



All-fiber Smart Applicators for Percutaneous Tumor Laser Ablation

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Telecommunications



01. ALITE in a Nutshell

Organization

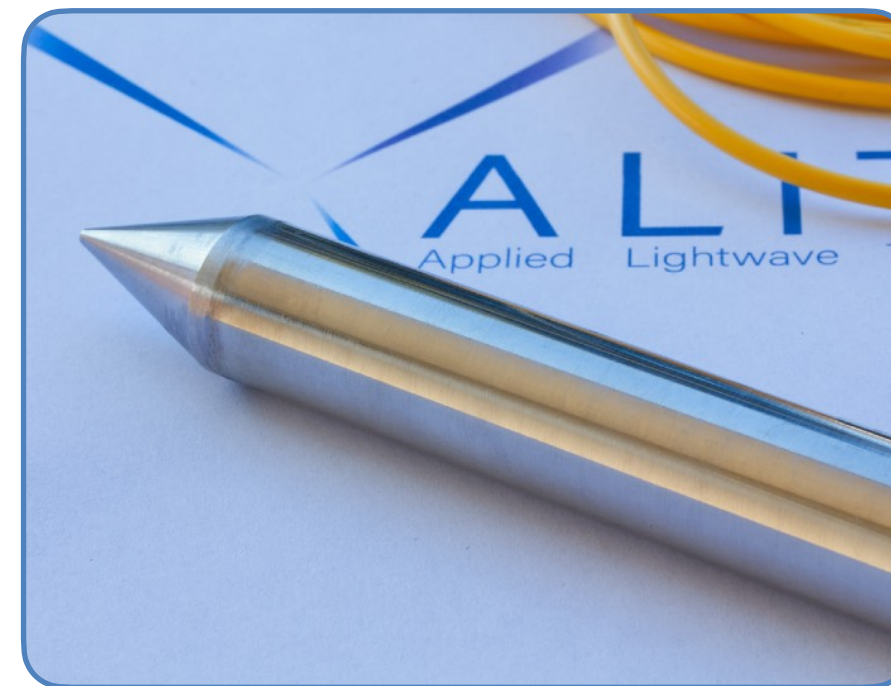
LASER

- Custom laser sources.
- High-power hybrid beam combiners.



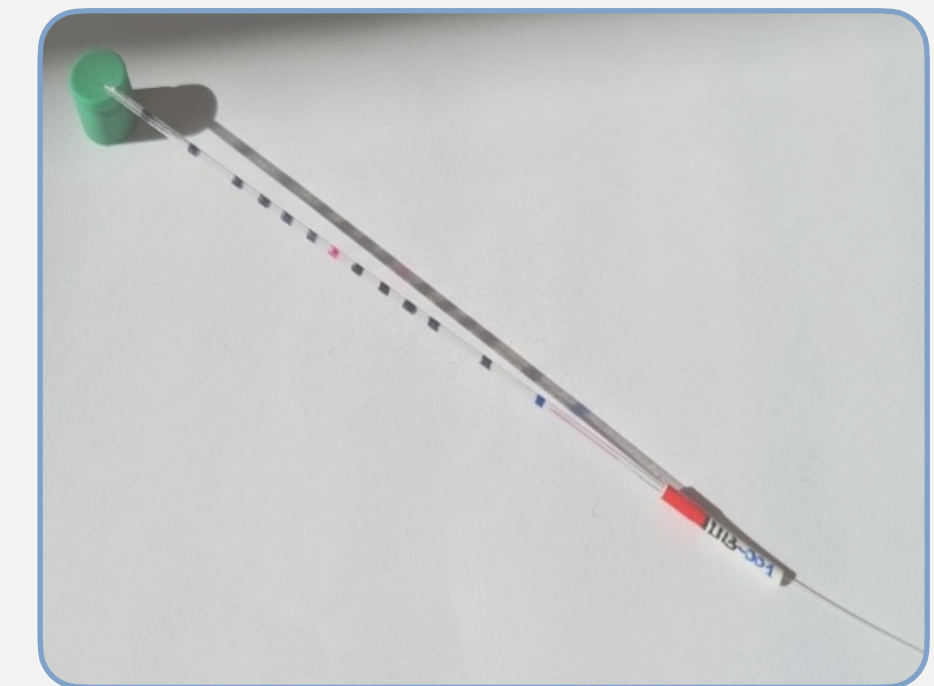
SENSING

- Fiber monitoring systems (temperature, vibrations, water pollutants).



MEDICAL

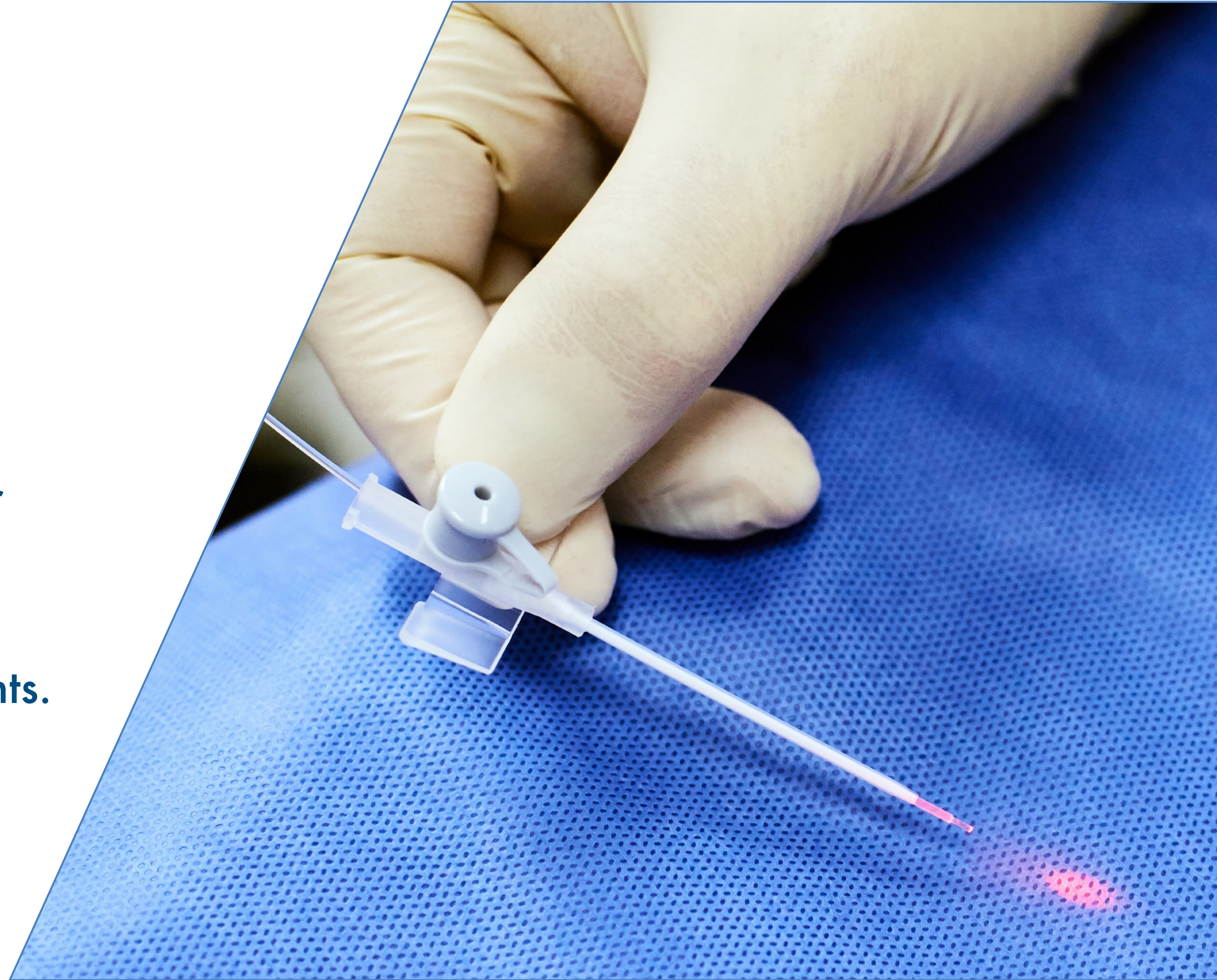
- Laser delivery applicators.



02. ALITE Medical

Laser delivery applicators

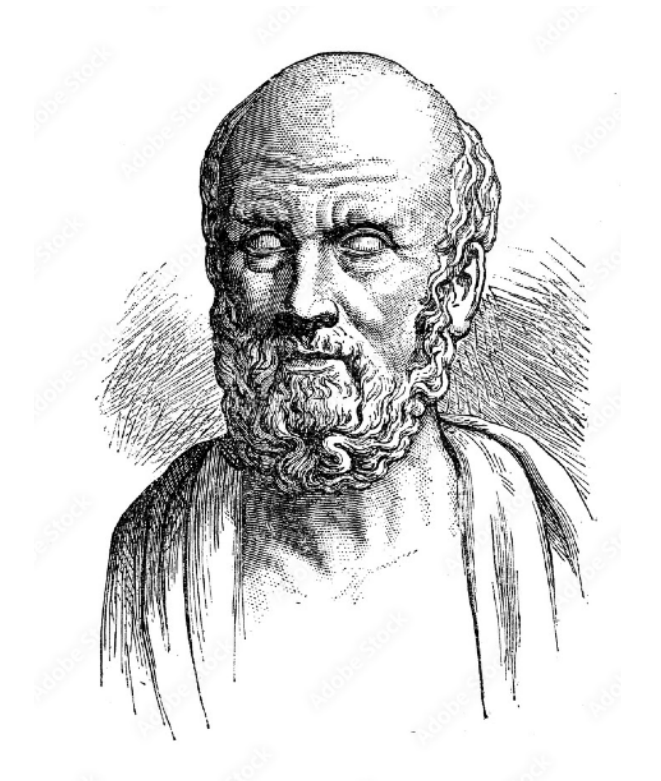
Develop fiber technologies for the **combined** high-power laser beam delivery and sensing to improve the quality of **percutaneous** thermal treatments.



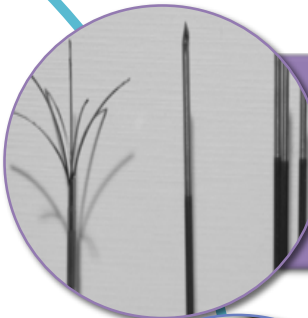

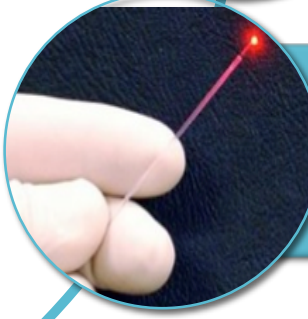
02. ALITE Medical

Thermal therapies

*Those diseases which medicines do not cure, iron cures; those which iron cannot cure, **fire** cures; and those which fire cannot cure, are to be reckoned wholly incurable.*



Hippocrates

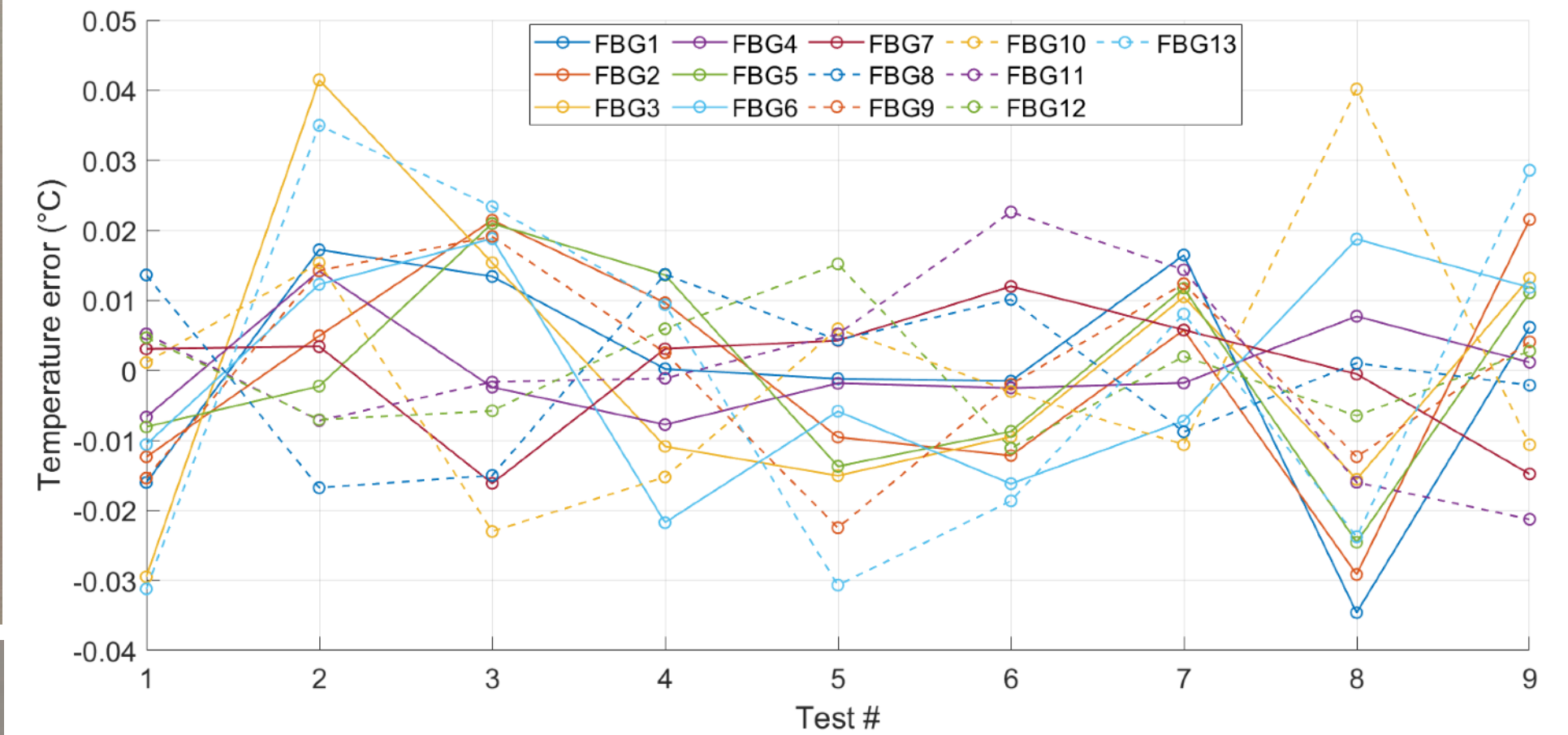
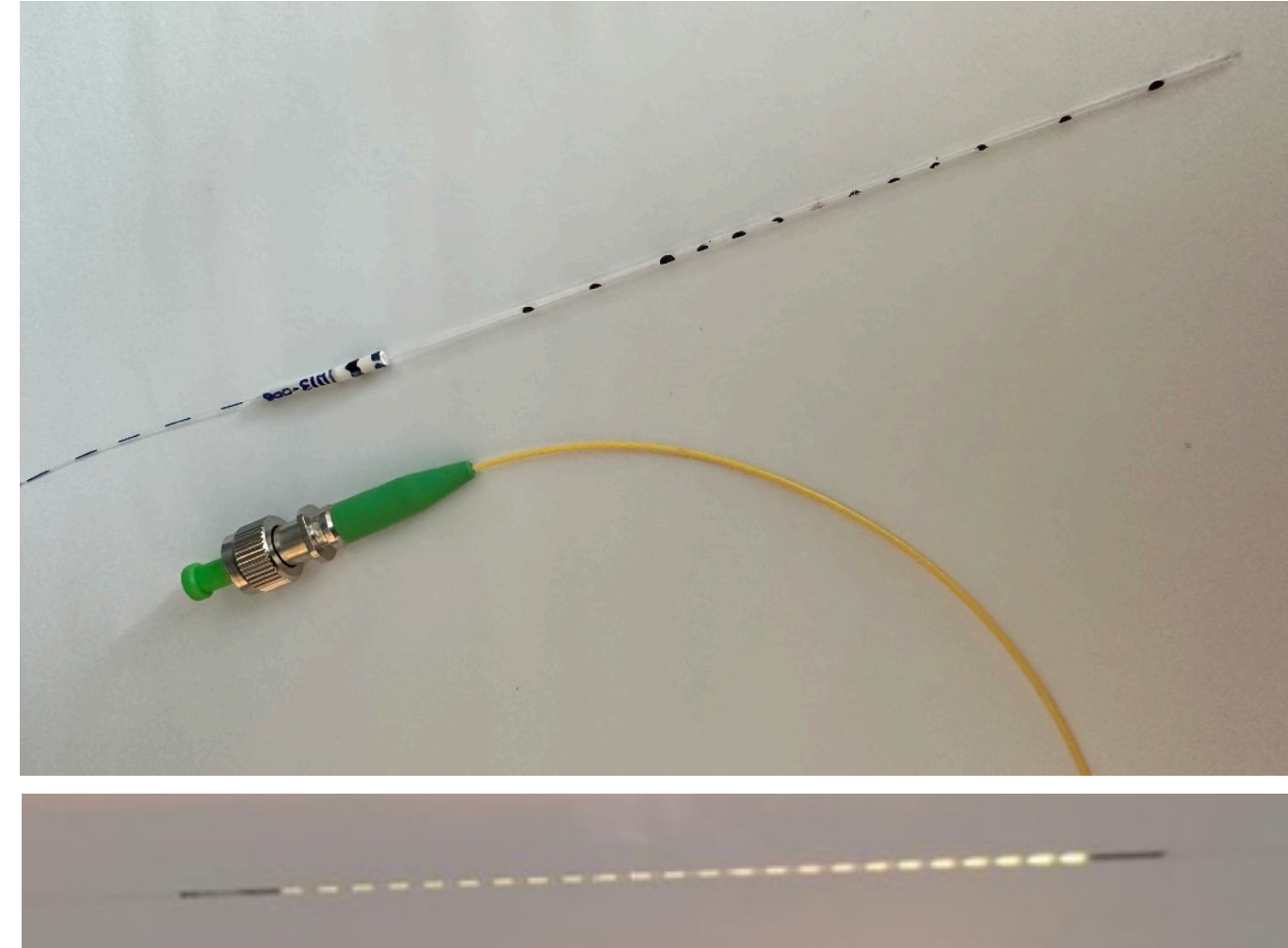
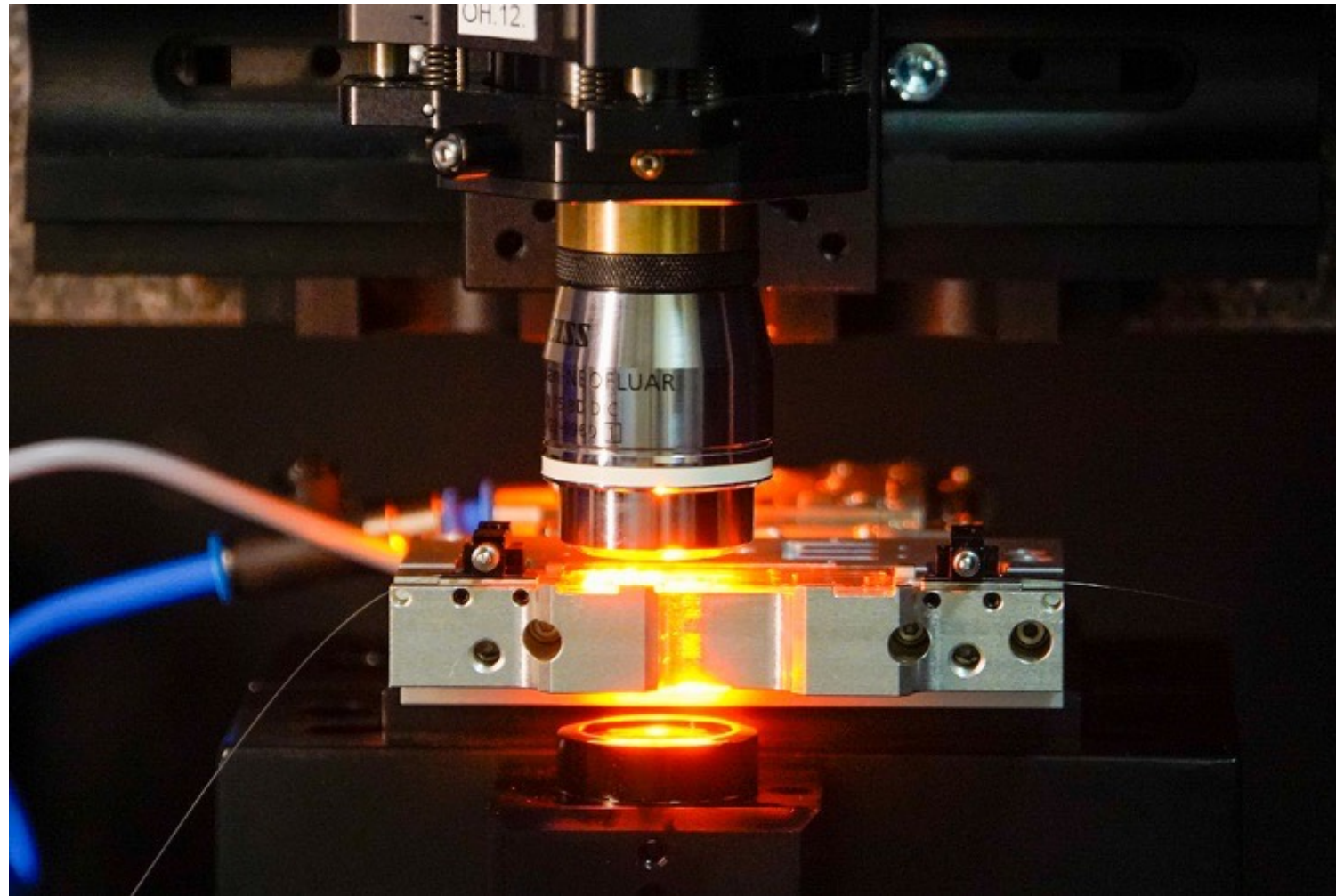
-  Radio Frequency Ablation: $f = 450 \text{ kHz}$
-  Micro Wave Ablation: $f = 2.4 \text{ GHz}$
-  Laser Ablation: $\lambda = 0.8 - 10.6 \text{ m}$

Temperature	Time Requirements	Biological effects
30-39 °C	No time limit	Normal cell growth
40-46 °C	30-60 minutes	Hyperthermia
47-55 °C	> 10 minutes	Irreversible injuries
> 55 °C	Few minutes	Coagulative necrosis
100-300 °C	Seconds	Vaporization
> 300 °C	Fractions of second	Carbonization

Optimal treatments require accurate planning of temperature in the entire tumor mass and monitoring the outcomes during the entire procedure.

03. Measuring Temperature

Fiber multi-point thermometers



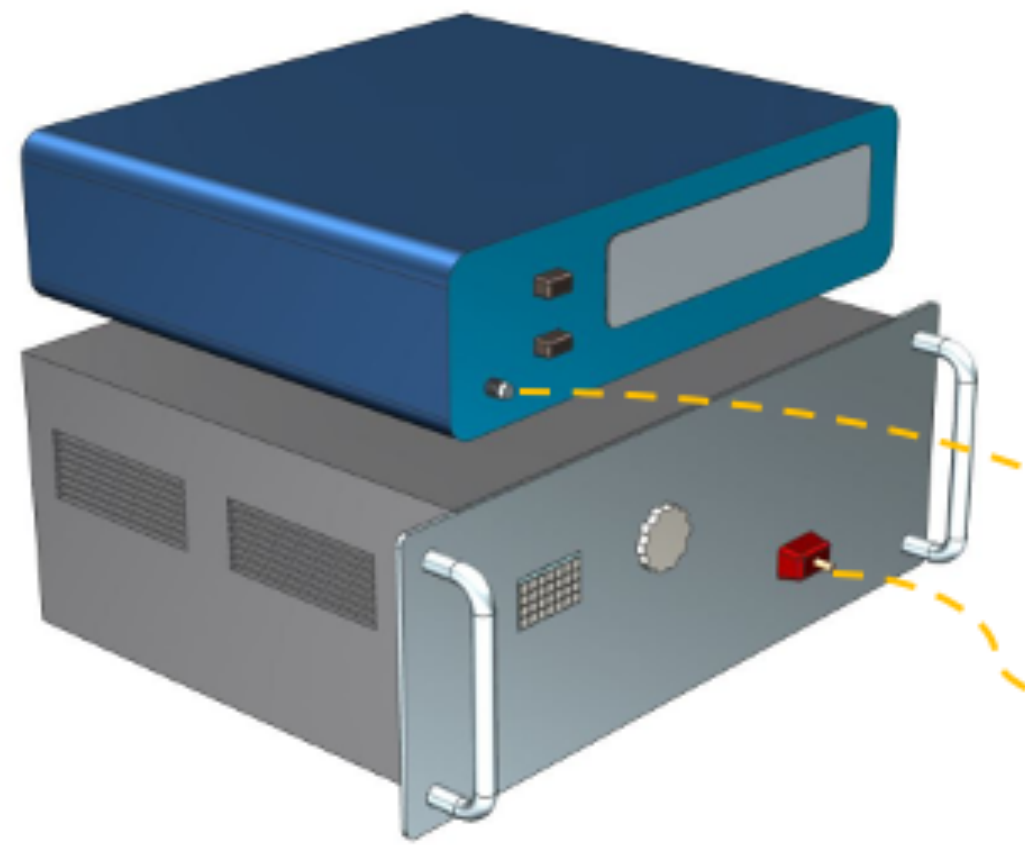
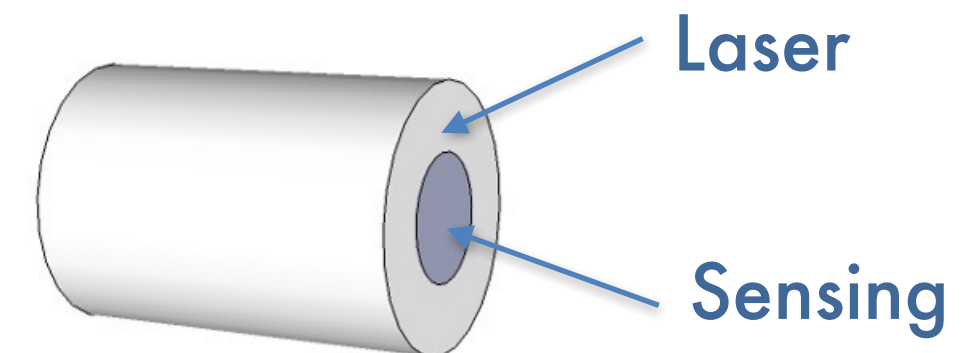
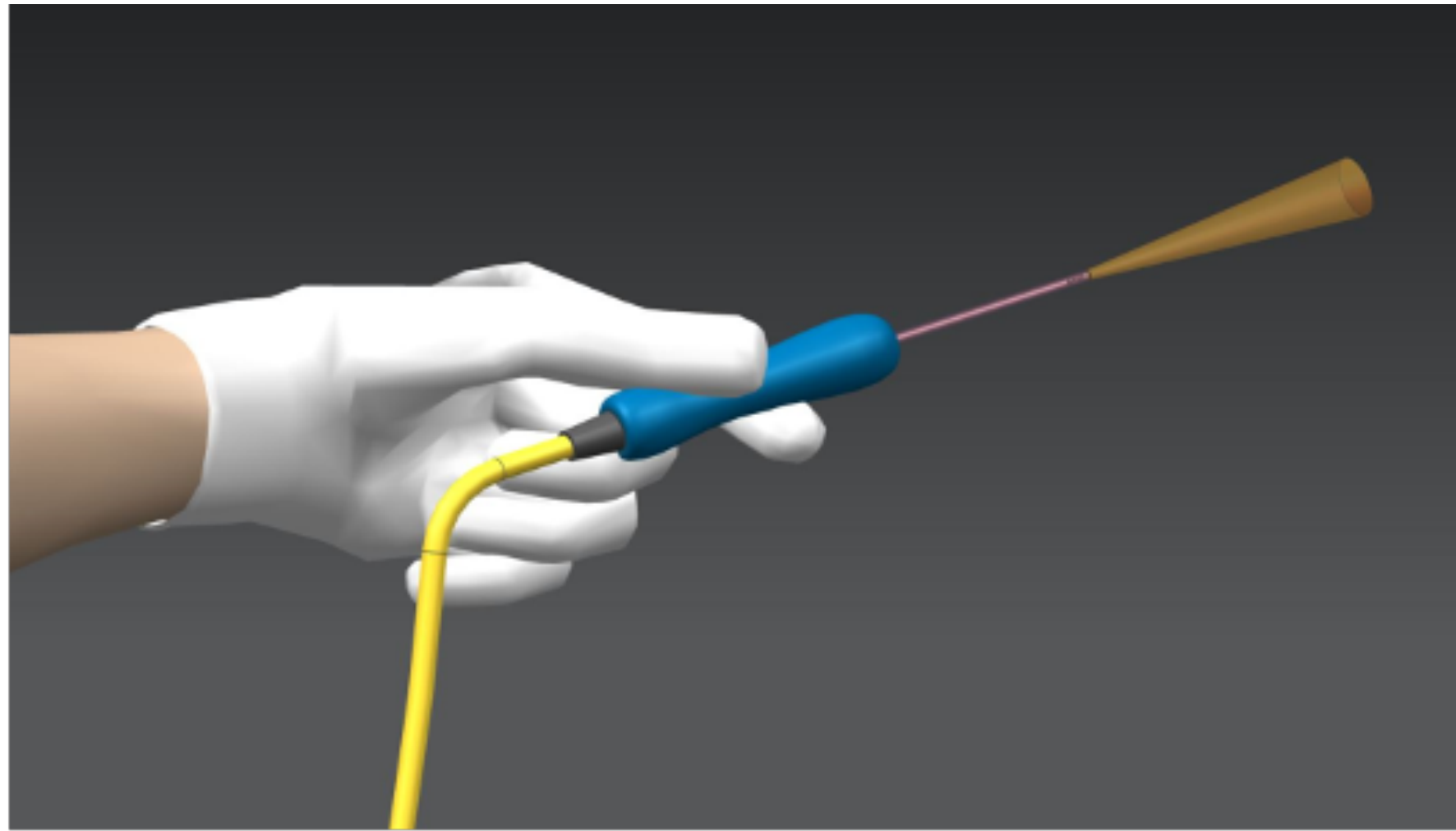
All-dielectric thermometers based on femtosecond-written FBG arrays:

- Laser and MRI compatible
- Up to 30 sensing points along the same fiber
- Possibility of ultra-dense arrays with sub-mm spatial resolution
- <0.05 °C temperature error
- Minimum invasive impact: different solution with $250\mu\text{m}$ – 2mm diameter



04. Smart Applicators

Fiber delivery and sensing



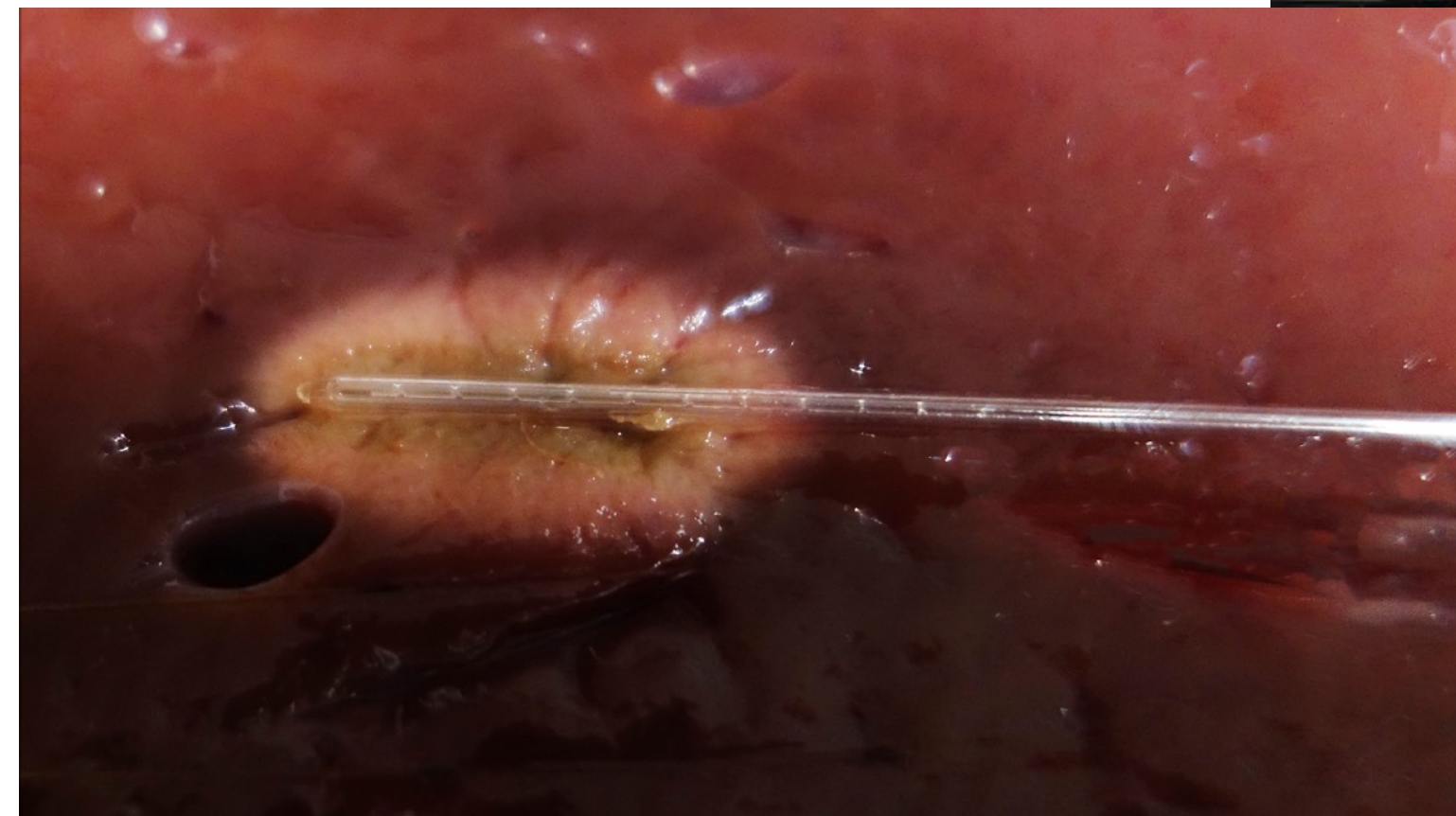
Challenge #1: combining laser deliver and temperature sensing

- Writing FBGs in the delivery fiber tip → safety feature



04. Smart Applicators

Laser thermal therapies



Ex-vivo and preliminary in-vivo tests.

05. Planning Tool

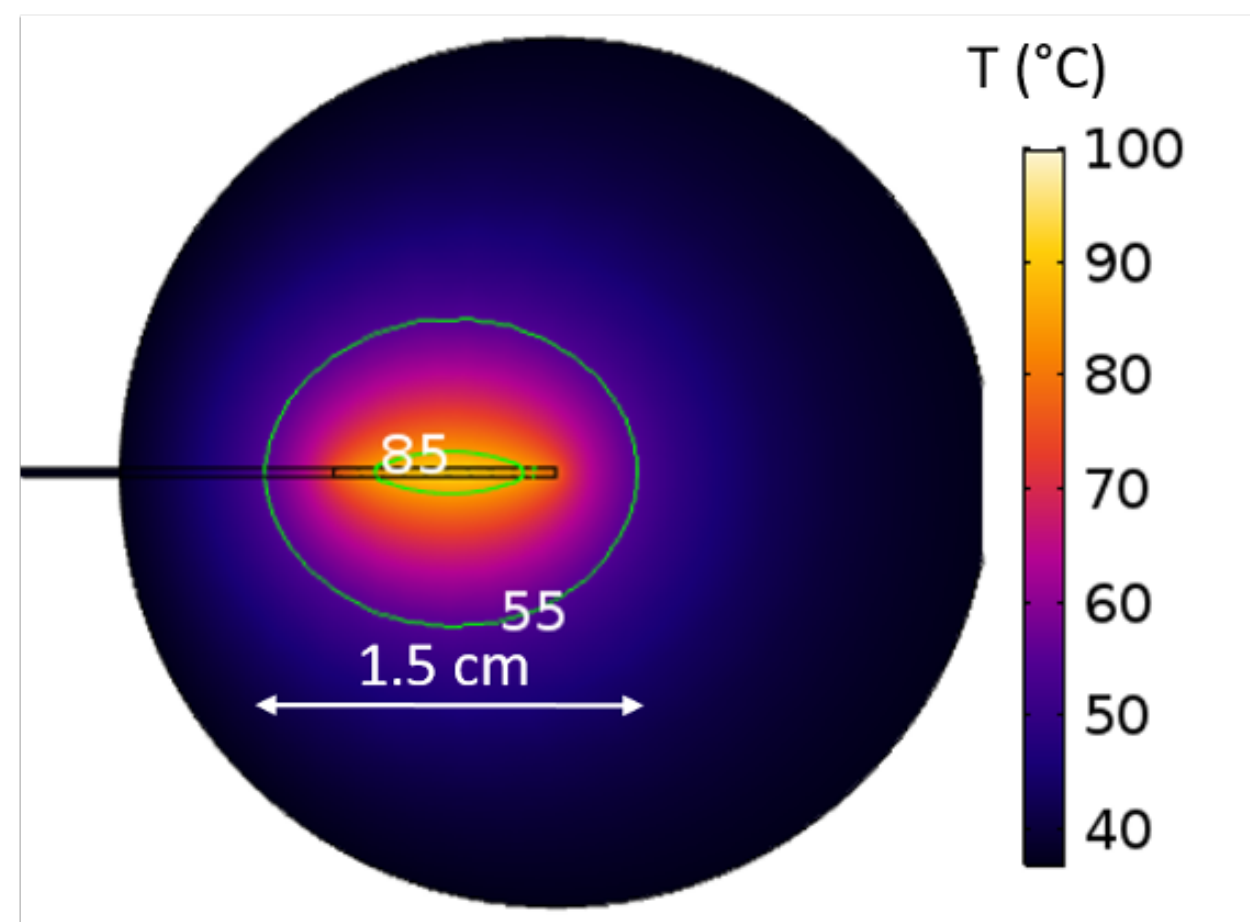
System to recover the temperature map

Challenge #2: estimating the temperature distribution

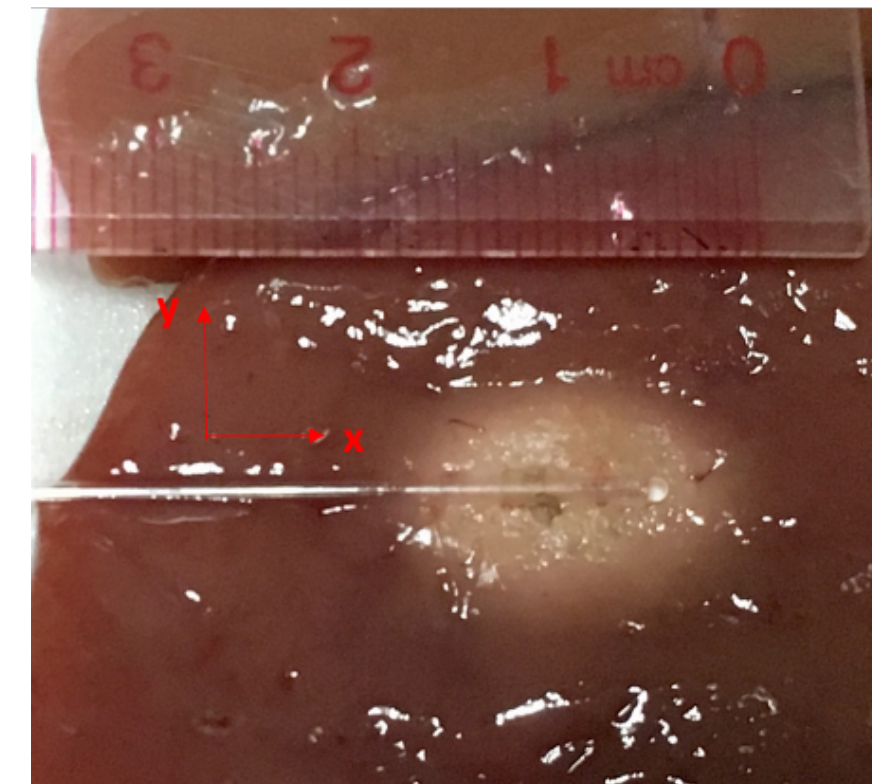
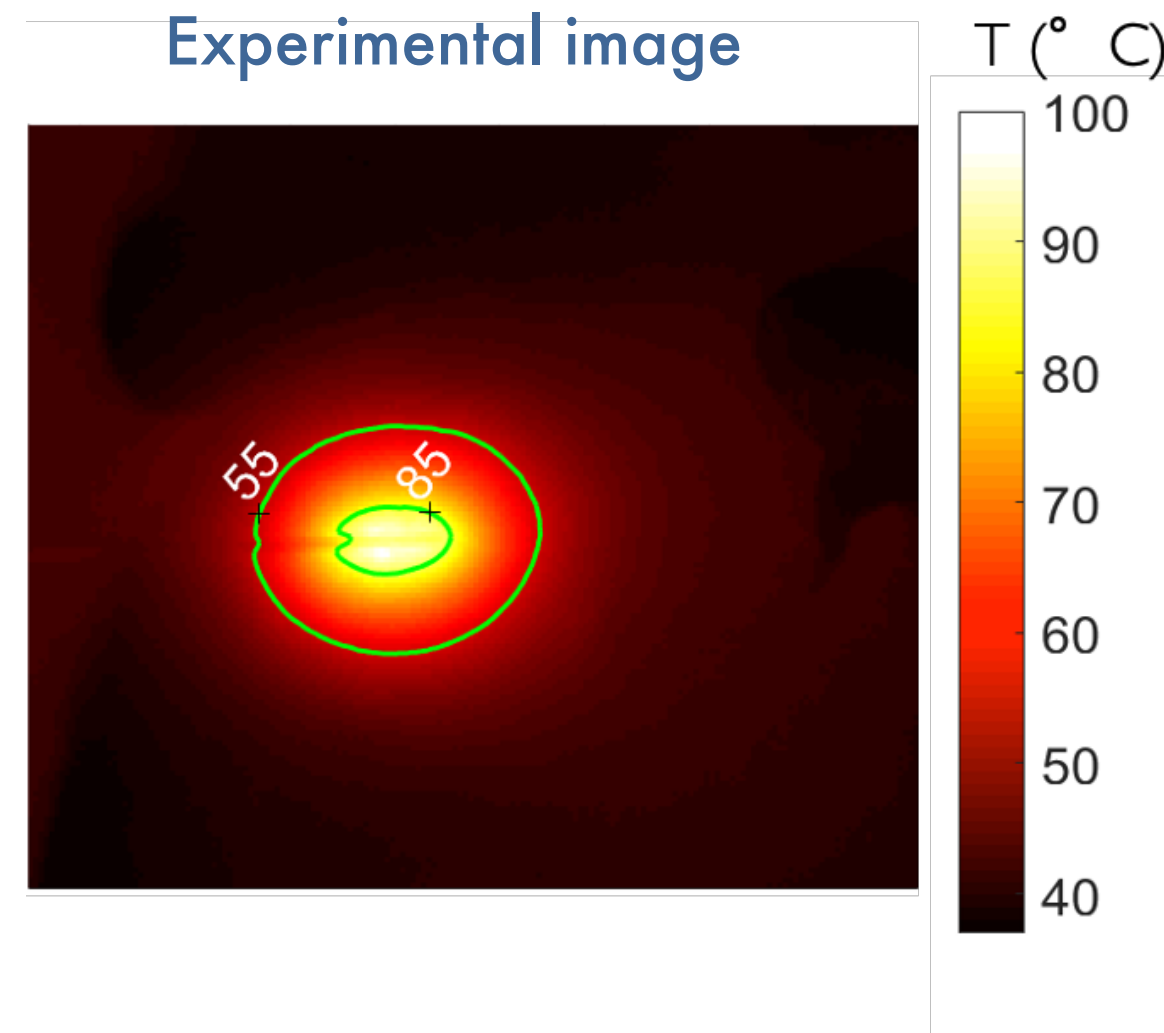
- Applicators with integrated FBG arrays
- Procedure to estimate tissue optical and thermal parameters
- Temperature map recovery algorithm by matching measurements with models



Thermal simulations



Experimental image

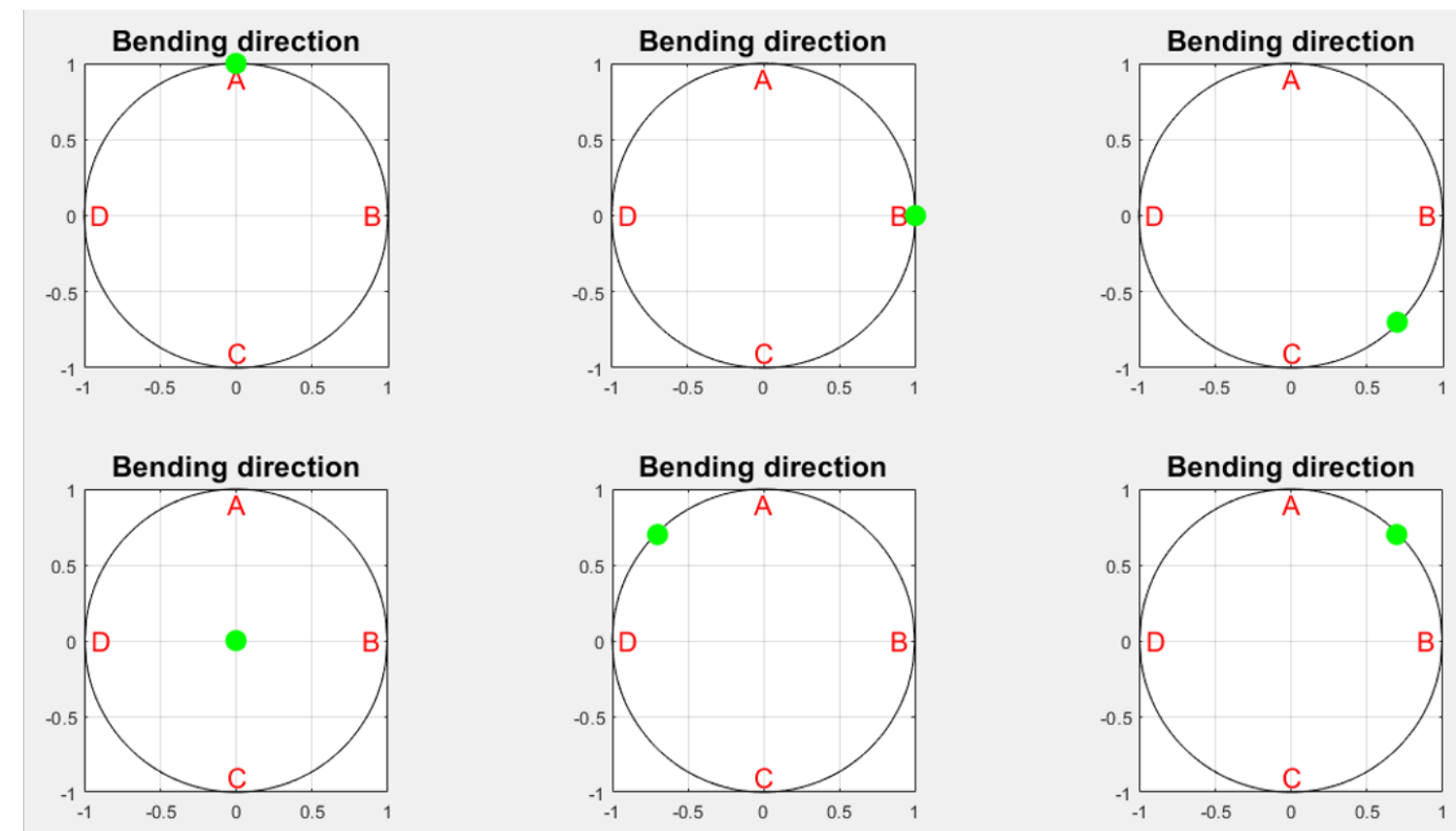
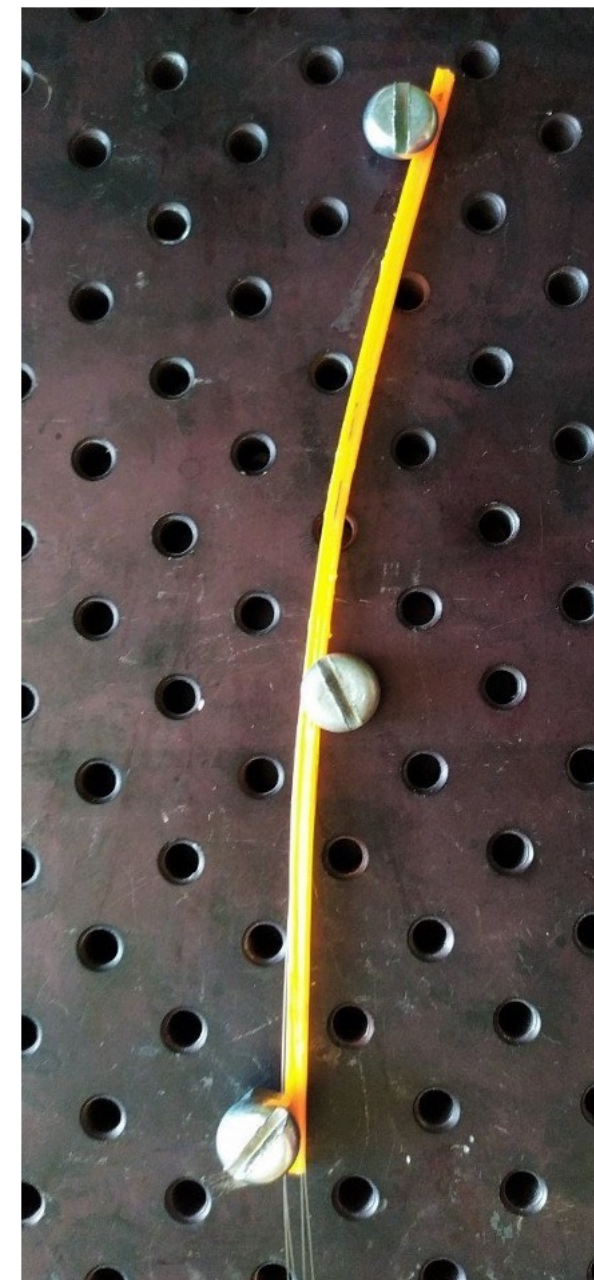
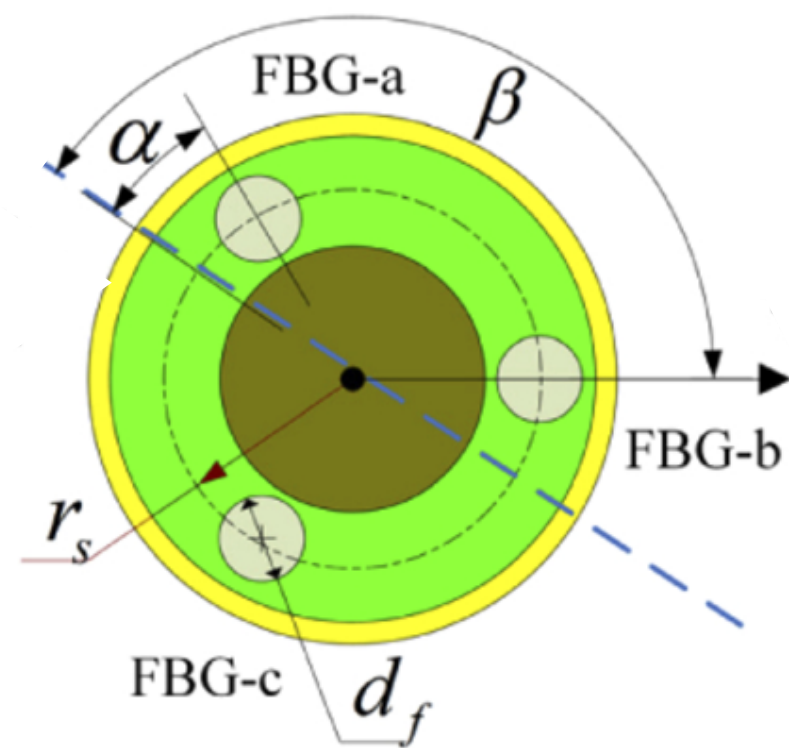


06. Improved Smart Applicators

System to "navigate" within the body

Challenge #3: detect bending

- Applicators with integrated multiple FBG arrays
- Enhanced software analysis capabilities



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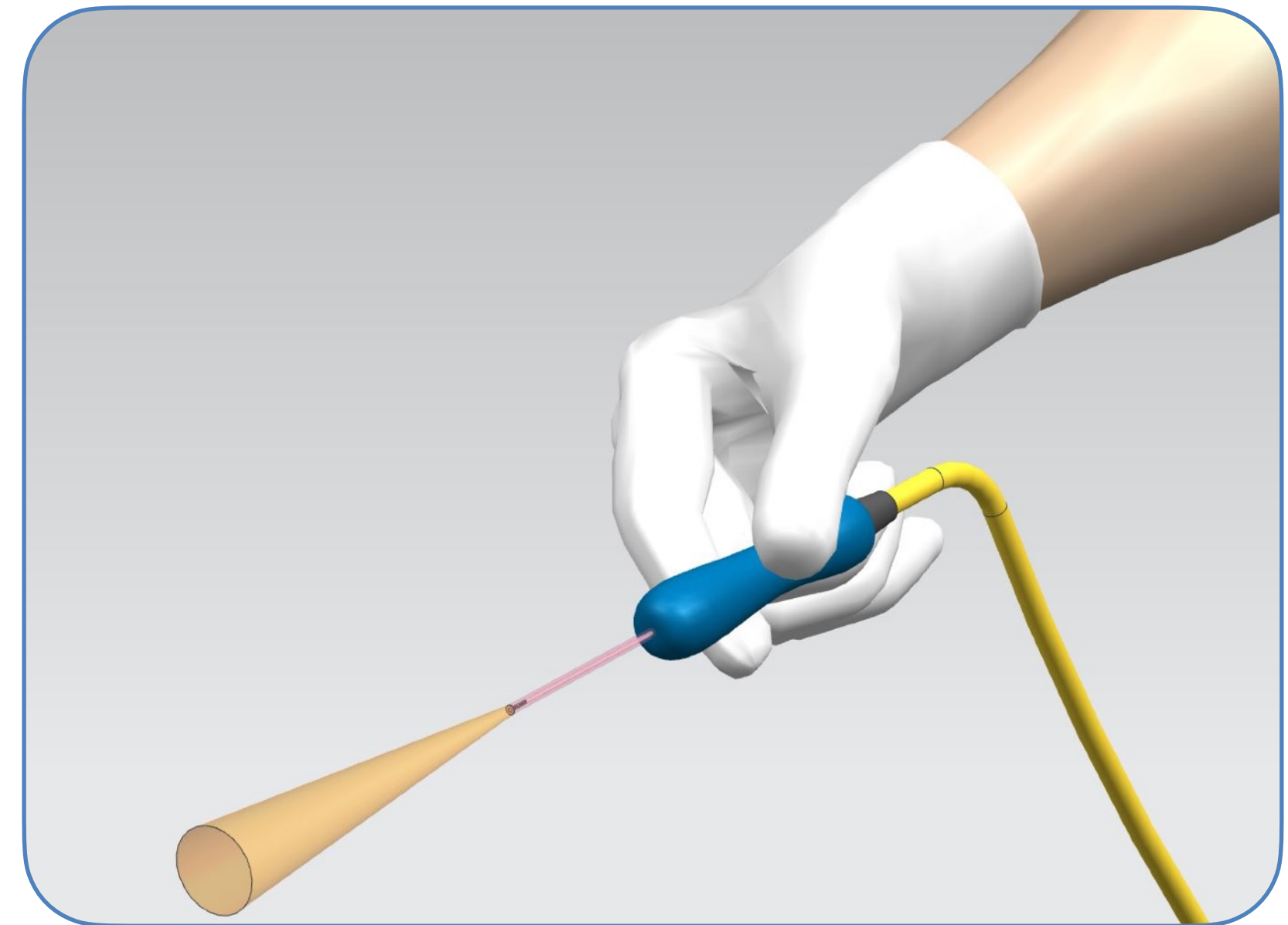
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07. ALITE & Polito

Needs

Looking for cooperations:

- to further validate the systems
- to increase TRL and setup manufacturing
- for participation in EU projects



08. Meet ALITE & Polito

Coming presentations at Photonics West 2024

Conference Presentation

Temperature profile reconstruction during tumor laser ablation using percutaneous all-fiber smart applicators

27 January 2024 • 11:20 AM - 11:40 AM PST

Conference Presentation

In-fiber stabilization of high-power blue multiemitter modules

28 January 2024 • 2:40 PM - 3:00 PM PST

Conference Presentation

FBG inscription for monolithic lasers in soft glass fibers

30 January 2024 • 10:20 AM - 10:40 AM PST

Conference Presentation

Towards a fiber-optic sensor for monitoring bacterial contaminations in water

27 January 2024 • 4:40 PM - 5:00 PM PST

Thanks for your attention



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