

# Commercial Technologies for Maintenance Activities (CTMA)

## *Leak Test Technology Development*

**CTMA Technology Review**  
**April 16, 2002**

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**Director of Sales, Industrial Leak Detection division**



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# Team Members

National Center for Manufacturing Sciences  
(NCMS)

Argonne National Laboratory (ANL)

University of Michigan

Ford Motor Company

Vacuum Instrument Corporation (VIC)

Laser Imaging Systems (LIS)

DaimlerChrysler Corporation

Jacksonville Naval Air Depot (NADEP)

Honeywell, Kansas City Plant



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# Leak Test Technology Introduction

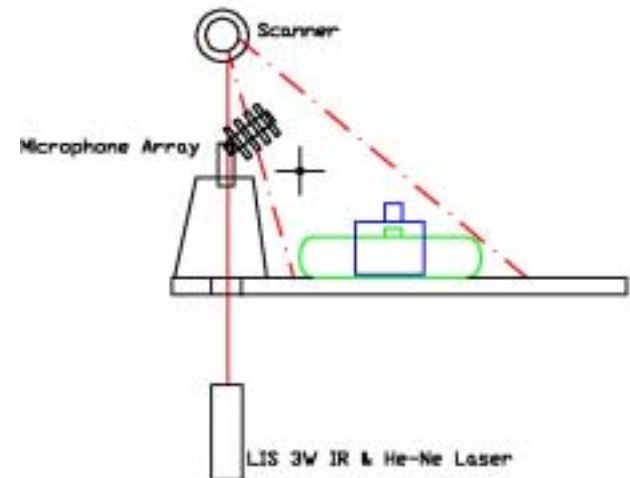
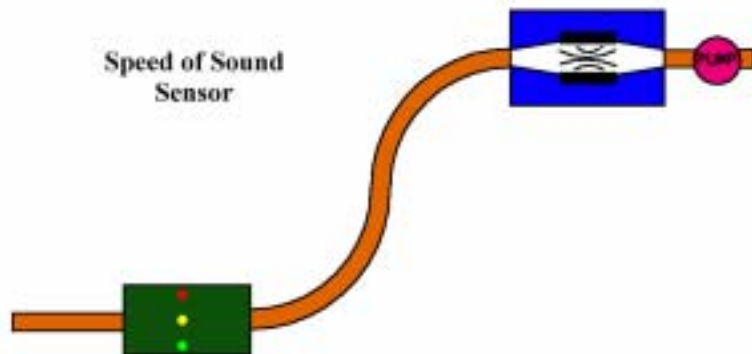
→ Two advanced leak testing technologies Developed by Team Members:

→ Speed of Sound

→ with the Vacuum Instrument Corporation complementary SmartChargeII - Backfill and Evacuation System

→ Photo Acoustics

Along with the GasVue using laser absorption principles to create an image developed by LIS.



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# Speed of Sound (SoS)

- SoS is a medium sensitivity technology in a portable sniffer configuration for component and connector leak testing.
- SoS has a sensitivity of  $\approx 1E-4$  sccs and can detect leaks so small that they cannot be seen with surfactant bubble tests.
- A trial of SoS is currently underway at the JAXNAS for leak testing the F-14 fighter aircraft.
- Preliminary results from JAXNAS indicate that the unit has helped several times to quickly diagnose problems that would not be found using the standard leak testing procedures.



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# SoS Principle of Operation

- Air samples are continuously drawn through a small cavity where an ultrasonic pulse is launched between two walls.
- Reflections off the wall are timed and compared to a baseline value.
- If Helium gas from a leak is present in the cavity the speed of sound changes, enabling measurement of the leak level.
- SoS works with any gas different from the molecular weight of air such as H<sub>2</sub>, Rn, nerve gas, fuel vapor...etc.



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# Sound speeds and times of flight over a path of 11.43 cm

Gases	Sound Speed, m/sec	TOF Difference, $\mu$ sec
He	1015	217.7
Ne	454	78.5
Ar	322	-24.7
Kr	223	-182.3
Xe	177	-323.7
Air	346	0.0
H <sub>2</sub>	1315	243.3
D <sub>2</sub>	930	207.4



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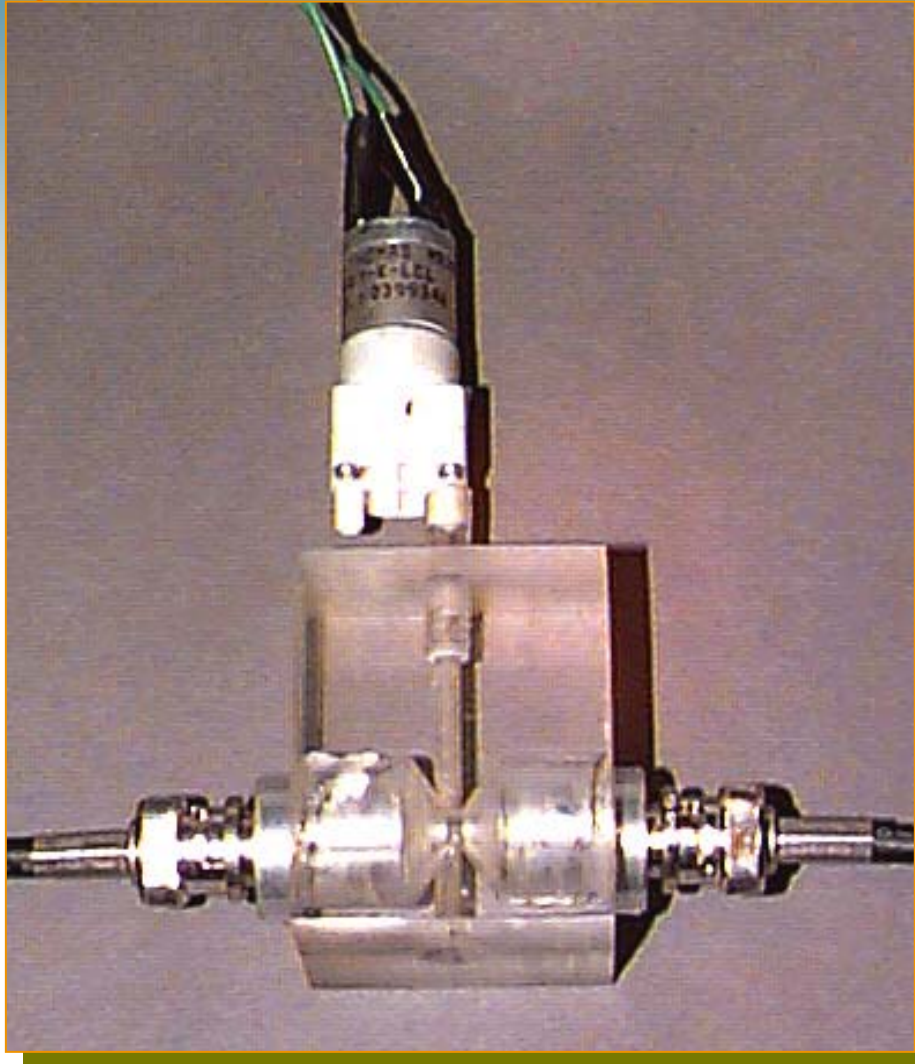


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# SoS Leak Detector



## Description:

The ANL ultrasonic leak detector detects trace gases (e.g. He) in air by measuring changes in sound velocity. It consists of an acoustic cavity and a pair of piezoelectric transducers operated in a pitch-catch mode.

## Instrument features:

- Hand-held instrument
- Rugged
- Low cost
- Easy operation

## Applications:

- Leak detectors for Helium, Hydrogen, and SF<sub>6</sub> gases
- Smoke detector



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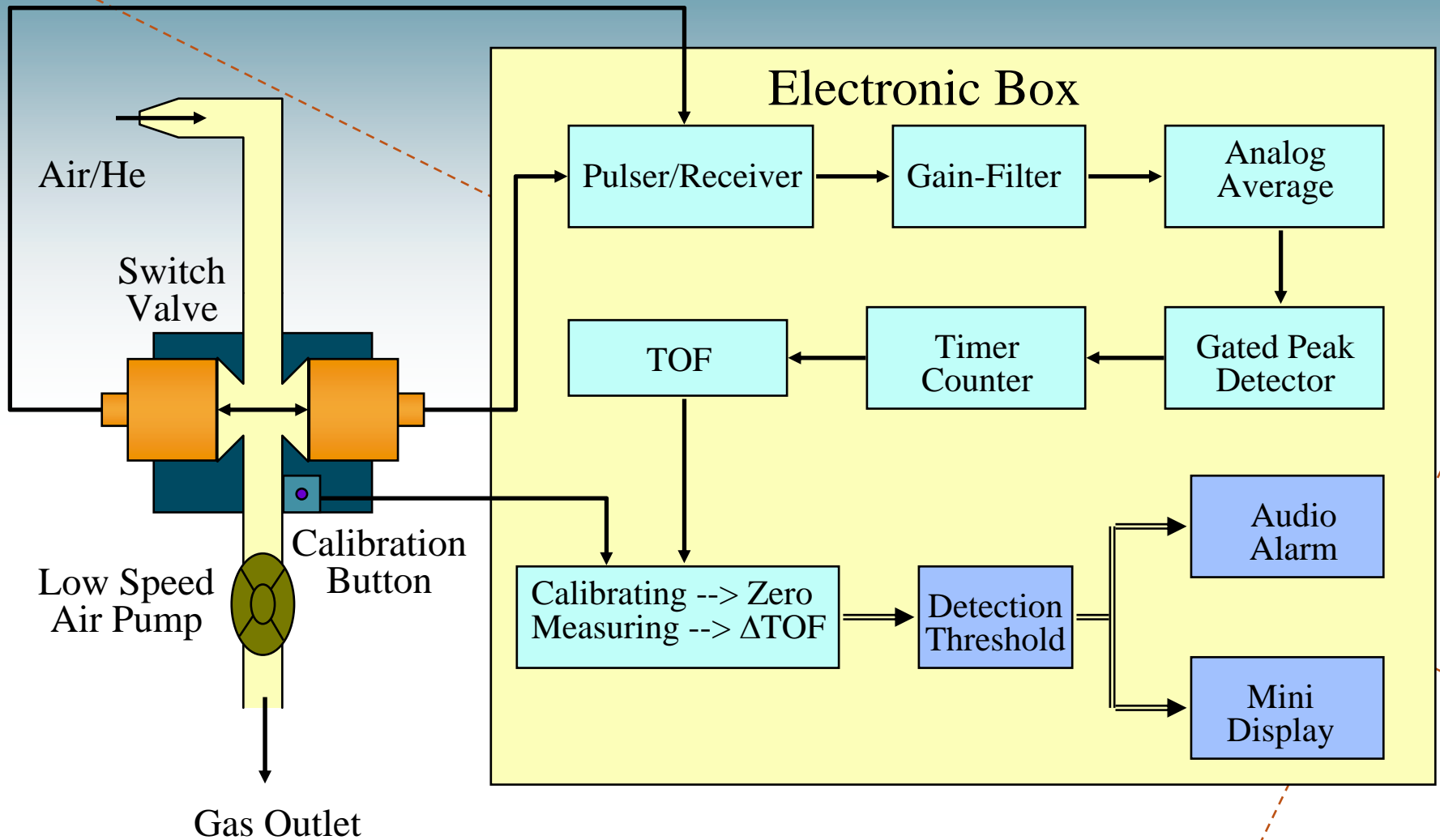


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# SOS Leak Detector



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# SOS Helium Leak Detector Prototype IV



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# SoS Leak Detector Specifications

## → Components:

- Ultrasonic sensor
- Air pump
- Sniffer
- Electronics

## → Power:

- Rechargeable battery  
(4 hours operating time)
- AC (110 volts)

## → Output Features:

- Audio alarm
- Earphone alarm
- LED alarm light
- Bar graph indicator
- Digital display
- Remote data acquisition (RS-232)

## → Detection Capabilities:

- Range: 0.0001 scc/sec and up
- Resolution: 0.0001 scc/sec

## → Response Time:

- Instantaneous sensor response/recovery
- System delay depending on sniffer length and pump speed

## → Calibration:

- Push button self-calibration  
(correct environmental effects, e.g. pressure and temperature)

## → Environment:

- Temperature: -40°C ~ 70°C
- Vibration: no affect



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# Smart Charge II™ Backfill & Evacuation System

The Vacuum Instrument Corporation Smart ChargeII™ gas handling unit is the perfect complement to the SOS leak detector. The "genius" in tracer gas backfill equipment, the Smart ChargeII™ is a fully automatic system capable of being custom configured to the specific charging requirements of the product. A menu-based configuration scheme ensures optimum performance under a variety of test conditions that can include nitrogen proof with pressure decay, helium backfill, or helium recovery.



## Specifications:

Performs evacuation (25" Hg), vacuum decay leak test and tracer gas backfill to 300 psig. Can be configured to perform evacuation to lower vacuum levels, proof test with pressure decay, high pressure operation (to 750 psig), gas recovery and communication interface.



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# Vacuum Instrument Corporation Smart Charge-II

## Performance:

**Pressure Transducer** - Solid state with all welded construction. Resolution of 0.1 psi (0.2" Hg) in vacuum mode, 1.0 psi in pressure mode. Accuracy of +/- 0.25%.

**Valving** - Fast acting pull type solenoid featuring epoxy encapsulated design.

**Manifolding** - Seamless tubing with compression fitting interconnects. Helium leak tested to  $1.0 \times 10^{-6}$  ATM-cc / sec @ 600 psig.

**Evacuation Pump** - 3.6 CFM oil-less vacuum mechanical pump. Ultimate vacuum level 25.5" Hg.

**Electronics** - Advanced microprocessor-based housed in NEMA 12 enclosure.

**Gauging** - Two independent 2-1/2" liquid filled pressure and vacuum gauges.

**Operator Interface** - Menu based operation with 2 x 40 character alphanumeric display. Includes automatic or manual sequencing of valves, diagnostics, password security protection and full user programmable test parameters, audio alarm provided for end of cycle, and test completion.

**Power** - 115 VAC 50/60 Hz Other voltages available upon request.

**Power Consumption** - 720 Watts



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# SoS Application within STMA

- All aircraft, and land vehicle fuel system leak checks similar to the JAXNAS F-14 testing
- Vehicular powertrain and AC components
- Fuel Cells
- Any closed system leak testing of critical connections and components currently using pressure decay, air under water or surfactant bubble testing techniques (ie. Railroad tank cars, Sonar bouys, torpedo castings, etc.)



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# Photo Acoustics

- Detect and simultaneously locate leaks at a level of  $1\text{E-}6$  scc/s (*He*)
- Cycle time of 6 sec for a 2' x 2' area
- On-line and non-contact implementation
- Interface indicating leak and location to the operator
- Decreases process scrap and repair costs



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# Photo Acoustics Theory\*

- Illuminate surface with CO2 laser
  - gas matched to laser (SF6)
- Acquire sound data
- Take a FFT to determine if a leak exists
- If FFT so indicates, then use Match Field Processing to find leak



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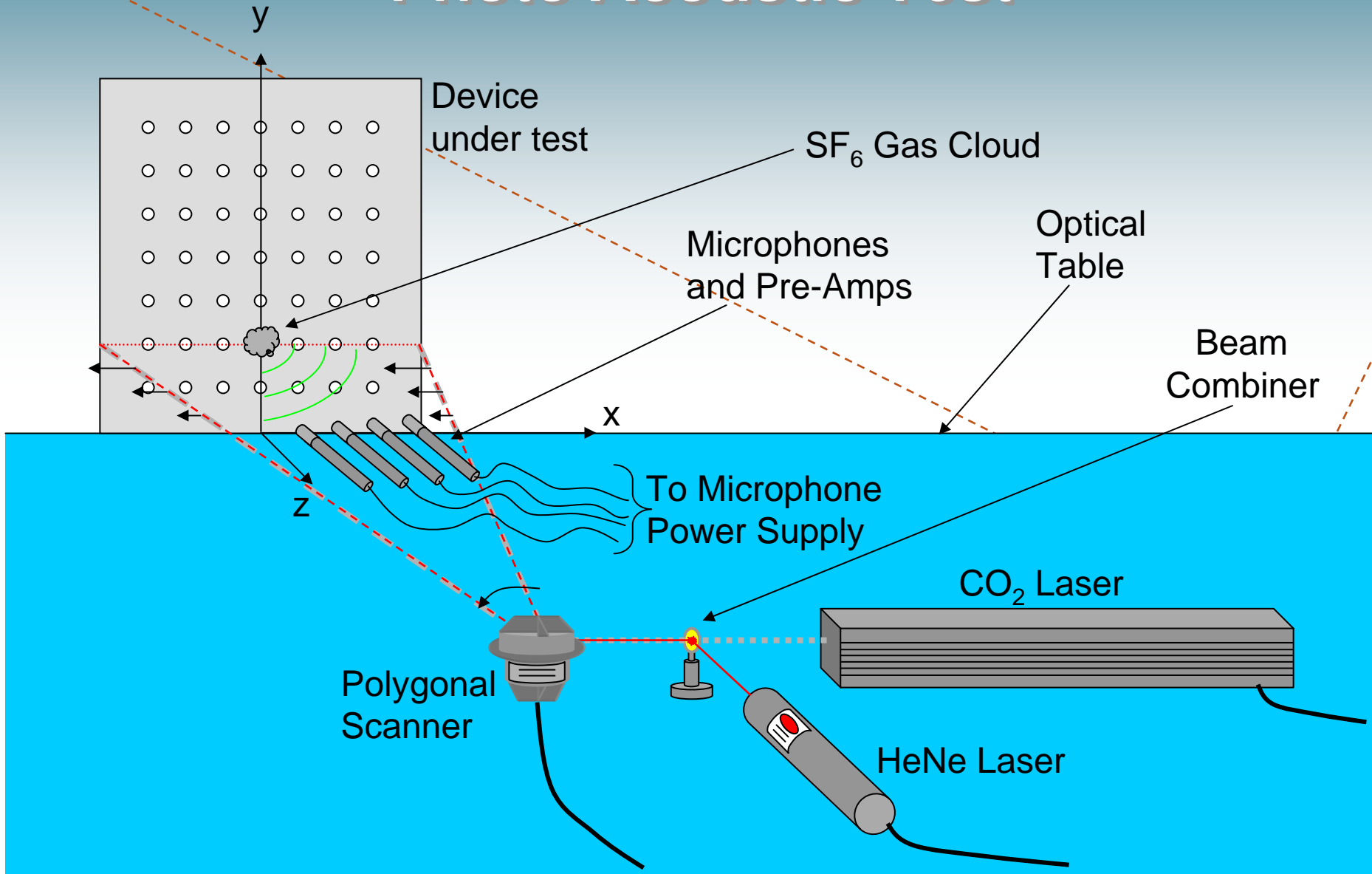
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# Photo Acoustic Test



# Photo Acoustics

- This technology provides low leak rate specification detection and location capability using SF6 as the tracer gas and can be used on applications such as:
  - Compressors
  - Evaporators
  - Torque Convertors
  - Condensers
  - Fuel Cells
  - Electronics



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# The Laser Imaging Systems GasVue® Technology

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- Designed specifically for locating leaks (to  $10^{-4}$  scc/sec)
- Allows rapid (real-time) wide-area leak surveys
- Can pinpoint leaks at distances up to 30 meters



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# LIS GasVue®

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- What is it?
  - A qualitative 3-dimensional vapor detection scheme which makes normally invisible gases “visible”



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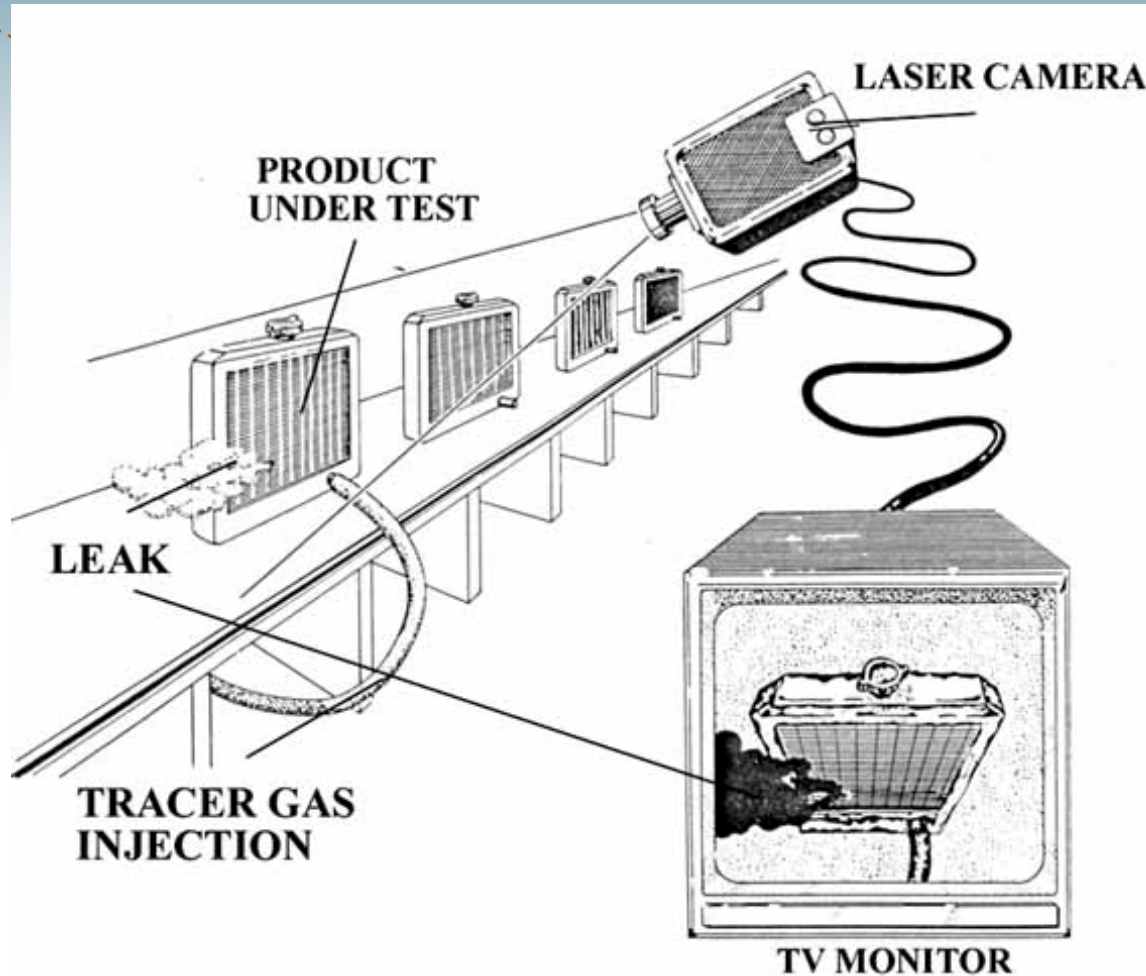
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# LIS GasVue: Assembly Line Application



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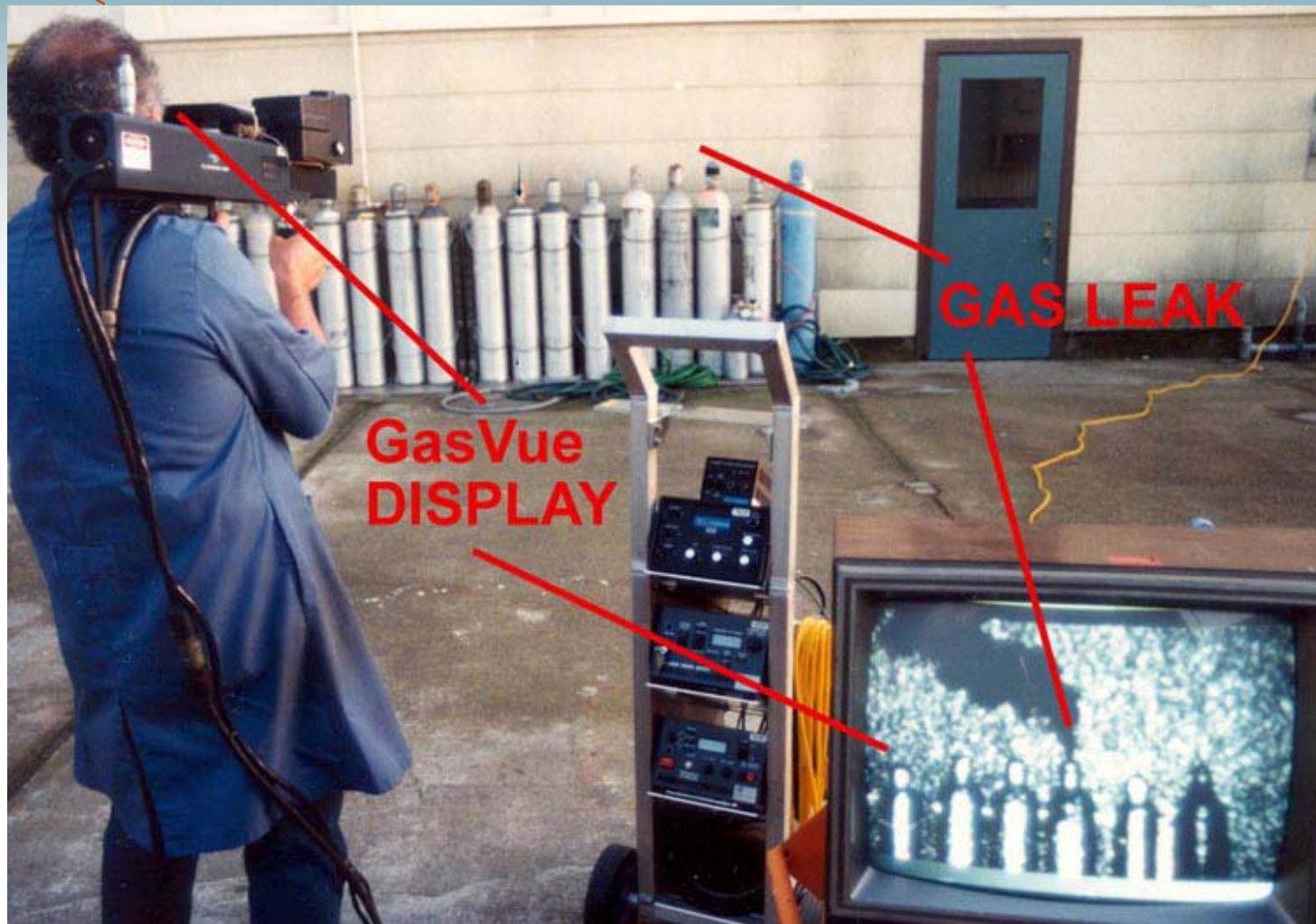


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# LIS GasVue leak visualization demonstration



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# The LIS GasVue TG-5



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# SoS, Photoacoustics & LIS GasVue and other emerging technologies - available for pilot testing in the next Phase of Leak Test Technology Development

Demonstrations of the SoS and LIS GasVue  
units are available during the exhibit



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# Summary

- The LTTD Consortium, has developed leak test technologies to address the problems of productivity, cost, efficiency, and cycle time. We plan to offer these along with other emerging leak testing technologies for pilot testing in industrial and military depot operations.
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