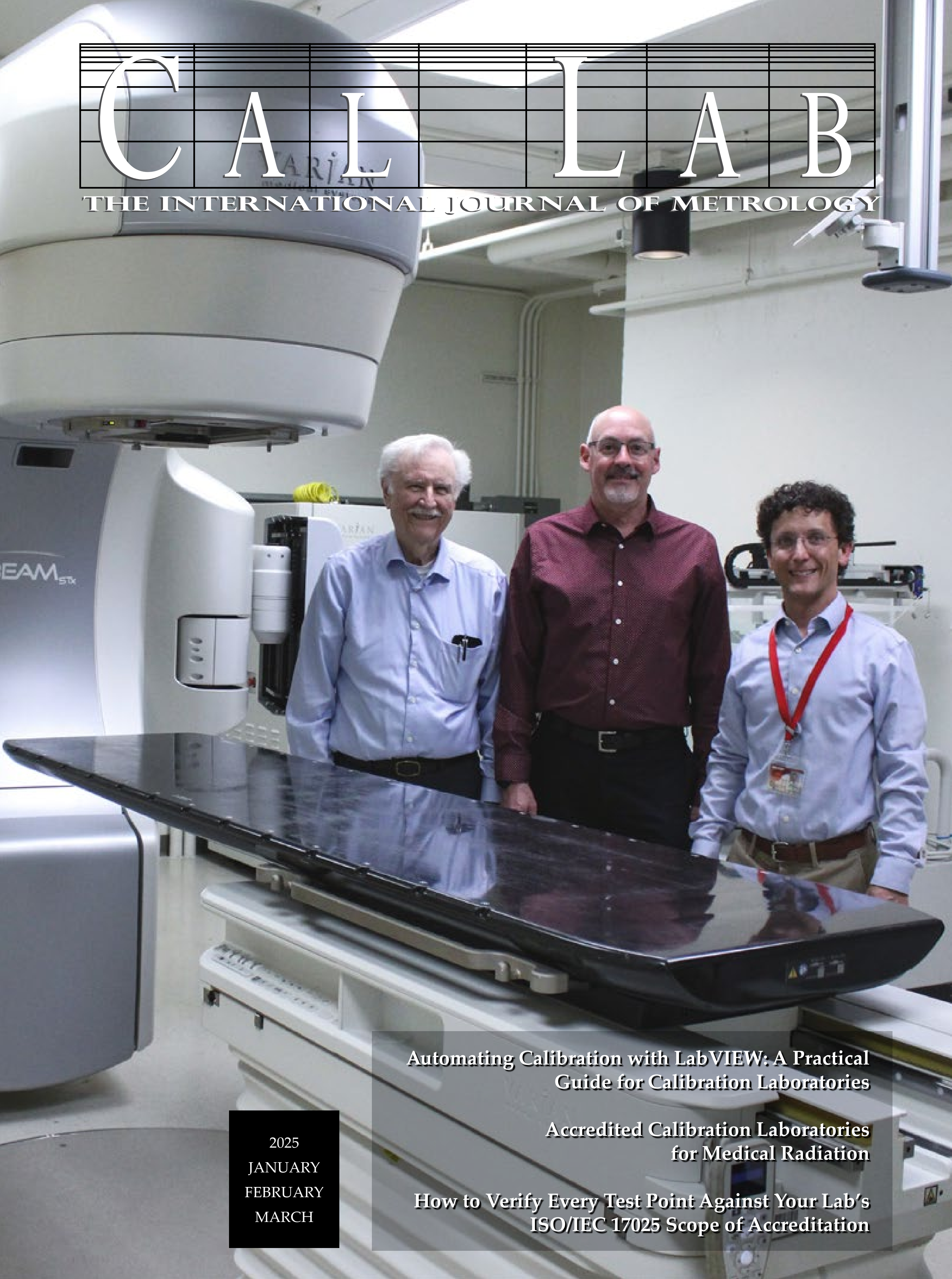
CAL LAB
THE INTERNATIONAL JOURNAL OF METROLOGY



2025
JANUARY
FEBRUARY
MARCH

Automating Calibration with LabVIEW: A Practical Guide for Calibration Laboratories

Accredited Calibration Laboratories for Medical Radiation

How to Verify Every Test Point Against Your Lab's ISO/IEC 17025 Scope of Accreditation

CAL LAB
THE INTERNATIONAL JOURNAL OF METROLOGY

VOLUME 32, NUMBER 1

www.callabmag.com

FEATURES

DEPARTMENTS

ON THE COVER: Photograph of the University of Wisconsin Medical Radiation Research Center (UWMRRC) Varian TrueBeam Linear Accelerator. In photo from Left to Right: Larry DeWerd, PhD, FAAPM, FABS Professor and UWMRRC Director Medical Physics Department; Daniel Anderson UWADCL Associate Director Medical Physics Department; and Wesley Culberson, PhD, DABR, FAAPM Associate Professor, CHS UWADCL Director Department of Medical Physics.

CALENDAR

UPCOMING CONFERENCES & MEETINGS

The following event dates are subject to change. Visit the event URL provided for the latest information.

May 6-8, 2025 International Conference on Electronics, Energy and Measurement. Algiers, Algeria. The 3rd IC2EM covers: Electronics and electrical engineering systems, such as the following topics: Electronic Systems, Energy Systems, Measurements, Instrumentations, Telecommunications and Power electronics and drives. https://ic2em2025.usthb.dz/

May 6-8, 2025 SENSOR+TEST. Nuremberg, Germany. SENSOR+TEST is the world's leading forum for sensor, measurement and testing technology. https://www.sensor-test.de/en/

May 6-8, 2025 Sensor and Measurement Science International. Nuremberg, Germany. As the only major international sensor and metrology conference, SMSI brings together intelligent sensor technology and instrumentation, digitalization-oriented measurement science with cognitive features as well as modern quantum technology-based metrology including the secure digital exchange of certificates. https://www.smsi-conference.com/

Jun 18-20, 2025 IEEE 12th International Workshop on Metrology for AeroSpace. Naples, Italy. MetroAerospace aims to gather people who work in developing instrumentation and measurement methods for aerospace. Attention is paid, but not limited to, new technology for metrology-assisted production in aerospace industry, aircraft component measurement, sensors and associated signal conditioning for aerospace, and calibration methods for electronic test and measurement for aerospace. https://www.metroaerospace.org/

Jun 20, 2025 ARFTG Microwave Measurement Symposium. San Francisco, California. The 105th ARFTG Microwave Measurement Symposium will be co-located with IMS-2025. https://arftg.org/

CAL LAB
THE INTERNATIONAL JOURNAL OF METROLOGY

PUBLISHER
MICHAEL L. SCHWARTZ

EDITOR
SITA P. SCHWARTZ

CAL LAB
PO Box 111113
Aurora, CO 80042
TEL 303-317-6670 • FAX 303-317-5295
office@callabmag.com
www.callabmag.com

ISSN No. 1095-4791

EDITOR'S DESK

A Light on Metrology Research

I've made attempts over the years to get more content about metrology-related programs from community colleges. They have dwindled over the years, so sometimes it takes more than a Google search to find them. I received bites from Monroe County Community College (MCCC) in Michigan and Butler Community College (BCC) in Pennsylvania. They have kindly contributed a few articles over the years to Cal Lab Magazine about their metrology and outreach programs.

I further reached out to universities and received an interesting and enlightening paper, included in this issue, on a calibration laboratory that supports the Medical Radiation Research Center at the University of Wisconsin (UWMRRC). The Center's activity, located in the University's Medical Physics department at the Wisconsin Institutes for Medical Research (WIMR), provides a window to the role of calibration in medical radiation metrology. Professor DeWerd and his colleague, Dr. Khan, contributed their paper, "Accredited Calibration Laboratories for Medical Radiation," summarizing the activities and contributions of the UWMRRC. A photo of the lab and Directors of the Medical Physics department is featured on our cover.

As for a Metrology 101 paper, Mr. Ajay MV obliged our request for a LabVIEW primer which we hope will turn into a series of articles for LabVIEW users! "Automating Calibration with LabVIEW: A Practical Guide for Calibration Laboratories," includes detailed steps in creating a calibration verifier tool and other helpful resources.

For our last Feature Article, we have an updated paper from our publisher, Michael Schwartz, where he explains a use-case for digitization: "How to Verify Every Test Point Against Your Lab's ISO/IEC 17025 Scope of Accreditation." If you missed a previous version of this paper, first presented at the International Metrology Congress (CIM) in March of 2023 in Lyon, France, here is chance to find more about the ongoing work of the NCSLI Measurement Infrastructure 141 Committee (MII) in the use of a metrology taxonomy.

Finally, Dan Wiswell shares with us his collection of vintage "meatballs" and regional history of GE meter manufacturing.

Happy Measuring,

Sita Schwartz

CALENDAR

SEMINARS & WEBINARS: Dimensional

May 7-8, 2025 Surface Roughness, Texture, and Tribology. Livonia, MI. Michigan Metrology. The annual,2-day class is a thorough and affordable opportunity to learn the fundamentals of surface texture, and practical applications for controlling wear, friction, sealing, surface energy, paint appearance, and more. To learn more about the class and to download the registration form visit michmet.com/classes/.

May 13-15, 2025 EDU-114: Dimensional Gage Calibration and Repair. Aurora, IL. Mitutoyo. The course combines modern calibration and quality management ideas with best practices and "how-to" calibration methods for common calibrations. The course is ideal for those operating in ISO/IEC 17025 accredited laboratories or in gage labs supporting manufacturing operations. https://www.mitutoyo.com/training-education/

May 15-16, 2025 Hands-On Precision Gage Calibration and Repair Training. Houston, TX. IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. https://calibrationtraining.com/

May 20-21, 2025 Virtual Hands-On Precision Gage Calibration and Repair Training. IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. https://calibrationtraining.com/

Jun 5-6, 2025 Hands-On Precision Gage Calibration and Repair Training. Atlanta, GA. IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. https://calibrationtraining.com/

Jun 17-18, 2025 Virtual Hands-On Precision Gage Calibration and Repair Training. IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course.

Recommended for people interested in pursuing the ASQ CCT Exam. https://calibrationtraining.com/

Jun 18-19, 2025 EDU-113: Dimensional Gage Calibration. Aurora, IL. Mitutoyo. The course combines modern calibration and quality management ideas with best practices and "how-to" calibration methods for common calibrations. The course is ideal for those operating in ISO/IEC 17025 accredited laboratories or in gage labs supporting manufacturing operations. https://www.mitutoyo.com/training-education/

Jun 26-27, 2025 Hands-On Precision Gage Calibration and Repair Training. Bloomington, MN. IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. https://calibrationtraining.com/

Jul 29-30, 2025 Virtual Hands-On Precision Gage Calibration and Repair Training. IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. https://calibrationtraining.com/

Aug 12-13, 2025 Hands-On Precision Gage Calibration and Repair Training. Portland, OR. IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. https://calibrationtraining.com/

Aug 18-19, 2025 Hands-On Precision Gage Calibration and Repair Training. Santa Clarita, CA. IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. https://calibrationtraining.com/

Aug 21-22, 2025 Hands-On Precision Gage Calibration and Repair Training. Las Vegas, NV. IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. https://calibrationtraining.com/

Sep 10-11, 2025 Hands-On Precision Gage Calibration and Repair Training. Schaumburg, IL. IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. https://calibrationtraining.com/

Sep 17-18, 2025 Hands-On Precision Gage Calibration and Repair Training. Omaha, NE. IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. https://calibrationtraining.com/

Sep 29-30, 2025 Virtual Hands-On Precision Gage Calibration and Repair Training. IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. https://calibrationtraining.com/

Oct 9-10, 2025 Hands-On Precision Gage Calibration and Repair Training. Bloomington, MN. IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. https://calibrationtraining.com/

Oct 23-24, 2025 Virtual Hands-On Precision Gage Calibration and Repair Training. IICT Enterprises. Enhance your career knowledge in Metrology with this in-depth Gage use, Calibration, and Repair course. Recommended for people interested in pursuing the ASQ CCT Exam. https://calibrationtraining.com/

SEMINARS & WEBINARS: Electrical

May 1, 2025 High-Voltage Test and Measurement. Lindfield, NSW. Australian NMI. This one-day workshop provides hands-on experience and practical techniques involved in performing high-voltage tests and measurements, and explains how to make such tests and measurements in accordance to relevant international and Australian standards. https://shop.measurement.gov.au/

Jun 9-12, 2025 MET-101 Basic Hands-On Metrology. Everett, WA. Fluke Calibration. This Metrology 101 basic metrology training course introduces the student to basic measurement concepts, basic electronics related to measurement instruments and math used in calibration. https://www.fluke.com/

Sep 29-Oct 2, 2025 MET-301 Advanced Hands-On Metrology. Everett, WA. Fluke Calibration. This course introduces the student to advanced measurement concepts and math used in standards laboratories. https://www.fluke.com/

SEMINARS & WEBINARS: Flow

Sep 23-26, 2025 Gas Flow Calibration Using molbloc/molbox. Phoenix, AZ. Fluke Calibration. This is a four day training course in the operation and maintenance of a Fluke Calibration molbloc/molbox system. https://www.fluke.com

SEMINARS & WEBINARS: Force & Torque

Sep 8-12, 2025 Fundamentals of Force Metrology: Practical Approach. Pretoria, South Africa. NMISA. At the end of the course, attendees should have a good understanding of the fundamentals of force metrology principles and force measurements. https://www.nmisa.org/applied-metrology/Pages/Metrology-Training-Centre.aspx

Sep 15-19, 2025 Fundamentals of Torque Metrology: Practical Approach. Pretoria, South Africa. NMISA. At the end of the course, attendees should have a good understanding of the fundamentals of torque metrology principles and torque measurements. https://www.nmisa.org/applied-metrology/Pages/Metrology-Training-Centre.aspx

SEMINARS & WEBINARS: General

Sep 15-19, 2025 Fundamentals of Metrology. Gaithersburg, MD. NIST. The 5-day Fundamentals of Metrology seminar is an intensive course that introduces participants to the concepts of measurement systems, units, good laboratory practices, data integrity, measurement uncertainty, measurement assurance, traceability, basic statistics and how they fit into a laboratory Quality Management System. https://www.nist.gov/pml/owm/owm-training-and-events

SEMINARS & WEBINARS: Industry Standards

May 7-8, 2025 Understanding the Requirements and Concepts of ISO/IEC17024:2012. Live Online Event. This course is designed to introduce organizations considering accreditation by ANAB to the international standard ISO/IEC 17024, General requirements for bodies operating certification schemes for persons. The standard is a globally accepted benchmark for bodies managing the certification of persons and is being increasingly recognized by the U.S. federal government, the certification industry, and organized labor. https://anab.ansi.org/

May 12-15, 2025 Understanding ISO/IEC 17025:2017 for Testing & Calibration Labs. Virtual. A2LA WorkPlace Training. This course is a comprehensive review of the philosophies and requirements of ISO/IEC 17025:2017. https://a2lawpt.org/

May 12-15 Auditing Your Laboratory to ISO/IEC 17025:2017. Virtual. A2LA WorkPlace Training. This ISO/IEC 17025 auditor training course will introduce participants to ISO/IEC 19011, the guideline for auditing management systems as applied to ISO/IEC 17025:2017. https://a2lawpt.org/

May 15, 2025 Internal Auditing Best Practices. Online. NIST. This 2-hour webinar will consider internal auditing techniques and best practices that are used by a metrology laboratory to comply with ISO/IEC 17025:2017 criteria. https://www.nist.gov/pml/owm/owm-training-and-events

Jun 9-12, 2025 Understanding ISO/IEC 17025:2017 for Testing & Calibration Labs. Virtual. A2LA WorkPlace Training. This course is a comprehensive review of the philosophies and requirements of ISO/IEC 17025:2017. https://a2lawpt.org/

Jun 9-12, 2025 Auditing Your Laboratory to ISO/IEC 17025:2017. Virtual. A2LA WorkPlace Training. This ISO/IEC 17025 auditor training course will introduce participants to ISO/IEC 19011, the guideline for auditing management systems as applied to ISO/IEC 17025:2017. https://a2lawpt.org/

Jun 10-11, 2025 Understanding the Requirements and Concepts of ISO/IEC 17025:2017. Live Online. Understand requirements of ISO/IEC 17025:2017, including general, structural, resource, process, and management system requirements. Learn practical concepts, such as impartiality, documents control, ensuring validity of results and risk management. Gain an understanding of an ISO/IEC 17025:2017 laboratory management system. https://anab.ansi.org/find-training/

Aug 11-14, 2025 Understanding ISO/IEC 17025:2017 for

Testing & Calibration Labs. Virtual. A2LA WorkPlace Training. This course is a comprehensive review of the philosophies and requirements of ISO/IEC 17025:2017. https://a2lawpt.org/

Aug 11-14, 2025 Auditing Your Laboratory to ISO/IEC 17025:2017. Virtual. A2LA WorkPlace Training. This ISO/IEC 17025 auditor training course will introduce participants to ISO/IEC 19011, the guideline for auditing management systems as applied to ISO/IEC 17025:2017. https://a2lawpt.org/

Sep 16-17, 2025 Understanding ISO/IEC 17025:2017 for Testing & Calibration Labs. Virtual. A2LA WorkPlace Training. This course is a comprehensive review of the philosophies and requirements of ISO/IEC 17025:2017. https://a2lawpt.org/

Sep 16-17, 2025 Auditing Your Laboratory to ISO/IEC 17025:2017. Virtual. A2LA WorkPlace Training. This ISO/IEC 17025 auditor training course will introduce participants to ISO/IEC 19011, the guideline for auditing management systems as applied to ISO/IEC 17025:2017. https://a2lawpt.org/

Sep 16-17, 2025 ISO/IEC 17043:2023 and Statistical Analysis for Proficiency Testing. Virtual. A2LA WorkPlace Training. This course provides the participant with a comprehensive look at Proficiency Testing (PT), including the design and operation of PT schemes, statistical methods, reporting, and interpretation. https://a2lawpt.org/

Oct 13-16, 2025 Understanding ISO/IEC 17025:2017 for Testing & Calibration Labs. Virtual. A2LA WorkPlace Training. This course is a comprehensive review of the philosophies and requirements of ISO/IEC 17025:2017. https://a2lawpt.org/

Oct 13-16, 2025 Auditing Your Laboratory to ISO/IEC 17025:2017. Virtual. A2LA WorkPlace Training. This ISO/IEC 17025 auditor training course will introduce participants to ISO/IEC 19011, the guideline for auditing management systems as applied to ISO/IEC 17025:2017. https://a2lawpt.org/

SEMINARS & WEBINARS: Mass

Oct 6-10, 2025 Mass Metrology Course for High Accuracy: OIML class F - E. Pretoria, South Africa. NMISA. The course provides fundamentals of mass measurements, looking at what affects reliability and accuracy of mass measurements, and how to ensure traceability in weighing. It also covers the evaluation of different weighing techniques used to calibrate mass pieces and the requirements for and calibration of weighing instruments. https://www.nmisa.org/applied-metrology/Pages/Metrology-Training-Centre.aspx

SEMINARS & WEBINARS: Measurement Uncertainty

May 6-7, 2025 Uncertainty, Sampling and Data Analysis: Understanding Statistical Calculations. Live Online. ANAB. This course provides an introduction to statistical concepts and techniques used for the collection, organization, analysis, and presentation of various types of data. The course touches on both descriptive statistics and inferential statistics, including how to compute measures of central tendency and dispersion, and how to assess the relationship between two variables. https://anab.ansi.org/

May 20-21, 2025 Introduction to Measurement Uncertainty. Virtual. A2LA WorkPlace Training. This course is a suitable introduction for both calibration and testing laboratory participants, focusing on the concepts and mathematics of the measurement uncertainty evaluation process. https://a2lawpt.org/

Jun 5-6, 2025 Measurement Uncertainty: Practical Applications. Live Online. ANAB. This class covers concepts and accreditation requirements associated with measurement traceability, measurement assurance, and measurement uncertainty. https://anab.ansi.org/

Sep 9-10, 2025 Introduction to Measurement Uncertainty. Virtual. A2LA WorkPlace Training. This course is a suitable introduction for both calibration and testing laboratory participants, focusing on the concepts and mathematics of the measurement uncertainty evaluation process. https://a2lawpt.org/

CALENDAR

SEMINARS & WEBINARS: Pressure

Apr 28-May 2, 2025 Principles of Pressure Calibration. Phoenix, AZ. Fluke Calibration. A five-day training course on the principles and practices of pressure calibration using digital pressure calibrators and piston gauges (pressure balances). The class is designed to focus on the practical considerations of pressure calibrations. https://www.fluke.com

Jun 18-19, 2025 Pressure Measurement. Port Melbourne, VIC. NMI of Australia. This two-day course (9 am to 5 pm each day) covers essential knowledge of the calibration and use of a wide range of pressure measuring instruments, their principles of operation and potential sources of error — it incorporates extensive hands-on practical exercises. https://shop.measurement.gov.au/

SEMINARS & WEBINARS: RF & Microwave

Sep 1-5, 2025 RF & Microwave Metrology Fundamentals. Pretoria, South Africa. NMISA Training Center. This course is aimed at teaching theoretical and practical principles of measurements and calibrations in RF and Microwave Metrology. https://www.nmisa.org/applied-metrology/Pages/Metrology-Training-Centre.aspx

SEMINARS & WEBINARS: Software

Apr 28-May 2, 2025 MC-205 MET/TEAM® Asset Management. Everett, WA. Fluke Calibration. This five-day course presents a comprehensive overview of how to use MET/TEAM® Test Equipment and Asset Management Software in an Internet browser to develop your asset management system. https://www.fluke.com

May 5-9, 2025 MC-206 Basic MET/CAL® Procedure Writing. Everett, WA. Fluke Calibration. In this five-day Basic MET/CAL Procedure Writing course, you will learn to configure MET/CAL software to create, edit, and maintain calibration solutions, projects and procedures. https://www.fluke.com

May 6-9 2025 VNA Tools Training Course & VNA Expert Day. Wabern, Switzerland. METAS. VNA Tools is a free software developed by METAS for measurements with the Vector Network Analyzer (VNA). The software facilitates the tasks of evaluating measurement uncertainty in compliance with the ISO-GUM and justifying metrological traceability. The software is available for download at www.metas.ch/vnatools. The three day course provides a practical and hands-on lesson with this superior and versatile software. Day 4: State of the art primary S-parameter traceability and how VNA Tools can support. https://www.metas.ch

May 19-23, 2025 TWB 1051 MET/TEAM® Basic Web-Based Training. Online. Fluke Calibration. This web-based course presents an overview of how to use MET/TEAM Test Equipment and Asset Management Software in an Internet browser to develop your asset management system. https://www.fluke.com

Jun 23-27, 2025 TWB 1031 MET/CAL® Procedure Development Web-Based. Online. Fluke Calibration. Learn to create procedures with the latest version of MET/CAL, without leaving your office. https://www.fluke.com

Jun 26, 2025 Software Verification and Validation, Part 1. Online. NIST. Session I (June 26, 2025) and Session II (July 17, 2025) are two 2-hour sessions that will focus on the use of Microsoft Excel in calibration laboratories and examine the ISO/IEC 17025:2017 requirements related to software. Part I will provide guidance and resources for ensuring software quality assurance, documenting evidence of verification and validation, and provide the tools for ongoing software evaluation. https://www.nist.gov/pml/owm/owm-training-and-events

Jul 8-10, 2025 MC-203 Crystal Report Writing. Everett, WA. Fluke Calibration. This course is designed for those who are involved with modifying or writing custom reports for use with MET/TEAM®. https://www.fluke.com

Jul 28-Aug 1, 2025 MC-206 Basic MET/CAL® Procedure Writing. Everett, WA. Fluke Calibration. In this five-day Basic MET/CAL Procedure Writing course, you will learn to configure MET/CAL software to create, edit, and maintain calibration solutions, projects and procedures. https://www.fluke.com

Sep 8-12, 2025 MC-206 Basic MET/CAL® Procedure Writing. Everett, WA. Fluke Calibration. In this five-day Basic MET/CAL Procedure Writing course, you will learn to configure MET/CAL software to create, edit, and maintain calibration solutions, projects and procedures. https://www.fluke.com

Oct 6-10, 2025 MC-207 Advanced MET/CAL® Procedure Writing. Everett, WA. Fluke Calibration. This course covers advanced topics and requires an existing knowledge of MET/CAL® calibration software. Students are strongly encouraged to first attend the MC-206 course, followed by 6 months of procedure editing/development experience prior to enrolling in MC-207. https://www.fluke.com

SEMINARS & WEBINARS: Temperature & Humidity

Aug 18-22, 2025 Non-Contact Thermometry Metrology. Pretoria, South Africa. NMISA Training Center. https://www.nmisa.org/applied-metrology/Pages/Metrology-Training-Centre.aspx

Sep 3, 2025 Testing Temperature Controlled Enclosures. Lindfield, NSW. NMI of Australia. This one day course is for people involved in routine performance testing of temperature-controlled enclosures (oven, furnace, refrigerator and fluid bath). It incorporates an extensive overview and comparison of AS2853 and IEC 60068-3-5 requirements, and it also includes an overview of the medical refrigeration equipment temperature mapping requirement to AS3864.2 https://shop.measurement.gov.au/

SEMINARS & WEBINARS: Validation & Verification

May 28, 2025 Validation and Verification of Analytical Methods. Live Online. ANAB. This course provides an introduction to validation and verification of analytical methods and ISO/IEC 17025 & ISO/IEC 17020 requirements. https://anab.ansi.org/

Jun 16-18, 2025 Method Validation. Pretoria, South Africa. NMISA Training Center. The objective of this course is to introduce analysts to the basic concepts of method validation and quality control. https://www.nmisa.org/applied-metrology/Pages/Metrology-Training-Centre.aspx

SEMINARS & WEBINARS: Volume

Aug 11-15, 2025 Volume Metrology. Pretoria, South Africa. NMISA Training Center. https://www.nmisa.org/applied-metrology/Pages/Metrology-Training-Centre.aspx

Sep 22-26, 2025 Volume Metrology Seminar. Gaithersburg, MD. NIST. The 5-day OWM Volume Metrology Seminar is designed to enable metrologists to apply fundamental measurement concepts to volume calibrations. A large percentage of time is spent on hands-on measurements, applying procedures and equations discussed in the classroom. https://www.nist.gov/pml/owm/owm-training-and-events

Visit **www.callabmag.com/calendar/**
for upcoming metrology
events & training!

KEBS mass metrology staff measure the values of a NIST mass comparator set in a 2024-2025 NIST-KEBS bilateral comparison. The mass set will be transported back and forth between Kenya and the U.S. and its values compared at NIST and KEBS metrology laboratories over the course of a 1-year period. Credit: O. Nyangau/KEBS

NIST OWM and KEBS: Building Metrology Capacity for the RMOs

January 7, 2025, NIST Updates - NIST Office of Weights and Measures (OWM) and the Kenya Bureau of Standards (KEBS) [https://www.kebs.org/] are currently conducting an interlaboratory mass comparison as part of a larger, multifaceted mass metrology training program being developed by Dr. Ombati Nyangau, OWM's NIST International Associate and KEBS's lead mass metrologist. The results of this comparison will assist the KEBS mass laboratory with improvement actions that will be integrated into its mass proficiency testing (PT) program and overall metrology training portfolio. This capacity building and knowledge transfer effort is geared toward a future rollout of a metrology training program within the Intra-Africa Metrology System (AFRIMETS) [http://www.afrimets.org/] community as one of six regional metrology organizations (RMOs) [https://www.bipm.org/en/liaison/regional] comprised of National Metrology Institutes (NMIs).

This mass interlaboratory comparison is being performed at the mass Echelon I level with OIML Class E2 mass standards under the purview of the NIST OWM Proficiency Testing (PT) Program [https://www.nist.gov/pml/owm/laboratory-metrology/proficiency-testing-pt]. The mass standards used range from 100 g to 10 mg. The calibration methods used for this PT to determine true mass and associated uncertainties are the OIML R 111-1 (2004) ABBA weighing cycle and NIST SOP 5 (2019) "Using a 3-1 Weighing Design." The results of the interlaboratory comparison will assist the KEBS mass laboratory with improvement actions from past key comparisons and assist the NIST OWM training program in the evaluation of its traceability to the International System of Units (SI) via an external NMI. The results will be discussed and shared in a future article.

Throughout 2025, Dr. Nyangau will continue to work with OWM staff to develop a "blended" mass metrology training curriculum comprised of hands-on training, recorded training videos, and supplemental materials that will be available online. The resultant training videos will benefit both the OWM Laboratory Metrology Program and significantly expand the scope of training and outreach activities in KEBS. As a lead metrology trainer for KEBS, Dr. Nyangau will then travel to the externally qualified laboratory locations and institutes within AFRIMETS and provide trainer-led mass metrology instruction. NIST OWM will utilize the developed training materials to support its state laboratory metrology program and extend additional training to institutes within the Inter-American Metrology System (SIM) RMO.

Source: https://www.nist.gov/news-events/news/2025/01/nist-owm-and-kebs-building-metrology-capacity-rmos

NIST Offers New Calibration Service for Wavemeters

NIST Updates, December 23, 2024 — For more than three decades, the National Institute of Standards and Technology (NIST) has calibrated the wavelengths of lasers used in industry, academia, and government laboratories. NIST has now expanded its service to include the calibration of wavemeters—specifically those that measure light at telecommunication wavelengths, which are used to transmit data over fiber-optic cables.

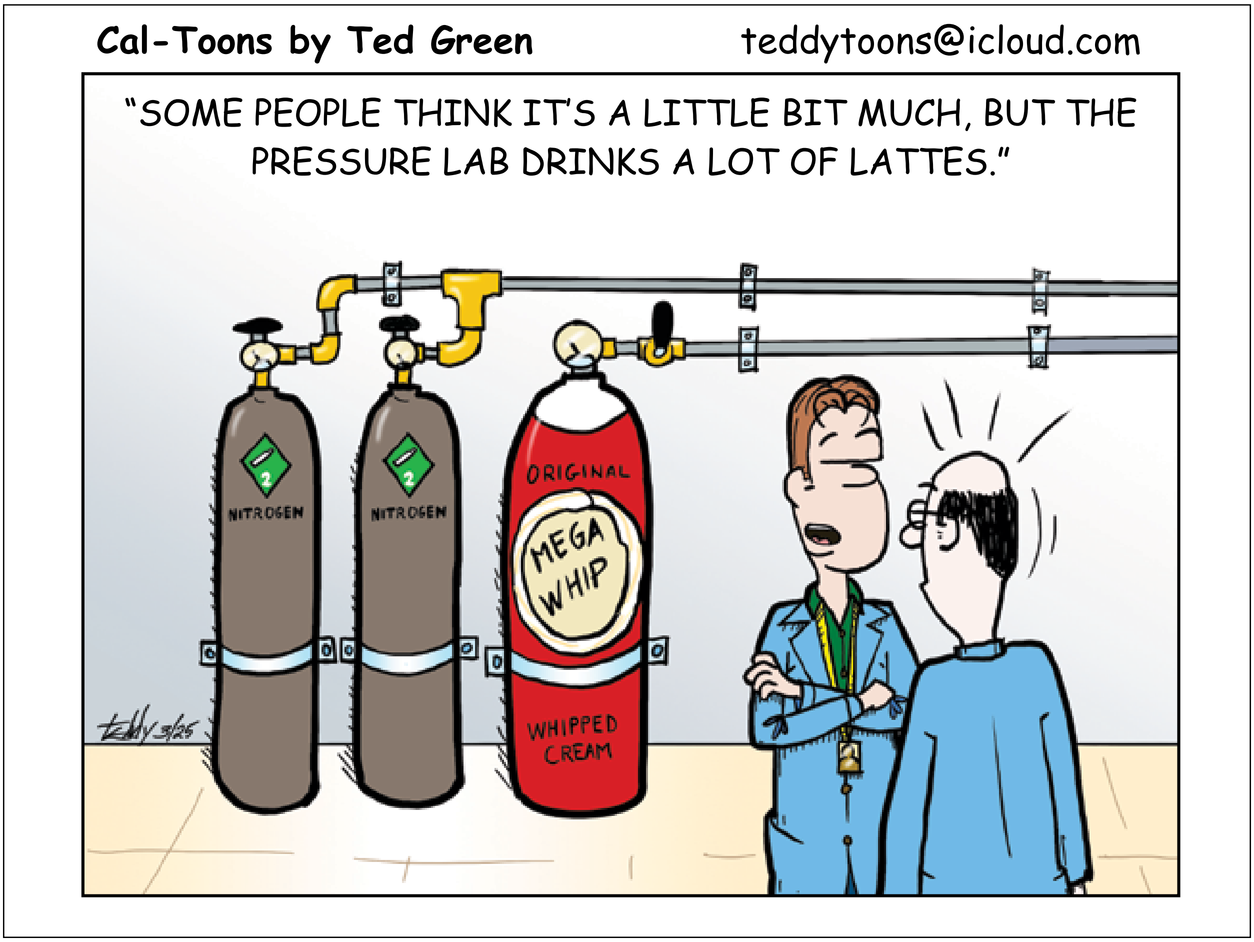
A typical fiber-optic cable uses several wavelengths to carry information, with each wavelength constituting a separate channel for data. To keep up with the demand for data transmission, engineers and scientists are feeding a greater number of telecommunication wavelengths into each cable.

As a consequence, calibration of the devices that measure these wavelengths has become more crucial. For example, if two closely spaced wavelengths traveling in the same cable overlap because they have not been precisely measured, it could severely hamper the relay of information.

That's why Johnny Jiménez, a metrologist with the Costa Rican Institute of Electricity, an autonomous public arm of the government of Costa Rica, came to NIST last August. He arrived at Patrick Egan's dimensional metrology laboratory for a two-month stay, carrying a wavemeter from his institute.

"With new technological trends, new fiber-optic network standards and higher data transmission requirements worldwide, there's a pressing need to expand the range of wavelengths measured by wavemeters and improve the accuracy of these devices," said Jiménez. In addition to improving the capabilities of fiber-optic network, more precise wavemeters support the development of new materials and equipment with properties that depend on the chosen wavelength, he added.

To calibrate a wavemeter, Egan relies on an optical frequency comb—a series of evenly-spaced frequencies that act like ticks on a ruler to measure light. The comb is linked to an oscillator that vibrates at a frequency steered by the global positioning system, allowing the calibration to be directly traceable to the International standard unit for the second.



Egan described the method online on November 7 in *Metrologia**.

"NIST was able to calibrate our standard wavemeter at a specific wavelength range of great importance with a level of accuracy unrivaled by any other national metrology institute," said Jiménez.

Egan says he expects the demand for wavemeter calibrations to increase as telecommunication networks carry an increasing amount of high-speed data. NIST now calibrates wavemeters at telecommunication wavelengths ranging from 1520 to 1570 nanometers (nm), and at a single wavelength of red light, 633 nm. Jiménez extended the capability to the important telecommunication wavelengths of 1310 nm and 1625 nm.

Upon request, Egan said, NIST may consider calibrating wavemeters that measure other wavelengths.

* Paper: Wavemeter calibration by frequency comb. P. F. Egan. Metrologia, vol. 61, no. 6, published Nov. 7, 2024. DOI 10.1088/1681-7575/ad8927

Source: https://www.nist.gov/news-events/news/2024/12/nist-offers-new-calibration-service-wavemeters

A Milestone for Hydrogen Metrology

PTB-News 1.2025 — In cooperation with European metrology institutes and partner companies from industry, PTB has laid the foundations for a reliable infrastructure for the volume measurement of liquid and gaseous hydrogen. For the first time, a traceability chain for calibrating flowmeters has been realized in this field.

As an intermediate energy storage, hydrogen plays a decisive role in the green energy transition. For this purpose, industry and measurement technologies must rapidly adapt to the specific requirements of hydrogen. A high energy density is required to efficiently store hydrogen, i.e., under high pressure or liquefied. In particular in the high pressure and low temperature range required, not enough was known about the accuracy of the required measuring techniques.

The European MetHyInfra project coordinated by PTB focused on establishing critical flow Venturi nozzles as transfer standards for gaseous hydrogen. Venturi nozzles of different size, shape and surface roughness were manufactured and calibrated to be used in the traceability chain for high-pressure hydrogen. A Coriolis mass flowmeter was used as a transfer standard, which had previously been calibrated against a gravimetric primary standard using hydrogen. New flow simulations make it possible to represent the nozzles' behavior under realistic boundary conditions. In the long term, flow rate measurements carried out with alternative gases at standard pressure will thus help to predict the flow rate of hydrogen at high pressures. In this way, it would be possible to use test rigs that were previously not adequate for measuring hydrogen or with which hydrogen measurements were considerably more expensive.

Moreover, the equation of state for gaseous hydrogen at high pressures was updated. This is a prerequisite for realizing flow rate measurements and for dimensioning practically all components used in the hydrogen industry (production, transfer, storage, application, etc.). The density virial coefficients of hydrogen, which are among the parameters required for this purpose, were determined and validated accurately by dielectric constant gas thermometry.

Three approaches were examined for the traceability of liquid hydrogen. They cover a wide range of flow rates and have helped to better understand the challenges and transferability of results obtained with other media to liquid hydrogen. A cryogenic flow rate test rig showed that a flowmeter calibrated at ambient temperature can also be used under cryogenic operating conditions, i.e., with liquefied gases.

The project results are an important step towards trusted traceability over the entire hydrogen volume measurement range.

Contact: Hans-Benjamin Böckler, Department 1.4, Gas Flow, hans-benjamin.boeckler(at)ptb.de

Scientific publication: H.-B. Böckler et al.: Metrology infrastructure for high-pressure gas and liquified hydrogen flows. A brief outline of the MetHyInfra project, measurement challenges, and first results. Measurement 232, 114675 (2024). DOI: 10.1016/j.measurement.2024.114675

Source: https://www.ptb.de/cms/en/presseaktuelles/journals-magazines/ptb-news.html

The cryogenic flow rate test rig provided by the Karlsruhe Institute of Technology (KIT) when operating with liquid nitrogen at PTB. Credit: PTB

Automating Calibration with LabVIEW: A Practical Guide for Calibration Laboratories

Ajayvignesh Manonmani Velumani
Makkal Limited, Ireland

Introduction

Calibration verification is a critical step in ensuring that instruments function within their specified tolerances. Before calibration begins, it is essential to verify whether an instrument is operating within acceptable limits. This process ensures accurate measurements and compliance with industry standards, such as ISO/IEC 17025. Automating this process not only improves efficiency but also reduces human error, making it indispensable for modern calibration laboratories.

LabVIEW (Laboratory Virtual Instrument Engineering Workbench), developed by National Instruments, is a graphical programming environment widely recognized for its versatility in data acquisition, instrument control, and industrial automation. Since its release in 1986, LabVIEW has revolutionized how engineers and scientists design and deploy test and measurement systems. Its graphical programming language, known as "G," enables users to create applications by connecting functional blocks rather than writing traditional text-based code. This approach simplifies complex workflows, making LabVIEW accessible even to those without extensive programming experience.

LabVIEW's capabilities extend far beyond basic automation. It supports real-time data acquisition, signal processing, embedded system design, and control systems. Industries ranging from aerospace to manufacturing rely on LabVIEW for tasks such as automated testing, product validation, and process control. In calibration laboratories specifically, LabVIEW provides tools for automating verification processes, logging results, and generating reports—all while maintaining traceability and compliance with quality standards.

Key Benefits for Calibrators:

- **Ease of Use:** LabVIEW's intuitive graphical interface allows calibrators to quickly create custom verification tools tailored to their specific workflows.
- **Automation:** Automating repetitive tasks like data acquisition and reporting frees up time for technicians to focus on higher-value activities.

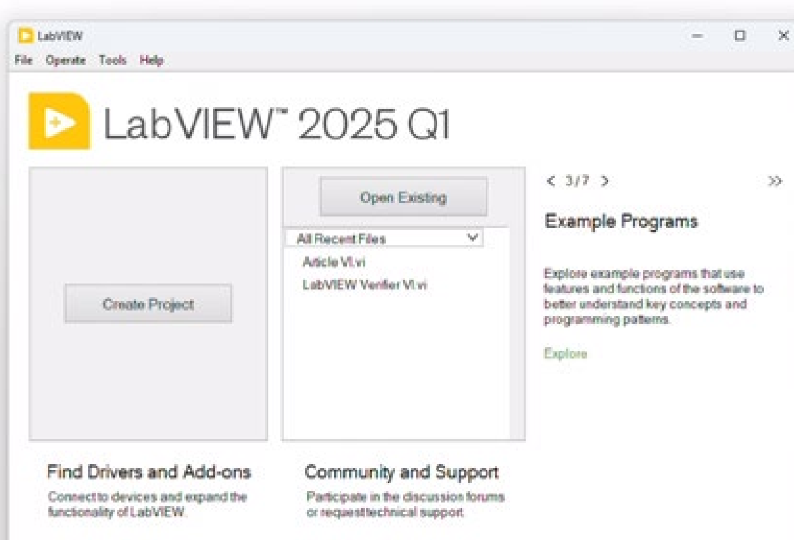


Figure 1. Launch Window of LabVIEW Helps to start a project or Virtual Instrument (.vi) file.

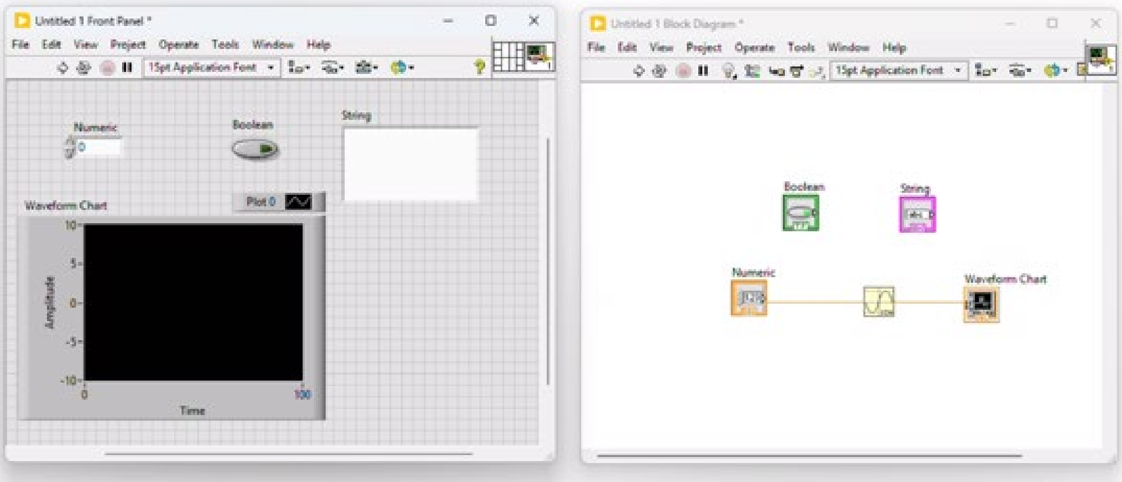


Figure 2. Components of a Virtual Instrument (.vi) file that has both front panel and block diagrams. Front panel has numeric, boolean, string controls and a waveform indicator. Block diagram has a sinusoidal function for waveform generation based on numerical input with boolean & string controls in an unused state.

- **Traceability:** LabVIEW's built-in logging features ensure complete records of "as-found" and "as-left" measurements, improving compliance with auditing requirements.
- **Scalability:** From simple CSV reports to advanced Digital Calibration Certificates (DCCs) [6], LabVIEW can scale with the needs of calibration laboratories as they transition toward digital processes.

LabVIEW enables calibrators to establish automated verification processes that document both "As-Found" and "As-Left" measurements, creating a complete record of the calibration process while reducing manual data entry errors [1].

Downloading LabVIEW

For those interested in exploring LabVIEW without a commercial license, National Instruments offers the LabVIEW Community Edition [2]. This free version is ideal for personal projects, learning, or research.

Understanding LabVIEW for Calibration Applications

LabVIEW uses a graphical programming approach where users create programs by connecting functional blocks rather than writing text-based code. This visual approach makes it particularly accessible for calibration technicians who may not have extensive programming backgrounds.

Components of LabVIEW

Virtual Instruments (VIs) are the fundamental building blocks of LabVIEW programs, similar to subroutines or functions in traditional text-based programming. Each VI consists of three main components:

1. **Front Panel:** The user interface where technicians interact with the program. It includes controls (inputs) and indicators (outputs) that can be dropped from the control palette (see Figure 2).
2. **Block Diagram:** Where the graphical code resides. It uses nodes (functions) and wires (data flow) to define the program's functionality. These nodes can be dropped from the function palette (see Figure 2).
3. **Connector Pane:** Defines the inputs and outputs of the program, allowing it to be used as a subroutine within other programs.

The visual programming environment allows calibration technicians to easily create and modify verification procedures without extensive programming knowledge, enabling rapid development of custom calibration solutions tailored to specific instruments and requirements.

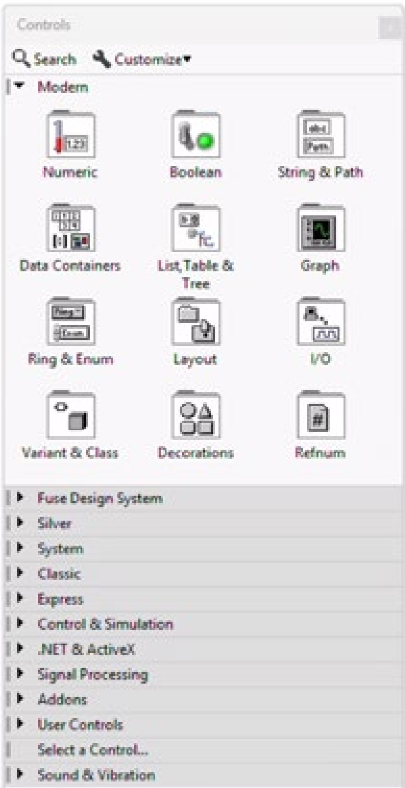


Figure 3. Control palette with various controls (inputs) and indicators (outputs) that goes into the front panel.

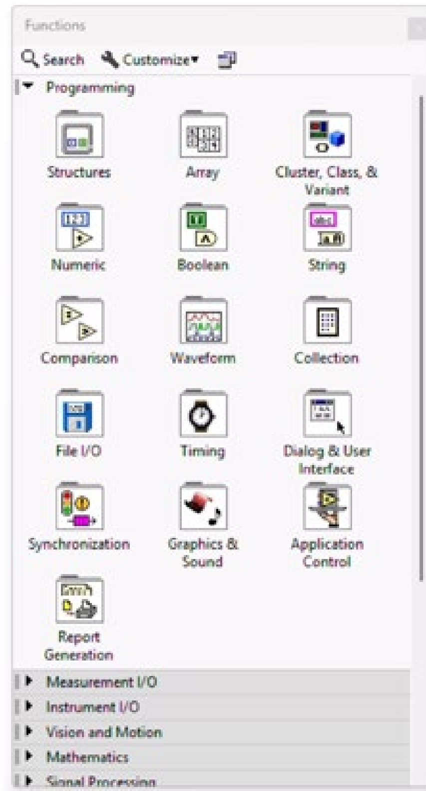


Figure 4. Function palette with various nodes for logical blocks that goes into a block diagram.

Creating a Calibration Verifier Tool in LabVIEW

Let's explore how to develop a practical calibration verification tool using LabVIEW with a simple 5 step approach. The entire solution is publicly available at GitHub source [3].

Step 1: Sketching the User Interface

Before starting with LabVIEW, sketch out your desired user interface to visualize the layout and required elements.

How to achieve this:

1. Use digital sketching tools like Figma or Excalidraw, or even simple pen and paper sketches.
2. Include inputs for set points, measurements, and tolerance limits.
3. Plan where pass/fail indicators will appear.
4. Consider the workflow from the calibrator's perspective.

A well-designed interface reduces training time and human error by creating an intuitive workflow that matches the natural calibration process. As seen in Figure 5, this planning stage allows calibrators to design a tool that mirrors their specific verification procedures.

Step 2: Designing the Front Panel

Using various controls (inputs) and indicators (outputs) in the control palette in LabVIEW's Front Panel window, create the user interface based on your sketch. For this front panel we used a few numerical controls and Booleans LED indicators in a cluster control and placed them in an array control. Labels are used for the title. Keep in mind that calibrators will use this GUI (Graphical User Interface) on a regular basis for every calibration.

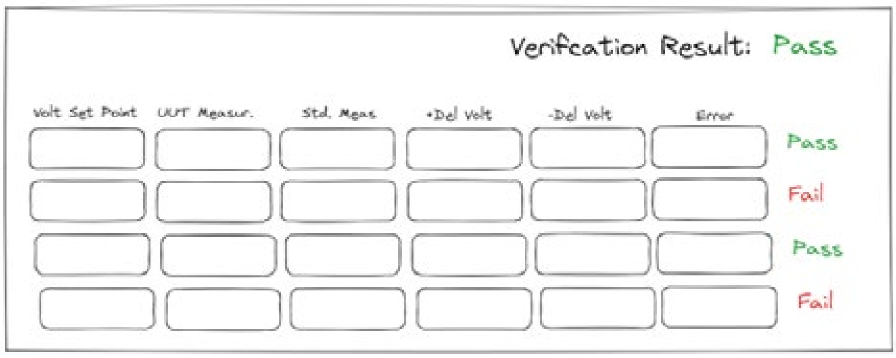


Figure 5. Sketch the User Interface.

How to achieve this:

1. Open a new VI in LabVIEW (File→New VI or Ctrl+N).
2. Right-click on the Front Panel to access the Controls palette.
3. Add numeric controls for voltage set points.
4. Add indicators for UUT and standard measurements.
5. Include Boolean indicators for pass/fail status.
6. Use decorative elements (frames, labels) to organize the interface.

The Front Panel serves as the direct interface for calibration technicians. As shown in Figure 6, a well-organized Front Panel allows calibrators to:

- Quickly input test parameters without confusion.
- Clearly see measurement results at a glance.
- Easily identify pass/fail status for verification points.
- Document the verification process with minimal effort

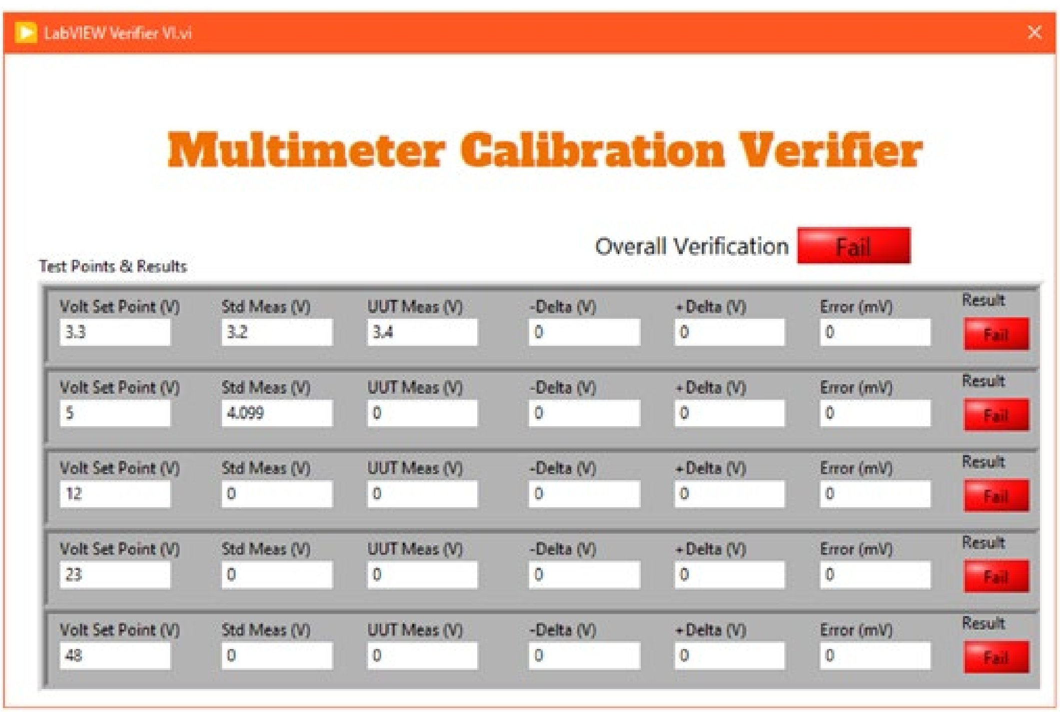


Figure 6. Design front panel using controls and indicators from control palette.

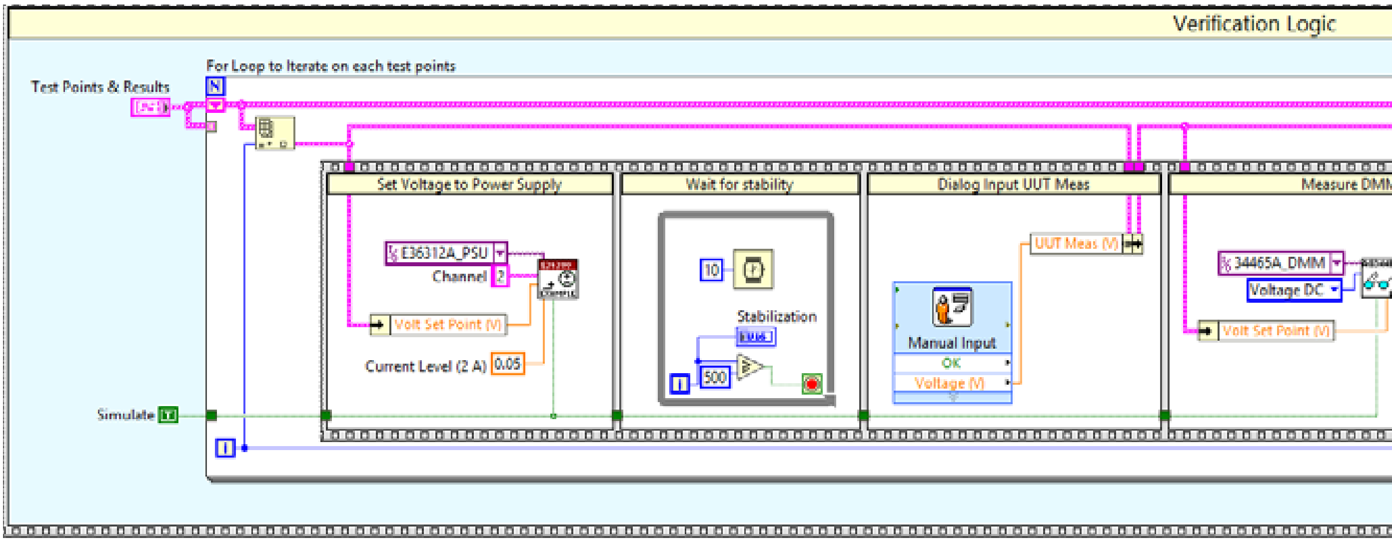


Figure 7. Block diagram logic to write set point to power supply instrument, get manual entry of handheld DMM value and read high-precision DMM
image format.

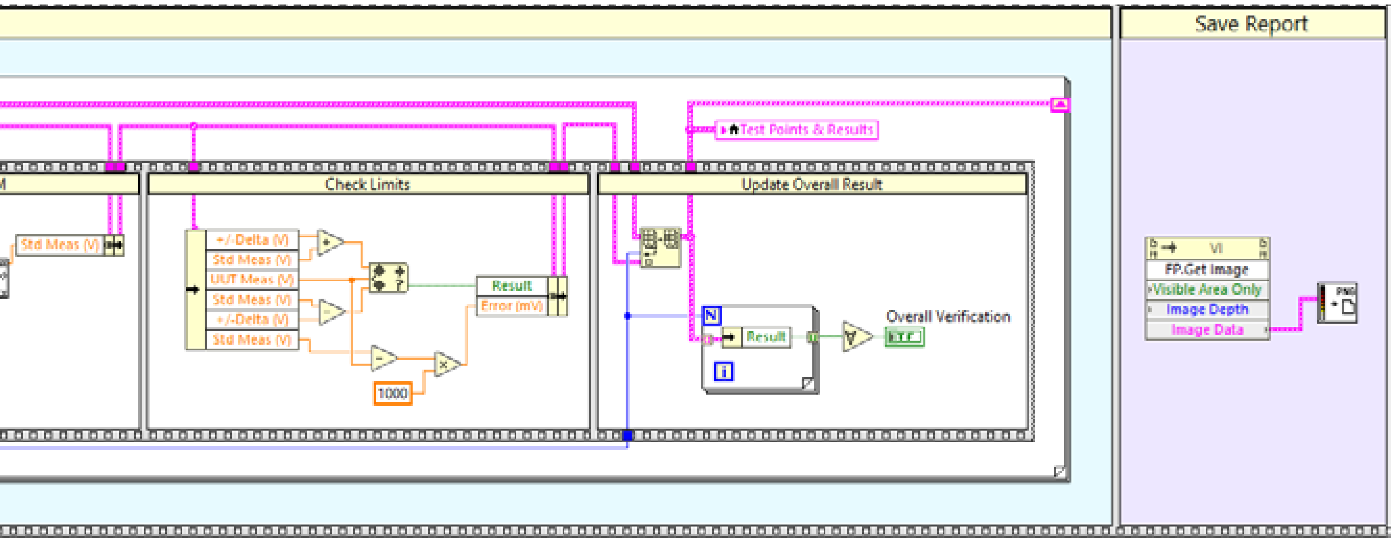
Step 3: Implementing the Block Diagram Logic

The Block Diagram contains the functional code that powers your verification tool. This is where you write logic to set the test points to exciters and read measurements from reference devices and UUT devices. Using the function palette, start connecting the controls and indicators with wires, adding function blocks to connect the external equipment to read & write the measurement points and setpoints. Use GitHub source [3] to check it for yourselves.

How to achieve this:

1. Switch to the Block Diagram view (Ctrl+E or Window menu→ Show Block Diagram).
2. Drop various functions readily available for the instrument from LabVIEW Device Driver [5] or using native VISA functions in function palette to communicate with instruments. Typical functions you look for are:
   - Configure Serial Port for instrument setup
   - Write to send commands
   - Read to receive responses

Figure 8. The screenshot demonstrates the execution of a calibration verifier tool, which automates the setting of power supply values and reading of high-precision DMM measurements, while allowing manual entry of values from a hand-held DMM.



1 value, compare them to Pass/Fail the set-point verification. This iterates in a for loop for a number of setpoints and finally saves the report in PNG

3. Implement a loop structure to iterate through test points.
4. Add mathematical functions to calculate errors and compare with tolerances.
5. Use comparison operators to determine pass/fail status.

Automation through LabVIEW significantly improves the calibration process by reducing the chances of human error, leading to more accurate and reliable results. As seen in Figure 7, automated systems ensure "consistency in operations that an operator may not be able to achieve manually," allowing calibrators to:

- Focus on proper instrument setup rather than manual control.
- Take multiple readings for better statistical significance.
- Implement standardized verification procedures.
- Eliminate transcription errors when recording measurements.

Step 4: Running and Testing the Verifier

Now it's time to rock and see the light bulbs. Once your Block Diagram is complete, test the functionality of your verification tool [4].

How to achieve this:

- Connect all necessary hardware.
- Run the VI by clicking the Run button.
- Enter required parameters.
- Observe the execution and verify correct operation.
- Test with known reference values to confirm accuracy.

This testing phase ensures:

- Reliable verification results that comply with quality standards.
- Traceable calibration data that meets ISO requirements.
- Repeatable processes that maintain consistency across different technicians.
- Confident verification decisions based on automated calculations.

Step 5: Implementing Data Logging and Generate Certificates

The final step is to add functionality for logging results and generating documentation.

How to achieve this:

1. Add file I/O functions to save verification data.
2. Implement report generation to create measurement data files.

This step enables the creation of calibration certificates that offer "efficient handling" compared

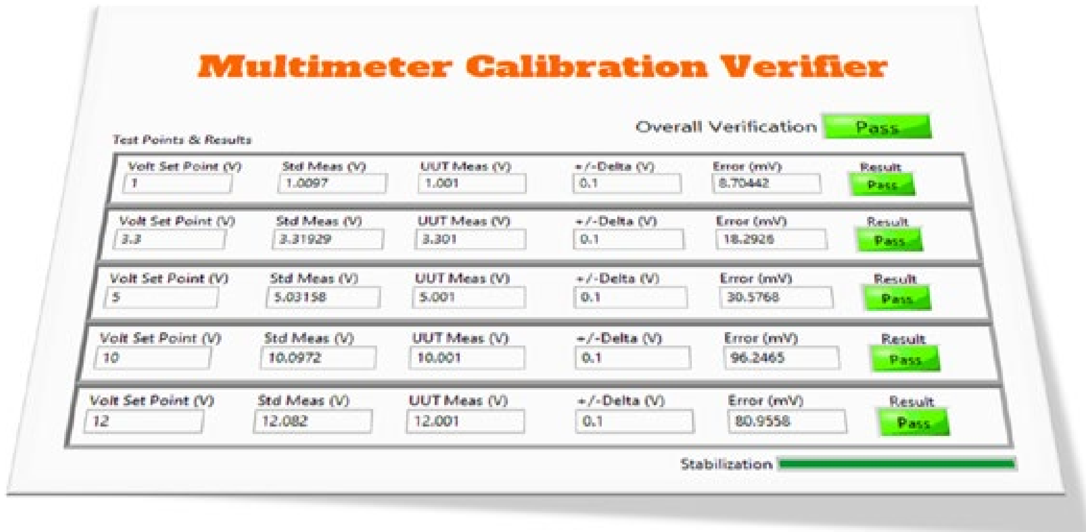


Figure 9. Final filled measurement values that could be generated as picture or spreadsheet (Excel) file and can be used for generating certificates.

to paper certificates. Although this could be improved to DCC (Digital Calibration Certificate), as calibration laboratories transition to digital processes, these capabilities provide:

- Seamless integration with digital quality systems.
- Enhanced traceability through machine-readable formats.
- Reduced administrative burden through automated reporting.
- Future-proofing as industry standards evolve toward digital documentation.

Conclusion

Creating a calibration verifier tool using LabVIEW offers significant benefits for calibration laboratories. By automating verification processes, calibrators can achieve greater accuracy, consistency, and efficiency while transitioning toward digital documentation through Digital Calibration Certificates.

This article represents the first step in a comprehensive exploration of LabVIEW for calibration automation. Future articles will delve deeper into design patterns, specific instrument calibration, and complete workflow automation, ultimately leading to the full implementation of Digital Calibration Certificates.

References

[1] https://www.ni.com/en/support/documentation/supplemental/16/self-calibration-for-rf-hardware.html

[2] https://www.ni.com/en/shop/labview/select-edition/labview-community-edition.html

[3] Github Source: https://github.com/makkal-co/simple-calibration-verifier/

[4] YouTube Source: https://www.youtube.com/watch?v=iYnxTtRLqwI

[5] LabVIEW Device Driver: https://www.ni.com/en/support/downloads/instrument-drivers.html

[6] Digital Calibration Certificate from PTB https://www.ptb.de/dcc/

Ajayvignesh Manonmani Velumani (Ajay MV) is a Certified LabVIEW Architect and Certified TestStand Architect from National Instruments with over 15 years of experience. Ajay leads a dedicated team specializing in calibration management systems, with a focus on DCC (Digital Calibration Certificates) through their SaaS product, Gagemakkal, and LabVIEW automation services (Makkal). Ajay can be reached at ajay@makkal.co. Further information about Gagemakkal and Makkal can be found at https://gagemakkal.com and https://makkal.co respectively.

We understand the situation you are in out there...

- **You can't find qualified entry level technicians**
- **You can't find actual intermediate level technicians**
- **Forget about finding an advanced technician, or Metrologist**
- **You calibration workload is growing exponentially...**

SINE CALIBRATION SCHOOL

Q: How do you easily progress in metrology knowledge and experience?

A: In the past, your career progression was very much tied to where you had an opportunity to work, or if you had the opportunity to attend training events through work. At Sine, one of our top priorities was to give people working in our industry the opportunity to continue to progress in metrology, even if they do not have the equipment at their current employer.

We offer training in levels, currently from 1-3. Level 1 can be taken 100% online and at-your-own-pace. This program has been very popular for a new employee's training, that can free up manager time. The online course currently offers the following courses:

General Metrology
Electronics
Temperature
Pressure
Force
Torque
RF and Microwave
Dimensional

What is level 3? What is our certification?

Let's set up a time to chat!
information@sinecalibration.com

We are highly customizable and can help you improve your training processes. We can even teach at YOUR location!

Accredited Calibration Laboratories for Medical Radiation

Larry A. DeWerd, PhD, FAAPM, FABS
Ahtesham U. Khan, PhD
Department of Medical Physics
University of Wisconsin-Madison

1. Introduction

The overall goals of the University of Wisconsin Medical Radiation Research Center (UWMRRC) are to 1) educate members of the medical physics community, 2) perform cutting-edge research in radiation metrology and dosimetry, and 3) provide calibration services to the global community. The UWMRRC occupies space in the Medical Physics department at the Wisconsin Institutes for Medical Research (WIMR). Part of the UWMRRC is an Accredited Dosimetry Calibration Laboratory (ADCL) which is accredited by the American Association of Physicists in Medicine (AAPM) as well as the American Association of Laboratory Accreditation (A2LA). Professor DeWerd started the laboratory in 1976, and the secondary calibration laboratory became accredited in 1981. Since then, the UWMRRC has successfully grown to include three faculty members, fourteen staff members, and supports 12 to 15 graduate students at any given time pursing a doctoral degree in medical physics. The aim of this article is to summarize the scholarly activities of the UWMRRC and highlight the key contributions made to the field of radiation metrology and medical physics.

2. Calibration and Research

The UWMRRC provides calibrations for medical radiation applications. These applications include diagnostic x-ray imaging beams or radiation sources used for the treatment of cancers or non-oncological diseases. The physical quantities used for calibrations, such as absorbed dose to water, are measured by the National Metrology Institutes (NMIs) using equipment referred to as primary standards. In the United States of America, the relevant NMI is the National Institute of Standards and Technology (NIST) similar to the National Research Council (NRC) in Canada. For this audience, NIST needs no description other than to say they maintain standards for quantities used in medical physics, nuclear medicine, and radiation oncology. All these metrology laboratories share their research at the annual meeting of the Council of Ionizing Radiation Measurements and Standards (CIRMS). CIRMS also involves other radiation applications in industry and government such as radiation processing & material effects and radiation protection & homeland security. Additionally, CIRMS is one of the main organizations that includes annual needs reports on standards for radiation.

The UWMRRC has a close working relationship with NIST and both institutes collaborate on research to further the field of radiation metrology for use in medical physics. Standards have been developed in conjunction with NIST throughout the years and a summary for each one is provided below. Besides the contribution to development of standards, other research involving metrology and dosimetry has been performed that has been immensely impactful for the field of medical physics.

2.1 Free Air Chambers for X-Ray Beams

A free air chamber (FAC) is an instrument that measures the radiation exposure from x-ray beams such that no liberated electrons hit the walls providing the charge generated in the sensitive volume. Thus, the instrument must be made large enough so that even the most energetic generated electron will be completely stopped before hitting the walls. Figure 1 is an example schematic of a FAC. A FAC that can measure exposure from x-ray beams with energies up to 60 kVp was developed at UWMRRC to determine the exposure of mammography beams; this resulted in a PhD thesis and the developed instrument was transferred to NIST and the FDA [1], [2]. This chamber was unique in the sense that it included extrapolation features, that is the volume of detection could be changed. In this way the air attenuation could easily be measured by keeping the center or distance from the aperture fixed while changing the volume or the amount of radiation detected. Using this device, the standard for mammography beams was established.

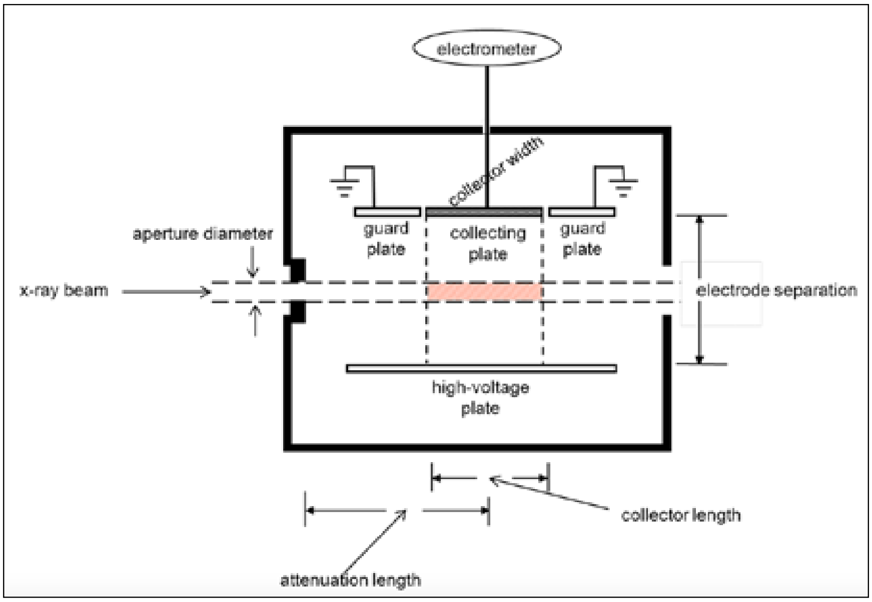


Figure 1. Schematic of a free air chamber is shown (adapted from Seltzer [4]).

Another FAC that can measure exposures from x-ray beams with energies up to 300 kVp has been recently developed for the measurement of exposure from radiobiology beams [3]. The development of this instrument also was part of a PhD thesis. This subject matter was a part of two other theses and will be part of another thesis in the future. This final thesis (and to be written paper) will include the establishment of radiobiology beams for cabinet irradiators at UW and NIST.

2.2 Brachytherapy Calibrations

The UWMRRC developed a Variable Aperture FAC to measure Air KERMA strength from Low Dose Rate brachytherapy sources. We were able to compare the measurements with NIST as well as provided another means to independently check the calibration of these ^{125}I, ^{103}Pd and ^{131}Cs sources. Also using the Attix FAC mentioned above, we explored the calibration and parameters of a low energy X-ray source. This was also compared with NIST and their FAC. These measurements allowed widespread use of these radioactive sources for ocular and prostate cancers.

The UWMRRC also developed the first calibration for high dose rate brachytherapy sources, such as ^{192}Ir [5]. This standard has remained in use for the United States for over 25 years without change. The traceable calibration for this source has been established via an interpolated calibration coefficient for an ion chamber and the use of measurement at 7 distances from the source. In this manner, the scatter and attenuation that may interfere with the actual measurement can be determined and subtracted. Recently, we have confirmed the calibration of the chamber with a known volume chamber, which shows agreement at much less than 0.5%. We also developed calorimeters to determine the output of these sources.

2.3 Extrapolation Chambers

Extrapolation chambers are useful to determine radiation dose on the surface or within a short distance from the source. The clinical community has developed sources with beta emissions for treatment of shallow disease such as skin or ocular cancers. These types of sources are best measured using an extrapolation chamber which can determine the dose rate at the surface. The UWMRRC has done this for ophthalmic applicators to establish a calibration [6]. Figure 2 displays the schematic of one such extrapolation chamber. In addition, the UWMRRC developed an extrapolation chamber that measures the eye plaque for a curved beta-emitting source [7]. The curved source is to fit in the eye to irradiate tumors.

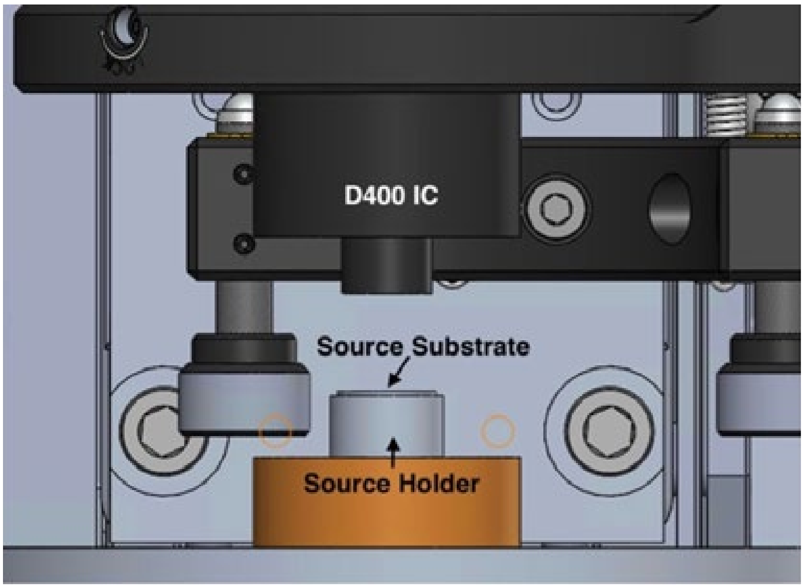


Figure 2. Example schematic of an extrapolation chamber (Adapted from Khan et al. [8]).

A new application of extrapolation chambers is for Radiopharmaceutical Therapy where a radionuclide is injected, and part of the radionuclide goes to a tumor. This procedure is still in research phase, but the UWMRRC is developing a dose calibration for better precision for both beta and alpha particles [8], [9].

2.4 Calorimeters

A calorimeter measures the heat produced by the absorbed radiation, which can then be used to determine the absorbed dose. The temperature rise is on the order of 10^{-4} K/Gy. The UWMRRC developed calorimeters for external beam and brachytherapy applications [11]. We have made calorimeters out of aluminum and other materials and then convert the dose to water. Figure 3 shows an example of an aluminum calorimeter developed for high energy electron beams. One of the most interesting calorimeters is an interference calorimeter, using a laser beam and counting the movement of the fringes during the heating process.

2.5 Ongoing Research

There is intense ongoing metrology and dosimetry research at the UWMRRC aiming to develop standards for unsealed radionuclides used for radiopharmaceutical therapy, development of mammography calibration beams, establishing traceability for radiobiological beams, and creation of calorimeter arrays. These advances will pave the way for enhanced precision and accuracy of the quantities involved in medical physics improving treatment outcomes and reducing unnecessary radiation exposure to patient population.

3. Education

The members of the UWMRRC are affiliated with the Medical Physics department at the UW-Madison. The faculty teaches graduate classes such as Radiation Physics Metrology, Physics of Radiotherapy, and Radiological Physics & Dosimetry. The UWMRRC graduate students are advised by the faculty and enroll in classes pertaining to the Medical Physics degree. The equipment at the UWMRRC, such as linear accelerators or radioactive sources, is actively used for conducting laboratory classes and other didactic activities. There are continuing education courses provided to clinical medical physicists that aid in the American Board of Radiology (ABR) Maintenance of Certification (MOC) program. In summary, the UWMRRC is actively involved in educating the next generation of medical physicists and updating the current members of the medical physics community on the advances made in radiation metrology and dosimetry.

4. Conclusion

The UWMRRC is associated with a secondary laboratory and does metrology research in conjunction with interactions with NIST. We have covered all aspects of the application of radiation for medical uses. During this process, we have been able to train numerous students in metrological research. The educational, research, and calibration services provided by the laboratory have made a tremendous impact on the field of medical physics.

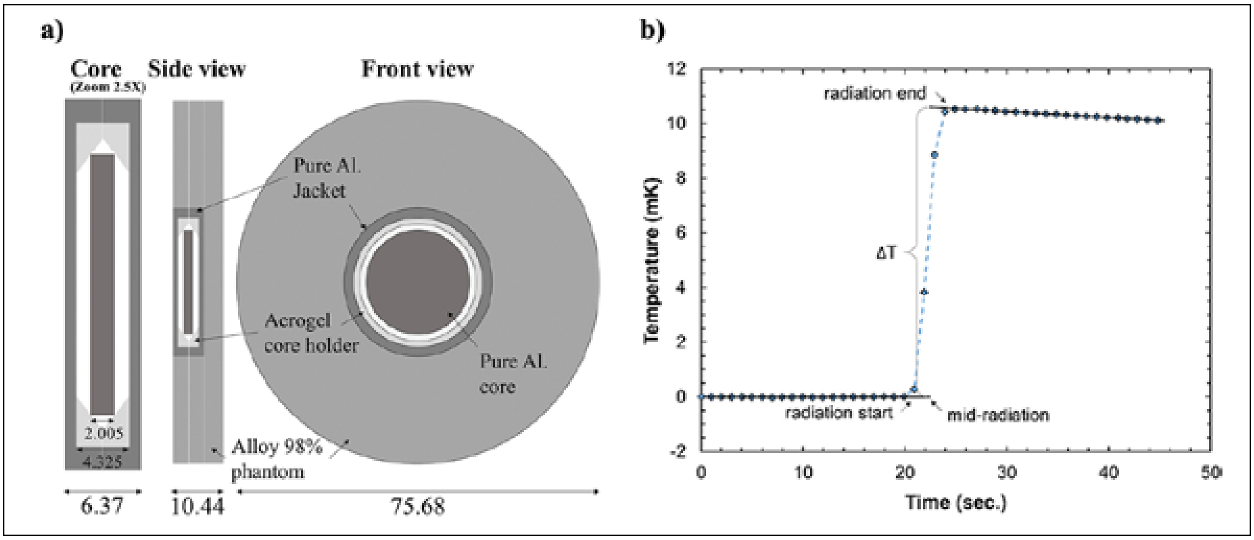


Figure 3. a) Schematic of an aluminum calorimeter is shown along with the b) temperature rise during irradiation (Adapted from Bourgouin et al. [12]).

References

[1] J. G. Coletti, D. W. Pearson, and L. A. DeWerd, "Mammography exposure standard: Design and characterization of free-air ionization chamber," *Review of Scientific Instruments*, vol. 66, no. 3, pp. 2574–2577, Mar. 1995, doi: 10.1063/1.1145590.

[2] J. G. Coletti, D. W. Pearson, L. A. DeWerd, C. M. O'Brien, and P. J. Lamperti, "Comparison of exposure standards in the mammography x-ray region," *Med Phys*, vol. 24, no. 8, pp. 1263–1267, Aug. 1997, doi: 10.1118/1.598148.

[3] E. J. King, N. N. Viscariello, and L. A. DeWerd, "Development of Standard X-Ray Beams for Calibration of Radiobiology Cabinet and Conformal Irradiators," *Radiat Res*, vol. 197, no. 2, pp. 113–121, Oct. 2021, doi: 10.1667/RADE-21-00121.1.

[4] S. M. Seltzer, "Correction Factors for the NIST Free-Air Ionization Chambers Used to Realize Air Kerma fromW-Anode X-Ray Beams," US Department of Commerce, National Institute of Standards and Technology, Gaithersburg, MD, Oct. 2012. doi: 10.6028/NIST.IR.7887.

[5] B. E. Rasmussen, S. D. Davis, C. R. Schmidt, J. A. Micka, and L. A. Dewerd, "Comparison of air-kerma strength determinations for HDR 192Ir sources," *Med Phys*, vol. 38, no. 12, pp. 6721–6729, 2011, doi: 10.1118/1.3656683.

[6] S. J. Goetsch and K. S. Sunderland, "Surface dose rate calibration of Sr-90 plane ophthalmic applicators," *Med Phys*, vol. 18, no. 2, pp. 161–166, Mar. 1991, doi: 10.1118/1.596702.

[7] J. B. Hansen, W. S. Culberson, and L. A. DeWerd, "A convex windowless extrapolation chamber to measure surface dose rate from 106 Ru/ 106 Rh episcleral plaques," *Med Phys*, vol. 46, no. 5, pp. 2430–2443, May 2019, doi: 10.1002/mp.13488.

[8] A. U. Khan, J. Radtke, B. Palmer, J. Hull, K. Kunugi, and L. DeWerd, "Development and evaluation of a standard for absorbed dose to water from alpha-particle-emitting radionuclides," *Metrologia*, vol. 60, no. 6, p. 065003, Dec. 2023, doi: 10.1088/1681-7575/acfb89.

[9] A. U. Khan, J. Radtke, and L. DeWerd, "Characterization of a segmented printed circuit board (PCB) as a standard for absorbed dose to water from alpha-emitting radionuclides," *Med Phys*, no. December 2023, pp. 1–12, Jan. 2024, doi: 10.1002/mp.16940.

[10] I. Billas et al., "Development of a primary standard for absorbed dose from unsealed radionuclide solutions," *Metrologia*, vol. 53, no. 6, pp. 1259–1271, Dec. 2016, doi: 10.1088/0026-1394/53/6/1259.

[11] E. Flores-Martinez, M. J. Malin, and L. A. DeWerd, "Development and characterization of an interferometer for calorimeter-based absorbed dose to water measurements in a medical linear accelerator," *Review of Scientific Instruments*, vol. 87, no. 11, Nov. 2016, doi: 10.1063/1.4967490.

[12] A. Bourgouin et al., "Calorimeter for Real-Time Dosimetry of Pulsed Ultra-High Dose Rate Electron Beams," *Front Phys*, vol. 8, no. October, pp. 1–10, Oct. 2020, doi: 10.3389/fphy.2020.567340.

Larry A. DeWerd (ladewerd@wisc.edu), PhD, FAAPM, FABS and Ahtesham U. Khan, PhD, Medical Radiation Research Center, Department of Medical Physics, School of Medicine and Public Health, University of Wisconsin-Madison, Madison, WI 53705 USA.

How to Verify Every Test Point Against Your Lab's ISO/IEC 17025 Scope of Accreditation

Michael L. Schwartz and David Wolfe
Cal Lab Solutions, Inc.

Digitalization of business processes is essential for future metrology, and all stakeholders, such as calibration labs, customers, and Accreditation Bodies (ABs), will need to move into the 21st century. A critical use case for digitization is the process of verifying measurement uncertainties on an accredited certificate of calibration. To accomplish this, we need digital representations of a Scope of Accreditation (SoA) containing a calibration lab's calibration measurement capabilities (CMC). But digitization is more than just a lab's PDF copy of their SOA found on the Accreditation Body's (AB) website.

Using the NCSLI 141 MII Committee's beta version of a "Metrology Taxonomy" database used for creating a digital version of a Scope of Accreditation, it is now possible for a computer to verify every test point's measurement uncertainty against the Lab's SoA. This paper will demonstrate the steps required (with sample code) to modify a Digital Calibration Certificate (DCC) by adding taxonomy tags, using those tags to compare the uncertainties in the DCC against the measurement uncertainties in the lab's SoA, and then show the user what, if any, measurement uncertainties are not in accordance with the lab's SoA.

Introduction

Calibration labs using automation often find that automation software is generating measurement uncertainties below the calibration lab's accredited calibration measurement capabilities (CMCs). This can result in a finding by the auditor and a huge undertaking updating the automation software if that is even possible.

Well, there is no simple solution! In the majority of cases, the solution is either rewriting the software or creating some manual process where a technician can verify and edit each and every test point on an accredited calibration!

The Digital Metrology Solution

The NCSLI (National Council of Standards Laboratories International) MII (Measurement Information Infrastructure) 141 Committee's charter is to create a set of normative standards that unambiguously define data structures, taxonomies, service protocols, and security for locating, communicating, and sharing measurement information. At the heart of this technology is the creation of a catalog containing all of the unique "Metrology Taxon" definitions for every known measurement and then use that catalog of metrology taxonomies to link data from different systems, formats, and technologies.

The examples covered in this paper will show how the Metrology Taxonomy can be used to verify the measurement uncertainties generated from inside an automated calibration against a calibration lab's Scope of Accreditation. And to keep things simple, we will be using the Source.Voltage.AC.SineWave taxon.

Source.Voltage.AC.SineWave Taxon

Source Voltage AC Sinewave as a taxon is a generic description or tag for anything that can generate a known sine wave voltage. "Source" means it is created or generated as opposed to being measured. The second element, "Voltage," is the quantity kind of metrological interest. Lastly, the "AC.SineWave" is a further description of the "Voltage" element.

Along with the unique name "Source.Voltage. AC.SineWave," the taxon definition also requires us to provide two additional elements: Voltage and Frequency. These two elements are required because, without them, it would be impossible to create an AC sine wave signal. Additionally, the taxon definition allows for additional elements like Impedance or anything else the user may want to include.

This is a high level of abstraction that breaks the measurement requirements down into the root data elements independent of the hardware required to source AC voltage at a given voltage and frequency.

More information on creating and understanding Metrology Taxonomies can be found http://miiknowledge.wikidot.com/start.

Taxon vs. Technique

The hardest part of the Metrology Taxonomy is understanding the separation of taxon vs. technique. The taxon/taxonomy is the generic definition, the big picture, or the abstraction of the metrology process. It is the idea of the measurement without regard to the specific hardware or measurement process, whereas techniques are the implementation of a Metrology Taxon. This is where the specific hardware and measurement process are included. A technique can have a process based on a single instrument or multiple standards to perform the task.

For example, a technique could use a meter to measure and adjust the output of a device, then use the meter's value as the known value for a Source.xxx taxon.

Source.Voltage.AC.SineWave Technique

Looking at the three examples below (Table 1), a typical multi-function calibrator could generate a known 120V @60 Hz, but only a few could generate 10 V @ 1 MHz. Hardware to generate 100 kV @ 60 Hz is not as common.

Techniques and implementations can vary. How a lab generates a known voltage is independent of the Source.Voltage.AC.SineWave's generic definition. For example, a lab could use a long-scale multimeter with a variac to get a known 120.000 V from the AC power outlet. If the lab could prove proficient in using a variac with a DMM to generate "a known" AC Voltage, it could be added to a lab's scope of accreditation.

	Voltage	Frequency
Source.Voltage.AC.SineWave	120 V	60 Hz
Source.Voltage.AC.SineWave	10 V	1 MHz
Source.Voltage.AC.SineWave	100 kV	60 Hz

Table 1.

Test Points, Specifications, and Taxons

Next, we need to look at the relationship between the UUT's specifications and the test points performed by the calibration lab. Typically, there are two taxons at every test point.

The first taxon is related to the UUT and the specification that is being tested. This is a link back to the UUT's published specifications represented in the Test Point's upper and lower test limits.

The second taxon relates to how the UUT's specifications are tested. This is directly tied to the work performed by the calibration lab. A Test Result is tied to a specific point in time under specific test conditions. It is the documentation of the measurement made and should not be confused with the instrument's specifications.

A calibration lab needs to verify the uncertainty of measurement made by the calibration lab against the lab's Scope of Accreditation. Not the UUT's specification or the test limits of a test point. It is the calculated/reported uncertainties that need to be checked against the Scope of Accredation.

Digitizing the Scope of Accreditation

Part of the NCSLI 141 Committee's efforts have focused on creating a digital version of a calibration lab's Scope of Accreditations. The short history is back in 2015, when a group of us tried to digitize a lab's SoA as a proof of concept and discovered that much of the details needed were unstructured and found in the notes column of a typical SoA. This made searching an SoA for a set of relieving CMCs impossible, let alone calculating measurement uncertainty.

This challenge was quickly adopted into the mission statement of the 141 Measurement and Information Infrastructure Committee (MII). In 2016, at NCSLI, David Zajac presented the first XML schema to represent a calibration lab's SoA in a digital format. The group continued evaluating CMCs from over 1300 accredited labs across the US. In 2017, Qualer loaded all of the CMC into https://search.qualer.com, allowing users to search CMCs by unit of measure and quantity type.

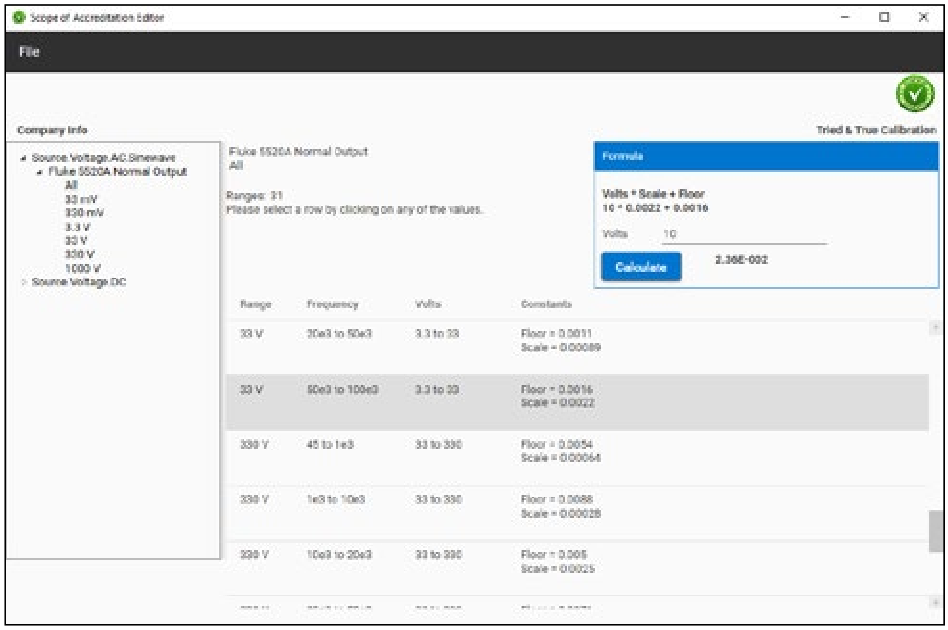


Figure 1. Screenshot of the Scope of Accreditation Editor.

What we learned was that searching by the unit of measure, quantity types, and or keywords was insufficient to aggregate data from different CMC, SoA, or accreditation bodies. Even after collecting over 250k CMCs and putting them into a single format, the data was still far from machine-actionable.

Here are some of the problems we discovered:

1. **1.2 g** as a unit of measure. One would think this is grams, but it was a vibration measurement.
2. **30 fpm** as a unit of measure. We had to call the lab; it was frequency flashes per minute.
3. **10 °** What is a degree? Temperature, plane angle, magnitude phase….
4. **3000 °C** Does the lab really have a furnace that goes that high?

These are just a few examples of situations where simply using the unit of measure is unreliable. Even when using a quantity type identifier, the data is not machine-actionable because it can be ambiguous. The problems still remain: First, was the lab sourcing or measuring the value? And second, as in temperature, does the lab really source a known 3000 °C?

So, the committee zeroed in on Metrology Taxons to identify better what an individual CMC was doing metrologically. Using the problems posed above:

1. **1.2 g** gets extended with **Measure.Acceleration.Vibration.**
2. **30 fpm** gets extended with **Source.Frequency.**
3. **10 °** gets extended to **Measure.Phase.TransmissionFactor.**
4. **3000 °C** gets extended to **Measure.Temperature.Simulated.Thermocouple.**

The 141 Committee is working weekly, and on occasion with other organizations around the world, to further define taxons in additional measurement areas. We are in the process of setting up a public GitHub site where we can maintain all of the official taxons.

Scope of Accreditation Editor

In 2022, Cal Lab Solutions, Inc. released beta version 1.0 of the Taxonomy Editor and the Scope of Accreditation Editor. These two tools are open-source and maintained on GitHub: https://github.com/CalLabSolutions/Metrology.NET_Public.

You don't have to be a developer; simply download the files, then navigate to /Source/Executables/SoA_Editor. You can start digitizing your SoA today. NOTE: This software is still in beta, so feedback is appreciated.

Another important thing to note is the SoA Editor is not just text; the formulas and calculations are functional as well. Users can define fixed values or more complex calculations and then pass in values like:

Nominal = 10,
Range = 10,
and the SoA Editor will calculate the uncertainty!

The SoA Editor is open-sourced, so other organizations and accreditation bodies could use it freely and with few restrictions. Our motive is to move metrology into the digital age by promoting solutions for stakeholders, not profits to shareholders.

SoA Calculation Service

The SoA tool is great for checking calculations, communicating, and coordinating with an accreditation body. However, it was never designed to integrate with other applications. This is where a RESTful application programming interface or API comes into play.

This was the majority of our work in 2023 and the highlight of this paper. Now that we have a digitized version of our SoA in an XML format, we need a simple and easy way to connect it to all of our automated calibration software. Service-oriented architectures allow us to make a decoupled call to a server requesting some data, and the server will securely return the resulting data to my application.

The way this works is by sending an encrypted data package in a JSON format to an https server on port 443 using a REST call. It may sound strange, but this is how the whole internet works!

The UseCase, illustrated in Figure 2, is fairly simple. After the technician in green on the left has uploaded the XML file, the technician in blue on the right is able to run a calibration where the software can check each and every test result's measurement uncertainties against the SoA.

As each test result is saved back to the server, a REST call to the Unc Calc will be executed, passing the specifics of the test result to the SoA Uncertainty Calculation Service. The JSON data package will contain the exact requirements for the uncertainty calculation requested from the lab's SoA, generically, meaning it will contain the metrological specifications, not the specific CMC line in the SoA. The JSON formatted data looks like this inside:

Taxonomy= Source.Voltage.AC.SineWave
Voltage= 3.5
Frequency= 100e3

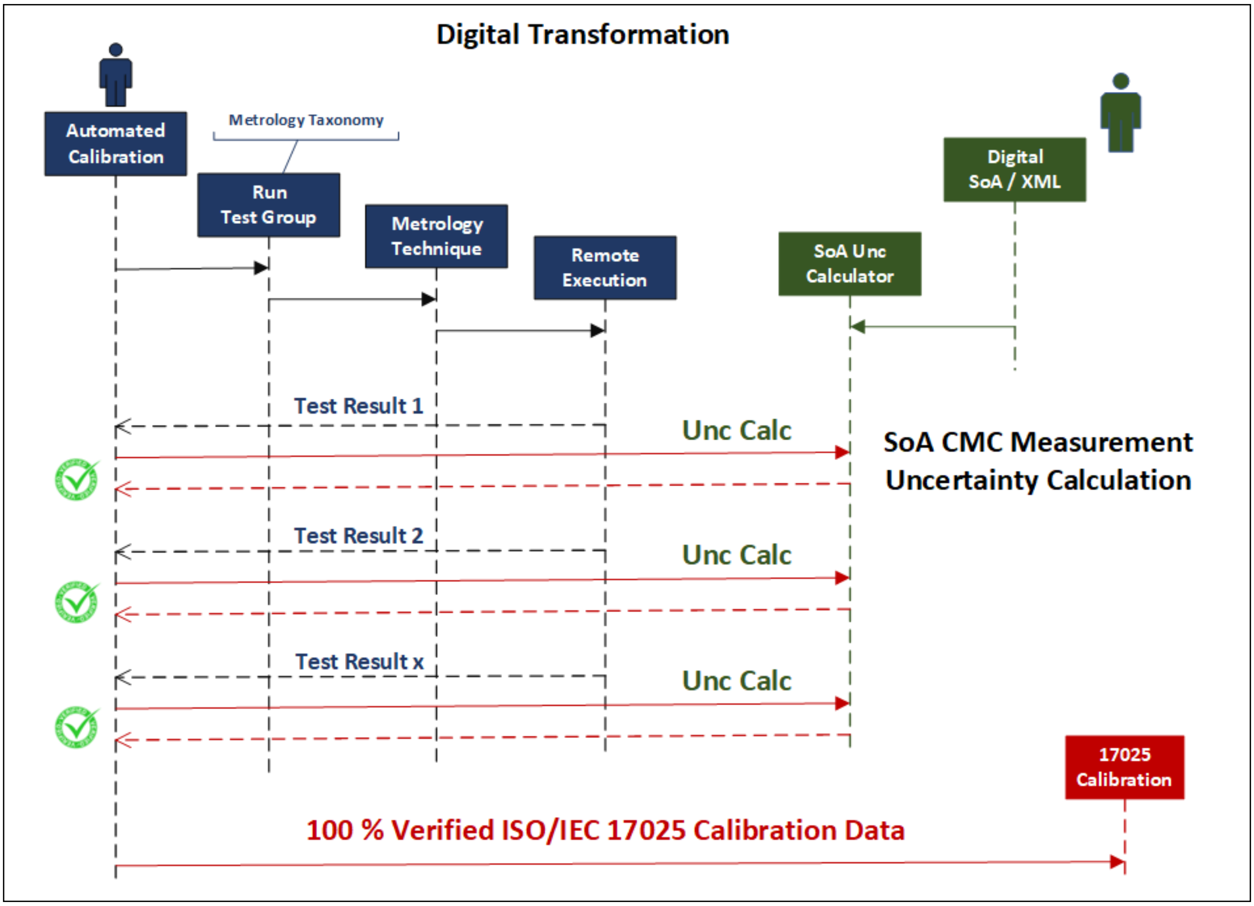


Figure 2.

The data will be sent using a POST to an API URL like this: https://metrologymanager.com/data/UncCalc/SoA_FileID, where the API will return a list of CMCs-based measurement uncertainty calculations matching the request parameters.

Item1
- Uncertainty = 6.2e-4
- Technique = Fluke 5720A
- Range = 2.2 to 22
- Volts = 3.5
- Frequency = 50e3 to 100e3

Item2
- Uncertainty = 1.8e-3
- Technique = Fluke 5720A
- Range = 2.2 to 22
- Volts = 3.5
- Frequency = 100e3 to 300e3

Item3
- Uncertainty = 9.3e-3
- Technique = Fluke 5520A Normal
- Range = 3.3 to 33
- Volts = 3.5
- Frequency = 50e3 to 100e3

From the list of Items returned, the software can now select the best matching CMC or the lowest CMC, depending on the requirements.

When the application receives the uncertainty calculations from the SoA Calculation Service, it can then determine the uncertainties to report on the accredited calibration. If the user has selected an alternate uncertainty calculator overriding the in-app calculation, it will then compare the result to the SoA uncertainties.

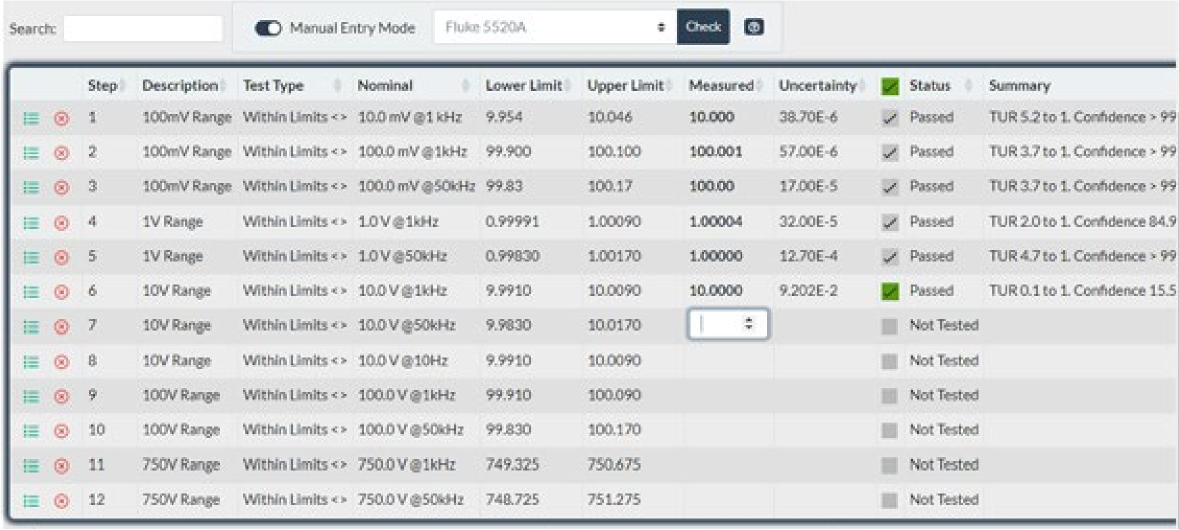
If the SoA's uncertainty calculation is greater than the software's uncertainty calculation, it will report the SoA's uncertainty and note this test point for future audits. Otherwise, it will use the uncertainties produced by the software in the calibration results.

Mock Example

For our test case, we wanted to do a mock accredited calibration on an HP 34401A using a Fluke 5730A calibrator. In the example, the calibration lab is accredited with their Fluke 5520A. They just received a new 5730A with a 5725A Boost amplifier with an accredited calibration, but they have yet to update their accredited uncertainties with their accreditation body.

They can perform accredited calibrations with their Fluke 5730A; they just can't overstate their uncertainties.

Here we see the software will place a light green check mark on all the test points the lab is accredited for, but the software used the best uncertainties from the SoA in place of the 5730A's in-app calculated uncertainties (Figure 3). It will place a dark green check mark everywhere the in-app or alternate uncertainty calculations are equal to or greater than the SoA's uncertainty. If the lab was not accredited at that test point, the check marks in the accredited column were all left blank.


Search:
Manual Entry Mode
Fluke 5520A
Check

Step	Description	Test Type	Nominal	Lower Limit	Upper Limit	Measured	Uncertainty	✓	Status	Summary
1	100mV Range	Within Limits <>	10.0 mV @1 kHz	9.954	10.046	10.000	38.70E-6	✓	Passed	TUR 5.2 to 1. Confidence > 99
2	100mV Range	Within Limits <>	100.0 mV @1kHz	99.900	100.100	100.001	57.00E-6	✓	Passed	TUR 3.7 to 1. Confidence > 99
3	100mV Range	Within Limits <>	100.0 mV @50kHz	99.83	100.17	100.00	17.00E-5	✓	Passed	TUR 3.7 to 1. Confidence > 99
4	1V Range	Within Limits <>	1.0 V @1kHz	0.99991	1.00090	1.00004	32.00E-5	✓	Passed	TUR 2.0 to 1. Confidence 84.9
5	1V Range	Within Limits <>	1.0 V @50kHz	0.99830	1.00170	1.00000	12.70E-4	✓	Passed	TUR 4.7 to 1. Confidence > 99
6	10V Range	Within Limits <>	10.0 V @1kHz	9.9910	10.0090	10.0000	9.202E-2	✓	Passed	TUR 0.1 to 1. Confidence 15.5
7	10V Range	Within Limits <>	10.0 V @50kHz	9.9830	10.0170				Not Tested	
8	10V Range	Within Limits <>	10.0 V @10Hz	9.9910	10.0090				Not Tested	
9	100V Range	Within Limits <>	100.0 V @1kHz	99.910	100.090				Not Tested	
10	100V Range	Within Limits <>	100.0 V @50kHz	99.830	100.170				Not Tested	
11	750V Range	Within Limits <>	750.0 V @1kHz	749.325	750.675				Not Tested	
12	750V Range	Within Limits <>	750.0 V @50kHz	748.725	751.275				Not Tested	

Figure 3.

Referring to Figure 4, the application software calculated an uncertainty of ±4.9e-4 V using only the Type B 95% specifications of the Fluke 5730A. Then by calling an alternate calculator, where the calibration lab added additional contributors like traceability, repeatability, and reproducibility resulting in an expanded uncertainty of ±6.2e-4 V., the software is able to check against the SoA uncertainties. Because the lab is only currently accredited to ±9.3e-3 V using their Fluke 5520A, they cannot report an uncertainty below that value. So the software replaces the 6.2e-4 V uncertainty with 9.3e-3 V and reports that value on the certificate of calibration.

Each test point and test result is checked. The difference in uncertainty between a 5730A and a 5520A is huge. The software will be able to check and verify small values just as well. If the application using a 5520A generated an uncertainty of ±9.2e-3 V, it would have replaced it with ±9.3e-3 V because at the time of calibration ±9.3e-3 V is the maximum value the labs is accredited to on their Scope of Accreditation.

Conclusion

Moving metrology into the digital age, there is still a lot of work that needs to be done!

This paper and software example is the first attempt at creating an architecture to allow a software application to verify each and every test point against a calibration lab's Scope of Accreditation. Over time, the systems will become more polished as technologies advance.

As the NCSLI MII 141 committee continues to push technology forward, we're learning what works and what doesn't, innovating at the leading edge of technology.

Michael L. Schwartz (mschwartz@callabsolutions.com), CEO of Cal Lab Solutions, Inc. and Publisher of *CAL LAB*, Aurora, Colorado.

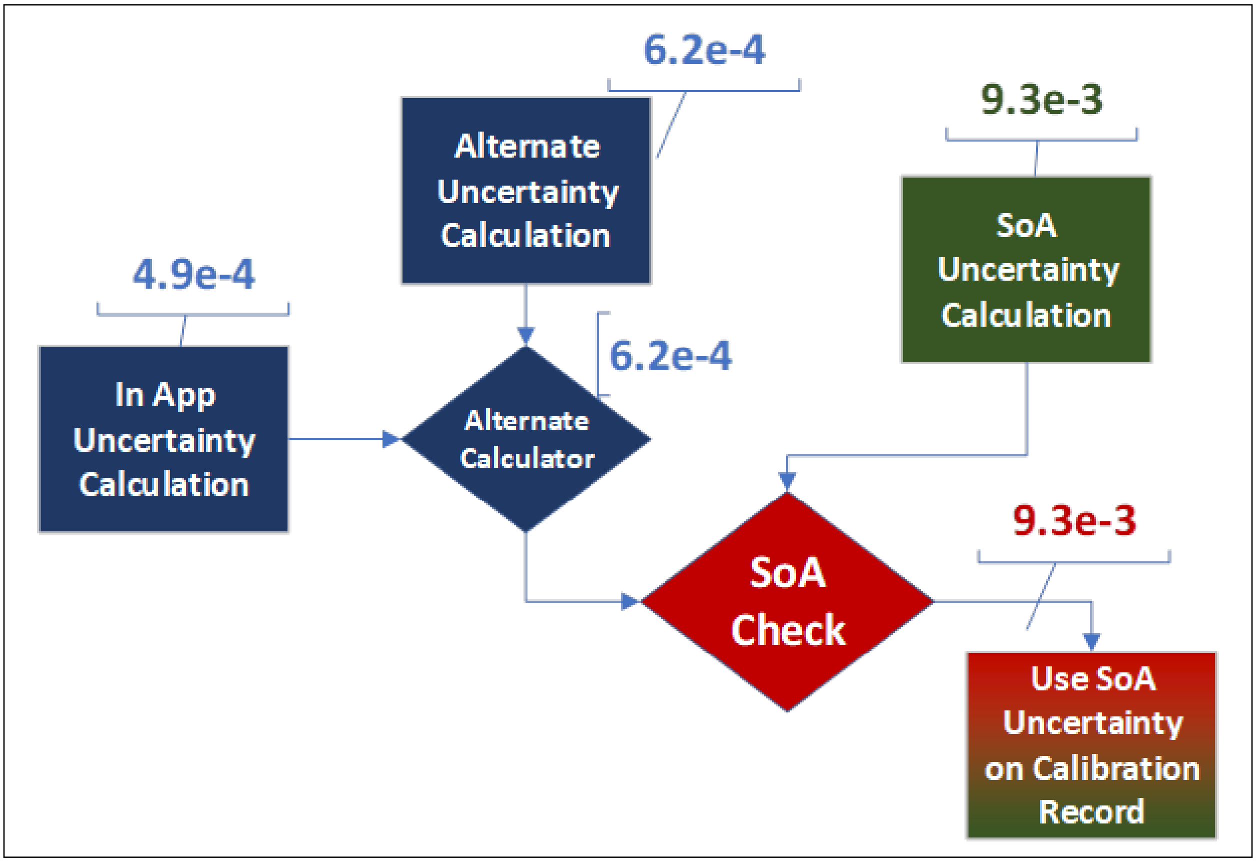


Figure 4.

A Collection of Meatballs

Dan Wiswell
Amblyonix Industrial Instrument Company

I was moving through some of the equipment in my archive recently when I concluded that I may have to create a separate wing dedicated exclusively to General Electric. I don't know how it happened, but now, there is just too much equipment to present here in one article. On several occasions, I found some of the specimens in small collections of equipment when local companies went out of business. Sometimes, just by a twist of fate, I happened to be in the right place and the universe appears to have provided. So, let's get into it.

As a young metrologist in the 1970s, I used to repair industrial test instruments at the Mancib Company, Inc., located in Burlington, Massachusetts. Back then, there was a fair mix of old-fashioned analog, and the more modern digital test equipment of that time, coming through our repair department. It was a busy lab with eight metrologists and an assortment of other individuals working in sales and our value-added department. Hundreds of pieces of equipment flowed through the lab each week. A fair portion of it was made by General Electric.

Early Meatballs

Many people know that Thomas Edison was one of the founders of General Electric. It is an interesting study to read about his innovations and of his association with other visionaries of his time. He had the ability to attract the interest of powerful men, the likes of which J. P. Morgan was one. Mr. Morgan was on General Electric's board of directors and was also a founding father of the company.

By themselves, these gentlemen were major contributors to the advancement of technology in the evolving world of those times. By combining their energies, they helped elevate society to a technological level only imagined just a few decades before.

Timing seems to also have played a hand. The company's first government contract was to design and construct the electrical control system for the locks and safety features of the Panama Canal. It was the largest fully electric supervisory and control system of its kind in the world. Control rooms that monitored ship traffic in the canal were equipped with complete, working, miniature models of the canal that replicated all the working features of each portion of the canal that they served. The entire system stood as a testament to the prowess and ingenuity of the GE technical team.

Soon after commissioning the Panama Canal site, orders for General Electric products began streaming in from around the globe. As the company grew, it became easier to list products that were not made by GE than to encompass their entire product offering. From heavy industrial electrical equipment and locomotives to a myriad of household appliances, all products sported the stylized GE logo, affectionately known as the GE meatball. My first recollection of seeing this logo was on my grandparents' refrigerator that they purchased in the 1940s.

Picture 1. GE ammeter that pre-dates the popular P-Series.

Picture 2. GE Type P3 Ammeter calibrated May 20, 1911.

Picture 3. GE Type P3 Ammeter repaired October 15, 1948.

Schenectady Ammeters

I felt as if my horizons were broadened when I began seeing the variety of electrical instruments the company also made. Most of GE's electrical instruments were made at its large factory located in Schenectady, NY. Many tens of thousands of an extensive range of electrical instruments were made there during the wooden box era of test equipment design in the late nineteenth and early twentieth centuries.

Most of the Schenectady plant's production of early instruments was focused on portable instruments that measured the electrical power parameters of voltage, current, power and power factor. The Type P3 and P4 series of instruments were some of the most popular GE products that passed through the Mancib Company's lab when I worked there. Pictured here are some examples of Type P3 and P4 ammeters that I have retained over the years. However, the first example pre-dates the P series designation. It was calibrated in 1910 at the factory in Schenectady and still measures current within its original tolerance (Picture 1).

Another example of a Type P3 Ammeter is shown in Picture 2. This unit was calibrated at the GE plant located in Lynn, Massachusetts on May 20, 1911. To the right of this unit is a Type P3 ammeter that was repaired by the Alvin S. Mancib Company on October 15, 1948. A record of this repair is inscribed on the meter scale of the instrument, as can be seen in the picture's detail. In those days, the Mancib Company was located in Cambridge, Massachusetts and was a full-service distributor of GE measuring instruments.

The General Electric facility located in Lynn, Massachusetts has been a large employer of the local population for over 130 years. Some of my employees that worked as metrologists at Cal-Tek Company also worked previously at the GE Lynn plant. Now a part of GE Aerospace, this facility is where the first American jet engine was made during World War II. It had an extensive laboratory where many GE instruments were standardized or recalibrated over the years. The Type P4 ammeter below was calibrated there on August 14, 1911. Adjacent to the P4 ammeter is a Type P3 voltmeter calibrated at the same facility nearly thirty years later. Both were owned by the Boston Edison Company.

Picture 4 and 5. GE Type P4 Ammeter and Type P3 Voltmeter.

Watt Meters

Moving on to watts, to the right are some examples of Type P3 watt meters. I found some of these at motor repair shops. Judging by the volume of the surviving examples of these instruments, they appear to have been very popular in their day.

Picture 6 and 7. GE Type P3 Watt Meters.

A Few More of Note

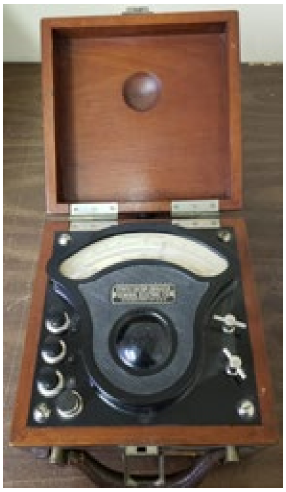
Lastly in this series, I have included some examples of power factor measuring instruments. It is obvious that the front panel layout of the Type P3 and P4 series of instruments lent itself well to a broad range of products.

These instruments were not the only types of instruments manufactured at the General Electric plant in Schenectady, NY. Chart recorders and many other instruments were made there as well. Clamp-on current meters and portable watt meters like those shown (Pictures 11 and 12) also came out of the Schenectady plant.

To me, some of the most beautiful instruments that were produced in the early twentieth century by General Electric were the PL2 Series of laboratory standards. Pictures 13, 14, and 15 were the primary standards of the Alvin S. Mancib Company. These were their laboratory standards for AC current, voltage, and watts. They were located in the inner sanctum of the laboratory.

Only a few metrologists in the company were allowed access to them. I feel privileged to have them in my archive. They were in use for over fifty years and were replaced in the late 1970s by calibrators made by the Rotek Company located at the time at 220 Grove Street in Waltham, Massachusetts.

As I was taking pictures of these products it was interesting for me to see the various calibration stickers from local laboratories that have calibrated these devices over the years. It brought a smile to my



Picture 8, 9, and 10.

IN DAYS OF OLD

face to see the names of metrologists in the support documents that add to the provenance of each instrument. I revered these gentlemen as a young man.

Looking back, it could have been possible for five generations of my family to have worked in the test and measurement field in the Boston area. Were he so inclined, my great grandfather could have used some of the instruments that I still pass by each day. That is probably why, to this day, I still feel compelled to keep them all in good working condition.

Picture 11 and 12. GE Clamp-on current meter and portable watt meter manufactured at the GE plant in Schenectady, NY.

Dan Wiswell (dcwiswell@aol.com), North Billerica, Massachusetts.

Picture 13, 14, and 15. Laboratory standards for the Alvin S. Mancib Company, replaced by calibrators in the late 1970s.

IndySoft Unveils the IndySoft Scales Calibration App, an Easy, Quick Way to Complete NIST Handbook 44-Compliant Calibrations

New app works offline, provides everything technicians need to get the job done fast and on target

CHARLESTON, S.C., March 19, 2025 /PRNewswire/ -- IndySoft (www.indysoft.com), a global leader in calibration and asset management software, introduces the IndySoft Scales Calibration App- a fast, easy-to-use solution designed to help scale calibration companies maximize accuracy, productivity, and customer satisfaction.

Built to meet NIST Handbook 44 requirements, the app features a simple, intuitive interface with built-in procedures for Truck Scales, Platform Scales, Tank Scales, and Balances. It works offline, eliminating the hassle of clipboards, spreadsheets, and unreliable internet connections—allowing technicians to complete jobs faster and with greater precision.

The IndySoft Scales Calibration App is built on the trusted IndySoft platform, used by leading metrology organizations worldwide. It gives scale organizations and calibration technicians the tools they need to:

- **Ensure compliance**: Helps organizations stay compliant with specifications, tolerances, and technical requirements for devices like scales, fuel dispensers, and meters used in commerce and law enforcement.
- **Streamline scale calibration workflows**: Provides a complete scale calibration solution that helps technicians meet NIST Handbook 44 requirements quickly and reliably.
- **Capture every charge and boost profitability**: Logs all billable items—parts, labor, mileage—on the spot to ensure accurate invoicing.
- **Improve customer satisfaction**: Generates fast, accurate reports and labels to help customers pass inspections with ease.
- **Increase technician productivity**: Offers an intuitive interface with built-in procedures for common scale types — meaning technicians can ditch the clipboards and Excel sheets and get more done with greater precision.
- **Complete scale calibration efficiently**: Cuts calibration time by automating setup and test calculations, even offline, so techs can finish jobs quicker and move on.
- **Reduce training time and improve accuracy**: Built for technicians, the app is simple to use, reducing training time and errors.

"The IndySoft Scales Calibration App solves the problem of missing job details, Microsoft Excel sheets that don't sync, and spotty Internet that slows down calibration processes," said Rhett Price, CEO of IndySoft. "It ensures that reports are on time, customers are happy, and compliance is fast and easy."

Get Started with the IndySoft Scales Calibration App

The IndySoft Scales Calibration App is available for immediate implementation. Businesses can set it up independently or work with IndySoft's cloud team for a seamless deployment. Whether in a scale dealership, a government agency, or a calibration lab, the IndySoft Scales Calibration App makes scale calibration faster, easier, and more accurate than ever before.

Learn more at: https://indysoft.com/scalescalibrationapp or contact sales@indysoft.com.

Durable New 1.0mm Test Cable Assemblies Provide Superior Signal Integrity Up to 110 GHz

Fairview Microwave's Latest Line Is Designed for High-Performance Testing

IRVINE, Calif. – Fairview Microwave (www.fairviewmicrowave.com), an Infinite Electronics brand and a leading provider of RF, microwave and millimeter-wave products, has announced the launch of its new 1.0mm test cable assemblies, designed for high-performance test setups requiring superior durability and signal integrity.

Made with an armored, ultra-low loss, phase-stable coax cable, these assemblies are available in 1.0mm male-to-male and 1.0mm male-to-female configurations. They support frequencies up to 110 GHz. In addition, they provide exceptional phase stability, low insertion loss and rugged crush resistance, making them ideal for long-term, demanding test environments in industries such as telecommunications, aerospace and defense.

The armored construction of these cables offers maximum durability, enabling them to withstand mechanical stress, repeated handling and harsh environments. Their crush-resistant design provides enhanced protection against physical damage, making them a reliable choice for long-term use.

"Our new 1.0mm test cable assemblies deliver the reliability and precision that engineers require in high-frequency testing," said Senior Product Line Manager Amar Ganwani. "By combining ultra-low loss performance with armored durability, these cables meet the needs of even the most rigorous testing environments."

Fairview's new 1.0mm test cable assemblies are in stock and available for same-day shipping. For inquiries, please call +1-972-649-6678.

NEW PRODUCTS AND SERVICES

PTI Introduces a New Proficiency Testing Approach

The international community uses proficiency testing as evidence of the competence of a laboratory. But many laboratories see proficiency test participation as just a requirement of the ISO/IEC 17025 standard rather than a very useful tool. Several years ago, I wrote an article about proficiency testing for an accrediting body. I asked the question: "Who do you want to tell you there is an error in your measurement results? Your PT provider or your customer." Obviously, not your customer. Proficiency testing can be a valuable tool.

Things You Should Know About Proficiency Testing

The difference between a Proficiency Test (PT) and Interlaboratory Comparison (ILC) is how the value of the measurements are derived. An Assigned Value in a proficiency test for calibration laboratories is one that is determined by calibrations from reference laboratories. This is a known value. A Consensus Value in an ILC is one that is derived from the data collected from the participants of a particular test (an average of all participants data, for instance). In other words, a PT uses a known (assigned) value for each measurement, whereas an ILC may use a calculated (consensus) value.

The Proficiency Testing, Inc. Process

Our process is a PT where all measurements are known values as determined from one or more reference laboratories.

At Proficiency Testing, Inc., we have devised a unique process for providing test artifacts to our participants.

1. Our test windows start on a Monday of your choice.
2. Your lab has until the following Tuesday for return shipment.
3. You are not required to ship the test kit to another laboratory.
4. Preliminary reports are available through your secure portal, usually the same day as data submittal.
5. Should you have outliers, as indicated on your preliminary report, you have time to investigate and correct the issue and resubmit your test results.
6. Your corrective actions for outliers can be uploaded to your portal for easy access during your assessment.
7. Our artifacts are calibrated by high accuracy, accredited reference laboratories rather than using consensus values based on the average of all participants.
8. At the end of each test cycle, a complete report is issued to allow you to compare your results with other participants using you lab code.
9. All reports issued by PTI bear the ANAB symbol indicating all requirements of ISO/IEC 17043:2023 are met.

About Proficiency Testing, Inc.

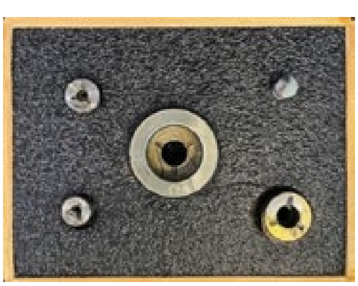
The PTI project was started in 2021 with the purpose of devising PT schemes that provided participants with preliminary results before they had to send the artifacts to the next laboratory. Our kits are returned directly to us unless agreed in advance. Our aim is to have enough kits available to allow each participant adequate time to complete the testing without pressure to send to another laboratory.

PTI is proud to be accredited by ANAB to ISO/IEC 17043:2023. We were the first US proficiency test provider for calibration laboratories to be accredited to the latest edition of the standard.

Test kits are available in DC Low Frequency, Dimensional, Dimensional Inspection, Pressure and Vacuum, Torque, Force, Thermodynamics and Time and Frequency. Coming soon are RF devices and mass.

For more information and test descriptions, visit www.proficiencytestinginc.com , email us at sales@proficiencytestinginc.com or call 352-899-2064.

To see test details and availability, you must register. There is absolutely no obligation to register. The link is www.proficiencytestinginc.com/client-registration.



Sample cylindrical plug gage, gage block and pressure / vacuum kits.

Rohde & Schwarz Launches R&S NRP140TWG(N) Thermal Power Sensor: A New Benchmark for F Band Applications

Munich, 13 Mar 2025 — Rohde & Schwarz presents the new R&S NRP140TWG(N) thermal power sensor, designed to meet the growing demands of applications in the F band utilizing a WR 8 waveguide connector. The NRP140TWG(N) is fully traceable to the National Metrology Institute (NMI) in Germany (PTB) and is temperature compensated, ensuring accurate and reliable measurements. With its plug-and-play capability, users can easily connect via USBTMC or LAN digital connectivity, making it an ideal solution for a wide range of applications.

The new R&S NRP140TWG(N) power sensor ideally suited to F band applications due to its native WR 8 waveguide connector. (Image: Rohde & Schwarz)

The new R&S NRP140TWG(N) follows the excellent R&S NRP170TWG power sensor which was the first thermal power sensor to cover the full D band. With the new sensor, Rohde & Schwarz now also offers a dedicated solution for precise power measurements in the F band, using an WR 8 waveguide connector.

Accuracy is vital to complex wideband measurements. Therefore, the sensors are fully calibrated for long-term stability and can compensate for environmental temperature influences within the specified operating range from 0°C to + 50°C. R&S NRP140TWG(N) sensors have a dynamic range of –35 dBm to +20 dBm and up to 500 measurements per second, making them extremely fast with outstanding performance. They are the only NMI-traceable RF power sensors for the F band.

Prepared for new upper-band automotive radar and SatCom applications

As the ADAS/AD community collaborates with standardization authorities to define new frequency bands for automotive radar, the R&S NRP140TWG(N) is ready to facilitate safer radar-based ADAS and autonomous driving technologies. With the increasing exploration of higher frequency bands in satellite communications, the R&S NRP140TWG(N) has already attracted orders from major space companies, underscoring its relevance in this critical industry. Further, the sensor is essential for RF power measurements in any application utilizing WR 8 waveguide connectors, including T&M instrument level verification, amplifier characterization, device development, and regulatory compliance.

Ease of use

All Rohde & Schwarz NRP power sensors are easy to use and stable with excellent connectivity, letting researchers, developers and production engineers focus on more challenging tasks. R&S NRP140TWG(N) sensors provide stable power readouts even at low power levels, have excellent drift performance and are resilient to external temperature changes or out-of-band signals. R&S NRP140TWG(N) are easy to use thanks to USB or LAN connectivity.

NMI traceability

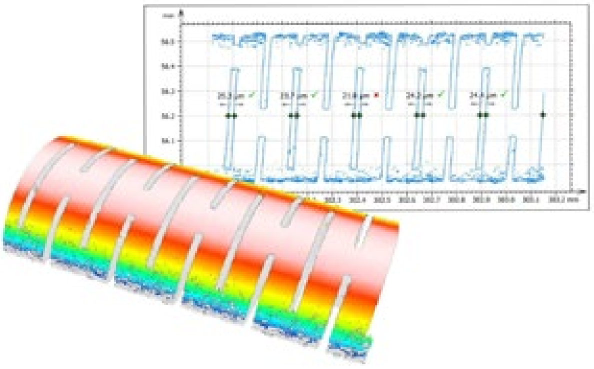
In collaboration with Germany's national metrology institute Physikalisch-Technische-Bundesanstalt (PTB) and other European NMIs Rohde & Schwarz was first to establish NMI traceability up to 170 GHz for the R&S NRP170TWG. Now, the new R&S NRP140TWG(N) sensor offers full NMI traceability in the frequency range from 90 GHz for to 140 GHz. NMI traceability is a prerequisite for commercial and industrial utilization of a frequency band.

The new R&S NRP140TWG(N) thermal power sensors are now available from Rohde & Schwarz. For further information visit: https://www.rohde-schwarz.com/

New Software Release for Precision Surface Analysis

Peak Metrology and Digital Surf launch advanced profilometry software for precision surface analysis

Pittsburgh, PA and Besançon, France – Jan 30, 2025 — Peak Metrology (www.peakmetrology.com), automated metrology equipment designer and manufacturer, and Digital Surf (www.digitalsurf.com), editor of analysis software solutions for profilometry, microscopy and spectroscopy, have announced the release of Peak Metrology Surface Analysis, a profilometry software package powered by Mountains® technology that enables engineers, scientists and metrologists across industries to analyze precision scanned surface data.



The key capabilities of this analysis software include:

- **Comprehensive surface characterization:** Peak Metrology Surface Analysis analyzes surface geometry, profiles and topography with exceptional precision, supporting measurements from microns to nanometers.
- **Versatile sensor compatibility:** the software works seamlessly with Peak Metrology scanning equipment and supports data from multiple sensor types including confocal sensors and microscopes, laser profile sensors, interferometers and other non-contact optical measurement devices.
- **Automation and replication:** users can build recipes and templates that allow for automated surface analysis that minimizes or eliminates the need for operator intervention. Measurements can be performed repeatably and without common error sources that plague operator-driven software packages.

Peak Metrology Surface Analysis software includes a suite of tools allowing the extraction of actionable data from the raw surface measurements generated by the scanning equipment. Main customer applications include:

- **Measuring flatness and coplanarity** of surfaces.
- **Measuring surface geometry** such as distances, areas, step heights, angles and volumes.
- **Analyzing individual layer thicknesses and total thickness variation (TTV)** of surfaces.
- Calculating and evaluating **surface roughness and texture**.

"Our collaboration with Digital Surf marks a major advancement for our customers," said RJ Hardt, President of Peak Metrology. "By combining our cutting-edge scanning equipment with Digital Surf's renowned analysis software, we are delivering a powerful, seamless solution for precision surface analysis that empowers our customers to achieve unmatched accuracy and reliability."

"Partnering with Peak Metrology has allowed us to extend the reach of our software into new, innovative applications," said Christophe Mignot, CEO of Digital Surf. "Together, we are providing users with an automated, user-friendly solution that converts raw surface measurements into meaningful results, enabling breakthroughs in research and industrial quality control."

About Peak Metrology

Peak Metrology designs and manufactures surface metrology equipment. Working across the semiconductor, consumer electronics, medical device, aerospace, automotive, energy and defense industries, Peak Metrology's engineers solve customers' complex surface metrology challenges with equipment solutions that leverage more than 50 years of experience. Customers trust Peak Metrology to deliver precision equipment that reduces measurement uncertainty and increases process automation. Visit www.peakmetrology.com.

Additel Introduces New Handheld Pressure Pumps for Precision Calibration

Brea, California (February 18th 2025) – Additel Corporation, a global leader in pressure calibration solutions, is excited to announce the launch of its latest series of handheld pressure pumps: the ADT997, ADT993, and ADT992. Designed to provide reliable and versatile solutions for both vacuum and high-pressure testing, these advanced pumps redefine efficiency and precision in the field. The ADT997 hydraulic pressure pump covers an extensive range up to 10,000 psi, while the ADT993 and ADT992 pneumatic pressure pumps offer a range up to 1,000 psi and 700 psi, respectively. Engineered with a dual-stage pre-pressure piston, these pumps reduce effort and enhance efficiency compared to traditional scissor pumps.

Key features of the new Additel handheld pumps include:

- Versatile Pressure Range: Capable of handling up to 10,000 psi.
- Efficient Dual-Stage Piston: Enables broad range operation with reduced effort.
- Rapid Stabilization: Innovative system for quick and stable pressure adjustments.
- Precision Control: Fine adjustment screw ensures highly accurate pressure settings.
- Ergonomic Design: Longitudinal layout improves handling and user comfort.
- Flexible Positioning: Multiple operating positions allow customized use.
- Modern Replacement: An ideal upgrade for testing, calibration, and maintenance applications.

"Our new handheld pumps are designed with technicians in mind, providing a more efficient, precise, and user-friendly experience for a wide range of calibration and testing needs," said a spokesperson Jon Sanders from Additel Corporation. "The innovative design enhances usability while maintaining the high-performance standards our customers expect."

Product Availability

The Additel Handheld Hydraulic Pressure Pumps are available now. For more information, visit: www.additel.com

Troubleshooting Automation Software

Michael L. Schwartz
Cal Lab Solutions, Inc.

I can't tell you how many times I have received an email or text message saying, "It doesn't work!" Well, what doesn't work? Can you give me any details? So I thought I would put together some basic troubleshooting steps followed by what you should add to your cryptic message of "It doesn't work!"

I want to start by saying, computers do EXACTLY what they were instructed to do each and EVERY TIME. They follow the instructions they were given. Computers get old and can break, but software doesn't wear out.

1. **Repeat Tests –** Most errors are found when a test point fails or the results don't look right. When this happens, the first thing you should do is repeat the test a few times. If the results are consistent, then you know the error is systematic. If the results are inconsistent, then the problem is random and will be harder to track down and find a solution.
2. **Check Standards** − The next step is always to "check your standards!" The more accurate the reference standard, the more things can go wrong. Double-checking your reference standard should be common practice.

   Checking a reference standard is a pretty simple task. Simply find a comparable standard in the lab and compare the two. Grab a comparable digital multimeter and measure the output to see if your reference standard is a calibrator outputting DC voltage. This isn't a calibration; this is just a sanity check, and it helps identify an error before it affects several calibrations.
3. **Check Settings** − Next, check the equipment settings against the manual. This is usually an easy step if the software stopped on the test point in question. If the software stops, then you should be able to turn the output on and verify the measurement. At this time, you can check the instrument-specific setting against the manual.
4. **Record if Possible** − You can also start an I/O trace and repeat the test. This will allow you to see the commands getting sent to the instruments. Most I/O trace tools will allow you to save the trace and send it with a support ticket.

   Another option is to record a video of the UUT and the reference standards as the calibration runs. The I/O trace shows the commands paired with a video of the equipment can really make remote troubleshooting easy.
5. **Check Specs** − The next check should be the test limits. Check the limits in the automation to the written calibration procedure. Then, check the written procedure test limits against the equipment's published specifications.

Hopefully, after following these five steps, the problem has been identified. But even if the exact problem is still unknown, you have gathered enough information to formulate an intelligent email that will help get to a resolution.

When you write the email, include the results of the repeated tests. If you just say it fails, I will respond with "equipment sometimes fails calibration." If you say, "I ran it several times, and the numbers are all over the place," or "consistently low," then I have an idea of what to look for in the code.

If your email says, "I checked the manual, and the device settings are wrong; the instruments need to be configured as follows," then changes can be made quickly, and an update is usually that day.

The same goes for errors in the test limits. Don't assume the manufacturer's manual's calculated test limits are correct – I can't tell you how many errors we have found.

Finally, if you have a video or I/O trace, you can attach it to the email. That makes it easier to track down problems. I hope this helps my customers and other automation engineers get the data they need from their users.

Additel 992 / 993 / 997
Handheld Pressure Pumps

Additel
Metrology Made Simple

Handheld Operation Capability

Adjustable Reference Connection

Up To 10,000 PSI Range