

Work Packages for the 2nd Innovation Connections Application: DRAFT

Phibion Pty Ltd and the University of Queensland

If both parties are able to secure the 2nd round of Innovation Connections funding from the Commonwealth of Australia, University of Queensland will perform all four work packages (WPs) in the description below for a budget of AU\$100,000 (Exc GST) in the first 12 Months. It is the clear intention of the participants to develop a work plan to continue the project for another 3 years with the aim to finalize and commercialize the newly developed contactless dielectric antenna system and data processing techniques.

Within the first project funded by the Innovation Connections (IC) Programme (2019-2020) the concept of measuring dielectric permittivity non-invasively from a MudMaster was proven. In this connection, an HF antenna for contactless dielectric measurements has been developed and tested. Based on numerical simulations with variation of the surface topology and permittivity a calibration procedure for the antenna was developed and a dataset produced based on computational simulations that was used to train a Neural Network for analysing measurements with the antenna. For completing the proof-of-concept, the antenna and the analysis system were tested during a large-scale test at the premises of Phibion Pty Ltd. Water content and density of the material under test (soil from the Port of Brisbane) could be quantified during the test.

Based on the outcomes of the first IC project in form of the antenna and the analysis procedure using the Neural Network, the aim of the second project is to further develop this antenna concept to an operational prototype and to bring it into operation on a selected mine site in Queensland. For this purpose, the proposed contactless dielectric measurement system will be integrated on Phibion's Mud-master vehicle for the purpose of evaluating the density and water saturated condition of tailings.

The focus of the second IC project is to further develop the established concept of a non-invasive measuring system to an operational prototype. Any necessary modifications and further developments of the antenna design and the analysis procedure needs to be the subject of the follow-up ARC Linkage Project.

The following research and development activities will be carried out in the second one-year IC project:

WP 1: Merging of antenna and VNA, and assembly of the system on the MudMaster (Brisbane)

Key Activities (with dates and location(s) for implementation):

1. Kick-off meeting of the 2nd IC project with clarification on how the assembled antenna system will be installed on the MudMaster. Special attention needs to be given to minimizing soiling of the antenna and risk of damaging it. Furthermore, the antenna system needs to be movable to allow calibration at different distances to the absorber. A possible solution for implementing this step is already available at Phibion (02/04/2021, Phibion).
2. Development of a concept to merge antenna and vectorial network analyser (VNA) and manufacturing of a housing to hold both items in a vibration proof way. The specialised housing can be produced at the workshop at UQ by 3D printing (by 14/05/2021, UQ).
3. Performance test of the antenna system under controlled laboratory environment conditions and development of a continuing measuring mode for the VNA using a Python code controlled by a conventional PC (25/06/2021, UQ).
4. Mounting of the antenna system on the MudMaster including wiring and integration of the antenna system into the measuring system existing for the MudMaster (23/07/2021, Phibion)

Expected Outcomes:

- Design of a mounting system for the antenna system on the MudMaster.
- Housing for the assembly of antenna and VNA to create an antenna system.
- Control software based on Python for continuous measurements using the antenna system.
- Antenna system integrated on the MudMaster in a ready to operate condition.

Dates: Start date: 1 April 2021; End date: 31 July 2019

WP 2: On-site calibration procedure for antenna and material (Brisbane)

Key Activities (with dates and location(s) for implementation):

1. Design, purchase and preparation of absorbers that can be easily transported and laid out for calibration measurements in the field (by 30/07/2021, UQ).
2. Development of a calibration procedure for lay operators accommodating different distances between antenna system and absorber. The measuring system needs to allow for the implementation of a single measurement to be marked as calibration measurement (by 27/08/2021, Phibion).
3. Development of an on-site measuring procedure for lay operators for quantifying water content and density. Both data are then used to quantify the expected permittivity based on calibration functions measured in the laboratory (by 27/08/2021, UQ).
4. Test of calibration procedures for antenna and material at the Port of Brisbane or at the premises of Phibion including operation of the MudMaster with operating antenna system (by 24/09/2021, Port of Brisbane/Phibion)

Outcomes:

- Transportable absorbers for conducting on site calibration of the antenna system while mounted on the MudMaster.
- Simplified on site material calibration procedure.
- Full-scale test of the antenna system and calibration procedures at the Port of Brisbane/Phibion.

Dates: Start date: 1 April 2021; End date: 30 September 2021

WP 3: Library of calibration functions for tailings materials (Brisbane)

Key Activities:

1. Decision within a meeting with Phibion what locations at the mine site need to be characterised and how and in which form measuring data will be stored (by 23/07/2021, Phibion).
2. Development of a testing procedure to effectively measure dielectric spectra of tailings materials over a broad frequency range with quantification of water content, density, mineralogy and grading (by 23/07/2021, UQ).
3. Implementation of tests with selected tailings samples from the mine site and further mines (number of materials to be decided on by 23/07/21) provided by Phibion with integration of measurement results in a data system (until end of project, UQ/Phibion).

Outcomes:

- Procedure for effective measurement of dielectric data for tailings.
- Database of the electromagnetic parameters of tailings and basic soil parameters.
- IP protected, and a next-stage development and commercialization plan is proposed.

Dates: Start date: 1 April 2021; End date: 31 March 2022

WP 4: Field test with data analysis

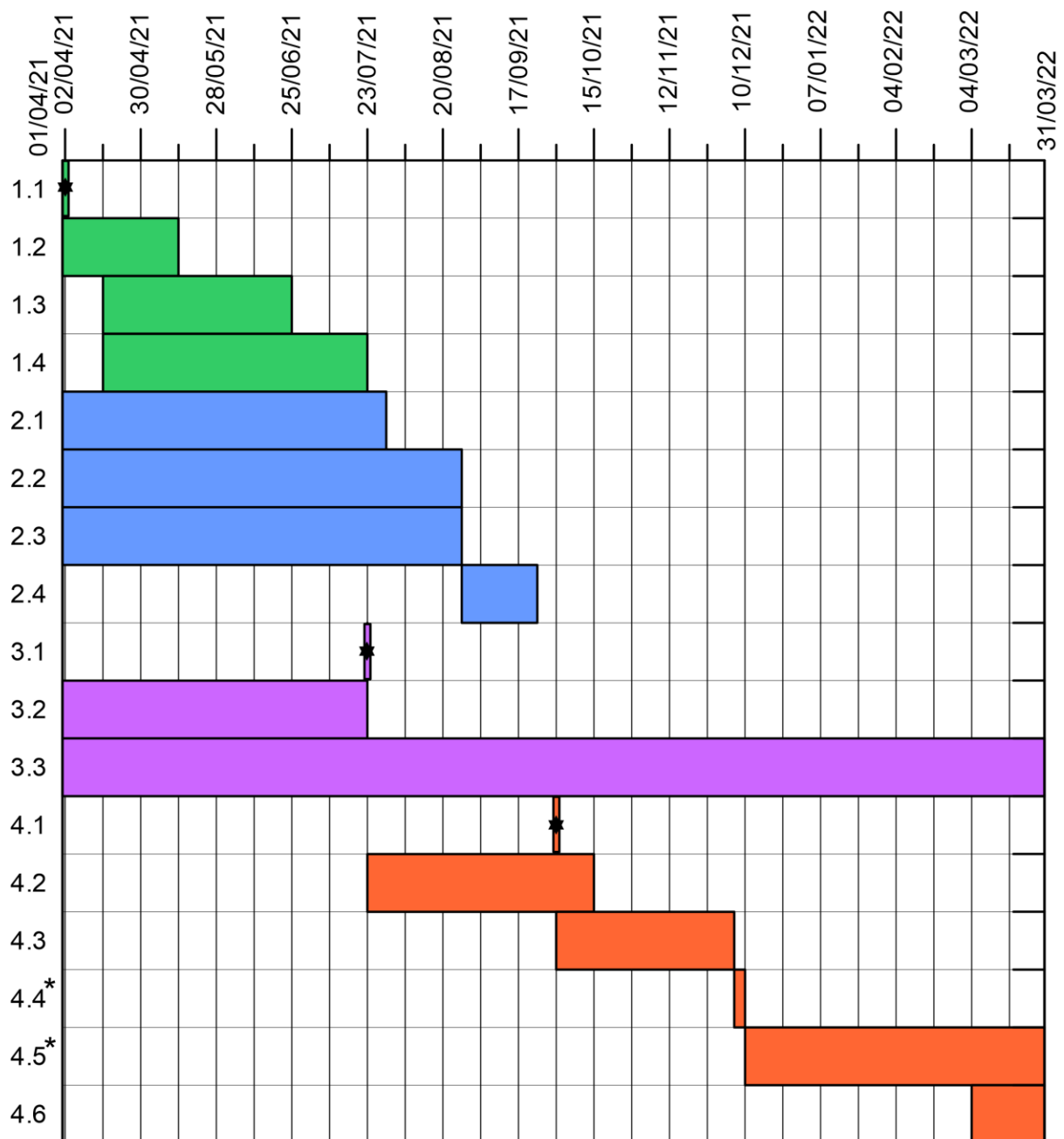
Key Activities:

1. Key milestone meeting to prepare field application of the antenna system at a selected mine site in Queensland (01/10/2021, Phibion).
2. Development of a protocol to be implemented regularly by operators of the MudMaster including quality and functionality check, and calibration procedures (by 15/10/2021, UQ/Phibion).
3. Training of the operators of the MudMaster into operation of the measuring system including checking protocol and calibration procedures for antenna system and material (by 06/12/2021, Phibion/Port of Brisbane/Mine Site).
4. Visit of mine site (ca. one week) at the beginning of operation to ensure correct and smooth operation of the antenna system. If required, the mounting system needs to be delivered to mine site, and the antenna system needs to be mounted to the MudMaster on site (06/12/2021 to 10/12/2021, mine site).
5. Operation of the antenna system with ongoing analysis of the incoming measurements (until end of project, UQ/Phibion/mine site).
6. Analysis of the learnings from the mine site operation to identify shortcomings and needs for further development (at the end of the project/Phibion).

Outcomes:

- Training procedure for lay operators for handling of the antenna system and implementation of calibration.
- Identification of shortcomings and preparation of improvement suggestions.

Dates: Start date: 1 October 2021; End date: 31 March 2022.



*working packages involving operation at mine site ★ key meetings