## AOM ZBR Command Line User Manual v1.0



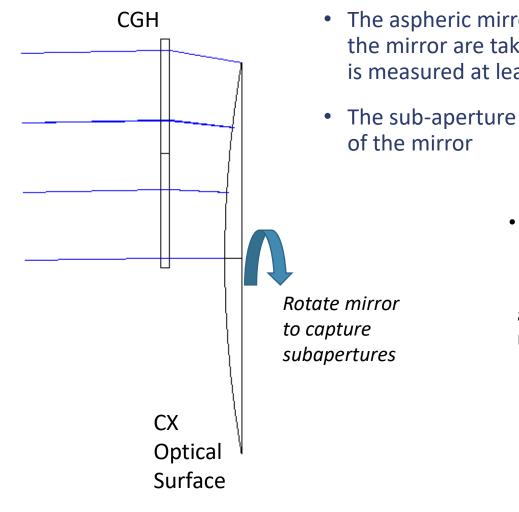
### **AOM Stitching Software ZBR**

- ZBR stitches sub-aperture measurements enabling full surface map measurement of large optics
  - Stitching is necessary for large flats (larger than the available TF), large convex spheres and aspheres (larger than the beam size of a TS), long cylinders, etc.
  - ZBR takes sub-aperture measurement inputs in a variety of data formats, such as Zygo's datx and xyz, 4D's H5, ESDI's hdf, etc
  - To facilitate sub-aperture measurements that covers the entire surface, precision mechanics that allows rotation and/or translation of the surface is required
  - ZBR is available with a self-calibrating option, which removes systematic contributions of each subapertures, reducing error in the final stitched map

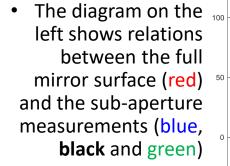
ile Edit Windows Help Number of data files:							ZDI
Number of data files. 9							ZBF
	Data file	name	CX_SA	cy_SA	CX_FA	cy_FA	SA_angle
1 G1_9.datx			320	240	-235	-235.3000	
2 G1_8.datx			320	240	235.6000	-235.3000	(
3 G1_7.datx 4 G1_6.datx			320	240	-235	235.3000	c
5 G1_5.datx			320	240	235.6000	235.3000	a
6 G1_4.datx			320	240	0.3000	294,1000	q
7 G1_3.datx			320	240	0.3000	-294,1000	a
8 G1_2 datx			320	240	294.4000	0	a a
9 G1_1.datx			320	240	-293.8000	0	d
			320	240	0.3000	0	d
							7
٢							
Surface Type:							
Flat		Subtract a saved reference map?					>
O Cylinder Power axis angle in	90						
O Sphere	90	Reference Calibration					
		Calibrate the reference map before st Zernike Curvature Terms representing the Calibrate the mid-high frequency refer	itching?				
		Calibrate the mid-high frequency refer	e reference(e.g. "4	.5,10:37"): 7:3	7		
		Calibrate the mid-high frequency refer	ence map before i	stitching?			
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AOM ZBRSttchinglCTWT zbr							

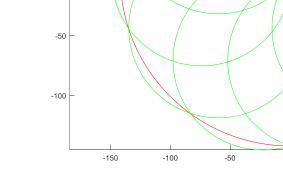


### Sub-aperture measurements of a large convex optic with a CGH



- A CGH is designed to test an off-axis portion of a large convex aspheric mirror
- The aspheric mirror can be rotated about its axis. Sub-aperture measurements of the mirror are taken at different clocking angles. Make sure every part of the mirror is measured at least once.
- The sub-aperture measurements are stitched with ZBR to get the full surface map of the mirror





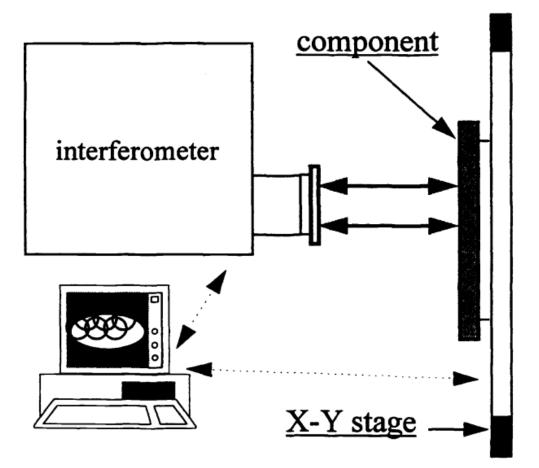
Sub-aperture distribution

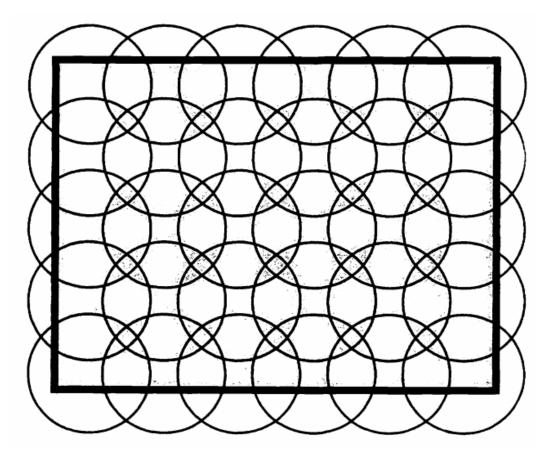
0

150

100

### **Example setup for large flat measurements**





Sub-aperture distribution over the full surface



### **Software Requirements**

The distortion correction tool requires Matlab 9.10 (R2021a) Runtime. This is a free runtime tool which can be downloaded from the MathWorks website here:

https://www.mathworks.com/products/compiler/mcr/ index.html

+ → C	https://www.mathworks.com/proc	lucts/compiler/matlab-runtime.html				0
🕽 Import favorites 🛛 🦚	Intranull - Home 🏼 🛞 JOB Board 💠 EN	IGR Board   MFG Board 💠 Enginee	ring Status [ } cloud storage - Can 🤹	🗞 Quick Start – React 🛛 🛐 isolved People C	loud	Q
	MATLAB Compiler		s. S	Search MathWorks.com	Q	0
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	3. Double click the installer and fo	llow the instructions in the installati	on wizard.			
	See the MATLAB Runtime Installer	documentation for more informatio	n.		1	+
	Release (MATLAB Runtime Version#)	Windows	Linux	Мас		
	R2023b (23.2)	64-bit	64-bit	Intel 64-bit / arm64		
	R2023a (9.14)	64-bit	64-bit	Intel 64-bit		
	R2022b (9.13)	64-bit	64-bit	Intel 64-bit		J
	R2022a (9.12)	64-bit	64-bit	Intel 64-bit		
	R2021b (9.11)	64-bit	64-bit	Intel 64-bit		
	R2021a (9.10)	64-bit	64-bit	Intel 64-bit		
	R2020b (9.9)	64-bit	64-bit	Intel 64-bit		
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	R2017b (9.3)	64-bit	64-bit	Intel 64-bit		÷

Select the correct installer for your computer



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#### Software Inputs and Outputs

#### <u>Inputs</u>

- 1. Measurement of your subapertures, in .xyz OR .datx format
- 2. ZBR (.zbr) file detailing your subapeture details
- 3. ZBR config file (.txt) detailing the stitching configuration data

#### **Outputs**

- 1. Undistorted measurement of your part, in .xyz or .datx format
- 2. Figures of the stitching performance, in .pdf format



Stage 1

## **Data Preparation**



- 1. Create your ZBR file
- 2. Create your ZBR Configuration file

A ZBR file defines the subapertures, surface, and more stitching details required by ZBR.

The full file format is a UTF-8 formatted text file saved with a .zbr extension. See the full file description to the right for how to write your own.

Line #	File Content		Remark
1	Filename.zbr		ZBR file name
2	C:\Path\To\Measurements		Path to your subaperture measurements
3	Cylinder		Type of surface. Enum of Cylinder   Flat   Sphere
4		90	If cylinder type, cylinder's power axis angle with respect to the +x axis of the stitched map
5	2		Number of sub-aperture data maps
6	Test_x1_y1xyz		No. 1 subaperture data file name
7		0	No. 1 SA map's reference pixel x coordinate (0 means the CENTER pixel's x coordinate). The lower left pixel is (1,1).
8		0	No. 1 SA map's reference pixel y coordinate (0 means the CENTER pixel's y coordinate). The lower left pixel is (1,1).
9		464.1	X coordinate of No. 1 SA map's reference pixel in the stitched map coordinate (round to integer in calculation)
10		926.9	Y coordinate of No. 1 SA map's reference pixel in the stitched map coordinate (round to integer in calculation)
11		0	Clocking angle of the SA map wrt to the +x of the stitched map in degrees (+ means clockwise)
12	Test_x1_y1xyz		No. 1 subaperture data file name
13		0	No. 1 SA map's reference pixel x coordinate (0 means the CENTER pixel's x coordinate). The lower left pixel is (1,1).
14		0	No. 1 SA map's reference pixel y coordinate (0 means the CENTER pixel's y coordinate). The lower left pixel is (1,1).
15		464.1	X coordinate of No. 1 SA map's reference pixel in the stitched map coordinate (round to integer in calculation)
16		926.9	Y coordinate of No. 1 SA map's reference pixel in the stitched map coordinate (round to integer in calculation)
17		0	Clocking angle of the SA map wrt to the +x of the stitched map in degrees (+ means clockwise)
18	Test_ref.hdf		Reference data file name (optional)



#### 1. Create your ZBR file

2. Create your ZBR Configuration file

A ZBR file defines the subapertures, surface, and more stitching details required by ZBR.

An example for a flat surface called CTMT.zbr is provided to you for your reference.

File Edit Format View Help						
CTMT.zbr						^
C:\GIT\zbr\						
Flat						
9						
G1_9.datx						
320.000000						
240.000000						
-235.000000						
-235.300000						
0.000000						
G1_8.datx						
320.00000						
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235.600000						
-235.300000						
0.000000						
G1_7.datx						
320.000000						
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-235.000000						
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0.00000						
G1_6.datx						
320.000000						- 1
240.000000						
235.600000						
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0.00000						
G1_5.datx						
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G1_4.datx						
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- 1. Create your ZBR file
- 2. Create your ZBR Configuration file

A ZBR configuration file defines the location to save your stitched data and the self-calibration terms to use.

The full file format is a UTF-8 formatted text file saved with a .txt extension. See the full file description to the right for how to write your own.

Line #	File Content	Remark
1	C:\Path\To\Save\To.datx	Save file path for where to save your stitched map to. Must have matching extension to input data (.xyz or .datx depending on your input subaperture maps)
2	5,7:21	Zernike terms to use in self-calibration. Can format as comma separated or with a colon to be inclusive of numbers. NOTE: NEVER include terms 1,2,3,4 for fitting! These are degenerate modes and cannot be fit. If fewer than 2 rotations are available in the subaperture measurements, you cannot fit astigmatism (Zernike terms 5 and 6).



- 1. Create your ZBR file
- 2. Create your ZBR Configuration file

A ZBR configuration file defines the location to save your stitched data and the self-calibration terms to use.

An example for a surface, which fits Zernike terms 5:11 for selfcalibration, called CTMT\_config.txt is provided to you for your reference. CTMT\_config - Notepad - C X
File Edit Format View Help
C:\GIT\zbr\stitched\_twe\_map.datx
5:11

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Stage 2

# Running ZBR from Command Line



#### 1. Starting ZBR

- 1. Open command prompt (or create bash file)
- 2. Run ZBR command with ZBR and config file args passed in.
- 2. Viewing status and log file
- 3. Viewing results
- 4. Running in GUI mode

Command Prompt	_	×
Microsoft Windows [Version 10.0.19045.3930] (c) Microsoft Corporation. All rights reserved.		^
C:\Users\LoganGraves>		
		~



#### 1. Starting ZBR

1. Open command prompt (or create bash file)

e

- 2. Run ZBR command with ZBR and config file args passed in.
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ZBR command input:

ZBR.exe -zbr\_file "full\_zbt\_ file\_name.zbr" - config\_file "full\_config\_file\_name.txt"

Command Prompt	—		$\times$
licrosoft Windows [Version 10.0.19045.3930] c) Microsoft Corporation. All rights reserved.			^
C:\Users\LoganGraves>C:\Users\LoganGraves\Desktop\zbr\ZBR.exe -zbr_file "C:\Users\LoganGraves\Desktop\zbr\ Fig_file "C:\Users\LoganGraves\Desktop\zbr\CTMT_config.txt"	CTMT.	zbr" -	con
			~



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The final output of the command window will let you know if the stitching was successful, and, will inform you of the log file location, which details all of the runtime events for ZBR. This can be helpful for debugging as well. The log file is always written to "C:\AOM\zbr\_log\_YYYY\_MM\_DD\_HH\_MM\_SS" where 'YYYY\_MM\_DD\_HH\_MM\_SS' is the time of running in year, month, day, hour, minute, second format.

G Command Prompt	- 0	×
C:\Users\LoganGraves>C:\Users\LoganGraves\Desktop\zbr\ZBR.exe -zbr_file "C:\Users\LoganGraves\Desktop\zbr\0 fig_file "C:\Users\LoganGraves\Desktop\zbr\CTMT_config.txt" Running stitching. Please be patient Calculating weighting mask	CTMT.zbr"	-con 🔨
time4mask =		
0.3039		
Flat Calculating Qmat		
time4Qmat =		
1.6952		
time_SAVariation =		
0.1235		
time_Stitching =		
0.3125		
Saved updated measurement surface map to C:\GIT\zbr\stitched_twe_map_daty		
:\Users\LoganGraves>		~



#### 1. Starting ZBR

- 1. Open command prompt (or create bash file)
- 2. Run ZBR command with ZBR and config file args passed in.
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ZBR will let you know where your saved stitched map is. This save location was defined in your config file. The stitched map and the figures detailing the stitching performance are located here.

Command Prompt	_		×
C:\Users\LoganGraves>C:\Users\LoganGraves\Desktop\zbr\ZBR.exe -zbr_file "C:\Users\LoganGraves\Desktop\zbr\ fig_file "C:\Users\LoganGraves\Desktop\zbr\CTMT_config.txt" Running stitching. Please be patient Calculating weighting mask	\СТМТ.	zbr" -	- con 🔺
time4mask =			
0.3039			
Flat Calculating Qmat			
time4Qmat =			
1.6952			
time_SAVariation =			
0.1235			
<pre>time_Stitching =</pre>			
0.3125			
Saved updated measurement surface map to C:\GIT\zbr\stitched_twe_map.datx. Stitching completed succes+ully. See log +ile at: C:\AOM\zbr\zbr_log_2024_01_31_14_16_46.txt for details.			
C:\Users\LoganGraves>			~



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Navigate to your save folder to find the stitching results and stitched map. You can load your .xyz or .datx stitched map in Zygo Mx software for further analysis. You can open the pdfs to view details of the stitching.

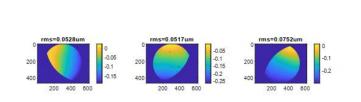
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stitched_twe_map_2024-01-31_14-17-05_figure	8 1/31/2024 2:17 PM	Foxit PDF Reader 960 KB	
stitched_twe_map_2024-01-31_14-17-05_figure	e7 1/31/2024 2:17 PM	Foxit PDF Reader 90 KB	
stitched_twe_map_2024-01-31_14-17-05_figure	e6 1/31/2024 2:17 PM	Foxit PDF Reader 742 KB	
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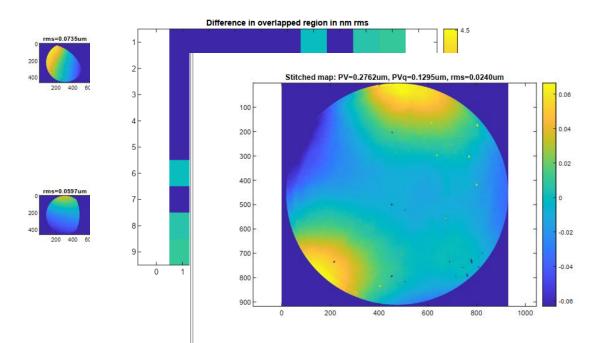


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You can also run ZBR in GUI mode, which launches the traditional ZBR user interface. To do so, run ZBR.exe with no arguments passed in. C:\Users\LoganGraves>C:\Users\LoganGraves\Desktop\zbr\ZBR.exe



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1									ZBI
	Data file name		cx_SA	cy_SA	cx_FA		SA_angle		
1 a.hdf			0	0	0	0	0		
Surface Type:		Subtract a saved reference m	iap?						
Surface Type:		Subtract a saved reference m	ap?						
⊖ Flat	90	Subtract a saved reference m Reference Calibration	ap?						
<ul> <li>○ Flat</li> <li>● Cylinder Power axis angle in degrees:</li> </ul>	90	Reference Calibration	p before stitching?						
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<ul> <li>○ Flat</li> <li>● Cylinder Power axis angle in degrees:</li> </ul>	90	Reference Calibration Calibrate the reference may Zernike Curvature Terms repre-	p before stitching?			[			
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<ul> <li>○ Flat</li> <li>● Cylinder</li> <li>Power axis angle in degrees:</li> </ul>	90	Reference Calibration Calibrate the reference may Zernike Curvature Terms repre-	p before stitching? senting the reference(e.g. "4,5,10						
Flat     O Cylinder Power axis angle in degrees:	90	Reference Calibration Calibrate the reference may Zernike Curvature Terms repre-	p before stitching? senting the reference(e.g. "4,5,10						

