



Aceleradores lineales: una aplicación en la seguridad pública en los Arcos de Seguridad del Estado de Puebla

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Goal



- **Arcos de Seguridad** (Puebla): Has two linear accelerators designed to switch energy pulse by pulse. These are used in the non-invasive inspection of containers and vehicle to security applications



CX-Portal

Huejotzingo, Puebla

- Tunnel inspection
- Operating room
- Linac room



- The inspection system is a source of X-ray radiation and detectors, where the vehicle to be inspected is passed through a fan beam of radiation in a inspection tunnel.

Tunnel inspection

- Safety device
- Primary wall
- Sensors
- Detectors



Linac room

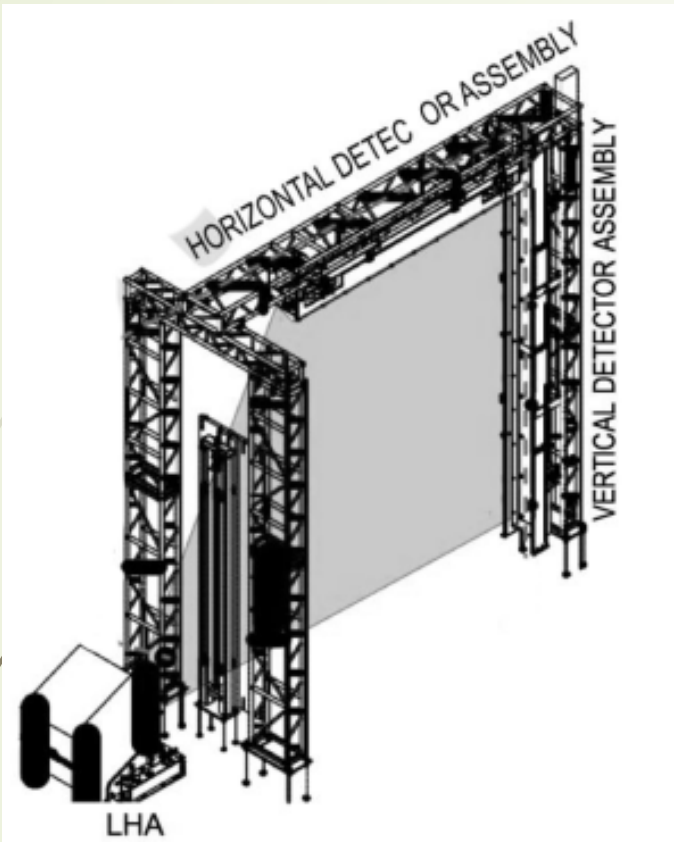
- ▶ Lineal accelerator.
- ▶ Collimator: two blocks of steel.
- ▶ Blocks beams can be adjusted to focus and rotate the beam in detectors.



Operating room



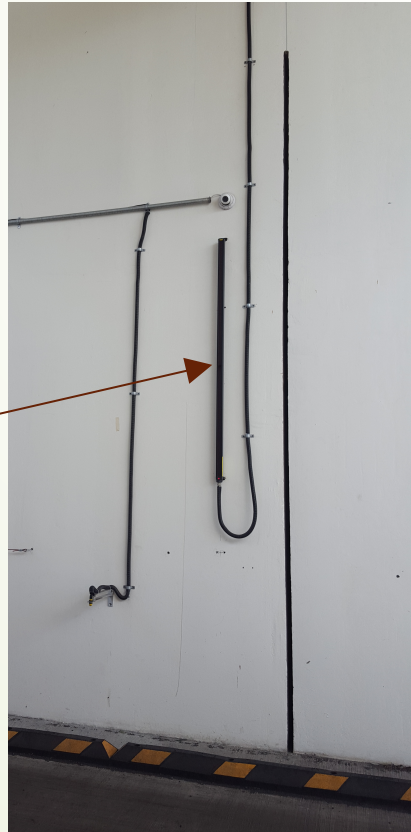
➤ GAP detection



Safety devices

The system has light curtain for air gap detection, this system doesn't allow cabin irradiation.

Transmitter



Receiver



4 Sensors of metal

4 Sensors of metal half tunnel.

- The first sensors detect the vehicle and the last two sensors detect vehicle passing through the light curtain.



Detect the vehicle.

Passing through the light curtain.

8 E-Stop

Tunnel: 4 E-Stop

- These are found in the wall, both are at the beginning of the tunnel and the other two are at the end of the tunnel.
- 1 E-Stop in the Linac
- 1 E-Stop Linatron



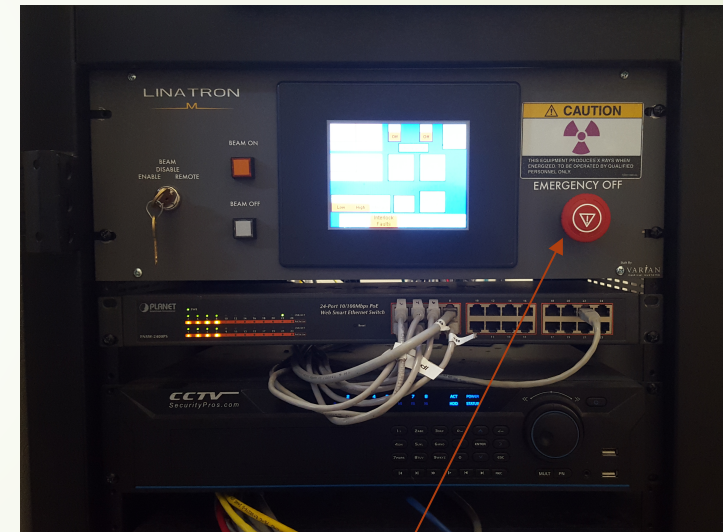
E-Stop Linatron



- 1 E-Stop: Control Console
- 1 E-stop: Console Linac



Control Console



Console Linac

4 motion detectors (MDS)

- MDS 1.- is located on the input side to the tunnel and is oriented to the plane of X-rays.
- The MDS2.- is located on the output side of the tunnel near the plane of X-rays and is aimed at the tunnel exit.
- The MDS3 is located on the inlet side of the tunnel near the plane of X-rays and is aimed at the entrance door.
- The MDS4 is located on the output side of the tunnel and is also opposite the entrance.



3 Interlock

- Control console.
- Room linac: door
- Linatron.



12 Vehicle sensors

Vehicle sensors are located on the center line (Buried).

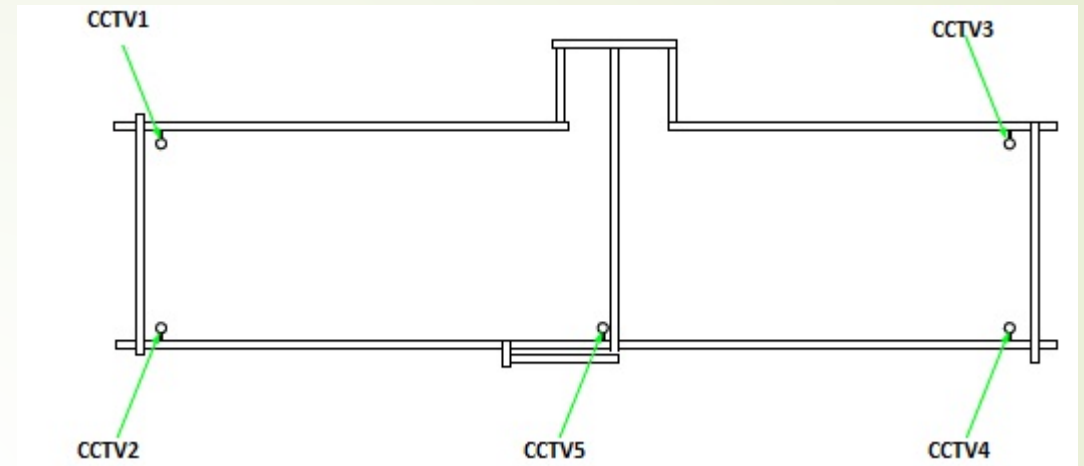
- 2 Sensors in the beginning
- 10 Sensor in the end of the tunnel.



Systems CCTV

The installation has 8 camera.

- 5 in the tunnel
- 1 room linac
- 2 in the corner



A warning light

It is located in the center of the tunnel inspection on the plane of X-ray. Warning light it glows green when power is supplied to the portal. It lights green and amber when high voltage. And it glows green, amber and red when the X-rays are active.



Traffic light

The traffic light TL is left at the tunnel entrance vehicle inspection. A green arrow is lit when the LHA is ready for operation. The traffic light with a red X on when the system detects that the vehicle is in the tunnel.



Linear Accelerator

- Linatron Mi-6 (Varian)
- Nominal energy outputs: 6 MeV and 4 MeV.
- Alternating energies allow enhanced material discrimination
- The X-Ray beam quality is specified using HVLsteel.



Linatron Mi-6

Model	Nominal Energy (MeV)	HVL (in)
Mi-6	4.0	1.00
	6.0	1.10

- Discriminate between materials based on their density characteristics (by rapidly alternating between two distinct energy levels).

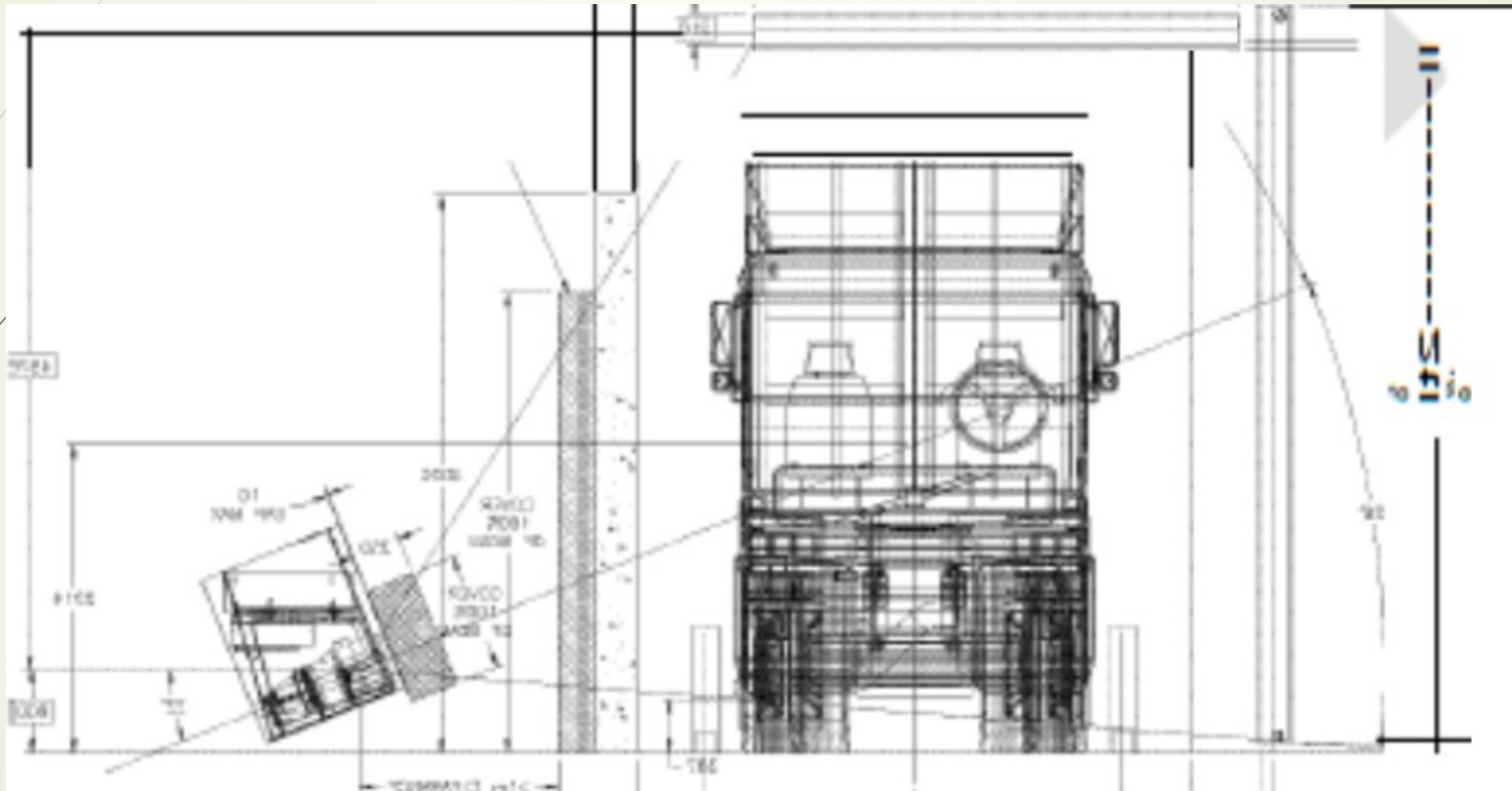


Control console

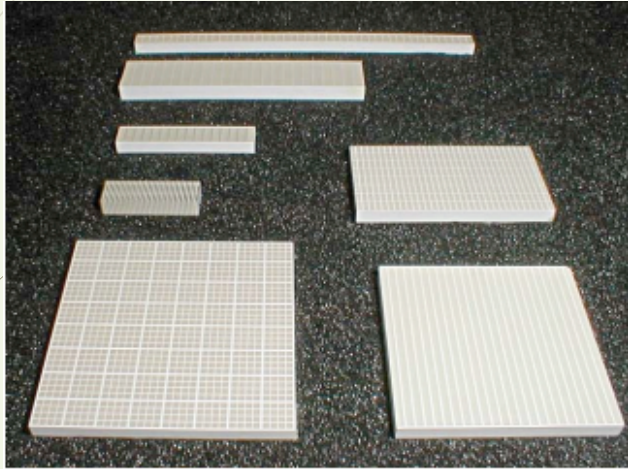


X-Ray head/RF unit

The inspection system is a line scanner, where the object to be inspected is passed through a fan beam of radiation.



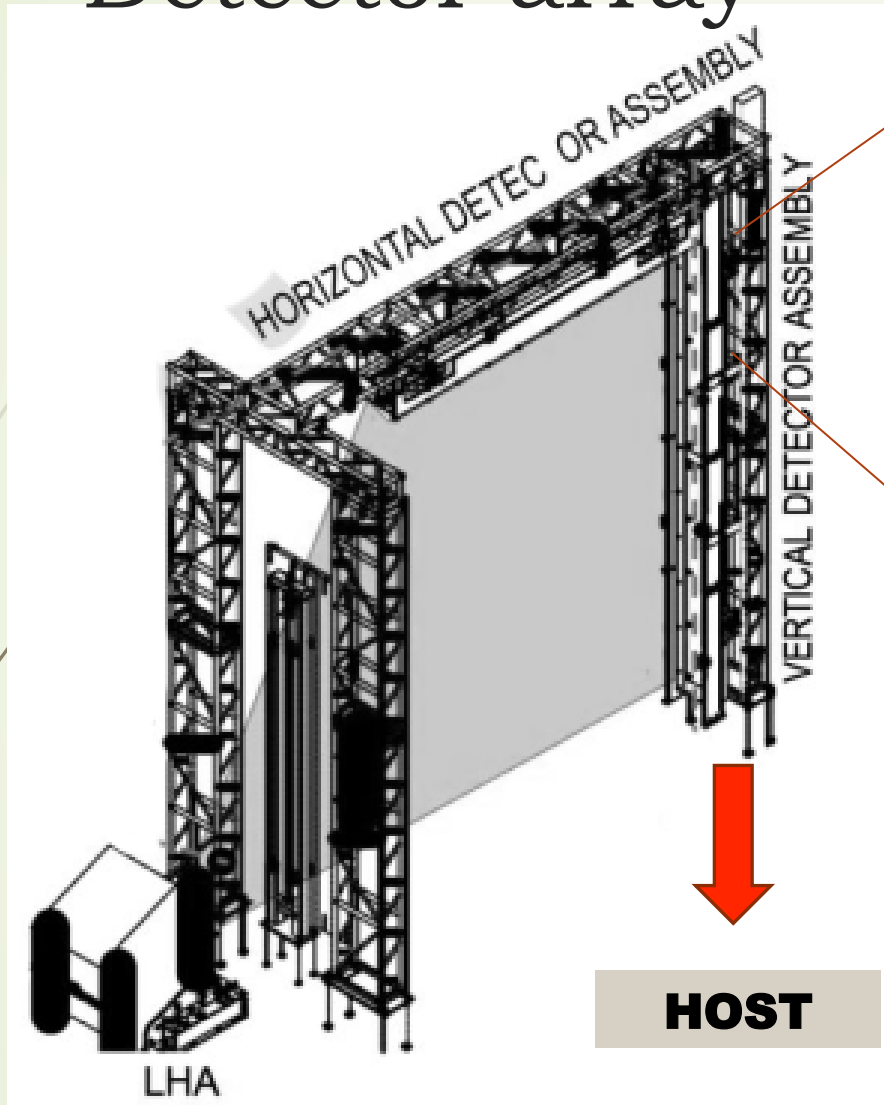
Detector: Cadmium tungstate CdWO_4



- **Detector:** Scintillation Material
- The emission maximum is at 475 nm



Detector array

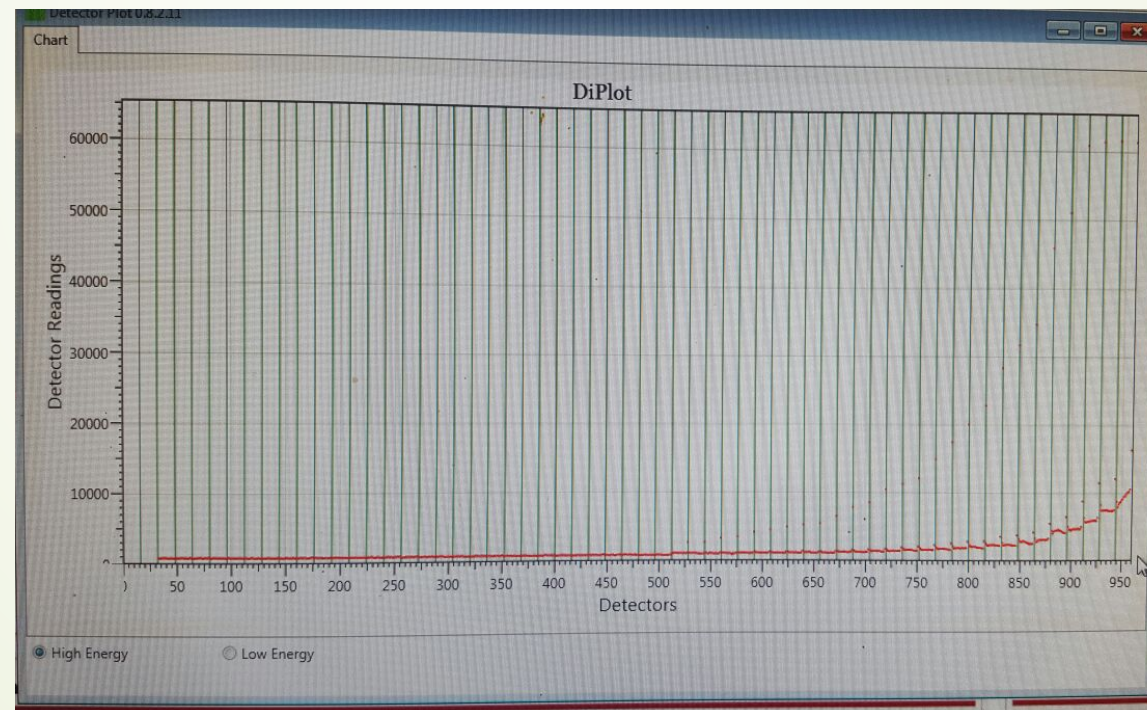


- Vertical detectors contains 69 boards
- Horizontal detector contains 32 boards

- The array set of detectors used to capture converts X-rays after passing through the vehicle to a control panel

Host

- Host computer know image processing or data acquisition system.
- Host is responsible for data acquisition, processing them, the same file server as well as a case of images for analysis workstation.



Dashboard

Graphical interface to monitor and control the operational functions of CX Portal

- Status bar indicators
- Safety system
- Real time display
- Linac system information
- Scanning status

The dashboard features a top status bar with indicators for Linac Status, Scan Status, Detectors Status, and Safety Status. The main interface is divided into several sections:

- Real Time Display:** A large empty white box for real-time data.
- Safety Systems:** A schematic diagram showing various safety components like VS1-VS13, MDS1-MDS4, ES1-ES6, KEY, LIGHT, and DOOR.
- Linac System Information:** A table showing system health and mode.

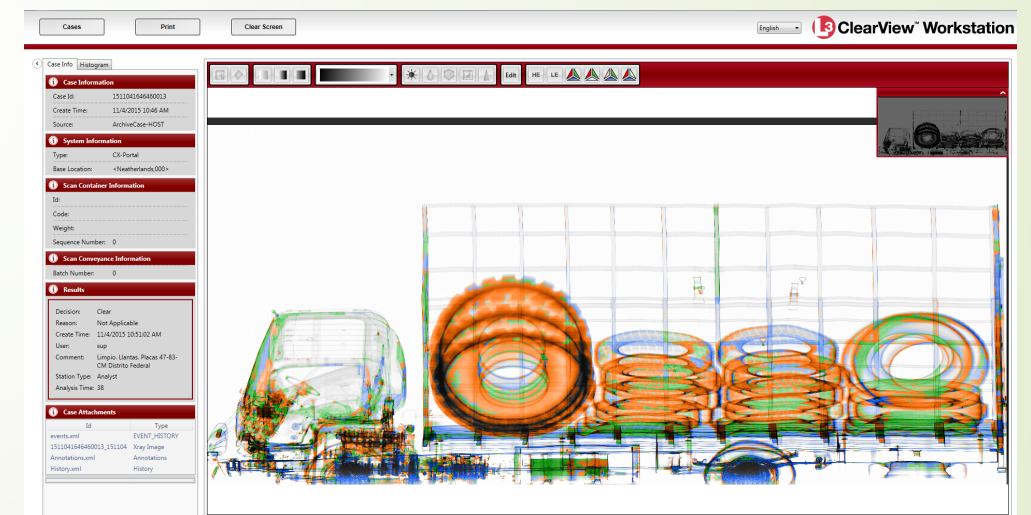
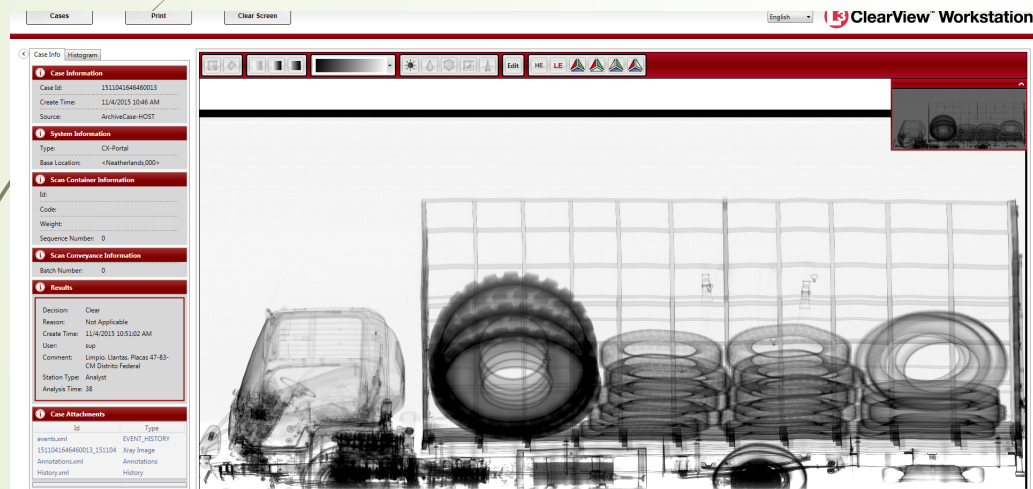
Current Status	Linac State
System Healthy	Powered On
Selected Mode	Material Discrimination
- Scanning Status:** A table showing current and previous scan steps and mode.

Current State	Scan Step
Ready to perform scan	99
Scan Area	Previous Scan Step
Prevent Scanning	99
Scan Mode	Cargo Only
- Safety Faults:** A button labeled "Clear Safety Faults".
- Calibration Control:** A button labeled "Start Calibration".
- Scan Type:** A button labeled "Set to Calibration Mode".

At the bottom, there are navigation buttons for "Log Off System", "Linac System", "Scan System", and "Safety System". The logo "ClearView™ Dashboard" is visible in the bottom right corner.

Workstation Clearview

- Used to inspect the scanned images
- Software tools allow material discrimination





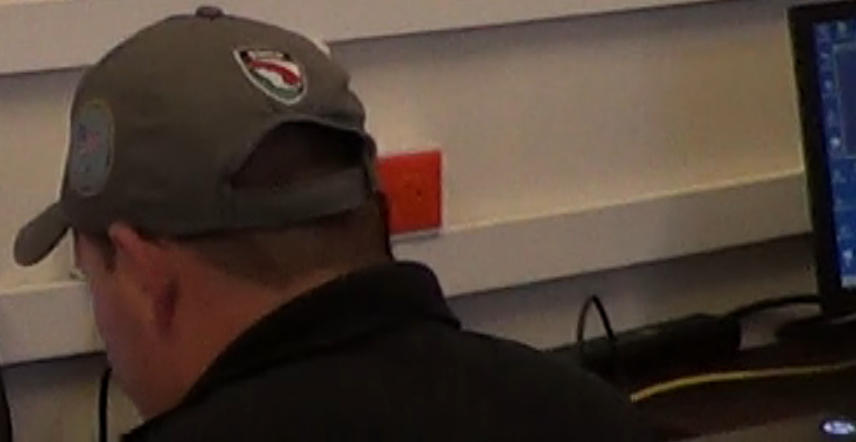
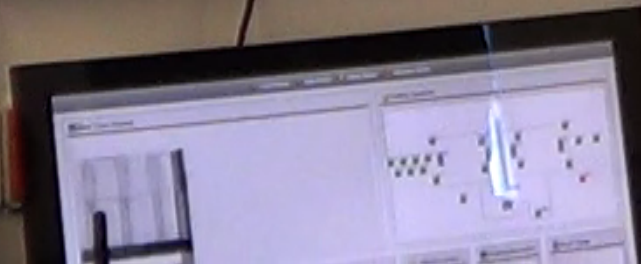
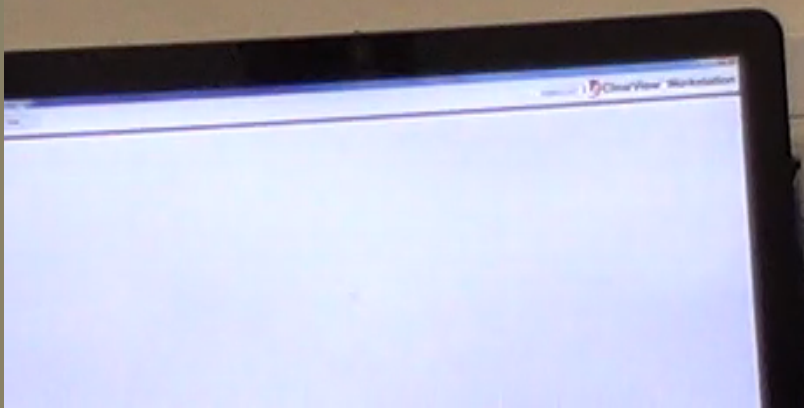
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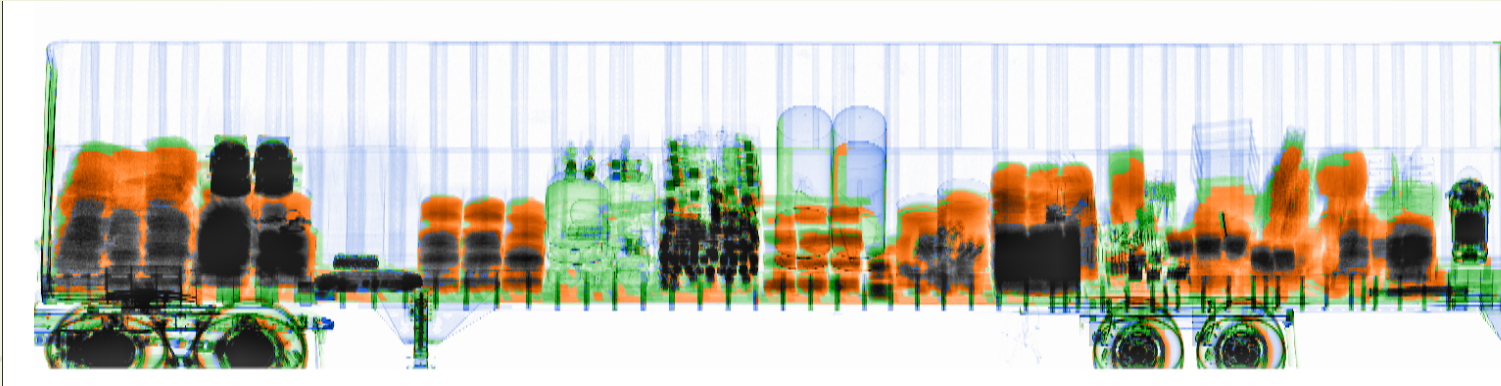
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Saenz

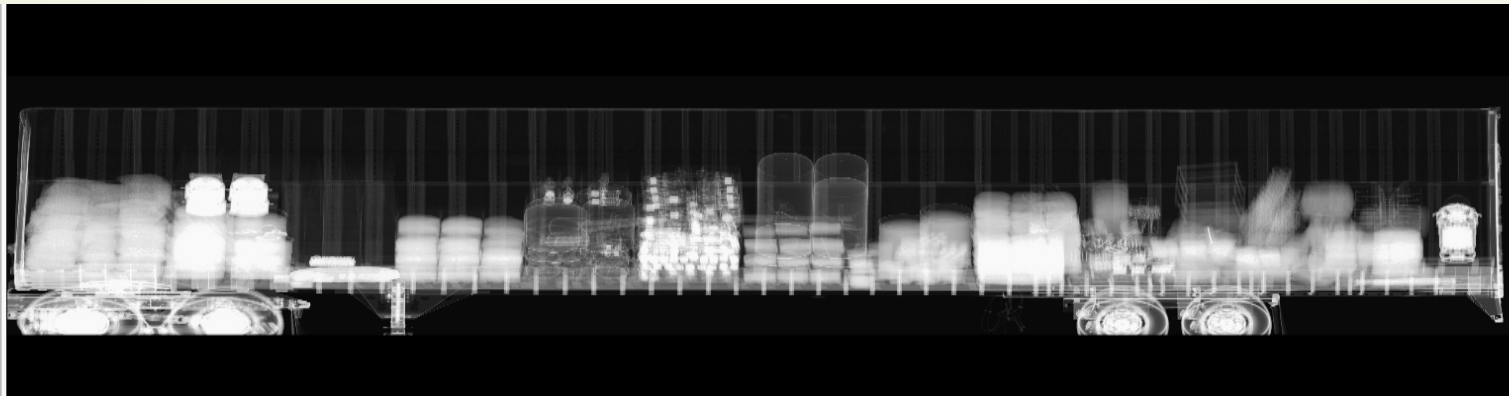



PROHIBIDO CONSUMIR
ALIMENTOS EN ESTA AREA

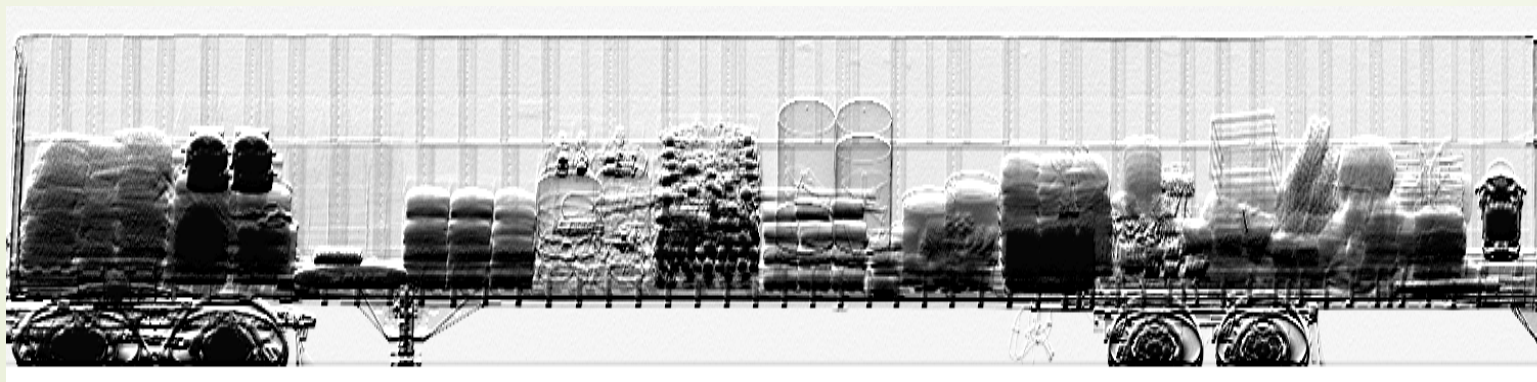




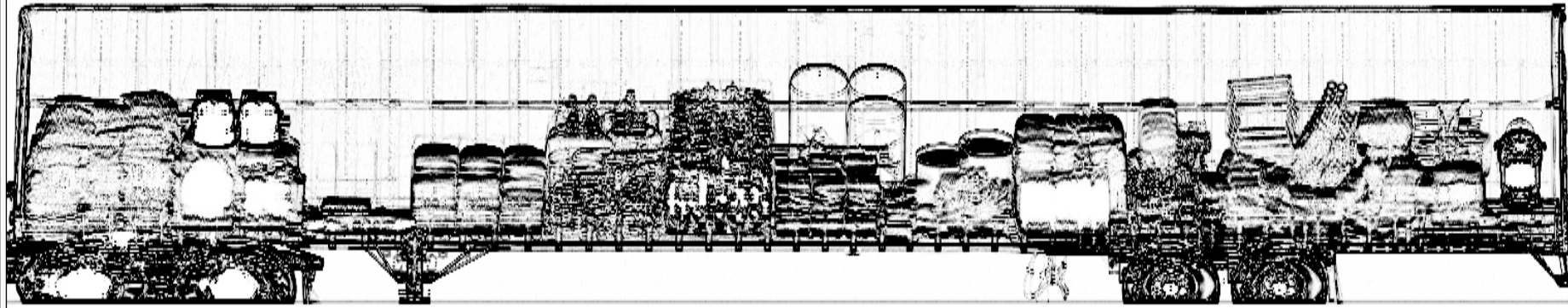
Material
discrimination



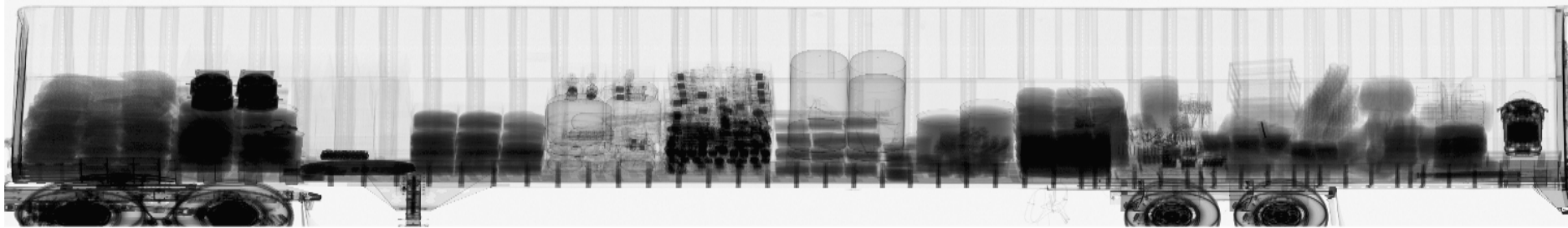
Invert effect



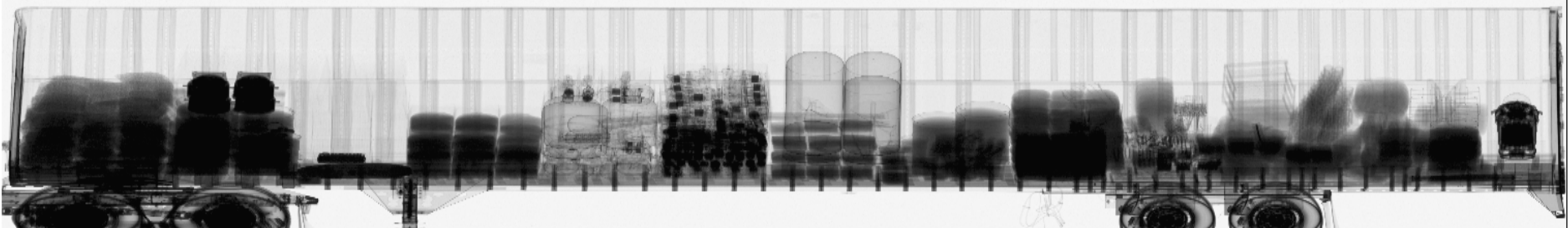
Sharpened effect



Edge
effect



HE



LE



Equipo CX-Mobile G3

Palmar de Bravo, Puebla


Tunnel inspection



Designed to explore all kinds of cars.



The Vehicle has three room:

- Conductor area
 - Analysis room
 - Linac room
- 

Conductor area

In this area the driver select the velocity for the scan.

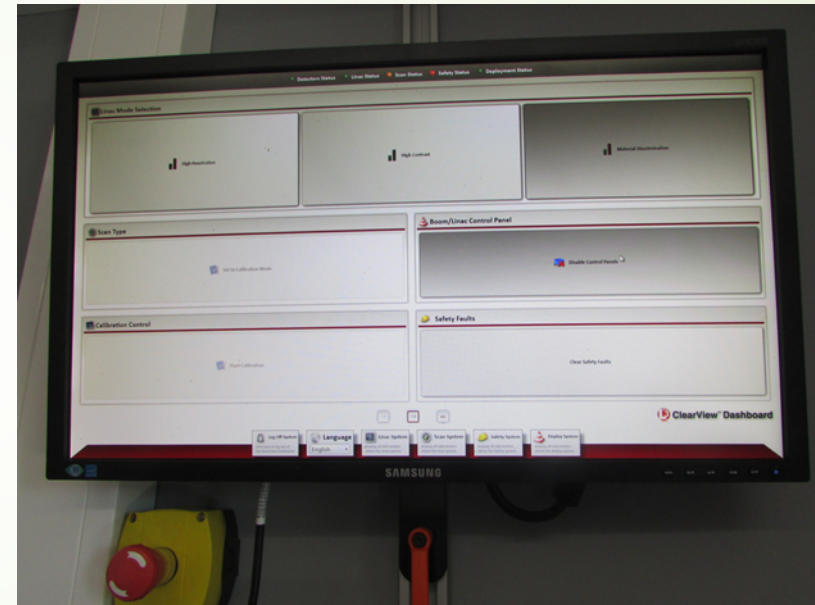
- 1 Velocity 1.0 m/s (2.24 mph)
- 2 Velocity 0.4 m/s (0.9 mph)
- 3 Velocity 0.2 m/s (0.4 mph)
- 4 Velocity 0.1 m/s (0.2 mph)



Analysis room



Workstation y Dashboard



Linac room



Acommodation y
deployment of Linac




CX- Mobile G3

- This car has 3 different kinds energy:
 - High Penetration (6 MeV)
 - High contrast (4 MeV)
 - Material Discrimination (4 and 6 MeV)



Security devices

The G3 Mobile has:

- E-Stops
 - Switch to race
 - Interlock
 - Deadman switch
 - Vehicle sensors (Portal mode)
- 

Switch to race

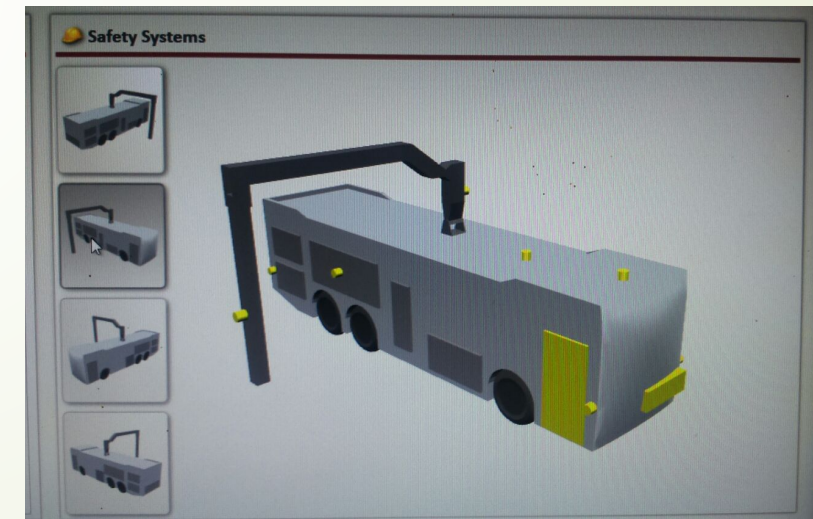
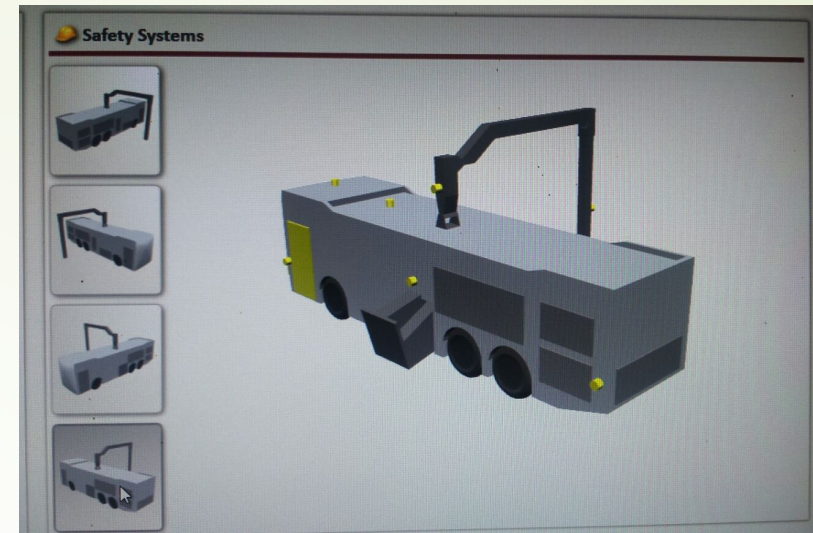
- Vertical Boom stow deployed/retracted
- Mastil deployed/retracted
- Linac deployed/retracted



E-Stops

The ClearView Dashboard computer, the operator can see where is the E-Stop activated.

- The Vehicle has 12 E-Stop.



Interlock

The vehicle has two interlock:

- The driver door
- The operator door



Deadman switch

This allow deployed/retracted
the linac y boom.



Vehicle sensors (Portal mode)

- This sensor is in the hydraulic area and detects the incoming vehicle.
- Sensor is in the linac area and detects when the vehicle passing through of the x-ray.

Velocity Sensors

- This sensors detects the vehicle incoming and exiting of the x-ray.



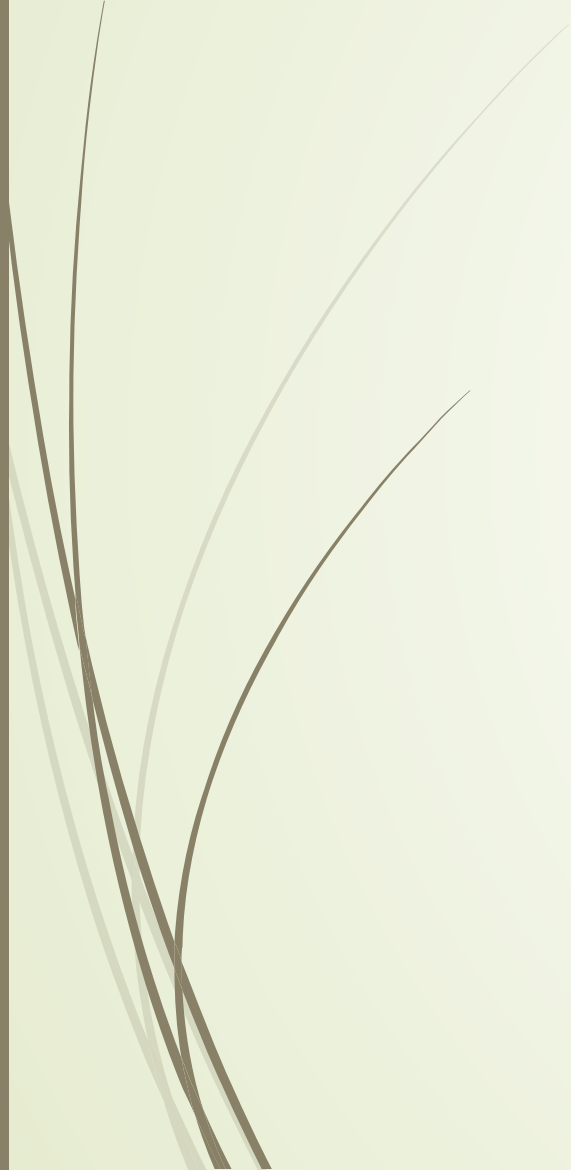
CCTV System

The CX-Mobile has four camera. It is are in the corners of the vehicle.

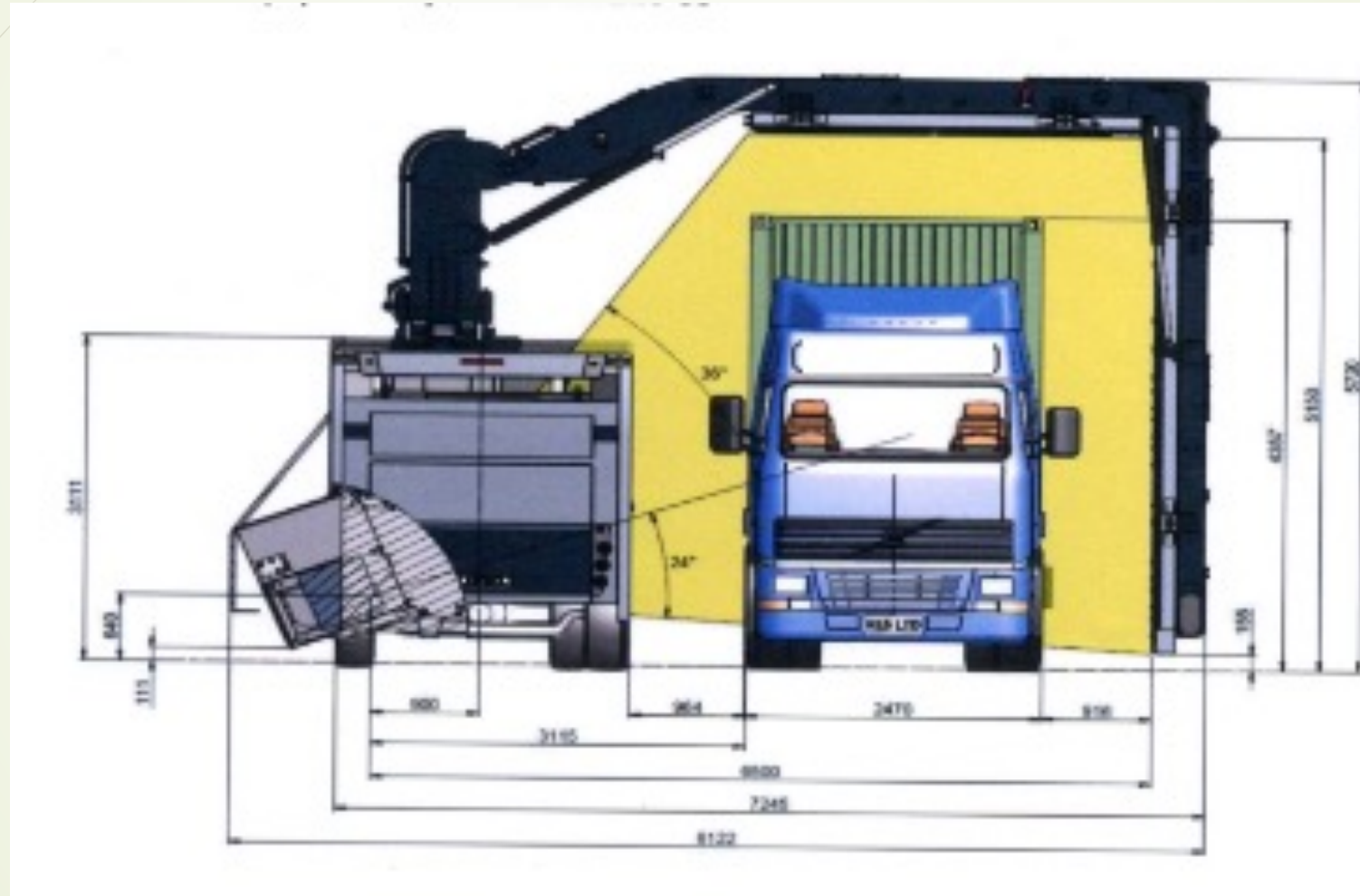


Deployment LINAC

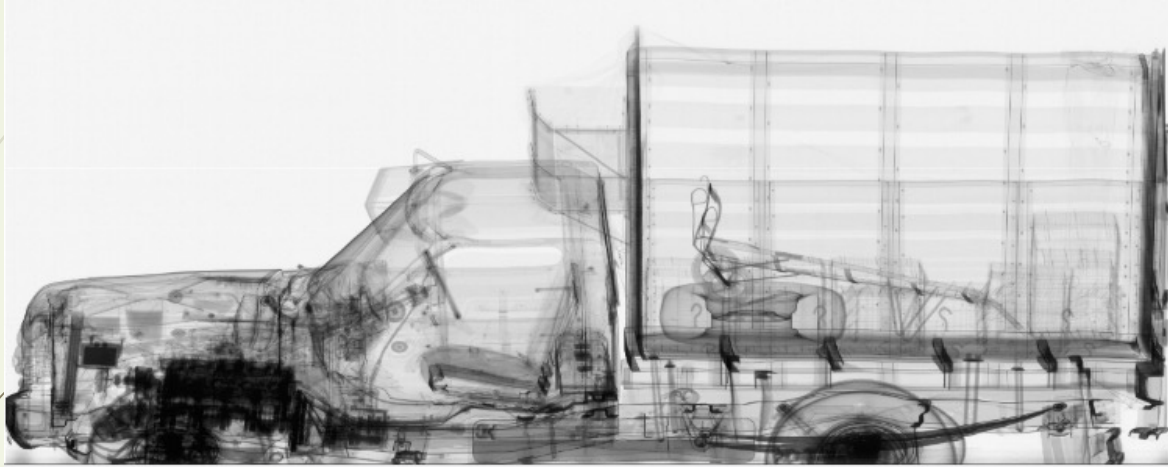




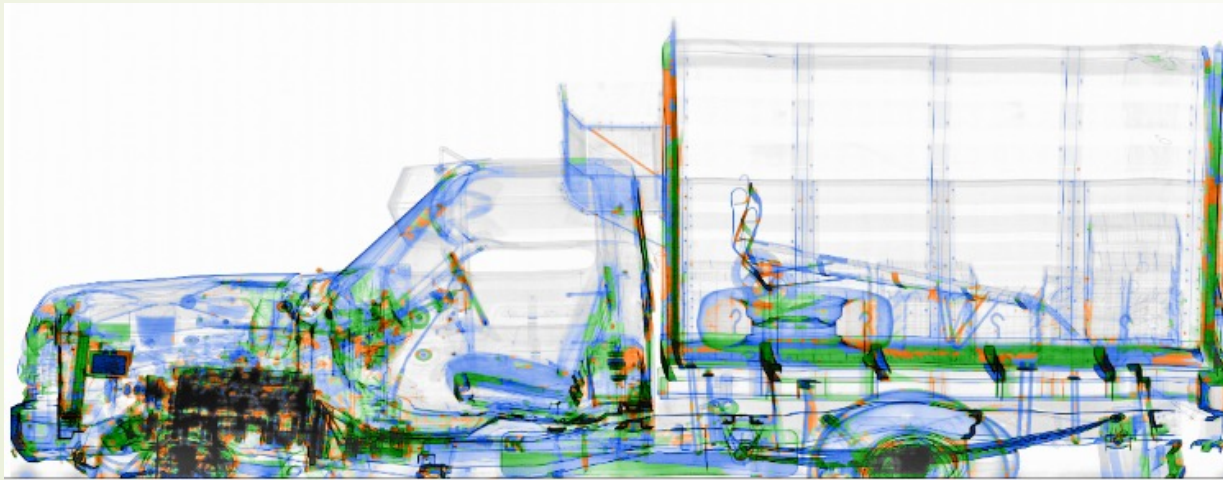
Beam geometry CX-Mobile G3



ClearView Images

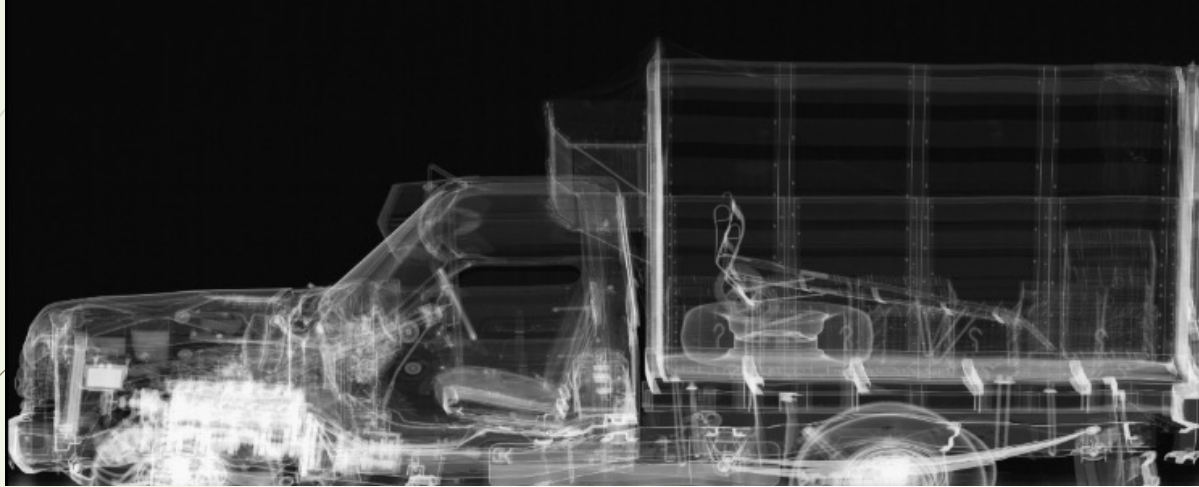


Blur effect

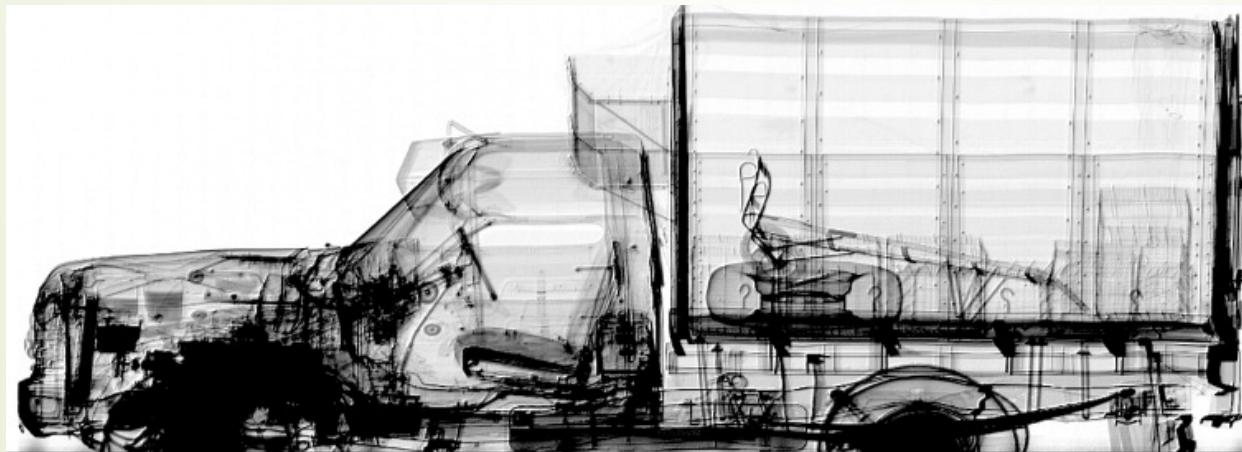


Discrimination effect

ClearView Images



Invert effect



Sharpen effect



Gracias por su atención



Agradecimientos

- Procuraduría General de Justicia del Estado de Puebla,
Dirección General de la Policía Ministerial
 - Personal Ocupacionalmente Expuesto
- 



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