



SOMMACT Self Optimising Measuring MACHine Tools

Grant Agreement no.: **CP-FP 229112-2**

Start Date: 2009-09-01

Duration: 36 month



SOMMACT

Partners:

ALESAMONTI S.r.l. (IT) - Project Coordinator

API VARESE (IT)

FIDIA S.p.A. (IT)

HAVLAT GmbH (DE)

IBS PE BV (NL)

INRIM (IT)

ISM-3D SL (SP)

KOVOSVIT MAS AS (CZ)

SUPSI (CH)

TTS S.r.l. (IT)

University of Huddersfield (UoH) (UK)

WEISS GmbH (DE)

Deliverable D3.1

Study on possible reference structures

Document title: **D3_1_Ref_Struct_Draft.doc**

Reference WP/Task: **WP3 / T3.1**

Lead Task beneficiary: **ISM-3D**

Author: **Eugen TRAPET**

Date: **2010-07-03**

Revision: **00**

Status: **Draft** Final

Nature ¹⁾: **R**

Dissemination level ²⁾: **RE**

1) **R** = Report, **P** = Prototype, **D** = Demonstrator, **O** = Other

2) **PU** = Public, **PP** = Restricted to other programme participants, **RE** = Restricted to a group specified by the consortium, **CO** = Confidential, only for members of the consortium



Executive summary

A study has been performed, reviewing the known reference structures for

- full geometry error assessment,
- re-assessment to tune low order terms of these errors, and for finding
- the possibility to be integrated into the machines.

A short validation of these methods for the purposes of SOMMACT was made.

While for the full error assessment many suited methods exist, the re-tuning approaches still require optimization of the reference structures, the measurement processes and the error “injection” into the CNC correction file structure.

Re-tuning shall allow for process intermittent on the machine measurement.

Most existing reference structures are made for coordinate measuring machines; thus adaptation is still required for machine tools (robustness of the structures and fixturing).

For the reference objects serving for re-tuning, suggestions are made (flexible tetrahedron, ball bar, flexible 3-ball plate and 4-ball plate with calibrated height adaptor).

The machine integration requires completely different structures.

Such structures are suggested here in a generic form, even though they vary from machine to machine. Electronic levels are one suggestion, the 6 dof extensometer beam another, and the 1D extensometer yet another.



Table of contents

Executive summary.....	2
1 Introduction	4
2 Task	5
3 External reference structures	7
3.1 1D reference structures	7
3.2 2D reference structures	19
3.3 3D reference structures (3D in calibration and in arrangement of the probed elements) ..	27
4 The use of process intermittent measurements, using simple reference structures	32
5 Machine integrated reference structures.....	36
5.1 1D reference structures (machine integrated).....	36
5.2 Approaches using 1D, 2D and 3D extensometers to measure machine deformations and to calculate low order error corrections	40
5.3 Machine integrated multiple degrees of freedom reference structure	43
5.4 The use of electronic levels	47
5.4.1 Electronic level as integral part of a horizontal reference structure.....	48
5.4.2 Electronic level in form of a taut wire as a reference structure.....	48
6 Conclusions.....	50
6.1 Fundamental error assessment.....	50
6.1.1 Ball beam 3D with self-centring probe.....	50
6.1.2 Ball beam 2D with camera sensor.....	50
6.1.3 Laser tracer, laser tracker, other optical systems.....	50
6.1.4 Ball plate 2D with self-centring probe	50
6.1.5 Ball plate 2D with camera sensor	50
6.2 Error re-tuning by user.....	50
6.2.1 Ball tetrahedron 3D with self-centring probe	50
6.2.2 Ball plate 2D with self-centring probe	50
6.2.3 Ball beam 1D, 2 balls with self-centring probe	50
6.3 Integrated reference structures	50
6.3.1 Improved scales (zero CTE), improved assembly of scales (multiple, fixed thermo-mechanically corrected)	50
6.3.2 Electronic levels,	50
6.3.3 Extensometer Bars up to 6D (different designs)	50
6.3.4 Extensometer bars 1D.....	50