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DEPARTMENT OF AGRICULTURAL ENGINEERING

Development and first tests of a system for the automatic identification of operating machines based on RF technology.

Aldo Calcante[1], Fabrizio Mazzetto[2]

[1]Università degli Studi di Milano – Department of Agricultural Engineering
[2]Free University of Bozen – Faculty of Science and Technology

Introduction

(NRC USA, 1999)

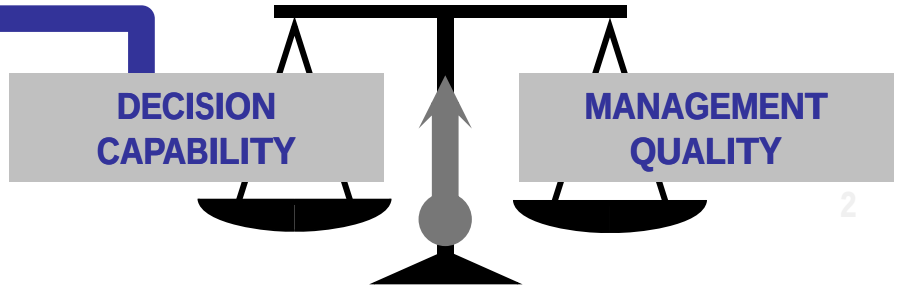
PRECISION FARMING (PF) IS A MANAGEMENT STRATEGY THAT COLLECT DATA FROM MULTIPLE SOURCES AND USE THEM TO TAKE DECISIONS RELATED TO FARM PRODUCTION ACTIVITIES

PF is firstly a MANAGEMENT STRATEGY…

FARM PRODUCTION ACTIVITIES

- ARABLE
- LIVESTOCKS
- VITICULTURE
- ORTICULTURE

DECISION MAKING PR. BASED ON TARGETED INFORMATION



The Operative Monitoring (1)

Monitoring operative conditions is one of the most important aspects of modern agricultural management. This in order to improve the efficiency of the data collection procedure and to improve the precision with which agricultural operations are managed.

The subsequent management of the collected data, which is realised via **farm management information system (FMIS)**, allows the farmer to process and store the data using models and databases, depending on the type of decisions required from farm management, and to convert data into information for use in decision making.

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The Operative Monitoring (2)

Recording of all ACTORS involved in the mechanized operation

The measurement of PHISICAL EFFECTS occurring during the event

What?
Where?
Who?

How?

NECESSITY TO AUTOMATE THE OPERATIVE MONITORING

IDENTIFICATION SYSTEMS

SENSORS

FIELD DATALOGGERS

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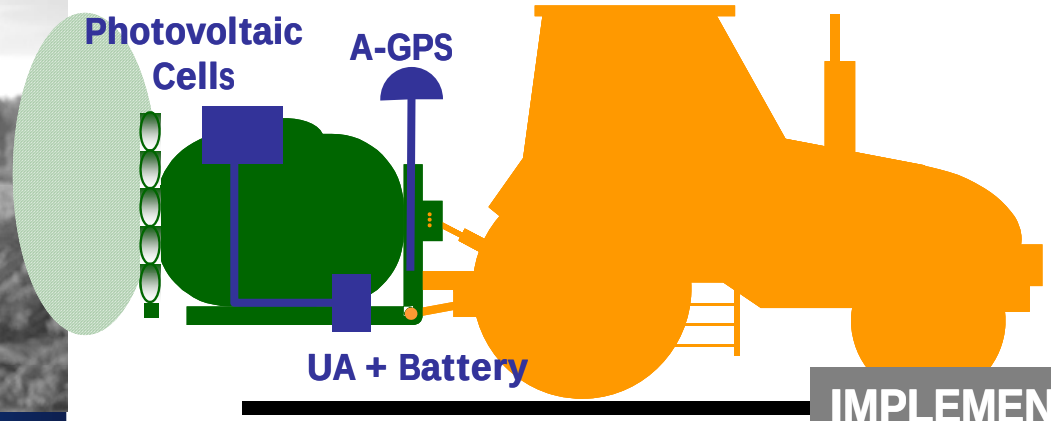
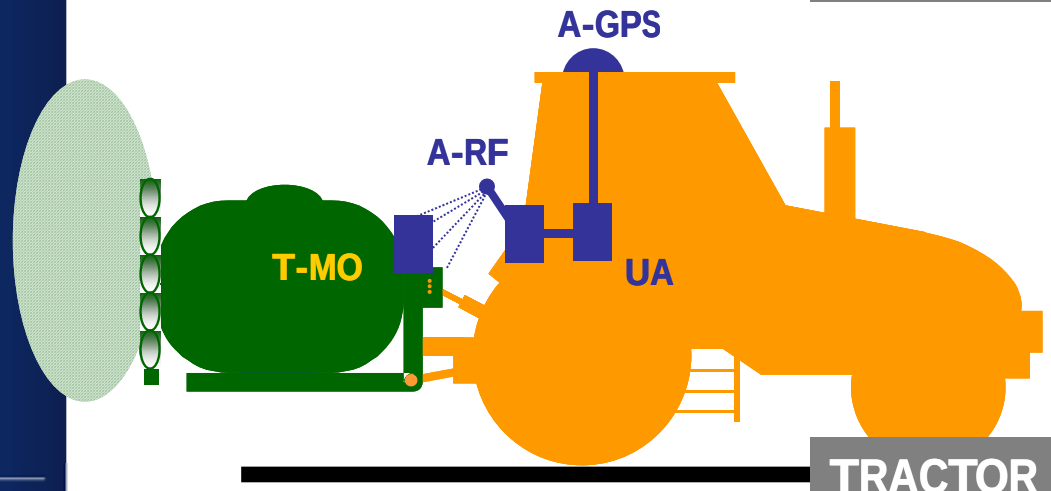
The basic architectures

Problem: to supply the electric power for the monitoring system



Monitoring system installed on board of specific operating machines.

IMPLEMENT - ORIENTED



Monitoring system installed on board of tractor.

TRACTOR - ORIENTED

THE BASIC ARCHITECTURES

Problem: to identify the operation

The inference engine

Automatic identification of the events associated to field activities and determined from the knowledge of:

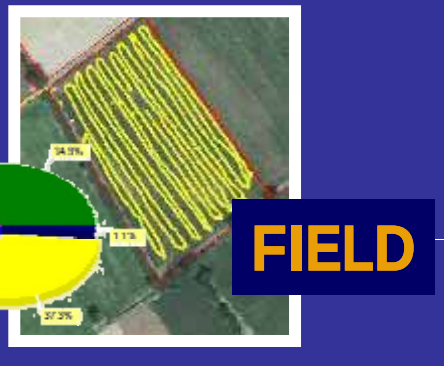
1. *Tractor*; **2.** *Operating Machine*; **3.** *Field*;

4. *Specification of work*

Automatic update of the FMIS

+

+



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DETAILS OF WORK

The identification of the Operating Machines

Optical systems (bar code, infra-red lectures)

Expensive

not suitable for work in a dusty/dirty workplace

Transponders (passive and active)

Expensive

they require a large receiver antenna on the tractor

Connections by wire

Expensive (es. ISOBUS)

they are subject to breakage and

they are subject to accidental or intentional forgetfulness by the farmer

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Materials and Methods

Radiofrequency systems

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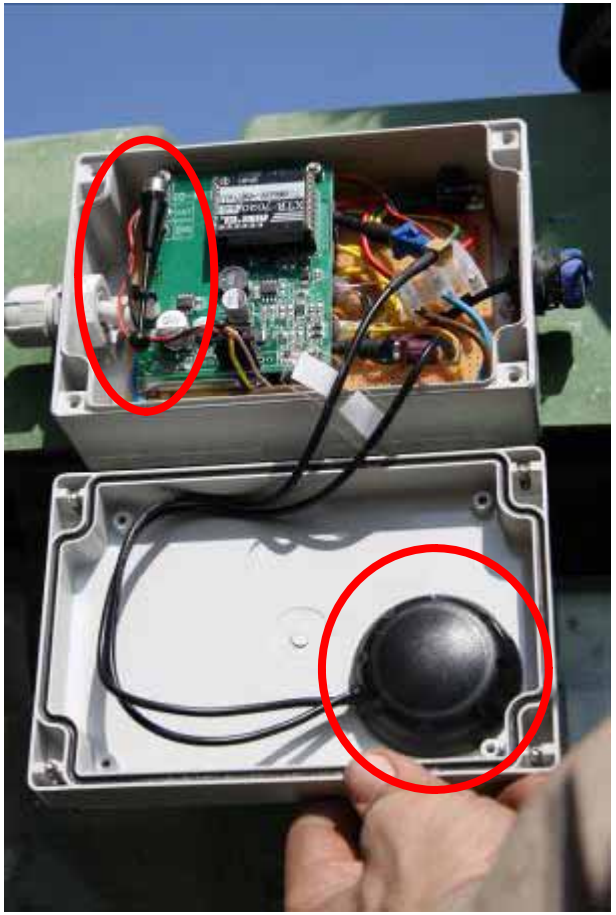
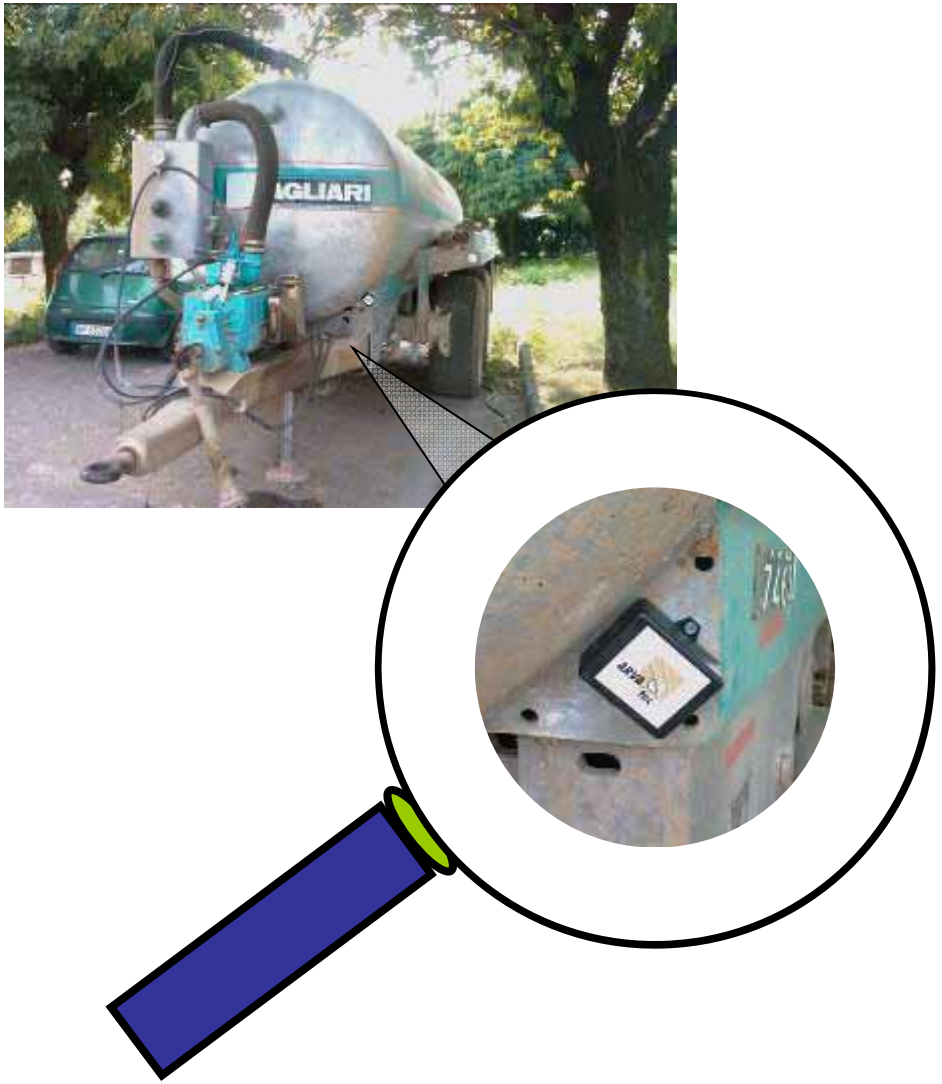
Operative objective:

- To allow, in the operative monitoring context of field mechanized activities, the automatic recognition of the operating machine coupled to the tractor. This in order to identify, without ambiguity, the work carried out;
- this is made possible through the transmission of an univocal numeric code generated from a radiofrequency system installed on-board of the operating machines.

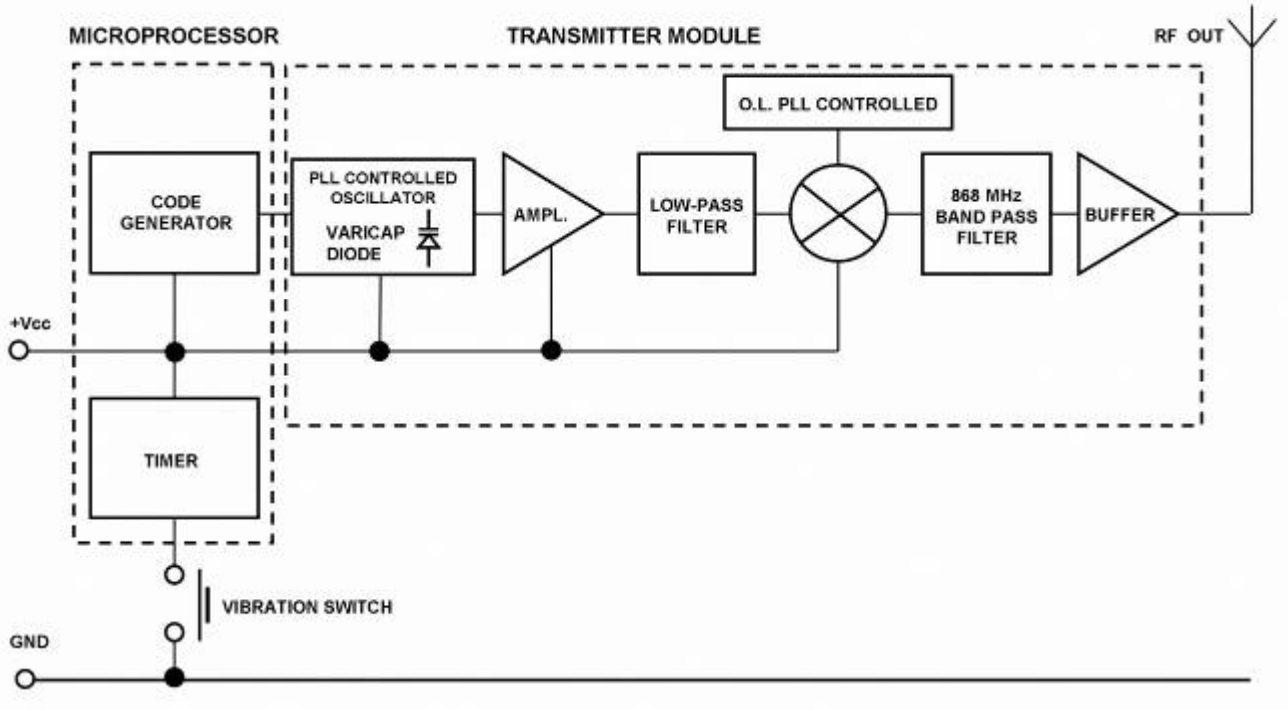
Materials and Methods

The developed hardware





Materials and Methods



Power supply : 3.6 V

Frequency band: 868-870 MHz

Modulation: FM-FSK

Code: 10 alphanumeric charachters

Ex. set(mo='CCCCCCCCCC,B')

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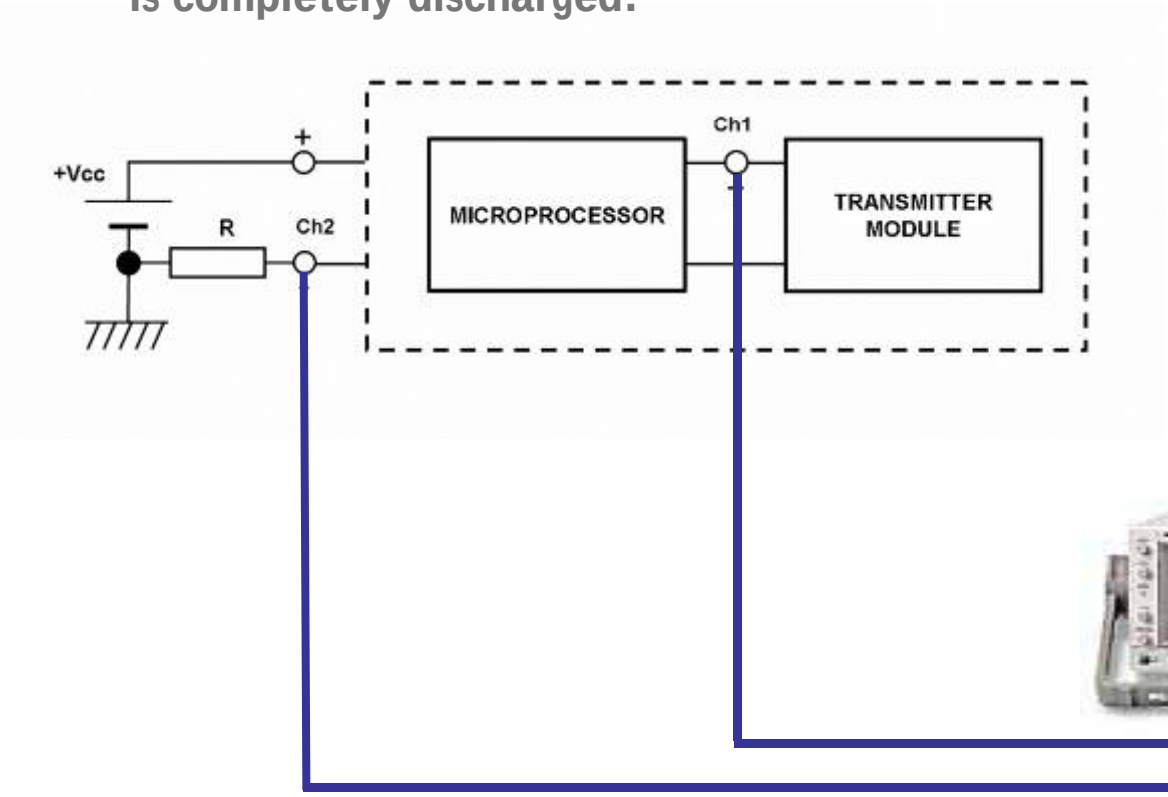
Materials and Methods: the lab tests

Aim of lab tests:

1) to evaluate the effective energetic absorption of the transmitting devices at two different power levels: PW 0 and PW 1 in order to estimate the life of the transmitter;

2) evaluation if it is a more convenient to substitute only the battery or if it is more efficient to replace the entire transmitter when the battery is completely discharged.



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Materials and Methods: the field tests (1)

Location of the receiver device on board of a John Deere tractor:

A) on the left mudguard,

B) at the top of the cabin

C) on the front part of the engine's hood

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Materials and Methods: the field tests (2)

- The field tests were conducted on a level field on which was traced a **1m x 1m** virtual grid, with the tractor positioned in the centre.
- The transmitter was placed at two height on a topographic stake : **0.8** and **1.6 m**.
- Through the manual registration of all the coordinates in which the code was correctly received, it has been possible to graphically realise the **2D-beam power patterns** related to every height of the transmitter with respect to the soil and for every location of the receiver device on board the tractor.

The virtual grid

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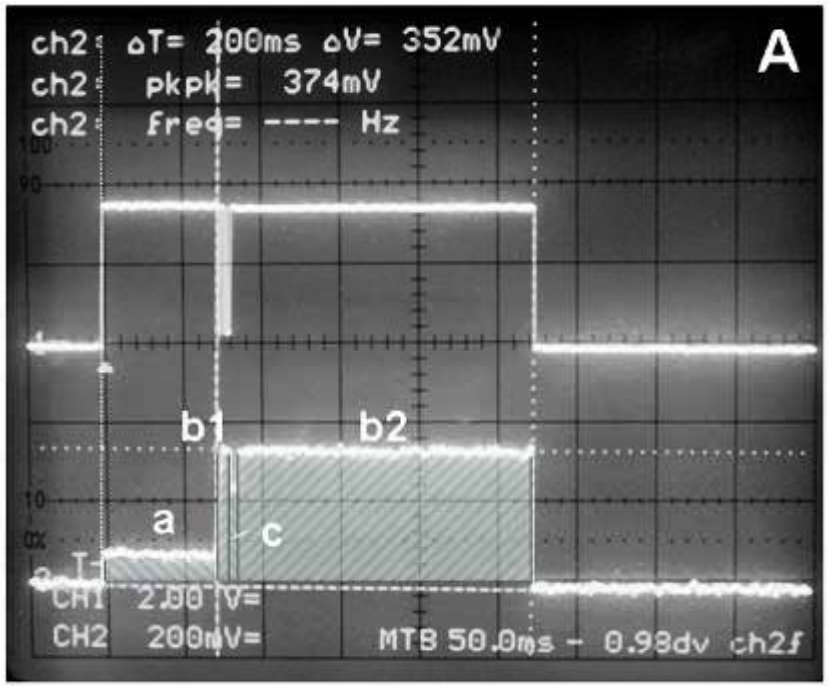
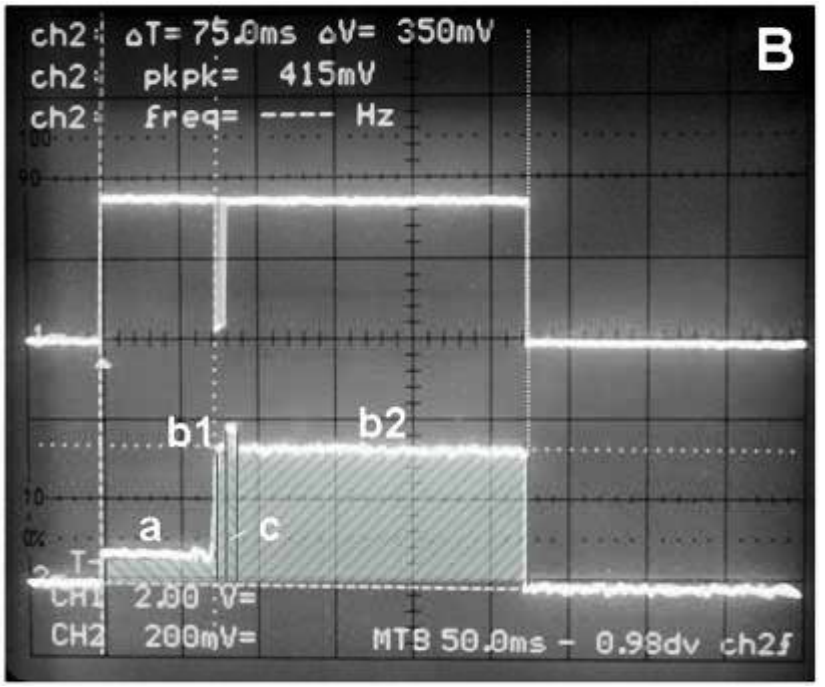
Results and discussion: the lab tests





Power absorption at POWER LEVEL 0:
7.63 mAs

Power absorption at POWER LEVEL 1:
7.70 mAs

2 code/minute

10 h/day for 90 days/year

9 years

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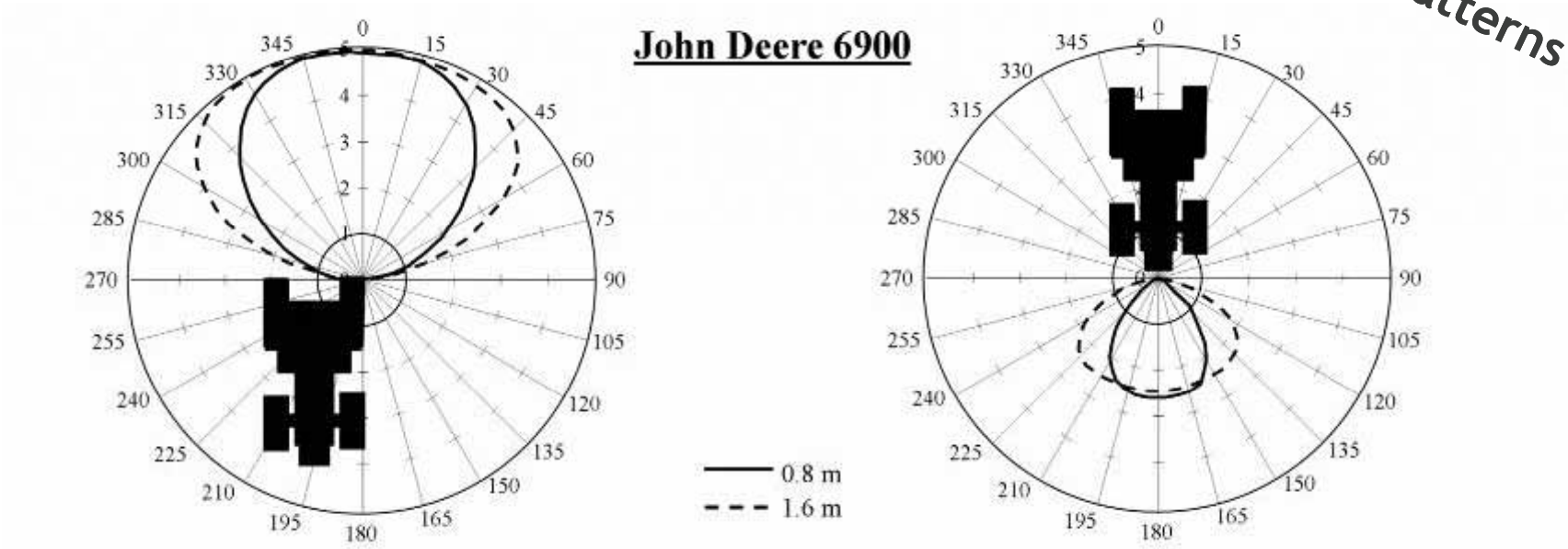
Results and discussion: the field tests

POWER LEVEL: PW 0

2D-power beam patterns



Two receivers to identify front and rear coupled operating machines

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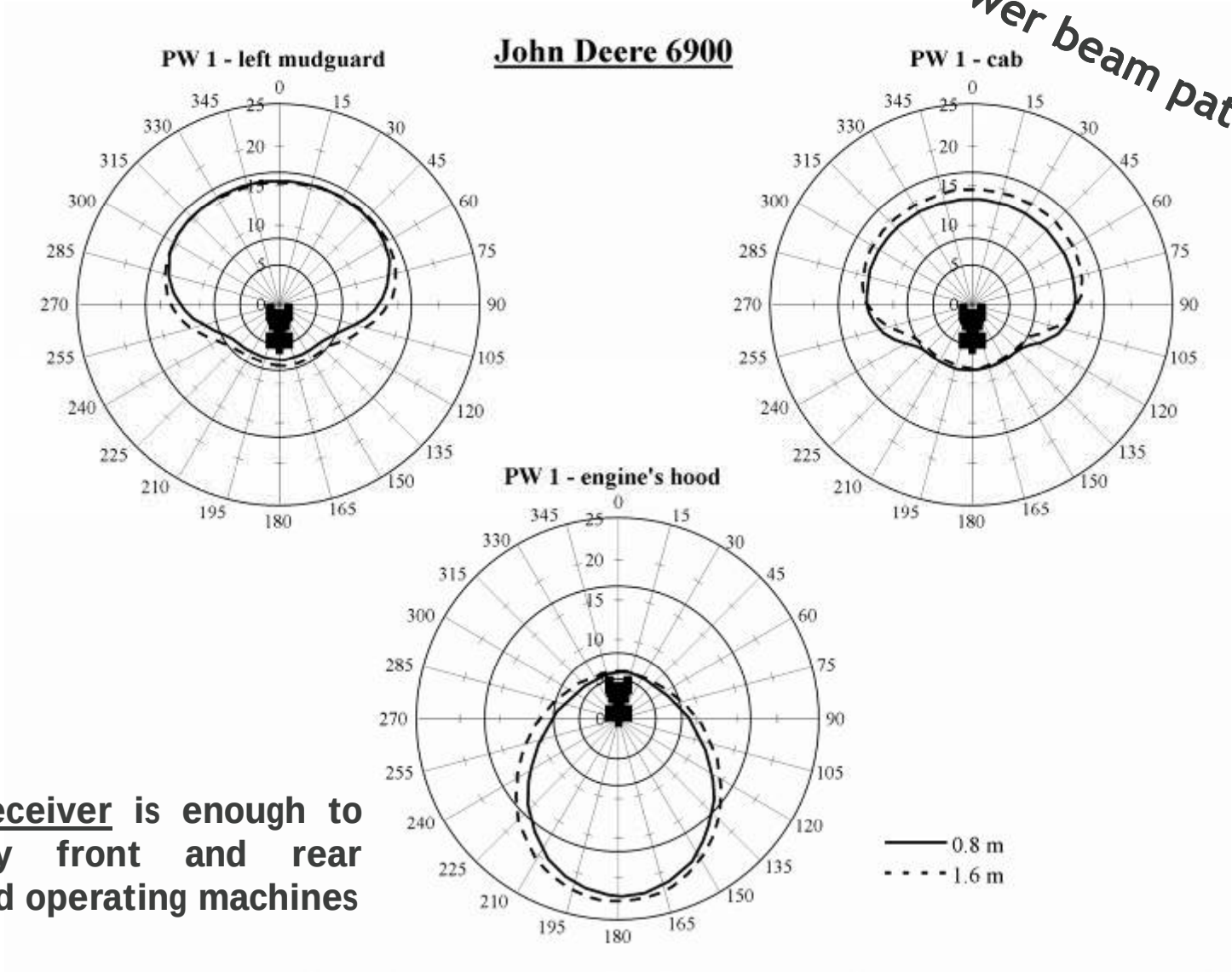
Results and discussion: the field tests

POWER LEVEL: PW 1

2D-power beam patterns



One receiver is enough to identify front and rear coupled operating machines

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Results and discussion

The measured data and their interpretation

842845f5-2ba6-481f-a52e-71d568508765	240310	090920.00	240310	090922.00	45.3257183333333	9.26746666666667	A	True		False			
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842845f5-2ba6-481f-a52e-71d568508765	240310	090851.00	240310	090852.00	45.3256566666667	9.267505	A	True	2.970	False	0000000019,0		
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Conclusions

- From the energetic point of view, adopting a vibrating sensor that only manages the circuit ignition when the operating machine is in its work phase should promote longevity in transmitter life;
- the solid technological level achieved contains the cost of production of a single transmitter (it is worthwhile to replace the entire transmitter when battery power is discharged rather than replacing only the battery);
- the identification process, based on a wireless connection, permits a flexible and reliable system that is able to work in all operative conditions;
- the configuration of the transmitter with a transmit power of PW 1 and the position of the receiver at the rear of the tractor cab allow the use of a single receiver to identify front and rear coupled machines;
- the influence of climate on real battery life remains unknown. To ascertain this, the transmitters installed on the operating machines that belong to the University of Milan's experimental farm are being evaluated.

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Thank you for your attention!
aldo.calcante@unimi.it
fabrizio.mazzetto@unibz.it

Functional typologies of FDL

Different typologies classifiable on the grounds of the following point of view:

- **ORGANIZATIONAL** — Domain of monitored events
  - PARTIAL
  - GLOBAL
- **OBSERVATION CAPABILITY** — Capability to recognize the monitored events
  - AUTONOMOUS RECOGNITION
  - ASSISTED RECOGNITION
- **ACTIVATION OF THE SISTEM** — Type of system activation
  - AUTOMATIC ACTIVATION
  - MANUAL ACTIVATION

The tractor-oriented architecture

Different levels of complexity