

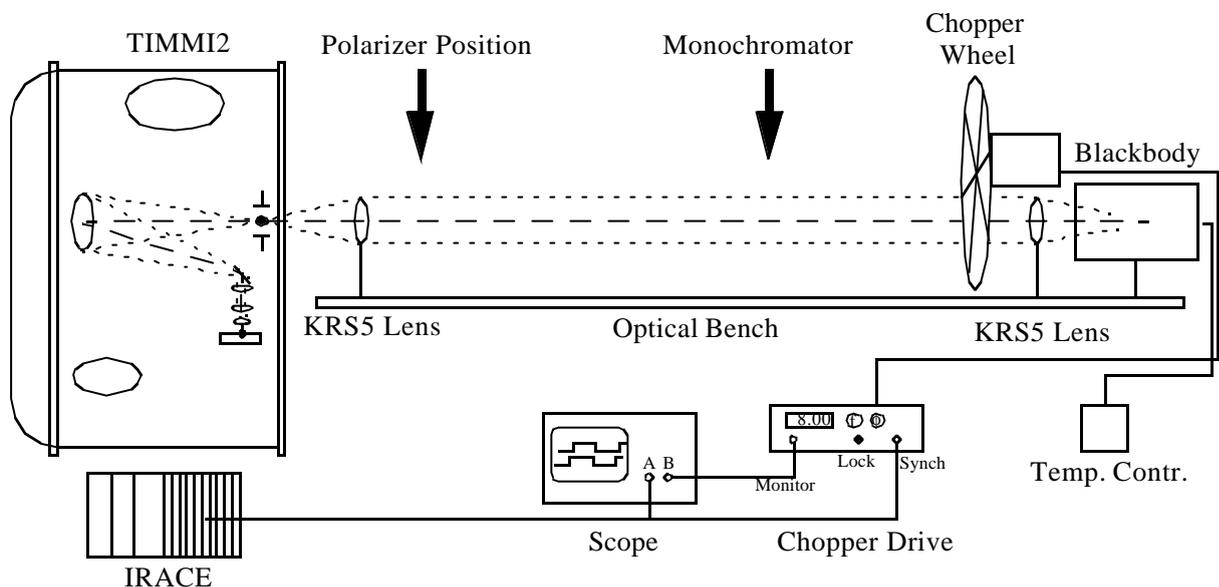
TIMMI2 Calibration

05.07.2004 UWE

A) Polarizer Calibration

Preparation:

- TIMMI is cold, dismantled from the f/35 adapter and arranged on the workbench in the lab.
- Calibration stand is put in front of TIMMI.



Procedure:

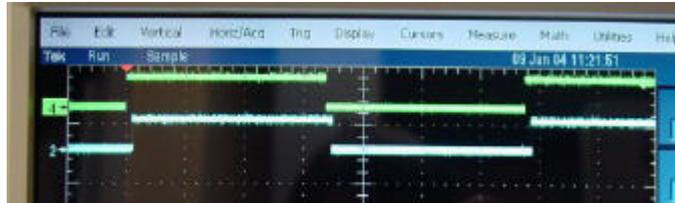
1. Connect the power supply of the black body to mains and set temperature to 800 °C
2. Connect the chopper drive to the chopper wheel and to mains
3. Connect the chopper synch. signal from the IRACE CLDC to the synch. input of the chopper drive
4. Connect a scope to the monitor output of the chopper driver and to the synch. signal (use a BNC T)
5. Start DCS acquisition with DIT ~6 - 10 ms and bring up the RTD display, select the DIT to be displayed.
6. Select the following set-up for TIMMI in the ICS:
Mask 0.2" - Filter 11.9 OCLI - Objective N-Ima-0.2" - Polarizer OUT
7. Monitor the synch. signal of the IRACE and see if the frequency is of the order of 8 Hz. If not, adjust NCREAD or DIT accordingly (DIT = 6.25 ms and NCREAD = 10 is a good choice...)
8. Watch the RTD DIT and see if the images are saturated. Possibly they will, so one can select also the NeII filter, or the blackbody temperature can be lowered until the image is OK.
9. Select INT display on the RTD. If the set-up is correct and you're lucky, a bright spot from the blackbody source should be visible on the RTD. But most probably this is not the case.

Proceed as follows:

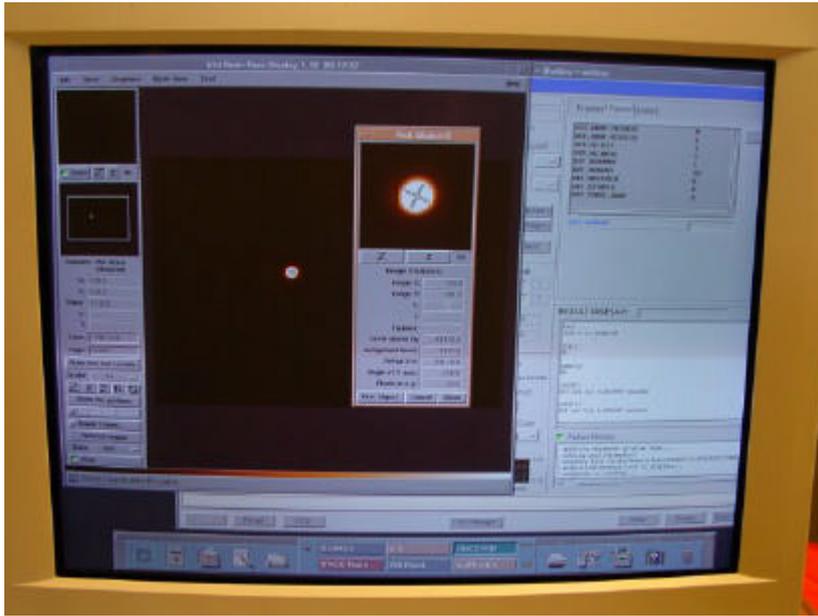
10. Synchronize the chopper - therefore switch off first the synch. switch on the chopper drive.
11. Trigger the scope on the IRACE signal



12. Adjust the frequency control such, that on the scope the two traces are almost the same frequency. Don't care if one of the signals (the un-triggered channel) is leading or lagging.
13. When both signals are more or less OK, switch on the synch. switch and wait until the chopper drive locks on the IRACE control. Now, the two signals are the same frequency, but maybe still out of phase.

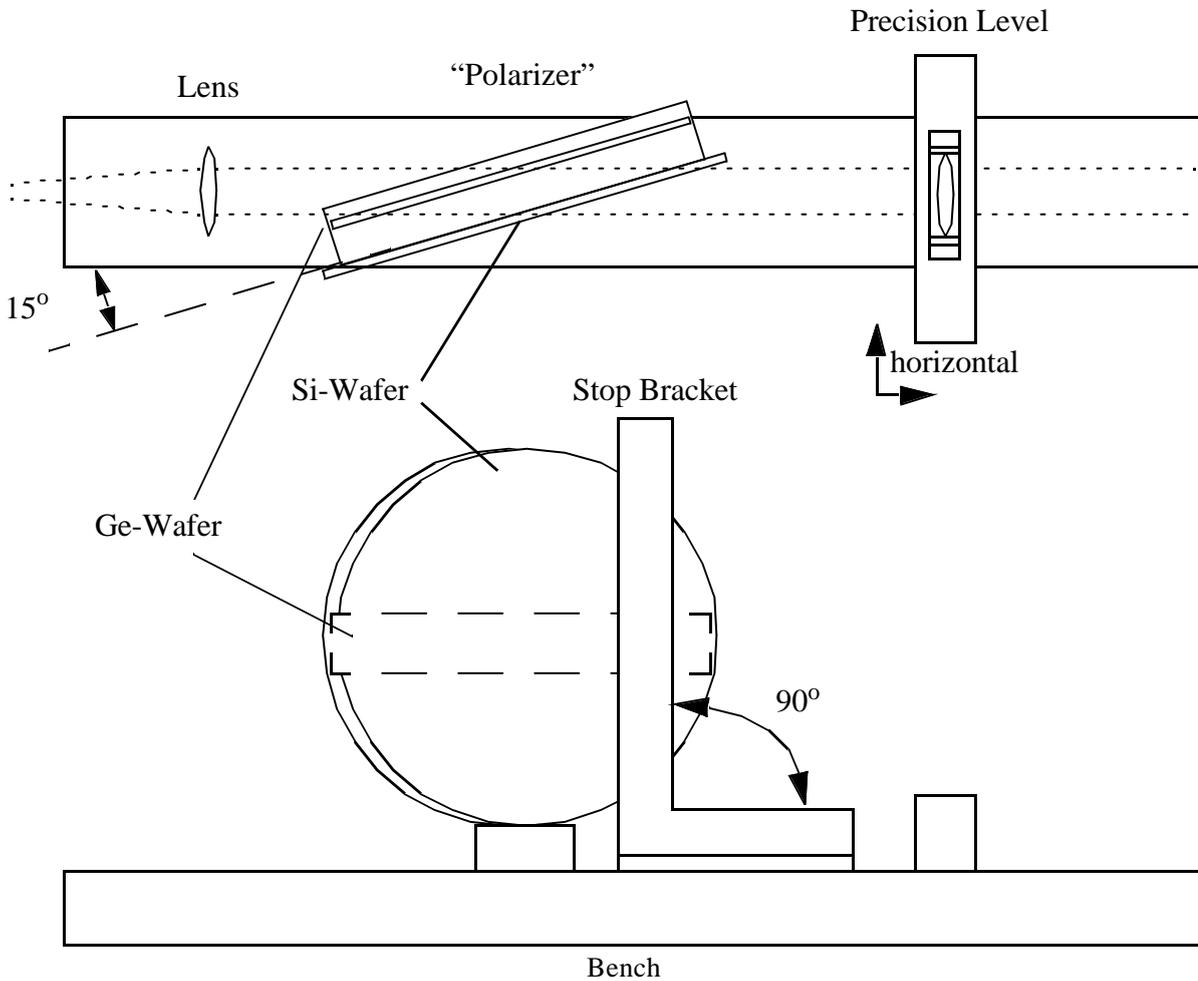


14. Adjust the phase Control on the chopper drive to get the two signals in-phase.
15. Again, check on the RTD INT display if you see the spot.
16. Now, align the optical bench w.r.t. optical axis of TIMMI2. One can do this roughly by eye.
17. Adjust the blackbody position and the lens in front of TIMMI such that they stay where the marks are put on the rail.
18. If the spot is visible, it should be focused by sliding the upper rail w.r.t. the lower rail. This way the distance between BB and lens is being kept, and only the projection onto the TIMMI mask wheel changes.
19. The spot should be of the order of 15 - 20 pixels in diameter and it should be round.



Now set up the bench and TIMMI for polarizer mode:

20. Insert the polarizer elements at the arrow position as indicated in the first picture.



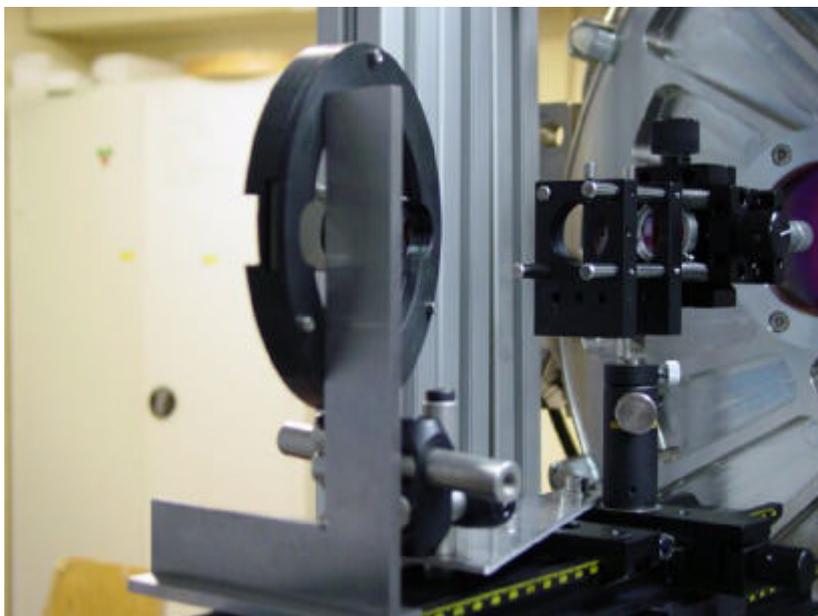
The adjustment of this Polarizer has to be done as follows:

21. The polarizer has to be aligned in three axis on the bench

- a. the bench has to be horizontal as indicated by the precision level in the picture



- b. the polarizer frame has to be set vertically onto the bench as indicated by the stop bracket in the picture



- c. the polarizer has to be turned by 15° with respect to the optical axis. This angle is the Brewster angle, which can be calculated from the formula below:

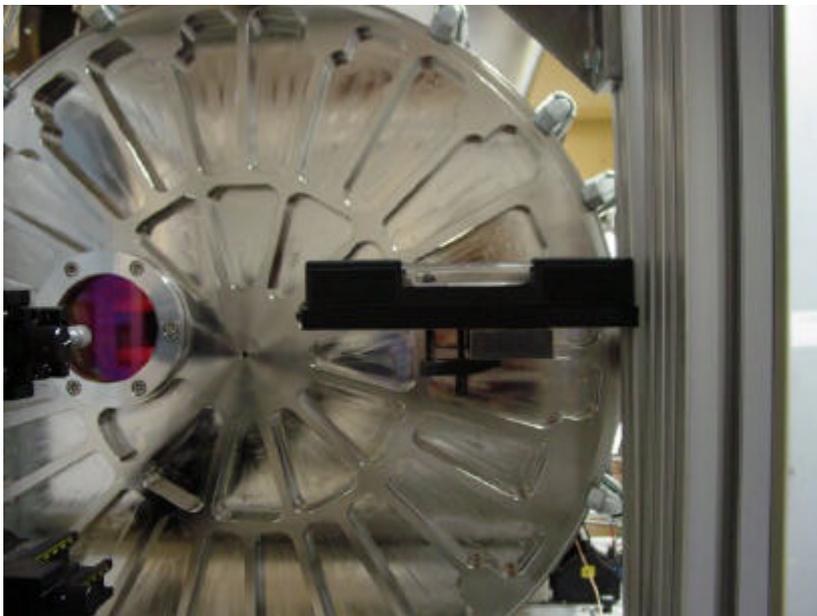
$$\theta_B = \tan^{-1} \left(\frac{n_2}{n_1} \right).$$

For Ge with $n_2 = 4.0$, Si with $n_2 = 3.5$ and for air with $n_1 = 1$ we get:

$\arctan((4.0+3.5)/2) = 75.07^\circ$ or: 15° turn with respect to the optical axis.



22. TIMMI2 has to be put horizontal as well. Check with the precision level that the ribs of the front flange are perfectly horizontal. The adjustment can be done with a 13mm wrench on the base of the Bosch structure.



23. Watch out, that the polarizer is well aligned within the beam. Due to the small angle of only 15° it is critical, that the Ge and the Si wafer are well inserted in the beam, as indicated in the figure.

24. Check on the RTD that the spot is still there, but at only $\sim 60\%$ of its former intensity. If the image is too faint, another filter can be selected or the blackbody temperature can be increased.

Set-up TIMMI to polarization mode:

25. Set polarizer to IN position and turn it to 0°

26. Again, the intensity of the spot on the RTD will have diminished, which is OK. Adjust the cuts to see the spot.

Measurements for the Calibration table:

27. Start at a nominal position of say 0° and turn the polarizer by increments of 10° .

28. Note down the intensity of the spot, using the Pick Object tool of the RTD.

29. Identify the minimum of the curve and do a more accurate scan in steps of 1°

30. Plot this curve in an EXCEL spread sheet. ADU vs. encoder steps

31. Over-plot the 2nd degree polynomial fit and display the coefficients of the form ax^2+bx+c

32. Resolve the derivative $dy/dx = 2ax+b = 0$ to find the minimum. $x = -b/2a$

33. The minimum is corresponding to the offset, which has to be entered in the configuration file.

34. login as 'timmigr' on 'wtimmi'

35. Edit the file `$INS_ROOT/SYSTEM/COMMON/CONFIGFILES/timcfgINS.cfg` and enter the encoder value nnnn in:

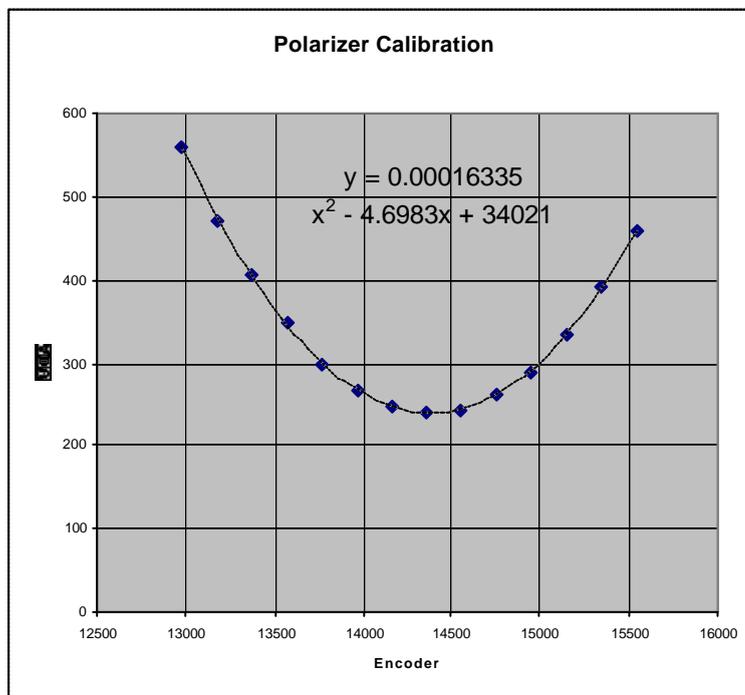
```
INS.POS1.OFFSET    nnnn; # Reference Position
```

36. Execute the command `'icbConfigSet TIMMI'`. This will update and also back-up the data base, such that the new value becomes active after init of the function

37. In ICS set the polarizer rotation function OFF - STANDBY - ONLINE

38. The new value is active now, please check again if the polarizer at 0° gives a minimum of flux on the detector for this new zero position

39. Note down the calibration values in the logbook and paste also a copy of the plot.



40. If everything is fine, remove the polarizer from the bench, store the Si-wafer in its box and put it into the drawer.

Calibration with respect to the fixed Polarizer:

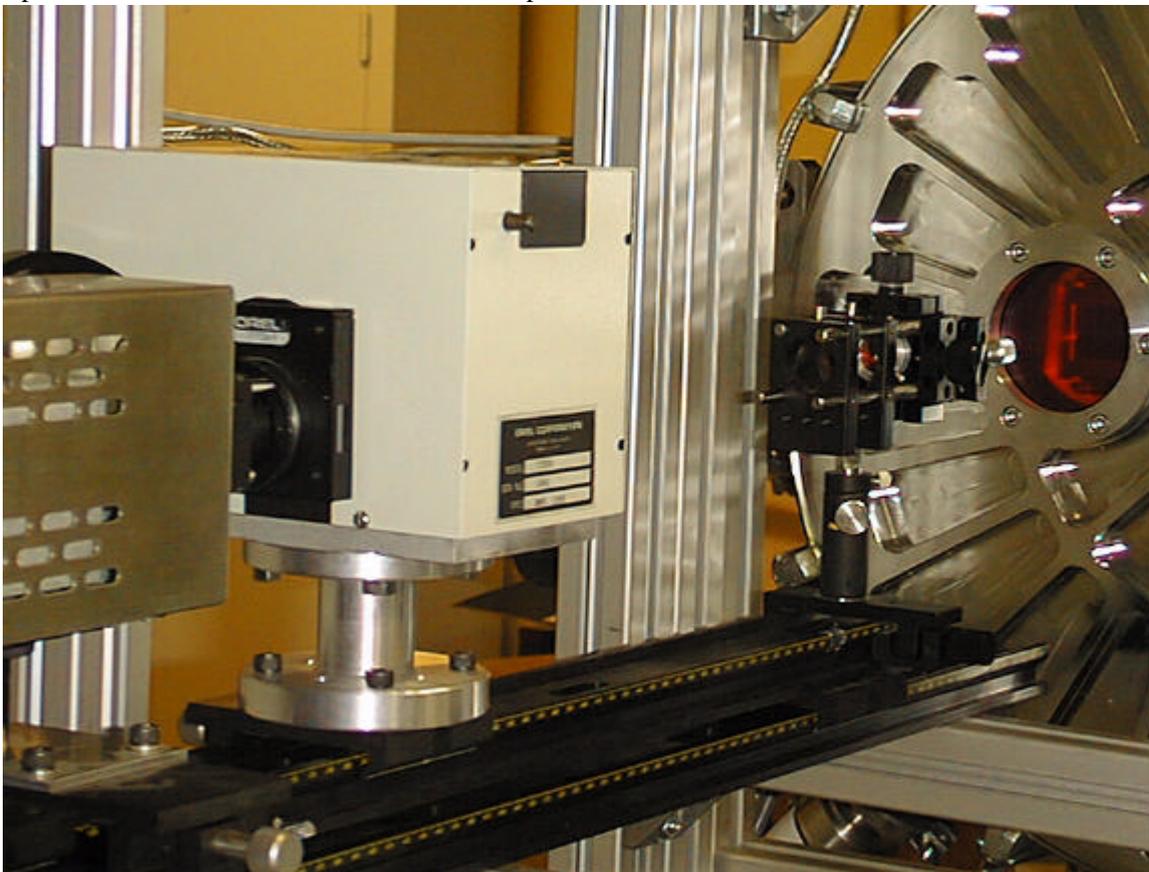
41. Select now the following set-up for TIMMI in the ICS:
Mask 0.2" - Filter N + Polarizer - Objective N-Ima-0.2" - Polarizer IN
42. Repeat the measurement described in 27. - 33.
43. The minimum found, will be a reference for the polarizer, and it can be used as a regular test of the calibration also when TIMMI is at the telescope or during the preparation for a new set-up.
44. Note down this value in the logbook and also inform the TIMMI astronomer.
45. Normally, one proceeds with the spectrograph calibration as indicated in the next paragraph.

B) Wavelength CalibrationPreparation:

- TIMMI is cold, dismantled from the f/35 adapter and arranged on the workbench in the lab.
- Calibration stand is put in front of TIMMI.

Procedure:

46. Insert the Monochromator at the arrow position, as indicated in the first picture.
47. Set up TIMMI for imaging mode in N-Band:
Mask 0.2" - Filter 11.9 OCLI - Objective N-Ima-0.2" - Polarizer OUT
48. Check that Blackbody, Monochromator Lens and TIMMI are all on the optical axis. (This is important in order to assure that the light passes through the monochromator)
49. Open the slits on the entrance and on the output of the monochromator to its maximum.



50. Open the diaphragm at the output of the monochromator too.

51. Adjust the wavelength setting to the “Zero Order”

- a. set the dial to 0000
- b. watch the spot on the RTD and try to optimize the setting to obtain max. throughput
- c. note down this dial reading, as it is required to correct the wavelength setting later

52. Close the entrance slit of the monochromator (the one at the BB side) step by step while assuring that the spot on the RTD is not being lost. If this would be the case, open the slit again a little and try to optimize the alignment of the BB and the monochromator on the bench.

53. If the entrance slit is finally at .120, and the spot is still OK, the output slit can be reduced too.

54. A final setting of .120 would be optimum, but it's not always possible to get there. In any case, if the slit is too large, the resolution of the monochromator will be too low, which can make the spectral calibration difficult later.



55. Set up TIMMI for through-slit imaging mode:

Slit 1.2" - Filter 11.9 OCLI - Objective N-Spec - Polarizer OUT

56. Adjust the DIT if necessary, and synch. the chopper properly if the frequency has changed.

57. If the spot is not falling exactly onto the slit of TIMMI (which will be the case in 99.9% of the time...), one has to adjust the whole calibration stand vertically and horizontally.

58. When the spot is well aligned near the center of the slit at ~ row 120, TIMMI can be set up for spectroscopy mode:

Slit 1.2" - N-Band Grism - Objective N-Spec - Polarizer OUT

59. With the monochromator still at “Zero Order” position the whole spectrum should be visible as one line in row ~120.

60. The monochromator has now to be tuned to the correct wavelength. Refer to the table for an approximate idea for both, 10 and 20 μm grism.

Wavelength Range

	lower limit ~ pix. 15	center wavelength ~ pix. 160	upper limit ~ pix. 315
10 μm	7.8	10.7	13.8
20 μm	14.9	19.2	23.8

61. Convert the values in the table to nanometer and divide by 24 to get the monochromator setting. I.e. for 10.7 μm the monochromator dial has to be set to 445.8.
62. Using as a guide the values given on the web page at URL: http://www.lis.eso.org/lasilla/sciops/3p6/timmi/html/calib_waves20030501.txt or the measurements noted down in the TIMMI logbooks, one can now take approx. 11 measurements along the detector.
63. Note down the pixel where the maximum of the spot is. Use the **Center Object** feature of the RTD to do this.
64. Create the new table values by carefully adding the Zero Order offset to each of the monochromator readings!
i.e. if the zero order is at -1.5, the setting for 10.7 μm would have to be $445.8 + (-1.5) = 444.3$
65. Repeat the same measurements for 20 μm .
66. Adjust the DIT if necessary, as the background conditions will be different for the longer wavelength.
67. Also correct the chopper frequency accordingly and assure proper synchronization as explained in the polarizer calibration procedure.
68. After finishing the calibration note down the values in the log book and edit the calibration file if necessary.
69. Distinguish between two cases:
- The instrument has been opened and optical elements have moved: Do a complete calibration
 - The instrument has not been intervened: Take three points at both ends and in the center only to check if calibration changed.
70. Inform the TIMMI astronomer about the results of the calibrations.
71. Shut off and dismount the calibration equipment and store it in a safe, dust-free place.