

# FlowPhotoChem EXPLOITATION WORKSHOP

04 NOVEMBER 2022, KAMPALA, UGANDA

Concentrated solar light for the production of sustainable chemicals –  
Solar test facilities at the German Aerospace Center

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# The German Aerospace Center at a glance



- Research Center, Space Management Agency und Project Agency
- Research Fields:

- Aeronautics
- Space
- Energy
- Transport
- Security (cross-sectoral)
- Digitalisation (cross-sectoral)



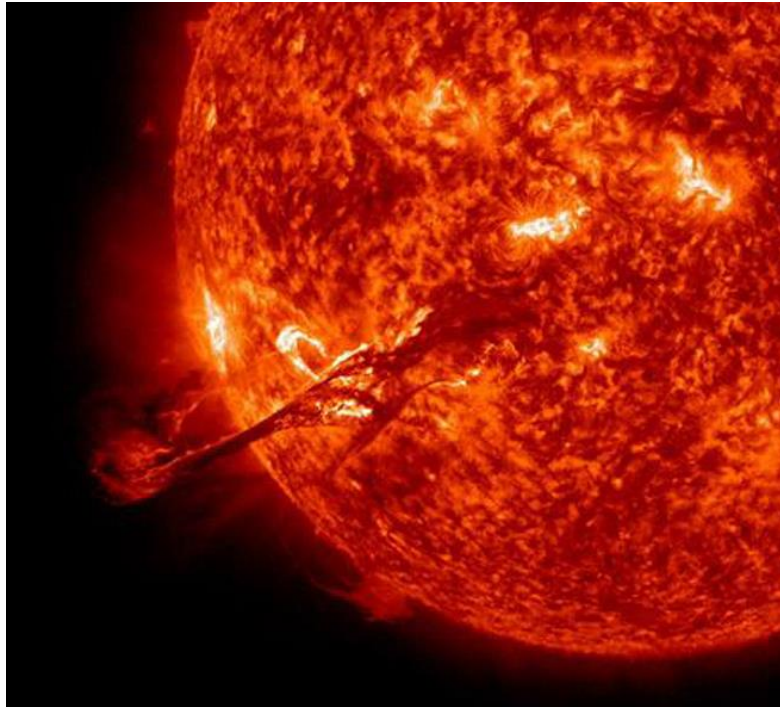
Credit: Nonwarit/Fotolia

- 10,000 employees in 55 research institutes and facilities at 30 locations
- Offices in Brussels, Paris, Tokyo and Washington D.C.
- Budget for research and operations: 1,155 Mio. € (2019)

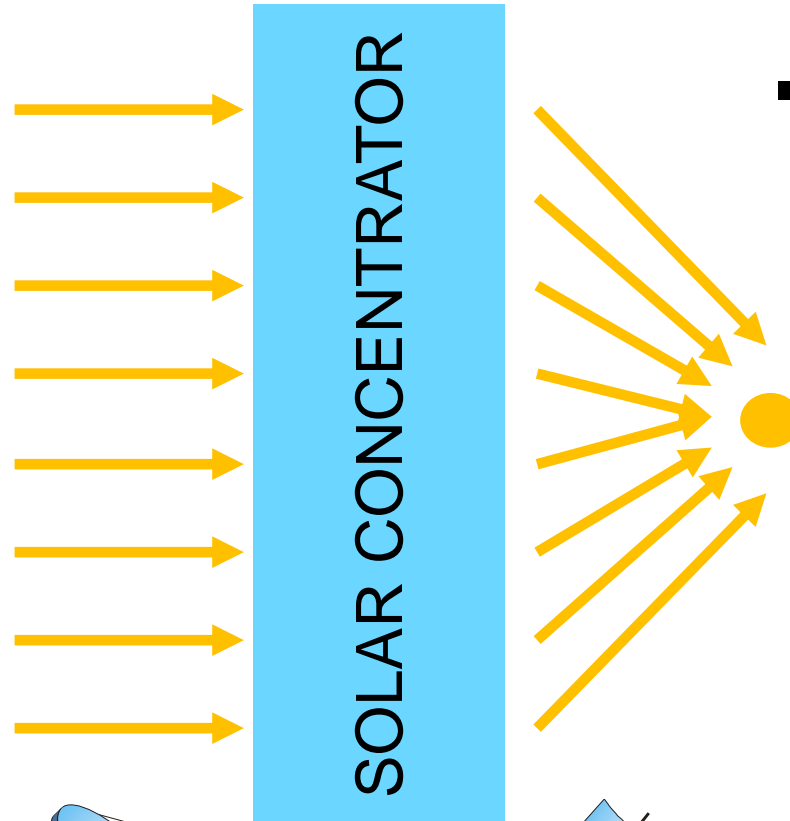


# Concentrated solar light and applications

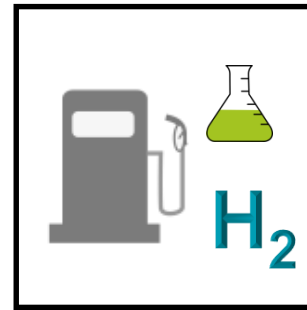
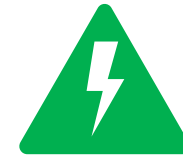
SOLAR LIGHT



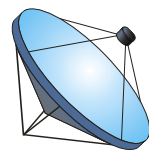
HUGE POTENTIAL



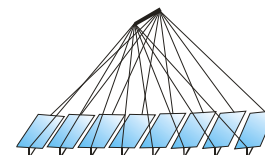
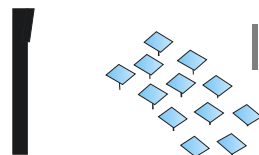
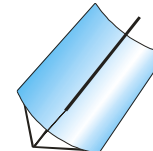
- High photon flux



Solar fuels  
and chemicals



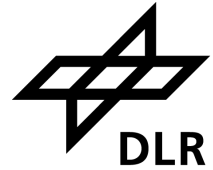
Mirrors  
or  
lenses



# DLR's solar test facilities

- Test and qualification of systems and components
- Demonstration of solar-driven processes

Natural sunlight



Artificial (sun-)light



Solar Furnace



Synlight



Solar Towers



SoCRatus

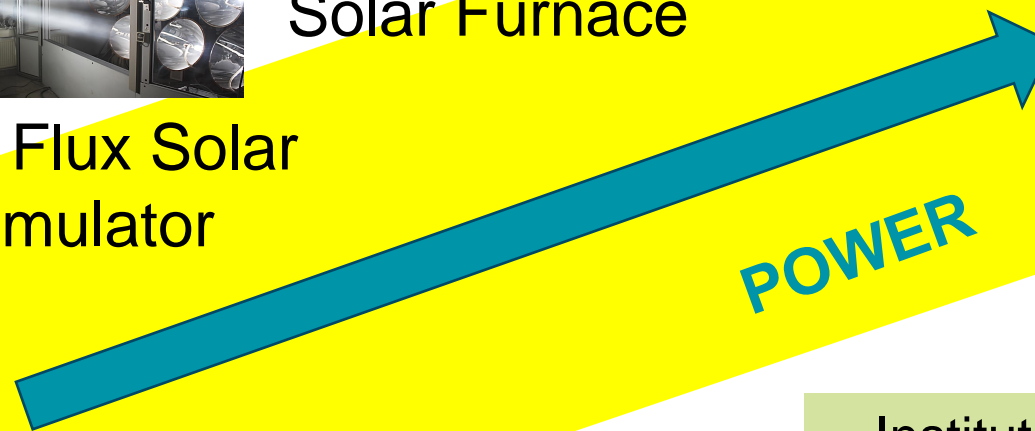


High Flux Solar Simulator



LED light source

Laboratory scale  
~ 100 W



Industrial scale  
~ 2 MW

Institute of Future Fuels

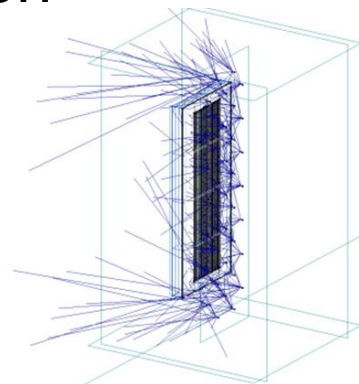
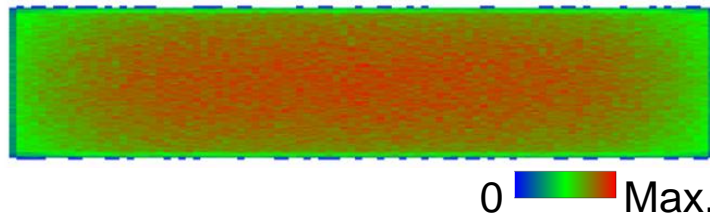
Institute of Solar Research

# LED LIGHT SOURCE

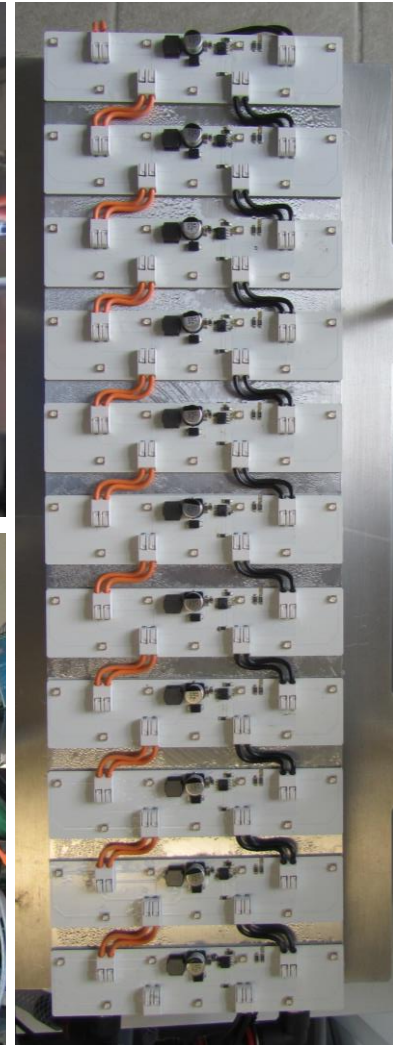
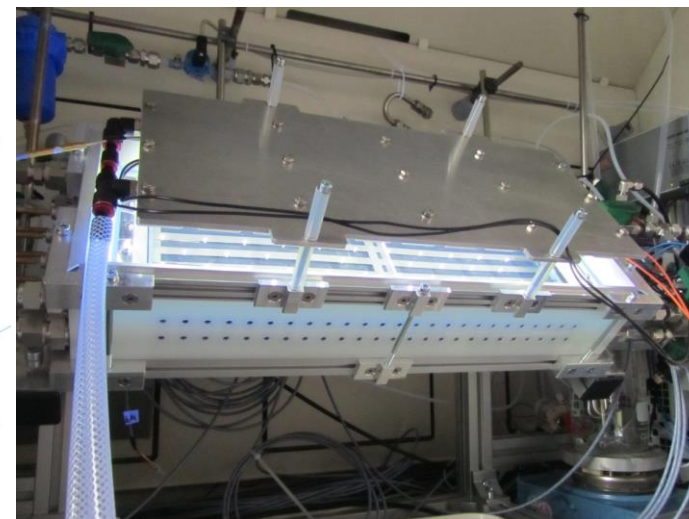


# LED Light Source – Key facts and example of application: DuaSol

- 11 LED arrays à 7 LEDs (77 LEDs in total)
- LG LEUVA33W70RL00
  - Typical peak wavelength: 365 nm
  - View angle 130°
- Nominal total radiative power: 105.1 W
- Length: 420 mm, width: 120 mm
- Good homogeneity of irradiation



- Water-cooled aluminium body







# SoCRatus

Michael Wullenkord, Institute of Future Fuels, 04 October 2022

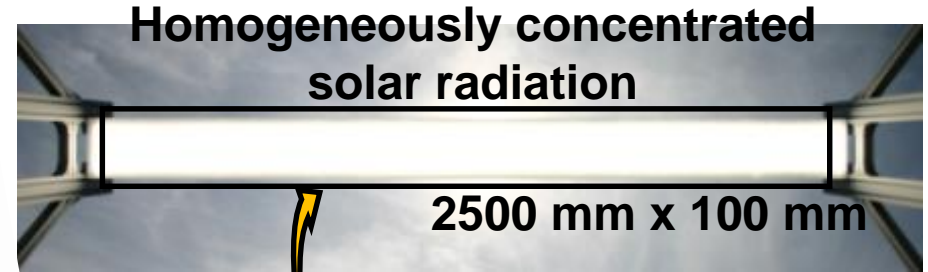
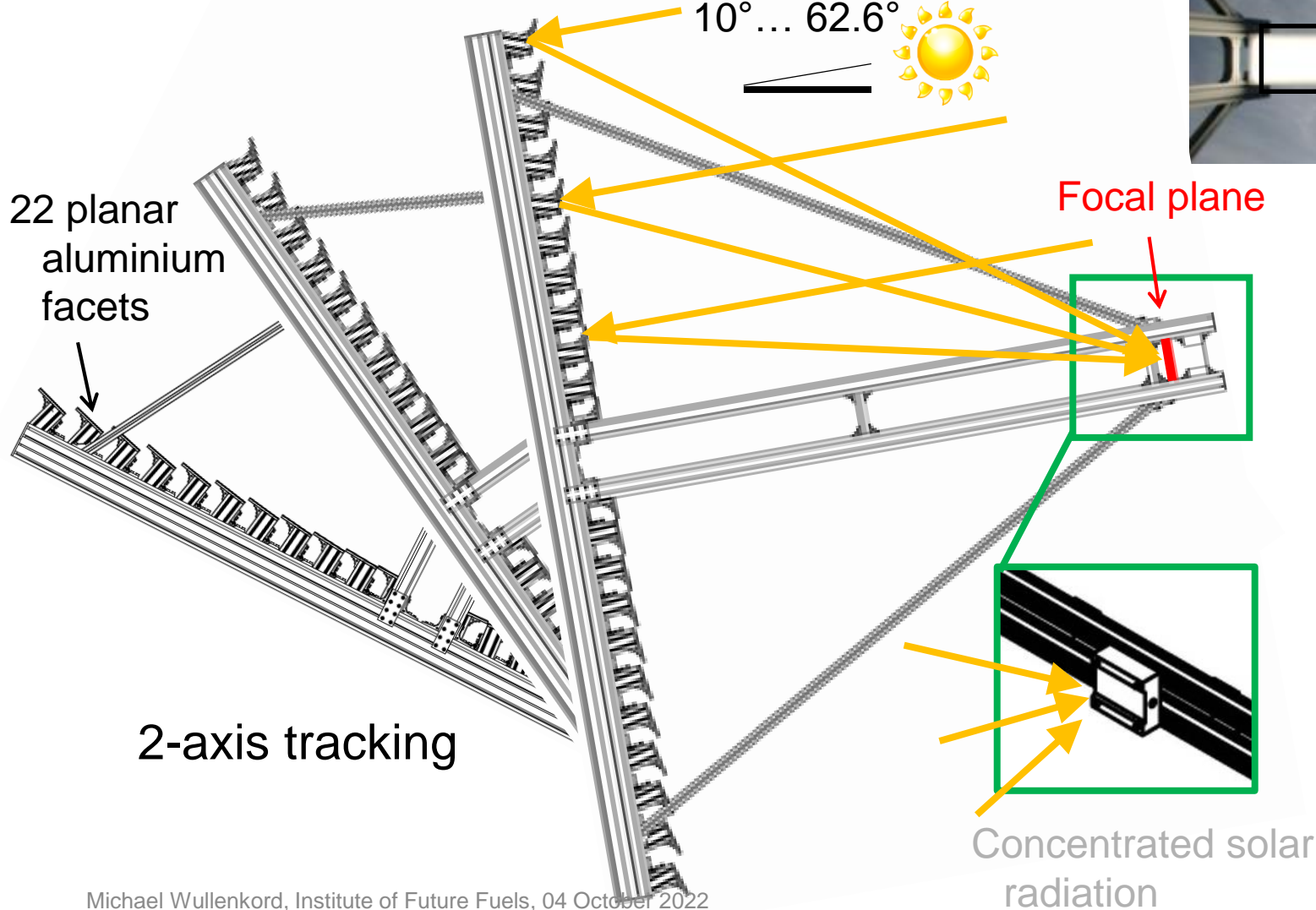


# SoCRatus – Principle of operation

## Solar Concentrator with a Rectangular Flat Focus



Solar radiation Solar altitude angle:  $10^\circ \dots 62.6^\circ$





# SoCRatus – Key facts



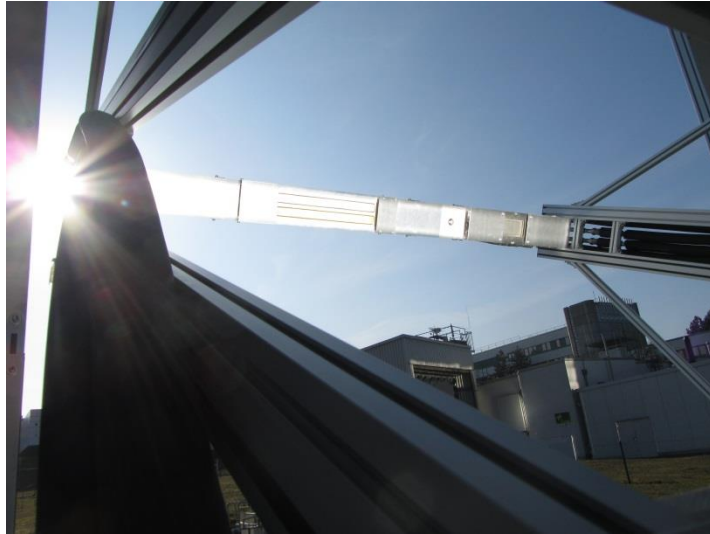
- Aperture area: 8.8 m<sup>2</sup>
- Geometric concentration ratio: 20.2
- Effective concentration ratio: 17.6
- Solar power input: up to ~ 4 kW
- Facets can be covered using a shutter



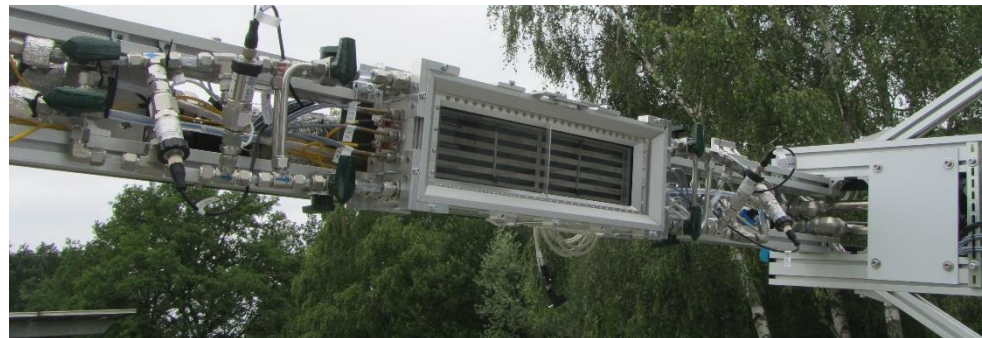
# SoCRatus – Examples of application



## Project PECDEMO (2014-2017)



## Project DuaSol (2014-2018)



SPONSORED BY THE



Federal Ministry  
of Education  
and Research







# HIGH FLUX SOLAR SIMULATOR

# High Flux Solar Simulator: Key facts

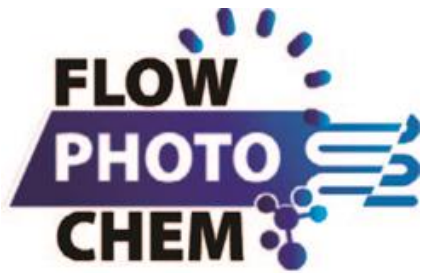
- Ten xenon arc lamps: ellipsoid, individually adjustable
- Electrical power: up to 60 kW
- Power on target: up to 21 kW
- Flux density: up to 4.1 MW/m<sup>2</sup>
- Maximum temperature: 2100°C
- Operating temperature: 300-1600°C



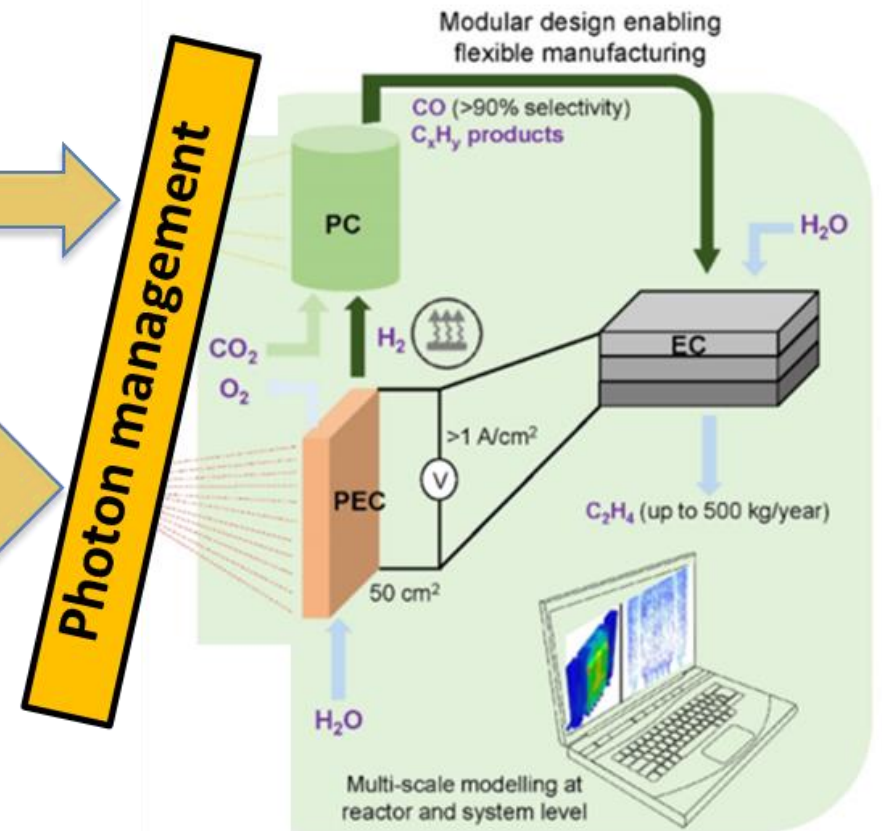


# High Flux Solar Simulator: Example of application

- Will be used in



DLR HFSS

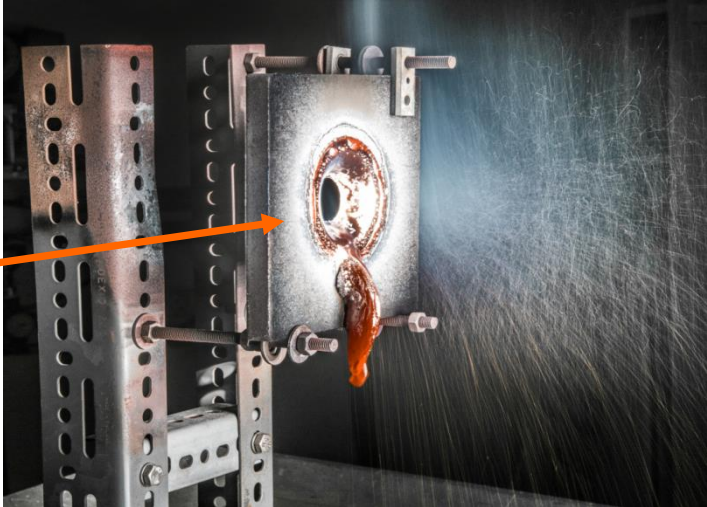
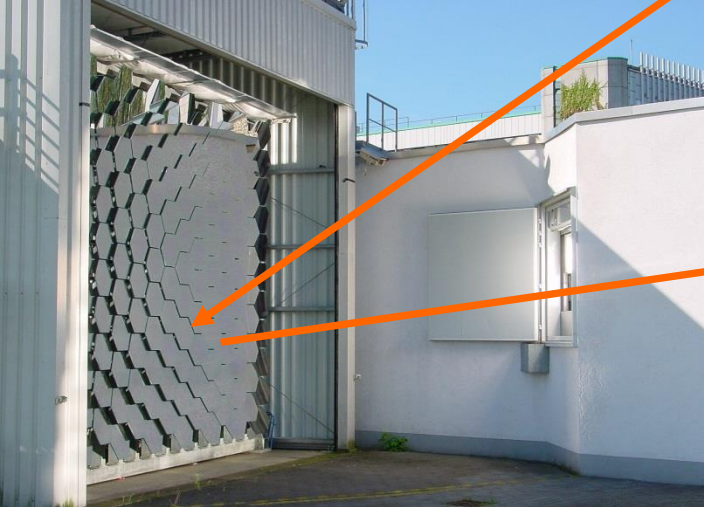
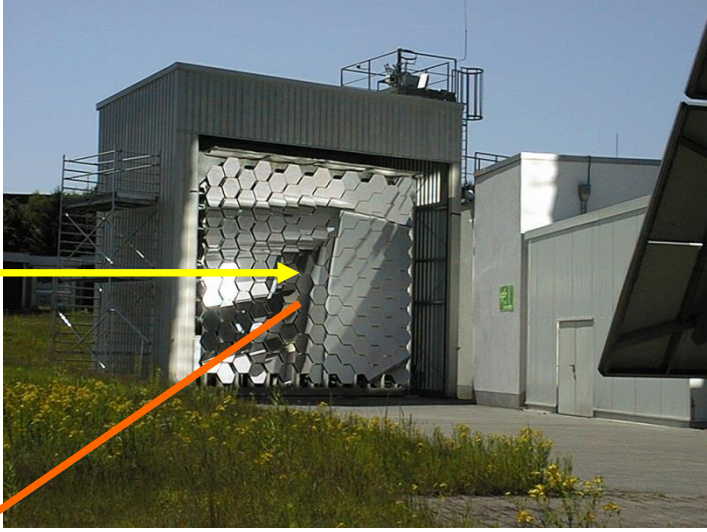
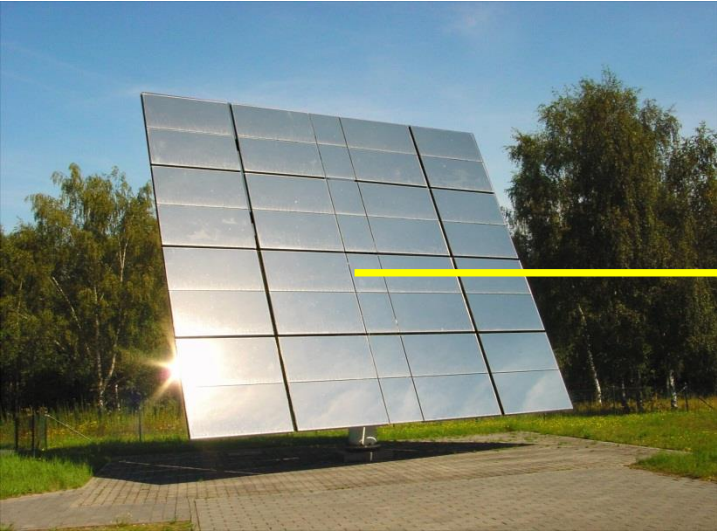




# SOLAR FURNACE



# Solar Furnace – Principle of operation



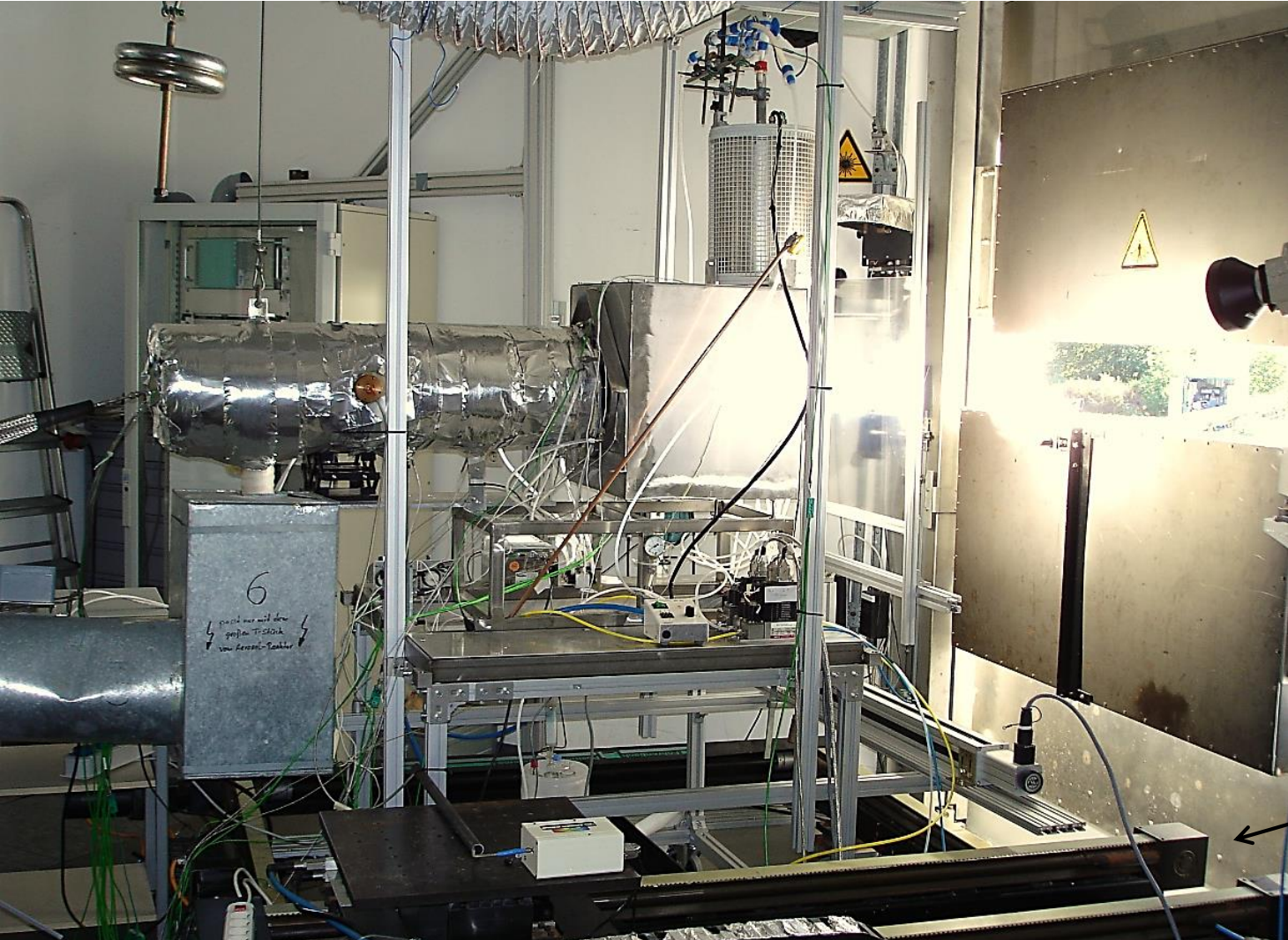
# Solar Furnace – Key facts

- 159 spherical facets: can be individually adjusted or covered
- Power on target: up to 22 kW
- Flux density: up to 4.5 MW/m<sup>2</sup>
- Maximum temperature: 2500°C
- Operating temperature: 300-1300°C





# Solar Furnace – Example: Solar splitting of sulphuric acid



IR camera

Shutter

3-axis-table



# SYNLIGHT

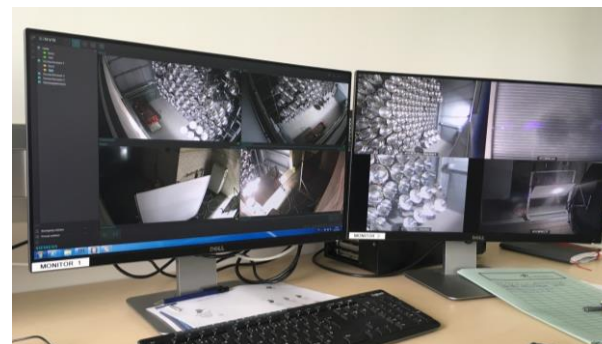
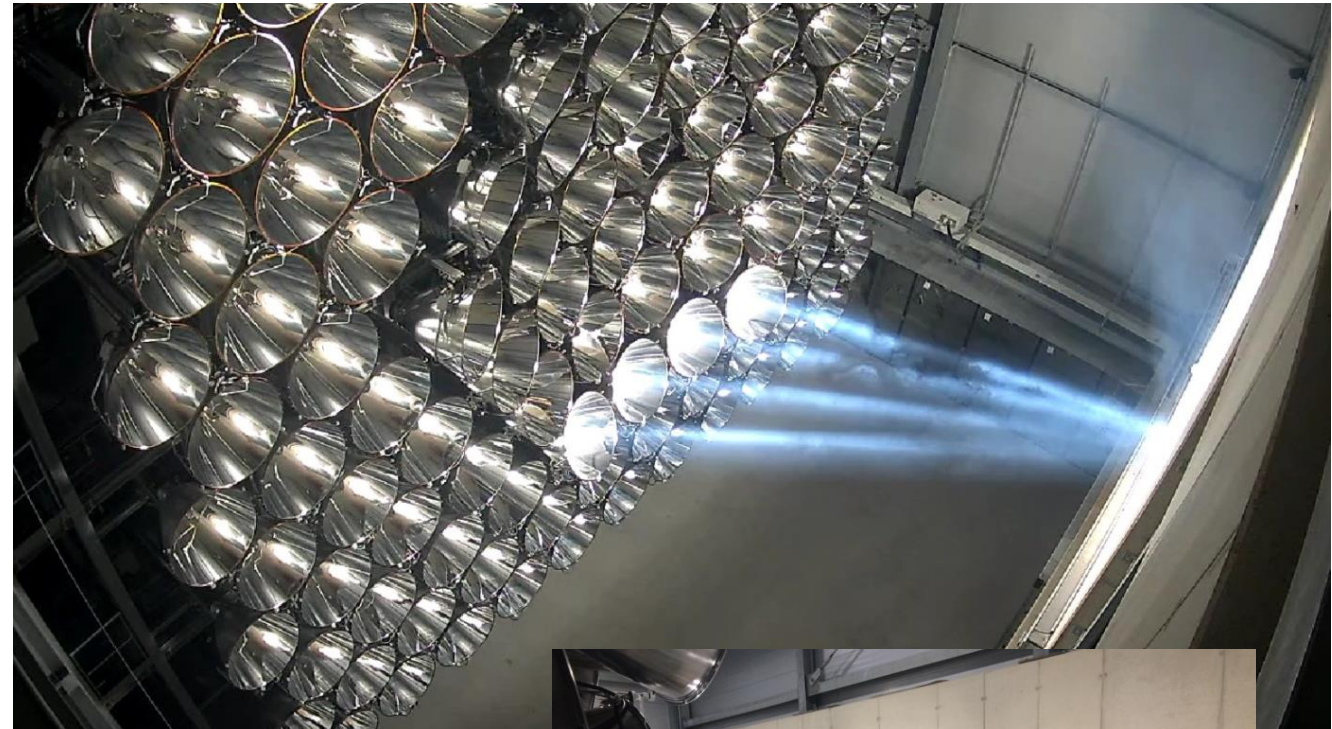


# Synlight – Key facts

synlight



- 149 identical modules
- 7 kW<sub>el</sub> xenon lamps
- 310 kW maximum radiation power
- 12.5 MW/m<sup>2</sup> peak flux
- 4 m x 4 m maximum aperture size
- 3 movable axes per module
- PLC-based control
- Three test chambers and control rooms





# Synlight – Example of application: INDIREF

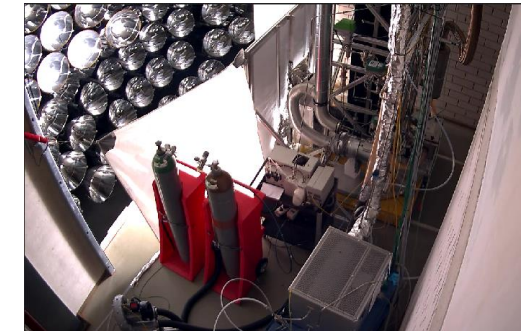


- Indirectly solar-heated reforming at 20 kW<sub>th</sub>-scale



Reformer

Receiver



EUROPEAN UNION  
Investing in our Future  
European Regional  
Development Fund



EFRE.NRW  
Investitionen in Wachstum  
und Beschäftigung



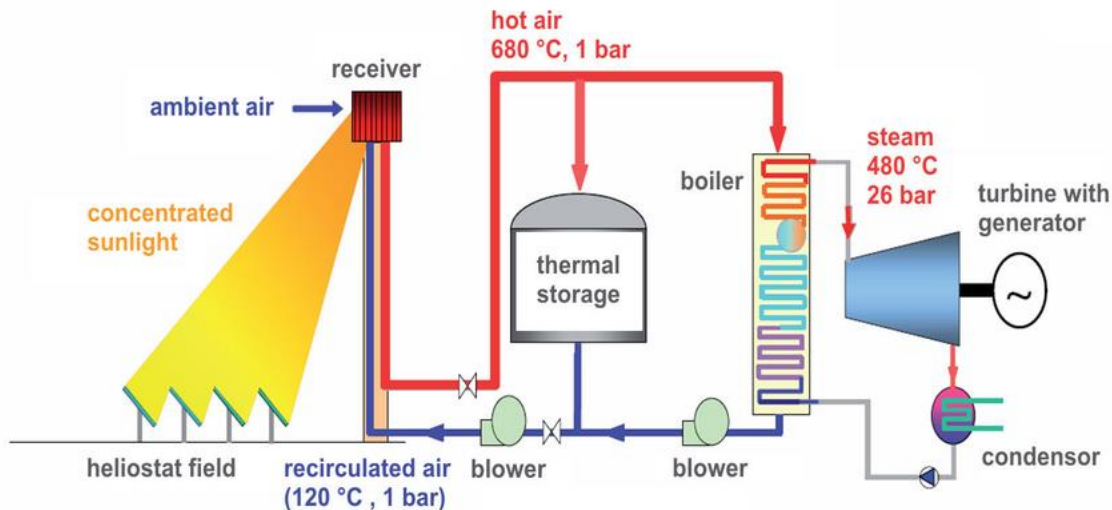
# SOLAR TOWERS



# Jülich Solar Tower Demonstration Plant



- >2000 heliostats / 18,000 m<sup>2</sup>
- 8.2 MW<sub>th</sub> / 1.5 MW<sub>el</sub>
- 1 hour thermal storage
- Research platform





# Multifocus tower (MFT)

- Three additional test platforms
- Technical profile
  - Flux up to 1 MW/m<sup>2</sup>
  - Max. thermal power of test reactors/ receivers 2 MW
  - One platform designed for solar chemical experiments
  - Gas storage for solar chemical applications
  - Parallel operation



# MFT – Example of application: Solar Syngas Production

## Partner: Synhelion

- First successful test of a solar thermal process for the production of synthesis gas in a pilot plant.
- Receiver: 250 kW
- Syngas forms feedstock for liquid fuels production, particularly kerosene.
- Promising technological approach to implement climate protection goals in the mobility sector.

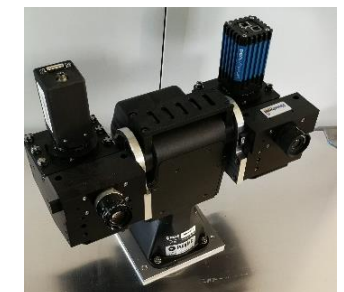
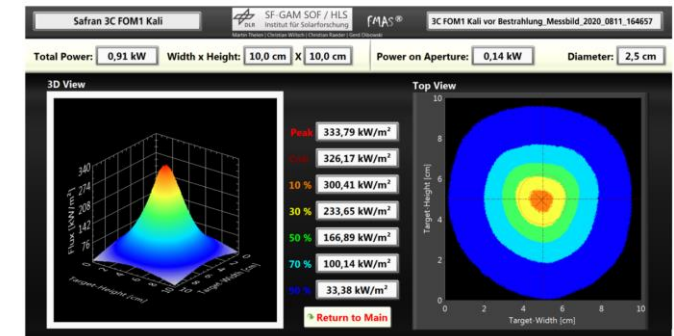
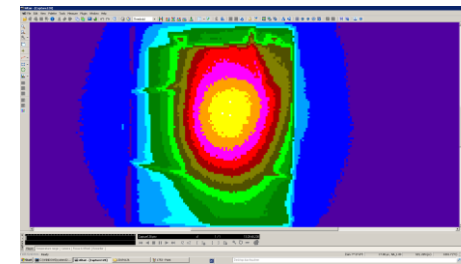
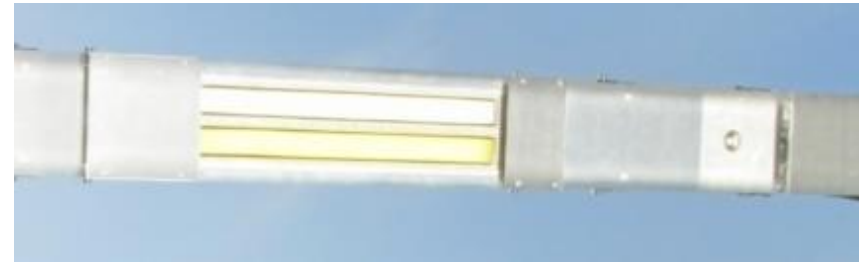




# Equipment for ensuring proper irradiation – exemplarily



- Spectrometers: Spectral irradiance
- Pyrheliometer: DNI
- IR cameras
- Flux measurement system FMAS<sup>®</sup> (camera target)
- Hyperspectral imaging systems: 300 nm ... 1000 nm
- Tailored secondary optics to meet irradiation profile requirements



# Summary



- DLR operates a wide range of solar test facilities
- Assessment and enhancement of processes, systems and components for the production of solar fuels and sustainable chemicals under practical conditions
- Open for collaboration



LED light sources



SoCRatus

Laboratory scale  
~ 100 W



High Flux Solar Simulator



Solar Furnace

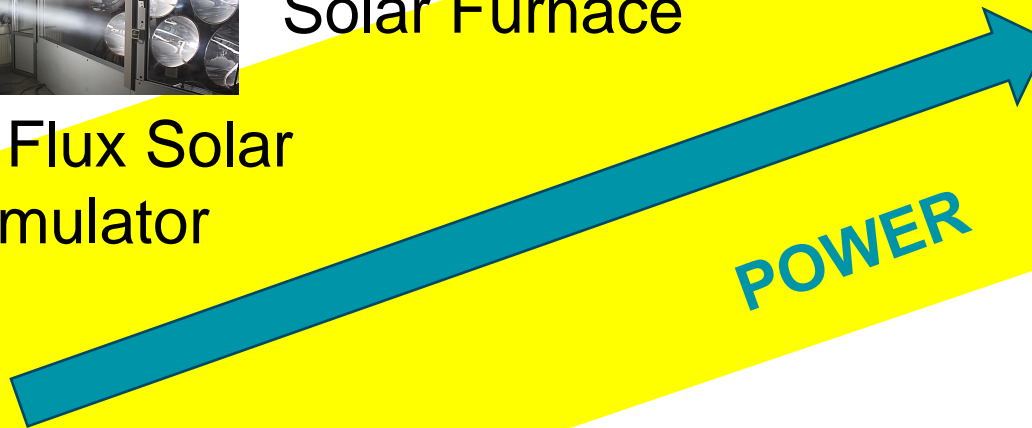


Synlight



Solar Towers

Industrial scale  
~ 2 MW





Thank you for your attention.



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Solar refinery (photo composition: DLR)