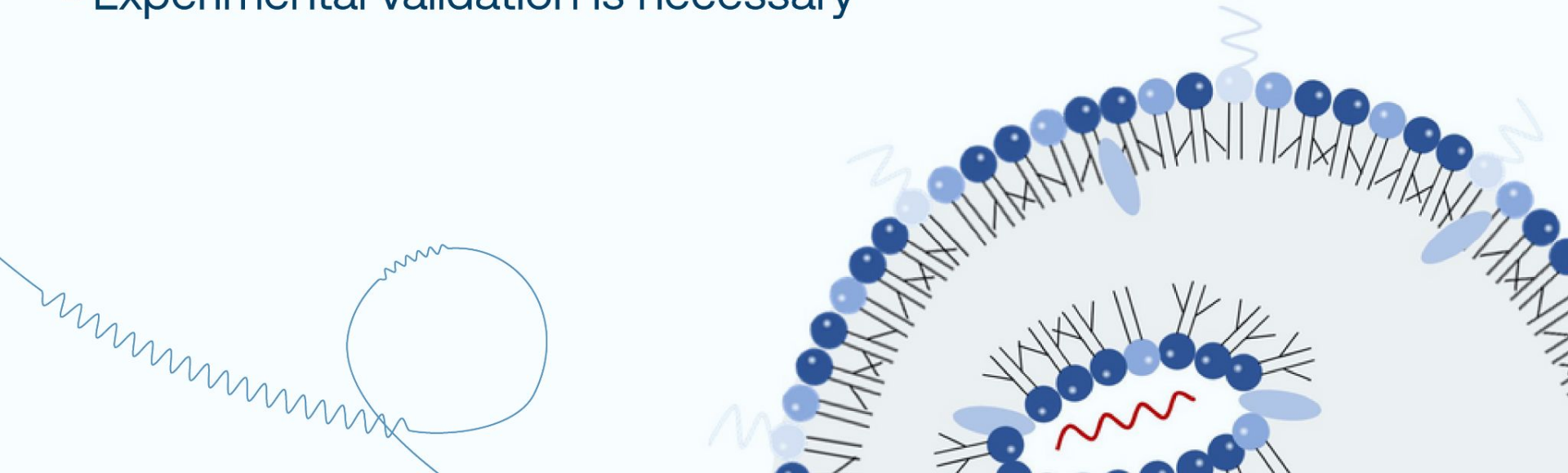# High-throughput pH Measurement

Olin College SCOPE for moderna

Lipid nanoparticle formulations deliver mRNA to the body

- Each mRNA product requires a different LNP formulation
- There's no model to predict performance
- Experimental validation is necessary

Moderna needs to characterize thousands of LNP formlations

pH is one of the most basic electrochemical measurements and is relevant to both the stability and biocompatibility of drug products
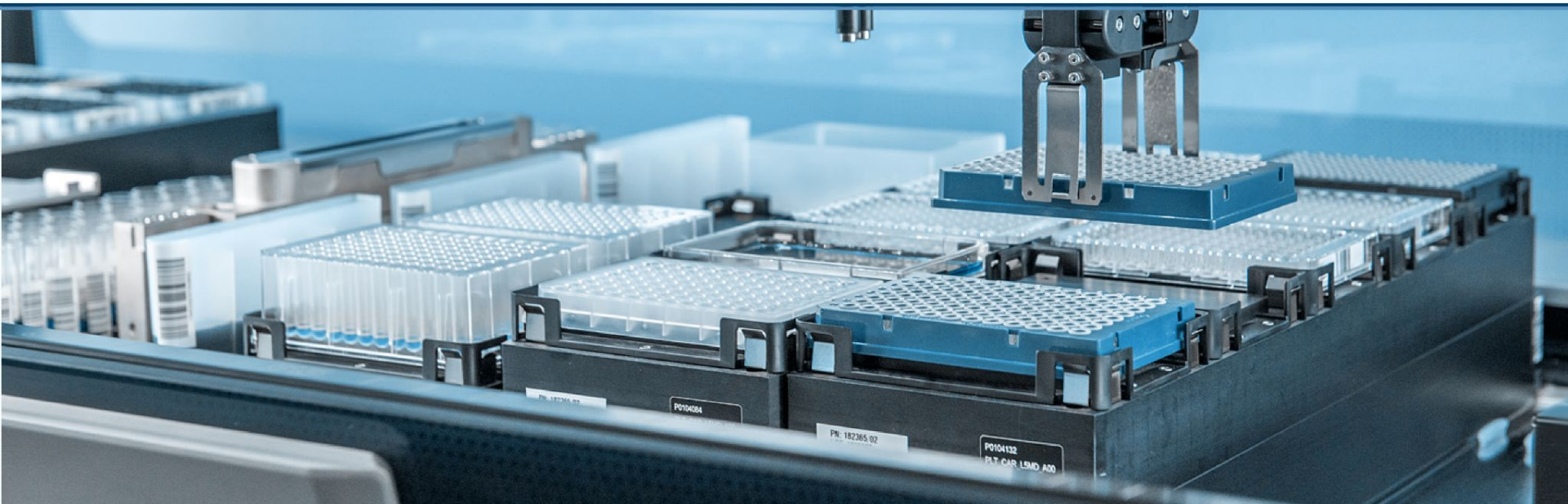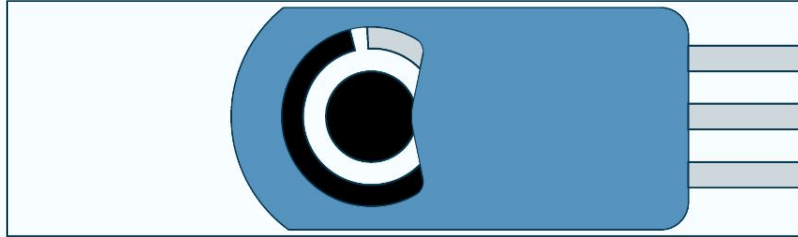
Single probes are rate-limiting

Because no multichannel probes exist, even robotic solutions are still very slow (~90 minutes to measure 96 samples).
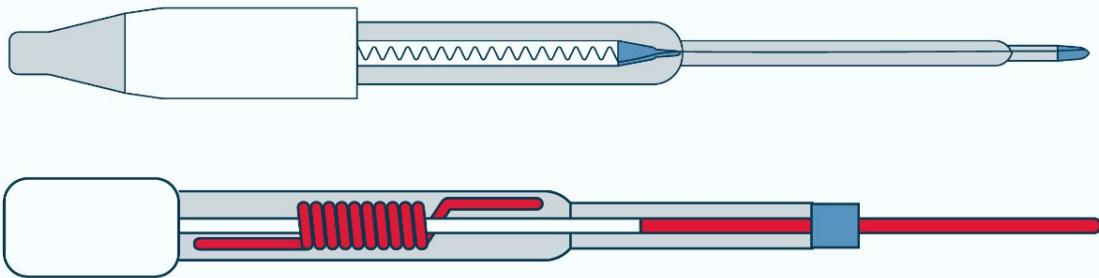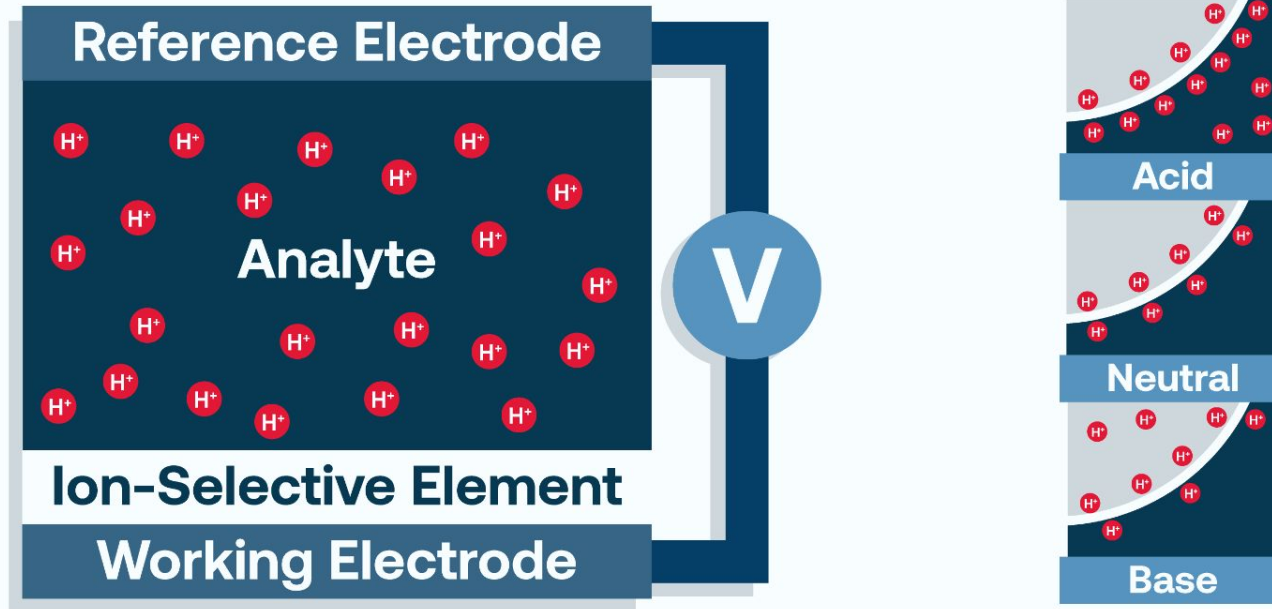
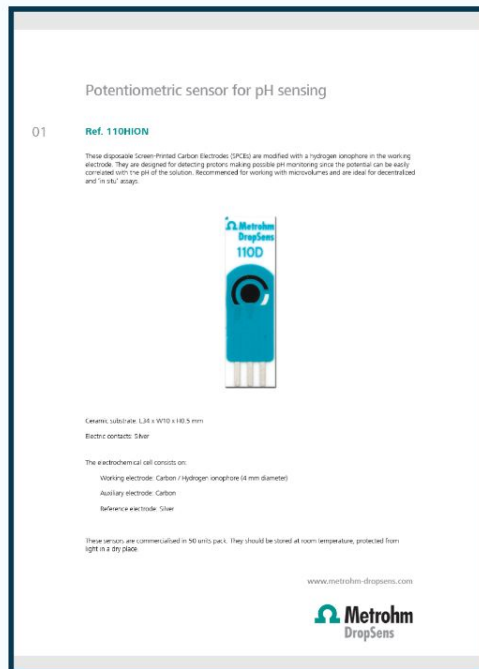# Screen Printed Electrodes (SPEs) offer benefits over glass probes

- Fluids can be pipetted directly onto the surface
- Many sensors in one device
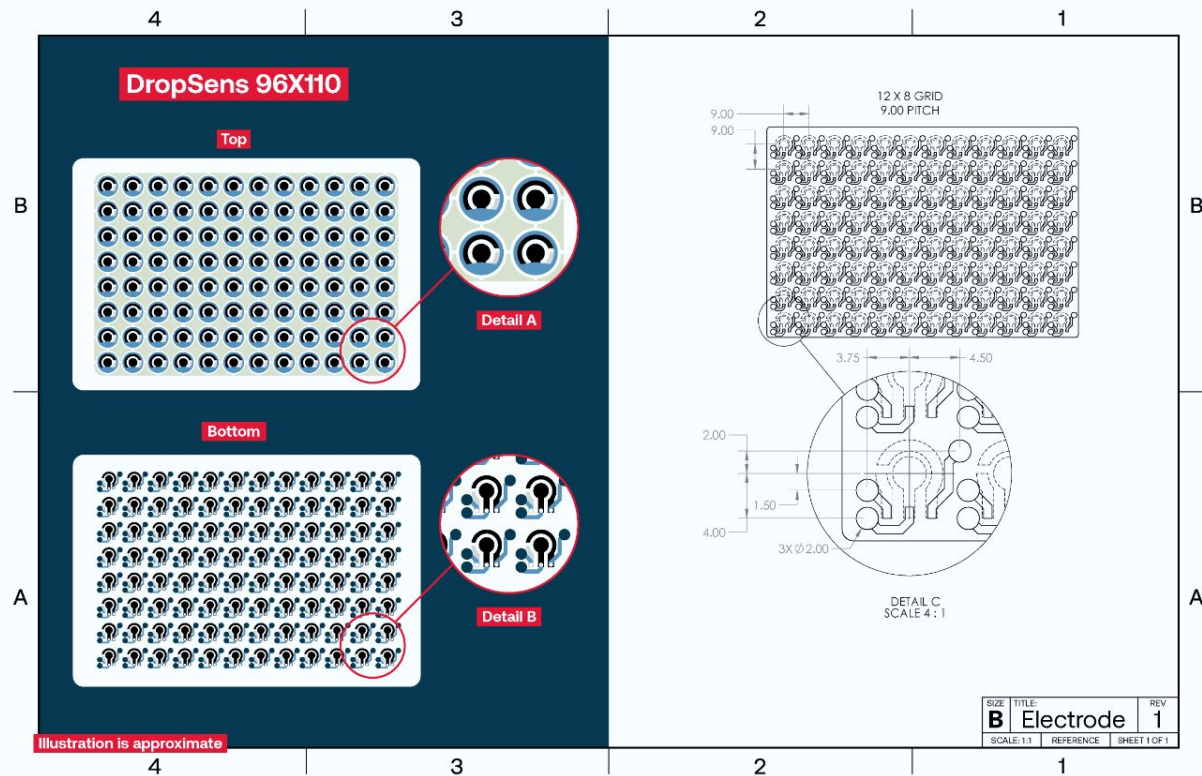- No risk of crashing

pH measurement requires a selective element to distinguish between ions
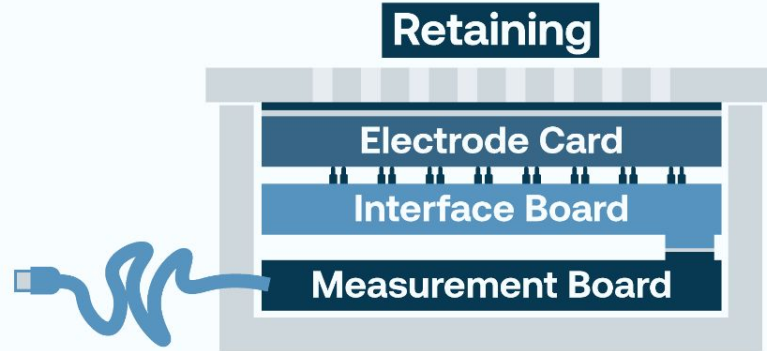
No ion-selective electrode card existed

Now one does!
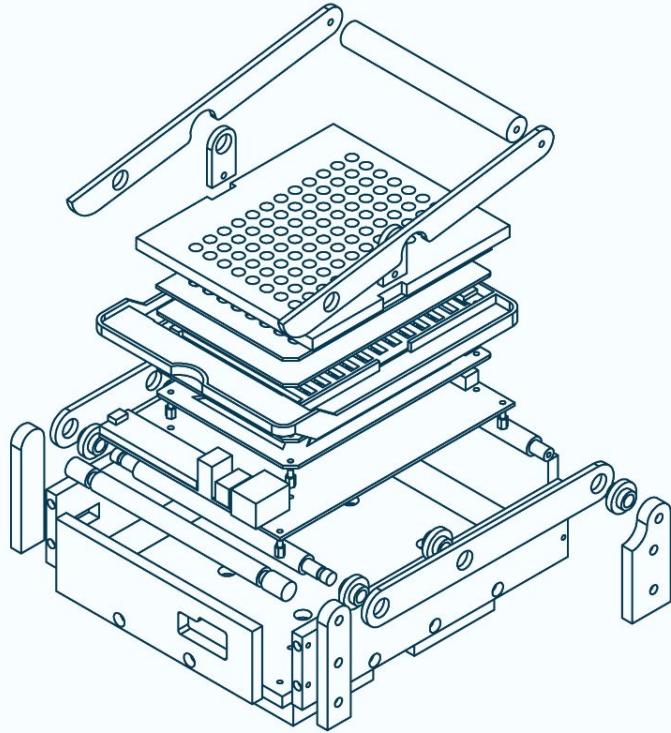
We built a pH sensor that can take 96 measurements in 15 minutes.

System Overview

Retaining System
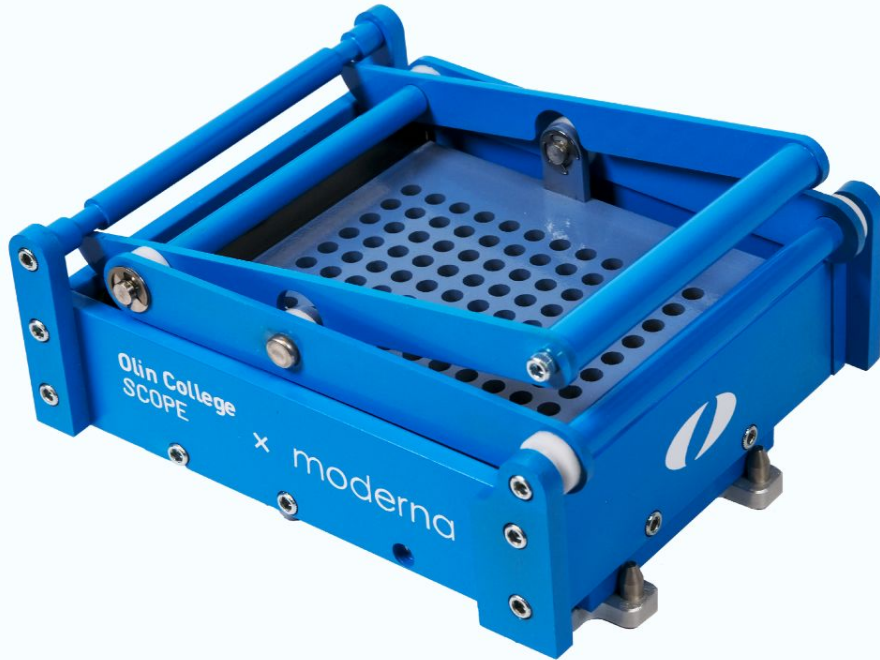
Retaining System
Electrode Card
Interface Board
Measurement Board
Software

Electrode Card

Retaining System
Electrode Card
Interface Board
Measurement Board
Software

Interface Board

Retaining System
Electrode Card
Interface Board
Measurement Board
Software

Measurement Board

Retaining System
Electrode Card
Interface Board
Measurement Board
Software

Software

```
# show -p
Showing pH values from the most recent measurement in pH units. To see the associated voltages, use 'show -v'.

        1       2       3       4       5       6       7       8       9      10      11      12

  A   10.00   10.00   10.00    4.00   10.00   10.00   10.00   10.00    4.00   10.00   10.00    4.00
  B    4.00   10.00   10.00    4.00   10.00   10.00   10.00    4.00   10.00   10.00    4.00   10.00
  C    9.81   10.00    8.12    4.00    4.00   10.00    5.18   10.00   10.00    4.00   10.00    4.00
  D    4.00   10.00   10.00   10.00    5.23    4.00    4.00   10.00   10.00    5.38   10.00    9.16
  E   10.00    5.50    4.00   10.00   10.00   10.00    4.00   10.00   10.00    4.00   10.00   10.00
  F    4.00    4.62   10.00   10.00   10.00    4.00    4.00   10.00    4.00    4.00    4.00   10.00
  G    4.89   10.00    4.00    6.81   10.00   10.00   10.00    5.79   10.00    4.00   10.00   10.00
  H    4.00    4.00    4.00    4.00   10.00    4.00    4.15   10.00    4.00    7.39    4.00   10.00

#
```
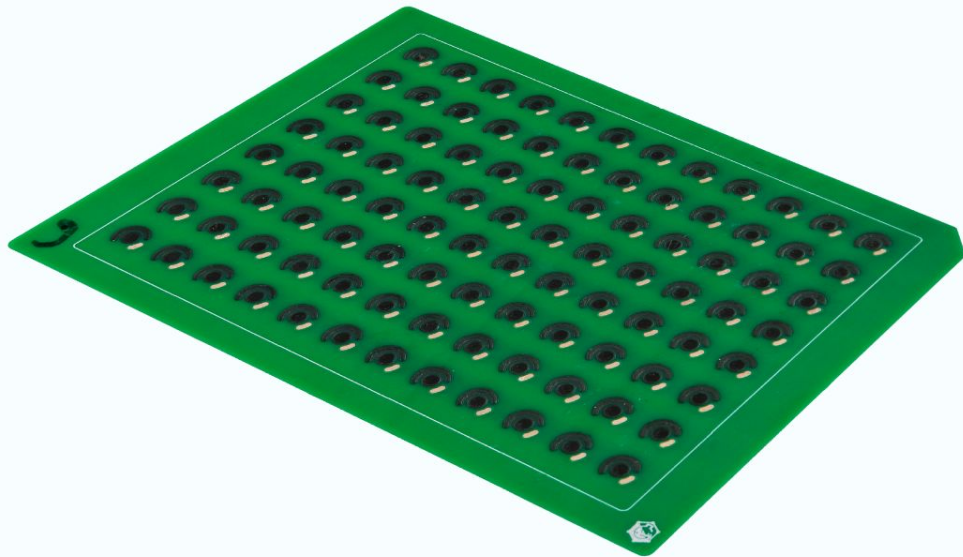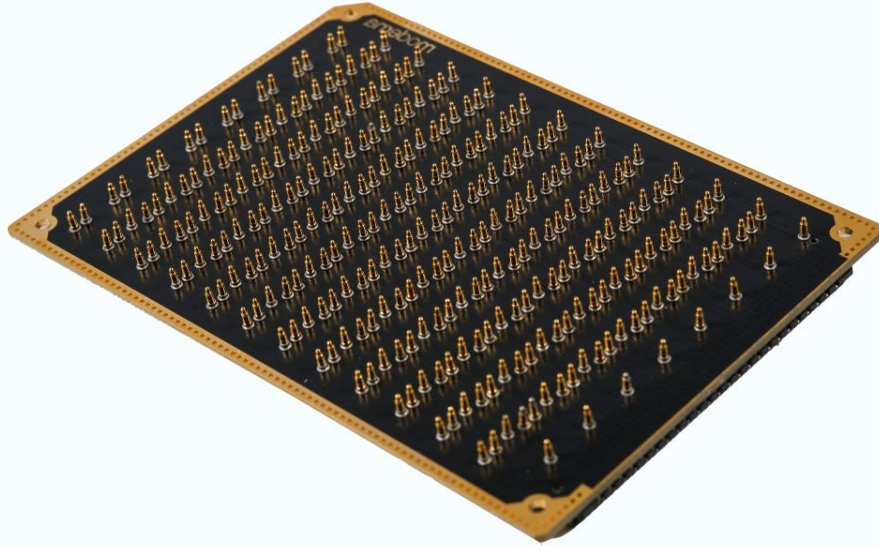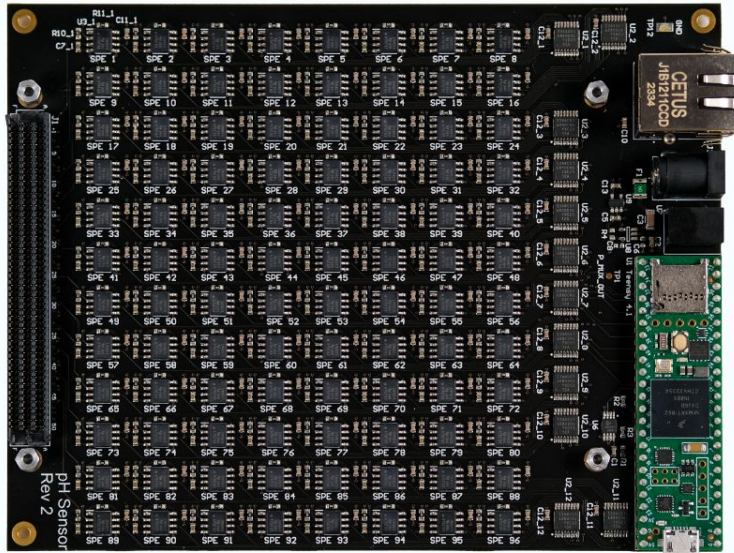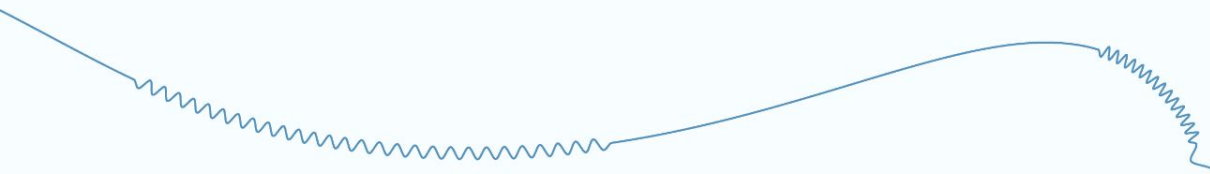
Retaining System
Electrode Card
Interface Board
Measurement Board
Software

Our Device

- Increases throughput by 30x
- Works with microvolume samples
- Removes manual data entry
- Enables use of a liquid handling robot

and allows Moderna to...

- Characterize more LNP solutions
- Ultimately develop mRNA medicines faster

Thank You!

- Thank you to our wonderful advisor, Alessandra
- Thank you to folks at Moderna: Rud, Xavier, Stephanie, Nick, Andrew