GLOphotonics

Jérôme Alibert

GLOphotonics

The Hollow-Core PCF and Photonic MicroCell™ Company

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

THE VENTURE

- a 'start-up' based in Limoges to commercialise an IP portfolio

From University of Bath, XLIM (CNRS/Limoges) & NKT

- exploiting gas-phase materials & specialty fibre in compact photonic devices (PMC)

Multi-award and highly praised technology

LaserFocusWorld Commendation of technical excellence 2008

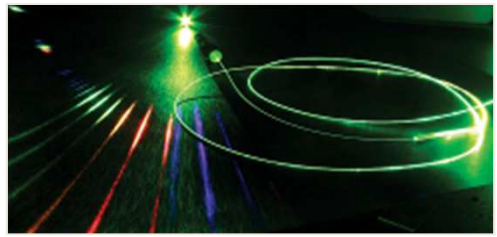
Prism award finalist 2015

- world-leading technical team

Benabid: 2005 Fresnel Prize, Optical Society of America Fellow 2010

An Xlim team with world-class expertise in optical fibre

- A scientific and logistical support from a CNRS laboratory



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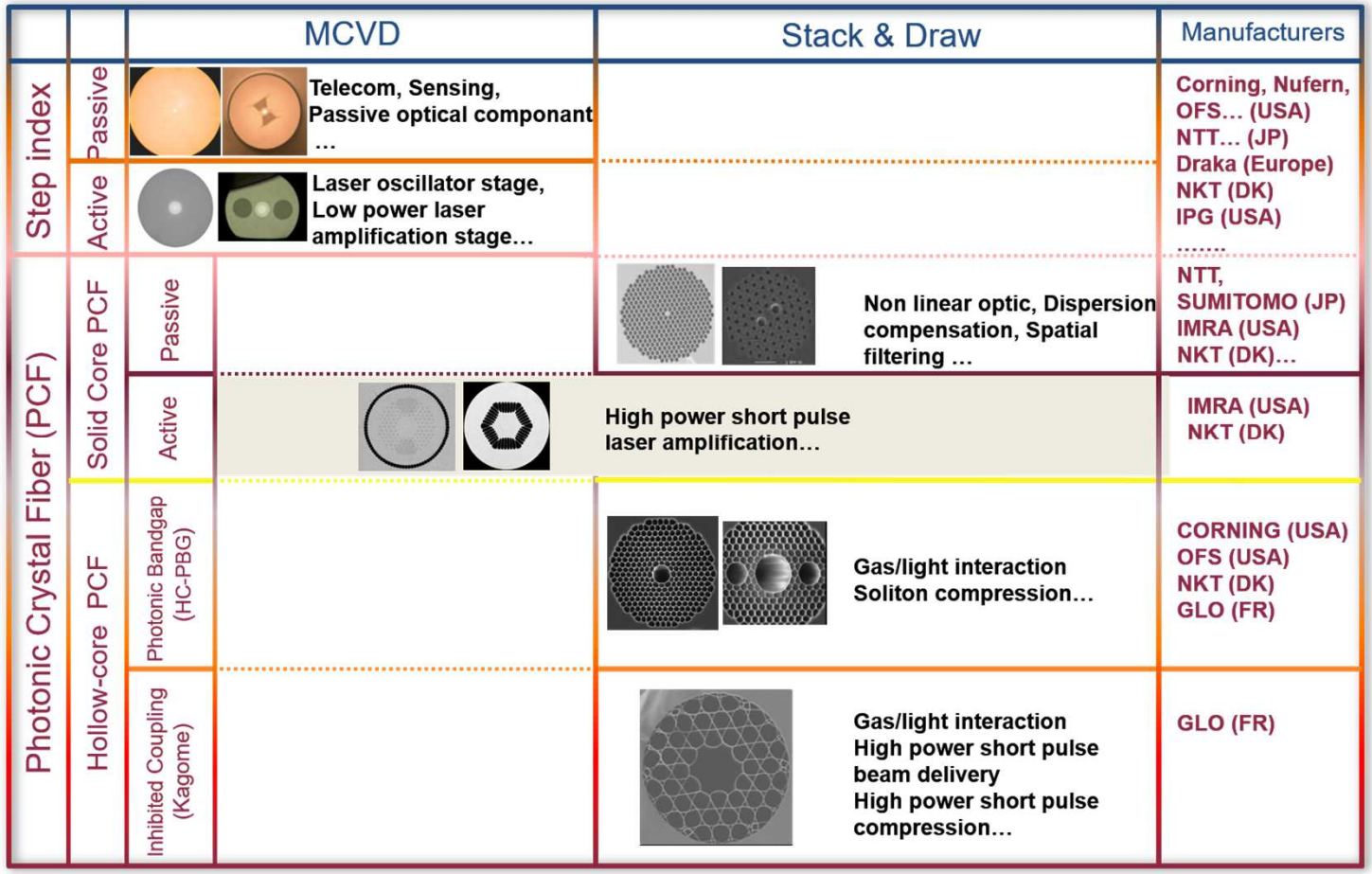
Optical fibre Landscape



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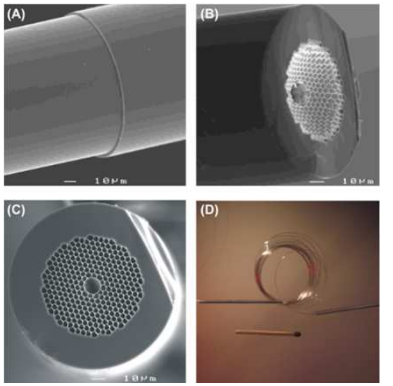
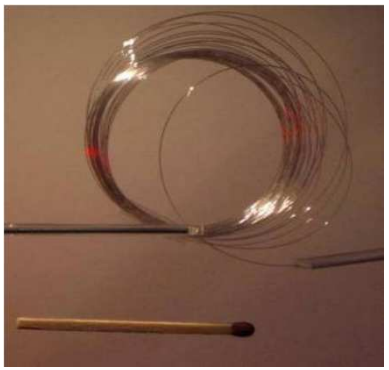
The Photonic MicroCell™(PMC): a unique photonic component



A PMC IS

1. **HOLLOW-CORE PHOTONIC CRSYTAL FIBRE FILLED WITH A GAS MEDIUM AND TERMINATED ENDS**



2. **HIGHLY COMPACT AND INTEGRABLE IN THE GROWING LASER MARKET**

3. **A PLATFORM TECHNOLOGY WITH SEVERAL UNIQUE FUNCTIONALITIES**

- New laser wavelengths
- Flexible high power and ultra-fast laser pulse delivery
- New laser applications

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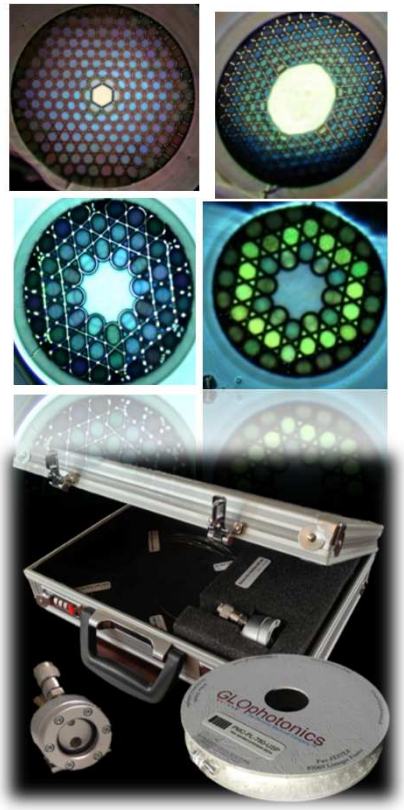
GLO prototype-product family



- **PMC-OEM**

Description: A length of Hollow-Core Photonic Crystal Fibre (HC-PCF) with protecting metallic cap
Applications/Clients: Research/Scientific lab, R&D/Laser manufacturers

- **PMC-FC**

Description: A length of Hollow-Core Photonic Crystal Fibre (HC-PCF) filled with frequency-converter gas medium and with sealing end terminations.
Applications/Clients: Research/Scientific lab, R&D/Laser manufacturers, Micromachining /Laser manufacturer & machine integrators, DNA sequencing and cell imaging/ Diagnostic labs and surgery

- **PMC-PL**

Description: A length of Hollow-Core Photonic Crystal Fibre (HC-PCF) filled with frequency-converter gas medium and with sealing end terminations.
Applications/Clients: Research/Scientific lab, R&D/Laser manufacturers, Micromachining /Laser manufacturer & machine integrators, DNA sequencing and cell imaging/ Diagnostic labs and surgery

- **PMC-TECSOL**

Description: A bespoke Hollow-Core Photonic Crystal Fibre (HC-PCF) and or PMC and/or feasibility study
Applications/Clients: Research/Scientific lab, R&D for industrials

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GLOphotonics HIPERDIAS contribution : Overview

- Extensive knowledge of Kagome fibre drawing and industrialization

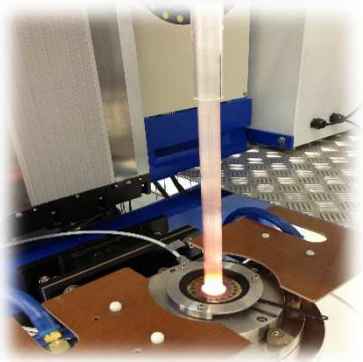
D4.7

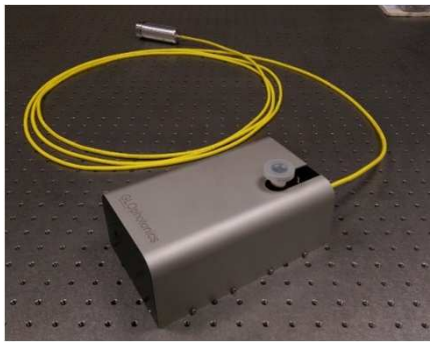
- Fibre characterization benches

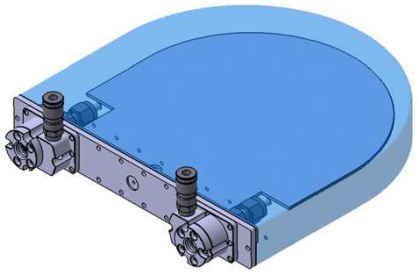
D7.4

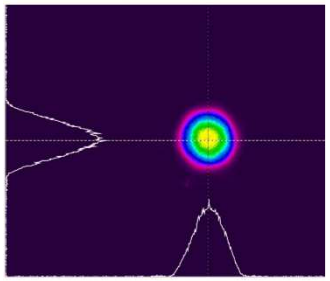
- Mechanical Design and prototyping abilities

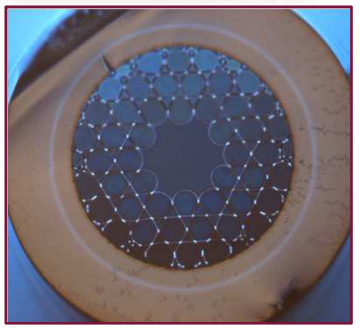
D4.4 ; D4.4 ; D4.7











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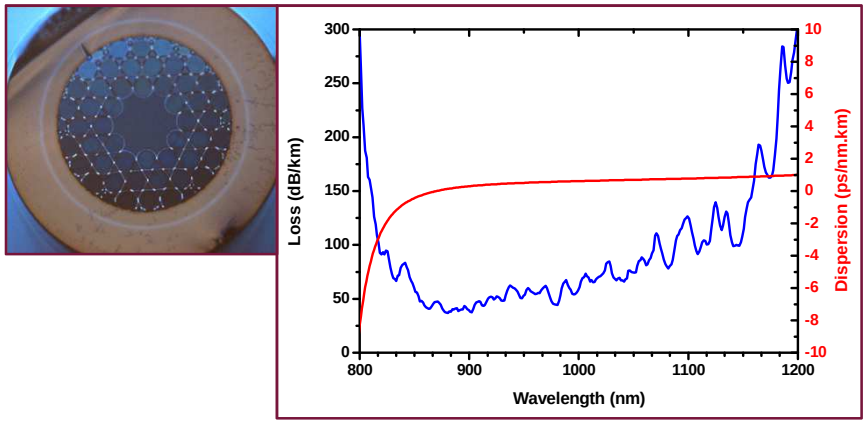
GLOphotonics HIPERDIAS contribution :

- Fabrication and characterization of photonic microcell (PMC) module for fibre-delivery of ultra-short high power pulse in operational environment

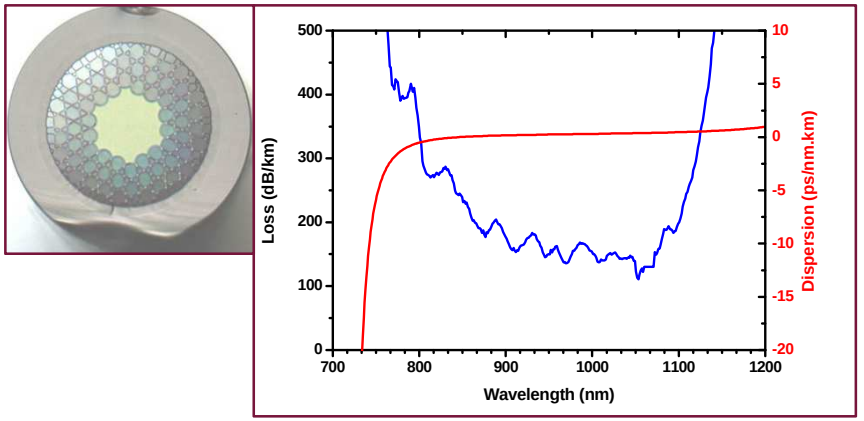
Based on GLO standardized HC-PCF

Two fibers will be used to qualify the fiber delivery module :

(1) PMC-C-Yb-7C [MFD: 30-50 um]



(2) PMC-RnD-Y-19C [MFD: 70-100 um]



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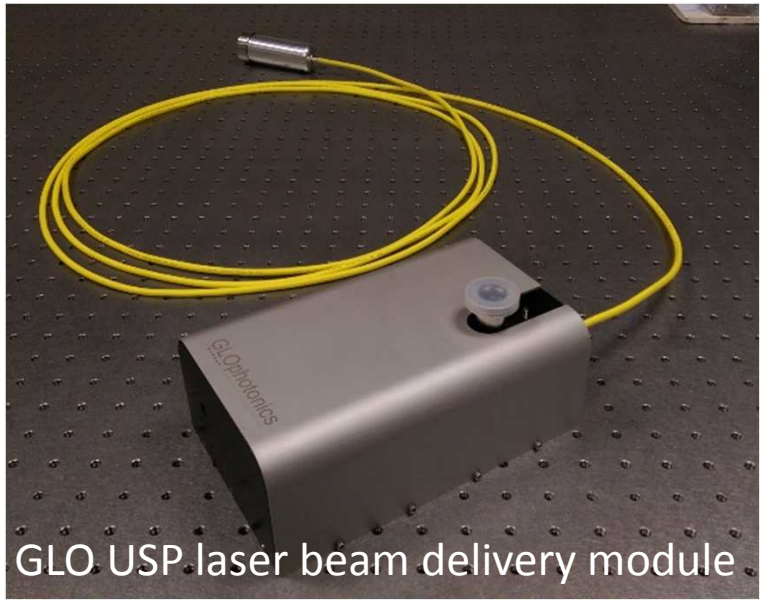
GLOphotonics HIPERDIAS contribution :

- Fabrication and characterization of photonic microcell (PMC) module for fibre-delivery of ultra-short high power pulse in operational environment

Based on USP laser delivery module



GLO USP laser beam delivery module

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H2020 Financial processes, rules & Reporting

Kite Innovation
Deborah Trabut

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Financial processes

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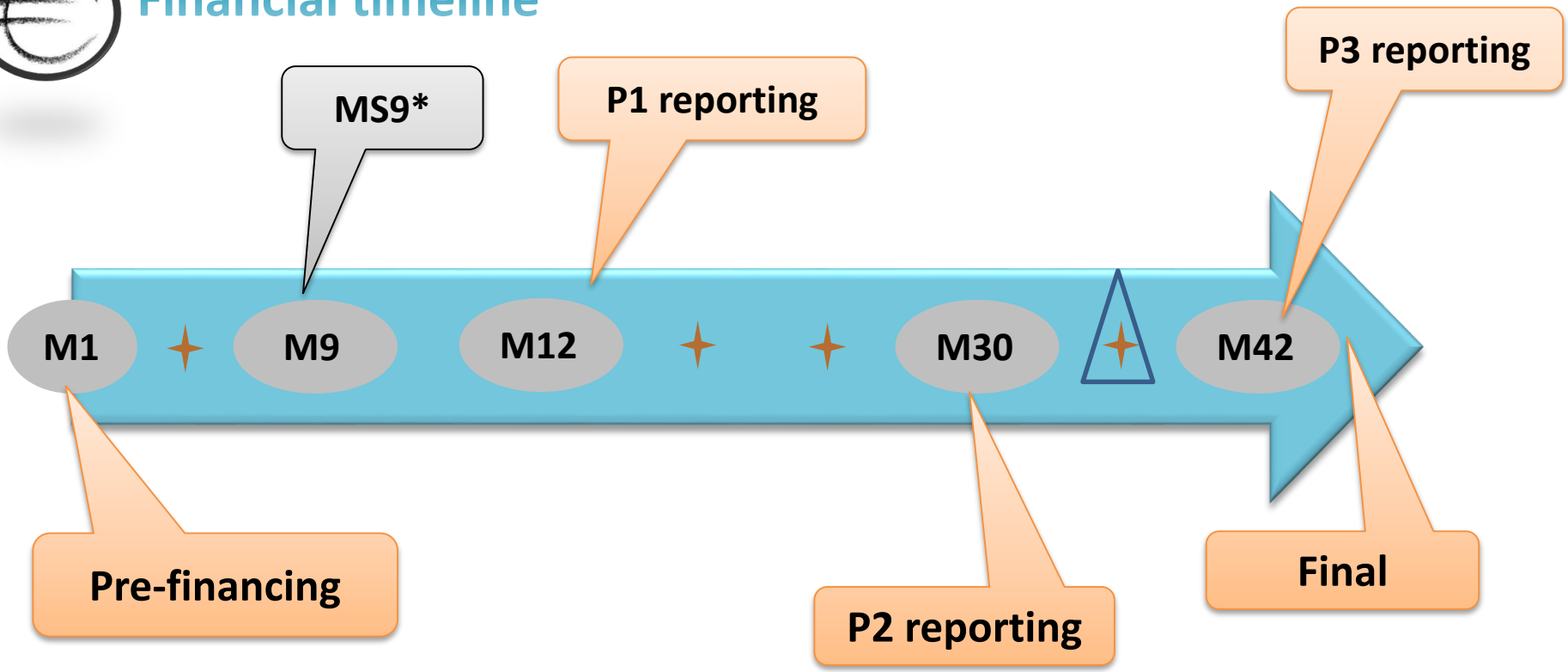
Financial timeline



✦ – at six monthly intervals, the management board will request updated technical & financial reports

*MS9 – Completion of reporting "dry run" with all partners. T9.2 Means of verification: Draft financial report generated

△ – at M36 financial internal audit to be carried out by each institution

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Project pre-financing breakdown

	Pre-financing distribution		
Total EU Contribution (€)	Received	Guarantee Fund	Total Net amount transferrable
€ 3,640,307.50	**€ 1,577,345.24**	**€ 182,015.38**	**€ 1,395,329.87**
	~43.33% of total EU Contribution	= 5% of total EU Contribution	= Total received minus Guarantee fund

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Partners pre-financing breakdown

			Pre-financing distribution		
Partner	Partner short Name	Total EU Contribution (€)	Received	Guarantee Fund	Total Net amount transferrable
1	USTUTT	€ 909,187.50	€ 393,950.94	€ 45,459.38	€ 348,491.57
2	AMP	€ 555,750.00	€ 240,806.48	€ 27,787.50	€ 213,018.98
4	AMO	€ 371,742.50	€ 161,076.03	€ 18,587.13	€ 142,488.90
5	BOSCH	€ 499,002.50	€ 216,217.78	€ 24,950.13	€ 191,267.66
6	XLIM	€ 299,500.00	€ 129,773.35	€ 14,975.00	€ 114,798.35
7	LASEA	€ 441,750.00	€ 191,410.28	€ 22,087.50	€ 169,322.78
8	GLO	€ 289,750.00	€ 125,548.68	€ 14,487.50	€ 111,061.18
9	E6	€ 123,417.50	€ 53,476.80	€ 6,170.88	€ 47,305.93
	E6 UK	€ 8,832.50	€ 3,827.12	€ 441.63	€ 3,385.50
10	KITE	€ 141,375.00	€ 61,257.79	€ 7,068.75	€ 54,189.04
TOTAL		**€ 3,640,307.50**	**€ 1,577,345.24**	**€ 182,015.38**	**€ 1,395,329.87**

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

Project interim payments

90% of the maximum grant amount

minus

Pre-financing and previous interim payments

equals

Maximum interim payment

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Project final payment

10% Retention

plus

5% Guarantee Fund

equals

Maximum final payment

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Partners payment breakdown throughout project*

Max interim payment = 90% limit of max grant amount – received pre-financing

Partner	Partner short Name	Total EU Contribution (€)	Pre-financing distribution			90% limit of max grant amount	Max interim payments during project	Max final payment at the end of project	Total check = net pre finance + Period payment + final payment
			Received	Guarantee Fund	Total Net amount transferrable				
1	USTUTT	€ 909,187.50	€ 393,950.94	€ 45,459.38	€ 348,491.57	€ 818,268.75	€ 424,317.81	€ 136,378.13	€ 909,187.50
2	AMP	€ 555,750.00	€ 240,806.48	€ 27,787.50	€ 213,018.98	€ 500,175.00	€ 259,368.52	€ 83,362.50	€ 555,750.00
4	AMO	€ 371,742.50	€ 161,076.03	€ 18,587.13	€ 142,488.90	€ 334,568.25	€ 173,492.22	€ 55,761.38	€ 371,742.50
5	BOSCH	€ 499,002.50	€ 216,217.78	€ 24,950.13	€ 191,267.66	€ 449,102.25	€ 232,884.47	€ 74,850.38	€ 499,002.50
6	XLIM	€ 299,500.00	€ 129,773.35	€ 14,975.00	€ 114,798.35	€ 269,550.00	€ 139,776.65	€ 44,925.00	€ 299,500.00
7	LASEA	€ 441,750.00	€ 191,410.28	€ 22,087.50	€ 169,322.78	€ 397,575.00	€ 206,164.72	€ 66,262.50	€ 441,750.00
8	GLO	€ 289,750.00	€ 125,548.68	€ 14,487.50	€ 111,061.18	€ 260,775.00	€ 135,226.32	€ 43,462.50	€ 289,750.00
9	E6	€ 123,417.50	€ 53,476.80	€ 6,170.88	€ 47,305.93	€ 111,075.75	€ 57,598.95	€ 18,512.63	€ 123,417.50
	E6 UK	€ 8,832.50	€ 3,827.12	€ 441.63	€ 3,385.50	€ 7,949.25	€ 4,122.13	€ 1,324.88	€ 8,832.50
10	KITE	€ 141,375.00	€ 61,257.79	€ 7,068.75	€ 54,189.04	€ 127,237.50	€ 65,979.71	€ 21,206.25	€ 141,375.00
TOTAL		**€ 3,640,307.50**	**€ 1,577,345.24**	**€ 182,015.38**	**€ 1,395,329.87**	**€ 3,276,276.75**	**€ 1,698,931.51**	**€ 546,046.13**	€ 3,640,307.50

**subject to change throughout the project and validation of financial reports by EU*

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Budget transfers

The estimated budget breakdown indicated in Annex 2 may be adjusted by transfers of amounts between beneficiaries or between budget categories (or both).
This does not require an amendment according to Article 55, if the action is implemented as described in Annex 1.

However, the beneficiaries may not add costs relating to subcontracts not provided for in Annex 1, unless such additional subcontracts are approved by an amendment or in accordance with Article 13.

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Project reporting

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6 monthly Internal updates

- Technical progress
- Management of the resources

Periodic report

- All activities
- All costs

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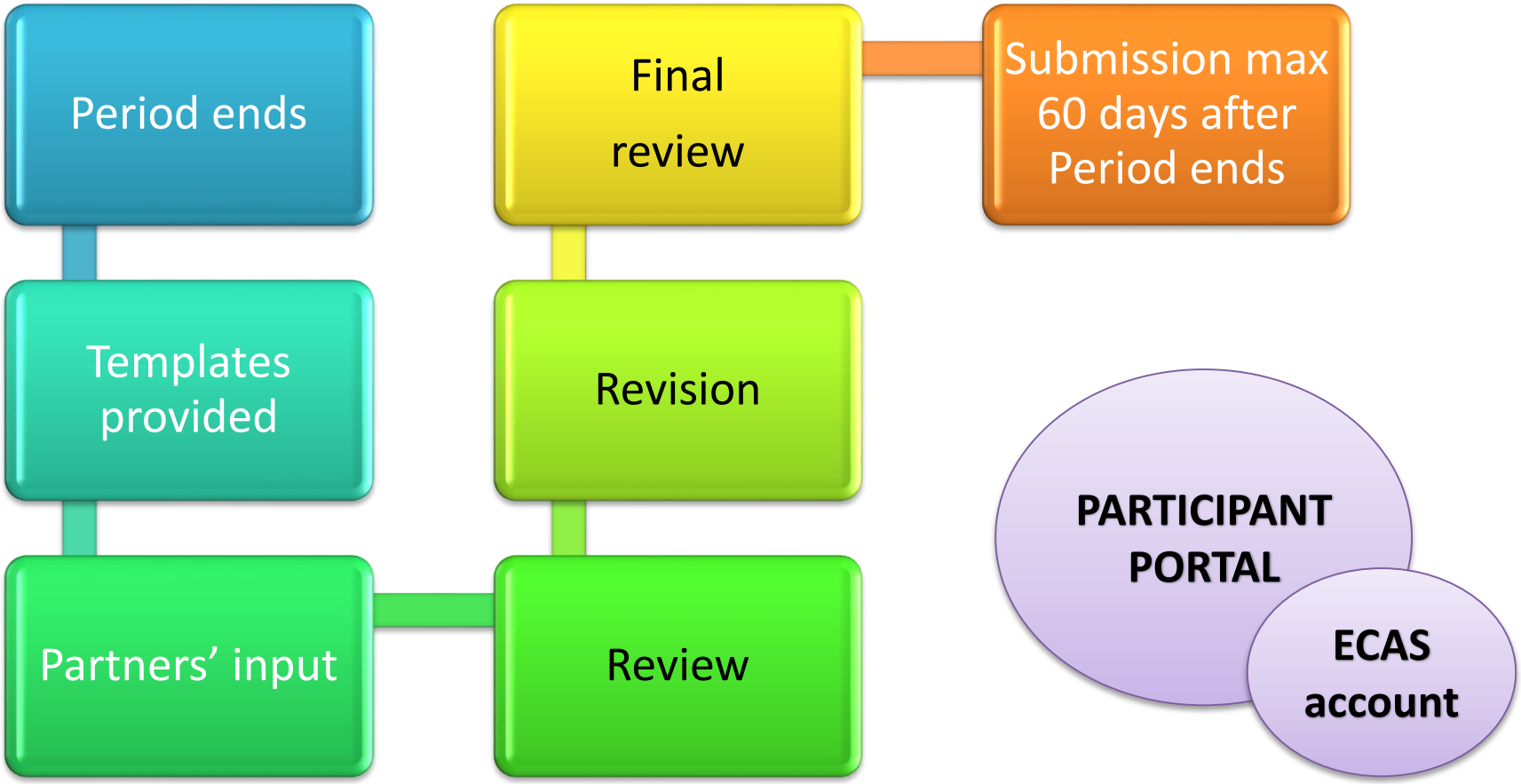

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FINANCIAL

- All costs incurred in the Period
- Per activity type
- Per cost type
- With detailed explanation
- Include the receipts of actions (see article 5.3.3)

TECHNICAL

- Explanation of the work carried out
- Overview of progress towards DoA & deviations
- A summary for publication
- The answers to the questionnaire covering issues related to the action implementation

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H2020 financial rules and requirements

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Project documentation

Grant Agreement

- **Core**
- **Annex I – DoA (Part A & Part B)**
- **Other annexes**

Consortium Agreement

Guidance available on the Participant Portal

- **Rules for participation**
- **IPR helpdesk**
- **Etc…**

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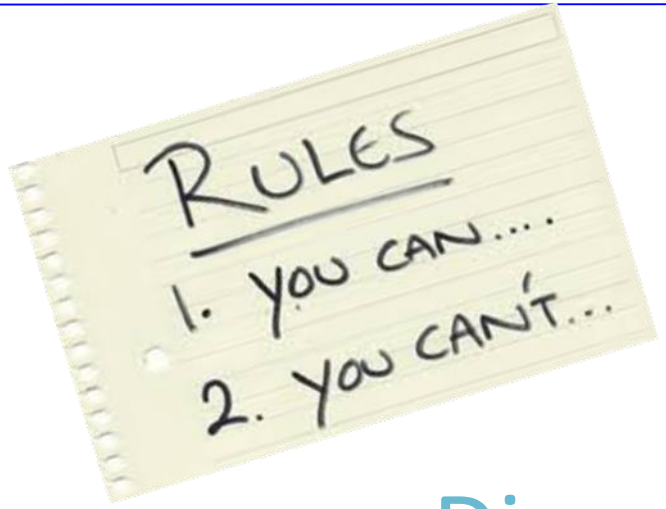

Direct Costs /Indirect Costs

Eligible Costs

Non-eligible Costs

Currency for financial statement

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Direct costs

Are costs that are directly linked to the action implementation and can therefore be attributed to it directly. They must not include any indirect costs

Indirect costs

Are costs that are not directly linked to the action implementation and therefore cannot be attributed directly to it.

Indirect costs are eligible if they are declared on the basis of the **flat-rate of 25% of the eligible direct costs** (see Article 5.2), from which are excluded:

- costs of subcontracting and
- costs of in-kind contributions provided by third parties which are not used on the beneficiary's premises;

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Eligible costs

- ✓ they must be actually incurred by the beneficiary
- ✓ they must be incurred in the period set out in Article 3, with the exception of costs relating to the submission of the periodic report for the last reporting period and the final report (see Article 20)
- ✓ they must be indicated in the estimated budget set out in Annex 2
- ✓ they must be incurred in connection with the action as described in Annex 1 and necessary for its implementation
- ✓ they must be identifiable and verifiable, in particular recorded in the beneficiary's accounts in accordance with the accounting standards applicable in the country where the beneficiary is established and with the beneficiary's usual cost accounting practices
- ✓ they must comply with the applicable national law on taxes, labour and social security, and
- ✓ they must be reasonable, justified and must comply with the principle of sound financial management, in particular regarding economy and efficiency

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Eligible direct costs

- ✓ Personnel costs (for full details refer to GA page 15 to 19)
- ✓ Travel costs and related subsistence allowances
- ✓ The depreciation costs of equipment, infrastructure or other assets
  - *(new or second-hand) as recorded in the beneficiary's accounts are eligible, if they were purchased in accordance with Article 10 and written off in accordance with international accounting standards and the beneficiary's usual accounting practices*
- ✓ The cost of renting or leasing equipment, infrastructure or other assets
  - *(including related duties, taxes and charges such as non-deductible value added tax (VAT) paid by the beneficiary) are also eligible, if they do not exceed the depreciation costs of similar equipment, infrastructure or assets and do not include any financing fees.*
- ✓ Cost of other goods and services
  - *consumables and supplies, dissemination (including open access), protection of results, certificates on the financial statements (if they are required by the Agreement), certificates on the methodology, translations and publications.*
- ✓ Capitalised and operating costs of "large research infrastructure"
  - *The value of the large research infrastructure represents at least 75% of the total fixed assets (at historical value in its last closed balance sheet before the date of the signature of the Agreement or as determined on the basis of the rental and leasing costs of the research infrastructure*)
  - *the beneficiary's methodology for declaring the costs for large research infrastructure has been positively assessed by the Commission ('**ex-ante assessment**')*
  - *the beneficiary declares as direct eligible costs only the portion which corresponds to the duration of the action and the rate of actual use for the purposes of the action, and*
  - *they comply with the conditions as further detailed in the annotations to the H2020 grant agreements.*

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Ineligible costs

- costs related to return on capital
- debt and debt service charges
- provisions for future losses or debts
- interest owed
- doubtful debts
- currency exchange losses
- bank costs charged by the beneficiary's bank for transfers from the Commission
- excessive or reckless expenditure
- deductible VAT
- costs incurred during suspension of the implementation of the action (see Article 49)
- Cost declared under another EU grant

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Certificate on the financial statements

A '**certificate on the financial statements**' (CFS) will have to be submitted at the end of the project if the request for total contribution **is EUR 325 000 or more**.

- ✓ USTUTT
- ✓ AMP
- ✓ AMO
- ✓ BOSCH
- ✓ LASEA

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Some common mistakes

- Estimated costs
- Costs before the start of the Project
- Identifiable deductible VAT
- Incorrect exchange rate
- Indirect costs charged as Direct costs
- Employment costs for people not directly employed nor paid by beneficiary
- Incorrect calculation of the hourly rate
- Unreliable/ Inexistent timesheet
- Travel costs / conference costs
- Equipment costs

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Article 18.1 – Obligation to keep records and other supporting documentation

- ✓ The beneficiaries must — for a period of ***five*** **years** after the payment of the balance — keep records and other supporting documentation in order to prove the proper implementation of the action and the costs they declare as eligible.

- ✓ They must make them available upon request (see Article 17) or in the context of checks, reviews, audits or investigations (see Article 22).

- ✓ If there are on-going checks, reviews, audits, investigations, litigation or other pursuits of claims under the Agreement (including the extension of findings; see Articles 22), the beneficiaries must keep the records and other supporting documentation until the end of these procedures.

- ✓ **The beneficiaries must keep the original documents.** Digital and digitalised documents are considered originals if they are authorised by the applicable national law. The *Commission* may accept non-original documents if it considers that they offer a comparable level of assurance.

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Article 20.6 – Currency for financial statement and conversion into euro

- ✓ **Financial statements must be drafted in euro**.

- ✓ Beneficiaries *and linked third parties* with accounting established in a currency other than the euro must convert the costs recorded in their accounts into euro, **at the average of the daily exchange rates published in the C series of the *Official Journal of the European Union***, calculated over the corresponding reporting period.

- ✓ If no daily euro exchange rate is published in the *Official Journal of the European Union* for the currency in question, they must be converted at the average of the monthly accounting rates published on the Commission's website, calculated over the corresponding reporting period.

- ✓ Beneficiaries *and linked third parties* with accounting established in euro must convert costs incurred in another currency into euro according to their usual accounting practices.

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Any questions?

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Kite Innovation (Europe) Ltd

Company Profile

Julie Devall

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

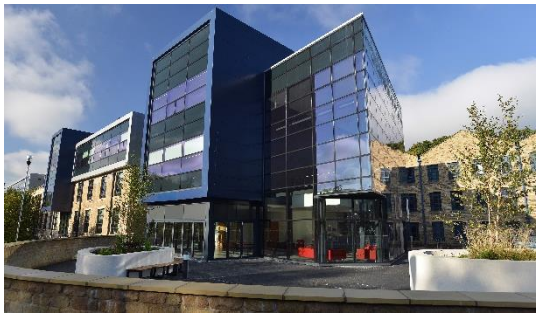
Background

- Formed in 2006 with offices in Scotland and Yorkshire
- 13 members of staff
- Over 10 years experience of working with FP7 and now Horizon 2020

Our Services include;

- Proposal Writing
- Project Management Services
- Exploitation Planning and Commercialisation Services
- Strategy Development and Implementation Services

KITE INNOVATION EUROPE
Knowledge Innovation Technology Enterprise



Huddersfield Office

We have over “30” FP7 and Horizon2020 projects under management in our current portfolio

Sectors include; Health, ICT, Energy, Nanotechnologies, Environmental Science, Security and Transport

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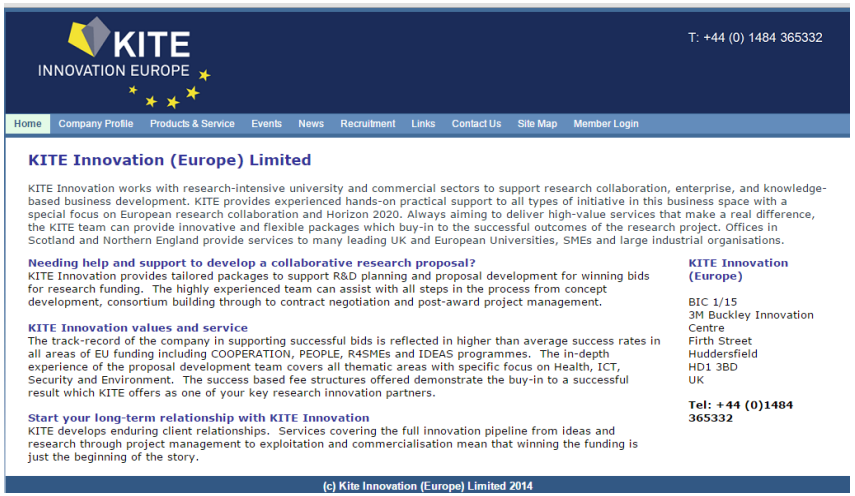
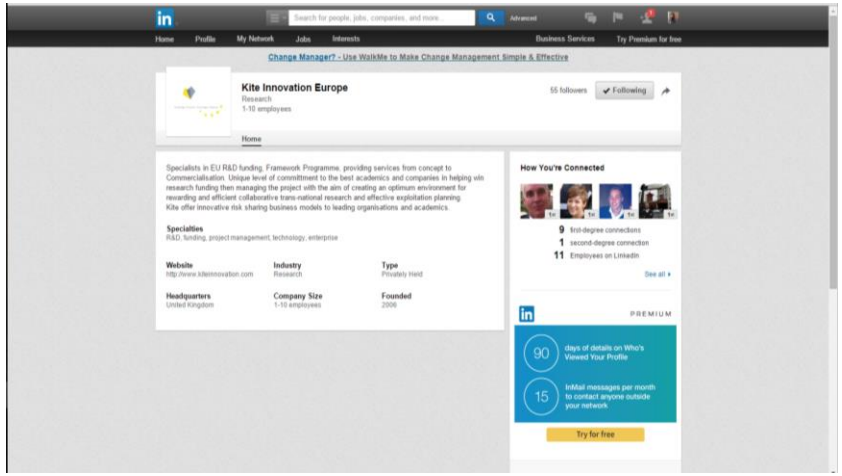
- Website

www.kiteinnovation.com



- You can follow us on

LinkedIn



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Kite Innovation (Europe) Ltd

Project Management (WP9) & Exploitation Planning & Dissemination (WP8)

Julie Devall

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- **Main objective of today is to highlight the following:**

➢ Governance & Management Structure

➢ Project Management

➢ Reporting Procedures, Frequency and Format

➢ Deliverables

➢ Dissemination Planning and Execution

➢ Next 6 month overview

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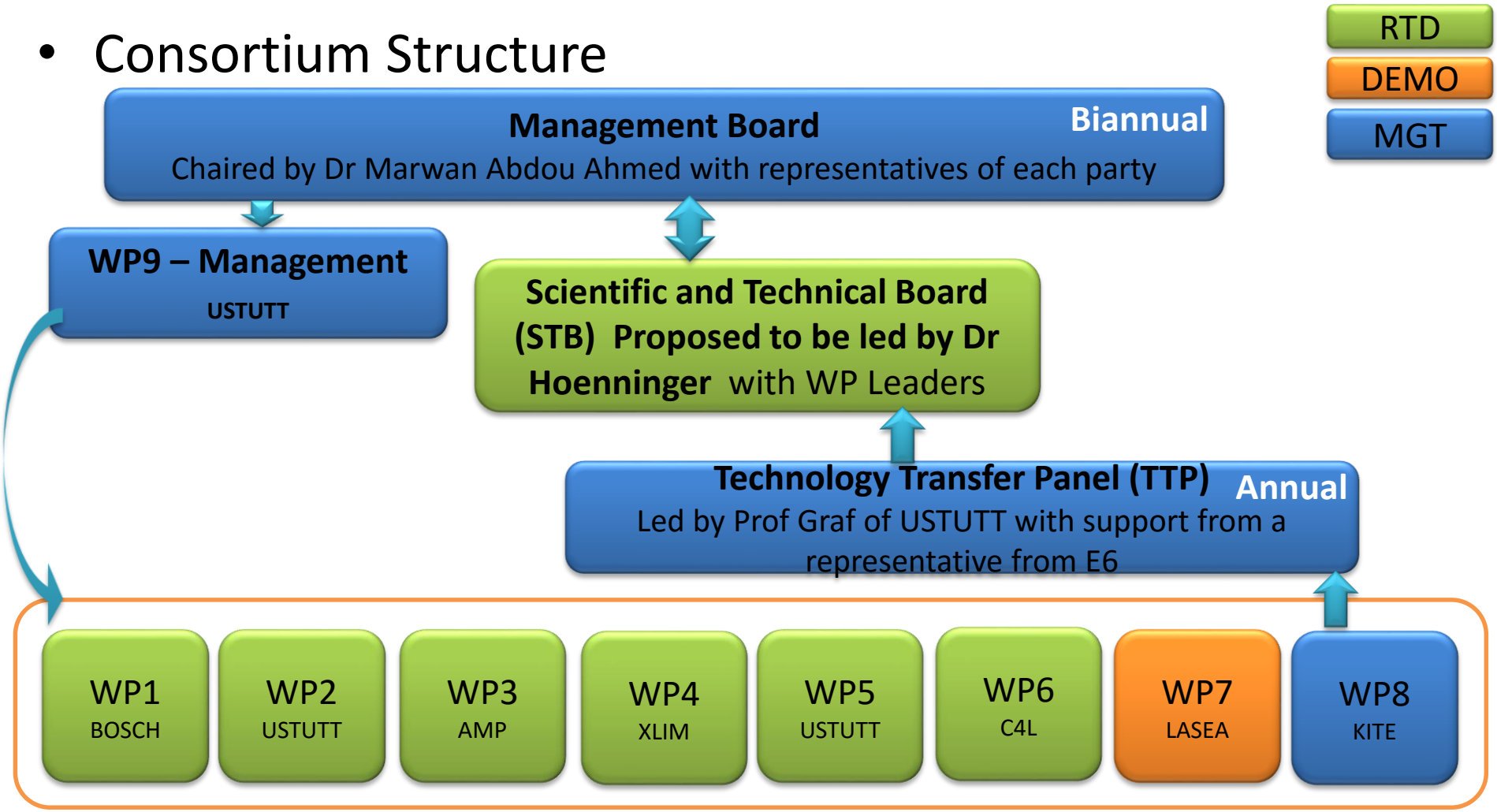
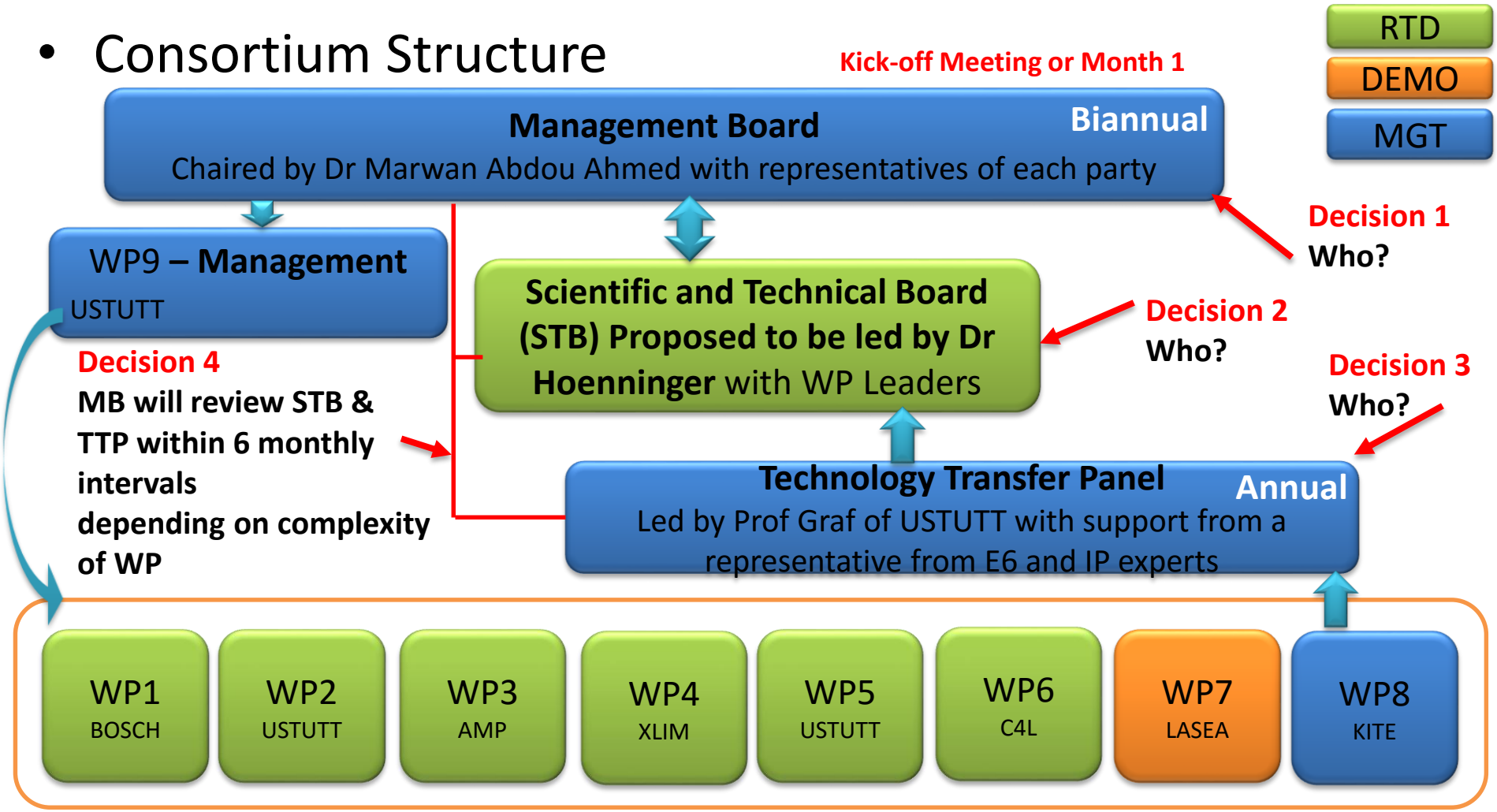
- Consortium Structure



Section 4 (9) in the Grant Agreement Annex 1 (Description of the Action) in Part B2. 3.4

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

- Consortium Structure



Section 4 (9) in the Grant Agreement Annex 1 (Description of the Action) in Part B2. 3.4

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Communication within the Consortium

3.2 Management Structure and procedures Part B of GA (p48)

- Early briefing to partners on the expectations and preparations required for the kick-off meeting
- Regular informal contact between the management team and the WP Leaders
- Brief updates every month of progress requested of each partner
- Progress reports posted on the project website on a regular monthly basis
- Formal updates every quarter and annually

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Project Management

3.2 Management Structure and procedures Part B of GA (p46)

- Coordination of the technical & research activities of the project at consortium level
- Overall legal, contractual, ethical, financial and administrative management
- Preparing, updating and managing the consortium agreement between partners
- Set-up and maintenance of the Hiperdias secure online collaboration tool for project management

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Project Management

3.2 Management Structure and procedures Part B of GA (p46)

- Coordination of knowledge management and other research-related activities
- Managing competitive calls or tenders to select sub-contractors and/or new partners
- Supervising relevant science and society issues related to research activities
- Managing the exploitation and dissemination activities

SQUADRON™ (p 39 & 50)

Hiperdias will appoint an end-user advisory Group to verify the technology (p50)

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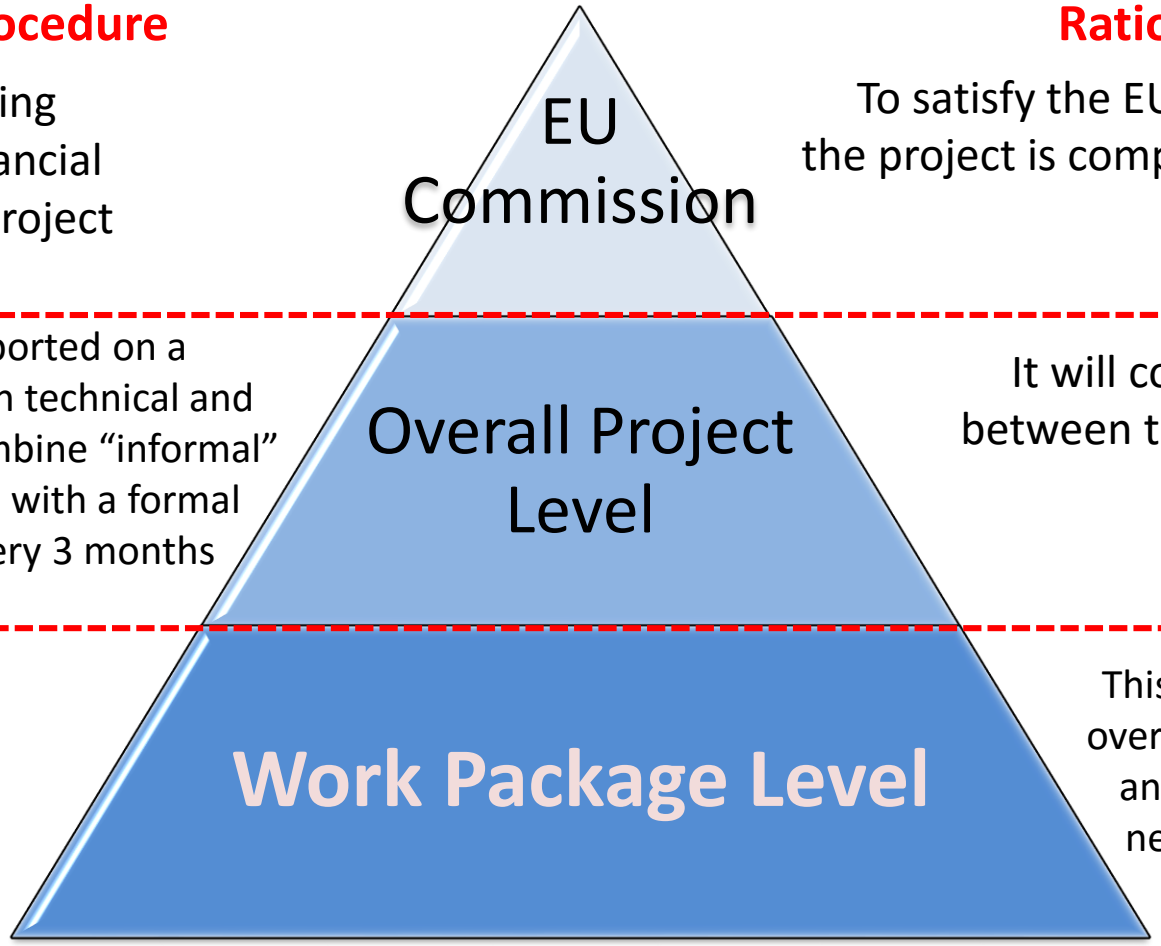
Reporting Procedures, Frequency and Format

Procedure

Periodic Reporting
Technical & Financial
3 times in the project

Rationale

To satisfy the EU Commission that the project is compliant and on track



Progress will be reported on a quarterly basis both technical and financial. It will combine "informal" updates per month with a formal progress report every 3 months

It will cover the periods in between the formal Periodic Reports to the EU commission

WP Members Report to WP Leader each month but this can increase

This will contribute to the overall project level report and will provide "project news" for dissemination purposes

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Reporting Procedures, Frequency and format

3 Formal Periodic Reports

1. Contains Technical & Financial Reporting
2. MB will give CPO feedback within 45 days
3. The CPO must submit report on EU SyGMa within 60 days

The CPO will generate the report & circulate for MB approval within 30 days of the end of the reporting period

14 Quarterly Reports

1. Management Overview
2. A Description of the progress towards the scientific and technological objectives

3. The identification of the problems and suggested corrective action to be taken
4. Progress towards publication

An overview of the actual costs

42 Monthly WP Reports (Informal)

Should contain:

1. WP progress during the month
2. Issues /Concerns
3. Dissemination activities / achievements / collaborations

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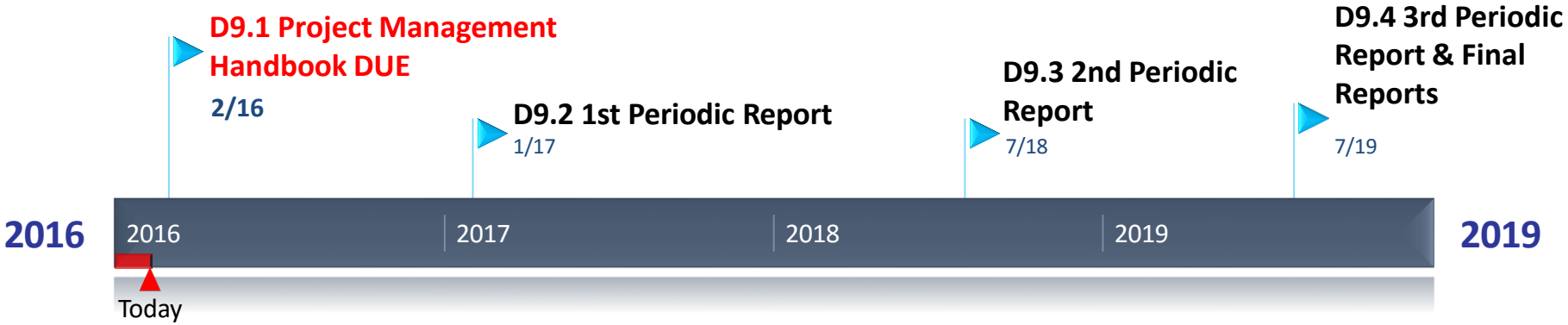
W9 Timeline

- The Lead Beneficiary of a Deliverable Report will be responsible for working in collaboration with partner/s to produce a detailed report on the subject area
- The deliverable should be sent to the Coordinator 2 weeks prior to submission date
- Once verified by the Coordinator the PM will submit the deliverable via the portal



T9.1 Management and Coordination of the project	Feb 1, 2016 - Jul 31, 2019
T9.2 Financial Management including Auditing	Feb 1, 2016 - Jul 31, 2019
T9.3 Management of Ethical and Gender Related Issues	Feb 1, 2016 - Jul 31, 2019
T9.4 Establishment of Consortium Bodies, Planning & Organisation of Meetings	Feb 1, 2016 - Jul 31, 2019
T9.5 Management of the Consolidation of Technical & Financial Reports and coms. with the Commission	Feb 1, 2016 - Jul 31, 2019
T9.6 Monitoring and Progress Chasing / submission of Deliverables & Milestones	Feb 1, 2016 - Jul 31, 2019

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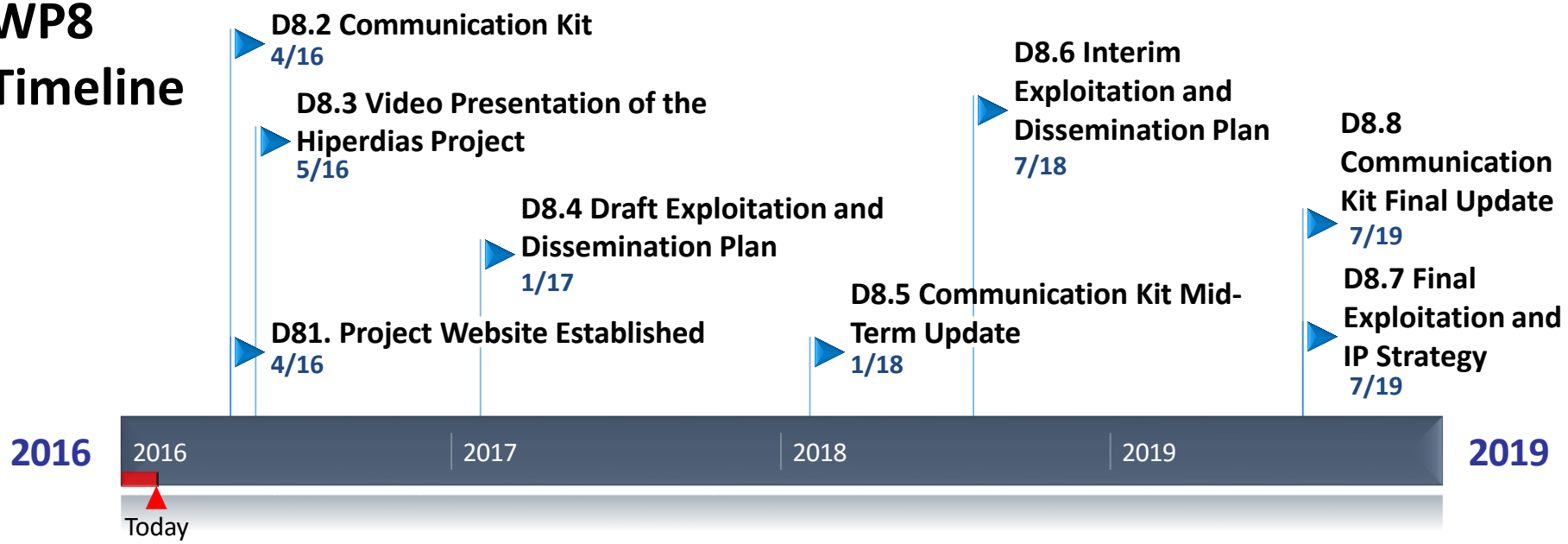
WP8 Timeline



T8.1 Website	Feb 1, 2016 - Jul 31, 2019
T8.2 Dissemination	Feb 1, 2016 - Jul 31, 2019
T8.3 Exploitation	Aug 1, 2016 - Jul 31, 2019
T8.4 Intellectual property and supply chain	Aug 1, 2016 - Jul 31, 2019
T8.5 Management of Intellectual Property	Feb 1, 2016 - Jul 31, 2019
T8.6 Training	Aug 1, 2016 - Jul 31, 2019

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Planned specific activities include; (part B, p42)

- The creation of a project website designed to inform interested parties of the progress of the project as well as informing the general public
- The partners will issue a press release to local and international press at the beginning of the project
- A promotional video clip will be produced for YouTube and the project website
- Two end-user advisory sessions will be scheduled at project kick-off and immediately prior to the commencement of WP7
- A project workshop will showcase the demonstration activities in the final phase of the project.
- Journals, websites, events and conferences will be targeted.

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"Should have Started Tasks";

WP No	WP Leader	Lead B	Participants	T.no	Task Description	Start	Finish
WP1	BOSCH	BOSCH	BOSCH,E6,C4L	T1.1	Collection of end-user application specifications	1	4
WP1	BOSCH	LASEA	C4L	T1.4	Interface requirements	1	12
WP4	XLIM	USTUTT	AMP,AMO	T4.1	Design of grating compressors	1	18
WP5	USTUTT	USTUTT	USTUTT	T5.1	Design of the thin-disk multipass amplifier	1	6
WP8	KITE	KITE	ALL	T8.1	Web site	1	42
WP8	KITE	KITE	ALL	T8.2	Dissemination	1	42
WP8	KITE	KITE	ALL	T8.5	Management of Intellectual Property	1	42
WP9	USTUTT	KITE	KITE	T9.1	Management and coordination of the project	1	42
WP9	USTUTT	KITE	KITE	T9.2	Financial management of the project	1	42
WP9	USTUTT	KITE	KITE	T9.3	Management of ethical and gender related issues	1	42
WP9	USTUTT	KITE	KITE	T9.4	Establishment of consortium bodies, and of consortium meetings	1	42
WP9	USTUTT	KITE	KITE	T9.5	Management of the consolidation of technical and financial reports	1	42
WP9	USTUTT	KITE	KITE	T9.6	Monitoring and progress chasing and submission of deliverables and milestones	1	42

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LASEA

Jose Antonio Ramos
David Bruneel

LASER ENGINEERING APPLICATIONS

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

Lasea at a glance

- Highly qualified team (41) including 28 Engineers
- Laser Expertise / Solution provider
- Laser Machine manufacturing
- Laser Equipment installation and maintenance

From application labs to production

Process Development

OEM systems and laser workstations

Laser production line

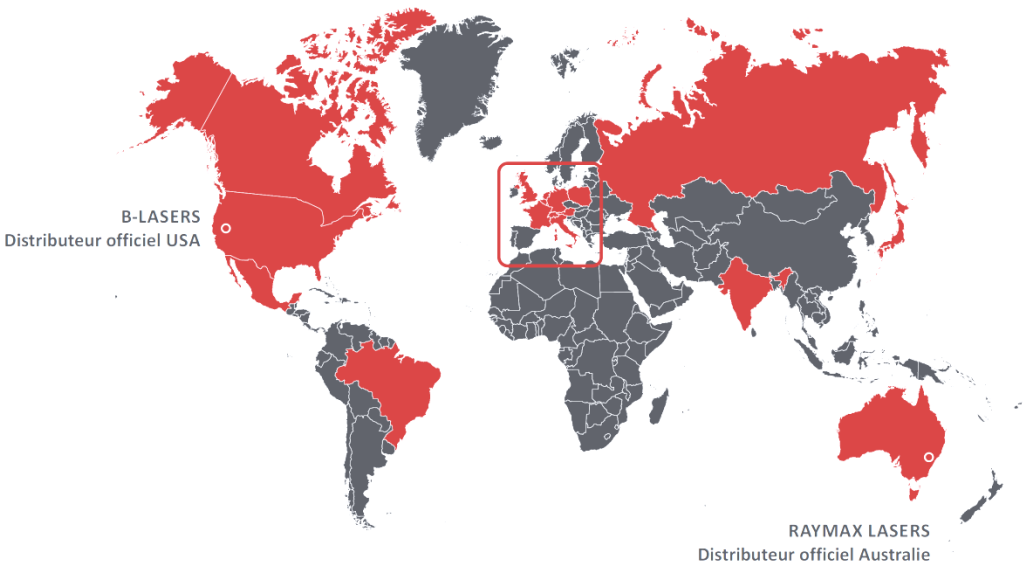
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 687880

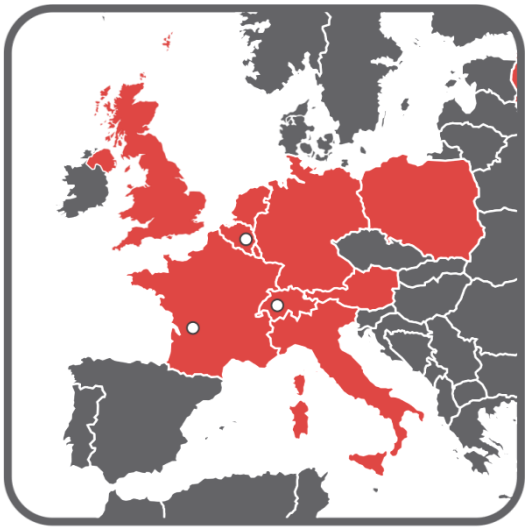
Serving world class companies

PILKINGTON NSG Group Flat Glass Business · AGC · GUARDIAN · SAINT-GOBAIN · InBev · DAIKIN AIR CONDITIONING · Valeo · Johnson Matthey

Baxter · GlaxoSmithKline · Cochlear · SANOFI · UNIVERSITY OF BIRMINGHAM · haute école arc · PATEK PHILIPPE GENEVE · Tupperware

Already 200 systems over the world





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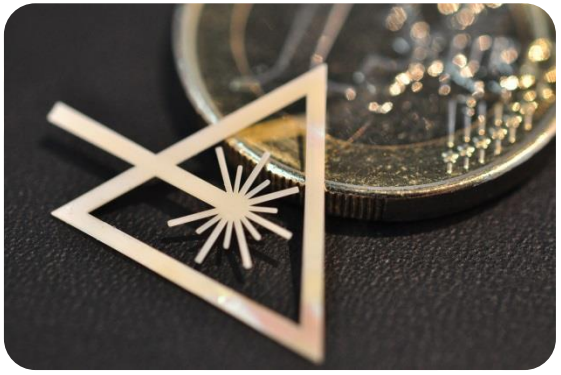
Laser Cutting

Laser cutting applies to all materials (hard, fragile, soft, etc.).

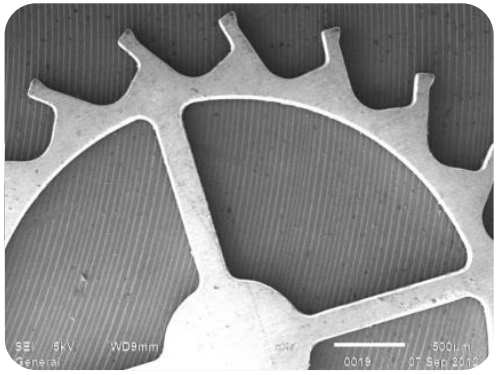
"Ressort spiraux" (Metal)

"Ressort spiraux" (Sapphire)

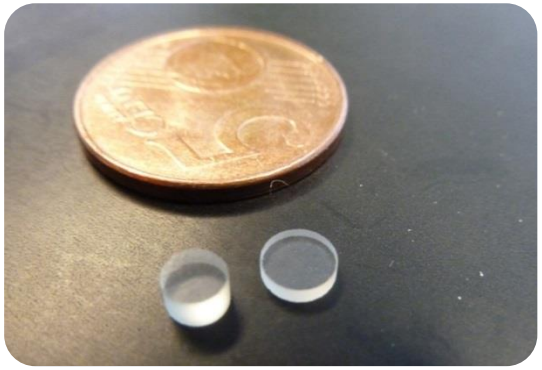
IOL (Polymer)



"Applique" (Mother of pearl)



"Roue d'échappement" (Metal)



(Glass)

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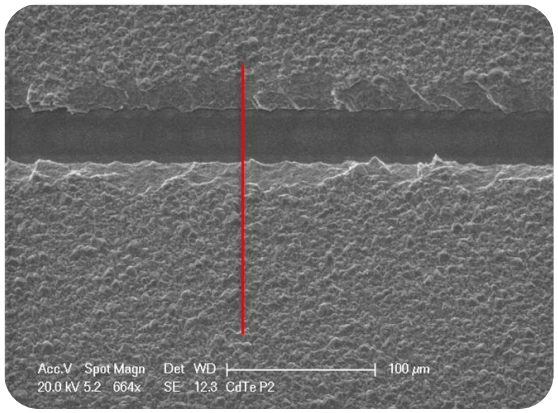
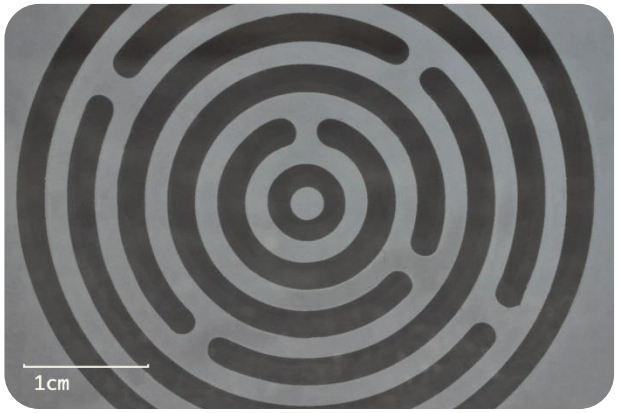
Laser Thin Film removal

Laser thin film removal enables selective engraving without delamination, bumps or micro cracks in the fields of solar cells, OLED's and microelectronics.

PET coating removal



P2 PV scribing



Coating removal of a metal layer on glass

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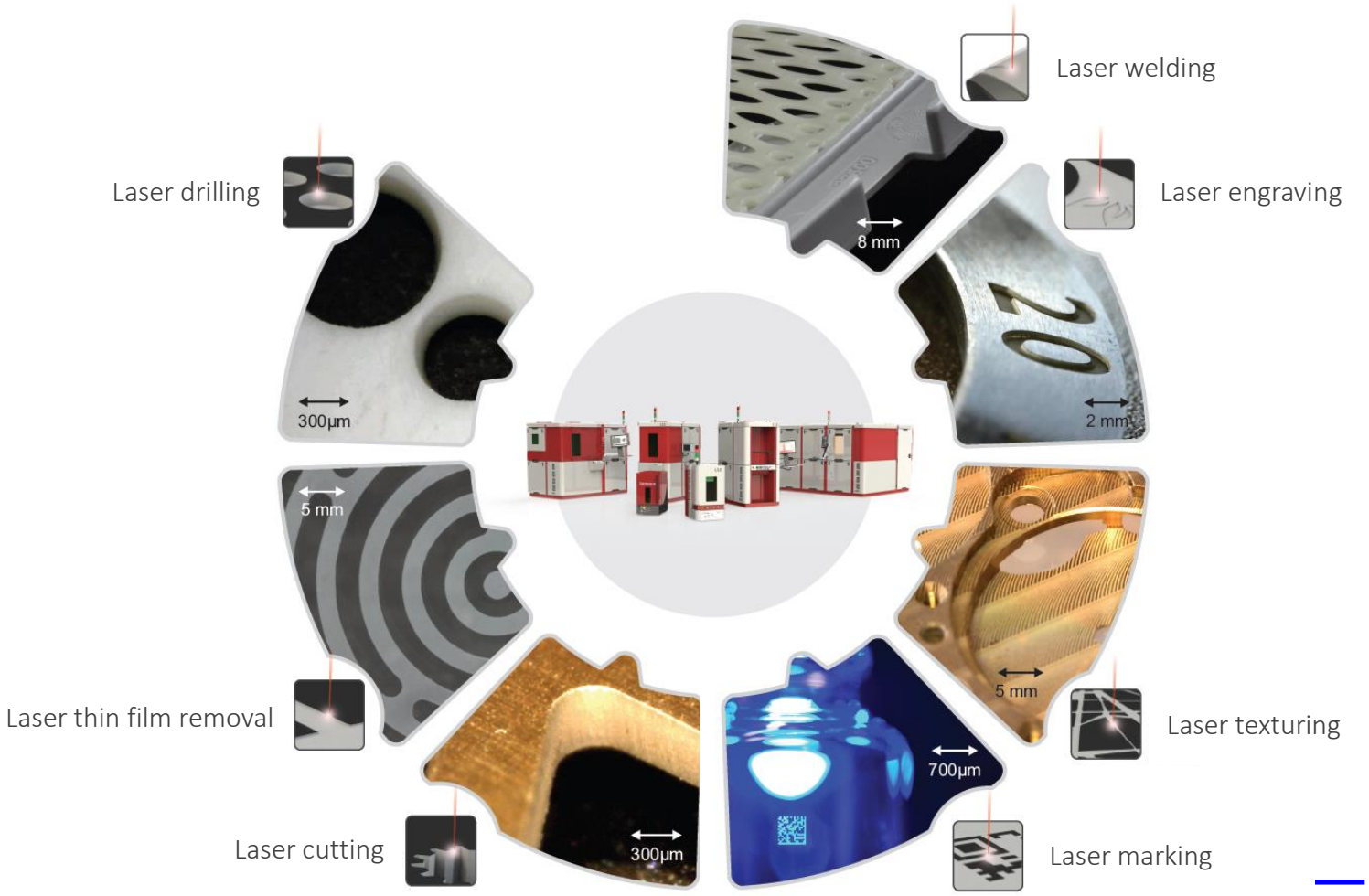
For each application a laser solution and machine



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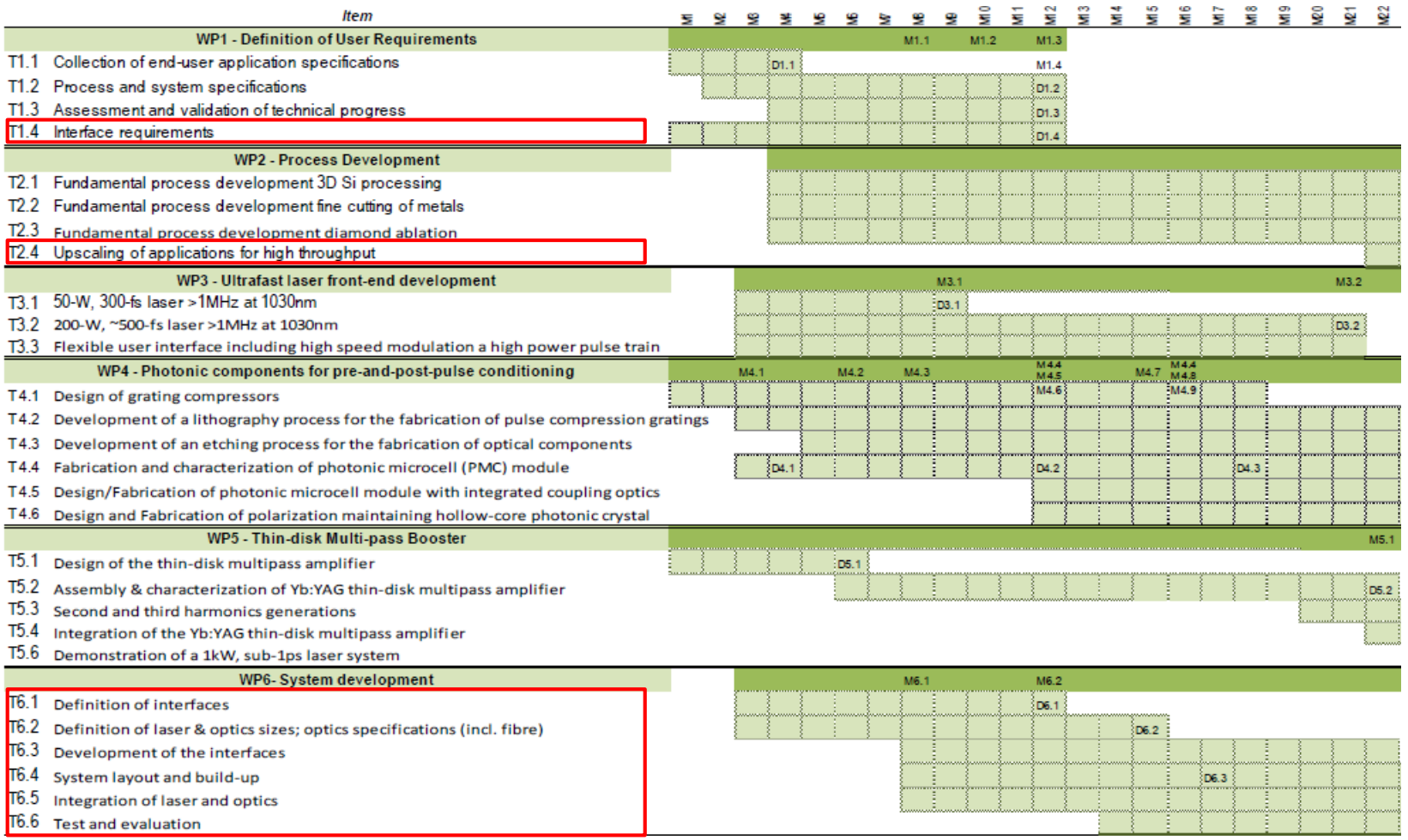
- Gantt of the first year



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Lasea's involvement

- WP1: collection of all partners' requirements, end-users specifications
- WP2: Process development: high throuhput 3D silicon processing, diamond processing and fine cutting materials
- WP6: System development: definition of system's interfaces and features to integrate for proof of concept

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- WP1 – Definition of user requirements
  - Task 1.4 (Leader) : Interfaces requirements : Laser, Scanner, motion, opto-mechanics, software communication
- WP2 – Process development
  - Task 2.1: 3D Si processing : Influence on system design
  - Task 2.4 : upscaling 3D Si processing with BOSCH and USTUTT

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- WP6 – System development
  - Task 6.1 (Leader): Interfaces definition : protocols and connections to control : scanner (XYZ), axes (XYZ), laser, joystick, vacuum system, fume extraction
  - Task 6.2: Defining optics specifications, laser beam delivery, systems mechanical limitations
  - Task 6.3: Design and development of software interfaces, control combining laser, CNC and Scanner.

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- Task 6.4: Design of the system and build up : Integration of XYZ axes, scanner, camera, fume extractor, sample vacuum system

- Task 6.5: Integration of beam delivery optics, scanner, laser, control units. Functionality checks.

- Task 6.6 (Leader): Evaluation of the system's properties
  - use of own low power laser,
  - characterisation of positioning tolerances of scanner and XYZ
  - Characterisation of laser-matter interaction
  - Guarantee of the sample vacuum fixture system, fume extraction system

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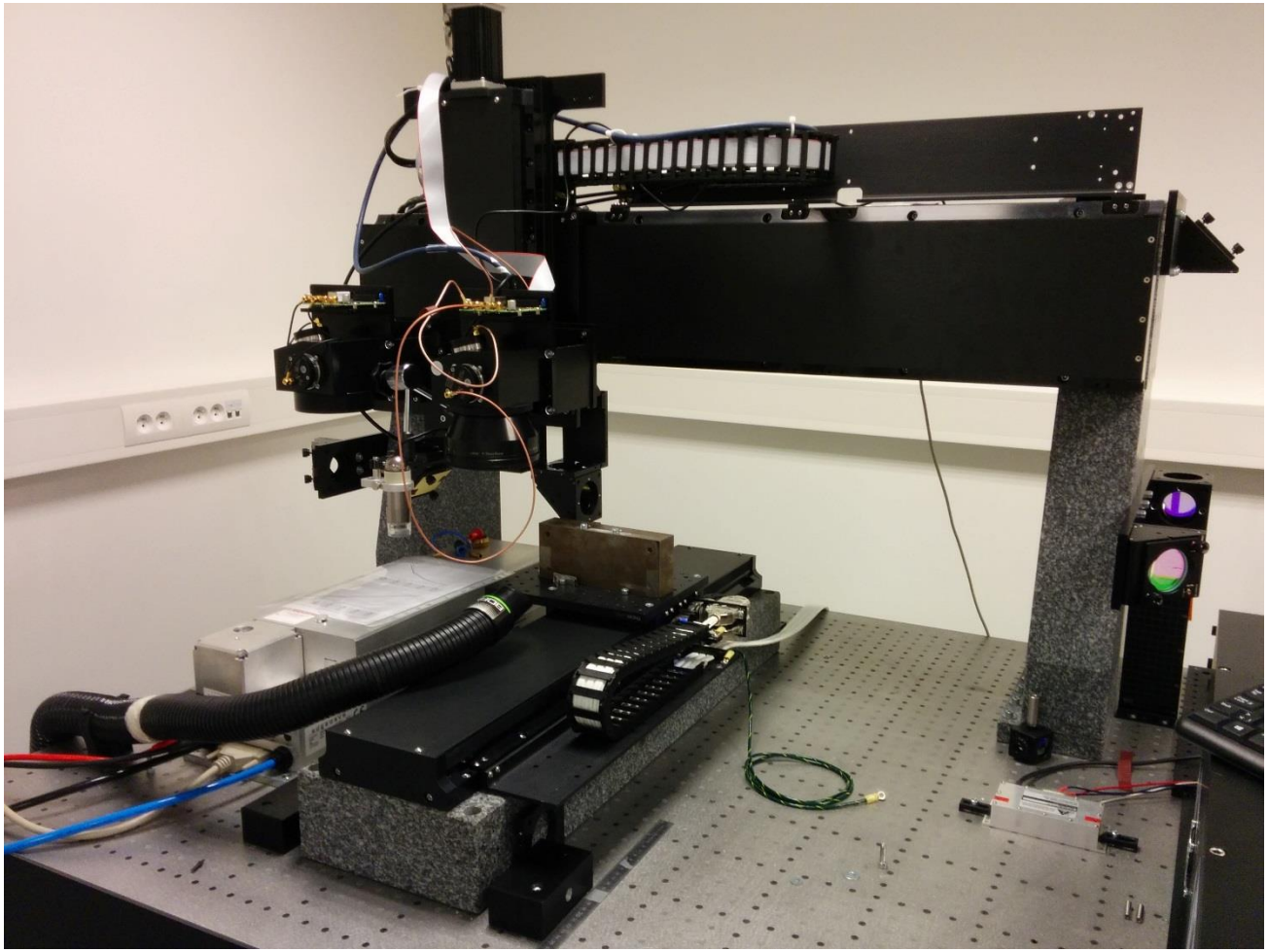

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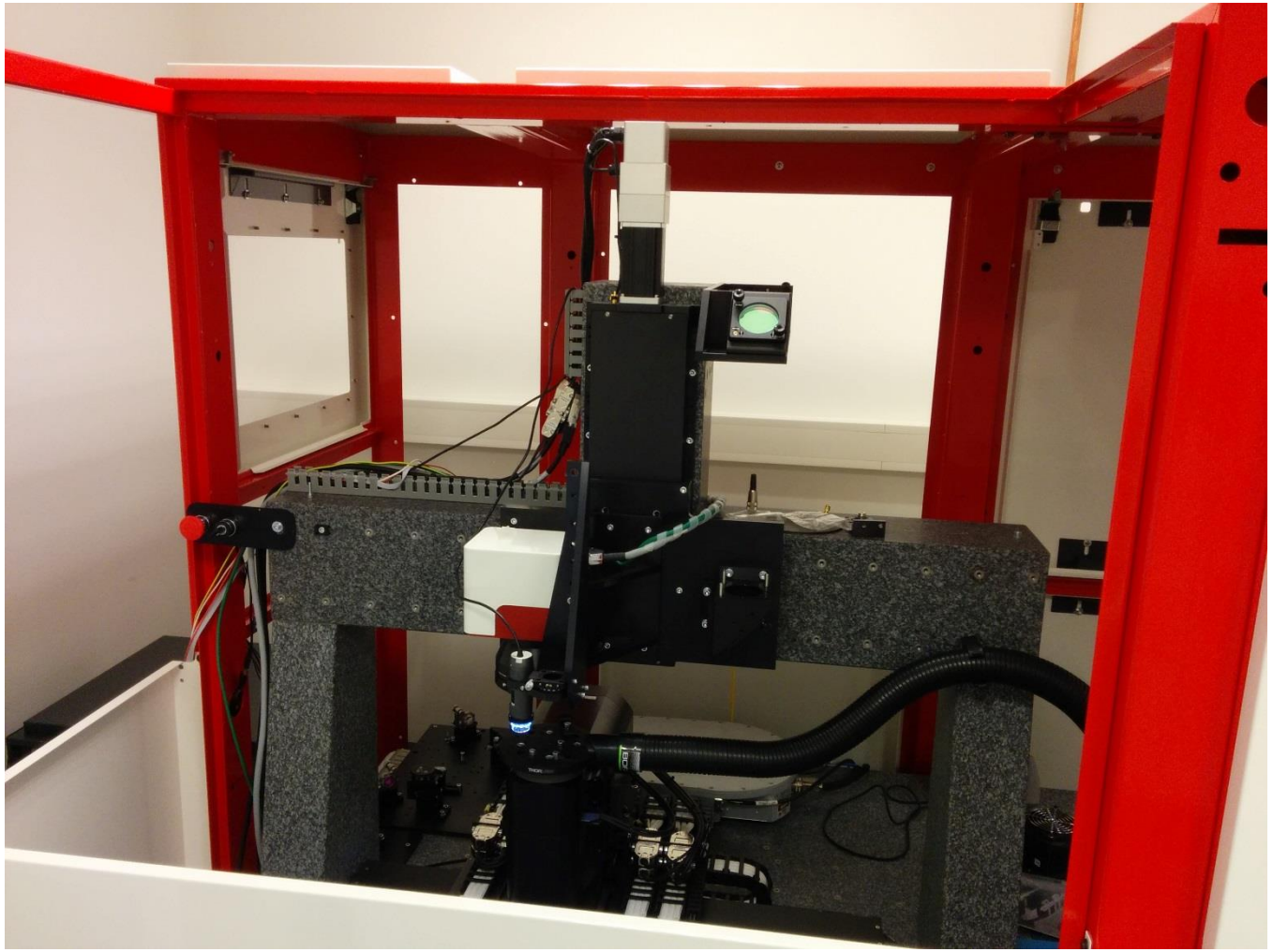


This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 687880

HIgh throughPut lasER-based processing of DIamond And Silicon (HIPERDIAS)

Marwan Abdou Ahmed

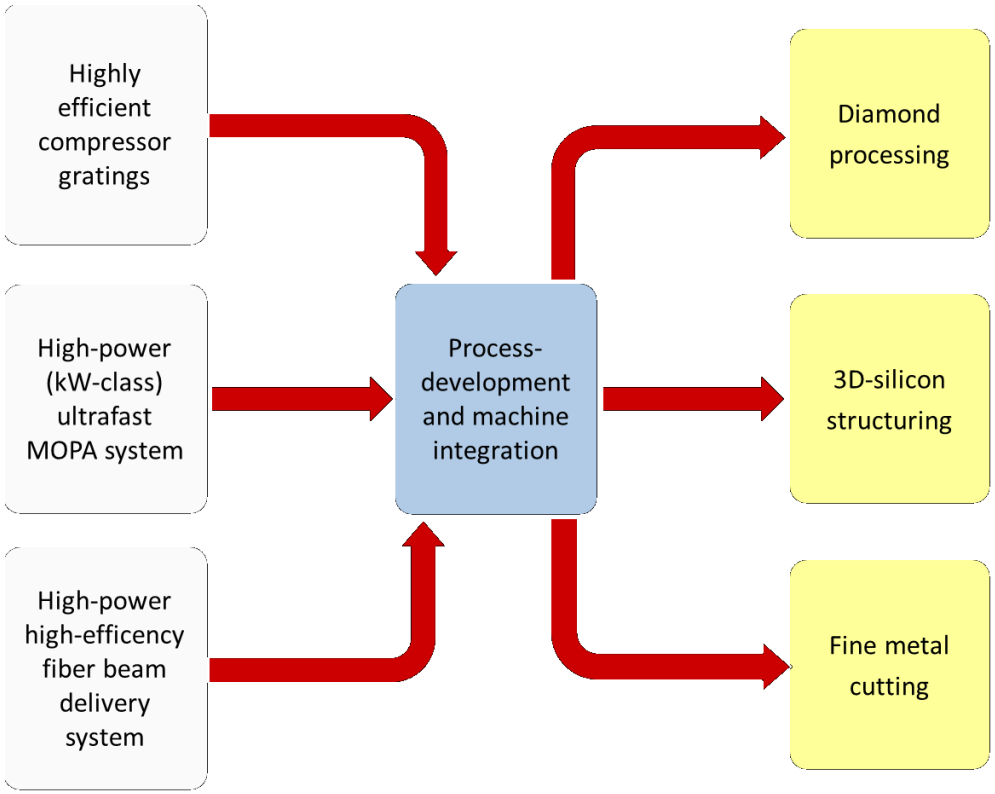
Overall presentation of the project

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

- Call H2020-ICT-27-2015:
  - High-throughput laser-based manufacturing: High-power, high-efficiency laser sources (both continuous wave and pulsed); novel technologies and devices for beam delivery and for processing of multiple beams from laser source arrays; high-performance optical devices and systems; fast synchronisation of laser source and high-speed scanning devices.
  - All RTD actions should address also the related materials, manufacturability, validation of results for the target applications, and standardisation activities, as appropriate. They should demonstrate strong industrial commitment, be driven by user needs and concrete business cases supported by strong exploitation strategies, and cover the value/supply chainas appropriate.

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

- Brief project overview
  - Project duration: 42 Months
  - Project budget: ~4.4 Mio€ (~3.6 Mio€ from EC + ~0.8 Mio€ fro SNF)



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- Objectives: Applications
  - **HIPERDIAS** will demonstrate USP **laser-based material processing at unprecedented (high-throughput) levels of productivity and precision**
  - **Three attractive applications shall be investigated to demonstrate the high-throughput laser-based manufacturing:**
    - 3D silicon structuring at high-speed: >1mm³/s (~ X10 vs SoA)
    - Precision processing of diamond material : >0.15mm³/s (~ X5-6 vs SoA)
    - Fine cutting of metal for the watch and the medical industry: 500mm/min (~ X2-4 vs SoA)

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

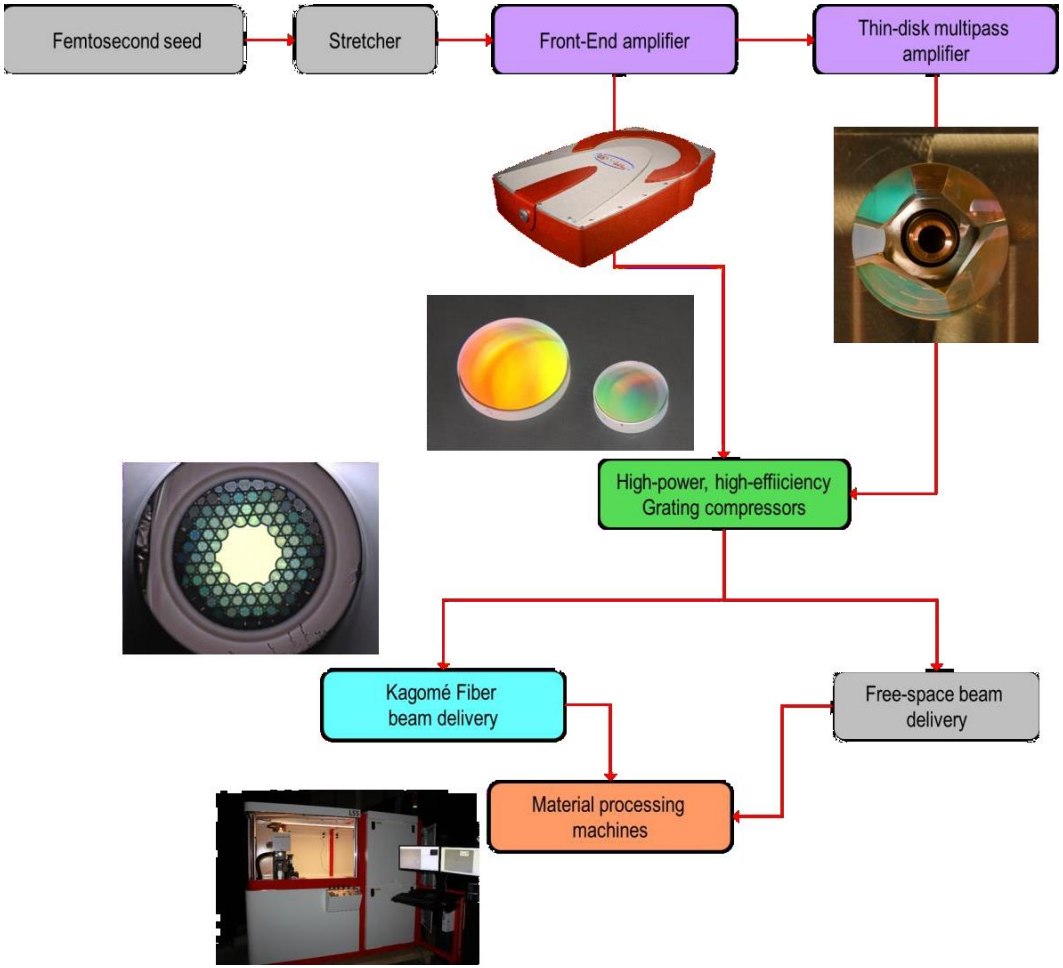
- Objectives: laser sources and components
  - Flexible high-power CPA-based femtosecond laser sources
    - 50W, 300fs, at 1-2 MHz (system 1: hybrid fiber-bulk amplifer)
    - 200W, 600fs, at 1-2 MHz (system 2: hybrid fiber-bulk amplifier)
    - 500W, 500 fs, 1-2 MHz (system 3: system 1 boosted using a thin-disk multipass amplifier)
    - 1000W, sub-1ps, 1-2 MHz (system 4: system 2 boosted using a thin-disk multipass amplifer)
  - High-power suitable fiber beam delivery (Kagomé fibers)
    - Delivery of >500W (up to 1kW) , sub-1ps pulses
  - High-power capable pulse compression gratings
    - >99% diffraction efficiency (per pass) over >5-10 nm spectral bandwidth

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

- Objectives: material processing and machine integration
  - Fundamental process development
  - Upscaling for high-throughput
  - Demonstration of productivity increase
  - Integration of system and high-power suitable machines for:
    - 3D silicon ablation
    - Diamond processing and fine-cutting of metal

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

- Overall of the HIPERDIAS project



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

- Work packages
  - WP1: Definition of User Requirements
  - WP2: Process Development
  - WP3: Ultrafast Laser Front-end development
  - WP4: Photonic components for pre- and post-pulse conditioning
  - WP5: Thin-disk multi-pass Booster
  - WP6: System Development
  - WP7: Demonstrators
  - WP8: Exploitation Planning & Dissemination
  - WP9: Project Management

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- Deliverables & Milestones
  - 46 Deliverables
  - 45 Milestones

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HIgh throughPut lasER-based processing of Diamond And Silicon (HIPERDIAS)

Marwan Abdou Ahmed
USTUTT

IFSW
UNIVERSITÄT STUTTGART
INSTITUT FÜR STRAHLWERKZEUGE
STUTTGART LASER TECHNOLOGIES

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

- USTUTT is mainly involved in
  - WP2: process development (3D silicon processing in collaboration with Bosch)
  - WP4: Photonic components for pre- and post-pulse conditioning (development of grating compressors in collaboration with AMO)
  - WP5: thin-disk multipass Booster (in collaboration with AMP)
  - WP7: Demonstrators (in collaboration with Bosch and Lasea)
  - WP9: Project coordination (in collaboration with Kite for the project management)

- USTUTT will be leading WP2, 5 and 9

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- WP2: Process development
  - TASK 2.2: Fundamental process development fine cutting of metals (M04-M24)
    - In collaboration with C4L
  - TASK 2.4: Upscaling of applications for high throughput (M22-M30)
    - In collaboration with Bosch and Lasea or the 3D Si processing
    - In collaboration with E6 and C4L for the diamond processing and the fine cutting of metal

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

- WP4: Photonic components for pre- and post-pulse conditioning (grating compressors)
  - TASK 4.1: design of (fully dielectric) grating compressors (M01-M18)
    - Design and Spectroscopic characterization for sub-sequent optimization of gratings
  - TASK 4.2: Development of an optimization of a lithography process for the fabrication of pulse compression gratings (M03-M3**0)**
  - TASK 4.3: Development and optimization of an etching process for the fabrication of optical components (M05-M30)
  - Deliverables:
    - **D4.1**: Report on simulation of pulse compression gratings with diffraction efficiency>=99% over large spectral bandwidth (5-10 nm) around 1030 nm (M04)

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

- WP5: Thin-disk multipass Booster
  - TASK 5.1: design of the thin-disk multipass amplifier(M01-M06)
  - TASK 5.2: Assembly & characterization of a Yb:YAG thin-disk multipass amplifier(M06-M22)
  - TASK 5.3: Second and third harmonics generations(M20-M28)
  - TASK 5.4: Integration of the Yb:YAG thin-disk multipass amplifier(M22-M28)
  - TASK 5.5: Demonstration of a 1kW, sub-1ps laser system (M30-M38)

  - Deliverables:
    - D5.1: Design of the multipass amplifier (M06)
    - D5.2: Thin-disk multipass amplifier with 500W, 1MHz, sub-500fs (M22)
    - D5.3: Demonstration of 200W green and 100W UV laser beams at 1MHz and sub-500 fs pulse (M28)
    - D5.4: Thin-disk multipass amplifier with 1000W, >=1MHz, sub-1ps (M38)

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

- WP7: Demonstrators
  - TASK 7.1: 500W Laser source integration (M18-M24)
  - TASK 7.3: Integration of the optical fibre (M24-M28)
  - TASK 7.4.1: Processes analysis on reference samples (M24-M36)
  - Upgrade of the 500W system in the machine to the 1000W (maximal power available) system on one of the pre-defined application (M30-M42)

  - Deliverables;
    - **D7.8** Report on the performance of the 1000 W demonstrator (M42)

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

- Objective for the next 6 months:
  - Design of grating compressors
  - Design of thin-disk multipass amplifier
  - Purchase of high-power diode and components (pumping module for thin-disk and Yb:YAG crystals)

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XLIM-GPPMM

Fetah BENABID

GPPMM
Gas-Phase Photonic & Microwave Materials
Xlim institut de recherche

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

GPPMM: GAS-PHASE PHOTONIC & MICROWAVE MATERIALS

GPPMM expertise

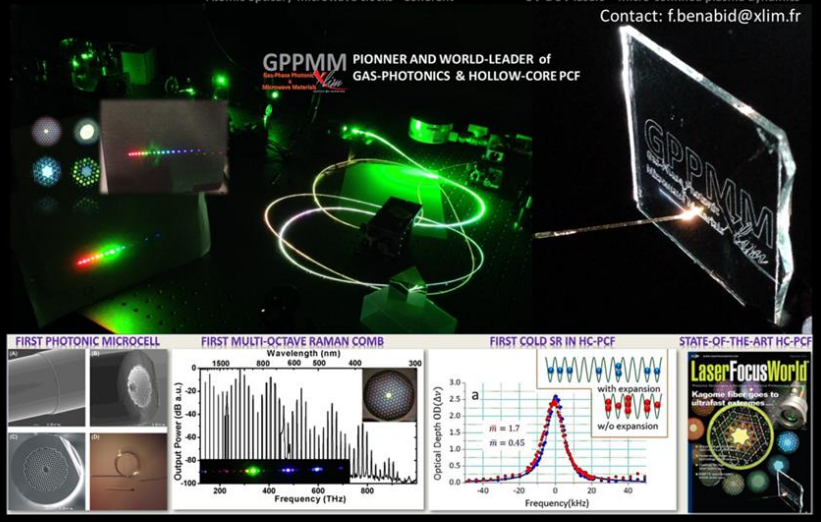
Fiber photonics
-Design and fabrication of PCF -Fiber components

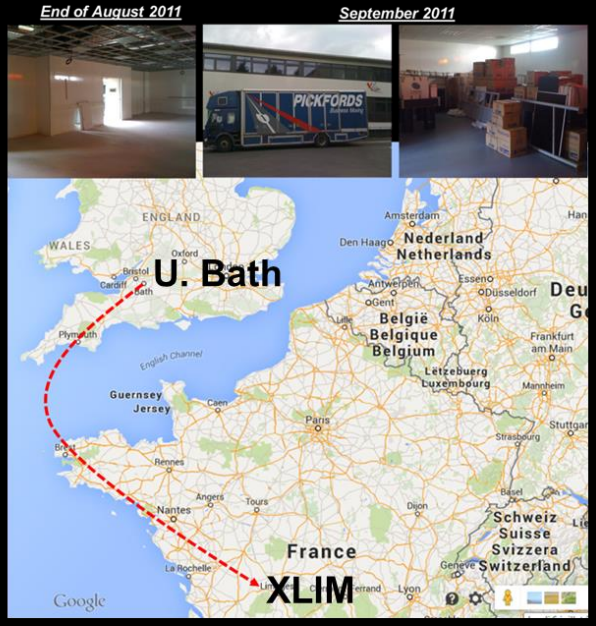
Gas nonlinear opitcs
Frequency conversion -Ultra-broad comb generation
-Pulse compression & High field photonics

Atom optics & laser metrology
Atomic optical / microwave clocks -Coherent

Plasma photonics
-UV-DUV lasers -Micro-confined plasma dynamics

Contact: f.benabid@xlim.fr





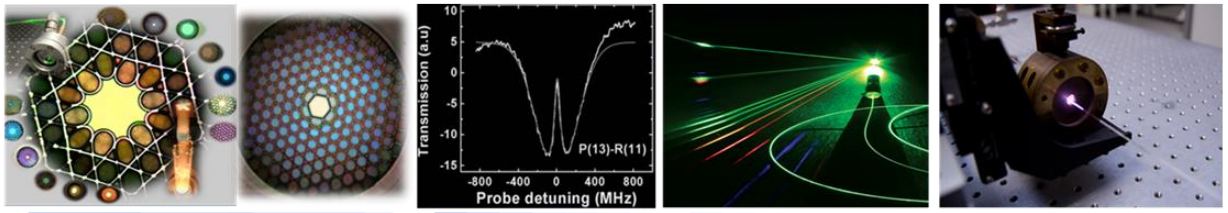
Permanents
F. Benabid, F. Gerome, J.M. Blondy, C. Restoin, D. Cros
Post-docs
B. Debord, E. Elinova, A. Benoit, A. Baz
PhD students
X. Zheng, M. Chafer, M. Adnan, A. Amsanpaly, D. Kergoustin, M. Maurel
Past members
Y.Y. Wang, C. Fourcade-Dutin, B. Beaudou, T. Bradley, F. Vial, K. Gardone, D. Arestier, M. Dontabactouny. M. Alharbi

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

GPPMM RESEARCH PROJECT

I. AN OUTREACHING OPBJECTIVE:

Anticipating the advent of the "classical" photonic computer by developing photonic components for optical frequency generation, control and processing.



AXE 1
PHYSICS AND TECHNOLOGY OF HC-PCF

AXE 2
ATOM AND QUANTUM OPTICS

AXE 3
COHERENT & NONLINEAR OPTICS

AXE 3
PLASMA PHOTONICS

Gas-phase based Photonic Materials
For
Wave-guidance; optical sources, spectral filtering; optical resonators; couplers…

Quantum/atom Optics
For
Optical information processing; photonic clocks and storage

Coherent Nonlinear Optics
For
Multi-octave coherent comb; Optical waveform synthesis; oscillators…

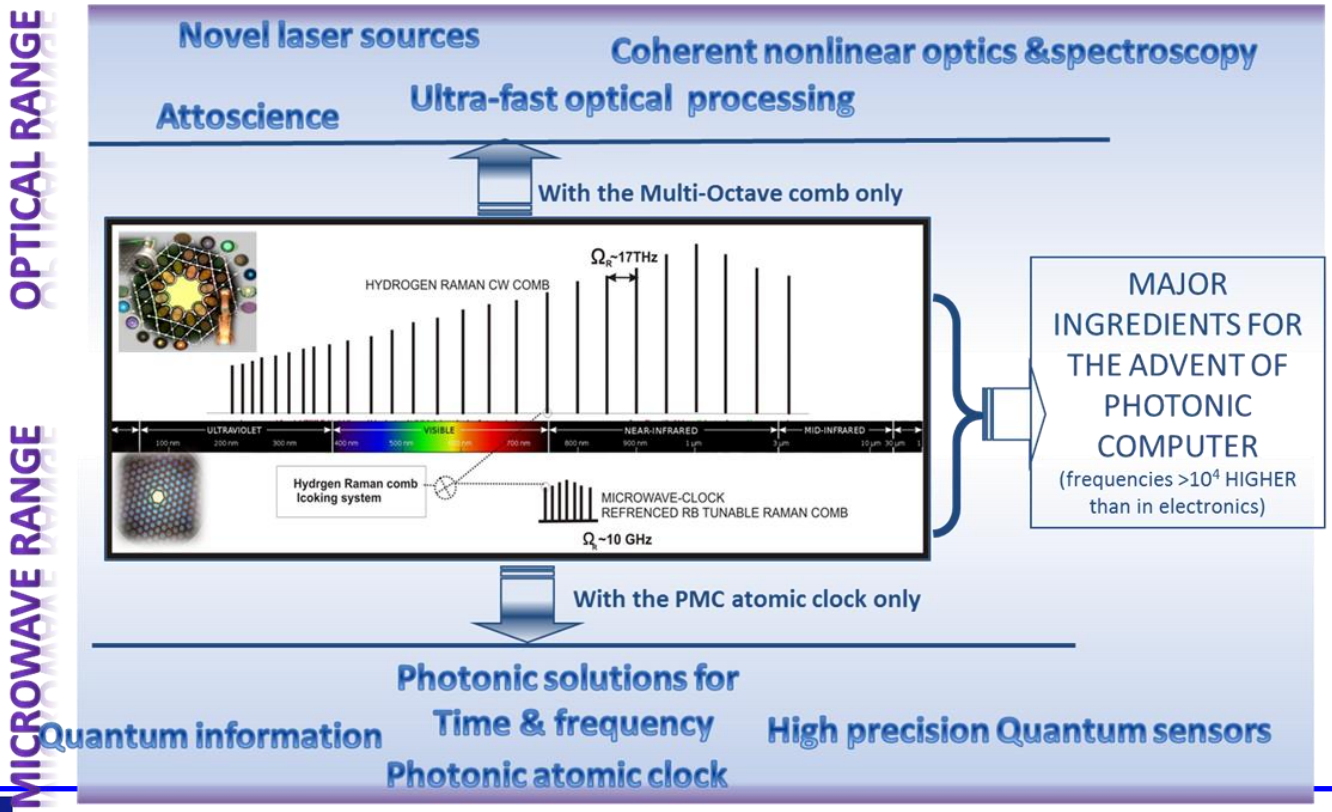
1. PROCESSOR (oscillators, synthesiser, Gates)
2. CLOCKS
3. MEMORIES/BUFFERS

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

GPPMM RESEARCH PROJECT

II. An original approach:

Building an atomic clock referenced photonic synthesiser based on gas-phase materials micro-confined in HC-PCF



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GPPMM RESEARCH PROJECT

III. Synergetic cross-disciplinary methodology:

One platform technology for 4 scientific axes:

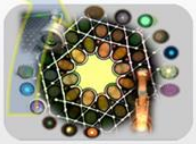
1. FIBRE PHOTONICS	2. GAS NONLIEAR OPTICS
3. ATOM OPTICS & METROLOGY	4. PLASMA PHOTONICS

AXE 1 *Hollow-core PCF Science and Technology*

In the first theme, we explore the physics of photonic guidance in hollow-core photonic crystal fibre (HC-PCF). We design tailored HC-PCF structures and fabricate state-of-the-art fibres and photonic microcells; and develop innovative fabrication processes and post-processes

World leadership in:

- ✓ Design and fabrication of HC-PCF
- ✓ Physics of guidance mechanisms
- ✓ Photonic MicroCell assembly
- ✓ HC-PCF optical resonators and component



AXE 2 *Nonlinear and Coherent Optics*

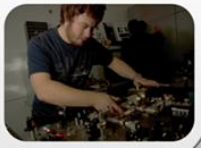
The second theme focuses on the investigation of light-gas interaction in highly confining photonic structures such as HC-PCF; the generation of ultra-broad optical frequency comb and synthesize optical waveform to the attosecond time-scale; engineering optical wave mixing and parametric interactions for the generation of exotic wavelengths including correlated photon-pairs; and recently HC-PCF for high-field regime.

- ✓ Raman comb generation (CW and pulsed)
- ✓ Frequency conversion for mid-IR and biophotonic applications
- ✓ Correlated and entangled photon states generation
- ✓ Ultrafast laser applications

AXE 3 *Molecular and Atom Optics*

The third theme is related to Laser frequency metrology, atom optics and quantum sensors with innovative photonic structures based on photonic microcells; the development of photonics based microwave and optical atomic clocks, magnetometers, telecom frequency standards; and the in-fibre laser cooling and portable solutions for high resolution spectroscopy.

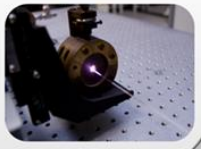
- ✓ Molecular frequency standards and optical processing
- ✓ Ceramic coated core HC-PCFs for atomic vapour PMC
- ✓ Photonic microwave atomic clock
- ✓ In-fibre laser cooling



AXE 4 *Plasma Photonics*

The fourth theme concerns the development of compact and original solutions to generate and confine ionised gases (plasma) in HC-PCF; the development of highly miniaturised UV-DUV laser sources; and the exploration of nonlinear optical phenomena in preformed microwave plasma.

- ✓ Generation and confinement of microplasma in HC-PCFs
- ✓ Miniaturized microwave plasma generator
- ✓ Diagnostic and dynamics of microconfined plasma in HC-PCFs
- ✓ UV laser applications



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GPPMM RESEARCH PROJECT

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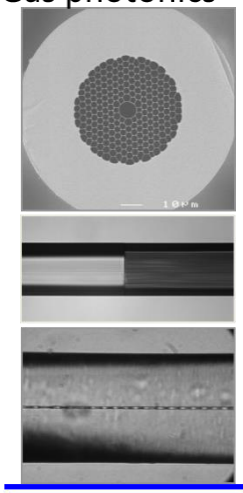
Facilities

2 drawing towers

Fibre postprocessing & Gas photonics



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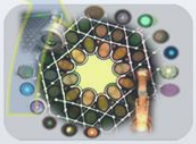

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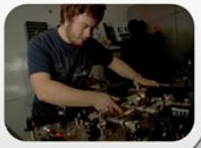

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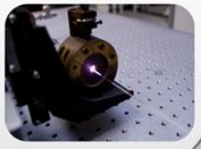

HIPERDIAS

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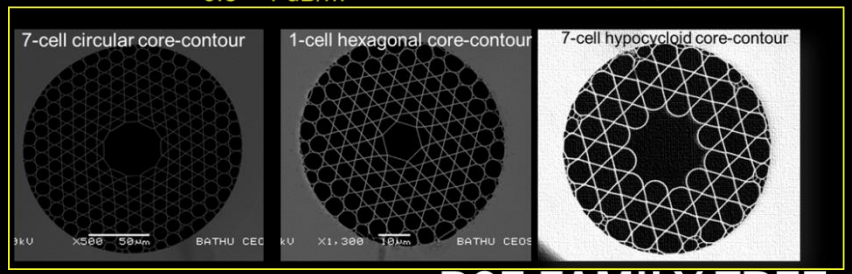
Hollow core photonic crystal fibers

Two guidance mechanisms: Photonic bandgap (PBG) guidance and Inhibited Coupling (IC) guidance

IC guiding Kagome HC-PCF

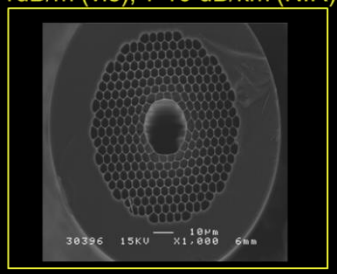
0.5 – 1 dB/m

10-30 dB/km

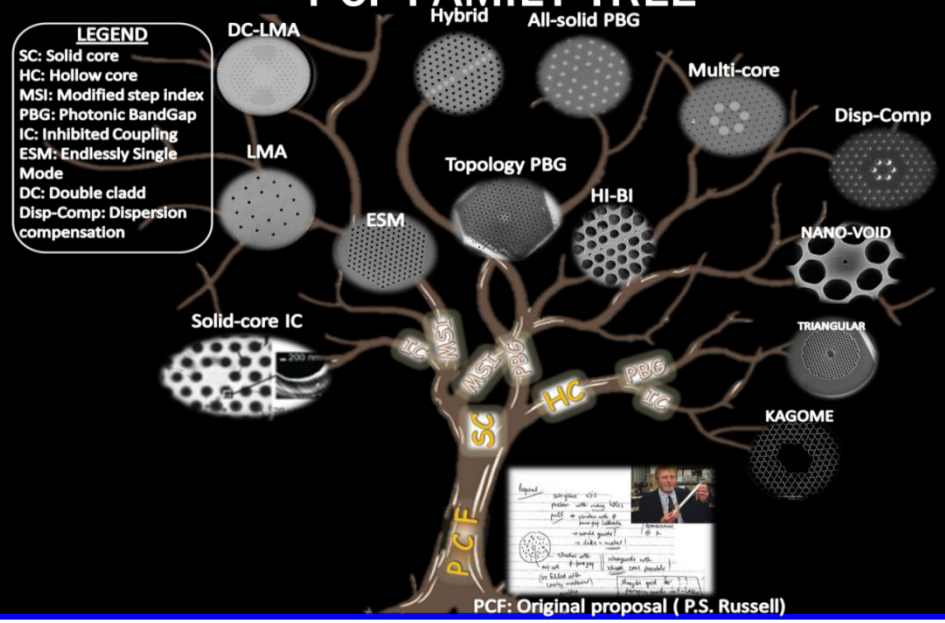


19-cell PBG guiding HC-PCF

1dB/m (vis), 1-10 dB/km (NIR)



PCF FAMILY TREE



PCF: Original proposal (P.S. Russell)

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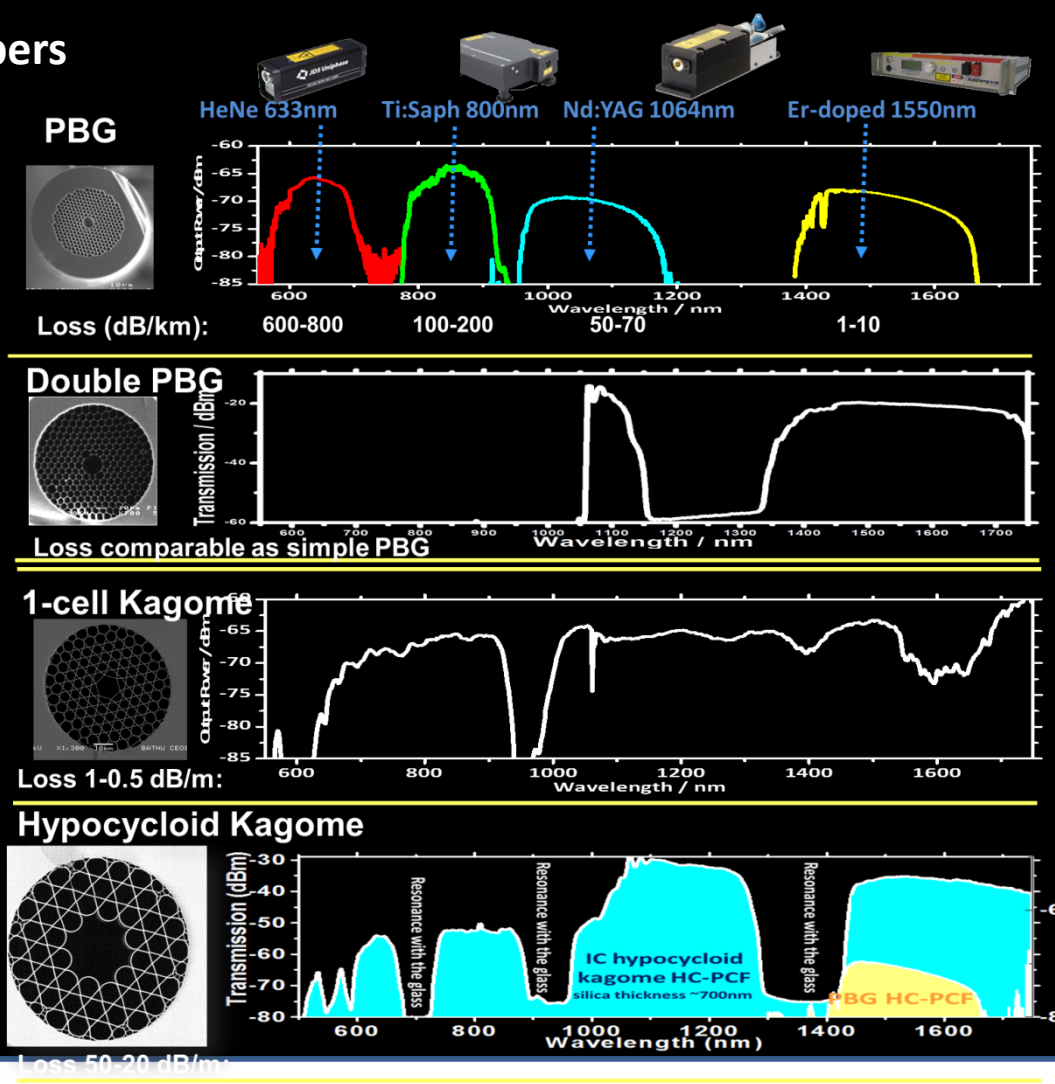
Hollow core photonic crystal fibers

PBG guiding HC-PCF

vs

IC guiding HC-PCF



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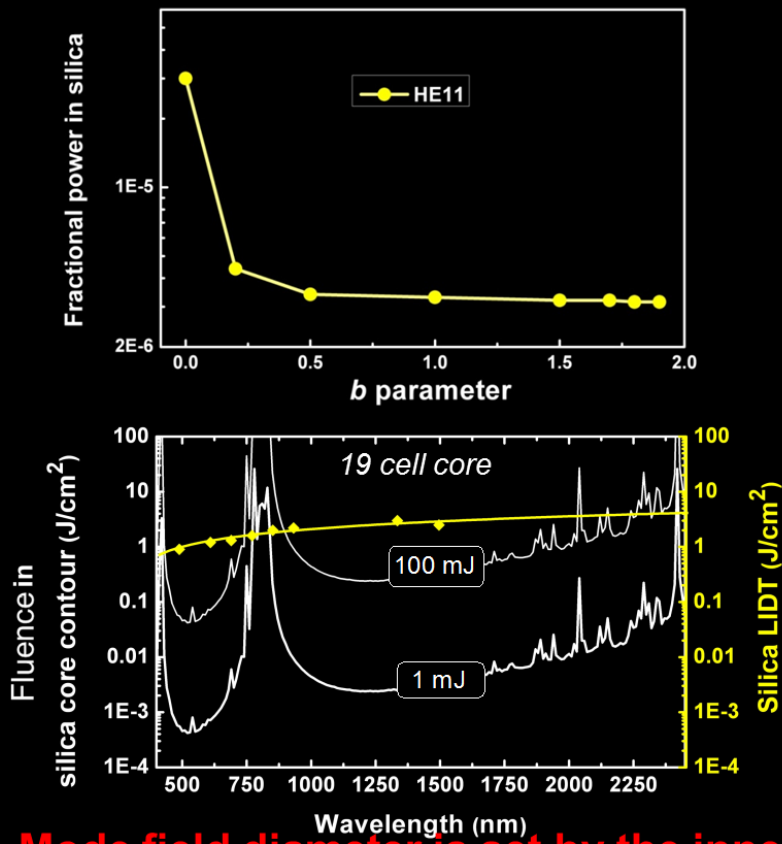
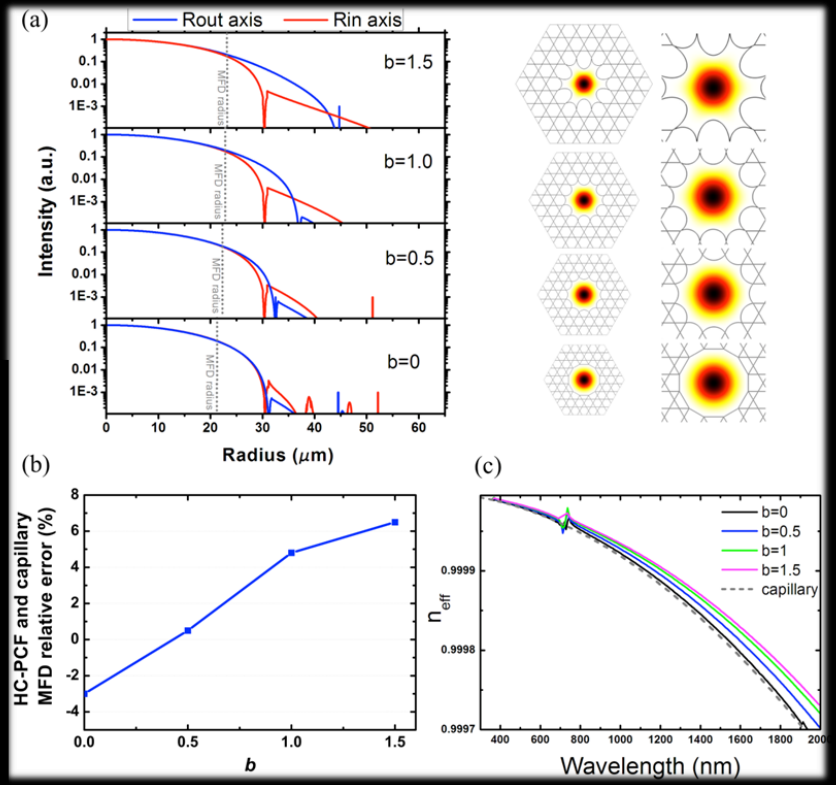
Why IC guiding Kagome HC-PCF for high energy USP laser beam delivery





- **Mode field diameter is set by the inner radius of the hypocycloid core-contour**
- **Decrease of power overlap with silica surround to a ppm level**

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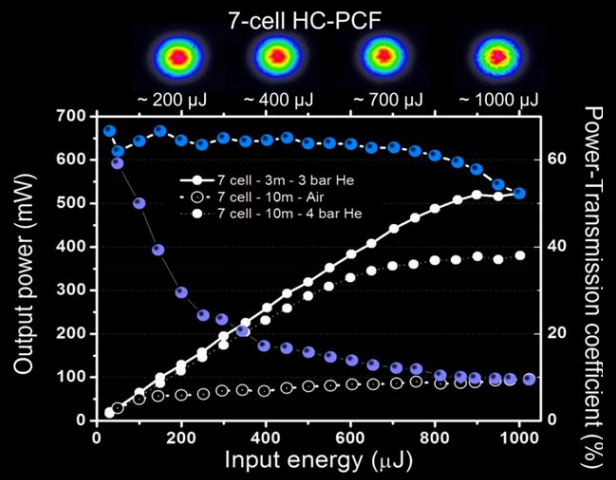
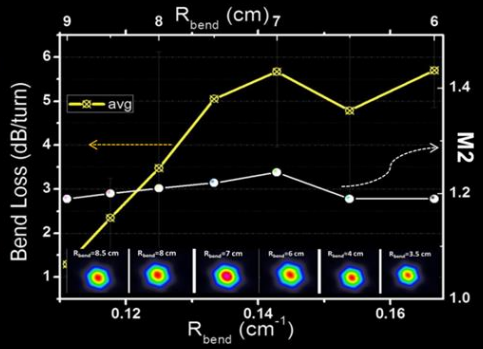
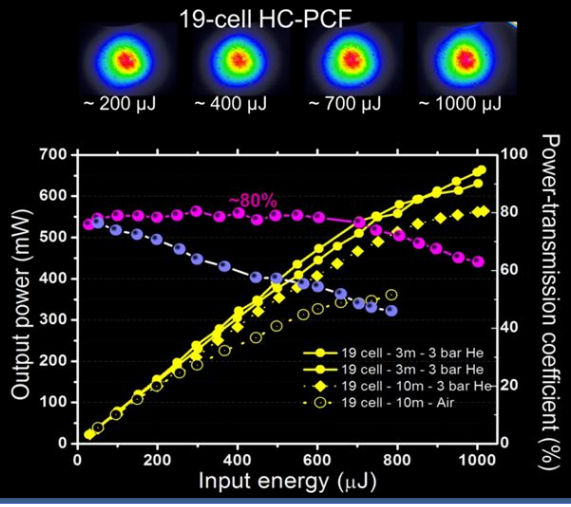
Why IC guiding Kagome HC-PCF for high energy USP laser beam delivery



Bend loss

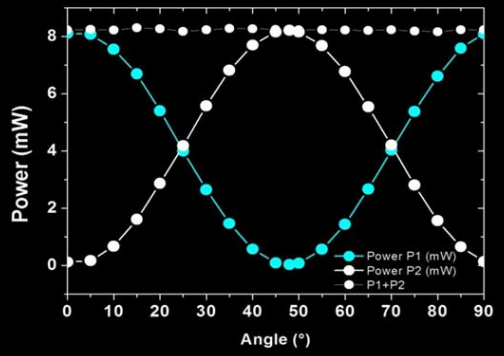
3-dB/turn radius ~8 cm
Single mode operation intact upon bend
Measured M2 ~1.2





PER

A staggering figure of 25dB PER was measured



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Why IC guiding Kagome HC-PCF for high energy USP laser beam delivery

Tuning to your desired optical nonlinearities

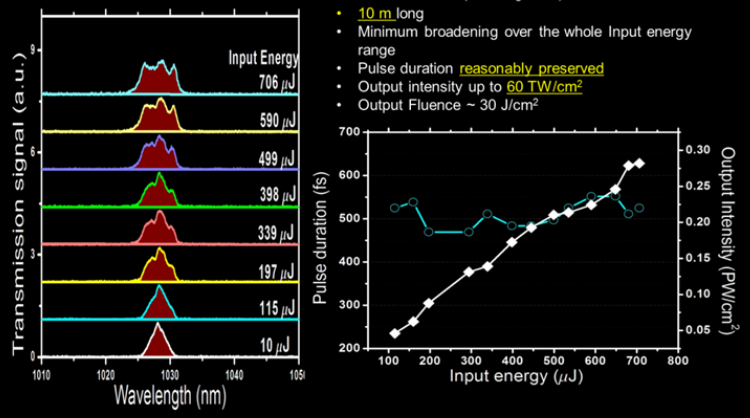
1. Control parameters: fiber dispersion, effective area, gas choice
2. Nonlinear regimes: (i) Ultra-low nonlinearity for « HiFi » USP transportation. (ii) Solitonic self-compression, (iii) SPM broadening

	He-filled 19 cell fiber	Air-filled 19 cell fiber	He-filled 7 cell fiber	Air-filled 7 cell fiber
Dispersion length, $L_D\ (m)$	555	577	28	28
Nonlinear length, $L_{NL}\ (m)$	1.9	0.09	0.9	0.04
Self-focusing critical power, $P_{cr}(\mathrm{GW})$	2026	9.5	2026	9.5
Ionization threshold intensity, $I_{it}(\mathrm{TW}.cm^{-2})$	200	40	200	40

Nonlinear transmission #1

19-cell hypocycloid kagome HC-PCF
(He flowing in core)

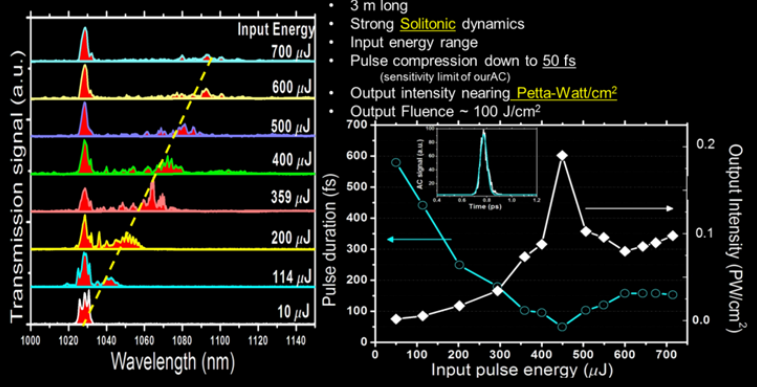
- 10 m long
- Minimum broadening over the whole Input energy range
- Pulse duration reasonably preserved
- Output intensity up to 60 TW/cm²
- Output Fluence ~ 30 J/cm²



Nonlinear transmission #2

19-cell hypocycloid kagome HC-PCF
(Air in core)

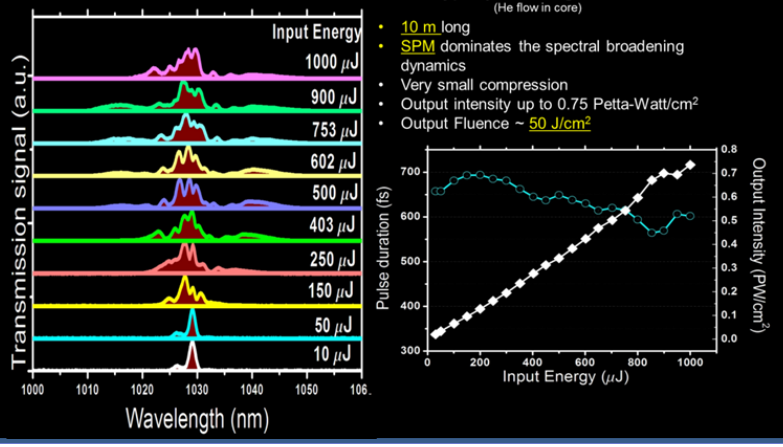
- 3 m long
- Strong Solitonic dynamics
- Input energy range
- Pulse compression down to 50 fs (sensitivity limit of ourAC)
- Output intensity nearing Petta-Watt/cm²
- Output Fluence ~ 100 J/cm²



Nonlinear transmission #3

7-cell hypocycloid kagome HC-PCF
(He flow in core)

- 10 m long
- SPM dominates the spectral broadening dynamics
- Very small compression
- Output intensity up to 0.75 Petta-Watt/cm²
- Output Fluence ~ 50 J/cm²



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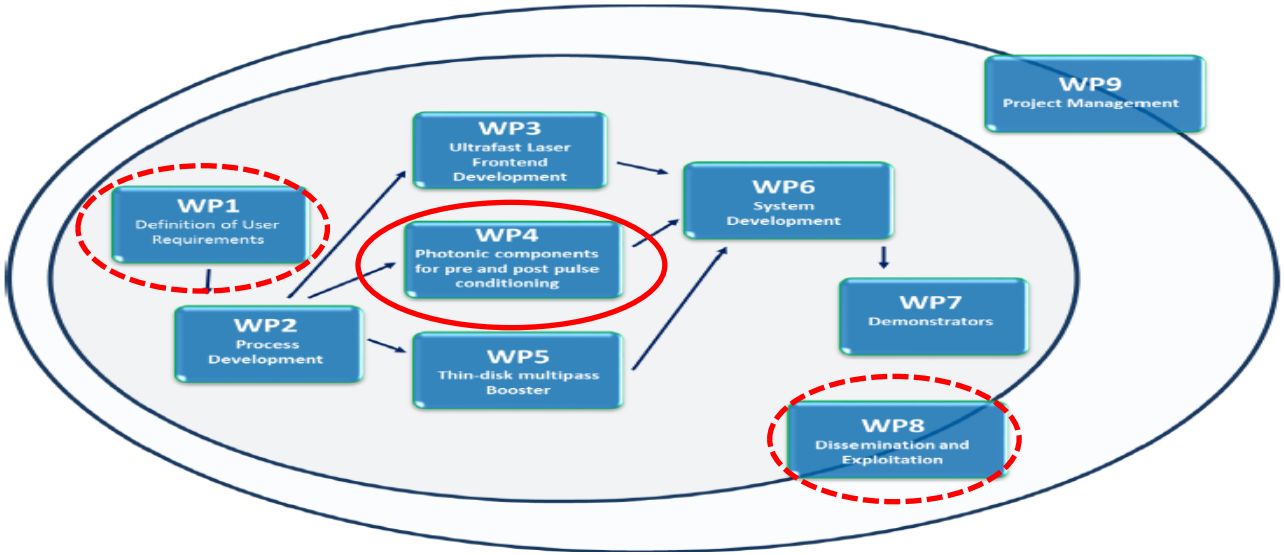
XLIM/GPPMM POSITION IN HIPERDIAS VALUE CHAIN



Demand Chain – Silicon processing			Demand Chain – Diamond processing	
Robert Bosch	3D processing of Silicon		**E6**	Polishing of synthetic diamond
LASEA	Integrated machine & process development		**C4L**	Integrated machine & process development

GLO/XLIM	Fibre delivery customised to application
AMO, USTUTT	Pulse Compressors – large area
AMP	Development of 50W laser (TRL4 to TRL7) and 200W laser (TRL3 to TRL7)
USTUTT	Development of high power 1000 W thin-disk booster amplifier (TRL 4 to TRL7)

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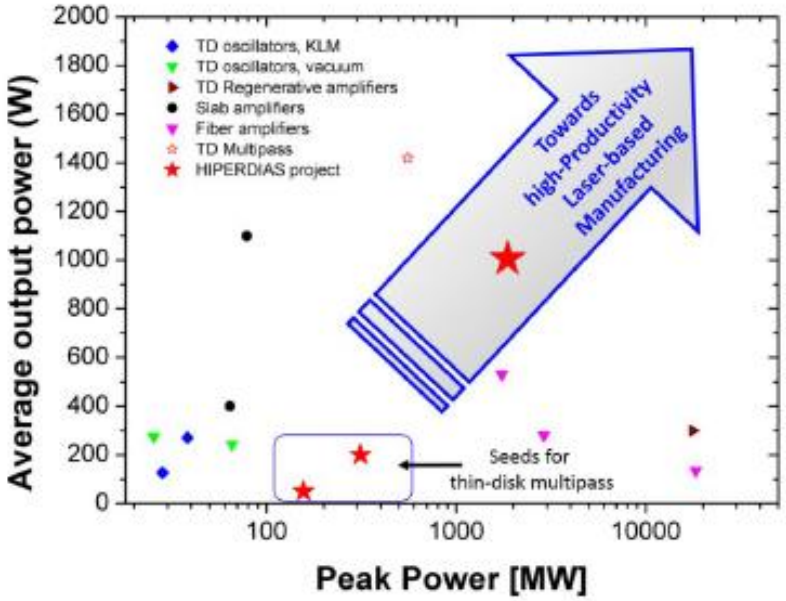

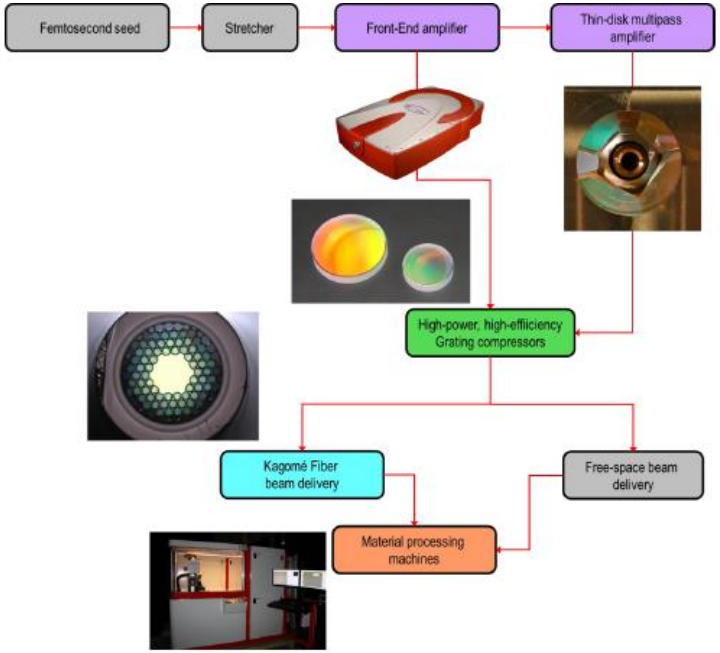

	Parameter	Current State-of-the-Art	HIPERDIAS Target
Laser system	Average power/peak power	1.4 kW (lab)/ 588 MW	1 kW / >1 GW
	Energy	4.7 mJ	1 mJ @ 1 MHz
	Pulse duration	8 ps	<1 ps
Beam delivery	Average power / Peak power	150W/2GW (reported). Note: peak power is not limiting factor in kagome fiber. Challenge is to handle larger avg power	>500W and up to 1kW />1 GW
	Propagation loss	20-50 dB/km (typical)	10-20 dB/km typical (down to 1 dB/km is aimed for
	PER	17 dB (typical)	>20dB

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XLIM/GPPMM POSITION IN HIPERDIAS VALUE CHAIN

Team: F. Benabid, F. Gerome and JM Blondy

WP	Roles/Major Contribution	Experience
WP 01	Contribute to specification and requirements definition from the perspective a guided photonics.	GPPMM is a pioneering research group and a world leader in the field of gas-photonics and hollow-core photonic crystal fibers (HC-PCF). The group has been at forefront with innovative HC-PCF and their implementation in a various applications including the ones relevant to the present project namely ultra-short pulse laser beam delivery and pulse compression.
WP 04	Workpage leader; Designing and fabricating Polarization maintaining HC-PCF for USP beam delivery	Design and fabrication of Hollow-core photonic crystal fibre. Pioneer and leader in Gas photonics.

TIMELINE FOR THE MATURATION OF HIPERDIAS TECHNOLOGY

NOLOGIES / MONTHS	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12	M13	M14	M15	M16	M17	M18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29	M30	M31	M32	M33	M34	M35	M36	M37	M38	M39	M40	M41	M42
50W laser (D3.1)	TRL4					TRL6		TRL7																																		
200W laser (D3.2)						TRL3			TRL4					TRL5						TRL6		TRL7																				
TD Amplifier (D5.5)	TRL4																	TRL5												TRL6												TRL7
Gratings (Large)												TRL5																														TRL7
HC-PCF (D4.6)												TRL3							TRL4					TRL5						TRL6							TRL7					
PMC module (D4.5)												TRL5																								TRL7						

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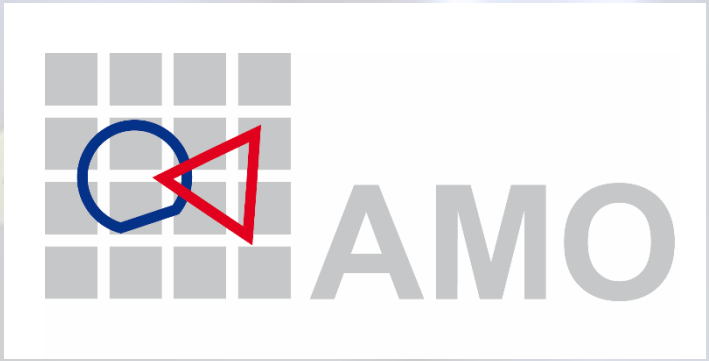
THANK YOU

AMO GmbH

AMICA

(Advanced Microelectronic Center Aachen)

Michael Moeller



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Gesellschaft für Angewandte Mikro- und Optoelektronik mbH

Managing Director:
Univ. Prof. Dr. phil. Heinrich Kurz

- 57 R&D Cooperation
- 45 Industry Cooperation

AMO

- "Research Foundry"
- Operating since 1997 AMICA
  (**A**dvanced **Mi**croelectronic **C**enter **A**achen)
- 40 staff members
- 9 EU-Projects
  8 national Projects
  (BMBF, BMWI & DFG)

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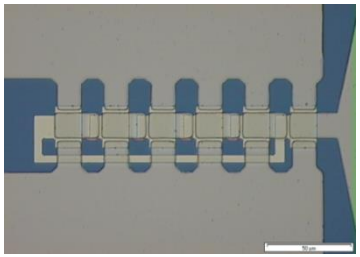
Hiperdias Consortium Kick-Off Meeting – 10th of February 2016

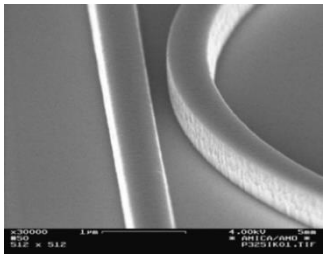
Nanoelectronics

- Graphene electronics and optoelectronics
- SOI FinFet integration for low power CMOS
- Epitaxial gate oxides and metal gate integration
- Nanowire technology



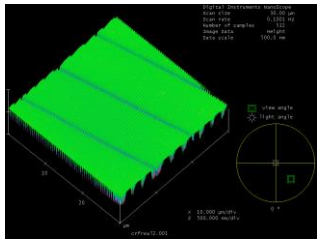
Nanophotonics

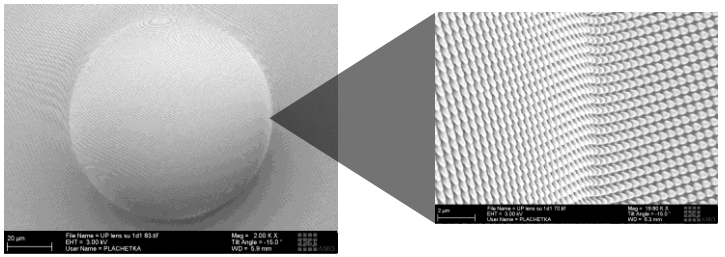
- Integrated silicon photonic systems
- Passive and active device prototype development
- High resolution / high quality fabrication for low-loss waveguides



Sensor Technology

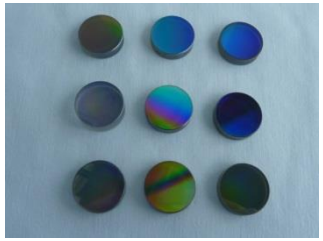
- Plasmonic surfaces for SEVS
- Structures for light management (subwavelength, diffractive, refractive pattern)
- Simulation for adapted designs
- Chips for biochemical agent screening

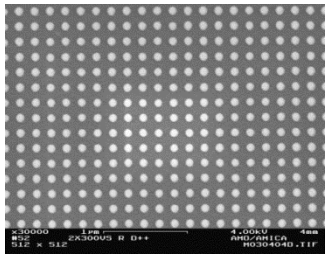


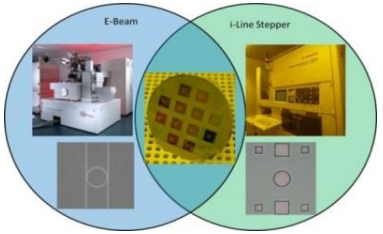


Nanofabrication

- Advanced lithography techniques (EBL, i-line, UV-NIL, IL)
- Advanced pattern transfer (Mix-Match-Lithography)
- Process & template development
- Si-CMOS technology platform







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- **WP4: Photonic components for pre- and post-pulse conditioning**
  (Partner: USTUTT, AMP, XLIM, GLO)

- **Task 4.2: Development of an optimization of a lithography process for the fabrication of pulse compression gratings**

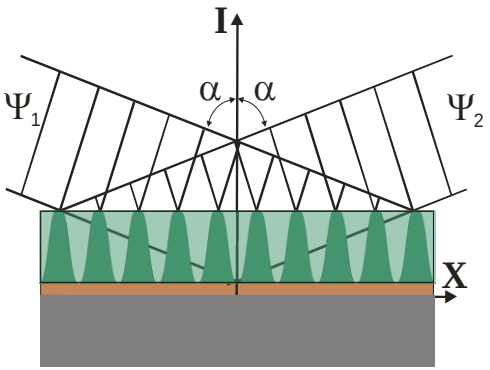
  - Photoresist coating process with maximal uniformity and reproducibility
  - Lithography process modification for large area gratings

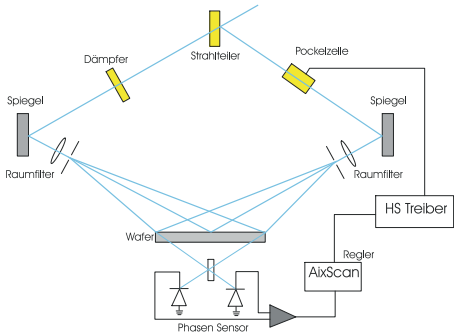
- **Task 4.3 Development and optimization of an etch process for the fabrication of optical components**

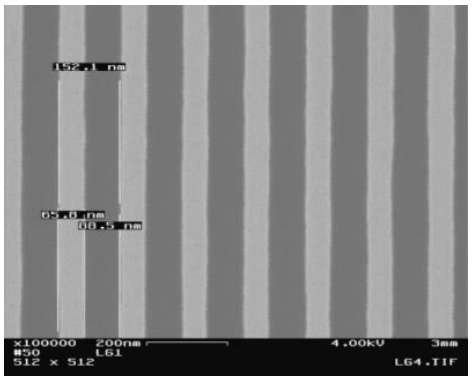
  - Investigation of photomask stability and minimizing thermal abrasion
  - Adressing etch depth and duty cycle uniformity via SEM and AFM
  - Efficient process control

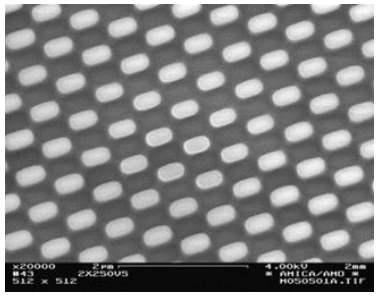
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 687880

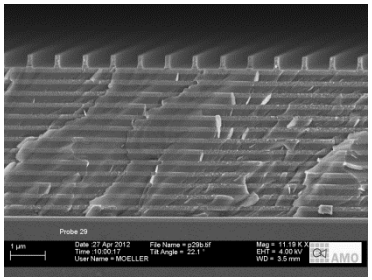
Interference lithography

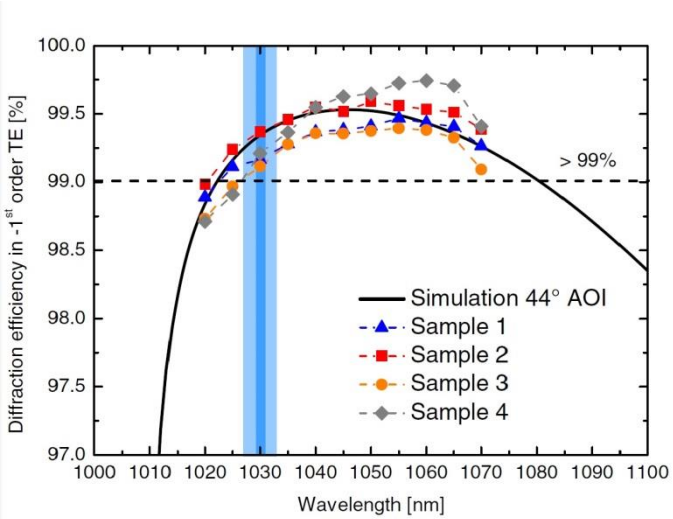












Broadband pulse compression gratings with measured 99.7% diffraction efficiency, Martin Rumpel, Michael Moeller, Christian Moormann, Thomas Graf, and Marwan Abdou Ahmed January 15, 2014 / Vol. 39, No. 2 / OPTICS LETTERS

Grating pitch:

$$p = \frac{\lambda}{2\sin(\alpha)}$$

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

Amplitude Systèmes

Clemens Hönninger

Amplitude SYSTEMES

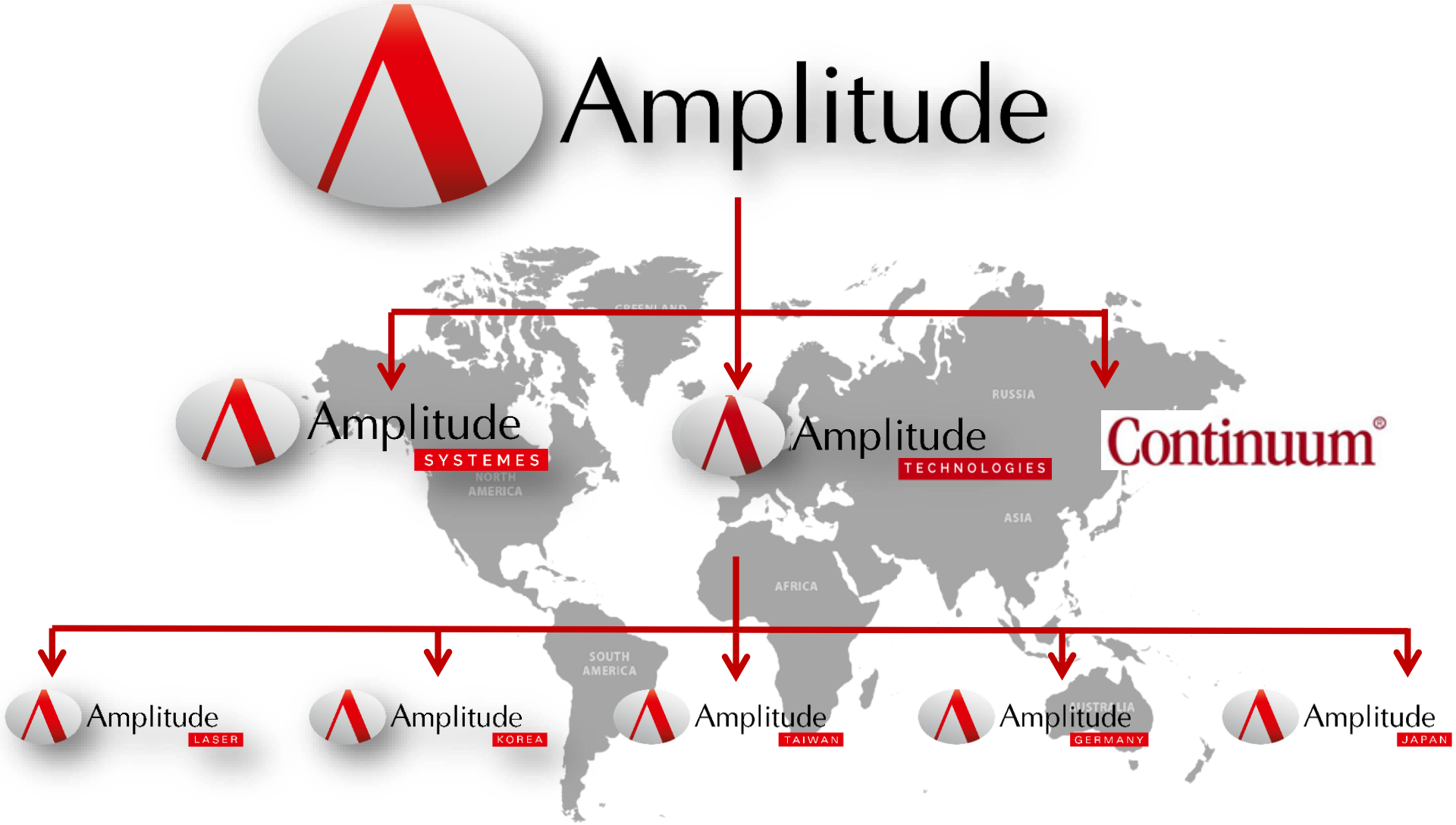
nothing but ultrafast

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

Who we are?

- Largest ultrafast laser company in the world
- More than 300 employees in ultrafast lasers
- Extensive R&D and engineering teams
- Products sold worldwide since 2001
- ISO 9001 and 13485 certified

ISO 9001
BUREAU VERITAS
Certification

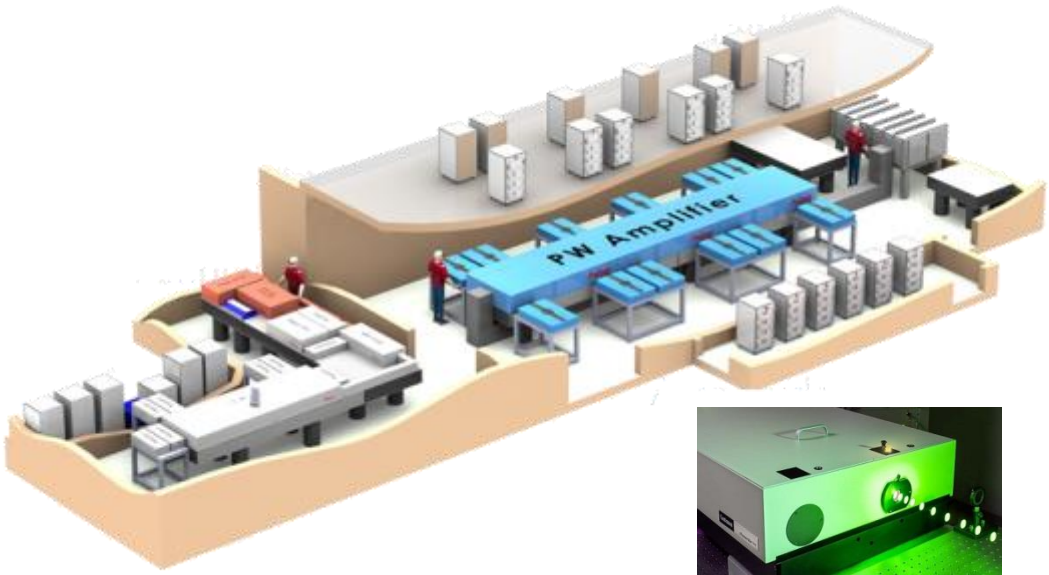

Amplitude
Amplitude
SYSTEMES
Amplitude
TECHNOLOGIES
Continuum
Amplitude
LASER
Amplitude
KOREA
Amplitude
TAIWAN
Amplitude
GERMANY
Amplitude
JAPAN
GREENLAND
NORTH AMERICA
RUSSIA
ASIA
AFRICA
SOUTH AMERICA

Who are we?

Amplitude TECHNOLOGIES

High energy lasers

Scientific and medical



Amplitude SYSTEMES

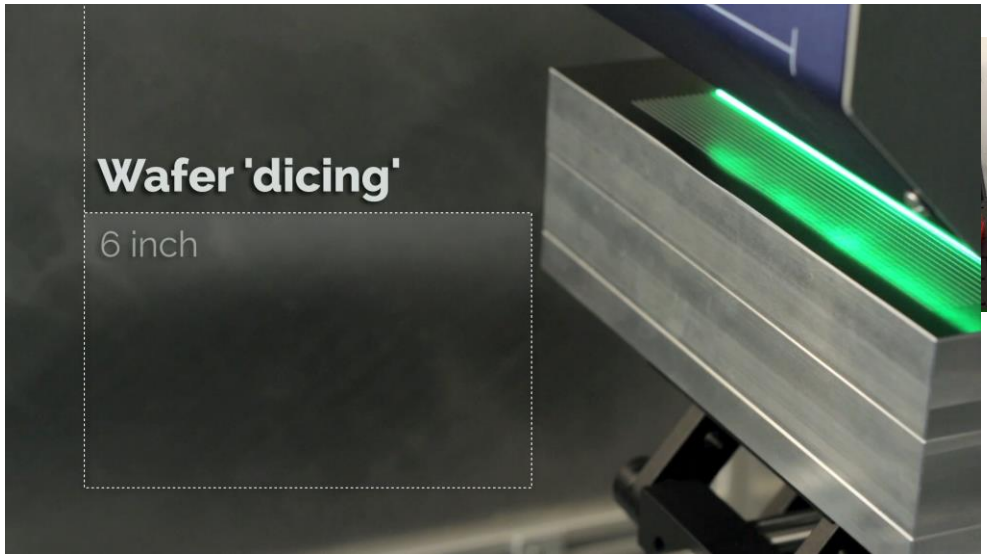
Small size, high speed

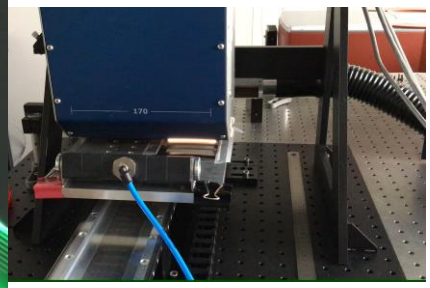
Industrial and medical

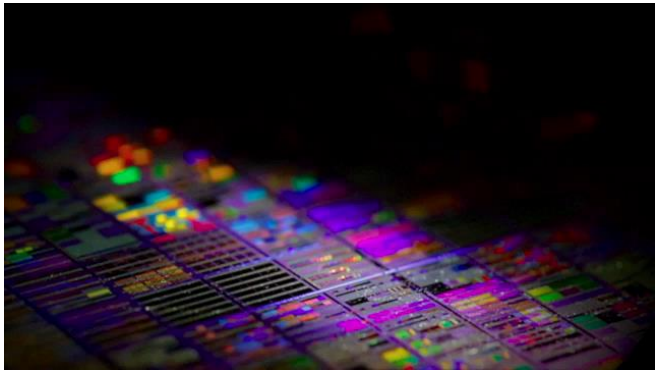
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 687880

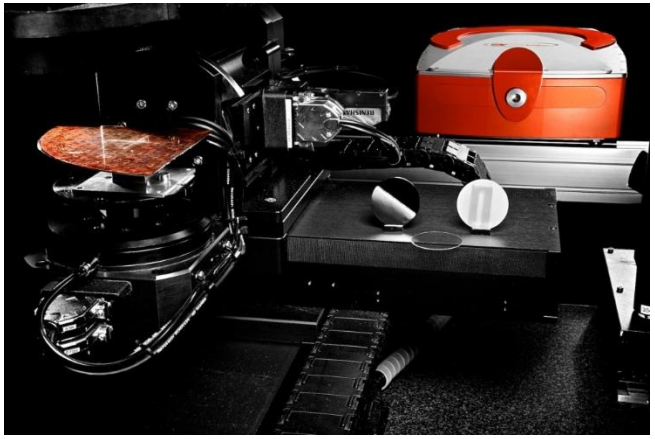
Semiconductor wafer scribing and dicing

Credits: NextScan



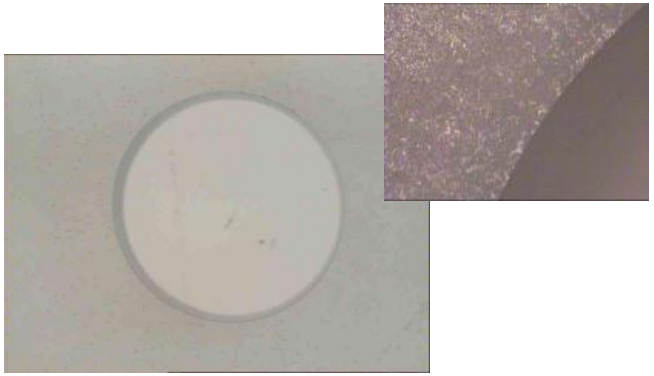






This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 687880

Transparent material cutting or marking



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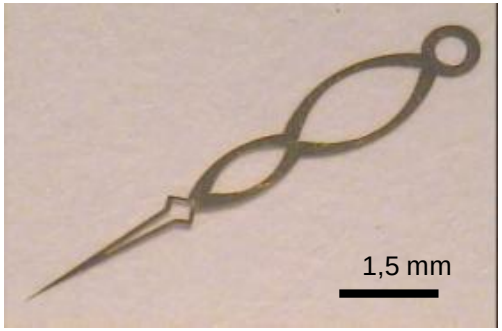
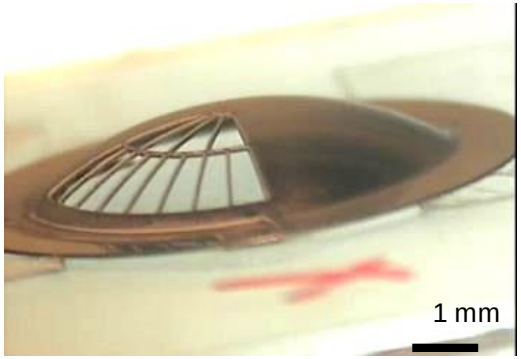
Metal engraving and cutting

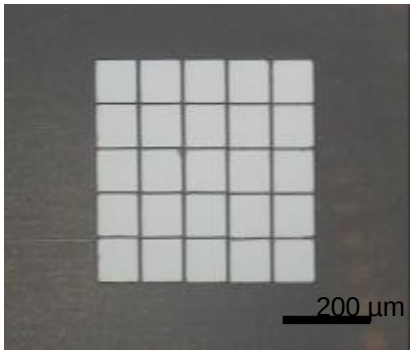
Pioneer in watch industry ultrafast process



Gold - thickness.25µm



Metal - thickness.50µm
Bars width 90µm



Platinum - thickness.10µm
Bars width 10µm

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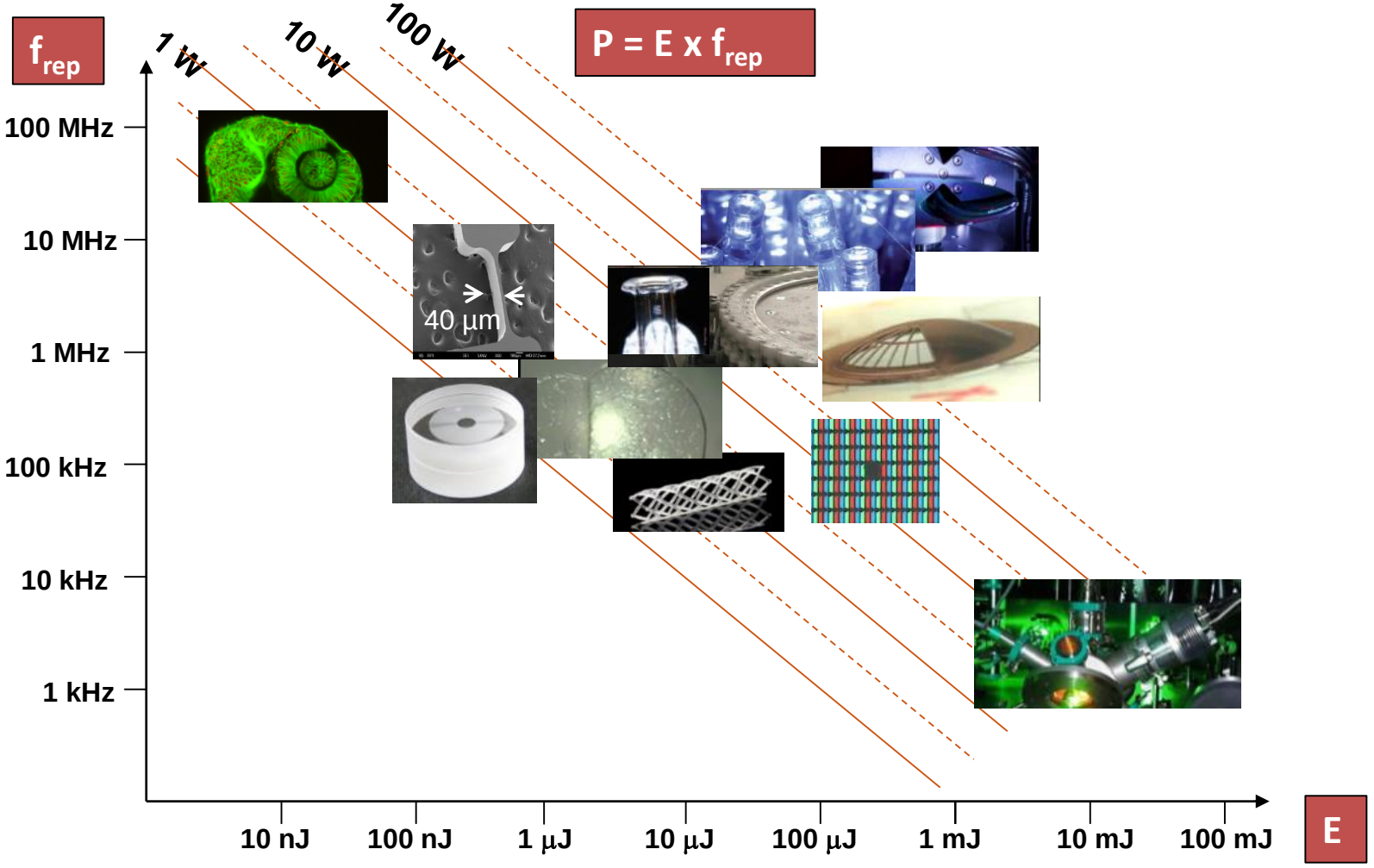
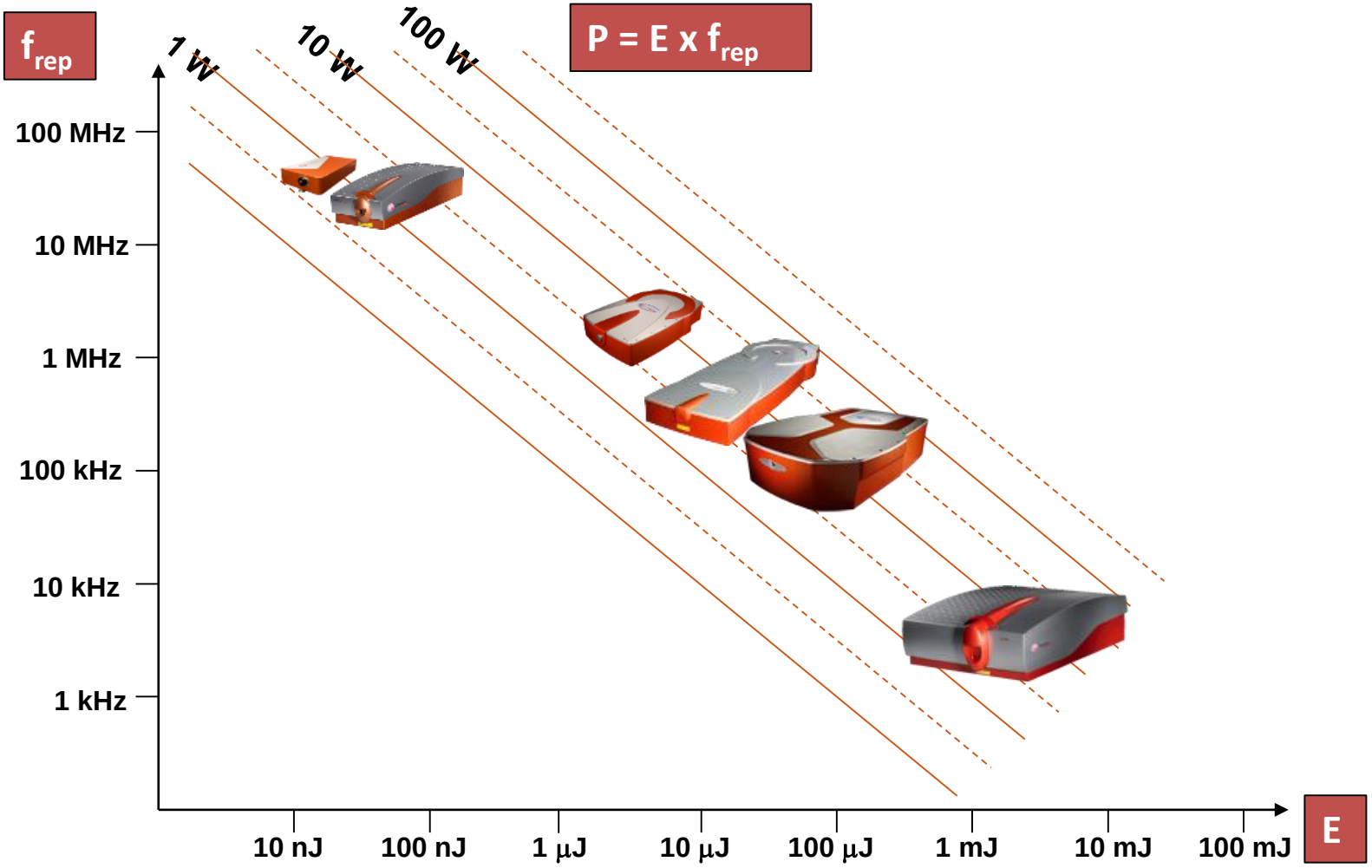
Applications & Performance



A wide range of specifications



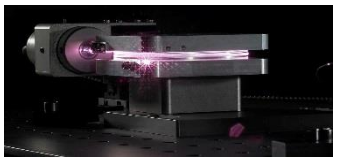
A wide range of technologies

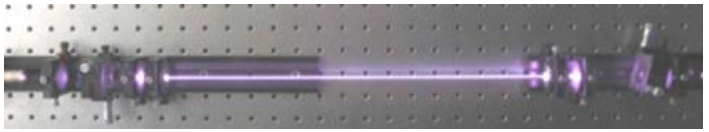
OSCILLATORS

Solid State Technology:
Highest reprate – Moderate energy

Flexible fiber

Fiber lasers
Rod PCF



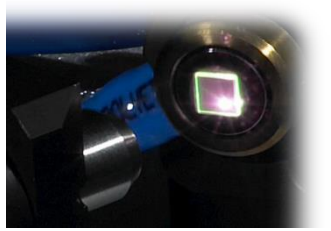


AMPLIFIERS
Bulk crystal

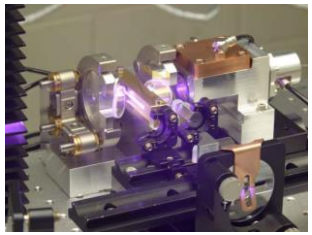
AMPLIFIERS

Solid state lasers

Thin disk



Our roles in the project



WP 1: Definition of user requirements

- Participation in the definition of specifications and requirements of user interface

WP 3: Ultrafast laser Frontend development

- 50-W, 300-fs laser with >1MHz and **spectrally tailored** for injecting an Yb:YAG thin disk amplifier (T0+9)
- **200-W**, ~500-fs laser at >1MHz (T0+21)
- A high power capable user interface including **high speed modulation** of the amplified pulse train

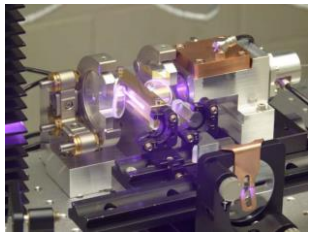
WP 4: Photonic components for pre- and post-pulse conditioning

- Compressor gratings (AMO): participation in specifications, testing under industrial conditions
- Kagomé fiber transport (GLO/XLIM): participation in specifications, testing under industrial conditions

WP 5: Thin-disk multi-pass booster

- Provide seed lasers
- Participate in thin-disk experiments and characterisation
- Participation in high power frequency conversion to green and UV

Our roles in the project



WP 6: System development

- Participation in interface definition and interface development

WP 7: Demonstrators

- Participation in 500-W demonstrator (fiber-based seed) integration
- Participation in 200-W demonstrator integration (high power seeder)
- Participation in optical fiber (transport) integration
- Participation in upgrade of 200-W demonstrator to 1kW demonstrator

WP 8: Dissemination



Amplitude
SYSTEMES
Nothing but ultrafast.

Thank you for your attention



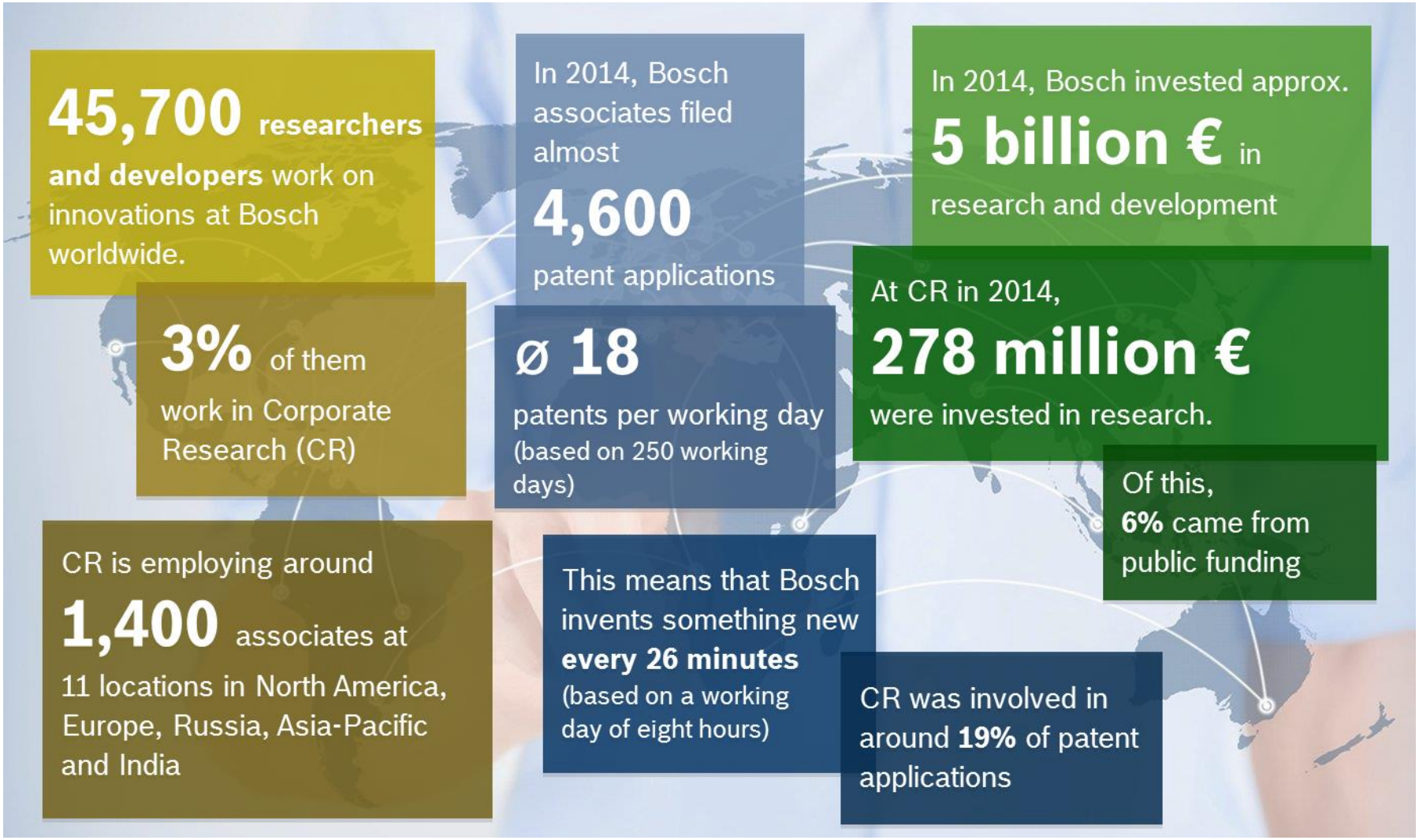
Robert Bosch GmbH

Andreas Michalowski

BOSCH
Invented for life

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

Hiperdias Consortium Kick-Off Meeting – 10th of February 2016



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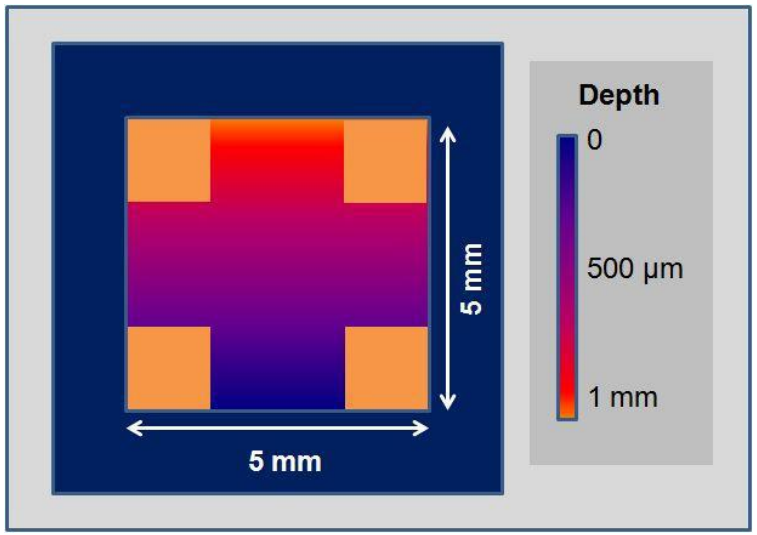
HIPERDIAS TEAM @ Bosch

- Andreas Michalowski / andreas.michalowski@de.bosch.com / +49 (0) 711 811 43423
- Mawuli Ametowobla/ mawuli.ametowobla@de.bosch.com / +49 (0) 711 811 34422
- Stephanie Karg/ stephanie.karg2@de.bosch.com / +49 (0) 711 811 21166
- Lisa Grad/ tbd / tbd / PHD student starting February 15
- Gerhard Kunz/ gerhard.kunz@de.bosch.com / +49 (0) 711 811 24266 / start September



Key Performance Indicator	Measure	Target
average ablation rate	mm³/s	≥1
peak ablation rate	mm³/s	≥3
shape deviation	µm	≤10 (ripple)
surface roughness	µm	≤1
thickness of surface damage	µm	tbd
surface defects	1/mm²	tbd
min. achievable edge radius	µm	as small as possible
max. edge-steepness	degree	≥70

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Hiperdias Consortium Kick-Off Meeting – 10th of February 2016

Bosch is participant in WP's

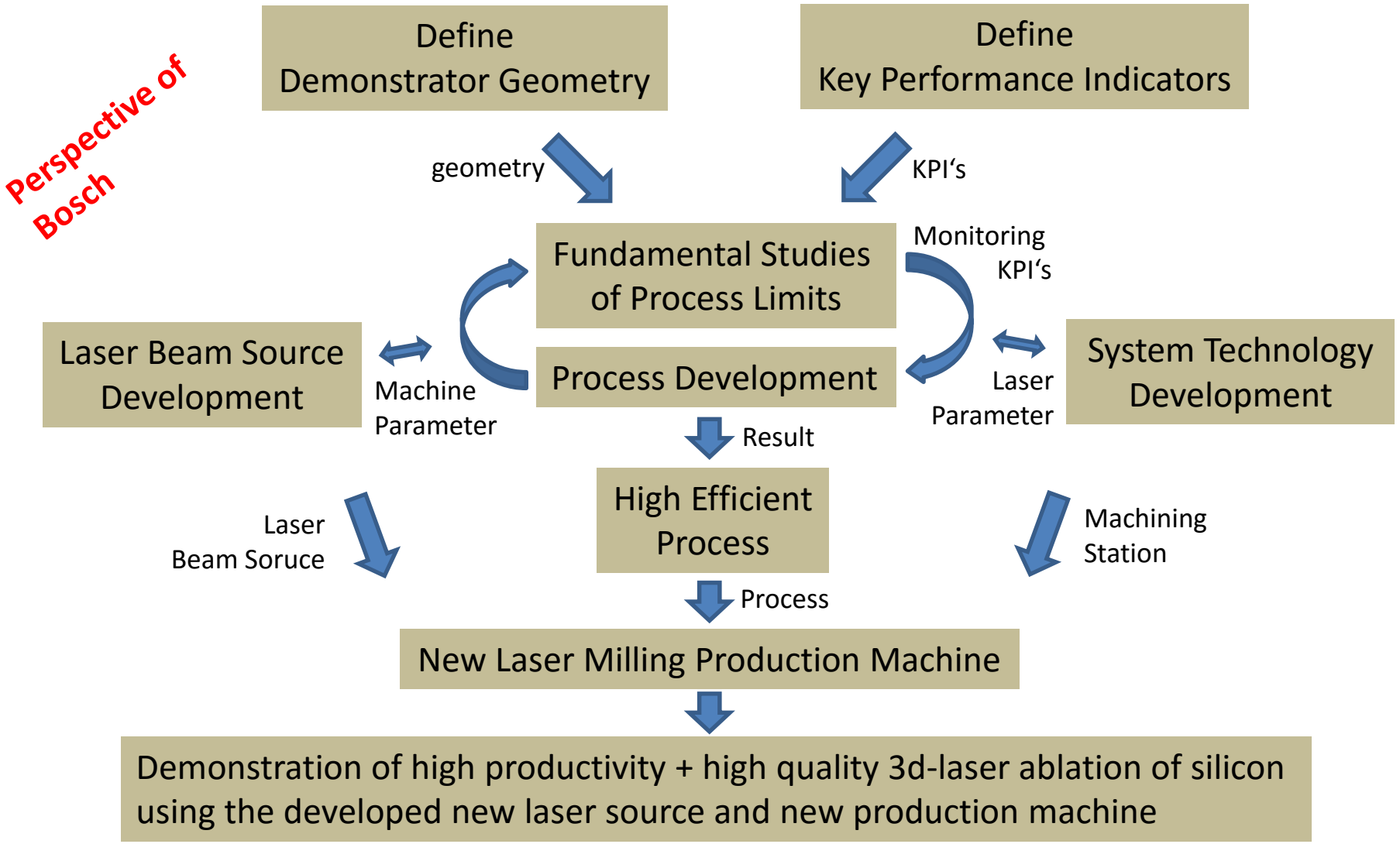
- **TASK 1.1: Collection of end-user application specifications (M01-M04, Lead: BOSCH, Participants: C4L, E6)**
- **TASK 1.2: Process and system specifications (M02-M12, Lead: BOSCH, Participants: All)**
- **TASK 1.3: Assessment and validation of technical progress (M04-M12, Lead: BOSCH, Participants: C4L, E6)**
- **TASK 2.1: Fundamental process development 3D Si processing (M04-M24, Lead: BOSCH, Participants, LASEA)**
- **TASK 2.4: Upscaling of applications for high throughput (M22-M30, Lead: USTUTT, Participants: C4L, BOSCH, LASEA)**
- **TASK 6.1: Definition of interfaces (M03 – M12, Lead: LASEA, Participants: AMP, C4L, BOSCH, E6)**
- **TASK 6.6: Test and evaluation (M12-M42, Lead: LASEA, Participants: USTUTT, AMP, C4L, BOSCH, E6)**
- **TASK 7.4.1: Processes analysis on reference samples (M24-M36, Lead: BOSCH, Participants: USTUTT, LASEA)**

Bosch is responsible for delivery (report)

- **D1.1 End-user application specifications, M04**
- **D1.3 Prototypes and progress validation, M12**
- **D2.1 Process limits 3D Si processing, M24**
- **D2.4 Processing strategies for high power 3D Si processing, M30**
- **D7.5 Report on the performance of the 500W demonstrator (3D-Si processing), M36**

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

Hiperdias Consortium Kick-Off Meeting – 10th of February 2016



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Class 4 Laser

Noémie Dury, Stephan von Wolff

Class 4 Laser Professionals AG

– See the light* –

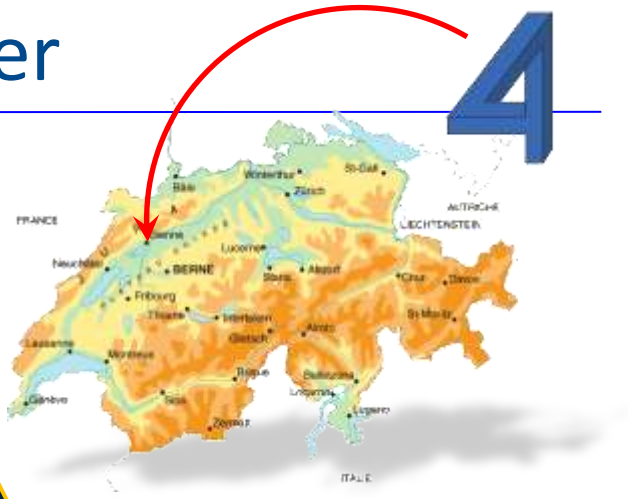
*Do not forget to wear protection glasses

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

Présentation de Class 4 Laser

Class 4 laser est Fondée en 2011
Par 3 associés

Class 4 Laser est Affiliée à Reith laser



Notre équipe est aujourd'hui forte de 16 personnes

Une entité sœur C4L System est fondée en 2012

C4L Systems a installé plus de 15 systèmes dans le monde depuis 2012

Nous disposons d'un labo d'essais laser et de mesures complet

Spécialisés dans les micro applications lasers

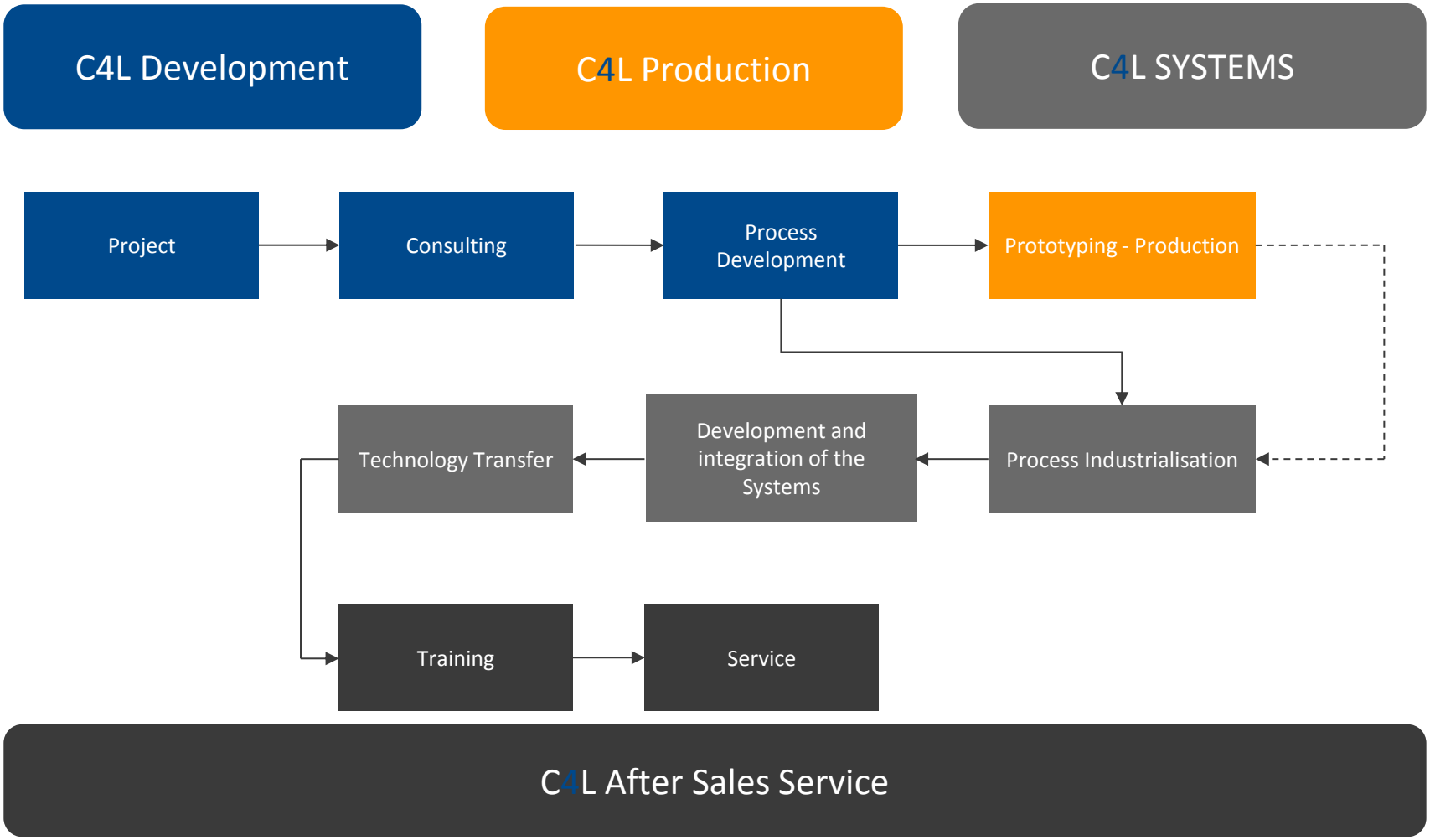
Développement de procédés, production et fabrication de systèmes lasers

Découpe fine, soudage, structuration Perçage à fort ratio…

Toute l'équipe vous accueille à Lyss (Bienne)

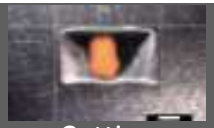
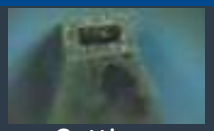
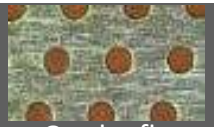
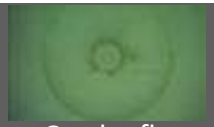
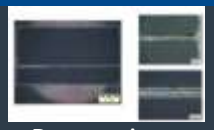
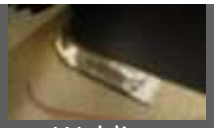
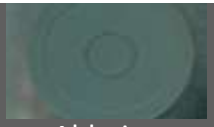
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 687880

Fonctionnement de Class 4 Laser



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

Nos marchés et applications

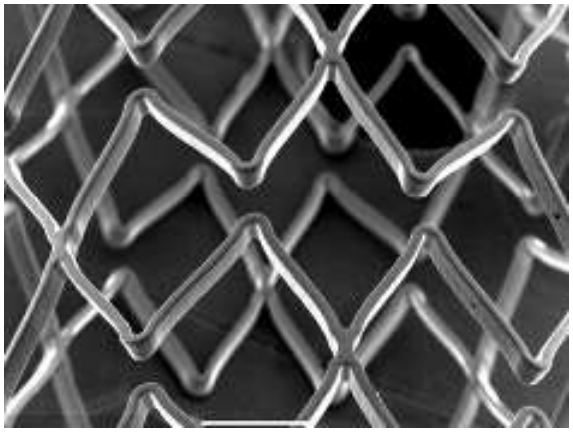
Medical Industry	Watch Industry	Aerospace	Tooling	Automotive	Electronics
 Cutting	 Cutting	 Cutting	 Cutting	 Cutting	 Cutting
 On the fly	 On the fly	 On the fly	 On the fly	 On the fly	 On the fly
 Single Pulse	 Percussion	 Percussion	 Percussion	 Percussion	 Percussion
 Welding	 Welding	 Welding	 Welding	 Welding	 Welding
 Ablation	 Ablation		 Ablation		

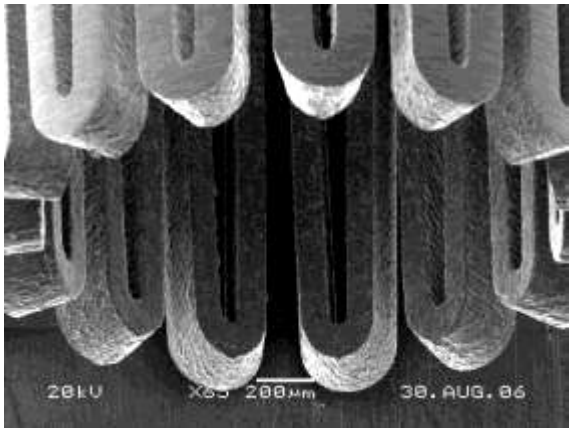
HIPERDIAS

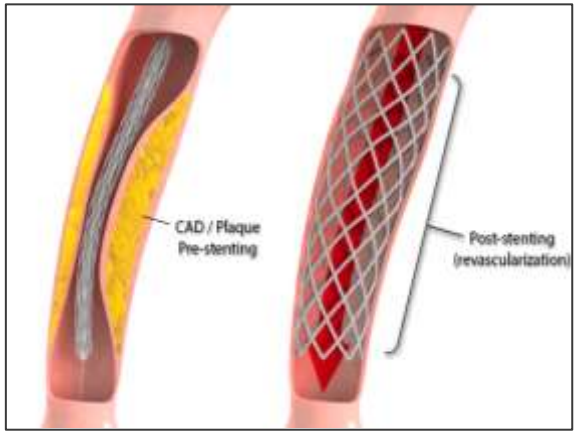
This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 687880

Example of C4L applications for USP laser

Stent cutting







Material

- Nitinol
- Stainless Steal
- Organic Material
- Magnesium

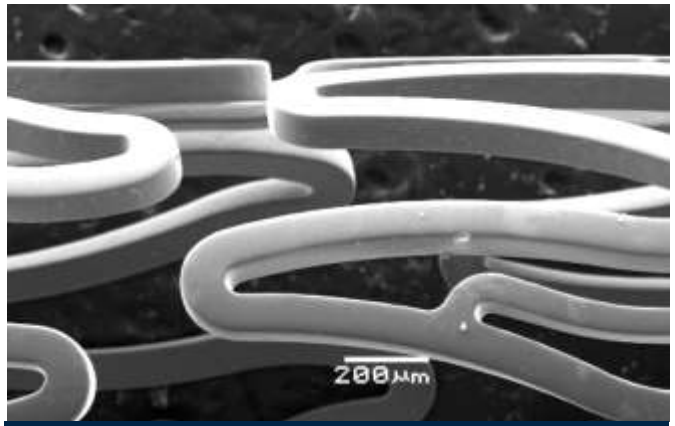
Applied Processes

- Thermal cutting
- Plasma Cutting
- Ultra Short Pulse cutting

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

Example of C4L applications for USP laser

Intern structuration of stents



SEM micrograph of stent

With the courtesy of FHNW

- Goals
  - Construction of a Structure (Pyramid stump)
  - Laser structuring of Embossing tools (Round material HSS-Stahl < 2 mm)
  - Targeted line width and distance of about 1µm
- System
  - Laser 355nm Coherent
  - Pulselenght ca 20 ns

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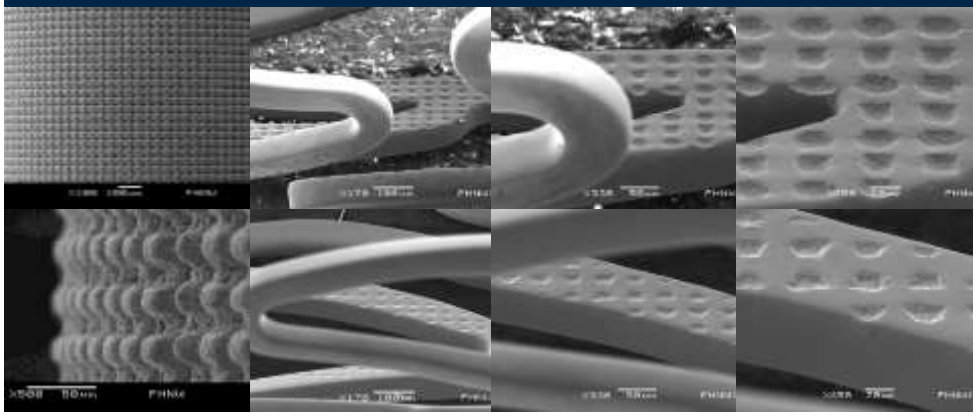
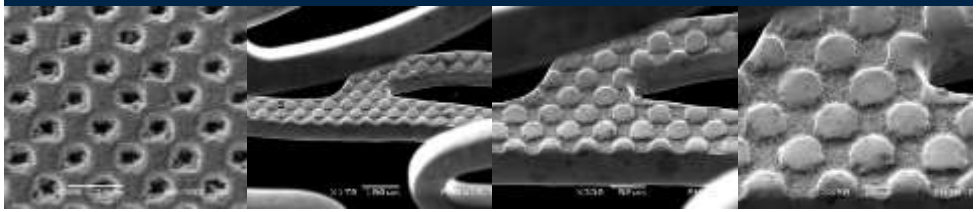
Example of C4L applications for USP laser

Intern structuration of stents

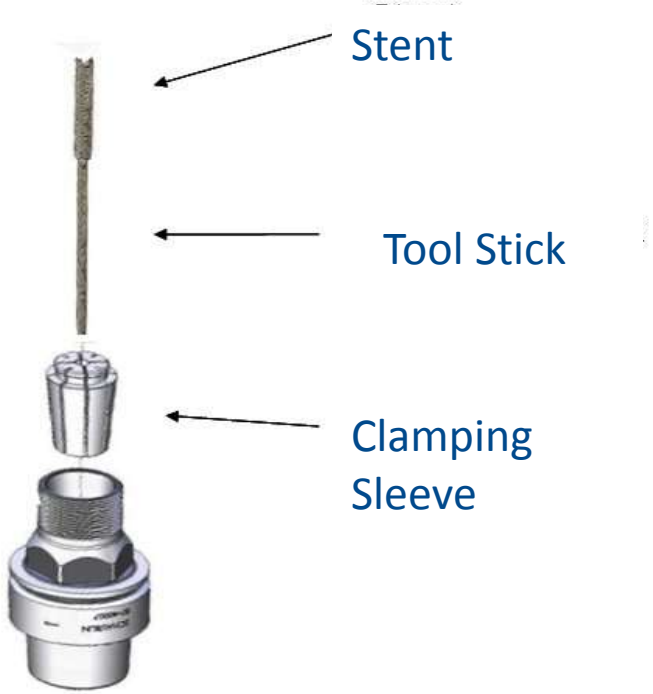
Zäpfchen in Linienstruktur



Näpfchen in Schachtstruktur



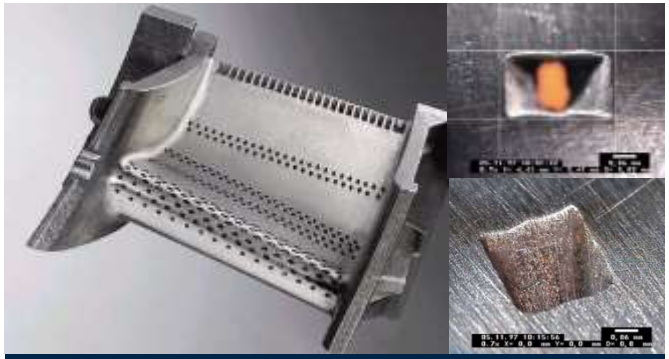
With the courtesy of the FHNW



Embossing System: Schematic description

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

Example of C4L applications for USP laser

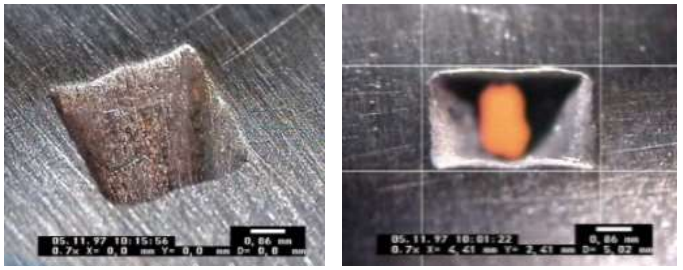


Parameters: 12 J Pulse energy,
0.6 ms Pulse length, 3 s/hole

Parameters: 25 J Pulse energy,
0.8 ms Pulse length, 2 s/hole

Turbine blades drilling and shaping

- Material
  - Ni and Co based alloys
- Specifications
  - Recast, Cracks, geometry
- Shaping of the hole done by USP Laser



Holes shaping

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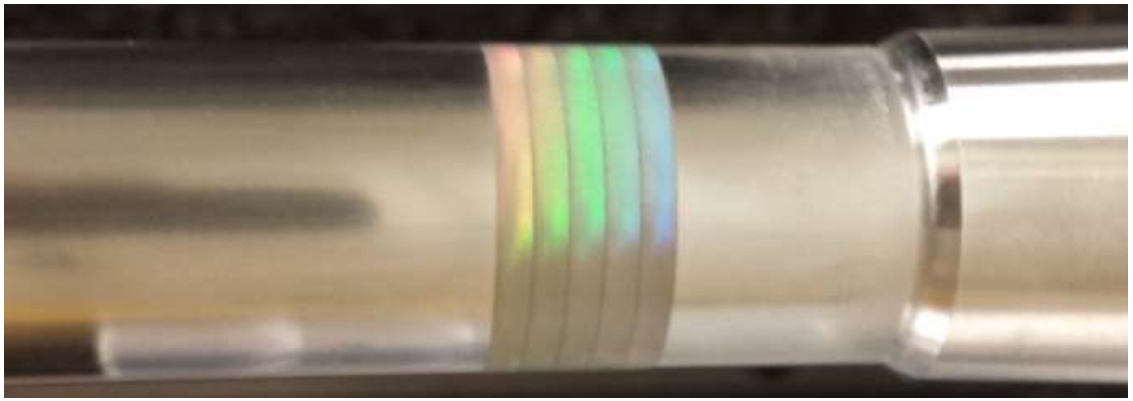
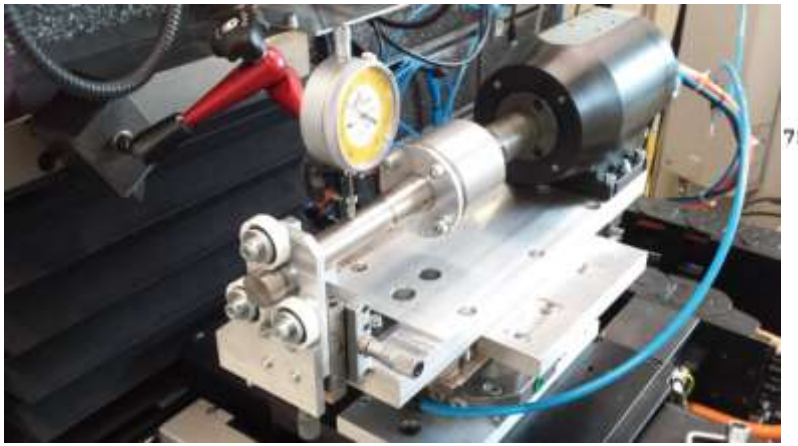
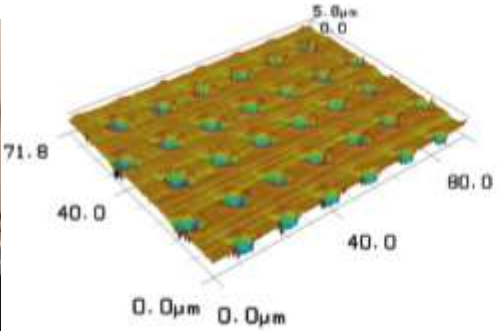
Example of C4L applications for USP laser

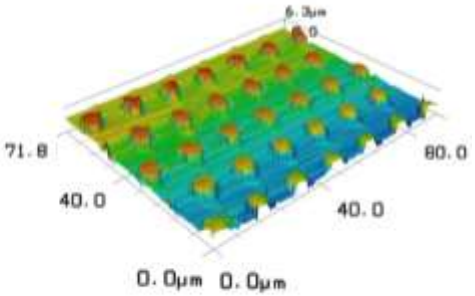
Structuring of mould cores







Structure 1 (negative)



Structure 1 (positive)

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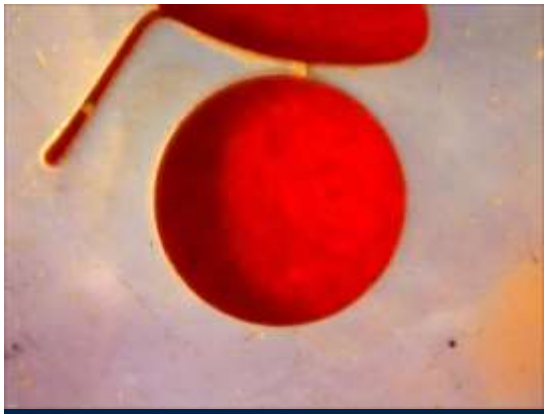
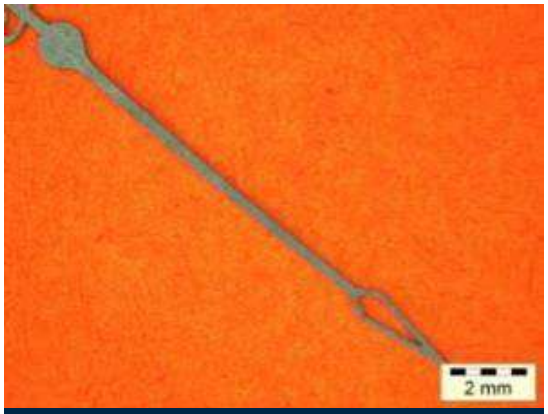
C4L in HIPERDIAS: Cutting of watch components



Découpe de nacre

Découpe d'Index

Découpe laiton



Découpe d'aguilles

Découpe d'or

Découpe d'argent

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C4L in HIPERDIAS: Cutting of watch components

Watch parts cutting

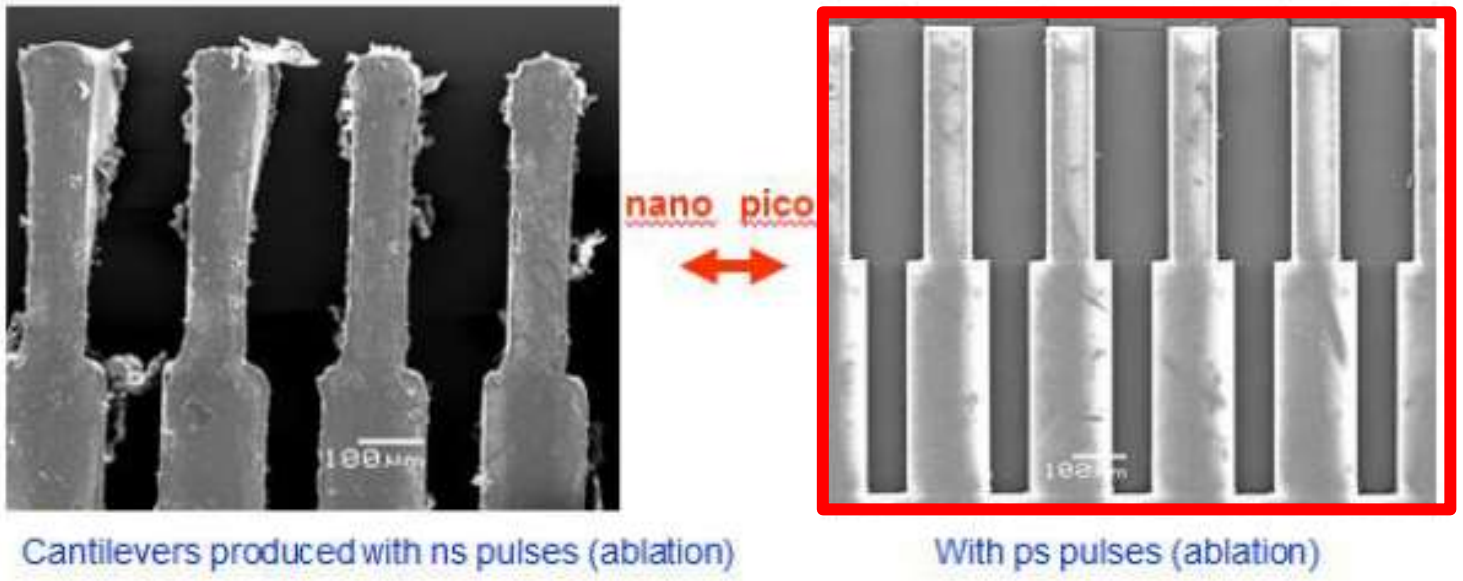

Fig.1.9: Comparison of fine cutting of materials using ps and ns pulses

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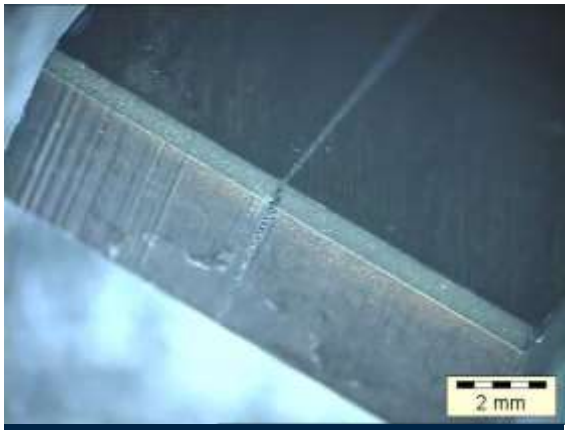
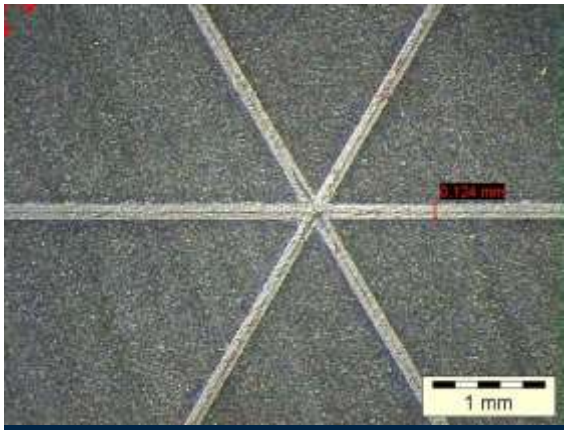
C4L in HIPERDIAS: machining of PCD

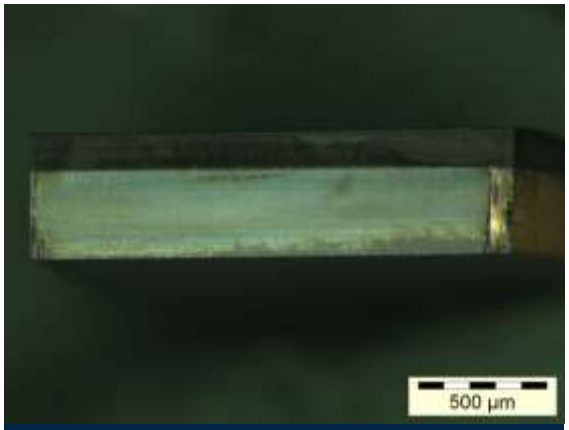


USP cutting and ablation on PCD

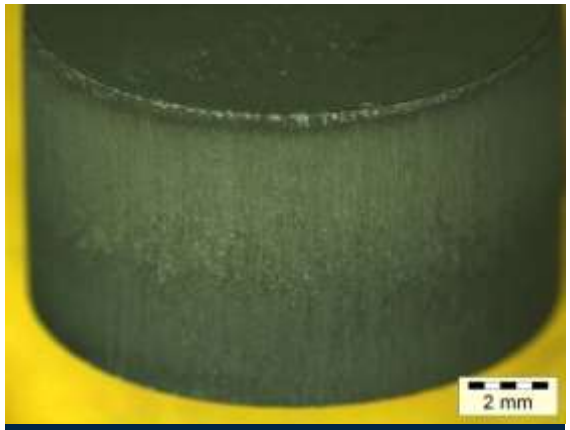
Structuration of PCD



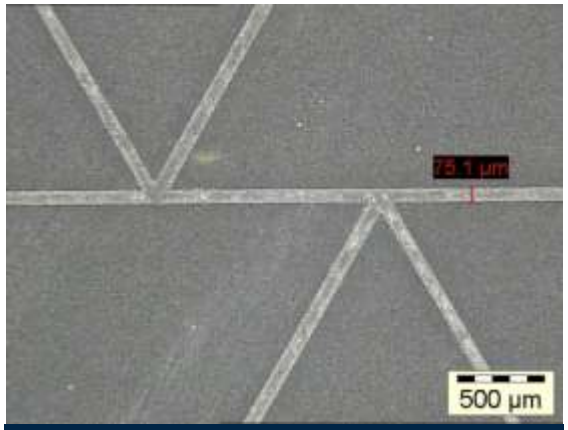
Cutting of PCD



USP Laser cleaning on PCD



Cutting of hard metal



Cutting of CBN

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C4L in HIPERDIAS: Specifications

- Strong focus on the vision system development
- 3D measurement system to adapt to the original diamond plate shape
- Rotating optic for watch part cutting
- All in one system
- First trials for process development on a tunable low power ps-fs laser

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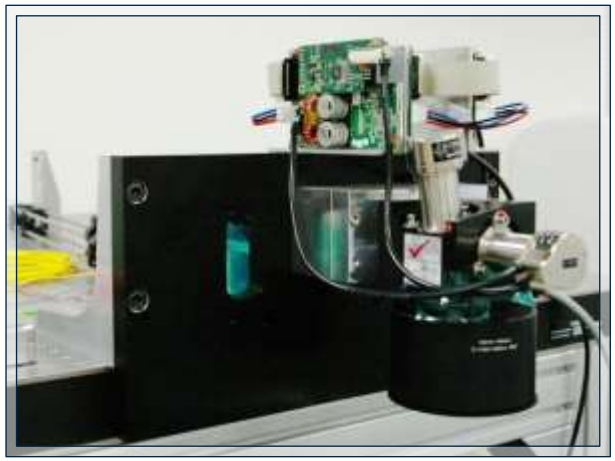
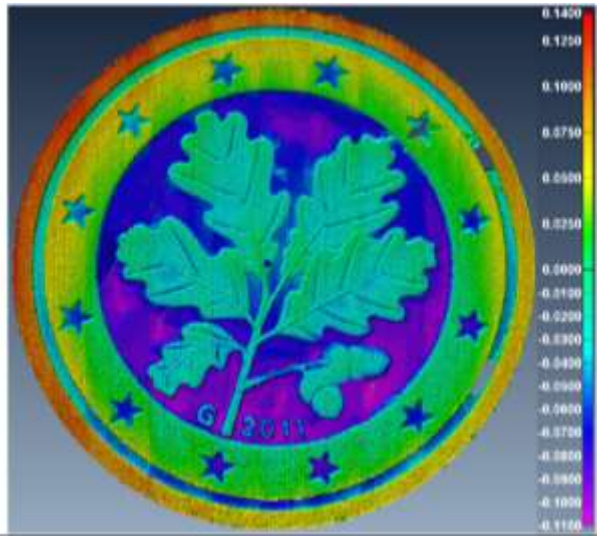
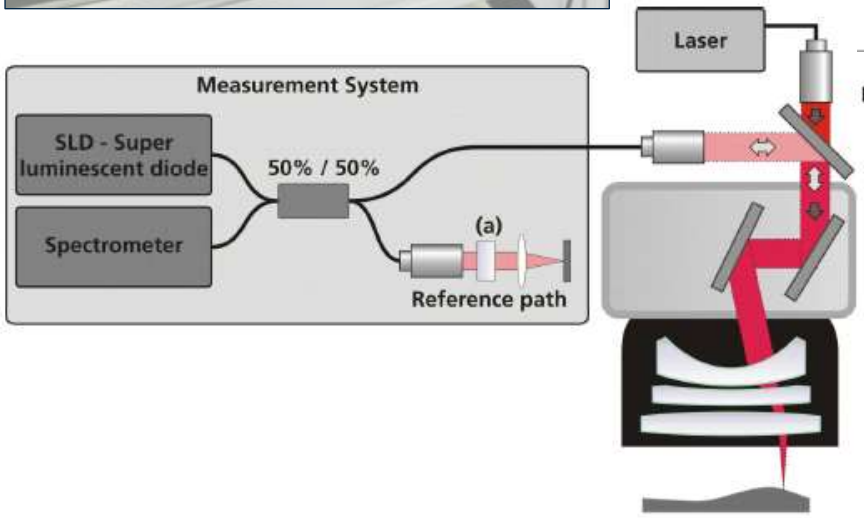
C4L in HIPERDIAS: System development

3D live measurement system



Measurement of a 2 cent euro coin





- Measuring range: ±1.3 mm
- Measuring system repeatability: 100 nm
- Measuring frequency: Max. 70 kHz

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C4L in HIPERDIAS: System development

C4L Systems

15 systèmes dans le monde depuis 3 ans

Systèmes sur mesure

- Systèmes de Vision variés
- Architecture sur mesure
- Intégration toute source laser

Logiciel flexible
Gestion du procédé, de la production, de la clientèle

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C4L in HIPERDIAS: Working Packages

WP	Roles/Major Contribution	Experience
WP 01	Support of end users, input for fine cutting and ablation process from the laser process sight.	Process development for the watch and tooling industry applied in customers project and public projects.
WP 02	Task leader for fine cutting and highly involved in the diamond ablation task. Process development and trials tasks. (ps laser and eventually fs)	Process development for the watch and tooling industry applied in customers project and public projects.
WP 06	WP leader, building of the system	System development for own customers for 3D ablation and fine cutting. (watch and tooling industries)

Demand Chain – Silicon processing			Demand Chain – Diamond processing	
Robert Bosch	3D processing of Silicon		**E6**	Polishing of synthetic diamond
LASEA	Integrated machine & process development		**C4L**	Integrated machine & process development

GLO/XLIM	Fibre delivery customised to application
AMO, USTUTT	Pulse Compressors – large area
AMP	Development of 50W laser (TRL4 to TRL7) and 200W laser (TRL3 to TRL7)
USTUTT	Development of high power 1000 W thin-disk booster amplifier (TRL 4 to TRL7)

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C4L in HIPERDIAS: Team

- Noémie Dury: Project manager – noemie.dury@clas4laser.ch
- Stephan Von Wolff: Engineer – Systems & Process – stephan.vonwolff@class4laser.ch
- Reiner Witte: Head of systems division
- William Scalbert (E6): Engineer – Process development

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elementsix™

a De Beers Group Company

HIPERDIAS

Opening Meeting

10/02/2016

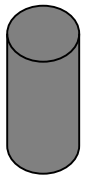
ELEMENT SIX

ELEMENT SIX PROFILE

- World's leading supplier of industrial Diamond[1] supermaterials
- International company with head office registered in Luxembourg
- Processing and manufacturing facilities in Germany, **Ireland**, UK, Netherlands, Sweden, South Africa and China
- 2500 employees worldwide and sales of ~$500 million
- Over 50 years experience of delivering innovative Diamond solutions
- **Manufactures Diamond from carbon using high pressure high temperature (HPHT) synthesis and chemical vapour deposition (CVD)**
- **Developed 30,000 unique products for our 10,000 global customers**

Note: 1. The term Diamond encompasses Diamond and Diamond like materials such as cubic boron nitride (CBN) or silicon carbide Diamond (SCD)

ELEMENT SIX PROFILE



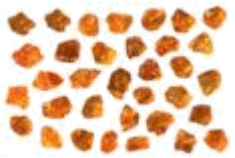
Graphite
(hexagonal)

Synthesis

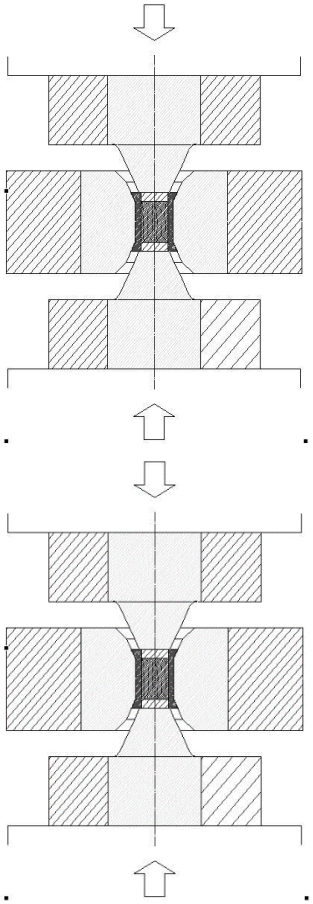
hBN

Synthesis

Diamond
(cubic)



cBN



Sintering

Sintering

PCD

PcBN

ELEMENT SIX PROFILE

One HPHT Press

One of Element Six Cubic Press Hall

- High pressure generated through the concentration of hydraulic force on a small area
- **High Pressure**: 55,000 atmospheres (tower of 5000 family-sized saloon cars stacked on a jar of peanut butter)
- **High Temperature**: 1500°C – > melting point of steel

ELEMENT SIX DIVISIONS

Oil & Gas

Global leader in polycrystalline Diamond cutters for **Oil & Gas drilling.**

Advanced Materials

Precision grinding, **Precision Machining,** and **Construction & Extraction** applications of Diamond.

Hard Materials

Carbide tools for the **Road Restoration**, **Mining** and **Wear parts** markets.

Technologies

Global leader in synthesis of higher quality Diamond exploiting the many other extreme properties beyond hardness.

ELEMENT SIX EXPECTATIONS

ELEMENT SIX MANUFACTURING CHAIN LINE

Synthesis

EX Press

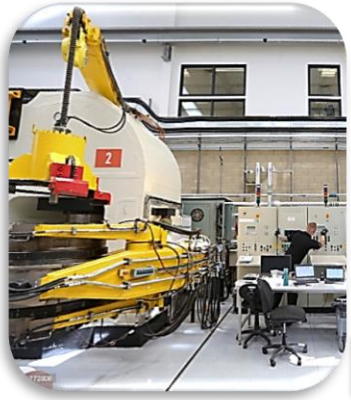
Pre-polis

HIPERDIAS

ERDIAS

Segmentation

Bulk processing chain line



Press for synthesis

Wire EDM workshop

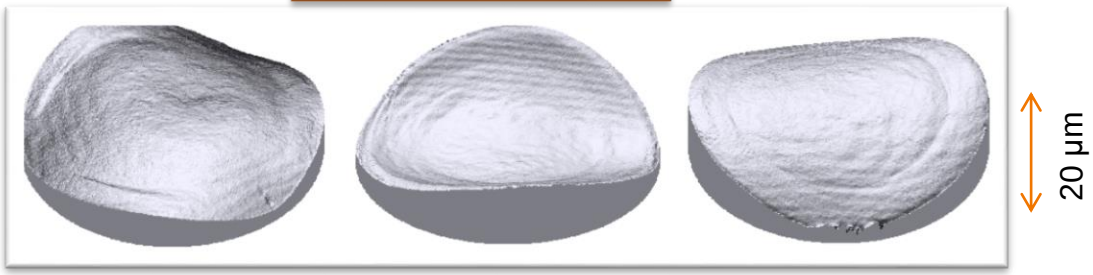
ELEMENT SIX POLISHING PROCESS

- **Mechanical polishing process is extremely challenging in E6.**
- Issues due to process itself:
  - **Costly (60% of total processing cost)**
  - **Long process (6/10 hours to process 5 discs)**
  - Grain size/shape/angle distribution
  - Temperature control (dry process)
  - Manual

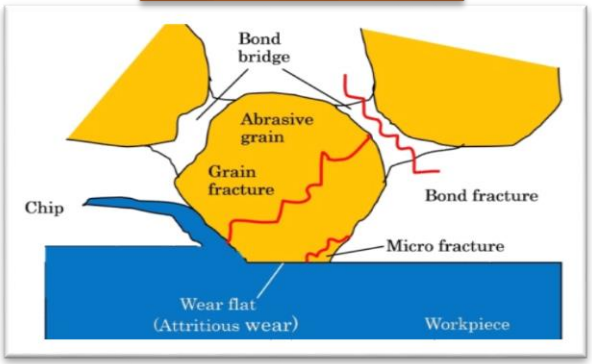
  Low processing yield
- Issue due to high variation in incoming material

Polishing machine

Material to be polished



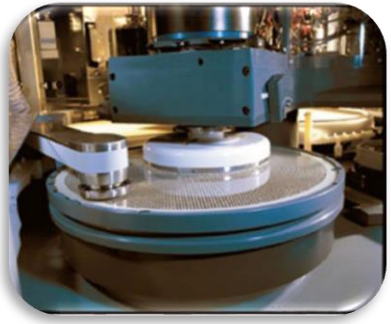
Polishing process



MECHANICAL POLISHING PROCESS ALTERNATIVES

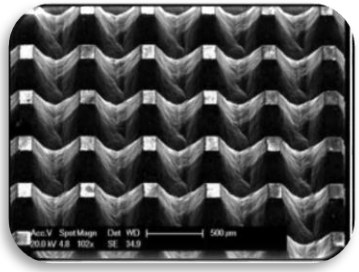
Element Six has been trying for years to develop alternative processes to replace mechanical polishing process without any real success… yet!

- Via internal projects
  - Chemical/mechanical polishing



    - Lapping machine
    - Acid slurry mixed with diamond grit
    - Dissolve top surface

- Via European projects
  - DIPLAT



    - Machining of an engineered polishing surface
    - Every parameter accurately controlled
  - HIPERDIAS
    - ….

SCOPE OF HIPERDIAS PROJECT FOR ELEMENT SIX

Main scope

- Replacement of mechanical polishing machines by Laser machines to Laser ablate PCD up to a mirror surface finish:
  - **Low processing cost**
  - **Fast processing (???)**
  - Cold ablation -> no thermal effect
  - Laser spot machining with controlled Laser parameters
  - Automatic process
  - Deal with various topographies thanks to top surface scanner/personalised program

Higher processing yield

- In Ireland, 55 polishing machines (new 20 polishing machines purchased last year)

DEVELOPMENT OF TOP SURFACE SCANNER IN COLLABORATION WITH CLASS 4

Oil & Gas Cutters

Advanced Material Cutter

Top Surface Scan → Generation of Personalised Ablation Program → Specific Laser Ablation

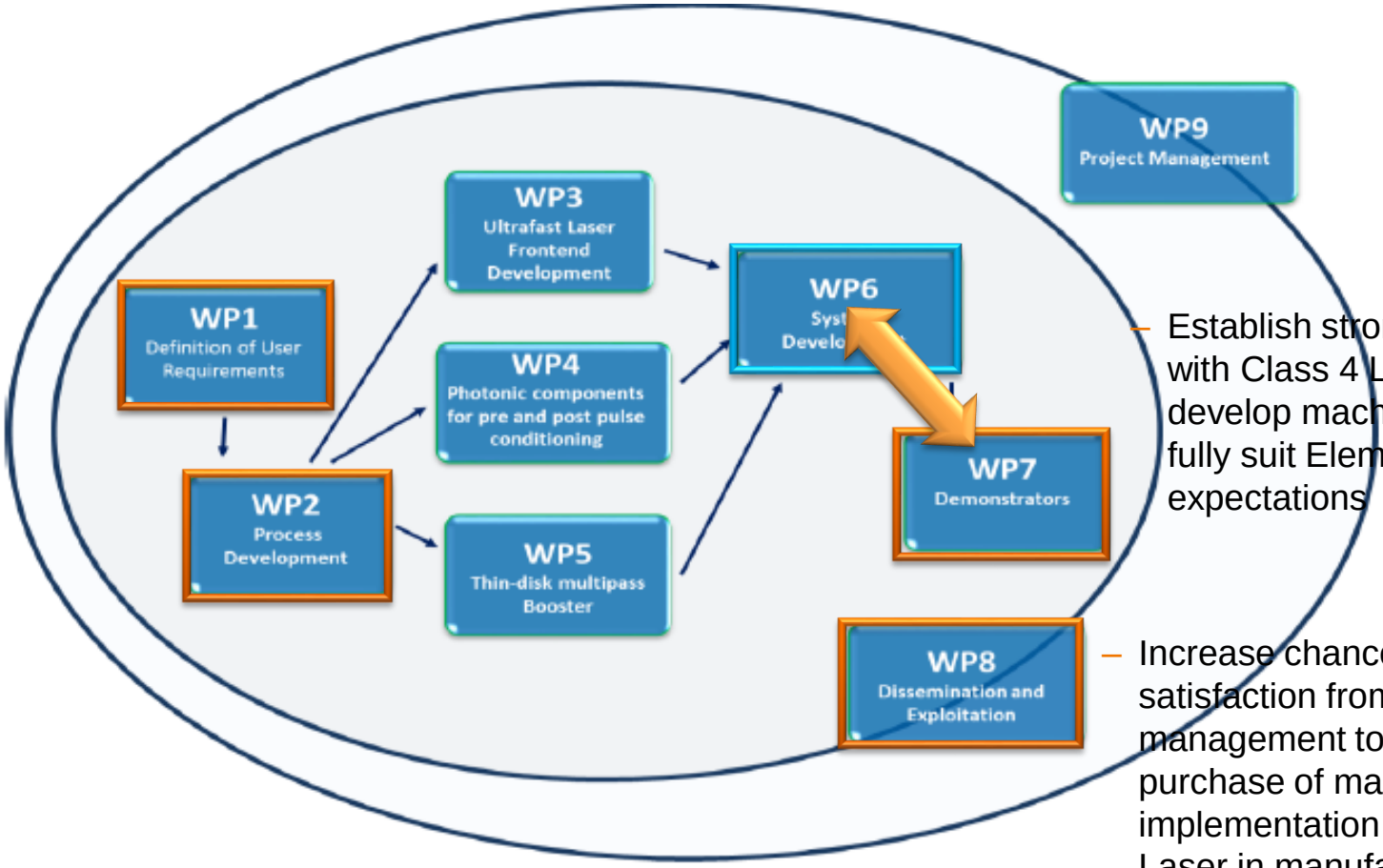
Further scope

able of … m diameter disc, nely wi… arise!

- Polishing …s
- Polishing
- Polishing
- Polishing 3D forms
- Polish other surfaces than PCD (PcBN)

ELEMENT SIX INVOLVEMENT

ELEMENT SIX WORK PACKAGES



- Establish strong relationship with Class 4 Laser AG to develop machine that would fully suit Element Six expectations
- Increase chance to get full satisfaction from Element Six high management to deliver capital for purchase of machines for direct implementation of HIPERDIAS Laser in manufacturing chain line.

THANK YOU