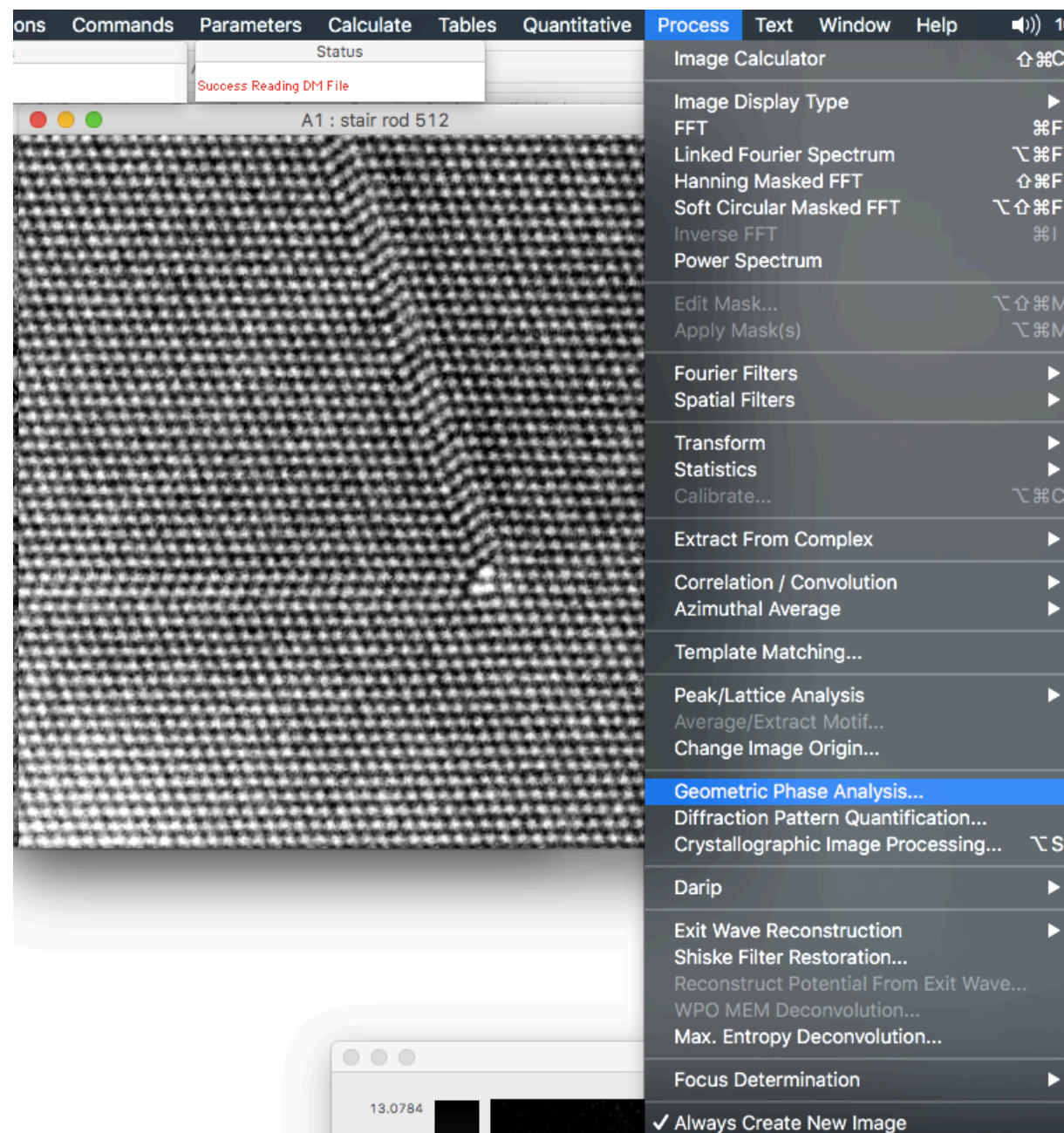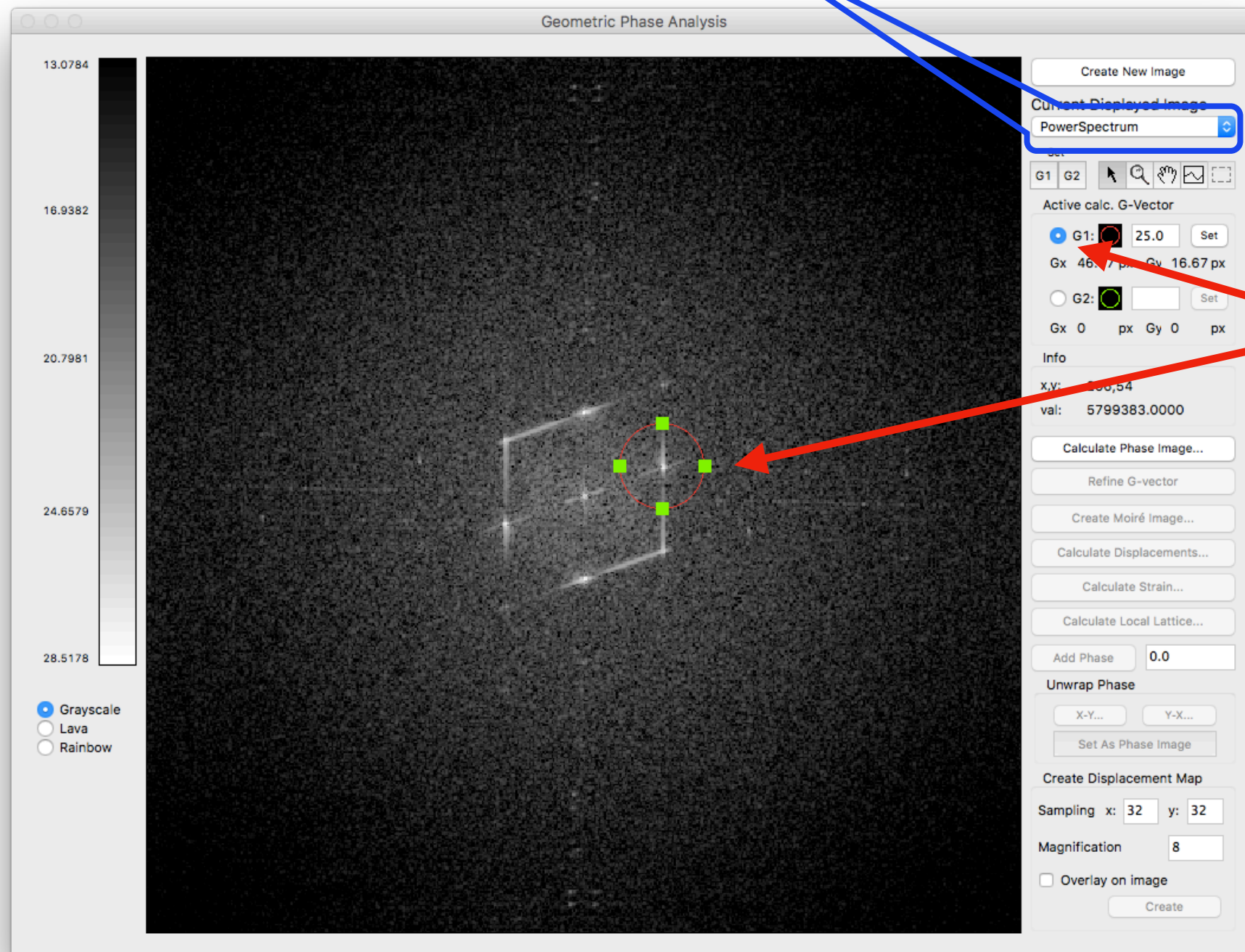# Geometric Phase Analysis Basic Overview

The Geometric Phase Analysis (GPA) is based on the retrieval of small variations of local lattice parameters from the information around the Bragg reflections in reciprocal space.

One starts with a HRTEM image of an area of crystalline material where there are small changes in the lattice parameters across the field of view

Selecting GPA from the menubar (Process) gives a new window which by default shows the Power Spectrum (PS) of the image. The image being displayed is determined by the drop down menu
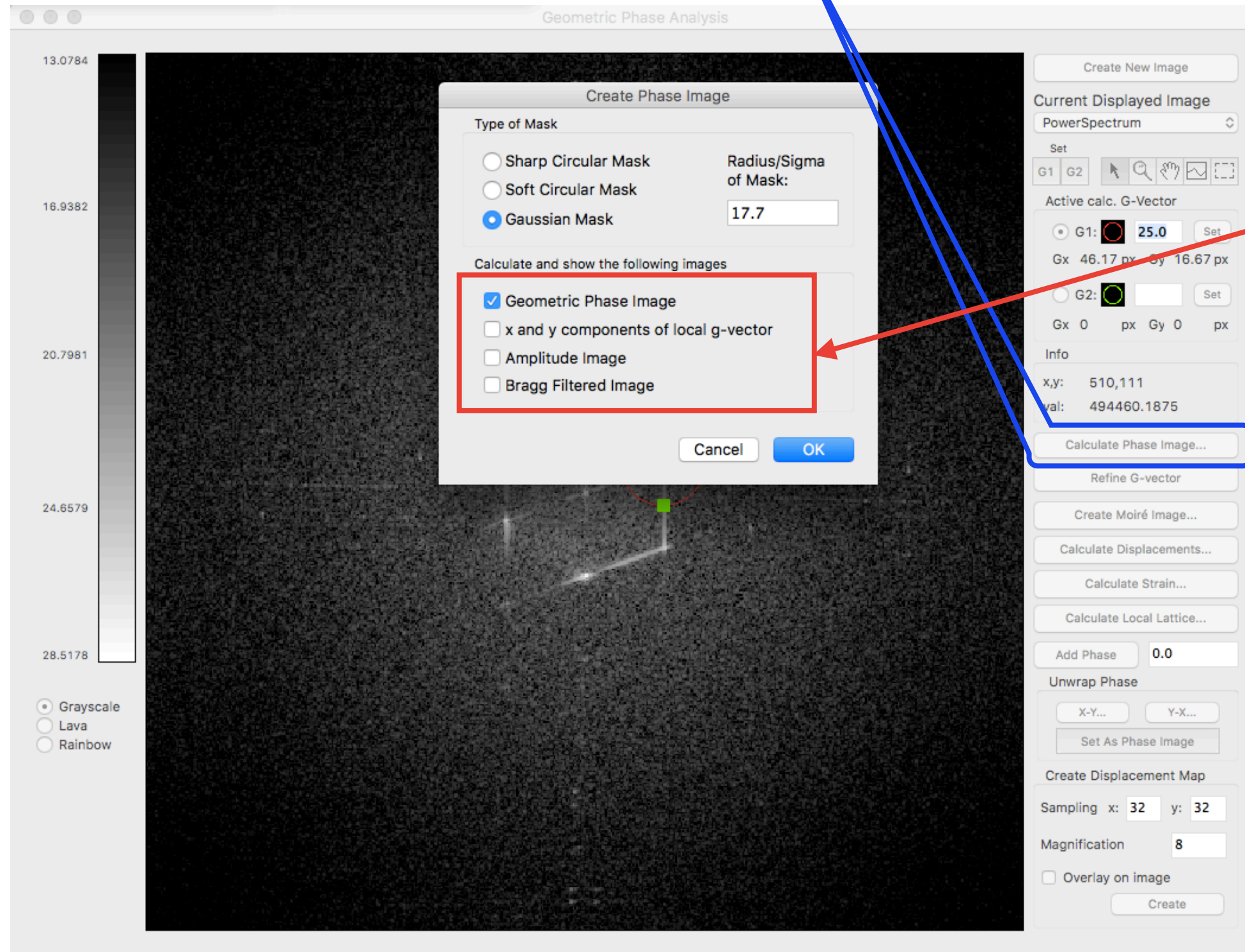

Usually the first thing to do is to select one of the Bragg reflections defining the crystal lattice (G1)

With the G1 Tool being selected, one clicks on the main Bragg reflection.

This then gives a circle around the reflection and one can change the radius by dragging the handles or typing in the value in the text field
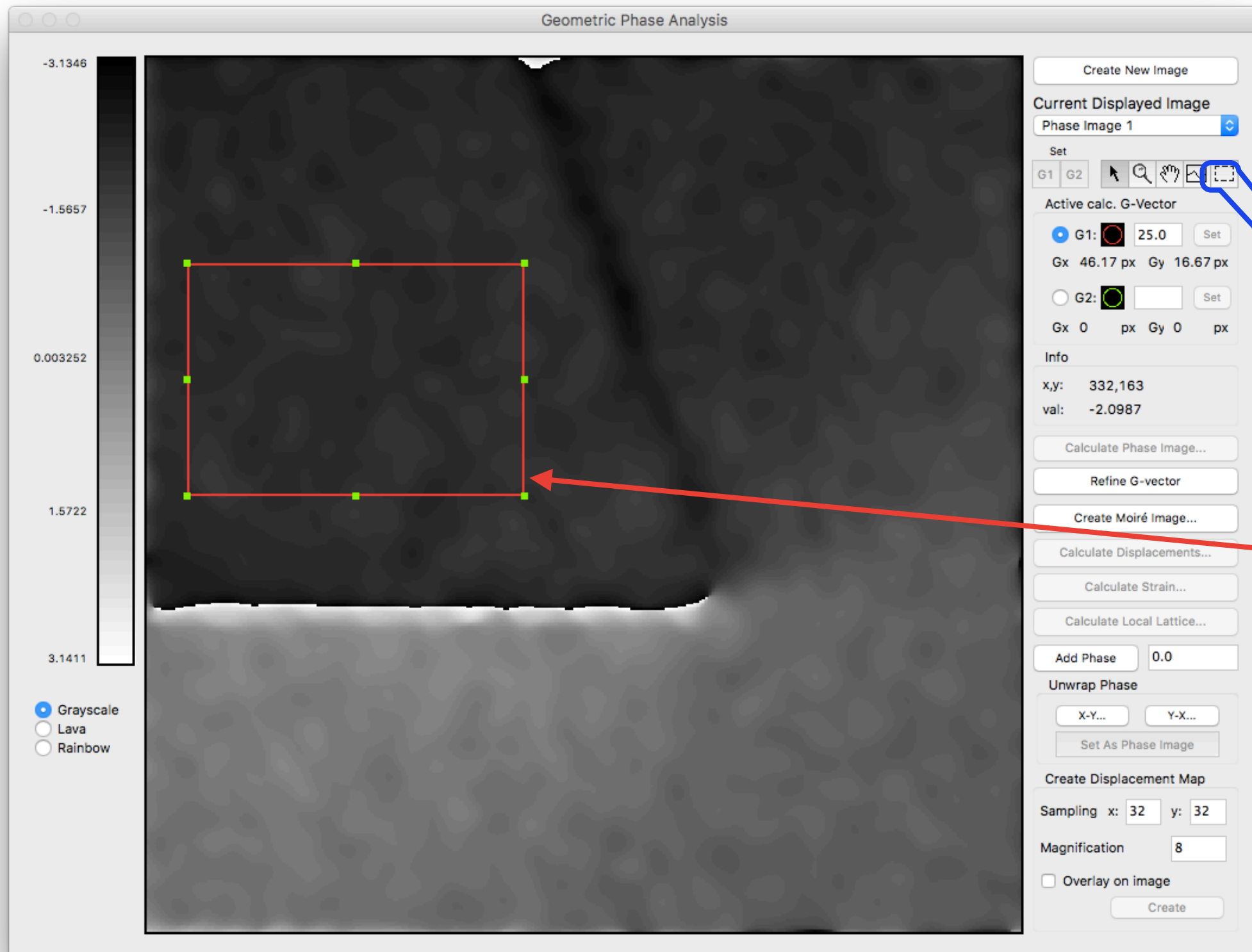
The next step is usually to calculate the Geometric Phase Image (Phase Image 1) which is given by doing an Inverse Fourier Transform from the information contained within the circle around the reflection g_1.

When clicking on "Calculate Phase Image…" one is given the option to calculate the "Geometric Phase Image" as well as other information that can be derived from the single sided Inverse Fourier Transform.
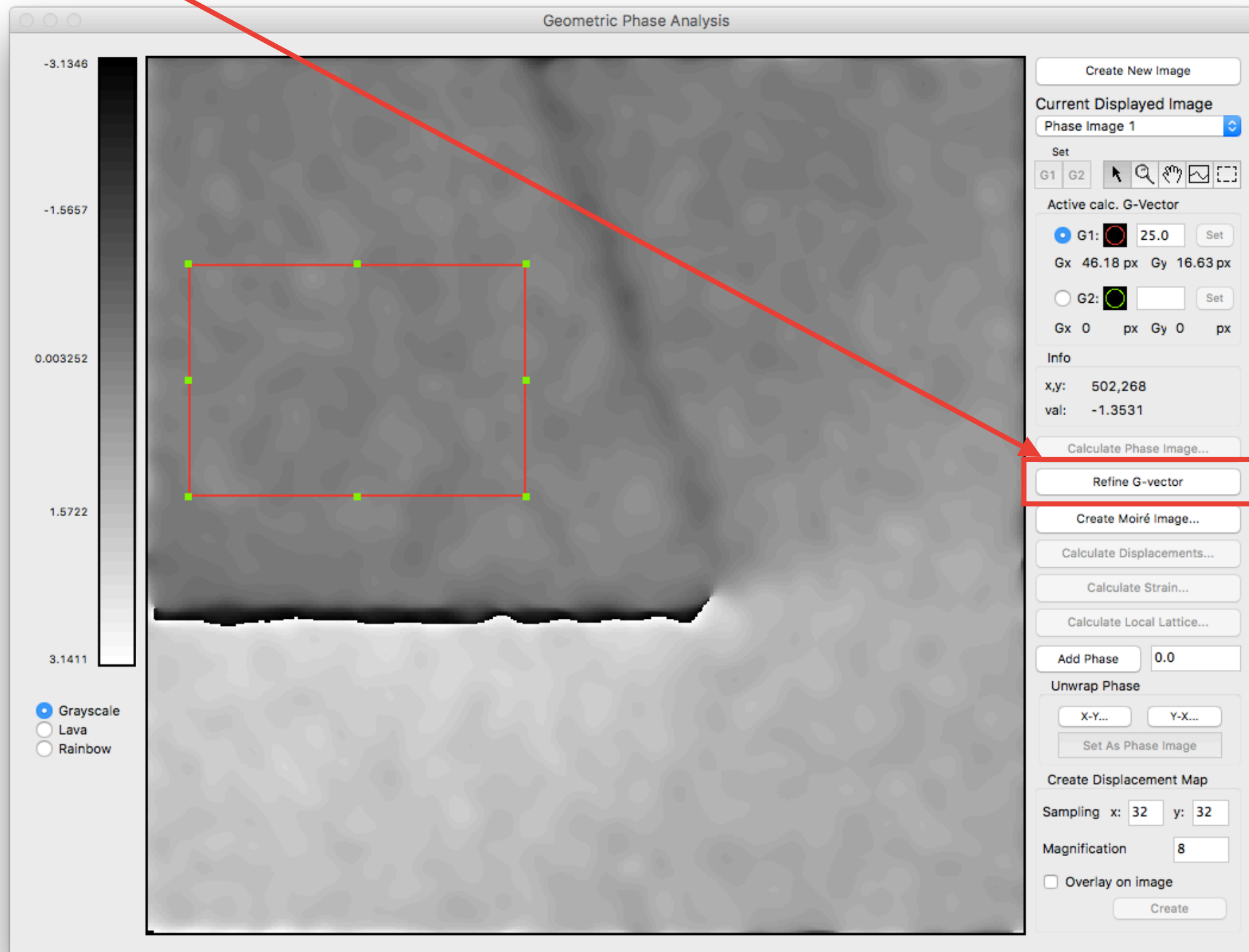
After Clicking OK to calculate the Geometric Phase Image, the Current Displayed Image changes to display "Phase Image 1".

The next step is to identify a region which is to be used to define the "reference" crystal lattice. This is because all deviations need to be relative to a reference lattice and we choose a region which has a uniform lattice parameter.

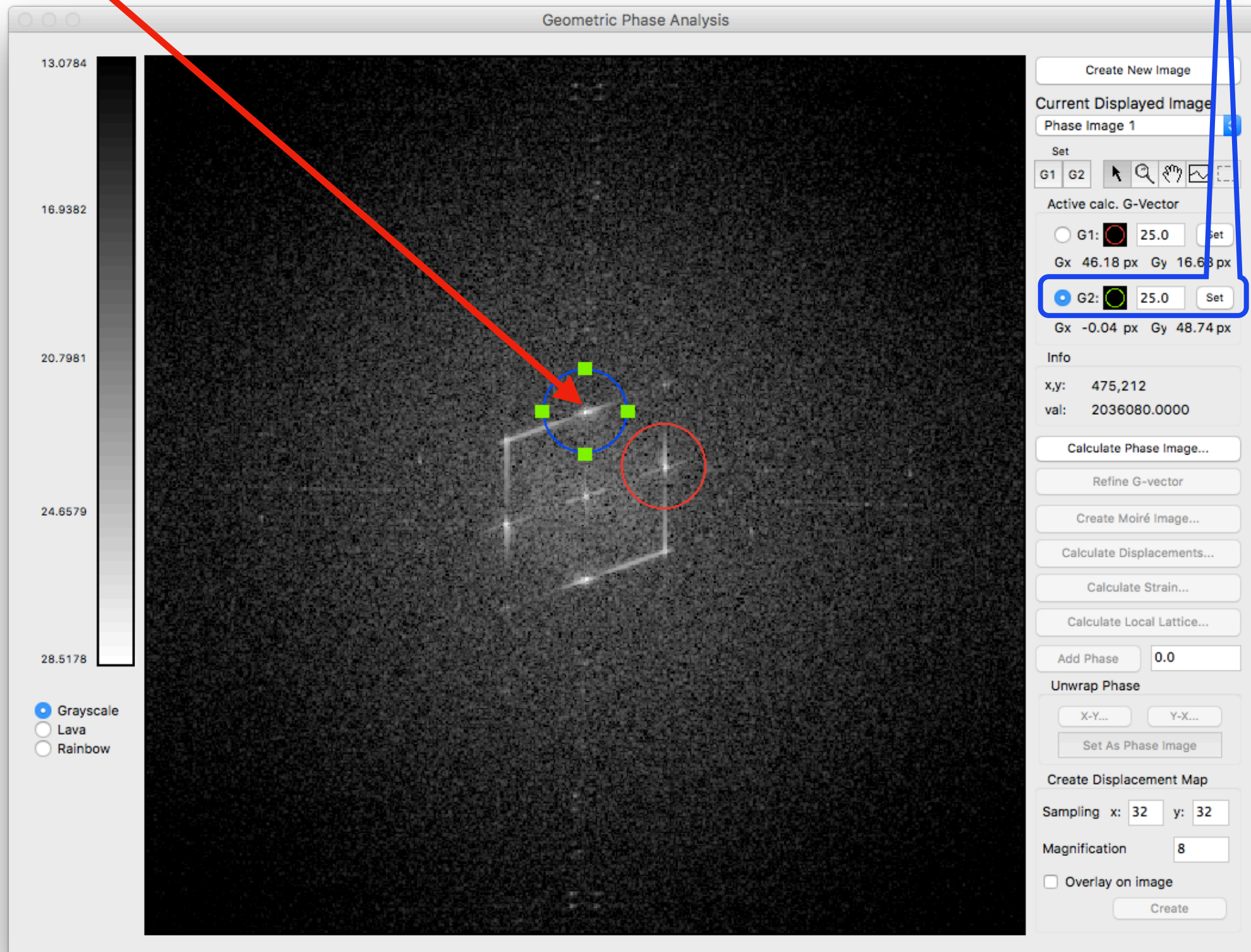We use the "Selection Tool" to mark this region in the image

After selecting the area which will define the reference lattice (**a**,**b**), one then needs to refine the lattice parameter defined by the reciprocal lattice vector **g**$_1$ (and **g**$_2$)
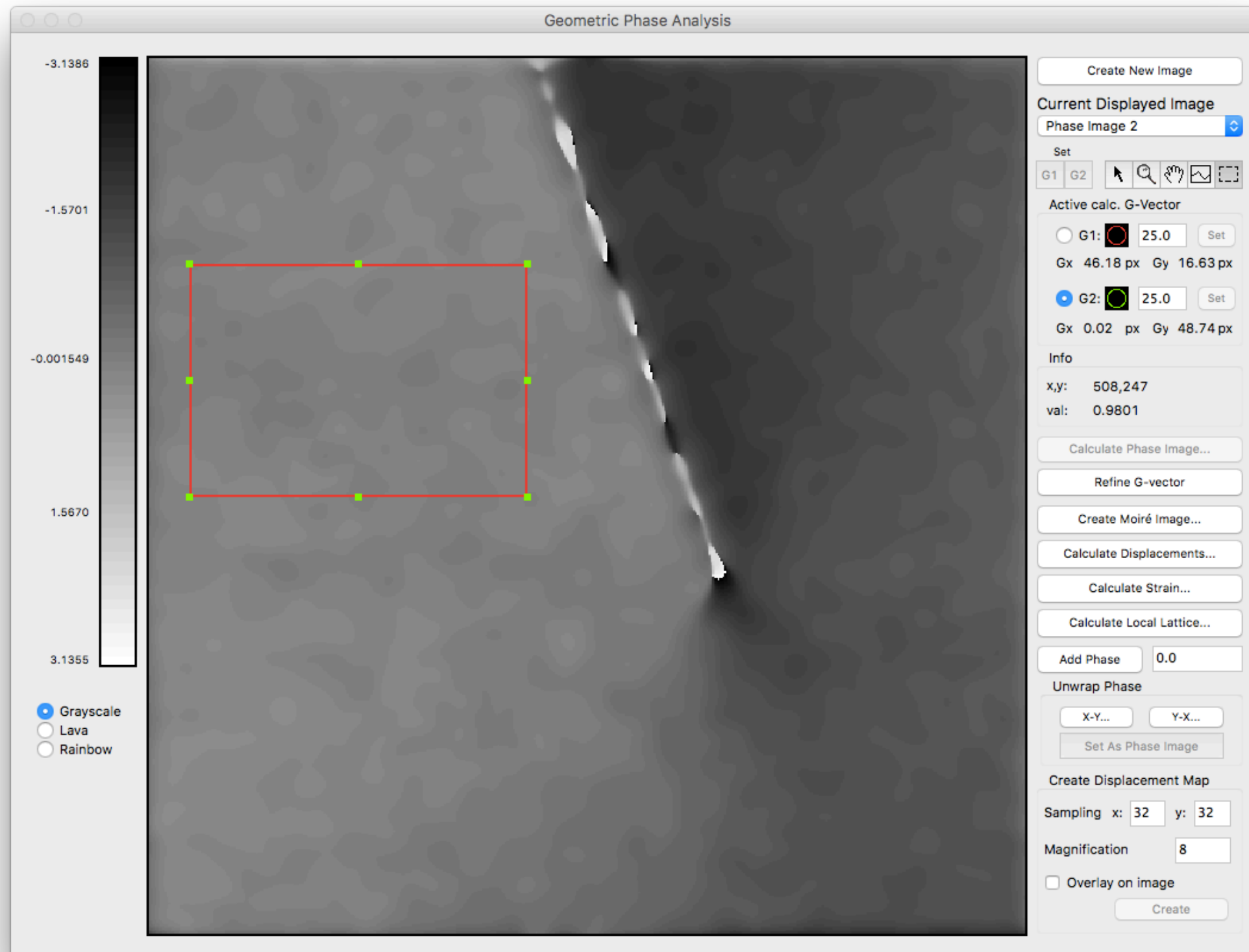

The first step is now done: We have created "Geometric Phase Image 1" based on a reference vector **g**$_1$

Next step is to define the reference lattice vector **b**, by selecting G2 and clicking on the reflection which will be used as the basis for defining the reciprocal lattice vector g_2
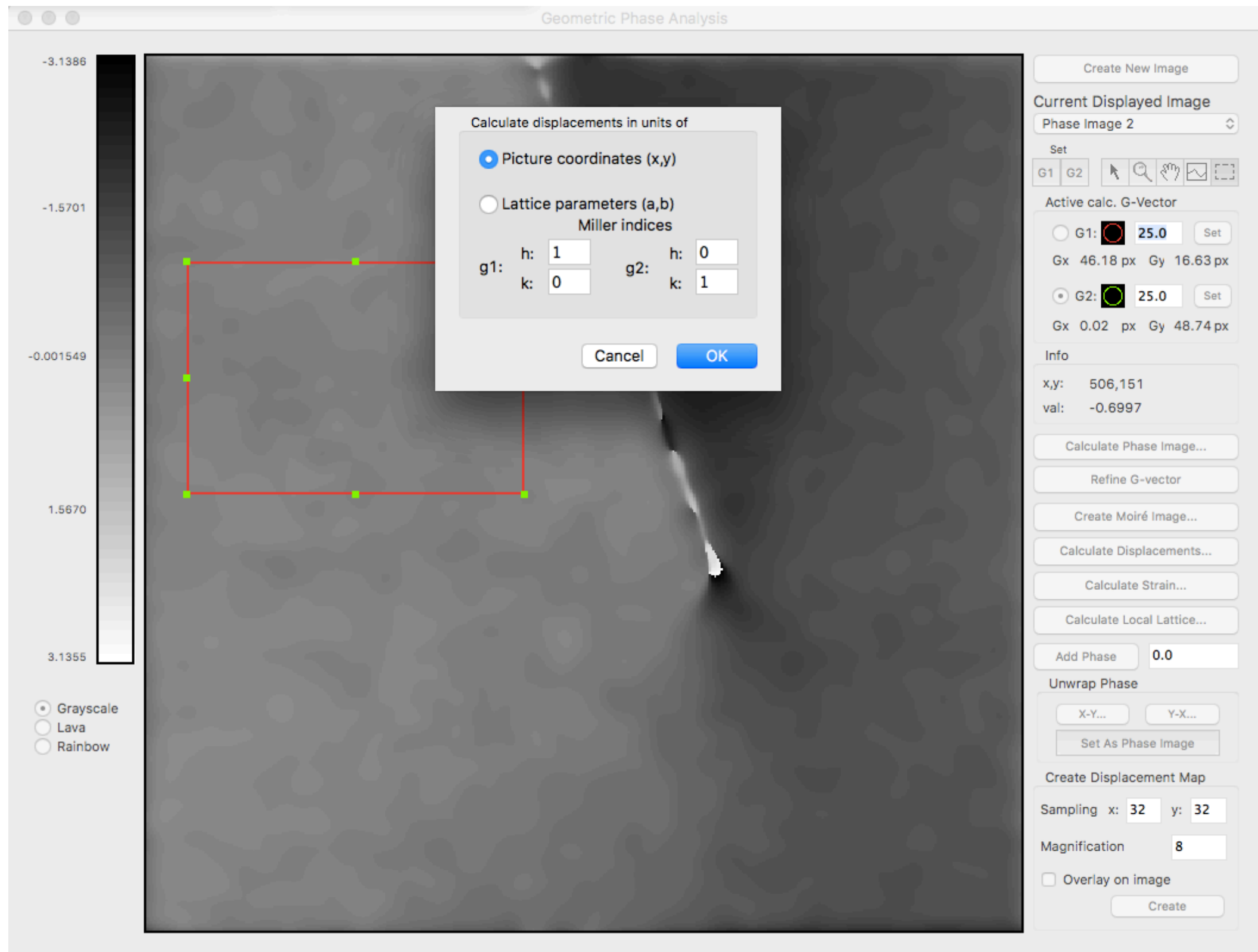
One then proceeds to calculate the Geometric Phase Image (Phase Image 2) which is given by doing an Inverse Fourier Transform from the information contained within the circle around the reflection G2.

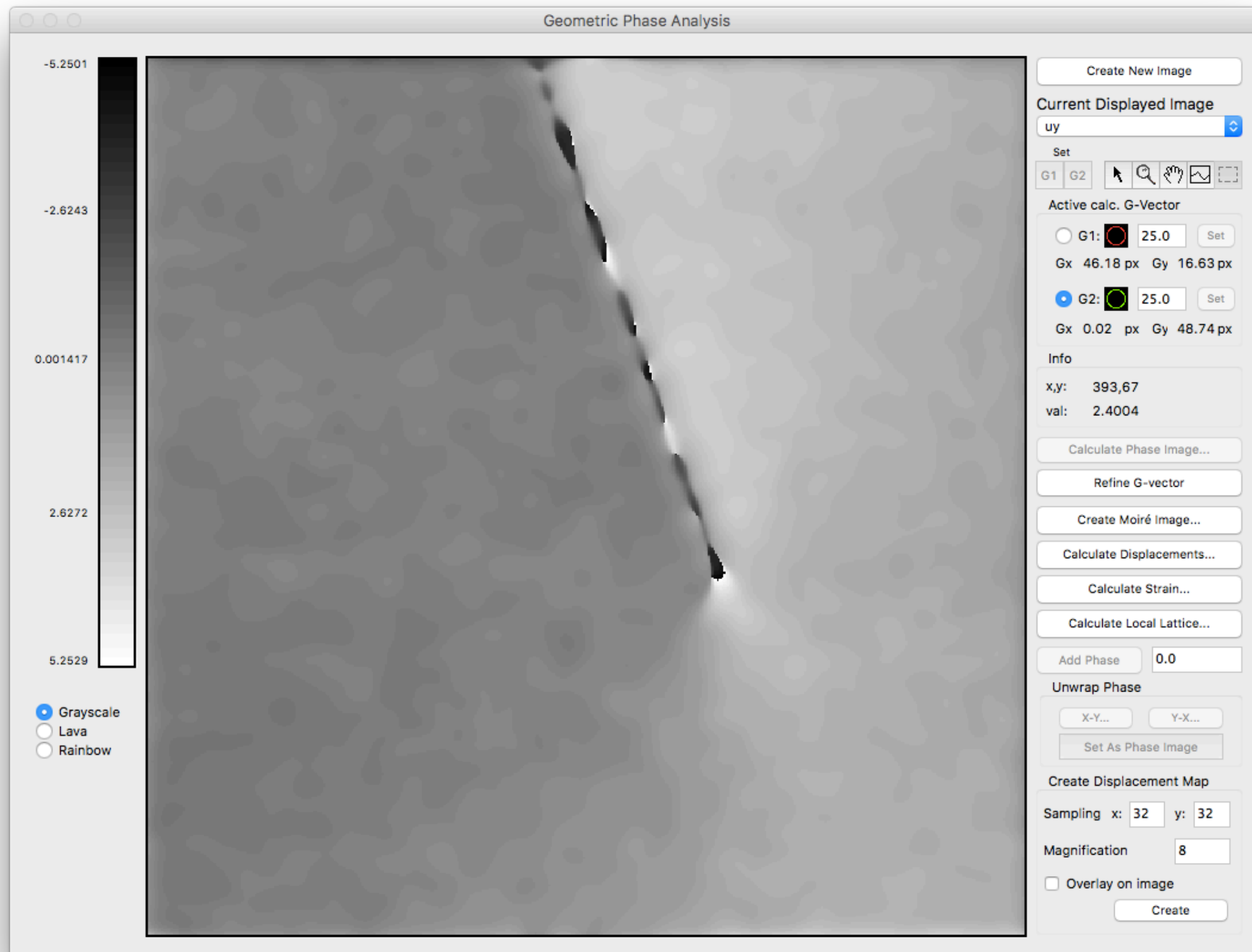We proceed with the same step as done earlier, namely refining the G-vector to arrive in determining "Phase Image 2"

This now gives us two phase images based on the two reciprocal lattice vectors g_1 and g_2

Having calculated two phase images and having determined the two reference reciprocal lattice vectors **g**$_1$ and **g**$_2$ which then define the reference lattice (**a**$_0$,**b**$_0$), one can now proceed to calculate local lattice parameters, local lattice displacements and local strain.
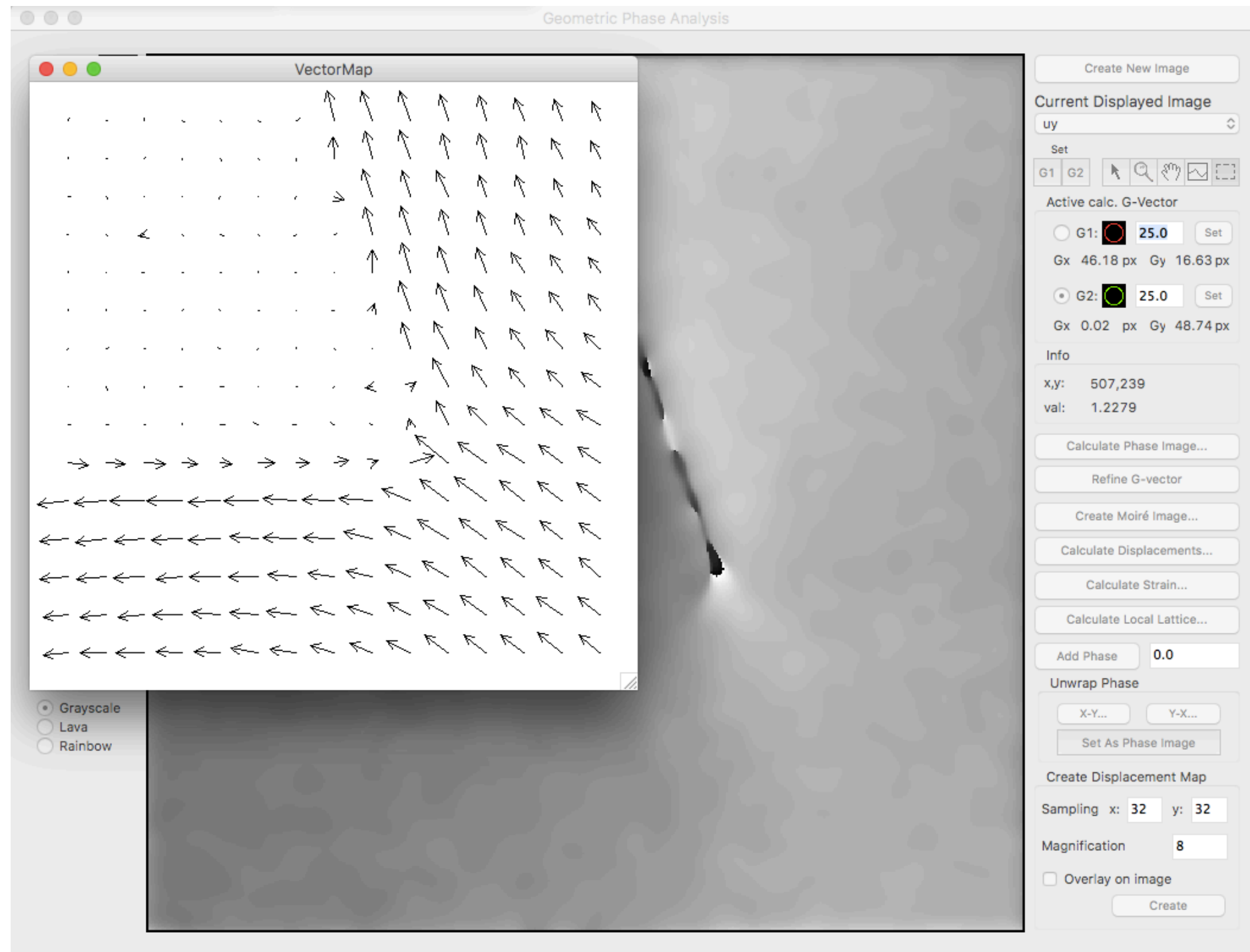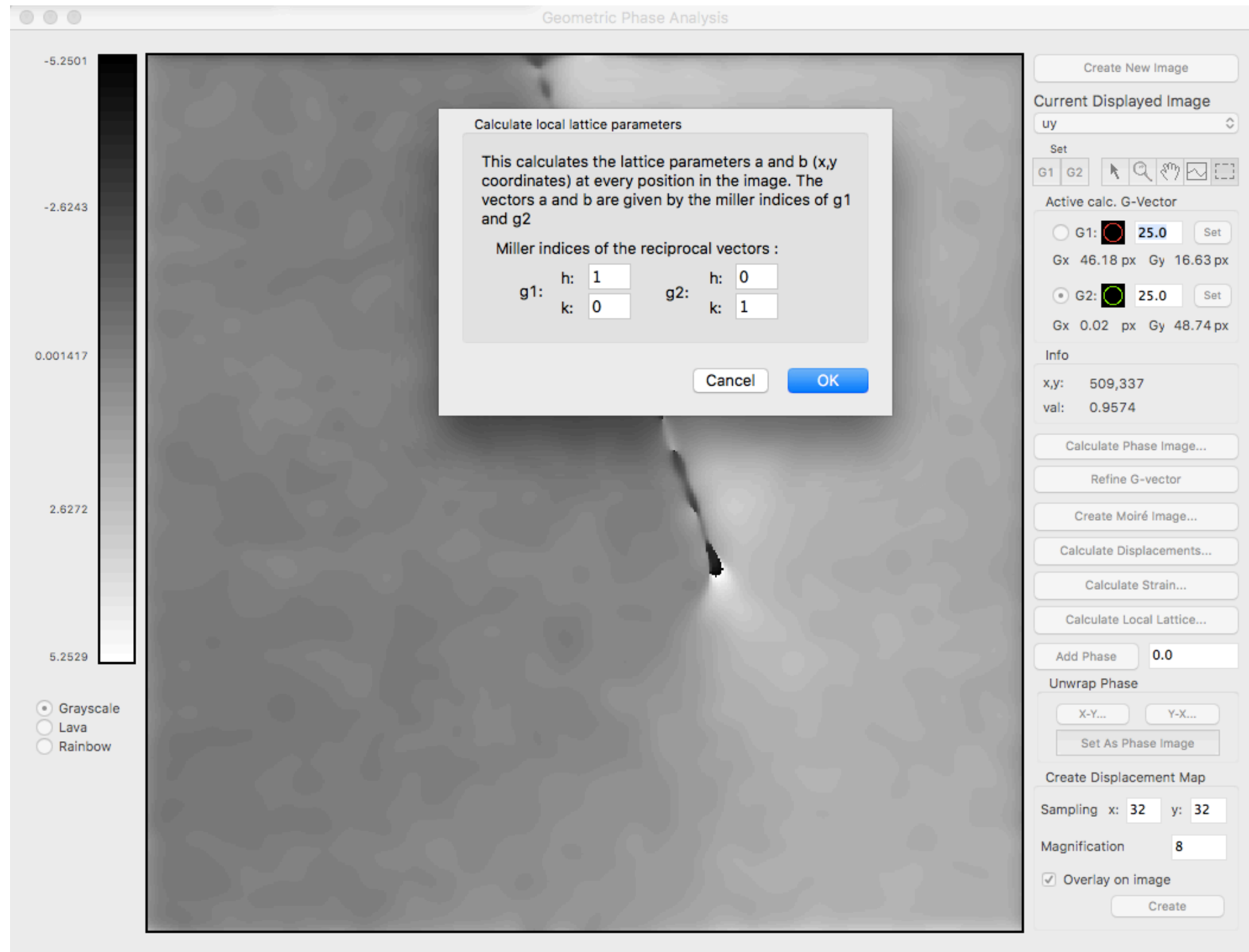
Calculating Displacements gives two images ux and uy which are the displacements in the x,y directions.

The information in the two displacement images ux and uy can be used to show the displacements from the reference lattice as a vector map

The information in the two phase images can then also be used to calculate local strain which can then be displayed as well.

All the various information such as lattice parameters, displacements, strain etc. are stored quantitatively as numbers in the various images.