

Water Measurement Methods In Natural Gas

Moisture Analysis

- Water (moisture) analyzers are called **Hygrometers**
- They can be water content or water dewpoint analyzers
- Hygrometers are used in many industries:
 - Food, pharmaceutical, semi-conductor, compressed air, etc.
 - Natural gas

DewPoint vs. Water Content

- Moisture content analyzers
 - Measure water content then calculate dewpoint
- Water Dewpoint analyzers
 - Measure dewpoint directly, can calculate content as needed
- Both are measurements of water (moisture) vapor
- They are related
 - But different Measurements
- One can “calculate” one from the other

Water Measurement Technology

Two Different Measurements Principles

Water **CONTENT** Measurement



Water **DEWPOINT** Measurement

ElectroChemical

PiezoElectric (QCM)

IR Absorption Spectr

Stain Tubes

Gravimetric

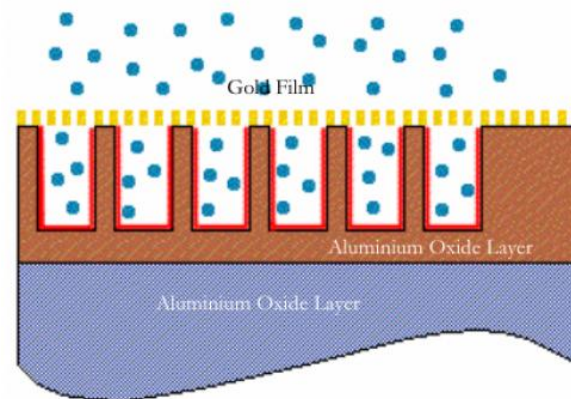
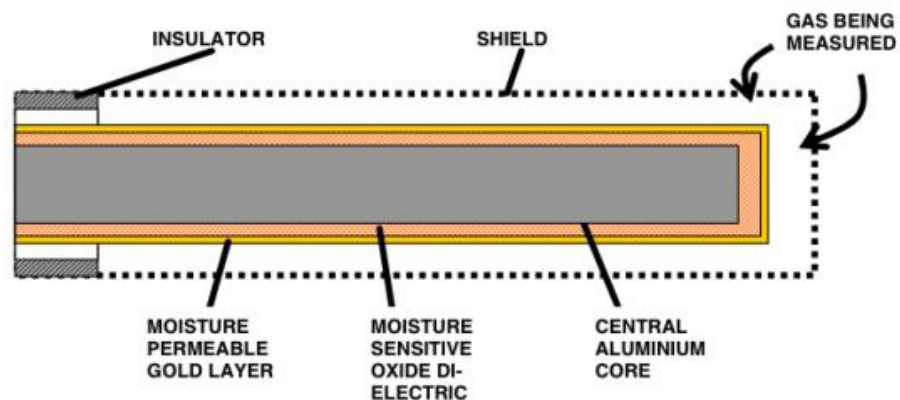
Fiber-Optics coupling

Other

Manual Chilled Mirror

Automated Chilled Mirror

Capacitance Sensor

**Pros:**

Inexpensive

Sensitive when dry

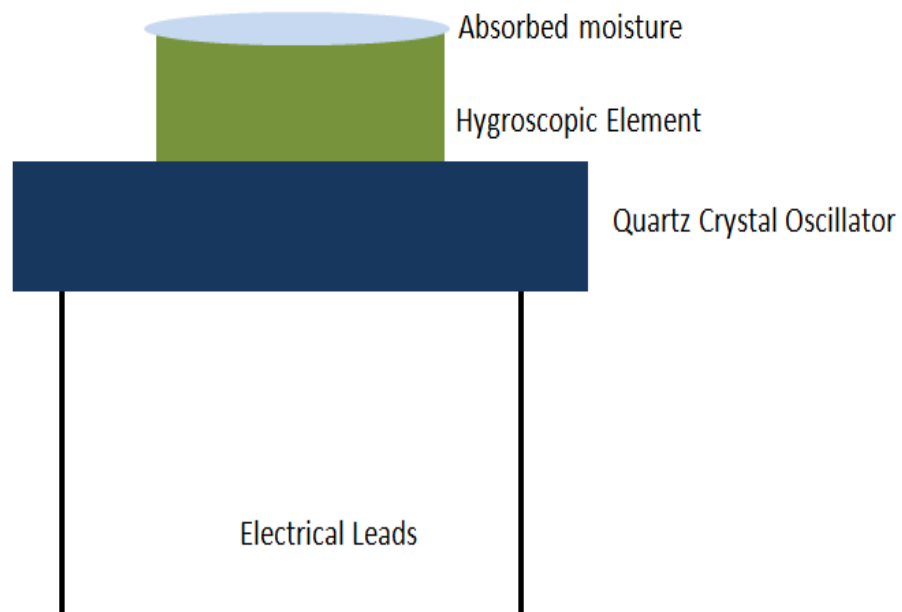
Cons:

Susceptibility to contamination

Long drying time

Significant drift

Quartz Crystal Monitor

**Pros:**

Sensitive

Cons:

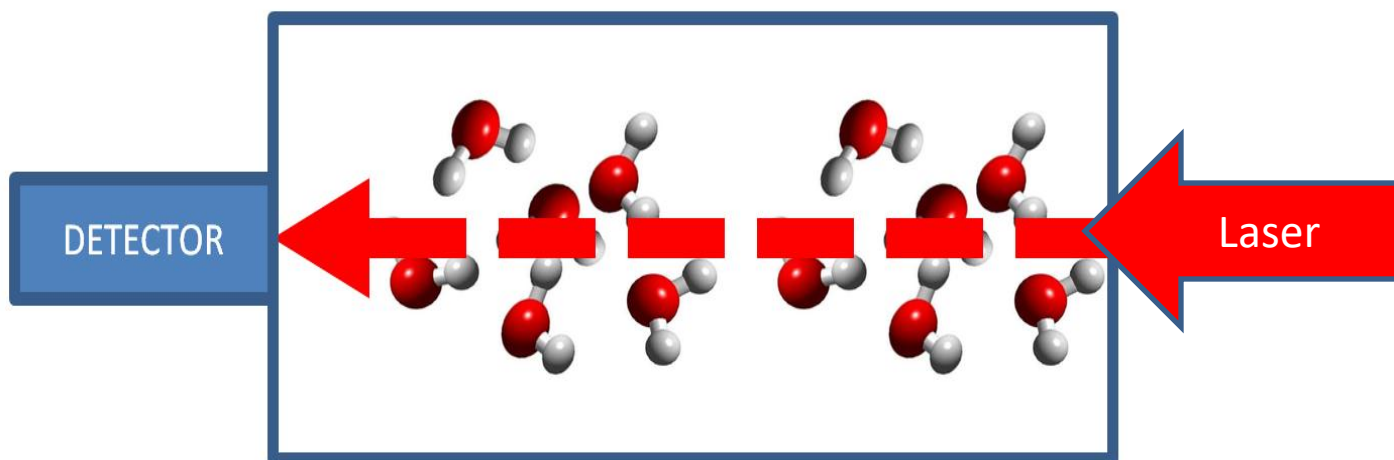
Susceptibility to contamination

Expensive

Temperature drift

Maintenance intensive

TDLAS (Tunable-Diode Laser Absorption Spectroscopy)

**Pros:**

“Non-invasive”

Much more specific than other “content” methods

Cons:

Can only operate at near-room pressure

Expensive

Water **CONTENT** Measurement

- Each **CONTENT** measurement method has advantages and disadvantages
- Most content measurement instruments
 - Measure content at room pressure.
 - Can calculate a dewpoint
- Dewpoint is higher at higher pressures.
 - For a given water content

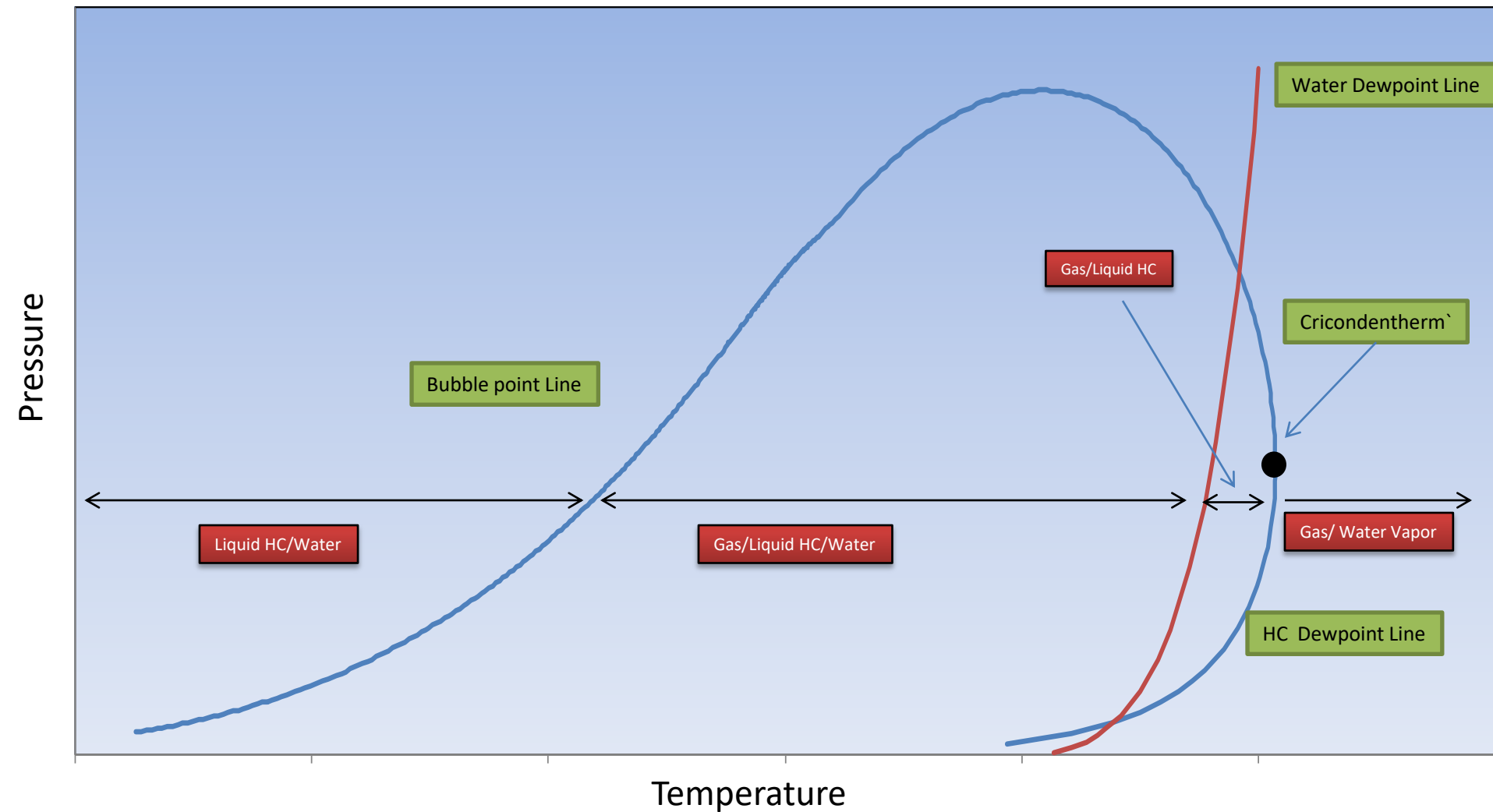
Water measurement in Natural Gas

- Typical water content in Sales quality Natural Gas
 - Between 20ppm (very dry) to 200ppm
 - Typical custody transfer at 80ppm and 140ppm
 - Typical Dewpoint tariffs -5 C
- Dewpoint is pressure dependent
 - 20ppm -> DP of -54C at atmospheric pressure
 - 20ppm -> DP of -23C at 500 psig
 - 200ppm -> DP of -35C at atmospheric pressure
 - 200ppm -> 2 C at 500 psig

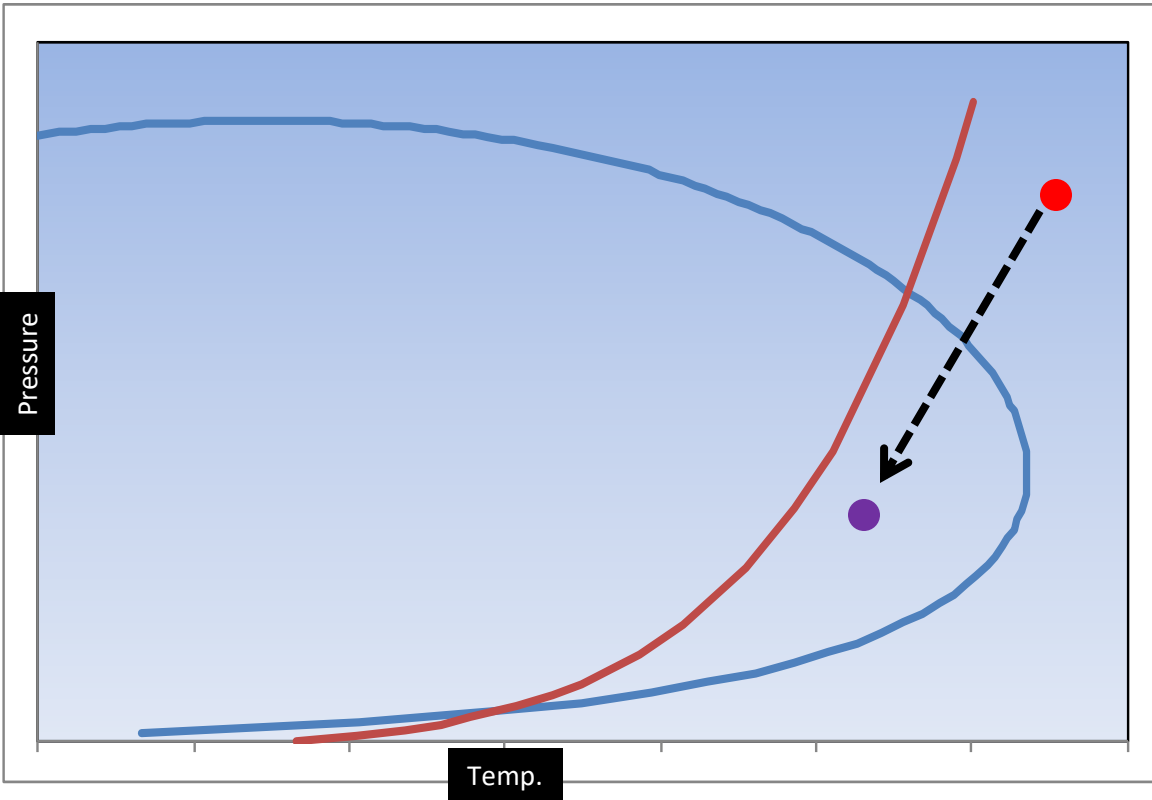
Dewpoint measurement vs. content measurement

- Advantages of direct water dewpoint measurement
 - Dewpoint is a **FIRST PRINCIPLE** measurement
 - Dewpoint can be measured at line pressure
 - Does not need pressure reduction
 - But content measurement has to be done at atm. Pressure
 - It needs a sample system with pressure reduction
 - Pressure reduction can cause significant changes in the composition
 - Dewpoint is a direct measurement
 - Using water content measurement, one has to calculate DP, indirectly
 - Calculation is equation and composition dependent.

PHASE DIAGRAM-Natural Gas



Joule-Thomson Effect During Pressure Reduction
Combination of both pressure and temperature reduction



- ✓ Pressure reduction creates cooling effect
- ✓ Even if the gas is substantially outside the phase envelope, the combination of pressure reduction and cooling may cause it to cross into the phase envelope.
- ✓ Mostly happens during sample preparation and pressure reduction.

Dewpoint measurement vs. content measurement

- Advantages of direct water dewpoint measurement
 - The only sensor that needs to be calibrated is the surface temp. sensor
 - Having a permanently calibrated sensor is routine
 - Therefore, dewpoint measurement does not normally need calibration

For DEWPOINT Measurement

You need Three Elements

- A Cold Surface
 - A means of cooling a surface
- A method to detect the surface temperature
- **A method to detect the onset of condensation**

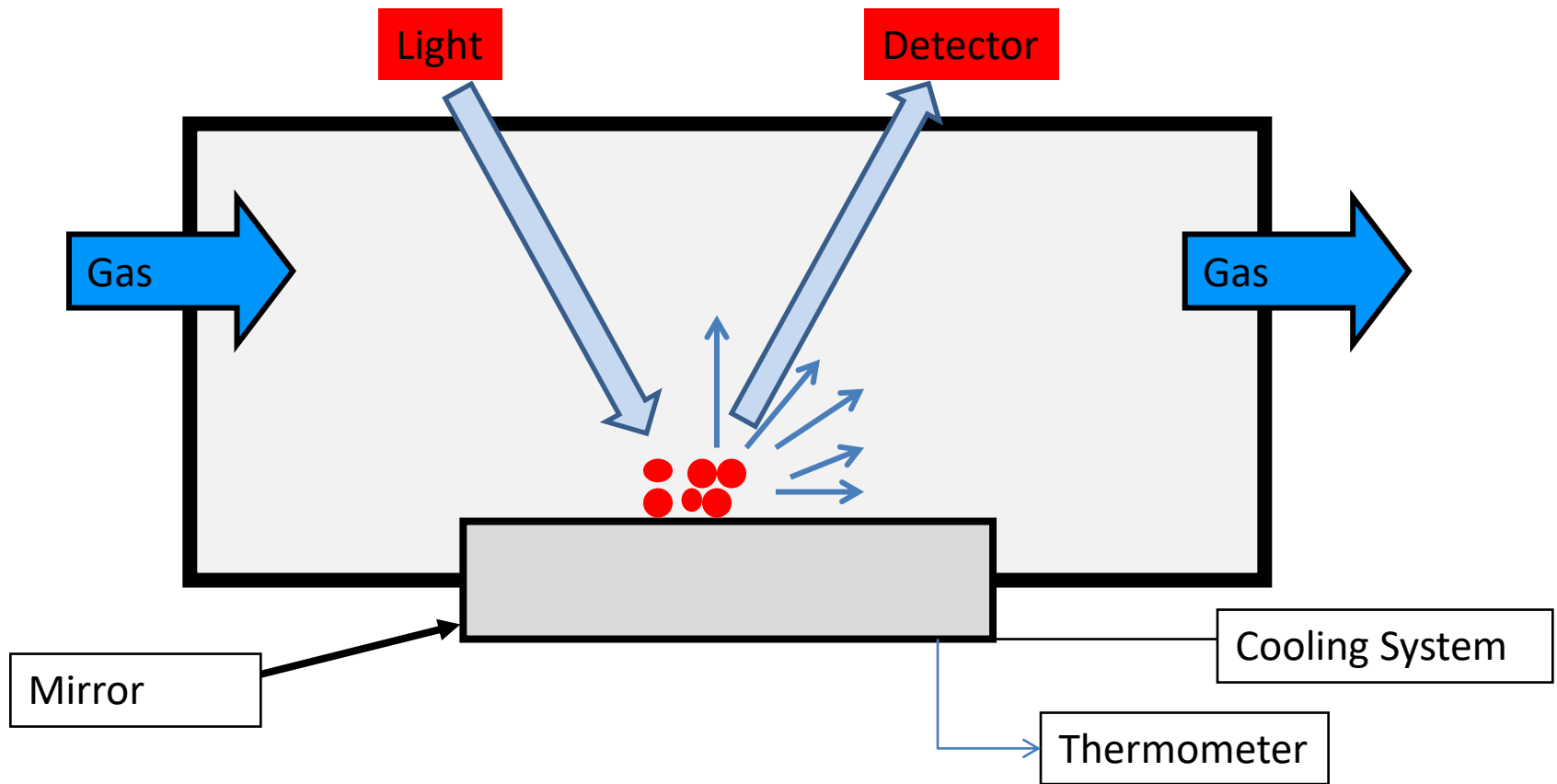
Water **DEWPOINT** Measurement

- Manual
 - Human Eye detects the onset of condensation
 - Fairly subjective, cumbersome to use
- Automated:
 - Two methods
 - Light scattering
 - CEIRS (Chilled Mirror Evanescent IR Spectroscopy)
- Units:
 - Dewpoint has units of temperature

Automated Chilled Mirror Systems

- Light Scattering
 - Ametek
- CEIRS™
 - Chilled Evanescent IR Spectroscopy
 - ZEGAZ Instruments

Light Scattering Method



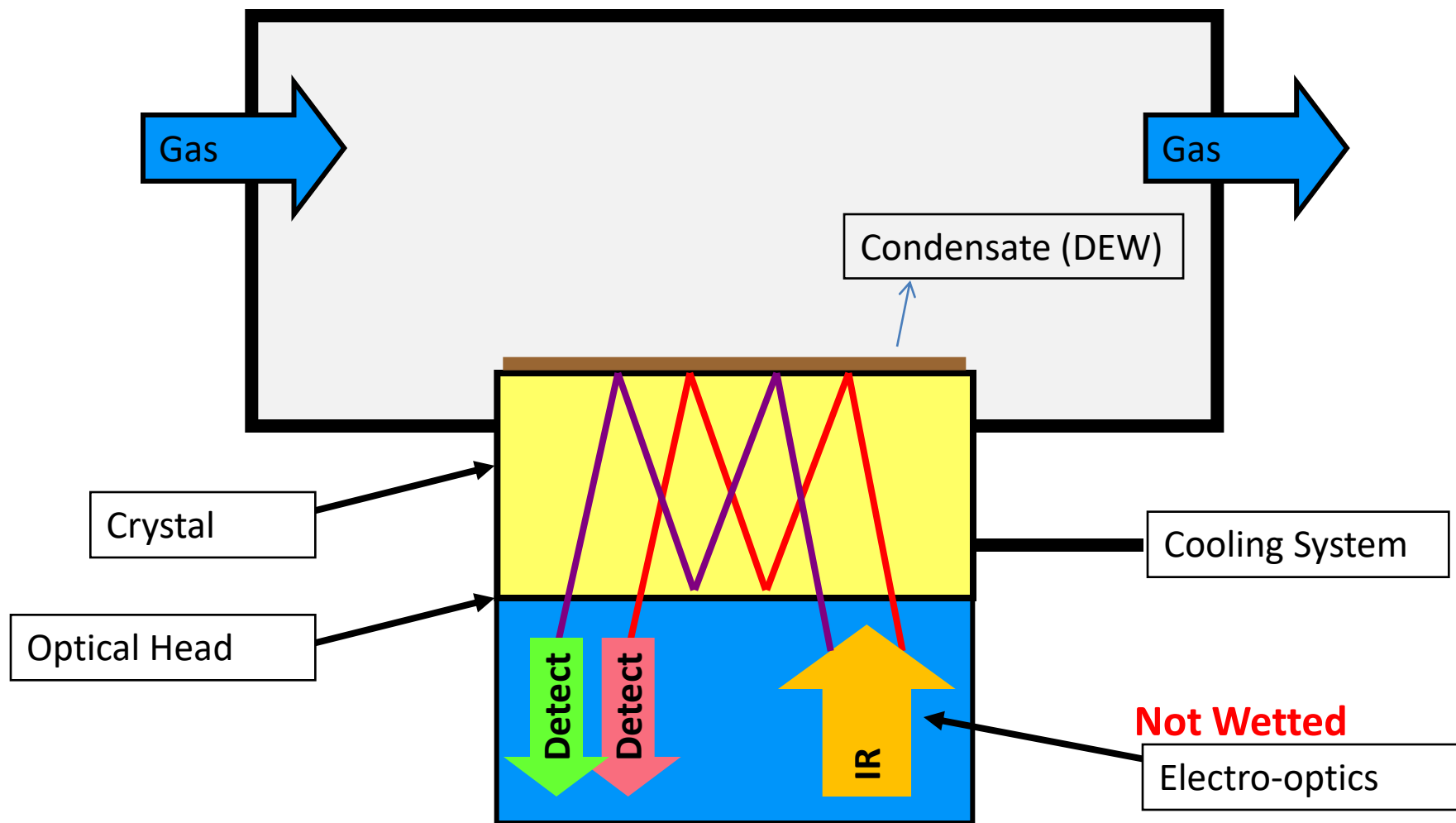
ZEGAZ Instruments'
Groundbreaking

CEIRS™ Technology

Chilled-Evanescent InfraRed Spectroscopy

- The most accurate, reliable, maintenance free method
- The only spectroscopic based method
- Developed and patented by **ZEGAZ Instruments**

CEIRS™ Technology



Advantages of CEIRS™

- A non-metallic mirror
 - Immune to **ALL** contaminants, including acids, H₂S, glycols, etc.
 - Low thermal mass of the mirror, leads to low-power, longer life
 - Extremely hard material, will not get damaged or scratched.
- A spectroscopic method
 - Can distinguish between HC and water dewpoint based on IR absorption
 - Will not respond to other chemicals
- Internal mirror as opposed to external mirror
 - No entrance and exit windows needed, eliminating false signals.