



Institute for Cell Mimetic Space Exploration-NASA URETI

From the Cell to the Galaxy:  
Pioneering Multi-Scale Cell Mimetic Systems for Space Exploration

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**A URETI funded by NASA w/ matching fund from UCLA:  
\$3.5M per year**

**Cooperative Agreement of NASA: 5 years + 5 years option**

**Starting Date: September, 2002**

**17 Faculty at 5 Universities  
(approximately 45 post-doctorates and students)  
1 to 2 projects in each Research Group**

**Over 90% fund is used for research**

## NASA's interest in this technology

- Health care of human astronauts in space for long duration flights
- Self-healing aeronautic systems for safer space missions
- Intelligent robotics to assist human exploration of space and planets

# Multidisciplinary Institute

CMISE: 17 research groups

11 faculty in 6 different types of engineering field

3 faculty in the chemistry

3 faculty in the School of Medicine

*National Academy of Engineering*

Prof. Chih-Ming Ho

*Institute of Medicine*

Prof. Edward McCabe

*Fellow of the Royal Society*

Prof. Fraser Stoddart

*Feynman Prize in Nanotechnology - Experimental*

Prof. Carlo Montemagno (2003)

Prof. James Gimzewski (2001)

Prof. Bruce Dunn

Prof. Robin Garrell

Prof. Jack Judy

Prof. Chang-Jin Kim

Prof. James Liao

Prof. Chiara Sabatti

Prof. Michael Teitell

Prof. Ming Wu

Prof. Xiang Zhang

Prof. Yu-Chong Tai

Prof. Helen Reed

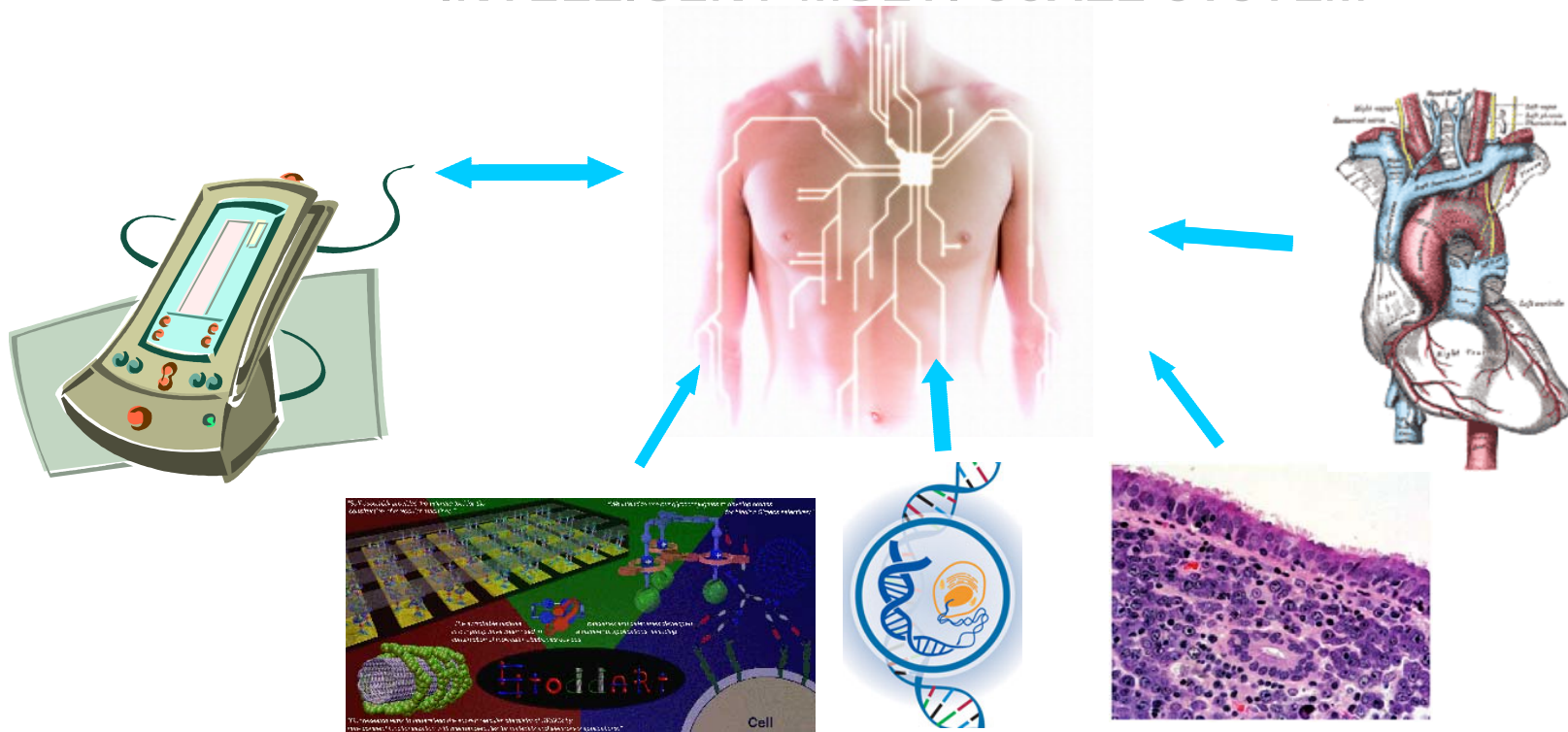
Prof. Eric Mjolsness

# Biotechnology, Nanotechnology and Information Technology:

1. Medical researchers engineering nano-devices
2. Engineers developing a new wave of biotechnology tools



## INTELLIGENT MULTI-SCALE SYSTEM



## Example 1: Medical devices based on nanotechnology

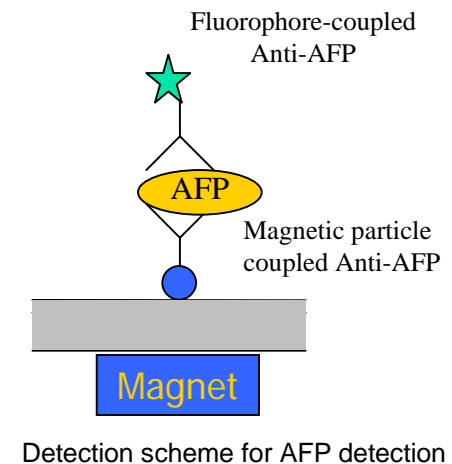
Automated, portable system for liver cancer screening in third world countries

### 1. Goals:

Miniaturized system - handheld (**enables testing outside of diagnostic laboratory**)

Automated preparation - whole blood samples (**removes technician dependency**)

High sensitivity for Alphafetoprotein (AFP) - below 500ng/mL (**clinical indication of liver cancer**)

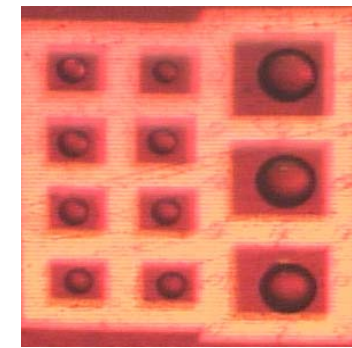
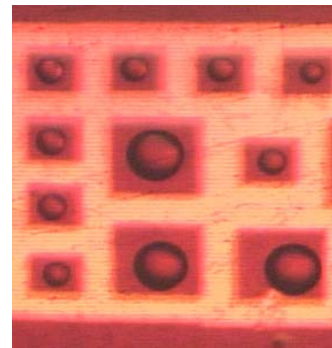
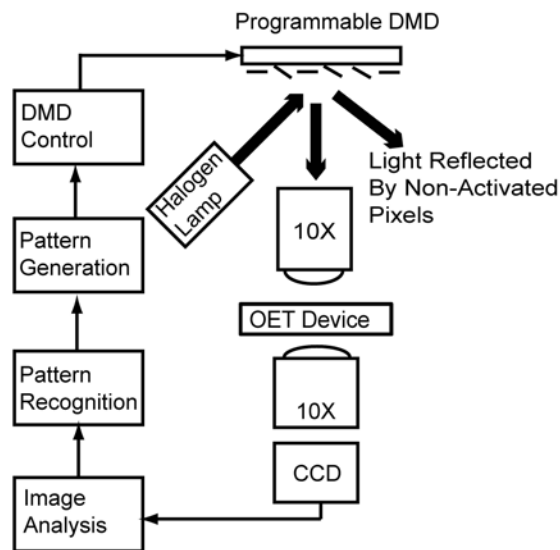


Project initiated by Jonnson Comprehensive Cancer Center

## Example 2a: New Wave of Biotechnology Tools

### Light Manipulators for Living Cells

Applications: stem cell research, tissue engineering, cell-based drug discovery, etc.

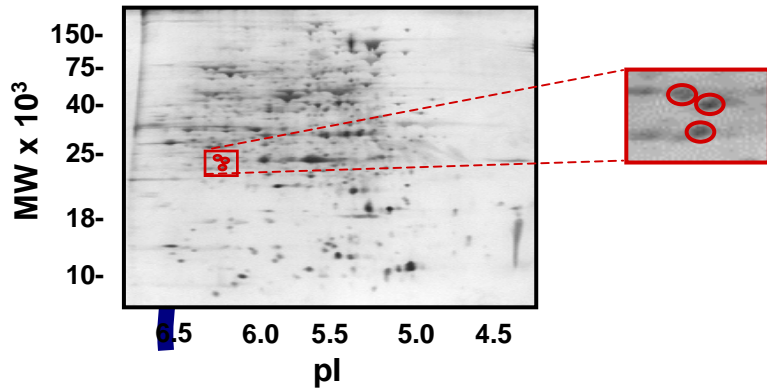


### Requires:

1. Specialized microfluidic chip
2. Simple optical microscope setup
3. Light Source (e.g. UV lamp)
4. Graphic software
5. Graphic controller
6. CCD camera

## EWOD-Mediated Sample Preparation of MALDI-MS Applications: proteomics, metabolomics, etc.

### 2-D Gel Electrophoresis



Excise separated protein spots



Process Sample

Sample purification

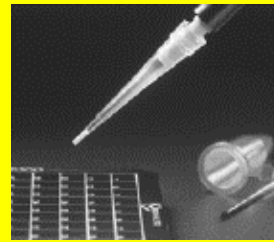
Disulfide reduction

Tryptic digest

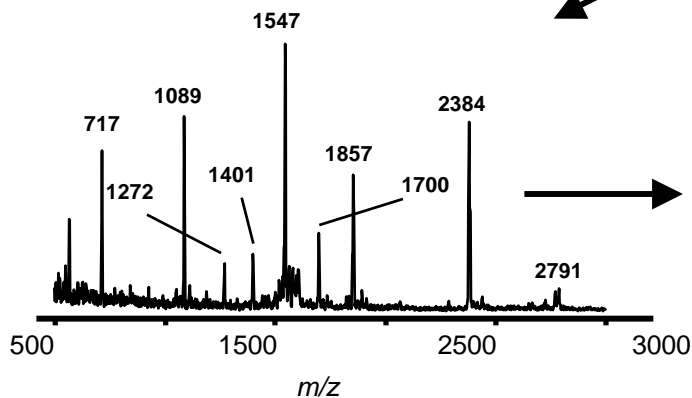
Sample purification

Recover peptides

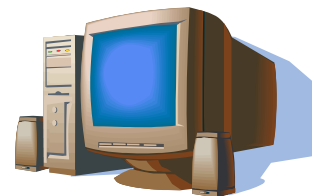
Crystallize sample with matrix



Collect Peptide Mass Fingerprint



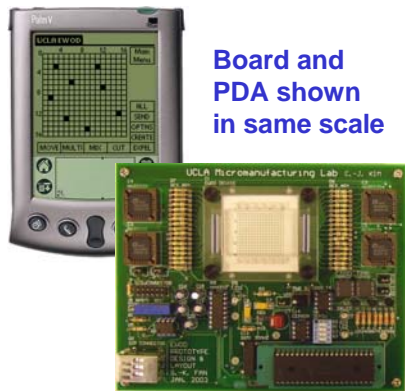
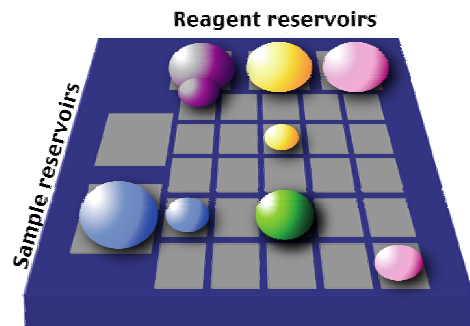
Identify protein by searching proteomic databases



**Integrate for high throughput**

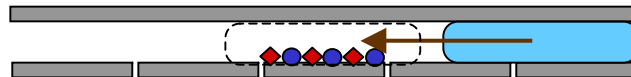
# Example 2b: New Wave of Biotechnology Tools

EWOD-Mediated Sample Preparation of MALDI-MS  
Applications: proteomics, metabolomics, etc.

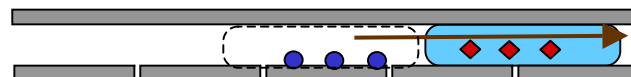


## Rinse

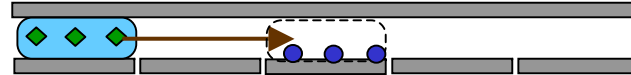
Move 1  $\mu\text{L}$  droplet of water to dried spot



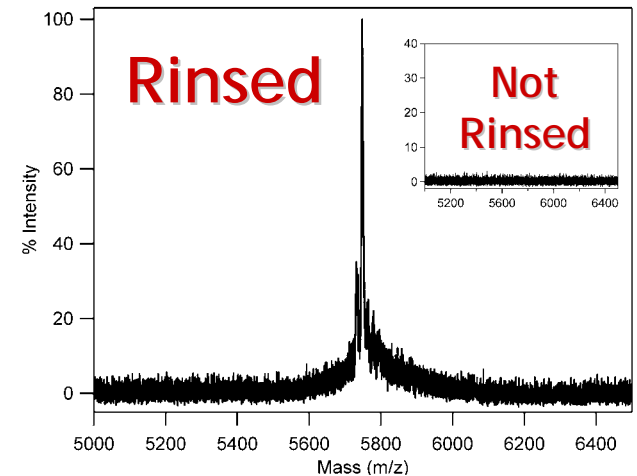
Remove water + urea



Move and dry 0.6  $\mu\text{L}$  droplet containing matrix



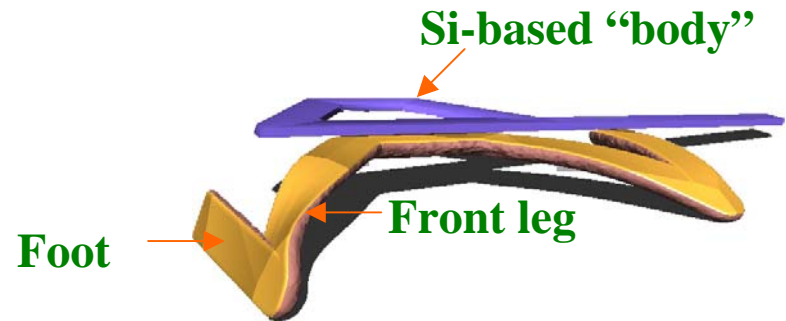
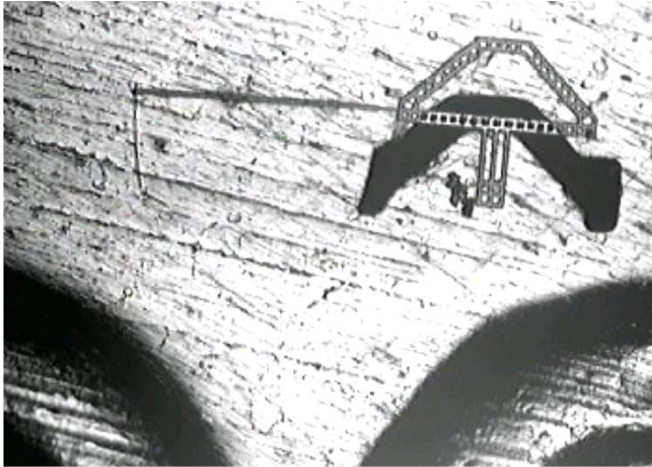
1  $\mu\text{M}$  insulin (5733 Da)  
in 7.5 M Urea



Removal of salts and non-volatile solvents to reduce degradation of analyte-of-interest signals

## 2C: BioMEMS platform for functional testing of tissues

micro-robot made from cardiac tissues muscle and silicon backbone



Micro-robot made from Silicon and Cardiac Muscle Cells