ILA R&D GmbH Research and Development

Turntable system

(a) (b) (c)

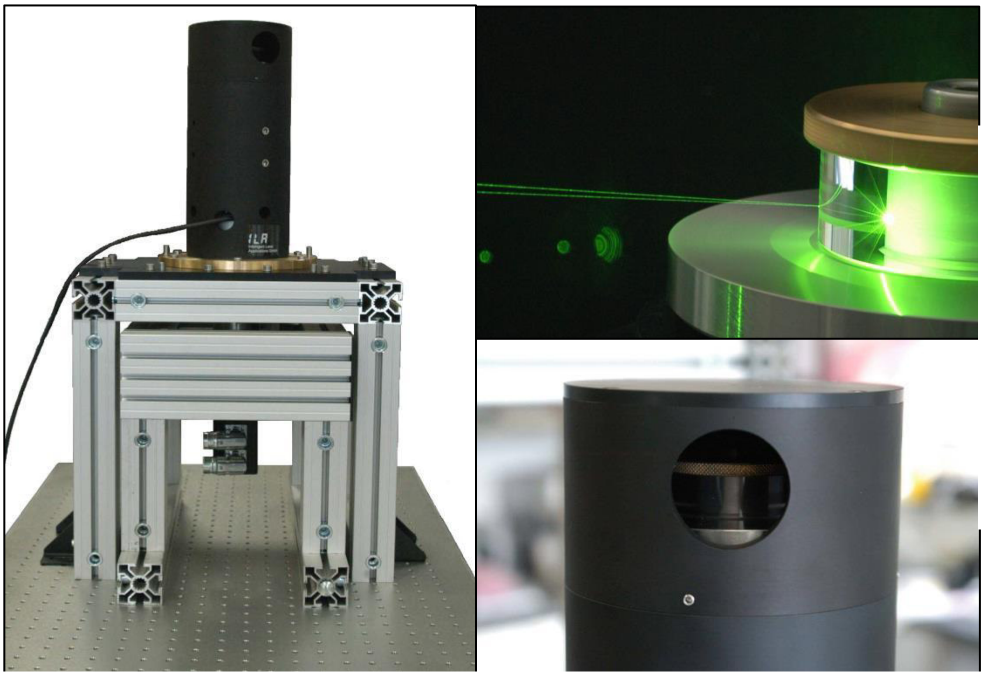

Fig. 1: Turntable system (a) with detailed views of the glass cylinder without (b) and with cover plate (c)

The turntable system (Fig. 1) is a metrological velocity standard developed by ILA R&D and the german metrological institute PTB Braunschweig for the calibration of LDV probes. An LDV system 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 $\Delta\boldsymbol{x}$ of the interference fringe pattern in the measuring volume.

$$\boldsymbol{v_{LDV}} = \Delta\boldsymbol{x} * \boldsymbol{f_D} \quad (1)$$

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 the exact known radius of the cylinder. It depicts the then known surface velocity v of the glass cylinder and compares it to the velocity measured with the LDV system. This allows the calculation of the actual fringe distance.

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

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The complete measuring volume can be calibrated by traversing the LDV probe in two directions with linear stages.

Figure 2 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 against reflections 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. The 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. In the theoretical worst case scenario the maximum relative measurement uncertainty of the turntable system adds up to ±0,023 % at 22 °C.

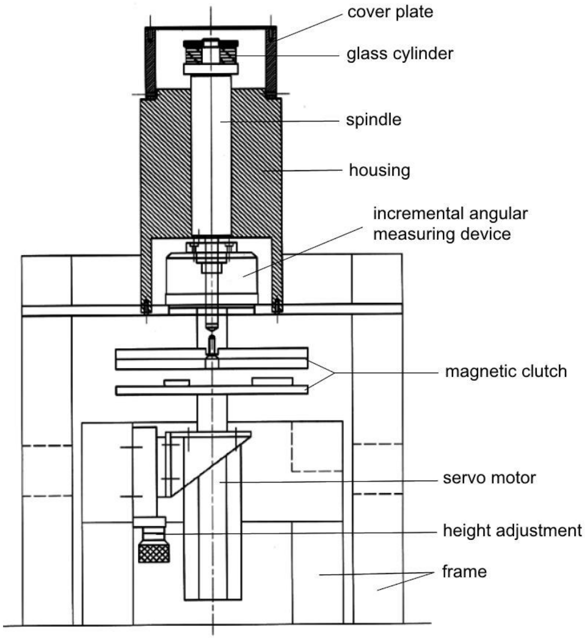

Fig. 2: General design of the turntable system

This includes the following uncertainties:

- Triggering (Error≈0)
- Incorrect zero-impulse measurement (Error ≈ $1{,}25 * 10^{-6}$ for n= 3000 u/min)
- Circumferential Velocity (Error ≈ $1{,}628 * 10^{-4}$)
- Timer card (Error ≈ $2{,}34 * 10^{-4}$)

The complete measurement uncertainty is estimated at ±0,05 %.

The TurntableRocker-Software (as seen in fig. 3) 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.

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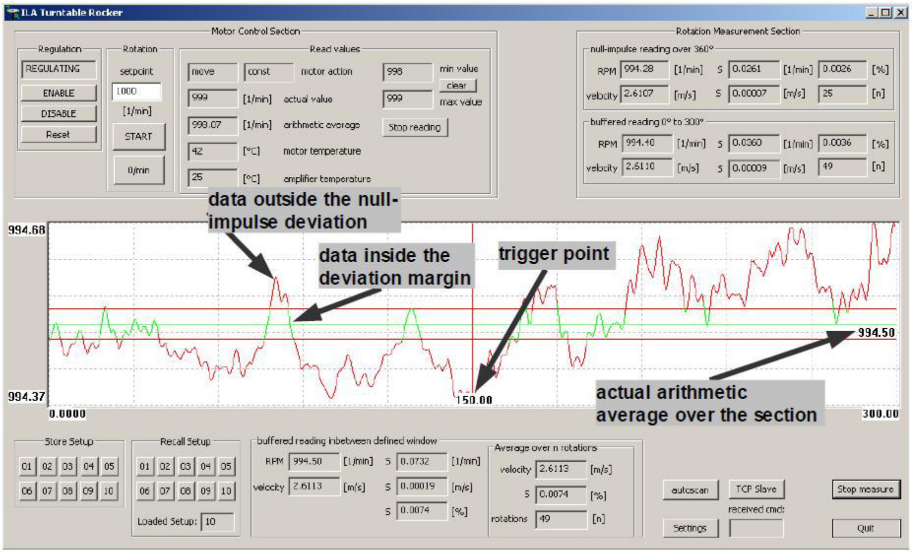

Fig. 3: Visualization of the TurntableRocker-Software

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

Specifications

Dimensions	640 x 378 x 378 mm
Relative measurement uncertainty	±0,05 %

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	50mm /±1mm

(measured with uncertainty of 1µm)

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