극초단 레이저 생산제조 기술워크숍 2019
Ultrafast Laser Processing Workshop 2019

Advanced Industrial High Power Ultrafast Laser and Strategy for High Throughput

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30/05/2019

Amplitude

Summary

01

Who Are We?

02

Technology Roadmap

03

Conclusion

Amplitude

Worldwide Leader in Ultrafast Lasers since 2001

Expert manufacturer
in ultrafast laser technology

3 000 +
lasers in the field

Financing capacity quoted as
« strong » by Banque de France

Innovative & visionary company,
created in 2001

300 +
employees worldwide

…9 offices and production
plants around the world.

Amplitude Laser Group Headquarters,
near Bordeaux, France

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3 Main Markets

3 main markets,+300 employees working with the same passion, and delivering the best products.

Industry

- Display
- Semiconductor
- Consumer Electronics
- Micro processing

Science

- Lifescience
- High Intensity and Energy Physics
- Spectroscopy and Imaging
- Instrumentation

Medical

- Ophthalmology
- Protontherapy
- X-Ray Imaging
- Medical Device Manufacturing

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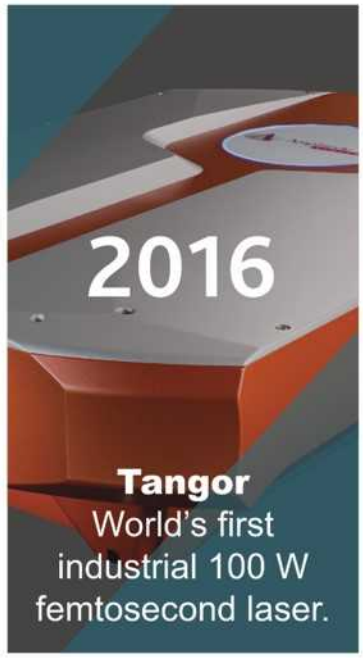
A Company and Environment Built for Reliability

Reliability is one of our core values. So we make sure to have the best quality standards at every step of the way.

- Externally certified clean room environment
- ISO 9001 and 13485
- Continuous improvement process
- Field data tracking
- Supplier Evaluation
- Experienced in projects with complex integration

Amplitude's World Firsts



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02

Technology Roadmap

Product development strategy

High power ultrafast lasers for high throughput processing

Beam engineering for additional flexibility

Industrial OEM lasers from proven technology platforms.

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Industrial High Power Ultrafast Lasers

High Power Lasers

Air-cooled Fiber Lasers

OEM Lasers

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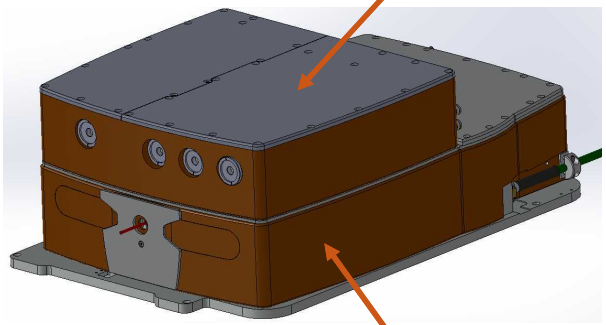
Satsuma for display market - New laser design

New Solution : Satsuma Display

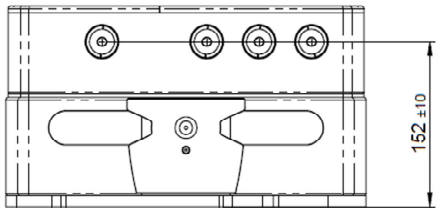
Dimension of full system: 500x330x185mm

New design of harmonic module integrated on the top of laser head for improving mechanical stability and footprint



No change for the laser head

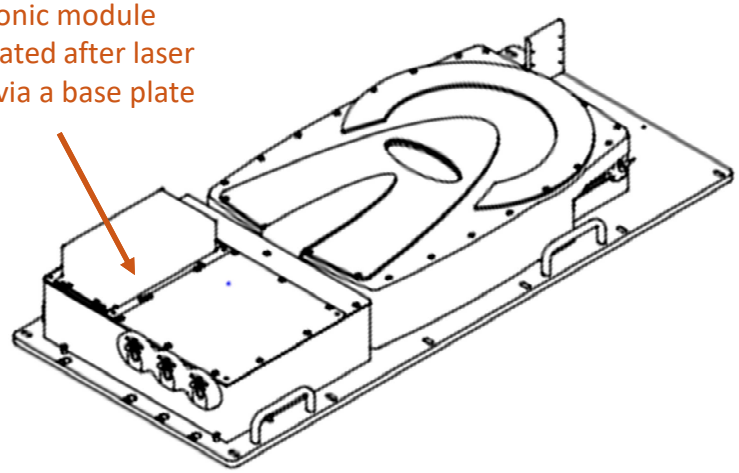
Outputs height: 152mm ±10mm



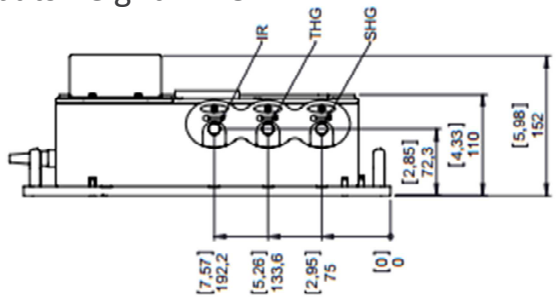
Current Solution : Satsuma 3C

Dimension of full system: 908x400x152mm

Harmonic module integrated after laser head via a base plate



Outputs height: 72.3mm



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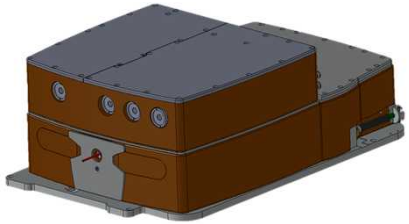
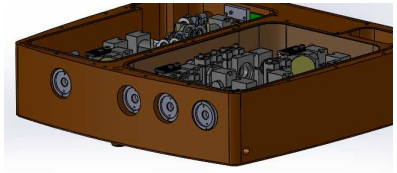
Satsuma Display – New components and options

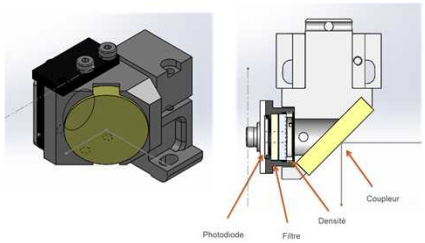
- New harmonic box that includes:
  - ✓ New compact design → Harmonic box integrated on the top of laser head
  - ✓ New wavelength switch technology: Solenoid → 1 million iterations validated
  - ✓ New mounts integrating sensors for power monitoring (for each wavelength)
  - ✓ 4 individual outputs for IR, SHG, THG and FHG options
  - ✓ External axes for easy “on site” maintenance



New compact design



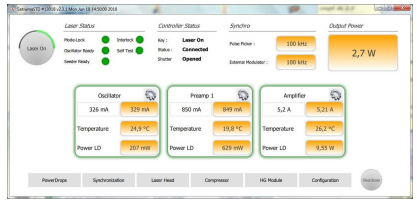
4 individual outputs



New mounts with integrated sensor

- New power supply and new software that include:
  - ✓ New software interface → more user friendly
  - ✓ New command protocol (TCP modbus) → faster and stronger
  - ✓ Real power setting (with absolute value) instead of percentage of AOM attenuation
  - ✓ 1000 steps power attenuation precision for each wavelength
  - ✓ Automated pulse duration adjustment when Amplifier frequency is changed
  - ✓ 4.0 ready → log functions and possibility to connect the laser for remote maintenance

New power supply



New S/W interface

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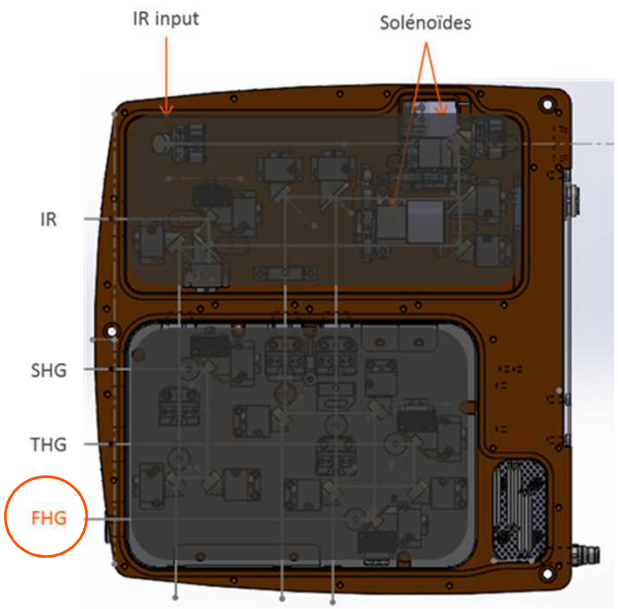
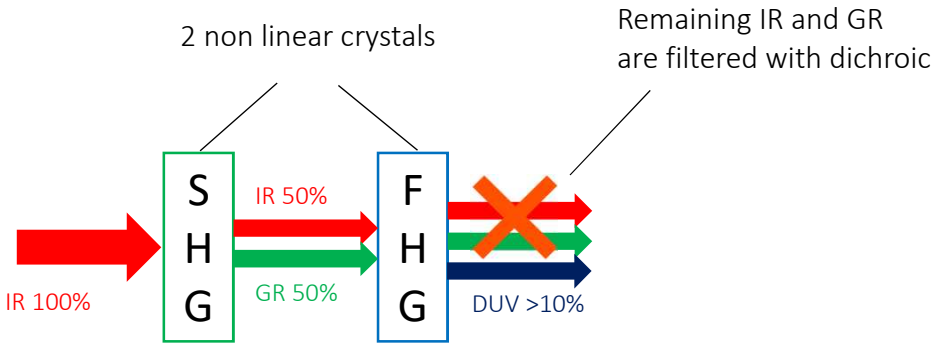
New FHG option – DUV (257nm)





Scheme of fourth harmonic generation

- 2 non linear crystals necessary to generate fourth harmonic
- Around >10% conversion efficiency (power/energy)
- 3000 hours expected life time
- Easy “on site” replacement of the non linear crystals
- FHG power monitoring option available for preventive maintenance plan

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Beam engineering

FIBER

Fiber coupling

MULTI

Beam shaping and
Parallel processing

GLASS

Glass cutting

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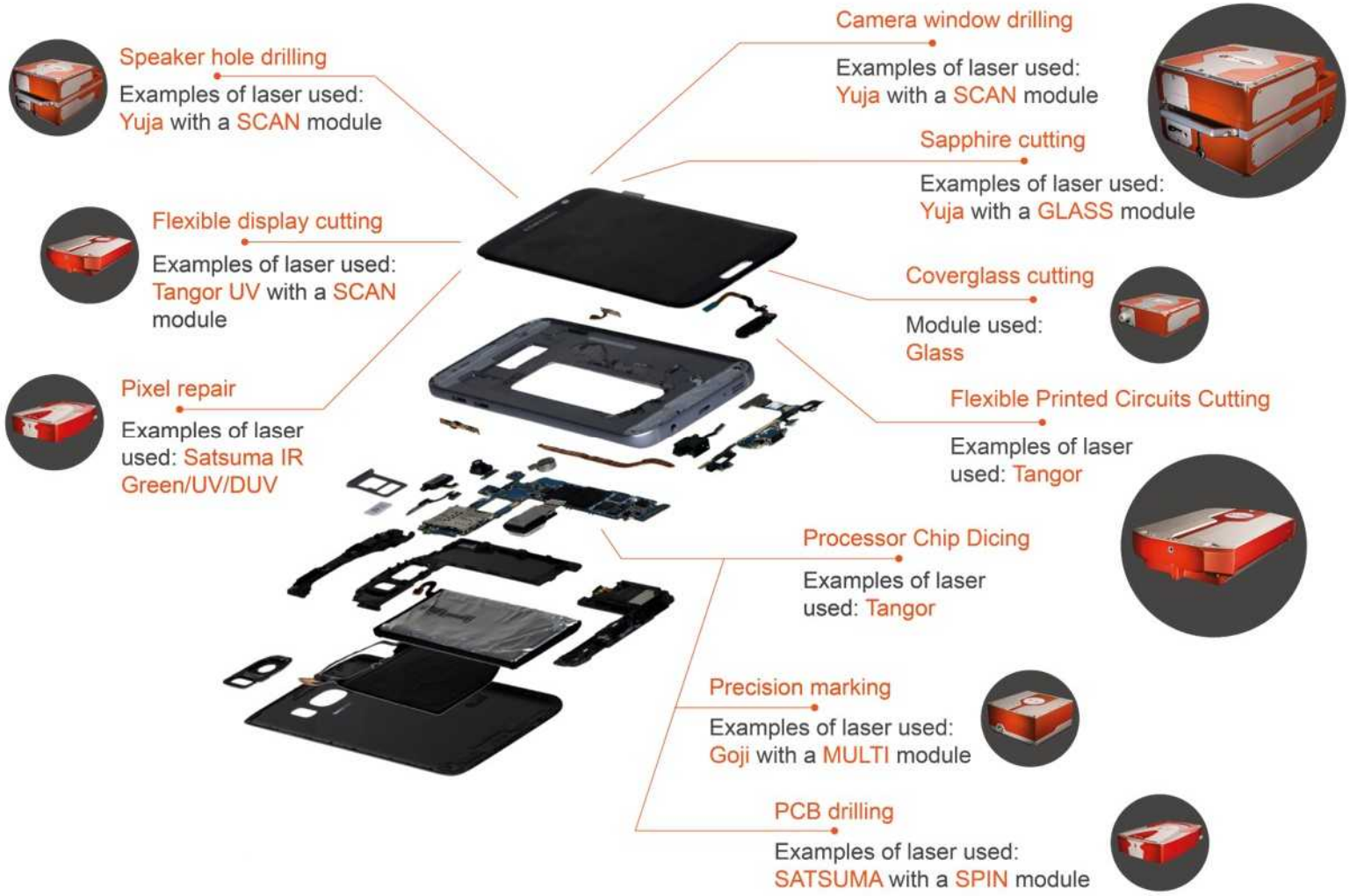
Smartphone Example : All You Can Do With a Laser



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High power femtosecond lasers

1000x increase in average power in 20 years

2001	2014	2016	2018	2020
1W	10-50W	100-200W	500W	kW
	 PRISM AWARDS WINNER	 PRISM AWARDS FINALIST		Horizon 2020 European Union Funding for Research & Innovation

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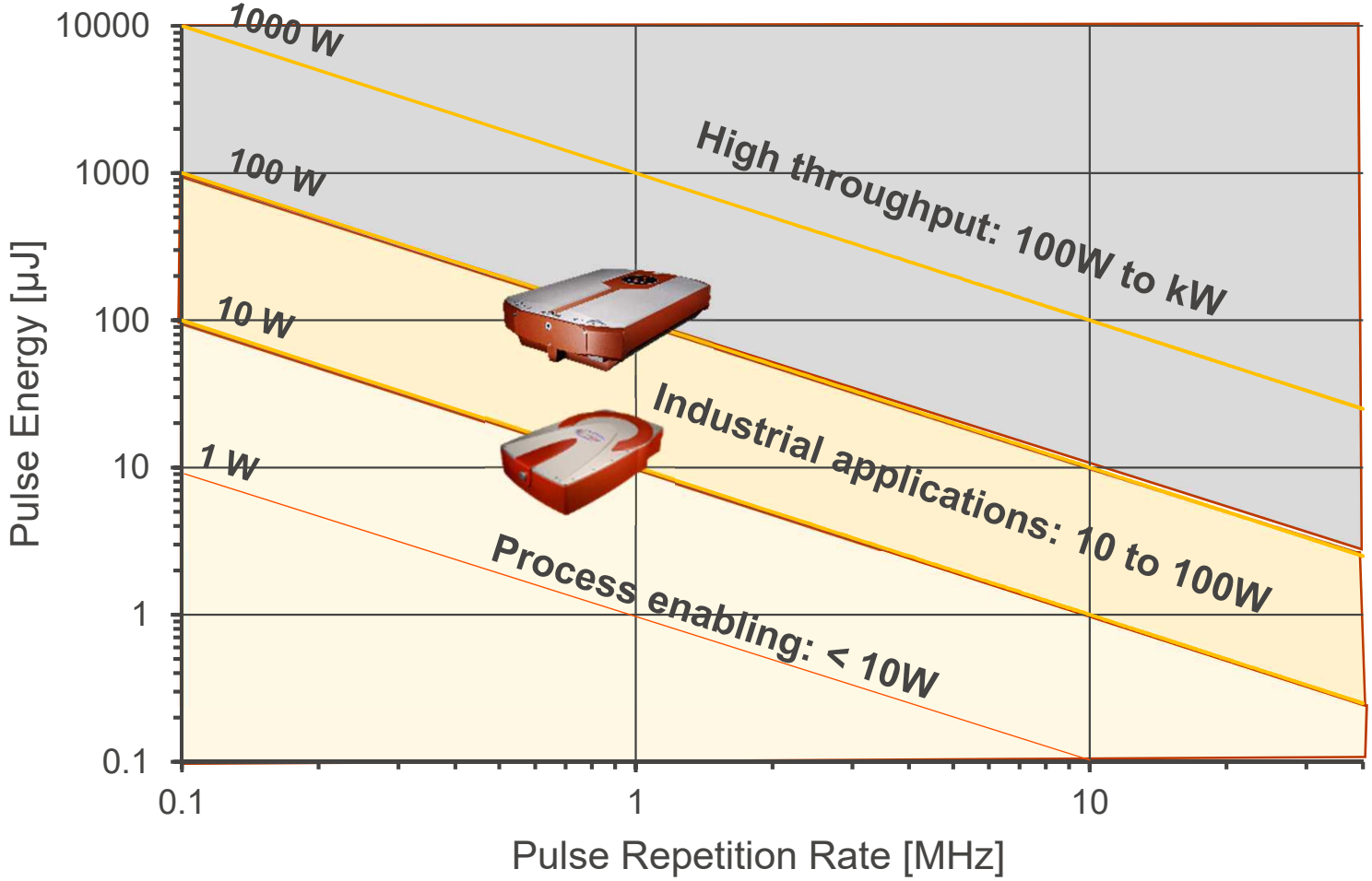
Ultrafast lasers application space



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High power femtosecond roadmap

	2018	2019	2020	2021	2022
300-W prototypes					
300-W pre-series					
300-W fs Laser					
>500-W fs demonstration					
>kW fs prototype					
kW fs Laser					
>50-W **UV** Laser					
>100-W **UV** demonstration					
>100-W **UV** Laser					

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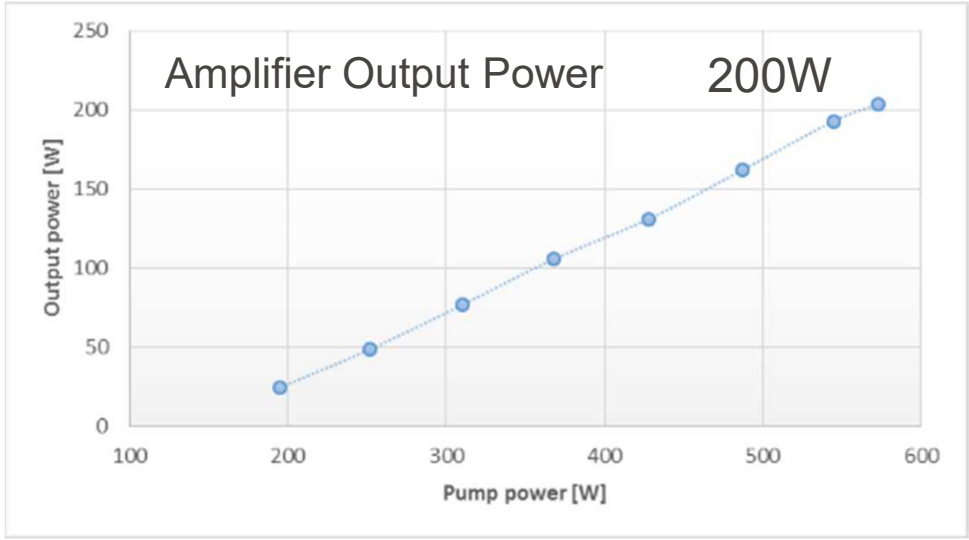
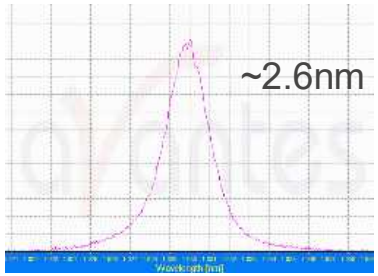
Power Scaling to 200W - Tangor platform



- 160µJ, 1MHz (160 W), 440fs
- 1mJ, 100kHz (100W), 680fs
- bandwidth limited pulse duration



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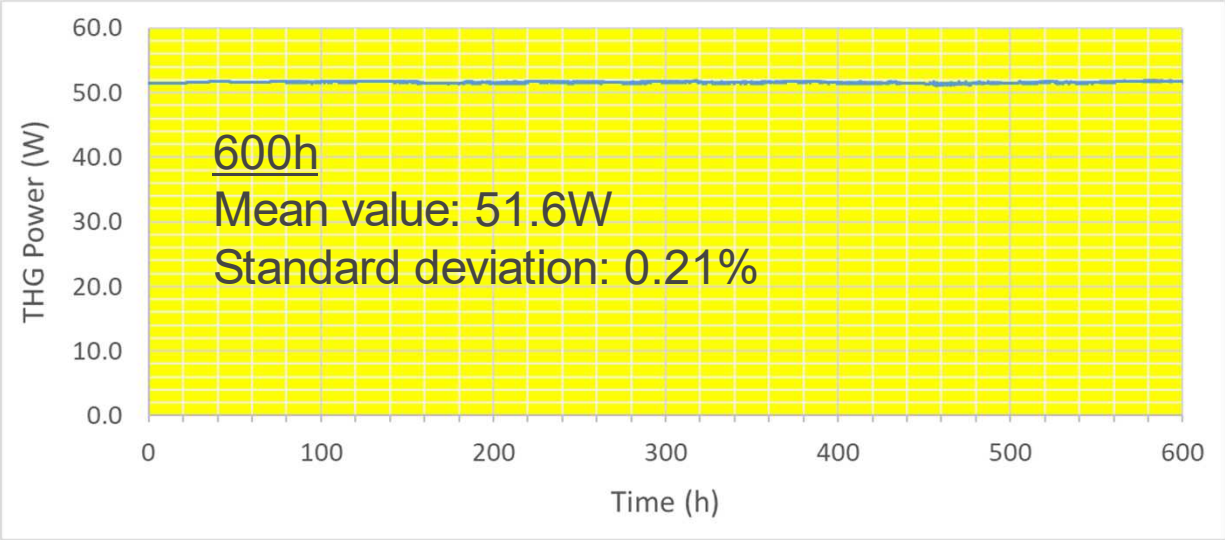
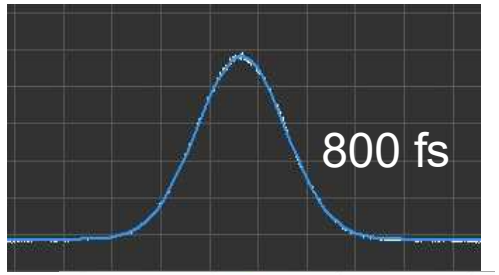
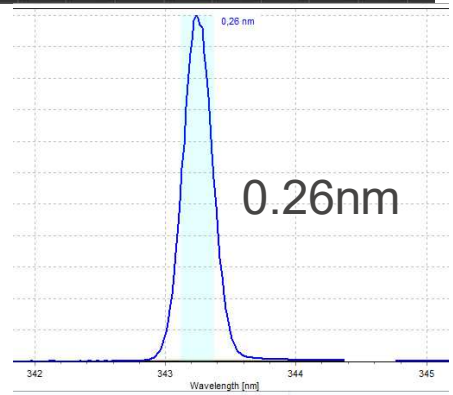
Tangor: 50-W Femto-UV!

IR Power	>100 W
UV Power	**50 W**







Femto advantage over Pico:

- higher peak powers allow relaxed focusing conditions
- Lower load on NL crystals, longer lifetime

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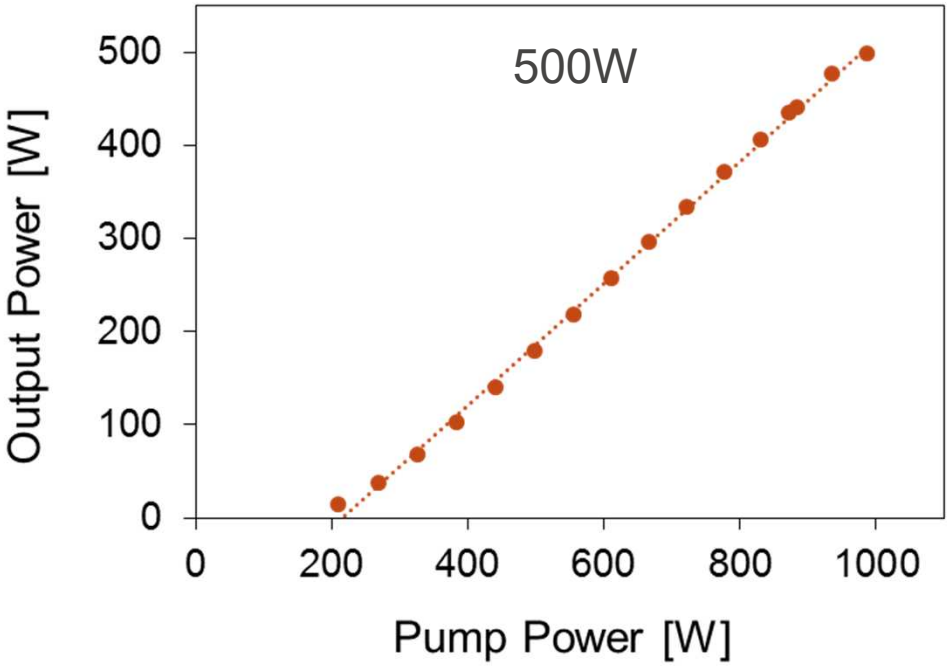
Power Scaling : 500W to kW

500 W, 400 fs, 20 MHz



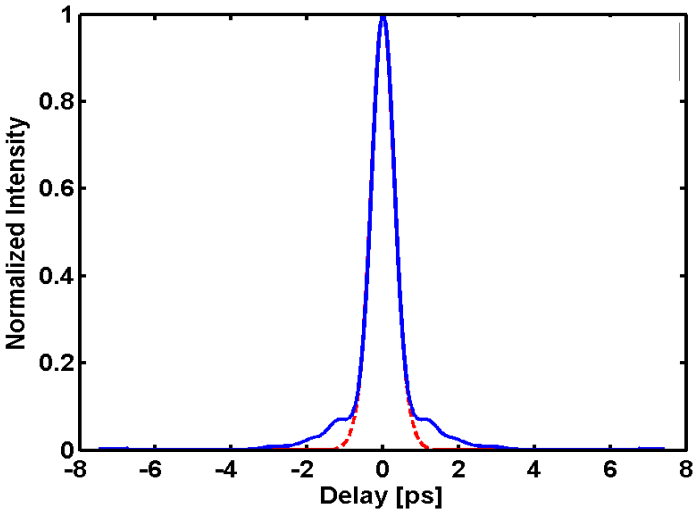
Direct amplification, no CPA

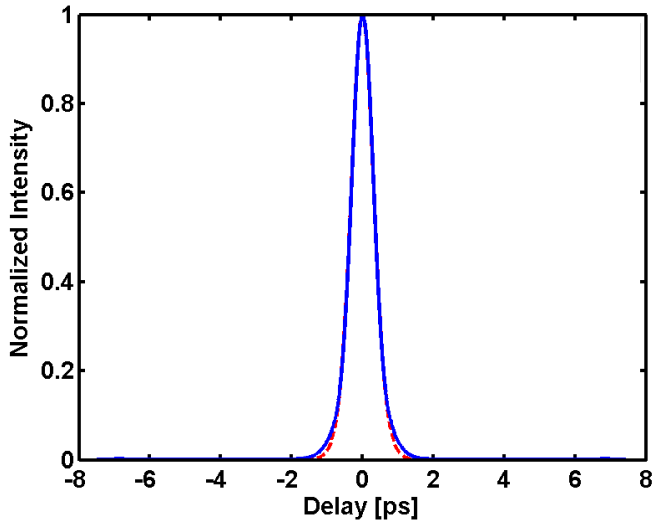
- higher pulse energies with CPA

20

High power & high energy - CPA

Power	330W	330W
Energy	**1.1mJ**	165µJ
Rep rate	300kHz	2MHz
Pulse width	460fs	480fs





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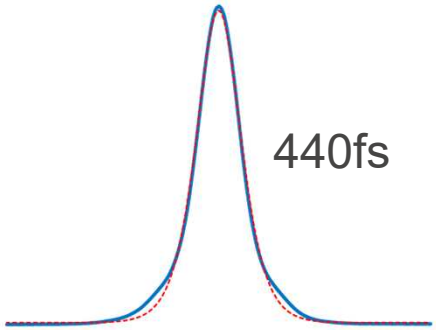
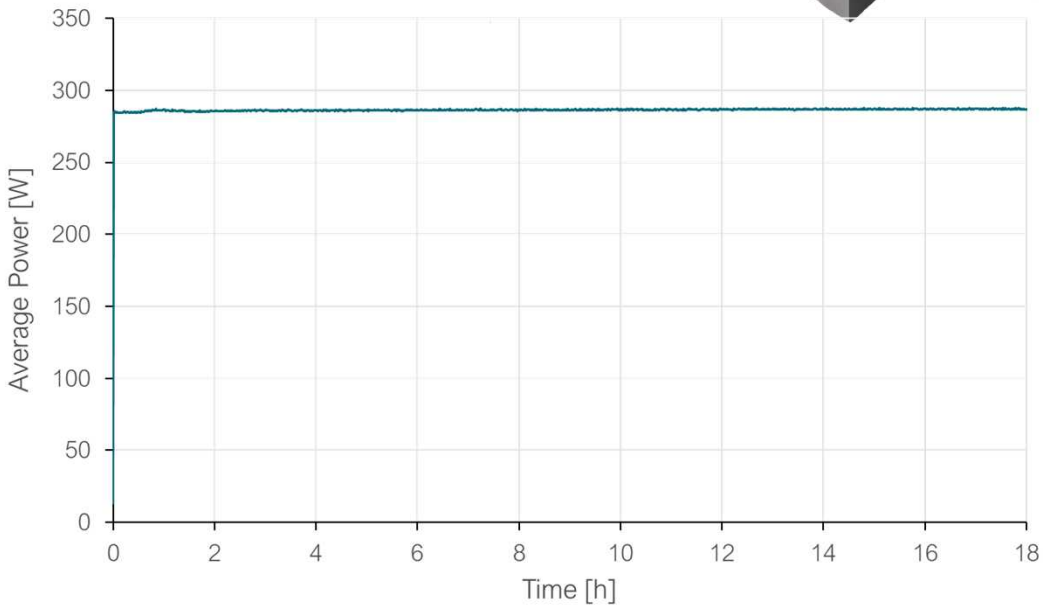
High power & high speed

Power	300W
Energy	12µJ
Rep rate	**25MHz**
Pulse width	440fs





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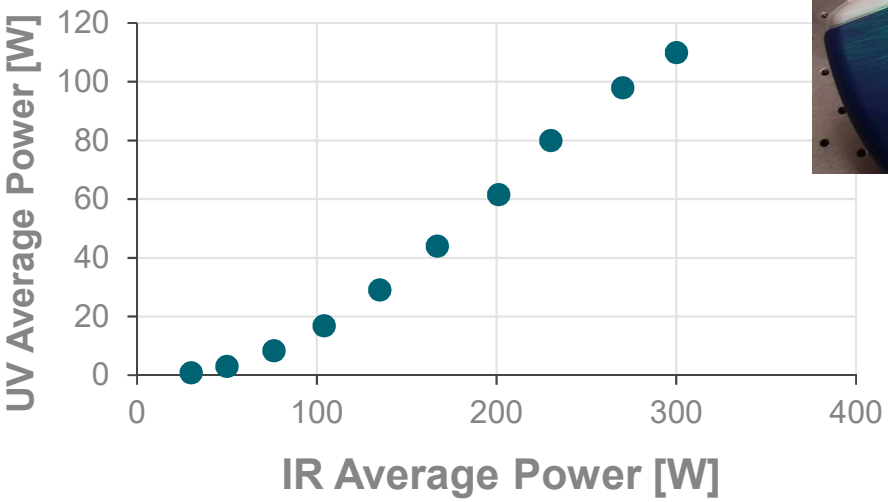
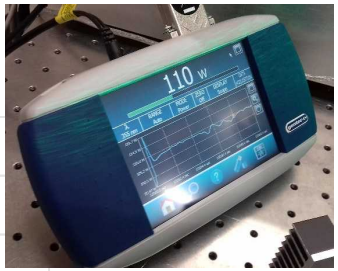
>300-W IR and 100-W UV

IR: >300 W, >100-µJ, 420 fs, 3 MHz

UV: 110 W, >35% conversion





Highest UV power from an industrial femtosecond laser!

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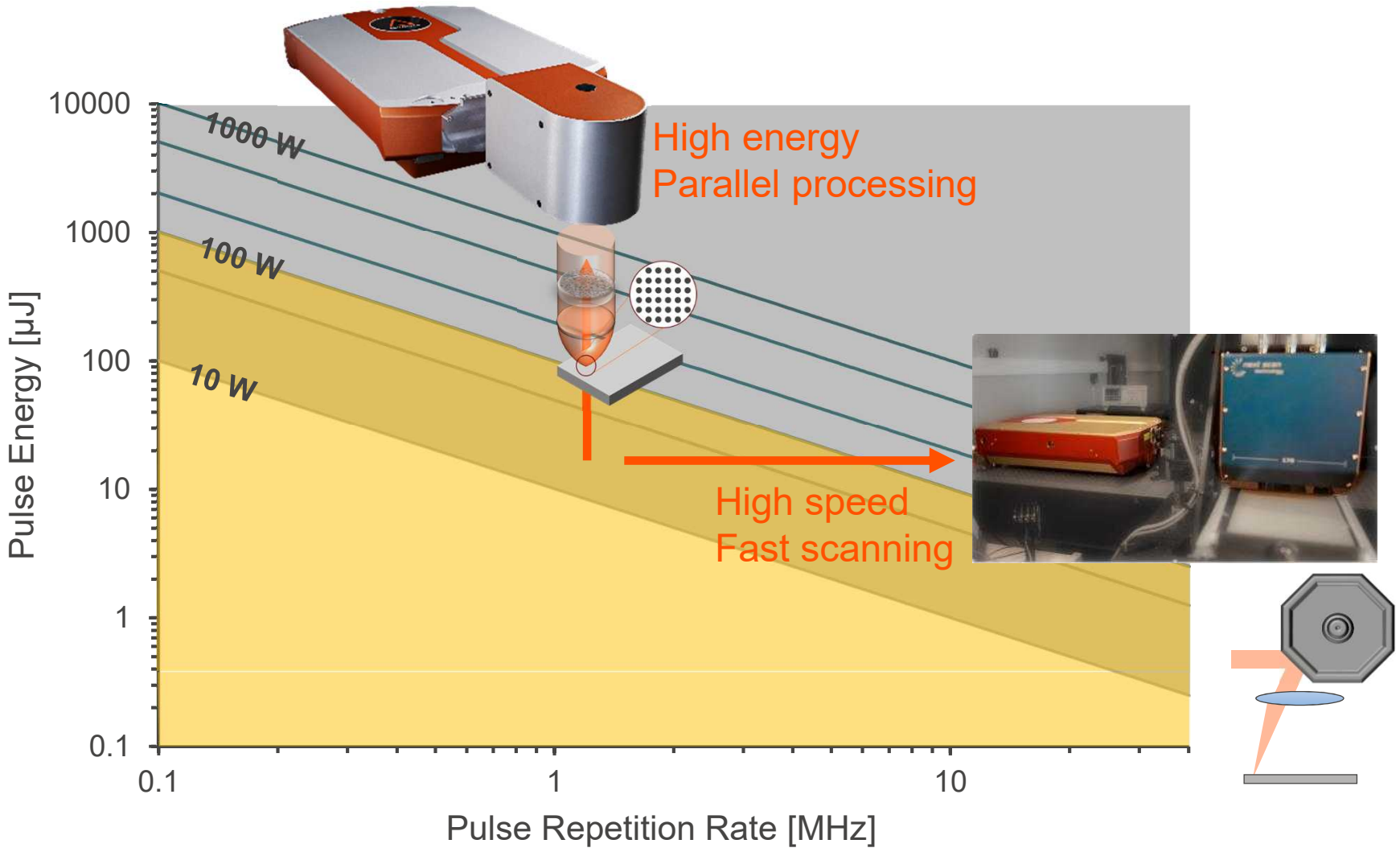
Processing strategies for High Throughput



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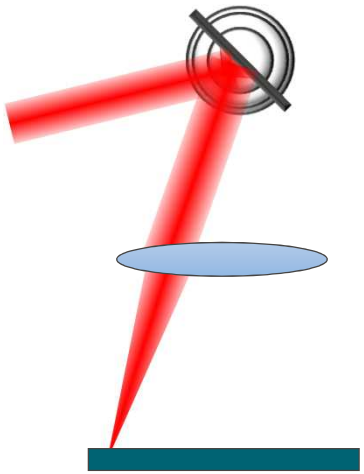
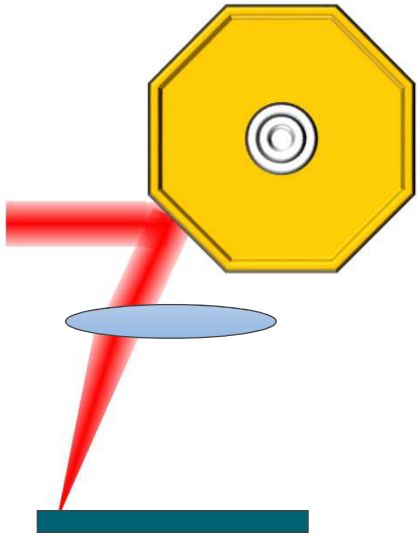
High speed processing

- Spatial beam shaping opens new ways for high speed processing

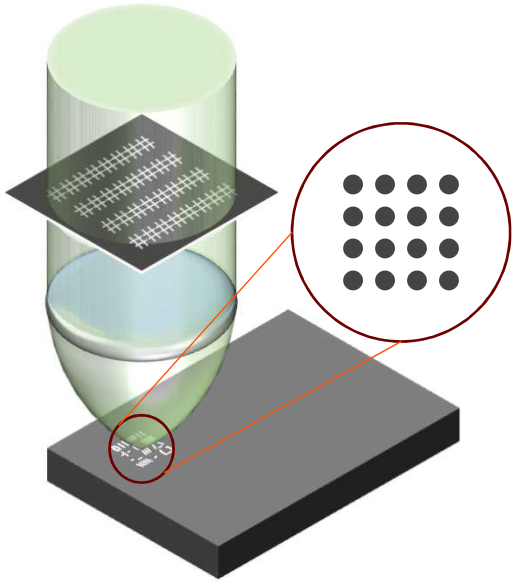
Galvo Scan



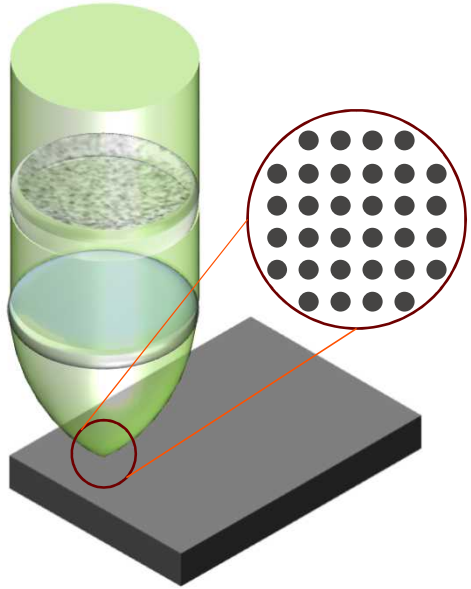
Polygon Scan



Static spatial Shaping



Programmable Spatial shaping



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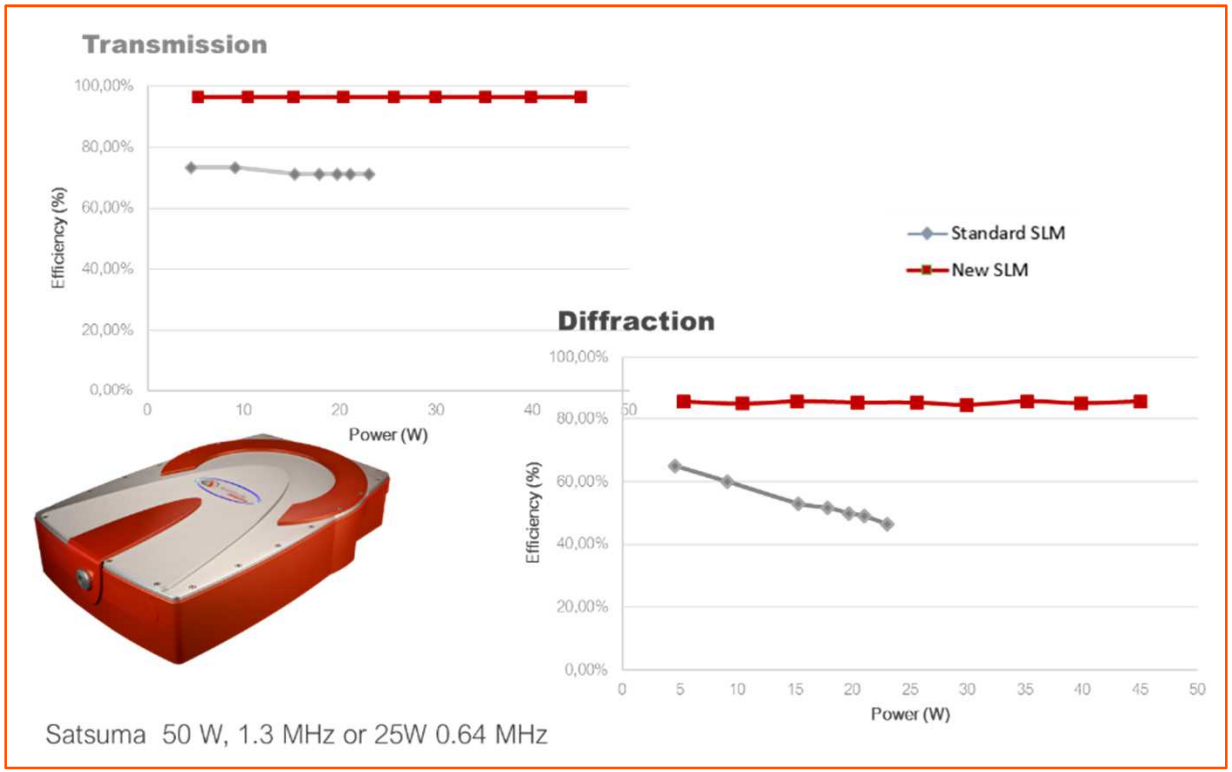
Spatial light modulator

- Spatial Light Modulators (SLM) have been in use for 20 years

- Renewed interest in the technology due to high power handling capability



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Beam shaping

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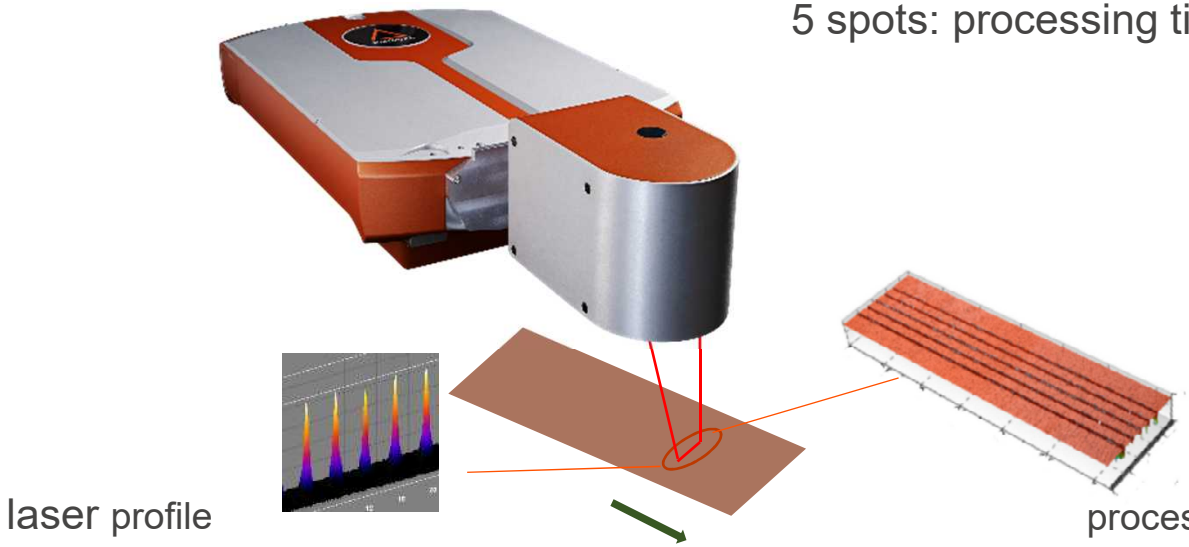
Parallel processing

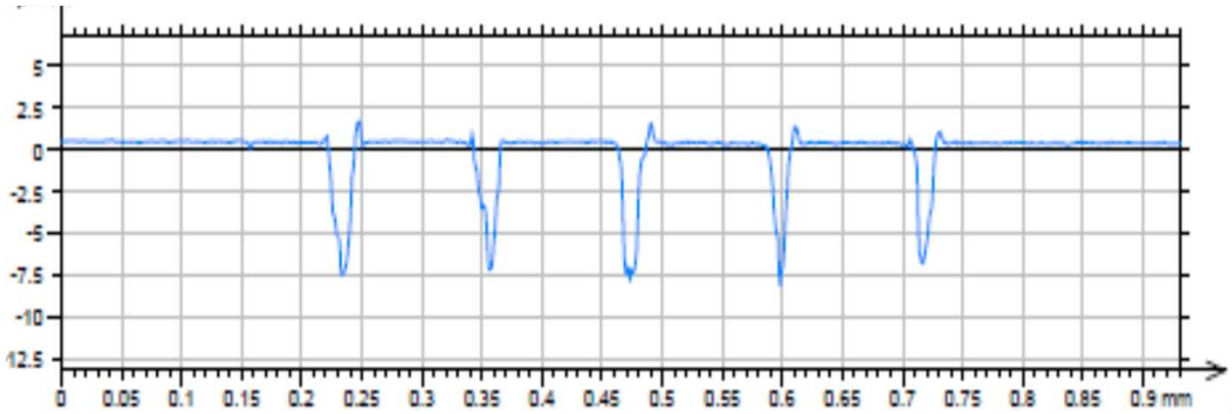
5 spots: processing time divided by 5



laser profile
on sample

sample movement V

processing result
on sample



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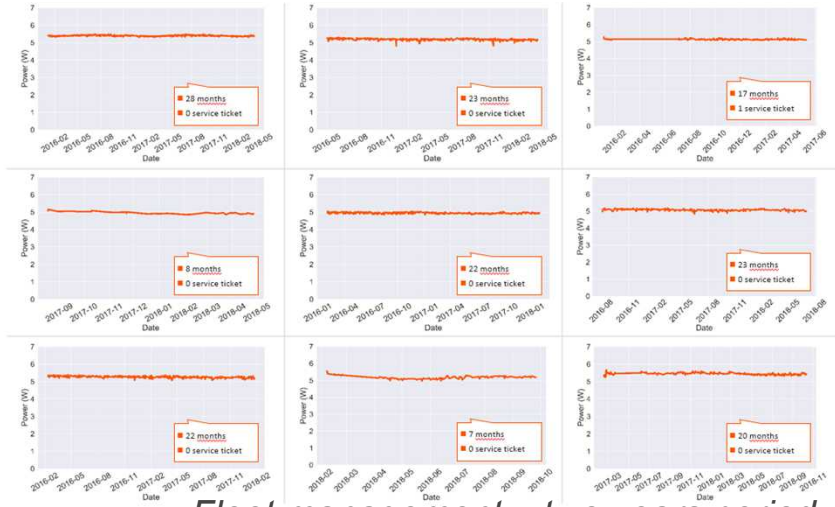
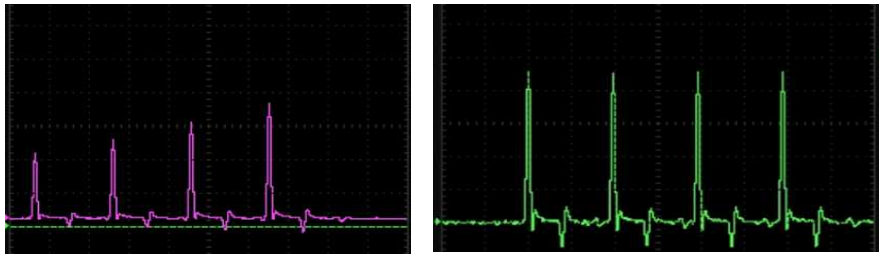
And also

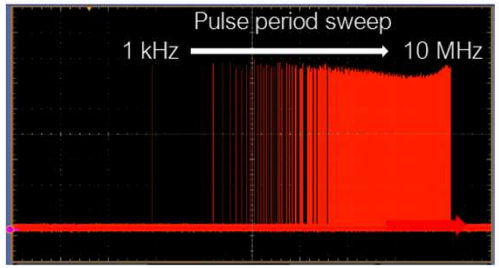
- Laser 4.0
  - Predictive maintenance
  - Self diagnostic
  - Fleet management



Fleet management – two years period

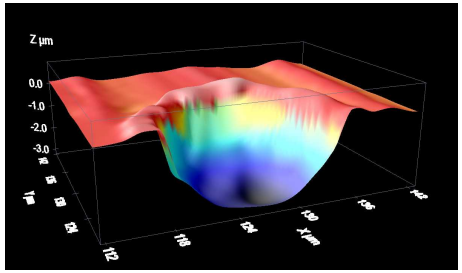
- FemtoBurst & FemtoTrig
  - Advanced synchronization for high speed applications





- GHz processing
  - High efficiency laser ablation

High Efficiency Femtosecond Laser Ablation with Ghz Level Bursts (M603)
Eric Mottay, Konstantin Mishchik, Eric Audouard, Clemens Hoenninger, Amplitude Systemes; John Lopez, Inka Manek-Hönninger, Univ. of Bordeaux



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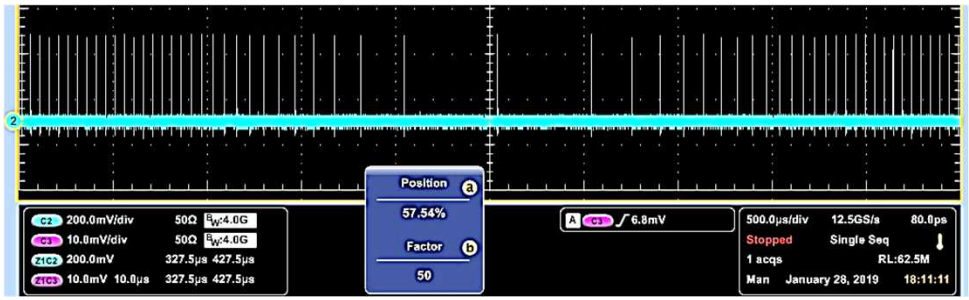
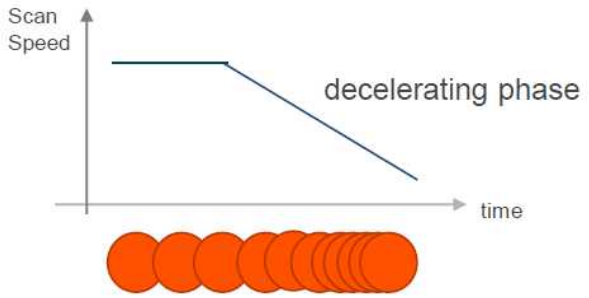
FemtoTrig®

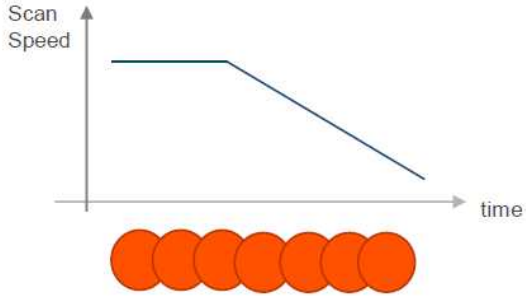
- **Free triggering** of pulses with high precision
- **Constant** pulse energy
- **Jitter** only one oscillator period!



- **Precise positioning** of laser on workpiece
- Exploit acceleration/deceleration phases, **reduce dead times, allow contours**



constant pulse period



FemtoTrig®, pulse period adapted to scan speed

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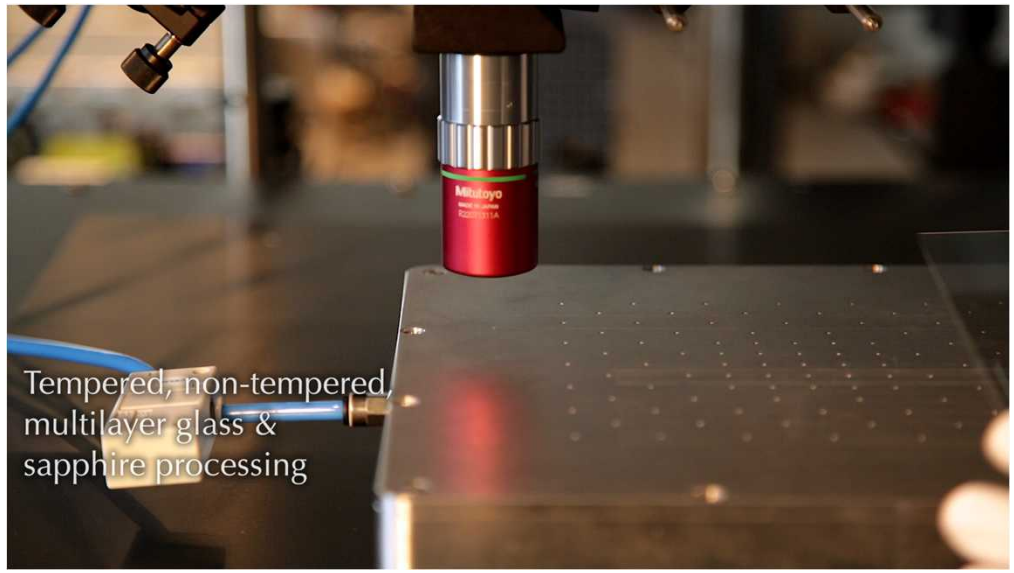
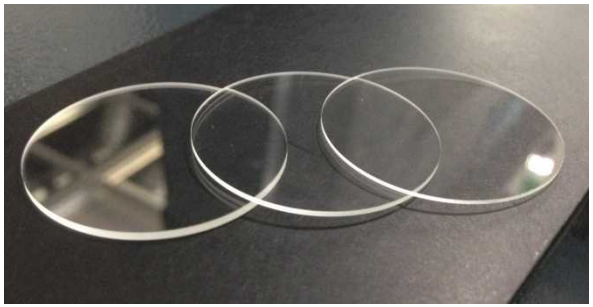
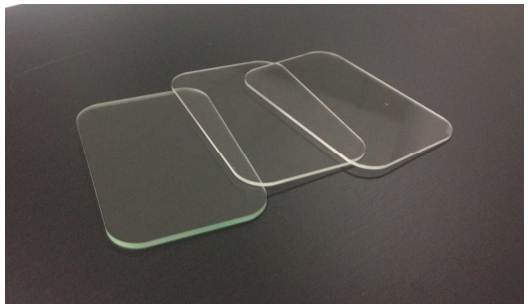
PROCESSING MODULES: GLASS



- Non-abblative patented method
- Inducing oriented volume micro-cracks (free shapes)
- No chipping & low Ra





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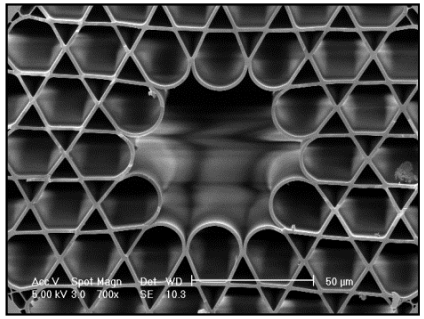
PROCESSING MODULES: FIBER

- Up to 10m fiber length
- Preserve short pulse duration
- Industrial connectors and cable
- Available up to 20W
- 100W coming soon



Hollow core fibers – guiding by inhibited coupling (IC) :

Kagome circular core, Kagome hexagonal core, Kagome hypocycloidal core & Tubular core

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03

Conclusion

Making a difference on the market

Amplitude is the only company who can provide

Deep innovation and flexibility with industrial quality and engineering

Collaborative mindset with no conflict of interest

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Thank you for your attention!

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