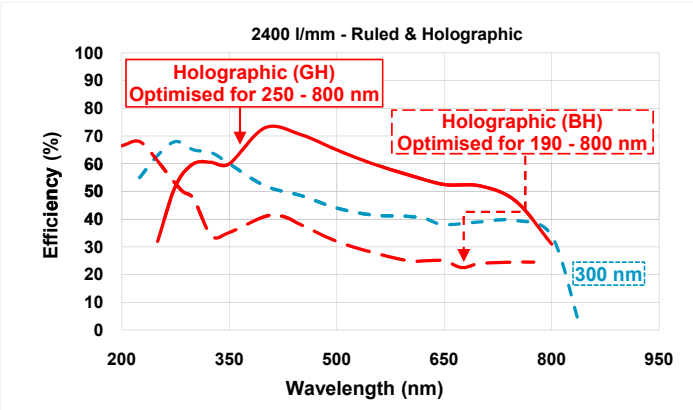


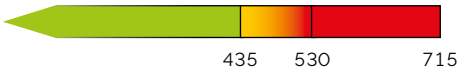












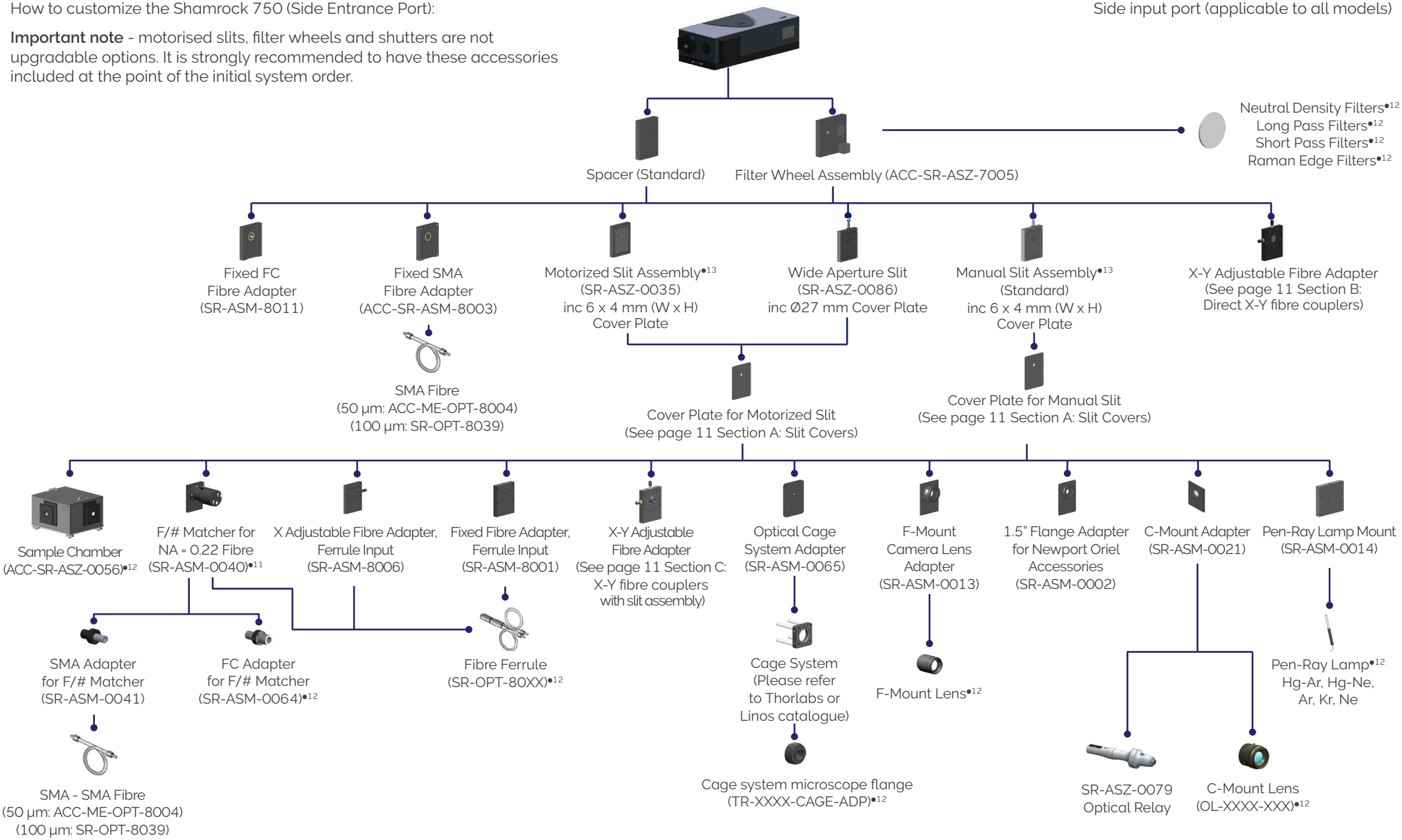
Important Consideration

System throughput is dependent on the grating's angle of operation and may decrease with higher grating operating angles.

Step 3a - Selecting The Correct Light Coupling Interfaces

How to customize the Shamrock 750 (Side Entrance Port):

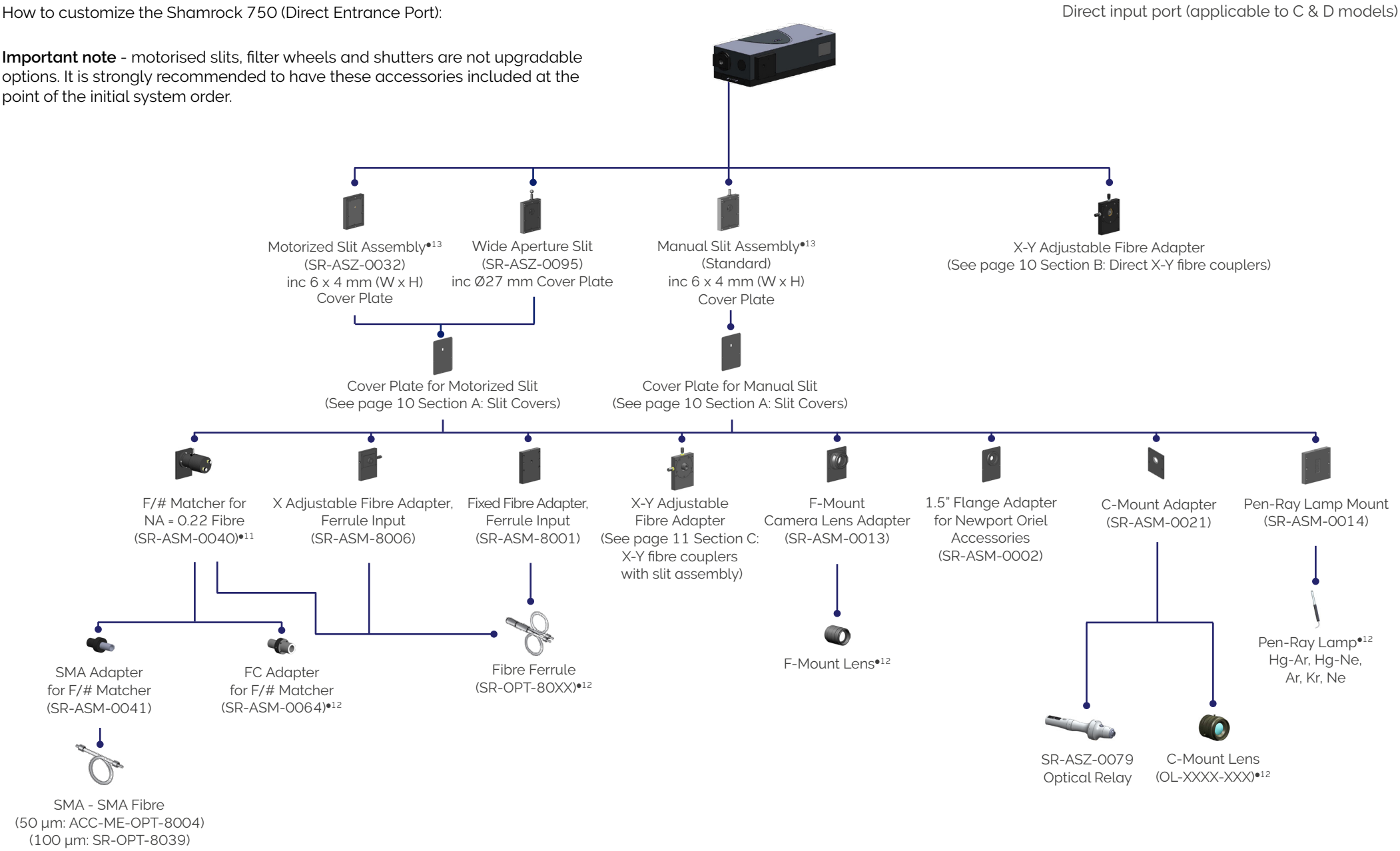
Important note - motorised slits, filter wheels and shutters are not upgradable options. It is strongly recommended to have these accessories included at the point of the initial system order.



Step 3b - Selecting The Correct Light Coupling Interfaces

How to customize the Shamrock 750 (Direct Entrance Port):

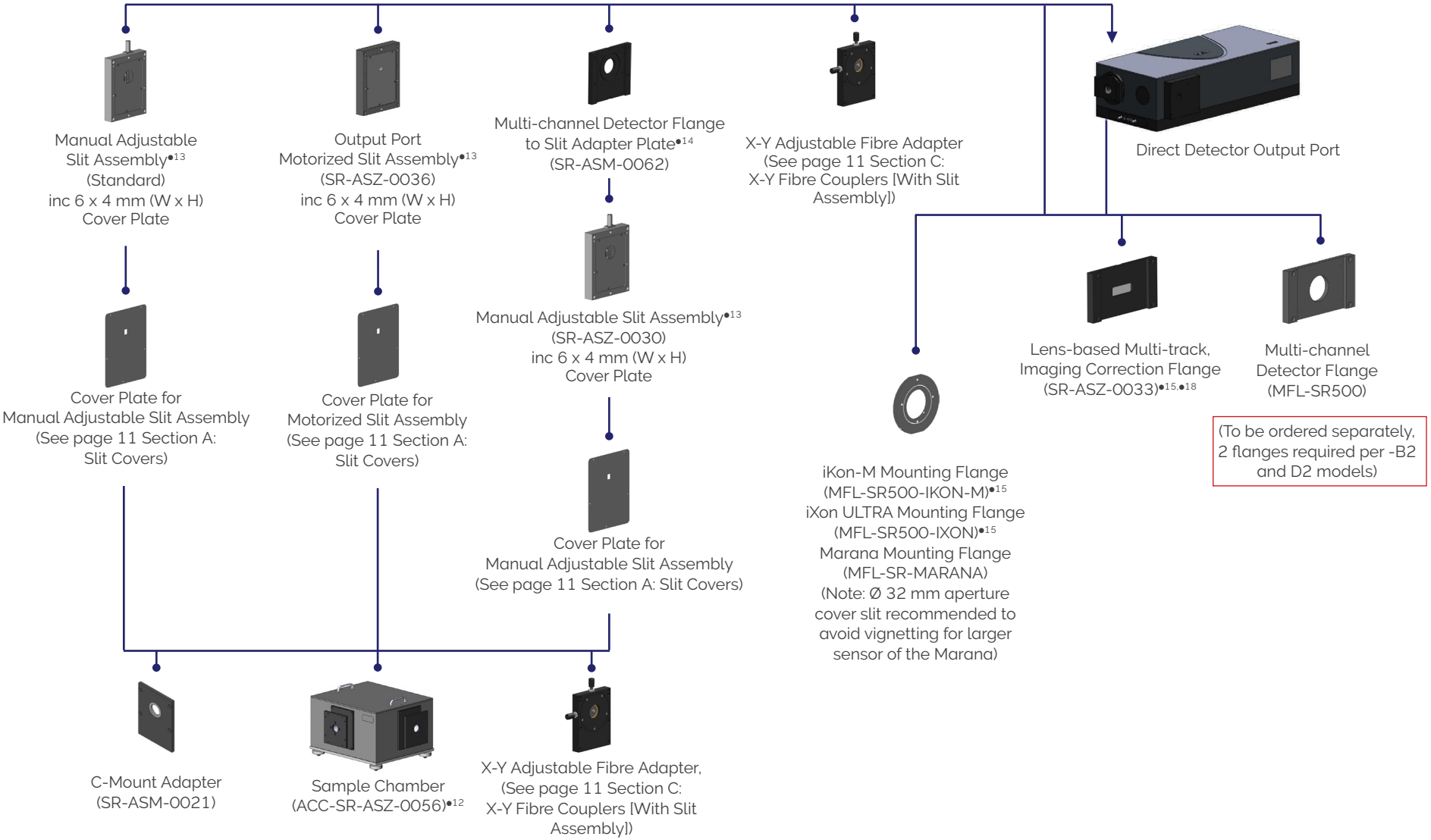
Important note - motorised slits, filter wheels and shutters are not upgradable options. It is strongly recommended to have these accessories included at the point of the initial system order.



Step 4 - Cameras & Output Port Flanges

How to customize the Shamrock 750:

Side Output Port (Applicable to B & D models)

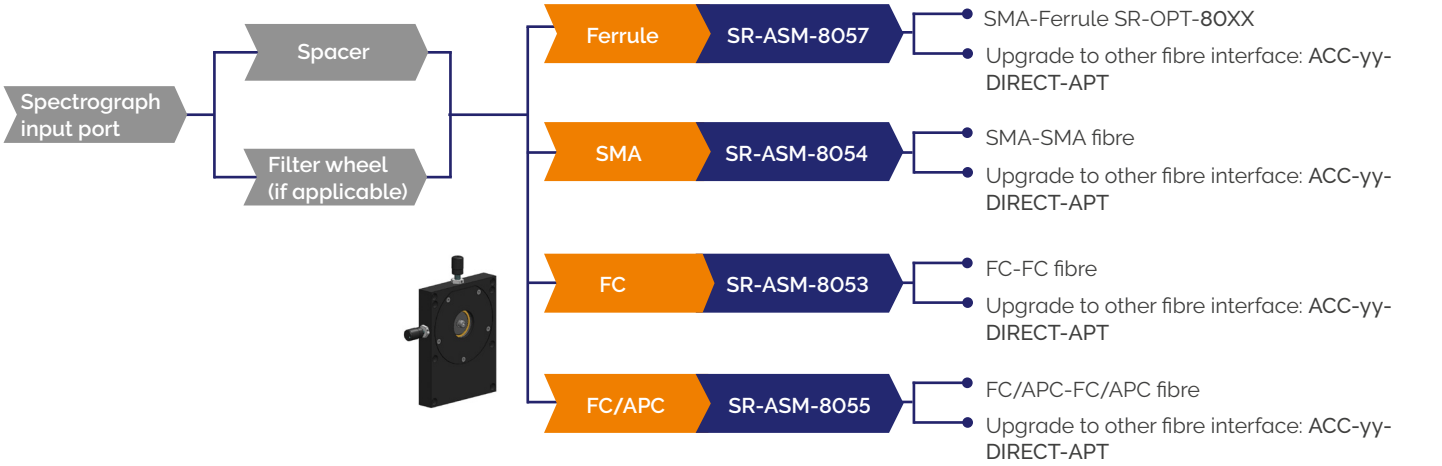


Note: a flange MUST be ordered separately for any configuration involving a multichannel or InGaAs detector.

Step 4A: Slit Covers

Size	Motorised Slit	Manual Slit
6 x 4 mm (W x H)	SR-ASM-0016•[14]	SR-ASM-0025
6 x 6 mm (W x H)	SR-ASM-0017	SR-ASM-0026
6 x 8 mm (W x H)	SR-ASM-0010	SR-ASM-0027
6 x 14 mm (W x H)	SR-ASM-0011	SR-ASM-0029•[14]
Ø 27 mm	SR-ASM-0072•[15]	SR-ASM-0100•[15]
(Ø 32 mm aperture)	SR-ASM-0107	SR-ASM-0106

Step 4B - X-Y Fibre Coupler (with NO slit)



Where yy = SMA, FC, FC/APC or FERRULE

Step 4C - X-Y Fibre Coupler (with slit assembly)

Notes:
- For connection to manual slits, please also order Ø27 mm slit cover plate SR-ASM-0100
- For connection to motorized slits, please also order Ø27 mm slit cover plate SR-ASM-0072
- For connection to manual slits, please also order Ø32 mm slit cover plate SR-ASM-0106 (Marana sCMOS)
- For connection to motorized slits, please also order Ø32 mm slit cover plate SR-ASM-0107 (Marana sCMOS)

Where zz = SMA, FC or FERRULE, option not available

A - Selecting A Software Option

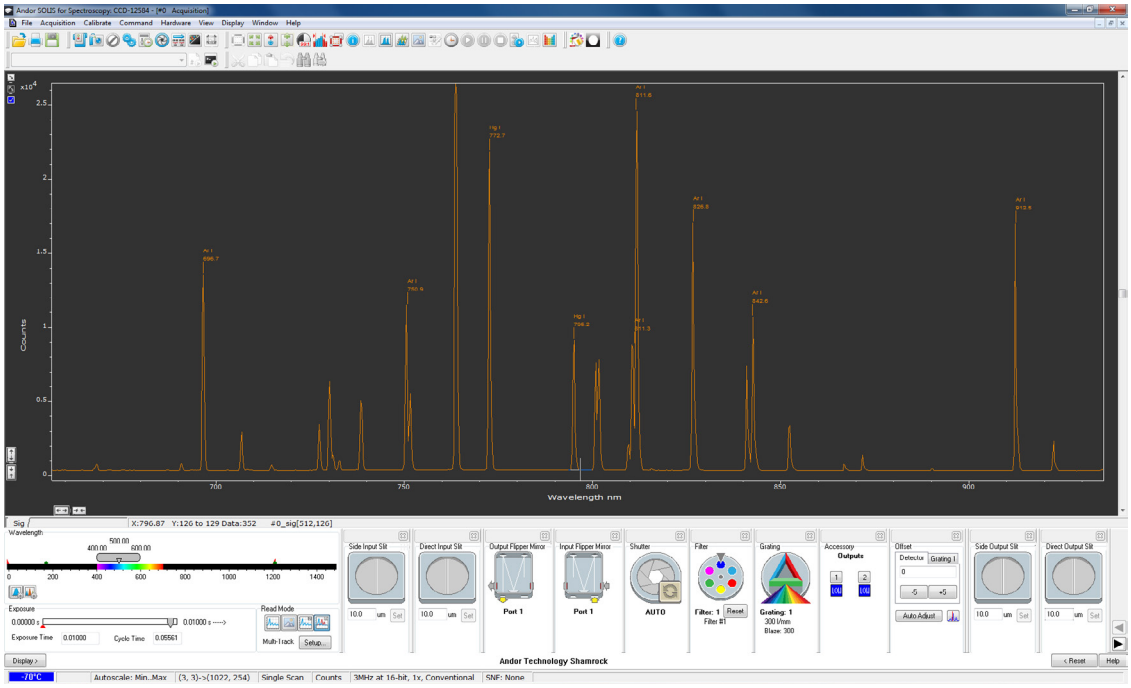
The Shamrock 750 requires at least one of the following software options:

1 - Solis Spectroscopy A 32-bit and fully 64-bit enabled application for Windows (8.1 and 10) offering rich functionality for data acquisition and processing, as well as Andor cameras, spectrograph and motorized accessories simultaneous control. AndorBasic provides macro language control of data acquisition, processing, display and export.

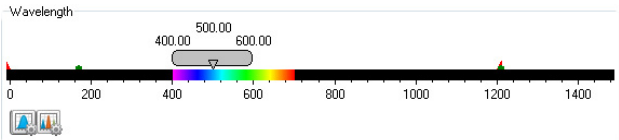
2 - Standalone Solis Spectroscopy GUI for standalone spectrograph operation

3 - Andor SDK A software development kit that allows you to control Andor products from your own application. Available as 32/ 64-bit libraries for Windows (8.1 and 10) and Linux. Compatible with C/C++, C#, Delphi, VB.NET, LabVIEW, MATLAB and Python.

Solis Spectroscopy: Dedicated spectroscopy acquisition software

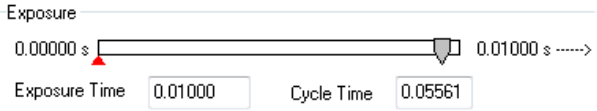


Wavelength drive



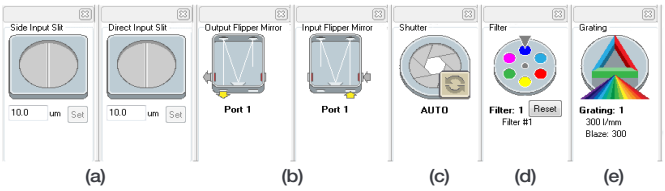
Set the wavelength range for the current grating - drag slider to desired wavelength or just type in appropriate value

Exposure time



Set the exposure time for the detector - quick access for easy acquisition optimization.

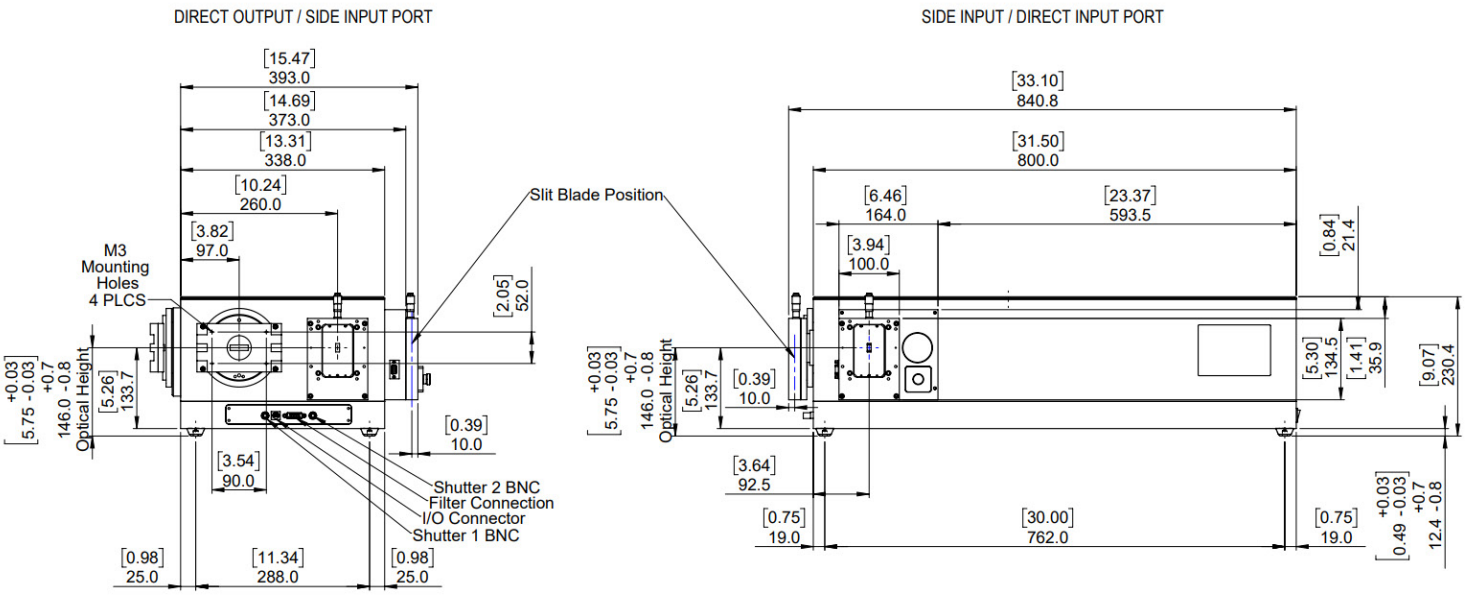
Real Time Control



(a) Slit drive: Control the spectrograph slit width - drag blades on icon or type in required slit width
(b) Flipper motor: Used to select the appropriate exit port
(c) Shutter: Synchronization mode selection for shutter operation
(d) Filter wheel: Used to select a particular filter on the filter wheel - just click on the desired filter position
(e) Grating turret: Used for setting grating turret to a new position and bringing desired grating in the optical path - just click on the desired grating

Product Drawings

Dimensions in mm [inches]



Weight: 35 kg [77.16 lbs approx]
Note: Output flanges & filterwheel are for illustration purposes only (sold separately).
Please refer to accessory tree diagrams or contact your local sales representative.

Optical Axis
The optical path height is shown with standard feet attached.

Screw Type Requirements

CCD flange to Spectrograph flange	4 off, M4 x 16
Camera to CCD flange	4 off, M3 x 10
iXon camera to iXon flange	4 off, M5 x 10, countersunk, hex head

Connecting to the Shamrock 750

USB Shamrock Control
Connector type: USB 'B' type

Shutter Control
Connector type: BNC Female, 50 Ω

Shutter Specifications

Maximum repetition rate	2 Hz
Minimum open/close time	15 ms
Minimum lifetime	Better than 100K cycles

Optical Property

Focal plane size (mm, W x H)	30 x 14
Stray light •[19]	
FVB (1 nm from laser)	1.1×10^{-4}
FVB (10 nm from laser)	2.6×10^{-5}
1 mm strip (1 nm from laser)	1.1×10^{-4}
1 mm strip (10 nm from laser)	2.6×10^{-5}

Wavelength Drive Performance

Wavelength accuracy •[20] Center	0.03 nm
Wavelength repeatability •[21]	10 pm

Wavelength Side Accuracy

Wavelength side accuracy •[22]	0.08 nm

Multi-track Capabilities

Imaging, or multi-track, refers to the ability - in the context of a spectrograph - to isolate a series of individual, vertically-stacked spectrum channels with minimum cross-talk.

Czerny-Turner spectrographs are based on off-axis imaging, which introduces distortion at the output focal plane due to aberrations. The introduction of toroidal optics to correct for these aberrations is common for instrument with shorter focal length, i.e. below 600 mm. These 'imaging' correction optics effectively pull together the focal plane of best spectral and best spatial resolutions, known respectively as the tangential and sagittal planes.

However, greater focal length spectrographs, such as Shamrock 750, are principally used for very high spectral resolution from a single spectrum. These instruments are therefore based on classical spherical mirrors and lead to some elongation of the signal in the vertical/imaging axis as shown on Figure 1a, hence limiting stacking of multiple spectral channels.

Andor's optional accessory, SR-ASZ-0033, allows correction of the optical line elongation as shown on Figure 1b, whilst maintaining the spectral resolution performance of the system. Moreover, this accessory introduces a demagnification of around 0.75 therefore increasing the possible density of tracks in the vertical/imaging direction.

Figure 2 illustrates this optical improvement through the use of a broadband source, showing the well-defined narrow channels with minimum cross-talk.

Please contact your local sales representative for further information on high-density, multi-channel fibre-optics.

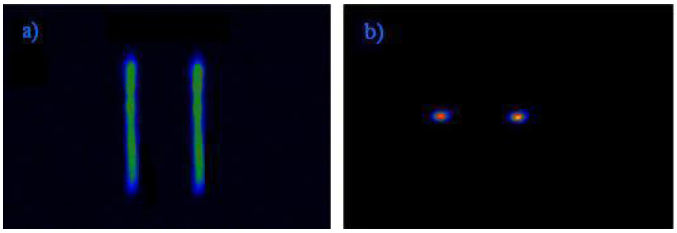


Figure 1. Images produced at the exit of the Shamrock 750 with light from a Mercury source (577 and 579 nm lines) and 100 µm core fibre-optic.
a. Shows elongation of spectral lines when using the standard Shamrock 750 spherical mirrors - well suited to high-resolution, single spectrum acquisition.
b. Shows demagnification of spectral lines with optional correction optics SR-ASZ-0033 - this allows stacking of multiple spectral channels with minimum vertical cross-talk and with no impact on spectral resolution.

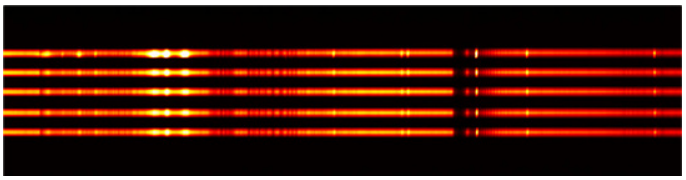
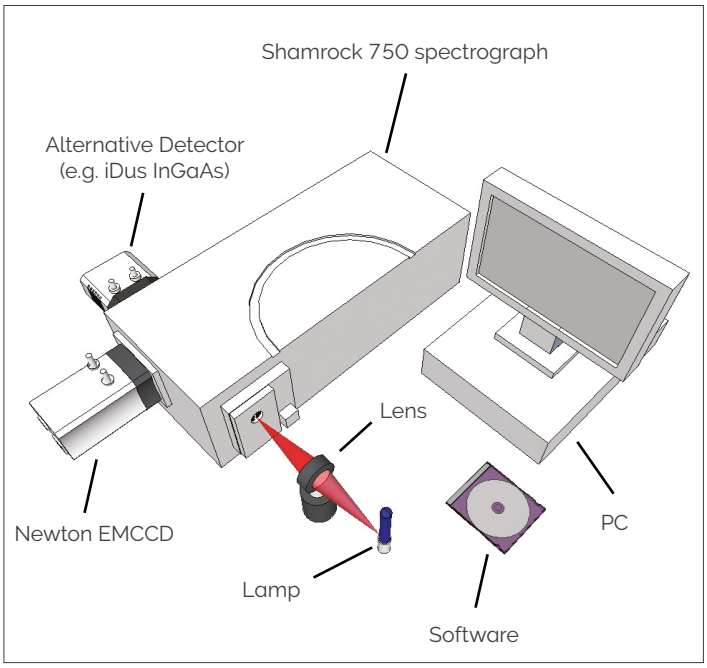


Figure 2. Image produced at the exit of the Shamrock 750 with a combination of broadband and Mercury light sources. A 5-way, 100 µm core fibre-optic assembly was used at the entrance of the spectrograph.

Typical Setup - Spectroscopy



Our Cameras for Spectroscopy

Spectroscopy-based diagnostics in the fields of Material Science, Chemistry, Life Science or Fundamental Physics & Optics rely on the capture and analysis of optical and chemical signatures with a high degree of precision.

Andor's range of detectors offer a wide range of sensitivity, time-resolution and sensor formats to best suit specific experimental conditions from UV to SWIR, nanosecond to hours time resolution, high photon flux to single photon with super dynamic range and resolution.

High Sensitivity & Dynamic Range

- ✓ Long exposure
- ✓ High sensitivity UV-SWIR
- ✓ Large pixel well depths
- ✓ High resolution matrix

iDus CCD & InGaAs | Newton CCD & EM

ns to µs Time-Resolution

- ✓ Nanosecond gating
- ✓ High sensitivity down to single photon
- ✓ On-head DDG with ps accuracy

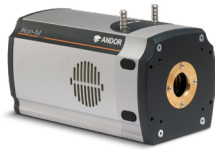
iStar CCD & sCMOS

kHz Spectral Rates

- ✓ µs to ms time-resolution
- ✓ High sensitivity down to single photon
- ✓ High resolution matrix

Newton CCD & EMCCD | iXon EMCCD | ZL41 Wave sCMOS | Marana sCMOS

Extended Multi-fibre Spectroscopy



- ✓ Large area sensors
- ✓ Ultrafast sCMOS and EMCCD options
- ✓ High sensitivity down to single photon

iKon-M CCD | iXon EMCCD | ZL41 Wave sCMOS Marana sCMOS | iStar CCD & sCMOS

Learn more about our detector range here.

Learn more about our spectrograph solutions here.

Order Today

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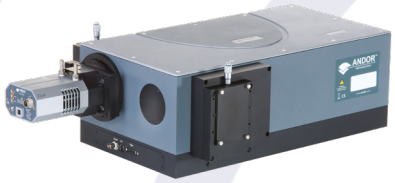

Footnotes: Specifications are subject to change without notice

1. In the case of a multiple grating turret order, please specify desired grating configuration for each turret.
2. SR-SHT-9002 calls for 1x shutter. For dual input port options (C, D1 & D2) it is recommended to order a shutter for each port. Shutter operation only requires BNC to SMB cable from USB cameras.
3. Typical values quoted with 27.6 mm wide CCD, e.g. Newton DU940.
4. Typical values quoted with 10 µm slit and 13.5 µm pixel CCD, e.g. Newton DU940.
5. Typical values quoted at 500 nm centre wavelength.
6. Typical values quoted at 300 nm centre wavelength.
7. Typical values quoted at maximum efficiency wavelength or blaze wavelength unless otherwise stated..
8. Wavelength within the recommended operating spectral region.
9. Indicative values; the working range of these gratings is principally in the region where optical aberrations may alter the system resolution performance quoted.
10. Values shown are representative of a triple grating system, where resolution has been Optimized to give the best performance for the three gratings and across the full recommended wavelength range. Useful signal is assumed to be imaged on the entire height of a 6.9 mm sensor (i.e. Newton DU940) and fully vertically binned.
11. Please refer to F/# matcher specification sheet for magnification considerations.
12. Please refer to the local sales representative or website for further information on available options and complimentary accessories.
13. Slit widths range from 10 µm to 2.5 mm.
14. For B2 and D2 configurations only - to be ordered separately.
15. Please specify relevant port at time of order.
16. Provided as standard.
17. Recommended for use with fibre-optics and C-mount accessories.
18. Please refer to Shamrock 750 multi-track, imaging technical section for further information.
19. Measured with a 633 nm laser and a 1200 l/mm grating for Full Vertical Binning (FVB) on a 6.9 mm high sensor, and a 1 mm strip vertically centred on the optical axis.
20. Average measurements using > 30 calibration lines, covering the recommended grating angle operating range with a 1200 l/mm grating.
21. The standard deviation of 20 measurements of a peak's centre-of-mass position: between each measurement the drive is moved 10x including both wavelength and grating changes to reflect typical use.
22. Side accuracy measured using a 27.6 mm wide sensor, reflecting the dispersion calibration and step-and-glue accuracy.
23. Only Andor CCD platforms (Newton, iDus, iKon) can be controlled in conjunction with Kymera and Shamrock spectrographs in EPICS software.

Operating and Storage Conditions

- Operating Temperature: stable ambient between 0°C to 30°C
- Relative Humidity: < 70% (non-condensing)
- Storage Temperature: -25°C to 50°C

Power Requirements

- 100 - 240 VAC 50 - 60 Hz

Items shipped with your spectrograph:

1x 3 m USB 2.0 cable Type A to Type B
1x Power supply with 3 m mains cable
1x User guides in electronic format
1x Individual system performance booklet
1x Electronic copy of software (if ordered)
1x Hex key set (2 mm, 3 mm & 5 mm)

Regulatory Compliance

Compliant with the requirements of the EU EMC and LVD Directives, compliant with the international EMC and safety standards IEC 61326-1 and IEC 61010-1.

Minimum Computer Requirements:

- 3.0 GHz single core or 2.4 GHz multi core processor
- 2 GB RAM
- 100 MB free hard disc to install software (at least 1 GB recommended for data spooling)
- USB 2.0 High Speed Host Controller capable of sustained rate of 40 MB/s
- Windows (8.1 and 10)

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