

The Gold Standard in Clinical Image Processing

MUSICA

*20+ years of experience: "The diagnosis is in the details"*

**AGFA**   
HealthCare

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# Image Quality (IQ): A Journey through Time...

1895



Now



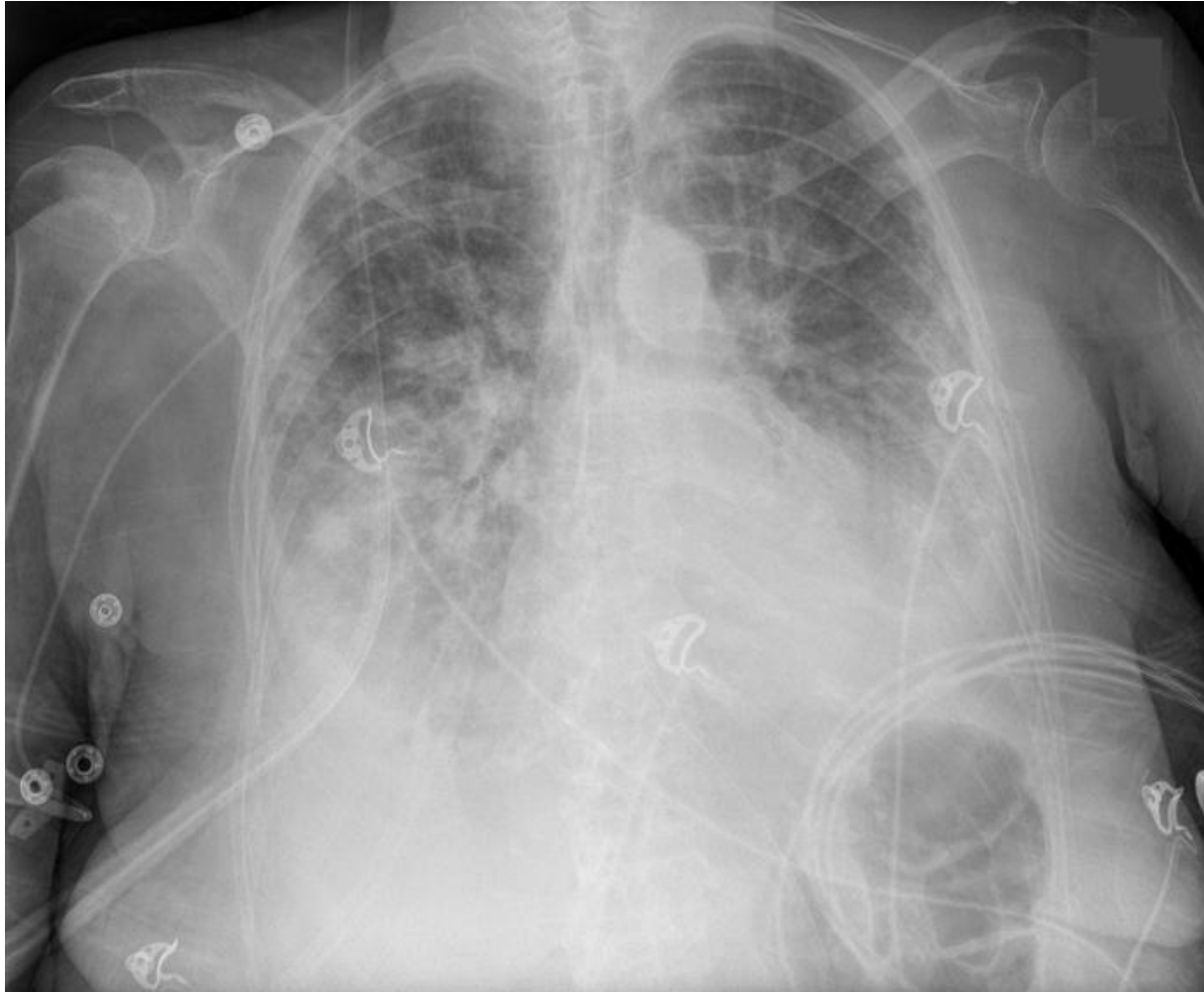
# Intelligent Image Processing



Looking deep into the universe

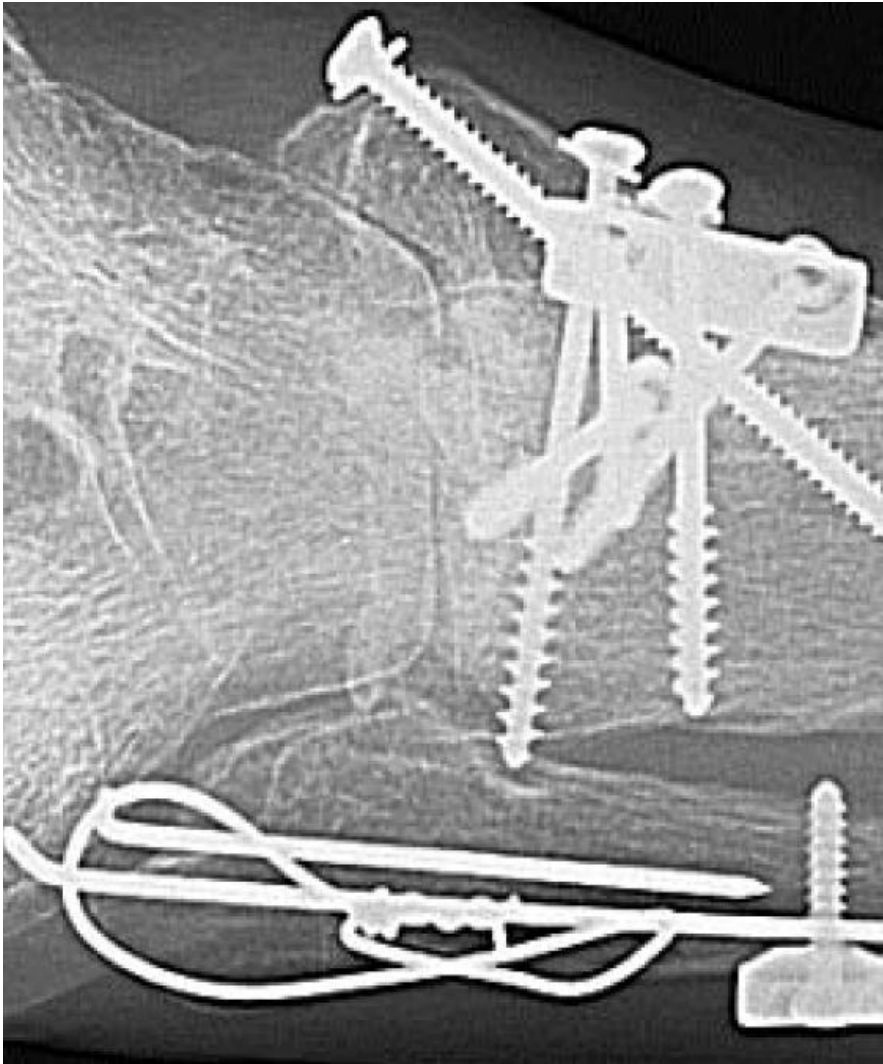


# Intelligent Image Processing



Looking deep into the human body

# Image Processing: The Pitfalls



- Conventional enhancement (e.g. unsharp masking, edge enhancement) can produce artifacts around high-contrast objects.
- Note the **over- and undershoots** around the metal hardware, which could be mistaken for **delamination**.
- Intelligent Clinical Image Processing is required.



## MUSICA

# Intelligent Image Processing

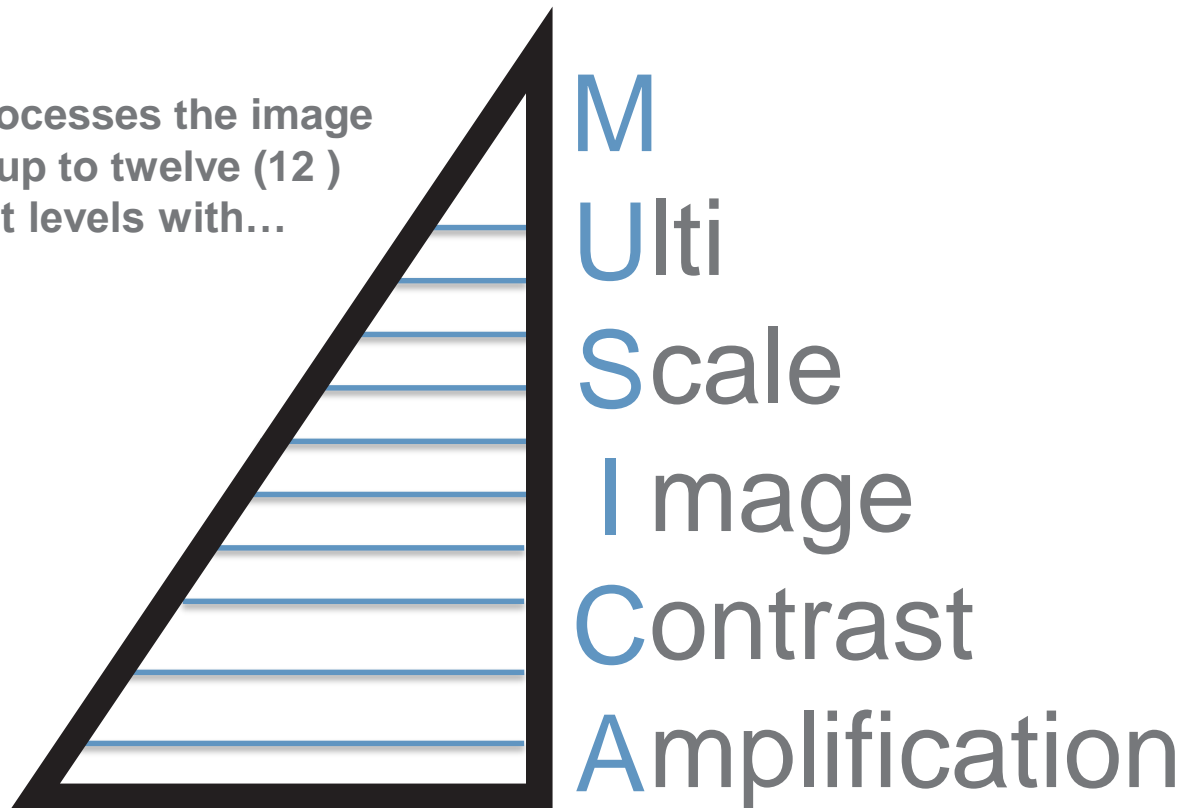


## MUSICA Multi-Scale Image Contrast Amplification

# MUSICA: Intelligent Image Processing

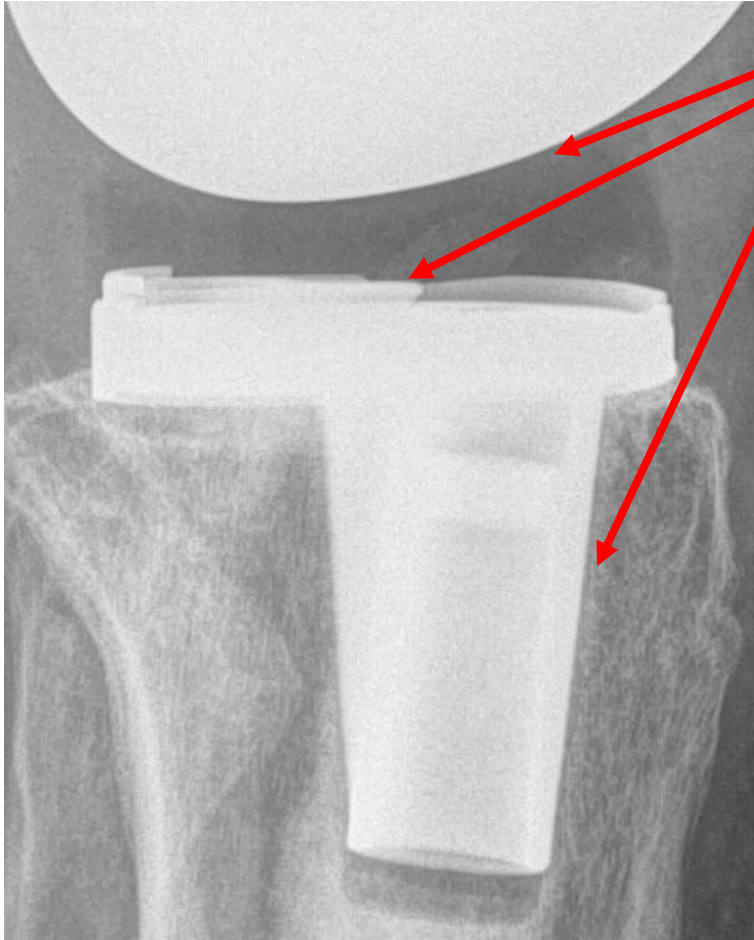
- Agfa pioneered and patented multi-scale processing in medical imaging in the mid-90s. MUSICA is now in its 3rd generation

Agfa processes the image data at up to twelve (12) different levels with...





# MUSICA Intelligent Image Processing



No artifacts around the sharp transitions while having a “sharp” image.

# MUSICA: Intelligent Image Processing



**Standard**

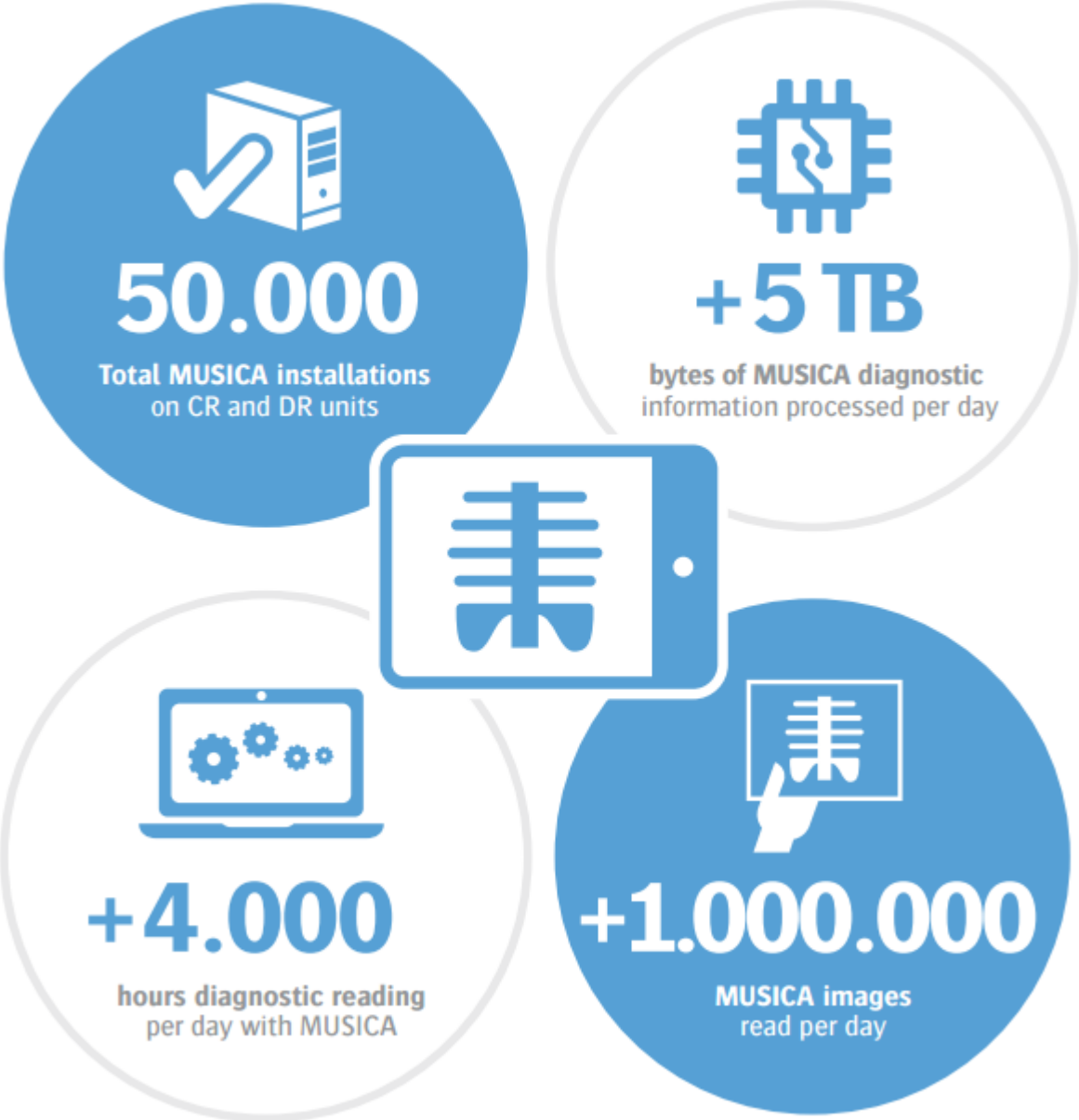


**MUSICA**

# MUSICA: What do our customers say...

- "Thanks to MUSICA, no other solution can beat its image quality. Today, the radiologists will not accept any imaging solution that cannot work with MUSICA."
  - Sally Grady, Director of Imaging Services, Celebration Health, Florida, USA
- "Thanks to MUSICA, the continuous quality seen in all images means better diagnostic confidence for the radiologist."
  - Andrew Featherstone, Section Manager, General X-ray and Theaters, Sydney Adventist Hospital, Australia

# MUSICA





# MUSICA 3

- Back in the 90's, Agfa established a breakthrough in digital image processing with its invention of **MUSICA** contrast enhancement founded on multiscale mathematics

**MU**lti-**S**cale **I**mage **C**ontrast **A**mplification

- Now **20 years later**, we again take a major innovative step with **Fractional Multiscale Processing (FMP)** as the core of the third generation **MUSICA** (Patented)

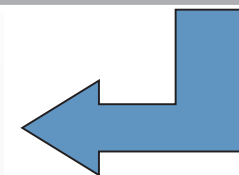


# MUSICA: Intelligent Image Processing

- **MUSICA1**
  - 2,000,000,000 instructions per image
  - 200 instructions / pixel
- **MUSICA2**
  - 3,000,000,000 instructions per image
  - 300 instructions / pixel
- **MUSICA3**
  - 10,000,000,000 instructions per image
  - 1,000 instructions / pixel

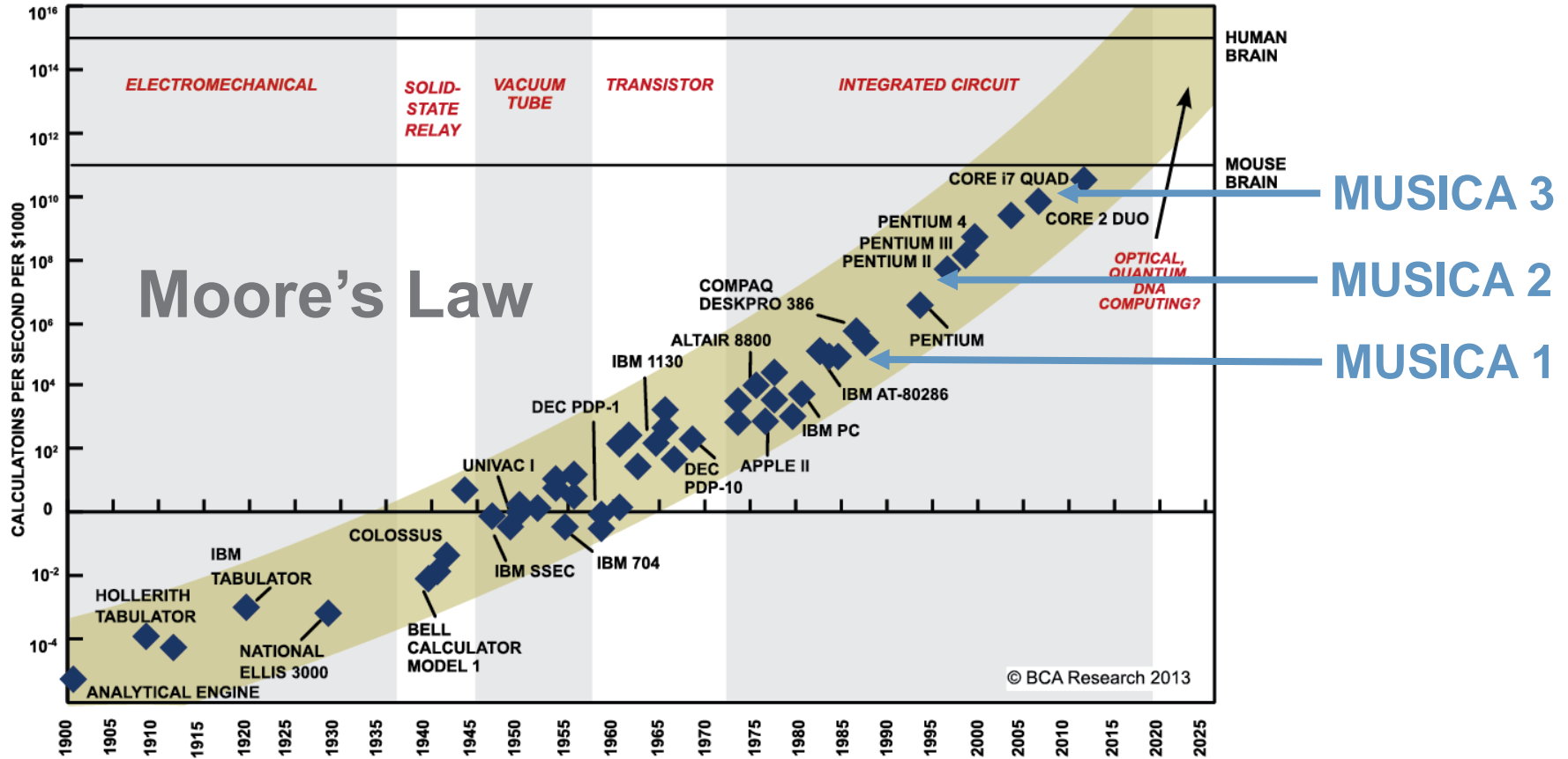


1 0,000,000,000



**MUSICA** advances need **increasing computing power**

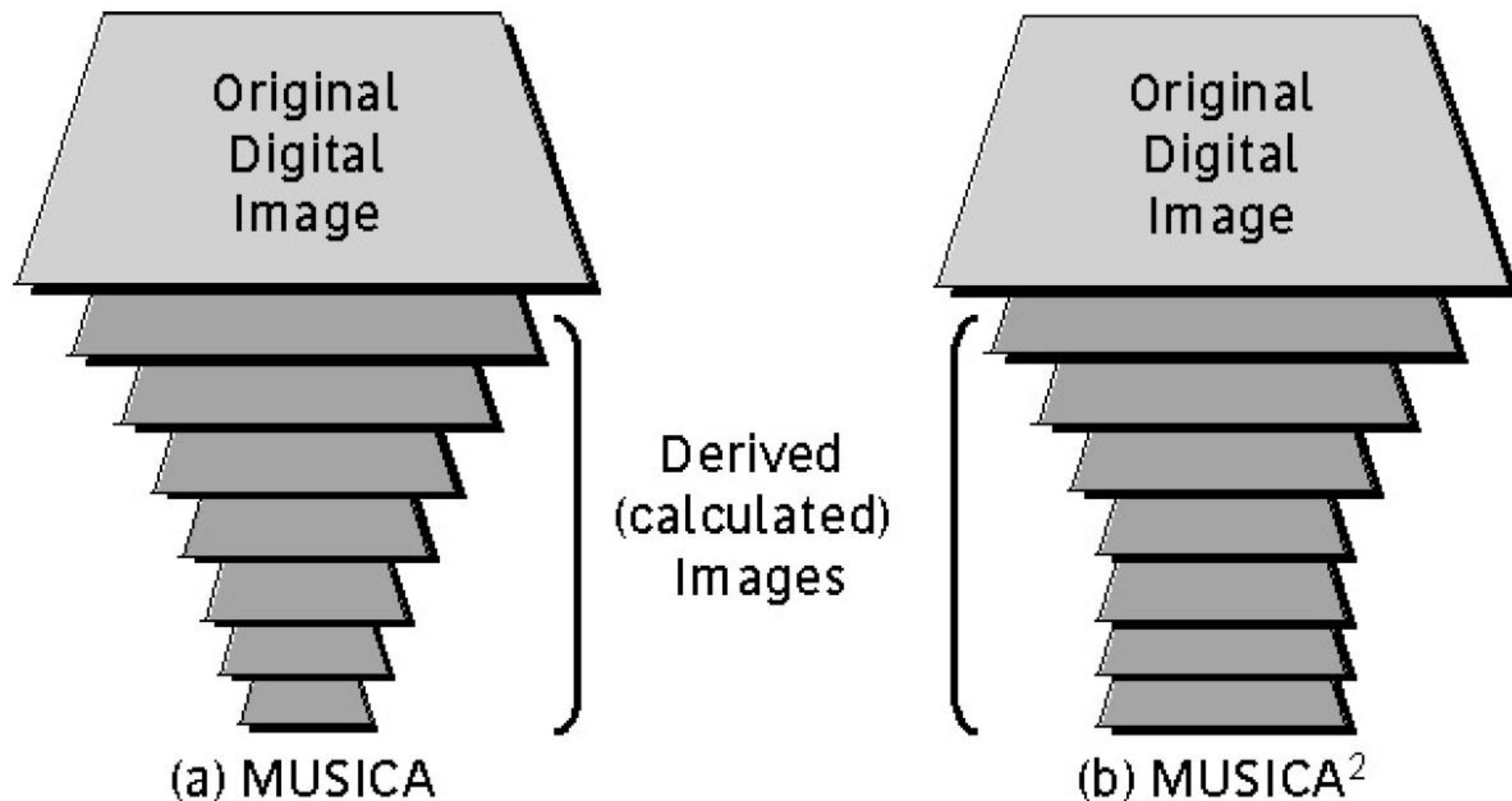
# MUSICA: Intelligent Image Processing



SOURCE: RAY KURZWEIL, "THE SINGULARITY IS NEAR: WHEN HUMANS TRANSCEND BIOLOGY", P.67, THE VIKING PRESS, 2006. DATAPPOINTS BETWEEN 2000 AND 2012 REPRESENT BCA ESTIMATES.

MUSICA advances need increasing computing power

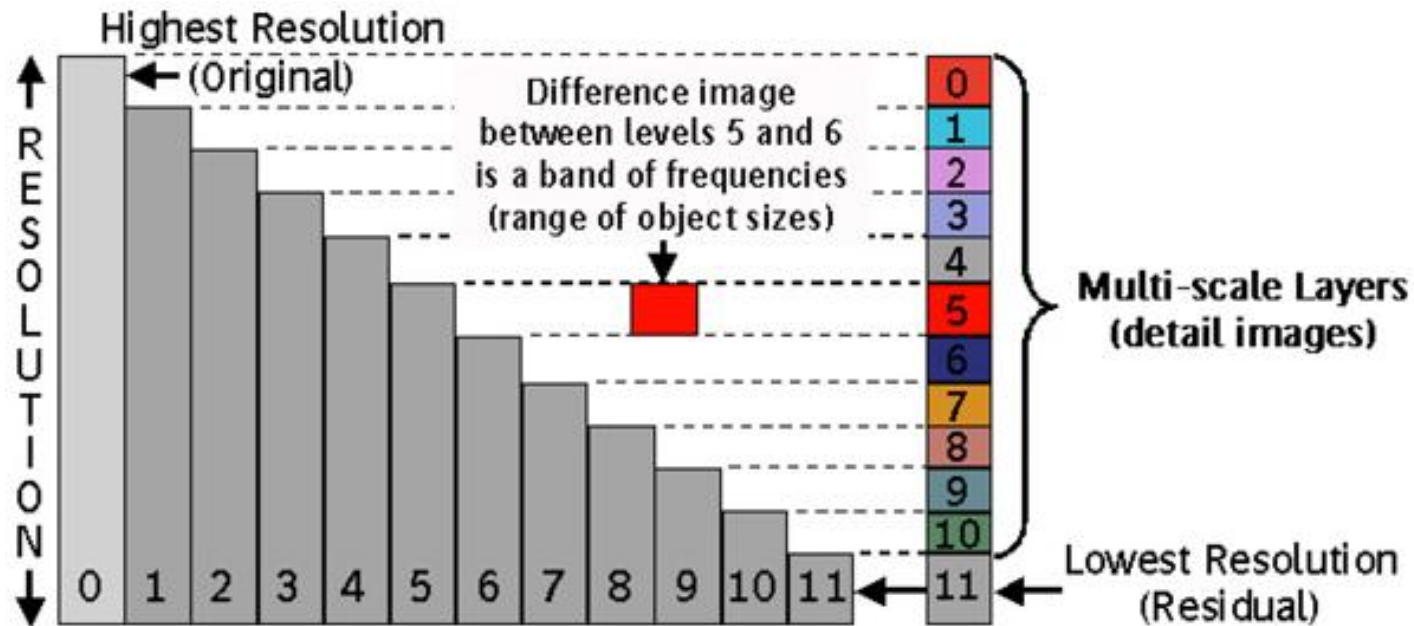
# MUSICA 1 >< MUSICA 2



**Multi-scale** transform. (a) MUSICA uses a pyramidal structure, with matrix sizes decreasing continuously; (b) MUSICA2 uses a funnel (no sub-sampling in lower layers).

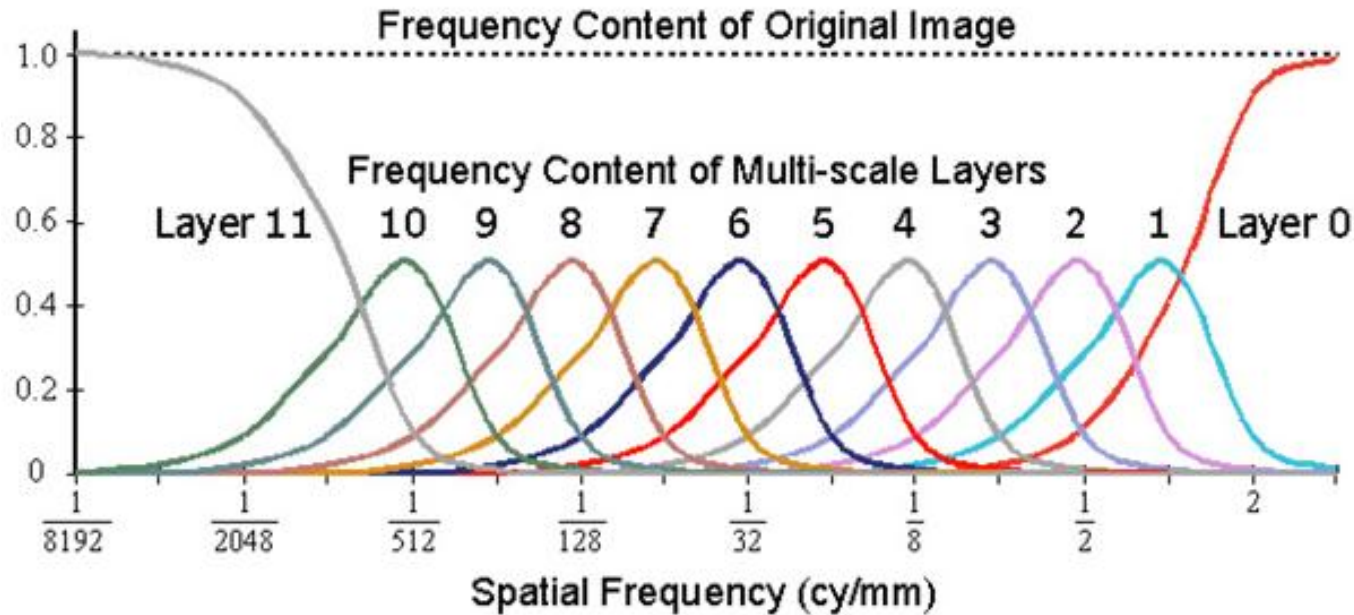


# MUSICA 2



The concept of the [multi-scale transform](#). The original grayscale image (0) is converted by low-pass filtering into a set of grayscale images (1-11) with progressively lower spatial resolution. The lowest resolution image (11) is the residual. The pixel-by-pixel difference between each pair of neighboring images is a detail layer of the multi-scale representation, and contains details (contrast) in a sub-band of the total frequency range.

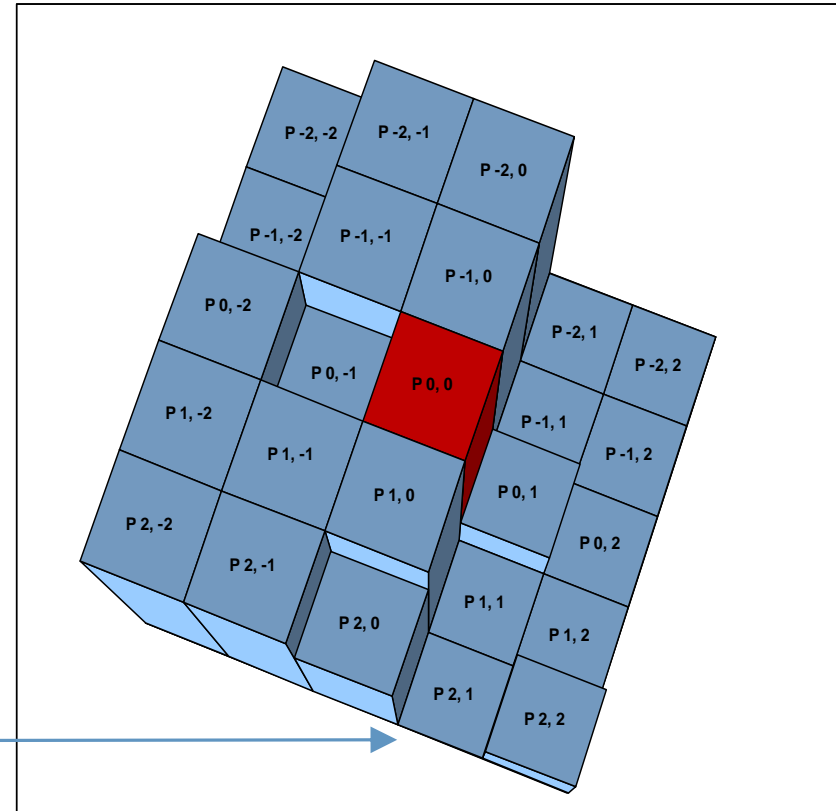
# MUSICA 2



The actual frequency content of the detail layers in the [multi-scale transform](#). The frequencies present in the original image are represented by the horizontal dotted line. The frequency content of each detail layer (12 in this example) is given by one of the curves.

# MUSICA 2

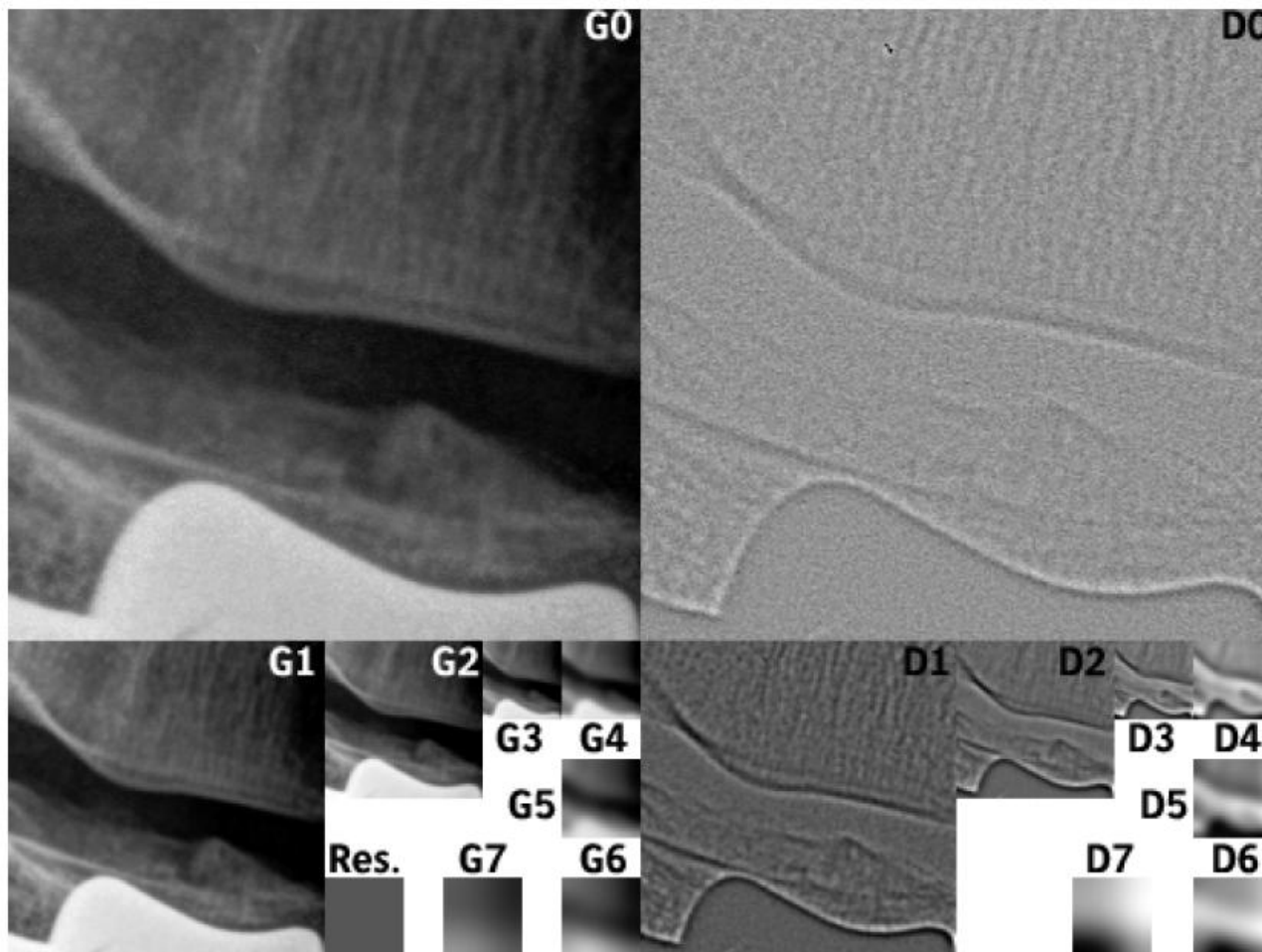
- Multi-scale Processing



High contrast edge

The amount of contrast enhancement is calculated based on the weighted average of the kernel pixels.

# MUSICA 2



The **MUSICA<sup>2</sup>** funnel of a knee image.

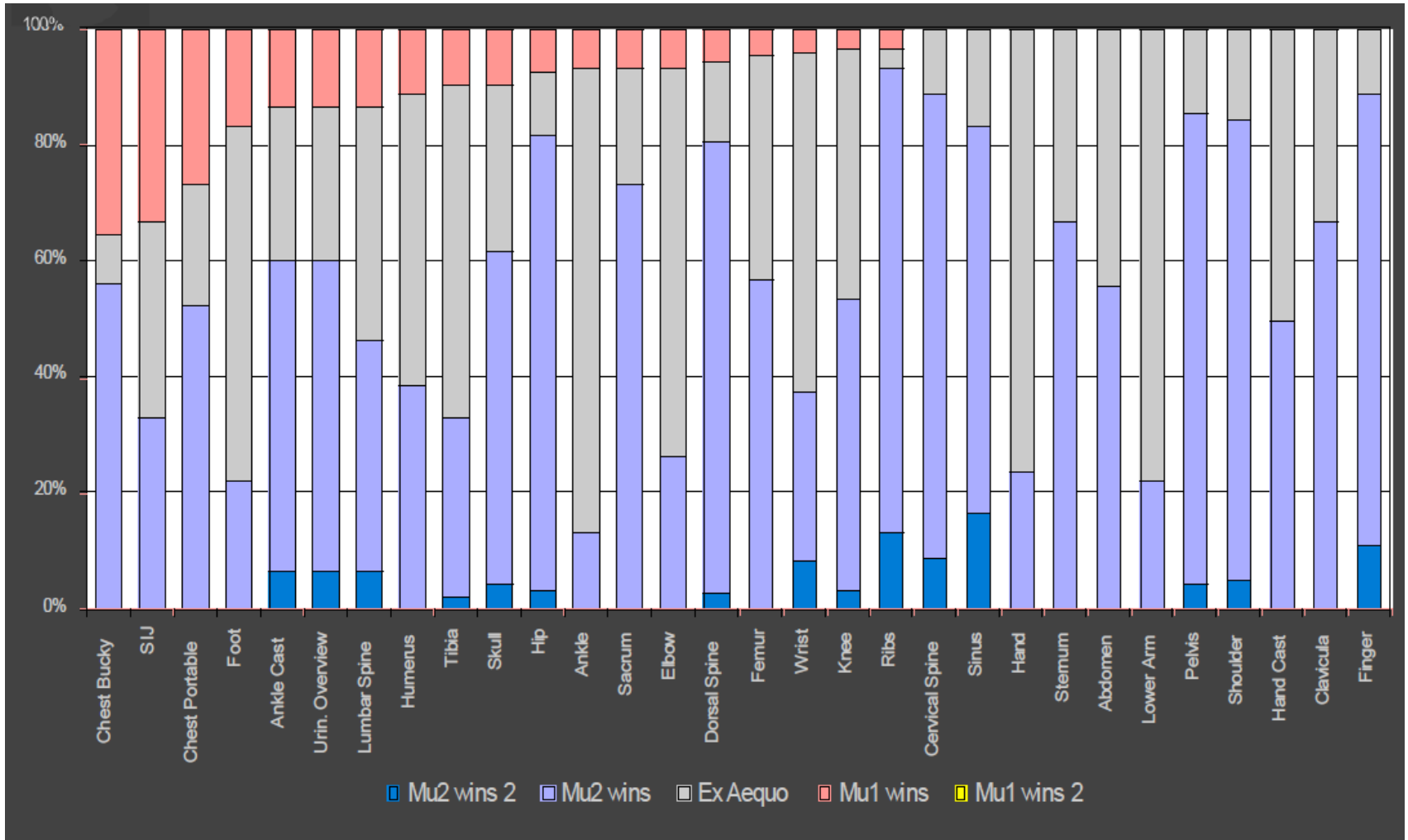
**Gx** labeled images are the grayscale image stack.

**Dx** labeled images are the detail image stack.

Note that the scale of the details gets coarser at deeper levels in the stack.



# MUSICA 1 >< MUSICA 2



## Clinical study: Global Preference by Examination class

# MUSICA 1 >< MUSICA 2

MUSICA



MUSICA<sup>2</sup>



## Example: Bone Rendering

# MUSICA 1 >< MUSICA 2

MUSICA



MUSICA<sup>2</sup>



## Example: Bone Rendering

# MUSICA 1 >< MUSICA 2

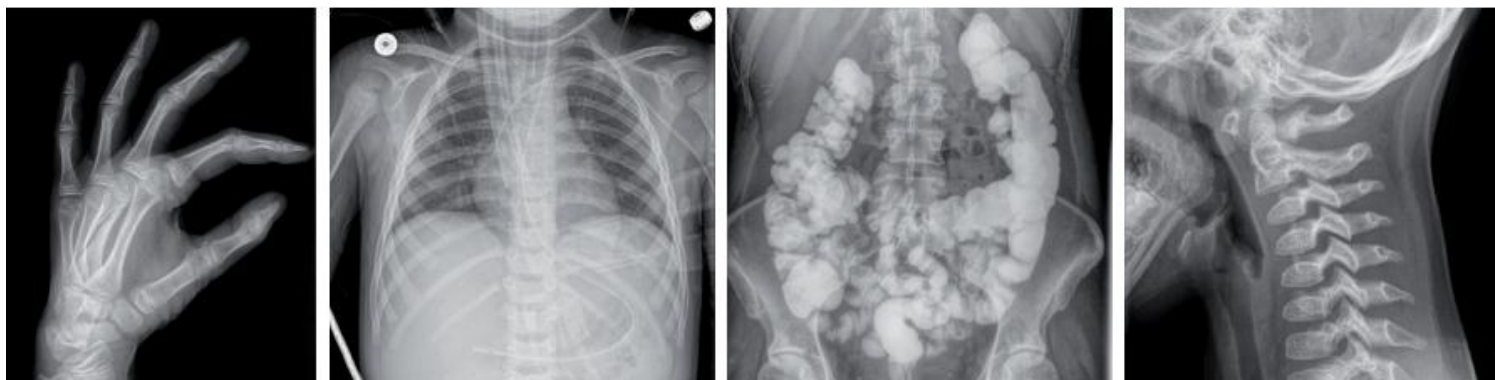


## Example: Soft Tissue Rendering



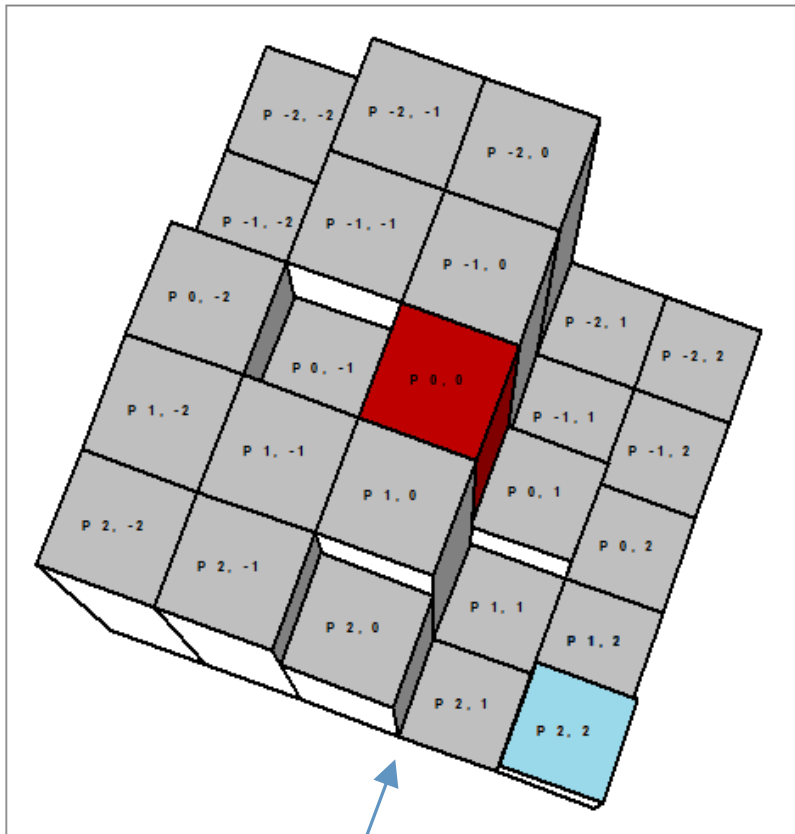
# MUSICA 3

- **Fractional Multiscale Reconstruction (FMR):**
  - This new technology takes multi-scaled image processing to a new level of excellence. **FMR** is the new mathematical substructure of Agfa HealthCare's image processing software, which further decomposes image components in **microscopic fractions for separate processing**.
  - **FMR** results in a more accurate multi-scale enhancement model, a balanced participation of all filter kernel pixels in the enhancement process, and **better preservation of low contrast details next to high contrast steps**.



# MUSICA 3

- Fractional Multiscale Processing

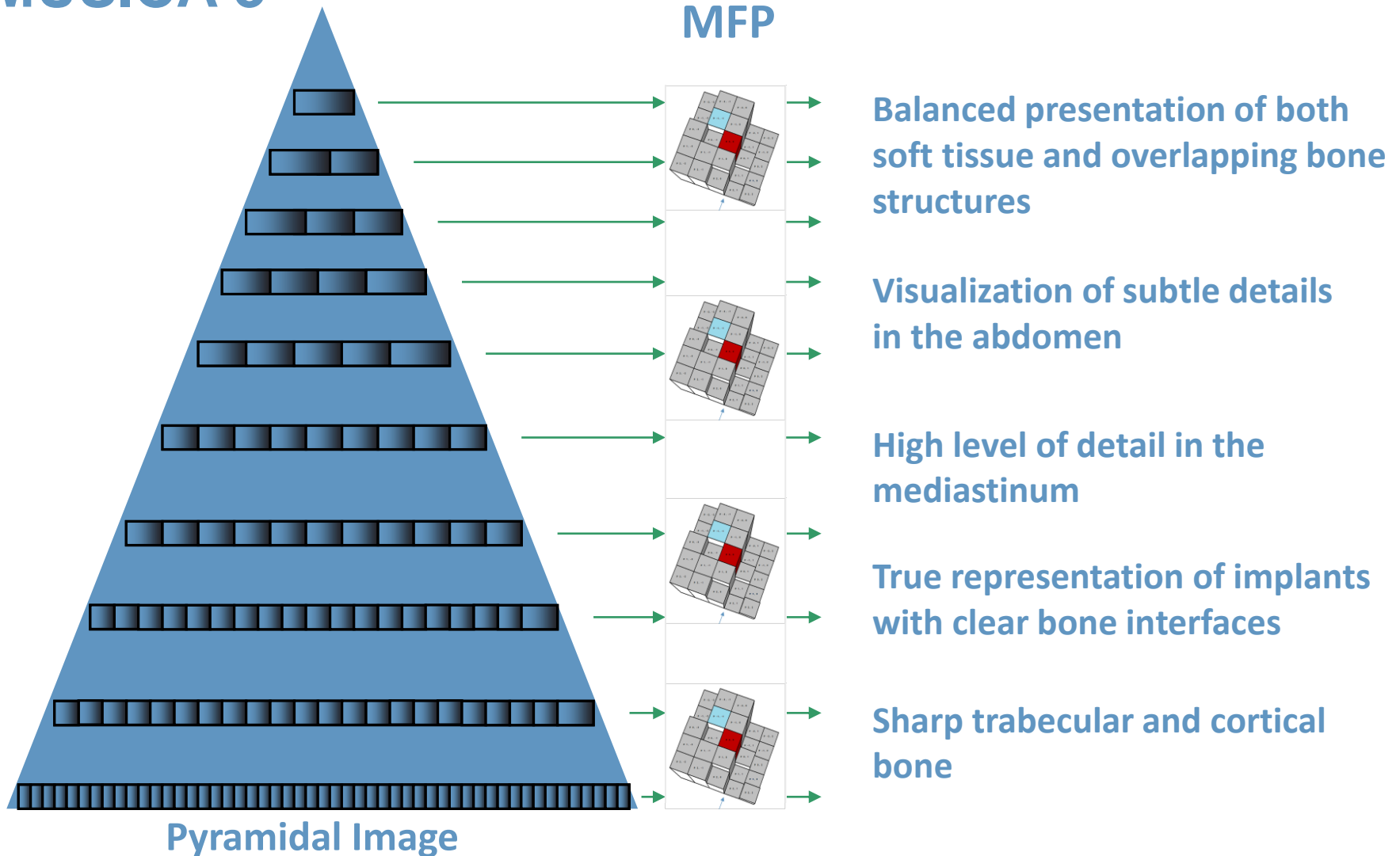


High contrast edge

The amount of contrast enhancement is calculated considering the relationship between the central pixel and each pixel in its neighborhood. (Each fraction of the kernel)

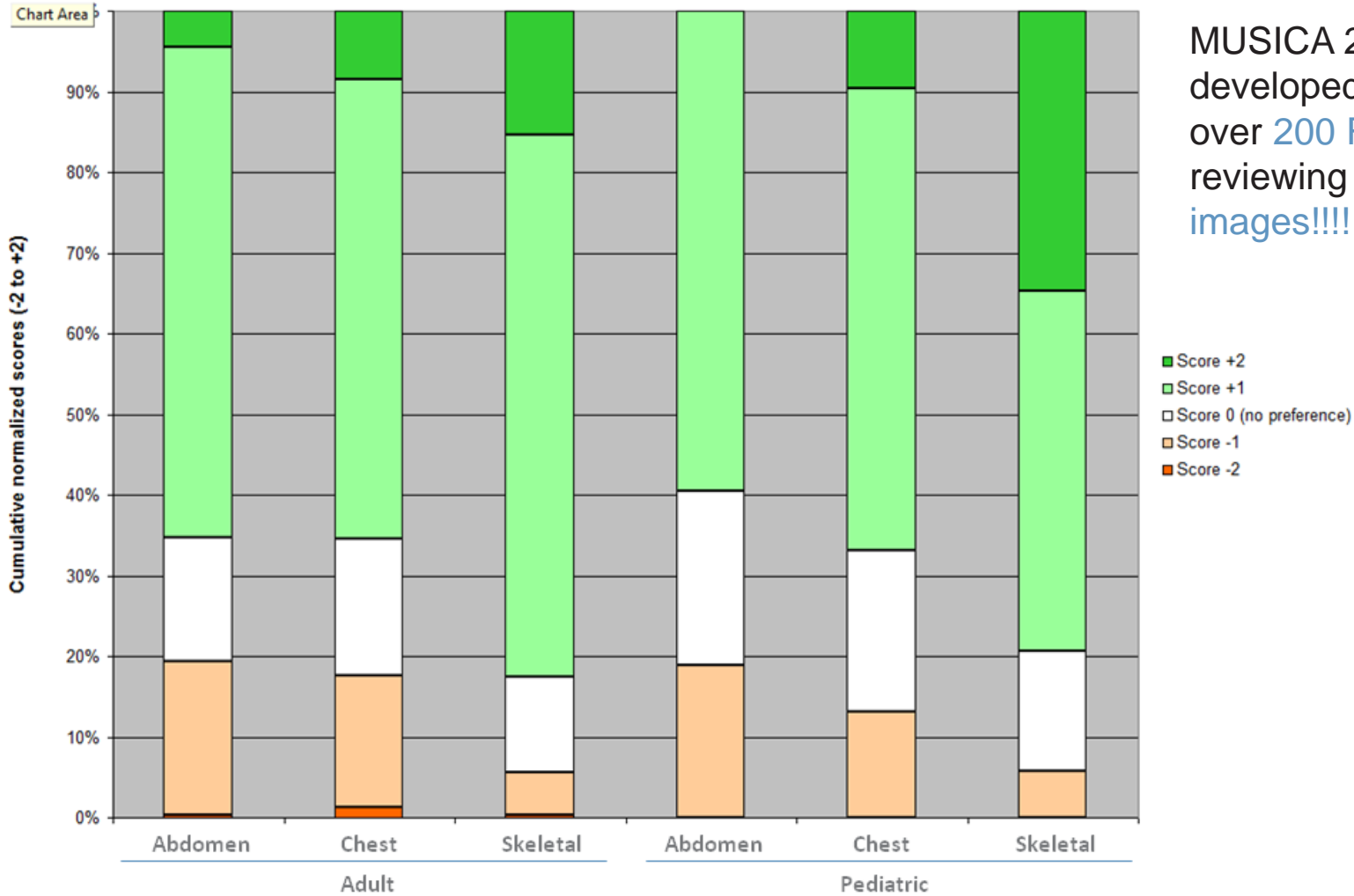
Each pixel  $\Leftrightarrow$  central pixel  
Each pixel  $\Leftrightarrow$  high contrast edge

# MUSICA 3



Use of FMP technology allows true enhancements at all levels of the pyramidal image

# MUSICA 3 >< MUSICA 2



MUSICA 2 and 3 were developed with input of over 200 Radiologist reviewing over 10,000 images!!!!

## Clinical study: Global Preference by Examination Type

# MUSICA 2



# MUSICA 3

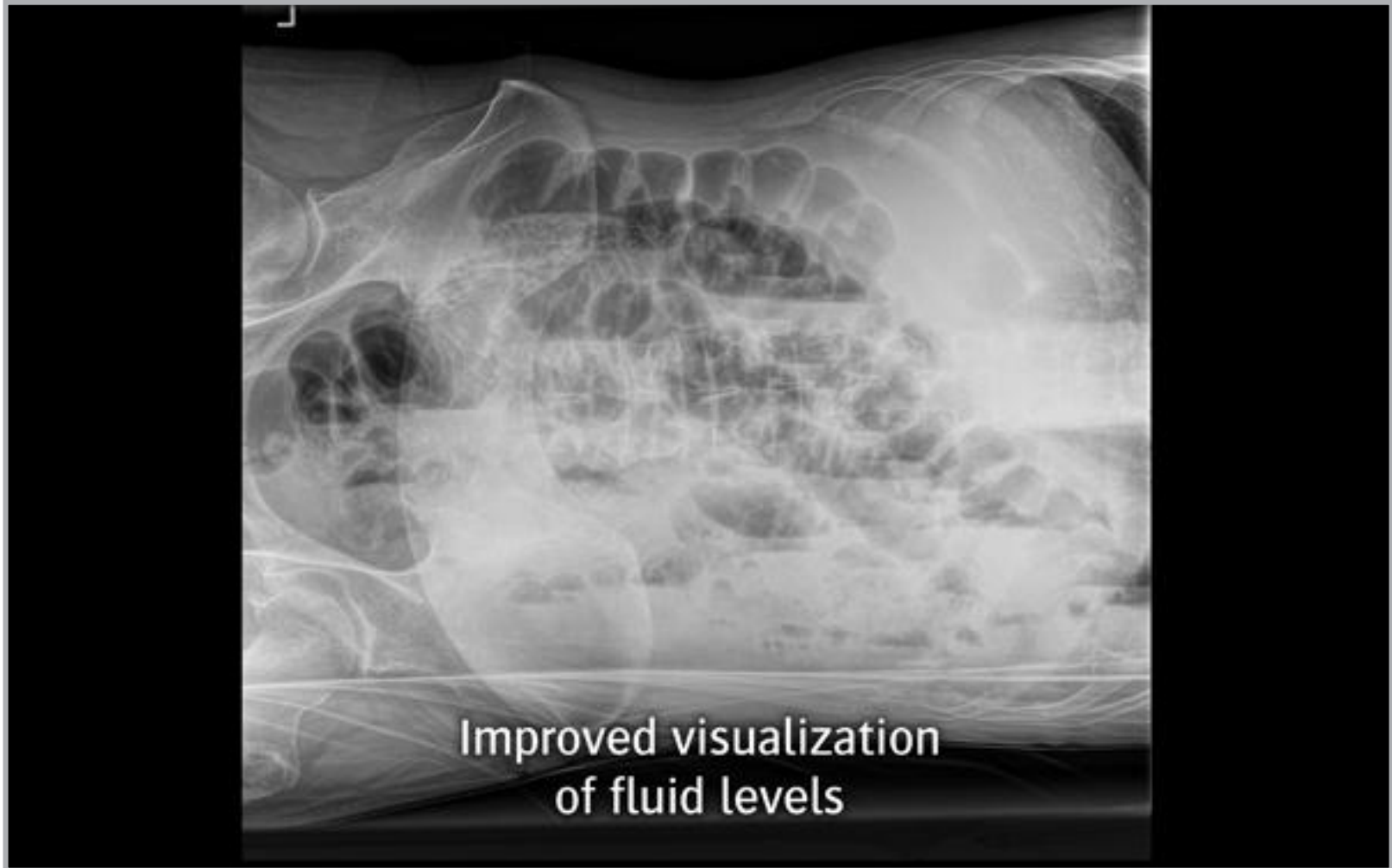




# MUSICA 2



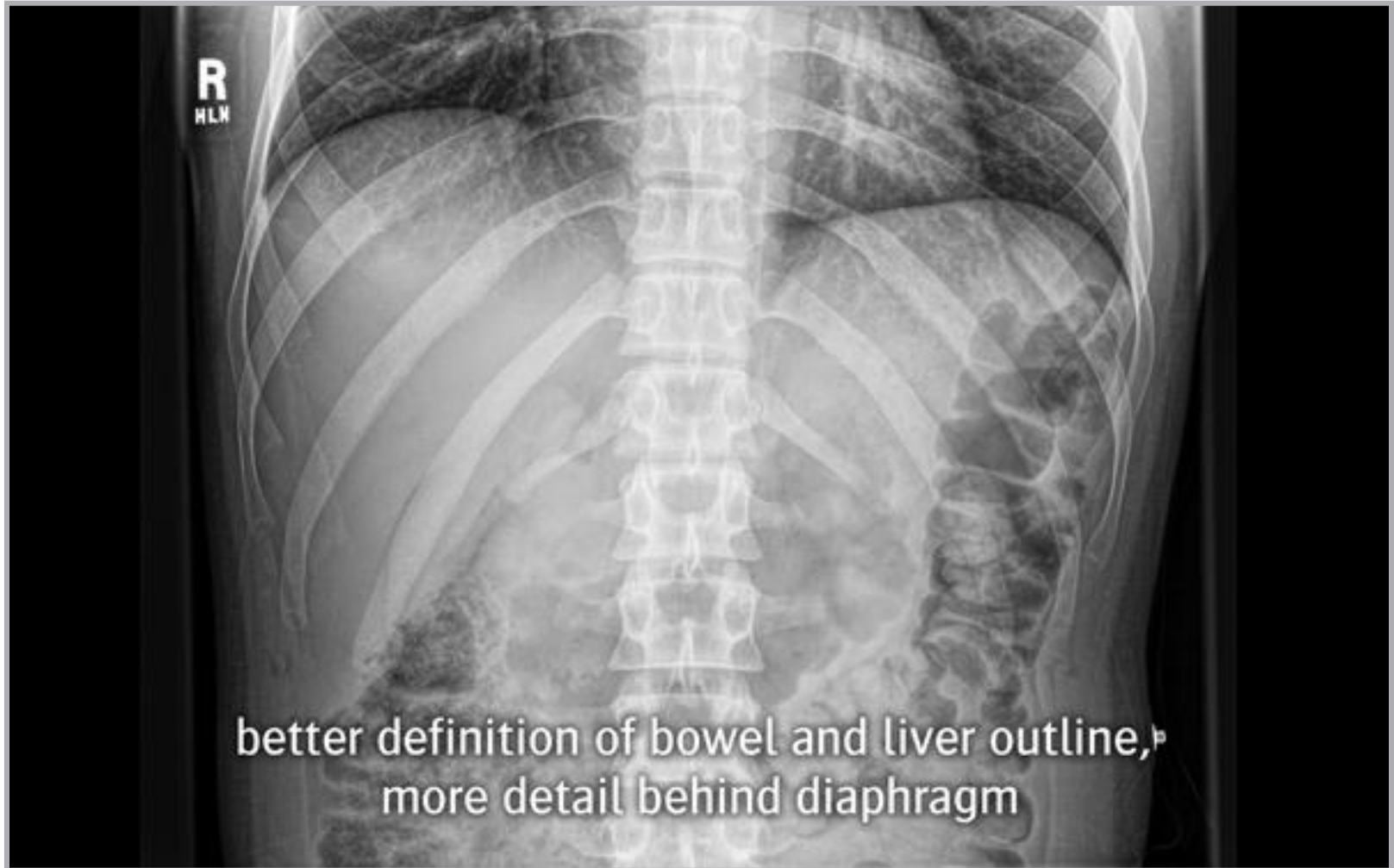
# MUSICA 3



# MUSICA 2



# MUSICA 3



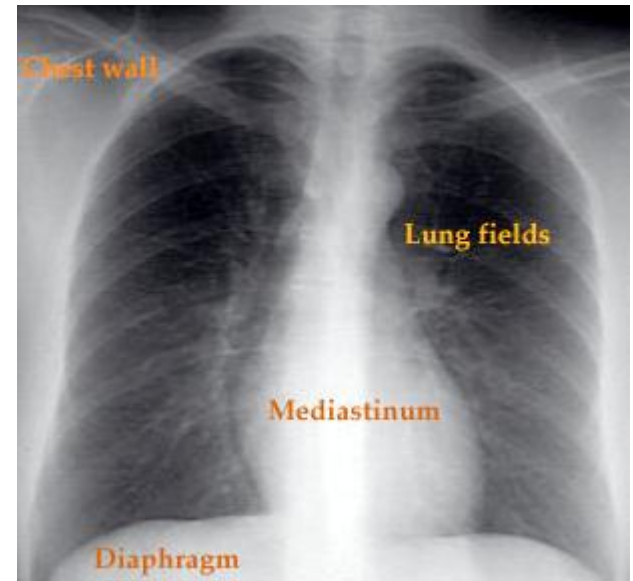
# MUSICA Intelligent Image Processing

- **Consistently high image quality**
  - Across CR and DR platforms
  - Self adapting : consistent image quality and robust against variations such as patient size, tube quality, exposure settings,..
  - Optimized for chest, skeleton, abdomen and neonatal
- **Window level adjustment no longer required**
  - Optimal rendering of all relevant data in the image, adapted to the sensitivity of the eye.
  - See everything available in the image without the need to window level.
  - Enhancing workflow for techs and radiologists
- **Ultimate goal:**
  - Best IQ, lowest possible dose, outstanding workflow & productivity



# MUSICA Intelligent Image Processing

- Consistently high image quality
- Window level adjustment no longer required
- **Get more out of your images**
  - High level of detail in the mediastinum





# Before



# After



# Before



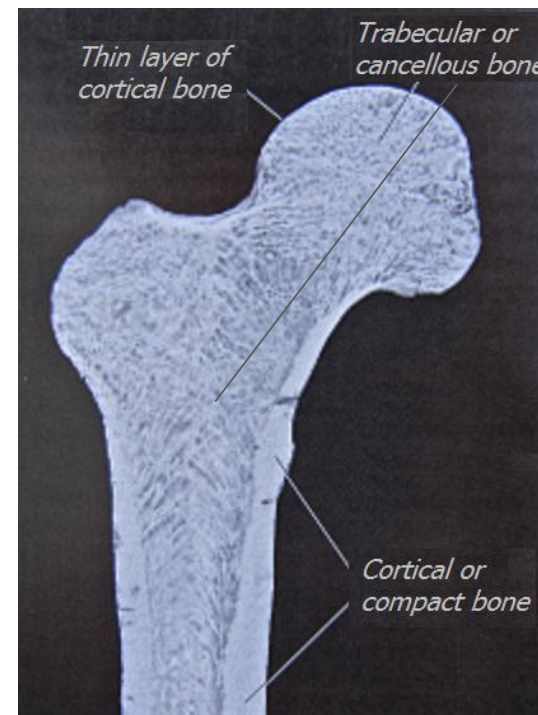
# After





# MUSICA Intelligent Image Processing

- Consistently high image quality
- Window level adjustment no longer required
- **Get more out of your images**
  - High level of detail in the mediastinum
  - Sharp trabecular and cortical bone



# Before





# After



# Before



After



# MUSICA Intelligent Image Processing



“ Once it became clear where improvement was needed, Agfa HealthCare invested a great deal of time, effort, and dedication to make things happen. Non-university institutions like ours don't always find manufacturers to be such good listeners. This is an excellent result! ”

**PRIM. DR. HANS PETER SOCHOR**  
Chief Radiologist at Landeskrankenhaus Hietzing and Medical Director at Diagnostikum Gersthof, Vienna, Austria

“ Details like bone trabeculae, hairline fractures, and the alimentary canal are crucial in differential diagnosis. ”

**PRIM. DR. HANS PETER SOCHOR**

# MUSICA Intelligent Image Processing

- Consistently high image quality
- Window level adjustment no longer required
- **Get more out of your images**
  - High level of detail in the mediastinum
  - Sharp trabecular and cortical bone
  - Balanced presentation of both soft tissue and overlapping bone structures



Before

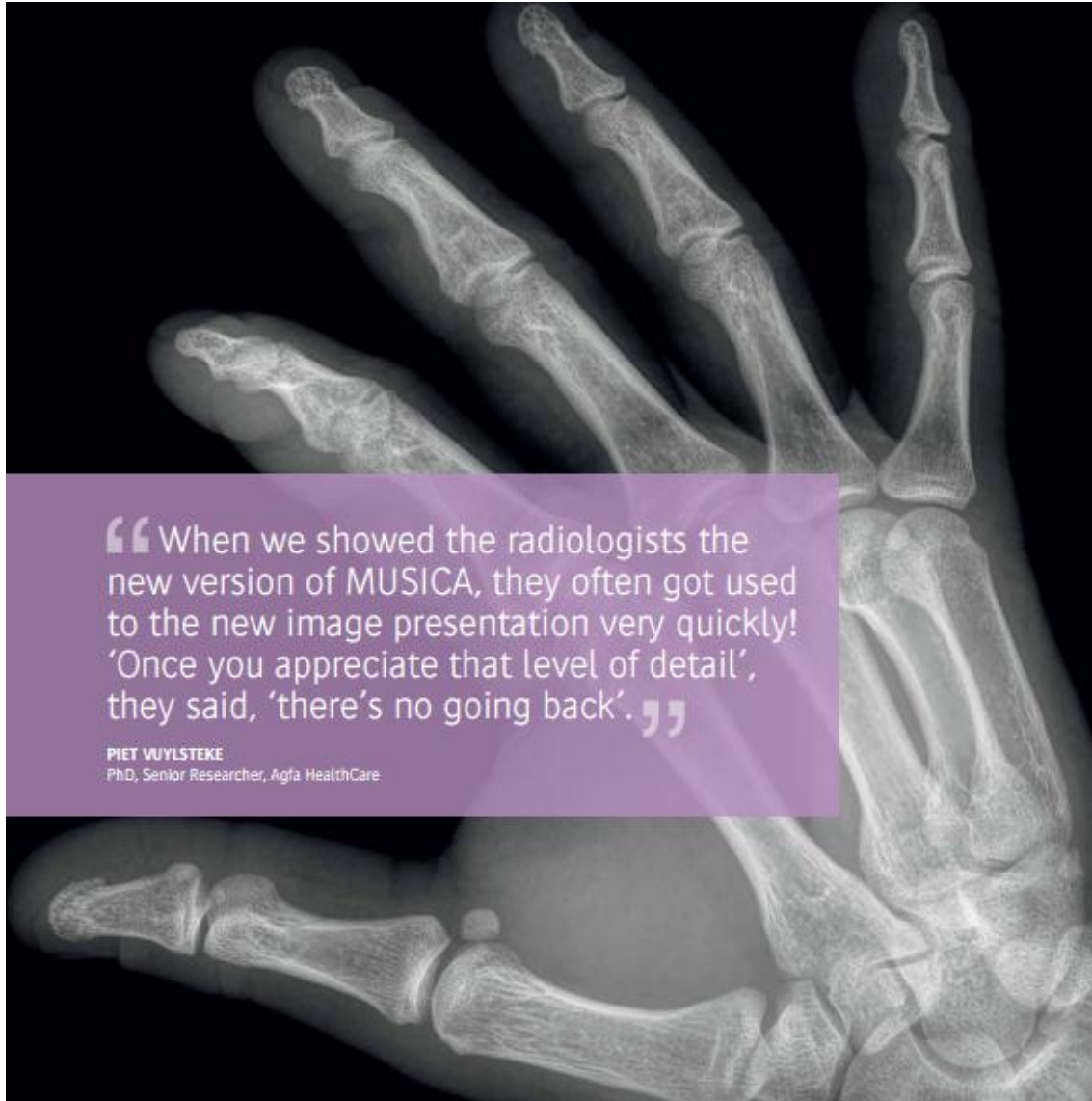




After



# MUSICA Intelligent Image Processing



“When we showed the radiologists the new version of MUSICA, they often got used to the new image presentation very quickly! ‘Once you appreciate that level of detail’, they said, ‘there’s no going back’.”

PIET VUYLSTEKE  
PhD, Senior Researcher, Agfa HealthCare

# MUSICA Intelligent Image Processing

- Consistently high image quality
- Window level adjustment no longer required
- **Get more out of your images**
  - High level of detail in the mediastinum
  - Sharp trabecular and cortical bone
  - Balanced presentation of both soft tissue and overlapping bone structures
  - Visualization of subtle details in the abdomen

# Before





# After



# MUSICA Intelligent Image Processing

- Consistently high image quality
- Window level adjustment no longer required
- **Get more out of your images**
  - High level of detail in the mediastinum
  - Sharp trabecular and cortical bone
  - Balanced presentation of both soft tissue and overlapping bone structures
  - Visualization of subtle details in the abdomen
  - True representation of implants with clear bone interfaces



# Before



After

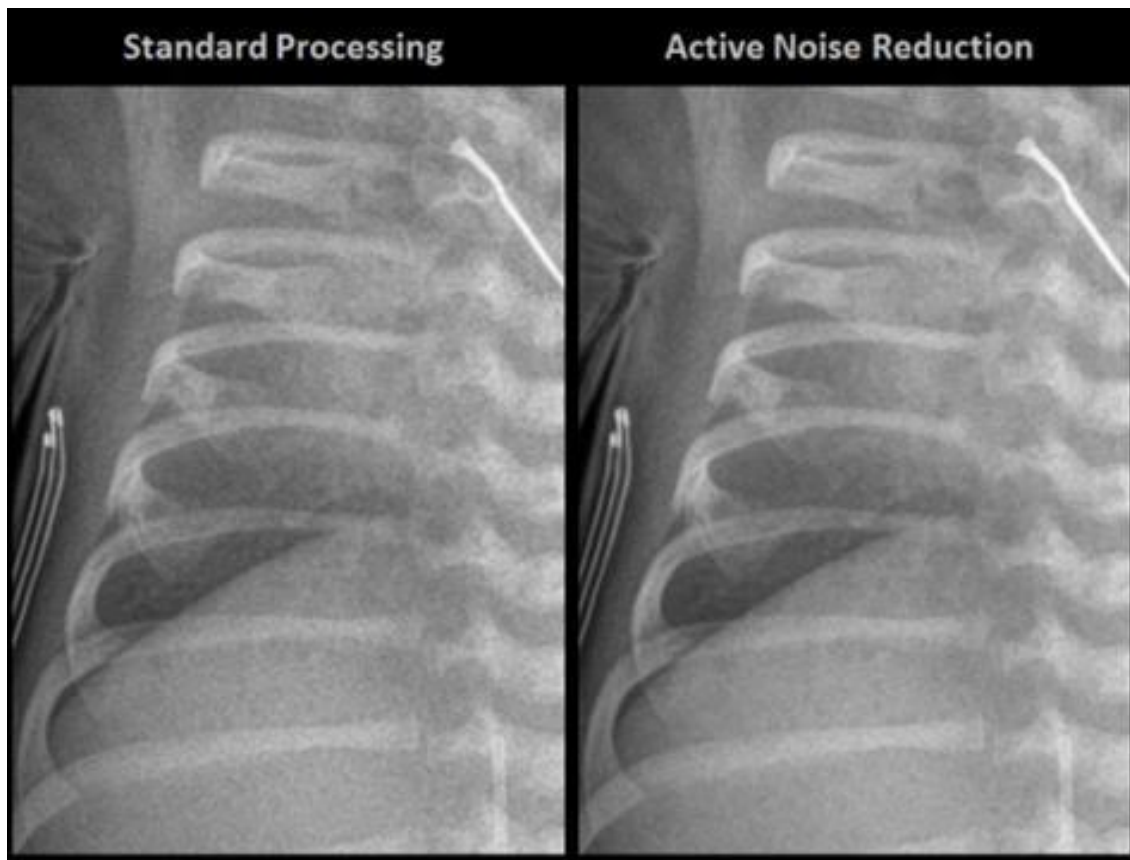


# MUSICA Intelligent Image Processing

- **Consistently high image quality**
- **Window level adjustment no longer required**
- **Get more out of your images**
  - High level of detail in the mediastinum
  - Sharp trabecular and cortical bone
  - Balanced presentation of both soft tissue and overlapping bone structures
  - Visualization of subtle details in the abdomen
  - True representation of implants with clear bone interfaces
- **Active noise suppression**
  - **Very important at low dose exposures (neonatal, pediatric,...)**

# MUSICA Intelligent Image Processing

- How does MUSICA support low dose?
  - Improves image quality at low dose exposures! (neonatal, pediatric,...) with **Active Noise Suppression!**

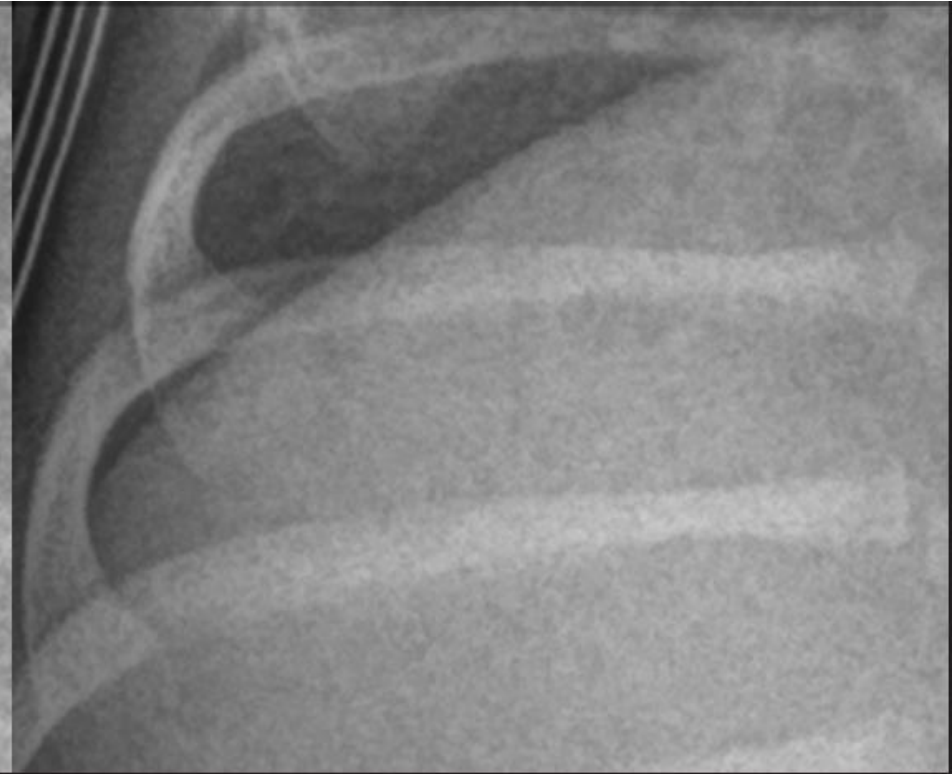


# MUSICA Intelligent Image Processing

- MUSICA uses Active Noise Reduction



Standard Processing

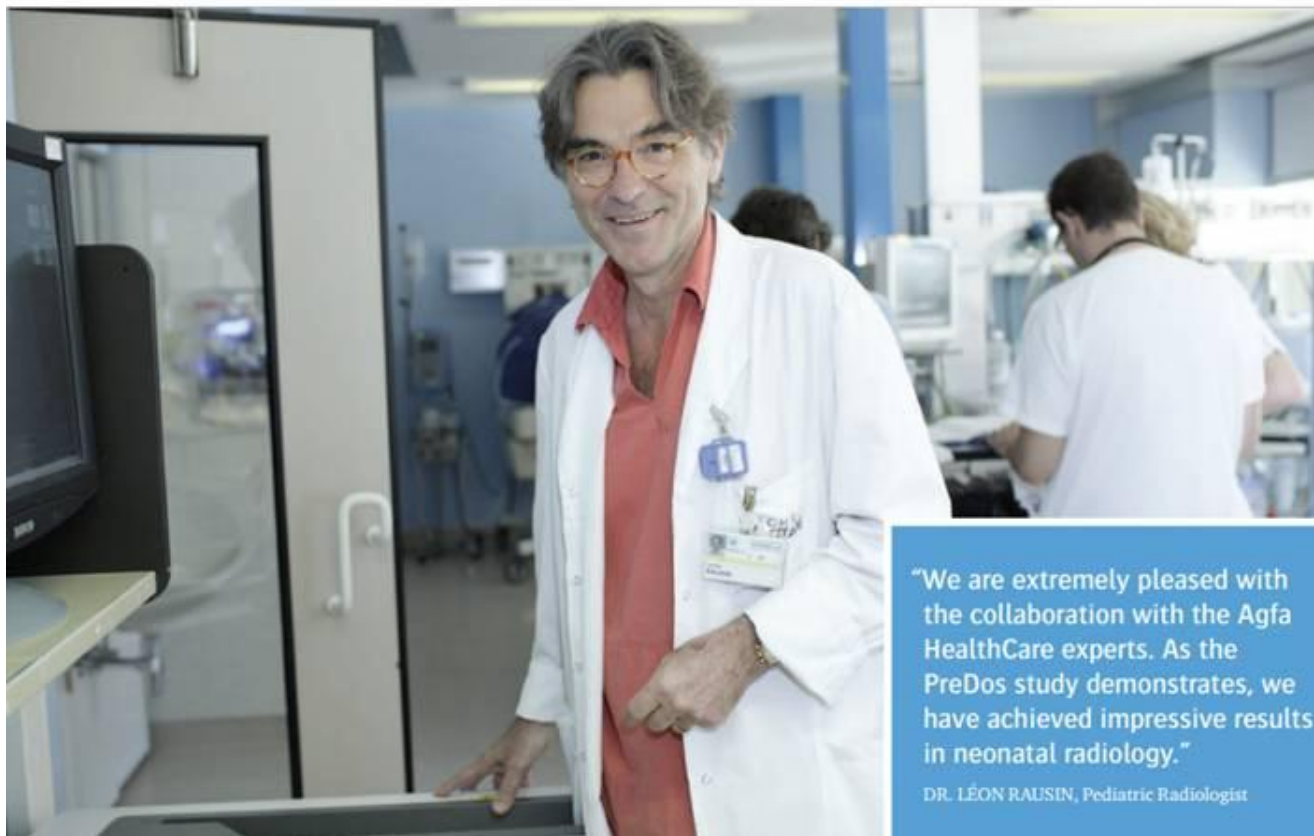


Active Noise Reduction

# MUSICA Intelligent Image Processing

## Reduced radiation dose and fewer exams for neonates

**INTERVIEWEE** Dr. Léon Rausin, Pediatric Radiologist

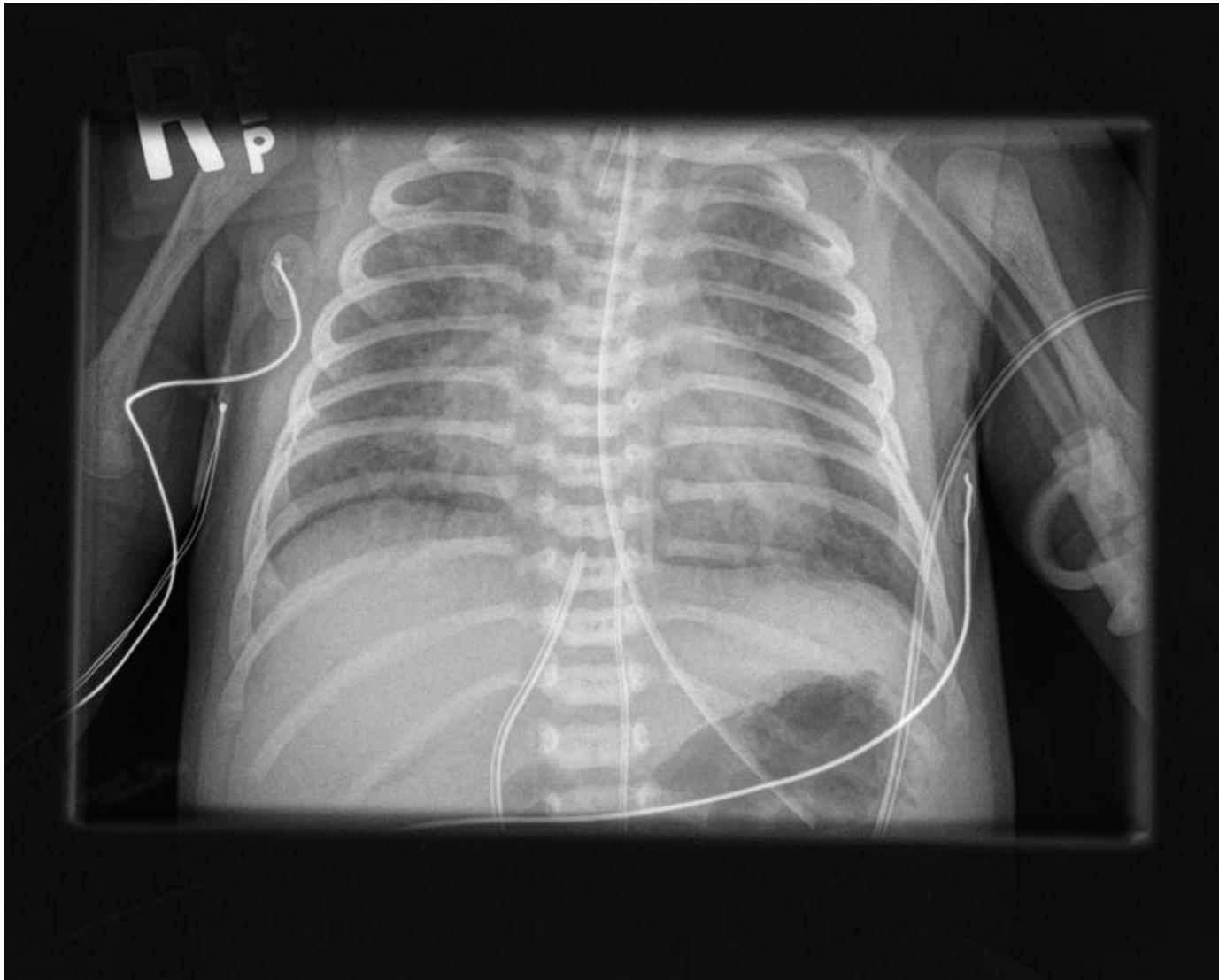


“We are extremely pleased with the collaboration with the Agfa HealthCare experts. As the PreDos study demonstrates, we have achieved impressive results in neonatal radiology.”

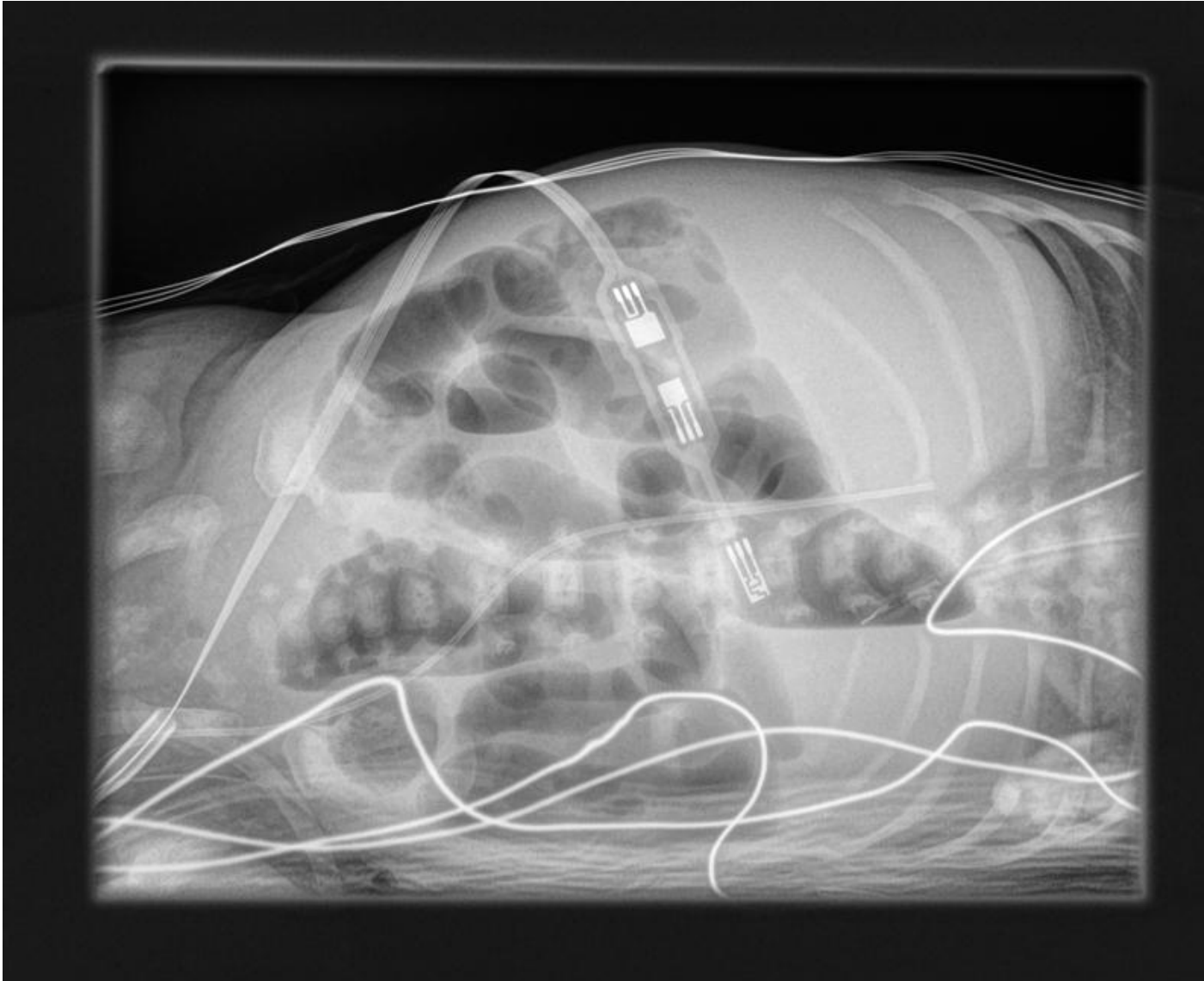
DR. LÉON RAUSIN, Pediatric Radiologist



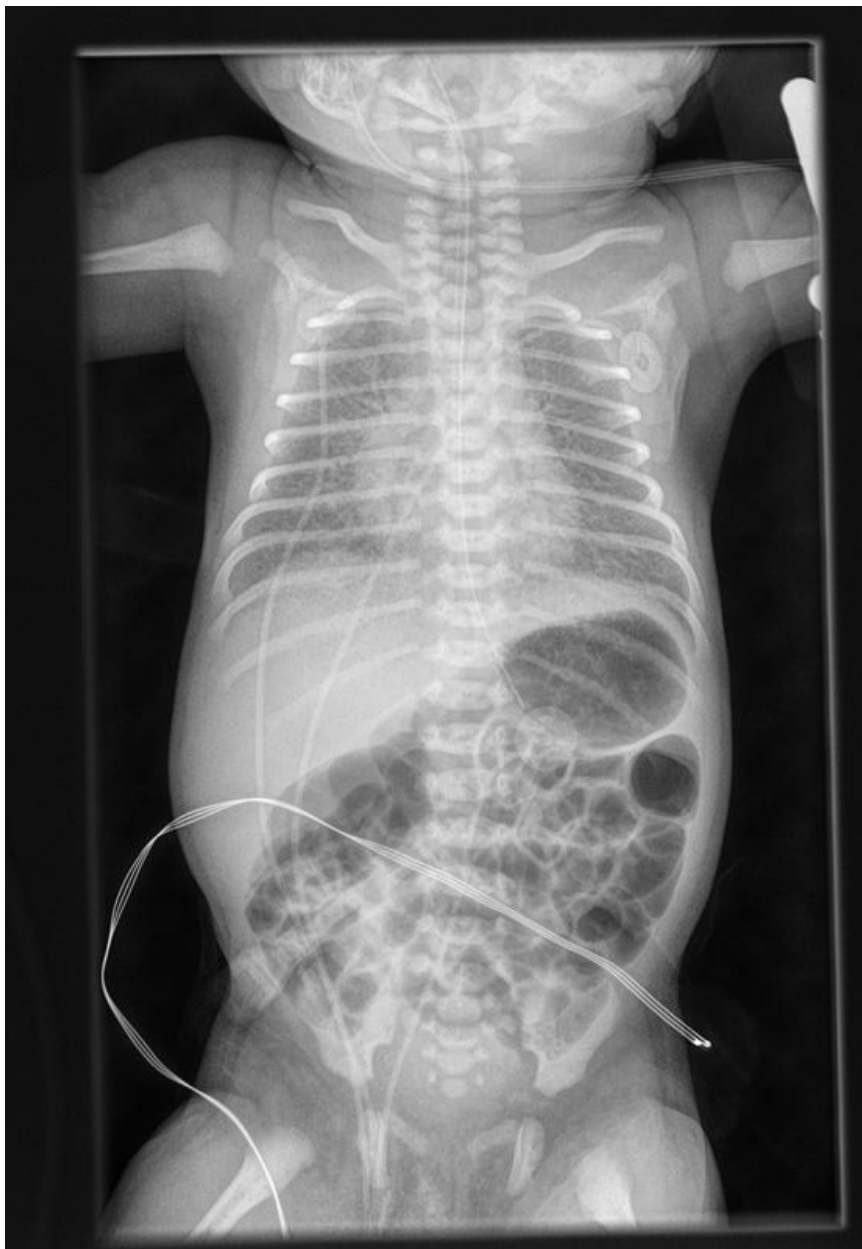
# MUSICA Neonatal



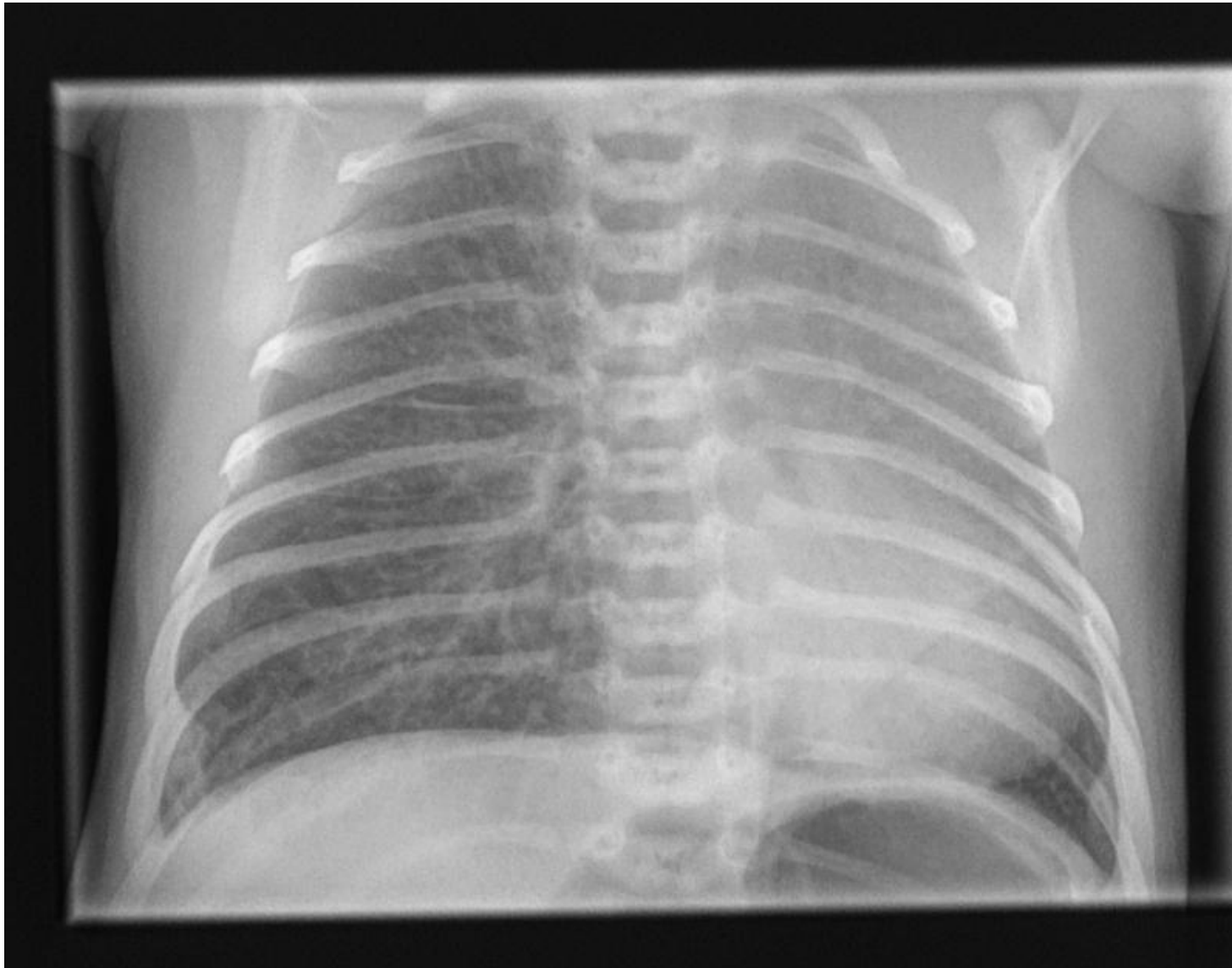
# MUSICA Neonatal



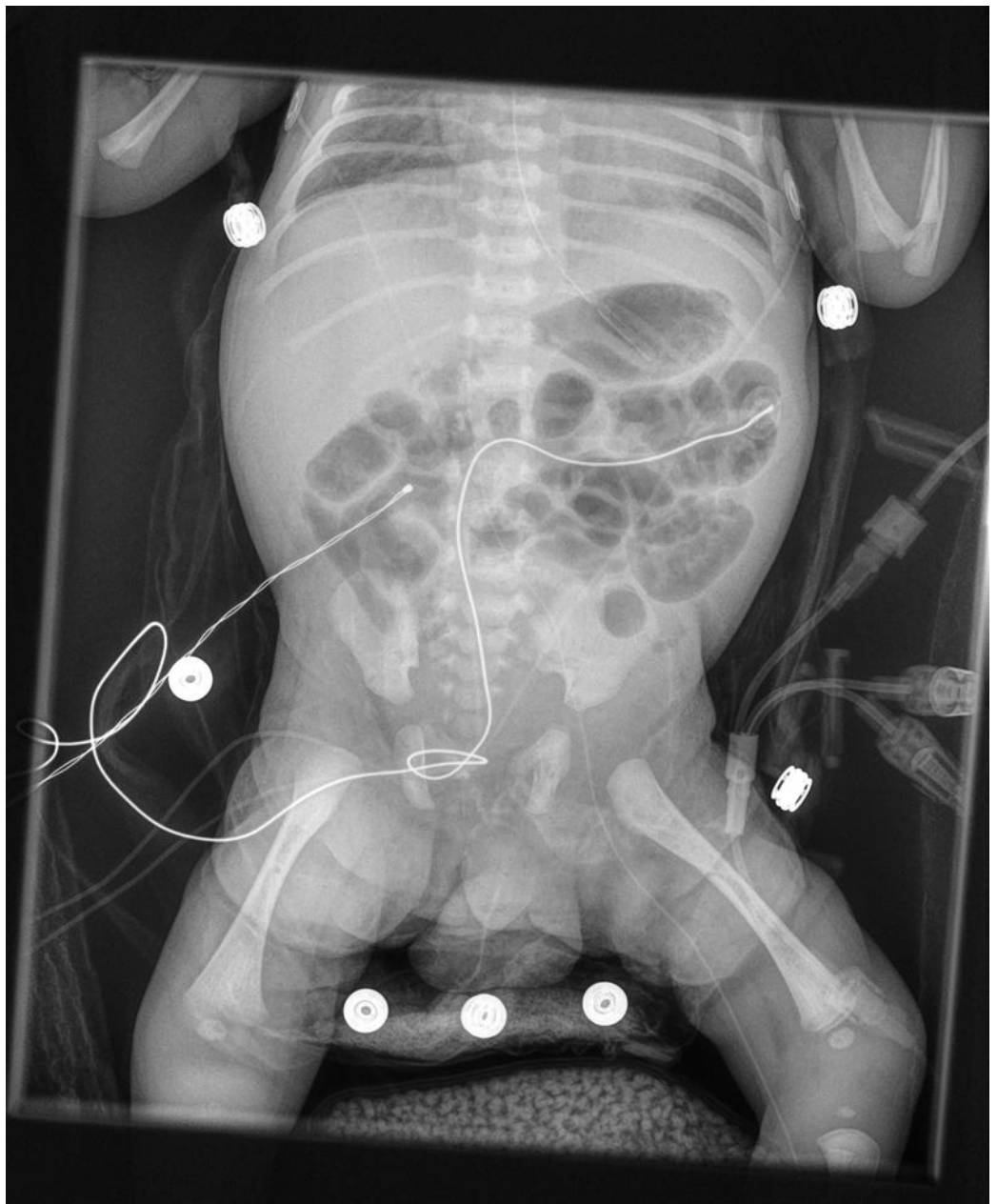
# MUSICA Neonatal



# MUSICA Neonatal



# MUSICA Neonatal





# MUSICA Neonatal





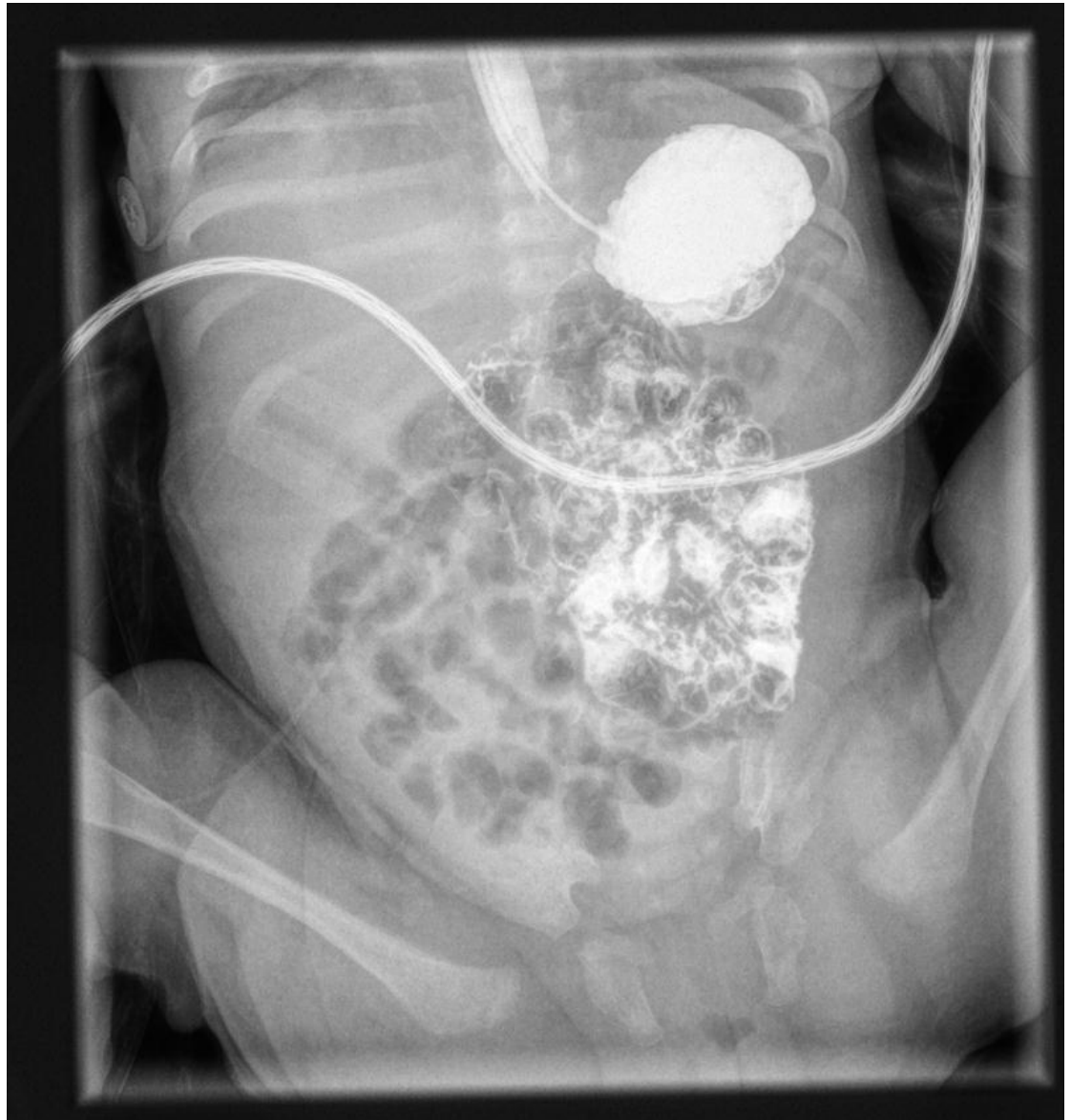
# MUSICA Neonatal



# MUSICA Neonatal



# MUSICA Neonatal



# MUSICA Neonatal



# MUSICA Intelligent Image Processing

- **Consistently high image quality**
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- **Get more out of your images**
  - High level of detail in the mediastinum
  - Sharp trabecular and cortical bone
  - Balanced presentation of both soft tissue and overlapping bone structures
  - Visualization of subtle details in the abdomen
  - True representation of implants with clear bone interfaces
- **Active noise suppression**
- **Anti-Scatter**
  - Large patients, no grid,...

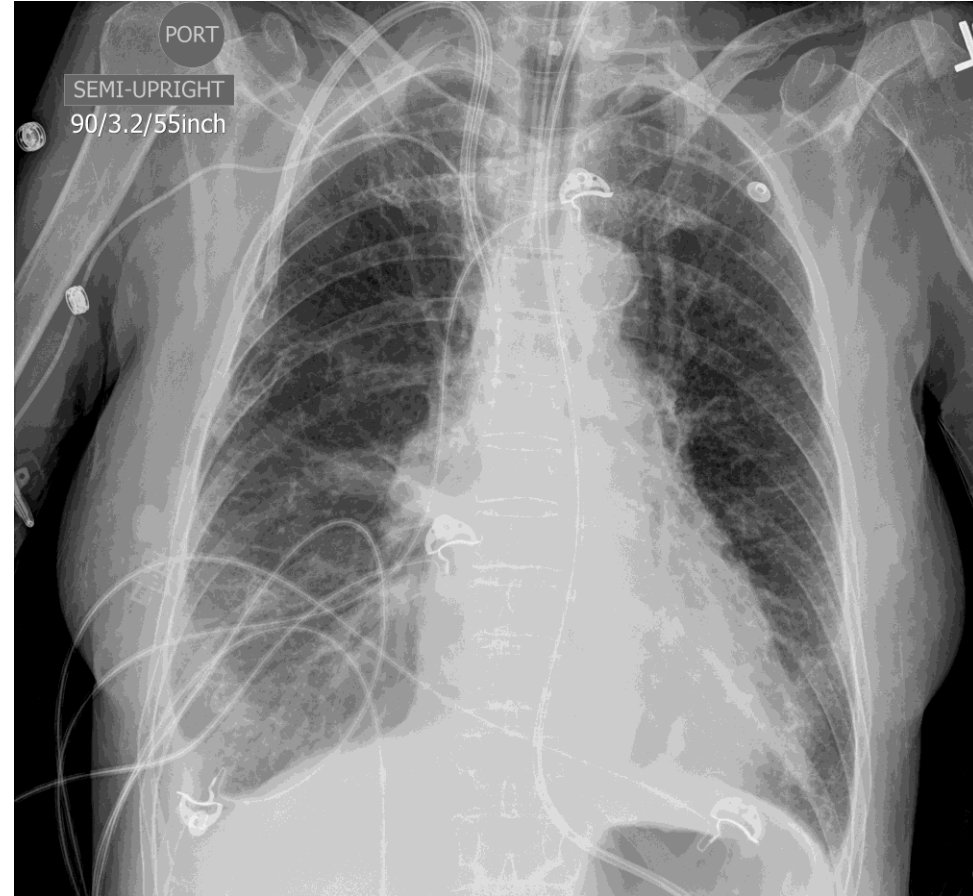


# MUSICA Intelligent Image Processing

Non Agfa DR



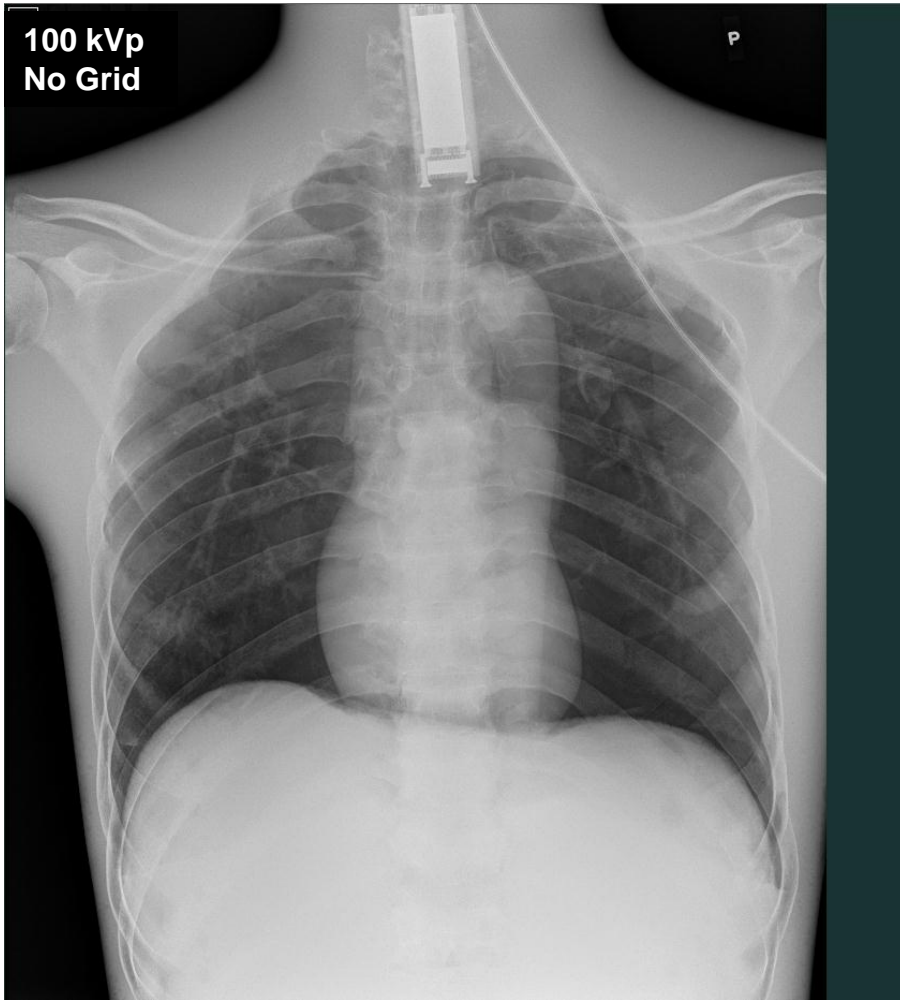
Agfa DR with MUSICA



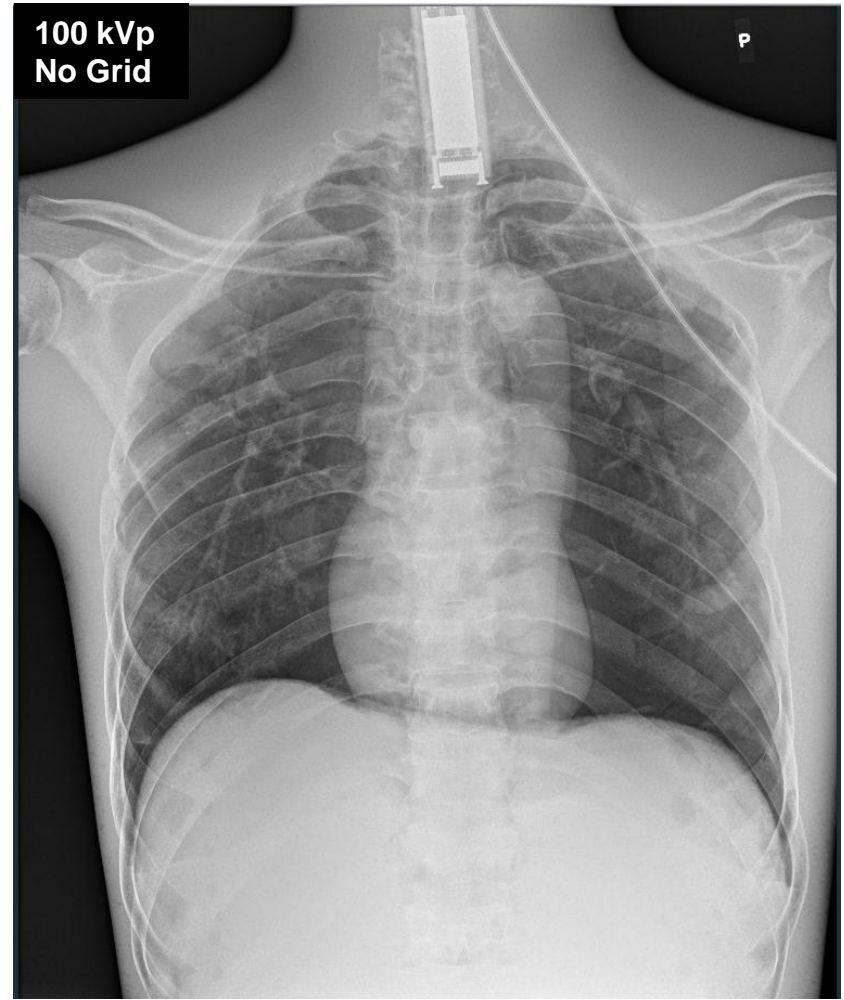
MUSICA determines the **frequency of scatter** and uses **multi-frequency subtraction** processing to reduce the scatter



# MUSICA Intelligent Image Processing: No Grid



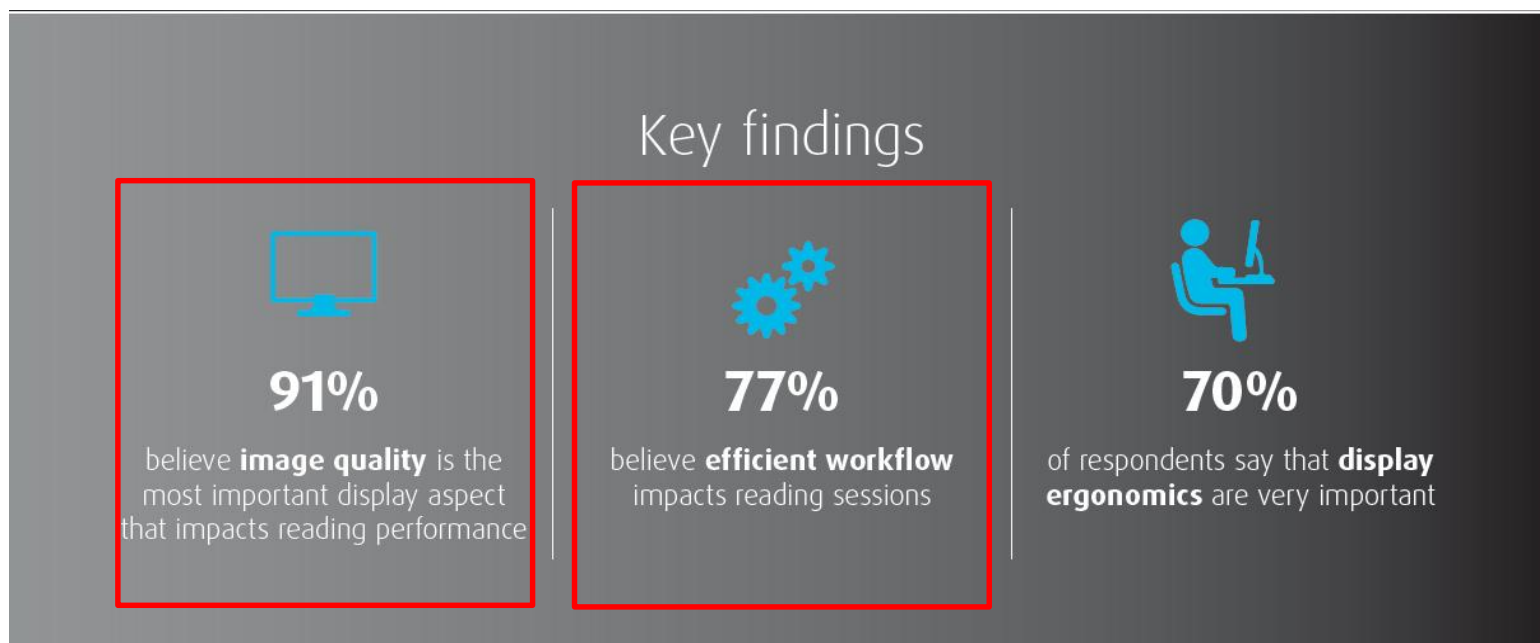
MUSICA 2



MUSICA 3

# MUSICA Intelligent Image Processing

- **Dose concerns** are growing (especially neonatal, pediatric,...)
- Online Survey by **Barco**
  - **91%** of radiologists are concerned about **image quality**
  - **77%** are concerned about **efficient workflow**



# MUSICA Intelligent Image Processing



The Gold Standard in Clinical Image Processing

MUSICA

*20+ years of experience: "The diagnosis is in the details"*

**AGFA**   
HealthCare