

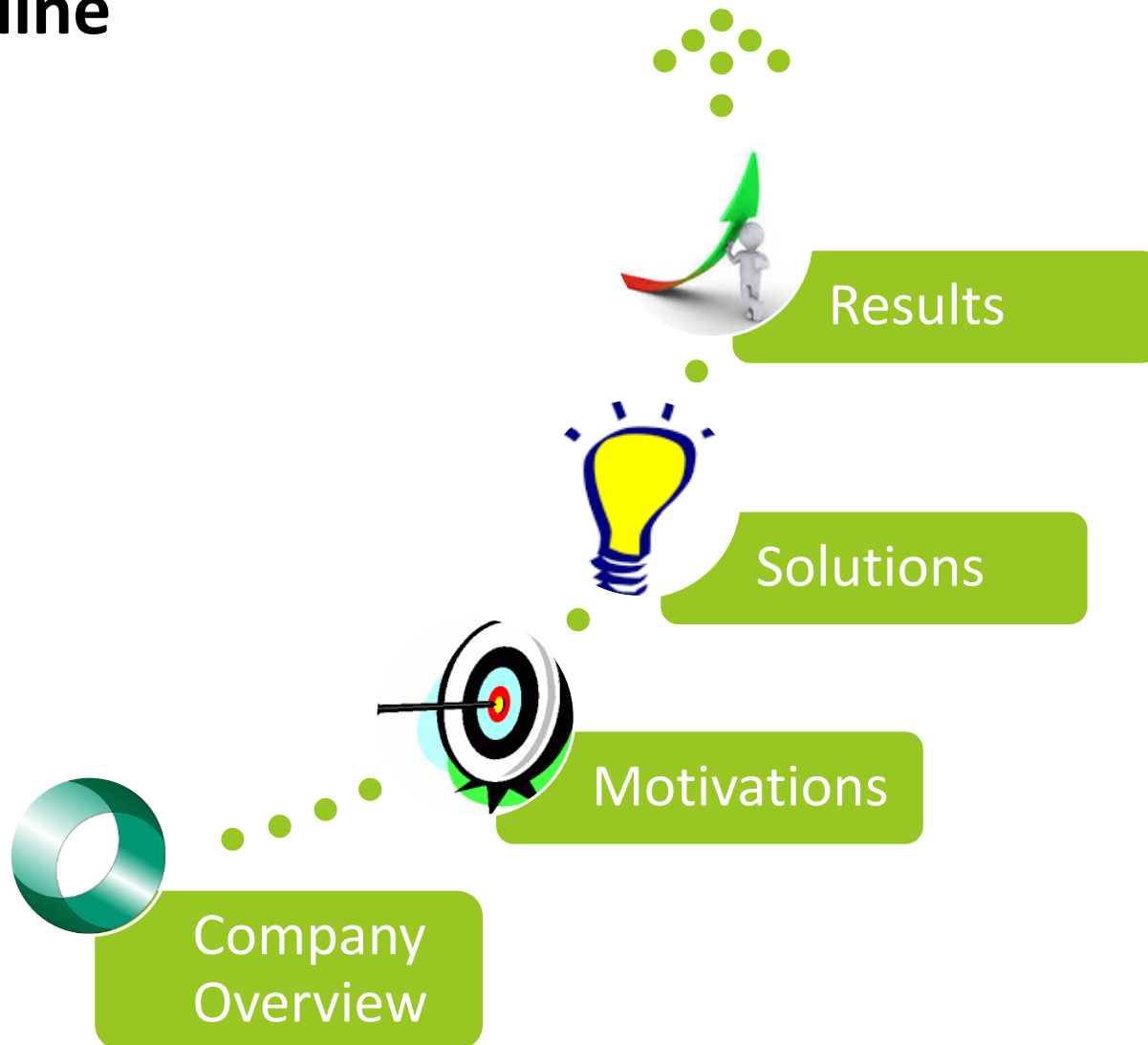
INNOVATIVE FIBRE CABLES FOR SHORT LASER PULSE DELIVERY

Dr. Andrea Braglia, CEO

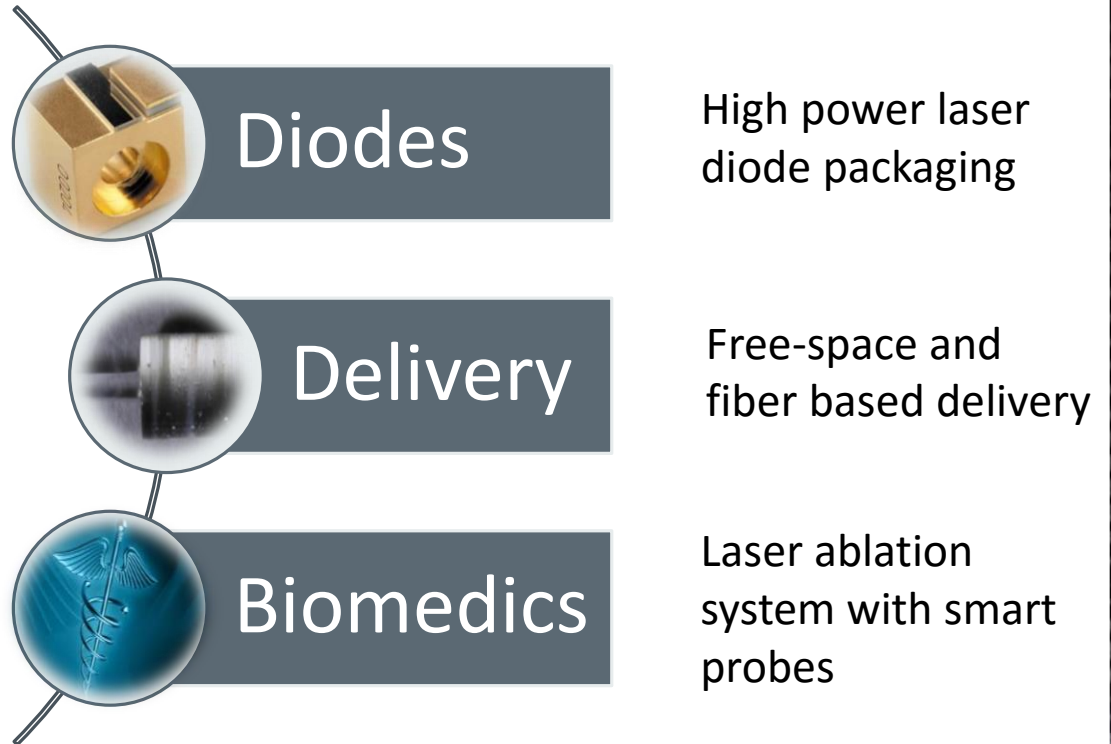
OPI Photonics



Outline



COMPANY OVERVIEW



Mission: Transfer the cutting-edge know-how generated from academic research in high power photonics into flexible industrial solutions for material processing & biomedical applications

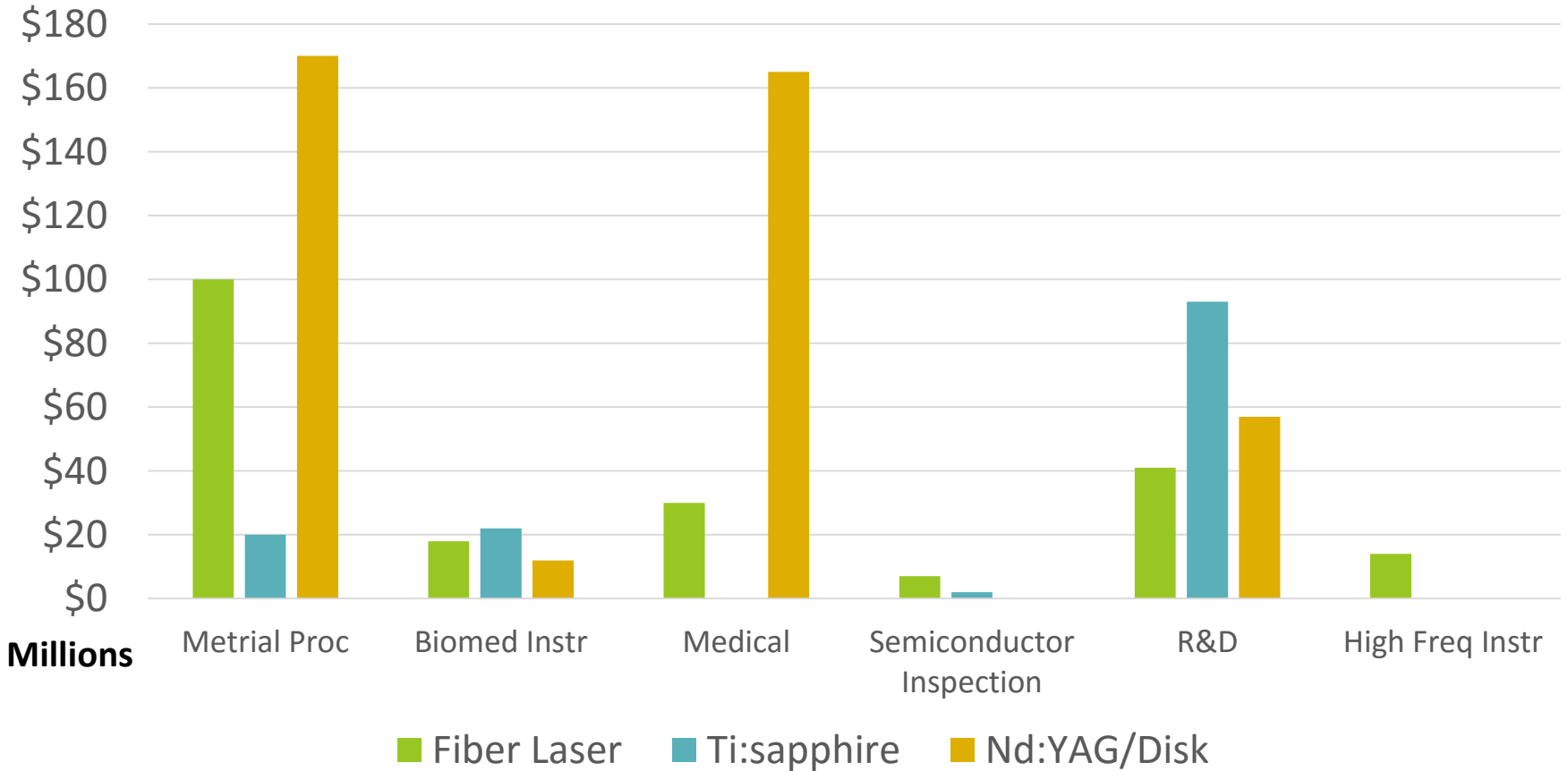
MOTIVATIONS - SHORT PULSE LASERS

Total Ultrafast Market 2014 to 2019 (Strategies Unlimited)

Summary	2014	2015	2016	2017	2018	2019	CAGR 2015-2019
Femtosecond							
Units	2'678	3'227	3'836	4'475	5'188	6'000	16,8%
Revenues (M\$)	548	640	742	844	958	1'088	14,2%
Picosecond							
Units	1'417	1'542	2'015	2'437	3'028	3'572	23,4%
Revenues (M\$)	222	210	239	273	310	352	13,8%
Total							
Units	4'096	4'770	5'851	6'912	8'215	9'572	19,0%
Revenues (M\$)	769	850	981	1'117	1'268	1'440	14,1%

MOTIVATIONS - SHORT PULSE LASERS

Ultrafast Laser by Application and Type by 2014 Revenue (Strategies Unlimited)



LIMITATIONS AND SOLUTION

Today: free-space

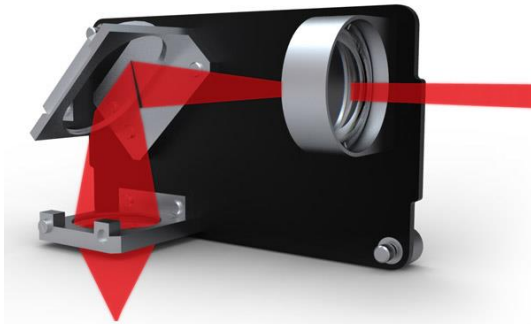


OPI Solution

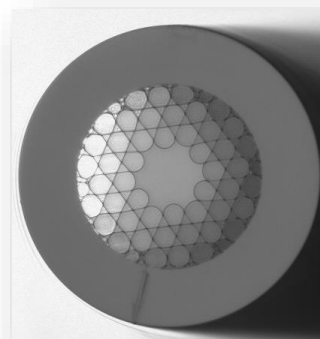


Applications

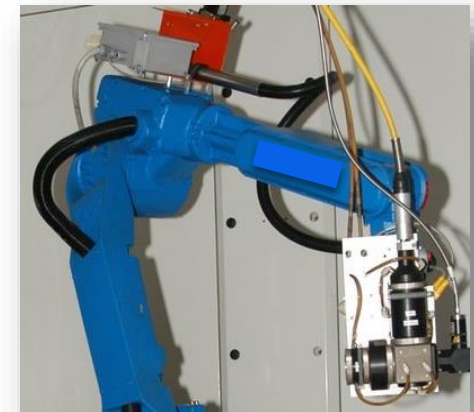
Pulsed laser: free-space delivery system required



+



Robot based applications



Innovative cable system specifically developed to allow the fiber delivery of high peak power, ultra-short laser pulses in industrial applications

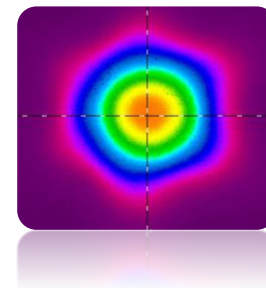
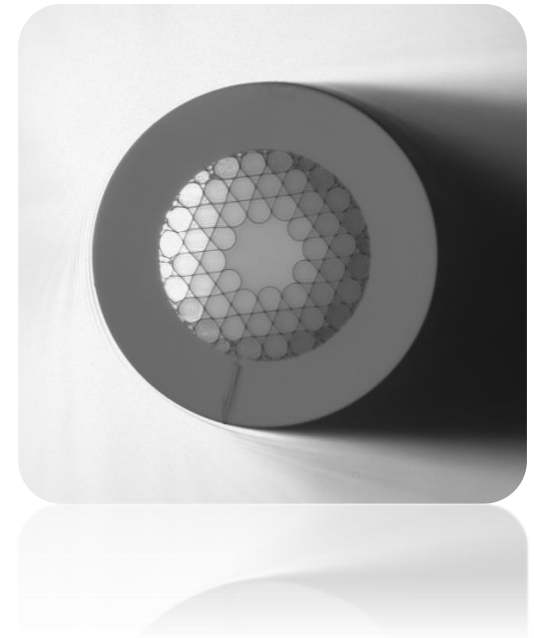
DELIVERY ENGINEERING - THE FIBER

- **Hollow Core Photonic Crystal Fiber**

- Large core size
- Nearly single mode
- Air guiding
- High laser damage threshold
- Operating wavelengths 900 – 1100 nm

- **Challenges**

- Low NA: alignment optimization and stability
- Cost
- Attenuation & Dispersion



DELIVERY ENGINEERING – CONNECTOR & CABLE

■ Connector

- Improved thermal management
- High power AR-coated window
- Connector type TBD
- Safety interlock



■ Cable

- Inner Hose: Stainless steel
- Outer Hose: Flexible reinforced plastic
- Bending radius $> 30\text{mm}$
- Maximum length: 10 m (*80dB/km loss*)
- Safety interlock

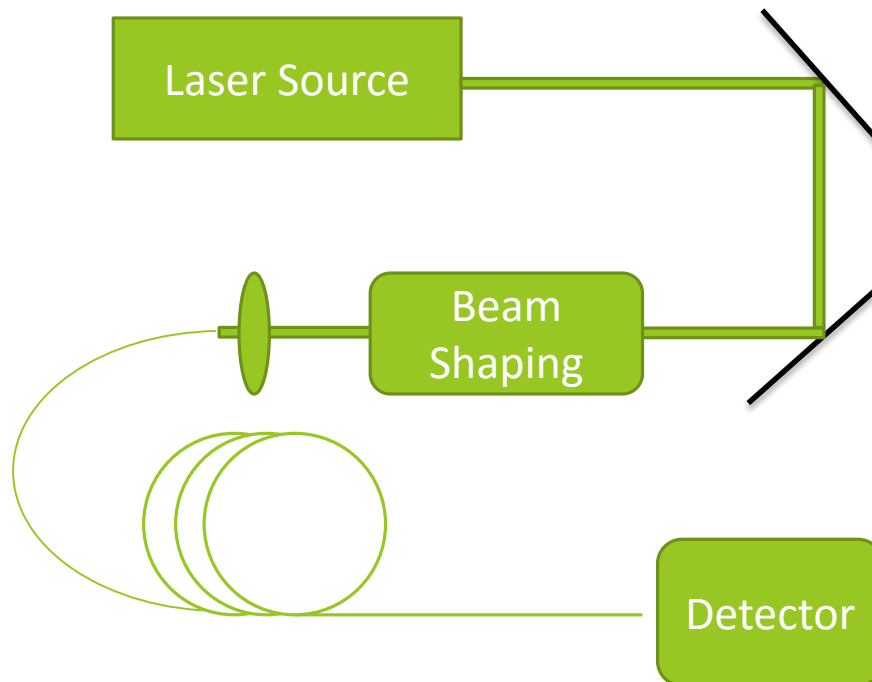


CABLE ENGINEERING – ALIGNMENT SYSTEM

Fiber requires **0.5 μm** Alignment Tolerance



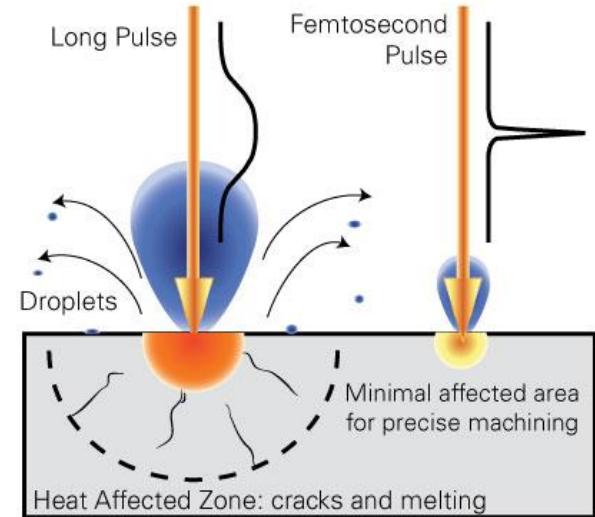
- Proprietary alignment system with sub micron positioning accuracy
- Long term stability (*critical*)



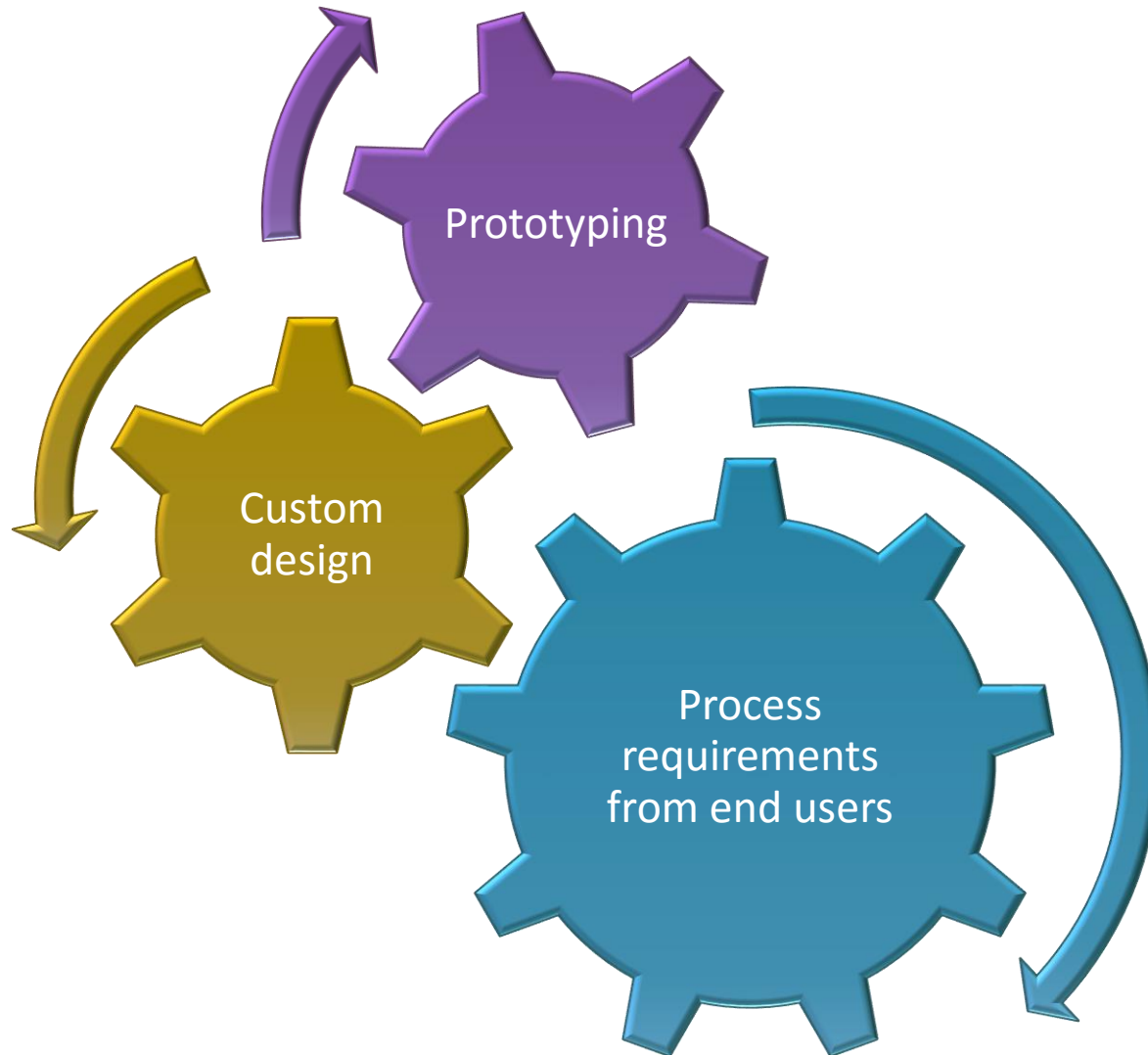
PRELIMINARY PERFORMANCES

Testing condition:

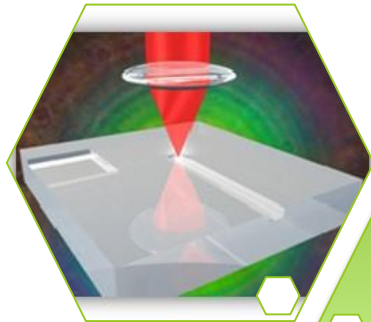
- 1-5mJ@1ns; 10-100 μ J@1-20ps
- $M2 < 1.2$
- Coupling Efficiency 85-90%
- Pulse compression (SPM) in air
- No pulse distortion in He
- Reliability test ongoing



CABLE ENGINEERING – CUSTOMIZED SOLUTIONS

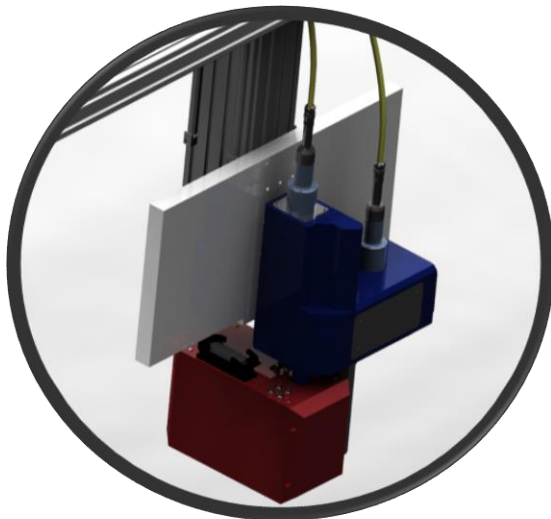
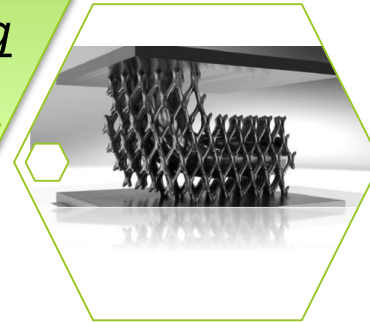


TARGET APPLICATION – HYBRID MATERIAL PROCESSING



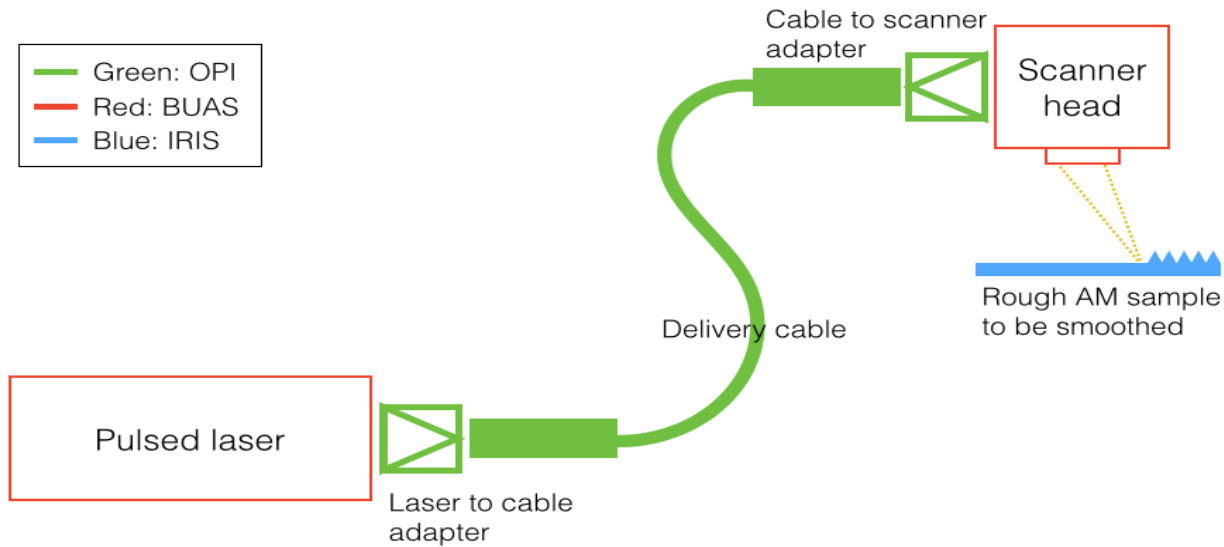
Subtractive
Ablation

Additive
3D printing



Metal powder sintering + surface refinement

Experiment focused on demonstrating the delivery of short pulses



THANKS FOR YOUR ATTENTION

