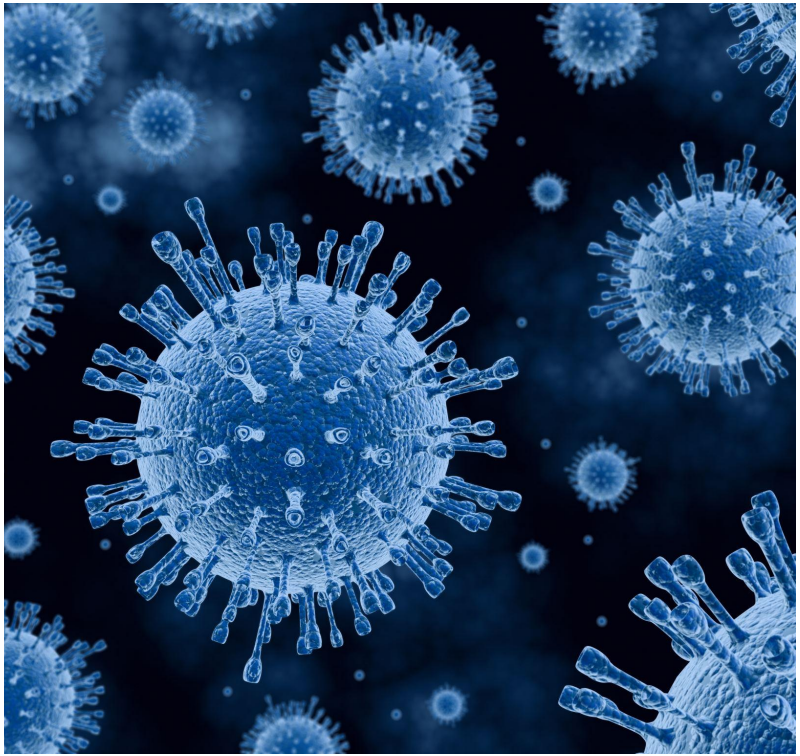

Smartphone-based Plasmonic Sensing for Respiratory Viruses

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Faculty Advisor: Dr. Zhenpeng Qin

Graduate Assistants: Tingting Zhang, Yaning Liu

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01 BACKGROUND

Antigen based test:

Lateral flow: Delivers results in 30 mins.

- 30% less effective
- Not effective for early detection

- **Nucleic acid based test:**

  PCR: Takes a day or 2 for results to accurately appear.

- Takes roughly 24-72 hours
- expensive equipments
- Professional operation

Goals:

- Accurate detection results
- Rapid detection
- User-friendly test
- Less expensive

https://www.northamptonshire.gov.uk/news/council-news/Pages/university-of-northampton-lateral-flow-device-testing-site-to-resume-staff-and-student-testing-only.aspx
https://www.cornerstoneuc.com/2020/11/07/lab-testing-and-the-covid-19-pandemic/

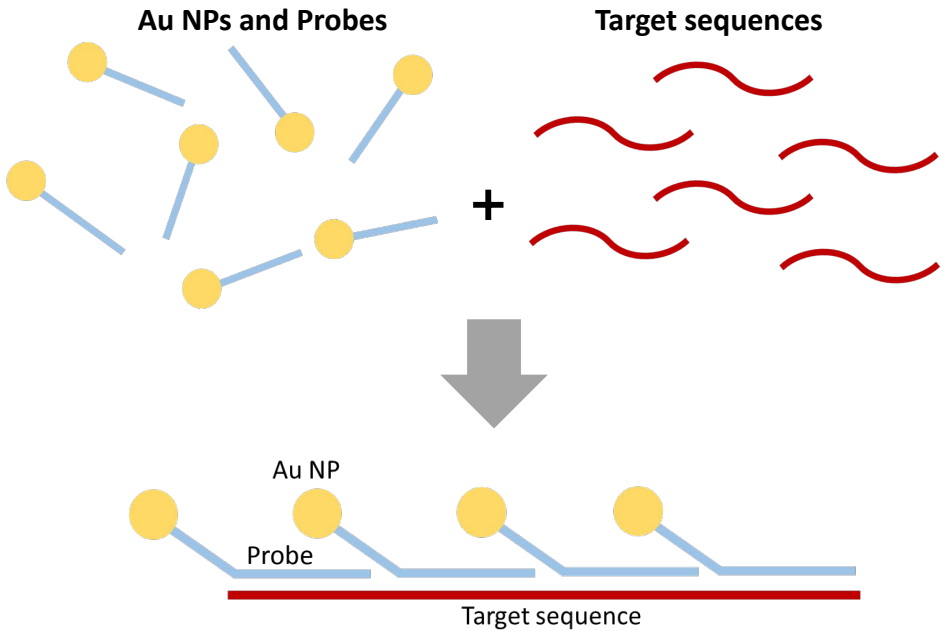
02 PRINCIPLES

- **Gold Nanoparticles**

Gold nanoparticles have different optical responses to different wavelengths of light.

Absorption and scattering properties of gold nanoparticles can be changed by altering the **shape** and **size**.

- **Gold Nanoparticle Based Nucleic Acid Detection**



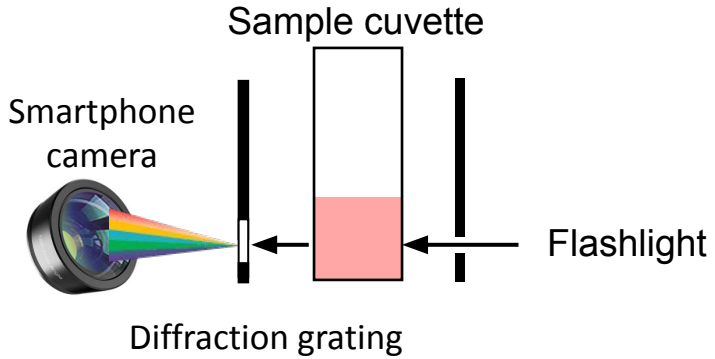
02 PRINCIPLES

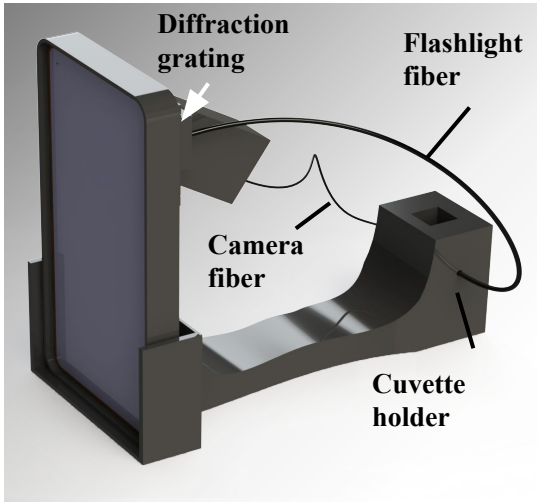
Benefits:

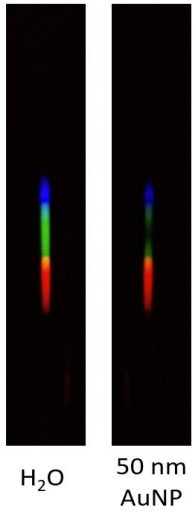
- Less Expensive
- User Friendly
- More Accurate Results

Parts of the model:

- Smartphone case
- Cuvette Holder
- Flashlight Fiber
- Camera Fiber
- Diffraction Grating







03 EXPERIMENTAL DETAILS

Gold Nanoparticle Synthesis

Chemicals:

- Au 15 nm Seeds
- $HAuCL_4$
- Sodium Citrate
- Hydroquinone

Key steps:

- Mix the chemicals in the order above
- Let particles synthesize overnight
- Wash 3 times before use

Gold Nanoparticle - DNA Probes Synthesis

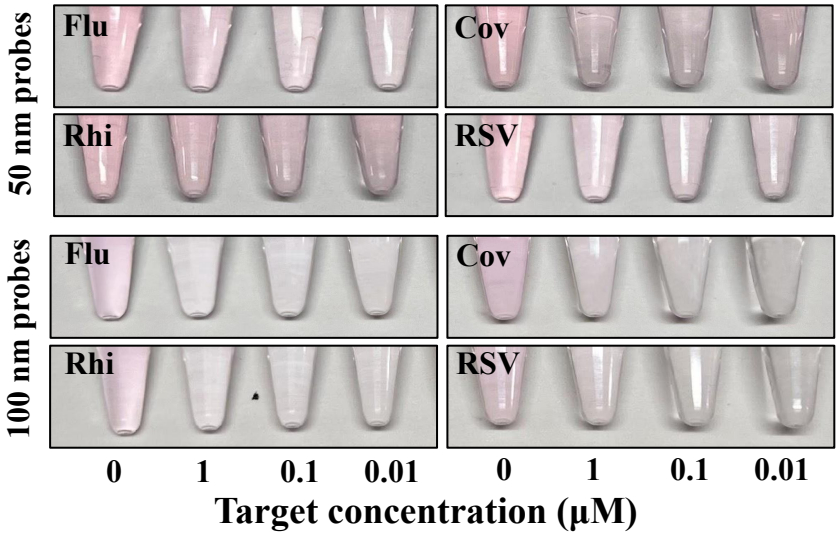
Chemicals:

- 50 mM citrate buffer with 3.0 pH
- Oligonucleotide (ssDNA)
- Gold nanoparticles

Key steps:

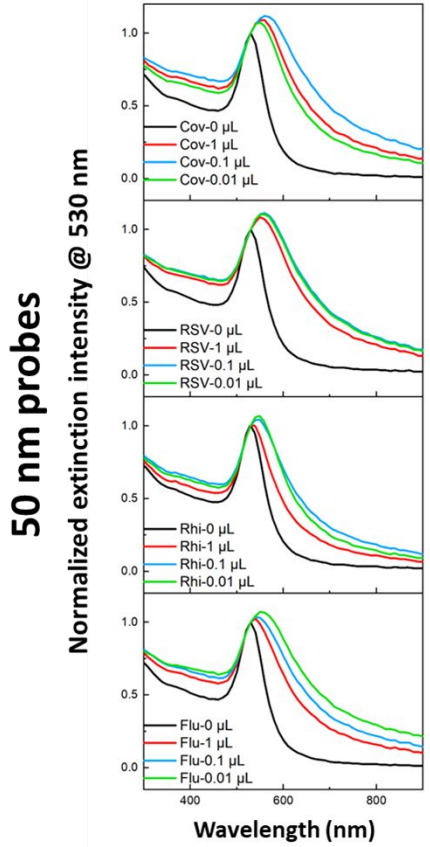
- Incubate overnight
- Wash 3 times before use

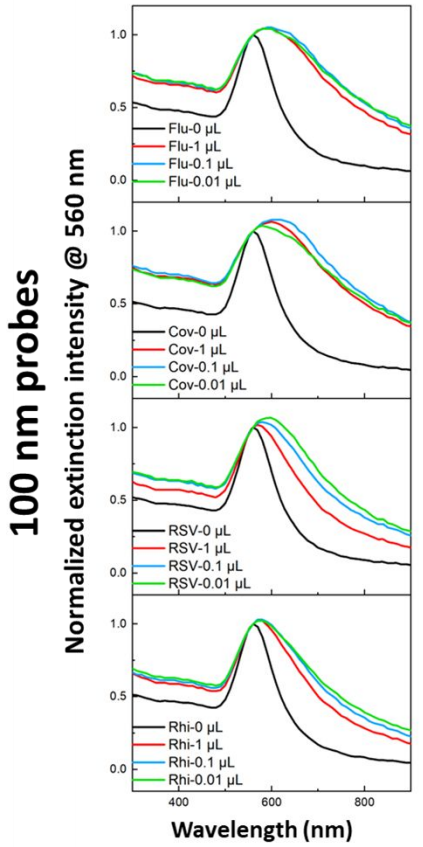
04 RESULTS AND DISCUSSION



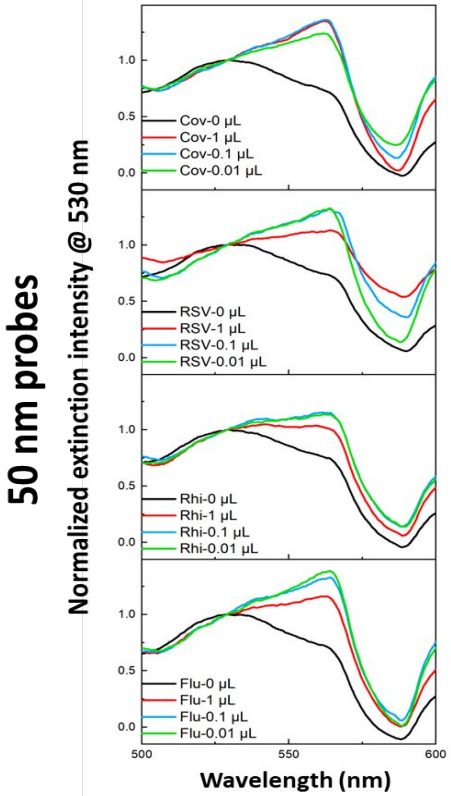
Noticeable Observations:

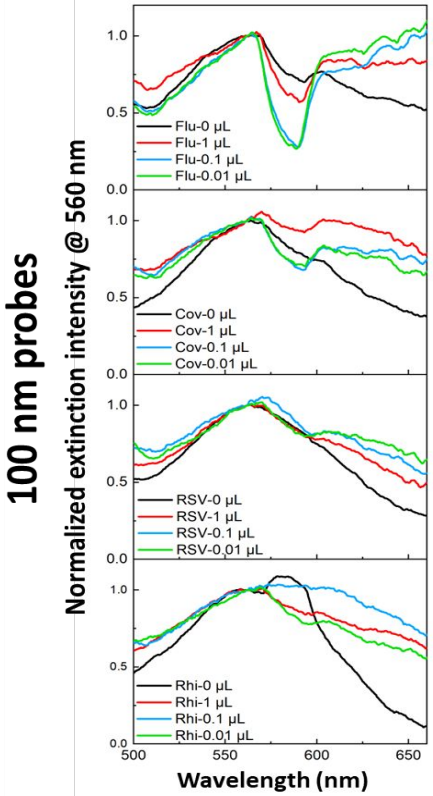
- Peak wavelength shifts to the right
- Peak broadens





04 RESULTS FROM PHONE APPARATUS





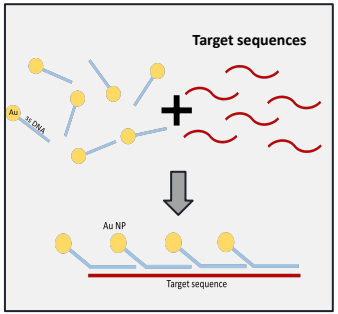
Why use a smartphone?

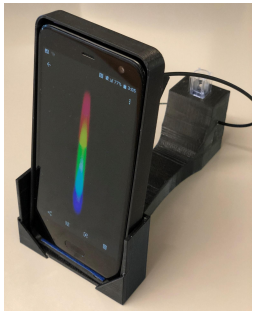
- Spectrometers are expensive and tedious to use
- Everyone has a smartphone (and take it basically everywhere), so why not?

05 CONCLUSION & FUTURE PERSPECTIVES

What did we find?

By utilizing the changes in absorption properties of gold nanoparticles, we created a **fast** and **accurate** detection test for respiratory viruses including COVID-19, influenza, rhinovirus, and RSV using smartphones.





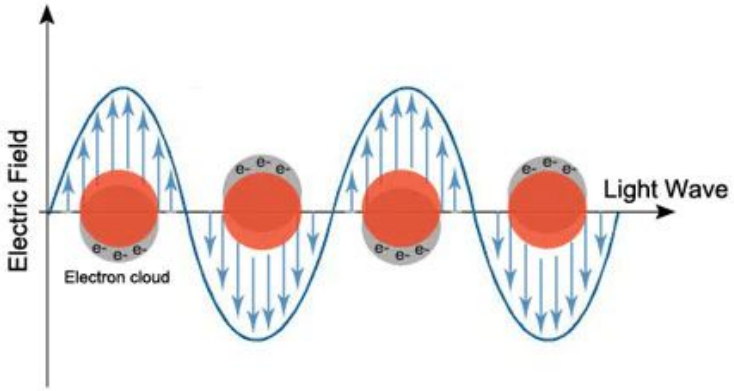
How could we take this further?

- Multiplex detection - multiple targets per test
- Microfluidic chip - design a chip to optimize the device so it can automatically do the procedure
- Combine newest nucleic acid amplification method with our current platform
- Optimize current procedure - probe concentration, sequence design, etc.

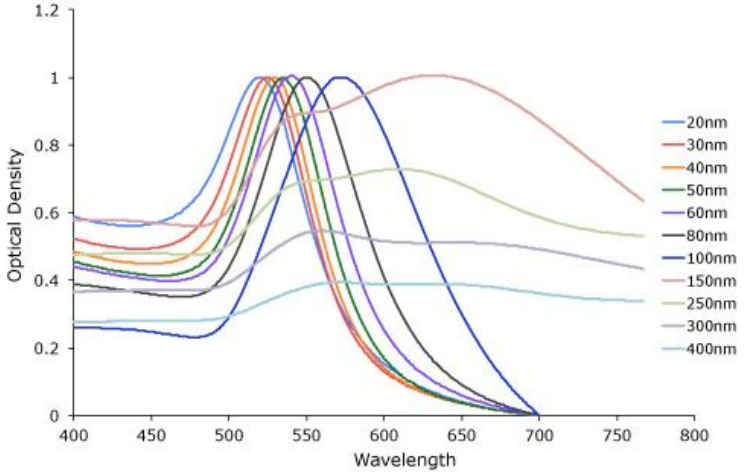
SPECIAL THANKS TO:

- Dr. Zhenpeng Qin
- Tingting Zhang
- Yaning Liu
- Vijay Karthikeya Raja
- Steven Nguyen

EXTRA PRINCIPLES



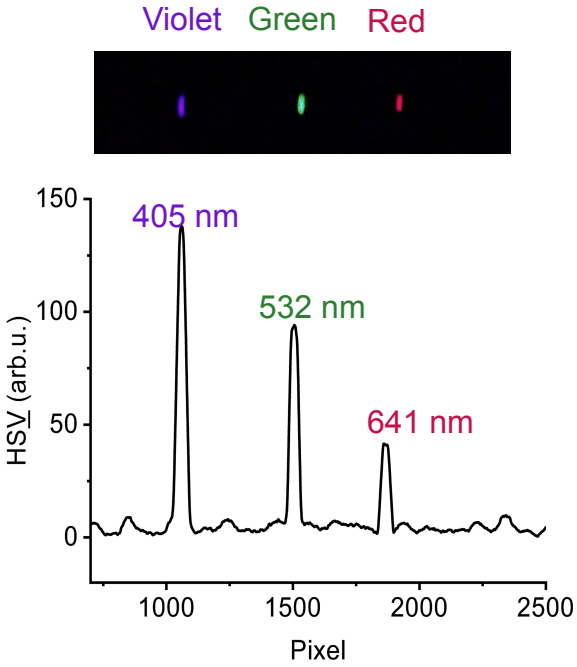
From cytodiagnostics.com

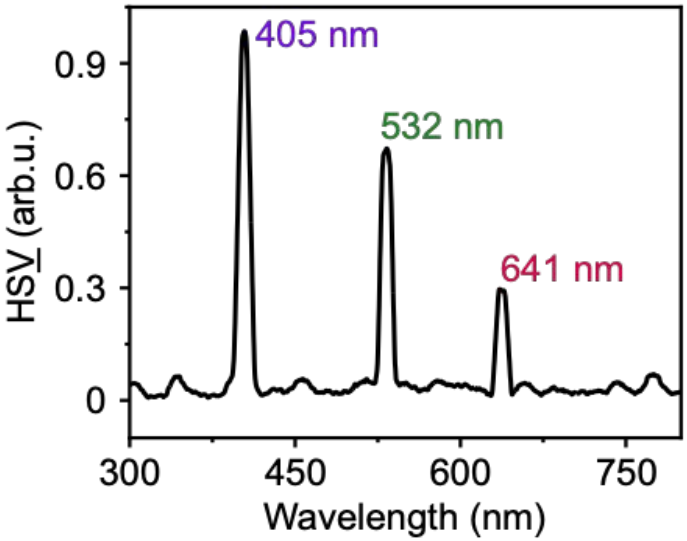


From cytodiagnostics.com

EXTRA PRINCIPLES

Smartphone-based spectrometer: wavelength calibration





EXTRA DNA INFORMATION

RSV:
AGGGTTGACTTGACTCCTGGTGTTGTTGAAGCTAGTATGGTGGTGATTTGTG
ATGTAATTTCAGACGGATTAGAGGGACTGATTCCAAGCTGAGGATTCT

Probe A: AAAAA AAAAA AAAAA AGAAT CCTCA GCTTG GAATC AGTCC
Probe B: AAAAA AAAAA AAAAA CTCTA ATCCG TCTGA AATTA CATCA
Probe C: AAAAA AAAAA AAAAA CAAAT CACCA CCATA CTAGC TTCAA
Probe D: AAAAA AAAAA AAAAA CAACA CCAGG AGTCA AGTCA ACCCT

Covid:
CCCAATAATACTGCGTCTTGGTTCACCGCTCTCACTCAACATGGCAAGGAAGA
CCTTAAATTCCCTCGAGGACAAGGCGTTCCAATTAACACCAATAGCA

Probe A: AAAAA AAAAA AAAAA TGCTA TTGGT GTTAA TTGGA ACGCC
Probe B: AAAAA AAAAA AAAAA TTGTC CTCGA GGGAA TTTAA GGTCT
Probe C: AAAAA AAAAA AAAAA TCCTT GCCAT GTTGA GTGAG AGCGG
Probe D: AAAAA AAAAA AAAAA TGAAC CAAGA CGCAG TATTA TTGGG

Flu:
GATTACAGGTACACGTACCGATGCCATAGAGGTGACACACAAATACAAACCC
GAAGATCATTTGAAATAAAGAAACTGTGGGAGCAAACCCGTTCCAAAG

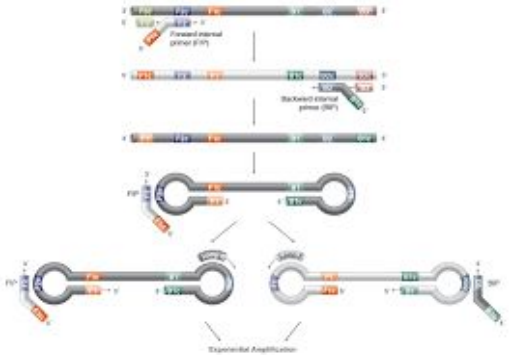
Probe A: AAAAA AAAAA AAAAA CTTTG GAACG GGTTT GCTCC CACAG
Probe B: AAAAA AAAAA AAAAA TTTCT TTATT TCAAA TGATC TTCGG
Probe C: AAAAA AAAAA AAAAA GTTTG TATTT GTGTG TCACC TCTAT
Probe D: AAAAA AAAAA AAAAA GGCAT CGGTA CGTGT ACCTG TAATC

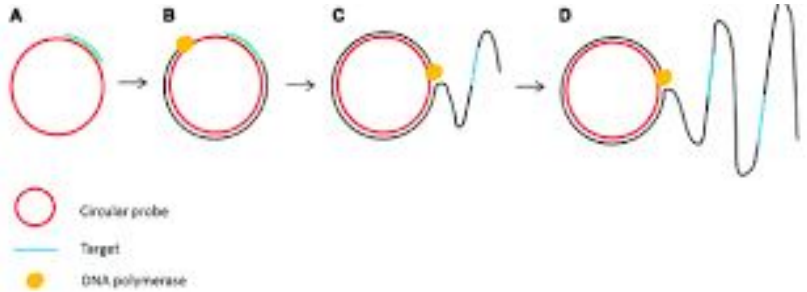
Rhino:
GATGGGTACCAACAACAAGAAGTAGTGATTATGGATGATTTAAATCAGAATC
CTGATGGTCAAGACATTAGTATGTTCTGCCAGATGGTGTCATCAGTTG

Probe A: AAAAA AAAAA AAAAA CAACT GATGA CACCA TCTGG CAGAA
Probe B: AAAAA AAAAA AAAAA CATAC TAATG TCTTG ACCAT CAGGA
Probe C: AAAAA AAAAA AAAAA TTCTG ATTTA AATCA TCCAT AATCA
Probe D: AAAAA AAAAA AAAAA CTACT TCTTG TTGTT GGTAC CCATC

EXTRA CONCLUSION & FUTURE PERSPECTIVES

Nucleic acid amplification---Isothermal amplification





Loop-Mediated Isothermal Amplification

Advantages:

- Quick technique
- Naked-eye detection

Rolling circle amplification

- High sensitivity
- Simple operation

Thanks for listening

Research Team:

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Julia Pan

Rishi Rai

Luke Ting

Faculty Advisor :

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