

# The EIC Pathfinder Open MULTISCOPE project

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# The EIC Pathfinder MULTISCOPE project

## Real-time cancer diagnosis and treatment with light and plasma

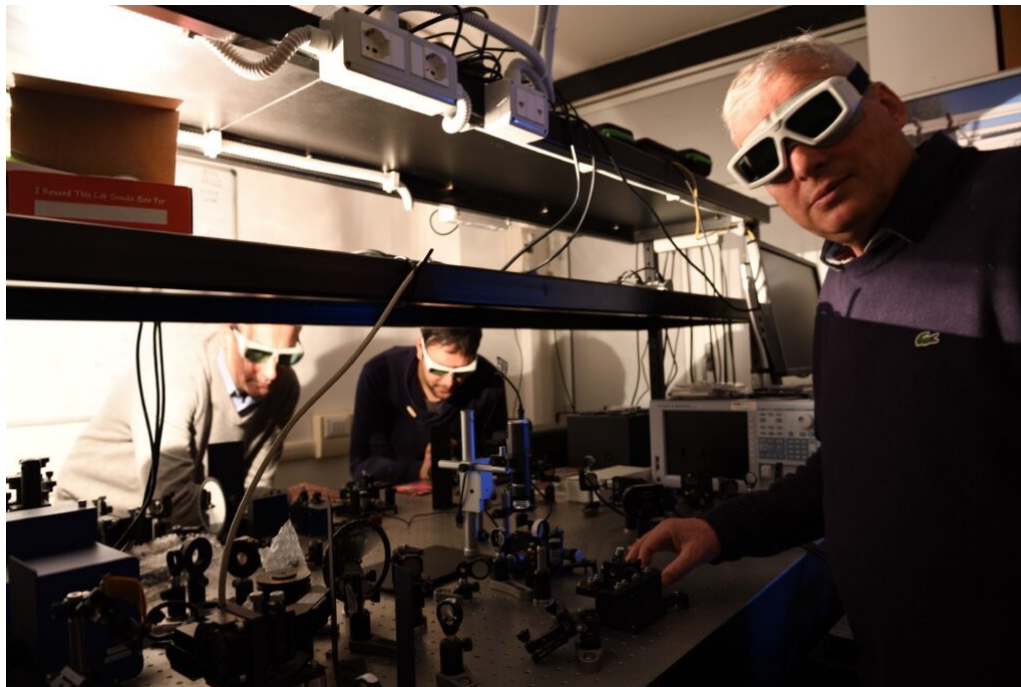
Endoscopy is crucial for diagnosing gastrointestinal disorders, but it still relies on histopathology for cancer diagnosis, causing delays and high costs. With this in mind, the EIC-funded MULTISCOPE project addresses this challenge with a revolutionary photonic technology.

By combining optical biopsy and cold atmospheric plasma therapy, MULTISCOPE introduces a dual-function device capable of real-time, in vivo diagnosis and immediate therapeutic intervention.

The device harnesses spatiotemporal control of light in advanced multimode fibres, overcoming previous limitations. Initially focused on gastrointestinal endoscopy, the technology aims to transform medical diagnostics across various fields, offering reliable, instantaneous diagnoses and targeted cancer treatments without the need for invasive procedures.

# The EIC Pathfinder MULTISCOPE project: how did we get there?

1: ERC Advanced Grant 2016 STEMS: Spatiotemporal multimode complex optical systems (2017-22)



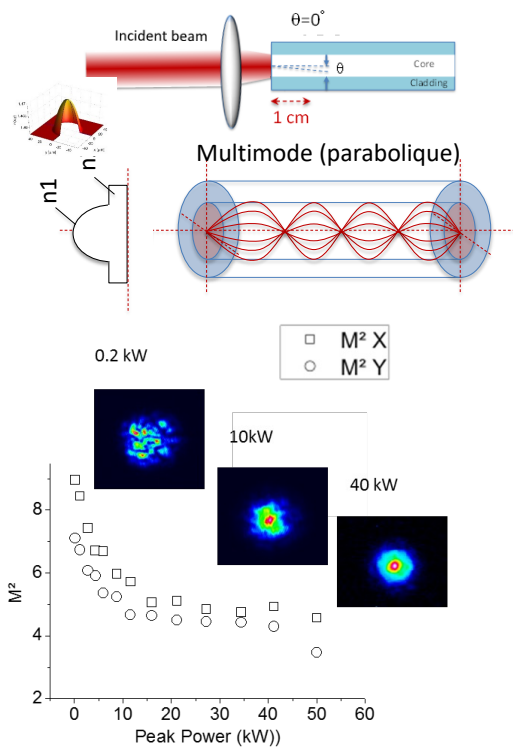
**European Research Council**

Established by the European Commission

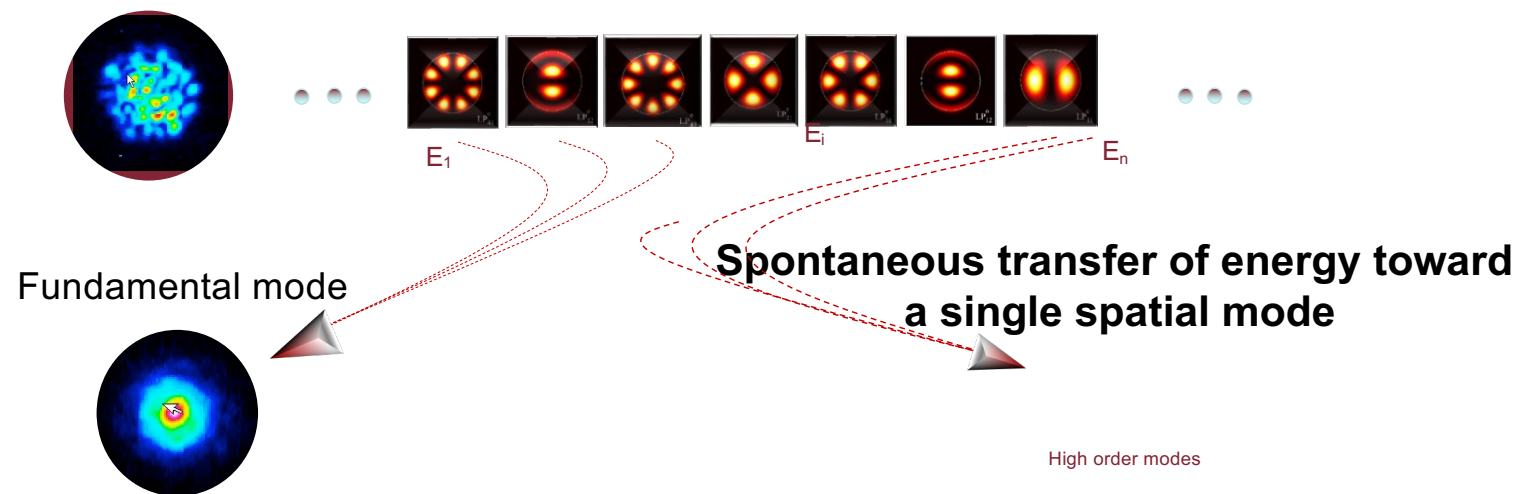
# Main topic of STEMS: study spatial Kerr self-cleaning (light condensation) in multimode fibers



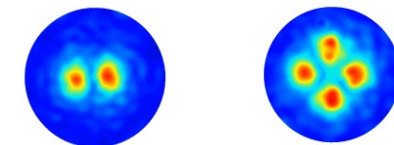
European Research Council  
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Found conditions to obtain light self-organization  
in multimode fibers for single mode emission



- ❑ K. Krupa et al., *Nature Photonics* volume 11, pages 237–241 (2017),
- ❑ Aschieri et al., *Phys. Rev. A* **83**, 033838 (2011).
- ❑ Picozzi, A. & Rica, *Opt. Commun.* **285**, 5440–5448 (2012).
- ❑ Picozzi, A. et al., *Phys. Rep.* **542**, 1–132 (2014).
- ❑ Fusaro et al., *Phys. Rev. Lett.* **122**, 123902 (2019)



# The EIC Pathfinder MULTISCOPE project: how did we get there?

2: FARE 2018 project WASHING: Waveshaping of optical beams for the control of light pulses by multimode fibers (2020-22)



# The EIC Pathfinder MULTISCOPE project: how did we get there?

3: ERC Proof-of-Concept Grant 2019 WAVESCOPE:  
Wavefront shaping system for nonlinear fiber based  
microscopy and endoscopy (2019-21)



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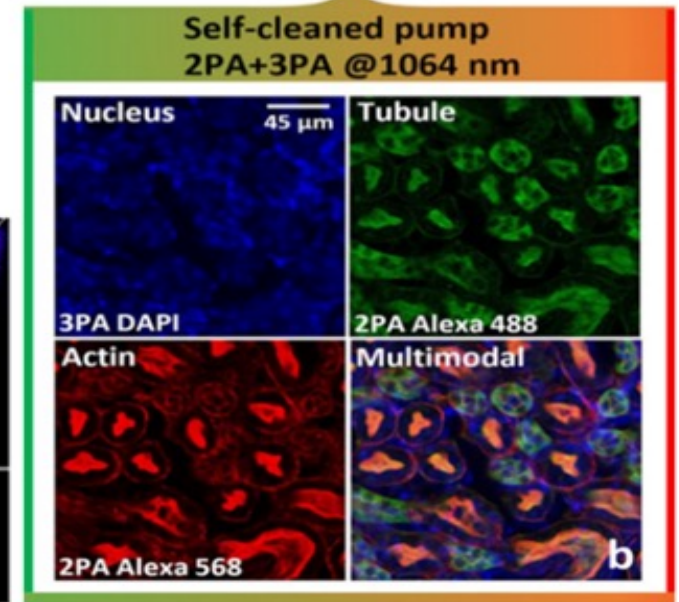
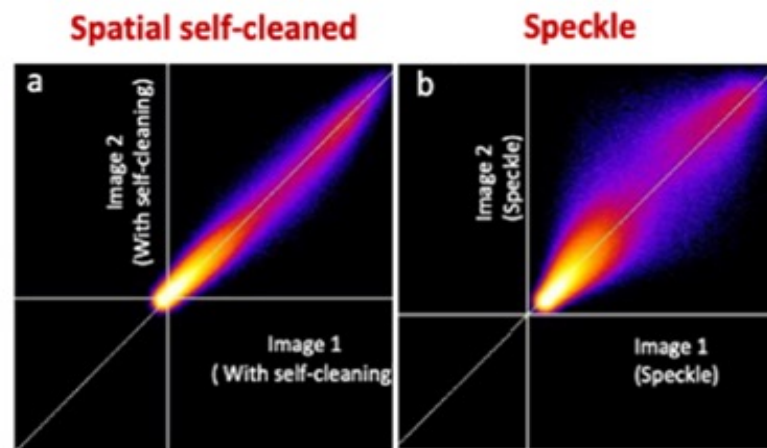
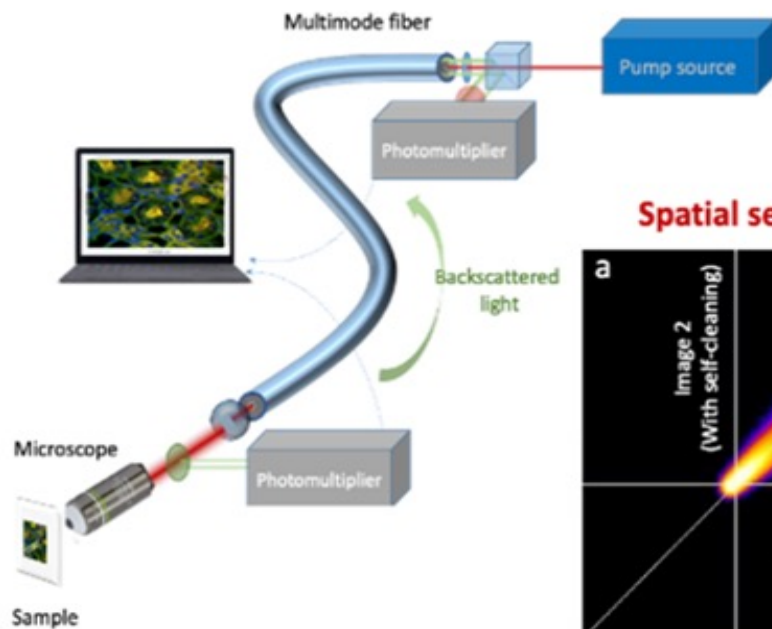
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# WAVESCOPE results: Optical Diagnosis

PCT/EP2017/057760; EP3885827A1; US2021296841A1.  
PCT/EP2022/082471; WO2023110287A1; FR3130403A1.  
WO2023/088636A1; PCT/EP2022/079337; FR2112129A.



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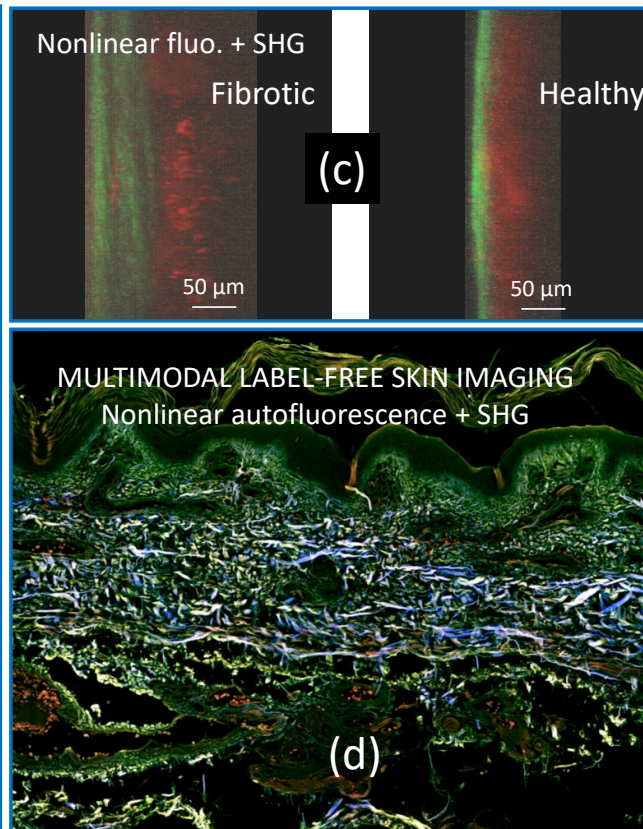
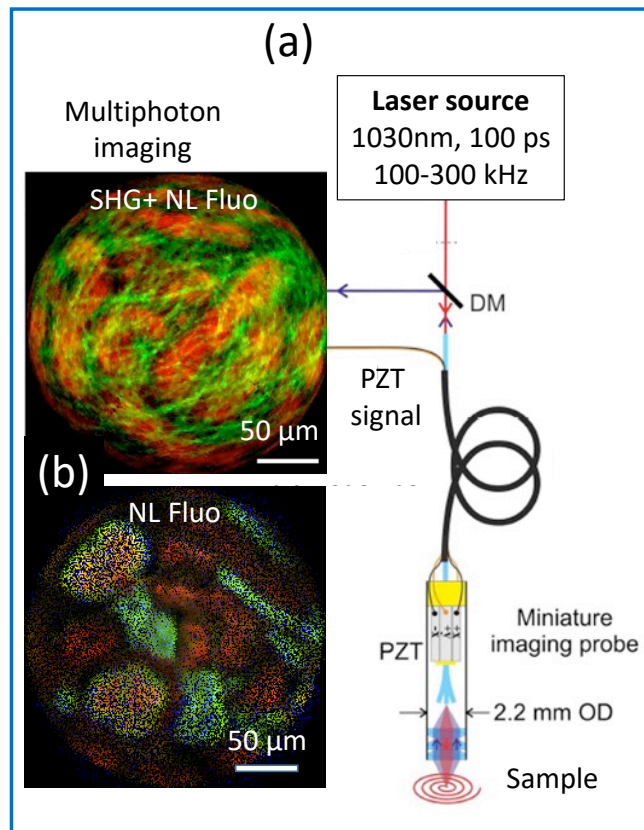
Wavescope system based on **photonic condensation** in multimode fiber (non-linear fluorescence, coherent Raman, Second Harmonic Generation)

N. O. Moussa et al., Nature Scientific Reports **11** (1), 18240

# WAVESCOPE result: Multimode fiber based microendoscope for real time optical biopsy



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- (a) Schematic representation of the endoscopic system;
- (b) examples of label-free image; SHG in green and nonlinear fluorescence in red of fibrotic kidney capsule (top image) and nonlinear multifluorescence (bottom image) obtained in endoscopic configurations with multimode fiber from a kidney of mouse;
- (c) image of fibrotic and healthy tissues;
- (d) SHG and multiphoton image of cancerous tissues.

## After ERC, we moved to EIC Transition Scheme

- We made 3 (failed) submissions to **EIC Transition** scheme
- Transition from the lab to the clinical trial of our real-time optical biopsy imaging endoscope, with the addition of medical device industry partner and end-user (Gemelli hospital)
- Main reason for failure: not clear advantage with respect to several other competing optical biopsy technologies, some of them commercial

**After ERC, we moved «backwards» in TRL to EIC Pathfinder, by adding a new key element to our proposal**



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del Sacro Cuore

Gemelli



Fondazione Policlinico Universitario A. Gemelli  
Università Cattolica del Sacro Cuore



Université  
de Limoges



erbe



**MULTISCOPE**

European  
Innovation  
Council



## MULTIMODE NONLINEAR FIBER BASED ENDOSCOPIC IMAGING AND TREATMENT

**Stefan Wabnitz**, Sapienza University of Rome,  
Italy



**Massimiliano Papi**, Università Cattolica del  
Sacro Cuore, Italy



**Ivo Boskoski**, Fondazione Policlinico Universitario  
Agostino Gemelli IRCCS, Italy



**Vincent Couderc**, XLIM - CNRS University of  
Limoges, France

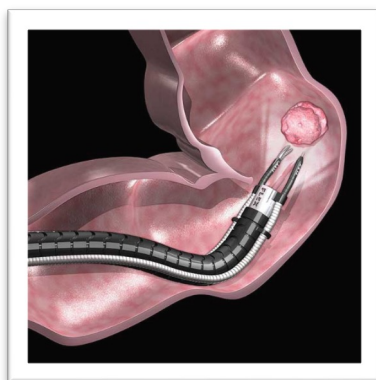


**Sanja Hermanns**, ERBE Elektromedizin GmbH,  
Germany

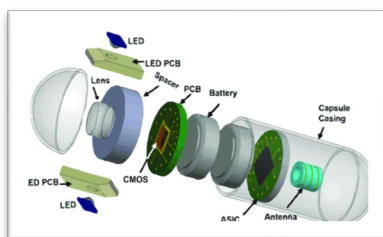


# State of the Art (but no clinical practice/not **widespread** use)

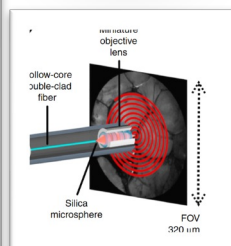
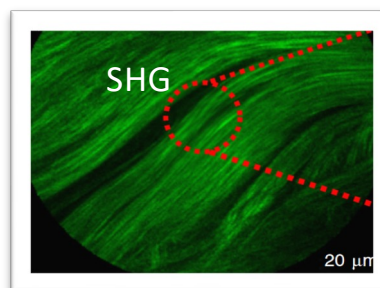
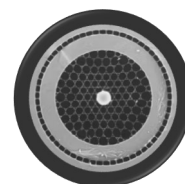
## Endoscopic robot surgery/biopsy



## Robotic capsule

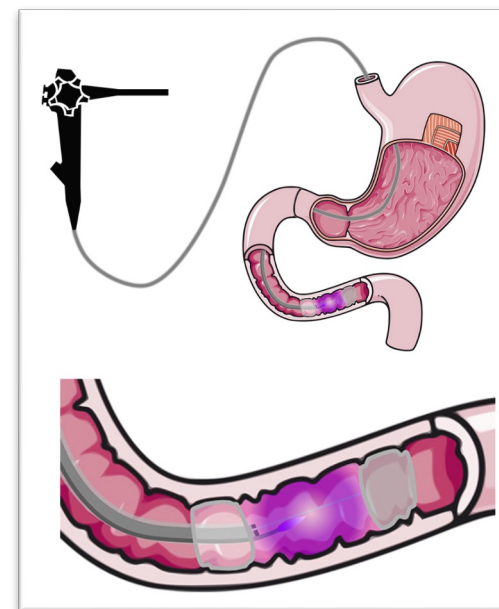


## Microendoscopy: Multimodal endoscopy targets real-time biopsy



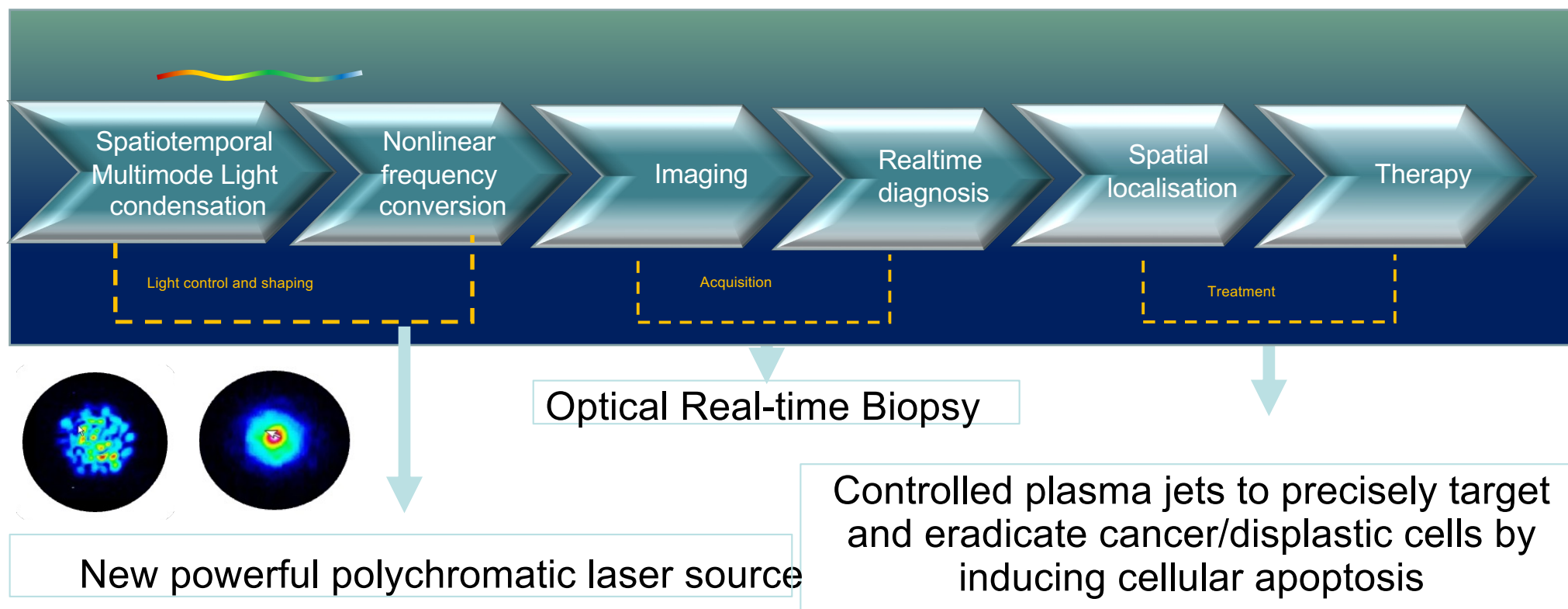
Nonlinear fluorescence,  
Raman and parametric  
processes

## Phototherapy application

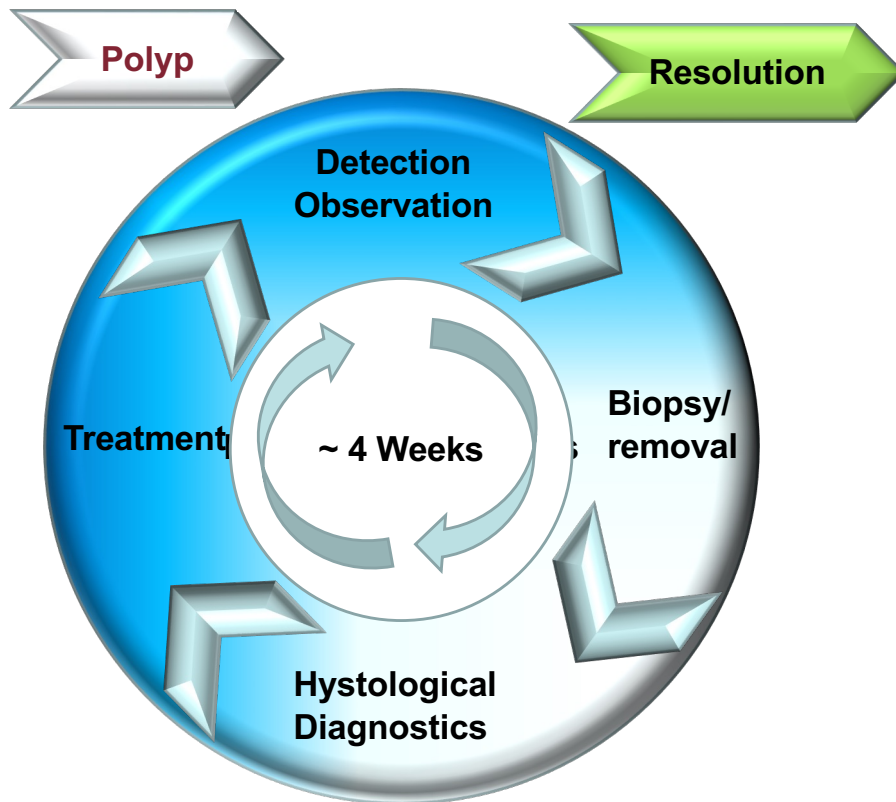


Cold atmospheric plasma  
for ablation

## Key innovation: **endoscopic** diagnosis & Treatment based on light condensate

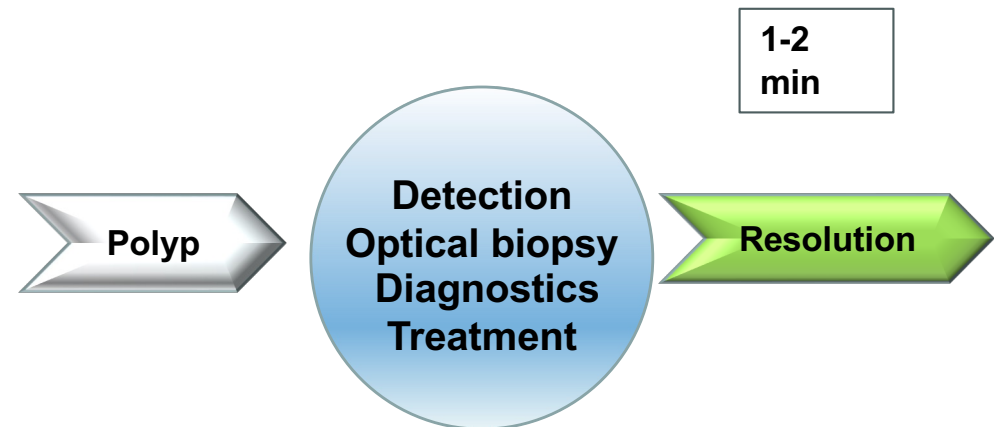


## Currently



ESD: long learning curve

## Multiscope

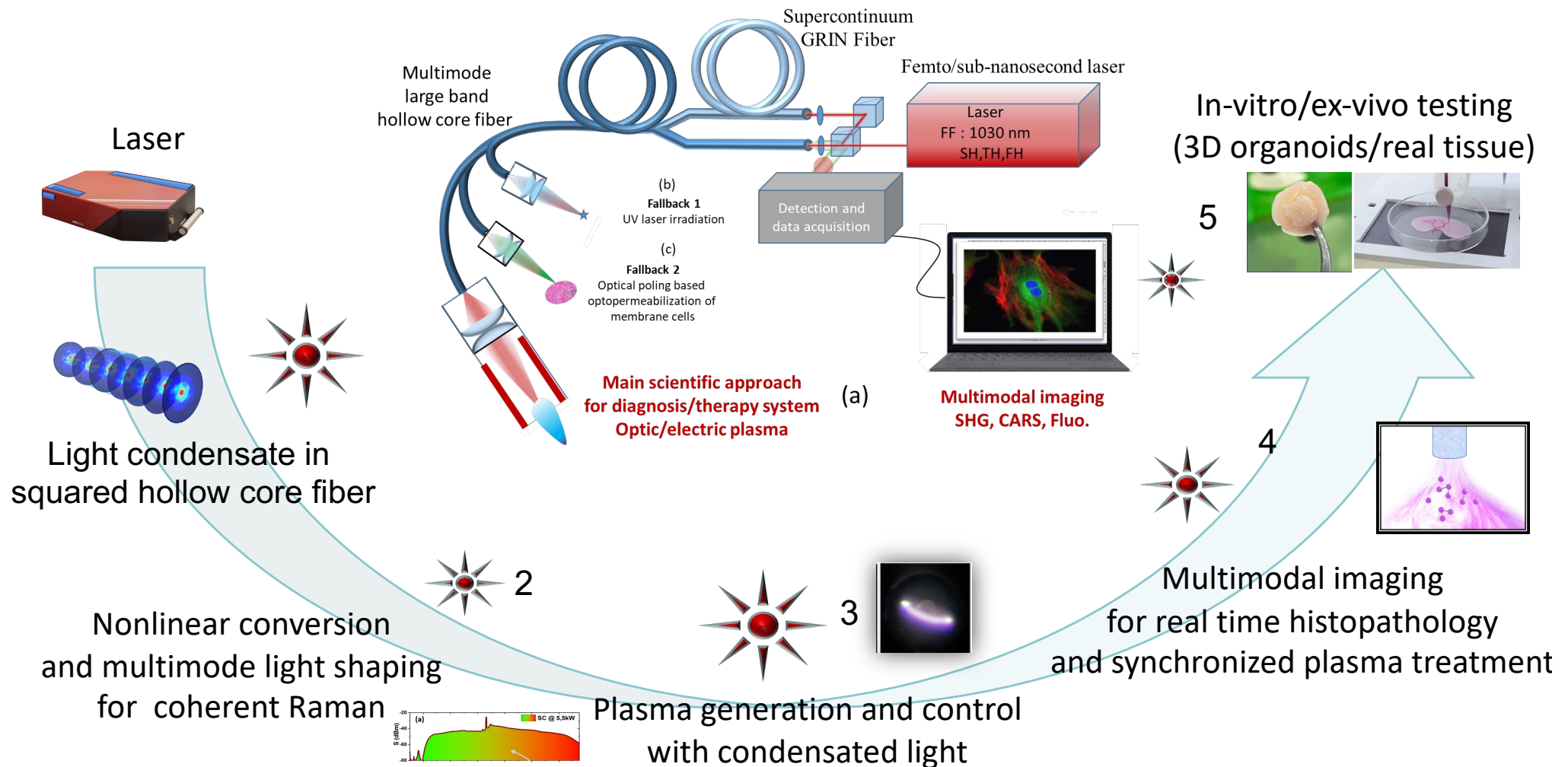


advantages:

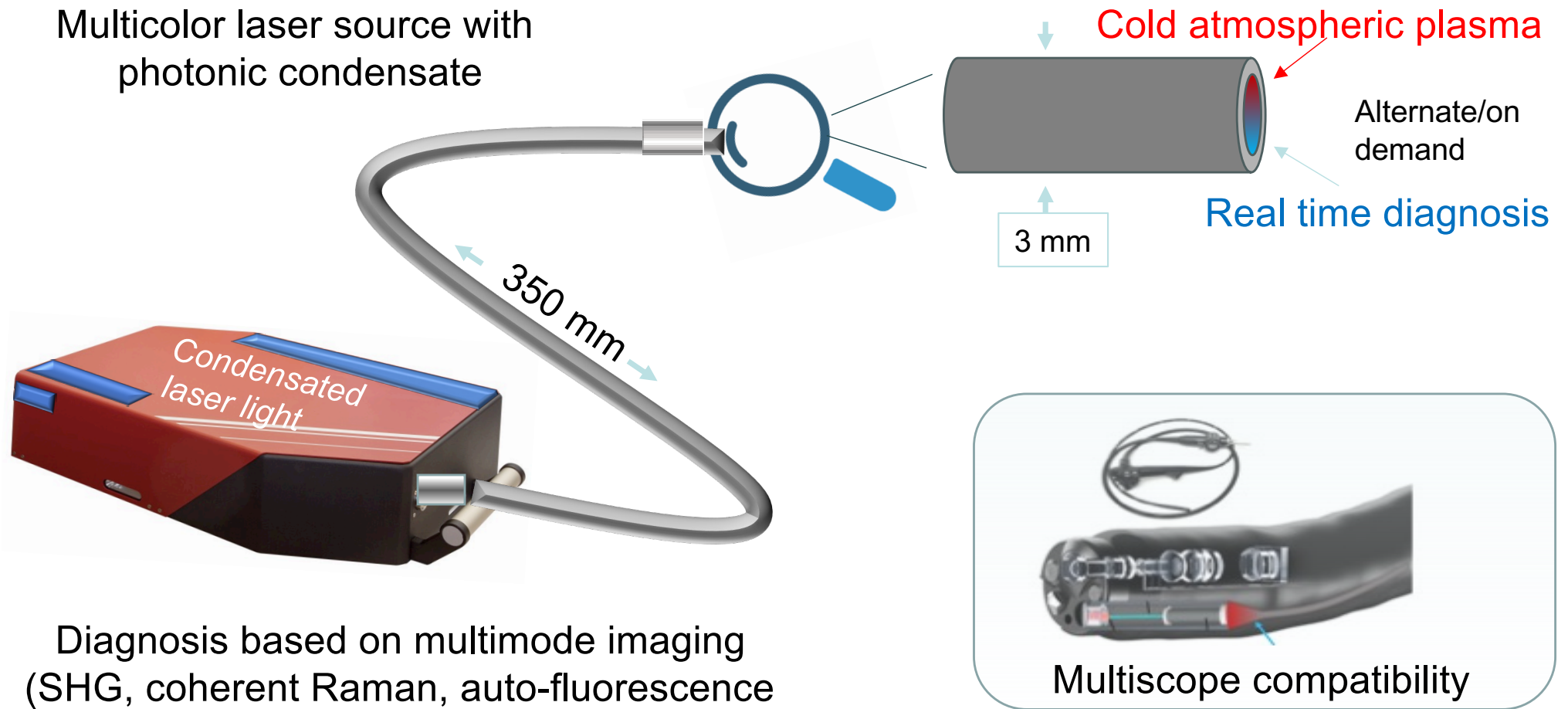
- Short diagnostic-treatment cycle
- Easy procedure with no specific learning
- Compatible with current endoscopes used

# Challenges and ultimate goals


## Real-time in-situ histopathology and treatment: MULTISCOPE



## MULTISCOPE Innovative device



# ESR feedback from evaluators

Proposal Evaluation Form		
	EUROPEAN COMMISSION Horizon Europe Framework Programme (HORIZON)	Evaluation Summary <b>Report (Review task) - PATHFINDER - OPEN</b>

## Evaluation Result

**Total score: 4.90 (Threshold: 0 )**

## Panel comments on proposal

According to the predefined scoring scale the proposal is Excellent.

The evaluation committee agrees with the evaluators that the long-term vision of MULTISCOPE, which aims at developing a novel endoscopic approach combining advanced optical diagnostics and therapy is disruptive and convincing, and it encompasses a valuable long term impact.

The objectives are concrete and plausible, and they are well-described, both technically and quantitatively. The science-towards-technology breakthrough relies on leveraging the beam self-cleaning effect in optical fibers to advance both diagnosis by means of multimode non-linear imaging and treatment using cold atmospheric plasma.

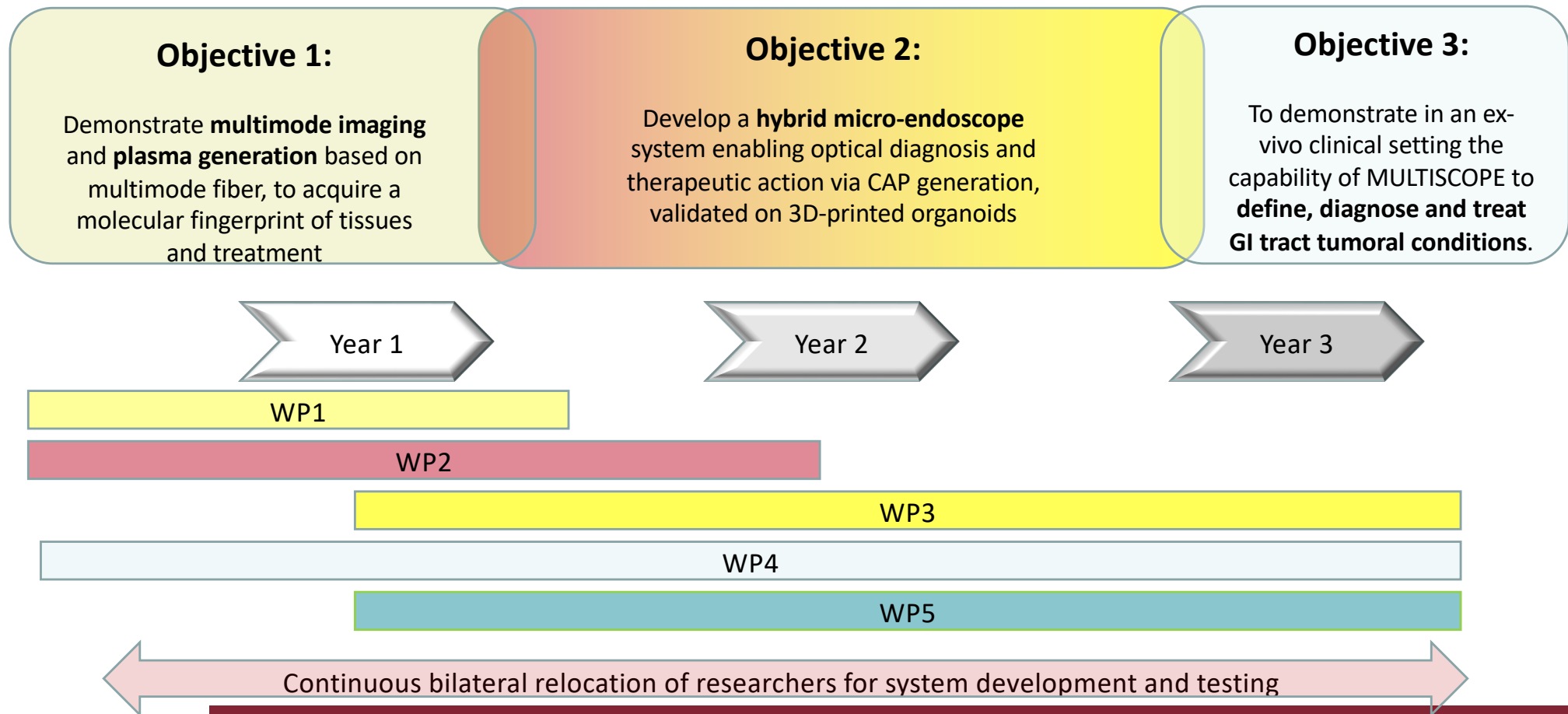
The evaluation committee supports the view of the evaluator who questions the novelty of each aspect individually, but also acknowledges that their integration in the same device goes beyond the state-of-the-art and can provide significant advancements. The high-risk/high-gain condition of the proposal is well satisfied.

Moreover, the interdisciplinarity, which ranges from plasma physics and optics to biomedical imaging and medicine, is crucial and fundamental in this proposal.

Finally, the evaluation committee agrees with the evaluators that the workplan is mostly sound and robust, but they also share the opinion of the evaluator who points out that the implementation of the CAP therapy part of the project is not sufficiently described.

# Objectives and implementation

Five leading laboratories providing latest-generation equipment and cutting-edge know-how



# WP1 & WP2 Development and fabrication

(Leader)

WP1 Device assessment, design & validation of technical specifications

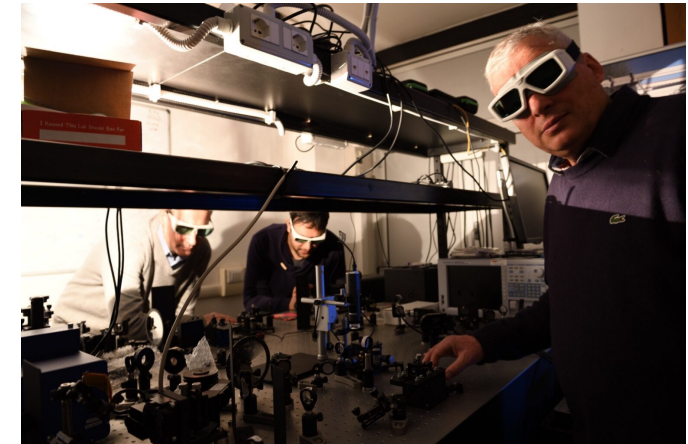
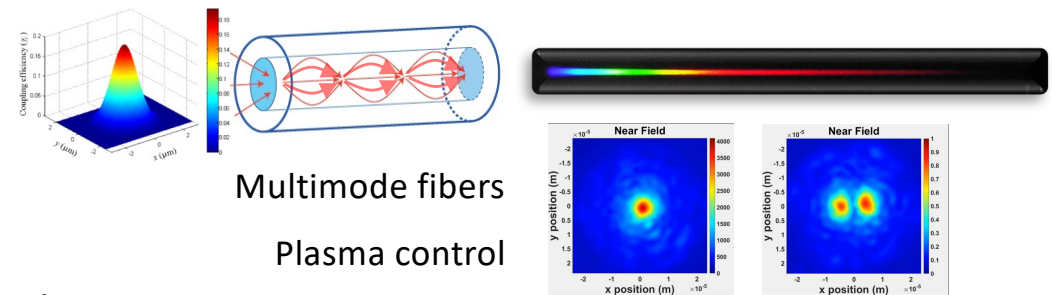
WP2 Fabrication and performance testing

## Innovation

- New multimode hollow core fibers for light condensation
- 50  $\Omega$  hybrid fiber system with adjustable impedance for plasma
- Mixed optical /electrical plasma generation

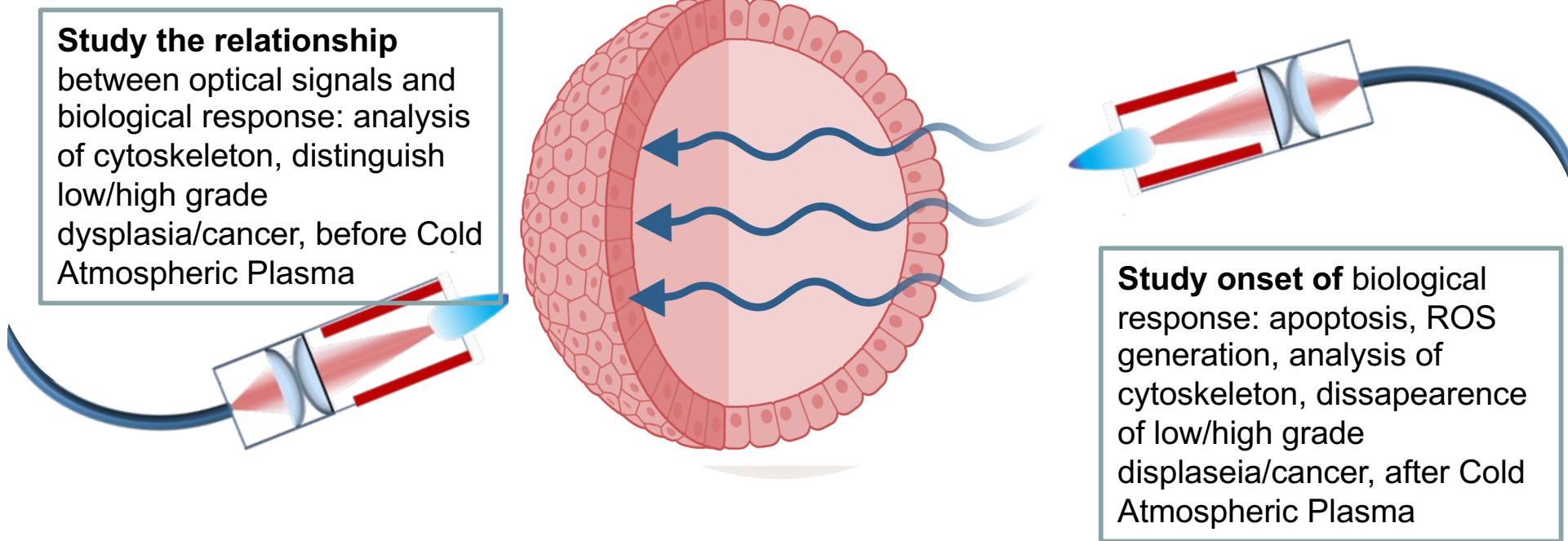
## Breakthrough

- Real-time alternated imaging and plasma application for treatment monitoring (Coherent Raman spectroscopy, Second Harmonic Generation Nonlinear Fluorescence; Plasma, UV, Poling)



## WP 3: Direct in vitro studies

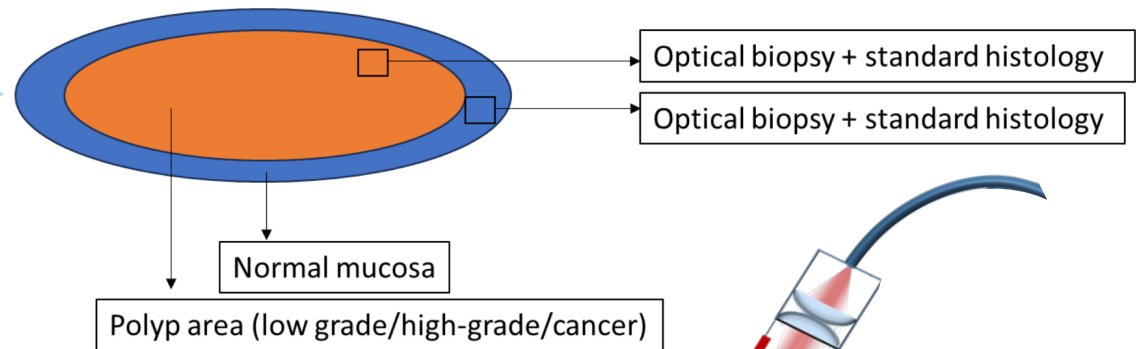
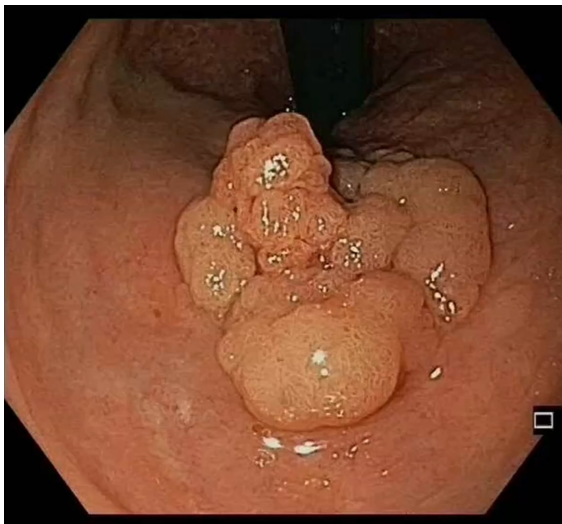
- Multimodal imaging on in vitro & organoids and complex 2D & 3D bio printed cancerous tissues (intestinal complex/dysplastic/cancerous) in-vitro validation and device optimization; Instantaneous impact of cold plasma on molecular destructureation – organoids with different dimensions



# WP 4: ex-vivo optical Diagnosis

(Leader)

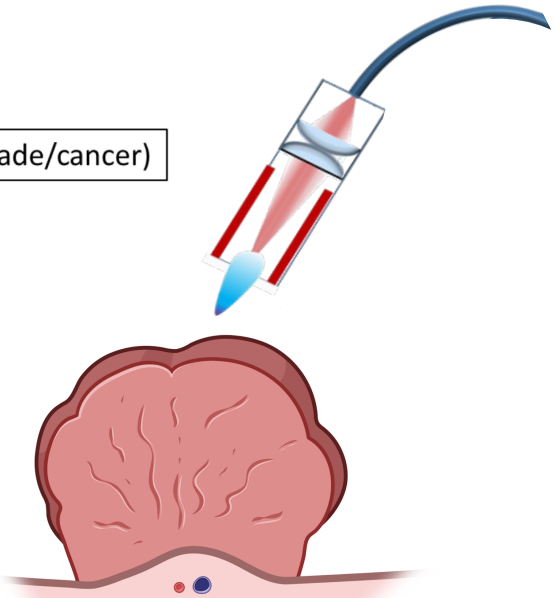
- To assess the diagnostic accuracy of the device for precancerous and cancer conditions of the gastrointestinal tract when compared to standard biopsy



## To understand:

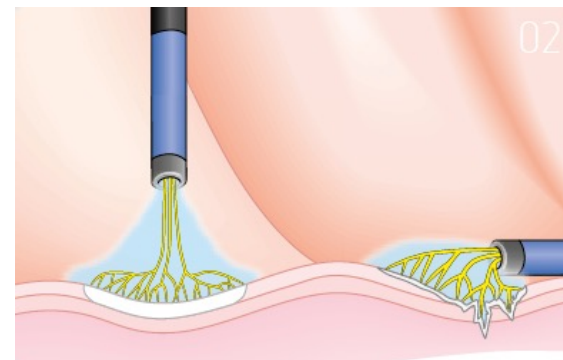
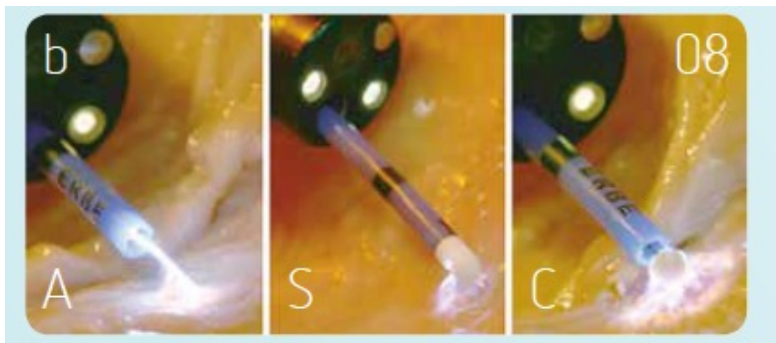
- Sensitivity, specificity, accuracy, predictive positive and negative values.
- Which polyps/cancers?
- Which dimensions?
- Which deepness?
- Study characteristics of tissues.

(30 G-ESD + 30 CR-ESD)



# WP 5: Technology hybridization and performance evaluation

- ERBE will provide alternative photonic technologies for tissue recognition like DRS and OES. Both methods allow to characterize tumor tissue and are advanced regarding their translation into medical products
- ERBE will develop design concepts for contamination prevention of GRIN lenses; In addition, the soiling tendency of the full system will be tested on an appropriate test stand
- To tune the plasma energy (task 1.6) with regards to the desired tissue effect electronic modulations will be tested and optimized according to their tissue modifying effects
- To optimize the CAP generation and effect, a thorough comparison to other types of plasma will be performed



**MULTISCOPE webpage:**

[www.multiscope.it](http://www.multiscope.it)

<https://cordis.europa.eu/project/id/101185664>

**Project logo**



**social media:**

[https://x.com/MULTISCOPE\\_EU](https://x.com/MULTISCOPE_EU)

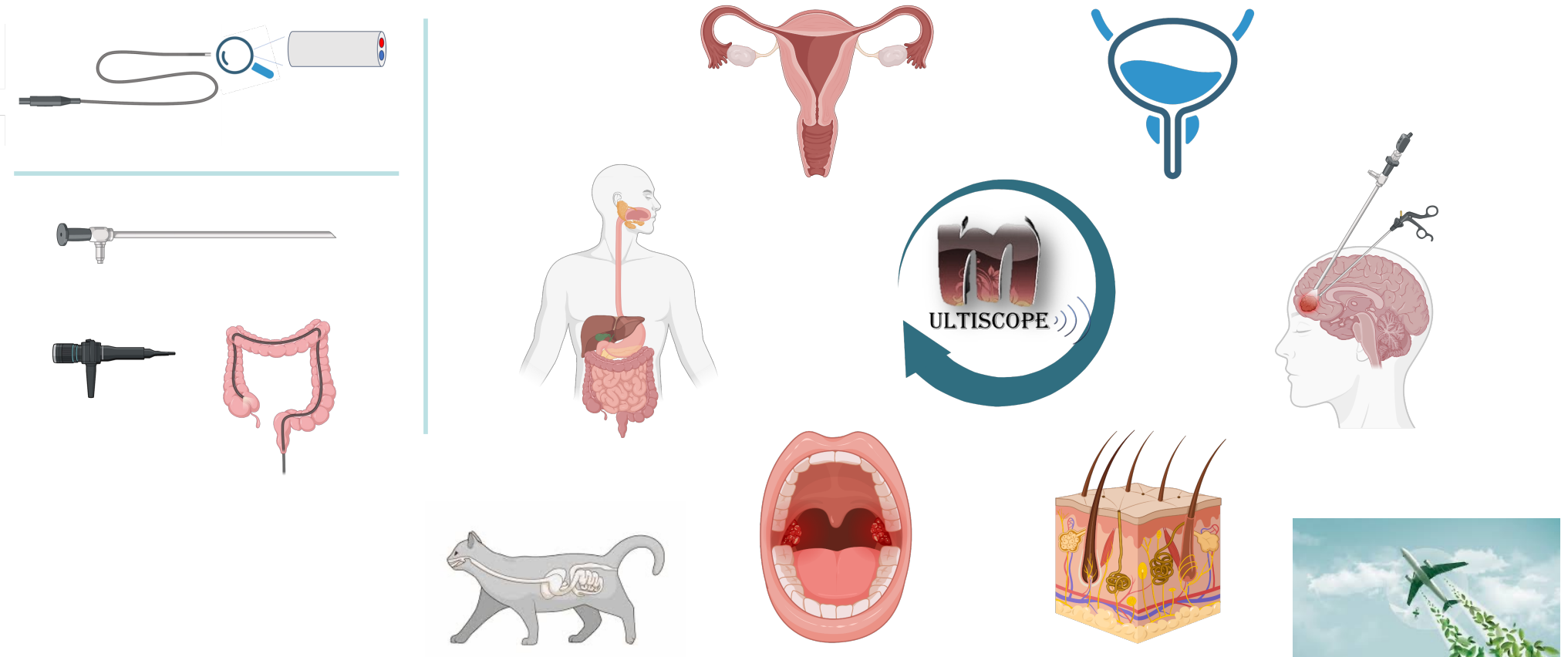
<https://www.linkedin.com/company/multiscope-eu/>



EIC Pathfinder Open MULTISCOPE Funding Agency



# MULTISCOPE technology: Other fields of potential use



Our multiscope can be used for other diagnostics and treatments of the human body, animals, and complex industrial devices such as aircraft engines to monitor in real time the composition of gas emissions (future green aircraft).