One of the most fascinating applications of lasers is the set-up of a laser gyroscope. This absolute measurement system is a very important tool in daily life: navigation in airplanes and ships, alignment of telescopes, survey of landscapes and high precision rotation measurements to name only a few. The educational kit demonstrates to students the optical and mechanical components of a laser gyroscope as well as the practical work of alignment and measurement of such a system. The gyroscope is an active laser gyroscope and contains a ring laser consisting of an open frame He-Ne tube and a triangular resonator. The whole ring laser is set up on a motorized rotational platform. The rotational velocity can be varied allowing to the dynamic range of the Gyroscope to be investigated. Counter-rotating modes of the ring laser are coupled out and are superimposed for demonstration and measurement of the Sagnac effect. The resulting interference is detected and electronically converted to a frequency proportional to the rotational velocity. The lock-in threshold is determined by variation of the rotation frequency. Single mode operation is achieved by an etalon mounted in the ring resonator. For the experiments a 100 MHz oscilloscope is required and can be offered by eLas optionally.

**Educational Objectives of Investigation**

- HeNe Ring Laser
- Ring Laser Modes
- Interference
- Single Mode Etalon
- Sagnac Effect
- Mode Lock-in
- Measurement of Rotation
- Dynamic Range
Setup and Components

1. Ring laser setup with HeNe laser tube, resonator mirrors, single mode etalon and detection unit
2. Amplifier and comparator for the detector signals
3. HeNe power supply
4. Rotation stage
5. Controller for the rotation stage with Joy-Stick
6. Adjustment laser for the resonator alignment
7. Frequency counter (not shown)
8. Optics cleaning set (not shown)
9. User manual (not shown)

Ordering Information

For ordering the Laser Gyroscope kit (CA-1310) use ordering number: 490091310
Measurements and Handling

Some of the possible measurements are presented in the following list:

- **Alignment of the ring laser system**
  
  The Laser gyroscope consists of a ring laser which is formed by a He-Ne laser tube and three resonator mirrors. The gyroscope is mounted on a base plate, which can be rotated by a rotating turntable of high precision. The first task of the experiment is to adjust the ring laser and bring the laser to operation. Mode selection is achieved by a single mode etalon, inserted in the ring laser beam path.

- **Adjustment and detection of the output signals**
  
  In a next step the two counter propagating signals of the ring laser are brought to interference. The interference signals are detected, amplified, forwarded to a comparator and then a TTL signal is generated. Finally, the beat frequency is measured with a frequency counter.

- **Determination of the scaling factor**
  
  At the beginning of the measurements the scaling factor of the laser gyroscope has to be determined, which gives the relation between the measured signal frequency $v$ and rotational frequency $\omega$ of the gyroscope. For that the rotation table is driven with a series of increasing angular velocities. The slope of the resulting linear relation gives the desired scaling factor.

- **Lock-In threshold**
  
  For this measurement one selects a range of small angular speeds and lowers the velocity stepwise. Again, the measured frequencies plotted in a graph as a function of the angular speed result in a straight line which, however, does not go through the origin, but drops at a certain point down to zero. The rotation velocity at which the interference signal disappears is the lock-in threshold.