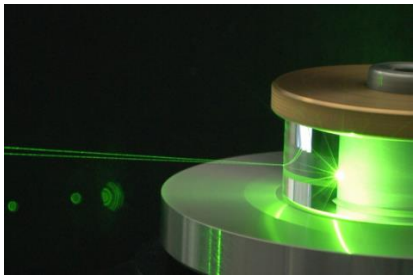
Turntable System

a)

b)



c)

d)

Fig. 1: Turntable System (a) with detailed views of Turntable (b), calibrated glass cylinder without (c) and with cover plate (d)

Overview

The ILA-Turntable System (see Fig. 1) is a velocity standard developed by ILA R&D in collaboration with the German National Metrology Institute (PTB-Braunschweig) for the calibration of LDV probes. LDV systems can be used for high-precision velocity measurements and also as a reference standard for the calibration of other velocity probes.

The velocity $\boldsymbol{v_{LDV}}$ is calculated from the measured Doppler frequency $\boldsymbol{f_D}$ and the constant fringe distance $\boldsymbol{\Delta x}$ of the interference fringe pattern in the measuring volume.

$$\boldsymbol{v_{LDV} = \Delta x * f_D}$$

While the theoretical fringe distance can be calculated, the actual fringe distance may deviate due to a multitude of influencing factors in the assembly of the probe. Therefore it has to be calibrated. The Turntable System calculates the surface velocity of the rotating glass cylinder with counted impulses, measured time and the exact known radius of the glass cylinder (Fig. 1, c). With these data the velocity of particles sticking on the surface of the glass cylinder can be calculated and compared to the measured velocity of the LDV. This allows the calculation of the actual fringe distance by the measured Doppler frequency and the measured particle velocity on the surface.

$$\boldsymbol{\Delta x} = \frac{v}{\boldsymbol{f_D}} = \frac{\omega * r}{\boldsymbol{f_D}} = \frac{2\,\pi * n * r}{\boldsymbol{f_D}}$$

Because the fringe distance is changing over the length of the measuring volume the probe can be moved by a traversing unit to measure the fringe distance on different positions inside the measuring volume (see Fig. 2).

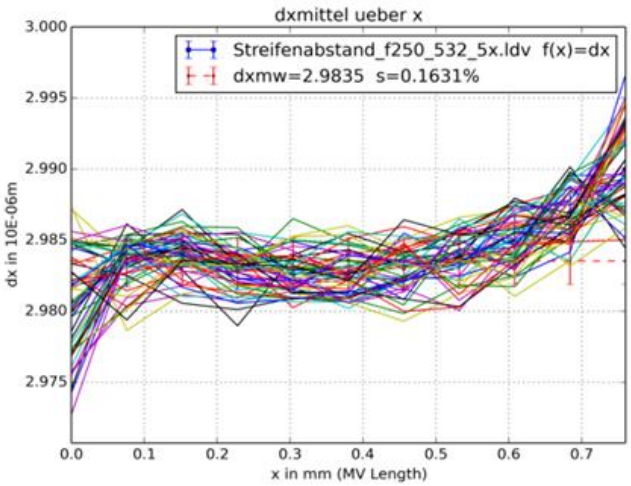


Fig. 2: Distribution of the fringe distances inside the measuring volume of an ILA-fp50 Probe measured with an ILA-Turntable System.

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Figure 3 shows the general design of the turntable design. A glass cylinder, manufactured with high precision, is mounted on a spindle and fixed with a securing disc. The spindle is driven by a servomotor, connected with a specially designed magnetic clutch. The glass cylinder can be covered from the top. An incremental angular measuring device counts the rotation number on the output side of the magnetic clutch and is connected to a timer card. An encoder simultaneously reads the time of a zero-impulse for reference and of single impulses. The motor rotation number is controlled with the ILA R&D TurntableRocker-Software and a controller. The uncertainty of the ILA-Standard is between 0,05% and 0,1% depending of the chosen turntable components and according to the PTB-Braunschweig laboratory report.

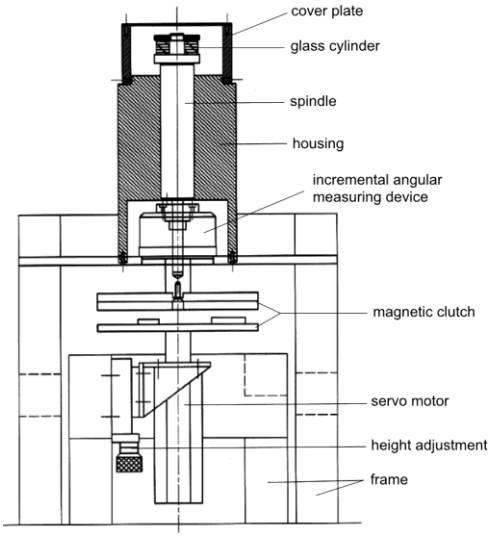

Fig. 3: General design of the ILA-Turntable

The ILA-TurntableRocker software (Fig. 4) offers the complete package from one source. As mentioned before, it allows the control of the motor, and therefore the adjustment of the glass cylinders surface velocity. It also includes the analysis and evaluation of measurement. A visualization module shows the rotation number in real time over a definable section. Advanced users can adjust many set values, i.e. for the motor control, rotation measurement and mechanical dimensions.

If you are using the ILA-TurntableRocker software together with the LDA Evaluation Software ILA-LDA Control Qt you can set them to a master-slave relationship and calibrate your system directly within the LDA Control Qt software.

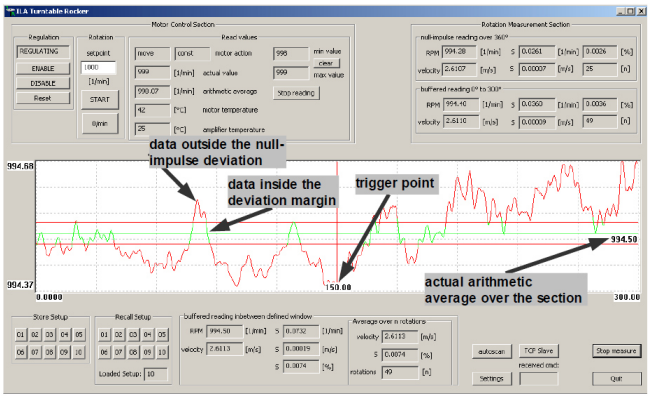

Fig. 4: Visualization of the ILA-TurntableRocker software

Specifications

Turntable

Dimensions	640 x 378 x 378 mm
Expected uncertainty	0.05% to 0.1%

Encoder

Zero-impulse	1 per rotation
Single impulse	18000 per rotation

Timer card

Clock	$20 * 10^{6}$ Hz ± $25 * 10^{-6}$ Hz

Rotating glass cylinder

Diameter	50 mm ±1 mm, incl. calibration certificate of exact diameter with uncertainty of1 µm

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