

Dose management at Ziehm Imaging for 2D imaging

An educational paper on general dose principles and concepts as well as further insights on dose management for 2D imaging at Ziehm Imaging.

International organizations like the International Commission in Radiology Protection (ICRP), the European ALARA Network, the American Association of Physicists in Medicine (AAPM) and Image Gently are driving a rise in recognizing the importance of dose management and appropriate treatment. In addition, users and staff all over the world are more and more aware of this topic and raise concerns about their own safety, applying the right amount of radiation exposure to patients and finding the balance between the best image quality and a minimized dose.

As an internationally recognized innovator in the area of medical imaging with mobile C-arms, Ziehm Imaging sets its primary goal as providing the right solutions and giving the best opportunities to lower the dose by maintaining excellent image quality in daily clinical OR practice.

ALARA as an industry guideline

The medical field is always pushing for better image quality at lower radiation doses, whether it is to meet current regulatory requirements or to comply with hospital administrations calling to push the dose to even lower levels. The US Federal Code of Regulations (10 CFR 20.1003) defines the ALARA principle as “as low as reasonably achievable,” and the European ALARA Network also has a commission for the research and optimization of occupational exposure. Globally, the idea is to move to a low-dose practice. But the ultimate decision for selecting the appropriate dose with optimal image quality for a procedure is the responsibility of the end user. Ziehm Imaging provides the tools and training to raise users’ awareness and help them use these tools right in order to minimize the dose.

SmartDose Concept – Ziehm Imaging's comprehensive dose management

The comprehensive concept consists of a broad, clinically proven application portfolio to address the daily challenges of low doses and high image quality. With significant dose savings, Ziehm Imaging sets the benchmark in user-friendly adjustments of dose exposure.

Since 2017, the SmartDose Concept¹ comes in a further developed version with the Beam Filtration² technology. The new dose reduction technique for an optimized X-ray spectrum supports an enhanced imaging chain. The combination of the latest imaging technology with CMOS and Beam Filtration enables an exceptional reduction in the skin entrance dose for all CMOSline³ systems in comparison with systems using conventional filtration technology.²



LASER POSITIONING DEVICE

integrated in flat-panel or I.I. and generator housing for accurate and dose-free positioning of C-arm



OBJECT DETECTED DOSE CONTROL (ODDC)

to automatically analyze the area of interest and minimize dose while optimizing image quality



HIGH-SPEED ADR

for intelligent, fast regulation of pulse rate to lower the dose level



LOW DOSE MODE

in all anatomical programs for particularly dose-sensitive procedures, e.g. in pediatrics



AUTOMATIC ADJUSTMENT

for large patients – with no additional increase in dose



VIRTUAL COLLIMATORS

for exposure-free positioning of collimators



REDUCTION OF PULSE FREQUENCY

manually or fully automatically to lower the accumulated dose



ANATOMICAL PROGRAMS

with automatic optimization of dose and image quality for best results



ZAI ALGORITHM AND FILTERS

to display fast-moving objects like guide wires and even the smallest vessels in razor-sharp image quality



PREMAG

for exposure-free magnification of X-ray images



REMOVABLE GRID

to reduce dose in pediatric and other dose-sensitive procedures



BEAM FILTRATION

for reduced skin entrance dose without compromising on image quality

Measurements for three main principles

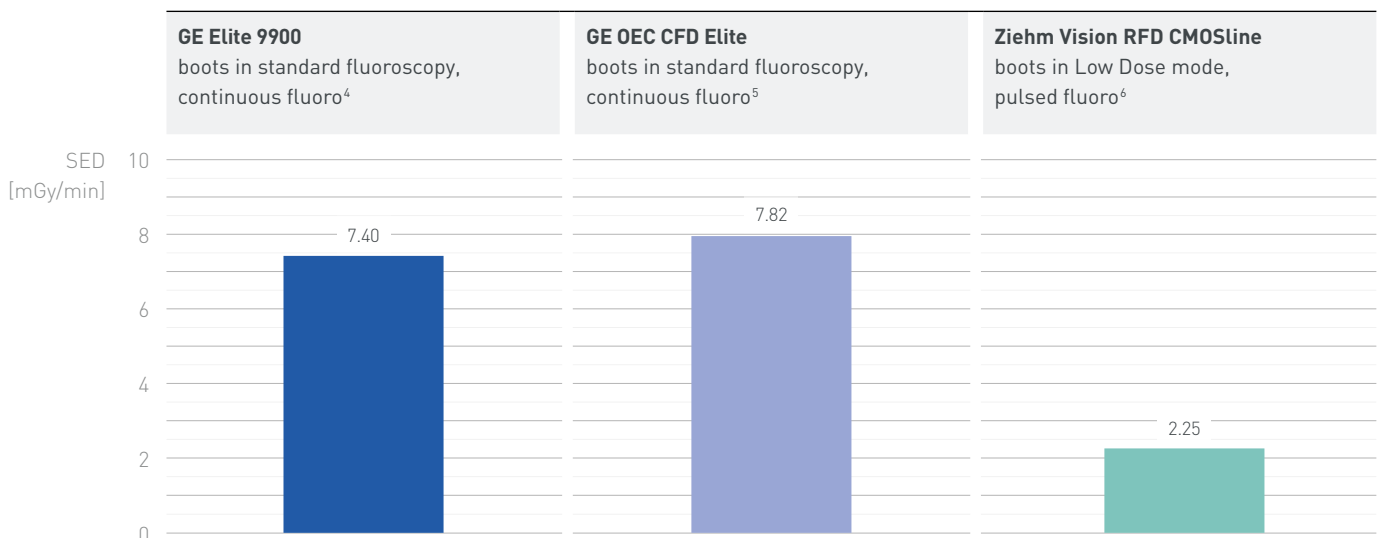
The principle “as low as reasonably achievable” – ALARA – serves as a rule of thumb for dealing radiation exposure. But in the end, hard facts are what matter most. The following chapter gives an overview of the three main principles of 2D imaging and their impact on radiation dose. We will also show facts and figures regarding the radiation dose of the premium line systems of Ziehm Imaging, called “CMOSline.” All measurements were done on the basis of the skin entrance dose (SED). The measurements are according to the IEC 60601-2-43:2010, 203.5.2.4.5.101 norm, which is recognized as the standard measurement technique in the industry for publications.

Principle one:

Ziehm Imaging’s CMOS flat-panel technology allows boot up configuration in Low Dose mode.

In comparison with conventional C-arms, the latest flat-panel technology, CMOS, achieves higher spatial resolution due to smaller pixel sizes combined with lower noise levels and a higher read-out speed at full resolution. Because of these features, the CMOS technology enables improved overall efficiency. Therefore the boot up configuration of all CMOSline systems of Ziehm Imaging is originally set to the Low Dose mode, providing excellent image quality with significant lower dose levels (Table 1).

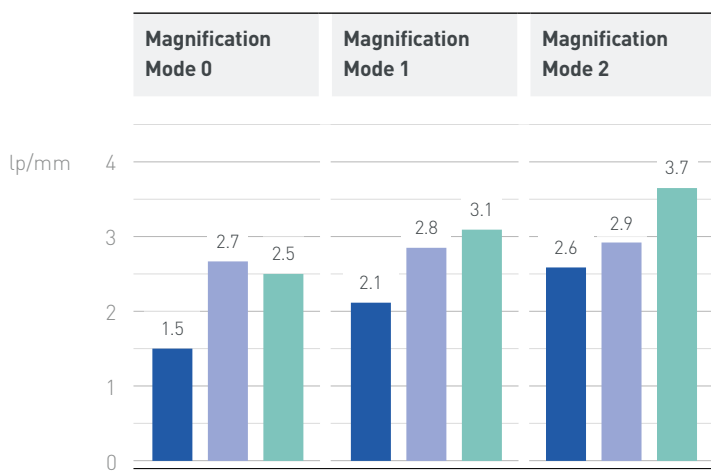
Table 1: Boot up configuration



Principle two:

No increase of radiation dose in the magnification modes.

Table 2: Line pair comparison in magnification modes

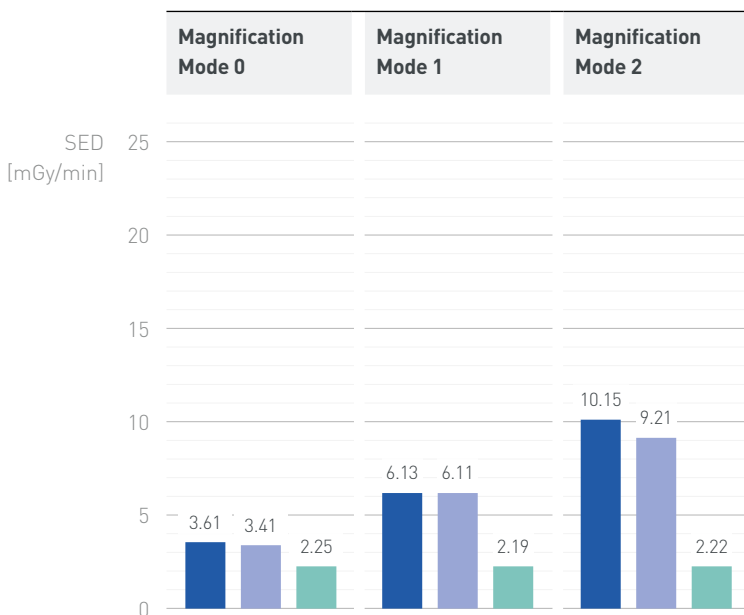


In comparison with conventional image intensifiers, flat-panel systems with a-Si or CMOS technology show constant dose levels in the magnification modes (Table 3). This can be rated as a clear advantage of flat-panel technology over image intensifiers. But until now, a-Si flat-panel detectors with a pixel size of 150–210 μm were less competitive or even inferior with regard to native resolution when compared to image intensifiers. Due to a pixel size of 100 μm in Ziehm Imaging's CMOS wafers, this disadvantage can now be overcome for Ziehm Imaging systems (Table 2).

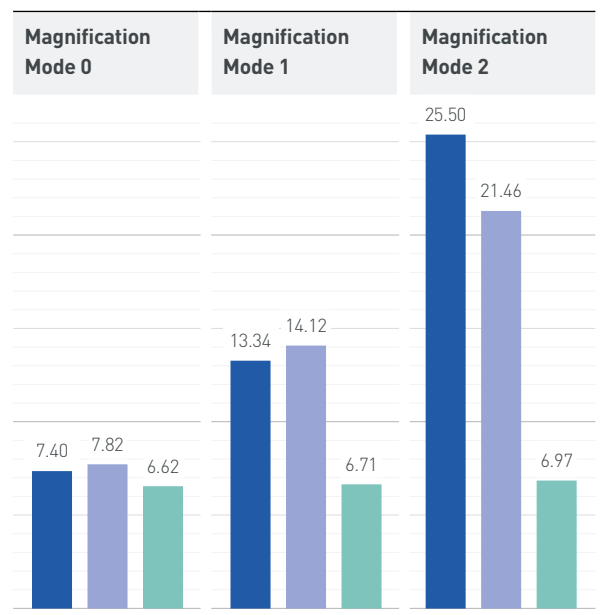
With a spatial resolution of more than 3.7 line pairs per millimeter and a native resolution with no interpolation (true resolution) of up to 30 images per second, the Ziehm Imaging 31 cm x 31 cm detector achieves greater resolution and better dose levels over all magnification modes (Table 2 and 3). This results in an improved image quality, especially over conventional technology such as image intensifiers and conventional flat-panel systems.

Table 3: Dose levels in magnification modes

Low Dose mode



Standard mode



■ GE Elite 9900 with 12" image intensifier⁷
■ GE OEC CFD Elite with CMOS flat-panel detector; 31 cm x 31 cm, 198 μm pixel size⁵
■ Ziehm Vision RFD CMOSline with CMOS flat-panel detector; 31 cm x 31 cm, 100 μm pixel size⁸

Principle three:

Pulsed fluoroscopy done right is the leading industry standard in fluoroscopy.

Like fixed installed systems and the latest mobile C-arm systems, pulsed fluoroscopy is known as the standard technology in fluoroscopy. Pulsed fluoroscopy with the proper selection of anatomical programs, program modifier and pulse rate can provide a less-accumulated dose than a continuous X-ray system in a low-dose setting. Therefore, pulsed fluoroscopy must be done right. There is no way to generate the lowest-possible dose levels by decreasing image quality to a minimum.

Especially for high demand applications, like cardiovascular interventions where motion is critical and image quality is key, pulsed fluoroscopy is a must for sharp images. As the innovation leader in the field of mobile imaging, Ziehm Imaging has

used pulsed fluoroscopy since the beginning of the 2000s. Ziehm Imaging systems are able to show the maximum image quality at any reduced pulse frequency with accordingly reduced dose levels.

The images below show a comparison between Ziehm Imaging's and GE's pulse technology. The comparison in the upper line clearly shows a constant image quality of Ziehm Imaging over the different pulse rates. The SmartDose Concept enables Ziehm Imaging systems to lower the dose in each available pulse rate to a minimum by holding the image quality at a constant level. This feature works for certain organ programs automatically. The lower line shows the image quality of GE's systems, where a minor image quality can be recognized with lowered pulse rates which could only be eliminated with the introduction of higher dose levels.

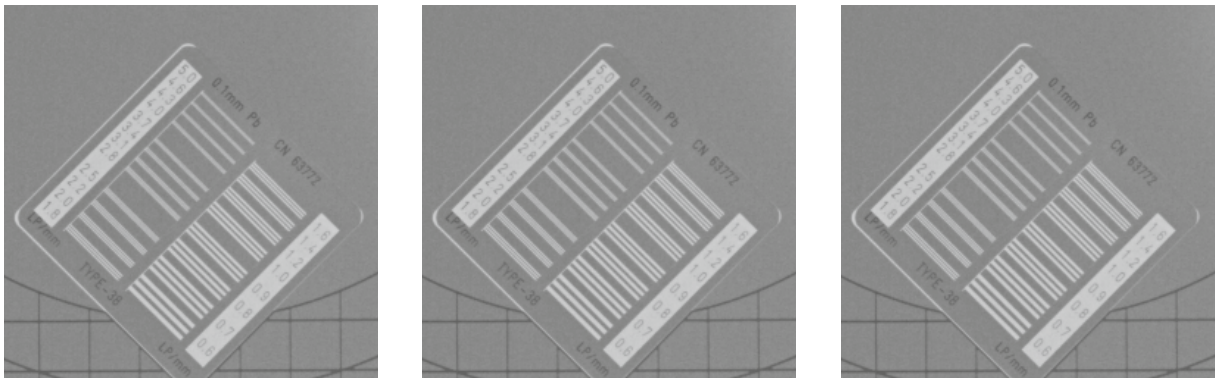


Image quality comparison of Ziehm Vision RFD CMOSline with maximum pulse rate [25] / 8 / 1 pulses/sec

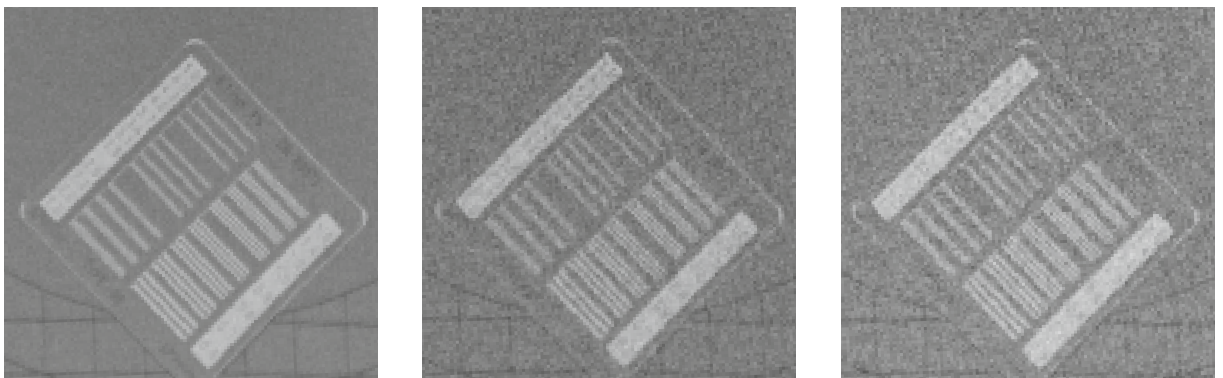


Image quality comparison of GE Elite 9900 with maximum pulse rate [Cont] / 8 / 1 pulses/sec

Conclusion

As the innovation leader in the field of mobile X-rays, Ziehm Imaging is committed to the mission of setting new technology standards and benchmarks in dose reduction. With the CMOS imaging technology, pulsed fluoroscopy and by providing the right and latest hard- and software features through the comprehensive SmartDose Concept, we demonstrate responsible and innovative behavior regarding the important topic of doses, which engages the whole medical imaging industry.

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- ¹ The SmartDose Concept includes a variety of hardware and software features. Due to regulatory reasons, the availability of each feature may vary. Please contact your local Ziehm Imaging sales representative for detailed information.
- ² The technology Beam Filtration reduces dose exposure for all CMOSline systems in comparison with conventional filtration techniques (status before September 2017). Data on file. Results may vary.
- ³ CMOSline represents a system configuration that is based on a Ziehm Imaging CMOS flat-panel detector.
- ⁴ Internal measurement of Ziehm Imaging acc. to IEC 60601-2-43:2010, 203.5.2.4.5.101. Data on file. Results may vary.
- ⁵ Line pair comparison according to GE Technical Datasheet; Dose values according to GE OEC Elite user manual 2018, Rev. 5483603-8DE-09, in Low Dose/standard fluoroscopy, continuous fluoro.
- ⁶ Internal measurement acc. to IEC 60601-2-43:2010, 203.5.2.4.5.101 in the anatomical program Bone Trunk. Data on file. Results may vary.
- ⁷ Line pair comparison according to GE Technical Datasheet; Dose values according to internal measurement of Ziehm Imaging acc. to IEC 60601-2-43:2010, 203.5.2.4.5.101, in Low Dose/standard fluoroscopy, continuous fluoro. Data on file. Results may vary.
- ⁸ Line pair comparison according to internal measurements (industry standard DIN 6868-150:2013-06); Dose values according to internal measurement (IEC 60601-2-43:2010, 203.5.2.4.5.101) in the anatomical program Bone Trunk, in Low Dose/standard mode, pulsed fluoro. Data on file. Results may vary.