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## INTRODUCTION

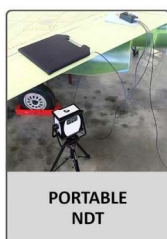
### Background

**X-RIS** ([www.xris.eu](http://www.xris.eu)) is a company active in the development stationary solutions in digital X-ray. The company was founded in 2010. The team gathers today 20 people among whom 9 engineers and 4 technicians. X-RIS won the Deloitte Technology Fast 50 – 2015 in all categories, and again in 2017 in the category hardware. In 2018, X-RIS was ruled as 'innovative company' by the Belgian government. Since 2017, X-RIS manages a collaboration project gathering 3 companies and 2 universities for the development of **Automatic Defector Recognition tools**.

The company has among his customers :

- **Safran Helicopter Engines** (5 Digital HD X-Ray system upgrades + viewers), **Safran Aero Boosters** (Fully Automatic Digital HD X-ray system piloted with a robot with a varifocus generator - 2018), **Safran Transmission System Poland** (Fully Automatic Digital HD X-ray system piloted with a robot for a microfocus generator – 2018), **Safran Nacelles** (Fully Automatic Real Time Digital HD Weld Inspection System of 6 x 6 x 7 m – 20 T), **Safran training center** at Villaroche, and : **Safran Aircraft Engines Guiyang** for a Dereo RAD 4040.
- **TOTAL** (the oil company) that has ordered to X-RIS 10 different digital Xray systems from 2013 till today. X-RIS is currently developing for TOTAL a CT system (3D X-ray). X-RIS also supplies British Petroleum.
- **Numerous casting companies** such as **MTU Aero (Munich)**, **CPP (Belgium and Slovakia)**, **Precimetal**, **Precicast**, **Fonderies Fallais**, **Settas**, ... ; ammunitions and guns manufacturers (Nexter, Thalès, FN, ...), and inspections companies (**TUV Nord**, **AIB Vinçotte**, ...).
- **FBI** (3 orders), several deminors squads (France, Slovakia, Libya, Belgium, Kosovo, ...), Fighters Jet maintenance (F-18 of the Australian army ; F-16 of the Belgian and Dutch armies), Composites manufacturers (Sonaca, MS Composites, Sobelcomp ...).

### X-RIS ( X-Ray Imaging Solutions )



PORTABLE  
NDT



PORTABLE  
SECURITY



STATIONARY  
SYSTEMS



SPECIAL  
SOLUTIONS

**User-friendliness in Digital Radiography**  
Pragmatism – close to the Application



See also : **Dxbox-320-6** : [https://www.youtube.com/watch?v=P6m\\_MWohS8](https://www.youtube.com/watch?v=P6m_MWohS8)

**Dxbox-μ150-R4** : <https://www.youtube.com/watch?v=sLO9cC9Oa34>

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## TECHNICAL SPECIFICATIONS

X-RIS solution is a revolutionary system using **radio-transparent support** so that X-ray parts can be inspected from any direction **without moving them**.

This principle is unique in the world and is particularly important for the applications where the complexity of the parts is such that they must be X-rayed **with different angles** to achieve the required performances.

Process

At the start of the process, the door of the cabin is opened and the support plate is positioned in front of it.

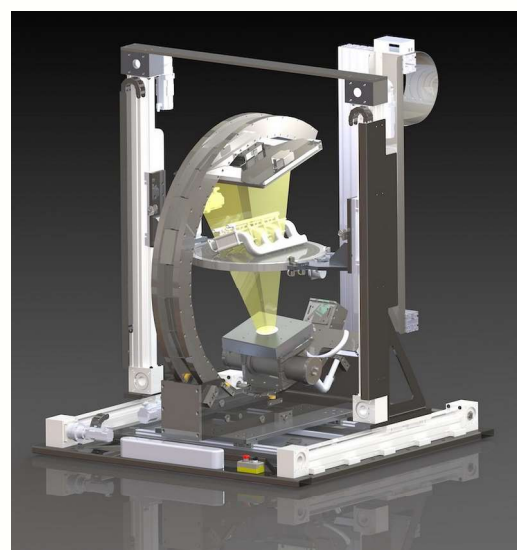
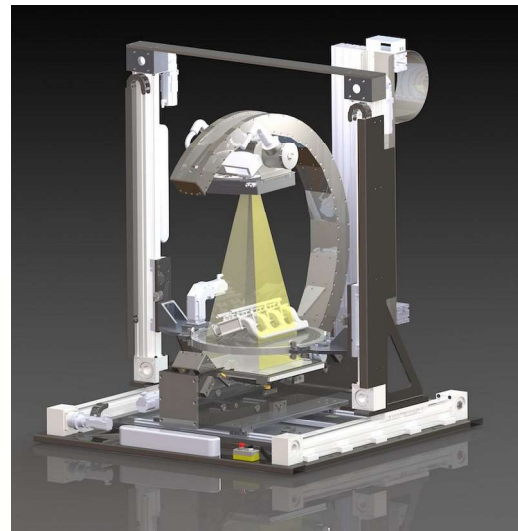
The parts can be displayed on the support according to their number. The active area of **65 cm** of diameter enables to use a maximum of parts ( such a huge surface is a unique feature ! )

As an option, rubber sheets indicating where to put the parts can be supplied for the localisation.

Once the parts are positioned, the operator just needs to launch the **recipes** ( sequence of shots ) and the inspection of all the parts will be automatically performed, under any angle, at the right kV and mA, and with the right filters (!). The pictures are automatically saved in the specified location under DICONDE format in keeping all the information in a unique file.

More, it is important to remind that the programming of the sequence of shot is extremely **user-friendly**... It is hidden-task performed by the level 3 when he determines the shots required for the inspection.

After the sequence of shots has been done (or even during it time is critical) **Maestro Viewer** can be use to review the parts.



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## 2. System components

### 2.1. X-ray generator

For parts up to 10 mm, a 225 kV generator may be enough for the application. Nevertheless, we follow the requirements and suggest

#### 320 kV X-ray generator from COMET with MXR-320/HP11

0.4 mm ( 700 W max )

1.0 mm ( 1500 W max )

This generator is a robust and proven technology. Several thousands have been installed around the world. A basic maintenance has to be done yearly and can be performed by end-user technicians.

It is oil cooled. The same oil could be used both for the TITAN (GE's brand) and the COMET generator given GE X-ray tubes are in fact Comet X-ray tubes manufactured for GE.



Bipolar design

Voltage : 100 – 320 kV

Focal spot ( IEC 12543 with 25% threshold )

0.40 mm ( 700 W ; 2.8 mA @ 250 kV )

1.00 mm ( 1800 W ; 7.2 mA @ 250 kV )

Target angle : 11°

Angle beam : 40° x 30°

Water cooling : 14 l/m

Output connectors : R24

Terminal type : R24

Weight : 40 kg

Size : L:55 cm x d:15 cm

## 2.2. Flat panel detector

**Dereo RAD 4040** : 40 x 40 cm - 200  $\mu\text{m}$  @Si – intrinsic D7 panel – GadOx scintillator DRZ standard – 1 fps

Note that Dereo RAD will be **HE-upgraded** ( HE = High Energy ) for this application so that it can hold the 320 kV shots.

X-ray DDA solution for film replacement  
in your **shielded cabinet**

**APPLICATIONS**

- Weldings on pipes and plates
- Al, Fe, Ti, inconel and other alloys, plastic casting defects such as porosities, shrinkages and inclusions ...
- Honey combs structures, composite materials (wrinkles, inclusions, ...)
- Historical assets
- Forensic investigations



**Dereo RAD**






**KEY FEATURES**

**Digital**

- Direct digital image on the computer screen [no manual process]
- User-friendly thanks to very **intuitive Maestro NDT** software
- Post-processing with real time filters
- DICOM, TIFF & JPG formats available
- Easy archiving & reporting
- Efficiency and profitability drastically increased

**Film -> digital radiology**

- Dereo RAD** is the easiest tool to work with in order to switch from traditional X-ray films to digital radiology inspection

**X-ray video**

- X-ray video (1 fpsscopy) for perfect and **rapid image adjustment** : No more headaches about the kV and mA calculation

**Image quality**

- Dereo RAD 4040** (200  $\mu\text{m}$ ) complies with ISO 17636-2
  - Class A from 3 to 12 mm Fe
  - Class B for thickness higher than 12 mm
- Dereo RAD 2530** (139  $\mu\text{m}$ ) complies with ISO 17636-2
  - Class A from 2 to 8 mm Fe
  - Class B for thickness higher than 8 mm
- !!! Image quality goes even **better** with mini and micro focal spots !!!
- Excellent signal to noise ratio (SNR) and contrast resolution better than 1% (EN 462-1)
  - 14 or 16 bit
  - Automatic and fast averaging
  - Different scintillator thickness available

**Quick set-up**

- Very easy set-up (plug & play) and use thanks to smart hard- and software features

**Compatible with any high energy sources**

- Electronics of **Dereo RAD** are very well shielded and protected from X-ray dose. Thanks to that, it works with any other kind of constant potential generator, gamma sources (Se, Ir, Co) as well as betatrons and linear accelerators. Synchronization is not needed. Delivery and installation is achieved very easily with existing generators at customer site.

**Reinforced casing**

- In order to prevent scratches and knocks on the flat panel, **X-RIS** designed a reinforced casing which contains the DDA, a mains power supply, tough connectors, as well as the necessary lead shielding.

**Dereo HE** ( HE = High Energy ) is designed to work in **heavy duty xray** environment.

It is delivered in a tough customized housing.

Dereo HE is specially dedicated to NDT and can withstand very high exposure.

Its design is very particular with a physical size wider than the active area. The electronic circuits and components more sensitive to the X-rays are located on the edges and can therefore be shielded.

Systems can withstand to a cumulated exposure > 1.000.000 Rad or 10.000 Gy.

In the current application, **calibration is the key point to achieve the image quality performances.**

**X-RIS** will provide the appropriate calibration process and tools.

After calibration, SNR often reaches values up to 1000 (on perfect steel plate to measure system performances and not the discontinuities on the surface of the samples).

Collimation and management of the scattered X-rays and potentially filtering is the 2<sup>nd</sup> criteria to achieve the highest end image quality. A dedicated motorized collimator can also be supplied as an option.

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### 2.3. **Maestro Software**

**X-RIS** has developed a HMI (Human-Machine Interface) particularly **user-friendly** and that makes his renown among end-users. The software offers the full range of tools to comply with the standards and to get the best image quality. **Maestro** manages pictures under DICOMDE forma and complies with Pr5250 (Safran). It was validated several times in the context of NADCAP certifications. Maestro interface is in English.

The software comprises different modules :

- Grabber : to interface different DDA (X-RIS made or from any other company, depending on the customers needs) ;
- Calibration : to perform calibration (dark, gain, bad pixels) depending on kV and thickness and efficient and fast way
- Viewer : to display, treat and annotate pictures with the following tools (among others) :
  - \* magnifier (which is different from other magnifiers): for an optimal local display and picture ;
  - \* **real time highly performing filters** ;
  - \* a « bad pixel map display » that allows to display in 1-click the bad pixels on the X-ray picture ;
  - \* ...
- Generator Control : to pilot the generator (kV, mA, focal spot, exposure time, ...) in the interface
- Electromechanical control : to control each axis independently
- Recipes : to register and launch sequences of shots automatically
- NDT Tools : to measure SNR, CNR, ... and perform the periodical check of the DDA ;

## 2.4. Additional components

### 2.4.1. Motorized collimator ( [option](#) )

One of the reason for the degradation of image quality is :

- the X-ray scattered by the environment
- the “blurring” of the panel due to the direct X-ray (X-ray sent to the panel without crossing any object)

Both these problems can be reduced in using a collimator that will add a lead blade to stop the direct X-ray. In doing so, the X-ray scattered by the environment are also reduced.

The collimator can also be used as an obturator, which makes the reheating much more easier.

### 2.4.2. Calibration plates ( [option](#) )

Digital X-ray flat panel requires 3 calibrations :

- dark (also named offset)
- pixel gain (also named flat)
- bad pixel

This is a key point to warranty image quality. Some specifications require multi-gain calibration particularly when there are simultaneously thin and thick zones in the parts. Maestro software was designed to perform this automatically.

X-RIS has also developed a very performing calibration process using “plates” of different thicknesses.

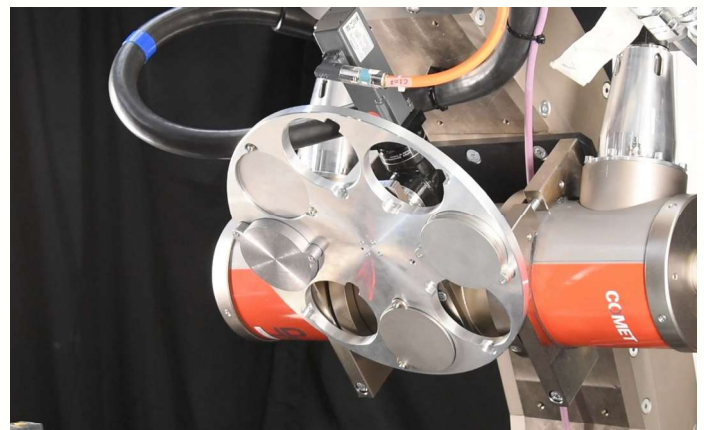
To get a maximum of image quality behind thick parts, a plate of the same thickness is used during the calibration.

### 2.4.3. Filters

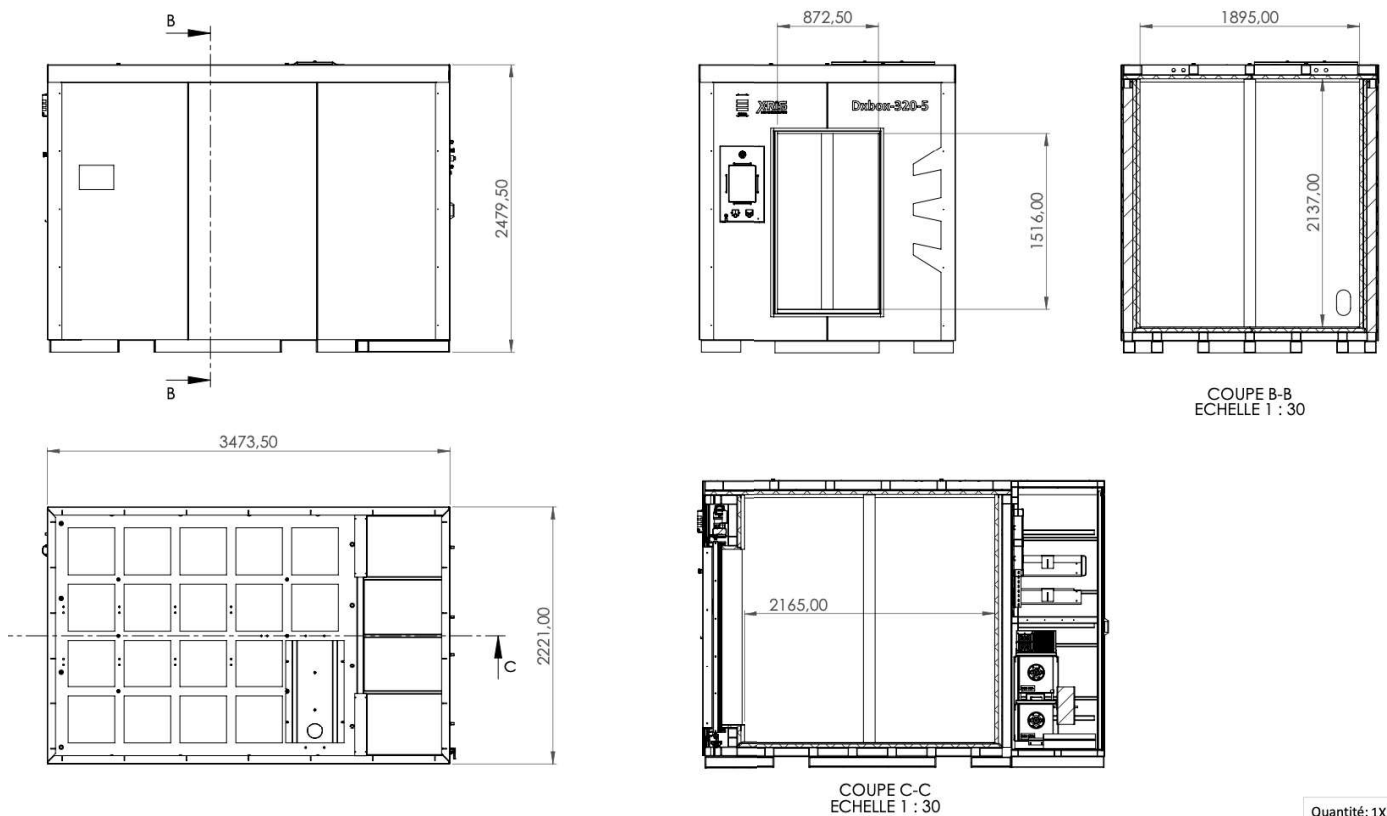
It is nearly impossible to X-ray simultaneously parts for which the thickness ratio is in a factor 10 (eg 2 and 20 mm), even if this has to be checked case by case.

A way used to counter this problem is to “filter” the beam with a plate of a given thickness (eg. 2 mm). That way instead of making X-ray simultaneously on 2 and 20 mm (ratio 10), it is done on  $2+2 = 4$  mm and  $20+2 = 22$  mm (ratio 5.5).

A turning disk controlled automatically by the Maestro places the right filtration according to the inspected part in order to offer the appropriate dynamic



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**2.5. Shielded X-ray cabinet**

- External dimensions: W:3474 x D:2221 x H:2480 mm
- Internal dimensions: W:2165 x D:1895 x H:2137 mm
- Front door dimensions: W:872 x H:1516 mm
- Weight around 14 tons
- Shielded for 320 kV – 800 W with  $< 1 \mu\text{Sv/h}$  at 10 cm from surface
- Maximum part weight : 50 kg

They comply with IEC 61010-2-091 for radioprotection.

## 2.6. Positioning system

**X-RIS** offers a revolutionary solution based on a radio-transparent support (disk) to position the parts to X-ray.

The motorized axes are the following ones :

- Radio-transparent support :
  - rotation around Z ( ROT\_Z )
  - translation along Z ( move Z )
  - translation along Y ( move Y )
- X-ray generator and C-Arm :
  - rotation around X ( ROT\_X )
  - translation along X ( move X )

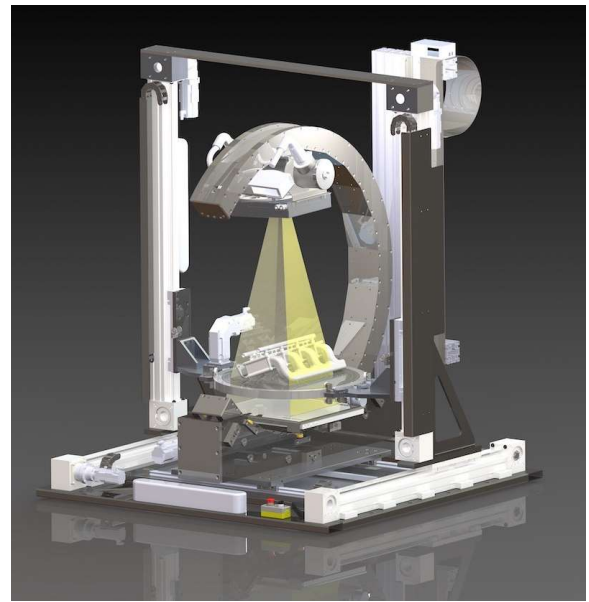
→ that way it is possible to x-ray parts from any angle and with the right magnification, without the intervention of the operator to move the part with the hands.

More, the risk to see the part drop is zero given it stays always horizontal.

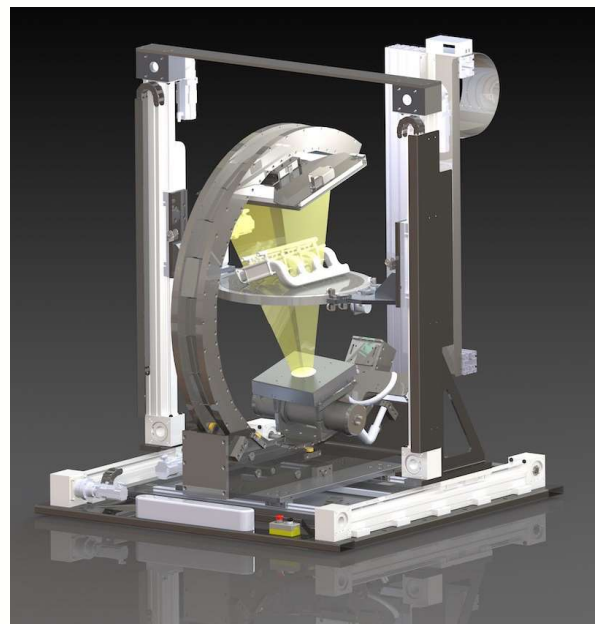
The radio-transparent plate can hold **50 kg**.

Its useful dimension is 65 cm diameter, ie more than the double of the surface of a traditional 40 x 40 DR system.

In option, rubber pad (as mouse pads) can be supplied to ease the appropriate positioning of the parts to inspect. Other radio-transparent support that could be entered and taken off the cabin can be designed and supplied. This would enable to prepare the parts 'outside' the cabinet when there are several ones.



vertical shot



move Z and rot X

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A touch screen is installed next to the door.  
Operator can easily manually control and move the system with the door open.

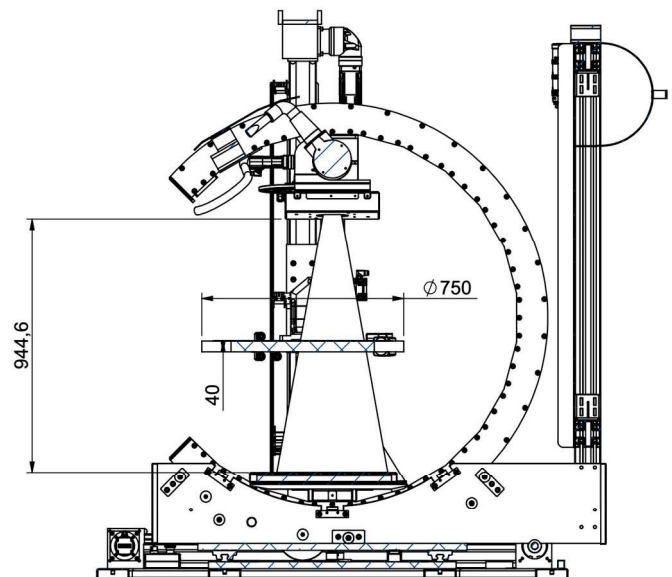
An invisible safety barrier prevent somebody to enter the system while its in motion.



Inside view from the front door

The radio-transparent plate has a diameter of 750 mm but available area is 650 mm diameter because of the guiding system.

The minimal distance between the tube and the detector is 944 mm (with collimator and filter options)



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### 2.6.1 Positioning system control

#### *Manual mode*

- a dedicated interface can be used to move any of the  $3 + 2 = 5$  axes
- digital cameras permit to visualize the movements and check against collision.
- kV, mA, exposure time, ... can be fixed immediately
- X-ray can be done and the image saved at the right place.

#### *Automatic mode*

- parts are positioned
- operator chooses the recipes ( this can be done through a bar code to enter a reference number )
- the system automatically follow the process :
  - radio-transparent support is entered
  - door closes
  - Systems goes to the 1<sup>st</sup> position
  - Xray is done and images is saved at the right place (decided in the recipes)
  - systems goes the the 2<sup>nd</sup> position,
  - ...
  - when all pictures are taken, door opens
  - radio-transparent support goes out

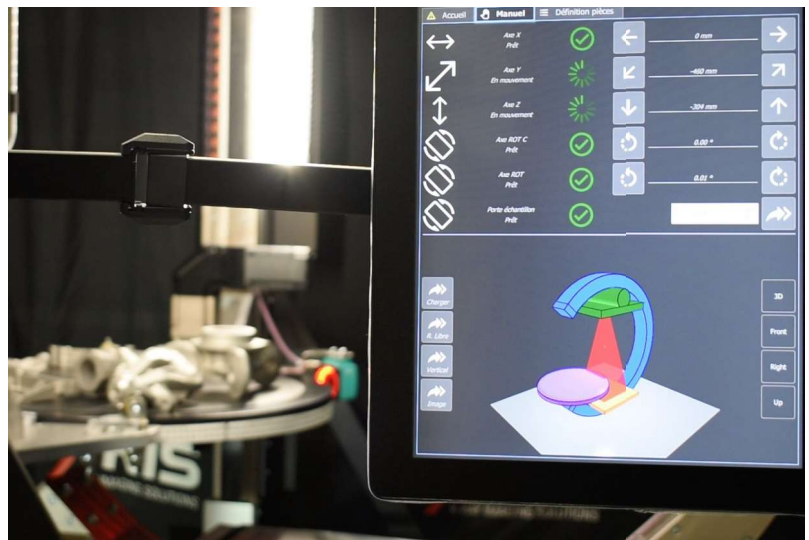
#### Return on Investment :

The automatisisation of the inspection process has a return on investment as long as several shots must be done. Given the radio-transparent plate has 2 times a wider surface than the panel it will be case automatically.

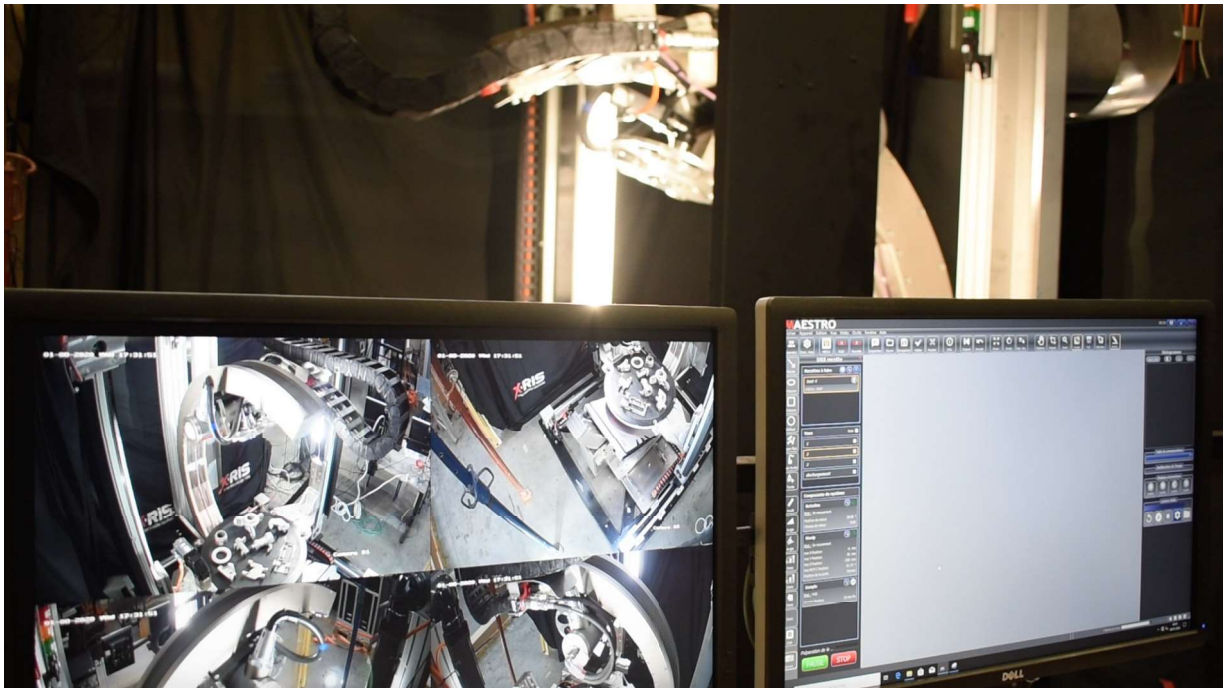
An intuitive HMI design offers a live 3D position feedback of the system.

The operator can visualize the current position and control each axis independently.

**An anti-collision monitoring is performed in realtime.**



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Live camera feedback from inside the shielded cabinet on left screen. Right screen displays the X-RAY image and controls the automatic recipe.



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