excillum

MetalJet F

Brighter. Faster. Smarter.

Introducing MetalJet F

The next generation of high-performance microfocus X-ray sources is here. The result of twenty years of integrated innovations, MetalJet F combines unparalleled speed, precision and versatility to meet the highest demands of cutting-edge research and high-throughput industrial inspection. Among a series of advanced integrated technologies, the new MetalJet F platform combines the world's first high-pressure electromagnetic pump with significantly extended cathode lifetime to enable new levels of non-stop operation.

Features and benefits

Extreme microfocus power
- Up to 27x higher bremsstrahlung than conventional microfocus X-ray sources

Increased brightness and radiant flux for:
- Higher scan speed with maintained signal to noise and resolution

Selection of available target materials
- Characteristic emission from Gallium (9.2 keV) or Indium (24 keV)

Simplified and robust design for 24/7 industrial use
- Higher uptime and lower cost of ownership
- Very long life-time LaB_6 cathodes

Dual port option with two opposite X-ray beams
- Use two experimental setups simultaneously

ISO 13849-1 compliant
- Tested and documented in accordance with standard for easy certification of integrated system

MetalJet F models

F1000 series
Sources that can run up to 160 kV acceleration voltage for the highest throughput requirements. This comes in two variants: F1016 that has a maximum power of 1600 W and F1010 that can reach 1000 W.

F100 series
Sources that can run up to 100 kV acceleration voltage and that are completely radiation shielded when shutters are closed. This means that they are suitable for applications where opening and closing of the X-ray cabinet is needed (e.g. for sample handling). The F110 runs at 100 kV and 1000 W.

F10 series
Sources running up to 70 kV acceleration voltage. They are self-shielded like the F100 series but limited to 70 kV to accommodate easy installation of MetalJet F in cabinets that have been designed for earlier generations of MetalJet sources. There are two variants: F12 that is able to run at 250 W and F15 that brings the most out of the 70 kV source at 500 W.

Technical specifications

Source model		MetalJet F1016	MetalJet F1010	MetalJet F110	MetalJet F15	MetalJet F12
Anode type		Liquid jet				
Acceleration voltage		30-160 kV		30-100 kV	30-70 kV	70 kV
Radiation tight[1]		No		Yes		
E-beam power[2]		0-1600 W	0-1000 W		0-500 W	0-250 W
Max e-beam current		10 mA	6.25 mA	10 mA	7.14 mA	3.57 mA
Typical X-ray spot size at max power[3,4]		35 µm	35 µm	25 µm	20 µm	
Minimum e-beam focus[2,5]		≤ 20 µm				
Emission stability		< 1%				
Position stability		< 1 µm				
Minimum source-to-object distance		17.5 mm without shutter				
		24.8 mm with shutter				
X-ray beam full cone angle		30° without shutter				
		20° with shutter				
Jet pressure		400 bar	240 bar	400 bar		240 bar
X-ray output filtering		100 µm carbon and 200 µm Beryllium				
Max power	**ExAlloy-G1**	1600 W	1000 W	1000 W	500 W	250 W
	ExAlloy-I1			850 W	420 W	
	ExAlloy-I2	1380 W	932 W	731 W	361 W	-
	ExAlloy-I3	1600 W	1000 W	882 W	435 W	250 W

1) Dose rate is close to background rate with closed shutter and below 100 kV.
2) Depends on spot size, acceleration voltage, jet alloy and cathode.
3) Measured as full width at half maximum (FWHM).
4) Smaller X-ray spot size possible depending on configuration and settings.
5) May be larger below 50 kV depending on e-beam power.

Available target alloys

Target alloy	Gallium [weight %]	Indium [weight %]	Tin [weight %]	Main application
ExAlloy-G1	95	5	0	9 keV analytical
ExAlloy-I1	68.5	21.5	10	General imaging
ExAlloy-I2[6]	47	37	16	24 keV analytical
ExAlloy-I3	75	25	0	24 keV analytical

6) ExAlloy-I2 is not molten at room temperature and therefore requires heater jackets, two separate chillers and some additional maintenance. ExAlloy I2 is not available for F12.

Performance examples[7]

MetalJet F1016

Jet material	ExAlloy-I1
Acceleration voltage	160 kV
Nominal X-ray spot size[8]	35 µm
E-beam power	1600 W

Energy range	**Peak brightness** [photons/(s mm² mrad²)]	**Radiant flux** [photons/(s mrad²)]
8-15 keV	2.9×10^{10}	1.6×10^{7}
9.2 keV (Ga Kα)	2.2×10^{10}	2.3×10^{7}
15-30 keV	1.6×10^{10}	1.8×10^{7}
24 keV (In Kα)	3.8×10^{9}	4.5×10^{6}
30-60 keV	1.3×10^{10}	1.4×10^{7}
60-160 keV	1.2×10^{10}	1.0×10^{7}

MetalJet F1010

Jet material	ExAlloy-I1
Acceleration voltage	160 kV
Nominal X-ray spot size[8]	35 µm
E-beam power	1000 W

Energy range	**Peak brightness** [photons/(s mm² mrad²)]	**Radiant flux** [photons/(s mrad²)]
8-15 keV	1.8×10^{10}	1.9×10^{7}
9.2 keV (Ga Kα)	1.4×10^{10}	1.4×10^{7}
15-30 keV	1.0×10^{10}	1.1×10^{7}
24 keV (In Kα)	2.4×10^{9}	2.8×10^{6}
30-60 keV	8.2×10^{9}	8.5×10^{6}
60-160 keV	7.4×10^{9}	6.5×10^{6}

MetalJet F110

Jet material	ExAlloy-G1
Acceleration voltage	100 kV
Nominal X-ray spot size[8]	25 µm
E-beam power	1000 W

Energy range	**Peak brightness** [photons/(s mm² mrad²)]	**Radiant flux** [photons/(s mrad²)]
8-15 keV	7.0×10^{10}	3.9×10^{7}
9.2 keV (Ga Kα)	5.6×10^{10}	3.1×10^{7}
15-30 keV	1.2×10^{10}	7.0×10^{6}
24 keV (In Kα)	1.1×10^{9}	6.2×10^{5}
30-60 keV	1.3×10^{10}	7.1×10^{6}
60-100 keV	5.2×10^{9}	2.2×10^{6}

MetalJet F15

Jet material	ExAlloy-G1
Acceleration voltage	70 kV
Nominal X-ray spot size[8]	20 µm
E-beam power	500 W

Energy range	**Peak brightness** [photons/(s mm² mrad²)]	**Radiant flux** [photons/(s mrad²)]
8-15 keV	5.2×10^{10}	1.9×10^{7}
9.2 keV (Ga Kα)	4.1×10^{10}	1.4×10^{7}
15-30 keV	9.9×10^{9}	3.4×10^{6}
24 keV (In Kα)	6.3×10^{8}	2.3×10^{5}
30-60 keV	8.4×10^{9}	2.6×10^{6}
60-70 keV	6.2×10^{8}	1.4×10^{5}

MetalJet F12

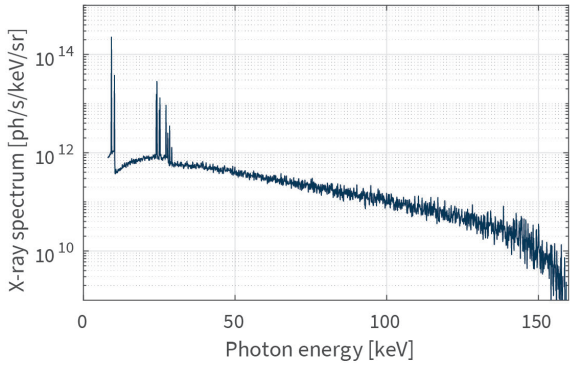
Jet material	ExAlloy-G1
Acceleration voltage	70 kV
Nominal X-ray spot size[8]	20 µm
E-beam power	250 W

Energy range	**Peak brightness** [photons/(s mm² mrad²)]	**Radiant flux** [photons/(s mrad²)]
8-15 keV	4.3×10^{10}	1.1×10^{7}
9.2 keV (Ga Kα)	3.4×10^{10}	8.6×10^{6}
15-30 keV	8.1×10^{9}	2.1×10^{6}
24 keV (In Kα)	5.1×10^{8}	1.4×10^{5}
30-60 keV	6.9×10^{9}	1.6×10^{6}
60-70 keV	5.1×10^{8}	8.4×10^{4}

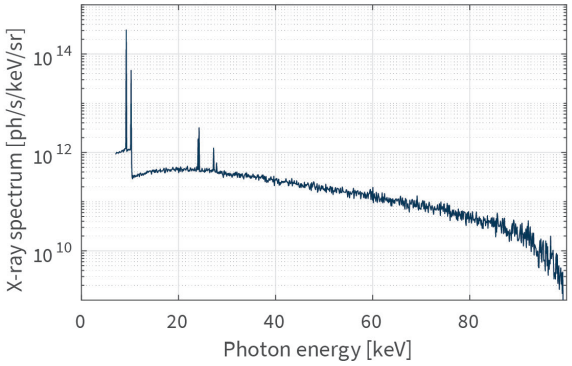
7) Examples are based on simulations that typically correspond well to experimental validation. Please contact us for details on such simulations vs. experiment validations including experimental method.
8) The spot size is measured as the full width at half maximum (FWHM) of the X-ray intensity distribution integrated in the horizontal and vertical directions respectively. The X-ray spots are realized by various degree of e-beam line focus. Actual spot size may differ depending on viewing angle and may have different width and height. Please contact us for more details.

Characteristics

X-ray spectrum for MetalJet F1016 with ExAlloy-I1 at 160 kV, 1600 W (0.1 keV bin width)



X-ray spectrum for MetalJet F110 with ExAlloy-G1 at 100 kV, 1000 W (0.1 keV bin width)



Installation and operation

The source consists of the source head, the jet pump module, a high-voltage generator, a power module and a chiller as shown in the picture. The jet pump module must be located below the source head within certain distances. All other modules are connected with 5 m long cables. Sources operating with ExAlloy-I2 are equipped with heater jackets around parts in the alloy recirculation loop (not shown).

The source can be remotely operated through TCP/IP or directly through the GUI if it is equipped with monitor, keyboard and mouse. An API is available for integration with external software applications.

The MetalJet source is intended to be incorporated into or assembled with other components such as radiation enclosures, safety systems and radiation detectors.

For more information about the full scope of configurability, please contact us.

Mains: AC, single phase, 200-240 V, 2.6 kW-3.5 kW (depending on configuration), 50/60 Hz.

Ambient: 20-30 °C (stable within ± 0.5 °C for optimal source stability), max 85 % relative humidity.

1) Source head 2) Chiller 3) Jet pump module 4) Power module 5) High-voltage generator.

More information

Detailed data for MetalJet F is available on our website.

Demo capabilities

In-house demonstration facilities are available for test and validation. Contact us for details.

About Excillum

Excillum is the global source for X-ray innovation. We develop, manufacture, and service the world's brightest and most advanced industrial and laboratory X-ray sources. In close collaboration with best-in-class scientific, industrial and system integration partners we enable new science, improve medicine and enhance manufacturing. Headquartered in Stockholm, Sweden, Excillum is pushing the limits of X-ray source technologies since 2007.

Safety and compliance

For information about the safety and compliance of all Excillum X-ray sources, please visit our website: excillum.com/compliance

Legal notice

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