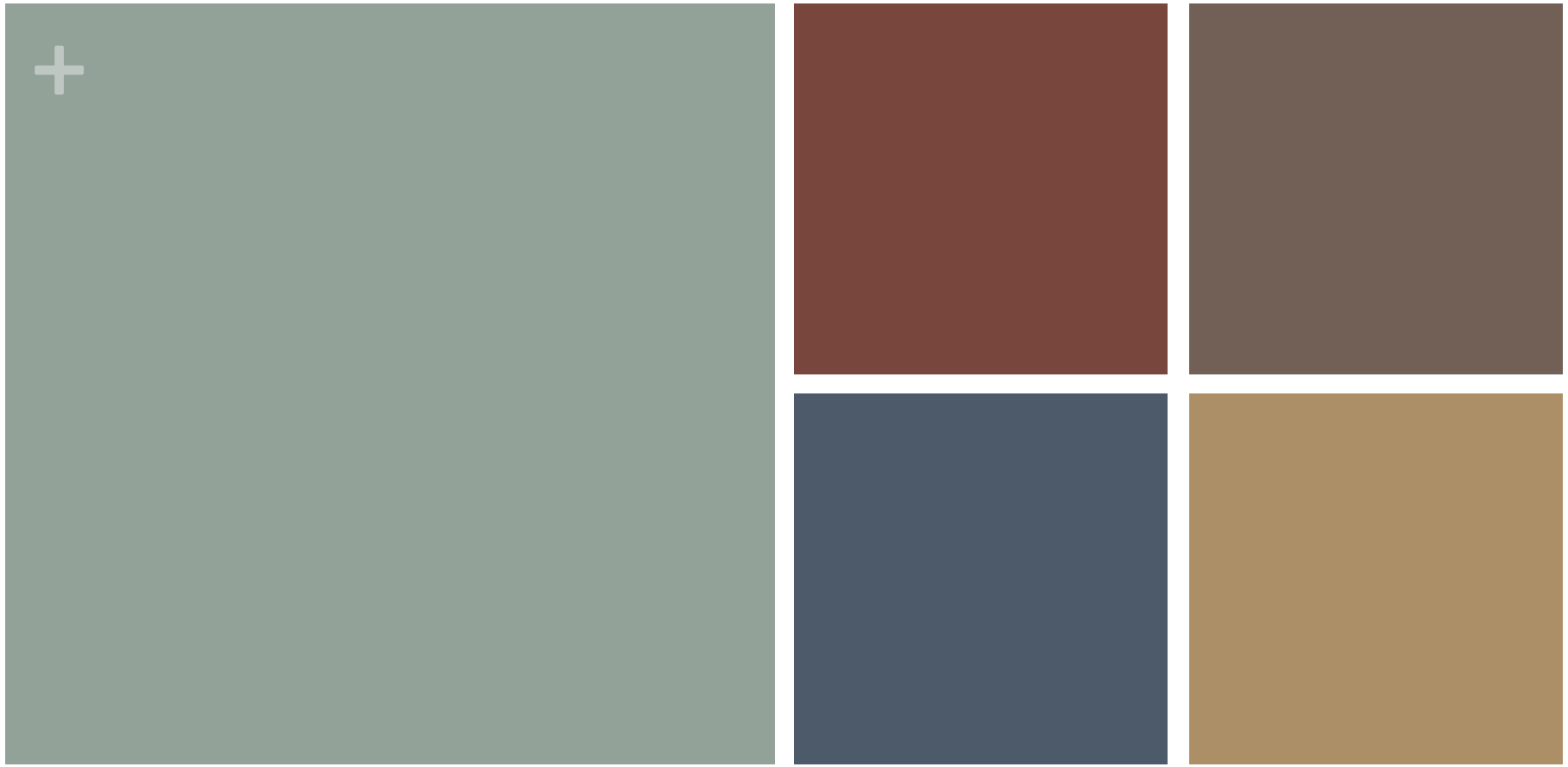


Sensor technology

Carl A. Batt
Cornell University

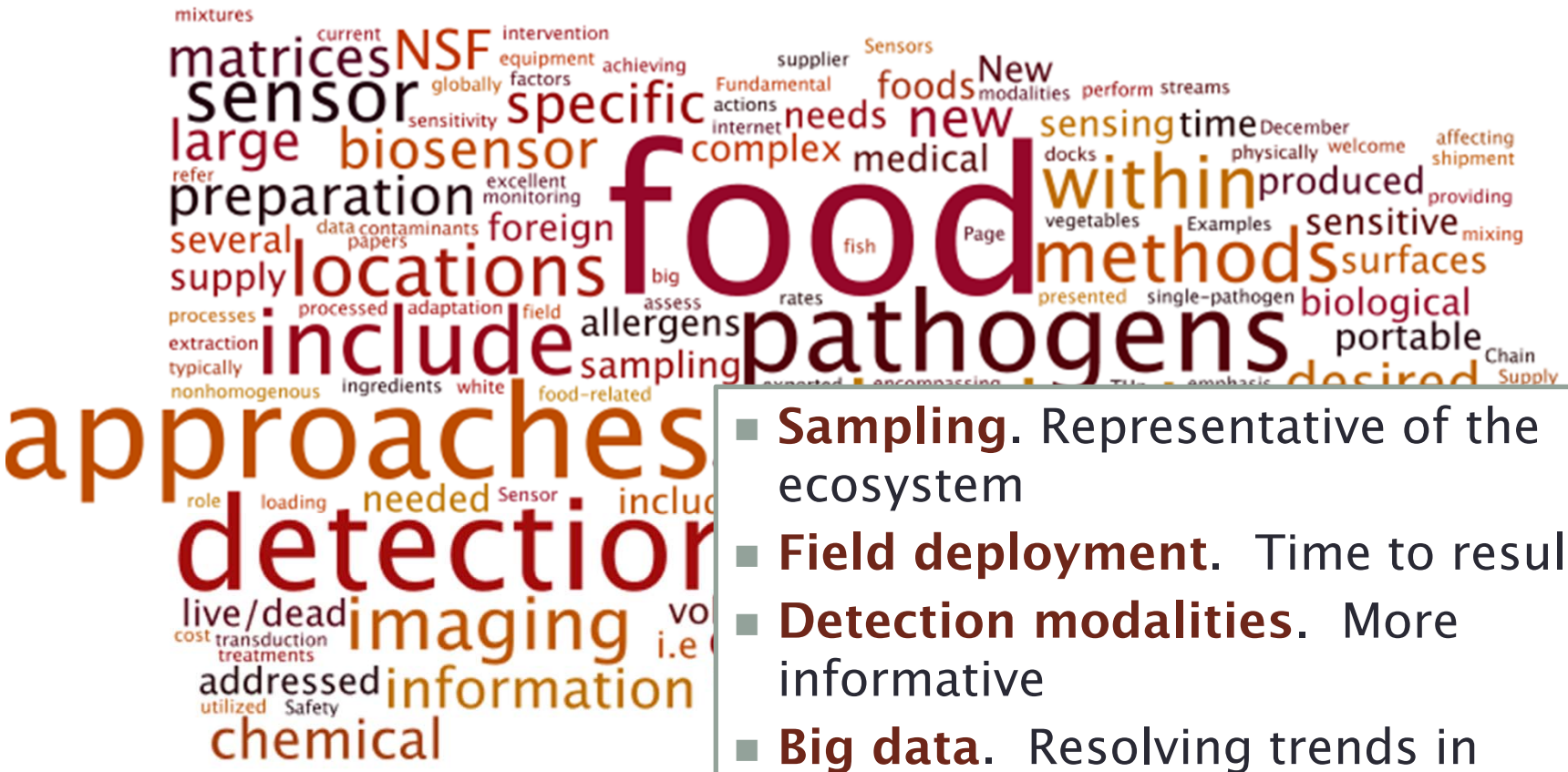
NATIONAL SCIENCE FOUNDATION
WORKSHOP ON

FOOD SAFETY GLOBAL SUPPLY CHAIN NEEDS

FINAL REPORT

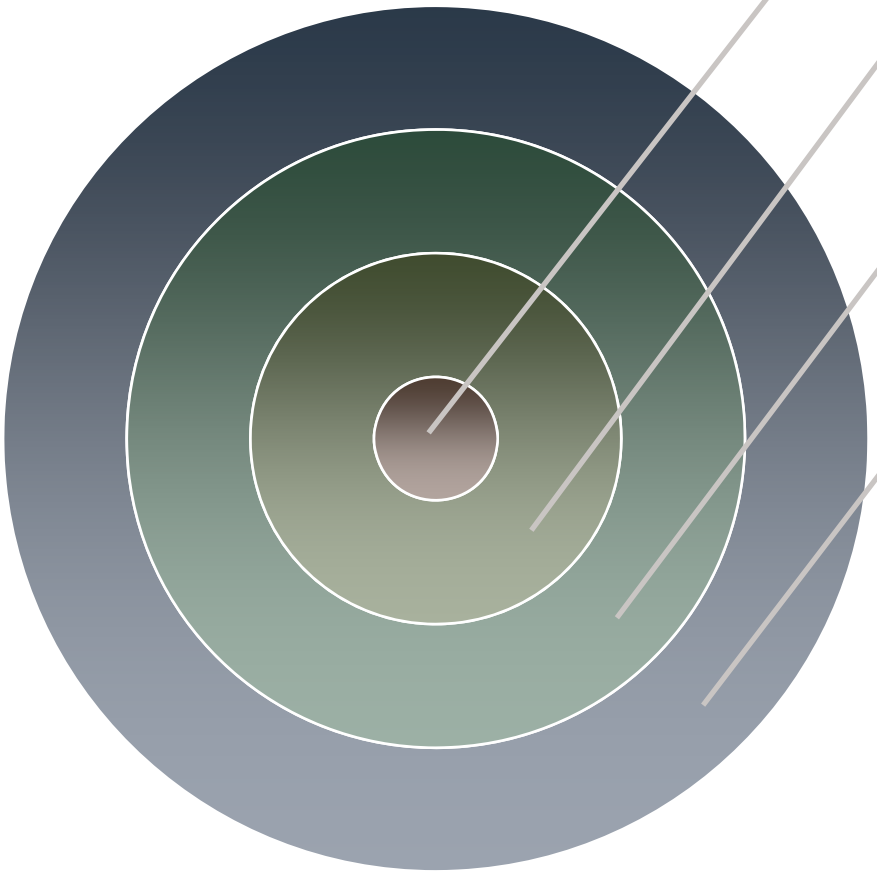
October 29–30, 2014
Alexandria, VA

Highlights



- **Sampling**. Representative of the ecosystem
- **Field deployment**. Time to result
- **Detection modalities**. More informative
- **Big data**. Resolving trends in advance of events.

bigger picture



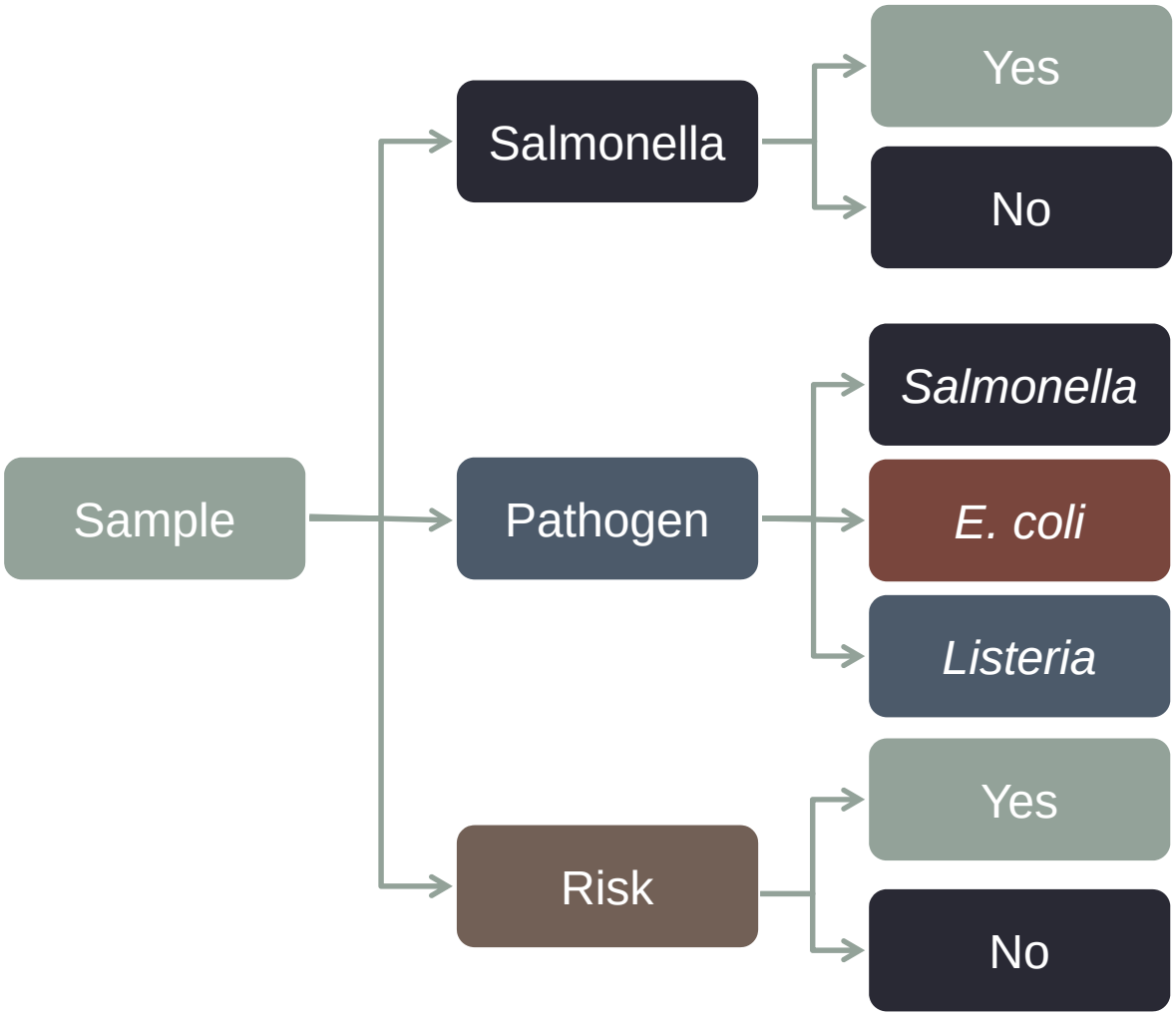
tools

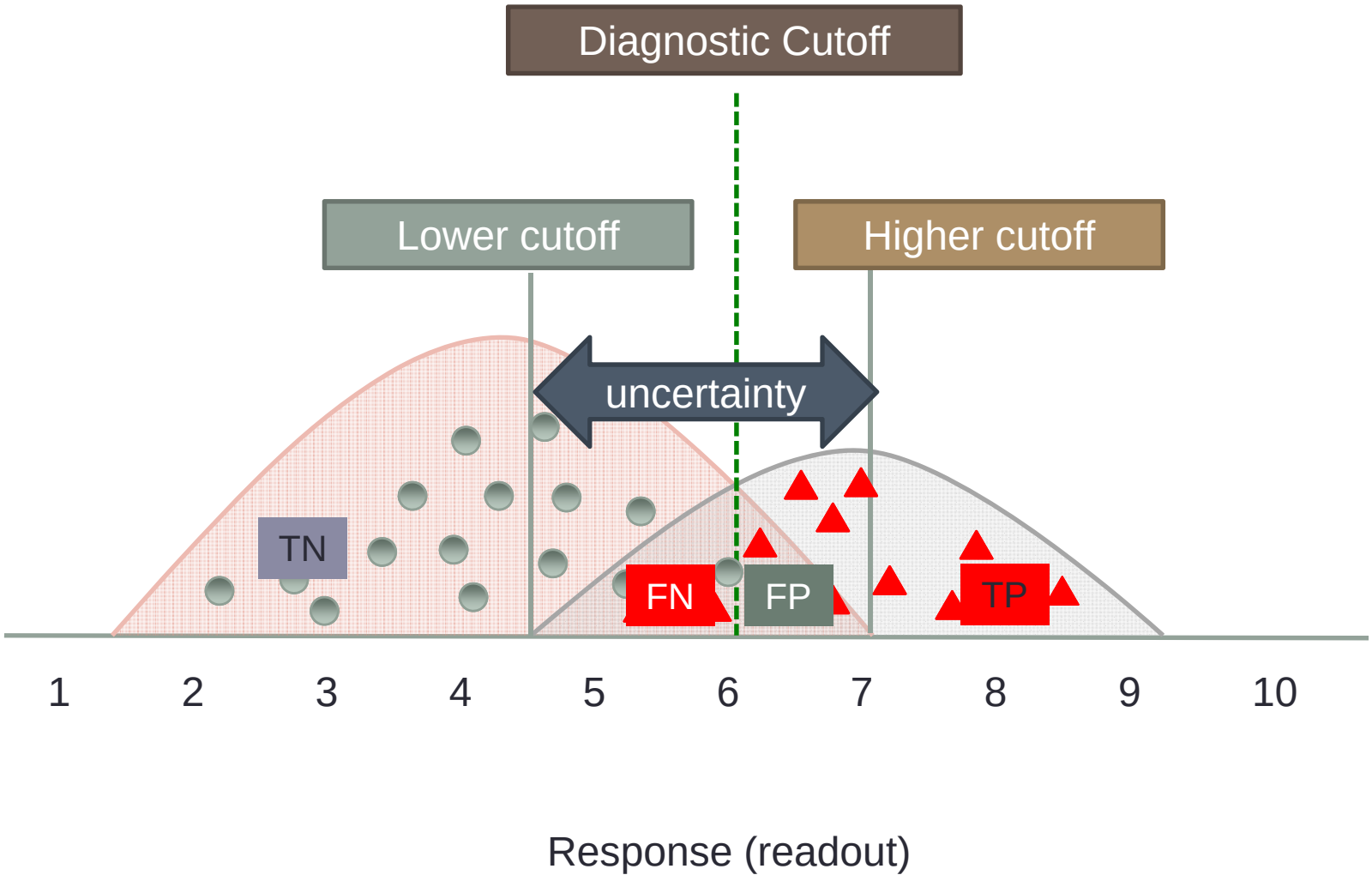
data analytics

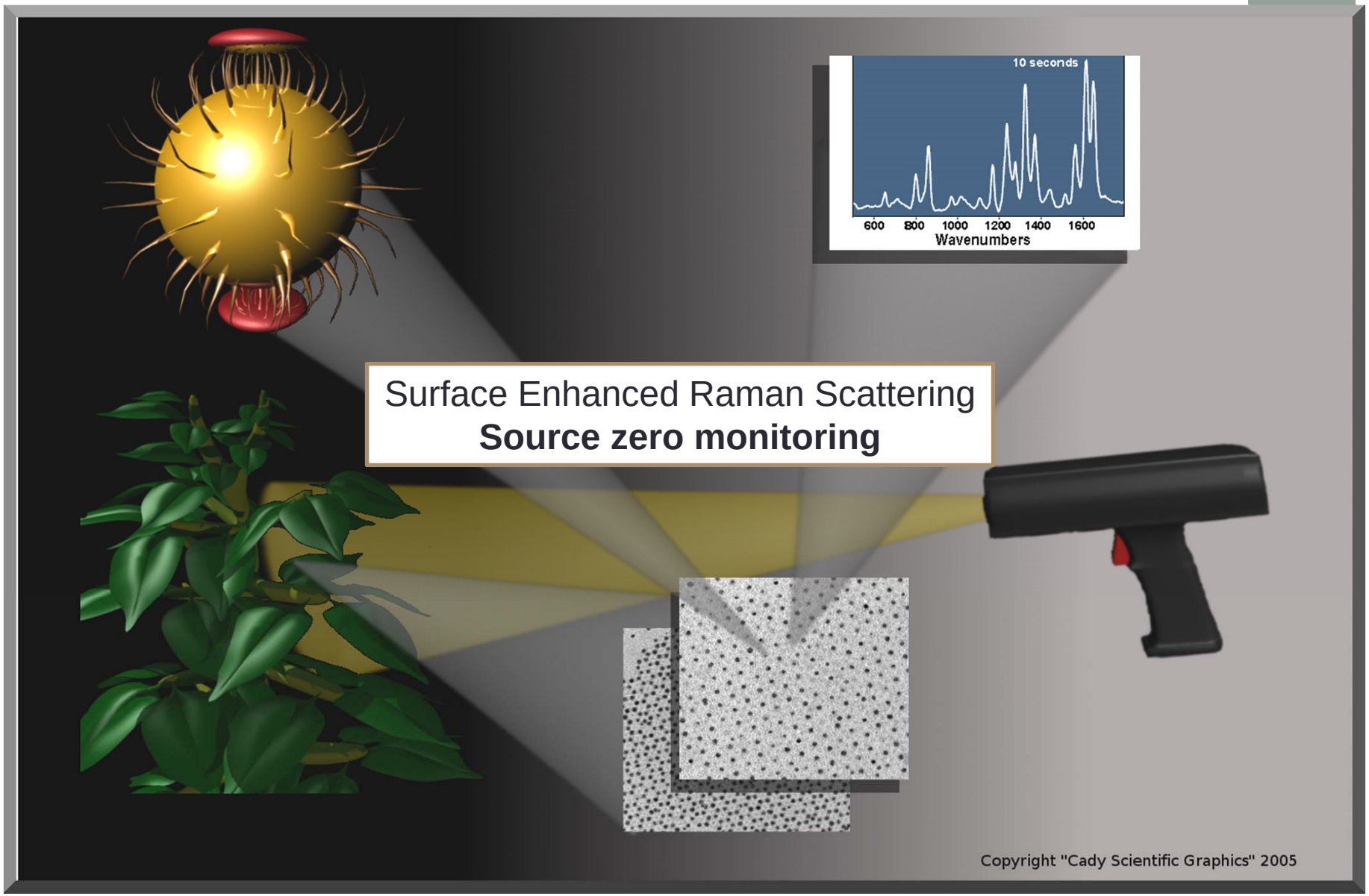
actionable plan

regulatory alignment

Routes to the ‘truth’




Diagnostic Cutoff
Lower cutoff
Higher cutoff
uncertainty
TN
FN
FP
TP
1
2
3
4
5
6
7
8
9
10
Response (readout)


10 seconds
600
800
1000
1200
1400
1600
Wavenumbers
Surface Enhanced Raman Scattering
Source zero monitoring
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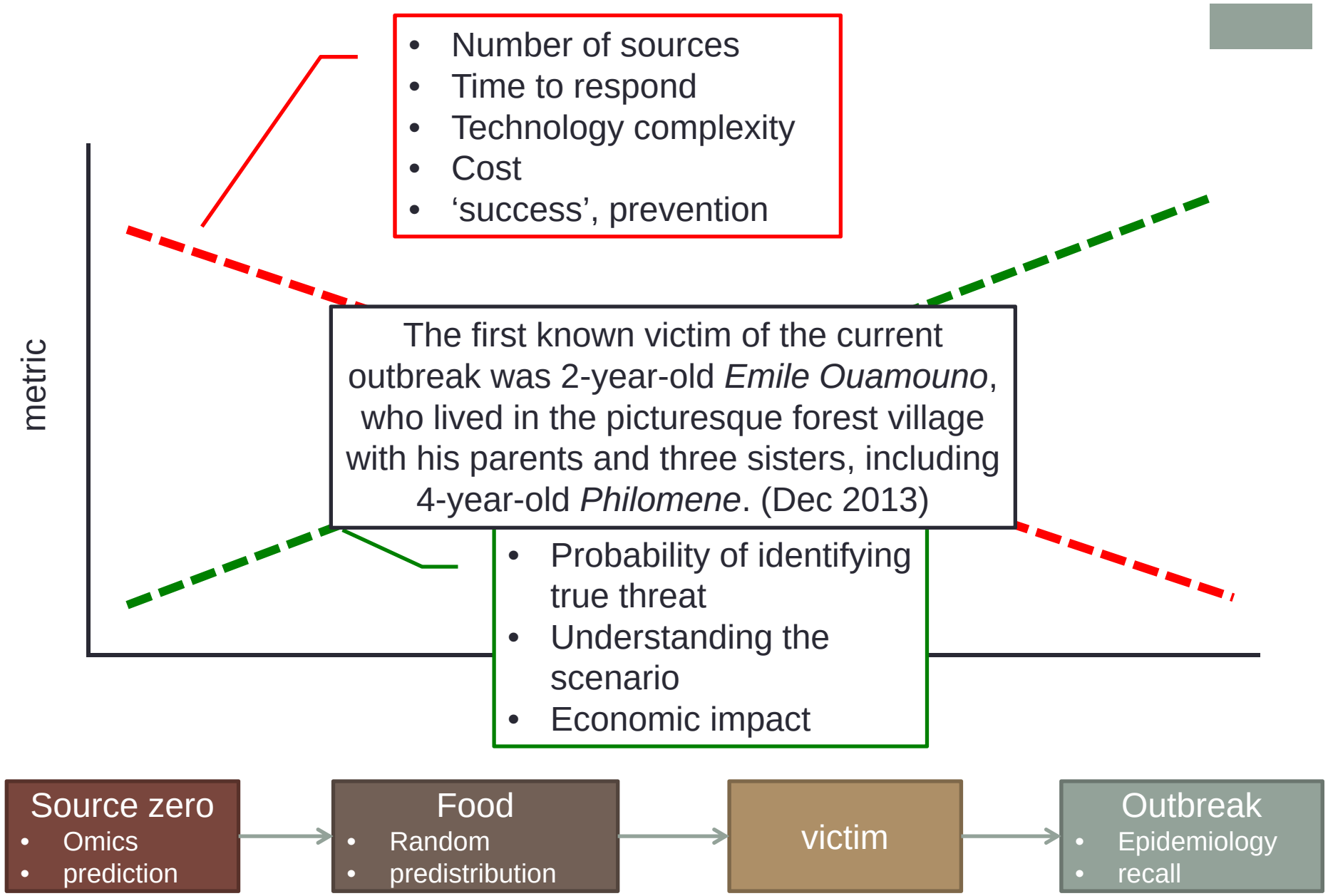
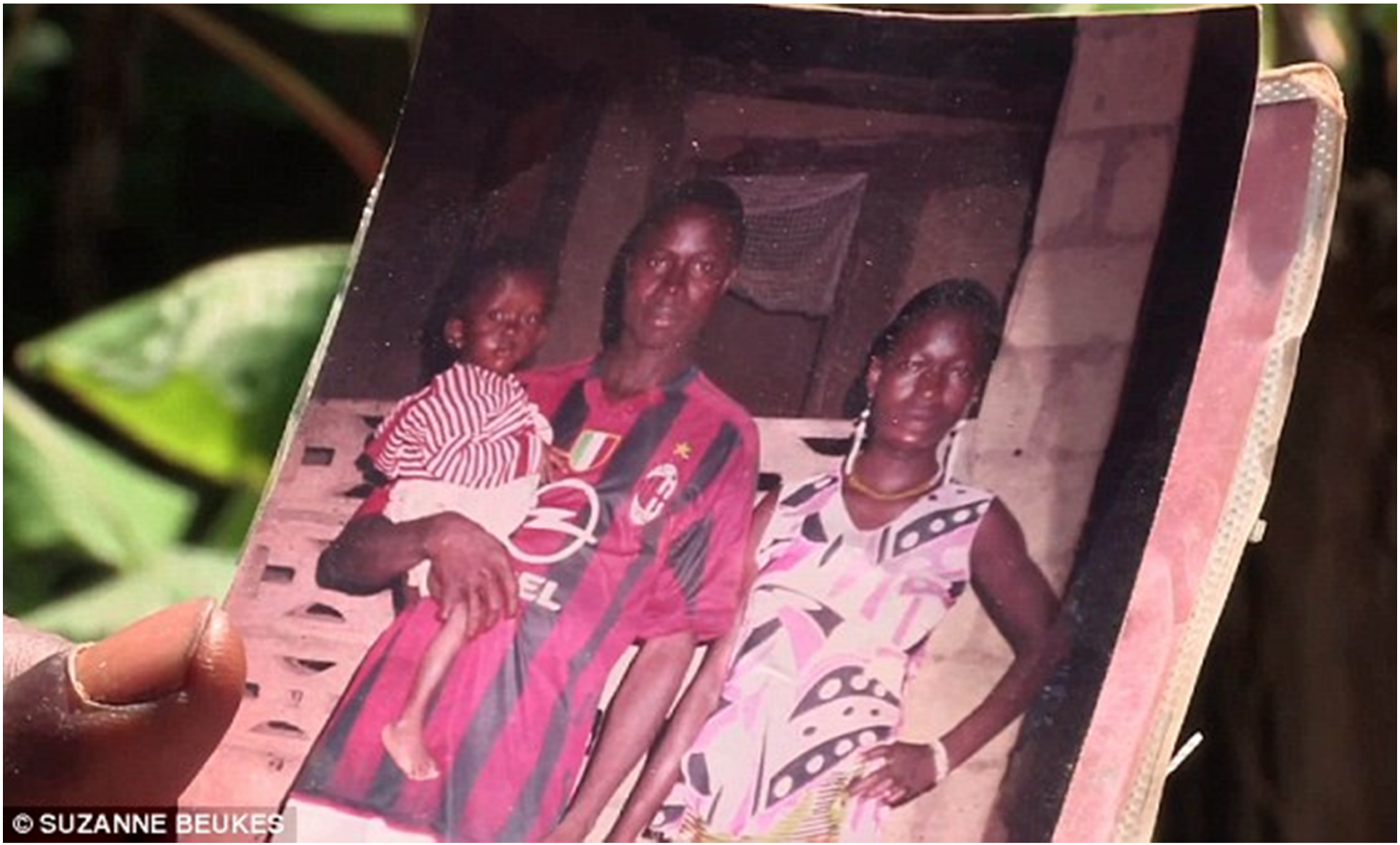
R&D needs for ‘source zero’ monitoring

- Instrumentation
  - distance
  - power
  - on board analytics
- Chemistry and reagents
  - specificity, sensitivity
- Quantification
  - correlation of peak amplitude with target concentration


metric
Number of sources
Time to respond
Technology complexity
Cost
'success', prevention
The first known victim of the current outbreak was 2-year-old *Emile Ouamouno*, who lived in the picturesque forest village with his parents and three sisters, including 4-year-old *Philomene*. (Dec 2013)
Probability of identifying true threat
Understanding the scenario
Economic impact
Source zero
Omics
prediction
Food
Random
predistribution
victim
Outbreak
Epidemiology
recall

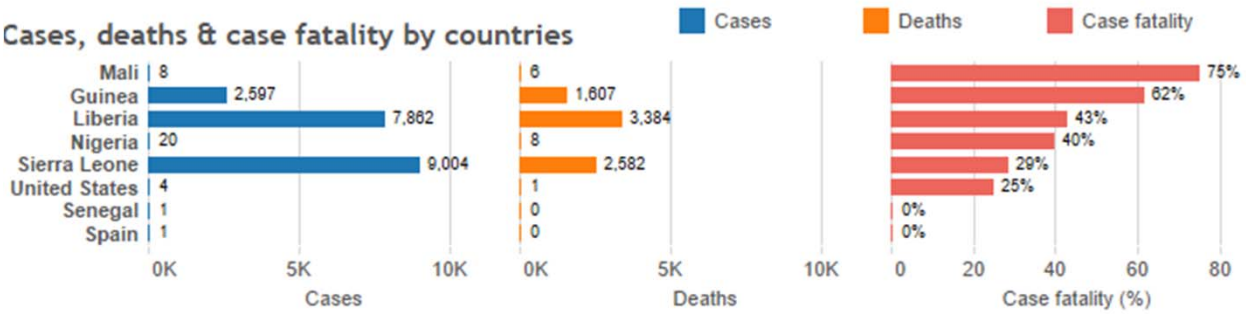

© SUZANNE BEUKES

Ebola virus disease outbreak, West Africa 2014

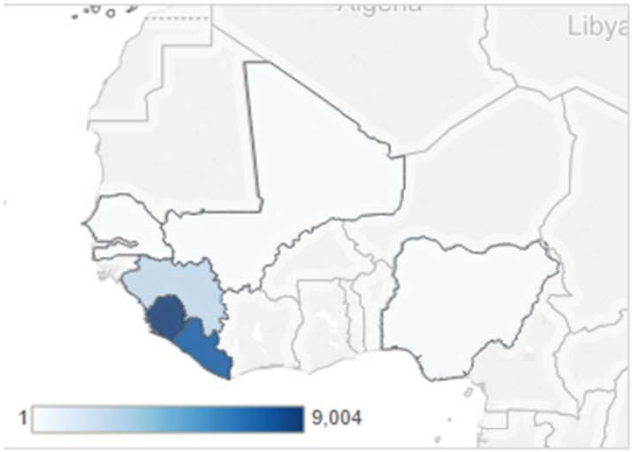
19,497	7,588	39%
cases	*deaths*	*case fatality ratio*

Select the date to show data
12/21/2014

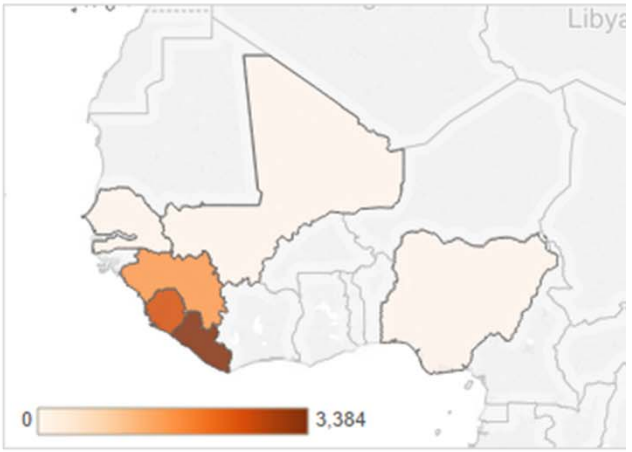
Cases, deaths & case fatality by countries



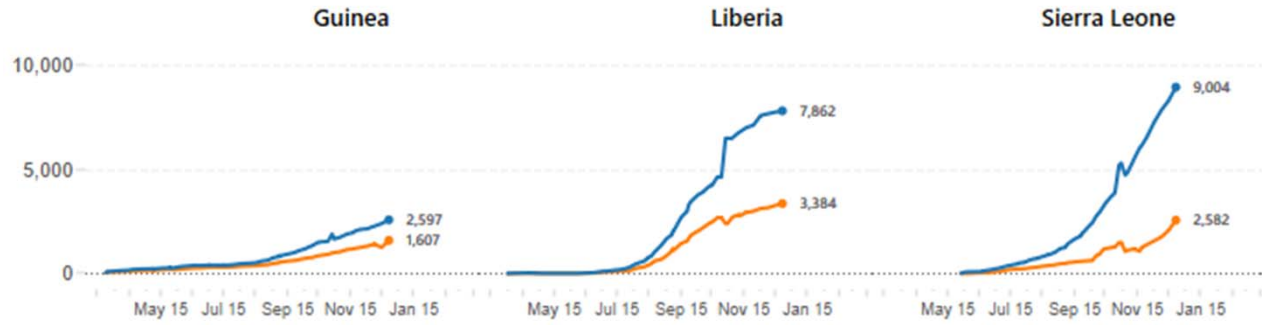
Geographic distribution of cases



Geographic distribution of deaths



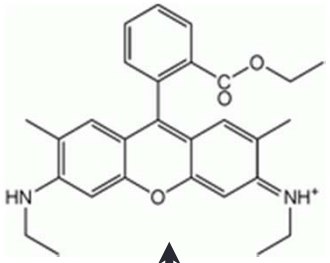
Cases and deaths reported in countries with widespread and intense transmission



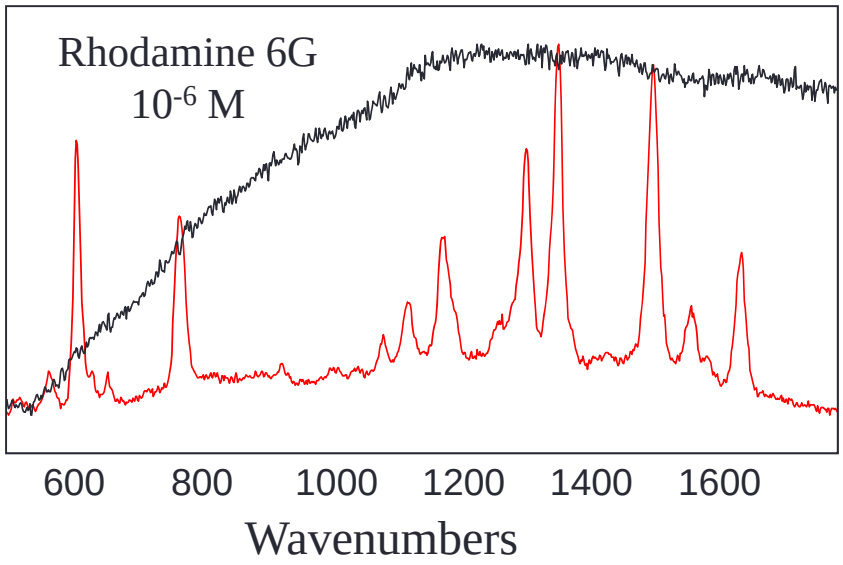
Source: Ebola virus disease, West Africa. Global Alert and Response, World Health Organization (WHO). **Updated** December 21, 2014
Author: Ramon Martinez @HlthAnalysis

Surface Enhanced Raman Scattering (SERS)

- ✓ High polarizability of nobel-metal surfaces leads to >10^6 fold increase in Raman signal
- ✓ Attomolar detection limits possible
- ✓ Species not near the metal surface are “invisible”

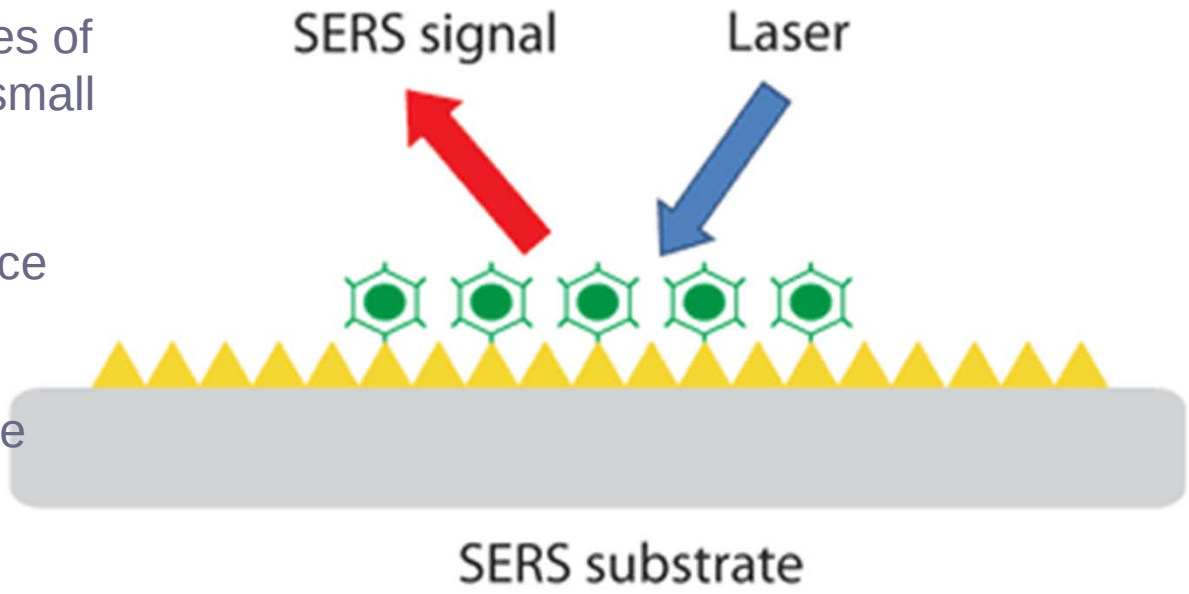


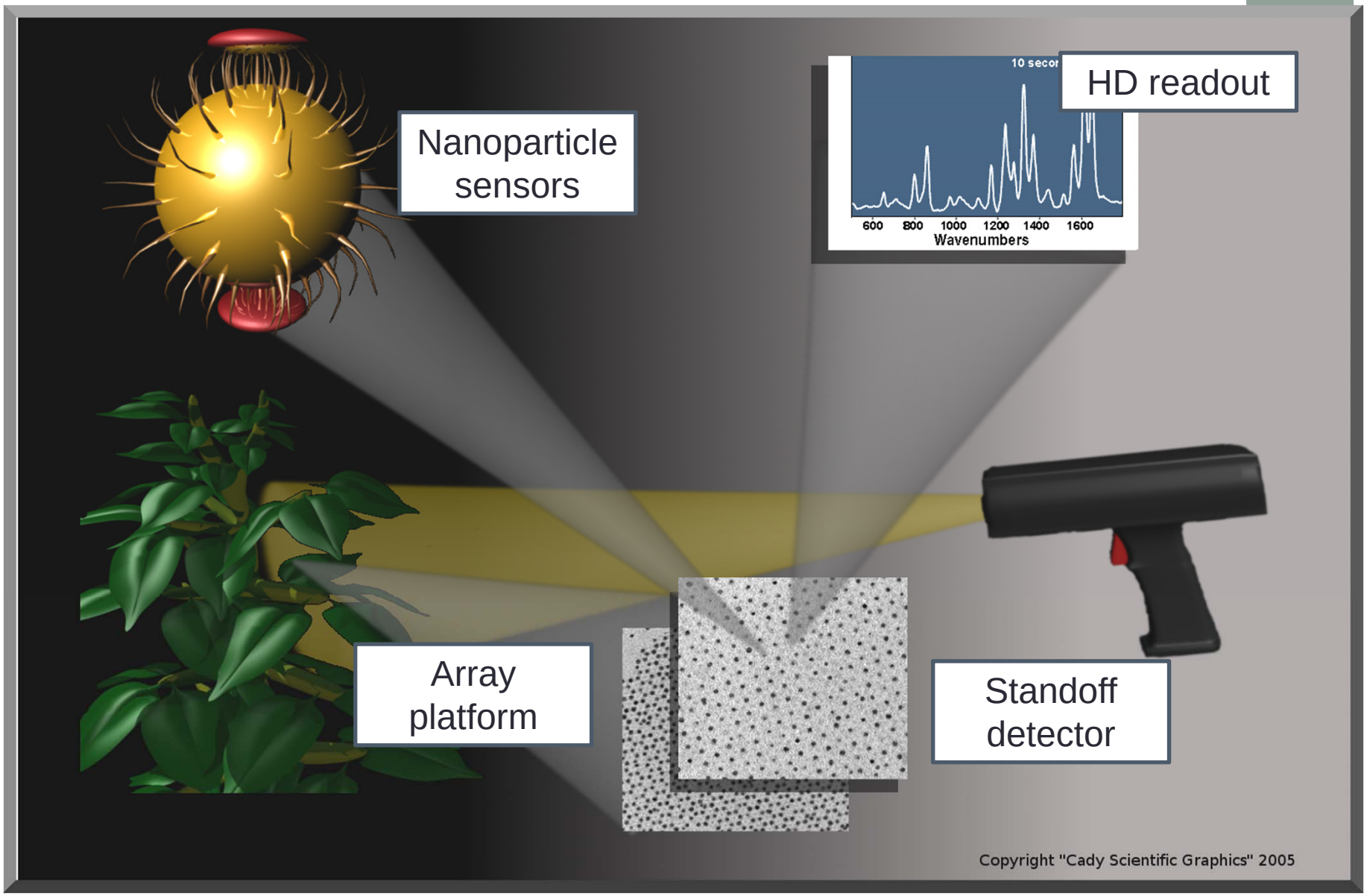
Au



SERS

- Information rich output that is diagnostic.
- Widely applicable to all types of targets including proteins, small molecules and DNA.
- Robust and signal is distance dependent
- Challenge is to have analyte specificity and multiplex capability




Nanoparticle sensors
HD readout
600
800
1000
1200
1400
1600
Wavenumbers
Array platform
Standoff detector
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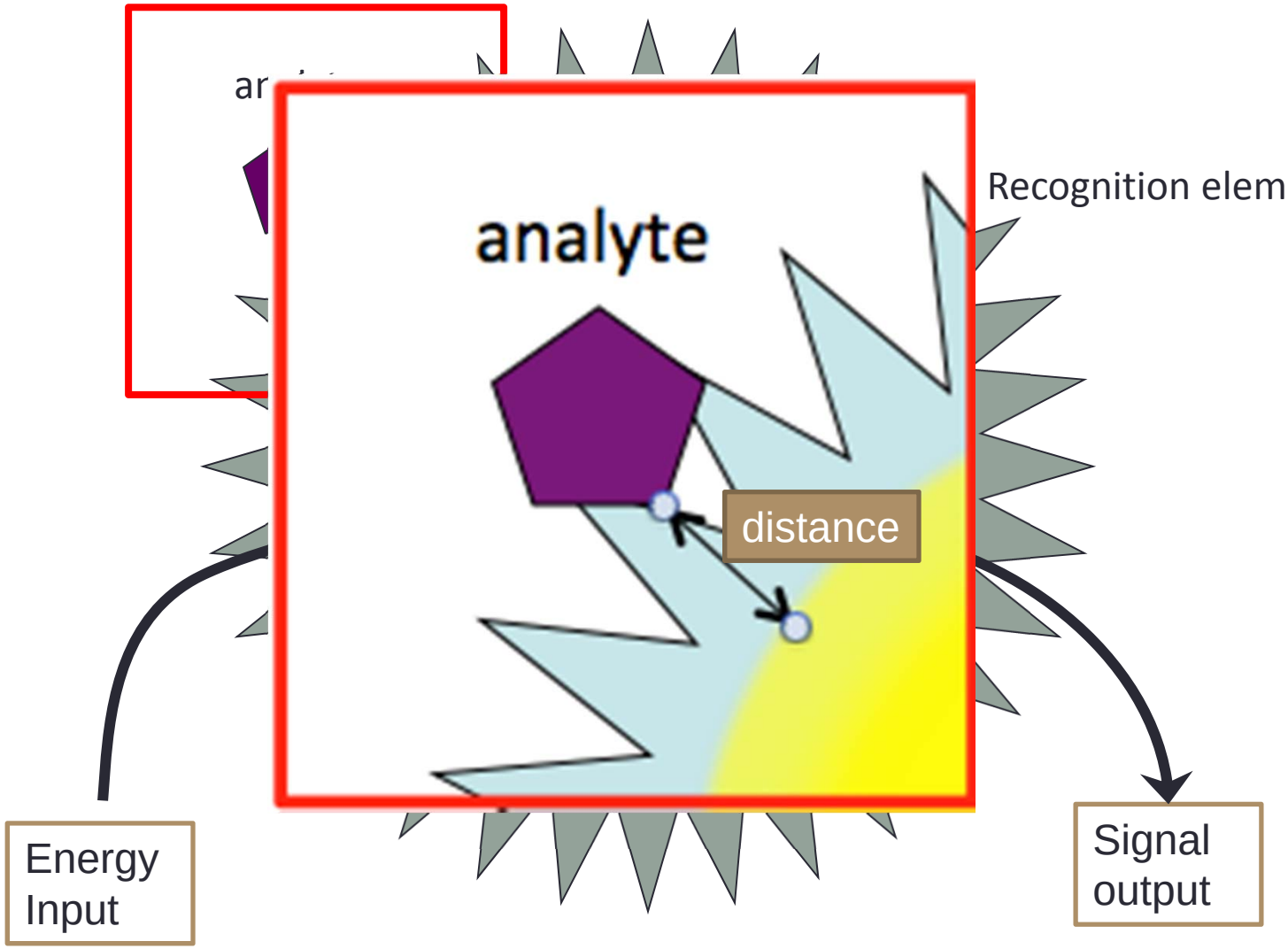
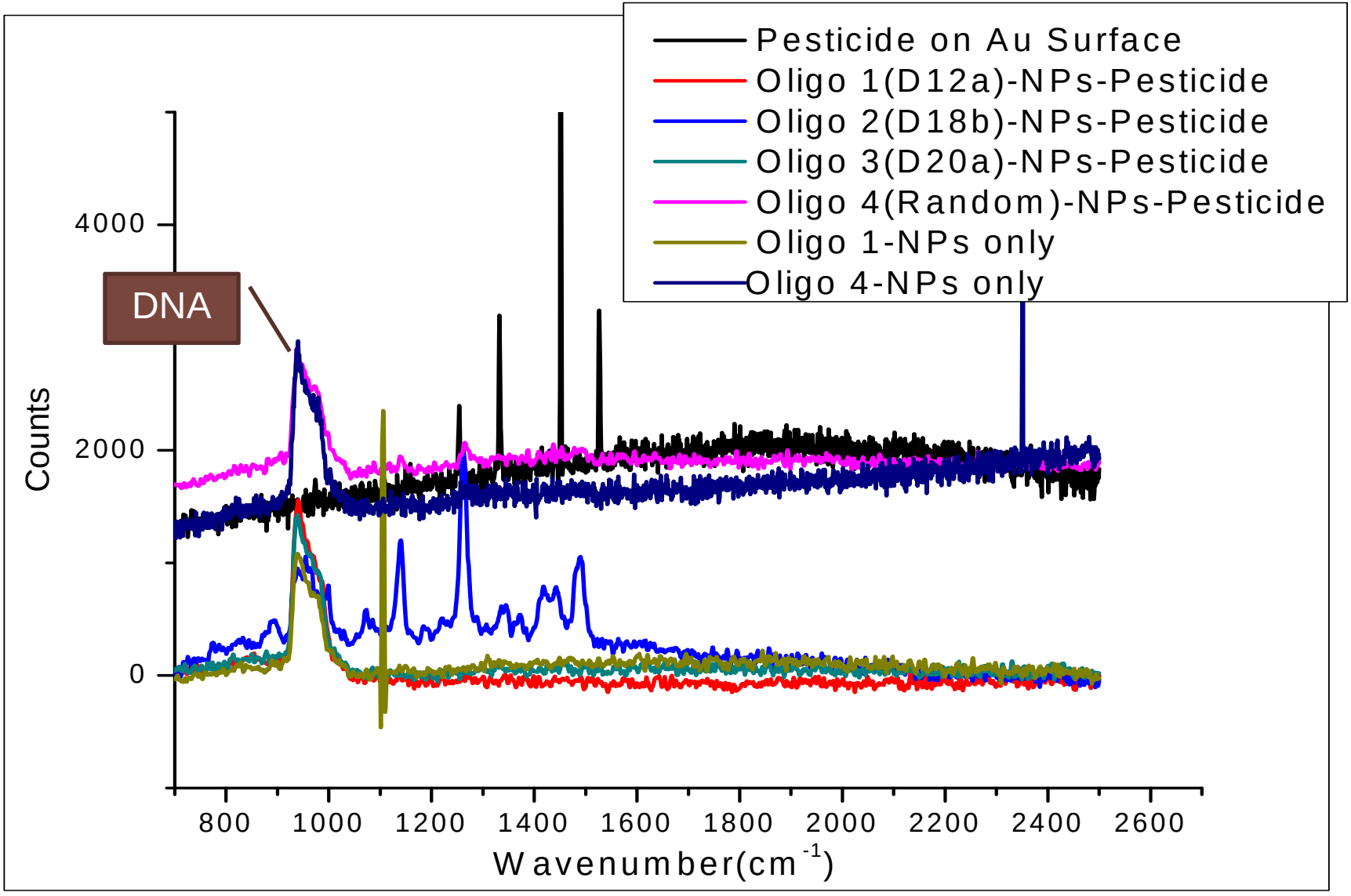
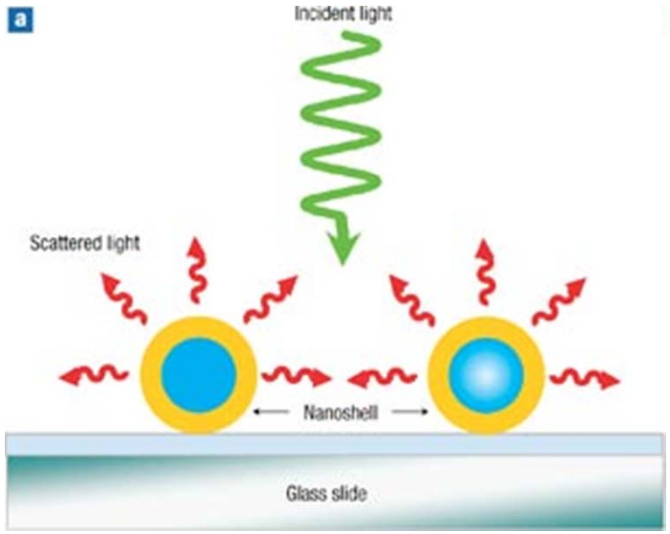
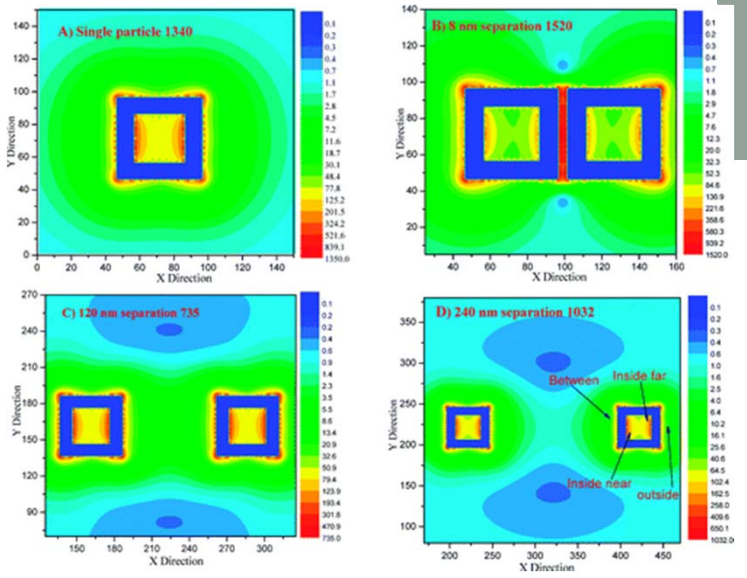
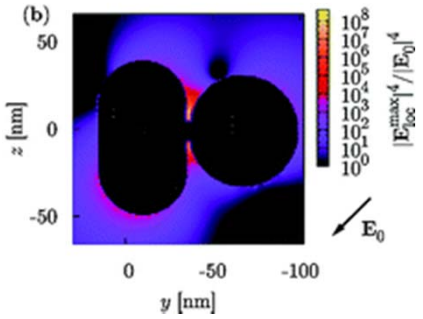

analyte
Recognition element
distance
Energy
Input
Signal
output

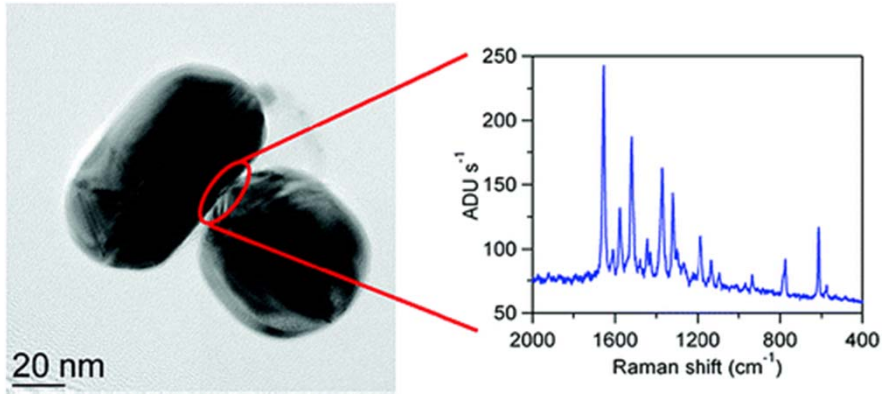

Pesticide on Au Surface
Oligo 1(D12a)-NPs-Pesticide
Oligo 2(D18b)-NPs-Pesticide
Oligo 3(D20a)-NPs-Pesticide
Oligo 4(Random)-NPs-Pesticide
Oligo 1-NPs only
Oligo 4-NPs only
DNA
Counts
4000
2000
0
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
Wavenumber(cm-1)

Influence of particles on SERS

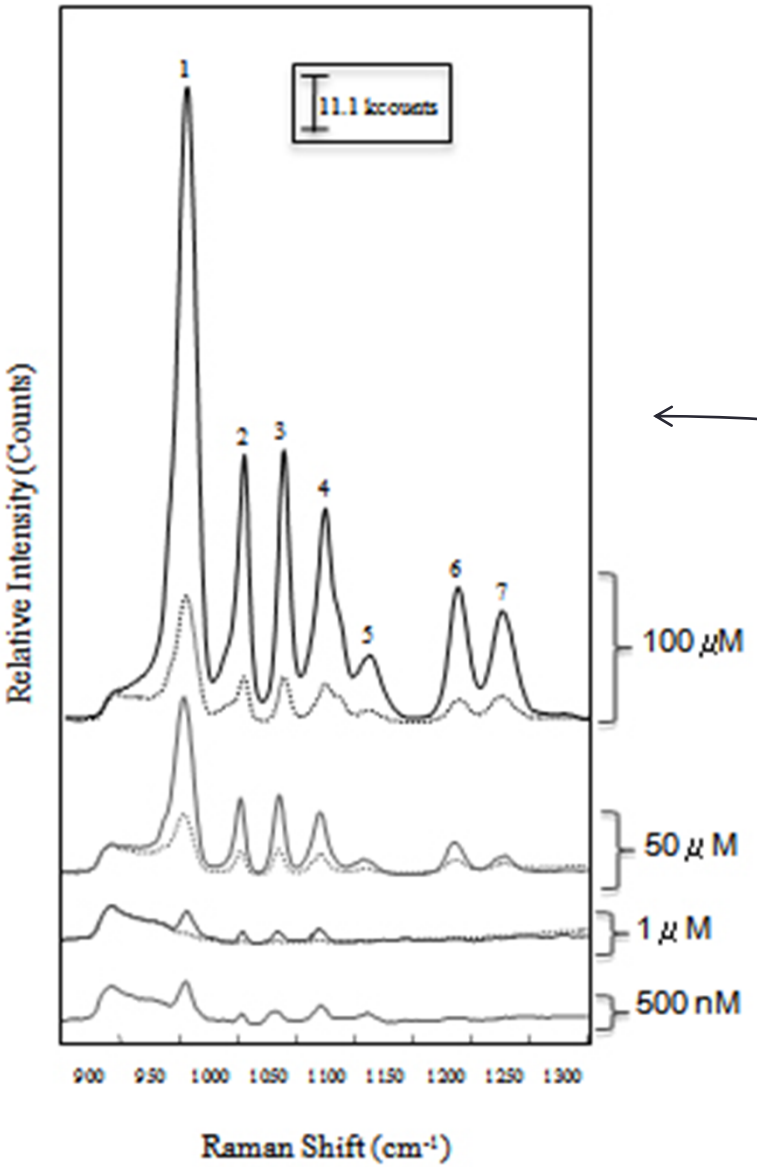




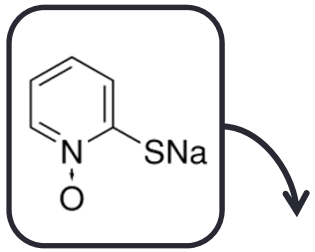


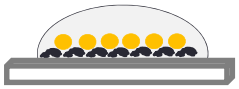


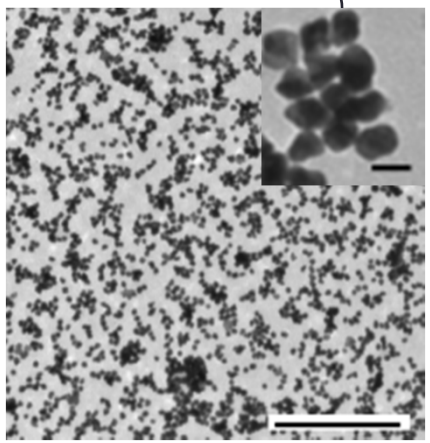
SERS signal from arrayed NPs

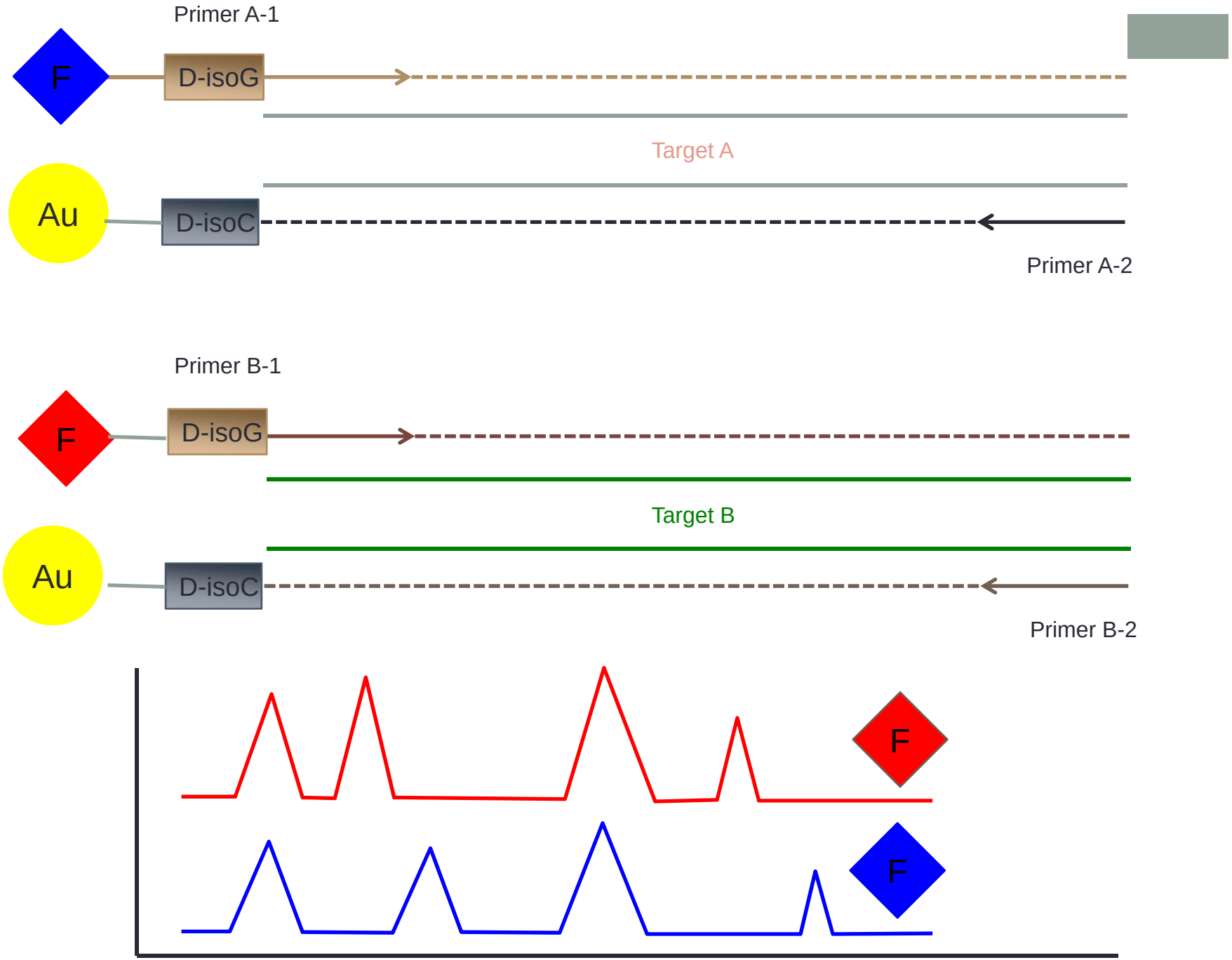


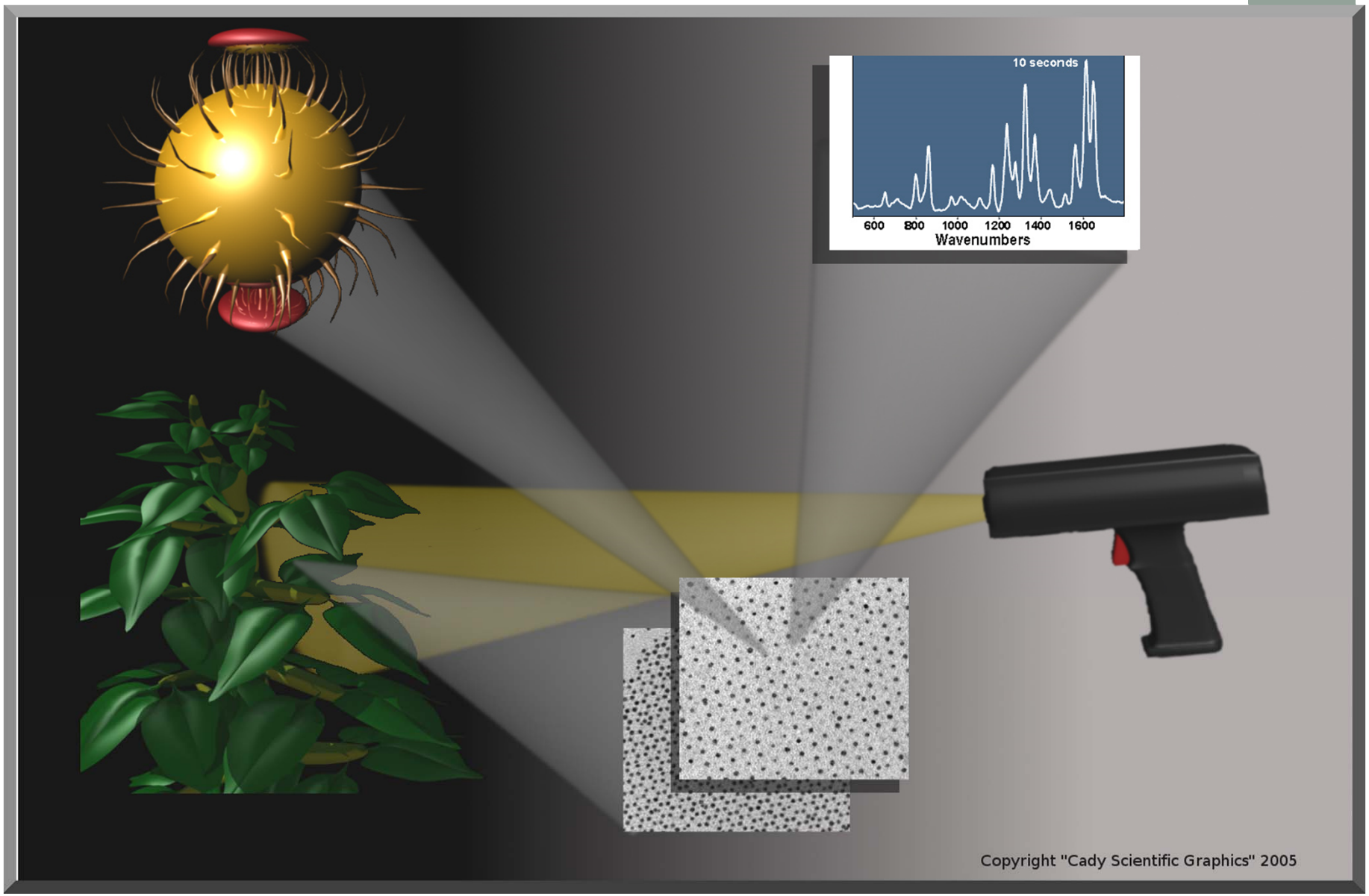
2-mercaptopyridine



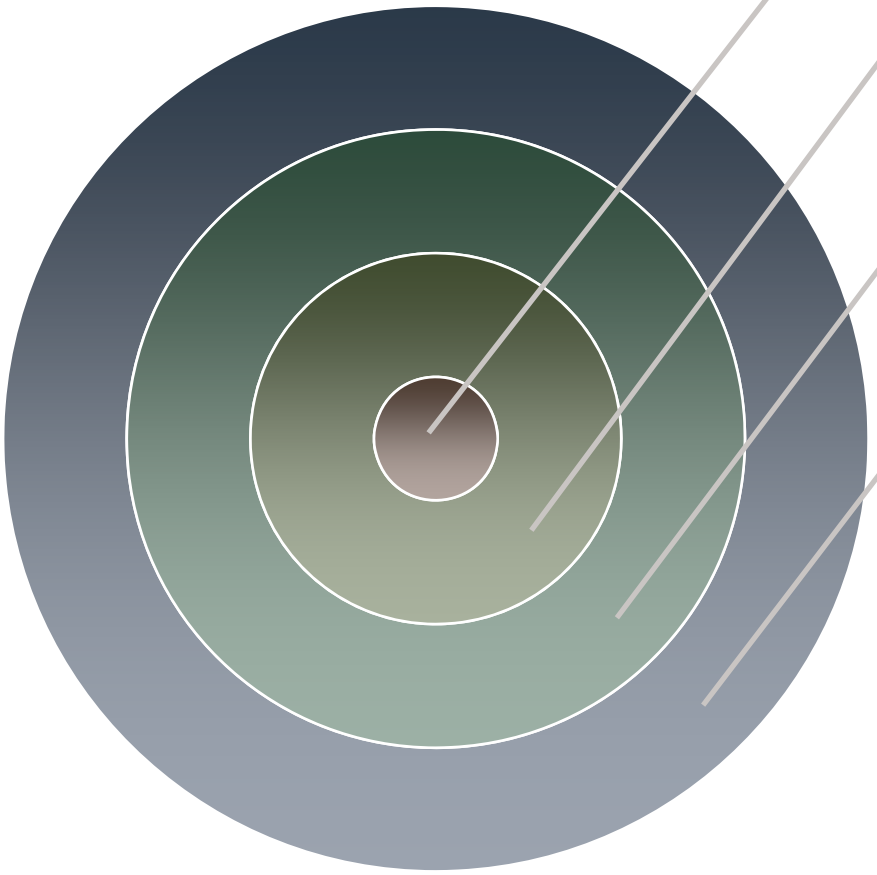





Primer A-1
F
D-isoG
Target A
Au
D-isoC
Primer A-2
Primer B-1
F
D-isoG
Target B
Au
D-isoC
Primer B-2
F
F


10 seconds
600
800
1000
1200
1400
1600
Wavenumbers
Copyright "Cady Scientific Graphics" 2005

bigger picture



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