AI REDGIO 5.0 OPEN CALL 1

Technical annex

07-EDGE-MICROFY

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ACRONIM OF THE EXPERIMENT	EDGE - MICROFY
TOPIC[1]	AI at the Edge applications and edge-to-cloud continuum
SME NAME	Microfy Systems SL
SME COUNTRY	Spain
SME REGION	Barcelona (Catalonia)

[1] TOPIC 1: AI at the Edge applications and edge-to-cloud continuum
TOPIC 2: Industry 5.0 and human-centric, resilient and sustainable manufacturing
TOPIC 3: TERESA (Technology Regulatory Sandboxes) experiments

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1. TECHNICAL EXCELLENCE

1.1. The Need and the Solution

There are many different analyses in the agrifood processing chain which are done with traditional microscopy with the aim to detect, count, or even classify microscopic particles/microorganisms in the samples. Microscopy is key in the food manufacturing industries. Typical examples are those with active fermentation processes within the manufacturing process, for instance. But there are many other examples like detection of contaminants, quality assessment, or microorganisms counting, in which traditionally there is an expert technician, observing a sample in detail through a standard light microscope, during long and exhausting periods (sometimes even an hour per test!).

These traditional operations in the food manufacturing industry are labour intensive, tough, repetitive, must be carried out by hand by widely trained experts, and are expensive if externalized to specialized labs. In addition, when these kinds of analysis are externalized to specialized labs, the manufacturing companies receive the results deferred (days, or more than a week), so they lose real-time control of the product, and the process.

All these microscope analyses within the food manufacturing industry are perfect candidates to integrate autonomous AI-powered devices (coupled with image processing algorithms and trained neural networks) to allow faster and cheaper operations, while increasing control of their products. Unfortunately, the commercially available solutions of autonomous scanning microscopes are too expensive for the food sector (typically ranging from 25k€ to 120k€), since they are generally conceived and designed by large firms specifically for the MedTech and BioTech industries, which are more complex/demanding, and typically count with larger purchasing budgets for this type of laboratory equipment.

In view of this clear business need for affordable, easy-to-use and autonomous scanning microscopy device, at Microfy Systems our team started by 2020 to design and manufacture specific solutions for the automated quality control specifically designed for the agrifood industry, by means of robotizing a basic digital microscope (to act as a self-driven autonomous device), coupled with an AI-based image processing pipeline hosted in AWS, which acts as the "intelligence" of the system. Our solutions are specifically conceived for non-expert end-users.

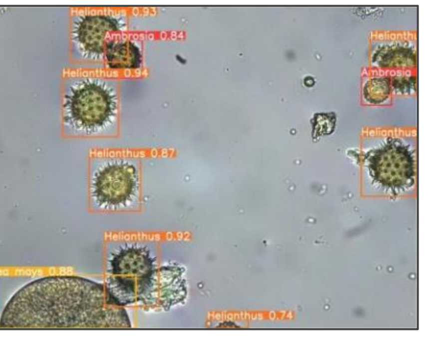
With our devices we aim to assist humans within the control checks usually performed in the food manufacturing industry, including specific optical analysis to determine different parameters as: the presence of a contaminant, the concentration measuring of different particles, the texture of a sample, the number and species of microorganisms or its size in a culture, for instance.

Considering our technology platform (robotized hardware + AI software) as the basis of the business model, our team develops different branded solutions for each different application/market:

- Honey.AI (www.honey-ai.com) is our current flagship product, 100% designed for the honey processing industry.

The first manufacturing industry that we decided to target was the honey industry. The reasons are simple: In Europe, due to the directives and best practices of the sector, honey packers must conduct a very specific and complex quality check, which is the "pollen analysis". It is done mainly for 3 reasons: 1) To classify the kind of honey marketed as polyflora or monofloral, and the specific botanical type (lavender, eucalyptus, thymus, rosemary, etc.), to meet the labelling legal requirements, 2) as a measure of product valorization between producers/importers/exporters/traders/packers. The highest purity the honey has, the more expensive it becomes in the market, and, 3) to help preventing food fraud, as a scanning technique to identify floral and geographical origin of the product.

The problem is that pollen analysis is a very manual test which involves looking at samples under the microscope for 1 hour to detect and classify the pollen grains in the sediment. It must be done by technicians who have been trained and are widely experienced, because there are >300 pollen types, only in EU. The cost of the test performed by a specialized laboratory ranges from 40€ to 80€, and takes 7 – 14 days to get the result back.



Traditional analysis is expensive, time-consuming, usually involves subjectivity and human error, and the results are obtained deferred. Honey.AI is the first smart microscope worldwide that performs automated pollen analysis (pollen counting and specie classification) on honey samples with image processing and AI.

The device, also performs other types of quality analysis, such as colour, starch detection, crystallization degree, and yeast counting (see Annex).

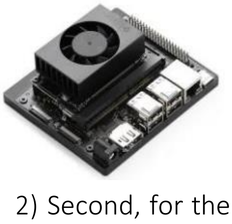
- Ferment.AI – By taking advantage of the work done with Honey.AI, the second product is intended to target beer and wine industries, to perform automated counting of yeast and bacteria cells during different fermentation stages in the production chain, while also discriminating dead/alive cells, based on colour range. This application is on Beta stage, not yet commercial.
- Fungi.AI – Last but not least, the last application is for mycelium growth monitoring (including time-lapse analysis), mostly for the alternative-protein manufacturing industry based in mycoprotein production, and for the pharma sector.

As previously mentioned, our image processing AI-pipeline is currently hosted in the cloud (specifically AWS), where our architecture employs on-demand CPU and GPU EC2 instances to perform the analysis when requested by the users from the APP, after deploying the specific DL-models for each application. This cloud architecture was initially chosen because of the cybersecurity assured by AWS environment to host our models, and also for the availability of powerful GPU to run our models, and re-train them frequently.

However, as our applications grow, there are specific critical disadvantages associated with cloud-computing, such as 1) the limitation of the requirement of high-bandwidth internet for the end-users (not existing in some locations), 2) high dependance on external provider, and 3) the economic costs paid for the infrastructure and GPUs, since some analysis (as pollen one) compute during more than an hour, with more than 5k High-Quality pictures processed per analysis. This is traduced in high GPU demand, which also sometimes are not available.

One year ago, our team tried to migrate to an embedded edge-hybrid architecture in which a specific part of the pipeline (pollen detection) should had been done on a Jetson Nano. However, the computing capacity on Jetson Nano was too low for our MaskRCNN pollen detection model, so a YoloV5 low- accurate model had to be considered, while classification step on EfficientNet models was kept on the cloud. The accuracy decreased a lot.

In that sense, our AI REDGIO 5.0 experiment considers 2 overall goals:



1) On one hand, evolve Honey.AI to an edge-hybrid architecture to migrate to a Jetson Orin Nano (see picture on the left) the pollen detection step, in order to avoid uploading thousands of non-useful images to the cloud, thus reducing AWS costs for our company, and avoiding large amounts of data traffic, while not reducing the accuracy/precision of the models.

2) Second, for the other three applications and also future ones, assess the feasibility of migrating a whole AI-pipeline to the edge, while taking into account cybersecurity constraints. If successfully implemented, our devices would become 100% autonomous and be self-controlled by the user through the HMI touchable display (see picture on the right), instead of an external laptop of the user.

1.2. Objectives of the experiment

With this project, our experiment is totally aligned with the AI REDGIO 5.0 open call objectives: 1) Enabling the evolution of Manufacturing SMEs towards Industry 5.0, not only on our side, but also on the our clients', from the agrifood manufacturing industry, 2) Evolution of cloud AI Technologies to AI-at-the-Edge procedures, showcase the advantages AI can bring to manufacturing enterprises when this is performed at the edge, making use of the edge-to-cloud continuum, capitalizing on the capabilities that are today offered by novel cloud-to-edge execution frameworks and infrastructures. In our case, It is not possible to use AI-REDGIO Open Hardware to the limitations on size and computing capacity, due to the complexity and size of our DL-models.

The specific objectives for this experiment will be:

1. The goal of use case 1 is the detection of pollen grains in images using a detector that can run in real time. The goal is to filter the images that do contain pollen grains before sending them to a cloud for further classification. The algorithms to be used are instance detectors that generate a bounding box and a segmentation mask for each object in the image. Five different categories have been identified for this particle detector use case: “Not Pollen”, “Honeydew”, “Pollen”, “Yeast”, “Starch”.
2. The goal of use case 2 is the detection and classification of pollen in images with a larger model that processes everything, thus removing the need of the cloud or connectivity. This classification is done at pollen species, which have a lot of variety. The categories for this application are ~95 pollen species.
3. The goal of the third use case will be to implement also the application for microorganisms detection and classification used in cell/spore counter and viability analysis based on colour

To allow the deployment of the models within the support NVIDIA Jetson Orin Nano, specific export and optimization modules to convert all the different models to ONNX and further TensorRT to provide a quantized version for each one of the models. Then adapt and train the AI models for pollen detection in the embedded hardware to get the maximum performance per watt using the state-of-the-art NPU.

4. Last goal will be to commission and test the new version of the device, validate performance and KPIs it in real operational field and compare overall results with the current version in terms of cloud processing figures, inference time, overall processing lead times, accuracy on detection, accuracy on classification, overall price of the device (current cost is 2.2k, and expected to increase by <600 euros only), and AWS costs.

The quantifiable objectives and criteria for success is:

a) Cost of Goods < 2,700€
b) Validate the accuracy, overall lead time, computing needs on AWS, and size of data transferred:
    a. Goals use case 1 (edge-cloud hybrid architecture): i) 30% traffic reduction ii) 20% GPU needs reduction iii) 20% lead time reduction iv) x25% costs reduction.
    b. Goals use case 2 and 3 (full edge): i) 80% AWS cost reduction ii) <3% reduction on overall accuracy, iii) <20% increase on overall lead time per analysis.

1.3. Experiment overview

Our device now is a combination of 4 subsystems interconnected:

1) The robotized microscope with sample stage, built with three integrated high-precision stepper motors for X-Y-Z translational movement (2 micron precision), and a 5MP digital camera that takes thousands of pictures per test. The microscope “scans” the glass slide area at 400X or 600X where the sample is spread, in different types of glass slide or glass chamber depending on the type of analysis done (yeast/bacteria/spore counting, pollen analysis, crystallization rate, or mycelium growth time-lapse tracking). It includes a self-designed control PCB, responsible of controlling the hardware.
2) The control APP as an executable desktop application developed in C++ for PCs, the application oversees the communication and movement control of the positioning system, as well as SDK communication with the digital camera. This APP also controls the communication with the cloud, using our API.
3) API, AWS and Cloud User Platform - The API is responsible of the tests management and on-demand cloud computation to run the deep learning models. The API also communicates with a MongoDB database and the Clients’ Platform, the communication tool for our customers.
4) AI-pipeline module ▸ Including different image processing algorithms and different deep learning models (mainly Convolutional Neural Networks architectures and Transformers) that have been trained with property datasets (internally developed) with thousands of images of each specific specie to allow the system to learn and recognize the patterns. For pollen analysis we count on more than 200k pictures.

While the current solution depends on the end-user’s laptop for connectivity and communication with the cloud, one of the goals of this experiment is to develop a fully autonomous device that locally computes the full pipeline, without increasing too much inference time, nor losing significant accuracy.

With this experiment we are targeting the industry of agrifood processing sector, including different specific markets and applications. Specifically, the technologies involved would be robotics, digital microscopy, instance detection and segmentation, object classification, traditional computer vision and image processing, and quality analysis/assurance. The hardware involved will be Jetson Orin Nano, due to the good relationship between GPU computing specifications and commercial price.

1.4. Scientific and Technological Excellence

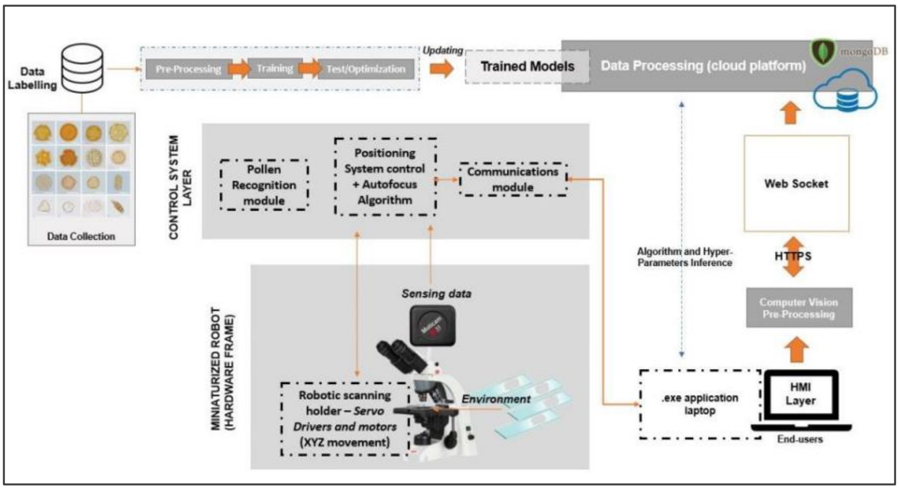
- Novelty and state-of-the-art

Honey.AI is the first smart device that conduct automated quality analysis of honey based on microscopy. There's no other commercially available solutions that conduct these type of analysis.
The substitute alternatives are the labs who have palynology experts. Approximately, there are 1-3 reference laboratories for honey matters per country (including specialized research groups in Universities). The most important ones are Eurofins, Quality Services International, Intertek Group, Apinevada (ES), Fera (UK), Analytica (NZ), Alnumed (GE), ALS Global(IT), Ventlabs (US), ALFA Chemistry(US). Honey.AI solution would become direct competitor of their business. Honey.AI's value proposition for end-users is:

- Time. Results obtained on-site, in less than 1hour.
- Results. Higher repeatability and no human errors.
- Honey Quality. Honey packers gain real-time process control in their plants when mixing/blending different batches from different beekeepers/traders, since they are able to characterize each batch, thus also estimate the concentration of the resulting marketed product.
- Costs. Investment recovered the 1st year of operation.

- Overall architecture [now]

The scheme on the right shows the current architecture that we have, considering the device, the APP, the API, MongoDB, AI pipeline and models, EC2 instance on demand.



- Challenges of the experiment and TRL

The overall challenge is to be able to migrate to an NVIDIA GPU computing on the edge which not increases too much the cost of the equipment, is small enough to be integrated within the current device control case, and assures that inference time and overall precision of our models are not significantly impacted, compared to our current architecture with cloud computing on AWS.
While Honey.AI application is already on Beta stage in the market, Fungi.AI and Ferment.AI are on TRL6. If this experiment ends with successful conclusions and performance KPIs, TRL after the project would be TRL8.

2. IMPACT

2.1. Expected impact on the SME

- Impact on Microfy Systems

Our solution is a combination of hardware and software that work interconnected for the best accuracy. We implement a B2B Business Model with an innovative approach with 2 revenue streams:

A. Direct sales of the Device – A purchasing price of 4,800€ for the automated microscope.

B. Recurrent payments for database consultation during each analysis conducted as an additional *pay-per-use* fee per complete honey analysis. It depends on the type of analysis and market. While pollen analysis is at 12€, between 5-10 times cheaper than laboratories, we also consider a subscription model for Fungi.AI.

Honey.AI is already a commercial product that our team has started to sell by summer 2023. Although it is still a Minimum Viable Product to run basic pollen analysis (to assist with botanical origin) and other basic quality parameters, we already count with 15 clients from 9 different countries, and the interest raised among the industry stakeholders is very promising. With this project, it is envisaged 2 different types of impacts for us:

1. COMMERCIAL IMPACT → With a stand-alone device we would be able to reach new applications and collaborations faster, since we are not dependent on cloud architecture, nor variable costs of on-demand GPU. There are specific applications for laboratories in the public sector that demand for standalone alternatives, as well as partnerships with companies that have already developed the AI pipeline for other applications but are very interested in collaborating with us in regard to the automated affordable HW.Thanks to this experiment we could definitely migrate to a full edge-computing architecture.

2. ECONOMIC IMPACT → The impact on the economic side would be related with the reduction of variable costs per analysis on a AWS hosted full AI-pipeline. By reducing the requirements of GPU on AWS our company would we able to increase profit margin per analysis and offer the service even cheaper to clients, thus increasing the number of customer portfolio.

- Impact on our clients: food manufacturing/processing SMEs

1. DIGITALIZATION IMPACT → As previously summarized, our technical solution addresses focus area of Human-machine co-working, in which there is a smart use of an automated robot to avoid tough, repetitive labours in the companies, with low added-value. Our solution assists food processing companies to improve their workplaces, increase control of their production processes with almost real-time data, and facilitates human work to implement real added-value tasks.
   The food sector is very traditional and has strong resistance to adopt new technologies and approaches to their daily operations, mainly due to the low commercial margins considered in this industry. The reluctance to invest in emerging technologies such robotics, AI, edge-computing, etc. is very high in this sector, but the potential advantages for them are very high, such as productivity increase, product's control increase, and also economic savings. For instance, for Honey.AI, The Return On the Investment [ROI] is between 6 and 24 months, due to the attractive savings obtained by the cheaper prices, compared to those of the labs. The example of a business case would be:
   - A specific honey packer performs 150 analysis per year at the labs, at an average price of 40 €/analysis.
   - So, this packer spends 150x40 = 6k€. per year, plus 150x10 = 1.5k€ to cover samples' shipment to labs.
   - It means that the packer spends 7.5k€ per year in pollen analysis now.
   - With Honey.AI purchase, the annual expenditure would be only 1.5k€.
   - Payback: the investment of Honey.AI purchase is recovered the 1st year!

- Impact on the overall Project AI REDGIO 5.0

✓ We offer specific use-cases of the agrifood manufacturing sector. The application field is extremely different to the current fields presented within current use-cases.

✓ Our team already designed the new version of stand-alone device with state-of-the-art edge-hybrid distributed architecture to reduce the GPU cloud computing currently used, as well as assure lower latency, higher reliability in remote locations, reduce traffic, bandwidth and data storage. The problem was that the device was not powerful enough, and the results were poor. In our case, our team is highly motivated to test different alternatives and provide the consortium with a real benchmarking of all the alternatives tested.

✓ Our project includes a high demanding AI/ML application, with significant computing needs, and with 2 years of previous data gathered with cloud computing at AWS, so we have plenty of information to compare with.

✓ Last but not least, our company commits to collaborate with the platform AI-on-demand and upload specific datasets of our property to be shared for educational applications.

- **KEY PERFORMANCE INDICATORS (KPIs)**

The Key Performance Indicators related with the objectives of the experiment are those ones, which will be tracked on evolution and final results at the end of the project. Their target values are on the objectives section:

1. Inference Time per picture and location (position of the sample scanned, with different focal planes)
2. Overall Lead Time per analysis, considering the mechanics for sample scanning + inference.
3. Overall costs Spent on AWS architecture for GPUs/CPUs on demand (EC2 Instances)
4. Precision and Recall for each application, comparing both pipelines (cloud, hybrid and full-edge)

2.2. Dissemination and exploitation plan

Microfy Systems owns full property rights of our solution, including robotized hardware, custom PCB, APP, AI-pipeline, and database. Our team has a collaboration agreement with Motic Europe (as exclusive distributors), who are the suppliers of the basic microscope and the commercial industrial camera as components of our hardware. We are currently selling Honey.AI within the honey supply chain:

1. Honey packers ▸ Honey packers are those that buy bulk honey from traders, cooperatives and beekeepers and process it (filtering, homogenization, blending, pasteurization) and pack it for retail. They currently analyse almost all the external purchases of honey they do. As an example, considering a large honey packer (≅ €15M turnover) that imports part of their packing production, spends around 50-100k€ per year in externalized honey analysis (up to 400 tests), since they do not have an expert team, nor expensive equipment to conduct complex testing at their premises. Our affordable, fast and easy-to-use device would help them to save thousands of euros per year, if used as a screening technique at their premises, and to obtain real-time data without the need of sending samples to the lab.
2. Traders of bulk honey ▸ Better control of their purchases, specifically for large containers coming from those countries with highest incidence of honey fraud, such as China, Ukraine, and Turkey. Traders usually work with large international laboratories able to accurately identify any kind fraud, but the results are obtained 7-14 days after sending the honey sample, thus negatively impacting on their business. As honey trading is a highly speculative business and most of large purchases are done right after harvesting period, traders would benefit of a compact, on-site system, able not only to detect fraud, but also to assess the botanical purity of the sample at real time. The purer the honey is, the higher its commercial value results.

Our team has an approach of direct commercialization with own salesforce in target regions for our technologies, instead of reaching potential clients through industrial distributors. The selling approach is justified by:

i) The industries we target still are niche market, with very well identified audience, and generally is very accessible to reach decision-makers within the entities,
ii) we introduce a new business model in the sector, who are used to subcontract analysis services, thus there are not stablished industrial distributors of laboratory equipment focused in producers/traders,
iii) the clients interested in its acquisition would probably first request a validation of performance with their specific samples, therefore live demonstrations during inverse trade missions are envisaged at our premises, or with free webinars, and finally,
iv) Installation and maintenance will constitute both an additional revenues stream for us

The selling approach and dissemination strategy is mostly based into 3 verticals:

- ✔ Creating market references and technology acceptance and reliance among the stakeholders. We will achieve this by means of formal meetings with lobby groups and decision-making organisms.
- ✔ Second strategy is focused into spread the word with international trade fairs attendance (alimentaria, SIAL, Gulfood, Anuga, Apimell, etc) , public symposiums held in reference conferences, free webinars for stakeholders, direct marketing actions, publications in key journals, and own sales force promoting free-demo periods and inverse trade missions performing technical one-to-one free demonstrations. Microfy will also be very active within their network to spread the work and explain the advantages of the devices,

preparing free "business Cases" for all their clients to demonstrate the potential savings promoted by our invention.

- ✔ The communication channels will be mostly prescribers' strategy, as well as direct e-mailing, LinkedIn.

Microfy is very active to spread the work and explain the advantages of our technology on different verticals in dissemination activities.

FINANCIAL GOALS BY 2027

447
Cumulated customers

€2,36 M
Revenue

€1,01 M
EBITDA

43%
EBITDA Margin

- ✔ International trade fairs/shows attendance ➤ This year we are attending Alimentaria Barcelona, IoT WorldCongress, Food4Future and 4YFN. Our team participates in key fairs and will be an active participator in further editions:, National Honey Show (UK), Anuga, Sana, SIAL, FoodexSaudi, GulFood (UAE), BIOFACH (GE), International Production and Processing Expo (US), Organic&Natural Products Expo Dubai (UAE), International Trade Fair of food processing technologies (PL), FoodTech (DK).
- ✔ Conferences – specific sector ➤ The following events will be attended as speakers to create awareness among industry stakeholders: Apimondia, International Conference on Apiculture and Honey Bees, American Beekeeping Federation Conference & Tradeshow,, congreso apicultura nacional.
- ✔ Publications in specialized journals and magazines ➤ In terms of in specialized press, key magazines have been identified: Apicultura Iberica, Vida Apicola, Bee Culture, American Bee journal, Bee World, Apiservices.

3. IMPLEMENTATION

The Gantt Chart of the 8-months project (between June 2024 and January 2025) and tasks description is below:

3.1. Work plan

WORK PACKAGES	M1	M2	M3	M4	M5	M6	M7	M8
Work Package 1 ▶ Experiment Design								
Technical specifications								
Work Package 2 ▶ Experiment Development and Integration								
AI pipeline								
APP/API/Cloud								
Mechatronics				D1, D2				
Work Package 3 ▶ Experimentation and Assessment								
Commissioning and internal testing								
Real Experimentation with comparative analysis								
Benchmarking and conclusions								D3
Work Package 4 ▶ Exploitation and Dissemination								
Dissemination								
Exploitation								D4

As can be seen, it will be implemented on a 3-step roadmap: Experiment Design, Experiment Development and Integration and Experimentation and Assessment. Also an additional work package for dissemination and exploitation tasks, running in parallel all project. There is 1deliverable per WP, as indicated in the Guidelines.

Work Package 1 ▶ Experiment Design				
Duration	Starting month:	1	Ending month:	1
Task description: During this first task, we will detail the technical specifications of the experiment (including testing plan and models to migrate), as well as the overall architecture for each use-case and the data pipelines. Our team will define the required specific modifications for the APP, the API, MongoDB, current AWS architecture, components used in the experiments, tools to migrate models and carry out the deployment, tools for benchmarking				

analysis, and phases of the experiment. We will also look for specific compatibility of a Jetson Orin Nano with our specific versions of Pytorch, Detectron2 and CUDA.

Main results: Technical specifications and tasks, **identification of AS IS and TO BE values of experiment KPIs.** As an outcome, in this task our team will also create an implementation calendar and deadlines to be integrated in JIRA (internal project management).Milestone: Cost of Goods confirmed, deadlines and compatibilities confirmed, assessment of GPU capacities confirmed for different Use Cases.

Deliverable: **D1. Technical Specifications, Architecture and Data Pipelines (month 4)**

Work Package 2 ▶ Experiment Development and Integration				
Duration	Starting month:	2	Ending month:	4

Task description: This task is framed on four different sub-tasks, specifically impacting on different parts of our current architecture: the AI-pipeline (including DL-models), the C++ APP, the API and the cloud (including dashboard and MongoDB) and the overall mechatronics design. The work to be done in this experiment is:

AI-pipeline ▶ Adapt the neural network to be deployed in the embedded hardware to get the maximum performance per watt by means of using specific open-source tools such as Kenning. As our aim is to place the AI models on an Edge device with almost no loss of accuracy, the models that we want to test must be very efficient. The inference time is also a limitation for us, as we don't want to block the acquisition of images due to having a large queue of images pending to be processed. We aim to keep our current AI object detection architecture in MaskRCNN, and migrate the pollen detector from current AWS cloud computing site to our specific HW selected. Also test options for the different functionalities: crystals, yeasts, colour and starch detection functionalities. Our expert will work on model optimization, export models, and migrate to TensorRT to get the highest efficiency. Additionally, the other image processing steps currently coded in Phyton will be migrated to C++ to be integrated in the APP.

C++ APP ▶ Re-code the App to make it compatible with the new acquisition hardware and to compile in the new ARM architecture, as well as change the GUI to make it usable without a full OS running in the background (functions to configure, WIFI, network, OTA updates, power control etc.). It is essential for us also to remove Qt libraries from the current APP to avoid paying license in the new stand-alone device. Also include the option to connect with local WiFi and develop a touchable keyboard once removing Qt.

API/Cloud ▶ Modify all the communications pipeline between the APP and the API/MongoDB, in order to allow that the AI pipeline runs on the edge an keep the values there during the analysis. The values gathered on MongoDB must be communicated to APP in different steps.

Integration/Mechatronics ▶ Physical integration of Jetson Orin Nano within the case of the device and connection with PCB board. For the experiment, the developer Kit is considered, since it already include the microSD and the USB inputs, which facilitates the integration with the device and also the camera. Manufacture and assembly the new version of the device, test it and do first trials to compare its performance with the current version.

Main results: AI models migrated and optimized, evolved APP, evolved API, new source code.

Milestone: AI pipeline deployed within Jetson Orin Nano – functional version (Month 4)

Deliverable: D2 - **Experiment implementation, Integration and Testing (Month 4)**

Work Package 3 ▶ Experimentation and Assessment				
Duration	Starting month:	5	Ending month:	8

Task description: During this stage, the task will be to run and replicate real analysis on the different pipelines available and compare results by doing a real benchmarking and analysing the evolution of KPIs. The goal is to analyze if success KPIs are met (usability, repeatability, traffic reduction, accuracy, lead-time, latency, GPU computing needs) and compare them with the Beta Version performance. Also compare with with Manual Counting by our expert. The evaluation methods to be evaluated are: learning and error curves, F1-score, precision, operating characteristic curve (ROC), area under the ROC (AUC), handling of false positives/negatives and analysis of the confusion matrix. Analyze the time taken to capture a entire location (movement included), this will allow us to compare with different solutions also having into account factors like power consumption, temperature of the device, dissipation needs, etc. The performance analysis in terms of AI models will be done using a subset of our datasets of pollen, yeast and color. As feed forward layers of the neural network have a small stochastic component, the variance of the inference time can be significant. To overcome this issue, we will evaluate our model multiple times (at least 10) to average the metrics in each run and obtain a more accurate performance analysis. The metrics that we are going to evaluate at each run are: loading time of the model, inference time, precision and memory usage.

At the end of the task, our team will also create specific AI-Assets for the AI on demand platform, including partial datasets of our applications for educational/research purposes.

Main results: All the data abovementioned and results gathered will be included in a benchmarking analysis of all the solutions tested during the experiment, to evaluate the performance of each one and relate it with commercial price of each solution. The final decision will take price, dimensions, and performance into account. Final conclusion must be a Go/No-Go decision to commercialize the new version of this device and the final price.
Milestone: Prototype ready to be commercialized (after CE review and final optimization)
Deliverable: D3. Experimentation and Measurement of technical-business KPIs (month 8)

Work Package 4 ▶ Exploitation and Dissemination				
Duration	Starting month:1	1	Ending month:	8

Task description: Our company is very active in exploitation & dissemination actions. We have just launched a very disruptive product into a traditional sector and our aim is to disseminate the invention all around the globe. We will attend different events related with agritech, food, IA and IoT, including fairs, conferences and symposiums. In addition, we will additionally do a press release and include our information in our website and social networks (LinkedIn). Publications in specialized journals and magazines. We will also prepare a commercial video of the new stand-alone product and actively look for other opportunities with other partnerships that aim to integrate our HW.
Milestone: Commercial descriptive video for the evolved product (month 8) and leaflet/briefing.
Deliverable: D4. Dissemination and exploitation + communication material (month 8)

3.2. Budget of the experiment

The costs of the experiment are personnel costs, cost of good and services, subcontracting and indirect costs associated with the action, considering the budget categories accepted on the Horizon Europe rules for Innovation Actions. The detailed breakdown and explanation of the costs are described here:

- **Personnel costs:** For this project, it is envisaged internal efforts covering electronics, API development, APP modification, ML migration and optimization, deployment, lab technician an testing, and management and coordination tasks. The overall personnel effort would be **58,500€** (≈13.4 PMs at 30€/h average hourly rate)
- **Other direct costs**: **V7Labs**, Darwin annotation tool costs – Our team uses a specific software as automatic annotation tool to create the datasets for training. Estimated costs for this project of 8 months is **1500€**, **Consumables** –testing and tests development, with inventory of honey samples and laboratory consumables. Estimated at **1,000**€ for all project. **Hardware costs** – For the project, it is considered to acquire the components and parts for an evolved prototype manufacturing. Considering the microscope, camera, electronica, motors, mechanical parts and electrical items, the overall costs would be **3,000€**. We also consider the HW purchased for testing purposes. **Travel/Dissemination** – It is considered a budget of **3000€** for travelling purposes and fairs/events, **AWS costs** – Specific costs applied for benchmarking at **5,000€**.
- **Subcontracting** It is considered a subcontracting budget of **10,000€** to cover a technical expert consultancy on cybersecurity on the edge and how to protect/codify deployed models within the device.

Indirect Costs: A indirect costs flat-rate of 25% on direct costs has been considered (Horizon Europe rules)

TOTAL COST OF THE PROJECT	100,000€
FUNDING RATE (%)[2]	60%
FUNDING REQUESTED	60,000 €

[2] **Funding rate:** the funding rate follows Horizon Europe rules, the funding rate applicability for the selected SMEs or for-profit entities is 60% of eligible costs, while for non-profit organisations it is 100% of eligible costs.

3.3. Participant presentation

Microfy Systems is an industrial manufacturer of deep tech industrial machinery/equipment for the food processing industry. Due to our innovative solutions offered to food processing industry, our company has been featured many times in journals, press, radio, and even Spanish TV. We have been also awarded with different prizes, and also joined acceleration programmes as NVIDIA, AWS and EIT FOOD FAN. See Annex for more details.

Our team started the development of microscopy device in 2020, and currently counts with 8 employees, with multidisciplinary profiles to cover the whole value chain. Our headquarters are located in Barcelona, which includes the technical office, the mechanical workshop, the electronics lab, the quality lab, production area meeting rooms, and testing areas for all the development stages. At Microfy Systems we are very proud to say that each step of the technical development is 100% developed internally by our own personnel, so our team covers all the technology's value chain. Meet our team (only those involved in the project), built from biologists, computer vision/AI engineer, electronics, mechanical and SW engineers:

- Iratxe Perales [CEO] has a Joint MSc degree in Chemical and Industrial Engineering and a Master degree in Project Management from the Polytechnic University of Catalonia (UPC). During the last 5 years she was the Head of Operations at Envisyo, leading a technical team of more than 40 engineers. She also has previous experience coordinating EU-funded projects (FP7 and H2020).
- Naoufal Amrani [PhD. Artificial Intelligence] 7+ years of professional experience in machine learning, deep learning, computer vision, remote sensing, image processing and data science experience with a proven track record of designing and implementing a large scale of algorithms. Large experience applying Python, R, Java, C, Matlab for algorithm design, data modelling, statistical learning , prediction analysis and data compression. Hands-on experience on applying ML algorithm and data prediction to real world problems: Neural Networks, Object detection & recognition, camera calibration, data compression, Nonlinear Transforms and 3D scanner.
- **Álvaro** Suarez [Cloud/Web developer and Junior AI] Álvaro is a Senior Software Engineer specialized in Software Architecture at the University of Las Palmas de Gran Canaria.
- Eduard Lopez [Mechanical Design of Honey.AI] Senior technician specialized in manufacturing processes with more than 16 years of experience in CAD design, mechanical development, manufacturing of prototypes, and the adaptation of manufacturing techniques to the final production process.
- Pau Cardellach, PhD. [CSO] Dr. Pau Cardellach has a degree in biology with a master's in vegetal biotechnology from the Technical University of Munich (TUM). He has focused his professional career on scientific research and the dissemination of the plant world. He has a Ph.D. in environmental science and technology from the research centre ICTA of the Universidad Autónoma de Barcelona.
- Miguel Moreno [Embedded firmware] - Miguel is a Computer Engineer specialized in Computer Science graduated from Universitat Politècnica de Catalunya, where he also obtained a master degree in Graphics and VR. He has had previous experience developing applications in C++, focusing on both back-end and front-end.
- Julian Rodriguez [Community manager, Customer service and marketing] Julian has a degree in marketing and international business (Universidad Autónoma de Occidente) specializing in digital strategy and creativity. In his role, he is in charge of marketing, sales, BackOffice and customer assistance.

PREVIOUS EXPERIENCE WITH EU FUNDED PROJECTS ▸ Microfy Systems has been previously awarded with different EU grants to develop different stages of the product, for instance, a VEDLIoT open call to test open-source HW/SW for AI on the edge, and BonsAPPs and DIGIFED to develop the first version of the stand-alone device with the simplified pipeline integrated within a basic Jetson Nano. The results were not good enough to launch a commercial version, so our company still has the need to experiment with more powerful HW and ML models.