Moderne Fokussysteme in der Bildverarbeitung

Technologien und Anwendungen

Topics

- Technologies
  - Liquid Lenses: Varioptic + Optotune
  - *Applications*

  - Sound Lenses: TAG Optics
  - *Applications*

Technologies

Varioptic – Optotune – TAG Optics

Electrowetting

„ … manipulating the shape of a liquid by applying a voltage … “

www.wikipedia.com

Varioptic´s Liquid Lenses

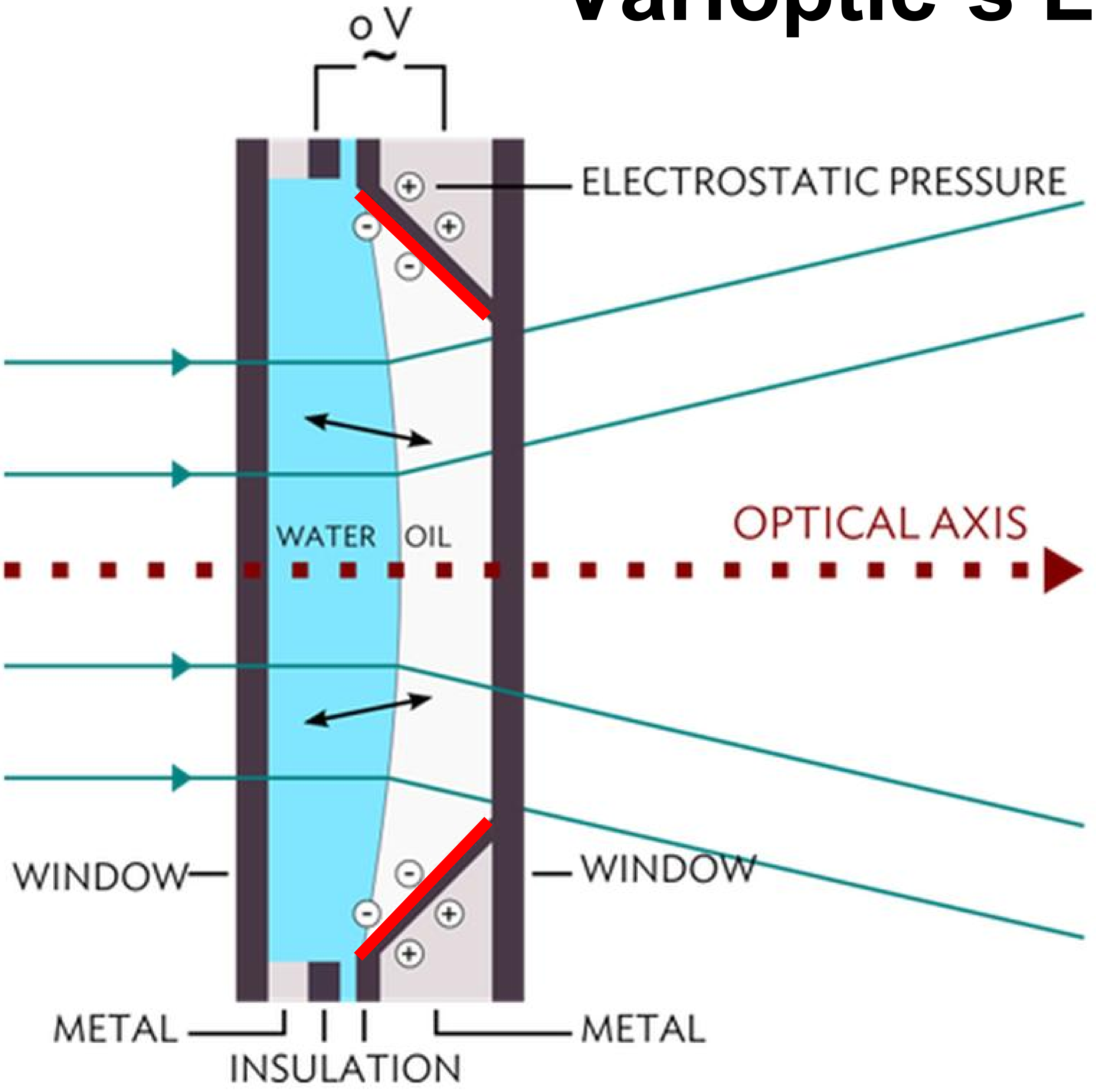

Image courtesy of Varioptic

Varioptic´s Liquid Lenses

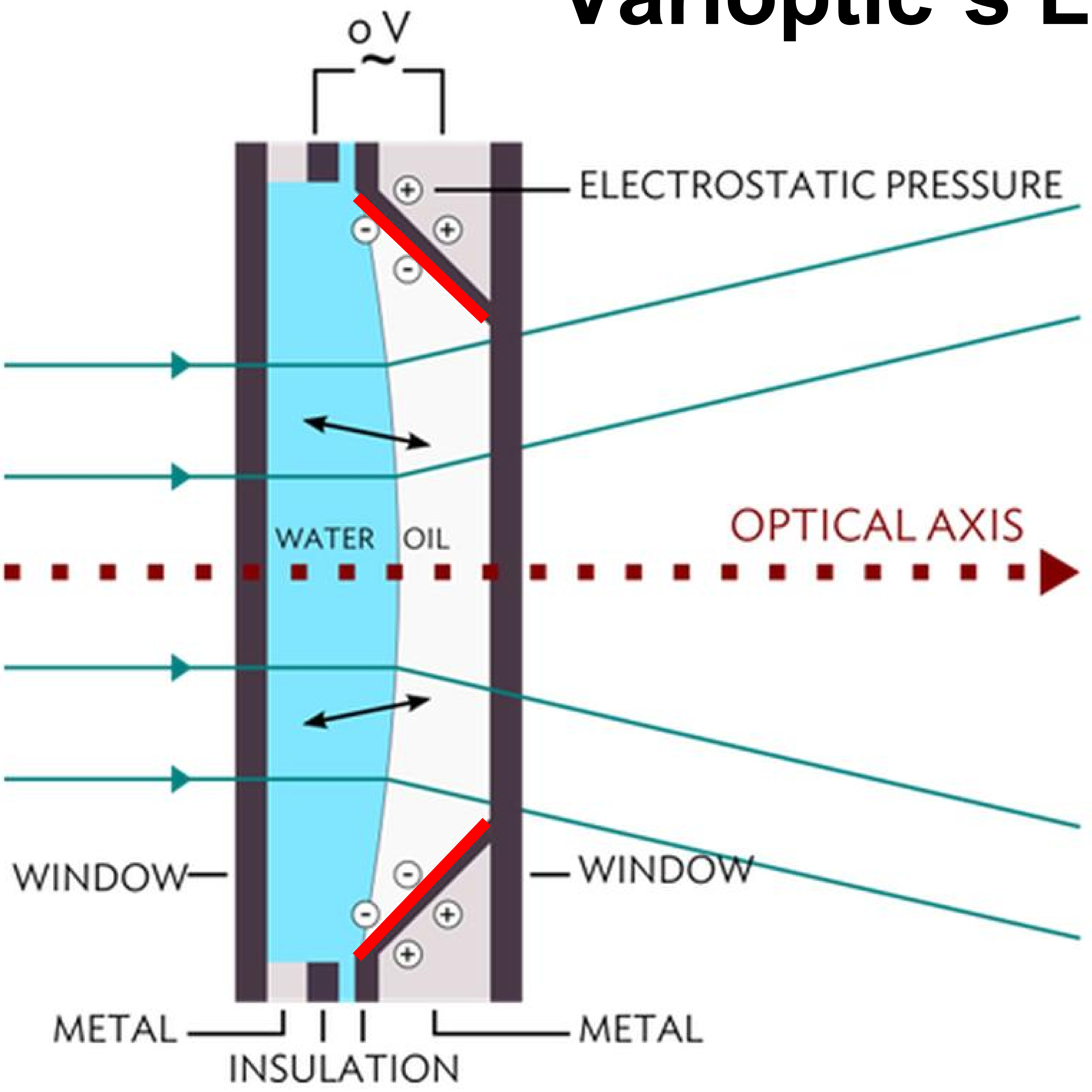

Image courtesy of Varioptic

Constraints on the fluids:

- Identical mass density
- Not mixable
- Difference in refractive index

Varioptic´s Arctic Series

- Clear Apertures: 2.5 mm // 3.9 mm
- Life Time: > 100,000,000 cycles
- VIS and NIR AR Coatings
- Transmission > 97% (VIS)
- Operating Temperatures: -20°C – 60°C
- No heating // no power consumption
- High voltages: up to 60V

Image courtesy of Varioptic

Technologies

Varioptic – **Optotune** – TAG Optics

Optotune´s Liquid Lenses

- Voice-coil actuator
  → ring pushing membrane

- Increasing Current
  → more liquid in the center

- Current-driven: ~100s of mA // 5V

- Power dissipation → HEAT // focal length correction

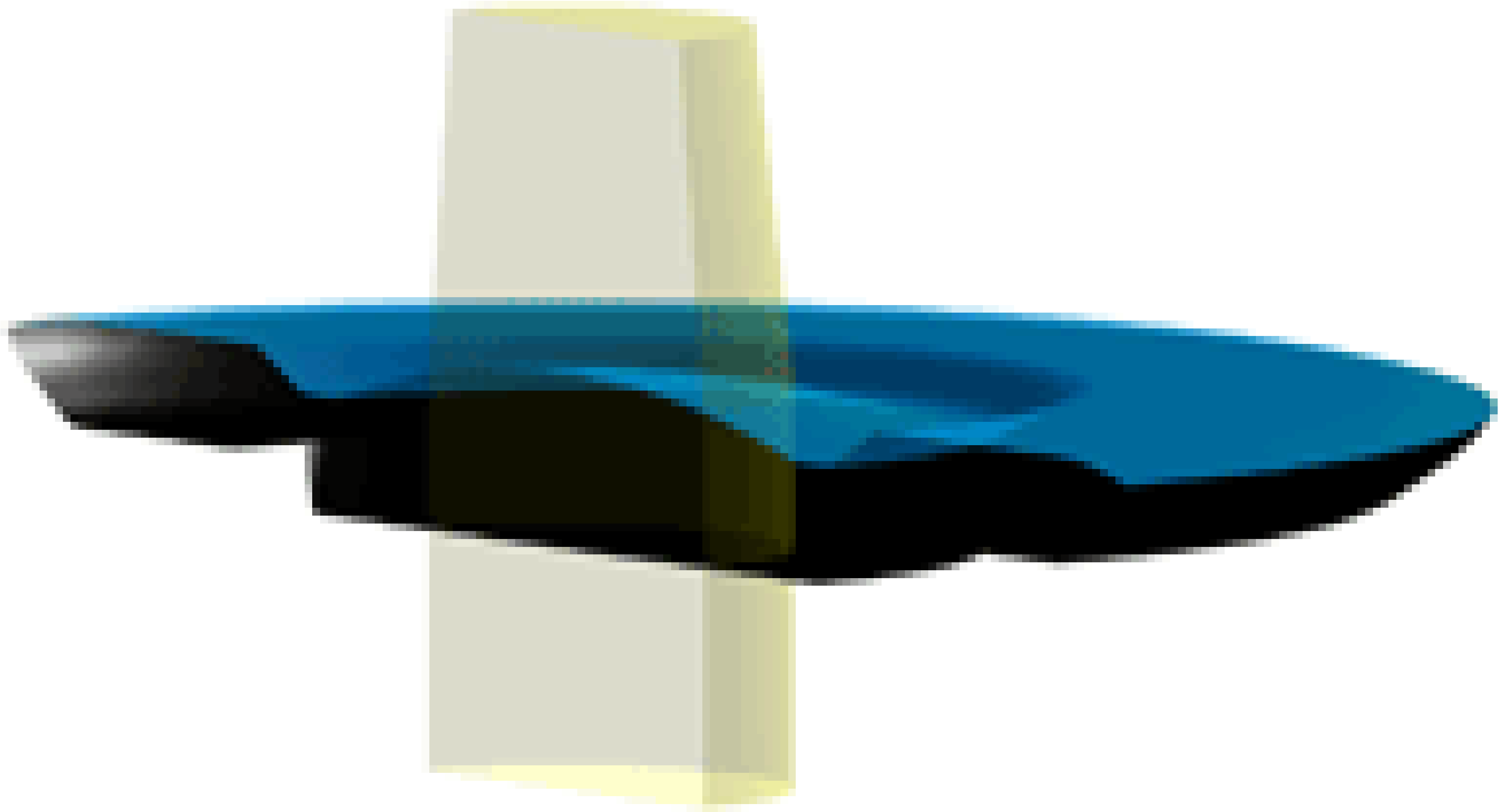

Image courtesy of Optotune

Optotune´s Liquid Lenses

- Clear aperture: 6 mm // 10 mm // 16mm

- VIS and NIR AR cover glasses
- Offset lenses

C-mount version

- 1,000,000,000 cylces
- -40°C – 70°C operating temperature
- Higher damage threshold → laser applications

- Large apertures → Gravity-induced aberrations

Image courtesy of Optotune

In comparison ...

Varioptic – Electrowetting	Optotune – Mechanical
Voltage (~70V)	Current (~100s mA, 5V)
No power consumption	Dissipate power
Small apertures, 3.9mm	Up to 16mm clear aperture
Needs hardware integration	C-Mount version available

Challenges + Advantages of Liquid Lenses

- Temperature
- Implementation
- (Gravity)

- Fast [~10ms]
- Compact
- No moving parts

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ALTERNATIVES

Motorized Lenses

Multiple cameras

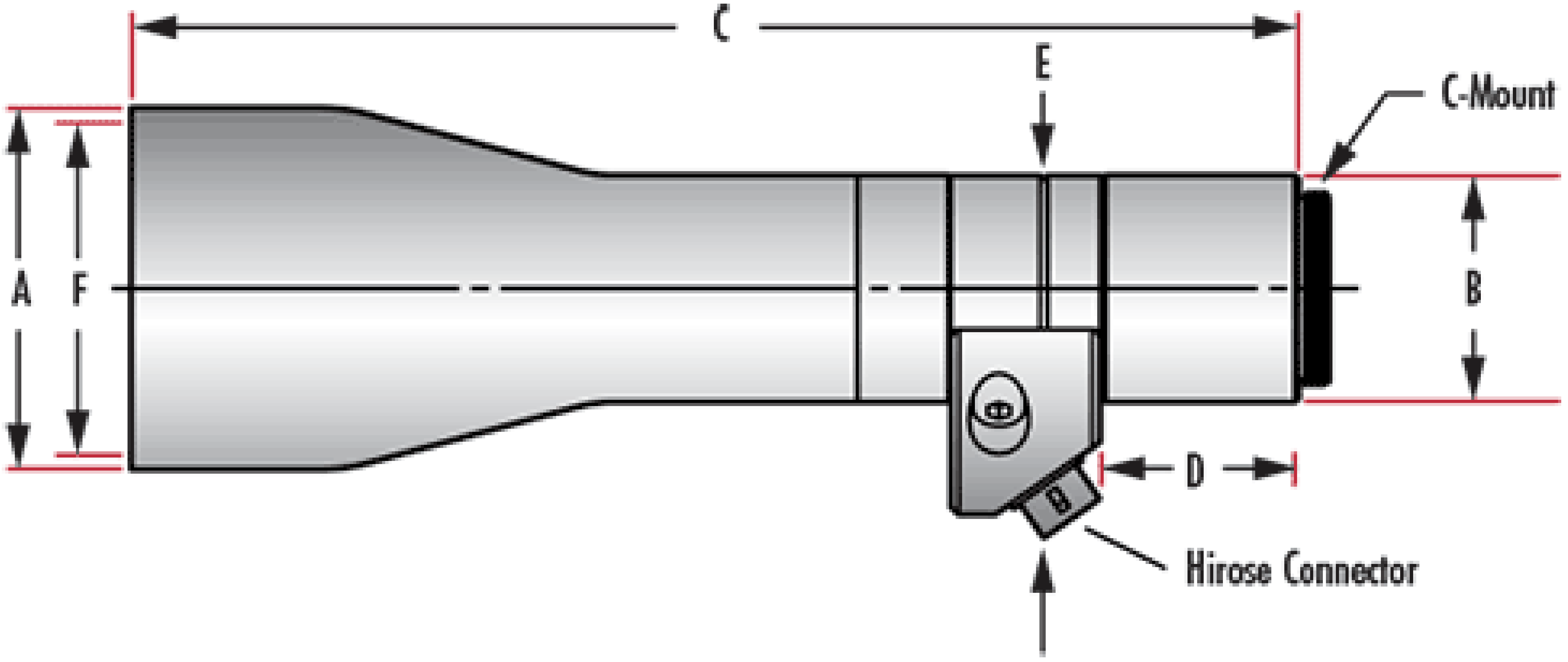
Slow f/# lenses

Move the object

Barcode Sanning

Image courtesy of Cognex
Image courtesy of Datalogic

Test + Measurement



Microscopy – Focus Stacking

www.wikipedia.com

Technologies

Varioptic – Optotune – TAG Optics

Sound-driven GRIN Lenses

- **Piezos** creating a standing wave in a liquid

→ Density modulation

→ Tuneable **index of refraction gradient**

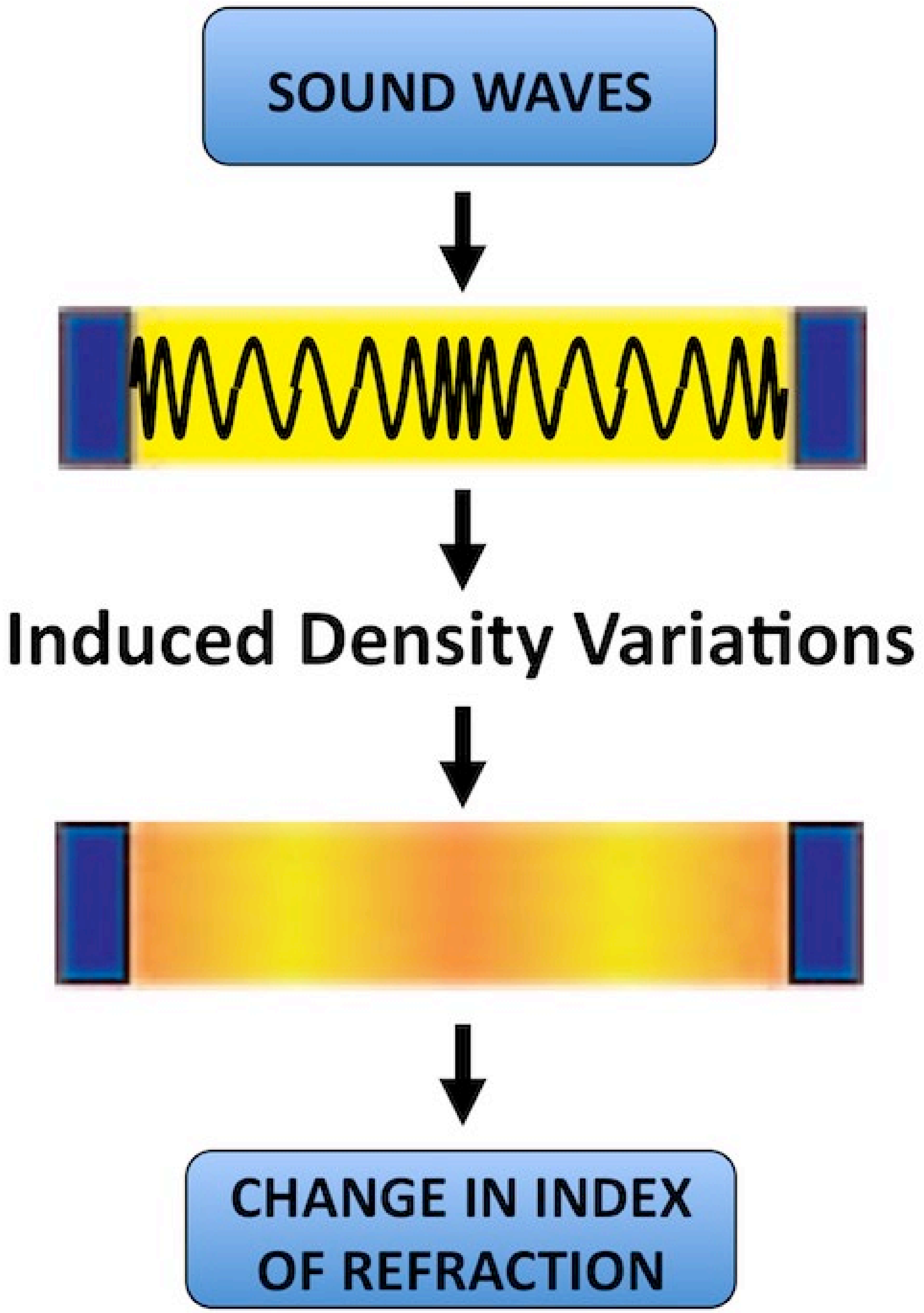


Image courtesy of TAG Optics

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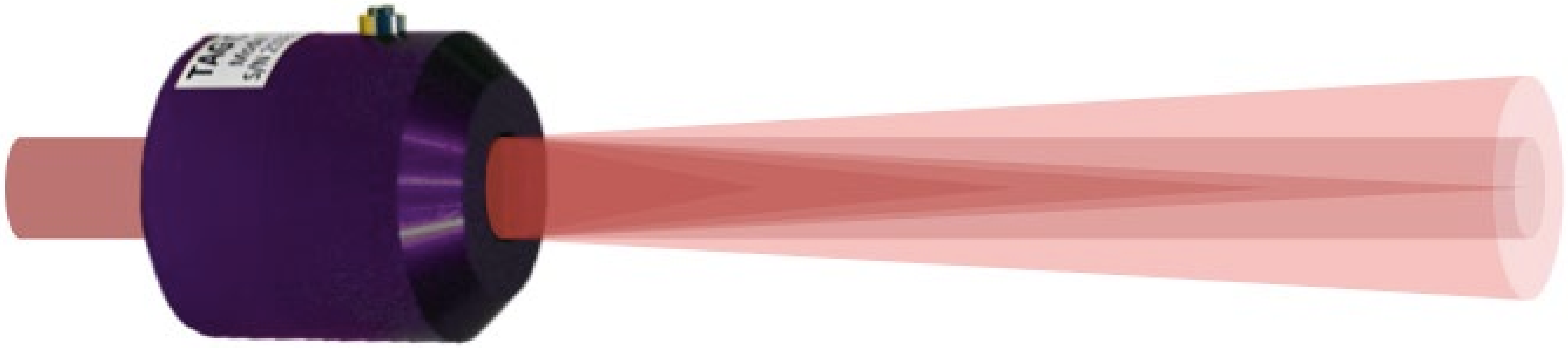


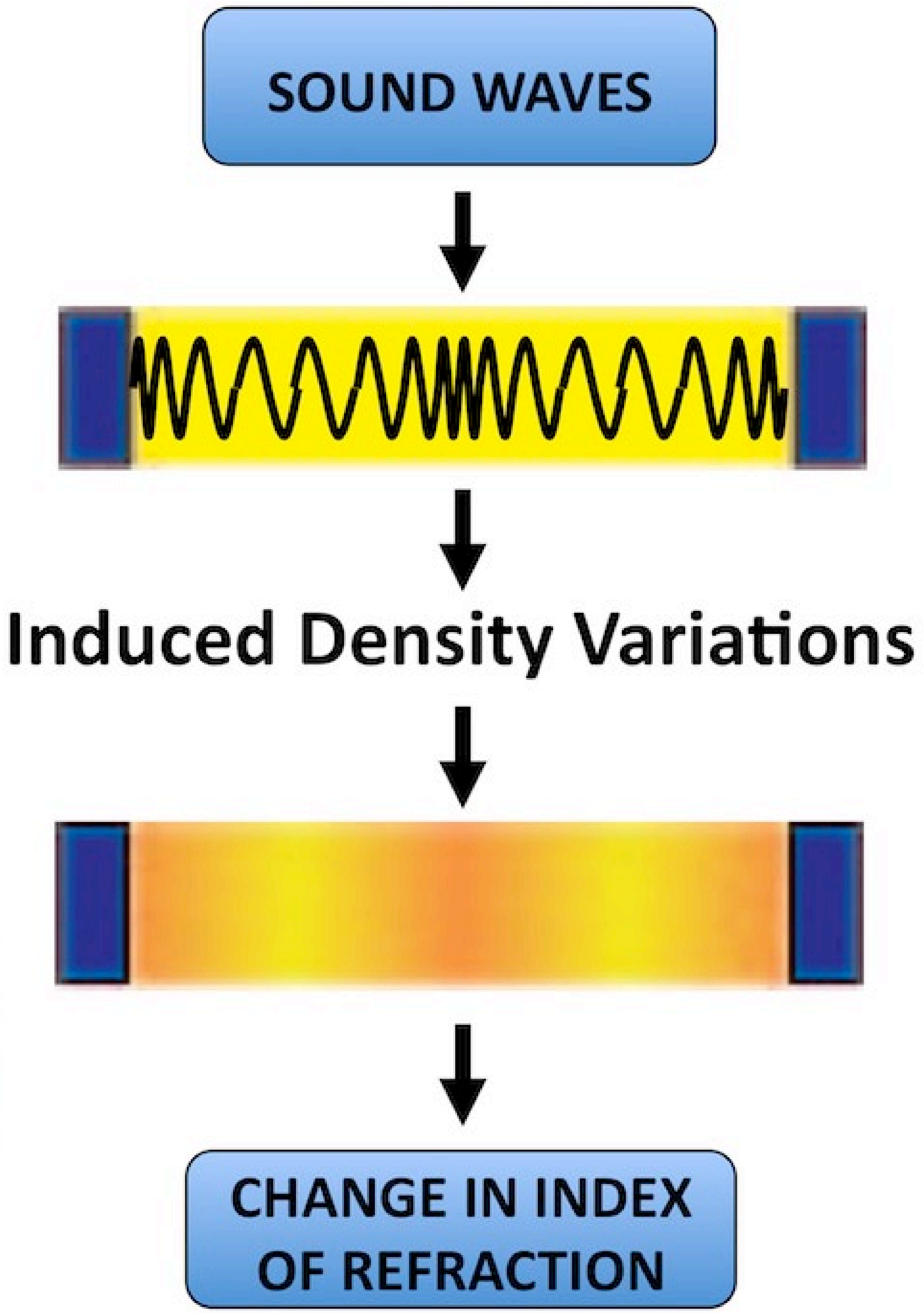
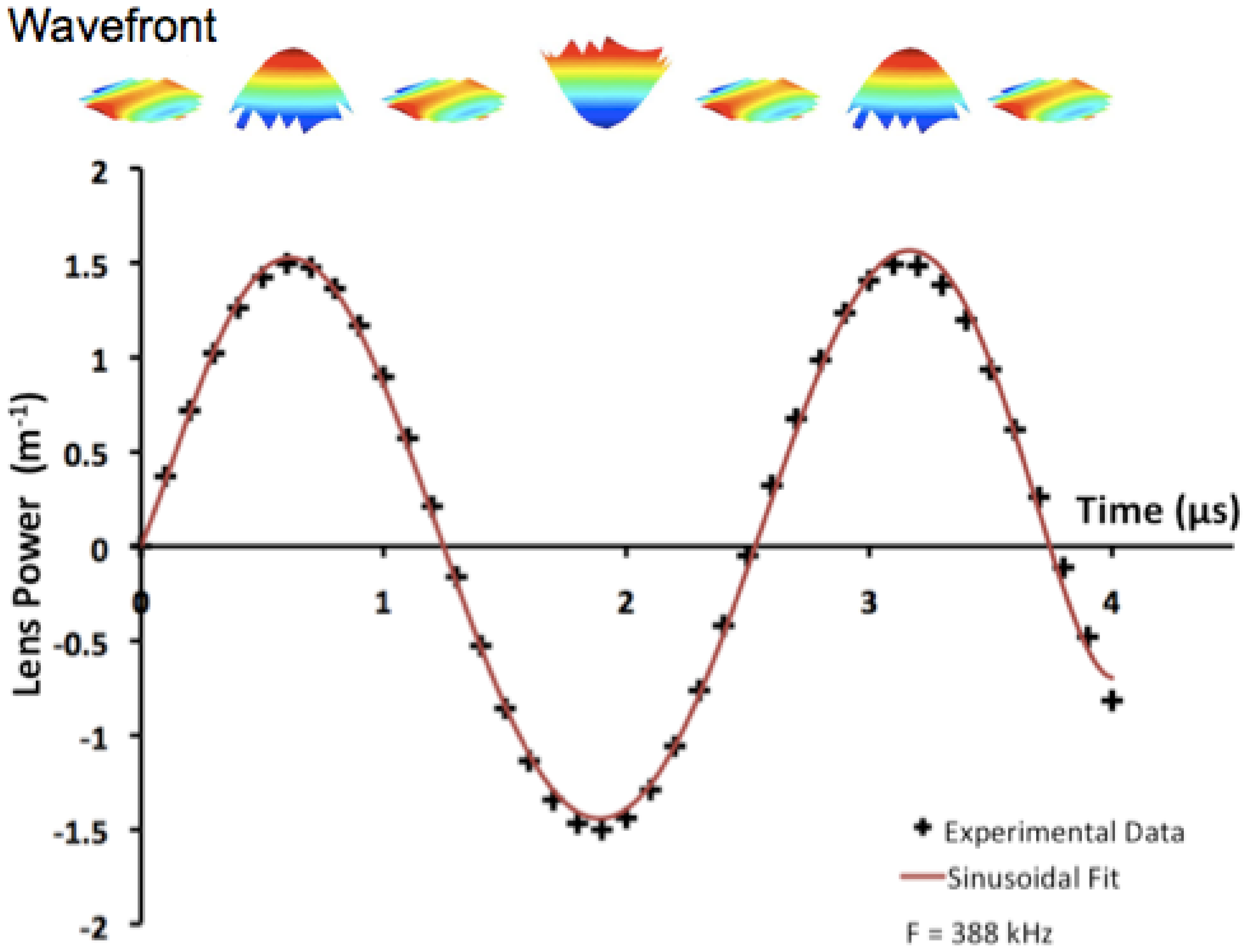


Image courtesy of TAG Optics

Ultrafast – Controlled Timing

- Lens driver provides sinusoidal signal
- Up to 500 kHz!
- Change the focus position for each frame



Full Depth of Field Imaging

- Assume camera provides 90 fps
- Acquire image stream @ 30fps at three different focus positions
- Only limited by the camera´s frame rate

Conclusion

Dankeschön! Fragen?

Literature // 24.06.2019

- TAG Optics – Website – Peer-reviewed papers
  Applications (primarily microscopy) and Technology

  https://www.tag-optics.com/publications.php

- Wikipedia – Electrowetting
  https://de.wikipedia.org/wiki/Elektrobenetzung

- Corning Varioptic – Product Brochure
  https://www.corning.com/media/worldwide/Innovation/documents/Varioptic/CorningVariopticLenses_Brochure_v11.pdf

- Optotune – Publications
  Applications (Microscopy)
  https://www.optotune.com/technology/publications