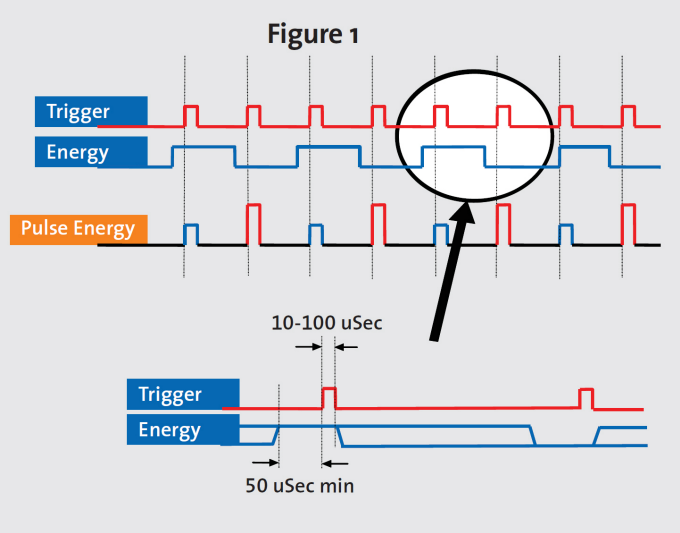
Linatron® - Mi™

Modular high-energy X-ray source

The Linatron®-Mi™ is a modular high-energy X-ray source with pulse to pulse energy switching capability, especially designed for cargo screening and security applications. By rapidly alternating between two distinct energy levels, systems incorporating the Mi X-ray source can be designed to discriminate between materials based on their density characteristics. Figure 1 illustrates the automated switching between two energy levels.



Specifications

1.0 Standard Equipment and Services

1.1 Control Console
The standard control console is a touch screen display system. An optional desktop PC control console is available (see section 4.6).

Touchscreen Control Console

1.2 X-ray Head/RF Unit
The Mi X-ray head includes the RF unit which work together to generate X-rays.

2.0 Performance

X-ray Head and RF Unit

1.3 Modulator/Power Distribution Cabinet
External signal interface.

1.4 Temperature Control Unit (TCU)
The TCU is used to keep the system components at a nominal 30°C. The TCU is connected to a separate 13-kVA power source and can operate on line voltages from 220 VAC and 400 VAC, 50Hz, or 220 VAC and 460 VAC, 60Hz. A cold temperature rapid startup options is available. This increases the TCU power requirement to a peak of approximately 20 kVA during the warm up period.

1.5 Standard Spare Parts Kit
The standard spare parts kit includes over 40 items such as PC board and individual components.

1.6 Interconnecting Cables and Hoses (X-ray Head to Modulator. Modulator to Console) and Hoses (TCU to X-ray Head) Included. Lengths up to 100 meters.

1.7 Manuals and Data Books
Two sets of operator and maintenance manuals and data books.

1.8 Installation Supervision and Start-up Assistance

1.9 Varex's Standard Warranty

2.0 Performance

2.1 X-ray Beam Quality 10 x 10 cm Field
The X-ray beam quality is specified using Half Value Layer (HVL) in steel. This corresponds to the nominal X-ray energy shown in Table 1. The HVL numbers in Table 1 are derived from a compilation of broad beam data.

Table 1

Model	Nominal Energy (MeV)	HVL (in)	Flatness (% @ 7.5°)	Max. Dose Rate (Gy/min)
Mi-6	4.0	1.00	>69.0	2.5
	6.0	1.10	>62.0	8.0
Mi-9	6.0	1.10	>62.0	10.0
	9.0	1.18	>55.0	30.0

Note: Dose output occurs during each pulse as shown on the waveform representation in Figure 1.

2.2 X-ray Field Size
A 30° cone or 22.5° square defines the field. Also see section 4.1.

2.3 X-ray Beam Focal Spot Size
The focal spot size does not exceed 2.0 mm in diameter. Also see section 4.4.

2.4 X-ray Beam Symmetry
The beam asymmetry does not exceed 5% at +/- 7.5° off the central axis for all energies.

2.5 Energy Switching Rate
Energy is switched pulse to pulse when controlled through the control console. Pulse sequencing can be defined for different combinations through customer interface (see Table 2).

Table 2

Mode	Pulse Range (pps)
Low	50-400
High	50-350
Interlaced	50-400

2.6 Standard Leakage Radiation
The leakage radiation is measured along the horizontal axis at 1 meter from the beam centerline at angles 60° and greater, outside the primary beam. The values in Table 3 are a fraction of the primary beam central axis dose rate measured with a 10 cm x 10 cm collimator. See section 4.1 for lower leakage radiation options. Neutron shielding must be provided by the user when a Linatron is operating at ≥ 6.1 MeV energy. A 6.1 MeV beam may produce up to 1.0 x 10^{-5} rem of neutrons per X-ray rad in the primary beam. A 9.0 MeV beam may produce a worse case 1.0 x 10^{-4} rem of neutrons per X-ray rad in the primary beam. Refer to NCRP 144 and NCRP 79 handbooks for shielding guidance.

Table 3

Operating Energy	Leakage (fraction)
6 MeV, 9 MeV	1x10^{-3}

3.0 Customer Facility Requirements

3.1 Electrical Requirements
The Linatron-Mi operates from a single 15-kVA 50/60 Hz power source. Two voltage ranges are available.

3.1.1 Low Voltage Option
220 VAC, 3 phase, 3 or 4 wire plus ground, 60 Amp minimum surge per leg. +/- 5% voltage regulation is required.

3.1.2 High Voltage Option
400 VAC, 3 phase, 4 wire plus ground, 40 Amp minimum surge per leg. +/-5% voltage regulation is required.

3.2 Operating Environment

3.2.1 Indoor Service
The operating environment for control console and modulator must be between 4°C (39° F) and 35°C (95°F), with 90% maximum relative humidity (non-condensing).

3.2.2 Outdoor Service
Consult factory about outdoor use of the Linatron system.

3.2.3 Ventilation
The approximate heat given to room air from each component with system operating at full power is given below:

Modulator

X-ray Head: 1.0 kW
Modulator Cabinet: 2.0 kW
RF Unit: 1.0kW
Temperature Control Unit: 6.0-12.0kW
Touchscreen Control Console: Negligible

4.0 Optional Equipment

4.1 Lower Leakage Options are listed in Table 4.

Table 4

Model	Leakage (fraction)		RF Unit/Head Wt. (lbs) - Low profile leakage	
	Super Low	Ultra Low	Super Low	Ultra Low
Mi-6	2×10^{-5}	2.5×10^{-6}	2,300	5,100
Mi-9	2×10^{-5}	N/A	2,300	N/A

4.2 Voltage Regulator
Recommended for installations where line power fluctuations are greater than +/-5%. The regulator is CE and UL approved.

4.3 Small Focal Spot
1.0 to 1.5 mm available for the Mi-9 only. Consult factory for output dose rates for smaller spot size options.

Energy Switching Rate
Energy switching is provided under software control and can be set from minimum of 0 to a maximum of 300 energy changes per second. The system is limited

CE Marking

All Linatron-Mi models are designed and manufactured in accordance with the Electromagnetic Compatibility Directive 89/336/EEC and Low Voltage Directive 73/23/EEC.

ETL Marking

All Linatron-Mi models conform to UL STD 61010A-1 and are certified to CSA 1010.1.

CSA certification is pending for the Mi-6 and Mi-9 products.

Quality Standard

Varex Imaging Corporation, Las Vegas Facility, Quality Management Systems is registered to ISO 9001:2008.

BSI REGISTERED

ISO 9001:2000
FM 80701

Linatron® - Mi™

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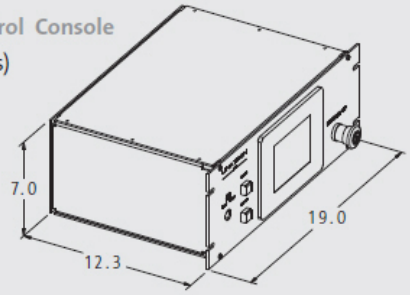
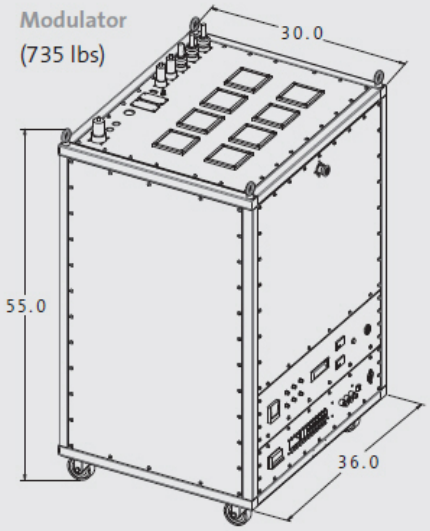
5.0 Physical Description

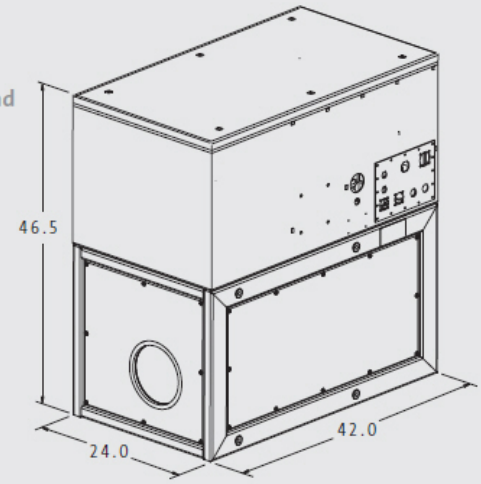
Control Console
(9 lbs)



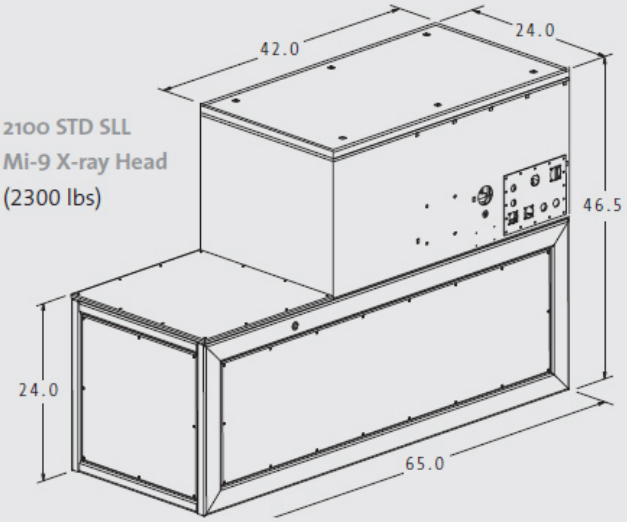
Modulator
(735 lbs)



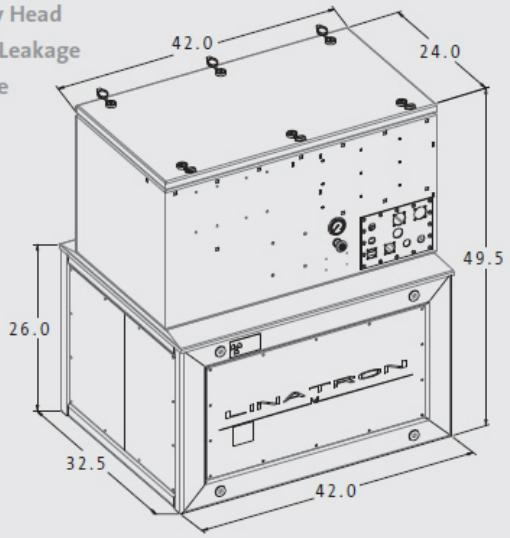
1800 STD SLL
Mi-6 X-ray Head
(2171 lbs)



2100 STD SLL
Mi-9 X-ray Head
(2300 lbs)



Mi-6 X-ray Head
Ultra-low Leakage
Low Profile
(5100 lbs)



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