

Building Quality and Confidence in Carbon Measurement Systems

ORAP Panel
Dec 3, 2024

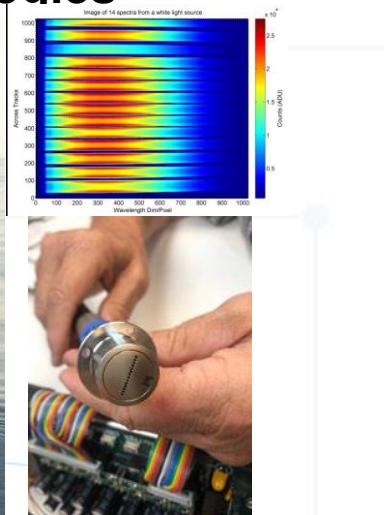
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NIST, Department of Commerce

Promotes U.S. innovation and industrial competitiveness by advancing measurement science, standards, and technology to enhance economic security and improve our quality of life.

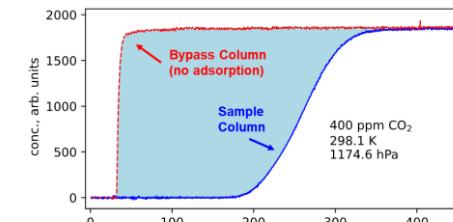
Measurement Technologies



Develop critical measurement science to accelerate innovation, scalability, & **reduce uncertainties**

Benchmark Measurements Data & Materials

[Standard Reference Materials | NIST](#)



<https://doi.org/10.1021/acs.iecr.2c04050>



Facilitate **traceability, rigor and reproducibility** across measurement ecosystems

Documentary Standards

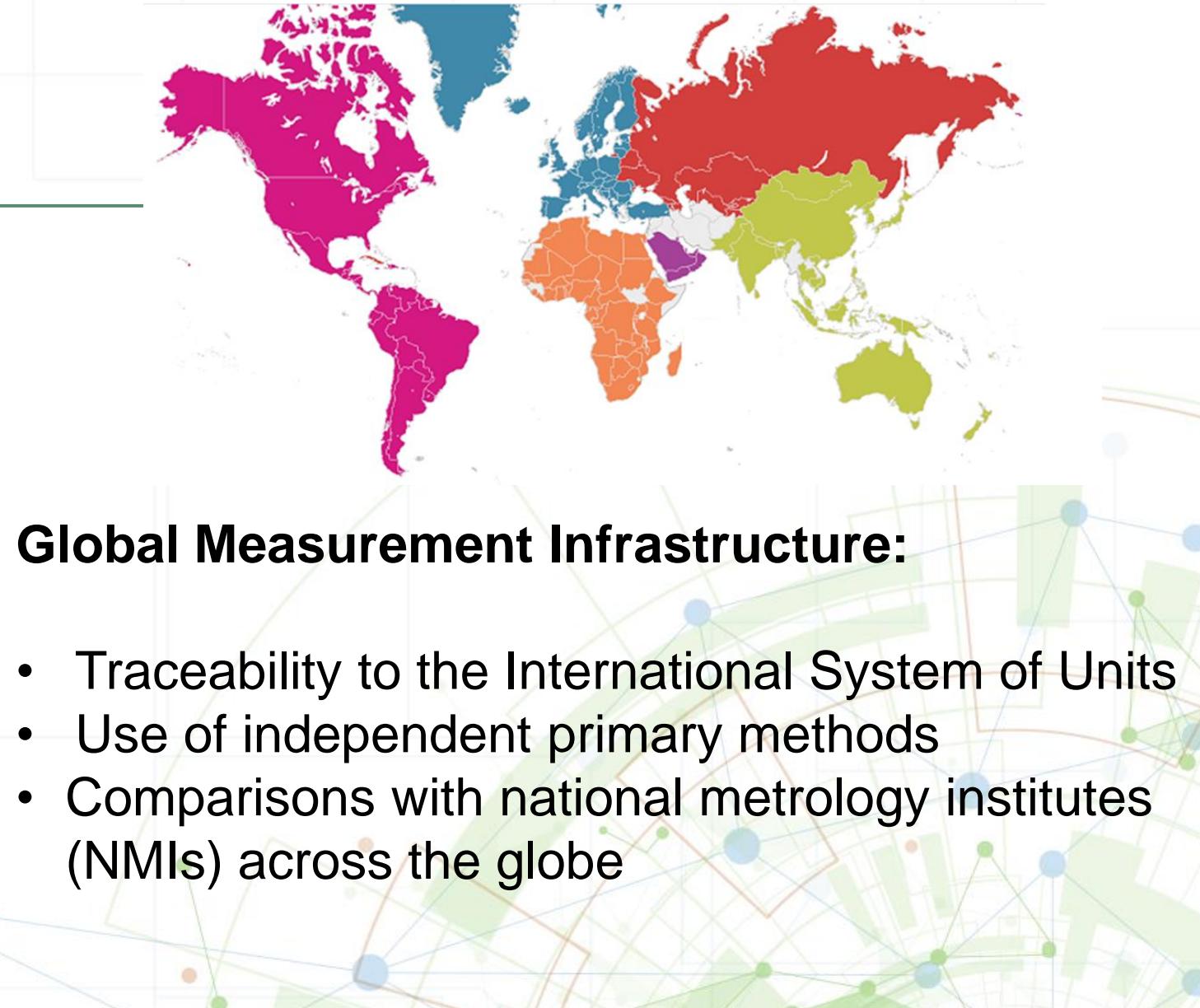
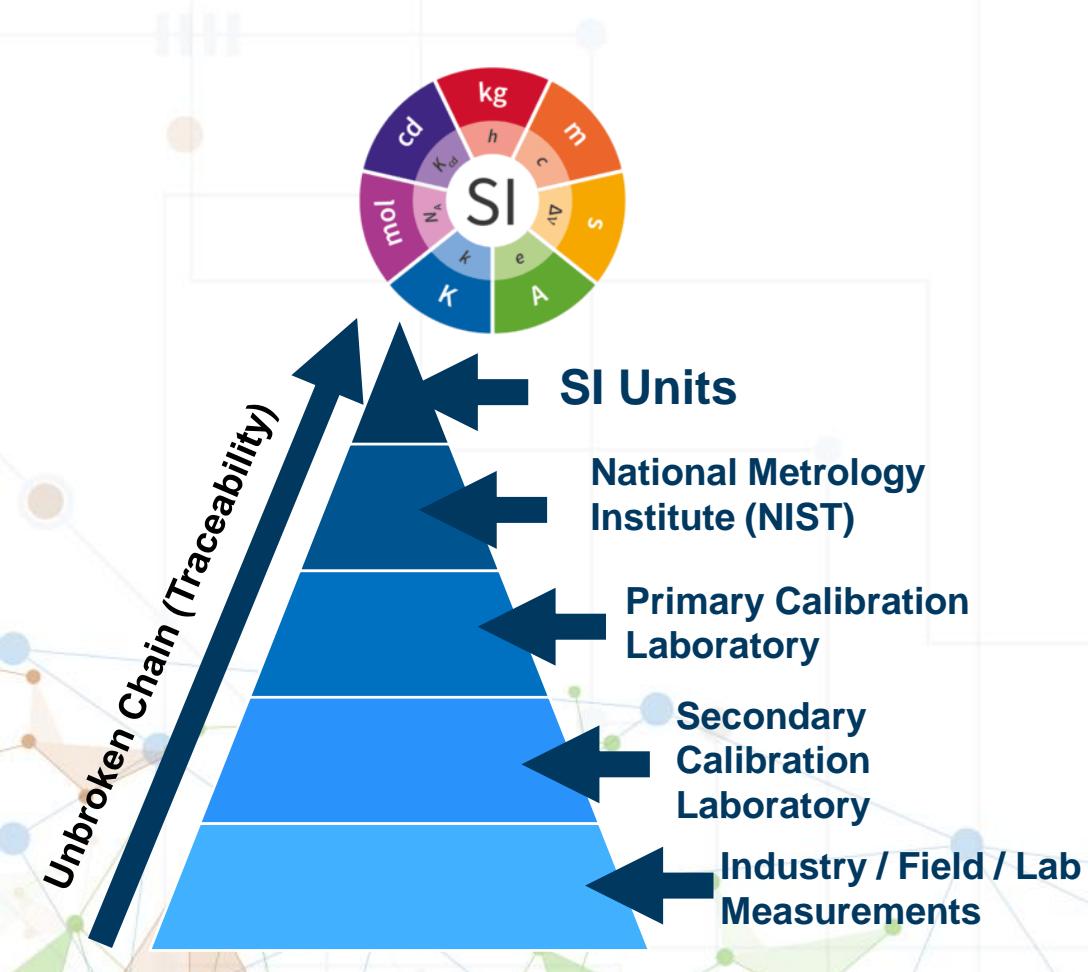
[Standards.gov | NIST](#)

Consortia,
Accreditation,
Conformity
Assessment



Support industry and government use of **voluntary consensus standards**

Measurement Quality



Global Measurement Infrastructure:

- Traceability to the International System of Units
- Use of independent primary methods
- Comparisons with national metrology institutes (NMIs) across the globe

Unique NIST Products and Services



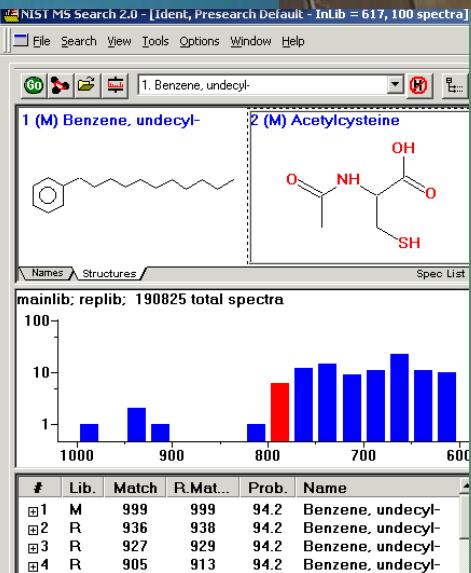
1,200 Standard Reference Material (SRM) products

100+ Standard Reference Data (SRD) products

700 measurement services

webbook.nist.gov

2M views a month



Every year:

32,000 SRM units sold

13,000 calibrations and tests

800 accreditations of testing and calibrations laboratories

20,000 SRD products downloaded or purchased

Related Program Areas

Measurements and Monitoring

Greenhouse gases (GHGs)

Carbon Dioxide Removal (CDR)

- Measurement traceability and technologies
- Ensuring data quality and standardization

Decarbonization of the Economy

- Manufacturing
- Energy infrastructure
- Built environment
- Carbon capture, Utilization, and Sequestration (CCUS)

Adaptation and Resilience

- Disaster and failure studies
- Wildland-Urban Interface fires
- Community resilience
- Connected systems resilience

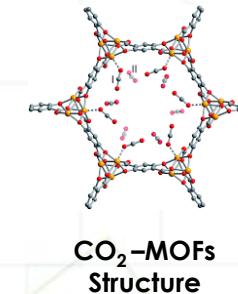
Life Cycle Analysis, Carbon Accounting

Advancing Carbon Dioxide Removal

Examples of current focus areas include:

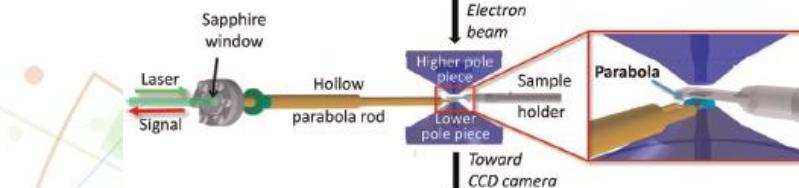
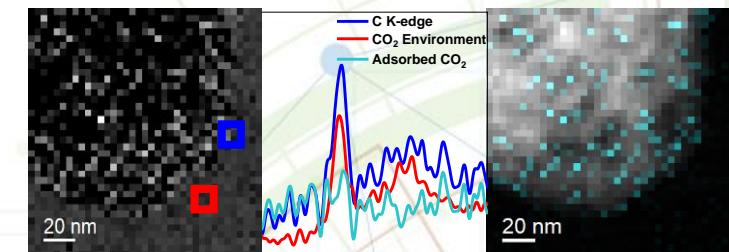
- [Direct Air Capture Sorbent Materials Characterization](#)
- [Low Carbon Cements and Concretes Consortium](#)
- [Next Generation Seawater CO₂ Reference Materials](#)
- [Ocean Color Satellite Calibration](#)
- [CO₂ Measurements and Reference Materials](#)
- [Forested Optical Reference for Evaluating Sensor Technology](#)
- Standards to Underpin MRV
- Standards and Conformity Assessment Considerations for Carbon Markets and Accounting
- CO₂ Pipeline Material Reliability
- Convergence with
 - [GHG Measurements](#)
 - [Circular Economy](#)

Direct Air Capture Sorbent Materials Characterization



Crystal structures
nanosecond
dynamics via
neutron scattering

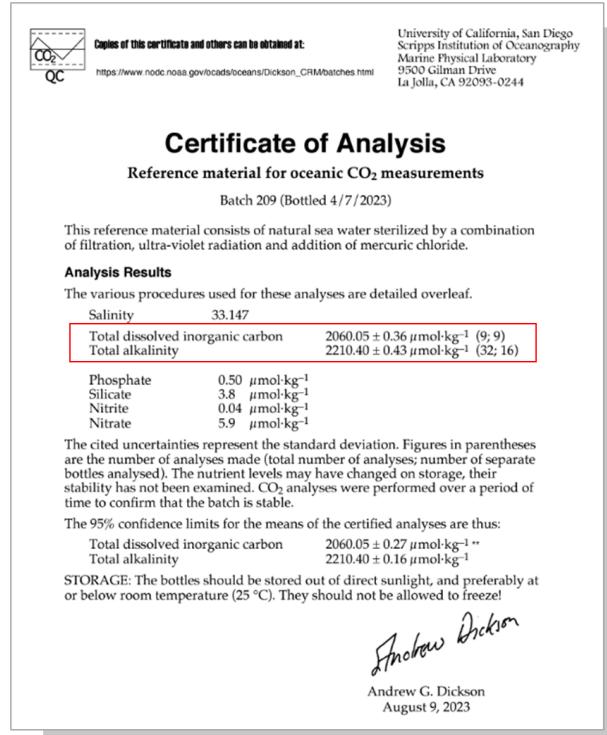
CO₂ adsorption via in-situ STEM-EELS imaging



US Patent US9431211B2 Hybrid electron microscope; Ultramicroscopy 150, 10 (2015)
Nature Materials 18 (6), 614–619 (2019)
Microscopy and Microanalysis 27 (S1), 800-801 (2021)

Seawater Carbon RM Production

NIST



MARINE RESEARCH

Ocean scientists confront a critical bottleneck

The world's only source of essential seawater reference samples could soon close



Carefully characterized seawater samples have been key to marine research.

science.org/doi/10.1126/science.acx9252

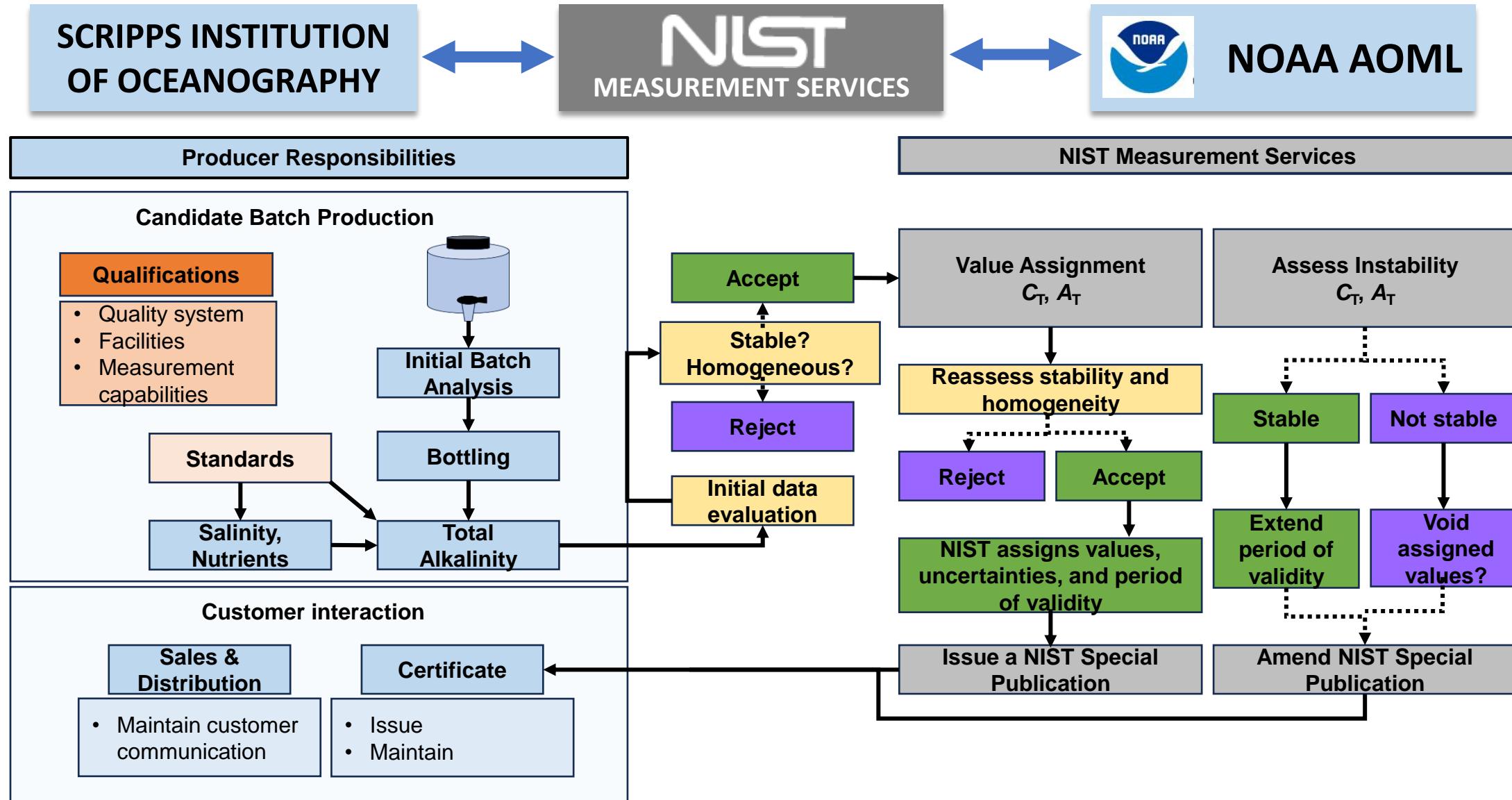
SCRIPPS INSTITUTION OF OCEANOGRAPHY

Global Customers
(> 62 countries)

U.S. Customers
(31 % of sales)

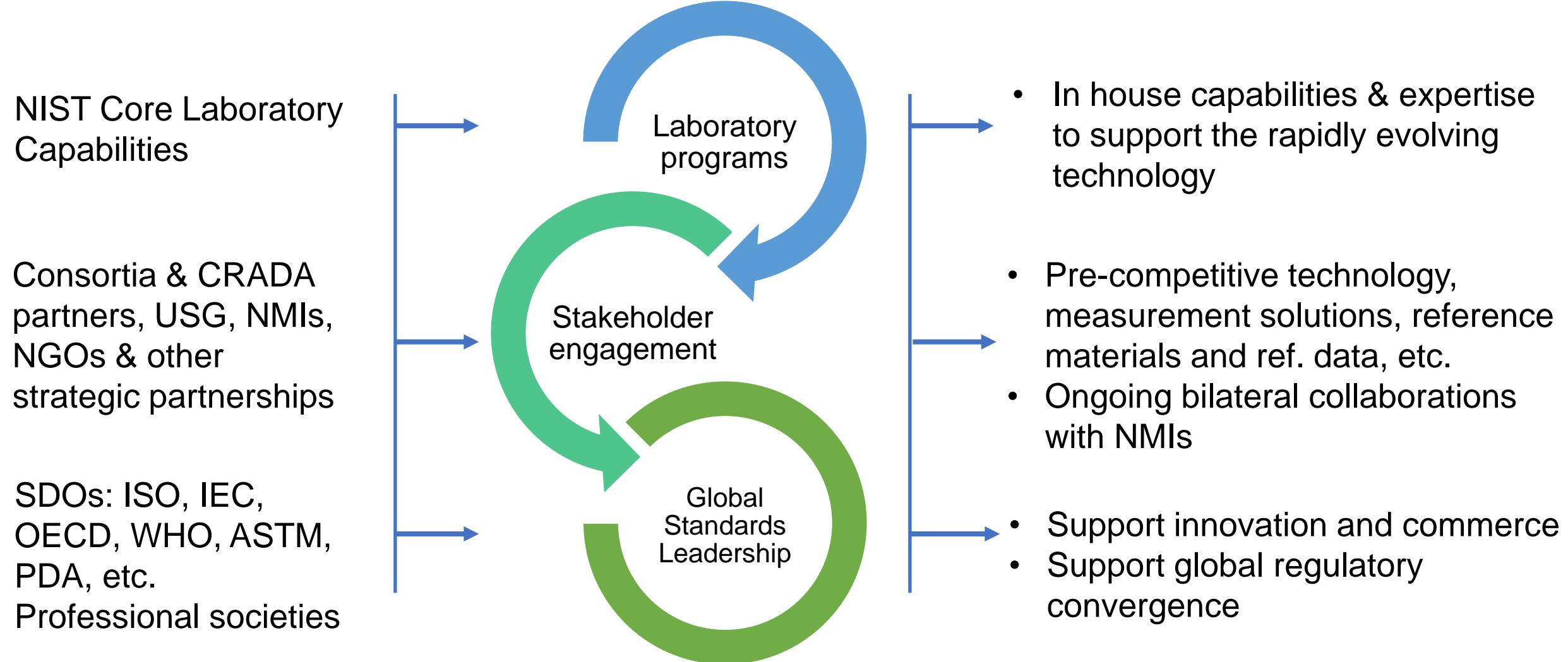
Quality System Development

NIST



From Laboratory Programs to Standards

NIST



Example Consortia: Public-Private Partnerships to Address Pre-competitive Challenges towards Standards Development

NIST

NIST Currently has - 24 Active Consortia; 691 Consortia CRADAs



NIST GENOME IN A BOTTLE (GIAB) CONSORTIUM

Provides authoritative characterization of benchmark human genomes



NIST GENOME EDITING CONSORTIUM*

Develops measurement solutions and standards needed to increase confidence and reduce risk
Formal members: 47



NIST FLOW CYTOMETRY STANDARDS CONSORTIUM*

Accelerates the adoption of quantitative flow cytometry in biomanufacturing
Formal members: 33



NIST RAPID MICROBIAL TESTING METHODS CONSORTIUM

Addresses measurements and standards needed to increase confidence in the use of rapid testing
Formal members: 44

Low Carbon Cements and Concretes Consortium



- ▷ Accelerate adoption of innovative low-carbon building materials – Cements & Concretes
- ▷ Initiated in 2022 –
- ▷ 52 Member Organizations - Private and Public Sectors
- ▷ Coordinates with voluntary consensus standards organizations, e.g. ASTM
- ▷ Facilitate standards development, interlaboratory comparisons, reference materials
- ▷ Coordinate with other agencies EOP, DOE, EPA, DOT

• AIA	• CarbonBuilt	• Kline Consulting, LLC	• Sublime Systems
• Argos	• CarbonCure	• MIT - Concrete Sustainability Hub	• Sutter Engineering
• ASCC	• CMHA	• NEU	• U.S. Army Corp of Engineers
• Ash Grove	• Continental Cement	• NETL	• UC Davis
• Biomason	• DOE	• NIBS	• UCLA
• Blue Planet Systems	• EPA	• NRMCA	• Ultra High Materials, Inc
• Boise State Univ.	• FHWA	• NSF	• Univ. of Miami
• Brimstone	• Fortera	• Outside the Box Materials	• Univ. Texas at Arlington
• Buchi	• Georgetown Univ.	• Ozinga	• WAP Sustainability
• Building Transparency	• Georgia Tech.	• PCA	• WR Meadows
• Bureau of Reclamation	• Heidelberg Materials	• Purdue Univ.	• WRI
• CalPortland Company	• Holliday Rock	• Spherical Block, LLC	
• CarbiCrete	• Iowa State	• St Mary's Cement	
• Carbon Limit	• Kiewit		

Meeting Schedule



Steering Group

*Twice per year
and as needed
(online)*



4 Working Groups

*Once every two
months (online)*

*Quantifying carbonates
Performance specifications
Carbon Accounting
Innovative Materials*



Full Consortium

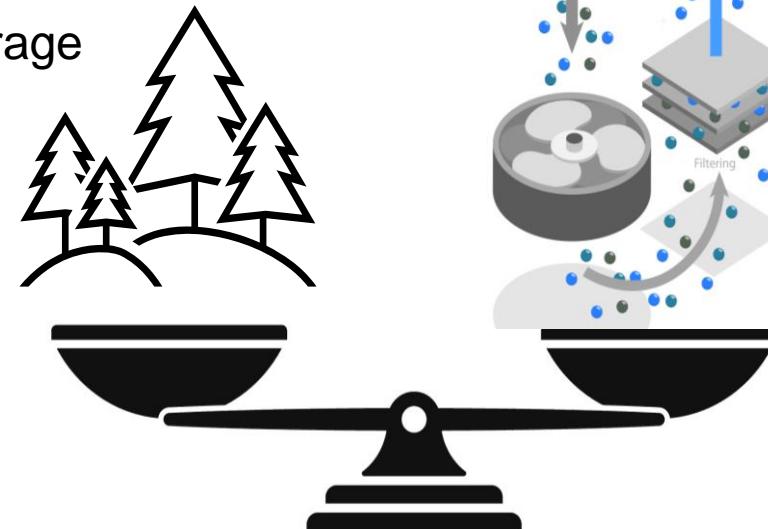
*ACI Spring &
Fall Conventions*

*Standalone Event
(1-2 days) in July*



Pathways

- **Afforestation, Reforestation, Improved Forest Management**
- Blue Carbon Management
- Biochar
- Biomass Carbon Removal & Storage
- **Direct Air Capture & Storage**
- Direct Ocean Capture & Storage
- Enhanced Rock Weathering
- Ocean Alkalinity Enhancement
- Ocean Fertilization
- Peatland and Coastal Wetland Restoration
- Soil Carbon Management
- Etc.



Additional Attributes

- Permanence
- Additionality
- Leakage
- Sustainability
- Development Goals
- Etc.

Carbon Dioxide Removal



Challenges



Trust

- Lack of trust in offset claims creates
- Risks – reputational and legal
- Disincentivizes demand



Quality

- Difficult to quantify offset properties
- Limited independent verification



Scaling the Market

- Bottlenecks in project review and verification
- Myriad of standards
- High barriers to entry



Role of VCM

- Varied views on the role of voluntary versus regulatory carbon markets
- Need to ensure innovation is not stifled

Opportunities



Data Transparency & Accessibility

- Builds trust
- Increases demand



Science & Technology

- Expands measurements and access to objective data
- Enables validated models
- Enhances knowledge and confidence
- Stimulates innovation



Standardization - Harmonization

- Streamlines approval process
- Builds quality & confidence
- Enables trade with globally accepted standards



Market Structure - Transparency

- Avoids conflicts of interest
- Increases market accessibility
- Attracts capital



Policy - Alignment

- Enhances marketplace integrity
- Increases demand
- Stabilizes prices

Carbon Dioxide Removal Consortium



Initial Stakeholder Engagement:

- Georgetown Workshop Sept 2023
- 1-on-1 discussions
- North American Carbon World-March 2024
- SF Climate Week – April 2024



Increase the market efficiency and scale with measurements and standards

- ▷ Carbon Dioxide Removal Consortium - Initiated in 2024
- ▷ Precompetitive and CRADA-Based
- ▷ On-boarding phase; Meetings to commence early 2025
- ▷ Initial Focus 1) Direct Air Capture and 2) Forests
- ▷ Inquiries – email CO2removal@nist.gov

Partnerships, Engagement & Convening

NIST is growing partnerships & convening stakeholders to help build trusted MRV and carbon accounting.

- Quantify CDR across engineered and nature-based pathways.
- Enable measurement comparability for informed CDR and CCUS decisions
- Promote equitable trade

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