



The European Light Source

Standards, Best Practice, Testing and Calibration in Global Navigation Satellite System (GNSS)

Outline

- Introduction
- Standards in Surveying
- Best Practice in GNSS
- Testing & Calibration in GNSS
- Review of ISO17123 Part 8
- Conclusion

The ESRF

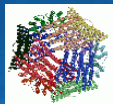


The European Synchrotron Radiation Facility (ESRF) is located in Grenoble, France
 It is a joint facility supported and shared by 18 European countries.
 It operates the most powerful synchrotron radiation light source in Europe.
 For this complex machine to function correctly, alignment is of critical importance.

Science at the ESRF (What is a synchrotron?)



Biology. Concentrating on proteins
Chemistry. Ultra-rapid reactions
Medicine. The inside story
Earth science. Our mysterious planet
Physics. Small is especially beautiful
Materials. Smart stuff
Environment. Maintaining a natural balance
Industry. Tomorrow's technology



The thirst for knowledge drives us to explore the world around us. Some legitimate questions include :

- what is our planet made of?
- what are the processes that sustain life?

Most of these questions cannot be answered without a profound knowledge of the intimate details of the structure of matter. To help in this quest, scientists have developed ever more powerful instruments capable of resolving the structure of matter down to the level of atoms and molecules.

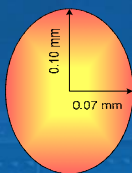
Synchrotron radiation sources, which can be compared to "super microscopes", reveal invaluable information in numerous fields of research. There are about 50 synchrotrons in the world being used by an ever growing number of scientists.

Alignment at the ESRF

Level closure over the 850 m circumference is less than 0.15mm

Point height uncertainty at 2σ (i.e. 95% confidence) is 0.08 mm

Planimetric error ellipse parameters over the 850 m circumference are:
 Semi-major axis 0.10 mm
 Semi-minor axis 0.07 mm



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

The ESRF ALignment and GEodesy (ALGE) group is responsible for the installation, control and periodic realignment of the ESRF accelerators and experiments. Alignment tolerances are typically less than one millimeter and often in the order of several micrometers.

Alignment at the ESRF



To achieve these results we must get the most we can out of our instruments.

One very important component in alignment at the ESRF is instrument verification and calibration.

Instrument calibration is an integral part of the ESRF alignment group activity.

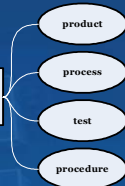


The ESRF has an internationally recognized calibration laboratory with a French accreditation authority COFRAC accreditation for EDM and Laser Tracker distance meter instruments.

Under the ISO17025 Standard
 Accreditation Number 2-1508

Standards in Surveying

Best
 Criteria



What is a Standard?

A standard is a rule or requirement that is determined by a consensus opinion of users.

It prescribes the accepted and (theoretically) the best criteria for a product, process, test, or procedure.

The benefits of a standard are safety, quality, interchange ability of parts or systems, and international consistency.



Benefits



Standards in Surveying



Clients want the most from what they pay for.

Legislative authorities as well as private and public companies require confidence that the services rendered are in conformity with globally accepted best practice rules.

Generally this involves the application of internationally recognized standards.

Surveyors as professionals must fulfill certain legal, regulatory and/or accuracy requirements for their clients.

Typically they will strive to do this in an optimal cost effective way using the most appropriate equipment for the job at hand.

Naturally this requires a good understanding and assurance in the people and instrumentation employed.

Standards in Surveying

What Standards apply to the Surveying Community?

ISO (International Organization for Standardization) is the world's leading developer of International Standards required by business, government and society.

Several ISO standards are applicable to the Geomatics profession:

- The ISO 19XXX family (digital geographic information),
- Of particular interest is ISO 19111 - Spatial referencing by coordinates (i.e. geodesy)
- ISO17123 parts 1 through 8,
- Of particular interest is part 8 "GNSS field measurement systems in real time kinematic (RTK)",
- ISO9000 (quality management).



Best Practice in GNSS

What is Best Practice?



Most Effective

Most Efficient

Best Practice is a management idea which asserts that there is a technique or method that is more effective and efficient than any other.

Fewer Problems

It maintains that with proper processes, checks, and testing, a desired outcome can be delivered with fewer problems and unforeseen complications.

Repeatable

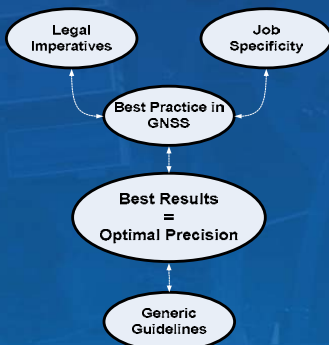
Best practice is generally based on repeatable procedures that have proven themselves over time for large numbers of people.

Evolutive

Best practice can be expected to evolve as new information, instrumentation and methodology becomes available.

Best Practice in GNSS

What is Best Practice in GNSS?



Best practice in surveying and GNSS in particular may be colored by some very job specific aspects.

There may be legal imperatives that influence what is the best practice approach to a job.

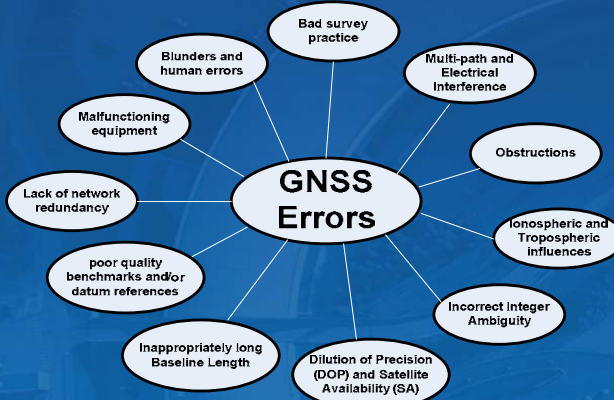
Nevertheless, normally an important objective in a survey is to get the best possible results

This is typically synonymous with the highest attainable precision.

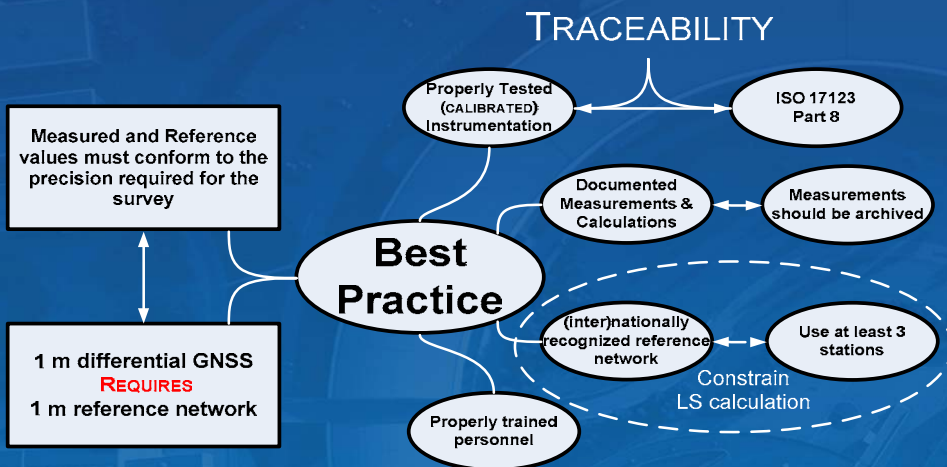
There are several commonly accepted generic guidelines for GNSS to achieve optimal measurement results.

Best Practice in GNSS

These guidelines typically minimize the errors associated with GNSS measurements



Best Practice in GNSS: Guidelines



Testing and Calibration



Field Testing

Testing is intended to verify the suitability of a particular instrument for the required application at hand, and to satisfy the requirements of best practice standards.

The instrument uses its own measurements to qualify and quantify its performance.

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Calibration

Calibration links the instrument by comparison directly to international reference standards and ensures traceability.

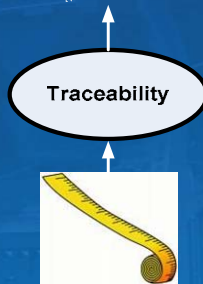
Standard: an instrument or method that will measure more accurately and precisely the desired quantity than the measuring instrument itself

Traceability

The NPL 633 nm iodine stabilised laser system shown above can approach a reproducibility of 1 part in 10^7 .



... NIST F1, the world's best clock (as of Sept. 2005). The clock uses a fountain-like movement of cesium atoms to determine the length of the second so accurately that if it were to run continuously it would neither lose nor gain one second in 60 million years.

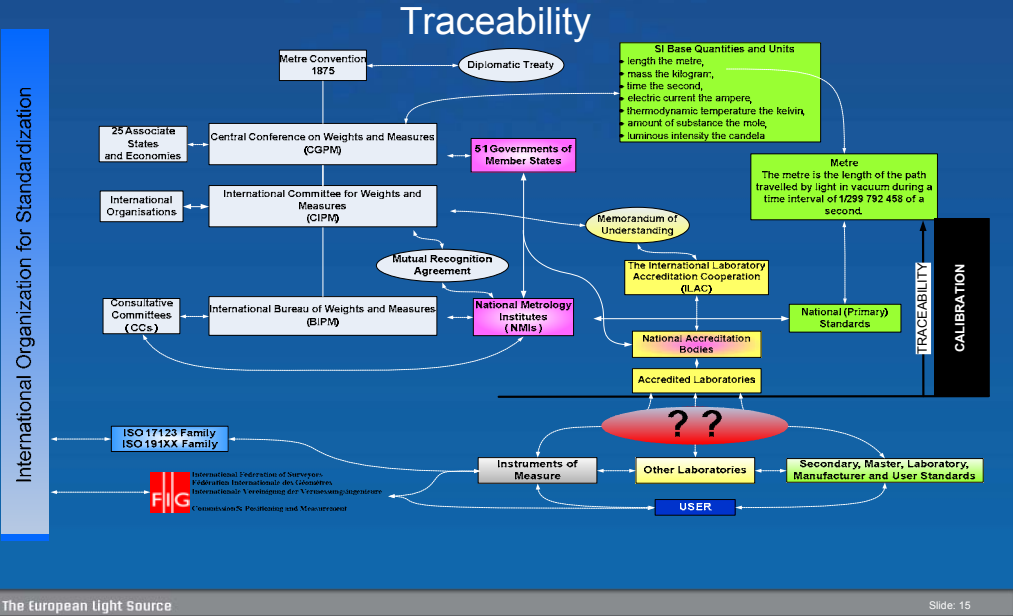


One of the pillars of instrument calibration and all legal metrology is the notion of traceability.

Traceability is a method of ensuring that a measurement (even with its uncertainties) is an accurate representation of what it is trying to measure.

With traceability, it is possible to demonstrate an unbroken chain of comparisons that ends at a national metrology institute (NMI).





ISO17123 part 8 GNSS field measurement systems in real time kinematic (RTK)



September 15 2007

This standard specifies field procedures to be adopted when determining and evaluating the precision (repeatability) of Global Navigation Satellite System (GNSS) field measurement systems (this includes GPS, GLONASS as well as the future systems like GALILEO) in real-time kinematic (GNSS RTK) and their ancillary equipment when used in building, surveying and industrial measurements.

Primarily, these tests are intended to be field verifications of the suitability of a particular instrument for the required application at hand, and to satisfy the requirements of other standards.

They are not proposed as tests for acceptance or performance evaluations that are more comprehensive in nature.

Conclusion

