

# Biomedical Engineering in the 21<sup>st</sup> Century and in the Future

Marek Penhaker

# What is Sci- Fi now?

## Fairy Tales:

- Flying carpet - airplanes, space shuttles, helicopters
- Seven-miles shoes - Cars, Segway
- Self cutting axe - chainsaw
- Crystal prediction ball - Mobile Phones
- Waterman, fairy - divers, submarines, holography
- Life water -??



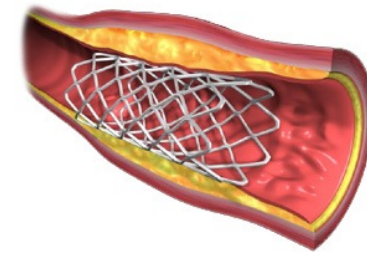
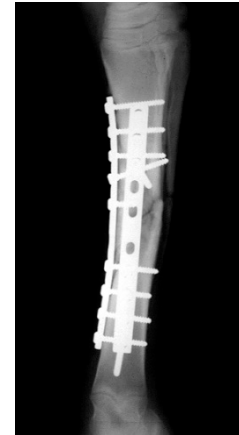
## Fathers of Sci-fi:

- J.Verne, S. Lem, K. Čapek,
- O. Neff, M. Shelley

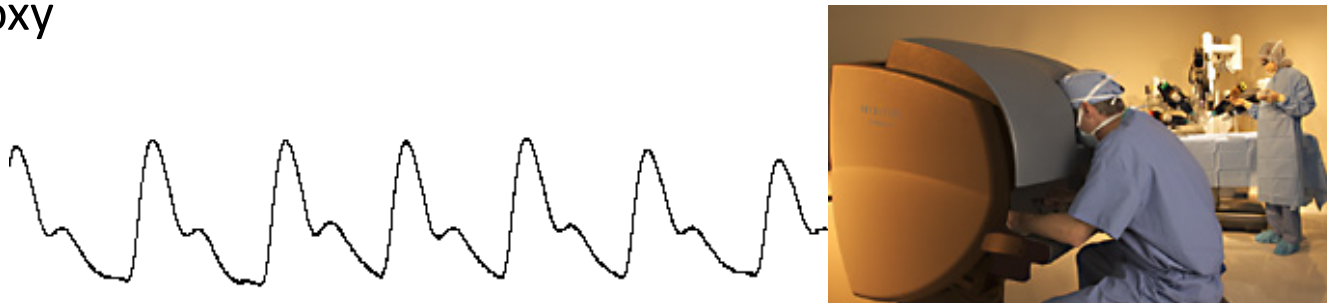


# What about medicine ?

- Telemedicine-diagnosis, surgery, treatment
- Robotic surgery - da Vinci Surgery
- Micro and nano - scopy
- Genetic interventions
- Memory materials - joints, fractures
- Refunds organs and implants
- Imaging - CT, NMR, ...
- Stimulators – pacemakers, defibrillators, neurostimulators
- Hyperbaroxy

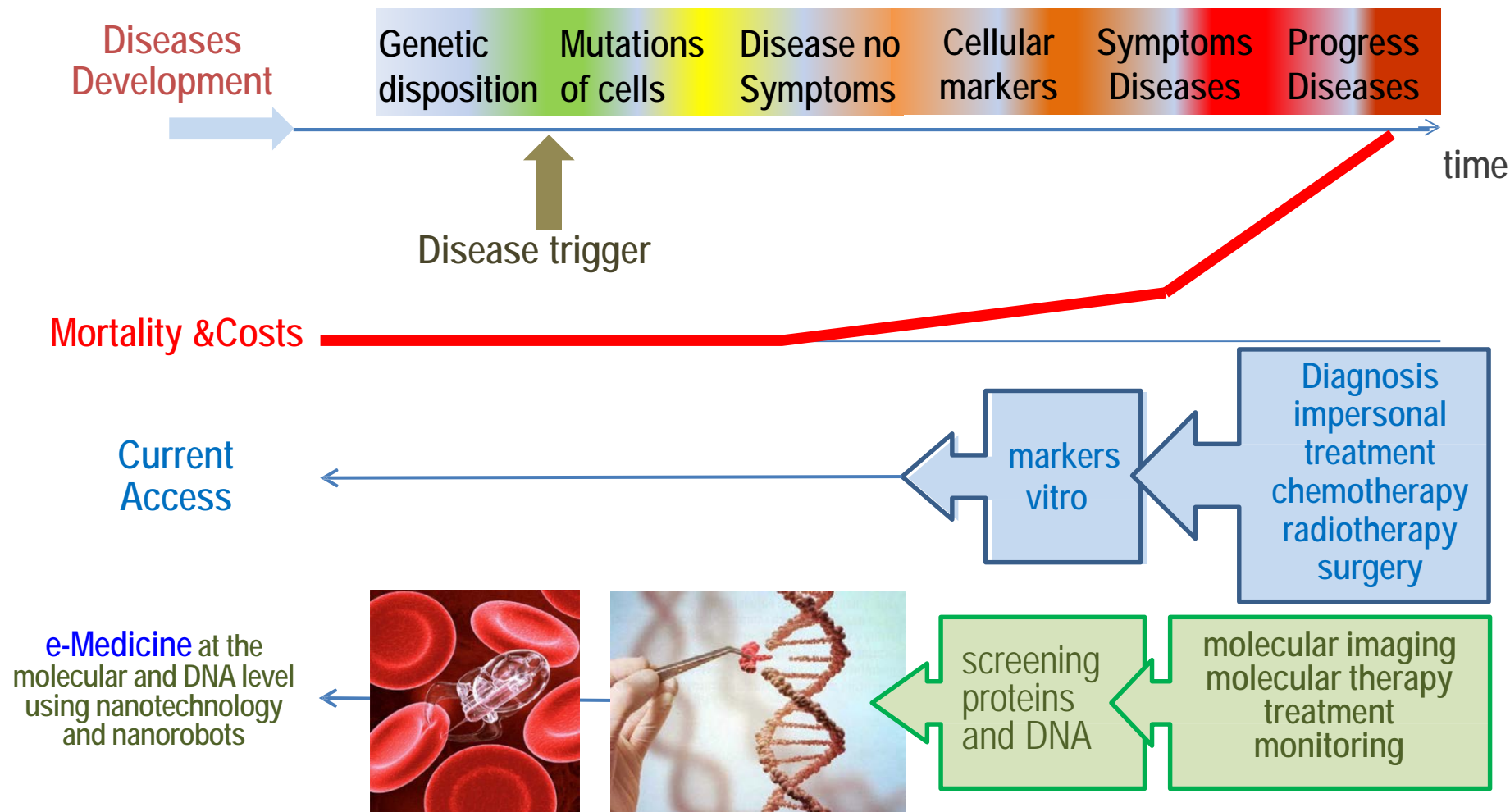


[nanotechweb.org](http://nanotechweb.org)





# The Future = e-Medicine at the molecular level



# How to visualize?

- Technology science fiction movies at your workplace - HELIODISPLAY
- Hand movement to control object and its rotation
- Price 22,500 - \$ 47,000

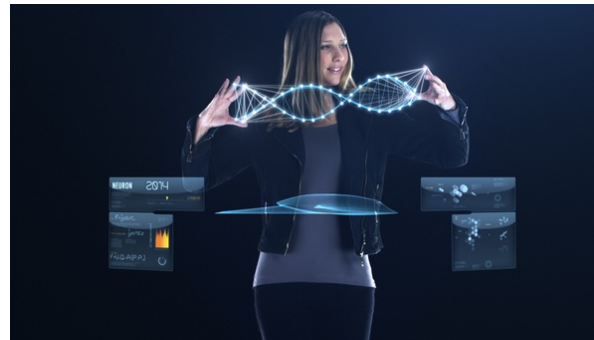


# Like real 3D

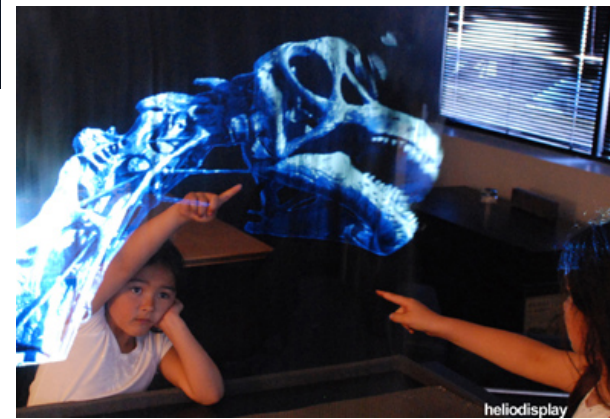
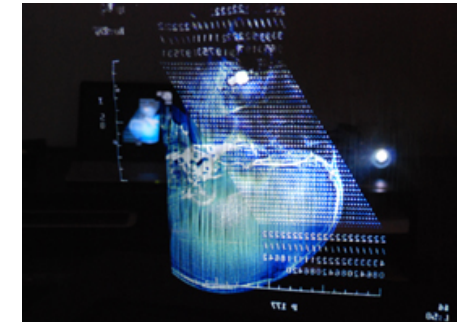
- Levitating images not on the principle of holography, lasers projected image into the air at high speed
- Meanwhile resolution as the desktop image sizes of around 80 cm



<http://io2technology.com/>



<http://www.pinterest.com>



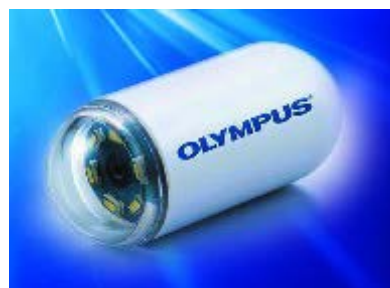
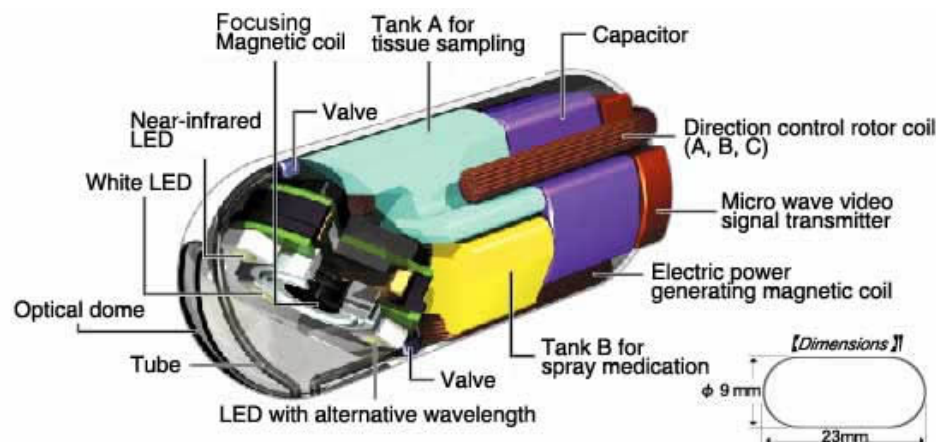
The Next Generation Capsule Endoscope



*Sayaka*



- Colonoscopy of the intestines

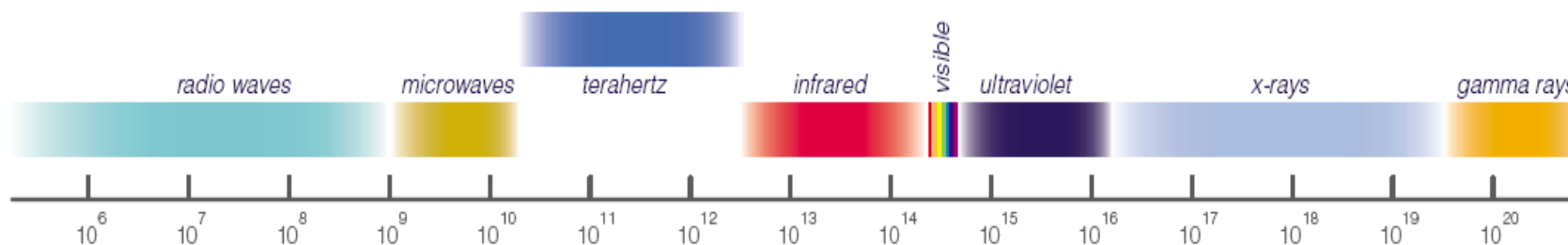




# T - rays

- Elektromagnetic waves ( $10^{12}$  Hz)

## Terahertz and the spectral fingerprint



The terahertz gap: 40 GHz to 4 THz or  $1.33 \text{ cm}^{-1}$  to  $133 \text{ cm}^{-1}$  or 7.5 mm to 75  $\mu\text{m}$

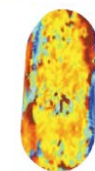
- 1995 AT & T Bell Laboratories
  - Energy of a few meV, of which 20% heat
  - power of 3.5 mW
- ☺ X-ray electrons in matter, T water content
  - ☺ Water is absorbed, Plastics, Textiles passes
  - ☺ Non-ionizing → safe
  - ☹ small penetration depth of about 5 cm

<http://www.teraview.com/>

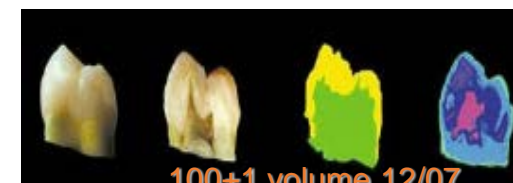
## 'Good' vs 'Poor' tablet coatings



'Good' – uniform outer coating thickness

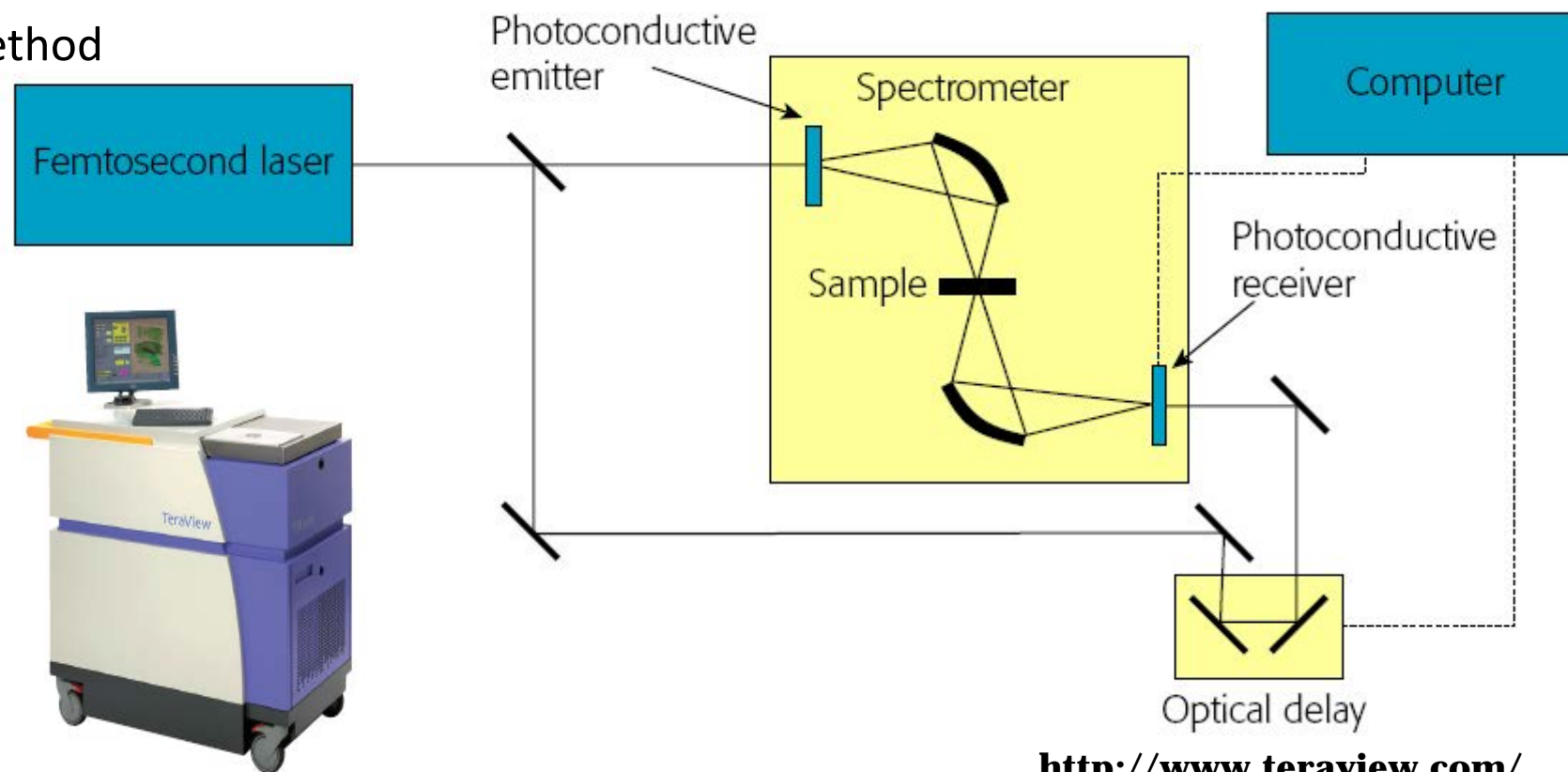


'Poor' – poor uniformity of outer coating with holes



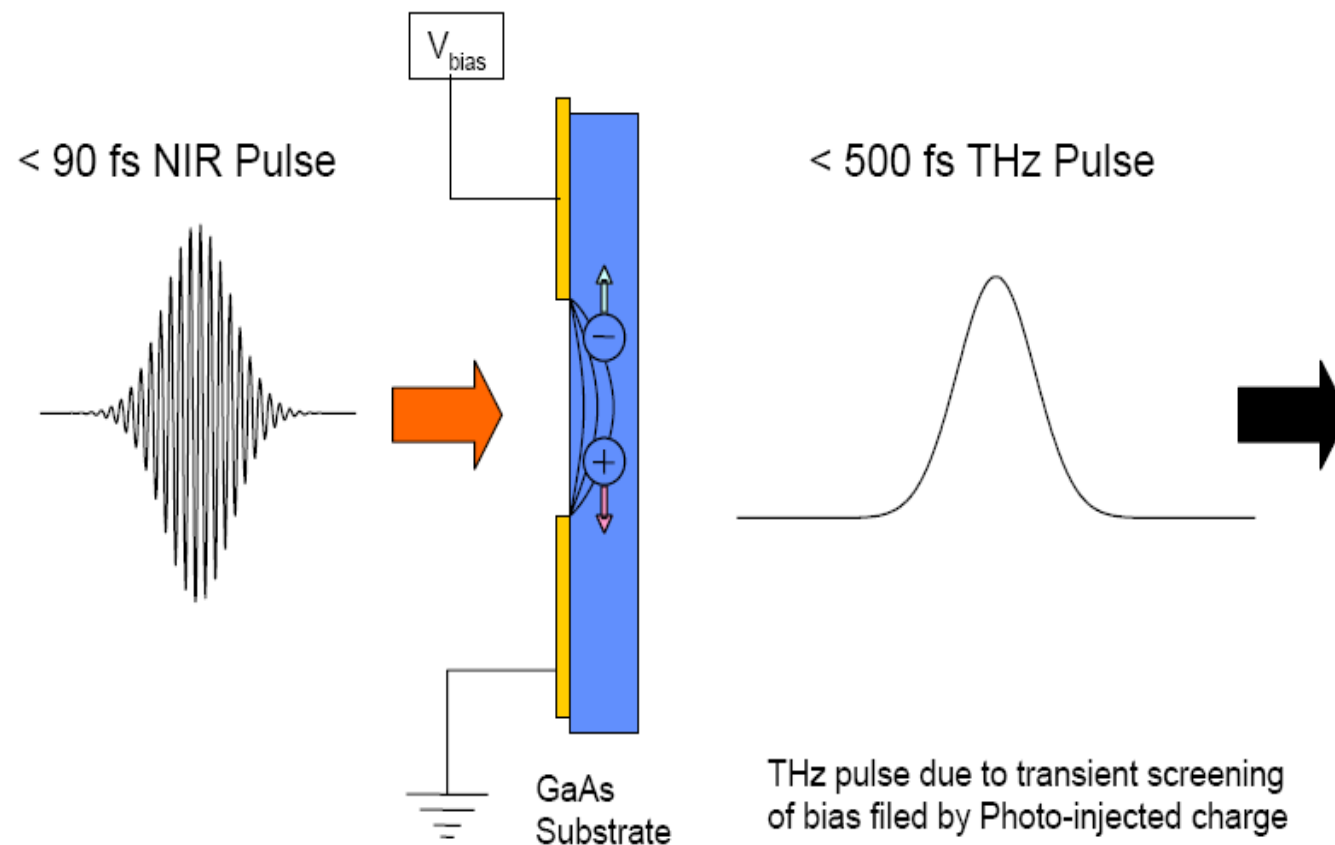
# Principle of THz technology

- Generation of THz pulse laser source
- Measuring the time delay
- Through reflection method





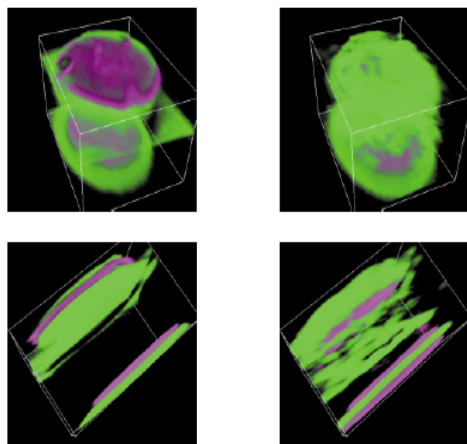
# Generation of T Hz pulse



# Applications of THz technology

- The development of new drugs
- The quality of the manufacture of drugs (TeraView)

3D Tablet imaging

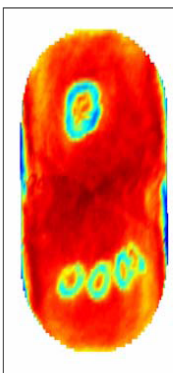


Model tablet without active ingredients

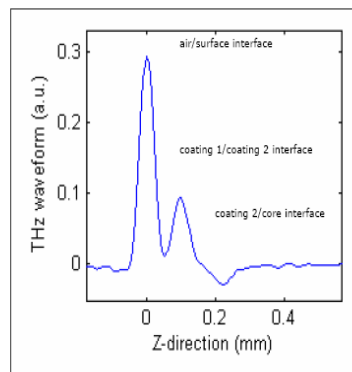
Model tablet with active ingredients

<http://www.teraview.com/>

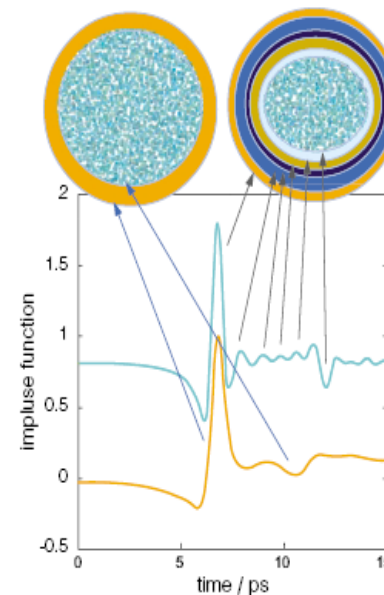
3D TPI Image



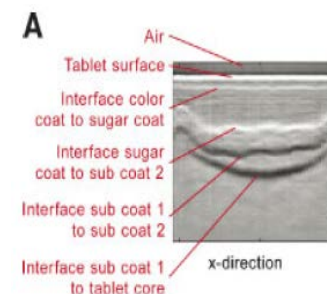
THz time-domain waveform



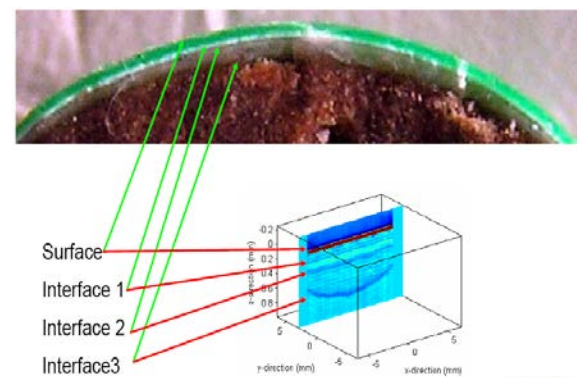
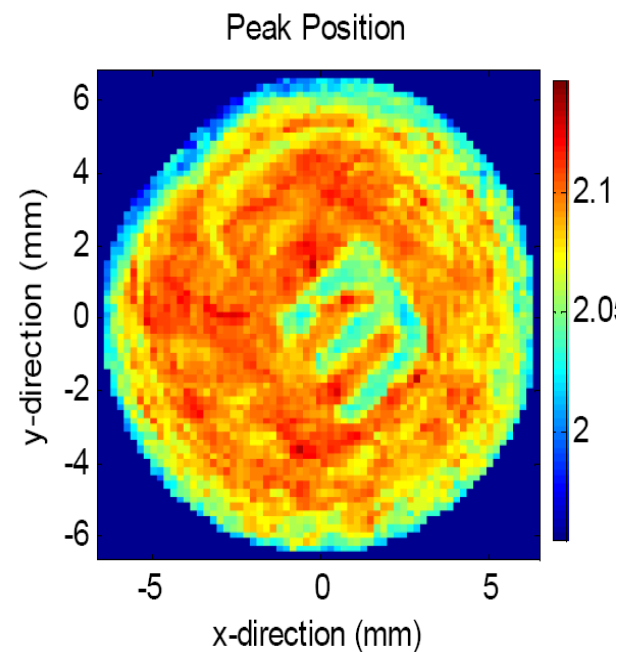
Identification of tablet coating structure



Comparison between different tablet constructions

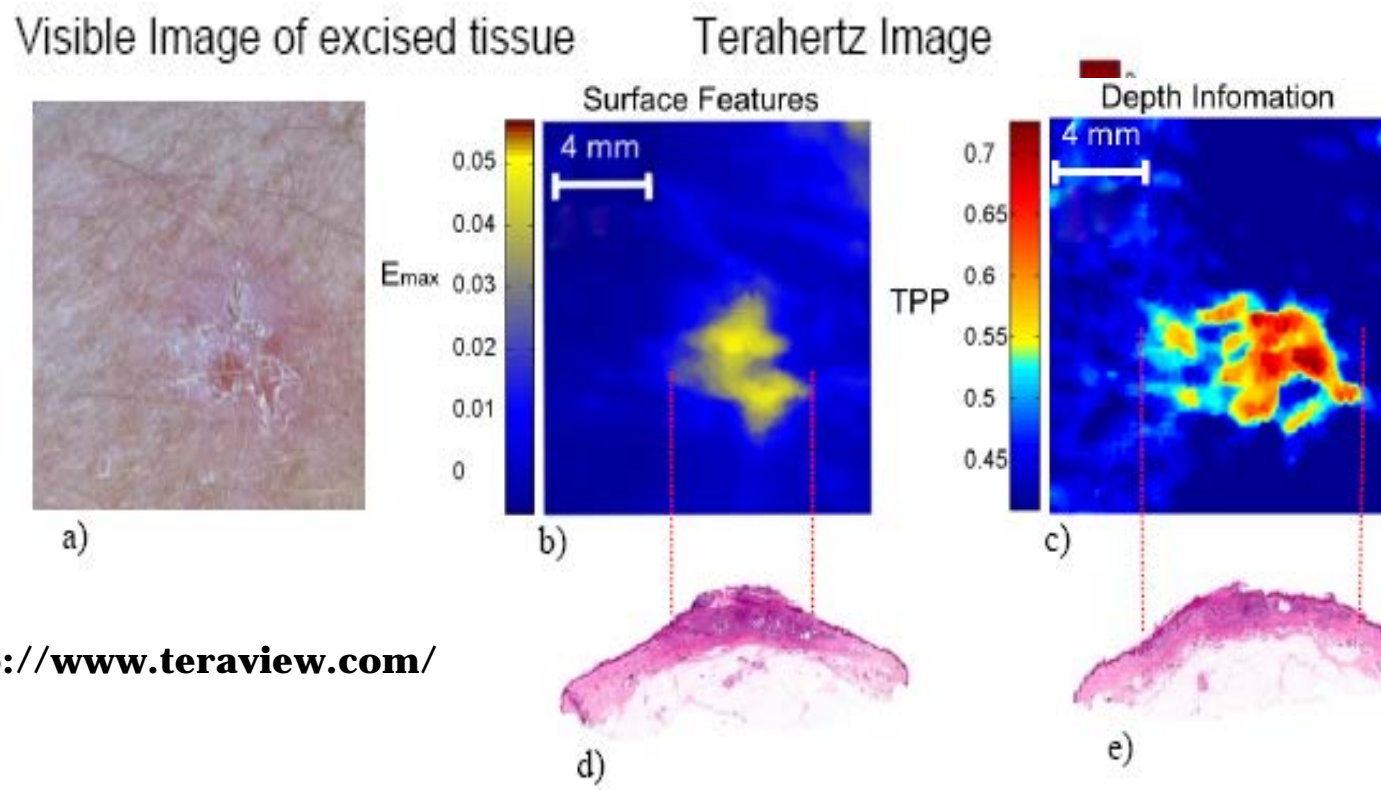


# THz visualisation

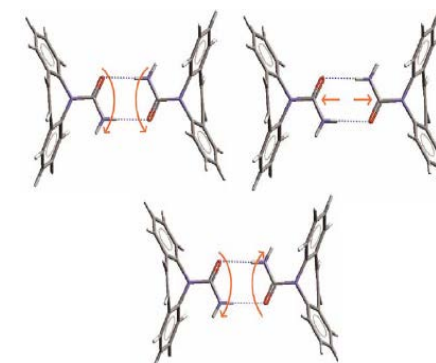


# Application of T Hz technology

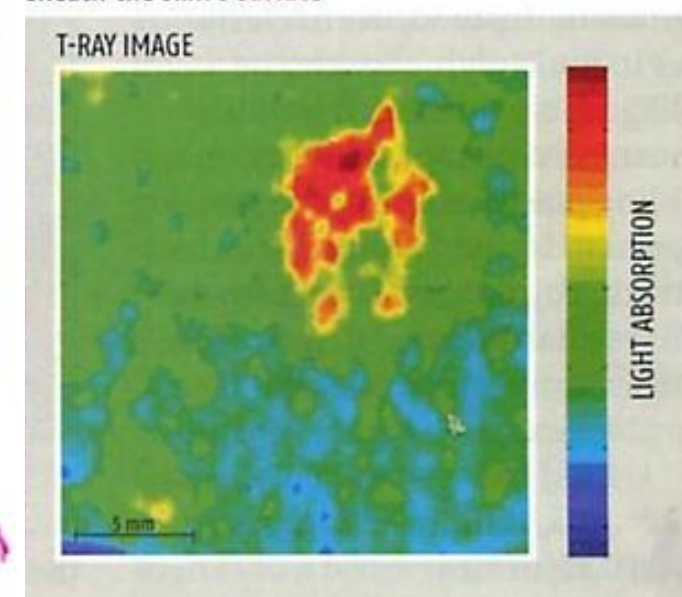
- Accurate determination of tumor cells bearing
- Selective treatment of cancer (greater water content)



<http://www.teraview.com/>



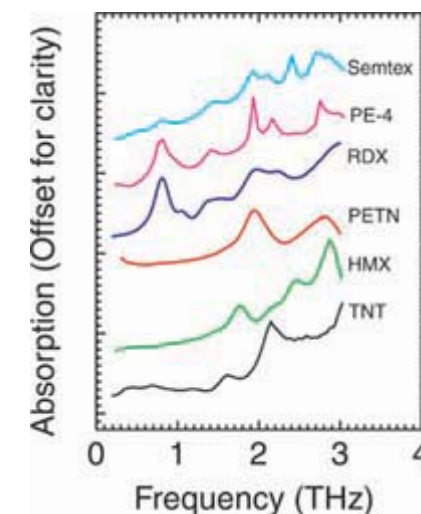
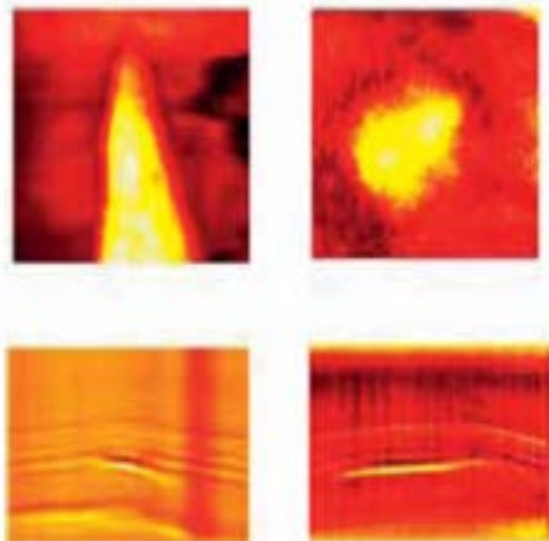
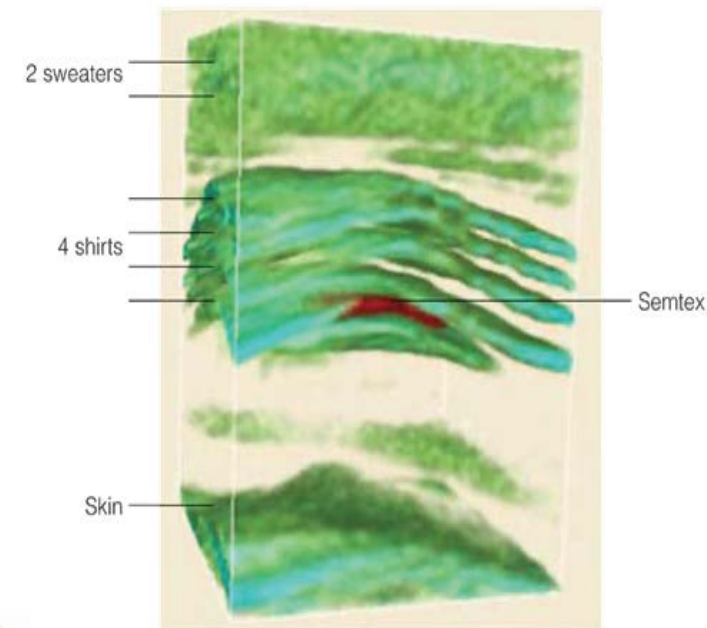
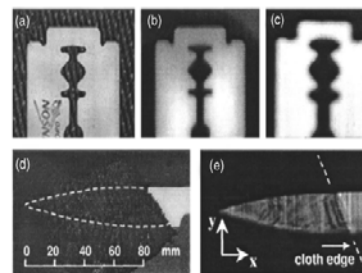
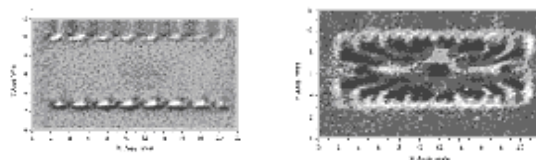
eneath the skin's surface





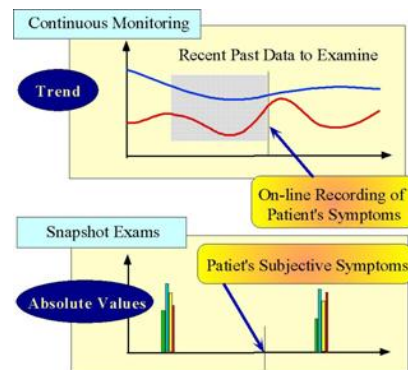
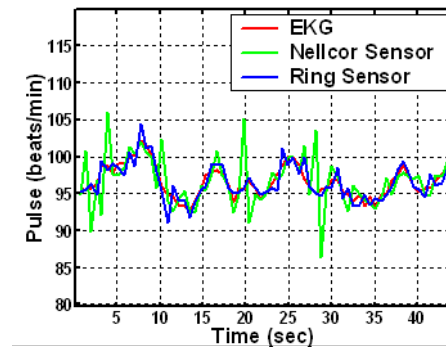
# Other applications of T Hz rays

- Scanners people x terrorism
- Detection of arms
- Chemicals
- Explosives (Semtex)



# Perspective of THz

- Noninvasive overall examination of the body and 4D models
- Non-invasive biochemical analysis
- The concentration of sugar
- Cholesterol
- Fat
- Blood pressure...



, Graduate Researcher

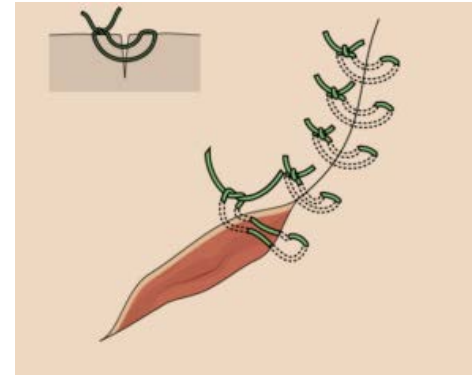
<http://www.early-pregnancy-tests.com>

<http://web.mit.edu/pshaltis/www/overview.html>

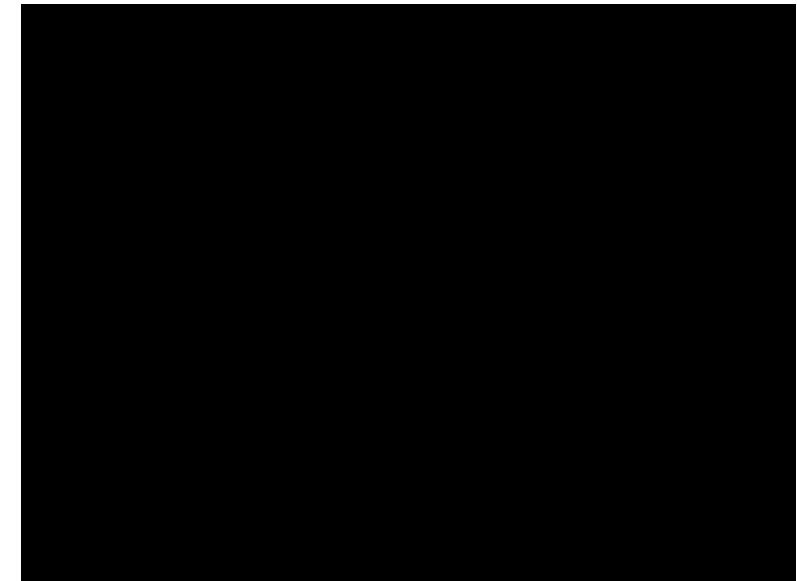


# Stitches without threads?

- Dermabond © Octyl - 2 - Cyanoacrylate Adhesive
- Mending wounds without surgical needle and thread
- It forms a solid liquid stitches, such as glue
- The optimal environment for faster wound healing
- After five to ten days dissociate themselves
- Prevents excessive downloading and compressing tissue and maintains the smooth edges of scars.

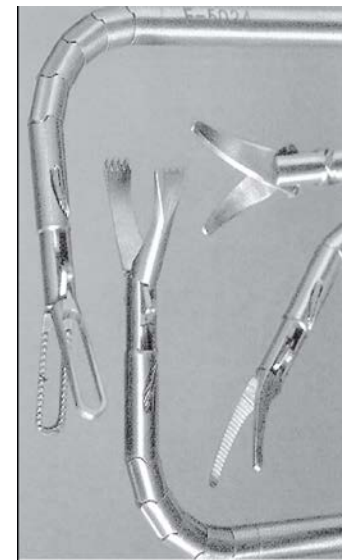
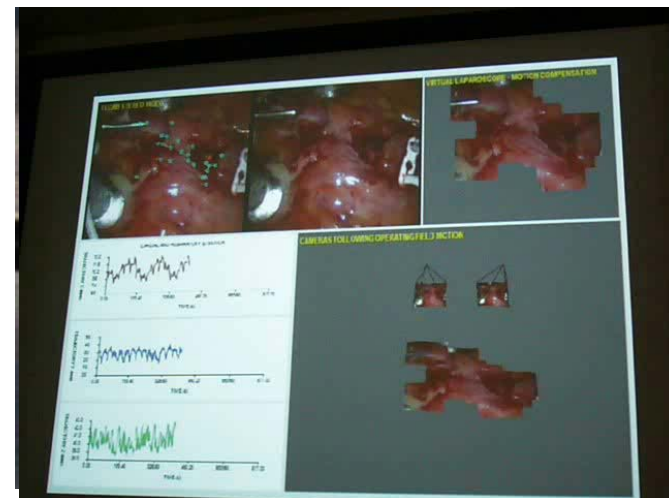
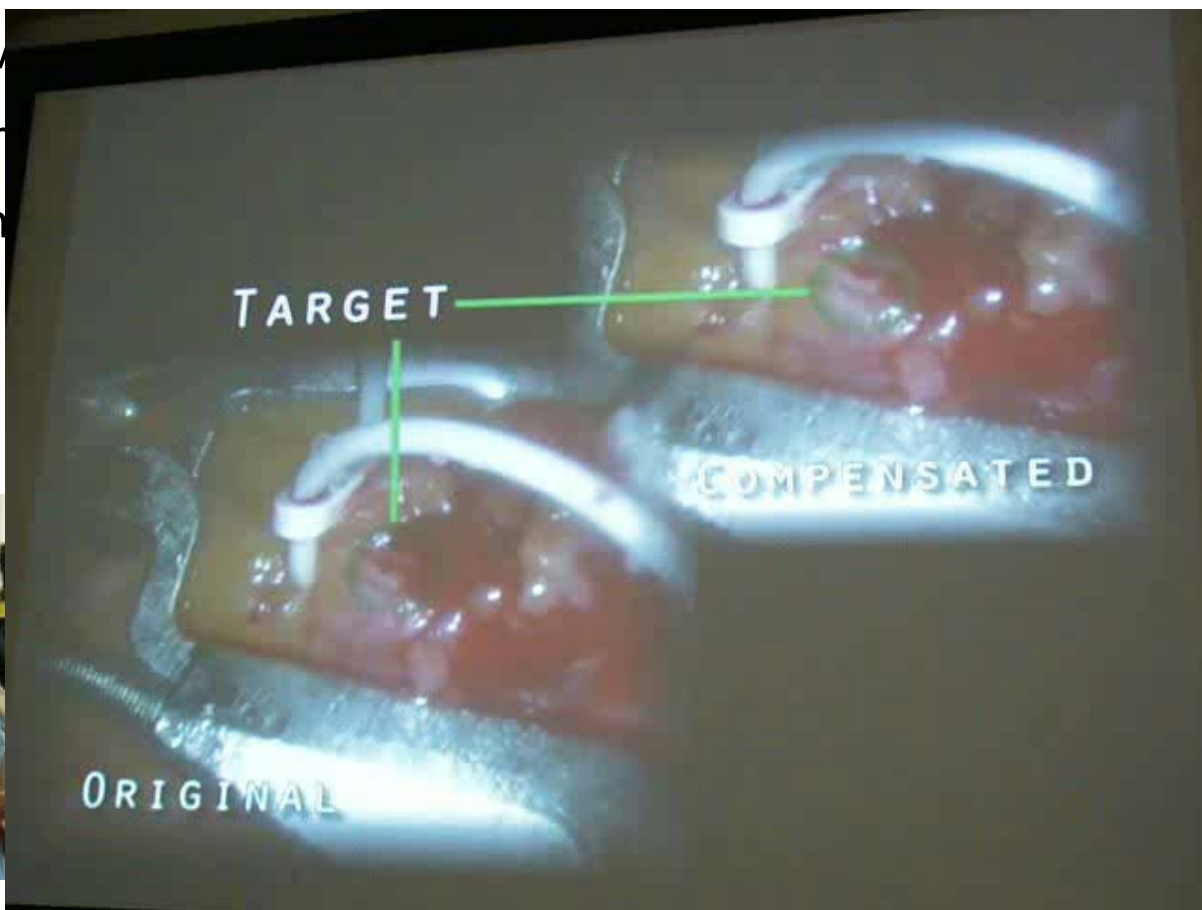


OR



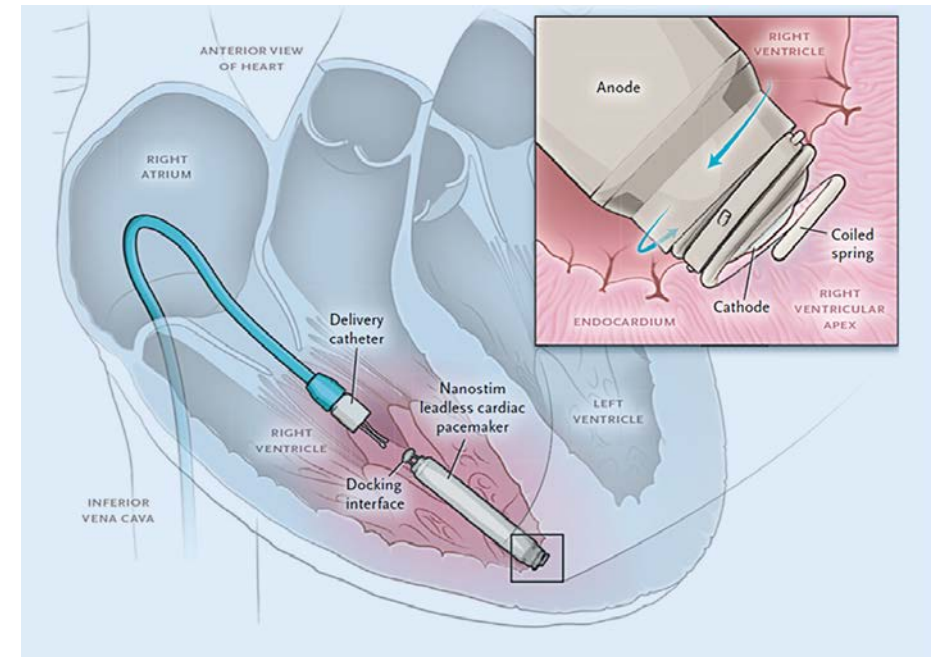
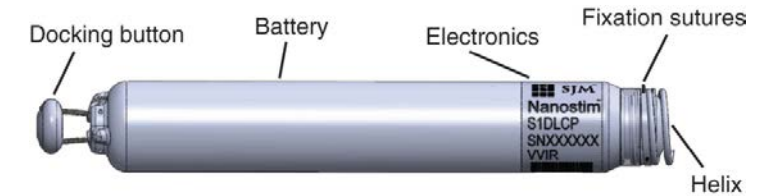
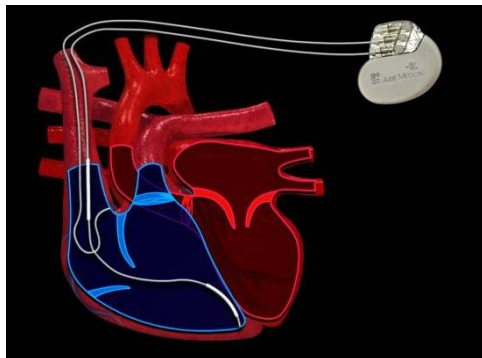
# Laparoscopic surgery or improve?

- Feedback robotic systems
- Compensation mov
- Instruments with m
- Stereo visualization



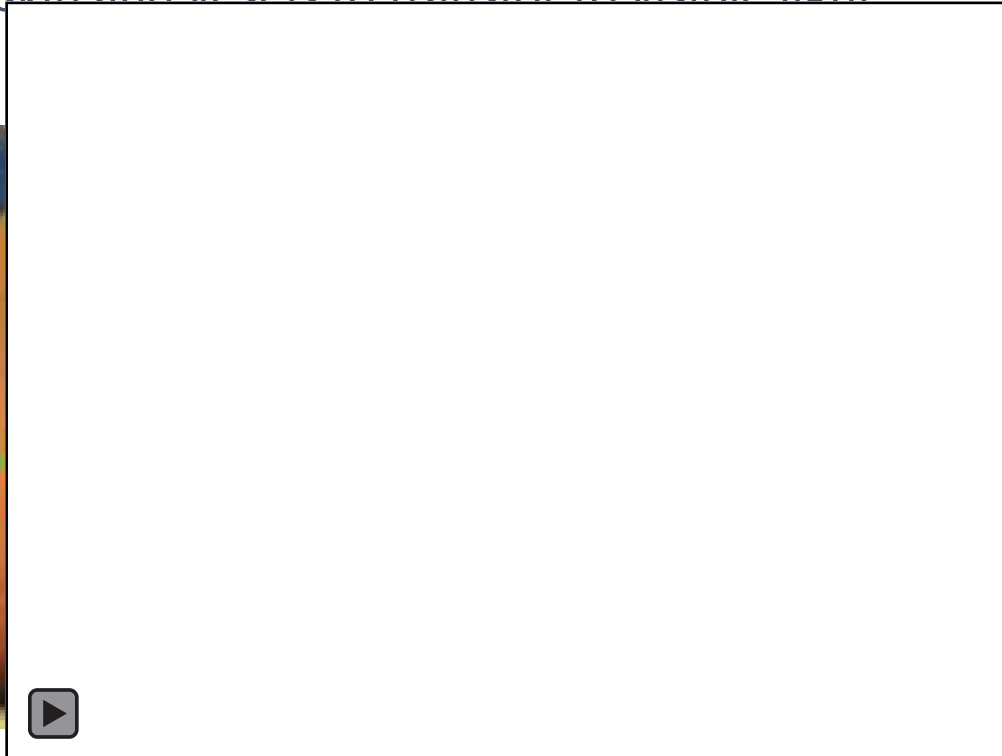
# Electrodeless pacemaker

- Complex implantation inserted through the nearest blood vessel
- Sized for AAA battery
- 10% of the size of standard CPs



# Vein Viewer

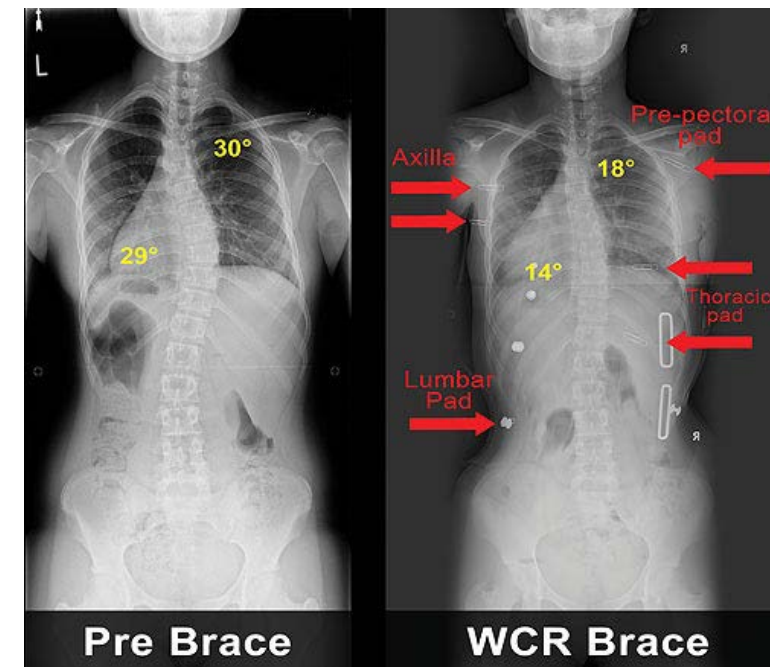
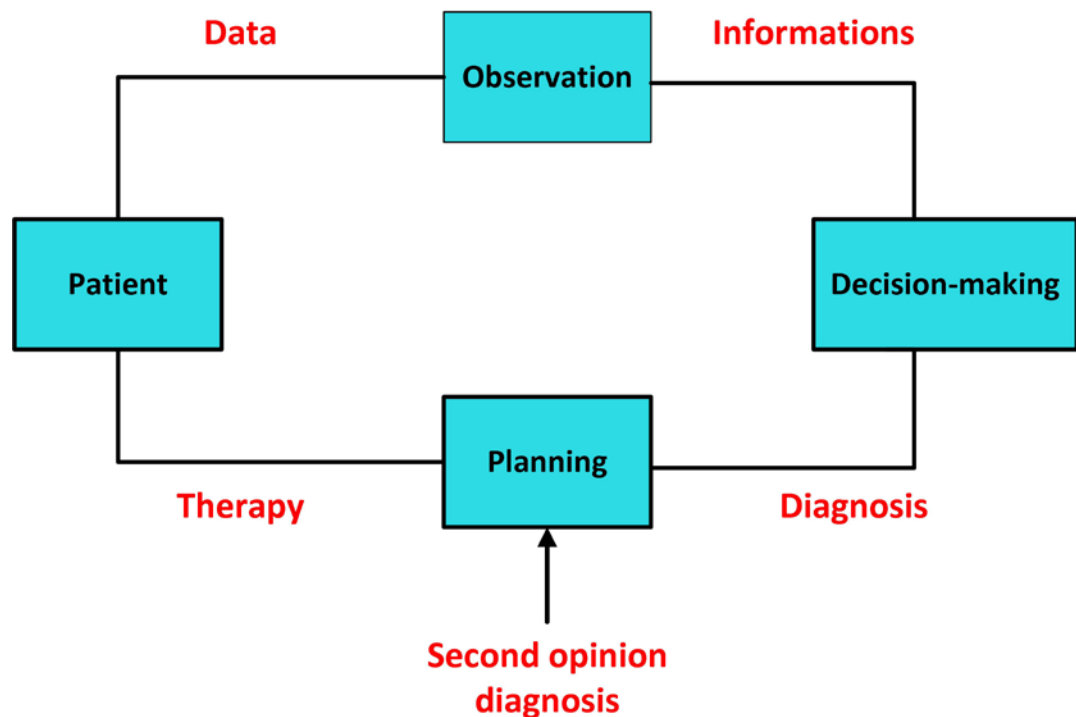
- Non-invasive imaging of the vasculature to a depth of 0.8 mm
- Measuring temperature of skin and vessels to transfer to visible light





# Illness Prevention and Progression

- Second Opinion diagnosis as artificial intelligence and diagnosis reliability and rate.



Project **Research and development of the new MEDIMONITOR system for intelligent prognosis forecasting** - CZ: Výzkum a vývoj nového systému MEDIMONITOR pro inteligentní prognózování vývoje diagnóz- OPPIK –MPO: CZ.01.1.02/0.0/0.0/20\_321/0024858,

# Anticonception - Coso



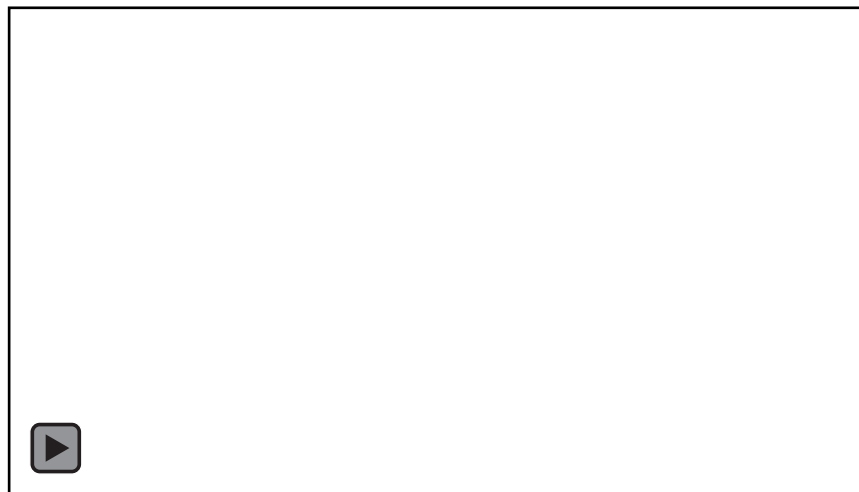
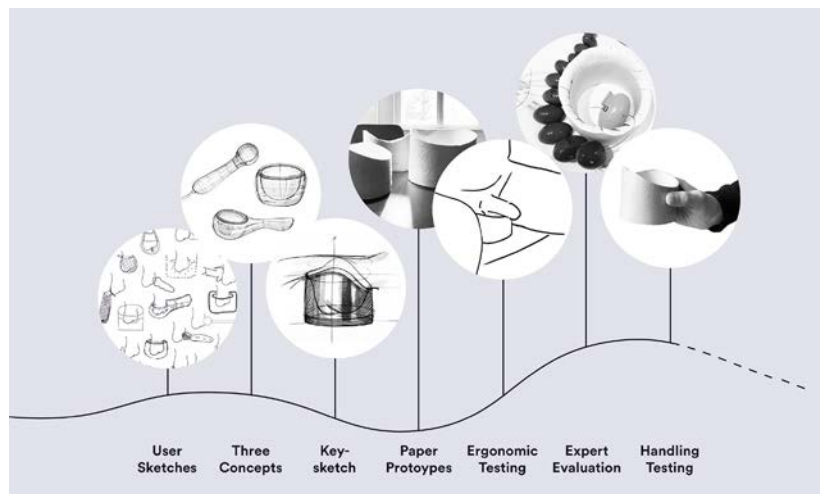
„Life is the most common disease and is disseminated by sexual contact“ - Prof. Josef Zámečník – pathologist

Rebecca Weiss designer - James Dyson Award - **Coso** male contraceptives!

Temporary male sterilization with the help of ultrasound for two months

Can be discontinued six months before planned conception.

The system does not use hormones or any other invasive method of contraception!



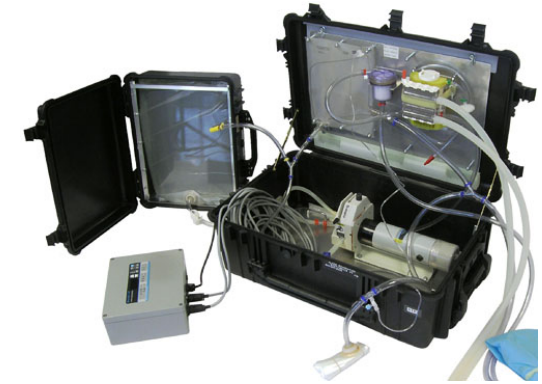
<https://vimeo.com/569047001>  
[www.designmag.cz/](http://www.designmag.cz/)





# Immortality?

- Yes cryonics!!
- 1773 B. Franklin writer, politician, naturalist
- 1969 - K. Werner - New York
- Cooling procedure 2 days 79 ° C - vitrification
- - 196 ° C clinical death (USA 150, UK 40, Russia 2)
- Price 28 000 – 75 000 USD (head, body)



# The prospect of mankind?

- The prospect of mankind - space flights - hibernation
- Alpha Centauri 100 years at a rate of 1/20 the speed of light



**Coma Michael Crichton 1978**

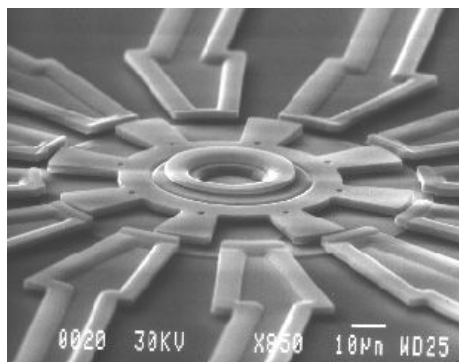


# Nano world and perspectives

(R.Feynman) 1959

"There is Plenty of Room at the Bottom"

- Miniaturization to four carbon
- Implementation of nano-robots



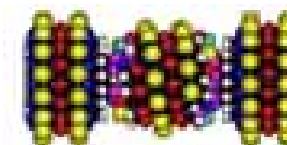
- Hair 0.05 mm
- Worm. corpuscle 8 micron ( $10^{-6}$  m)
- Virus 100 nm ( $100 \cdot 10^{-9}$  m)
- Nanobot 1-100 nm ( $10^{-9}$  m)

From the 6th Alcor Conference  
*An Inside Look at the Science  
and Medicine of Tomorrow*  
[www.alcor.org](http://www.alcor.org)

Clip from:

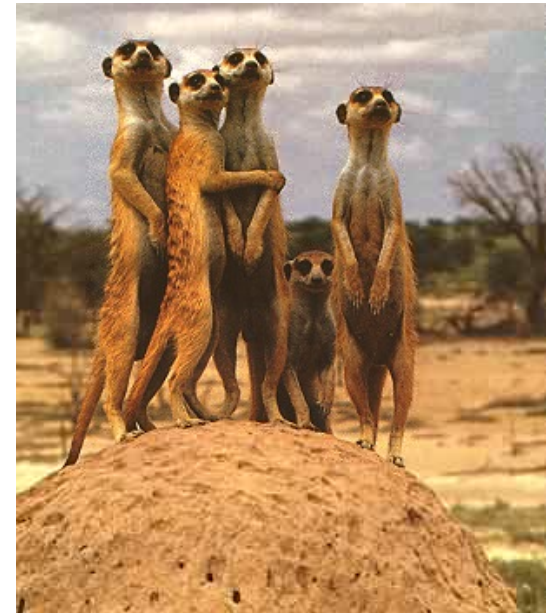
Robert A. Freitas Jr.  
*Nanomedicine and Medical Nanorobotics:  
The Path Forward*

<http://www.foresight.org>



# Conclusion...

- The Information Age, yet untapped (finance, knowledge, Finland)
- Cooperation Techniques & medic in the development
- Technology will progress forward fast
- The human touch all over!!



# Thank you for your attention

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**<http://bmeng.vsb.cz>**