iQonic

# IQONIC

## Innovative strategies, sensing and process chains for increased Quality, re-configurability, and recyclability of Manufacturing Optoelectronics

# Deliverable

## D2.1 User Requirements

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# Table of Contents

# DISCLAIMER

# EXECUTIVE SUMMARY / ABSTRACT

The work within this task has focused on use cases and business objectives of ALPES, PRIMA, FILAR and BRIGHTERWAVE, following closely the needs of technical/research partners that have provided a detailed set of requirements and specifications both for end users and technical developers of iQonic project. The requirements are developed and configured following technical objectives, hardware and software needs of components within this project. End users and all technical partners of the iQonic consortium have consolidated their business, technical, non-technical requirements (i.e. wishes) and other type of requirements on how to build the iQonic system as a general solution to be applied within the optoelectronics industry in the future. The approach is based on the systems engineering and application and management of systems engineering process standard (ISO/IEC 26702) and will encompass the steps of stakeholders' identification, scenario definition, research needs and final requirements validation. Furthermore, scenarios will be defined addressing the use of iQonic components in the project pilots. During the proposal phase it was defined that iQonic will use an "Iterative Feedback approach with users in the LOOP" (IFLOOP), where the initial output of the task T2.1 will be used for the design of WP3-WP6 components. The user feedback and updated requirements will retrofit and improve s/w and process chain designs.

# SCOPE

The iQonic supply chain and concept will be built with the utmost objective to provide new solutions addressing the needs for flexibility, efficiency and sustainability when manufacturing optoelectronics and photonics, bringing innovative and competitive products to the market, face future challenges regarding standards and legislation, and spread the knowledge to as many other sectors of the European manufacturing industry as possible. The scope of this work is to define and collect requirements and needs of iQonic consortium based on the defined methodology within this work as well as to solicit requirements at system-component and system-horizontal levels and make the final consolidation of the processed input. Furthermore, the final output will also identify KPIs to be monitored for the use case evaluation within the task T8.6 that will be reported in the confidential deliverable *D2.4* iQonic *Use Cases*.

# ABBREVIATIONS

| | |
|---|---|
| Key Performance Factors | KPF |
| Technical Objective | TO |
| Key Performance Indicator | KPI |
| Electrostatic Discharge | ESD |
| Internet of Things | IoT |
| Cyber-Physical System | CPS |
| Reverse Supply Chain | RSC |
| Decision Support System | DSS |
| Manufacturing Execution Systems | MES |
| Maintenance Management System | MMS |
| Enterprise Resource Planning | ERP |
| Optoelectronics Research Centre | ORC |
| Laser Diode | LD |
| Light-Emitting Diode | LED |
| Augmented Reality | AR |
| Virtual Reality | VR |
| Requirement | RQ |
| Original Equipment Manufacturer | OEM |
| Human-Machine Interface | HMI |

# 1 Objectives

Today, the demand for optoelectronic devices is rising and the advances in optoelectronics technologies is causing a revolution in consumer electronic goods, solar energy, communications, light-emitting diode (LED), industrial laser and other fields as well. However, the optoelectronics manufacturing is facing significant challenges in dealing with the evolution of the equipment, instrumentation and manufacturing processes they support. The optoelectronics and photonics industry is striving for higher customisation and individualisation since it is facing with the increment in complexity and variable volume of demand combined with the pressure to control production costs. Thus, the systems configurations need to change more frequently and dynamically including the automation and sustainability strategies as a most logical route to reduce production costs. Nowadays, the optoelectronics manufacturing should introduce new processes and technologies towards digital, virtual, flexible, zero-defect and resource-efficient factories in order to improve process efficiency, increase yield, reduce defect rates and the assembly costs.

In order to follow and accomplish the current market demands, the stakeholders' wishes and requirements as well as technical needs, specifications and possibilities, are to be defined, mapped and analysed. The scenario definition, analysis and final requirements validation will cover all these steps by following end users To-Be cases and Technical Objectives over the three iteration periods during the life time of this task, while implementing architecture and strategies of the iQonic vision.

## 1.1 Technical Objectives

During the proposal phase, the iQonic project has defined Technical Objectives (TO) as the main technological achievements to be followed, applied and updated (if necessary) after the revision of RQs in M20. The eleven TO will lead the project, allowing the optoelectronic industry to implement the eight zero-defect manufacturing strategies: DIAGNOSE, PREDICT, ADJUST, PREVENT, DETECT, MANAGE, SUSTAIN and REDESIGN in order to increase quality, re-configurability and recyclability. Identified use cases of consortium members ALPES, PRIMA, FILAR and BRIGHTERWAVE will be presented due M05 (*D2.4 iQonic Use Cases)*, covering the pilot As-Is positions and iQonic To-Be scenarios, followed by the further elaboration due end of the WP2 (M20). The specific process chain architecture reported due M07 (*D2.3 iQonic system architecture process chain & Strategies)*, TO as well as implementation of related strategies and their details, components and tools, will be monitored and reported together with revised TO (if necessary) within the deliverable *D2.5 Strategy implementation report* due M20 as a final output.

***Technical Objective No.1 - Development of diagnostic system for adjustment of production processes.***

The diagnostic system will be developed which goal is going to be to prepare the whole process chain for 20% faster reconfigurations, while maintain increased quality for higher yields (20%). This DIAGNOSE strategy will adjust the production processes for different factors of optical manufacturing such are:

- geometries (complex 3D shape),
- surfaces (contamination and scratch sensitive, coated),
- materials (fragile, brittle, soft) and
- weight and dimensions (small and medium sizes).

Furthermore, the process will be adapted respecting the three sensitivities of material, electrostatic discharge (ESD) and contamination, which will be reflected on the feeding, handling, alignment and bonding processes along the typical optoelectronics manufacturing process chain. The system will monitor and track the above key performance factors (KPFs) and the related sensitivity throughout the process chains and alter the production through the ADJUST strategy and ensure zero-defect from component to system level. iQonic will cover the overall process chains transferring the zero-defect requirement (RQ) from the component to the system level i.e., the opto-electrical system design for assembly and disassembly. Finally, the sensitivity will be taken care of as well, which will push iQonic on a major leap towards zero-defect production of opto-electronics components.

***Technical Objective No. 2 - Development of continuous monitoring of the condition and performance.***

This continuous monitoring of the multi-stage optoelectronics manufacturing systems will be developed on component and machine level that will enable sustainable and competitive manufacturing, i.e., data

management, sensors, processes design and setup as well as defect life-cycle management, disassembly and remanufacturing. Regarding the monitoring at machine level but also to collect and aggregate the data from existing and new sensors, the Internet of Things (IoT) i-Like Machine system of HOLONIX will be employed. Consequently, the online monitoring will be transformed from component to system characterisation during the assembly process chain. The processes itself, the handling-feeding tool, will take care of not only the contamination and defects (i.e., geometrical, semiconductor, layer defects), but also of the optical properties of the (partially) aligned system during assembly operating in real-time covering at least 90% of the production. iQonic will exploit the already installed actuators and sensors, along with the installation of the new sensing equipment provided during the projects life to acquire readings about the machine status, the in-process measurements (e.g. electronic nose, adaptive optics) and the optical sensors to evaluate the quality (high frequency laser).

***Technical Objective No. 3 – employment of a highly flexible handling tool.***

This handling and highly flexible tool will be able to provide a standardised interface allowing the handling both miniaturised and macroscopical parts – i.e. diverse designs (dimensions, geometry) – sensitivity, offering a new flexible process for material handling. The precise grasping hand of SHADOW will be able to establish electrical contact to active electro-optical components, either for grounding or for in-situ driving of the component. The grasping hand will receive input from the diagnostic and monitor (highly flexible) tool in order to reach the component accurately and safely during the alignment and bonding tasks. As a result, the handling tool will provide an interface for easy, precise and automated tool exchange technology by FICONTEC, that will take care of the specific sensitivity aspects through the monitoring of the component state from feeding to handling, to alignment and bonding. The data produced during these processes will be fed into the aggregated database ready to be processed by the event modelling and the artificial intelligence to PREDICT, DETECT, PREVENT, SUSTAIN and MANAGE any generated defect as well as to provide feedback allowing better designs and optimise the process chain for future iterations.

***Technical Objective No. 4 - Employ a smart tag scanning process between the production stages.***

The scanning process will be employed between the production stages in order to read the products specific requirements and automatically set-up the machine parameters, loading the actuators that configure the quality inspection solution. The barcode information provided from the higher levels (MES) and the production order itself will link all the data for each component not only to automate the loading process for programming the actuators but also to minimise the possibility of using the wrong set-up of process parameters for any given product. In addition, the metrology sensors will detect dimensional deviations and geometrical characteristics adding an extra layer of control to ensure zero-defects applications. This solution will be based on current “portable” metrology solutions developed by SENSAP and it will require both hardware and software integration with Online Data Management System of MANAGE Strategy. This involves advanced metrology, calibration and sensing, signal processing and model-based virtual sensing that will occur before each iteration in the workstations. Event pattern and anomaly detection, prognostics and positive/false alarm rates will be measured after a 6-month period of being employed.

***Technical Objective No. 5 - Develop a reliable and precise non-destructive sensing system.***

The sensing system will be developed for in-process evaluation of material and functional component properties. Its goal is to produce data about the material behaviour and its reactions to any given set of production parameters, allowing correlation of the various design and material characteristics with their behaviour during processing, and last with the outcome of the whole process through the quality inspection system. It will comprise the two innovative sensors:

- an adaptive optics laser and
- an odour sensing system.

The derived knowledge will allow optimal operations and strategies to minimise the generation of defects. The laser will receive in real-time an optical feedback about the features by the change the optical response adjusting the optics during the process to eliminate the generation of defects. The odour sensor will detect the organic compounds and will produce notifications to aware the operators. As the contamination sensitivity alters, the sensor will flag the production for deeper examination if there is a threat detected. The contamination scans, will be correlated with the quality and the ambient conditions during the processing.

***Technical Objective No. 6 - Develop a radical new design for sustainability process chain.***

The new design will be developed for a sustainability process chain for the assembly and disassembly in order to increase the pool of available components without affecting the quality. Disassembly as a very important matter for sustainability is very unusual in optics so far due to the fact that the properties of an optical component are typically irreversibly changed during assembly, in particular during bonding/fixation. iQonic via its intelligent engine and knowledge management, will provide feedback from the strong monitoring system to (re)design for sustainability benefitting the assembly chain. The dismantling and disassembly of optoelectronics components will be a subject of study in order to support decisions on their reuse (totally, partially), requalification and repair, as well as to develop a new process at their end-of-life. A cyber-physical system (CPS) will be used to evaluate both the functionality and integrity in order to proceed to downstream stages or upstream. The new Reverse Supply Chain (RSC) process will take action based on the components' design and material, so as the iQonic will either "consume" the products/material downstream, or "supply" them upstream to internal or external tiers. The holistic monitoring of iQonic will be active to the whole process chain, allowing more accurate decisions on their characterisation and testing approaches, to either move one stage forward, or stage(s) backward, or removed from production entirely. The new process of reverse supply chain and requalification of components at their end-of-life will aim for more than 20% introduction of recycled and recovered parts in the production to reduce the material costs by 12%.

***Technical Objective No. 7 - Develop a machine learning system to predict quality.***

This machine learning system for quality prediction will be developed according to each pre-selected setting having the overall performance indicator simulated to examine how they will affect the final cost. The retuning for optimal performance will reduce the costs by 20% and increase the yield by 22%. In order to increase the sustainability of optoelectronics components with different sensitivities and process requirements, iQonic will reduce the uncertainty around the process failures and delays, estimating the best planning, alternatives and adaptations. Such capabilities will be complemented by failure analyses methods to drill down at the root of a defect in order to allow 15% faster reconfiguration of the system against changing designs, process requirements, conditions, environments or system degradation. The learning controller will maintain a quality of 95% repeatability and 95% accuracy (inside the acceptable limits). The simulation system will perform an initial estimation of the future states, providing an expected outcome in availability, quality and performance. These will be updated based on historical and real time acquired data, taking into account the past, present, and future data to adjust. The system will be verified by checking if it preserves the desired quality in predefined pilot testing consistently, with controlled conditions, i.e. 1000 known samples, in controlled conditions.

***Technical Objective No. 8 - Introduction of a self-adjusted inference engine.***

By the introduction of the inference engine, detecting, measuring and monitoring the variables, events and situations will increase the performance by 20% and reliability of manufacturing systems from 0.85 to 0.9. iQonic will deploy an autonomous and self-adjusted early stage inference engine for real-time inspection, condition monitoring and control diagnosis at the shop-floor (i.e. process and artificial intelligence implementation). Data streams from multiple and disparate sources (e.g. sensors and actuators) will be collected, organised and consolidated through relevant models. The system will continuously mine these data streams and run the respective models to monitor operations and quality performance, to model designs (KPIs, sensitivity data), machines, processes and process chains. This will allow learning from experience in order to categorise products into classes on the basis of (nearly) real-time quality metrics, enabling not only detection of defects, but also prediction of their occurrence for each design. Overall, the proposed engine will perform monitoring, inspection and control at workstation, process and product level to issue warnings, alerts (e.g. about deviations from production and quality requirements), reports on (potential) defects or defect prone situations and pass related information to a higher level Decision Support System (DSS) for iQonic at manufacturing and enterprise level. A complementary goal relates to the reduction of false alarms based on lessons learnt, previous alarm activations, trends and by sharing information from one machine or process variant to another. To respond to changes in the production and product requirements (e.g. due to changing customer demand) the engine will allow algorithms to adapt to (frequent) changes/ reconfigurations of the production system. The generator will be able to adapt individual algorithms to the changes in the production

based on input received from existing information systems i.e. Manufacturing Execution Systems (MES), Maintenance Management System (MMS), Enterprise Resource Planning (ERP), etc., and instructions received directly from the higher level iQonic DSS.

***Technical Objective No. 9 – Development of a higher-level Decision Support System.***

The higher level DSS will be develop in order to assess the process chain's performance and accurately detect and predict defects deciding on actions to prevent their occurrence and provide recommendations about the strategies to activate at each time. The goal of this system is actually to increase both the flexibility and the quality by introducing self-adjustment mechanisms to maximise the performance, while synchronising material handling and feeding. In summery it will:

- deploy a new Internet of Things (IoT) middleware that is built on the existing solutions of integration and i-Like Machines to realise semantic interconnection of sensors and relative processes with the iQonic core elements and existing information infrastructure,
- develop multi- parametric models of production processes (at single stage) and investigate a sampling method and
- build an autonomous, self-adjusted intelligence engine for real-time inspection and control at the shop-floor and decision support towards measurable performance and process chain improvement, by triggering the strategies to DIAGNOSE, ADJUST, PREDICT, DETECT, PREVENT, MANAGE; SUSTAIN; and a complimentary REDESIGN strategy for increased sustainability in future operations.

***Technical Objective No. 10 - Integrate different strategies for production monitoring and quality control.***

The eight iQonic strategies will be developed to achieve the goal of sustainable manufacturing, based on modelling, simulating and forecasting the behaviour of production processes and resources. The strategies will DIAGNOSE the given designs, ADJUST the processes for production, assembly, and dismantling to handle complex shapes and versatile components, while PREDICT, DETECT, PREVENT, SUSTAIN and MANAGE defects during the production lifecycle phases. They will decide for non-repairable defect cases, calling for reuse and requalification actions and adjust the material handling, bonding, feeding, assembly and disassembly processes. Last, the lessons learnt will help to REDESIGN sustainable products. The outcome will be an integrated product-process-production system that will be embedded into their social, environmental and economical context of each opto-electrical factory.

***Technical Objective No. 11 - Widespread adoption of IQONIC results.***

While some of the largest activities concerning optoelectronics, manufacturing is concentrated in Germany, iQonic will spread its results to more areas to boost the innovation on photonics technologies. To this end the expertise of the Optoelectronics Research Centre (ORC) at the Tampere University of Technology (TUT), which is the strongest hub in Scandinavia concerning development of laser diode (LD) technology covering GaAs, InP-, and GaSb-based material systems, will be expanded to provide access for Nordic photonics companies to rapid prototyping of LD-based sub-systems. We should note that ORC has been extremely successful in spinning-out optoelectronics technology, with currently 12 start-ups including major players in medical laser instrumentation (Modulight) and fibre laser (Corelase). The fast development trends on photonics activities in Finland with at least 50 SMEs1 will be the access point to advanced tools for optoelectronics assembly, which will be located at Tampere University of Technology is very timely. This role will be extended to Sweden via the strong interaction between the national photonics clusters (i.e. Photonics Finland and Photonics Sweden).

[1] http://www.photonics.fi/members/

# 2 Methodology

The work within this task T2.1 of iQonic project has been advanced considering the previous experience and know-how of the project consortium partners following and combining few methodologies for requirements definition. Following the research, end users and technical developers' needs, the requirements describe how the iQonic system behaves and it respectively consist of functional, non-functional requirements, presenting what and how the system should do and work and constrains that include application domain information. Below, few approaches have been reported and analysed where the methodology for encompassing this task has been defined as the combination of the reported approaches.

## 2.1 ISO/IEC 26702 Standard

The work within this task is based on ISO/IEC 26702:20072 standard or Systems Engineering - Application and Management of the Systems Engineering approach that defines the technical effort requirements of a business that are related to development of products, computers, software and processes that will sustain and evolve life cycle support for the products. The integrated technical approach of systems engineering process is periodically applied to develop or improve a product in order to satisfy market needs while providing related life cycle processes for product development, manufacturing, test, distribution, operation, support, training and disposal. This standard actually provides and approach for product development in a system context including the guidelines what organisational entities of a business must achieve to produce a quality, competitive product that will be marketable, will provide an acceptable return on investment to the enterprise, will achieve stakeholder satisfaction, and will meet public expectations. Also, its objective is to provide high-quality products and services, with the correct people and performance features at an affordable price and on time. This involves developing, producing, testing, and supporting an integrated set of products (e.g. hardware, software, data, etc.) and processes that is acceptable to stakeholders, satisfies enterprise and external constraints. This objective is achieved by simultaneous treatment of product and process content to focus project resources and design decisions for the establishment of an effective system design. This involves an integrated handling of all elements of a system, including those related to manufacturing, test, distribution, operations, support, training and disposal.
The extension of this approach, the ISO/IEC/IEEE 24748-4:20163 standard, identifies required processes for planning the Technical Management and execution of projects that implement considerable Systems Engineering efforts regarding the project's system products. The Technical Planning or Systems Engineering Planning should help to ensure that requirements related to the technical effort are elicited, documented, analysed, verified and managed.

## 2.2 Volere Approach

The Volere approach[4] was one of the methodologies investigated as potentially suitable for this work. It is used as a basis on the requirements specifications providing the details of each of the requirements types appropriate to nowadays software systems. The idea is to provide help in requirements discovery and to be able to group the requirements that are relevant to a specific expert specialty. The Volere approach specifies few types of requirements that are considered in this work that may provide the solutions of the project.

- ***Functional requirements***: fundamental or essential subject matter of the product, what the product has to do or what processing actions it must take.
- ***Non-functional requirements***: the properties that the functions must have (e.g. performance and usability).
- ***Project constraints***: restrictions on the product due to the budget or the time available to build the product whose design enforce limitations on how the product must be designed.

[2] ISO/IEC 26702:2007(E) IEEE Std 1220-2005 First edition 2007-07-15
[3] ISO/IEC/IEEE 24748-4:2016 (E) First edition 2016-05-15
[4] http://www.volere.co.uk/

- ***Project drivers***: the business-related forces (e.g. the purpose of the project is a project driver, as are all of the stakeholders each for different reasons).
- ***Project issues***: the conditions under which the project will be done. Basically, the reason for including this type is to present a coherent picture of all factors that contribute to the success or failure of the project and to illustrate how managers can use requirements as input when managing a project.

## 2.3 Alistair Cockburn Approach

Previously, Alistair Cockburn[5] have reported on how to write (or review) functional requirements for object-oriented software systems as well as for embedded software and business process re-engineering work. His work provided guidelines and it contains some preliminary information on how the requirement looks like (e.g. primary actor, extensions, variations), where do they fit into the overall requirements gathering work, etc. This approach was considered and few ideas from this methodology were included in the iQonic requirements approach described within this work.

## 2.4 DoIT Approach

The Department of Information Technology (DoIT) of New Mexico have defined the Requirements Collection Template[6] that was overviewed and considered in the purpose the iQonic requirement methodology definition within this work. They follow the business objectives as the starting point for the development of business requirements which are the basis of the project as well as further development of the product, that the project has been defined to develop. They also capture the requirements of what the project must do and the properties that the system(s) must have as:

- Business Requirements, the high-level needs of the project that are basically captured during the plan phase of the project, and
- User Requirements, the business users' needs in terms of functionality, usability, performance, security, legal compliance etc., that are captured during the definition phase of the project and will be used to develop the system requirements.

## 2.5 iQonic Requirement Approach Process

The previous sections provide an overview of various approaches and methodologies that have been taken into consideration for requirement definition and reporting. Combining these proposals, ATLANTIS prepared online workshop describing the iQonic approach to be followed during the consolidation of requirements for this task, providing the material, examples and template (Table 1-1). Encompassing use cases, eleven TO, business, research and technical needs as well as following the template, this task resulted in development and collection of business RQs of iQonic industrial partners and hardware/software RQs from all technical partners.

The work within the task is divided and respectively defined in three iteration periods.

- ***Iteration I (M01-M04)*** – requirement definition on the consortium needs according to their business and/or manufacturing processes, technical and non-technical needs, wishes and constrains. The requirement discovering will be led by the task leader and iQonic partners will provide their input.
- ***Iteration II (M12-M14)*** – revision and 1st quality check in order to establish the requirement priorities will be led by Technical Manager that will discuss with iQonic partners and decide on which requirements will be included in the system implementation.

[5] Writing Effective Use Cases. Humans and Technology. Alistair Cockburn 1999.
[6] http://www.doit.state.nm.us/project_templates.html

- ***Iteration III (M18-M20)*** – analysis and final validation by Technical Manager with help of iQonic partners. This final stage will involve various techniques (e.g. testing, prototyping, etc.) for the ultimate quality check.

This deliverable is the result of collecting RQs within the Iteration I period of the requirements system engineering process. The part of the information (*RQ ID, RQ Type, use case, Status, Parent Requirement, Summary, Rationale, Reporter and Date*) from the template (Table 1-1) is used as the starting point in this first iteration. Since this task is the periodical process and not a single stage process of the project, the possibility to outline and analyse all aspects of the iQonic system is provided during the end of the WP2. This document and (*full)* template will be applied collecting the rest of the information required further on throughout the two other respective Iterations (II and III) of the project that will encompass the process itself and complete this list of requirements in order to be deployed at the end of the project.

**Table 1-1: The iQonic requirement template**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **RQ ID** | < id, e.g. AL-XX, AT-T-XX, etc.> | | **RQ Type** | <Business, Technical, Non-technical, Constrain> | | **Use Cases #** | <end users, e.g. FILAR> | |
| **Status** | ***New*** | <x> | ***Agreed-to*** | <x> | ***Baselined*** | <x> | ***Rejected*** | <x> |
| **Parent Requirement #** | <Enter the unique id (s) for each requirement that this requirement supports. Note, this field will be empty (N/A) for high level requirements i.e., business requirements.> | | | | | | | |
| **Title (Summary)** | <Enter concise description of requirement.> | | | | | | | |
| **Rationale (why, what, how)** | <Provide a brief rationale, and or business value for the requirement.> | | | | | | | |
| **Reporter** | <Name of RQ. Provider, e.g. ATLANTIS> | | | **Assignee** | | < WP Leader, Component owner, Techical Manager e.g. FRAUNHOFER > | | |
| **Priority** | ***Essential*** | <x> | ***Major*** | <x> | ***Medium*** | <x> | ***Optional*** | <x> |
| **Pre-conditions** | <Describe known pre-conditions. Whenever possible, make sure they are measurable or verifiable.> | | | | | | | |
| **Acceptance/Fit Criteria** | <Provide a target that makes it possible to test if requirement was satisfied> | | | | | | | |
| **Exceptions** | <Specify possible exceptions that should be handled> | | | | | | | |
| **Dependencies** | <List another requirement, provide id(s) that this requirement is dependent on> | | | | | | | |
| **Component/s** | <Specify> | | | | | | | |
| **Date (change history)** | <List history of changes to this requirement> | | | | | | | |

# 3 iQonic partnership and their intentions

The actors and stakeholders of iQonic project (Table 1-2) is a team made from industrial and academic associates that are experienced in cutting-edge technologies and active in the EU manufacturing research and innovation projects. These seventeen EU-based partners have gathered together following today's market needs and current technology approaches in order to cover all aspects of technical, industrial and business requirements and needs by providing a complete value chain through iQonic product and its services to the market.

**Table 1-2: The iQonic project consortium**

| Short name | Name | Country |
|---|---|---|
| **FRAUNHOFER*** | *FRAUNHOFER GESELLSCHAFT ZUR FOERDERUNG DER ANGEWANDTEN FORSCHUNG E.V.* | Germany |
| **ATLANTIS** | *ATLANTIS ENGINEERING AE* | Greece |
| **BRUNEL** | *BRUNEL UNIVERSITY LONDON* | United Kingdom |
| **CORE** | *CORE INNOVATION AND TECHNOLOGY OE* | Greece |
| **POLIMI** | *POLITECNICO DI MILANO* | Italy |
| **SHADOW** | *THE SHADOW ROBOT COMPANY LIMITED* | United Kingdom |
| **HOLONIX** | *HOLONIX SRL-SPIN OFF DEL POLITECNICO DI MILANO* | Italy |
| **SENSAP** | *SENSAP SWISS AG* | Switzerland |
| **IP-ASCR** | *FYZIKALNI USTAV AV CR V.V.I* | Czech Republic |
| **PRIMA** | *PRIMA ELECTRO SPA* | Italy |
| **ALPES** | *ALPES LASERS SA* | Switzerland |
| **FORTH** | *FOUNDATION FOR RESEARCH AND TECHNOLOGY HELLAS* | Greece |
| **FILAR** | *FILAR-OPTOMATERIALS SRL* | Italy |
| **SACMI** | *SACMI COOPERATIVA MECCANICI IMOLA SOCIETA COOPERATIVA* | Italy |
| **FICONTEC** | *FICONTEC SERVICE GMBH* | Germany |
| **TUT** | *TTY-SAATIO* | Finland |
| **BRIGHTERWAVE** | *BRIGHTERWAVE OY* | Finland |

* Project Coordinator and Technical Manager within the iQonic project.

## 3.1 Industrial Partners

Industrial partners of iQonic project have provided their machines and services in several manufacturing sectors while proposing a novel approach for inspecting, handling and reusing opto-electrical parts. ALPES, PRIMA, FILAR and BRIGHTERWAVE and their main aims have been introduced respectively and briefly through the following sub-sections.

### 3.1.1 ALPES

ALPES is a very important fabless company in the fields of laser diodes and assembly, representing the huge sector of laser manufacturers. Their aims are to integrate the quality control of its outsourced processes, as well as its in-house processes, into a "single window platform", which will allow them to have a better overview of the production process.

### 3.1.2 PRIMA

PRIMA Electro is a division of PRIMA INDUSTRIE Group that is a worldwide leader in the field of the laser machinery for the metal sheet cutting and welding applications in 2D and 3D. Through iQonic, PRIMA is planning to achieve optimised configurations of the diodes that will make it possible to overcome customisation limits, exploiting in an efficient way the laser process for different applications, according to the features of the beam.

### 3.1.3 FILAR

FILAR is a reliable supplier of photonic and optical materials manufacturing, representing big industrial sectors of supplying optical (synthetic) and laser crystals. By introducing the iQonic, FILAR expects to benefit by adding value to both on-line and off-line monitoring of the process chains by seeking more accurate feedback to deeper understanding and analysis.

### 3.1.4 BRIGHTERWAVE

BRIGHTERWAVE is a company developing miniaturised RGB lasers for Augmented Reality (AR) and Virtual Reality (VR) eyewear products to consumers and professionals. Their idea is to use iQonic and address the increased yield through the quality control of the produced lasers, and also speed-up the reconfiguration of the processes to host the high-volume production.

## 3.2 Technological providers partners

Beside the industry partners (iQonic end users) the consortium consists of:

- Research partners, that have a massive experience in research and development projects, especially in the Advanced Manufacturing and Photonics sector (FRAUNHOFER, BRUNEL, ATLANTIS, HOLONIX, CORE, TUT, POLIMI, FORTH, SHADOW, IP-ASCR) and
- Technology providing SMEs, that have successfully commercialised past EU project results and these results they are bringing on-board to improve and optimise addressing new challenges, i.e., HOLONIX (i-Like system), ATLANTIS (Decision Supply Chain - DSS, Reverse Supply Chain-RSC and Middleware), SENSAP (Metrology), SHADOW (Smart Grasping), FICONTEC (Flexible Reconfiguration), SACMI (Electronic Nose).

# 4 Industrial partners requirements

One of the steps of this work was to collect business requirements and high-level needs of our four pilots that are basically captured during the plan phase of the project but also elaborated during the task's life time. The idea is for these wishes, on how to build the iQonic system, to be followed that will provide guides how the general iQonic solution shall be applied within the optoelectronics industry in the future.

## 4.1 ALPES

| **RQ ID** | AL-B-01 | **RQ Type** | Business | **Use Cases** | ALPES |
|---|---|---|---|---|---|
| **Parent Requirement** | FORTH technology sensitive to the problem. | | | | |
| **Title (Summary)** | Defective hard-mask during front-end processing shall be detected prior to selective regrowth. | | | | |
| **Rationale (why, what, how)** | Devices with defective hard-mask are un-usable. Detecting this problem early will allow either to repeat the deposition process or scrap the wafer in which case the problem is detected early and not only at the end of the front-end fabrication and thus saves resources. FORTH's technology might be sensitive to mask-adhesion problems. | | | | |
| **Reporter** | ALPES | | | **Assignee** | FORTH |
| **Priority** | ***Essential*** | No | ***Major*** | Yes | ***Medium*** | No | ***Essential*** | No |
| **Date (change history)** | 07.01.2019 | | | | |

| **RQ ID** | AL-B-02 | **RQ Type** | Business | **Use Cases** | ALPES |
|---|---|---|---|---|---|
| **Parent Requirement** | N/A | | | | |
| **Title (Summary)** | Local defects on wafers shall be detected at various front-end processing stages and reported to the DSS. | | | | |
| **Rationale (why, what, how)** | Functional test is done after COS assembly. Defective devices that can be sorted-out prior to assembly and scrapped will not consume resources unnecessarily. Problem: Front-end processing is executed at remote FAB. | | | | |
| **Reporter** | ALPES | | | **Assignee** | FORTH, ATLANTIS |
| **Priority** | ***Essential*** | No | ***Major*** | Yes | ***Medium*** | No | ***Essential*** | No |
| **Date (change history)** | 07.01.2019 | | | | |

| RQ ID | AL-B-03 | RQ Type | Business | Use Cases | ALPES |
|---|---|---|---|---|---|
| Parent Requirement | Defect aggregation performed in DSS; FICONTEC built machine can be used by ALPES. | | | | |
| Title (Summary) | Aggregated mapping data shall be used to sort devices on wafer in different categories (scrap, client 1, product 1, …) | | | | |
| Rationale (why, what, how) | Using automated equipment to do the sorting helps the streamlining and speeds-up the process. | | | | |
| Reporter | ALPES | | Assignee | FICONTEC | |
| Priority | ***Essential*** | No | ***Major*** | No | ***Medium*** | No | ***Essential*** | No |
| Date (change history) | 07.01.2019 | | | | |

| RQ ID | AL-B-04 | RQ Type | Business | Use Cases | ALPES |
|---|---|---|---|---|---|
| Parent Requirement | N/A | | | | |
| Title (Summary) | Processed wafers with defects that reduce device lifetime shall be detected systematically and immediately after front-end processing. | | | | |
| Rationale (why, what, how) | ALT testing performed systematically during incoming inspection on wafers arriving from front-end processing. Setup will be built by ALPES. Data can be interfaced with DSS etc. | | | | |
| Reporter | ALPES | | Assignee | ALPES, FRAUNHOFER | |
| Priority | ***Essential*** | No | ***Major*** | Yes | ***Medium*** | No | ***Essential*** | No |
| Date (change history) | 07.01.2019 | | | | |

| RQ ID | AL-B-05 | RQ Type | Business | Use Cases | ALPES |
|---|---|---|---|---|---|
| Parent Requirement | FICONTEC machine accessible to ALPES | | | | |
| Title (Summary) | COS assembly shall be performed by automated equipment. | | | | |
| Rationale (why, what, how) | COS assembly has to be performed prior to functional test; automatizing this step will make ALPES' products and QCL-based solutions in general more competitive and interesting. | | | | |
| Reporter | ALPES | | Assignee | FICONTEC, FRAUNHOFER | |
| Priority | ***Essential*** | No | ***Major*** | Yes | ***Medium*** | No | ***Essential*** | No |

| | |
|---|---|
| **Date (change history)** | 07.01.2019 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **RQ ID** | AL-B-06 | **RQ Type** | Business | **Use Cases** | ALPES | | | |
| **Parent Requirement** | FICONTEC machine accessible to ALPES | | | | | | | |
| **Title (Summary)** | Device facet and top-contact inspection performed by automated equipment. | | | | | | | |
| **Rationale (why, what, how)** | Automatizing acquisition of front- and back-facet pictures with SoA inspection equipment will enhance efficiency of the process and yield precise information on waveguide geometry that can be fed-back to front-end fabrication and device analysis. | | | | | | | |
| **Reporter** | ALPES | | | **Assignee** | | FICONTEC, FRAUNHOFER | | |
| **Priority** | ***Essential*** | No | ***Major*** | Yes | ***Medium*** | No | ***Essential*** | No |
| **Date (change history)** | 07.01.2019 | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **RQ ID** | AL-B-07 | **RQ Type** | Business | **Use Cases** | ALPES | | | |
| **Parent Requirement** | FICONTEC machine accessible to ALPES | | | | | | | |
| **Title (Summary)** | For high-volume product functional device test shall be performed on assembly machine for device pre-selection. | | | | | | | |
| **Rationale (why, what, how)** | QCL's for spectroscopic applications have stringent constraints on spectral purity; sorting-out multi-mode devices as early as possible will help save testing resources. | | | | | | | |
| **Reporter** | ALPES | | | **Assignee** | | FICONTEC, FRAUNHOFER | | |
| **Priority** | ***Essential*** | No | ***Major*** | No | ***Medium*** | No | ***Essential*** | No |
| **Date (change history)** | 07.01.2019 | | | | | | | |

## 4.2 PRIMA

Within the 1st iteration period, PRIMA has defined three business requirements. Their details are presented below.

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | PR-B-01 | **RQ Type** | Business | **Use Cases** | PRIMA |
| **Parent Requirement** | N/A | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Title (Summary)** | In-line Inspection: The product shall be inspected in a non-time-consuming way, avoiding the expensive stages performed only at the end of the packing process. | | | | | | | |
| **Rationale (why, what, how)** | PRIMA uses iQonic to model the diode packing using the robotic cell with high accuracy and automated self-reconfiguration. This will allow to obtain optimized and customized configurations based on the different requests to be satisfied. The online inspection process will immediately be able to detect faults and failures, giving the possibility to intervene where necessary and avoid damage. This will increase the flexibility of the process, the saving of materials and the production times. | | | | | | | |
| **Reporter** | PRIMA | | | **Assignee** | | iQonic Consortium | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 26.11.2018. | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | PR-B-02 | **RQ Type** | Business | **Use Cases** | PRIMA |
| **Parent Requirement** | N/A | | | | |
| **Title (Summary)** | Reconfiguration of the production line: Reduction of the Time-To-Market of new products | | | | |
| **Rationale (why, what, how)** | Thanks to a reconfigurable production line in a short time thanks to CPS process control and data analysis. Through the data analysis it is possible to obtain lines of different types and consequently products with different characteristics (for example in our case diode with different power). This allows savings on the machinery to be used and therefore operating costs, savings on production times and the ability to more easily reach customers with different needs. Reduction of the Time-To-Market of new products, increasing the flexibility and modularity of the production process thanks to a new production line able to produce diodes with different power, wavelength and geometry, adapting the source for the specific application of the customer. | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Reporter** | PRIMA | | | **Assignee** | | iQonic Consortium | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 26.11.2018. | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | PR-B-03 | **RQ Type** | Business | **Use Cases** | PRIMA |
| **Parent Requirement** | N/A | | | | |
| **Title (Summary)** | Process Monitoring: Disassembly, Remanufacturing & Reuse of the components, currently, these aspects are not managed due to the higher vertical production and the high operating costs. | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Rationale (why, what, how)** | Through iQonic it will be possible to have an optimization of these three phases, thanks to real-time monitoring and better data management along the process steps. Monitoring is a strategic point for process management and complete traceability from the initial phase to the final phase of the diode production process. Monitor means collecting data for zero defect manufacturing. This will save on the waste of the raw material, also influencing the final cost of the components. | | | | | | | |
| **Reporter** | PRIMA | | | **Assignee** | | iQonic Consortium | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 26.11.2018. | | | | | | | |

### 4.3 FILAR

Within the 1st iteration period, FILAR has defined two business requirements. Their details are presented below.

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | FI-B-01 | **RQ Type** | Business | **Use Cases** | FILAR |
| **Parent Requirement** | N/A | | | | |
| **Title (Summary)** | Improvement of coated surfaces quality for laser applications. | | | | |
| **Rationale (why, what, how)** | In the ICONIQ framework, FILAR intends to improve the quality control process. It is necessary to reinforce the existing methods and tools and introduce advanced solutions that are particularly important in understanding material structure composition. Other important factors to be considered are LDT (Laser Damage Threshold), luminescence and material performance and reliability in real laser systems and devices. | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Reporter** | FILAR | | | **Assignee** | | IQONIC Consortium | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 16.01.2019 | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | FI-B-02 | **RQ Type** | Business | **Use Cases** | FILAR |
| **Parent Requirement** | N/A | | | | |
| **Title (Summary)** | Boosting mechanical process for rods production. | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Rationale (why, what, how)** | Through IQONIC we expect to refine both the extraction system and the various phases of mechanical process. By employing sensors and new microcontrollers, FILAR intends to increase its machine reliability, removing imperfections and reducing the running time. | | | | | | | |
| **Reporter** | FILAR | | | **Assignee** | | IQONIC Consortium | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 16.01.2019 | | | | | | | |

## BRIGHTERWAVE

Within the 1st iteration period, BRIGHTERWAVE has defined six business requirements. Their details are presented below.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **RQ ID** | BR-B-01 | **RQ Type** | Business | | **Use Cases** | BRIGHTERWAVE | | |
| **Parent Requirement** | N/A | | | | | | | |
| **Title (Summary)** | The yield of assembly process for frequency-converted laser light sources shall be increased. | | | | | | | |
| **Rationale (why, what, how)** | BRIGHTERWAVE uses the iQonic to optimize the assembly process (alignment and bonding phases) of a frequency-converted laser module. | | | | | | | |
| **Reporter** | BRIGHTERWAVE | | | **Assignee** | | iQonic Consortium | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 04.12.2018. | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **RQ ID** | BR-B-02 | **RQ Type** | Business | | **Use Cases** | BRIGHTERWAVE | | |
| **Parent Requirement** | N/A | | | | | | | |
| **Title (Summary)** | The quality inspection for the components used in the assembly process of frequency-converted laser light sources shall be improved. | | | | | | | |
| **Rationale (why, what, how)** | BRIGHTERWAVE uses the iQonic to improve the yield of a frequency-converted laser module assembly by improving the incoming quality inspection of the optical components used in the module. | | | | | | | |
| **Reporter** | BRIGHTERWAVE | | | **Assignee** | | iQonic Consortium | | |
| **Priority** | ***Essential*** | No | ***Major*** | Yes | ***Medium*** | No | ***Optional*** | No |

| | |
|---|---|
| **Date (change history)** | 04.12.2018. |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **RQ ID** | BR-B-03 | **RQ Type** | Business | | **Use Cases** | BRIGHTERWAVE | | |
| **Parent Requirement** | N/A | | | | | | | |
| **Title (Summary)** | The yield of assembly process for ultra-compact laser projector shall be increased. | | | | | | | |
| **Rationale (why, what, how)** | BRIGHTERWAVE uses the iQonic to optimize the assembly process (alignment and bonding phases) of a laser projector module consisting of several optical components. | | | | | | | |
| **Reporter** | BRIGHTERWAVE | | | **Assignee** | | iQonic Consortium | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 04.12.2018. | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **RQ ID** | BR-B-04 | **RQ Type** | Business | | **Use Cases** | BRIGHTERWAVE | | |
| **Parent Requirement** | N/A | | | | | | | |
| **Title (Summary)** | The quality inspection for the components used in the assembly process of laser projector modules shall be improved. | | | | | | | |
| **Rationale (why, what, how)** | BRIGHTERWAVE uses the iQonic to improve the yield of a laser projector assembly by improving the incoming quality inspection of the optical components used in the module. | | | | | | | |
| **Reporter** | BRIGHTERWAVE | | | **Assignee** | | iQonic Consortium | | |
| **Priority** | ***Essential*** | No | ***Major*** | Yes | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 04.12.2018. | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **RQ ID** | BR-B-05 | **RQ Type** | Business | | **Use Cases** | BRIGHTERWAVE | | |
| **Parent Requirement** | N/A | | | | | | | |
| **Title (Summary)** | The reuse-requalification of the components shall be improved. | | | | | | | |
| **Rationale (why, what, how)** | BRIGHTERWAVE uses the DSS to reuse/requalify components rejected in the incoming quality inspection of the assembly process (components could be used for modules intended for example at different wavelength/colour, lower output power or different operation temperature). | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Reporter** | BRIGHTERWAVE | | | **Assignee** | | iQonic Consortium | | |
| **Priority** | ***Essential*** | No | ***Major*** | No | ***Medium*** | No | ***Optional*** | Yes |
| **Date (change history)** | 04.12.2018. | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **RQ ID** | BR-B-06 | **RQ Type** | Business | | **Use Cases** | BRIGHTERWAVE | | |
| **Parent Requirement** | N/A | | | | | | | |
| **Title (Summary)** | The yield of manufacturing process for laser crystals used in laser modules shall be increased. | | | | | | | |
| **Rationale (why, what, how)** | BRIGHTERWAVE employs smart-tagging system to increase the yield of laser crystals (a key sub-component for laser modules). | | | | | | | |
| **Reporter** | BRIGHTERWAVE | | | **Assignee** | | iQonic Consortium | | |
| **Priority** | ***Essential*** | No | ***Major*** | No | ***Medium*** | No | ***Optional*** | Yes |
| **Date (change history)** | 04.12.2018. | | | | | | | |

# 5 Technological providers requirements

The technical and research partners requirements of iQonic, are important for this task and essence for the development of the project in general. As technological providers, the needs (not the solution) have been provided following the iQonic requirements approach, based on hardware and software components of consortium partners. The idea is to start with the RQs that will be used for the design components within WP3-WP6, get the user feedback and updated requirements that will retrofit and improve s/w and process chain designs within iQonic solution. In details, during the first iteration period (M01-M04) the requirement collection on the consortium needs have been reported below, following manufacturing processes, technical and non-technical needs and wishes and constrains. The requirement discovering was led by the task leader and iQonic technological providing partners provided their input president in respective sub-sections below.
It has to be noted that this task could be challenging since it is beginning of the project and some of the reported requirements within this first iteration period could have been described in a generic way. However, since there are other two iteration periods defined for quality check, reassessment and refinement of all reported requirements in this deliverable (and not only) they have been accepted for the current iteration.

## 5.1 HOLONIX

Within the 1st iteration period, HOLONIX has defined eight technical requirements. Their details are presented in respected sections.

### 5.1.1 KBS – Production process

| **RQ ID** | HO-T-01 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
|---|---|---|---|---|---|
| **Parent RQ** | N/A | | | | |
| **Title (Summary)** | The Knowledge Base System (KBS) shall store the whole information related to production processes, assets and products. | | | | |
| **Rationale (why, what, how)** | KBS shall guarantee a coherent storage of the whole information in order to enable a correlation between the different pieces, e.g.: production stage – process parameters - defect generation. A triple store DB will be developed on this purpose. | | | | |

| **Reporter** | HOLONIX | | | **Assignee** | | FRAUNHOFER | | |
|---|---|---|---|---|---|---|---|---|
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 20.12.2018. | | | | | | | |

| **RQ ID** | HO-T-02 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
|---|---|---|---|---|---|
| **Parent RQ** | HO-T-01 | | | | |
| **Title (Summary)** | The Knowledge Base System (KBS) shall store information according to a semantic model in order to be easily accessible by the users | | | | |
| **Rationale (why, what, how)** | KBS shall make use of a semantic model to optimize the accessibility of information and the easiness of data retrieval by the users. | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Reporter** | HOLONIX | | | **Assignee** | | FRAUNHOFER | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 20.12.2018. | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **RQ ID** | HO-T-03 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | | |
| **Parent RQ** | HO-T-01 | | | | | | | |
| **Title (Summary)** | The Knowledge Base System (KBS) shall transform raw data from the shopfloor to be stored according to the iQonic semantic model | | | | | | | |
| **Rationale (why, what, how)** | KBS shall have a component (RDFizer) to transform raw data from sensors/machines and company's ERP/MES into triplets suitable to be stored in the ontological DB | | | | | | | |
| **Reporter** | HOLONIX | | | **Assignee** | | FRAUNHOFER | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 20.12.2018. | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **RQ ID** | HO-T-04 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | | |
| **Parent RQ** | HO-T-01 | | | | | | | |
| **Title (Summary)** | The Knowledge Base System (KBS) shall make inference to make correlation between defects and process parameters | | | | | | | |
| **Rationale (why, what, how)** | KBS shall help users to reduce/eliminate defects through the development of a reasoner that will make correlation between products defects and process parameters | | | | | | | |
| **Reporter** | HOLONIX | | | **Assignee** | | FRAUNHOFER | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 20.12.2018. | | | | | | | |

### 5.1.2 KBS – Products reuse/requalification

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | HO-T-05 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Parent RQ** | N/A | | | | | | | |
| **Title (Summary)** | The Knowledge Base System (KBS) shall store the whole information related to product defects and technologies and tools for products reuse and requalification. | | | | | | | |
| **Rationale (why, what, how)** | KBS shall guarantee a coherent storage of the whole information in order to enable a correlation between the different pieces, e.g.: defective product – technology to be applied – assets and tools. Data will be stored according to a semantic structure. | | | | | | | |
| **Reporter** | HOLONIX | | | **Assignee** | | POLIMI | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 20.12.2018. | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | HO-T-06 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | HO-T-05 | | | | |
| **Title (Summary)** | The Knowledge Base System (KBS) shall store information according to a semantic model in order to be easily accessible by the users | | | | |
| **Rationale (why, what, how)** | KBS shall make use of a semantic model to optimize the accessibility of information and the easiness of data retrieval by the users. | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Reporter** | HOLONIX | | | **Assignee** | | POLIMI | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 20.12.2018. | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | HO-T-07 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | HO-T-05 | | | | |
| **Title (Summary)** | The Knowledge Base System (KBS) shall transform raw data from the shopfloor to be stored according to the iQonic semantic model | | | | |
| **Rationale (why, what, how)** | KBS shall have a component (RDFizer) to transform raw data from sensors used for quality control and information related to reuse and requalification technologies into triplets suitable to be stored in the ontological DB | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Reporter** | HOLONIX | | | **Assignee** | | POLIMI | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 20.12.2018. | | | | | | | |

| RQ ID | HO-T-08 | RQ Type | Technical | Use Cases | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
|---|---|---|---|---|---|
| Parent RQ | HO-T-05 | | | | |
| Title (Summary) | The Knowledge Base System (KBS) shall make inference to make correlation between defective products and reuse/requalification technologies | | | | |
| Rationale (why, what, how) | KBS shall help users to reduce/eliminate scraps through the development of a reasoner that will make correlation between defective products, technology to be applied to reuse/requalify them and tool/assets required. | | | | |
| Reporter | HOLONIX | | Assignee | POLIMI | |

| Priority | *Essential* | Yes | *Major* | No | *Medium* | No | *Optional* | No |
|---|---|---|---|---|---|---|---|---|
| Date (change history) | 20.12.2018. | | | | | | | |

## 5.2 ATLANTIS

Within the 1st iteration period, ATLANTIS has defined twelve technical requirements and three non-technical requirements. Their details are presented in respected sections.

### 5.2.1 Decision Support System

| RQ ID | AT-T-01 | RQ Type | Technical | Use Cases | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
|---|---|---|---|---|---|
| Parent RQ | N/A | | | | |
| Title (Summary) | The higher-level Decision Support System (DSS) shall respond to the defects and their severity in an optimum way. | | | | |
| Rationale (why, what, how) | The higher-level Decision Support System (DSS) shall enable optimum response to other suggestions in order to minimize defects and their severity. | | | | |
| Reporter | ATLANTIS | | Assignee | FRAUNHOFER, ATLANTIS | |

| Priority | *Essential* | Yes | *Major* | No | *Medium* | No | *Optional* | No |
|---|---|---|---|---|---|---|---|---|
| Date (history) | 30.11.2018. | | | | | | | |

| RQ ID | AT-T-02 | RQ Type | Technical | Use Cases | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
|---|---|---|---|---|---|
| Parent RQ | AT-T-01 | | | | |
| Title (Summary) | The DSS shall analyse the defect types from all use cases. | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Rationale (why, what, how)** | The clarification and analysis of common causes of defects are to be produced by DSS in terms of defect severity, occurrence and impact on involved process chain and production. | | | | | | | |
| **Reporter** | ATLANTIS | | | **Assignee** | | FRAUNHOFER, ATLANTIS | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (history)** | 30.11.2018. | | | | | | | |

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|---|---|---|---|---|---|
| **RQ ID** | AT-T-03 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | AT-T-01 | | | | |
| **Title (Summary)** | DSS shall support risk assessment (IEC3110:2009) as well as to adopt risk-based thinking (in line with ISO 9001:2015). | | | | |
| **Rationale (why, what, how)** | DSS shall adopt risk-based thinking and support faster and better decision making at end users' shop-floor. | | | | |

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| **Reporter** | ATLANTIS | | | **Assignee** | | FRAUNHOFER, ATLANTIS | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (history)** | 30.11.2018. | | | | | | | |

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|---|---|---|---|---|---|
| **RQ ID** | AT-T-04 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | AT-T-01 | | | | |
| **Title (Summary)** | DSS shall incorporate autonomous and hierarchical decision support for optimum response to defects. | | | | |
| **Rationale (why, what, how)** | The DSS is to provide recommendations for optimum response to defects. | | | | |

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|---|---|---|---|---|---|---|---|---|
| **Reporter** | ATLANTIS | | | **Assignee** | | FRAUNHOFER, ATLANTIS | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (history)** | 30.11.2018. | | | | | | | |

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|---|---|---|---|---|---|
| **RQ ID** | AT-T-05 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |

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|---|---|---|---|---|---|---|---|---|
| **Parent RQ** | AT-T-01 | | | | | | | |
| **Title (Summary)** | DSS shall define rules and conditions to be met for each use case. | | | | | | | |
| **Rationale (why, what, how)** | DSS shall define rules and conditions to be met for each use case based on the semantic along with conditions for the activation of each one of the iQonic Strategies. | | | | | | | |
| **Reporter** | ATLANTIS | | | **Assignee** | | FRAUNHOFER, ATLANTIS | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (history)** | 30.11.2018. | | | | | | | |

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|---|---|---|---|---|---|
| **RQ ID** | AT-T-06 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | AT-T-01 | | | | |
| **Title (Summary)** | The DSS shall improve the efficiency of future recommendations, both for process-chain optimization and for iQonic Strategies activation. | | | | |
| **Rationale (why, what, how)** | DSS shall store and analyse the effects and impacts from iQonic Strategies activation through its machine-learning element and provide improved future recommendations to the end user. | | | | |

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| **Reporter** | ATLANTIS | | | **Assignee** | | FRAUNHOFER, ATLANTIS | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (history)** | 30.11.2018. | | | | | | | |

### 5.2.2 Reverse Supply Chain

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | AT-T-07 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | N/A | | | | |
| **Title (Summary)** | Reverse Supply Chain (RSC) of iQonic shall understand when the defected parts/products are detected in downstream stages and shall decide the possible redirection. | | | | |
| **Rationale (why, what, how)** | The RSC process of iQonic will be realized when the defected products/parts are detected in downstream stages, in order to decide their possible redirection, either to upstream stages for remanufacturing or to other supply-chain tiers for possible disassembly, recycling or disposal. | | | | |

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| **Reporter** | ATLANTIS | | | **Assignee** | | FRAUNHOFER, ATLANTIS | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |

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| **Date (history)** | 30.11.2018. |

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|---|---|---|---|---|---|---|---|---|
| **RQ ID** | AT-T-08 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | | |
| **Parent RQ** | AT-T-07 | | | | | | | |
| **Title (Summary)** | The RSC shall use a rule-based engine with rules defining the conditions to be met (e.g. defect severity and type, recoverable, value to recover, repairable, defect origin, stage, internal/external supply tier, etc.). | | | | | | | |
| **Rationale (why, what, how)** | The RSC shall use a rule-based engine with rules defining the conditions to be met considering the involved stages, tiers and conditions for product/part reuse and requalification. Semantic rules should be defined for the reverse process based on use-case input analysis. | | | | | | | |
| **Reporter** | ATLANTIS | | | **Assignee** | | FRAUNHOFER, ATLANTIS | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (history)** | 30.11.2018. | | | | | | | |

### 5.2.3 Middleware

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **RQ ID** | AT-T-09 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | | |
| **Parent RQ** | N/A | | | | | | | |
| **Title (Summary)** | Manufacturing execution systems (MES) and other higher-level management systems shall exchange data, alarms about predicted/detected defects, recommendations, production and product requirements. | | | | | | | |
| **Rationale (why, what, how)** | Manufacturing execution systems (MES) and other higher-level management systems shall communicate through middleware application that will be designed according to the standardized protocols and communication means (OPC, OPC-UA, UMCM), based on industrial standards (e.g. IEC 62714, IEC 62264, OPC UA). | | | | | | | |
| **Reporter** | ATLANTIS | | | **Assignee** | | FRAUNHOFER, ATLANTIS | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 30.11.2018. | | | | | | | |

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|---|---|---|---|---|---|
| **RQ ID** | AT-T-10 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | AT-T-09 | | | | |

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|---|---|---|---|---|---|---|---|---|
| **Title (Summary)** | The middleware shall perform the semantic modelling of the data to be exchanged with MES and other higher-level management systems. | | | | | | | |
| **Rationale (why, what, how)** | Perform the semantic modelling of the data to be exchanged for interfacing middleware with MES and other higher-level management systems. This calls for use of appropriate ontology elements and semantic annotation of all exchanged data. | | | | | | | |
| **Reporter** | ATLANTIS | | | **Assignee** | | FRAUNHOFER, ATLANTIS | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 30.11.2018. | | | | | | | |

### 5.2.4 General

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|---|---|---|---|---|---|
| **RQ ID** | AT-T-11 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | N/A | | | | |
| **Title (Summary)** | Data shall be collected and analyzed for monitoring of iQonic strategies implementation. | | | | |
| **Rationale (why, what, how)** | Both iQonic component level development (vertical) and process chains implementation level (horizontal) will be implemented at each pilot use case scenario and system operational environment. Furthermore, process chain status measurement analysis will be adapted to provide the means for process validation. | | | | |

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| **Reporter** | ATLANTIS | | | **Assignee** | | FRAUNHOFER, ATLANTIS | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 30.11.2018. | | | | | | | |

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|---|---|---|---|---|---|
| **RQ ID** | AT-T-12 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | AT-NT-13 | | | | |
| **Title (Summary)** | The collected data shall be analyzed in order to evaluate the effectiveness, reliability, impact and acceptance of ICONIC system. | | | | |
| **Rationale (why, what, how)** | The analysis of the collected data will allow to extrapolate trends and assess the effective performance of iQonic, and to draw conclusions on the fulfillment of expected impact and stakeholder's expectations, both in terms of effectiveness / efficiency / reliability / objectives / expectations fulfilment analysis, as well as social and economic impact on the manufacturing environment. | | | | |

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| **Reporter** | ATLANTIS | **Assignee** | FRAUNHOFER, ATLANTIS |

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|---|---|---|---|---|---|---|---|---|
| **Priority** | ***Essential*** | No | ***Major*** | Yes | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 30.11.2018. | | | | | | | |

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|---|---|---|---|---|---|
| **RQ ID** | AT-NT-13 | **RQ Type** | Non-Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | N/A | | | | |
| **Title (Summary)** | Data shall be collected and organized from pilot demonstrations. | | | | |
| **Rationale (why, what, how)** | The data for technical, user acceptance and factory impact indicators shall be gathered in different formats (rtf documents for user acceptance, questionnaires / online instruments, spreadsheets with data for technical KPIs, data of ERP-MES-SCADA repositories, data from impact checklists), organized from pilot demonstrations. | | | | |
| **Reporter** | ATLANTIS | | **Assignee** | FRAUNHOFER, ATLANTIS | |

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|---|---|---|---|---|---|---|---|---|
| **Priority** | ***Essential*** | No | ***Major*** | Yes | ***Medium*** | No | ***Optional*** | No |
| **Date (history)** | 30.11.2018. | | | | | | | |

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|---|---|---|---|---|---|
| **RQ ID** | AT-NT-14 | **RQ Type** | Non-Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | N/A | | | | |
| **Title (Summary)** | A Knowledge Management document shall be created incorporating the technical and business logic created during the project. | | | | |
| **Rationale (why, what, how)** | A Knowledge Management document shall be created, based on Data Management Planning, incorporating in a structured way the technical and business logic created during the project, describing how the acquired data and knowledge will be shared and/or made open, and how it will be maintained and preserved. Identifiable project data will be provided in a manner to define relevant knowledge, increase partner's awareness, validate the result and time frame of actions. | | | | |
| **Reporter** | ATLANTIS | | **Assignee** | FRAUNHOFER, CORE, ATLANTIS | |

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|---|---|---|---|---|---|---|---|---|
| **Priority** | ***Essential*** | No | ***Major*** | Yes | ***Medium*** | No | ***Optional*** | No |
| **Date (history)** | 30.11.2018. | | | | | | | |

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|---|---|---|---|---|---|
| **RQ ID** | AT-NT-15 | **RQ Type** | Non-Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |

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|---|---|---|---|---|---|---|---|---|
| **Parent RQ** | AT-NT-14 | | | | | | | |
| **Title (Summary)** | The project results obtained during the project life time shall be protected. | | | | | | | |
| **Rationale (why, what, how)** | The project results obtained during the project life time shall follow the IPR activities (e.g. patent searches, filling or patent or other IPR applications, develop protection licenses, etc.) in order to be protected. | | | | | | | |
| **Reporter** | ATLANTIS | | | **Assignee** | | FRAUNHOFER, CORE ATLANTIS | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (history)** | 30.11.2018. | | | | | | | |

## 5.3 SENSAP

Within the 1st iteration period, SENSAP has defined fifteen technical requirements and five non-technical requirements. Their details are presented in respected sections.

### 5.3.1 Inspection & metrology infrastructure to monitor the KPIs

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **RQ ID** | SE-T-01 | **RQ Type** | Technical | | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | |
| **Parent RQ** | N/A | | | | | | | |
| **Title (Summary)** | Visual Quality Inspection | | | | | | | |
| **Rationale (why, what, how)** | iQonic should define in all the use cases the requirements (e.g. resolution, accuracy, performance, classification of error types) and the potential positions in the production chain where the visual quality inspections will take place | | | | | | | |
| **Reporter** | Sensap Swiss | | | **Assignee** | | FRAUNHOFER | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 11/01/2019 | | | | | | | |

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|---|---|---|---|---|---|---|---|---|
| **RQ ID** | SE-T-02 | **RQ Type** | Technical | | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | |
| **Parent RQ** | SE-T-01 | | | | | | | |
| **Title (Summary)** | Visual Quality Inspection Methodologies and Techniques | | | | | | | |
| **Rationale (why, what, how)** | iQonic should investigate, update and develop the visual inspection system depicted from the user case requirements for the analysis of the quality of the final product or the semi-ready product throughout the production chain in order for a decision, based on the product quality, being made by the upper level systems of the iQonic platform. | | | | | | | |
| **Reporter** | Sensap Swiss | | | **Assignee** | | FRAUNHOFER | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 11/01/2019 | | | | | | | |

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|---|---|---|---|---|---|
| **RQ ID** | SE-T-03 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | SE-T-01 | | | | |
| **Title (Summary)** | In-Line metrology | | | | |
| **Rationale (why, what, how)** | iQonic visual inspection system should be directly integrated into the production process. The product under inspection is measured without detours, ejections or separate test stations. | | | | |
| **Reporter** | Sensap Swiss | | **Assignee** | FRAUNHOFER | |

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|---|---|---|---|---|---|---|---|---|
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 11/01/2019 | | | | | | | |

### 5.3.2 Smart tagging for automatic setting-up the process chain parameters

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|---|---|---|---|---|---|
| **RQ ID** | SE-T-04 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | N/A | | | | |
| **Title (Summary)** | Smart Product | | | | |
| **Rationale (why, what, how)** | A product should identify itself to the modules, providing all information required to accomplish its process on module. RFIDs/2D-Barcode are attached to the product following encoding standards (e.g. GS1-128), so that product-related information can be accessed | | | | |
| **Reporter** | Sensap Swiss | | **Assignee** | FRAUNHOFER | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Priority** | ***Essential*** | No | ***Major*** | Yes | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 09/01/2019 | | | | | | | |

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|---|---|---|---|---|---|
| **RQ ID** | SE-T-05 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | SE-T-04 | | | | |
| **Title (Summary)** | Smart Tag Scanning | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Rationale (why, what, how)** | A smart tagging scheme should be employed in order to linking all the data for each component to not only automate the loading process for programming the actuators, but also to minimize the possibility of using the wrong set-up of process parameters for any given product | | | | | | | |
| **Reporter** | Sensap Swiss | | | **Assignee** | | FRAUNHOFER | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 09/01/2019 | | | | | | | |

### 5.3.3 Multisensorial data acquisition network for manufacturing opto-electrical parts

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | SE-T-06 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | N/A | | | | |
| **Title (Summary)** | iQonic should be able to exchange data with existing infrastructure/assets (legacy systems) at the shop-floor | | | | |
| **Rationale (why, what, how)** | A layer that facilitate the data exchange, flow and sharing between software components/services, based on industrial standards (e.g. OPC UA) should be designed and developed. | | | | |
| **Reporter** | Sensap Swiss | | **Assignee** | FRAUNHOFER | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 02/01/2019 | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | SE-T-07 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | SE-T-06 | | | | |
| **Title (Summary)** | A common semantic data modelling. | | | | |
| **Rationale (why, what, how)** | Modelling of the data to be exchanged by the acquisition module to the upper level sub-systems of the iQonic should be designed and agreed between involved partners. | | | | |
| **Reporter** | Sensap Swiss | | **Assignee** | SENSAP, HOLONIX, ATLANTIS, FRAUNHOFER | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 02/01/2019 | | | | | | | |

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|---|---|---|---|---|---|
| **RQ ID** | SE-T-08 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |

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|---|---|---|---|---|---|---|---|---|
| **Parent RQ** | N/A | | | | | | | |
| **Title (Summary)** | Access to physical data using sensors | | | | | | | |
| **Rationale (why, what, how)** | The iQonic will provide the necessary mechanisms for sensing (i.e. to extract information from heterogenous data sources both physical and software assets) | | | | | | | |
| **Reporter** | Sensap Swiss | | | **Assignee** | | FRAUNHOFER | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 02/01/2019 | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | SE-T-09 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Parent RQ** | N/A | | | | | | | |
| **Title (Summary)** | The traceability of data collected, and machine/industrial assets observations should be guaranteed. | | | | | | | |
| **Rationale (why, what, how)** | All the data collected and extracted from machines/industrial assets must be related to a standard reference system to enable the connection, mapping and tracking of the extracted data and observations to machines/industrial assets, data analytics services, etc. | | | | | | | |
| **Reporter** | Sensap Swiss | | | **Assignee** | | FRAUNHOFER, | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 02/01/2019 | | | | | | | |

### 5.3.4 Integration of software – hardware platforms and tools

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|---|---|---|---|---|---|
| **RQ ID** | SE-T-10 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Parent RQ** | N/A | | | | | | | |
| **Title (Summary)** | iQonic needs to operate in a network based environment | | | | | | | |
| **Rationale (why, what, how)** | To use web-based technologies to allow all the components and layers within the system to connect with other part of the system itself that is available in the same network | | | | | | | |
| **Reporter** | Sensap Swiss | | | **Assignee** | | FRAUNHOFER | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 02/01/2019 | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | SE-T-11 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | BRIGHTERWAVE |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Parent RQ** | N/A | | | | | | | |
| **Title (Summary)** | The system should leverage standard as much as possible | | | | | | | |
| **Rationale (why, what, how)** | To design and develop a layer that deeply relies on standards to support and facilitate the integration of legacy and heterogeneous machines/industrial assets | | | | | | | |
| **Reporter** | Sensap Swiss | | | **Assignee** | | FRAUNHOFER | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 02/01/2019 | | | | | | | |

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|---|---|---|---|---|---|---|---|---|
| **RQ ID** | SE-T-12 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | | |
| **Parent RQ** | N/A | | | | | | | |
| **Title (Summary)** | To design, develop and install a ”non” intrusive system | | | | | | | |
| **Rationale (why, what, how)** | The system should not use communication technologies that interfere with existing communication infrastructure | | | | | | | |
| **Reporter** | Sensap Swiss | | | **Assignee** | | FRAUNHOFER | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 02/01/2019 | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **RQ ID** | SE-T-13 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | | |
| **Parent RQ** | N/A | | | | | | | |
| **Title (Summary)** | iQonic platform and communications should be secure | | | | | | | |
| **Rationale (why, what, how)** | Several data sources generate data that needs to be collected and sent over public and/or private networks to a possibly remote infrastructure in order to be analyzed. In the same way, data generated on a remote location received back to the iQonic module in order to integrate the received information into the process | | | | | | | |
| **Reporter** | Sensap Swiss | | | **Assignee** | | FRAUNHOFER | | |
| **Priority** | ***Essential*** | No | ***Major*** | Yes | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 02/01/2019 | | | | | | | |

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|---|---|---|---|---|---|
| **RQ ID** | SE-T-14 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |

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|---|---|---|---|---|---|---|---|---|
| **Parent RQ** | N/A | | | | | | | |
| **Title (Summary)** | iQonic system should employ modularity principle. | | | | | | | |
| **Rationale (why, what, how)** | System components should be loosely coupled and reconfigurable on a plug and play principle so as the system be able to respond to changing customer requirements and overcome internal system failures. | | | | | | | |
| **Reporter** | Sensap Swiss | | | **Assignee** | | FRAUNHOFER | | |
| **Priority** | ***Essential*** | No | ***Major*** | No | ***Medium*** | **Priority** | ***Essential*** | No |
| **Date (change history)** | 09/01/2019 | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **RQ ID** | SE-NT-15 | **RQ Type** | Non-technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | | |
| **Parent RQ** | N/A | | | | | | | |
| **Title (Summary)** | iQonic platform architecture shall support cloud infrastructure | | | | | | | |
| **Rationale (why, what, how)** | A cloud infrastructure should be supported so as the iQonic could aligned with Industry 4.0 specification and benefit from it (secure, scalability, etc) | | | | | | | |
| **Reporter** | Sensap Swiss | | | **Assignee** | | FRAUNHOFER | | |
| **Priority** | ***Essential*** | No | ***Major*** | Yes | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 02/01/2019 | | | | | | | |

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|---|---|---|---|---|---|---|---|---|
| **RQ ID** | SE-NT-16 | **RQ Type** | Non-technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | | |
| **Parent RQ** | N/A | | | | | | | |
| **Title (Summary)** | iQonic platform | | | | | | | |
| **Rationale (why, what, how)** | The iQonic platform shall provide technical support, business support services to platform users. | | | | | | | |
| **Reporter** | Sensap Swiss | | | **Assignee** | | FRAUNHOFER | | |
| **Priority** | ***Essential*** | No | ***Major*** | No | ***Medium*** | Yes | ***Optional*** | No |
| **Date (change history)** | 11/01/2019 | | | | | | | |

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|---|---|---|---|---|---|
| **RQ ID** | SE-NT-17 | **RQ Type** | Non-technical | **Use Cases** | ALPES, FILAR, PRIMA, |

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|---|---|---|---|---|---|
| | | | | | BRIGHTERWAVE |

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|---|---|---|---|---|---|---|---|---|
| **Parent RQ** | N/A | | | | | | | |
| **Title (Summary)** | iQonic platform | | | | | | | |
| **Rationale (why, what, how)** | Architecture shall comply with the emerging standards (RAMI 4.0 and the Industrial Internet Consortium) | | | | | | | |
| **Reporter** | Sensap Swiss | | | **Assignee** | | FRAUNHOFER | | |
| **Priority** | ***Essential*** | No | ***Major*** | Yes | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 11/01/2019 | | | | | | | |

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|---|---|---|---|---|---|
| **RQ ID** | SE-NT-18 | **RQ Type** | Non-technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |

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|---|---|---|---|---|---|---|---|---|
| **Parent RQ** | N/A | | | | | | | |
| **Title (Summary)** | iQonic Data modelling | | | | | | | |
| **Rationale (why, what, how)** | The semantics of modelling in iQonic must be based on standardized meta-models and ontologies and should support the production and be extensible. | | | | | | | |
| **Reporter** | Sensap Swiss | | | **Assignee** | | FRAUNHOFER | | |
| **Priority** | ***Essential*** | No | ***Major*** | Yes | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 11/01/2019 | | | | | | | |

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|---|---|---|---|---|---|
| **RQ ID** | SE-NT-19 | **RQ Type** | Non-technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |

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|---|---|---|---|---|---|---|---|---|
| **Parent RQ** | N/A | | | | | | | |
| **Title (Summary)** | iQonic Security | | | | | | | |
| **Rationale (why, what, how)** | The security framework shall ensure confidentiality of data and prevent unauthorized access to the platform. | | | | | | | |
| **Reporter** | Sensap Swiss | | | **Assignee** | | FRAUNHOFER | | |
| **Priority** | ***Essential*** | No | ***Major*** | Yes | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 11/01/2019 | | | | | | | |

| RQ ID | SE-T-20 | RQ Type | Technical | Use Cases | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
|---|---|---|---|---|---|
| Parent RQ | N/A | | | | |
| Title (Summary) | Provide a set of Human Machine Interfaces (HMI) to allow humans to interact with it | | | | |
| Rationale (why, what, how) | iQonic should provide graphical interfaces for data visualization The data visualization will ensure the visualization of the KPI over the time, the possibility to define new KPIs and the necessary mechanisms to support the human in the decision making process. | | | | |
| Reporter | Sensap Swiss | | Assignee | FRAUNHOFER | |
| Priority | ***Essential*** No | ***Major*** Yes | ***Medium*** No | ***Optional*** No | |
| Date (change history) | 02/01/2019 | | | | |

## 5.4 ficonTEC

Within the 1st iteration period, ficonTEC has defined ten technical requirements. Their details are presented below.

### 5.4.1 Hardware for automated assembly

| RQ ID | FIC-T-01 | RQ Type | Technical | Use Cases | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
|---|---|---|---|---|---|
| Parent RQ | N/A | | | | |
| Title (Summary) | Assembly process chain | | | | |
| Rationale (why, what, how) | The assembly process chains used at the end users should be documented to allow FICONTEC to make a conceptual study about possible assembly machine layout for the project. | | | | |
| Reporter | FICONTEC | | Assignee | ALPES, FILAR, PRIMA, BRIGHTERWAVE | |
| Priority | ***Essential*** Yes | ***Major*** No | ***Medium*** No | ***Optional*** No | |
| Date (history) | 16.01.2019 | | | | |

| RQ ID | FIC-T-02 | RQ Type | Technical | Use Cases | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
|---|---|---|---|---|---|
| Parent RQ | FIC-T-01 | | | | |
| Title (Summary) | Component size and quantity | | | | |

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|---|---|---|---|---|---|---|---|---|
| **Rationale (why, what, how)** | The size of the photonic components to be handled and assemble should be documented to choose a proper handling mechanism. | | | | | | | |
| **Reporter** | FICONTEC | | | **Assignee** | | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (history)** | 16.01.2019 | | | | | | | |

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|---|---|---|---|---|---|
| **RQ ID** | FIC-T-03 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | FIC-T-01 | | | | |
| **Title (Summary)** | Alignment processes | | | | |
| **Rationale (why, what, how)** | The concepts used for the alignment of optical components needs to be documented. This could be either passive (vision based) or active (device under operation) processes. The alignment tolerances should be reported to decide for a proper machine layout. | | | | |

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| **Reporter** | FICONTEC | | | **Assignee** | | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (history)** | 16.01.2019 | | | | | | | |

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|---|---|---|---|---|---|
| **RQ ID** | FIC-T-04 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | FIC-T-01 | | | | |
| **Title (Summary)** | Fixation processes | | | | |
| **Rationale (why, what, how)** | The way how the optical components are fixed after alignment needs to be documented to allow for a proper machine layout. This includes the used material for fixation for bonding or epoxy based processes. | | | | |

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|---|---|---|---|---|---|---|---|---|
| **Reporter** | FICONTEC | | | **Assignee** | | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (history)** | 16.01.2019 | | | | | | | |

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|---|---|---|---|---|---|
| **RQ ID** | FIC-T-05 | **RQ Type** | Technical | **Use Cases** | FORTH |
| **Parent RQ** | N/A | | | | |

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|---|---|---|---|---|---|---|---|---|
| **Title (Summary)** | Inspection system | | | | | | | |
| **Rationale (why, what, how)** | The characteristics of the digital adaptive optics system need to be known for implementation into the machine. | | | | | | | |
| **Reporter** | FICONTEC | | | **Assignee** | | FORTH | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (history)** | 16.01.2019 | | | | | | | |

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|---|---|---|---|---|---|
| **RQ ID** | FIC-T-06 | **RQ Type** | Technical | **Use Cases** | FORTH |
| **Parent RQ** | FIC-T-05 | | | | |
| **Title (Summary)** | Hardware of inspection system | | | | |
| **Rationale (why, what, how)** | The dimensions and weight as well as typical hardware interface like electrical and mechanical connections of the digital adaptive optics system needs to be known for implementation into the machine. | | | | |

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|---|---|---|---|---|---|---|---|---|
| **Reporter** | FICONTEC | | | **Assignee** | | FORTH | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (history)** | 16.01.2019 | | | | | | | |

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|---|---|---|---|---|---|
| **RQ ID** | FIC-T-07 | **RQ Type** | Technical | **Use Cases** | FORTH |
| **Parent RQ** | FIC-T-05 | | | | |
| **Title (Summary)** | Software interface of inspection system | | | | |
| **Rationale (why, what, how)** | The software interface of the digital adaptive optics system needs to be known for implementation into the machine. | | | | |

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|---|---|---|---|---|---|---|---|---|
| **Reporter** | FICONTEC | | | **Assignee** | | FORTH | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (history)** | 16.01.2019 | | | | | | | |

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|---|---|---|---|---|---|
| **RQ ID** | FIC-T-08 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | N/A | | | | |
| **Title (Summary)** | Sensor data | | | | |

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|---|---|---|---|---|---|---|---|---|
| **Rationale (why, what, how)** | The amount of required sensor data and the format in which the data needs to be saved needs to be known to allow for use of evaluation of this data for artificial intelligence algorithms. | | | | | | | |
| **Reporter** | FICONTEC | | | **Assignee** | | BRUNEL | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (history)** | 16.01.2019 | | | | | | | |

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|---|---|---|---|---|---|
| **RQ ID** | FIC-T-09 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | N/A | | | | |
| **Title (Summary)** | Electronic nose | | | | |
| **Rationale (why, what, how)** | The interface to the electronic nose needs to be known for proper implementation into the assembly machine. | | | | |

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| **Reporter** | FICONTEC | | | **Assignee** | | Sacmi | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (history)** | 16.01.2019 | | | | | | | |

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|---|---|---|---|---|---|
| **RQ ID** | FIC-T-10 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | N/A | | | | |
| **Title (Summary)** | Electronic nose | | | | |
| **Rationale (why, what, how)** | The chemicals which can be detected by the electronic noise should be known to plan for a proper use in the assembly machine | | | | |

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| **Reporter** | FICONTEC | | | **Assignee** | | Sacmi | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (history)** | 16.01.2019 | | | | | | | |

## 5.5 SACMI

In the first iteration SACMI has defined seven technical requirements and two constraints. Their details are presented in respected sections.

### 5.5.1 Interfacing of SACMI instrument to the data acquisition system

| RQ ID | SA-T-01 | RQ Type | Technical | Use Cases | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
|---|---|---|---|---|---|
| Parent RQ | N/A | | | | |
| Title (Summary) | Input/output between system controller (DSS) and electronic nose shall be involved within the sub-system and components. | | | | |
| Rationale (why, what, how) | Input from system controller (DSS) shall be involved within the sub-system and components by the usage of HMI, RS-232 or remote control (via GSM) that will provide direct control over the electronic nose.<br>It is also necessary to define which outputs the system controller (DSS) requires. | | | | |
| Reporter | SACMI | | Assignee | | BRIGHTERWAVE, FICONTEC, FRAUNHOFER, BRUNEL, ATLANTIS, HOLONIX, TUT, POLIMI, FORTH, SENSAP, SHADOW, IP-ASCR (HiLASE) |

| Priority | *Essential* | Yes | *Major* | No | *Medium* | No | *Optional* | No |
|---|---|---|---|---|---|---|---|---|
| Date (change history) | 10.12.2018. | | | | | | | |

### 5.5.2 Environmental operational condition

| RQ ID | SA-T-02 | RQ Type | Technical | Use Cases | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
|---|---|---|---|---|---|
| Parent RQ | N/A | | | | |
| Title (Summary) | Environment experimental condition (temperature and humidity) shall be examined within the sampling chamber. | | | | |
| Rationale (why, what, how) | (what): The sampling chamber and the sample itself shall be involved within the sub-system and components. and it shall be checked that the range of temperature and humidity within the chamber are, respectively, between 0° and 60 °C, and between 0% and 60 %. The scope is to inform the operators of the assignee on the procedure to follow and the parameters to respect in order to avoid mistakes leading to the malfunction of the electronic nose. | | | | |
| Reporter | SACMI | | Assignee | | ALPES, FILAR, PRIMA, BRIGHTERWAVE |

| Priority | *Essential* | No | *Major* | Yes | *Medium* | No | *Optional* | No |
|---|---|---|---|---|---|---|---|---|
| Date (change history) | 10.12.2018. | | | | | | | |

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|---|---|---|---|---|---|---|---|---|
| **RQ ID** | SA-T-03 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | | |
| **Parent RQ** | N/A | | | | | | | |
| **Title (Summary)** | Environmental operational condition shall be examined within the room where the electronic nose is placed. | | | | | | | |
| **Rationale (why, what, how)** | (what): The room where the electronic nose is placed shall be part of the involved sub-system and components and shall respect some conditions, i.e. it has a temperature range from 15 to 30 °C, relative humidity range from 0 to 50 %, in absence of dust in the air. The scope is to inform the assignee's operators on the environment characteristics and parameters to be respected since he is not informed on the parameters and procedures to respect. | | | | | | | |
| **Reporter** | SACMI | | | **Assignee** | | FRAUNHOFER, ALPES, FILAR, PRIMA, BRIGHTERWAVE | | |
| **Priority** | ***Essential*** | No | ***Major*** | Yes | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 10.12.2018. | | | | | | | |
| **RQ ID** | SA-T-04 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | | |

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|---|---|---|---|---|---|---|---|---|
| **RQ ID** | SA-T-04 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | | |
| **Parent RQ** | SA-T-02 | | | | | | | |
| **Title (Summary)** | Ambient air shall be used as gas carrier within the chamber | | | | | | | |
| **Rationale (why, what, how)** | The scope of this requirement is to ensure that the samples are not maintained in vacuum or in inert atmosphere during the measurement phase, since the electronic nose is calibrated to work in ambient air. Inside the sampling chamber, the air composition and pressure to be maintained for the proper function of the nose shall be as close as possible to ambient air conditions, meaning that no significant excess of Oxygen, Carbon dioxide, Nitrogen or Argon (inert atmosphere) should be present. | | | | | | | |
| **Reporter** | SACMI | | | **Assignee** | | FRAUNHOFER, ALPES, FILAR, PRIMA, BRIGHTERWAVE | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |

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| **Date (change history)** | 10.12.2018. |

### 5.5.3 Sensor array

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|---|---|---|---|---|---|---|---|---|
| **RQ ID** | SA-C-05 | **RQ Type** | Constraint | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | | |
| **Parent RQ** | N/A | | | | | | | |
| **Title (Summary)** | The operator or control system shall wait for stationary signal from the electronic nose. | | | | | | | |
| **Rationale (why, what, how)** | The scope of this constraint is to inform the users on timing for the sampling, If the sampling time is not long enough to achieve a stationary signal, the output could not be representative of the sample. Approximately 5-10 minutes are required before starting sampling since the gas sample is presented to the electronic nose, or a change in measurement conditions occurs. As a consequence, the sampling rate of the device is not higher than one sample (or one batch of samples) every 5 minutes. Incorrect measurements can be generated if the operator does not wait the requested time because he/she is not informed, or the process of the user does not allow to wait 5 to 10 minutes. | | | | | | | |
| **Reporter** | SACMI | | | **Assignee** | | FRAUNHOFER, ALPES, FILAR, PRIMA, BRIGHTERWAVE | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 10.12.2018. | | | | | | | |

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|---|---|---|---|---|---|---|---|---|
| **RQ ID** | SA-C-06 | **RQ Type** | Constraint | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | | |
| **Parent RQ** | SA-C-05 | | | | | | | |
| **Title (Summary)** | Maximum number of different sensing signals to be recognized by the sensor array chosen to measure the concentration of particles in the air | | | | | | | |
| **Rationale (why, what, how)** | The scope of this requirement is to inform the assignee of this constraint that the classification algorithm is less efficient when the instrument is trained to detect more than 4 similar odors. If the instrument is trained to recognize a high number of odors with similar chemical composition, the probability of having wrong classifications increases. | | | | | | | |
| **Reporter** | SACMI | | | **Assignee** | | ALL | | |
| **Priority** | ***Essential*** | No | ***Major*** | No | ***Medium*** | Yes | ***Optional*** | No |

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|---|---|
| **Date (change history)** | 10.12.2018. |

### 5.5.4 Electronic nose

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|---|---|---|---|---|---|---|---|---|
| **RQ ID** | SC-T-07 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | | |
| **Parent RQ** | N/A | | | | | | | |
| **Title (Summary)** | Optimal and maximum tube length for connecting the electronic nose to the sampling chamber. | | | | | | | |
| **Rationale (why, what, how)** | The scope is to inform the assignee on the maximum distance between the electronic nose and the chamber. If they are more than 2mt distant the electronic nose cannot sample the odor. Main failure causes (why): The operator is not informed on the parameters to be respected. | | | | | | | |
| **Reporter** | SACMI | | | **Assignee** | | ALL | | |
| **Priority** | ***Essential*** | No | ***Major*** | No | ***Medium*** | Yes | ***Optional*** | No |
| **Date (change history)** | 10.12.2018. | | | | | | | |

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|---|---|---|---|---|---|---|---|---|
| **RQ ID** | SC-T-08 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | | |
| **Parent RQ** | N/A | | | | | | | |
| **Title (Summary)** | The electronic nose shall be powered using an external stable power supply | | | | | | | |
| **Rationale (why, what, how)** | An external stable power supply (220V, 50 Hz, max power consumption required 200W) shall be involved within the sub-system and components. The operator shall be informed on the parameters to be respected (220 V 50 Hz) since wrong values of the voltage or the current can damage the device. | | | | | | | |
| **Reporter** | SACMI | | | **Assignee** | | FRAUNHOFER, ALPES, FILAR, PRIMA, BRIGHTERWAVE | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 10.12.2018. | | | | | | | |

| RQ ID | SC-T-09 | RQ Type | Technical | Use Cases | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
|---|---|---|---|---|---|
| Parent RQ | N/A | | | | |
| Title (Summary) | The device shall be placed on a flat surface; its size is 40x20x50 cm and it weighs 15-20 Kg. | | | | |
| Rationale (why, what, how) | The scope of this requirement is to make awareness of the space required for the instrumentation, which include the electronic nose itself, the sampling chamber and a tube connecting the chamber and the instrument. If the room for the sensor is not adequate or the operator is not informed on the parameters and procedures to be respected the instrument will not work properly. | | | | |
| Reporter | SACMI | | Assignee | FRAUNHOFER, ALPES, FILAR, PRIMA, BRIGHTERWAVE | |

| Priority | *Essential* | Yes | *Major* | No | *Medium* | No | *Optional* | No |
|---|---|---|---|---|---|---|---|---|
| Date (change history) | 10.12.2018. | | | | | | | |

## 5.6 FRAUNHOFER

Within the 1st iteration period, FRAUNHOFER has defined nine technical requirements. Their details are presented in respected sections.

### 5.6.1 Design and architecture of process chain and strategies

| RQ ID | F-IOF-T-01 | RQ Type | Technical | Use Cases | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
|---|---|---|---|---|---|
| Parent RQ | N/A | | | | |
| Title (Summary) | The process chain and strategy for all KPF and solution functionalities. | | | | |
| Rationale (why, what, how) | Process chain architectures and strategies for photonics system assembly have to be transferred from standard, linear and sequential designs to a mixed architecture that contains feedback loops and interfaces to software intelligence. In particular emerging developments from Artificial Intelligence about planning and development of multi-variable processes shall be taken into account, respective interfaces to hardware process based functionalities have to be determined and qualitatively parametrized. | | | | |
| Reporter | FRAUNHOFER | | Assignee | FRAUNHOFER, FICONTEC, TUT | |

| Priority | *Essential* | Yes | *Major* | No | *Medium* | No | *Optional* | No |
|---|---|---|---|---|---|---|---|---|
| Date (history) | 13.01.2019 | | | | | | | |

| RQ ID | F-IOF-T-02 | RQ Type | Technical | Use Cases | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
|---|---|---|---|---|---|
| Parent RQ | F-IOF-T-01 | | | | |
| Title (Summary) | The process chain architecture and strategy layer structure | | | | |
| Rationale (why, what, how) | Process chain architecture and strategies for photonics system assembly shall contain three different layers representing different levels of details. The first, generalized and qualitative layer shall be composed of main process hardware/ software building blocks and interfaces, the second layer shall be quantitative in terms building block descriptions and main requirements, the third layer shall contain detailed quantitative requirements for building blocks and its sub-building blocks, and interfaces. | | | | |
| Reporter | FRAUNHOFER | | Assignee | FRAUNHOFER, FICONTEC, TUT | |

| Priority | *Essential* | Yes | *Major* | No | *Medium* | No | *Optional* | No |
|---|---|---|---|---|---|---|---|---|
| Date (history) | 13.01.2019 | | | | | | | |

### 5.6.2 Process Chain

| RQ ID | F-IOF-T-03 | RQ Type | Technical | Use Cases | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
|---|---|---|---|---|---|
| Parent RQ | N/A | | | | |
| Title (Summary) | Process chain building blocks and interfaces description | | | | |
| Rationale (why, what, how) | A common descriptor for process chain building block properties and performances, either hardware or software based, shall allow for a unified solution functionality description as well as for a unified hardware and software interface description. | | | | |
| Reporter | FRAUNHOFER | | Assignee | FRAUNHOFER | |

| Priority | *Essential* | Yes | *Major* | No | *Medium* | No | *Optional* | No |
|---|---|---|---|---|---|---|---|---|
| Date (history) | 13.01.2019 | | | | | | | |

| RQ ID | F-IOF-T-04 | RQ Type | Technical | Use Cases | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
|---|---|---|---|---|---|
| Parent RQ | F-IOF-T-03 | | | | |
| Title (Summary) | Process chain hardware building blocks and interfaces description | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Rationale (why, what, how)** | A common descriptor for process chain hardware building block properties and performances, shall allow for a unified solution functionality description as well as for a unified hardware interface description. The hardware descriptor shall focus on procedural, optical, mechanical, electrical, thermal, environmental, and assembly economics issues of the assembly chain. | | | | | | | |
| **Reporter** | FRAUNHOFER | | | **Assignee** | | FRAUNHOFER | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (history)** | 13.01.2019 | | | | | | | |

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|---|---|---|---|---|---|
| **RQ ID** | F-IOF-T-05 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | F-IOF-T-03 | | | | |
| **Title (Summary)** | Process chain software building blocks and interfaces description | | | | |
| **Rationale (why, what, how)** | A common descriptor for process chain software building block properties and performances, shall allow for a unified solution functionality description as well as for a unified software interface description. The software descriptor shall focus on procedural and multi-parameter control, usability and inter-operability amongst different photonics assembly platforms. | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Reporter** | FRAUNHOFER | | | **Assignee** | | FRAUNHOFER | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (history)** | 13.01.2019 | | | | | | | |

### 5.6.3 Solution Validation

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | F-IOF-T-06 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | N/A | | | | |
| **Title (Summary)** | Solution validation based on functional parameters | | | | |
| **Rationale (why, what, how)** | Individual solutions for the iQonic process chain shall be characterized by a matrix of KPF, independent from their application to individual use cases. Functionality test cases have to be defined that allow for simple, statistically reliable testing. In case functionality cannot be tested stand-alone, standardized interfaces to the process environment and control have to be defined, e.g. by defining hardware and/ or software simulators. | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Reporter** | FRAUNHOFER | | | **Assignee** | | FRAUNHOFER | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |

| | |
|---|---|
| **Date (change history)** | 13.01.2019 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **RQ ID** | F-IOF-T-07 | | **RQ Type** | Technical | | **Use Cases** | generic | |
| **Parent RQ** | F-IOF-T-06 | | | | | | | |
| **Title (Summary)** | Hardware process based solution validation based on functional parameters | | | | | | | |
| **Rationale (why, what, how)** | Hardware based process solution validation shall be defined in a way that statistically reliable testing can be done for a relevant number of processed samples. Procedures to evaluate the samples have to be defined. The samples shall reflect, if suitable, main features of user cases, but shall be independent for easier processing of in particular high numbers of samples for statistical reasons. If needed, a software simulator shall be used for the defined variation of software inputs. | | | | | | | |
| **Reporter** | FRAUNHOFER | | | **Assignee** | | FRAUNHOFER | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 13.01.2019 | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **RQ ID** | F-IOF-T-08 | | **RQ Type** | Technical | | **Use Cases** | generic | |
| **Parent RQ** | F-IOF-T-06 | | | | | | | |
| **Title (Summary)** | Software process based solution validation based on functional parameters | | | | | | | |
| **Rationale (why, what, how)** | For software based process solution validation a procedure following the guidelines of ISO/IEC/IEEE 29119 Software Testing standards shall be applied. Of particular interest is testing vs. a variability of hardware process parameter inputs, e.g. for range limits or out of bounds values, to prove stability of the software based process solution. If needed, a hardware simulator shall be used for the variation of these inputs. | | | | | | | |
| **Reporter** | FRAUNHOFER | | | **Assignee** | | FRAUNHOFER | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 13.01.2019 | | | | | | | |

### 5.6.4 Use Case Demonstration Evaluation

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | F-IOF-T-09 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | N/A | | | | |
| **Title (Summary)** | Evaluation performance methodology and requirements matrix | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Rationale (why, what, how)** | The evaluation methodology shall be deterministic, addressing a matrix of KPF requirements for each use case. In the same time, the methodology shall be adapted to the individual use cases and their specific requirements. In particular, evaluation procedures and their boundary conditions, e.g. number of samples to be processed for reliable statistics, test procedures on the samples to prove their performance etc., shall be defined to allow planning for the use case providers. The methodology shall also provide information about the progress vs. state of the art. | | | | | | | |
| **Reporter** | FRAUNHOFER | | | **Assignee** | | FRAUNHOFER | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 13.01.2019 | | | | | | | |

## 5.7 BRUNEL

In the first iteration BRUNELL sets ten technical requirements. These details have been reported in corresponding sections below.

### 5.7.1 Production Logic

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **RQ ID** | BU-T-01 | **RQ Type** | Technical | **Use Cases #** | ALPES, FILAR, PRIMA, BRIGHTERWAVE, Ficontec (All Manufacturers and OEMS) | | | |
| **Parent RQ** | N/A | | | | | | | |
| **Title (Summary)** | Full production process (Process Flow Chart), Precedence Chart, Station and Total production Cycle Times | | | | | | | |
| **Rationale (why, what, how)** | A full understanding of the production process described by OEM and the Manufacturer (each with their own interpretation and manufacturers with their interferences) | | | | | | | |
| **Reporter** | BRUNEL | | | **Assignee** | | All Manufacturers and OEM | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 28.12.2018. | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | BU-T-02 | **RQ Type** | Technical | **Use Cases #** | ALPES, FILAR, PRIMA, BRIGHTERWAVE, Ficontec (All Manufacturers and OEMS) |
| **Parent RQ** | N/A | | | | |
| **Title (Summary)** | Full Description/Specification/Tolerances/Equipment/ of Production Processes | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Rationale (why, what, how)** | A full understanding of the production process described by OEM and the Manufacturer (each with their own interpretation and manufacturers with their interferences). All necessary steps with clear indicators and measurements, tolerances, and all necessary technical details of processing that impact quality and material flow. | | | | | | | |
| **Reporter** | BRUNEL | | | **Assignee** | | All Manufacturers and OEM | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 28.12.2018. | | | | | | | |

### 5.7.2 Existing Machine State and Control Logic

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | BU-T-03 | **RQ Type** | Technical | **Use Cases #** | ALPES, FILAR, PRIMA, BRIGHTERWAVE, Ficontec (All Manufacturers and OEMS), Shadow |
| **Parent RQ** | N/A | | | | |
| **Title (Summary)** | Process Control Architecture, Mechanisms, Logic, Process Capability, Sensors and Actuation | | | | |
| **Rationale (why, what, how)** | A full understanding of the production process control logic sensing and actuation. What if scenarios? Monitoring and Actuation Capabilities, flexibilities and constraints.<br>This information linked to the quality evaluation and process capability will lead to identification of innovation steps for dexterity and flexibility in the production process (Shadow Robot)<br>Result: Identification of Gap in technology | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Reporter** | BRUNEL | | | **Assignee** | | All Manufacturers and OEM and Shadow Robot | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 28.12.2018. | | | | | | | |

### 5.7.3 Product and Process Quality Monitoring

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | BU-T-04 | **RQ Type** | Technical | **Use Cases #** | ALPES, FILAR, PRIMA, BRIGHTERWAVE, Ficontec (All Manufacturers and OEMS), Shadow |
| **Parent RQ** | N/A | | | | |
| **Title (Summary)** | Quality Control and Management | | | | |
| **Rationale (why, what, how)** | Quality control techniques, on-line and off-line, reporting mechanism, corrective actions, feedback time, actions and reactions, tolerances, machine state and product quality links (if exists). | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Reporter** | BRUNEL | | | **Assignee** | | All Manufacturers and OEM and Shadow Robot | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 28.12.2018. | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | BU-T-05 | **RQ Type** | Technical | **Use Cases #** | ALPES, FILAR, PRIMA, BRIGHTERWAVE, Ficontec (All Manufacturers and OEMS), Shadow Robot |
| **Parent RQ** | N/A | | | | |
| **Title (Summary)** | Machine State and Product/Process Quality Mapping | | | | |
| **Rationale (why, what, how)** | Detailed event analytics of the machine state and its relation with production quality. Real-time data acquisition capabilities, off-line quality assessments, expert views on types of defect and causal relations. | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Reporter** | BRUNEL | | | **Assignee** | | All Manufacturers and OEM and Shadow Robot | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 28.12.2018. | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | BU-T-06 | **RQ Type** | Technical | **Use Cases #** | ALPES, FILAR, PRIMA, BRIGHTERWAVE, Ficontec (All Manufacturers and OEMS) |
| **Parent RQ** | BU-T-05 | | | | |
| **Title (Summary)** | Machine Maintenance and failure modes | | | | |
| **Rationale (why, what, how)** | Reports and FMEA on machine tools failure, impact, risk and potential relationship between MTBF and quality assurance. | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Reporter** | BRUNEL | | | **Assignee** | | All Manufacturers and OEM and Shadow Robot | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |

| | |
|---|---|
| **Date (change history)** | 28.12.2018. |

### 5.7.4 Flexible, Predictive Manufacturing Platform

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **RQ ID** | BU-T-07 | **RQ Type** | Technical | **Use Cases #** | ALPES, FILAR, PRIMA, BRIGHTERWAVE, Ficontec (All Manufacturers and OEMS) | | | |
| **Parent RQ** | N/A | | | | | | | |
| **Title (Summary)** | Agile, Dexterous and Responsive Production System | | | | | | | |
| **Rationale (why, what, how)** | The new robotics, sensing and actuation technologies to be deployed for online predictive control system | | | | | | | |
| **Reporter** | BRUNEL | | | **Assignee** | | All Manufacturers and OEM | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 28.12.2018. | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **RQ ID** | BU-T-08 | **RQ Type** | Technical | **Use Cases #** | ALPES, FILAR, PRIMA, BRIGHTERWAVE, Ficontec (All Manufacturers and OEMS) | | | |
| **Parent RQ** | N/A | | | | | | | |
| **Title (Summary)** | Agile, Dexterous and Responsive Production System | | | | | | | |
| **Rationale (why, what, how)** | The new robotics, sensing and actuation technologies to be deployed for online predictive control system | | | | | | | |
| **Reporter** | BRUNEL | | | **Assignee** | | All Manufacturers and OEM | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 28.12.2018. | | | | | | | |

### 5.7.5 Circular Economy Modelling

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | BU-T-09 | **RQ Type** | Technical | **Use Cases #** | ALPES, FILAR, PRIMA, BRIGHTERWAVE, Ficontec (All Manufacturers and OEMS) |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Parent RQ** | N/A | | | | | | | |
| **Title (Summary)** | Principles of Circular Economy embedded in Manufacturing Control and Planning | | | | | | | |
| **Rationale (why, what, how)** | Understanding of the material evolution throughout production process, post production and reusability/recyclability | | | | | | | |
| **Reporter** | BRUNEL | | | **Assignee** | | All Manufacturers and OEM | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 28.12.2018. | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | BU-T-10 | **RQ Type** | Technical | **Use Cases #** | ALPES, FILAR, PRIMA, BRIGHTERWAVE, other partners involved in Reverse logistics and DSS (e.g. Atlantis) |
| **Parent RQ** | N/A | | | | |
| **Title (Summary)** | Production Economics, Environmental Impact Analysis, Logistics and Reverse Logistics | | | | |
| **Rationale (why, what, how)** | Full EIA of the production system and end products, production, recycling and reusability economic and sustainability analysis. Understanding the practical and technological barriers and suggestions for overcoming them. | | | | |

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|---|---|---|---|---|---|---|---|---|
| **Reporter** | BRUNEL | | | **Assignee** | | All Manufacturers and OEM | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 28.12.2018. | | | | | | | |

## 5.8 CORE

In the first iteration CORE sets requirements six technical requirements to the Early Malfunctional detection and prediction interface engine.

### 5.8.1 Early Malfunctional detection and prediction interface engine

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | CO-T-01 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | N/A | | | | |
| **Title (Summary)** | The machine learning algorithms must have access to synchronized data (common timestamp). | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Rationale (why, what, how)** | The common timestamp will ensure that the data from the sensors and machines can be properly matched with each other to identify anomalies. | | | | | | | |
| **Reporter** | CORE | | | **Assignee** | | HOLONIX, ALPES, FILAR, PRIMA, BRIGHTERWAVE | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 21.12.2018. | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | CO-T-02 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | CO-T-01 | | | | |
| **Title (Summary)** | Definitions of Normal Operation state and Anomaly state. | | | | |
| **Rationale (why, what, how)** | The data must be provided with labels that explicitly describe the state of the machine at every timestamp or at least when it operated with erroneous conditions (can be time range instead of singular timestamps – start/end). | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Reporter** | CORE | | | **Assignee** | | HOLONIX, ALPES, FILAR, PRIMA, BRIGHTERWAVE | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 21.12.2018. | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | CO-T-03 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | CO-T-02 | | | | |
| **Title (Summary)** | Definitions of the types of the errors in the Anomaly state. | | | | |
| **Rationale (why, what, how)** | The data must be provided with labels that explicitly describe the type of error (alarm codes, quality of the products, type of malfunction, etc.) when in Anomaly state, or suitable metadata formats (fused expert knowledge). | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Reporter** | CORE | | | **Assignee** | | HOLONIX, ALPES, FILAR, PRIMA, BRIGHTERWAVE | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 21.12.2018. | | | | | | | |

| RQ ID | CO-T-04 | RQ Type | Technical | Use Cases | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
|---|---|---|---|---|---|
| Parent RQ | N/A | | | | |
| Title (Summary) | Specifications of communication protocols. | | | | |
| Rationale (why, what, how) | This will allow to adapt the inference modules integration to every use case scenario. | | | | |
| Reporter | CORE | | Assignee | | ALPES, FILAR, PRIMA, BRIGHTERWAVE |

| Priority | *Essential* | Yes | *Major* | No | *Medium* | No | *Optional* | No |
|---|---|---|---|---|---|---|---|---|
| Date (change history) | 21.12.2018. | | | | | | | |

| RQ ID | CO-T-05 | RQ Type | Technical | Use Cases | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
|---|---|---|---|---|---|
| Parent RQ | N/A | | | | |
| Title (Summary) | Specifications/definitions of machine cycles in each end user scenario. | | | | |
| Rationale (why, what, how) | The duration of production the completes a machine cycle, which is necessary when designing machine learning algorithms to predict the future states. | | | | |
| Reporter | CORE | | Assignee | | ALPES, FILAR, PRIMA, BRIGHTERWAVE |

| Priority | *Essential* | Yes | *Major* | No | *Medium* | No | *Optional* | No |
|---|---|---|---|---|---|---|---|---|
| Date (change history) | 21.12.2018. | | | | | | | |

| RQ ID | CO-T-06 | RQ Type | Technical | Use Cases | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
|---|---|---|---|---|---|
| Parent RQ | N/A | | | | |
| Title (Summary) | Specifications and documentation of the historical data. | | | | |
| Rationale (why, what, how) | To design proper machine learning algorithms with increased interpretability by the end users, expert knowledge of the data (what, why, how, etc.) needs to be provided by the end users in the form of documentation. | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Reporter** | CORE | | | **Assignee** | | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 21.12.2018. | | | | | | | |

## 5.9 TUT

In the first iteration TUT sets requirements four technical requirements. Their details are presented below.

### 5.9.1 Sensitivity, Geometry, Material, Size definition for assembly and disassembly

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **RQ ID** | TA-T-01 | **RQ Type** | Technical | **Use Cases #** | ALPES. FILAR, PRIMA, BRIGTERWAVE | | | |
| **Parent RQ** | N/A | | | | | | | |
| **Title (Summary)** | Prototyping micro-optics assemblies | | | | | | | |
| **Rationale (why, what, how)** | A versatile and easily reconfigurable platform is needed to demonstrate many different types of zero-defect micro-optics assemblies for relatively small quantities (from several to some tens of assemblies). In order to define new assemblies fast, the platform should have advanced (semi) automatic calibration routines to define reference positions for the tooling and work benches. Moreover, the calibration routines could include visual or electronic inspection and recognition of tooling based for example on QR codes, visual inspection vs library or electronic IDs to verify correct tooling and quickly recalibrate their positions. The assembly system software should enable efficient teaching of motion trajectories using manual position guidance supported by cameras in a 3D environment. | | | | | | | |
| **Reporter** | TAU | | | **Assignee** | FRAUNHOFER | | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 19.12.2018 | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | TA-T-02 | **RQ Type** | Technical | **Use Cases #** | ALPES. FILAR, PRIMA, BRIGTERWAVE |
| **Parent RQ** | TA-T-01 | | | | |
| **Title (Summary)** | Metrology enhanced tooling for UV-bonding | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Rationale (why, what, how)** | In order to mitigate the alignment issues caused by the shrinkage of UV-adhesives, the movement during the curing could be traced by measuring the relative position of the fastened optical component using optical interferometry. Recorded movement may indicate that the gluing process is defective and the output may not fulfill quality requirements. Furthermore, metrology enhanced tooling can adaptively compensate the movement during the UV-curing. Such functionality would allow faster set-up time and lower prototyping cost as one could simply measure glue shrinkage for each assembly component rather that to find out it through iterative process. Moreover, in production environment tooling could be used to monitor if glue shrinks in a constant way from day to day – this could be great help for zero defect manufacturing to find defective components. Practical realizations of this type of tooling include various different optical metrology instruments like for example different type of imaging or non-imaging interferometers. | | | | | | | |
| **Reporter** | TAU | | | **Assignee** | | FRAUNHOFER | | |
| **Priority** | ***Essential*** | No | ***Major*** | No | ***Medium*** | No | ***Optional*** | Yes |
| **Date (change history)** | 19.12.2018 | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | TA-T-03 | **RQ Type** | Technical | **Use Cases #** | ALPES. FILAR, PRIMA, BRIGTERWAVE |
| **Parent Requirement #** | TA-T-01 | | | | |
| **Title (Summary)** | Die/submount bonding | | | | |
| **Rationale (why, what, how)** | Die/submount bonding with thin, uniform, and flux-free solder is required to achieve high reliability and low thermal resistance between the die and the heat sink. Moreover, after the die/submount bonding process, the solder joint quality must be investigated in order to avoid solder joint failures. The possible reworking, if the soldering process turns out to be defective, damaged, or misplaced, should follow the inspection. Scenario where soldered submount is reworked is realistic in any environment. Self-alignment of solder bond based on pattern defined on wafer level could improve zero-defect manufacturing in certain cases where tightest possible alignment is required and active alignment is not possible. This could be for example when bonding together laser diode chip on silicon photonics platform. | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Reporter** | TAU | | | **Assignee** | | FRAUNHOFER | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 19.12.2018 | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | TA-T-04 | **RQ Type** | Technical | **Use Cases #** | ALPES. FILAR, PRIMA, BRIGTERWAVE |
| **Parent Requirement #** | AT-T-07 | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Title (Summary)** | Insitu testing of a chip, bar or submounted light source | | | | | | | |
| **Rationale (why, what, how)** | Insitu testing of components enables to identify a defective light source, to address the source causing the indicated defect, and to define the possible changes in the supply chain. The insitu testing is carried by beam diagnostic tool (BDT) that supports both testing and assembly. | | | | | | | |
| **Reporter** | TAU | | | **Assignee** | | FRAUNHOFER | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 19.12.2018 | | | | | | | |

## 5.10 POLIMI

In the first iteration POLIMI has identified thirteen technical requirements presented in the sub-sections below.

### 5.10.1 Evaluation of functionalities and downstream strategies

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **RQ ID** | PO-T-01 | **RQ Type** | Technical | | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | |
| **Parent RQ** | N/A | | | | | | | |
| **Title (Summary)** | Definition of technically feasible defect management strategies. | | | | | | | |
| **Rationale (why, what, how)** | The identified defect management strategy that will be defined for each defect type, selecting among (i) defect repair by downstream compensation, (ii) disassembly for direct reuse of components, or (iii) disassembly for reuse through remanufacturing and regeneration, shall be technically feasible, meaning that the required skills, technologies, tools and methods shall be accepted by the end-users. | | | | | | | |
| **Reporter** | POLIMI | | | **Assignee** | | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 20.01.2019. | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **RQ ID** | PO-T-02 | **RQ Type** | Technical | | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | |
| **Parent RQ** | PO-T-01 | | | | | | | |
| **Title (Summary)** | Defect repair by downstream compensation | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Rationale (why, what, how)** | A model-based approach for the determination of compensation variables and entities shall be applicable to the end-user case, and the nominal process settings shall be adjustable depending on the conditions of the defective part. | | | | | | | |
| **Reporter** | POLIMI | | | **Assignee** | | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 20.01.2019. | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | PO-T-03 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | PO-T-01 | | | | |
| **Title (Summary)** | Disassembly for direct reuse of components. | | | | |
| **Rationale (why, what, how)** | The functionality of the reusable component shall be preserved after the disassembly process, meaning that non-destructive disassembly shall be applied. | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Reporter** | POLIMI | | | **Assignee** | | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 20.01.2019. | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | PO-T-04 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | PO-T-03 | | | | |
| **Title (Summary)** | Component design for non-destructive disassembly. | | | | |
| **Rationale (why, what, how)** | The component suitable for reuse should be designed with the purpose to be reversibly disassembled, meaning that irreversible joints, such as glue and welding, should be absent. | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Reporter** | POLIMI | | | **Assignee** | | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |

| | |
|---|---|
| **Date (change history)** | 20.01.2019. |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **RQ ID** | PO-T-05 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | | |
| **Parent RQ** | PO-T-01 | | | | | | | |
| **Title (Summary)** | Disassembly for reuse through remanufacturing and regeneration. | | | | | | | |
| **Rationale (why, what, how)** | Remanufacturing and regeneration should be technically feasible and should preserve the functionality of the component. | | | | | | | |
| **Reporter** | POLIMI | | | **Assignee** | | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 20.01.2019. | | | | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **RQ ID** | PO-T-06 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | | |
| **Parent RQ** | PO-T-05 | | | | | | | |
| **Title (Summary)** | Remanufacturing of components for reuse. | | | | | | | |
| **Rationale (why, what, how)** | Remanufacturing should bring back the quality and the geometry of the component to the “as good as new” conditions. | | | | | | | |
| **Reporter** | POLIMI | | | **Assignee** | | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 20.01.2019. | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | PO-T-07 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | PO-T-05 | | | | |
| **Title (Summary)** | Remanufacturing of components for reuse. | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Rationale (why, what, how)** | The remanufacturing process should be less energy intensive than the production of the new component, should be less expensive, and accepted by the customer. | | | | | | | |
| **Reporter** | POLIMI | | | **Assignee** | | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 20.01.2019. | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | PO-T-07 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | PO-T-05 | | | | |
| **Title (Summary)** | Re-assembly after regeneration. | | | | |
| **Rationale (why, what, how)** | The regeneration process should provide a component that is in specification and of sufficiently good quality to support re-assembly. | | | | |

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|---|---|---|---|---|---|---|---|---|
| **Reporter** | POLIMI | | | **Assignee** | | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 20.01.2019. | | | | | | | |

### 5.10.2 CPS for product reuse and requalification

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | PO-T-08 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | N/A | | | | |
| **Title (Summary)** | Cyber-physical system (CPS) architecture definition. | | | | |
| **Rationale (why, what, how)** | The architecture of the CPS should be properly integrated within the iQonic system architecture. | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Reporter** | POLIMI | | | **Assignee** | | FRAUNHOFER | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 20.01.2019. | | | | | | | |

| RQ ID | PO-T-09 | RQ Type | Technical | Use Cases | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
|---|---|---|---|---|---|
| Parent RQ | PO-T-08 | | | | |
| Title (Summary) | CPS data gathering module. | | | | |
| Rationale (why, what, how) | The data gathering module of the CPS shall be connected to the Knoweldge Base System (KBS) to continuously receive in input updated information about the product at the previous production stages before requalification. | | | | |
| Reporter | POLIMI | | Assignee | HOLONIX | |
| Priority | ***Essential*** Yes | ***Major*** No | ***Medium*** No | ***Optional*** No | |
| Date (change history) | 20.01.2019. | | | | |

| RQ ID | PO-T-10 | RQ Type | Technical | Use Cases | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
|---|---|---|---|---|---|
| Parent RQ | PO-T-08 | | | | |
| Title (Summary) | CPS intelligent data analysis module. | | | | |
| Rationale (why, what, how) | The intelligent module of the CPS, where the most proper solution for requalification is selected depending on the product conditions, should guarantee a computational time that is shorter than the lead time between the stage where data are gathered and the stage where the requalification takes place (requalification does not create blocking). | | | | |
| Reporter | POLIMI | | Assignee | HOLONIX | |
| Priority | ***Essential*** Yes | ***Major*** No | ***Medium*** No | ***Optional*** No | |
| Date (change history) | 20.01.2019. | | | | |

| RQ ID | PO-T-11 | RQ Type | Technical | Use Cases | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
|---|---|---|---|---|---|
| Parent RQ | PO-T-08 | | | | |
| Title (Summary) | CPS actuation module. | | | | |

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|---|---|---|---|---|---|---|---|---|
| **Rationale (why, what, how)** | The CPS should influence the quality characteristics of the component by acting automatically or manually on the downstream process parameters. | | | | | | | |
| **Reporter** | POLIMI | | | **Assignee** | | HOLONIX | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 20.01.2019. | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | PO-T-12 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | PO-T-08 | | | | |
| **Title (Summary)** | CPS data exchange. | | | | |
| **Rationale (why, what, how)** | The data exchange protocol among the physical layer and the digital layer of the CPS should be based on machine-to-machine communication standards such as OPC-UA. | | | | |
| **Reporter** | POLIMI | | **Assignee** | HOLONIX | |
| **Priority** | ***Essential*** Yes ***Major*** No ***Medium*** No ***Optional*** No | | | | |
| **Date (change history)** | 20.01.2019. | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | PO-T-13 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE |
| **Parent RQ** | N/A | | | | |
| **Title (Summary)** | CPS Human-machine Interface (HMI). | | | | |
| **Rationale (why, what, how)** | The HMI reporting to the operator the suggested requalification for re-use action shall make it possible to (i) report to the operator the defect cause and the suggested correction action, (ii) suggest to the operators specific procedures for requalification depending on the component defect entity, (iii) let the operator accept the suggested strategy or manually select a different strategy for requalification. | | | | |
| **Reporter** | POLIMI | | **Assignee** | ALPES, FILAR, PRIMA, BRIGHTERWAVE | |
| **Priority** | ***Essential*** Yes ***Major*** No ***Medium*** No ***Optional*** No | | | | |

| | |
|---|---|
| **Date (change history)** | 20.01.2019. |

## 5.11 FORTH

In the first iteration FORTH have defined one technical requirement presented in the sub-section below.

### 5.11.1 The adaptive in-process optics for real time and thin layer quality inspection

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **RQ ID** | FO-T-01 | **RQ Type** | Technical | **Use Cases** | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | | |
| **Parent RQ** | N/A | | | | | | | |
| **Title (Summary)** | Definition of the "defects" that will be imaged. | | | | | | | |
| **Rationale (why, what, how)** | The identification of the parameters that affect the image quality will apply to the optical correction strategy. This shall dictate the adjustment of the adaptive optics imaging setup to meet the optical demands of those corrections. Consequently, the definition of the "defects" that will be imaged, shall provide the base for the calculation and implementation of the optical parameters correction. | | | | | | | |
| **Reporter** | FORTH | | | **Assignee** | | ALPES, FILAR, PRIMA, BRIGHTERWAVE | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 29.12.2018. | | | | | | | |

## 5.12 SHADOW

In the first iteration period, SHADOW summarised a requirement as a business / not applied specifically to the project. As they need Demo Site requirements first, this RQ will be re-evaluated, edited and refined as the project evolves.

### 5.12.1 General

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | SRC-T-01 | **RQ Type** | Technical | **Use Cases #** | ALPES. FILAR, PRIMA, BRIGTERWAVE |
| **Parent Requirement #** | **Shadow Robot requirements list for ICONIQ project**<br>Shadow designs and manufactures state-of-the-art anthropomorphic robot hands & related systems. We're one of Britain's longest-running robotics firms and the leading experts for technology around grasping and manipulation for robotics.<br><br>For the project we are proposing to use a hand attached to an arm in order to manipulate electronic components or tools.<br><br>One of our grippers look like the picture below: | | | | |

A break down of the system to assess the requirements can be found below:

**Hardware list:**
Robotic Hand (Dexterous Hand)
Robotic Arm (UR10)
Computer to operate the hardware

**Arm Specifications (UR10):**
Payload: 10KG
Reach: 1300mm
Weight: 33.5KG
Footprint: 190mm

**Hand specifications:**
Weight: 4.2KG
Communication: Ethercat protocol through LAN
Joint speed from min to max: 1hz
Materials: aluminium, brass, acetyl, polycarbonate and polyurethane flesh
Joint position sensing: 0.2 degrees
Power consumption: 48V 2.5A

**Computer specifications and software:**
The Shadow Dexterous Hand will be supplied with a powerful computer that runs Linux (Ubuntu 16.04) and is fully compatible with ROS (Robot Operating System www.ros.org) providing a full range of capabilities including:
• Control
• Visualisation
• Simulation
All of the software is based on ROS and allows communication with other platforms and modules. Most of the control software is written in Python

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Title (Summary)** | General Requirement and specification | | | | | | | |
| **Rationale (why, what, how)** | This provides a summary of requirement for Shadow as a business / not applied specifically to the project as we need Demo Site requirements first | | | | | | | |
| **Reporter** | Shadow | | | **Assignee** | | | | |
| **Priority** | ***Essential*** | <x> | ***Major*** | <x> | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | <List history of changes to this requirement> | | | | | | | |

### 5.13 IP-ASCR

HiLASE centre (part of IP-ASCR) is focused on development of high intensity diode pump solid state lasers (DPSSL) with short (ns) and ultra-short (ps) pulses. They have defined four business requirements.

#### 5.13.1 High intensity diode pump solid state lasers (DPSSL)

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **RQ ID** | IP-B-01 | **RQ Type** | Business | | **Use Cases** | HiLASE | | |
| **Parent Requirement** | FI-B-01, FI-B-02 | | | | | | | |
| **Title (Summary)** | Selection of laser gain media and coatings | | | | | | | |
| **Rationale (why, what, how)** | In cooperation with FILAR select materials and coatings of main importance. Based on this selection, define KPF. According to existing knowledge propose most critical parameters in production chain and propose way of documenting them. | | | | | | | |
| **Reporter** | HiLASE | | | **Assignee** | | FILAR | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 17.01.2019 | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | IP-B-02 | **RQ Type** | Business | **Use Cases** | HiLASE |
| **Parent Requirement** | FI-B-01, FI-B-02 | | | | |
| **Title (Summary)** | Influence of mechanical processes to coatings quality on laser gain media | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Rationale (why, what, how)** | Based on experience, HiLASE team recognized that all mechanical processes (cutting, grinding, polishing, and cleaning) are strongly influencing final performance (LIDT as well as operation in the laser system) of laser gain media. In line with mentioned we propose to define KPFs, propose way of surface inspection after each mechanical process and document them. | | | | | | | |
| **Reporter** | HiLASE | | | **Assignee** | | FILAR | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 17.01.2019 | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | IP-B-03 | **RQ Type** | Business | **Use Cases** | HiLASE |
| **Parent Requirement** | FI-B-01 and-02, IP-B-01 and -02 | | | | |
| **Title (Summary)** | Testing of coated surfaces quality of laser gain media for laser applications. | | | | |
| **Rationale (why, what, how)** | Prepared laser gain media (with well documented production parameters in each production step) will be tested at HiLASE for LIDT (with HiLASE laser systems) and their performance will be investigated in some real laser systems. Performance of laser gain media will be correlated with production parameters. In order to produce laser gain media with defined KPFs, it will be selected a way of improvements in each production step and will be designed monitoring and control systems. | | | | |

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|---|---|---|---|---|---|---|---|---|
| **Reporter** | HiLASE | | | **Assignee** | | IQONIC Consortium | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 17.01.2019 | | | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| **RQ ID** | IP-B-04 | **RQ Type** | Business | **Use Cases** | HiLASE |
| **Parent Requirement** | IQONIC system testing on production of thin-disk head | | | | |
| **Title (Summary)** | Production of thin-disk head | | | | |
| **Rationale (why, what, how)** | Production of thin-disk head is very complex with very low rate of success. Therefore, production of one head can take several months. This production can strongly benefit from usage of IQONIC system while many similar problems (glue shrinking during bonding for example) will be addressed. | | | | |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Reporter** | HiLASE | | | **Assignee** | | IQONIC Consortium | | |
| **Priority** | ***Essential*** | Yes | ***Major*** | No | ***Medium*** | No | ***Optional*** | No |
| **Date (change history)** | 17.01.2019 | | | | | | | |

# 6 Conclusion and next steps

User requirements from industry, technical and research partners have been consolidated within the first iteration period (M01-M04) of this task and reported in this deliverable. The use cases, technical objectives and technologies that were defined in the proposal phase of this project, have been considered and served as a guideline during this first definition and collection process. Further on, technical objectives will be validated by technical and research partners and finalised (if necessary) after the revision of RQs due M20 and any updates or changes will be reported in D2.5. Also, the use case elaboration will be finalised upon end-users input analysis in M05 and reported in respective deliverable D2.4. Furthermore, the second (M12-M14) and third (M18-M20) iteration periods of the task will be used for reporting new RQs and quality checks in general. All RQs will be re-assessed during the two last iteration periods and refined if necessary, specifying in details pre-known conditions, criteria - target that makes it possible to test, exceptions that should be handled and listing other dependencies (if any). The RQs will be used for the design of components within WP3-WP6, obtaining the users feedback, updating the requirements that will retrofit and improve s/w and process chain designs within iQonic solution. These elaborations will provide guides to consortium on how to build the iQonic system and how shall the general iQonic solution be applied within the optoelectronics industry in the future.

# 7 List of Tables