X-ray security screening system for introscopy of heavy vehicles

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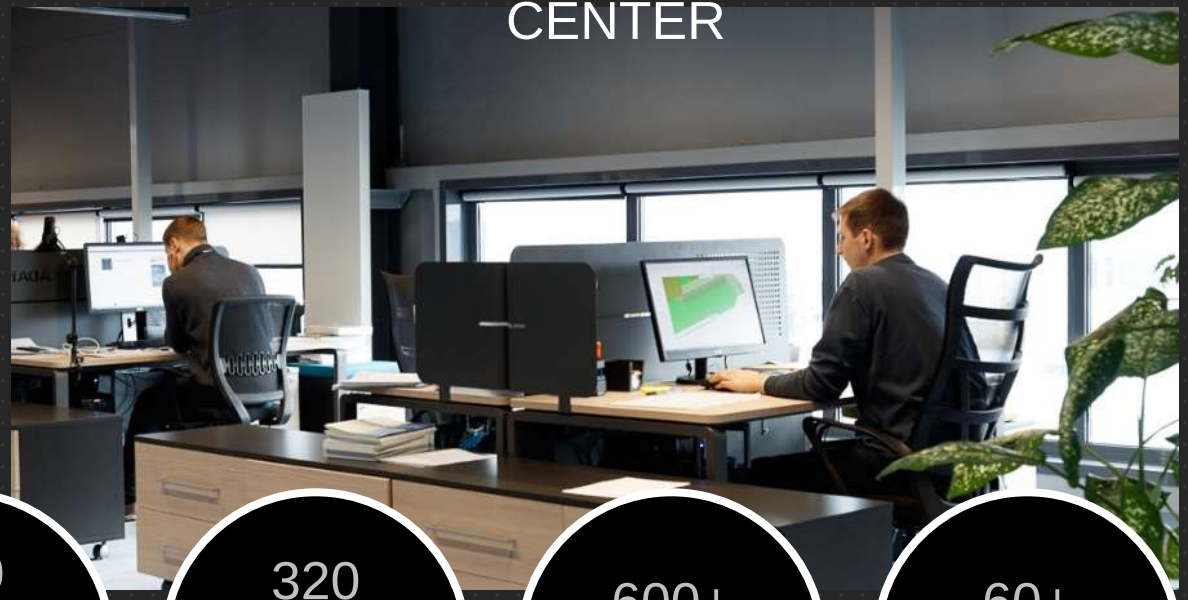
ADANI IN SHORT

ADANI (established in 1991) is a world-class high-technology corporation with full customer-focused disruptive innovation cycle working in security, medical and safety markets

COMPLETE CYCLE MANUFACTURING CENTRE

- 25 000 SQM
- Clean laboratory
- 5 X-ray shielded labs
- 100 R&D engineers

HI-TECH INNOVATIONS CENTER



- 320 manufacturing specialists
- 600+ employees
- 60+ patents

SECURITY SOLUTIONS

PEOPLE SCREENING

Full body smart personal inspection technology. Drug detection software.

BAGGAGE INSPECTION

All tunnel sizes: 50x30, 60x45, 60x80
100x100, 175x65, 175x180

VEHCLES INSPECTION

Light and passenger vehicles inspection.
Cargo and trucks inspection.

Cargo and Vehicle X-ray Inspection

Drive-Through Portal (DTP) X-ray systems are high-energy scanners designed for non-intrusive inspection of vehicles, cargo, containers and goods in various inspection sites.

X-ray security screening system for introscopy of heavy vehicles

Detectors are among the most expensive parts of any screening system.

Up to now, ADANI imports thousands of detection units every year from Europe and China.

To reduce a dependence from importation and a cost of an end-product ADANI initiated R&D projects to develop a screening system equipped with detectors developed and produced by ADANI.

The recently developed screening system contains:

- a pulse radiation source with an energy up to 7,5 MeV (betatron) and a pulse repetition rate from 300 to 400Hz,
- a set of highly sensitive radiation detectors,
- a subsystem for control and data acquisition,
- appropriate interfaces and software.

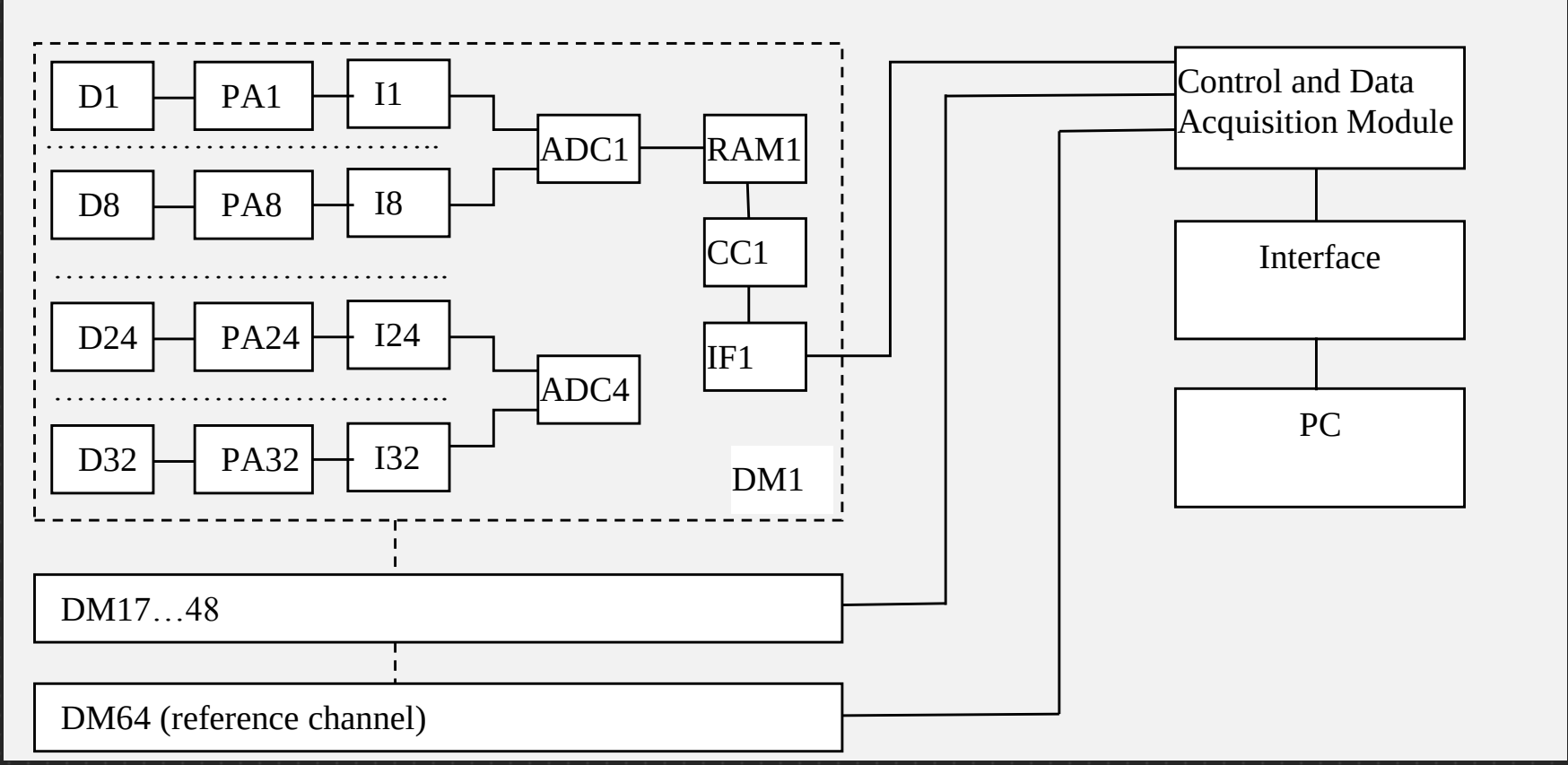
X-ray security screening system for introscopy of heavy vehicles

A feature of the system is an increased sensitivity due to the accounting of the pulse nature of the betatron radiation and its high duty cycle. To do this, an additional pre-amplifier is introduced, which contains low and high-pass filters with optimally selected bandwidth. It allowed to increase the gain without increasing the noise.

Due to the high pulse duty cycle, one can use CsI(Tl) scintillation crystals without deterioration of the image contrast, since our studies have shown that at a duty cycle greater than 400 Hz, the afterglow effect does not exceed 0.1% of the signal level.

To increase the speed of transmission from the detection units to the computer, the original scheme was used, which allowed to increase the number of detection units up to 64.

X-ray security screening system for introscopy of heavy vehicles



Block diagram of a security screening system: D – detection cell (scintillator + photodiode), PA – preamplifier, I – integrator, ADC - 20 bit ADC, CC – control circuit, IF – interface of detection module, DM – detection module.

Detectors for Cargo and Vehicle X-ray Inspection

Lightweight (700 g) high performance detectors for X-ray applications in an energy region from 450 keV to 15 MeV.

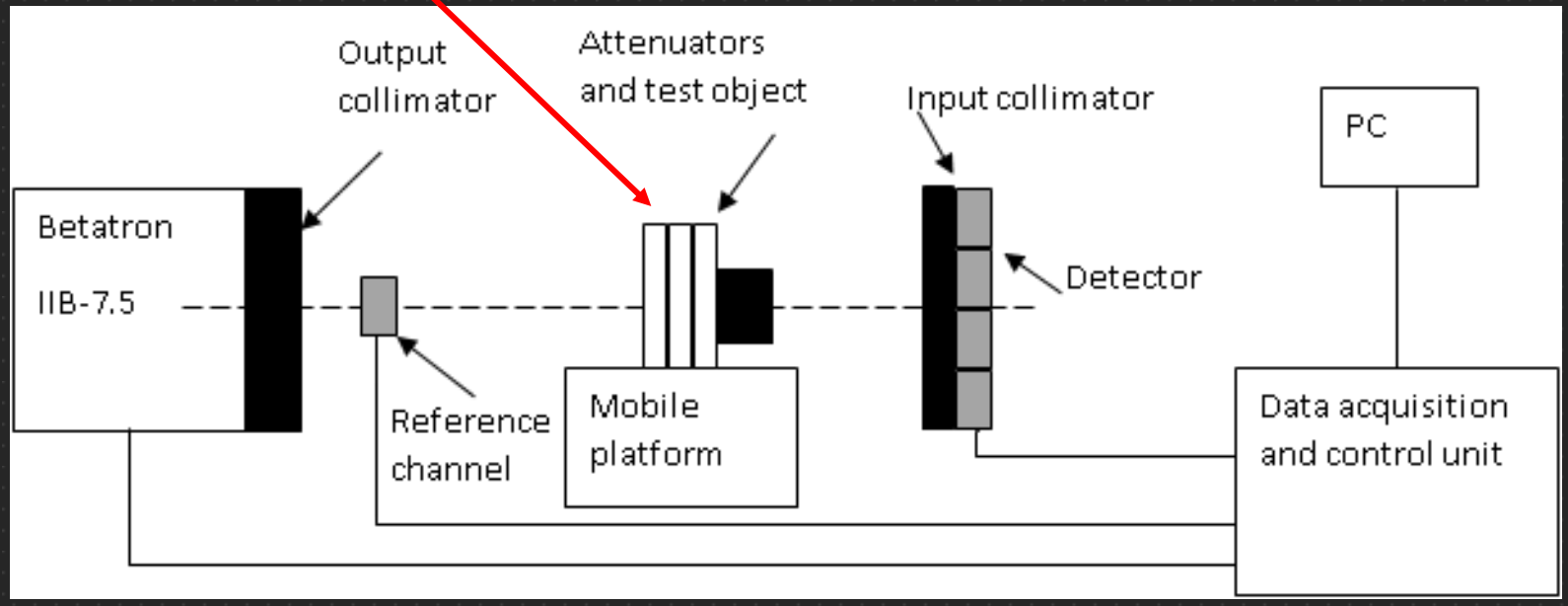
1	Number of pixels	32
2	Scintillation element size (pitch x width x height x length), mm	4,6x3,8x7x30
3	Upper energy level for ionizing radiation quanta, MeV, not less than	7,5
4	Maximal power consumption, W	2,4
5	Range of supply voltages, V	9-15
6	Transmission coefficient, steps; pC	7; 2,5-17,5
7	Maximal frequency for 64 modules scanning, Hz	400
8	Integration time, µs	50
9	Dynamic range depending on the transmission coefficient, bit	13.8-16.5

Tests setup and tested parameters

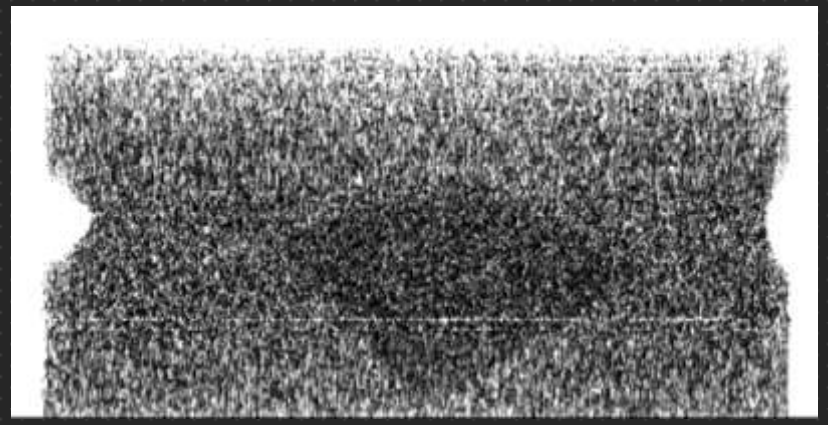
Speed of Mobile platform: 8 km/h

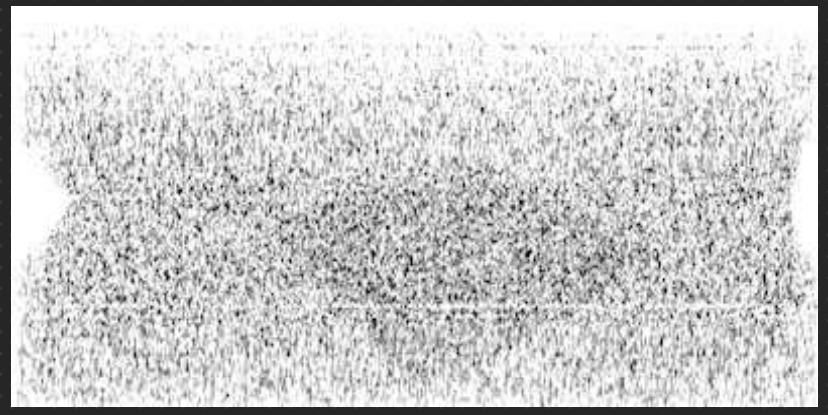
According to ANSI 42.46 standard, an effectiveness of an introscopy system is estimated through the following parameters:

- penetrating ability of the system;
- resolution;
- detecting ability by wire;
- contrast sensitivity.



Test results: penetrating ability

1. 

2. 

According to ANSI 42.46 penetrating ability is defined as a maximal thickness of steel absorber when steel test object is still recognizable.

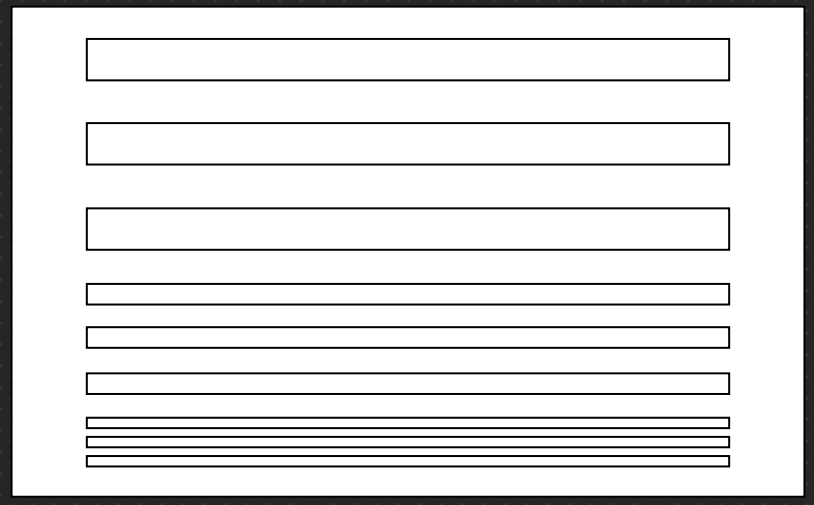
On the left is an X-ray image of a steel arrow of 7 cm thickness positioned behind a steel absorber:

1) absorber thickness is 35 cm;
2) absorber thickness is 30 cm.

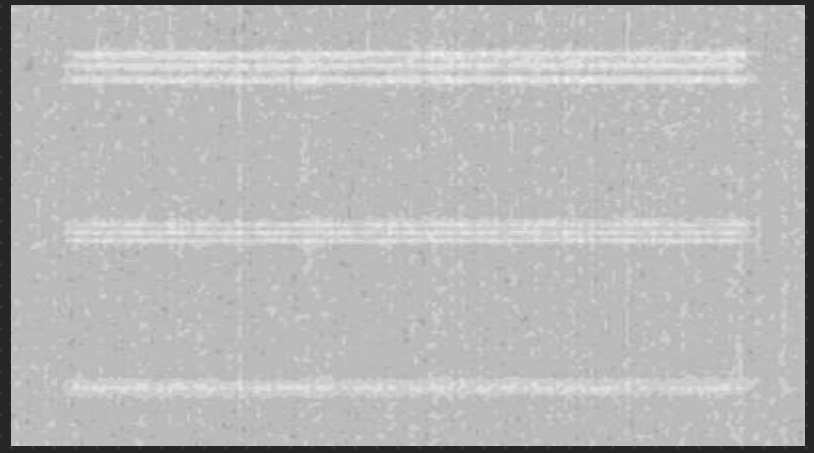
Penetrating ability is 350 mm

Test results: resolution

1.



2.



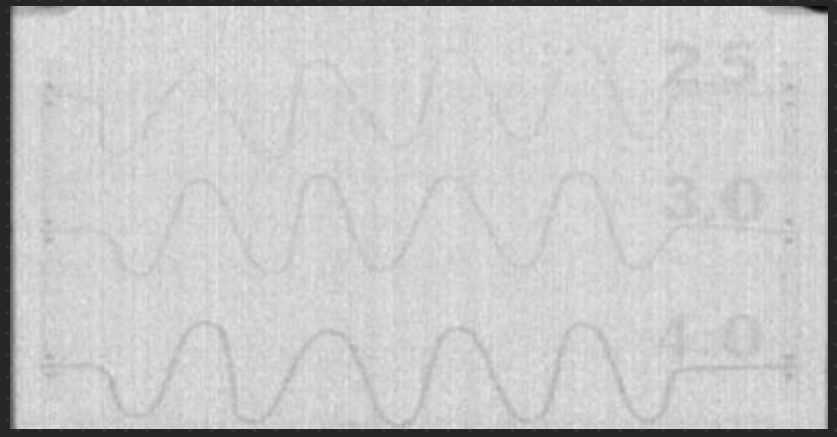
According to ANSI 42.46 resolution corresponds to a minimal size of a slot made in a steel plate.

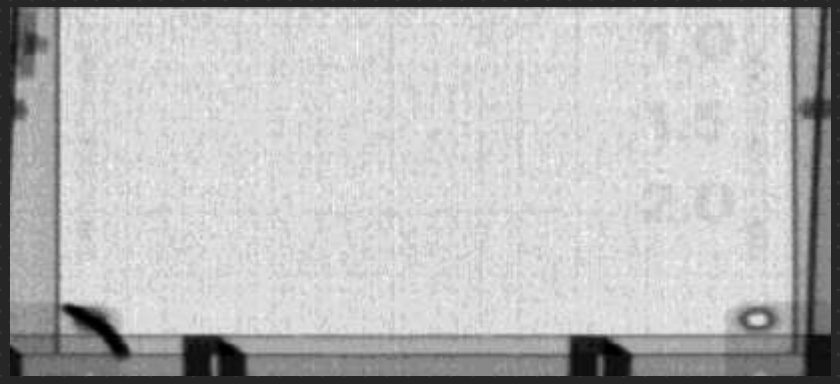
On the left:

1) schematic image of a steel plate with sets of slots of 2, 3, 5, 10, 15, 20 mm size;
2) X-ray image of a steel plate.

The smallest slots resolved have size 3 mm.

Test results: detecting ability by wire

1. 

2. 

According to ANSI 42.46 detecting ability is estimated by a set of copper wires of various thickness, which have sinusoidal shape.

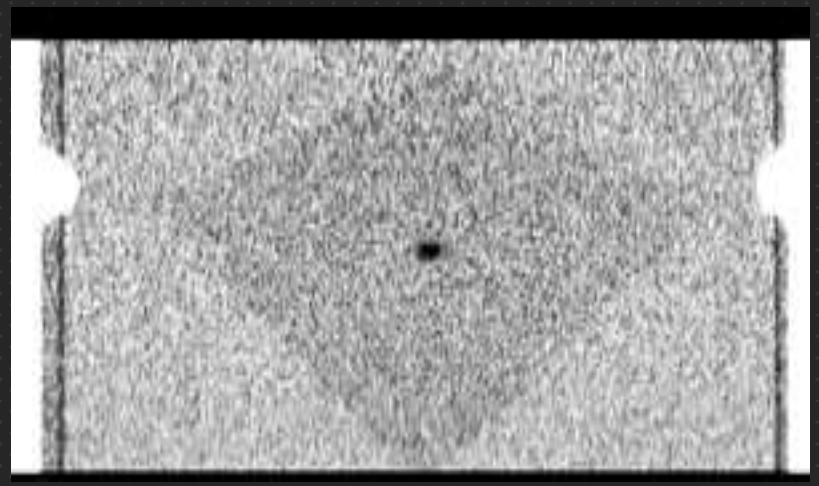
On the left:

1) X-ray image of copper wires with 2.5, 3.0, and 4.0 mm thickness;
2) X-ray image of copper wires with 1.0, 1.5, and 2.0 mm thickness.

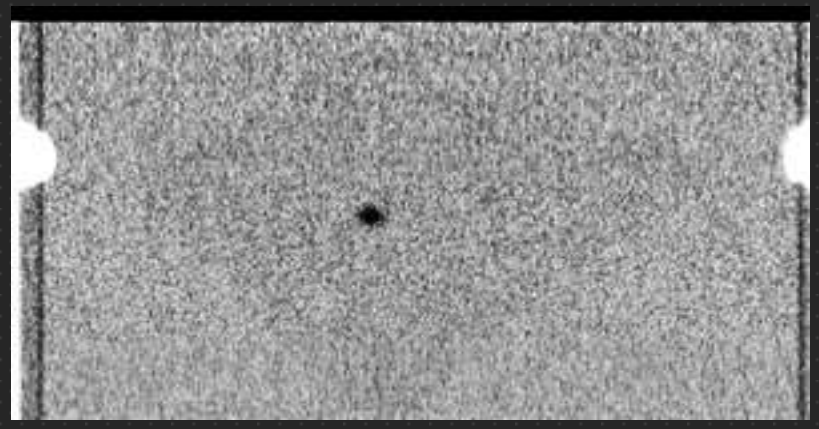
Detecting ability is 2 mm.

Test results: contrast sensitivity

1.



2.



According to ANSI 42.46 contrast sensitivity *C* is calculated as

$$C = D_{obj}/(D_{obj} + D_{abs}) \cdot 100\% ,$$

where D_{abs} – thickness of absorber, D_{obj} – thickness of steel arrow positioned behind an absorber.
Set of arrows with thickness from 1 to 5 mm.

On the left:

1) X-ray image of arrow of 4.0 mm thickness positioned behind 10 cm absorber;
2) X-ray image of arrow of 4.0 mm thickness positioned behind 10 cm absorber.

Contrast sensitivity is 2 %.

Conclusion

An X-ray security screening system for introscopy of heavy vehicles is developed and experimental unit is produced and tested.

The system has the following characteristics:

- penetration capacity of up to 350 mm of steel equivalent;
- spatial resolution on the wire of 3 mm;
- detecting ability of 2 mm;
- contrast sensitivity of 2 %.

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Thank you!