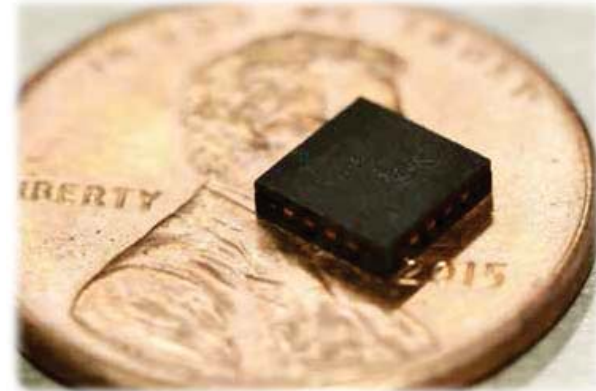




N5 Sensors, Inc.

smart sensors for a safer world

**Developing Testing Program and
Infrastructure for a Sensor Start-Up**
Motayed, Founder, CEO



June 2017

IoT: A Sensor Heavy World



- SENSORS**
- Accelerometer
 - Gyro
 - E-Compass
 - Barometric Pressure Sensor
 - Heart Rate Sensors
 - Proximity Sensors
 - Hall Sensors
 - GPS
 - Camera
 - Temp/Humidity



Sensors are enablers for host products and services



Monitoring Trends and Activities

Sleep, Athletic, Heart Rate, Energy Usage, Safety

***Environmental sensors are in their infancy....
A billion dollar opportunity!***

N5's Chip-Scale Gas/Chemical Sensor Technology

Less than 10 milliwatts

Manufactured using same methods as standard
 integrated circuits

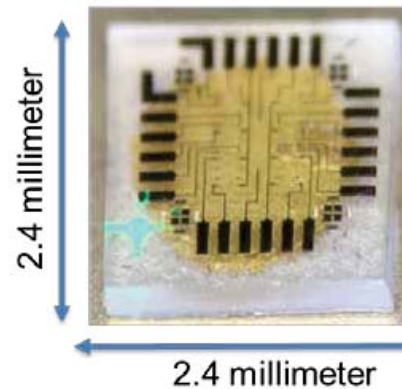
Low-Power, Highly-Scalable, low-cost

Patent-pending design allows for detection of
 variety of gases and chemicals – CO, CO₂, CH₄, H₂,
 NO₂, NH₃, H₂S, HCl, HCN, CL₂, VOCs (relevant to
 fire-gas and TIC/TIM)



Platform Technology

Chip-Scale Design (Ideal for Wearables and
 Compact Solutions)

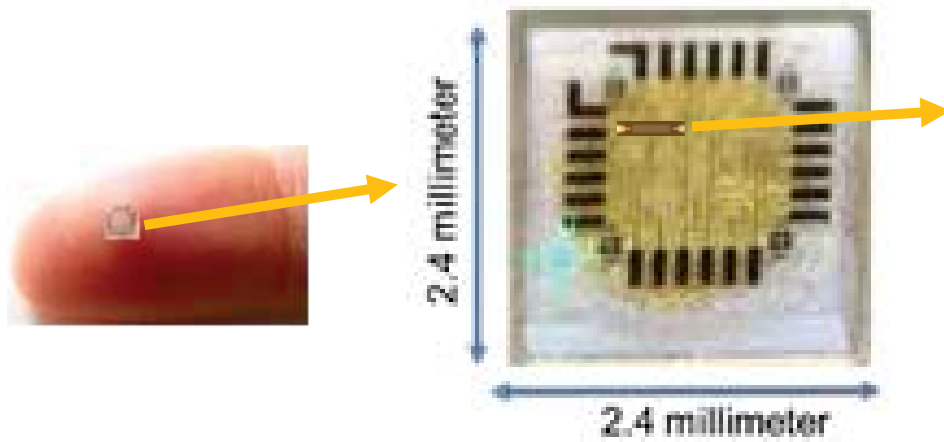


A single chip contains multiple
 micro-sensors designed to
 detect different target gases

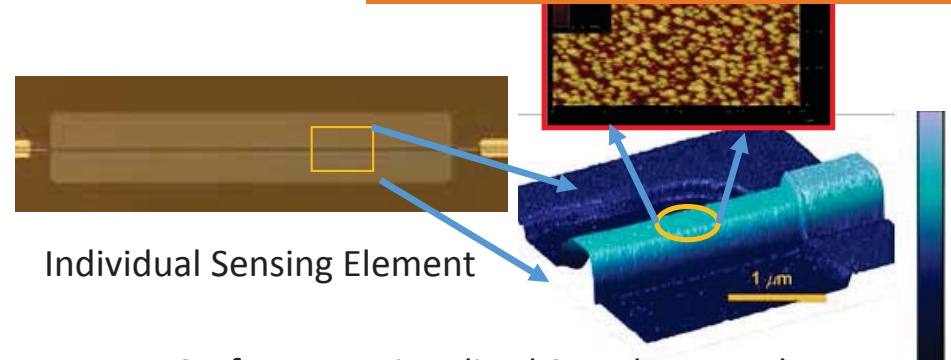
Robust and Reliable Sensors
 (Ideal for Industrial Applications)

Longer life-time and operation
 in wide temperature and
 humidity range

Technical – Sensor Design

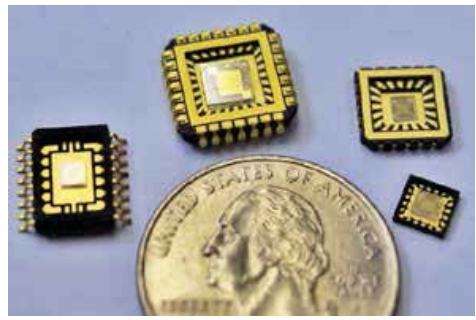


Nanophotocatalytic Functionalization



Individual Sensing Element

Surface Functionalized 3-D Photoconductor



Packaging Can Make or Break the Product

600 dies to test

	A0-1	A0-2	A0-3	A0-4	A0-5	A0-6	A0-7	A0-8	A0-9	A0-10	A0-11	A0-12	A0-13	A0-14	A0-15	A0-16	A0-17	A0-18	A0-19	A0-20	A0-21
	A1-1	A1-2	A1-3	A1-4	A1-5	A1-6	A1-7	A1-8	A1-9	A1-10	A1-11	A1-12	A1-13	A1-14	A1-15	A1-16	A1-17	A1-18	A1-19	A1-20	A1-21
	A2-1	A2-2	A2-3	A2-4	A2-5	A2-6	A2-7	A2-8	A2-9	A2-10	A2-11	A2-12	A2-13	A2-14	A2-15	A2-16	A2-17	A2-18	A2-19	A2-20	A2-21
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	A4-1	A4-2	A4-3	A4-4	A4-5	A4-6	A4-7	A4-8	A4-9	A4-10	A4-11	A4-12	A4-13	A4-14	A4-15	A4-16	A4-17	A4-18	A4-19	A4-20	A4-21
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Challenges of Developing a Cost-Effective Testing Program

Cost

Turn Key or Custom Built

Accurate and Reliable

Reproducible Vapor Stream and Concentration Set points and Profile

Effective

Able to Produce Multitude of Testing Conditions

Versatile

Able to Test Sensors, Packages, Modules, Systems

High-Throughput

Rapid Testing and Fully-Automated

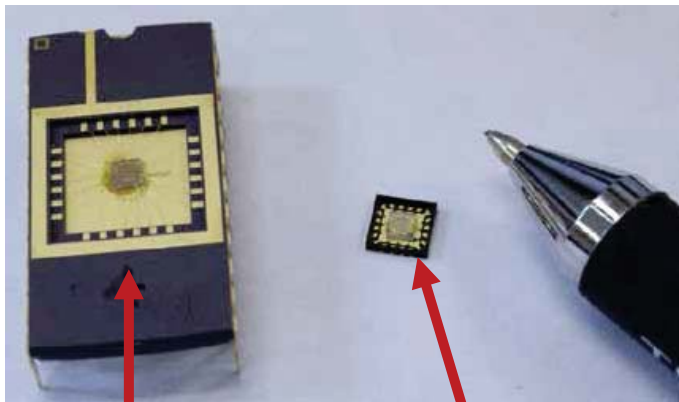
Upgradable

Future Programs and Products

Maintenance and Repair

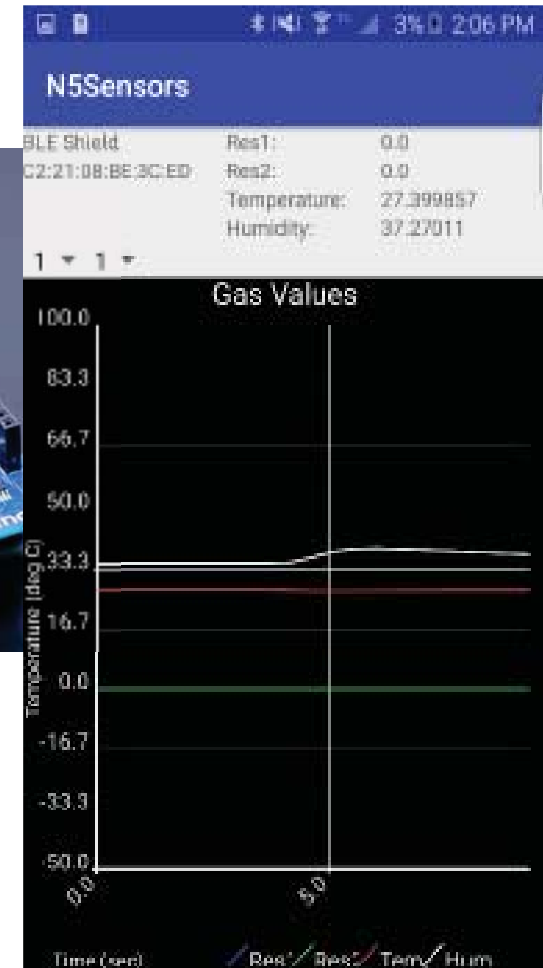
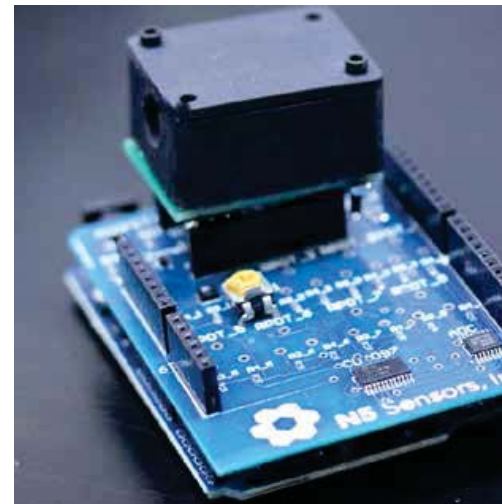
Fast Turnaround, Redundancies

Sensors Vs. Systems Testing



2015

2016

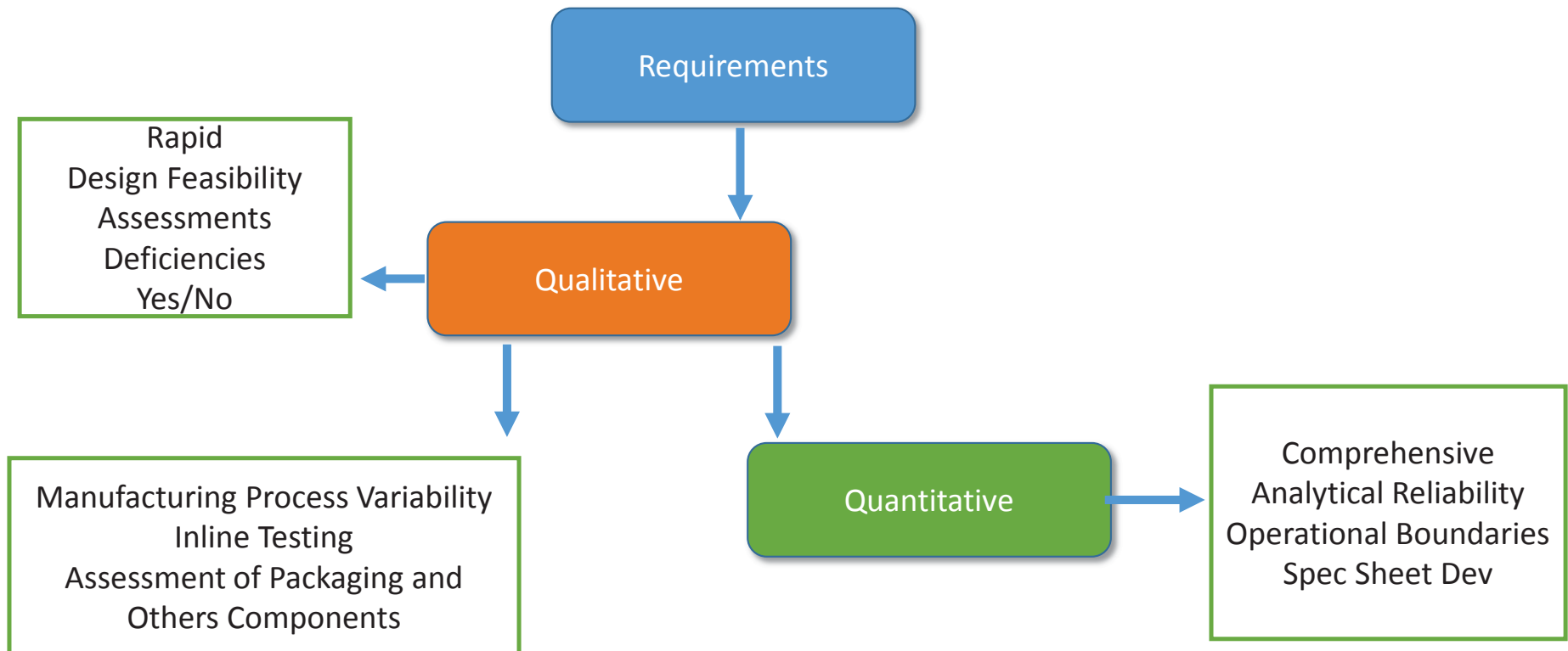


N5 Sensor Testing Lab

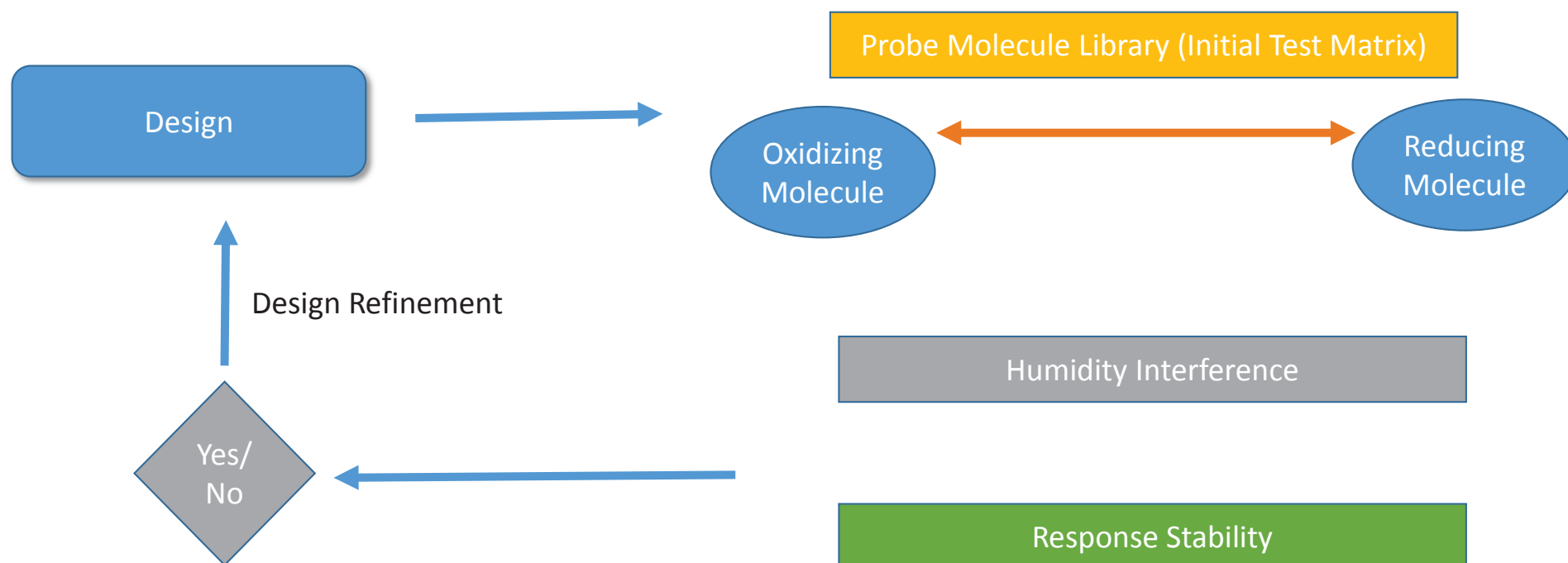


2 Independent Mixing
Manifolds
Corrosive
Non-Corrosive Gases
8-Channel Manifolds
Independently controllable
Carrier Gas – Air or Inert, O₂
Lean or Rich
Ability to Derive Flow from
Certified Gas Tanks and Bubbler
Bronkhorst Accurate Humidity
Controller 0 – 95% RH (1% RH
Delta)
Inline Humidity Monitoring
Mode – Unattended, or Manual
Able to Program Test Plans
Software Developed by N5

Developing a Testing Methodology

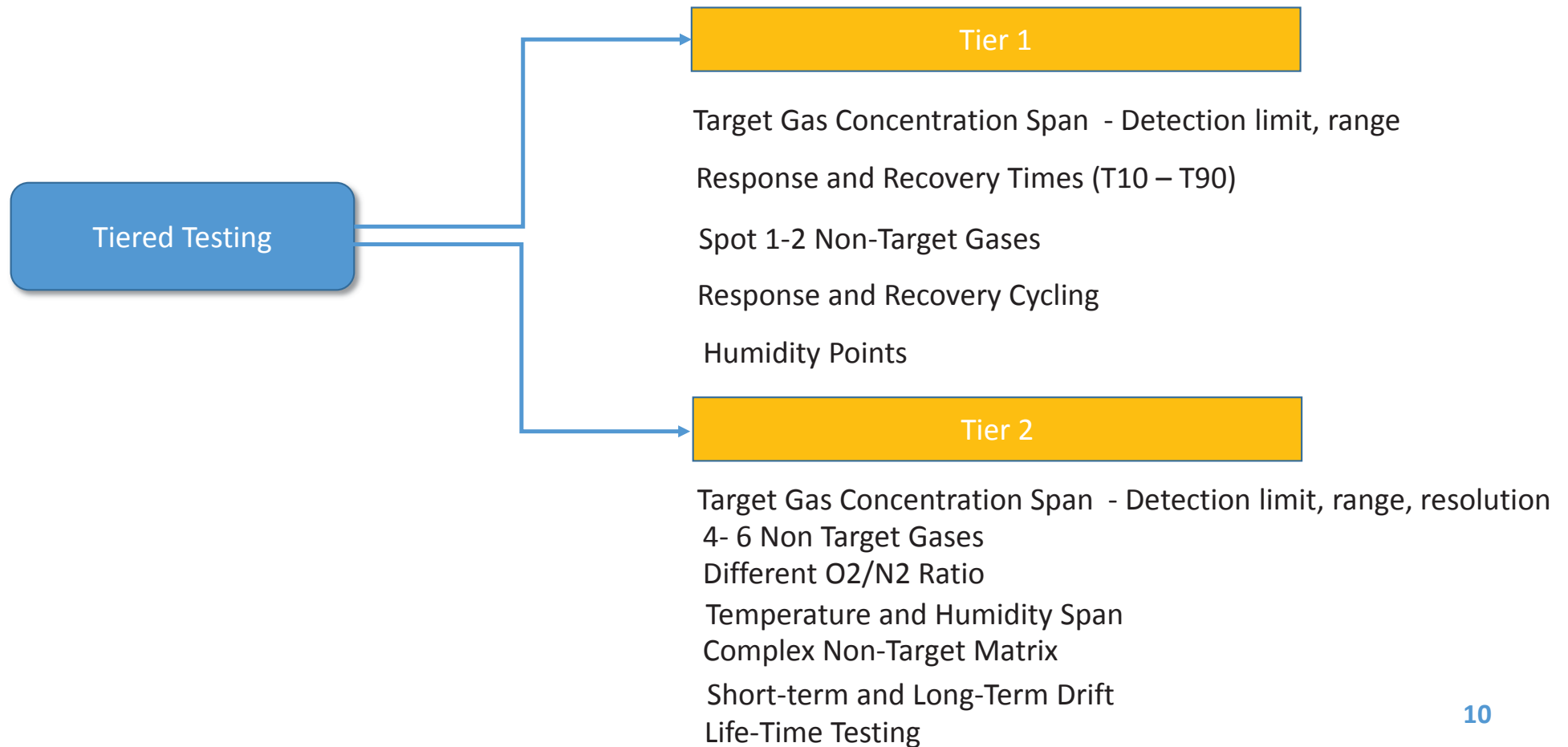


Qualitative Testing – Validation of Initial Sensor Design

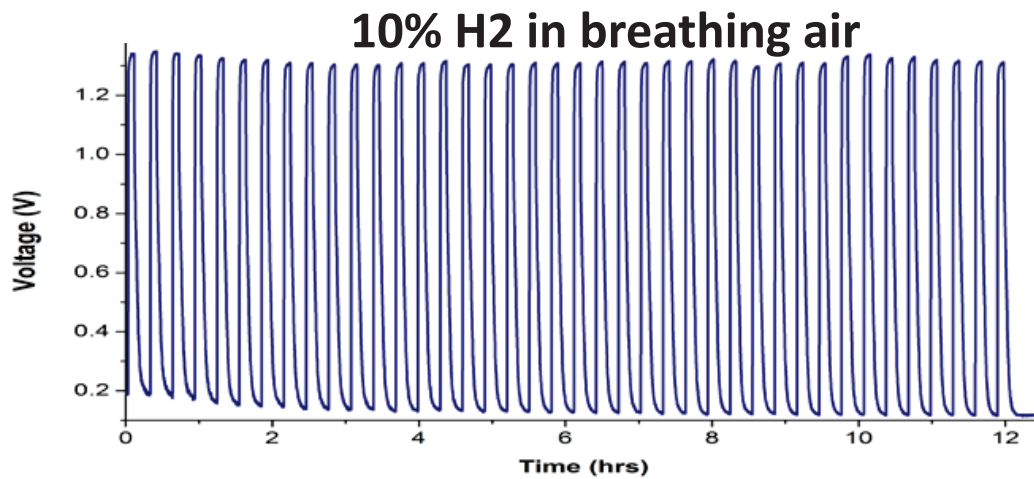
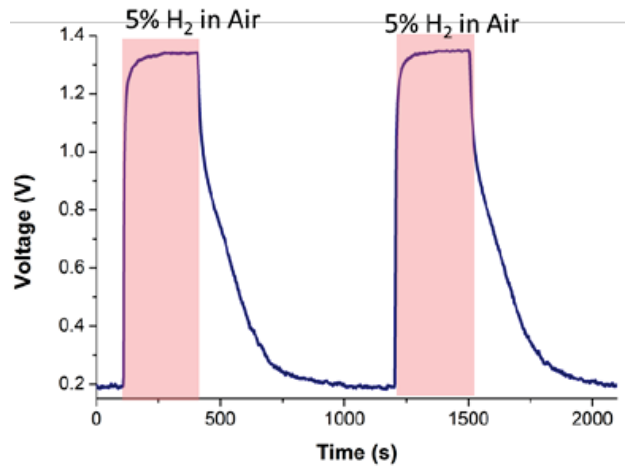


Goal – Finalizing the Design with Least Amount of Time and Money

Quantitative Testing – Comprehensive Data Generation



Some Examples



Analyte	Range of Detection	Response (%) = $(R_{\text{gas}} - R_{\text{air}}) / R_{\text{air}}$
Ammonia	1 – 100 ppm	15
Chlorine	0.5 – 10 ppm	212
Hydrogen chloride	1 – 100 ppm	74
Hydrogen cyanide	1 – 100 ppm	10
Hydrogen sulphide	10 – 1000 ppm	20
Hydrogen	0.5 - 10%	500
Oxygen	10 - 30%	40
Carbon dioxide	0.1 - 1%	2
Carbon monoxide	10 – 300 ppm	15
Nitrogen dioxide	100 – 500 ppm	2
Nitric oxide	5 – 1000 ppm	2.6
Methane	50 – 5000 ppm	9




Acknowledgements

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