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AMI
Advanced
Molecular
Imaging

See further. Go beyond.

Vereos PET/CT

The revolutionary digital breakthrough in PET imaging

Soluzioni Philips nell'ambito della diagnostica per immagini – Molecular Imaging

ESTAR
Ente di supporto tecnico-amministrativo regionale

Imaging diagnostico in Sanità
Stato attuale e prospettive

Sandro Paini AMI & Oncology

Pisa 20.12.2016

Fully digital SiPM (**dSiPM ©**) invented within Philips Research

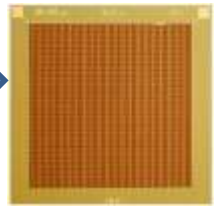
PMT

70 years

APD(analog)

30 years

SiPM(Analog)



8 years

dSiPM(Digital)

New technology

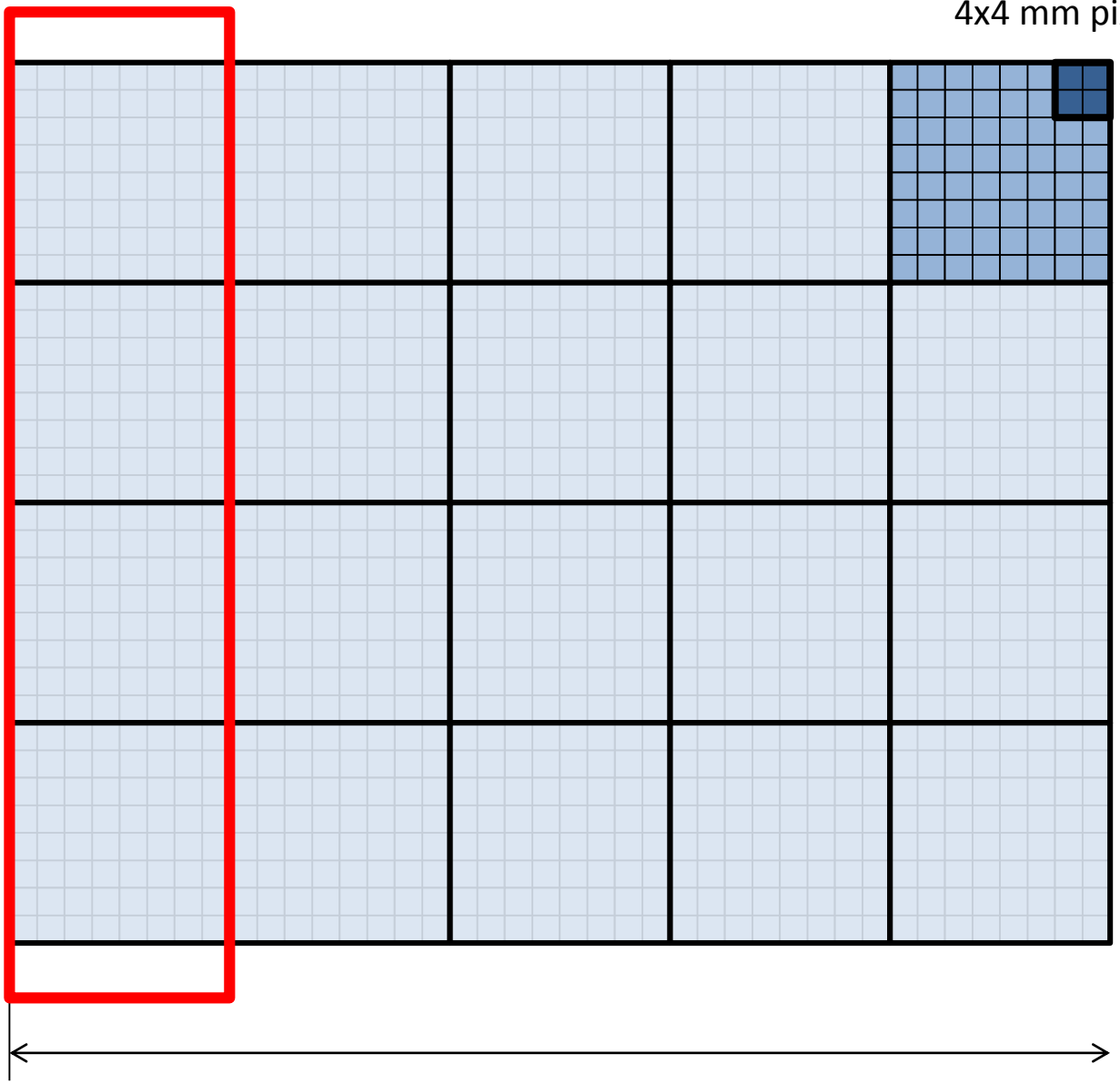
Solid state

Detector Module – Tile – Die – Pixel – Micro-cell

4x4 mm pixel

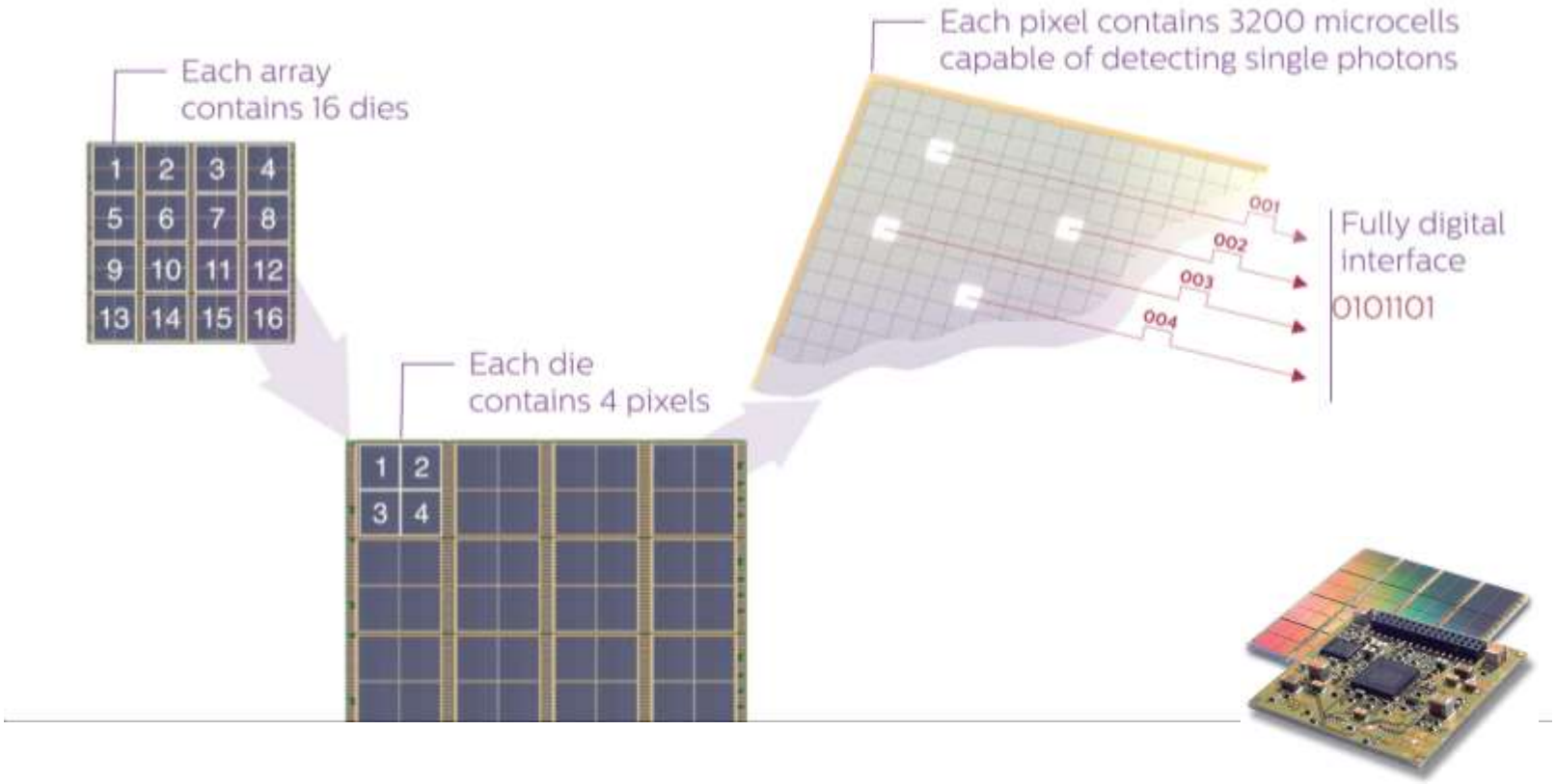
Veyron System has
18 Modules

Ring: Means a tile length of PET ring



How Digital Photon Counting works

The Digital Photon Counter converts scintillating light directly to a digital signal



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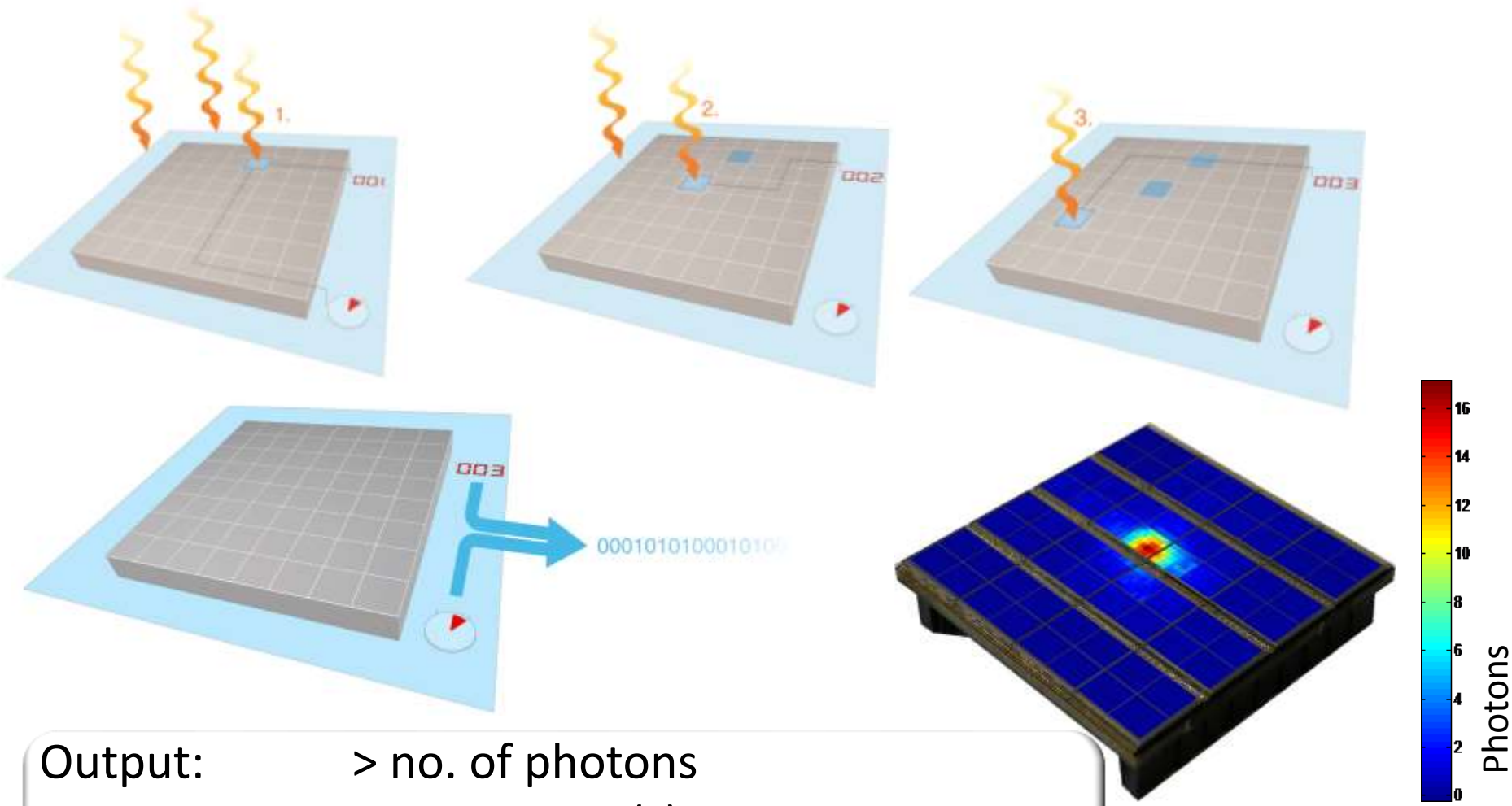
Now Photons are Counted Directly



Output: > no. of photons

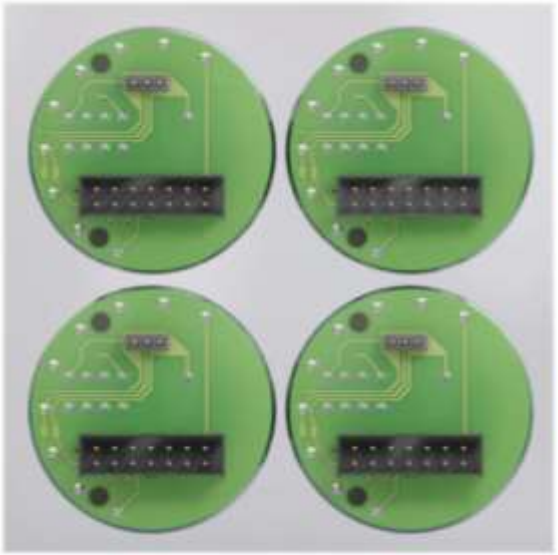
> time stamp(s)

No analog post-processing necessary!

Analog vs. Digital Photon Counting

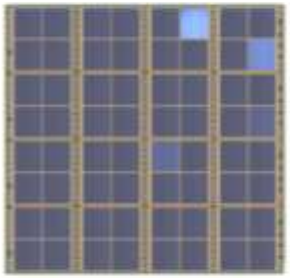
Over 50 times more detectors than analog detection systems.

Analog



420 detectors

Digital Photon Counter



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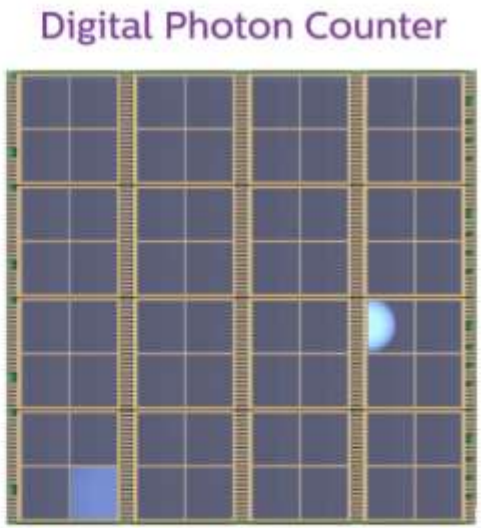
The advantages of Digital Photon Counting



- 1:1 coupling
- Dramatically higher count rate
- Excellent timing resolution
- Faster Time of Flight performance
- Superb SUV quantification
- Improved contrast resolution

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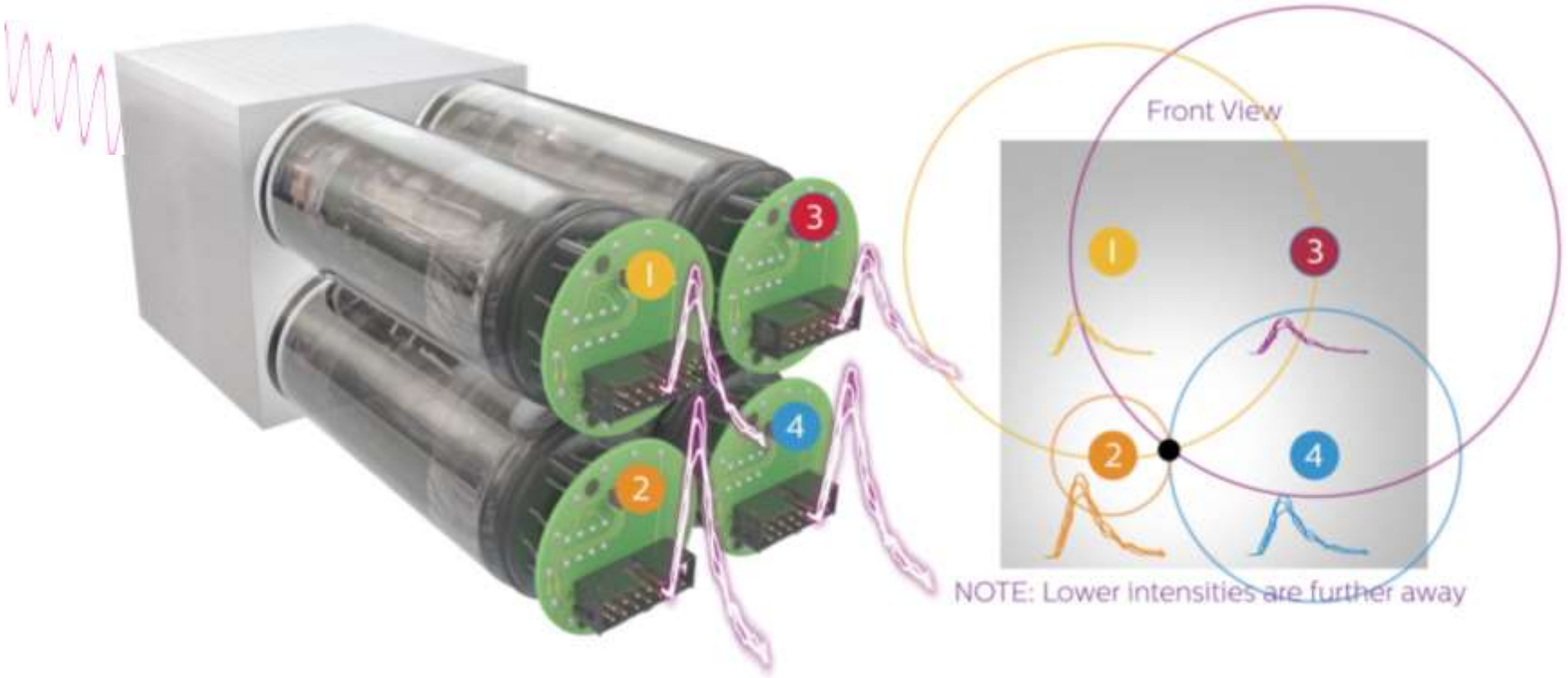
How today's analog detection works

Photomultiplier tubes approximate the location of an event.



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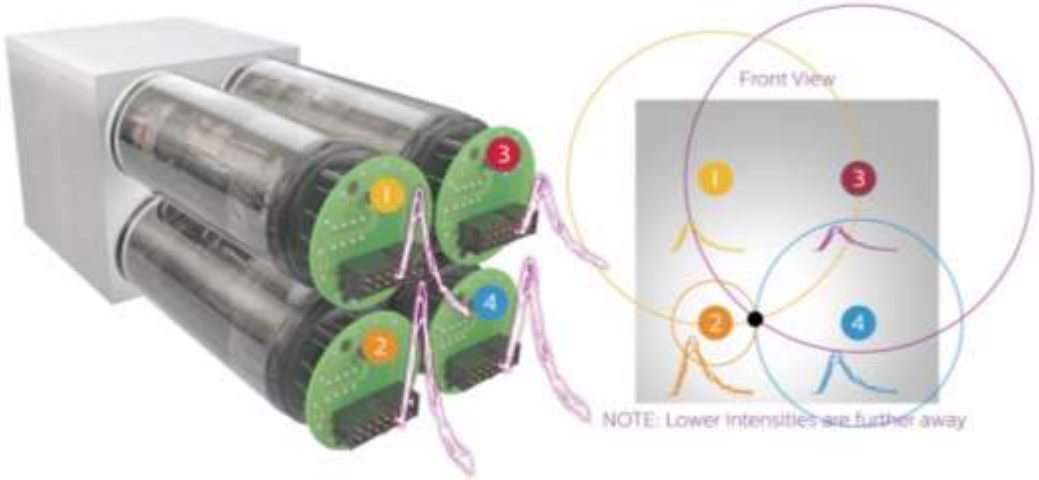


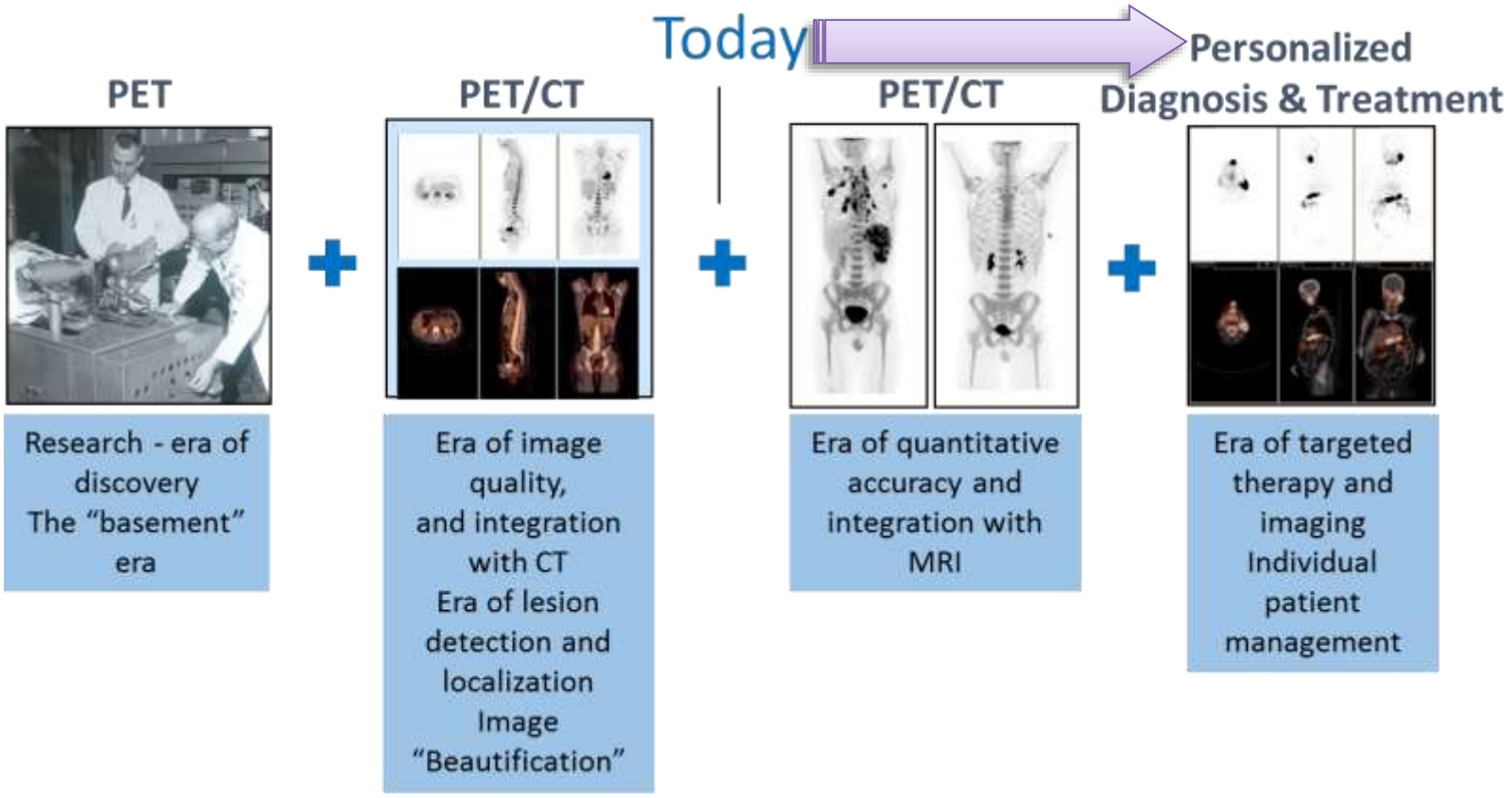
As the signal is amplified, the electrical noise is also amplified causing a noisy output signal

The intensity of the signals are averaged in order to estimate the origin of the signal.

With a **noisy signal** and **an inaccurate localization** of the signal,
the output of the PMT-based system is extremely inaccurate.

Technology
to Clinical
Performance.

Evolution of PET



Concept & slide copyright:
Piotr Maniawski

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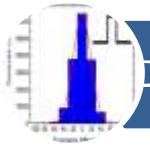
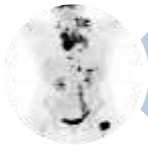
Digital Photon Counting



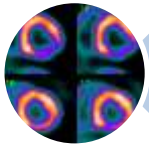
Digital Time of Flight

1:1 Coupling

Improved spatial resolution*



Improved timing resolution*

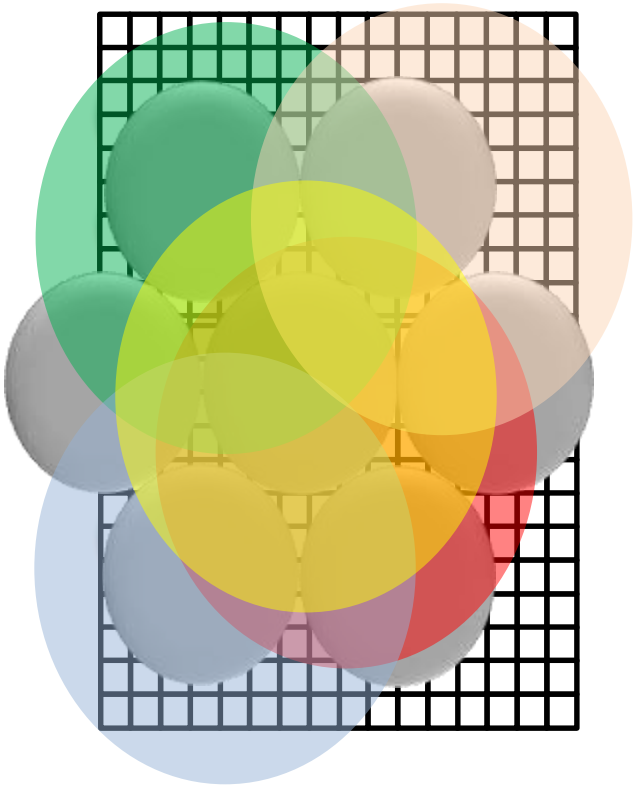


Improved count rate performance*

* Analog (*GEMINI TF)* to digital comparison

Digital Photon Counting

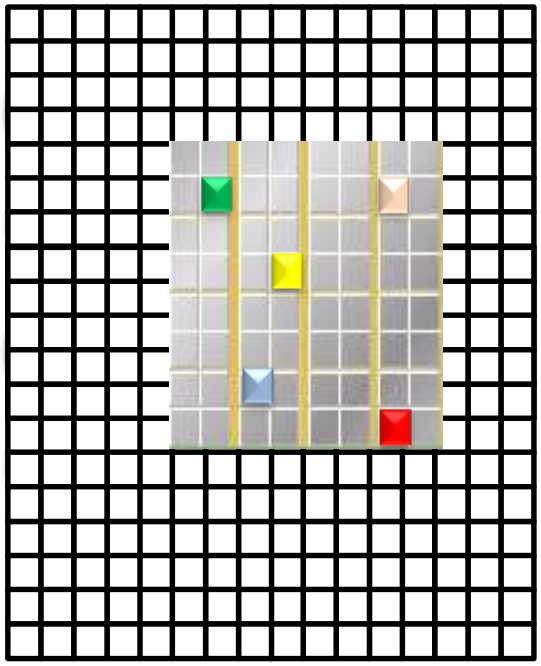
1:1 coupling.



DPC reduces the traditional tradeoffs between sensitivity gains and resolution gains.

Conventional block detector limitations

- Optically isolated for surrounding blocks
- PMTs are used to localize
- Light collection dropoff at edges of blocks
- Light collection variability with position



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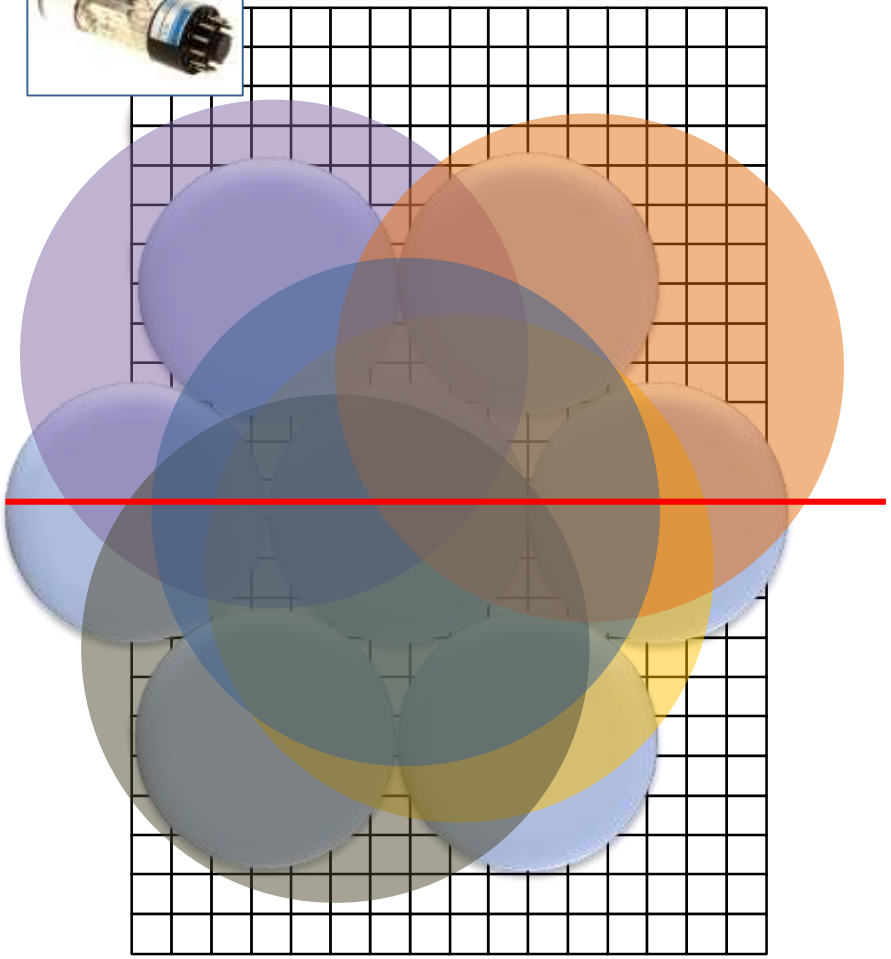
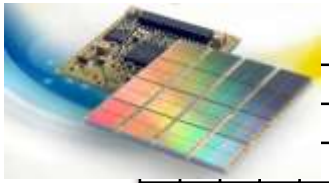
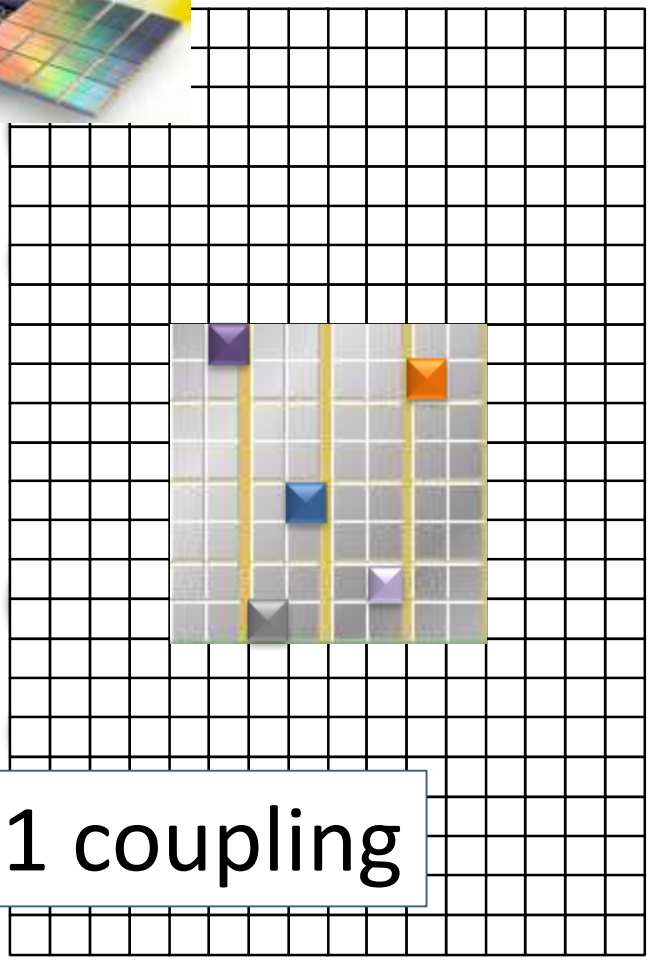
1:1 Coupling

Multiple events overlapping

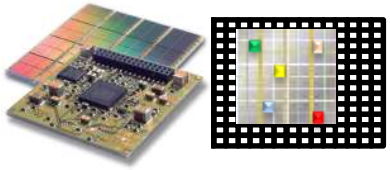




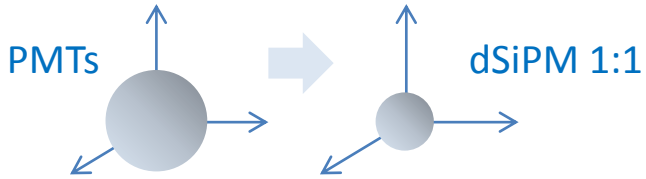


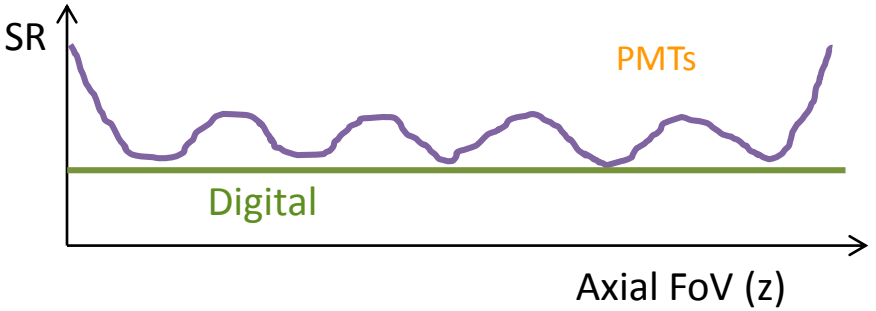
1:1 coupling

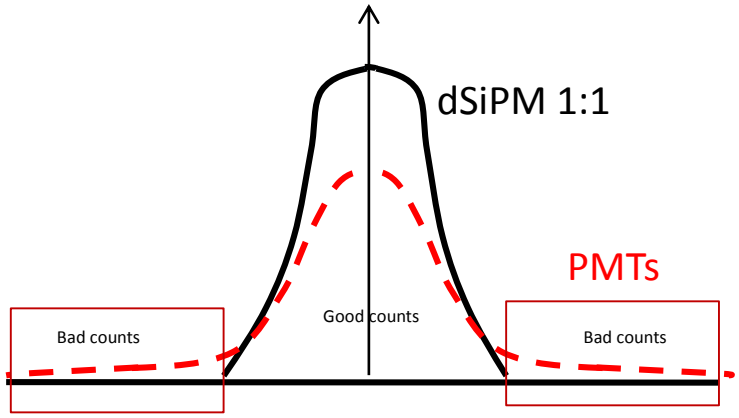
1:1 Coupling – Resolution



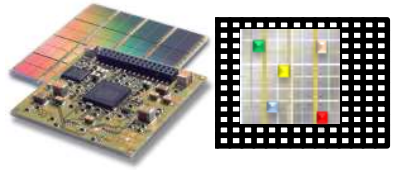
- **Factor of 2 volumetric resolution gain**
  - 3D, (axial*radial*tangential)
    64 mm^3
- **Uniform detector resolution across all detector surface**
  - Digital: Constant in axial direction
  - PMT Tubes: worse resolution under the tubes and at the edges
- **Bad counts vs. good counts**
  - No “bad tail”; all are good counts for Vereos







1:1 Coupling – Resolution

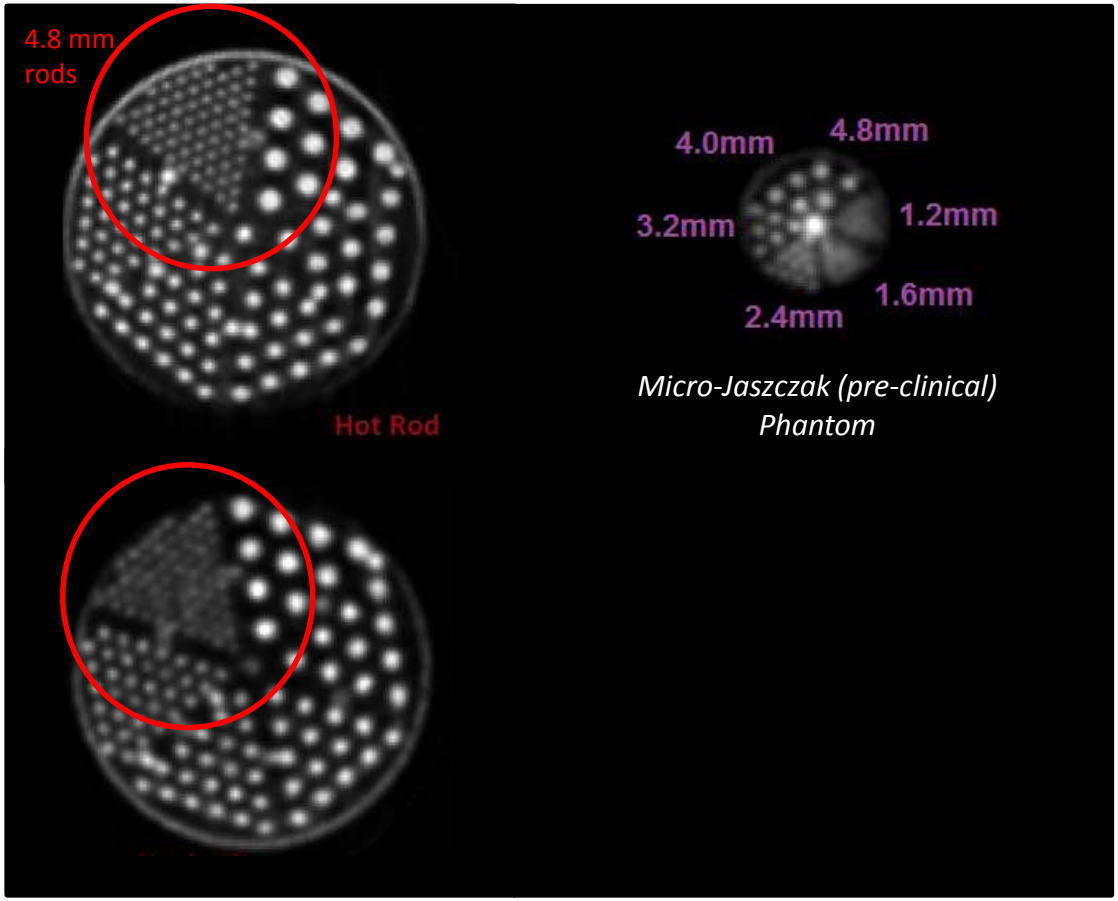


Improved spatial resolution seen with conventional clinical phantoms.

Digital

Analog*

**GEMINI TF 16*



Deluxe Jaszczak Phantom

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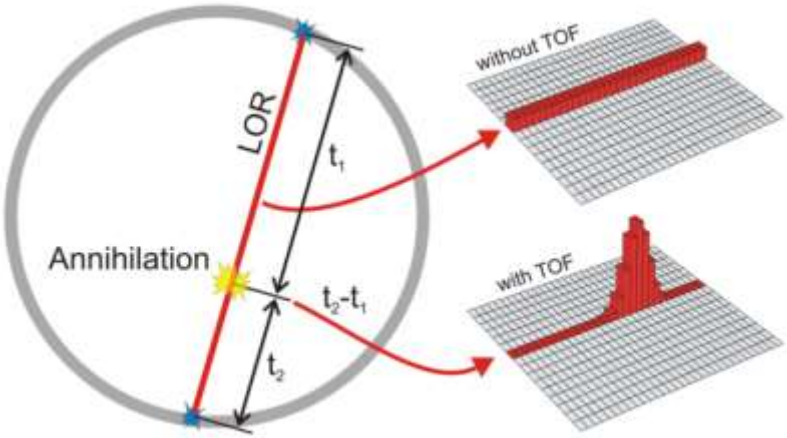
Time of Flight

Δx = position uncertainty along LOR = $c \cdot \Delta t/2$

Effective Sensitivity gain = $D/\Delta x$

Δt – Time Resolution, D – Diameter of Object;
c – light speed; Δx - position uncertainty



Time Resoltuion (ps)	Non-ToF	1000	550	495	345	300	100
Spatial Unceternity (cm)		15.0	8.3	7.4	5.2	4.5	1.5
Sensitivty Gain for 20 cm	1	1.3	2.4*	2.7*	3.9	4.4	13.3
Sensitivty Gain for 30 cm	1	2.0	3.6*	4.0*	5.8	6.7	20.0
Sensitivty Gain for 40 cm	1	2.7	4.8*	5.4*	7.7	8.9	26.7

*Sensitivity gains for analog technology need to be corrected for dead times

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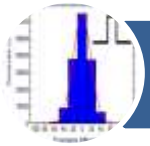
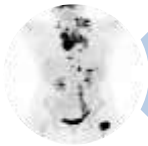
Digital Photon Counting



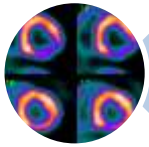
Digital Time of Flight

1:1 Coupling

≈ 2x improved volumetric resolution*



≈ 2x sensitivity gain*



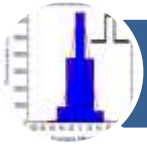
≈ 2x improved quantitative accuracy*

* Analog (*GEMINI TF)* to digital comparison

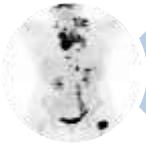
Digital Photon Counting

≈ 2x improved volumetric resolution*

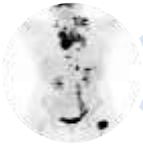
? Earlier detection



Digital Time of Flight

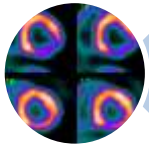


≈ 2x sensitivity gain*



? Lower dose

1:1 Coupling



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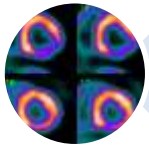
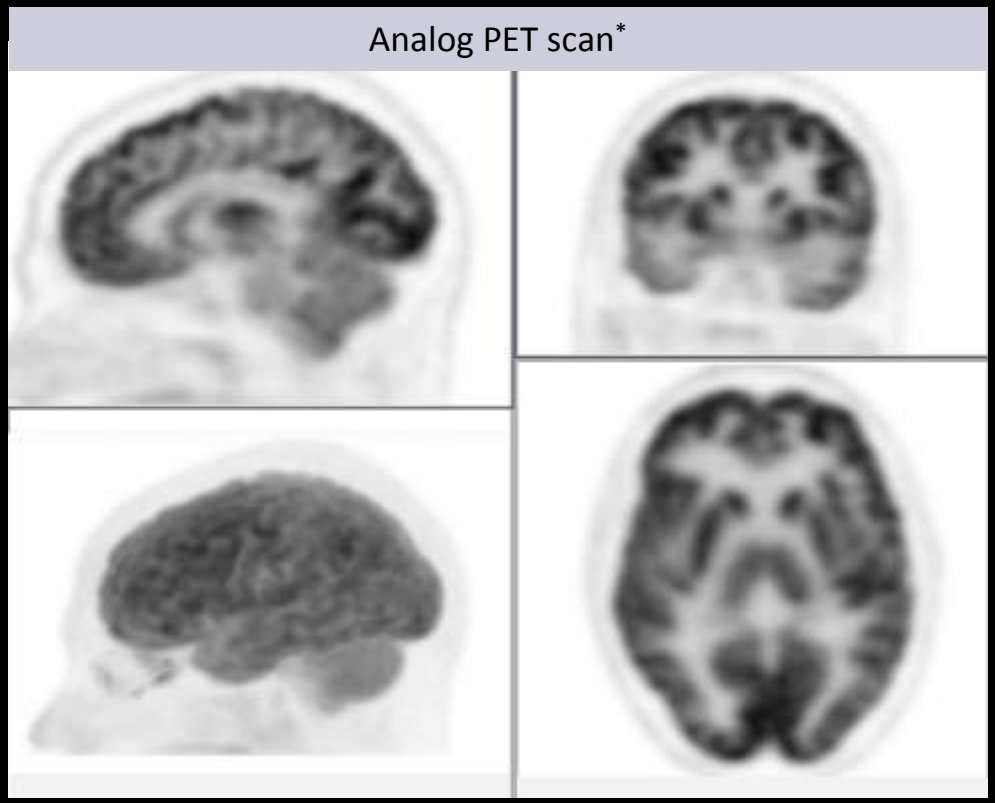


? Responders vs non-responders

* Analog (*GEMINI TF)* to digital comparison

Clinical Performance.

See further



**GEMINI TF 16*

Images courtesy of University Hospitals Cleveland

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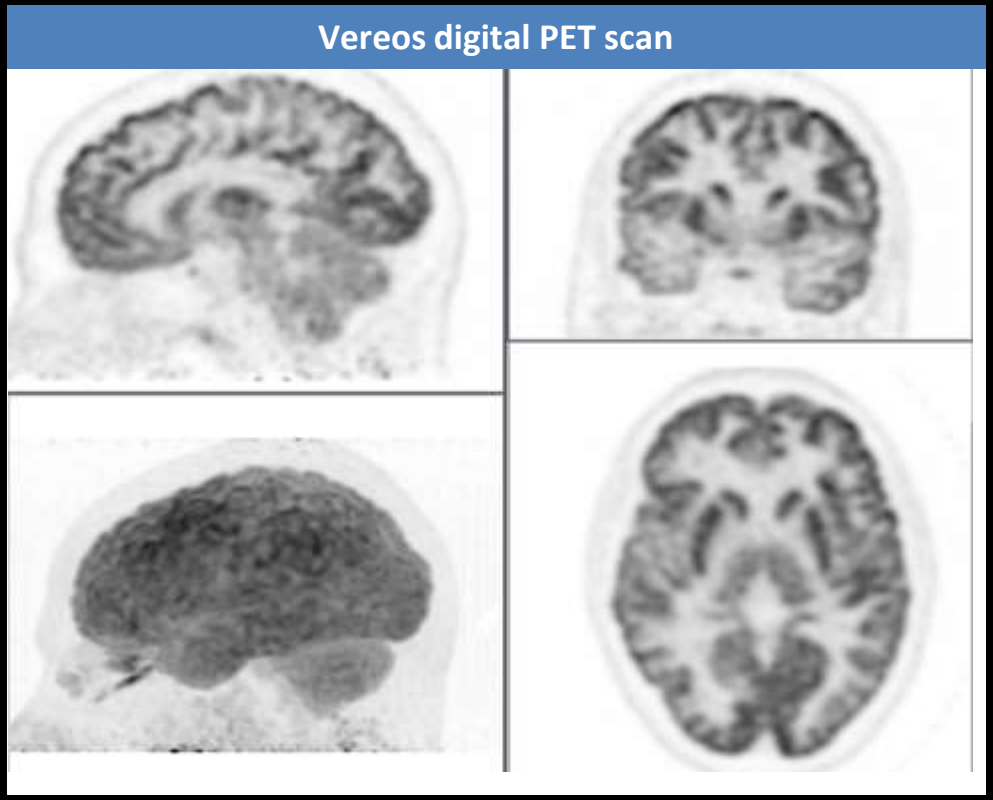
See further

Superb spatial resolution provides exceptional detail in brain images.



Images courtesy of University Hospitals Cleveland

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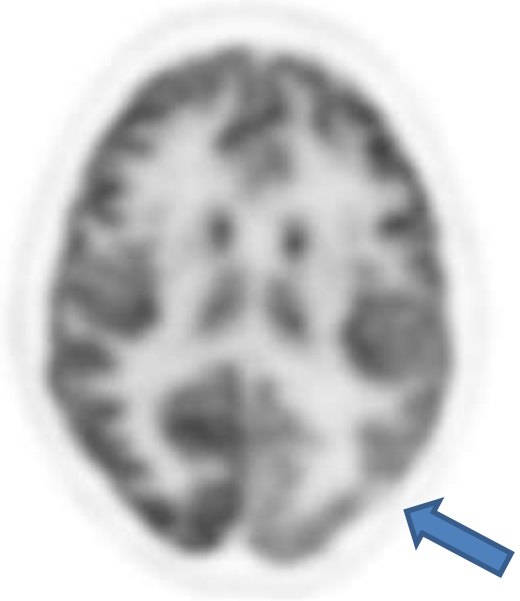
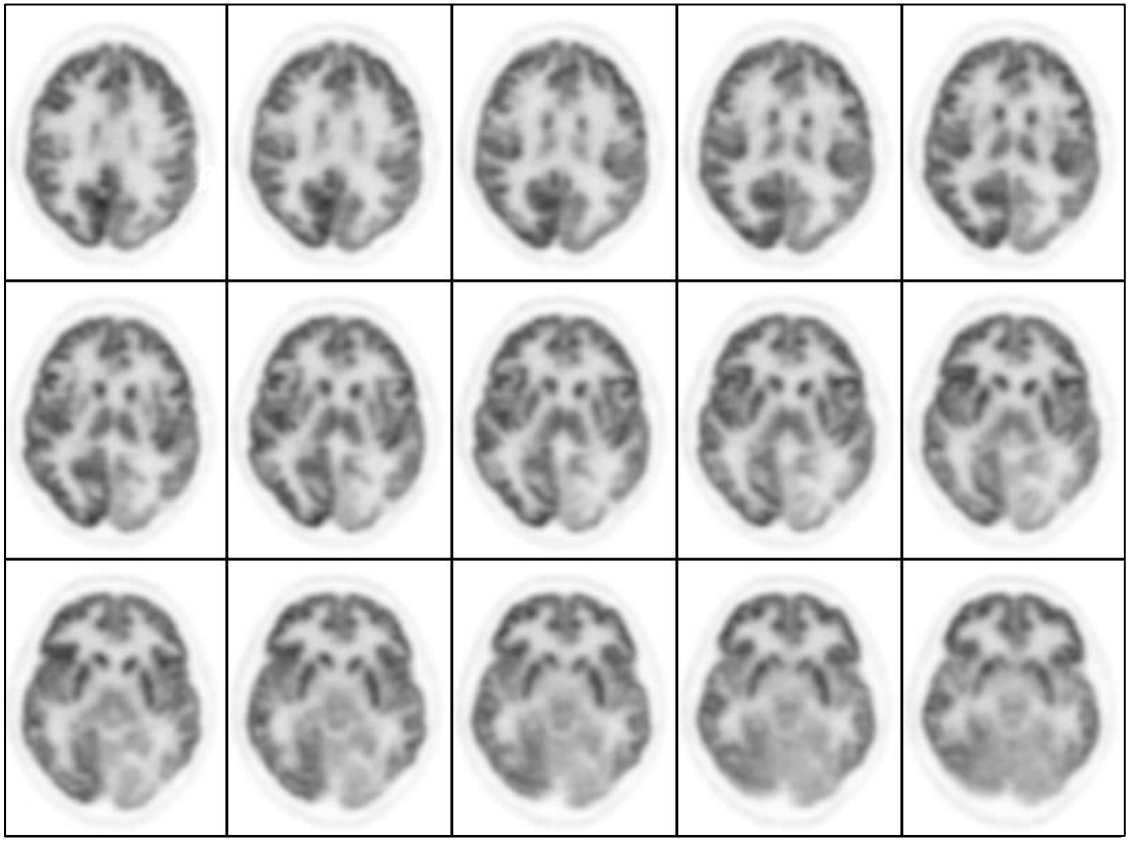
Improved image contrast in evaluation of post-operative changes.

Analog PET scan*





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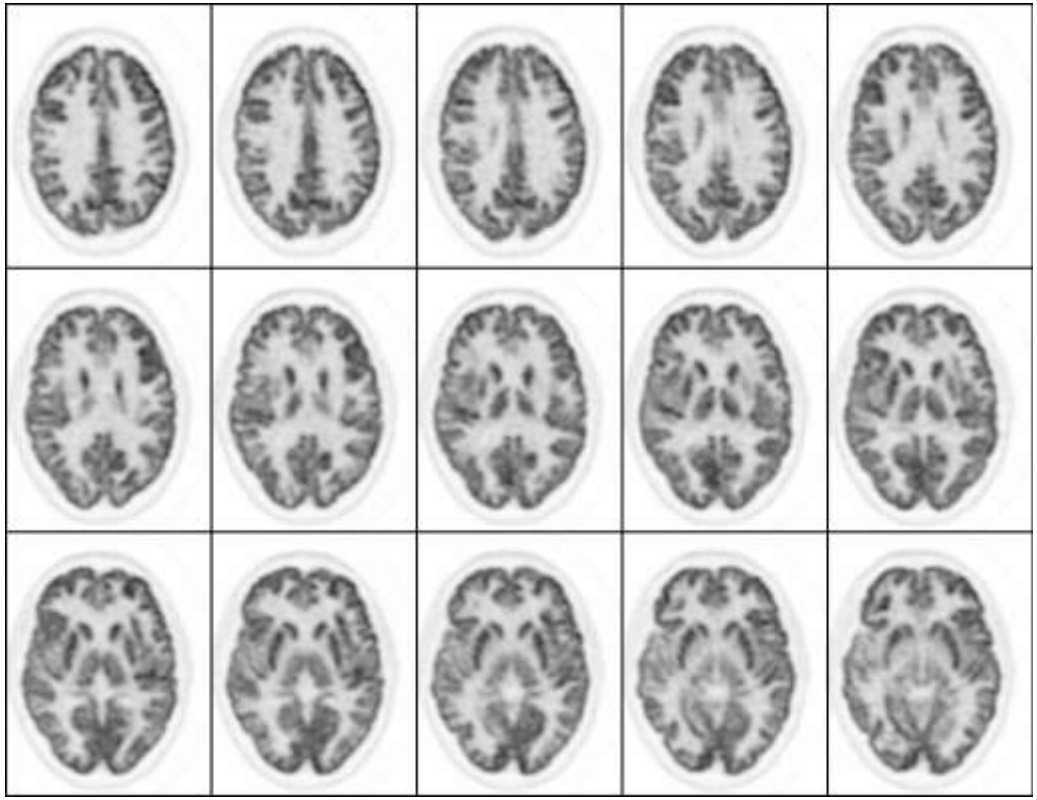

Images courtesy of University Hospitals Cleveland

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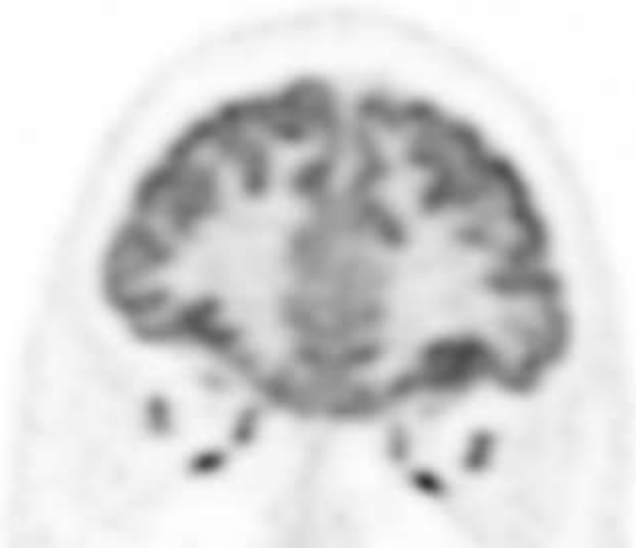
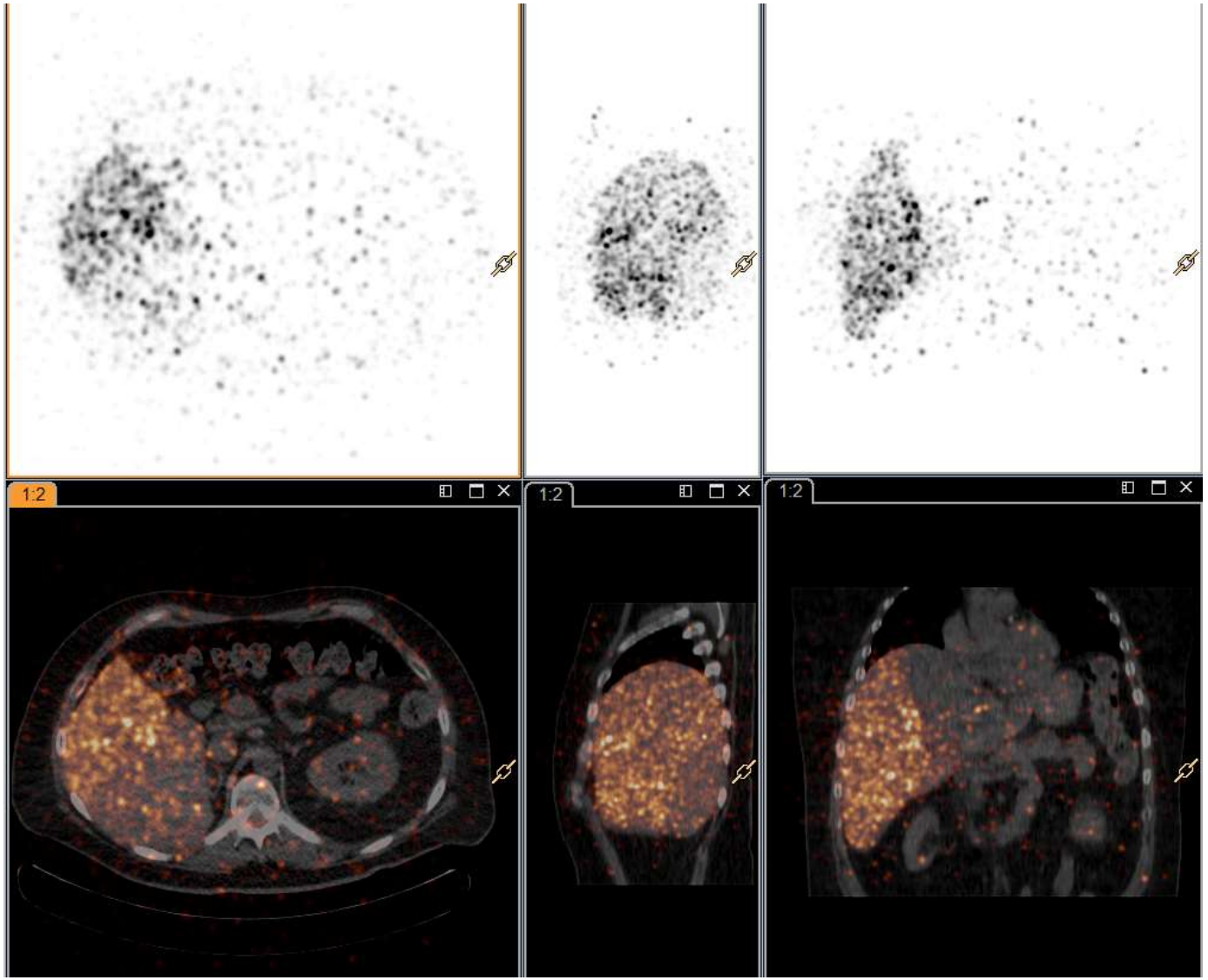


Y-90 Microspheres preliminary – GEMINI TF



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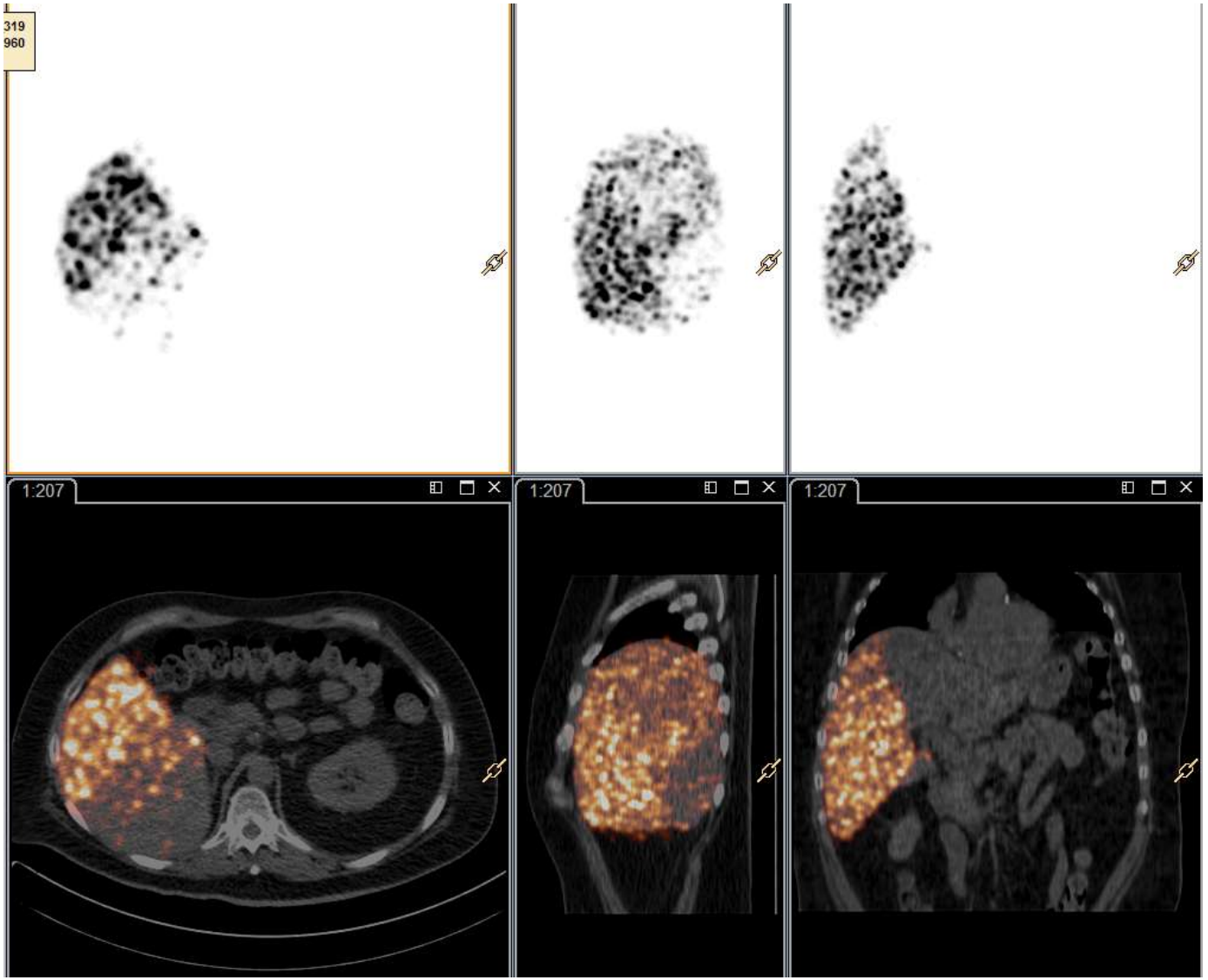
Y-90 Microspheres preliminary - VEREOS



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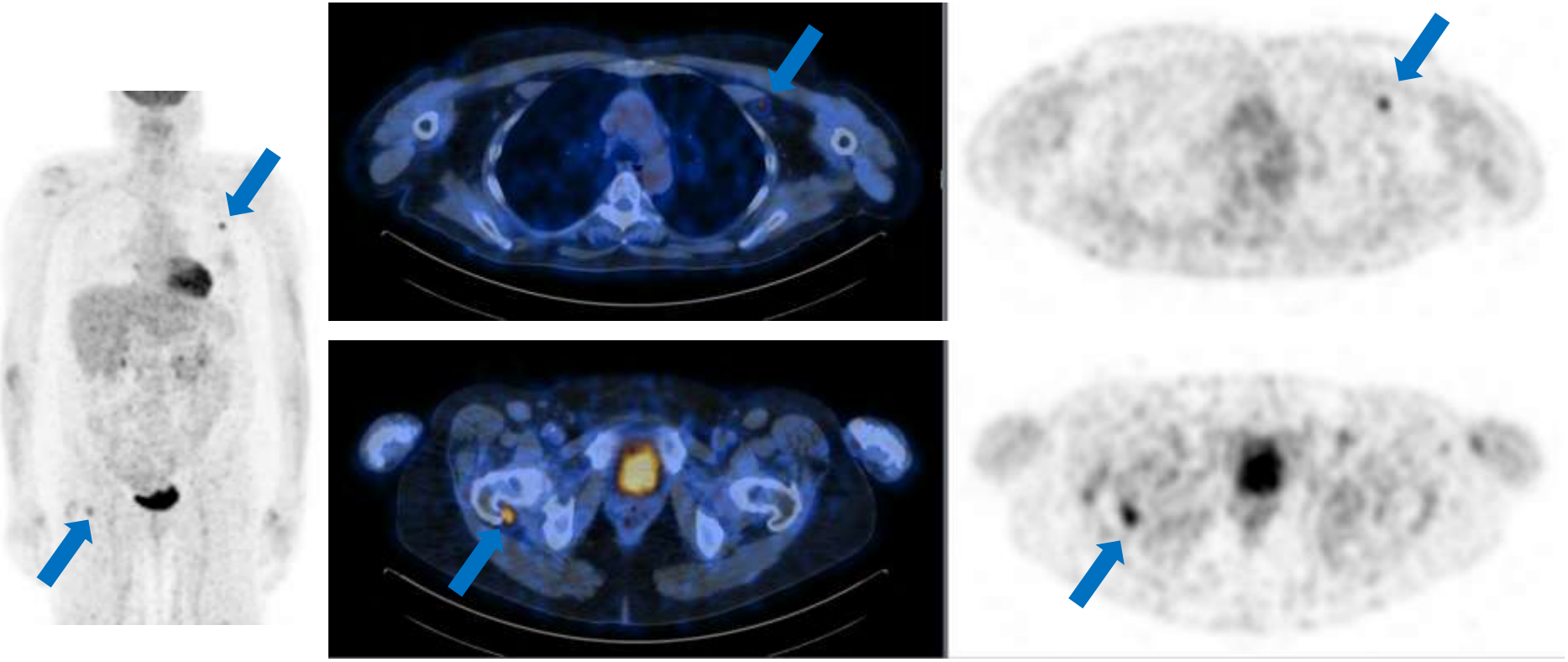
Oncology case 418



Total Body PET acquisition time: <u>81 seconds</u>

Designed for patient comfort

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Vereos PET/CT Wins Global Design Award

Praise for digital PET continues…

Vereos PET/CT wins iF product design award 2014!

Fondly nicknamed in the industry as the "Design Oscars," the iF Product Design is awarded annually by the iF International Forum Design after reviewing more than 2,000 applications. In its 61st year, the iF seal of good design is independently awarded to outstanding achievements in product, communication, and packaging design.

Philips Design was instrumental in the new industrial product design of Vereos PET/CT. The design team utilized a whiter, fresher palette in order to create a new identity. Vereos PET/CT stands apart from the crowd with its patient-focused design elements such as the light ring around the system parameter, table elements including arm rests, and a rear zone where clinical staff can store and attach accessories. This project took almost two years to complete. The result is a simplified design that improves patient comfort and increases clinical staff pride.