

# SiP in Vivo

“System in a Package”  
enters the human body

**IMAPS 23 March 06**



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# Introduction

- If we survive to be old we will all suffer from urinary incontinence
- it is estimated that 2 - 4.5 million people in the UK are currently affected.
- Electronic devices now exist to alleviate this condition

Implant device

Bladder

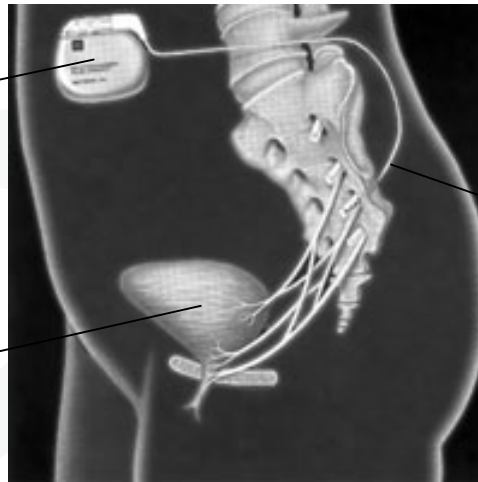


Image from:  
[http://urology.med.miami.edu/questions/clinical\\_void\\_interstim\\_therapy.asp](http://urology.med.miami.edu/questions/clinical_void_interstim_therapy.asp)

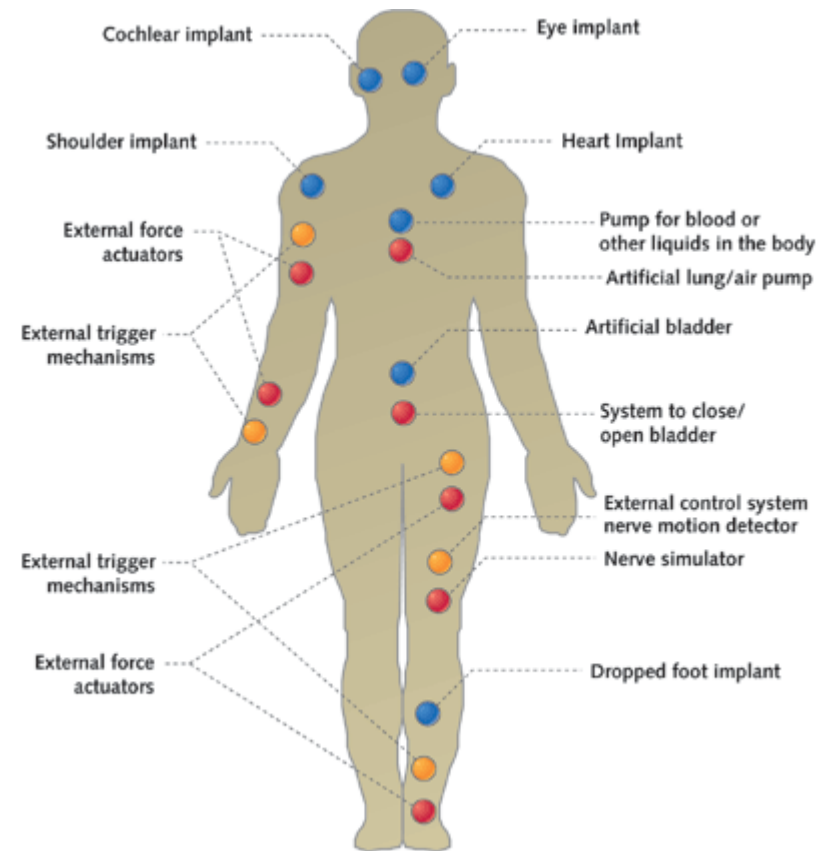
Further info: [www.interstim.com](http://www.interstim.com)

Electrode simulates sacral nerve to operate sphincter

- Will we all be contemplating such devices as we get older?

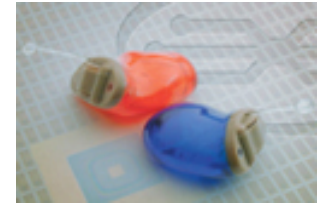
# Electronics defies age and infirmity?

- There are electronic devices for other conditions such as:
  - **Heart conditions**
  - **Paralysis**
  - **Diabetes**
  - **Deafness**



# Medical Devices that enter the body

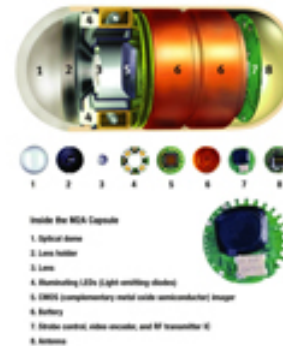
- Devices need to be small
- Autonomous, self sufficient
- Reliable, your life may depend upon it!



“In the ear”  
hearing aid



Pacemaker

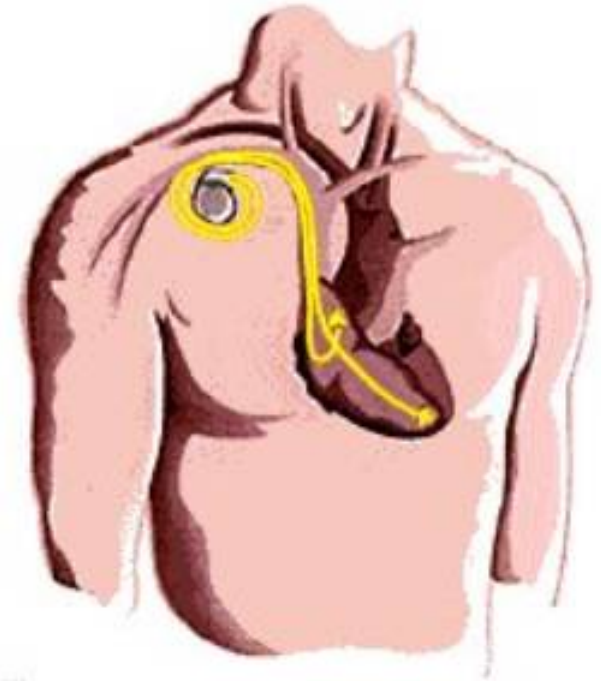
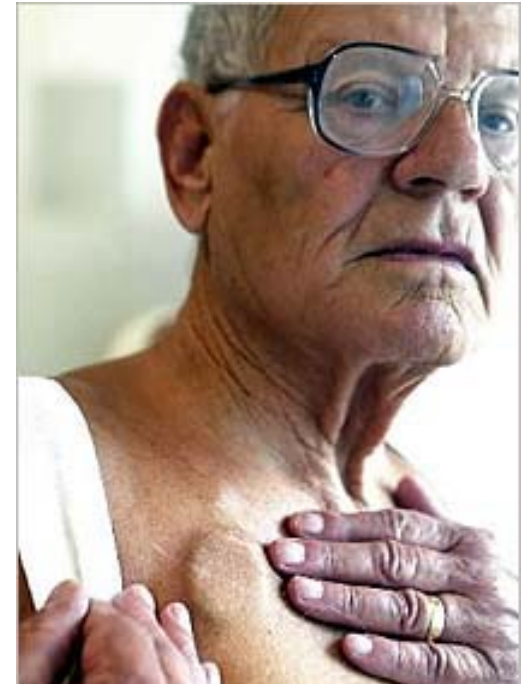


Camera pill



# Pacemakers

- **Implanted in shoulder under local**
- **Electrode / catheter to heart**
- **Function: to supply missed heart beat pulses**
- **Last 7 years on one battery**
- **Whole pacemaker replaced**

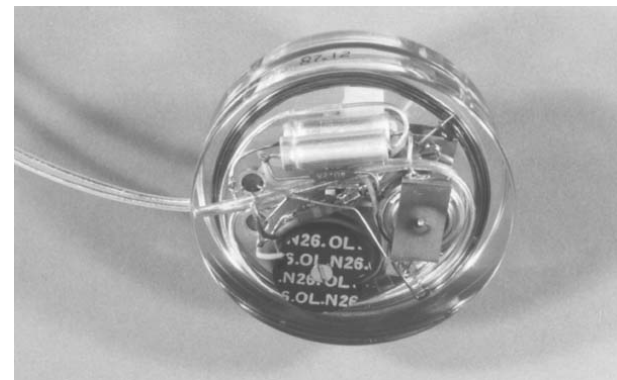


# Do pacemakers really work?

## ARNE LARSSON



- ➔ Received first implantable heart pacemaker on October 8, 1958
- ➔ Died December 28, 2001 after 43 years with a pacemaker
- ➔ Lived longer than the inventor of the pacemaker!



# Pacemaker Packaging requirements compared to Mobile Phone's

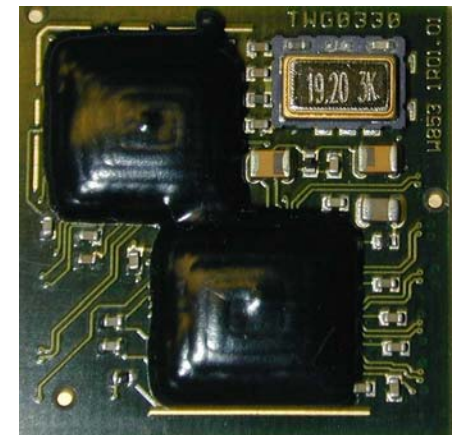
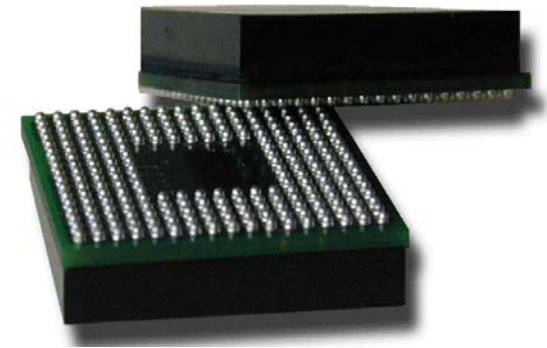
- **Aspects similar to mobile phone requirements**
  - Smaller slimmer pacemakers preferred by patients
  - Additional features continually being added by suppliers
    - Eg Defibrillation
  - Low power consumption to preserve battery life
  - RF communication
  
- **Differences from mobile phone's requirements**
  - Lower volumes
  - High reliability
  - Long design and approvals cycle

# Why SiP suits implants

- **Mixed analogue and digital, silicon and passives**
  - Small SMT components used. High cost of passives on silicon
  - Mixed semiconductor technologies used HBGT, CMOS, EEPROM
  - Odd devices integrated eg crystals – more complete system in SiP
- **Space requirements**
- **Modularity**
  - Tested subsystem
  - simplicity of design for customer
  - Variants for customers, each implant is a different shape
- **Optimised performance**
  - lower power,
  - lower parasitics
- **Cost effective for moderate volume**
  - “System on a Chip” (SoC) too expensive for moderate market size
  - Lower NRE, CMOS mask set \$20K

# Zarlink's SiP expertise developed from Telecoms SiP

- **Smaller**
  - 2"x2" PCB to 1"x1" square SMT component
- **Mixed IC technologies**
  - SiGe
  - CMOS
- **better performance**
  - Microclimate
  - Shorter interconnects – less jitter
- **One per card feasible**
  - SMT format allows accurate timing to be distributed through out system



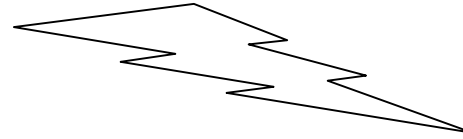
Telecoms  
Timing SiP

# Zarlink Ultra Low Power Radio SiPs for pacemakers



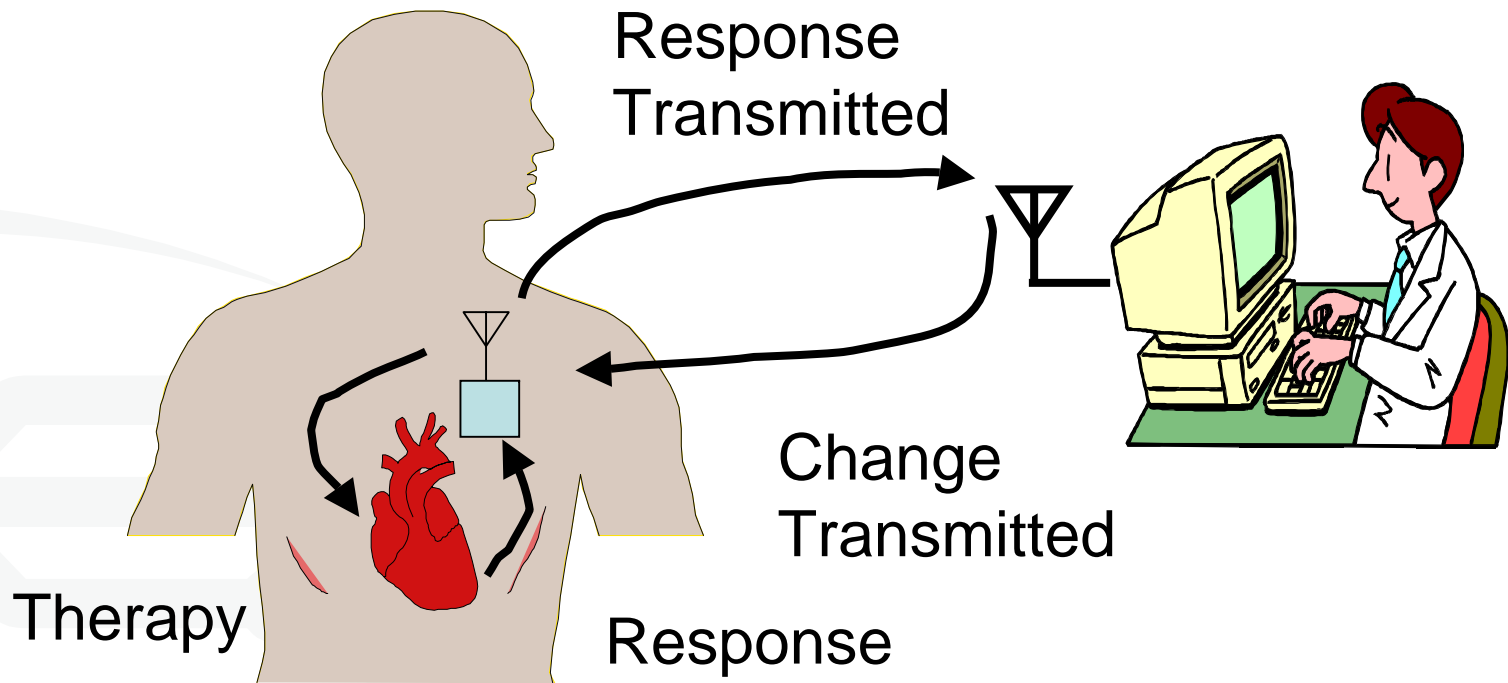
Doctor

3 metre  
range



Patient

# CLOSING THE LOOP



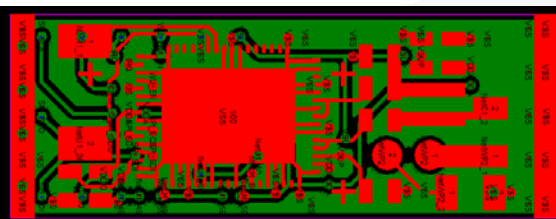
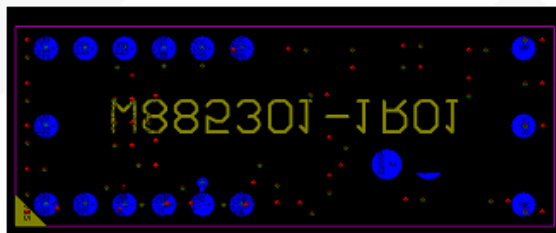
# Zarlink's RF medical SiP

- **Required “System in a Package” approach**

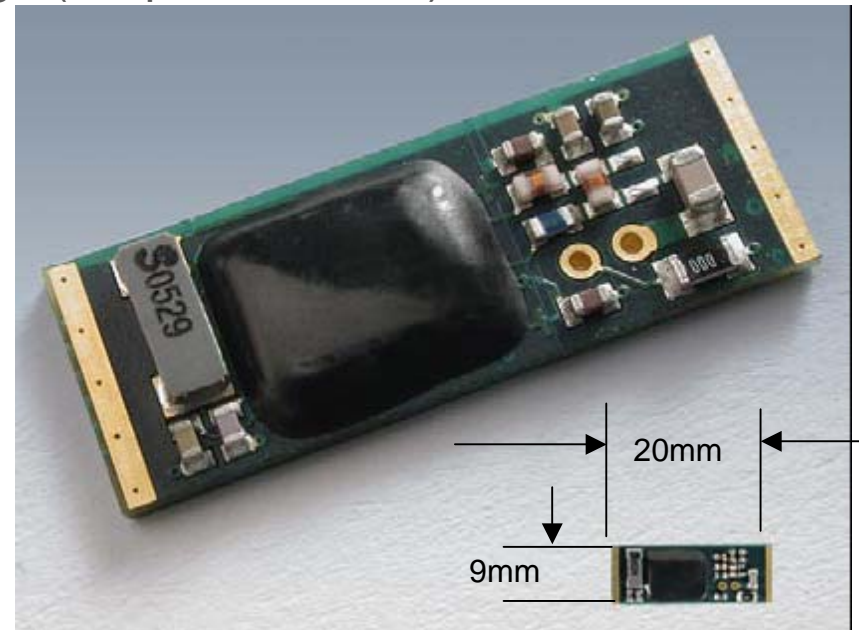
- Digital and analogue
- Small size required
- Small volumes
- Customers wish to avoid RF design ( as picture below)

- **Example Picture**

- Delivered in within 2 months



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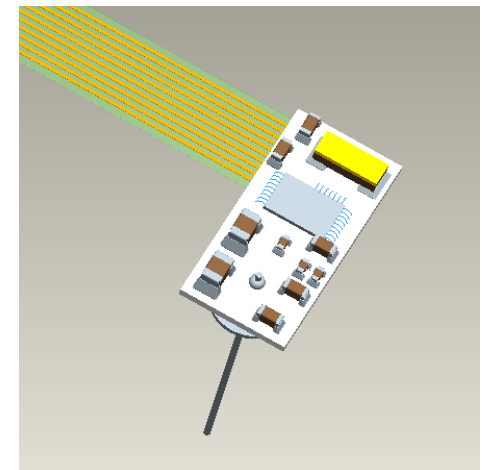
# Variants of Zarlinks RF SiP

## Different customer requirements:

- RF shields
- HV protection
- ESD protection
- Feedthroughs
- Flex interconnects
- BGA
- Lead free

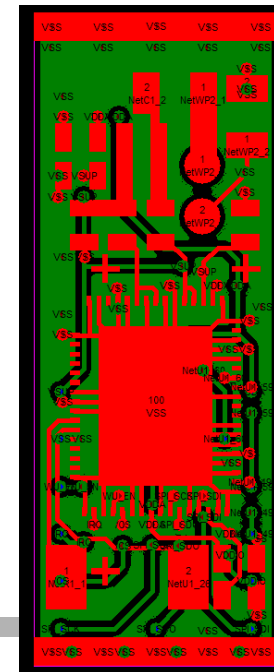
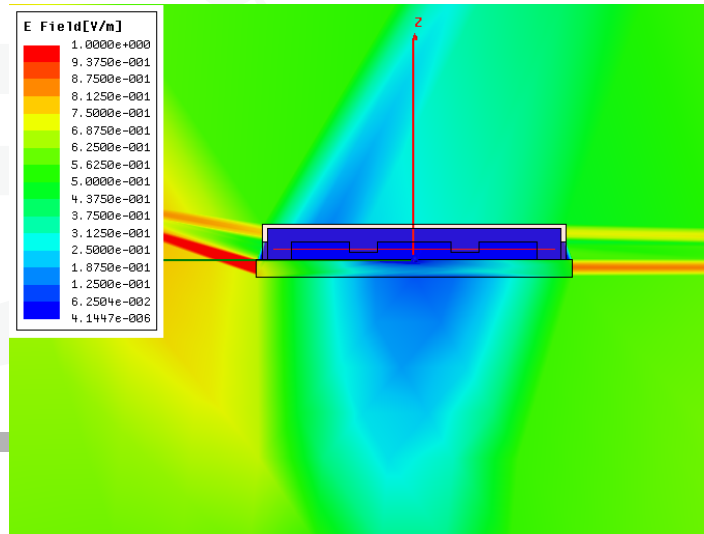
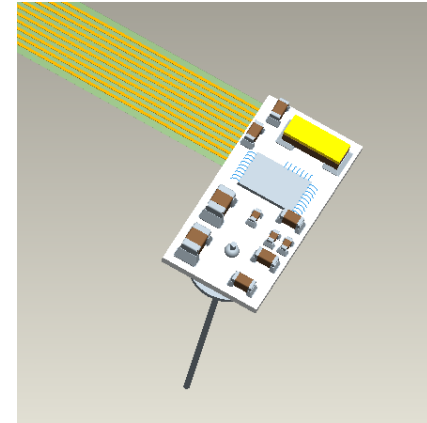


View inside can  
(3D CAD picture)



# Design CAD systems for RF SiP

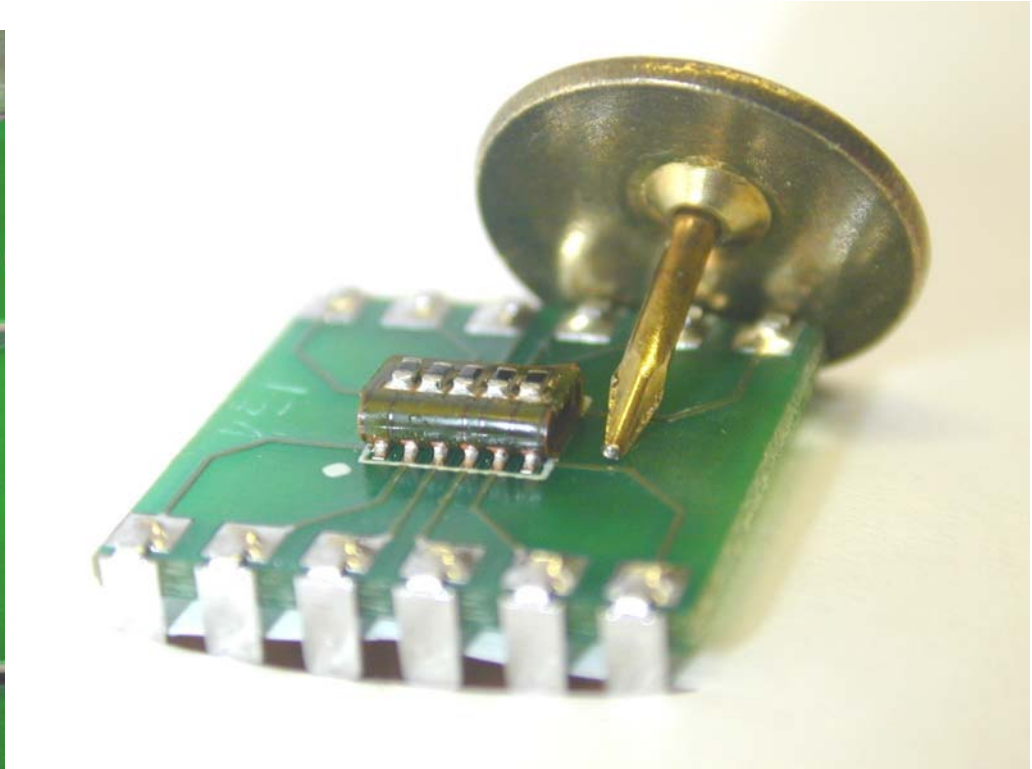
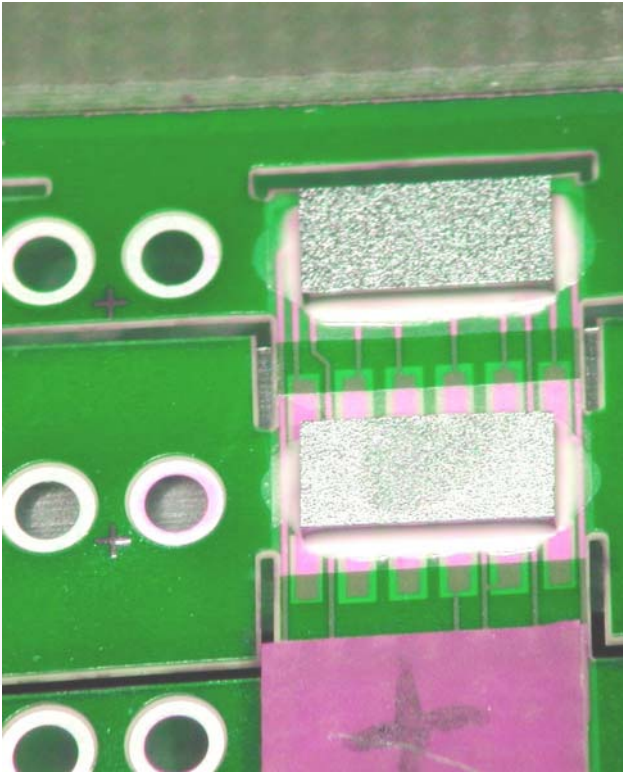
- Extensive use is made of CAD systems
- 3D CAD
  - To present concepts
  - To ensure device fits customers design
  - To provide drawings for components eg shields
- PCB layout
  - To design PCB
- EMI simulation
  - HFSS



# The Future for “SiP in Vivo”?

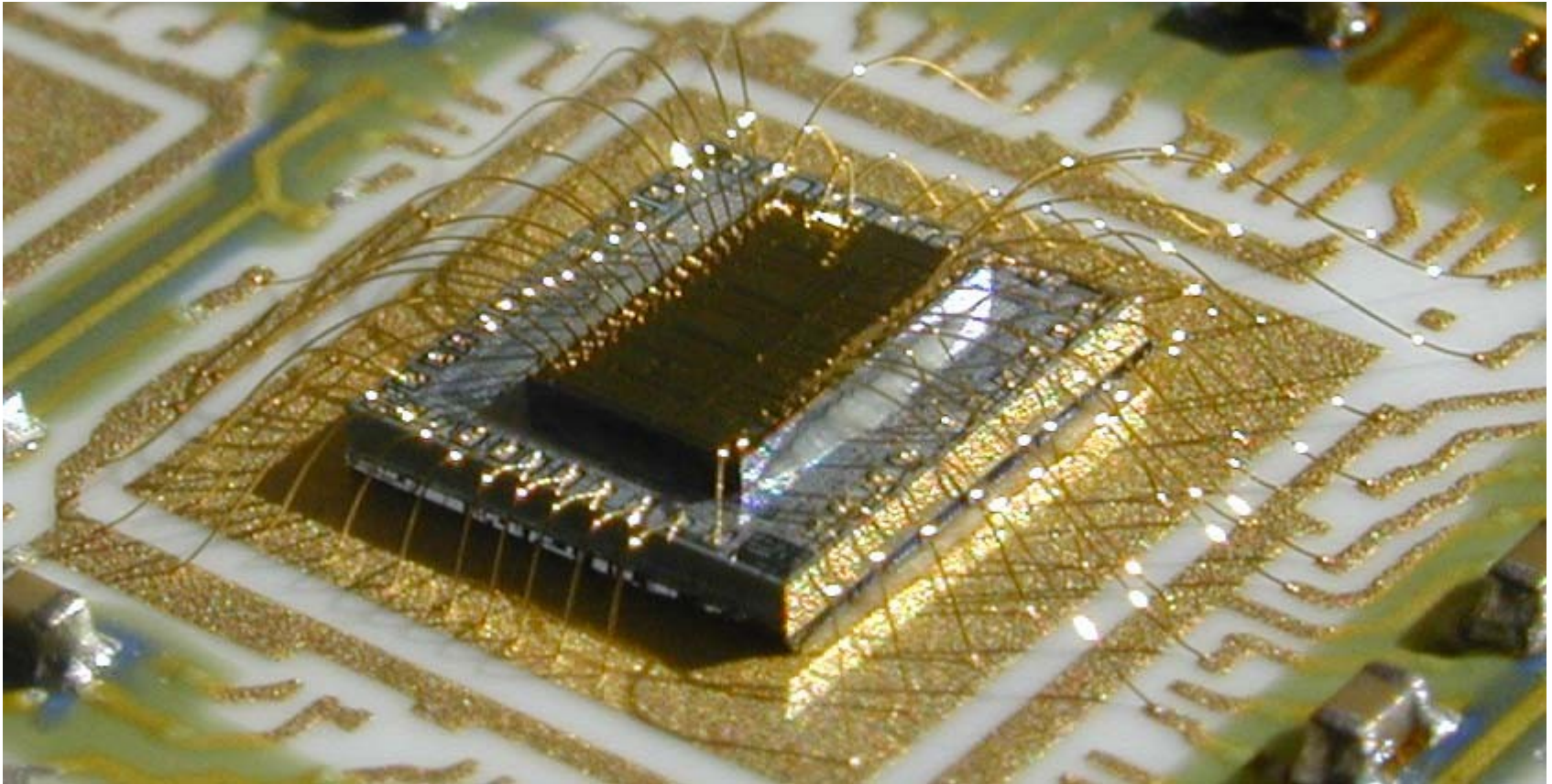


# Future SiP Packaging for Zarlink?



- **Surge protector: flip chip and flex**
- **2 flip chips and 5 passives**

# Chip stacking?



# The Future for medical devices and SiP packaging?

- **Asian subcontractors**

- Quality systems have been a hurdle for subcontractors
- This will not last for ever!

- **Increased use of:**

- Flip chip
- die stacking
- smaller components eg 0201

- **New Packaging techniques**

- Embedded components?
  - within laminate?
  - plated SLA's?

- **Demography and expectation**

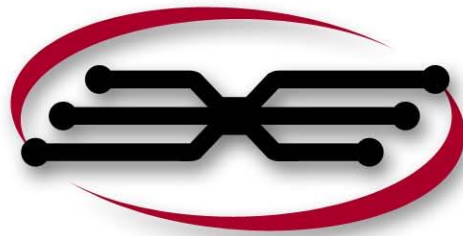
- Increasing elderly Western population
- Expecting a healthy and active life
- Rising health expectation in the East

- **Many active development projects for medical devices**

- EU “Healthy Aims” project

For “SiP in Vivo”:

- the future is bright,  
.....the future is Silver



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SEMICONDUCTOR

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