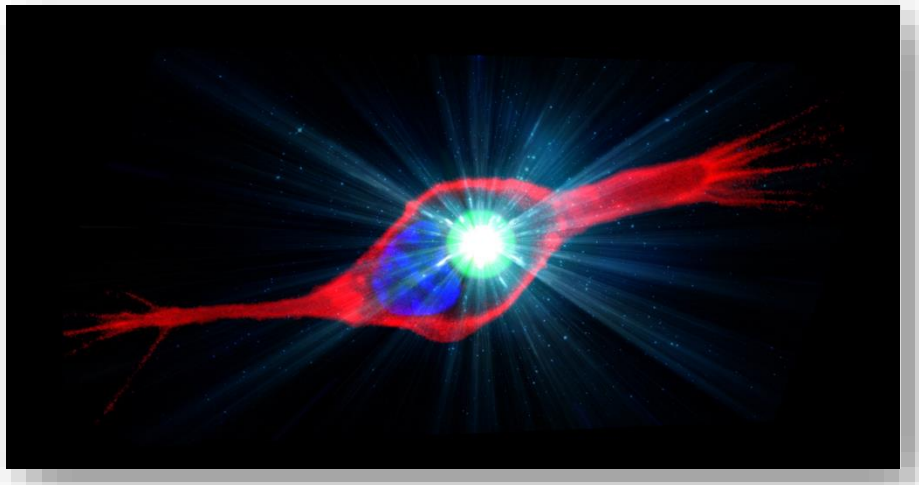
Cell-Lasers

Coupling of optical resonances with biological processes



Matjaž Humar

Assistant Professor

Jožef Stefan Institute, Slovenia

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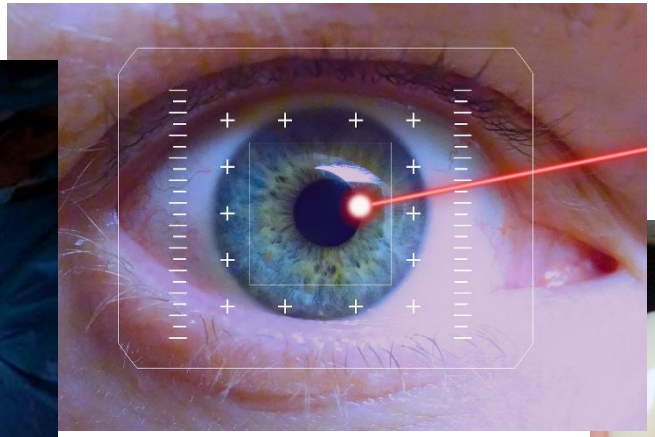
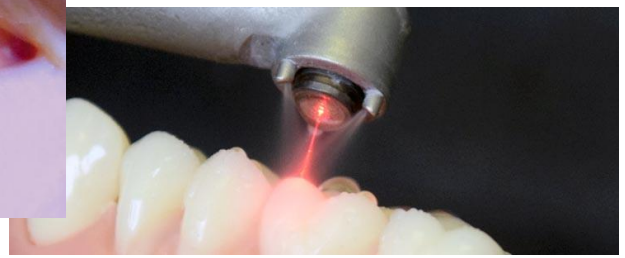
http://humarlab.ijs.si

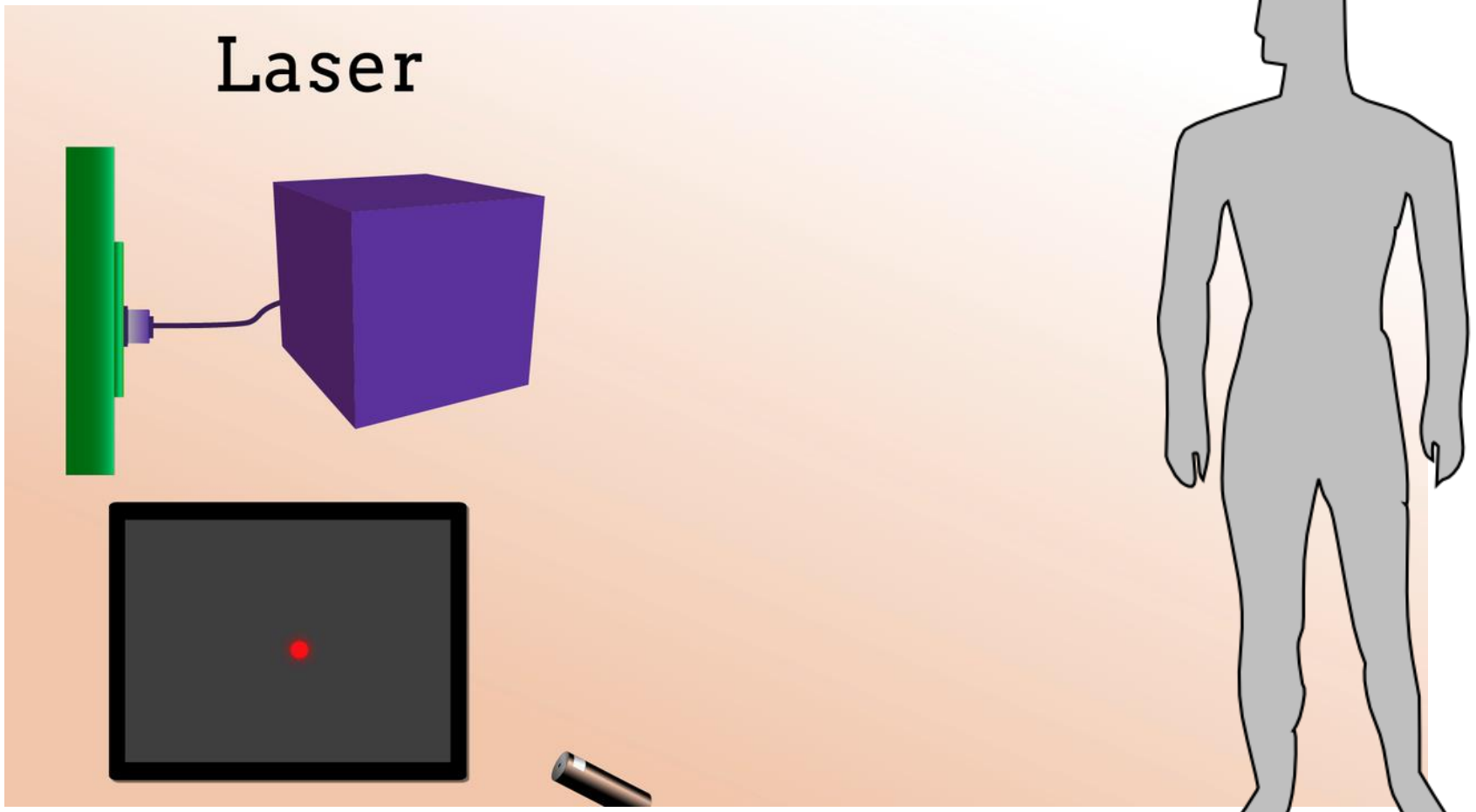
"Jožef Stefan" Institute

Use of lasers in medicine and biology



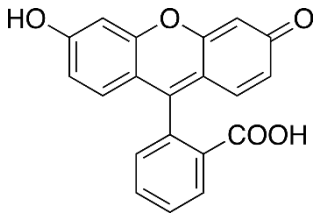


Laser inside biological tissues – paradigm shift

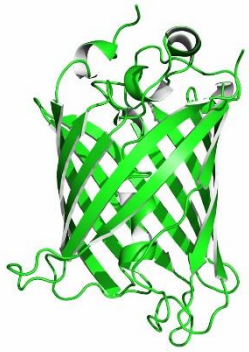


Current biological luminescent probes

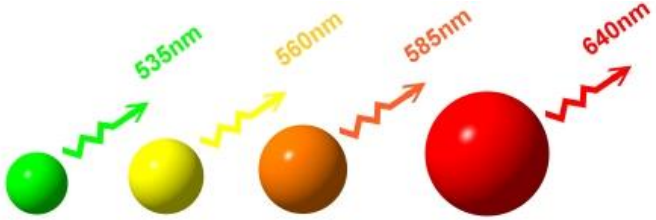
Organic fluorophores

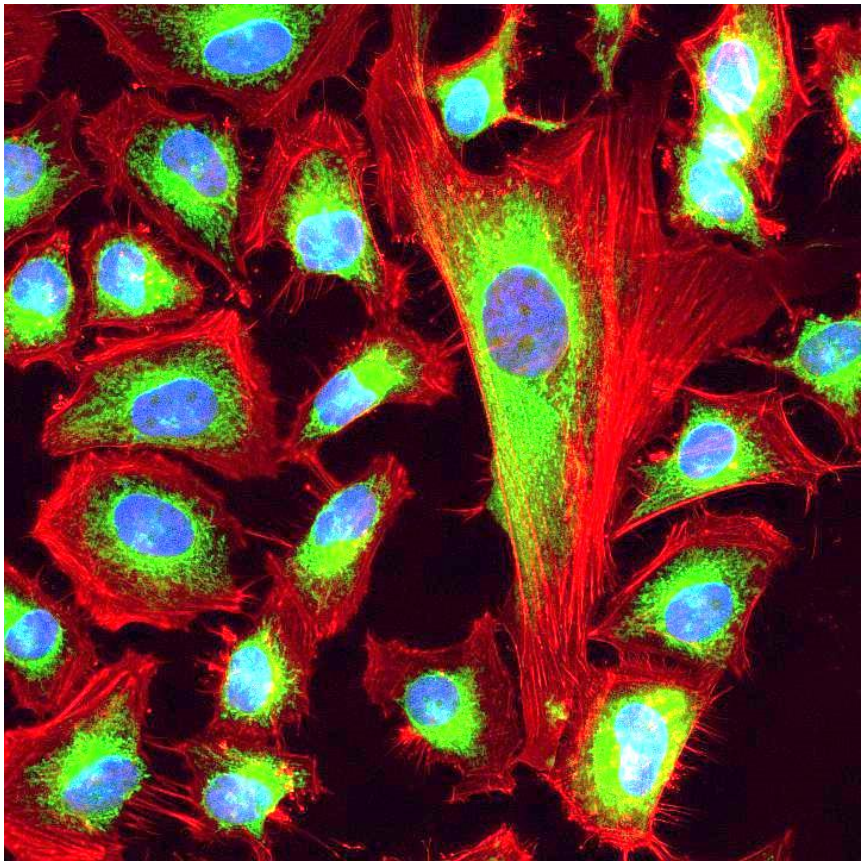


Fluorescent proteins

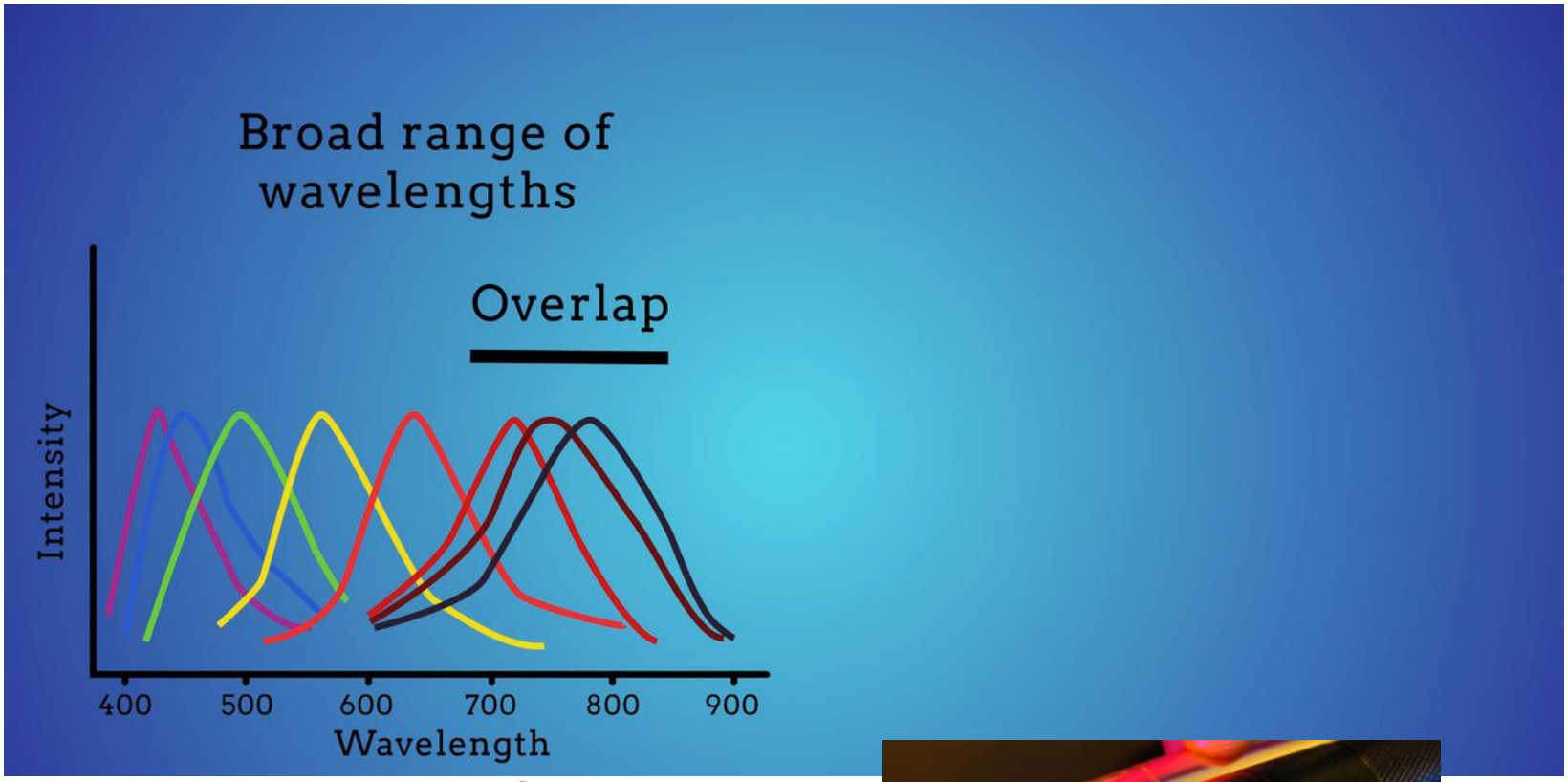


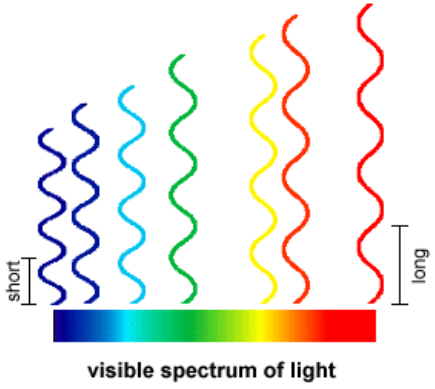
Nanoparticles





Fluorescent probes vs lasers





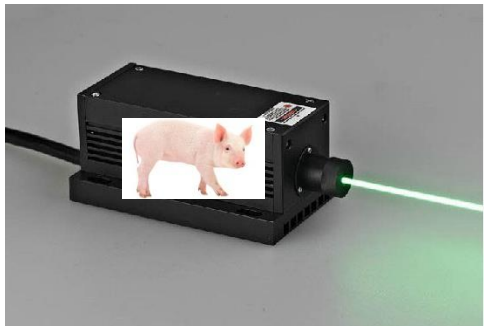
Bio-integrated laser

Laser

Treatments, diagnostics

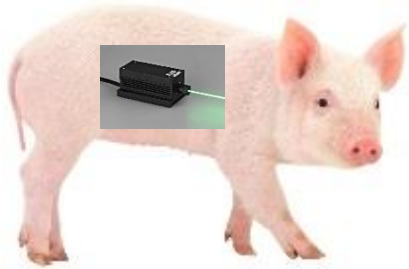
Biological system

Laser as part of the device



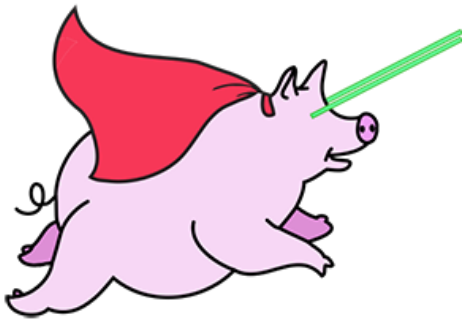
Example: cell inside a laser

Laser inside a biosystem



Example: laser inside tissue

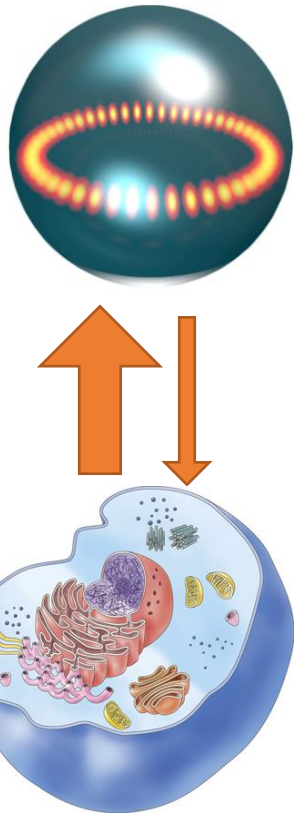
Laser = Biosystem

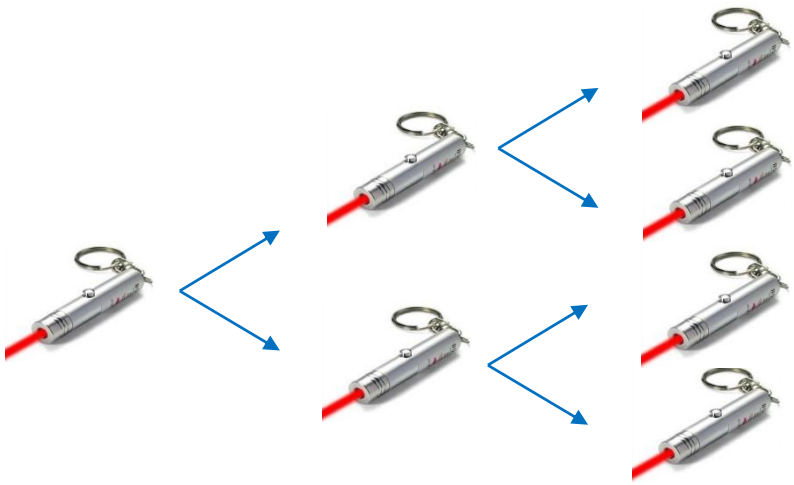


Example: cell as laser

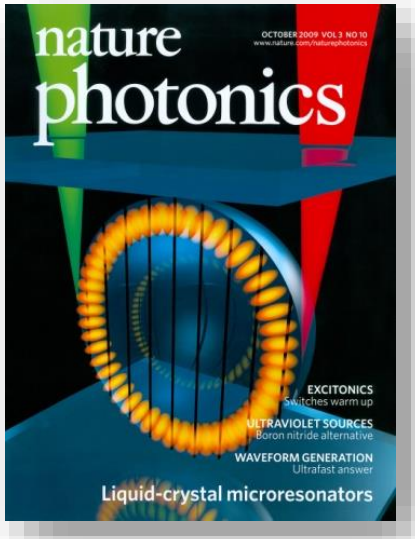
Why bio-integrated photonics

- Better coupling between the device and the biological system
  - Better sensors
  - Targeted medical treatments
- Live lasers: Self-reproduction, self-assembly, adaptation, self-healing
- New human-robot interfaces (Cyborg)



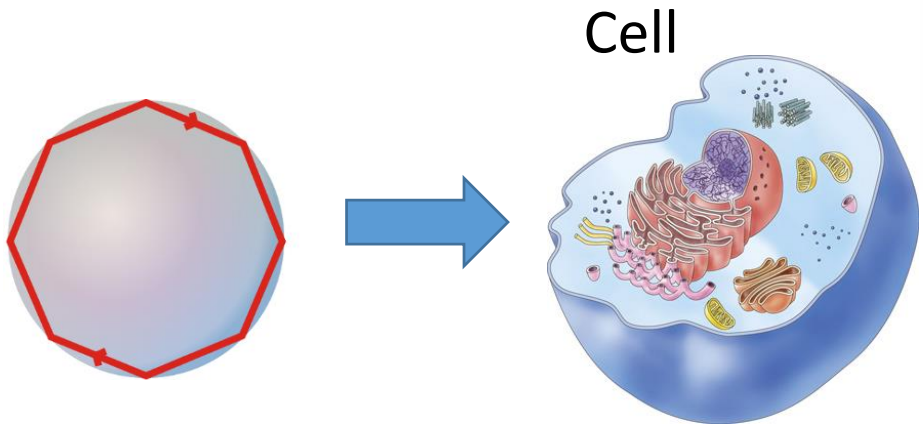


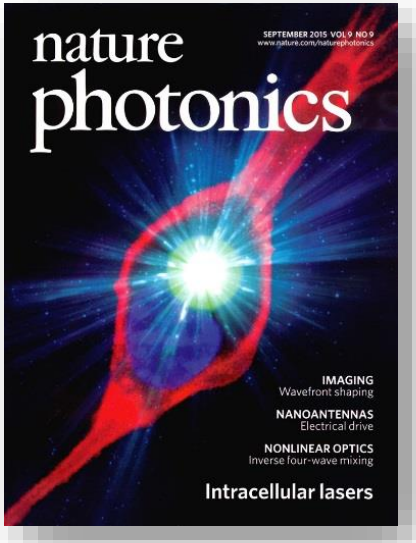
WGM cavities in cells



Whispering-gallery mode laser

- Light circulates due to total internal reflection
- Fluorescent dye as gain
- External laser pumping



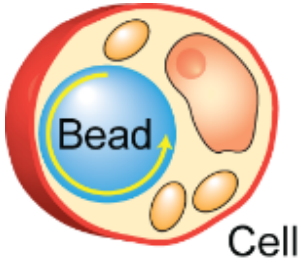


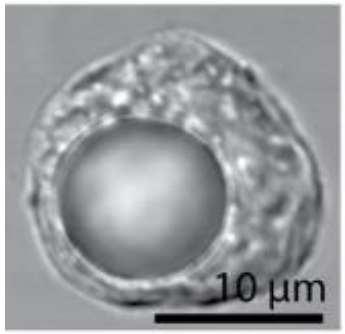
M. Humar, M. Ravnik, S. Pajk, and I. Muševič, Electrically tunable liquid crystal optical microresonators, Nat. Photonics 3, 595–600 (2009).

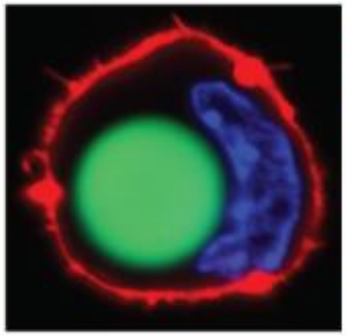
M. Humar, S.-H. Yun, Intracellular Microlasers, Nature Photonics 9, 572-576 (2015).

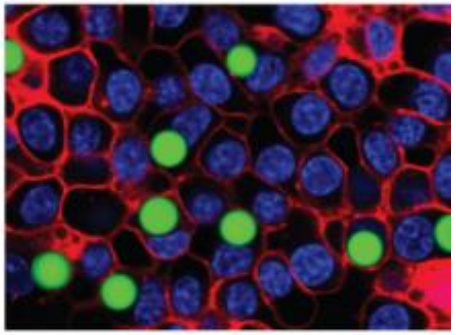
Solid beads – uptake by cells

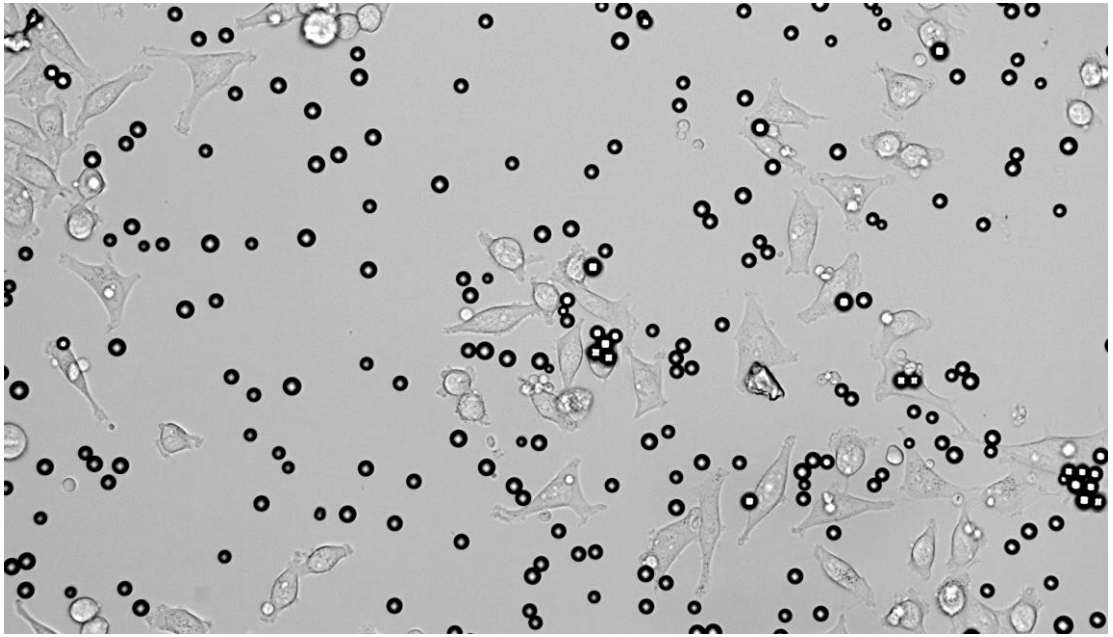
- Microbeads (4 – 20 µm)
- Engulfed by cells



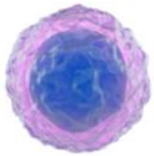








Media impact



nature

nature photonics

Science AAAS

nature methods

FOX NEWS

the business of photonics optics.org

Smithsonian

MIT Technology Review

YAHOO! NEWS

the business of photonics optics.org

The Boston Globe

ScienceDaily

TECH TIMES

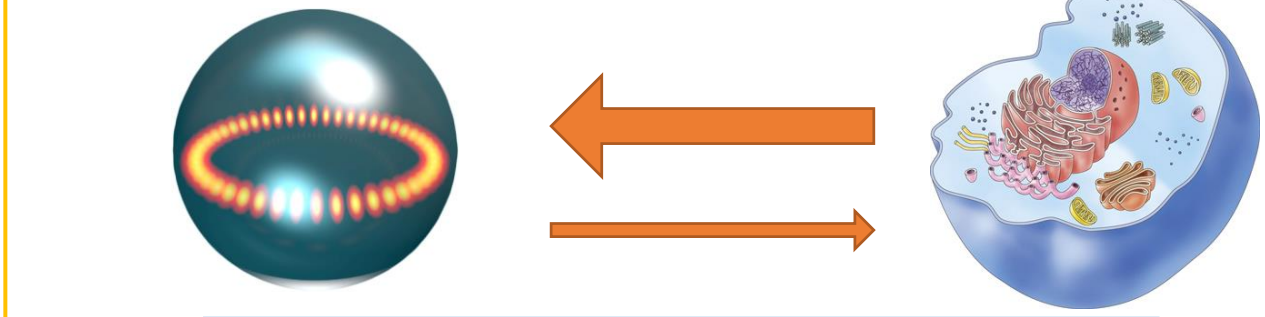
DiscoveryNews

NewScientist

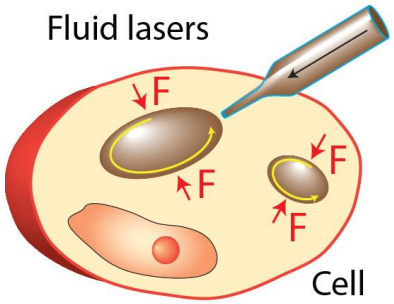
rvet

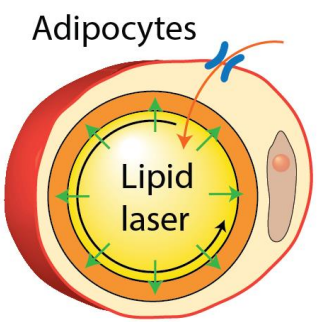
Osebnost Primorske meseca julija

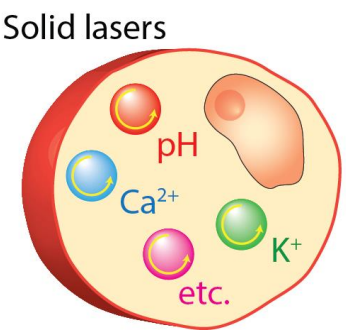
Objectives of Cell-Lasers

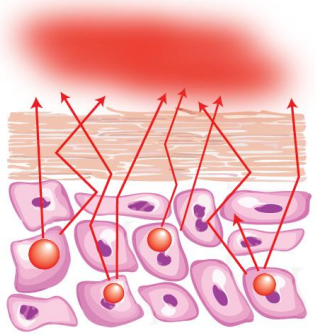


Interaction between intracellular lasers and live cells

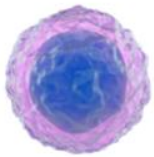






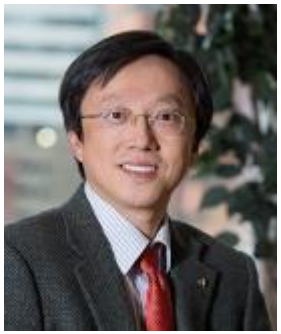


Tissue
(brain,
skin, etc.)



The real story

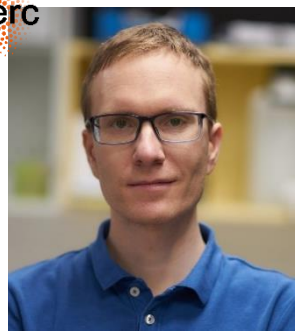
Research group at Harvard (postdoc position)



Seok-Hyun (Andy) Yun

Malte Gather
2009-2011

Sedat Nizamoglu
2011-2013

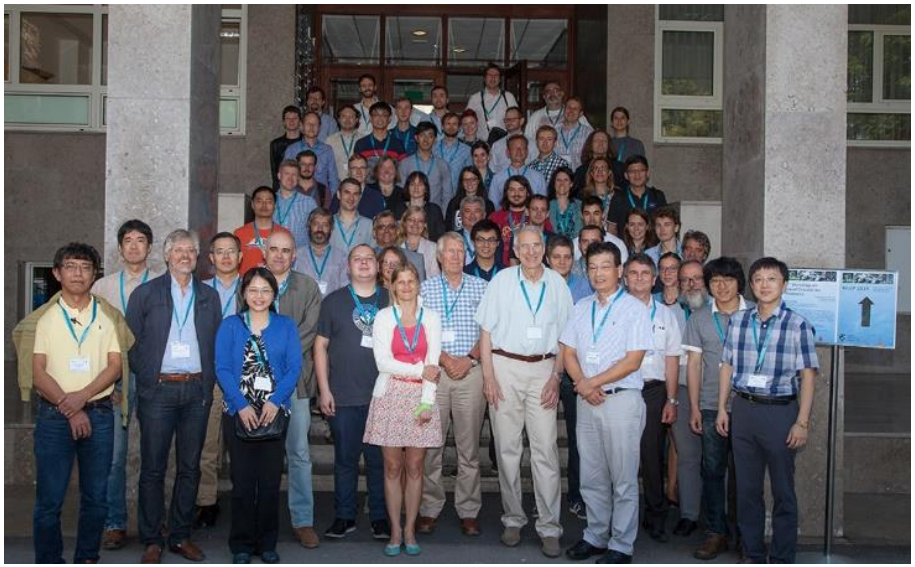


Matjaž Humar
2013-2016

Nicola Martino
2015-

HARVARD MEDICAL SCHOOL

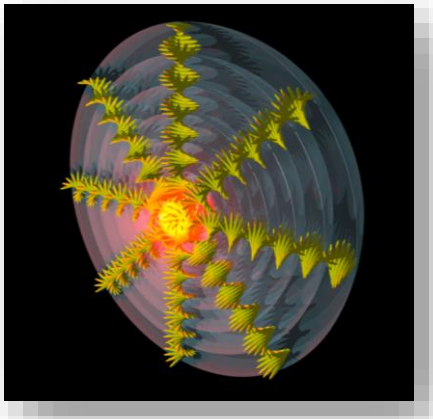
MASSACHUSETTS GENERAL HOSPITAL



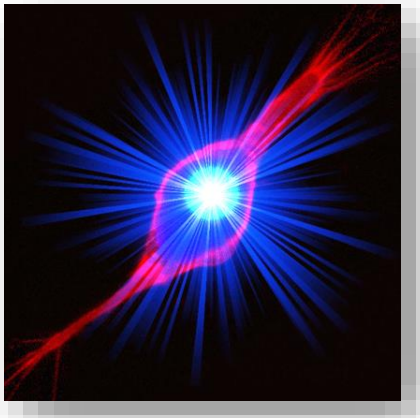
6th Workshop on Liquid Crystals for Photonics, September 2016, Ljubljana, Slovenia

"Jožef Stefan" Institute

Exotic photonics

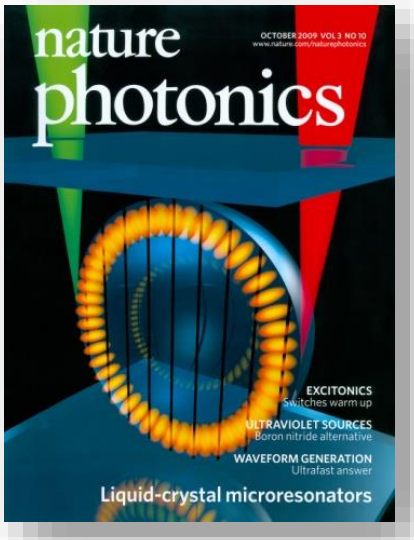


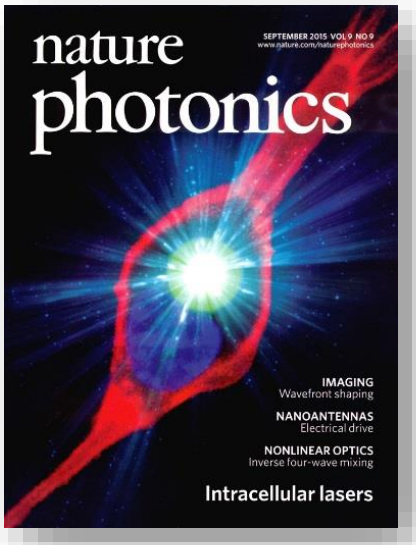
Soft photonics



Live photonics

Edible photoncs





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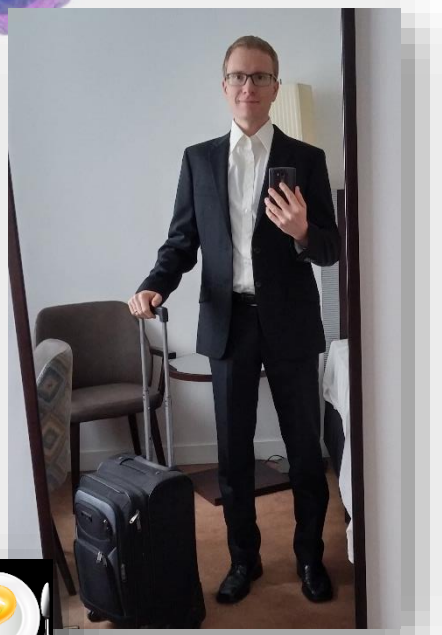
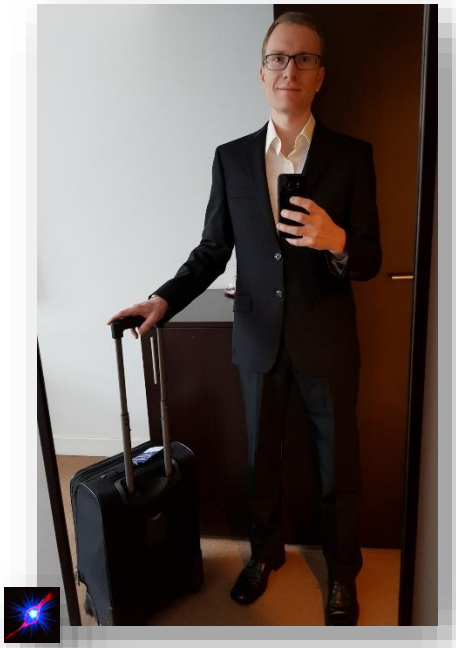
Brussels 3x

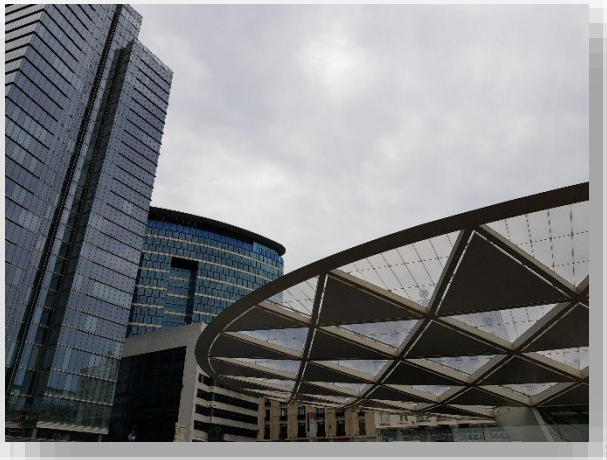


2017

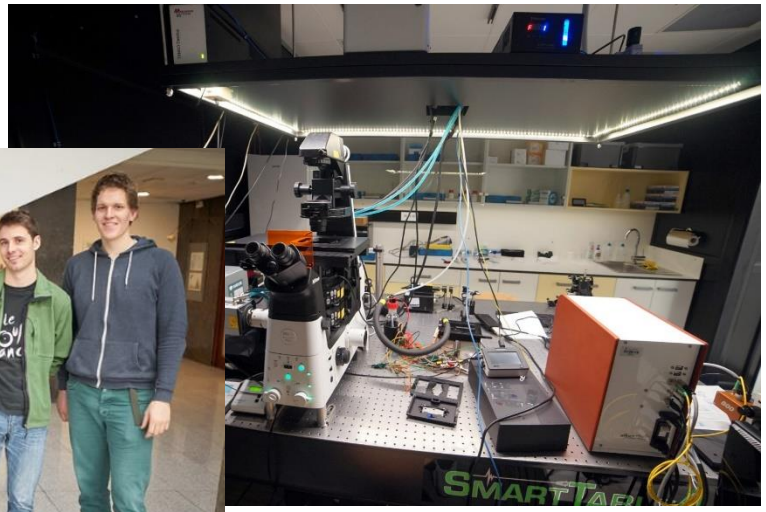
2018



2019

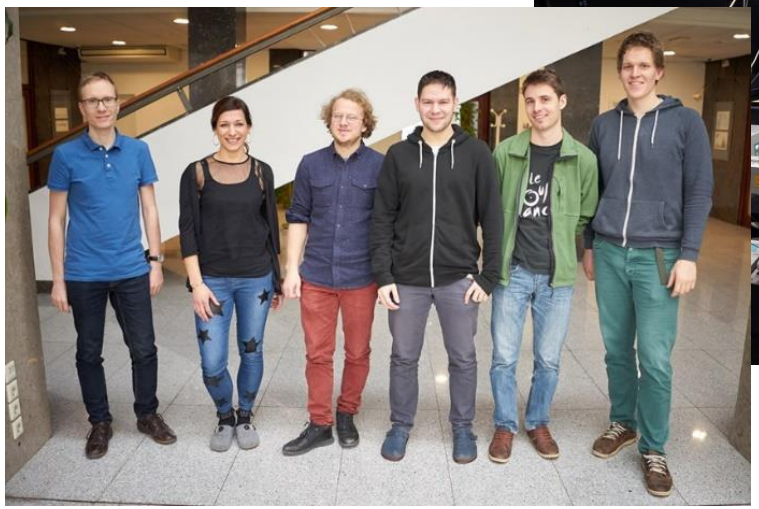


Zahvala vsem, ki so prispevali k temu uspehu



Current team

- Maja Garvas (postdoc)
- Maruša Mur (postdoc)
- K. P. Zuhail (postdoc)
- Gregor Pirnat (PhD student)
- Matevž Marinčič (PhD student)
- Aljaž Kavčič (Master's student)
- Zala Potočnik (undergrad)
- Xiaoxuan Wang (visiting)



ERC Starting Fund

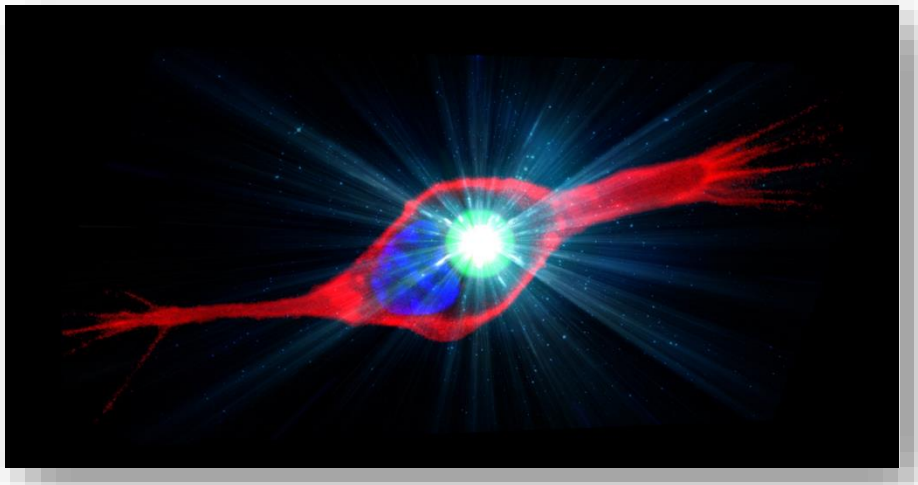
- Marie Curie International Outgoing Fellowship
- Marie Curie Reintegration Fellowship

Director's Fund, Jožef Stefan Institute

- ARRS Komplementarna shema 2018
- ARRS Komplementarna shema 2019
- ARRS Raziskovalni projekt 2019
- ARRS Pečat odličnosti 2019

National Natural Science Foundation of China (Research Fund For International Young Scientists)

Thank you!



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