



# LNG CUSTODY TRANSFER, QUALITY MEASUREMENTS

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# MY TODAY TOPICS

Background

Sampling comments

Analysis components

Data assurance

Pitfalls Data handling

Raman initiative's

# LITTLE HISTORY

Shell First plant in 1960's

First methods, sampling and Analysis developed by the first major Japanese customer

- Vaporization steam and later electrical
  - First Dome with water seal, later waterless Dome
  - 2004 online GC custody transfer (used in contracts)
  - 2007 piston sampler; Alternative sampler, piston grab, robust
- ISO 8943 , SC5, TC28 Covers the main critical elements for sample taking

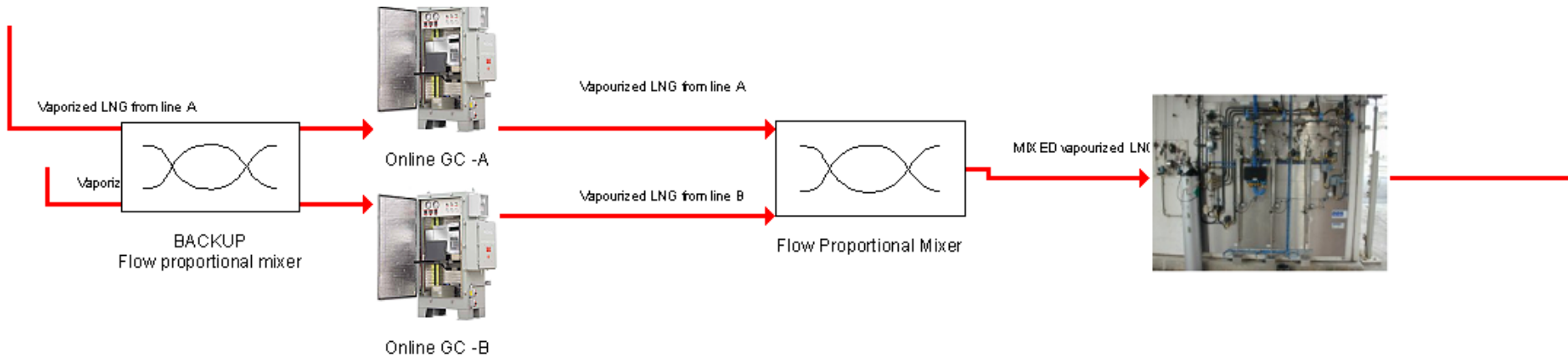
Analytical component analysis GPA 2261 vs ISO 6974

# ISO 8943 COMMENTS 1(3)

How to deal with multiple loading lines

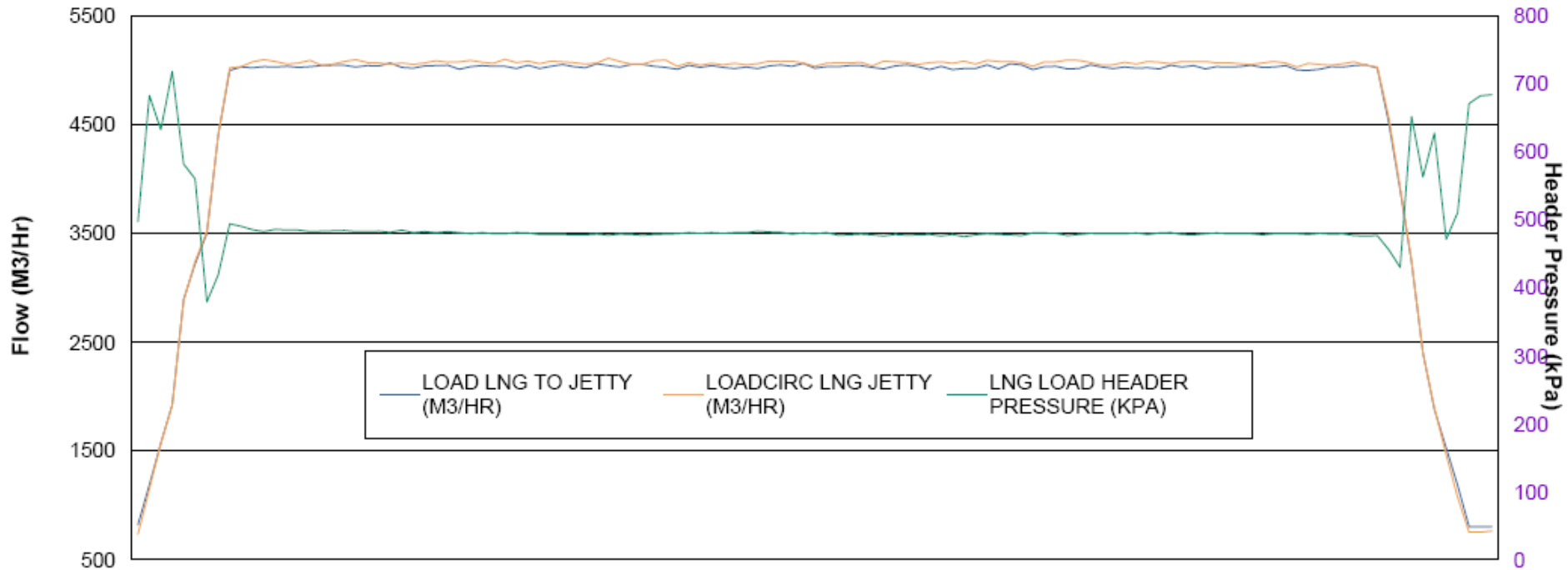
- 2 Loading arms running at full capacity
- vapor return line(s)

# FLOW/TIME PROPORTIONAL SAMPLING FOR MULTIPLE LINES

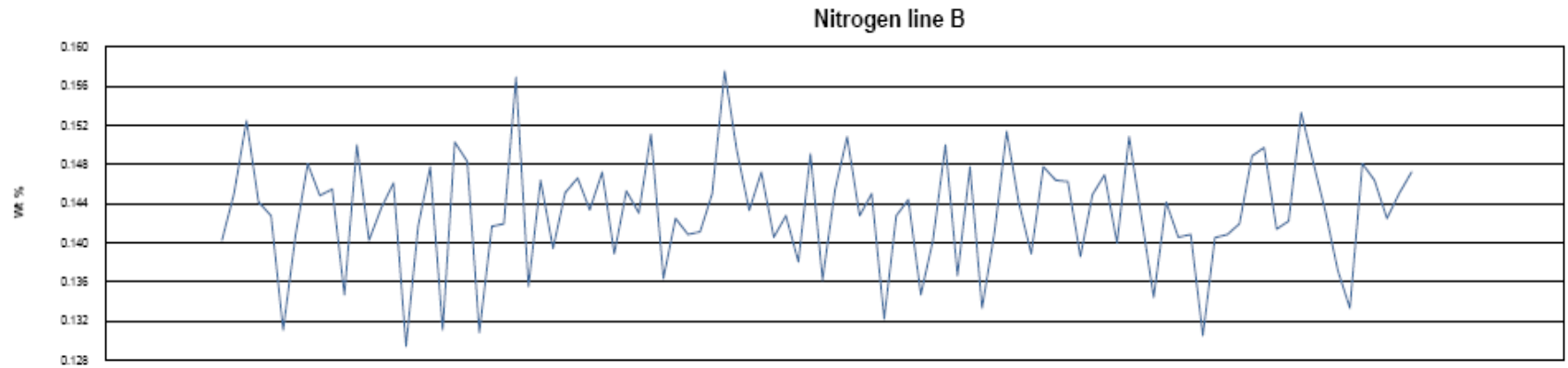
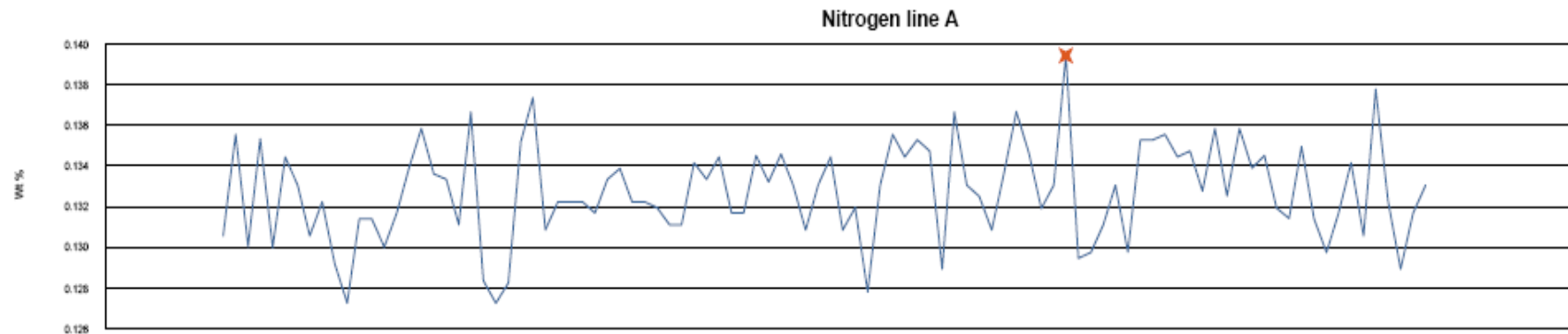


# ISO 8943 COMMENTS 2(3)

Outliers, stable vaporization is the best assurance.



# AVOID OUTLIERS TREATMENT (GIIGNL)





## ISO 8943 COMMENTS 3(3)

Unspecified retained gas volume

Measurements Impurities, use ISO 10715

- Oxygen
- Mercury
- Sulfur components

Validation of ISO 8943, even after 30 years



# COMPONENT MEASUREMENTS

## ISO 6974

Linearity confirmed

Strong Calibration criteria  
resolution peak separation criteria set.

## GPA 2261

Linearity based on reduced injection  
pressure

Weak Calibration criteria  
No peak separation criteria

# COMPOSITION ANALYSIS

ISO 6974, Atlantic basin, GPA 2261, Asia-Pac

Component	ISO 6974 part 5		ISO 6974 part 3		ISO 6974 part 6		GPA 2261	
	Mol Fraction Range %		Mol Fraction Range %		Mol Fraction Range %		Mol Fraction Range %	
	Min	Max	Min	Max	Min	Max	Min	Max
Helium			0.01	0.5	0.002	0.5	0.01	10
Hydrogen			0.01	0.5	0.001	0.5		
Oxygen			0.1	0.5	0.007	5	0.01	20
Nitrogen	0.001	15.0	0.1	40	0.007	40	0.01	100
Hydrogen Sulphide <sup>4</sup>							3.00	100
Carbon dioxide	0.001	8.5	0.1	30	0.001	10	0.01	20
Carbon Monoxide				0.001	1			
Methane	75	100	50	100	40	100	0.01	100
Ethane	0.001	10.0	0.1	15	0.001	15	0.01	100
Ethyne (Acetylene)					0.001	0.5		
Ethene					0.001	0.5		
Propane	0.001	3.0	0.001	5	0.001	5	0.01	100
Propene					0.001	0.5		
isoButane (2-methylpropane)	0.001	1.0	0.001	2	0.0001	1	0.01	10
n- Butane	0.001	1.0	0.001	2	0.0001	1	0.01	10
neo-Pentane (2,2-dimethylpropane)	0.001	0.5	0.001	1	0.0001	0.5		
isoPentane (2-methylbutane)	0.001	0.5	0.001	1	0.0001	0.5	0.01	2
n-Pentane	0.001	0.5	0.001	1	0.0001	0.5	0.01	2
Hexanes + sum of all c6 and higher hydrocarbons	0.001	1.0	0.001	0.5	0.0001	0.5	0.01	2

# UNCERTAINTY

typical values and based on GUM (ISO21748) k=2

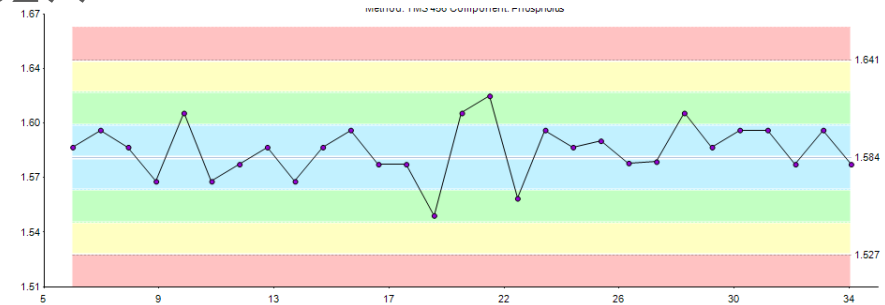
Component	Range Mol %	GPA 2261	ISO 6974 p5	ISO 6974 p3	ISO 6974 p6
		Uncertainty	Uncertainty	Uncertainty	Uncertainty
Nitrogen	0.07	± 0.00346	± 0.00109	± 0.00148	± 0.00012
Carbon Dioxide	-				
Methane	78.11	± 0.00035	± 0.00004	± 0.00010	± 0.00001
Ethane	11.99	± 0.00099	± 0.00020	± 0.00148	± 0.00012
Propane	7.17	± 0.00099	± 0.00059	± 0.00148	± 0.00012
Isobutane	1.14	± 0.00198	± 0.00307	± 0.00297	± 0.00049
n-Butane	1.44	± 0.00198	± 0.00099	± 0.00198	± 0.00020
Isopentane	0.03	± 0.00297	± 0.00535	± 0.00297	± 0.00049
n-Pentane	0.02	± 0.00297	± 0.00099	± 0.00297	± 0.00049
C <sub>6</sub> <sup>+</sup>	0.03	± 0.01485	± 0.00297	± 0.00297	± 0.00049

# DATA ASSURANCE

Calibration material traceable to ISO14111

Statistical Quality Control, ASTM D6299

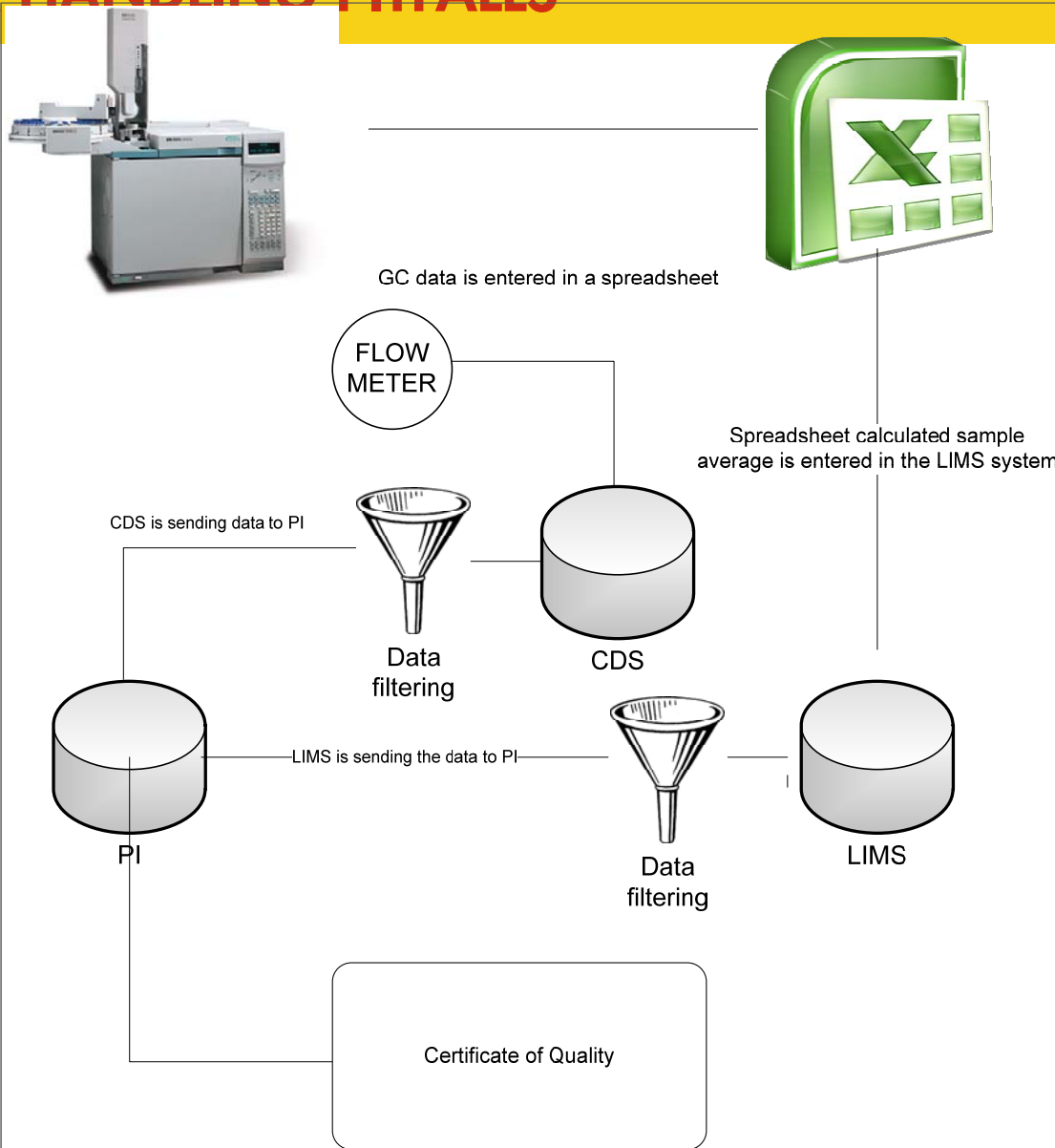
- Online GC (ASTM\_D3764)
- Offline GC (ISO 17025)
- Between online and offline GC



Online will be within the same Quality regime as Laboratory.

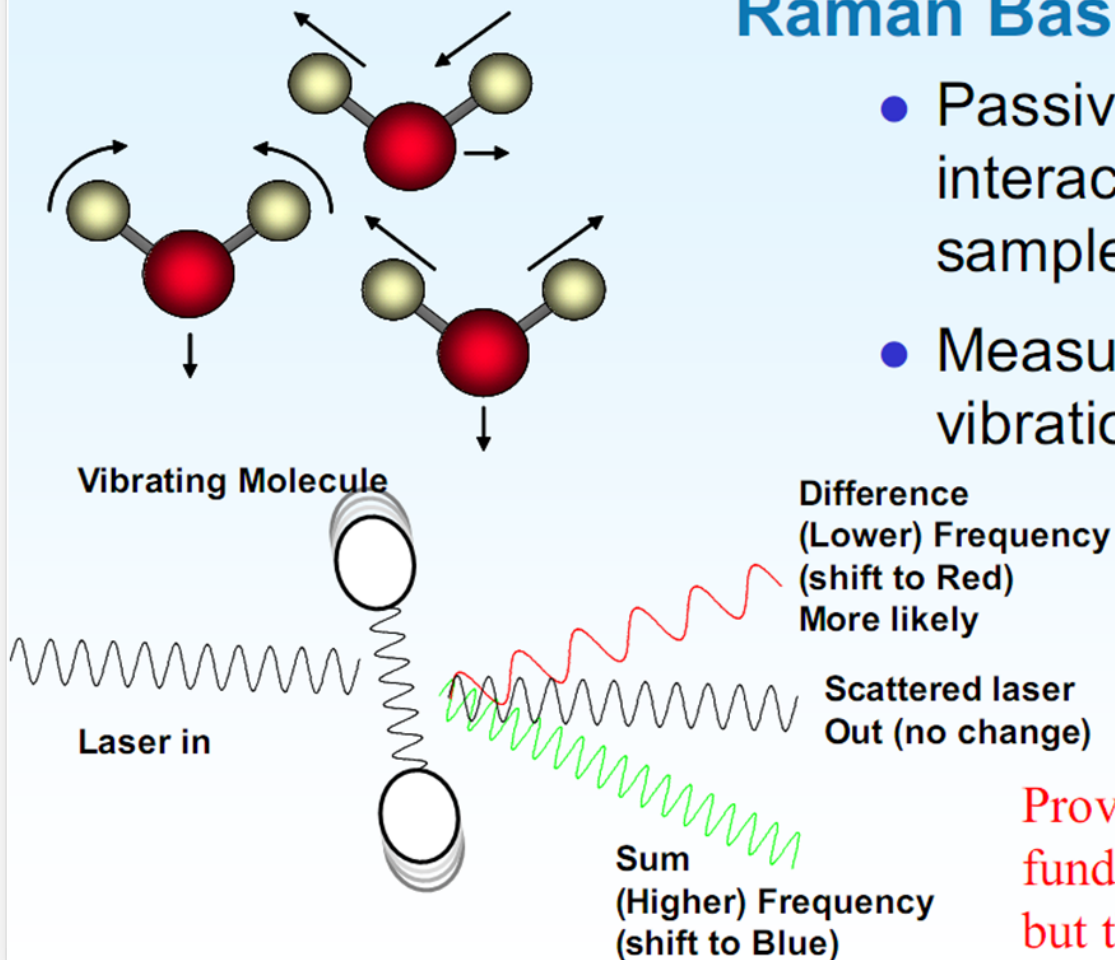
Proficiency testing (which is not the same as customer buyer crosschecking) true versus consensus

# DATA HANDLING PITFALLS



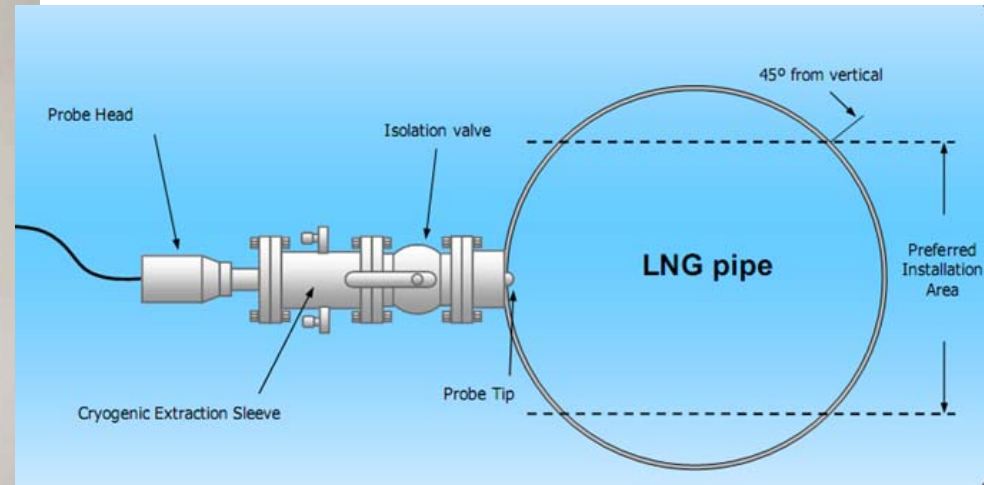
## Raman Basics

- Passive, scattering interaction with sample material.
- Measures the vibrational modes.

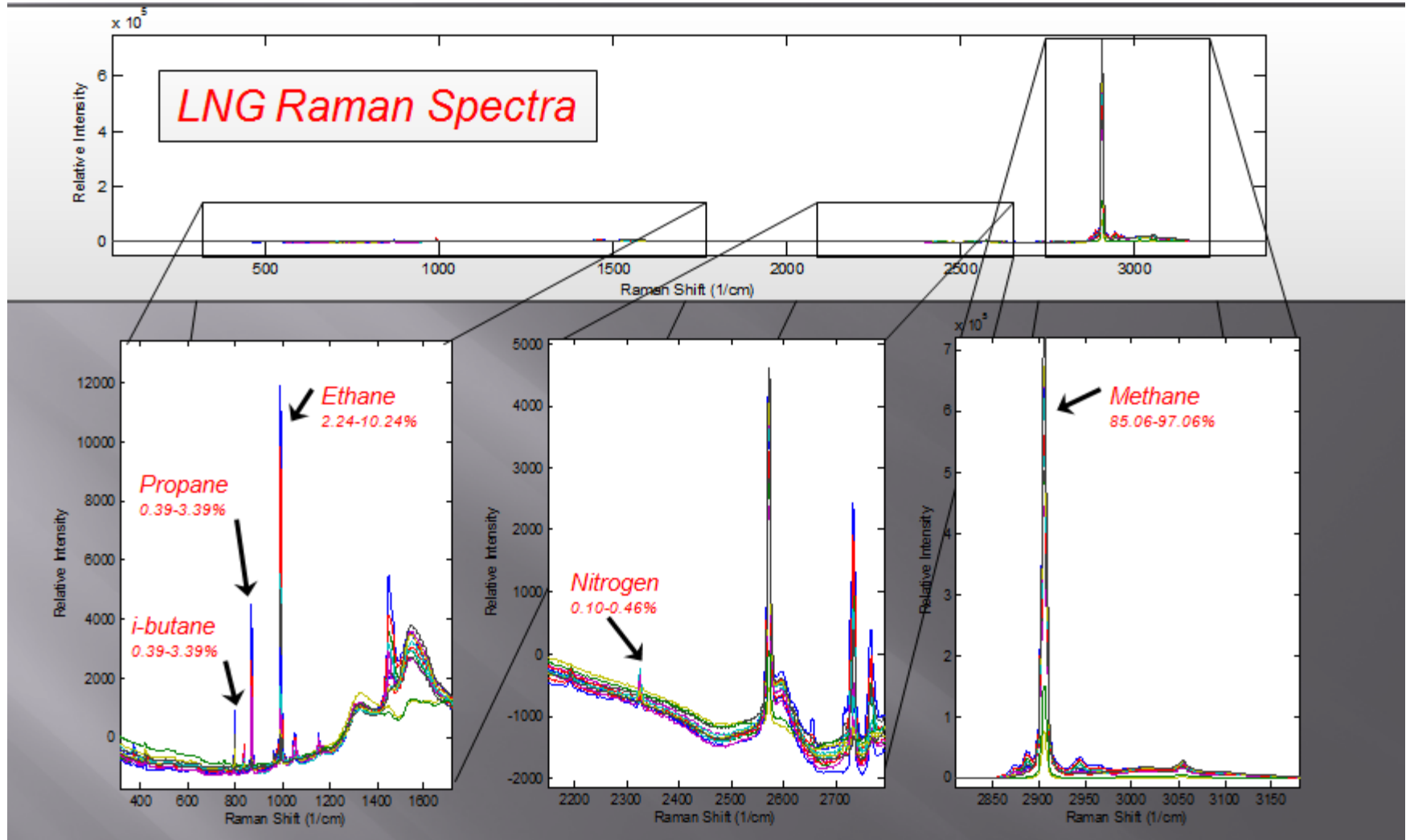


Provides access to fundamental bands, but the effect is weak

# FIELD TEST SINCE 2008 AND CRYOGENIC CONDITIONS



# EXAMPLE LNG SPECTRA





**END.... TO BE CONTINUED**