BASIC PRINCIPLES TO PROTECT YOURSELF FROM RADIATIONS IN THE CATHLAB



CATHPAX
A LEMER PAX GROUP COMPANY



Although the benefits of catheter-guided procedures for patient outcomes are unquestionable, the X-rays used during these interventions also concern the operator.[1] While considerable attention is devoted to minimizing patient exposure, the occupational impact of radiation dose on medical professionals should not be overlooked. **Each intervention exposes operators to a relatively small dose, yet these doses accumulate over procedures, and this cumulative nature deserves closer attention.**

Scientific literature has associated long-term occupational radiation exposure with several health hazards among interventional staff, including deterministic and stochastic risks or mulsculoskeletal disorders.

To limit radiation exposure, the ALARA principle (As Low As Reasonably Achievable) was originally developed with patient protection in mind. However, its application also benefits medical personnel, as measures taken to reduce patient dose often lower operator exposure in turn.

International and national authorities, such as the International Commission on Radiological Protection (ICRP), continue to work toward reducing the maximum dose received by medical personnel, and limits are regularly lowered as scientific understanding of radiation effects improves. For instance, the equivalent dose limit for the eye lens has been lowered from 150 mSv to 20 mSv to prevent cataract development.[13] However, personal dosimeters are frequently worn incorrectly or not worn at all, meaning that recorded values are often non-representative and lower than the actual doses received by cathlab workers.

Operators, however, no longer have to endure the physical burden of lead aprons as an inherent part of the job. With adequate radiation protection systems, it is now possible to work lead-free while enhancing radiation safety, reducing both radiation exposure and the musculoskeletal risks historically associated with personal shielding equipment.

Medical professionals should not have to compromise their long-term health as a routine cost of practice. Concrete measures must be implemented to ensure the safety of all interventional staff.



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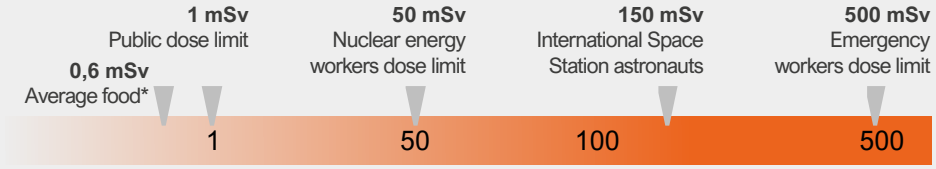
X-RAY EXPOSURE OF CATHLAB WORKERS

THE LEGEND OF THE ZERO DOSE IN RADIATION

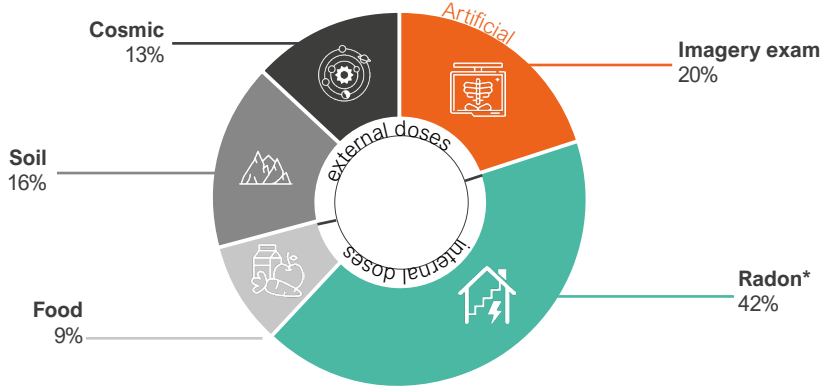
NATURAL DOSE

Radiation has always been present all around us. Every day, we are exposed to natural background radiation, with dose rates varying according to altitude, soil composition and even dietary intake. These doses accumulate over time, forming an individual's annual dose.

ANNUAL RADIATION DOSE EXAMPLES[3,4]



* Due to incorporation of naturally occuring radionuclides (French adult population)



Worlwide distribution of radiation exposure

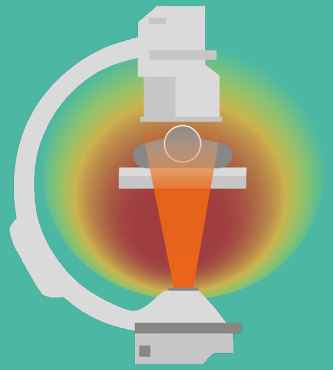
*Radon is a radioactive inert gas produced from the decay of uranium and is classified as a Group I human carcinogen, with direct evidence linking it to lung cancer risk.

CATHLAB DOSE

In interventional medicine, occupational exposure adds another layer: the primary beam generated by X-ray tube, and scattered radiation spreading out the patient's body in all directions. Each additionnal dose increment contributes to the individual's annual dose.

The main source of operator exposure is scattered radiation. Dose rate vary according to procedure type and the thickness of the patient's body being imaged. For example, neuroradiology procedures capturing skull generate less scattered radiation than interventional cardiology procedures capturing upper abdomen due to differences in tissue density.

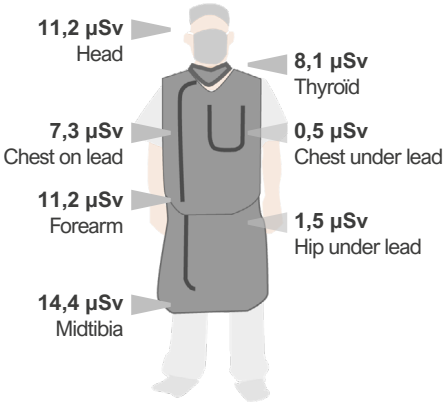
WHAT TO PROTECT FROM



Primary Beam: primary source of radiation exposure. Physicians and medical staff are not exposed to Primary Beam, unless their hands or body parts are directly placed in its area.

Scattered X-ray: radiation coming from patient body that spreads in all directions, making it the largest source of radiation exposure for medical staff.

Over the past 50 years, great attention has been paid to minimizing patient exposure, allowing for a growing number of procedures to be performed. Yet, operator exposure has not received the same level of consideration. Even today, most interventionalists protect themselves with individual equipment that have not much evolved (lead aprons, lead glasses, lead caps, etc.), offering radiation protection only in a heterogeneous way.



Mean doses per procedures
NOVARAD multicenter study results

MAIN PRINCIPLE TO PROTECT YOURSELF

THE RULES FOR MASTERING RADIATION PROTECTION

EFFECTIVE DOSE

The energy absorbed from exposure to radiation is called a dose. Radiation dose quantities are described in three ways: absorbed, equivalent, and effective.

Effective dose is the whole body indicator to express radiation sensitivities by organ. For example, bone marrow is much more radiosensitive than muscle or nerve tissue, due to cellular division.
To obtain an indication of how exposure can affect overall health, the equivalent dose is multiplied by a tissue weighting factor (w_T) related to the risk for a particular tissue or organ.

The result is the effective dose. The unit used for effective dose is the sievert.

ALARA

ALARA "As Low As Reasonably Achievable" is the main principle to reduce your radiation exposure. It states that whenever radiation has to be applied, exposure should be as low as reasonably achievable while still maintaining a suitable image quality for diagnosis or treatment.

This principle has been introduced in 1977 to evaluate the balance between risks and benefits by the International Commission on Radiological Protection (ICRP).
At first thinking for the patient, it also impacts physicians, by reducing the primary beam and so scattered radiation.

LEAD APRON'S WEIGHT in kg

	0.50mm lead eq.	0,35mm lead eq.	0,25mm lead eq.
Lead jacket (medium size)	5.07	3,55	2,45
Lead skirt (medium size)	4.47	3,13	2,24
Total	9.54	6,68	4,77



ALARA+

Recently, a meeting gathering different societies and industry representatives in the radiation protection field in interventional cardiology during the SCAI 2025 congress claimed for a call to action to change the ALARA principle into an ALARA + principle « as low and as light as reasonably achievable » promoting the implementation of collective radiation protection technologies and better imaging systems.

The focus of discussion was on the dual dangers of both ionizing radiation and the musculoskeletal injuries associated with current-generation protection equipment.[1]

THE THREE FUNDAMENTAL RULES

Distance is the operator's most powerful ally, as radiation intensity decreases with the square of the distance from the source. Meaning that even a small step back from the X-ray tube can produce a substantial reduction.
Time refers to minimizing the duration of exposure itself: the shorter the fluoroscopy time, the lower the cumulative dose received by the operator.
Shielding forms the third pillar, physically attenuating radiation before it reaches the operator's body.



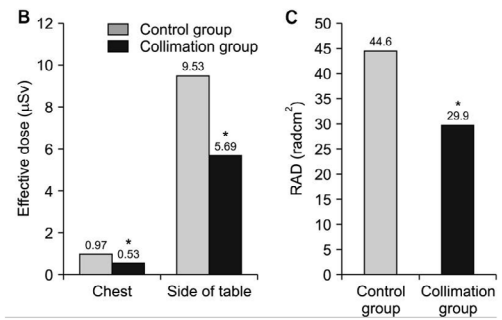
TIPS AND TRICKS FOR RADIATION PROTECTION

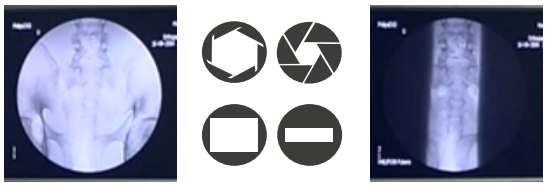
PUTTING THE RULES INTO PRACTICE

MECHANICAL ELEMENTS

COLLIMATION AND CENTERING

Collimation is a simple method to reduce significantly the radiation exposure. This consists in reducing the radiographic area without changing the radiographic mode as observed below.





A study compared the radiation exposure using the general imaging method and using collimation. Results show that when the imaging area was reduced by 33%, the absorbed dose decreased by 40.3%, the effective dose measured on the table decreased by 41%, and the effective dose measured outside the chest of the operator decreased by 46% (see figure above).[11]

The radiation exposure can also be consistently reduced during the procedure by placing the target lesion in the center of the field of view. This will minimize the need to reposition the patient under fluoroscopy.

FLUOROSCOPY MODE AND TIME ON PEDAL

Basically, fluoroscopy use should be minimized by avoiding pressing the fluoroscopy pedal when not looking at the image.

Limit the use of cineangiography. It has been demonstrated in the literature that the radiation dose by image acquisition through cineangiography is higher than during fluoroscopy.[7]

Optimise "Pulse Mode" for fluoroscopy reducing radiation absorbed dose by 32%[10] and minimize the rate to 7.5 frames/sec.
By choosing the pulsed mode, the radiation exposure will be lower by reducing the irradiation time.[9] As lower as the number of frames will be, the radiation exposure reduction will be higher as observed in the table below.[8]

Research shows that average dose savings of 22%, 38%, and 49% are found for the pulsed mode at 15, 10, and 7.5 frames, respectively.

Today, thanks to improved image reconstruction techniques, the dose can be reduced while maintaining the same image quality.[7]

LOW DOSE MODE

Thanks to the low-dose mode, you will be able to capture images in the same frame but the radiation exposure will be reduced.

This needs to be considered as a reasonable balance between image quality and radiation exposure :

- Low dose : running a guide
- High dose : device placement

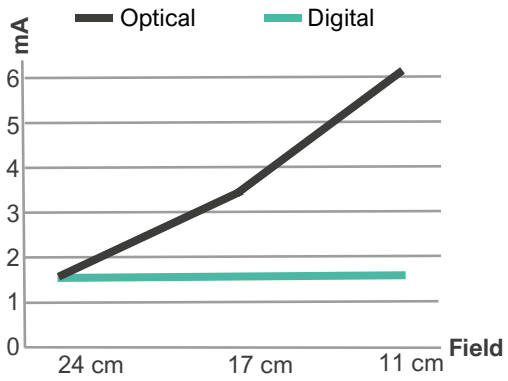
Globally, a study demonstrated that the low dose mode resulted in a 57% reduction.[10]

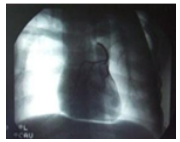
PULSE MODE CONFIGURATION

Configuration	Reduction of radiation exposure
15 frames/sec	-22%
10 frames/sec	-38%
7.5 frames/sec	-49%

LIVE ZOOM

Live zoom is another efficient method for reducing radiation exposure.[12] Mechanical zoom is the fluoroscopic equivalent of optical zoom performed during X-ray shoot. It switches to a smaller field of view, and increases dose rate to maintain image quality. Software-based live zoom works differently, after X-ray shoot. It acts as a digital zoom, reconstructing and magnifying the already-acquired image without changing the X-ray field or the dose delivered to the patient. This gives operators a magnified view for precise visualization, without the dose penalty of conventional optical zoom.





24cm
Dose x1

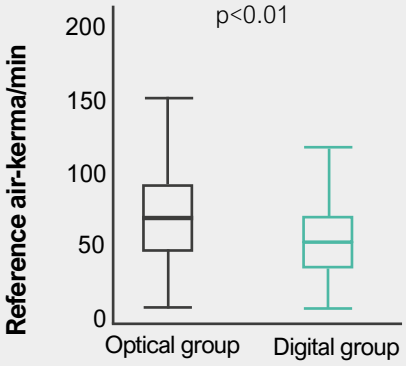


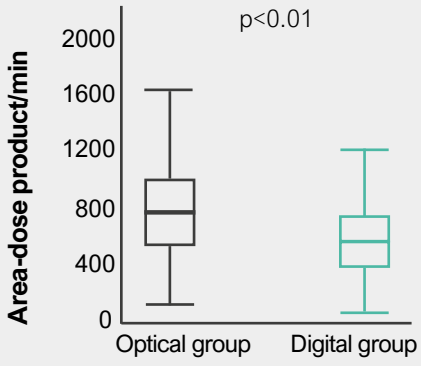
17cm
Dose x2



11cm
Dose x5

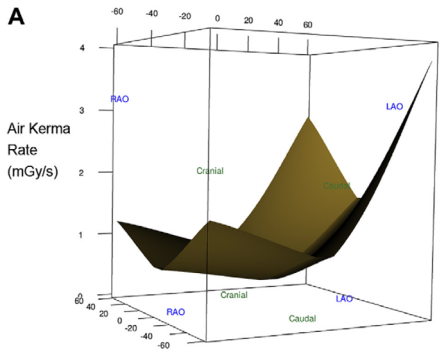
REFERENCE AIR KERMA AND AREA-DOSE PRODUCT



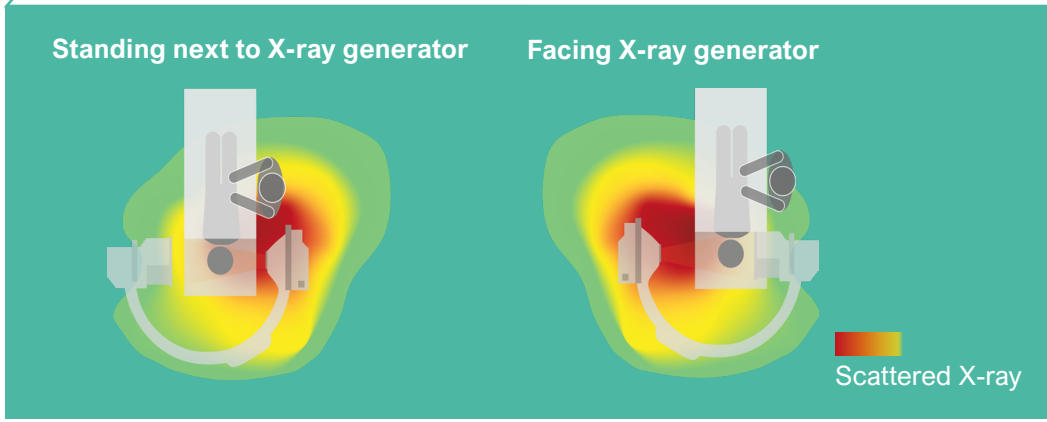


C-ARM ANGULATION

C-arm angulation also plays a significant role in operator exposure. If possible, extreme angulations should be avoided or limited, as they drastically increase operator exposure due to their proximity to the primary beam. Among these, the left anterior oblique (LAO) projection generates the highest exposure for the operator.[5,7]



SECONDE C-ARM ANGULATION



OPERATOR ELEMENTS

TIME

Basically, the time variable involves optimizing the efficiency of the procedure to avoid any increase in radiation exposure for both the patient and the medical staff.

It is commonly observed that a more experimented physician will complete a procedure using less fluoroscopy, leading to a lower level of radiations for the same procedure.

It is also observed that interventionalists will get higher radiations than fellows by managing more complex cases, but interestingly, when correcting for the complexity of the procedure, by comparing the relative operator exposure (E/DAP), fellows were exposed to a higher relative exposure compared with experimented interventionalists.[2]

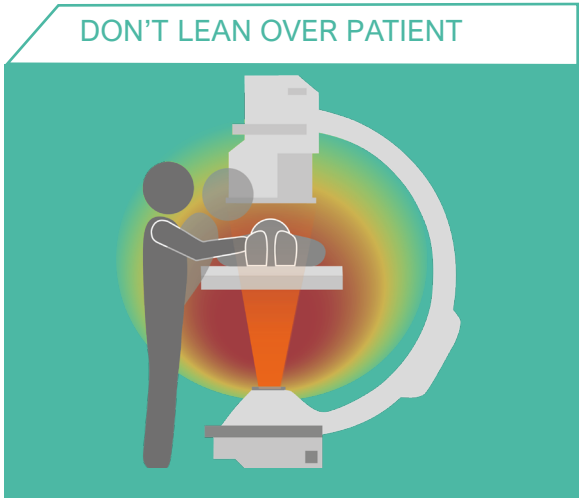
DISTANCE

Exposure decreases exponentially with each step away from the source. When the distance is doubled, the primary beam exposure is reduced by a factor of four. It concretely means that by stepping away by only meter you will receive 1/4 of the dose. This also works for scattered radiation.

A study demonstrated that a distance from the table of only 20 cm reduced scattered radiation by 73%.[3]

Avoid leaning over the patient, especially when making contrast injection to stay as far away as possible from the source of exposure.

DON'T LEAN OVER PATIENT



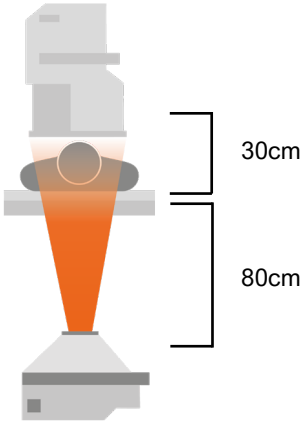
PATIENT-DETECTOR DISTANCE

Another recommendation to decrease exposure to the operator is to optimize the table height, the distance of the image detector to the patient, and operator position.
Minimizing the distance between the image detector and the patient (low subject–image distance) and maximizing the table height from the x-ray tube (see figure below), that is to say that the X-ray generator needs to be as far away from the patient as possible and the detector needs to be as close as possible to the patient.[6]

KEEP YOUR DISTANCE

Exit the cathlab if possible as controled images generate a lot of radiations coming from the tube and consequently from the patient.

Manifold extension tubing or an auto-injector system (e.g. ACIST, MedRad, etc.) should be used.



PERSONAL SHIELDING

Personal protective equipment is available in various lead equivalences, typically ranging from 0.25 mm to 0.5 mm, and includes lead aprons, radiation-absorbent surgical caps, and lead glasses designed to shield sensitive organs. While effective in principle, this equipment protects the operator heterogeneously, leaving certain body regions directly exposed to scattered radiation.

Furthermore, the weight of lead aprons places sustained mechanical strain on the cervical spine and lumbar region, and prolonged use has been associated with a higher prevalence of musculoskeletal disorders.

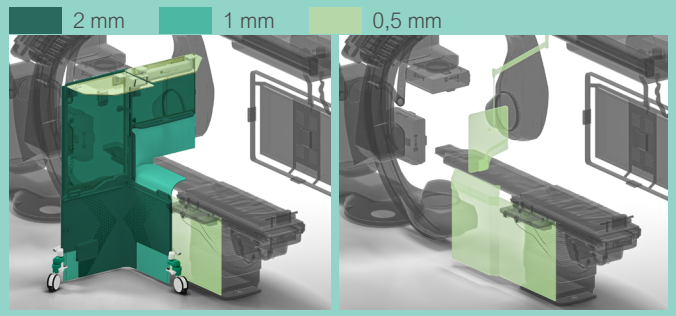
COLLECTIVE SHIELDING

Collective shielding systems offer a fundamentally different approach to radiation safety in the cathlab. Rather than relying on individually worn devices that leave gaps in coverage, collective shielding provides homogeneous protection from head to toe.

Nova-X® is the only radiation protection system, available on market, that offers a 2mm lead equivalence. Enhancing safety and removing the physical burden imposed by lead aprons, it reduces deterministic* and stochastic risks and also muscolosketal disorders by making lead-free procedures a reality.**

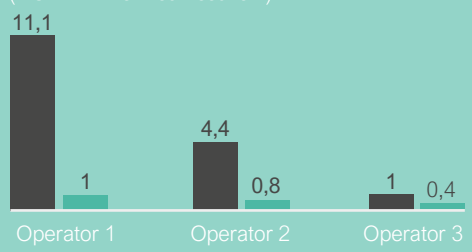
NOVA-X® : THE ULTIMATE RADIATION PROTECTION

1. The only **2mm lead equivalence system available on the market**



2. **Full-body** and **team-wide** protection

Global body dose* per operator (in µSv)
(NOVARAD clinical results**)



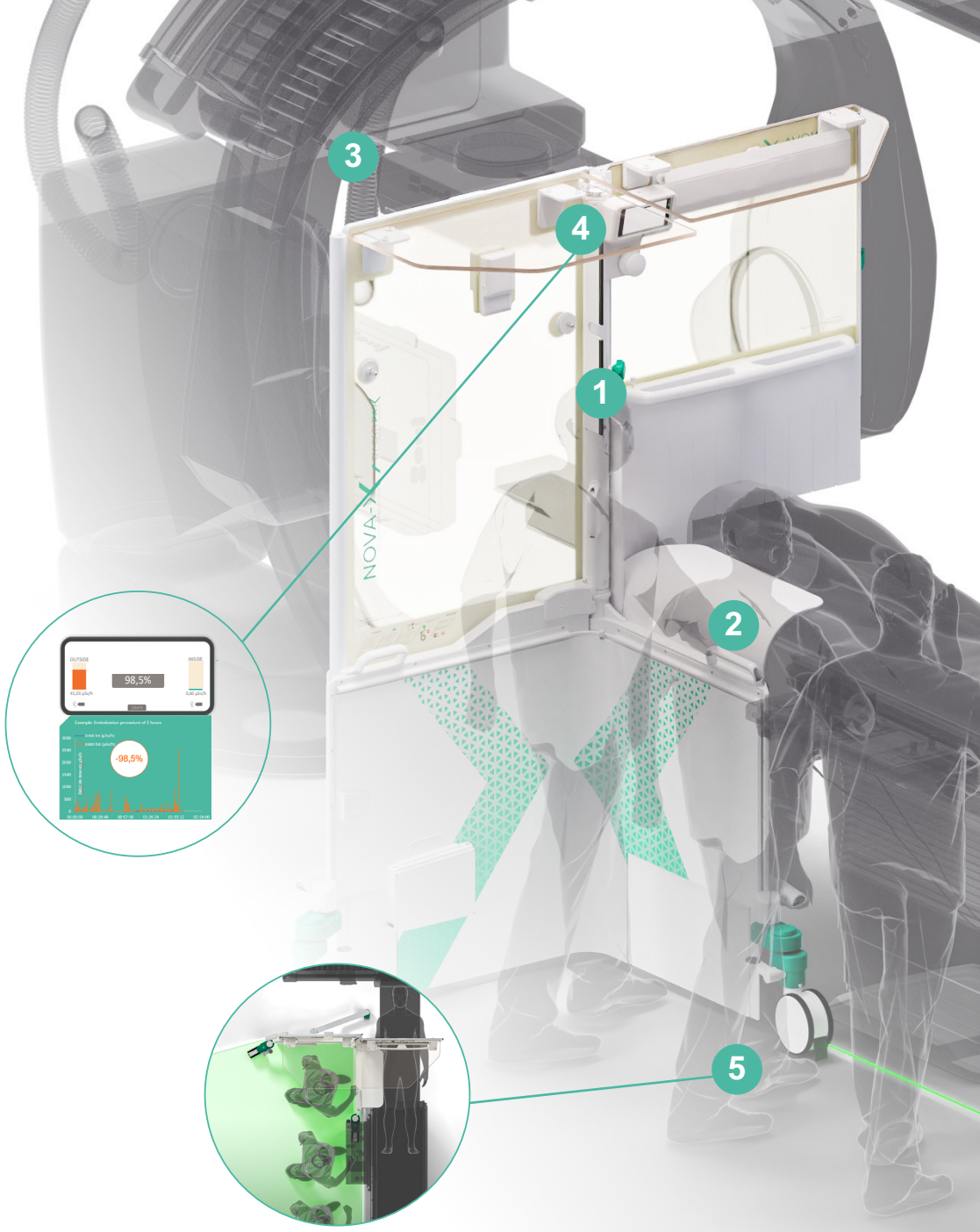
Without Nova-X®
With Nova-X®

* Arithmetic mean of the doses received by the operator on lead apron (head, thyroid, forearm, chest, hip, midtibia)
** Multicentric study, scheduled for publication in Q4 2026

3. **Full bi-plane** and **single-plane** compatibility

4. **Real-time dose rate reduction display** (Dosicath®)

5. **Controlled radiation protection zone** figured on the floor with lasers (Laserguard®)



* Deterministic effect : health effect, which is directly related to the absorbed radiation dose and the severity of the effect increases as the dose increases.
** Stochastic effect : effect of ionizing radiation on the human body that occurs by chance, usually without a dose threshold. the probability of occurrence of stochastic effects is proportional to the dose, but the severity of the effect is independent of the dose received.

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ABOUT CATHPAX

About CathPax, a Lemer Pax group company

Founded in 2024, Cathpax designs, develops and commercialises innovative, full-body, team-wide radiation protection systems for cath lab staff during interventional procedures. Spin-off of the Lemer Pax group, the company leverages more than 50 years of innovation in the radiation protection field. A pioneer in ionising radiation protection since the 1970s, Lemer Pax spent the past two decades developing groundbreaking innovations to advance its mission of Protecting Life® over the last two decades. The group has created cutting-edge radiation protection materials and technologies used in thousands of products worldwide. Today, Lemer Pax covers three major areas of expertise through three different entities: Lemer Pax (Civilian nuclear sector, radiopharmacy, nuclear medicine and radiology), GMP (therapy radioisotope production) and Cathpax (interventional medicine).

Developed over more than 10 years of research & development, Nova-X® is Cathpax's second-generation radiation protection system. Protected by more than 10 patents, Nova-X® is currently the only available solution on the market providing 2 mm lead equivalence*. The system features a unique dose monitoring system displaying real-time dose rate reduction (Dosicath®). Nova-X® also boasts a built-in laser system that projects two green laser beams onto the floor, clearly marking out a controlled zone for Healthcare providers (Laserguard®). Thanks to all these unique features, Nova-X® drastically improves cath lab staff safety and comfort, promoting stress-free working conditions through efficient full-body and team-wide protection against radiation injuries, ultimately benefiting the patient.
Based in Nantes, France, Cathpax aims to become the world leader in full-body, team-wide radiation protection in interventional medicine in the coming years.

**based on a competitive analysis on similar devices and conventional actual shieldings in the cathlab (lead-aprons, suspended shielding, lower table shielding). 2 mm lead eq. on 70% of the surface of the product.*

Nova-X® is a Class I medical device.
The Nova-X® consumable kit is a Class Is medical device.
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MKT_White Paper Best practices in radiation protection_09SEPT2026_EN

CATHPAX, A LEMER PAX GROUP COMPANY
14, Avenue de Syrma I 44470 CARQUEFOU
I France
+33 (02)2 402 524 04
contact@cathpax.com

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