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# Fraunhofer IOF

## »Solutions with light«

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Fraunhofer Institute for  
Applied Optics and Precision  
Engineering IOF

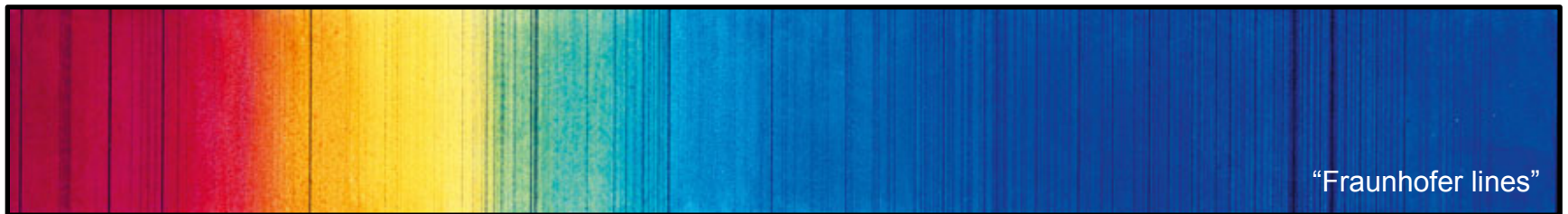
Director

Prof. Dr. Andreas Tünnermann

[www.iof.fraunhofer.de](http://www.iof.fraunhofer.de)

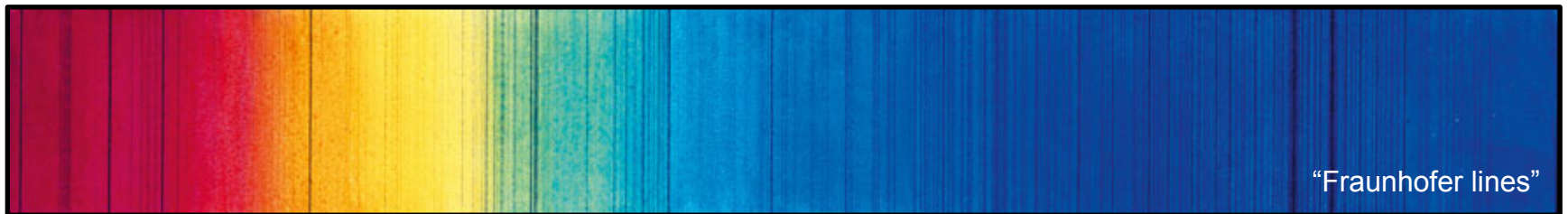
# Fraunhofer-Gesellschaft, the largest organization for applied research in Europe

- 67 institutes and research units
- More than 23,000 staff
- €2 billion annual research budget totaling. Of this sum, more than 1.7 billion euros is generated through contract research.
  - Roughly two thirds of this sum is generated through contract research on behalf of industry and publicly funded research projects.
  - Roughly one third is contributed by the German federal and *Länder* governments in the form of base funding.



# Mission Statement

- The Fraunhofer-Gesellschaft promotes and conducts applied research in an international context, to benefit private and public enterprise and is an asset to society as a whole.
- Fraunhofer Institutes help to reinforce the competitive strength of the economy in their region, throughout Germany and in Europe.
- As an employer, the Fraunhofer-Gesellschaft offers a platform that enables its staff to develop both professional and personal skills.



# Joseph von Fraunhofer (1787 — 1826)



© Deutsches Museum

## Researcher

→ Discovery of the “Fraunhofer lines” in the solar spectrum

## Inventor

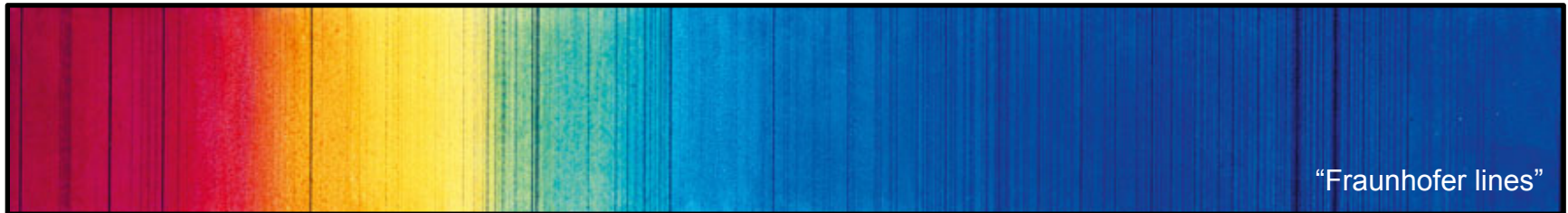
→ New methods for processing lenses

## Entrepreneur

→ Director and partner in a glassworks



© Fraunhofer-Gesellschaft



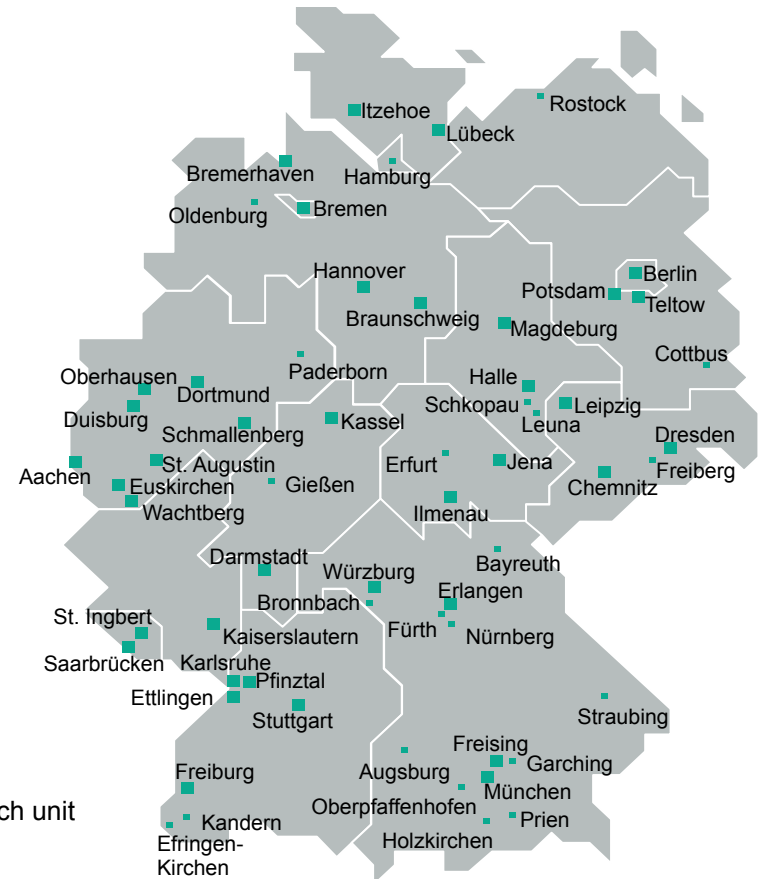
“Fraunhofer lines”

# Fraunhofer-Gesellschaft

## Locations in Germany

Data 2013

- 67 institutes and independent research units
- 7 Fraunhofer Groups
- Worldwide locations



■ institute or independent research unit  
■ other research unit

# Pooling expertise

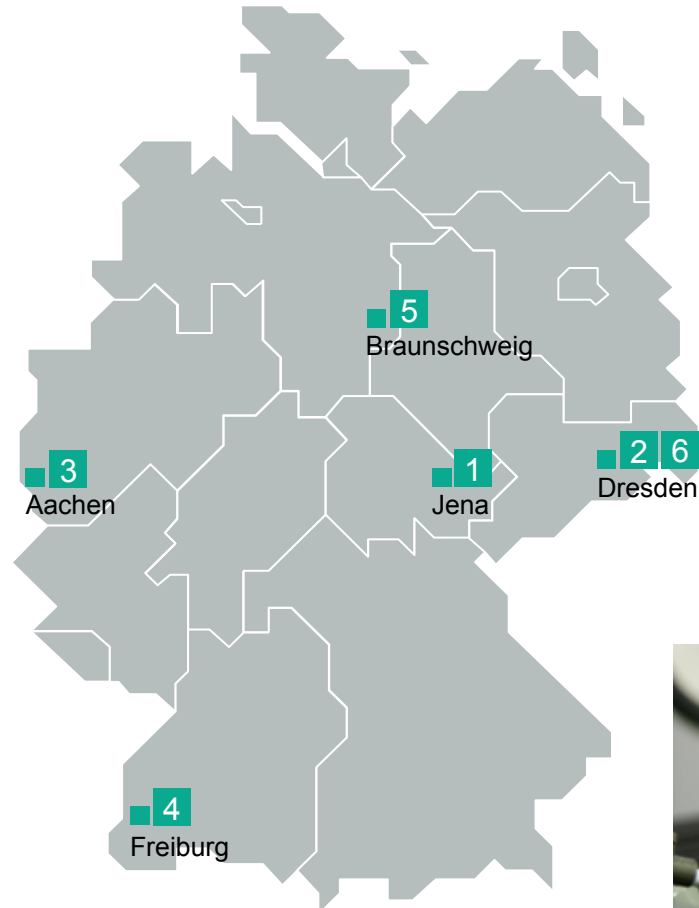
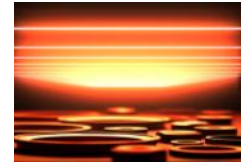
## Fraunhofer Groups



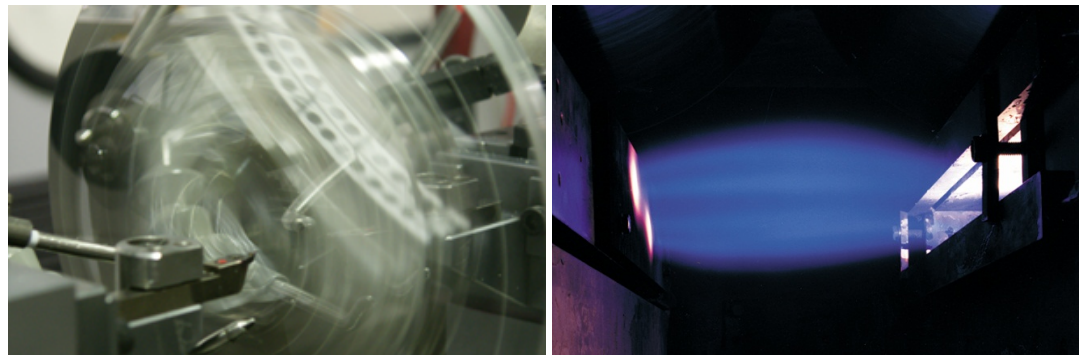
- Institutes working in related subject areas cooperate in Fraunhofer Groups
  - foster a joint presence on the R&D market
  - help to define the Fraunhofer-Gesellschaft's business policy

- ICT
- Life Sciences
- Light & Surfaces
- Microelectronics
- Production
- Materials and Components – MATERIALS
- Defense and Security VVS

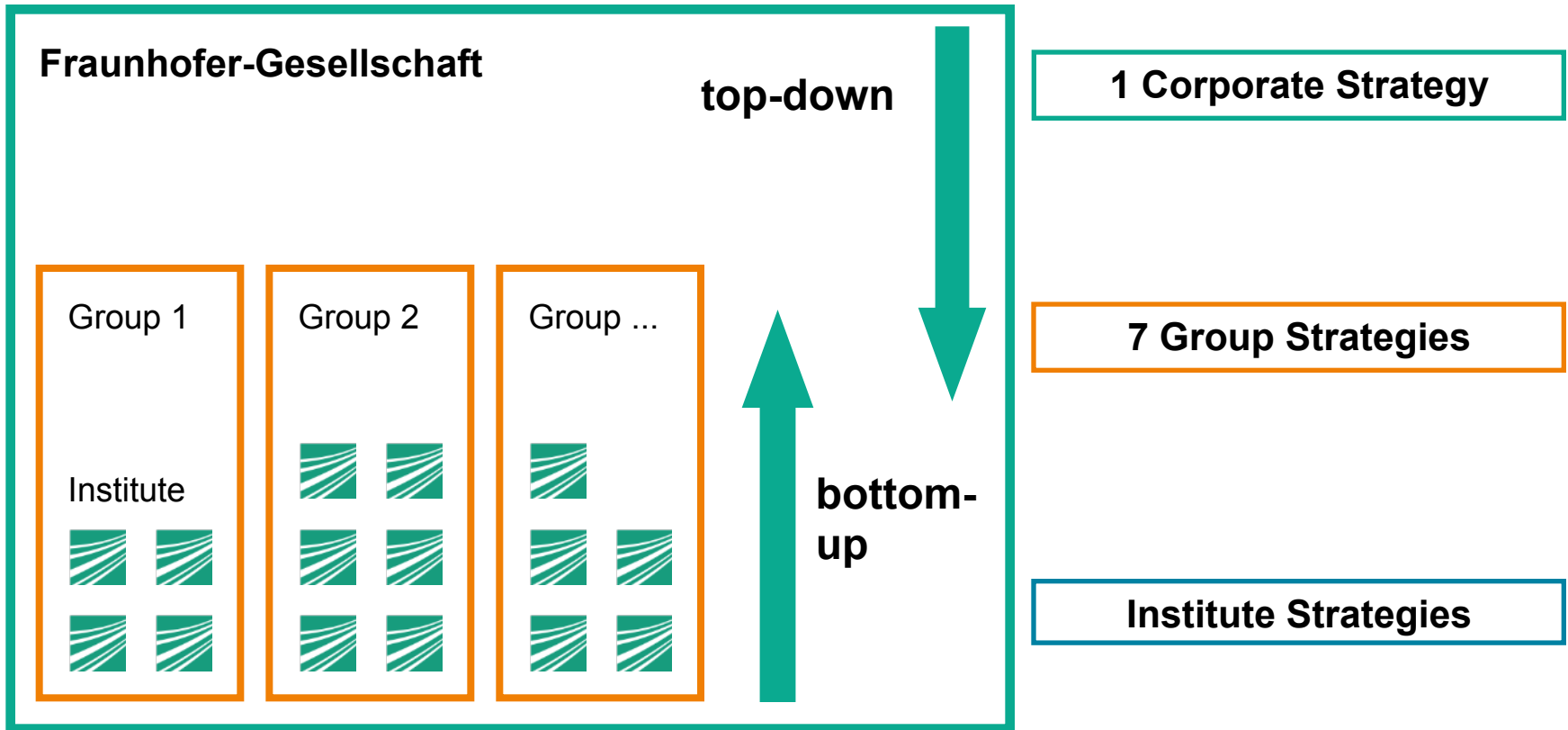
# Fraunhofer Group for Light & Surfaces



- 1 Applied Optics and Precision Engineering **IOF**
- 2 Electron Beam and Plasma Technology **FEP**
- 3 Laser Technology **ILT**
- 4 Physical Measurement Techniques **IPM**
- 5 Surface Engineering and Thin Films **IST**
- 6 Material and Beam Technology **IWS**

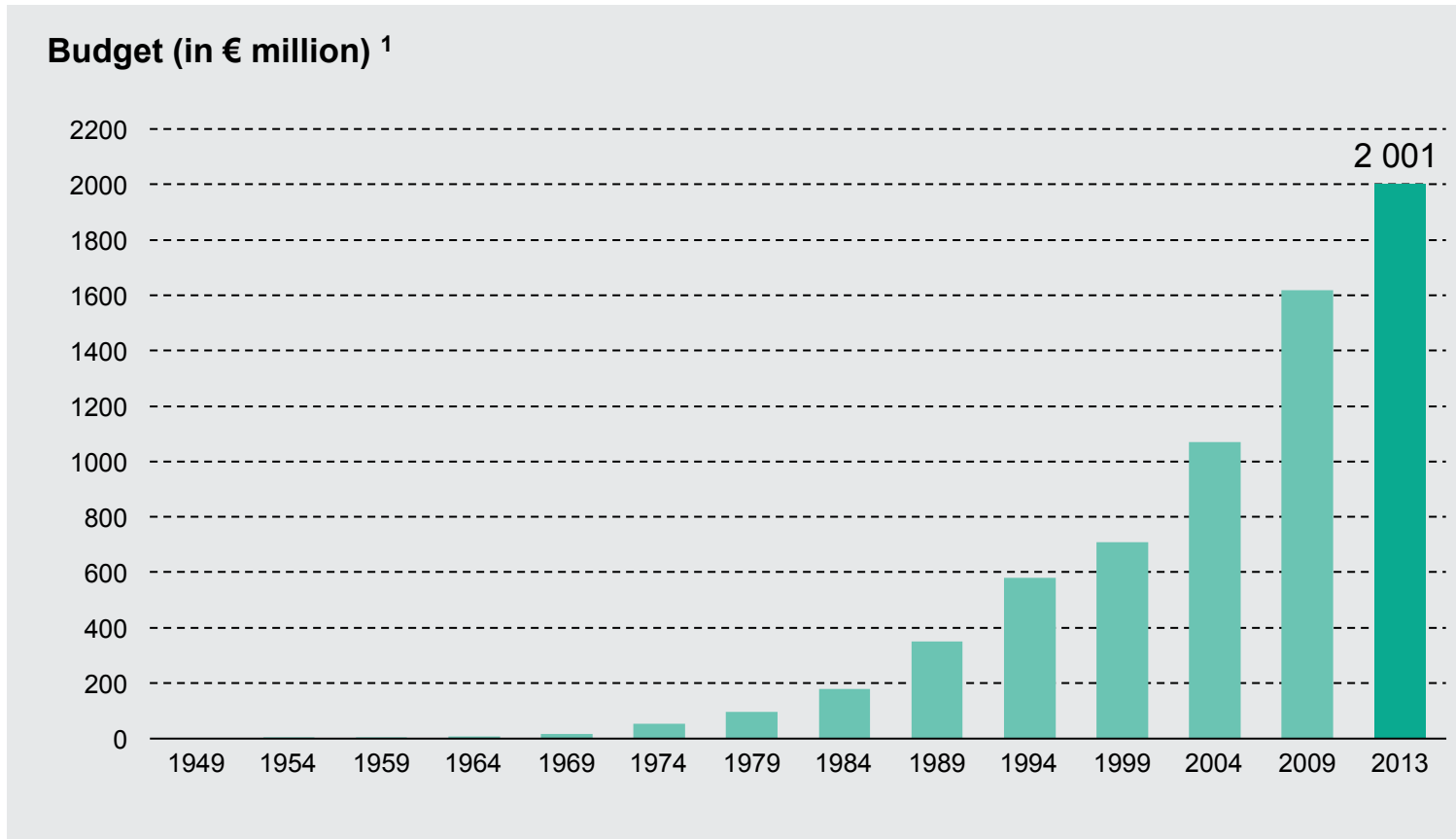


# Strategy planning at the Fraunhofer-Gesellschaft



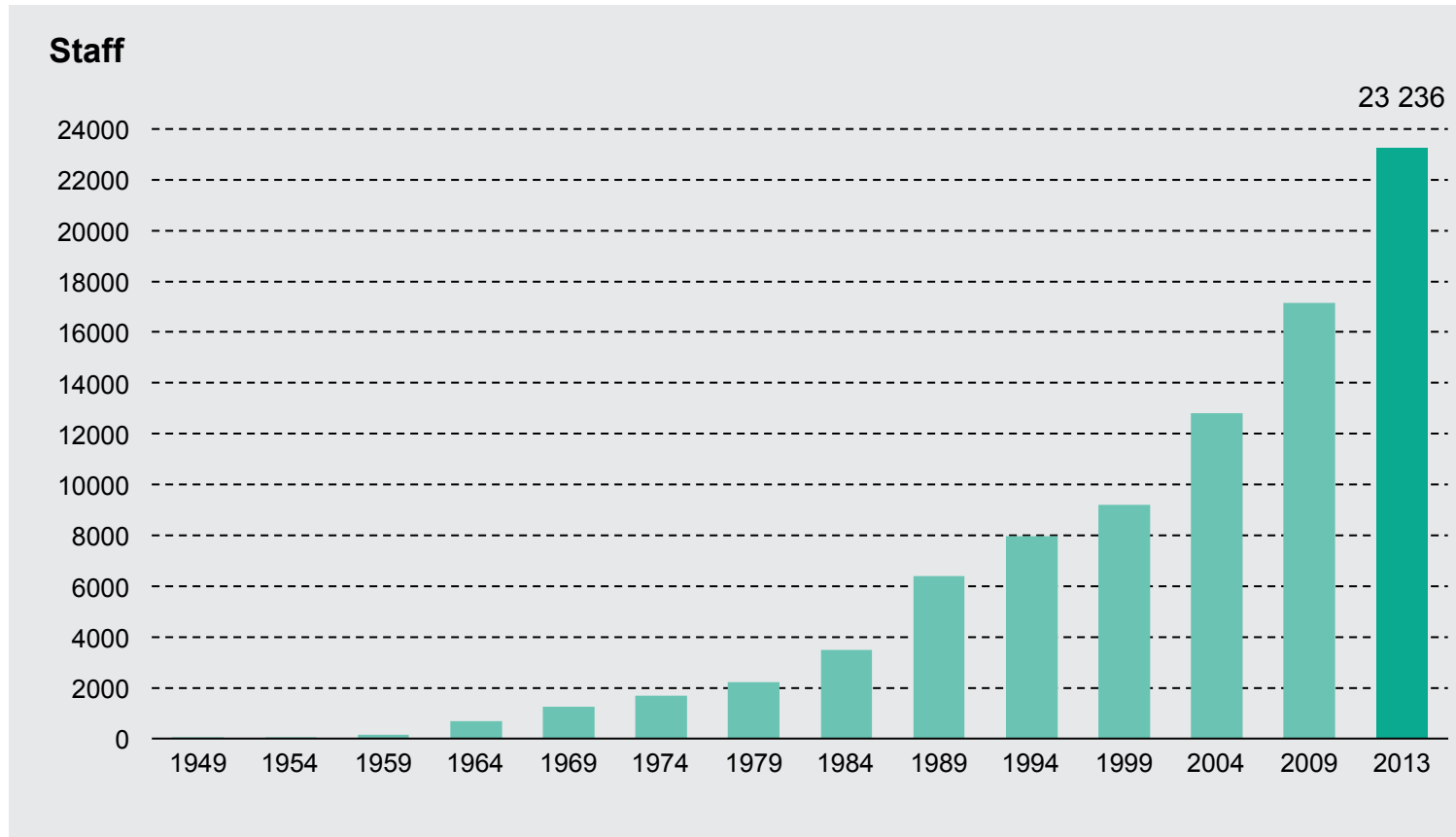


# From a small association to the leading organization for applied research in Europe



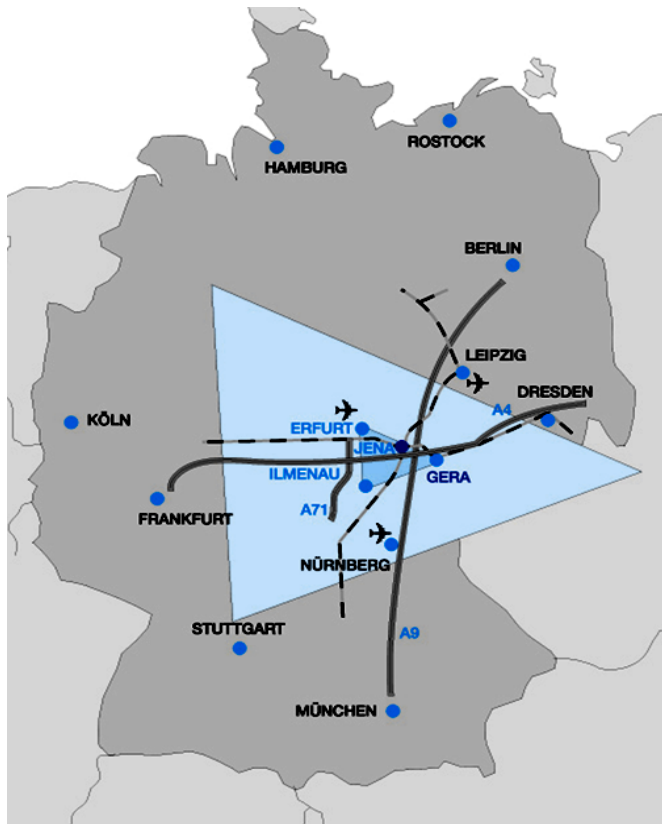
<sup>1</sup> 2013: preliminary

# From a small association to the leading organization for applied research in Europe



# Optics Region - Thuringia

## Economic data in the field of optical technologies



<b>Enterprises</b>	<b>188</b>
<b>Turnover</b>	<b>€ 2800 Mio.</b>
<b>R&amp;D rate</b>	<b>10 %</b>
<b>Export rate</b>	<b>66 %</b>
<b>Employees</b>	<b>15.350</b>
<b>scientist in research institutes</b>	<b>1.200</b>
<b>Turnover development since 2010</b>	<b>+ 4 % p.a.</b>

© OptoNet e.V. 2013

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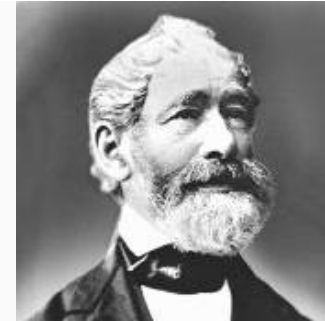
# Jena – City of Light

Example for collaboration of industry and university

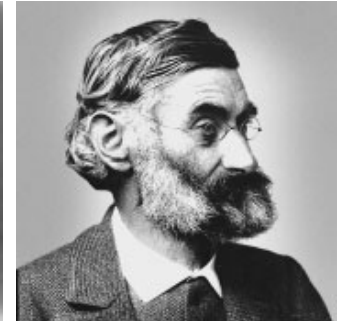
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Friedrich-Schiller-University (1558)



Carl Zeiss



Ernst Abbe



Otto Schott

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# Jena – City of Light

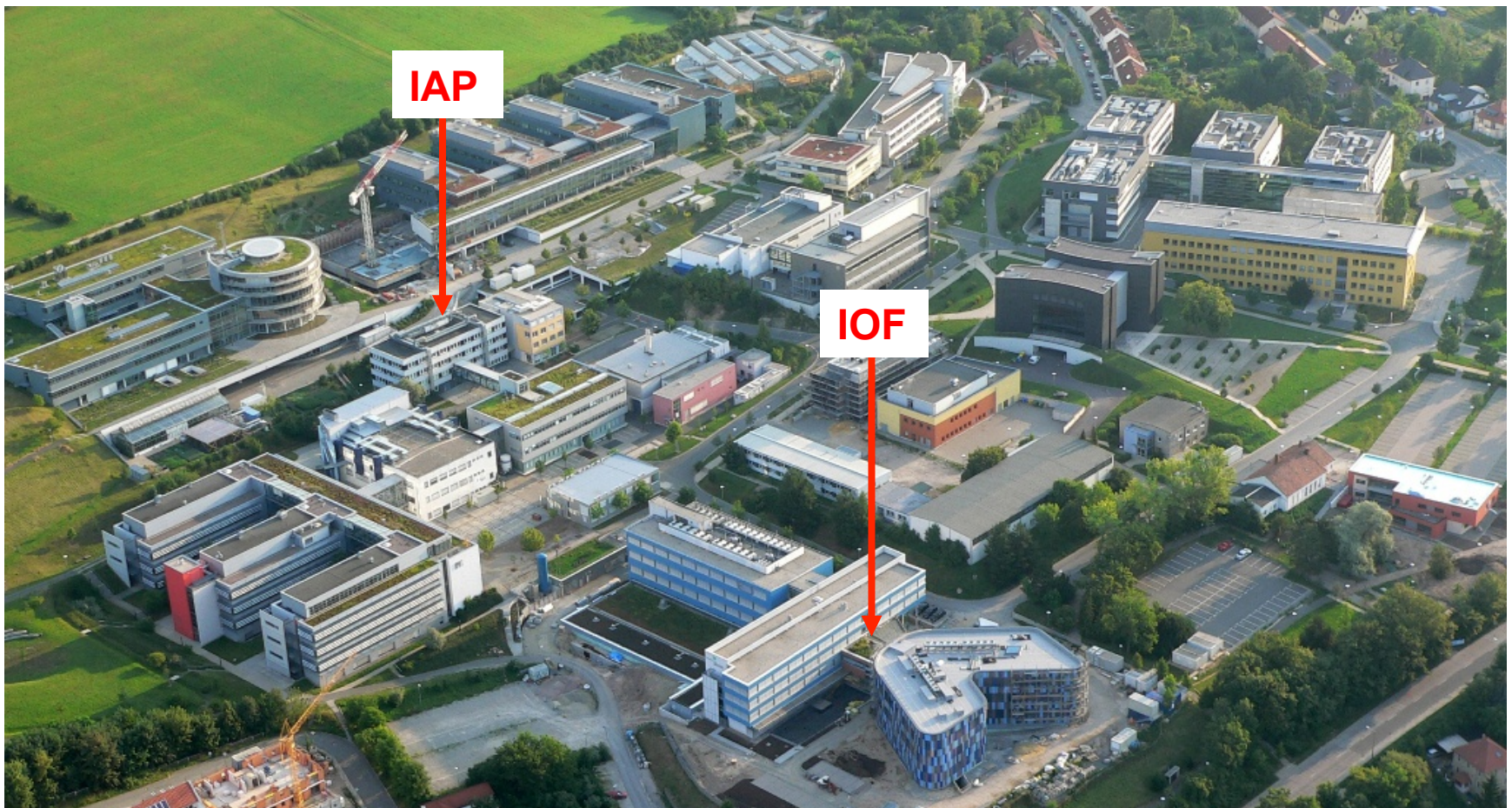
Example for collaboration of industry and university

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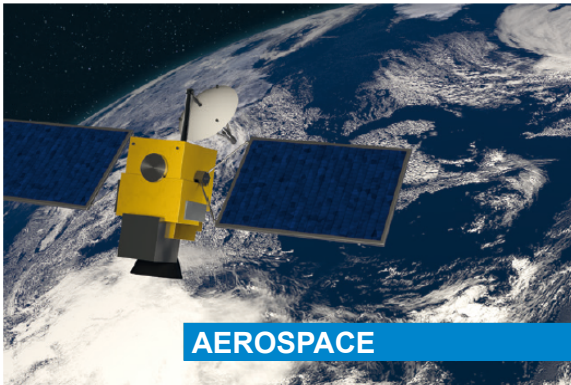
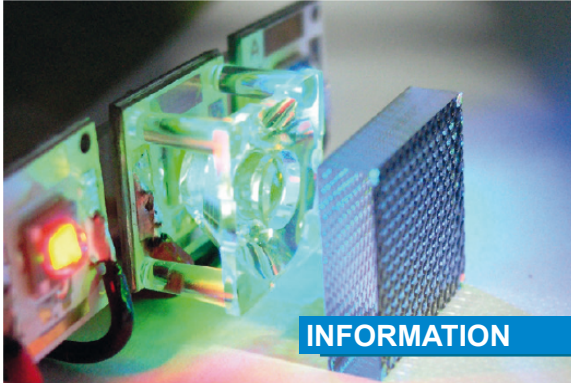


# Jena – City of Light

## Beutenberg Campus

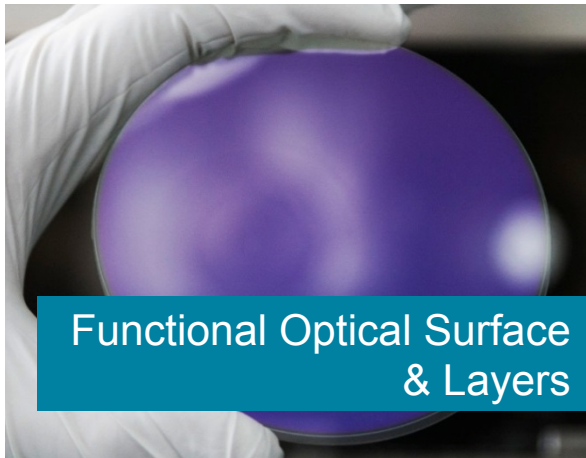
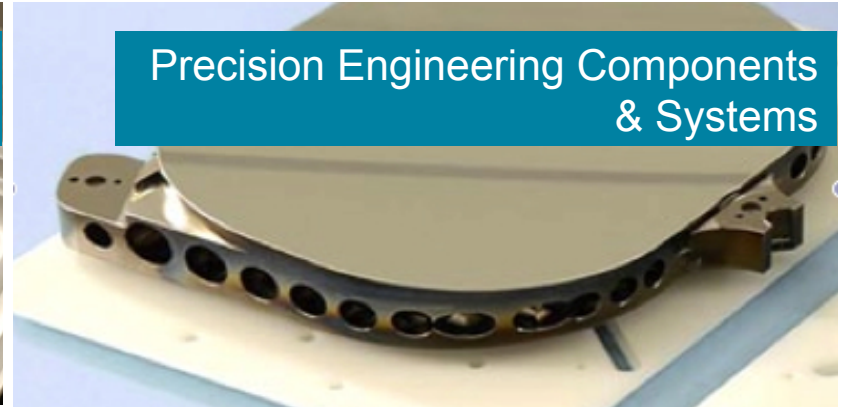
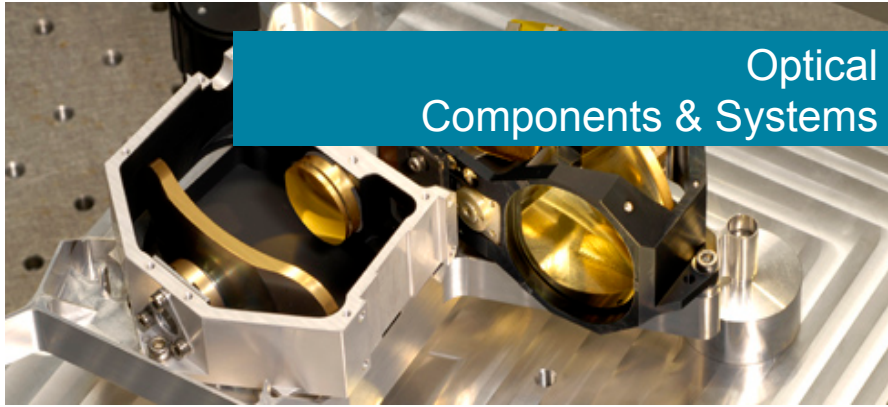


# Fraunhofer IOF Markets



# Fraunhofer IOF

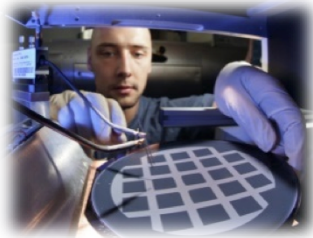
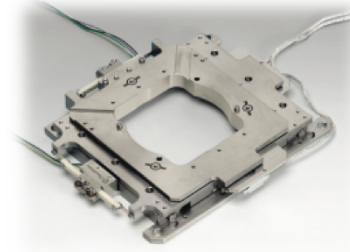
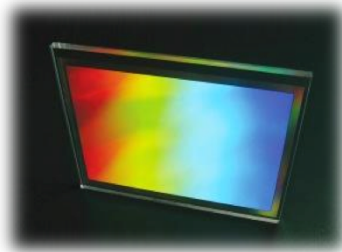
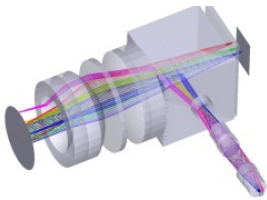
## Business Fields





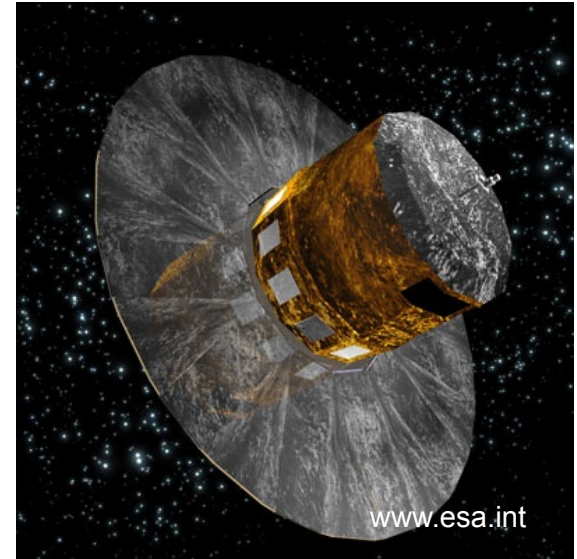
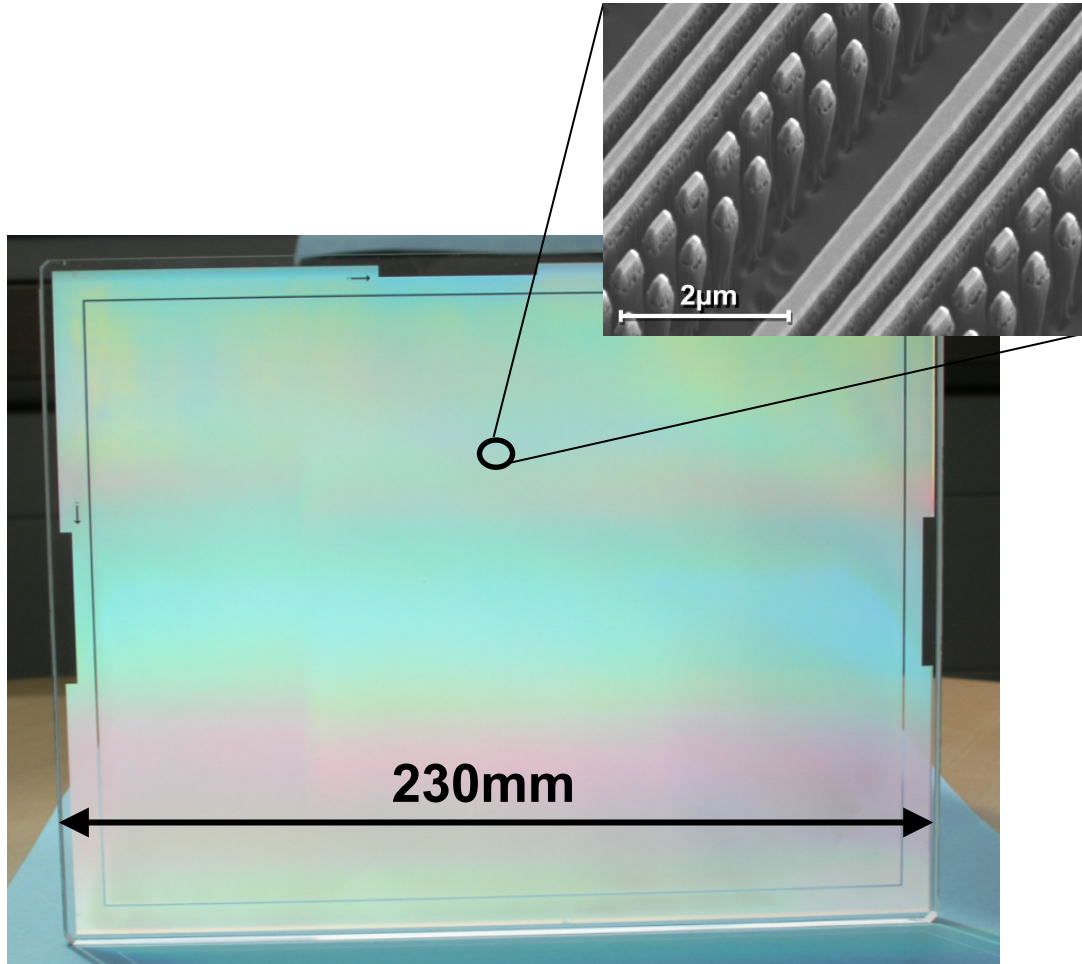
# Fraunhofer IOF

## Photonic Process Chain



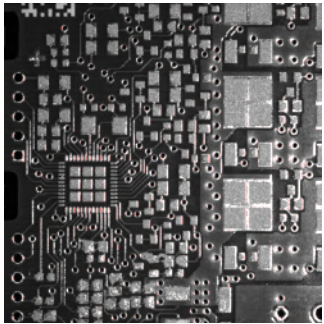
**The Fraunhofer IOF charts the entire process chain, from the system design to the manufacture of prototype systems.**

# Highlights Aerospace

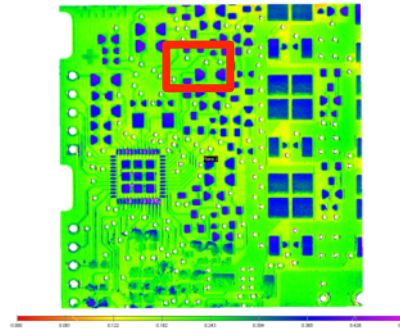
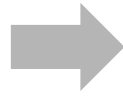


GAIA effective media grating

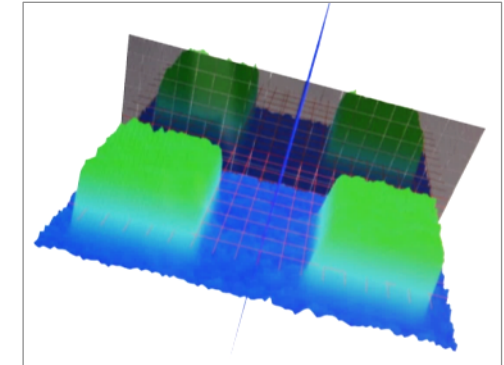
# Highlights Production



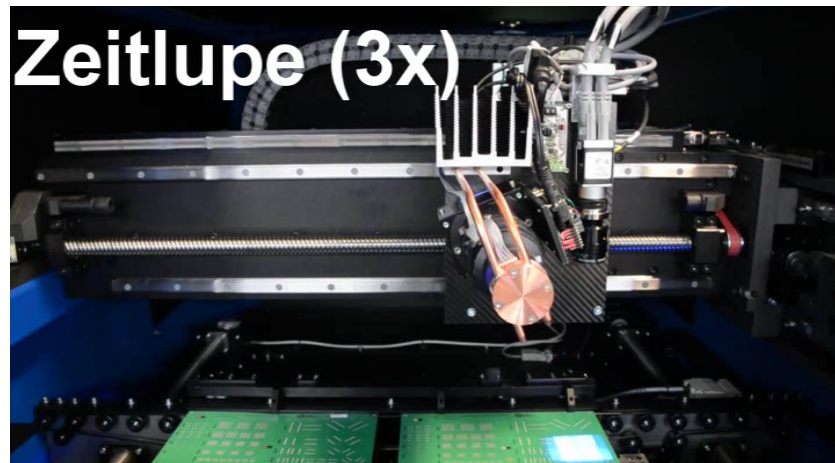
Section of circuit board



Measurement result, color-coded height



Solder paste volume, height, defects



- **Image and computation**  
= 30 Million 3D point/s (10 3D-image/s)
- **Worldwide leading data rate**

# Highlights

## Coatings for EUV collectors

### Challenges

- Reflection > 70%
- $\lambda = (13.5 \pm 0.03) \text{ nm}$
- 660 mm substrate size



# Highlights

## Coatings for EUV collectors

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**optiXfab.**



Thuringian Research Prize 2008

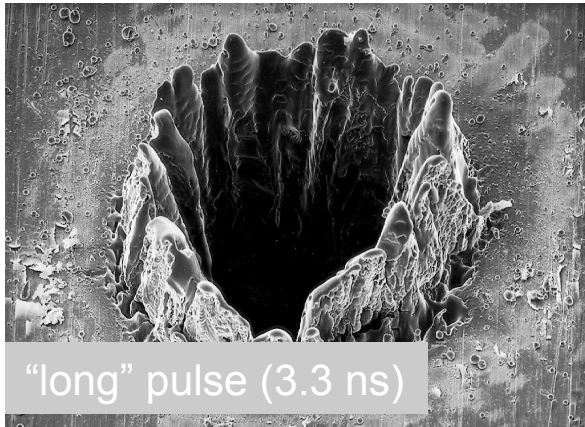
Joseph von Fraunhofer Prize 2012

# Highlights

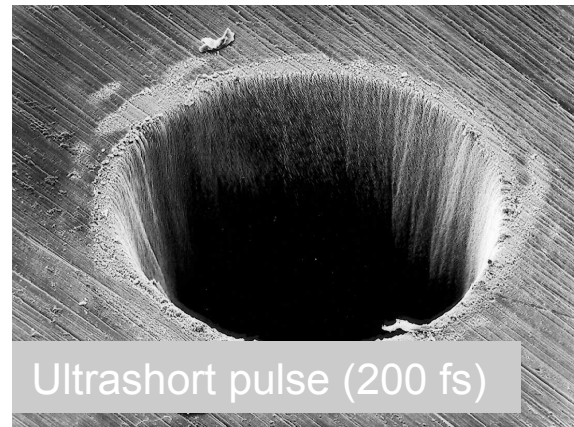
## Micro processing with ultrashort laser pulses



DEUTSCHER ZUKUNFTSPREIS  
Preis des Bundespräsidenten  
für Technik und Innovation

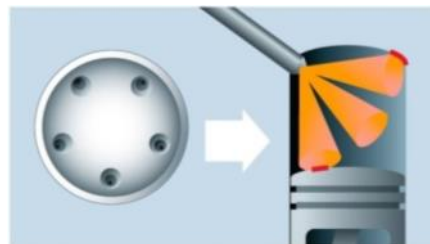


“long” pulse (3.3 ns)

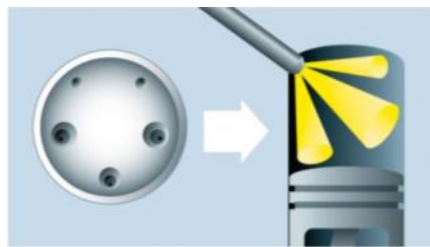


Ultrashort pulse (200 fs)

Drilling of injection nozzles in serial production



up until 20% less  
gas consumption



Photos:  
BOSCH



**BOSCH**

# Fraunhofer IOF – Solutions with light

