C-thrue

All-in-one Ground Penetrating Radar (GPR) for Non-Destructive Testing of Concrete Structures

User Manual

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1 INTRODUCTION

This document describes the C-thrue radar system, and it refers to the concepts the user should learn before initiating the utilization of this device. Therefore, it is mandatory to carefully reading the entire document before starting the system.

This manual contains a complete description of the C-thrue radar system, detailing the assembly procedure, and the operating procedures of the system.

1.1 Purpose

Reading this document will provide all the necessary knowledge relating to:

- System description and set up.
- Safe utilization of the system and instructions for its general maintenance.
- Use of the acquisition software and managing the results.

1.2 Application field

This system is dedicated to locating rebars, voids, post-tension cables, cavities, conduits, and any other object embedded into the structure, before cutting or drilling the concrete. It can be used in every construction sites and operations including building renovation, overpasses, bridges and tunnels surveys, as well as for detailed analysis of the original engineering project and comparison with the as-built structure.

1.3 Authorization for use – national restriction

The use of C-Thrue system may be subject to a license and/or an authorization by the Competent Ministry of the country where the system will be used.

An individual license and restrictions are in place to date in the following European countries:

France: https://www.anfr.fr/en/broadcasting-authorisation/reseaux-professionnels/les-frequences-utilisees-a-titre-temporaire/les-systemes-dimagerie-radar-de-type-gpr-wpr/

Germany: https://www.bundesnetzagentur.de/SharedDocs/Downloads/DE/Sachgebiete/Telekommunikation/Unternehmen_Institutionen/Technik/InverkehrbringenvonProdukten/Schnittstellenbeschreibungen/OrtungsfunkOR/SSBOR_NN022.pdf?__blob=publicationFile&v=4

Portugal: https://www.anacom.pt/render.jsp?categoryId=389647

Romania: https://www.ancom.ro/radio-spectrum_2749

Spain: https://www.boe.es/diario_boe/txt.php?id=BOE-A-2011-19146

Sweden: https://www.pts.se/sv/bransch/radio/radiotillstand/ansokningshandlingar/

Liechtenstein and Switzerland: https://www.bakom.admin.ch/bakom/en/homepage/frequencies-and-antennas/frequency-use-with-or-without-licences/radiocommunication-licences-in-general.html

For more details with reference to the restriction, please refer to the following website:

ECO Frequency Information System (cept.org)

	CH	DE
	ES	FR
	LI	PT
	RO	SE

The use of the C-thrue Remote Desktop Connection (RDC) may be subject to local regulations.

In Europe, according to the ECC Decision ECC/DEC/(04)08, the use of the RDC is authorized for indoor use only.

1.4 CE Marking

This equipment complies with the essential requirements and other relevant provisions of Directive 2014/53/UE. The full Declaration of its Conformity can be found either on the CD or a separate document included with this product.

This is a Class A product. In a domestic environment it may cause radio interference. If so, the user may need to take adequate measures.

1.5 UKCA Marking

This equipment complies with the essential requirements of the Radio Equipment Regulations 2017 (S.I. 2017/1206). The full Declaration of its Conformity can be found either on the CD or a separate document included with this product.

Licensing requirements in UK can be found here: https://www.ofcom.org.uk/manage-your-licence/radiocommunication-licences/licensed-short-range

1.6 Intended readership

The intended reader of this manual should be the technician in charge of using the system that has undergone the IDS GeoRadar training for C-thrue.

2 HOW TO READ THE MANUAL

2.1 Manual Layout

This manual is composed of several parts. After an Introduction, the first part describes the device and its components, with the explanation of the main features.

The second part shows the procedure to setup the device and how to configure it correctly (Assembly Procedure).

The third part illustrates the main features of the software, and its use on the work field.

Eventually, the maintenance plan, and additional information are illustrated.

2.2 Glossary & Acronyms

DAD: Digital Antenna Driver

RADAR: RAdio Detection and Ranging

LASER: Light Amplification by Stimulated Emission of Radiation

USB: Universal Serial Bus

GPR: Ground Penetrating Radar

AC: Alternate Current

HF: High Frequency

Q.R: Quick Response Code

2.3 Glossary & Acronyms

Raw data: unprocessed data obtained during a field survey.

Maps: graphics showing the change in received radar signal with respect to the scanning direction.

Survey: the name given to a collection of acquisitions, which together cover all the areas of an investigation: typically, an entire job area.

Scan: a single movement of the system from the beginning to the end of a pre-established path.

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

Encoder: a distance measurement device which constantly signals the distance travelled from the start of the scan back to the Control Unit.

Transmitter: part of the antenna dedicated to emitting the radar signals.

Receiver: part of the antenna dedicated to detecting the radar signals.

Receiver: part of the antenna dedicated to detecting the radar signals.

Augmented reality: Digital on-site representation of data and targets through the external PC.

2.4 Symbols

Warning messages are an essential part of the safety concept of the instrument. They appear wherever hazards or hazardous situations can occur.

Type	Description
WARNING	Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.
DANGER	Indicates a potentially hazardous situation or an unintended use which, if not avoided, could result in death or serious injury.
CAUTION	Indicates a potentially hazardous situation or an unintended use which, if not avoided, may result in minor or moderate injury.

In particular, warning messages:

- make the user alert about direct and indirect hazards concerning the use of the product.
- contain general rules of behavior.

For the user's safety, all safety instructions and safety messages shall be strictly observed and followed. Therefore, the manual must always be available to all persons performing any tasks described herein.
DANGER, **WARNING**, **CAUTION** and are standardized signal words for identifying levels of hazards and risks related to personal injury and property damage.
For your safety it is important to read and fully understand the table below with the different signal words and their definitions. Supplementary safety information symbols may be placed within a warning message as well as supplementary text.

The following messages can be inserted to stress some procedure or to give some advice to the user:


Note text to keep in mind


Tip text

3 SAFETY DIRECTIONS

3.1 Description

The following directions enable the person responsible for the product, and the person who uses the equipment, to anticipate and avoid operational hazards.
The person responsible for the product must ensure that all users understand these directions and adhere to them.

3.2 Definition of Use

Intended use:

- Concrete inspections.
- Rebars and void detection and mapping.
- Measuring horizontal and vertical position of rebars and void.
- Creation of concrete tomography imaging.

3.3 Reasonably Foreseeable Misuse

- Use of the product without instruction.
- Use outside of the intended use and limits.
- Opening the product using tools, for example screwdriver, unless this is permitted for certain functions.
- Modification or conversion of the product.
- Use after misappropriation.
- Use of products with obvious damages or defects.
- Use with accessories from other manufacturers without the prior explicit approval of IDS GeoRadar s.r.l
- Inadequate safeguards at the working site.

3.4 Limits of Use

Environment: Suitable for use in an atmosphere appropriate for permanent human habitation. Not suitable for use in explosive environments.

DANGER: Local safety authorities and safety experts must be contacted before working in hazardous areas, or close to electrical installations or similar situations by the person in charge of the product.

3.5 Responsibilities

Manufacturer of the product - IDS GeoRadar s.r.l. is responsible for supplying the product, including the user manual and original accessories, in a safe condition.

Person responsible for the product - The person responsible for the product has the following duties:

- To understand the safety instructions on the product and the instructions in the user manual.
- To ensure that it is used in accordance with the instructions.
- To be familiar with local regulations relating to safety and accident prevention.
- To inform IDS GeoRadar s.r.l. immediately if the product and the application becomes unsafe.
- To ensure that the national laws, regulations and conditions for the operation of electromagnetics transmitters are respected.

3.6 Hazard of use

CAUTION: Watch out for erroneous measurement results if the product has been dropped or has been misused, modified, stored for long periods or transported.
Precautions:
Periodically carry out test measurements and perform the field adjustments indicated in the user manual, particularly after the product has been subjected to abnormal use and before and after of important measurements

DANGER: Because of the risk of electrocution, it is dangerous to use poles and extensions near electrical installations such as power cables or electrical railways.
Precautions:
Keep at a safe distance from electrical installations. If it is essential to work in this environment, first contact the safety authorities responsible for the electrical installations and follow their instructions.

WARNING: During dynamic applications, for example stakeout procedures there is a danger of accidents occurring if the user does not pay attention to the environmental conditions around, for example obstacles, excavations or traffic.
Precautions:
The person responsible for the product must make all users fully aware of the existing dangers.

CAUTION: If the accessories used with the product are not properly secured and the product is subjected to mechanical shock, for example blows or falling, the product may be damaged.
Precautions:
When setting-up the product, make sure that the accessories are correctly adapted, fitted, secured, and locked in position.
Avoid subjecting the product to mechanical stress.

WARNING: Inadequate securing of the working site can lead to dangerous situations, for example in traffic, on building sites, and at industrial installations.
Precautions:
Always ensure that the working site is adequately secured. Adhere to the regulations governing safety and accident prevention and road traffic.

WARNING: Only IDS GeoRadar authorized technical service are entitled to repair this product.

WARNING: If the product is improperly disposed of, the following can happen:

• If polymer parts are burnt, poisonous gases are produced which may impair health.

• If batteries are damaged or are heated strongly, they can explode and cause poisoning, burning, corrosion or environmental contamination.

• By disposing of the product irresponsibly you may enable unauthorized persons to use it in contravention of the regulations, exposing themselves and third parties to the risk of severe injury and rendering the environment liable to contamination.

Precautions:

RECYCLING 

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 GeoRadar. When you decide to dispose of the equipment, contact IDS GeoRadar and follow the system that IDS GeoRadar 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.

WARNING: If the product is used with accessories, you may increase the risk of being struck by lightning.

Precautions:

Do not use the product in a thunderstorm

WARNING: High mechanical stress, high ambient temperatures or immersion into fluids can cause leakage, fire or explosions of the batteries.

Precautions:

Protect the batteries from mechanical influences and high ambient temperatures. Do not drop or immerse batteries into fluids.

WARNING: During the transport, shipping or disposal of batteries it is possible for inappropriate mechanical influences to constitute a fire hazard.

Precautions:

Before shipping the product or disposing of it, discharge the batteries by running the product until they are flat.

When transporting or shipping batteries, the person in charge of the product must ensure that the applicable national and international rules and regulations are observed. Before transportation or shipping contact your local passenger or freight transport company.

4 C-THRUE HARDWARE DESCRIPTION

4.1 General

The C-thrue and its accessories are delivered within a dedicated suitcase, Fig. 1 :

Fig. 1 – C –thrue suitcase.

The C-thrue system is composed by the following parts:

- C-thrue unit.
- 2 rechargeable, 15 Volts, Li-ion batteries.
- Battery charger (with universal adapter)
- Safety lace to hook the system to the wrist
- Six reflective bars for 2D positioning system
- Adhesive gum for 2D positioning system
- Grid paper pad
- USB key including user manual and printable paper sheet

The whole system is shown in Fig. 2 and Fig. 3.

Fig. 2 – The C-thrue.

4.1.1 C-thrue main body

The main body of the system consists of the following parts (Fig. 3 – Image of the C-thrue and its main components.):

- Multi-Touchscreen for the embedded PC.
- Integrated Control unit
- 4 wheels for distance measurement and encoder-to-DAD input
- Handle
- Battery compartment

- USB port for radar data transfer, software and firmware updating, Fig. 4.
- Power button to switch on/off the system, Fig. 4.
- Auxiliary connector, Fig. 4.

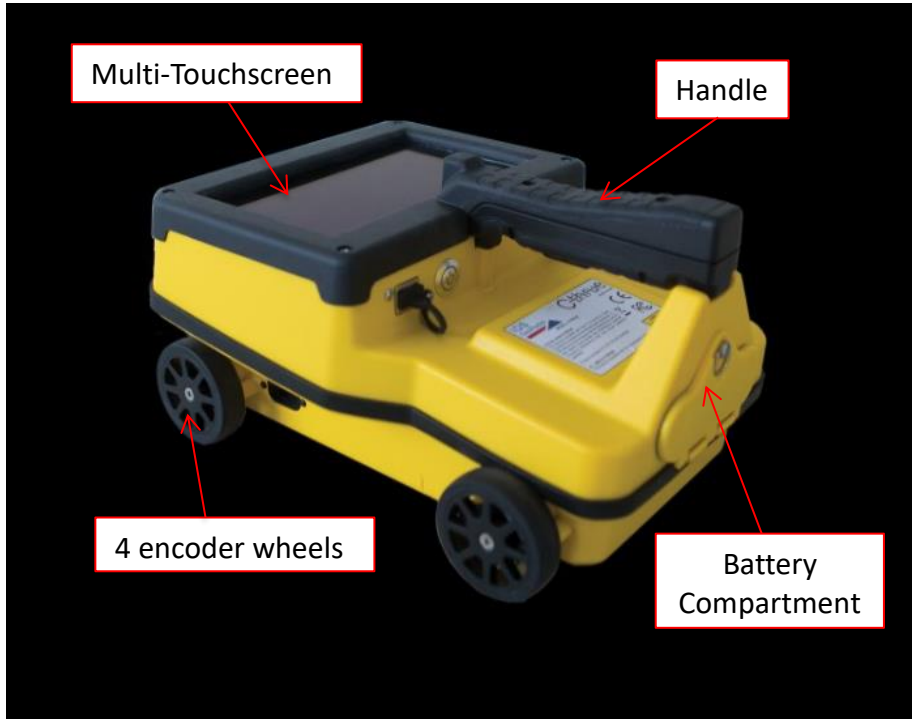


Fig. 3 – Image of the C-thrue and its main components.

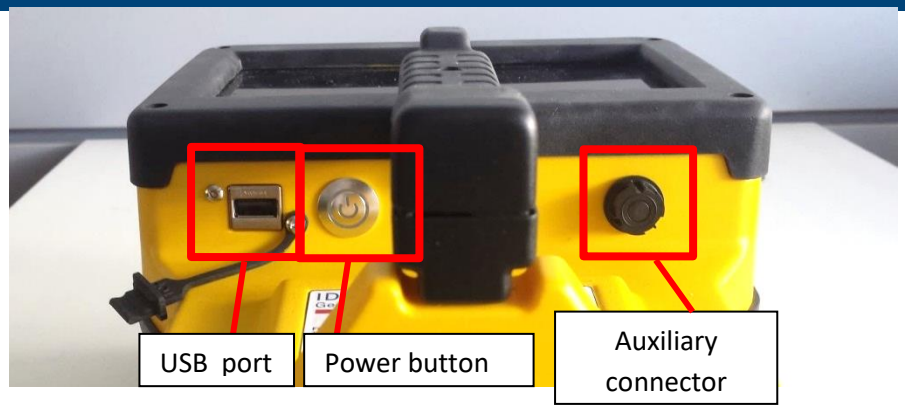


Fig. 4 – Detail of the USB port, Power button and remote-control connector interfaces.

The USB port use is intended only for survey folder transfer, firmware and software updating through USB stick. Do not insert in the USB port any other type of external device.

4.1.2 Antenna

The C-thrue System is developed with a dual polarization antenna, with a central frequency of 2 GHz.

Dual polarization permits detection on both first and second levels of rebars. (Fig. 5). The offset between the deep and shallow antenna centre, is 10 cm (see Fig. 5 and Fig. 6).

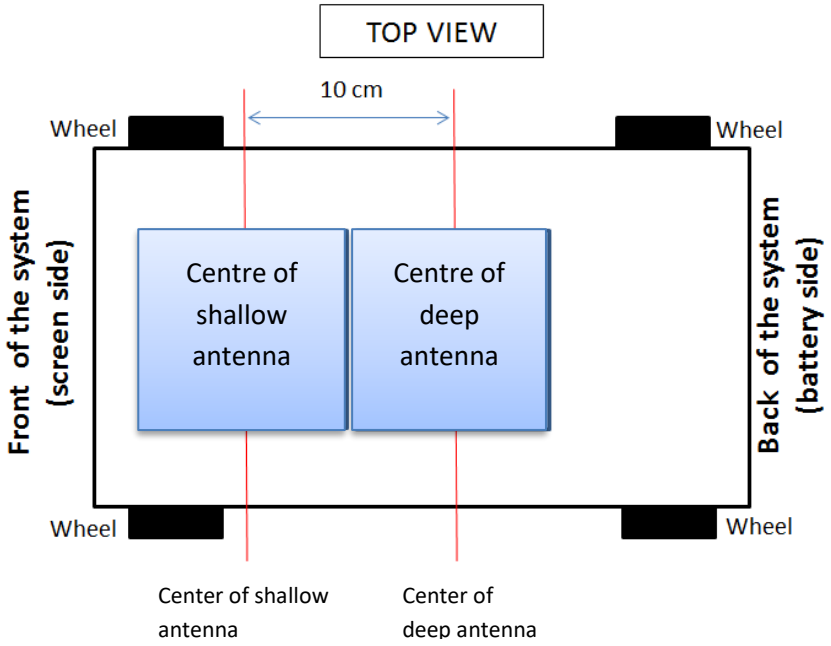


Fig. 5– C-thrue Internal sketch.

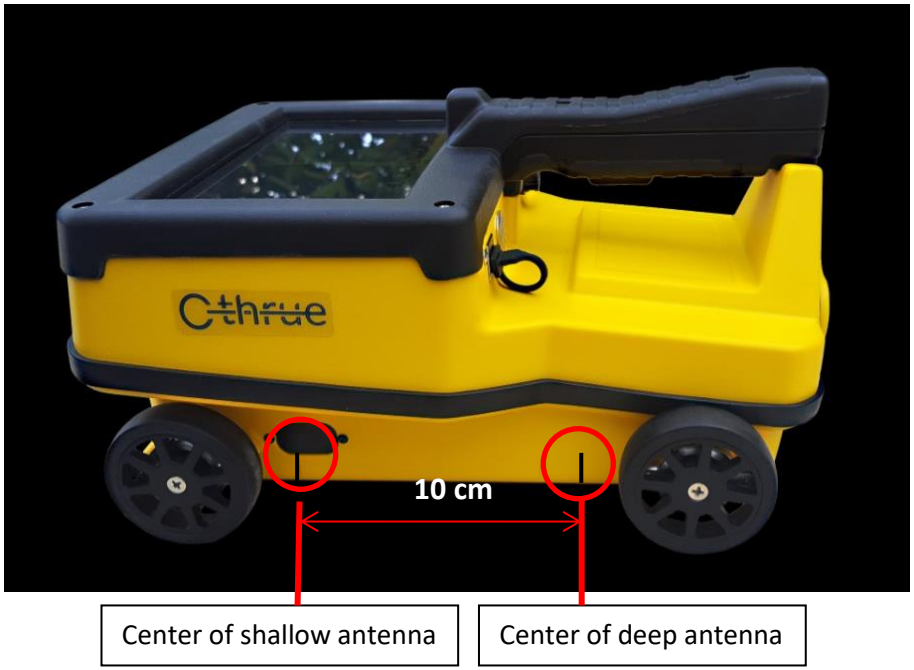


Fig. 6 –Deep and shallow centre position.

Note that, to catch the real position of rebars, the reference system centre of C-thrue is located in the front of the system. This is the reference point for position markers and target markers (Fig. 7).

Fig. 7 – Reference point for position marker and target marker.

4.1.3 Wheels

The C-thrue is able, at the same time, to collecting distance and radar data, both forward and backward, regardless which one of the four wheels is in direct contact with the surface.

This feature ensures that the distance is correctly registered even in rough surface when, at times, not all the wheels are in contact with it (Fig. 8).

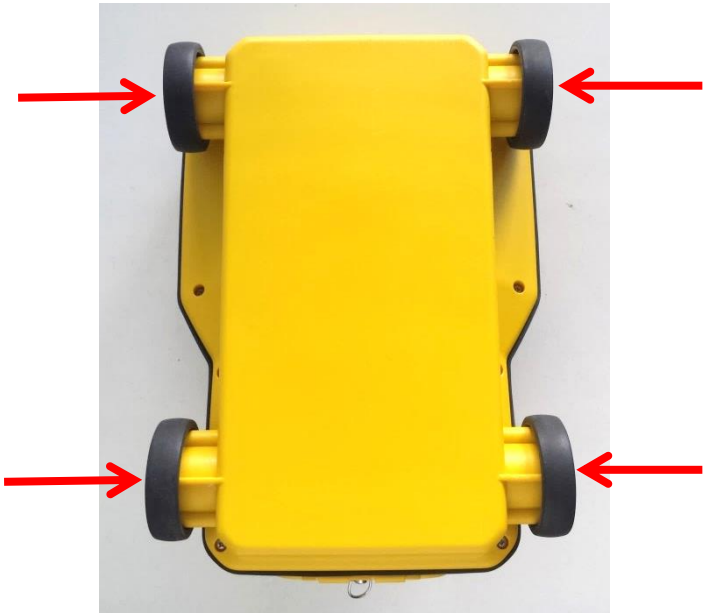


Fig. 8 – Wheel encoder (red arrows).

4.1.4 Lasers

Three laser interfaces are integrated in the main body of the C-thrue.
One is in the front part, and the other two are in the right and left side of the system (Fig. 9). They are mounted exclusively for the 2-D positioning system used with reflective bars (Par 4.4).

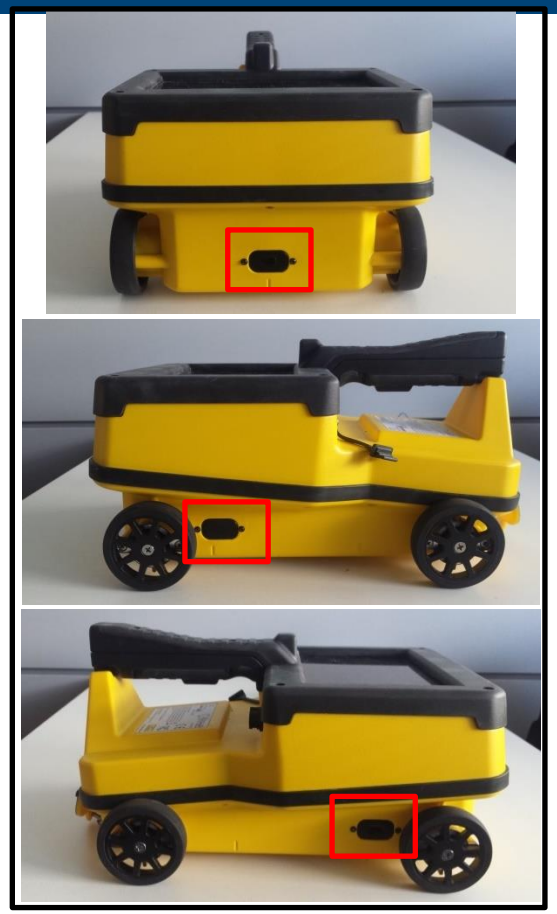


Fig. 9 – Lasers position on C-thrue main body.

This is a CLASS 1 Laser. This means that the laser is not detected by a naked eye and is not dangerous for the eyes itself.

4.1.5 Handle

The C-thrue handle (Fig. 10) is ergonomic and designed to operate the system only with one hand.

Fig. 10 – C-thrue handle.

A safety tie (Fig. 11) is provided to attach the system to the wrist.

Fig. 11 – Safety tie.

The User should make a knot around the C-thrue handle with the slimmest part of the lace, and then wear the lace on wrist from the wider side of the lace (Fig. 12).

Fig. 12 – How to use the lace/tie.

In the upper part of the handle there is a start/stop acquisition and positioning marker button (Fig. 13, red square) easy to use with the thumb (Fig. 13).

For FCC rules and regulations, there is an additional button under the handle (blue square, Fig. 13). It is necessary to hold this button during the acquisition, release at the end of it. The acquisition is stopped after about one second after the release of the button. Use only the forefinger to use the button.

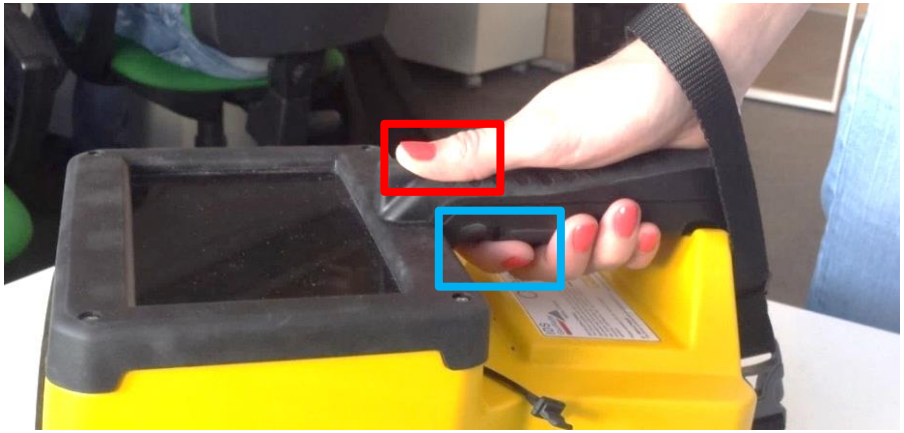


Fig. 13 – Button for start/stop acquisition and marker positioning (red square) and the additional button (blue square) for FCC regulations.

4.2 Batteries

The C-thrue is powered by rechargeable Li-ion Battery (15V-3.2Ah) with 2.5 hours runtime (Fig. 14).

The system is supplied with three batteries.

Fig. 14 – Li-ion batteries for C-thrue.

The C-thrue Li-Ion Battery is lodged in the rear part of the system, under the handle.

To open the battery compartment cover, the user should make a ¼- turn left screw. Turn to the right side to close it. Insert the battery from rear side of the system as shown in the following pictures (see Fig. 15).

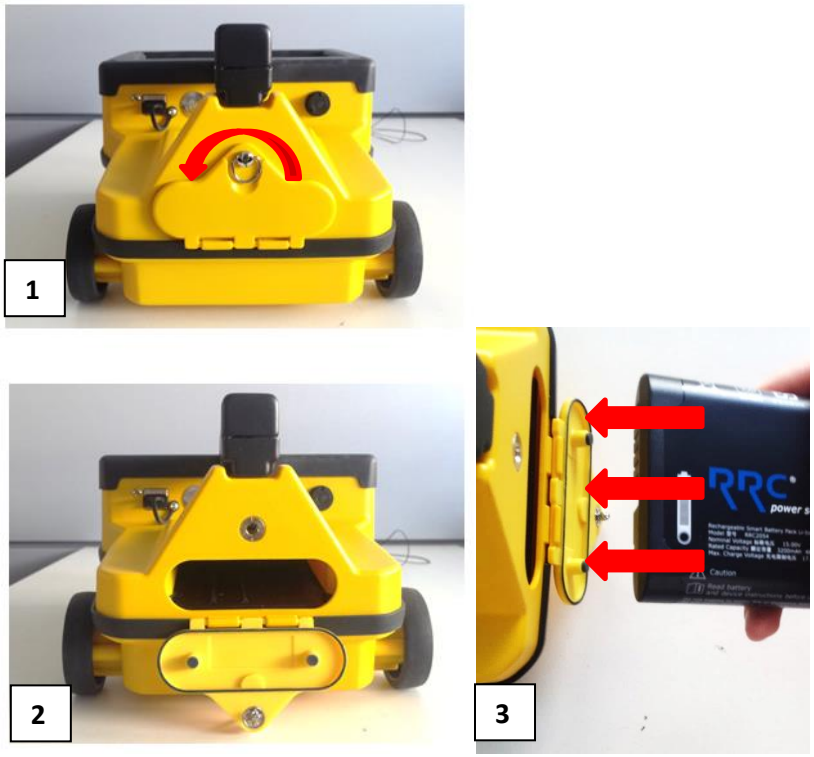


Fig. 15 – Battery compartment cover.

4.3 Battery charger

The battery charger (Fig. 16) must be connected to the electricity mains at AC 110/220V.

It is composed of three parts: an electrical transformer, a cable from transformer to the main AC, and battery housing. (see Fig. 16).

The battery charging is concluded when the LED turns green.

Fig. 16 – Battery charger components.

4.4 Reflective Bars for system positioning

The C-thrue is provided with positioning bars kit (Fig. 17) allowing the User to create a local reference system axis. Thanks to their reflective side (Fig. 18), on board Lasers are able to detect them, measuring distances.

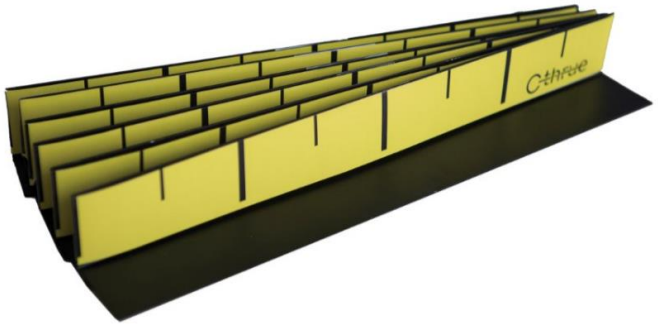


Fig. 17 – Positioning bars.

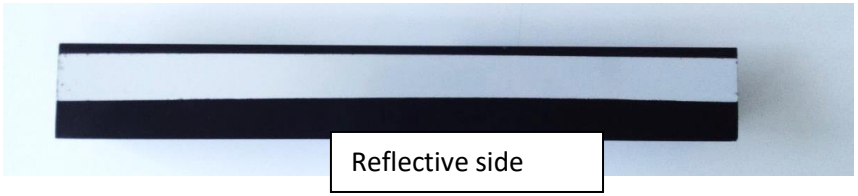


Fig. 18 – Reflective side of the bars.

To fix the reflective bars to a wall or pavement surface, an adhesive gum is provided (Fig. 19).

Fig. 19 – Sticky modelling paste.

4.5 Paper Grid

The Paper Grid (Fig. 20) provide to the User a direct reference system on Grid acquisition modality, allowing the right spatial positioning of the instrument and a total survey area coverage.

The C-thrue base configuration will supply two papers, included in to the current suitcase. Each paper cover 100cmx50cm area both for shallow and deep channels.

The user can decide to use only the first one paper in order to cover a single area or to use both papers in order to double the coverage area (Fig. 21).

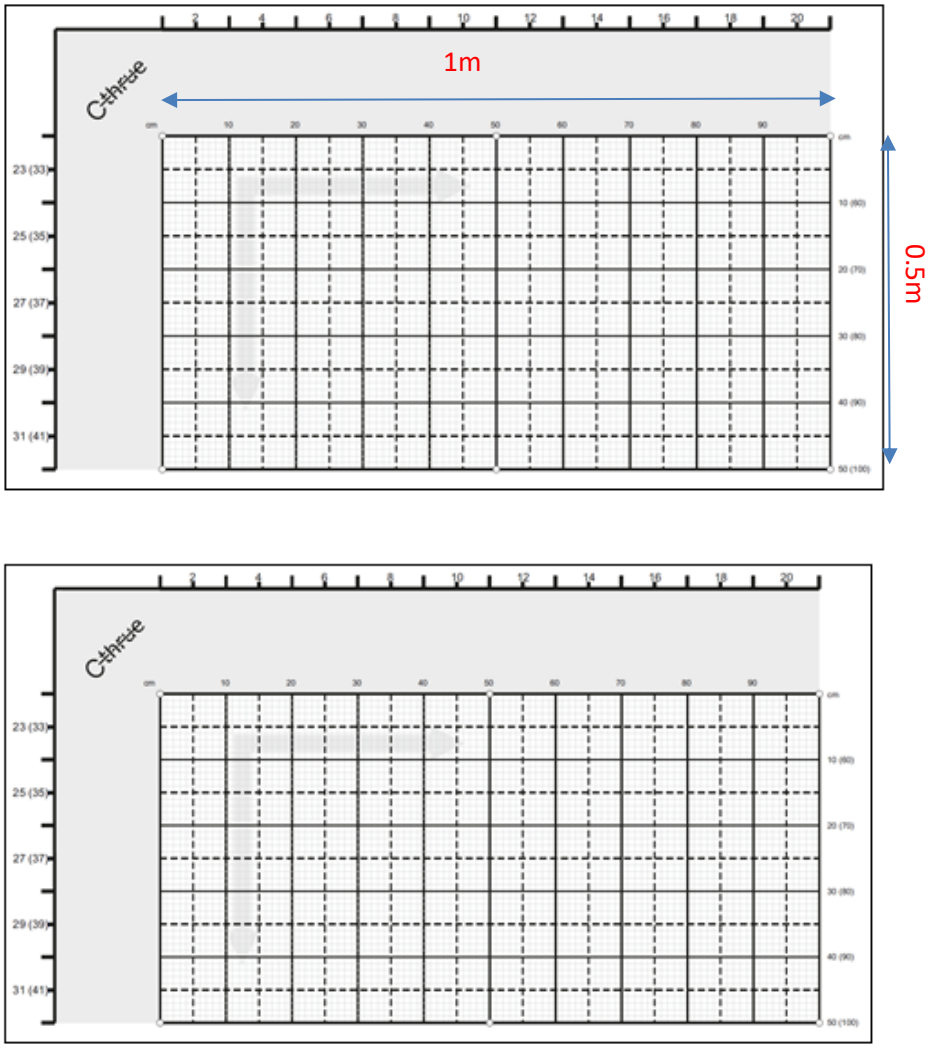


Fig. 20 – Paper Grid.

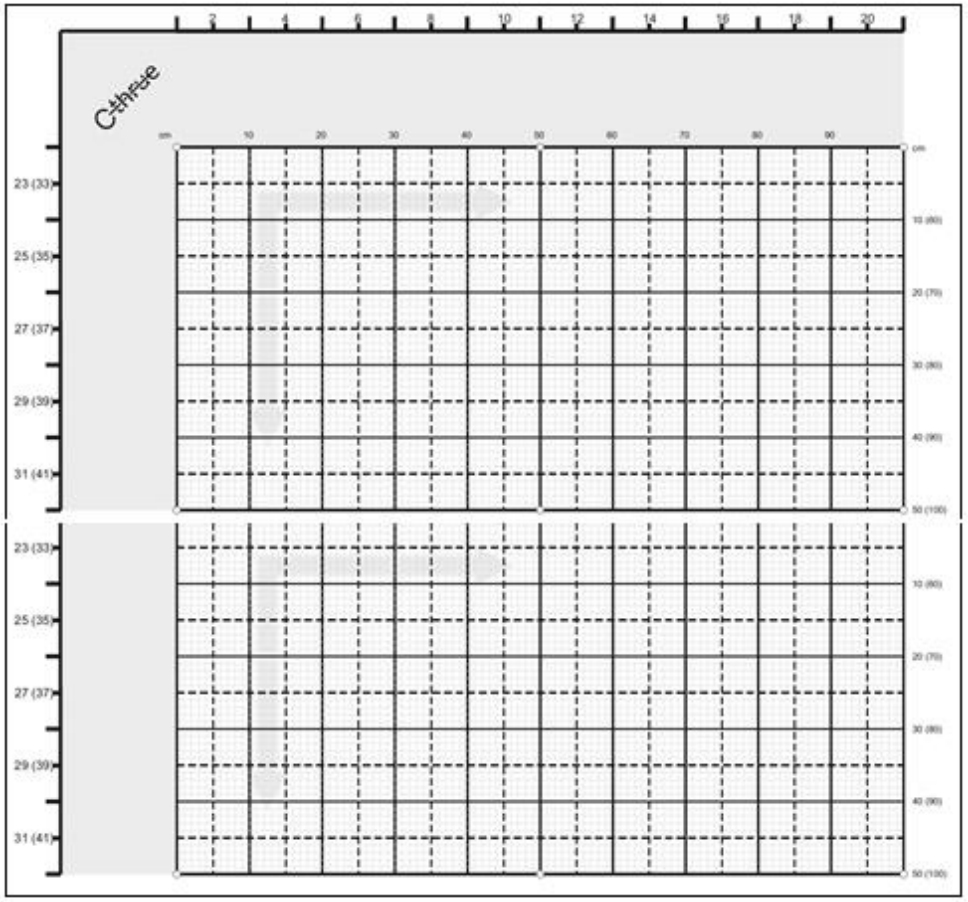


Fig. 21 – Paper Grid double array.

4.6 Accessories

4.6.1 Telescopic Pole

In addition to the C-thrue, a telescopic pole is provided (Fig. 22), and this can be attached to the C- Thrue handle. This allows the user to acquire data on the hardest surfaces and make the acquisition easier.

Fig. 22 – Telescopic pole.

4.6.2 C-thrue external controller

The C-thrue is provided with an external controller (Fig. 23), which allows to a second user to a real time remote control, data processing and representation of results in Augmented Reality.

- Display 10.1 inch;
- Glove-sensitive touch screen;
- Fully-rugged chassis
- Integrated RFID
- Processor Intel® Core™ i5-6300U vPro
- Graphic board Intel HD 520
- RAM 4GB
- 8 Mpixel camera
- Windows 10
- Waterproof and dust proof (IP65)
- Weight 1.1 Kg

Fig. 23 – FZG1 for remote desktop connection and augmented reality

The Panasonic FZ-G1 comes with 2 preinstalled software, called *C-THRUE REMOTE DESKTOP* and *C-THRUE AUGMENTED REALITY.*

4.6.3 Marker for augmented reality

In addition, in the system suitcase, the user can find four QR stickers for the augmented reality. These markers need to be put, in a certain order, on the investigated surface (Fig. 24). They are used to visualize the results of C-thrue survey and to allow an operator to mark the examined surface while the tablet camera frames it. In each sticker, it is indicated where it must positioned respect to the reflective bars (Fig. 25).

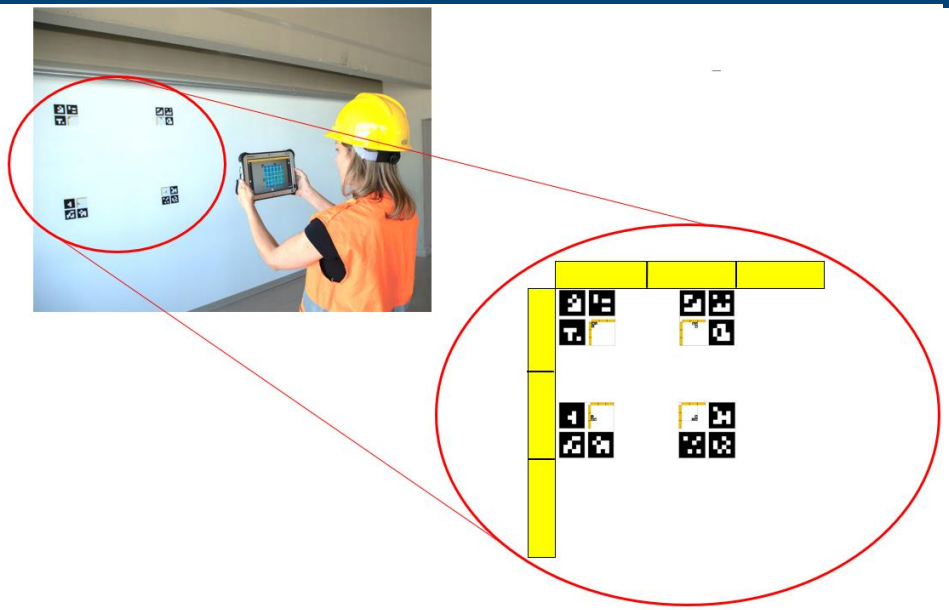
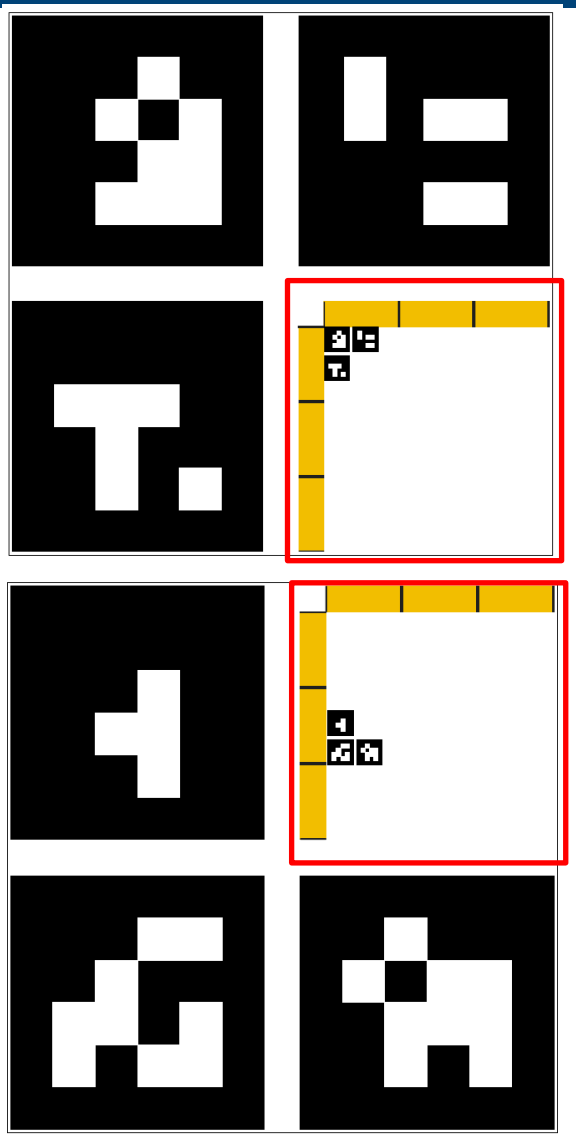


Fig. 24 – Q.R marker positioning.



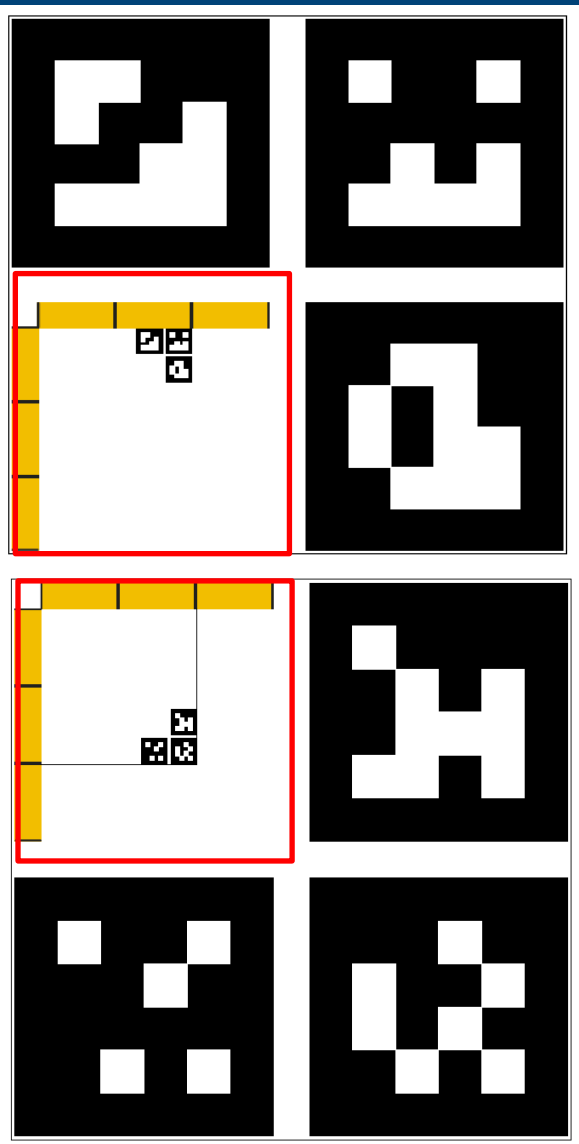


Fig. 25 - QR for augmented reality. The red squares in each sticker indicates each position respect to the reflective bars.

5 ASSEMBLY PROCEDURE

The procedure to assemble the C-thrue is straightforward and can be performed by one person.

To assemble the system the User should follow these steps:

1. removing the radar main body from the luggage, Fig. 26;

Fig. 26- The system and its luggage.

2. Fixing the safety lace to the system, Fig. 27;

Fig. 27- The safety lace.

3. Inserting the battery, Fig. 28;

Fig. 28 - The battery case.

4. Wearing the safety lace to the wrist, Fig. 29;

Fig. 29- Wearing the safety lace.

5. Switching on the system from the power button, Fig. 30 ;

Fig. 30- The switch button.

5.1 Assembling procedure for telescopic pole

The telescopic rod is composed by two main part: a pivoting head and a telescopic rod.

To assemble the telescopic pole on the C-thrue, the user has to follow the following steps:

1. Pass the black-headed screw under the handle. This step must be done while the pivoting head is not completely resting on the top of the C-thrue handle (Fig. 31)

Fig. 31 – Pivoting head mounting.

2. Once the screw is under the handle, place the pivoting head plate on the C-thrue handle. At this point, tighten the screw by lifting it up to the stop and tightening (Fig. 32).

Fig. 32 – pivoting head mounting

3. Insert the rod into the pivoting head hole. to do this, match the metal ball with the vertical incision on the pivoting head (Fig. 33). Once inserted, turn the rod 180 degrees clockwise to secure the grip. Then, close the red level as in Fig. 34.

Fig. 33 – Metal ball and Vertical notch matching

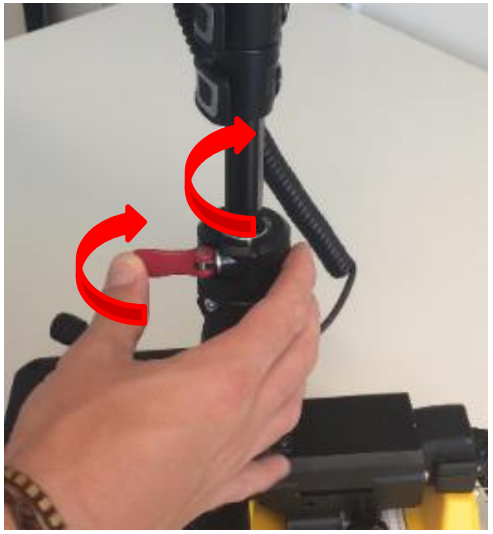


Fig. 34 – Last step for rod securing

4. Finally, connect the cable to connector located on the right side of C-thrue handle. This allows the user to control the acquisition as the same way of the button on C-thrue handle.

Fig. 35 – Telescopic rod final assembling

For FCC rules and regulations, there is an additional button on the telescopic rod (red button, Fig. 35. It is necessary to hold this button during the acquisition, release at the end of it. The acquisition is stopped after about one second after the release of the button.

6 C-thrue GUIDE

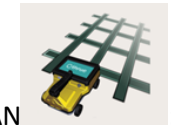
6.1 Starting

Switching on the system from the power button under the handle, after a few seconds the main menu window of the C-thrue software will appear (Fig. 36)

Fig. 36- Main Menu.

6.2 Main Menu

The C-thrue software main menu contains 4 main commands:

1. SINGLE SCAN  : this command gives the opportunity to run single or multiple scan, viewing the radargrams in real time.
2. GRID SCAN  : this command gives the opportunity to acquire radargrams within a grid of 1mx1m, with a scan step of 5 cm. The user can activate also lasers for this mode.
3. OPEN SURVEY  : this command permits to visualize all the previous acquisitions and copy them in a USB stick. It can contain an additional sub-folder where all the screen shots eventually catch have been automatically saved.
4. SETTINGS  : this command permits to change system measurements, language, and update firmware and software.

In the Menu bar at the top of the screen (Fig. 36), 2 icons are present:

1.  click it to activate/deactivate lasers. This function is available only in Grid mode. This also shows laser status.

2.  : click it to activate/deactivate EM sensor; when it is active the icon is coloured, when it is not active the icon is grey.

3.  : click it to activate/deactivate Wi-Fi link between C-thrue system and C-thrue Remote Desktop (Panasonic FZG1). If in one of these devices the wi-fi link is not activated, the icon will be  .

In the bottom right of the main window, the radar battery status is shown. ()

The battery level displayed on the SW screen, sometimes, cannot be indicative of the real remaining charge of the battery, as instead indicated by the LED on the battery itself.

6.3 Settings

From the main menu (Fig. 36), the user should click on  in order to visualize the settings menu. This is divided in five tabs:

1. Radar settings
2. International settings
3. Update settings
4. Network and Survey settings
5. About

6.3.1 Radar Settings

In the Radar settings (Fig. 37) the user can change seven different parameters:

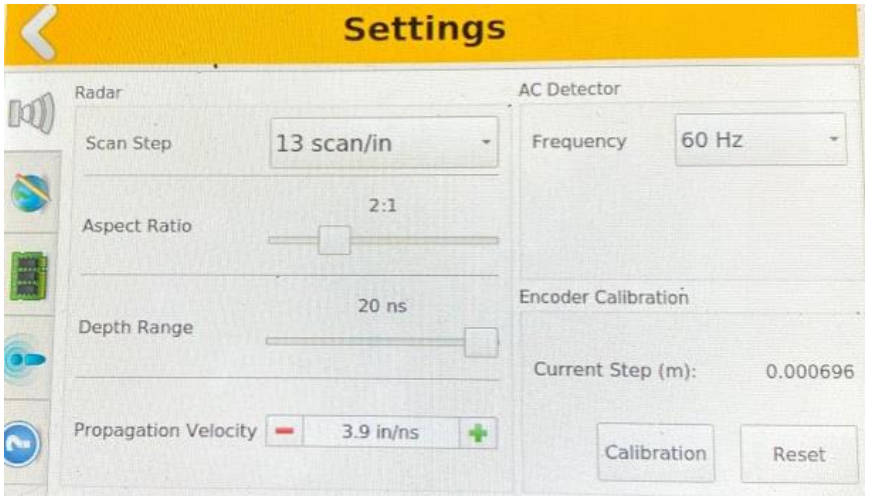


Fig. 37 – Radar Settings

- **Scan Step:** it is possible to choose how many measures the system taker per unit of distance, the possible values are shown in Fig. 38; the default value is 5 scan/cm (13 scan/inch).

International measurement System	Imperial measurement System
3 Scan/cm	8 Scan/inch
4 Scan/cm	10 Scan/inch
5 Scan/cm	**13 Scan/inch**
8 Scan/cm	20 Scan/inch

Fig. 38 – Scan Step

- **Aspect Ratio:** this will change the ratio between x-axis and y-axis in the radargrams, in Fig. 39 is shown an example of aspect ratio 1:1 (left picture) and an aspect ratio 3:1 (right picture).

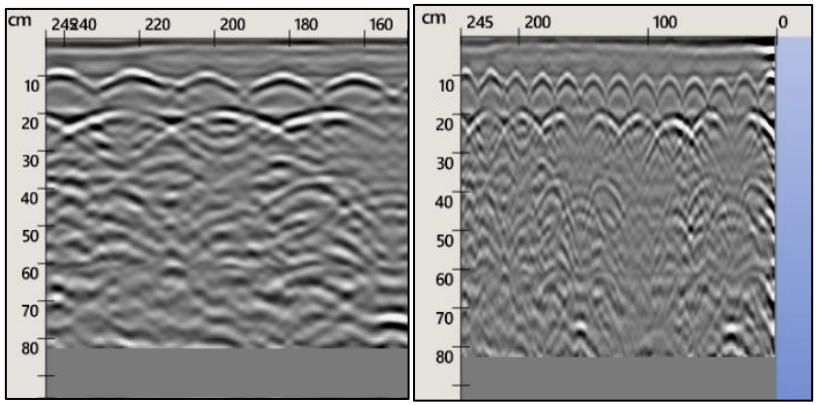


Fig. 39 – Different aspect ratio: 1:1 (left picture), 3:1 (right picture)

- **Depth Range**: this will increase/decrease the full-scale value (range). It is possible to choose a value between 8 ns and 20 ns.
- **Propagation Velocity**: here it is possible to choose the propagation velocity of the radar wave, the default value is 10 cm/ns; this value can be adjusted later during the scan, see paragraph 6.4.3.
- **Frequency**: this permits to switch from 50 Hz to 60 Hz the detecting frequency of the electromagnetic fields generated by buried live power cables.
- **Encoder Calibration**: this allows the user to calibrate the encoder wheels. Click the "Calibration" button to start the procedure. A new window will open (Fig. 39). Click the "Start" button and push or pull the C-Thrue until the bar reaches 100%.

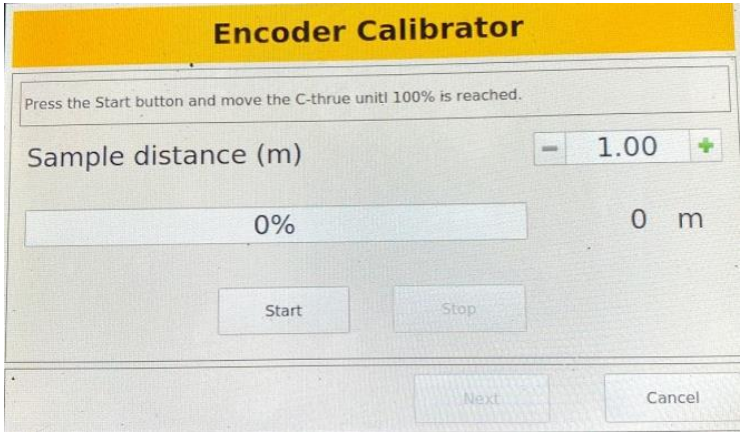


Fig. 40– Encoder Calibration window

Once the bar reaches 100% click the "Stop" button (Fig. 41). The user can change the distance travelled at the top right of the screen by clicking the – and + buttons. Click the "Next" button to see the new spatial resolution (Fig. 42). Click the "Cancel" button to exit out of the calibration window without saving the new resolution.

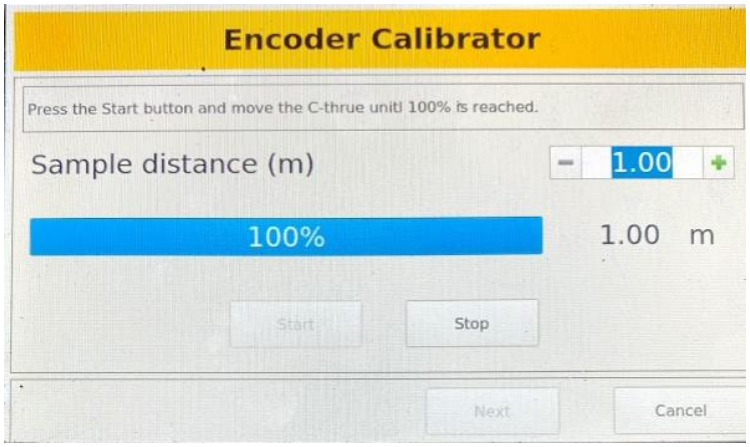


Fig. 41–Completed calibration

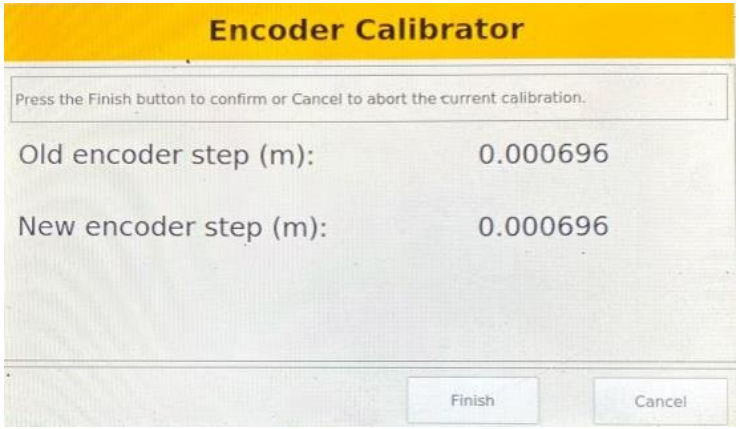


Fig. 42– Window with new spatial resolution

Click the "Finish" button to save the new encoder step or the "Cancel" button to abort the current calibration. On the settings screen (Fig. 42) you can click the "Reset" button to change the encoder step back to the default setting.

6.3.2 International Settings

Fig. 43– international settings

In the **International Settings** menu (Fig. 43,) the user has the opportunity to change:

- System of measurement: the available systems are metric (meters and centimetres) and Imperial (inches and feet).
- Languages: select the preferred language in the shown list.
- Date and Time (clicking on "Edit time").

6.3.3 Update Settings

The **Update Settings** menu ( ) shows the current software version and firmware (Fig. 44).

When a newer software and/or firmware version are released by IDS GeoRadar, these can be uploaded in the C-thrue, in order to update the system. This can be done copying the released software or firmware only on a USB stick, connect it to the USB port shown in Fig. 4. Done this, the icon became coloured, and the list of available updates on the USB stick will be shown in the white window.

At the end of the installation procedure, the system should be manually rebooted.

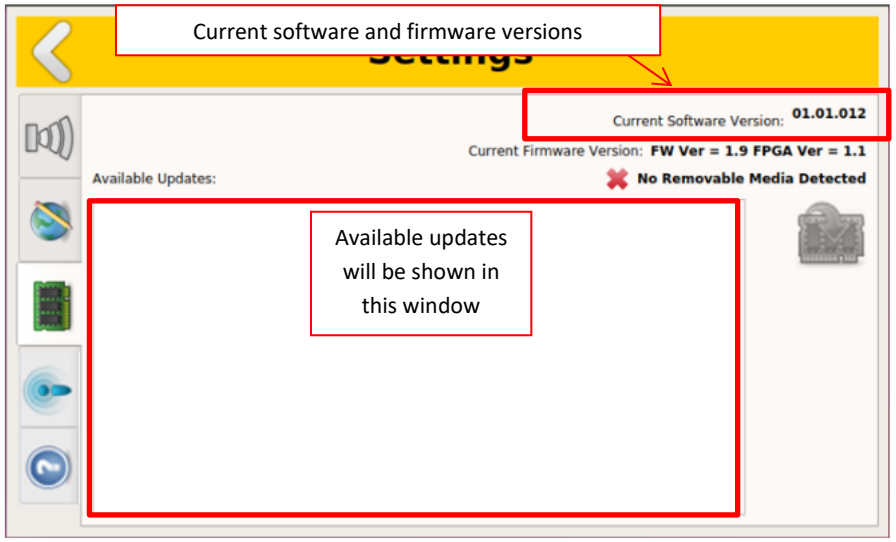


Fig. 44– Update Settings.

It is possible to change Date and Time also using the Remote Desktop function, in this case, after changing the date/time, press "Update C-thrue" to synchronize the two devices

In order to transfer Software and Firmware updates, files must be in .zip format.

6.3.4 Network and Survey Menu

In this tab it is possible to set up the connection with the Remote Desktop, see Par. 6.8.1. It also shows the Grid Settings and Default Processing Filters.

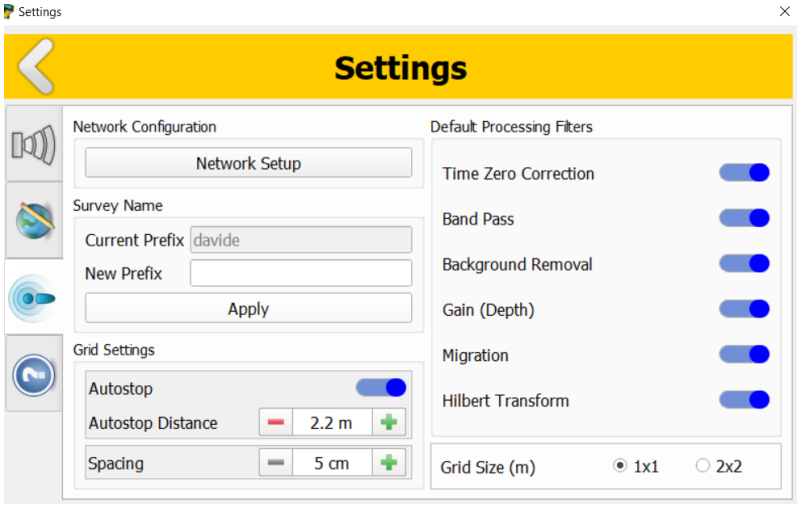


Fig. 45– Network settings menu in C.thrue software

- **Grid Settings**: this allows turning on the Autostop function for grid acquisition. Slide the bar next to "Autostop" to turn the function on. Once the bar is turned on and blue, the user can input the length of the grid lines in the "Autostop Distance" box (Fig. 46). When collecting in grid mode, the C-thrue will now automatically stop at the distance chosen by the user. The user can set the "Spacing" between two consecutive scans from 5cm up to 20cm with 1cm step and "Grid Size (m)" with 1X1m and 2mX2m. The grid 2X2m is only available in manual grid mode not with the laser.

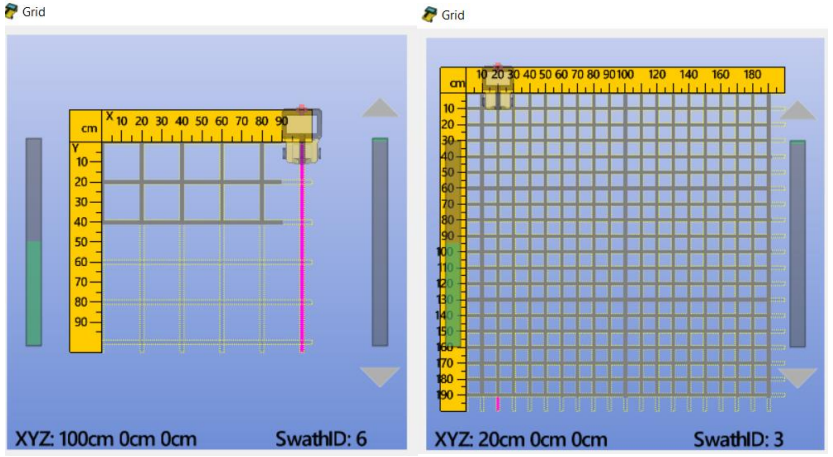


Fig. 46– Grid Settings Spacing and Grid Size (m)

- **Default Processing Filters**: allows user to turn on/off processing filters that will be applied during data acquisition.

6.3.5 About

The **About menu** (*Fig. 47*) ( ) shows:

- C-thrue software version
- Phone and mail Contacts of IDS Customer Care Department.
- End User License Agreement for the C-thrue software

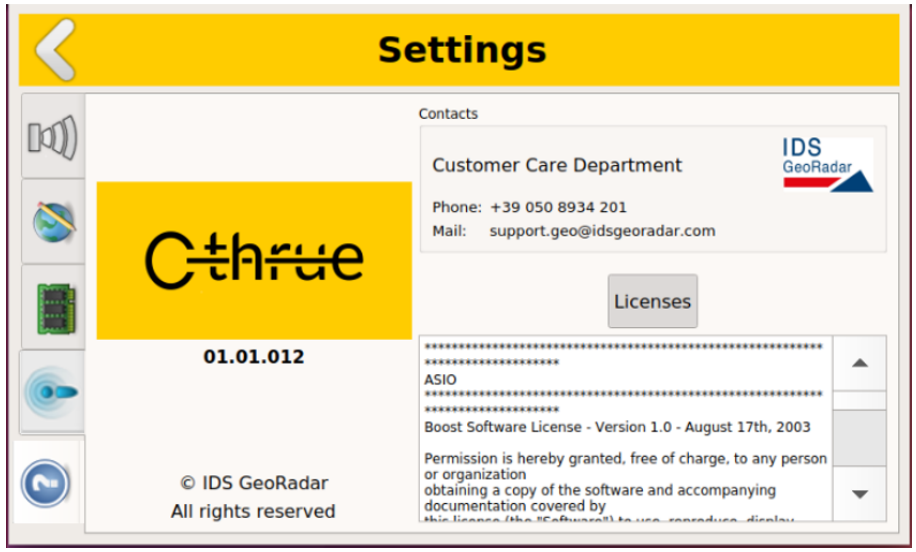


Fig. 47– "About" menu.

6.4 Single Scan mode

In this mode, the user can acquire single or multiple scan. In this mode the only reference system is the distance travelled and recorded by the encoder wheel, and the user can pull or push the radar (as preferred, the system automatically recognizes the acquisition direction) for radar data acquisition.

Clicking the single scan command () from the main menu (Fig. 36). The acquisition main window automatically opens as inFig. 48: By pressing with finger on the B-scan will display the distance and depth on the bottom side of the window.

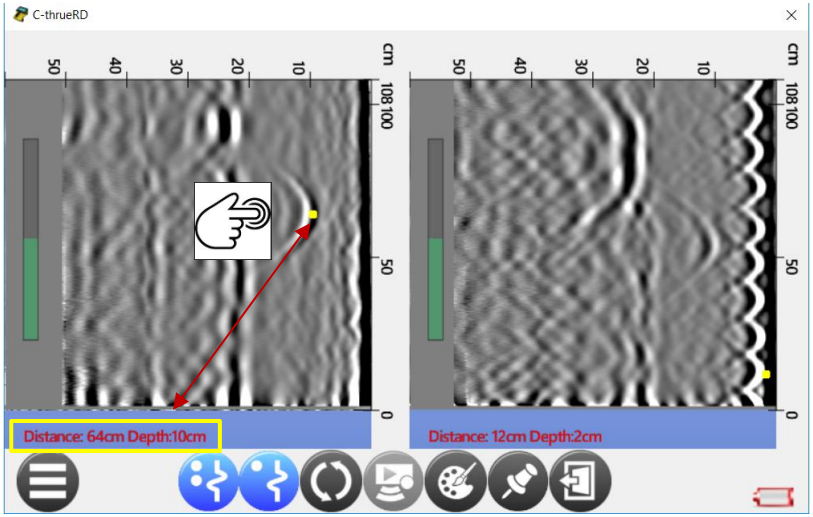


Fig. 48– Single scan main window

6.4.1 Acquisitions commands

In the acquisition window, in the lower part of the screen there is an acquisition commands toolbar (Fig. 49):

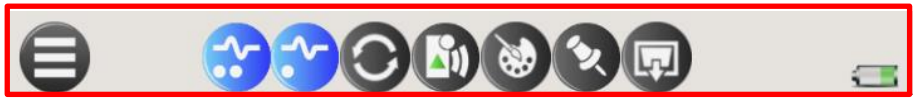


Fig. 49– acquisition toolbar.

Each icon of the toolbar is explained below:

- Clicking on  , automatically other 4 icons will appear on the touchscreen:
  I.  From every screen of a single scan or Grid mode, using this button it is possible to make a screen shot of what is currently displayed on the screen (toolbar excluded). The screen shot will be saved as .jpeg file in a proper folder which will be automatically created in the survey folder; after saving, a message of “Report completed” will be shown on the screen (Fig. 50)

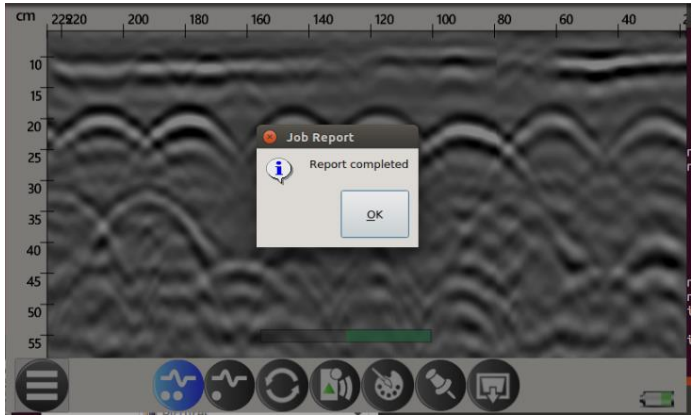


Fig. 50 – Advise when a screen shot (Job Report) is completed and saved in the survey folder.

II.  Propagation velocity evaluation: clicking this button, the user can adjust the propagation velocity of EM wave by either (Fig. 51):

1. moving the cursor along the horizontal line if the inspected concrete is wet or dry
2. Entering a known propagation velocity
3. Manually adjusting the dielectric constant
4. Click on OK button to apply the estimated velocity

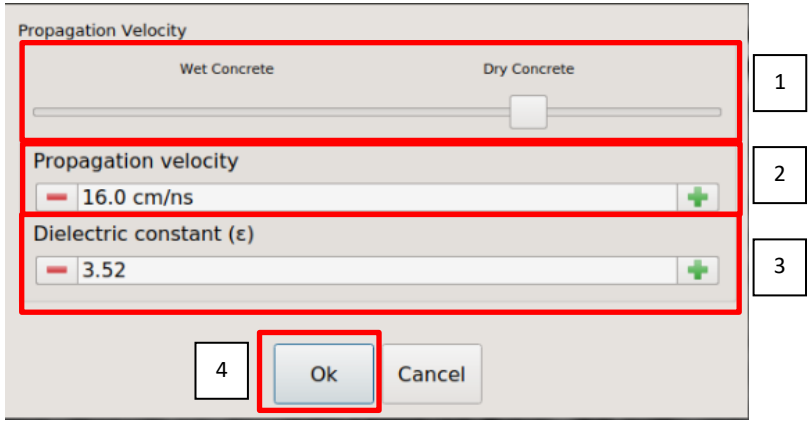


Fig. 51 – Propagation velocity evaluation window

III.  Erase swath: clicking this button, the user can delete the last swath collected. Clicking this button will enable a new window to appear (Fig. 52). This will ask the user to confirm erasing the swath.

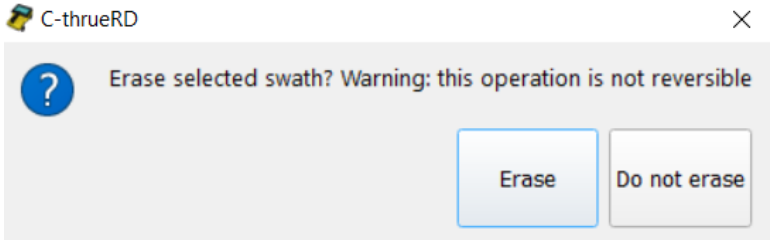


Fig. 52 – Confirmation window to delete swath

IV.  Swath information: clicking this button will open a new window with the survey name, swath number and time of last modification (Fig. 55).

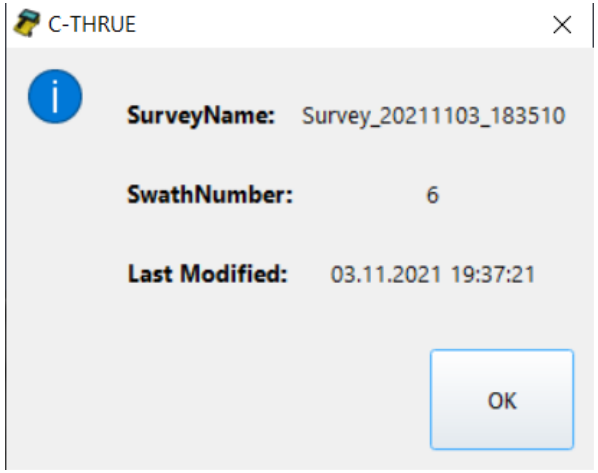


Fig. 53– Swath information

Click  button to start; the icon will become  and a warning single “beep” sound will be emitted by the system. At the end of a scan, the

user should click it to stop and save the last acquisition ( ). A warning double “beep” sound will be emitted by the system

The user can do the same actions just by pressing the button on the handle (red square inFig. 54) to start acquisition, then hold the same button at the end of acquisition.

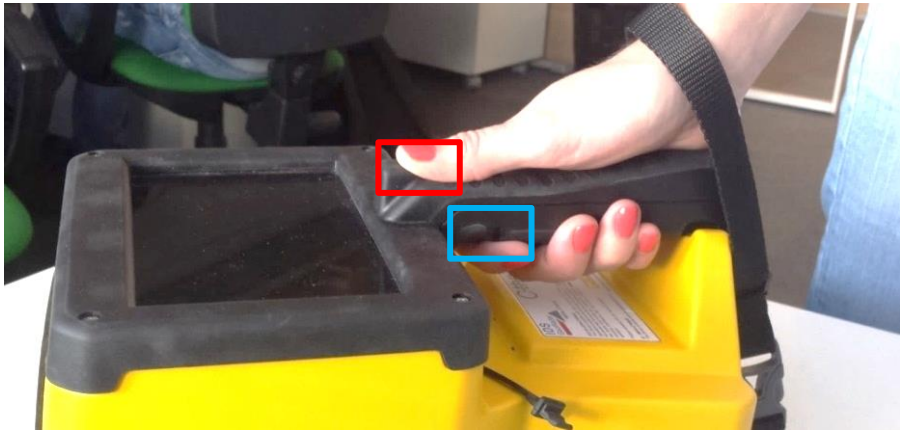


Fig. 54 – Standard handles button (red square) and additional button (blue square) for FCC regulations.

For FCC rules and regulations, there is an additional button under the handle (blue square, Fig. 13. Hold this button during the acquisition, release at the end of it. The acquisition is stopped after about one second after the release of the button. Use only the forefinger to use the button.

-  click this button to see only the shallower radargram (Fig. 55):

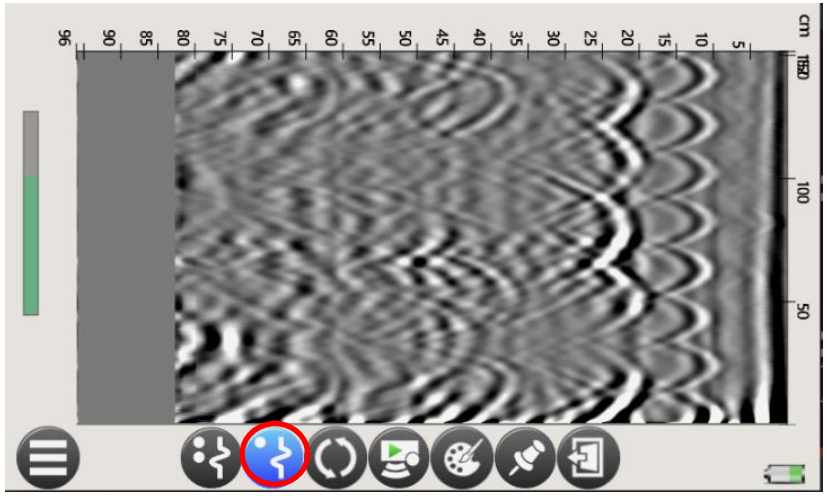


Fig. 55 – Shallower visualization.

-  click this button to see only the deeper radargram:

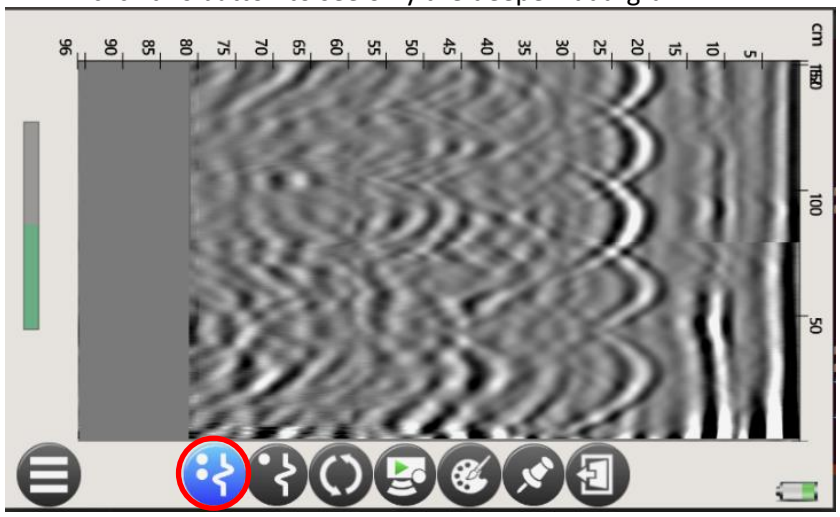


Fig. 56 – Deeper visualization.

-  Click this in order to rotate 90° the radargrams. This lets the User adjust the visualization depending on how the system is orientated and on how the operator prefers to scan.
-  Click this to choose different colour palettes for the radar maps visualization
-  Click it to show/hide the target marker already inserted
-  Click the button to stop the current Project and go back to the main menu. In this case, If the acquisition is still running (), a message appears as in Fig. 57:

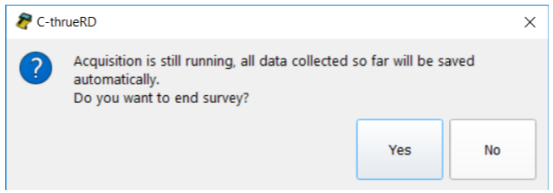


Fig. 57 – Exit message if the user is still in acquisition.

Click YES if you want to end survey, click NO if you want to continue with the acquisition.

-  status of the battery level
-  By moving the finger along this bar the user can adjust the contrast of each radargram.

6.4.2 Shallow and deep radargrams

Thanks to the different configuration of the two antennas present, C-thrue, is capable to investigate the structure at different levels.

The **shallow** antenna provides an excellent quality and clarity of the upper part of the concrete and the first layering of irons/cables/tubes underlying the investigated surface. This antenna better detects those objects that are arranged in an orthogonal direction with respect to the scanning path.

The **deep** antenna, allows to investigate in a clearer way the underlying concrete portion, identifying a possible second layer of rebars, voids and cavities, again arranged in an orthogonal direction with respect to the scanning path.

Fig. 58 shows the two radargrams in real time, complete with horizontal scale (distance travelled) and vertical scale depth. It's possible to see clearly a first level of metallic rebar with the shallow component. Then, with the deeper component, it's possible to locate the second level of rebars.

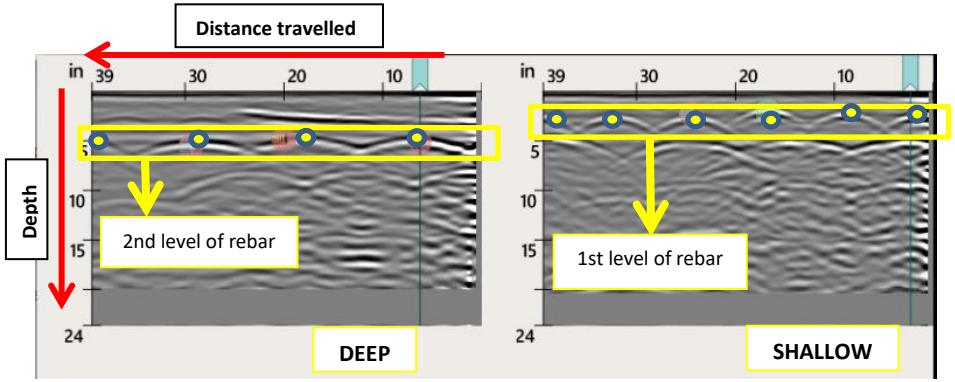


Fig. 58 – Shallow and deep radargrams.

The C-thrue allows to the user the display of two radar sections simultaneously or only one individually, as explained in the previous par 6.4.1.

During the first scan, the software uses a very short part of the radar scan (less than ten centimetres) to evaluate concrete characteristics and to

calculate the best graphic settings for the visualization of radargrams. Following this, the software continuously adjusts those settings for providing the best visualization in any condition.

Thanks to the multi-touch screen, the user can interact with the radargrams as follows:

- Starting out with fingers together and then spreading them, the user can zoom IN the radargrams. On the contrary, with 2 fingers, starting out separated and then brought together, the user can zoom OUT the radargrams.
- If the radar section is too long to be displayed at the selected zoom level, the user can scroll it using the finger on it; the scrolling is synchronized if the user is visualizing both radar maps.
- Add position markers Fig. 59) during the acquisition, clicking the button on top the handle at the selected position (the same button as start/stop acquisition), or add target marker holding the finger on the radargram on a point of interest. As shown in the picture, the same marker will be in a different position in the radargrams, because is referred to the physical position of shallow and deep antennas in the system, and so in their respective radargrams.

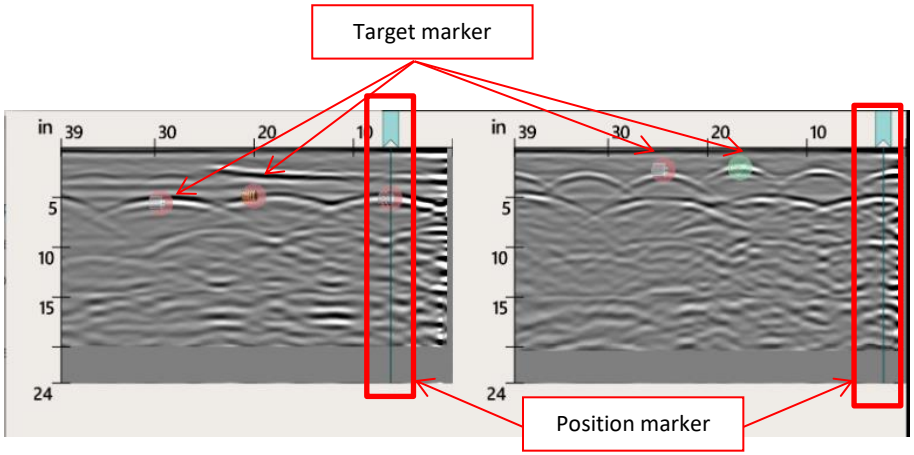
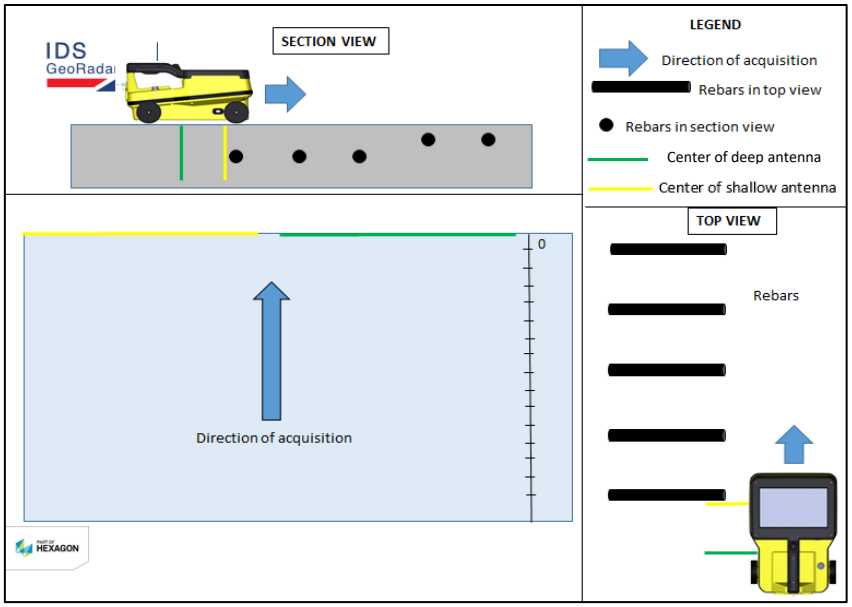
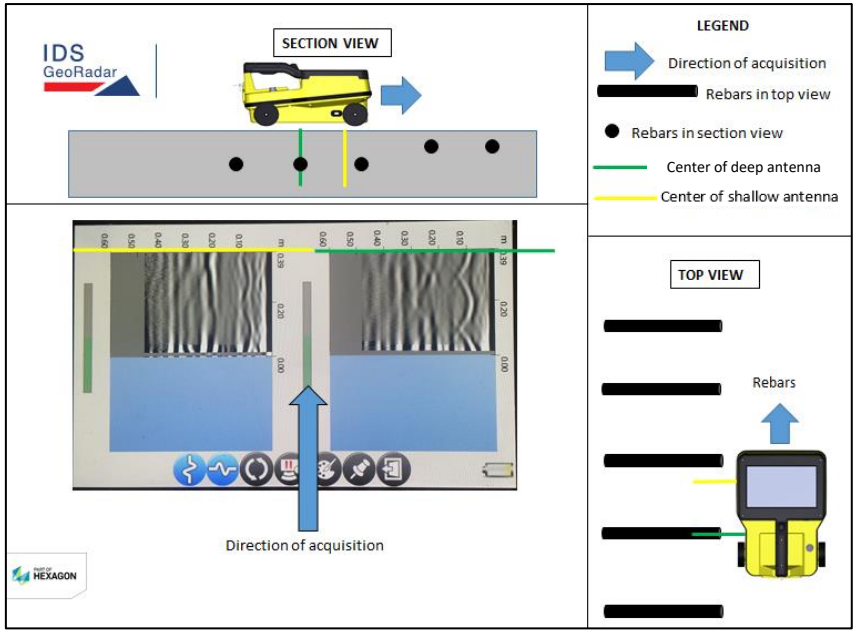


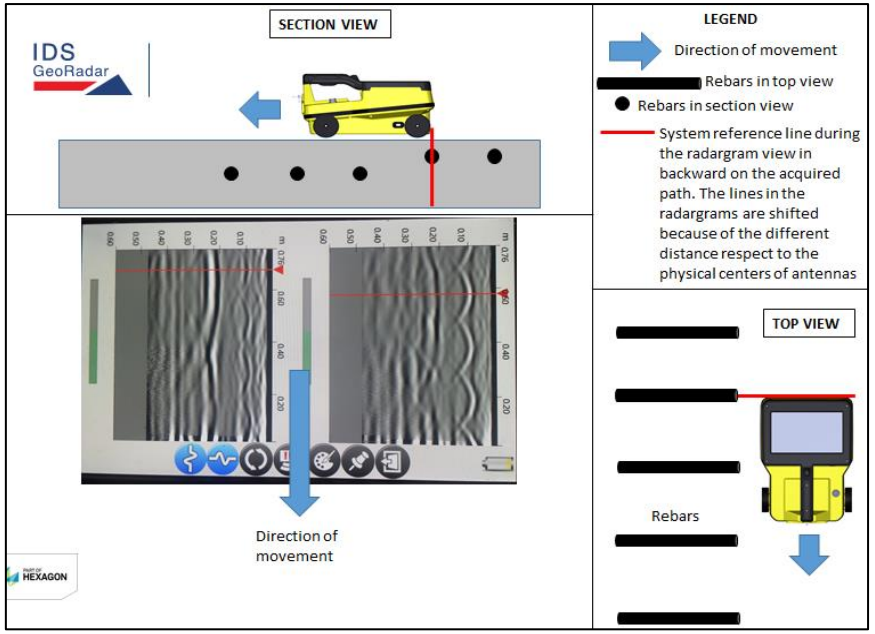
Fig. 59 – Position marker and target marker.

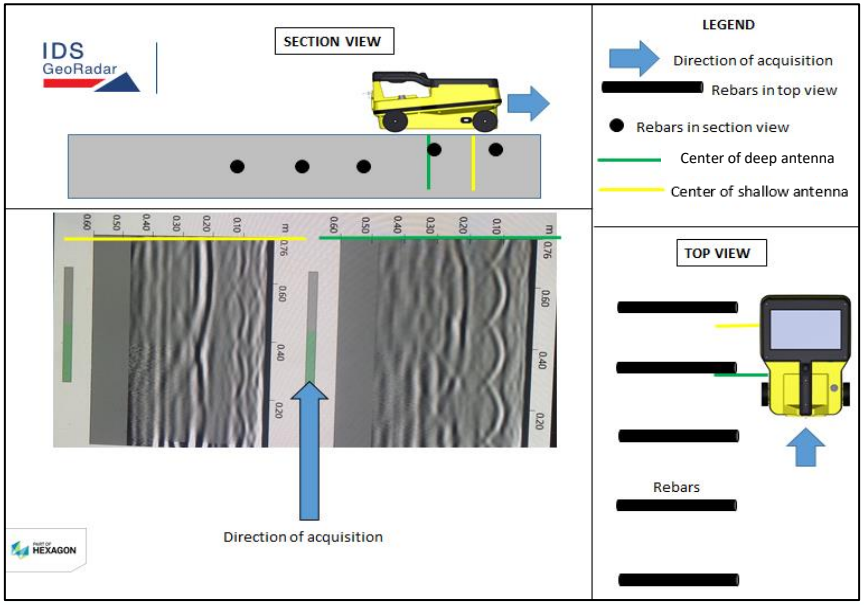
After the first passage in a direction (pull or push as the user prefer), the user, still in acquisition, can return on the acquired path, to see and check the position of the interesting point. Here the reference line is respect to the front part of the system, this permit to the user an easier marking of the concrete.

This last point is explained in the sketches below (in temporal order):









6.4.3 Target Commands

Holding a finger on a specific anomaly seen in the radargrams, the user automatically opens the **Place/Modify Target** toolbar (red square in Fig. 60).

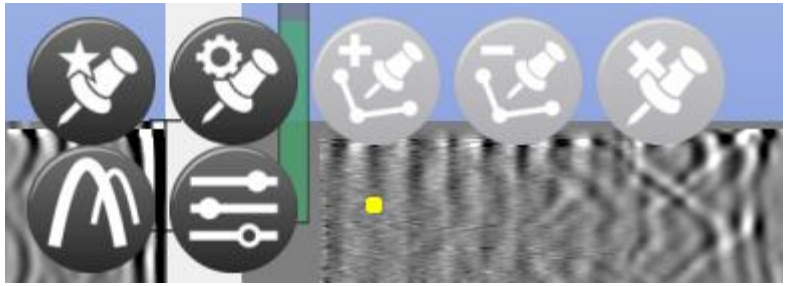


Fig. 60 – Place/Modify target toolbar.

Clicking the first button on the left ( ), the user can select different type of target shown in the list (Fig. 61):

The user should pick and hold the interesting point with high accuracy, especially for automatic detection, to avoid error with target type. Using is zoom is suggested

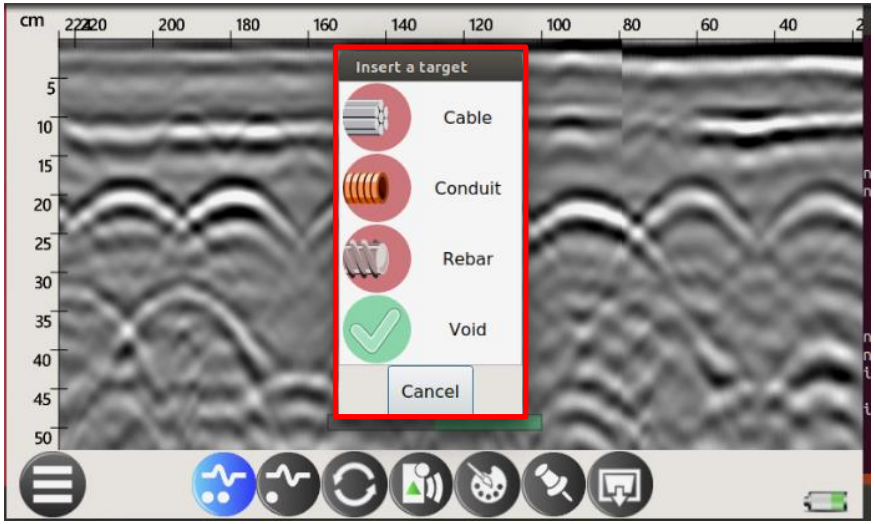


Fig. 61 – Target type list.

Clicking , the user will activate the automatic recognition. In this way the software automatically recognizes which kind of anomaly the user has selected before (between rebar and void category) and put one target marker from the previous list. If the software is not able to recognize which kind of anomaly is present, the target will be shown as .

Click this if the user wants to add a target marker connected to the previous one inserted with and this to delete it.

Click this if the user wants to delete all the target inserted with

Click it to set the propagation velocity for the radar map, using the hyperbola fitting method. To perform it, follow the procedure below:

1. Find a hyperbola on the radargram on which to perform the velocity analysis;
2. Press and hold the screen on the hyperbola (Fig. 62), the software will automatically locate the top and a setting window will be opened Fig. 62); to better positioning the synthetic hyperbola, use the blue arrows on the Propagation Velocity window (Fig. 62).
3. Adjust the EM waves propagation velocity to adapt the synthetic hyperbola to the real one visible in the radargram (Fig. 62); it is possible to use the slider (1), insert the Propagation Velocity(cm/ns) (2) or Dielectric constant value (Ɛ) (3) on the proper window.
4. Click on OK button to apply the estimated velocity. It will be applied to the entire survey.

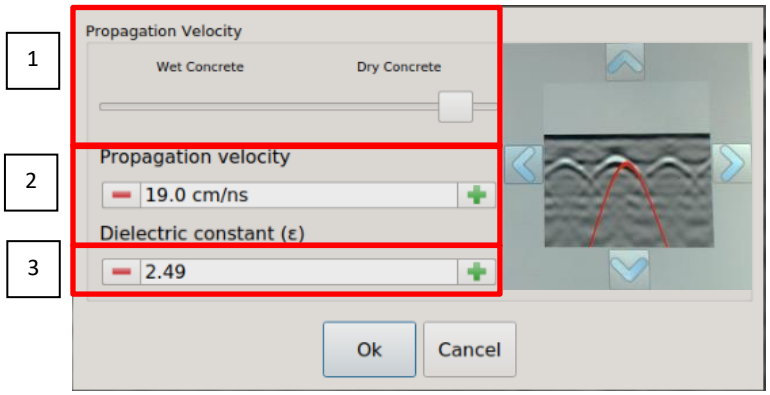
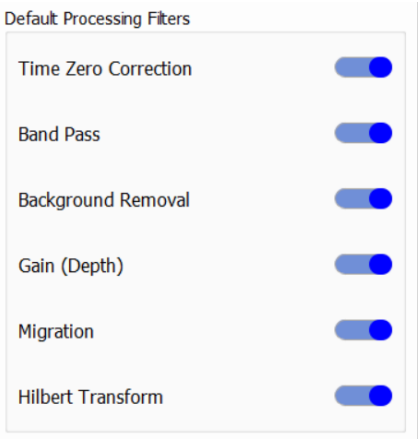


Fig. 62 – Propagation Velocity window

Clicking  , the user will activate the processing filters. By sliding the bars from grey to blue, the different filters will be applied to the data.



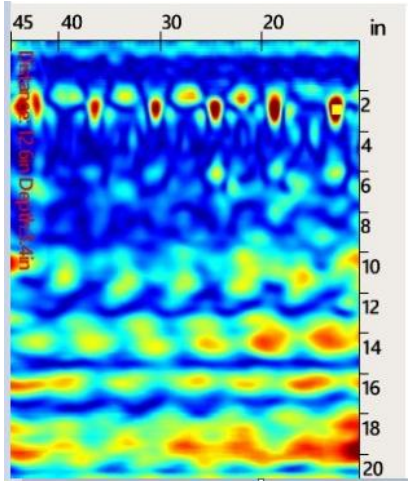


Fig. 63 – Processing filters and B-scan display

6.5 Grid scan mode

6.5.1 Acquisition mode with LASER and GRID.

From the main menu window (Fig. 64) first click  icon to activate the lasers (the icon must be green), then click  icon to select the GRID mode.

Fig. 64 – Activation of Lasers.

Before starting the acquisition, the user must position the reflective bars on the wall/pavement/deck (Fig. 65). In the pictures here below is shown how to do it.

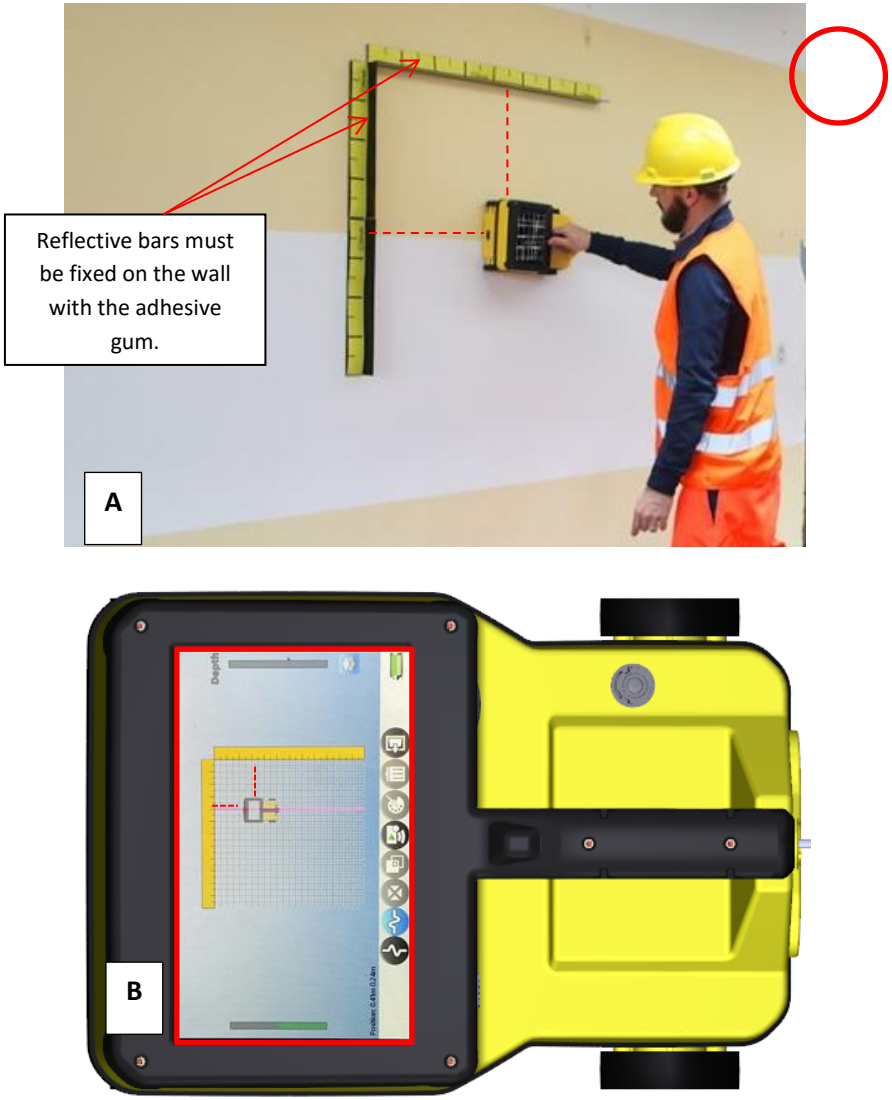
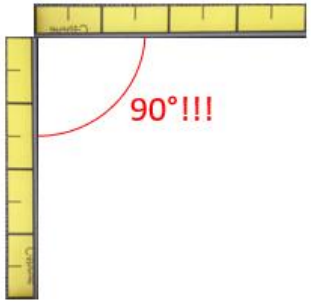


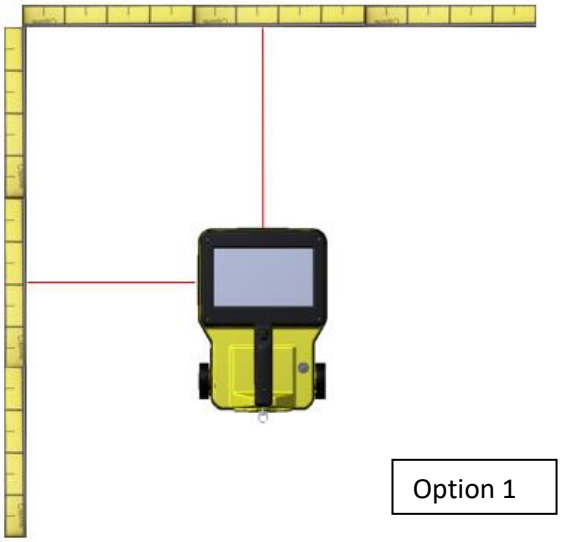
Fig. 65 – sketch representing the real positioning of reflective bars on wall (A) and what the user will see on the screen. The C-thrue is orientated as in the real situation, thanks to the lasers that calculate the position in real time respect to the reflective bars.

Step 1: on the wall, position the horizontal bar first with the adhesive gum:

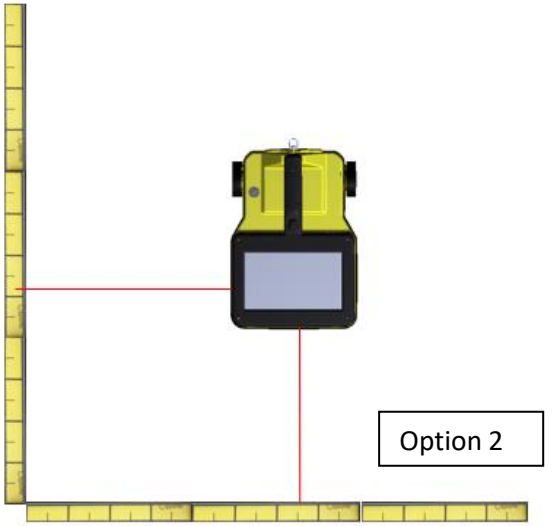
Step 2: Position the vertical bar in the corner of the horizontal bar, and be sure that the internal angle is 90°.



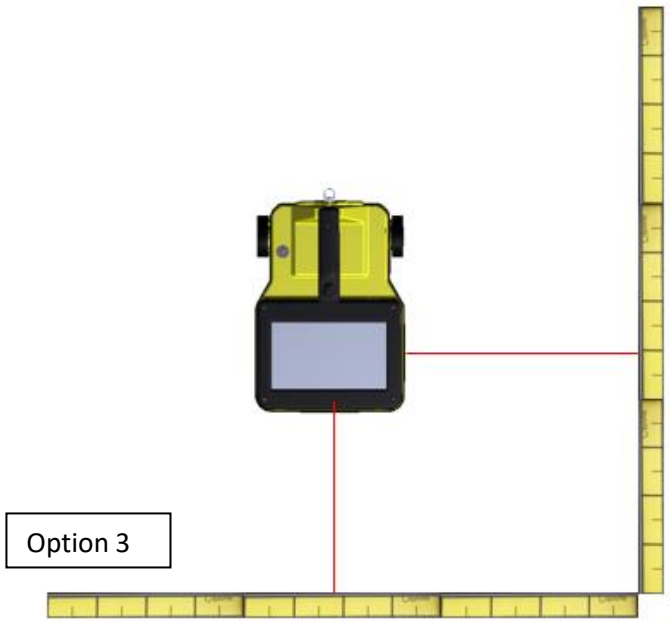
Step 3: add the other reflective bars as the user prefer (six in total). It's also possible to rotate the reference system (i.e horizontal bar on top or in the bottom of the reference system, vertical bar on the left or on the right):



Option 1



Option 2



In grid scan mode, the screen shows B-Scan and C-Scan simultaneously;

Be careful to respect the measurement mark on the reflective bars. If the system is not aligned with one of these, the purple line will disappear until the correct position is reached.

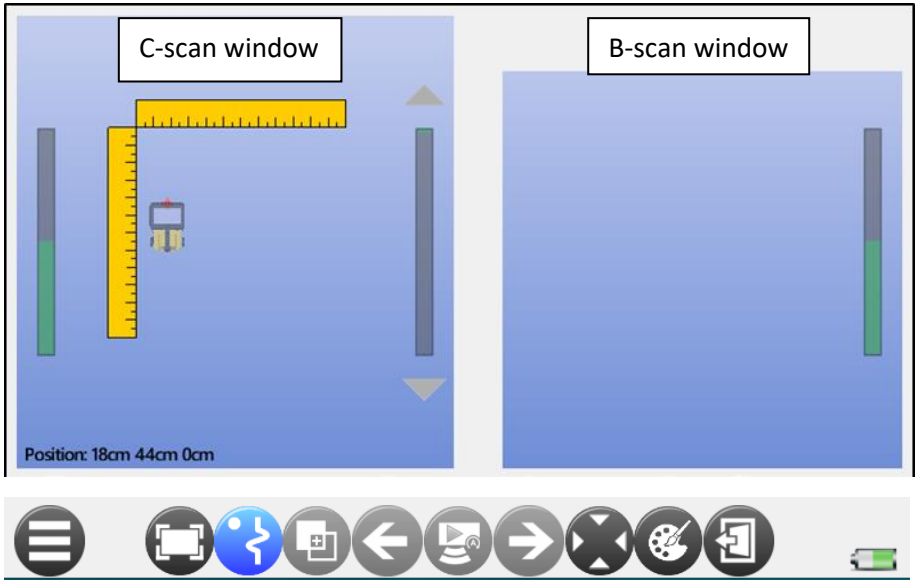


Fig. 66 – Grid Scan mode screen

In acquisition with laser and grid, the reflective bars are shown in the x and y axis, and the lasers automatically recognizes in which grid position the system is, highlighting the lines in purple.

The user can acquire the radar scans following a predefined grid of 1m x 1m with the spacing between the scans of 5 cm. The spacing between the scans must be physically respected, to correctly locate targets.

Once the reflective bars are positioned and the system is positioned on the surface ready for the acquisition, click  on the acquisition toolbar to visualize the grid (Fig. 66).

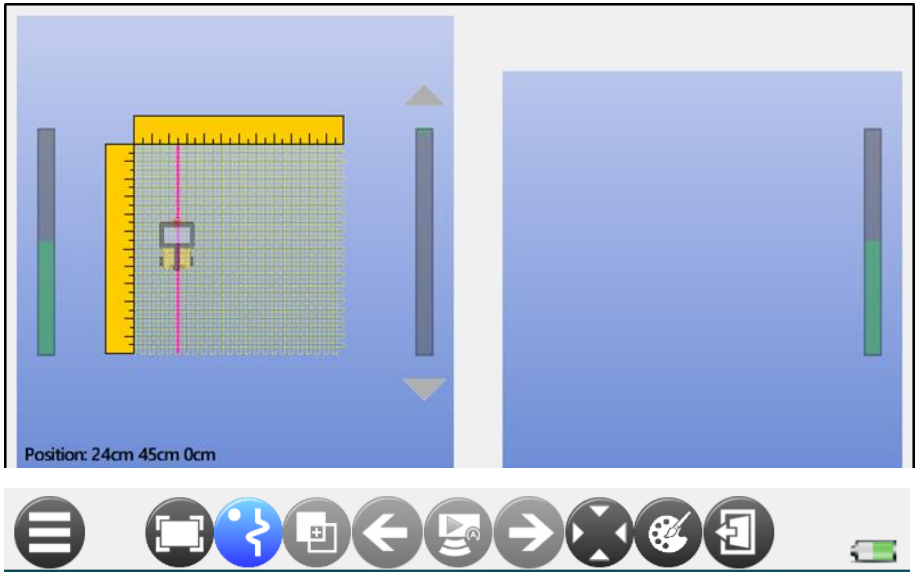


Fig. 67 – Grid activation

From now on, for this command three modes are available:

- automatic mode, with all the laser sensors active;
- the laser in opposite side respect to reflecting bars is deactivated; it is a useful tool in those case in which an obstacle interferes with the acquisition, activating the laser that should not work.
- all the lasers are deactivated; the position of the system is no longer available and the acquisition is the same of the grid without reflecting bars.

- Position the system at the corner of reflective bars (Fig. 68)

Fig. 68 – starting point for Grid plus Laser acquisition.

- Click button to start; the icon will become and a warning single "beep" sound will be emitted by the system. At the end of a scan, the user should click the icon to stop and save the last acquisition (→); a warning double "beep" sound will be emitted by the system. The user can do the same actions just by pressing the button on the handle (red square in Fig. 69) to start acquisition, then hold the same button at the end of acquisition.
  The scan the user is acquiring is highlighted in purple.

Repeating a scan that has already been acquired will erase the previous swath, replacing it with the new one.

For FCC rules and regulations, there is an additional button under the handle (blue square, Fig. 13. Hold this button during the acquisition, release at the end of it. The acquisition is stopped after about one second after the release of the button. Use only the forefinger to use the button.

In grid visualization mode (), click in the toolbar  to display  and  are related exclusively to which radargram is displayed (shallow or deeper radargram respectively, just one per time).

With  activated, the user can visualize the tomography map obtained by interpolation of the single acquisition lines (Fig. 69); it's possible furthermore set the visualization mode, choosing between:

- Tomography and radargram relating to shallow antenna, clicking on 
- Tomography and radargram relating to deep antenna, clicking on 

When many swathes are acquired in the Grid mode, the merge operation could be slow, that is the screen gets darker. Please wait until the operation is completed.

- Tomography relating to both antennas (shallow + deep), holding with a finger in blue screen in background of the c-scan window (), and clicking on the  .

This information comes from Data Fusion processing, which generates new tomography merging data coming from the two antennas: the shallow antenna will influence the first centimetres of the radargrams and the deep antenna the remaining portion.

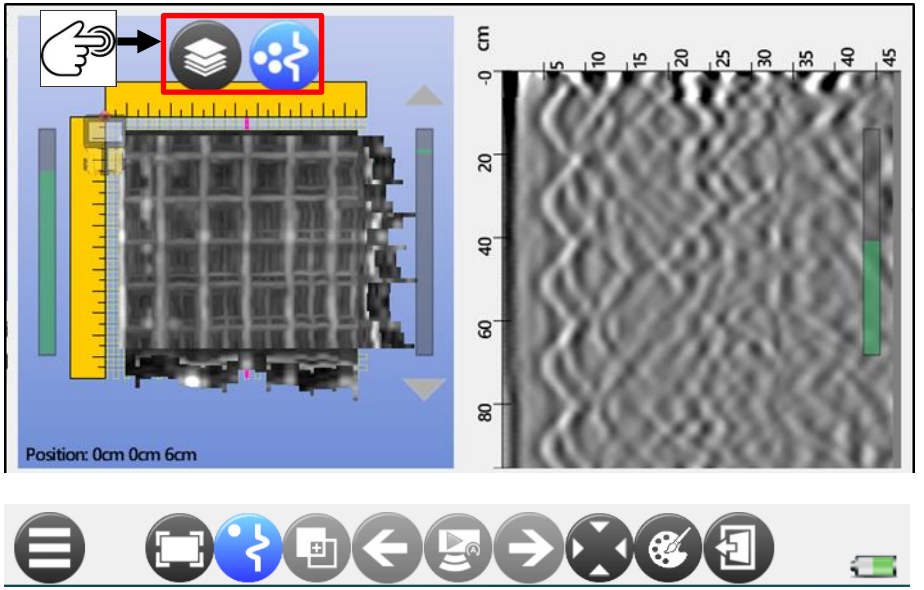


Fig. 69 – Tomography in real time.

Furthermore, Activating the icon  The user can specify the depth of the tomography view. To do this, use the vertical bar to the right of the GRID, or pressing the up  and down  arrow at the extremities of the bar (Fig. 69)

Deactivating the icon  ,the entire volume is collapsed in a single view and all tomography sections are illuminated (Fig. 69).

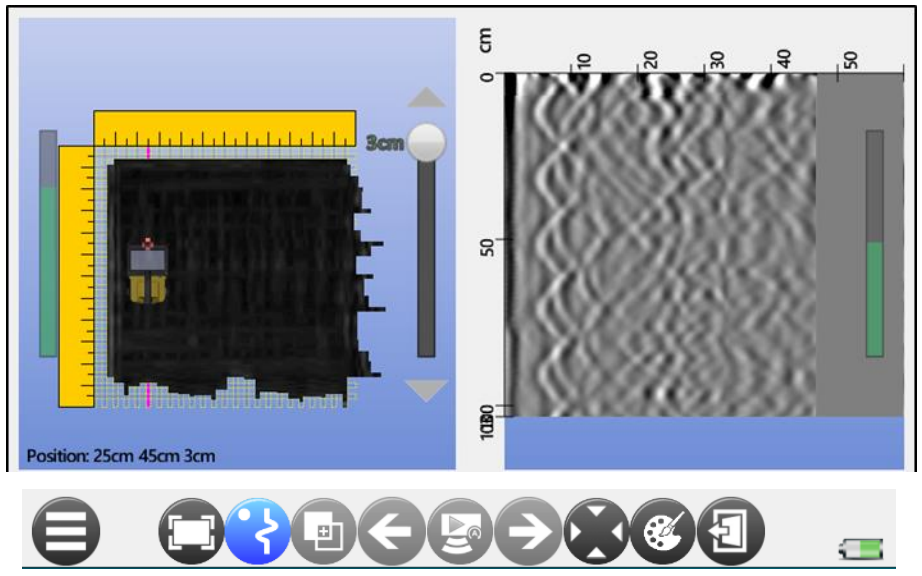


Fig. 70– Tomography section at 3 cm.

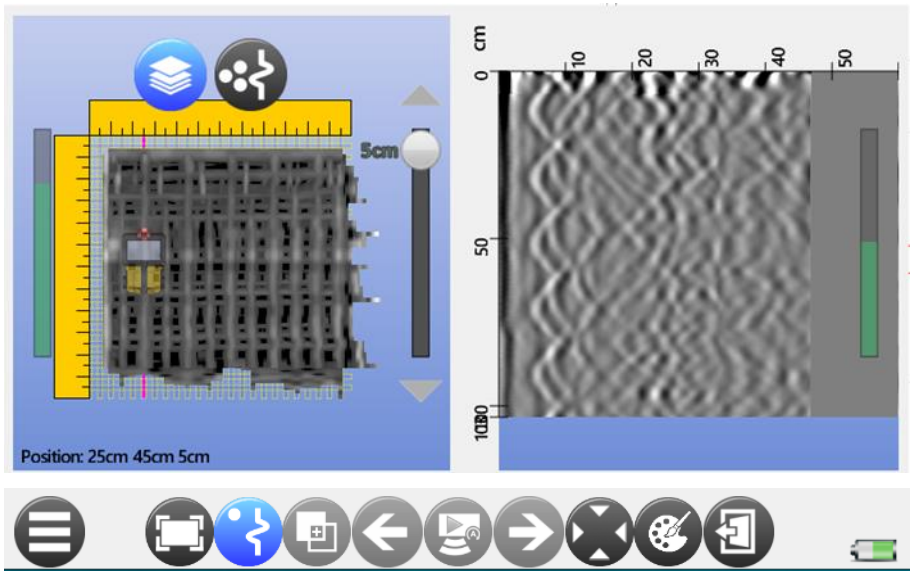


Fig. 71–Tomography section at 5 cm.

- Clicking on  button, automatically other 4 icons will appear on the touchscreen:

  I.  From every screen of a single scan or Grid mode, using this button it is possible to make a screen shot of what is currently displayed on the screen (toolbar excluded). The screen shot will be saved as .jpeg file in a proper folder which will be automatically created in the survey folder; after saving, a message of "Report completed" will be shown on the screen (Fig. 72).

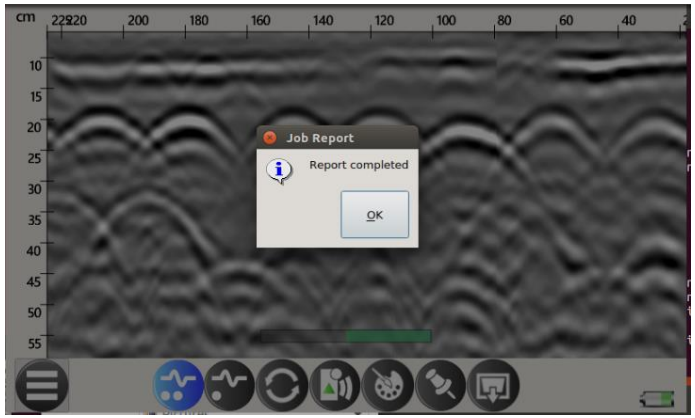


Fig. 72 – Advise when a screen shot (Job Report) is completed and saved in the survey folder

II.  Click it to set the propagation velocity for the radar map, using the hyperbola fitting method. To perform it, follow the procedure below:

1. Find a hyperbola on the radargram on which to perform the velocity analysis;

5. Press and hold the screen on the hyperbola (Fig. 73), the software will automatically locate the top and a setting window will be opened; to better positioning the synthetic hyperbola, use the blue arrows on Propagation Velocity window .

2. Adjust the EM waves propagation velocity to adapt the synthetic hyperbola to the real one visible in the radargram (Fig. 73); it is possible to use the slider (1), insert the Propagation Velocity(cm/ns) (2) or Dielectric constant value (Ɛ) (3) on the proper window.
3. Clicking on OK button, the estimated velocity will be applied to the entire survey.

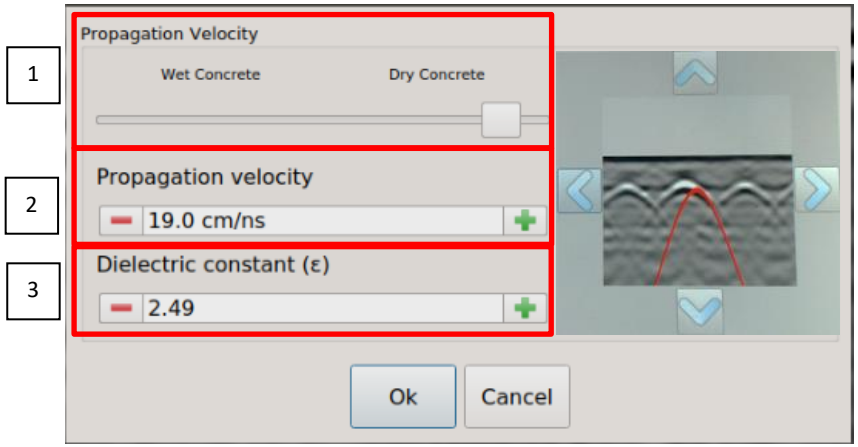


Fig. 73 – Propagation velocity window

III.  Erase the last swath acquired. This button is available only when the system is not in acquisition (); a message for confirmation appear:

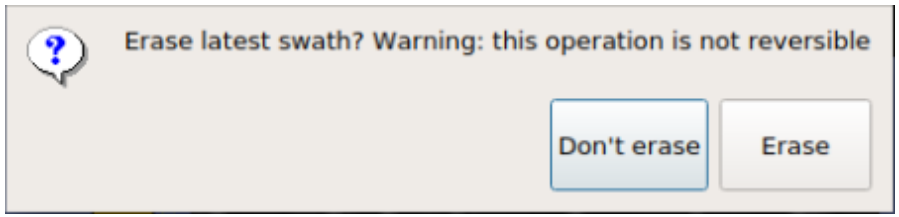


Fig. 74 – Erase swath confirmation message.

IV.  Survey information. clicking this button will show a new window with the survey name, swath number and time of last modification

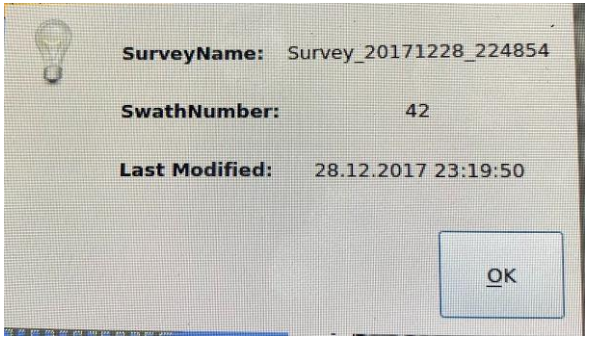


Fig. 75 – Erase swath confirmation message.

-  Click this to choose different colour palettes for the radar tomography and Bscan. Clicking this will automatically bring up the colour palette button on the Bscan window (Fig.) but is only enabled for the tomography after the visualization of the tomography is enabled with this button  .

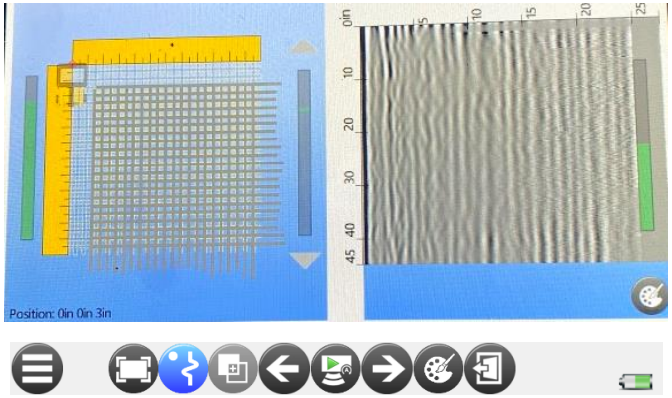


Fig. 76 – Colour palette activation

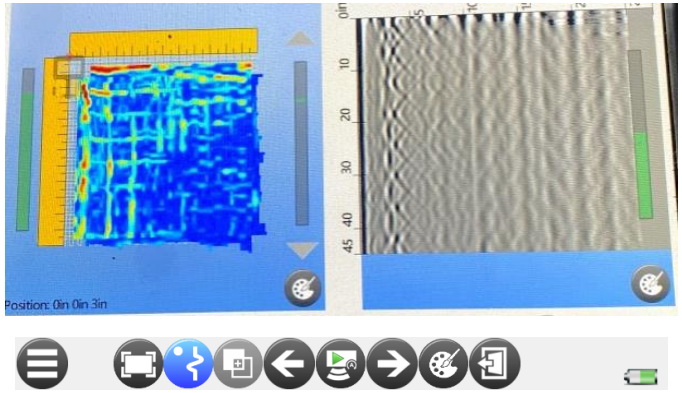


Fig. 77 – Colour palette activation in both windows after enabling the tomography view

- Through  buttons, it is possible to shift from one scan to the previous/next, both during acquisition and review mode.

-  Click the button to stop the current project and go back to the main menu. In this case, If the acquisition is still running (), a message appears as in Fig. 78

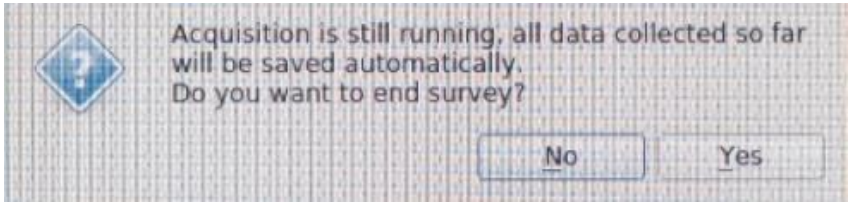


Fig. 78 – End survey confirmation message.

Click yes if you want to end survey, click no if you want to continue.

-  Moving the finger along this bar the user can adjust the contrast of each radargram.

Once the acquisition is concluded, the user can move the system on the scenario to locate physically on the area the regions of interest (free areas or rebar).

In grid acquisition, the palette can be changed only if the merge swath is enabled

In fact, the lasers continue to provide and display the current position in real time.

The user should use the red cross as reference point, for locating and marking interest point (Fig. 79)

Fundamental is to leave the reflective bars in the same position as during the acquisition.

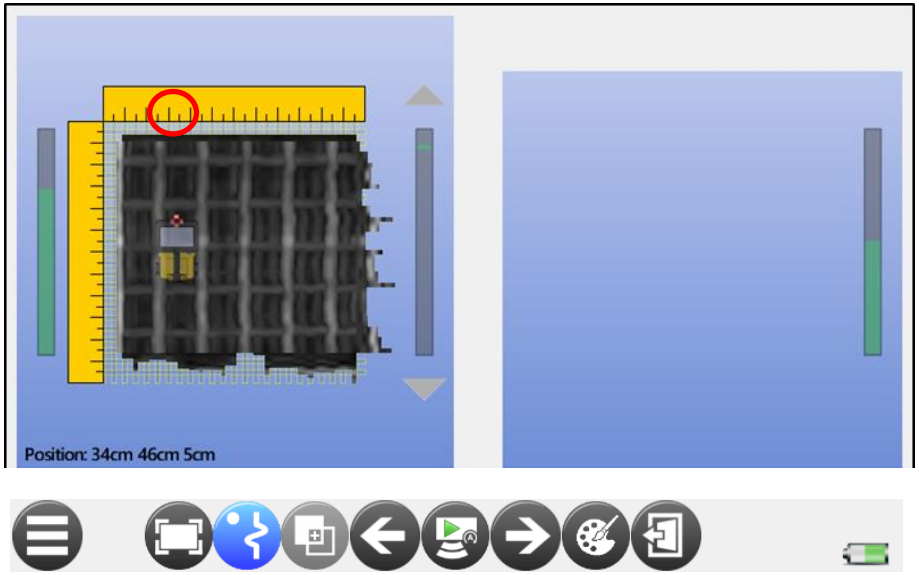


Fig. 79 – Red cross as reference point for locating rebars/voids.

6.5.2 GRID acquisition mode without LASER

When the **Grid** button is selected from the main menu (Fig. 36), the **Grid** acquisition window opens automatically (Fig. 80); before this, be sure that the lasers are disabled ( ).

In this mode the user can acquire the radar scans following a predefined grid of 1m x 1m with the spacing between the scans of 5 cm. The spacing between scans must be physically respected, to correctly locate the target.

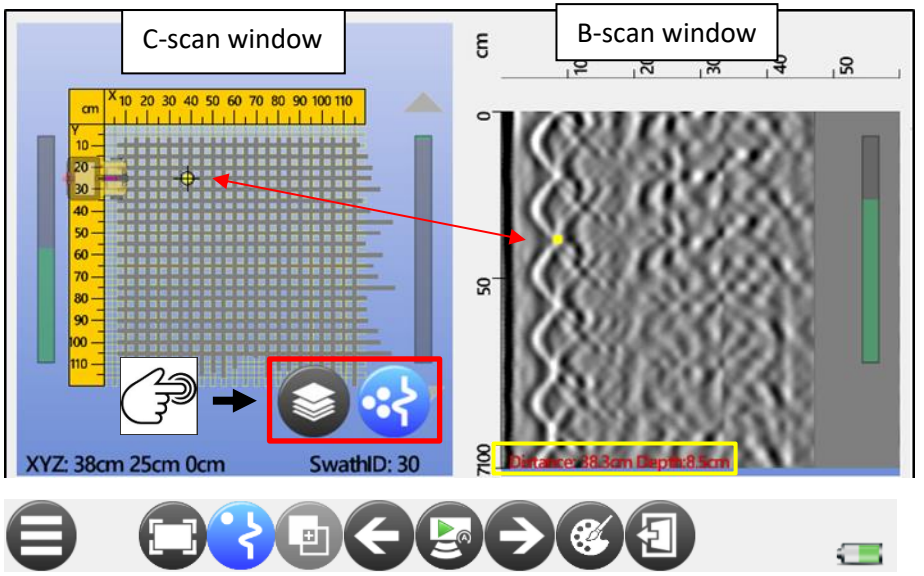


Fig. 80 – main window for GRID mode, without laser.

Click button to start; the icon will become and a warning single "beep" sound will be emitted by the system. At the end of a scan, the user should click the icon to stop and save the last acquisition ( ); a warning double "beep" sound will be emitted by the system. The user can do the same actions just by pressing the button on the handle (red square Fig. 81) to start acquisition, then hold the same button at the end of acquisition.

> Markers and Bookmarks can be inserted in the grid mode, but only in the radar scan view

In grid visualization mode (), the toolbar commands double click on the bottom to visualize the  and  are related exclusively to which radargram is displayed (shallow or deeper radargram respectively, just one per time).

With  activated, this allows to the user the visualization of the tomography map, obtained by interpolation of the single acquisition lines (Fig. 81).

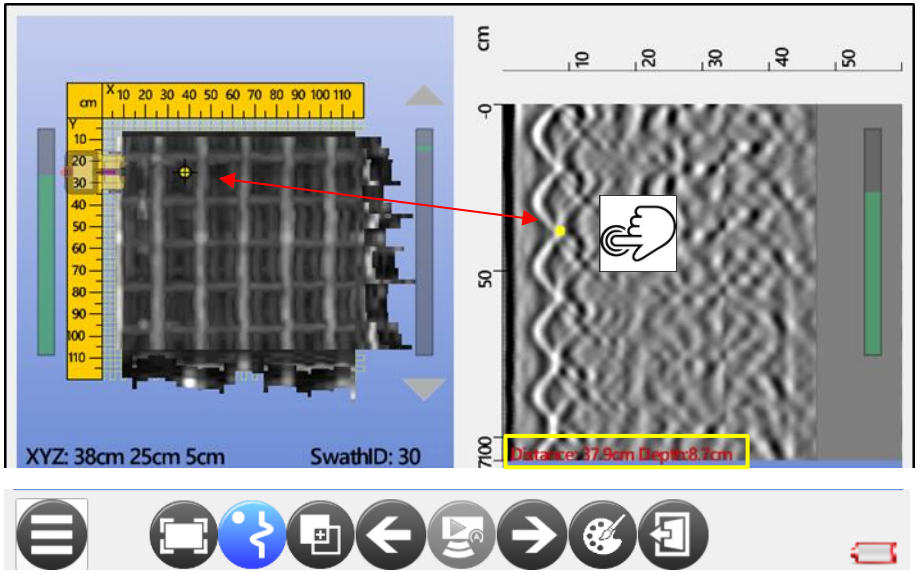
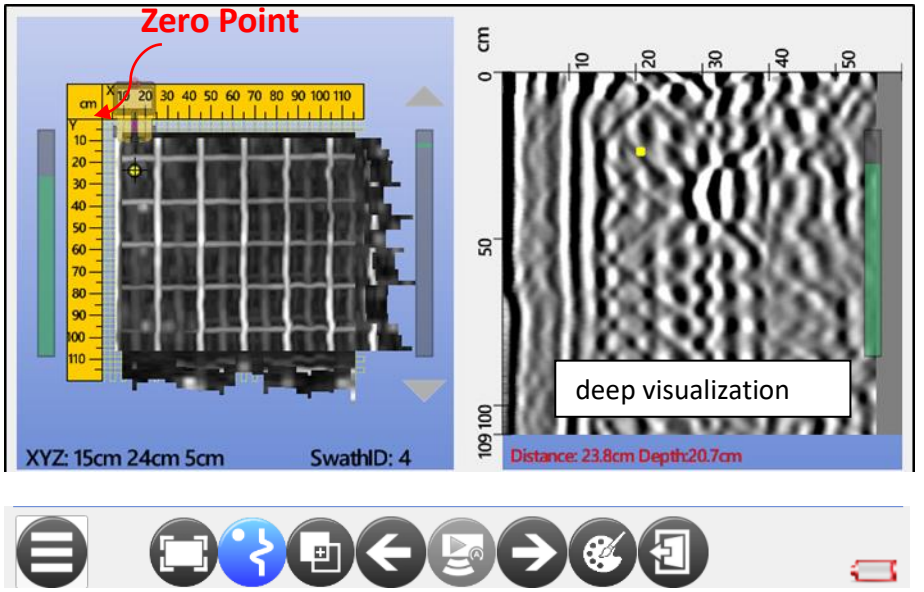


Fig. 81 – Merging data in grid mode.

As the B-Scan and the C-Scan (the tomography) are synchronized, when the user selects a point onto the B-Scan its position shall also be visible on the C-scan . In this case, the horizontal and vertical distance of the selected point are visualized in terms of distance from the beginning of the scan and depth, respectively (yellow square Fig. 80, Fig. 81); depth and distance information's it will be update when the user:

- Acquires new swath
- Changes channel
- Changes swath

All data acquired by deep and shallow antennas are referred to a unique zero point (*Fig. 82*); in fact, during the acquisition or in review modality, due to physically offset between antennas, there is blank part visible on the shallow B-scan.



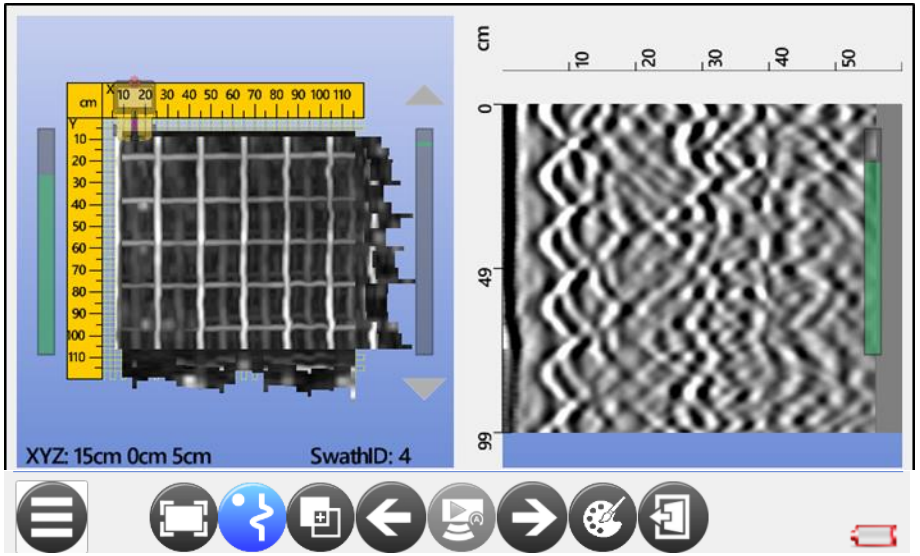


Fig. 82 – B-scans visualization.

The others toolbar commands of GRID mode, are the same as the GRID mode with lasers already explained in Par 6.5.1 (page 40-43).

In addition, a paper grid is provided.

The Paper Grid provide to the User a direct reference system on Grid acquisition modality, allowing the right spatial positioning of the instrument and a total survey area coverage.

The C-thrue base configuration will supply two papers and the User can decide to use only the first one, covering a single area (100x50cm), or to use both papers in order to double the coverage area (100x100cm) (Fig. 21).

To obtain the right Grid Paper matching in the double array, the user must align the three top holes of the bottom pad with the three bottom holes of the upper pad (as shown in Fig. 84); these holes can be even use as reference point on survey surface to better position the target.

By select the button  the user can display only the grid without B-scan

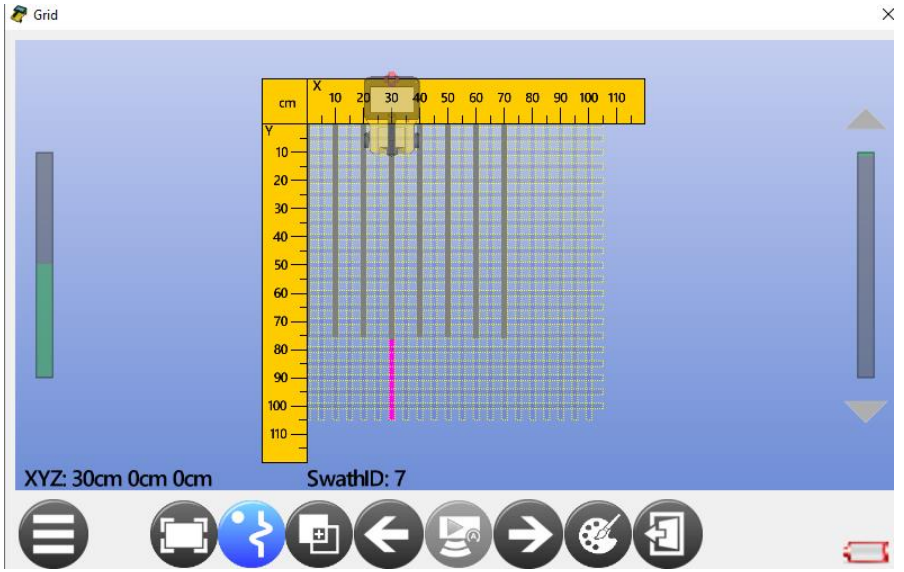


Fig. 83 – Grid Focus

The Paper Grid is even released in inch format with a single covering area of 40x20In and 40x40In matching the two papers; moreover the distance among the swaths is 2In.

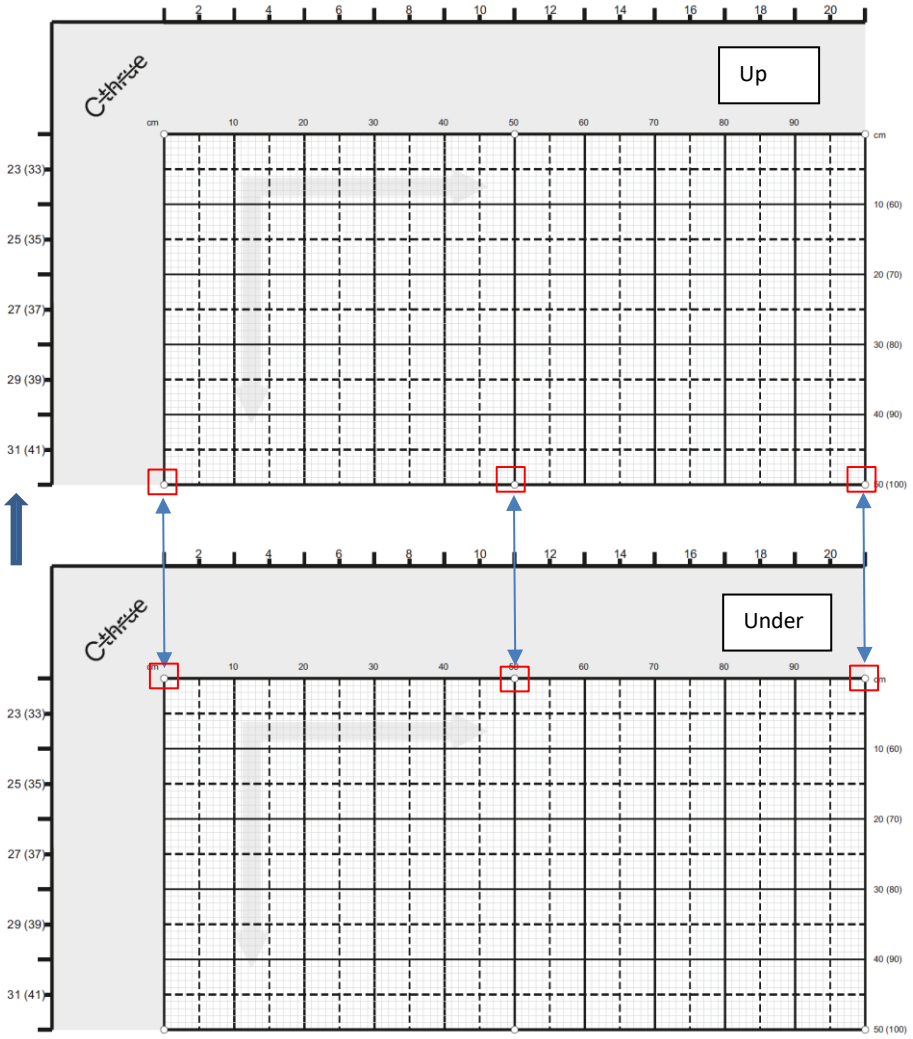


Fig. 84– Grid paper pad double array setting.

At the start of every swath, the top of the system has to be aligned with the lines indicated by the red arrows .

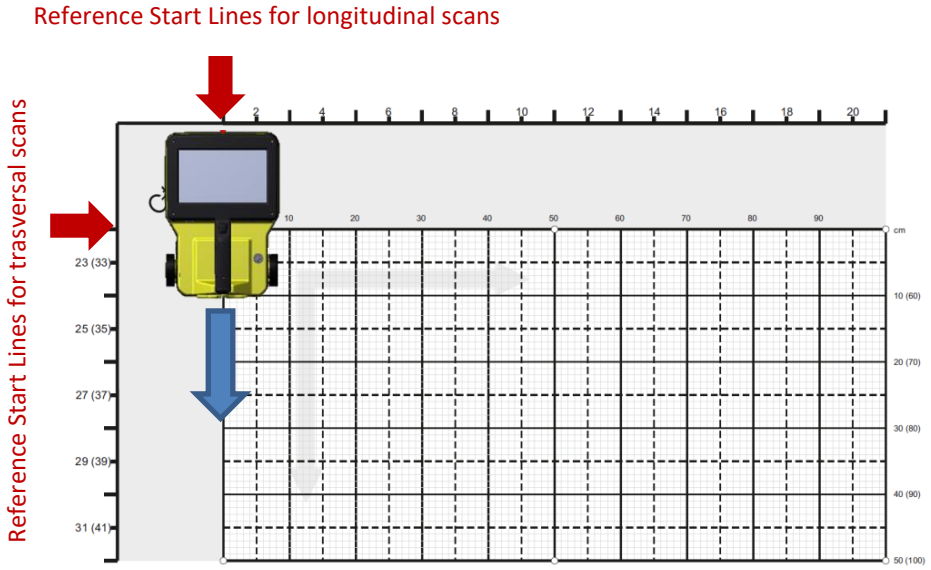


Fig. 85 – System longitudinal positioning.

To obtain a total coverage of the survey area (grid area), the User has to acquire data in both direction (longitudinal and transversal), pulling the radar and shift the system for every scan with a step of 5cm (Fig. 85-76). They grey area will be not covered by radar data.

There is a unique zero point and the whole coverage data are referred to the grid paper zero point (Fig. 87), making easier and more accurate the target positioning.

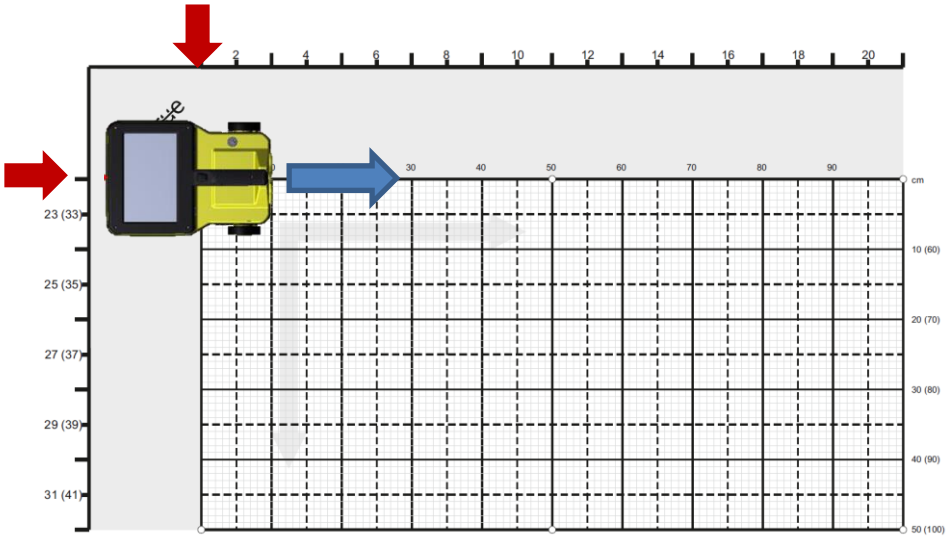


Fig. 86 – System transversal positioning.

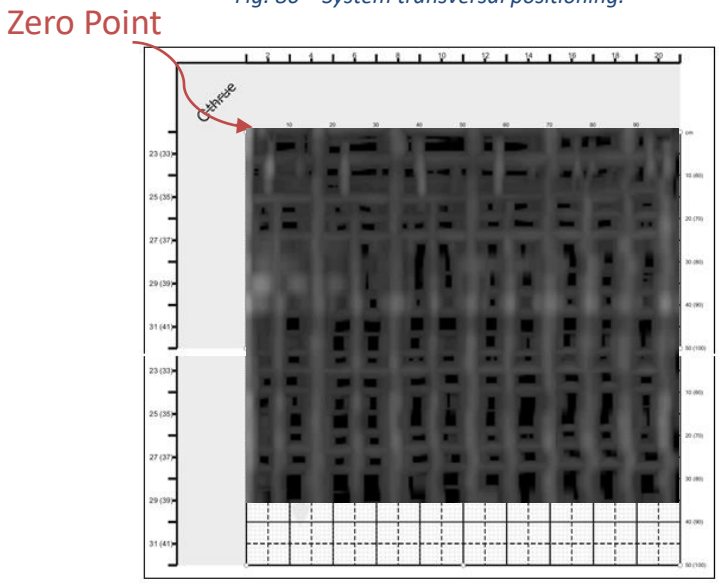


Fig. 87 – Data reference to the zero paper point.

6.6 Power Detector EM sensor

From the main menu window (Fig. 88) first click  icon in order to activate the Power Detector (the icon must be green).

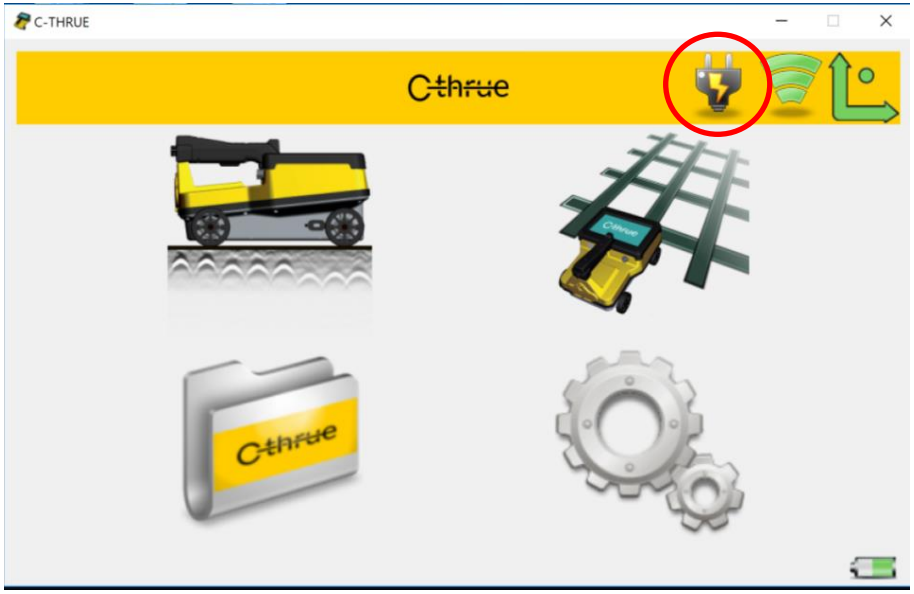


Fig. 88 – Main menu.

It is a passive sensor used to detect Electromagnetic fields generated by buried live power cables; when it is active, a yellow line will appear superimposed to the radargram, as is shown in *Fig. 89*:

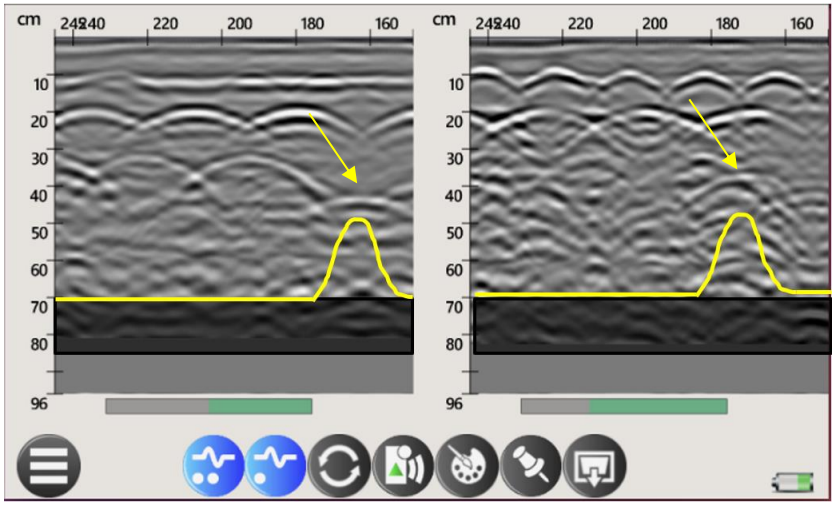


Fig. 89 – Undisturbed (flat yellow line) and peak yellow line of EM sensor (live buried cable detected)

When the antennas pass over a live cable, a wave appears on the yellow line, whose peak is located in correspondence of the buried cable, as is show in the following in *Fig. 89*:

The lines are displayable even in review mode.

The AC detection performance may vary depending on the system's speed of use. The lower the speed the higher is the accuracy.

6.7 Survey Explorer

The **Survey explorer** icon in the main menu (Fig. 90) is used to manage the existing surveys. You can see the number of swaths collected in the bottom right corner of the C-thrue image.

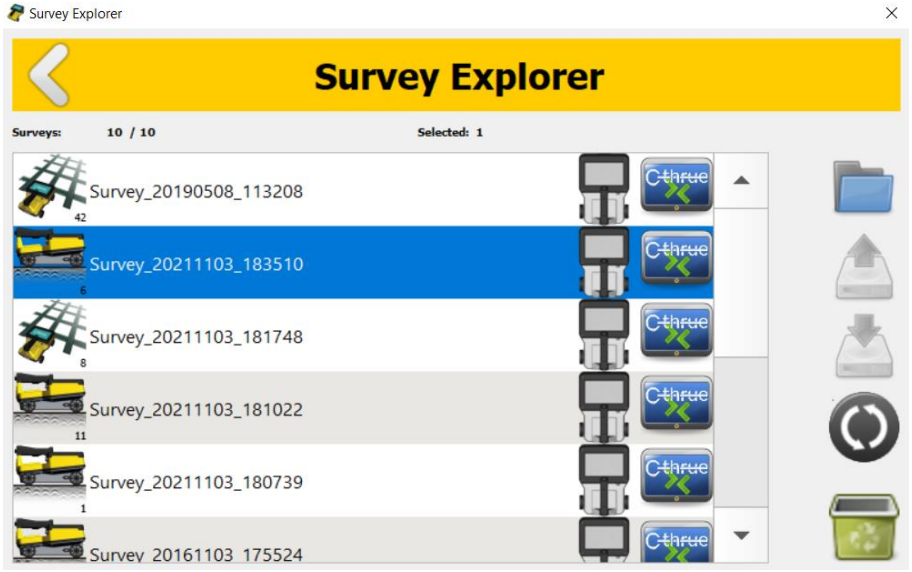


Fig. 90 – Survey Explorer window.

To do it, click on the desired survey in the list and then click:


To opens the **survey.**


To permit the uploading of a survey from the C-thrue memory to the USB stick.


To disconnect correctly the usb stick.


To delete permanently an acquired survey.

6.8 Remote desktop connection and Augmented reality

The C-thrue system is provided with an external controller (Fig. 91), which allows to a second User to follow and operate from remote in all those case when the site to investigate is of difficult access.

	• Display 10.1 inch; • Glove-sensitive touch screen; • Fully-rugged chassis • Intel® Core™ i5 v Pro™ • Integrated RFID • Waterproof and dust proof (IP65) • Weight 1.1 Kg

Fig. 91 – C-thrue remote controller specifications

The C-thrue external controller comes with 2 preinstalled software, ***C-thrue Remote Desktop*** (RDC) ***and C-thrue Augmented Reality*** (), which are described below.

6.8.1 Remote Desktop Connection (RDC)

C-thrue Remote Desktop () enables the remote desktop connection between FZG1 and C-thrue, connecting the two devices through a wi-fi network.
Trough C-thrue Remote Desktop it is possible to control all the C-thrue functions or just monitor the survey carried out by the main User.

6.8.1.1 Wi-Fi connection initialization

Before starting this procedure, be sure that only one of the present C-thrue is on.

In order to link the FZG1 remote device with C-thrue system, the user has to follow the steps here below:

- Turn on both FZG1 and C-thrue systems
- Open C-thrue Remote Desktop on FZG1 desktop
- Enabling wi-fi on Remote Desktop by, clicking the icon on the top right part of the main window.
- Open Window Network on FZG1 and select the Network C-thrueRD-Net
- Insert the default password **12345678** and click connect
- Select on the Remote Desktop SW the icon to connect the FZG1 to the C-thrue system

If the wi-fi is enabled in one device, while in the other is still off, the icon will be (), as per Fig. 93 . f the devices are wi-fi linked, the icon will be in both devices.

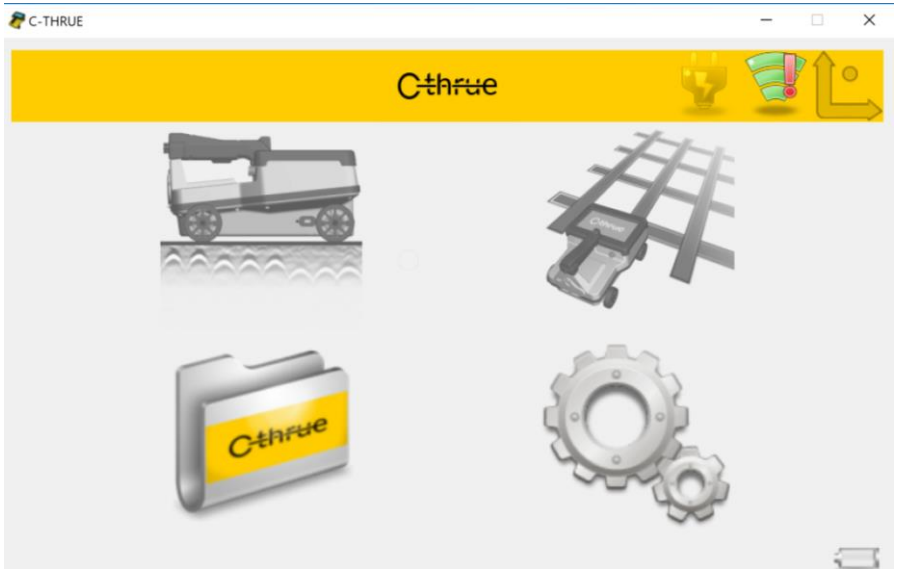


Fig. 92- C-thrue Remote Desktop main interface.

6.8.1.2 Settings and data visualization

The remote desktop connection allows the user to share the screen, during the acquisition and software navigation to change settings and survey explore.

The rule is that everything concerning the radar itself, is synchronized.

Is up to the user to change visualisation in each device.

Referring to Settings (. ), many of the options are the same as the ones in the C-thrue software, with the following differences:

In the **International Settings** menu (), the “Update time” button is replaced by “Update C-thrue”, with this command the C-thrue time and RD time will be synchronized (Fig. 93).

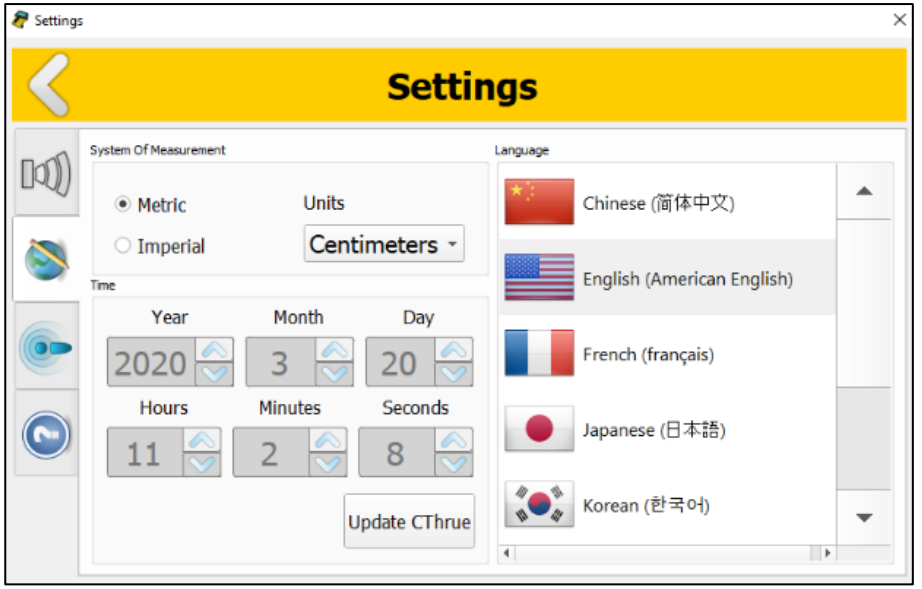


Fig. 93 – RD International Settings

In the ***Network settings*** Menu ( ) it is also possible to change the Survey base name and (Fig. 94).

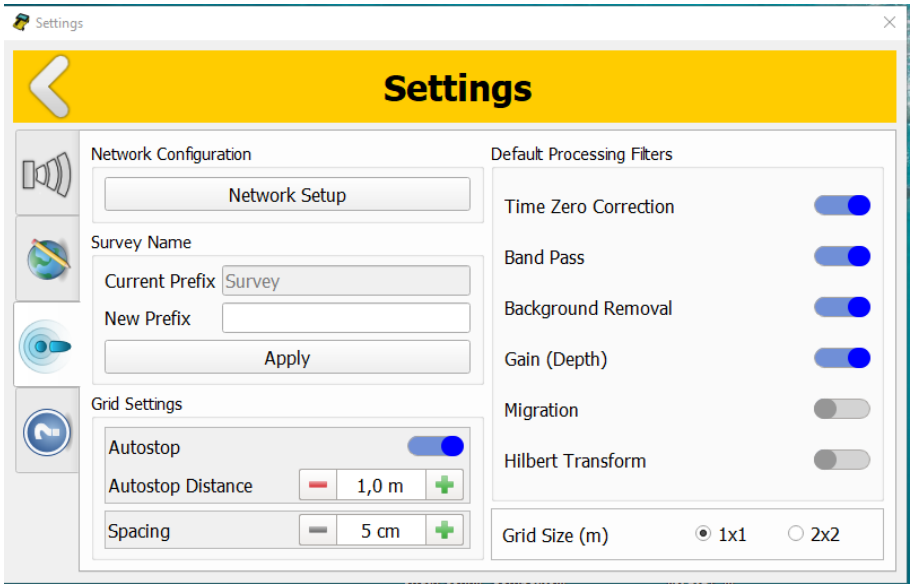


Fig. 94 – Network Configuration

Every C-thure machine has its own proper network, default named as ***C-thrueRD-Net***. The User may change the Wi-fi name of each C-thrue, following the procedures described below.

1) Connect both default wi-fi network (in both devices).

2) In ***C-thrue Remote Desktop***, go in Settings ( ) → Network Configuration ( ).

3) By clicking on Network Setup (Fig. 94) a ***Configuration Window*** will be automatically display (Fig. 95).

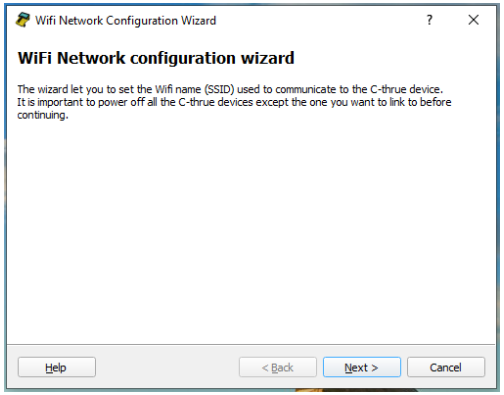


Fig. 95 – Network Configuration window

4) By clicking on Next > the User will be able to rename the default wifi network (**C-thrueRD-NET**) with any required name (i.e C-thrueRD-NET_TEST; Fig. 96).

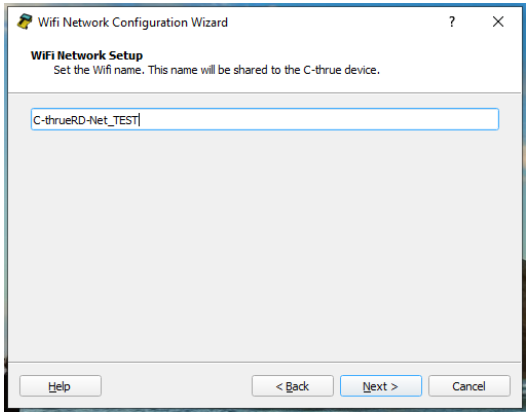


Fig. 96 – Network rename

5) By selecting Next >, a new interface will let the User to set a new access password for the renamed wifi network or keep the default setting (Fig. 97).

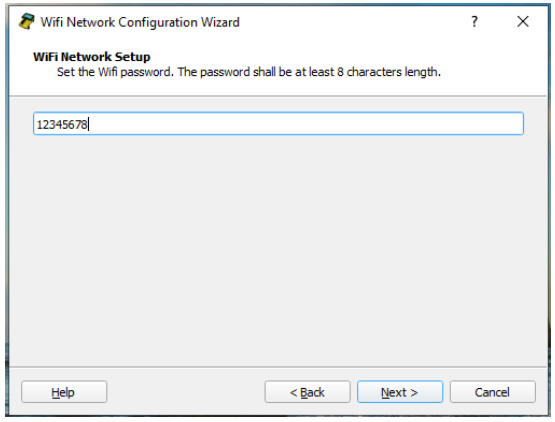


Fig. 97 – Network password setting

6) By clicking on Next > and Finish all the network changes will be applied (Fig. 98).

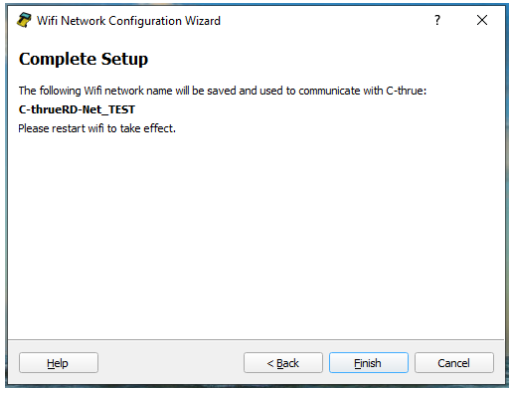


Fig. 98 – Complete Setup window

7) In order to restore the devices communications, the User need to select the renamed network (Fig. 99) and insert the related password.

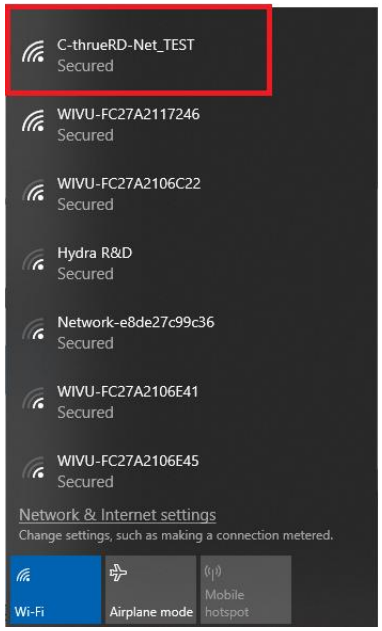


Fig. 99 – Network dropdown menu

8) Now the user can work on the renamed wi-fi network.

Both devices are interoperable, so the user can change settings from each device.

The synchronized parameters can be changed on both devices.

Do these procedures only after the systems are connected to the wi-fi, otherwise the settings will be lost.

9) To come back to the original wi-fi default name, the User need to click on  and then repeat the passages previously described. Network name and password will be automatically set as default.

In order to ensure the devices communications, the User need to keep deactivated the PC *"Public Network"* Firewall from the dedicate Firewall & Network protection area.

Referring to Single scan mode (), if the user wants to interact with the radarmaps, adding markers or changing the propagation velocity, start/stop scan acquisition, these actions will be applied in both devices.

Interacting with the icon  will affect only C-thrue Remote Desktop visulization(Fig. 100).

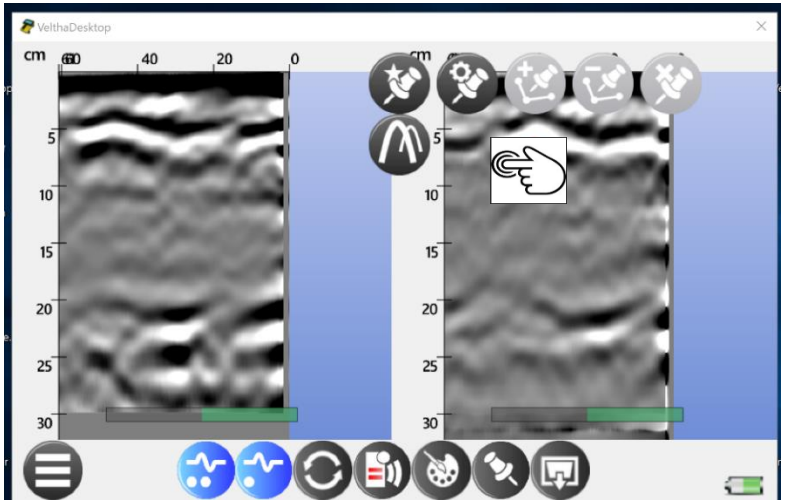


Fig. 100 – Single Scan in C-thrue Remote Desktop.

A new function is present on C-thrue Remote Desktop GRID MODE, clicking  and then  (Fig. 101). this will allow the user to create time slices and a *Slices.xml* saved in the survey folder.

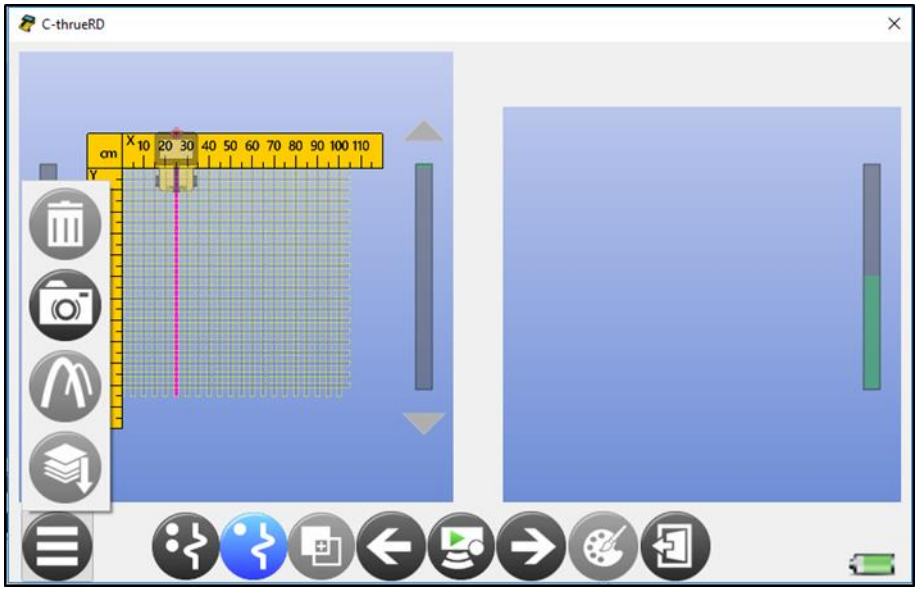


Fig. 101 – Grid Mode in C-thrue Remote Desktop

When taking a snapshot, in addition to the standard image option, in RD it is also possible to export an image of the tomography slices, one each 2 cm (or 1 inch), to do it select "Slices" when exporting the images (*Fig. 102*).

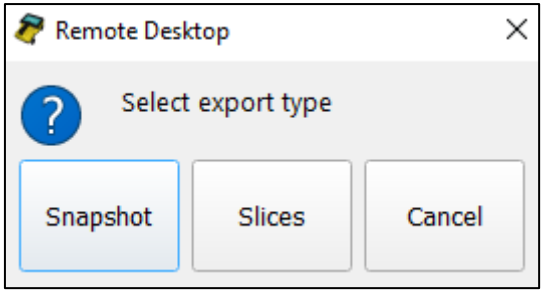
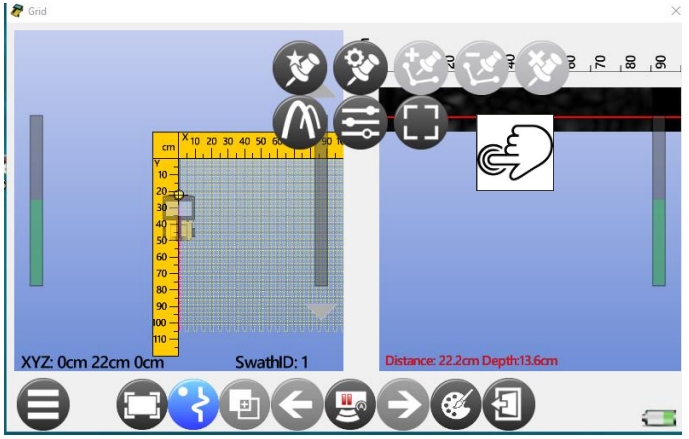


Fig. 102 – Slices export

When the export is done, a confirmation message will appear (Fig. 103).

Fig. 103 – Slices export complete

By selectin the option  the user can disable the the vertical and horizontal reference in order to display the full path of the system



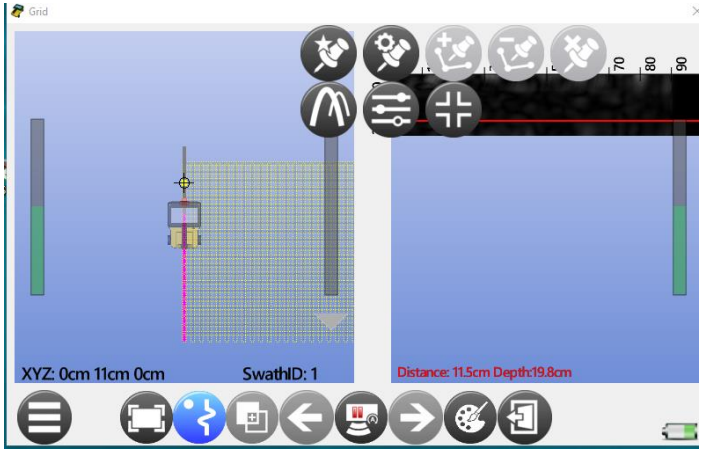


Fig. 104 – Option ON/OFF vertical and horizontal reference

6.8.1.3 *Survey import/export between devices*

It is also possible to import/ data from “Open Survey” folder ( )of one or more C-thrue distinctly. All the import data are saved in a single “Survey Explorer” folder of the C-thrue Remote Desktop (Fig. 105).
The import/export possibilities are explained in the table below:

In order to ensure the missions export, the User need to use USB 2.0 FAT 32; others USB format are unreadable from the device.

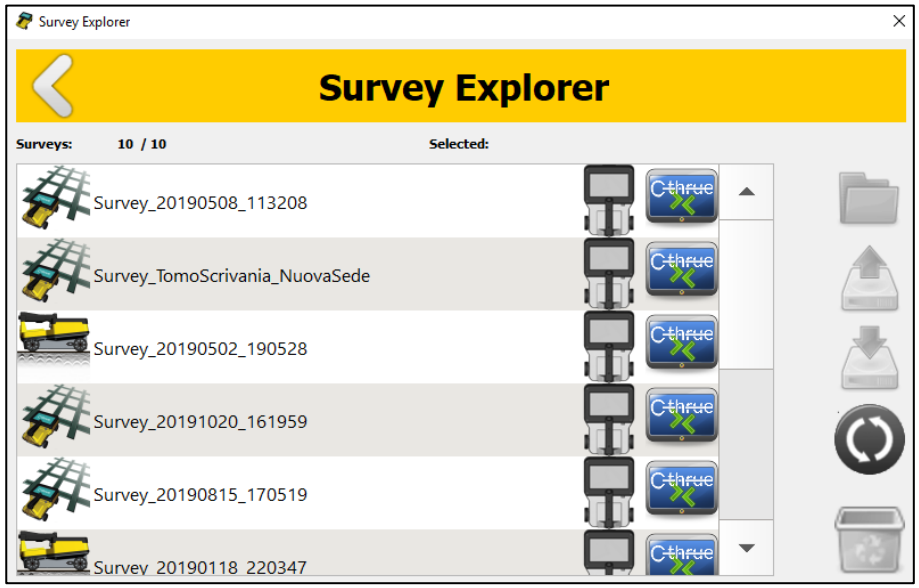


Fig. 105 – C-thrue Remote Desktop “Survey Explorer” interface.

The user has the following options:

 select a survey clicking on the row, then click on the icon to open it in review

 Export a survey to the C-thrue device

 Import a mission from C-thrue device

 To reload the survey list (in case of error)

 Delete a mission

The icons will change accordingly to the location and to the latest modification of the selected surveys, as in the table below:

 **Icons coloured**= Survey present in C-thrue sw and/or C-thrue Remote Desktop .

 **Grey icons**= the survey is not present in the device

 **Coloured icons with star**= One of the device has the most updated survey respect to the other one.

The following table shows the possible combinations and the meaning of it.

Survey status	Related icons	Possibilities to import/export in both devices	Related icons for the import/export between devices	Final status of the icon after the action
The survey is present only in the C-thrue memory		Only import in C-thrue remote desktop		
The survey is present only in velta desktop		Only export in C-thrue system.		
The survey is present in both devices, with the same status		Both import and export		
The surveys is present in both device, but the one in C-thrue device is the latest modificated one.		Both import and export. The user can import the latest modification in C-thrue remote desktop, or he can discard the latest operation in C-thrue clicking export, and come back to the original or previous version		
The surveys is present in both device, but the one in C-thrue remote desktop device is the latest modificated one.		Both import and export. The user can export the latest modification in C-thrue remote desktop, or he can discard the latest operation in C-thrue clicking import, and come back to the original or previous version		

6.8.2 Augmented reality

The C-thrue ARApp (

), is an application developed for the remote desktop Tablet. It is used to visualize the results of C-thrue Georadar survey and to allow an operator to mark the examined surface while the tablet camera frames it (Fig. 106).

QR code is the trademark for a type of matrix barcode (or two-dimensional barcode). A barcode is a machine-readable optical label that contains information about the item to which it is attached. A QR code uses four standardized encoding modes (numeric, alphanumeric, byte/binary, and kanji) to store data efficiently.

By framing an area delimited by markers, the app superimposes the C-thrue Georadar images over the bounded area.

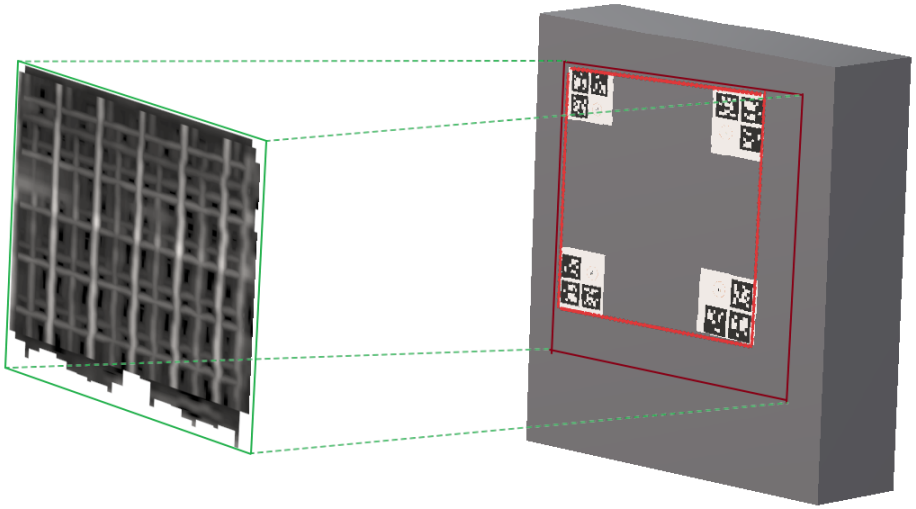


Fig. 106 – Superimposition example

The Georadar slices are raster images and represent the radar scans at different depths. The Georadar images are described in an .xml file. Each raster image represents a surface with area up to 1.20 meters x 1.20 meters.

In each sticker, it is indicated where it has to positioned respect to the reflective bars (Fig. 107).

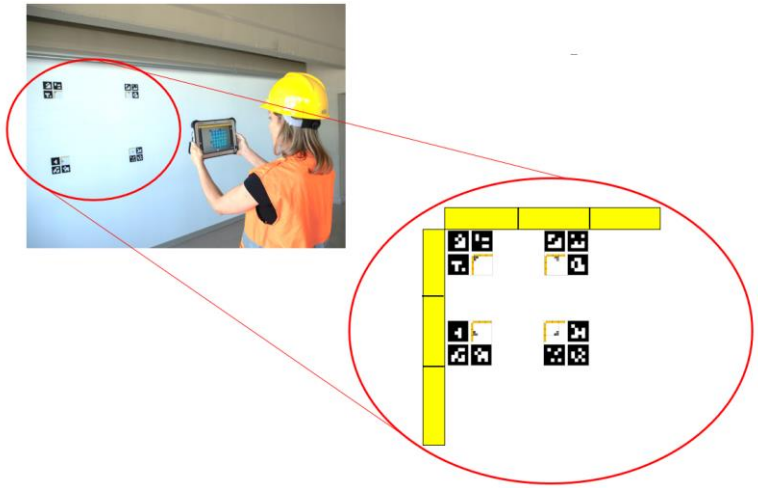


Fig. 107 – position of the stickers respect to the reflective bars

The tablet camera can recognize from one to four markers and each marker symbol is unique (top left, top right, bottom left and bottom right).

The user can choose the depth and transparency of the GeoRadar image to visualize using a slider.

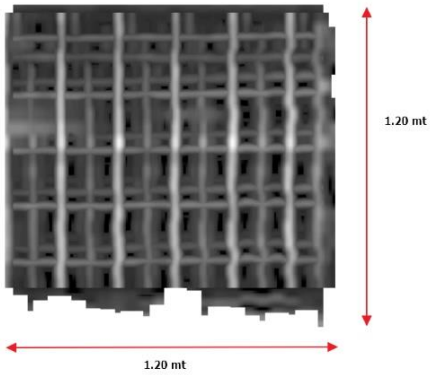


Fig. 108 - Georadar slice image

6.8.3 User Interface and AR App usage

This section details each component of the ArApp main interface.

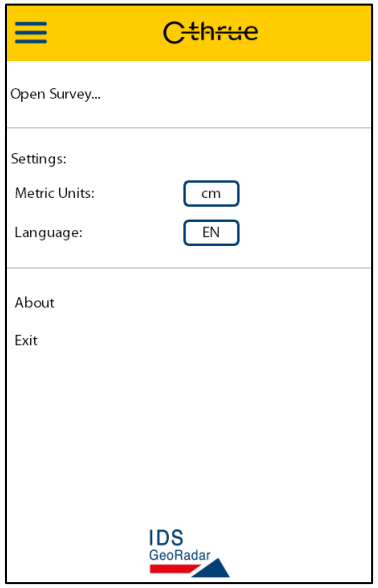


Fig. 109 – Open survey and settings window

Click on the ***Open Survey…*** button (Fig. 110), from the open dialog choose the folder where is located the dataset (for dataset details), the slice's images are loaded according to *Slices.xml* dataset description file.

Also, from the menu the following setting can be changed:

- **Metric Units**: metric units used for Depth slider (cm/inches);
- **Language**: allows to switch between English and Italian;

The image (Fig. 110) shows the ArApp interface components:

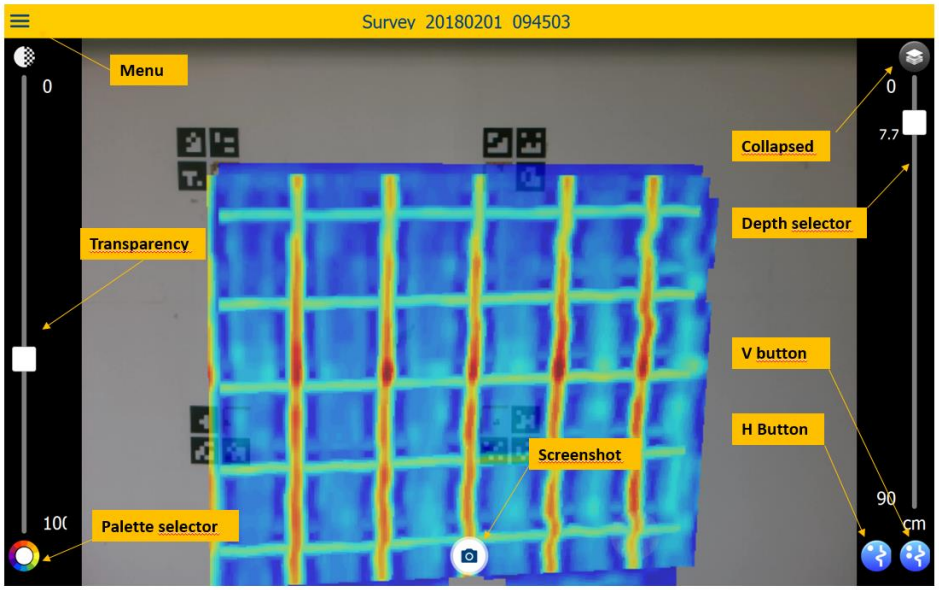


Fig. 110 - ArApp main interface

On the main window is shown the video captured from tablet camera.

To visualize the slice's image on the marker a dataset must be loaded, click on the ***Menu*** button. The menu is shown.

The H and V button () are used to choose which slices dataset will be used:

- **H button checked**: the dataset *Array HH* will be used.
- **V button checked**: the dataset *Array VV* will be used
- **V and H buttons both checked**: the dataset *Array HH+VV* will be used.

The ***Depth slider*** is used to choose which slice's image in the corresponding dataset will be visualized on the markers. If the Collapse button is checked () the Depth slider will be disabled and the collapsed slice's image, if present in the dataset, will be visualized. If the *Collapse* dataset attribute of the *Slices.xml* is set to  , the *Collapse* button will be disabled.

The ***Transparency slider*** is used to control the transparency of slice's image currently, the value 0 for slider means the slice's image is completely transparent, while a value of 100 means the slice's image is visualized without transparency.

The ***Take screenshot*** button is used to store the current visualized image on png image file in the directory *<dataset folder>/pictures*, the saved screenshot image file will have this format:
screenshot_<year>_<moth>_<day>_<hours>_<minutes>_<seconds>.png

The ***Palette Button*** selects the palette used to visualize the slice's image on the markers. If the black and white palette button is selected the slice's image will be visualized in grey scale (Fig. 112). While if the colour palette button is selected the slice's image will be visualized with colours according to the jet palette (Fig. 112).

Fig. 111 - Black and white palette button

Fig. 112 - colour palette button

7 CARE AND TRANSPORT

7.1 Cleaning Information

Before cleaning any external part of the apparatus, make sure that USB port and the battery compartment cover has been closed. 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 using it.

The C-thrue should be cleaned periodically using a damp cloth.

Do not use solvents or abrasive detergents.

Do not apply any liquid directly onto the electrical contacts of the connectors.

If a specific spray is used to clean the touchscreen, make sure it is not flammable; in any case, do not spray it directly on the screen, instead, spray it onto the cleaning cloth.

7.2 Battery Removal Information

Radar batteries:

Manufacturer: RRC

Type: rechargeable lithium-ion

Characteristics: 15V-3.2Ah

Removal instructions:

- Be sure that the system is off.
- Use the ¼ turn left screw to open the battery compartment cover
- Remove the battery from the compartment (optional) opening the strap.

CAUTION: insert the battery under dry conditions

7.1 Periodical Check

The Operator should periodically check the status of the System

7.1 Proper system use

The following points must be followed to operate in safety conditions, to avoid any issues to the system parts and to secure a long life to the system

- **Surface of use:** operating the system over very rough or sharp surface is not recommended.
- **A**t least one of the 4 wheels must be always in contact to the surface during the acquisition, in order to measure correctly the distance travelled. The best radar image results are reached when all the 4 wheels are in contact with the surface itself
- **Safety lace:** the operator must to use the safety lace secured to wrist and to the system.
- Under every condition during the acquisition phase, the optimal height of the system's antenna is reached when all the 4 wheels are in contact with the surface itself
- **Allowed velocity**: the system must be pushed/pulled only manually moving it, avoiding abrupt acquisition velocity changes.
- **Moving and correct usage of the system**: to transport the system from one site to the next, always use its suitcase.

- **Positioning bars**: after the acquisition, always remove and safely store the positioning bars.
- **Positioning bars**: use at least 3 squares of sticky modelling paste for each bar. Do not use any other type of material.
- **Positioning bars:** if the bars are attached to the ceiling, always use safety helmet and safety glass, during both system's set up and data acquisition.
- **For FCC regulations:** do not tamper the switch under the handle in any way.

8 ERROR MESSAGES AND TROUBLESHOOTING

If an error or malfuctioning occurs, a pop-up icon, in the bottom right of the touchscreen, will appear (), as in Fig. 113. Clicking on the icon, the user can visualize the error/warning message:

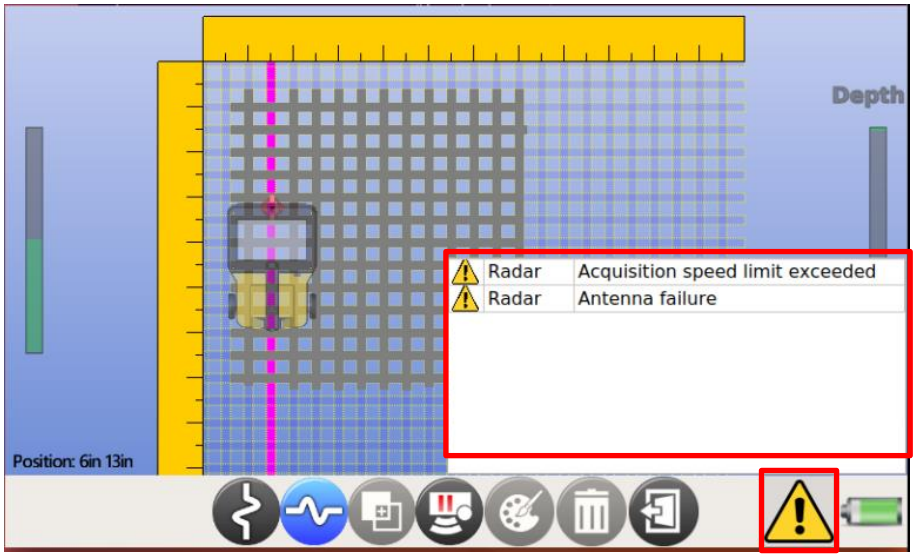
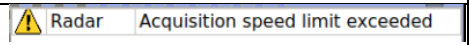
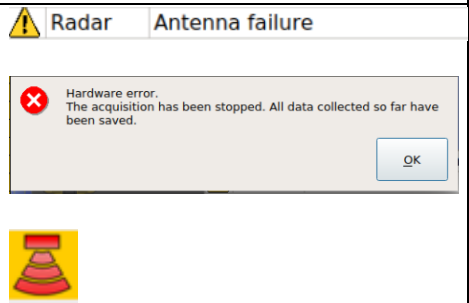
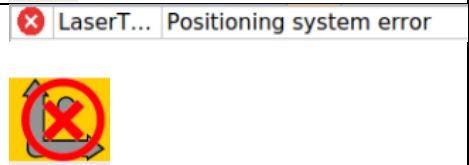
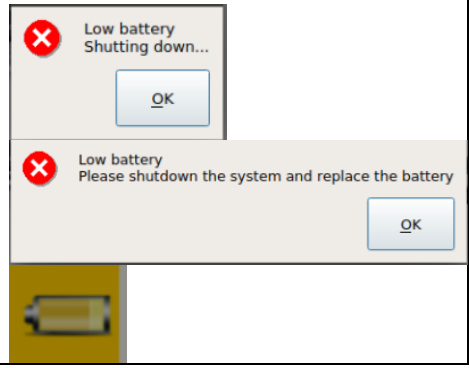


Fig. 113– Pop-up message.

Here below the list of possible messages, and applicable troubleshooting:

System's part	Error message	How the error is showed	Troubleshooting
Radar	Acquisition speed limit exceeded		The user has moved the radar too fast. Please go slowly
Radar	Antenna failure		One of the antenna is not working. Switch off and on the system. If the error persist, please contact IDSGeoRadar Customer Care service
Laser	Positioning system error		The user should turn off and on the system; if the problem persists contact the IDS GeoRadar customer care.
Battery	Low battery		Please recharge the battery. In case the error persists after the charging, a replacement of the battery is necessary.

9 IDS GEORADAR ON-LINE ASSISTANCE

9.1 Download area

The Georadar section of the IDS GeoRadar website has a download area you can access to get the latest update of software, manuals, guides and other useful tools.

To do this, the first step is to request an account activation in http://idsgeoradar.com/customer-area/customer-area-registration

The request will be handled by the Customer Care of IDS GeoRadar, after which you will receive an email with your credentials for accessing the download area during login at https://support.idsgeoradar.com/

APPENDIX A - Technical Specification

C-thrue	
SYSTEM SPECIFICATIONS	
Antenna Center Frequency	2.0 GHz
Maximum measured e.i.r.p. in air (Wi-Fi switched off)	0.042 mW
Number of Antennas	4
Antenna Polarization	Horizontal and Vertical
Number of Radar Channels	2
Scan Interval	Up to 10 scans/cm
Depth Range	Up to 80 cm (up to 31.5 in.)
Display modes	B-Scan and C-scan (radar tomography)
Positioning system	"Virtual Pad" (based on 3 High safety - Class 1 laser sensors with reflective bars)
AC Power Conduits Detection	EM sensor integrated (50/60 Hz)
Battery	Li-ion battery, 15V, 3.2Ah, 2-hour runtime
Data Storage	32 GB
Connectivity	USB, Wi-Fi
Wi-Fi Module	Frequency Range: 5.15GHz-5.85GHz* Ouput Power: about 4 mW (802.11ac / 5GHz protocol) Antenna gain: 4.9 dBi **Use subject to local regulations
ENVIRONMENTAL SPECIFICATIONS	
Operating Temperature	-20°C to +50°C (-4°F to +122°F)
Storage Temperature	-40°C to +60°C (-40°F to +140°F)
Environmental	IP65

MECHANICAL SPECIFICATIONS	
Dimensions (length x width x height)	285mm x 200mm x 160mm (11,2in x 8,6in x 6,3in)
Weight	2.4 kg (5 lb) with battery
Display	7.0 inches TFT multi-touch
SOFTWARE FEATURES	
C-thrue software	• Quick start-up • Real time radar data acquisition, processing and visualization in B-Scan • Real time feature marking, management and editing tool • Rebar/Void automatic discrimination • VirtualPad - Positioning & navigation system • Visualization of C-scan (radar tomography) • Real time diagnose of radar and the other devices • Metric and imperial units

Exposure to Radio Frequency (RF) Signals:

The product is designed to be handheld and the minimum distance between the user and any radiating elements is about 100 mm.

SAR evaluation is not required because the output power value is less than exemption limit at such separation distance.

APPENDIX B - DISCLAIMER

1. Generals.

i. The present Disclaimer applies to all products designed, produced and distributed by IDS GeoRadar s.r.l., its Subsidiaries, Affiliated and authorized Distributors (the "Products"). IDS GeoRadar s.r.l. reserves full ownership and intellectual property rights of any "Information" contained in this Disclaimer including Trade Marks and Graphics. No part of this Disclaimer may be used or reproduced in any forms without the prior written agreement of IDS GeoRadar s.r.l.

ii. In the event that any provision of this Disclaimer may be invalid, unlawful or incapable of being enforced by a rule of law, all other provisions shall, nonetheless, remain in full force and effect. Failure to either enforce or exercise any right, privilege, or legal remedy at any time, any provision contained in this Disclaimer, shall not be deemed a waiver of such provisions or right, remedy, or privilege.

iii. This Disclaimer shall be interpreted, governed, construed and enforced in accordance with the laws of Italy. User/Buyer hereby consents to the exclusive jurisdiction of Pisa.

2. Initial Precautions for Setting-up and Use of the Products.

i. The User/Buyer, for setting-up and using the Products, shall consult the official documentation provided by IDS GeoRadar s.r.l. for the Products ("Reference Documentation") and carefully ascertain the compliance with national laws and requirements, which may limit or even forbid their use.

ii. For Products which shall operate by circulation in Public Areas/Roads, with or without moving traffic, Buyer/User shall verify the approval of local authority and/or site's owner according to their specific procedures. IDS GeoRadar s.r.l. shall not be liable for any direct, indirect, special, incidental or consequential damages or injuries, including without limitation, lost revenues or lost profits, resulting by un-authorized use of the Products in Public Areas/Roads.

iii. Buyer/User further warrants:

- that these Products are not being used, in the design, development, production or use of chemical, biological, nuclear ballistic weapons. Buyer/ User will defend, indemnify and hold IDS GeoRadar s.r.l. harmless against any liability (including attorney's fees) for non-compliance with the terms of this article.
- That, if IDS GeoRadar s.r.l. requires that Buyer/User shall carry out a training with reference to some Product categories, no operation or use of the Products shall be started before its designated Operator/s has got the User Certificate, as defined by IDS GeoRadar s.r.l. specific procedure which the Buyer confirms to know and accept.

iv. For Products which include specific "Operational" software with automatic data processing and analysis "Tools", e.g. the IBIS Products and Hydra Products, User shall be aware that the results provided by these "Tools" may be not error free. User that completely relies on the outcomes provided by these Tools only, does it at his own risk.

v. In no event IDS GeoRadar s.r.l. shall be liable for special, direct, indirect, incidental, exemplary, punitive or consequential damages including, but not limited to, loss of profits or revenue, caused by the use of the Products, either separately or in combination with other products or relied upon the results provided by the above "Tools".

3. Disclaimer for the "Use" of the Products.

i. The User shall follow the instructions provided by IDS GeoRadar s.r.l. in its official "Reference Documentation" for the Product, in particular the User's Technical Manual which contains all the specific steps and recommendations for a correct setting-up and use of the Product.

ii. In no event IDS GeoRadar s.r.l. shall be liable for special, direct, indirect, incidental, exemplary, punitive or consequential damages including, but not limited to, loss of profits or revenue, caused by the missed or incomplete observance of the instructions and prescriptions for the use of the Products, either separately or in combination with other products, including but not limited to the following main aspects:

a. Use of IDS GeoRadar s.r.l. Products outside its limitation of use, without proper and adequate scientific/technical knowledge or without specific training.

b. Use of results/outcomes of the measurements performed by the Product aimed to safety aspects without using adequate control procedures and assessment by skilled personnel.

c. Opening of the Equipment (for HW Products) without express written authorization of IDS GeoRadar s.r.l.;

d. Unauthorized changes and additions to the Products.

e. Use of the Products connected to suspected non-working equipment or with equipment (mainly PC) having characteristics not in compliance with the required specifications of IDS GeoRadar s.r.l. not expressly authorized by IDS GeoRadar s.r.l.;

f. Poor or faulty operation of the electrical and telecommunication networks not directly managed by IDS GeoRadar s.r.l. or its delegates.

g. Poor or faulty operation Software/Hardware of the third parties connected with IDS GeoRadar s.r.l. Equipment.

h. Poor or faulty operation of the Products due to Software Virus which infected the Products after their delivery.

i. Use of the Products which have encountered suspected manumissions, accidents, electrostatic shocks, flashes, fire, earthquake, flooding or other natural disasters or unexpected events.

Use or storage of the Products outside the limits of the “Operational Temperature Range” specified by IDS GeoRadar S.r.l

APPENDIX C – WARRANTY CONDITIONS

A. Standard Warranty Conditions

1. IDS GeoRadar s.r.l, warrants that its products shall be free from defects in material and workmanship, for a period of 12 months from the delivery date duly registered and certified ("Effective Date") in the "Warranty Registration Form" enclosed hereto. IDS GeoRadar shall repair or replace Products or parts thereof found faulty (the "Faulty Parts") which are returned to IDS GeoRadar, and which, at IDS GeoRadar's judgment, were defective or became defective during its normal use. Seller's obligations shall not apply to Faulty Parts that:
   (a) Buyer do not properly store, install, use, or maintain;
   (b) Buyer modify, or perform tests which are not approved in writing by the Seller;
   (c) Buyer have subjected to any kind of misuse, detrimental exposure beyond its intended purpose or damaged in an accident or by natural disaster or calamities.
   (d) Are repaired by other than IDS GeoRadar personnel; in which have been installed HW/SW accessories not supplied by IDS GeoRadar; are integrated or connected to equipment different from the ones supplied by IDS GeoRadar (except the PC data Logger conform to IDS GeoRadar specifications);
   (e) Whose operational software was not installed as per IDS GeoRadar instruction (see IDS GeoRadar User's Guide for the Data Acquisition Software);
2. Seller's Products may include specific "Operational" software with automatic data processing and analysis tools (SW) supplied under a License agreement (EULA). While every effort is made to ensure the accuracy of the information/results provided by these tools, they must not be intended as a substitute for people analysis; rather, they have to be intended as an advisor and the user must not completely rely on the results provided by them. Under no circumstances does IDS warrant that the SW will operate uninterrupted or error free The SW is provided "as is" without warranty of any kind. IDS GeoRadar warrants for a period of sixty (60) days from the Effective date that, under normal use, the SW support media will be free of defects in material and workmanship; in such case the provisions of above point a) apply
3. Any different warranty, granted by the Buyer to its retailers and clients, even as final consumers, pursuant to the European Union law in force regarding the rights of the consumers, does not engage IDS GeoRadar in anyway.
4. The above mentioned warranty excludes any other remedies and it has to be considered the only and exclusive remedy foreseen for the Buyer and its retailers and clients, with reference to IDS GeoRadar Products purchase, being, expressively understood that any kind of limitation and/or discharge of responsibility provided by the present warranty is referred to both (I) the responsibility as against any third parties, pursuant to the legislation regarding the producer responsibility and (II) the warranty provided by the law in force.

B. Warranty Procedure

1. To proceed in the application of warranty terms, Buyer shall have to contact IDS GeoRadar Customer Care Office to get the clearance to return the Faulty Parts.

2. The Faulty Parts once received by IDS GeoRadar will be inspected to verify they are eligible for repair or replacement..

3. Buyer is responsible for ensuring that the Faulty Parts be returned to IDS GeoRadar with a suitable packing (it is recommended that the original packing be saved for a better understand of the failure cause); IDS GeoRadar will not be obliged to repair or replace Faulty Parts damaged from abuse, misuse, negligence, accident loss or damage in transit.

4. The Shipping costs for Products returned during the warranty period, are as follows:
   (f) From Buyer Site to Seller site ➔ shipping costs, as per Incoterms CIP, are borne by Buyer
   (g) From Seller Site to Buyer site ➔ shipping cost, as per Incoterms CIP, are borne by Seller

5. The warranty period on the repaired or replaced Faulty Parts is 6 (six) months or the unexpired portion of warranty on such Faulty Parts whichever date comes later.

C. Special Warranty Conditions for IBIS Products

Without prejudice to the Warranty terms defined in the above Clauses A and B, the following special conditions apply to the IBIS products.

1. IDS GeoRadar offers to the Buyer, optionally, special Support and Maintenance Plans to be performed along the life of the equipment. These plans set forth special Warranty conditions which are detailed in the relevant options purchased.

2. IBIS Product Family is subject to export/import regulations as per EU export control regime Council Regulation (EC) No. 428/2009 and successive amendments. The category of exportation for IBIS F product family is 6A008.d. Buyer warrants that the IBIS Products to be purchased: a) shall not be re-exported, directly or indirectly, outside Buyer's country in violation of any law or regulation or to embargoed or otherwise restricted countries, b) shall not be used, in the design, development, production or use of chemical, biological, nuclear ballistic weapons. It is Buyer's responsibility to know the law pertaining to export/import procedures in the country of destination of the Products. Buyer will defend, indemnify and hold Seller harmless against any liability (including attorney's fees) arising out of Buyer's failure to comply with the terms of this article. Should the Authorities issue an export restriction which leads to the cancellation of a purchase order already accepted by IDS GeoRadar, IDS GeoRadar only liability shall be to return to Buyer any account paid without interests. Buyer shall

comply with the laws and procedures in force in the country of destination of the Products.

3. IBIS can be used in Critical Monitoring for safety purposes applications, like real time monitoring of unstable slopes including Opencast Mining. Buyer shall be aware and agree that the assessment of the stability conditions of the observed target must be tasked to skilled and certified operator/s able to understand data supplied by either IBIS or others. The performance of IBIS can be, in fact, influenced either by the parameters introduced by the operator/s or by particular environmental conditions which may distort its outcomes, thus giving rise to false or missing alarms.

4. IDS GeoRadar assumes no liability for any direct, indirect special, incidental or consequential damages or injuries caused by such reliance or for the use of IBIS Products by operator who have not achieved a training course certified by IDS GeoRadar. Any person or entity that completely relies on information obtained from the automated data processing/analysis tools only or by operators who have not achieved a training course certified by IDS GeoRadar, does so at his own risk

D. Limited Liability

Without prejudice to the exclusion of liability stated at the above Clause C.

1. Seller's sole obligation and liability under this Agreement shall be limited to the repair or replacement of the Product, or the refund of the purchase price at the Seller's sole option. This Article sets forth the sole and exclusive remedies for claims based upon defects or nonconformity of the Products, whether the claim is on contract, warranty, tort (including negligence), strict liability, or otherwise.

The cumulative liability of Seller, including its subcontractors or suppliers, for any and all claims, including but not limited to claims based on Seller's negligence of any degree, strict liability, breach of contract, warranty, reliance on the accuracy, reliability, or timeliness of the information provided by the SW, patents or otherwise, shall not exceed the sums cashed by IDS GeoRadar for the purchased Products, which give rise to the claim, and any such liability shall terminate upon the expiration of the warranty period.

APPENDIX D – CONFORMITY TO EUROPEAN REGULATION

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:

2014/053/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.

Receiver test according to EN 302 066 v. 2.1.0

The unit has been tested according to the provision of the EN 302 066 v. 2.1.0.
Specifically, for the receiver test (that tests the influence of an interferer signal to the device), the following performance criterion has been used (see ETSI TS 103 361)
Performance criterion: The difference D between the Rx signal noise (increased by an interferer) and the maximum input signal for the Rx in the linear region of operation
Level of performance: Dmin>*30 dB*

CE

APPENDIX E - IMPORTANT NOTICE FOR THE US CUSTOMER

FCC ID: UFW-CTHRUE

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 Through-wall imaging system system is prohibited by FCC regulations.

APPENDIX F - IMPORTANT NOTE FOR CANADIAN CUSTOMERS

Canadian Requirements of RSS-220 for Hand-held Antennas

IMPORTANT NOTE FOR THE CANADIAN CUSTOMERS

IC Certification Number: **8991A-CTHRUE**

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

This In-wall Radar Imaging Device shall be operated where the device is directed at the wall and in contact with or within 20 cm of the wall surface.

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

NOTE IMPORTANTE POUR LES UTILISATEURS CANADIENS

Numéro de certification : **8991A-CTHRUE**

Cet appareil est conforme aux exigences de la norme RSS IC-220

Cet appareil de radar de structure (murs, poutres, dalles…) ne doit être utilisé qu'en contact avec la structure ou à 20 cm maximum décollé de cette structure.

Cet appareil de radar de sol ne doit être utilisé que par les forces de l'ordre, les instituts de recherche scientifiques, les sociétés minières, les sociétés de construction, et les organisations de secours d'urgence ou de combat du feu.

CANADIAN REPRESENTATIVE

Company Name : Leica Geosystems Ltd

CN Number : 3177B

Contact Name : Sudha Sachdeva

City : SCARBOROUGH, Ontario M1W3S2

Telephone No : +1 416 497 2463

Email : sudha.sachdeva@leicaus.com

Canadian Requirements of RSS-220 for Ground Antennas

IMPORTANT NOTE FOR THE CANADIAN CUSTOMERS

IC Certification Number: **8991A-CTHRUE**

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.

NOTE IMPORTANTE POUR LES UTILISATEURS CANADIENS

Numéro de certification : **8991A-CTHRUE**

Cet appareil est conforme aux exigences de la norme RSS IC-220

Cet équipement géoradar doit être utilisé que lorsqu'il est en contact ou à moins de 1 mètre du sol.

Cet équipement géoradar doit être utilisé que par des organismes d'application de la loi, des instituts de recherche scientifique, des sociétés minières commerciales, des entreprises de construction et de secours d'urgence ou les organisations de lutte contre les incendies.

CUSTOMER SUPPORT

The IDS GeoRadar Support team is available to answer any question about:

general enquiries

request of advertising material

technical issues

any other business

As well as listening to your suggestions too.

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