Challenges and Opportunities for Calibration Laboratories 2020 to 2050

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For you. For us.
For growth.

Abstract

- There are many technological advances afoot that will change both the types of instruments that calibration laboratories service and the way that they will perform calibration
- As Industry 4.0 is embraced by manufacturers, it will drive the installation of numerous sensors into many processes
- New models for ensuring metrological traceability will have to be developed, and some of the calibrations will be performed with intrinsic standards that can directly realize the SI, so they won’t require recalibration.
- This presentation will illustrate what the future may look like and proposes some possible solutions to address these challenges.

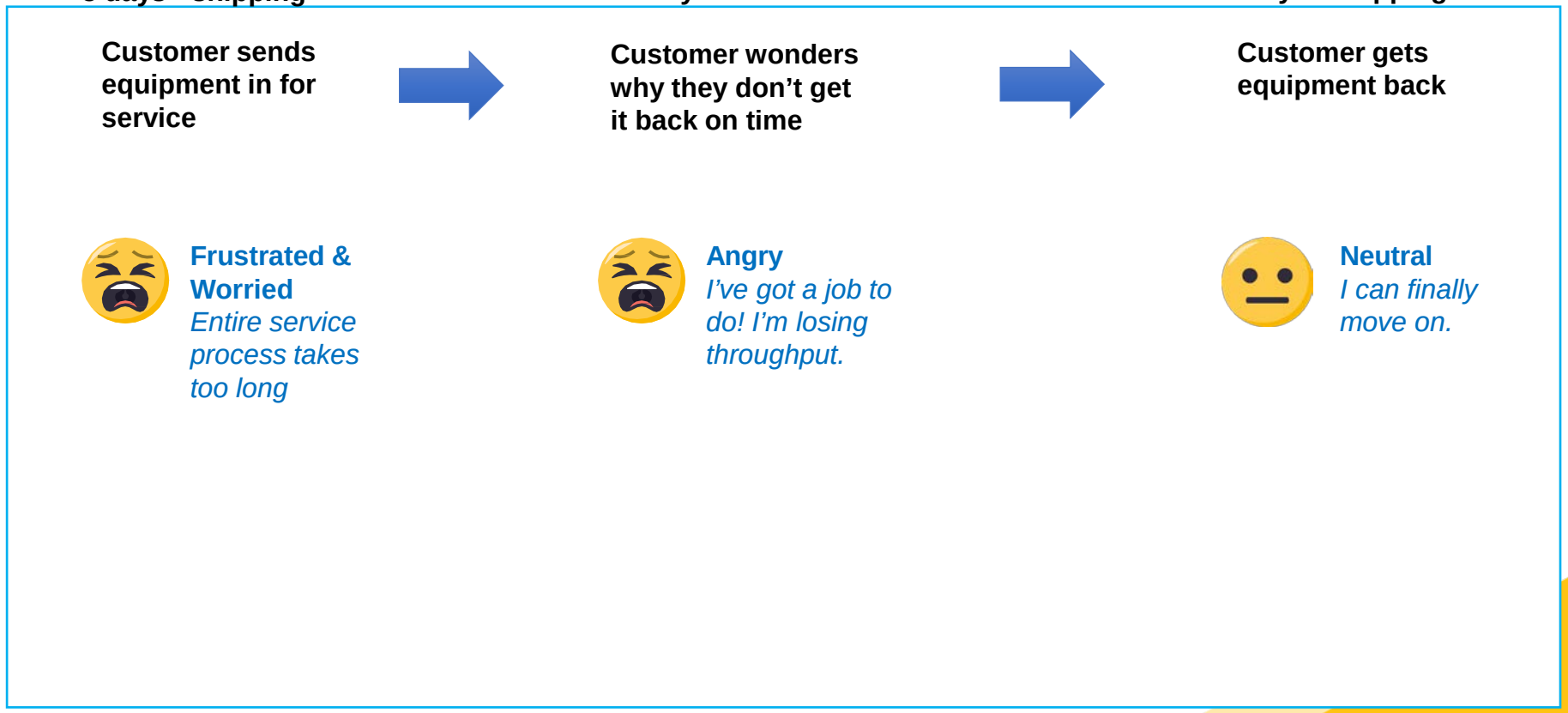
The World Depends on Data More than Ever

Coordination in the Age of Industry 4.0
Leslaw Pietrewicz
International Journal of Management Sciences and Business Administration

What parts of the calibration workflow are most painful for our customers Today?

Turn Around Time Promised (shipping excluded): **5 days**
Actual: **12-28 days**

Simplified Calibration Workflow



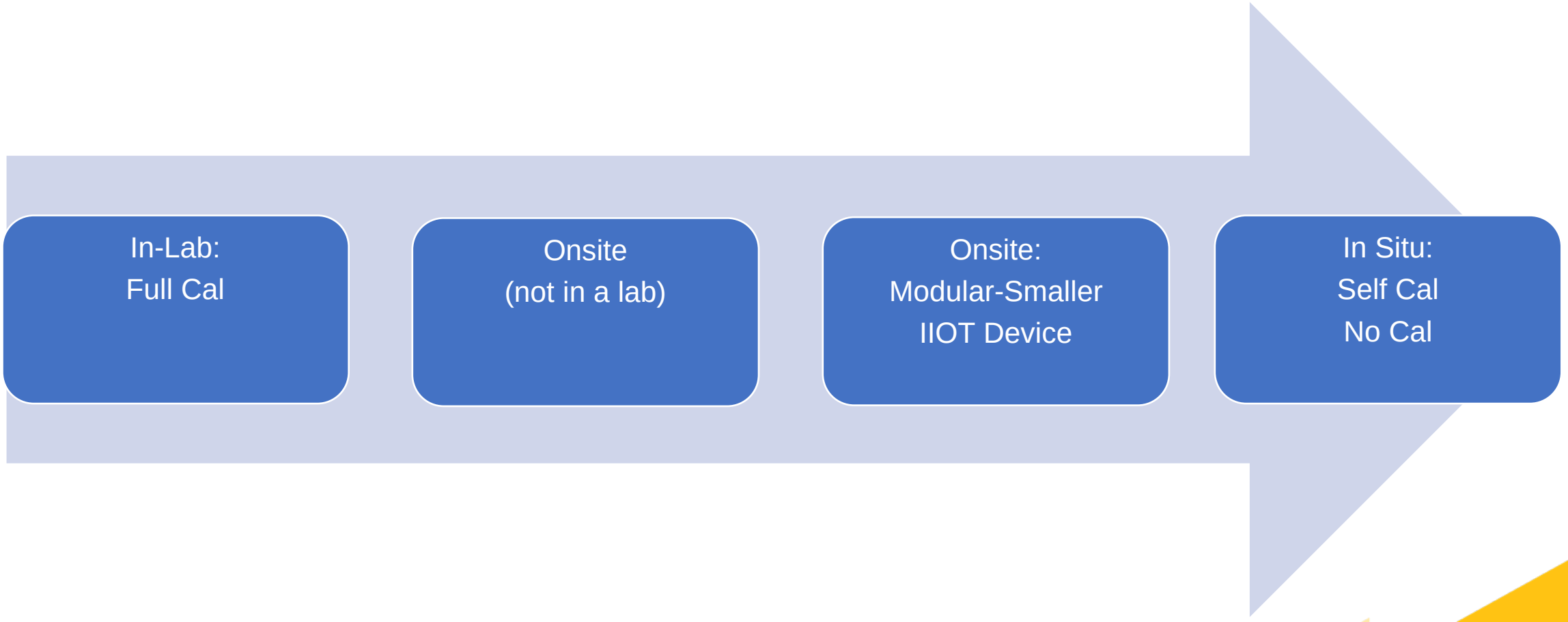
"It takes 2 hours to cal. the DUT. Why does it take 30+ days to get it back to the customer?"

Calibration = pain for test equipment users

- Sending Equipment to Manufacturer – 5 to 30 days
- Onsite calibration – 1 to 2 days
- Downtime
- Spares Inventory

How do we reduce or eliminate this pain for test equipment users?

The Evolution of Calibration



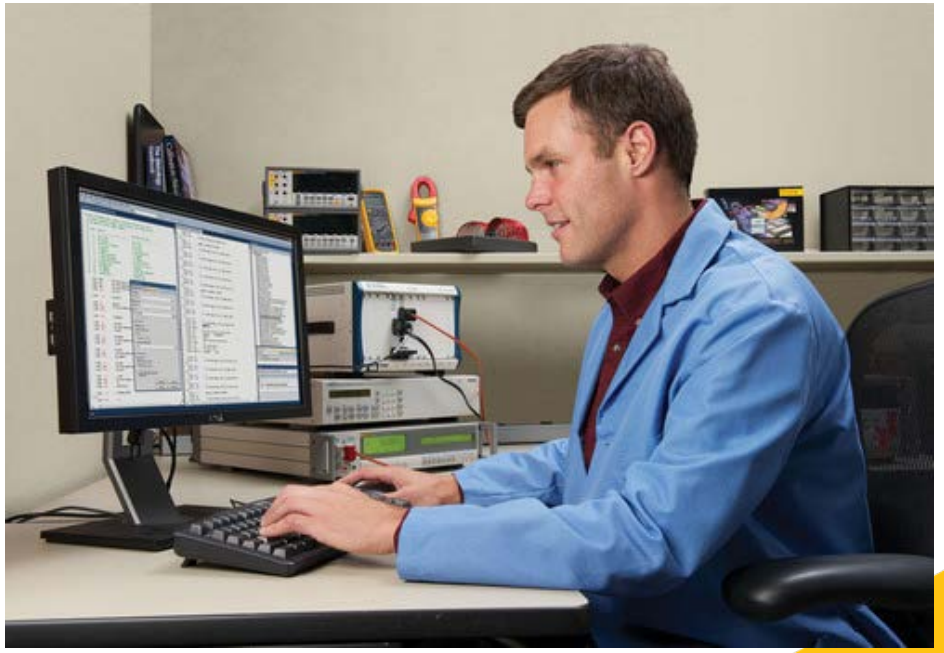
New technologies = New Test and Measurement

- 1750B 3 phase power energy logger

- 3561 FC vibration sensors

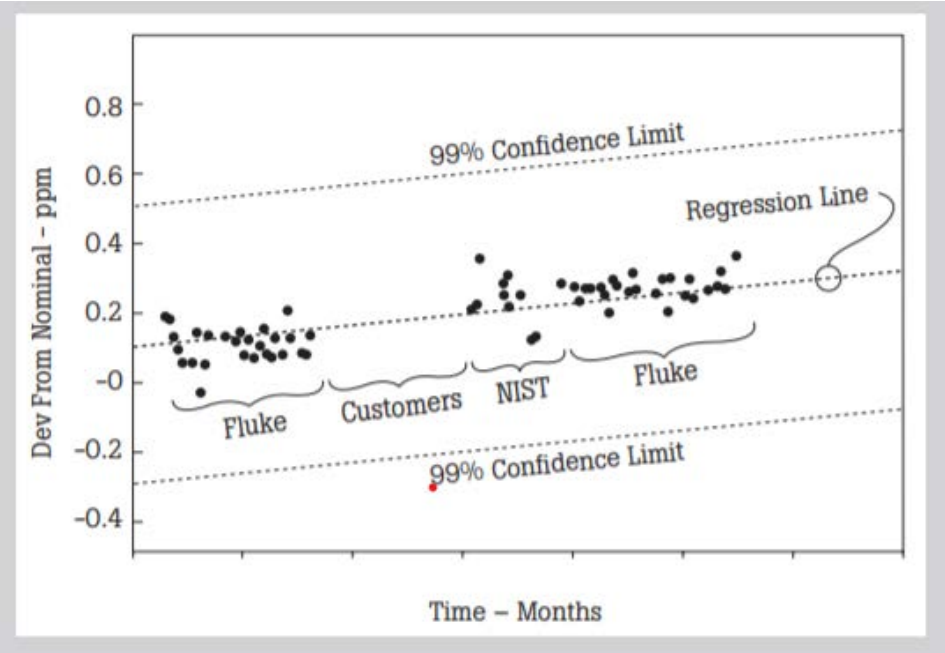
Next Phase – Sending References Onsite and calibrating over the Internet

Internet



Example - Fluke 732 Calibration

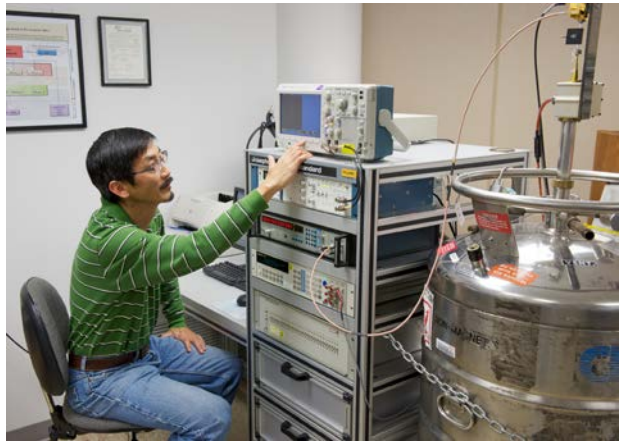
- The DVMP: practical and cost-effective fractional ppm SI traceability
- A unique and practical service available to our U.S. customers
- The Direct Voltage Maintenance Program gives you fractional ppm SI traceability without ever shipping your standards out of your lab.
- The DVMP uses Fluke-owned 732Bs so your standards are never exposed to the risks of shipment and are always available when you need them
- Typical DVMP transfer uncertainties of ± 0.05 ppm allow your 732B to be calibrated with an absolute uncertainty of about ± 0.4 ppm.
- NVLAP Accredited



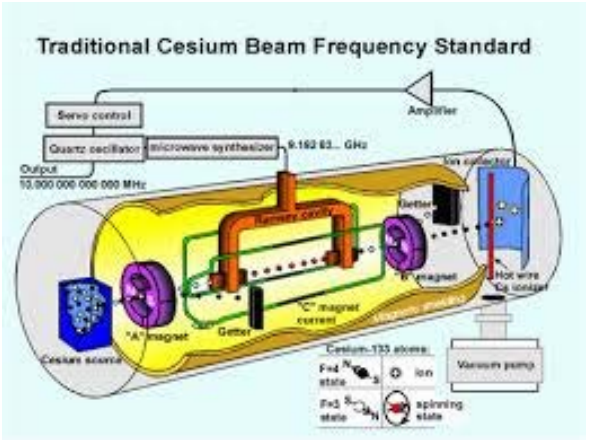
Final Phase – Quantum Metrology for very long or no calibration intervals

- What is Quantum Metrology?
- The application of knowledge associated with quantum mechanics to develop precise measuring equipment/calibration standards

Quantum Hall Resistance Standard (ohm)



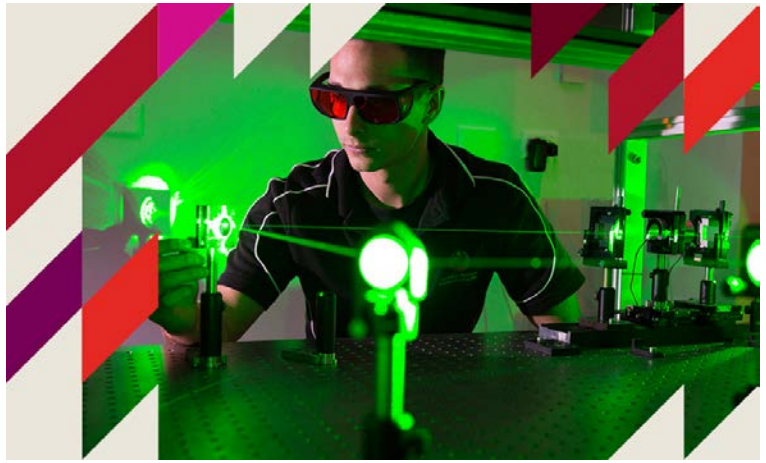
Josephson Voltage System (DC volt)



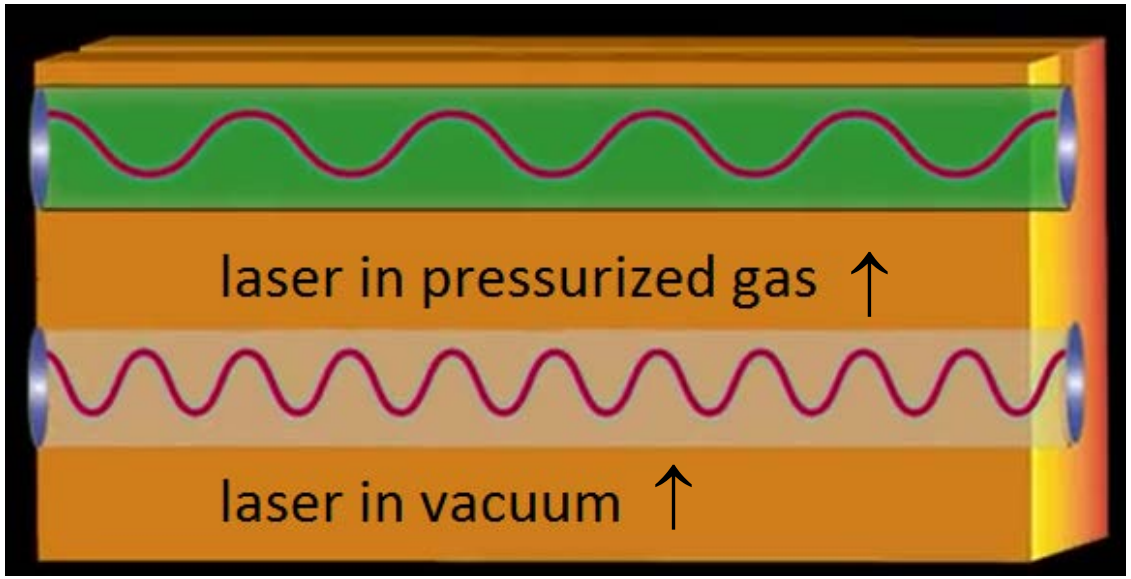
Cesium Beam Frequency Standard (second)

Requires Miniaturization Cryogenic Cost improvements

- **Photonic Metrology** – the branch of technology concerned with properties of and transmission of photons
- A subfield of Quantum Metrology
- We can measure frequency better than any other quantity
- It is fairly easy to measure 1 million times better than 1 ppm (1×10^{-12}), which in seconds would be 1 second in every 31,700 years
- Ties into measurements of optical wavelength/frequency



NIST Fixed Length Optical Cavity

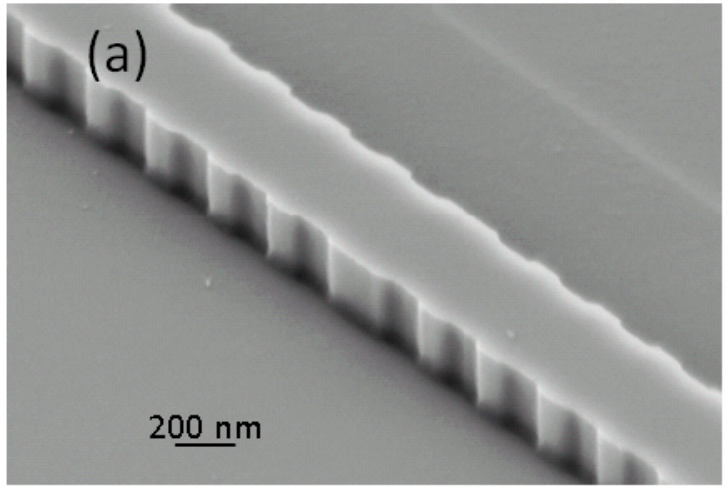


- Uses lasers to measure pressure
  - laser beam is split and passed through both cavities
  - Wavelength of laser in gas (He) changes as a function of pressure
  - Difference in wavelengths are measured
  - Capable of sub-ppm accuracy

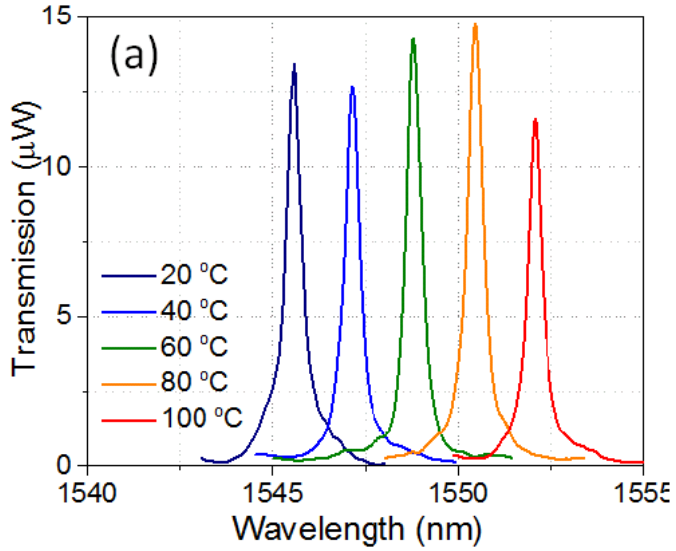
- One of several NIST initiatives to base many measurements on frequency/light
  - NIST has already decommissioned their primary standard for pressure (ultrasonic manometer) in favor of this technology
  - Validated with Fluke Piston Gage

Standard Photonic Thermometer

- Temperature sensor is a silicon photonic Bragg grating
- Creates a reflected wavelength around 1550 nm



- The high thermo-optic coefficient of silicon changes the wavelength value as a function of temperature
- Sensitivity of 82 pm/ºC ~ 18 mK
- Sensors don’t need recalibration



Conclusions

- Predicting the Future is difficult!
- Intrinsic/Quantum Standards will require us to re-think how we think about SI Traceability
  - Stopwatch analogy
- Protocols need to be developed to address internet security
- Cost and uptime will be the necessity/drivers