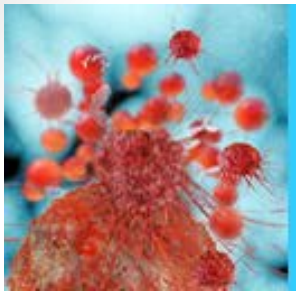


BioSensors for Cancer Diagnosis

Thursday 21 July 2016
London

Trends in BioSensors for Cancer Diagnosis

Michael Brand PhD SM FRSC
Sensor100

About Sensor100

- An international network of people and organisations developing biosensor technology
- Publishes a free monthly eNewsletter
- Conference series:
  - Sensors in Medicine 2016
  - Innovation in Environmental Monitoring 2016
  - Sensors in Food and Agriculture 2016

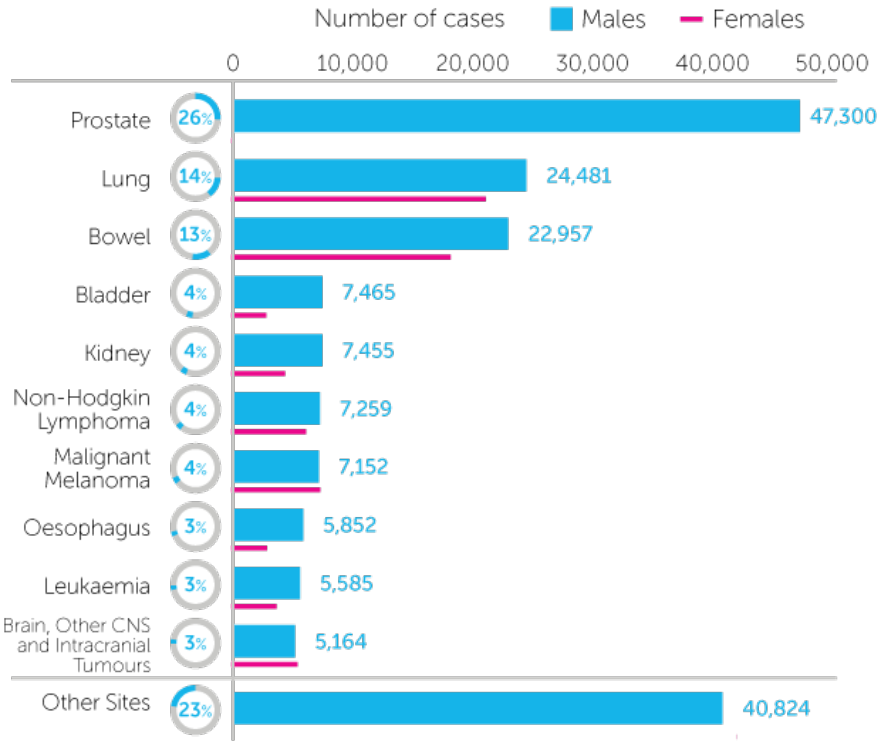
www.sensor100.com

Agenda

- Early Diagnosis – Why?
- Some Approaches
- Where Next?

Incidence of UK Cancer

New Cases of Cancer 2013



Source: Cancer Research UK

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Bowel Cancer Mortality

Total new UK cases 41,112 (2013)

Stage	% of cases	# of cases	5 Year Survival %	5 Year Survivors
1	14.6	6002	97.4	5846
2	22.2	9127	84.7	7731
3	23.7	9744	62.7	6457
4	21.7	8921	7.5	669
Unknown	17.7	7277	16.9	1230
			Total	**21933**
If **ALL** Cases Diagnosed at Stage 1				**40043**

Source: Cancer Research UK

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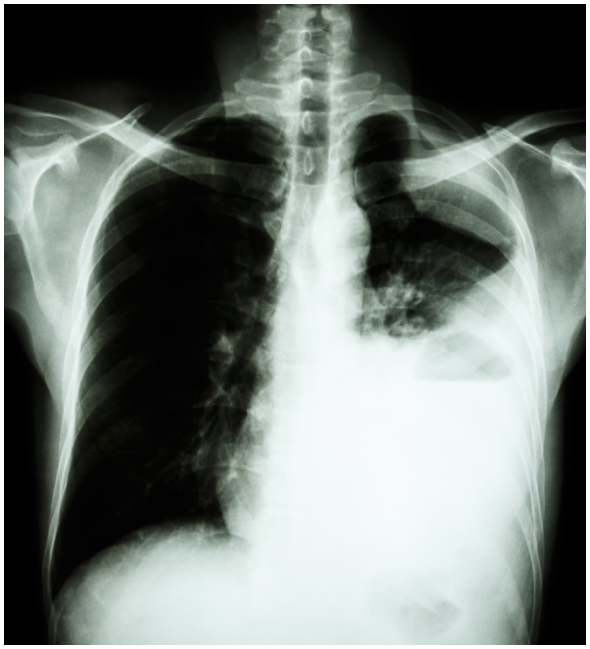
Cancer Diagnosis

Diagnosis is made **AFTER** the cancer is sufficiently advanced to be visible or causing symptoms



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"I wish I'd known sooner..."
The Cancer Challenge

The Ideal Cancer Diagnostic Tool

- Highly accurate
- Low cost
- Non-invasive or minimally invasive
- Easily repeatable
- Effortlessly operated by a lay-person
- Has minimal impact on the person's daily activities.

Biosensor technology offers the most obvious solution

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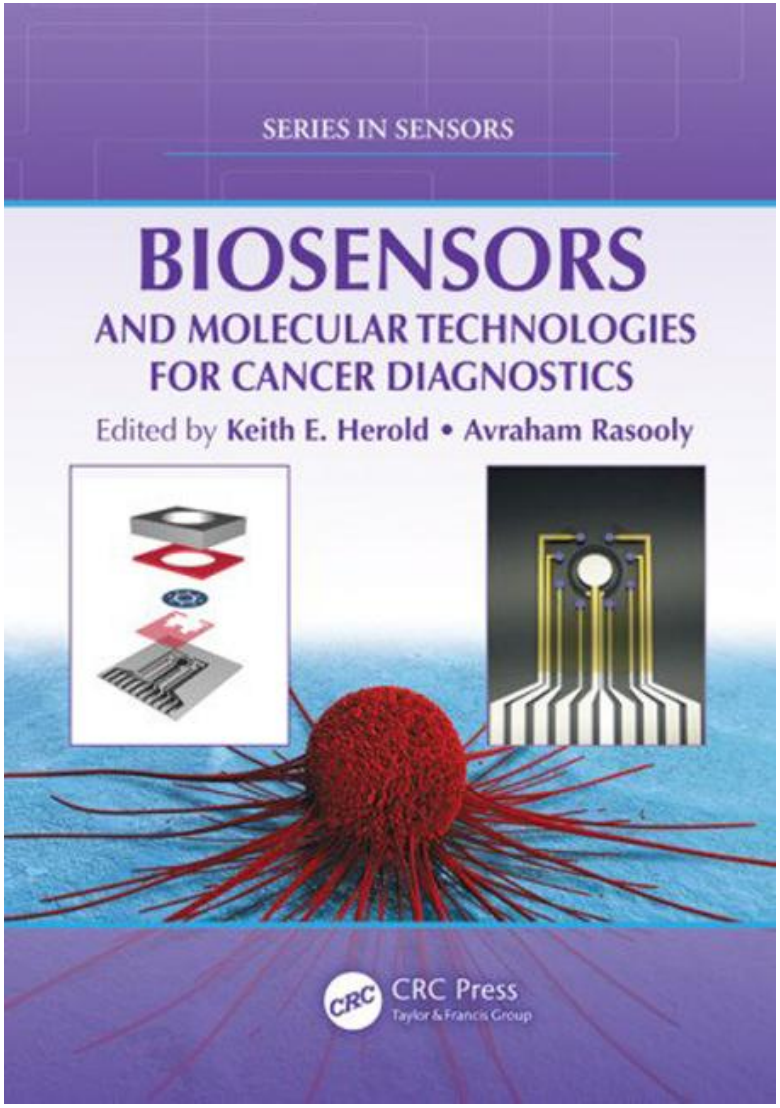
Is this a “hot” topic?



May 29, 2012 by CRC Press
Reference - 844 Pages - 417 B/W Illustrations
ISBN 9781439841655 - CAT# K11937
Series: Series in Sensors

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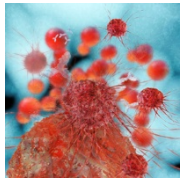
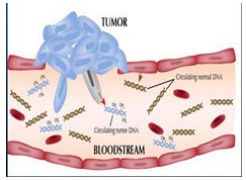
Biomarkers

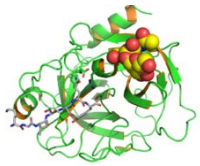
- Circulating tumour cells (CTCs)
- Exosomes and microvesicles
- Circulating tumour DNA (ctDNA)
- Micro RNA (mRNA)
- Proteins and antibodies (e.g. PSA)
- Volatile organic compounds (VoCs) in breath and urine



CTC



ctDNA



PSA

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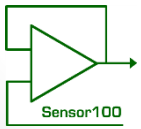
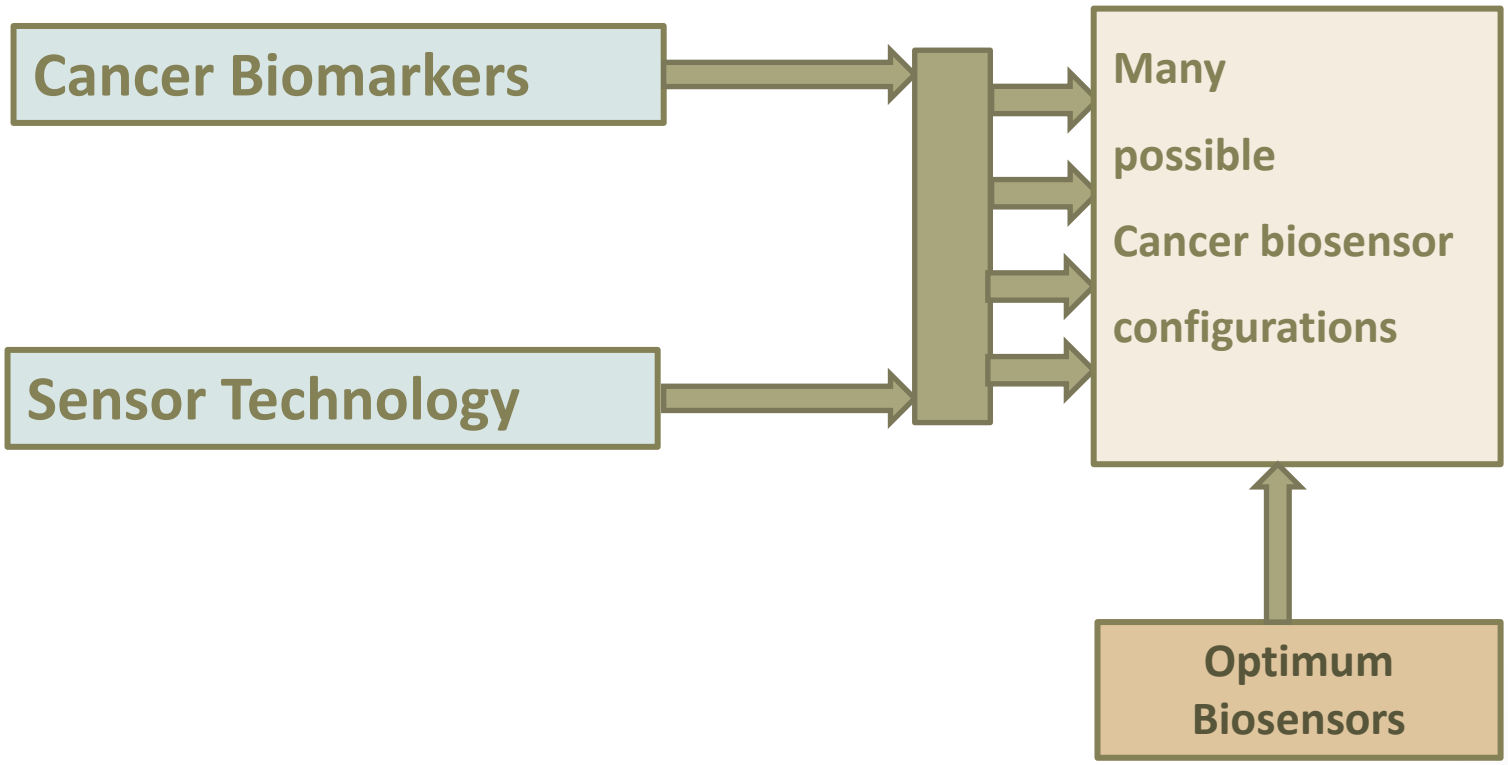
Sensor Platform Technologies

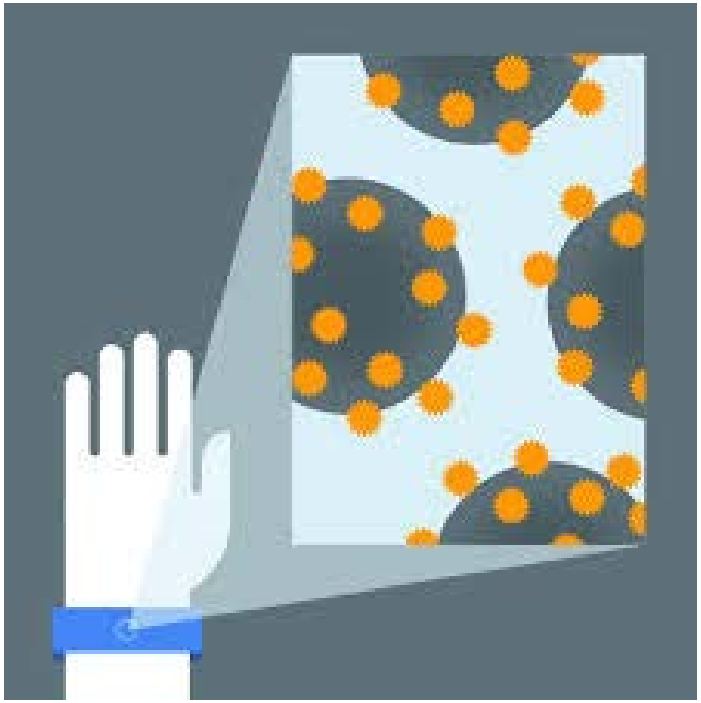
- **Electrochemical**
  - amperometric
  - potentiometric
  - ISFET, stripping voltammetric, impedometric etc.
- **Spectroscopic**
  - optical imaging,
  - fluorescence, luminescence, refractive index detection
  - surface enhanced Raman spectroscopy
- **Acoustic**
  - photoacoustic analysis
  - surface plasmon resonance
  - surface acoustic wave
- **Others**
  - magnetic, thermal, MEMS etc.



Optimum Biosensor



In vivo nano sensor



"This is years, not decades, away"
Dr. Andrew Conrad, Verily Inc*

**Formerly* Google Life Science

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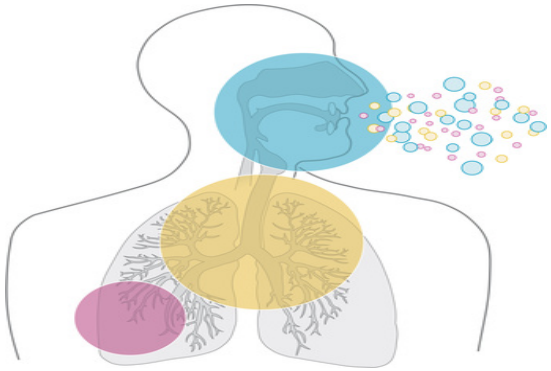
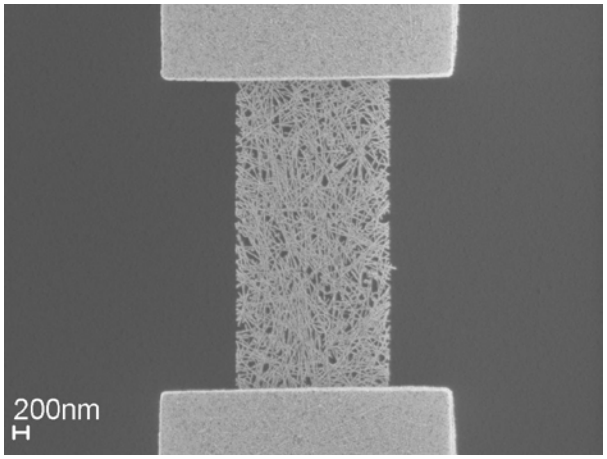
VOC Sensors





Pathologies produce many volatile organic compounds.

Sensitive biosensors can identify profiles of disease states

Single-walled carbon nanotube (SWNT) rolled-up graphite sheet, provides unique characteristics which enable requisite sensitivity. Applying functional surface layers selectively differentiates between unique VOC patterns

Alpha Szenszor **CNTnose: alphaszenszor.com**

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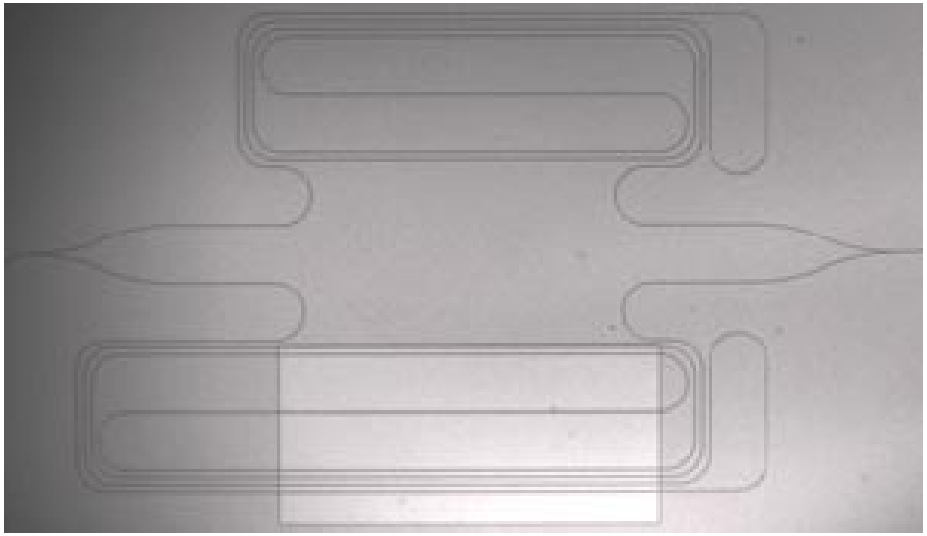
MicroRNAs in Urine



A silicon photonic biosensor that can detect tiny changes in the phase of a light beam caused by hybridization between an immobilized DNA probe and target microRNAs in a sample.

The two arms of the interferometer used to detect microRNAs in urine samples. The top one is the reference arm while the bottom one is the sensing arm.

A*star Research, Singapore
Biosensors and Bioelectronics , 2015

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D3 – Digital Diffraction Diagnosis

The device attaches to a smartphone, allowing the phone to take images of cells and samples.

- Collect patient cells (blood sample, biopsy, Pap smear)
- Load cells onto slide, inserted into D3 device, attached to smart phone
- Antibodies detect cancer cells
- Cell-antibody emits light signal
- The smartphone camera records data on more than 1 million cells all in a single image

Center for Systems Biology at Massachusetts General Hospital

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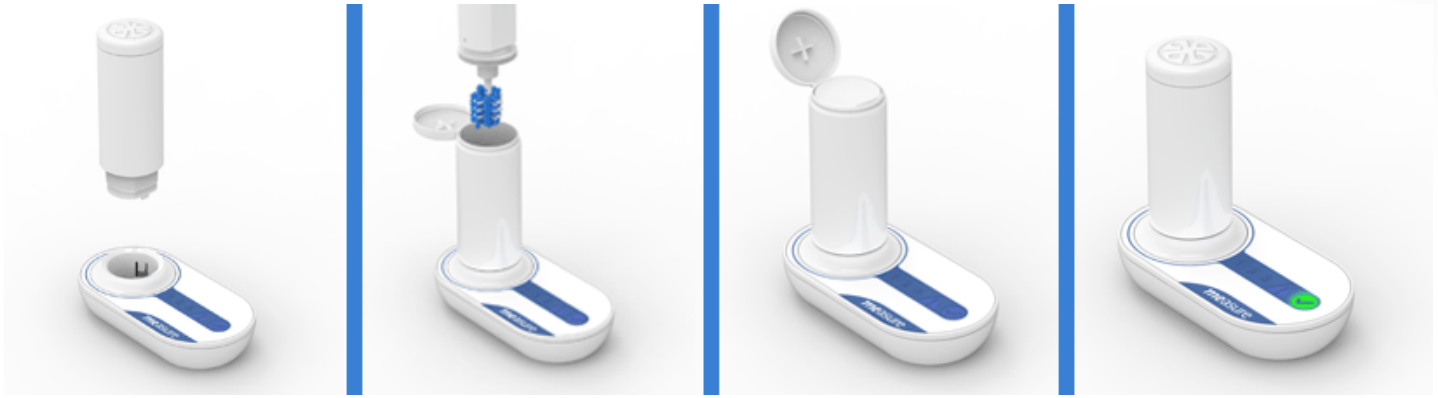
Fecal Blood Sensor



Retail electrochemical sensor system for fecal blood, said to be easier to use than the NHS system, and produces near instant results

Mode Diagnostic Limited
www.modedx.com

Linear flow for bladder cancer

- Arquer has designed, manufactured and CE-marked an ELISA kit for Mcm5 for use in hospital path labs
- Arquer is in the early stages of developing a point of care test for rapid diagnosis.

ARQUER DIAGNOSTICS

www.arquerdx.com

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Smartphone as Sensor

Cervical Cell Impedance Sensor

ZedScan uses Electrical Impedance Spectroscopy (EIS) to differentiate between normal, pre-cancerous and cancerous tissue on the cervix according to its electrical properties

ZedScan measures the electrical impedance at 14 different frequencies which creates a characteristic spectrum according to the structure of the tissue

zilico™
real-time medical diagnostics

zilico.co.uk

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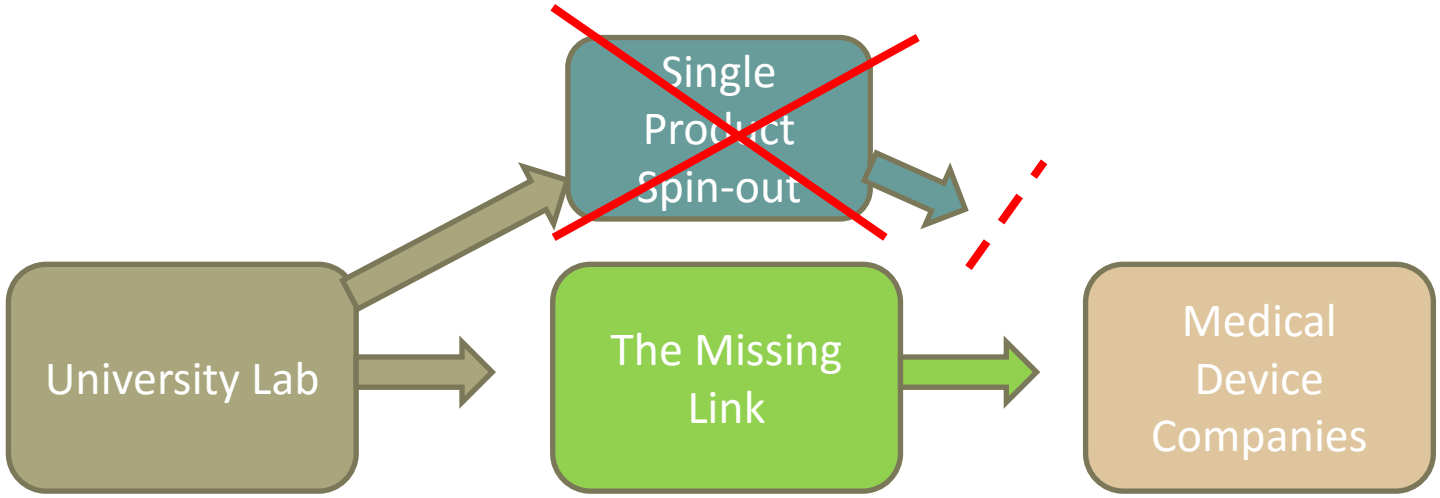
Conclusions

- Very few biosensors in clinical use
  - Fecal blood; skin lesion imaging; cervical EIS
- Some biosensors in clinical trials
  - VOCs; markers for breast, colon, lung, prostate cancer
- Many biosensors in development
  - Few make it to the clinic!
- Worldwide research effort on biomarkers
  - FDA requires companion diagnostics for new drugs

What's needed



- Challenge: biosensors for cancer
- Identify optimum biomarker /sensor systems

- Fraunhofer /imec type organisation for biosensors
- Develop biosensors ready for clinical trial

- Steer through FDA / EMA
- Guidance on markets & manufacturing

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The Cancer Challenge

- **Innovation Challenge** to identify best biomarker/sensor systems
  - On-line cloud based innovation platform – NOT panel of judges
  - Needs funding
- Bigger **Conference** – in the USA
  - Early 2017, Boston MA?
- Set up **The Missing Link** organisation
  - Secure funding

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FUNDING REVOLUTIONARY IDEAS, FASTER

£200,000 to support truly innovative, ground-breaking ideas from any discipline, with the potential to change the way we understand, prevent, diagnose or treat cancer

Applications close 5 September 2016
Visit cruk.org/pioneeraward to find out more

CANCER RESEARCH UK

Sensors in Medicine 2016

9 - 10 November

Linking academic clinical and commercial worlds

Topics

- Infectious diseases
- Diabetic monitoring
- PoC diagnostics
- Wearable sensors
- Implantable sensors
- New sensor technology

- Invited and contributed papers
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- Exhibited technology
- Panel discussion
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