Project Overview

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 687880

The Hiperdias Concept

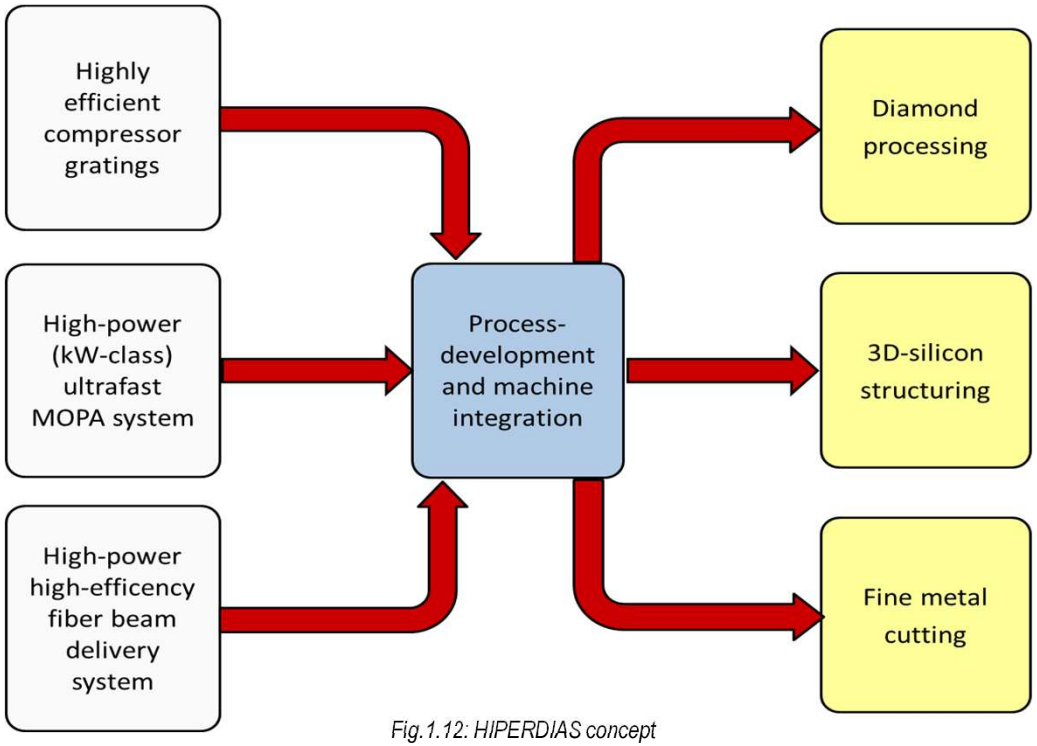

Fig.1.12: HIPERDIAS concept

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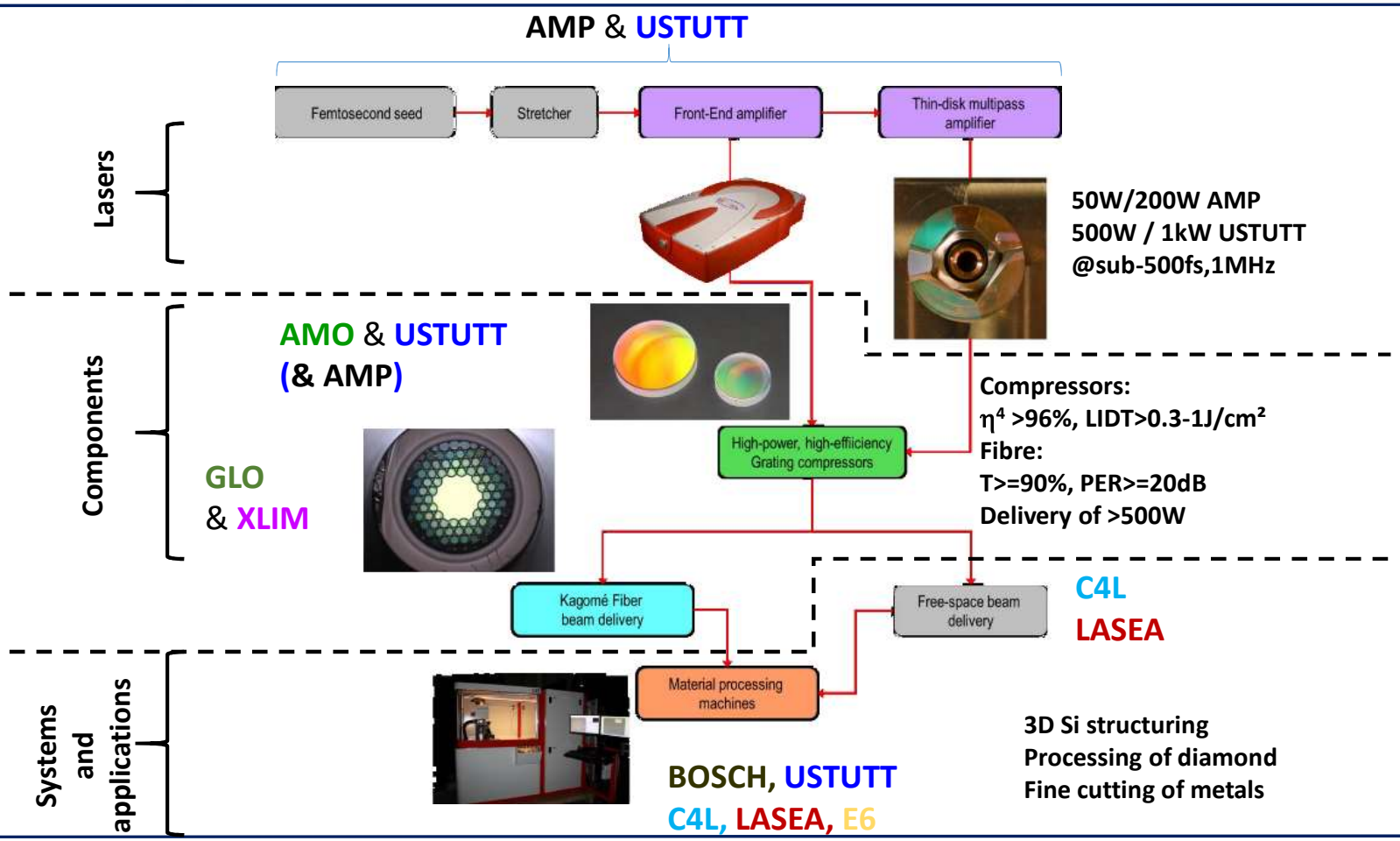

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Consortium

The HIPERDIAS Project is made up of ten partners across Europe:

- Universitaet Stuttgart (USTUTT) - Germany
- Amplitude Systemes SA (AMP) – France
- Class 4 Lasers Professionals AG (C4L) – Switzerland
- AMO GmbH (AMO) – Germany
- Robert Bosch GmbH (BOSCH) – Germany
- CNRS / Universite de Limoges (XLIM) – France
- Laser Engineering Applications SA (LASEA) – Belgium
- GLOphotonics (GLO) – France
- Element Six Limited (E6) – Ireland
- MODUS Research and Innovation Ltd (MODUS) – United Kingdom

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Main goals and objectives

Objective 1: Highly flexible high-power and high-efficiency femtosecond laser source with average output power of up to 1000 W at the megahertz (MHz) including flexible fibre beam delivery.

- IR "seed" laser with 50W/200 W and a pulse duration of 300fs/450fs achieved including burst mode operation
- IR laser beam with an output power of >513W, M^2<1.3 and a pulse duration of <300 fs achieved.
- Frequency-doubled (515nm) Laser beam with an output power of 240W/320W, a M^2=1.2/1.8 and a pulse duration <320 fs.
- Frequency-tripled (343nm) laser beam with an output power of 52W, a M^2~2.2 and pulse duration < 320 fs
- First experiment with beam delivery prototype: successful propagation >150W USP laser beam in hollow core fiber.
- Modulation of high-power pulse train successfully implemented

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Objective 2: Cost-efficient solutions (power scaling, pulse compression & fibre transport) for a broad range of applications.

- Larger area for the grating 50mm x 30mm on a 75mm x 50mm substrate
- Efficiency >99% over >10 nm spectral bandwidth
- New state-of-the-art in HCPCF
- High PER of up to 30 dB
- BDS with cooling version successfully implemented
- Demonstration of 400W CW in the BDS fibre
- Demonstration of >150W at sub-300fs at the output of the BDS fibre

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Objective 3.1: 3D ablation of Silicon (Si)

Good progress in developing processing strategies. Conducted high power Si Ablation test using two-step process which has yielded promising results:

- Burst mode identified as key process parameter
- High surface roughness, fast ablation (3-5 mm^3/s) using burst mode
- Low surface roughness (Sa<2 µm) at 0.63mm^3/s ablation rate
- Smoothing step to get target surface roughness, decreasing the fluence, reducing the number of pulses per burst

Overall progress is good. Work continues to combine highest achievable ablation rate and targeted Sa.

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Objective 3.2: Diamond polishing

Good progress in developing processing strategies.

- At > 95% pulse overlap, the ablation rate increases (heat accumulation effect).
- Demonstrated that Removal rate increases with fluence until an optimal point after which the removal rate decreases.
- Demonstrated that Grain size affects optimal fluence
- Findings on impact of fluence on graphitization
- Determined that two-step processing is desirable:
  - Smoothing step
  - Finishing step

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Objective 3.3: Fine cutting of metals

Good progress in developing processing strategies (performed with brass and steel).

- Need to include visual inspection of surface homogeneity for quality assessment
- Demonstration that achieving smooth surfaces require high pulse energy.
- Estimated that >=150uJ pulse energy is needed from power-scaled laser.
- Demonstrated all KPIs for quality are achievable

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Summary of achievements

- Good progress has been made in all work packages
- Excellent collaboration and communication between consortium partners established
- Significant advances achieved within RP2

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Work Packages

The HIPERDIAS Project is made up of 9 Work Packages:

- WP1 – Definition of User Requirements – BOSCH Lead
- WP2 – Process Development – USTUTT Lead
- WP3 – Ultrafast Laser Front-end Development – AMP Lead
- WP4 – Photonics Components for pre- and post-pulse conditioning – XLIM Lead
- WP5 – Thin-disk Multi-pass Booster – USTUTT Lead
- WP6 – System Development – C4L Lead
- WP7 - Demonstrators – LASEA Lead
- WP8 – Dissemination and Exploitation Planning – MODUS Lead
- WP9 – Project Management – USTUTT Lead

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Status Report

- 17 of 26 deliverables due in RP2 are submitted
- 17 of 21 milestones achieved

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Delayed deliverables

No.	Title	Lead beneficiary	Due date	Estimated date
D2.2	Process limits fine cutting of metal	C4L	M24	M33
D2.5	Processing strategies for high power fine cutting of metal	C4L	M30	M39
D2.6	Processing strategies for high power diamond processing	E6	M30	M39
D4.6	End-capped PMC module for beam delivery	GLO	M30	M36
D4.7	PMC module based on HC-PCF with improved PER at 1µm (>20 dB)	GLO	M30	M36
D6.4	Integration of laser and optics	C4L	M24	M33
D7.2	500W system test	LASEA	M24	M33
D7.3	200W system test	C4L	M24	M33
D7.4	Testing of the optical fibre	GLO	M28	M34

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Deviations, Delays and Management Issues

- Amendment to terminate KITE and add MODUS
- Delay in installation of 200W “seed” laser
  - An additional 100W laser source was made available for partners C4L/E6
  - Laser has been shipped to USTUTT and shall be installed on the 09-11. October 2018

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Delay in installation of 200W seed laser

The main task not fully implemented in P2 is T2.4.

- The purpose of this task is to power scale the processing strategies developed in T2.1, T2.2 and T2.3.
- The experimental work of C4L (fine cutting of metals) and E6 (diamond polishing) in T2.4 is delayed.

The main consequence of delays in T2.4 are experienced in WP7 system testing.

- Re-planning of the project began as soon as the delays in getting the required stability of operation in the 200W seed materialised.
- The revised schedule compresses slightly the available time for experimental work in each of the application areas and the system integration efforts but without compromising the ability of the project to achieve the targeted results in the three key applications.

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Use of Resources

- 155 person months of effort (including project management) charged to the project in P2
- 92% of the estimated effort for the 2nd period
- 75% of the total planned effort for the project has been claimed in the first and second period combined

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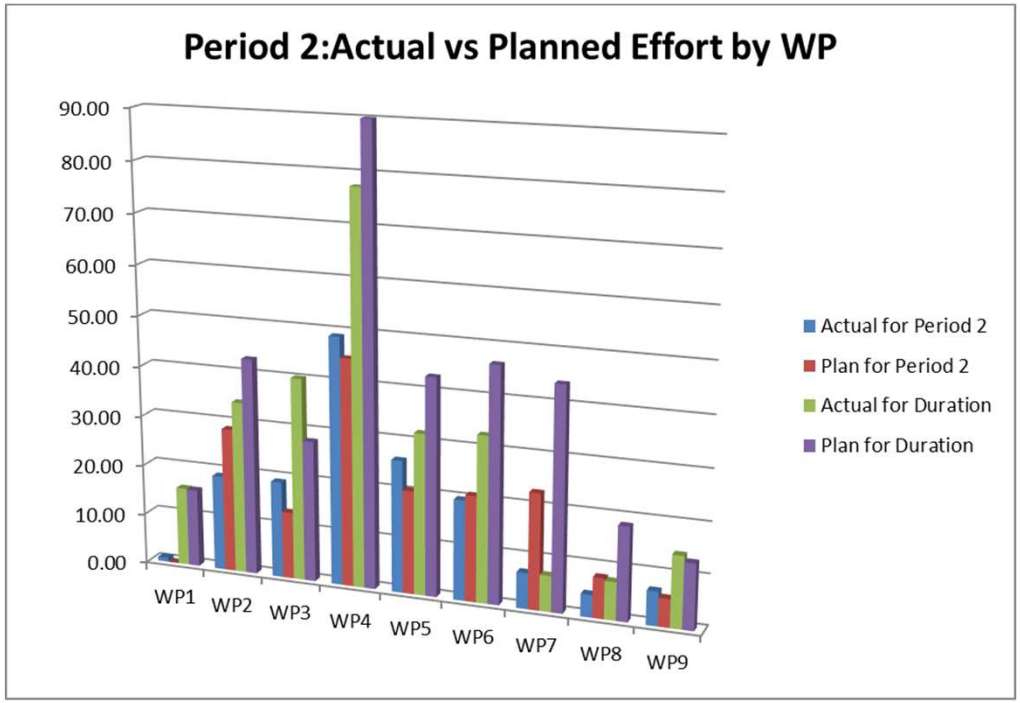
Use of Resources

Majority of Work Packages are on track regarding expected effort.

- WP2 is under estimated effort due to delays in the availability of the high powered laser
- T2.4 in diamond polishing and fine metals particularly effected
- Work Package 7 has encountered knock-on effects from WP2 delays



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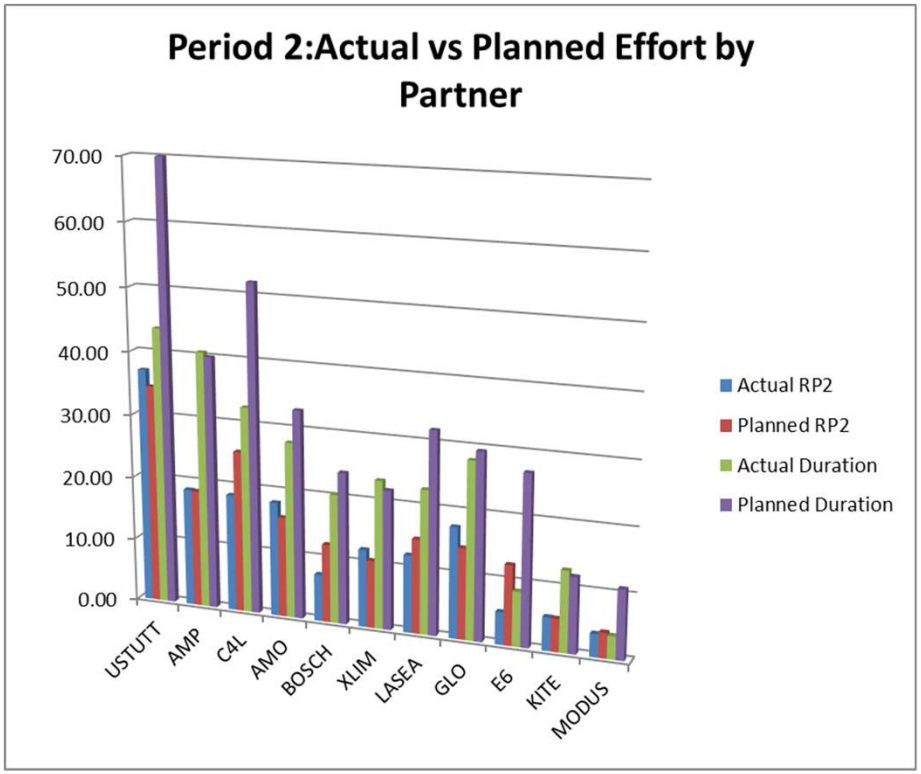
Use of Resources

From a partner perspective, all partners are where we would expect them to be in terms of reported effort for the period.

- Noticeable deviations from C4L, BOSCH and E6
- Due to delays in starting the power scaled implementations of developed processing strategies.



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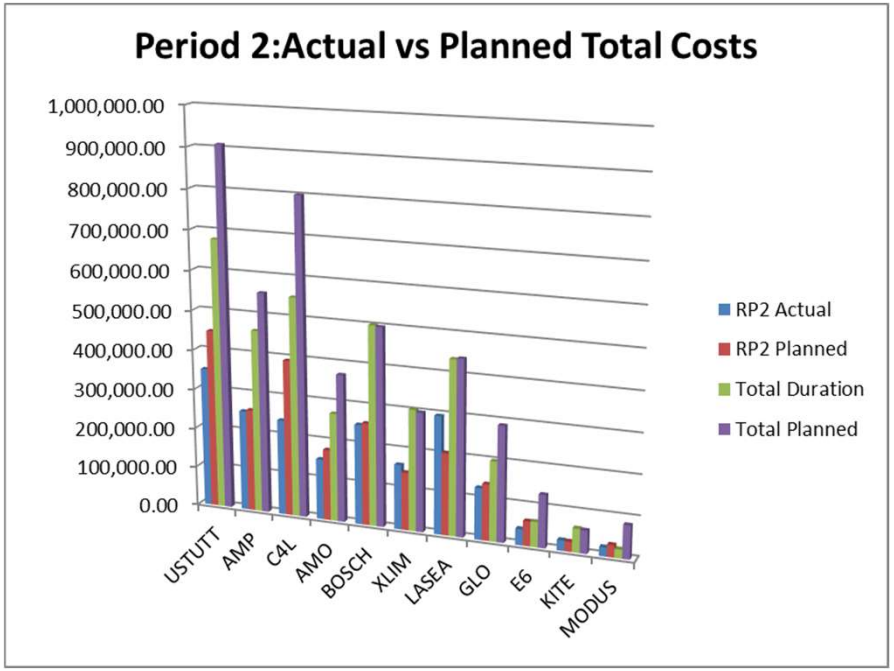
Use of Resources

- €1,663,089.47 including indirect costs have been charged to the project in the second period
- €1,903,629.47 of costs including those incurred by C4L which are not charged to the project
- Just under 90% of the estimated costs for the second period
- Just under 44% of the total planned costs for the project
- Combined costs of period 1 and 2 are just over 81% of the total planned costs for the project



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