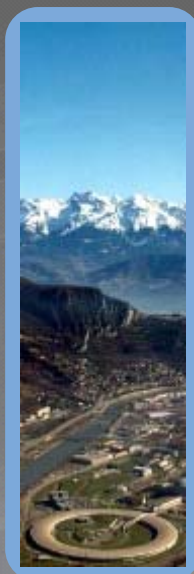


Instrument Calibration at the ESRF

D. Martin

- The European Synchrotron Radiation Facility (ESRF),
- Spherical Measurement Systems,
- Angle and distance calibration at the ESRF,
- Uncertainty and calibration results,
- Summary.

Introduction

- The European Synchrotron Radiation Facility (ESRF) is located in Grenoble, France.
- It is a joint facility supported and shared by 18 European countries.
- It operates the most powerful synchrotron radiation light source in Europe.

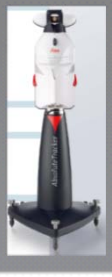
Synchrotron Radiation Science

- Many questions in modern science cannot be answered without knowledge of the intimate details of the structure of matter;
- Synchrotron radiation light sources are particle accelerators;
- They can be compared to "super microscopes" revealing invaluable information in numerous fields of research.

FOR THE ESRF TO WORK, ALIGNMENT IS OF CRITICAL IMPORTANCE.

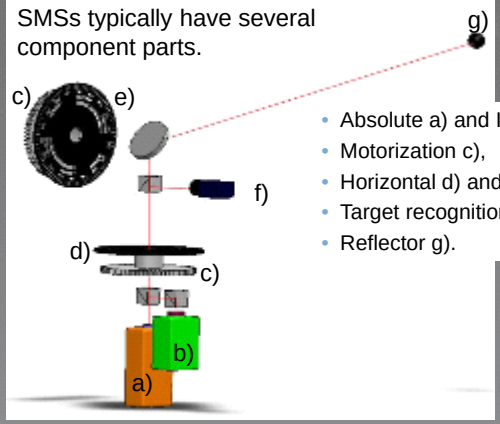
Spherical Measurement Systems
Robotic Total Stations and Laser Trackers

- Spherical Measurement Systems (SMSs) are a family of instruments composed of Robotic Total Stations (RTSs) and Laser Trackers (LTs).
- They determine three dimensional point coordinates by measuring two orthogonal angles (horizontal and vertical) and a distance to a Spherically Mounted Retro-Reflector (SMR).



SMS Component Parts

SMSs typically have several component parts.



- Absolute a) and Interferometric b) distance meters,
- Motorization c),
- Horizontal d) and Vertical e) angle encoders.
- Target recognition system f)
- Reflector g).

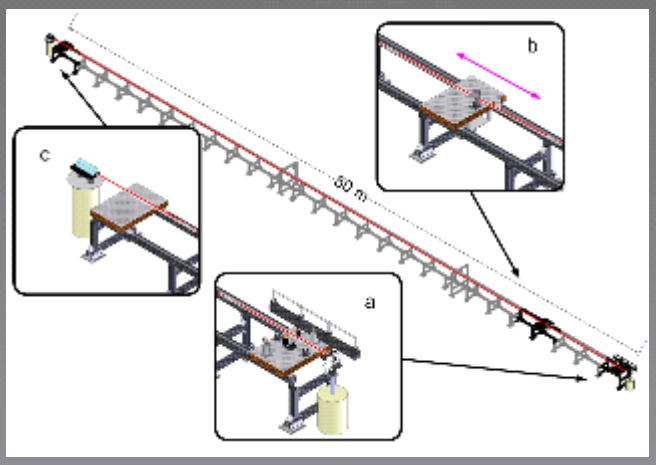
A comprehensive understanding of the behavior of these component parts is essential to improve upon their results.

Distancemeter Calibration Bench

The ESRF has an internationally recognized COFRAC accredited Distance meter Calibration Bench for SMS instruments.

Under the ISO17025
Standard
Accreditation Number 2-1508

Distancemeter Calibration Bench



Distancemeter Calibration Bench

IFM

Interferometric Distance Meter

(Laser Tracker)

ADM

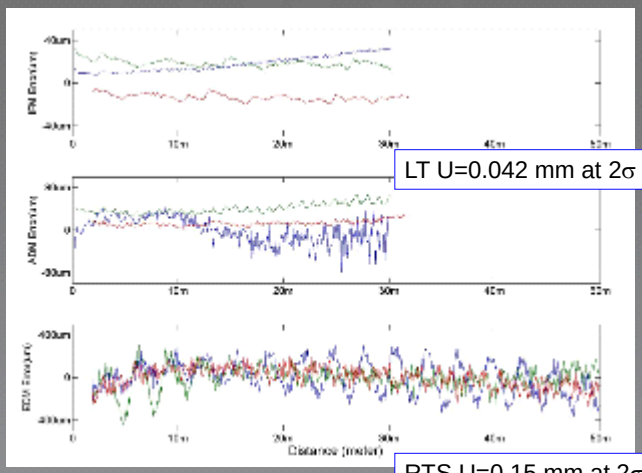
Absolute Distance Meter

(Laser Tracker)

EDM

Electronic Distance Meter

(Robotic Total Station)



LT U=0.042 mm at 2σ

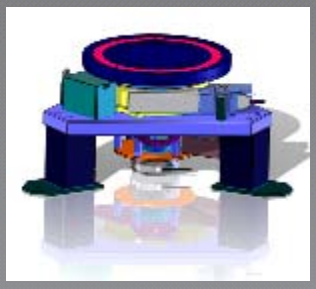
RTS U=0.15 mm at 2σ

Angle Calibration

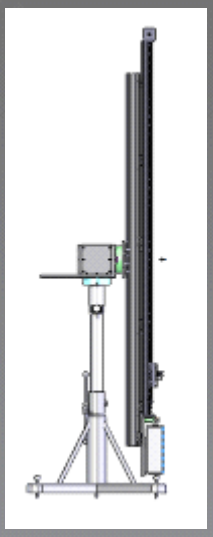
At the ESRF two instrument standards have been developed to calibrate horizontal and vertical angles issued from SMS instruments:

- The Horizontal Circle Comparator (HCC);
- The Vertical Circle Comparator (VCC).

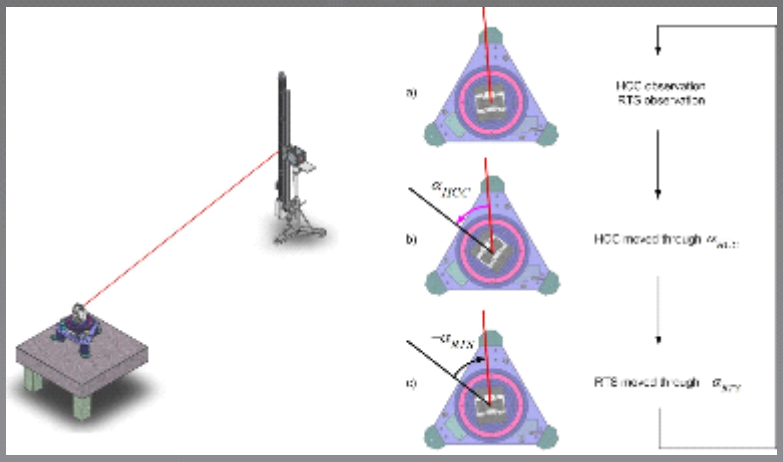
HCC



VCC

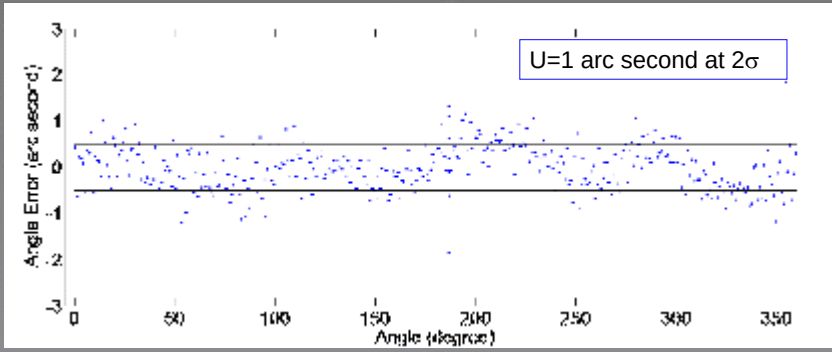


Angle Calibration using the HCC and VCC

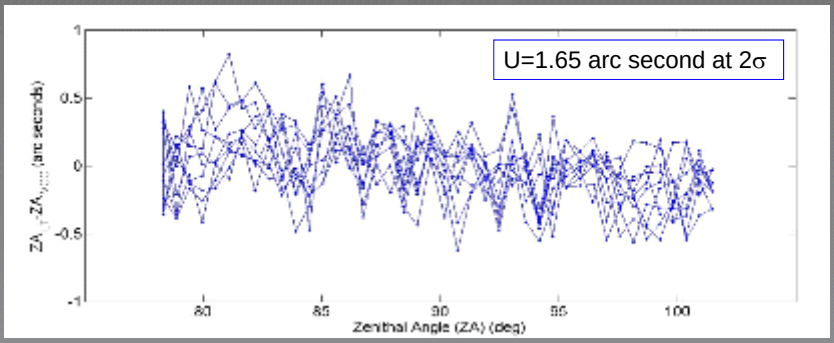


Angle Calibration using the HCC and VCC

Horizontal Angle Calibration



Vertical Angle Calibration



Summary - Calibration at the ESRF

- It is important for surveyors to have a clear understanding of the performance their instrumentation;
- Calibration can provide the means to correct systematic instrument errors;
- Calibration provides confidence and traceability of the results issued from instruments;
- A full accredited calibration suite of instrument standards exist at the ESRF for distances and angles issued from RTS and LT instruments.

Under the ISO17025 Standard
Accreditation Number 2-1508

U_{DCB}=0.15 mm at 2σ

U_{HCC}=1 arc second at 2σ

U_{VCC}=1.65 arc second at 2σ