# Nanoparticle-Supported Rapid Electronic Detection of Syphilis

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## Introduction

**Syphilis infection rates have been rising over the past 20 years**

- Estimated economic impact of $39 million in 2013 [1]
- In 2022, the US had 207,000 syphilis cases, a 220% increase since 2013 [2]

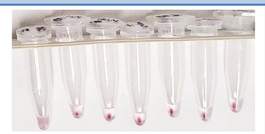
The NasRED system tests for **one specific protein,** and is low cost, miniaturized, highly sensitive, and rapid.

- Testing focused on **protein TP0216.** This is an ideal target protein because it is syphilis-specific and can cooperatively bind to multiple probes.

**Research Question**: Which configuration of probe proteins will be most useful to detect Tp0216 on the attomolar level?

## Data Collection

**Before Centrifugation**
Nanoparticles are mostly free floating in solution, resulting in red coloration.
No nanoparticle aggregation, so NC and target solutions are indistinguishable.



**Before Readout**
Nanoparticle solution after centrifugation and vortexing.
Target solutions become clear, with noticeable clumping at the bottom.
**Note: negative control (NC) shows no clumping and retains red coloring.**

## Methodology

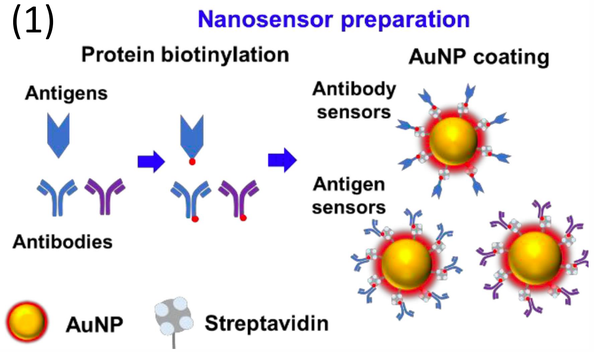
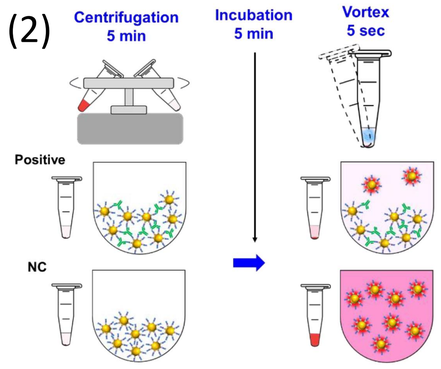



**Figure 1: Nanosensor Preparation:** Mixing of gold nanoparticles and probe proteins creates 'sticky' nanoparticles [2]

**Figure 2: Experimental Procedure:** Nanoparticle solutions undergo centrifugation to induce clumping, then controlled vortexing to resuspend non-aggregated particles [2]

*Figures adapted from Choi et al., Nanoparticle-Supported, Rapid, and Electronic Detection of SA CoV-2 Antibodies and Antigens at Attomolar Lev Reprinted with permission from Dr. Chao Wang's research group at Arizona State University.*




## Experimental Plan

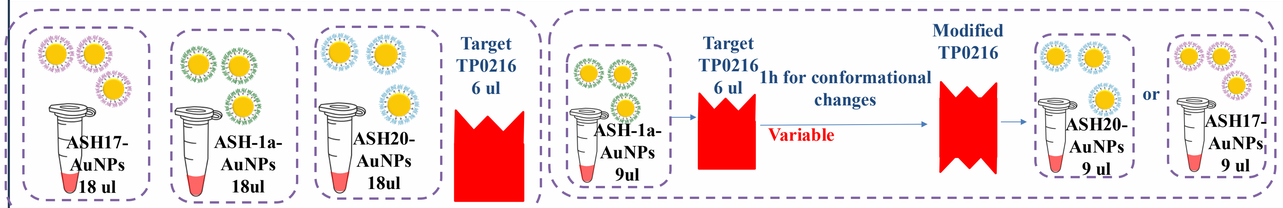



*Diagram adapted from internal presentation materials provided by Seyedsina Mirjalili. Used with permission.*

**Stage 1: Monobinders:** Each probe protein bound to gold nanoparticles and tested independently

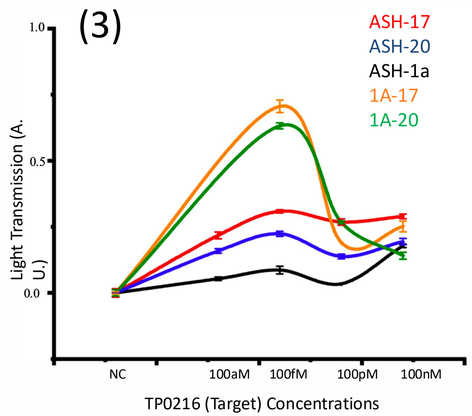
**Stage 2: Cobinders:** ASH-1a is incubated with target protein to induce conformational changes.

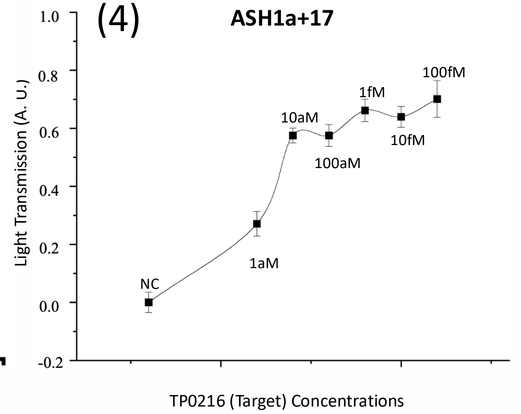
Next, the solution is conjugated with either ASH17 or ASH20. In theory, cobinders should have a stronger binding affinity

## Results

**Figure 3: Monobinders and Cobinders:** measured light transmission through PBS Buffer 1a, 17, 20 , 1a+20 and 1a+17, with TP0216 from 100fM to 100nM. Conducted in PBS buffer solution.

**Figure 4: ASH1a+17.** Measured light transmission through solution of for ASH1a-17 with TP0216 ranging from 1aM to 100fM. Conducted in PBS buffer solution.




## Conclusions

All configurations exhibit a significant drop-off in transmission rates over 100fM - possible that **higher concentrations saturate nanoparticle binding sites**, reducing aggregation (Figure 3)

Compared to monobinders, **cobinders show a significantly higher transmission rate** at target concentration of 100fM (Figure 3).

Currently, the best probe conformation is ASH1a+17. **It maintains high binding affinity with low target concentrations (10aM-100fM),** indicating **a** high degree of sensitivity (Figure 4).

Future experiments will maintain the 10aM-100fM range, testing with ASH1A-17. Next, the 1 hour incubation period for ASH-1a to induce confirmational changes to TP0216 will be removed to test its effect.

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## References

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