Process Insights™

PREMIUM INSIGHTS
INTO PROCESS

Overview Moisture Measurement

Process Insights

20IND06 PROMETH2O
Training course Chivasso - Italy
Thursday 7th of March 2024

Thomas Klein

Agenda

MBW

- MBW Principle of Operation and Core Technology
- MBW Product Overview

Tiger Optics

- CRDS Principle Overview
- Introduction to Product Line

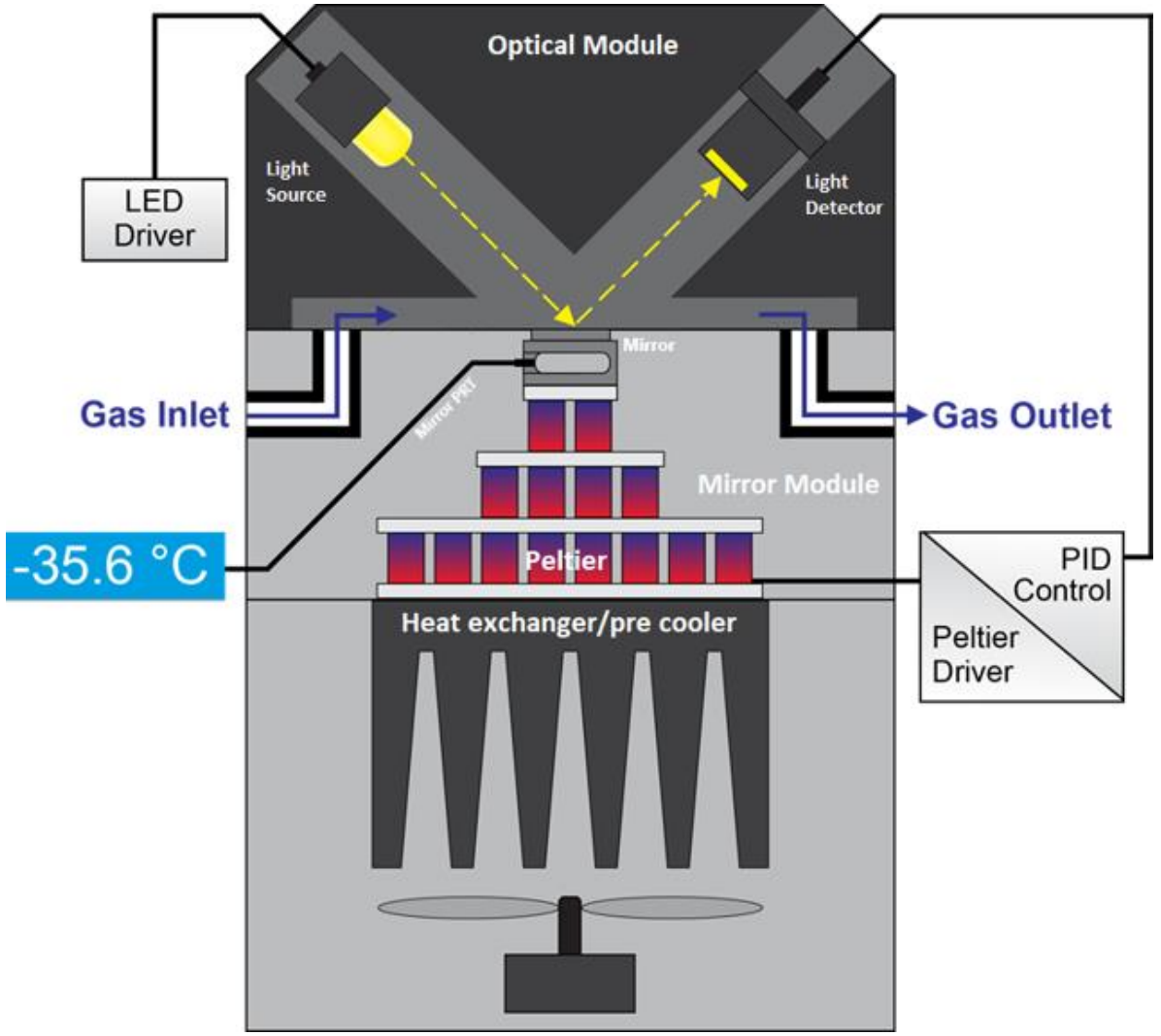
Cosa Xentaur

- Principle Overview
- Introduction to Product Line

Extrel

- APIMS

Dew Point Mirror – Chilled Mirror – Condensation Hygrometer



Swiss Engineering – Precision and Quality

Tough enough for any application

MBW started in **industrial applications** in 1965

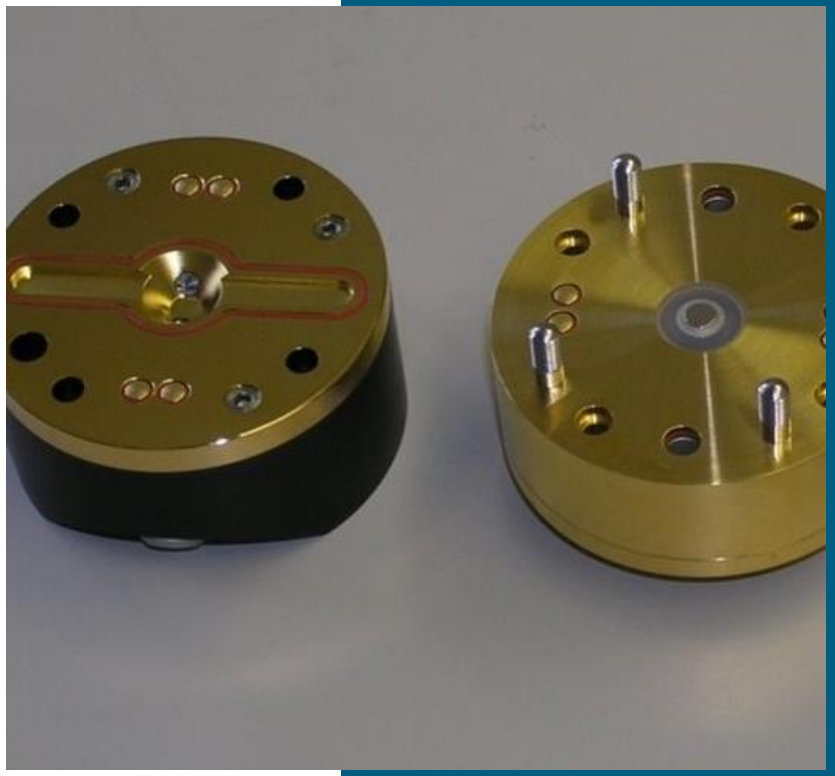
- Heat treatment
- Evolution into reference standards
- Superb reputation for precision and longevity

ALWAYS use the very best materials and components

- No compromise
- Highly robust and stable systems
- And yes, that is gold plated…

Robust practical mechanical design

- Easy mirror access
- User replaceable optical modules



Cool Mirrors….

Rhodium plated mirror is **standard**

- Rhodium over gold over copper
- Virtually indestructible
  - Suitable for all applications

- Carefully selected Pt100 mirror temperature sensors
  - Best possible precision and long-term stability

- Highly skilled craftsmen for assembly and calibration
- Stable and experienced engineering team
- Long term performance and stability over decades…

DPM – Points to Note

- Accuracy, Range, and Speed Required
- Mirror fouling from particulates
- Cooling capability (Low Water Vapor)
  - Low frost points
  - High ambient temperature
- Hydrocarbon presence (oils, glycols, etc.) – condensable in the dew point measurement range

✓Application Discussions

✓Low-cost particle filters

✓Auxiliary cooling capability available on MBW instruments
  - ✓ 573 water cooling circuit
  - ✓ 973L Stirling cooler
  - ✓ 373L / LX refrigeration system

✓Awareness and review of hydrocarbon presence
  - ✓ PI product availability

MBW Product Overview

473 Dew Point Mirror

- Cable mounted dew point measuring heads
- Measuring head flow modules (SH)
- Two stage Peltier, -30°C_{fp}…99°C_{dp} range
- External PRT for temperature reference
- Pressure measurement option
- RS232 interface (standard)
- Analogue output option

573 Dew Point Mirror

- Heated measuring head
- Heated internal sample lines
- **Configurable sampling**
- Three stage Peltier, -50…95°C_{dp} range
- Rack mountable
- Direct replacement for legacy DP3, DP30
- Internal pressure sensor
- External PRT for temperature measurement
- 10 bar pressure option
- RS232 interface (standard)
- Analogue output option
- **Heated sample hose controller**

373 Dew Point Mirror

- Flagship product – Transfer standard used at NIST
  - Standard against which other instruments are compared
- -95…140°C_{dp} measurement capability
- Second mirror PRT for connection to an external resistance
- bridge
- Heated and controlled measuring head and sample path
- Integrated refrigerant cooling system
  - Extend lower range
  - Sample gas pre-cooling
- Internal pressure measurement
- Barometric pressure
- Dynamic pressure correction system
- External PRT for temperature

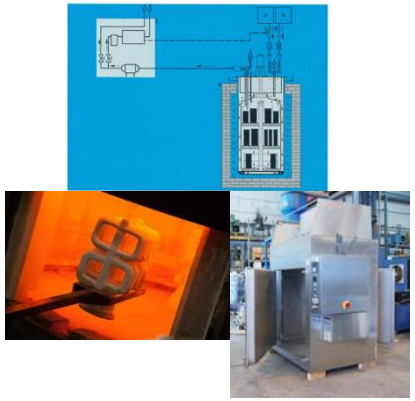
973-573 Applications

Calibration Transfer Standard

- Relative Humidity Calibration
  - Up to ambient dew point temperature
- Dew/Frost point calibration
  - Measurements are in the range of -60 to -10 °C dew point
  - Combines with the HFG1 flow mixer
  - Calibration manifolds available

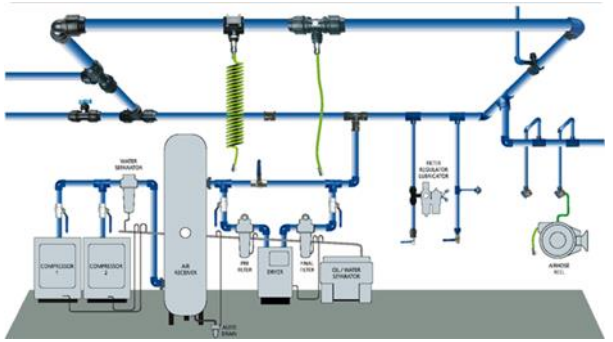
Heat Treatment

- The first MBW application in 1960’s
- Heat treatment of metals
  - Annealing / Sintering / Carburizing
- Inert dry gases
- Precise humidity measurement and control improves quality
- Sampling from furnaces



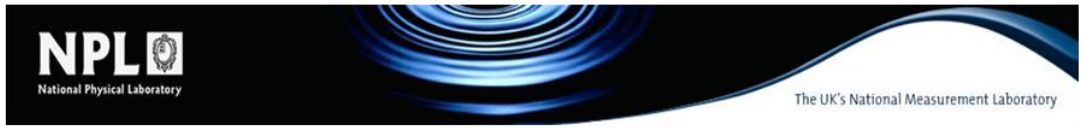
Compressor/dryers

- Manufacturers and users
- System validation and test
  - Dew point sensor calibration
- Supporting energy saving through
- improved control



Process Insights™

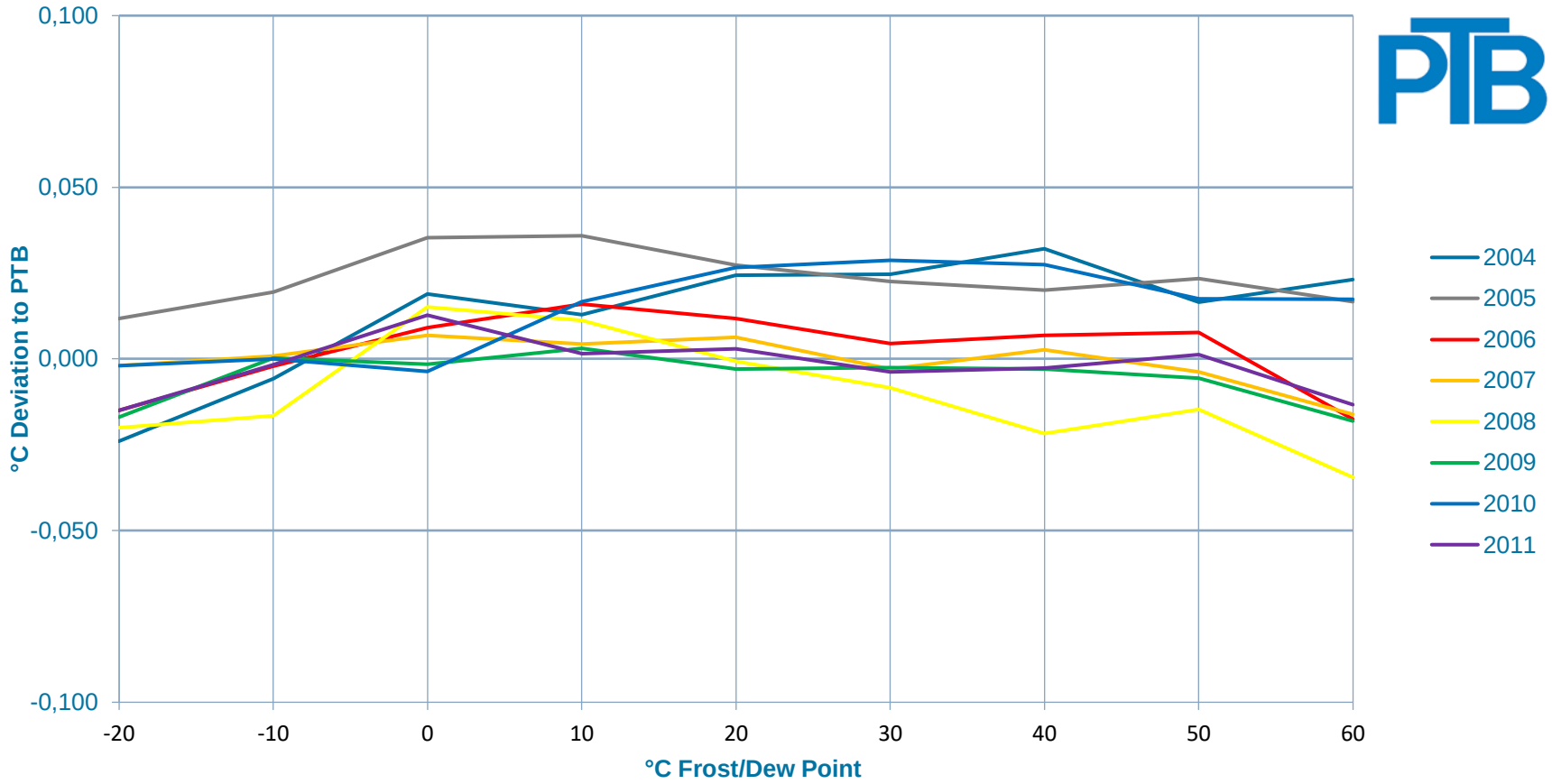
373 Key Application – Transfer Standard



National Metrology Institutes

- Calibration transfer standard
- Validation of primary generators
- World standard
- At every NMI or DI you'll find a 373
- **Superb reference for new customers**

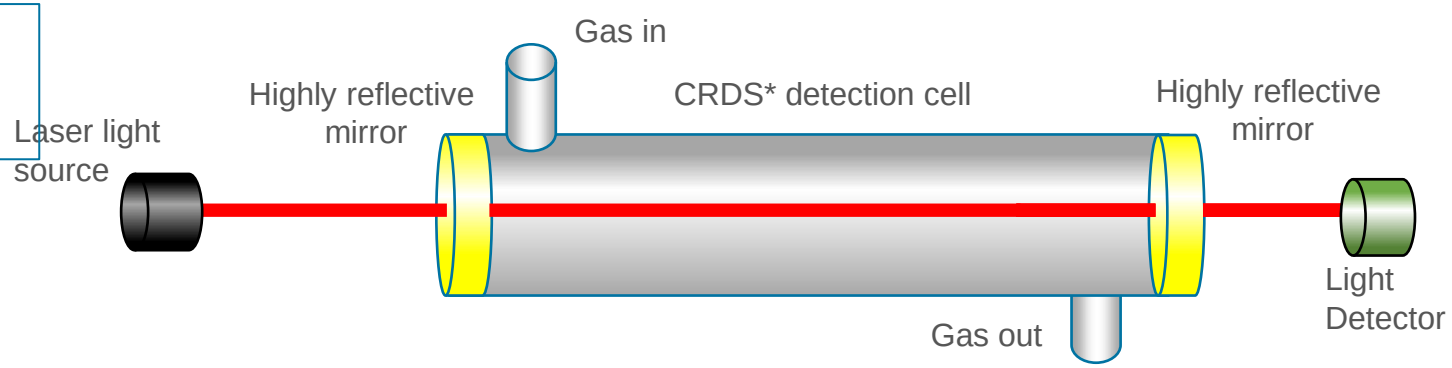
MBW Long Term Stability



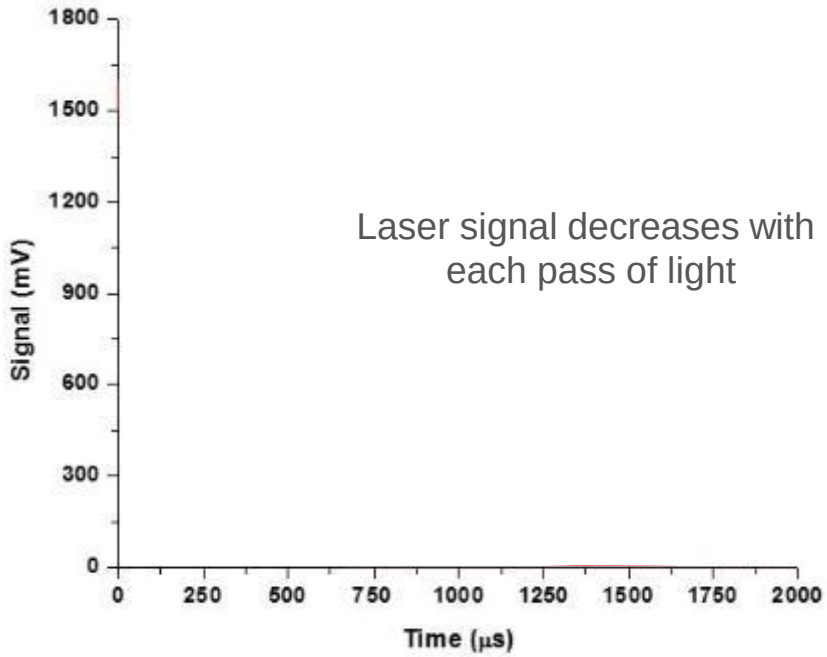
CRDS Technology

CRDS Principle of Operation

Laser shuts off and ring-down event starts



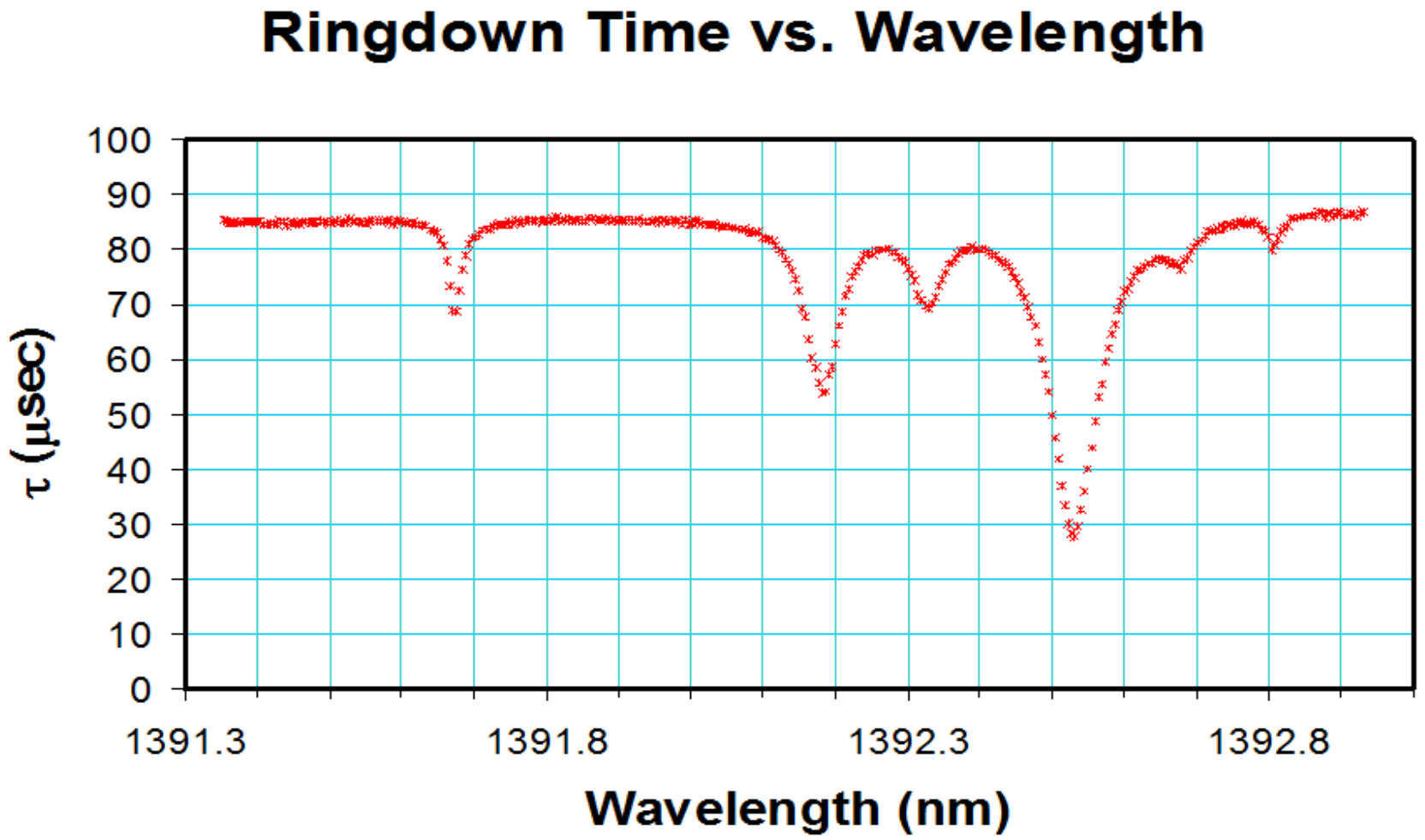
- Continuous-wave, communications-grade laser tuned to target molecule
- Highly reflective mirrors allow for enormous optical path length (~100 km)
- Detection is time-based and absolute, independent of intensity fluctuations



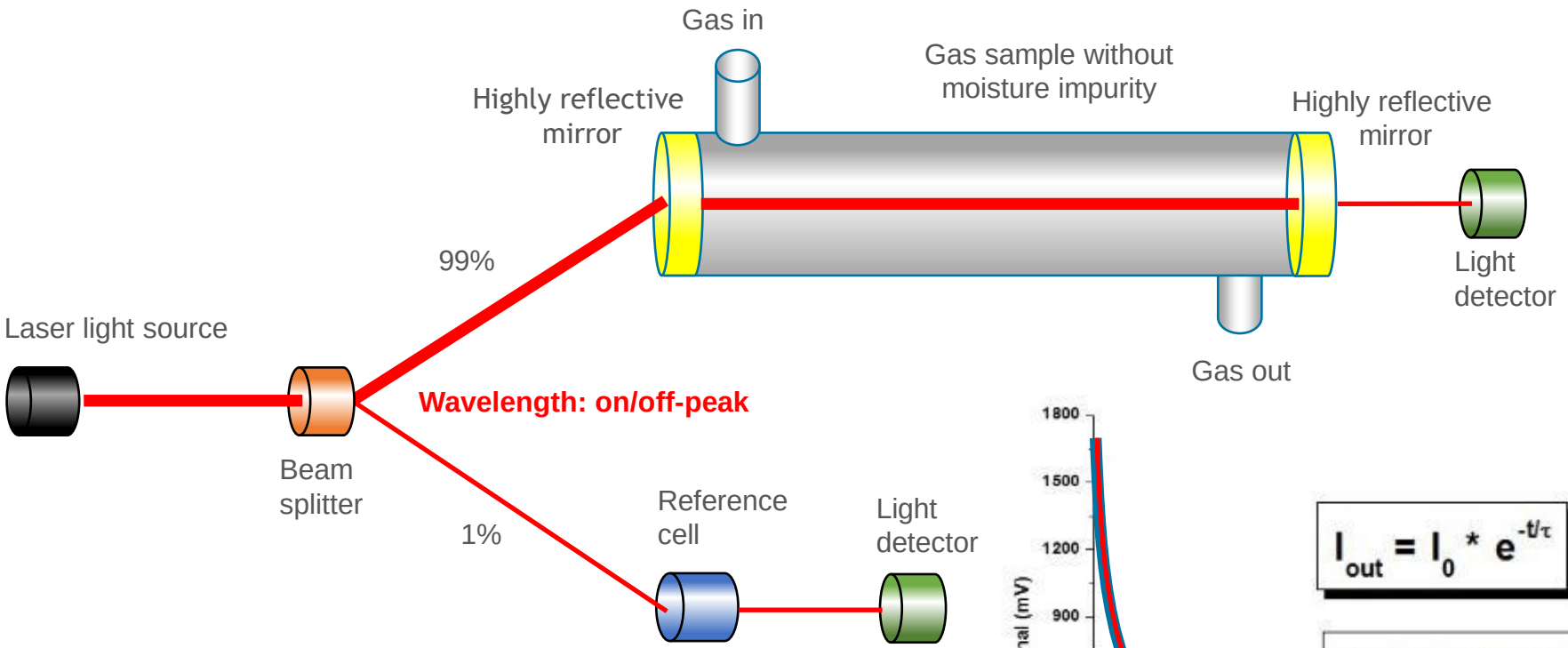
Laser signal decreases with each pass of light

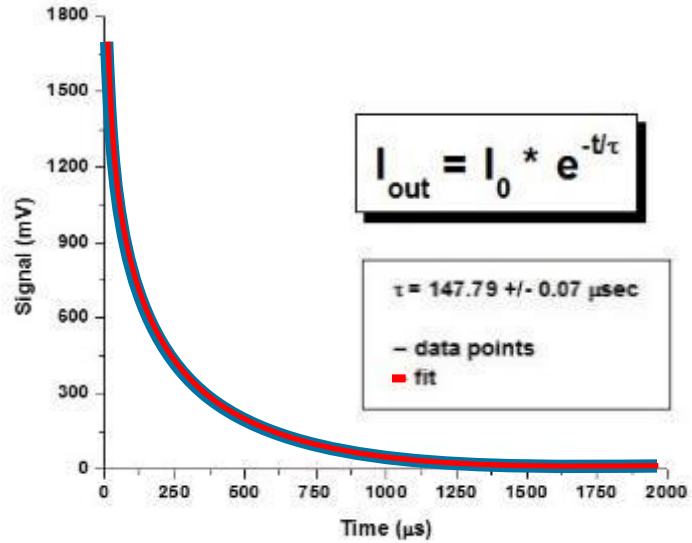
*CRDS: Cavity Ring-Down Spectroscopy

Typical CRDS Scan



Stability Guaranteed – How We Avoid Drift





- Tiny amount of laser energy directed to a cell containing a trace amount of the analyte
- Laser's emission wavelength adjusted in real time using the reference cell detector's signal

CRDS Product Overview

Advantages of CRDS Technology

High Accuracy, Specificity & Stability

Rapid Deployment & Fast Speed of Response

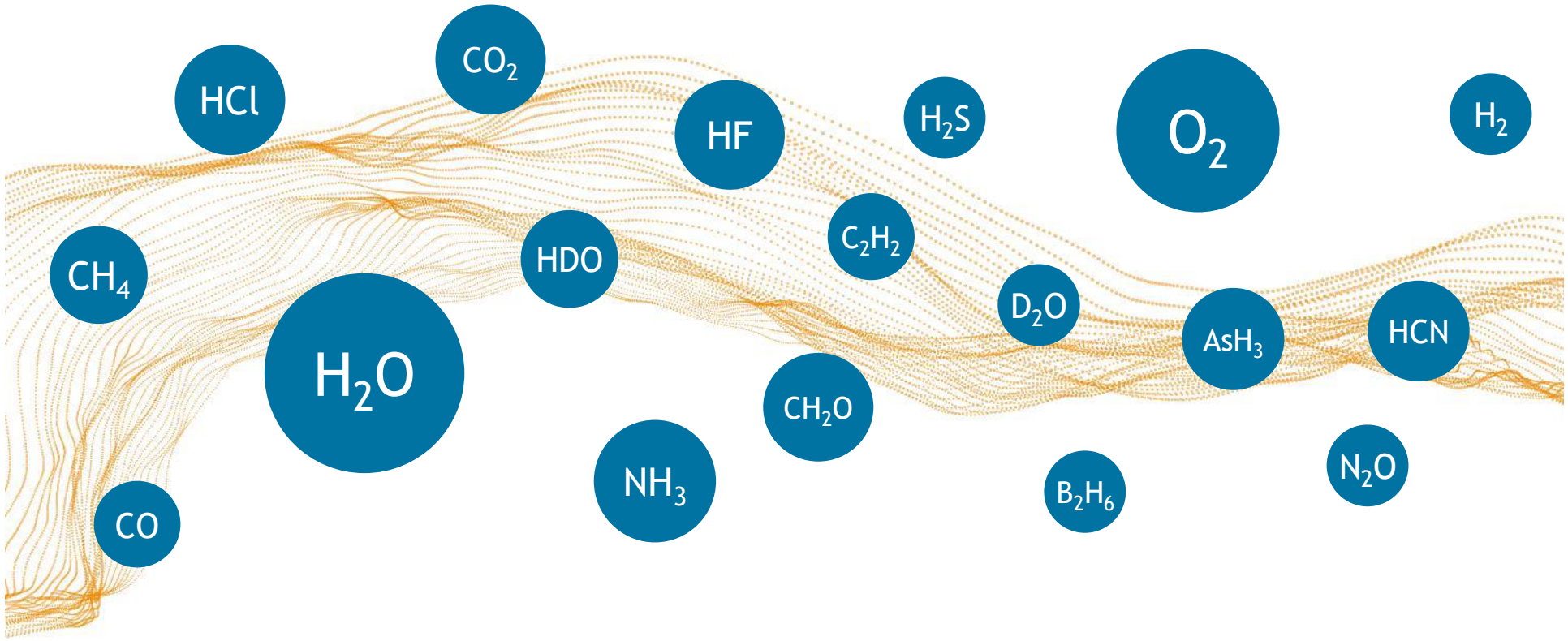
Versatility & Ease of Use

Unparalleled Sensitivity

Outstanding Reliability

Exceptionally Low Cost of Ownership

Impurity Analysis from PPT to % Levels



Tiger Optics' Versatile Platforms

Inert & Passive Gases — N_2 H_2 Ar He Ne Kr Xe

Oxygenated Gases — O_2 CDA CO CO_2 N_2O NO

Corrosives — Cl_2 HCl HBr

Hydrides — NH_3 PH_3 AsH_3 GeH_4 SeH_2

Fluorinated Gases — SF_6 NF_3 BF_3 C_xF_y

Various Mixtures *(stack gas, Syngas, ambient air etc.)*

Compatibility with a Large Array of Background Gases

HALO Max QCL

Industry-best continuous analysis for CO and CO_2 impurities

Spark Series

Low-cost, easy-to-use analyzer for industrial gases

HALO Series

Fast & sensitive, the Gold Standard for trace analysis

Prismatic 3

Next-generation CRDS analyzer for multi-species detection

T-I Max Series

Analyzer for airborne molecular contaminants

ALOHA+ H_2O

Trace moisture in ammonia for HB-LED production

HALO OK

Ultra-trace (ppt to ppm) oxygen analyzer

HALO H2

Trace H_2 impurity measurements in inert gases & CDA

CO-rekt Series

Class I, Div. 2 certified for use in hazardous locations

Low-Cost Spark

Ideal for Gas Analysis from PPB to PPM

- Wide range of analytes & matrices
- Ease of use and low-maintenance are hallmarks of Tiger's CRDS
- Fast, accurate and no calibration requirements
- Compact, robust & affordable

Summary of Spark H_2O Performance Validations

- Not affected by methane to ~100 ppm nor by other hydrocarbons to similar levels
- Freedom from calibration, low CoO, easy to use
- Wide range of background gases & other impurities

Gas Matrix	Range	LDL (3σ)	Precision (1σ) @ zero
N_2	0 − 2000 ppm	12 ppb	4 ppb
O_2	0 − 1000 ppm	6 ppb	2 ppb
Ar	0 − 900 ppm	4.5 ppb	1.5 ppb
He	0 − 450 ppm	3 ppb	1.0 ppb
H_2	0 − 1750 ppm	7.5 ppb	2.5 ppb
CDA	0 − 1800 ppm	10 ppb	3 ppb
Ne	0 − 450 ppm	30 ppb	10 ppb
Kr	0 − 1100 ppm	5.5 ppb	1.8 ppb
Xe	0 − 1300 ppm	7.5 ppb	2.5 ppb
CF_4	0 − 1300 ppm	9 ppb	3 ppb
SF_6	0 − 1300 ppm	15 ppb	5 ppb

Tiger's Capabilities for H_2 & Syngas

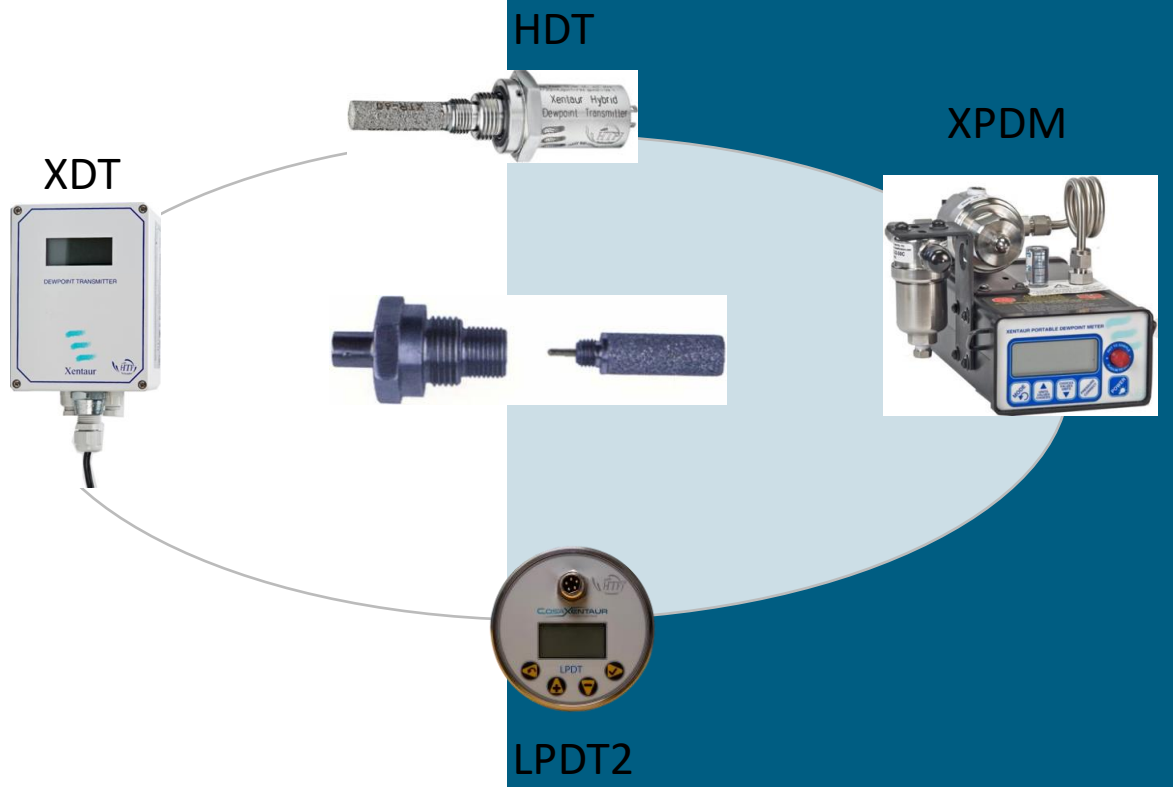
	HALO 3			
Performance*	Range	LDL (3σ)		
CO	0 – 2500 ppm	50 ppb	0 – 2000 ppm	150 ppb
CO_2 (Low range)	0 – 20 ppm	400 ppb	0 – 1500 ppm	500 ppb
CO_2 (High range)	---	---	0 – 30,000 ppm	2000 ppb
H_2O (Low range)	0 – 16 ppm	1.2 ppb	0 – 16 ppm	1.0 ppb
H_2O (High range)	---	---	0 – 400 ppm	6 ppb
CH_4	0 – 8 ppm	1.6 ppb	0 – 100 ppm	7 ppb

*Specifications are based on 40% CO/60% H_2 mixture or pure H_2; specs will vary with syngas composition

Aluminum Oxide Dew Point Technology

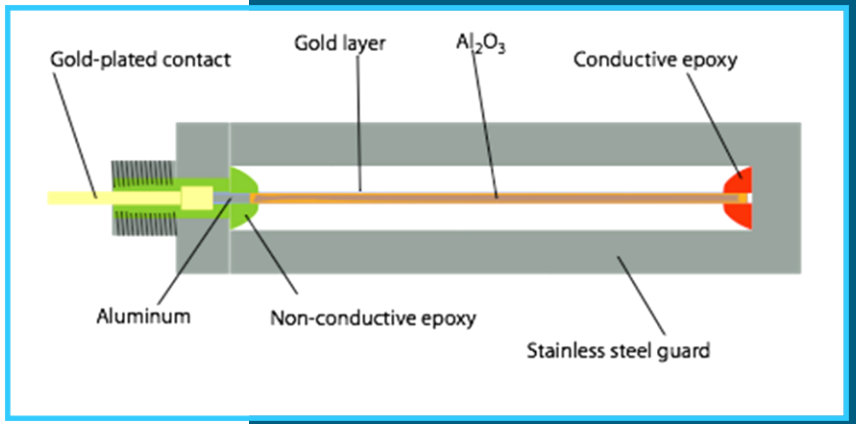
Worldwide Leader in Aluminum Oxide Dew Point Technology

- Fastest aluminum oxide sensor on the market with patented HTFTM (hyper-thin-film) technology.
- Unmatched Repeatability
- Field replaceable sensor options
- Versatile: Compatible with a wide range of gases and fits wide range of applications.
- Measurement range: -100 °C to +20 °C at ideal pressure.
- Minimal downtime and low cost of ownership.



Sensor Specifications

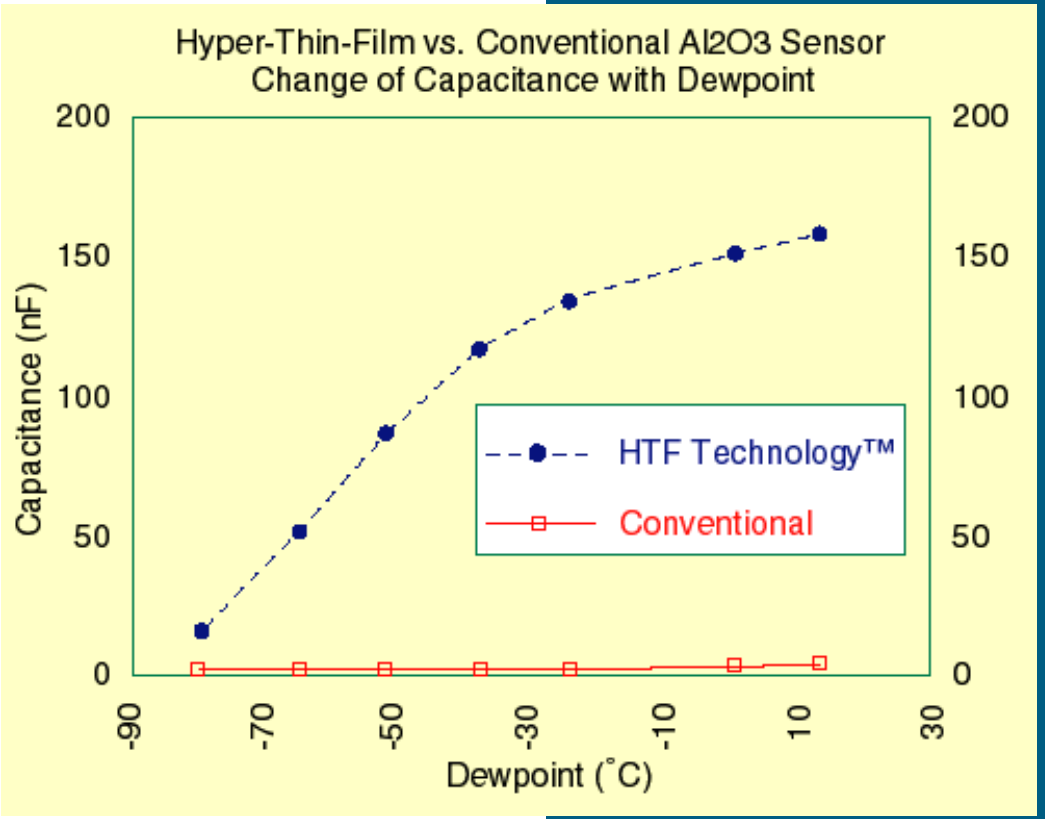
- Type: .....Hyper Thin Film HTF™ high capacitance Al2O3.
- Capacitance: ……...15nF to 200nF
- Accuracy: .....±5.5°F (±3°C)
- Repeatability: .....±0.9°F (±0.5°C)
- Operating Temperature: .....14°F to 158°F (-10°C to +70°C), non-condensing
- Storage Temperature: .....-40°F to+176°F (-40°C to +80°C), non-condensing
- Sample Flow range: ..... (Linear velocity @ 1ATM): Static to 100m/s
- Enclosure: .....encapsulated in 100ì sintered stainless steel
- Calibration method: .....Highly uniform sensors calibrated at low dewpoint and SpanCheck™, sensor saturates at dewpoint above +68°F (+20°C). NIST/NPL traceable multi-point factory calibration available optionally
- Hazardous Locations: UL Class I, II, Division 1, Groups A, B, C, D, E, F, G; ATEX: EEx ia IIC T6; intrinsically safe when installed per drawings



HTF™ Technology: Sensitivity

Xentaur HTF™ sensors are two orders of magnitude more sensitive than conventional aluminum oxide probes

- Better Sensitivity
- Better Repeatability
- Faster Response Times
- Negligible Temperature Coefficient



Top 10 Dew Point Consumer Industries

	Industrial Site	Applications
1	Air Separation Units	Cryogenic Gas Production, Storage
2	Refineries	Plant Air, Hydrocarbon Processing, Emissions Control, Air Dryers
3	Chemical Plants	Instrument Air, Plastic dryers, Catalyst Control
4	Natural Gas Transmission Sites	Pipeline, after acid gas removal, after dehy, at Truck loading
5	Power Transmission Sites	Instrument Air, Gas Turbine Inlet Air, Lubrication Oil, H2 Cooling Loop, Switchgear Maintenance, Transformer Maintenance, Maintenance Alarms
6	General Manufacturing	Instrument Air, Lubrication Oil, Storage, Quality Control, Welding Gases
7	Steel Industry	Heat Treating, Dryer Control
8	Semiconductor Manufacturing	Clean Rooms, Instrument Air, Glove Boxes, Environmental Chamber, PCB Manufacturing
9	Pharmaceutical Manufacturing	Glove Boxes, Instrument Air, Incubators, Stability Testing, Tablet Coating
10	Specialty Gas Producers	Gas production processes, Tank Loading, Testing, Transfers

Product Overview

Dewpoint Transmitters

- LPDT2
- HDT

Inline Dewpoint Meters

- XDT-DIN/PM-PB
- XDT-NEMA

Portable Dewpoint

- XPDM

Sample Systems and Analyzers

- ESS Sample Systems
- Mission Critical full analyzers

Loop Powered Dewpoint Transmitters

LPDT Series

- LPDT2
  - Display or Non-Display
  - Field Settable
  - Span Check
  - 4-20ma and Modbus RS485
  - Class 1 Div. 2 Grp ABCD

HDT Series

- Class 1 Div. 1 Grp A, B, C , D
- HDT-60 Designed for high Moisture
- HDT-LQ for H2O in Oils

Applications

- Air Dryer / Compressors OEM, Service or end user
- Glove Box OEM end User
- Chemical Pant / Refineries
- Natural Gas
- Gas Generator OEM

Who

- Service Maintenance Tech
- Manufacturing Engineer
- I&E

LPDT

LPDT2

HDT

XDT Dewpoint Meters

XDT Series

- Stand alone powered Meters
- XTR-65 or XTR-100 HTF Sensors
- 4-20ma, 2 relays, optional RS232
- Field sensor change
- Field Settable
- Span Check and Single point calibration

- **XDT-DIN/PM-PB**
  - Panel Mount with push buttons

- **XDT-NEMA**
  - NEMA 4X Enclosure
  - General Purpose to Class 1 Div. 2 Grp A, B, C, D
  - Optional NFPA 99 Hospital Requirement

Applications

- Air Dryer / Compressors OEM, Service or end user
- Refineries Chemical Plants
- Natural Gas, well head to transport
- Specialty gas manufacturers
- General Manufacturers
- Micro Chip Manufacturers
- Pharma

Who

- Service / Maintenance techs
- I&E
- Process Engineer

XDT-PM/PB (DIN)

XDT-NEMA

Portable Dewpoint Meter

XPDM Series

- Field Settable C, F, PPM, LBS
- Span Check and Single point
- Battery Powered 9 volt
- Optional integral sample system
  - Regulator and/or Coalescing Filter

XPDM-GP (General Purpose)

XPDM-IO

- 4-20ma and RS232 outputs with separate power input

XPDM-IS

- Intrinsically safe, Class 1 Div. 1 Grp A, B, C, D

Applications

Anywhere Moisture is measured,

- Substation Service, SF6, N2
- Natural Gas Wellhead to transport
- Air Compressor Service
- Gas Specialty Companies
- Refineries, Chemical plants
- General Manufacturers

Who

- Service / Maintenance techs
- I&E
- Process Engineer

COSA Xentaur Dew Point Transmitter options

	XDT	XPDM	LPDT2	HDT	HDT-LQ
Matrix	gas	gas	gas	gas	liquid
Sensor Options	**XTR-100, XTR-65**	**XTR-100**	**XTR-100, XTR-65**	**XTR-100, XTR-60**	**XTR-LQ**
Power	120VAC or 24VDC	9V Battery, External Jack on IO	Loop Powered	Loop Powered	Loop Powered
Measurement Method	In-Line, continous	Portable, Spot Check	In-Line, continous	In-Line, continous	In-Line, continous
Unit of Measure	**Field program** reading in °C, °F, ppmv, Lbs of H2O/Million scf, Gramsof H2O/m3	**Field program** reading in °C, °F, ppmv, Lbs of H2O/Million scf, Gramsof H2O/m3	**Field program** reading in °C, °F, ppmv, Lbs of H2O/Million scf, Gramsof H2O/m3	**Factory Set** reading in °C, °F, ppmv, Lbs of H2O/Million scf, Gramsof H2O/m3	**Factory Set** reading in °C, °F, ppmv, Lbs of H2O/Million scf, Gramsof H2O/m3
Out Put Options	4-20ma, RS-232	4-20ma, RS-232	4-20ma, RS-485	4-20ma	4-20ma
Span Check	✓	✓	✓	X	X
Single Point Calibration	✓	✓	✓	X	X
Pressure Correct setting	User	User	None	Factory	Factory
Intercahngable Sensor	✓	X	X	X	X
Dual Alarms	✓	X	X	X	X
Approvals/Classifications	General Purpose, CE, CSA, Class 1 Div 2	General Purpose, CE, IS, Class 1 Div 1, ATEX, Zone 1	General Purpose, Class 1 Div 2, CSA, CE, Atex Zone 2	IS, Class 1 Div1, CSA, CE, Atex Zone 1	IS, Class 1 Div1, CSA, CE, Atex Zone 1

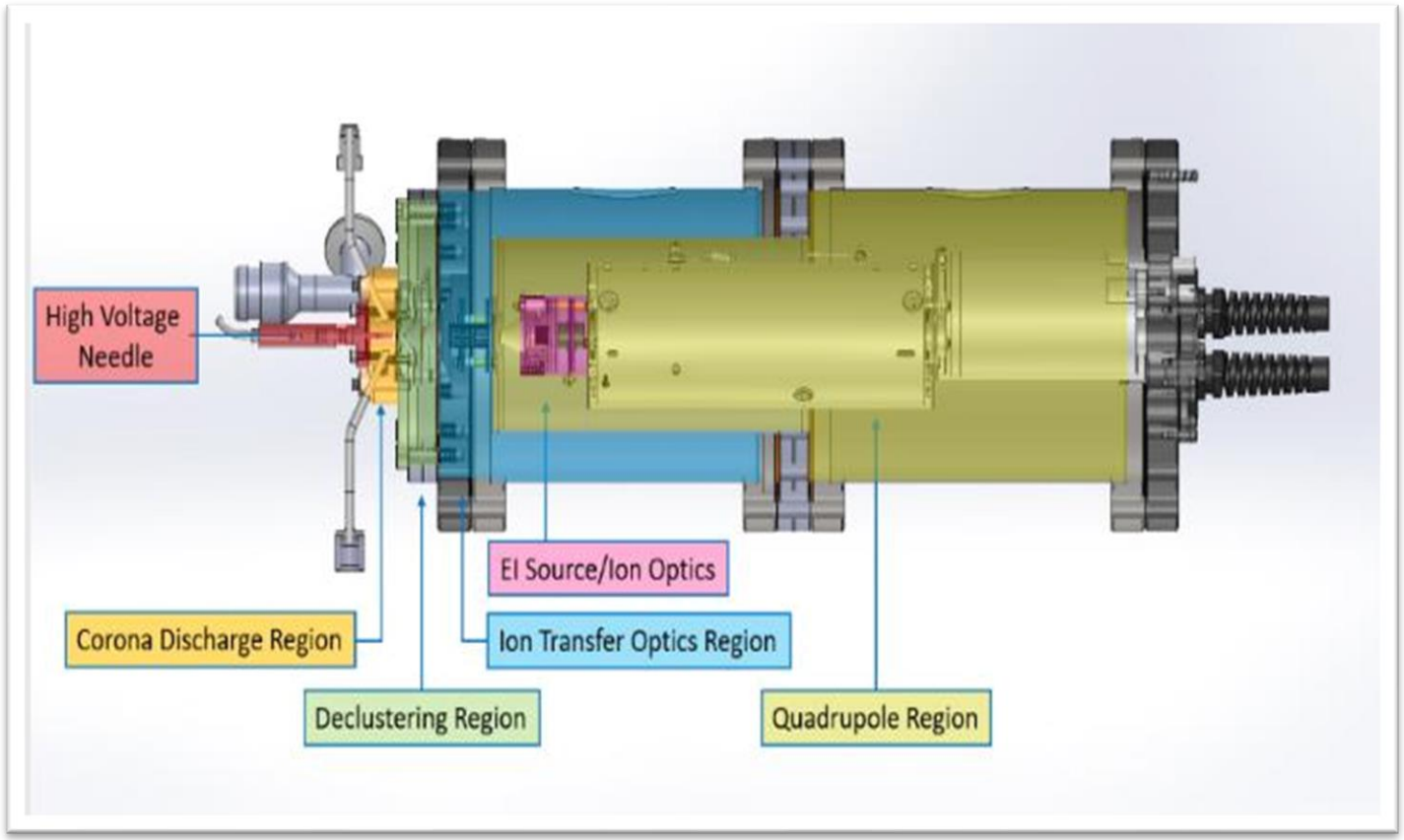
APIMS- atmosphere pressureionization mass spectrometer

Extrel VeraSpec APIMS

Advantages for Contamination Control:

- Real-time, multi-species monitoring for ALL Critical Impurities in bulk electronic gases including trace O2, H2, H2O, CH4, CO, CO2, Xe and more
- Well-established, powerful mass spectrometry technology
- Developed in conjunction with UHP gas analysis experts at Tiger Optics
- Unparallel measurement range from PPT to 100% with unique dual-source ionization configuration
- Easy to use with integrated User Interface and scheduled automated calibrations
- Industry-best customer support and applications team

Unmatched Detection Range- ppt to 100%



- Extrel-Exclusive Dual Source Configuration
- Analysis of impurities from ppt levels to 100% concentrations
- Allows for great flexibility
- Provides two mass spectrometers in one

Low System Maintenance

- Dual ion source for convenience of diagnostics
- Heated API ion source
- Built-in software calibration procedures
- Oil-free pumping system
- Low maintenance frequency – once per year
- Low calibration frequency

APIMS System Detection Limits

Trace Impurity*	Bulk Gas				
	N_2	Ar	He	H_2	O_2**
Hydrogen (H_2)	100 ppt	100 ppt	50 ppt	n/a	500 ppb
Oxygen (O_2)	10 ppt	10 ppt	10 ppt	10 ppt	n/a
Methane (CH_4)	10 ppt	10 ppt	10 ppt	10 ppt	100 ppb[1]
Water (H_2O)	10 ppt	10 ppt	10 ppt	10 ppt	100 ppb[1]
Carbon Monoxide (CO)	50 ppt	10 ppt	10 ppt	50 ppt	100 ppb[1]
Carbon Dioxide (CO_2)	5 ppt	5 ppt	5 ppt	5 ppt	100 ppb[1]
Nitrogen (N_2)	n/a	200 ppt	10 ppt	150 ppt	100 ppb
Argon (Ar)	200 ppt	n/a	10 ppt	50 ppt	75 ppb

*Additional impurities are available

** Impurities in O2 are measured using the included EI source

[1] See next slide for additional complimentary products from Tiger Optics for lower detection limits in O2

APIMS Summary

- Lowest detection limits and highest flexibility compared to other technologies
- Ultra-high precision and long-term stability
- Fast measurement speed for real-time process control
- Extremely low maintenance requirements
- Proprietary fully customizable, automated process control software
- Multi-port sample selector options available
- Industry-best customer support and applications team

hank You!