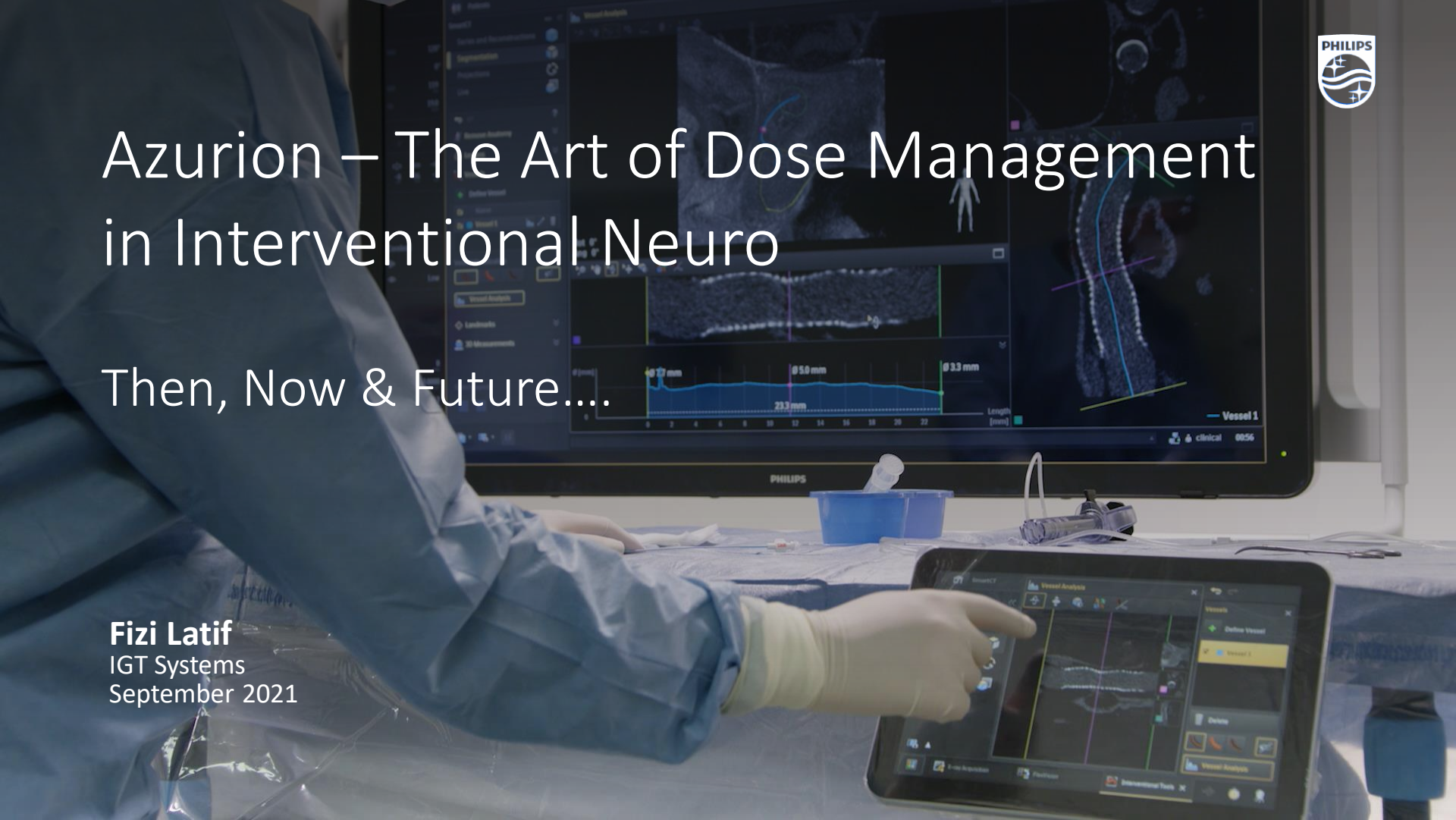


Azurion – The Art of Dose Management in Interventional Neuro

Then, Now & Future….

Fizi Latif
IGT Systems
September 2021

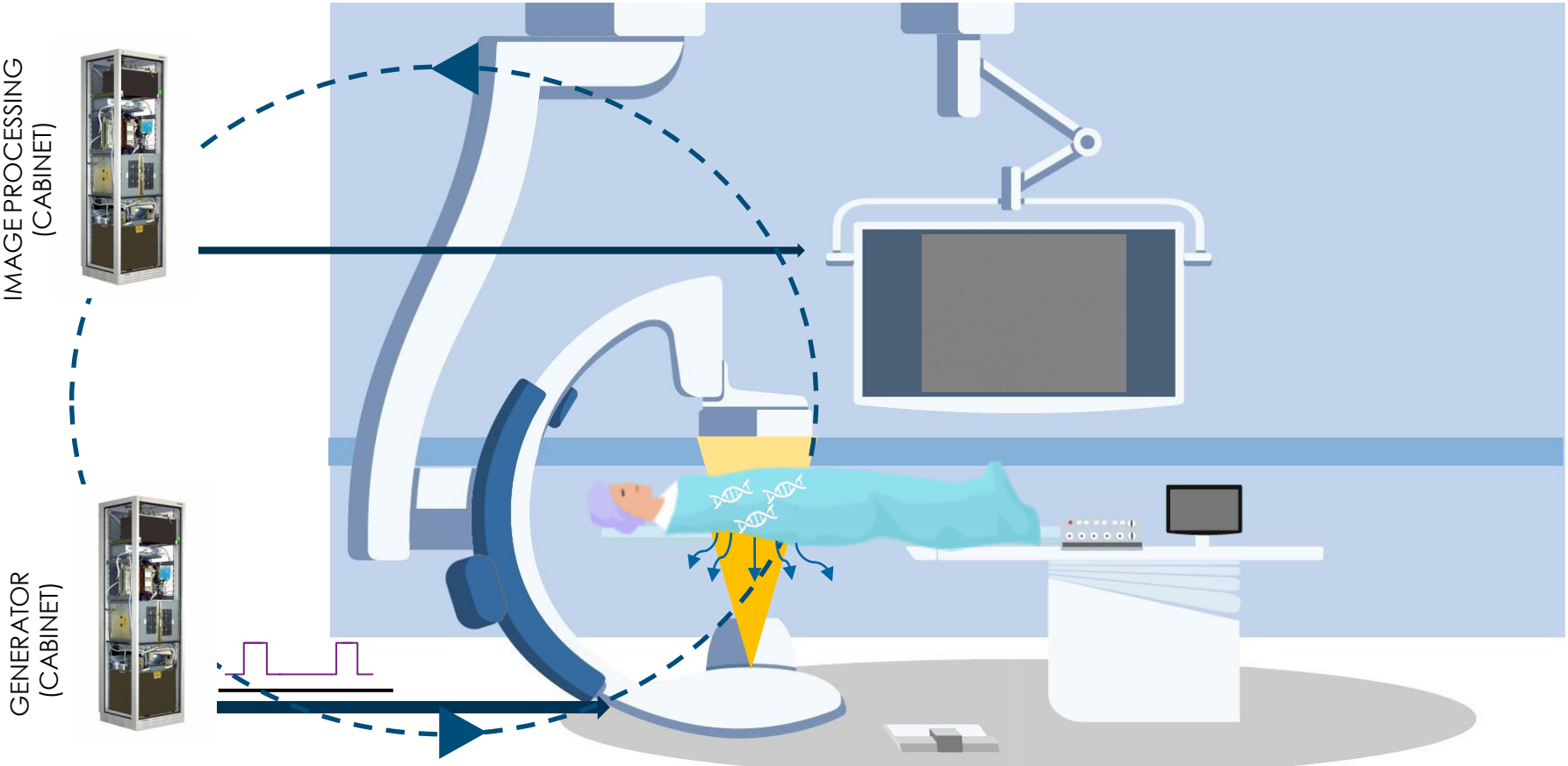
PHILIPS

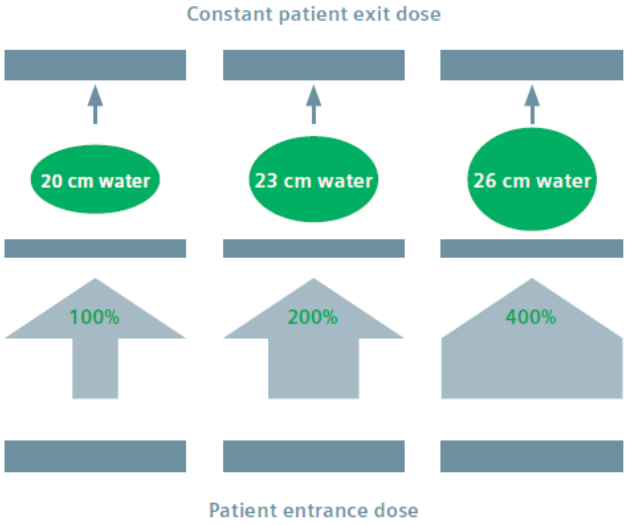
www.philips.com

THE FUNDAMENTALS……

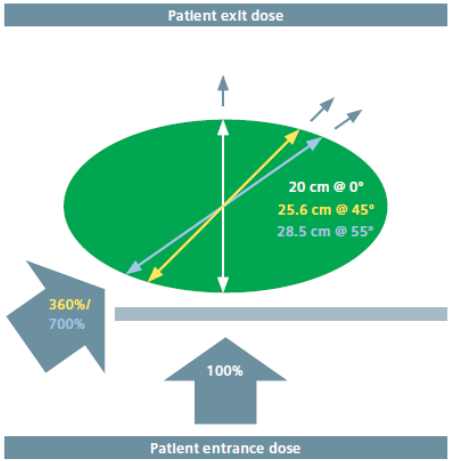
innovation you

TYPICAL ANGIOGRAPHY ROOM AND SYSTEM BEHAVIOR

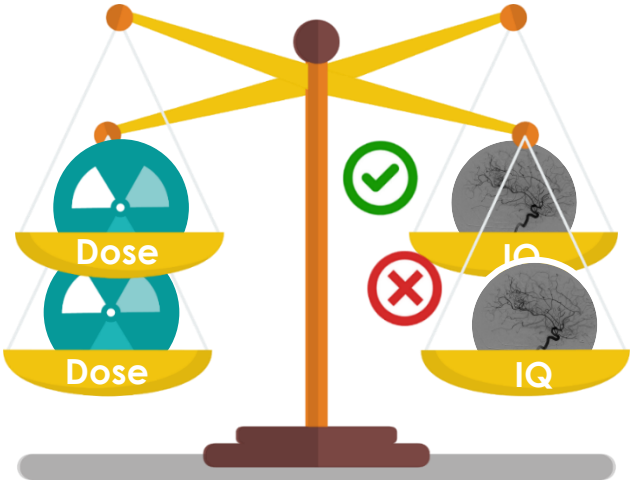




Dose depends on patient thickness



Patent thickness also changes depending on the system projection

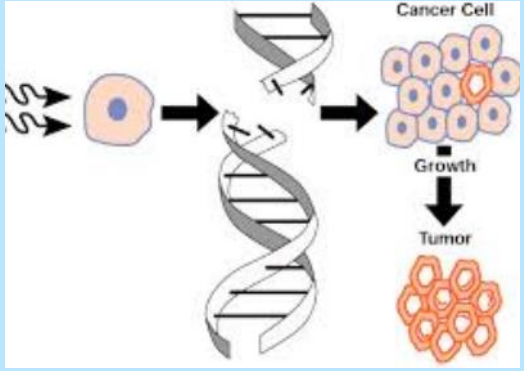


Why we care about dose?

PATIENT

SKIN BURN

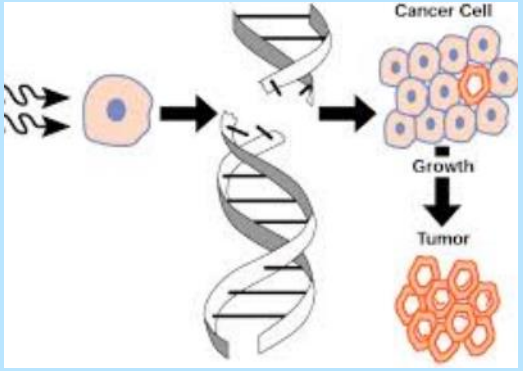
CANCER



STAFF

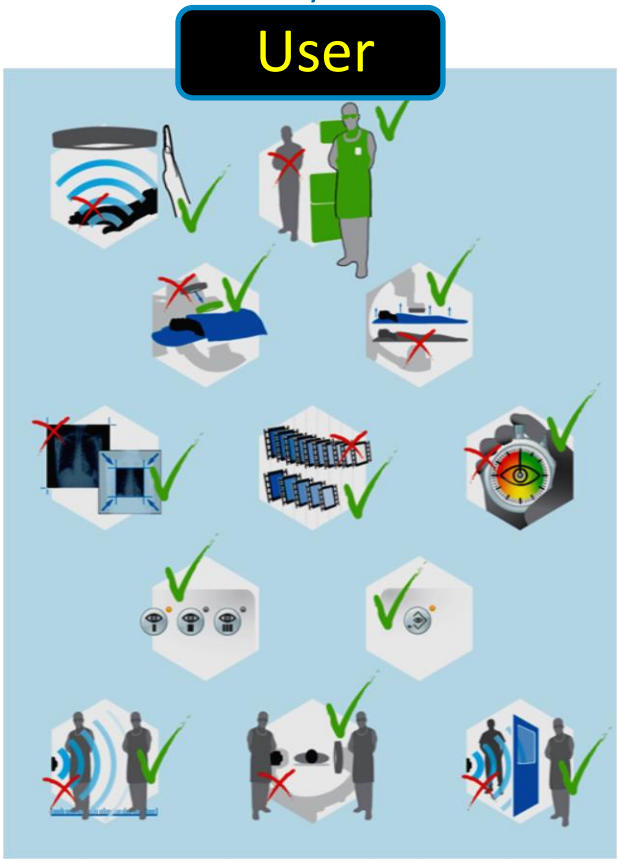
CATARACTS

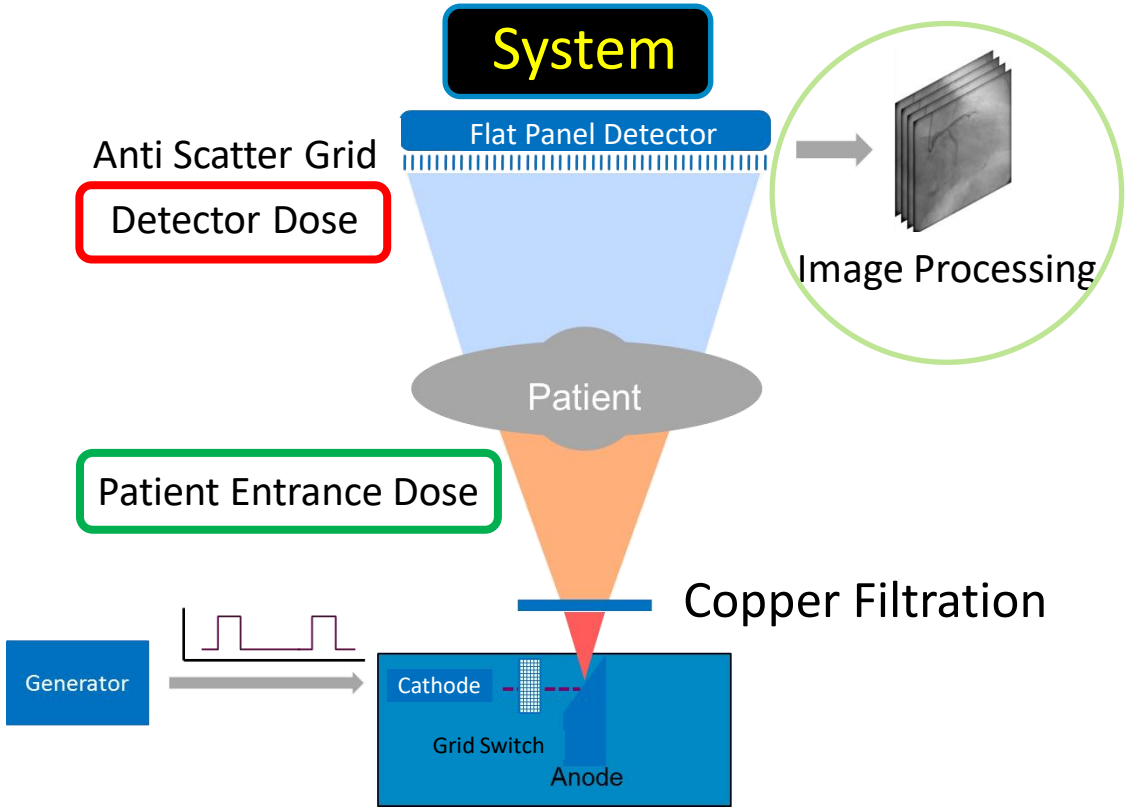
CANCER



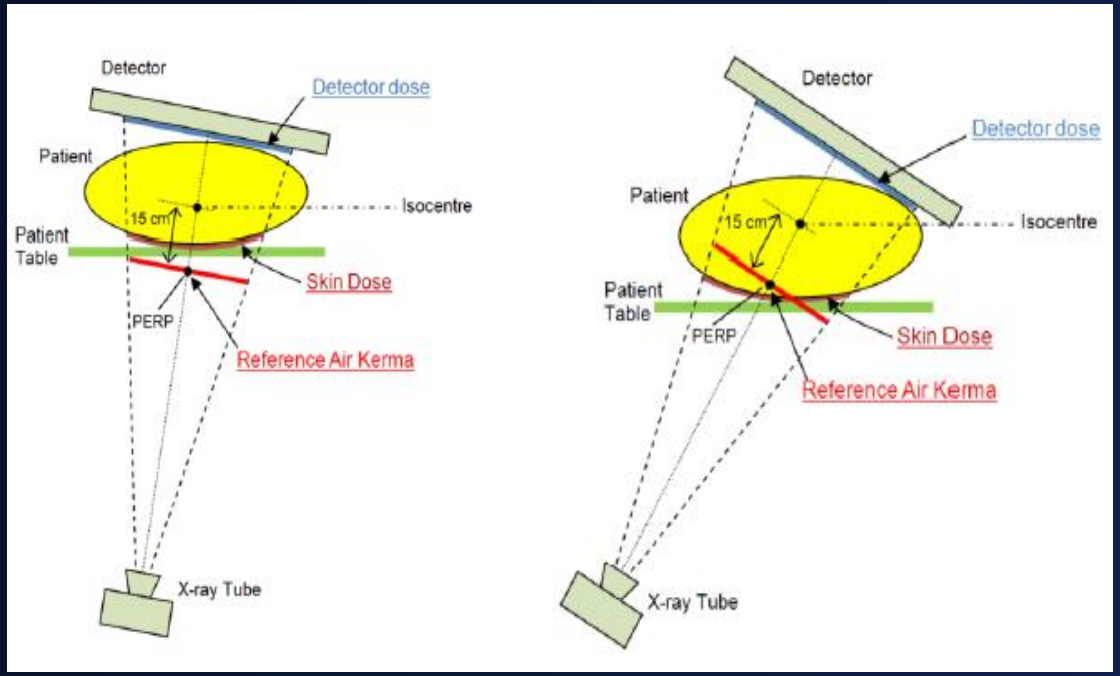
Dose Reduction at Angiography Systems

Behavior vs. System

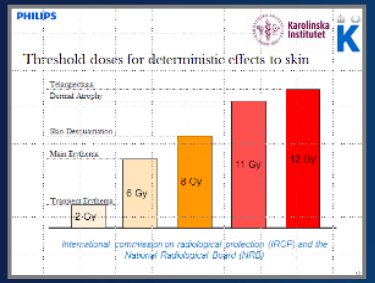




AirKerma [Gy]: *representation of the skin entrance dose at the PERP*[1]



[1] Patient Entrance Reference Point is an approximation for the location of the patient's skin (see IEC 60601-1-3:2008, 3.43 and IEC 60601-2-43:2010, 203.5.2.4.5.101d) ; It is located on the central axis of the X-ray beam, 15 cm from the isocenter, towards the focal spot. Depending on the patient's size, the table height and the direction of the X-ray beam, the PERP may be outside the patient (as in the left figure), may coincide with the skin surface, or may be inside the patient (as in the right figure).



Representation of skin effects.
There are thresholds below which NO changes occur.

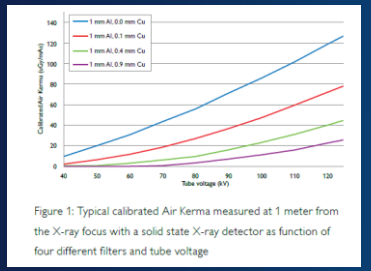
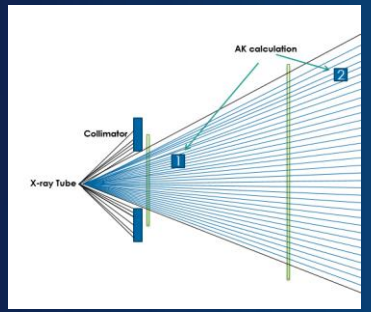


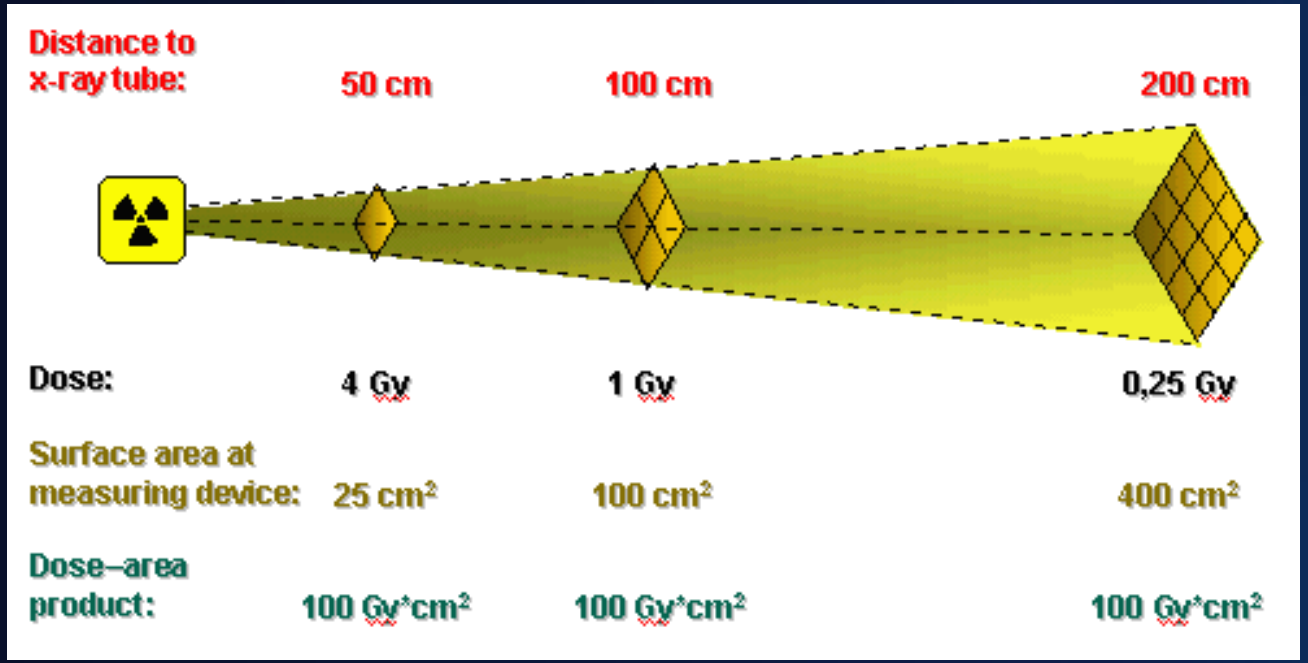
Figure 1: Typical calibrated Air Kerma measured at 1 meter from the X-ray focus with a solid state X-ray detector as function of four different filters and tube voltage

AK is calculated
(based on a system calibration function of kV and pre-filters)



AK is higher closer to the tube
(Ak1 >> Ak2)

DAP [mGy.cm2]: The product of the area of a cross-section of an X-ray beam and the averaged Air Kerma over that cross-section



Representation of the stochastic effects.
There are NO thresholds.

DAP (previously measured) is calculated from Rel 8
DAP meter (Wellhöfer KermaX ionization chamber) remains an optional item

DAP is not affected by tube distance

[1] (see IEC 60601-2-54:2009, 201.3.203 and IEC 60601-2-43:2010, 203.6.4.5). DAP is independent of the distance to the focal spot.

Legacy of leadership in Philips Image Guided Therapy

2000 Integris Allura Family
Advanced CCD imaging

2003 Allura Family
Market leader in FD imaging

2013 AlluraClarity
Dose and image quality optimization

2017 **Azurion Family**
Enhanced imaging and efficiency solutions optimized for a new healthcare environment

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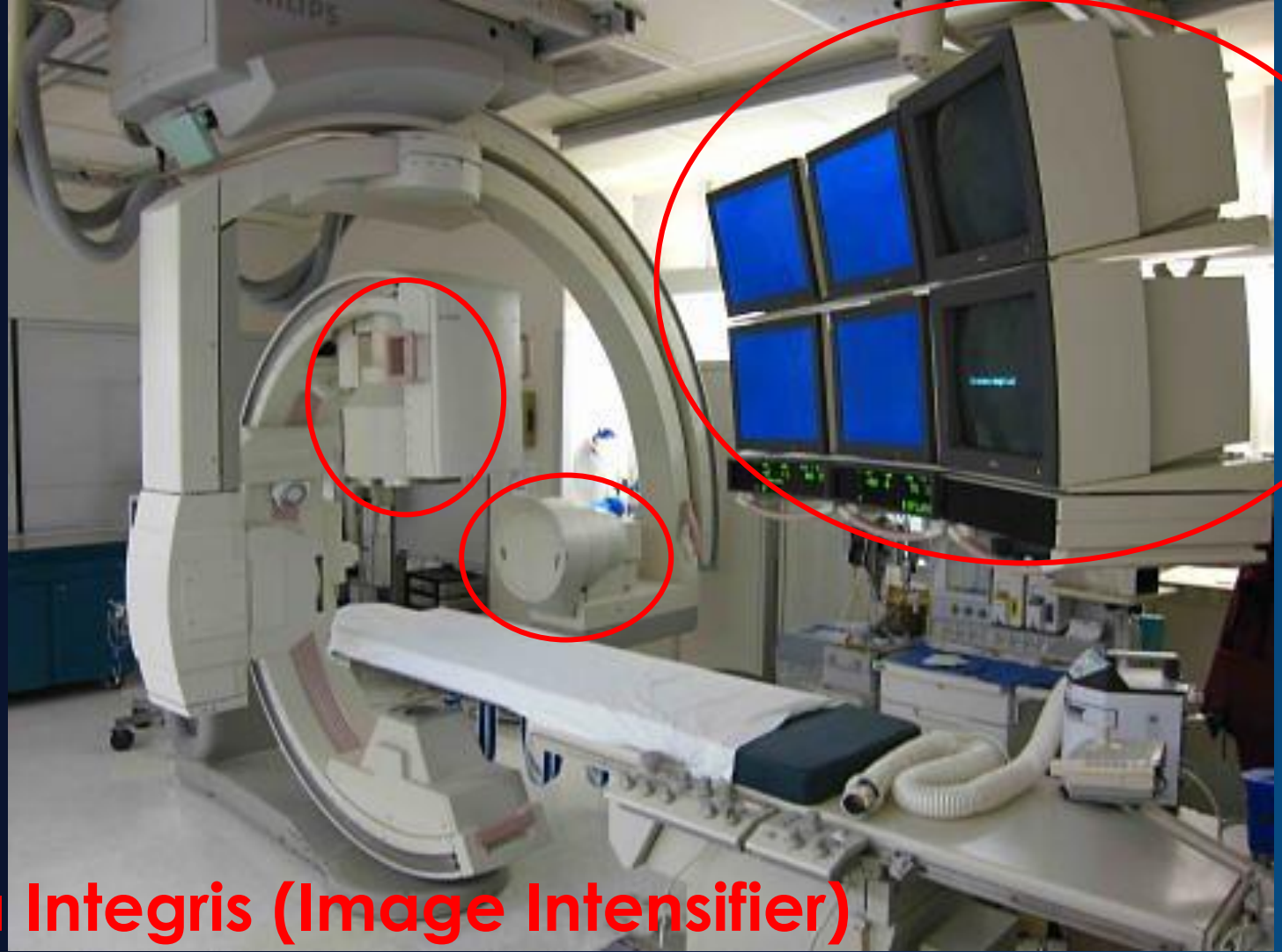
THEN.....

innovation you



Allura Integris (Image Intensifier)

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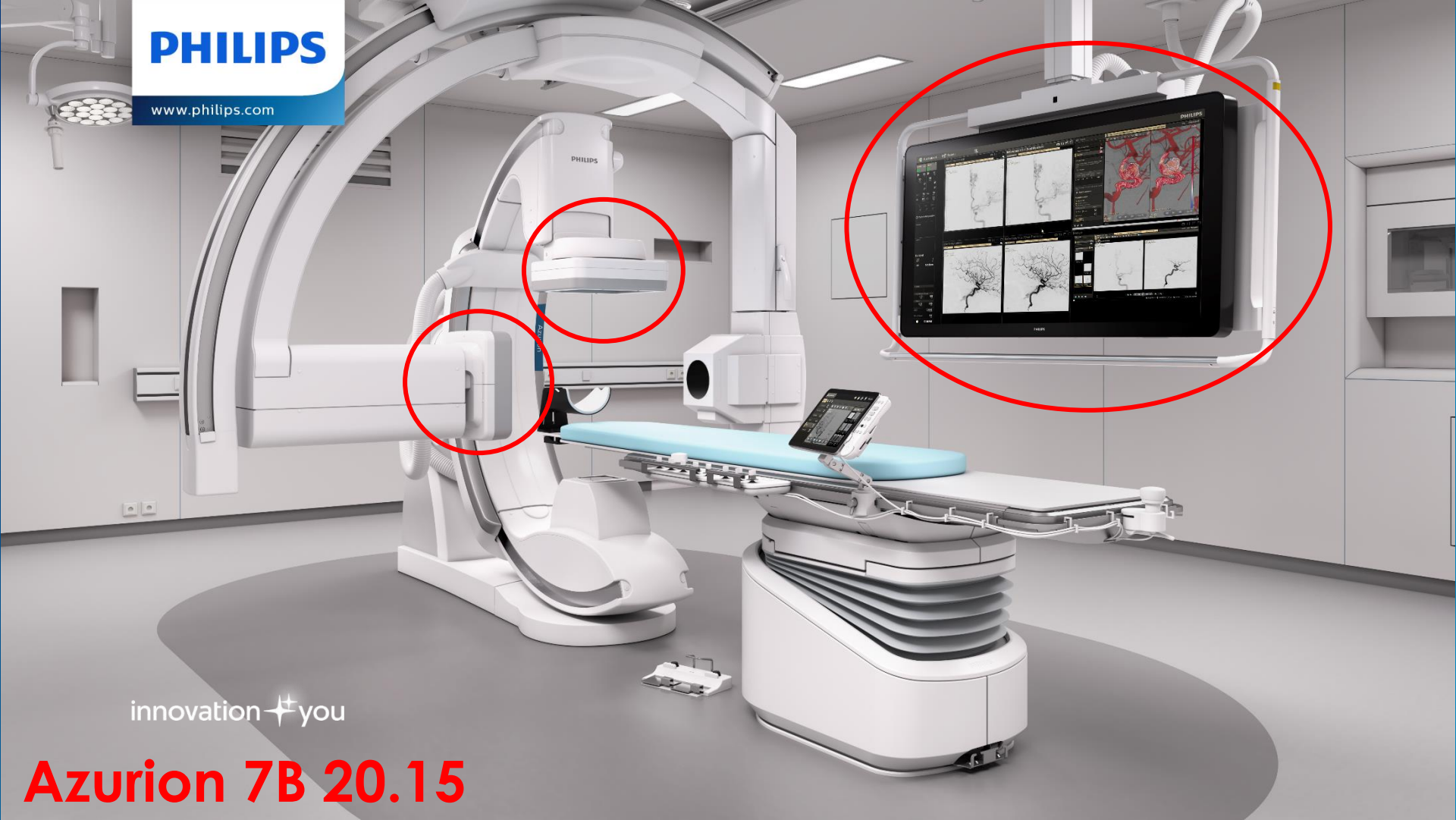
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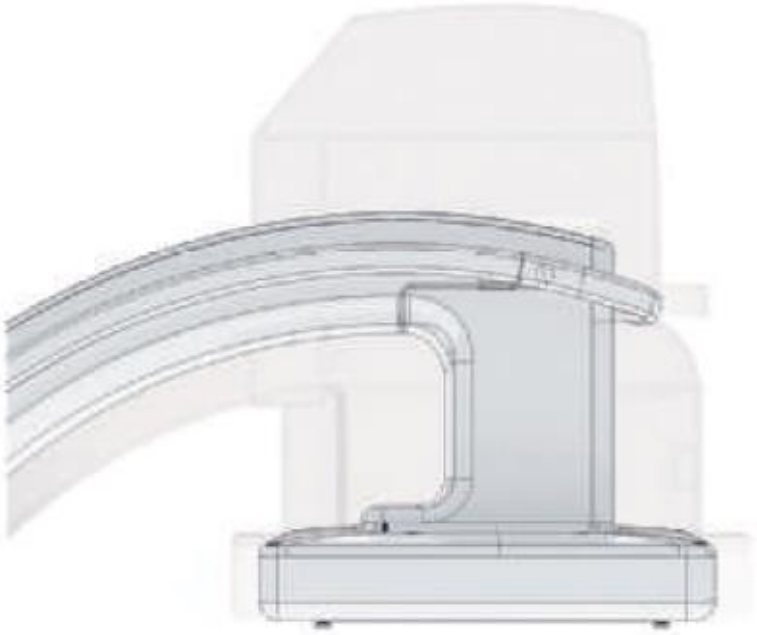
Azurion 7B 20.15



Super thin flat detector as compared to traditional image intensifier

Trixell detector used in Philips Cathlabs

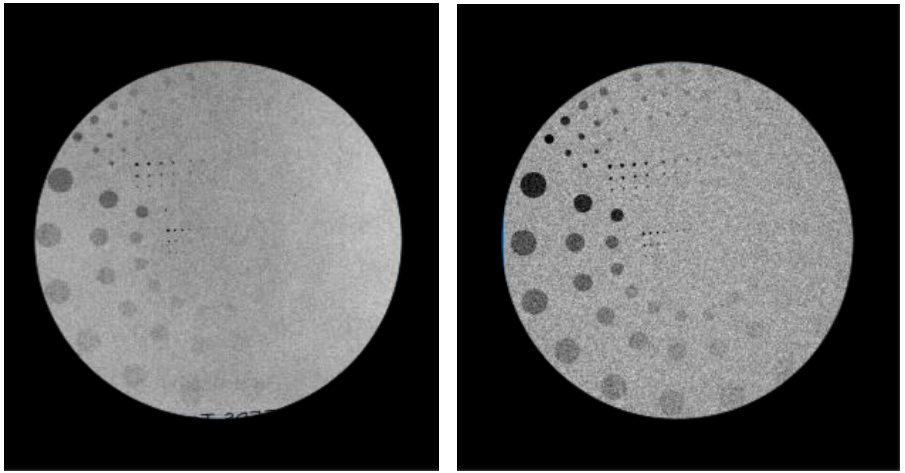
	II	Trixell FD
Matrix size	1024x1024 (CCD)	20” : 2480 x 1900 or 12” : 1344 x 1344
Pixel pitch	-	184µm (15”) or 154 µm (12”)
Contrast ratio	1:4096	1:32000
DQE	(Typical) 65%	70 – 78%

Dynamic range and contrast resolution

FD

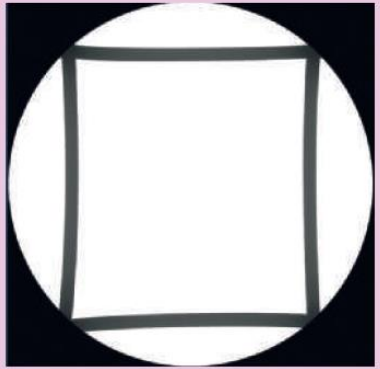
II

See more with 8 x the Dynamic range

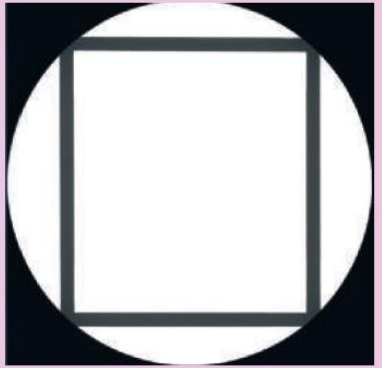


Contrast Resolution II vs FD

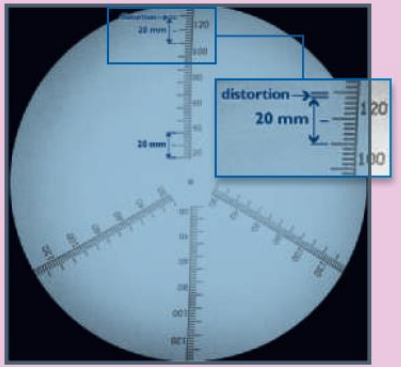
Distortion free imaging



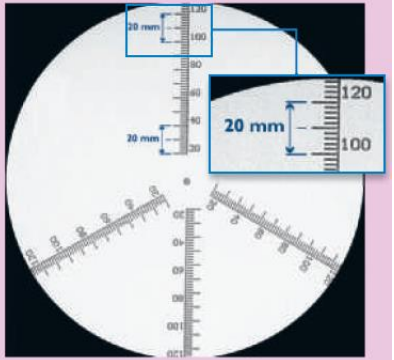
Typical image intensifier distortion of a square figure



Flat detector image with no geometric distortion



Measurements are less accurate at image intensifier edges due to distortions

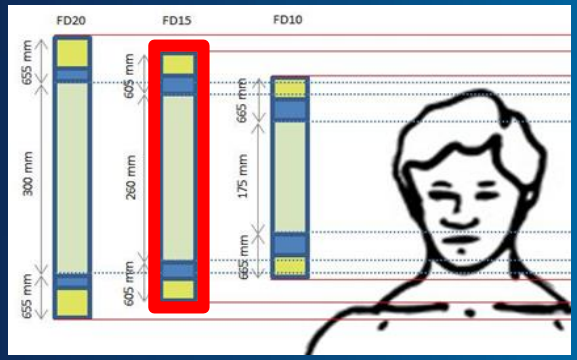


Distortion-free flat detector images allow accurate measurements throughout the field of view

Azurion 7B 20" /15" Flat Detectors

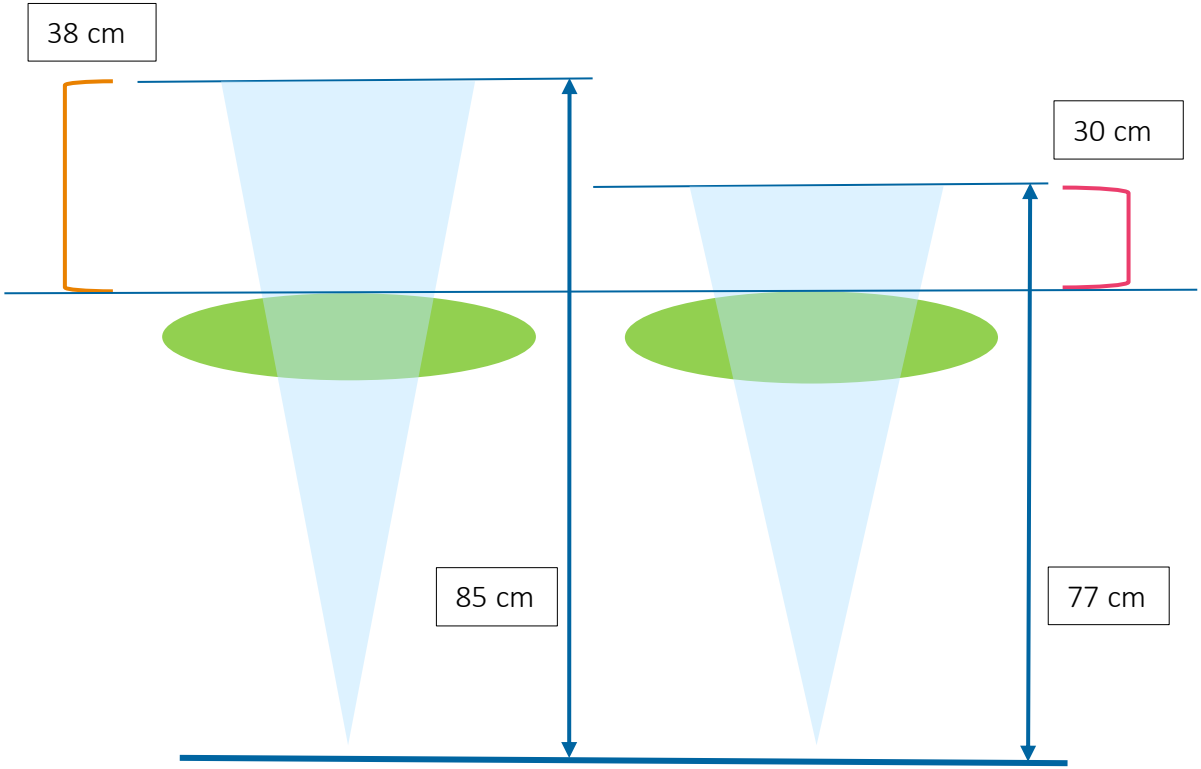
Optimal design for optimal imaging with less dose

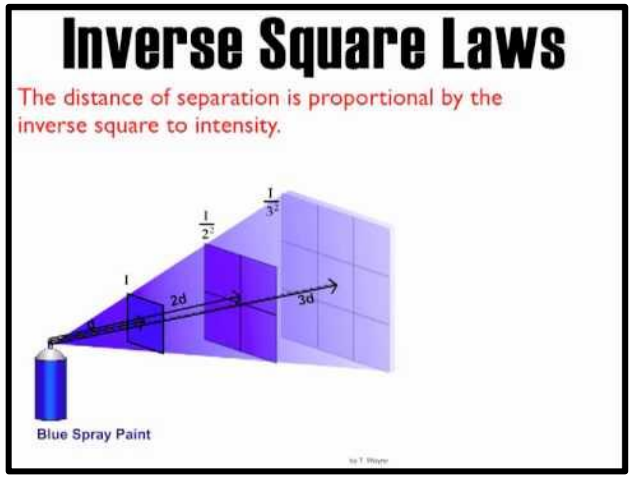
- Over shoulder lateral FD
- Less Dose
- Sharper Image Quality



7 formats

Scattered radiation calculation



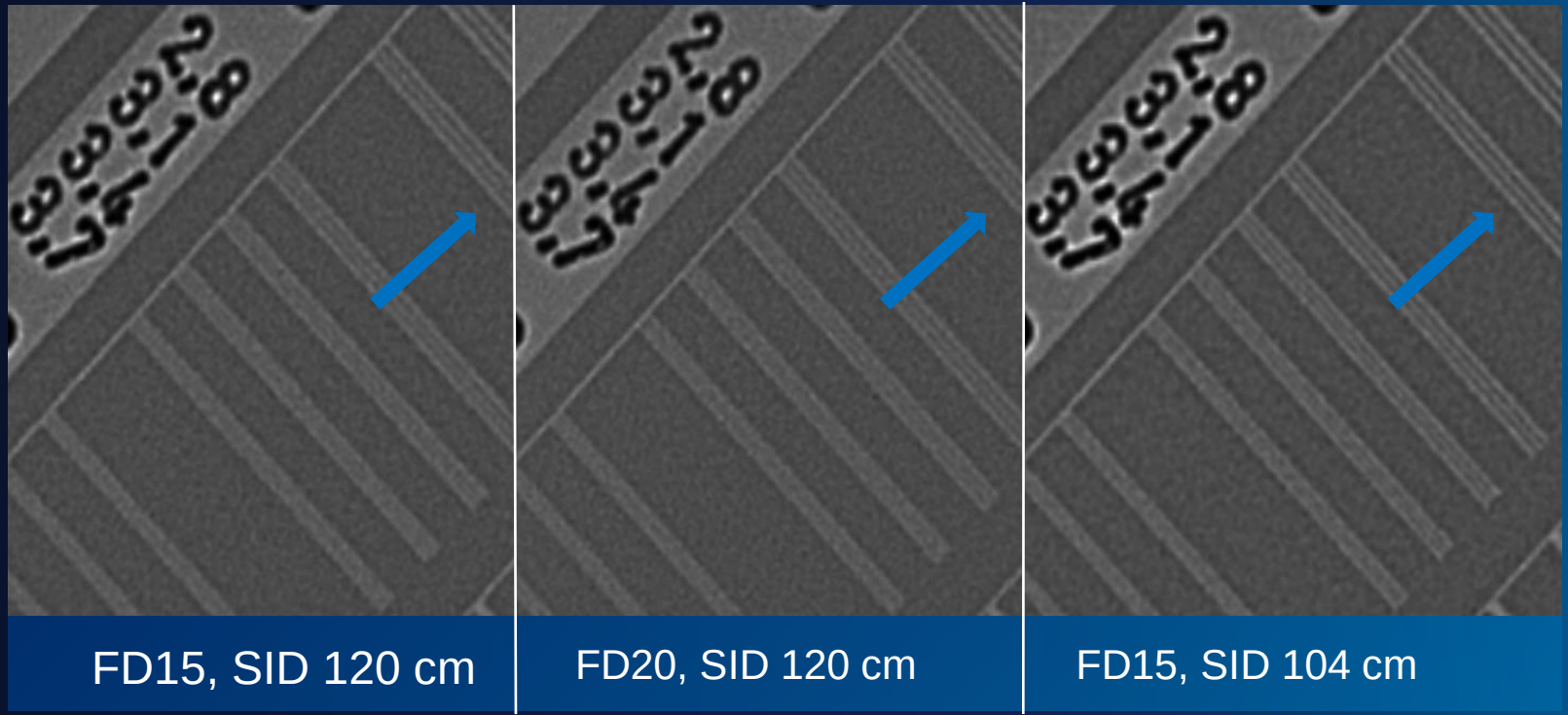


30 X 30= 900

38 X 38= 1444

Lateral FD15 full brain coverage as compact as possible!

Close to the head increases sharpness at reduced X-ray dose

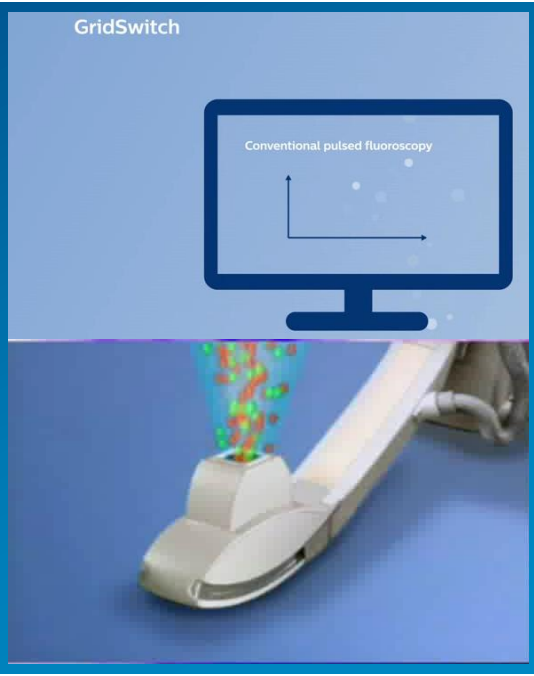


FD15, SID 120 cm | FD20, SID 120 cm | FD15, SID 104 cm

Dose Management Technologies are state of the art

Philips DoseWise

- Grid Switch
- Additional Cu-Filtration
- Manual reduction of frames per second
- Store Fluoroscopy
- Collimation based on Last Image Hold (LIH)
- Low Dose CT Imaging
- Basic Image processing (Edge enhancement, Noise reduction, man. Pixelshift)
- Dose awareness display
- …

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MRC Grid Switch 200+
Double the POWER!
Philips unique platform MRC with Grid Switch X-ray tube with legendary performance and reliability, now with improved performance:
• Increased Maximum anode cooling rate 910 → 1750 kHU/min
• Increased Maximum anode heat storage 2.4MHU → 6.4MHU
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Azurion 7B 20.15

Innovation Leader & Trend Setter

DoseWise
Perfect image. Perfect sense.

Philips MRC **Grid-Switch** Technology
with SpectraBeam Dose Management
Productivity redefined

NEW! Latest Generation! MRC+ 2018

More than 10 years experience

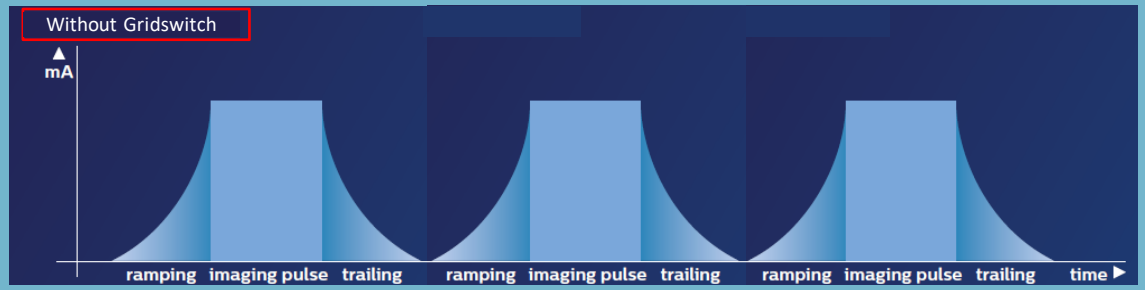
2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013… 2019

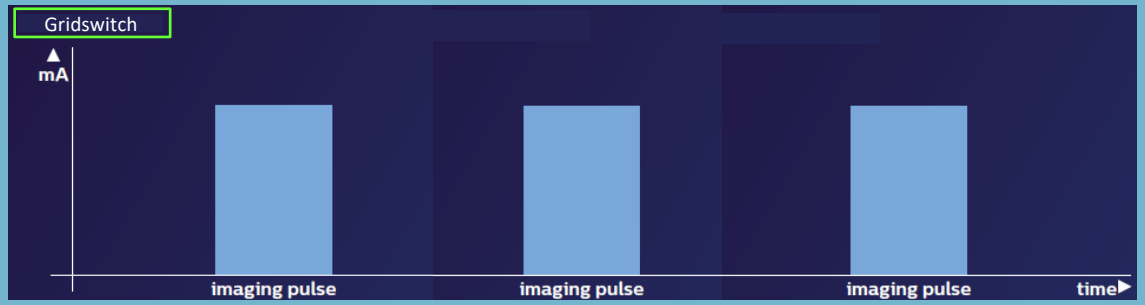
Gigalix Plus

The follower

Philips MRC Tube design with GridSwitch Tech

Efficient X-ray dose management



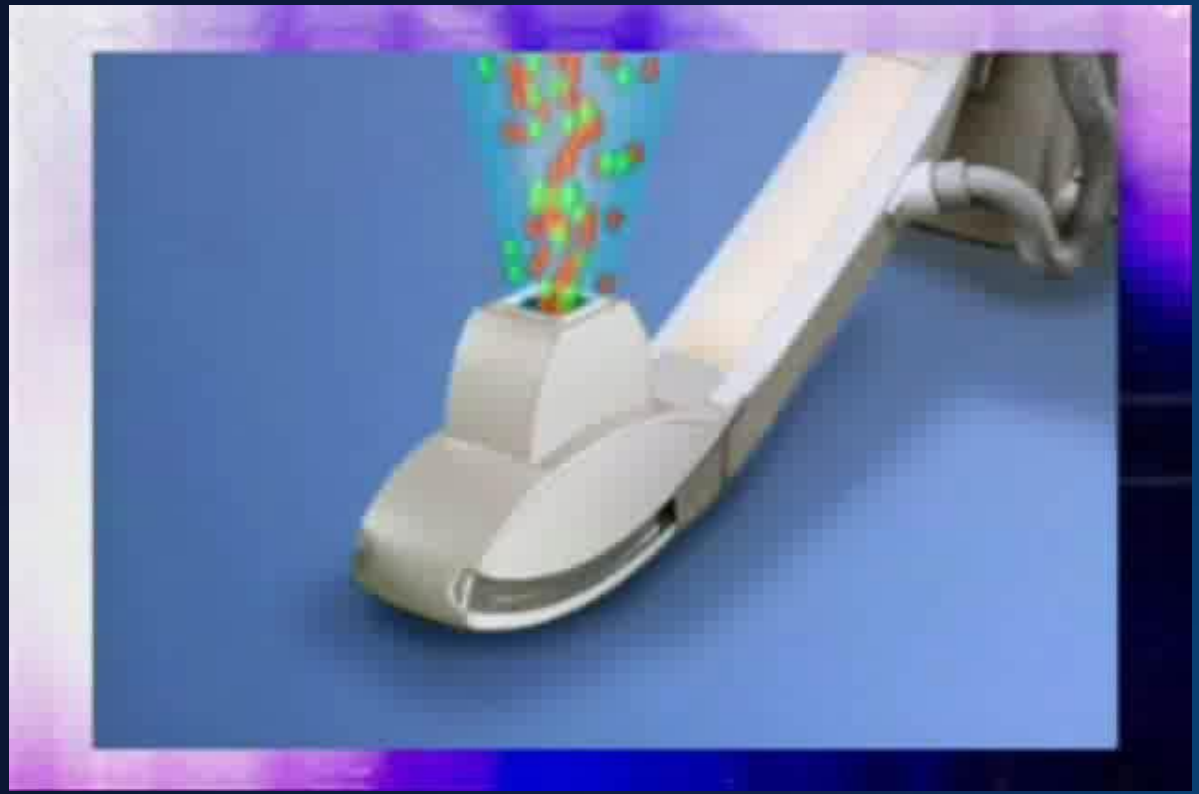


Delivers sharp edges by reducing soft radiation that does not contribute to the image production

DoseWise
Perfect image. Perfect sense.

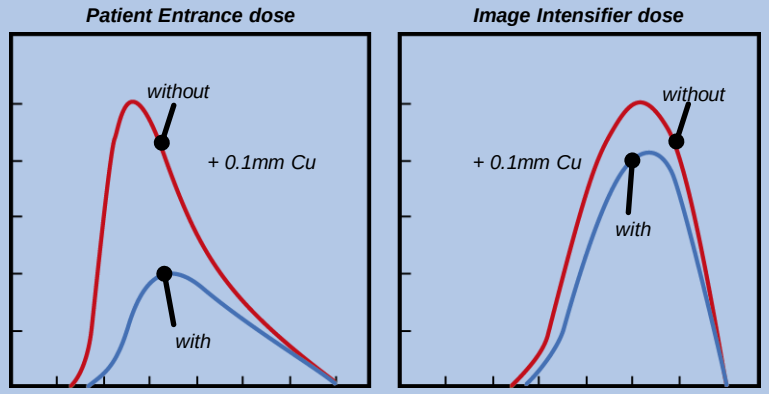
SpectraBeam (fixed Copper filters

Safety to your patient and yourself



Unique Spectrabeam filters

Efficient X-ray dose management



Block unwanted ‘soft’ radiation →
Reduce patient X-ray dose by 40% while maintaining high image quality

Efficient beam filters with an additional 0.1 mm of copper and 1 mm of aluminum increase the quality of the X-ray beam, allowing a 40% reduction in skin entrance dose rate compared to the minimum filtering required by international standards.*

*Compared to conventional filtration of **3 millimeters aluminum** as required by IEC 60601-2-43, 2010.

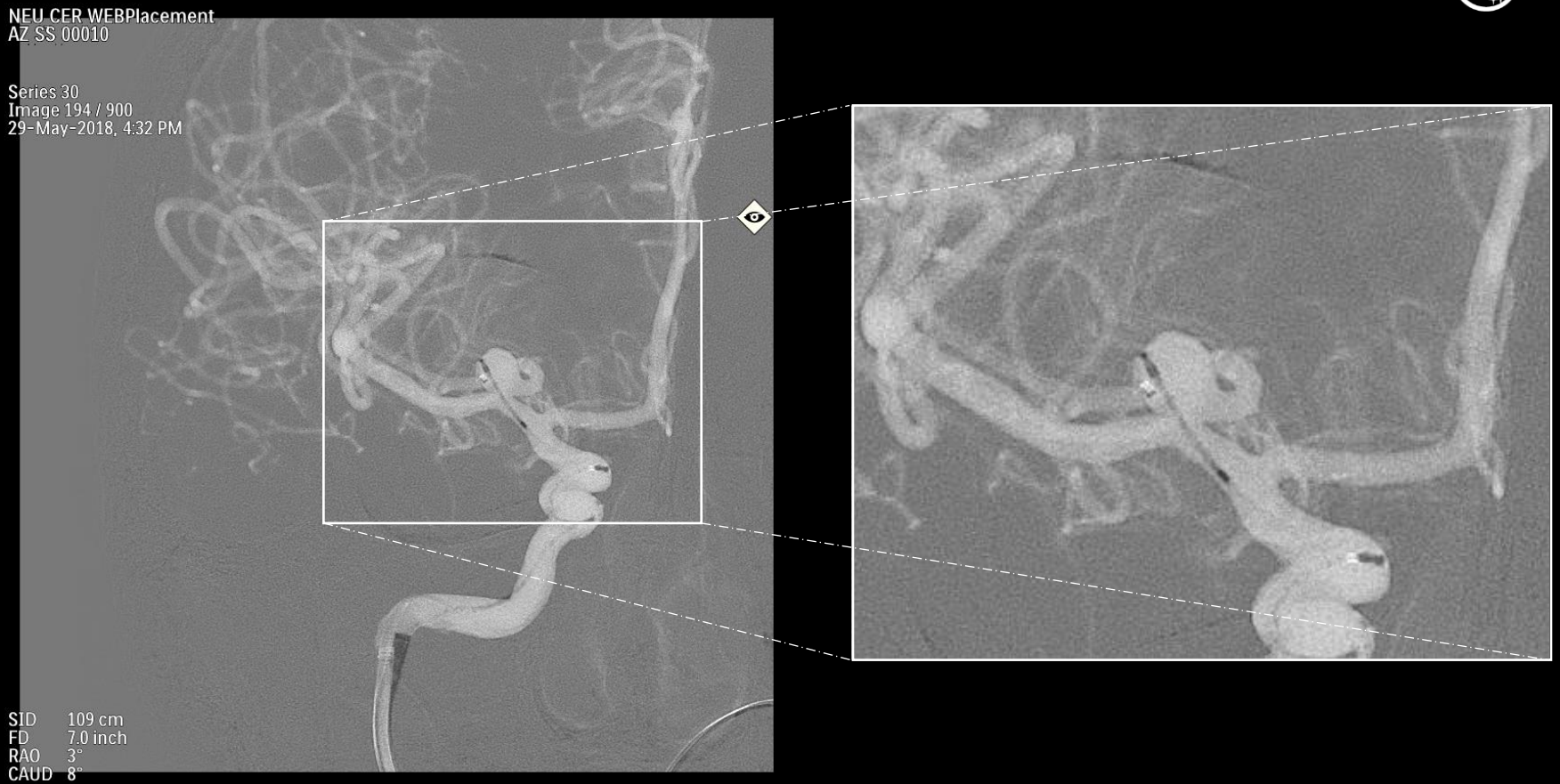
COLLIMATION, SHUTTER and WEDGES

OPTIMIZED X-RAY PROTOCOLS

ZERO DOSE POSITIONING

FLUORO CHOICES and FLUOROSTORE

Deployment of a WEB Device (Low Fluoro Mode)



Azurion is powered by ConnectOS

real-time multi-workspot technology designed specifically for the Azurion interventional suite

From

One application
one user

Examples

EMR

Examples

RIS/PACS

To

multi-workspots; multiple users can work seamlessly together on different workstations on the same applications and on the same and different patient

Exam Room

Control room

Touch Screen Module


Philips Azurion FlexVision Pro
Full control at tableside

TSM PRO :

Quick Access, Control 3rd party applications at tableside, Tablet like functions, Easy Communication between ER/CR & Guided Protocol (Remote Control Included)

FlexSpot :

Customizable & resizable pre-configured layout, change signal sources on-the-fly & Fast access to all application including 3rd party within one screen

Control Module :

Ease of use, Intuitive design & Visible light buttons

FlexVision PRO :

Customizable & resizable pre-configured layout, change signal sources on-the-fly, Quick Access & Control 3rd party applications at tableside

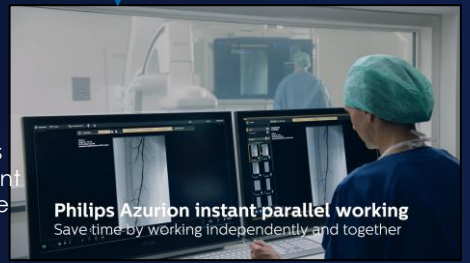
Efficiency + Time Saving

Procedure Cards :

Consistent Workflow, customizable workflow menu, Fast Setup & procedure cards connected through RIS

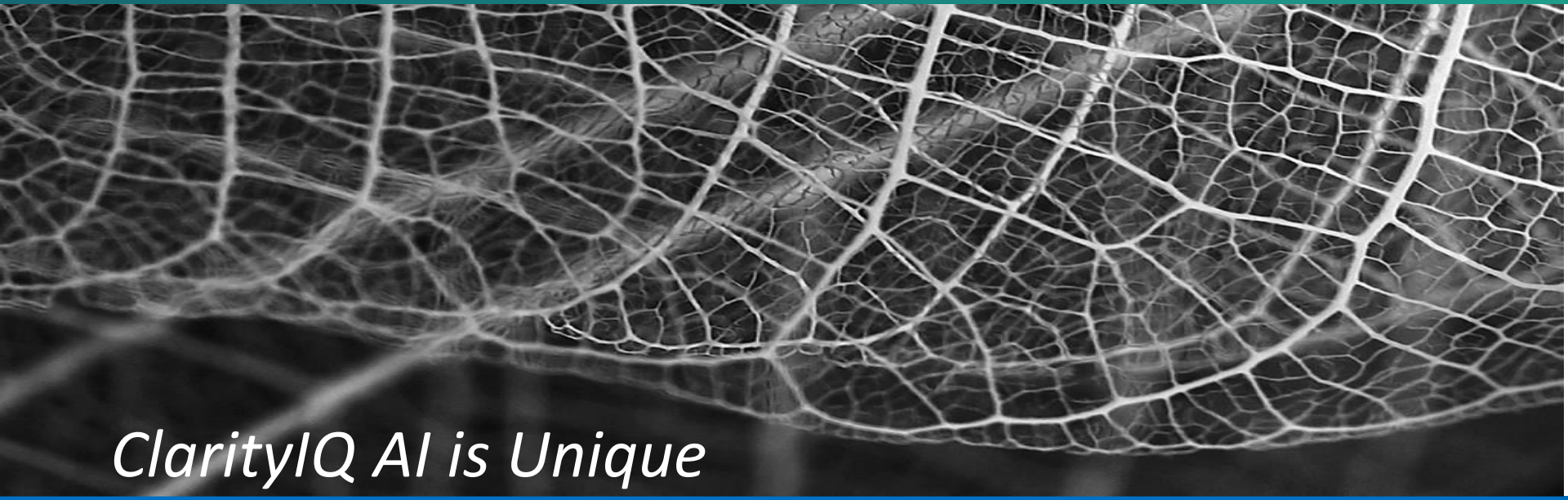
Instant Parallel Working :

No interruption, Quick Access to previous patient files, Pre-registration of next patient & post process during ongoing procedure



Checklist & Protocols :

Minimize Error, Reminder & Consistent Workflow

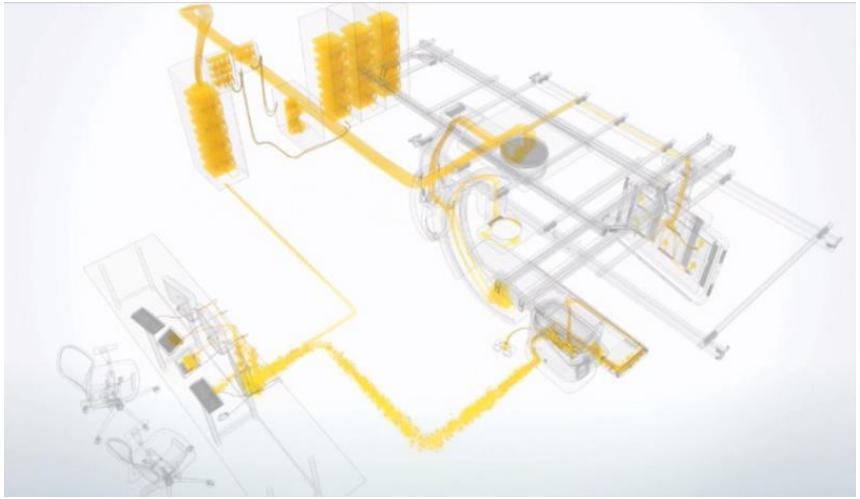


ClarityIQ AI is Unique

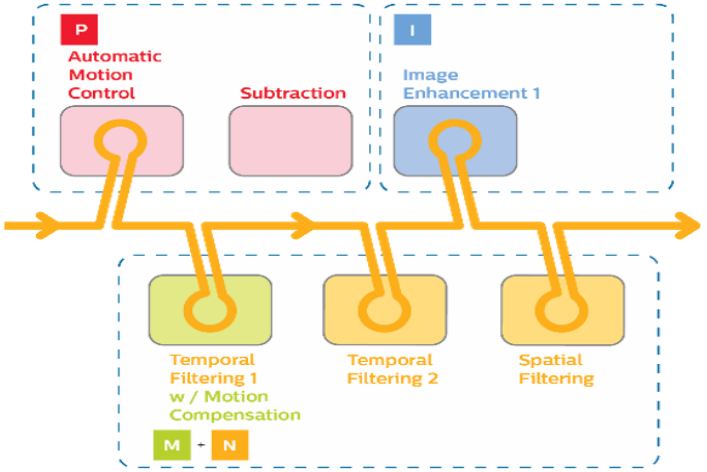
The first fixed interventional fluoroscopy x-ray system in the USA commercially available with clinically proven claims on radiation dose reduction without affecting procedural performance. [1]

[1] In routine neuroendovascular procedures*, the AlluraClarity system with ClarityIQ technology may reduce patient dose (as dose-area product) by as much as 62% (in routine diagnostic neuroendovascular procedures) and as much as 65% (in routine interventional neuroendovascular procedures)** for the total procedure without affecting the procedural performance (fluoroscopy time and number of DSA images) as compared to equivalent procedures on an Allura Xper system, as demonstrated in one single-center study.***
*Routine neuro interventions comprise of DSA and fluoroscopy usage.
** (95% CI 56%, 68% for routine diagnostic neuroendovascular procedures, 95% CI 58%, 71% for routine interventional neuroendovascular procedures). The results of the application of dose reduction techniques will vary depending on the clinical task, patient size, anatomical location and clinical practice. The interventional radiologist assisted by a physicist as necessary has to determine the appropriate settings for each specific clinical task.
*** Results based on total dose area product from a single center retrospective historically controlled cohort study (Karolinska Hospital - Solna, Sweden) on 614 patients (302 for Allura Xper and 312 for AlluraClarity) undergoing neuroendovascular procedures. [Söderman M, Mauti M, Boon S, Omar A, Marteinsdóttir M, Andersson T, Holmin S, Hoornaert B. Radiation dose in neuroangiography using image noise reduction technology: a population study based on 614 patients. Neuroradiology. 2013; 55:1365-1372]

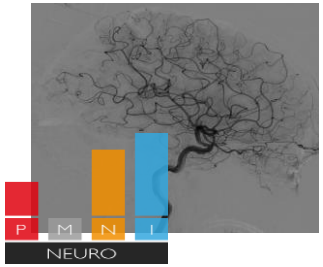
ClarityIQ - Real-time Image Processing

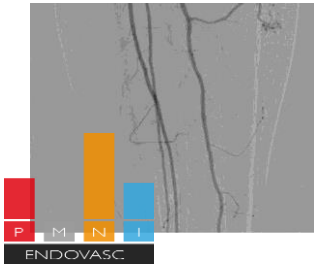


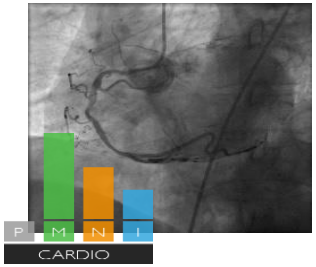
Angio-System with **real-time** HW

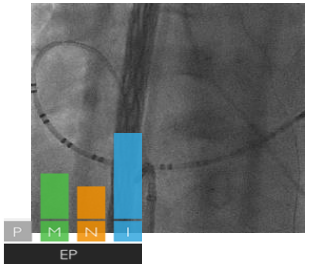


Flexible Imaging Pipeline



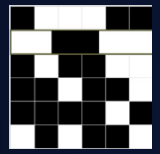






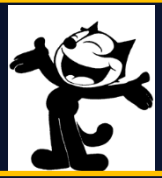
CLARITYIQ TECHNOLOGY: ADVANCED REAL-TIME IMAGE NOISE REDUCTION ALGORITHMS

P



Automatic Pixel Shift (APS)

N



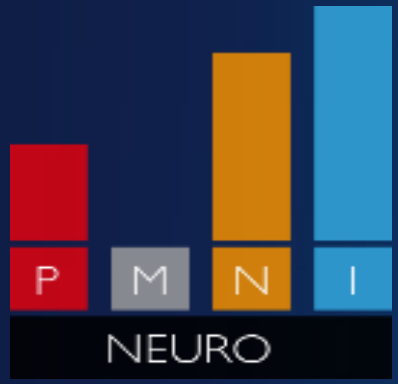
Spatial Noise Reduction

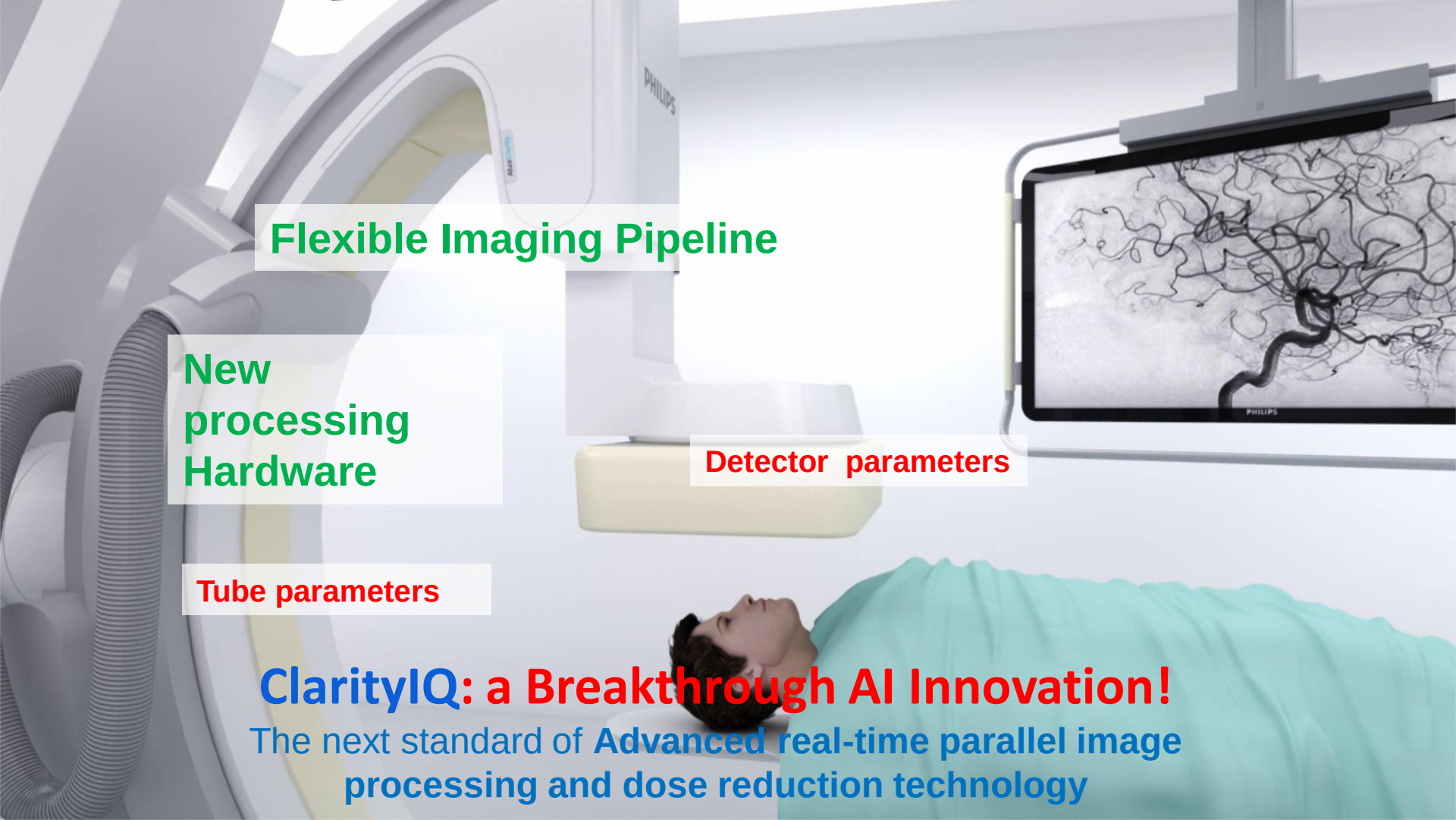
M

Temporal Noise Reduction

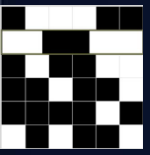
I

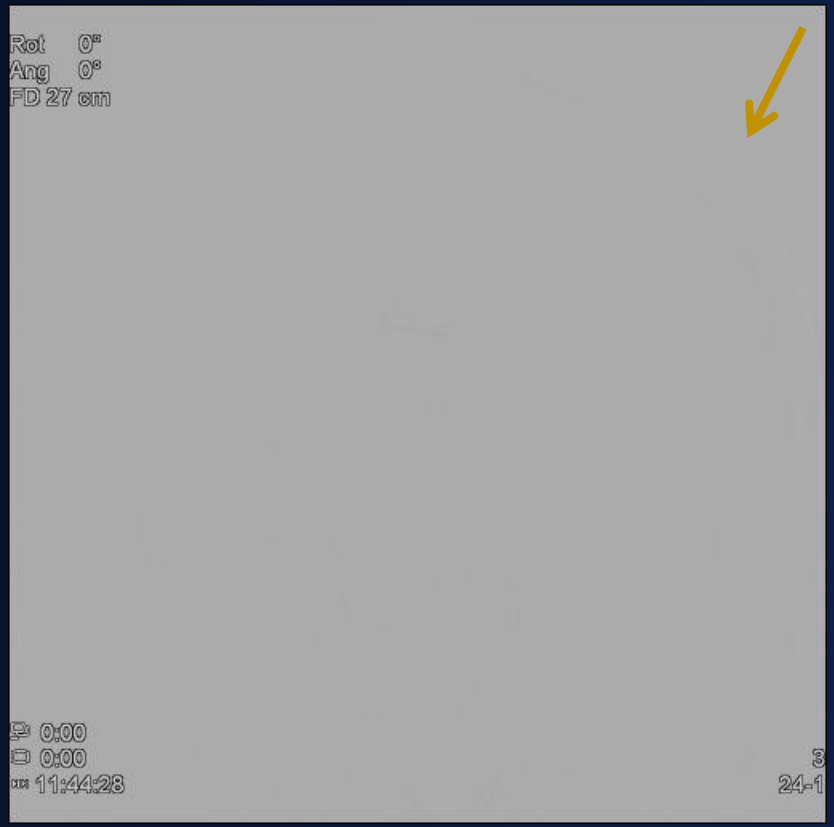
Image Enhancement

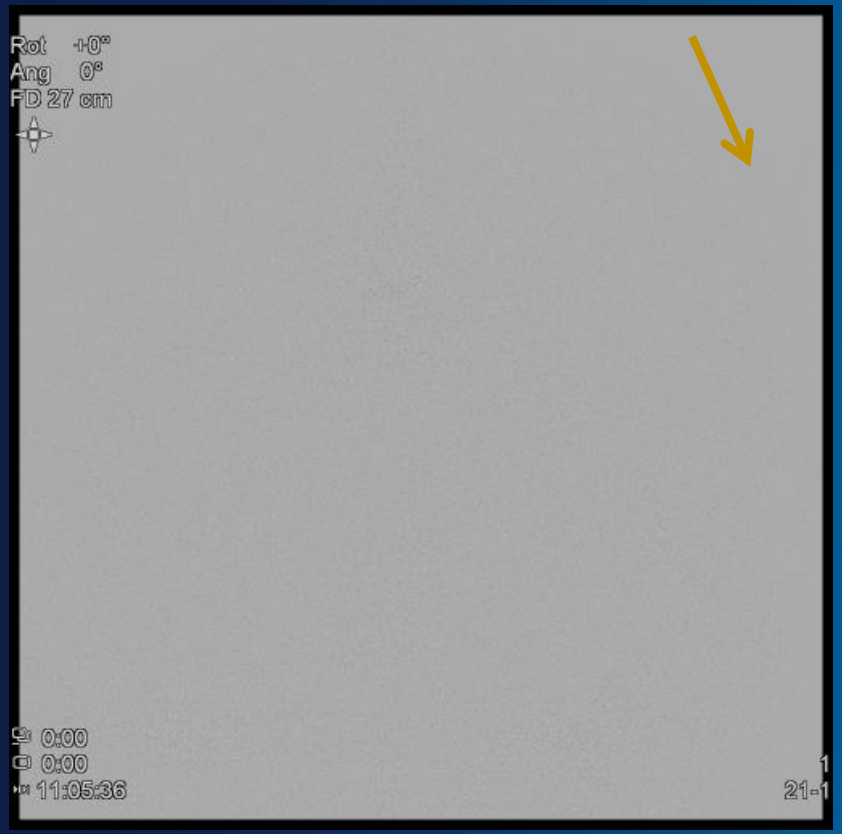



Flexible Imaging Pipeline
New processing Hardware
Detector parameters
Tube parameters
ClarityIQ: a Breakthrough AI Innovation!
The next standard of Advanced real-time parallel image processing and dose reduction technology

CLARITYIQ TECHNOLOGY: AUTOMATIC PIXEL SHIFT – A SIMPLE EXPERIMENT







Non-ClarityIQ

Bony anatomy becomes visible, fiducial stays hidden.

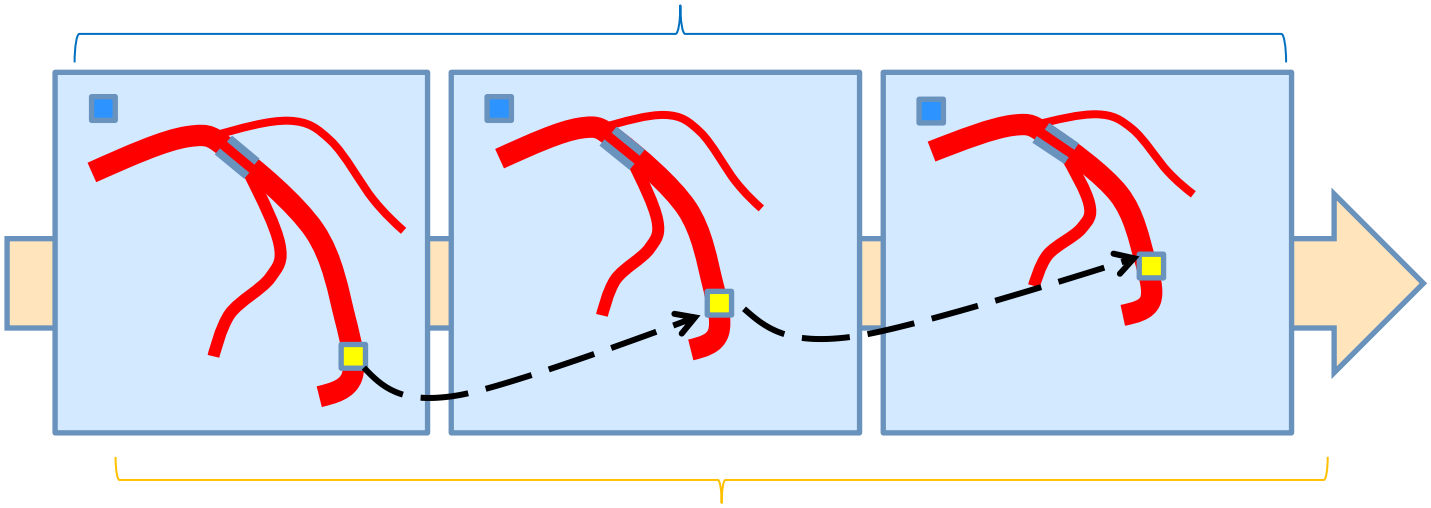
ClarityIQ

Bony background not visible, but fiducial becomes visible.

PHILIPS

Real-time Auto Motion Compensation

Large kernels distinguish noise from clinical information

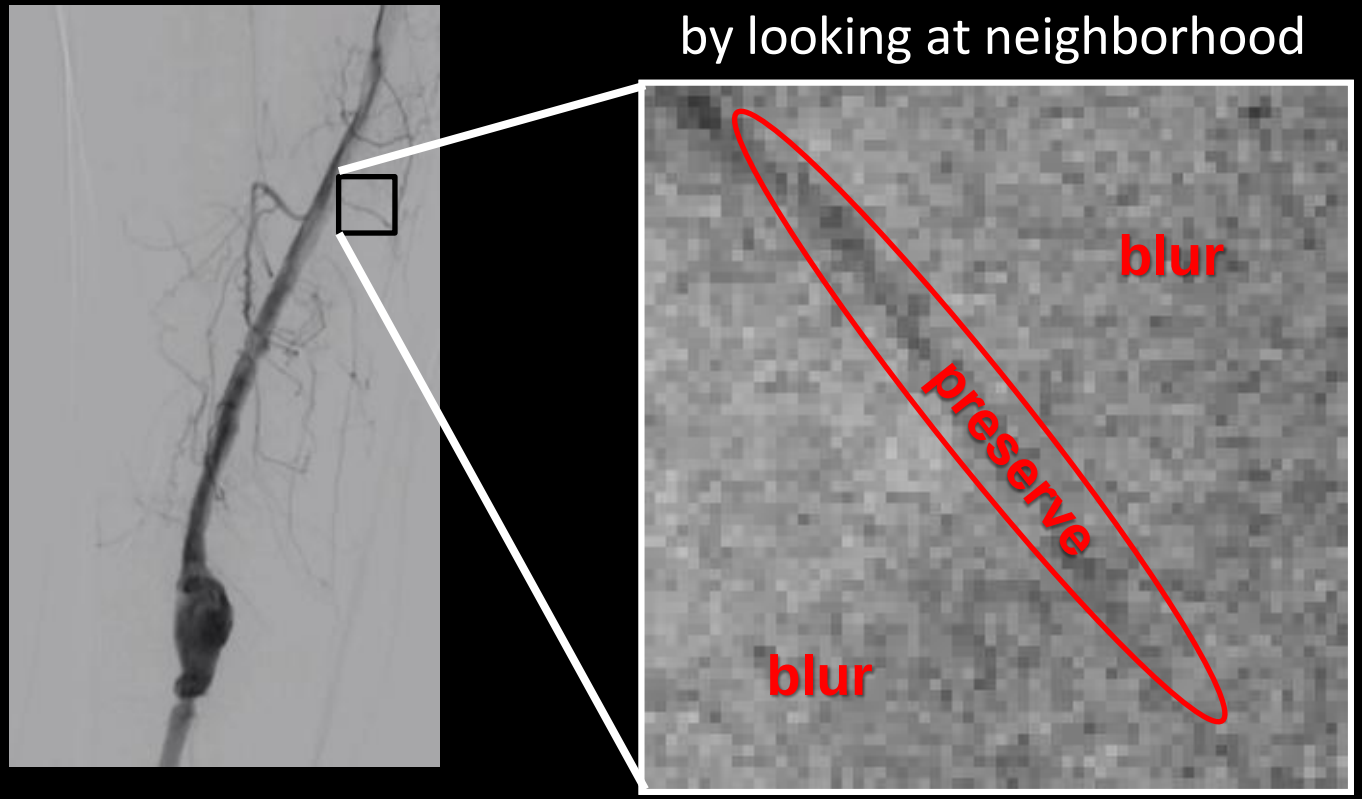


Real time anatomy position detection

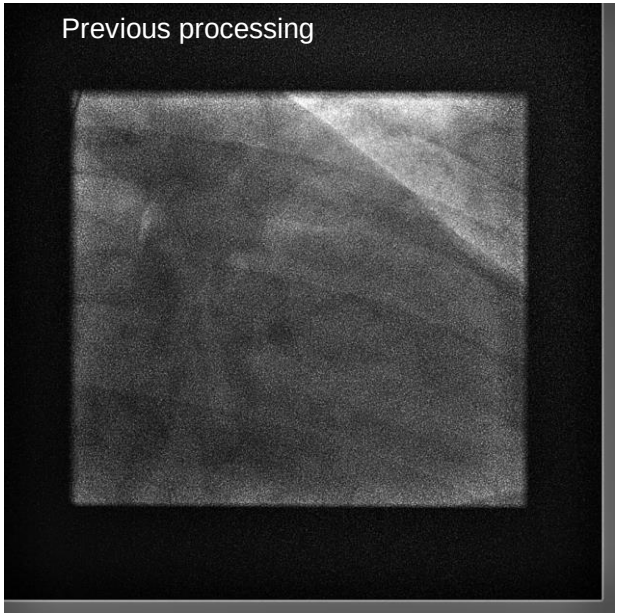
N

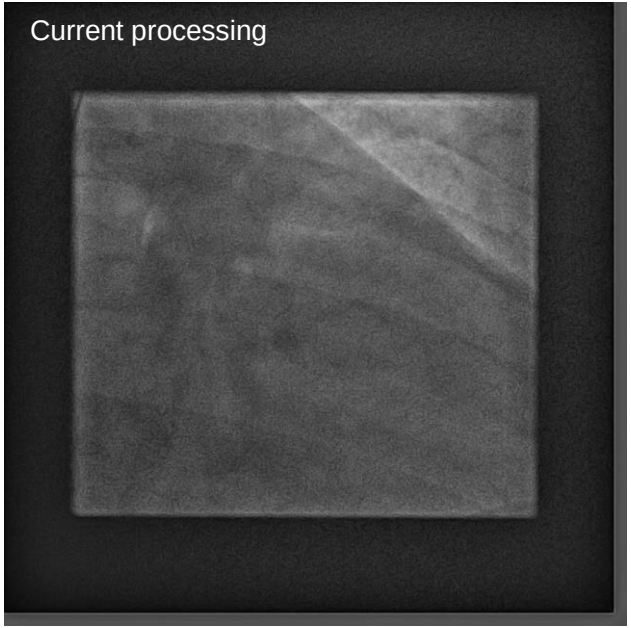
Spatial Noise Reduction

Determine if pixel is noisy
by looking at neighborhood



Advanced image processing Real-time Auto Motion Compensation



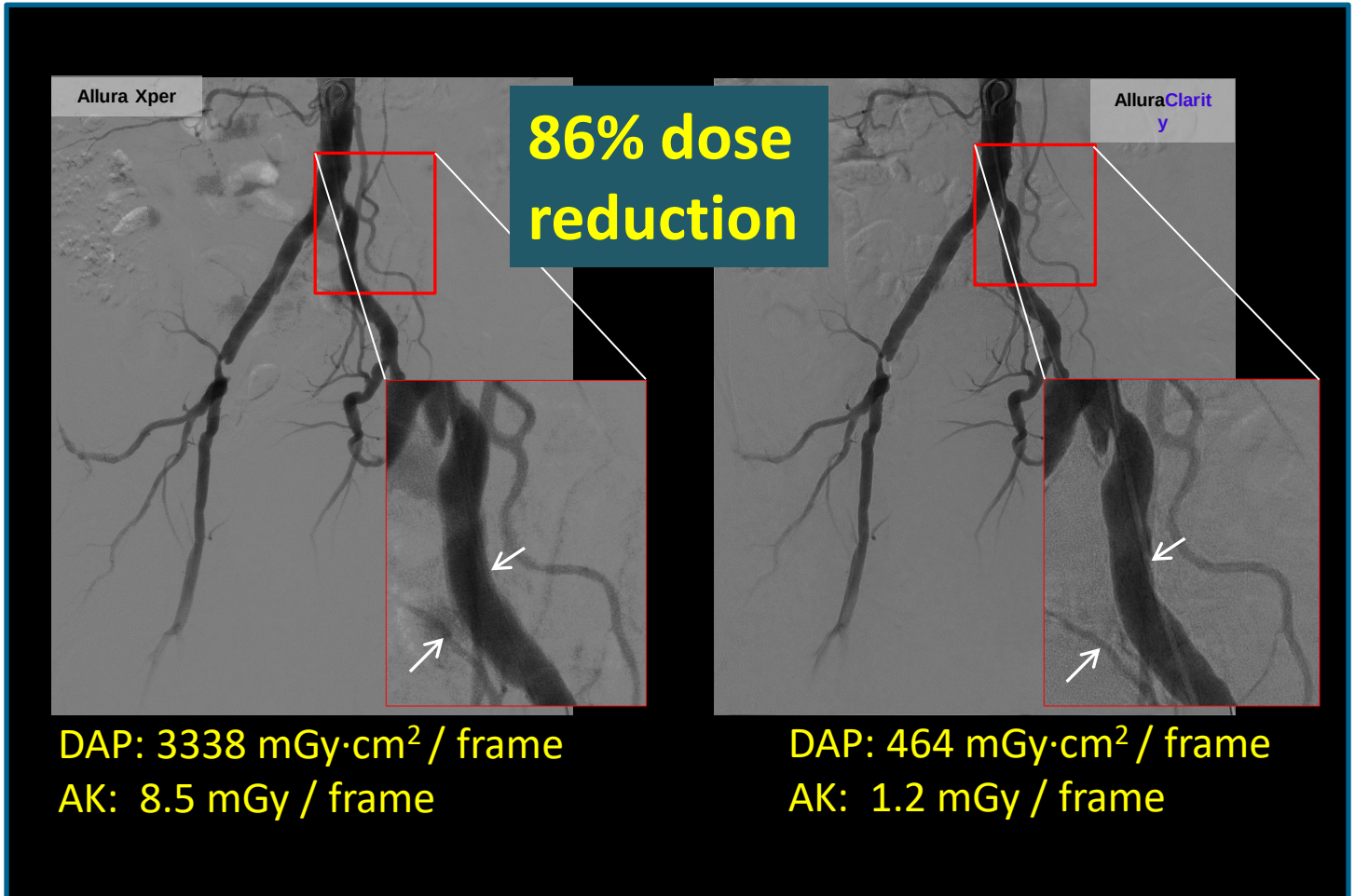


Advanced image processing

- Improved spatial and motion adaptive filtering for enhanced clinical content
- Procedure specific image processing

PHILIPS

Bilateral iliac Stenosis



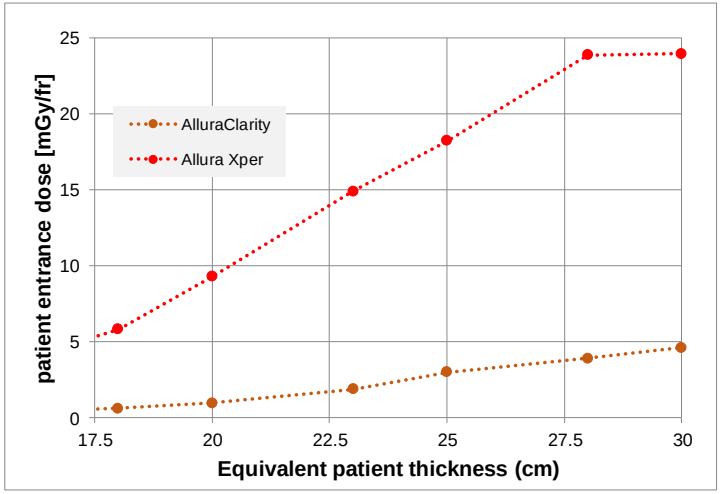
PHILIPS

Automatic Motion Control: MORE details!

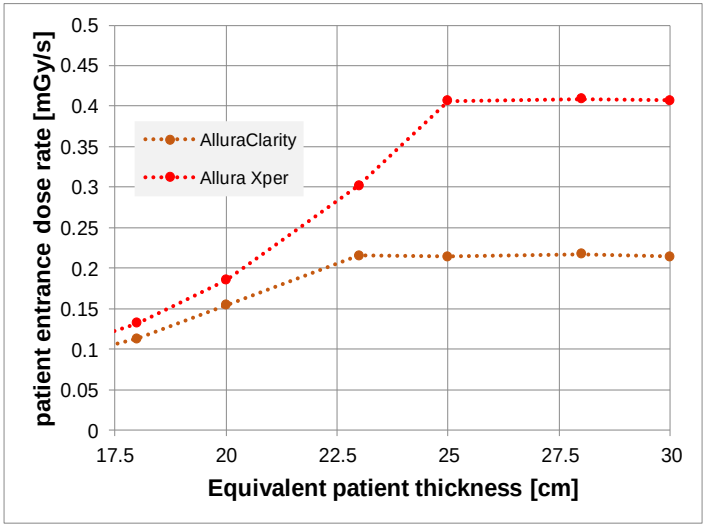
Impact of ClarityIQ

Neuro DSA and Fluoro

Cerebral DSA



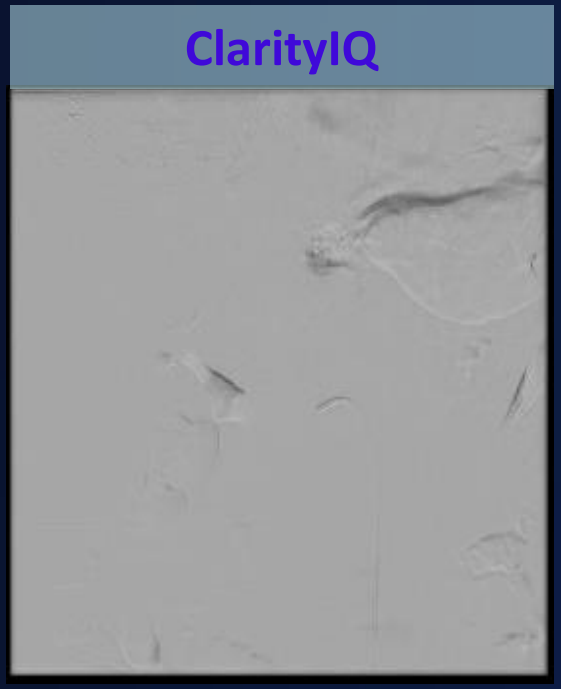
Cerebral Fluoro



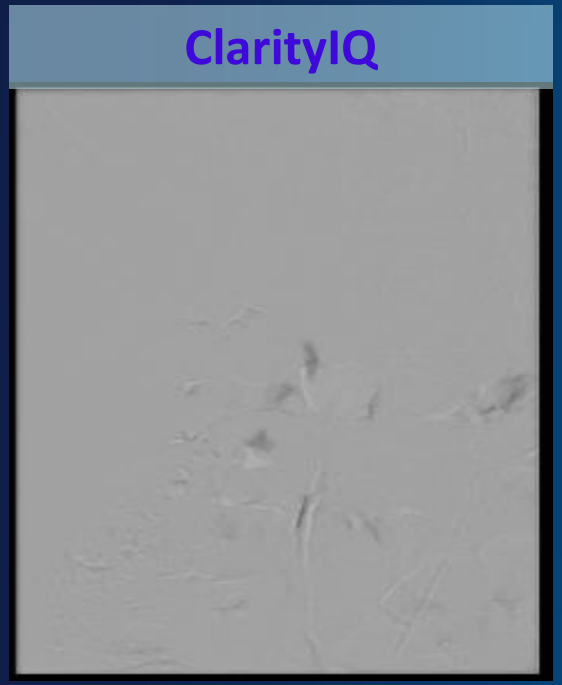
NOTE: Entrance dose measured on phantom according to IEC standard using the default x-ray protocol for each system.

Impact of ClarityIQ

Enabler for contrast medium reduction



75% Dose Reduction protocol
Contrast Media no Dilution



75% Dose Reduction protocol
Contrast Media 50% Dilution

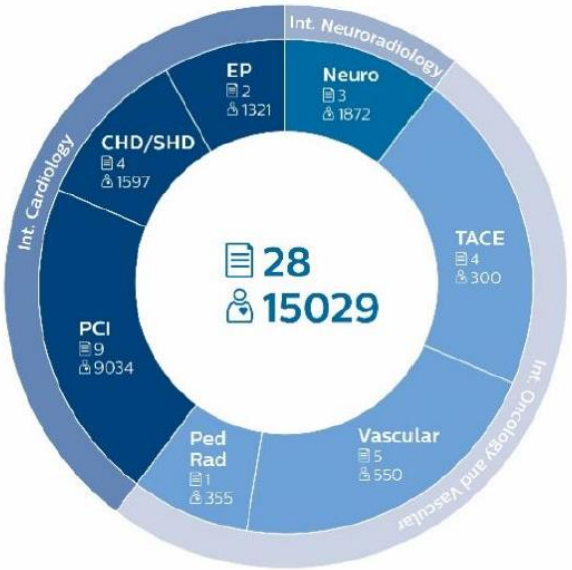
Courtesy : Kosin Uni. Gospel Hospital

ClarityIQ Technology (Clinically Validated)

Advanced real-time parallel image processing & Extended dose reduction technology (Min -50% vs Conventional System)

Auto Pixel Shift, Real Time Motion Compensation, Noise Reduction & Multi-band Image Enhancement

ClarityIQ peer-reviewed comparative studies per clinical area



CLINICAL STUDY

Patient Radiation Dose Reduction during Transarterial Chemoembolization Using a Novel X-Ray Imaging Platform

Ryan Kohlbrenner, MD, K. Pallav Kolli, MD, Andrew G. Taylor, MD, PhD, Maureen P. Kohi, MD, Nicholas Fidelman, MD, Jeanne M. LaBerge, MD, Robert K. Kerlan, MD, Vishal K. Agarwal, MD, Evan D. Lehrman, MD, Sujal Nanavati, MD, David E. Avrin, MD, and Robert Gould, DSc

ABSTRACT

Purpose: To evaluate radiation dose reduction in patients undergoing transarterial chemoembolization with the use of a new image acquisition and processing platform.

Materials and Methods: Radiation-dose data were obtained from 176 consecutive chemoembolization procedures in 135 patients performed in a single angiography suite. From January 2013 through October 2013, 85 procedures were performed by using our institution's standard fluoroscopic settings. After upgrading the x-ray fluoroscopy system with an image acquisition and processing platform designed to reduce image noise and reduce skin entrance dose, 91 chemoembolization procedures were performed from November 2013 through December 2014. Cumulative dose-area product (CDAP), cumulative air kerma (CAK), and total fluoroscopy time were recorded for each procedure. Image quality was assessed by three interventional radiologists blinded to the x-ray acquisition platform used.

Results: Patient radiation dose indicators were significantly lower for chemoembolization procedures performed with the novel imaging platform. Mean CDAP decreased from 3,033.2 dGy · cm² (range, 600.3–9,404.1 dGy · cm²) to 1,640.1 dGy · cm² (range, 278.6–6,779.9 dGy · cm²; 45.9% reduction; $P < .0001$). Mean CAK decreased from 1,445.4 mGy (range, 303.6–5,233.7 mGy) to 971.7 mGy (range, 144.2–3,312.0 mGy; 32.8% reduction; $P < .0001$). A 20.3% increase in mean total fluoroscopy time was noted after upgrading the imaging platform, but blinded analysis of the image quality revealed no significant degradation.

Conclusions: Although a small increase in fluoroscopy time was observed, a significant reduction in patient radiation dose was achieved by using the optimized imaging platform, without image quality degradation.

ABBREVIATIONS

AP = anteroposterior, CAK = cumulative air kerma, CDAP = cumulative dose–area product, DSA = digital subtraction angiography, FOV = field of view

Diagnostic and therapeutic procedures in interventional radiology routinely result in the exposure of patients to ionizing radiation (1–3). Cognizance of the potential deterministic and stochastic effects of cumulative radiation exposure to patients and interventionalists is therefore important (4,5). Although modern x-ray angiographic equipment allows modification of imaging parameters to reduce radiation exposure, image quality must be maintained to complete each procedure safely, efficiently, and effectively.

A new image acquisition and processing platform (AlluraClarity; Philips, Best, The Netherlands) has been shown to reduce patient radiation dose in various body interventional and neurointerventional procedures (6–9). This platform employs an advanced noise-reduction algorithm and optimized system settings, including increased beam filtration, to reduce the incident radiation required to produce a digital image of diagnostic quality. In addition to demonstrating a decrease in

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Significant Dose Reduction for Pediatric Digital Subtraction Angiography Without Impairing Image Quality: Preclinical Study in a Piglet Model

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Todd Abruzzo[1]
Manish Patel[1]
Kamlesh Kukreja[1]
Neil Johnson[1]
Mark den Hartog[3]
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Rami Nachabe[3]

Keywords: digital subtraction angiography (DSA), dose reduction, image quality, pediatrics

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Cincinnati Children's Hospital Medical Center, Department of Radiology, Division of Interventional Radiology has a master research agreement with Philips Healthcare. J. Racadio has had travel expenses paid for Philips Healthcare–sponsored symposiums. He has not received any speaking honorariums, is not paid by Philips Healthcare, and does not have any stock options or other financial incentives in Philips Healthcare or any Philips Healthcare products. R. Nachabe, M. den Hartog, and B. Hoornaert are employees of Philips Healthcare. However, the authors who are not Philips Healthcare employees had full control of inclusion of any data and information that might present a conflict of interest for those authors who are Philips Healthcare employees.

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*AJR*2014; 202:904–908

0361–803X/14/2204–904

OBJECTIVE. The purpose of this study was to validate the hypothesis that image quality of digital subtraction angiography (DSA) in pediatrics is not impaired when using a low-dose acquisition protocol.

MATERIALS AND METHODS. Three piglets corresponding to common pediatric population sizes were used. DSA was performed in the aorta and renal, hepatic, and superior mesenteric arteries using both the commonly used reference standard and novel radiographic imaging noise reduction technologies to ensure pairwise radiation dose and image quality comparison. The air kerma per frame at the interventional reference point for each DSA acquisition was collected as a radiation dose measure, and image quality was evaluated by five interventional radiologists in a randomized blinded fashion using a 5-point scale.

RESULTS. The mean air kerma (± SD) at the interventional reference point with the novel x-ray imaging noise reduction technology was significantly lower (1.1 ± 0.8 mGy/frame) than with the reference technology (4.2 ± 3.0 mGy/frame, $p = 0.005$). However, image quality was statistically similar, with average scores of 3.2 ± 0.4 and 3.1 ± 0.5 for the novel and reference technologies, respectively ($p = 0.934$); interrater absolute agreement was 0.77.

CONCLUSION. The DSA radiation dose for pediatrics can be reduced by a factor of four with a novel x-ray imaging noise reduction technology without deterioration of image quality.

Digital subtraction angiography (DSA) is used for a wide range of vascular procedures in pediatric patients; however, the radiation dose from DSA is relatively high. In a study using anthropomorphic phantoms, the effective radiation dose delivered to the head of a 5-year-old child from 10 DSA frames was estimated to be equivalent to approximately 1 minute of fluoroscopy [1]. In that same study, the authors showed that in a typical cerebral angiography procedure, the radiation dose from DSA is nearly three times that from fluoroscopy [1].

Pediatric patients are more sensitive to the effects of radiation than adults and have a greater lifetime risk of radiation-induced cancer [2]. As part of the Image Gently public service campaign, an interventional radiology phase, "Image Gently, Step Lightly," was instituted to encourage radiation protection during pediatric interventional radiology procedures [3]. Specific radiation dose reduction measures for DSA that were suggested in the campaign included tight collimation to the anatomic area of interest and appropriate choice of the acquisition frame rate (number of exposures) to adequately evaluate the vascular anatomy of interest [3]. Although measures such as these can help to reduce radiation dose as much as possible, further reduction is limited using existing x-ray imaging technology.

In a recent study [4], 20 adult patients underwent two consecutive cerebral DSA examinations performed first with a standard reference technology and then with a novel noise reduction technology that was associated with a one quarter radiation dose protocol. Paired comparison of the DSA images revealed no significant difference in image quality, while the radiation dose was reduced by a factor of four. However, these data cannot necessarily be extrapolated to the pediatric population because the smaller size of the patients may make relatively small changes in image quality more significant. The data also cannot necessarily be extrapolated to other anatomic regions. Because it would be ethically unacceptable to perform an additional DSA examination on pediatric patients and it would be difficult to define image quality in a phantom from a clinical perspective, we chose to use an

TYPE OF FUSION

PRE-ACQUIRED WITH REAL TIME

CT/MRI – FLUOROSCOPY:

Advantages:

- **excellent** for pre-procedural **planning**
- large volume of the **3D data-set anatomy** available
- High spatial resolution
- Information not easily visible in real-time modalities

Disadvantages:

- not real-time
- single phase
- no motion compensation

MULTIMODALITY REAL-TIME

TEE – FLUOROSCOPY

Advantages:

- **real-time** soft tissue and devices
- **Physiological** information on fluoro
- Deformation-proof

Disadvantages:

- small volume of 3D data-set
- unable to do pre-procedural planning

A single imaging modality can NOT provide all the necessary information

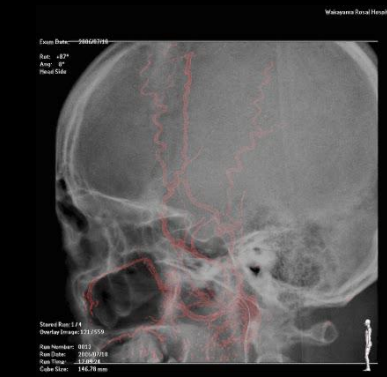
EchoNavigator provides a real time imaging fusion of live X-ray and live echo

IMAGE FUSION

SmartCT (CBCT & 3D-Rotational Angio)

Head end – Propeller Scan

Nurse Side – Roll Scan



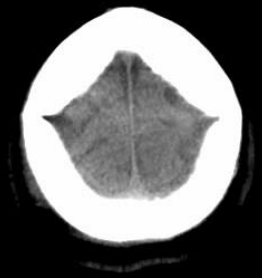
PHILIPS

SmartCT (CBCT & 3D-Rotational Angio)

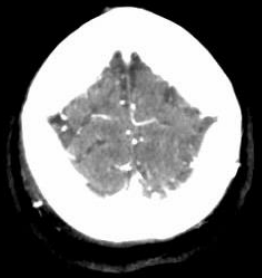
Head end – Propeller Scan

Nurse Side – Roll Scan

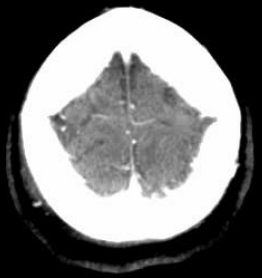
Pre : Identify bleeding and ischemic changes

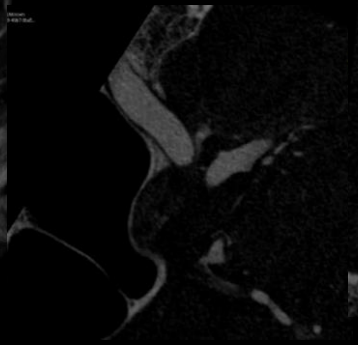


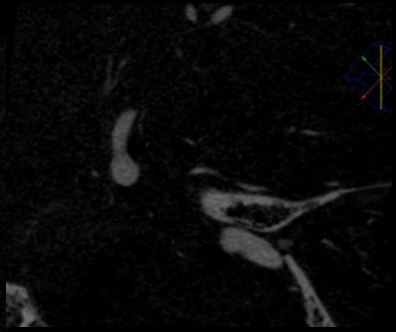
Arterial Phase : Identify proximal occlusion



Delayed Phase : Identify collaterals



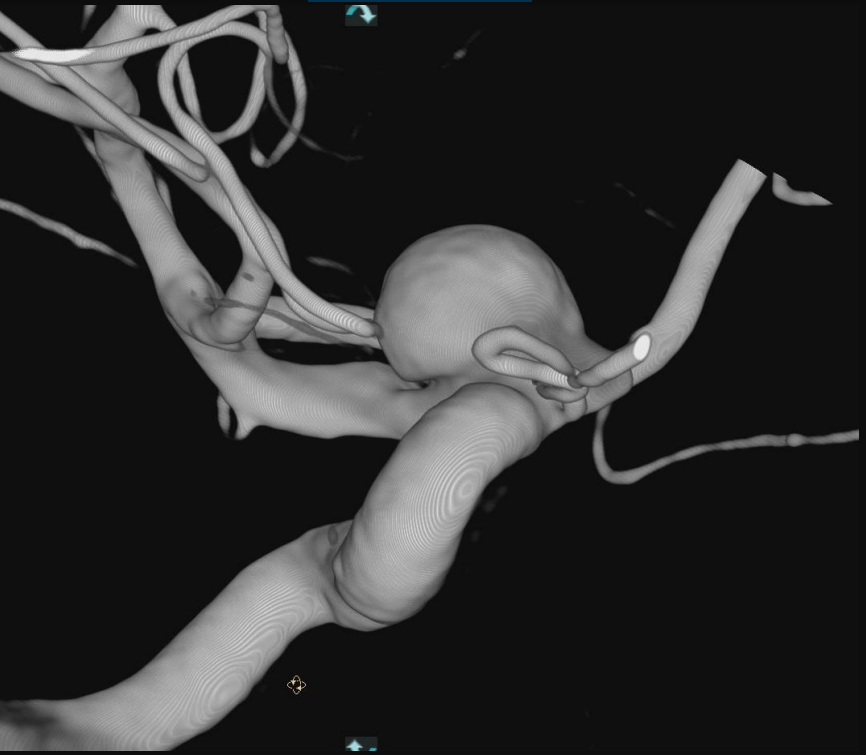




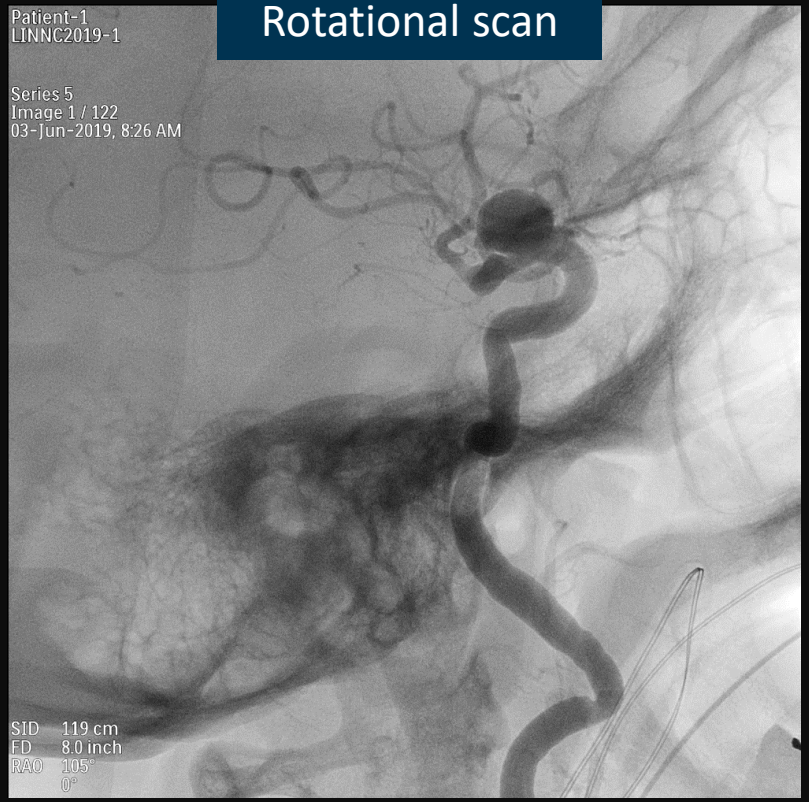
PHILIPS

Identifying the aneurysm on top of the ICA Syphon.

3D-RA



Rotational scan



SmartCT

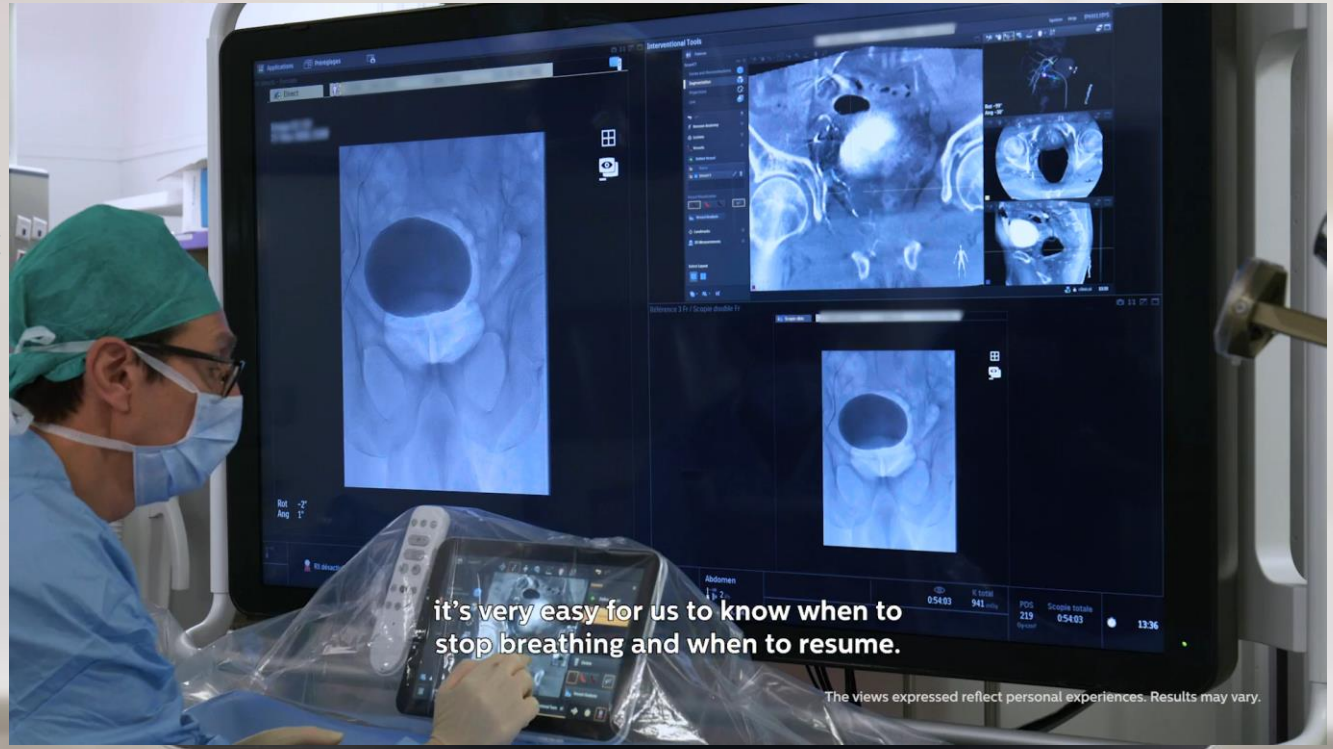
Intuitive interactions with the 3D images on the TSM

- Rotate
- Zoom
- Pan
- 2 points 3D measurement
- Lesion segmentation
- Vessel center line
- Vessel segmentation

SmartCT

Intuitive interactions with the 3D images on the TSM

- Rotate
- Zoom
- Pan
- 2 points 3D measurement
- Lesion segmentation
- Vessel center line
- Vessel segmentation



VasoCT with Metal Artefact Reduction (MAR)

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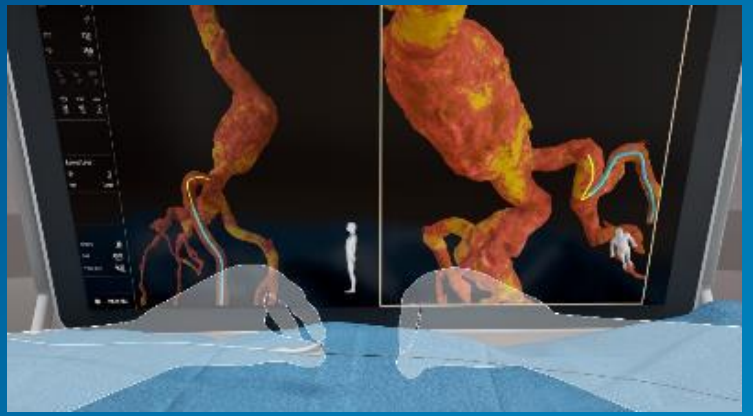


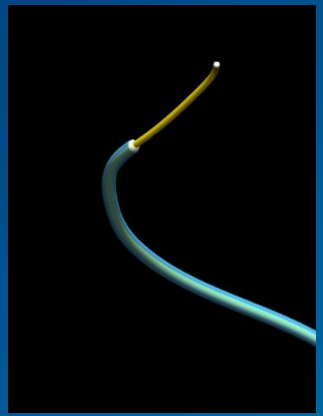
Fiber Optic RealShape Technology

Sparking a new era in image guided therapy

innovation + you

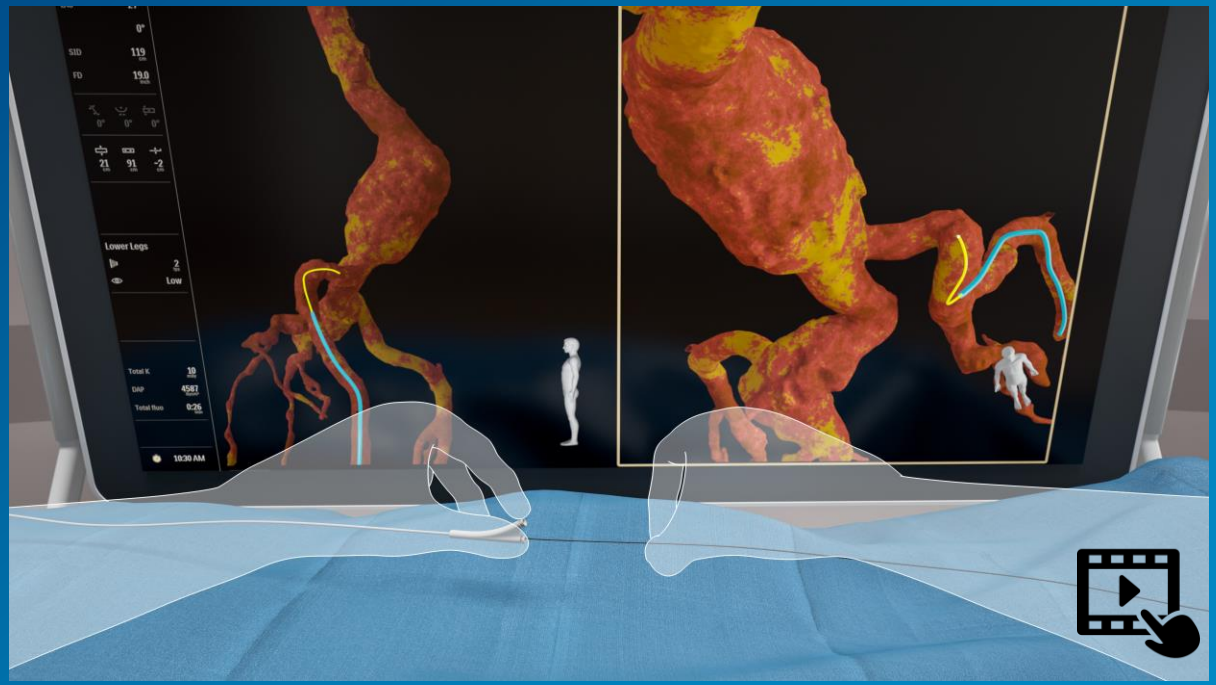
Not for distribution

FORS Guidance is a breakthrough technology in Image Guided Therapy



Gold-standard:

X-ray 2D, black and white images Ionizing radiation



Fiber Optic RealShape (FORS) technology

Enables real-time, 3D device visualization, in context of the anatomy, and this without using fluoroscopy

ClarifEye Augmented Reality Surgical Navigation for spine surgery

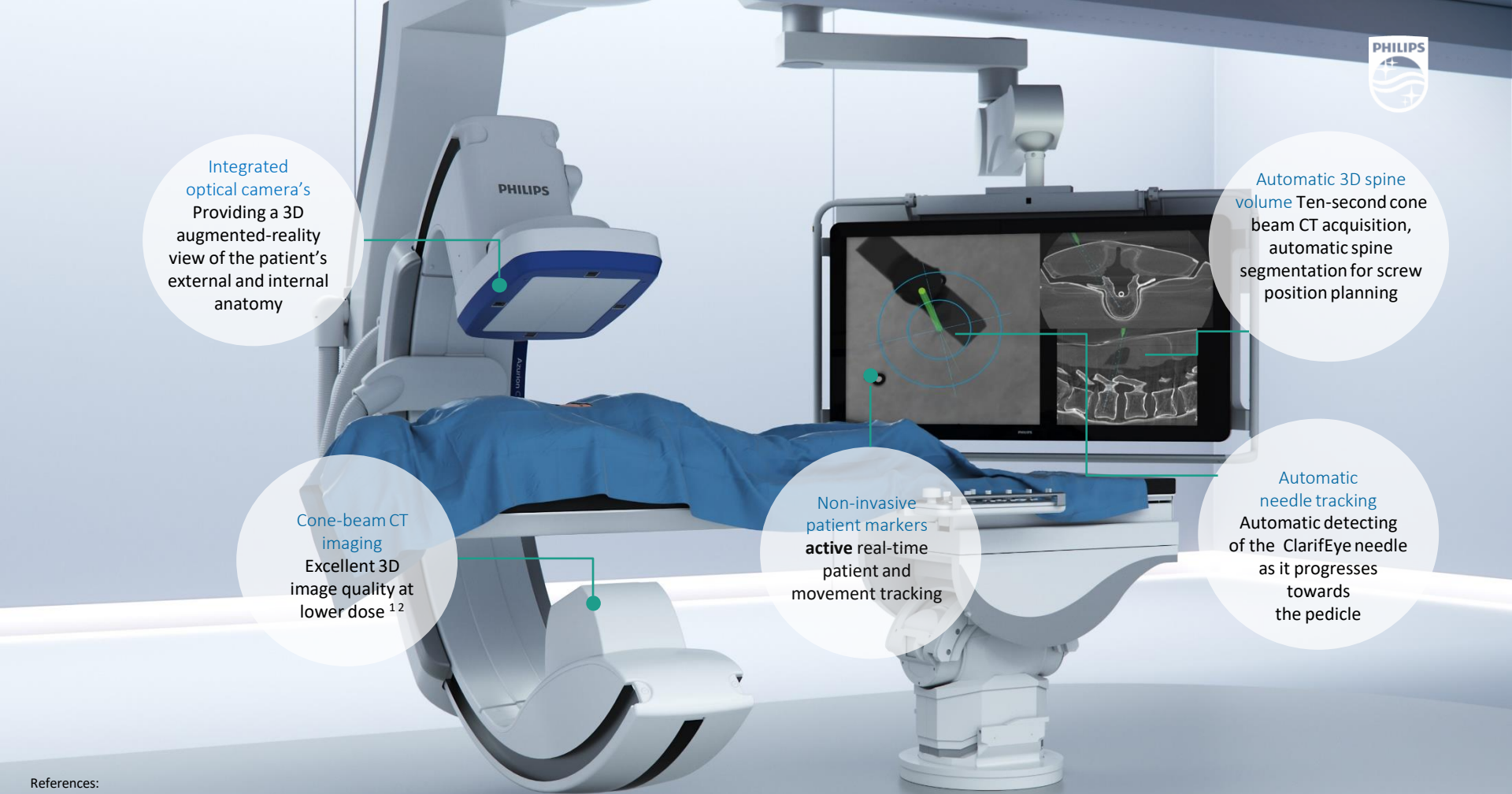
A unique all-in-one imaging and augmented reality (AR) surgical navigation solution, that assists device guidance for accurate[1] placement of pedicle screws.

- Excellent 2D and 3D visualizations at low X-ray dose reveal the complexity of spinal anatomy to support precise planning and implant placement.
- Intra-operative guidance increases clinical accuracy. Patients having received navigated surgeries are subject to less revision surgeries compared to the conventional method [1,2]
- Unique 3D augmented reality technology provides live visual feedback for accurate placement of pedicle screws.

"The augmented reality surgical navigation helps us to place pedicle screws in positions where we actually couldn't or wouldn't do that otherwise."

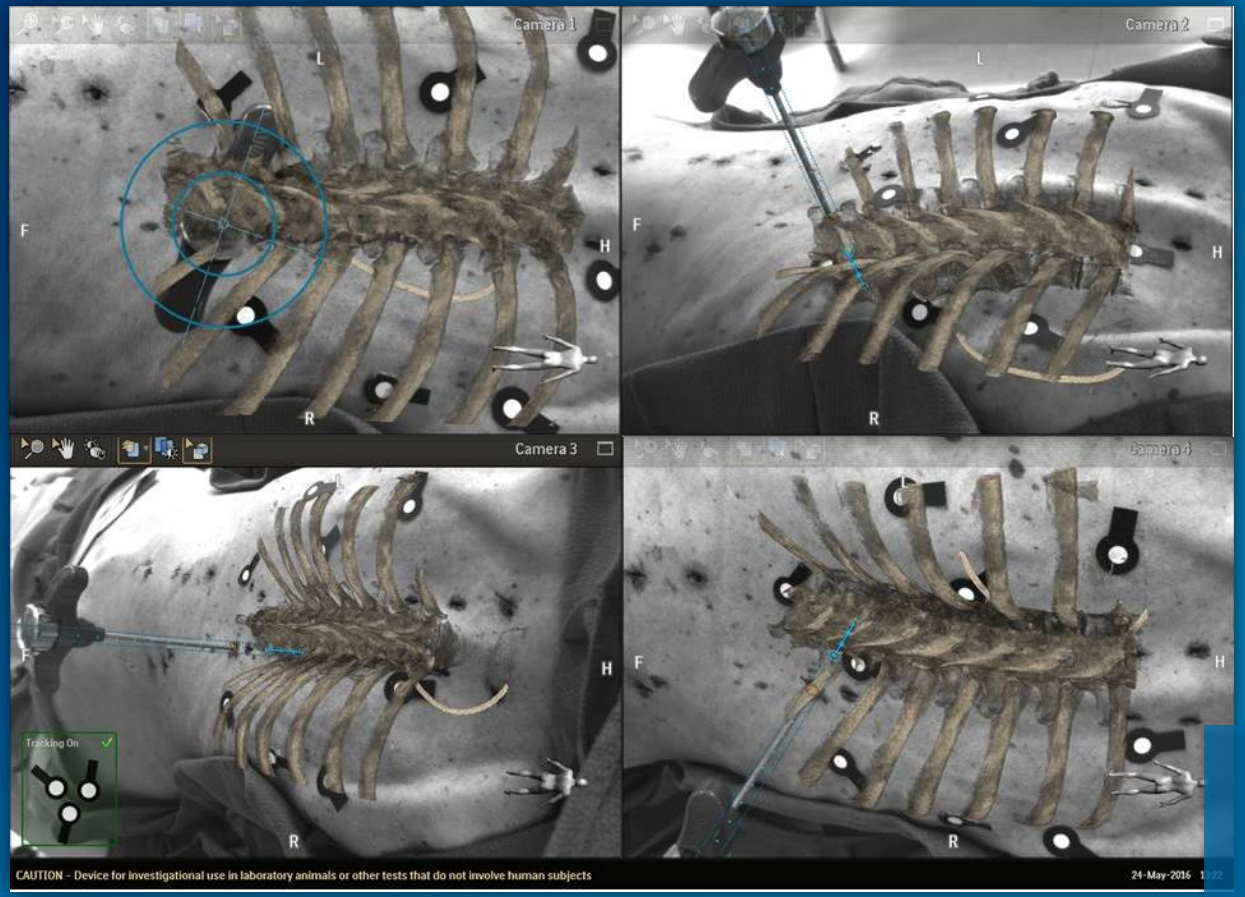
Dr. A Elmi-Terander, MD, PhD Sr Consultant Neurosurgery Karolinska University Hospital, Stockholm, Sweden

1. Dea N, Fisher CG, Batke J, Strelzow J, Mendelsohn D, Paquette SJ, Kwon BK, Boyd MD, Dvorak MFS, Street JT. Economic evaluation comparing intraoperative cone beam CT-based navigation and conventional fluoroscopy for the placement of spinal pedicle screws: a patient-level data cost-effectiveness analysis. The Spine Journal (2016) 16: 23–31.
2. Fichtner J, Hofmann N, Rienmüller A, Buchmann N, Gempt J, Kirschke JS, Ringel F, Meyer B, Ryang Y-M. Revision Rate of Misplaced Pedicle Screws of the ThoracolumbarSpineComparison of Three-Dimensional Fluoroscopy Navigation with Freehand Placement: A Systematic Analysis and Review of the Literature. World Neurosurg. (2018) 109: e24-e32.



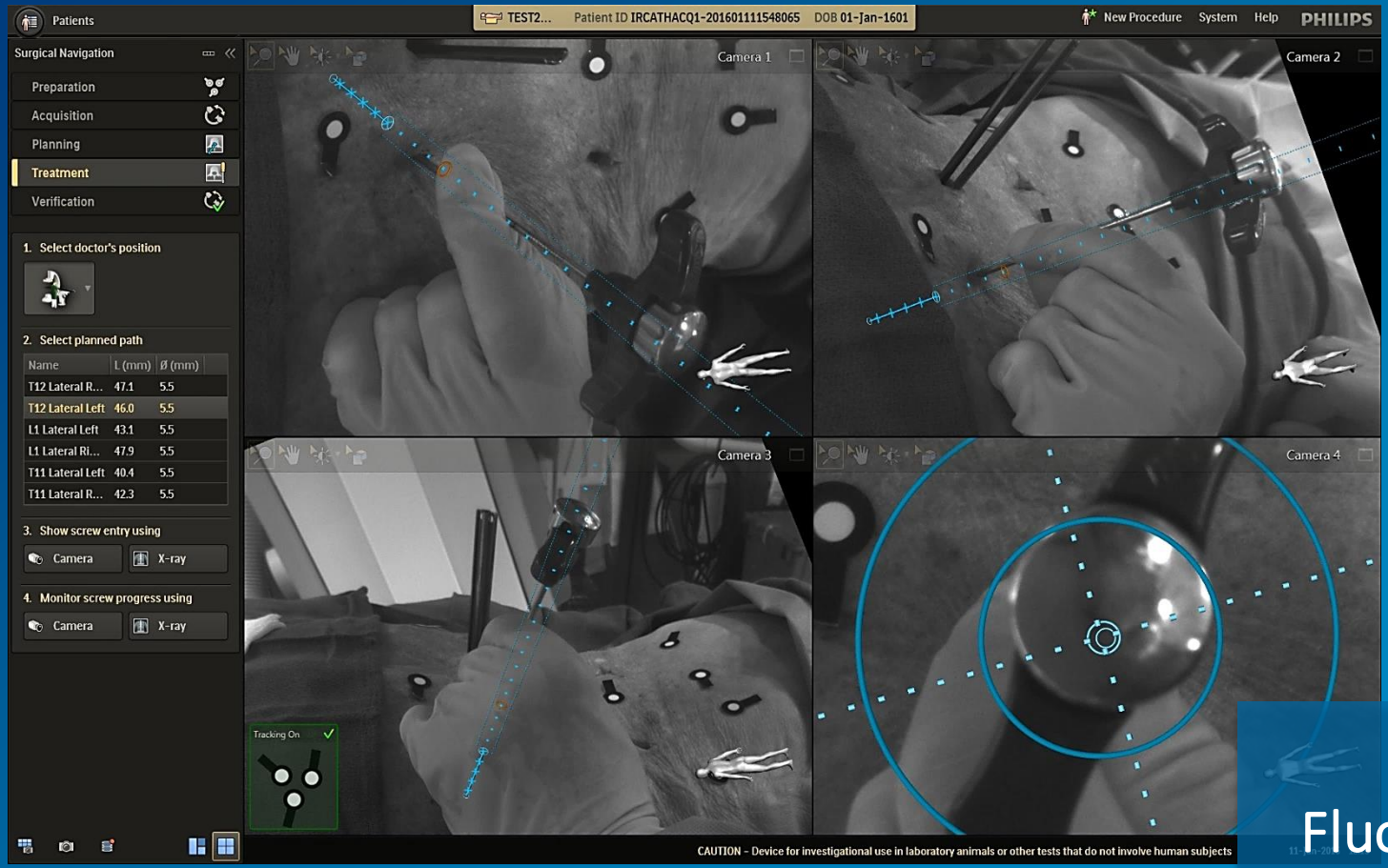
References:
1. Nevzati E, et al. Validation and accuracy of intraoperative CT scan using the Philips Allura Xper FD20 angiography suite for assessment of spinal instrumentation. British Journal of Neurosurgery. 2017 31:6, 741-6.
2. Nachabe et al. Radiation dose and image quality comparison during spine surgery with two different, intraoperative 3D imaging navigation systems. – Medical Imaging 2018. Single center pre-clinical study on industry-standard phantoms comparin
a Philips interventional X-ray system to mobile CBCT.

Philips Surgical Augmented reality – 3D Image Navigation



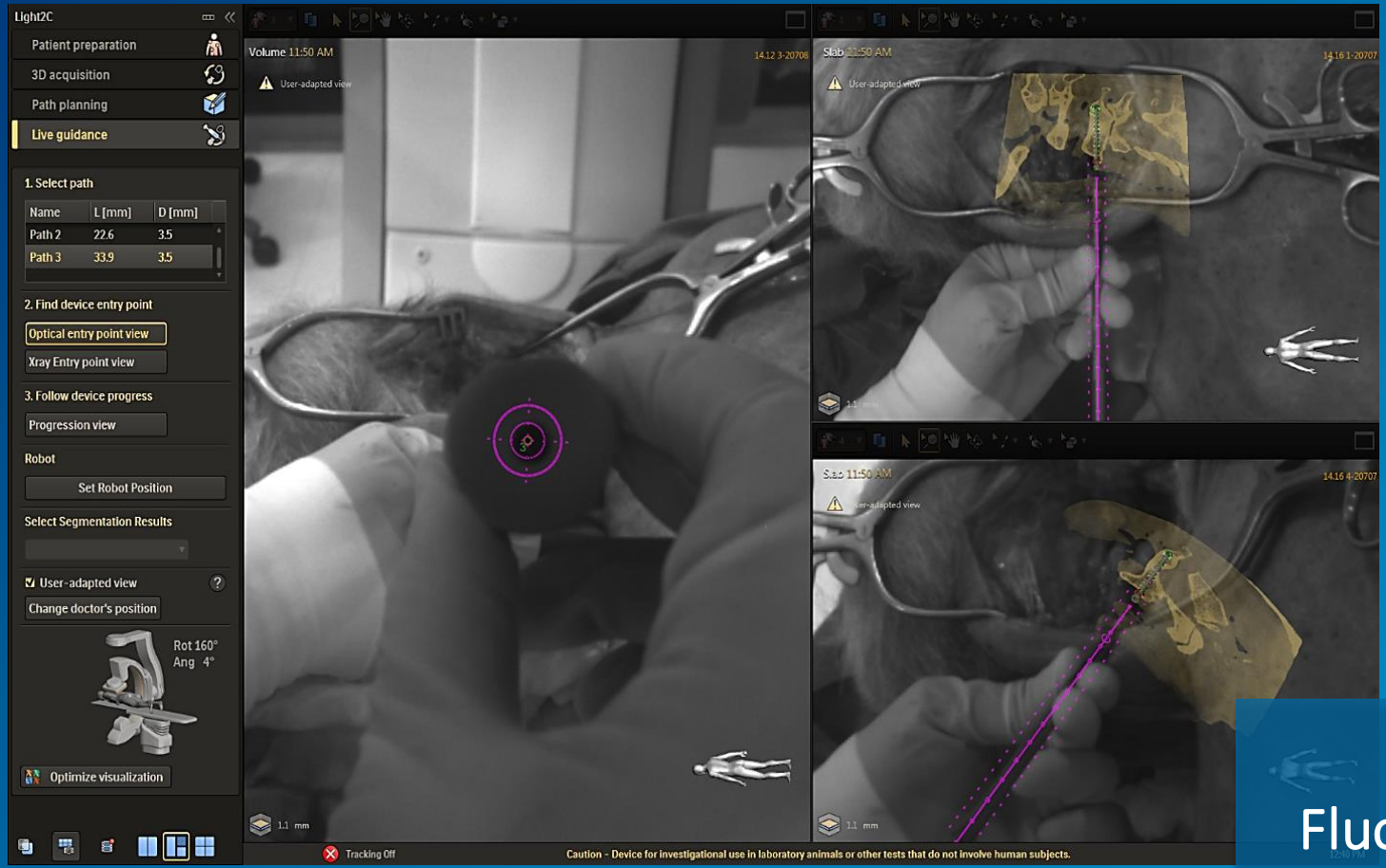
Without Fluoroscopy

Philips Surgical Augmented reality - Patient Tracking



Without Fluoroscopy

Philips Surgical Augmented reality – Integrated Workflow



Without Fluoroscopy


PHILIPS