REHABILITATION OF HYDRO-TECHNICAL CONSTRUCTIONS DEVELOPED FOR IRRIGATION PERIMETERS BY THREE-DIMENSIONAL INVESTIGATION

Radu MUDURA, Lecturer – USAMV Bucuresti - FIFIM , radu.mudura@gmail.com
Doru MIHAI, Lecturer – USAMV Bucuresti - FIFIM, doru.mihai@rosa.ro
Severin CAZANESCU, PhD Candidate – USAMV Bucuresti - FIFIM, cazanescu@gmail.com
Bogdan VENEDICT. UAI-Iasi, bogdan.venedict@yahoo.com
Nicoleta SARBU, Lecturer – USAMV Bucuresti – FIFIM, sarbu_nicoleta2001@yahoo.com

***Abstract**: While depreciation of irrigation systems, they require rehabilitation works. One step is to assess the current situation and comparing it with the original project. A modern investigation method, which allows high data needed to assess the situation, is the three-dimensional scanning. This method is in fact a high definition survey. The result is a three dimensional image on which you can measure distances and angles, you can calculate volumes and other parameters you are interested in. This method is very useful in cases where the original documentation of the objective was lost or destroyed.*

***Keywords:** Laser Scanner, 3D scanning, point cloud*

1. Introduction

In time lot of buildings, installations or other objectives suffered more or less modifications. Also, for many of them, their original documentation and projects were lost. In order to be able to rehabilitate them a technical documentation is needed. Classical methods of disclosing are resource and time intensive.

A new method is now available, the 3D laser scanning. 3D laser scanning is a process by which survey point data is acquired at such a resolution that details and shapes of objects can be made out in what is termed a “cloud” of x,y,z point data. The scanner uses robotic mirror and rotation control coupled with a laser rangefinder and internal digital camera to capture a project site from a given point of view. The time of flight of the laser beam from when it is emitted from the scanner to when the refracted return is received is measured against the speed of light to determine the distance to each point, while a mirror tilts to advance the laser position, gathering those points in a vertical line. The scanner turns in tiny horizontal increments to capture successive vertical lines of scan points, travelling 360 degrees around its axis. This is accomplished at a rate of up to 50,000 points per second. Additional scans might be made in other locations on the site, for example, so all sides of a building can be included in the same cloud. Once this data is acquired, the scans are aligned in a registration process, and noise that might have been collected, such as personnel passing through the scan area can be cleaned from the data. The resultant cloud of points represents not only an image of the site or object scanned, but each of the dots represent survey grade accurate data points, between which, highly accurate measurements can be made for the basis of design and construction. When the point cloud model is oriented to a geographic reference system, every point in the cloud will represent a real-world coordinate and elevation.

3D laser scanning provides the engineer a unique opportunity to have detailed and accurate "as-built" 3D dimensional knowledge of a specific area of a plant before a retrofit design project is started in that area. In the past, the engineer relied on outdated facility drawings and equipment information, as well as a limited number of field measurements which were obtained with a handheld laser measuring device or a standard metal tape. The most critical portions of a retrofit design are typically found in difficult to access areas such as elevated pipe racks and towers, or environmentally hazardous areas due to chemicals or high temperature processes. This often leads to unsafe and time-consuming field measurement practices. In addition, the plants are often located at significant distances away from the engineer’s office, requiring significant travel and the associated expenses for each visit to the plant. This results in work inefficiencies and costly mistakes, which can have dramatic effects on the project schedule and therefore profitability. A simple mistake, such as misrouting a pipe through an existing plant, can have severe schedule and financial repercussions on a project. With high-resolution 3D laser scanning, detailed 3D measurements can easily be obtained with just a click of the mouse safely, quickly and without revisiting the plant site.

The main benefits of the 3 D laser scanning are:

- Rapid non-contact measurement, thus increasing productivity;
- Develop accurate “as-built” documentation of an existing facility with minimal operational interference;
- Easy of integration with existing survey information;
- Minimize field verification man-hours required for a retrofit design project;
- Reduce fabrication, tie-in and assembly errors by validating the new work against the existing state prior to completion of the design;
- Reduce field fabrication costs due to design errors and omissions;
- Improve site safety by minimizing unsafe manual measurements practices and number of site visits required;
- Highly accurate Digital Terrain Model (DTM’s);
- Providing consistent and complete coverage over the desired survey area.

2. Study area

For the study project "Nicoresti-Tecuci Terrace" irrigation system was chosen. The system is located in the eastern part of Romania, near the confluence of the rivers Siret and Barlad (Fig. 1). In this irrigation system more specific objectives will be scan in 3D mode (pumping stations, pressure stations, hydro-technical nodes, channels, etc.).

In the first phase 3D scanning was performed to the hydro-technical node CD3 found on channel CA South at km 3+492. Here is a construction consisting of Gate G1/CA South and Gate G1/CD3 (Fig. 2 and 3).

3. Laser Scanner Survey

A laser scanner survey consists of many scans that cover the whole objective. Scans lignment and registration process were performed just by means of several artificial markers picked out in each points cloud. Therefore, reflective targets with particular geometrical features, allowing an accurate determination of the target center have been installed in the study area (Fig. 4). Each scanning station must guarantee the availability of at least three targets which can be detected by another scan position too, to be able to perform the alignment. If more than just three targets are visible, the resulting registration will be improved in terms of a stronger constraint and a lower error associated to this procedure.

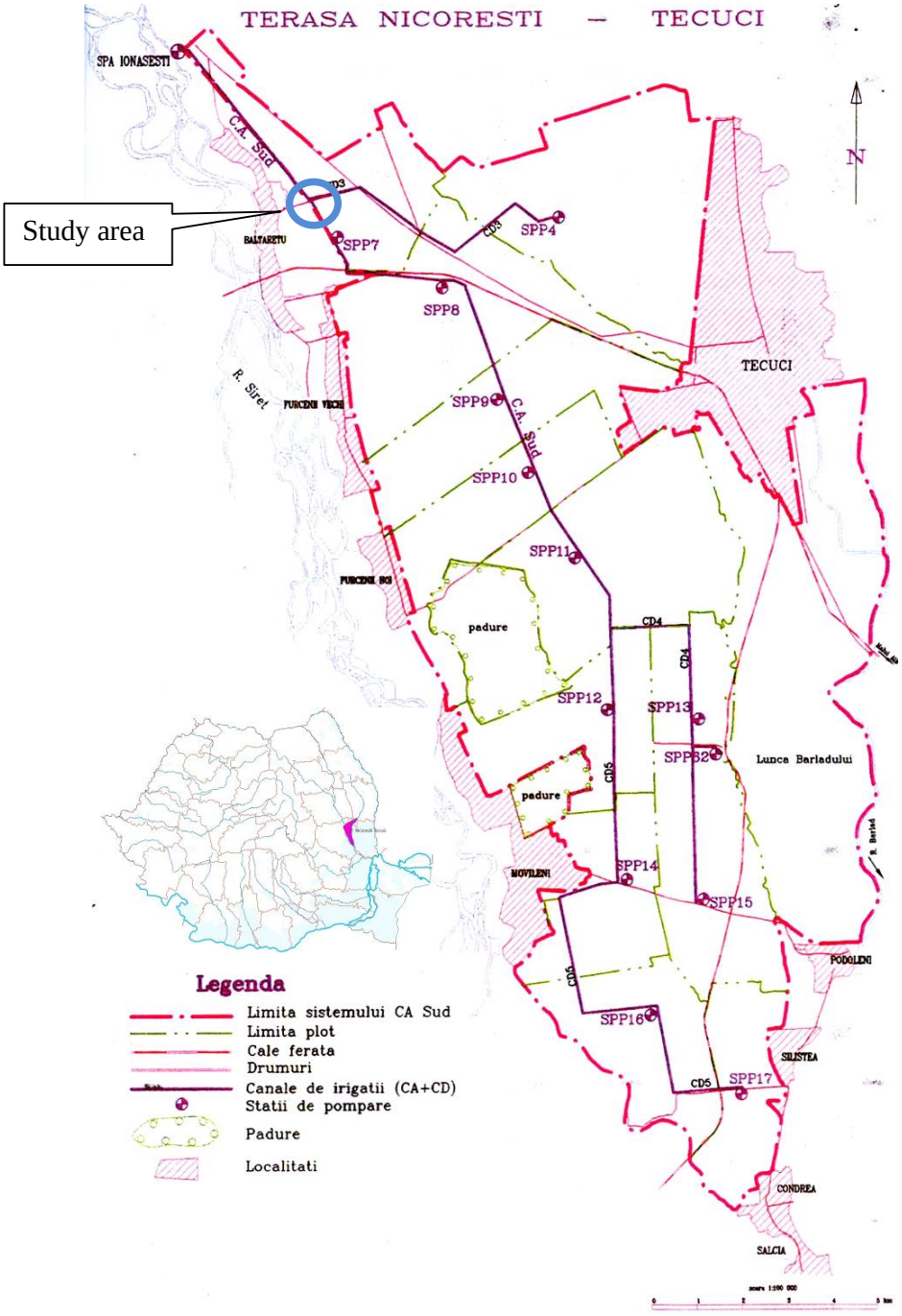

Fig. 1. "Terasa Nicoresti-Tecuci" irrigation system

The exact position of the targets was determined with a Smart Station using its facility of determining point with a GPS station.

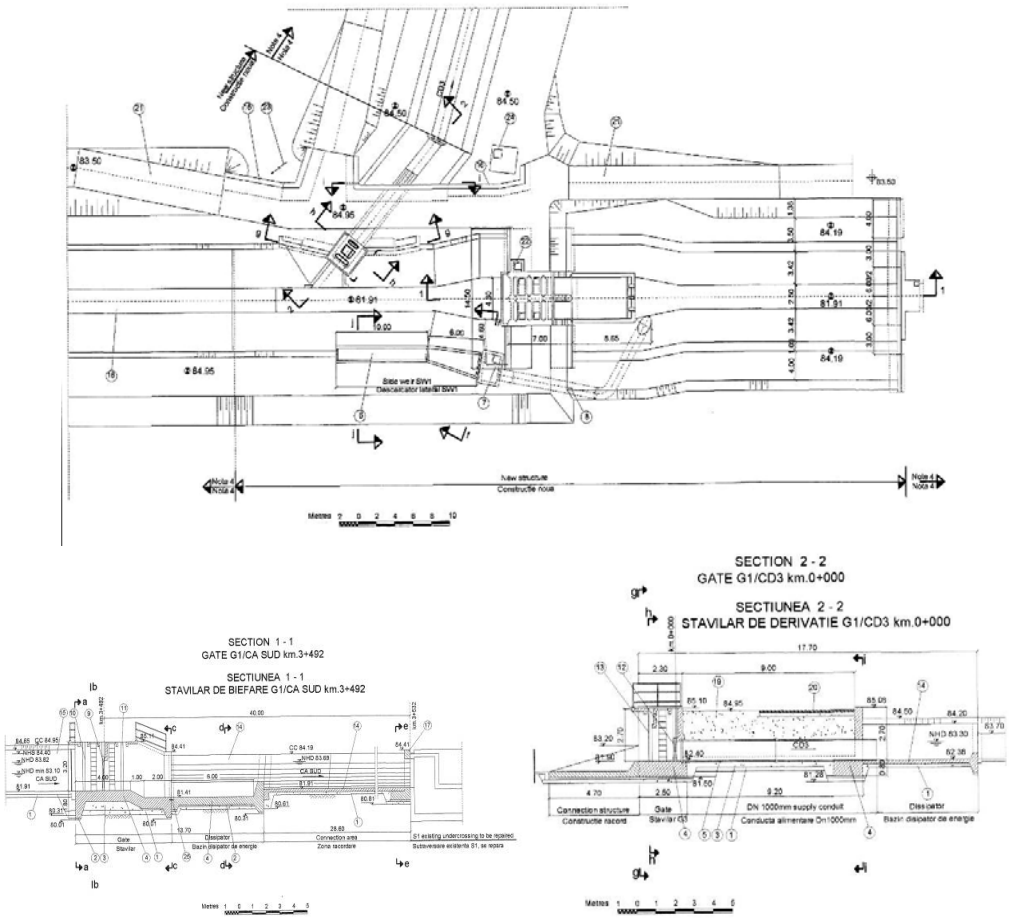

Fig. 2. Technical details of hydro-technical node

Fig. 3. The laser scan ready for action

Fig. 4. Targets

Because of the meteorological conditions we could perform only two scanning station (Fig. 5 and 6), but enough to create a digital model on which we could measure and determine the main characteristics of the constructions.

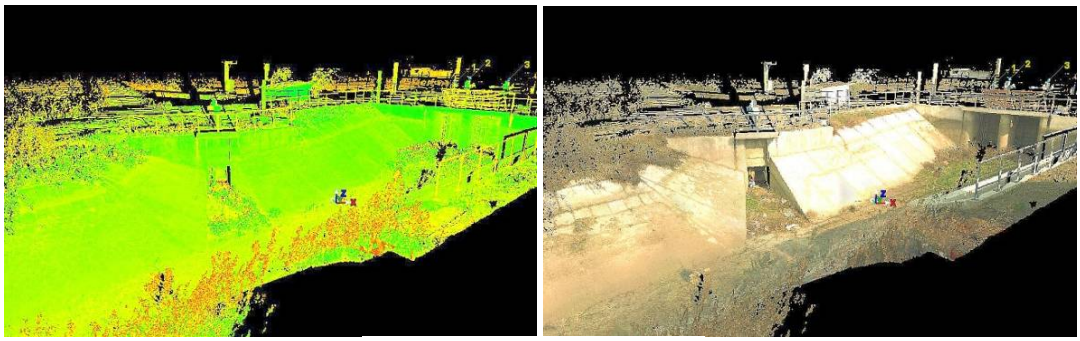

Fig. 5. First scanning station

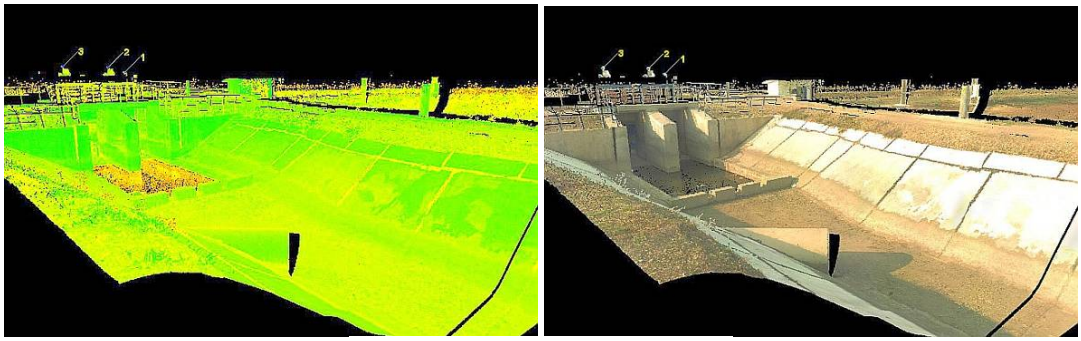

Fig. 6. Second scanning station.

After the scanning was done, the first operation was to merge the two resulted point clouds (Fig. 7 and 8).

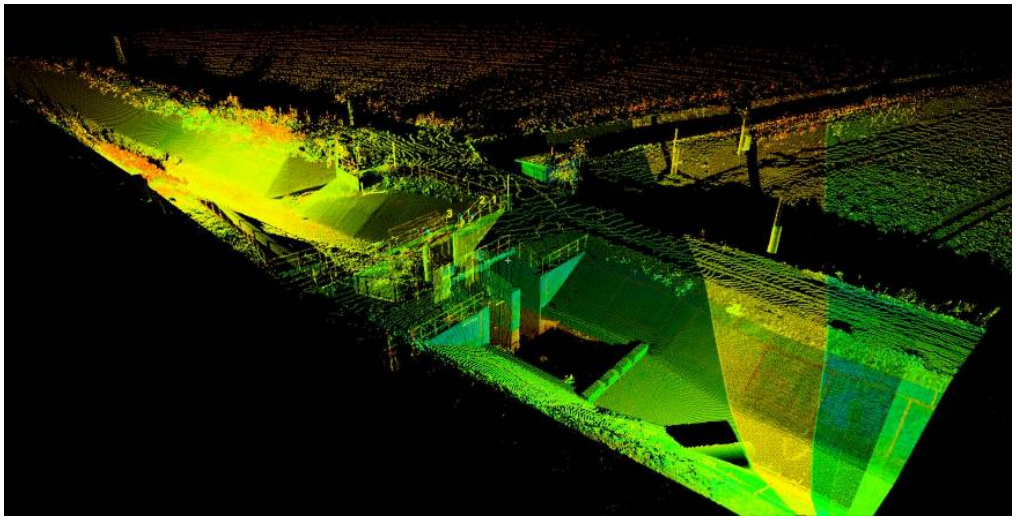

Fig. 7. Merged point clouds

Fig. 8. Ortho representation of the study area

On the resulting model there were performed several operations of modelling for different known elements (according to the project), and different measurements in order to verify if the present situation correspond with the initial parameters established in the designed project (Fig. 9 to 14)

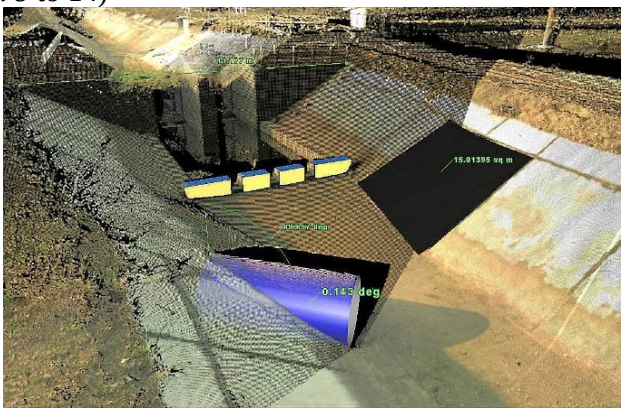

Fig. 9. Modelling

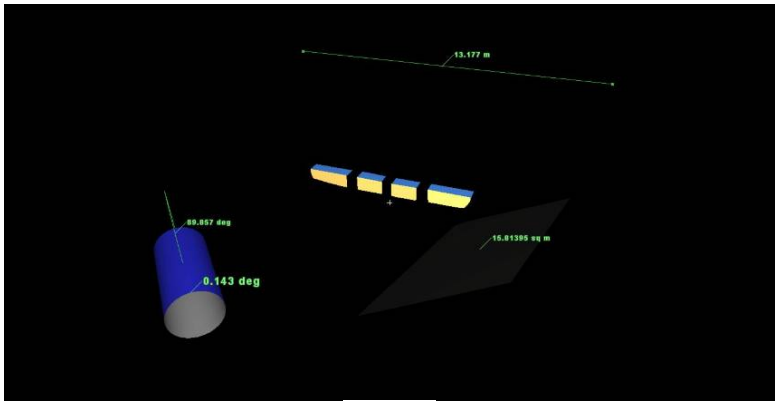

Fig. 10.

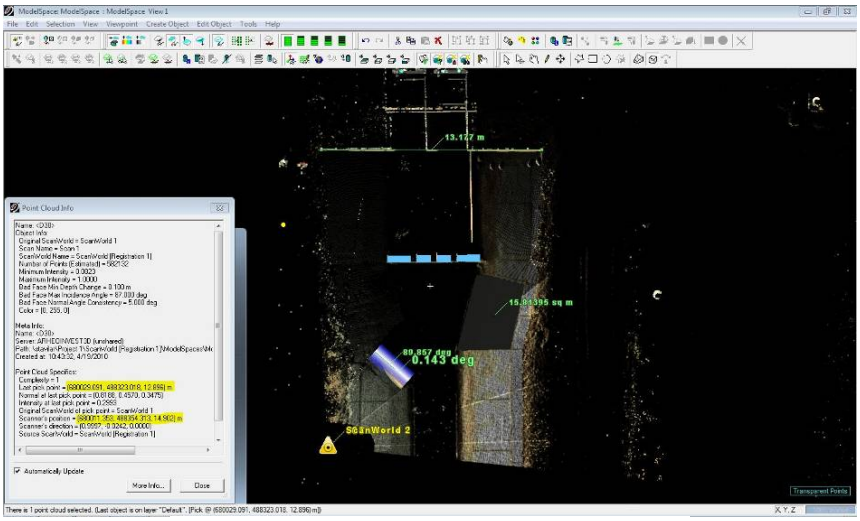

Fig. 11. Modelling, measuring, coordinates

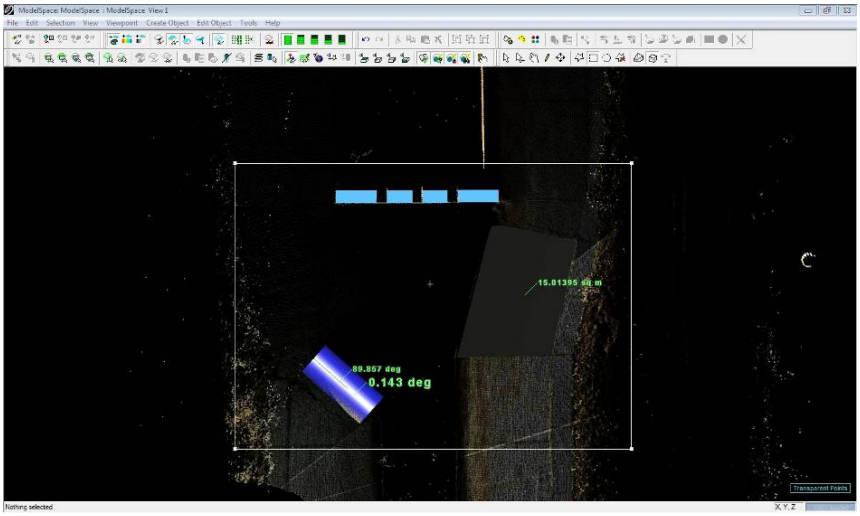

Fig. 12. 2D model extracting

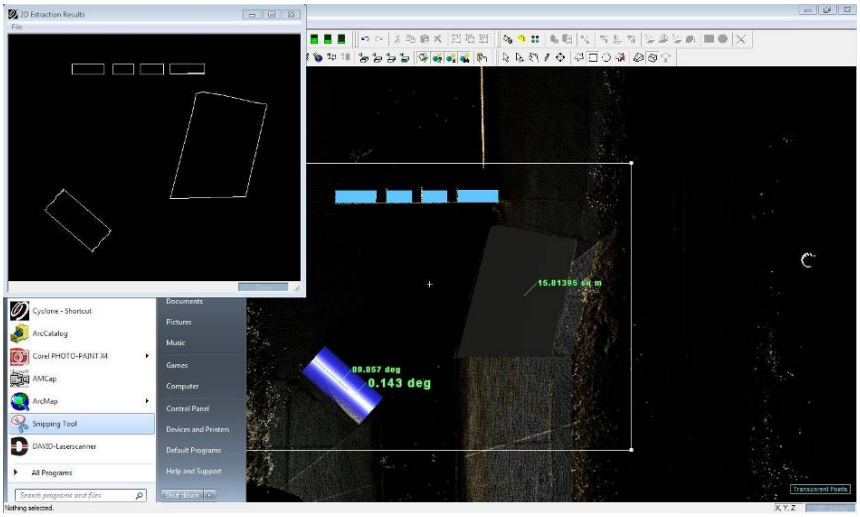

Fig. 13. The result of 2D model extracting

4. Conclusions

In this study, it was demonstrated that the LaserScan2 system from Leica is suitable for detail 3D data acquisition . As demonstrated in this study, it is clear that the 3D laser scanning is among the newest technology being deployed in the surveying field. It’s provided advance technology which gives a detailed, reliable, and accurate solution to many surveying and measurement problem. The HDS 3D laser scanner generates large amounts of dense information describing a surface. The capability to generate discrete points forming a sparse network is an advantage of HDS compared to the traditional surveying methods. Furthermore, laser scanning allowed the surveying to be performed without placing staff at the study area, whereas traditional methods do.

Due to the fast and automated scanning process and its high point density laser scanning increasingly represents an alternative to and/or an additional option for geodetic and others data acquisition methods. Because of the full 360° × 270° field-of-view it is recommended that the ScanStation 2 HDS to be used as an alternative methods for outdoor and indoor surveying applications. The ScanStation 2 can be very efficient and effective solution for land reclamation investigation.

5. References

1. *www.leica-geosystems.com/hds;*
2. *Ingensand, H., A. Ryf, and T. Schulz (2003): Performances and Experiences in Terrestrial Laserscanning. Proceedings of the 6th Conference on Optical 3D Measurement Techniques, Zurich.;*
3. *BALZANI M., SANTOPUOLI N., Grieco A., Zaltron N., “Laser scanner 3D survey in archaeological field: the Forum of Pompeii”, in atti International Conference on remote sensing archaeology, Beijing, Cina, 2004.*