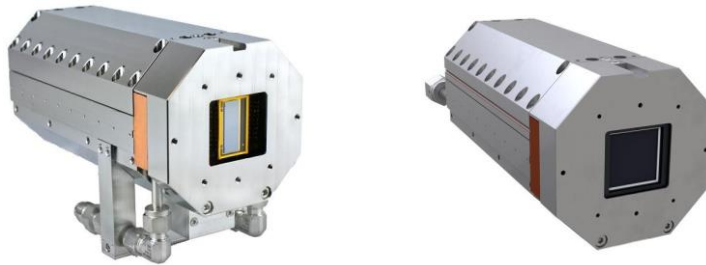




# Full-Frame Deep Cooling In-vacuum Scientific CCD Camera for Imaging and spectroscopy

LOTTEs/LOTTEi Series



**2023 V1**

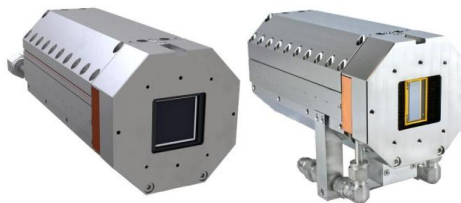
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## Full-Frame Deep Cooling In-vacuum Scientific CCD Camera for Imaging and spectroscopy

These full-frame deep cooling in-vacuum scientific CCD camera are the LOTTES series (including LOTTESs and LOTTESi). It is suitable for Photon Energy Range 5 eV - 20 keV.



LOTTE can be submerged, operated and positioned freely inside a vacuum chamber. Utilising scientific-grade back-illuminated CCD sensors for the detection of EUV, VUV and X-ray signals, LOTTE is equipped with a novel and advanced cooling concept enabling detector temperatures as low as  $-100\text{ }^{\circ}\text{C}$ . It is furthermore driven by the most powerful and versatile true 18-bit electronic platform available for in-vacuum use. This guarantees ultra low noise performance. One key feature that differentiates LOTTE from its nearest rivals is an innovative encapsulated stainless-steel housing, assuring extremely low outgassing at all times. The special design and unprecedented performance make the LOTTE a unique companion for demanding low-light scientific research applications. Additional handy features are further improving the user experience and adding true value.

### Camera Feature

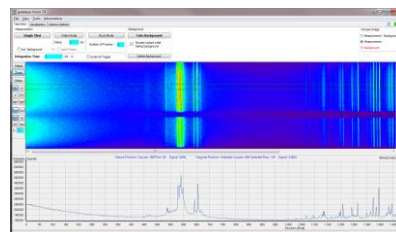
- Ultra deep TE cooling to  $-100\text{ }^{\circ}\text{C}$   
Lowest dark current for better detection limit
- GigE data interface  
Local or remote network operation – your choice
- Fast readout speeds up to 5 MHz  
Fast frame rates paired with low-noise electronics
- High QE up to 98%  
Very sensitive sensors for low light applications
- UHV Compatibility  
Encapsulated design delivers the lowest outgassing rate
- Flexible software options  
Camera software and SDKs available

### Vision Software

Vision software suite provides access to all camera functionalities. It includes comprehensive visualization, analysis and storage options and supports important features such as wavelength and geometric calibration, crop and burst modes and various file formats. The software runs on 32/64-bit Windows systems. For integration into other systems, a software development kit and drivers are available.

### Software Features

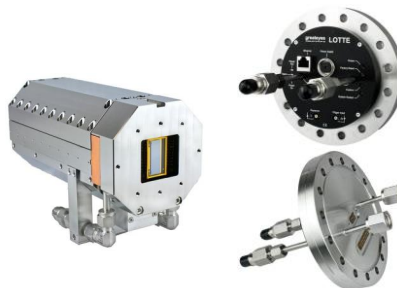
- Supports crop and burst readout modes for higher frame rates and precise time resolution
- Various file formats: JPG, BMP, TXT, TIFF (16-bit), DAT raw data
- Comprehensive visualization and image manipulation routines
- Supports flexible horizontal and vertical binning
- Many drivers available for integration into other systems
- Runs on 32/64-bit Windows systems
- Wavelength and geometric calibration
- Language support in English and German



## Full-Frame Deep Cooling In-vacuum Scientific CCD Camera for spectroscopy-LOTTEs Series

### Applications

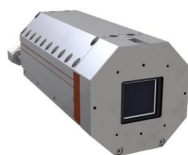
- Soft X-Ray Spectroscopy
- Plasma Emission Spectroscopy
- High Harmonic Generation Spectroscopy
- NEXAFS Spectroscopy
- Resonant Inelastic X-Ray Scattering



◆ This is a sc version, choose rc or sc version for your camera design before ordering

### Choose your camera design

#### “rc” Version



Order code:  
LOTTE-s 2k512 BIUV1 rc

- Compact in diameter, camera body fits into 6 inch tube
- Electrical and water connectors on the rear side

#### “sc” Version



Order code:  
LOTTE-s 1k256 FI DD sc

- Camera length only 189 mm
- Electrical and water connectors on the bottom side

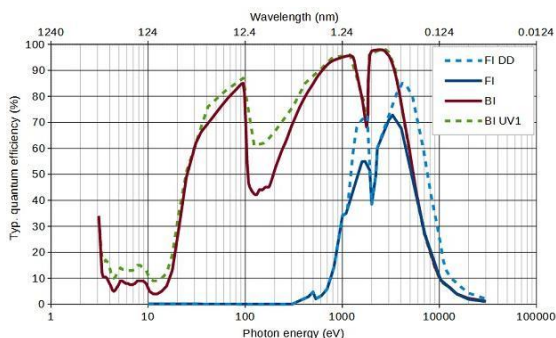
### Choose your camera model

LOTTE-s Series	LOTTE-s 1k256			LOTTE-s 2k512
Sensor code	FI FI DD BI UV1			FI BI BI UV1
Usable pixels (columns x rows)	1024 x 255			2048 x 515
Active image area	26.6 mm x 6.7 mm			27.6 mm x 6.9 mm
Pixel size	26 $\mu\text{m}$ x 26 $\mu\text{m}$			13.5 $\mu\text{m}$ x 13.5 $\mu\text{m}$
Full well capacity	500 ke <sup>-</sup> / 700 ke <sup>-</sup> (DD)			100 ke <sup>-</sup>
Register well	1 000 ke <sup>-</sup> / 1 400 ke <sup>-</sup> (DD)			400 ke <sup>-</sup>
Typ. read noise (e <sup>-</sup> )	@ 50 kHz			
	FI:4.2	BI:6.0	DD:5.4	3.5
	@ 1 MHz			
	FI:12	BI:13.1	DD:12.3	6.8
Typ. dark current (e <sup>-</sup> /pixel/s)@ -100 °C	0.0004 / 0.005 (DD)			0.00025
Gain (counts/e <sup>-</sup> )	0.4			1
	High capacity mode			
	/			0.34
CCD sensor type	Front-illuminated (FI), back-illuminated (BI), deep depletion fringe suppression (DD), enhanced back-illuminated (BI UV1)			

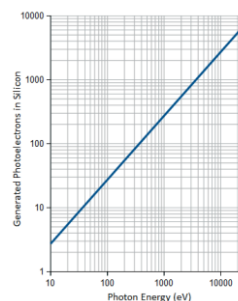
## Choose your accessories and software

Order code	Description
<b>A) Accessories for imaging purposes</b>	
GE-SR35	35mm in-vacuum shutter, including shutter driver module
<b>B) Accessories for cooling performance (LOTTE series can only be cooled by liquid cooling)</b>	
GE-CR01	Compact liquid cooling, circulating the coolant at room temperature for deep camera cooling
GE-CR02	Recirculating water chiller, PID control with temp. from 5°C to 30°C for ultra-deep camera cooling
GE-VacP01	2 × in-vacuum hoses, formed bellow 1/4", VCR male/female, 305 mm (standard accessory)
GE-VacP02	2 × in-vacuum hoses, formed bellow 1/4", VCR male/female, 1200 mm (upon request)
<b>C) Soft ware development kit (SDK) and drivers</b>	
GE-LX01	SDK for Linux (C/C++ based)
GE-PYT01	Python driver
GE-LAB01	LabVIEW driver
GE-EP	EPICS driver
GE-TAN	Tango driver

## Quantum efficiency curves



QE of the LOTTEs series



The mean energy of a photon to generate an electron-hole pair in silicon is 3.66 eV

## Specifications

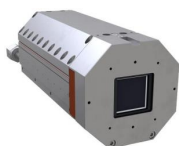
Pixel readout frequency	50/100/250/500 kHz, 1 MHz, 3 MHz (5 MHz visualization mode; up to 20 MHz by multi-output)
AD converter resolution	18-bit
Linearity	Better than 99%
CCD epitaxial thickness	15 μm standard, 40 μm for deep depletion (FI DD) models
Feedthrough Flange	CF DN100 flange with D-sub electrical feedthrough connectors and 6 mm liquid feedthrough tubes (airside: G 1/4 fitting female, vacuum side: VCR 1/4 fitting female)
Vacuum compatibility	10 <sup>-9</sup> mbar (UHV capability)
Bakeout temperature	Max. +80 °C
Flange - focal plane	6 mm (can be customised)
CCD sensor cooling	-100 °C to 20 °C (liquid cooling only)
Temperature monitoring	Two thermistors at CCD sensor and thermoelectric cooler (hot side)
Data link	Gigabit Ethernet
Software	Vision software for Windows 7 / 10
SDK and drivers	DLL for Windows; LabVIEW, EPICS, Linux, Python, Tango driver (optional)
TTL interface signals	1 Exposure out, 1 Trigger in
Power supply	80-264 VAC (typ. 115/230), 47-63 Hz (typ. 50/60), max. 1.1 A (230 V) / 1.9 A (115 V)
Certification	CE
Dimensions(W × H × L)	rc version: 98 mm × 90 mm × 235 mm   sc version: 90 mm × 127 mm × 189 mm
Weight	rc version: 4.9 kg   sc version: 5.0 kg
Blemish specification	Grade 0 or grade 1 (standard) as specified by sensor manufacturer

# Full-Frame Deep Cooling In-vacuum Scientific CCD Camera for imaging-LOTTEi Series

## Applications

- EUV Lithography
- X-Ray Tomography / Fluoroscopy
- Fourier Transform Holography
- X-Ray Diffraction
- X-Ray Phase Contrast Imaging
- Ptychographic Spectromicroscopy
- Grazing-Incidence Small-Angle X-Ray Scattering

## Images of ELESi series



LOTTE-i 1k1k /LOTTE-i 2k2k/LOTTE-i 2k2k plus

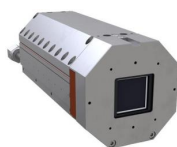


LOTTE-i 4k4k

◆ This is the sc version, choose rc or sc version for your camera design before ordering

## Choose your camera design

### “rc” Version



Order code:  
LOTTE-i 2k2k BI  
UV1 rc

### “sc” Version



Order code:  
LOTTE-i 1k1k  
BI DD sc

- Compact in diameter, camera body fits into 6 inch tube
- Electrical and water connectors on the rear side
- Camera length only 189 mm
- Electrical and water connectors on the bottom side

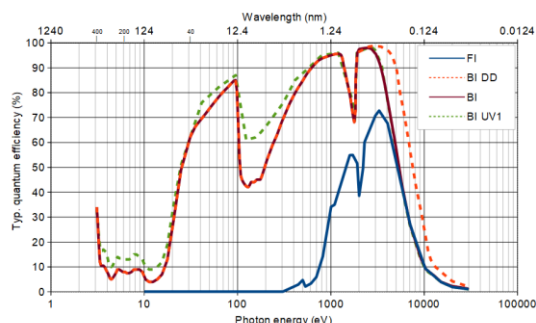
## Choose your camera model

LOTTE-i Series	LOTTE-i 1k1k		LOTTE-i 2k2k		LOTTE-i 2k2k plus	LOTTE-i 4k4k	
Sensor code	FI BI BI UV1	BI DD	FI BI	BI DD BI UV1	BI	BI	BI DD BI UV1
Usable pixels (columns × rows)	1024 × 1024 (FI) 1056 × 1027 (others)		2048 × 2052		2048 × 2064	4096 × 4096	
Active image area	13.3 mm × 13.3 mm		27.6 mm × 27.6 mm		30.7 mm × 30.7 mm	61.4 mm × 61.7mm	
Pixel size	13 μm × 13 μm		13.5 μm × 13.5 μm		15 μm × 15 μm	15 μm × 15 μm	
CCD sensor cooling	-100 °C to 20 °C				-80°C to 20 °C		
Full well capacity	100 ke <sup>-</sup>	120 ke <sup>-</sup>	100 ke <sup>-</sup>	150 ke <sup>-</sup>	150 ke <sup>-</sup>	150 ke <sup>-</sup>	350 ke <sup>-</sup>
Register well	400 ke <sup>-</sup>		400 ke <sup>-</sup>	600 ke <sup>-</sup>	/	/	/
Output node	/		/	/	900 ke <sup>-</sup>	900 ke <sup>-</sup>	600 ke <sup>-</sup>
Typ. read noise (e <sup>-</sup> )	@ 50 kHz						
	2.8		3.4		4.6	4.6	2.8
	@ 1 MHz						
	6.4		7		8.5	8.5	5.8
Typ. dark current (e <sup>-</sup> /pixel/s)@ -80 °C	@ 3 MHz						
	10.9		13.6		17	17	10.4
Gain (counts/e <sup>-</sup> )	0.0003		0.0003	0.015	0.0001	0.0001	0.006
	Standard mode						
	1		1		0.6	0.6	1
CCD sensor type	High capacity mode						
	/		0.34		0.2	0.2	0.34
Front-illuminated (FI), back-illuminated (BI), deep depletion fringe suppression (DD), enhanced back-illuminated (BI UV1)							

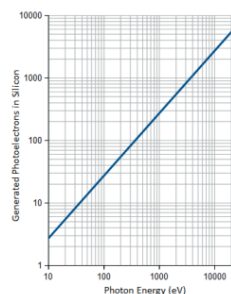
## Choose your accessories and software

Order code	Description
<b>A) Accessories for imaging purposes</b>	
GE-SR35	35mm in-vacuum shutter, including shutter driver module
GE-SR45	45mm in-vacuum shutter for 2k2k & 2k2k plus cameras, including shutter driver module
<b>B) Accessories for cooling performance (LOTTE series can only be cooled by liquid cooling)</b>	
GE-CR01	Compact liquid cooling, circulating the coolant at room temperature for deep camera cooling
GE-CR02	Recirculating water chiller, PID control with temp. from 5°C to 30°C for ultra-deep camera cooling
GE-VacP01	2 × in-vacuum hoses, formed bellow 1/4", VCR male/female, 305 mm (standard accessory)
GE-VacP02	2 × in-vacuum hoses, formed bellow 1/4", VCR male/female, 1200 mm (upon request)
<b>C) Software development kit (SDK) and drivers</b>	
GE-LX01	SDK for Linux (C/C++ based)
GE-PYT01	Python driver
GE-LAB01	LabVIEW driver
GE-EP	EPICS driver
GE-TAN	Tango driver

## Quantum efficiency curves



QE of the LOTTEi series



The mean energy of a photon to generate an electron-hole pair in silicon is 3.66 eV

## Specifications

Pixel readout frequency	50/100/250/500 kHz, 1 MHz, 3 MHz (5 MHz visualization mode; up to 20 MHz by multi-output)
Readout modes	2 output nodes for 1k1k & 2k2k cameras, 4 output nodes for 2k2k plus & 4k4k cameras
AD converter resolution	18 bit
Linearity	Better than 99%
CCD epitaxial thickness	15 μm standard, 40 μm for deep depletion (BI DD) models
Feedthrough Flange	CF DN100 flange with D-sub electrical feedthrough connectors and 6 mm liquid feedthrough tubes (airside: G 1/4 fitting female, vacuum side: VCR 1/4 fitting female)
Vacuum compatibility	10-9 mbar (UHV capability)
Bakeout temperature	Max. +80 °C
Flange - focal plane	1k1k camera: 6 mm; 2k2k, 2k2k plus & 4k4k cameras: 5 mm (all distances can be customised)
CCD sensor cooling	-100 °C to 20 °C( 1k1k camera), -80°C to 20 °C(LOTTE-i 2k2k, LOTTE-i 2k2k plus and LOTTE-i 4k4k cameras)
Temperature monitoring	Two thermistors at CCD sensor and thermoelectric cooler (hot side)
Data link	Gigabit Ethernet
Software	Vision software for Windows 7 / 10
SDK and drivers	DLL for Windows; LabVIEW, EPICS, Linux, Python, Tango driver (optional)
TTL interface signals	1 Exposure out, 1 Trigger in
Power supply	1k1k & 2k2k: 80-264 VAC (typ. 115/230), 47-63 Hz (typ. 50/60), max. 1.1 A (230 V) / 1.9 A (115 V) 2k2k plus & 4k4k: 85-264 VAC (typ. 115/230), 47-63 Hz (typ. 50/60), max. 1.9 A (230 V) / 3.8 A (115 V)
Certification	CE
Dimensions(W × H × L)	rc versions: 98 × 90 × 235mm(1k1k, 2k2k & 2k2k plus cameras) / 98 × 90 × 236 (4k4k cameras) sc versions: 90 × 127 × 189mm (1k1k, 2k2k & 2k2k plus cameras) / 94 × 127 × 190 (4k4k cameras)
Weight	rc versions: 4.9 kg (1k1k, 2k2k & 2k2k plus) / 5.1 kg (4k4k)   sc versions: 5.0 kg / 5.1 kg
Blemish specification	Grade 0 or grade 1 (standard) as specified by sensor manufacturer