



Optical Leak Testing (OLT) Technology

March 26, 2021



Optical Leak Test Features

- Simultaneous gross and fine leak inspection in 1 test.
- Up to 500 devices in a single test.
- Shorter test cycles. Sometimes only 6 minutes.
 - Eliminates helium bombing.
- Outputs results in L_{air} or L_{He} cc-atm/sec.
 - Reject limits in MIL-STD-883K are L_{air} .
 - OLT is only fine leak method available that can directly measure L_{air} .
- Test packages mounted to a circuit board.
- Usually less than 10 minutes to setup new p/n.
- High volume testing.
- Results can be networked for serial number tracking.

Hermetic Leak Test Methods

- Helium Mass Spectrometry, HMS (Fine)
- Bubble Leak testing (Gross)
- Dye Penetrant (Gross) (Destructive)
- Residual Gas Analysis (Destructive)
- Krypton 85 Fine and Red Dye for Gross
- Optical Leak Testing, OLT (Fine and Gross)



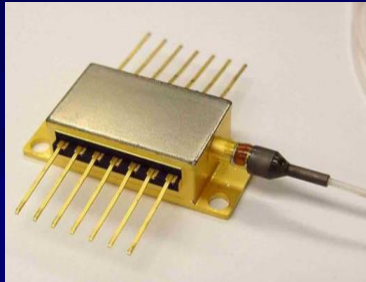
Technical Issues with HMS and Bubble Leak Testing

- Long helium bomb cycle times, usually 8 hours.
- Two helium bomb cycles.
 - One for HMS, another for bubble leak testing.
- Can not test at the board level.
- Gap in test coverage in the 1×10^{-5} cc-atm/sec range.
- Helium absorption by package causes false failures.
 - Typical problem with fiber optic cables attached.
- Product contamination by fluids during bubble testing.
- Bubble leak testing very operator dependent.
 - It's possible to miss seeing bubbles, so failed units escape.
- High cost of flourinert for bubble test.
- Environmental concern perfluorocarbon, bubble test.



Typical Package Types for OLT

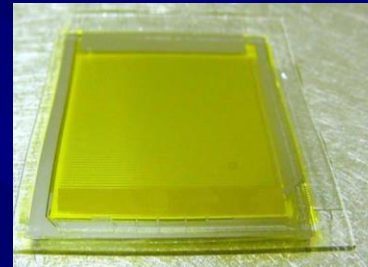
Butterflies



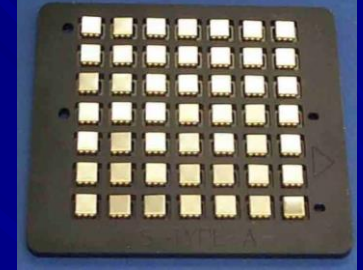
Pacemakers



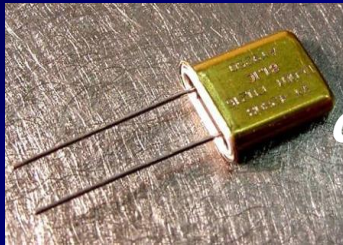
Display Devices



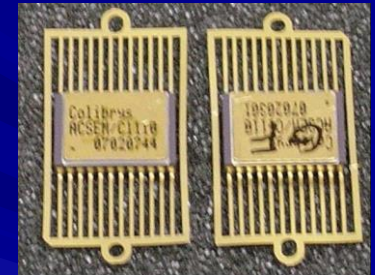
Frequency Control



Quartz Crystals



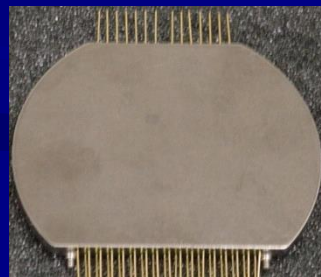
Hybrids



Fiber Optics



Custom



TO Styles

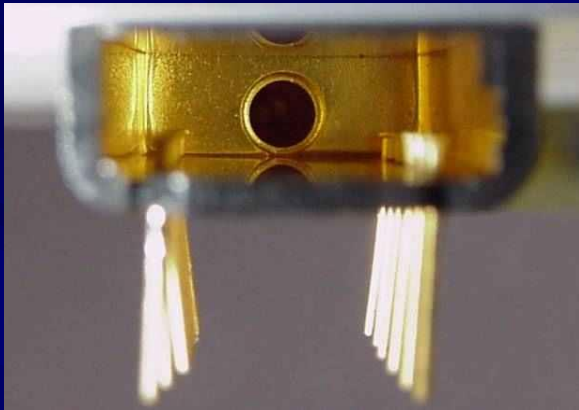
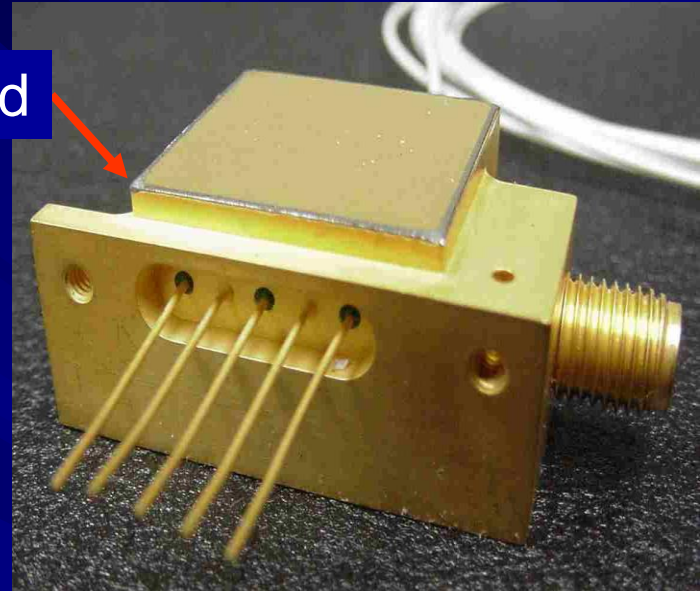


Power Devices



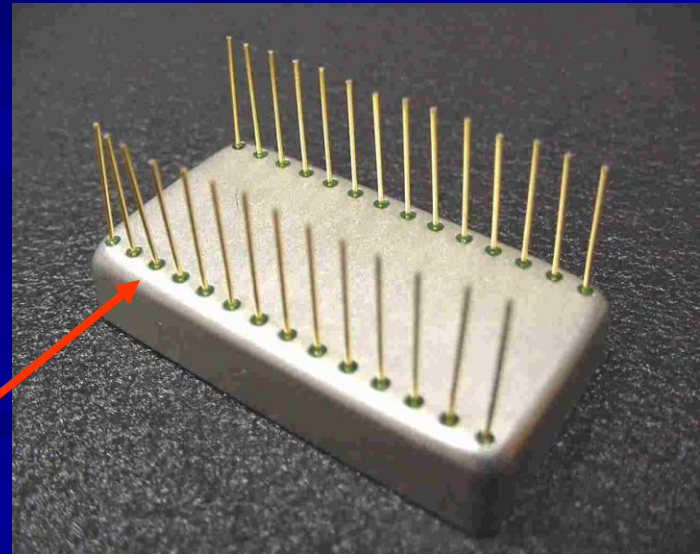
Sources of Leaks in Packages

Along the weld



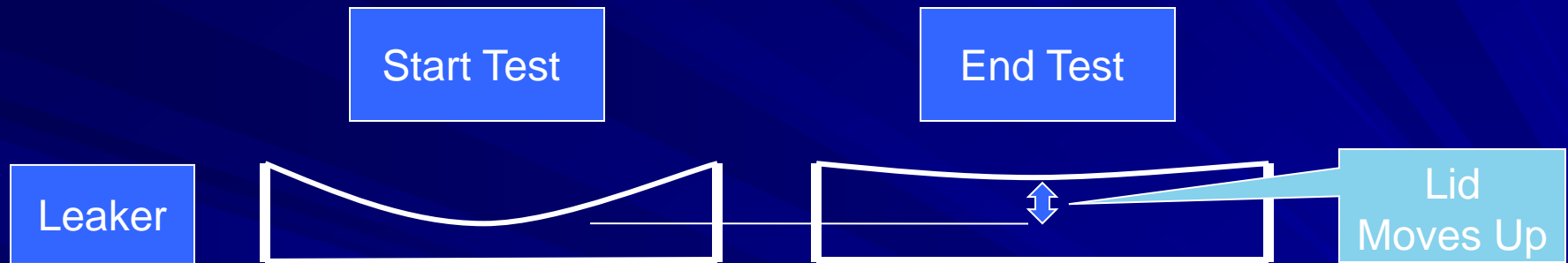
A defect in the lid
or housing

At the glass to metal
feed through

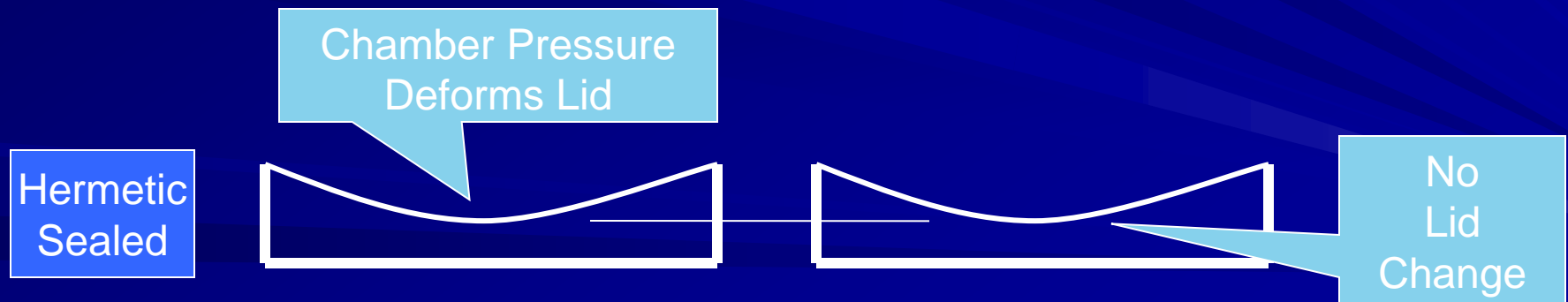


Theory Leaking vs Hermetic

- Side view of package.
- Chamber pressure causes lid to bow down “ ”.

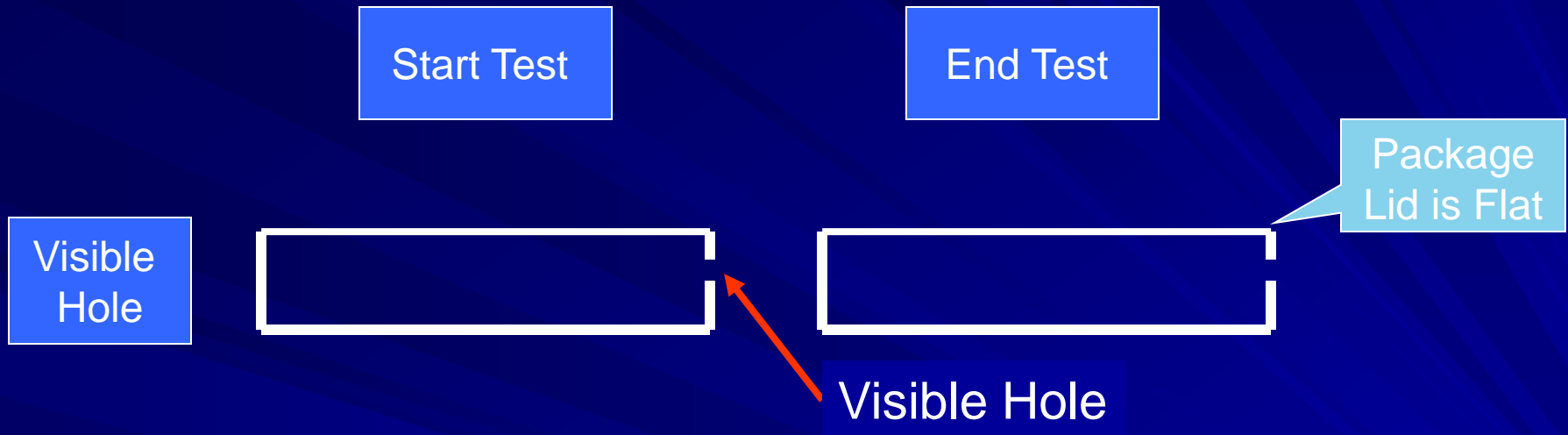


- Air rushes in on a leaking package to push lid up.

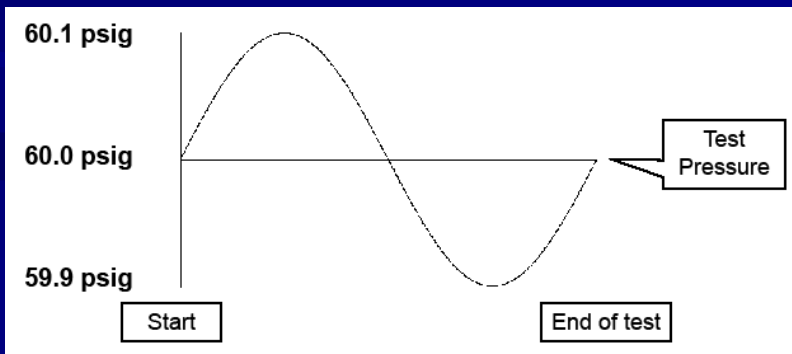


- Air can not get into sealed package to move lid.

Theory with Visible Hole



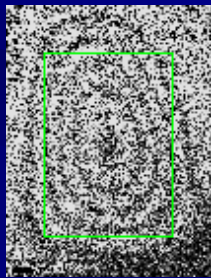
- Air rushes in through visible hole so lid stays flat.
- Add pressure modulation to measure spring rate of lid.
- Above lid stiffness is 0 um/psi. Hermetic > -0.02 um/psi.



- Typical pressure modulation for butterfly package with lid stiffness – 1um/psi.

Interference Fringes

- Fringe is short for Interference Fringe.
- Definition by britannica.com.
 - A bright or dark band caused by beams of light in phase or out of phase. Light waves will add their crests if they meet in the same phase (bright band). The troughs will cancel the crests if they are out of phase (dark band).
- Similar to dropping a pebble in water.



Live video fringe of
package with changing
pressure.

Convert with
software

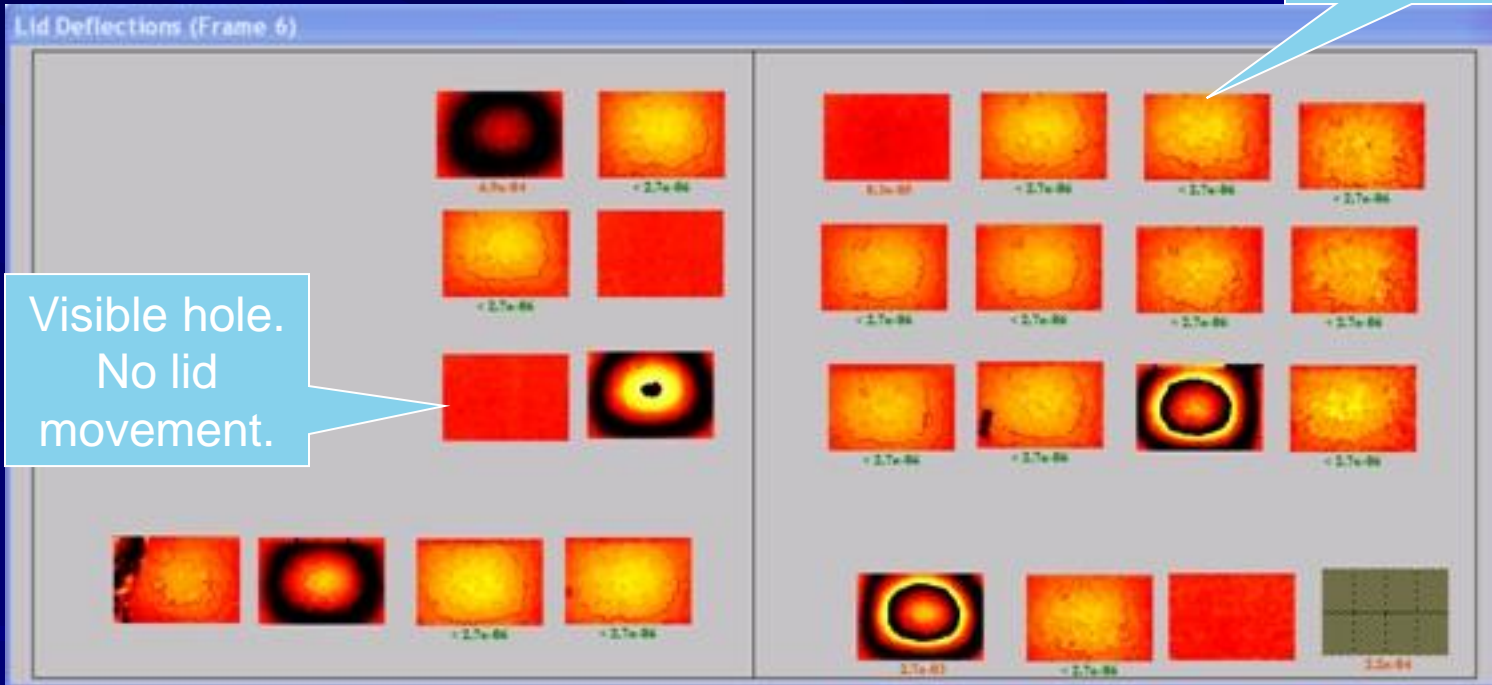


Phase map showing
fringes on leaking device.

Laser Interferometer Phase Maps

- Phase maps taken every 6 seconds or so throughout leak test.

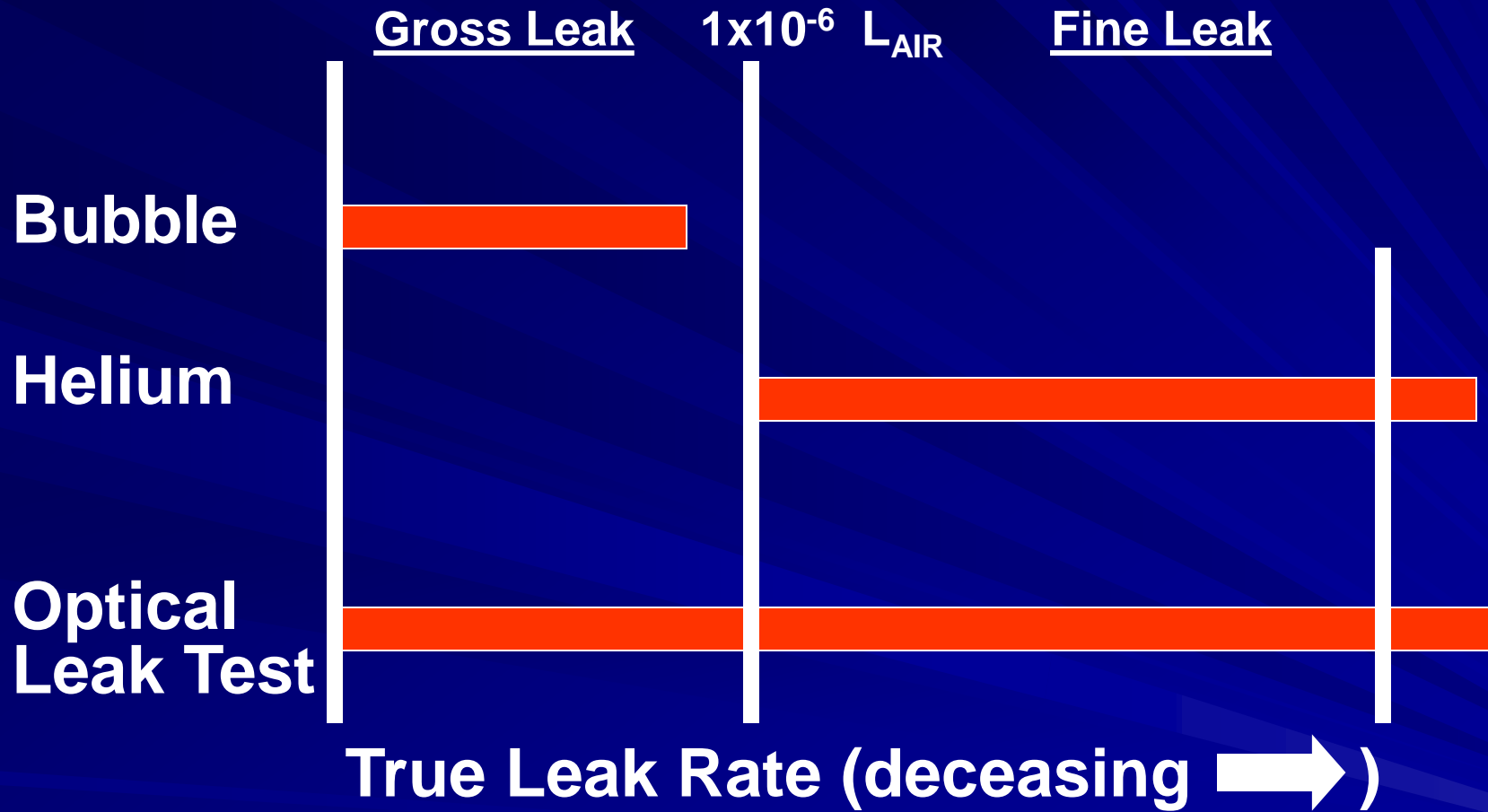
Hermetic:
only one
fringe



Leaker: Many fringes
indicate lid moving up.

1 fringe = 0.26 μm
= $\frac{1}{2}$ wavelength of light

No Gap in Coverage with OLT



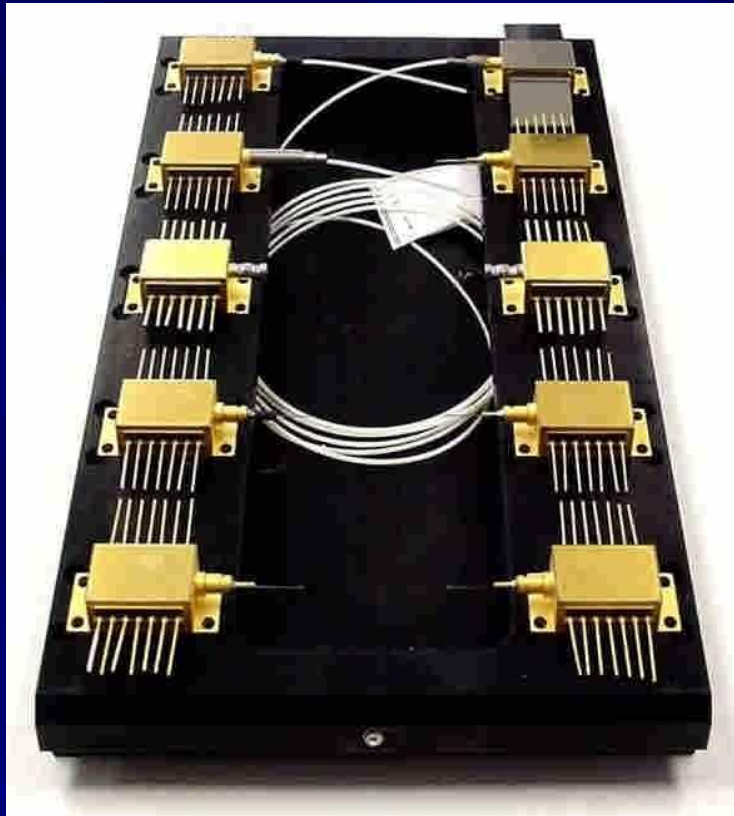
Only OLT Can Directly Measure L_{air}

- Table VII in MIL-STD-883K is proper table for reject limits, which are in L_{air} .
- HMS uses Howl Mann equation to convert R to L.
- Only OLT can directly measure L_{air} with air.

OLT Capability

- Recent test on wafer level device.
 - 24 hours, 64 psig, 0.01 cc,
 - stiffness -0.05 um/psi.
- $L_{\text{he}} = 1.04 \times 10^{-10}$ cc-atm/sec (actual)
- $L_{\text{air}} = 3.87 \times 10^{-11}$ cc-atm/sec (calculated)
- $R_1 = 3.93 \times 10^{-14}$ cc-atm/sec (calculated)
- OLT matches Krypton 85 capability.
- OLT exceeds HMS capability.

System Operation

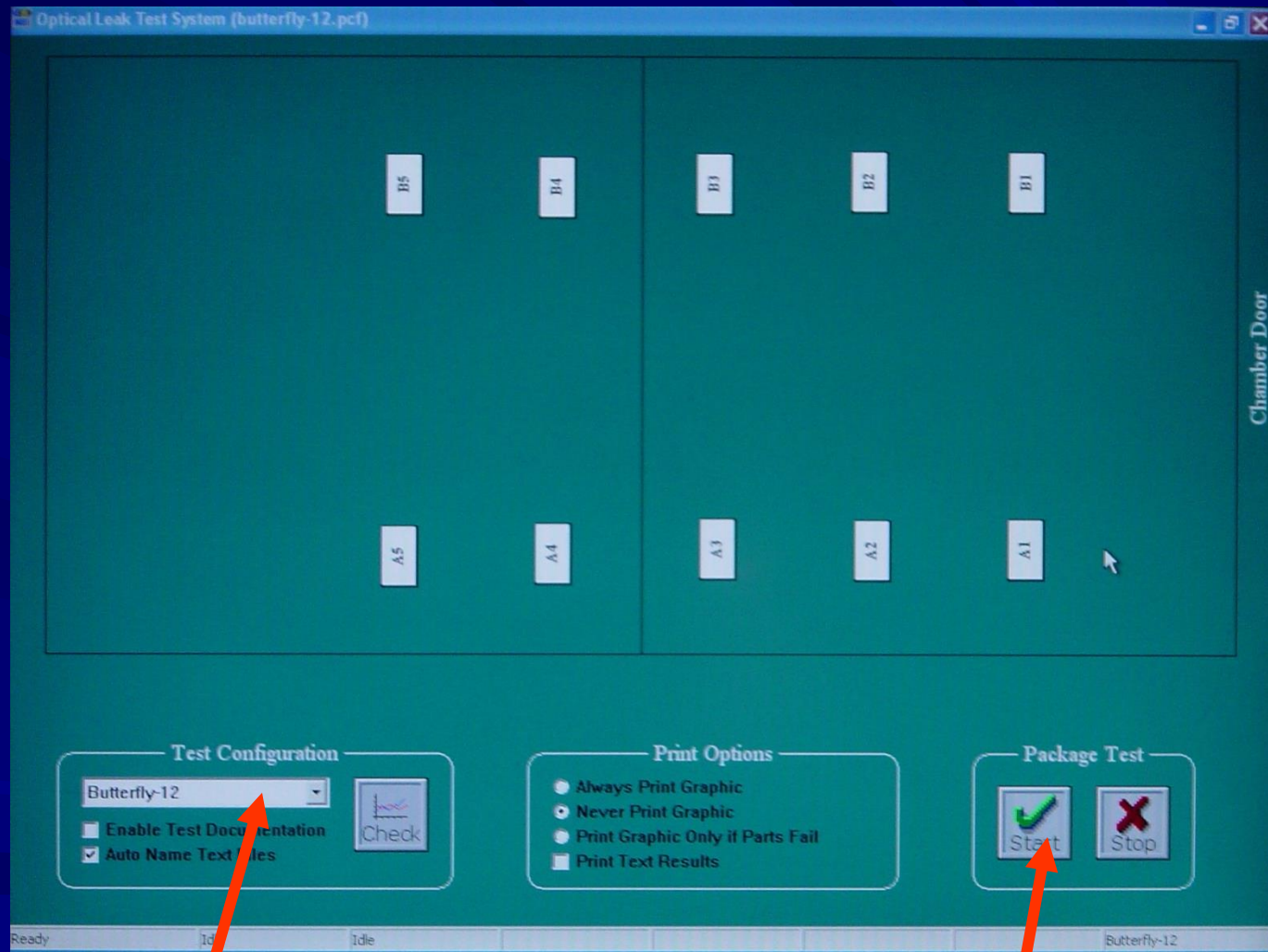


Butterfly devices with fiber optics in tray



Operator places tray into system and closes chamber door.

Simple to Start Test



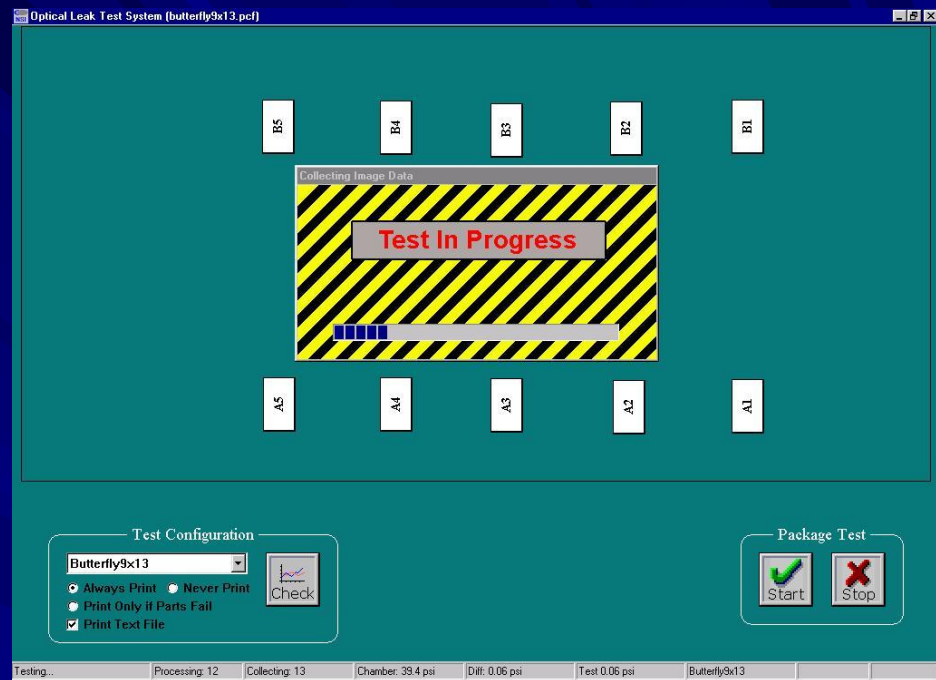
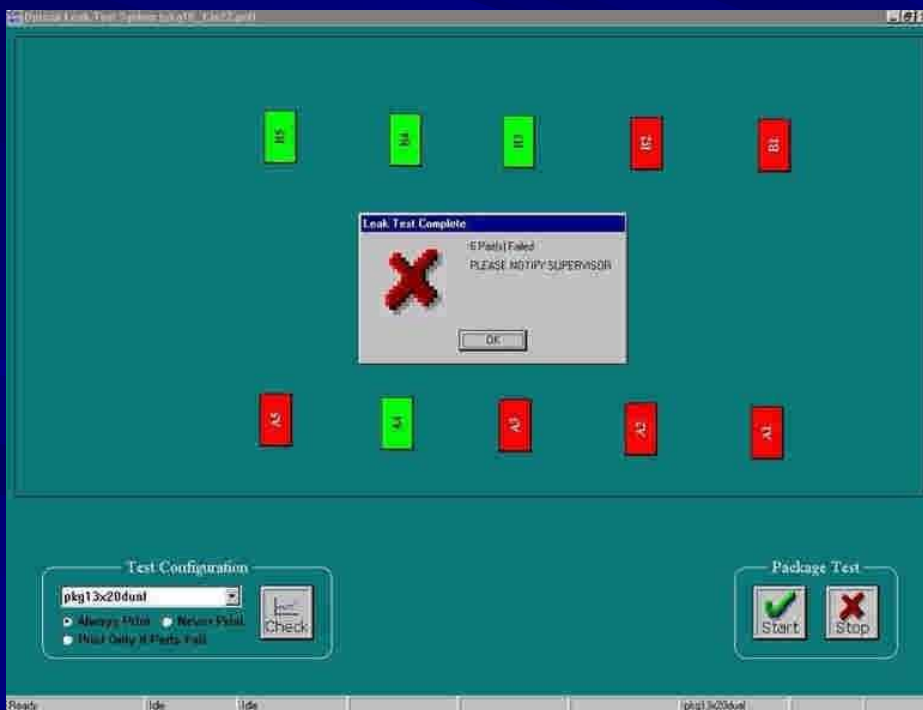
Choose from Menu

Press Start

Test Results

Shows 6 failing and 4 passing packages.

After Test



During Test

Test Report

System ID: LEAKTEST628-PC
 Software: LeakTest (20.1.0.0)
 Config: Butterfly1.pcf
 File Name: 20170214_0956_Butterfly1.txt
 Test Date: 2/14/2017
 Test Time: 9:56:53
 Package: Butterfly1
 Duration: 5 min
 Pressure: 30.002 psi
 Modulation: 0.13 psi
 Stiffness: -1 um/psi
 Volume: 1 cc
 Sensitivity: 8.67E-07 atm-cc/sec
 Crit Leak: 1.00E-06 atm-cc/sec

ID	Status	Leakage psi	Stiff um/psi	Lair Leak Rate atm-cc/sec	S/N
A01	Fail	0.001	-0.797	< 1.0e-06	B7
A02	Fail	2.345	-0.012	Gross	B8
A03	Fail	10.678	-0.794	4.51E-04	B9
A04	Pass	0.002	-0.791	< 1.0e-06	B22
A05	Fail	1.192	-0.842	8.30E-05	B6
B01	Fail	20.946	-0.703	2.50E-03	902
B02	Fail	1.257	-0.022	Gross	B10
B03	Pass	0.004	-0.865	< 1.0e-06	123
B04	Pass	0.001	-0.927	< 1.0e-06	B1
B05	Pass	0.011	-0.830	< 1.0e-06	B5

Status

Leak
Rate

Serial
#

Test Report

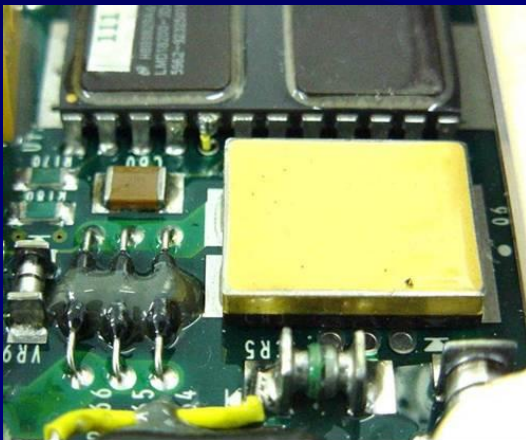
- Shows pass / fail status.
- Test result for each package.
- Serial numbers, s/n, can be entered with bar code reader prior to test.
- Text file can be uploaded to server for serial number and quality tracking.

Optical Leak Test System



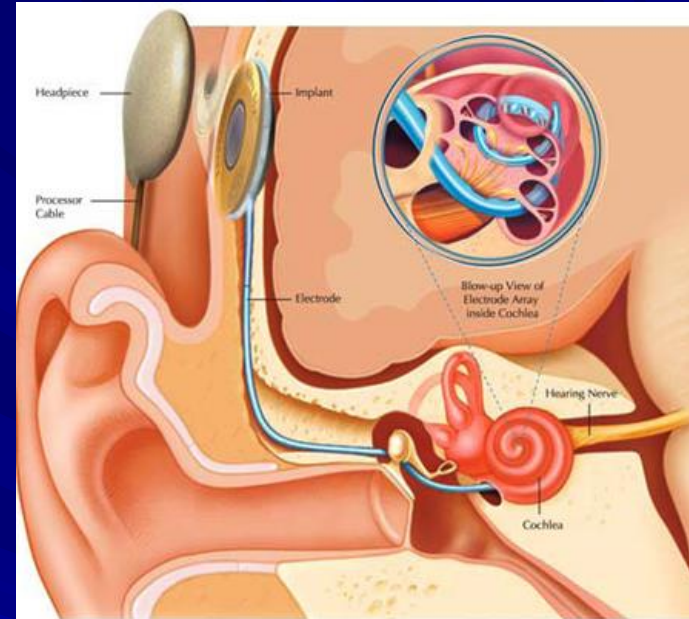
Model 2020-12

Testing Board Mounted Devices



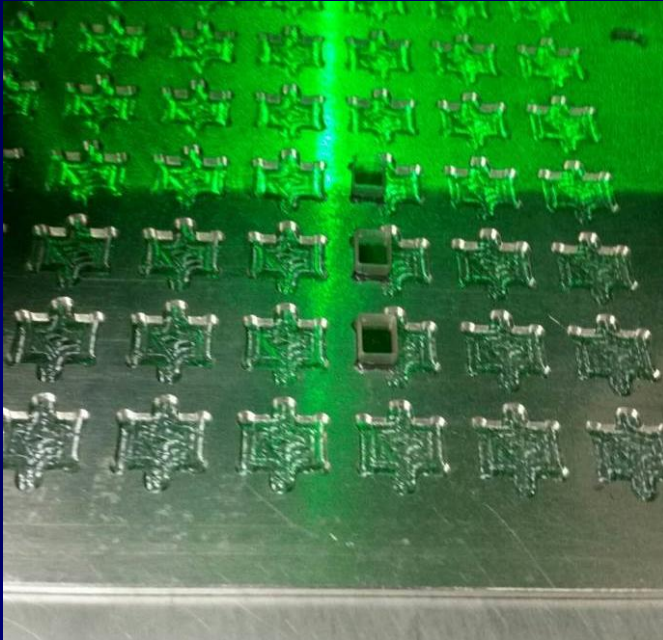
- Hermetic devices may fail during board assembly due to high temperature soldering process.
- Optical Leak Testing is not subject to gas absorption issues, so can test devices on assembled circuit boards.
- Since boards usually absorb helium, HMS can not be used.

Testing Implanted Medical Devices



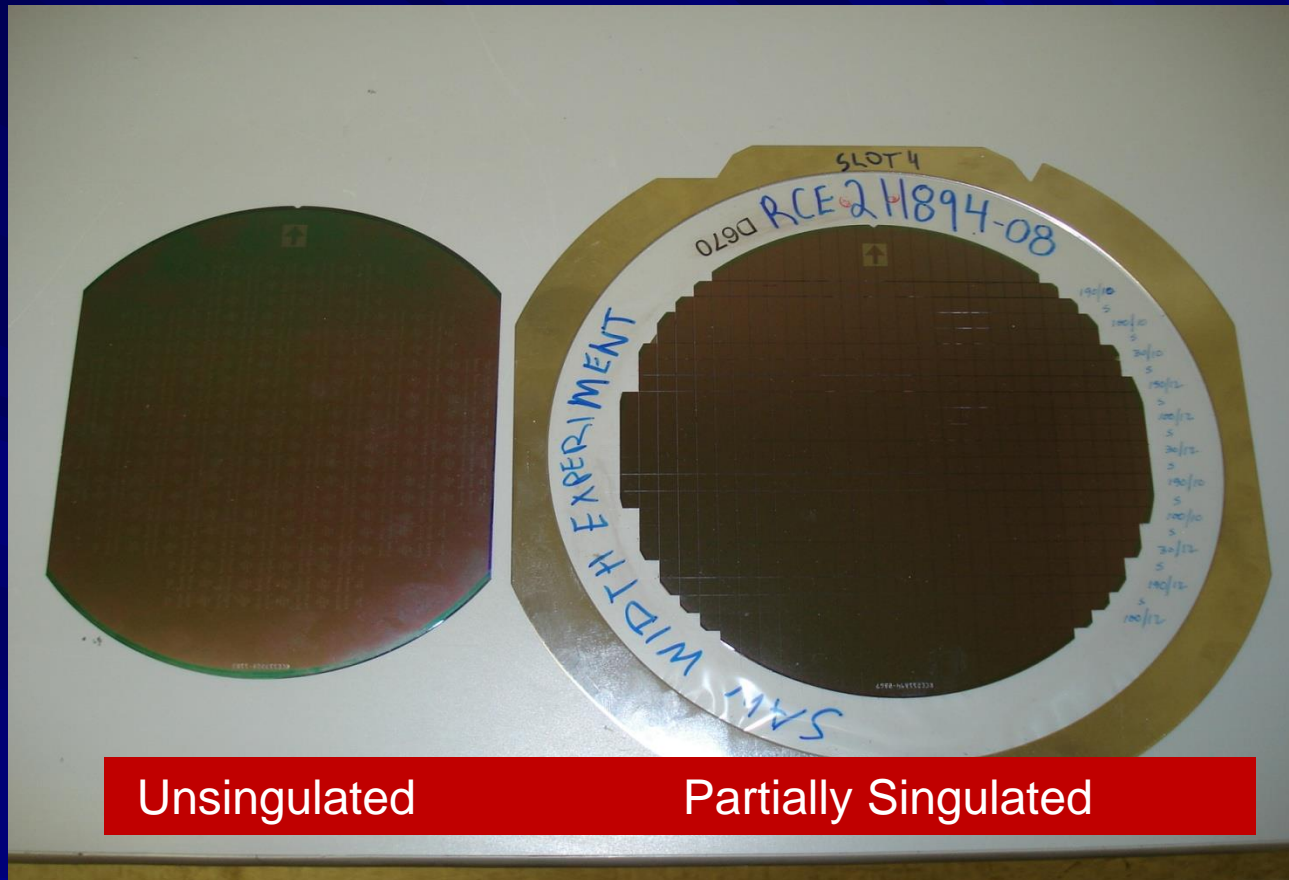
- Hearing implant can be inserted in the skull of a toddler and may last 80+ years.

OLT Leak Testing Retina Implant



- Module with clear window implanted on retina.
- Small: 3.5 x 5 x 2mm
- Applique or label to reflect laser light back to camera during OLT leak test (not shown).

Inspecting Wafer Level Devices



Because OLT is not susceptible to gas absorption, it's able to test wafer level parts that have cavities such as MEMS devices before or after they are diced.

Wafer Level Inspection



- Inspects up to 1000 devices per cycle
- Wafers can be tested while mounted to a saw frame

Optical Leak Technology Overview

- Tests for gross and fine leaks in one inspection
- Provides in-line, full matrix product testing
- No Helium bombing required
- No Helium absorption problems
- Inspects board mounted devices
- Eliminates bubble leak testing and use of Flourinert
- Easy to automate leak test operations and provide SPC



- Established in 1998 to support the Microelectronic, Medical, Automotive, Hybrid and Mems communities
- Over 300 installations in over 75 companies world wide
- The Optical Leak Testing method is listed in both Mil-std 883 TM1014 and Mil-std 750 TM 1071
- Mature technology with a proven track record
- NorCom provides training, and installation support, and full warranty service

Presentation Contact

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