PhotonHub Experience Centre

Optics and freeform optics:
design, prototyping, metrology and manufacturing

Course Provider

Brussels Photonics (B-PHOT)
Vrije Universiteit Brussel
Belgium

Course Overview

Lenses and mirrors are essential optical components in imaging and non-imaging systems and are currently used in all industry sectors. Optimizing the optics design in view of volume manufacturing in optical-grade glasses and plastics is key in maximizing system performance.

This 3-day industry training course provides engineers and product developers with the basic technical insights and skills in optics and freeform optics design, prototyping, metrology and manufacturing. The course covers the key aspects of spherical and aspherical optical lenses and mirrors and highlights the unique advantages of freeform optical surfaces. Prototyping, manufacturing and optical testing are illustrated with demonstrations and hands-on experience is provided with state-of-the-art pilot-line equipment. Practical applications from different industry sectors serve as illustrations.

This unique industry ‘hands-on’ training program includes dedicated tutorials, tutorial material, and mentoring by technical experts. Attendees will experience access to state-of-the-art facilities and hands-on experience with top-notch equipment.

Target Audience

It is desirable but not essential that course attendees have a basic understanding of optics. The course is ideally suited to those planning to use optical and freeform optical components for their particular imaging and non-imaging applications and to learn about sourcing them through pilot lines.

Expected Outcomes

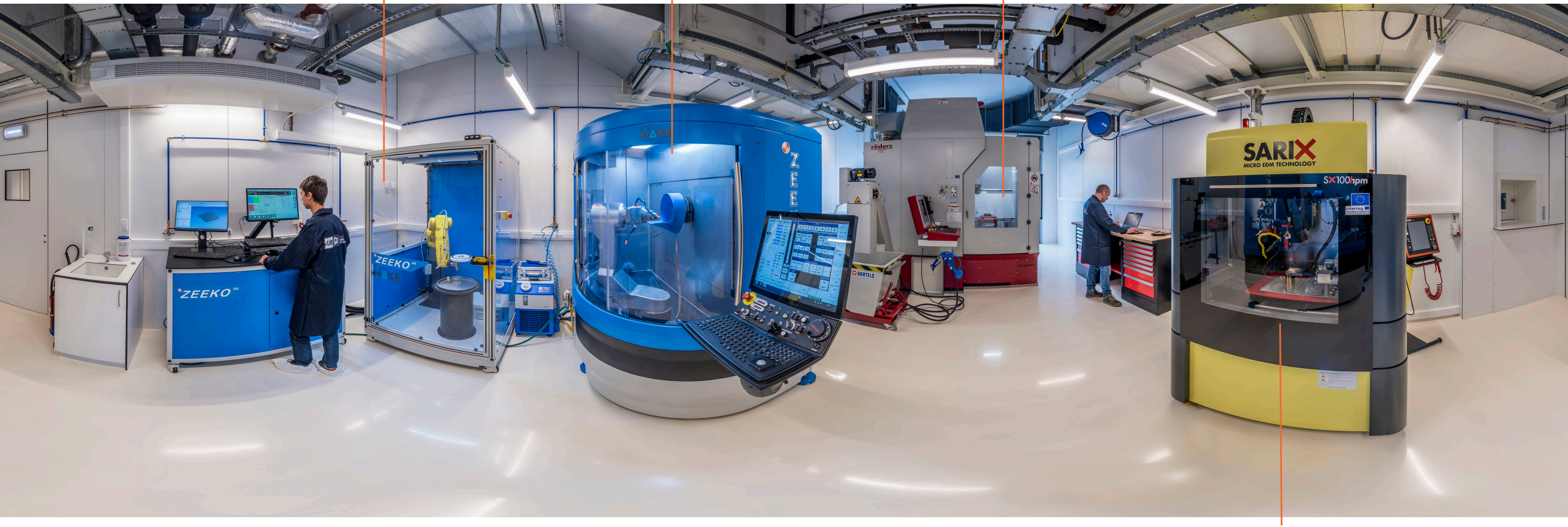
1) Basic understanding of first-time-right optics and freeform optics design, including tolerance analysis and design-for-manufacturing
2) Understanding of the unique advantages and applications of freeform optics over their conventional (a)spherical counterparts
3) Perform prototyping of optical components in in optical-grade glasses and plastics
4) Perform characterization and testing of optical components with high-end metrology instruments
5) Perform replication of optical components in optical-grade glasses and plastics

Course Equipment and Infrastructure

Fluid jet polishing robot

Ultraprecision bonnet polishing

Precision micro-machining for mould manufacturing



Micro-electron discharge machining for mould manufacturing

Course Equipment and Infrastructure

Injection moulding replication of plastic optics

Ultraprecision diamond tooling

Hot embossing replication of plastic optics

Glass press moulding replication of glass optics

Micro-injection moulding replication of plastic optics

Course Equipment & Infrastructure

Course Schedule

Day & Time	Training Activity
Day 1 (09:00 – 12:30)	Course Introduction Optics and freeform optics design Tutorial (lectures)
Day 1 (13:30 – 17:30)	Optics Pilot Line Facilities (guided tour) Freeform optics: imaging & non-imaging applications (lectures)
Day 2 (09:00 – 12:30)	Polymer optics prototyping: from ultraprecision diamond tooling to mould manufacturing (hands-on)
Day 2 (13:30 – 17:30)	Glass optics prototyping: grinding and corrective ultra-precision polishing (hands-on)
Day 3 (09:00 – 12:30)	Mass manufacturing through replication of polymer and glass optics (hands-on)
Day 3 (13:30 – 17:30)	Optics metrology and testing (hands-on)

Course Details (Day 1)

09:00

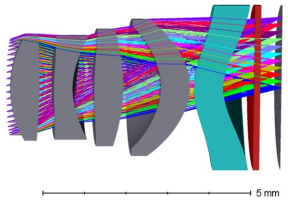
17:00

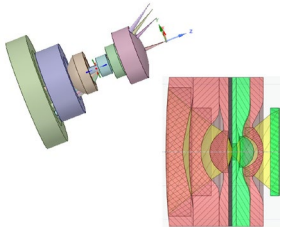
Day 1a. Course Introduction; Optics and Freeform Optics Design Tutorial (lectures)

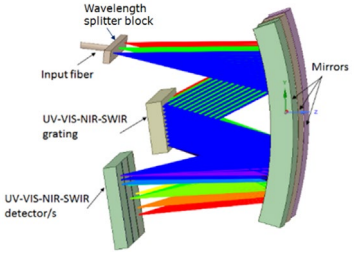
Location: VUB Photonics Innovation Center Meeting Room

Details: Lecture on first-time-right optical design for manufacturing of optics with several examples

Training Duration: 3 Hours







Day 1b. Visit of the Optics Pilot Line facilities (guided tour)

Location: Fabrication hall 1, Fabrication hall 2, Cleanroom of VUB Photonics Innovation Center

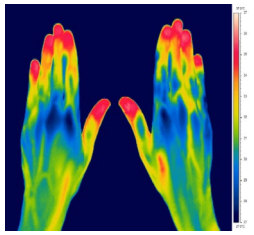
Training Duration: 0,5 Hours

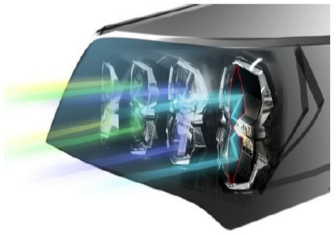
Day 1c. Freeform optics for imaging and non-imaging applications (lectures)

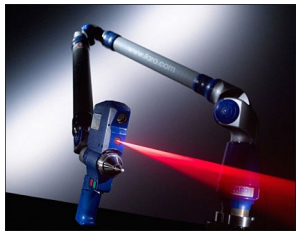
Location: VUB Photonics Innovation Center Meeting Room

Details: Lecture on the unique advantages of freeform optics over their (a)spherical counterparts and their applications

Training Duration: 3 Hours







Course Details (Day 2)

09:00

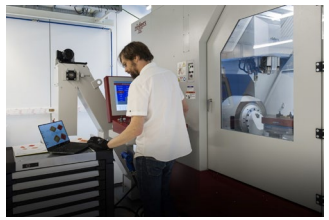
17:00

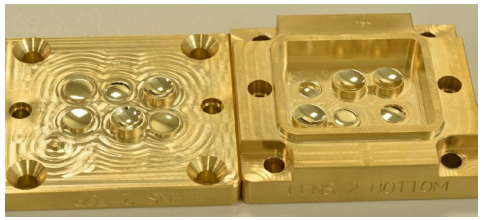
Day 2a. Polymer optics prototyping: from ultraprecision diamond tooling to mould manufacturing (hands-on)

Equipment Used: Ultraprecision diamond tooling, micro-electron discharge machining, 5-axis precision milling

Details: ultraprecision diamond tooling of optical grade plastics for direct prototyping and of mould materials for master machining

Duration: 3 Hours

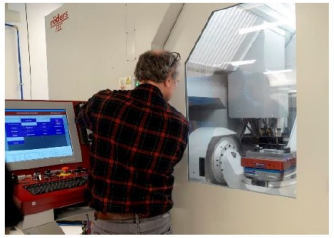
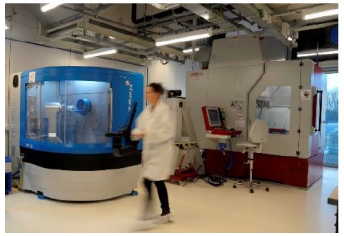
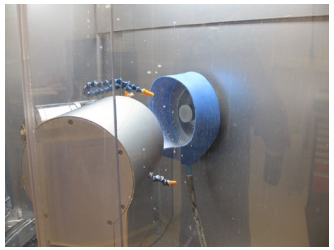
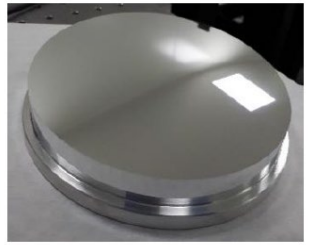


Day 2b. Glass optics prototyping: grinding and corrective ultra-precision polishing (hands-on)

Equipment Used: 5-axis precision milling & grinding, 7-axis ultraprecision bonnet & fluid jet polishing, full-field interferometer

Details: Grinding, synchrospiral polishing, raster scan corrective polishing of glass and associated interferometry metrology

Training Duration: 3,5 Hours


Course Details (Day 3)

09:00

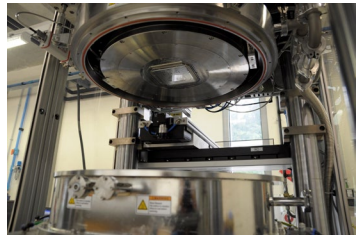
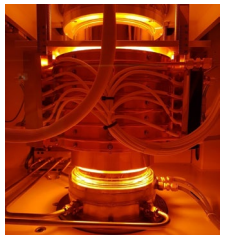
17:00

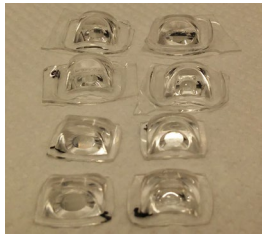
Day 3a. Mass manufacturing through replication of plastic and glass optics (hands-on)

Equipment Used: Hot embossing, micro-injection moulding, injection moulding, glass press moulding

Details: Using the moulds fabricated yesterday as a shim, plastic optics replication through hot embossing and (micro-)injection moulding as well as glass press moulding is performed

Training Duration: 3 Hours

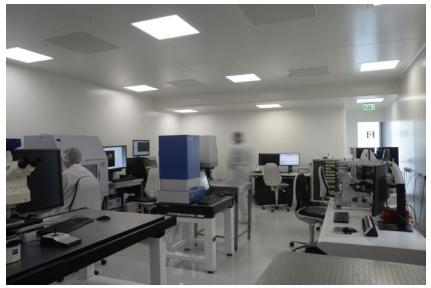



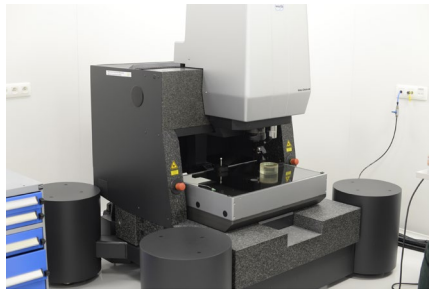
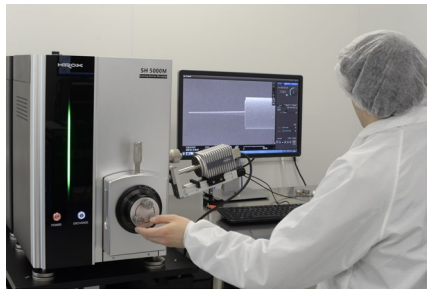
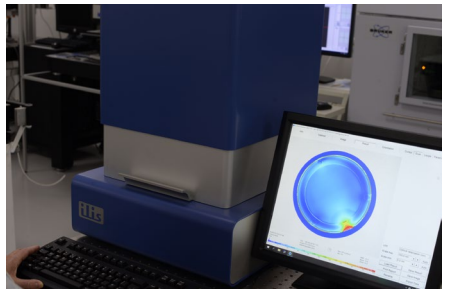
Day 3b. Freeform optics metrology (hands-on)

Equipment Used: Contact and non-contact profilometers, Interferometers (including tilted wave interferometer), Scanning electron microscope, Atomic force microscope, Coordinate measuring machine, Scatterometer, Polarimeter

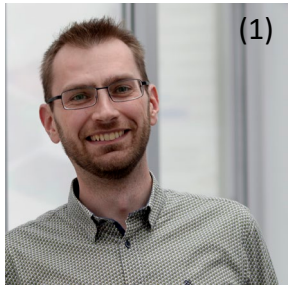
Details: Laboratory demonstration of instruments to determine the geometrical and optical characteristics of freeform optics and hands-on training on a selected set of instruments

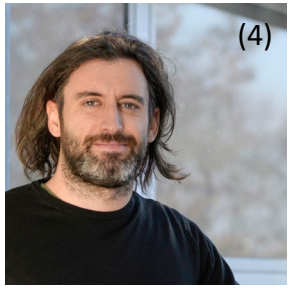
Training Duration: 3,5 Hours

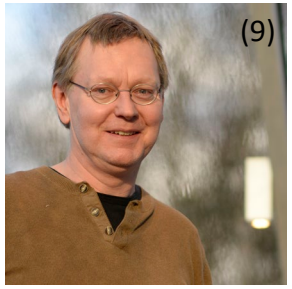


Course Trainers







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Course Manager: Prof. Jürgen Van Erps(1)

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Optics metrology: Prof. Heidi Ottevaere(11), Julie Verdood(12)

Optics replication: Prof. Michael Vervaeke(5), Prof. Jürgen Van Erps(1), Kurt Rochlitz(8), Dries Rosseel(7), Sergey Verlinksi(10)

Course Material (technical hand-outs)

PHOTONHUB EUROPE

PhotonHub Experience Centre

Course 02
Optics & Freeform Optics:
design, prototyping, metrology and manufacturing

Course Provider
Brussels Photonics (B-PHOT)
Vrije Universiteit Brussel
Belgium

Training Course Notes

Glass optics prototyping: grinding and corrective ultra-precision polishing

Equipment used: Röders 5-axis precision milling & grinding machine; Zeeko ultraprecision 7-axis polishing machine; Zygo full-field interferometer
Materials used: BK7 glass blanks; Corrective polishing CAM software
Training duration: 3,5 hours

A BK7 glass blank is first ground to a near-net lens shape, after which the glass lens is polished using a 7-axis ultraprecision bonnet polisher. The corrective polishing procedure is a deterministic process, where consecutive polishing runs are alternated with a metrology of the polished surface. The latter is done with a high-resolution full-field interferometer, allowing to quantify the shape and surface roughness of the sample. The deviation from the desired profile is then calculated and fed back into the polishing CAM software such that a corrective polishing run can then be executed. After a few iterations, the desired lens shape and surface roughness will be obtained.
Figure 1 shows the Zeeko 7-axis ultraprecision polisher and Figure 2 shows an example measurement of a polisher surface using a full-field interferometer.

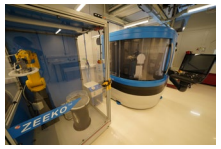

Figure 1: *Zeeko 7-axis ultraprecision bonnet polishing equipment*

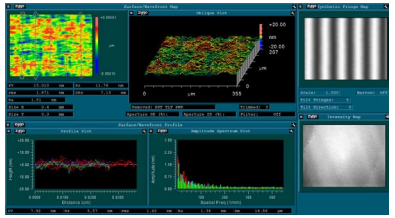

Figure 2: *Full-field interferometry example of a polished BK7 surface*

Course Location, Schedule & Cost

- Course Schedule (October, March – exact dates to be confirmed)
- Number of people (Groups of 2-3 persons per hands-on exercise with a maximum of 6 persons per course)
- Course Cost (750 Euros per person, includes course material, consumables, lunches and diners)

Further Information

- ExperienceCentre@b-phot.org
- www.b-phot.org
- www.photonhub.eu/euphotonicsacademy

Keywords

Freeform optics, first-time-right optical design, design for manufacturing, optical metrology Tolerance analysis, Pilot Line, Prototyping, Replication, Precision Manufacturing, Ecosystem, Equipment, Communications, Biomedical, Sensors, Agri-Food

Relevant Technology & Application Domains

Technology: Free-Space Photonic Components & Systems

Application: Relevant to all 6 key application domains covered by PhotonHub and Photonics21