



# How To Choose An X-Ray Machine

A Guide For First Time Buyers

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This pamphlet is designed to assist you in better understanding x-ray machines physical components, variants, software, and ultimately, how to choose the system that best suits your security needs. *How To Choose An X-Ray Machine* is divided into the following five sections:

- Section 1: The Basics of an X-Ray Machine
- Section 2: Types of Machines
- Section 3: Steel Penetration and Wire Resolution
- Section 4: Important Software Features
- Section 5: Conclusion and Contacts

### **Section 1: The Basics of an X-Ray Machine**

1. Inspection Tunnel= area in which items placed in the x-ray machine are exposed to x-rays and thereby scanned. This area is shielded by lead curtains and lead panels to protect from x-ray radiation.

The inspection tunnel size is based on the size requirements of the items to be scanned. For example, the XIS Series has machines with tunnel sizes ranging from 533 x 354 mm (21" x 13.9") to 1803 x 1807 mm (71" x 71.1"). The dimensional measurements for tunnel sizes are typically width by height.



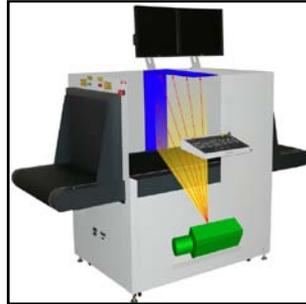
*Inspection Tunnel*

2. Conveyor Belt= the surface on which items to be scanned are placed and carried through the inspection tunnel. In cargo screening systems with large tunnel sizes, the conveyor belt may also be replaced by a roller bed.



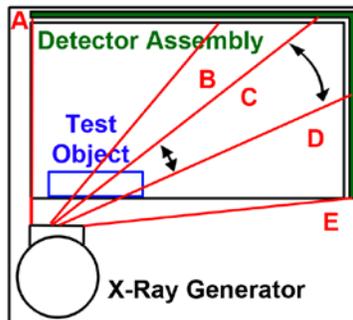
*Conveyor Belt*

3. X-Ray Generator= the standard x-ray generator emits an x-ray fan beam at an upward 90 degree angle into the inspection tunnel. The most common generators used in x-ray security applications are 90 kV, 160 kV, and 180 kV. Increased penetration screening for larger systems may require 320 kV or 450 kV generators. (Generator power is expressed in kilovolt (kV), 1 kilovolt = 1,000 volts).



*X-Ray Generator*

4. Detector Assembly= the detector assembly system uses x-ray penetration diode sensors to measure high and low energy. The detector assembly is L-shaped to capture all the energies released by the x-ray generator.



*X-Ray Detector Assembly*

5. Operator Control Panel= the operator control panel is the system tool operators use to access the machine, monitor system health, and most importantly, manipulate software images. The operator control panels thus allows for the real-time image manipulation of scanned objects.



Operator Control Panel

## Section 2: Types of Machines

There are different types of x-ray machines based on generator power and the positioning of the x-ray generator(s).

1. Generator voltage= the generator's voltage depends on the expected density of the items to be scanned, as well as the tunnel size of the system. The larger the tunnel size, the more the x-ray waves are dispersed and the less precise the density detection, thus requiring a more powerful generator. However, if a generator is too powerful, the x-rays will penetrate through the items scanned and will not produce a clear image.

Generator voltage can be anywhere from 90 kV for small machines, to a standard or 160 kV or 180 kV for medium to large machines, and up to 320 or 450 kV for very large systems or those requiring high density sensitivity.

2. Generator types and positioning= an x-ray generator can be manipulated to provide a more efficient design or make the system more precise. There are various types of generator positions; the most common systems have an up-shooting generator while side and down-shooting systems are also widely available. In addition, a dual view system contains two x-ray generators and may combine any of the above generator positions.

Up-Shooting: An up-shooting x-ray machine is a system where the generator is positioned at the bottom of the machine, vertically shooting x-rays upward. An up-shooting machine is among the most commonly manufactured x-ray systems.



*Up-Shooting X-Ray Machine (XIS-100X)*

**Side-Shooting:** Side-shooting machines have their x-ray generators located to the left or right side of the conveyor belt. X-ray energy from the generator passes through objects on the conveyor belt in a horizontal sideward fashion. Systems requiring heavy object screening commonly utilize these horizontal beams, including the XIS-5878.



*Side-Shooting X-Ray Machine (XIS-5878)*

**Down-Shooting:** An alternative to side-shooting, a down-shooting machine has the generator located at the top of the system, shooting x-rays vertically downward. Down-shooters allow the system to be redesigned for a lower conveyor belt, allowing for easier loading and unloading of heavy screening objects/crates/pallets etc. and is common in cargo screening systems.



*Down-Shooting X-Ray Machine (XIS-100XD)*

Dual View: A dual-view machine has both two generators that create dual screening perspectives and can typically be manipulated independently of each other. Dual View technology further aids an operator's object identification and likewise enhances timely and effective detection.

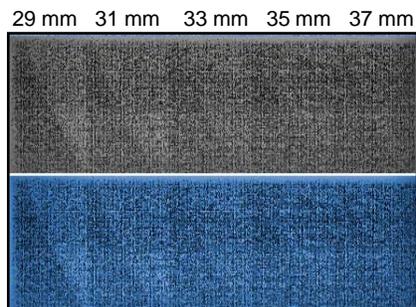


*Dual-View (Up-Shooting/Side Shooting) X-Ray Machine (XIS-100XDV)*

### **Section 3: Steel Penetration and Wire Resolution**

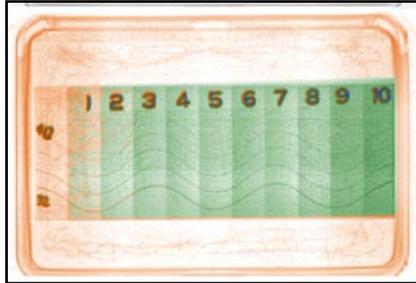
An x-ray machine's ability to penetrate steel and detect wire resolution (also known as special resolution) is crucial in identifying the system's image quality and detection abilities.

1. Steel penetration= the ability to detect an object behind or in the presence of a shielding object, typically a steel plate. Steel penetration is defined in millimeters (mm).



*Steel Penetration Gradient*

2. Wire resolution= the ability to detect incredibly thin wires. For example, the wire tested is as thin as the electrical wires possibly in a bomb timer's circuit. Wire resolution is expressed in terms of American Wire Gauge (i.e. 40 AWG). Note that the thinner the wire, the larger the gauge numeration.

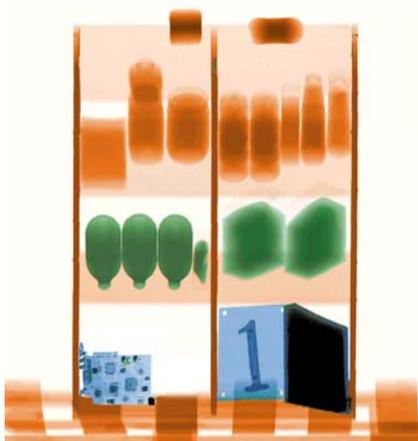


*Wire Resolution*

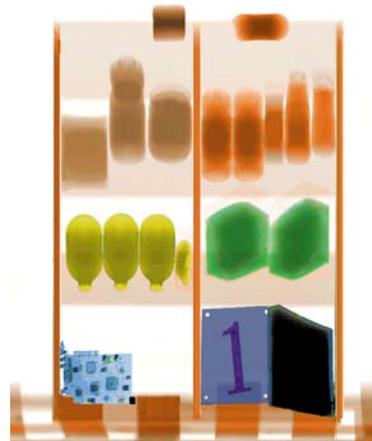
#### **Section 4: Important Software Features**

There are several important software features available on x-ray systems that greatly facilitate efficient detection by allowing operators to manipulate images and better interpret and identify objects screened. Most manufacturers have somewhat similar image manipulation software with different trademark names that essentially achieve the same results. However, the XIS Series transcends the basics with unmatched features including 6 color imaging, Atomic Z-Number Measurement, and Image Annotation. No other manufacturer currently offers these advanced features. Significantly, Astrophysics provides these unsurpassed features as standard on all their products, at no additional cost.

Six Color Imaging: Unlike other manufacturers that use only 3 color imaging, Astrophysics software produces 6 colors with an integrated grouping of objects based on their atomic numbers. The 6 colors include brown, orange, yellow, green, blue and violet. 6 Color Imaging assists operators in effectively identifying material groups and assessing possible threats. Please see Atomic Z-Number Measurement below as well as our 6 Color brochure for more information.



*3 Color Imaging*



*6 Color Imaging*

Atomic Z-Number Measurement: Astrophysics includes exclusive software that allows operators to draw a frame box around a particular object and identify the

object's atomic number, down to the decimal. This Atomic Z-Number Measurement materially groups objects in conjunction with 6 Color Imaging technology to create a software system that facilitates operator precision and screening speed. For additional information, please see Astrophysics 6 Color Imaging brochure.

Z-Number	Material Type	3-Color	6-Color	Examples	Possible Threats
0-8	Organic	Orange	Brown	Wood, Oil	C-4, TNT, Semtex
8-10	Low Inorganic	Orange	Orange	Paper, Alcohol	Cocaine, Heroin
10-12	High Inorganic	Green	Yellow	Glass	Propellants
12-17	Light Metals	Green	Green	Aluminum, Silicon	Gunpowder, Trigger Devices
17-28	Heavy Metals	Blue	Blue	Iron, Steel	Guns, Bullets, Knives
28+	Dense Metals	Blue	Violet	Gold, Silver	High-Value Contraband
-	Impenetrable	Black	Black	Lead	Shielding For Above Threats

Image Annotation: This program allows the operator to draw attention to a suspected area of an image and enter three alphanumeric letters as a code or reference. Operators can then transmit the image to a supervisor workstation or suspect search station for threat alert, secondary review, or reference.



*Image Annotation Example: "GUN"*

## Section 5: Conclusion and Contacts

Ultimately, choosing an x-ray machine is more than understanding the basics of an x-ray machine, but recognizing the importance of several factors ranging from



required tunnel size, generator voltage, steel penetration, wire resolution and specific software features.

If you need any additional information about how to choose an x-ray machine, please email Christian Chahine, Director of Marketing, at [cchahine@astrophysicsinc.com](mailto:cchahine@astrophysicsinc.com) or for product inquiries, please email [sales@astrophysicsinc.com](mailto:sales@astrophysicsinc.com) or call (909) 598-5488. Thank you.