SIXTEENTH ANNUAL
BiTS
TM
Burn-in & Test Strategies Workshop
March 15 - 18, 2015
Hilton Phoenix / Mesa Hotel
Mesa, Arizona
Archive – Session 1
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Session 1
Marc Mössinger
Session Chair

BiTS Workshop 2015 Schedule

Frontiers Day

Monday March 16 10:30 am

Putting MEMS to the Test

"'Taking MEMS Test and Calibration to the Next Level' - An Integrated Platform Approach Driving Further MEMS Growth"

John Rychcik - Xcerra Corporation

"The Target for Consumer MEMS Testing Should Be Under 1 Cent Level"

Vesa Henttonen - Afore Oy

"MEMS IC Manufacturing Test Cost Effective Strategies"

Wendy Chen & Andrei Berar - KYEC

"BURst Pressure (BURP) Stress Test for MEMS Pressure Sensors"

Peter Jones & Ray Sessego - Freescale Semiconductor

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BURst Pressure (BURP) Stress Test for MEMS Pressure Sensors

Peter Jones
Raimondo Sessego
Freescale Semiconductor

2015 BiTS Workshop
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Overview

- **BUR**st **P**ressure (BURP) Stress Test
- Custom wafer level pressure test system design and fabrication
- Used to verify differential pressure sensor meets minimum pressure strength specification.
- Built internally by Freescale Semiconductor.
- 200 mm wafer
- Pressures up to 2000 kPaG (290 psig, 20 bar(g)) for single device parallelism
- x2 Parallelism for production test pressures 500 kPaG (73 psig, 5 bar(g))

Sensors Solutions Division

	Pressure	**Automotive, industrial, medical** and **consumer** absolute and differential sensors *Flow, comfort management, HVAC, medical, engine control*
	Accelerometer	**Consumer and industrial** low-g sensors and tilt sensors **Automotive** medium- and high-g crash sensors *Vehicle stability, airbag, vibration monitor, tilt alignment*
	Magnetometer	**Consumer and industrial** magnetic field sensor and 3D compass *Orientation alignment, proximity detection, magnetic switch*
	Gyroscope	**Consumer and industrial** angular rate sensors and 6/9-DOF IMU **Automotive** roll sensor and IMU *Stabilization, motion and gesture HMI, inertial navigation, gaming*
	Sensing systems	**Consumer and industrial** MCU and sensor integrated platforms **Automotive** tire pressure monitoring system *Smart sensors, pedometer, anti-tamper, fault prognostication*

Automotive Pressure Sensors

Manifold Absolute Pressure (MAP)

Barometric Air Pressure (BAP)

Passive Occupant Detection System (PODS)

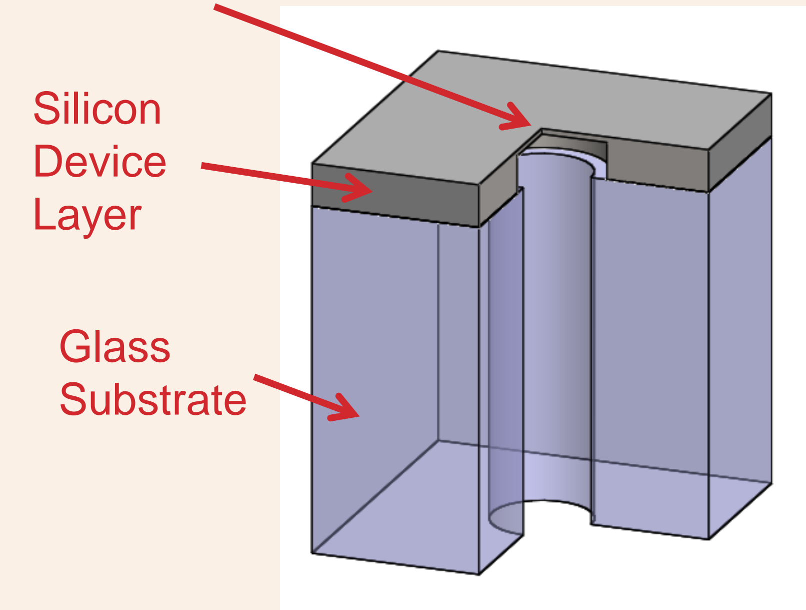
Tire Pressure Monitoring System (TPMS)

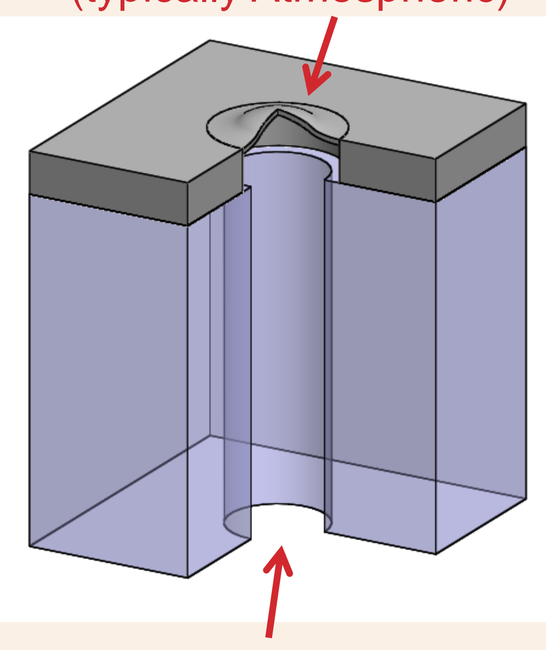
Side Airbag Impact Sensor

Fuel Vapor Pressure Sensor

PODS Device

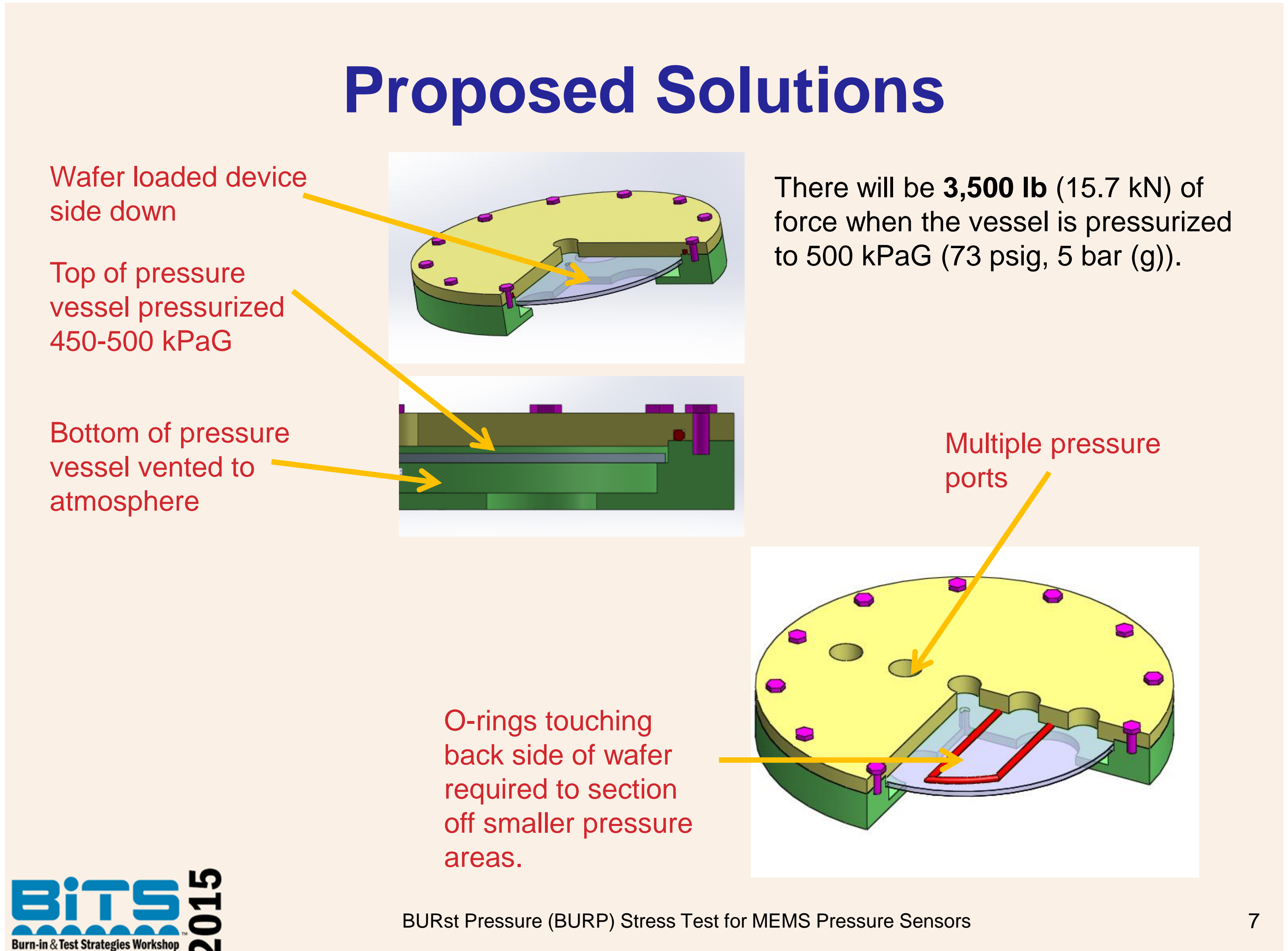
- Device is an approximate cube with a ~3mm length each side.
- Backside, Differential Pressure Sensor





Problem Statement

- Customer found pressure sensors would fail (diaphragm would burst) at pressures lower than the design specification 450 kPaG (65 psig, 4.5 bar(g)).
- Device is sold in die form, so no opportunity to test a fully packaged device (something that would make testing the design pressure easy).
- Prefer to test while devices are still in wafer form, before singulation.
- Apply 500 kPaG (73 psig, 5 bar(g)) to the device's backside.
- Wafer 200 mm diameter, 3.481 mm thick. Silicon wafer bonded to thick glass substrate.
- 2611 usable die on wafer.


Proposed Solutions
Wafer loaded device side down
Top of pressure vessel pressurized 450-500 kPaG
Bottom of pressure vessel vented to atmosphere
There will be **3,500 lb** (15.7 kN) of force when the vessel is pressurized to 500 kPaG (73 psig, 5 bar (g)).
Multiple pressure ports
O-rings touching back side of wafer required to section off smaller pressure areas.
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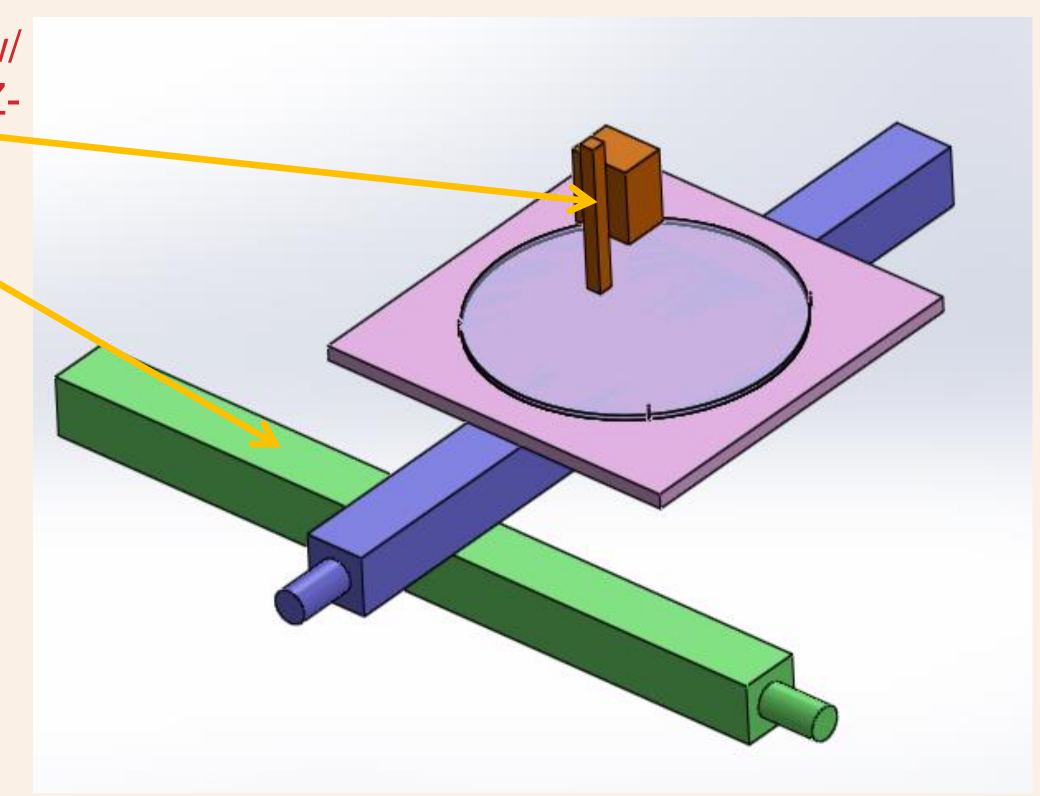
Final Concept
Test Small Portion of Wafer – Pressure Nozzle w/ XY Stage

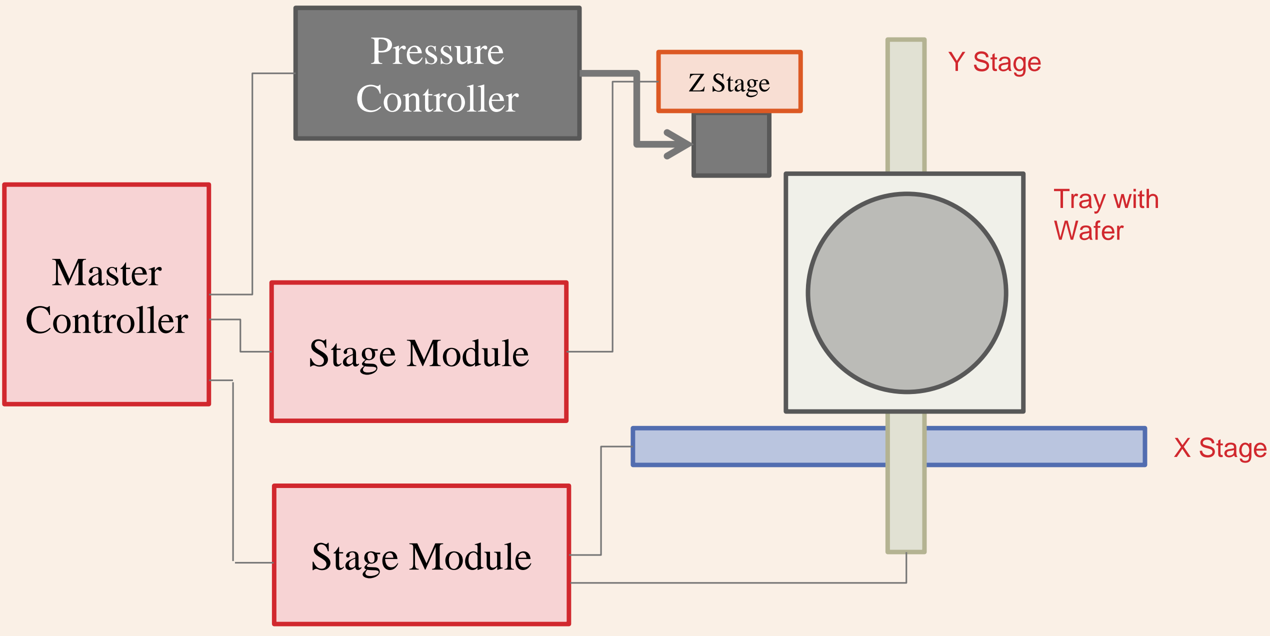
Pressure Nozzle w/ Force Controlled Z-axis stage

XY Stage



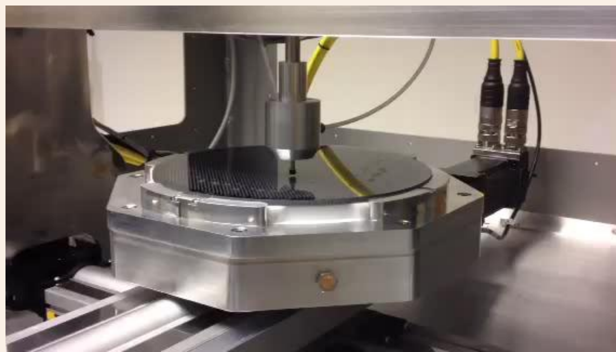
Greatly reduced force: for 1 mm diameter nozzle opening, 500 kPaG (73 psig, 5 bar(g)) results in force of 392 mN (8.8e-2 lbf).

Final Concept
Test Small Portion of Wafer – Pressure Nozzle w/ XY Stage



PST-8 (Phase I)

- Pressure Stress Test
- PST-8 System
  - 500 kPaG to “blow out” weak devices before probe
  - Test time 2 sec/DUT
  - 1.7 hour/wafer
- Capable of 2000 kPaG to characterize (destructively) the burst strength.



Production Test

Pressure Stress Test in action (Video)

PST-8 (Phase I)

Z Axis Actuator

Solenoid Valve

Pressure Transducer

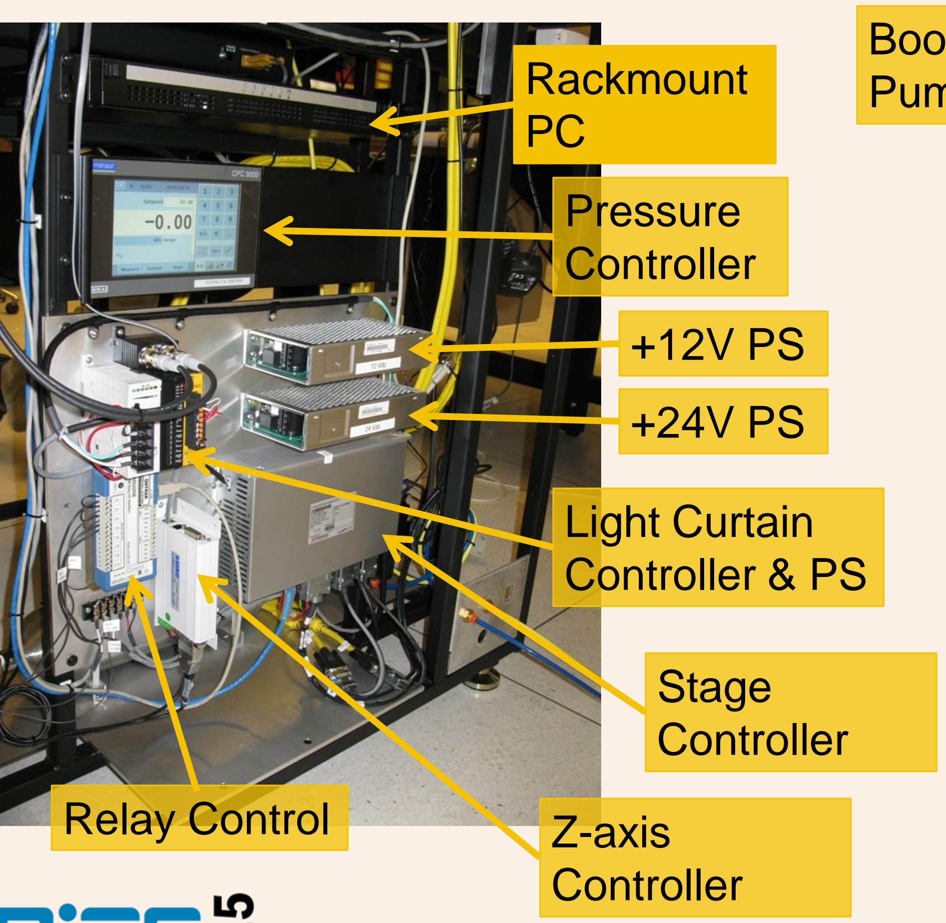
Pressure Nozzle

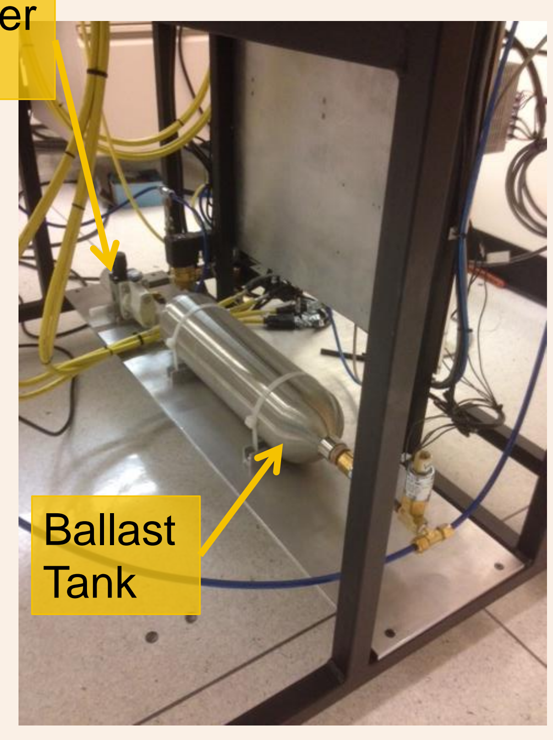
EMO

Wafer Chuck

XY Stage

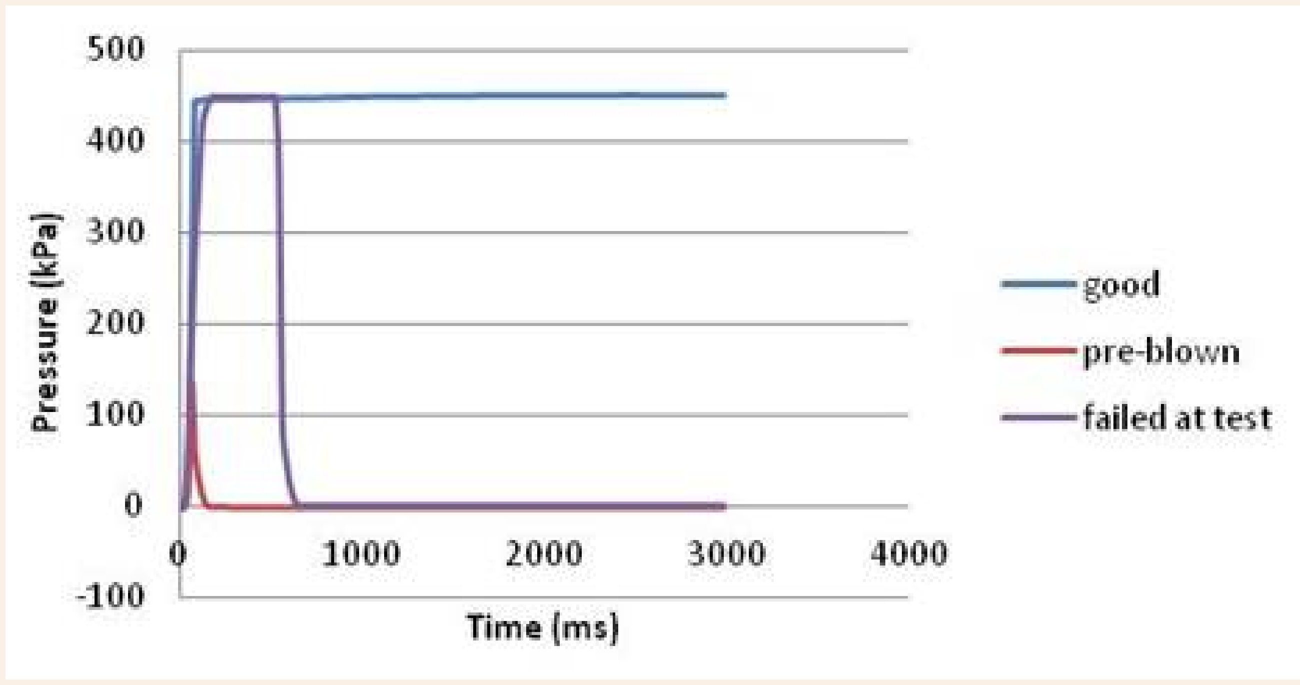
PST-8 (Phase I)





Pressure Profile

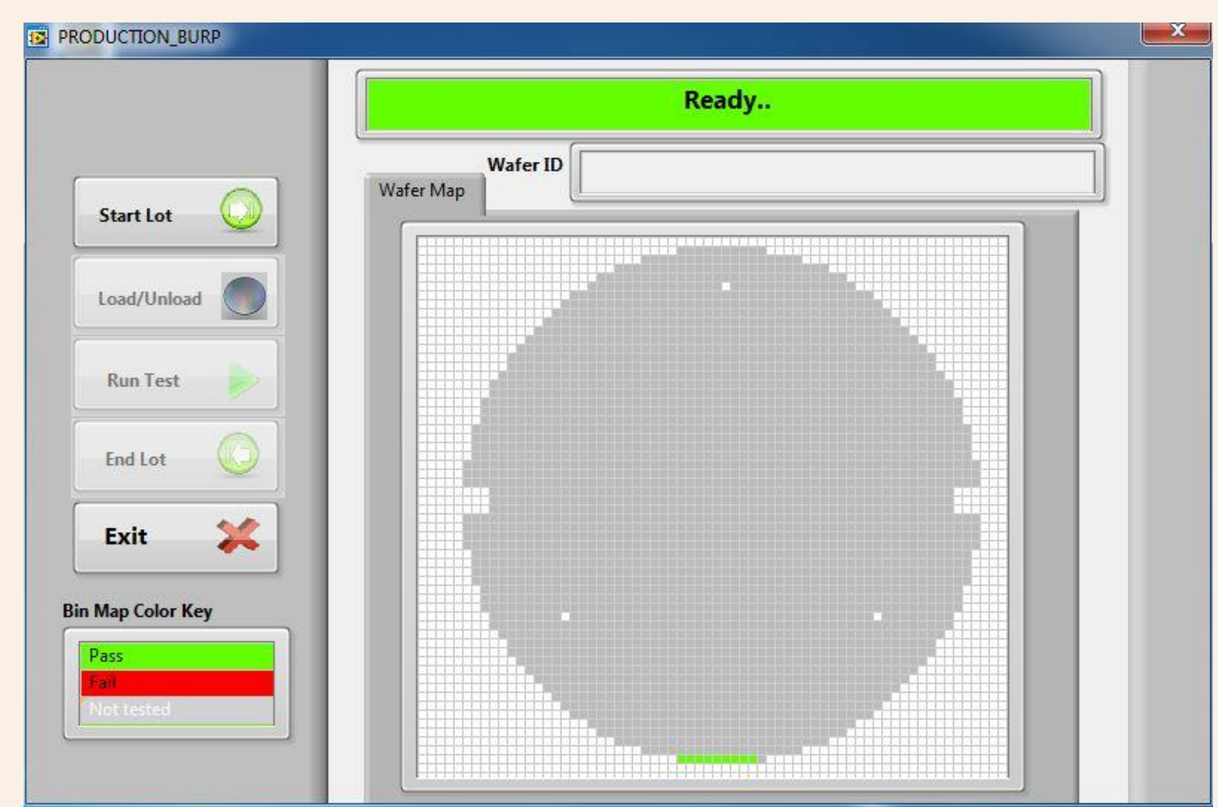
Detect failure by looking for pressure drop at nozzle



Note: This particular test used a pressure of 450 kPaG.

Operator Interface

- LabVIEW based
- Touch Screen Interface



Pressure Ramp Mode

Contour Plot for P_Meas [kPaG]

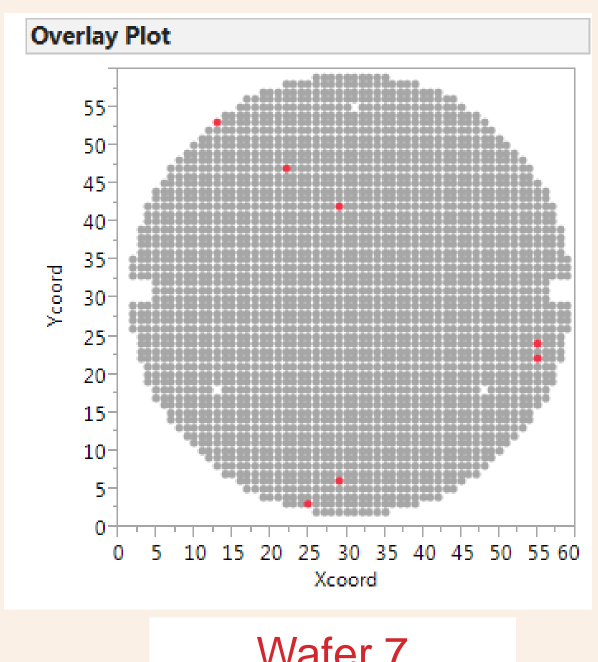
P_Meas [kPaG]

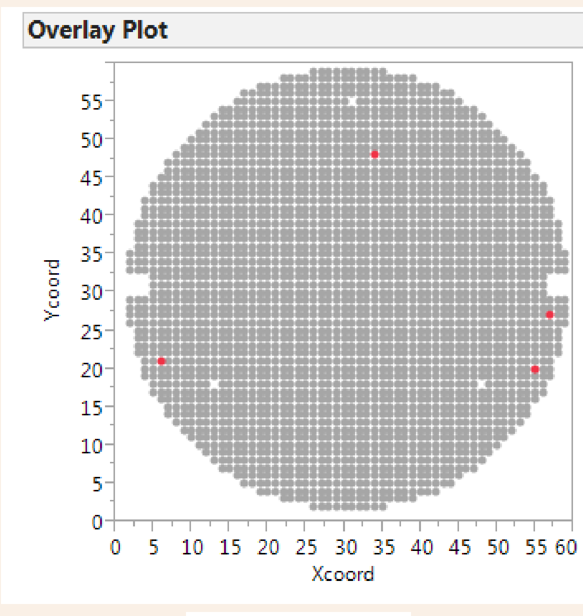
Summary Statistics

Mean	1505.5646
Std Dev	271.35899
Std Err Mean	5.3279388
Upper 95% Mean	1516.0121
Lower 95% Mean	1495.1172
N	2594

18 devices did not fail even at 2000 kPaG.

Pass/Fail (Production) Test





Wafer 7

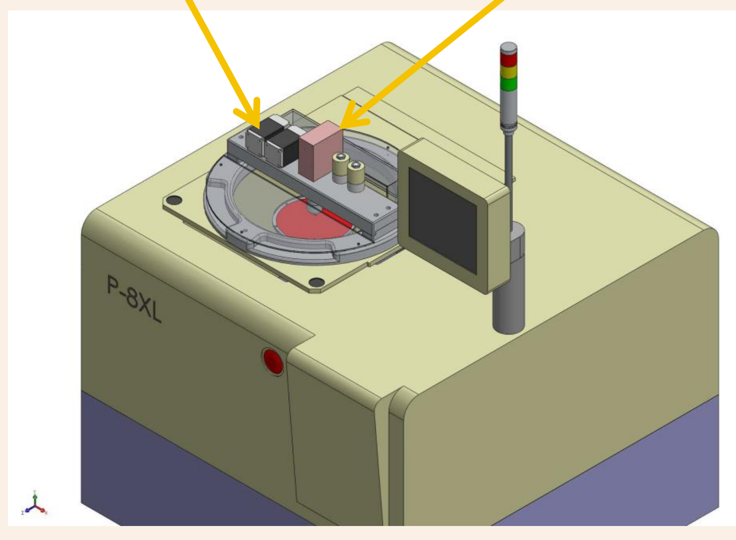
Wafer 15

Wafer 7	7 failures
Wafer 15	4 failures

Phase II System

- Solution for off-the-shelf prober
- x2 Parallelism
- A custom tray was developed to hold the wafer device side down, with clearance for air outflow. Sticky tray film will catch debris from the blown diaphragms.

Phase II System



Conclusion and Remarks

- Build a custom pressure system because nothing similar was commercially available.
- In the future, can the Test Equipment Industry provide economical solutions for testing pressure sensor devices.