Deposition Equipment for Laser Coatings on Small and Large Substrates

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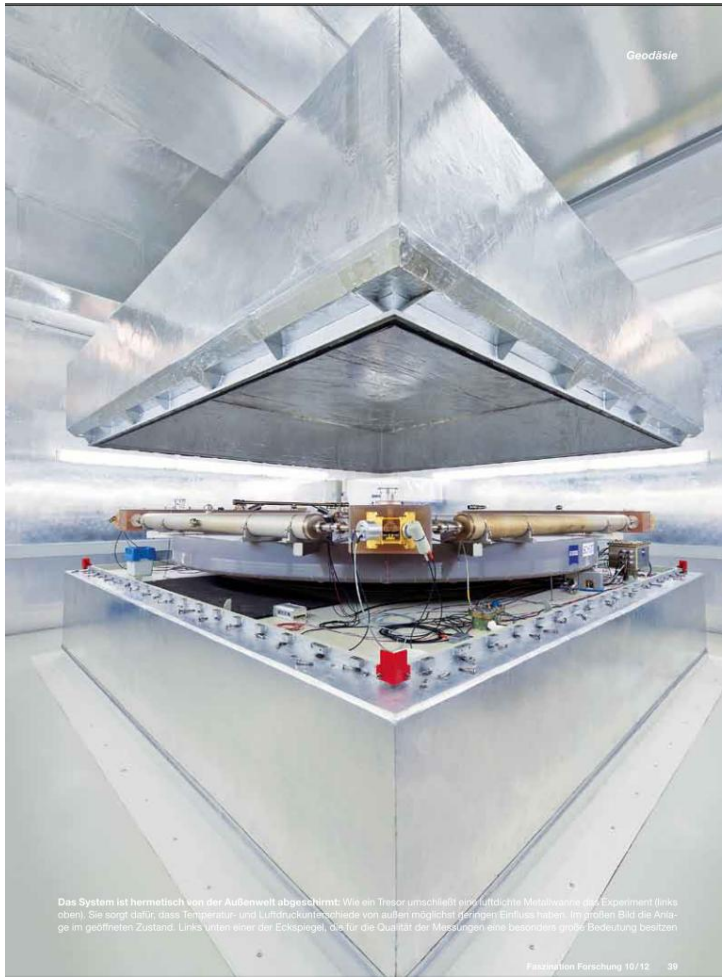
BÜHLER

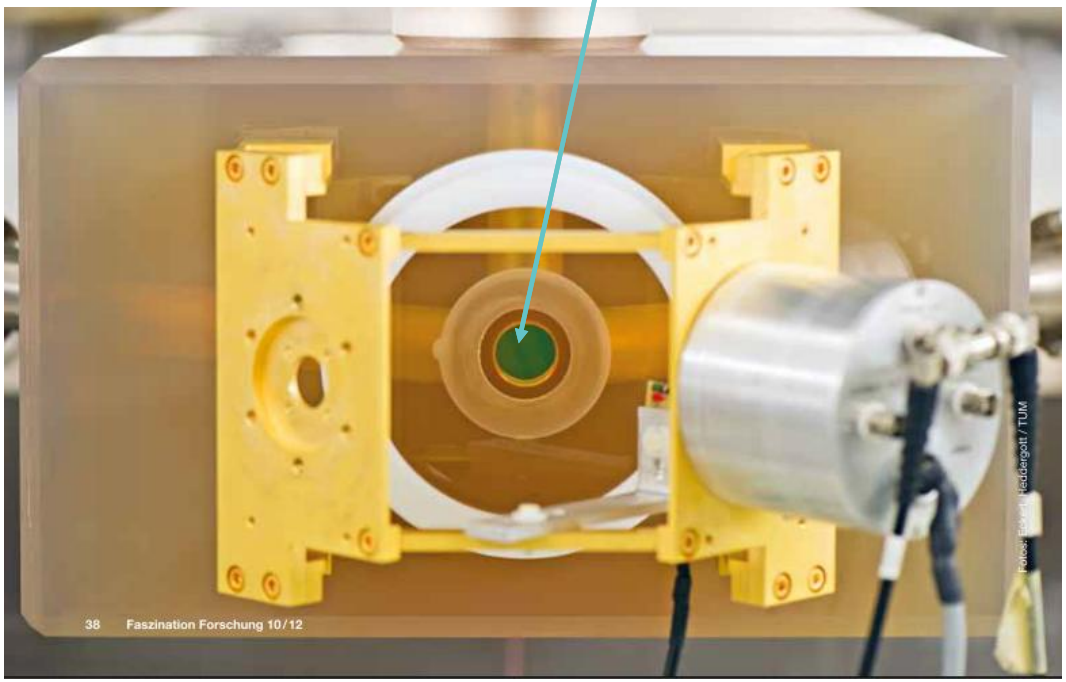
Outline

- Motivation
- Deposition system for laser coatings
  - Plasma assisted evaporation systems
  - Plasma assisted magnetron sputtering systems
  - Ion beam sputtering systems
- Conclusion

Ring laser gyroscope for exact navigation



R > 99,99xxx %



Geodätisches Observatorium Wettzell
www.fs.wettzell.de

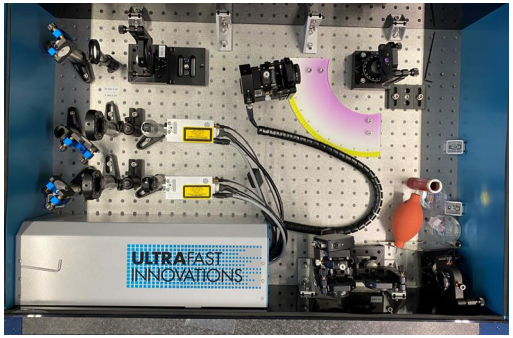
Plasma assisted evaporation systems

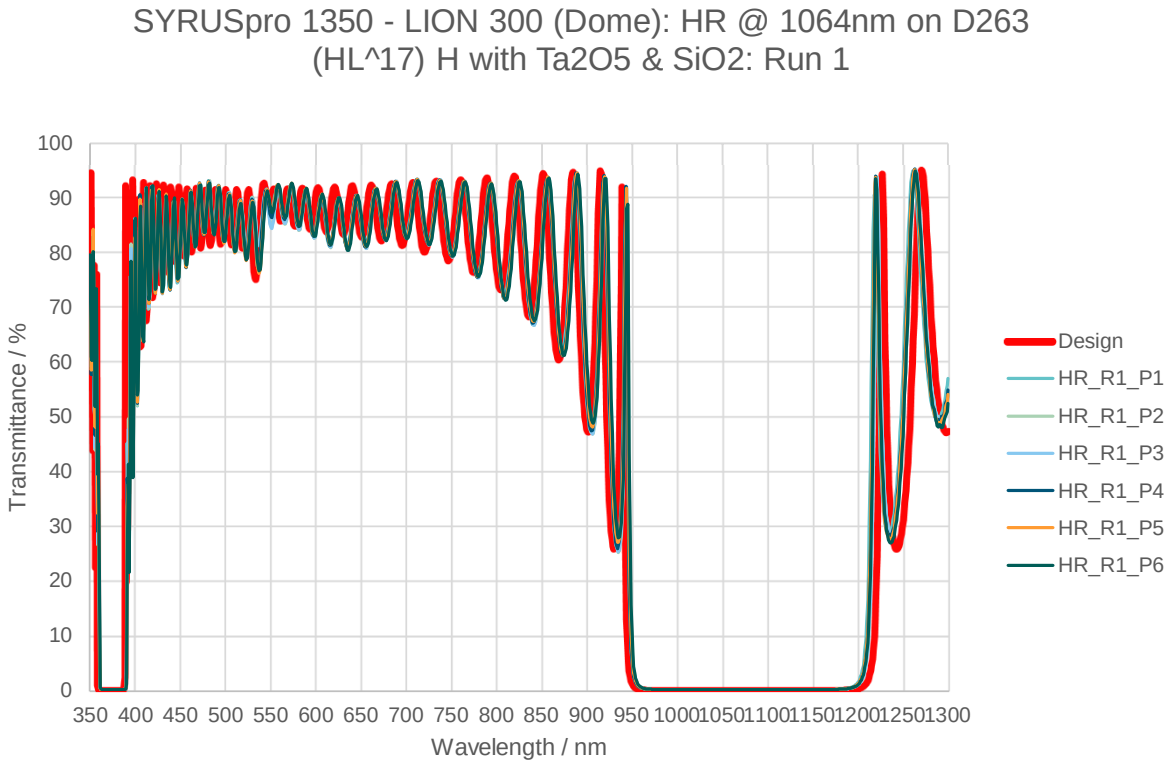
- Single precision dome
- Planetary system for large optics
- Ceramic front heater
- LION 300 plasma source
- EB-evaporator HPE12/10
- Optical monitoring OMS 5100

- Substrate size up to 1000mm

Process results HR mirror @1064nm

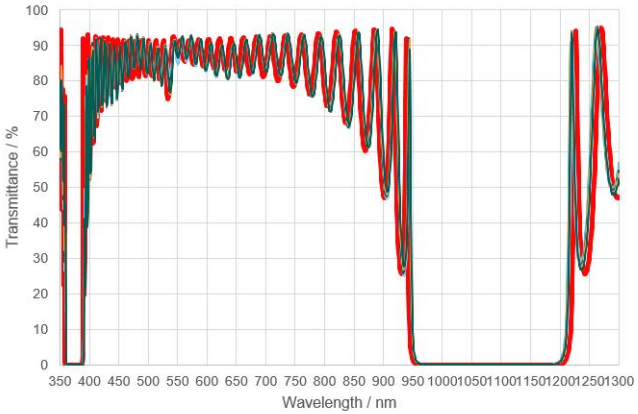
- **Excellent uniformity**
- **Total loss @ 1064nm 70ppm**
- **R > 99,99%**





Process results HR mirror @1064nm

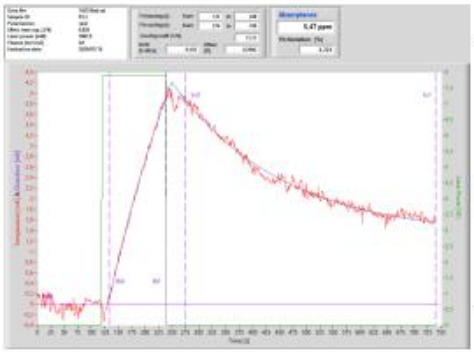
- **Excellent uniformity**
- **Absorption@ 1064nm ~ 5ppm**
- **R > 99,99%**



PH/LK/LZH 15952 -Bühler-1064nm .pdf 2020-08-05

LZH

2.2 Sample P2.3

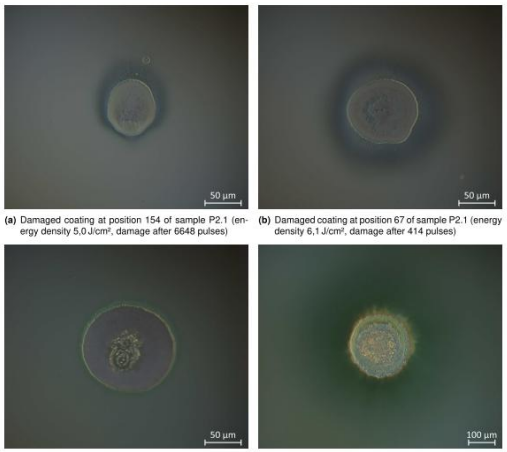


Geometry (d x th)	25.4x1 mm
Wavelength	1064 nm
Substrate material	FS
Sample mass	1.13 g
Spec. heat capacity	0.772 J/gK
Absorptance (expon.)	5.5 ppm
Data file	150720ab.cal
Power	7.88 W
NTC - Position	7 mm
Calibration Factor	1

Process results HR Mirror @1064nm

- **LIDT 8ns pulse**
- **10 – 30 J/cm²**
- **R > 99,99%**

2.1.3 Damage Morphologies



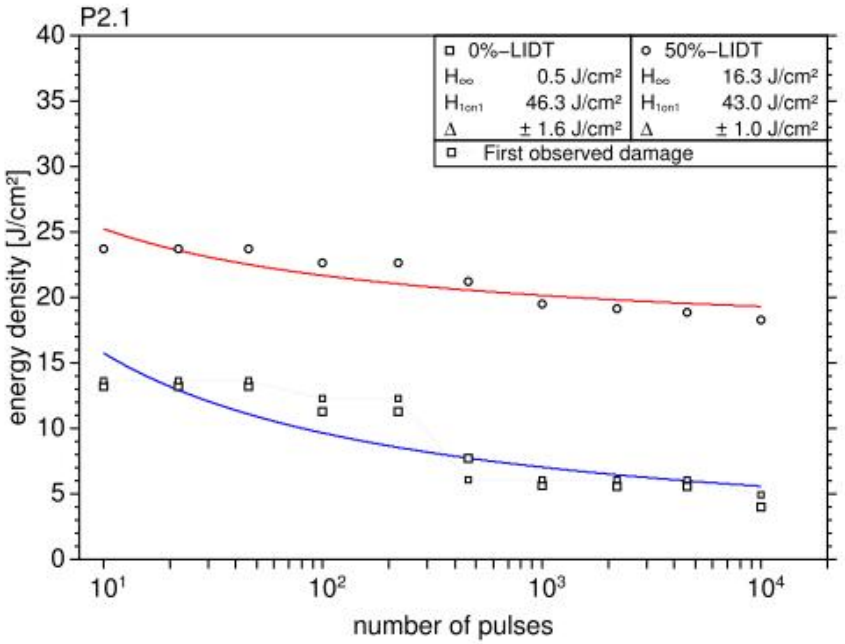
(a) Damaged coating at position 154 of sample P2.1 (energy density 5,0 J/cm², damage after 6648 pulses) (b) Damaged coating at position 67 of sample P2.1 (energy density 6,1 J/cm², damage after 414 pulses)

(c) Damaged coating at position 93 of sample P2.1 (energy density 8,1 J/cm², damage after 775 pulses) (d) Damaged coating at position 81 of sample P2.1 (energy density 11,7 J/cm², damage after 752 pulses)

Figure 4: Typical damage morphologies at four spot sites of sample P2.1.

Manufacturer: Bühler
Sample type: HR 1064 nm

2.1.1 Characteristic Damage Plot



Plasma assisted reactive magnetron sputtering

- Fast rotating turntable
- 3 Magnetron sputter sources
- RF plasma source
- Optical monitoring OMS 5100
- RF-SiO2 target option

- Recommended substrate size for laser application up to 100mm

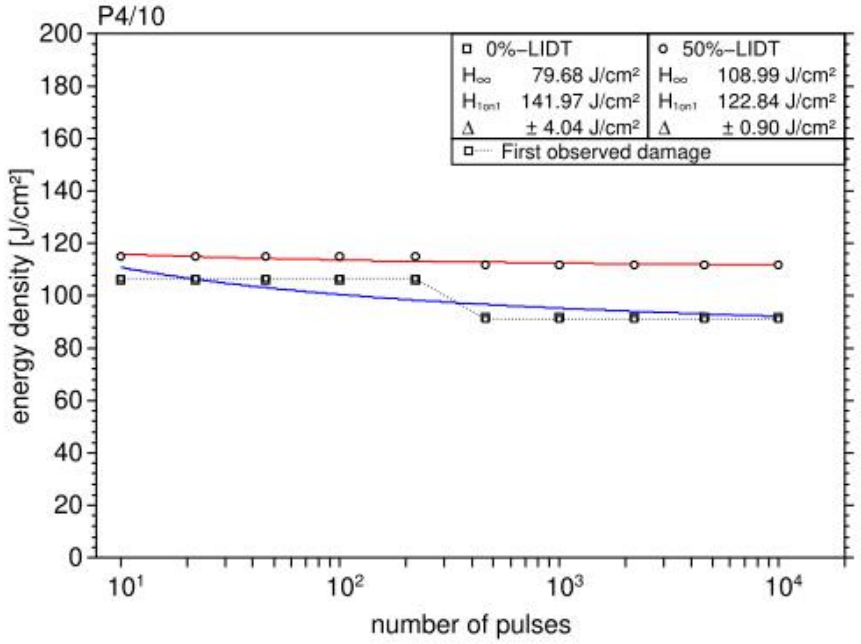
Laser coatings by RF Sputtering - HR Mirror @1064nm

	Laser Mirror @1064 nm
Design	HL^18L
Coating	SiO2 (RF) /HfO2 (MF) or Ta2O5(MF)
Substrate	Super polished fused silca
Reflection	~ 99.996%
Total loss (CRD)	15 - 40 ppm
Absorption	~ 5 ppm

2.3 Sample 191024-01 P4/10

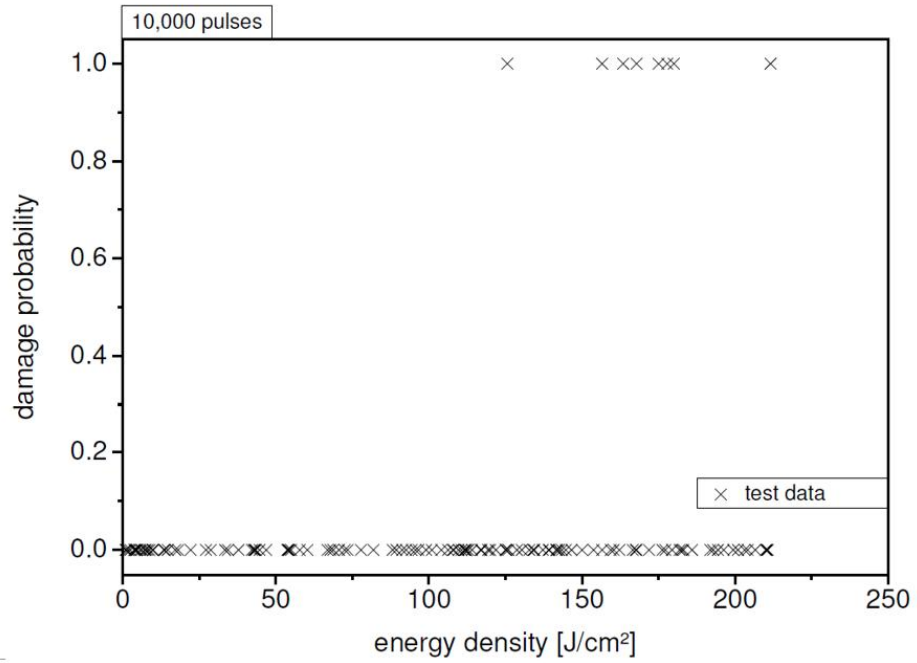
Manufacturer: Bühler
Sample type: HR 1064 nm

2.3.1 Characteristic Damage Plot

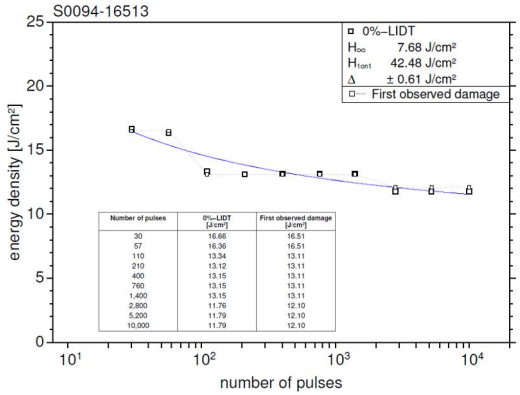


Laser coatings by RF Sputtering - High LIDT

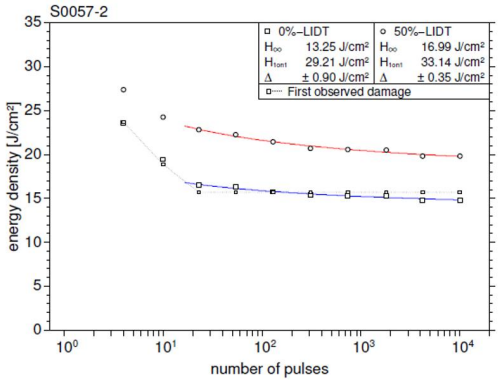
LIDT Messung @1064nm



LIDT Messung @266nm



LIDT Messung @355nm



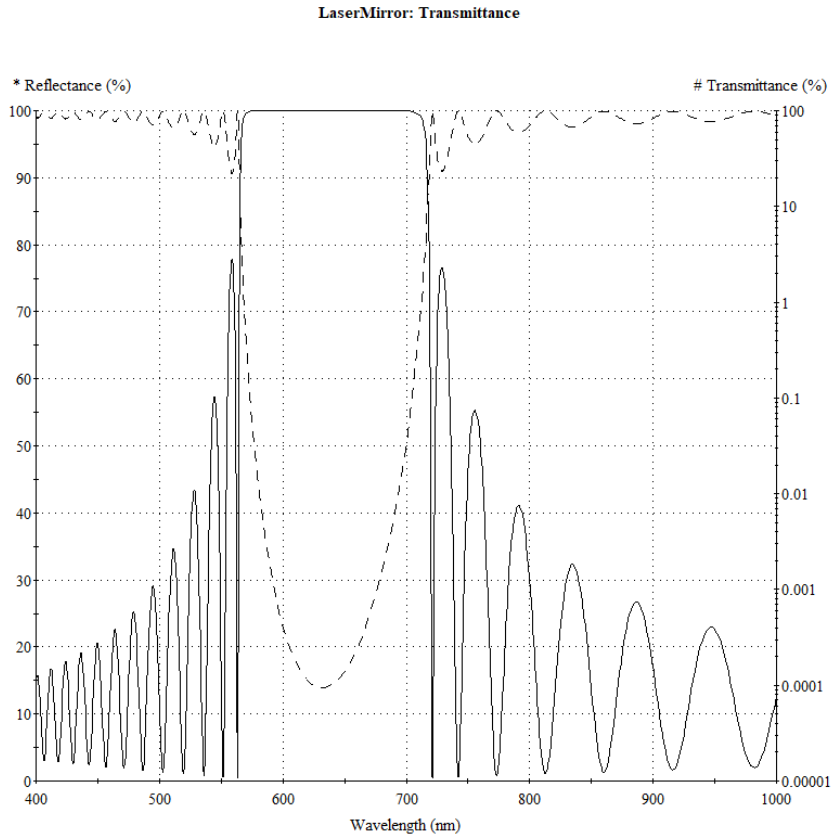
Ion Beam Sputtering systems

- Single precision flat palette or planetary substrate carrier
- Moveable multi-target tower
- RF- Ar sputter source
- RF -O_2 assist source
- Optical monitoring OMS 5100

- Substrate size up to 600mm

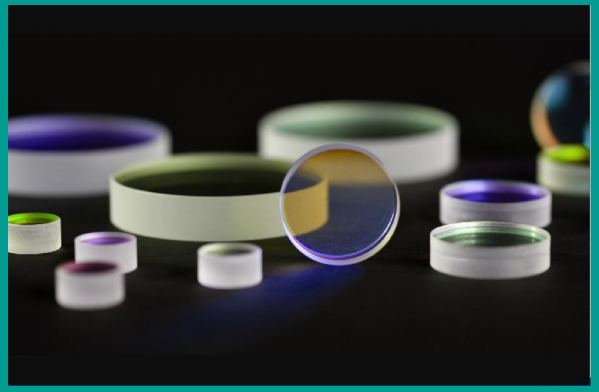
Low Loss Mirrors Refectance / Transmittance @ 633nm

- Material SiO_2 / Ta_2O_5
- Design (HL)^20 L
- Reflectance > 99.998 %@
- Transmittance loss ~ 1 ppm



Low Loss Mirrors Absorption loss @ 532nm

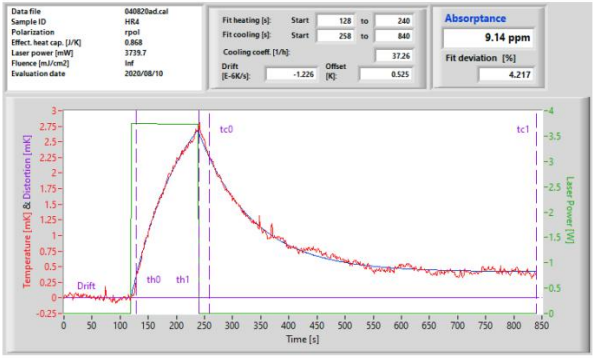
- Material SiO_2 / Ta_2O_5
- Design (HL)^20 L
- Absorption Loss ~ 9 ppm



LZH
LASER ZENTRUM HANNOVER e.V.

Absorptance measurement of optical laser components according to ISO 11551:2019 at 532 nm

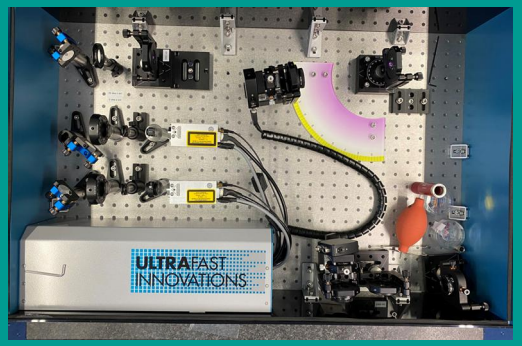
2.2.4 Sample HR4

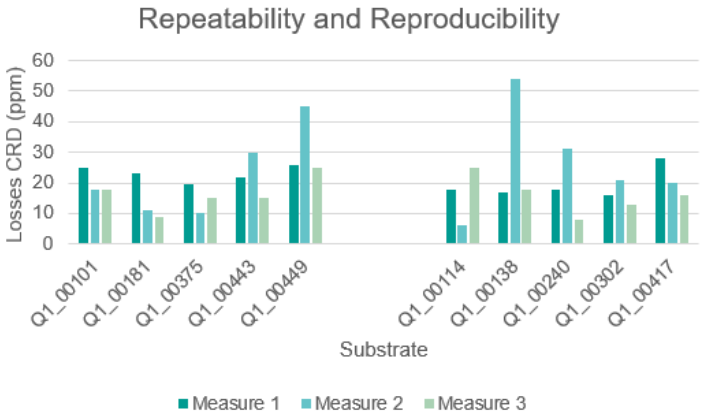


Geometry (d x th)	25.4x1 mm
Wavelength	532 nm
Substrate material	FS
Sample mass	1.06 g
Spec. heat capacity	0.772 J/gK
Absorptance (expon.)	9.2 ppm
Data file	040820ad.cal
NTC - Position	7 mm
Calibration Factor	1

Low Loss Mirrors Total loss @ 633nm by CRD

- Material SiO_2 / Ta_2O_5
- Design (HL)^20 L
- Total Loss < 20ppm





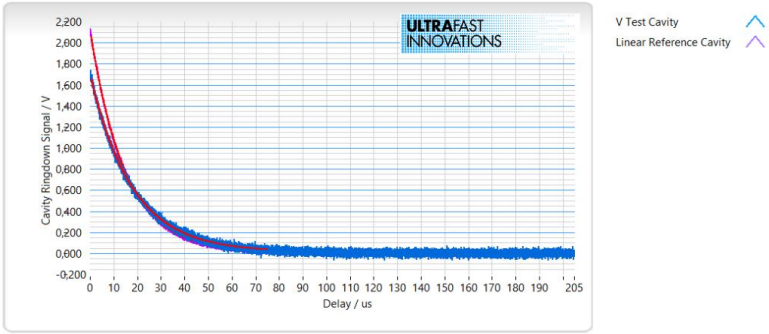
Test mirror loss: 8,27±0,32 ppm (99,999173±0,000032 % reflectivity) (r2 = 0,932471)

Average cavity mirror loss: 98,34±0,12 ppm (r2 = 0,994460)

Parameters:

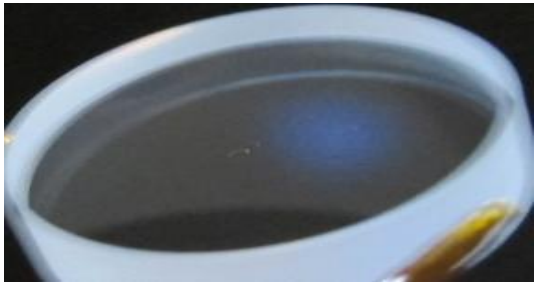
Wavelength: 633,0 nm
Angle of Incidence: 45 degrees
Operation mode: V cavity reflection measurement

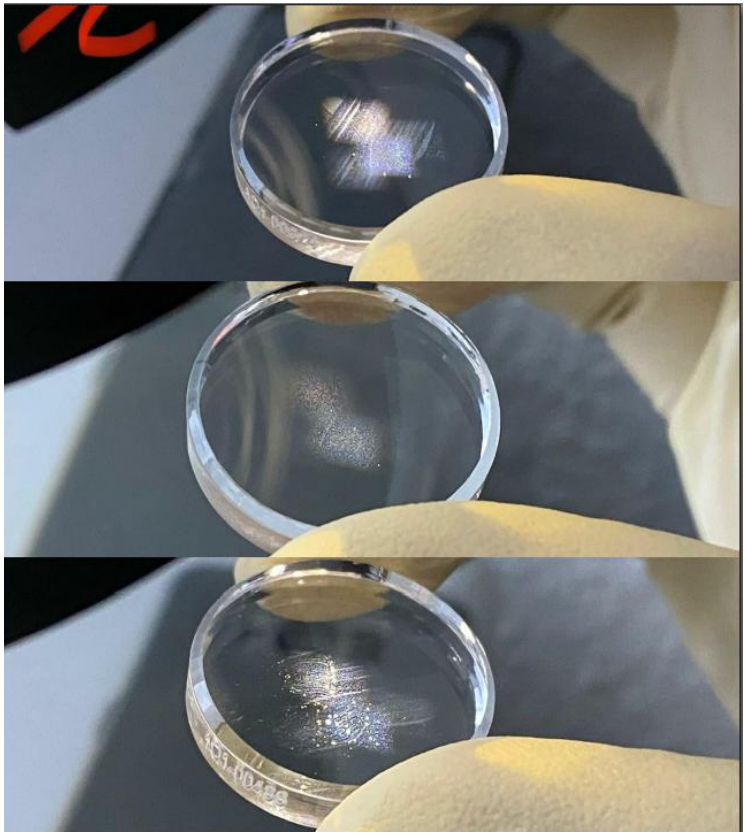
Cavity Ring-down Signals



Conclusion

- Standard deposition systems for laser coatings are available for substrate sizes up to 1000mm
- To minimize the scattering losses an energetic deposition process is necessary that keeps the absorption loss low
- Measurement below 20ppm total loss is a challenge
- For high reflecting laser mirror coating excellent surface quality is essential





Thank you for your attention !

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