

Chapter 11

Defining Zoom Systems

Contents

Defining Zoom (Multi-Configuration) Systems	11-3
Command Mnemonics	11-3
Command Summary	11-3
Introduction to Zoom (Multi-configuration) Systems	11-8
Restrictions on Solves in Zoom Systems	11-9
Syntax Rules for Zooming Systems	11-9
Entering Zoomed Data in the GUI.....	11-12
Entering Zoomed Data from the Command Line	11-16
Zoom System Examples	11-19

Figures

Figure 1. Zoom System dialog box	11-12
Figure 2. Zooming a parameter in the GUI	11-13
Figure 3. Zoom position toolbar	11-14
Figure 4. Zoom Data review spreadsheet	11-14
Figure 5. Specifying active zoom positions	11-15
Figure 6. Typical option screen for a zoomed lens	11-16
Figure 7. Example of a lens to be specified as a classical zoom lens	11-19
Figure 8. Example of a laser scanner	11-21
Figure 9. Closeup of the scan mirror in a laser scanner	11-21
Figure 10. Laser scanner example: Specifying zoomed Alpha-Tilt values	11-22

Defining Zoom (Multi-Configuration) Systems

Many optical systems are not completely represented by only one lens configuration. These types of systems include the “classical” zoom systems, where only lens spacings change, and also systems where other lens parameters change, such as tilt angles, glasses, etc. These systems are sometimes referred to as multi-configuration or multi-use systems. In CODE V, these systems are all called zoom systems, even if they are not classical zoom lenses. When any lens parameter is changed from one zoom position (configuration) to another, we refer to it in CODE V as “zooming” the parameter.

To define a zoom system, you first need to specify the number of zoom positions. You then define each lens parameter that changes across zoom positions by specifying a value for each zoom position. You can also remove a parameter from the zoomed list (dezoom the parameter), or you can reduce the entire zoomed lens to a single configuration (dezooming the lens).

Command Mnemonics (alphabetical)

COP DEL DEZ INS POS ZOO

Command Summary

Defining Zoom Positions

To define zoom positions in the GUI, choose the **Lens > Zoom Lens** menu to display the **Zoom System** dialog box. The following table describes the controls in the **Zoom System** dialog box, as well as the corresponding commands.

Command Syntax	
Screen Control	Explanation
ZOO num_total_pos	
Number of Zoom Positions	Establishes total number of zoom positions. Range: 1 to 99. If lens is already zoomed, decreasing the number of positions abandons the zoomed data above the total number of positions specified (num_total_pos); increasing the number of positions extends zoomed data for the highest prior position into the added positions. From the command line, if lens has not previously been zoomed, each item of lens data to be zoomed must be designated with ZOO prefix. Command examples (assumed to be done in sequence): ZOO 3 – Defines 3 zoom positions ZOO? – Tells current number of zoom positions ZOO 4 – Puts pos. 3 data into new pos. 4, too ZOO 2 – Discard pos. 3 & 4, retain 1 and 2

Command Syntax	
Screen Control	Explanation
N/A	
Description	GUI command only. Optional. Enter a description of the zoom position; the description can contain letters, numbers, and spaces. This description will display in windows and dialog boxes beside the zoom position number, and allows you to specify additional information about a particular zoom position that will help you easily identify it as you work in the GUI.
DEZ num_of_desired_pos	
Delete	In the Zoom System dialog box, select all zoom positions that you want to delete and click the Delete button. This effectively dezooms the lens system. From the command line, DEZ dezooms lens to position designated by num_of_desired_pos; this position becomes the non-zoom lens and data for all other positions is abandoned. Range: 1 to highest current zoom position. Command example: DEZ 3 – Dezoom the lens, moving position 3 in as the non-zoom lens
POS Zk Zi.j [ONL] Yes No	
Active	Designates active zoom positions for option calculations and output. In the Zoom System dialog box, select the checkbox in the Active field for each active zoom position. By default, all zoom positions are designated as active. From the command line, specify the zoom position or zoom position range, and then Yes or No to make the designated zoom positions active or inactive: Yes – Zoom position is active (on) No – Zoom position is not active (off) Use the ONL keyword to make a single zoom position active -- and all other positions inactive, or to make a single position inactive -- and all other positions active. Command examples: POS Z3 No – Turns off the 3rd zoomposition for all options following, until altered by another POS command POS Z2 ONL Y – Makes zoom position 2 active, while making all other positions inactive POS? – Displays status of current switches

Command Syntax	
Screen Control	Explanation
INS Zk Zi..j	
Insert	Insert a zoom position or a range of zoom positions. Note that the Insert button only adds a single zoom position. In the Zoom System dialog box, select the zoom position row in the Zoom System dialog box immediately below where you want to insert a new zoom position. Click the Insert button. Repeat for each zoom position you want to add. Existing zoom positions following each new position are incremented by one. From the command line, if Zk is specified, the new zoom position is inserted at the position of Zk, and all existing zoom positions with an index of Zk or higher are incremented by one position. If Zi..j is specified, the new zoom positions are inserted starting at the position of Zi, and all existing zoom positions with an index of Zi or higher are incremented in position by the number of new zoom positions. A new zoom position or range of zoom positions can be appended to the existing zoom positions by using a Zk or Zi..j qualifier with indices higher than the highest index of the existing zoom positions. The appended zoom position or range of zoom positions are assigned positions starting with an index which is one higher than the highest index of the existing zoom positions regardless of the index of Zk or Zi..j. If the addition of new zoom positions causes the total number of zoom positions to exceed the number of allowed zoom positions, the insert command will be ignored and an error message will be issued. The values of zoom position parameters for the new zoom position or range of zoom positions are taken from the zoom position immediately preceding the new zoom position or range of zoom positions (Zk-1 or Zi-1, unless k or i is 1, in which case the values are taken from the first existing zoom position).
DEL Zk Zi..j	
Delete	Delete a zoom position or a range of zoom positions. In the Zoom System dialog box, select the zoom position row(s) that you want to delete. Click the Delete button. Existing zoom positions following the deleted position(s) are moved down by the number of positions deleted. From the command line, if Zk is specified, all zoom positions with an index higher than Zk will be moved down by one position. If Zi..j is specified, all zoom positions with an index higher than Zj will be moved down in position by the number of zoom positions deleted. A Za qualifier will delete all existing zoom positions, but a single default zoom position with an index of 1 will remain.

Defining Zoomed Parameters

To zoom a parameter in the GUI, select the parameter and choose the **Edit > Zoom Parameter** menu to display the **Zoom Editor** dialog box. If you're working in a dialog box, and therefore can't access the menu bar, you can zoom a parameter by right-clicking on the parameter and choosing **Zoom** from the shortcut menu.

Command Syntax	
Screen Control	Explanation
ZOO parameter or ZOO parameter values....z	
Edit > Zoom menu	In the GUI, select the parameter you want to zoom and choose the Edit > Zoom Parameter menu. If you're working in a dialog box, and can't access the menu bar, zoom a parameter by right-clicking on the parameter and choosing Zoom from the shortcut menu. Enter the values for each zoom position in the Zoom Editor dialog box. By default, the current (non-zoomed) 1st position value is extended to all defined zoom positions. From the command line, the ZOO prefix converts non-zoomed parameter into zoomed parameter: parameter Command mnemonic for LDM lens data + essential qualifiers (surface number, code, label, etc.) needed for unambiguous identification values Values appropriate for this command (may be numbers, Yes/No, REA/VIR, etc.) If values....z are omitted, the current (non-zoomed) 1st position value is extended to fill all defined positions; if one value is supplied, it fills all positions; if values are numeric, a No will use the 1st position value in that zoom position; otherwise, include all defined positions. Examples: ZOO PIM Zooms, extends implied yes to all positions ZOO PIM n y y n Zooms, puts no in pos. 1 & 4, yes into 2 & 3 ZOO THI S4 Zooms, puts current value into all positions ZOO THI S5 0.1 Zooms, extends 0.1 to all positions If the selected parameter can be variable in Automatic Design, its control code is also zoomed and the values needed to freeze are entered (100). Only valid for a system for which the number of zoom positions has been previously defined. Up to 890 parameters can be zoomed in any system. Two of these are taken up by a parameter that can be variable (the parameter and its control code; zoomed glass takes up four (GLA, GLC, GCH, RMD). Zoomed tolerances are handled differently.

Command Syntax																																															
Screen Control	Explanation																																														
DEZ parameter																																															
Dezoom	Converts zoomed parameter into a non-zoomed parameter, whose value is the 1st position value. In the GUI, right-click over the parameter and choose Dezoom from the shortcut menu. Or, select the parameter and choose the Edit > Dezoom Parameter menu. From the command line, use the DEZ prefix as follows: parameterCommand mnemonic for LDM lens data + essential qualifiers (surface/field number or range, code, label, etc.) needed for unambiguous identification Examples: <table><tr><td>DEZ</td><td>PIM</td><td></td><td></td><td></td><td>Dezooms, using 1st position value</td></tr><tr><td>DEZ</td><td>THI</td><td>S4</td><td></td><td></td><td>Dezooms, using 1st position value</td></tr><tr><td>DEZ</td><td>CIR</td><td>S5</td><td>EDG 'Mir'</td><td></td><td>Dezooms, using 1st position value</td></tr></table> If selected parameter can be variable in Automatic Design, its control code is also dezoomed to its 1st position value.	DEZ	PIM				Dezooms, using 1st position value	DEZ	THI	S4			Dezooms, using 1st position value	DEZ	CIR	S5	EDG 'Mir'		Dezooms, using 1st position value																												
DEZ	PIM				Dezooms, using 1st position value																																										
DEZ	THI	S4			Dezooms, using 1st position value																																										
DEZ	CIR	S5	EDG 'Mir'		Dezooms, using 1st position value																																										
parameter [values....z]																																															
Command line only	Change by entering parameter and at least one value: <table><tr><td>parameter</td><td>Command mnemonic for LDM lens data + essential qualifiers (surface number, code, label, etc.) needed for unambiguous identification</td></tr><tr><td>values</td><td>Values appropriate for this command (may be numbers, Yes/No, REA/VIR, etc.)</td></tr></table> At least one value must be supplied; if one value is supplied, it fills all positions; if values are numeric, a No will suppress change for that zoom position; otherwise, include all defined positions. Examples: <table><tr><td>PIM</td><td></td><td></td><td></td><td></td><td>Extends implied yes to all positions</td></tr><tr><td>PIM</td><td>n</td><td>y</td><td>y</td><td>n</td><td>Puts no in pos. 1 & 4, yes into 2 & 3</td></tr><tr><td>THI</td><td>S5</td><td>.1</td><td></td><td></td><td>Extends 0.1 to all positions</td></tr><tr><td>THI</td><td>S6</td><td>n</td><td>0.2</td><td>0.3</td><td>n</td><td>Leaves unchanged pos. 1 & 4, puts 0.2 and 0.3 into pos. 2 & 3</td></tr><tr><td>THI</td><td>S7</td><td>0.1</td><td>n</td><td>0.3</td><td>n</td><td>Leaves unchanged pos. 2 & 4, puts 0.1 in pos. 1, 0.3 into pos. 3</td></tr><tr><td>CIR</td><td>S5</td><td>EDG 'Mir'</td><td>5.0</td><td>5.0</td><td>4.0</td><td>4.0</td><td>3.0</td><td></td><td>Puts changed values into 1st, 2nd, ...5th pos.</td></tr></table> Only applies to previously zoomed parameters.	parameter	Command mnemonic for LDM lens data + essential qualifiers (surface number, code, label, etc.) needed for unambiguous identification	values	Values appropriate for this command (may be numbers, Yes/No, REA/VIR, etc.)	PIM					Extends implied yes to all positions	PIM	n	y	y	n	Puts no in pos. 1 & 4, yes into 2 & 3	THI	S5	.1			Extends 0.1 to all positions	THI	S6	n	0.2	0.3	n	Leaves unchanged pos. 1 & 4, puts 0.2 and 0.3 into pos. 2 & 3	THI	S7	0.1	n	0.3	n	Leaves unchanged pos. 2 & 4, puts 0.1 in pos. 1, 0.3 into pos. 3	CIR	S5	EDG 'Mir'	5.0	5.0	4.0	4.0	3.0		Puts changed values into 1st, 2nd, ...5th pos.
parameter	Command mnemonic for LDM lens data + essential qualifiers (surface number, code, label, etc.) needed for unambiguous identification																																														
values	Values appropriate for this command (may be numbers, Yes/No, REA/VIR, etc.)																																														
PIM					Extends implied yes to all positions																																										
PIM	n	y	y	n	Puts no in pos. 1 & 4, yes into 2 & 3																																										
THI	S5	.1			Extends 0.1 to all positions																																										
THI	S6	n	0.2	0.3	n	Leaves unchanged pos. 1 & 4, puts 0.2 and 0.3 into pos. 2 & 3																																									
THI	S7	0.1	n	0.3	n	Leaves unchanged pos. 2 & 4, puts 0.1 in pos. 1, 0.3 into pos. 3																																									
CIR	S5	EDG 'Mir'	5.0	5.0	4.0	4.0	3.0		Puts changed values into 1st, 2nd, ...5th pos.																																						
COP Zi Zj																																															
Command line only	Copies the values of the parameters for zoom position Zi to zoom position Zj.																																														

Introduction to Zoom (Multi-configuration) Systems

Multi-configuration systems are more than just “zoom” systems but, for convenience, the CODE V feature that handles them is called the Zoom/Dezoom facility. It can handle such diverse applications as:

- True zooms (changing airspaces only)
- Scanning systems
- Multiple conjugate optimization, such as macro lenses
- Multiple eye positions for display systems
- Flip in/out attachments or alternate attachments
- Multi-channel systems
- Spectrally beam-divided systems
- Depth-of-focus enhancement (dual image plane)

New uses are always being discovered; the zoom facility should be thought of whenever multi-use systems are involved or whenever constructs within CODE V seem to limit your ability to model what you want. For brevity the word “zoom” will be used to describe the changes handled for all such systems.

The zoom facility features are:

- Any lens data parameter (with few exceptions) can be zoomed, up to a total of 890.
- Up to 99 positions (configurations) are allowed
- Simultaneous optimization over all defined positions
- All zoom data saved as part of lens in library
- Ability to deactivate selected zoom positions for option calculations
- Ability to “dezoom” lens to any selected zoom position

The concept of modeling a zoom system is as follows:

1. The starting point is a non-zoomed lens: Set up the lens in the first zoom position either by defining its data or opening it from the lens library.
2. Use the **Zoom System** dialog box (**Lens > Zoom System** menu, or ZOO command) to define the total number of zoom positions. This tells CODE V to handle this lens as a zoom system and to accept zoom inputs.
3. Use the **Zoom Editor** (accessible by right-clicking on a parameter field and choosing **Zoom** from the shortcut menu) to input the values for a parameter for each defined zoom position. From the command line, use the ZOO prefix in front of any lens data input command for which zooming is allowed (shown by the [...z] in the syntax) - converts that item from non-zoom to zoom and supplies the values of the parameter for the added positions. Complete for all zoomed parameters - ones that change values from position to position (all non-zoomed parameters use the same, unchanging value in all positions).
4. Display zoom data in the **Zoom Data** window (**Review > Zoom Data** menu, or ZLI command) or in the **List Zoomed Parameters** text output window (**Display > List Lens Data > Zoom Data** menu, or LIS command), for confirmation; you can also display first-order system parameters in all zoom positions side-by-side by choosing **Display > List Lens Data > First Order Data** (FIR command).
5. If any position is to be temporarily deactivated for the next option(s), use the **Zoom System** dialog box (POS command in the LDM) to turn off the positions to be skipped. Lens data for deactivated positions remains available for later use. Option data for deactivated positions will be ignored. Note that any

calculations that are critical to establishing parameters affecting all positions (e.g., default apertures) are run, regardless, in all positions; only the output and the required calculations for it are deactivated.

6. In options, zoomable commands (denoted byz in command descriptions) can be used to alter calculations for each position; single value (non-zoomed) commands are applied with the one value in all active positions.
7. To change one lens data item that was previously zoomed, access the **Zoom Editor** to change any value in any zoom position. From the command line, just enter the command with values for each position - no ZOO prefix is needed; a No in any position leaves that position unchanged.
8. To dezoom one lens data item that was previously zoomed, delete zoom position values in the **Zoom Editor** for that lens data item. From the command line, precede the command with the prefix DEZ - the first position value is retained for use in all positions.
9. To reduce the number of zoom positions, delete selected zoom positions in the **Zoom System** dialog box. From the command line, reduce the number of zoom positions to n with the ZOO n command. Data for the deleted positions is thrown away. Adding zoom positions will generate the new positions with data the same as the highest position previously defined.
10. To convert the zoom lens to a non-zoom lens for a given position, delete all other zoom positions in the **Zoom System** dialog box. From the command line, use the DEZ command with the one selected position; this is most often desirable for using an option, like Element Drawing (ELE), that functions only in the first position. Zoomed lens data is thrown away for the other positions (save the lens first to retain); change zoomed option data so the first position corresponds to the single retained position.

Restrictions on Solves in Zoom Systems

A number of solves cannot be used when the thickness or curvature is zoomed, nor can they be used with a Reduction Ratio solve. See “Solves in Zoom Systems” on page 4-50 for more details.

Syntax Rules for Zooming Systems

In CODE V documentation, such as the *CODE V Reference Manual*, the *CODE V Prompting Guide*, and online help, any lens database parameters which can be zoomed across zoom positions are indicated as such in their descriptions. Also, in the various options, any option commands which can accept zoomed inputs are also indicated as such in their command descriptions.

Zooming LDM Parameters

[...z]	is NOT typed; it is shown in the LDM to mean that the parameter is zoomable; only after it has been zoomed by use of the ZOO command can changes be made in the zoomed formats implied by ...z
...w[,z]	is NOT typed; it is shown in the LDM to mean that the parameter is zoomable;
...f[,z]	only after it has been zoomed by use of the ZOO command can changes be made in the zoomed formats implied by ...w,z or ...f,z
[Zk], [Zk Zi..j]	shows that command is applied only to those zoom positions included; if omitted it applies to all positions
Selective changes after zooming	After a parameter has been zoomed with, for example, <pre>ZOO CUY S3 value1 value2 value3</pre> it may be changed at any time with <pre>CUY S3 new_value1 new_value2 new_value3</pre> Using No for any of these values will leave it unchanged: <pre>CUY S3 N new_value2 new_value3</pre> would leave the first position value unchanged. A range or single position values(s) may be changed by using Zk Zi..j: <pre>CUY S3 Z2 new_value2 or CUY S3 Z1..2 common_value</pre> Note: To avoid undue complexity, the use of No is not shown in the LDM command statements.

Zooming Option Parameters

....z is NOT typed;z means that multiple entries may be made up to the total number of
f zoom positions allowed or active. This also means that a specific zoom position or range
w of positions can be used by including the qualifier Zk|Zi..j prior to the value. Similarly
 for wavelength (....w) and field (....f).

THUS: IFR incr_lines_per_mm....z means you can enter all zoom position values in one
 record, if they are the same, with

IFR 10

or IFR 10 10 10 10 10 10 (for 6 positions)

If the values are different, use, for example:

IFR 10 10 20 20 20 20 (for 6 positions)

But, you also can modify the 3rd zoom position with

IFR Z3 30

or the 4th through the 6th can be modified with

IFR Z4..6 50

....f,z is NOT typed; it shows that a 2-dimensional table is enterable. Using WTF
 (....f,z) as an example, acceptable formats are:

If the system is not zoomed:

WTF Fk field_weight – fills Fk

WTF field_weight....f – fills each field

If the system is zoomed:

WTF Fk Zk field-zoom_weight – fills Fk,Zk field

WTF Fk field-zoom_weight – fills Fk, all pos the same

WTF Fk field-zoom_weight....z – fills Fk in each pos

WTF Zk field-zoom_weight....f – fills each field of Zk

Similarly forw,z. Use of ranges (Zi..j,Fi..j,Wi..j) allows the filling of any submatrix
 of the 2-D table with a single value. Example:

WTF Z3..5 F2..3 1.0 - would fill 1.0 into fields 2, 3 of zoom positions 3, 4, 5.

Zk, Zk|Zi..j is the only way to assign values for commands that require 2 or more entries per zoom
 position. If Zk or Zi..j is omitted, the values are the same in all positions; exception:
 AUT specific constraints default to Z1.

Entering Zoomed Data in the GUI

To enter zoomed data, you must first zoom the lens, and then specify the values for parameters that change across zoom positions.

Specifying a Zoomed Lens

To specify the lens as a zoomed lens, choose the **Lens > Zoom Lens** menu to display the **Zoom System** window.

- Enter the number of zoom positions in the **Number of Zoom Positions** field.
- The **Description** field lets you enter a text description for each zoom position.
- To add a zoom position, click the **Insert** button, increase the number in the **Number of Zoom Positions** field, or right-click over a zoom position and select **Insert** from the shortcut menu.
- To delete a zoom position, click the **Delete** button, decrease the number in the **Number of Zoom Positions** field, or right-click over the zoom position you want to delete and select **Delete** from the shortcut menu.
- To make your changes to the lens system, click the **Commit Changes** button.
- Click the Close button  in the titlebar to close the **Zoom System** window.



Tip: The **Insert** button in the **Zoom System** dialog box only inserts a single zoom position. To enter multiple zoom positions at one time, enter the total number of desired zoom positions in the **Number of Zoom Positions** field, and press the Enter key.



Note: If you try to zoom a parameter without first zooming the system, the **Zoom System** window automatically displays. You must first zoom the lens before you can zoom a parameter.

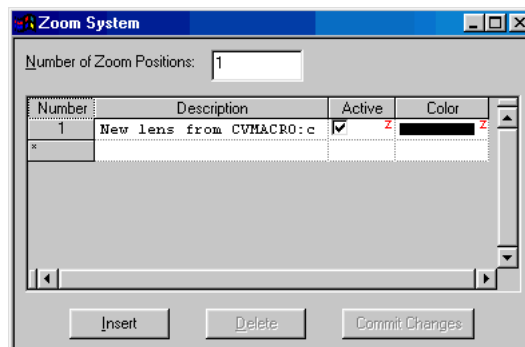


Figure 1. Zoom System dialog box

Zooming Lens Parameters

To zoom a lens parameter, just right-click over the parameter in any window or dialog box. This displays a shortcut menu. Select **Zoom** from the shortcut menu to access the **Zoom Editor** dialog box. (You can also select a parameter in a window and choose the **Edit > Zoom** menu; however, using the shortcut menu works in any window and dialog box.) In the **Zoom Editor**, you can enter the value for each zoom position. The **Zoom Editor** contains two columns:

- The left column, labeled **Zoom**, displays each zoom position number and its description (if defined).
- The right column label reflects the type of parameter that is being zoomed. For example, if you're zooming a surface thickness, then the column label is **Thickness**. Enter the parameter value for each zoom position. By default, the value is the same in each zoom position.
- Click the **Replicate Z1 Value** button to copy the lens parameter value from zoom position 1 to the currently selected zoom position.

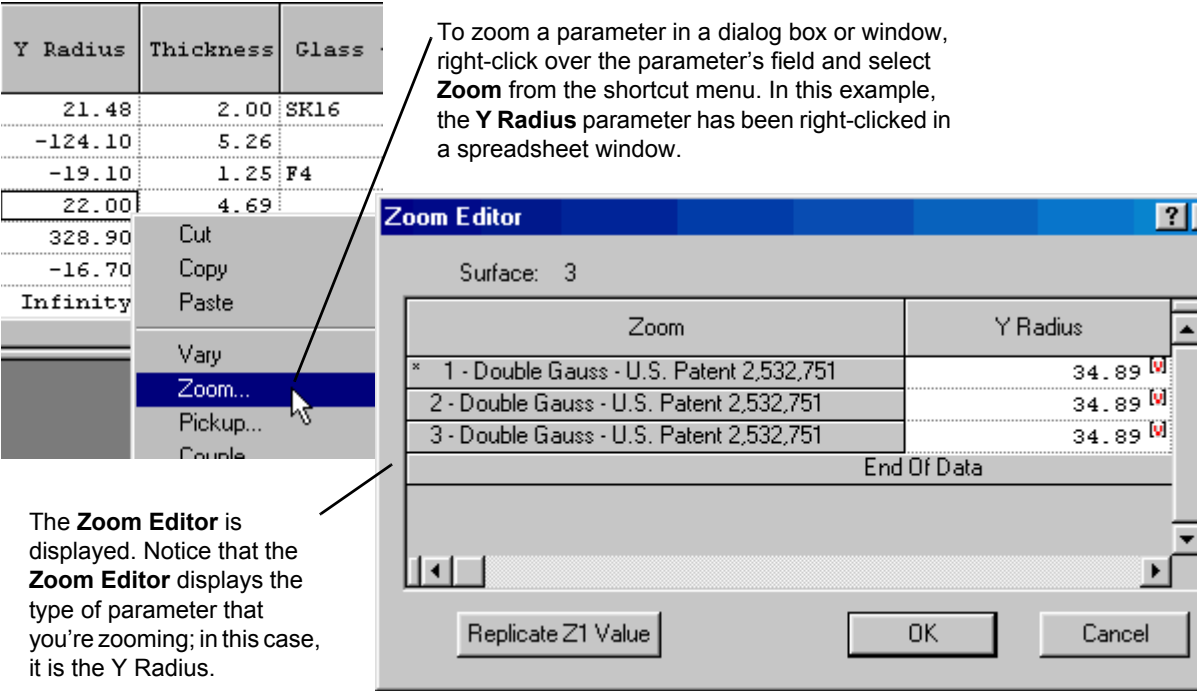


Figure 2. Zooming a parameter in the GUI

Click **OK** when you're done. If you look at the parameter value in the window or dialog box where you started, there is a "z" status indicator displayed next to the value; this lets you know that the parameter is zoomed. Note that you can left-click on the z status indicator to display the **Zoom Editor**.

For example, a spreadsheet field would look like this: 2.50 z

Reviewing and Modifying Zoomed Data

By default, the **Lens Data Manager** window displays data for zoom position 1. You can display the data for other zoom positions using the zoom position toolbar.



Figure 3. Zoom position toolbar

Select the zoom position in the zoom position toolbar by clicking the down arrow and selecting the zoom position from the list. Both the zoom position number and description (if defined) are displayed in this list. The **Lens Data Manager** window will update to display the data for the zoom position selected. The zoom position toolbar always indicates the zoom position for which data is currently displayed. This provides a convenient way to modify lens data for a particular zoom position. The zoom position toolbar also provides quick access to the Zoom System dialog box; just click the **Z** button in the toolbar.

If you want to review or modify zoomed data for all zoom positions, choose the **Review > Zoom Data** menu to display the **Zoom Data** window, where you can change any zoomed data, add or delete a zoom position, or delete zoomed parameters:

- To dezoom a parameter, select the row containing the parameter, right-click, and choose **Dezoom** from the shortcut menu.
- To add or delete a zoom position, click a zoom position column heading, right-click, and choose either **Insert Zoom Position** or **Delete Zoom Position** from the shortcut menu. To delete all zoom positions, select the column of the zoom position you want to dezoom to, right-click, and choose **Dezoom to this Position** from the shortcut menu.
- To limit the display to show only zoomed specification data or zoomed surface data, select the **Show Specification Data** checkbox or the **Show Surface Data** checkbox. By default, both of these checkboxes are selected.

	Surface #	Parameter	Label	Type	Wavelength	Field	Coefficient	Zoom -
1	25	Paraxial I					-1	Yes
2	25	Thickness					-1	15.359
3	6	Thickness					-1	2.500
4	11	Thickness					-1	30.971
5	13	Thickness					-1	1.724
6	Image	Thickness					-1	-0.032

Figure 4. Zoom Data review spreadsheet

You can also use the **Zoom Data** window to change the variable/frozen status of a zoomed parameter for optimization. Right-click over a parameter which can be varied or frozen, and choose **Vary** or **Freeze** from the shortcut menu. Notice that the status indicator changes, depending on the parameter's status: if the parameter is frozen, then no status indicator is displayed; if the parameter is varied for optimization, a "v" status indicator is displayed.

Dezooming the Lens or Lens Parameters

You can dezoom a zoomed lens to a single configuration based on any of the defined zoom positions. Choose the **Lens > Zoom Lens** menu to display the **Zoom System** window.

- To dezoom to the first zoom position, enter **1** in the **Number of Zoom Positions** field. All zoom positions except for the first will be deleted.
- To dezoom to any zoom position, select all zoom positions that you want to delete, and click the **Delete** button (you can also right-click over the selected zoom positions and choose **Delete** from the shortcut menu). You can select a range of adjacent or nonadjacent zoom positions. To select adjacent zoom positions, click and drag across each zoom position. To select non-adjacent zoom positions, hold down the CTRL key and click on each zoom position you want to delete.

Click **Commit Changes** when you're done.

You can also dezoom an individual parameter. There are a couple of ways to do this:

- Right-click over a field containing the zoomed parameter, and choose **Dezoom** from the shortcut menu.
- Choose the **Review > Zoom Data** menu to display the **Zoom Data** window. Select the row containing the zoomed parameter, right-click to display the shortcut menu, and choose **Dezoom** from the shortcut menu.

Designating Active Zoom Positions

When a lens is zoomed, you can designate selected zoom positions as active or inactive. This means that when an option is entered, that option is not performed on the zoom positions which are inactive (except for Automatic Design). To specify the active and inactive positions, choose the **Lens > Zoom Lens** menu to display the **Zoom System** dialog box. In the **Active** field, select or deselect the checkbox for each zoom position. By default, all zoom positions are active. **At least one zoom position must be active.**

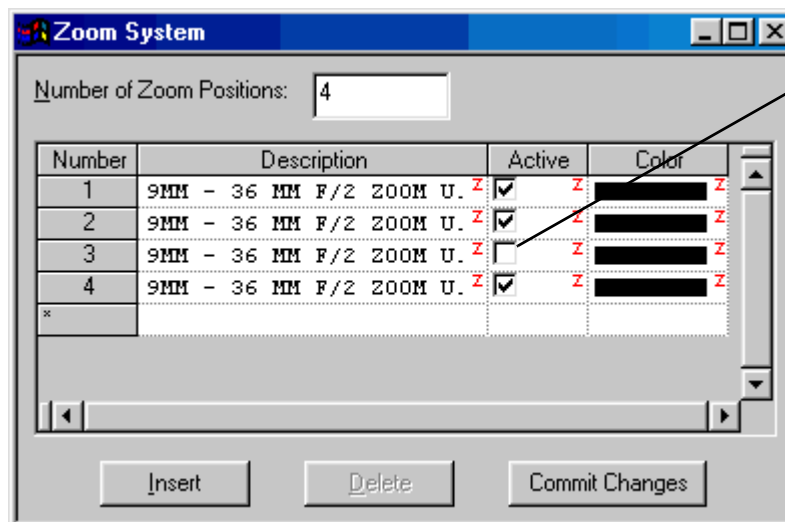


Figure 5. Specifying active zoom positions

In the **Zoom Data** window (**Review > Zoom Data** menu), inactive zoom positions are highlighted; however, you can modify values for inactive positions.

Options and Zoomed Systems

When you have a zoomed system and enter an option, then any parameter for that option that can accept different values for different zoom positions is marked with a **z** status indicator. An example is shown in Figure 6, which is the first tab in the **Ray Aberration Curves (RIM)** option dialog box (**Analysis > Diagnostics** menu) for a lens with three zoom positions.

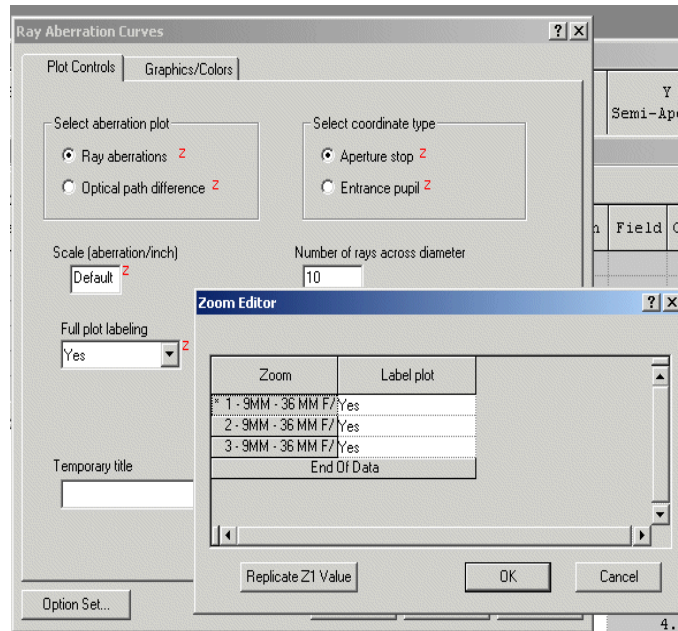


Figure 6. Typical option screen for a zoomed lens

As shown in Figure 6, each parameter displayed with the red **z** indicator next to it can be zoomed. To enter different values in each zoom position for a parameter, double-click over the parameter. The **Zoom Editor** displays, and there you can enter the data in each zoom position.

Entering Zoomed Data from the Command Line

The process of entering zoomed data from the command line is similar to working in the GUI: you must first zoom the lens, and then specify the values for parameters that change across zoom positions.

Setting Up a Zoomed Lens from the Command Line

To set up a zoomed system, first the system must be defined to have more than one zoom position; this is done with the **ZOO** command. For example,

```
CODE V> ZOO 3                ! Specifies the lens to be a zoom lens with three zoom
                             ! positions
```

Then each parameter which changes values across zoom positions is zoomed and its values entered; this is also done with the **ZOO** command. If the values are not entered, the original unzoomed value is used for all zoom positions. For example,

```
CODE V> ZOO THI S3 1 2 3    ! Zooms the thickness of surface 3 and enters the values
                             ! for each position
CODE V> ZOO THI S4          ! Zooms the thickness of surface 4 and uses the same
                             ! value for all zoom positions
```

Modifying Zoomed Data from the Command Line

Changing zoomed data uses the same command as used for changing unzoomed parameters, but with data for each zoom position. If only one value is given, it is used for all zoom positions. For example,

```
CODE V> ZOO THI S6          ! Zooms the thickness for surface 6
CODE V> THI S6 2 4 6        ! Changes the values of surface 6 for each zoom position
CODE V> THI S6 3.5          ! Uses the value 3.5 for all zoom positions
```

An N can be given to not change the value in a given zoom position, and zoom qualifiers can be used to limit the range of zoom positions affected. For example,

```
CODE V> THI S6 2.5 N 4.5    ! Only change the values for zoom positions 1 and 3
CODE V> THI S6 Z3 5.1       ! Only change the value for zoom position 3
CODE V> THI S6 Z1..2 1.5    ! Change the values for zoom positions 1 and 2
```

When zooming a parameter which can be a variable in optimization, the parameter's status of frozen or variable is also zoomed. To change the status for any zoom position, use its appropriate variable code with 0 (variable) or 100 (frozen). For example,

```
CODE V> THC S8 0            ! Make thickness 8 a variable
CODE V> ZOO THI S8          ! Zoom the thickness for surface 8 (it is now variable
                           !   in all zoom positions)
CODE V> THC S8 0 100 0      ! It is now frozen in zoom position 2
```

Reviewing Zoomed Data from the Command Line

The zoomed data can be reviewed with the ZLI (zoom list) command. The command can accept surface qualifiers to limit its output. A parameter can be given to only list a certain type of zoomed parameter. To see only zoomed specification data, use ZLI SPC. For example,

```
CODE V> ZLI                  ! List all zoomed data for the current surface
CODE V> ZLI SA               ! List all zoomed data for all surfaces and all zoomed
                           !   specification data
CODE V> ZLI S1..3            ! list only zoomed data for surfaces 1 to 3 and all
                           !   zoomed specification data
CODE V> ZLI THI SA           ! List zoomed thicknesses for all surfaces
CODE V> ZLI SPC              ! List all zoomed specification data
```

Dezooming the Lens or Lens Parameters from the Command Line

A lens which has more than one zoom position can be dezoomed to a single configuration, selected from any of the zoom positions. This is done with the DEZ command. For example,

```
CODE V> DEZ 3                ! Dezoom the lens, using the data for zoom position 3
```

A zoomed parameter can also be dezoomed, or removed from the zoomed parameter list. This is also done with the DEZ command followed by the parameter to dezoom. For example,

```
CODE V> DEZ THI S3           ! Make thickness of surface 3 a non-zoomed parameter
```

Designating Active Zoom Positions from the Command Line

When a lens is zoomed, selected zoom positions can be “turned off.” This means that when an option is entered, that option is not performed on the zoom positions which are off (except for AUTO). This is done with the POS command; Yes means a position is turned on (default) and No means it is turned off. Note that at least one zoom position must be turned on. For example,

CODE V> ZOO 5	! Define a 5-position zoom lens, with all zoom positions
	! turned on.
CODE V> POS Z3 N	! Turn off zoom position 3
CODE V> POS ZA N	! Not allowed (error generated)
CODE V> POS ZL N	! Turn off the last zoom position
CODE V> POS Z1..L-1 Y	! Turn on all zoom positions except the last one

Options and Zoomed Systems: Command Line Considerations

When you have a zoomed system and enter some option, then any parameter for that option which can accept different values for different zoom positions has separate entries for each zoom position. If only one value is entered, it is used for all zoom positions. Zoom qualifiers can be used to limit the extent of the values. For example (for a three zoom position lens),

CODE V> MTF	! Enter the MTF option
MTF> MFR 100	! Use 100 for the MFR for all zoom positions
MTF> IFR 5 10 5	! Use different values for each zoom position
MTF> PLO FRE Z2..3	! Plot the MTF data for zoom positions 2 and 3
	! (the Yes is assumed)
MTF> GO	! Execute the MTF option and return to the LDM

Zoom System Examples

The following are examples of using the zoom feature in CODE V to model different types of systems. These examples present how data is entered in the GUI, and the command line equivalents are summarized at the end of each example.

Example 1 - Classic zoom lens

This lens will be zoomed to define a 3.8x zoom lens. The basic lens, shown in Figure 7, has what is called two moving groups. The first three lenses, surfaces 1 to 6, are fixed. The next three lenses, surfaces 7 to 11, move as a group. The next lens, surfaces 12 to 13, also moves. The rest of the lenses are fixed in position; notice that in this lens, the stop is inside the rear fixed group. To accomplish this, we need to zoom the thicknesses of surfaces 6, 11, and 13 (shown in Figure 7).

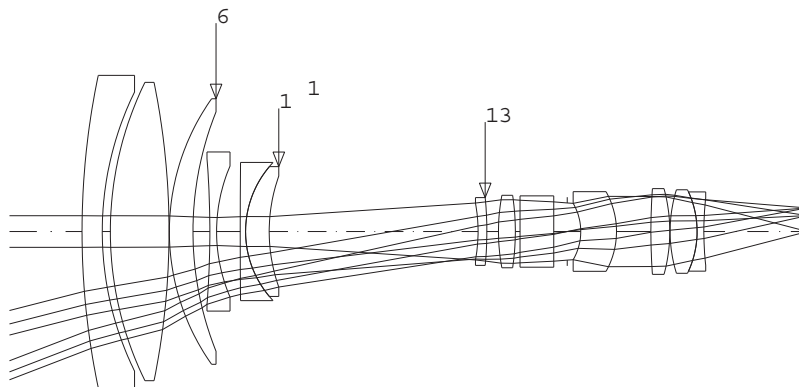


Figure 7. Example of a lens to be specified as a classical zoom lens

When we enter this zoomed data, the focal length in each zoom position will be different, and in general, the back focal length will also be different. (In this lens, we want the back focal lengths to be the same, but this will be controlled by constraints in optimization.) Thus, we should also zoom the paraxial image solve, and zoom the defocusing term.

Since the focal length is changing, the fields of view are also different in each zoom position, as is the entrance pupil diameter. In general, we may also need to zoom these parameters also. However, in this lens we will specify the fields by image height, which automatically computes the field angles, and specify the pupil by its f/number, which automatically computes the entrance pupil diameters.

Constructing the Zoom Data

Only some of the specification data and lens data are described; the entry of the surface data is not described (note that this example is the MOVIE lens supplied with CODE V).

To	Menu/Dialog Box Access	Screen Control Entries
Specify the pupil by its f/number	Lens > System Data---Pupil	• Pupil Specification: Image F/Number • Value: 2.0
Specify fields by image height	Lens > System Data---Fields/Vignetting	• Field Type: Paraxial Image Height • Enter the following Y Values: 0.0, 2.4, 3.6
Zoom thicknesses at surface 6	Lens Data Manager Window	• Select thickness value for surface 6. • Right-click and select Zoom (displays Zoom Editor). • Enter values for each zoom position: 2.500, 21.650, 31.500
Zoom thicknesses at surface 11	Lens Data Manager Window	• Select thickness value for surface 11. • Right-click and select Zoom (displays Zoom Editor). • Enter values for each zoom position: 30.971, 8.223, 1.910
Zoom thicknesses at surface 13	Lens Data Manager Window	• Select thickness value for surface 13. • Right-click and select Zoom (displays Zoom Editor). • Enter values for each zoom position: 1.724, 5.322, 1.785
Zoom paraxial image solve.	Lens > System Data--System Solves	• Select Paraxial Image Solve checkbox. • Right-click and select Zoom.
Zoom defocusing term.	Lens Data Manager Window	• Select thickness for surface 26. • Right-click and select Zoom (displays Zoom Editor). • Enter the following values: -0.032, 0.026, -0.019

Command Syntax: Classic Zoom Lens

```

FNO 2.0
YIM 0.0 2.4 3.6
ZOO THI S6 2.500 21.650 31.500
ZOO THI S11 30.971 8.223 1.910
ZOO THI S13 1.724 5.322 1.785
ZOO PIM
ZOO THI S26 -0.032 0.026 -0.019

```

Example 2 - Laser scanner

In a typical laser scanner, the input laser beam is fixed, and some moving element, such as a mirror mounted on a galvanometer or a rotating polygon mirror, is moved to cause the scanning action. The lenses after the scanner are usually fixed in position. The only parameter that needs to be zoomed is the tilt angle of the scanning element. Figure 8 shows the basic layout of the system, and Figure 11 shows the detail of the scan mirror.

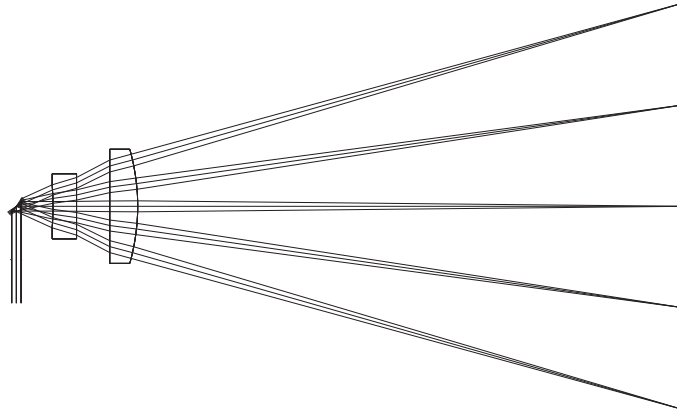


Figure 8. Example of a laser scanner

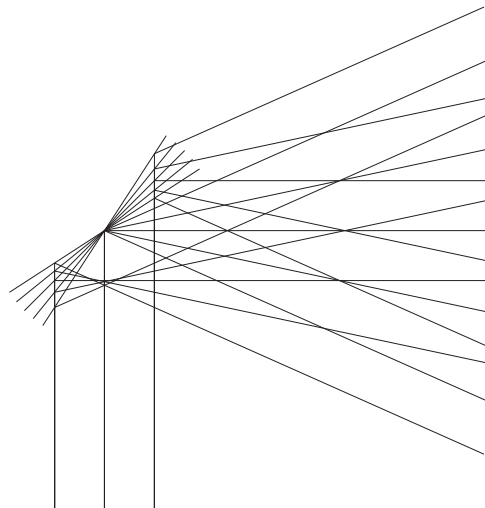


Figure 9. Closeup of the scan mirror in a laser scanner

Figure 9 shows that the scanner is modeled as a mirror with different tilt angles. For a total scan of $\pm 24^\circ$, this needs a maximum scan of $\pm 12^\circ$.

Constructing the Zoom Data

To construct the zoom data for the laser scanner example:

- Set up 5 zoom positions for the lens system in the **Zoom System** dialog box (**Lens > Zoom Lens** menu).
- Zoom the Alpha-Tilt for surface 3. Choose the **Lens > Surface Properties** menu to display the **Surface Properties** window. Select **3** in the **Surface** field, and click the **Decenters** tab. Right-click over the **Alpha-Tilt** field, and choose **Zoom** from the shortcut menu. Enter the following values for the 5 zoom positions in the **Zoom Editor** dialog box: **33, 39, 45, 51, and 57**, as shown in Figure 10.

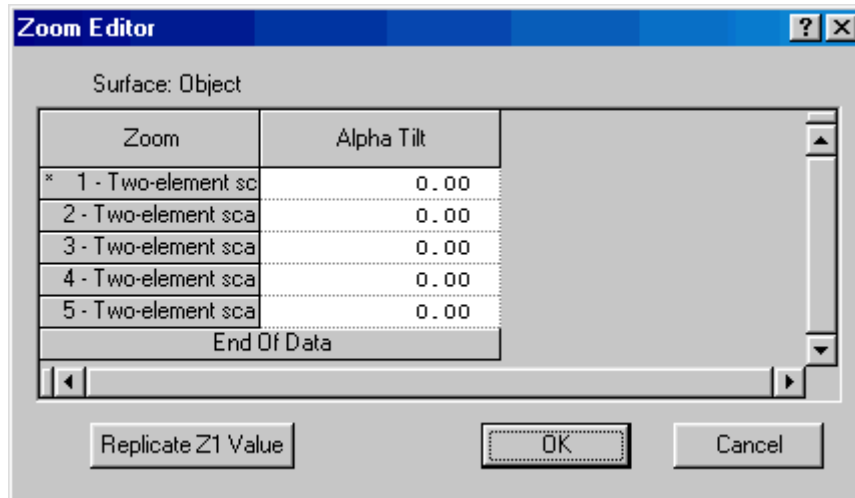


Figure 10. Laser scanner example: Specifying zoomed Alpha-Tilt values

Command Syntax: Laser Scanner

```
ZOO 5
ZOO ADE S3 33 39 45 51 57
```

Example 3 - Spectrometer

In this example, the spectrometer is to cover the visible spectrum, using the wavelengths 650, 600, 550, 500, and 450. The zoom feature is used to make each zoom position effectively only look at one of the wavelengths (if we looked at them all in one zoom position, CODE V would interpret the wavelength shifts as lateral color). The technique involves zooming the reference wavelength and the wavelength weights.

Constructing the Zoom Data

To construct the zoom data for the spectrometer example:

- Choose the **Lens > Zoom Lens** menu, and define 5 zoom positions in the **Zoom System** dialog box.
- Open the **System Data** window (**Lens** menu), and go to the **Wavelengths** page.
- Define five wavelengths in the following order: **650, 600, 550, 500, and 450**.
- Zoom the reference wavelength: Right-click on the **Reference Wavelength** field, and choose **Zoom** from the shortcut menu.
- Enter the following reference wavelength values for zoom positions 1-5 in the **Zoom Editor**: 1, 2, 3, 4, 5.
- In the **System Data** window, on the **Wavelengths** page, zoom the wavelength weights for each wavelength value:
 - For the first wavelength weight, enter these values for zoom positions 1-5: 1, 0, 0, 0, 0
 - For the second wavelength weight, enter these values for zoom positions 1-5: 0, 1, 0, 0, 0
 - For the third wavelength weight, enter these values for zoom positions 1-5: 0, 0, 1, 0, 0
 - For the fourth wavelength weight, enter these values for zoom positions 1-5: 0, 0, 0, 1, 0
 - For the fifth wavelength weight, enter these values for zoom positions 1-5: 0, 0, 0, 0, 1

Command Syntax: Spectrometer

```
WL 650 600 550 500 450
ZOO 5
ZOO REF 1 2 3 4 5
ZOO WTW W1 1 0 0 0 0
ZOO WTW W2 0 1 0 0 0
ZOO WTW W3 0 0 1 0 0
ZOO WTW W4 0 0 0 1 0
ZOO WTW W5 0 0 0 0 1
```

