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“Lab-on-a-Disk” Platform for Rapid Radiation Biodosimetry and Clinical Diagnostics

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Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin company, for the United States Department of Energy’s National Nuclear Security Administration under Contract DE-AC04-94AL8500

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Device Overview

Goal: Develop a point-of-care device for combined hematology and proteomic screening using a few μL of peripheral whole blood (i.e., finger puncture).

Key Attributes:

- Simultaneous cell counting and immunoassays
- < 10 minute sample-to-answer
- Fully-automated, limited user interaction
- Portable, hand-carried device

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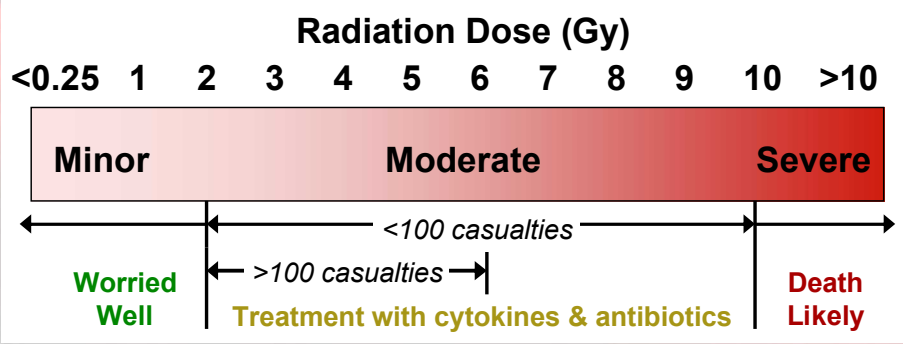
Motivation: Radiation Biodosimetry

*"Presently available methods are not satisfactory for managing the medical casualties from an R/N event and there is **urgent need** to develop new capabilities to assess radiation dose quickly with at least moderate precision."*

- DHS S&T Technology Assessment and Roadmap for the Emergency Radiation Dose Assessment Program (ERDAP), 2005.

Guidelines for treatment of victims:

(Adapted from: J.K. Waselenko et al. "Medical Management of the Acute Radiation Syndrome", Annals of Internal Medicine 2004)



"A significant survival advantage has been demonstrated in irradiated animals treated with [cytokines] in the first 24 hours" – Waselenko et al, 2004

- Early and rapid detection crucial for separating the worried well from victims requiring prompt therapeutic response.
- In a R/N event, there are an estimated 100-500 in the worried well for every person requiring treatment.

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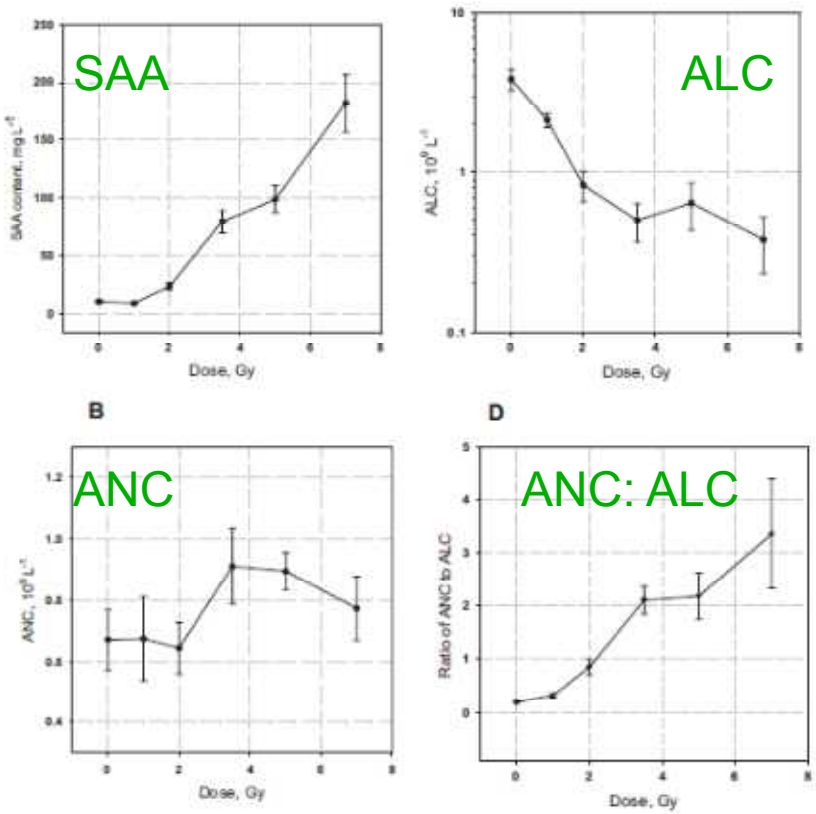
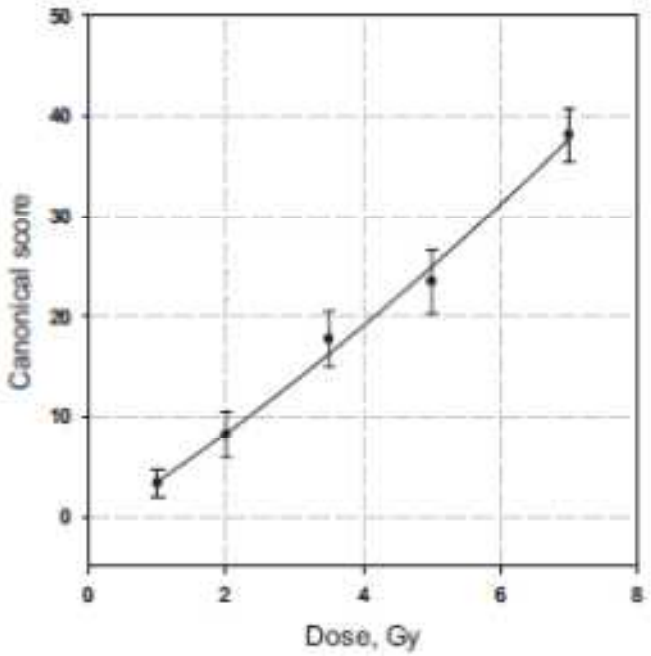
AFRRI Biomarker Panel

• The Armed Forces Radiobiology Research Institute (AFRRI) has established a patent-pending panel of protein and leukocyte biomarkers through extensive animal testing



Statistical dose assessment using SAA conc. and ANC:ALC ratio



Results from blood drawn 24 hours post exposure in mouse whole body irradiation study (recently published by AFRRI).

Ossetrova *et al*, Health Phys. 98(2):204 –208; 2010

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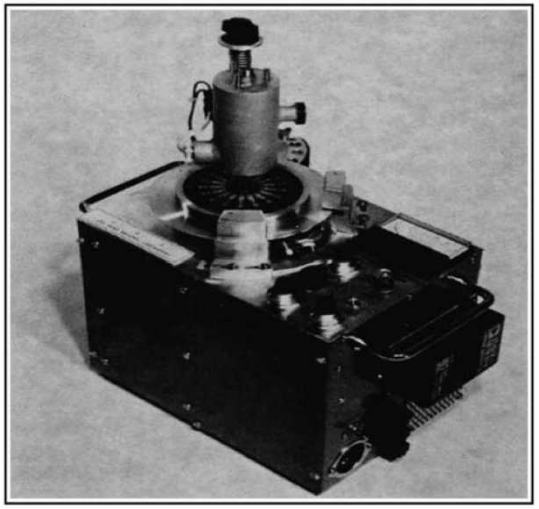
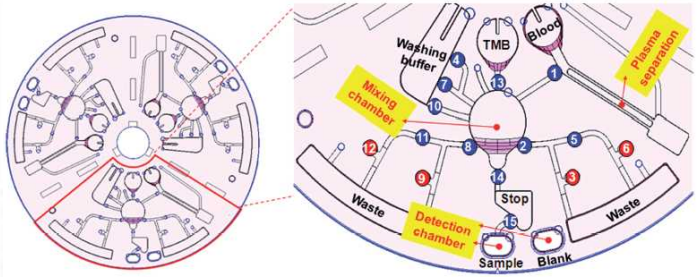
“Lab-on-a-CD” Microfluidics

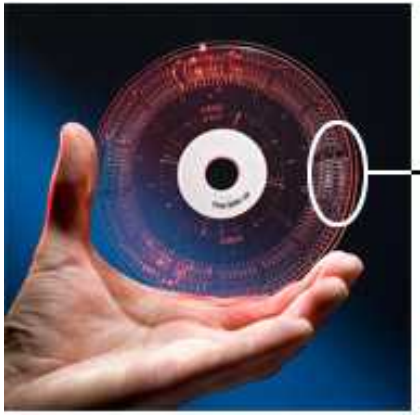


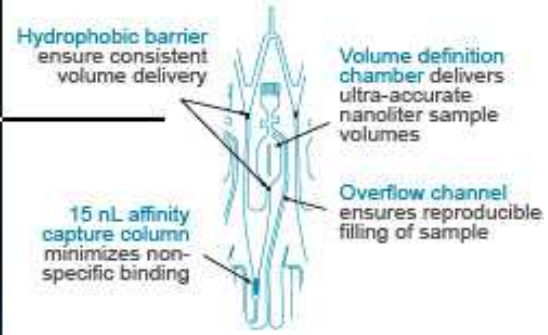
Burtis et al, *Clin. Chem.*, 1972, 18, 753-761



Lee et al, *Lab on a Chip,* 2009, 9, 1548-1555

www.abaxis.com





www.gyros.com

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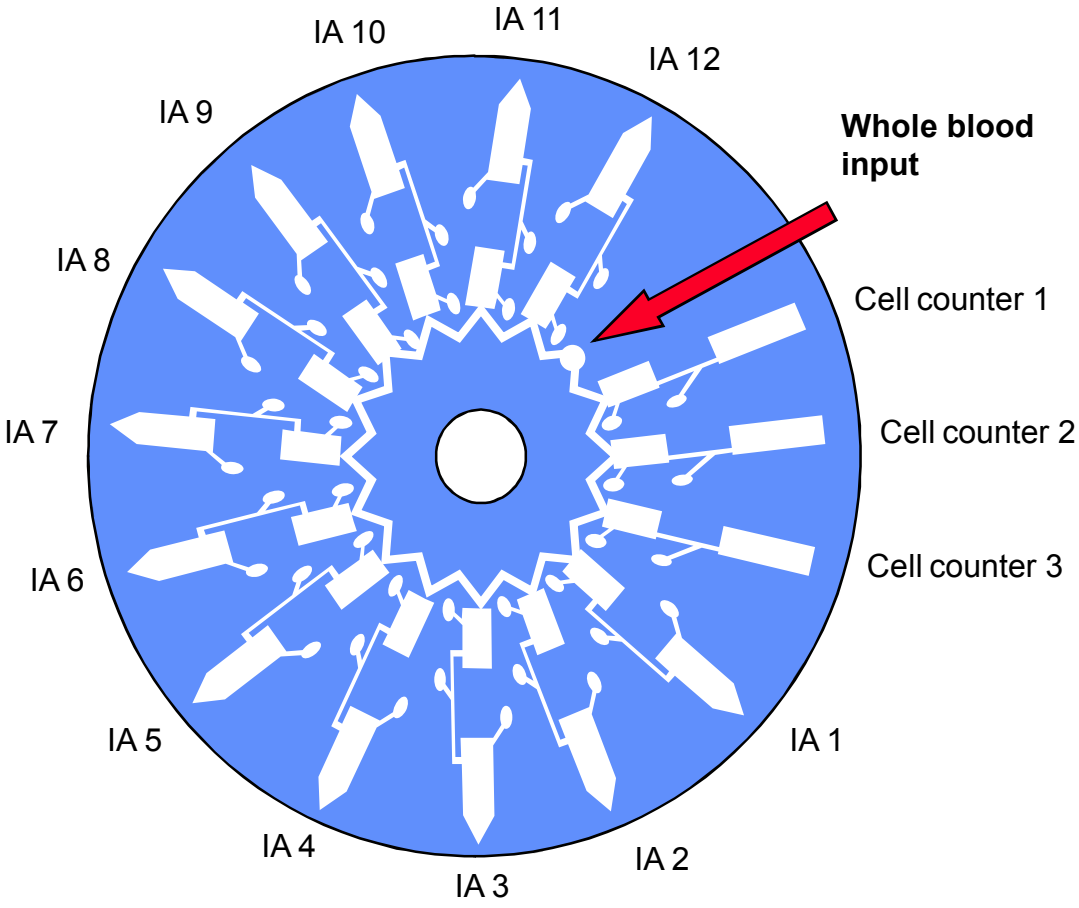
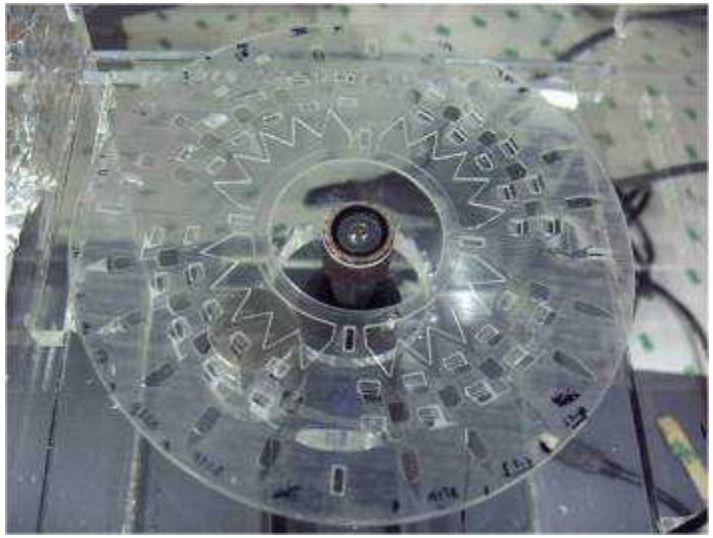
Lab Portable Assay Disk





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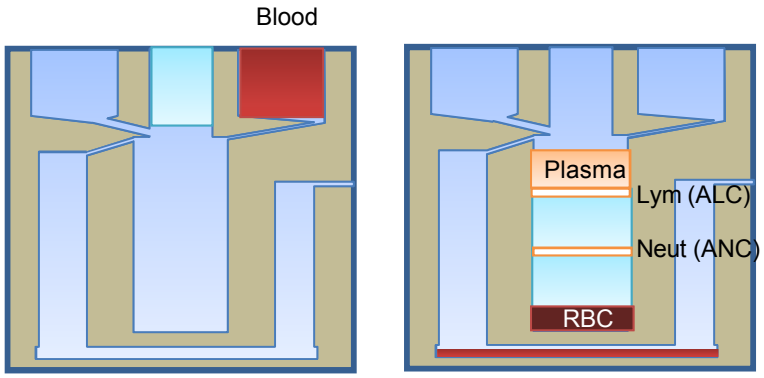
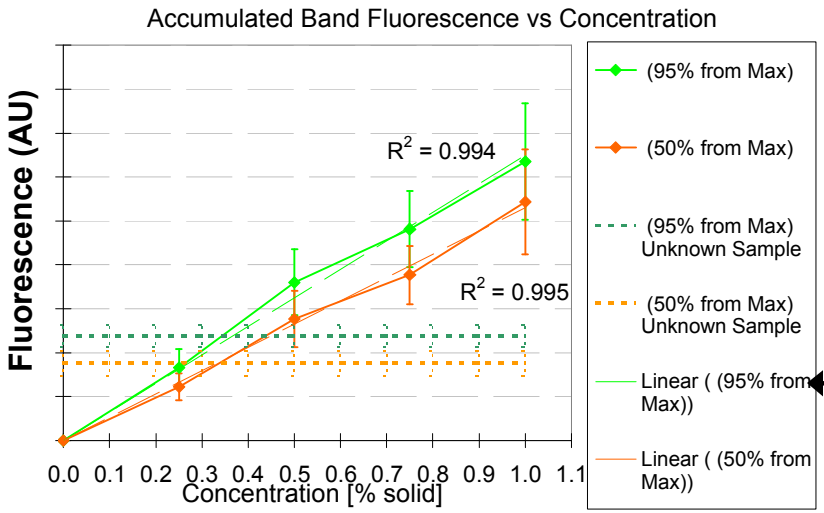
Centrifugal Leukocyte Separation and Counting



Sample loading
0 RPM

White cell separation
3 min at 5000 RPM



Multiplex sample preparation and reading on a CD
Different white blood cell types have different densities. Blood samples may be loaded into chips, separated by centrifugation within a spinning disk, and read by laser excitation. Dimensions and RPM are achievable on a standard disk drive.

Accumulated fluorescence across each band used to quantify particle (cell) concentrations

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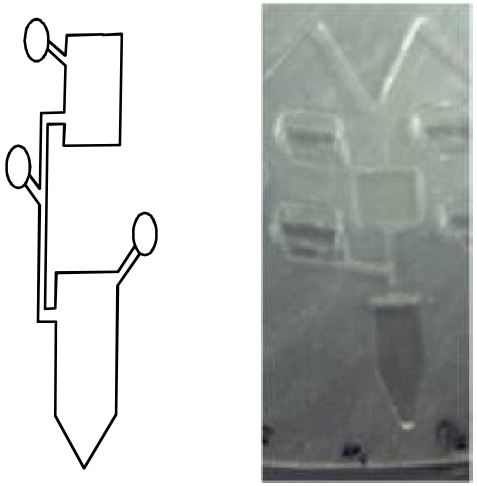
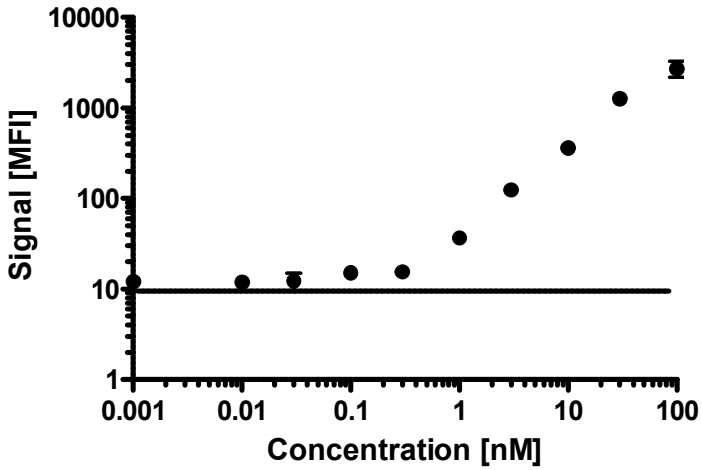
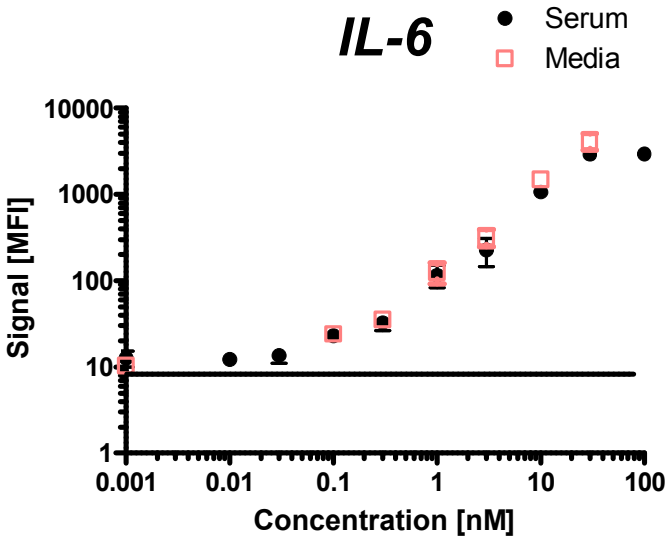
On-Disk Immunoassay Results



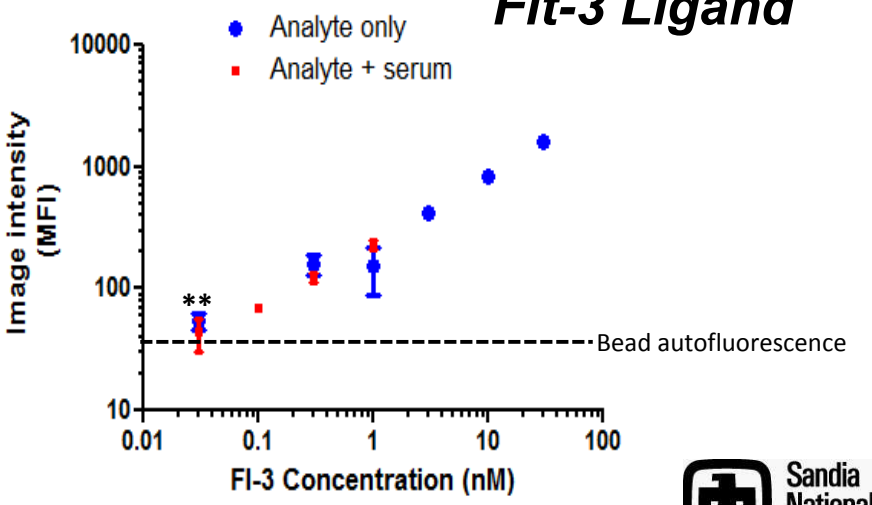
C-Reactive Protein



IL-6



Flt-3 Ligand



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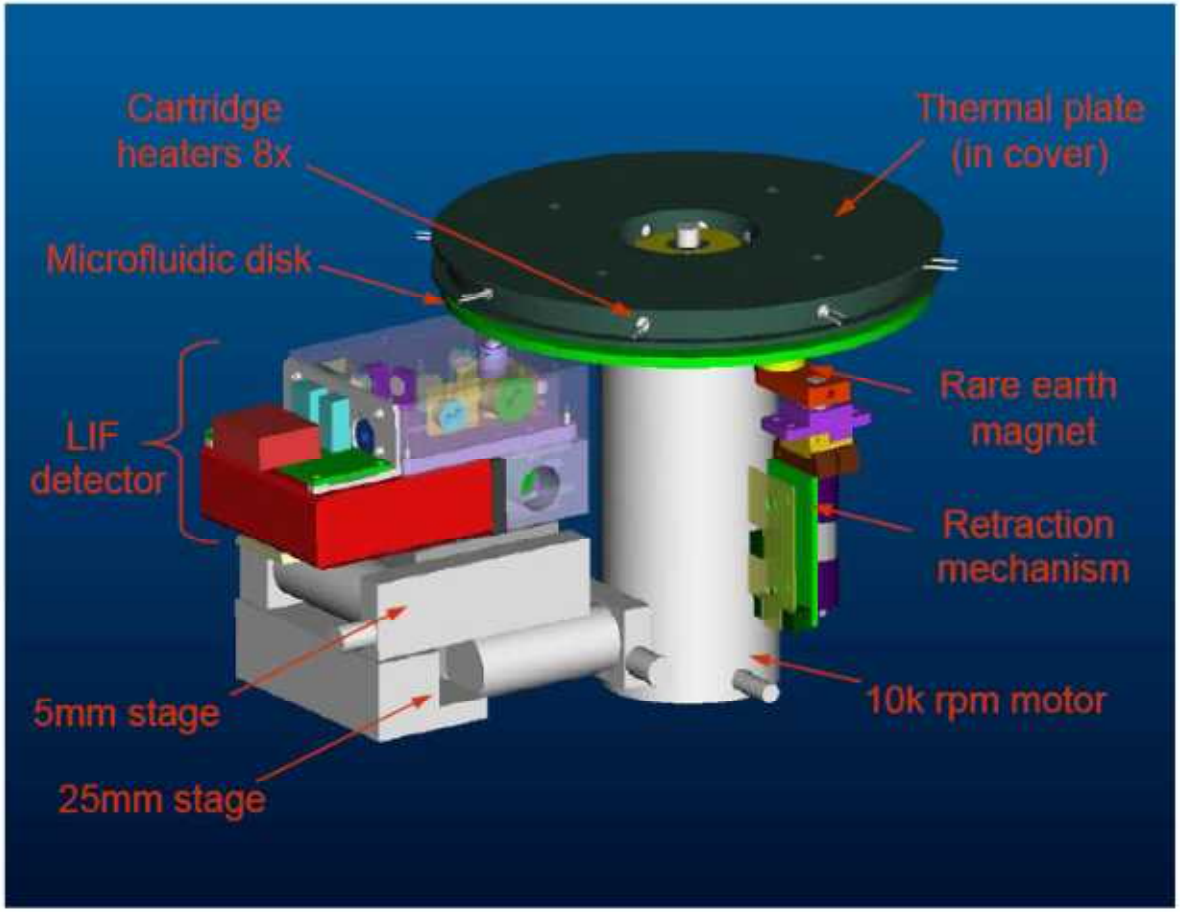
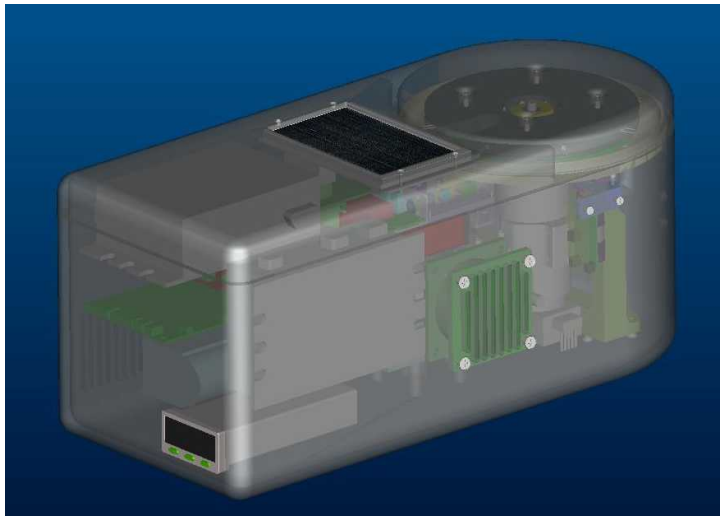
Device Integration and Packaging

- Integrated system leverages hardware, optics, and motion components previously developed at Sandia



Approximate dimensions: 15 x 15 x 15cm

Sandia's POC Biodosimeter



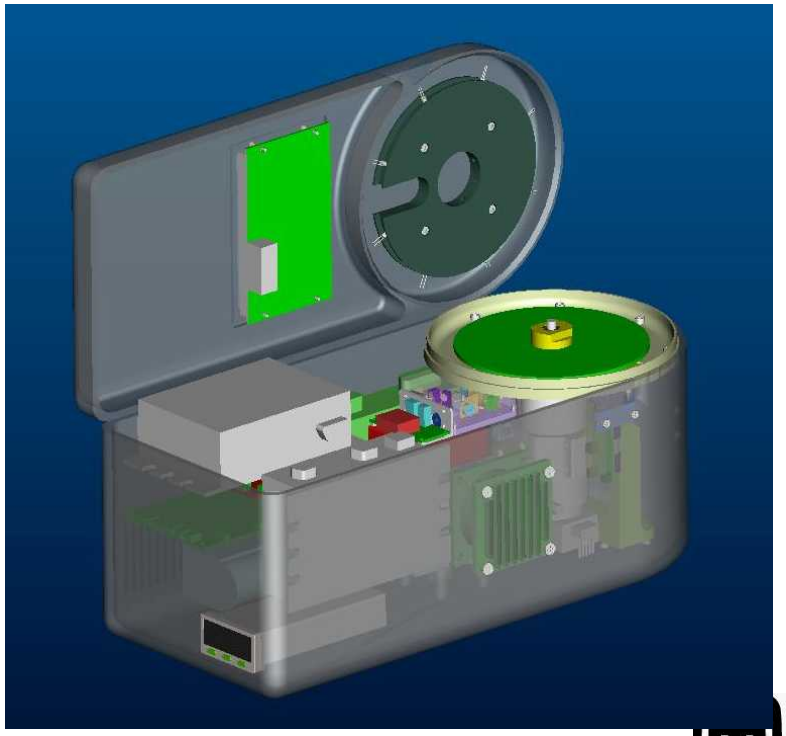
- Fully-integrated assay operation
- Touchscreen LCD control and results dissemination with embedded dose prediction algorithm
- Footprint: 17" x 8" x 9"

Targeted device capabilities

- Multiplexed, parallel detection of protein biomarker panel and cell counts

- Small drops (finger puncture) whole blood input

- Fully-automated sample-to-answer in <10 minutes



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