Core-Pitch Pro.

Non-contact measurement instrument for optical core pitch.

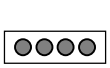
Permeating a white light source to the optical fiber array (FA), NFP (Near Field Pattern) optical profiler observes cores of the fiber array. NFP optical profiler will search the center-of-mass coordinates of each fiber cores by monitoring (CCD1 and CCD2) processes.

Motorized stage unit, which holds FA, travels until n numbers of cores, then, Laser Interferometer observes traveled position of the motorized stage.

From observing weighted point and traveled position by Laser Interferometer, our Core-Pitch Pro. enables to measure precise core positions of fiber arrays, and enables to measure exact pitches of optical fiber cores.

<Measuring Object>

Optical Fiber Array



<Measuring Accuracy>

Measuring Resolution	0.02um
Accuracy of Repeating processes	σ <0.05um

<Measuring Range>

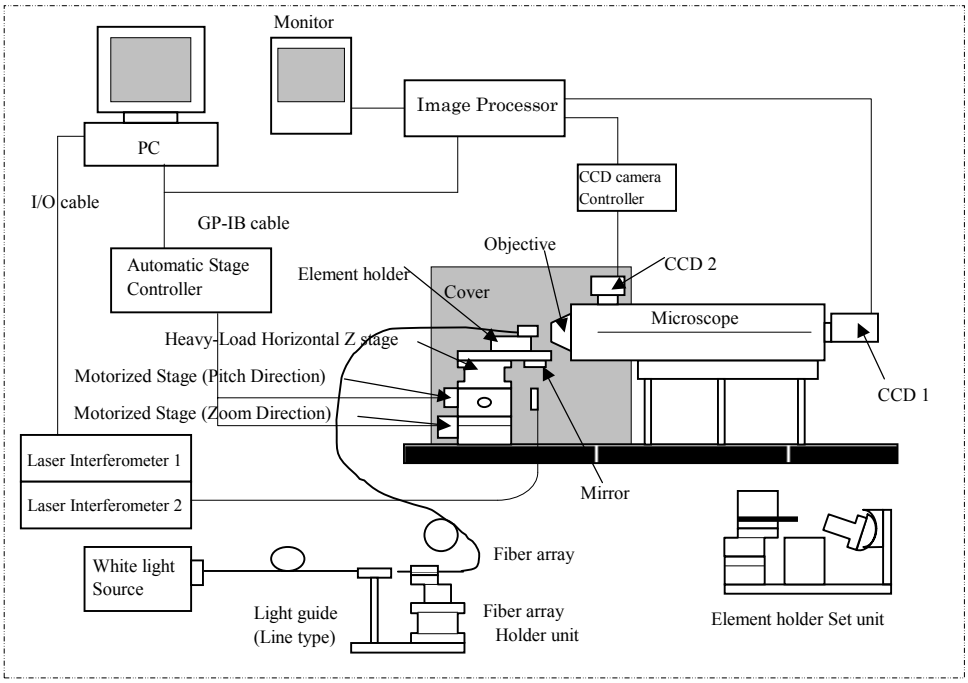
Less than 30mm

(Numbers of cores and core pitches can be settable)

<Measuring time>

Approximately 2 sec/axis

＜Device Structure＞



Each Device Specifications

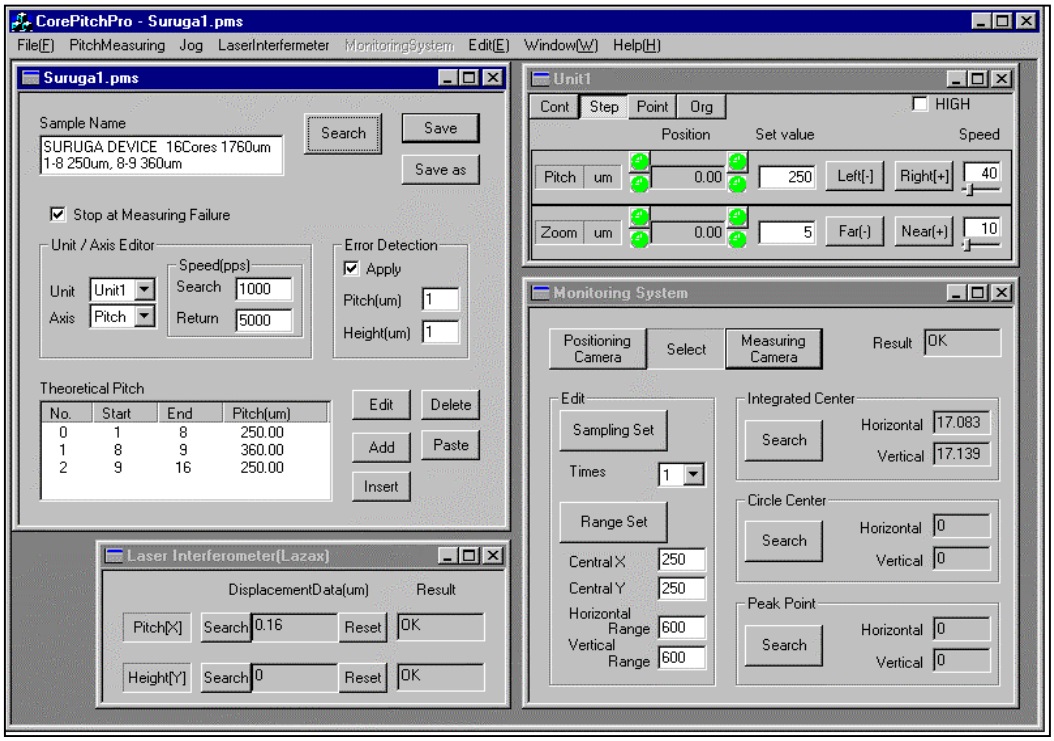
Device	Model	Specification	Manufacturer
Main Body		Size760(W)x240(H)x260(D)mm	
Motorized X stage (Pitch Direction) Motorized X stage (Zoom Direction) Heavy-Load Horizontal Z stage	K101-30R K101-20 B33-60A	Travel Range 30mm Resolution 2um/pulse Travel Range 20 Resolution 2um/pulse Travel Range ±3mm	
Device Holder	Customized		
Device Holder Systemized Unit	Customized		
Taped Fiber Holder Systemized Unit	Customized		
Automatic Stage Controller	D92 (2 axes)		
Laser Interferometer (2 axes)	LazaxL-DD-01	Resolution 0.01um	TOKYO SEIMITSU Co., LTD
Total Reflection Mirror	S01-40-1/10 S01-20-1/10	φ40mm Profile Irregularity λ/10 φ20mm Profile Irregularity λ/10	
Microscope	A4859-01	Objective Lens 20power (200power zoom at the measuring process)	Hamamatsu Photonics K.K.
Pictorial Processing System	MVS-7000	Resolution 0.002um	Hamamatsu Photonics K.K
CCD1(Measuring)	C3077	Display 2/3inches Monitor Upper View 34x30um	Hamamatsu Photonics K.K
CCD2(Positioning)	CS3330BL	Availability of Line Indication Display 2/3inches Monitor Upper View 1230x1080	teli
Monitor	9VM10A	9-inches	teli
Cold Light Source	MEGA100	Electric Consumption135w	HOYA-SCHOTT Corporation
Light Guide	VFGL9F-2000-W30R	Optical face 1x30mm Length of Light Guide 2m	HOYA-SCHOTT Corporation

P C Specifications

Operation System:	Windows98 or Windows NT
CPU:	Pentium Processor (Intel) or higher
Hard Drive:	10MB available space (Minimum)
Memory:	32MB available space (Minimum)
CD-ROM Drive:	Required
Required Boards:	PCI bus x2
	GP-IB Board
	I/O Board (NI Product)

<Software Function>

Main Menu

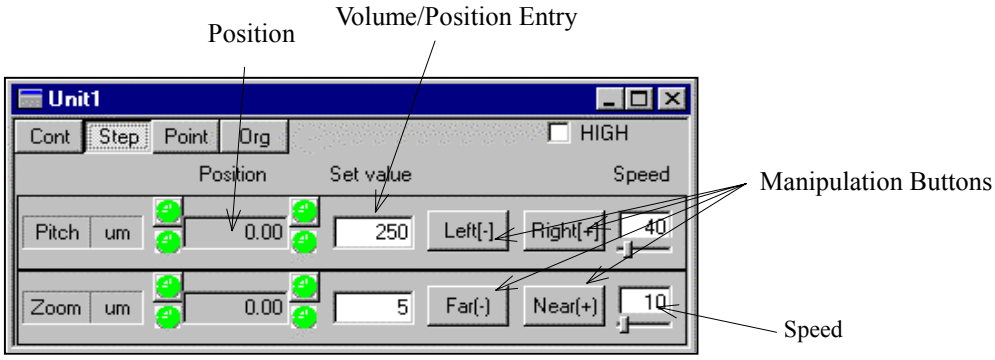


Core-Pitch Pro. Software enables following 4 main remarkable features:

1. Stage Jog Operation (JOG)
2. Pitch Measuring
3. Pictorial Process (MVS…Machine Vision System)
4. Laser Interferometer (Lazax)

(1) Stage Jog Operation (JOG)

Operating motorized stages by JOG operation



"Cont" ···· Click and hold the "Cont" button, the motorized stage travels continuously.

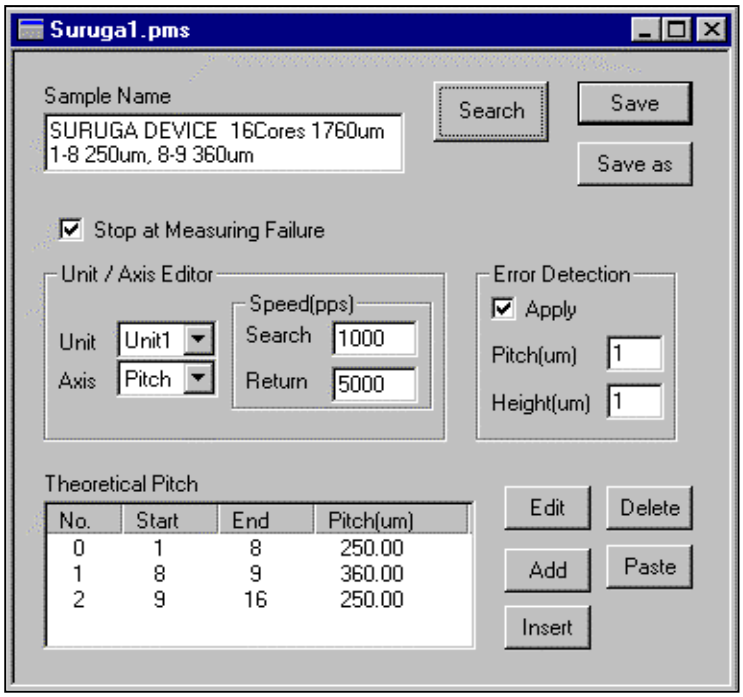
"Step" ···· Click the "Step" button; the motorized stage travels at designated units.

"Point" ···· Click the "Point" button; the motorized stage travels to the designated point.

"Org" ····· Click the "Org" button, the motorized stage returns to the origin.

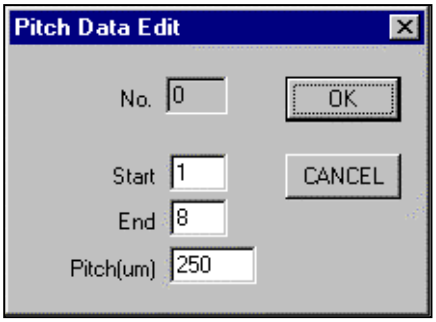
（2）Pitch Measuring

Start Pitch Measuring, and establish Parameter and Theoretical Pitch.



“Save”	Save present settings to overwrite the former saved data.
“Save as”	Save present settings that appearing at the PC display.
“Search”	Start searching
“Sample”	Enter the device name and condition to the box (60 characters Max.)
“Stop at measuring failure”	Stop measuring when pitch measuring is failed.
“Travel Unit & Axis Editor”	Select travel unit and measuring axis
“Error Detection”	When measured axes is outside of the predetermined error range, there will be an error notice on the PC display.
“Theoretical Pitch”	Enter the theoretical pitches of the devices. Indeed, the theoretical pitches are the travel units of the predetermined axes.
“Edit” “Insert” “Add” “Delete” “Paste”	By using Theoretical Pitch, “Edit”,“Insert”,“Add”,“Delete”, and “Paste” can be determined at the Pitch Data Edit dialog (below).

Pitch Data Edit Dialog



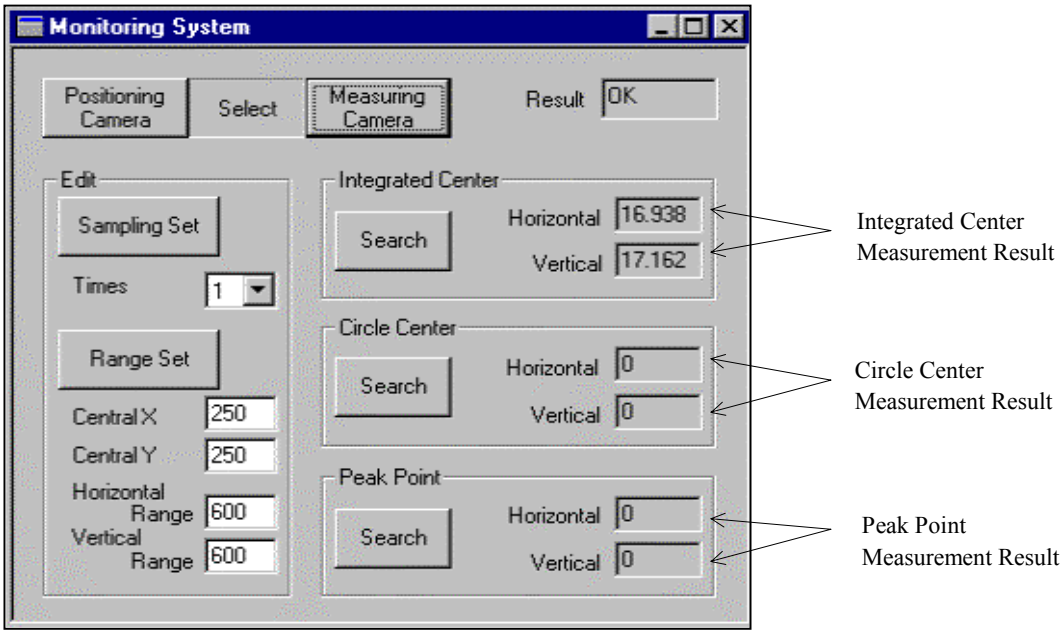
At Theoretical Pitch dialog, select a number and click Either “Edit”, “Insert”, “Add” button, Pitch Data Edit Dialog will be appeared.

Enter the length of intervals at the “Pitch” box.

Enter the number of times at both “Start” and “End” boxes.

（3）Monitoring System Operating Procedure

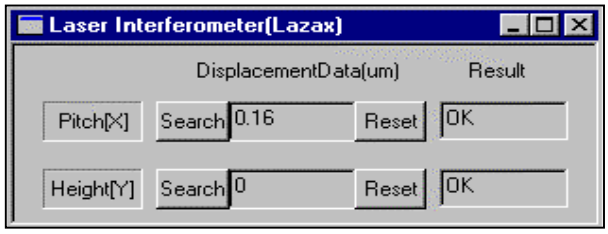
Editing parameters of monitoring system, and searching coordinates of the optical cores.



Integrated center search:	Searching coordinates of the integrated center of the optical cores' white parts by monitoring 2 divided images.
Circle center search:	Searching coordinates of the black part of the optical cores by monitoring 2 divided images.
Peak Point search:	Searching luminance points of the optical cores by monitoring process.
"Positioning Camera":	Outputting images that observed by positioning CCD camera (CCD2) to the monitoring display.
"Measuring Camera":	Outputting images that observed by measuring CCD camera (CCD1) to the monitoring display.
"Numbers of Sampling":	Enter the numbers of sampling core pitches outputting to the monitoring display.
"Search Range Editor":	Editing the effective ranges.
"Search":	Results of each measurement will be appearing at the right hand boxes.
	If the results are succeeded, "OK" will be appeared at the result box.
	If the results are failed, "Error" will be appeared at the result box.

（4）Laser Interferometer Operating Procedure

Editing the measuring values of Laser Interferometer. (values can be reset to 0 value)



Displacement Data

"Reset": Reset (0 value) the Displacement data.

"Search": The result of Displacement data search will be appeared at the column of Displacement Data.

Wavelength

"Search": Observing laser wavelength data, and the result will be appeared at the column of Wavelength.

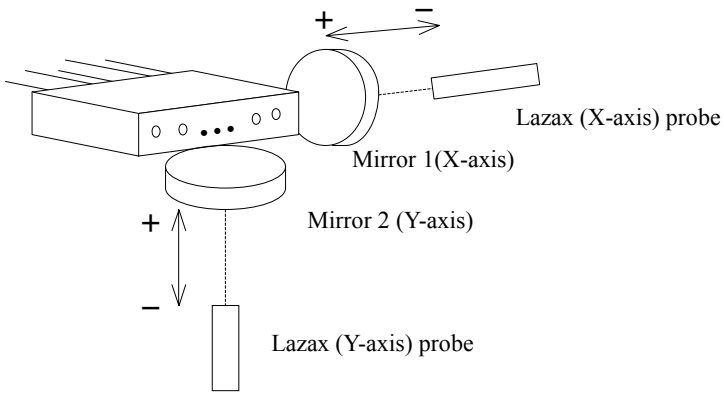
<Measuring Principle>

（1） Laser Interferometer (Lazax)

- Lazax are installed in both horizontal and vertical directions.
- To have highly precise sensing by Lazax, two total reflection mirrors (X-axis and Y-axis) are installed in the motorized stage, which holds a fiber array.
- Travels of the two total reflection mirrors are explained at the figure below. (Indeed, the stage traveling makes their movements.)

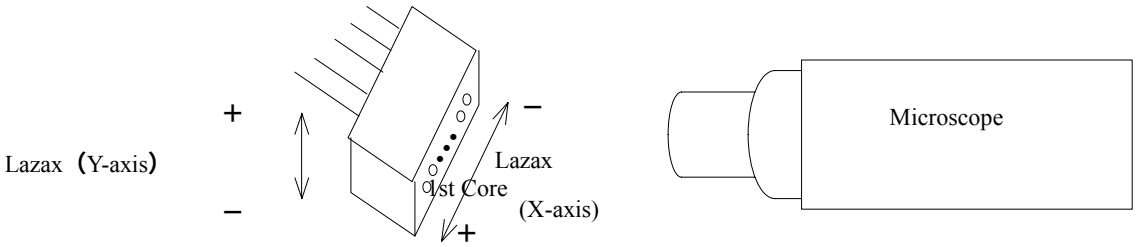
  "+" refers the direction that a total reflection mirror travels away from the Lazax in both X and Y axes.

  "-" refers the direction that a total reflection mirror travels close to the Lazax in both X and Y axes.



（2） Coordinate directions of Pictorial Process System (MVS…Machine Vision System) and Laser Interferometer (Lazax)

- Numbering fibers from the left hand (1st fiber) to the right hand (2nd, 3rd…. 8th….) by facing fiber array.
- The coordinates of fiber array and Lazax (X and Y axes) are illustrated at the figure below.



- The coordinates of Pictorial Process System (MVS) and Lazax.

There are not only the differences between actual directions of fibers and directions of fibers appeared at the monitoring display, but output images from positioning camera and measuring camera is also different.

Displayed fiber images that observed from both positioning and measuring cameras, X-axis (horizontal) direction is reversed (opposite direction) appearing at the display. (Figure 1)

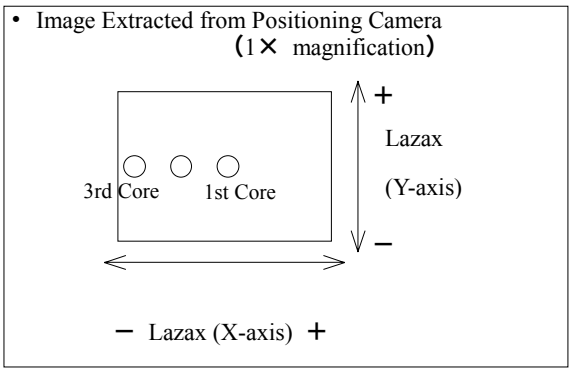


Figure 1

Displayed fiber images observed from positioning camera, Y-axis (vertical) direction is reversed. But not measuring camera (not reversed). (Figure 2)

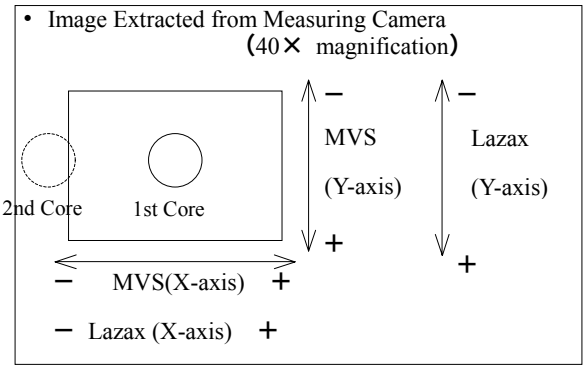


Figure 2

(3) Detail Explanation of X-axis Pictorial Processing

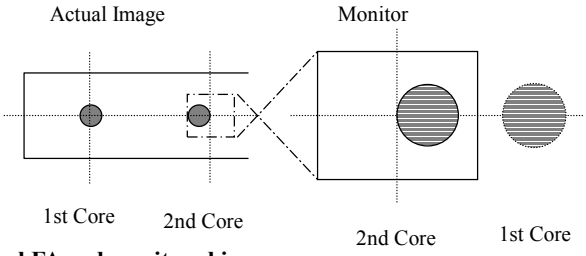
- X-coordinate of the 1st fiber is set as 0 point.
- The following definition will be applied to have X-coordinates of each fiber.

Actual X-coordinate value = {Lazax (n) – Lazax (1)} – {MVS (n) – MVS (1)}

n = a number of the targeting fiber

Example:

Lazax	X：２５０um
MVS	X： 5um (Right)
Actual Value	X：２４５um
Corrected Value	X： －５um



The fiber is 5um slid to the left between actual FA and monitored images.

(4) Detail Explanation of Y-axis Pictorial Processing

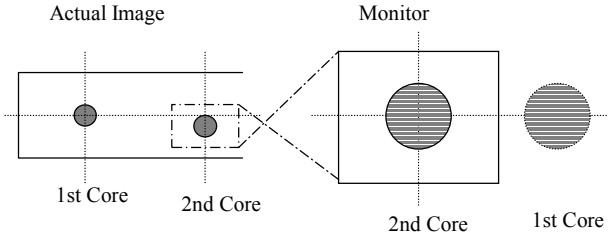
- Y-coordinate of the 1st fiber is set as 0 point.
- The following definition will be applied to have X-coordinates of each fiber.

Actual Y-coordinate value = {Lazax (n) – Lazax (1)} – {MVS (n) – MVS (1)}

n = a number of the targeting fiber

Example:

MVS	Y： 0um (Center)
Lazax	Y： 5um
Actual Value	Y：－５um

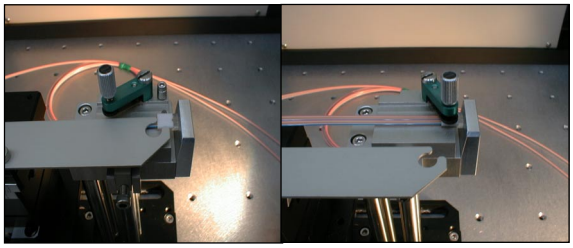


The fiber is 5um slid to the downward by facing FA between actual FA and monitored images.

<Measuring Procedure>

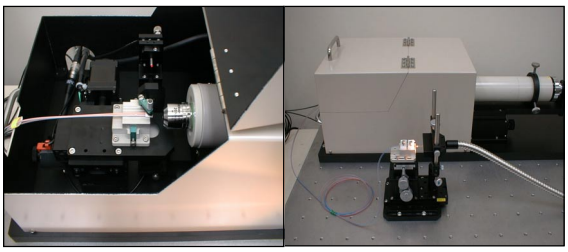
—— Having data from the same shape of device, step 4 can be skipped. ——

① Place the device holder, which holding the FA (Fiber Array), at a device holder jig. Slated optical device faces can be feasible to measure.

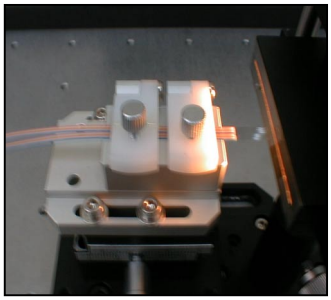


② Remove the device holder, which carrying the optical device,from the jig to be placed at the main body of the measuring Then, close the system lid, and ready for the core-pitch measurement.

Due to repeatability of installing the device holder, a positioning rotational error made by stage travel (zooming direction) will be less than 20um.

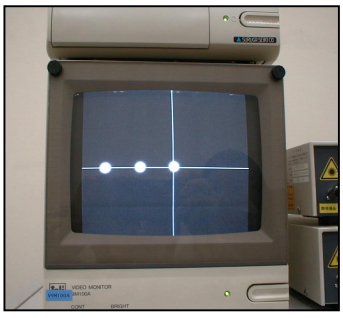


③ Setup the taped fiber in front of light guide.



④ By operating automatic stages (X-axis travel), move fibers to be placed at the center of monitoring display through monitor the images observed by positioning camera (CCD2).

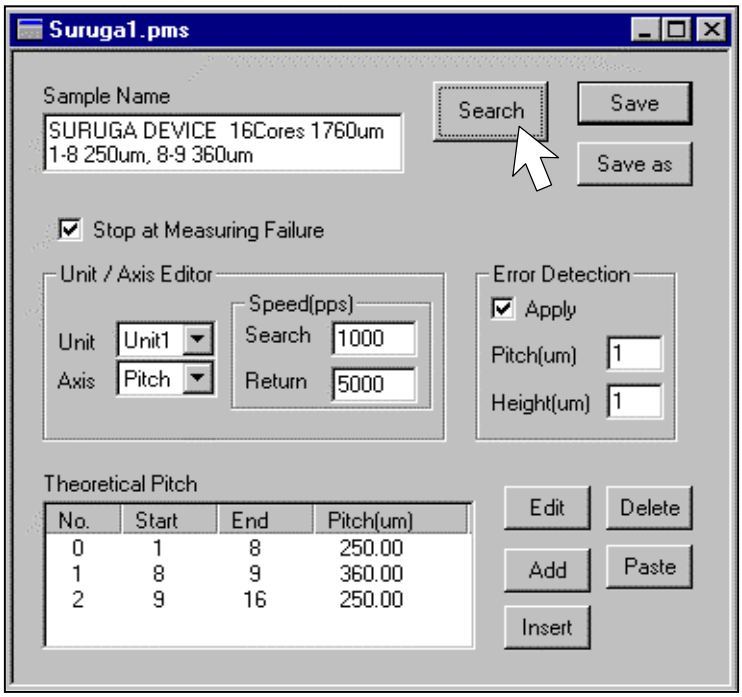
Adjusting the positions of fibers to be in focus at the monitor by automatic stage adjustment (zooming travel direction).



⑤ After the fibers are adjusted (focused), monitoring camera needs to be switched from the positioning camera to the measuring camera (CCD1).

By the same procedure as step 4, adjusting the positions of **cores** to be placed at the center of monitoring display through monitor the images observed by measuring camera. Thereafter, adjusting the positions of cores to be in focus at the monitor by automatic stage adjustment (zooming travel direction).

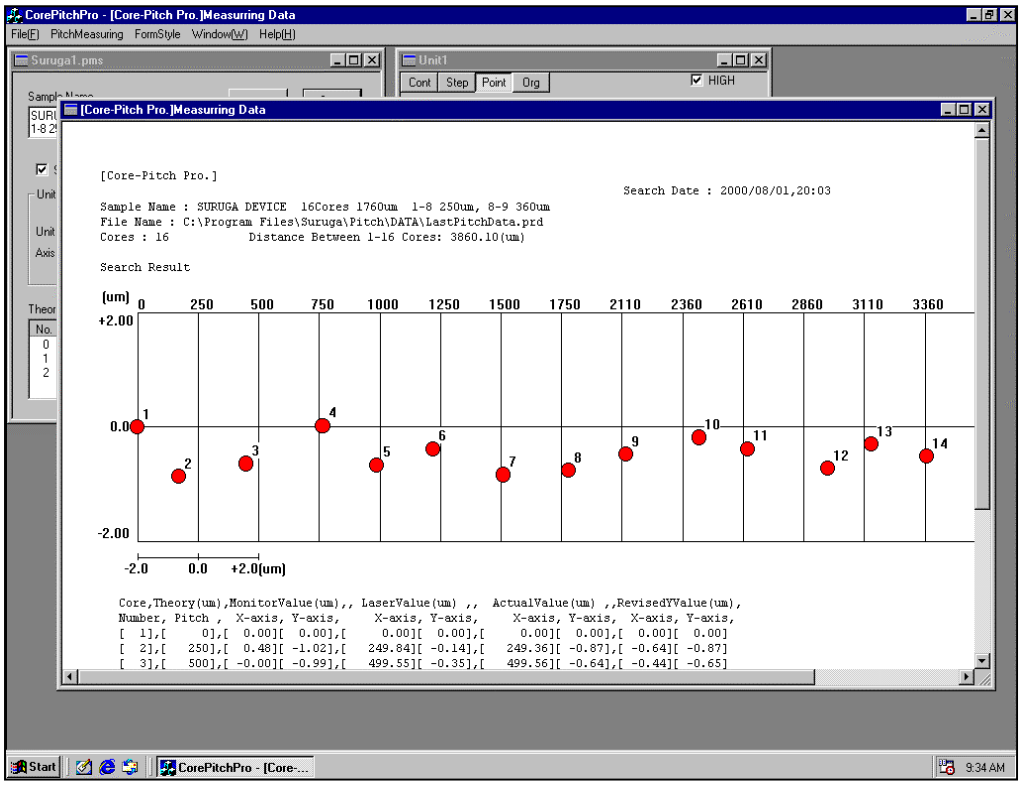
⑥ Sample name, Travel Unit & Axis Editor, Theoretical Pitch, and Error Detection can be arranged at Pitch Measuring menu below.



⑦ Click “Search” button to start measuring core pitches.

⑧ After finish up measuring, observed data results and graphical data will be appeared at your display

The results can be saved or printed out as your convenient references.



<Measuring Result>

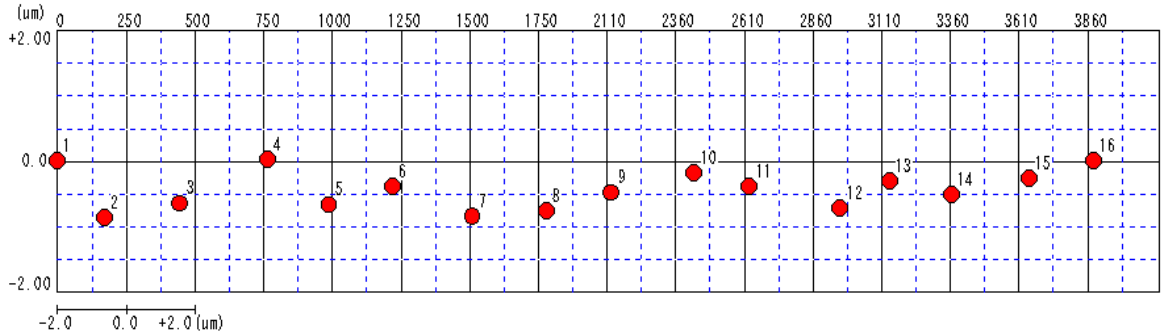
Measuring Data　Graph 1

[Core-Pitch Pro.]

Search Date : 2000/08/01,20:03

Sample Name : SURUGA DEVICE 16Cores 176Oum 1-8 250um, 8-9 360um
File Name : C:¥Program Files¥Suruga¥PITCH¥DATA¥SurugaDevice¥Measure01.prd
Cores : 16　　Distance Between 1-16 Cores: 3860.10(um)

Search Result



Core Number	Theory(um) Pitch	MonitorValue(um) X-axis	MonitorValue(um) Y-axis	LaserValue(um) X-axis	LaserValue(um) Y-axis	ActualValue(um) X-axis	ActualValue(um) Y-axis	RevisedYValue(um) X-axis	RevisedYValue(um) Y-axis
[1]	[0]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
[2]	[250]	[0.48]	[-1.02]	[249.84]	[-0.14]	[249.36]	[-0.87]	[-0.64]	[-0.87]
[3]	[500]	[-0.00]	[-0.99]	[499.55]	[-0.35]	[499.56]	[-0.64]	[-0.44]	[-0.65]
[4]	[750]	[0.08]	[-0.48]	[750.21]	[-0.51]	[750.12]	[0.03]	[0.12]	[0.02]
[5]	[1000]	[0.21]	[-1.22]	[1000.09]	[-0.57]	[999.88]	[-0.65]	[-0.12]	[-0.67]
[6]	[1250]	[0.30]	[-1.07]	[1250.05]	[-0.70]	[1249.74]	[-0.37]	[-0.26]	[-0.39]
[7]	[1500]	[-0.39]	[-1.72]	[1499.67]	[-0.91]	[1500.06]	[-0.81]	[0.06]	[-0.84]
[8]	[1750]	[-0.82]	[-1.77]	[1749.38]	[-1.03]	[1750.21]	[-0.74]	[0.21]	[-0.77]
[9]	[2110]	[-0.68]	[-1.65]	[2109.41]	[-1.21]	[2110.09]	[-0.44]	[0.09]	[-0.48]
[10]	[2360]	[-0.32]	[-1.52]	[2360.18]	[-1.38]	[2360.51]	[-0.15]	[0.51]	[-0.19]
[11]	[2610]	[-0.20]	[-1.91]	[2609.91]	[-1.56]	[2610.11]	[-0.35]	[0.11]	[-0.39]
[12]	[2860]	[-0.96]	[-2.35]	[2859.79]	[-1.66]	[2860.75]	[-0.68]	[0.75]	[-0.73]
[13]	[3110]	[-0.40]	[-2.03]	[3109.77]	[-1.77]	[3110.17]	[-0.26]	[0.17]	[-0.31]
[14]	[3360]	[-0.40]	[-2.49]	[3359.57]	[-2.04]	[3359.97]	[-0.46]	[-0.03]	[-0.52]
[15]	[3610]	[-0.04]	[-2.40]	[3610.17]	[-2.20]	[3610.21]	[-0.20]	[0.21]	[-0.26]
[16]	[3860]	[-0.05]	[-2.18]	[3860.05]	[-2.25]	[3860.10]	[0.06]	[0.10]	[0.00]

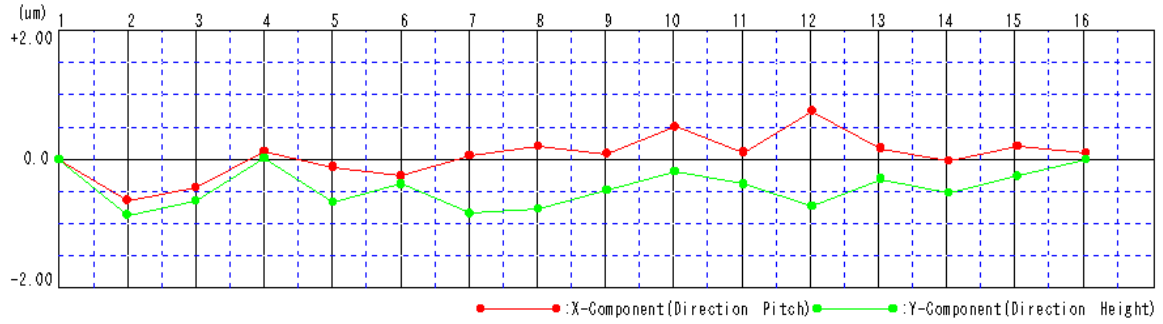
Measuring Data　Graph 2

[Core-Pitch Pro.]

Search Date : 2000/08/01,20:03

Sample Name : SURUGA DEVICE 16Cores 176Oum 1-8 250um, 8-9 360um
File Name : C:¥Program Files¥Suruga¥PITCH¥DATA¥SurugaDevice¥Measure01.prd
Cores : 16　　Distance Between 1-16 Cores: 3860.10(um)

Search Result



Core Number	Theory(um) Pitch	MonitorValue(um) X-axis	MonitorValue(um) Y-axis	LaserValue(um) X-axis	LaserValue(um) Y-axis	ActualValue(um) X-axis	ActualValue(um) Y-axis	RevisedYValue(um) X-axis	RevisedYValue(um) Y-axis
[1]	[0]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]	[0.00]
[2]	[250]	[0.48]	[-1.02]	[249.84]	[-0.14]	[249.36]	[-0.87]	[-0.64]	[-0.87]
[3]	[500]	[-0.00]	[-0.99]	[499.55]	[-0.35]	[499.56]	[-0.64]	[-0.44]	[-0.65]
[4]	[750]	[0.08]	[-0.48]	[750.21]	[-0.51]	[750.12]	[0.03]	[0.12]	[0.02]
[5]	[1000]	[0.21]	[-1.22]	[1000.09]	[-0.57]	[999.88]	[-0.65]	[-0.12]	[-0.67]
[6]	[1250]	[0.30]	[-1.07]	[1250.05]	[-0.70]	[1249.74]	[-0.37]	[-0.26]	[-0.39]
[7]	[1500]	[-0.39]	[-1.72]	[1499.67]	[-0.91]	[1500.06]	[-0.81]	[0.06]	[-0.84]
[8]	[1750]	[-0.82]	[-1.77]	[1749.38]	[-1.03]	[1750.21]	[-0.74]	[0.21]	[-0.77]
[9]	[2110]	[-0.68]	[-1.65]	[2109.41]	[-1.21]	[2110.09]	[-0.44]	[0.09]	[-0.48]
[10]	[2360]	[-0.32]	[-1.52]	[2360.18]	[-1.38]	[2360.51]	[-0.15]	[0.51]	[-0.19]
[11]	[2610]	[-0.20]	[-1.91]	[2609.91]	[-1.56]	[2610.11]	[-0.35]	[0.11]	[-0.39]
[12]	[2860]	[-0.96]	[-2.35]	[2859.79]	[-1.66]	[2860.75]	[-0.68]	[0.75]	[-0.73]
[13]	[3110]	[-0.40]	[-2.03]	[3109.77]	[-1.77]	[3110.17]	[-0.26]	[0.17]	[-0.31]
[14]	[3360]	[-0.40]	[-2.49]	[3359.57]	[-2.04]	[3359.97]	[-0.46]	[-0.03]	[-0.52]
[15]	[3610]	[-0.04]	[-2.40]	[3610.17]	[-2.20]	[3610.21]	[-0.20]	[0.21]	[-0.26]
[16]	[3860]	[-0.05]	[-2.18]	[3860.05]	[-2.25]	[3860.10]	[0.06]	[0.10]	[0.00]

The data results are saved as text format, so that you can use Word-pad or Excel to view the observed data by Core Pitch Pro.

Example: Using Word-pad to view the formatted data.

[Core-Pitch Pro.], 2000/08/01,20:03

Error Detection 1, 1.000000, 1.000000

Sample Name : SURUGA DEVICE 16Cores 1760um 1-8 250um, 8-9 360um

Distance Between 1-16 Cores: 3860.10(um)

Core,	Theory(um),	MonitorValue(um),		LaserValue(um) ,		ActualValue(um) ,		RevisedYValue(um),	
Number	Pitch	X-axis	Y-axis	X-axis	Y-axis	X-axis	Y-axis	X-axis	Y-axis
1,	0,	0.000,	0.000,	0.000,	0.000,	0.00,	0.00,	0.00,	0.00,
2,	250,	0.480,	-1.016,	249.836,	-0.143,	249.36,	-0.87,	-0.64,	-0.87,
3,	500,	-0.002,	-0.991,	499.554,	-0.354,	499.56,	-0.64,	-0.44,	-0.65,
4,	750,	0.083,	-0.483,	750.207,	-0.514,	750.12,	0.03,	0.12,	0.02,
5,	1000,	0.208,	-1.223,	1000.085,	-0.573,	999.88,	-0.65,	-0.12,	-0.67,
6,	1250,	0.303,	-1.068,	1250.048,	-0.700,	1249.74,	-0.37,	-0.26,	-0.39,
7,	1500,	-0.386,	-1.720,	1499.673,	-0.911,	1500.06,	-0.81,	0.06,	-0.84,
8,	1750,	-0.825,	-1.767,	1749.382,	-1.030,	1750.21,	-0.74,	0.21,	-0.77,
9,	2110,	-0.678,	-1.648,	2109.411,	-1.207,	2110.09,	-0.44,	0.09,	-0.48,
10,	2360,	-0.324,	-1.521,	2360.183,	-1.376,	2360.51,	-0.15,	0.51,	-0.19,
11,	2610,	-0.202,	-1.909,	2609.909,	-1.562,	2610.11,	-0.35,	0.11,	-0.39,
12,	2860,	-0.958,	-2.348,	2859.787,	-1.663,	2860.75,	-0.68,	0.75,	-0.73,
13,	3110,	-0.402,	-2.032,	3109.766,	-1.773,	3110.17,	-0.26,	0.17,	-0.31,
14,	3360,	-0.397,	-2.492,	3359.568,	-2.035,	3359.97,	-0.46,	-0.03,	-0.52,
15,	3610,	-0.038,	-2.396,	3610.171,	-2.196,	3610.21,	-0.20,	0.21,	-0.26,
16,	3860,	-0.050,	-2.181,	3860.049,	-2.246,	3860.10,	0.06,	0.10,	0.00,

MVS transformed value: The value that observed coordinate positions transformed to 0 value at the central point of the 1st core.

Laser interferometer

transformed value: Observed value from Lazax, and it had transformed to 0 value at the central point of the 1st core.

Actual value: The value that had combined with the MVS transformed value and Lazax measured value.

Corrected Y-axis value: The value corrected for the difference between actual value and theoretical value.

(Subtracted theoretical value from X-coordinate value, and the last core of the actual value based on the Y-coordinate value with the correction of optical device slating is the Corrected Y-axis value.)

－ MEMO －

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