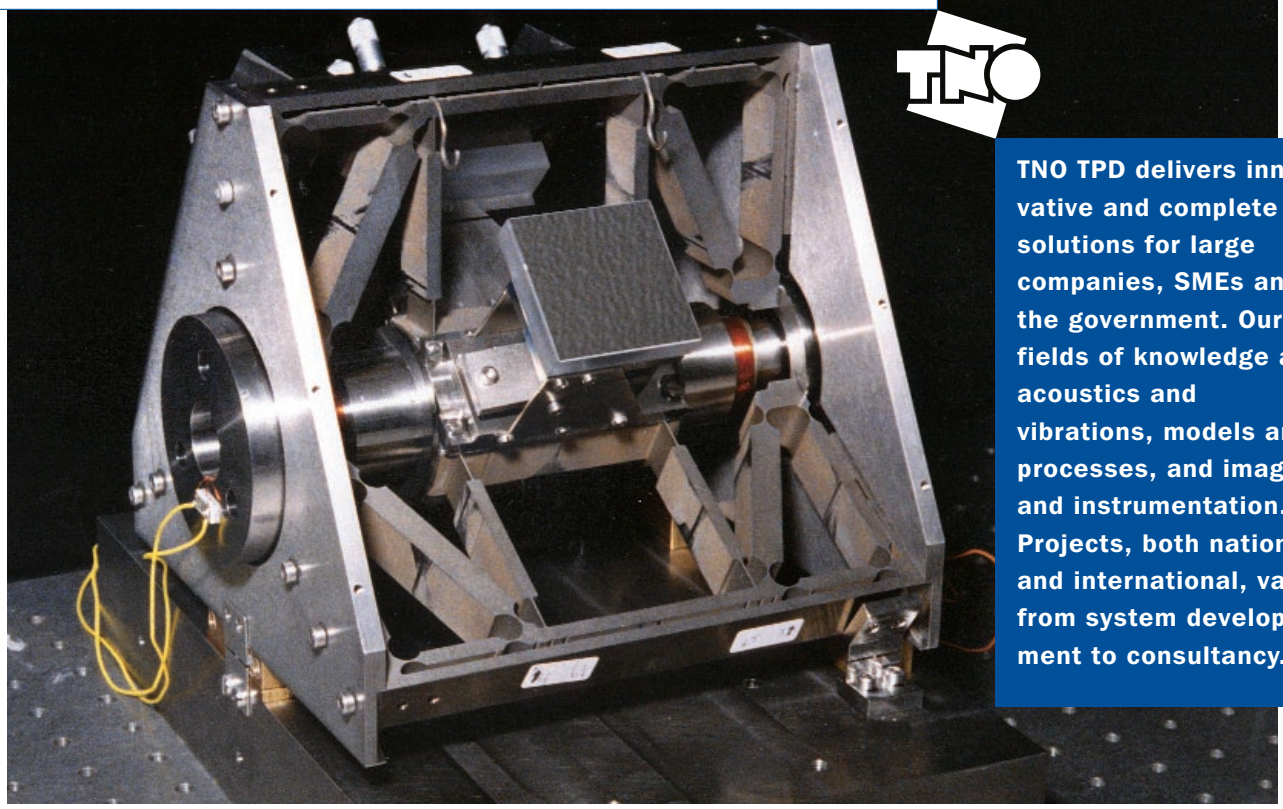
A linear guide with nanometer accuracy

ARCADE



TNO TPD delivers innovative and complete solutions for large companies, SMEs and the government. Our fields of knowledge are: acoustics and vibrations, models and processes, and imaging and instrumentation. Projects, both national and international, vary from system development to consultancy.

ARCADE (ARistoteles CAlibration DEvice) was developed for the on-board calibration of GRADIO, which is the core instrument of the Aristoteles satellite. GRADIO will measure the Earth gravity field with an accuracy of $5.10^{-5} m/s^2$ and a resolution of 100 km x 100 km at the Earth surface. GRADIO consists of four accelerometers mounted on a square plate of 0.9 m x 0.9 m.
The accelerometers are permanently calibrated by generating continuous (sinusoid) vibrations outside the measurement bandwidth. ARCADE is a specially developed linear guide system based on elastic elements. In ARCADE a mass of 0.76 kg moves with an amplitude of 3 mm and a maximum lateral deviation of 15 nm, while the required power is less than 2.5 Watt.

Specifications

- Stroke of moving mass
  6mm.
- Accuracy of moving mass motion
  maximum lateral deviation +/- 15 nm over +/- 3 mm stroke; maximum rotation $< 5\ \mu rad$.
- Power Consumption
  voice coil actuator < 2.5 Watt.
- Operating Temperature
  15° to 25°C was required, larger range feasible.
- Mass/dimensions
  mass 5.2 kg (moving mass 0.76 kg) dimensions 200 x 200 x 200 mm^3.
- Qualification status
  engineering model.

Features

- Negligible hysteresis
  all displacements are based on elastic deformations.
- Contactless voice coil actuator.
- Isostatic design
  no internal stresses/deformations due to thermal/manufacturing/ alignment effects.
- Symmetric approach
  ensures low sensitivity to manufacturing and thermal effects (thermal centre).
- Monolithic design
  stiff, strong, accurate interfaces, with good thermal/electrical conductance characteristics.
- Force compensation
  less power consumption.

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1964 - 1972
UV star spectrometer; telescope, spectrometer, gimbal systems and mechanisms
1969 - 1974
ANS (Dutch Astronomic Satellite); mirrors and shutter mechanisms
1974 - 1976
Leinax (Terrier-Sandhawk rocket experiment for X-ray detection); two mirror system
1976 - 1977
Hubble (Faint Object Camera); permanent magnet assembly for magnetically focused image intensifier
1984 - 1987
Hipparcos; refocusing mechanism for 'in-flight' adjustment of a modulating grid
1990 - 1993
Aristoteles gravitation mission (calibration mechanism); elastic linear guide system with 15 nanometer lateral motion (6 mm stroke)
1992 - 1995
Optical Aperture Synthesis Technologies study; interferometry test-bed, delay lines
1993 - 1997
Payload Interfaces for External Robotic Servicing (PIERS); mechanical interfaces for 'in-orbit' robotic manipulation of space instruments
1994 - 1995
ATLID; detector module for use in 'atmospheric LIDAR' experiment
1995 - 2000
DARWIN; long stroke optical delay line
1995 - now
Meteosat Second Generation; refocusing mechanism for the SEVIRI instrument
1998 - 1999
GAIA; test-bench for measurement of picometer changes in optical path length
1999 - 2000
EUCLID; beam steering
2000
Meteosat Second Generation; scan mechanism for AGIRS
2000 - now
DARWIN; achromatische phaseshifter breadboard
2001 - now
DARWIN; nulling breadboard
2001 - now
GAIA; high stability optical bench
2002 - now
SMART 2; high precision optical metrology
2002 - now
SMART 2; construction techniques

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