IDS
INGEGNERIA DEI SISTEMI S.p.A.

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DETECTOR DUO
USER MANUAL

DETECTOR DUO SYSTEM – User manual

Pisa, 12/02/2010

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KEY WORDS   GEORADAR, DETECTOR DUO, ANTENNA

SUMMARY   This manual contains a complete description of the Detector Duo radar system, detailing the assembly procedure, the correct use of the data acquisition software, the work procedure and the general operating procedures of the system.

Document Evolution		
Revision	*Data*	*Reason of modification*
Rev. 1.0	09/07/2009	First edition. It has been added a warning disclaimer and a new installation kit.
Rev. 1.1	12/02/2010	FCC Information updated

SW Versions covered by this manual
DETECTOR DUO V.02.00.000, 02.00.001, 02.00.006

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CONFORMITY TO EUROPEAN REGULATIONS

The equipment conforms to the following requirements set by EC regulations, including subsequent modifications, and to the legislation set by the member states that implement these regulations:

1999/05/EEC Radio Directive

Warning: this equipment is destined for use in industrial environments (Class A apparatus). In residential, commercial and light industry environments, this apparatus may generate radio interference: in this case, the user may be required to operate while taking appropriate countermeasures.

The apparatus is sensitive to the presence of external electromagnetic fields, which may reduce its performance.

$$C\,\epsilon$$

RADIO-FREQUENCY EXPOSURE COMPLIANCE

This product operated is usually operated at least 1 m from the operator.

Typical power density levels at a distance of 1 m or greater is below 1 $\mu W/cm^2$ (0.01 W/m^2) which are far below the levels specified by the current regulations.

Thus, this product pose no health and safety risk when operated in the normal manner of intended use.

![WARNING]	# CLEANING INFORMATION
! WARNING	Before cleaning any external parts of the apparatus, make sure that all cables have been disconnected, including the power supply cable. If a damp cloth is used, make sure it is not too wet, to avoid any damage to the electrical components of the equipment. Wait until the equipment is totally dry before reconnecting the cables.

The Detector Duo should be cleaned periodically using a damp cloth.

Do not use solvents or abrasive detergents.

Do not apply liquid directly to the electrical contacts of the various connectors. If a specific spray is used to clean the PC TFT monitor, make sure it is not flammable; ion any case, do not spray it directly on the screen, instead, spray it onto the cleaning cloth. |

BATTERIES REMOVAL INFORMATION

Laptop Batteries:

Manufacturer: PANASONIC

Type: Li-ion Ni

Characteristics: 10.65V 5.7Ah

Removal instructions:

1. turn off the laptop;
2. open the drawer with the symbol of the batteries;
3. extract the battery pack pulling the tab.

Radar batteries:

Manufacturer: FIAMM FG21202 / SAFT MP176065

Type: rechargeable lead acid / rechargeable lithium-ion

Characteristics: 12V & 12Ah / 15V & 6.8Ah

Removal instructions:

1. disconnect the battery from the instrument:
   a. pull the connector wings;
   b. separate the connectors;
2. remove the battery from the cover (optional) opening the strap.

RECICLYING

The crossed out wheeled bin symbol shown on the equipment indicates that the product must be recycled separately from other waste at the end of its useful life.

Separate waste disposal of this product at the end of its useful life will be organised and managed by IDS. When you decide to dispose of the equipment, contact IDS and follow the system that IDS has set up to permit the separate collection of the apparatus at its life end.

Adequate separate collection for its subsequent recycling, treatment and environmental friendly disposal contribute towards avoiding any unnecessary effects on the environment and to health and favour the reuse or recycling of the materials that make up the equipment. Unauthorised disposal of this product as unsorted waste by its possessor will lead to an administrative penalty foreseen by national regulations.

WARRANTY CERTIFICATE CONDITIONS

1) IDS Ingegneria dei Sistemi S.p.A, hereinafter referred to as IDS, warrants hardware/software products for a period of 12 months from the delivery date to the original customer;

2) The delivery date is certified by the "Warranty Registration Form";

3) IDS's hardware products will be free from defects in materials workmanship under normal use and service;

4) IDS's obligation is limited to repairing or replacing parts or equipment which are returned to IDS, without alteration or further damage, and which in IDS s judgment, were defective or became defective during normal use;

5) IDS' software will have to be installed on a PC according to the requirement of the IDS hardware (see IDS User's Guide the Software Data Acquisition);

6) IDS' s software products designed by IDS for use for IDS hardware products are warranted not to fail to execute their programming instructions due to defects during the warranty period, provided they are properly installed on IDS hardware products. IDS does not warrant if the IDS software will be used and operated in hardware and software combinations not selected by IDS;

7) IDS does not assumes any liability for any direct, indirect, special, incidental or consequential damages or injuries caused by proper or improper operation of its equipment whether defective or not defective;

8) This software may include automated data processing and analysis tools. While every effort is made to ensure the accuracy of the information provided by those tools, they must not be intended as a substitute for intelligent analysis; rather, they have to be intended as an advisor and the user must not completely rely on the results provided by them to give the complete answer. IDS assumes no liability for any direct, indirect special, incidental or consequential damages or injuries caused by such reliance on the accuracy, reliability, or timeliness of the information provided by those tools. Any person or entity who relies on information obtained from the automated data processing/analysis tools only, does so at his or her own risk;

9) IDS's warranty does not extend and shall not apply to:

    a) Products which have been repaired or altered by other than IDS personnel;

    b) Products which have been subjected to misuse, neglect, accident or improper installation;

    c) Products in which have been installed Hardware/Software accessories not supplied by IDS and/or without any approval by IDS;

    d) Products which have been connected to equipment different from the ones supplied by IDS (except the PC data Logger which must conform to IDS specifications;

    e) Products which have been damaged by natural disaster or calamities.

10) Before returning any equipment to IDS , you have to contact the IDS Customer Care Office that will authorize you to return the material to be repaired;

11) Once the parts/equipment to be repaired arrive to IDS, IDS may inspect the defective products to verify they are eligible for repair or replacement. All packing must be saved for inspection purpose in order to assist IDS to understand the cause of the defects. IDS, will not be obliged to repair, or replace for products returned as defective but damaged from abuse, misuse, neglicence , accident loss or damage in transit;

12) The final clients, is responsible for ensuring the defective products returned to be properly packaged;

13) The above warranty are sole and exclusive, and no other warranty, whether written or oral, is expressed or implied.

IMPORTANT NOTE FOR THE US CUSTOMERS

FCC ID: UFW-DETDUO-FW

This device complies with part 15 of the FCC Rules:

Operation is subject to the following conditions:

1. This device may not cause harmful interference, and

2. This device must accept any interference received, Including interference that may cause undesired operation

Warning: Changes or modifications to this unit not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

Operation of this device is restricted to law enforcement, fire and rescue officials, scientific research institutes, commercial mining companies, and construction companies. Operation by any other party is a violation of 47 U.S.C. § 301 and could subject the operator to serious legal penalties.

Coordination Requirements.

(a) UWB imaging systems require coordination through the FCC before the equipment may be used. The operator shall comply with any constraints on equipment usage resulting from this coordination.

(b) The users of UWB imaging devices shall supply detailed operational areas to the FCC Office of Engineering and Technology who shall coordinate this information with the Federal Government through the National Telecommunications and Information Administration. The information provided by the UWB operator shall include the name, address and other pertinent contact information of the user, the desired geographical area of operation, and the FCC ID number and other nomenclature of the UWB device. This material shall be submitted to the following address:

Frequency Coordination Branch., OET

Federal Communications Commission

445 12th Street, SW

Washington, D.C. 20554

ATTN: UWB Coordination

(d) Users of authorized, coordinated UWB systems may transfer them to other qualified users and to different locations upon coordination of change of ownership or location to the FCC and coordination with existing authorized operations.

(e) The NTIA/FCC coordination report shall include any needed constraints that apply to day-to-day operations. Such constraints could specify prohibited areas of operations or areas located near authorized radio stations for which additional coordination is required before operation of the UWB equipment. If additional local coordination is required, a local coordination contact will be provided.

(f) The coordination of routine UWB operations shall not take longer than 15 business days from the receipt of the coordination request by NTIA. Special temporary operations may be handled with an expedited turn-around time when circumstances warrant. The operation of UWB systems in emergency situations involving the safety of life or property may occur without coordination provided a notification procedure, similar to that contained in CFR47 Section 2.405(a)-(e), is followed by the UWB equipment user.

Notice: Use of this device as a wall imaging system is prohibited by FCC regulations.

IMPORTANT NOTE FOR THE CANADIAN CUSTOMERS

IC Certification Number: IC:8991A –DETDUOFW

This device complies with the requirements of IC Standard RSS-220

This Ground Penetrating Radar Device shall be operated only when in contact with or within 1 m of the ground.

This Ground Penetrating Radar Device shall be operated only by law enforcement agencies, scientific research institutes, commercial mining companies, construction companies, and emergency rescue or firefighting organizations.

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1. INTRODUCTION

The Detector Duo is an innovative system capable of detecting tubes and both metallic and non metallic cables buried underground.

Following standard radar principles, the Detector Duo uses a high performance electromagnetic sensor equipped with e.m. transmitters and receivers.

The fundamental characteristic of this system is the simultaneous use of two frequencies, permitting the identification of both shallow and deep utilities at the same time.

The groundbreaking control unit is extremely compact and lightweight at just 1 Kg , and is compatible with 2 ATS antennas with frequencies of 700MHz and 250MHz located in a single container. The simplicity of this instrument means that a brief training course is sufficient to permit it to be used correctly.

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Tab. 1.1 – Contact addresses for technical and sales assistance

The simple acquisition software and automatic data saving procedures operate well on both Windows 2000 Professional and Windows XP Professional. For details on the required characteristics of the notebook PC, see Paragraph 5.1.

From an operative point of view, the Detector Duo can perfectly adapt to all applications for pipe and cable detection in a typical roadworks environment, both over smooth and rough ground.

Contact IDS Georadar Division directly for all technical and commercial assistance.

1.1 Scope

This document describes how to use the Georadar Detector Duo, including both its hardware and software components.

1.2 Trademarks

❑ WINDOWS 2000 PROFESSIONAL /WINDOWS XP PROFESSIONAL	Microsoft Corporation
❑ DETECTOR DUO	IDS Ingegneria dei Sistemi S.p.A.

1.3 Acronyms and Definitions

1.3.1 Acronyms

DETECTOR DUO: double antenna digital pipe detection system.

1.3.2 Definitions

Antenna trolley: a unit that holds all the equipment necessary for acquisition in the field.

Centerpoint : the ideal point of the trolley, situated in the center of the box containing the antennas; it represents the starting point for all scans.

Data processing: this is applied to the raw data to permit the acquired sections to be viewed in a comprehensible way.

Field survey: a group of field acquisitions relating to a single survey.

Handle: a extractable handle is gripped by the operator to move the antenna trolley**.**

Maps: graphics showing the change in received radar signal (signal intensity in gray scale) with respect to the scanning direction.

Position sensor: a distance measurement device fixed inside one of the trolley wheels, which constantly signals the distance travelled from the start of the scan back to the Control Unit .

Raw data: unprocessed data obtained during a field survey.

Receiver : part of the antenna dedicated to detecting the signals. It is lodged in the same container as the transmitter.

Scan*:* a single movement of the antenna trolley from the beginning to the end of a pre-established path

Setup: initialization of a piece of equipment or a software process.

Survey: the name given to a collection of scans, which together cover all the areas of a large investigation: typically an entire town or a large urban area

Transmitter: part of the antenna dedicated to emitting the radar signals. It is lodged in the same container as the receiver.

Utilities: the objects the Detector Duo searches for, i.e. pipes supplying gas and water, electricity cables, etc.

2. OVERVIEW

2.1 How to use this manual

This Detector Duo user manual is subdivided as follows:

- Chap. 1: Introduction.
- Chap. 2: Overview.
- Chap. 3: User guide.
- Chap. 4: Assembly procedure.
- Chap. 5: The acquisition software.
- Chap. 6: Work procedure flowchart.
- Chap. 7: How to use Detector Duo.

2.2 Background knowledge required

The following background knowledge is required to be able to use Detector Duo:

➢ Windows 2000 Professional or Windows XP Professional operating system.

For any difficulties with this aspect, the user should make reference to publications available on this topic or to the manual provided with the system.

3. USER GUIDE

3.1 Description of the hardware

The Detector consists of the following parts (see Fig. 3.1):

- DAD DECT DUO Control unit(1).

- Two wheeled trolley used to move the system (2).

- Power cable (3).

- Inverted network cable (4).

- Antenna Box - Control Unit connection cable (5).

- Position sensor connection cable (6).

- Position sensor (7).

- Detector Duo Antenna (8).

- 12V lead battery (see Fig. 3.8) (9) .

- Notebook computer (10) (see specifications in paragraph 5.1).
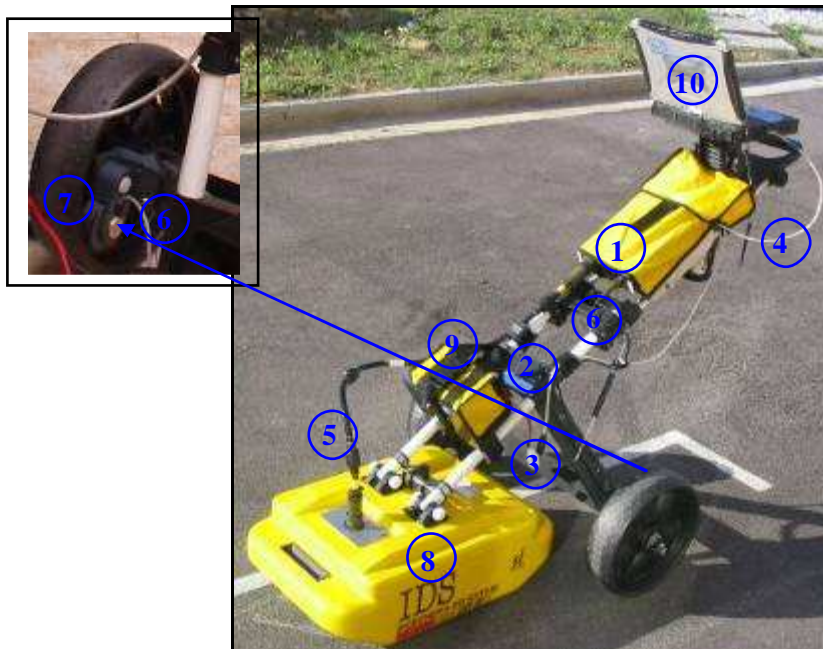
**Fig. 3.1 – Overview of the Detector Duo and its components**

3.1.1 The Detector Duo Control Unit

The control unit has the following main functions:

➢ To communicate with the antenna.

➢ To communicate with the notebook computer.

➢ To pilot the position sensor.

The control unit (Fig. 3.2) is fitted with the following connection ports:

➢ ***Position sensor** port (4)*: the position sensor is connected to the control unit using the specific cable. This port is marked as WHEEL.
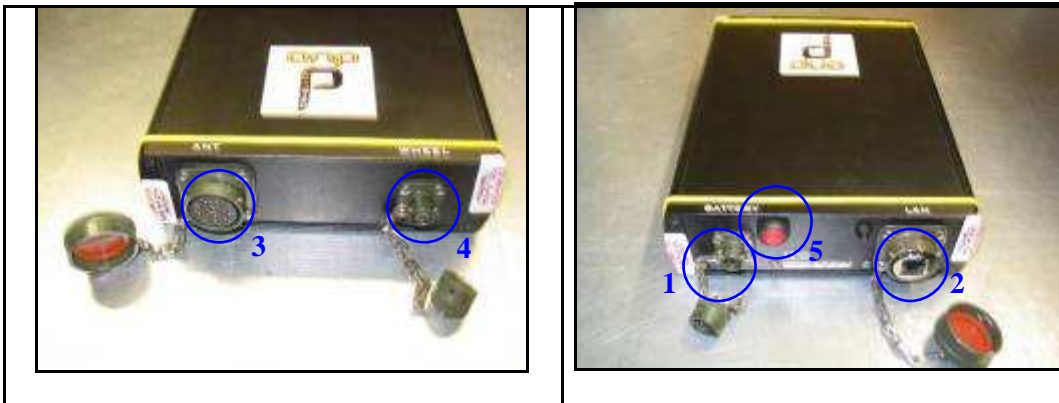
Fig. 3.2 – The Control Unit

➢ ***Antenna** port (3)*: using the cable shown in Fig. 3.3, this connects the Control Unit to the antenna. It is marked as ANT.1.

Fig. 3.3 – The Antenna-Control Unit connection cable

> *Network port (2)*: a inverted network cable (Fig. 3.4) connects the control unit to the notebook PC. This port is marked LAN.


Fig. 3.4 – The inverted network cable

Power supply port (1): this connects the battery to the Control Unit using the power supply cable (Fig. 3.5).

Fig. 3.5 – The power supply cable

> *On button (red – 5) with spy light (blue - 6)*: pressing this button starts up the entire system. A blue spy light switches on automatically when the button is pressed and indicates that the system is being powered (Fig. 3.2).
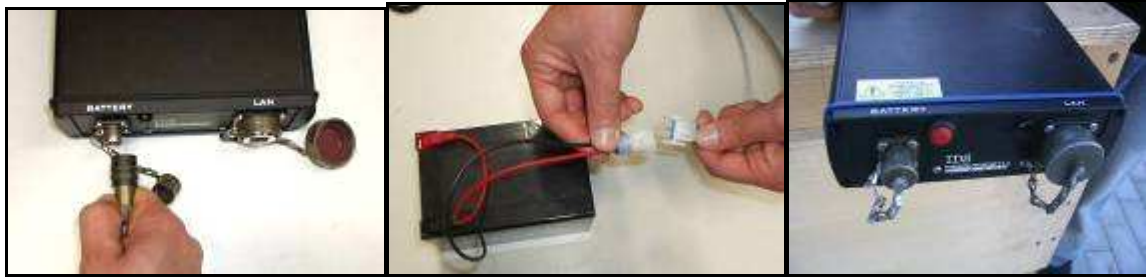
Fig. 3.6 – Battery cable connection for the notebook PC and the DAD, switch on button (red)

Press the red button to switch on the DAD control unit (Fig. 3.6). This button has to be kept pressed until the blue on switch lights up. If the DetectorDuo software is not activated within 30 seconds, the indicator light will start to flash. As soon as the DetectorDuo software is activated the indicator light stops flashing and appears a constant blue light. If, however, the Software is not activated within about 2 minutes 30 seconds, the DAD unit will automatically shut down. Once the DetectorDuo software has been shut down, the indicator will flash for about 30 seconds and will automatically shut down after 2 minutes.

GENERAL CHARACTERISTICS OF THE CONTROL UNIT	
NUMBER OF CONNECTABLE ANTENNAS	2
VOLTAGE	12V +/- 10%
ENVIRONMENT FEATURES	IP65
PANEL CONNECTORS	LAN, BATTERY, ANT.1, WHEEL
ABSORBED POWER	8W (1 antenna)
OPERATING TEMPERATURE	-10 / +40 °C

Tab. 3.1 – Control Unit characteristics

3.1.2 The antenna box

The detector duo system can be used with the box containing two antennas, one with a frequency of 700MHz and the other with 250 MHz (see Fig. 3.7):
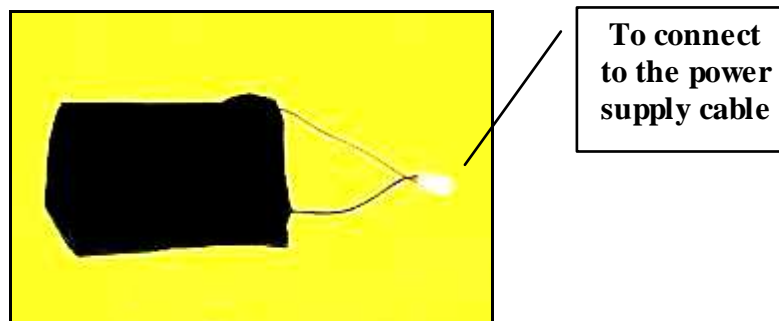

Fig. 3.7 – IDS ATS DUAL 250-700 antenna box

NOTE: it is also possible to connect the DAD to one of the two ATS single frequency models at 250MHz or 700MHz.

3.1.3 Power supply

The Control Unit is powered by :

➢ A lead 12V, 12Ah battery (see Fig. 3.8).

Fig. 3.8 – Lead Battery

3.1.3.1 Charge level and battery replacement

When the spy light is lit next to the power supply port on the radar, this indicates that the system is powered: if it is not lit, this means that either the cable is not connected correctly or that the battery is flat (less than 10V). The battery has an autonomy of around 12 hours. When the battery runs, down the instrument must be switched off, another battery connected, and the system can be started up again. A flat battery can be completely recharged in around 3 hours with the appropriate battery charger (see Fig. 3.9 right). A software message on the PC informs the user of the battery charge level with a BATT button (see Fig. 3.9 left), which changes color as follows:

- ➢ Green if the battery is fully charged,
- ➢ Yellow if it is semi-charged,
- ➢ Red if the battery is flat.

Fig. 3.9 – Battery status signal (left) and the battery charger (right)

4. ASSEMBLY PROCEDURE

## 4.1 How to assemble the trolley

Follow the procedure below to assemble the trolley:

➢ Remove the trolley from its bag (Fig. 4.1).

➢ Open the trolley from position (1) to the upright position (2), gripping the handle (3) shown in Fig. 4.2.
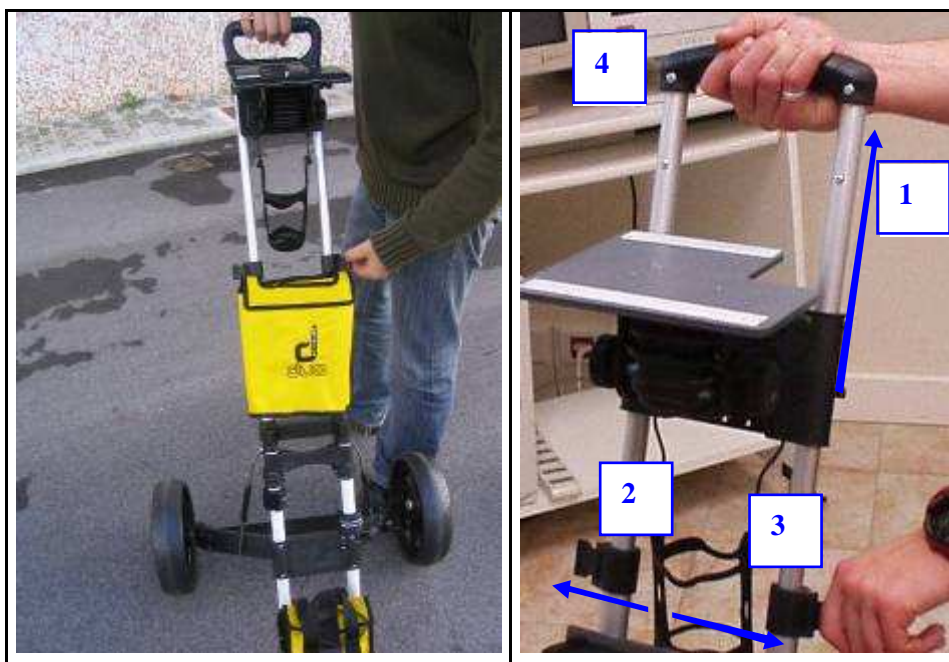

Fig. 4.1 – Trolley folded in its carrier bag

➢ Assemble the central part of the trolley (4) by automatically clicking the two cylindrical pins into their supports (see the detail of Fig. 4.2).
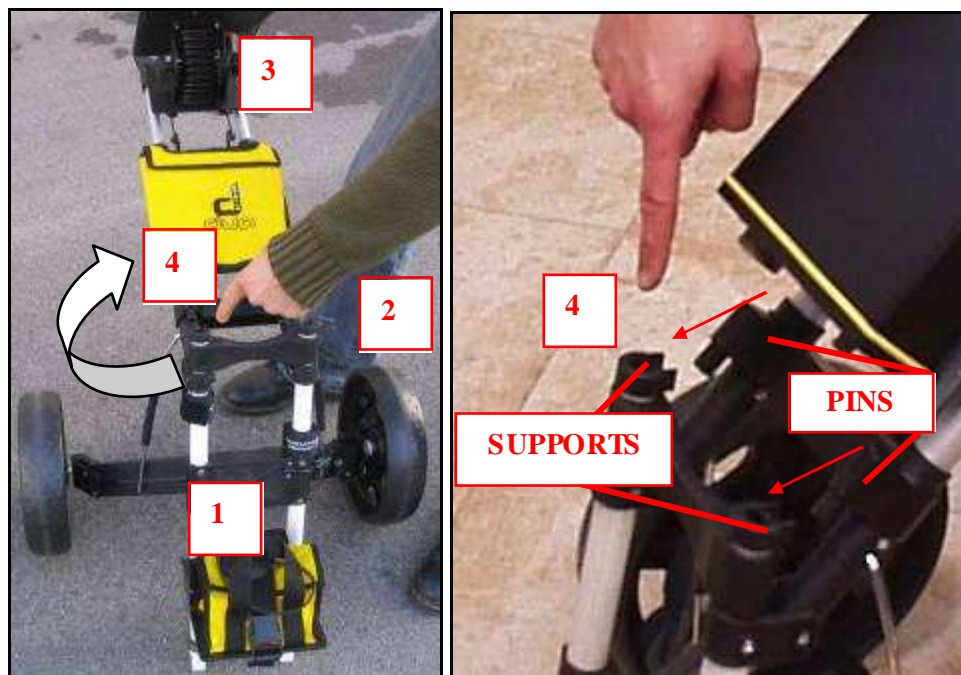
Fig. 4.2 – Opening the trolley

➢ Unlock the two unblocking levers by rotating them outwards (2 and 3) and pull the handle (4) upwards (1), regulating it as required (Fig. 4.3).
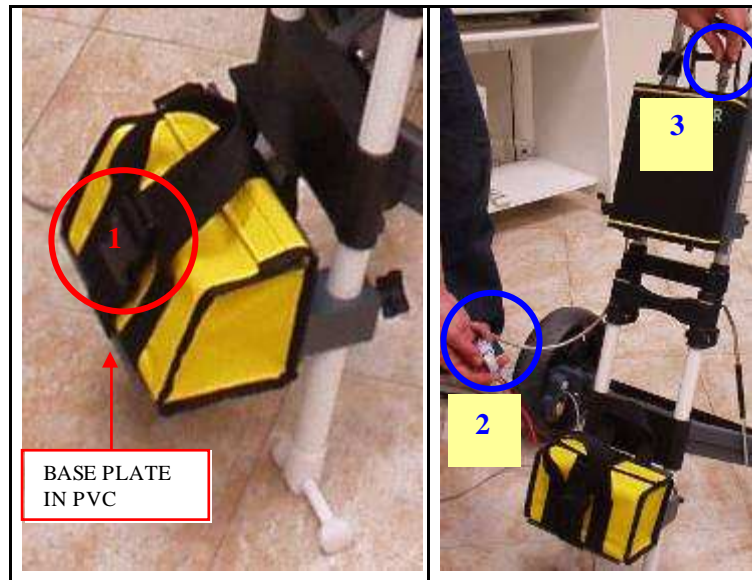

Fig. 4.3 – Upper blocking mechanism

4.2 Connecting the cables

4.2.1 Connecting the battery

Fig. 4.4 – Battery and cabling support

➢ Place the battery in its yellow bag (Fig. 4.4).

➢ Place the bag on the PVC base plate and fix the bag to the support with the strap provided (1).

➢ Connect the power supply cable to the BATTERY port on the Control Unit (3) and to the white connector to link it to the battery(2).
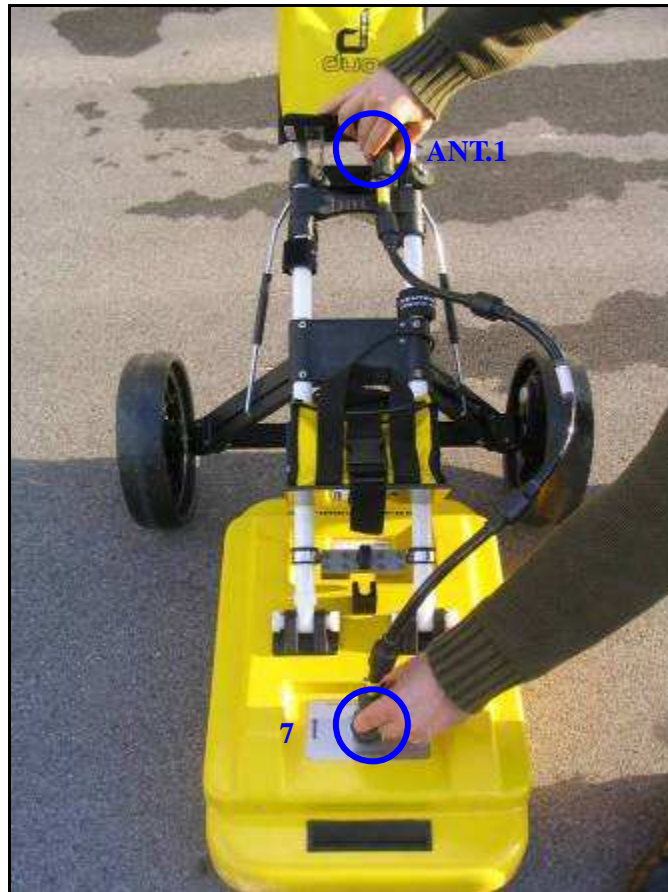
4.2.2 Mounting the antenna and connecting its cables

Place the antenna under the trolley (Fig. 4.5), inserting the two ends (1 and 2) into their PVC supports (3 and 4).

➢ Insert the pins (5 and 6) and block them with the nuts provided.

➢ Connect the cable linking the antenna port (7) to the ANT.1 port on the Control Unit (Fig. 4.5 and Fig. 4.6).

Fig. 4.5 – Fixing the antenna box


Fig. 4.6 – Antenna-radar connection

> ➢ Under the battery plate you can find the antenna-trolley locking system (see Fig. 4.7); in order to lock the trolley to the antenna, the user has to move the locking system down to the top of the antenna; then push down the front of the antenna and at the same time fix the system to the central pin. After this, turn down the lever and close it.
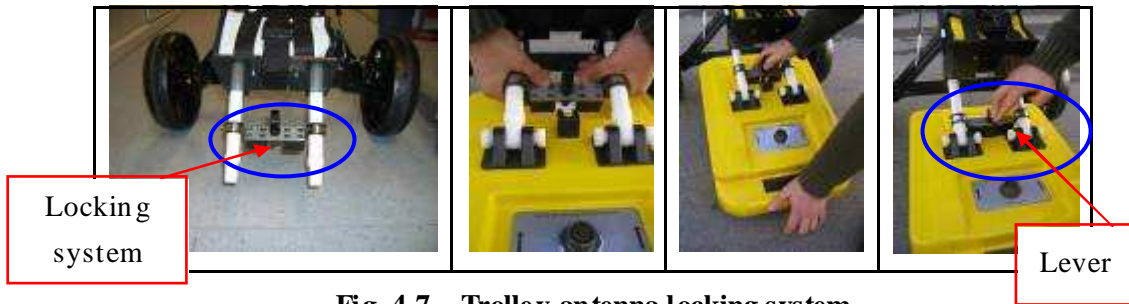
Fig. 4.7 – Trolley-antenna locking system

4.2.3 Mounting the PC notebook and the sunshade

➢ The upper base plate on the trolley(2) is used to fix the notebook PC (1) with four Velcro strips (A, B, C, D), as shown in Fig. 4.8.

➢ Once the notebook is fixed on the plate, connect the inverted network cable (see Fig. 3.4) by connecting the green connector to the PC network port (3) and the waterproof black connector to the radar port(4)
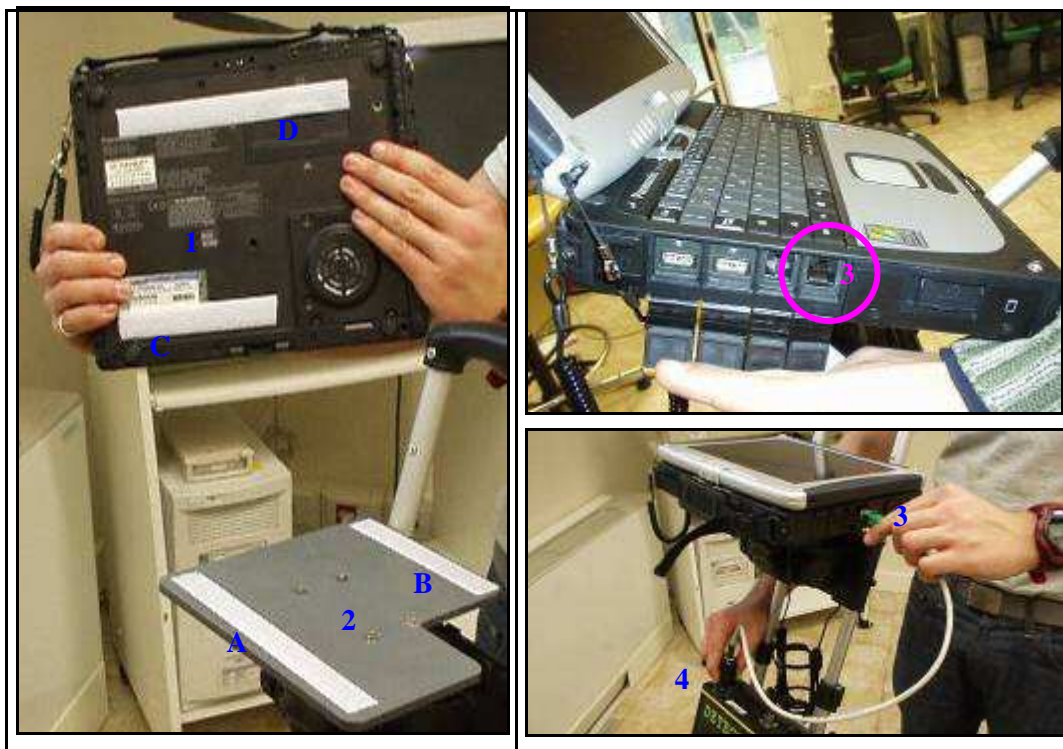
Fig. 4.8 – Fixing the notebook PC

> ➢ A sunshade can be applied to the notebook (see Fig. 4.9). Fix the lateral guides of the sunshade to the lateral sides of the notebook screen. Then close and tighten the belt behind the screen. The internal edges can be tightened as required.

LATERAL GUIDES

Fig. 4.9 – Assembling the sunshade

> ➢ Another possibility is to work with the horizontal touch screen (see Fig. 4.10). In this case, first take out the touch pen, then fix the lateral guides of the sunshade to the lateral sides of the screen. Then close and tighten the belt under the laptop. Finally, tighten the inner edges of the sunshade.

Fig. 4.10 – Sunshade on horizontal screen

4.2.4 Connecting the position sensor

Fig. 4.11 – Connecting the position sensor

> ➢ The system position sensor is situated inside one of the trolley wheels and turns in unison with it (Fig. 4.11).

> ➢ The sensor measures all movements of the Detector Duo from its starting point, which coincides with the system centerpoint (which is the center of the antenna).

> ➢ The sensor cable has to be connected to the WHEEL port (1) on the Control Unit.

4.2.5 Removing the trolley wheels

> ➢ If the wheels need to be removed for storage, press the black button labelled PRESS (indicated by the arrow) to the side of the wheel and pull the wheel outwards.

> ➢ To reinsert the wheel onto the axis, it is sufficient to push it into the support until the automatic block clicks into place (Fig. 4.12)

Fig. 4.12 – Removing the trolley wheels

! NOTE	Remember to disconnect all the cables before putting the trolley back into its storage bag (position sensor cable, antenna-DAD cable, network and power supply cable).

5. THE ACQUISITION SOFTWARE

5.1 The Notebook Computer

The **DETECTORDUO** acquisition SW is installed on a *Notebook Computer.* This SW is dedicated to the specific phases of setting up, acquiring and saving radar data.

IDS recommends to use one of two following laptops:

5.1.1 Hammerhead rugged tablet PC

The Hammerhead rugged tablet PC (Fig. 5.1), has the following specifications:

Form Factor

- Magnesium housing and shock absorbing rubber bumper system with carry handle, elastic hand straps and shoulder strap.
- Size: 10 5/8" X 8 ¼" x 1 9/16".
- Weight: 4.8lbs. with bumpers, battery and pen.

Processor / Core Logic

- 1.1 GHz Intel Pentium M Processor
- 1 MB cache
- System Bus 400 MHz
- Intel 855GME chipset

Memory / Storage

- 512 MB
- 40 GB hard drive

Display

(Pen Tablet PC Version)

- 10.4" XGA 1024x768 Reflective (bright sunlight readable) or Transmissive (indoor)
    - Proximity sensing high resolution electromagnetic digitizer using passive pen
    - More than 1000 dpi resolution
    - Right and left mouse button emulation

Fig. 5.1 – Hammerhead rugged tablet PC

Audio

- AC97 2.1 sound standard
- Integrated speaker

Expansion / Integration

- Integrated Intel PRO/Wireless 802.11 a/b/g Wi-Fi
- Bluetooth 1.2, Class 2-2.5mW
- 1 USB 2.0
- 1 RJ-45 10/100 Ethernet
- PCMCIA Type III (Accomodates up to 2 Type II devices)

Software

- Windows XP Professional (English Version)

Power Supply

- Memory-free "smart" Li-Ion battery technology provides accurate power gauge and controlled charging for maximum battery efficiency
- "Hot swappable" for uninterrupted use
- Battery life depends upon configuration, application, temperature, usage pattern and power management; 4 hour typical battery life with 2 batteries installed

How to store batteries when they're not in use

- The following storage tips will help you optimize the capacity and performance of your batteries. If the battery will not be in use for a month or longer, it is recommended that it is removed from the computer for

storage. Store batteries in a cool, dry place. Do not leave batteries in direct sunlight during the summer months or any other unusually hot location. Do not expose battery terminals to metal objects or moisture, which may short-circuit your battery. For long-term storage, store batteries below 50% state of charge because the deterioration of battery capacity is slower at lower state of charge. However, do not store batteries in a fully discharged state.

Power Management

- ACPI Advanced Configuration and Power Interface

Accessories (Optional)

- Legacy compatible docking for desk, vehicle, wall
- Port Replicators
- Universal AC adapter: 110V-250V, 50-60 Hz
- Cigarette lighter adapter

Environmental

(Temperature)

- Operating: -15°C to 60°C
- Boot temperature: 0°C without optional HDD heater and -20°C with heater
- Storage: -40°C to 70°C

(Shock)

- 4 ft. drop in case

(Vibration)

- MIL-STD-810F, Method 514.5, Category 1

(Ingress Protection)

- IEC 529, IP65 against rain and dust

(Humidity)

- 0 to 95% non-condensing humidity

Regulatory Approvals

(EMI/EMC)

- EN 55022 CISPAR 22 info. Tech. Equipment, Class B Emissions
- Immunity Measurements: IEC 61000-4-2; 1995

(Safety)

- Low Voltage Directive 73/23/EEC, EN 60950, CE

Warranty

- 1 year comprehensive warranty

5.1.2 Panasonic Toughbook rugged tablet PC

The Panasonic Toughbook CF-19 PC (Fig. 5.2), has the following characteristics:

- *CPU*: 1.6GHz Intel Core Duo.

- *Operating System*: Windows XP Professional SP2.

- *RAM/Expandable to*: 512MB SDRAM (DDR2)/4GB

- *Hard Drive/Speed*: 80GB shock-proof (mounted on a gel support or equivalent).

- *Optical Drive*: 2.4X DVD+R DL

- *Display Resolution*: 10.4 inches/1024 x 768

- *Graphics/Video Memory*: Intel 945GM video accelerator with up to 128MB shared video memory

- *Wireless Networking*: WLAN 802.11a/b/g, Bluetooth 2.0, Optional WWAN (EVDO, HSDPA) and GPS

- *Ports*: Two USB 2.0, Firewire, Ethernet, modem, headphone, mic, docking connector

- *Card Slots*: PC Card Type II, SD Card slot

- *Weight*: 5 pounds

- *Size*: 10.7 x 8.5 x 1.9 inches

- *Warranty/Support*: Three-year limited warranty, parts and labor lifetime toll-free 24/7.

- *Battery Life (Wi-Fi On/Off)*: 5h / 6h about

- *Environmental*: Water-proof (IP54)

Fig. 5.2 – Panasonic Toughbook CF-19

! NOTE	No communication software of the type Firewall, WiFi or Antivirus protection may be installed on the computer; these types of SW enter into conflict with the DETECTOR DUO acquisition SW. IDS takes no responsibility for any functional conflicts that may occur between their own software and any other software installed by the user onto the Notebook Computer. IDS doesn't guarantee that equipment performance will be maintained using configurations different to those recommended.

5.2 Basic characteristics of the notebook PC

If you decide to use a different notebook PC to the one suggested by IDS, it must have the following characteristics:

➢ Pentium processor > 1.5GHz or Centrino > 900 MHz.

➢ Ethernet 100 Mbit/sec card.

➢ monitor resolution (color) > 800x600.

➢ Operative system: Windows 2000 Professional (Service Pack 4) or XP Professional.

➢ HDD > 40 Gbyte, shock-proof (mounted on a gel support or equivalent).

➢ CD drive and/or floppy.

➢ Water-proof (>= IP54).

5.3 Software installation and configuration

Launch the icon of DetectorDuo setup file (Fig. 5.3).

Fig. 5.3 – Detector Duo setup icon

Click "Next" button on the window appearing (Fig. 5.4).
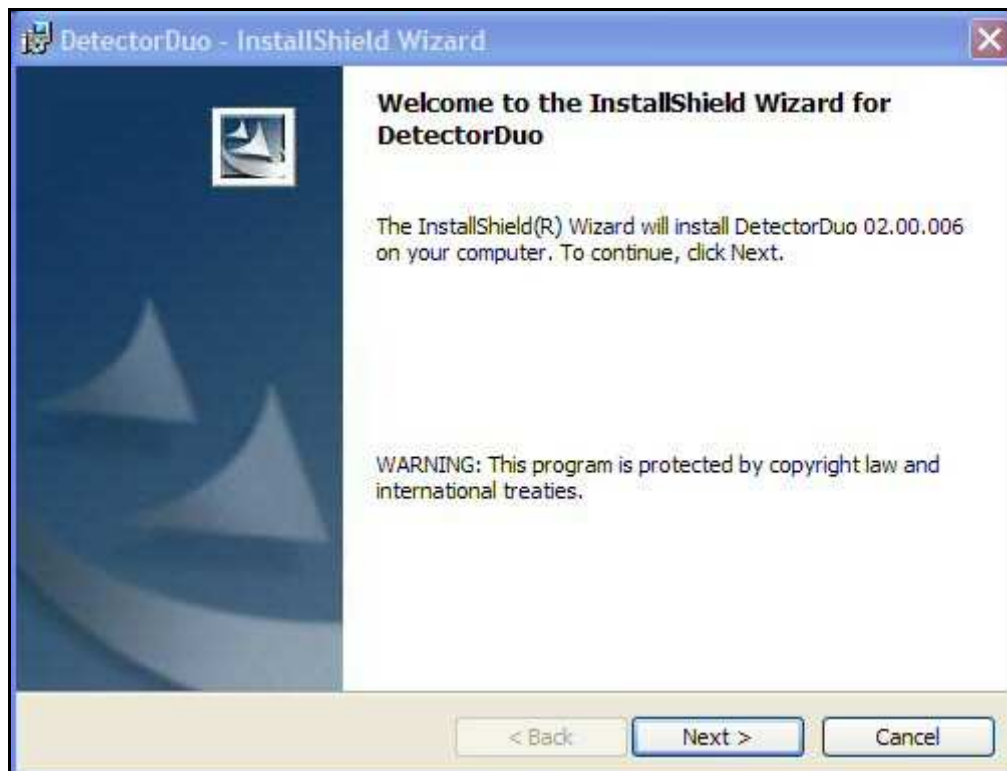
Fig. 5.4 – Detector Duo Welcome window

Select Typical setup type and then press "Next" button on the window appearing (Fig. 5.5).

Click "Install" button on the window appearing (Fig. 5.6).

Click "Finish" button on the window appearing (Fig. 5.7).

Fig. 5.5 – Setup type window

Fig. 5.6 – Pre-installation window

Fig. 5.7 – Installation completed window

Automatically a shortcut of the **DetectorDuo.exe** will be created on to desktop. The software will be installed automatically under **C:\DetectorDuo** directory.

Before using the Detector software, you have to configure the notebook network card. To perform this operation in Windows 2000 Professional or Windows XP Professional, follow the steps below:

➢ Select the *My Network Places* icon with the right mouse button;

➢ Select the *Properties* button.

➢ Select the *Local Area Connection (LAN)* file with the right mouse button.

➢ Select the *Properties* command.
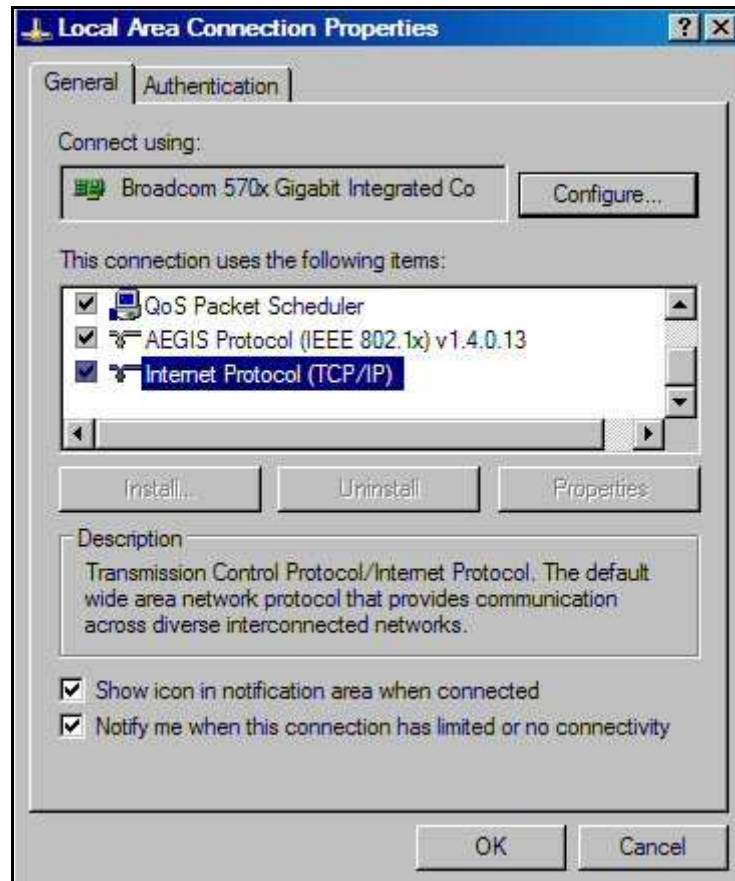
Fig. 5.8 – Selecting the Ethernet card (TCP/IP)

➢ Select *Internet Protocol (TCP/IP) from the list of components* (in the general menu) with the left mouse button (see Fig. 5.8).

➢ Select the *Properties* command.

➢ The window shown in Fig. 5.9 appears, in which you have to select *Use the following IP address.*

➢ Write the following number in the *IP* address field: 192 . 168 . 200 . 199.

➢ Write the following number in the *Subnet mask* field: 255 . 255 . 255 . 0.

➢ Press *OK* to confirm the changes

⚠ NOTE	Check that the **DetectorDuo** directory is copied into the **C:** drive and is not write protecting, otherwise the **DetectorDuo** SW will not function correctly.
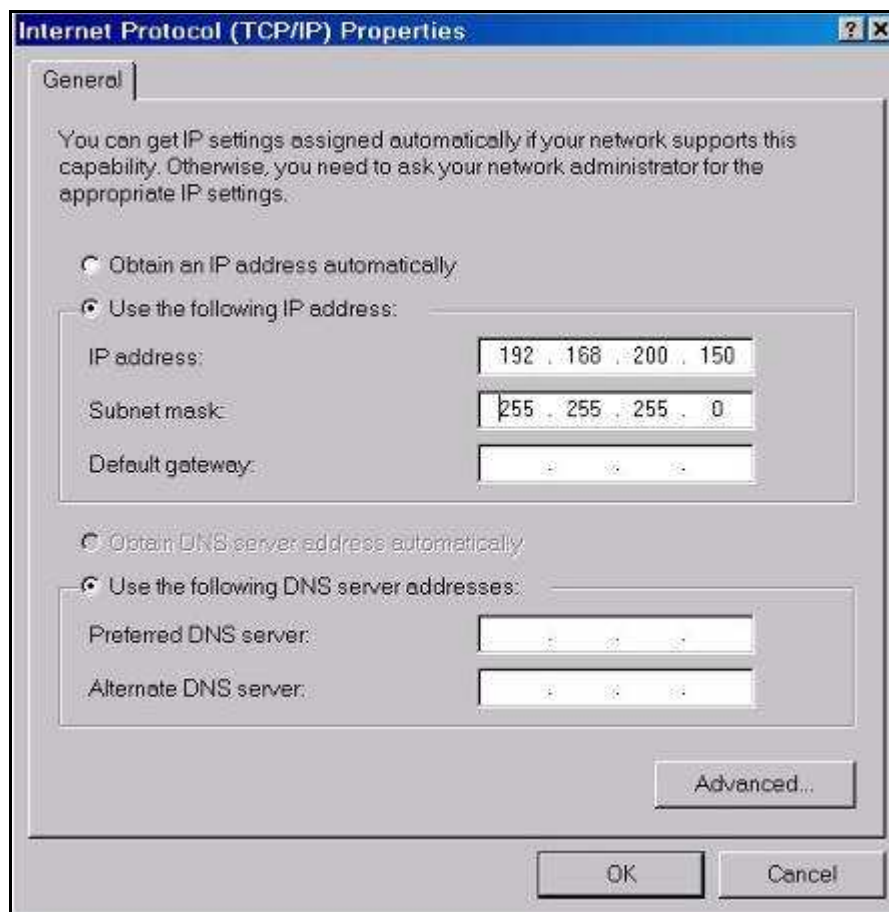
Fig. 5.9 – Changing the IP address

! NOTA	To guarantee the correct functioning of the DetectorDuo SW, launch the *Regional and Language Options* icon on the control panel then select *Regional Options* / *Customize* and the following configuration as shown below in the *Numbers* field in *Regional Options*.
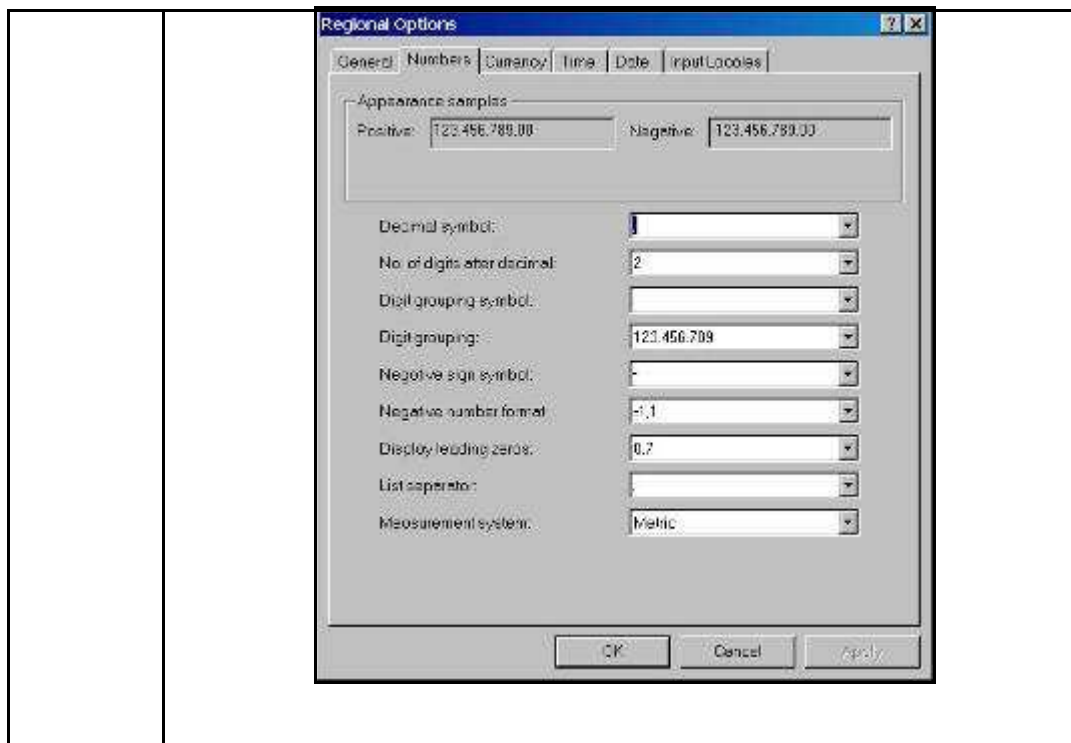
5.4 The operational phases

5.4.1 Running the software

The DetectorDuo software permits data to be acquired, saved and viewed directly in the field. Once the notebook has been switched on, the **DetectorDuo.exe** program has to be launched by clicking on the icon shown in Fig. 5.10.
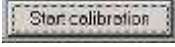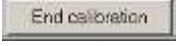
Fig. 5.10 – Acquisition software icon

Once the icon has been clicked, the software initializing window automatically opens (Fig. 5.11).
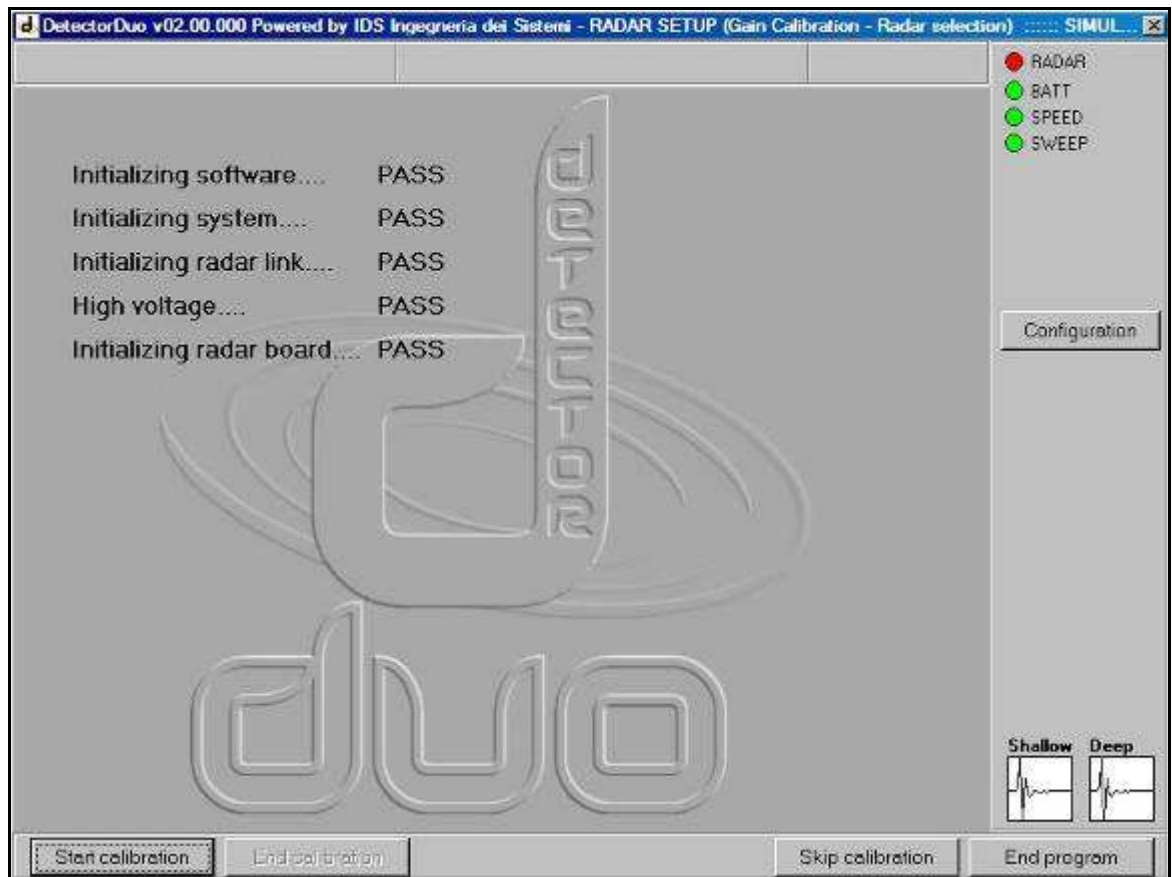
Fig. 5.11 – Initializing window

5.4.2 Pre-acquisition commands

➢ Pressing the [Start calibration] button activates the calibration procedure of the processing parameters used on the acquired data.

➢ To perform this calibration, push the trolley a few meters then press the [End calibration] button to save the parameters the software automatically calculates (see Fig. 5.12).

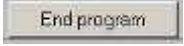| ⚠ NOTE	Calibration can be repeated as often as required during a survey, whenever the ground conditions change.
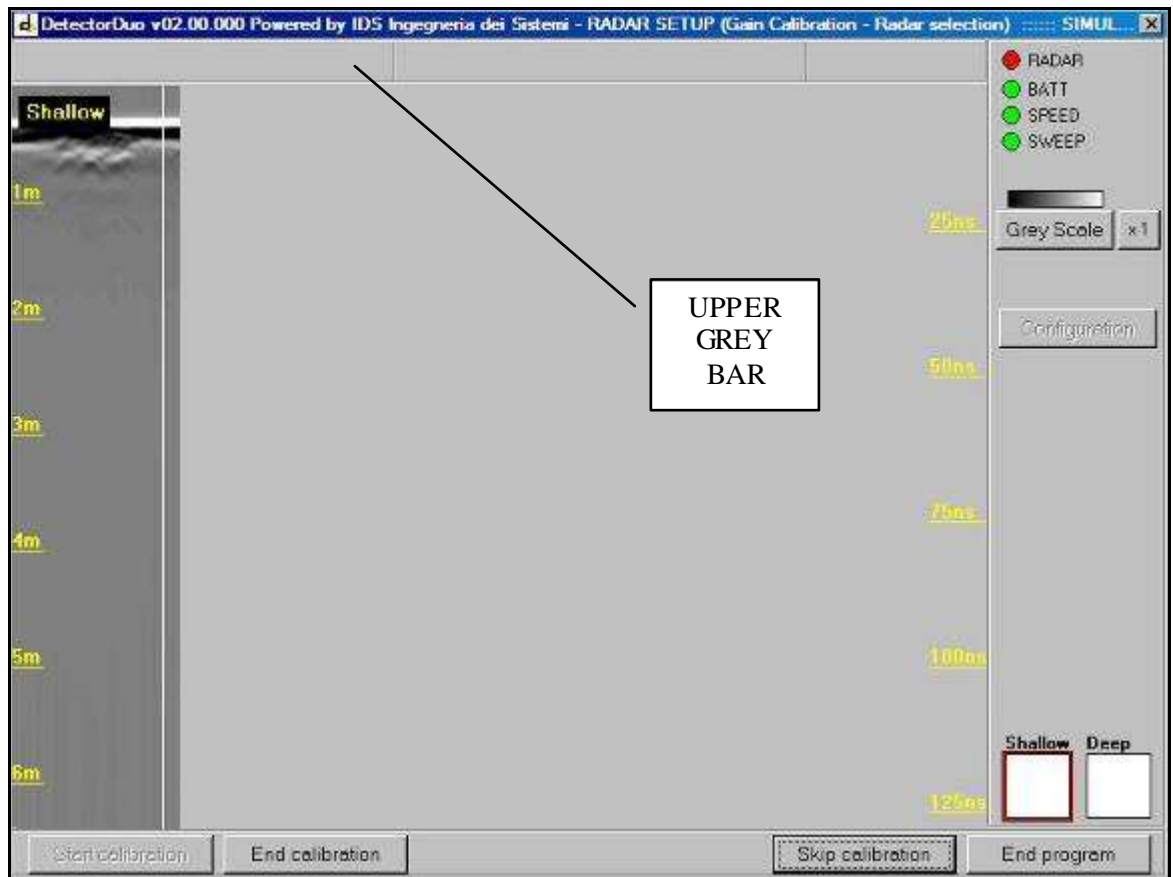
Fig. 5.12 – Gain calibration underway

➢ By pressing the [Skip calibration] button, you can avoid performing the gain calculations, but in this way you can only view pre-existing radar maps.

➢ The spy lights representing the radar (RADAR), battery (BATT), acquisition speed (SPEED) and acquired sweeps (SWEEP) indicate the current activity status of the system:
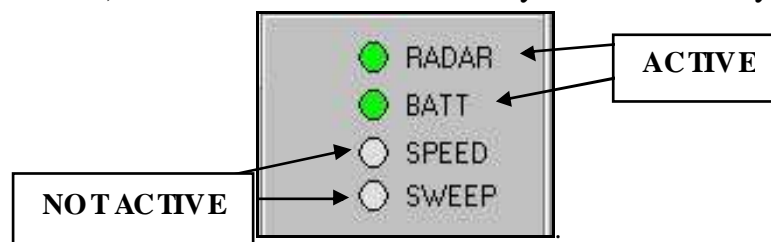

➢ Pressing the color scale button allows you to select the desired palette for viewing the radar maps: Grey Scale , Unipolar , ZCE-BW , ZCE-2CLR , PHE-2CLR , Russian , Transition , RAINBOW2 , BGR .
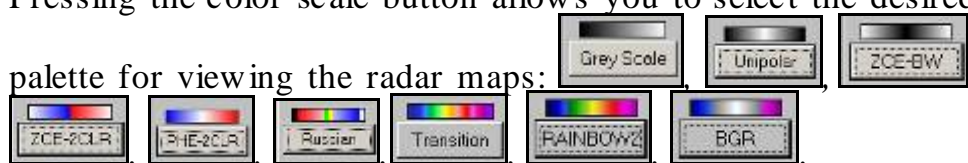
➤ You can zoom in on the maps up to a magnification of 4 by selecting one of these buttons: ⟦x1⟧, ⟦x2⟧, ⟦x3⟧, ⟦x4⟧.

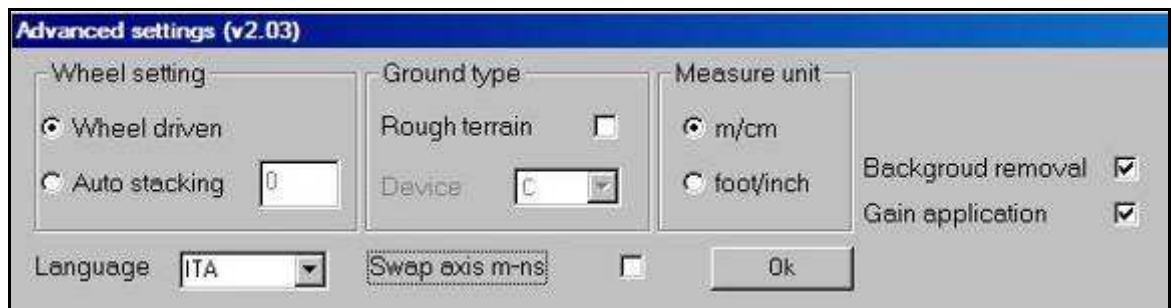➤ Press the ⟦End program⟧ button to shut down the software, then confirm your choice in the following message window
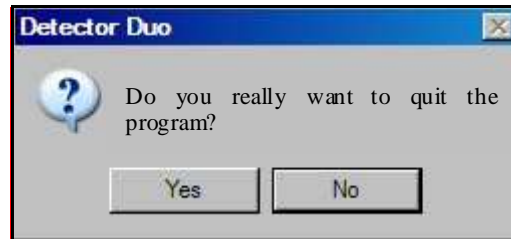
➤ Press "Yes"; this is followed by the final message

➤ Clicking twice on the upper grey bar of the first window (Fig. 5.12), opens the **Advanced settings** window (Fig. 5.13), where the following parameters can be set:
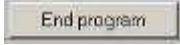
Fig. 5.13 – Advanced settings window

1. *Wheel setting* here you can set the acquisition mode of the system, which can be either

   a. **Wheel driven** field selected, in this mode, the radar acquisition is set using the position sensor

   b. If the wheel is not used, you can set the radar acquisition to be performed under a constant time regime; the value inserted in the **Auto Stacking** field indicates the number of sweeps averaged during the acquisition phase.

2. The *Ground type* field enables you to activate the **Rough terrain** option if it is necessary. When this option is activated, the radar data are temporarily saved on the selected **Device** during the acquisition phase. You can even select an external **Device** such as a flash memory to temporarily save the data during the acquisition phases. This option is recommended when the ground conditions are particularly rough, and when you may find that saving the data during the acquisition phase becomes critical due to the high number of vibrations in the system.

3. In the *Measure unit* field, you can choose the measurement units to be applied to the radar map visualized in real time. The alternatives are **m/cm** and **foot/inch**

4. In the *Swap axis* field, you have the choice of modifying the vertical scale of the radar map by setting the value in **m** or **nsec**

5. In the *Gain application* field, you can choose to view the radar map acquired in real time with or without gain applied

6. In the *Background removal field* you can set the Clear_x application for the acquired radar maps.

7. *Language* this permits you to change the language used on the software interface amongst those available (e.g. ITA = Italian, Eng = English).

5.4.3 Commands used during acquisition

Data acquisition is started using the window shown in Fig. 5.14.
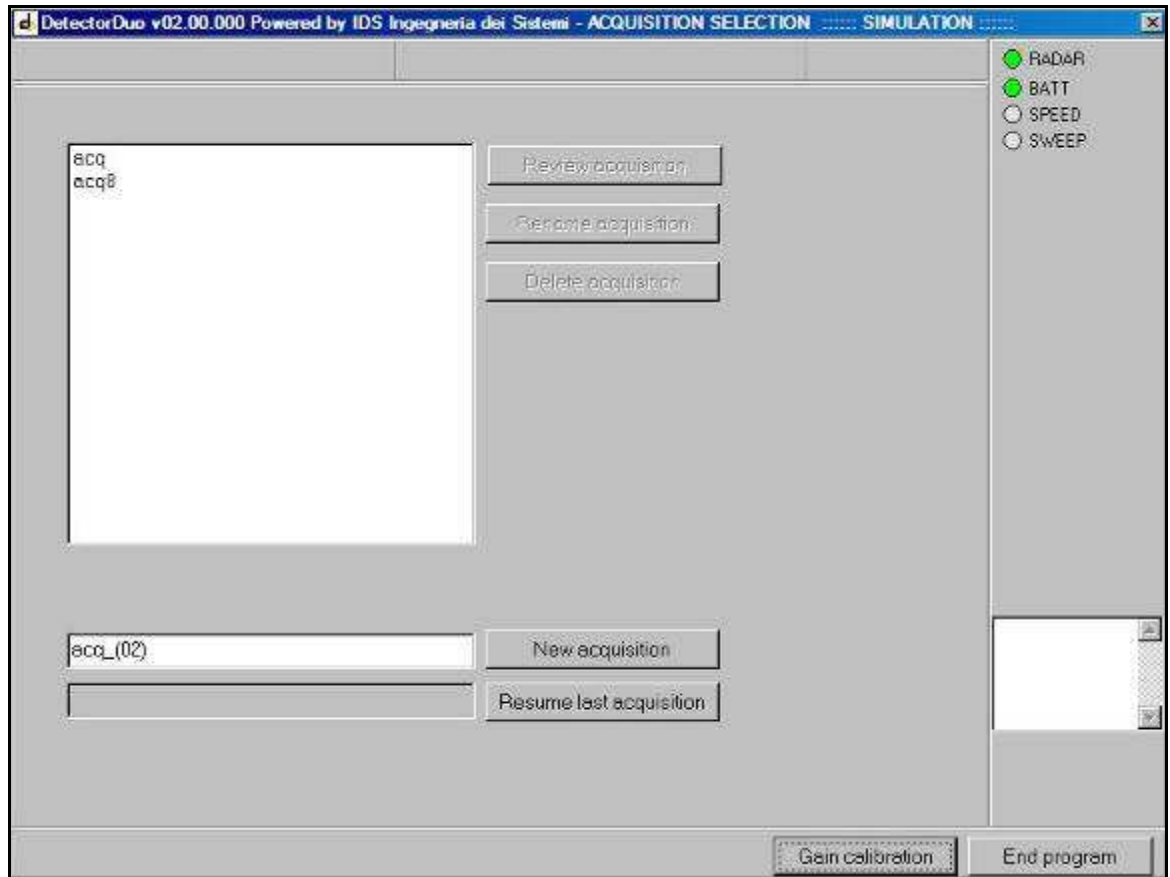
Fig. 5.14 – ACQUISITION SELECTION window

➢ Press the [Start calibration] button to go back to the pre-acquisition phase.

➢ Press the [End program] button to close the software.

➢ To start a new acquisition, write a name in the text box then press the button next to it
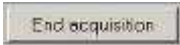
| Scan-01 | New acquisition |

This will open the window shown in Fig. 5.15.
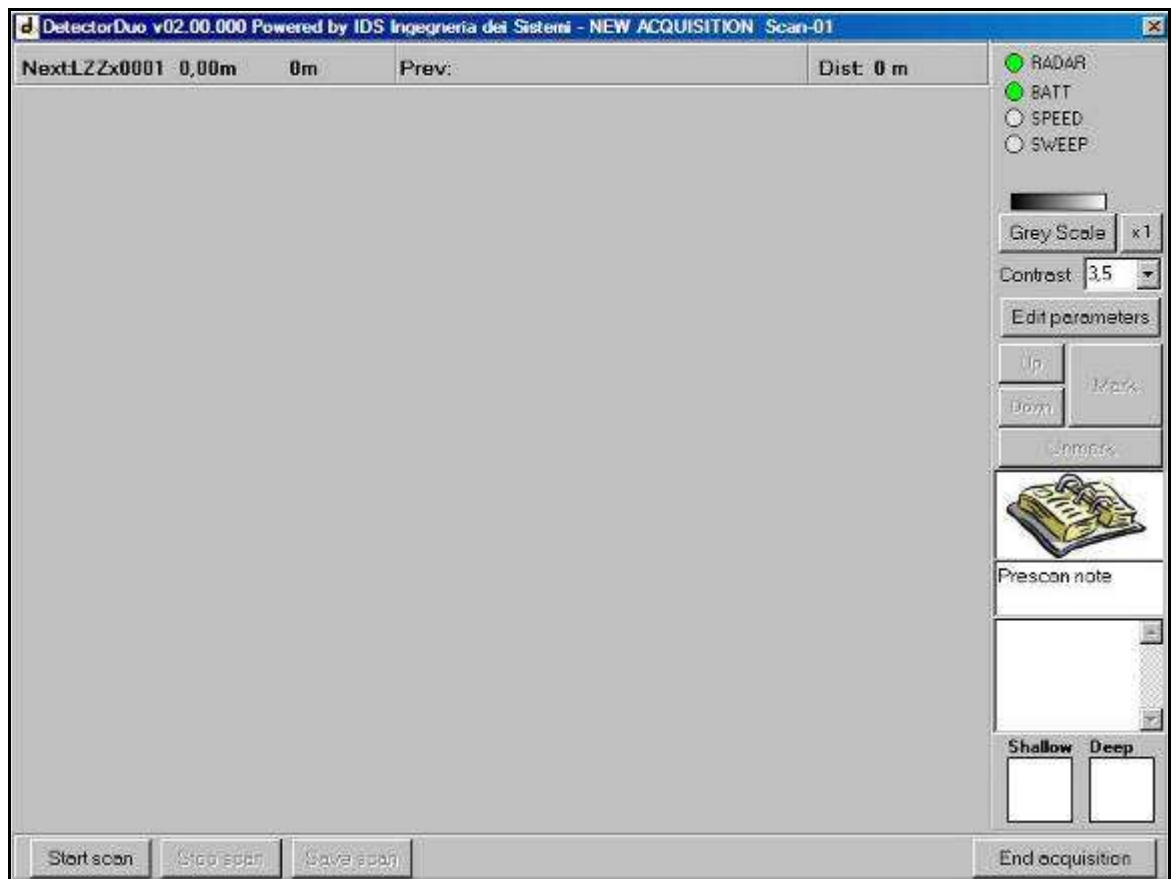
Fig. 5.15 –NEW ACQUISITION window

! NOTE	Once a name has been given to a new survey, a file is automatically created with the selected name in the C:\DetectorDuo\Mission\ directory. All data files containing acquired data will be automatically stored in this file.

> ➢ Press the ⬚ End acquisition button to stop and save the acquisition. The window shown in Fig. 5.14 then reappears.

> ➢ The icon below reminds you that you can write some notes on the scan in the text box underneath
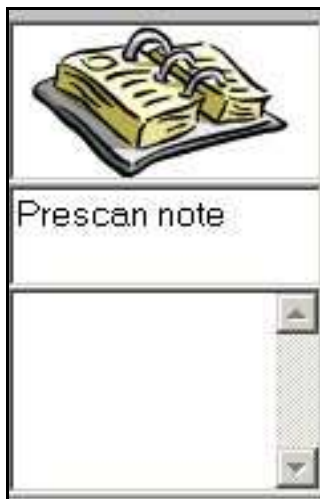
At this point you have two options:

1. perform radar scans without setting any reference coordinates simply to locally identify any buried utilities on-site;

2. perform geo-referenced scans to obtain an underground mapping of the site.

5.4.3.1 *Acquisition for on-site detection*

Press the [Start scan] button and start the acquisition by pushing the trolley. The window shown in Fig. 5.16 appears, displaying the icon
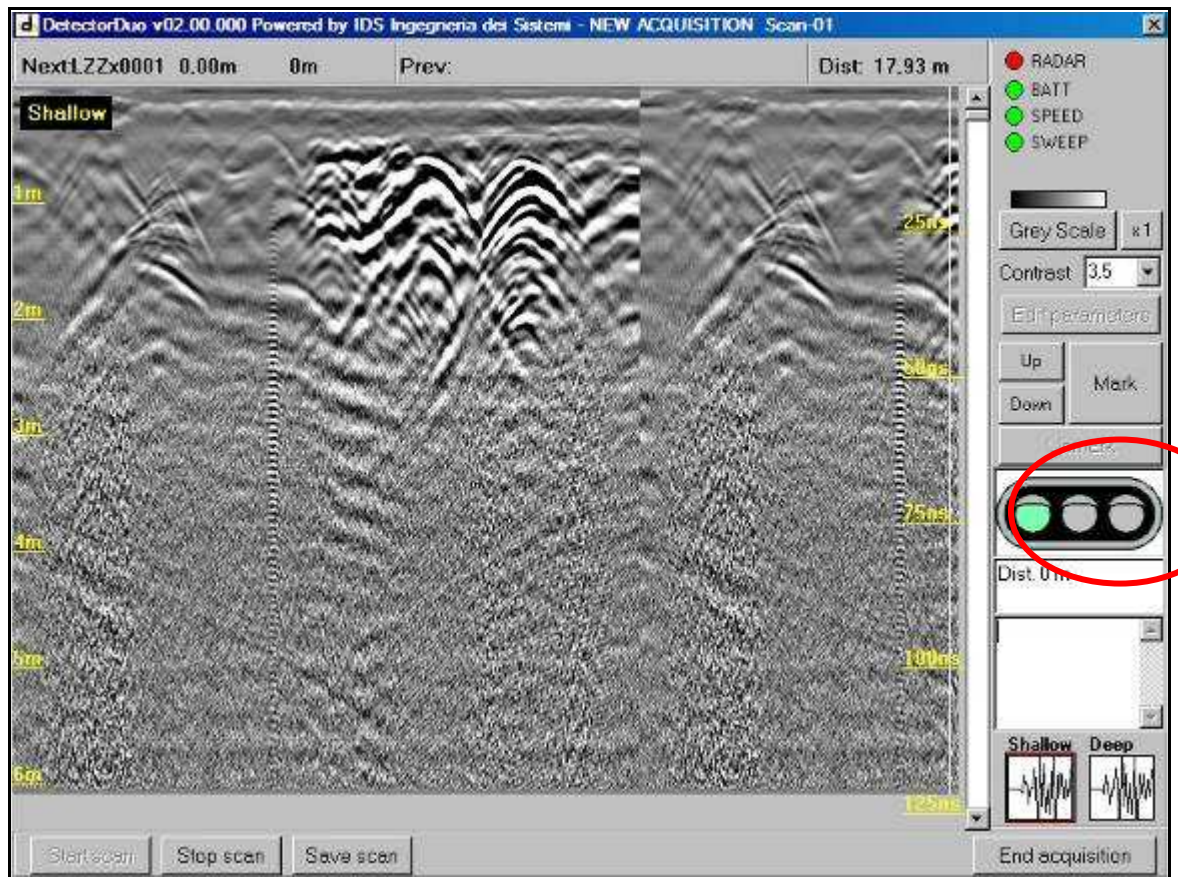
Fig. 5.16 – Radar map during the acquisition phase

➢ During the acquisition, the user can also change the contrast value in real time, through the function

editing the number in the side textbox, as shown in Fig. 5.16.

➢ If you note the appearance of a hyperbola on the screen during acquisition (generated by a buried pipe or cable), go back, moving the trolley in the opposite direction to the acquisition direction. This temporarily suspends acquisition and produces a vertical line on the data screen (see Fig. 5.17).
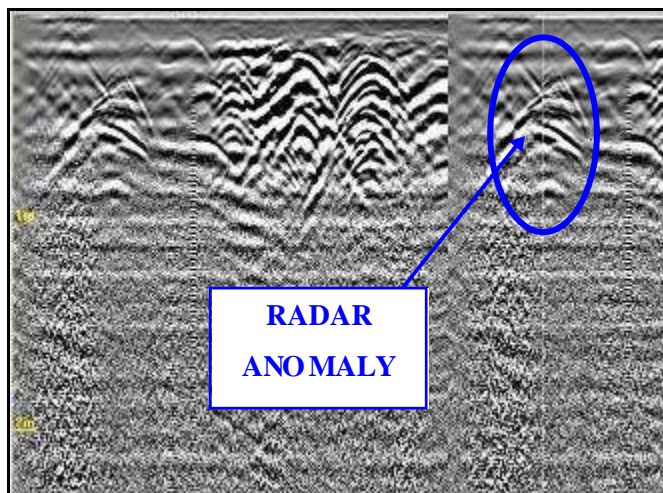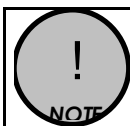
Fig. 5.17 – Identifying a target

> ➢ This vertical line permits you to position the trolley on the axis of the identified pipe or cable, you can then mark the position on the ground in correspondence to the center point of the antenna, as shown in Fig. 5.18.

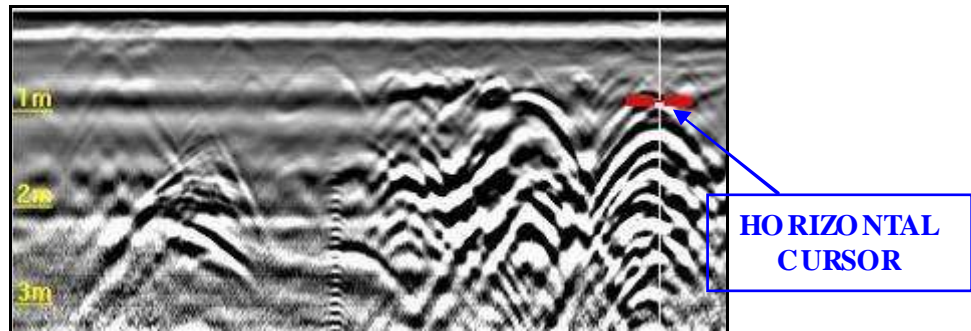**Fig. 5.18 – The antenna center point**

! NOTE	The centerpoint (1) of the system is situated in the central point of the antenna (see Fig. 5.18) and it represents the starting point when reading radar maps (red line on the ground).

> Use the [Down] and [Up] buttons to position the horizontal cursor on the peak of the chosen hyperbola (see Fig. 5.19).


Fig. 5.19 – UP/DOWN functions

In particular, during the acquisition phase, both the radar maps can be viewed (Fig. 5.20) when the DUAL 250-700 antenna is operated. In fact, initially, the software automatically displays the "*Shallow*" radar section (700MHz); to view both the sections together, click once with the left mouse button in the bottom right section named "Deep" to make the radar section for the 700MHz appear together with the 250MHz antenna. The two sections are separated by a yellow horizontal line.

Then by clicking twice with the left mouse button on the horizontal yellow line and dragging upwards or downwards, the two maps can be viewed in more or less detail. In addition, if the "Shallow" and "Deep" labels in the top left of the sections hide a target, they can be moved to the bottom right of the radar maps simply by clicking twice with the left mouse button on the yellow "Shallow" or "Deep" labels.
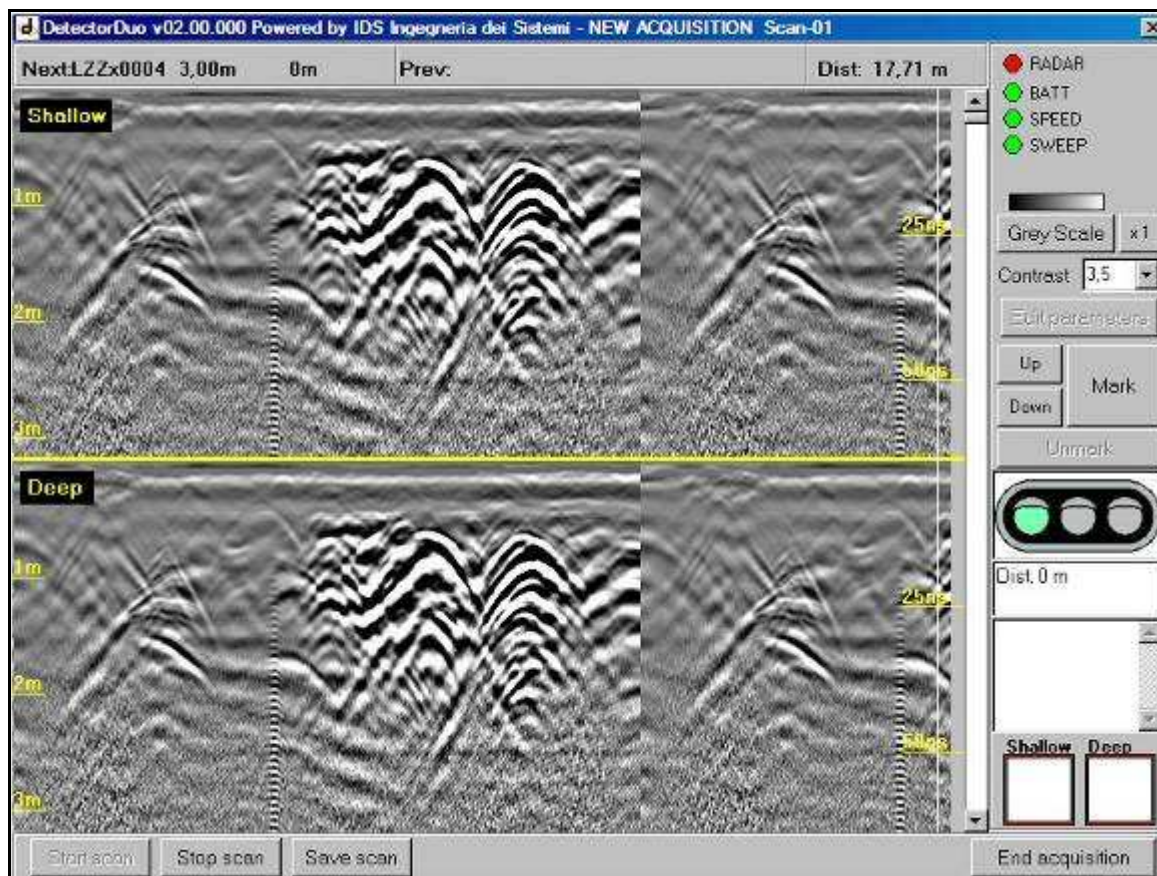
Fig. 5.20 –DUAL display during acquisition

➢ The [Marker] button permits the type of pipe and its position to be marked on the chosen point of the radar map. The window shown in Fig. 5.21 appears automatically. The icons represent some types of pipe (from the top left clockwise we have *Gas, Electric Cable , Telephone Cable , Water Pipe , Unknown Pipe, Sewage Pipe, Public Illumination cable, Traffic Light cable*.

Fig. 5.21 – Icons for types of pipes and cables

➢ By pressing the [Unmark] button, you can remove a previously selected marker.

! NOTE	The system can't identify the types of pipe or cable. This information can be found from other sources, such as opening manhole covers or consulting technical maps.

5.4.3.2 Acquisition for mapping

In this second case, select the [Edit parameters] button (Fig. 5.15) to set the starting point coordinate al fine; the window shown in Fig. 5.23 automatically opens.

You then have the chance to choose the following acquisition parameters:

- The acquisition direction as either **Longitudinal** or **Transversal.** When filling in this field, remember that *Longitudinal* (**L**) means the scans is performed parallel to the zero reference line (T axis), while a scan perpendicular to this line is called a *Transversal scan* (**T**) (See figure Fig. 5.22).
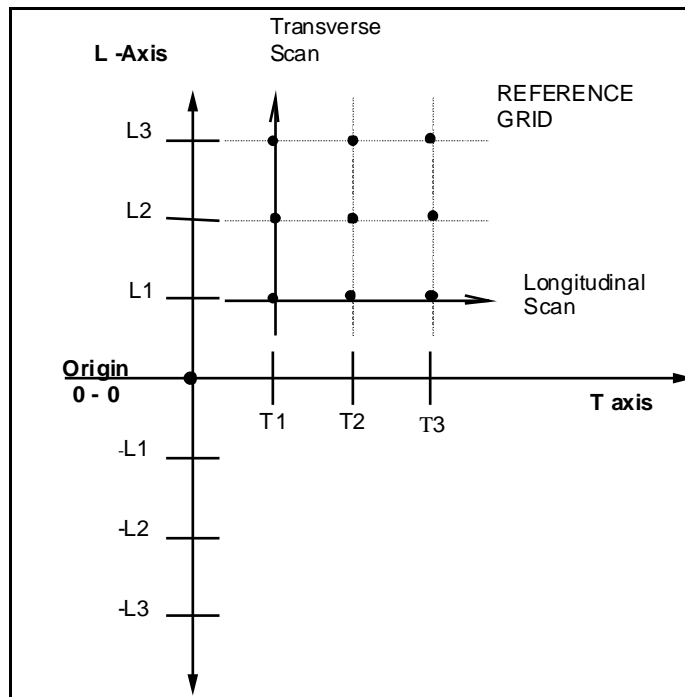
Fig. 5.22 – Diagram of the T-L cartesian reference system

- **Coordinate (m)**: This field allows you to insert the values of the set T or L co-ordinate. Remember to indicate if a coordinate is negative. Check the current T or L coordinate on the site and insert it into the relative field Remember that, despite the actual dimensions of the antenna box, it is represented in the Cartesian reference system by a single point that corresponds to its centerpoint. When moving the antenna box, make sure the centerpoint is on the scan line, at the defined coordinate.

  o **Coord. value**: insert the value of the coordinate to be maintained constant during the scan in this field.

  o **Coord. Step**: this field contains the step value that is added automatically to the current value when a scan is finished, leaving the system ready to start the next scan. The preset value = 2 m between scans. For example, if a longitudinal scan has been chosen and it starts from a point with coordinates **T, L** = 0 ;+2 m, the following values must be set:

- Longitudinal;

- 2 in the Coord value field;

- 2 in the Coord. Step field.

Once the scan is finished, the coordinate of the L value is automatically positioned on the value 4.


! BE CAREFUL

The Antenna Box may only be moved in one direction. It may only be pulled or pushed in the direction of increasing scanning coordinates.

- **Scan Offset (m)**: each radar scan is characterised by an initial L and/or T co-ordinate Therefore, once you have inserted the starting point co-ordinate for the investigation ("*coord. value*") as a function of the type of scan, the other reference co-ordinate must be defined in the "*Scan Offset (m)*" field. The following option must then be selected:

- **On L/T coordinate**" selection

  Here, you have to manually measure the value of the co-ordinate corresponding to the centerpoint of the antenna box with respect to the reference system selected previously, and insert it into the active field.

  For example, if you have to perform a transversal scan starting from the co-ordinate T=2 and L=2, you must set the type of scan to Transversal and then set the actual value of the T co-ordinate (e.g. 2 m) in the "*Coordinate (m)*" field. Next, activate the "*L coordinate*" in the "*Scan Offset (m)*" area, setting it to 2 in this case. The scan can now be performed.
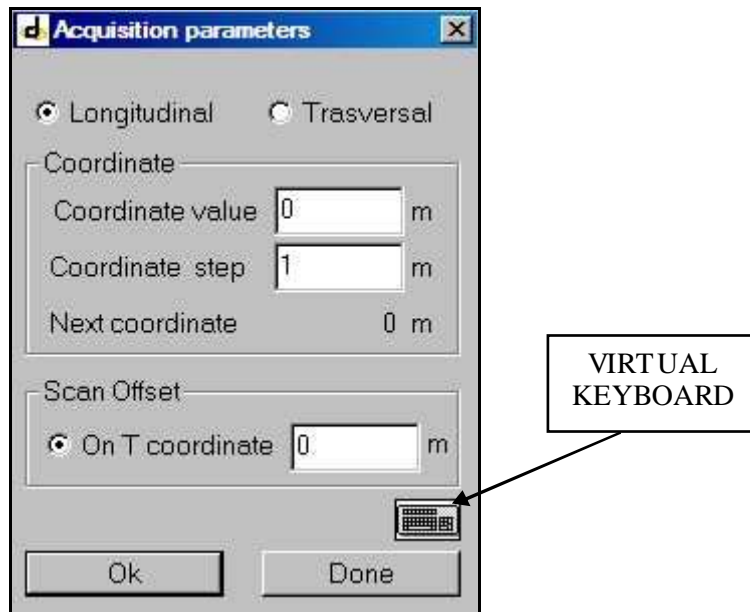
Fig. 5.23 – Acquisition parameters window

➢ There are three boxes in a grey bar above the acquired radar maps (Fig. 5.16) (see below) these show the following information:

Left box:

- o The name of the scan to be performed "Next" (in the example LZZx0003);
- o The "Coordinate value" (in this example 2.00m);
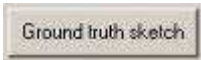- o The "Scan Offset" (0m in this example)

Central box :

- o The name of the preceding scan, "Prev" (in this example LZZx0002);
- o The "Coordinate value" (in this example 1.00m);
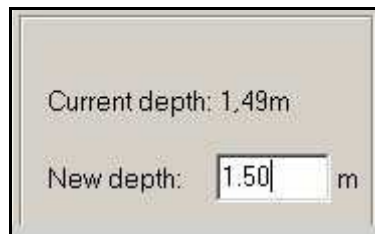- o The "Scan Offset" (in this example 0m);

Right box:

- o The distance travelled by this system, "Dist" (in this example, 13.47m).

5.4.4 Depth calibration

➤ Pressing the [Ground truth sketch] button produces a box where you can write the exact depth of the pipe or cable if it known from another source (for example from technical maps or from opening manhole covers)
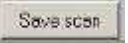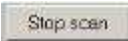
➤ Otherwise, the following window will be opened if the [Fitting] button is pressed
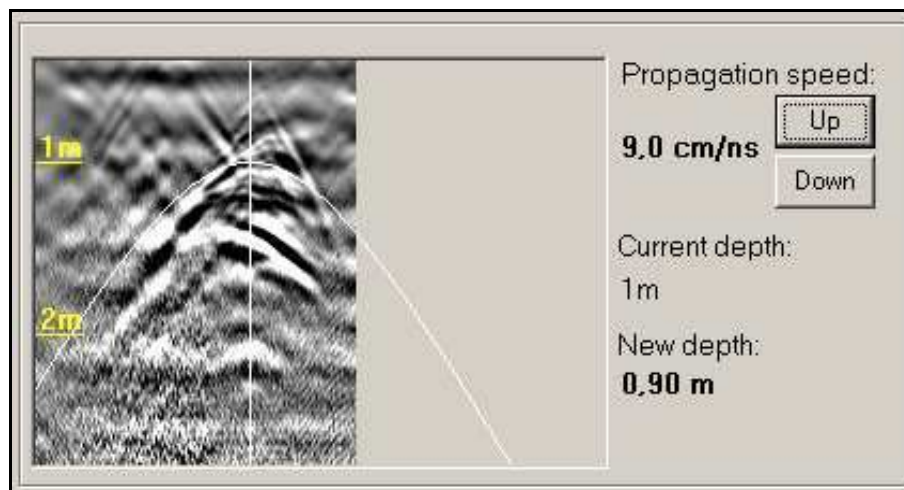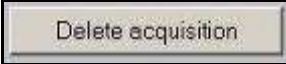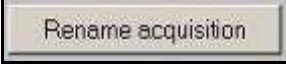
from where the correct propagation speed can be selected by adapting the curve to the hyperbolas using the [Up] and [Down] buttons.

| ! NOTE | In both cases, you have to select one of the icons shown in Fig. 5.21 to confirm the depth of the identified pipe. This operation can be repeated several times during the acquisition: a symbol will appear at calibration points describing the type of the characteristics of the detected pipe
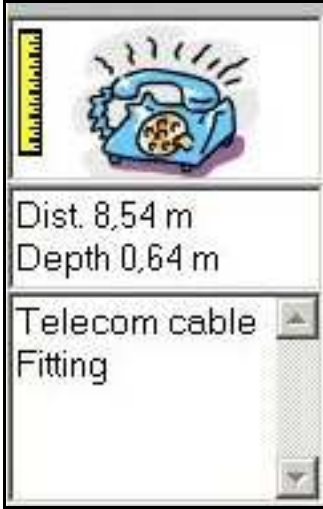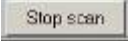
Dist. 8,54 m
Depth 0,64 m

Telecom cable
Fitting |

➢ Press the [Stop scan] button to finish the scan while remaining in the open survey.

➢ Press the [Save scan] button to save the scan file onto the computer hard disk (in the C:\DetectorDuo\Mission directory); you can continue the same scan by moving the trolley in the same direction.

➢ Press the [Stop scan] button to finish the scan and go back to the main menu shown in Fig. 5.14 to choose a new survey..

5.4.5 Post-acquisition commands
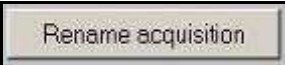
The following commands can be activated from the *ACQUISITION SELECTION* window (see Fig. 5.14):

1. [Delete acquisition] ;

2. [Rename acquisition] ;

3. [Resume last acquisition] ;

4. [Review acquisition] .

➢ Any of the surveys saved on the computer can be deleted by pressing the [Delete acquisition] button; select the survey name and press the delete button, the software requests you to confirm your choice (Fig. 5.24).
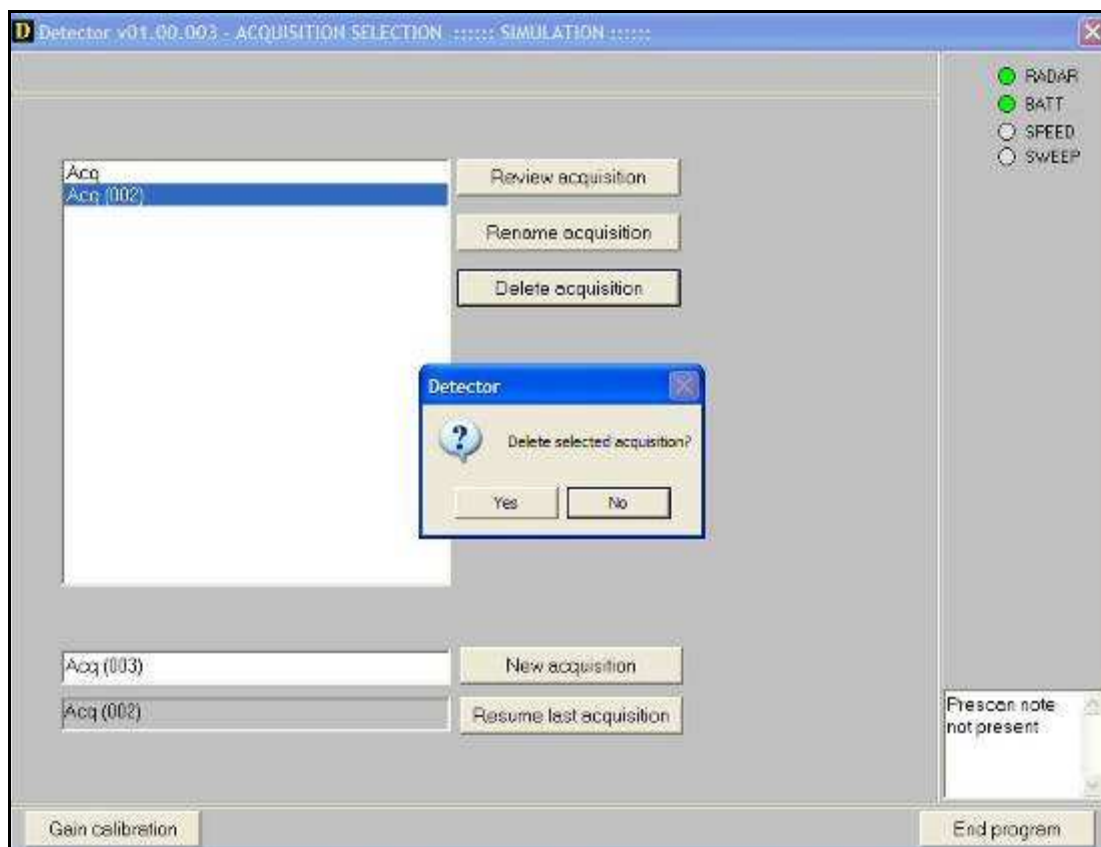
Fig. 5.24 – Deleting a survey

➢ By pressing the [Rename acquisition] button, the last survey can be reloaded to continue performing further scans in it (Fig. 5.25).
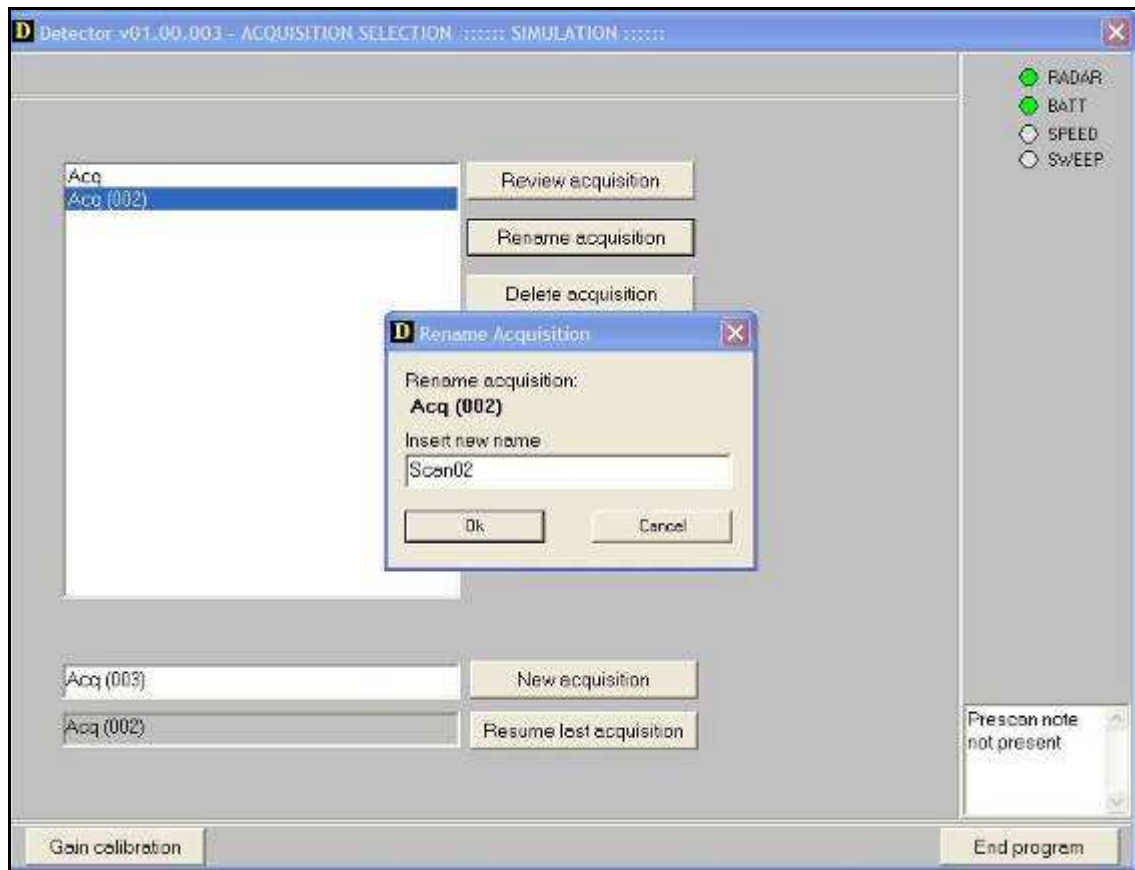
Fig. 5.25 – How to rename a survey
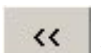
> By pressing the [Resume lost acquisition] button, the last survey can be reloaded so as to continue performing further scans in it.

> Press the [Review acquisition] button to review all the scans contained in the selected survey. The first radar map of the selected survey will appear, onto which further markers can be added if required as described previously. In addition, all previously identified hyperbolas will be marked with a circle and a vertical line (Fig. 5.26).
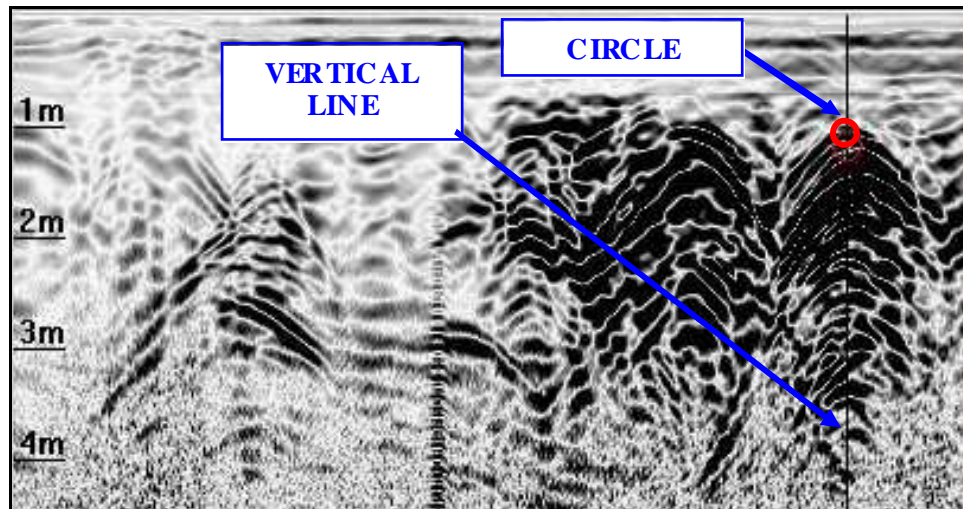
Fig. 5.26 – Insertion of a Marker during the review phase

! NOTE	Further hyperbolas can be selected or previously inserted information can be reloaded using the mouse or the buttons on the lower tool bar. It is sufficient to click in correspondence to the vertical line shown in Fig. 5.26.

➢ You can then press:
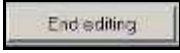
- The ⟩ button to move the review line about 2.5cm to the right;

- The ⟩⟩ button to move the review line about 50cm to the right;

- The ⟨ button to move the review line about 2.5cm to the left;

- The ⟨⟨ button to move the review line about 50cm to the left.

➢ the lower tool bar can also be used to select and reload:

- previous scans by selecting the [-] button,

- subsequent scans by pressing the [+] button.

➢ finally, the radar maps, together with all the additional information included on them can be oriented by pressing the [Print] button and selecting the desired printer (Fig. 5.27).

Fig. 5.27 – Print function

➢ press the [End editing] button to close the editing application, the window shown in Fig. 5.24 will reappear.

An example of a radar map printout is shown in Fig. 5.28.
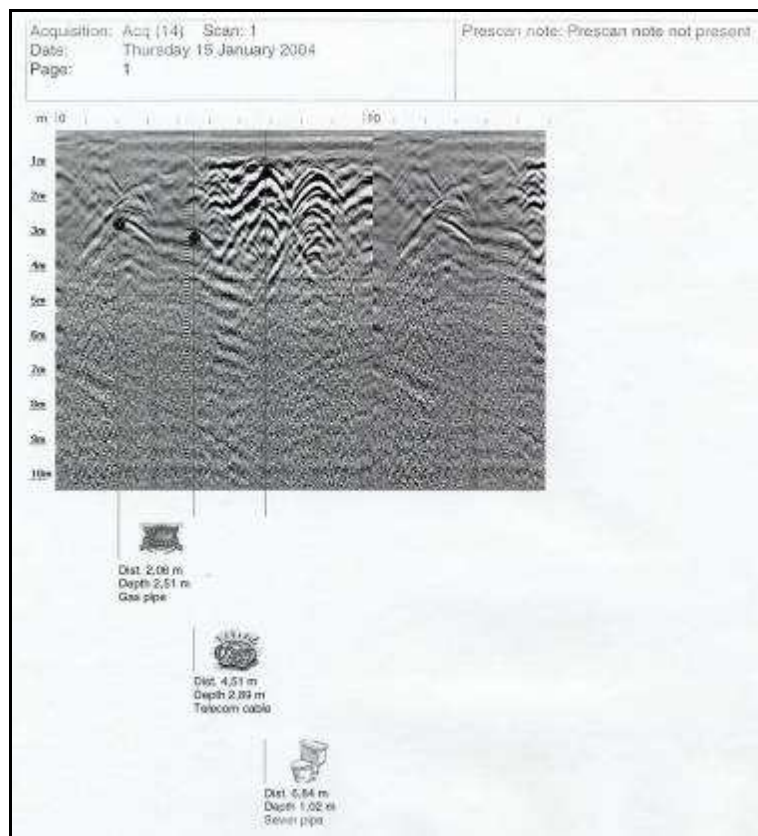
Fig. 5.28 – Final printout of a radar map

➢ press the [End program] button to close the program.

The window shown in Fig. 5.29 reminds you to disconnect the power supply cable from the Control Unit to avoid wasting battery charge.

Fig. 5.29 – Closing the program

5.5 Error messages

Error messages found in the program are listed below (in italics) followed by their solutions:

➢ *Network error. Retry or check hardware!*

Check that the network cable is connected properly to the PC and the Detector Control Unit. Try restarting the program.

➢ *New depth must be > 0. Please insert new value to continue.*

➢ *New depth must be > 0. Unable to set the depth*

➢ *New depth missing. Please insert value to continue.*

Select a new value for the depth of the identified pipe.

➢ *Warning. Unable to print on the selected printer*

Check that the printer is switched on and connected to the computer.

➢ *Unable to review: calibration file has been lost.*

The calibration files for the selected survey have been deleted. To be able to see the data, the Igr.bkg and Igr.stc files have to be copied from the main program directory (C:\DetectorDuo\) into the survey directory.

➢ *Unable to review: mark file has been lost*

A system file has been deleted, making it impossible to review the selected acquisition.

➢ *Unable to mark: marker already present at this distance!*

You have tried to insert a pipe in a point already containing one; select a new point.

➢ *Gain calibration has been skipped (or lost). Calibrate gain to proceed.*

➢ *Unavailable: gain calibration has been skipped (or lost).*

➢ *Unavailable: gain calibration has changed.*

A calibration has to be performed to be able to acquire data. See Paragraph 5.3.2. for calibration instructions

➢ *Unavailable: directory has been lost.*

The last acquisition cannot be recovered , select a new acquisition

6. WORK PROCEDURE FLOWCHART

```
┌─────────────┐
│    USE      │
│  TECHNICAL  │
│    MAPS     │
└──────┬──────┘
       │
┌──────▼──────┐
│ INSPECTION  │
└──────┬──────┘
       │
┌──────▼──────┐                    ┌─────────┐
│    OPEN     │                    │  PRINT  │
│  MANHOLES   │                    └────▲────┘
└──────┬──────┘                         │
       │                    ┌───────────┴──────────┐
┌──────▼──────┐             │  REVIEW              │
│  ASSEMBLE   │             │  ACQUIRED MAPS       │
│  DETECTOR   │             │  (SHALOW/DEEP)       │
│    DUO      │             └──────────▲───────────┘
└──────┬──────┘                        │
       │                    ┌──────────┴─────────┐   ┌──────────────┐
┌──────▼──────┐             │       END          │   │  ESTIMATE    │
│ SWITCH ON   │             │    SCANNING        │   │ PROPAGATION  │
│ DETECTOR    │             └──────────▲─────────┘   │    SPEED     │
│    DUO      │                        │             └──────▲───────┘
└──────┬──────┘          YES           ◆                    │
       │◄──────────────────────── CHANGE                    │
┌──────▼──────┐                   IN ──────────┐   ┌────────┴──────┐
│    GAIN     │               GROUND           └──►│               │
│ CALIBRATION │                TYPE                └───────────────┘
└──────┬──────┘                   ◆                       ▲
       │                      NO                          │
┌──────▼──────┐                                    ┌──────┴───────┐
│   SELECT    │◄────────────────                   │     GO       │
│   SURVEY    │◄──────────────────────────         │    BACK      │
└──────┬──────┘                                    └──────▲───────┘
       │◄─────────────────────────────────                │
┌──────▼──────┐                          ◆                 │
│ SCAN: PUSH  │              NO          PIPE              │
│  TROLLEY    │───────────────────────►  OR   ──── YES ────┘
└─────────────┘                          CABLE
                                          ◆
```
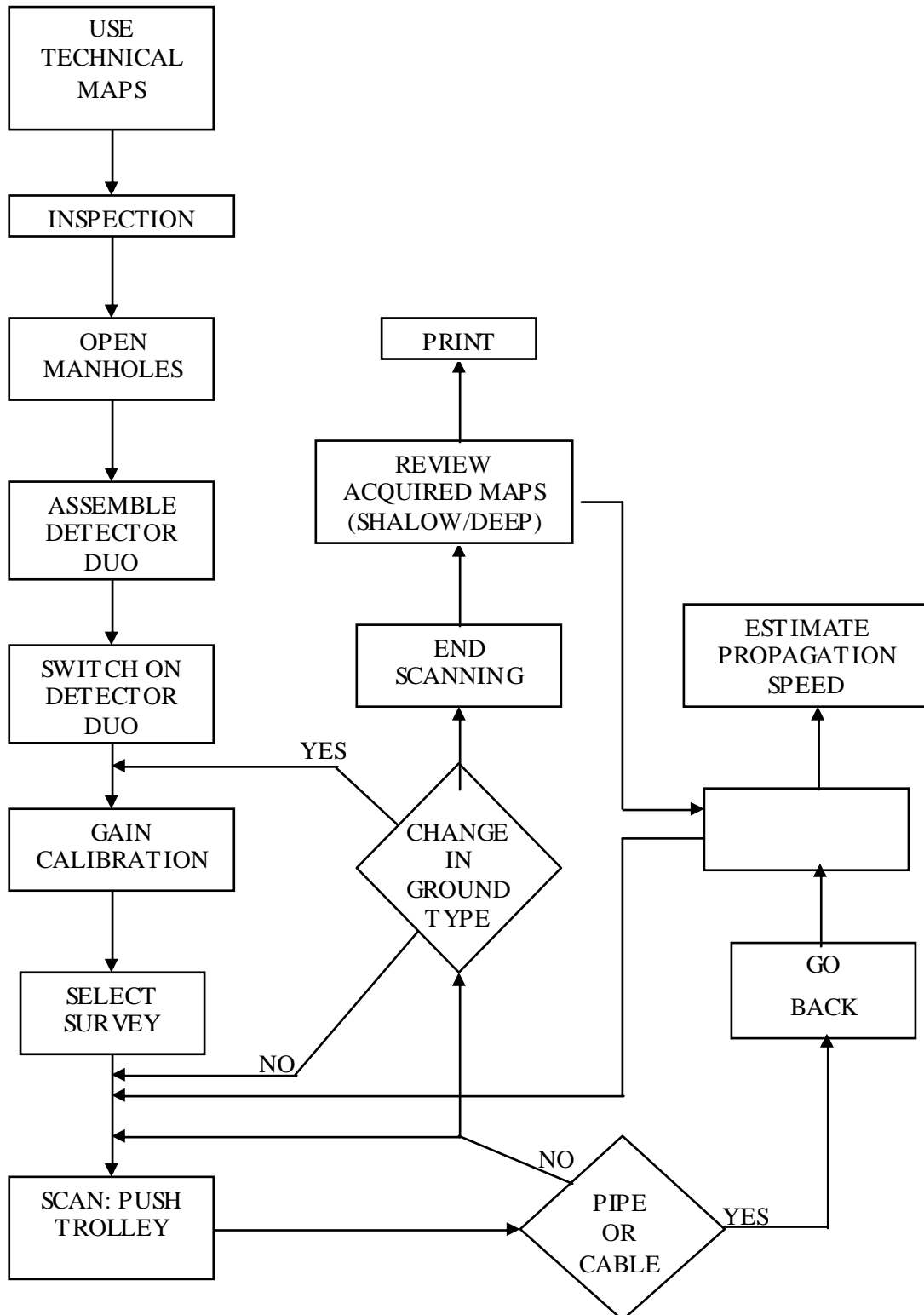
7. HOW TO USE THE DETECTOR

The main targets when performing utilities investigations with the DetectorDuo consist of either extended structures (such as an interface between layers, pipes parallel to the investigation direction etc.) or quite small structures (such as pipes perpendicular to the investigation direction, cavities and rocks etc.).

Fig. 7.1 shows how a flat interface gives rise to a flat trace while a small structure such as a pipe produces a hyperbolic trace. This is because the echoes form the flat plane at different values of x take the same time to reach the DetectorDuo. For the pipe, however, the echoes from its sides take a longer time to reach the DetectorDuo than the echoes from its top surface.
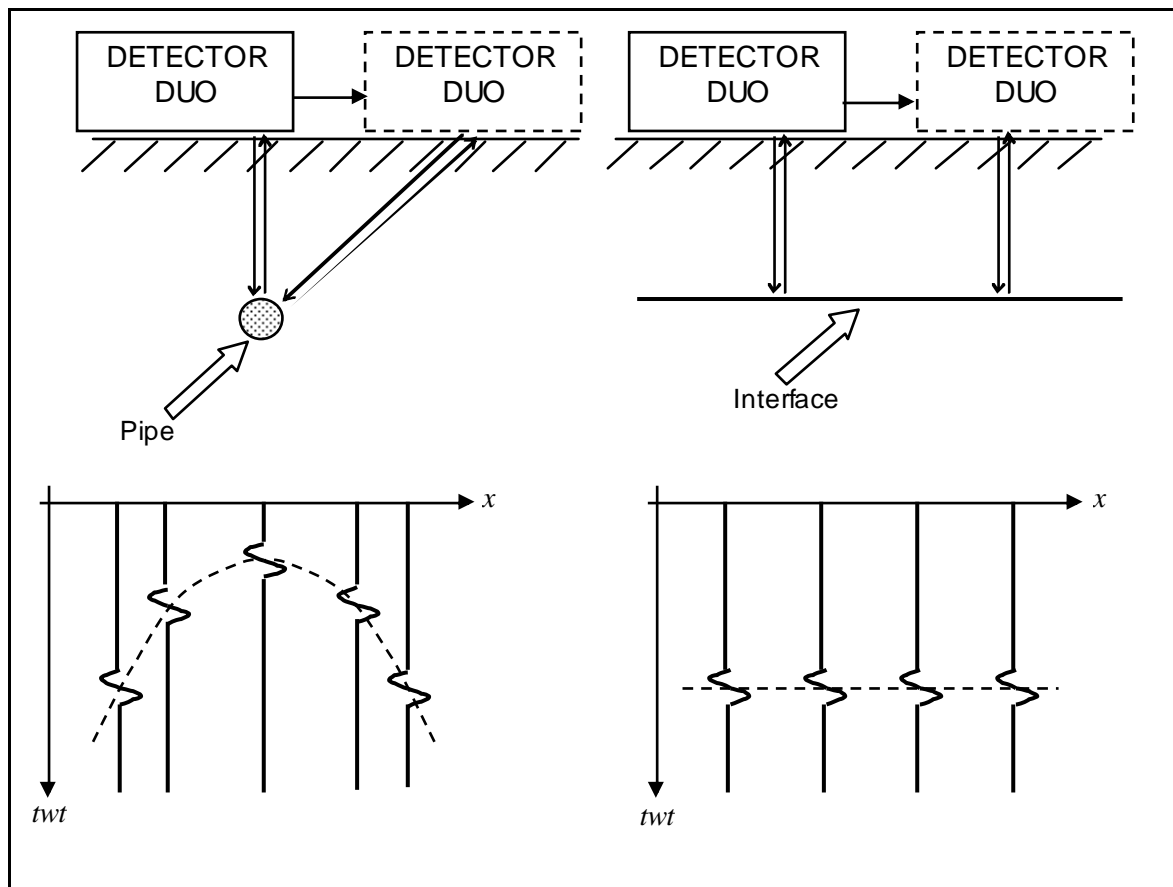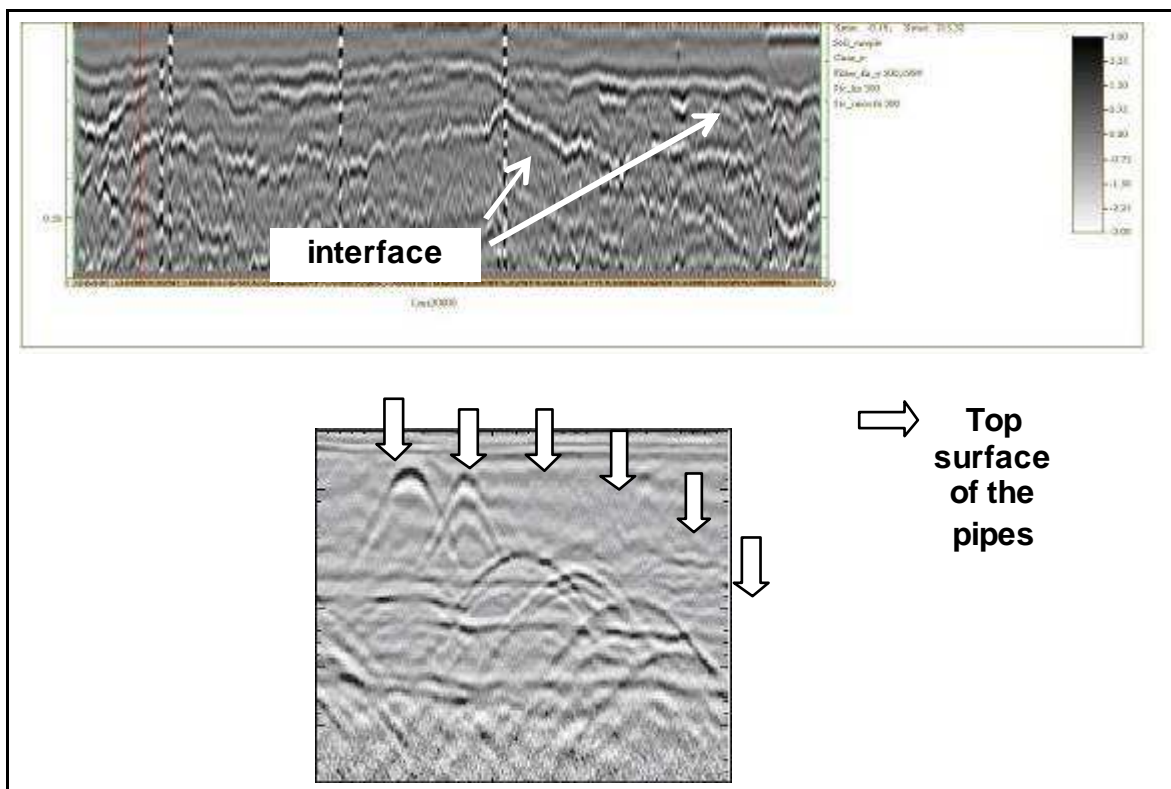

Fig. 7.1 – Trace of a pipe perpendicular to the direction of investigation and a flat interface

The aperture of a hyperbola depends on various factors:

o As the propagation speed in the medium increases (v_m), the ratio between the flight time of the outwards and return signal *twt* relative to echoes originating from lateral points and the *twt* relating to the top surface of the target decreases. Therefore the hyperbola widens with higher propagation speed, v_m.

o With increasing depth of the target, the ration between the *twt* relating to the echoes from the side points and the *twt* relating to the top surface of the target decreases. Again, the hyperbola widens with increasing target depth.

o For equal propagation speed, depth and type of target, the hyperbola will be wider for geometrically larger targets (for examples for wider diameter pipes).

When interpreting the maps, it is therefore a good idea to remember that the width of a hyperbola does not just depend on the geometrical size and shape of the target. Fig. 7.2 shows two maps featuring echoes of an irregular interface between two layers with different dielectric properties (asphalt) and six pipes situated perpendicularly to the direction of investigation.

Fig. 7.2 – Maps showing traces of an interface and pipes perpendicular to the direction of investigation

As can be seen in Fig. 7.2, the echo of a target doesn't simple consist of a single dark band, it consists of alternate dark and light bands. These derive from the signal minimums and maximums reflected back from the target (in fact, the black and white bands represented in the figure correspond to maximum and minimum signal amplitude respectively). A hyperbolic echo can be used to convert the ordinate of the map from time (nanoseconds = ns) to depth (meters= m). To do this, the hyperbola traced in ns ordinates is compared with a family of hyperbolas traced with ordinates in meters, obtained from that in ns ordinates with various values of v_m. The best v_m approximation to the real value is that with the most similar aperture to that of the one traced in time ordinate. Once v_m has been identified, the depth of the target corresponding to the hyperbolic section can be found. There are no definitive criteria for interpreting diagrams and often you have to depend on experience. In any case, it is best to collect the largest possible amount of information for an area under investigation, and use it to help choose the most appropriate equipment and investigation parameters. To conclude, we have an example below of a real situation featuring two pipes side by side (Fig. 7.3). This example is significant in that it shows the diagrams of the same structure (the pipe) placed perpendicularly then parallel to the direction of investigation.
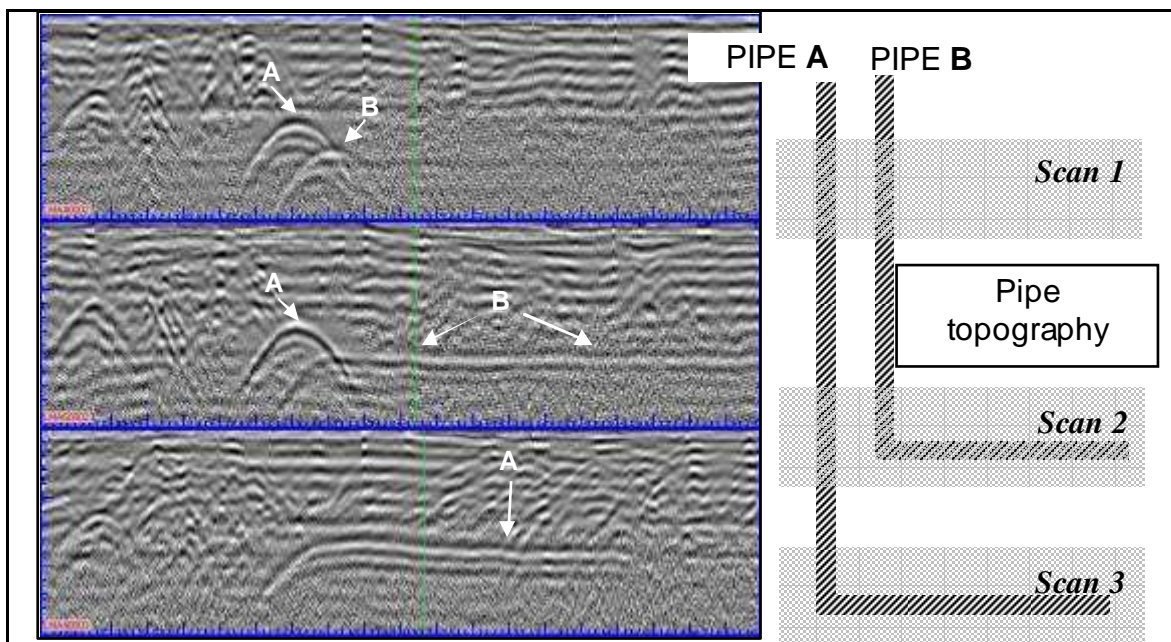
Fig. 7.3 – Example of map interpretation

8. ON LINE ASSISTANCE

8.1 Remote assistance using Webex Support Center

Webex Support Center is a service that allows the activation of a two host session, making an application, or the desktop available to the other user or letting you capture another remote desktop.

It can be used to perform web conferences and presentations.

It is easy to use thanks to its simple and intuitive interface.

Since there are no firewalls or other types of network configurations, it is a fast and secure means of reaching any client host in any part of the world. In fact, the client only has to accept to download a small plug used to permit the service authentication and functioning.

8.1.1 How to use the Webex service

You will receive an email from IDS Customer Care containing a link to the support session (see Fig. 8.1).
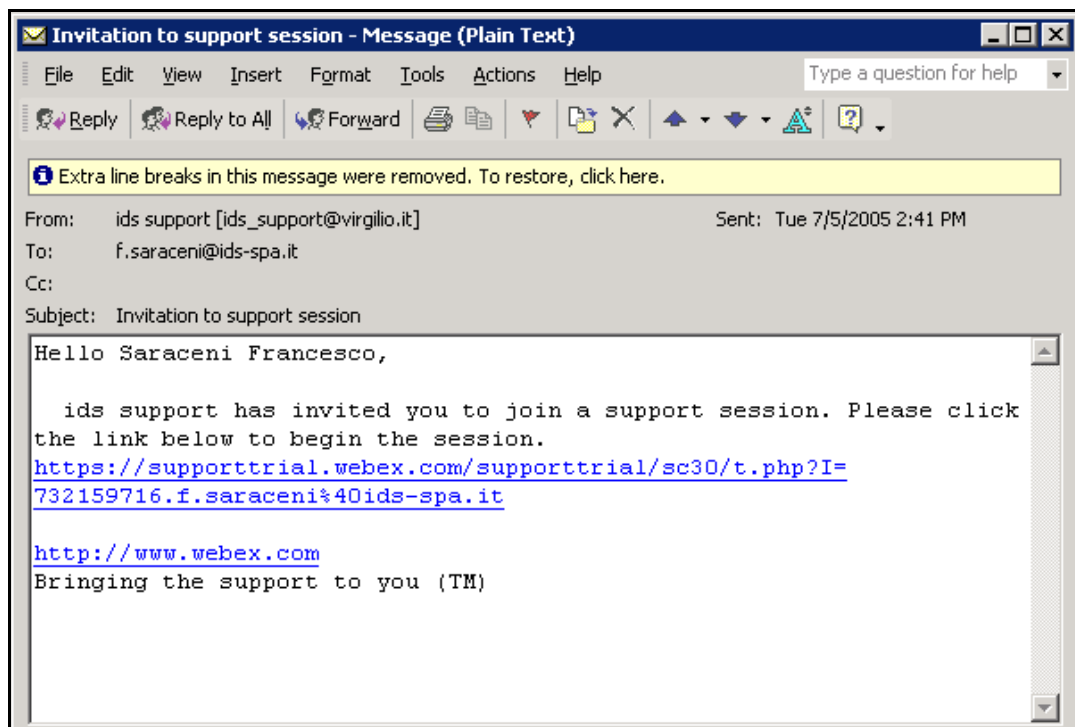
Fig. 8.1 – Mail sent by IDS to the client

Once you have clicked on the link sent by email, the following window will appear. Insert your data into the form (see Fig. 8.2).
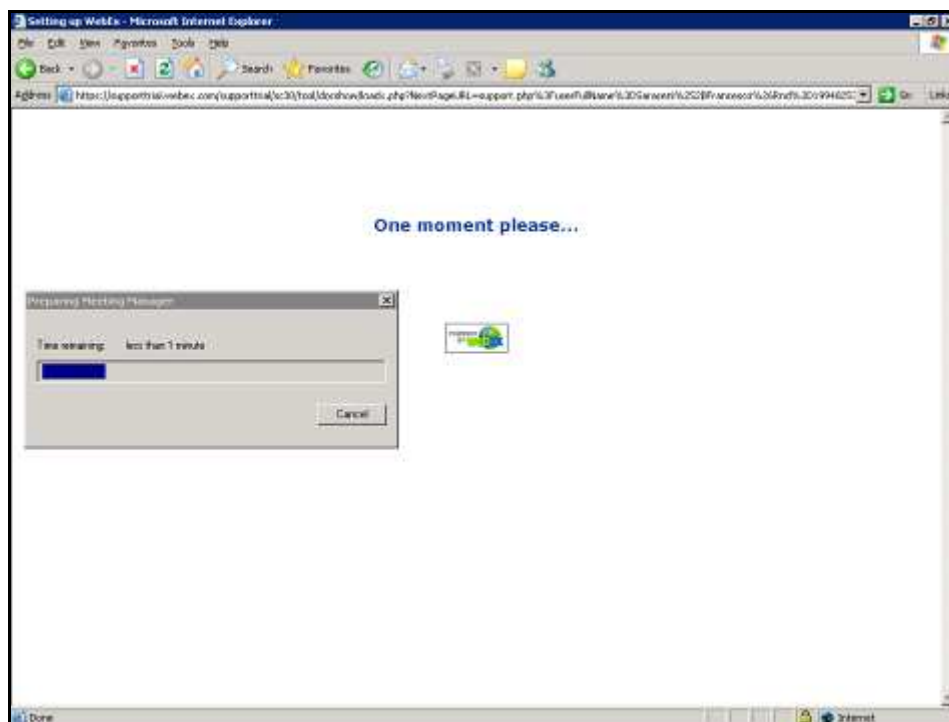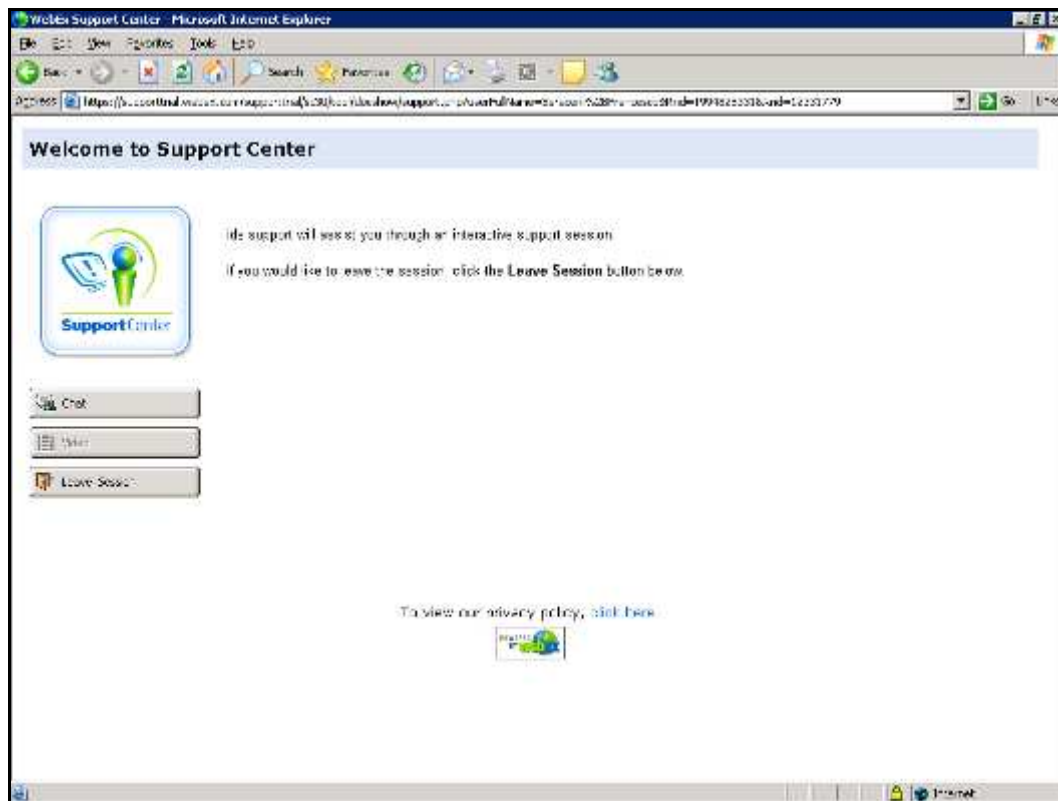
Fig. 8.2 – Client data insertion form

Once you have clicked **Submit,** the following page will appear showing a downloading bar. The session starts as soon as the download is complete. (see Fig. 8.3).

Fig. 8.3 – Webex Set up window

As you can see from the following screen (Fig. 8.4) you are given a console, just containing the **Chat**, **Video** and **Leave Session** commands.

Fig. 8.4 – Welcome to Webex Support Center window

At this point, IDS Customer Care can perform a range of operations on your desktop:

- Request control of the desktop using the Request Control command.

- Give you control of the IDS desktop using the Share Control command.

- Request to display the remote desktop using Request View.

- Share the visualisation of the IDS desktop using Share View.

Before each command is activated, you are asked for confirmation through the following window (Fig. 8.5).
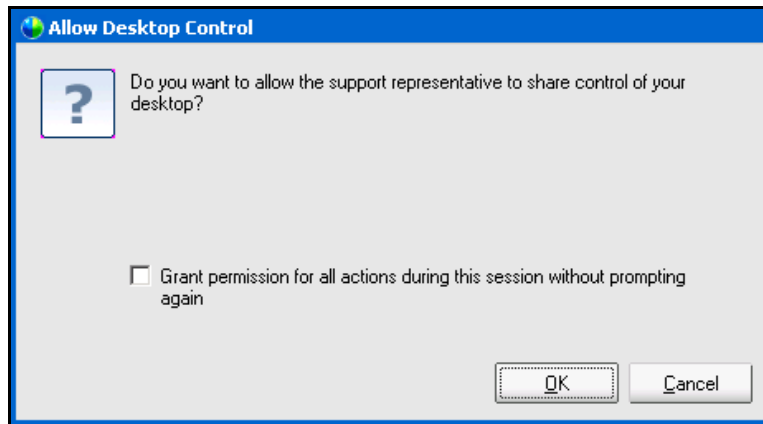
Fig. 8.5 – Command acceptance window

APPENDIX A - THE PRELIMINARY INVESTIGATION

The first fundamental phase for any field survey consists in the preliminary investigation: its scope is to acquire all the necessary information for the logistics of the operation, taking into account the objectives to be performed.

In the specific case of a georadar investigation for underground utilities searching, the first thing to consider is the accessibility of the site, in terms of taking into account the space available for the passage of the antenna trolley and considering any architectural obstacles that could cause an obstacle to the data acquisition phase. Often, in fact, the investigation is performed in streets, squares and on pavements with a relatively high level of urban traffic, and above all, in the presence of randomly parked cars.

The main points to be considered during this phase are described below:

➤ Specific permissions must be obtained (access to pedestrian zones, permission to interrupt the traffic flow, etc.);

➤ Any difficulties in accessing the site must be considered;

➤ The space available;

➤ The presence of parked cars;

➤ The level of traffic;.

It is the task of the user to take these points into consideration when programming the work.

APPENDIX B - THE TECHNICAL MAPS

Technical maps of the existing utilities are produced by the various utilities companies.

These give general indications in a schematic way about the type and position of the utilities that are managed and/or have been constructed by them.

These maps can be requested by faxing or writing to the cartographic or planning office of the companies, specifying clearly the streets and areas of interest.

The most important types of utilities (which may be managed by different agencies) to be considered are:

➢ Public Street Lighting

➢ Low, Medium and High Voltage Electricity Cables

➢ Water supply

➢ Gas

➢ Telephone Cables

➢ Sewers

Even though they may be very generic, these maps represent an important support during the extraction and data interpretation phases, since they give the user a first idea, if not an exhaustive one, of the utilities that are present.

For this reason, it is important that the user activates the procedures for obtaining these maps well in advance to make sure that they will be available during the data extraction phase.

APPENDIX C - OPENING MANHOLES

This phase is normally performed once the acquisition phase has been completed, and consists in opening the manholes present in the investigated site.

The data regarding the depth, diameter, and direction of the utility should be saved on the work sheet: this will provide you with further reference data during the interpretation phase, and will allow propagation velocity estimates to be performed in order to calculate the depth of the identified utility as precisely as possible.