

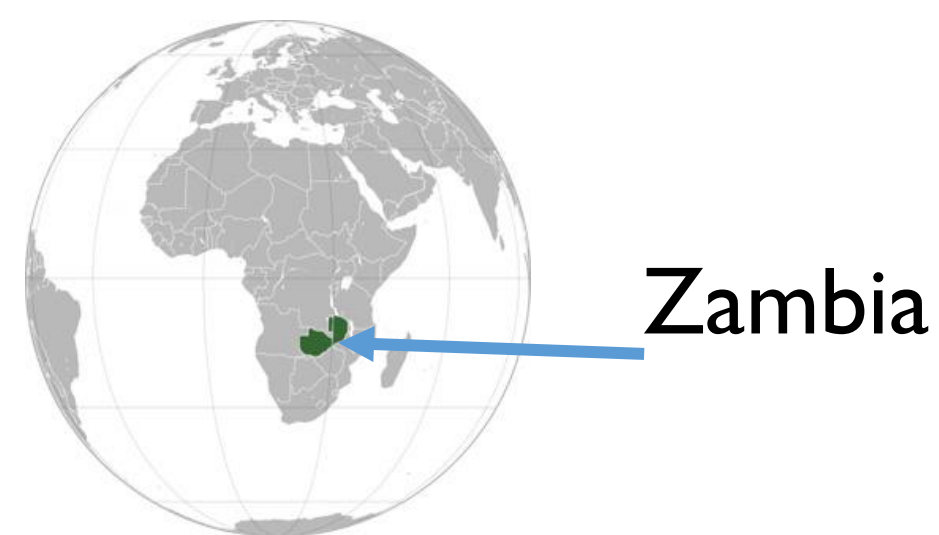
Developing a Low-Cost Optical HIV Viral Load Detection System

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THE NEED

HIV diagnosis and viral load monitoring in Zambia is limited to clinics with lab settings, and difficult to access for many people in rural areas.

The Macha Hospital in Zambia has partnered with us as we design an HIV viral load device.



Macha Mission Hospital



<https://eyecarefoundation.eu/projects/zambia/macha-eye-care-department/>

EXISTING DEVICE



<https://newlifescientific.com/cephheid-genexpert-w-18480698>

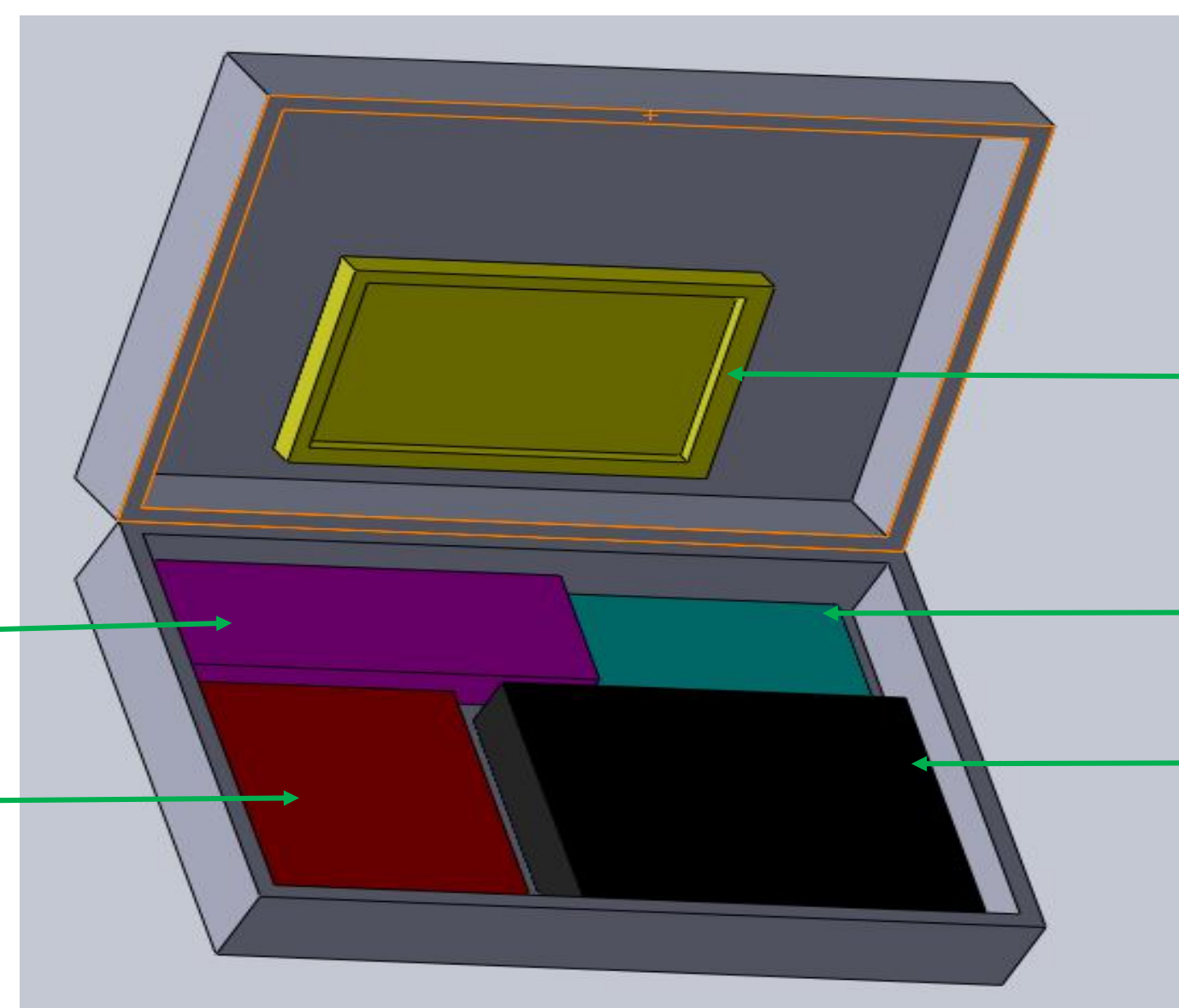
Needs lab setting
~\$15,000/device
~ \$10/test
< 1 hour
~30 viruses/mL

OUR DEVICE



Targets:
Portable (10" x 8" x 3")
~ \$1500/device
~ \$10/test
<10 minutes
~1000 viruses/mL

DEVICE INTEGRATION



Battery pack
5V; 10,000 mAh power

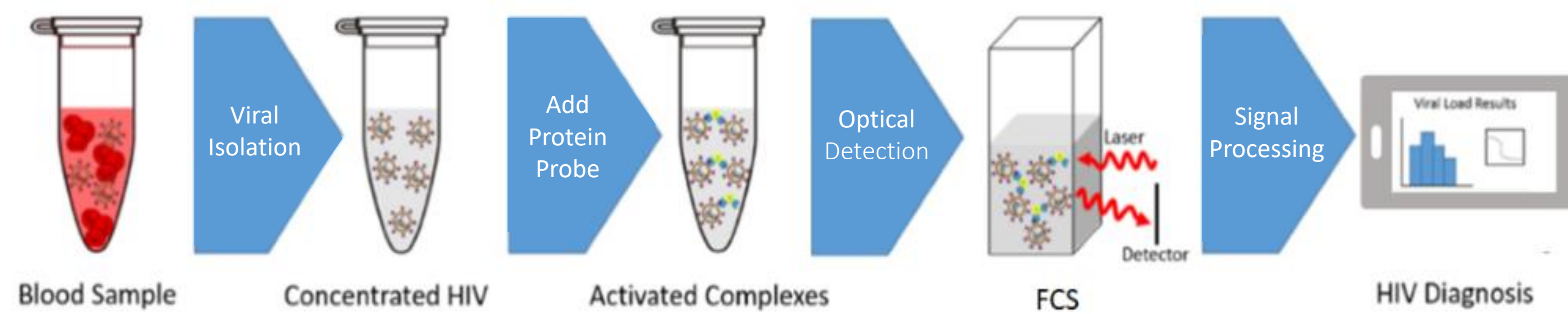
LCD
User interface/
display

PCB
Circuit with
SiPM
detector

**Optical
apparatus**
Caged dichroic
mirror, lens,
laser, and
objective

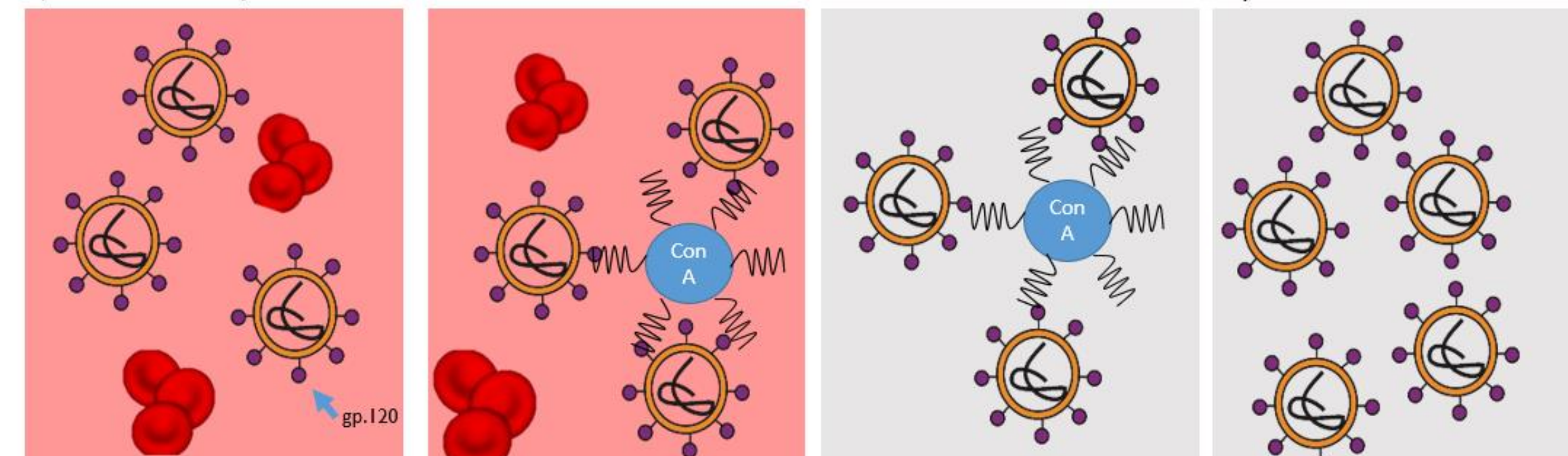
DIAGNOSTIC STRATEGY

The following Diagnostic Strategy has been proposed for HIV viral load determination:



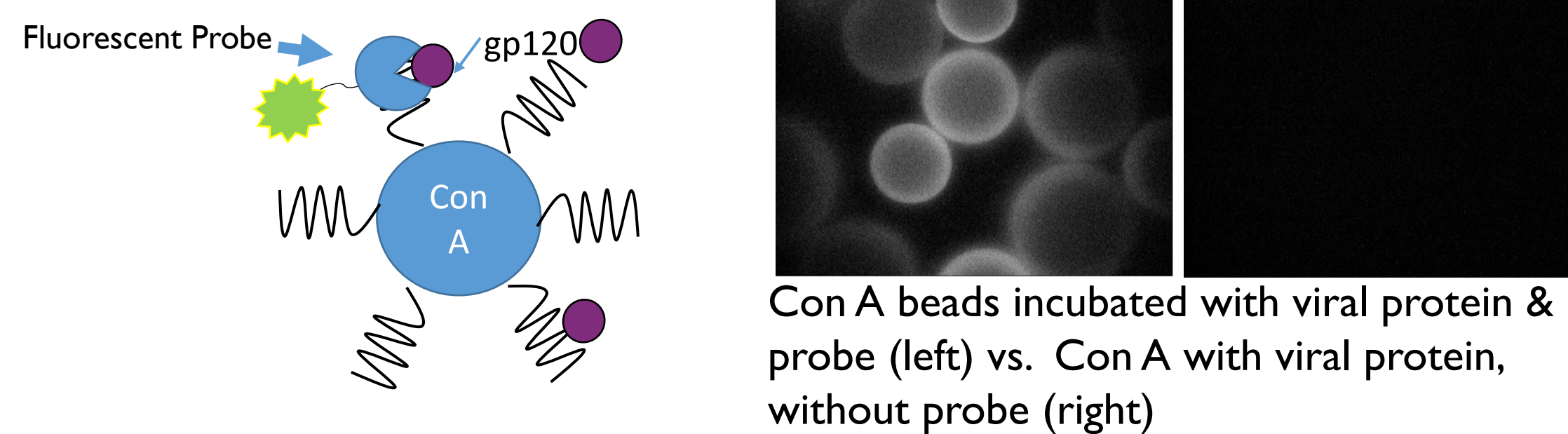
VIRAL ISOLATION

1) Blood sample 2) Con A binds HIV 3) Wash 4) Isolate Virus



STRATEGY

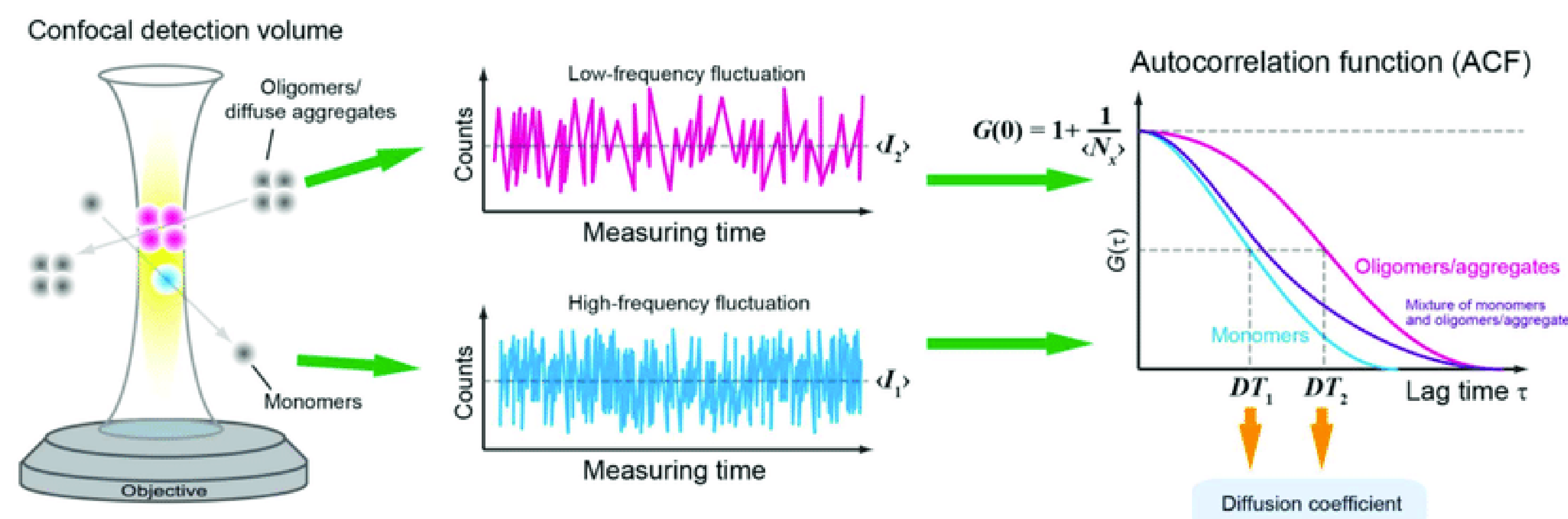
PROOF OF PRINCIPLE



Con A beads incubated with viral protein & probe (left) vs. Con A with viral protein, without probe (right)

OPTICAL DETECTION

PHYSICAL SETUP RAW DATA PROCESSED DATA



Reproduced from: Kitamura, Akira & Kinjo, Masataka. (2018). State-of-the-Art Fluorescence Fluctuation-Based Spectroscopic Techniques for the Study of Protein Aggregation. International Journal of Molecular Sciences. 19. 10.3390/ijms19040964.

COMPONENT SELECTION: LASER

LAB FCS LASER



Thorlabs.com

- \$1900
- Known power stability

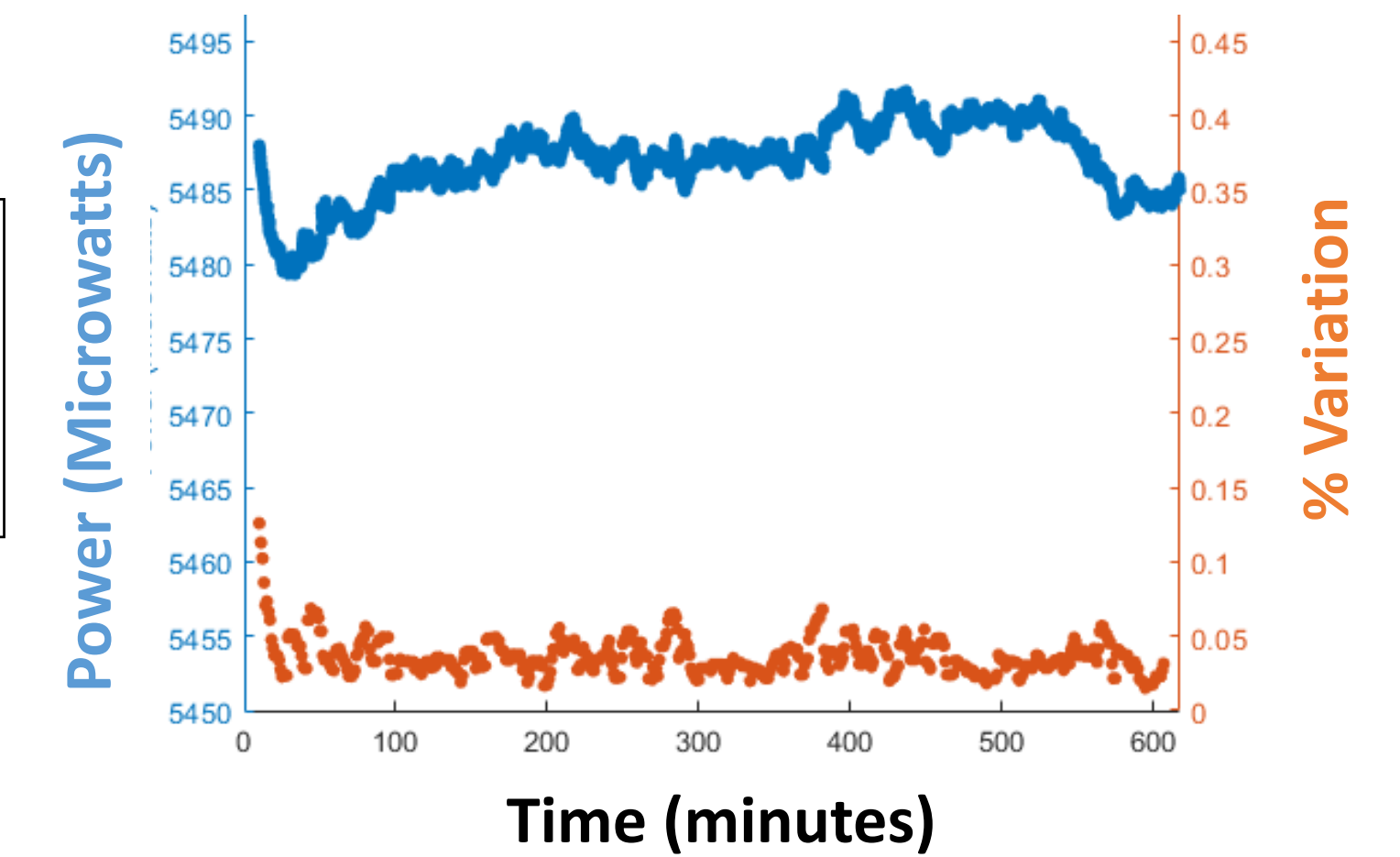
PORTABLE LASER



Thorlabs.com

- \$200
- Unknown power stability

PORTABLE LASER: POWER STABILITY TESTING

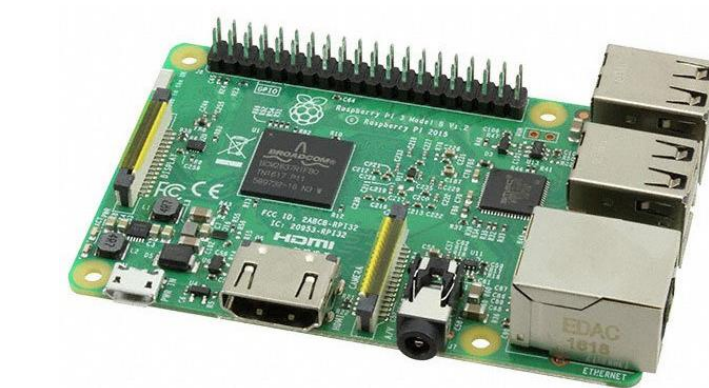


SIGNAL PROCESSING

Computer + Autocorrelator	Microprocessor / Single Board Computer	FPGA (SoC)
Bulky	Small	Small
High power	Low power	Low Power
Expensive	Cheap	Cheap
Fast	Too slow	Fast



<https://newlifescientific.com/cephheid-genexpert-w-18480698>



<https://www.digkey.com/product-detail/en/raspberry-pi/RASPBERRY-PI-3/1690-1000-ND/6152799>



<https://www.digkey.com/en/product-highlight/d/digilent/zybo-zynq-7000-development-board>

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DEPARTMENT OF MATHEMATICS, PHYSICS AND STATISTICS

