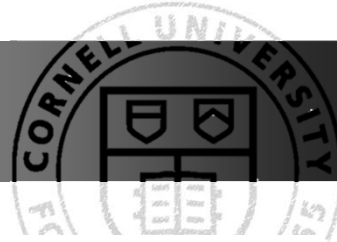


Cornell NutriPhone & KS-Detect

Pictures of Health



Smartphone Based Technologies for Mobile and Global Health

David Erickson
Associate Professor
Sibley School of Mechanical and Aerospace Engineering
www.ericksonlab.org



David's Odyssey

The last time I got my bloodwork done

Timeline

June – Time to get my Cornell Plan for Healthy living physical

October 1st – Cancelled phlebotomist appointment (overlap with teaching).

October 11th – Visit phlebotomist, have blood drawn, ~ 2hrs.

October 23rd – Visit doctor, get results, vitamin D deficient, need to take supplement (2000 IU).

1Y – Next scheduled blood test to see if actually working.

Lab Acquired: 10/11/12	Result	Reference Range
Test Name CBC ELECTRONIC (FMA)	-- Profile --	
WBC		3.6-9.6
RBC		3.90-5.70
HEMOGLOBIN (FMA/CMC/CTX)		12.1 - 17.2
HEMATOCRIT (FMA/CMC/CTX)		36.1 - 50.3
PLATELETS		150-400
LYMPH%		20.5-51.1
MIXED%		
NEUTROPHILS %		
MEAN CORPUSCULAR VOL		82.2-97.4
MEAN CORPUSCULAR HEMOGLOBIN		27.6-33.3
MEAN CORPUSCULAR HEMO CONCE		32.0-36.0
RDW		11.6-13.7
MEAN PLATELET VOLUME		6.5-11.0
Lab Acquired: 10/11/12	Result	Reference Range
Test Name VITAMIN D, 25 OH		30.0-100.0
Lab Acquired: 10/11/12	Result	Reference Range
Test Name COMPREHENSIVE METABOLIC PROF	-- Profile --	
ALBUMIN		3.8-5.5
ALK. PHOS.		22-95
ALT (SGPT)		10-40
AST (SGOT)		5-34
BUN		6-26
CALCIUM		8.6-10.2
CHLORIDE		94-112
CREATININE		0.6-1.4
CARBON DIOXIDE		21-32
GLUCOSE		70-105
SODIUM		134-149
TOTAL BILIRUBIN		0.2-1.3
TOTAL PROTEIN		6.3-8.1
POTASSIUM		3.6-5.5
GLOBULIN		2.0-4.8
LIPID PROFILE	-- Profile --	
CHOLESTEROL		120-200
HDL		30-70
TRIGLYCERIDES		30-200
LDL (CALCULATED)		0-129
VLDL (CALCULATED)		0-50

David's Odyssey
The last time I got my bloodwork done

Micronutrient & Vitamins

- Vitamin A, B₁₂, D
- Iron
- Folic Acid

Cholesterol

- 60% of American's have high cholesterol, 37 million have very high.


Lab Acquired: 10/11/12	Test Name	Result	Reference Range
	CBC ELECTRONIC (FMA)	-- Profile --	
	WBC		3.6-9.6
	RBC		3.90-5.70
	HEMOGLOBIN (FMA/CMC/CTX)		12.1 - 17.2
	HEMATOCRIT (FMA/CMC/CTX)		36.1 - 50.3
	PLATELETS		150-400
	LYMPH%		20.5-51.1
	MXED%		
	NEUTROPHILS %		
	MEAN CORPUSCULAR VOL		82.2-97.4
	MEAN CORPUSCULAR HEMOGLOBIN		27.6-33.3
	MEAN CORPUSCULAR HEMO CONC		32.0-36.0
	RDW		11.6-13.7
	MEAN PLATELET VOLUME		6.5-11.0

Lab Acquired: 10/11/12	Test Name	Result	Reference Range
	VITAMIN D, 25 OH		30.0-100.0

Lab Acquired: 10/11/12	Test Name	Result	Reference Range
	COMPREHENSIVE METABOLIC PROF	-- Profile --	
	ALBUMIN		3.8-5.5
	ALK. PHOS.		22-55
	ALT (SGPT)		10-40
	AST (SGOT)		5-34
	BUN		8-26
	CALCIUM		8.9-10.2
	CHLORIDE		94-112
	CREATININE		0.6-1.4
	CARBON DIOXIDE		21-32
	GLUCOSE		70-105
	SODIUM		134-149
	TOTAL BILIRUBIN		0.2-1.3
	TOTAL PROTEIN		6.3-8.1
	POTASSIUM		3.6-5.5
	GLOBULIN		2.0-4.3

Lab Acquired: 10/11/12	Test Name	Result	Reference Range
	LIPID PROFILE	-- Profile --	
	CHOLESTEROL		120-200
	HDL		30-70
	TRIGLYCERIDES		30-200
	LDL (CALCULATED)		0-129
	VLDL (CALCULATED)		0-50

Personalized Molecular Diagnostics
Glucose Meters and Pregnancy Tests




Quantitative Result & Lots of measurements

←

Non-Quantitative Result – Infrequent measurement

↓

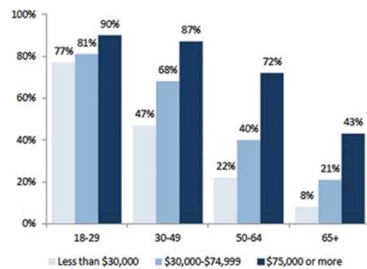




Smartphone Based Molecular Diagnostics

Can help reduce costs and improve the accessibility of healthcare

smartphone adoption in the US



It has everything

- GPS, High-res, Camera, Email, Facebook, computation, power, etc.
- Extremely rugged

You are already trained on it

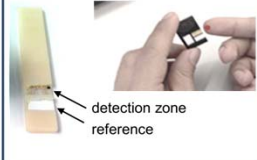
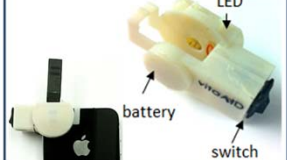

- Technology designed to be easy to use by nearly all age groups

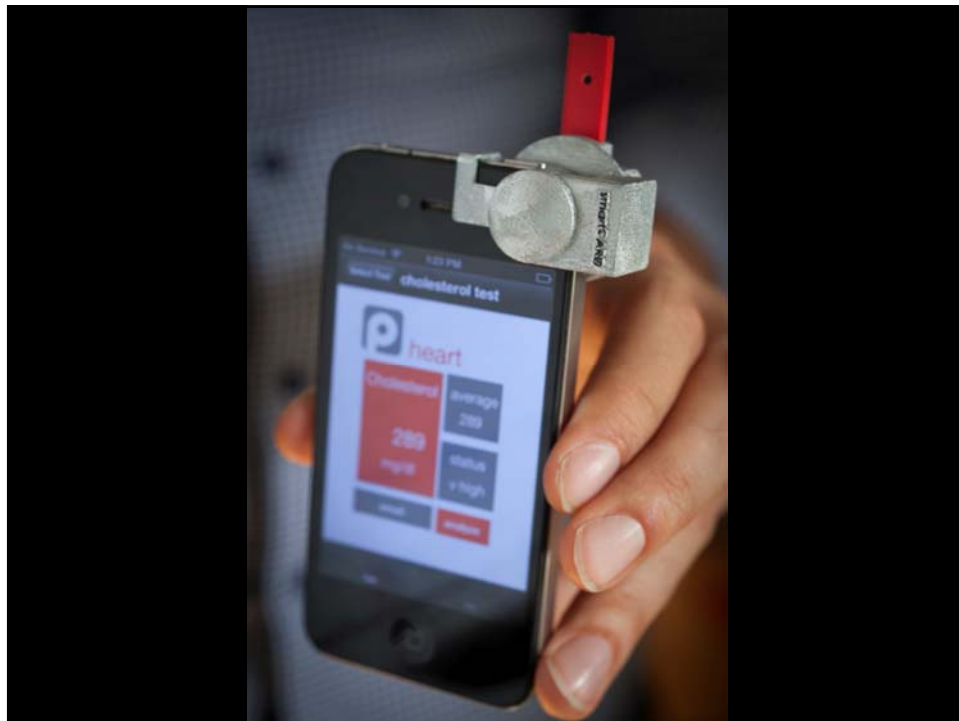
You already own it

- 260 million active smartphones in US by 2016
- Everybody is carrying one all the time

the SmartCard and NutriPhone platforms for cholesterol and micronutrient monitoring

Technology - 3 part system

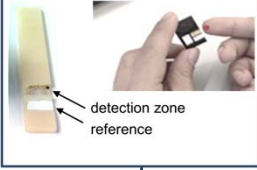
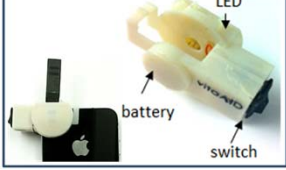
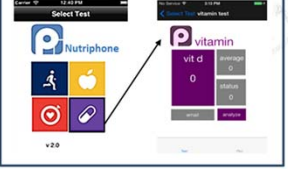
Test Strip	Smartphone Accessory	Smartphone App
<ul style="list-style-type: none">to detect micronutrients 	<ul style="list-style-type: none">to read out the test strip 	<ul style="list-style-type: none">to analyze data and display for users 




the SmartCard and NutriPhone

platforms for cholesterol and micronutrient monitoring

Technology – 3 part system

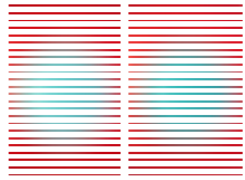
<p style="text-align: center;">Test Strip</p> <p style="text-align: center;">• to detect micronutrients</p>  <p style="text-align: center;">detection zone reference</p>	<p style="text-align: center;">Smartphone Accessory</p> <p style="text-align: center;">• to read out the test strip</p>  <p style="text-align: center;">LED battery switch</p>	<p style="text-align: center;">Smartphone App</p> <p style="text-align: center;">• to analyze data and display for users</p>  <p style="text-align: center;">vitamin vit d 0</p>
--	--	---

pH




Chemical reaction

cholesterol




Enzymatic reaction

vitamin D




Gold nanoparticle immunoassay




diet alkalinity monitoring


important in preventing enamel decalcification bellow a critical saliva pH



dietary choices

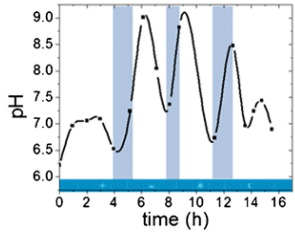


acidity and diet

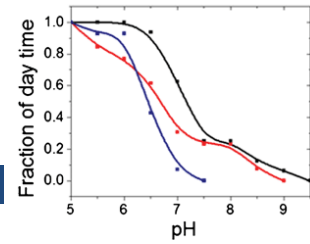


enamel decalcification bellow pH 6.2

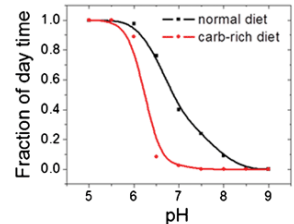
saliva pH variations




average pH for different users



Effect of different diets



Oncescu, V., Erickson, D. " A smartphone platform for cholesterol colorimetric testing" *Lab-on-a-Chip* (2013)



monitoring cholesterol levels

high serum cholesterol increases coronary heart disease mortality

increase in mortality rate for serum cholesterol levels above 210mg/dl

expensive devices
low accuracy
low tracking ability

accuracy in user trials

Actual cholesterol (mg/dl)	Predicted cholesterol (mg/dl)
135	135
155	155
165	165
175	175
185	185
195	195
210	210
220	220

Detecting erroneous measurements

Actual cholesterol (mg/dl)	Hue (0-360°)
100	40
125	180
150	180
175	180
200	180
225	180
150	130

Oncescu, V., Mancuso, M., Erickson, D. "A smartphone platform for cholesterol colorimetric testing" *Lab-on-a-Chip* (2013)

vitamin D deficiency testing

deficiency is highly prevalent and has been linked to many health issues

chronic deficiencies

hard to quantify supplement effects

accuracy vs ELISA kit

Actual concentration (nM)	Predicted concentration (nM)
10	10
20	20
40	40
110	110

serum samples

Serum sample	Red Bar (nM)	Black Bar (nM)
1	15	10
2	35	30
3	50	45


Lee, S., Oncescu, V., Mancuso, Mehta, S., Erickson, D. "A smartphone platform for the quantification of vitamin D levels" *Lab-on-a-chip* (2014)

24-06-2013

Mobile Internet Penetration in Nigeria Stands at 28percent

African Smartphone Penetration to Reach 40 Per cent by 2017

By Vince Matinde | Friday, June 21st, 2013 at 11:04am | 0 Comments |




Thursday, April 4th, 2013

Africa's smartphone revolution

Smartphone use in Africa is on the rise, and major distributors are starting to pay attention to the emerging market by producing devices that cater to the needs of the continent. How will increased smartphone use revolutionise the continent?

By Matthew Labrooy



Smartphone growth in Africa has increased by 43% every year since 2000, and experts predict that smartphone use in Africa will have Internet access by 2014. As a result, smartphone manufacturers have increased interest in the region in a bid to gain their share of half a billion potential customers. A simple budget smartphone produced for the African market is available on the streets of Lagos for €37 (US\$50) and has sold more than 300,000 units across the country.

Smartphone penetration in Africa is estimated between 17-19%, though rates vary by country. Nigeria, Africa's most populous nation, has a smartphone penetration as high as 19%, according to a report by Samsung Electronics West Africa explains the sudden influx of smartphones saying: "The advent of new privately owned submarine cables and their landing on the continent, and West African nations, including Nigeria, have significantly reduced the cost of smartphones and increased the adoption of smartphones on the Continent."

Africa on the brink of a smartphone revolution

by Eric Van Rookhuyzen
3 June 2013
Mobile


23 | 15 | 34 | 1

Tweet | Share | Like | +1

Africa is on the brink of a smartphone revolution with renewed mass market penetration into the African and South African market already underway thanks to a host of new entry level models from well-known brands like Samsung, Nokia, Blackberry and others as well as numerous 'unknowns' from China.

Against this backdrop the Starcom MediaVest Group's digital division Liquid Thread, under the stewardship of strategist Eric Van Rookhuyzen, is championing the rise of digital in the local market.

The local market for smartphones is diversifying. Whereas before it was a purely high end segment there are now also distinct middle and entry level brands. This means the price of smartphones is definitely dropping, in fact they're becoming so ubiquitous that consumers can now even buy them on their clothing account.





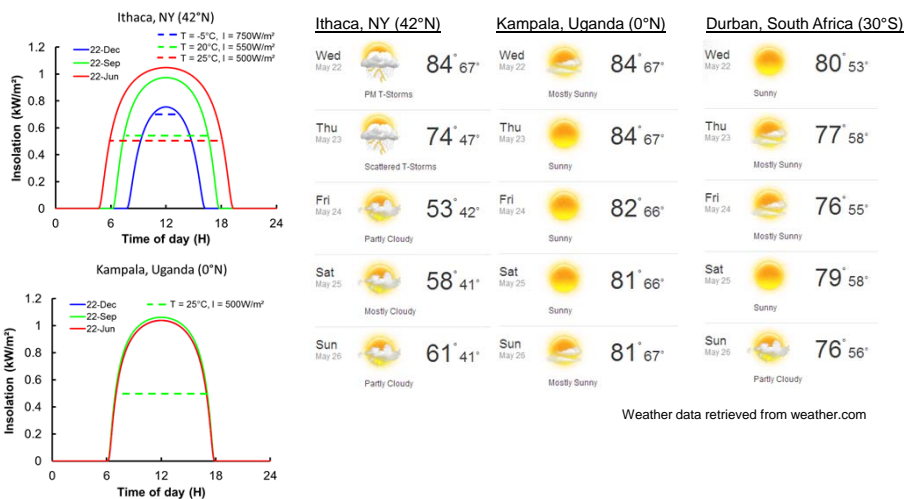
Kaposi's sarcoma

- Kaposi's sarcoma is an AIDS related cancer of lymphatic endothelial origin.
- Caused by infection with KS Herpes Virus (HHV-8) in immune compromised people
- One of the most prevalent cancers in sub-Saharan Africa



Solar-Thermal Molecular Diagnostics


Solar energy and Smartphones for PCR




KS Detect

Self-Contained Low Power Smartphone Driven PCR Based Diagnostics

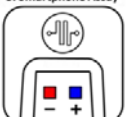
1. Biopsy Collection

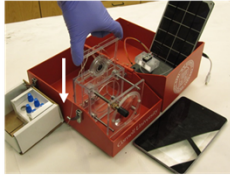
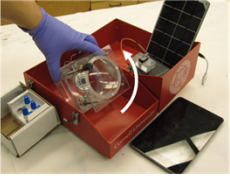
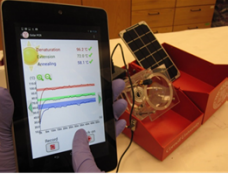
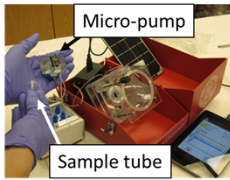
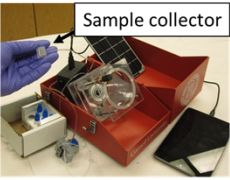
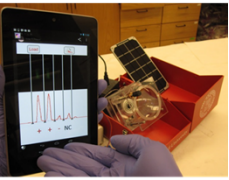


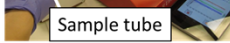
2. Solar-thermal PCR




3. Smartphone Assay



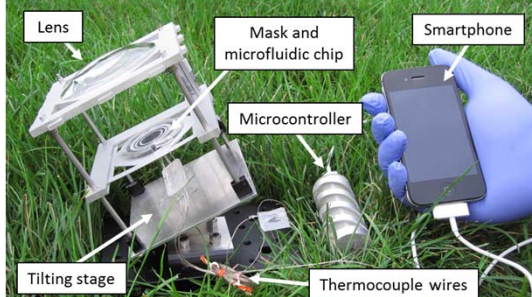
1. Insert cassette 
2. Tilt stage towards sun 
3. Read temperatures 
4. Pump sample through  **Micro-pump**
5. Collect sample  **Sample collector**
6. Read out results 

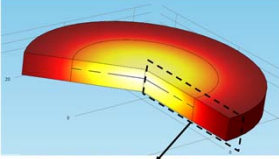
Sample tube 



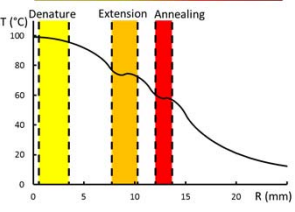
Solar-Thermal PCR

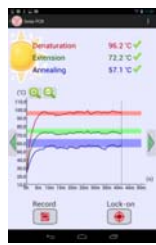
How it works

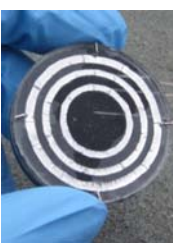





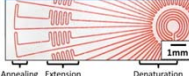
Segmented absorber layer






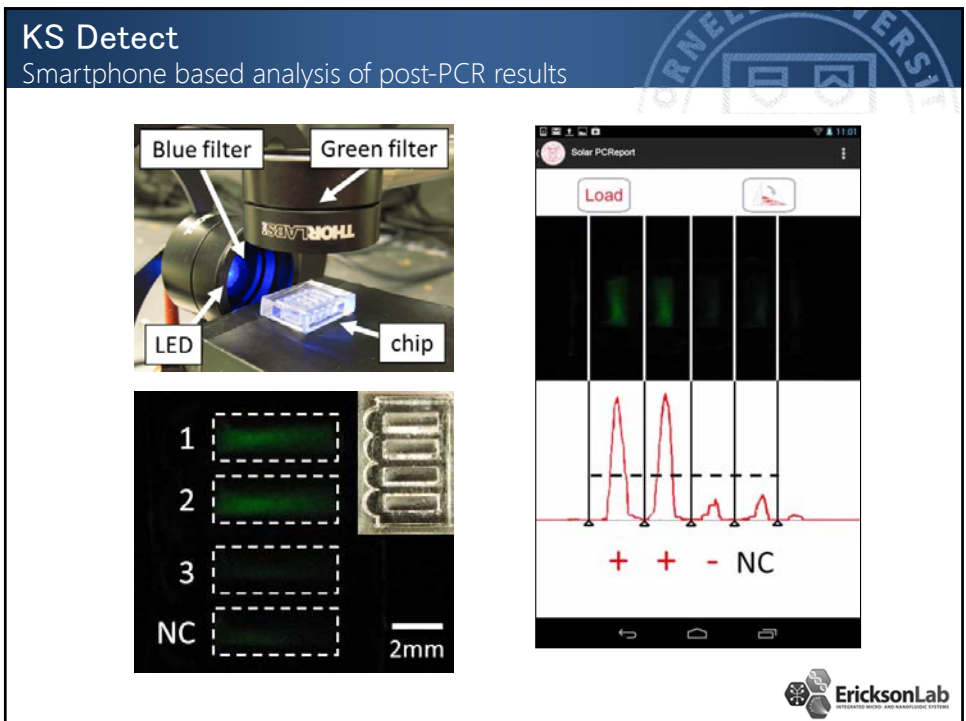
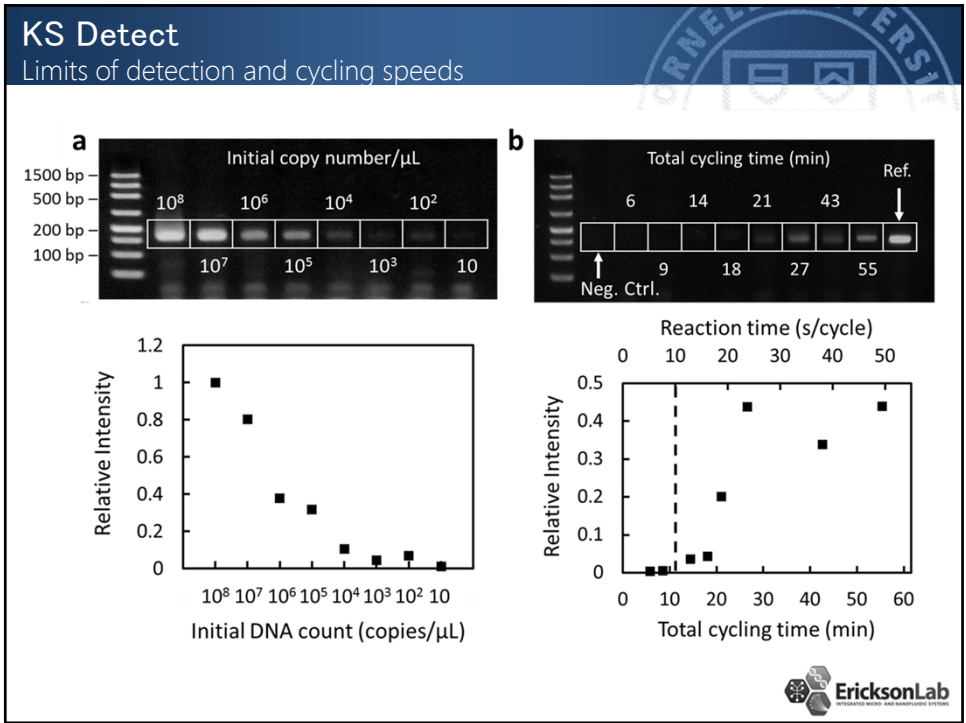







Annealing Extension Denaturation






KS Detect

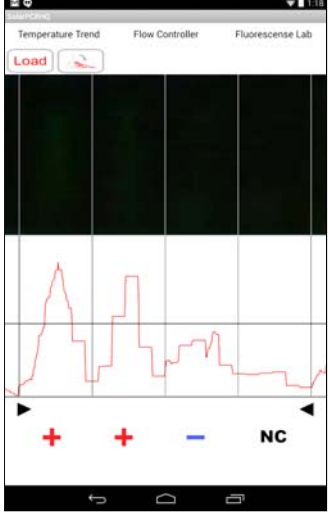
Field testing in Eldoret Kenya and Kampala Uganda





AMPATH
Eldoret, Kenya

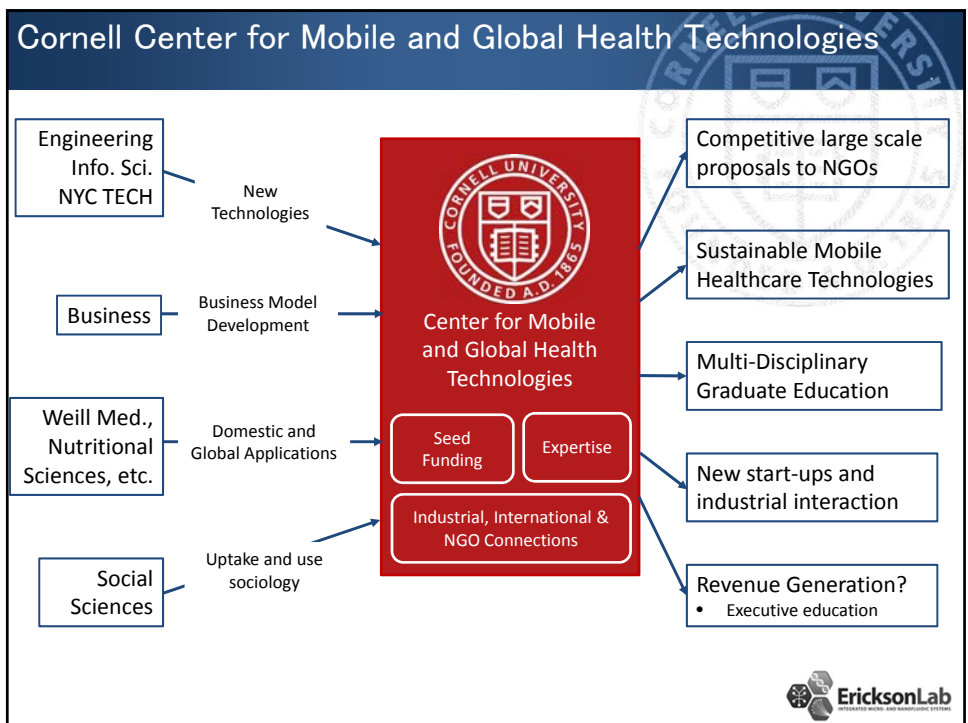


Infectious Diseases Institute
Kampala, Uganda










Cornell Center for Mobile and Global Health Technologies

Engineering
Info. Sci.
NYC TR

Competitive large scale
proposals to NGOs



Key Differentiators


1. Focus on mobile enabled technologies.
2. Focus on sustainable business case development from day #1.
3. Exploitation of broad Cornell expertise.

Busi

mobile
chnologies

Weill N
Nutrit
Sciences


ary
cation




Social
Sciences

and
raction

Uptake and use
sociology



Revenue Generation?
• Executive education



Optofluidics, Inc.

Cornell Start-up on Nanoparticle Analysis (opfluid.com)




2013 – Nature paper

LETTERS



Optical manipulation of nanoparticles and biomolecules in sub-wavelength slot waveguides

Alan H. J. Yang¹, Sean D. Moore¹, Bradley S. Schmidt¹, Matthew Klug¹, Michal Lipson¹ & David Erickson^{1*}


2011 – Begin operation in PHL, NSF + DARPA SBIR PI, private seed


2012 – Series A, sign license with Cornell.

2013 – NanoTweezer Product launch, first sales revenue.



2014 – Growth, planned series B, V2 system, foreign sales.



VitaMe Technologies, Inc.
Smartphone-based diagnostics



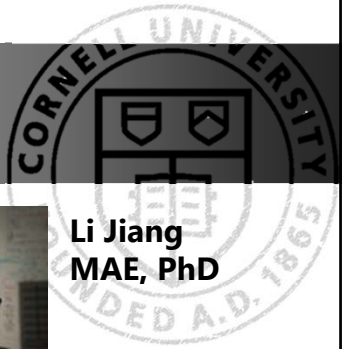
cholesterol test

p heart


Cholesterol	average
289	289
mg/dl	status
small	v high

vitaMe Technologies


Thank you
Any questions?




David Erickson
de54@cornell.edu
www.ericksonlab.org



Li Jiang
MAE, PhD



Mathew Mancuso
BME, PhD



EricksonLab
INTEGRATED MICRO- AND NANOFUIDIC SYSTEMS