Large Scale Metrology

Goal

- By 2005, provide the U.S. large-scale metrologists the tools to realize task specific measurement uncertainties, reduce calibration time by 50% while increasing the calibration cycle time by 50% effecting a direct saving of $60M and an indirect saving of $600M.

Deliverables

- A draft of the laser tracker standard
- A multi-configurable laser rail calibration system (LARCS)
- CMM installed and tested
- Implement reverse engineering system
- Large-scale artifact measurement services
- New technologies characterization

Customers and Collaborators

- Boeing, Caterpillar, Atlantic Marine Holding, U.S. Navy, U.S. Air Force, U. MASS, Springback Predictability Consortium

Draft Version L-2 Jan. 14, 2001

Evaluation of Laser Based Spherical Coordinate Measurement Systems

B89.4.19-2000

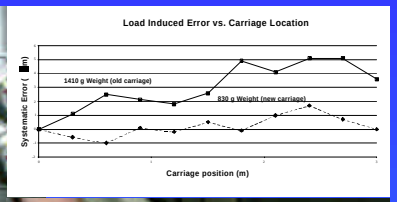
Abstract

The primary purpose of this Standard is to prescribe methods for performance evaluation of laser based spherical coordinate measurement systems. A secondary purpose is to facilitate performance comparisons among laser based spherical coordinate measurement systems. Definitions, environmental requirements, and test methods are specified. This Standard defines test methods capable of providing results for a majority of such instruments and is not intended to replace more complete tests that may be required for special applications. Instruments compliant with this Standard are considered to produce traceable point-to-point length measurements under the stated conditions. This document provides technical guidance useful in the calibration of laser based spherical coordinate systems for point-to-point length measurements.

1 Scope

This Standard establishes requirements and methods for specifying and testing the performance of Laser Based Spherical Coordinate Measurement Systems (see Appendix A). A Laser Based Spherical Coordinate Measurement System is defined as a device with a two-axis rotary steering mechanism that directs the light from a laser ranging instrument thereby forming a spherical

Laser Rail Calibration System (LARCS)



New LARCS carriage improves efficiency and accuracy of laser tracker calibrations

NSRP Reverse Engineering

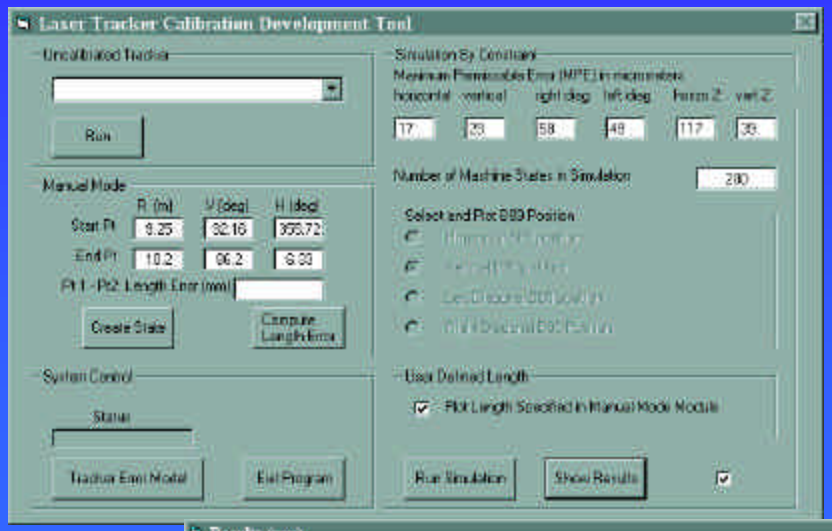
In process measurement system will replace measuring tape and templates

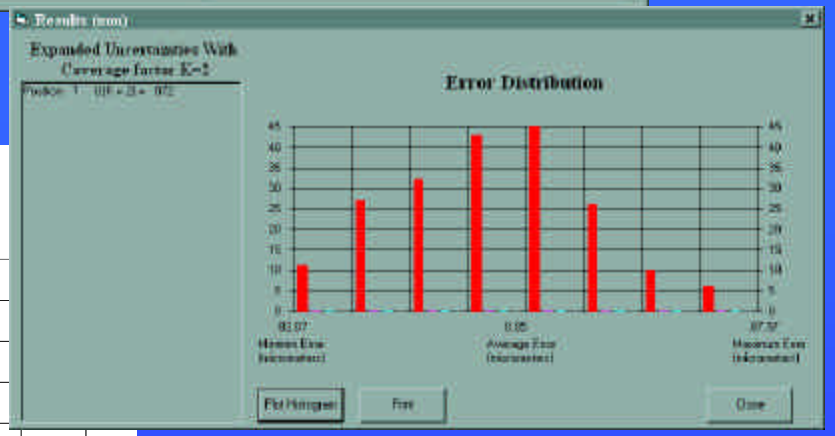
New Technologies

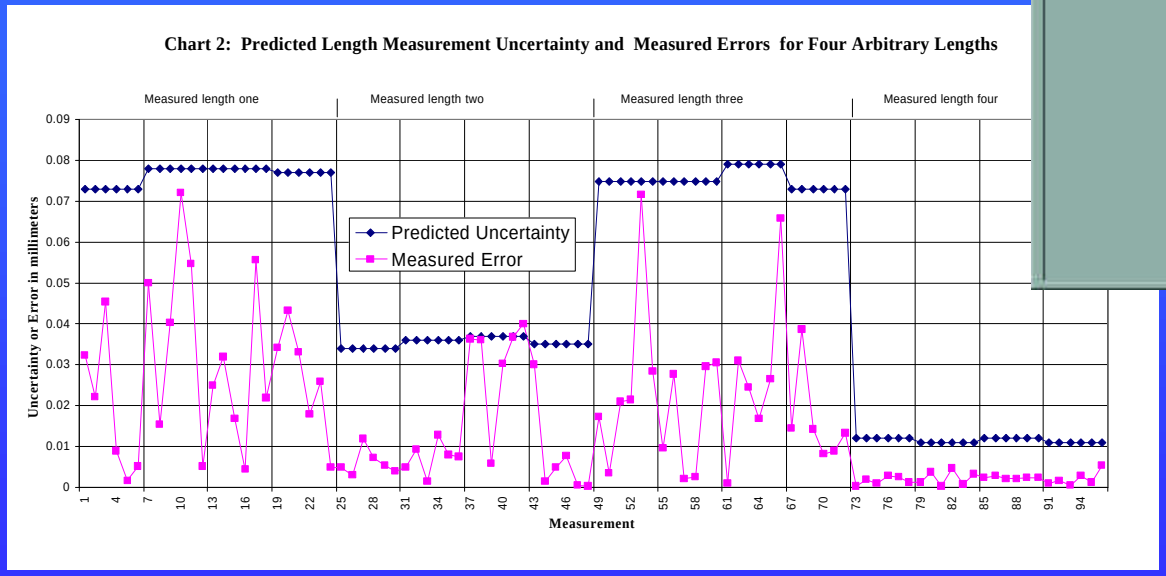
3D systems on the horizon

Laser Tracker

- *Developed alpha version software*
- *Performed verification testing of method*

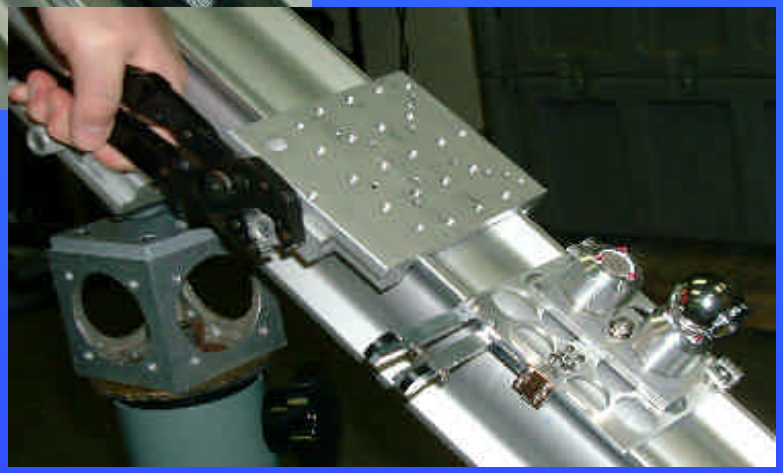


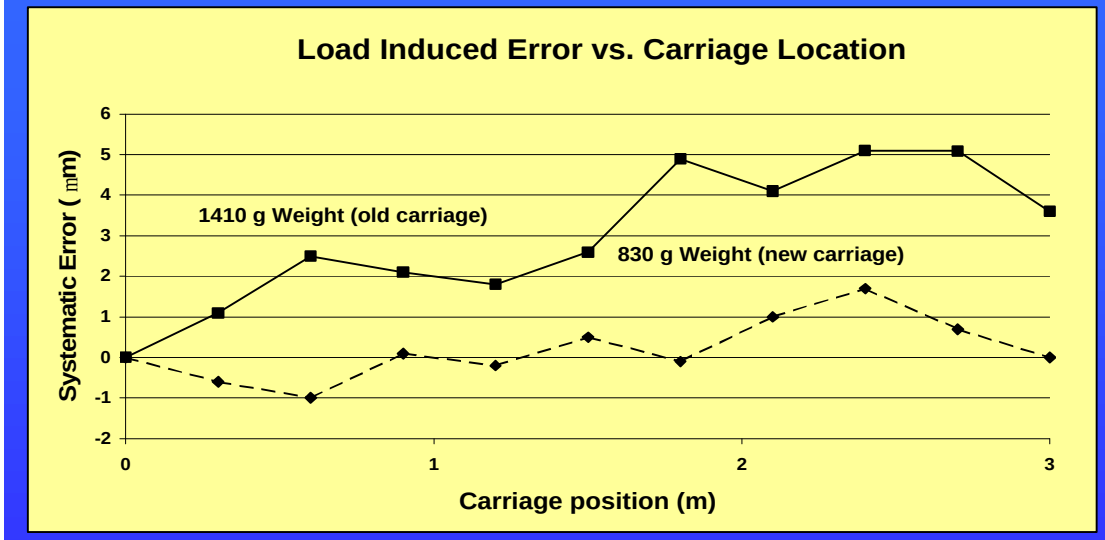




Laser Rail Calibration System (LARCS)

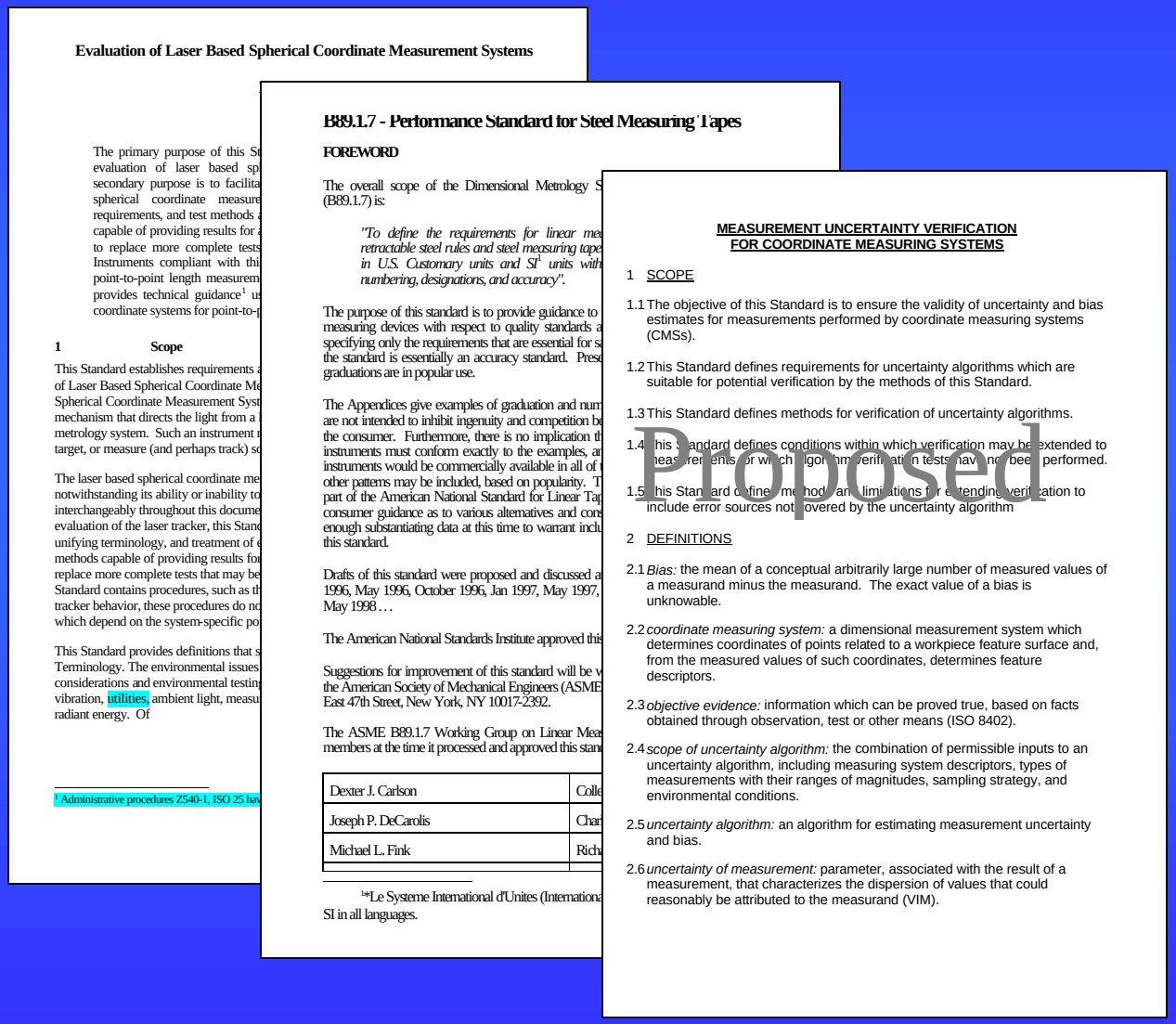
- ***Developed and tested a new carriage assembly***





Voluntary Standards

- *Performance standard for steel measuring tape*
- *Laser tracker standard*
- *CMM uncertainty standard*



Evaluation of Laser Based Spherical Coordinate Measurement Systems

The primary purpose of this St
evaluation of laser based sp
secondary purpose is to facilita
spherical coordinate measure
requirements, and test methods
capable of providing results for
to replace more complete tests
Instruments compliant with thi
point-to-point length measurem
provides technical guidance[1] u
coordinate systems for point-to-

1 Scope

This Standard establishes requirements
of Laser Based Spherical Coordinate Me
Spherical Coordinate Measurement Syst
mechanism that directs the light from a
metrology system. Such an instrument
target, or measure (and perhaps track) s

The laser based spherical coordinate me
notwithstanding its ability or inability to
interchangeably throughout this docume
evaluation of the laser tracker, this Stand
unifying terminology, and treatment of
methods capable of providing results fo
replace more complete tests that may be
Standard contains procedures, such as th
tracker behavior, these procedures do no
which depend on the system-specific po

This Standard provides definitions that
Terminology. The environmental issues
considerations and environmental testin
vibration, utilities, ambient light, measu
radiant energy. Of

[1] Administrative procedures Z540-1, ISO 25 ha

B89.1.7 - Performance Standard for Steel Measuring Tapes

FOREWORD

The overall scope of the Dimensional Metrology S
(B89.1.7) is:

*"To define the requirements for linear me
retractable steel rules and steel measuring tape
in U.S. Customary units and SI[1] units with
numbering, designations, and accuracy".*

The purpose of this standard is to provide guidance to
measuring devices with respect to quality standards a
specifying only the requirements that are essential for s
the standard is essentially an accuracy standard. Prese
graduations are in popular use.

The Appendices give examples of graduation and num
are not intended to inhibit ingenuity and competition be
the consumer. Furthermore, there is no implication th
instruments must conform exactly to the examples, ar
instruments would be commercially available in all of t
other patterns may be included, based on popularity. T
part of the American National Standard for Linear Tap
consumer guidance as to various alternatives and cons
enough substantiating data at this time to warrant inclu
this standard.

Drafts of this standard were proposed and discussed a
1996, May 1996, October 1996, Jan 1997, May 1997,
May 1998 …

The American National Standards Institute approved this

Suggestions for improvement of this standard will be v
the American Society of Mechanical Engineers (ASME
East 47th Street, New York, NY 10017-2392.

The ASME B89.1.7 Working Group on Linear Meas
members at the time it processed and approved this stan

Dexter J. Carlson	Colle
Joseph P. DeCarolis	Chai
Michael L. Fink	Richa

[1]Le Systeme International d'Unites (Internationa
SI in all languages.

MEASUREMENT UNCERTAINTY VERIFICATION
FOR COORDINATE MEASURING SYSTEMS

1 SCOPE

1.1 The objective of this Standard is to ensure the validity of uncertainty and bias estimates for measurements performed by coordinate measuring systems (CMSs).

1.2 This Standard defines requirements for uncertainty algorithms which are suitable for potential verification by the methods of this Standard.

1.3 This Standard defines methods for verification of uncertainty algorithms.

1.4 This Standard defines conditions within which verification may be extended to measurements for which algorithm verification tests have not been performed.

1.5 This Standard defines methods and limitations for extending verification to include error sources not covered by the uncertainty algorithm

2 DEFINITIONS

2.1 *Bias:* the mean of a conceptual arbitrarily large number of measured values of a measurand minus the measurand. The exact value of a bias is unknowable.

2.2 *coordinate measuring system:* a dimensional measurement system which determines coordinates of points related to a workpiece feature surface and, from the measured values of such coordinates, determines feature descriptors.

2.3 *objective evidence:* information which can be proved true, based on facts obtained through observation, test or other means (ISO 8402).

2.4 *scope of uncertainty algorithm:* the combination of permissible inputs to an uncertainty algorithm, including measuring system descriptors, types of measurements with their ranges of magnitudes, sampling strategy, and environmental conditions.

2.5 *uncertainty algorithm:* an algorithm for estimating measurement uncertainty and bias.

2.6 *uncertainty of measurement:* parameter, associated with the result of a measurement, that characterizes the dispersion of values that could reasonably be attributed to the measurand (VIM).

Proposed

NSRP (Formerly MARITECH)

- ***Identified and tested advanced metrology system for reverse engineering at Atlantic Marine, Mobile, AL***
- ***Currently at a stand still***

Measurement Services

- *Tapes and steel scales*
- *Hosted NSWCC propeller measurement demonstration*
- *Chaired Large Millimeter (LMT)Telescope metrology panel*

- **1 Measuring tape per week**
- **1 Scale per month**

The LMT will be installed on Cerro La Negra, one of the highest peaks of Central Mexico, in the state of Puebla, at 4,640 meters above sea level.

The LMT will have a primary reflector diameter of 50-meters. The overall surface accuracy for the LMT/GTM is 75microns. The primary surface is a parabola of revolution with a diameter of 50 m and a focal length of 17.5m. The primary surface consists of 5 rings of panels each approximately 3 by 5 m in size. The local radius of curvature varies from 35 m for the inner (#1) ring to 65 m for the outer (#5) ring. Each panel will be fabricated with a 15 microns rms surface accuracy.

CMM Installation and Testing

- *June FY00 CBD Solicitation*
- *Aug. FY00 Six bids evaluated*
- *Sept. FY00 Resource Eng. Inc. awarded contract*
- *Oct. FY01 Delivery date announced*
- *Jan FY01 Infrastructure Improvements started*

Old CMM.

- **The machine is wearing out mechanically.**
- **Obsolescence- this machine does not use the latest technology.**
- **Maintenance problems are accentuated by the fact that some of the suppliers of component parts are no longer in business**
- **Incompatibility with shop floor state-of-the-art.**
- **This machine is no longer typical of industrial machines**