A Low-Cost Dynamic Light Scattering System for Detection of Viral Aggregates

- Diagnostic for Viral Diseases -

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The Need
A Quantitative HIV Diagnostic

Macha Mission Hospital Image courtesy of MMH Blog

- ➔ Client: Dr. Phil Thuma at Macha Research Center in Zambia
- ➔ HIV diagnostics that can monitor viral load are limited
- ➔ Need a low-cost device that quantifies viral load

Spectrum of Diagnostic Methods

Quantitative- Viral Load

- $25-$50 per test
- $35,000-$100,000 per device
- Restricted to lab setting
- Sensitivity: 20 viruses/μl
- Nucleic Acid based

Qualitative- No Viral Load

- $10 per test
- No direct device cost
- Point of Care
- Non-Nucleic Acid and Nucleic Acid Based

Threshold for change in treatment
Sensitivity: 1000 Viruses/μl

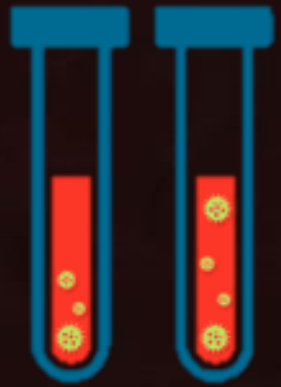
Source: Aidsinfo.nih.gov

DVD's Solution Criteria

Point-of-care

http://www.pennlive.com/bodyandmind/index.ssf/2013/08/two_harrisburg-area_doctors_br.html

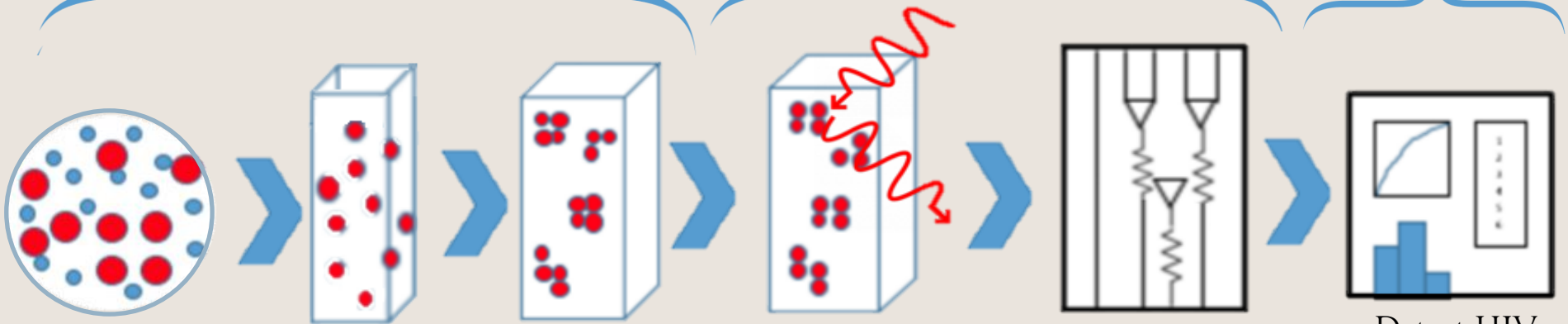
Quantitative



Low-cost

The Diagnostic

Protein Engineering + Detection (Dynamic Light Scattering) → HIV Diagnosis



Unfiltered blood sample

Isolated HIV clusters

Detect and size HIV (nanoparticles)

Detect HIV (nanoparticles)

Detection: Dynamic Light Scattering (DLS)

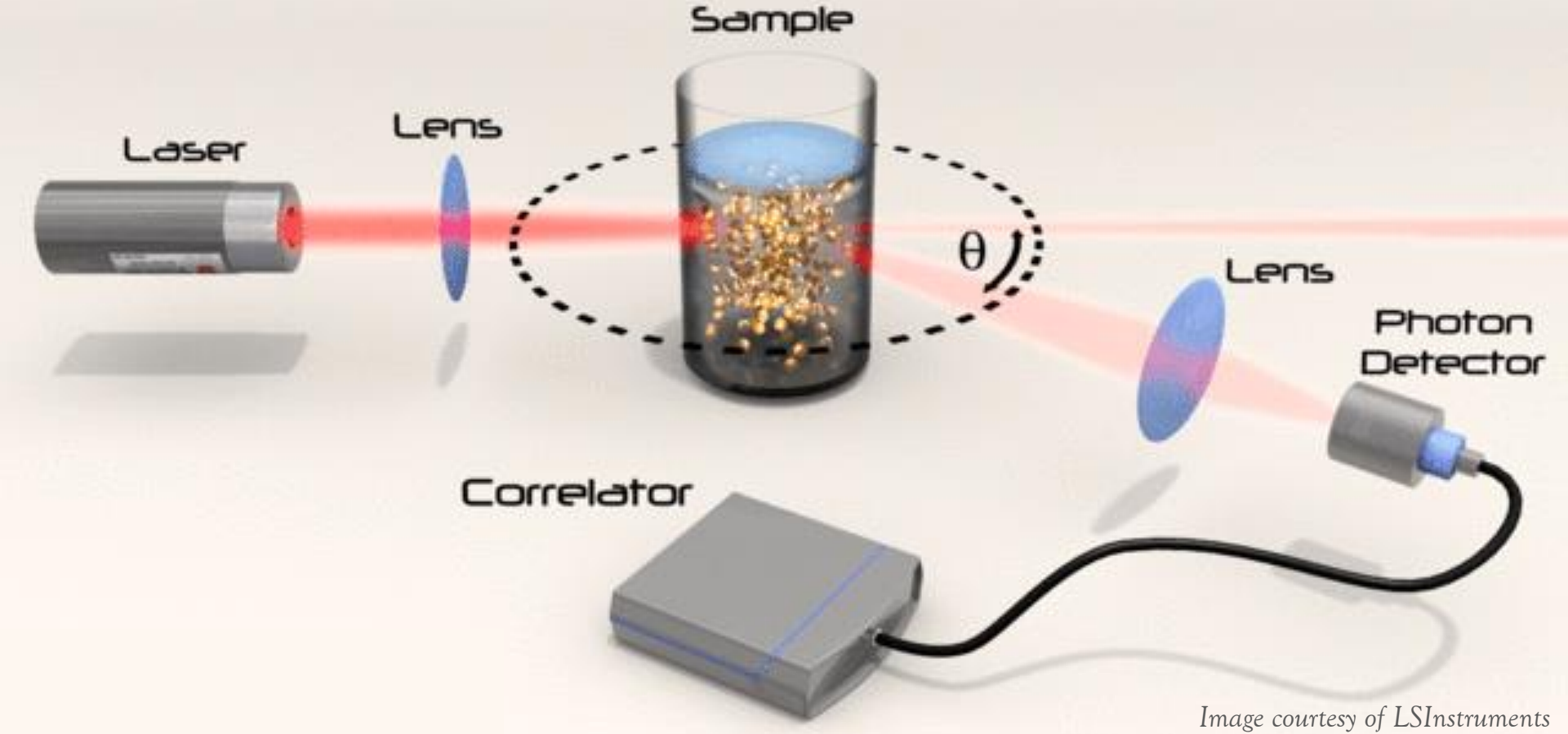


Image courtesy of LSInstruments

Detection: Dynamic Light Scattering (DLS)

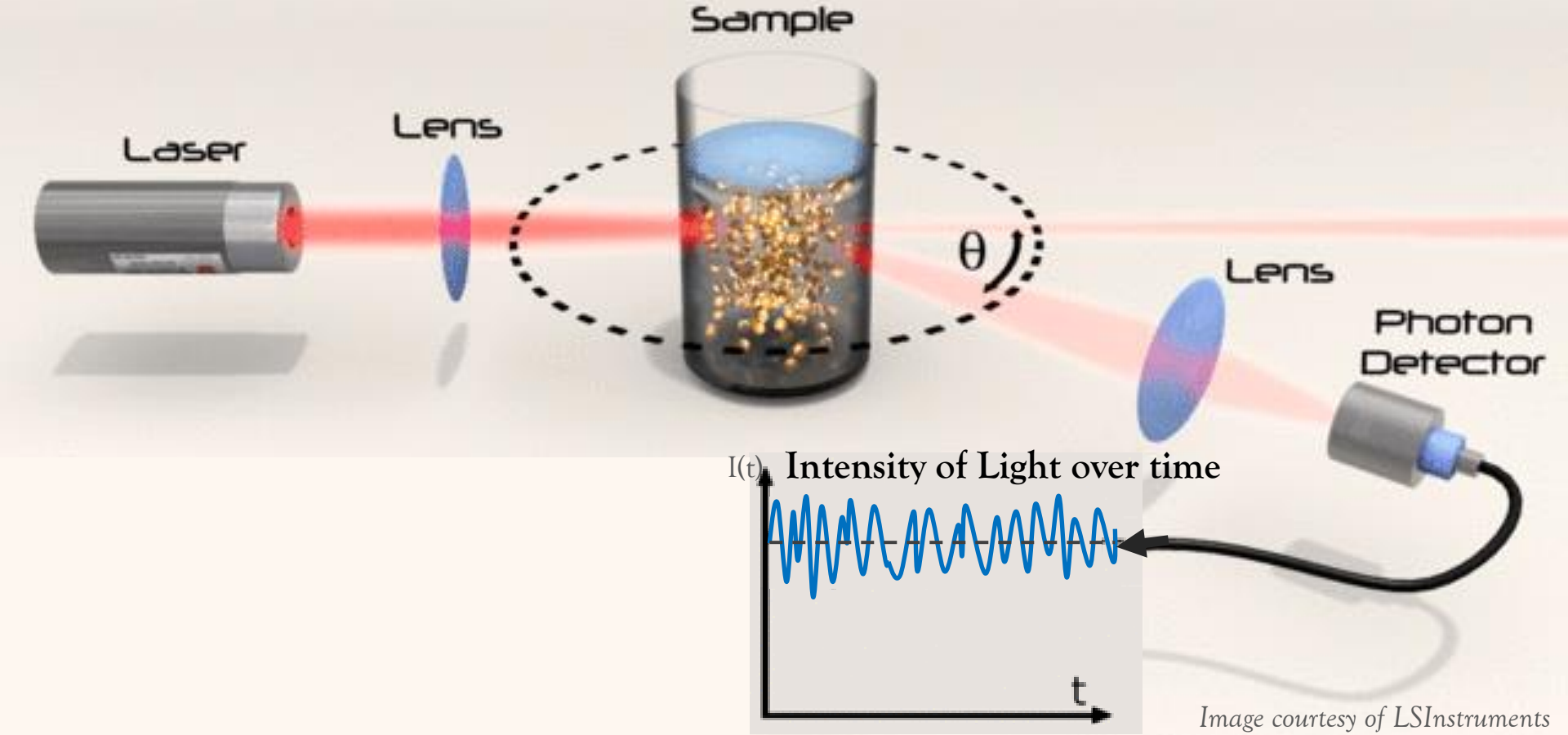


Image courtesy of LSInstruments

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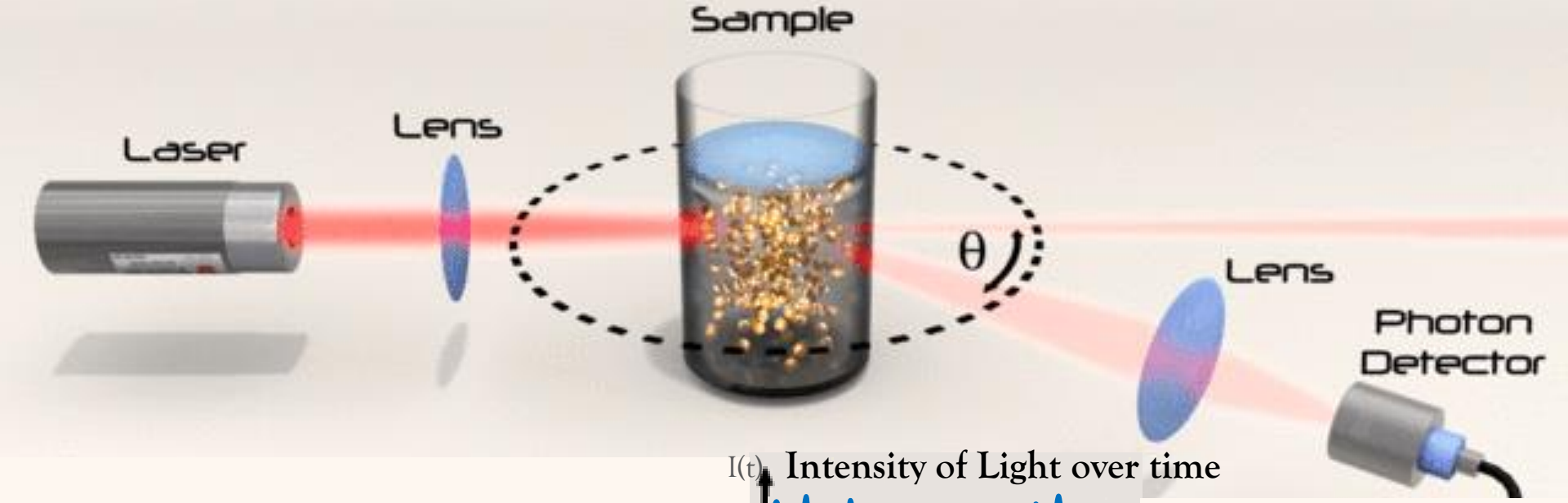
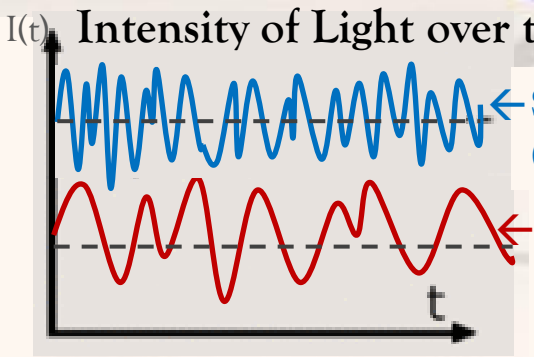


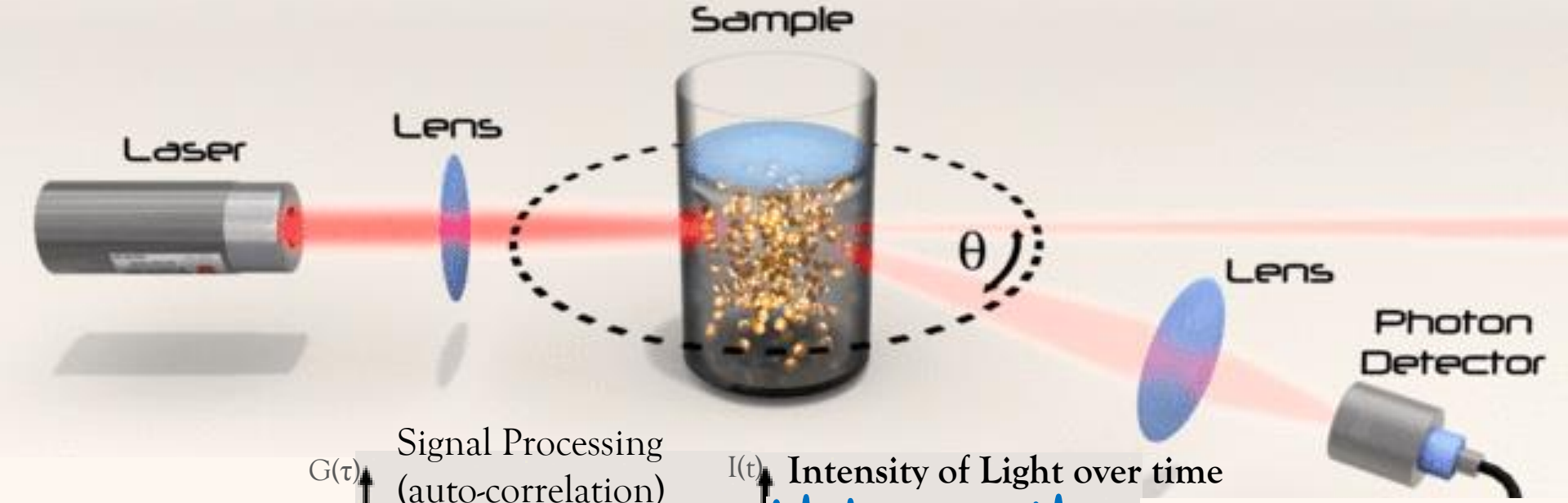


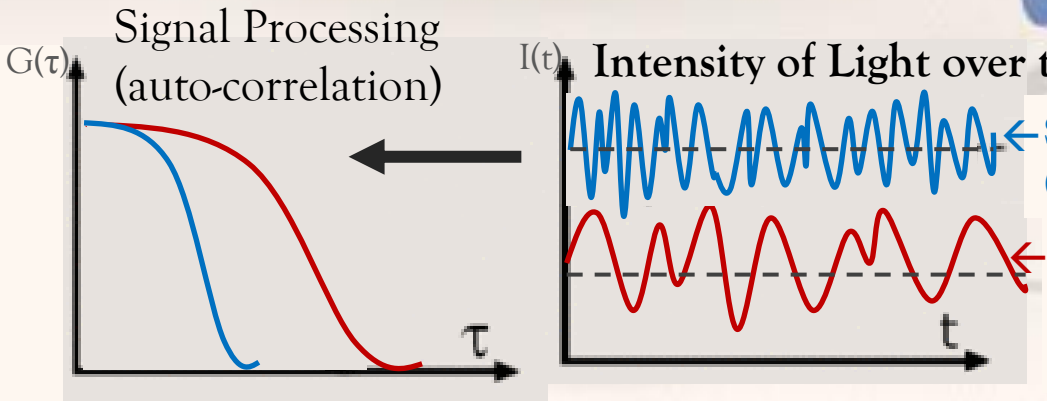
Small particles move faster (light flickers faster)

Large particles

Image courtesy of LSInstruments

Detection: Dynamic Light Scattering (DLS)





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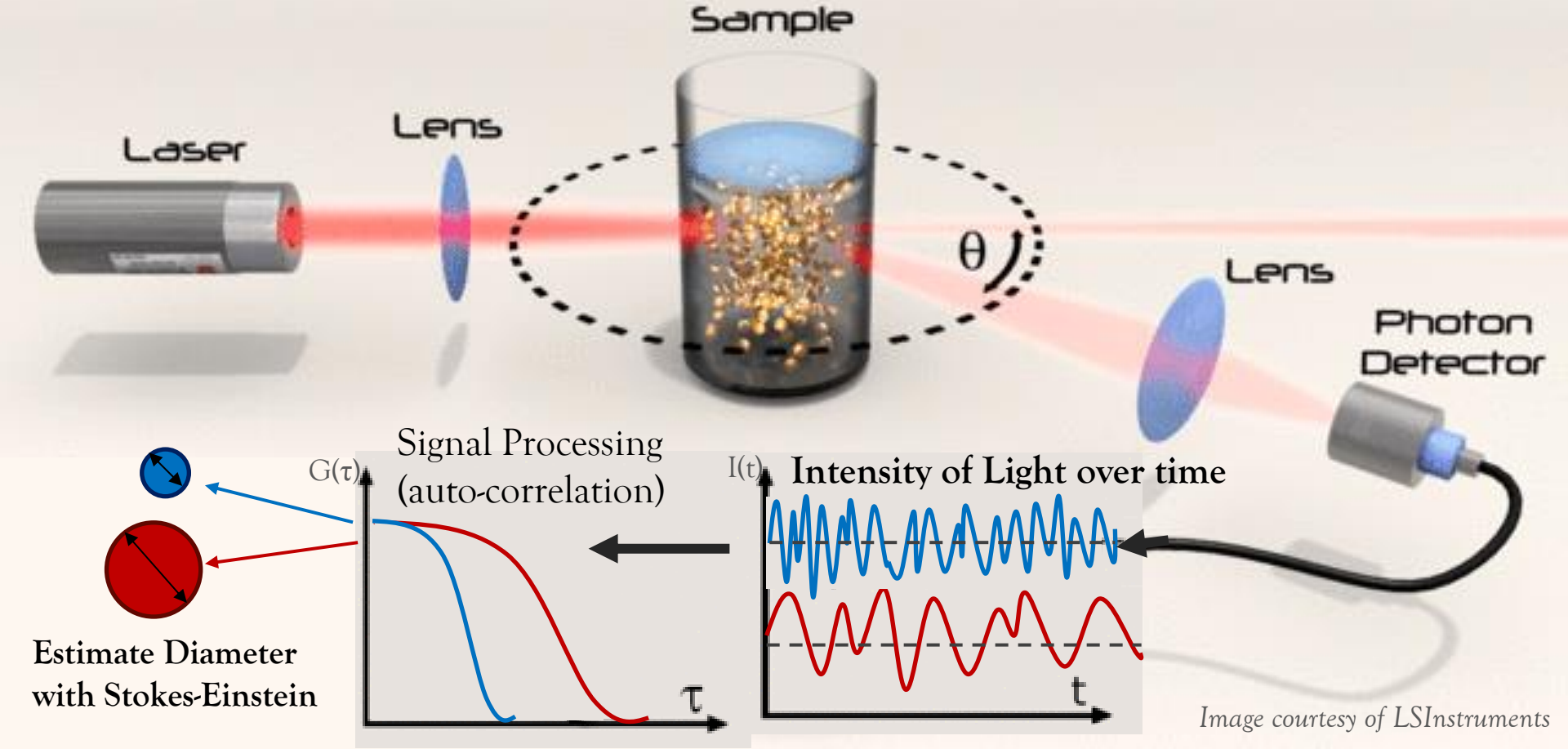
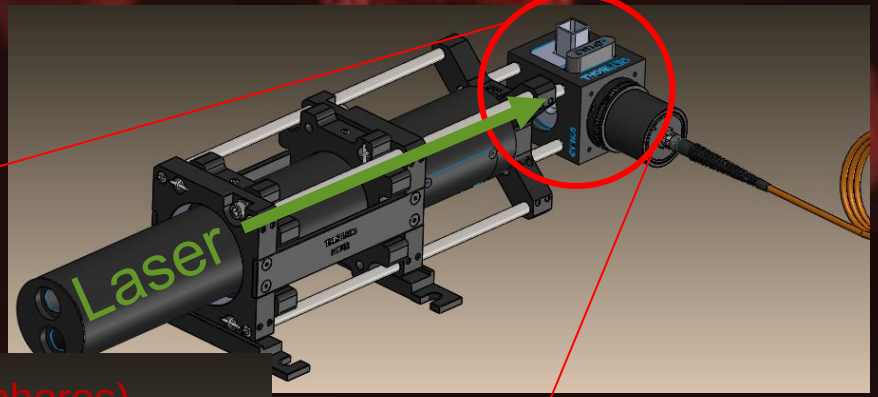
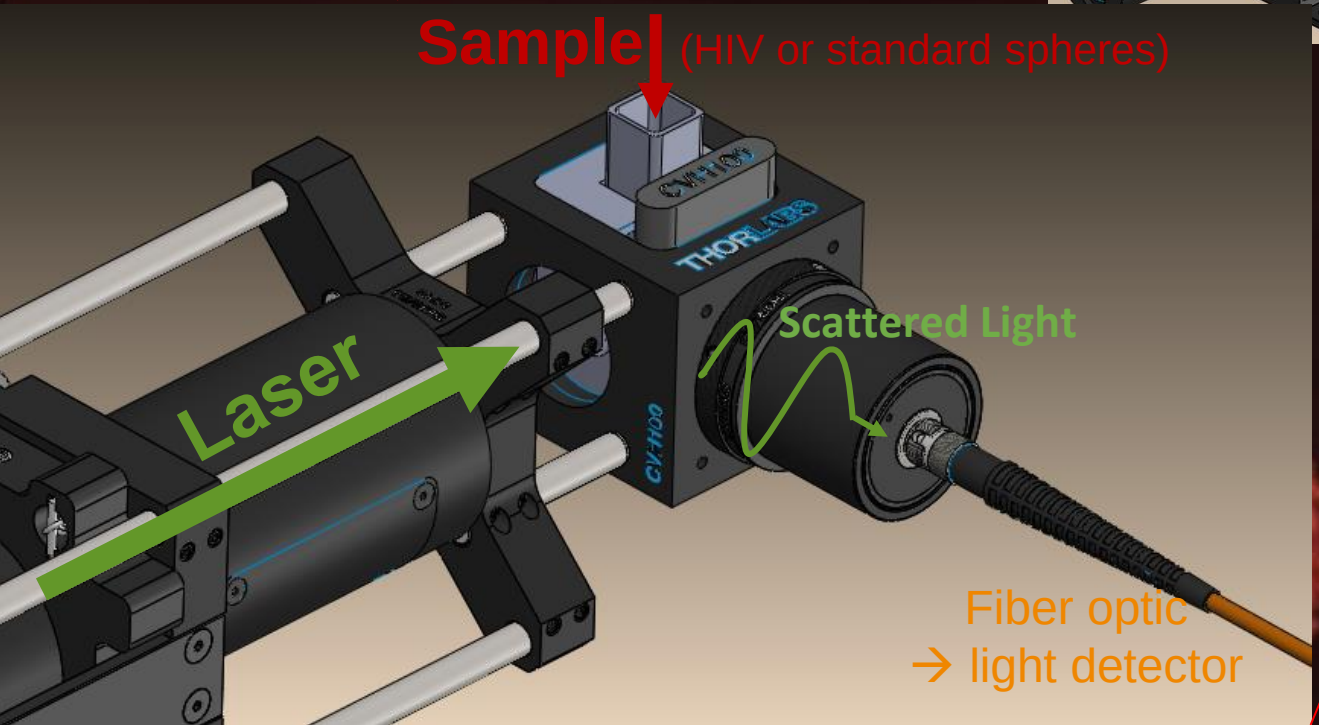


Image courtesy of LSInstruments

Our DLS Apparatus





Above: Schematic of entire apparatus. Detector connected to fiber not shown.

Left: Zoomed in to scattering sample.

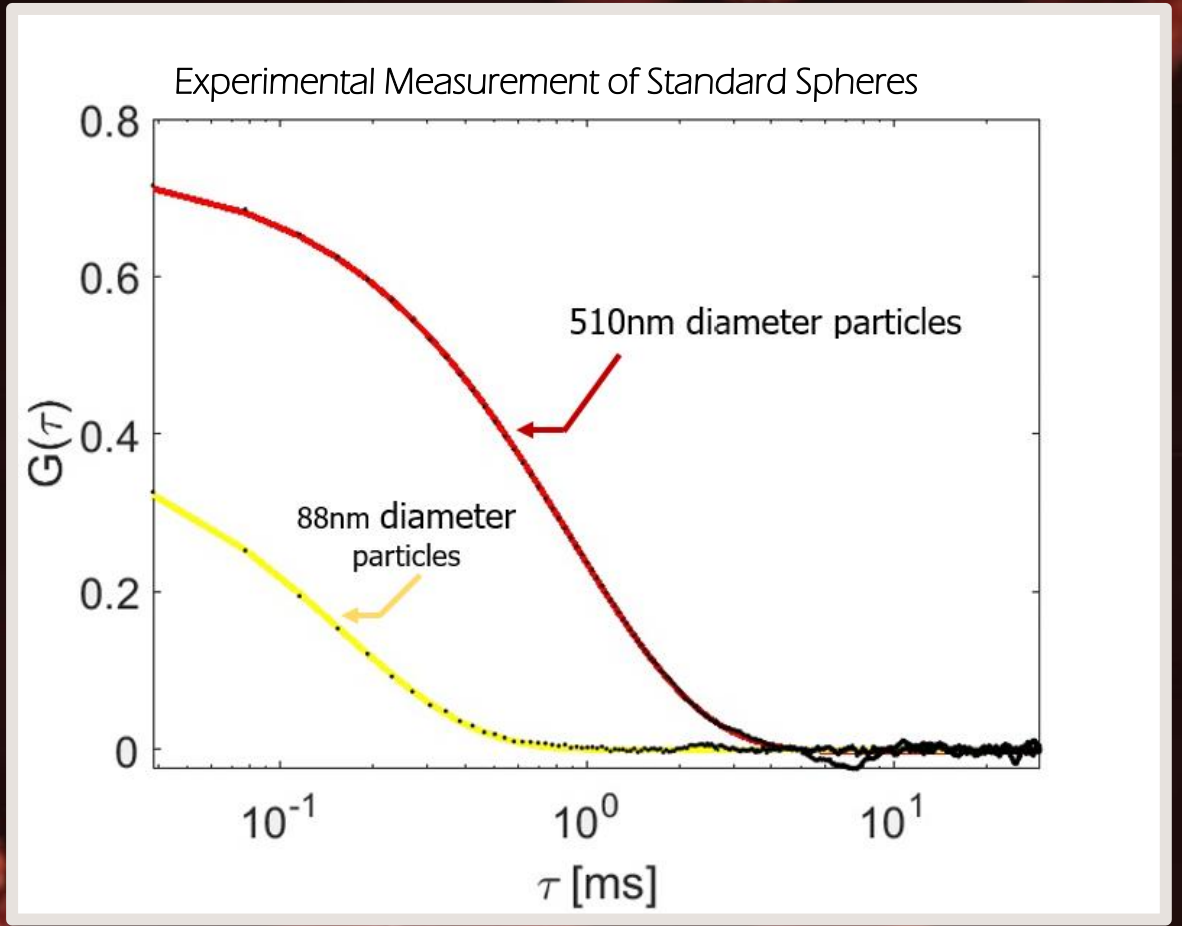
Results

A functional apparatus

✓ Sizes 88-510nm particles (HIV ≈ 100nm)

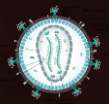
→ Sensitive to concentrations > 5,000 particles/uL

→ Systematic underestimate ≈ 20%



Size Comparison: HIV vs. Standard Spheres

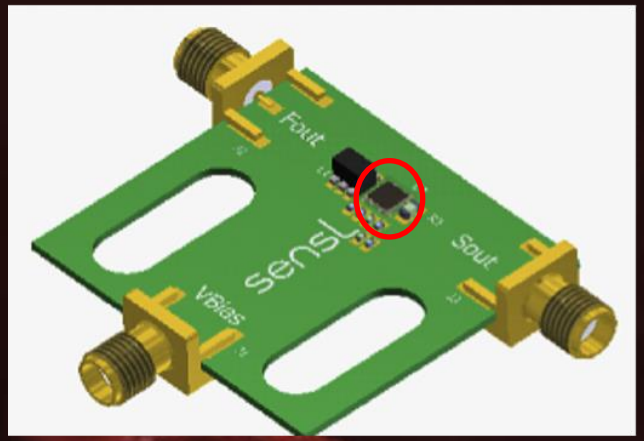
88 nm spheres

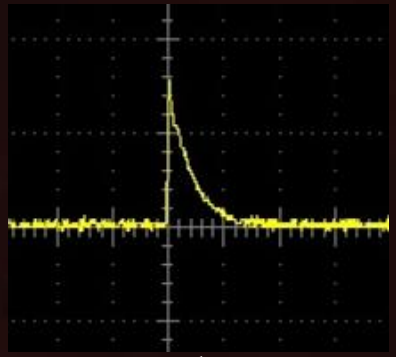


HIV ≈ 100nm

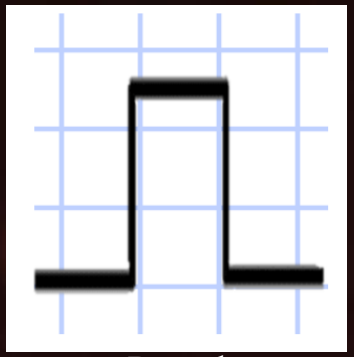
510 nm spheres

Detector





Analog

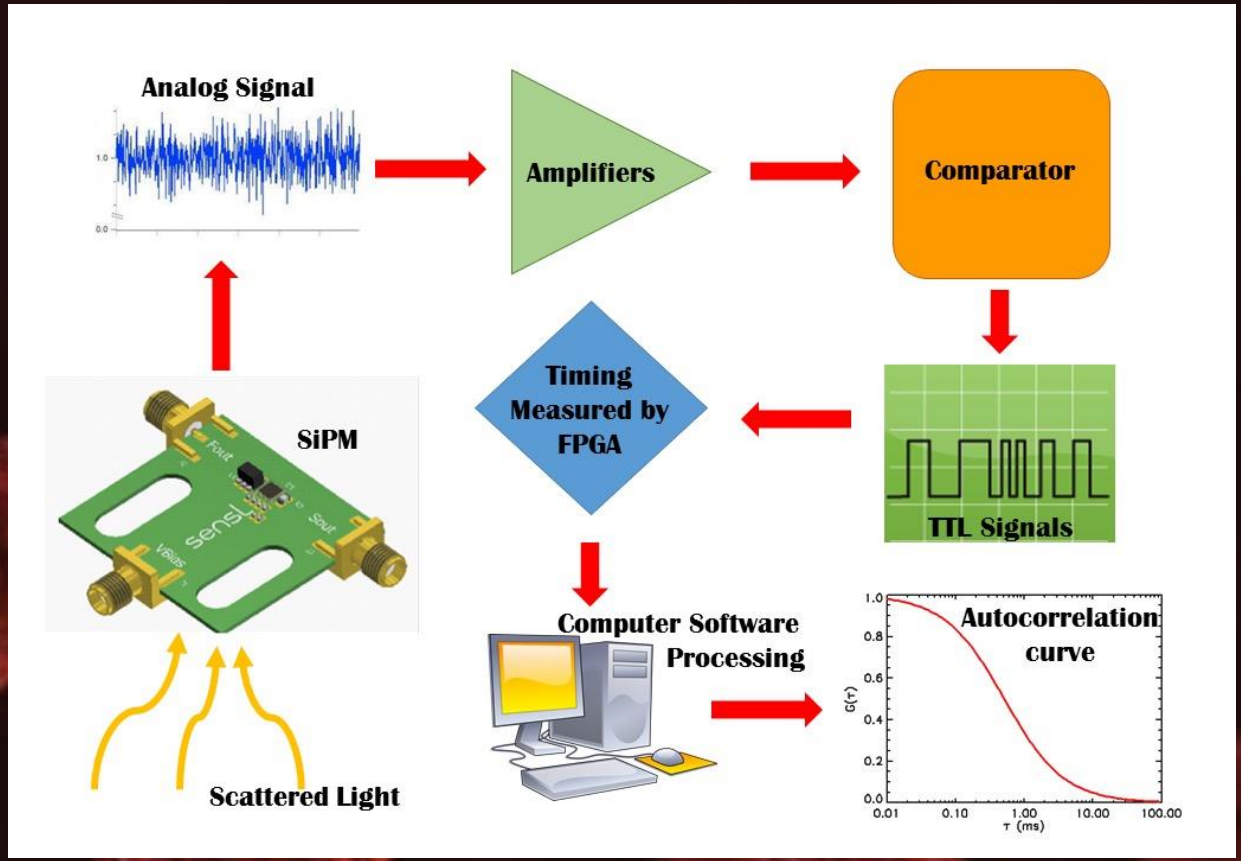


Digital

Needs:

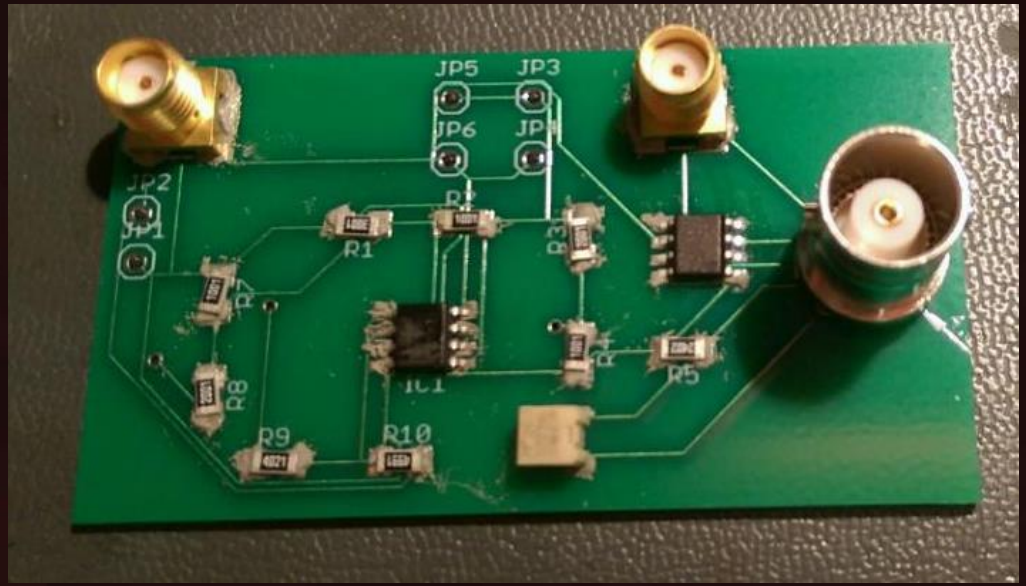
- Signal Processing
- Supply Power
- Component Integration

Signal Processing - Start to Finish



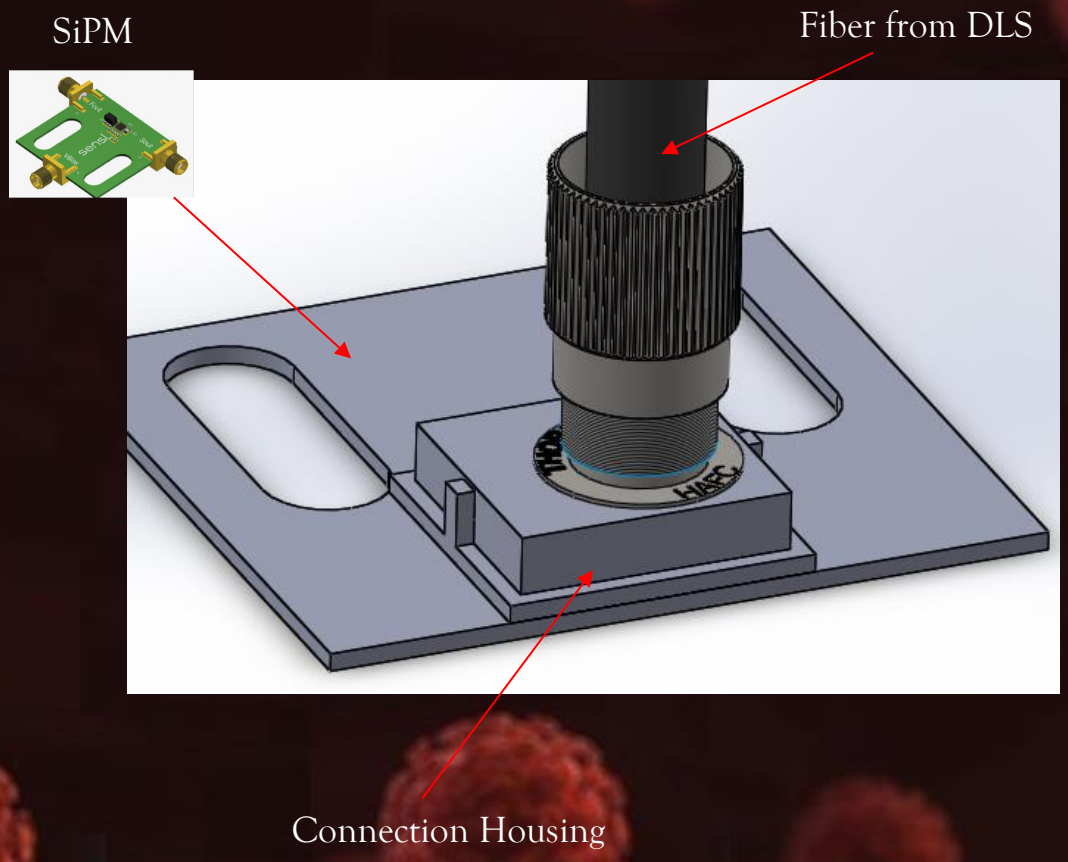
Final Results

- Identified amplifier for use
- Circuit designed and ordered
- Verified by computer simulation



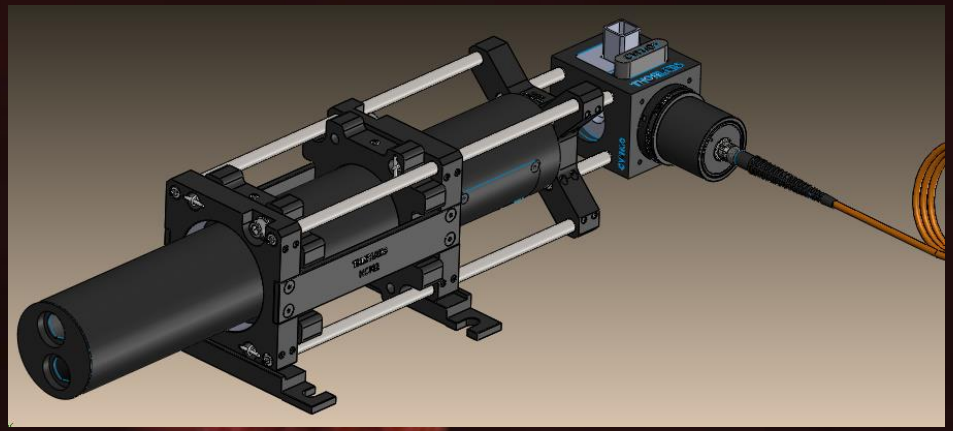
Final Results

- Designed Fiber-Detector interface
- Hold fiber over detector
- Keep out external light



Moving Forward

Goal: One integrated system that detects and sizes HIV clusters isolated in a sample



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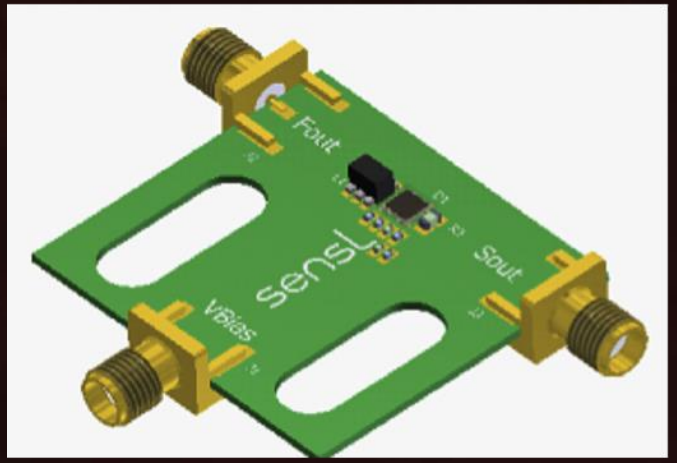

- Refine accuracy
- Portability (diode laser)

- Refine system
- Further testing

Acknowledgements

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Questions?