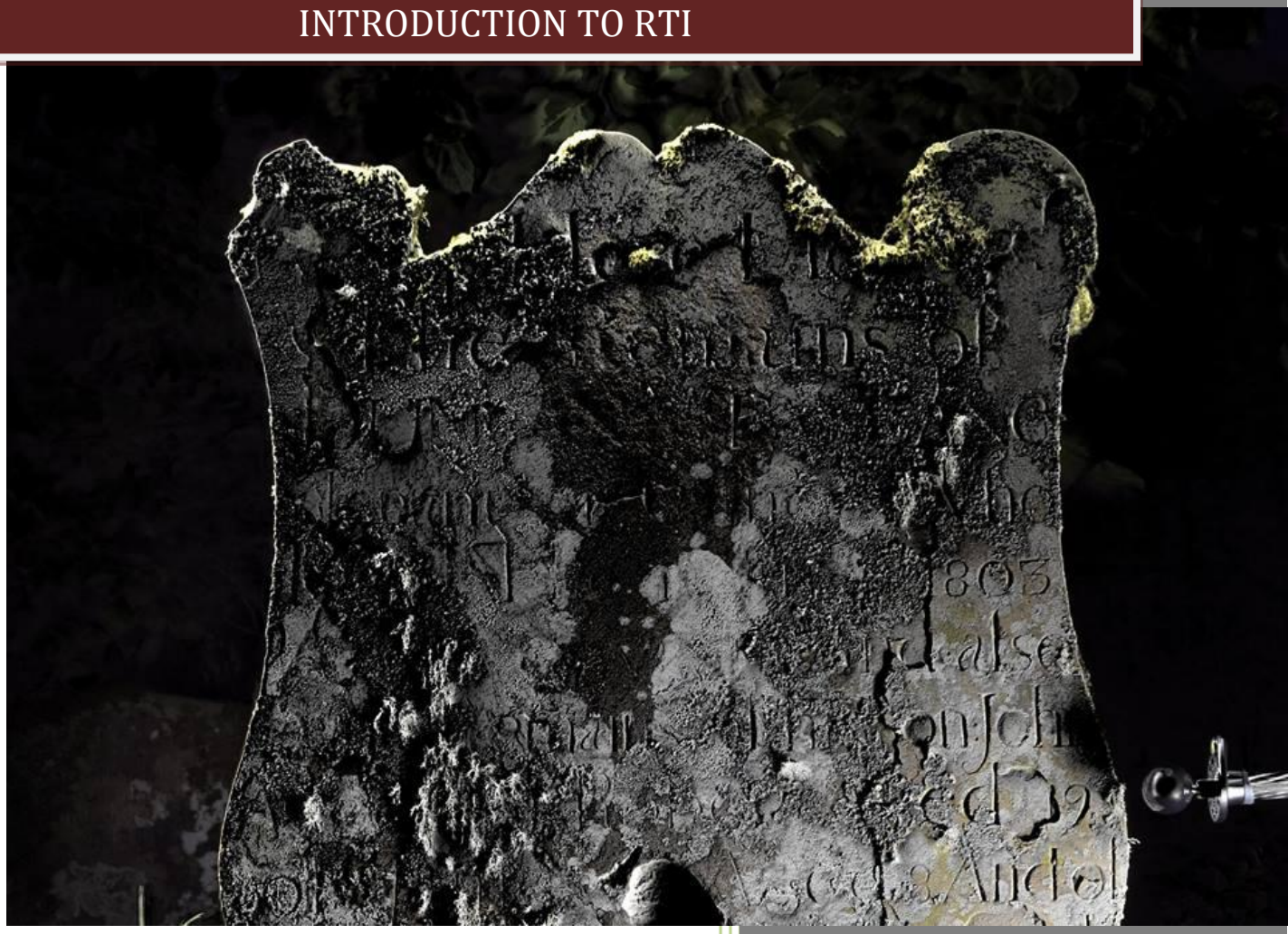
GUIDE FOR DIGITAL DOCUMENTATION OF GRAVESTONES

INTRODUCTION TO RTI



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What's RTI?

Reflectance Transformation Imaging (RTI) is an innovative multi-image technique that provides very detailed information of the surface of a material. RTI is a technique that was created by Tom Malzbender from HP Laboratories in 2001. An RTI file is composed of a series of photographs taken of a static object with a fixed camera and illuminated from different positions in each shot with an artificial light source . This photographic set is afterwards synthesised with a software using an specific algorithm that compiles all the images into a unique file (Duffy et al., 2013).

There are various methods that can be used for the creation of a RTI file, this will depend on the algorithm that the software uses for processing the data sets. This guide is going to focus on the Polynomial Texture Mapping (PTM) methods, as being the most developed in the heritage context and compatible with the most accessible way of data capture that will be explained on the Data Capture.

This recording method has been developed into the heritage field by the Cultural Heritage Imaging team, headed by Mark Mudge, Carla Schroer and Marlin Lum. This non profit research group is based in the US. They have developed a website [1], that contains the two main tools for RTI fitting and viewing, along with guidance for data capture and processing.

What do you need?

Core Toolkit

DSLRs camera - Many different cameras can be used to produce RTI. The minimum requirement is to be able to set the camera in **manual mode** to control parameters as shutter speed, the ISO, and the aperture. The camera has to also be able to **turn off** the autofocus mode. It is advised to use a camera with at least 8 megapixels.

Memory card - The photos should be taken in RAW format, what is considerably bigger than JPEG, so the memory card should be big enough to hold a full set of pictures (24-100).

USB cord or card reader - Once the photo set has been taken, they have to be transferred into the computer to be processed.

Reflective sphere - It is necessary to use a black or red shiny ball, like a snooker ball. Check the section "How to create your own RTI kit". The diameter of the sphere depends of the size of the object is going to be photographed, it is advised the diameter should be approximately 200 pixels of the picture.

Two tripods - One tripod for the camera and the second one for the reflective sphere. The tripods should be stable enough to not move during the data capture.

Cordless remote shutter - It will be used to take the pictures without the need for touching the camera, this will prevent unwanted vibrations.

Handheld light - The light source has to be proportionate to the size of the gravestone that is going to be documented, it has to be able to illuminate the whole object. In this guide a handheld LED light panel (15x12cm) was used.

Computer - A computer will be needed to process the pictures.

Photo edition software - Before processing the data there are a few adjustments that have to be done. Photoshop is the most known image manipulation program, but there are another free alternatives like GIMP [3].

Optional Equipment

Notebook - In order to keep good practice during the documentation project, a notebook will be very useful to make sketches of the location of the gravestone, annotate the reference number, to write down the parameters used to take the set of pictures, and any other metadata and paradata associated with the documentation process.

Colour checker - A colour chart is a good reference to calibrate the colour of the photographs before processing them.

Spare battery for the camera and the light - Field trips normally take hours, between setting the scene and taking the pictures. To make sure you don't run out of battery in the middle of a set it is a good idea to keep a spare charged battery for the camera and the light.

How to create your own RTI kit

You can find a RTI Highlight Capture Starter Kit at the Cultural Heritage Imaging website [1]. However, in this section it will be described how to create a very basic RTI kit.

In the first instance, a black or red snooker ball will be needed. There are various sizes that can be found on the market. In the example for this guide we will be using a snooker ball Size: 2.1/16" and 1.7/8".

The next step is to drill the snooker ball using a drill size 1/4" and make a hole between 5-10 mm deep. Before starting hands on, find a secure environment to work. Be sure to wear eye protection and a dust mask. Fix the ball in a way it cannot be moved, for example, in a secured holder.

Clean the hole from remaining dust. Use a flat screw driver to fix a *1/4'' to 3/8'' Threaded Nuts for Tripod* into the hole, this little adapter will allow you to attach your ball to the tripod. If the Nut is a bit loose use glue to attached permanently to the ball.

Fig.1 Drilling a snooker ball with a 1/4'' drill.

Fig.2 Fixing a 1/4'' threaded nut to the ball

On the field: Data capture

Setting up the scene

1. Positioning the tripods

The camera has to be set on one of the tripods, facing the gravestone. The distance of the camera in respect to the gravestone will depend on the lens that is going to be used. In this example the distance of the camera is 1.5m and the lens is 24mm.

The reflective sphere has to be fixed to the second tripod and be placed close enough to the gravestone to allow the sphere to be inside of the frame in the camera's view, but not covering any figure that is going to be recorded.

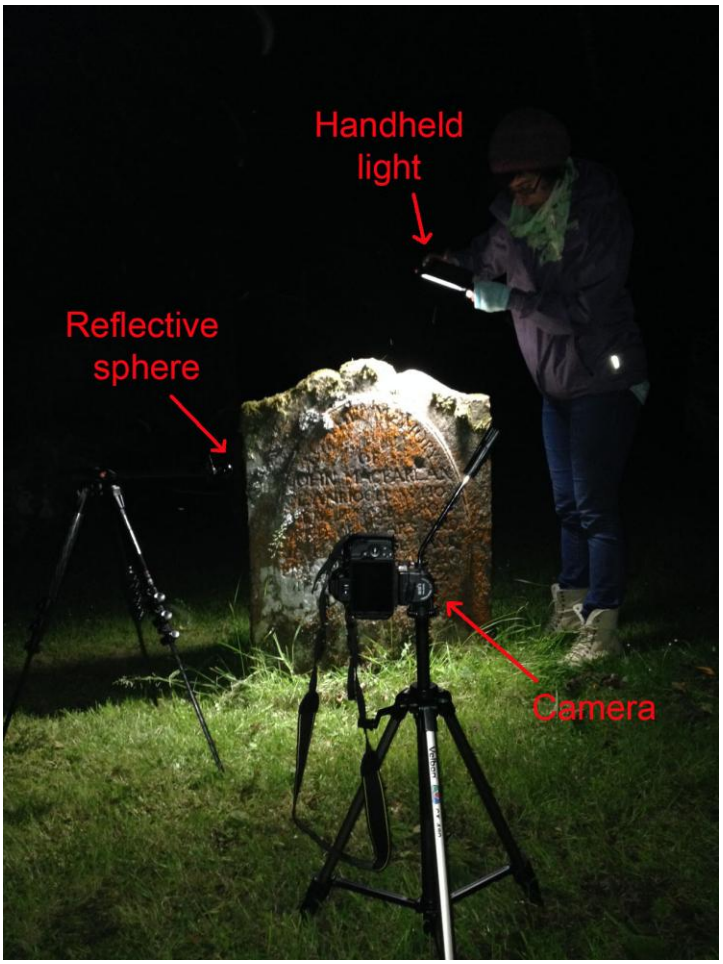


Fig. 3 Setting up the scene for RTI at BallyHennan Burial Ground

It is extremely important that the tripod is placed on a stable surface, any shake or vibration will ruin the data set and it will have to be taken again. It is important to ensure that nobody is walking around close to the scene to minimize the risks of vibrations.

2. Setting up the light distance to the gravestone

The Cultural Heritage Imaging advise that the light distance should be at 2 to 4 times the diagonal size of the target. However, this recommendation cannot be always followed because the distance will entirely depend on the strength of the light source. In the case of the LED panel light I have used, the distance should be between 1 and 1.5 times the diameters of the gravestone.

3. Setting up the camera

With the intention of getting the best results from the data capture, the camera has to be set in **manual mode**. It is highly recommendable to shoot in RAW format, this way it will be possible to control the white balance, if it is necessary, before processing the data sets. The key elements to take into account are the aperture, the light intensity and the shutter speed. The combination of these key elements will determine the quality of the final outcome.

The first step is to adjust the aperture. It is important to aim for enough depth of field that the shots are "sharp", however too high *ƒ* number can degrade the quality of the image. According to the CHI, the ideal aperture range should be between *ƒ* /5.6 and *ƒ* /11 (Cultural Heritage Imaging, 2013).

The next step is to choose the ISO. Due to the low light conditions during the data capture, the ISO should be higher than day time. Nevertheless, highest ISOs can produce noise on the image and therefore could result in a degradation of the quality. It would be recommendable use an ISO between 600 and 800.

The last step is to determine the shutter speed. According to the CHI, the best way to establish the shutter speed is to take two different shots, changing the angle of the illumination and use the average of them. The first shot should be taken by placing the light at 65 degrees from the surface of gravestone, and the other one with the light on a 15 degrees position.

4. Testing shots

Once the scene has been set, it is extremely important to remember that the camera, the tripod and the reflective sphere must not be moved while the photos are been captured. Before start taking pictures, it is recommended to take a few test shots to make sure that the photos are well exposed, and focused. To ensure the image is perfectly focused, it would be recommendable to put the autofocus on, take a shot, and without moving the lens, I change it to manual mode. With the purpose of double checking if everything is focused, zoom in one of the corners of the photograph, if it is not entirely focused, make the last manual adjustments, and if everything is sharp, the camera is ready.

5. Capturing the images

Once the scene and the camera have been set up appropriately, the capturing of the images can take place.

The photo set consists of a sequence of shots from the stationary camera, with one shot for each position of the light. Every RTI capture guide advises that the light should be positioned in an imaginary dome or umbrella around the object (Fig.4). The light should be placed between 15 and 65 degrees from the surface of the gravestone. It is recommended to take from 24 to 100 images.

At the time of taking the photographs a **cordless** remote shutter has to be used in order to avoid any movement of the camera. Between the shots it is always recommended to wait a few second to make sure the camera had enough time to process the previous image, and then move the light till the next position. Try to always move the light source in an organised manner to make sure all the surface has been successfully covered.

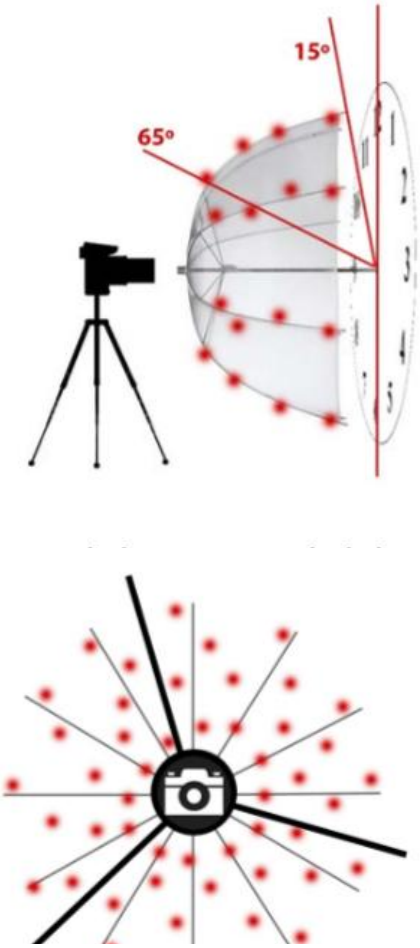


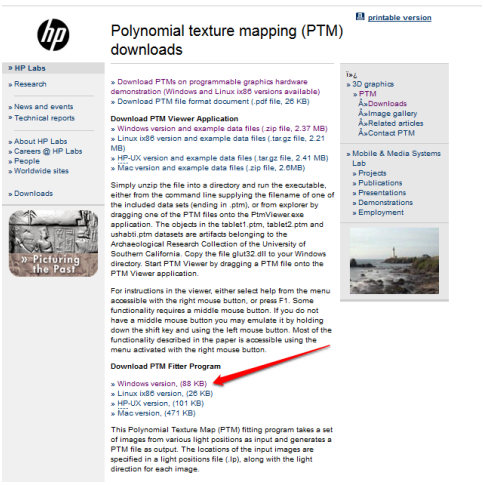
Fig.4 Light distribution towards the object. (Cultural Heritage Imaging, 2013)

How to process the data sets

Getting ready for processing

Installing the software

To be able to process and visualise the RTI images there are three elements that should be installed on the computer. **RTIBuilder**, this is the package used to combine all the shots into a unique file**. RTIViewer** is the package that allows the user to interact virtually with the lighting conditions. The last element that has to be installed in order to produce PTM images, it is called **PTM fitter** and can be found in the HP website (find all links at the end of this guide). There are various ways to create RTI images, in this guide describes the PTM fitter option.



Folders and Formats

Prior to processing the data sets a number of folders need to be created to contain the different types of files. Unfortunately, RTI software is not flexible with the naming of the folders, for this reason they need to be named and organised in a very specific way to avoid unknown errors in the processing.

The first folder could be called the project name and the ID number, for example 49-BH (49 is the ID number of the gravestone and BH stands for BallyHennan project). It is extremely important that the folder name does **not contain any spaces**.

The three different subfolders must be created with the following specific names :

49-BH

projectFolder

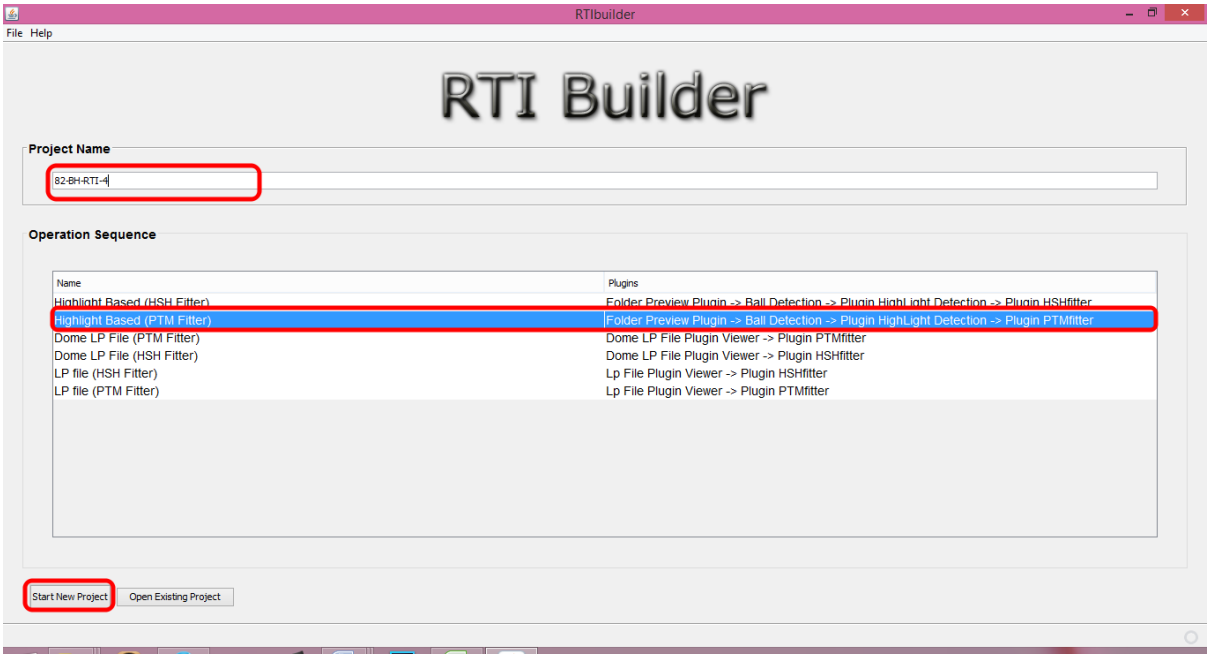
jpeg-exports

original-captures

Now that the folders have been created, it is necessary to convert the files from RAW to jpeg. The RAW files should be saved in the *original-captures* folder. At the same time that the files are going to be converted, it is a good opportunity to carry out any image editing if necessary, for example, to correct the white balance. Once the images are ready they must be saved as high quality **.jpeg with small letters** (JPEG with capital letters sometimes produces an error) on the *jpeg-exports* folder.

Processing the data

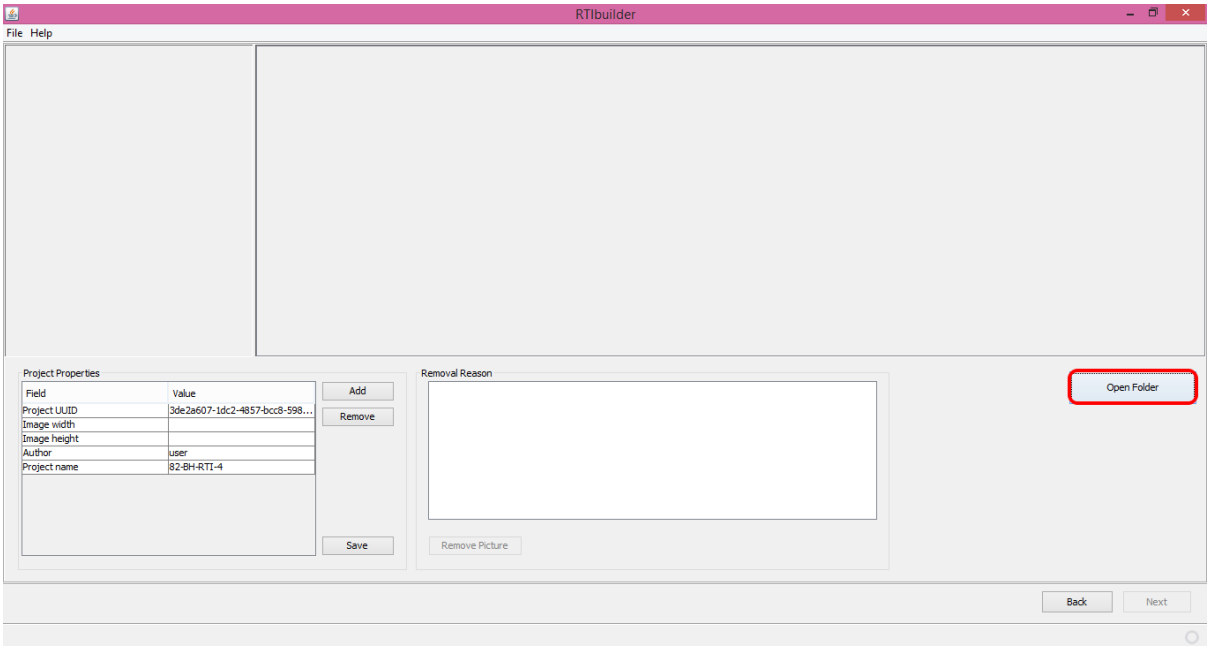
RTIBuilder



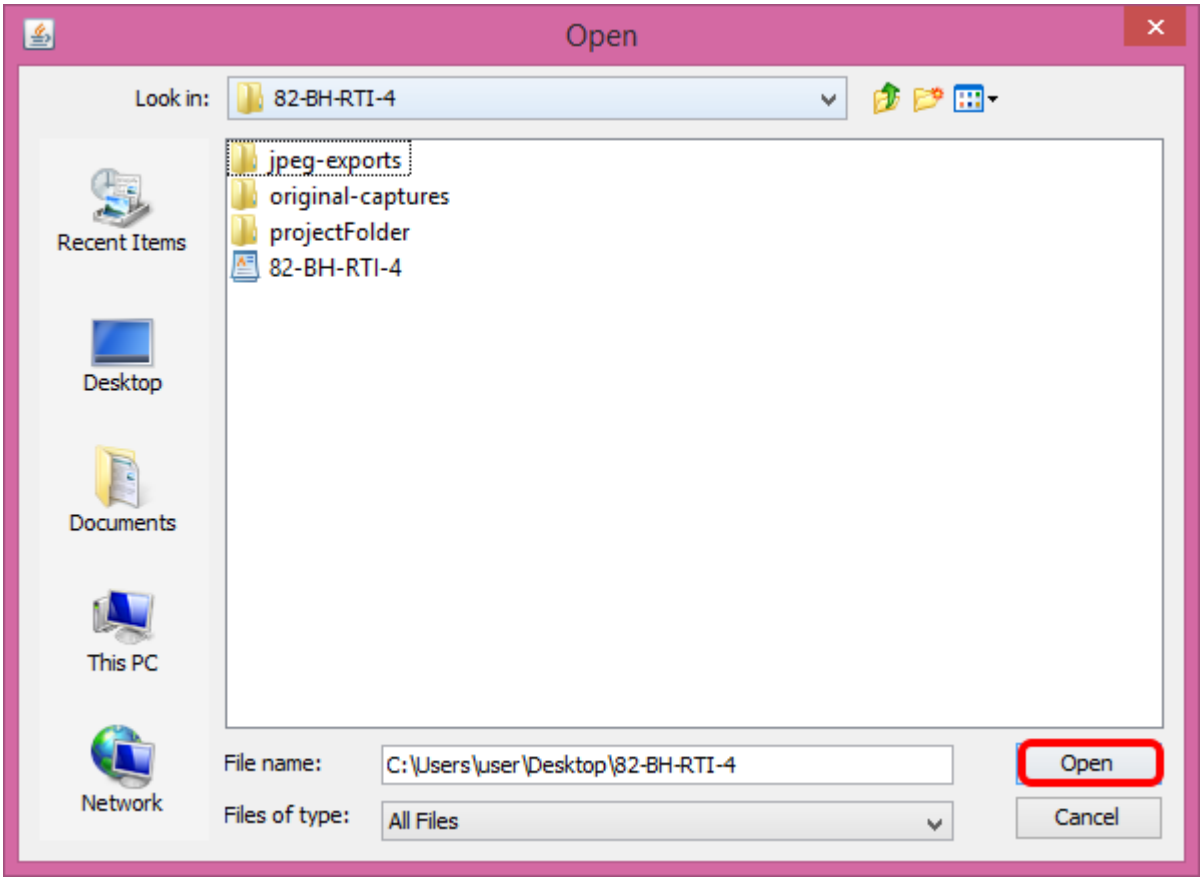
1.Enter the name of the project

2.Select the ***Highlight Based(PTM Fitter)*** option

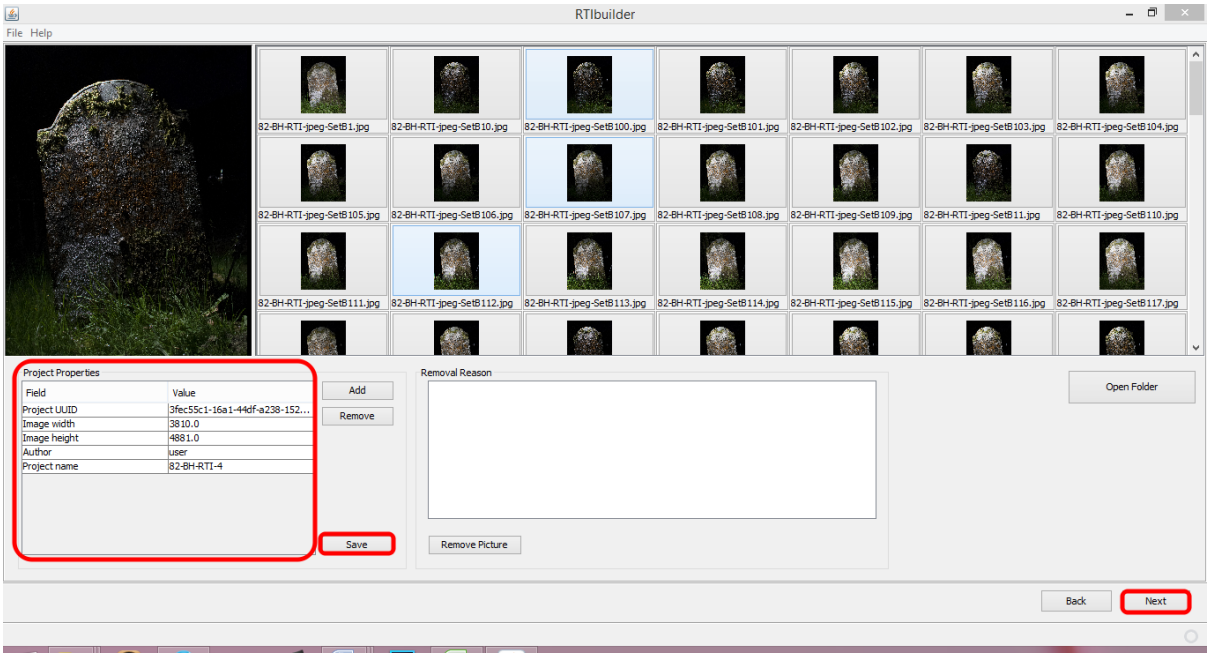
3.Click on *Start New Project*



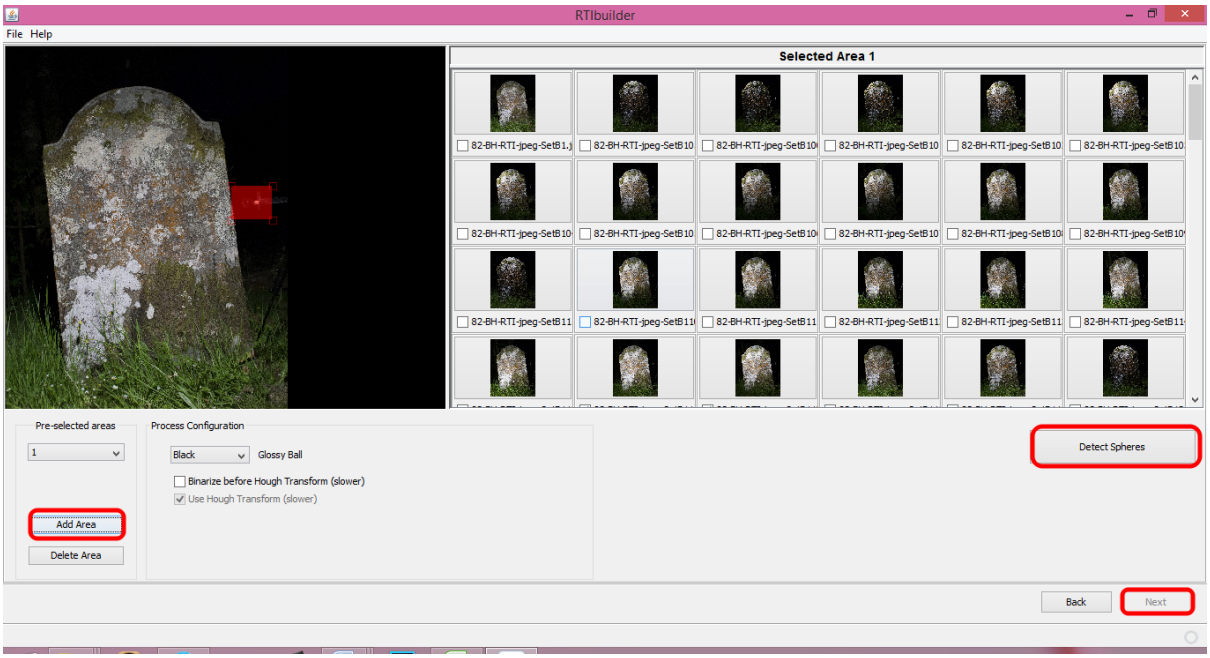
4.Click on Open Folder.



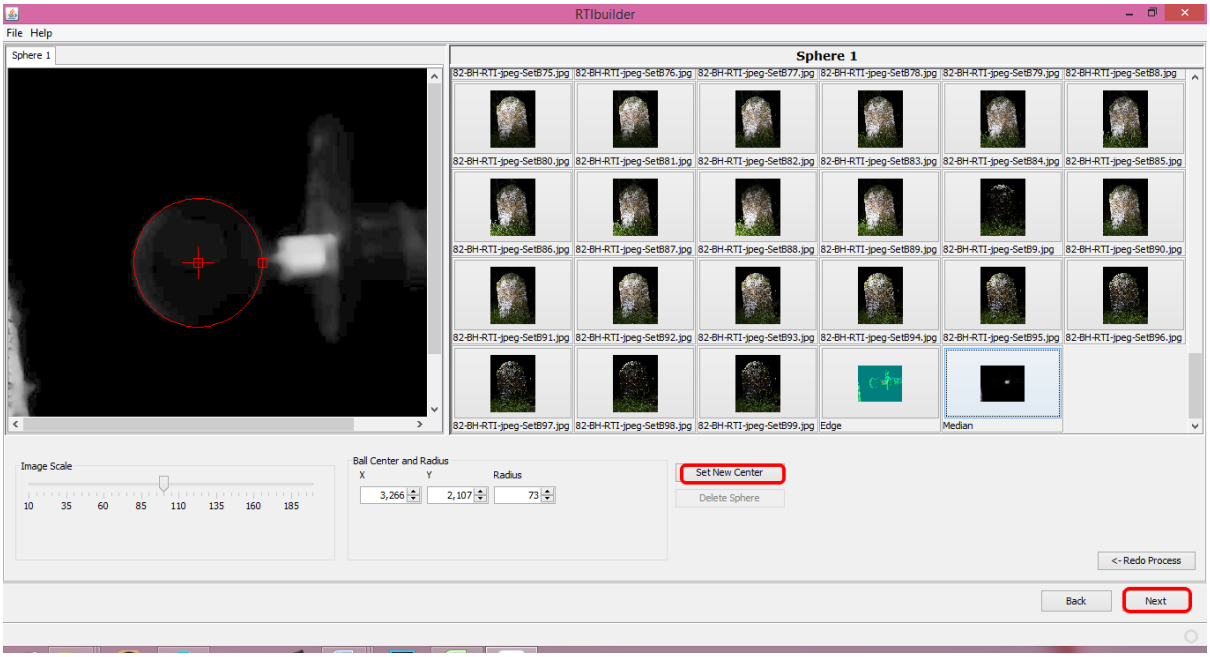
5. Select your *projectFolder* and click Open. The software will automatically find the images contained on the *jpeg-exports.*



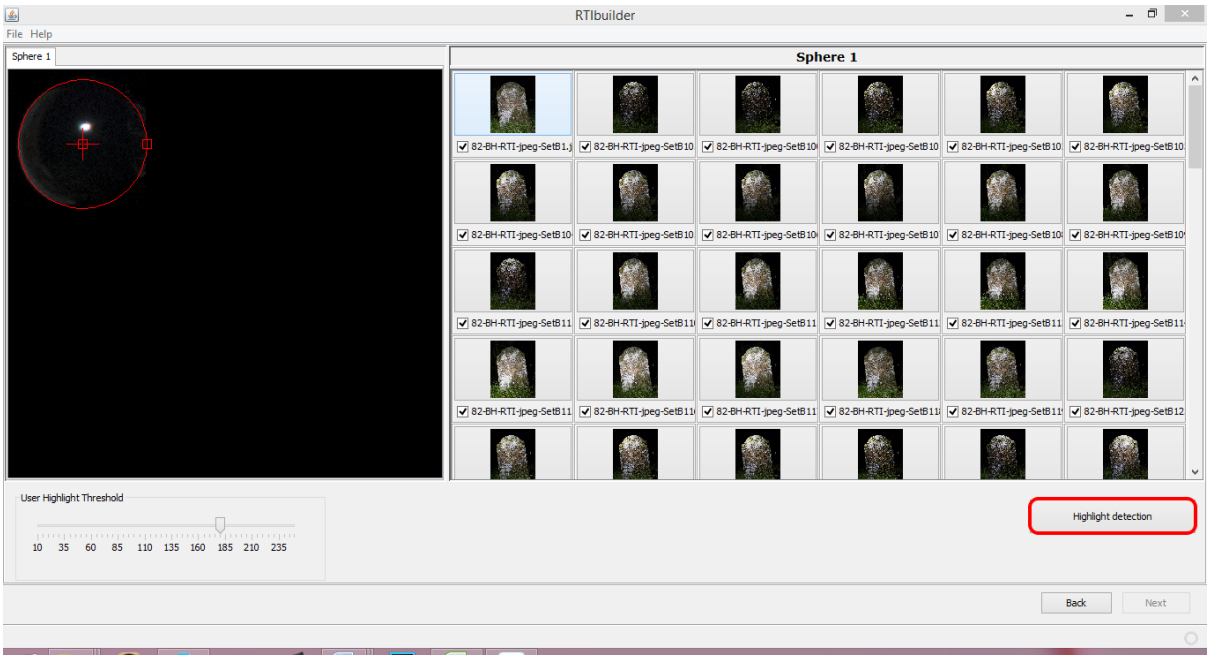
6. Fill the metadata box, Add new fields if it is necessary and click *Save.* The click Next.



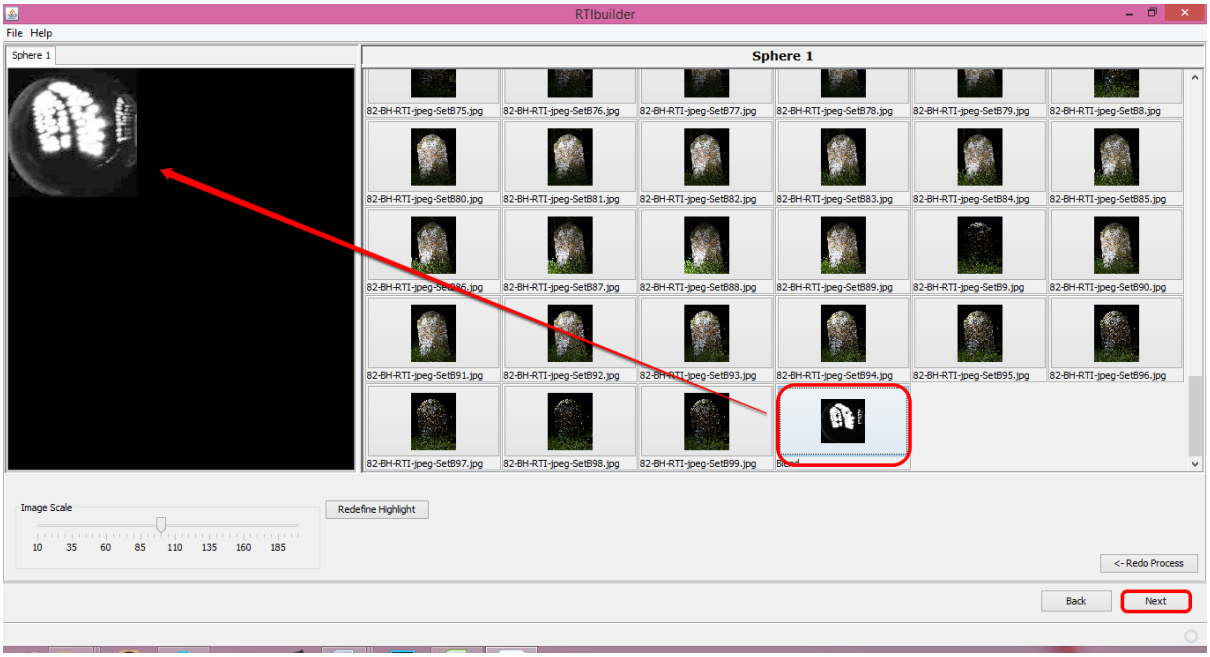
7. Select the position of the sphere within the picture and click on *Add Area*. When you click on *Detect Spheres*, the software will automatically locate the sphere in each of the images. This will allow the software to create a highlighting map of the reflexion of the light source on the sphere for each individual shot. To go to the next step click *Next*.



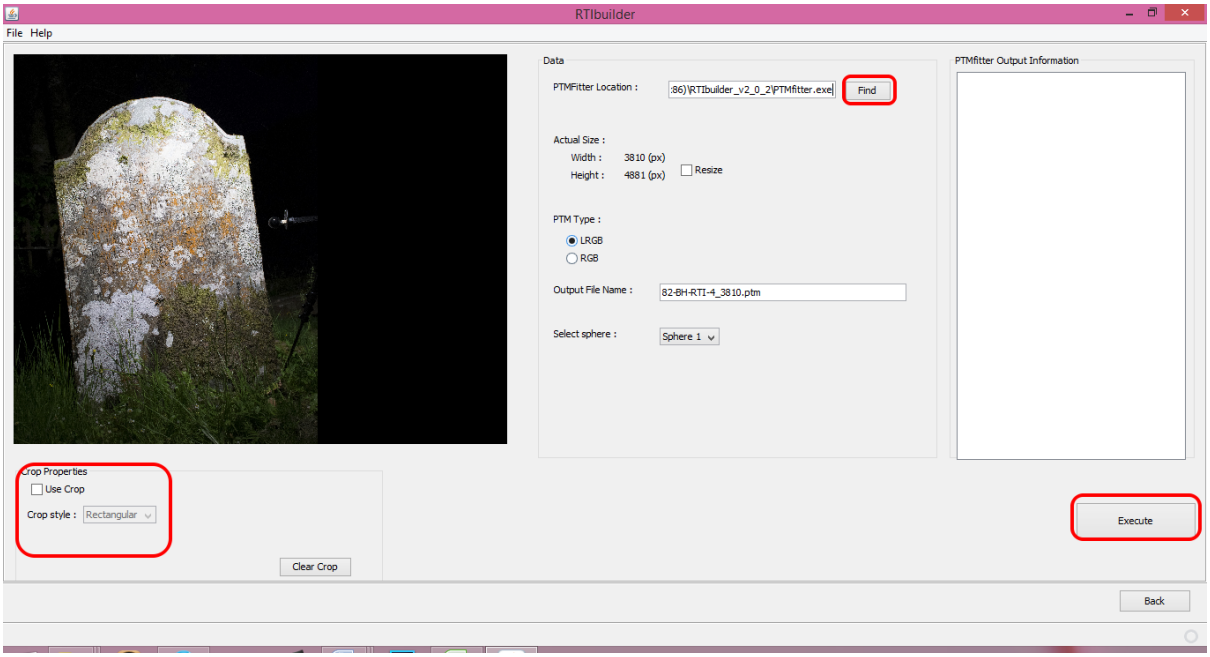
8. Adjust the size of the red ring till it covers the sphere and select *Set New Center* and then click *Next*.



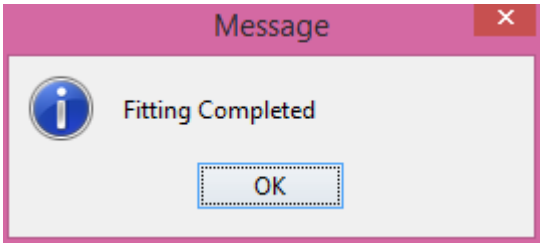
9. Click on *Highlight detection*.



9. Click *Next*.



10. This last window gives the option of cropping the image, but it is not needed. Select the bottom *Find* to locate the PTM Fitter file in your computer (this file was downloaded from the HP website, check the *Installing the software* section). To complete this process click on *Execute*.

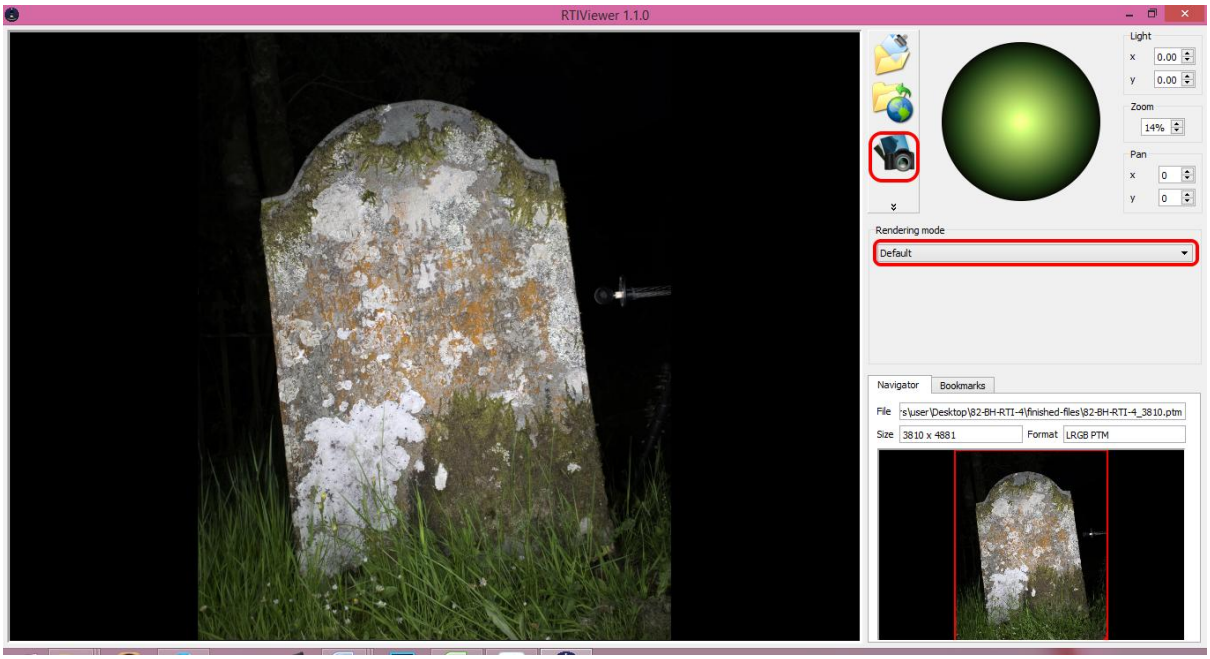


11. Once the RTIBuilder has processed the images a window will pop up advising that the fitting has been completed.

Interacting with RTI files

RTIViewer

Once the RTIBuilder has created the PTM file, it can be loaded in into the RTIViewer. This specialised software allows the user to manipulate the light conditions around the object making details on the surface visible that would not be seen by the naked eye. RTIViewer allows not only the lights to move around, but also to change the perception of the surface by, for example, changing the specular enhancement conditions or looking at the normal map of the surface.



Useful references

Duffy, S. et al., 2013. Multi-light Imaging for Heritage Applications D. Joan & P. Backhouse, eds., English Heritage Publishing.

Karsten, A. & Earl, G., 2010. HMS Stirling Castle, Kent: the Stirling Castle Wood Recording Project: a pilot study to compare traditional and innovative recording techniques for waterlogged wood: archaeological conservation report. *English Heritage Research Reports* 65/2010, 65-210

Mudge, M. et al., 2010. Principles and practices of robust, photography-based digital imaging techniques for museums. In and D. P. A. Artusi, M. Joly-Parvex, G. Lucet, A. Ribes, ed. *The 11th International Symposium on Virtual reality, Archaeology and Cultural Heritage VAST*.

Schroer, C., 2012. Advanced Imaging Tools for Museum and Library Conservation and Research. Bull American Soc Inform Sci Technol 38, pp.38–42.

Web links

[1] http://culturalheritageimaging.org/

[2] http://www.hpl.hp.com/research/ptm/downloads/download.html

[3] http://www.gimp.org/