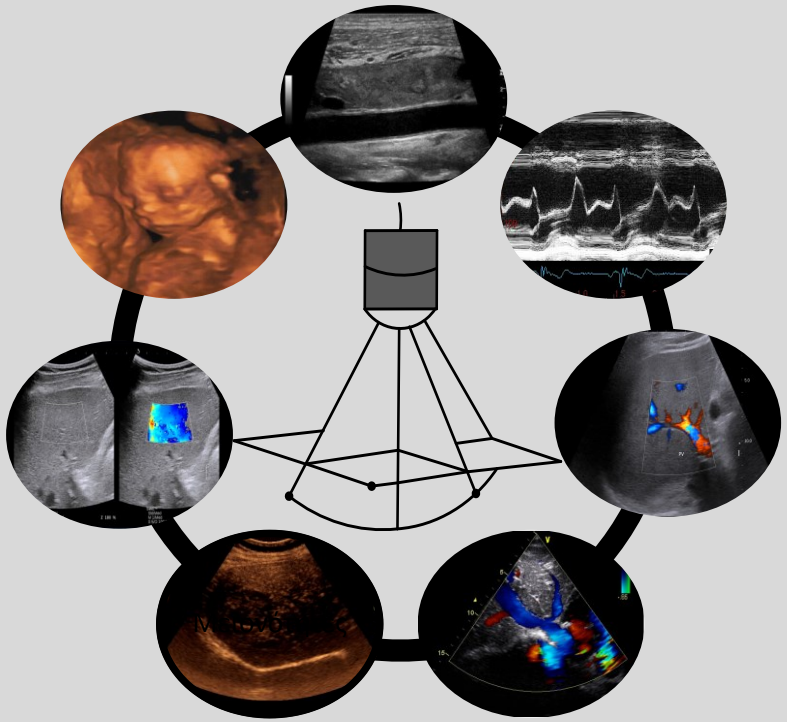
Ένωση Φυσικών Ιατρικής Ελλάδος

FUTURE OF US, INNOVATIONS AND TRENDS

Tsantis Stavros, PhD
Department of Medical Physics, University of Patras



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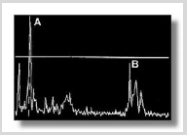
US Time Landmarks



1877
Rayleigh
Scattering

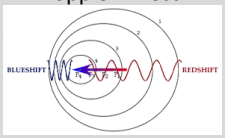
1916
SONAR

1949
A-Mode

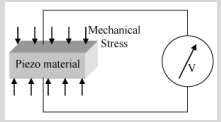
1955
B-Mode

1890 1900 1910 1920 1930 1940 1950 1960

1842
Doppler Effect

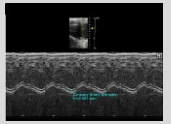


1880
Piezoelectric
Effect



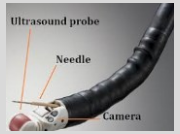
1942
Hyper-
Phonography

1950
M-Mode



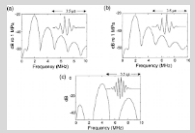
Imagine Mode driven…

US Time Landmarks



1978
Endo-esophageal

1990
Broadband
Transducers



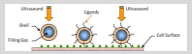
1996
THI

2004
Elastography
Coded Excitation

1970 1980 1990 2000 2010 2020

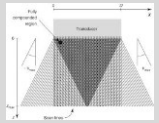
1968
Endoscopic US

1992
3-D
Contrast Agents
Digital
Beamforming



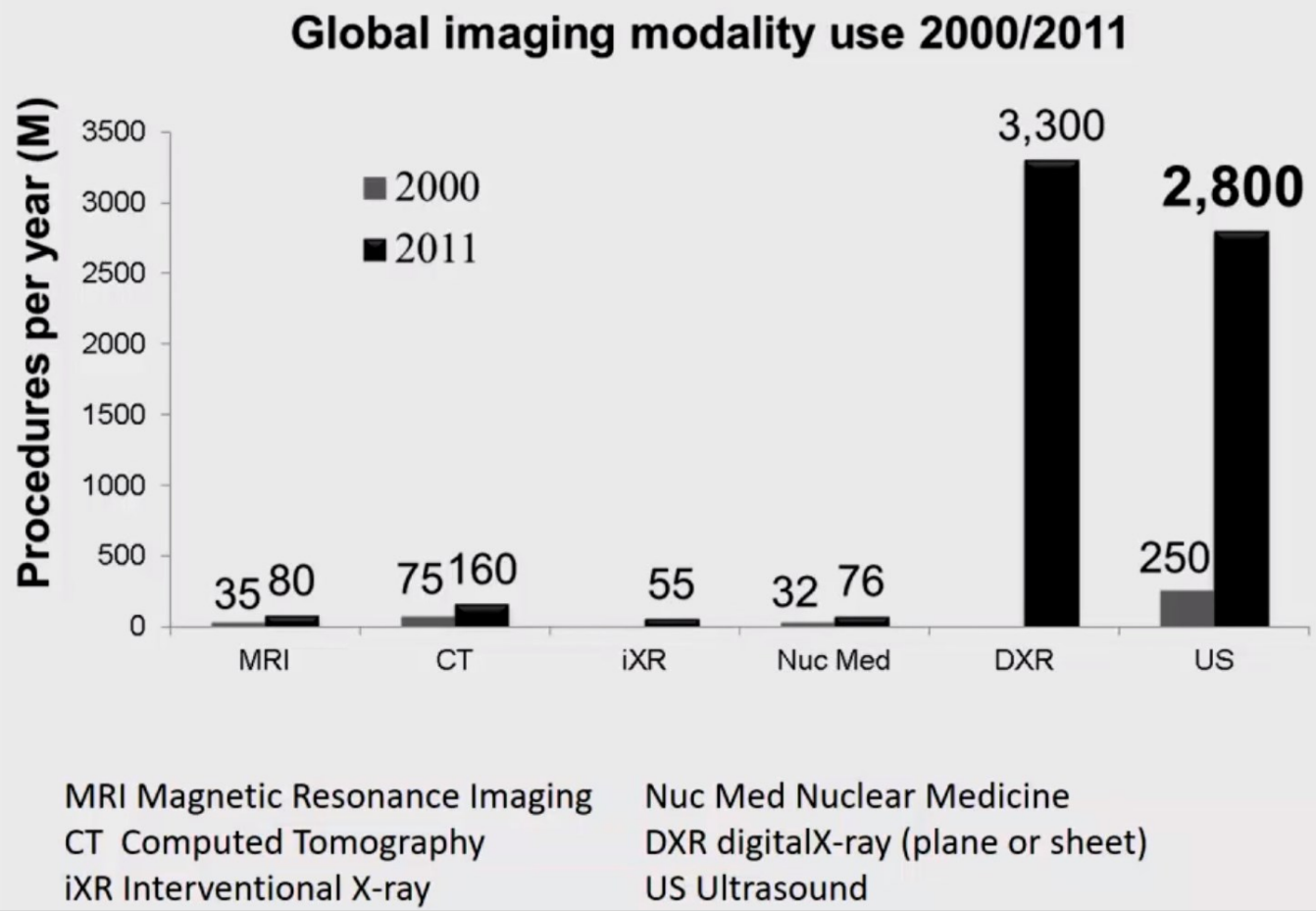
1998
4-D

2003
Spatial
Compounding



Technology & Software Driven…

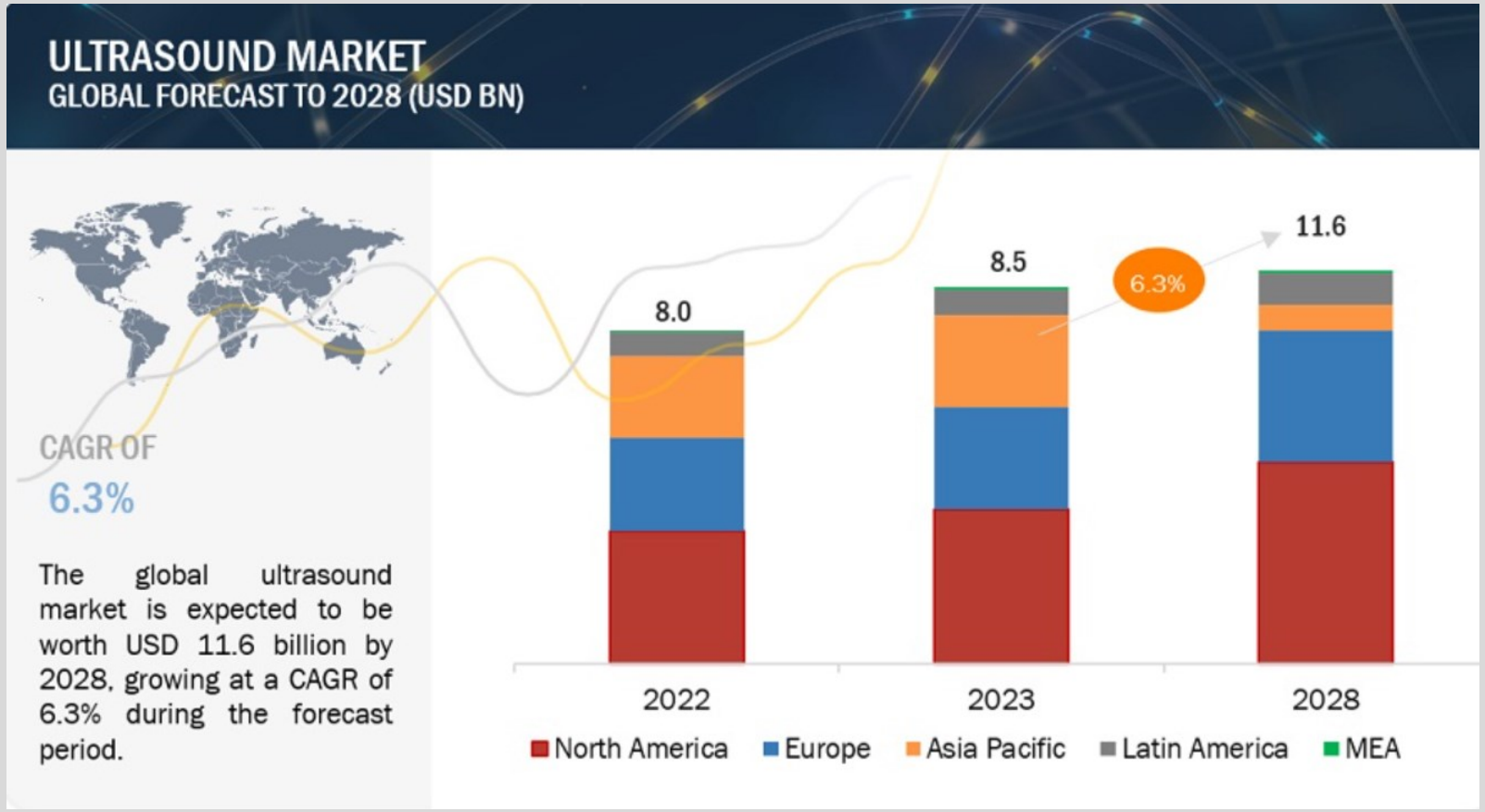
US Dominance



TL Szabo Diagnostic ultrasound imaging: inside out - 2004

- ✓ Ultrasound is now playing a key role across the complete care continuum:
  - ✓ Emergency medicine
  - ✓ Critical care
  - ✓ Anesthesiology departments

US Market Forecast



Ένωση Φυσικών Ιατρικής Ελλάδος

US SWOT ANALYSIS

Strengths

- Adoption of non surgical procedures
- Aging Patient and Surgical Population
- Prevalence of cancer and cardiovascular diseases

Weaknesses

- Higher Prices
- Dependence on Skilled Stuff
- Regulations and Compliance
- Insurance Reimbursement

Internal

SWOT Analysis

Opportunities

- AI
- Emerging economies (India, China and Canada)
- Expanding applications of therapeutic ultrasound
- preclinical applications segment of the ultrasound industry to register significant growth in the near future

Threats

- Unfavorable healthcare reforms in the US
- Competition
- Economic Conditions

External

Positive **Negative**

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Ένωση Φυσικών Ιατρικής Ελλάδος

Clinical Present and Future Trends in Imaging and therapy

Technology

1. **Enhanced Image Quality** (Advancements in ultrasound transducer design and signal processing techniques)
2. **3D and 4D Imaging** (3D and real-time 4D imaging will become more commonplace in clinical practice)
3. **Artificial Intelligence (AI) Integration**
4. **Wireless and Portable Devices** (miniaturization and wireless connectivity will lead to the development of more compact and portable ultrasound devices)
5. **Ultrasound-guided Interventions** (Improved visualization and needle tracking capabilities)
6. **Holographic and Virtual Reality Imaging** (Holographic and virtual reality-based ultrasound imaging could revolutionize medical education and training)
7. **Non-Medical Applications** (potential applications in non-invasive monitoring of structures like bridges and even exploring the depths of the ocean)

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Ένωση Φυσικών Ιατρικής Ελλάδος

Clinical Present and Future Trends in Imaging and therapy

Application

1. MRI Guided High Intensity Focused Ultrasound (HIFU) – Therapy
2. MRI – Ultrasound Fusion Imaging
3. Spatial Targeted Drug Delivery with Ultrasound and microbubbles – Therapy
4. US Molecular imaging using Contrast Agents
5. Near-Infrared (NIR) Photoacoustic Imaging
6. US neuromodulation – Therapy
7. Enhancements to Traditional Ultrasound Techniques
8. Micro-Vascular Imaging

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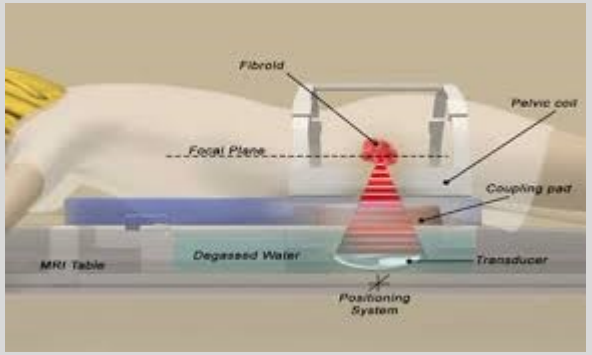
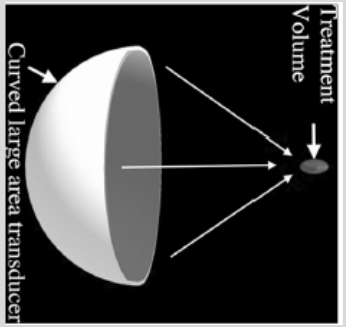
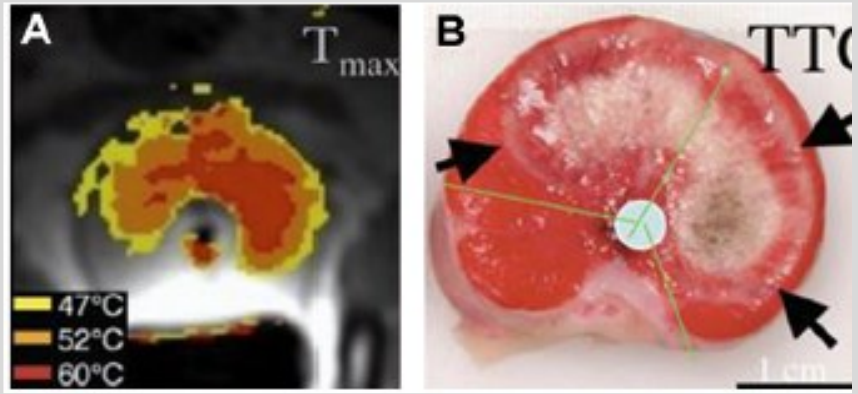
MRI Guided High Intensity Focused Ultrasound (HIFU)







Rouviere O, Souchon R, Salomir R,et al: Transrectal high-intensity focused ultrasound ablation for prostate cancer: Effective treatment requiring accurate imaging. Eur J Radiol 63(3):317-327,2007

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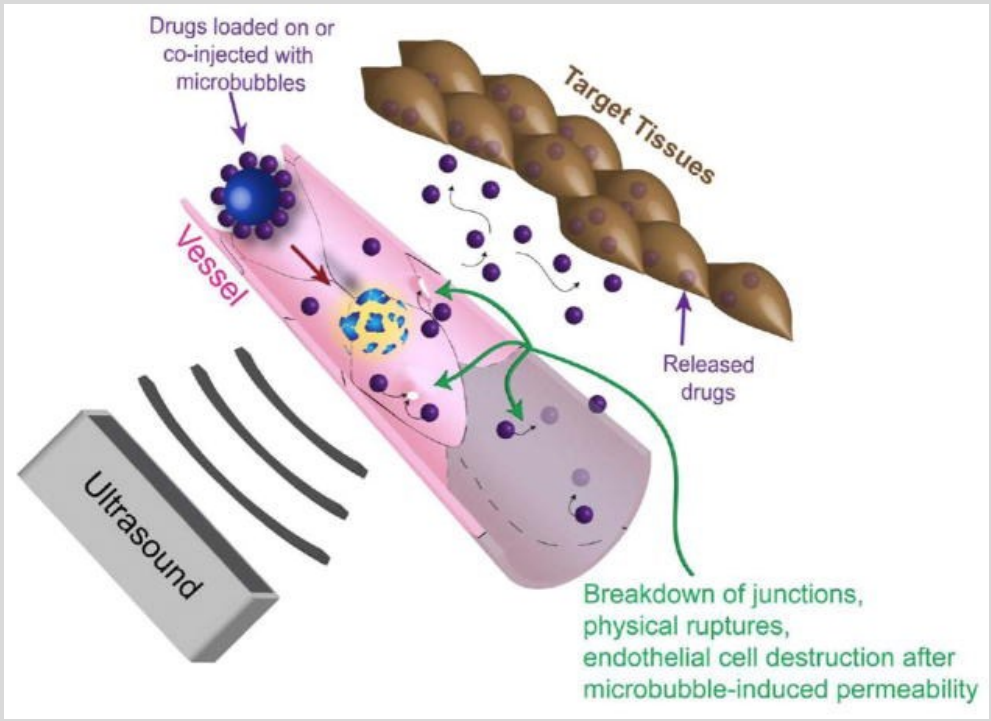
Spatial Targeted Drug Delivery with Ultrasound and Microbubbles

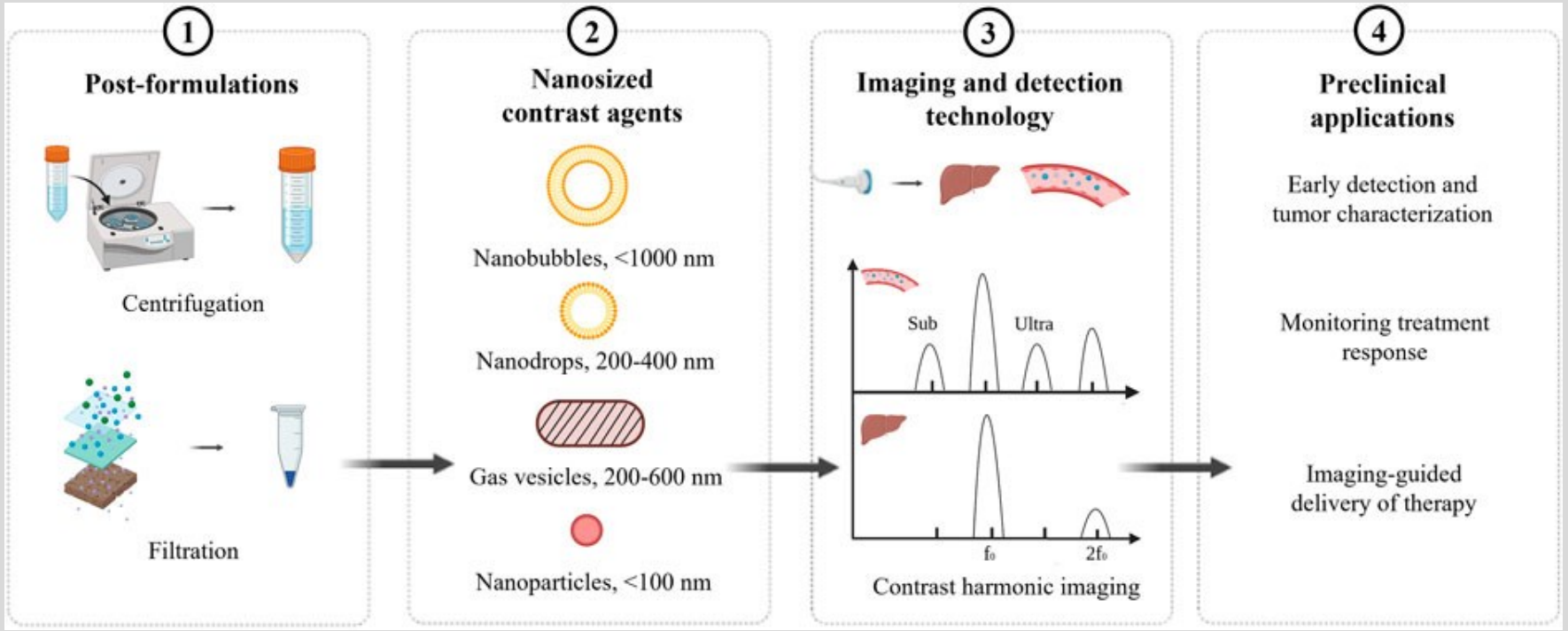


Tzu-Yin Wang, Katheryne E. Wilson, Steven Machtaler, and Jürgen K. Willmann
Ultrasound and Microbubble Guided Drug Delivery: Mechanistic Understanding and Clinical Implications Curr Pharm Biotechnol. 2014 Oct; 14(8): 743–752.

- ✓ Focused Ultrasound Insonation induces Microbubbles Acoustic Cavitation combined with Fluid Motion
- ✓ Spatio-temporal interactions are produced between microbubbles and cells or vessel walls
- ✓ **“Sonoporation” Procedure**
- ✓ Enhanced transport of therapeutic agents across these natural barriers

Ένωση Φυσικών Ιατρικής Ελλάδος

US Molecular imaging using Contrast Agents (MBs)



- ✓ Biologically-targeted ultrasound Nanosized Contrast Agents
- ✓ Enhance sensitivity, identification, and quantification
- ✓ Visualizing tumor vasculaturity
- ✓ Imaging inflammation
- ✓ Ischemia, injury zones

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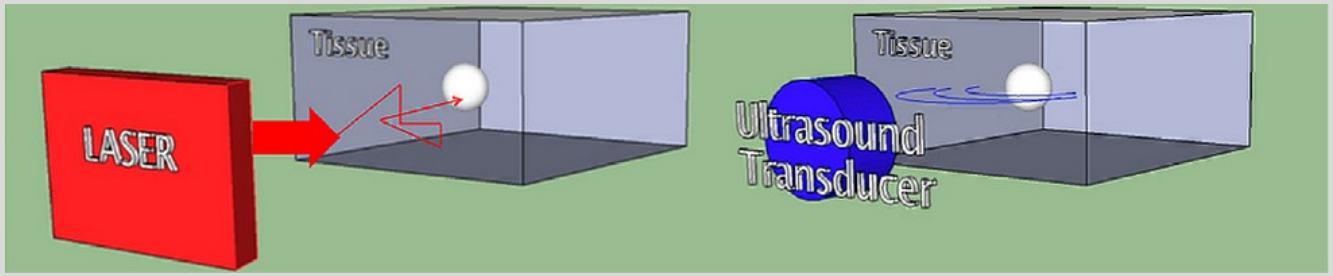
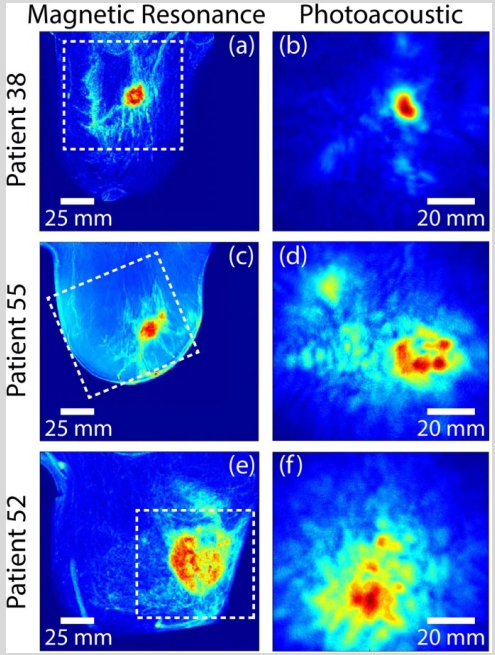
Near-Infrared (NIR) Photoacoustic Imaging



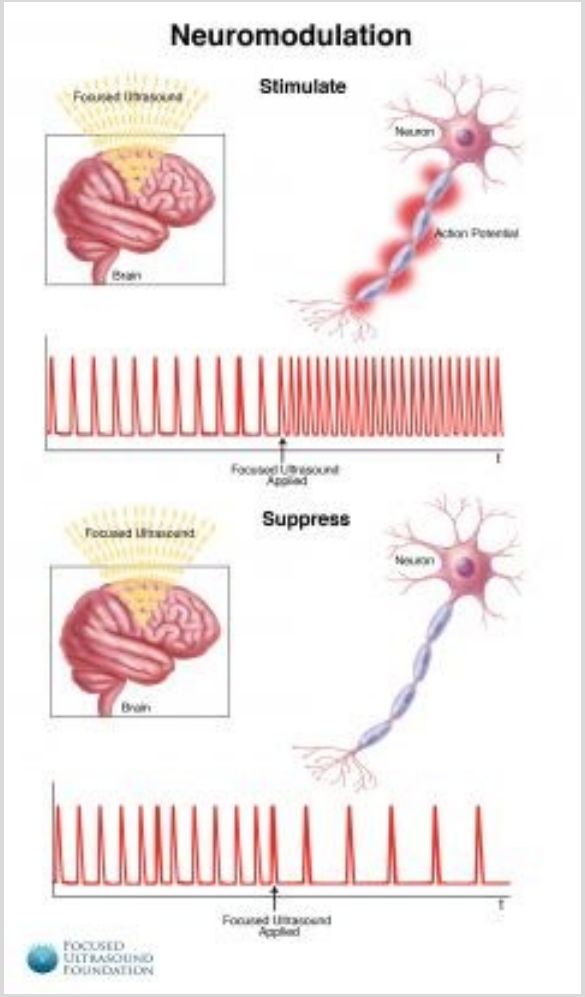


Wang LV: Tutorial on photoacoustic microscopy and computed tomography. IEEE J Sel Top Quantum Electron 14:171-179, 2008

- ✓ A pulsed laser excitation generates sound waves within human body
- ✓ The received signal is acquired with an ultrasound transducer.
- ✓ Laser focal spot size is multiple orders smaller than ultrasound beam producing higher image resolution compared to conventional ultrasound images.
- ✓ Differentiation between Breast Cancer Molecular Subtypes

Ένωση Φυσικών Ιατρικής Ελλάδος

Ultrasound Neuromodulation



https://www.fusfoundation.org/mechanisms-of-action/neuromodulation

- ✓ Focused ultrasound can stimulate or suppress neural activity
- ✓ The procedure depends on the parameters of the energy applied to neural tissue.

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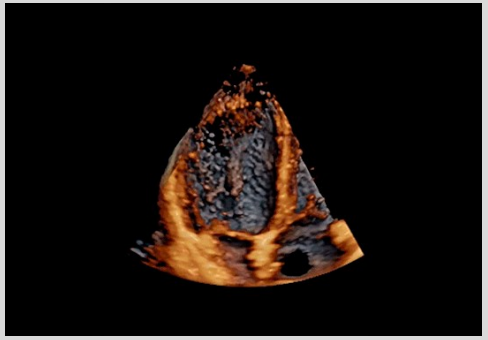
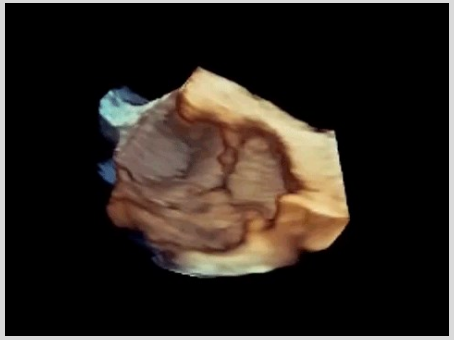
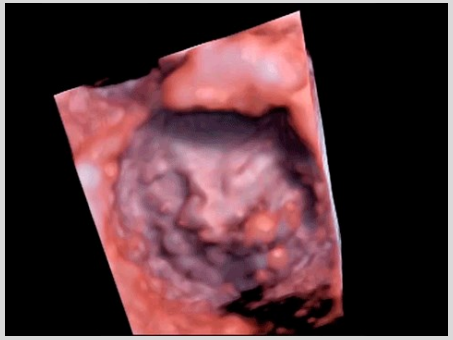
Enhancements to Traditional Ultrasound

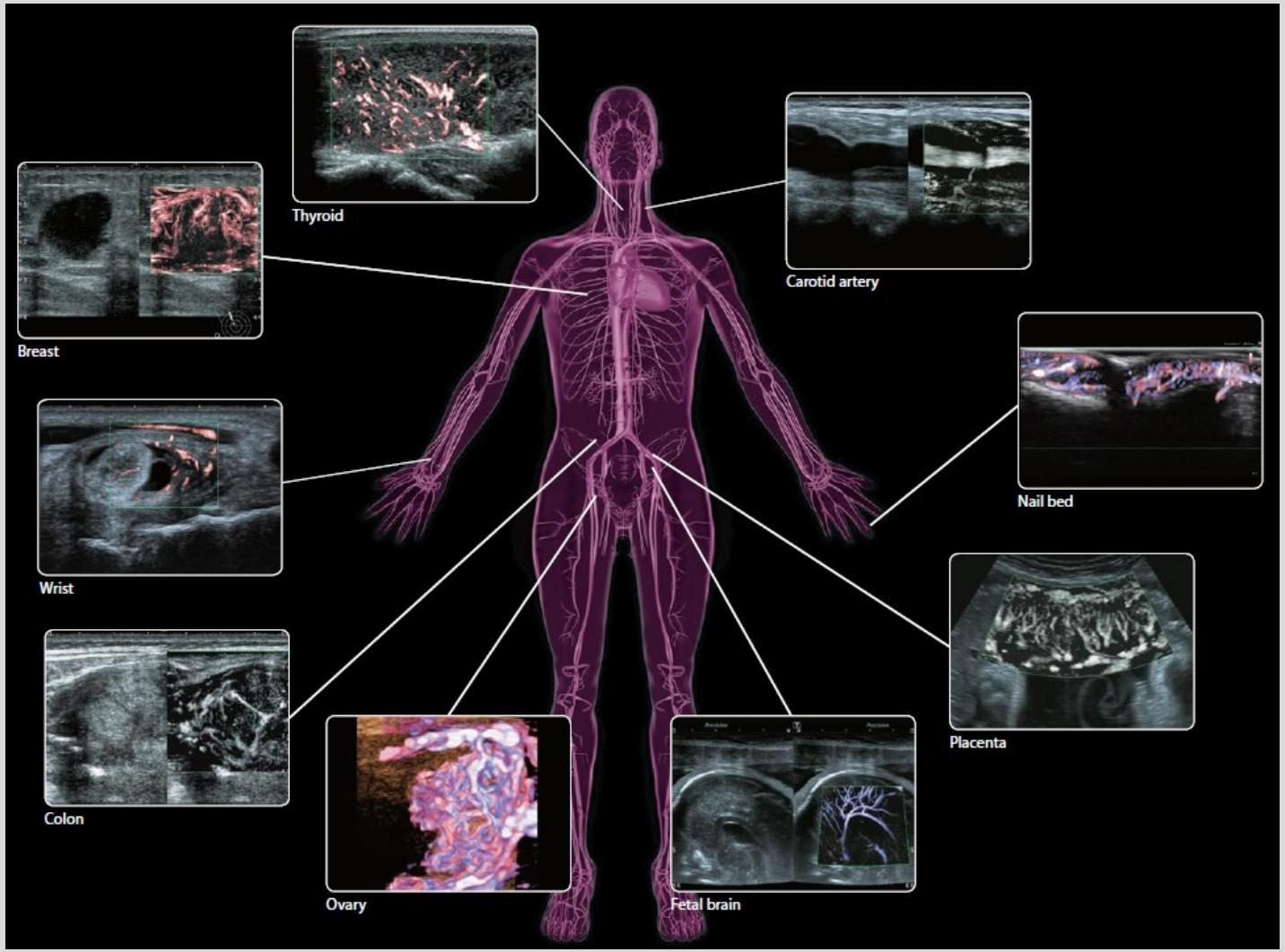
- ✓ More efficient 4-D US Imaging
- ✓ Higher acquisition rates push 3-D echo technology
- ✓ Reduce operator variability in scanning and interpretation
- ✓ Photo-realistic Lighting to Enhance 3D Echocardiography







Micro-Vascular Imaging



SMI Toshiba Medical

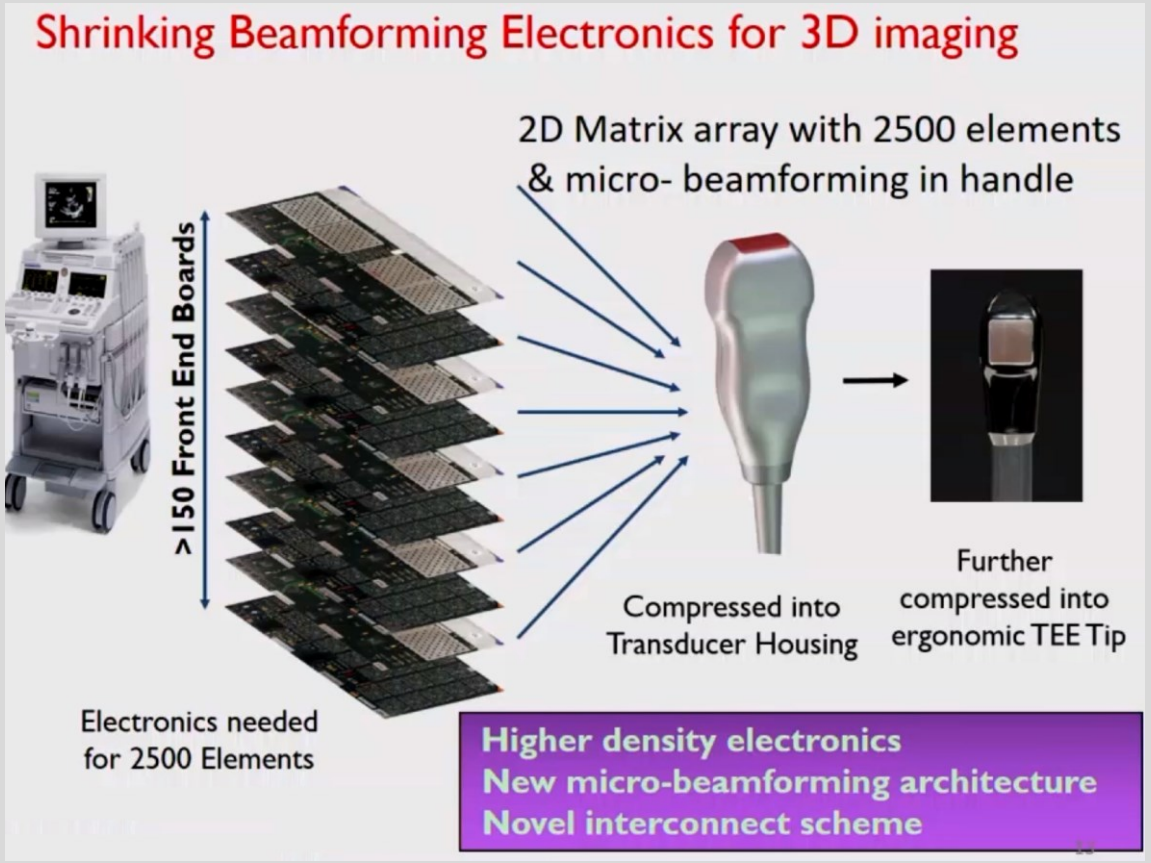
2-D images capture of vessels

Navi 4D Needle Positioning

http://www.mindray.com/en/presscenter/eSpacial_Navi__A_Step_Towards_a_New_Era_of_Accuracy.html

- ✓ Display the needle location even when it's outside the ultrasound beam!
- ✓ Magnetic field induction technology for both in-plane and out-of-plane techniques

Size Size Size Size Size Size Size



Philips HealthCare Ultrasound

Mobility – Portability

- ✓ Portable hand-held devices to the world's first wireless transducer
- ✓ Handheld, point-of-care (POC) solutions focused on improvements in image quality, productivity and ergonomics
- ✓ Cost-effective solutions that do not compromise high-quality imaging
- ✓ Point-of-Care Diagnostics

Ένωση Φυσικών Ιατρικής Ελλάδος

Present and Future Trends
CEOs Point of View

- ✓ **FUJIFILM Medical Systems USA,** "My prediction is that **all physicians will utilize highly mobile ultrasound in the future**."
- ✓ **GE**, "We have seen drastic **improvements in the quality, cost, and access of ultrasound overall**. Digital solutions immediately transfer diagnostic data into actionable clinical insights that benefit both clinicians and patients,"
- ✓ **Konica Minolta Healthcare Americas, Inc,** "The **development of mobile systems increases functionality for the point-of-care market**. Ultrasound mobility doesn't just bring the imaging modality to the bedside in hospitals; it also provides access to the real-time medical images of patients in surgi-centers, offices, and clinics."

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Present and Future Trends
CEOs Point of View

- ✓ **Mindray**, “Let **innovation** light the way”
- ✓ **Philips**, “**automation, reproducibility, and portability** continue to be trends driving ultrasound.”
- ✓ **Siemens Medical Solutions USA, Inc** “**Performance increment of ultrasound imaging** to provide benefits from a clinical perspective,“
- ✓ **Toshiba,** "A trend we have been seeing is **smaller systems, portable handheld ultrasound**, more different uses in point of care,"

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Predictions

- ✓ **Prediction #1:** Every Ultrasound System Will be Driven by AI
- ✓ **Prediction #2:** Ultrasound Training Will be Part of Most Medical School Programs
- ✓ **Prediction #3:** At-Home Ultrasound Use Will be Approved for Some Applications
- ✓ **Prediction #4:** Ultrasound Solutions Will Utilize Open Platforms and Integrations to Expand Use Across Medical Specialties
- ✓ **Prediction #5:** Ultrasound Technology Will Become Smaller Than Your Watch

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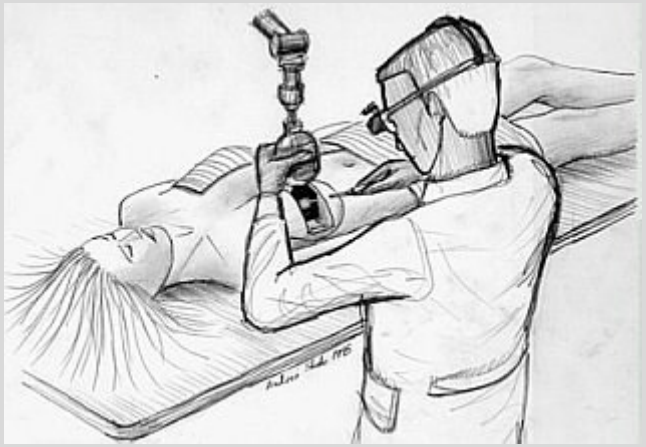
Augmented Reality Technology

- ✓ AR combines computer graphics with images of the real world.
  - ✓ *Ultrasound echography imaging*
  - ✓ *Video see-through head-mounted display (HMD)*
  - ✓ *High-performance graphics computer to create live images that combine computer-generated imagery with the live video image of a patient.*



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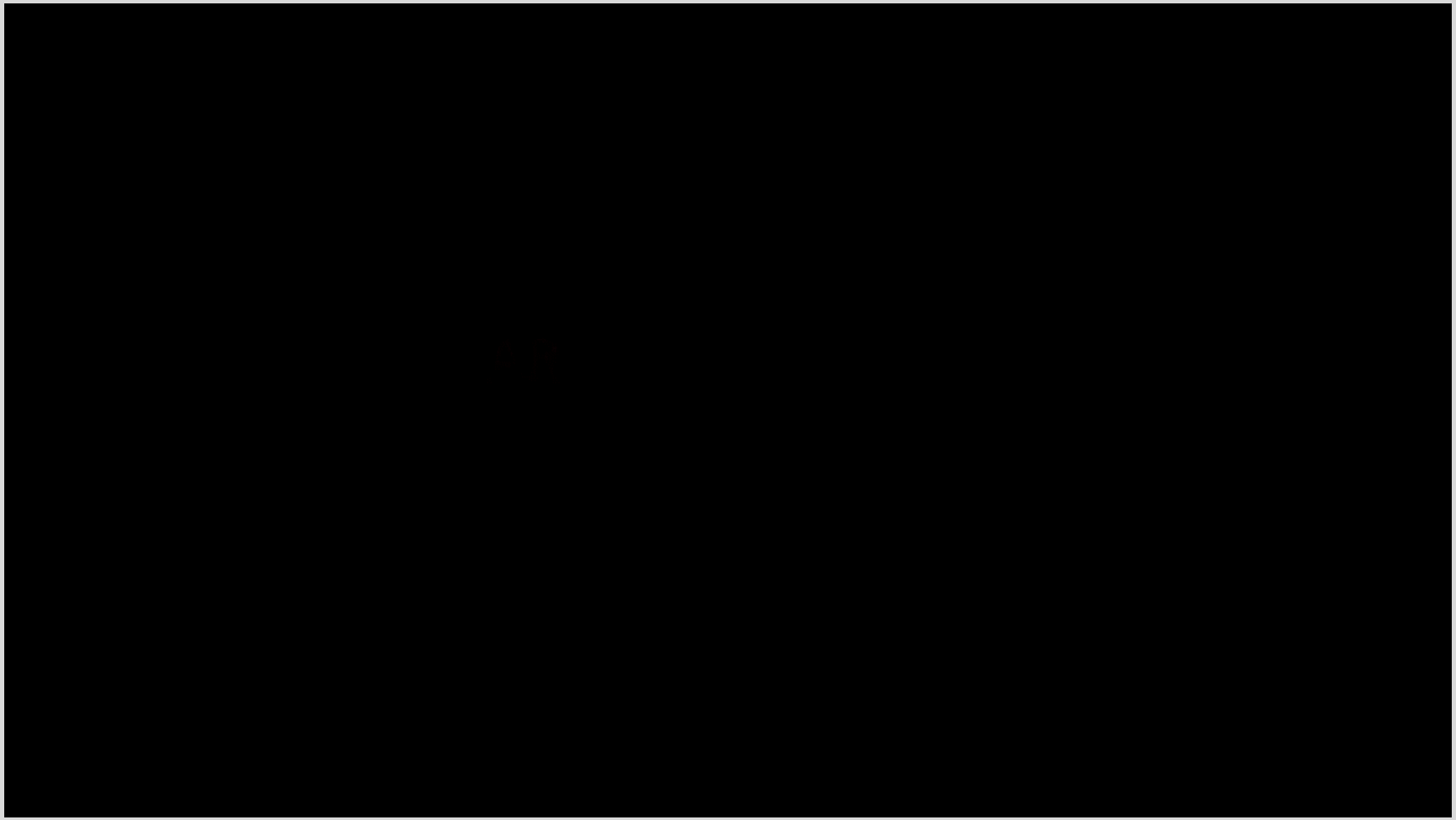
Augmented Reality Technology



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Thank you….

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