Microsystems for Medical Metrology

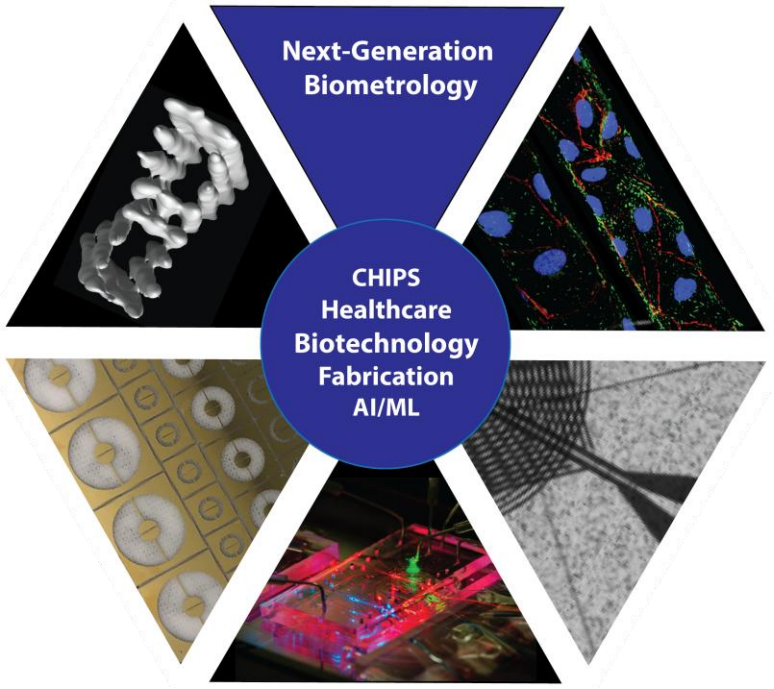
Dr. Matthew DiSalvo
National Institute of Standards and Technology
Microsystems and Nanotechnology Division
Biophysical and Biomedical Measurements Group

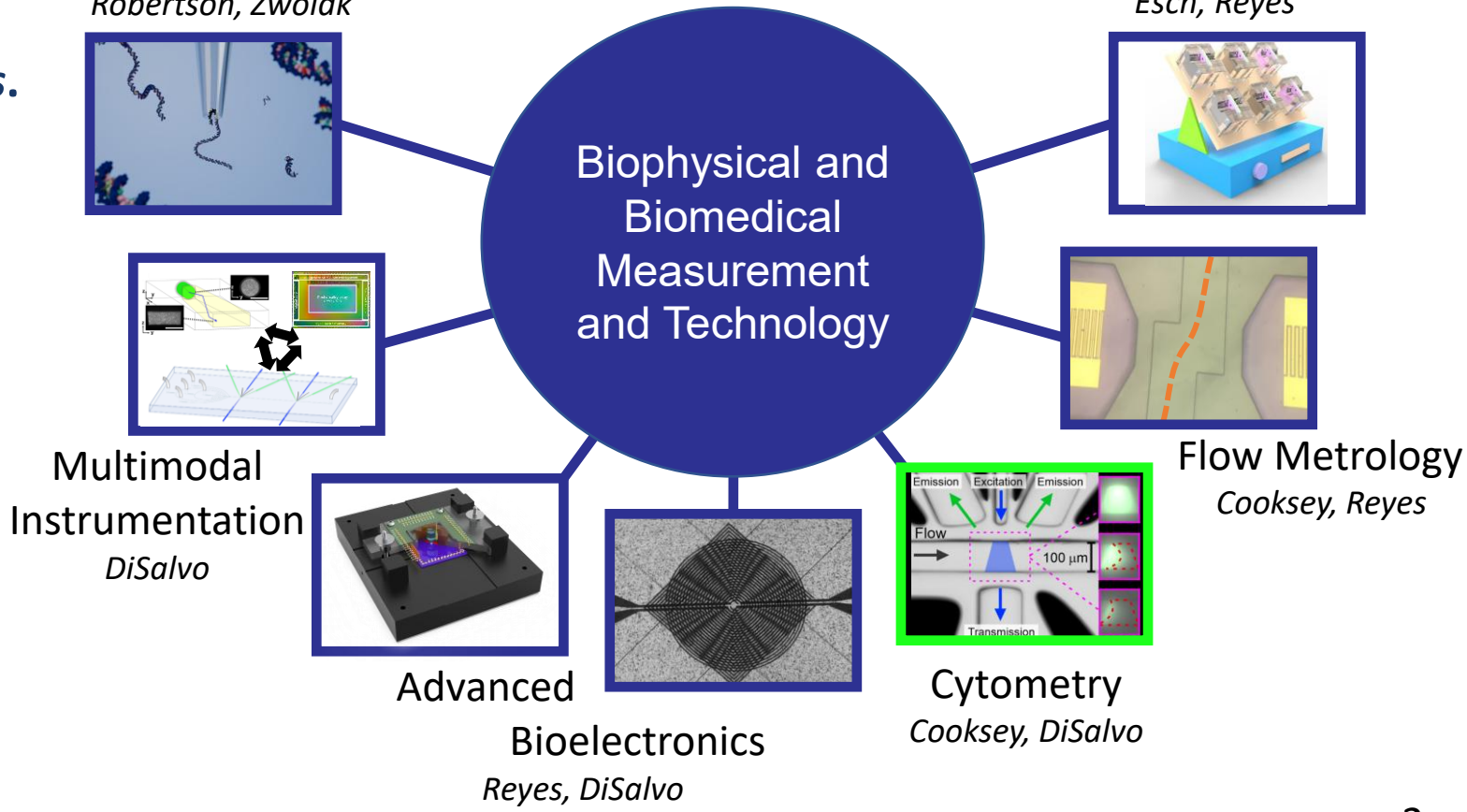
matthew.disalvo@nist.gov
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Group Overview

Biophysical and Biomedical Measurement

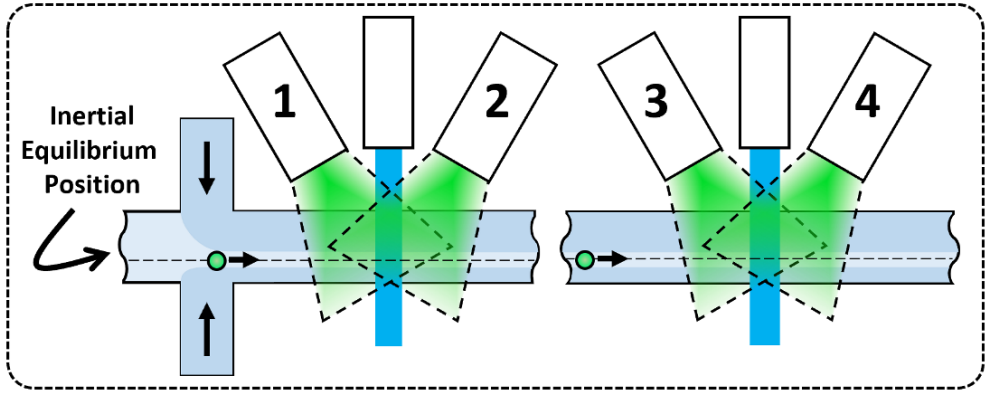
Advancing integrated microsystems and nanofabricated devices that *deliver trusted physical measurements of biomolecules, cells, and tissues to support national needs*.

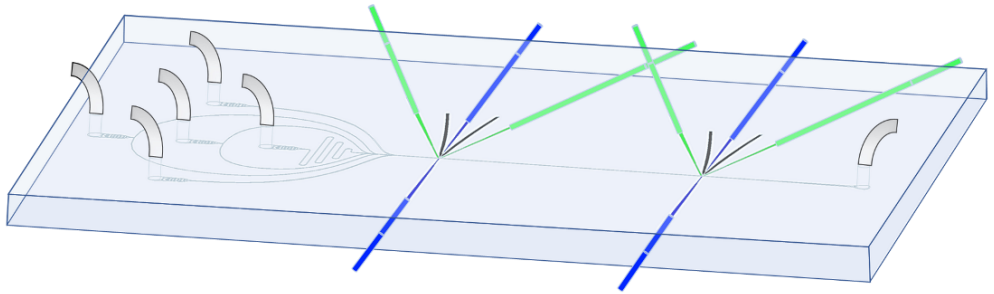




Serial Flow Cytometry

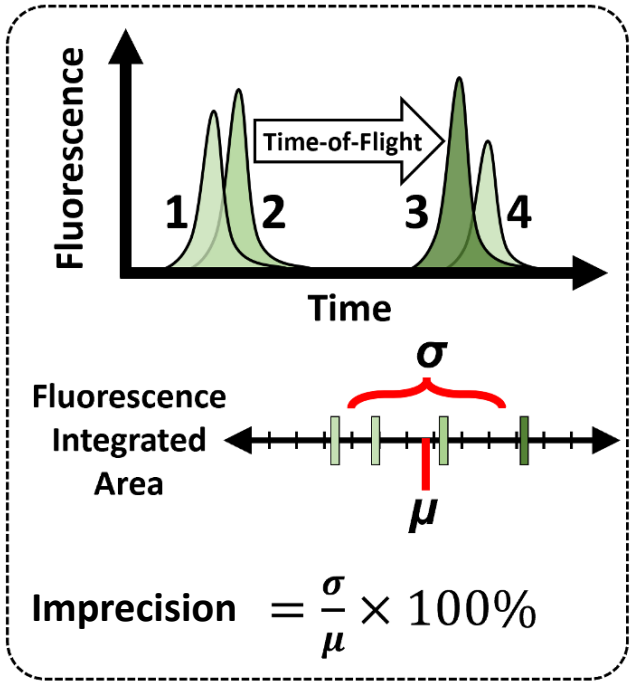
Replication of optical interrogation





Optofluidic serial flow cytometer

Per-particle uncertainty quantification



Serial Flow Cytometers Establish a Per-Cell Chain-of-trust

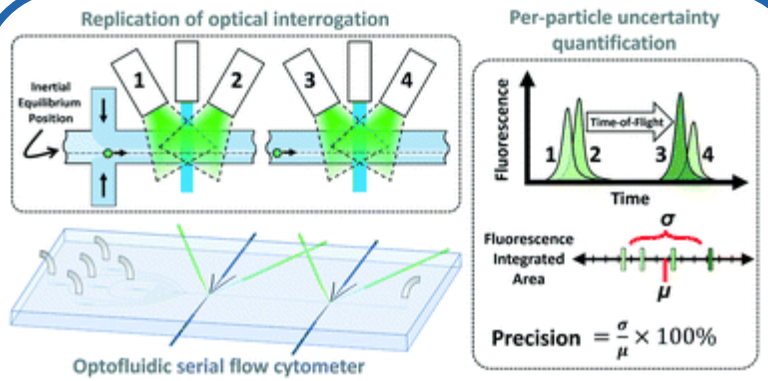
- ✓ Direct uncertainty quantification
- ✓ Measurement quality
- ✓ Benchmark instrument performance
- ✓ Develop & Validate model

Lab Chip, 2022, **22**, 3217-3228

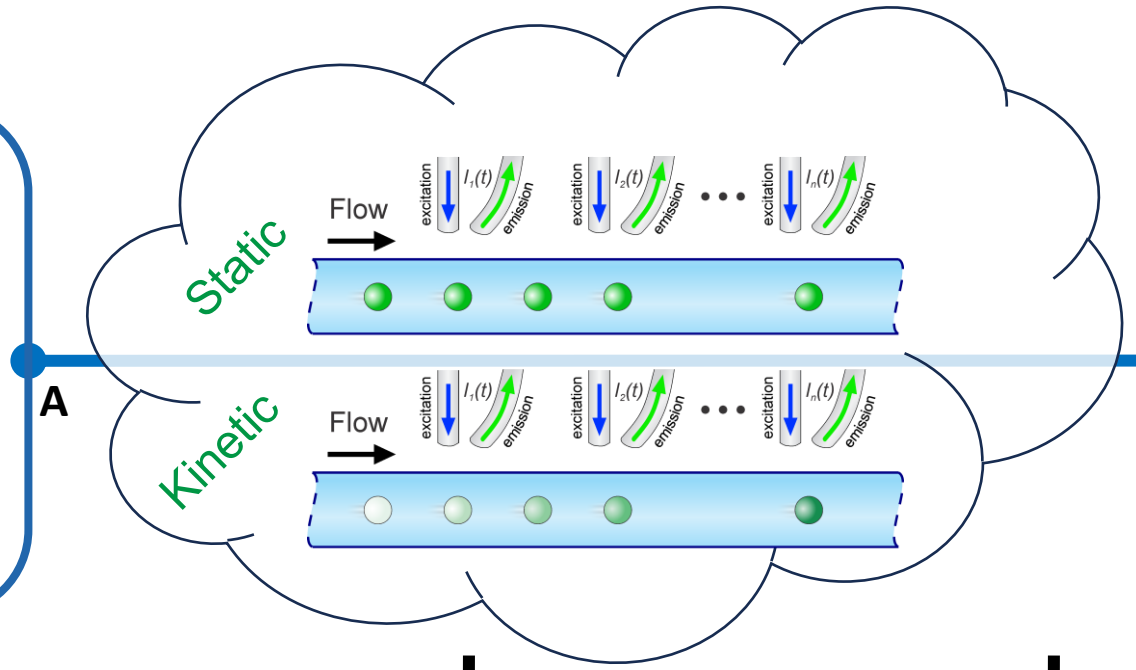
Cytometry Technology Innovation

CELEBRATING EST. 1901 NIST 125 YEARS | NATIONAL INSTITUTE OF STANDARDS AND TECHNOLOGY U.S. DEPARTMENT OF COMMERCE

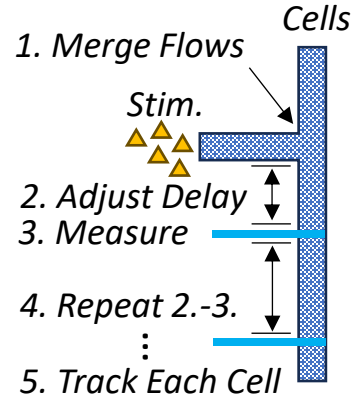
Serial Flow Cytometer (SFC)



Lab Chip, 2022, **22**, 3217-3228



Kinetic SFC

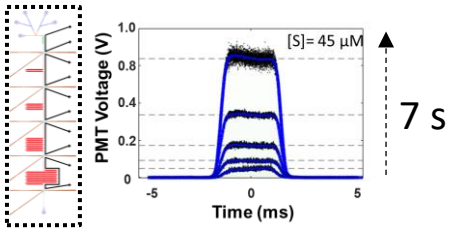


CYTO 2026

2019 — 2021 — 2023 — 2025 — Present

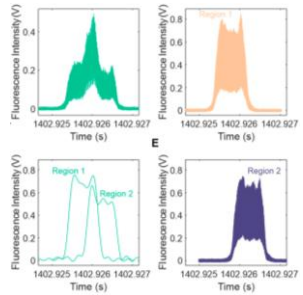
- ***PLoS ONE***, 2023, **18**, e0295502
- ***Cytometry Part A***, 2025, **107**, 508–523
- ***Cytometry Part A***, 2025, **107**, 524–537
- ***Cytometry Part A***, 2025; **107,** 587–596

Uncertainty Modeling



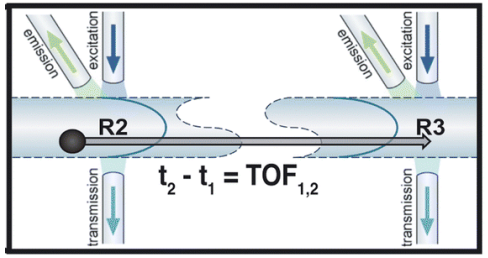
CYTO 2023

Microdroplet Kinetic Fluorimeter



Sensors, 2026, **26**, 1697

Amplitude Modulated SFC

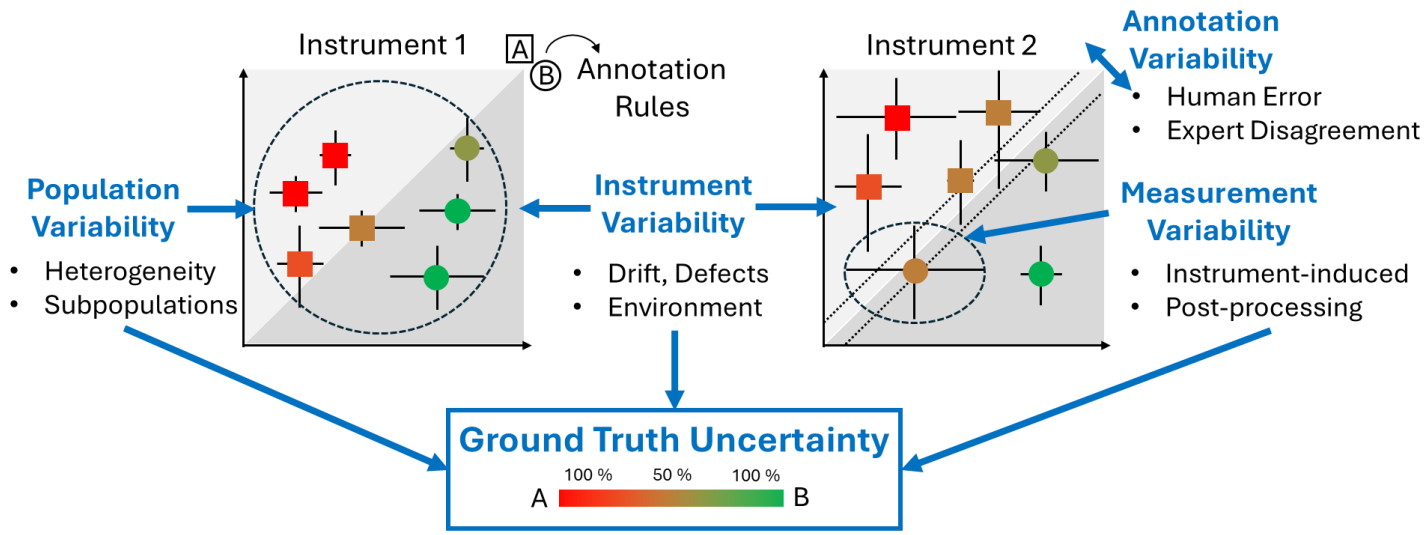


Lab Chip, 2026,**26**, 3168-3183

Mechanophenotyping SFC

Trusted Data for Biomedical AI/ML

Bottom-Up Uncertainty Quantification



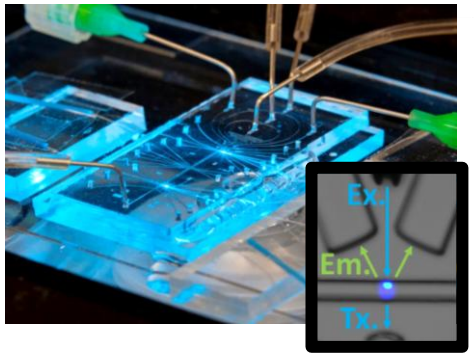
Strict Requirements for Biomedical Classifiers

- **High recall** (risk of missing a sick patient)
- **High precision** (risk of false alarms)
- **Robust to data bias** (risk missing rare cells)
- **Transferability** (risk failure on different machines)

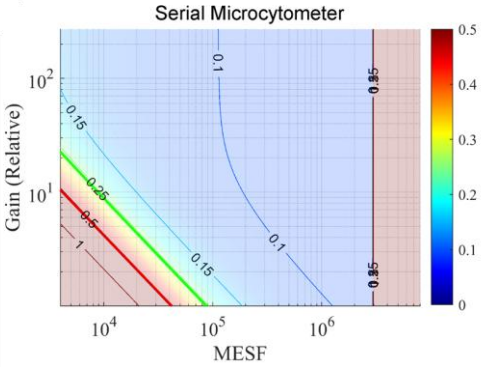
Physical Metrology for Cytometry

- ✓ Provide quantified uncertainty and traceability
- ✓ Validated & calibrated instruments/processes
- ✓ Comparability across instruments

NIST serial flow cytometer for direct UQ[1]



NIST models for inter-cytometer comparability[2]



1. DiSalvo, Patrone, Kearsley, & Cooksey, *Lab Chip*, 2022.
2. Catterton, DiSalvo, Patrone, & Cooksey, *Cyto:A*, 2025.