Laser Based CBE Stand-off Detection
and
the new Cooperation of the German Aerospace Center (DLR) with the University of Rome Tor Vergata in CBRNe Research, Didactic, and Training

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Institute of Technical Physic
German Aerospace Center (DLR)

2nd Scientific International Conference on CBRNe
SICC Series 2020
10-12 December 2020

Deutsches Zentrum
für Luft- und Raumfahrt
German Aerospace Center

DLR at a glance

- **Research Institution**
  - Space Administration
    - Project Management Agency

Locations and employees

More than 9000 employees work in 54 institutes and facilities at 30 sites across Germany.

International offices in Brussels, Paris, Tokyo and Washington D.C.

Institute of Technical Physics

National and international networking

Clients and partners: Governments and ministries, agencies and organisations, industry and business, science and research

Worldwide

Europe

Germany

HELMHOLTZ GEMEINSCHAFT

Bundesministerium für Bildung und Forschung

Bundesministerium für Wirtschaft und Energie

Bundesministerium der Verteidigung

SIEMENS DIEHL OHB AIRBUS LIEBHERR

DLR Deutsches Zentrum für Luft- und Raumfahrt

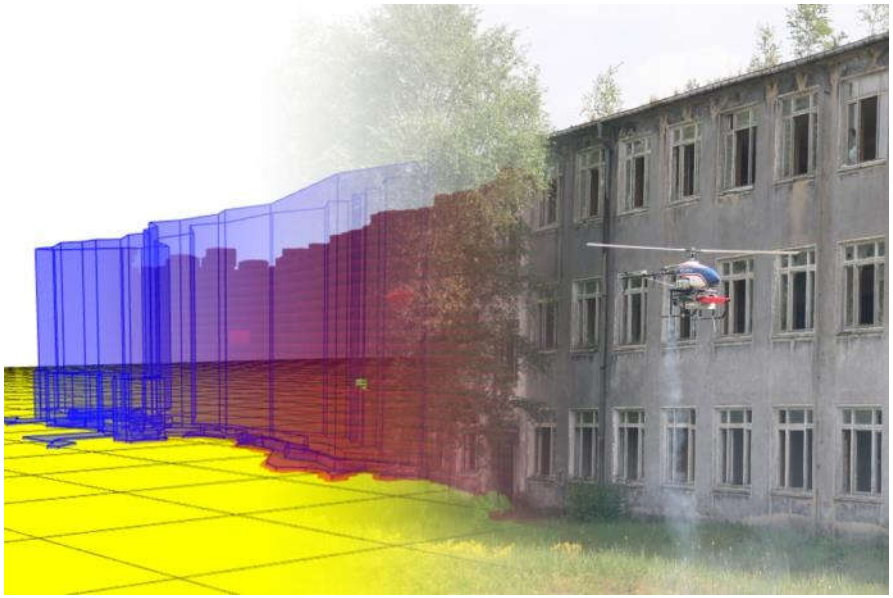
Areas of research:

- Aeronautics
- Space research and technology
- Transport
- Energy
- Security (cross-sectoral area)
- Digitalisation (cross-sectoral area)

Image:
Nonwarit/Fotolia

DLR Security cross-sectoral research area

- Coordination of the cross-focus defence and security-related research
- Development activities in consultation with partners in government, science, industry and international organisations
- Innovative organisational concepts for the development, testing and evaluation of technologies, as well as for the assessment of and consulting in connection with security-relevant applications



Structure / Organisation
DLR cross-sectoral area security

Security research programme

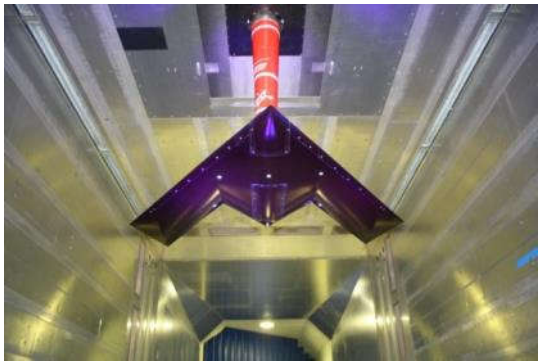
Defense technology research	Airborne platforms
	Satellite technology and sensor technology
	Impact, protection and cyber
	Responsive space
Civil security research	Security and dual use
	Maritime safety
	Corporate security

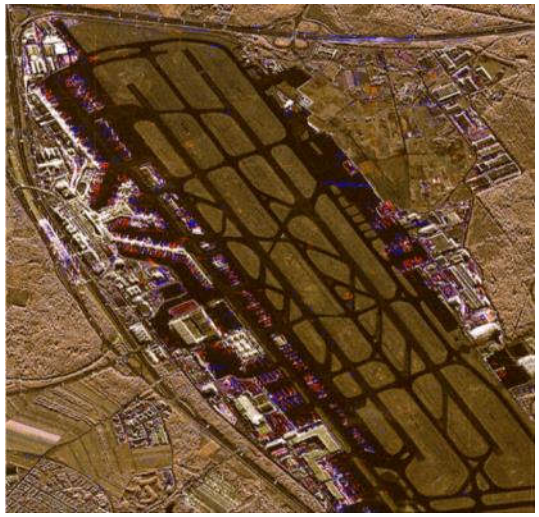
Operational safety

Total budget defense and security research approx. 80 Mio €/year (institutional and third party funding)

Defence technology research

- Contributes to meeting the Bundeswehr's needs and closing capability gaps
- Provides processes and facilities for the demonstration, testing and evaluation of defence-relevant technologies
- Serves to maintain and expand the analysis and evaluation capability for the Ministery of Defence and subordinate departments





Civilian security research

- Contributes to current and future capability profiles that are relevant to the protection and security of the...
  - population
  - borders
  - critical infrastructure
  - business enterprises
  - crisis and disaster management services
- Manages the activities and coordinates the research of the DLR research network ‘Maritime Security’

Institute of Technical Physics

80 Co-workers

Institute of Technical Physics

Laser technology and laser based systems for:

Aviation

Optical air data systems

Head: Oliver Kliebisch

Space

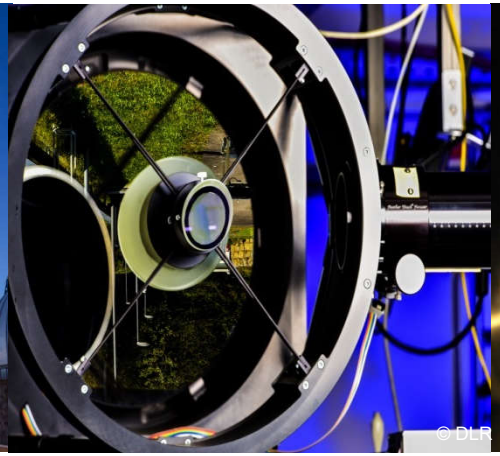
Detection, ranging and mitigation of space debris

Head: Wolfgang Riede

Security

Stand-off CBE detection
UAV carrier system

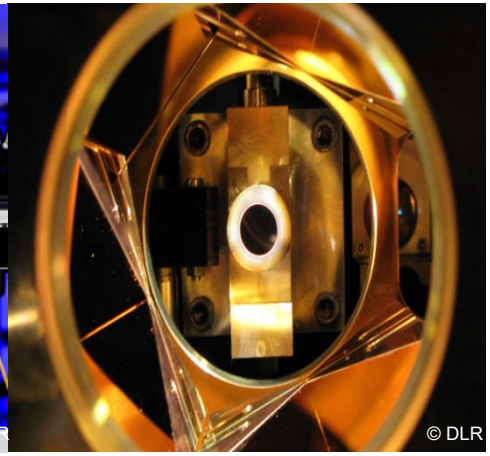
Head: Frank Duschek



Defence

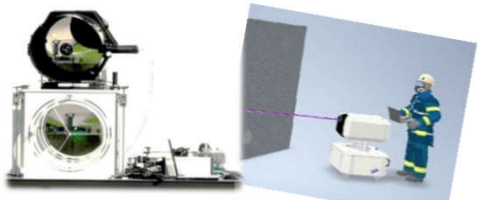
Directed energy laser systems

Head: Jochen Speiser

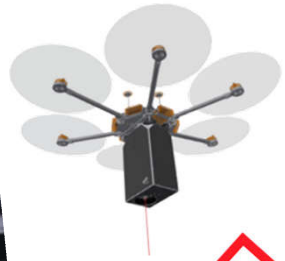


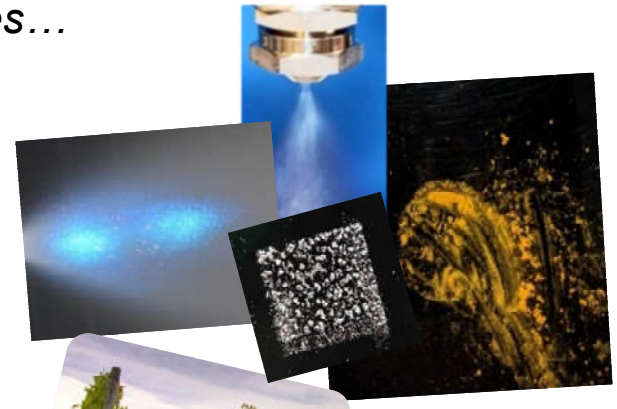
Detection of chemical, biological hazards and explosives

Basic & applied research…



… on CBE detection in aerosols, bulk material and on surfaces…





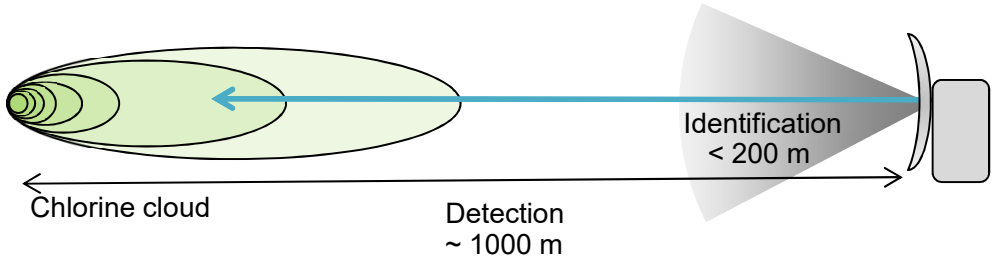
vinoLAS

… for applications in industry, public safety, food security and many others.

DLR

Chemicals and explosives

Laser based stand-off detection of chlorine gas



Chlorine

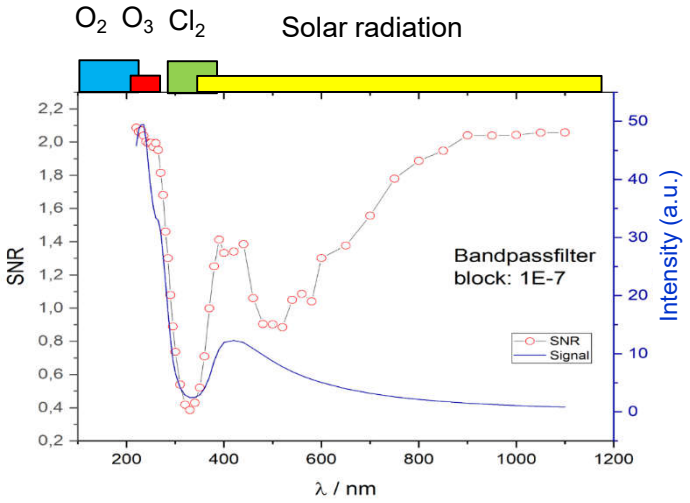
- Highly toxic
- IR-inactive
- Raman-active
- UV absorption

Environment

- Absorption (O_2, O_3, H_2O)
- Scattering (Aerosols)
- Light / Reflection
- Turbulence

Detection

- LIDAR / DIAL
  long range warning
- (UV-) Raman
  short /medium range
  identification



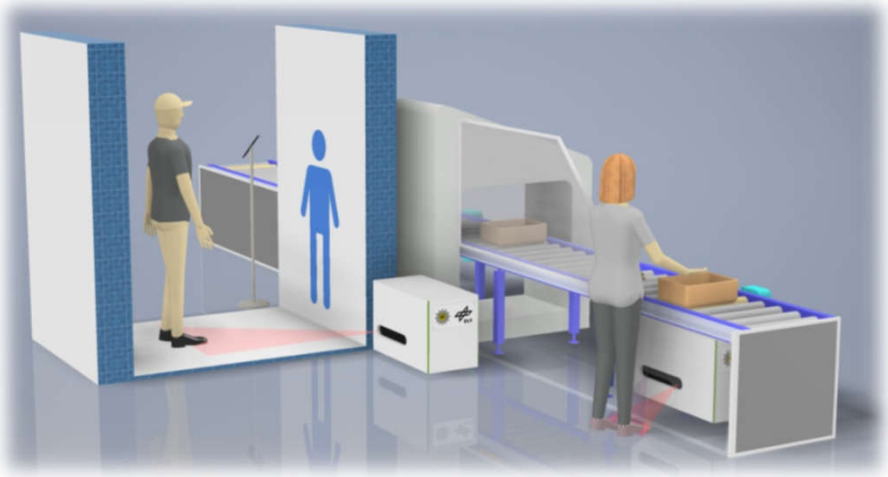
Modelling
Design & concept
From lab to test range
Proof of principle

Airport security
The PHYLAX-Project

Objective: Easy and reliable check of persons for explosives at entry points and/or security check points

Concept:

- Automated recognition of passengers between check-in and boarding
- Walk-by check at distances of 0.5 – 1 m during security check at airports
- Detection of explosives using laser spectroscopy



Advantages of laser spectroscopy:

- Contact-free measurements
- Fast measurements
- High sensitivity
- Substance-specific signals

PHYLAX system components

Recognition, pointing & tracking module

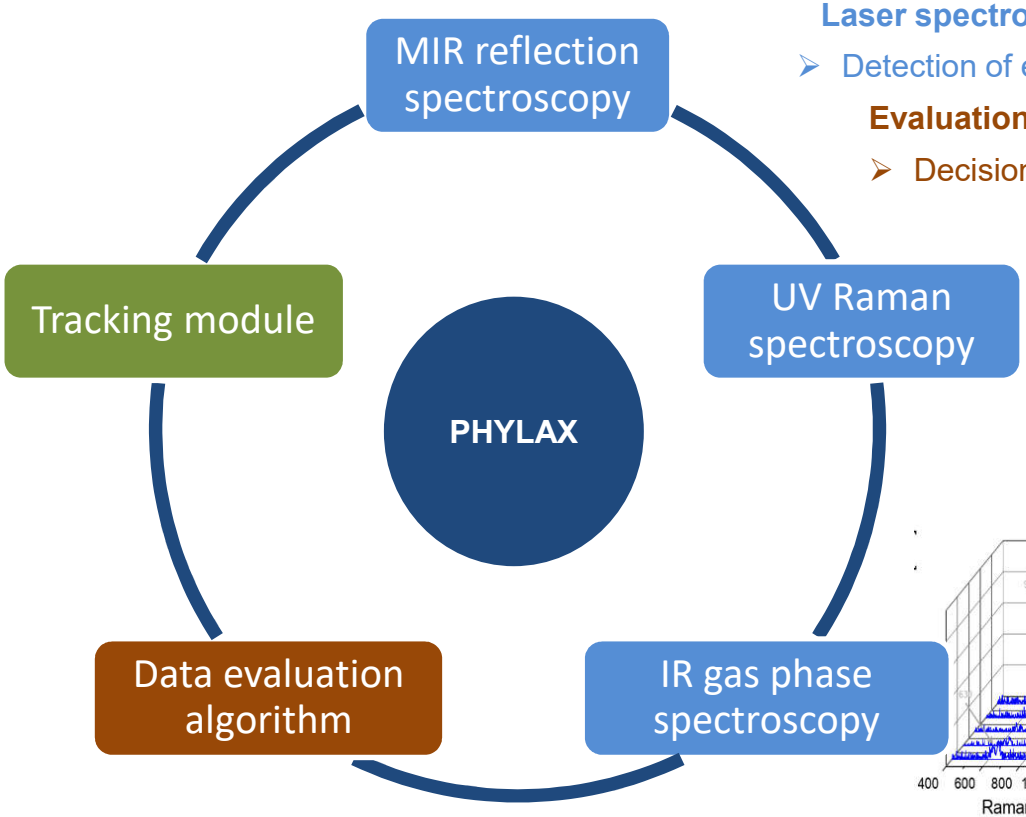
- Detection of targets and laser beam positioning on moving target

Laser spectroscopy systems

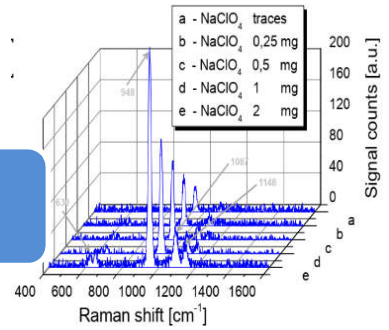
- Detection of explosive traces using different technologies

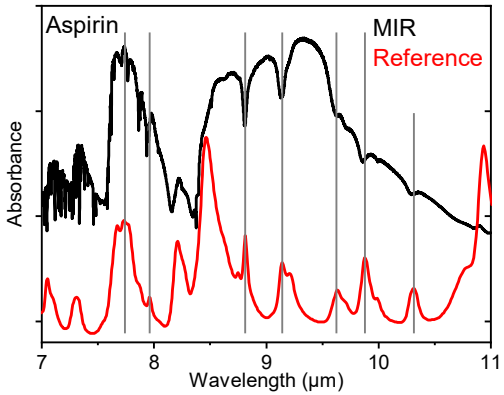
Evaluation

- Decision for alarm based on full, combined data



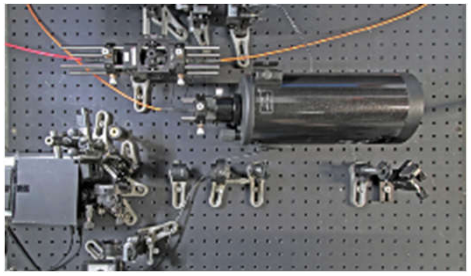
Merging Raman & MIR spectral data





Bio-agents

Development of a drone-based CBE stand-off detection system

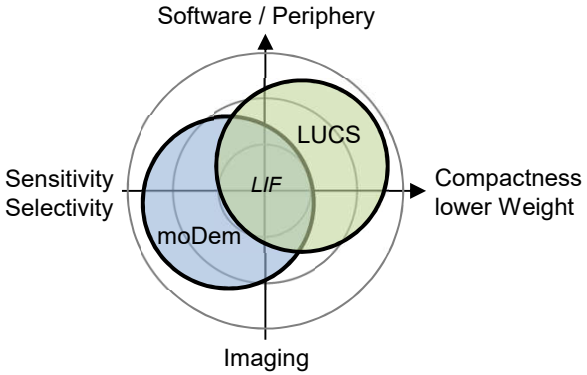


laboratory demonstrator

compaction

end-user feedback

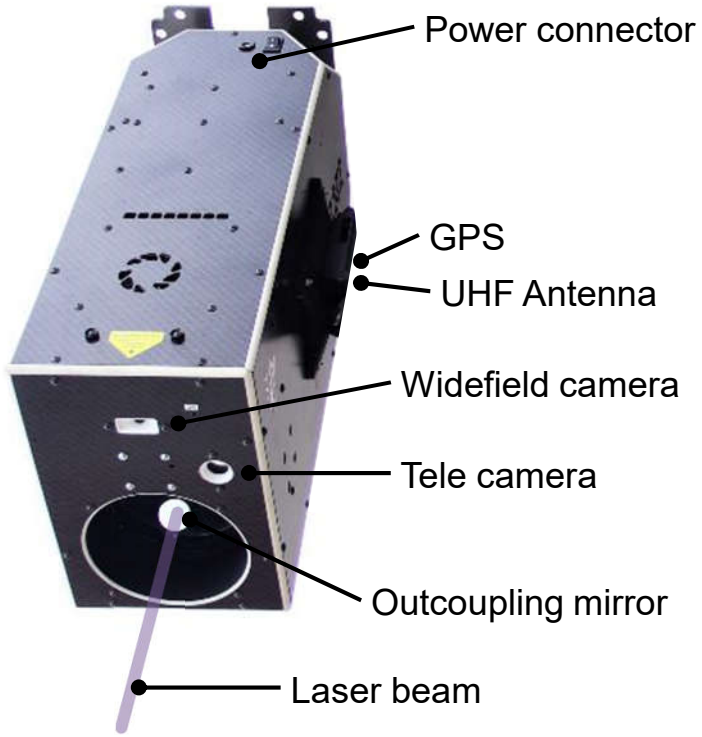
technology demonstrator

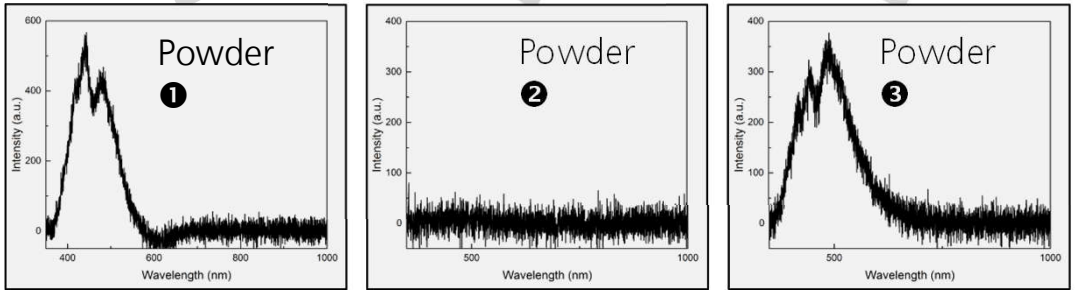


portable applications

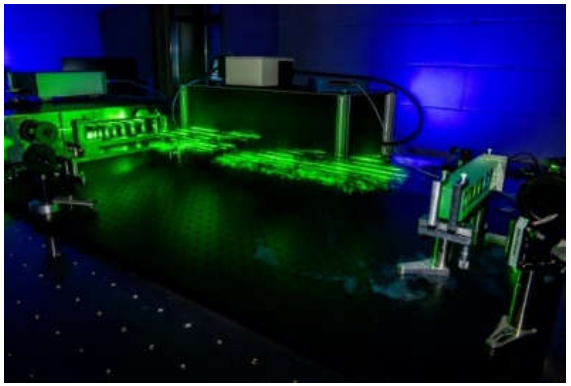
UAV aerial remote sensing of CBE agents by means of an laser-based stand-off detection system (LUCS)

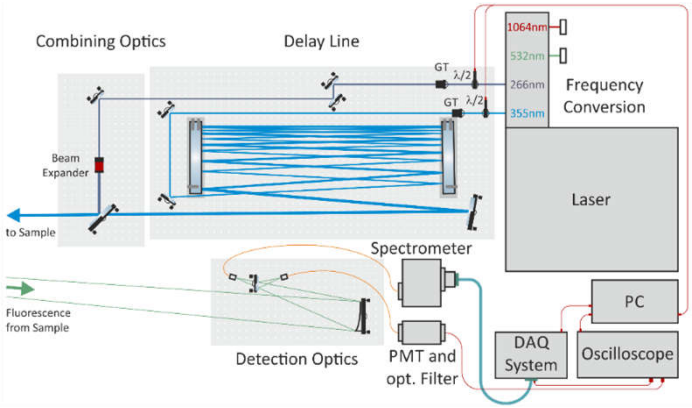
Compact, mobile LUCS sensor



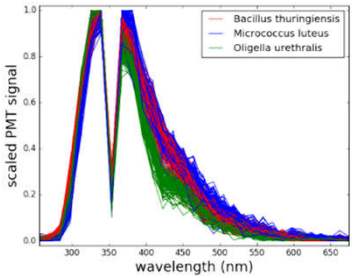


Improved LIF technology: retrieving full process information

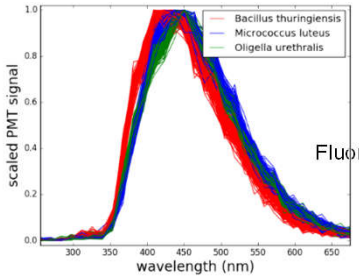


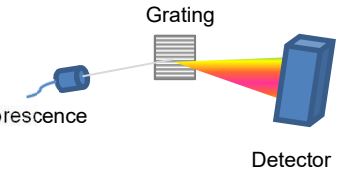


excitation: 266 nm

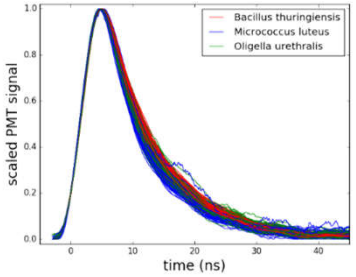


excitation: 355 nm

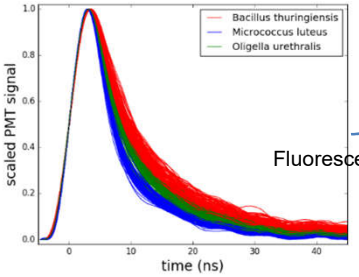


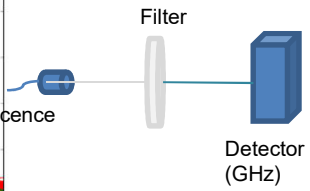


excitation: 266 nm
detection: 310 nm

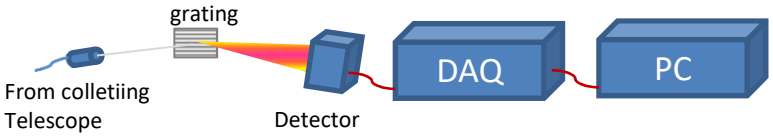


excitation: 355 nm
detection: 460 nm



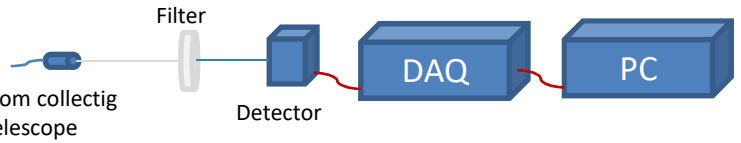


Fluorescence spectra



- 1024 spectral channels

Measurement of fluorescence decay



- 32 spectral channels
- 1 time-resolved channel

86 % accuracy
from 32 spectral channels

83 % accuracy
from 1 time-resolved channel

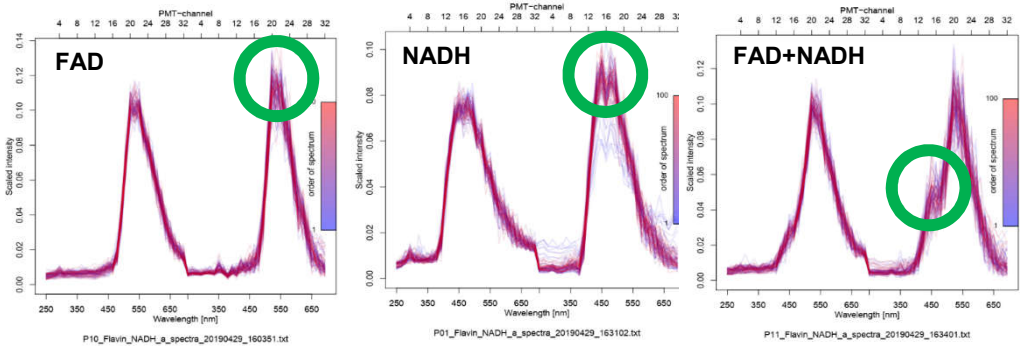
93 % accuracy
(from 1024 channels)

93 % accuracy
(from 33 channels)

Compact, cost-efficient sensor design

Fellner, Kraus, Gebert, Walter, Duschek, Sensors, *20 (2020), 2524.*

How-to interprete data from mixtures?



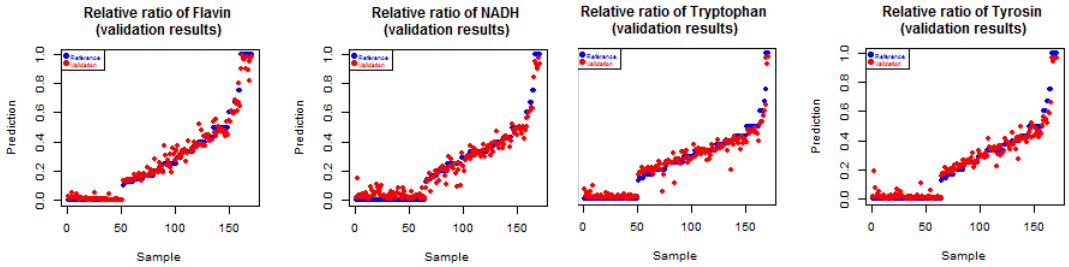
Problem

- signals not linear, not additive

Machine learning aproach applying combined neural networks

- prediction model #1:
  Fluorophore present
- prediction model #2:
  Relative amount for each fluorophore

Data ⇨ **Classification** ⇨ **Regression**



Results

- R2 >99 %
- Collaboration with University Tor Vergata

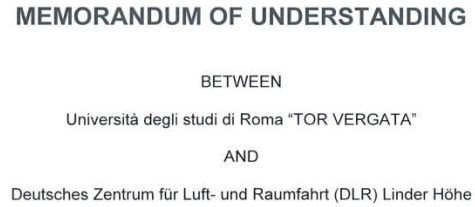
Thanks to the co-workers in the department of Dr. Frank Duschek

- Luca Cantu
- Lisa Dreier
- Lea Fellner
- Emanuela Gallo
- Karin Grünewald
- Jonas Grzesiak
- Anja Köhntopp
- Christoph Kölbl
- Marian Kraus
- Arne Walter

History, presence & future

1st SICC, Rome, May 2016

- Initialization of MoU during visit at DLR
- MasterCBRN Dr. Lea Fellner
- Collaboration at DLR
  - Valentina Gabbarini
  - Riccardo Rossi
  - joined publications
- Multiple Lectures by Frank Duschek during 1st & 2nd level master courses


MEMORANDUM OF UNDERSTANDING

BETWEEN

Università degli studi di Roma "TOR VERGATA"

AND

Deutsches Zentrum für Luft- und Raumfahrt (DLR) Linder Höhe

"Coming together is the beginning.
Keeping together is progress.
Working together is success."

Henry Ford

DLR Deutsches Zentrum für Luft- und Raumfahrt

DLR