

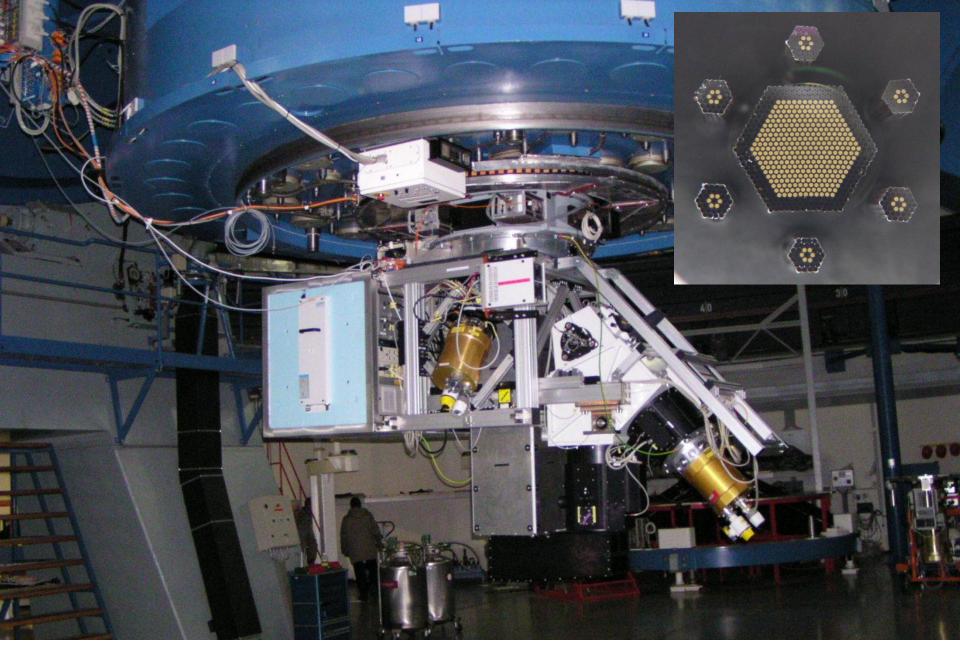
Astrophotonics

A New Star on the Horizon of Photonic Sensors

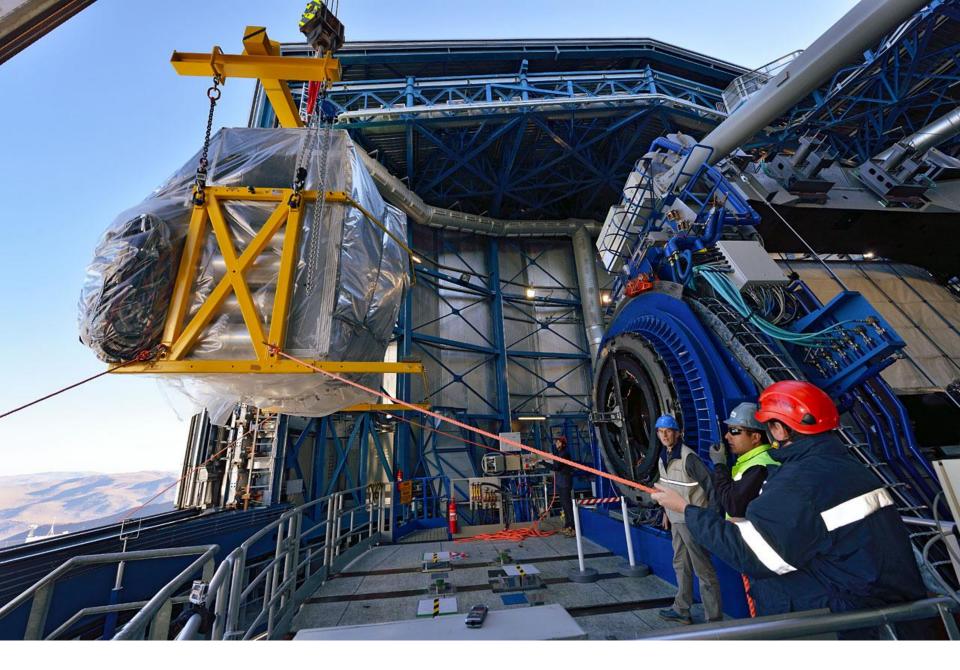
Martin M. Roth Leibniz-Institut für Astrophysik Potsdam (AIP) Universität Potsdam

EPIC World Photonics Technology Summit - Berlin, 29-08-2019

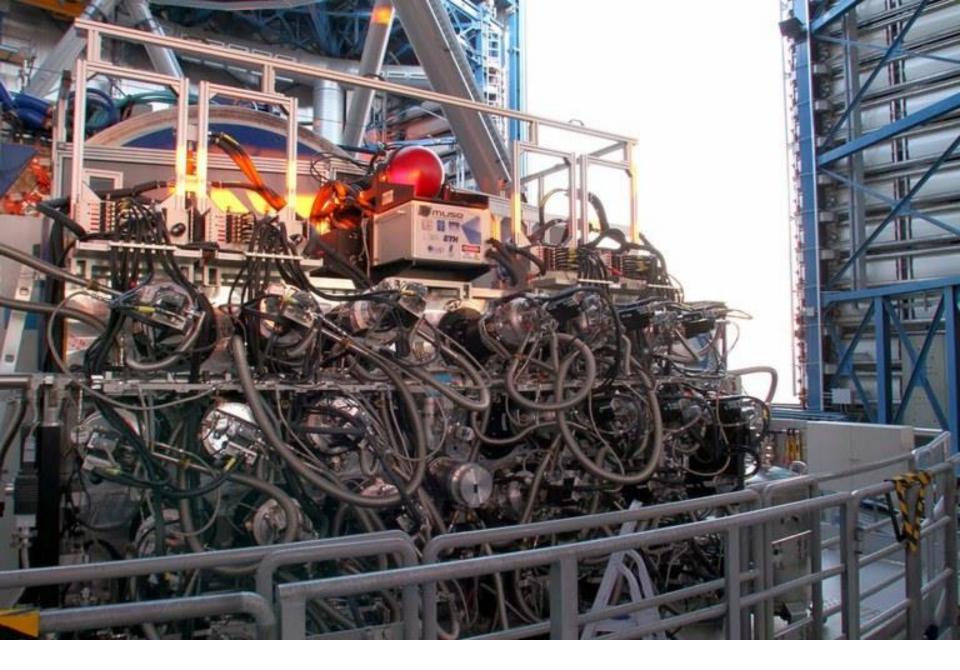
Leibniz-Institut für Astrophysik Potsdam (AIP)



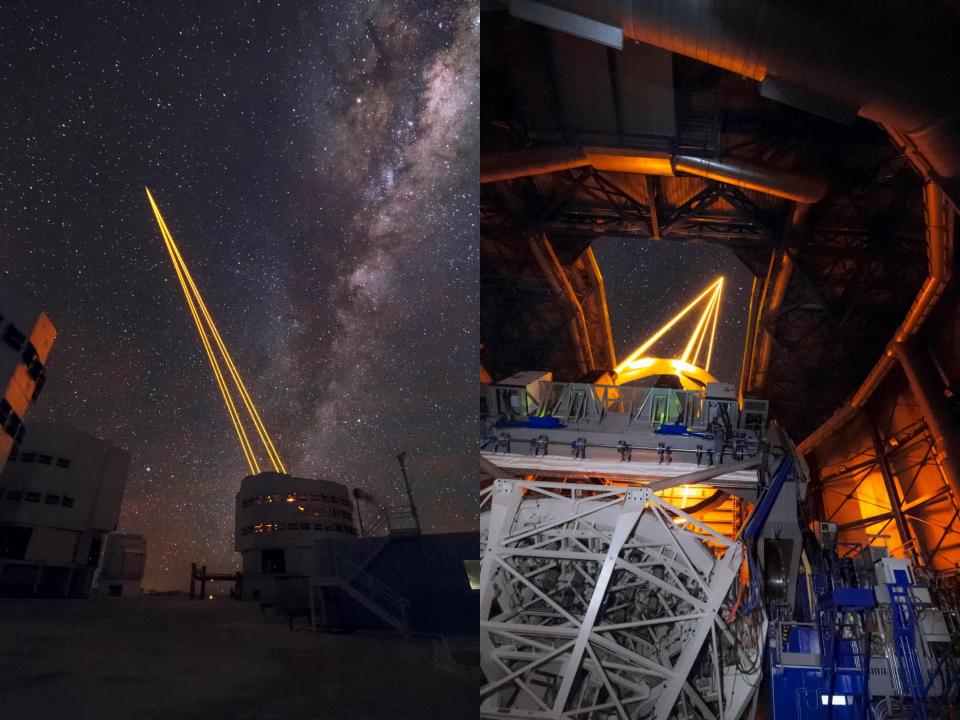
PMAS: 256x multiplex spectrograph @ Calar Alto Observatory

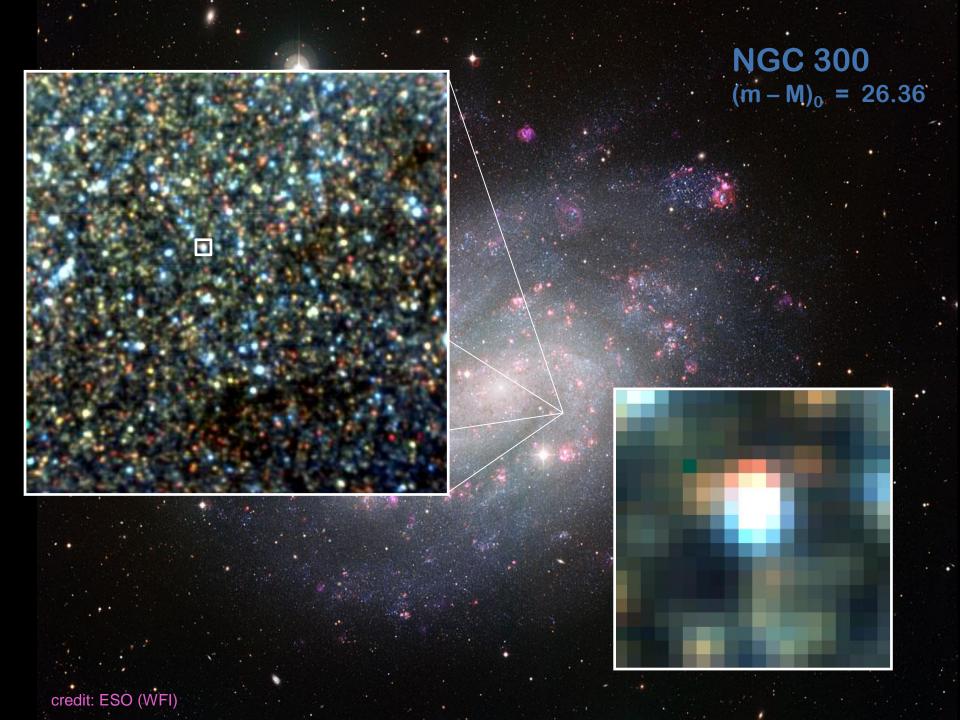


MUSE: 90.000x multiplex spectrograph @ ESO VLT



MUSE: 90.000x multiplex spectrograph @ ESO VLT

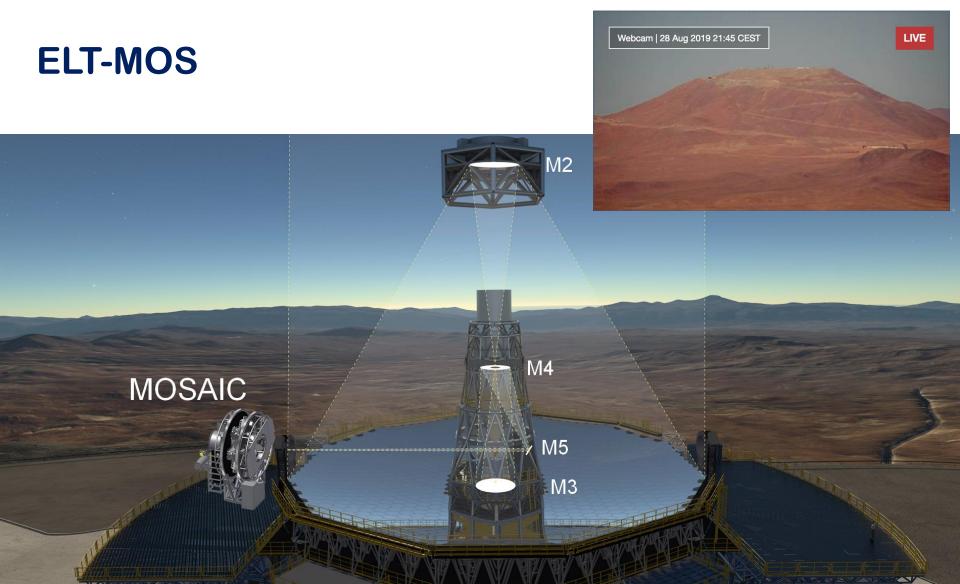
















innoFSPEC Potsdam: BMBF-funded innovation centre for fibrebased spectroscopy & sensing

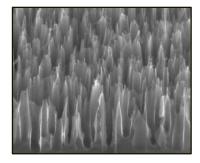
Headquarter at AIP Campus in Potsdam Babelsberg

Collaborations & Networks





Prof. Thomas Pertsch, FSU Jena $\rightarrow\,$ Meta Materials



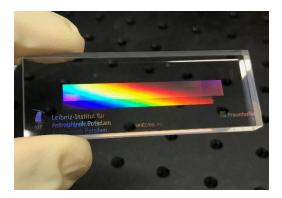


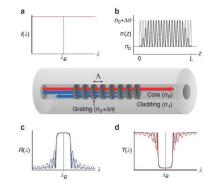


Prof. Bernhard Kley, FSU Jena Prof. Uwe Zeitner, FSU Jena \rightarrow eBeam Lithography



Prof. Stefan Nolte, FSU Jena \rightarrow FBG & ULI

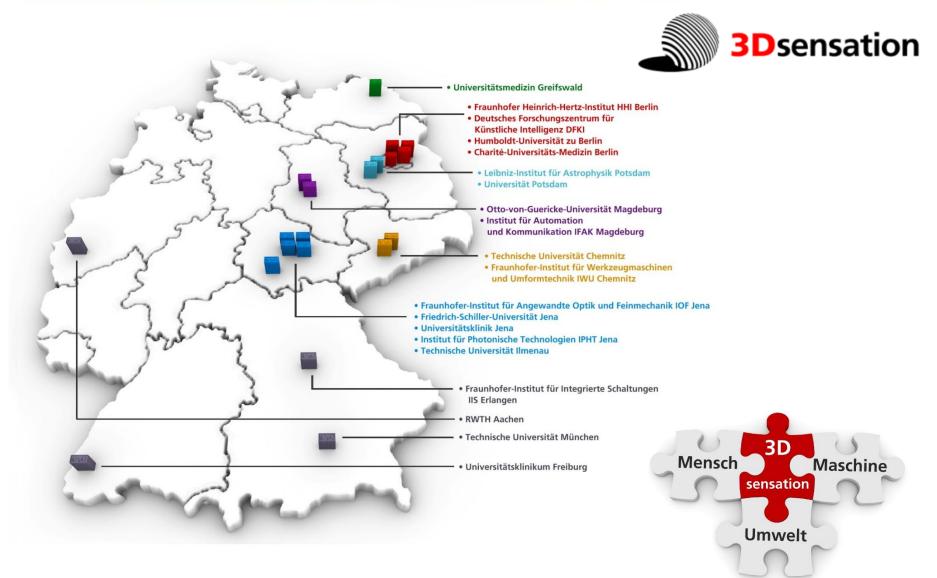




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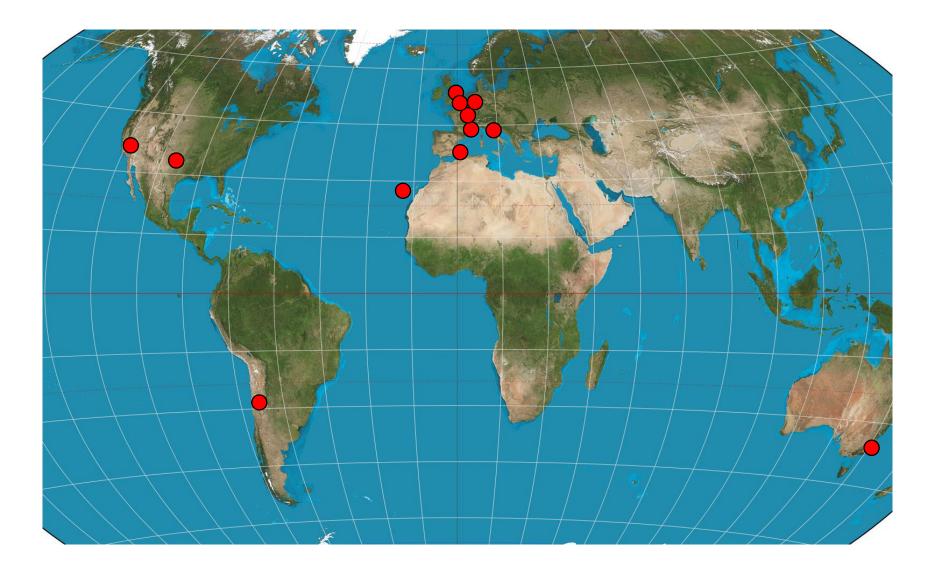
Collaborations & Networks





Collaborations & Networks

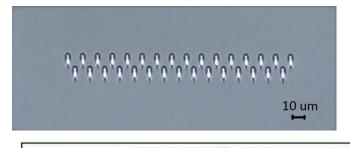




Discrete Beam Combiners

Main goal: optimize multi-telescope beam combiners (6T or more) for NIR based on using Discrete Beam Combiner Staff:

A first prototype of 6-Telescope beam combiner in Gallium-Lanthanum-Sulfide (GLS) was produced in Jena and tested in the laboratory in Potsdam using Ultrafast Laser Inscription (ULI)



Effect of the changing delay on the output of the DBC.

Applications:

The Four Auxiliary Telescopes at Paranal ESO PR Photo 51c/06 (22 December 2006) © ESO

- High-resolution spectro-images of protoplanetary disks.
- Astroseismology.
- Multi-channel phase sensors.

Dr. Aline Dinkelaker, with Ettore Pedretti, now **RAL** Oxford

Innovative faseroptische Sp und Sensorik







Optical Frequency Combs

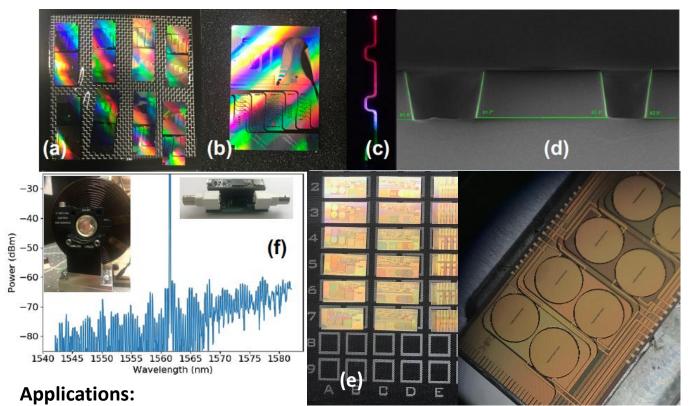


Dr. Jose Chavez Boggio

Daniel Bodenmüller

Staff:

Main goal: Develop miniaturized, actively stabilized NIR frequency combs based on integrated microring resonators (MRR) for the calibration of high-res and low-res spectrographs.

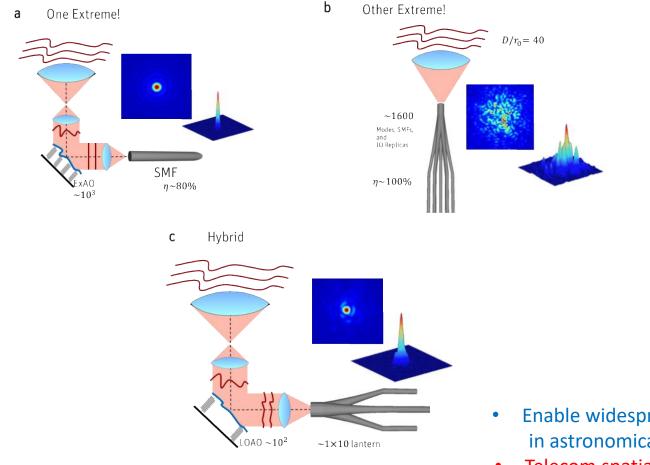


- Spectroscopic detection of exoplanets.
- Miniaturized optical clocks.
- GHz-rep-rate laser sources.

AO-assisted Astrophotonics



Main goal: Investigating the trade-off between the adaptive optics and the photonic lantern approaches to interface single-mode photonic components to astronomical telescopes.



Staff:



Dr. John Davenport



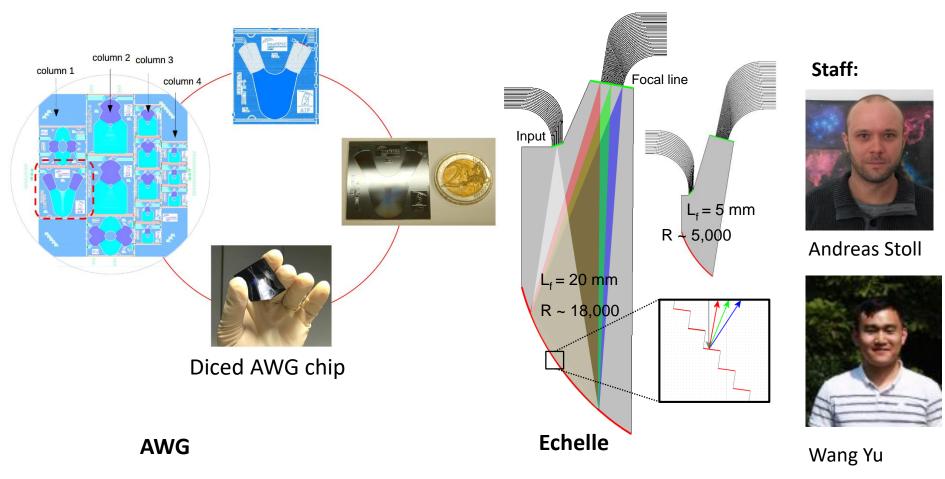
Momen Diab

- Enable widespread use of IO in astronomical instrumentation.
- Telecom spatial division multiplexing. 15

Arrayed Waveguide and Echelle Gratings



Main goal: Numerical simulations, design, fabrication and testing of AWG devices and echelle grating devices for deployment in a miniature spectrometer.



Sky Emission Filters

innovative faseroptische Spektroskopie und Sensorik



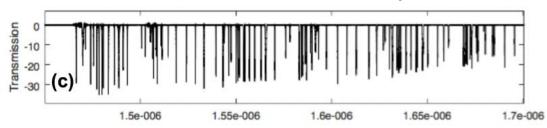
Main goal: Numerical simulations, design, fabrication and testing of sky NIR OH-emission background filters using complex Fiber Bragg Grating filters

Complex phase mask for direct fabrication of OHemission filters

No need for complex optial alignment



First in the world ! Designed by innoFSPEC Fabricated by Fraunhofer IOF



Staff:



Dr. Kalaga Madhav



Dr. Aashia Rahman

On-sky Demonstrators – NIR Detectors



Main goal: validating astrophotonics components on-sky using science grade NIR image sensors.

Motivation (1): test facility for astrophotonics devices

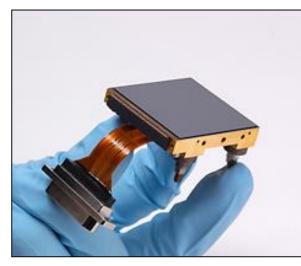
Motivation (2): introduce NIR technologies at AIP

Lab test facility:

- Integrated photonic spectrographs
- Interferometric beam combiners
- Multi-notch FBG in H band
- Ring resonator frequency combs

Collaborations:

- MPIA Heidelberg
- ESO
- Leonardo
- Calar Alto Observatory



Staff:



Dr. Alan Günther



MSc Rafael Bernardi

MSc Eloy Hermandez

Interdisciplinary Research: Raman Imaging

Main goal: validating Multiplex Raman Spectroscopy as minimal-invasive optical diagnostic for medicine

 Expertise in multi-channel spectroscopy, transferred to life science and minimal invasive cancer diagnostic

<u>Methodology</u>

integral field spectroscopy, transfer to medicine

Key Component(s)

- MUSE and MUSE clone spectrographs + periphery
- data reduction and analysis (P3D)

Collaborations:

- MRS: Charité Universitätsmedizin, Berlin
- HYPERAM: IPHT Jena, FBH Berlin
- Uro_MDD: IPHT Jena, Uni-Klinik Freiburg, Fraunhofer ISS, Schölly GmbH, Oberon GmbH, etc.

Staff:

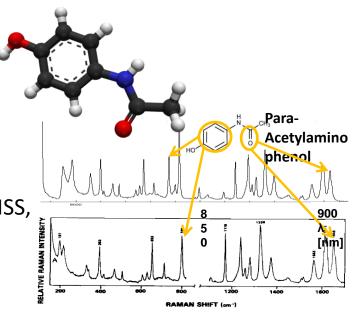




nnovative faseroptise

Dr. E. Schmälzlin

Dr. T. Urrutia



Interdisciplinary Research: Raman Imaging



http://www.3d-sensation.de/de/Projekte/Verbundvorhaben.html

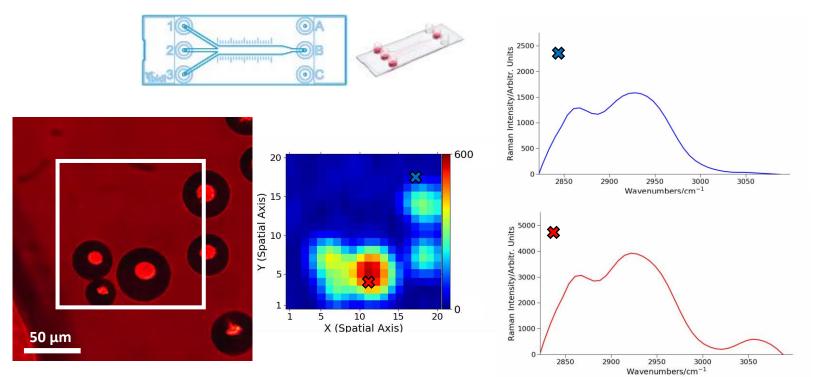
3Dsensation Mensch. Maschine. Umwelt. ZUKUNFT		
Startseite Projekte 3Dsensation	VISION 3DSENSATION V PROJEKTE 3DSENSATION V PARTNER DER ALLIANZ MEHR V	
Verbundvorhaben		
»Uro-MDD«	»Muse3h«	Kontakt
Endoskopische Panoramabildgebung und faseroptische Spektroskopie in der Urologie zur multidimensionalen Diagnostik.	Grundlegende musterprojektionsbasierte Sensorkonzepte für die hochauflösende, hochdynamische 3D-Erfassung.	Dr. Kevin Füchsel Leiter Koordinierungsstelle 3Dsensation Albert-Einstein-Str. 7 07745 Jena, Deutschland

Interdisciplinary Research: Raman Imaging

Raman video imaging

Raman Video Imaging: 50 µm Polystyrene Beads in Microchannel Plate

20× Microscpe objective, 532 nm laser excitation 1 s recording time + 2.4 s readout time per frame



worldwide first demonstration





3D-CANCER-SPEC





The Idea is to transfer technology from the MUSE integral field spectrograph at ESO's Very Large Telescope to minimal-invasive optical cancer diagnostics in medicine.



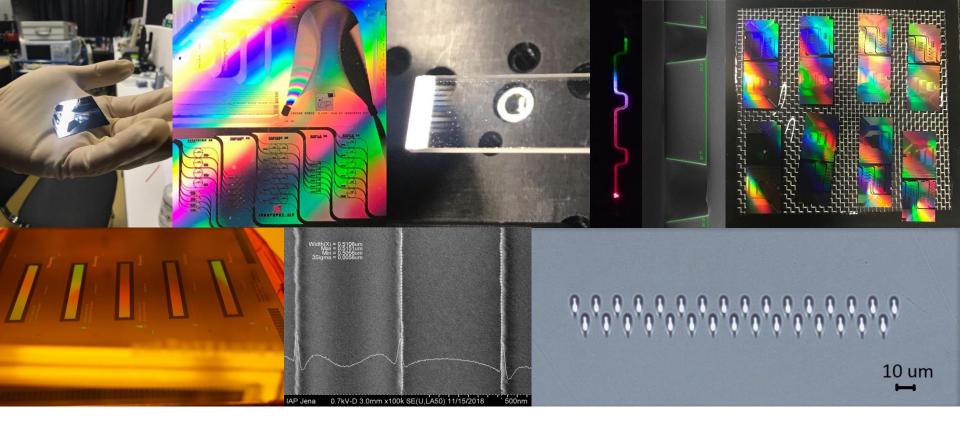
Imaging Raman spectroscopy is capable of distinguishing malign/benign tissue.

Applications have already been demonstrated for skin cancer diagnostics, and further use is being investigated jointly with clinical partners and SMEs for endoscopy (bladder/colon/cervix cancer)

Our project is coordinated by innoFSPEC Potsdam at Leibniz-Institute for Astrophysics Potsdam (AIP) and involves the company Winlight System, Pertuis (France)

We plan to liaise with Research Infrastructure European Southern Observatory (ESO)

Contact email mmroth@aip.de



Astrophotonics Group Team Leader: Dr. Kalaga Madhav <u>https://innofspec.de/en/research-focus/astrophotonics</u> kmadhavi@aip.de

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This presentation was presented at EPIC World Photonics Technology Summit 2019

HOSTED BY

