



Hub of Application Laboratories for Equipment
Assessment in Laser Based Manufacturing



Supported by the
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Commission



APPOLO Project Presentation

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www.appolo-fp7.eu
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CENTER
FOR PHYSICAL SCIENCES
AND TECHNOLOGY

Coordinator:

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The APPOLO Project

appolo

<http://appolo-fp7.eu/>



CENTER
FOR PHYSICAL SCIENCES
AND TECHNOLOGY



LUT
Lappeenranta
University of Technology



BIOAGE



MONDRAGON
ASSEMBLY



EMPA

Materials Science & Technology



POLITÉCNICA



Bern University
of Applied Sciences



next scan
technology

ABENGOA SOLAR



engage
Key Technology Ventures



AMSYS, LTD.



Lightmatif
ultrafast pulsed laser machining



onefive



Time-Bandwidth
Products



CENTRO
RICERCHE
FIAT



EKSPILA



SWG



Daetwyler
Graphics

supported by

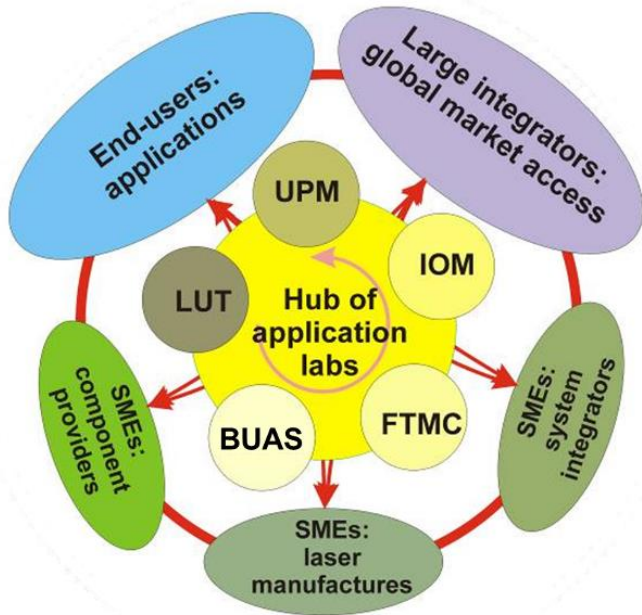
- **focuses on** emerging innovative laser technologies and processes, which need to be customised, tested and validated :
 - **Customized** – service of application labs for trials;
 - **Tested** – experiments at variable conditions;
 - **Validated** – reliability and process quality assessment in the close-to-manufacturing environment.

 - **exploits** the unique combination of distributed knowledge in
 - academic application labs,
 - equipment producers,
 - system integrators and
 - end-users
- to enable the development of innovative processes, products and machineries for industrial laser material processing applications.
- **seeks** to establish and coordinate the **Hub of laser application laboratories** to provide the high-quality integrated services.

- **establish and coordinate connections between**
 - **the end-users**, which have demand on laser technologies for (micro)fabrication;
 - knowledge accumulated in **the application laboratories** of research institutes and universities;
 - **the laser equipment manufacturers** (preferable SMEs: for integration, lasers, beam control and guiding, software, etc.),

&

- **facilitate**
 - **faster validation of the process feasibility**
 - **adaptation or customization of the technology & equipment for manufacturing conditions, including:**
 - reliability of components;
 - their interaction;
 - assessment of the dedicated production processes;
 - process speed, quality and repeatability;
 - economics issues.

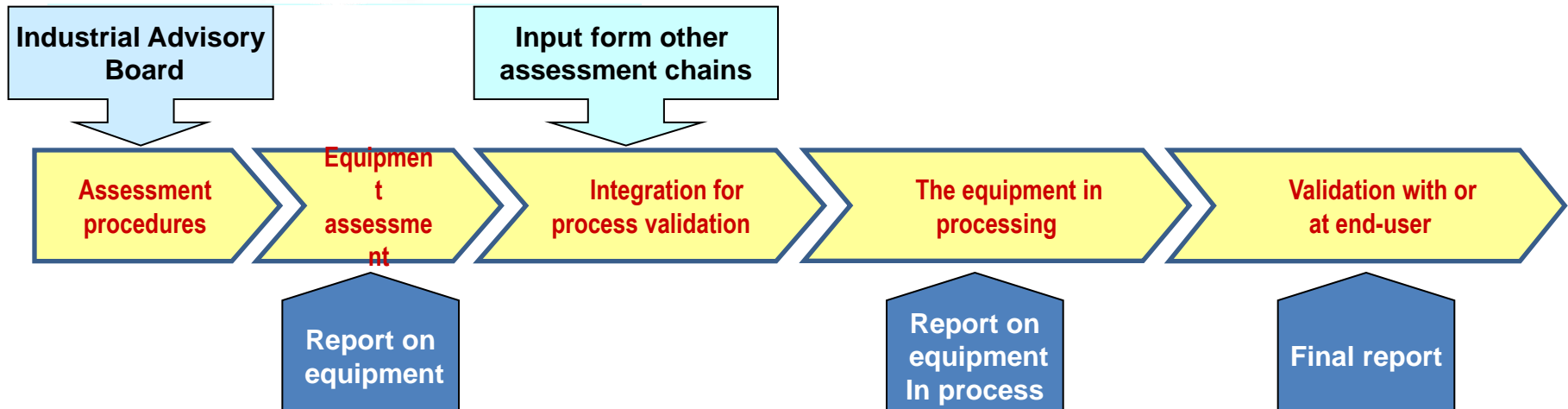


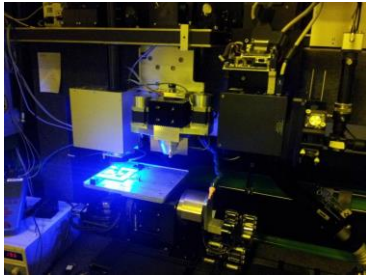
Hub of laser application laboratories

Core of the consortium - **laser application laboratories:**

- around Europe;
 - connected to a virtual hub, in order to
 - accumulate knowledge and infrastructure
 - promote the easy-to-access environment
 - develop and validate of laser-based technologies
- in

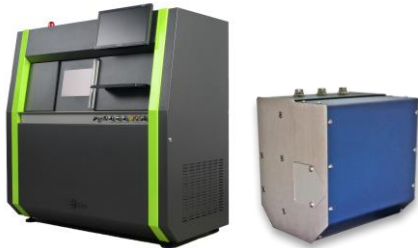
the **8+** equipment assessment value chains:





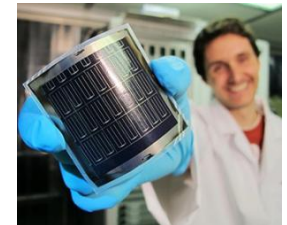
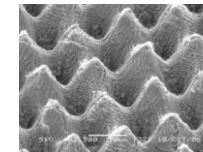
END-USERS:

- *Centro Ricerche Fiat SCPA*
- *Daetwyler Graphics AG*
- *Abengoa Solar New Technologies SA*
- *Mondragon Assembly Sociedad Cooperativa (SME)*
- *Sachsische Walzengravur GmbH*
- *Bioage SRL (SME)*
- *Flisom AG (SME)*
- ...



APPLICATION LABORATORIES:

- *Center for Physical Sciences and Technology*
- *Leibniz-Institut für Oberflächenmodifizierung e.V.*
- *Bern University of Applied Sciences*
- *Lappeenranta University of Technology*
- *Universidad Politécnica de Madrid*

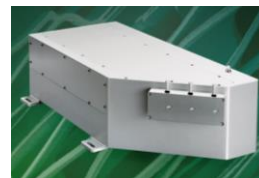


SUPPLIERS:

- *Ekspla UAB (SME)*
- *Time Bandwidth Products AG (SME)*
- *OneFive GmbH (SME)*
- *Next Scan Technology BV (SME)*
- *Amsys Ltd. (SME)*
- *ELAS UAB (SME)*
- *Lightmotif BV (SME)*
- ...



Picosecond



MATERIALS:

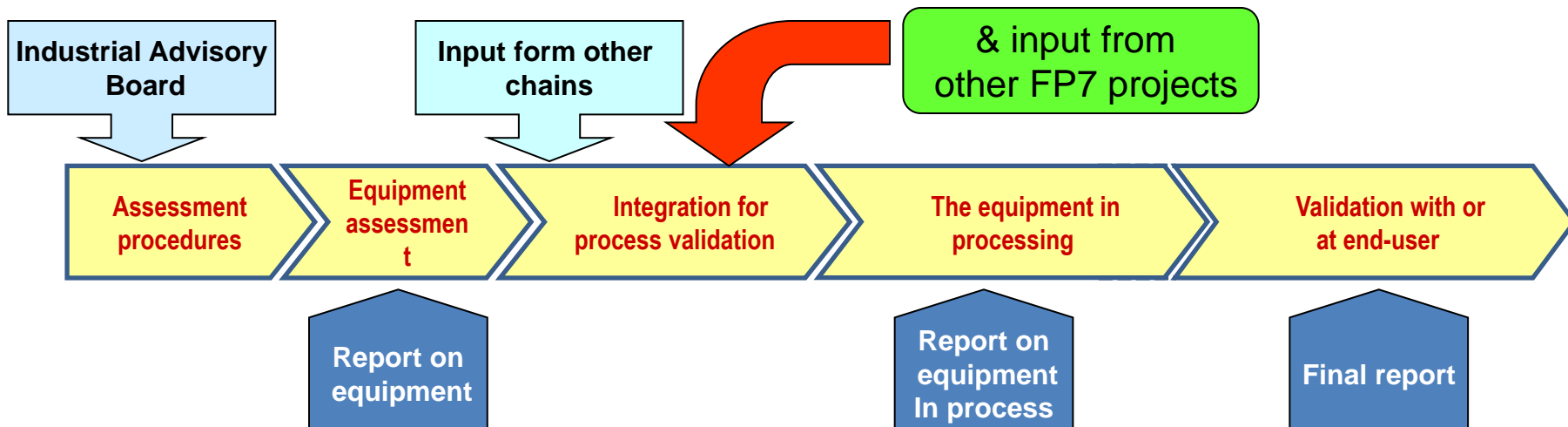
- *Eidgenössische Materialprüfungs- und Forschungsanstalt*

IPR MANAGEMENT & EXPLOITATION

- *engage AG (SME)*

Clusters of Activity

- **Thin film CIGS solar cell scribing with picosecond lasers:**
 - Novel lasers, scribing concepts, intelligent laser beam control & integration into machines
- **Laser surface texturing:**
 - New laser, high speed & precision laser texturing & dedicated nanostructures for surface functionalisation;
 - Integration in to machines for automotive and printing/decorative applications
- **Laser patterning for flexible 3D electronics:**
 - New patterning concepts, 3D patterning; Integration with other techniques (ink-jet, LIFT)
- Parallel activities on **sensing and monitoring techniques** for processing and validation.



WP10. Project management

Competitive Call for new projects
(~15% of budget allocated)

WP1. Operation of the hub of application laboratories (RTD)

Assessment projects (RTD):

CIGS cluster

WP2. Assessment of the ps-laser for CIGS scribing

WP3. Assessment of scribing technology with ps-lasers for CIGS solar cells

Texture cluster

WP4. High-speed surface texturing by lasers

WP5. Surface functionalization by laser texturing

LDW cluster

WP6. LDW for flexible 3D electronics

WP7. LDW for flexible electronics and photovoltaics

CC new cluster

WP11. New projects by Open calls

WP8. On-line monitoring and control

WP9. Dissemination, training and exploitation

Assessment procedures

Assessment project

Definition of measures

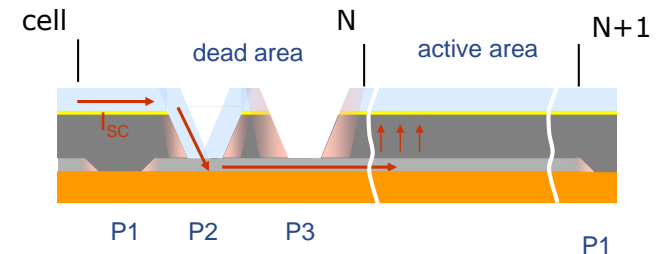
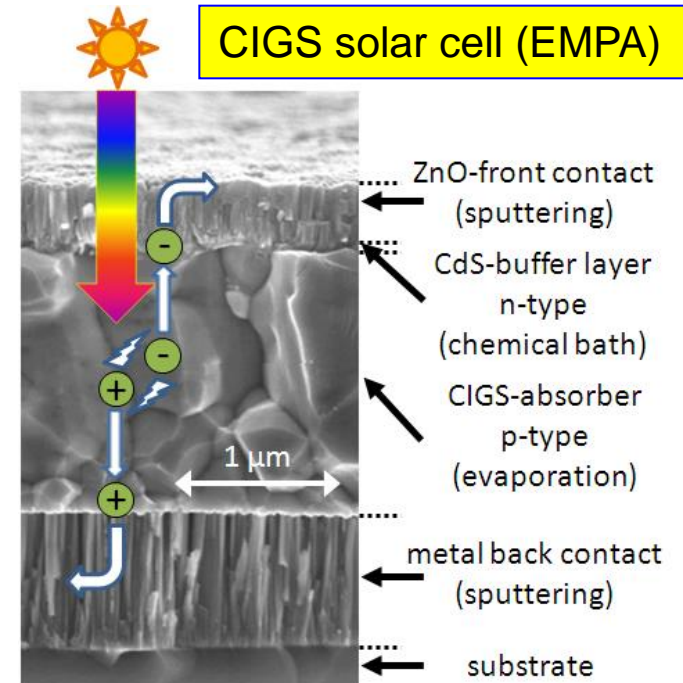
Components

Assembly

Validation

Analysis and feedback

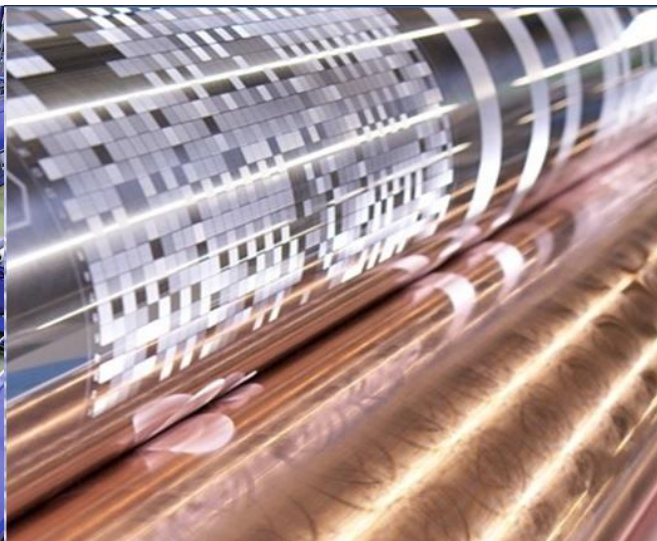
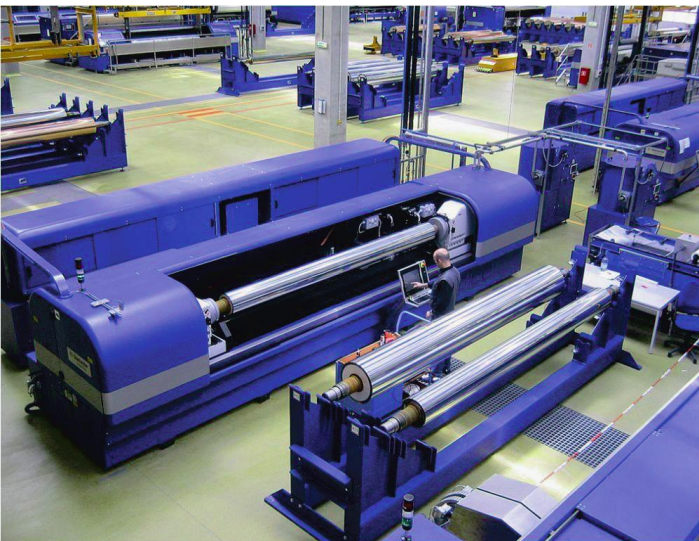
- Assessment of equipment and its interaction
 - 1.34 μm ps-laser
 - ps-fiber laser with pulse on demand feature
 - fast polygon scanner
 - on-line scribing process monitoring tool
- Integration & assessment in the process
- Final validation at end-user facility
- Approaches for thin-film CIGS solar cells on different substrates (glass, polymer, metal)
- Key issues:
 - selectivity in layer processing;
 - narrow “dead” interconnection zone;
 - minimised residual side effects;
 - high process speed.



Standard monolithic integrated interconnect scheme: P1, P2 and P3 scribing processes performed between deposition steps

High resolution 3D micro-structuring with ultra-short pulse lasers for embossing

- evaluation and validation of the lasers and fast scanning polygon devices;
- integration of the fast scanning devices on an existing gravure setup;
- evaluation of process strategies and process parameters for industrial production;
- validation of equipment in development of special structures for SWG.



- Surface engineering – to create **soft-touch and anti-glare effects** by functional textures on molds for automotive industry
- Assessment and optimization for 3D mold texturing method
- Validation of combined technology by production of real automotive part with added soft-touch texture



Leather imitation on moulded surfaces car's interior parts.



The machine developed in the FP7 project NANOCLEAN in process of structuring the demonstrator mirror cup mould.

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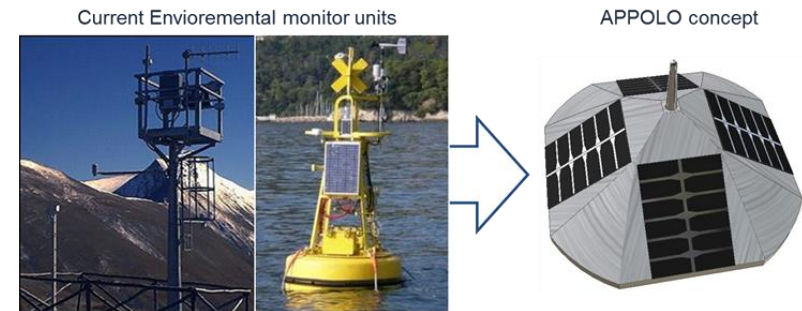


- Validate reliable schemes for direct writing of 3D wiring by laser radiation.
 - overcome basic problems of current state of the art;
 - process standard plastics instead of using highly specialized costly material;
 - saving resources by adding material for laser functionalisation.



Integrated switches in central console for interior commands.

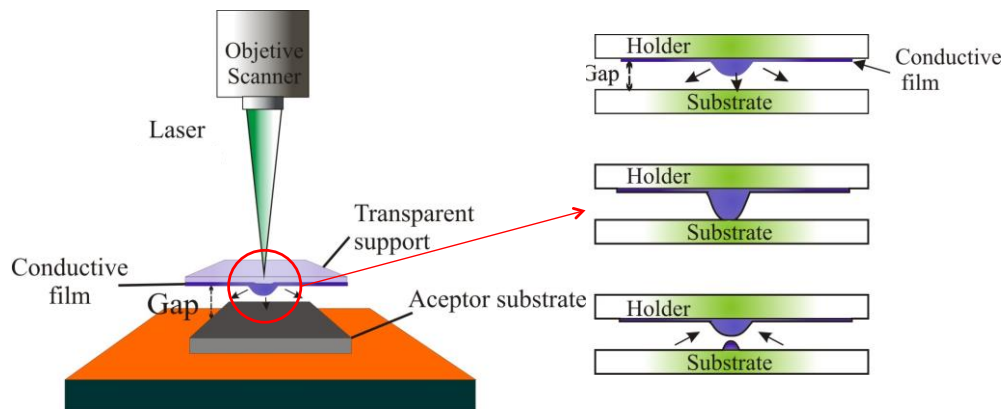
- Demonstration of new capabilities in surface functionalisation by lasers for 3D wiring and flexible electronics;
- Assessment of new laser beams for writing 3D / flexible electronics;
- Validation of the electric interconnections made by lasers in real conditions.



Example of APPOLO concept as applied in current environmental monitor unit.

The laser-induced forward transfer (LIFT) process is a local technique to transfer different materials. LIFT uses laser pulses to push thin disks of a ribbon material from a transparent substrate and deposit them onto an acceptor substrate.

- Laser direct writing of flex electronics and photovoltaics in planar geometry will be assessed and validated:
 - adding material techniques (especially LIFT):
 - post-deposit firing/curing techniques using laser technology.
- Particular goals are:
 - demonstration of new capabilities in surface functionalisation by lasers for flexible electronics and photovoltaics;
 - assessment of new laser beams (wavelength, etc.) for writing and metallization in flexible electronic including material deposition (LIFT), and laser curing/firing.
 - apply to define in a single step the fingers of front contact in a photovoltaics device.



Principle of LIFT process for metallisation of thin-film solar cells.

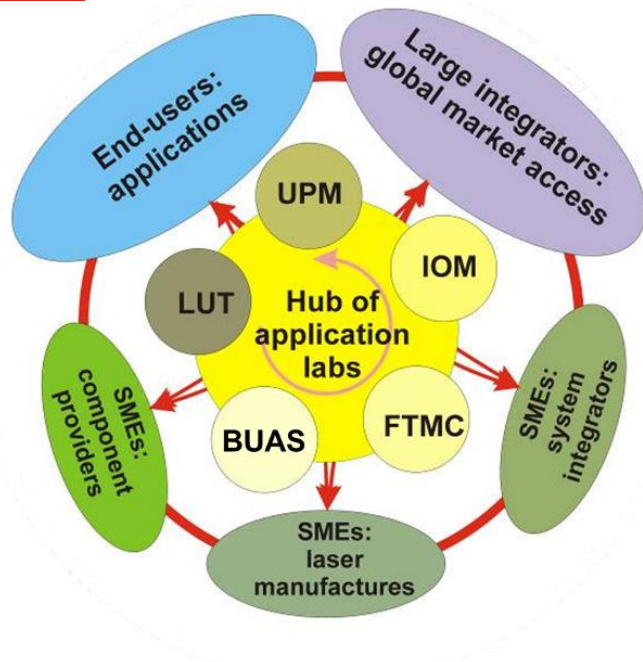
- Development and validation of on-line monitoring tools and beam control systems which are necessary:
 - process control during the assessment experiments;
 - on-line tools to be assessed and integrated into laser processing systems.

- On-line tools for integration into laser processing systems:
 - surface profile monitoring tool with polygon scanner;
 - auto-focusing unit for laser processing in 3D electronics.

Every innovations includes results of several stages in customization, testing and validation of laser-baser and sensing equipment and processes, which will be implemented by using the techniques:

- wavelength- and pulse- duration optimized processes of P1, P2 and P3 laser scribing in CIGS solar cells for monolithic interconnects;
- precisely synchronized scanning solution for surface texturing for increased throughput over traditionally chemical based processes;
- validated processes of laser-nano-structured & mould-replicated functional surfaces;
- LIFT based metallization processes for thin-film solar cells;
- direct real-3D laser-based formation of electro-conductive and piezo-resistive interconnections for electronics;
- enabling product innovation by sensor based solutions: real-time inspection and validation of laser patterning processes.

The HUB Model



■ Industrial Advisory Board (IAB)

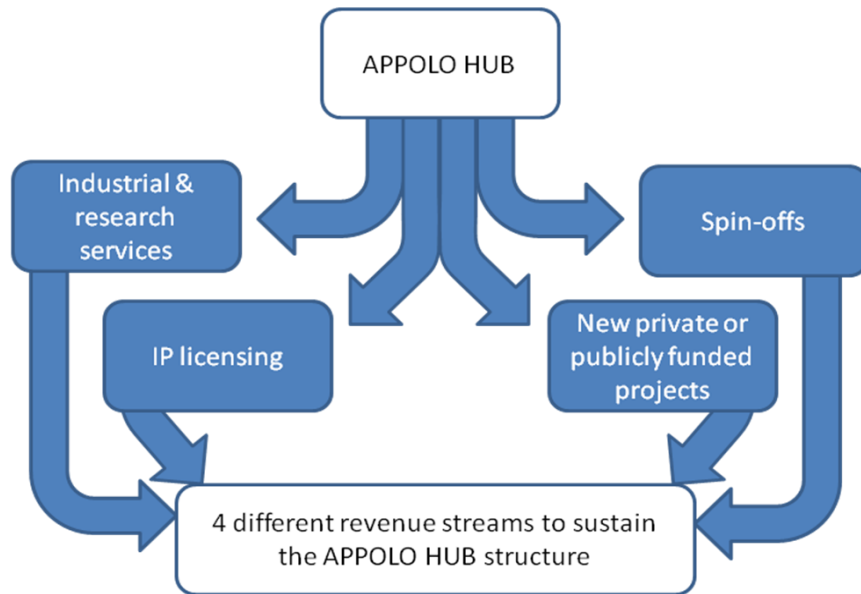
- industrial partners in the consortium
 - end-user companies interested in the project results but standing outside the consortium
 - industrial associations like EPIC
- IAB: technical requirements and procedures for assessment in specific application fields

■ Objectives of the HUB:

- prepare procedures for assessment service;
- manage and analyze of assessment projects;
- compare with alternative technologies.

■ HUB activities are intended to prepare

- operational procedures for efficient assessment execution;
- high-quality assessment service;
 - assessment procedures (IAB)
 - standards for assessment
 - certification of equipment
- attract potential HUB customers:
 - **equipment suppliers** looking for applications/validation;
 - **end-users** looking for solutions (equipment which can provide technology);
 - **system integrators** –specific requests they do not have possibility to test at home.
- pave a way for sustainable operation of HUB as laser technology service provider.



- 1. Services:** HUB participants perform services either for industrial or public/research customers (e.g. patterning, validation, ...)
- 2. IP licensing:** Jointly developed IP can be licensed centrally, avoiding costly and timely individual negotiations
- 3. New projects:** The HUB can act as a single entity to acquire new projects and can thus bring unparalleled depth, knowledge and excellence to bear.
- 4. Spin-Offs:** New companies, developed either in tandem with corporate partners or as spin-offs based on HUB IP can generate significant returns when the HUB exits its position (i.e. sale of shares, IPO).