Plop User's Manual

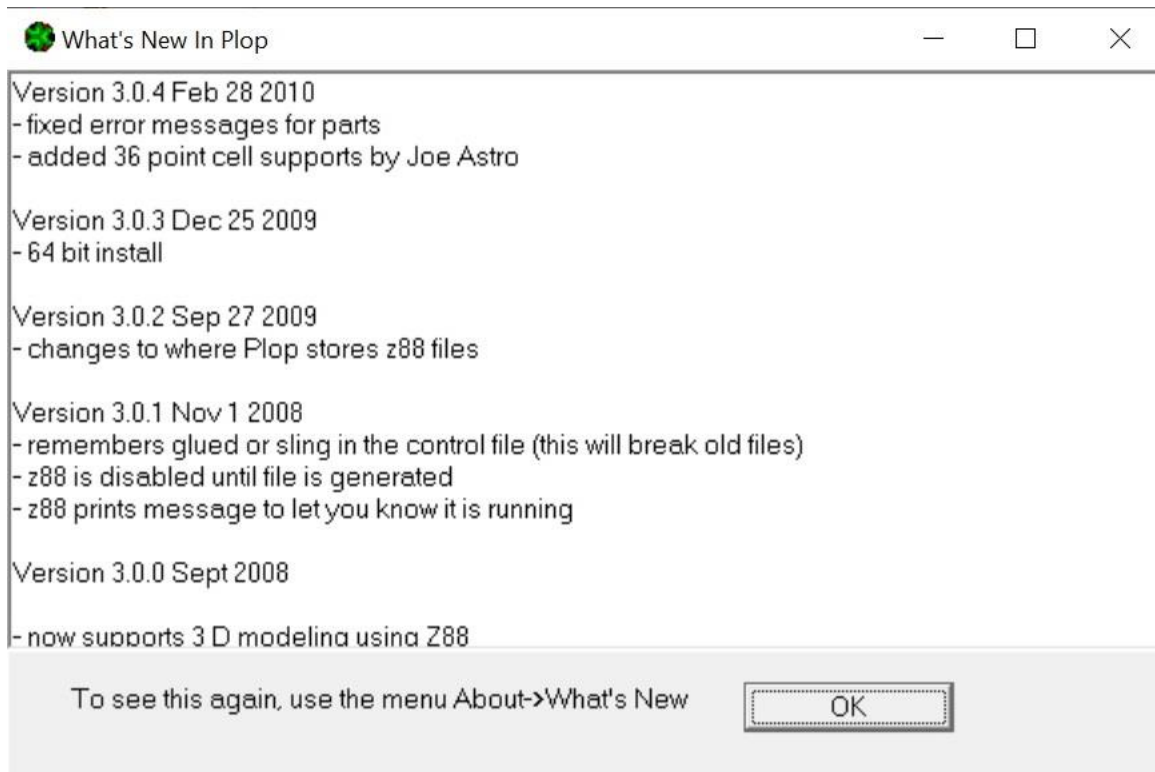David Lewis, Mar 2021

Introduction

Plop is a GUI-based analysis and optimization program for mirror cells. It is based on the Plate program by Toshimi Taki, and enhanced to run hundreds of times faster, so that it can support optimization of the mirror cell by adjusting the design to minimize the wavefront error. It also supports the FEM program z88 (https://en.z88.de/) which is a powerful and excellent program for FEM analysis written by Prof. Dr.-Ing. Frank Rieg and his team. Plop uses a very old version of Z88 (v12) which is adequate for its purposes. Due to the complexity of Z88, I have not been able to perform the same level of speedup needed to perform optimization, so Z88 is only for analysis, not optimization. However, being a 3D model, its results are more accurate than Plate, and it can also analyze mirror cells that are tilted with respect to the ground, while Plate only performs analysis of horizontal mirror cells.

What exactly does analysis and optimization mean? Analysis means that Plop will perform a calculation of the mirror to determine the wavefront error at each point on the mirror due to gravity acting on it. Optimization allows Plop to move around the positions of the supports, including both the radius and angle, if specified, and even the relative amount of force on each point, to minimize the wavefront error. Plop can produce pictures with the dimensions of each of the cell components and their locations.
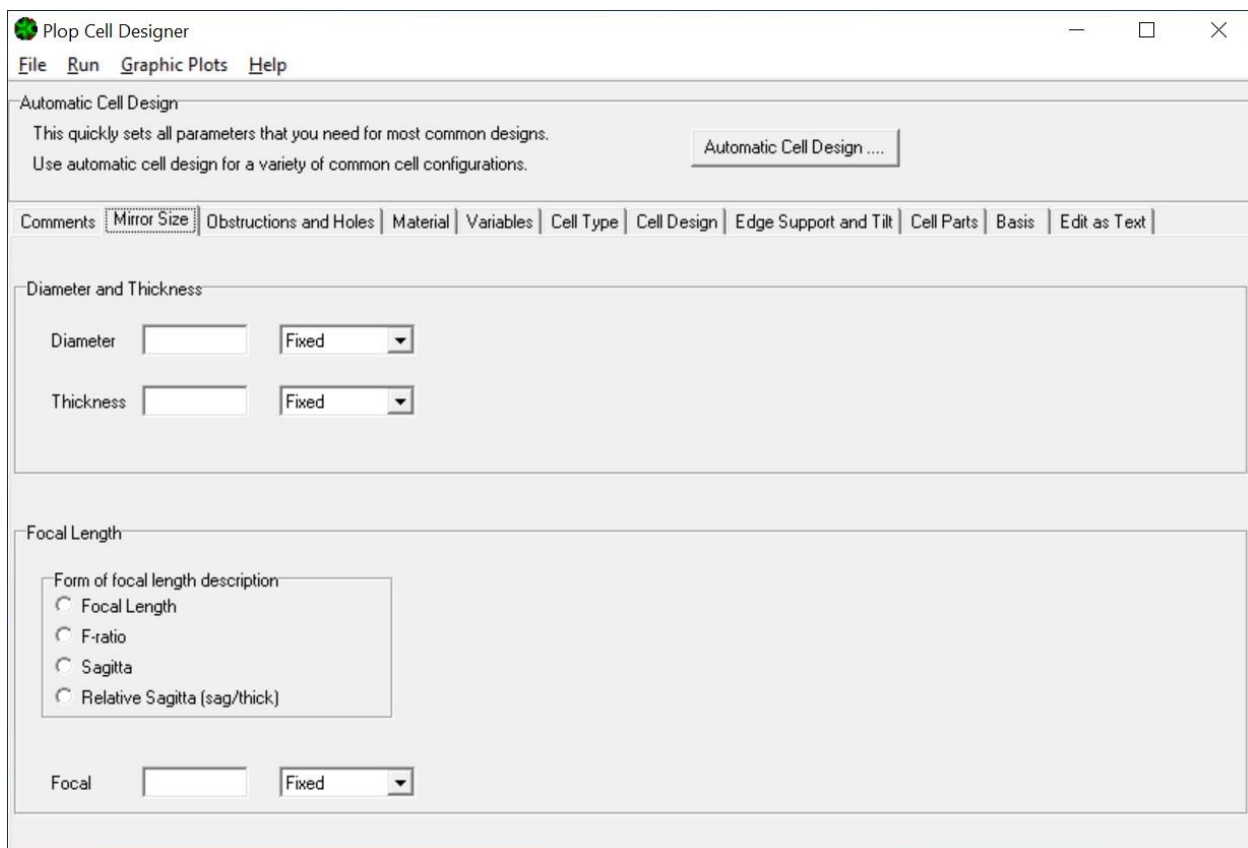
Plop contains a very general way of describing the mirror cell, but also has a design wizard that will handle almost all conventional cell designs.

Quick Start

After downloading and installing Plop, you should see it in your start menu under Gui Plop. The first time you start it you will see the What's New box. You can close this, and see it any time later under the Help menu item on the main page.

What's New In Plop

Version 3.0.4 Feb 28 2010
- fixed error messages for parts
- added 36 point cell supports by Joe Astro

Version 3.0.3 Dec 25 2009
- 64 bit install

Version 3.0.2 Sep 27 2009
- changes to where Plop stores z88 files

Version 3.0.1 Nov 1 2008
- remembers glued or sling in the control file (this will break old files)
- z88 is disabled until file is generated
- z88 prints message to let you know it is running

Version 3.0.0 Sept 2008

- now supports 3 D modeling using Z88

To see this again, use the menu About->What's New   OK

After closing this, you now see the main design form.

Plop Cell Designer

File   Run   Graphic Plots   Help

Automatic Cell Design

This quickly sets all parameters that you need for most common designs.
Use automatic cell design for a variety of common cell configurations.

Automatic Cell Design ....

Comments | Mirror Size | Obstructions and Holes | Material | Variables | Cell Type | Cell Design | Edge Support and Tilt | Cell Parts | Basis | Edit as Text |

Diameter and Thickness

Diameter [   ] [Fixed ▾]

Thickness [   ] [Fixed ▾]

Focal Length

Form of focal length description
○ Focal Length
○ F-ratio
○ Sagitta
○ Relative Sagitta (sag/thick)

Focal [   ] [Fixed ▾]

This form is the primary form for describing the mirror and starting other forms to run analysis or display results.

The majority of ATMs will be content with the Automatic Cell Design. This calls up a form that lets you select from a variety of commonly used cell designs.

Now you will see the automatic cell design form. This lets you enter the basic parameters of mirror diameter, thickness, focal length, and size of the central hole, if any. Enter all of these parameters and click Next. In this example we'll use a typical 300mm f/5 mirror. Note that all dimensions are in mm.

Plop Automatic Cell Designer

Diameter of the mirror in millimeters	300
Thickness of the mirror in millimeters	50
Focal length of the mirror in millimeters	1500
Diameter of the secondary mirror in millimeters	60
Diameter of central hole, if any, else leave blank	

Cancel   Next >>

Now you can select the type of cell that you want to use from the list. Lets use a 6 point cell which is completely adequate for this 300mm diameter mirror. There also is a check button if you want to allow the angles of the cell supports to be changed as part of the optimization. For simple cells such as 3,6,9 points, all of the angles must be multiples of 120 degrees, so leave this unchecked, but for more complex cells it is possible to allow the angles to vary. So leave it unchecked and continue.

Plop Automatic Cell Designer

Number of Points in the Cell
- ○ 3 points
- ● 6 points
- ○ 9 points
- ○ 18 points
- ○ 27 points
- ○ 36 points
- ○ 54 points

☐ Allow angles to vary

Select the cell style you want.

Check if you want to allow the angles to be adjusted.

<< Back   Cancel   Done

When you click Done, the Plop run form will appear. This is also accessed from the main form under the Run menu item. The run form contains a number of check boxes, which you should leave alone for most optimizations. The one that deserves some explanation is the Refocus Error Calculation. Refocus means

that when Plop calculates the wavefront error, it will assume that the eyepiece is adjusted to best focus. This is because in many cases, especially for mirrors with a small number of supports, the mirror will sag in a way that is in part paraboloidal. The visual effects of this sag can be removed by the user adjusting the focus of the mirror slightly. Plop will take this into account when performing the analysis and optimization if this box is checked. The run form has a box that will tell you the amount of this refocus, but I removed the code to calculate it at some point while restructuring the code. I'll try and fix this.


Just click Start Plop. Or, you can select one or more of the graphic plots from the Graphic Plots menu before you start it, and watch Plop do the optimization. It will only take a second or two for a simple cell to be run, and you will see a popup when it is done. Click it to go back to the run form.

Plop Execution Finished

Plop Execution Completed

OK

Plop Run Controls

Graphic Plots

Plop P-V Error	5.02596e-06	Num Trials	35	Z88 P-V Error	
Plop RMS Error	8.97036e-07	Step Size	0.000275462	Z88 RMS Error	

Refocus change in focal length | 0

Matrix Solution Progress ██

Run Plop | Zernike Polynomials | Monte Carlo | Trace |

☑ Update pictures as optimization progresses

☑ Refocus Error Calculation

☐ Refocus Includes Tilt in Mirror

☐ Use P-V error for optimization (almost always a bad idea)

☑ Use Basis (automatic if none specified in edit sheet)

☐ Generate Z88 input after running Plop

Z88 Run Controls

Run Z88

Run Plop Controls

Start Plop | Pause | Resume | Abort

The run form now tells you the error on the mirror surface. Double this to get wavefront error. You can see that it has both RMS and P-V errors.

Note that Plop does not include any surface error that is obscured by the secondary mirror, and won't try to make the surface error smaller in this region. That's why the mirror cell design includes the secondary mirror size as one of its parameters.

Lets take a view of some of the plots we can see. Under the Graphic Plot menu item, there are lots of entries.
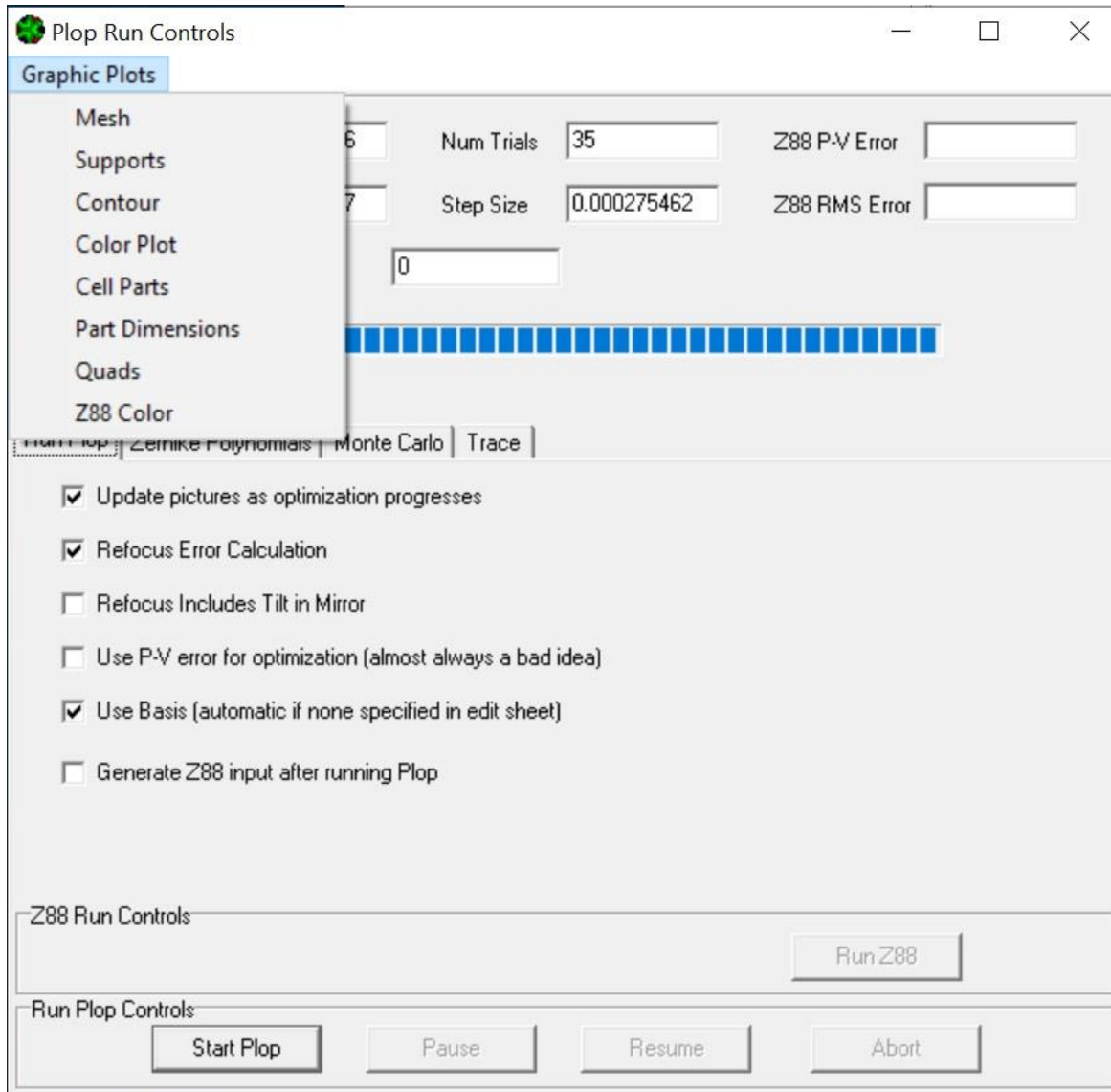
Click Color Plot to see a view of the surface deformation and a scale.
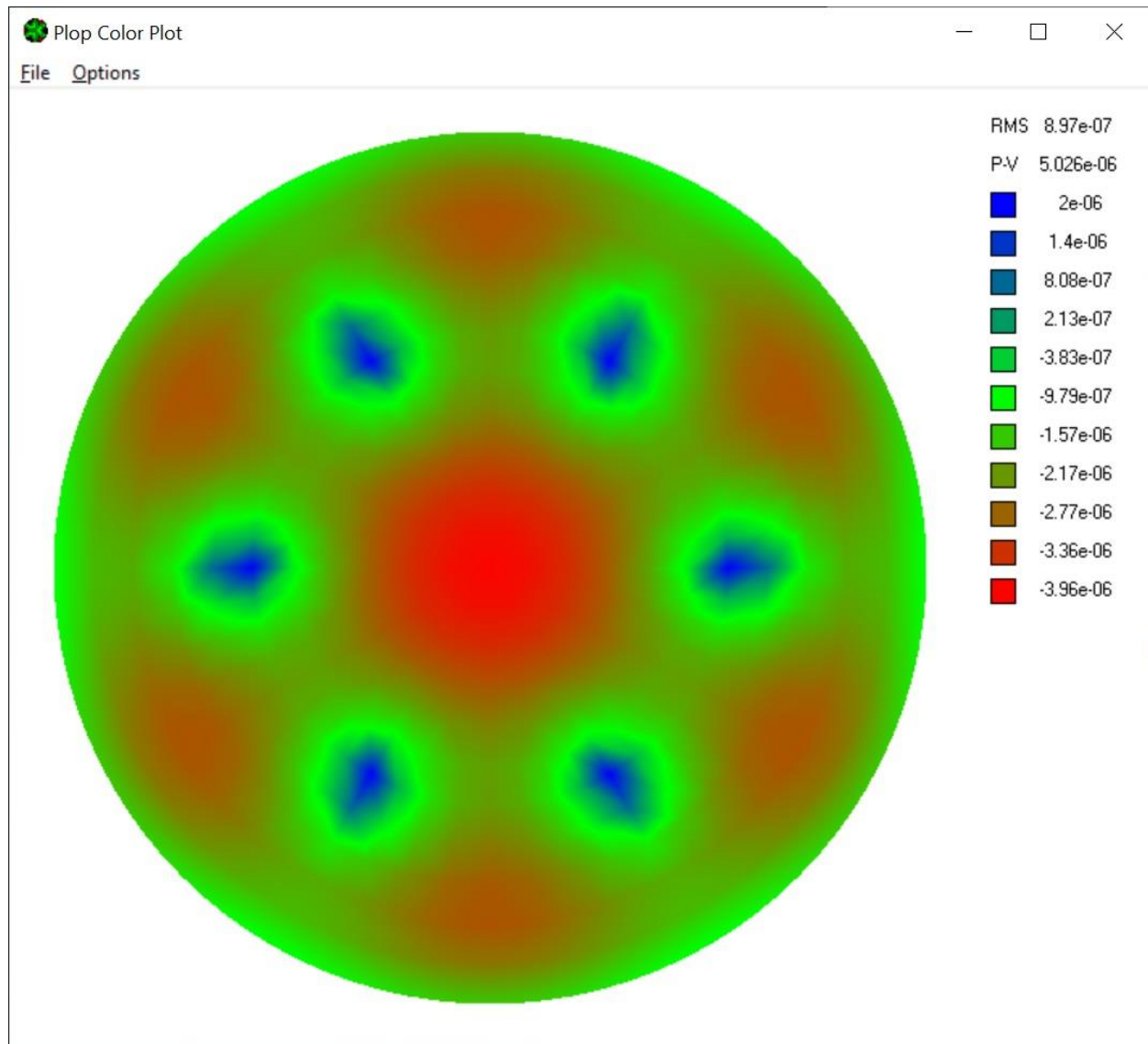
You can see how the mirror is high above the 6 support points, and low elsewhere. It also has a big depression in the center, since Plop doesn't attempt to reduce surface error where it doesn't matter.

You can see a diagram showing where the supports are located by using the Supports plot.
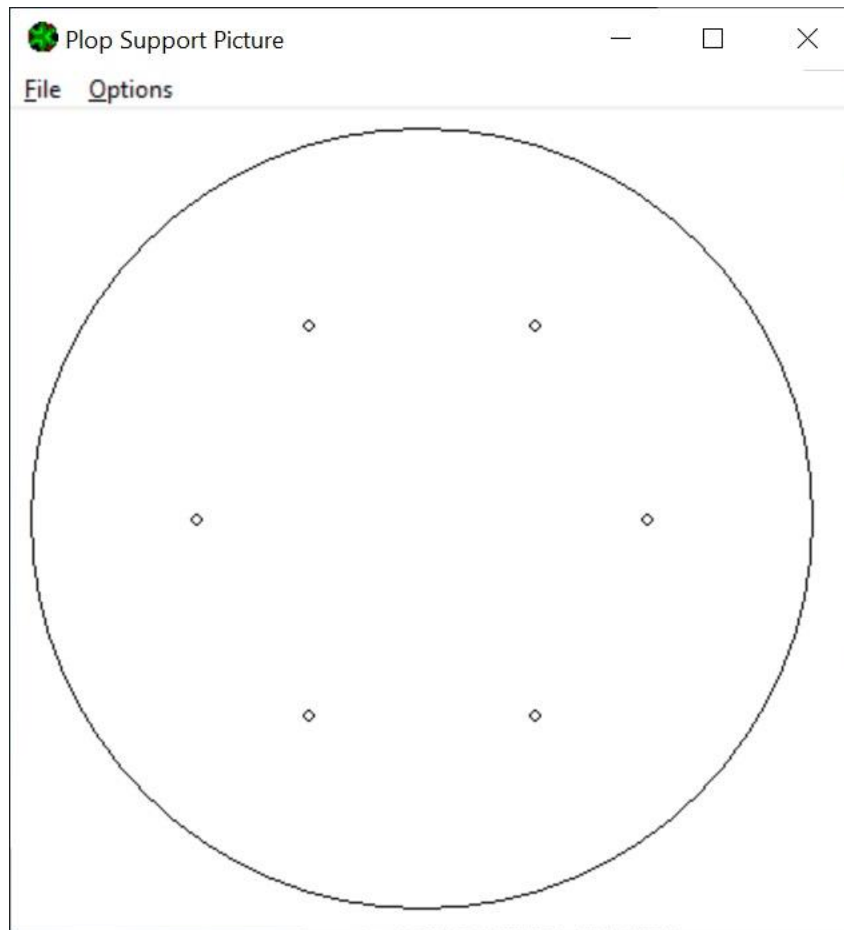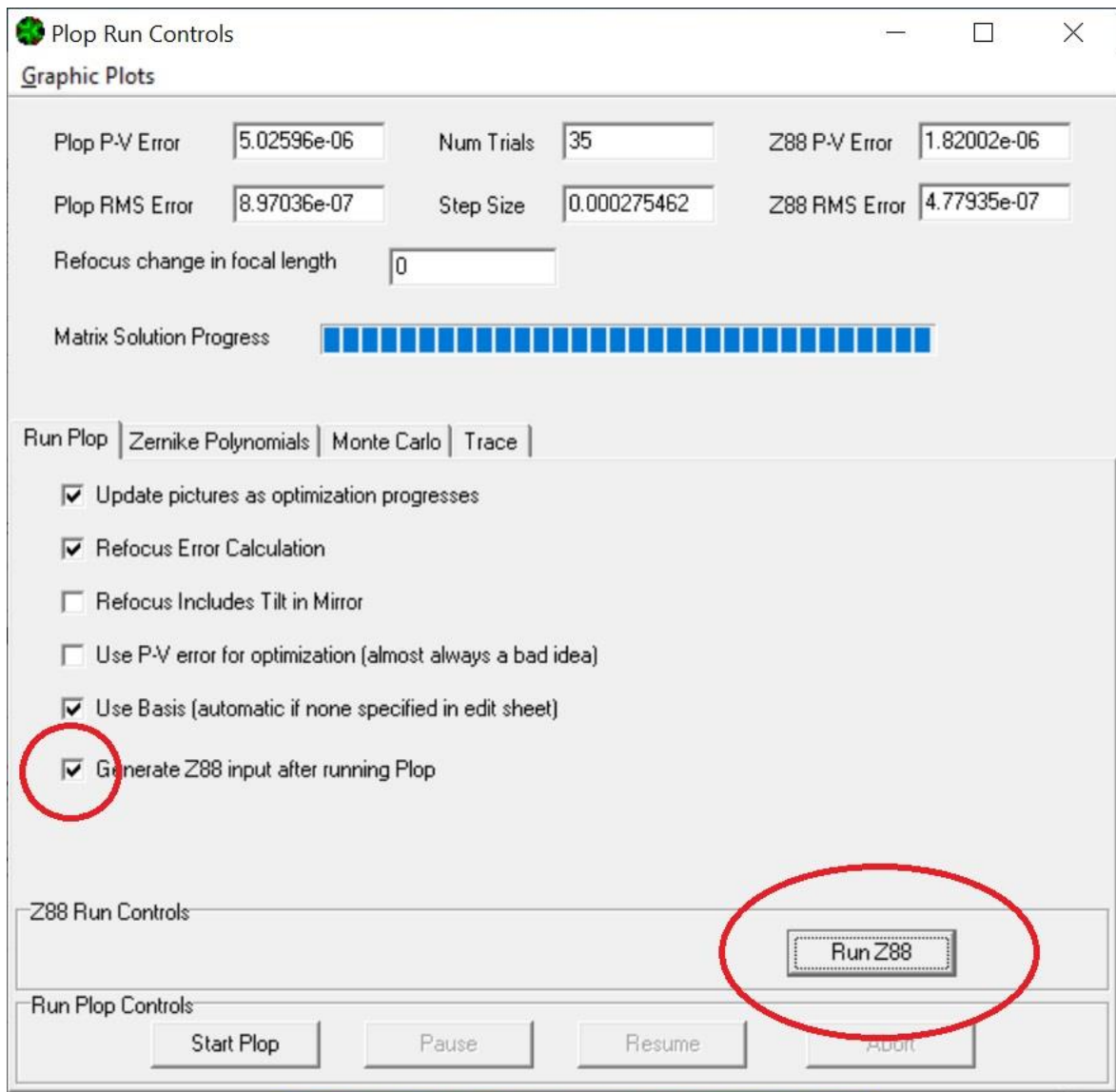
This is nice to look at, but doesn't have the information you need to build the cell. You need to use the Cell Parts and Part Dimensions plots. These will show a diagram of where the parts are, with labels on them, so you can refer between the two diagrams.
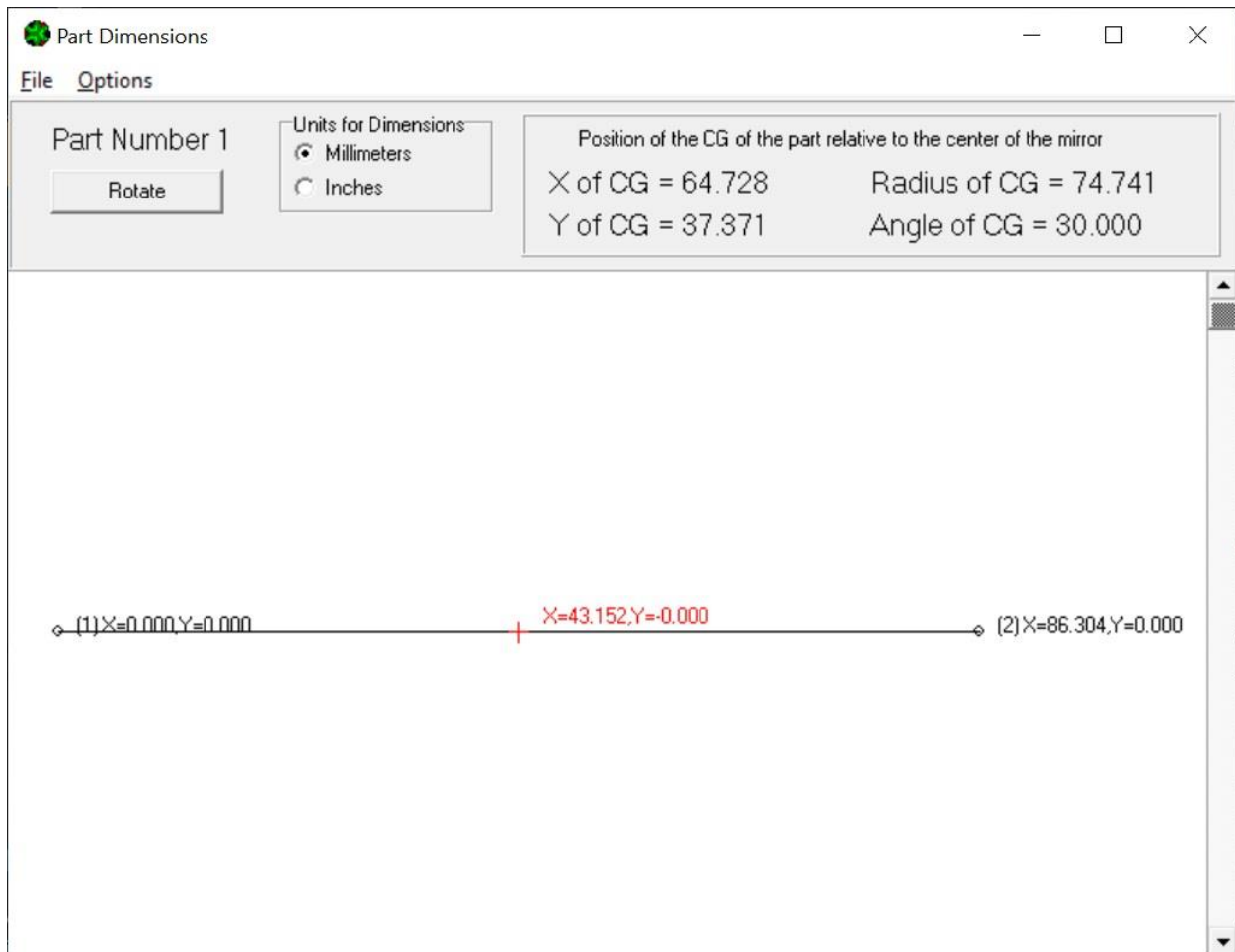
For our 6 point cell, there are 3 identical parts, which are bars. The distance between the points is shown as 86.304mm, and the center support is at 43.152. The plot also tells you where the center of the support should be located, both in polar and Cartesian coordinates. Note that there is a scrollbar on the part dimension form. You can use this to scroll between the various cell parts if there is more than one.

Using Z88

Using Z88 to analyze the mirror is optional. To do this you need to check the Generate X88 Input After Running Plop on the run form. This must be done before you run Plop. We could have done that originally, but we didn't, so check the box, then run Start Plop. It won't take as long because Plop has already optimized the cell. Now click the Run Z88 box.

Once this is done the error boxes for Z88 will also be loaded, and you can generate a graphic plot for the Z88 results as well. For smaller cells, Z88 will usually show a smaller surface deformation than Plate, but this is also more accurate. Plate's model of the mirror does not consider any compression of the thickness. Z88 models the mirror as a set of 3D regions, and models the forces in each of the 3 dimensions. We can visualize the difference by comparing the two diagrams below, showing how a single point support deforms the mirror. The Plate model treats the mirror as having no change in the thickness, while the Z88 model softens the peak above the support point. Thus, the Z88 analysis will show a smaller deformation, and is more accurate than Plate.
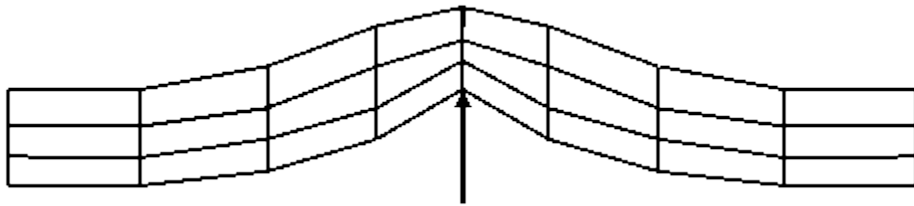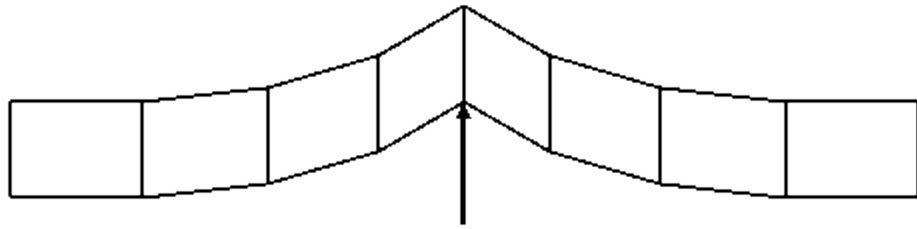
Now we take a look at the Z88 Color Plot and can visualize the softer peaks on the mirror surface.
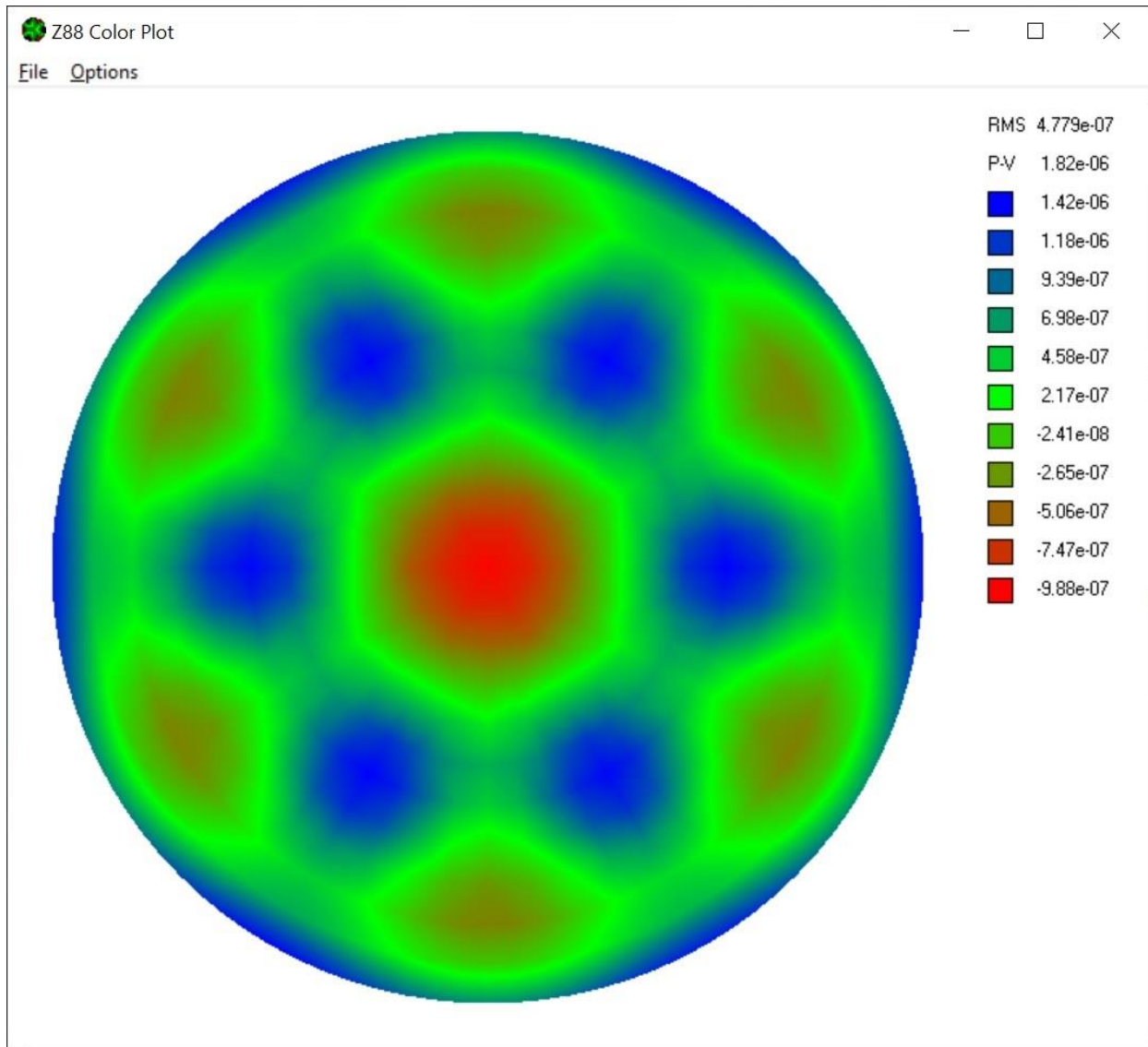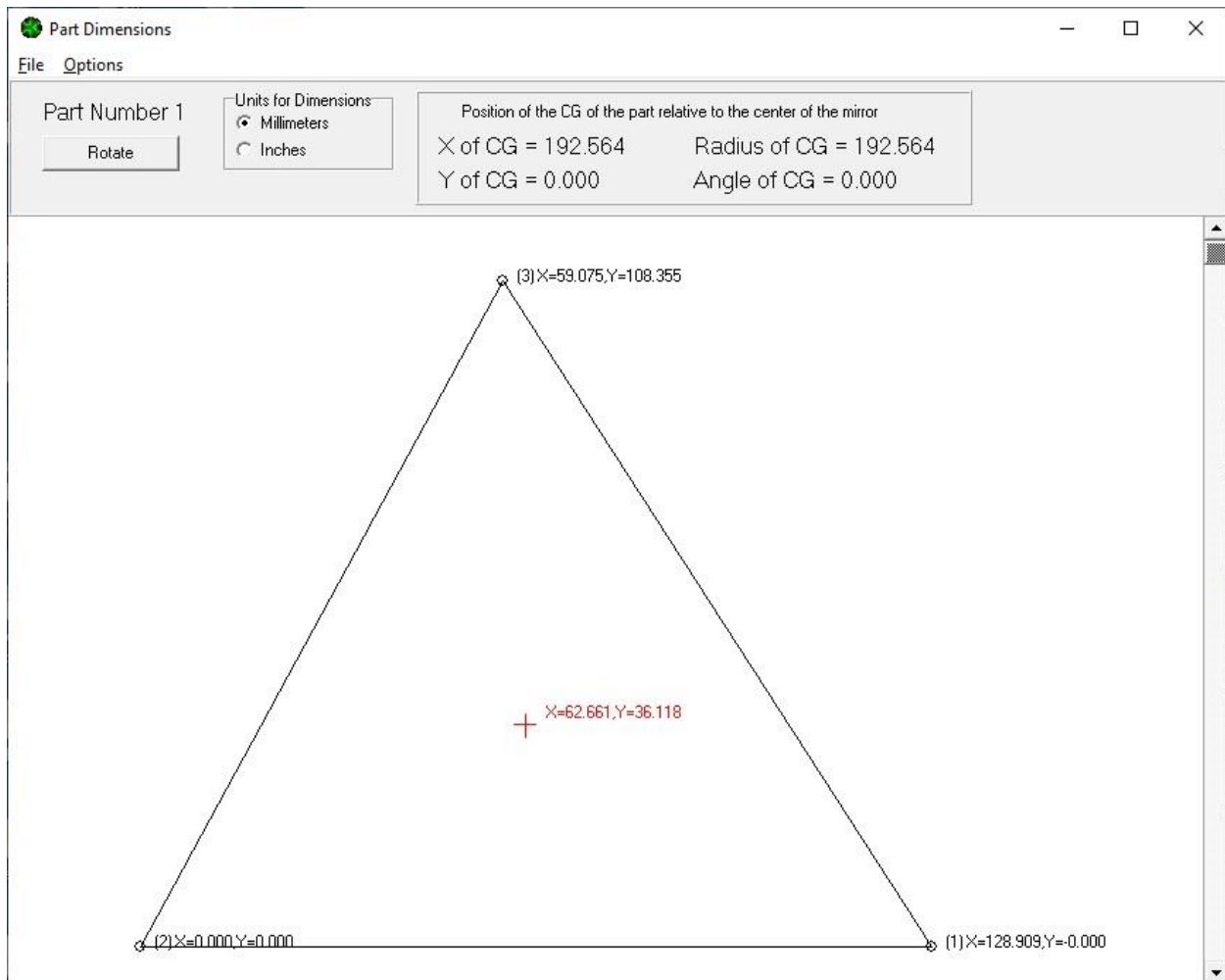
The vertical scale is different from the previous picture (you can constrain the Z scale under the Options menu), but you can see less pronounced peakiness compared to the previous color plot.
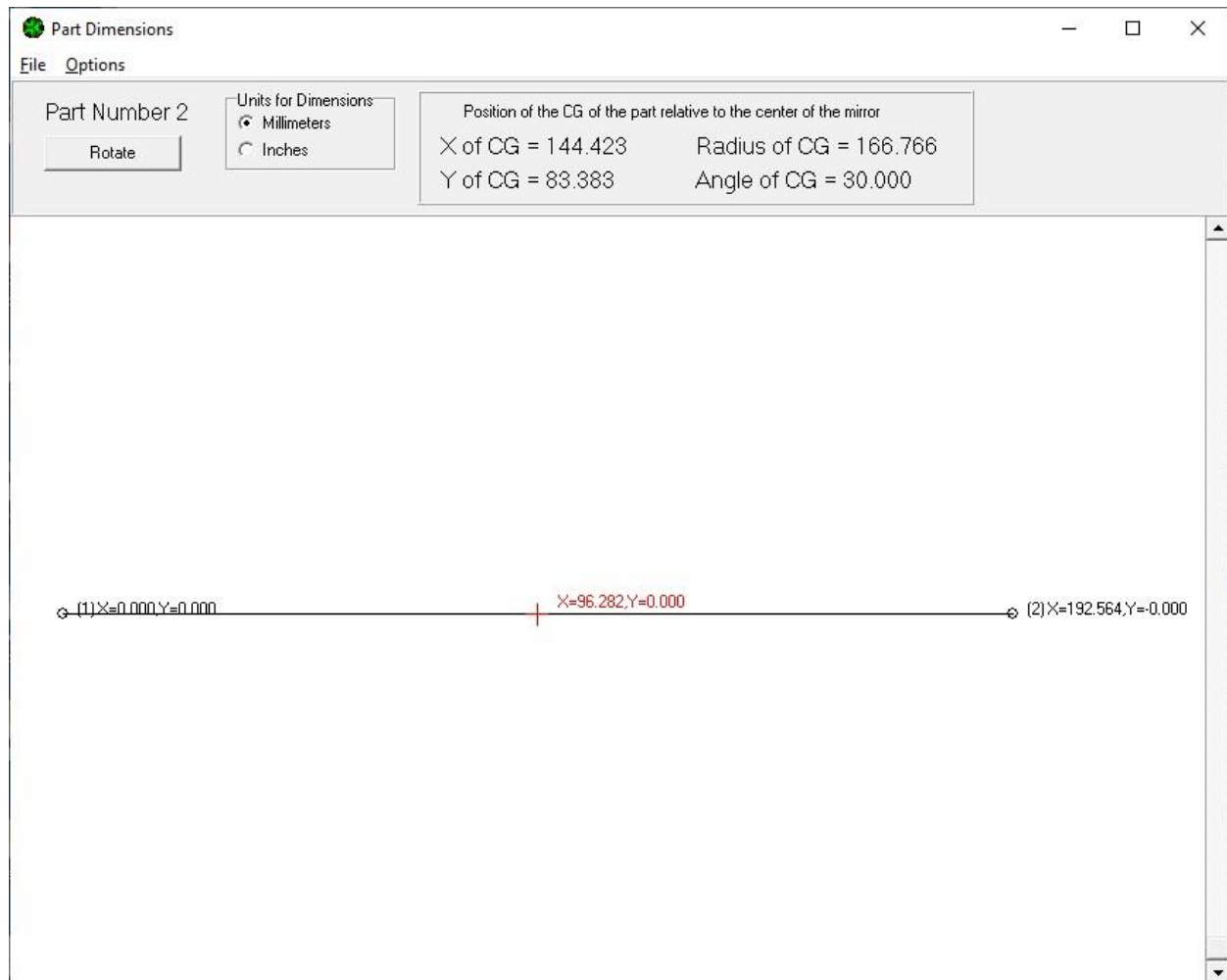
A More Complex Example

Use Automatic Cell Designer to create a 600mm diameter, 50mm thickness, 3000mm F/L mirror with 120mm secondary and 18 points. Run Plop and view the color picture.
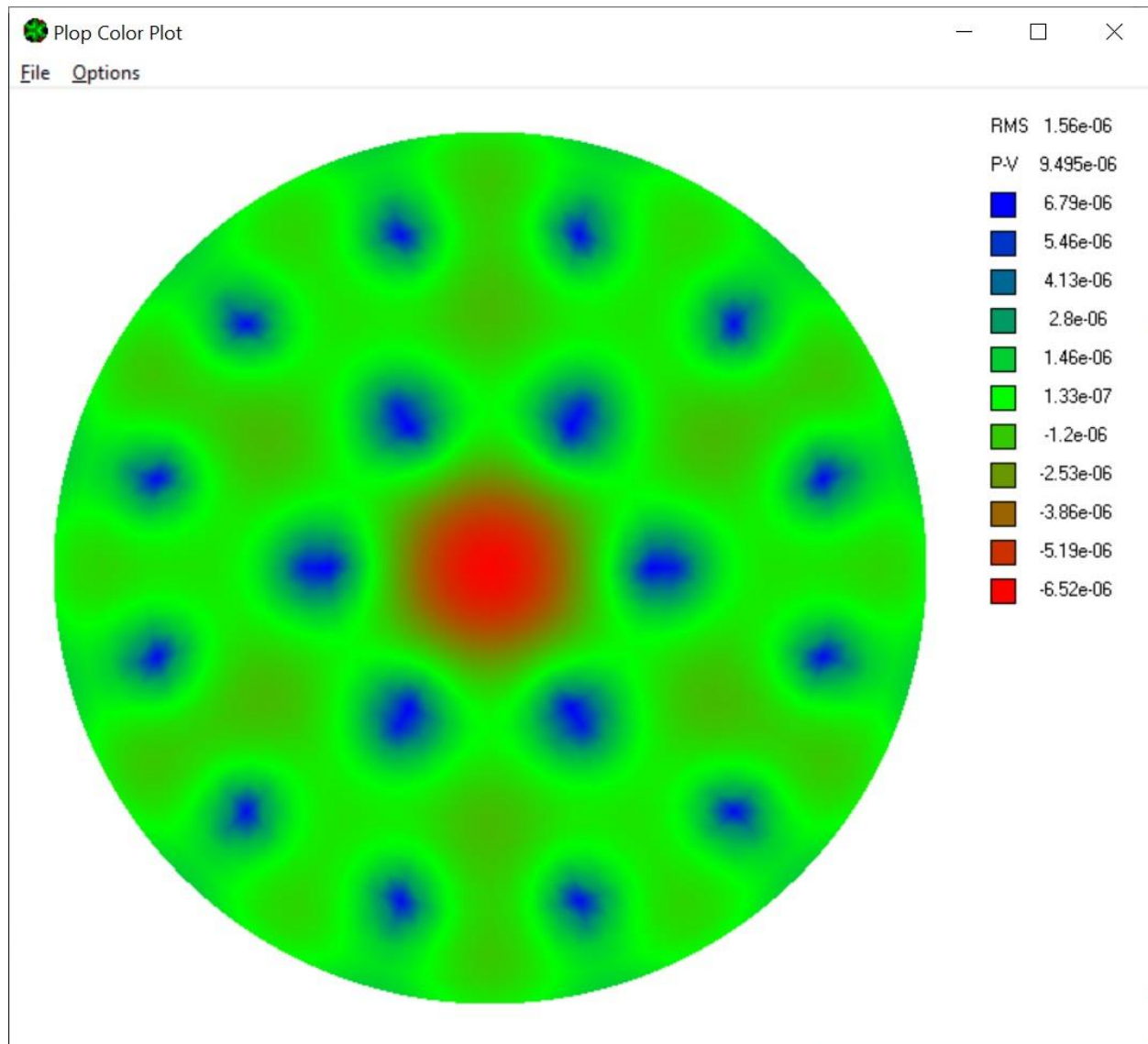
The parts diagram plot will now show the set of 3 bars and 6 triangles. Using the part dimension plot, you can scroll to see the exact dimensions and locations of the parts. Note the labels on each of the locations to help you orient the part with the overall design shown in the part diagram plot.

Part Dimensions

File Options

Part Number 1

[Rotate]

Units for Dimensions
- ⦿ Millimeters
- ○ Inches

Position of the CG of the part relative to the center of the mirror

X of CG = 192.564   Radius of CG = 192.564

Y of CG = 0.000   Angle of CG = 0.000

(3) X=59.075,Y=108.355

+ X=62.661,Y=36.118

(2) X=0.000,Y=0.000   (1) X=128.909,Y=-0.000

This should be enough for the vast majority of cell designers.

Z88 and Tilt