

Bio-Fluidic Chips (BioFlips)

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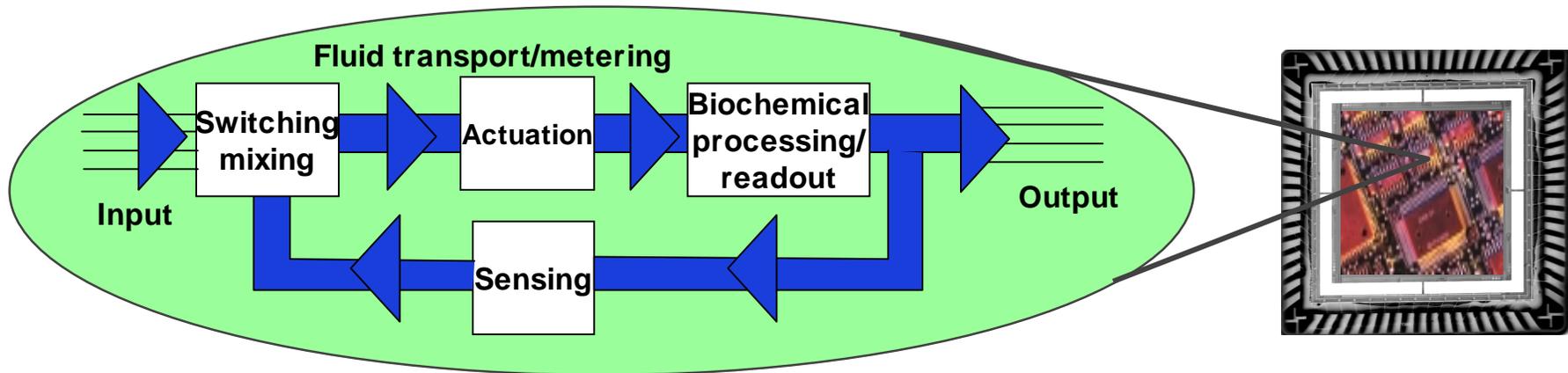
DARPA Tech 2000

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Microsystems Technology Office

Bio-Fluidic Chips (BioFlips)



- ❖ **Goal of Program:** Demonstrate integrated biofluidic microprocessor technologies capable of providing on-chip reconfiguration and self-calibration via feedback control

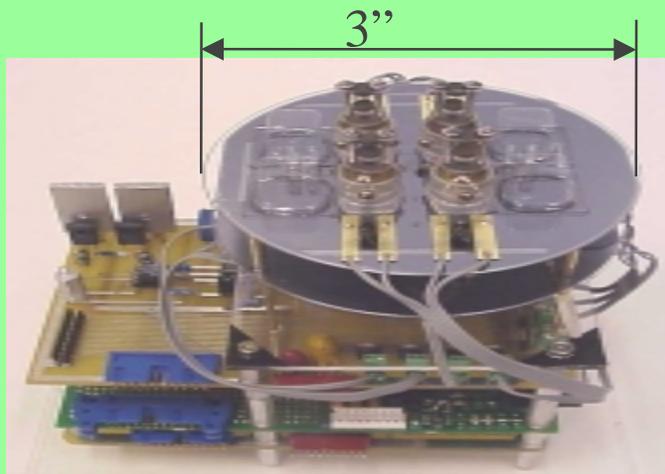
The prototypes developed in this program will demonstrate biological fluid assay capability which will form the basis for the future goal of real-time, unobtrusive monitor and control of health parameters of the warfighter.



Bioflips - A Paradigm Shift from MicroFlumes

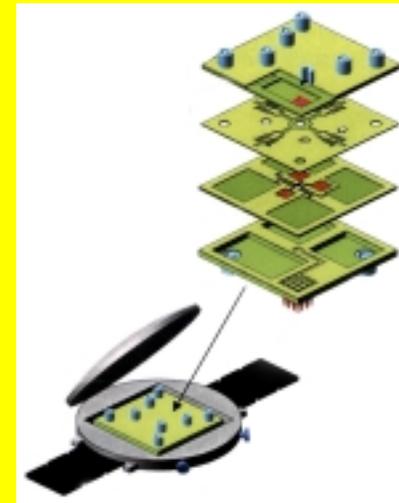
Microflumes

- ◆ Discrete microfluidic components
- ◆ Passive, fixed assays
- ◆ CBD, non-disposable

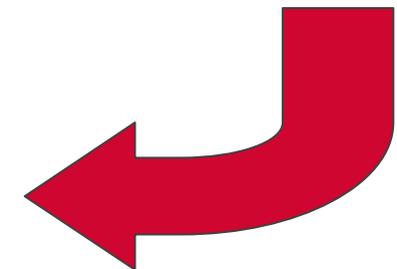
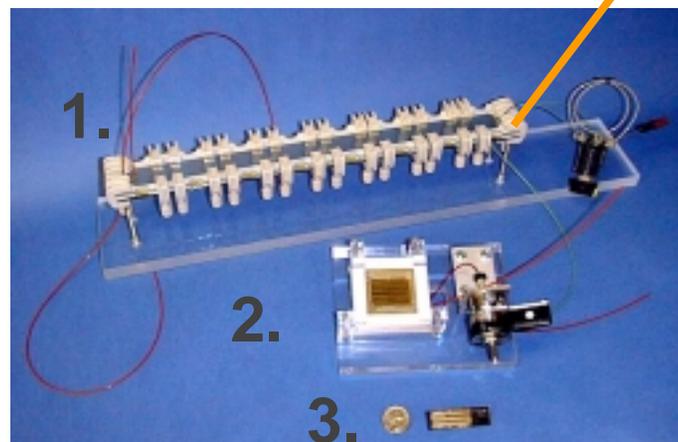
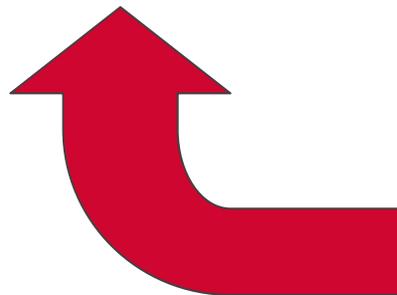
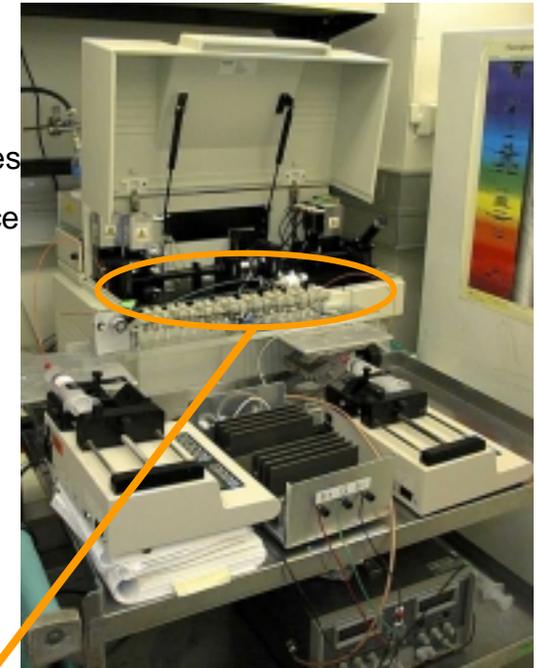
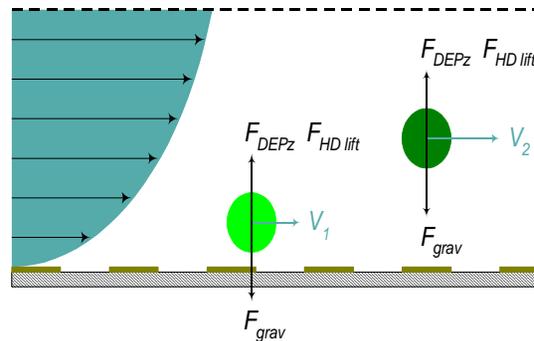
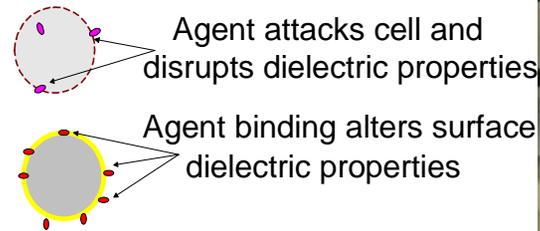
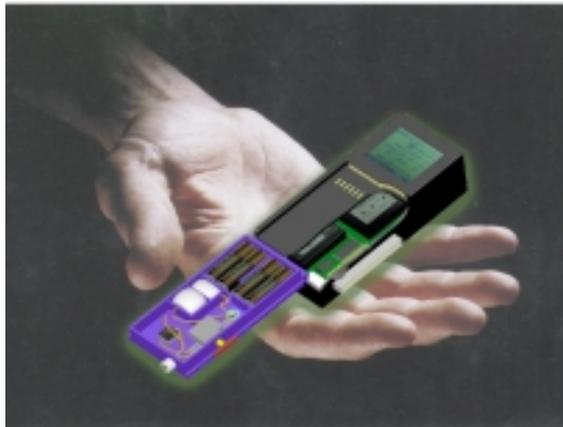


Bioflips

- ◆ Total integration platforms
- ◆ Active, reconfigurable assays
- ◆ Medical, disposable



The Microfluidic Molecular Systems Program (MicroFlumes)



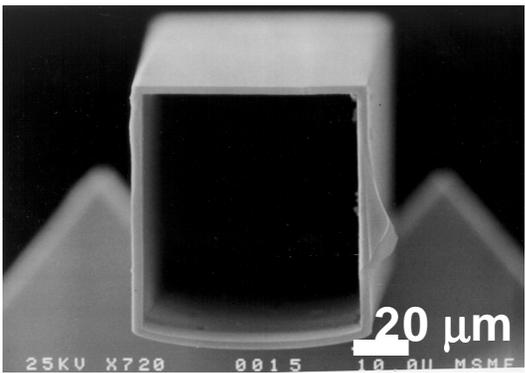
UTMDACC/
LLNL/Lynntech



“Versatility” of Microfluidics

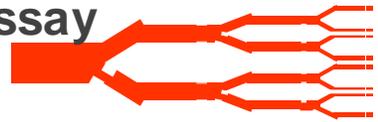
❖ Miniaturized channels and reservoirs

- Increase speed of reaction
- Reduce cost of reagents
- Reduce power consumption
- High surface to volume ratio/low Reynolds number
- Precise mixing/dosage and heating



❖ Integration

- Reduce cost of manufacture
- Minimize dead space, void volume
- Minimize sample carryover
- Multiplex capability: increased number of parameters monitored per assay



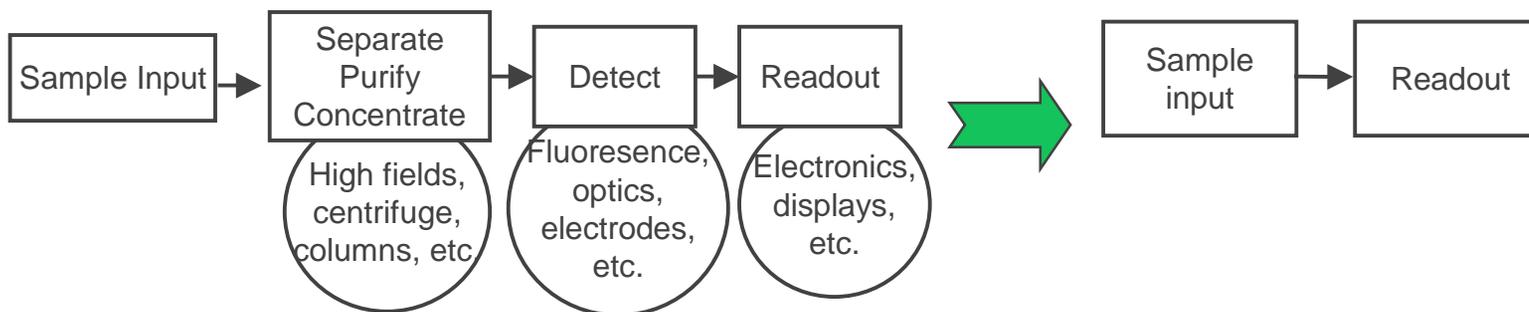
Integration Tasks and Technical Challenges

Technical Tasks	Challenges
1. Substrate processing for integrated fluidic transport and local flow control	Incompatible fabrication processes to integrate pumps, valves, channels, mixers, fluid sensors on single chips
2. Integrated fabrication of specific ligand receptors on passive and active surfaces	Incompatible fabrication conditions (temperature, sealing, patterning), surface conditioning and storage
3. Heterogeneous integration of disposable plastics with optical source/detector and electronics	Alignment, interconnection, optical components (e.g., lens), assembly
4. Integration of sample collection/delivery interface and sample storage	Sealing from contamination and pressure leakage, fabrication of protruding needles, z-direction flow control
5. Prototype integration and demo	Integration of fluidic and electronic interconnects; power consumption

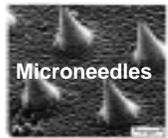
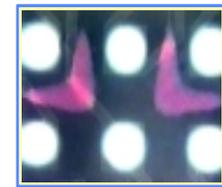


Technical Approach: Sample-to-Readout Multi-functional Micromachining Platforms

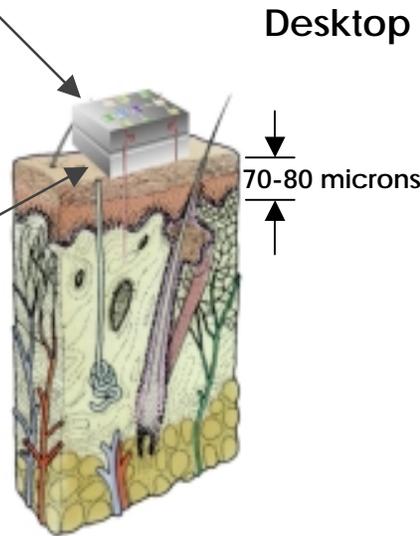
Enable the chip designer to design an integrated system meeting specific application specifications (analogous to CMOS for integrated circuits).



Bioflips Enables Ubiquitous Sampling, Analysis, and Synthesis of Biofluidics

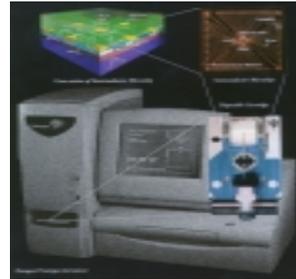


50 μm

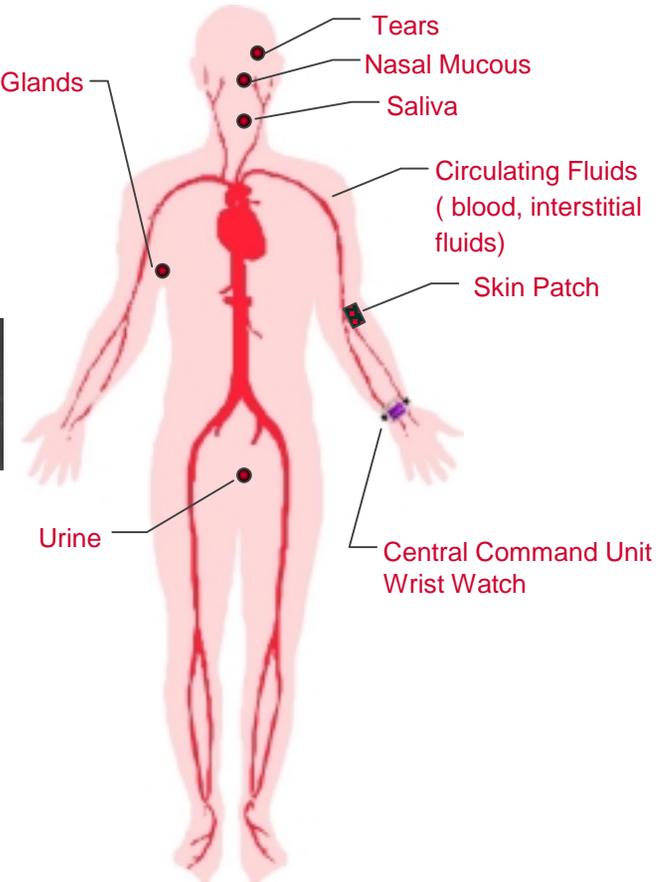


Desktop

70-80 microns



Body Fluids - Portals of Entry



Tears

Nasal Mucous

Saliva

Circulating Fluids
(blood, interstitial
fluids)

Skin Patch

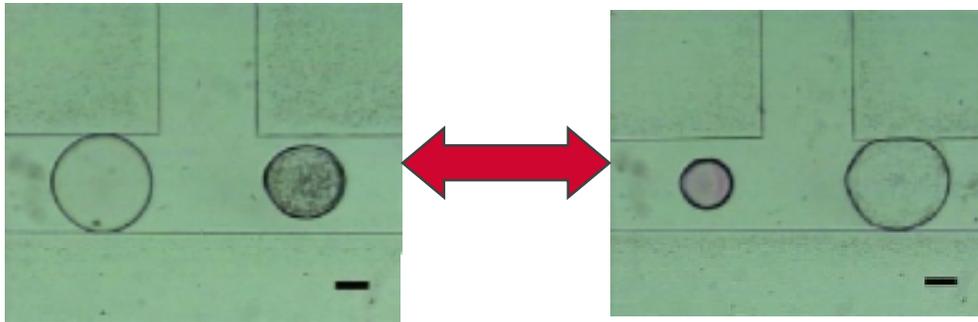
Urine

Central Command Unit
Wrist Watch

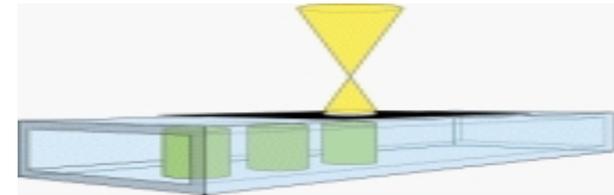


Microsystems Technology Office

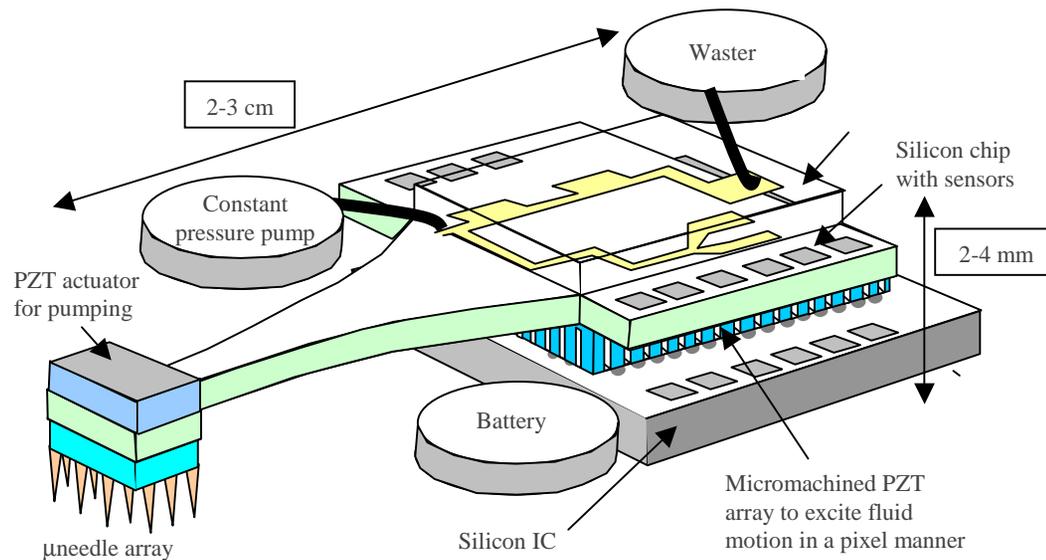
Two BioFlips Examples



U.Wisconsin/UIUC



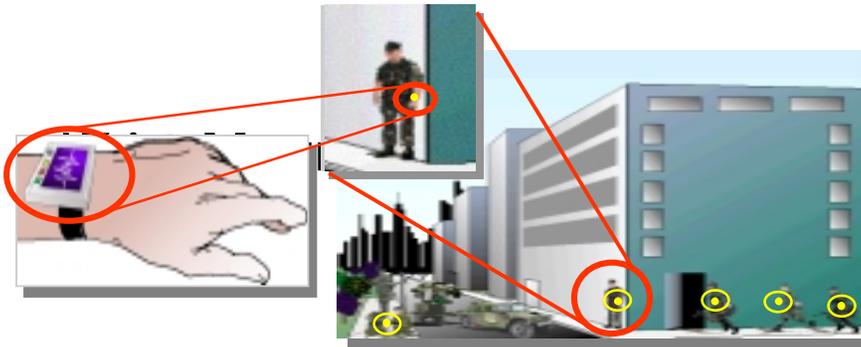
In situ polymerized/patterned/functionalized components



U.Wisconsin

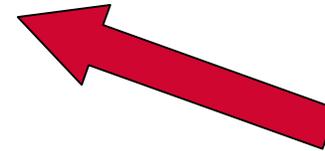
Piezoelectric micromachining platform for BioFlips



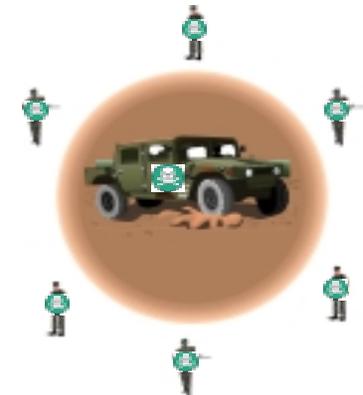


Distributed

Wrist-Mounted BioFlips



Central Units



It should be possible to detect a presymptomatic infection within the first hour by a cytokine profile

Commercial Applications

- ◆ Quick assessment of contaminated water and food sources
- ◆ On-demand chemical and drug synthesis
- ◆ Antidote delivery, swallowable and implantable chips
- ◆ Out patient care for high risk and chronically-ill patients

DoD Application

- ◆ Distributed, covert deployment of bio-detectors
- ◆ Rapid indication of CBW incident
- ◆ Indication of extent of problem and overall effect
- ◆ Battlefield triage information for medic
- ◆ Human responses during testing
- ◆ Performance enhancement drug delivery

