

# PROMETEUS – Preterm Brain-Oxygenation and Metabolic EU-Sensing: Feed the Brain

Grant Agreement Number 101099093

## PROMETEUS IN PRESENCE MEETING MINUTE

**Date and time:** June, 20th 2024, 9.00 am CET

**Meeting location:** University of Girona, Girona, Spain

**Meeting Chair:** Sabrina BRIGADOI - Unipd

**Participants:**

- Steering Committee members,
- Executive Board members,
- Other project participants (Frédéric Adam - UCC; Lou Legall - UCC; Berta Ben-Shachar - QULAB; Sharon Lefler - QULAB; Hila Masasa, QULAB, participated remotely, for the other participants list, see Attendance list)

**Staff and Guests:**

- Marta POZZA - Unipd, administrative staff (remotely)

## Objective

- Update from each WP leader and other partners on the activities of the WPs in which they're involved;
- First meeting with the Ethics Advisor for the project;
- Scheduling of next meetings, workshops, and seminars;
- Activities of Prometeus Exploitation Committee (PEC)
- Updates on 1<sup>st</sup> report and internal monitoring.

## Meeting Agenda

Time	Event	Speaker
09.00-09.10	Organisational welcome by Coordinator and local organizer	Sabrina BRIGADOI - Unipd Josep VEHI - UdG
09.10-09.40	WP 1 - Brain oxygenation and perfusion (neo-opticap)	Davide CONTINI - Polimi
09.40-10.10	WP 2 - Continuous Metabolic Monitoring (wearable sensor)	Idan TAMIR - QLAB
10.10-10.40	WP 3 - Metabolic Model and neonatal in silico avatar	Emmanuel BARBIER - UGA

10.40-10.55	Break	
10.55-11.15	WP 4 - Prometeus Nutritional Clinical Advisor (NCA)	Josep Vehi - UdG
11.15-11.45	WP 5 - Cloud-based platform (digital cloud twin)	Alberto Scarpa - DAVE
11.45-12.15	WP 7 - The social culture of preterm birth	Paola Rigo - Unipd
12.15-13.00	Meeting with the Ethics advisor	
13.00-14.00	Lunch break	
14.00-14.20	WP 8 - Dissemination and Communication	Sabrina BRIGADOI - Unipd
14.20-14.40	PEC Committee updates	Michele LACERENZA - Unipd
14.40-15.00	Admin updates/feedback on reporting	Marta Pozza - Unipd
15.00-15.30	Other issues at stake	All

## Meeting notes

Coordinator of the PROMETEUS project Sabrina Brigadoi, University of Padua, with Josep Vehi, who hosts the meeting, welcomes the participants. She presents the agenda and opens the meeting by asking all the participants to briefly introduce themselves, leaving the stage to each WP leader and partner representative involved in the ongoing activities.

### 1. WP 1 - Brain oxygenation and perfusion (neo-opticap)

Contini, leader of WP1 summarises the partners involved in the activities, the tasks and the timetable in which they have been involved and will be carried out, as well as the forthcoming deliverables. WP1 is progressing with the integration of the system.

Some delays in Task 1.2 will most likely be made up by the deadline. It is also compensated by an advance in task 1.3.

He shows how the sensors that are the main detection elements in the headset were developed and the principles that guided their design, choice of number, size, distribution and mounting.

Compared to the first version, the size has been reduced by 20% and a solid but flexible and comfortable structure has been created to house the 6 optodes.

The probes and the structure were designed with UCL and sent to Padua and Cork for feedback on their characteristics and wearability.

He describes the measurement layout and the neo-opticap layout, stressing that it is a scientific instrument, not a medical one, but that it has redundant safety systems to protect against loss of contact with the optode when turned on, also because of the population it is intended for.

The TD-NIRS module has been implemented by PIONIRS and work is already underway to integrate it with Neo-Opticap. He describes its characteristics and adds that an ad hoc firmware has been created and that the device is state of the art.

The SCOS module, realised by ICFO for the project, is also state-of-the-art equipment. Its main features are also listed.

The finished prototype is shown in a photograph that distinguishes the various components.

Contini reports that the switching time was deliberately left at <1s without further reduction to maximise detection accuracy, as the population on which it will be used could allow measurements of up to several seconds.

Then, he shows the test results and outlines the conclusions for these first 18 months of the project and what the next steps are.

Conclusions:

- Neo-Opticap specs, functionalities and layout defined
- TD-NIRS module deployed to PoliMi labs from PIONIRS
- SCOS module under deployment to PoliMi labs from ICFO
- First version of the Optical Probe under evaluation by clinical partners
- Main ancillary modules for integration under test

Work over the next six months includes:

- Development of the control Unit
- Integrating all the modules together
- Writing SW and FW for the synchronization and control of Neo-Opticap
- Optode finalization => Probe finalization

The approach they adopt, which guides construction and choice, is to meet multiple levels of safety and to be even more conservative than the basic rules that apply when the reference subjects are adults.

The discussion is then opened up.

Dempsey, UCC, says that after receiving the samples, they gave UCL some feedback and have some concerns about the surface area, the probe number and the relationship to the scalp skin, which is particularly sensitive in premature babies in terms of fixation, humidification, pressure on the skin, etc. The number and size of probes are particularly challenging.

Contini replies that probes won't be more than six, and this number allows all brain regions to be mapped. Torricelli - Polimi adds that a network structure may be better.

Dempsey gives the example of an EEG instrument with a spider structure that worked quite well. He asks if one probe does not work, what happens to the others and whether they can interfere with each other given their large size relative to the head on which they are applied. For the development of other instruments, they used preterm infant manikins.

Scarpa - DAVE and Contini answered that the interface allows you to select the fibers whose data you want to display, excluding some of them, and that the equipment itself also allows you to exclude fibers, which are independent of each other. Torricelli, then, points out that with a spider net, this would become impossible.

Brigadoi adds that also in neonatology in Padova they got the impression that the probes were too big (shows some pictures).

Contini says that even a 20 per cent reduction in their size will not change much. Torricelli adds that they have to put together and consider two aspects: to cover as many areas as possible, as was originally requested, and also to minimize the impact as much as possible and make the instrument comfortable. Without support, the probes can also be more flexible.

Lacerenza - PIONIRS proposes to reduce to three points that work separately. Contini adds that for the project research purposes they can also think to use one probe, while working on other layouts. The suggestion to use a manikin could be a good way of helping in the instrument design.

Lacerenza asks what is UCC's experience in the solutions to make the probes adhere.

In adults, report Dempsey, they have tried to replace everything adhesive on the skin with cups or non-adhesive media. Even in children at term and without special skin sensitivities. Pre-term babies have very delicate skin in addition to the interaction issue with other organs. He gives the example of C-PAP and non-invasive supports already on the market.

## 2. WP 2 - Continuous Metabolic Monitoring (wearable sensor)

QULAB is represented by Tamir. QULAB is reviewing what has been achieved in the first year and the activities that are being implemented for the realisation of the CMM sensor.

Two deliverables have been completed and one is in progress and should be delivered by month 24.

The *in vivo* safety and efficacy study in pigs is reviewed and the results are presented.

The study confirmed the safety of the sensor and allowed the initiation of clinical trials.

A safety study of the patch was conducted at the Meir Medical Centre.

The study showed no damage to the microprobes, either during insertion or removal. No oedema or erythema were observed, nor was there any pain or significant bleeding. Of course, this study was carried out on a very small group of healthy adults, and the transition to premature babies must be very gradual.

Through this first study, QULAB has established and validated a lactate threshold test protocol in adults.

As shown in previous meetings, the assembly, sterilisation and packaging processes have also been completed for the patch and applicator and the pre-clinical studies have demonstrated patch safety.

The patch and applicator have been tested on artificial skin *in vitro* and in humans.

The sensor, patch and electronics components were assembled.

Tamir then shows the results of the performance study of dual glucose and lactate sensors *in vitro*, adding that if two probes are placed too close together, there is significant crosstalk between the sensors. So, they have developed a system that reads them independently, one probe for lactate and one for glucose. They are about to test it in humans.

At the next meeting, they will also be able to present the results of the BHB studies, which have so far only been carried out *in vitro*.

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101099093



Dempsey asked how they planned to deal with the regulatory issue and what the timeframe would be.

Tamir replied that they have a consultant to help them with this, but the process has not yet started. Getting approval to test in neonates and premature infants can be a long process, and in any case, it will be necessary to wait for data to be collected from the First-in-Man study.

Support from clinical partners could help, including understanding what information needs to be generated and what needs to be brought to the attention of a regulatory authority.

### 3. WP3 - Metabolic Model and neonatal in silico avatar

Emmanuel Barbier speaks on behalf of WP3, outlining the partners involved, the tasks and their timing.

The currently active tasks are 3.1 in vivo animal study and 3.2 tracer and MRI analysis.

The in vivo study is carried out by UGA, using rat pups of only a few days old. The choice was made to use 13-day-old rats, which are very small in size but can eat and move independently, although their eyes are still closed.

Clotilde Courivaud UGA, who is in charge of the study, explains the study protocol that has been devised: 3 different diets (high protein, high fat, standard), 3 different glycaemic challenges to be tested on 9 groups of rat pups, with 12 subjects per group.

The protocol includes the infusion of glucose, BHB and lactate tracers and lactate and glycaemic clamp. Blood drops are taken to analyse glycaemic levels and arterial blood samples.

This involves the insertion of three catheters. The femoral catheter in particular is complicated to place, and they have searched on the market for one that is as thin as possible. They are also trying to evaluate if it can be placed differently.

The first mass spectrometry tests will be done in July. Two batches of 150 samples will be analyzed in December and May.

Salingue then takes the floor and says that the optimisation of the MRI at 9.4T is in progress. Experiments will start later this year. They are working with Polimi to perform NIRS on rat pups. The data they are working on at the moment is in-house and from adult subjects, so they will have to modify the mathematical model and adapt it to preterm infants.

The timetable for the activities is set and it is expected that the activities will be completed on time.

Marchiori - Unipd, presents work by Unipd on the modelling. So far, they have been working with the Glucose-Insulin-C-peptide Simulator (GIC Simulator) and in-house data.

Compared to the average model issues arise from the fact that preterm don't eat carbs and the glucose input is limited.

They imputed the decrease in  $P(t)$  to a change (increase) in insulin sensitivity (SI).

The 'new' model was first developed on an 'average' subject, whose parameters were extrapolated from an in-house population of 100 individuals. A previous study shows that in newborns of less than 32 weeks, glucose was administered to maintain the subjects in the euglycemic range. CGM was coupled with a glucose infusion algorithm to determine the GIR necessary to keep the newborn in a euglycemic range. As a result, insulin sensitivity should mimic Glucose Infusion Rate. The insulin sensitivity time course mimics the trend of glucose infusion.

This version of the simulator has been delivered to WP4.

A second step is to introduce two levels of variability: from the average subject to a population and in the insulin sensitivity parameters.

During question time Dempsey says that their Physiology department works a lot with the samples they are also working on at UGA and could be put in touch with them.

He then goes into some aspects concerning the diet of newborns and preterm infants, pointing out that even milk is variable in its components and from time to time, so setting a standard is challenging.

#### 4. WP4 - Prometheus Nutritional Clinical Advisor (NCA)

WP4 activities are presented by Oriol Bustos, who outlines the project timeline and introduces the partners involved.

The first meetings with UNIPD focused on the operation of NCA and the mathematical model and simulator.

The mathematical model is under development by UNIPD. Additional data are needed. However, UNIPD will provide an initial version of the simulator based on the data they have already analyzed.

The Current Objective Loop, different from the ideal, which will include data from the neo-opticap and CMM system, is based on data only from glycaemic control and is intended to result in recommended nutrition for HCPs through apps. HCPs will choose how to manage parenteral nutrition.

Bustos then shows the results of an initial simulation.

They are working in parallel with the metabolic model.

During the first trimester 2024, the UdG prepared a document defining the requirements. However, more information is needed to move forward.

The discussion then opens with questions from the WP4 working group on glycaemic control measures, how nutrition is managed in detail and by whom.

Dempsey and Brigadoi replied that the electrolyte solution and lipids could be together or in separate bags, and in parenteral nutrition, the composition of the nutrition does not change from bag to bag, but the amount does.

Parenteral nutrition is a whole and most children are fed this way, not just glucose.

Hypoglycaemia is an issue and a common episode that is managed with boluses separate from feeding.

##### 4.1 WP5

The WP5 leader, Scarpa, also briefly goes over his WP's objectives, tasks, deliverables. They are working on the communication protocol, the subject of the next deliverable.

For its realisation, the interaction with WP 1-2-4 is particularly important at this time.

The simulator is now active, and processes simulated data on the basis of real data examples. Everything is synchronised securely and with attention to data separation.

Scarpa shows the system architecture, hardware, the edge unit, the cloud service, and the communication protocol.

In addition, they are working together with Unipd and UCC on the design of the application for parents, which should be very simple and give information on how the child is doing.

It then shows the dashboard for HCPs, which can be customised and modified. It contains all the data that comes from the detection devices (cap and CMM) allowing certain cap probes to be disabled.

It then switches to the Nutritional Clinical Advisor interface, asking whether the nutrition practices in Padua and Cork are similar or whether important differences need to be considered.

Dempsey explains how glucose is handled, and lipids too.

Torricelli and Dempsey ask questions about the selection of probes and their location as well as about time windows for data collection.

They emphasise how everything must become immediately intuitive for HCPs and simple, even customisable.

Contini points out that they have introduced a variable in their system that also needs to be reported in the visualisation.

Durduran - ICFO adds that it could also be useful to know what the signal quality is for example with a traffic light mode (poor, acceptable, good). Dempsey adds that this information is also collected in other tools.

Lacerenza - PIONIRS intervenes by pointing out how, on the other hand, an excessive presence of information can make the dashboard not very usable, especially in the context of NICU care.

Contini and Scarpa point out the possibility of separating the two contexts: that of research, which can be experimented with multiple data collections and more complex, from a user interface that could be the final product the research tool aims at. In the first instance, they argue that it makes sense to collect and have available as much information as possible.

Dempsey agrees that for research purposes this configuration is good, but it should be reduced and summarised for a definite user interface to be potentially commercialised.

Scarpa adds that they need, then, to select information that can be pooled or hidden.

## 5. WP7 - The social culture of preterm birth

Paola Rigo summarises the objectives of the WP of which she is leader: evaluate the potential impact of on-body monitoring devices on parents and health care personnel (HCP) and their personal experience with prematurity e create the first Visual and Oral Archive of prematurity, containing longitudinal memories of the experience related to the device development and premature birth.

WP7 first deliverable is planned for the end of July and together with UCC they are working on task 7.3 and 7.4. Next step planned is longitudinal data collection.

Two qualitative ad hoc interviews were developed to evaluate the impact and perception of Prometheus on-body monitoring devices, both on parents and HCP. Pictures were also selected to show the devices. Italian version of interview was implemented online and now they are translating them in English.

They selected pictures of all devices, but they still need one of the patch.

A battery of standardized questionnaires to carry out a psychological assessment was selected for both parents and HCPs with a more recent literary review (May 2024). Moreover, to assess the impact of NICU experience, another battery of standardized questionnaires was selected. They are implementing the English translation.

UCC is adapting the original version of Integrated Patient Journey Mapping tool, an instrument that it can be described as a digital diary that takes into consideration the physical and emotional path of each patient to promote empathy and empowerment.

While the approval of Ethical Committee was given recently for UNIPD, it is still pending from UCC.

From the oral archive side, the WP7 partners developed a script manual for both parents and HCP, that consists of an interview protocol to follow. UNIPD conducted a pilot study with 11 mothers. Amato showed the first results of this pilot. They are adapting the scripts to administer the interviews longitudinally over a 4-month period and are adjusting the scripts of the narrative sessions to perform short interviews that will become part of the Visual and Oral Archive of Prematurity.

Adam - UCC - shows the journey mapping that UCC intends to use and is readjusting for the project. This bottom-up approach enables the co-creation of a human-centred approach to problem-solving that puts the needs of users, patients but also caregivers, at the centre of the design process. It also allows multidisciplinary teams to experience the vision of end-users, incorporating it in redesigning the product, the service, the solution.

The map integrates various aspects including emotional and physical journey aims to visually externalise insights around experiences. Empathy, respect, and empowerment are promoted through this approach.

Adam then shows the use of this instrument in maternal health and lists its strengths (shared syntax, visualisation, concreteness, malleability and closure).

To address the goal to explore the social culture of preterm birth they are developing a patient journey map for families who are going through this experience. Maps are shared with staff and patients and used as a backup to develop with them narratives that are consistent in language, timeframes and locations.

Maps will be drawn and shared amongst the team, then used in interviews with parents. This will be a powerful engagement tool that will enable the creation of a common scenario with parents of premature infants

Legall - UCC shows the app developed to collect the journey maps.

Barbier asks if they thought about using AI to analyse narrative scripts. Rigo finds this interesting and a possible opening for new insights.

## 6. Meeting with the Ethics advisor

Brigadoi introduces den Boer, Ethics advisor of the project and asks WP1 and 2 leaders to describe briefly the major issues to be addressed from an ethical point of view.

Contini says that at the moment they are dealing with the safety of the device and that they will then deal with the approval of the use of the device at the ethics committee. They are trying to bring their experience from previous projects here as well.

Brigadoi intervenes recalling that the neo opticap is a non-invasive instrument and that, separately, all components are based on models that have already been approved for use with children, except SCOS. Probably this part of the instrument, when considered individually, will not generate major problems.

Dempsey takes the floor and points out that from a concrete perspective the instrument may well be safe, but the key aspect to think about and decide on is, within the European system, which regulatory authority to start with, whether Italy or Ireland, and that this path has a long lead time.

The approval for the use of the sensor will probably be more challenging.

Lefter - QULAB recalls that the reviewers' comments on the project suggested experimenting on animals by introducing the age variable, thus on baby pigs. However, the instrument seems to work well and within a year they should be able to submit the application to the ethics committee.

Dempsey suggests that the agency should be consulted first anyway to understand what will be required. Premature babies, he recalls, are very different from any other population in physiological terms.

QULAB says it is willing to initiate contact.

Brigadoi points out that the nutritional advisor is also a component, albeit not a material one, of the device and could be considered less problematic because he does not replace medical decisions, but only makes suggestions.

Contini intervenes saying that, from experience on already tested systems, the independent action of the physician can be seen as a way to evaluate if the device works, but it is different from considering it a medical device.

den Boer recalls that the project has one aspect that could be considered high risk, which is the CMM sensor, this level of risk will drive the whole project in its different aspects, in front of a regulatory authority. The way of presenting the activities, the choice of words, will be of central importance in this.

Torricelli, Dempsey and Brigadoi intervened, saying that one solution could be to divide the components of the device and ask for approvals separately for each.

Algorithm and nutritional advisor will necessarily be presented later.

Durduran points out that if approval is centred on the individual device and the study of each, then in the same study they cannot be tested together.

Brigadoi, Dempsey suggest that, on the one hand, having parts of instruments and studies already approved may favour the approval of a study with several integrated instruments. However, separating the studies, den Boer notes, would be very time-consuming.

Could applications for studies of single devices and devices together be carried out in parallel? Brigadoi asks.

den Boer and Dempsey reflect that it depends on the goal of the project and that one way to decide might be to first interface with ethics committees to see how it is most straightforward to proceed.

Torricelli reminds us that for neo-opticap the approval of the Ministry of Health is not necessary and that an observational study with separate components could be a way to proceed with at least part of the activities.

Whether to combine or separate the studies is something that needs to be investigated further.

Brigadoi emphasises that full device approval is ultimately necessary for the different instruments to work simultaneously and that beyond the CE marking, the regulatory authority needs to define which instruments are used and how, as well as whether the study is classified as clinical or observational.

In six months, they could have the documentation of all the components ready.

Durduran again proposes to start conducting studies with the neo-opticap, if ready sooner, for scientific studies that can be cited as a prerequisite and databases to support the application for approval of the study as a whole.

den Boer and Dempsey make themselves available to explore with their local regulatory authorities what suggestions they can glean to decide which is the best way forward.

## 7. WP 8 Dissemination and communication

The PI, Sabrina Brigadoi, briefly updates those present on the dissemination and communication activities.

She reports that she has been contacted for an advertorial article in a special issue of the Italian newspaper "Il Sole 24 ore" and asks everyone if they agree with the publication. Expenses will be borne by the Coordinator.

Consortium approves.

She then presents some pictures of the cartoon seminar that is almost ready and warns the partners that they will soon be asked to translate the text. The product will be ready in the next few weeks.

Finally, Brigadoi asks the partners how they will handle the upcoming seminars, workshops and meetings remembering what is provided in the DoA.

She proposes that the first workshop be held on World Prematurity Day, November 16, 2024, and titled "Prematurity at 360°". Two round table discussions regarding premature birth and experience around prematurity will be organized.

UCC proposes to run a workshop aimed at society.

Brigadoi asks the other partners to assume other opportunities to conduct workshops on the project.

Polimi proposes to present the project at a Polimi event, ICFO will attend a workshop on the time domain in the spring and can present the project.

Lastly, a timetable for future meetings is speculated:

- this plenary meeting coincided with the SC annual meeting.
- was also an opportunity for EB to meet.

EB members will meet again in October and January, together with AB members.

The next plenary meeting in attendance will be held at UGA in mid-June, or October 2025.



The next ones will be at Polimi in 2026 and at UNIDP/UCC in 2027 at one of the two clinical centres.

## 8. PEC Committee updates

Lacerenza, for the PEC, shows the list of exploitable results that has been prepared. This is considered a living document, the result of a preliminary assessment, but under constant review to decide if and which elements to keep or take away, what impact they might have and how they can be disseminated and exploited.

The list currently contains 12 exploitable results, including 7 products and 5 services.

Around September 2024, the list will be pooled with partners for monitoring at the project and WP level. The consortium will be involved every 12 months.

The PEC will work internally every 6 months to monitor, extend, modify and update the list.

Services and events organised by the EU Innovation Network have been and will be used.

## 9. Admin updates/feedback on reporting

Pozza, an administrative staff member of the Coordinator, reports regarding the technical review and its outcomes and the financial review.

While the consortium got a review report for the technical part, the financial part is still being evaluated and will receive separate feedback.

She also reminds what rules are set by the GA for the distribution of interim payments.

By September, partners will be asked to collect data on the progress of activities and use of resources in the first 6 months of 2024. Monitoring will also be done by asking partners to make a forecast regarding the use of resources (in terms of PM and other costs) in the reporting periods.

Dempsey asks if the budget is flexible particularly in the personnel item, for enlisting a junior researcher.

Pozza responds that the budget is flexible, that there are some cost categories for which an amendment is necessary, but if non-specific such as SME owners or in-kind contribution, and the change is justified in relation to the activities to be carried out, one can revise what was planned at the beginning.

## Decisions Taken

- Organise the first workshop during World Prematurity Day, November 16, 2024, hosted by UNIPD;
- Plan and organise 4 workshops as described in paragraph 7;
- Plan the next plenary meeting in Grenoble during summer/fall 2025
- Plan and organise seminars by all partners



## Actions/To-Do Items

Description	Status (Open/In progress/Closed/On hold)	Schedule	Lead person in charge
Collect continuous monitoring data from partners	In progress	September 2024	Marta Pozza, Unipd
Decide on a date for the next plenary meeting	In progress	Early 2025	Sabrina Brigadoi, Unipd
Translate the seminar cartoon text into partner languages	To be started soon	End of July 2024	Partners from Spain, France, and Israel.
Take contacts with local Ethical Committees and Regulatory Authorities to receive the best suggestion on how the study protocol has to be submitted	To be started as soon as possible	Fall/winter 2024	Gene Demsey, UCC, Maria den Boer Ethics Advisor

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## Proposed date for next meetings

- October 2024 Executive Board meeting
- January 2025 EB + Advisory Board meeting;
- June/October 2025 in person plenary meeting + Steering Committee meeting + Executive Board meeting.

## Related documents

- Prometeus\_presentations\_20.06.2026 meeting - <https://www.prometeus-eic.eu/reserved-area/>.

# PROMETEUS - Preterm Brain-Oxygenation and Metabolic EU-Sensing: Feed the Brain

Grant Agreement Number 101099093

## **WP1: Brain oxygenation and perfusion (neo-opticap)**

**Davide Contini**  
**Politecnico di Milano (PoliMi)**



PROMETEUS

# Outline



**PROMETEUS**  
preterm brain-oxygenation  
and metabolic eu-sensing

- **WP Description**
- **Neo-Opticap Layout**
- **TD-NIRS Module**
- **SCOS Module**
- **Optical Switch**
- **Conclusions**

# Partners Involvement



**PROMETEUS**  
preterm brain-oxygenation  
and metabolic eu-sensing

Number	Role	Short name	Legal name	Country
2	BEN	QLAB	QULAB MEDICAL LTD.	IL
3	BEN	UdG	UNIVERSITAT DE GIRONA	ES
8	BEN	UGA	UNIVERSITE GRENOBLE ALPES	FR
8.1	AE	INSERM	INSTITUT NATIONAL DE LA SANTE ET DE LA RECHERCHE MEDICALE	FR

Neonatology

System integration and WP leading

Module TD NIRS

Module SCOS

Cloud-based platform (digital cloud twin)

Neonatology

Module HEAD CAP



Partner defining needs/constraints from other WPs



Partner designing, building, and testing the neo-opticap

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101099093



**Funded by  
the European Union**



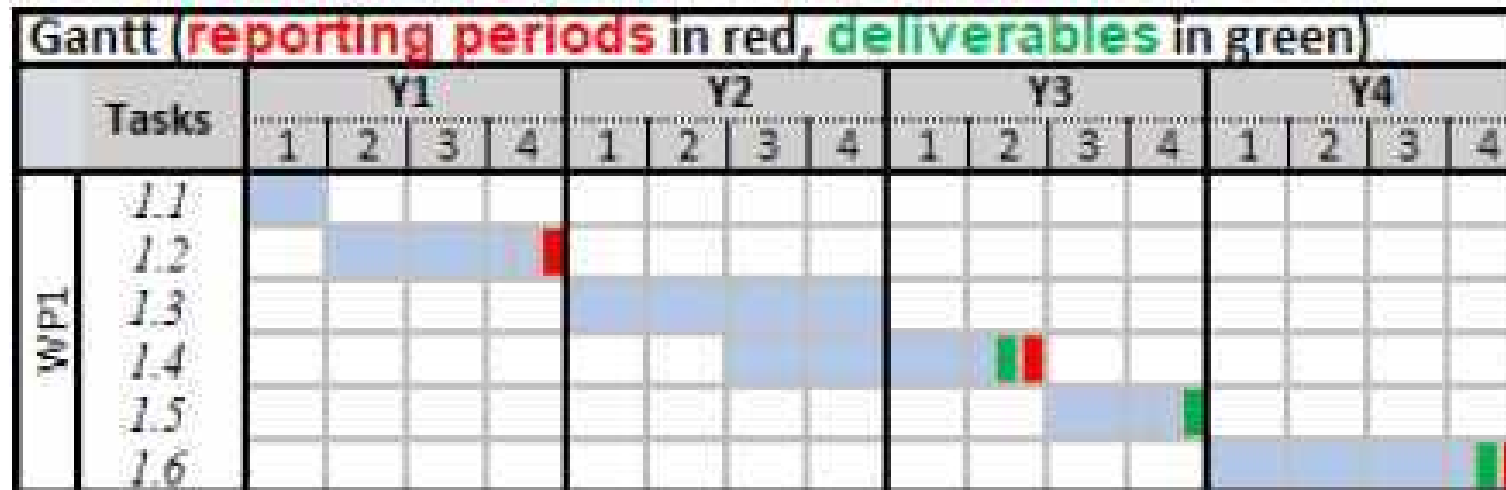
# Tasks and Timing



**PROMETEUS**  
preterm brain-oxygenation  
and metabolic eu-sensing

## Tasks:

- Task 1.1 (M1-M3) Definition of technical specifications (UNIPD, POLIMI, pioNIRS, UCL, ICFO, Dave, UCC).
- Task 1.2 (M4-M12) Module development (UNIPD, POLIMI, pioNIRS, UCL, ICFO).
- Task 1.3 (M13-M24) System integration (UNIPD, POLIMI, pioNIRS, UCL, ICFO, Dave).
- Task 1.4 (M19-M30) Testing, optimization, and validation (POLIMI, pioNIRS, UCL, ICFO).
- Task 1.5 (M31-M36) Investigational Medical device approval documents (UNIPD, POLIMI, pioNIRS, UCL, ICFO, UCC).
- Task 1.6 (M37-M48) Support to in vivo study and system revision (UNIPD, POLIMI, pioNIRS, UCL, ICFO, UCC).



# Deliverables and Milestones



**PROMETEUS**  
preterm brain-oxygenation  
and metabolic eu-sensing

## Deliverable D1.1 – Neo-opticap evaluation of performance

<b>Deliverable Number</b>	D1.1	<b>Lead Beneficiary</b>	4. POLIMI
<b>Deliverable Name</b>	Neo-opticap evaluation of performance		
<b>Type</b>	DEM — Demonstrator, pilot, prototype	<b>Dissemination Level</b>	SEN - Sensitive
<b>Due Date (month)</b>	30	<b>Work Package No</b>	WP1

<b>Description</b>
Evaluation of performance of the neo-opticap device, report of testing results

## Deliverable D1.2 – WP1 Medical Device Approval Documentation

<b>Deliverable Number</b>	D1.2	<b>Lead Beneficiary</b>	4. POLIMI
<b>Deliverable Name</b>	WP1 Medical Device Approval Documentation		
<b>Type</b>	R — Document, report	<b>Dissemination Level</b>	SEN - Sensitive
<b>Due Date (month)</b>	36	<b>Work Package No</b>	WP1

<b>Description</b>
Documentation for medical device approval by national authorities

## Deliverable D1.3 – WP1 Revision

<b>Deliverable Number</b>	D1.3	<b>Lead Beneficiary</b>	4. POLIMI
<b>Deliverable Name</b>	WP1 Revision		
<b>Type</b>	R — Document, report	<b>Dissemination Level</b>	SEN - Sensitive
<b>Due Date (month)</b>	48	<b>Work Package No</b>	WP1

<b>Description</b>
Revision of neo-opticap, based on feedback from first in human (WP6)

<b>Milestone No</b>	<b>Milestone Name</b>	<b>Work Package No</b>	<b>Lead Beneficiary</b>	<b>Means of Verification</b>	<b>Due Date (month)</b>
3	Neo-opticap	WP1	4-POLIMI	Fully operating prototype characterized using standardized protocols based on calibrated phantom Linked tasks: 1.1, 1.2, 1.3, 1.4 Linked deliverables: 1.1	30

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101099093

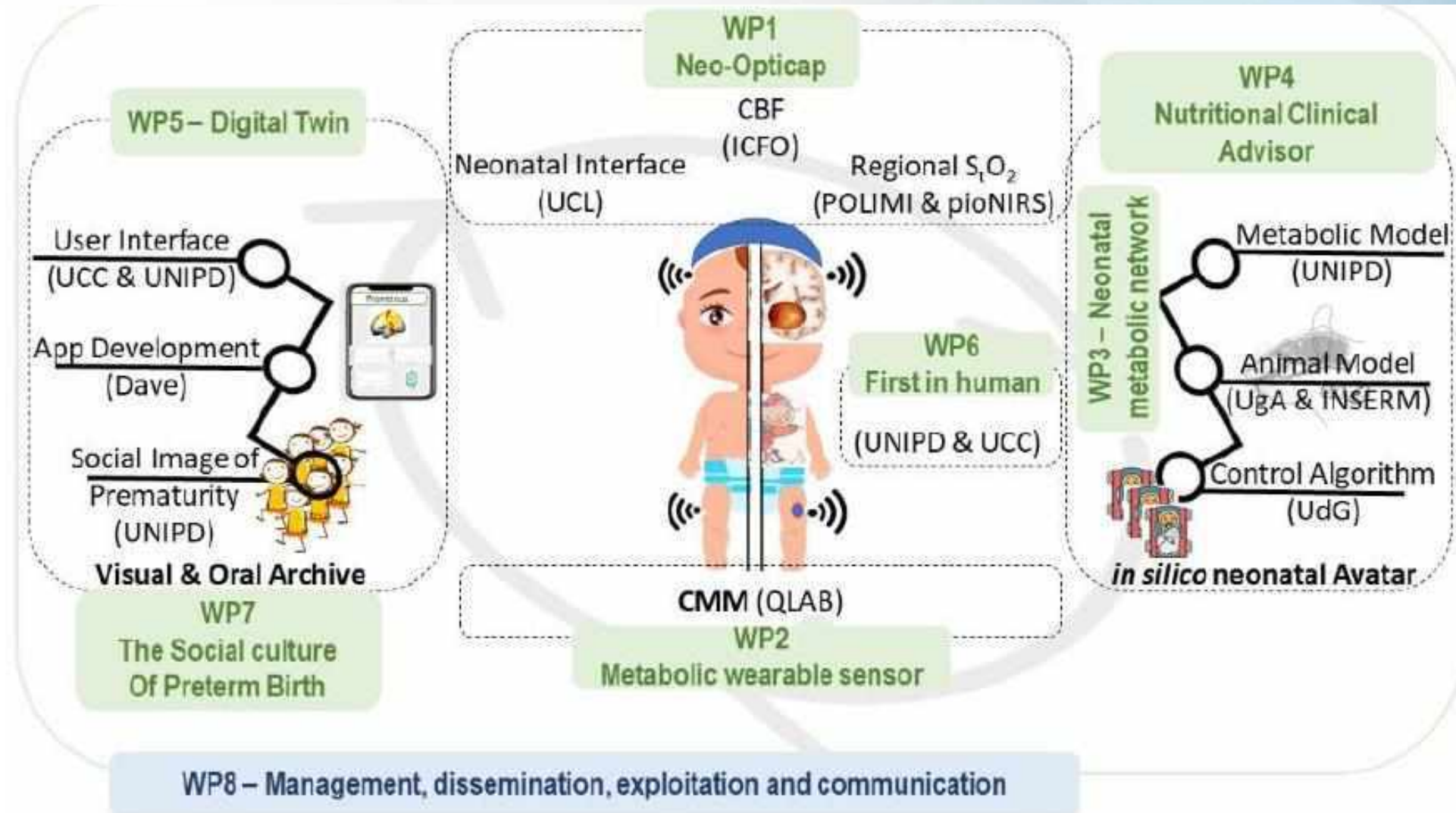
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# Links with other WPs



**PROMETEUS**  
preterm brain-oxygenation  
and metabolic eu-sensing



# Probe - General Concept



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and metabolic eu-sensing

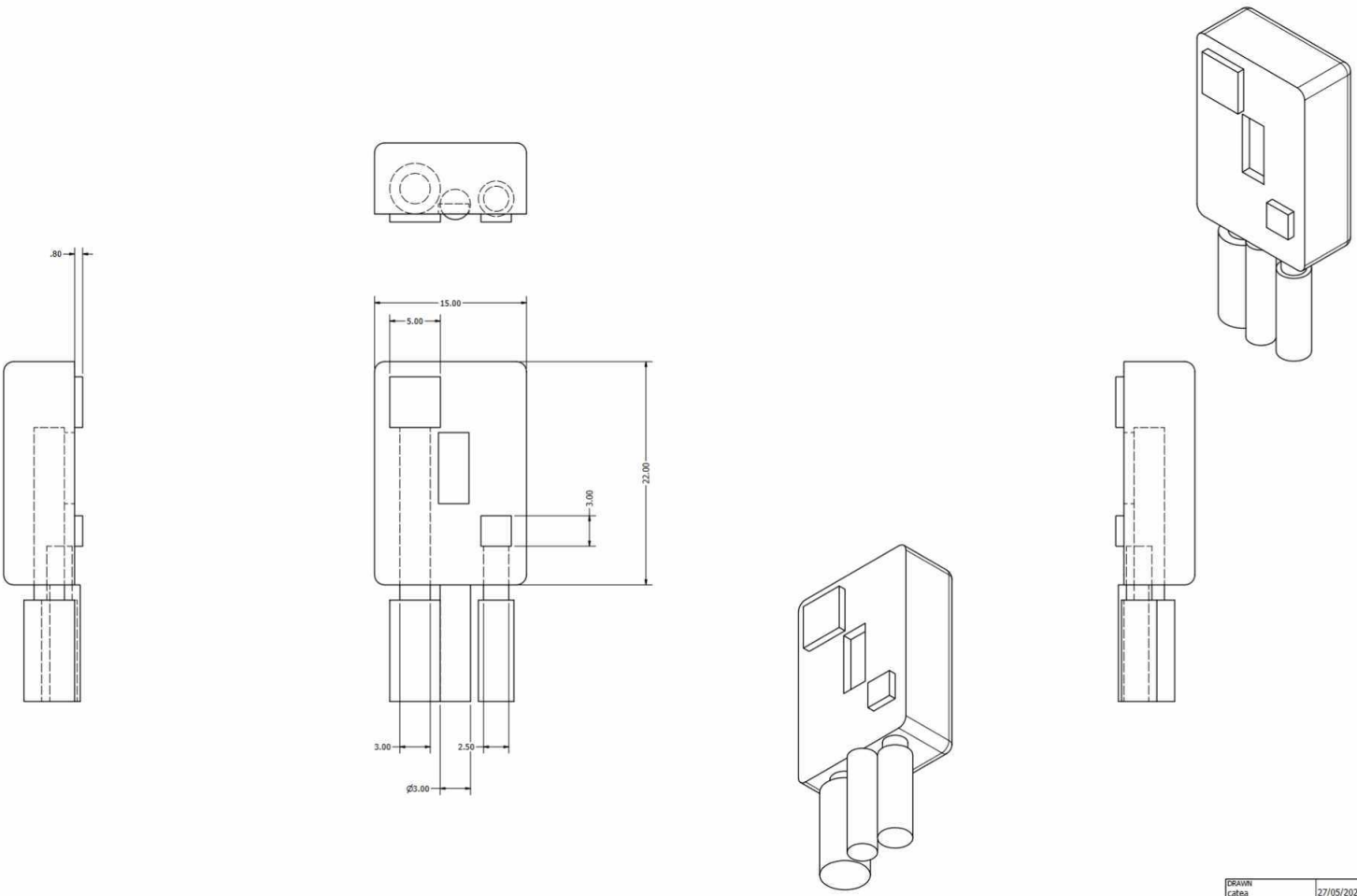


- Patient comfort.
- Smallest footprint allowing the hosting of the 6 optodes.
- Capability to ensure a good optical contact between optodes and patient head.
- Biocompatibility of all materials that contact the patient.
- Possibility to easily sanitize the probe or make parts disposable.
- No interference between the probe and baby's standard care.

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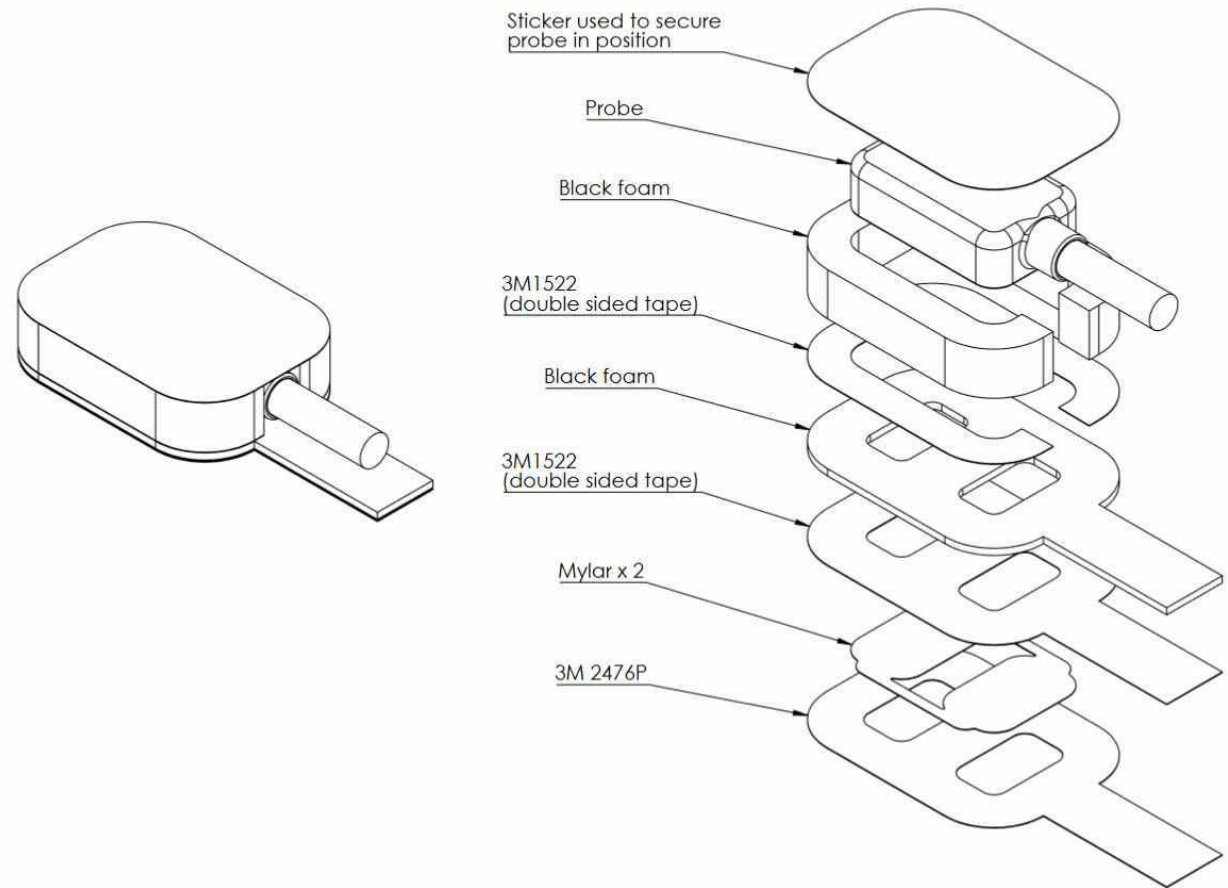
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QA		TITLE
INFO		
APPROVED		
	SIZE	DWG NO
	D	PROBE_V1_EXTERNAL-1



# Optodes – Probe Assembling



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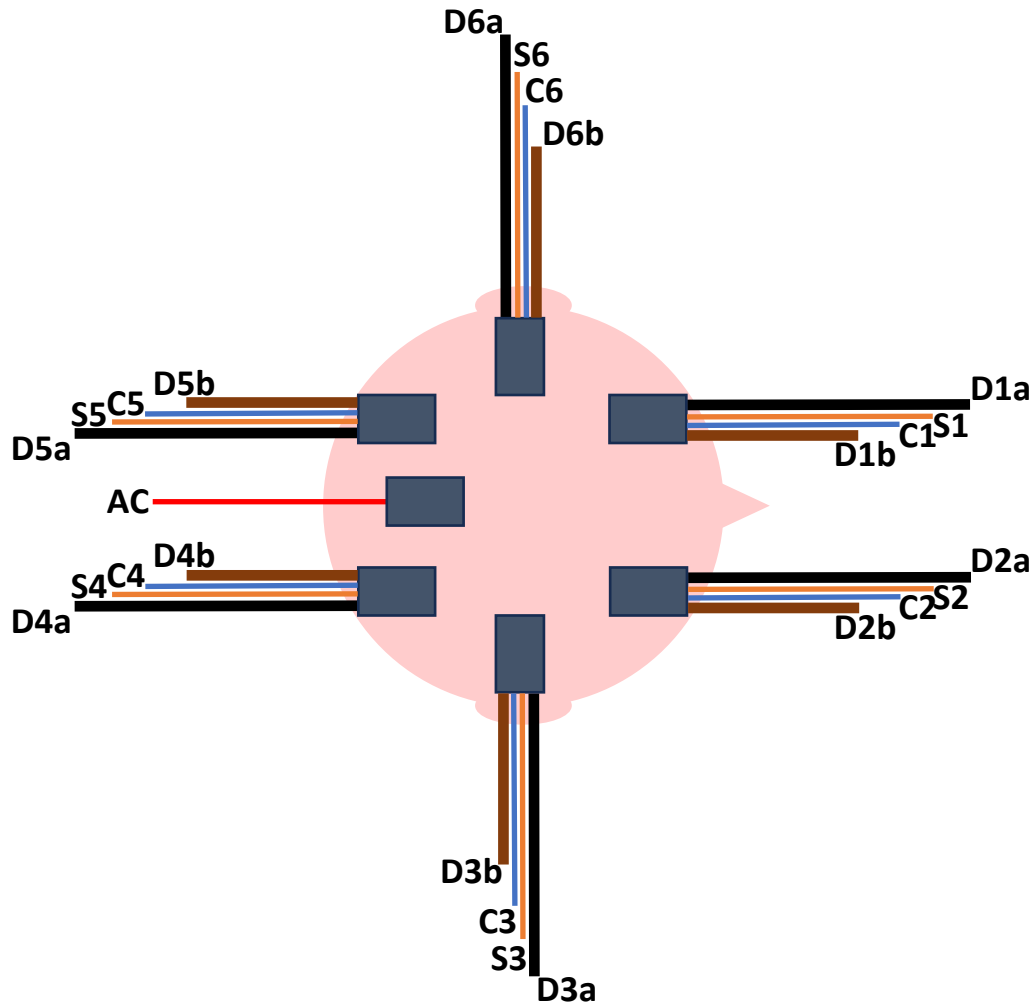
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# Measurement Layout



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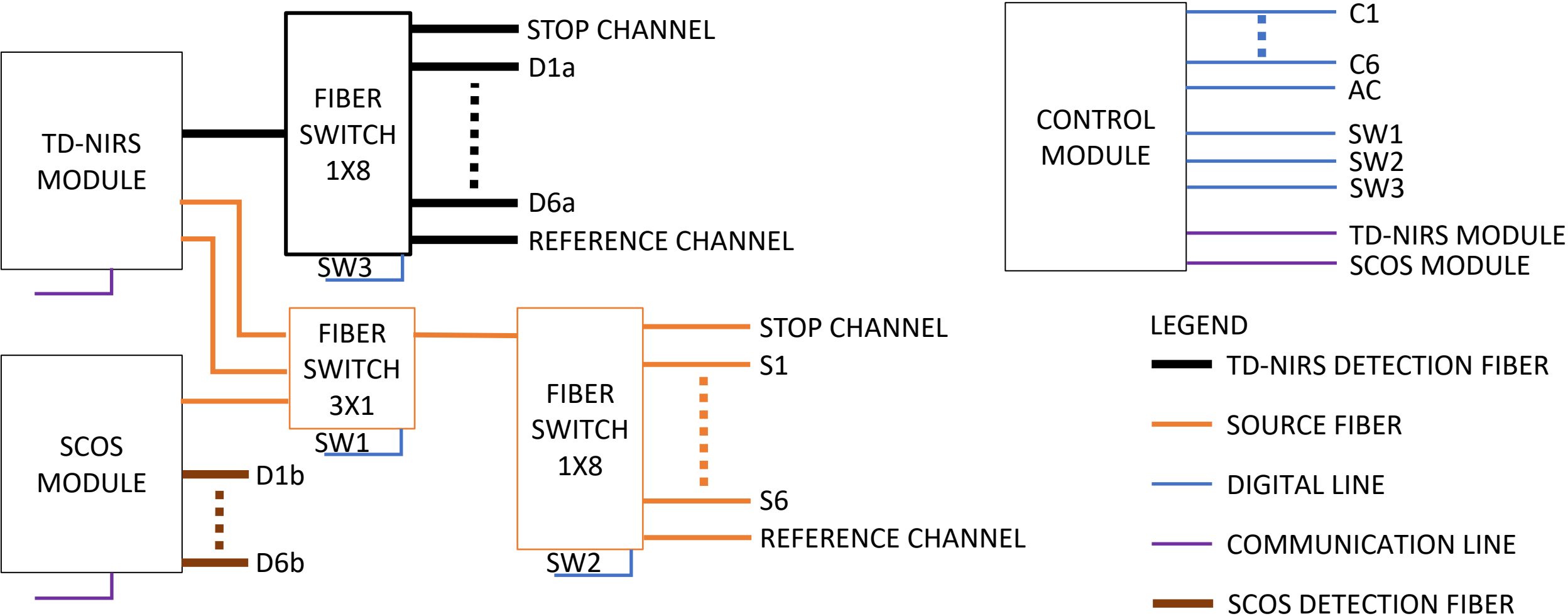
## LEGEND

- TD-NIRS DETECTION FIBER (D1a...D6a)
- SOURCE FIBER (S1...S6)
- CONTACT SENSOR ELECTRICAL CONNECTION (C1...C6)
- SCOS DETECTION FIBER (D1b...D6b)
- ACCELEROMETER ELECTRICAL CONNECTION (AC)

# Neo-Opticap Layout



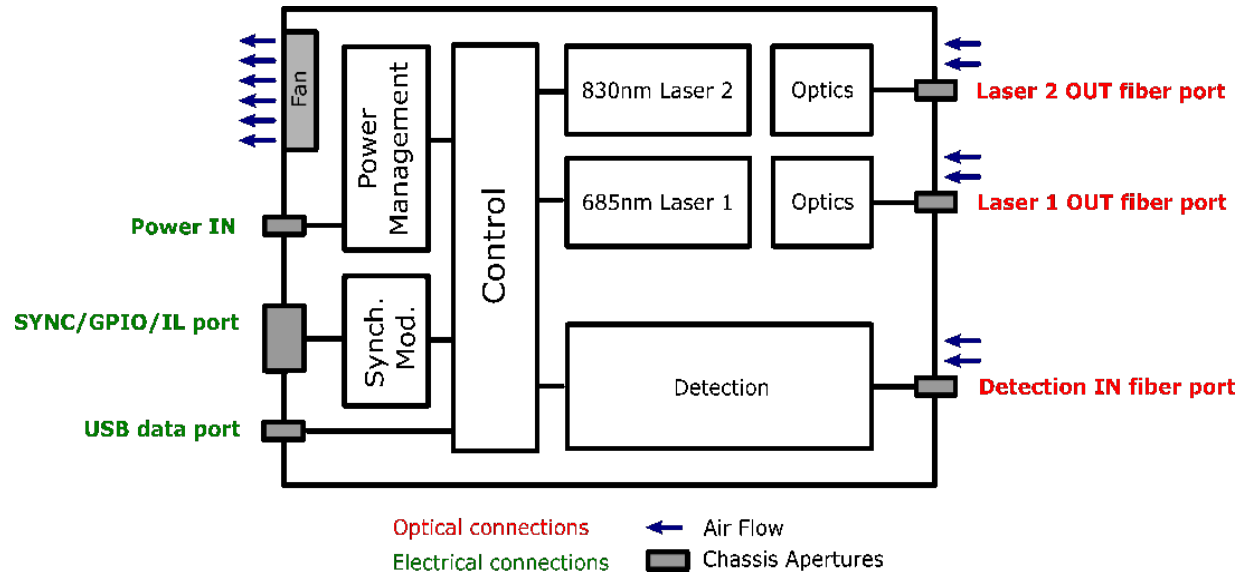
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and metabolic eu-sensing



# TD-NIRS Module



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and metabolic eu-sensing



- Two pulsed laser sources at 685 and 830 nm wavelengths (repetition frequency  $> 50$  MHz, average output optical power  $> 2$  mW  $< 5$  mW)
- Automatic equalization of the laser power delivered to the tissue
- A single-photon detection module, based on a solid state photodetector, with a photosensitive area larger than  $1.5 \text{ mm}^2$ , dark count noise lower than 50.000 counts per second and a temporal resolution better than 150 ps.
- A TCSPC- based (Time-Correlated Single-Photon Counting) timing electronic, able to measure arrival time of each detected photon with 10 ps resolution and conversion rate higher than 2 million events per second.
- Ad-hoc firmware
- A synchronization and GPIO sub-module.



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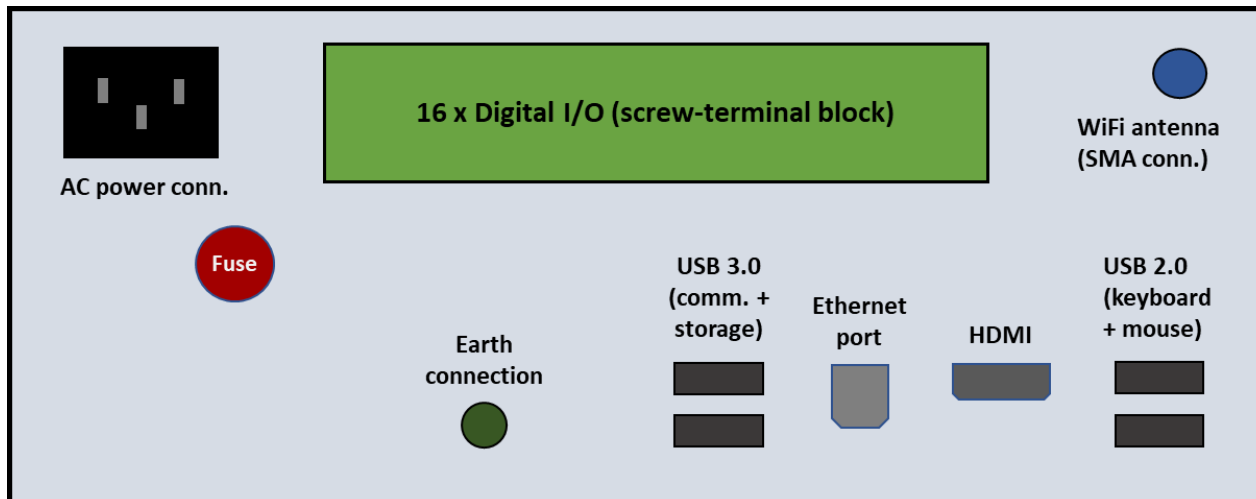
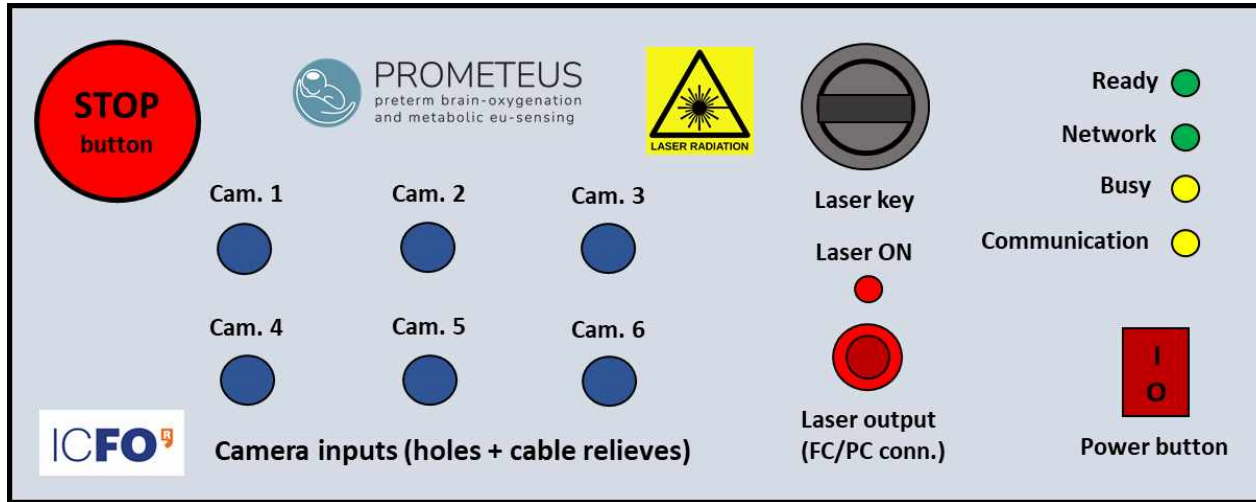
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# SCOS-Module



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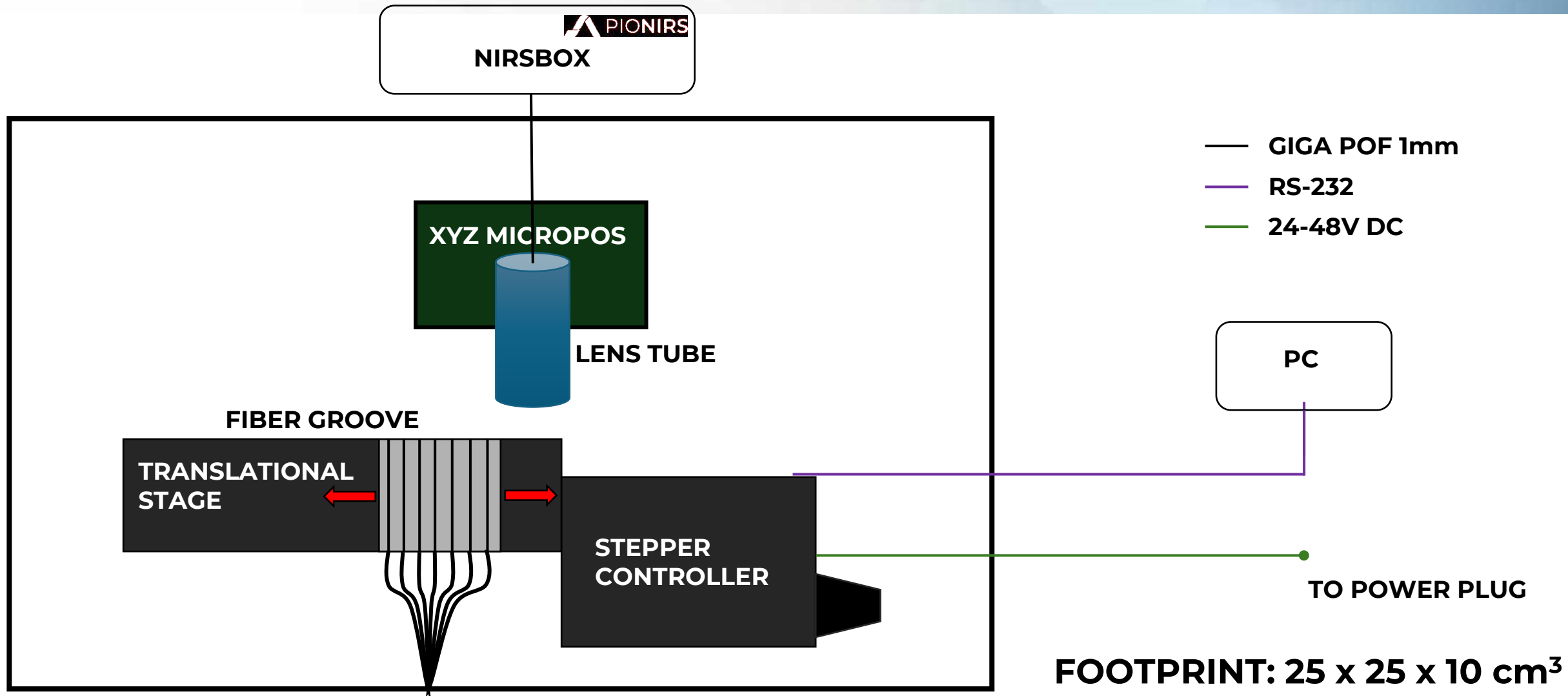


- A 785 nm laser with a coherence length  $>5$  m.
- Automatic safety control mechanisms to ensure Laser 1C operation (IEC 60825-1).
- Six ICFO custom SCOS detector modules ( $\sim 10^5$  independent speckles/detector) and electronics with appropriate optical coupling ( $\sim 2$  pixels/speckle,  $<0.001$  % cross-pixel contamination,  $\sim 150$  electrons/pixel/frame detection)
- A Dynamic-Linked Library tailored for the control of the module.
- Serial and network interfaces for the real-time transfer of processed data and the periodic transfer of raw data through cloud storage for the latter.
- Digital input/output lines for synchronization with the other modules.

# Optical-Switch - Layout (Multiplexing TD-NIRS detection channels)



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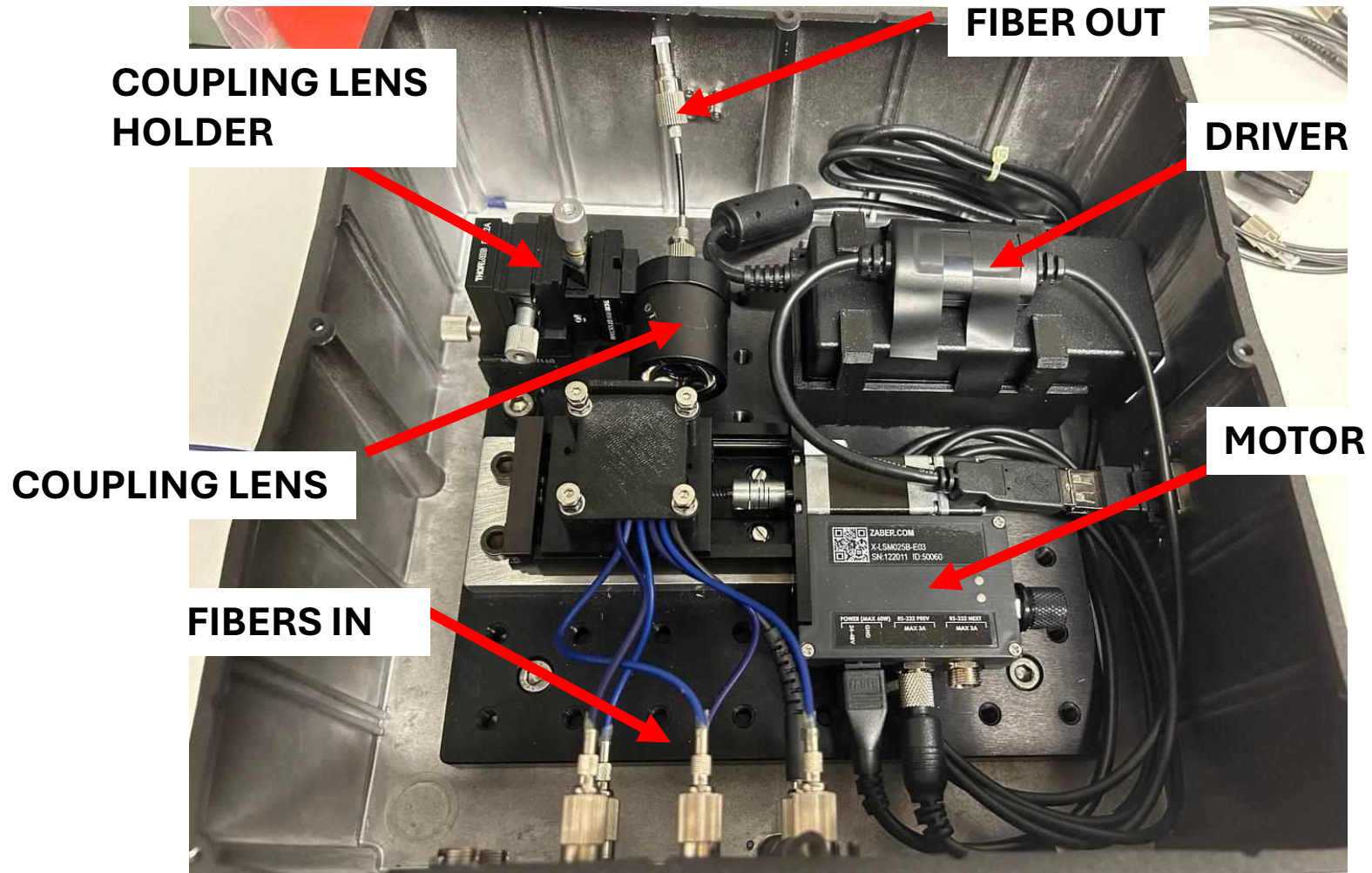


# Optical-Switch – Implementation (Multiplexing TD-NIRS detection channels)



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and metabolic eu-sensing

- 6x1 channels
- GI 1mm POF fibers
- Switching time < 1s
- Coupling efficiency around 50%





# Optical-Switch – Testing (Multiplexing TD-NIRS detection channels)



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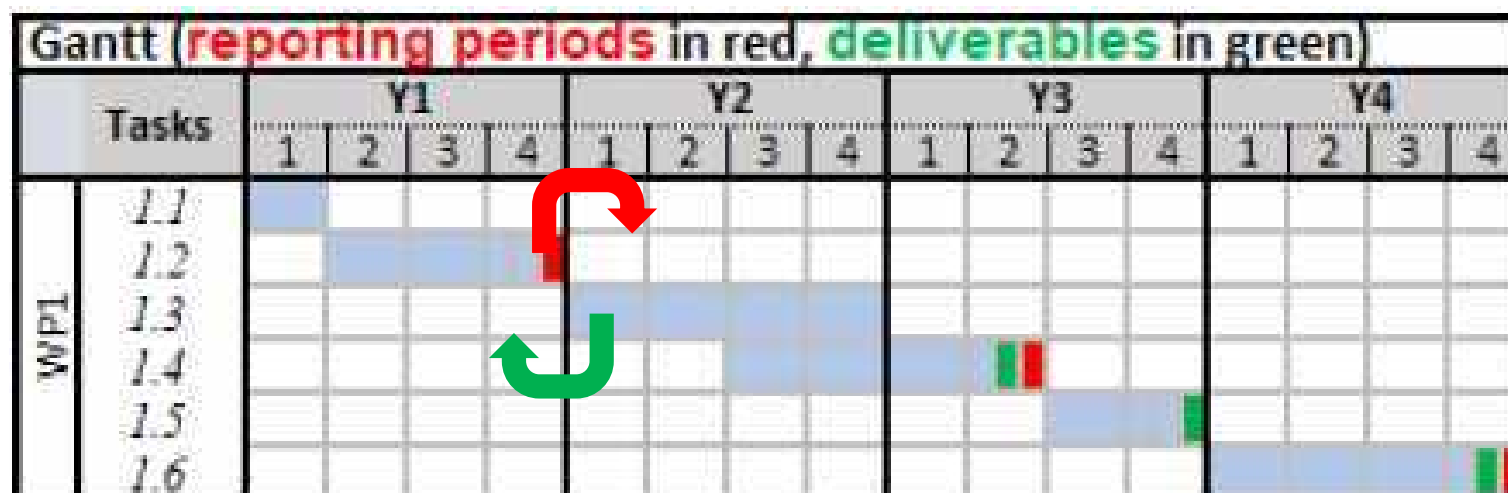
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# Conclusions



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and metabolic eu-sensing

- Neo-Optical specs, functionalities and layout defined
- TD-NIRS module deployed to PoliMi labs from PIONIRS
- SCOS module under deployment to PoliMi labs from ICFO
- First version of the Optical Probe under evaluation by clinical partners
- Main ancillary modules for integration under test



# Future (six-months) Steps



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and metabolic eu-sensing

- **Development of the control Unit**
- **Integrating all the modules together**
- **Writing SW and FW for the synchronization and control of Neo-Opticap**
- **Optode finalization => Probe finalization**

# PROMETEUS - Preterm Brain-Oxygenation and Metabolic EU-Sensing: Feed the Brain

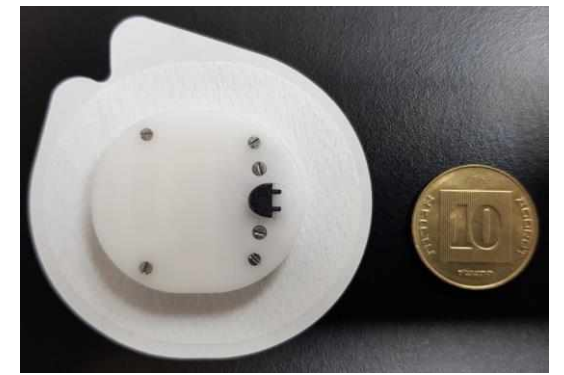


**PROMETEUS**  
preterm brain-oxygenation  
and metabolic eu-sensing

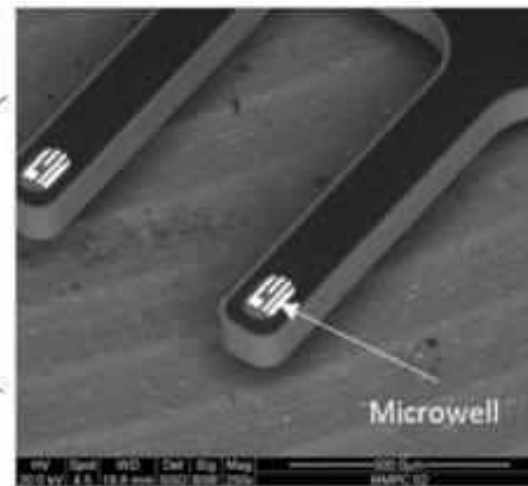
## PROMETEUS Executive and Advisory Board Meeting WP2 update 20-June-2024

Partners and Collaborators

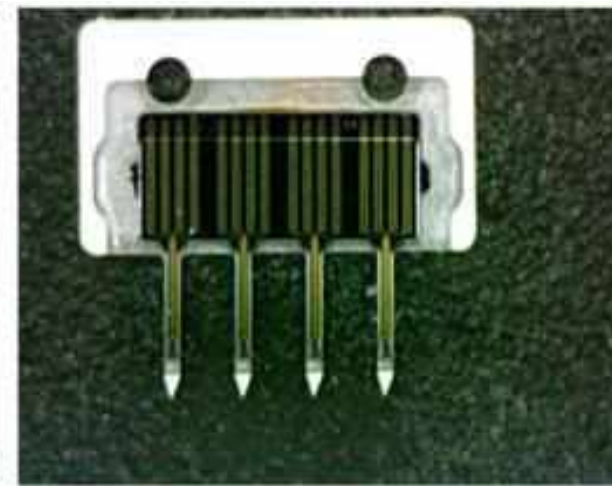




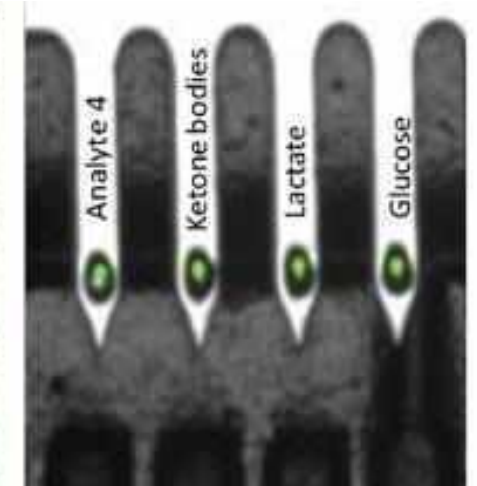
# First - The World's First Minimally-Invasive Patch for Continuous Metabolic Monitoring (CMM)



### Silicon microprobes with microwells



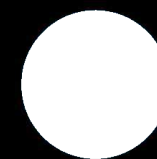
### Silicon microprobes on metal frame



### Functionalized sensors

## Capturing Your Personal Metabolism

# WP 2 - Continuous Metabolic Monitoring (wearable sensor)



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and metabolic eu-sensing

N	Deliverable name	Short description	WP	Leader	Type	Diss. level	Deliv. date
D1.1	Neo-opticap	Evaluation of performance	1	POLIMI	R	SEN	M30
D1.2	WP1 Approval	Documentation for medical device approval by national authorities	1	POLIMI	R	SEN	M36
D1.3	WP1 Revision	Revision of neo-opticap	1	POLIMI	R	SEN	M48
D2.1	Ethics pig	Ethics approval for animal study	2	QLAB	ETHICS	PU	M3
D2.2	Biocompatibility	Sensor biocompatibility on animal	2	QLAB	R	PU	M12
D2.3	CMM	Sensing components	2	QLAB	R	PU	M24
D2.4	Training CMM	Video for human study	2	QLAB	DEC	PU	M34
D2.5	WP2 Approval	Documentation for medical device approval by national authorities	2	QLAB	R	PU	M35
D2.6	WP2 Revision	Revision of CMM	2	QLAB	R	PU	M48
D3.1	Ethics rats	Ethics approval for animal study	3	UGA	ETHICS	PU	M4
D3.2	Animal	Evaluation of animal study	3	UGA	R	PU	M30
D3.3	Model & Avatar	Evaluation of metabolic model/avatar	3	UNIPD	R	PU	M32
D3.4	WP3 Revision	Revision of metabolic model	3	UNIPD	R	PU	M48
D4.1	NCA	NCA controller development	4	UdG	DEM	SEN	M30
D4.2	Testing	In silico testing of neo-controller	4	UNIPD	R	PU	M34
D4.3	WP4 Revision	Revision of NCA-Controller	4	UdG	R	SEN	M48
D5.1	Cloud app	Cloud-based app specifications	5	Dave	DEM	SEN	M4
D5.2	Prototype	Prototype app	5	Dave	DEM	SEN	M12
D5.3	Communication	Communication protocols and inter-operability	5	Dave	DEM	SEN	M22
D5.4	WP5 Revision	Adjusted prototype after parents/HCP feedback	5	Dave	DEM	PU	M30
D5.5	Compatibility	Compatibility of <i>Prometeus</i> components	5	Dave	R	PU	M32
D5.6	Training app	Video-handbook for human study	5	Dave	DEM	PU	M33
D6.1	Ethics human	Ethics approval for first in human	6	UCC	ETHICS	PU	M39
D6.2	Interim	Interim report on in vivo human trial	6	UCC	R	PU	M43
D6.3	First in human	Report on in vivo human trial	6	UCC	R	PU	M48
D7.1	Interview	Training material for video-interview	7	UNIPD	DEM	PU	M18
D7.2	Psychometric	Psychometric assessment	7	UCC	R	PU	M24
D7.3	Perception	Perception assessment tool	7	UNIPD	R	PU	M24
D7.4	Visual Archive	Video-interview of parents and HCP	7	UNIPD	R	PU	M30
D7.5	WP7 Revision	Neonatal medical devices specifications	7	UNIPD	R	PU	M36
D8.1	Management	Project management handbook & Risk assessment	8	UNIPD	R	PU	M2
D8.2	Website	Project website	8	UNIPD	DEC	PU	M3
D8.3	Outreach	Dissemination, exploitation and communication plan	8	UNIPD	R	PU	M4
D8.4	DMP	Data Management Plan	8	UNIPD	DMP	PU	M6
D8.5	1 <sup>st</sup> Report	<i>Prometeus</i> 1 <sup>st</sup> Progress report	8	UNIPD	R	PU	M18
D8.6	2 <sup>nd</sup> Report	<i>Prometeus</i> 2 <sup>nd</sup> Progress report	8	UNIPD	R	PU	M36
D8.7	Final Report	<i>Prometeus</i> Final report	8	UNIPD	R	PU	M48

## Deliverables Status

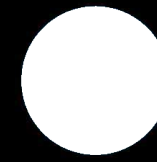
D2.1	Ethics pig	Ethics approval for animal study	2	QLAB	ETHICS	PU	M3
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D2.3	CMM	Sensing components	2	QLAB	R	PU	M24
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D2.5	WP2 Approval	Documentation for medical device approval by national authorities	2	QLAB	R	PU	M35
D2.6	WP2 Revision	Revision of CMM	2	QLAB	R	PU	M48

completed  
completed  
ongoing



## D2.2 Sensor Biocompatibility on Animal

### Safety and efficacy study in pig skin in-vivo



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and metabolic eu-sensing

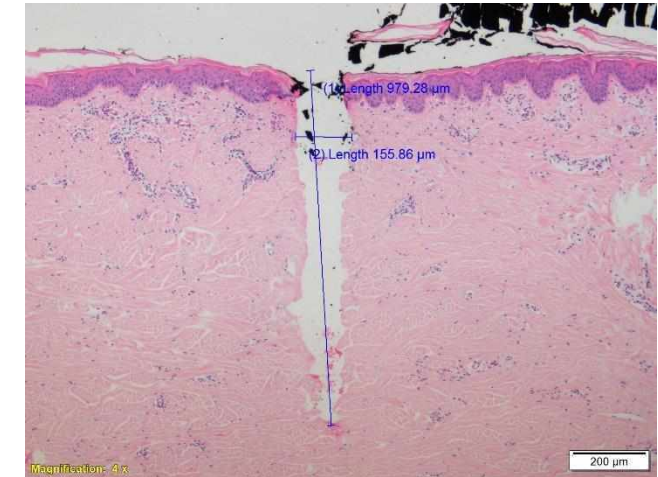


**Figure 1:** Patches mounted at different pig skin locations

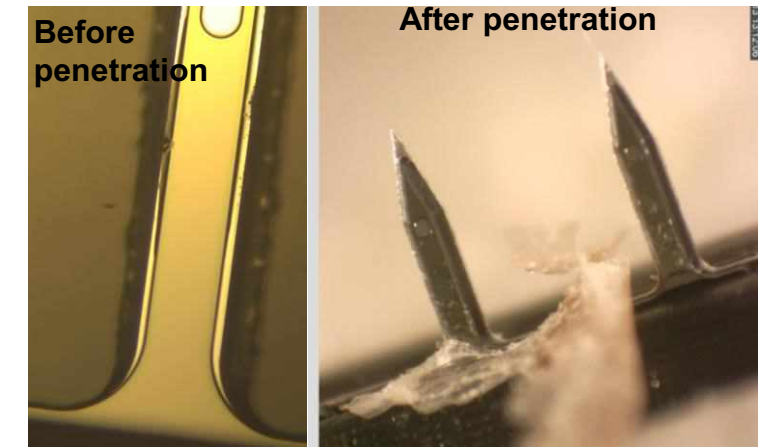


**Figure 2:** Patch #4 microprobes penetration marks on pig skin following patch removal

- Pre-clinical validation of 8-patches showed good correlation between visual inspection and histological analysis of the intradermal probe canal
- No break or other mechanical damage observed for the penetrating probes
- No skin irritation observed in any of the mounted patches



**Figure 3:** Sample #4 intradermal probe canal with measurements. X4, H&E

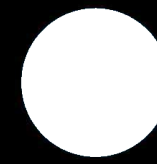


**Figure 4:** Representative microprobe patch after pig skin insertion and removal displaying tissue residues on probes (x20)



## D2.2 Sensor Biocompatibility – Pig Study

### Long-term (14 days) study of safety patch implantation

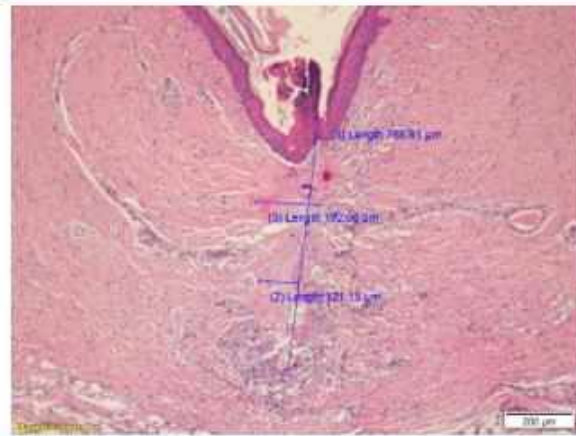


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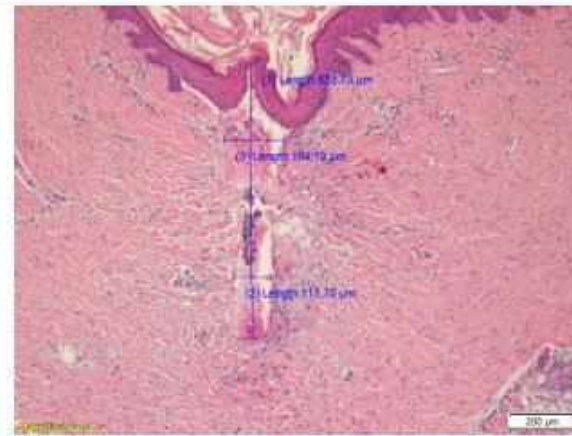
Day -1



Histological analysis of skin biopsy

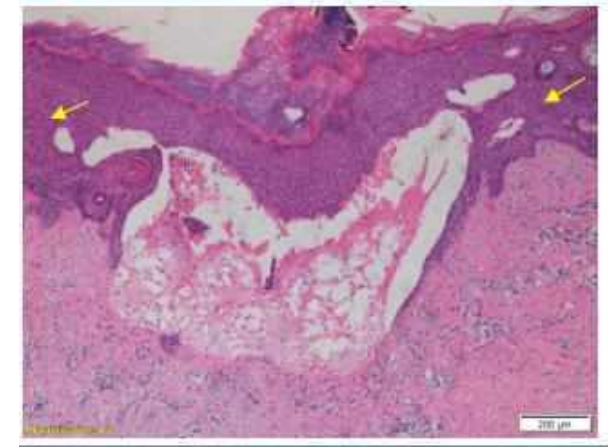


**Figure 1:** Sample# 1-1, Very clean needle canal with minimal inflammatory reaction. X4, H&E.



**Figure 2:** Sample# 1-2, Very clean needle canal with minimal inflammatory reaction. X4, H&E.

Commercial CGM skin biopsy



**Figure 4:** Sample# 4-1, Very strong proliferation of the epidermis (arrow) and only partial canal. X4, H&E.

- Histological analysis of skin biopsies taken after patch removal following 14-days' wear.
- Overall safety of the FirstQ patch sensor has been confirmed, establishing compliance for clinical studies.



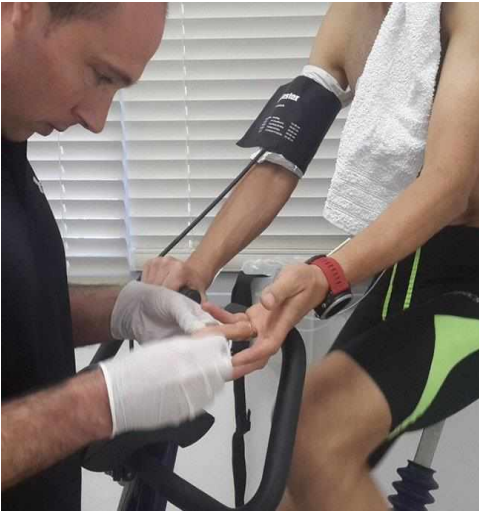
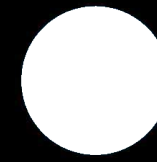
## 3. Deliverables and Milestones achieved

QuLab Medical (QLAB) leads WP2 of the program. Specific project deliverables for the first year of the PROMETEUS program:

1. Obtaining Ethics Committee approval for conducting patch studies in pigs (D2.1 – M3).
2. Finalizing pig biocompatibility studies (D2.2 – M12).

QLAB has successfully accomplished both deliverables, demonstrating the biocompatibility of its patch and microprobe chip components.

QLAB has demonstrated good patch safety and microprobe skin penetration efficacy in pigs, resulting in no microprobe fracture and excellent skin insertion up to a depth of 1mm in live pig skin.

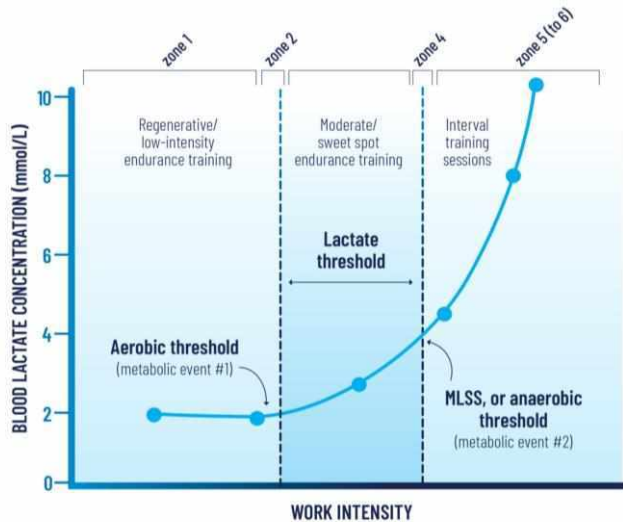


### 1. Patch safety performed at Meir Medical Center

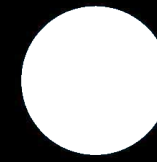
- No noticeable damage to microprobes upon skin insertion & after patch removal.
- No pain or noticeable bleeding.
- Skin edema or erythema were not observed.

### 2. Lactate Threshold Test Protocol established

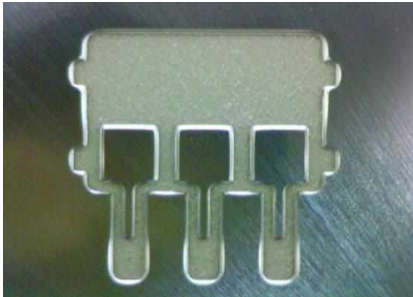
- Two minutes warm-up on bicycle/trainer.
- Thirty mins of extensive cycling under high load.
- Capillary blood is sampled before and following cycling and tested for lactate levels using a hand-held device.
- Lactate clearance is measured by additional capillary blood tests.
- Typical protocol execution results in fast (2min) elevation of lactate levels.
- Lactate levels rise from ~1 to 4-8 mM.



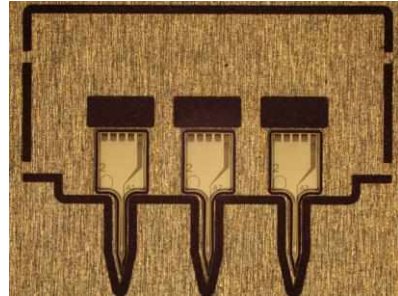




### Assembly, sterilization and packaging – lot release for FIM



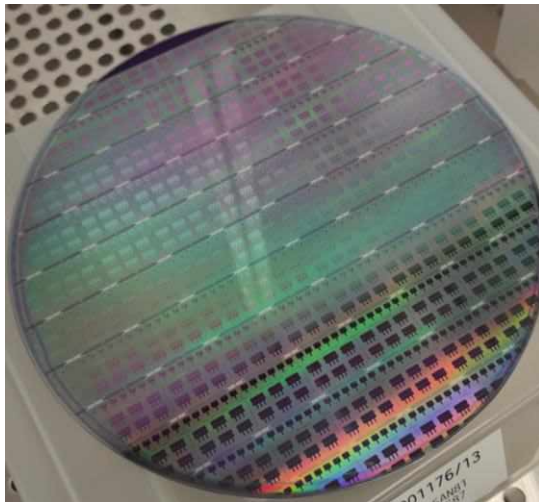
Silicon chips



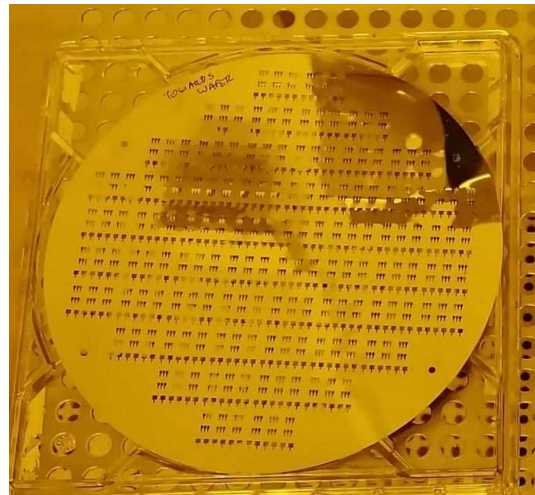
Silicon chips on Stainless steel support

- Pick-and-place of Sensor chips on metal support.
- The process for single batch release was successfully developed for final patch assembly

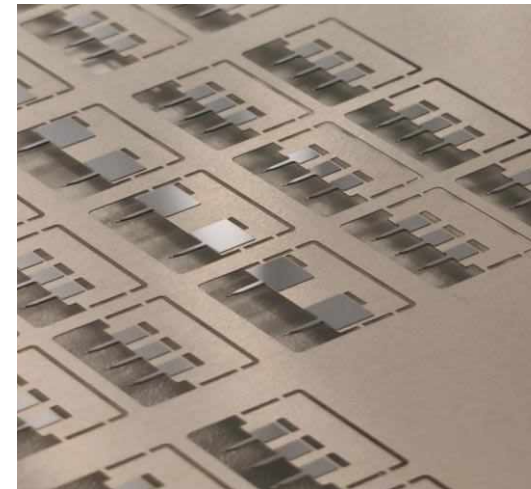
### ➤ Wafer level assembly process was established



CMOS wafer harboring FET electrochemical sensors



Stainless steel support wafer

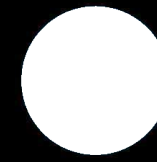


Silicon Probes on Metal

- Pre-clinical safety study of the microprobes with supported SS was successfully demonstrated in vivo (pig)

## D2.3 CMM Sensing Components

### Mechanical elements for FIM study



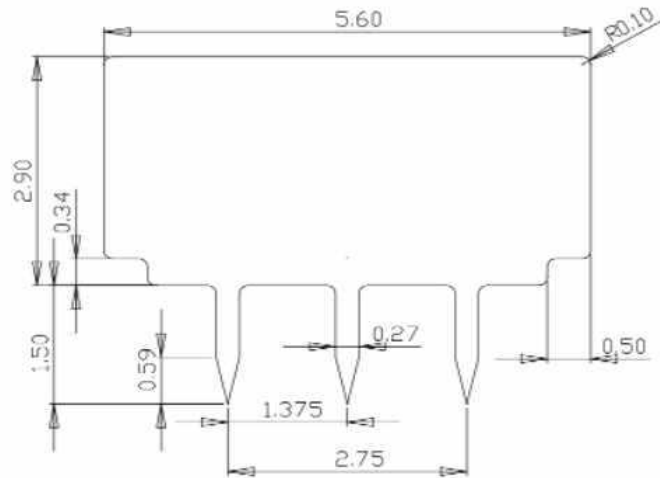
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In-vitro testing of the patch and applicator using artificial skin

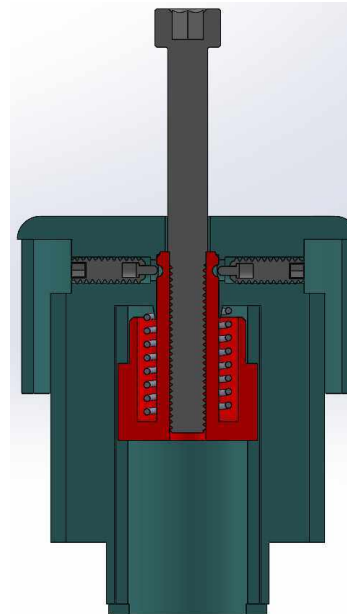
**A. Sensing Patch**

Connector to external electronics

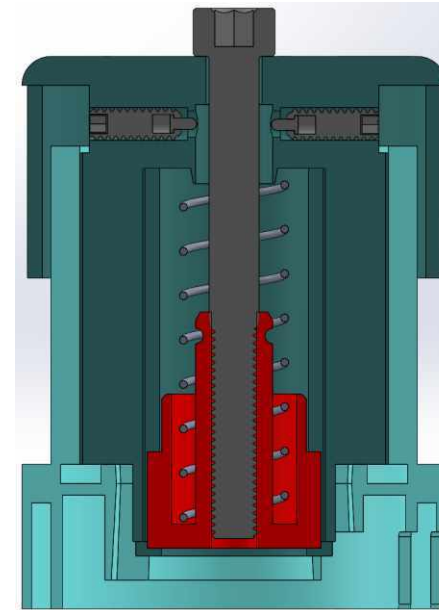
Sensing Unit



**B. Mechanical applicator**



Loaded without patch



Released with Patch

**C. Insertion into synthetic skin**

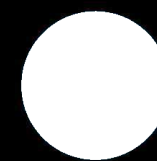


**D. Sensing patch with external electronics introduced into human skin.**

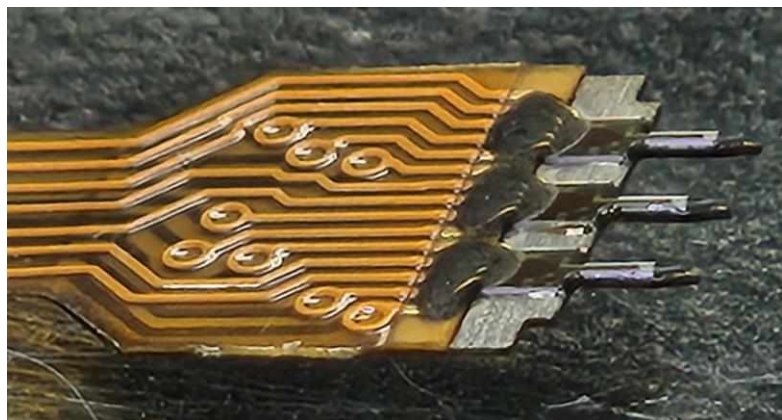


## D2.3 CMM Sensing Components

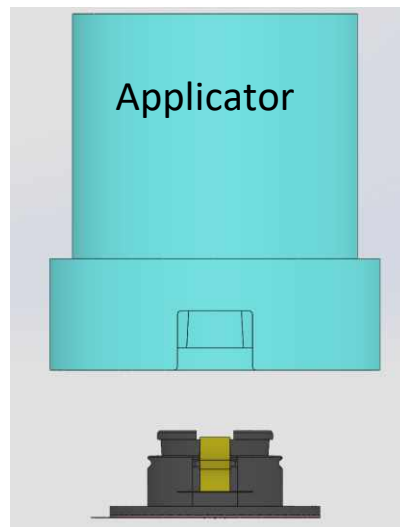
### DEVICE ASSEMBLY: SENSOR, PATCH & ELECTRONICS



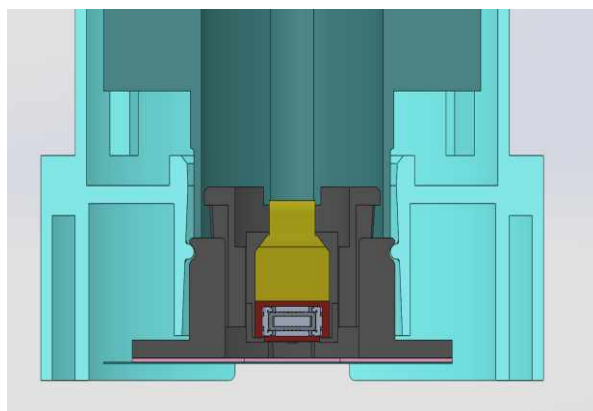
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Microprobe triplicate mounted on  
Metal support and flex cable



Insertion mechanism



1-Ch. Electronics

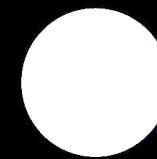


3-Ch. Electronics



## D2.3 CMM Sensing Components

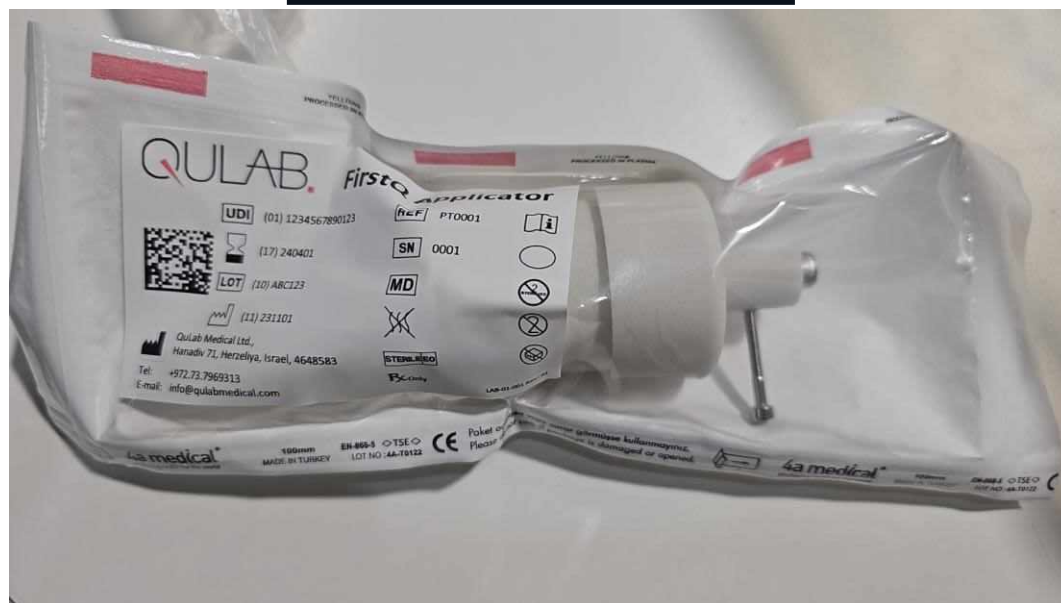
### Sterilization protocol for patch and introducer



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and metabolic eu-sensing

- ETO sterilization and single batch release of mechanical applicator and patch was successfully completed.
- Six months shelf life was established for this batch to allow for completion of FIM safety study.

Mechanical Applicator



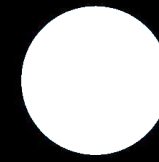
Sensing Patch





## D2.3 CMM Sensing Components

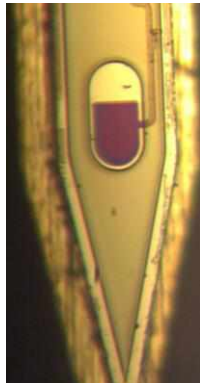
### Performance of dual Glucose and Lactate sensor - PoC



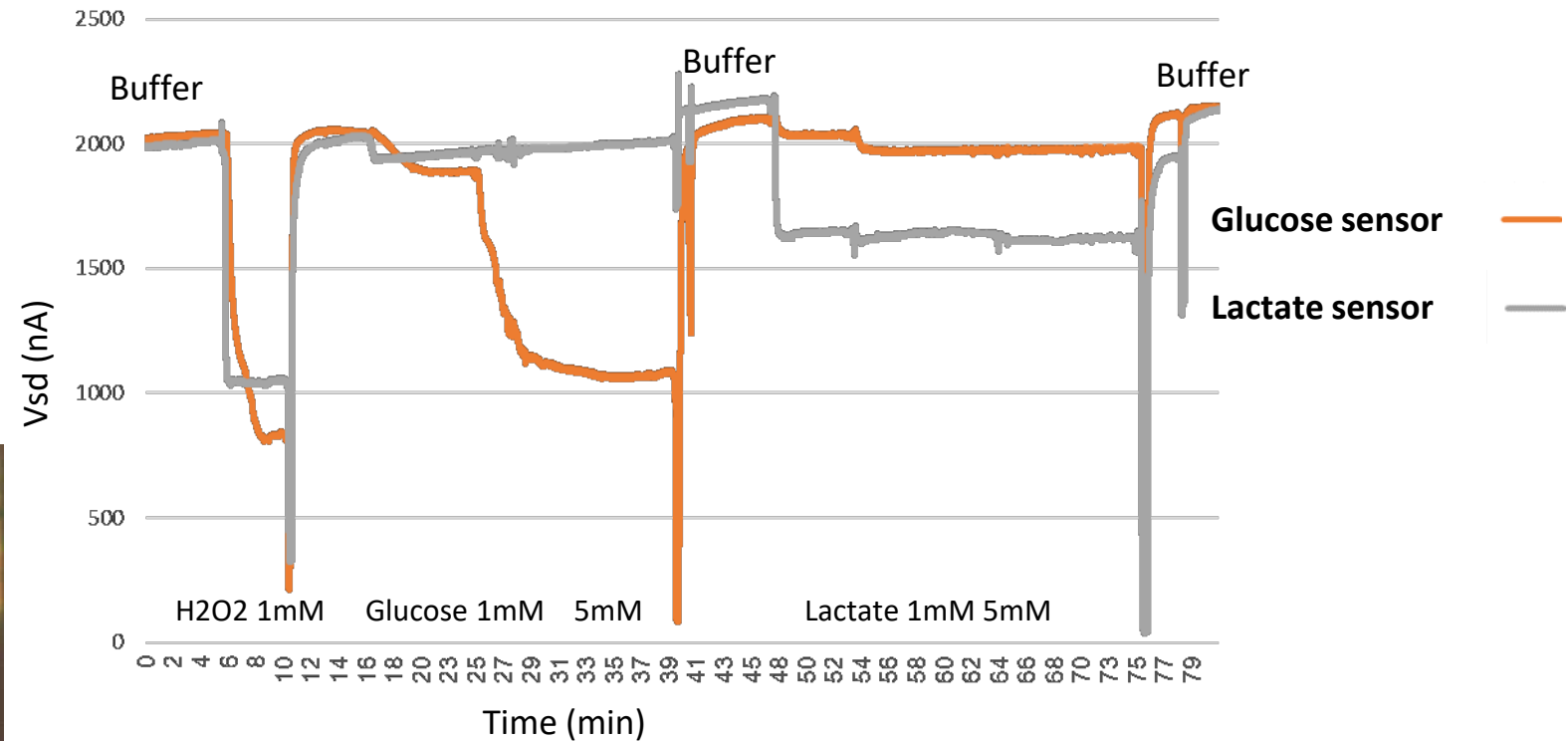
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preterm brain-oxygenation  
and metabolic eu-sensing

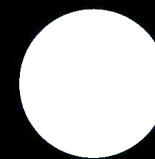


Parallel sensing electronics

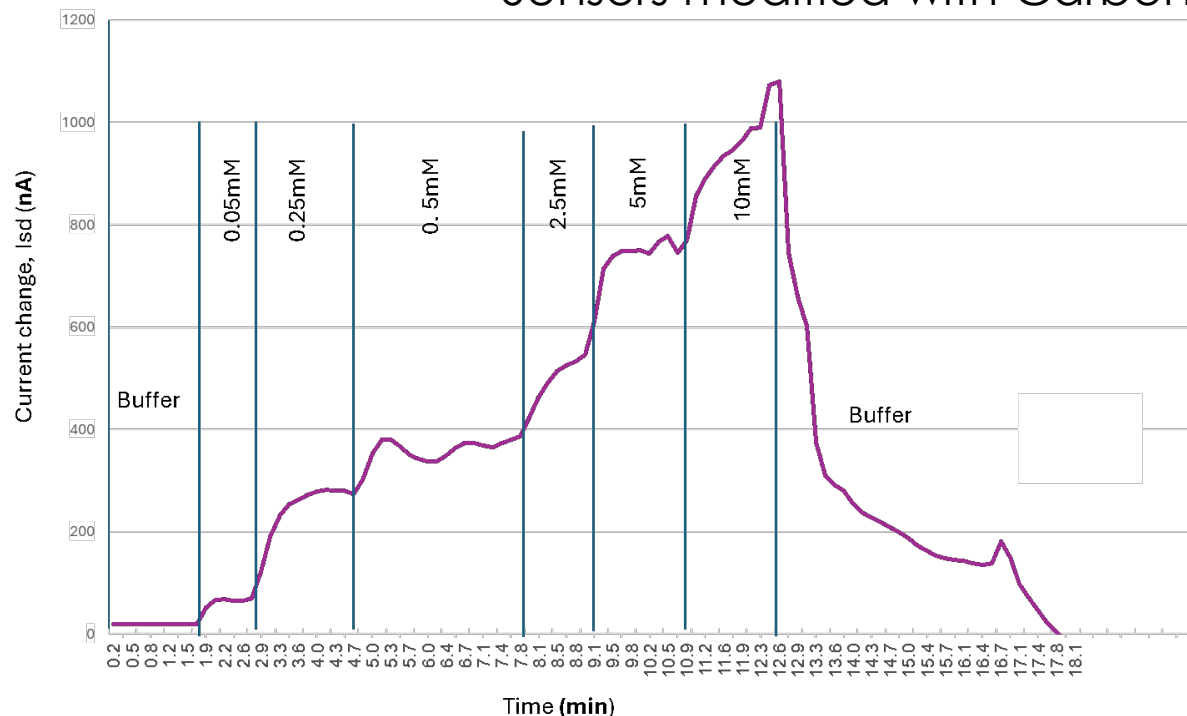


#### In-vitro Glucose-Lactate dual sensing

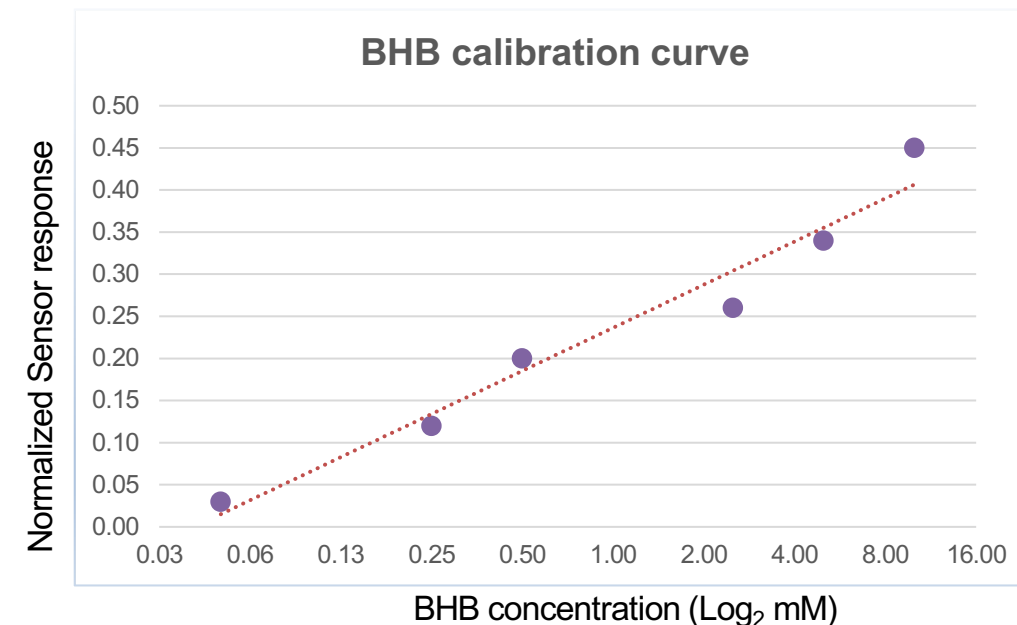




Sensors modified with Carbon ink-immobilized BHB-DH



0.05 -10mM BHB (PB 150mM ,0.2mM NAD<sup>+</sup>)



0.05 -10mM BHB (0.2mM NAD<sup>+</sup>)

# TEAM & ADVISORY BOARD

## TEAM

## ADVISORY



**Idan Tamir, PhD**  
CEO



**Sharon Lefler, PhD**  
CTO



**Berta Ben-Shachar, PhD**  
Head of Bioengineering



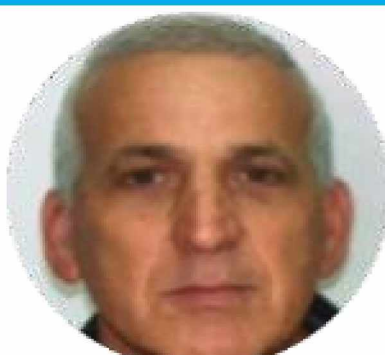
**Desmond Schatz, MD**  
UFHealth



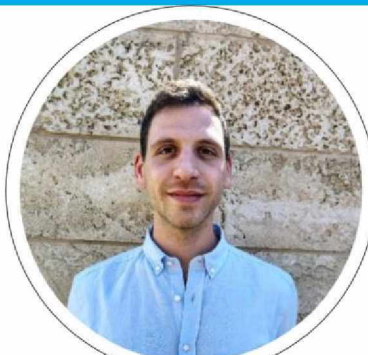
**Moshe Phillip, MD**  
Schneider Medical  
Center



**Hila Masasa, MSc**  
Head of Product  
Development



**Shai Finkman**  
Senior System Engineer



**Raanan Sarig**  
Mechanical  
Engineering



**Jeff Jacobs, MD**  
University of Florida



**Leor Perl, MD**  
Rabin Medical  
Center

# PROMETEUS - Preterm Brain-Oxygenation and Metabolic EU-Sensing: Feed the Brain

Grant Agreement Number 101099093

## **WP3 - Metabolic Model and Neonatal In** *Silico Avatar*

**Prof. Chiara Dalla Man**

Department of Information Engineering  
University of Padova

*Prometeus Annual Review Meeting, March 13<sup>th</sup> 2024*



# PROMETEUS



- University of Padova (UNIPD)
- University of Grenoble Alpes (UGA)
- University of Girona (UdG)



# Tasks



**PROMETEUS**  
preterm brain-oxygenation  
and metabolic eu-sensing

- Task 3.1 *In vivo* animal study (UGA, UNIPD)
- Task 3.2 Tracer and MRI analysis (UGA, UNIPD)
- Task 3.3 neonatal *in silico* avatar (UNIPD, UdG)
- Task 3.4 Metabolic model adaption to human data (UNIPD, UdG)

	TASKS	Y1				Y2				Y3				Y4			
		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
WP 3	3.1																
	3.2																
	3.3																
	3.4																





**WP3:** Development of the mathematical model of glucose, lactate and BHB utilization and production and their effect on CBF, StO<sub>2</sub> and CMRO<sub>2</sub> (brain hemodynamics).

➔ UGA: animal model

# Rat pups from P7 to P13



**PROMETEUS**  
preterm brain-oxygenation  
and metabolic eu-sensing

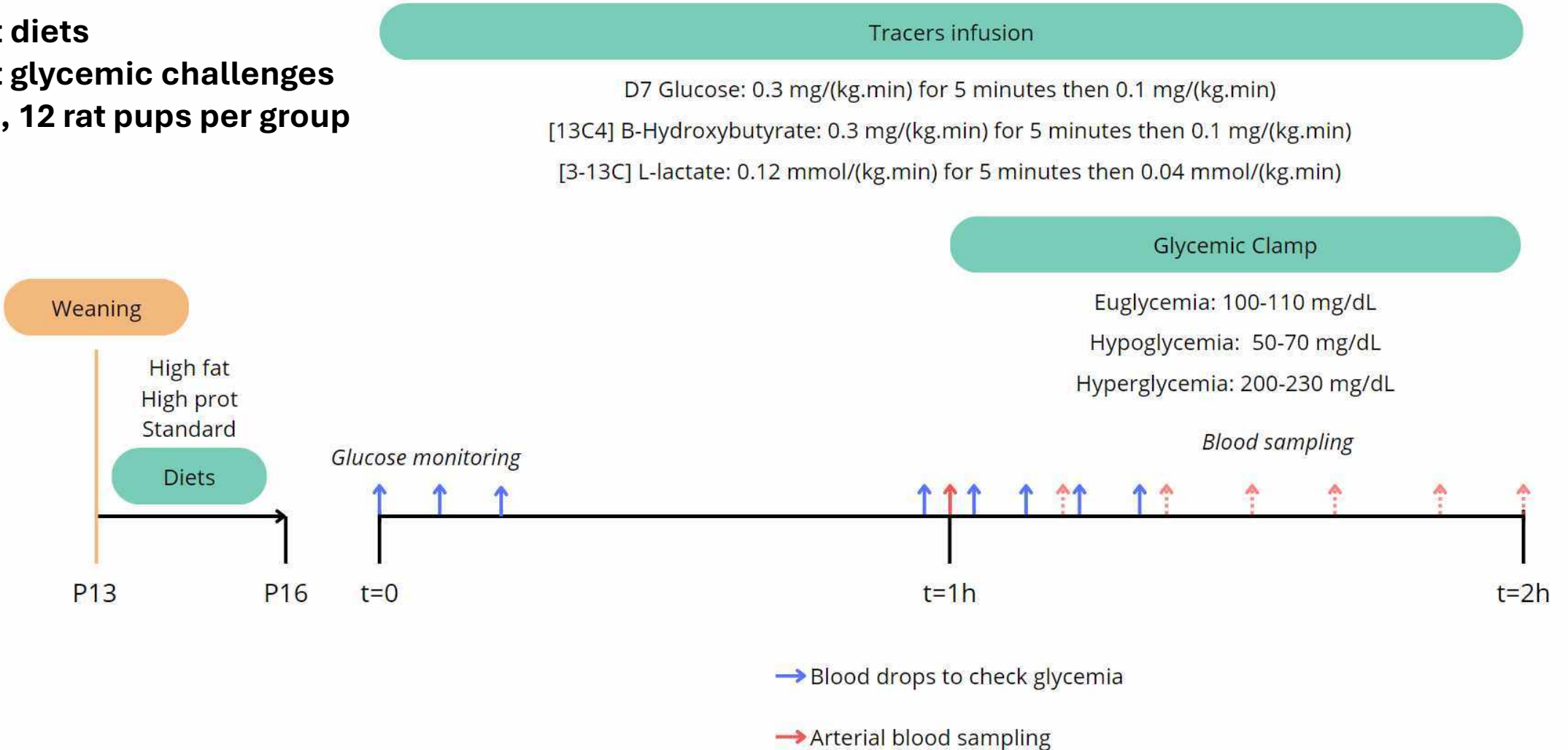


# Experimental protocol



**PROMETEUS**  
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and metabolic eu-sensing

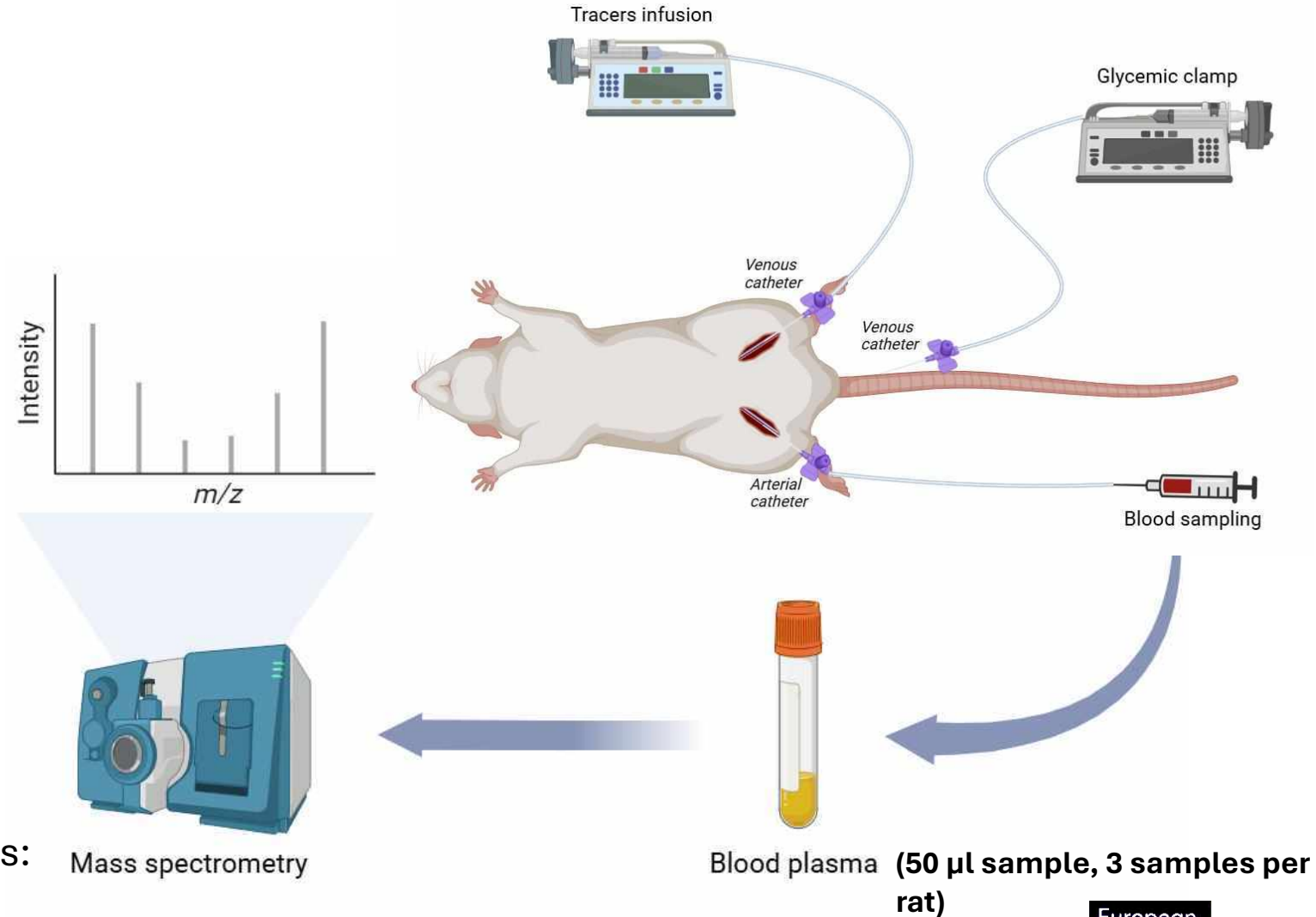
- 3 different diets
- 3 different glycemic challenges
- ➔ 9 groups, 12 rat pups per group



# 3 catheters per animal



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## Mass spectrometry analysis:

- First test in July
- 2 batches of 150 samples: (12/2024 and 05/2025)

Mass spectrometry

Blood plasma (50 µl sample, 3 samples per rat)

This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101099093

European  
Innovation  
Council

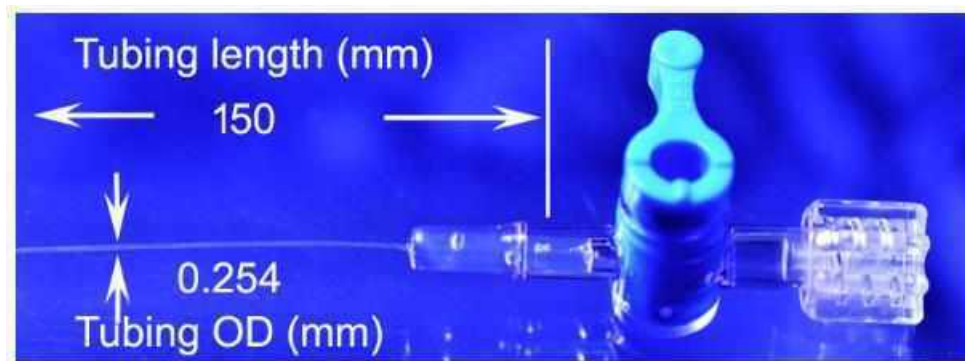
Funded by  
the European Union



# Surgical challenges: 250 $\mu$ m catheters



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and metabolic eu-sensing



This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101099093

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Funded by  
the European Union

# MRI optimization at 9.4T

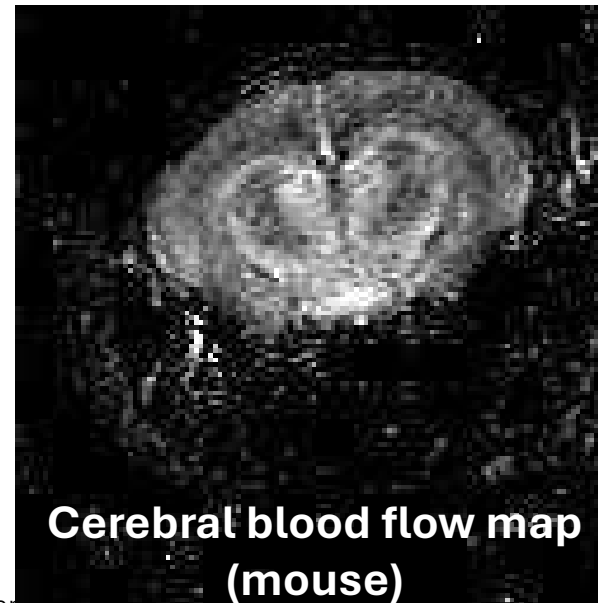
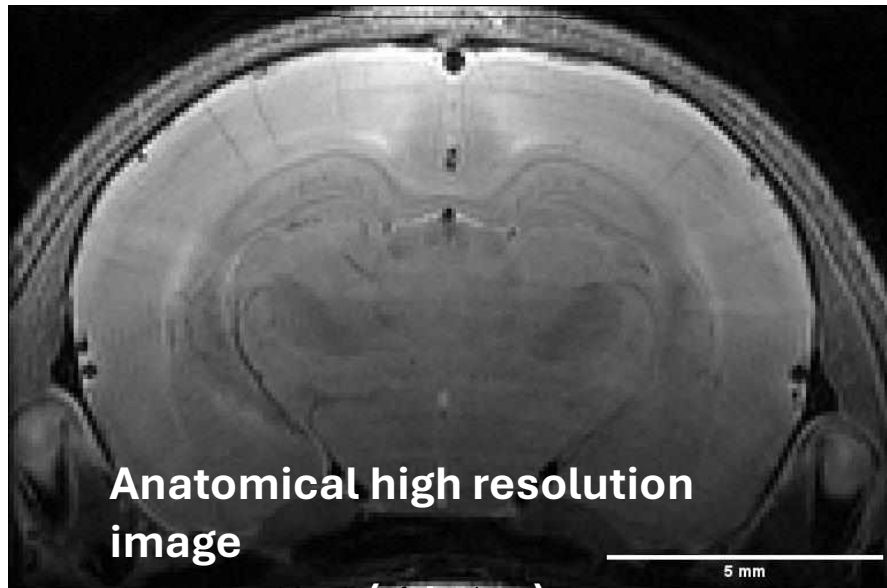
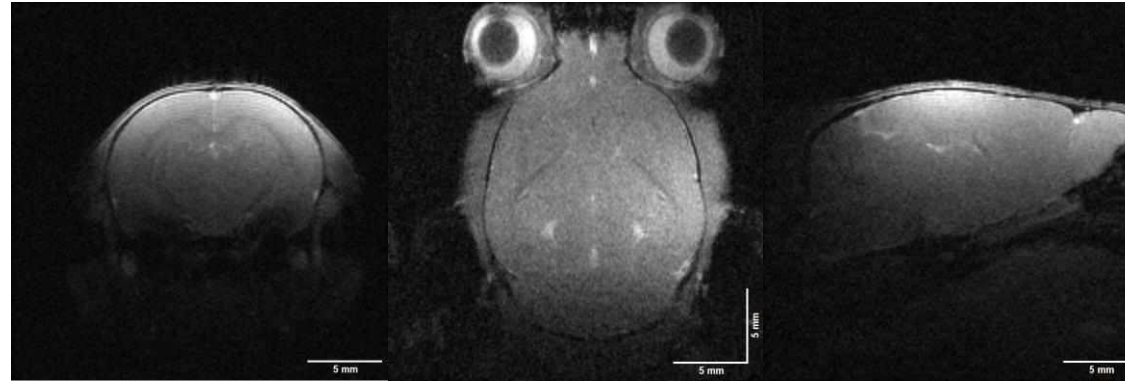


**PROMETHEUS**  
preterm brain-oxygenation  
and metabolic eu-sensing

## Ongoing:

- Test with ASL probe for CBF maps
- Beginning of the experiment by the end of the year

➔ Discussion with Polimi team to perform NIRS on rat pups



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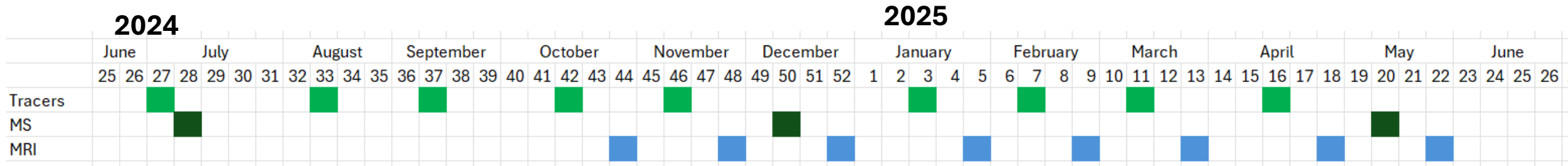
Funded by  
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# Agenda



**PROMETEUS**  
preterm brain-oxygenation  
and metabolic eu-sensing



This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101099093

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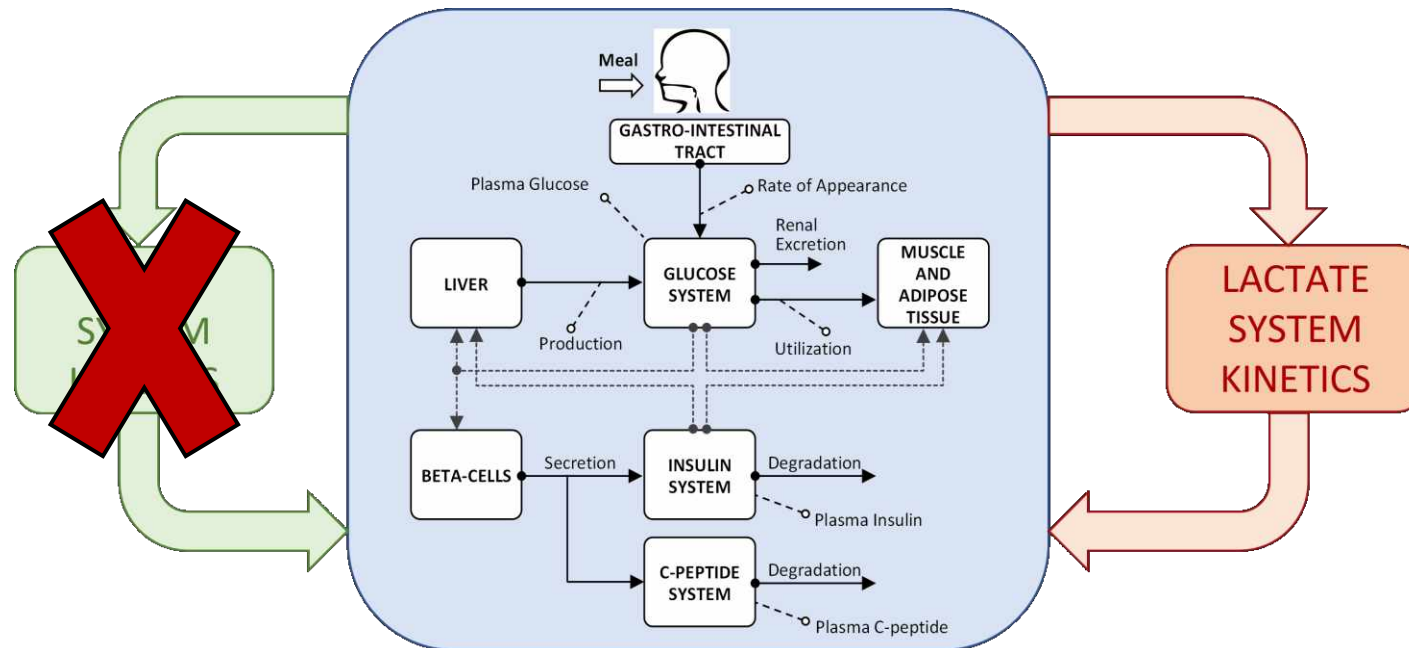


**WP3:** Development of the mathematical model of glucose, lactate and BHB utilization and production and their effect on CBF, StO<sub>2</sub> and CMRO<sub>2</sub> (brain hemodynamics).

➔ Padova: modeling



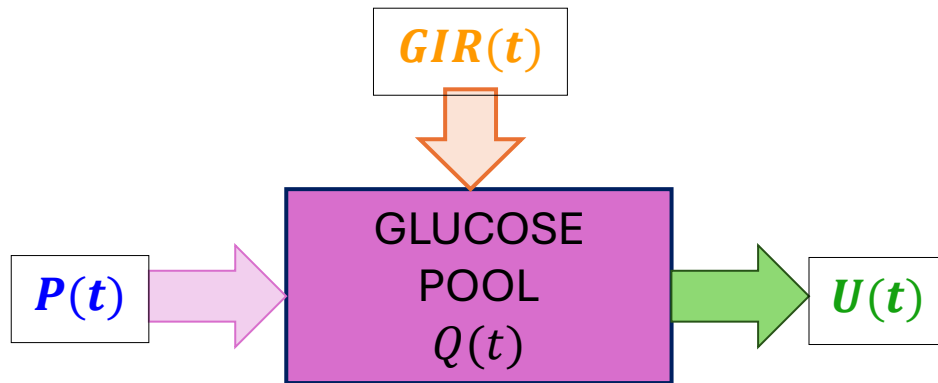
- Development of a model that describes glucose and lactate dynamics in preterm neonates.
- No data available. So far, we've been working with **The Glucose-Insulin-Cpeptide Simulator (GIC Simulator)** and in-house data.



Dalla Man et al IEEE Trans. Biomed Eng 2007; Visentin et al. Diabetes Technol Ther. 2020



## STEP 1: Average model



$$\dot{Q}(t) = P(t) - U(t) + GIR(t)$$

In healthy subjects, in steady state conditions,  $GIR = 0$ , meaning that the amount of glucose is kept constant when  $P(t) = U(t)$ .

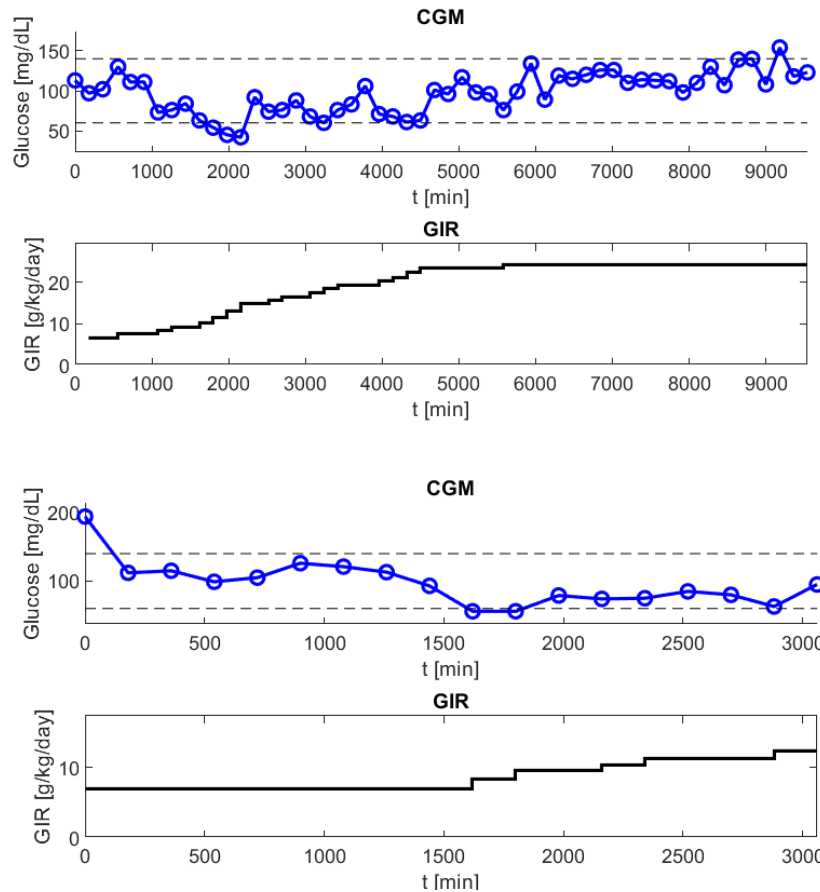
**ISSUE:** Preterm babies don't eat carbs, thus the glucose input is limited, meaning that  $U(t) > P(t)$ , thus an infusion of glucose ( $GIR > 0$ ) is needed.



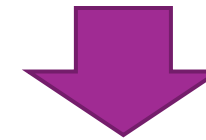
**IDEA:** We imputed the decrease in  $P(t)$  to a change (**increase**) in **insulin sensitivity (SI)**.

The 'new' model was firstly developed on an 'average' subject, whose parameter were extrapolated from an in-house population of 100 individuals.

**How can we find a reliable  $SI(t)$ ?**



**DATA:** newborns (age  $\leq 32$  week, weight  $\leq 1500$ g) monitored for a week with a CGM sensor. Glucose was administered to maintain the subjects in the euglycemic range. In the study, CGM was coupled with a glucose infusion algorithm to determine the **GIR necessary to keep the newborn in a euglycemic range.**



**$SI(t)$  should mimic  $GIR(t)$**





Starting from the average  
subject...



Weight

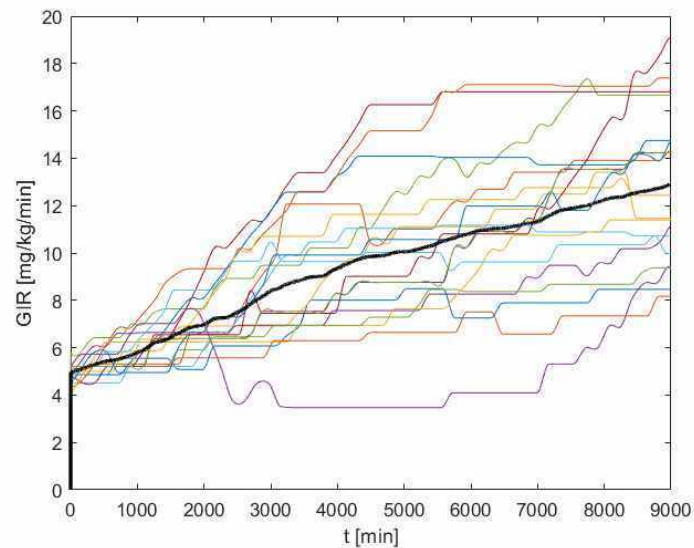
Age

Basal Glucose

Basal Insulin

[...]

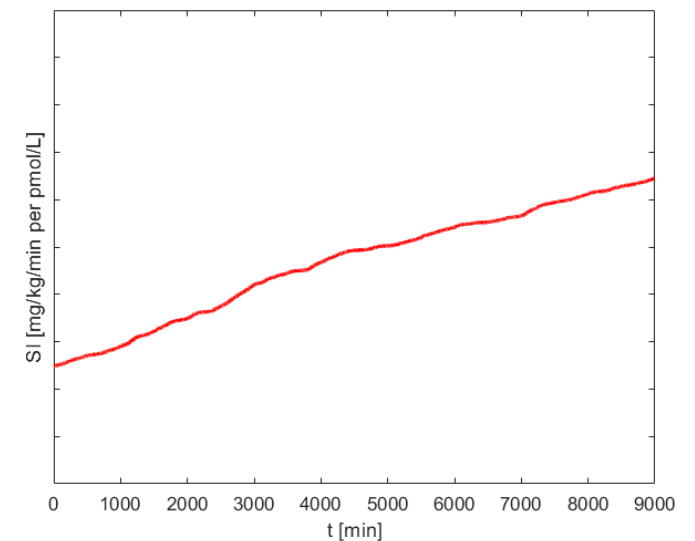
**GIR(t)**



Insulin sensitivity time  
course mimics the trend  
of glucose infusion



**SI(t)**



This version of the simulator has been delivered to WP4



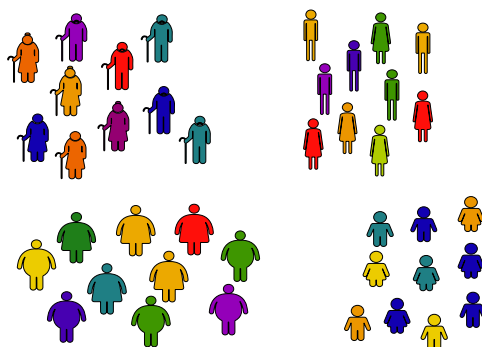
## STEP 2: Introducing variability

**Level one:** introduce variability in the subject parameters.

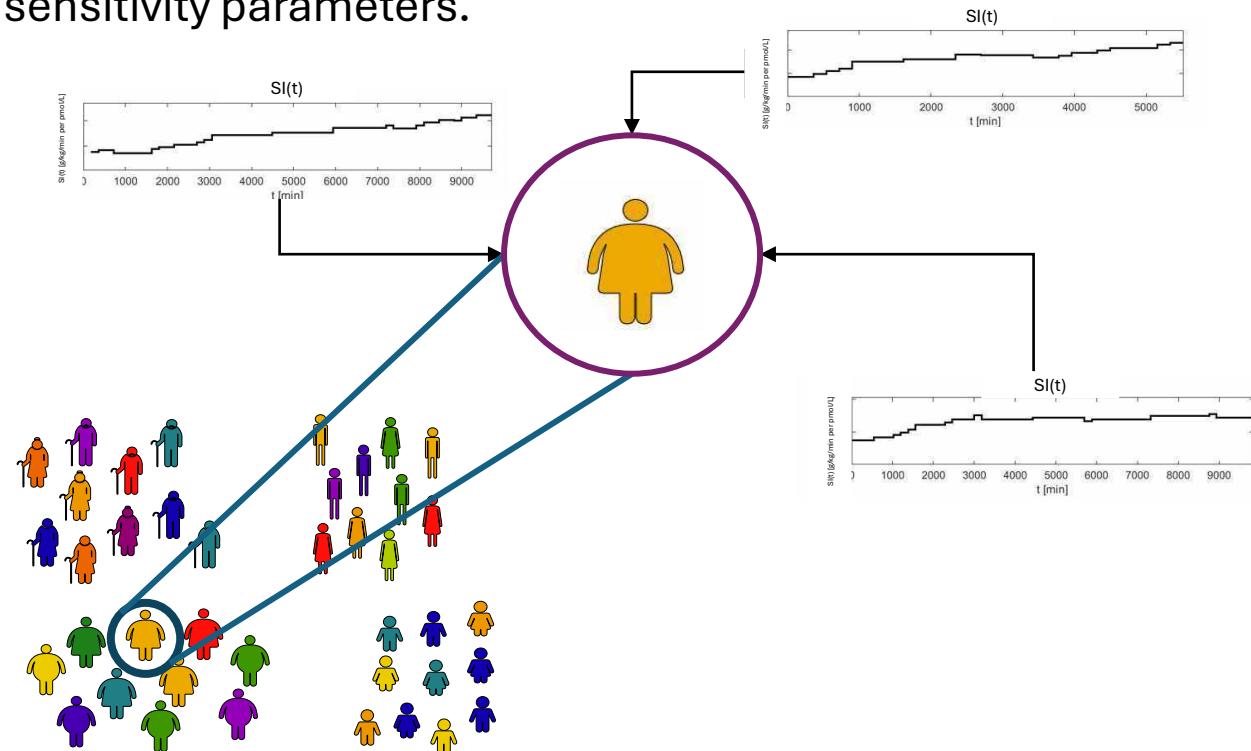
From average  
subject



To a population



**Level two:** introduce variability in the insulin sensitivity parameters.





**PROMETEUS**  
preterm brain-oxygenation  
and metabolic eu-sensing

# Thank you for your attention

# PROMETEUS - Preterm Brain-Oxygenation and Metabolic EU-Sensing: Feed the Brain

Grant Agreement Number 101099093

## **WP4 – Nutritional Clinical Advisor (NCA)**

Josep Vehí, Aleix Beneyto, Arthur Bertachi and Oriol Bustos  
**Micelab, Universitat de Girona**



# PROMETEUS

# Objective



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and metabolic eu-sensing

To develop a controller for glucose and nutrient infusion to target optimal brain development.

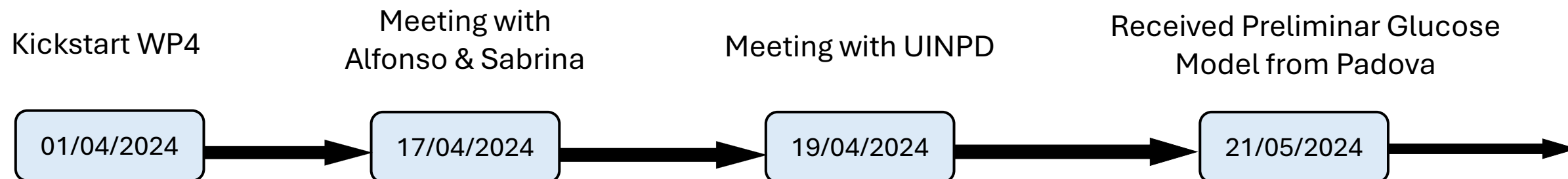




# Timeline



**PROMETEUS**  
preterm brain-oxygenation  
and metabolic eu-sensing



# 1° Meeting: Conceptualization



**PROMETEUS**  
preterm brain-oxygenation  
and metabolic eu-sensing

Date	Partners	Topic
17/04/2024	UNIPD: Dr. Alfonso Galderisi, Dra. Sabrina Brigadoi	-Discussion regarding the operation of the NCA.
	UdG: Dr. Arthur Bertachi, BSc. Oriol Bustos, Dr Aleix Beneyto, Dr. Josep Vehí	

- Controller will mainly suggest based on: glucose.
  - If glucose is within range but brain-related variables are suboptimal, adjusting the neonate's feeding will not enhance brain response.
- Doctors want recommendations every 15 minutes.

# 1° Meeting: Conceptualization



**PROMETEUS**  
preterm brain-oxygenation  
and metabolic eu-sensing

Date	Partners	Topic
17/04/2024	UNIPD: Dr. Alfonso Galderisi, Dra. Sabrina Brigadoi	-Discussion regarding the operation of the NCA.
	UdG: Dr. Arthur Bertachi, BSc. Oriol Bustos, Dr Aleix Beneyto, Dr. Josep Vehí	

- Control actions: 1) Deliver of glucose boluses; 2) Modify Glucose Infusion Rate (GIR); 3) Modify the lipid-protein formulation for the next 24-h.
- Brain-related variables should be continuously monitored, and if any measurements fall outside the desirable range, alarms should be triggered.

# 2° Meeting: Model Discussion



**PROMETEUS**  
preterm brain-oxygenation  
and metabolic eu-sensing

Date	Partners	Topic
19/04/2024	UNIPD: Dra. Chiara Dalla Mann, MSc. Hadija Marchiori, and MSc. Jacopo Bonet.	- Discussion regarding the mathematical model and simulator
	UdG: Dr. Arthur Bertachi, BSc. Oriol Bustos, Dr Aleix Beneyto, Dr. Josep Vehí	

- The mathematical model is currently under development, and UNIPD is awaiting additional data.
- In the meantime, UNIPD will provide an initial version of the simulator based on the data they have already analyzed.

# 3° Meeting: Preliminary Model



**PROMETEUS**  
preterm brain-oxygenation  
and metabolic eu-sensing

Date	Partners	Topic
21/05/2024	UNIPD: Dra. Chiara Dalla Mann, MSc. Hadija Marchiori.	- Presentation of the 1 <sup>st</sup> version of the simulator.
	UdG: Dr. Arthur Bertachi, Dr Aleix Beneyto, Dr. Josep Vehí	

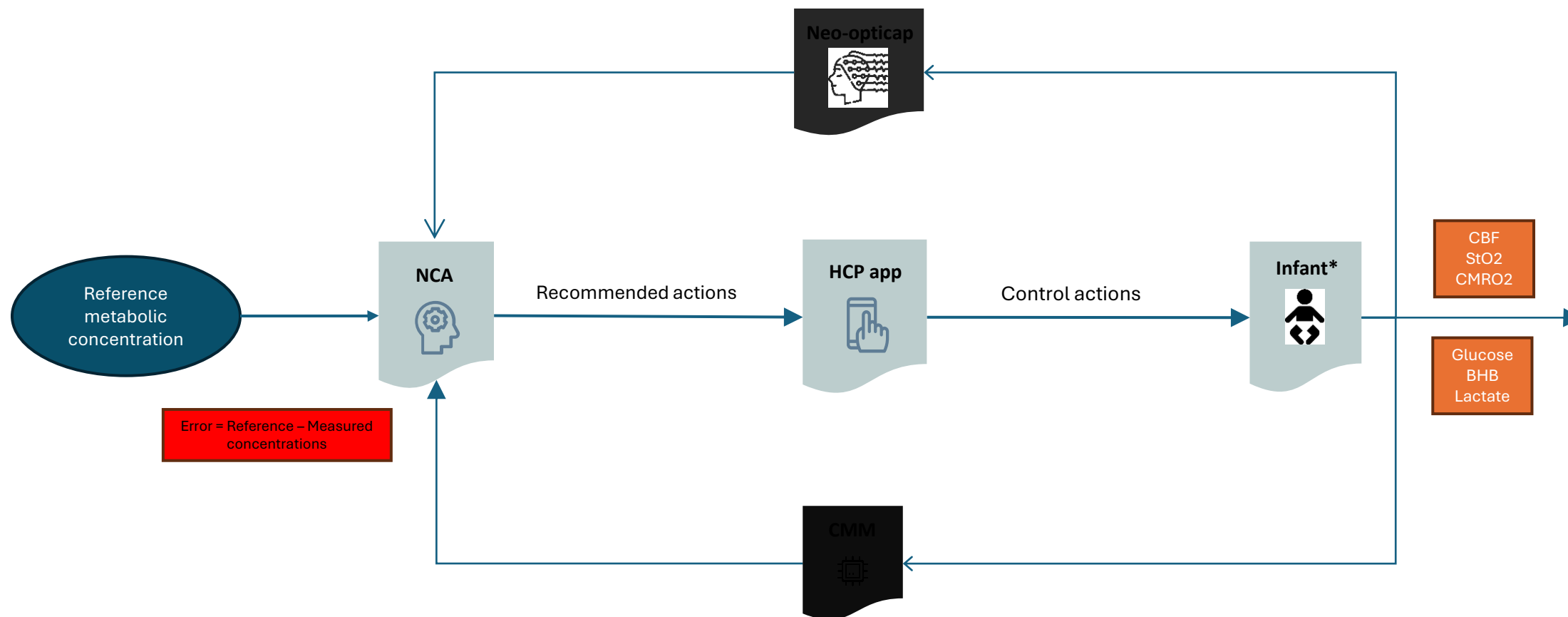
- The model is adapted from their previous diabetes simulator.
- Contains a single virtual patient.
- It incorporates variability in the parameters  $V_{mx}$  and  $kp_3$ , which are related to insulin dynamics.
- Modifiable GIR



# Ideal Loop



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and metabolic eu-sensing

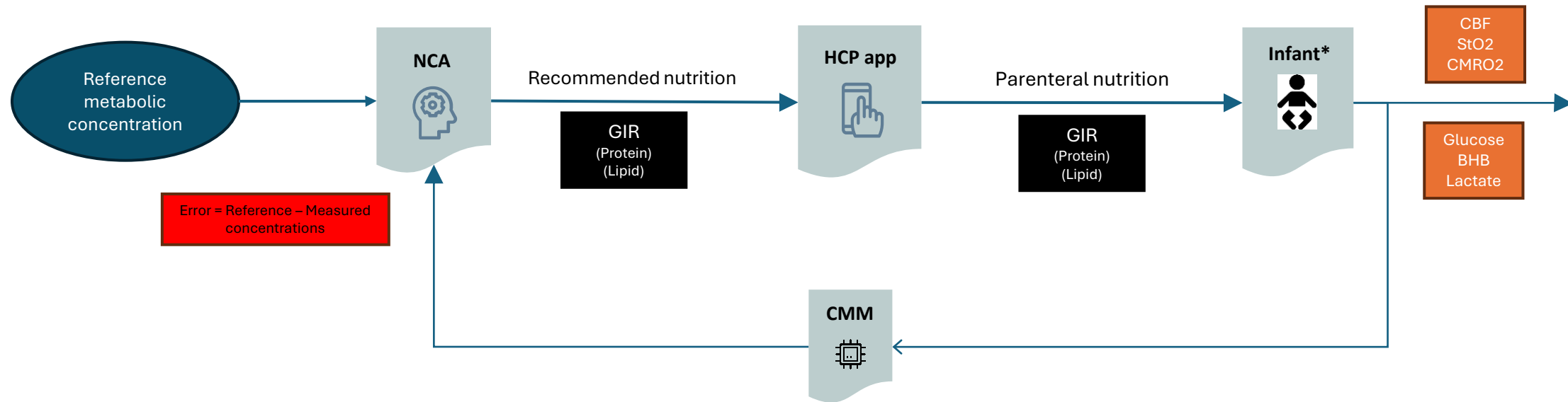


\* Or model

# Current Objective Loop



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and metabolic eu-sensing

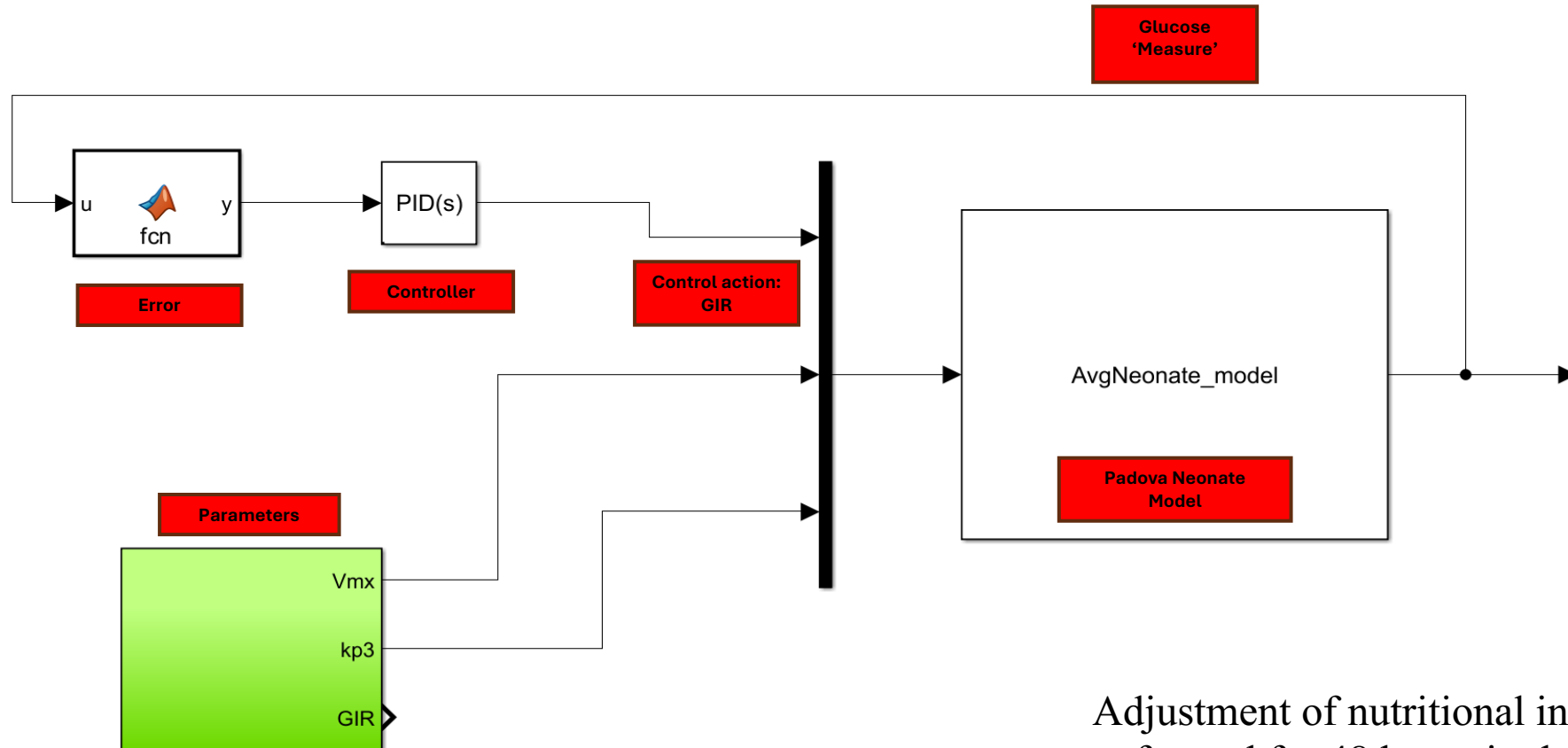


\* Or model

# Closing the Loop



**PROMETEUS**  
preterm brain-oxygenation  
and metabolic eu-sensing



Adjustment of nutritional intakes will be performed for 48 hours in the clinical trial

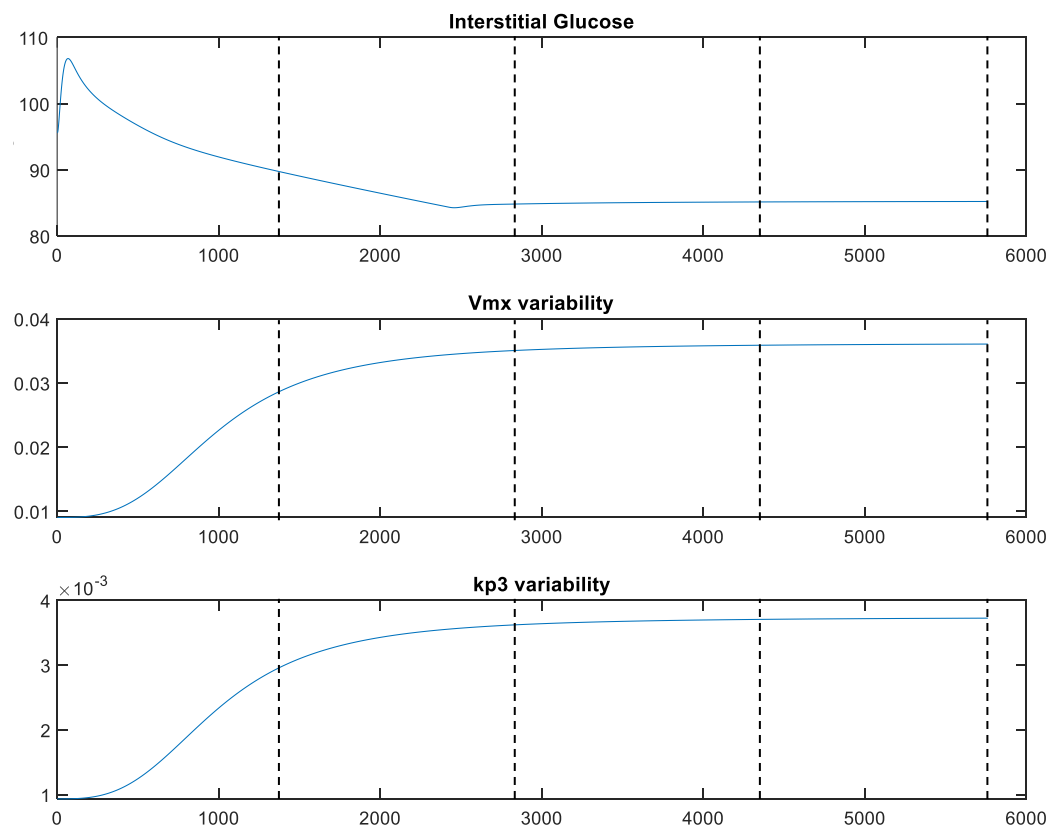
# Simulation: Preliminary Results



**PROMETEUS**  
preterm brain-oxygenation  
and metabolic eu-sensing

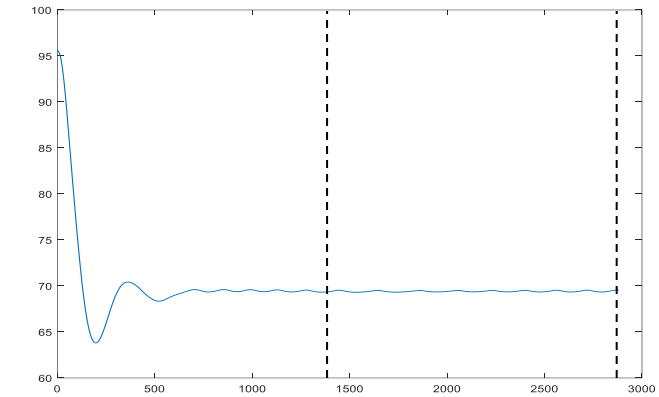
Baseline, no controller

SimLength: 4 days



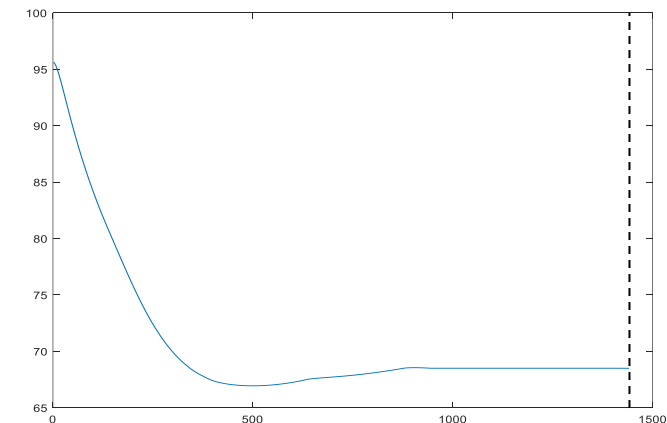
PID v1, Reference IG=70

SimLength: 2 days



PID v2, Reference IG=70

SimLength: 1 day



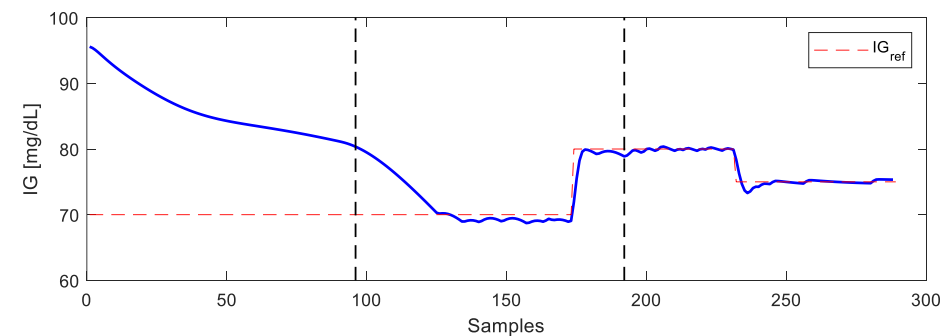
# Simulation: Preliminary Results



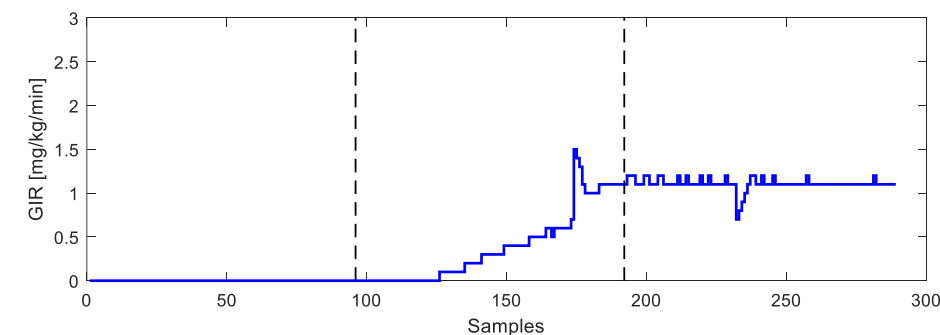
**PROMETEUS**  
preterm brain-oxygenation  
and metabolic eu-sensing

Discrete PID control: action every 15min.  
- Changing reference to challenge the controller

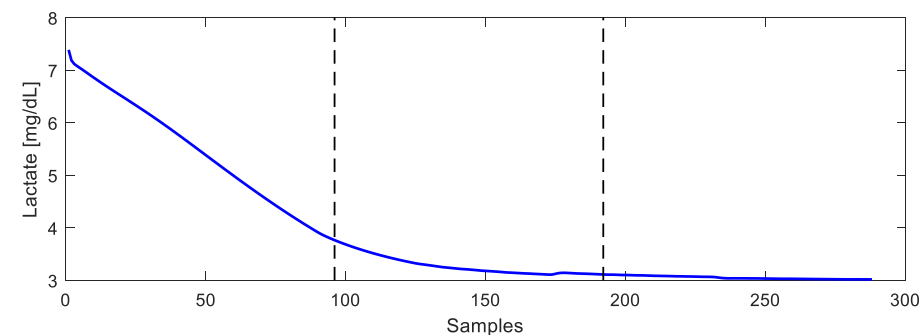
IG: Interstitial Glucose



GIR: Glucose Infusion Rate



Lactate





# Deviations from DoA



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and metabolic eu-sensing

- WP4.1: Document of requirements → Prepared, but we need information to complete it
  - (Y2Q1: April 2024)

WP4.1	Requirements (UNIPD, UdG)	System requirements definition	4
WP4.2	Controller (UNIPD, UdG)	Controller design	4
WP4.3	Testing (UNIPD,UdG)	In silico testing of neo-controller	4
WP4.4	Prometeus Platform (Dave)	Integration controller into Platform	4

		Y1				Y2				Y3				Y4			
						1	2	3	4	1	2	3	4				
WP3	3.1																
	3.2																
	3.3																
	3.4																
WP4	4.1																
	4.2																
	4.3																
	4.4																

# Discussion

# Glucose Control Actions



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and metabolic eu-sensing

- What will be the control action?
  - Glucose bolus infusion, change of Glucose Infusion Rate, both?
- Will these suggestions be checked and performed by a doctor / nurse?
  - In that case, how often? How many?

# Other Variables



**PROMETEUS**  
preterm brain-oxygenation  
and metabolic eu-sensing

- Is interstitial glucose our only variable to control?
  - Should the neonate receive a minimal amount of kcal. per day (or period)?
    - In case needed, can they be filled using protein and lipid intake?
    - Is there a maximum time without glucose infusion?

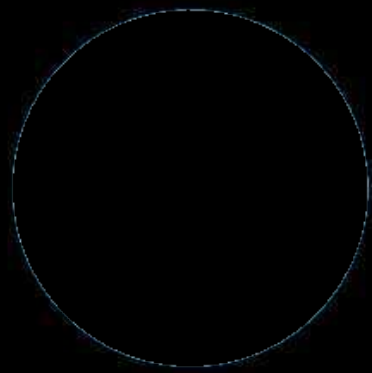
# Implementation details



**PROMETEUS**  
preterm brain-oxygenation  
and metabolic eu-sensing

- What format should the controller code be in?
- Sampling rate of the recommendations?
- Alarms? Who will generate them?
- Do we need to provide any additional information for the HCP?
  - E.g. Glucose On Board





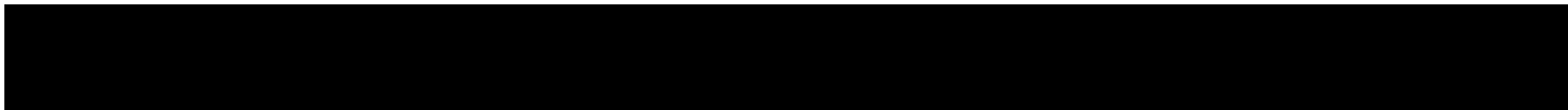
# PROMETEUS

preterm brain-oxygenation  
and metabolic eu-sensing

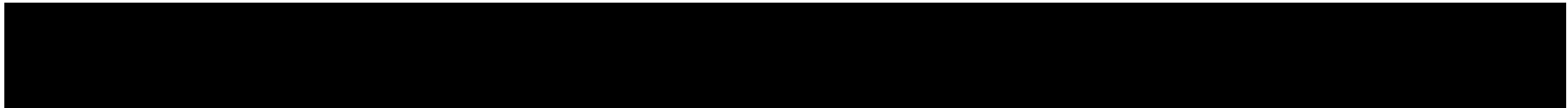
Plenary Meeting, 2024-06-20

Alberto Scarpa -





<b>WP number:</b> 5	<b>WP title:</b> Cloud-based platform ( <i>digital cloud twin</i> )
<b>Objective:</b> to develop the <i>Prometheus</i> Cloud-based environment for NICU on-body monitoring	
<p><b>Lead Partner:</b> Dave. <b>Task 5.1 Cloud app prototype (UNIPD, Dave, UCC).</b> HCP's app and parents' app will be integrated into the <i>Prometheus</i> platform through the following components: i) <i>PEU (Prometheus Edge Unit)</i>: field device which is in close proximity with the sensing devices and the patients and interoperates with the sensors through their docking stations, manages the Controller execution, interoperates with field equipment and other ICT platforms; ii) <i>PCS (Prometheus Cloud Service)</i>: cloud platform. <b>Task 5.2 Communication protocol and interoperability (Dave).</b> Compatibility of the linked devices (connectivity will be set during WP1, WP2) and porting of the control algorithm</p> <p>will be tested: number of connection failures under different environmental scenarios (e.g., distance, on body interference, room temperature); maximum availability, robustness and uptime, especially in the field, which are critical. <b>Task 5.3 Support <i>in vivo</i> study (Dave).</b> Remote support to the <i>in vivo</i> study in WP6 will be provided through remote assistance. 24/7 personnel will be available for troubleshooting for the investigators at the two sites of UNIPD and UCC. Dave will serve as data management site. <b>Task 5.4 Prototype revision (UNIPD, Dave, UCC).</b> To account for feedbacks from NICU personnel with respect to the clinical-user interface of <i>Prometheus</i> in NICU environment.</p>	

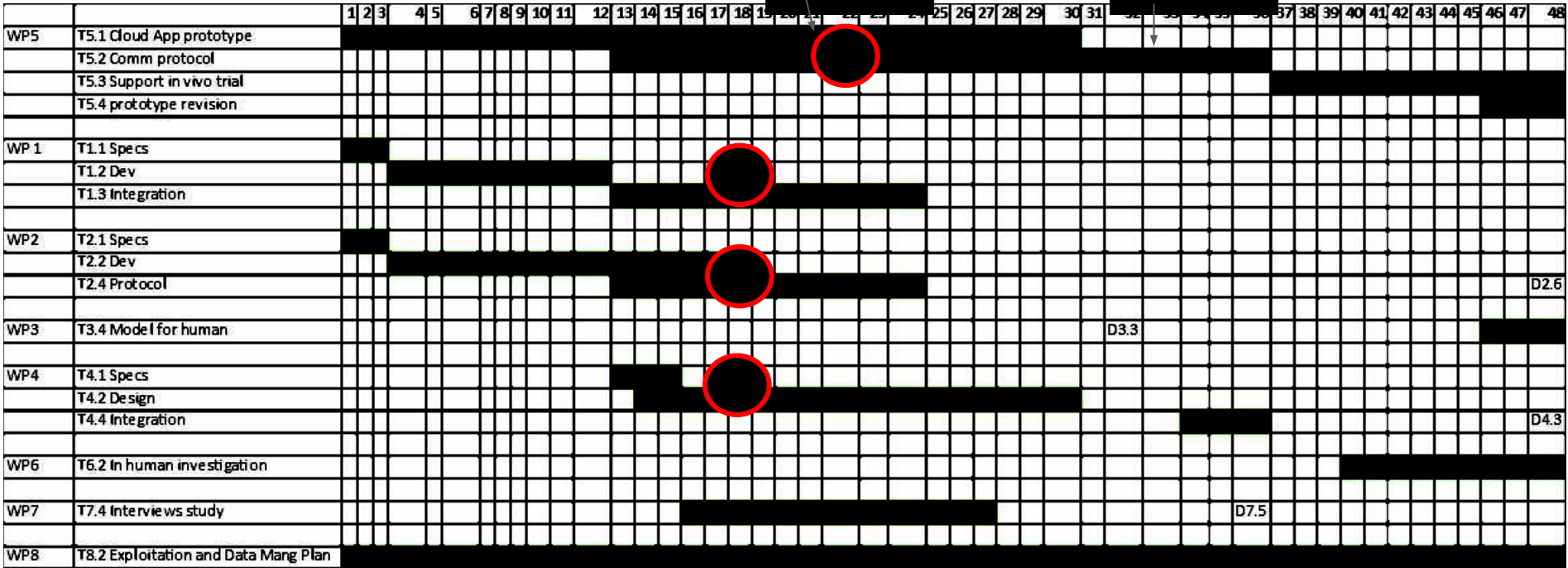


D5.1	Specifications of the cloud app	WP5	7 - DAVE	R — Document, report	SEN - Sensitive	4
D5.2	Cloud-app Prototype evaluation	WP5	7 - DAVE	DEM — Demonstrator, pilot, prototype	SEN - Sensitive	12
D5.3	Communication protocol	WP5	7 - DAVE	R — Document, report	SEN - Sensitive	22
D5.4	WP5 Revision	WP5	7 - DAVE	DEM — Demonstrator, pilot, prototype	PU - Public	30
D5.5	Testing of the cloud-based app	WP5	7 - DAVE	R — Document, report	PU - Public	32
D5.6	Training video for cloud-based app usage	WP5	7 - DAVE	DEM — Demonstrator, pilot, prototype	PU - Public	33

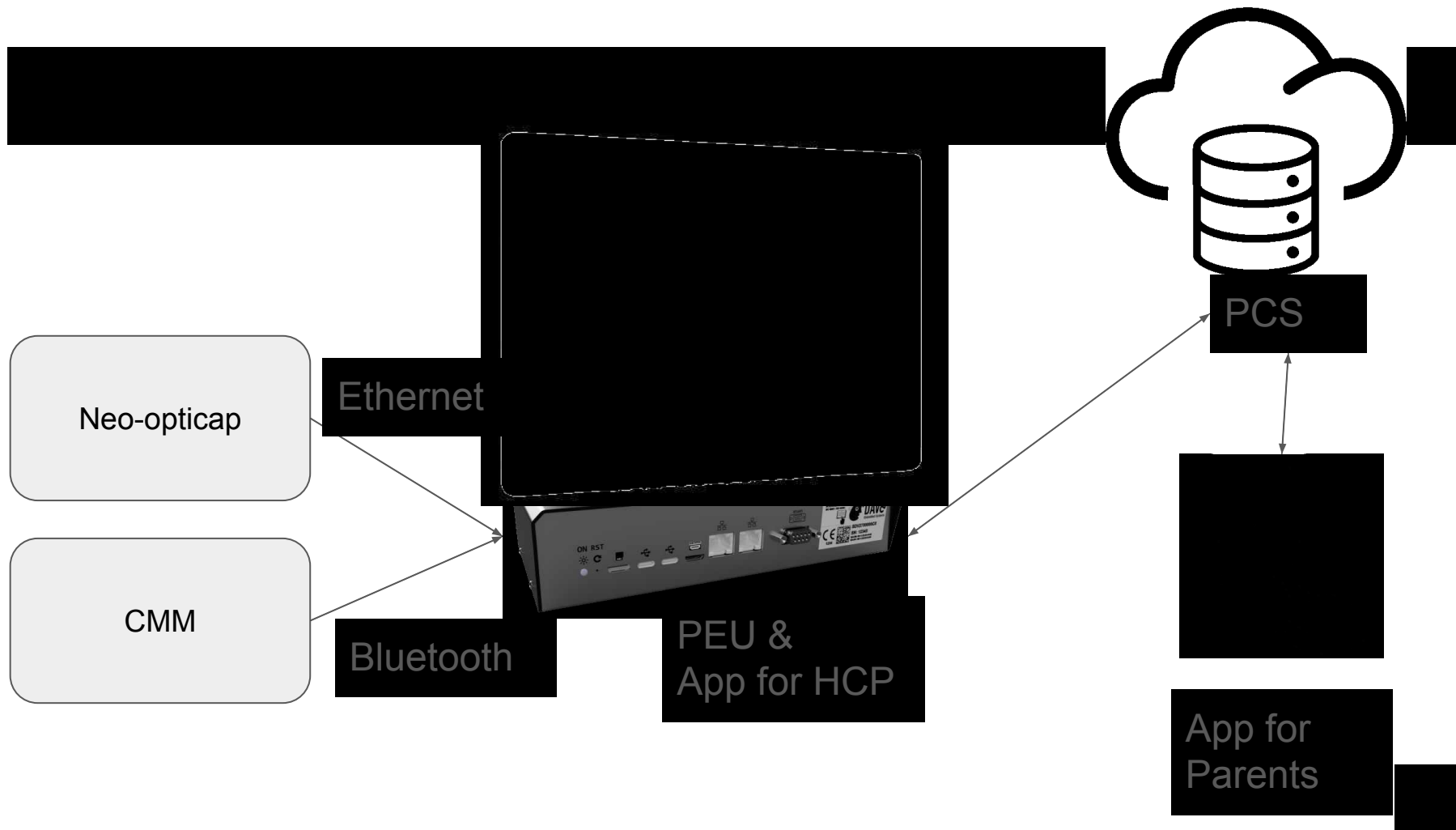


11-2024

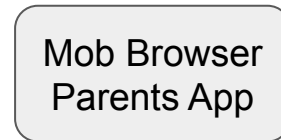
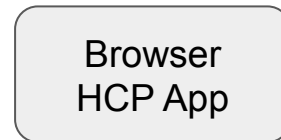
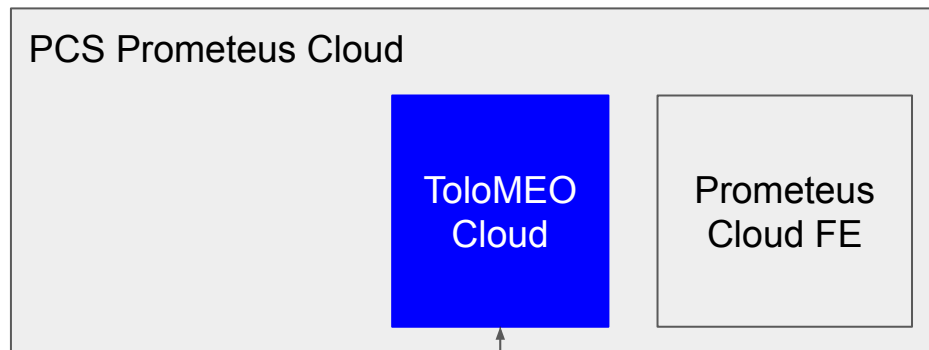
10-2025





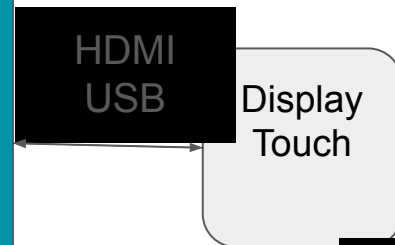
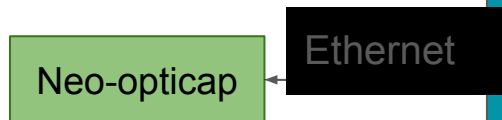
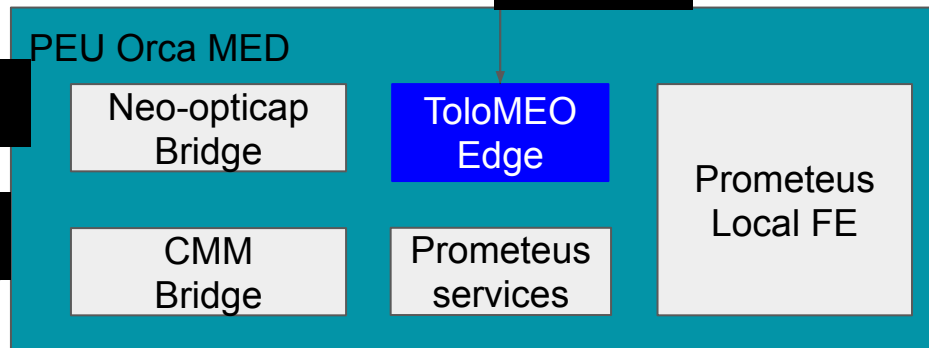




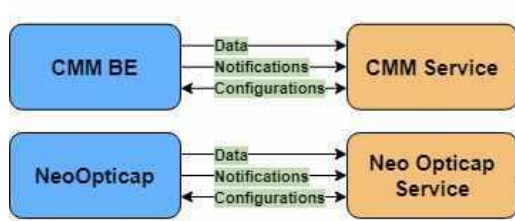


Lan/4G

A black rectangle with the text "Lan/4G" in white, representing the network connection between the cloud and the edge.



## Acquisition Services



## ToloMEO-Edge

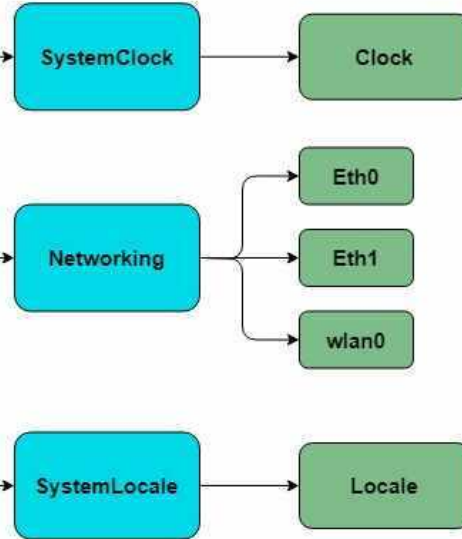
Alarms Service

NCA Service

Trends Service

## Processing Services

## System Control Services



Legend
ToloMEO-Edge Application
ToloMEO Service
Prometheus Service
Prometheus Backend Application
Rootfs Unit

# Prometeus Neo Opticap Sensor Data API 1.0.0

Introduction

SERVICES

production

staging

OPERATIONS

**SEND** sendData

**SEND** sendRawData

## Operations

**SEND** /data

Channel for sending data messages

Send data message

Operation ID **sendData**

Available only on servers:

**production**

**staging**

Accepts the following message:

**sendData.message**

**APPLICATION/JSON**

Message ID **sendData.message**

Payload **Expand all**

**Object**

**data** **Expand all**

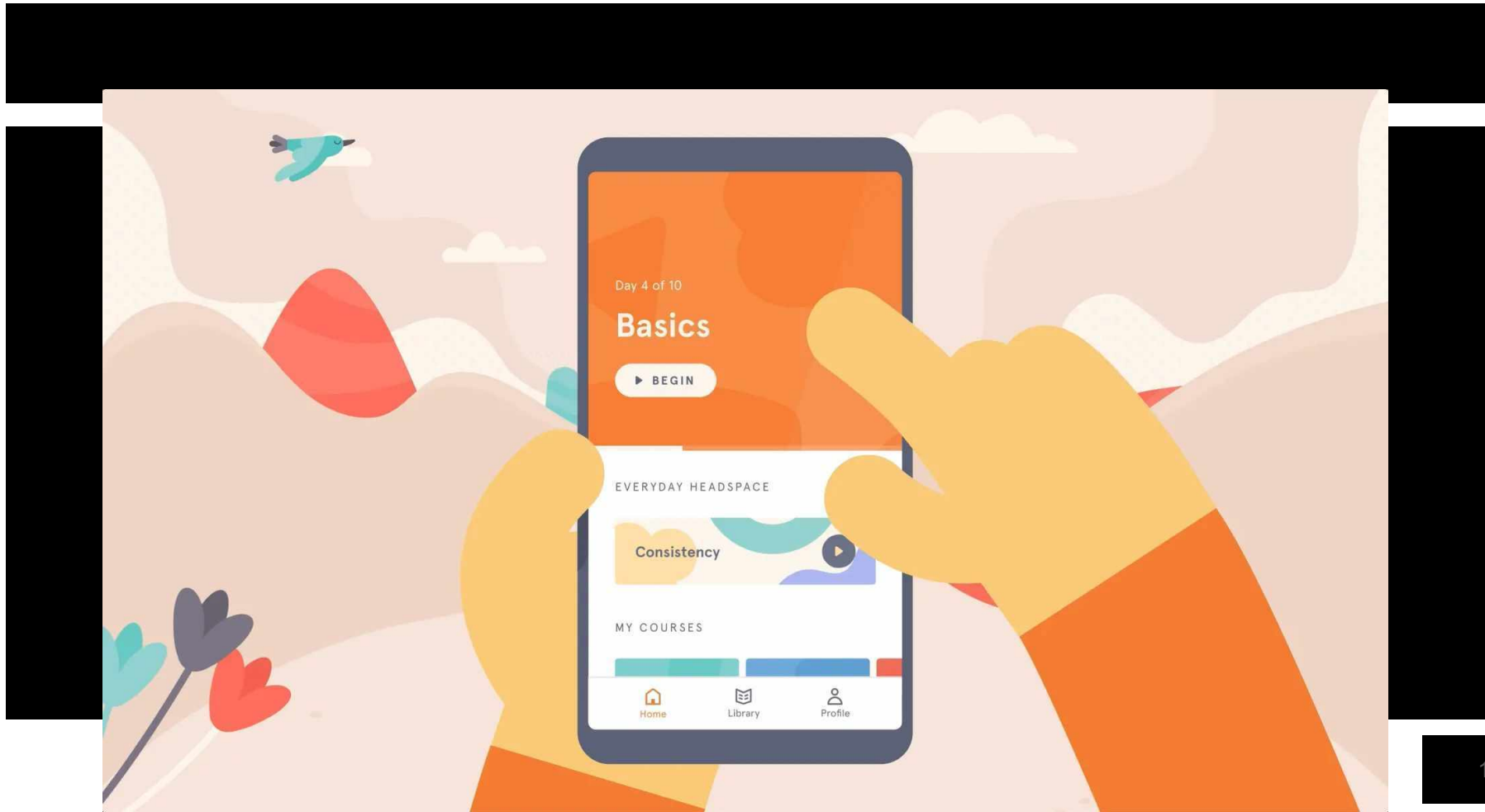
**Object**

<i>hbb.frontal_l</i> <small>required</small>	<b>Number</b> <b>format: float</b>
<i>hbb.frontal_r</i> <small>required</small>	<b>Number</b> <b>format: float</b>
<i>hbb.back_l</i> <small>required</small>	<b>Number</b> <b>format: float</b>
<i>hbb.back_r</i> <small>required</small>	<b>Number</b> <b>format: float</b>
<i>hbb.left</i> <small>required</small>	<b>Number</b> <b>format: float</b>
<i>hbb.right</i> <small>required</small>	<b>Number</b> <b>format: float</b>
<i>o2_hb.frontal_l</i>	<b>Number</b> <b>format: float</b>

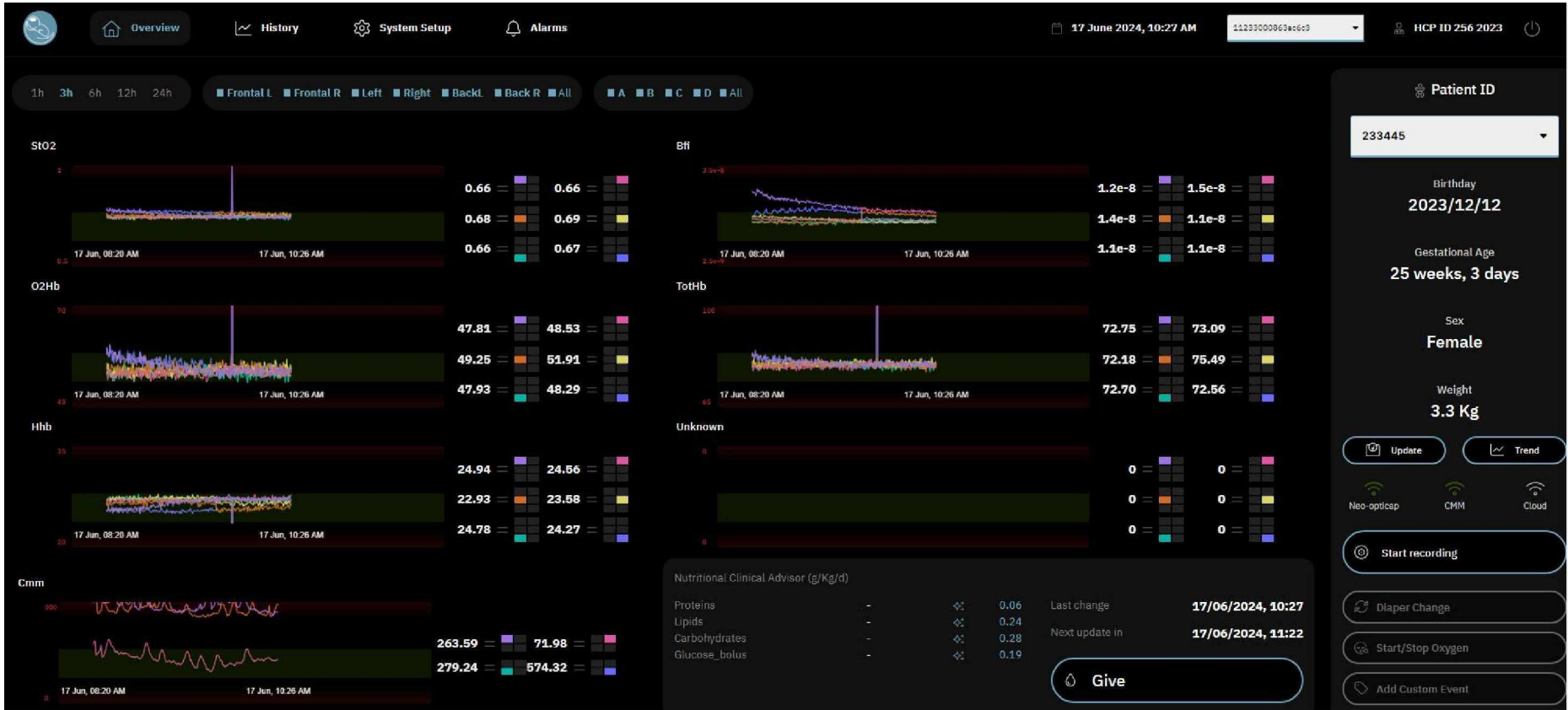
## Examples

**Payload** **^**

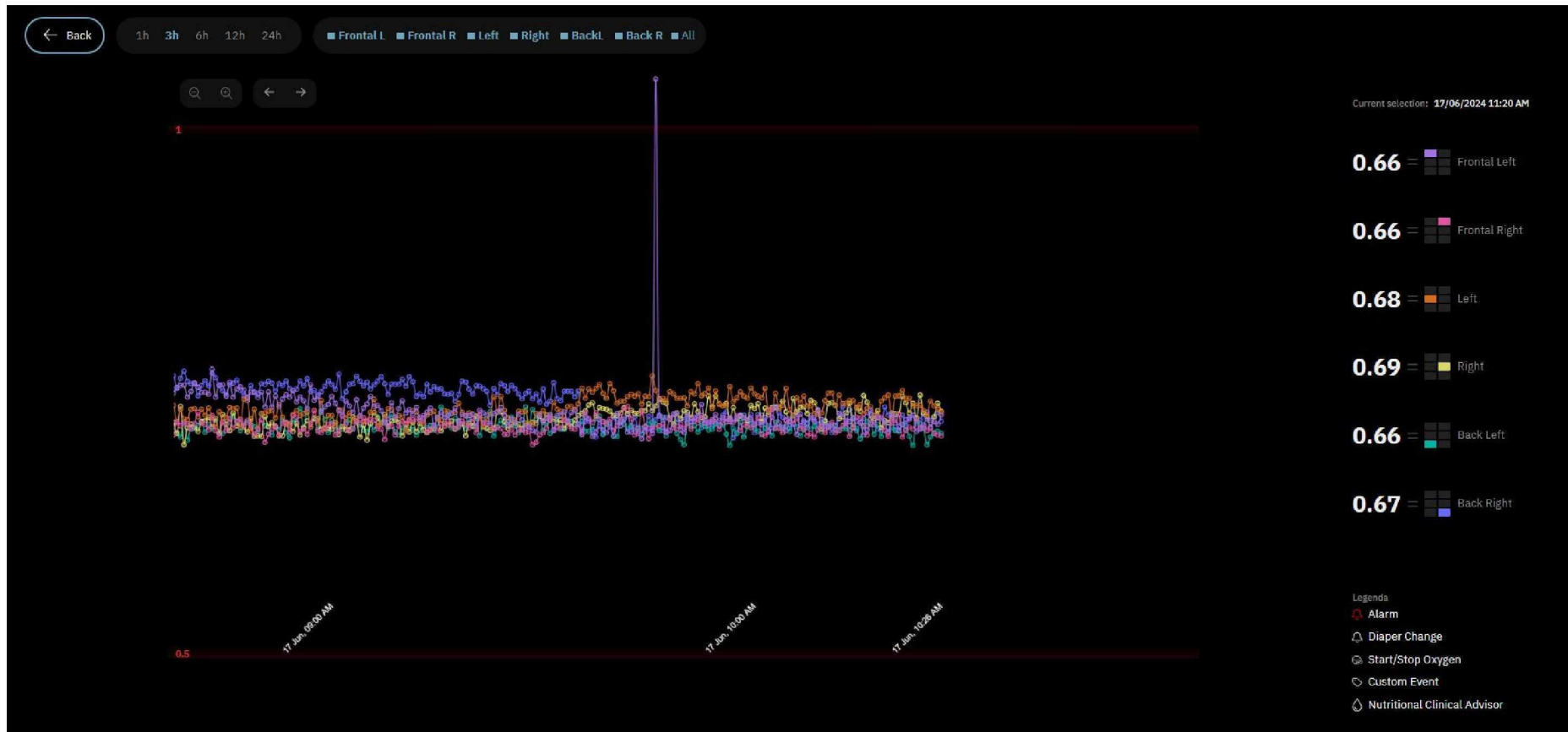
```
{
  "data": {
    "hbb.frontal_l": 0.1,
    "hbb.frontal_r": 0.1,
    "hbb.back_l": 0.1,
    "hbb.back_r": 0.1,
    "hbb.left": 0.1,
    "hbb.right": 0.1,
    "o2_hb.frontal_l": 0.1,
    "o2_hb.frontal_r": 0.1,
    "o2_hb.back_l": 0.1,
    "o2_hb.back_r": 0.1,
    "o2_hb.left": 0.1,
    "o2_hb.right": 0.1,
    "tot_hb.frontal_l": 0.1,
    "tot_hb.frontal_r": 0.1,
    "tot_hb.back_l": 0.1,
    "tot_hb.back_r": 0.1,
    "tot_hb.left": 0.1,
    "tot_hb.right": 0.1,
    "st_o2.frontal_l": 0.1,
    "st_o2.frontal_r": 0.1,
    "st_o2.back_l": 0.1
  }
}
```













# Nutritional Clinical Advisor

Please specify the date and hour:

Date

01	01	2023
02	02	2022
03	03	2021

Hour

01	01	-
02	02	AM
03	03	PM



Last refill



Suggested



Set new values

Proteins

3.0 g/Kg/d	3.0 g/Kg/d	-	0 g/Kg/d	+
------------	------------	---	----------	---

Lipids

5.0 g/Kg/d	5.0 g/Kg/d	-	0 g/Kg/d	+
------------	------------	---	----------	---

Carbohydrates

15.0 g/Kg/d	15.0 g/Kg/d	-	0 g/Kg/d	+
-------------	-------------	---	----------	---

Last change 27/06/2023, 7:32

Next update in 15m 27s

✓ Confirm and give

Proteins

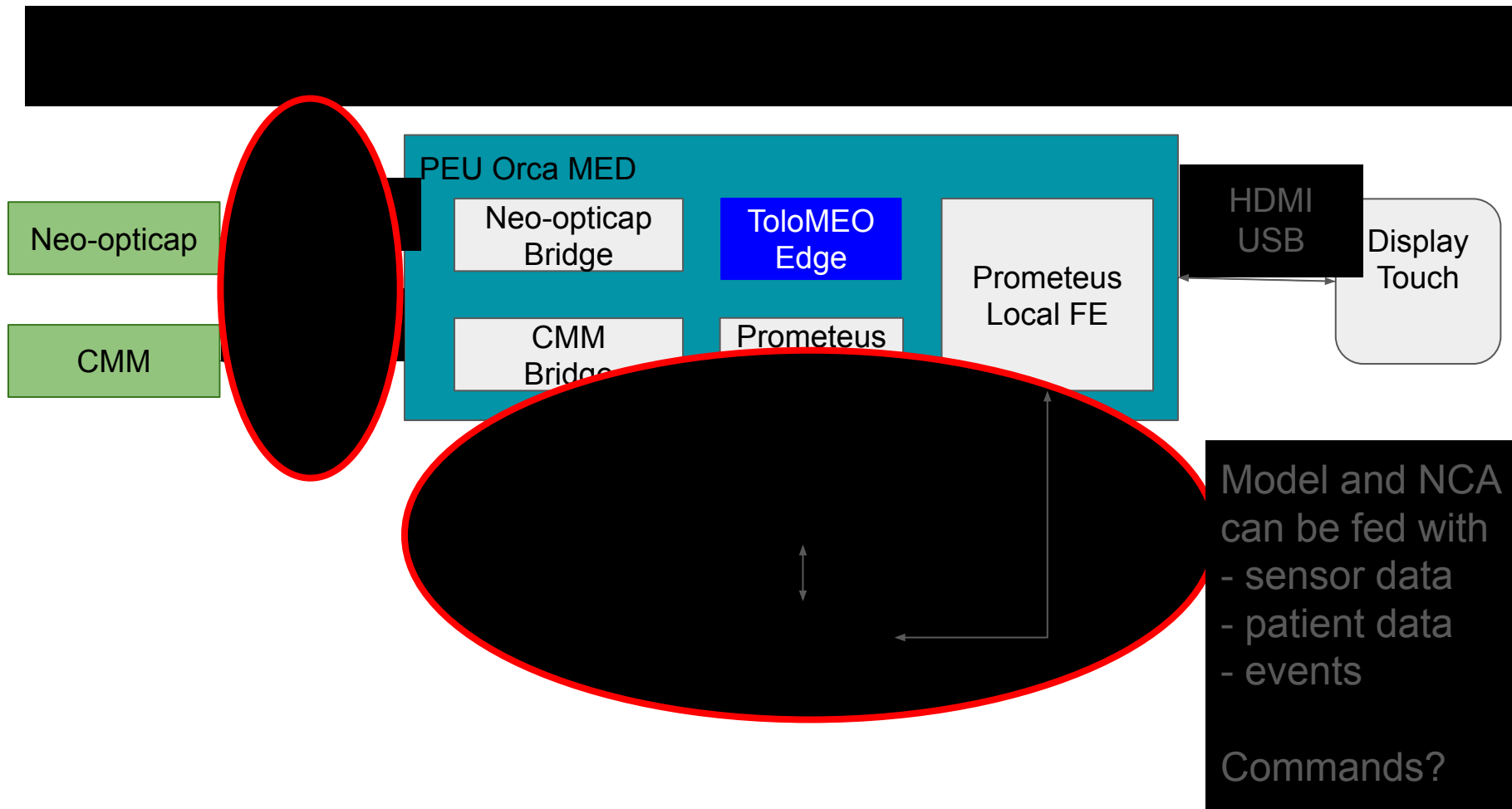
3.0 g/Kg/d	3.0 g/Kg/d	-	0 g/Kg/d	+
------------	------------	---	----------	---

✓ Confirm and give

<https://prometheus.tolomeo.io/>

This will be updated during the project with  
the latest version

- 2024-11: Deliverable D5.3
- 
- 2024-12: sensors protocol draft implementation
- 2024-12: Patient management
- 2024-12: Notification/Alarm management
- 2024-12: OTA + local update
- 2024-12: App for Parents



[REDACTED]

[REDACTED]

CMM <-> Prometheus Edge

Neo-Opticap <-> Prometheus Edge

NCA <-> Prometheus Edge

Prometheus Cloud Public API



Patient ID

233445

Birthday

2023/12/12

Gestational Age

25 weeks, 3 days

Sex

Female

Weight

3.3 Kg

Update

Trend

Neo-opticap

CMM

Wi-Fi

☐ Stop recording

Diaper Change

Start/Stop Oxygen

Add Custom Event

Start/Stop Oxygen

Last Change 27/06/2023, 7:32 AM

Please specify the date and hour of the latest event:

Session

☒ Start ▶

☐ Stop ■

FI02

— 0

Kg

+

Invasive?

☐ No

Date

Hour

01012023

02022022

03032021

0101-

0202AM

0303PM

✓ Save changes

Diaper Change

Last Change 27/06/2023, 7:32 AM

Please specify the date and hour of the latest change:

Date

Hour

01012023

02022022

03032021

0101-

0202AM

0303PM

✓ Save changes

Edit patient

Patient ID

233445

Birthday

Gender

01012023

02022022

03032021

☒ Female ♀

☐ Male ♂

Weight

Height

— 0 Kg +

— 0 cm +

Gestational Age

— 0 weeks +

— 0 days +

✓ Confirm and add

20

# PEU HW Selection

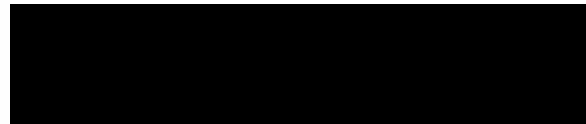
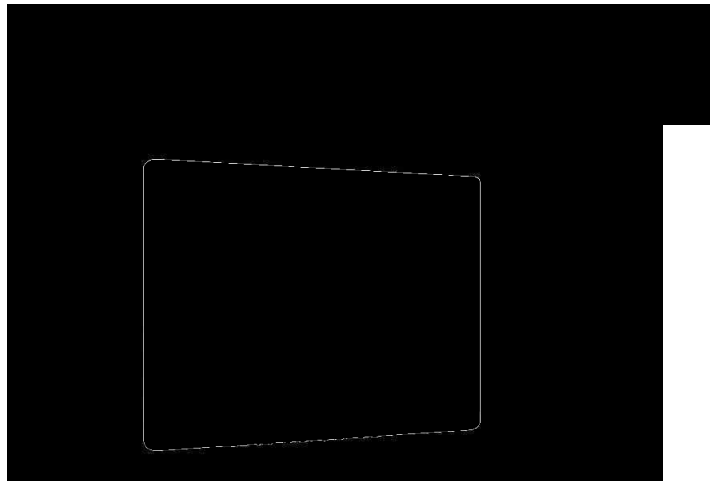


## ORCA MED

NXP i.MX8M Arm Cortex A53 with 8 GB  
LPDDR4, 2.3 TOPS Ai Engine, 2 ETH,  
WiFi+BT, Boxed.  
Compliant with ISO 60601



**Power Supply**  
GEM18I12-P1J  
18W  
IEC 60601-1



**Advantec PAX-121 (F Model)**  
21.5" 1080P  
Multi Touch Screen  
Stand and VESA support  
IEC 60601

**Monitor**  
15.6" 1080P  
Touch Screen  
Stand and VESA support  
**NO 60601**



**Any Monitor and mouse**  
provided by the hospital  
resolution 1080P

# PROMETEUS - Preterm Brain-Oxygenation and Metabolic EU-Sensing: Feed the Brain

Grant Agreement Number 101099093

## WP7

Partners involved:  
UNIPD, UCC



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# OB6: The social culture of the preterm birth

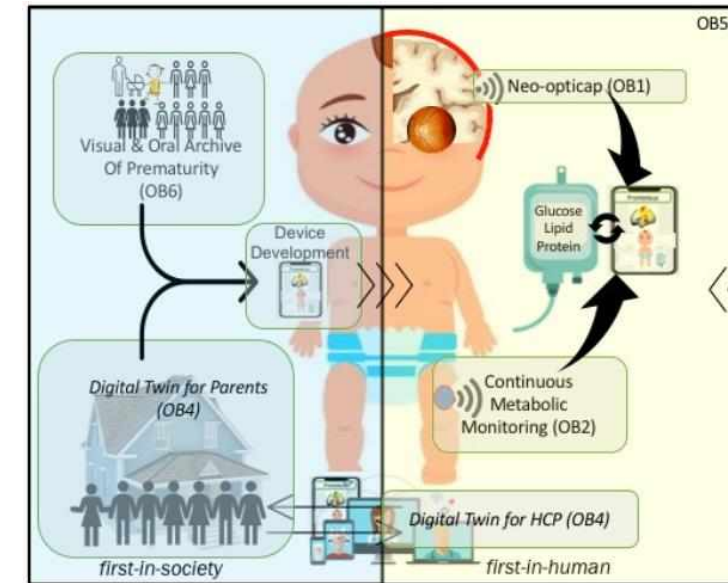


PROMETEUS  
preterm brain-oxygenation  
and metabolic eu-sensing



WP7 aims to:

- evaluate the **potential impact** of on-body monitoring devices on parents and healthcare personnel (HCP) and their personal experience with prematurity
- create the first **Visual and Oral Archive of prematurity**, containing **longitudinal memories** of the experience related to:
  - Prometeus devices development
  - premature birth



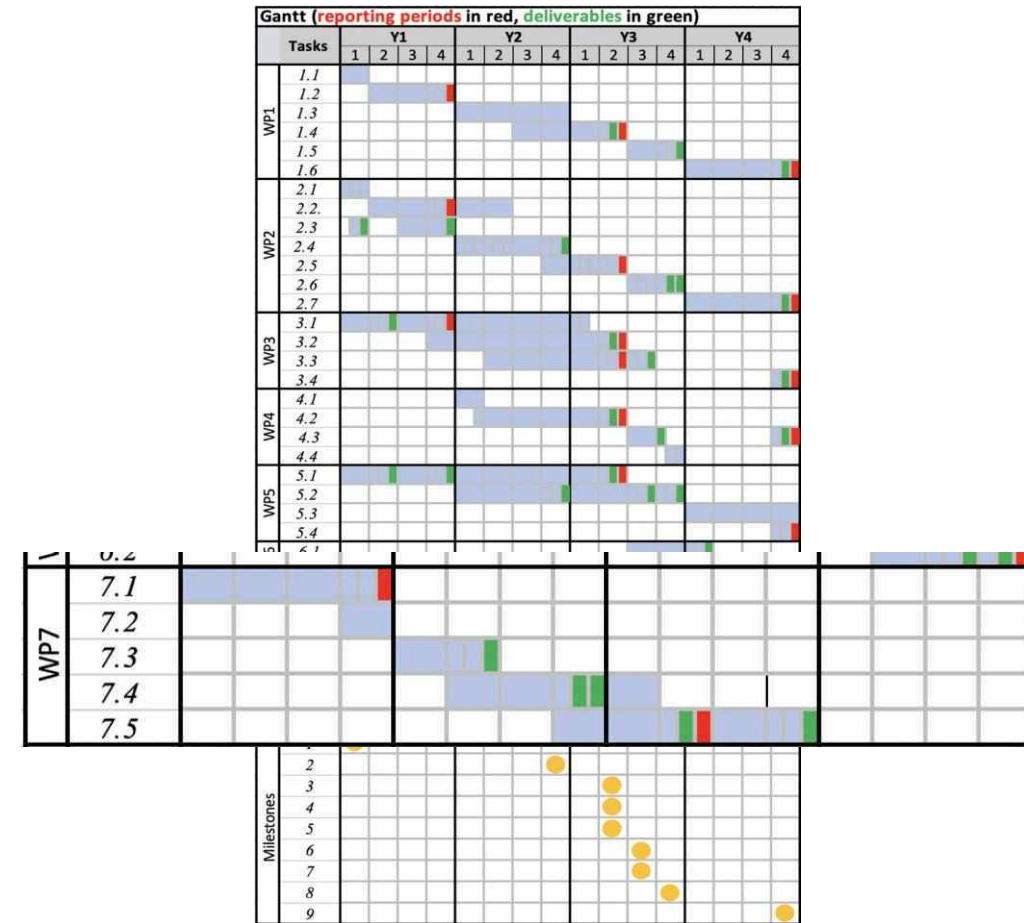


# PROMETEUS

preterm brain-oxygenation  
and metabolic eu-sensing

Task	Task Labels (from path-finder project)	Period
7.1	Development of assessment tool (UCC, UNIPD)	31/01/23 → 31/01/24
7.2	Ethical Committee Approval for the interview collection (UNIPD, UCC)	31/10/23 → 31/01/24
7.3	Script for video recording (UNIPD, UCC)	31/01/24 → 31/07/24
7.4	Assessment and interview study for parents and HCP on device development (UNIPD, UCC)	30/04/24 → 30/04/25
7.5	Visual and oral archive of prematurity (UNIPD)	31/10/24 → 31/01/26

Deliverables	Deliverables Labels (from path-finder project)	Deadline
D7.1	Training video for interview (UNIPD)	31/07/2024
D7.2	Psychometric assessment results (UCC)	31/01/2025
D7.3	Results on perception of medical devices (UNIPD)	31/01/2025
D7.4	Visual & Oral Archive of prematurity release	31/07/2025
D7.5	WP7 Revision	31/01/2026



# Task 7.1: Development of assessment tool



**PROMETEUS**  
preterm brain-oxygenation  
and metabolic eu-sensing

Task 7.1 was dedicated to the definition of tools to administer to parents and HCP over a longitudinal period.

Task	Task Labels (from path-finder project)	Dates
7.1	Development of assessment tool (UCC, UNIPD)	31/01/23 → 31/01/24
7.2	Ethical Committee Approval for the interview collection (UNIPD, UCC)	31/10/23 → 31/01/24
7.3	Script for video recording (UNIPD, UCC)	31/01/24 → 31/07/24
7.4	Assessment and interview study for parents and HCP on device development (UNIPD, UCC)	30/04/24 → 30/04/25
7.5	Visual and oral archive of prematurity (UNIPD)	31/10/24 → 31/01/26

**Next step planned:** Task 7.4 (Longitudinal data collection)





# Task 7.1: Development of assessment tool



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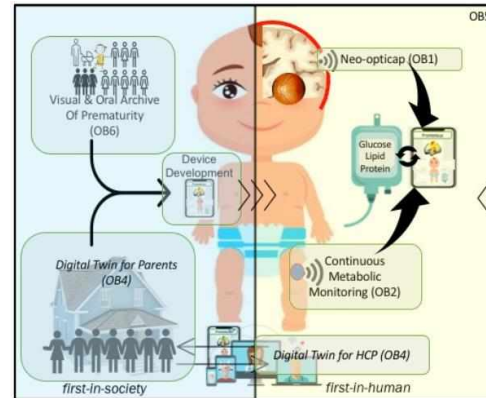


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University College Cork, Ireland  
Coláiste na hOllscoile Corcaigh

- Two qualitative ad hoc interviews were developed to evaluate the impact and perception of Prometeus on-body monitoring devices, both on parents and HCP.
- A few pictures were selected to show the different devices (next slide).



## *Impact of on-body monitoring devices*

*after Reporting Period 1 (gen24)*

- The Italian versions of the interviews have been implemented online on Qualtrics. Two separated links have been created, one with the interview for HCP and one with the interview for parents.
- **CURRENTLY:** We are translating the interviews in English.
- **NEXT STEP:** We will implement the English versions of the interviews on Qualtrics.

# Task 7.1: Development of assessment tool



**PROMETEUS**  
preterm brain-oxygenation  
and metabolic eu-sensing

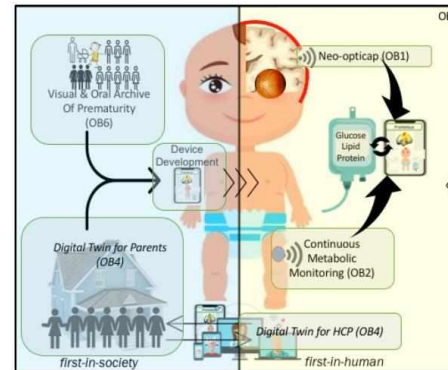
- A few pictures were selected to show the different devices, in collaboration with Prometheus experts (Sabrina Brigadoi, Alberto Scarpa, Alfonso Galderisi, Daniele Trevisanuto)
- Pictures selected:

Neo-opticap

Neo-opticap

Digital interface  
(NCA)

Digital interface  
(dashboard)



*Impact of on-body  
monitoring devices*

- **CURRENTLY:** We need a sketch or a picture of the sensor patch to complete the interview.
- Pictures still to select:

CMM (patch)

# Task 7.1: Development of assessment tool



**PROMETEUS**  
preterm brain-oxygenation  
and metabolic eu-sensing



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- A review of the literature was conducted in March 2023 to investigate which tools were mostly administered on parents of preterm infants and HCP working in NICU.
- A battery of standardized questionnaires to carry out a psychological assessment was selected for both parents and HCP.

## Selected questionnaires:

- **PERMA-Profiler** - wellbeing
- **STAI** - anxiety
- **BDI** - depressive symptoms
- **COPE** - coping strategies
- **PPQ** - PTSD symptoms related to childbirth
- **EPDS** - perinatal/postnatal depression



*Psychological  
assessment*

*after Reporting Period 1 (gen24)*

- A **second review** of the literature was conducted in May 2024 with the same criteria to update the results and include the latest articles published.
- The **italian** versions of the questionnaires have been implemented online on Qualtrics. Two separated links have been created, one with questionnaires for HCP and one with questionnaires for parents.
- **CURRENTLY:** We are implementing the **english** versions of the questionnaires on Qualtrics.

# Task 7.1: Development of assessment tool



**PROMETEUS**  
preterm brain-oxygenation  
and metabolic eu-sensing



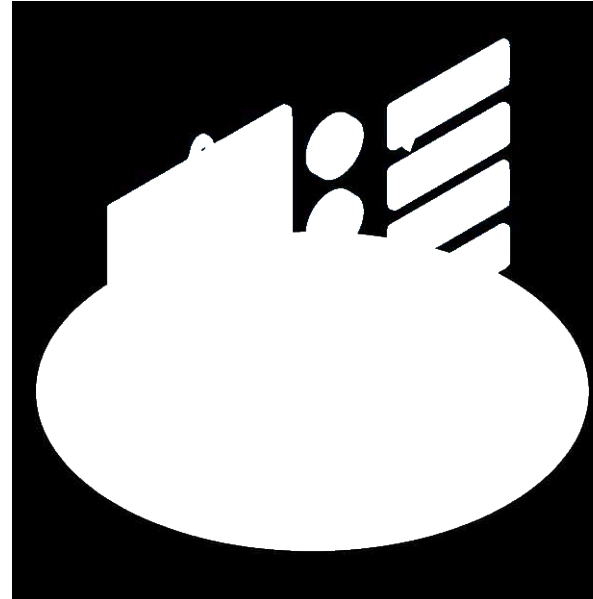
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- A battery of standardized questionnaires to investigate stressor perception in the NICU and the nurse-parent relationship was selected for both parents and HCP.

Selected questionnaires:

- **PSS-NICU** - stressors perception (parents)
- **PS-ICU** - stressors perception (HCP)
- **NPST** - perceived support (parents)



*Impact of NICU  
experience*

*after Reporting Period 1 (gen24)*

- The **italian** versions of the questionnaires have been implemented online on Qualtrics. Two separated links have been created, one with questionnaires for HCP and one with questionnaires for parents.
- **CURRENTLY:** We are implementing the **english** version of the questionnaires on Qualtrics.

# Task 7.1: Development of assessment tool



PROMETEUS  
preterm brain-oxygenation  
and metabolic eu-sensing



- A medical and emotional assessment of the families through a digital diary developed by UCC that takes into consideration the physical and emotional path of each patient to promote empathy and empowerment.



*Integrated Patient  
Journey Mapping tool*

*after Reporting Period 1 (gen24)*

- **CURRENTLY:** UCC is adapting the original version of the tool to the aim and the population of the project (parents of premature infants).

# Task 7.2: Ethical Committee Approval



**PROMETEUS**  
preterm brain-oxygenation  
and metabolic eu-sensing

Task 7.2 concerned the Ethical Committee Approval, required to start the data collection (Task 7.4).

Task	Task Labels (from path-finder project)	Dates
7.1	Development of assessment tool (UCC, UNIPD)	31/01/23 → 31/01/24
7.2	Ethical Committee Approval for the interview collection (UNIPD, UCC)	31/10/23 → 31/01/24
7.3	Script for video recording (UNIPD, UCC)	31/01/24 → 31/07/24
7.4	Assessment and interview study for parents and HCP on device development (UNIPD, UCC)	30/04/24 → 30/04/25
7.5	Visual and oral archive of prematurity (UNIPD)	31/10/24 → 31/01/26



COMITATO ETICO DELLA RICERCA PSICOLOGICA (AREA 17)  
Dipartimenti/Sezione di Psicologia - Università di Padova  
Via Venezia 8, 35131, Padova  
FAX. +39-0498276600, Email: [comitato.etico.area17@unipd.it](mailto:comitato.etico.area17@unipd.it);  
Sito WEB: <https://comitati-etici-unipd.scientificnetwork.org/>

Univocal code: 111-c  
Date of approval: 29/04/24



Pending

# Task 7.3: Script for video recording



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Task 7.3 was dedicated to develop the scripts to conduct ***longitudinal narrative sessions***, that are semi-structured interviews repeated over a 4-month period.

They aim to bring out **themes** related to parents and HCP experience of prematurity.

Task	Task Labels (from path-finder project)	Dates
7.1	Development of assessment tool (UCC, UNIPD)	31/01/23 → 31/01/24
7.2	Ethical Committee Approval for the interview collection (UNIPD, UCC)	31/10/23 → 31/01/24
7.3	Script for video recording (UNIPD, UCC)	31/01/24 → 31/07/24
7.4	Assessment and interview study for parents and HCP on device development (UNIPD, UCC)	30/04/24 → 30/04/25
7.5	Visual and oral archive of prematurity (UNIPD)	31/10/24 → 31/01/26

**Next step planned:** Task 7.5 (Visual & Oral Archive creation)





# Task 7.3: Script (manual) for video recording



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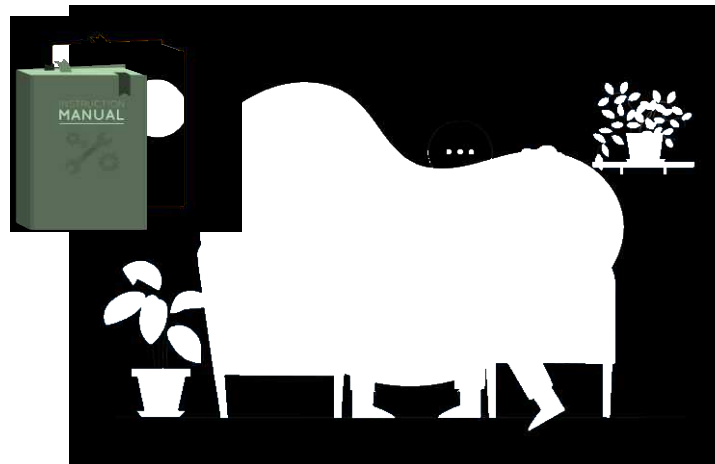


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and metabolic eu-sensing

*after Reporting Period 1 (gen24)*

## Narrative session:

- The scripts developed consisted of a protocol to follow in both sites when data collection starts, which defined the environment, the details of the meeting and the open-ended questions to use.
- The scripts were saved in **two manuals** (one for parents, one for HCP).
- UNIPD conducted a pilot study with 11 mothers (may-oct 2023) to test the **feasibility** and **accuracy** of the narrative sessions' script.



## CURRENTLY:

- We are adapting the scripts to administer the interviews longitudinally over a 4-month period (longitudinal narrative sessions).
- We are adjusting the scripts of the narrative sessions to perform short interviews that will become part of the Visual and Oral Archive of Prematurity. We are also implementing a **training video** of the protocol to follow during the Archive interviews (**D7.1, 31/07/2024**).

# Pilot study



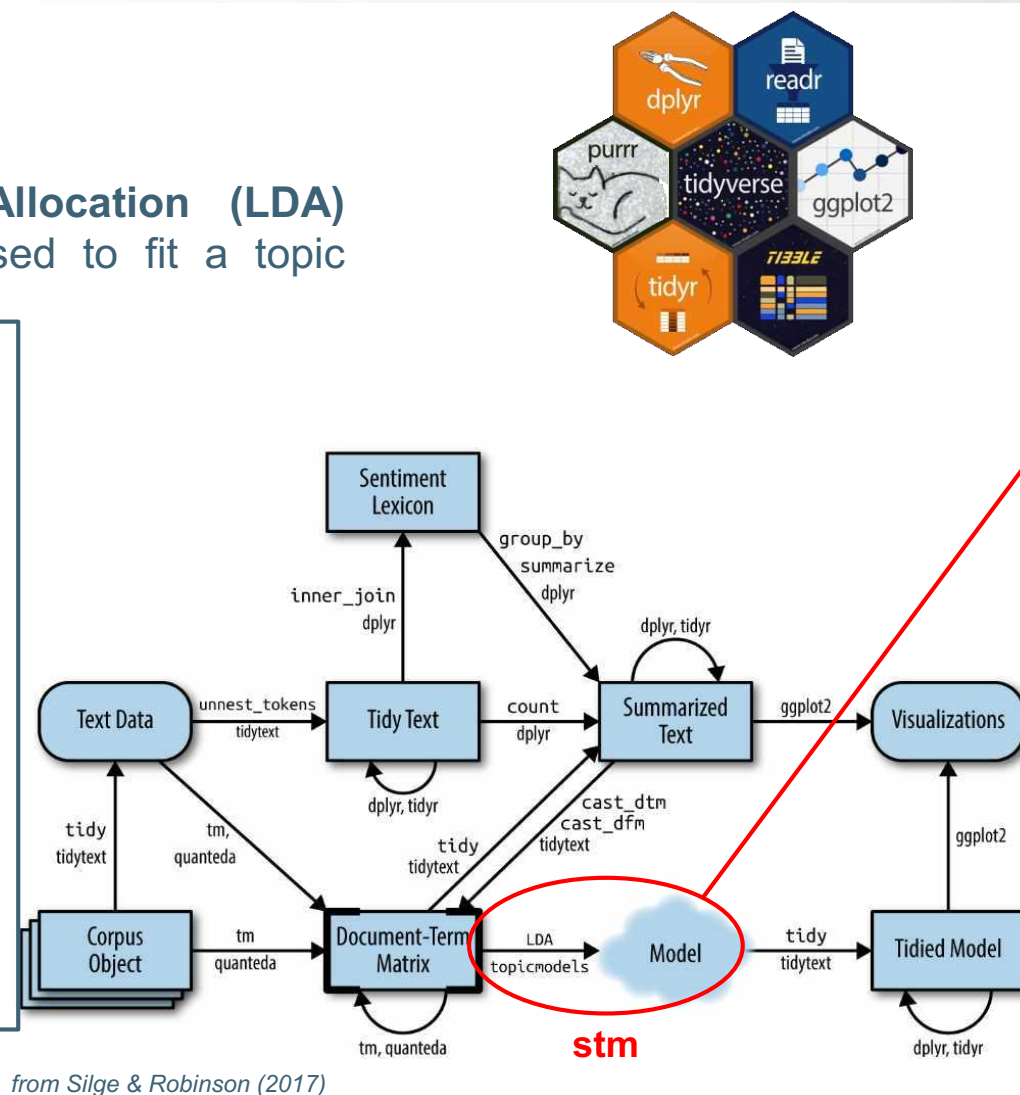
**PROMETEUS**  
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- **Latent Dirichlet Allocation (LDA)** was the method used to fit a topic model.

- **Text data:** import a CSV with UTF-8 encoding
- **Tidy text:** transform the text in tokenized words
- **Preprocessing:** remove stopwords (e.g. that, and)
- **Sentiment Lexicon:** classify the sentiment polarity
- **Summarized text:** calculate the frequency for each word
- **Document-Term Matrix:** convert the tidy text in a document-term matrix
- **Model:** fit a topic model using LDA or STM
- **Tidied Model:** tidy the model to make handling data easier
- **Visualizations:** visualize the output



from Silge & Robinson (2017)

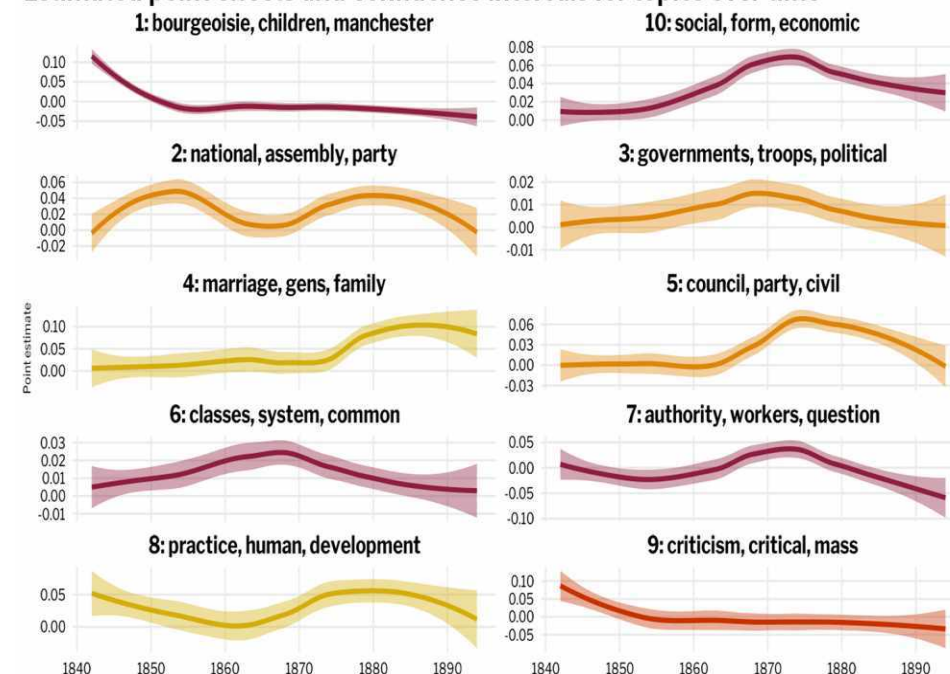


after Reporting Period 1 (gen24)

- **CURRENTLY:** We are testing the **Structural Topic Model (STM)** method, which allows to model the evolution of topical prevalence vectors over different time points.

example:

Estimated point effects and confidence intervals for topics over time



Structural Topic Modeling on the (mostly) Collected Works of Marx and Engels with R | DS4CS

# Journey Mapping as an Approach to Human-centred Design

Dr. Stephen McCarthy & F Adam

Department of Business Information Systems

Cork University Business School

Prof Eugene Dempsey

Department of Paediatrics

University College Cork, Ireland

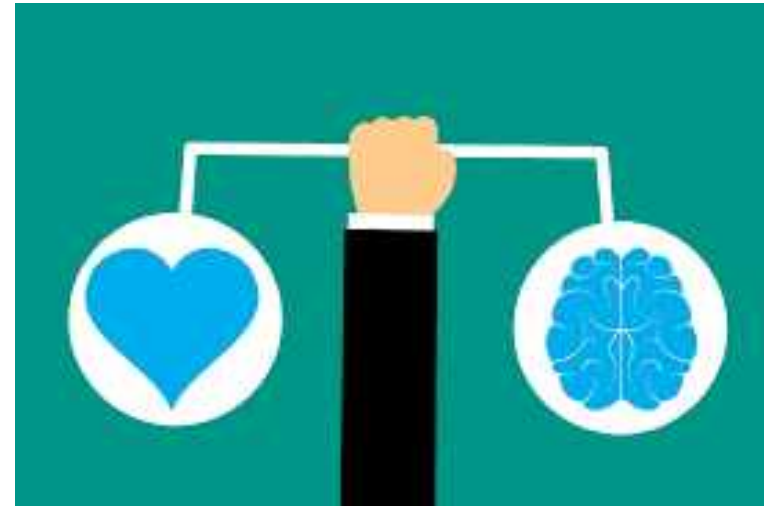
# Human-centred Design

- Human-centered design is a problem-solving technique that places user needs (e.g., patients, customers, and citizens) at the heart of the design process.
- Enables multi-disciplinary stakeholders to see services ‘through the eyes’ of the users when redesigning products, services, and solutions.
- Collaborative and ‘bottom-up’ approach to co-creation.

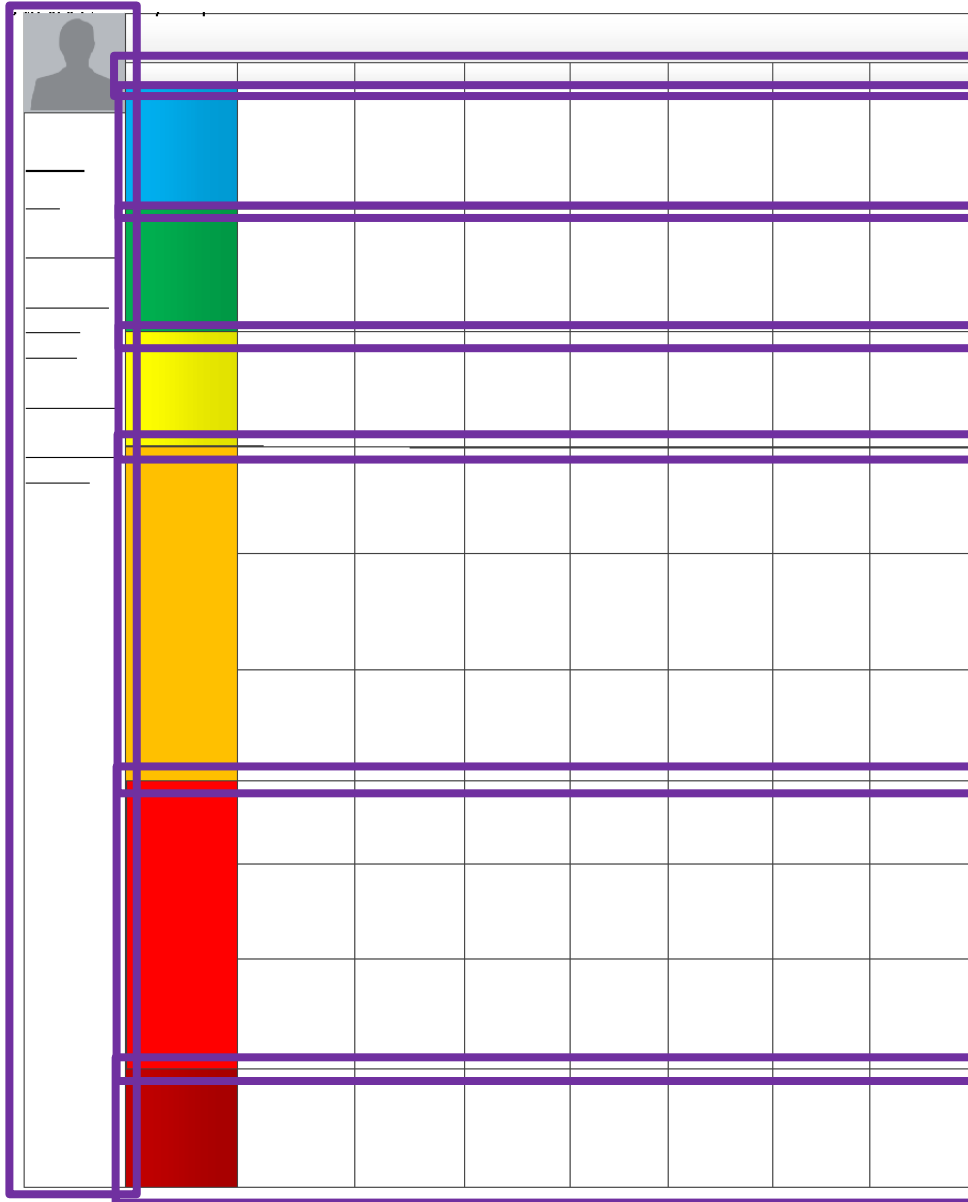


# Journey Mapping and Empathy

- The physical journey centres on a user's 'touchpoints' with products, services, or processes.
- The emotional journey relates to their feelings, attitudes, and motivations at each touchpoint e.g., elation/despair.
- Journey mapping aims to visually externalise insights around experiences to promote empathy, respect, and empowerment.



# The Integrated Journey Map



## Elements:

- Persona
- Timeline
- Emotional Journey
- Physical Journey
- Other Touch Points
- Encounters
- Tasks
- Safety and Governance

# Example: Journey Mapping in Maternal Health

- Aimed to develop an e-health system to detect hypertensive disorders of pregnancy.
- The system would monitor expectant mothers' well-being outside of normal appointments using an IT solution in their homes.
- Journey mapping was used for vision building and requirements gathering.





Age: 38

Occupation: Vet

**Risk profile:**  
Brenda is at high risk of hypertension during pregnancy. She has type II diabetes, and it has been 10 years since her last pregnancy.

Summary:

Brenda is diagnosed with severe gestational hypertension at week 24. Her BP quickly stabilises as an inpatient, and her

[illegible]

# Co-creation and Facilitation



**Write down your thoughts on post-its:**

Your daily life/personal perspective:

**(colour 1)**

The customer/patient perspective:

**(colour 2)**



# Clustering and Refining



Make clouds of your ideas!



# Exhibiting Results



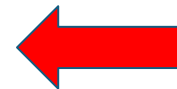
- Take a break, get some coffee and look at the results - the table facilitators can answer questions.
- **Pick topics you would like to work on further.**

# Journey Mapping - Strengths

Property	Description
Shared Syntax	To provide stakeholders with a common language which they can use to represent their knowledge.
Visualisation	To provide stakeholders with a common reference point for highlighting differences and commonalities.
Concreteness	To provide stakeholders with a concrete means for guiding dialogue.
Malleability	To enable stakeholders to jointly transform and negotiate their knowledge.
Closure	To allow stakeholders to jointly agree a state of affairs.

# WP7: The social culture of preterm birth

- Develop a patient journey map for families going through PTB
- Introduce the map to staff and parents
- Use the map as backup to develop narratives that are consistent in language, timeframes and locations
- Map can be agreed upon, translated etc...
- Work on developing IPJM is on going:
  - Develop some scenarios (eg: scheduled PT delivery, accidental PT delivery etc...)
  - Identify locations (home, delivery room, NICU etc...)
  - Identify participants
  - Identify encounters and tasks
- Draw the maps and share them amongst the team
- Translate and use in interviews with parents



# Resources

- McCarthy, S et al. (2016). An integrated patient journey mapping tool for embedding quality in healthcare service reform. Journal of Decision Systems, 25(1), 354-368.
- McCarthy, S. et al. (2020). Embedding the pillars of quality in health information technology solutions using “Integrated Patient Journey Mapping”(IPJM): case study. JMIR Human Factors, 7(3), e17416.
- Cabrera Research Lab  
<https://www.cabreraresearch.org/catalog>
  - Systems Thinking 101 (ST101)
  - Systems Mapping 201 (SM201)
  - Systems Leadership 301 (SL301)
- Miro <https://miro.com/app/dashboard/>



# Resources

- Stanford D.School <https://dschool.stanford.edu/resources>
  - Empathise, define, ideate, prototype, and test
  - Iterating between the concrete and emotional
  - Why-How Laddering
- IDEO Human-Centred Design Toolkit <https://www.designkit.org/>
  - Methods and templates
  - Case studies
- Persona and empathy map templates <https://miro.com/templates/>



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**Paola Rigo**  
Associate Professor  
WP7 Leader



**Donata Maria Amato**  
Research Assistant  
Starting period: 01/02/23



**Eugene Dempsey**  
Full Professor



**Frederic Adam**  
Full Professor



**Lou Legall**  
Intern  
Starting period: 08/02/24

# PROMETEUS - Preterm Brain-Oxygenation and Metabolic EU-Sensing: Feed the Brain

Grant Agreement Number 101099093



## EXPLOITATION PLAN (PEC)

# Identified exploitable results



**PROMETEUS**  
preterm brain-oxygenation  
and metabolic eu-sensing

Exploitable results	Consortium owner/s	IPR plan/status	Type innovation (e.g. services, new product, new process...)	Next steps	Potential customers /users	Responsible for dissemination
Interoperable App	Dave	industrial design / copyrights	service	SW development	IntensiveCareUnit: Healthcareproviders	Dave
Continuous metabolic monitoring (CMM)	QLAB	industrial design / patent	product/revise		sensor and pump manufacturers (Medtronic, Dexcom, Abbott, Insulet, Lilly, Roche) pharmaceuticals ((Lexicon, Sanofi)	QLAB
Novel hydrogel formulations for improved sensor performance	QLAB	industrial design / patent	product	HW development	Sensor and pump manufacturers (Medtronic, Dexcom, Abbott)	QLAB
Electronic circuitry architecture supporting multi-channel electrochemical signal collection and processing	QLAB	industrial design / patent	product/service		sensor manufactures	QLAB
Neo-opticap	UCL,POLIMI,ICFO, PIONIRS	industrial design / patent	product	HW development	Neuroimaging manufacturers (NIRxMedTech, ArtinisMedicalSystem, Gowerlabs)	UCL
Nutritional clinical advisot (NCA) controller	UdG	utility model	product/service		Intensive Care Unit, Healthcare providers, pump manufacturers (Braun, BD Alaris, Medtronic, Lilly, Insulet, Roche)	UdG
Prematurity Visual & Oral Archive	UNIPD	copyright			Preterms' Families and patients, Historians of Science; Psychologists; Exhibitions; Manufacturers / Industries of preterm accessories / medicaldevices	UNIPD
insilico neonatal avatar	UNIPD	copyright			Neonatologists, Biologists, Bioengineers	UNIPD
Nutritional recommendations	UNIPD, UdG	freely available / open source			Neonatologists; Neonatal Cochrane; Policymakers	UNIPD
OEM SCOS module	ICFO	patented	new product	Validation and deployment	Research Labs and clinicians	ICFO
Multi-channel FW upgrades	PIONIRS	industrial design / copyrights	new product	Validation and deployment	Research institutions, clinics	PIONIRS
Optical Switch for multi channel TD-NIRS	PIONIRS - POLIMI	industrial design / patent	New product	Prototype validation and deployment	optical system manufacturers	PIONIRS/POLIMI

**Work in progress...**

- Preliminary evaluation

**12** exploitable results

**7** products + **5** services

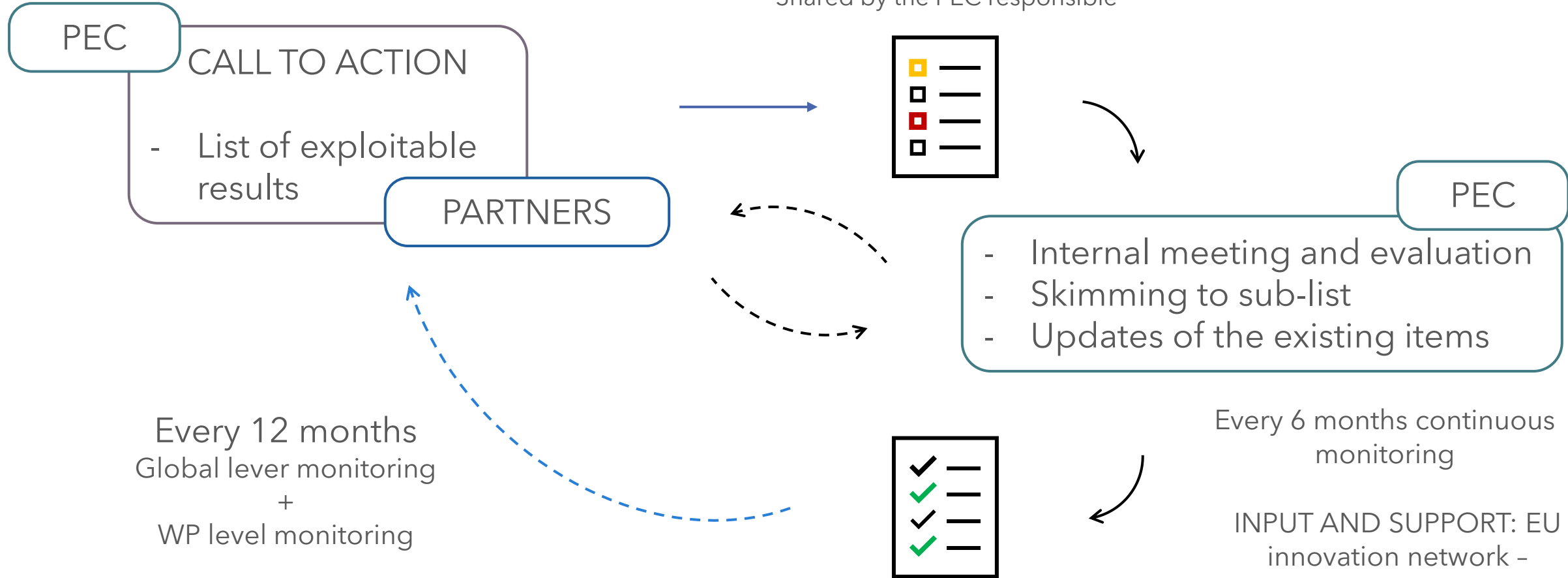


# Continuous IP monitoring WORK-FLOW



**PROMETEUS**  
preterm brain-oxygenation  
and metabolic eu-sensing

09/2024



# PROMETEUS - Preterm Brain-Oxygenation and Metabolic EU-Sensing: Feed the Brain

Grant Agreement Number 101099093



Thank you!



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# **Prometeus - Preterm Brain-Oxygenation and Metabolic EU-Sensing: Feed the Brain**

**Project meeting  
Girona 20 June 2024**

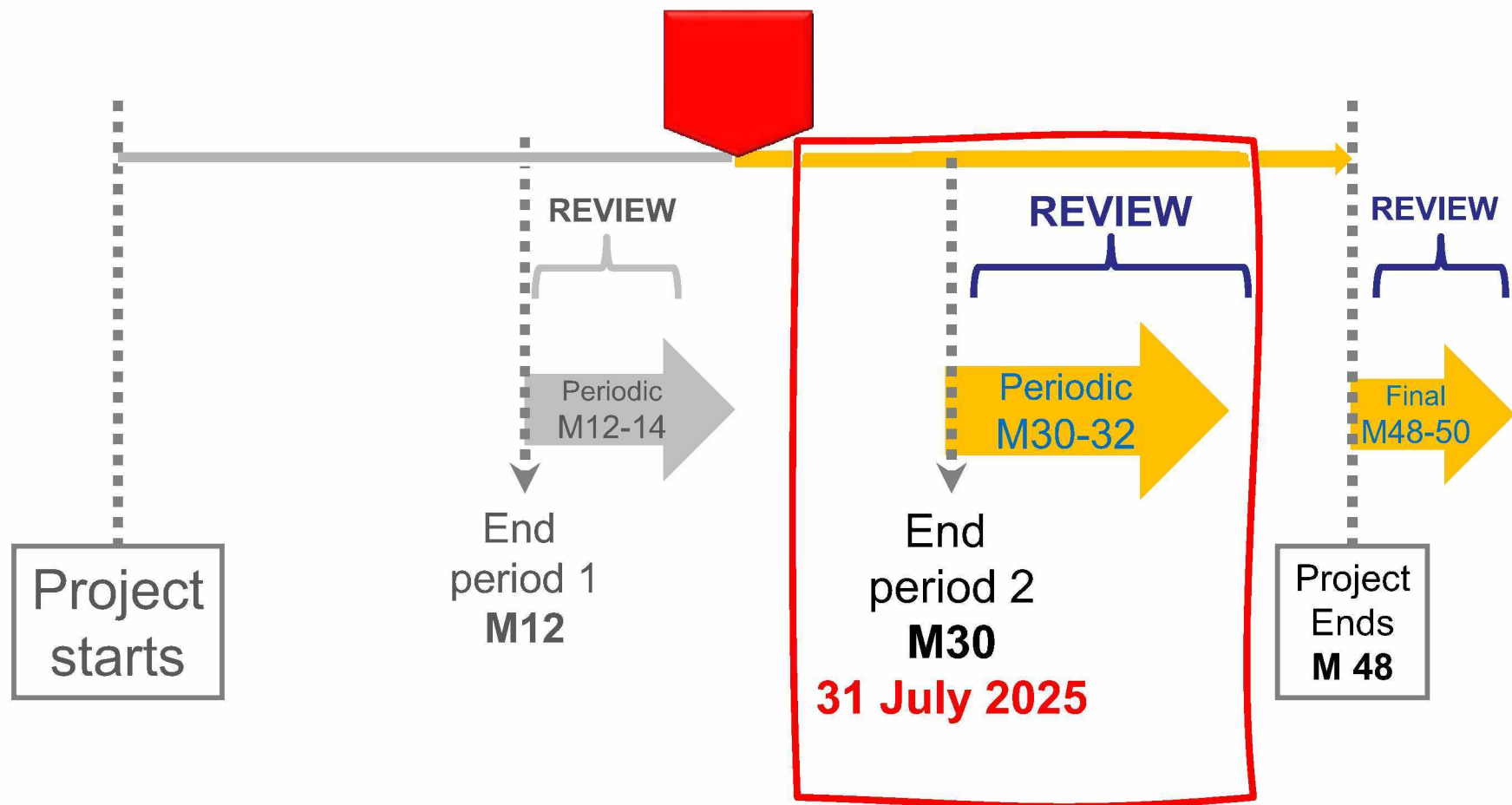
This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101099093

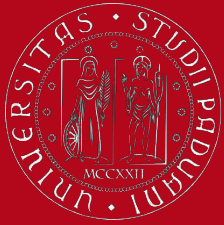


**Funded by  
the European Union**



- 1st report
- Upcoming monitoring





## Technical review:

- Good evaluation and some suggestions for future implementation
- Right to provide observations within 30 days after receiving the letter (1<sup>st</sup> July to Coordinator)

## Financial review:

- Some comments received and addressed through the 1° report
- Financial assessment will take place later on

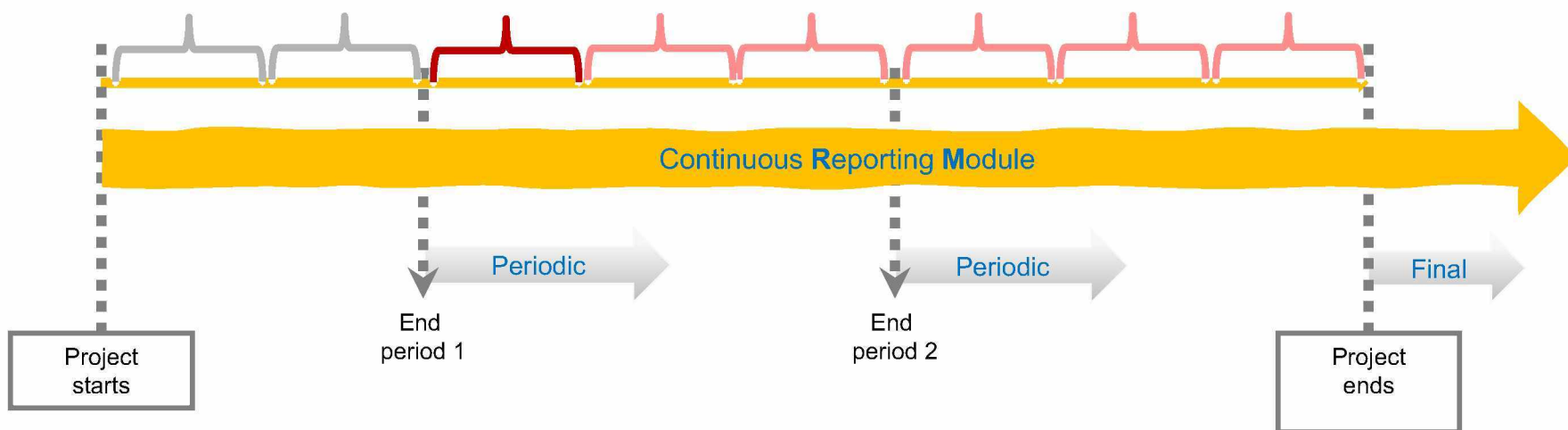
## Interim payment distribution:

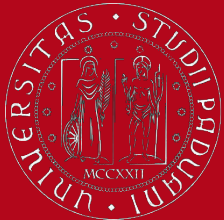
- Payments are suspended due to observations
- Upper ceiling 90% of total grant amount (- 5% MIM)




+ INTERNAL MONITORING

6 months





## + INTERNAL MONITORING

 <b>PROMETEUS</b> preterm brain-oxygenation and metabolic eu-sensing					
Preterm Brain-Oxygenation and Metabolic EU-Sensing: Feed the Brain - Prometheus					
GA n° 101099093					
Work progress					
Performed activities		Problems encountered		Deviations from plan	
Following months plan					
M1-M6	Partner full name (and acronym)				



## + INTERNAL MONITORING



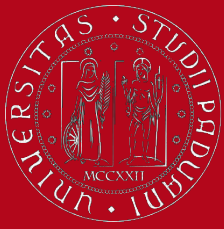
Internal continuous monitoring

Preterm Brain-Oxygenation and Metabolic EU-Sensing: Feed the Brain - Prometeus

GA n° 101099093

### Budget overview

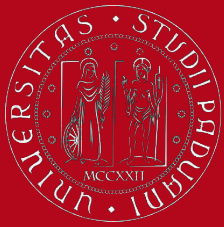
Participant			Type of expenditure	Budget [€]	Actual costs [€]								Total	% of total	Remaining [€]
#	Name	Total PM			M1-M6	M7-M12	M13-M18	M19-M24	M25-M30	M31-M36	M37-M42	M43-M48			
1	PARTNER ACRONYM	N. MONTHS	Personnel costs										€ -	✓ #DIV/0!	€ -
			Subcontracting										€ -	✓ #DIV/0!	€ -
			Other direct costs										€ -	✓ #DIV/0!	€ -
			Indirect costs										€ -	✓ #DIV/0!	€ -
			<b>Total costs</b>										€ -	✓ #DIV/0!	€ -
			<b>Total EC Contribution</b>										€ -	✓ #DIV/0!	€ -



## + INTERNAL MONITORING

Effort overview													
Participant		Total PM budget	WP	M1-M6	M7-M12	M13-M18	M19-M24	M25-M30	M31-M36	M37-M42	M43-M48	Tot	Rem
#	Name												
1	ACRONYM	N° OF TOTAL P/M BUDGETED	WP1 Brain oxygenation and perfusion (neo-opticap)									0	0,00
			WP 2 Continuous Metabolic Monitoring (wearable sensor)									0	0,00
			WP3 Metabolic Model and neonatal in silico avatar									0	0,00
			WP4 Prometheus Nutritional Clinical Advisor (NCA)									0	0,00
			WP5 Cloud-based platform (digital cloud twin)									0	0,00
			WP6 First in human									0	0,00
			WP7 The social culture of preterm birth									0	0,00
			WP8 Management, dissemination, exploitation and communication									0	0,00
			Total									0	#VALORE!





## + INTERNAL MONITORING

### 5.2 Use of resources

- A) Planned and Actual Person-Months per WP per Partner for the Specific Reporting Period and Actual Person-Months per WP per Partner relative to the overall project effort" Please provide the percentage of the PM spent in the current reporting period with respect to the total PMs.
- B) "Planned and Actual Other Direct cost per WP per the Specific Reporting Period and Actual Other Direct cost per WP per Partner relative to the overall project effort". Please provide the percentage of the overall budget spent in the Reporting period with respect to the total budget.

	WP	% Planned for RPX	% Used for RPX	Deviation from planned to used for given reporting period	% Used of planned for entire period
Partner A	Wp1				
	WP2				
	Total				



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**Thank you for your attention**