

# A GUIDE TO THE ULRICH J. SCHWARZ RADIO INTERFEROMETER



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## 0.1 Introduction



Figure 1: The RIF.

The Astrophysics Department at Radboud University Nijmegen owns our own radio telescope, a two-element radio interferometer, which is located on the roof of the Huygens building. This makes the Radboud University the only university in the Netherlands with its own radio interferometer. The Radio Interferometer (RIF) consists of two 3.5 m dishes that are used for teaching and student projects. The RIF was refurbished in 2011/2012, with both the mechanics and the electronics being completely renewed. After that, the RIF was re-opened on 29 June 2012, where it was renamed the Ulrich J. Schwarz Radio Interferometer.

The Netherlands has always been at the forefront of radio astronomy. This started with the 25-meter Dwingeloo Telescope in the fifties and sixties followed by the Westerbork Synthesis Radio Telescope, consisting of 14 x 25-meter dishes, in the seventies, and today the Low Frequency Array (LOFAR). The RIF contributes to training of the next generation of Dutch and Dutch-educated radio astronomers and as such helps to maintain the Netherlands's position as a leader on in worldwide radio astronomy.

### 0.1.1 Ulrich Schwarz

Ulrich J. Schwarz is a pioneer of radio astronomy who moved from his native Switzerland to the Netherlands to be involved in the first generation of radio telescopes. These included the Dwingeloo telescope and the Westerbork Synthesis Radio Telescope array. He also pioneered interferometry at the Parkes radio telescope in Australia. Through the efforts

of early pioneers such as Ulrich, the Netherlands is today among the most pre-eminent countries in radio astronomy in the world.

After his retirement and move to Arnhem, Ulrich became the guardian of the RIF and supervised the use of the RIF within the physics curriculum at Radboud University. During the move to the new Huygens-building he also provided the inspiration and overview for the refurbishment of the RIF.

Credit: The text was adapted with permission from the original (<https://astro.ru.nl/wiki/rif>) which was written by Dr. Marijke Haverkorn.

## 0.2 Characteristics, Properties and Important Information

Table 1: Telescope Properties

Dish Diameter	3.5 meters
Observing Frequency	1.4 GHz
Baseline Length	36 meters
Primary Beam FWHM	4.5 degrees
Raw data rate	40 MB/s

Table 2: Dish Pointing Offsets

Dish	RA CAL. Offset	DEC CAL. Offset
A	00 -5 50	21 00 00
B	00 -10 30	24 00 00

1. Login: account name: rifadmin, password: schwarz2012
2. Because the software was designed to run continuously and problems with doing so on two different accounts simultaneous, all users of the RIF have administrative permissions. **PLEASE DO NOT INSTALL OR UN-INSTALL PROGRAMS OR MAKE ANY CHANGES OF ANY KIND TO THE SETTINGS ON THE CONTROL COMPUTER.**
3. **THE CONTROL SOFTWARE SHOULD NEVER BE CLOSED AND THE CONTROL COMPUTER SHOULD NEVER BE SWITCHED OFF. When you are done observing, please leave the dishes tracking the sun and simply log out of the rifadmin account.** This ensures that the dishes are constantly moving, preventing rain water from collecting in them and the dishes from rusting.
4. **DO NOT CHANGE THE TIME ON THE CONTROL COMPUTER CLOCK. The time is set to Coordinated Universal Time (UTC) which is used by the telescope control software to point the dishes. You will thoroughly destroy the pointing if you reset the time to local time.**

5. When standing in the control room facing the control computers, you are facing nearly due South.
6. When standing in the control room facing the control computers, dish A is the dish on your right (the Western dish), dish B is the dish on your left (the Eastern dish).
7. If you are trying to observe anything except the sun or Cassiopeia A, the signal attenuators need to be removed (see Section 0.3.8).
8. When going outside, always take the remote control of the window blinds with you if it's sunny. If the sun shines is on the windows, the blinds will go down automatically, blocking the door.
9. If you spot mistakes in this document, have suggestions or queries, please contact me at [r.coppejans@astro.ru.nl](mailto:r.coppejans@astro.ru.nl) or come to speak to me at my desk in room HG02.076.

### 0.2.1 Trouble Shooting

Below is a list of problems and potential remedies. If none of these solutions solve your problem, please email me at [r.coppejans@astro.ru.nl](mailto:r.coppejans@astro.ru.nl) or come to speak to me at my desk in room HG02.076.

1. Problem: You are not getting any signal from your source.
  - (a) If you are trying to observe a source other than the sun or Cassiopeia A, the attenuators should not be in the signal path. For instructions on how to remove them, see Section 0.3.8.
2. Problem: The telescope pointing is off.
  - (a) Check that the computer time is in UTC. UTC time is the local time in Nijmegen minus two hours during summer time (from the first week of April to the last week of October) and minus one hour during winter time (from the first week of November to the last week of March).
  - (b) Check that the “Zero Offset HA” and “Zero Offset DA” values are set to zero for both dishes in the in the “Zero” tab of the Axis4 software that is shown in Figure 8.
  - (c) Check that in the “Service” tab of the Axis4 software the “RA CAL. Offset” and “DEC CAL. Offset” values (shown in Figure 9) are set to the values given in Table 2 and that the minus signs (if any) are in the correct position. NOTE: when entering an offset of 30 arcmin to the East, it should be entered as 00 -30 00 not as -00 30 00.
  - (d) If none of the above solutions work, the procedure described in Section 0.3.9 can be followed to zero the pointing.

3. Problem: You cant find your source.
  - (a) See the solutions to the problems “The telescope pointing is off” and “You are not getting any signal from your source”.
4. Problem, the python reduction scripts are failing with the error “Segmentation fault (core dump)”.
  - (a) This is often the result of a file being named incorrectly. Sometimes the slight time difference in creating the .dat and .cds files can cause the two filenames to differ (by a second) causing the error. To fix the problem, the incorrect file name needs to be corrected by hand.

## 0.3 A Step-By-Step Guide to the RIF

In this section, a point-by-point recipe with explanations is presented to lead first-time users through starting and setting up the RIF, taking data, shutting down and analyzing their data.

### 0.3.1 Starting Up

1. Check that the area around the dishes are clear and that there is nothing that the dishes could potentially crash into while moving. This could for example happen if work was done on the dishes and the platform used to reach dishes was not stowed away.
2. Log into the “rifadmin” account on the control computer using the password: schwarz2012. After successfully logging in you will see the desktop as displayed in Figure 2.
3. **NOTE: At the moment all users of the RIF have administrative permissions. PLEASE DO NOT INSTALL OR UN-INSTALL PROGRAMS OR MAKE ANY CHANGES OF ANY KIND TO THE SETTINGS ON THE CONTROL COMPUTER.**
4. You can find your targets, control the telescope and display data using the three icons at the top of the desktop. They are:
  - (a) Axis4: The telescope control software (TCS).
  - (b) RIF\_DAQ1.7.vi: The data acquisition, display and initial processing software.
  - (c) Stellarium: Used to find the coordinates of your target source.



3. At the top of the display, the time (in UTC and LST) and the hour angle (HA) and declination angle (DA) of each dish is shown.
4. Notes:
  - (a) **The HA value showed for each dish is not the right ascension (RA) of the dish, but the number of hours that the source is to the East or West of the great circle running from due North, through the zenith to due South. In other words, it tells you how many hours the source is away from passing through its maximum elevation.**
  - (b) **Similarly, the DA value is how many degrees the source is to the North or South of the North celestial pole and is not the declination (DEC) of the source. A DEC value of -5:00:00 will therefore be displayed as "S 5 00 00" while a value of 5:00:00 will be displayed as "N 5 00 00".**
  - (c) **Although the information for dish A is given on the left hand side of the display, dish A is the dish on your right when you sit in front of the control computer. Similarly the information for dish B is displayed on the right but dish B is on your left.**
5. For each dish, there are four tabs "Auto Control", "Manual Control", "Zero" and "Service" that controls the dish.
6. The "Auto Control" tab:
  - (a) This tab is used to point the dishes at a target and track the target.
  - (b) To slew to a new target, first make sure that the "Tracking HA" selector is set to "LST" and that the "Mode" is on "AUTO".
  - (c) Enter the RA and DEC of your target under the "R.A." and "DEC." labels and click on the "GO TO" button to make the dish move to the source.
  - (d) NOTE: When entering values a zero value can never be negative. For example if you want to enter a RA of minus 30 arcmin, it should be entered as 00 -30 00 not as -00 30 00.
  - (e) If the dish is already tracking a target there will not be a "GO TO" button but a "STOP" button next to where you enter the RA and DEC values (as is shown in Figure 3). In this case the dish will automatically move to your target as soon as you have entered the coordinates.
  - (f) After you have entered the RA and DEC of the source, the "Angle Error" indicator will jump to a bigger value and start decrease towards zero as the dish starts slewing towards the new coordinates. As the dish gets closer to the target coordinates, the "Angel Error" will decrease, reaching a small number (typically less than 0.005 deg) once the dish has reached the target coordinates.

- (g) The HA and DEC of where the dish is pointing are given in degrees in the “Hourangel A/B” and “Declination A/B” indicators.
  - (h) The “STOP” button can be used at any time to stop the dish from tracking a source.
  - (i) Note that for the reasons discussed above, the “R.A.”, “DEC.”, “Hourangel A/B” and “Declination A/B” indicators will differ from the HA and DA values displayed for each dish.
7. The “Manual Control” tab:
- (a) To control the dish manually, switch the “Mode” switch in the “Auto Control” tab from “AUTO” to “MAN” for both the RA and DEC controllers before navigating to the “Manual Control” tab shown in Figure 4.
  - (b) In the “Manual Control” tab, you can select in which direction to move the dishes and start them moving by clicking on the “START” button. The speed of the movement can be controlled using the “Speed” selector.
  - (c) If one of the limit lights switch on while you are manually moving the dishes, it means that the dish has reached one of its limits and can only move in the opposite direction.
  - (d) Notes:
    - i. Switching mode from “AUTO” to “MAN” disables tracking.
    - ii. **Please do not forget to switch the “Mode” back to “AUTO” before you leave so that the dishes can continue tracking the sun and rain water does not collect in them.**
8. The “Zero” and “Service” tab:
- (a) These tabs are used to zero the pointing, see Section 0.3.9.
9. At the bottom of the interface there are two sets of indicator lights for each of the dishes. One each for the RA and DEC drives.
- (a) “E limit”, “W limit”, “N limit” and “S limit”: indicates that the dish has reached one of its slewing limits.
  - (b) “Brake”: Indicates that the emergency brake is switched on. If this happens please contact Peter Dolron (p.dolron@science.ru.nl) for technical assistance.
  - (c) “End”: Indicates that the hard-wired limit switch has been activated. This should not happen and usually indicates that something is very wrong. If this happens please contact Peter Dolron (p.dolron@science.ru.nl) for technical assistance.
  - (d) “Zero”: Indicates that the dish is at its reference position. If this light switches on during an observation it can be safely ignored, it is only relevant when zeroing the pointing (see Section 0.3.9).

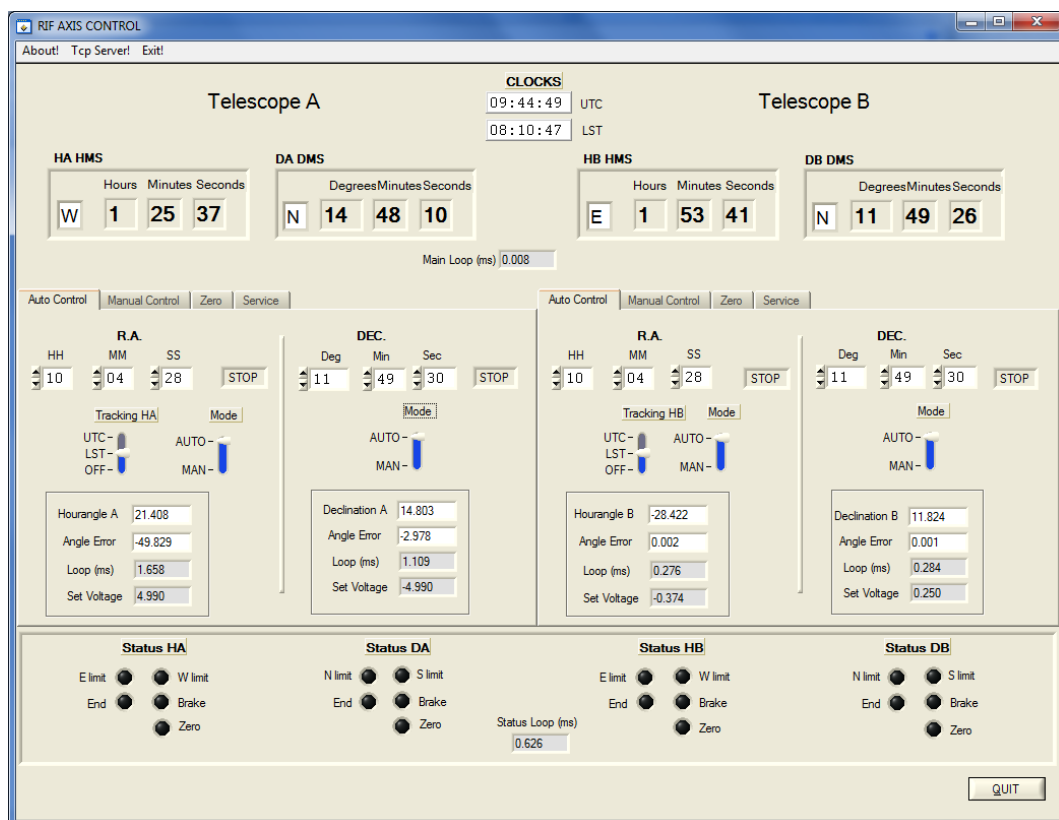


Figure 3: The Axis4 “Auto Control” tab.



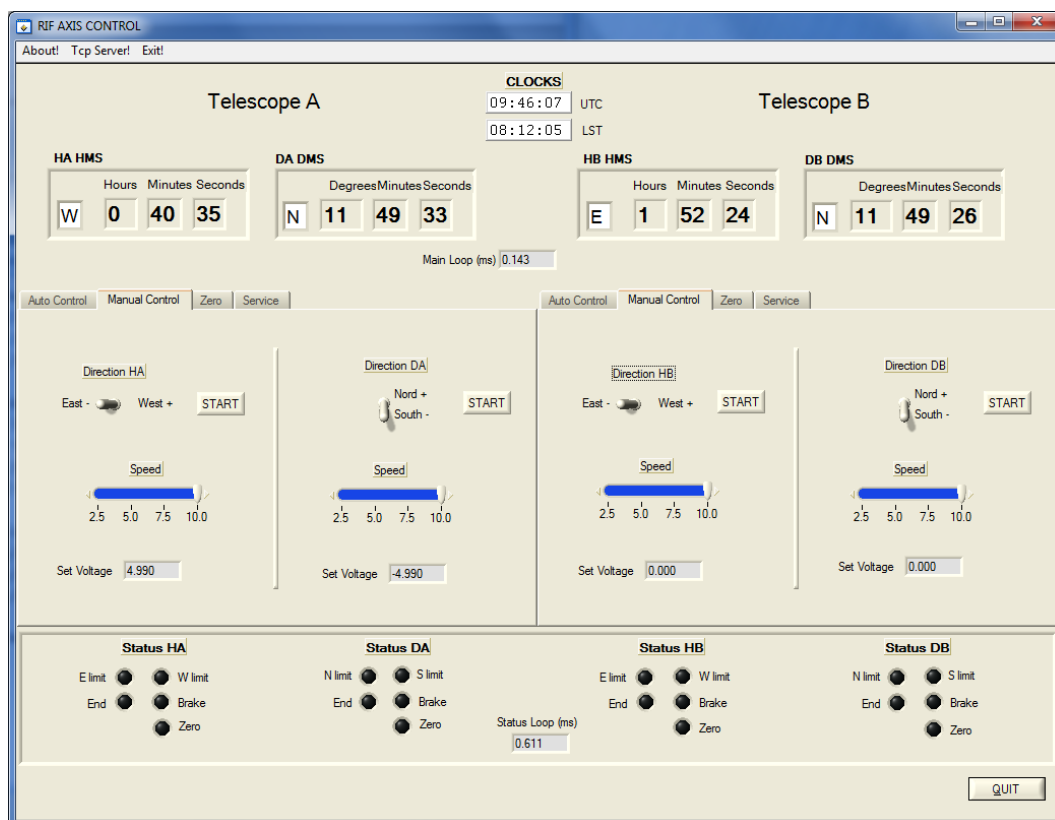


Figure 4: The Axis4 “Manual Control” tab.

### 0.3.4 How to do a Drift Scan

1. A drift scan of a source can be done by going to the “Zero” tab in the software and inputting a value for “Zero Offset HA” or “Zero Offset DA”. This introduces an offset, of the number of degrees specified, in the pointing of the dish.
2. You can now do a drift scan of your source by pointing at the source and manually moving the dish in the opposite direction as the input offset, thereby scanning across the source.
3. NOTE:
  - (a) DEC scans are of inferior quality due to a mechanical construction error.
  - (b) Putting in a positive offset value will offset the pointing East or North while a negative value will offset the pointing West or South.
4. **Please don’t forget to set all the offsets to zero again before you leave, otherwise the pointing will be off for the next person.**

### 0.3.5 Looking at and Saving Your Data

1. The “User Interface” tab (shown in Figure 5) of the RIF\_DAQ1.7.vi program can be used to both look at your data in real time and save it.
2. Note that since the telescope has not been absolutely calibrated, all the units are in analog to digital units and not in Jy.
3. The “Observation” section:
  - (a) “Observation length (s)” sets the total observation time in seconds.
  - (b) “START” and “STOP” starts and stops the observation. When an observation is in progress, the “Acquisition Status” indicator will light up.
  - (c) “Set Timer” starts an observation at a certain time and date.
  - (d) “Set interval” sets the intervals at which data are taken.
  - (e) “N. Interval” sets the number of intervals over which data are taken.
  - (f) “Every (s)” sets the time between intervals.
  - (g) For example “Observation length (s)” = 1000; “N. Interval” = 10; “Every (s)” = 3600 will result in a total observing time of 1000 seconds spread over ten intervals of 100 s each, with each interval starting one hour after the previous one.
4. The “Data Processing” section:
  - (a) “AVG\_Times (s)” sets the averaging time in seconds. The default value of 1 s is recommended. Due to pointing errors and limitations of the digitizer, using an averaging time of less than one second is not recommended.

- (b) “Total Power” plots  $A^2$  and  $B^2$  on the y-axis separately.
  - (c) “Summed total power” plots  $\sqrt{A^2 + B^2 + 2 \times A^2 \times B^2}$  on the y-axis.
  - (d) “2AB” plots the correlation  $2 \times A \times B$  on the y-axis.
5. The “Output” section:
- (a) “Time”, “Hourang” and “declination” plots the variables selected in the “Data Processing” section as a function of time (in UTC), RA and DEC respectively.
  - (b) “Destination File” is the path to where the data are saved. Note: Please do not save any data on the C: disk. You can save your data on in the J: disk in a folder with your name. Since space is limited, please delete your data as soon as your are done with it.
  - (c) “Raw Data File” saves the raw data to disk. Typically at a rate of  $\sim 40\text{MB/s}$ .
  - (d) “Processed Data” saves the data columns selected in the “Data Processing” section to disk.
  - (e) If you don’t tick the boxes next to “Raw Data File” or “Processed Data”, the data will only be displayed and not saved.
6. While data is being taken and displayed, the scale of the graph can be changed by simply clicking on the maximum or minimum y-value and typing a new value.
7. In the “Settings” tab, a time delay (in integer multiples of the averaging time) can be introduced between the signal from the two dishes. Inputting an one second shift in dish A means that dish is moved one second ahead (into the future) compared to dish B.

### 0.3.6 Shutting Down

1. **The Axis4 software should never be closed or the computer shut down.**
2. When you are done, point the telescope at the sun and leave it tracking the sun before logging out. When the sun sets, the telescope will stop at the horizon before starting to track it again the next morning.
3. **Never leave without the dishes tracking the sun. If the dishes stand still, rain water will collect in them, causing them to rust.**

### 0.3.7 Processing Saved Data

1. Data is saved in the directory specified in the “Output” section of the RIF\_DAQ1.7.vi program.
2. Note that since the telescope has not been absolutely calibrated, all the units are in analog to digital units and not in Jansky (Jy).

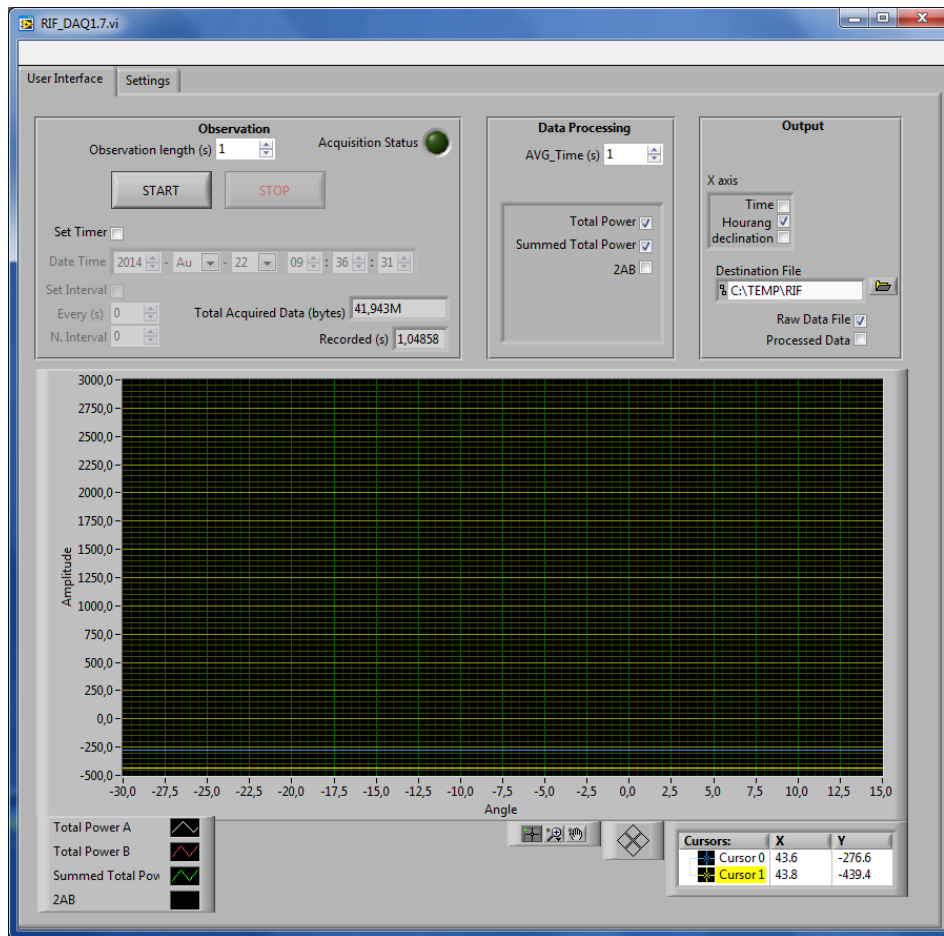


Figure 5: The RIF\_DAQ1.7.viData “User Interface” tab.

3. The saved files contain:

- (a) yyyyymmddhhmmss.cds: coordinate file with 11 columns: time in UTC (one column each for HH, MM, SS), HA\_A (deg), DEC\_A (deg), HA\_B (deg), DEC\_B (deg), error\_HA\_A, error\_DEC\_A, error\_HA\_B, error\_DEC\_B.
- (b) yyyyymmddhhmmss\_TPA.TXT: The file contains a single column with the total power from dish A in analog to digital units squared.
- (c) yyyyymmddhhmmss\_TPB.TXT: The file contains a single column with the total power from dish B in analog to digital units squared.
- (d) yyyyymmddhhmmss\_SSQ.TXT: The file contains a single column with the  $\sqrt{A^2 + B^2 + 2 \times A^2 \times B^2}$ .
- (e) yyyyymmddhhmmss\_Fringe.TXT: Unknown
- (f) yyyyymmddhhmmss.dat: Contains the raw data in binary format.

4. Running the reduction software on the Linux computer next to the control computer.

- (a) Log into the Linux computer to the right of the control computer using the password: schwarz2012.
- (b) **NOTE: At the moment all users of the RIF have administrative permissions. PLEASE DO NOT INSTALL OR UN-INSTALL PROGRAMS OR MAKE ANY CHANGES OF ANY KIND TO THE SETTINGS ON THE CONTROL COMPUTER.**
- (c) Create a folder on the desktop using your name as the folder name. **Please do not put data any where else than on the Desktop. Data that are not stored on the Desktop will be deleted first and questions asked later.**
- (d) Copy your data from the control computer into your folder using a flash drive.
- (e) Copy the reduction scrips and the file “\_rif.so” from the folder titled “REDUCTION\_SCRIPTS” on the desktop into the folder with your data.
- (f) You can now run the reduction scrips as described below.

5. Installing the reduction software on your own computer:

- (a) To install the reduction package on a computer you will need to have the following installed: Python, Numpy and C/C++ and FORTRAN compilers.
- (b) Copy the folder labeled “REDUCTION\_SCRIPTS” on the desktop to a computer running Linux.
- (c) Open a terminal and cd into the folder “Reduction\_Scriptsrif”.
- (d) Type “sudo python setup.py install” to install the software.
- (e) Test that the instillation was successful by going into python and typing “import rif”. If no errors are reported, the instillation was successful.

- (f) Copy the reduction scrips and the file “\_rif.so” from the folder titled “Reduction\_Scripts” on the desktop into the folder with your data.
  - (g) You can now run the reduction scrips as described below.
6. To run the scripts:
- (a) The scripts need to be in the same folder as your data.
  - (b) In the scripts, change the variable “RunNumber” to that of your data leaving out the extension. For example RunNumber = “20141029153945”.
  - (c) The scripts can now be run in Python in the normal way.
  - (d) If you get the error “Segmentation fault (core dump)” when running the scripts, it could be the result of a file being named incorrectly. Sometimes the slight time difference in creating the .dat and .cds files can cause the two filenames to differ (by a second) causing the error. To fix the problem, the incorrect file name needs to be corrected by hand.
7. Script outputs:
- (a) crosscorrelate\_dual\_channel.py: The script makes a plot of real (e.g. cosine; in blue) and imaginary (e.g. sine; in red) parts of the complex normalized cross correlation of the signal as a function of time.
  - (b) plot\_averagespectrum.py: The script makes a plot of power as a function of frequency for each of the two dishes.
  - (c) plot\_totalpower\_dual\_channel.py: The script makes a plot of power as a function of time for each of the two dishes.

### 0.3.8 The Signal Attenuators

If you are trying to observe anything except the sun or Cassiopeia A, the signal attenuators need to be removed from the signal path. Similarly if you are trying to observe the sun or Cassiopeia A, the signal attenuators need to be in the signal path to prevent the analog to digital converters from saturating. This section describes how to do this.

1. **BE VERY CAREFUL WHEN PUTTING THE ATTENUATORS IN THE SIGNAL PATH OR TAKING THEM OUT! THE CABLES CONNECTING THE ATTENUATORS ARE STIFF AND HEAVY, IF YOU ARE NOT CAREFUL OR FORCE THE ATTENUATORS IN OR OUT, YOU CAN DAMAGE OR BREAK THE PINS INSIDE THE CONNECTORS.**
2. The attenuators are on the wall directly behind and slightly to the right of the telescope control computers and are shown in Figure 6.
3. Each of the dishes have its own attenuator which in its self is made up of two smaller attenuators screwed together.



Figure 6: Image of the two signal attenuators in the signal path.

4. To remove or insert the attenuators, simply unscrew the signal cables (the black cables at the top) and screw in or screw out the attenuators before reconnecting the signal cables. **BE VERY CAREFUL WHEN DOING THIS, THE PINS INSIDE THE CONNECTORS CAN BREAK IF THE CABLES ARE BEING PULLED TO ONE SIDE WHILE SCREWING IN OR UNSCREWING THEM.**
5. Figure 7 shows a close up view of the attenuators where the attenuator for the left signal path has been removed.

### 0.3.9 How to Zero the Telescope Pointing

Below a description is given of how to recalibrating the telescope pointing if the pointing is off is given. In theory this only needs to be done once every few months or if the control software have been closed for more than a few days. In practice the telescope tends to decides from time to time that it likes where it is pointing and that it is going to point there no matter what you tell it. This can usually be fixed by zeroing the pointing.

1. Before doing anything, make sure that:



Figure 7: Close up image of the attenuators with the attenuator for the left signal path removed.



- (a) In the “Zero” tab (shown in Figure 8) the values for “Zero Offset HA” and “Zero Offset DA” are set to zero for both dishes.
  - (b) In the “Service” tab (shown in Figure 9), the values for “RA CAL. Offset” and “DEC CAL. Offset” are set to the values given in Table 2 and that the minus signs (if any) are in the correct positions.
    - NOTE: When entering values for the offset a zero value can never be negative. For example an offset 30 arcmin to the East should be entered as 00 -30 00 not as -00 30 00.
  - (c) If any of the above values were wrong, set them to the correct values. The pointing problem should now be fixed.
2. If the above values are correct, the telescope pointing can be checked by:
- (a) Point the telescope at the sun.
  - (b) Plot the total power received by each dish as a function of time as described in Section 0.3.5. Each dish should get a signal strength of around 1500 units. If the signal strength is less than 1500 the pointing is possibly off.
  - (c) While continuously plotting the signal strength for each dish, manual move each of the dishes (Section 0.3.3) North, South, East and West. In each case the signal strength should decrease as the dish is moved away from the center of the sun.
  - (d) If the signal strength increases by more than 100 units when you move the dish in a particular direction, it means that the pointing is off and that it needs to be re-calibrated.
3. If the telescope pointing is off, the pointing can be re-calibrated using the following steps:
- (a) The reason why the pointing slowly deteriorates over time is that the small errors in the encoders that tell the dish where it is pointing add up. Eventually this results in the dish pointing to a different place then where it thinks it is pointing (at least this is what happens when the telescope does not deliberately decide to be difficult and point every where except where you want it to point). To correct this the dishes are zeroed by pointing them at a RA and DEC reference position.
  - (b) The dish is zeros when both the “Status HA” and “Status DA” “Zero” lights are switched on at the bottom of the display.
  - (c) Each of the dishes can be moved to its zero position by:
    - i. For HA:
      - A. The HA zero switch is triggered when the dish is pointing due South. In other words you want to move the dish to point the same way that you are facing when sitting in front of the control computer. Turning the dishes to the West will turn them to the right while turning them towards the east will turn them to the left.

- B. Once you have selected the direction in which to turn the dish using the switch labeled as “Calibrate Towards” click on the “START” button to start the dish moving. When the dish reaches its reference position, it will stop moving and the zero light will switch on.
  - C. If the zero light does not switch on, but one of the limit lights does, it means that you have moved the dish in the wrong direction. In that case move the dish in the opposite direction until the zero light switches on.
- ii. For DA:
- A. The DA zero switch is located at an elevation of about  $60^\circ$  and is only triggered when moving towards the North.
  - B. Unless the dish is pointing close to the zenith, set the switch labeled as “Calibrate Towards” to North and click on the “START” button to start the dish moving. When the dish reaches its reference position, it will stop moving and the zero light will switch on.
  - C. If the zero light has not switched on by the time that the dish is pointing close to the zenith, or the dish was initially pointing close to the zenith, stop the dish from moving by clicking on the “STOP” button (the “START” button turns to a “STOP” button when you click on it and vice versa).
  - D. Set the calibration direction to South and start the dish moving. When the dish is pointing close to the horizon, stop the dish, set the calibration direction to North and start the dish moving. When the dish reaches its reference position, it will stop moving and the zero light will switch on.
- (d) Once all four the “Zero” lights are switch on, exit the Axis4 software using the “Exit” menu next to the “Tcp Server!” and “About!” menus in the top left of the screen. This saves the new positions. **Do not exit the program using the “×” icon in the top right of the screen. If you do this the new values will not be saved!**
  - (e) The pointing should now be fixed when you restart the program.
  - (f) After zeroing the dishes remember to put them back into “AUTO” mode as zeroing will automatically put them into “MAN” mode that disables tracking.
  - (g) If the pointing is still off, manually move the telescope to point somewhere completely different from its zero points and the re-zero the telescope.
  - (h) If this still does not work the procedure described in Section 0.3.10 can be followed.

### 0.3.10 How to Change the Pointing Offsets

If zeroing the telescope pointing (as described in Section 0.3.9) does not fix the pointing, the pointing can be fixed by changing the pointing offsets.

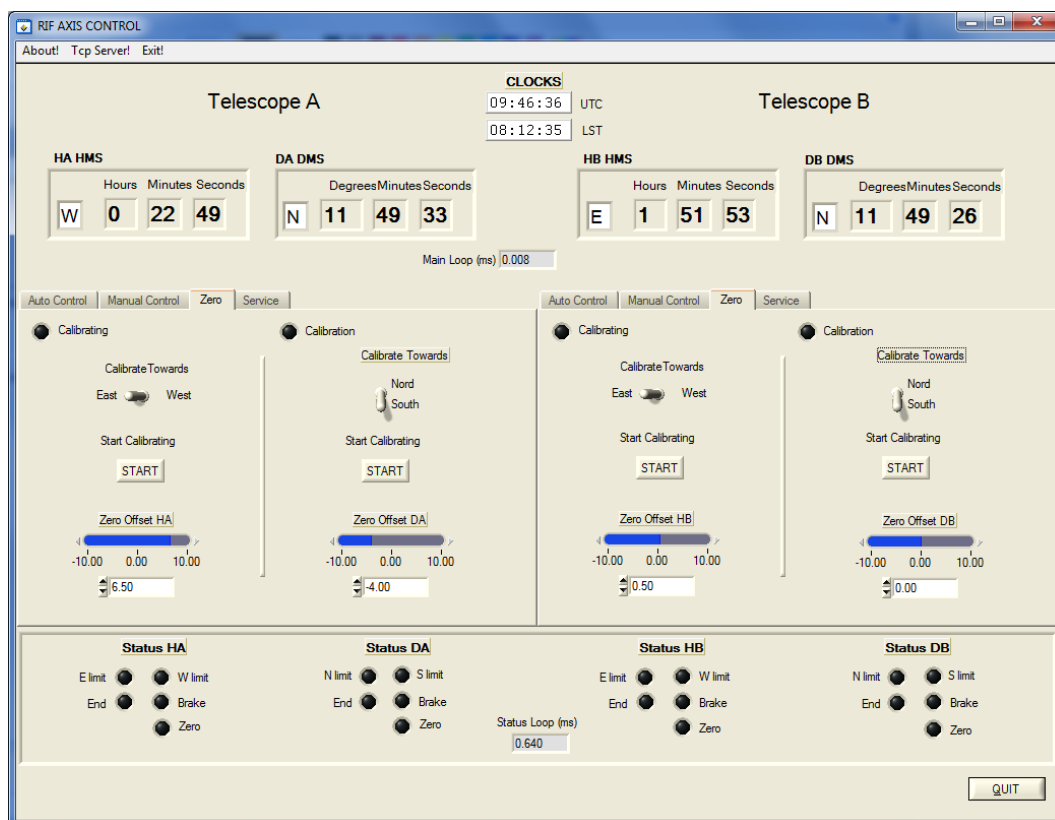


Figure 8: The Axis4 “Zero” tab.

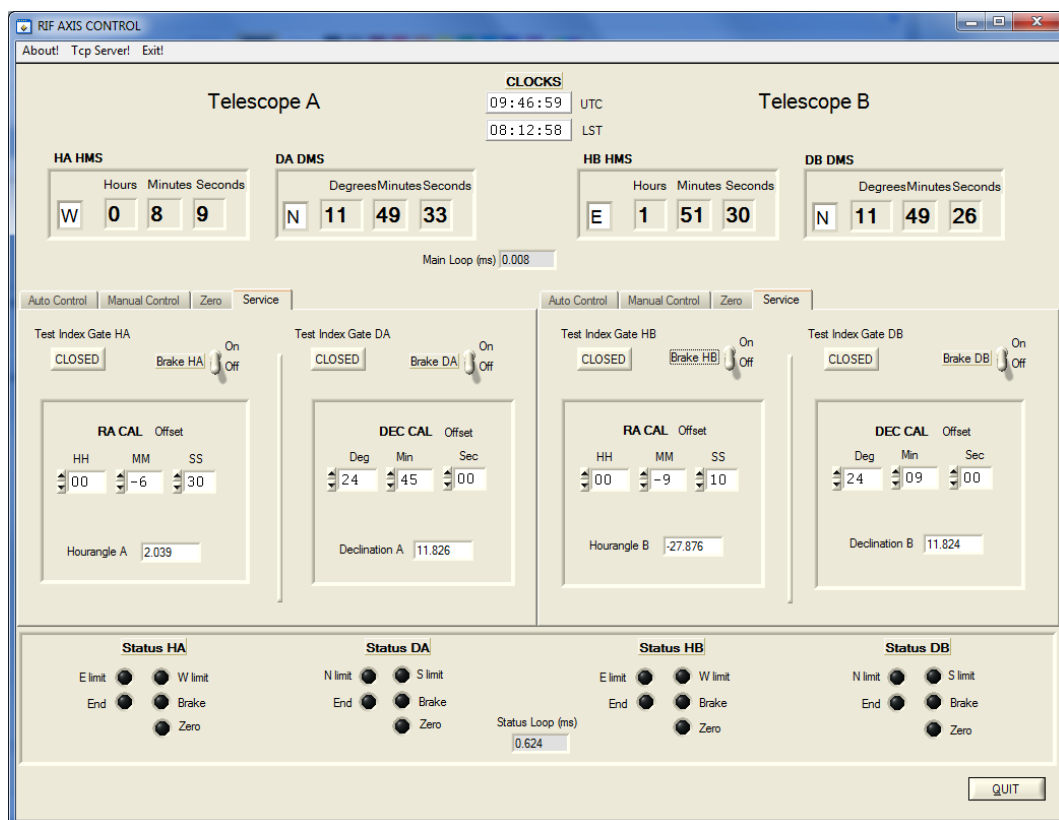


Figure 9: The Axis4 “Service” tab.

**NOTE: This should not be necessary and should not be done unless a major change has been made to the telescope. If you do this, please contact me at [r.coppejans@astro.ru.nl](mailto:r.coppejans@astro.ru.nl) or come to speak to me at my desk in room HG02.076 so that I can update the manual with the new values.**

**NOTE: If you do this and it turns out it was not necessary, you will screw up the pointing (which will result in me getting loads of emails from people that cant find their sources) I reserve the right to be very angry at you. Hence, make very sure this is necessary before you do this.**

**NOTE: If you do this and dont imidiatly email me saying you did it and give me the new zero values, I reserve the right to be insanely angry at you.**

1. Before doing anything, make sure that:
  - (a) In the “Zero” tab (shown in Figure 8) the values for “Zero Offset HA” and “Zero Offset DA” are set to zero for both dishes.
  - (b) In the “Service” tab (shown in Figure 9), the values for “RA CAL. Offset” and “DEC CAL. Offset” are set to the values given in Table 2.
2. If both sets of values above are correct, the pointing offsets can be changed by:
  - (a) Point the telescope at the sun.
  - (b) While continuously plotting the total power received by each dish as a function of time, change the values for “RA CAL. Offset” and “DEC CAL. Offset” for each dish in the “Service” tab. This will change the pointing offset of each dish with respect to its zero point.
  - (c) As you change the values, the dishes will automatically move to the new position changing the total power received by each of the dishes. The idea is to adjust the offset such that the maximum power is received by each of the dishes.
  - (d) Note that since the beam size is about 4.5 degrees there is no point in trying to get the pointing accuracy to better than 0.5’.
  - (e) To save the new calibration values exit the program using the “Exit” menu next to the “Tcp Server!” and “About!” menus in the top left of the screen. **Do not exit the program using the “×” icon in the top right of the screen. If you do this the new values will not be saved!**

### 0.3.11 Additional Notes

1. Export Data to Your Own Computer
  - (a) Open WinSCP Make a new session on host "helios.astro.kun.nl" with your own login name - don't save your password. It shows the local computer on the left and the remote on the right. Just drag files between folders to copy between computers.

## 2. Do Not Delete

- (a) There is a large data set at J:\20mrt2012 of the Sun at  $\text{DEC} = 0$ , taking by Peter. This data set can be used to aligned wave fronts exactly, and should not be deleted.

## 0.4 Elmar's New Software

This is notes that explain how use the new software that Elmar wrote and its peculiarities.

### 0.4.1 Starting Up

1. On the RIF controle computer:
  - (a) Start the Axis5 program by using the "Axis5.exe - Shortcut" link on the desktop and set the dishes tracking by clicking on "GO TO" next to the RA and DEC values of each dish in the "Auto Control" tabs.
  - (b) Using the Start menu, open Labview.
  - (c) Use the "Open Existing" tab to open "RIF\_DAQ\_DUAL\_CHANNEL\_EK\_UDP3.vi"
  - (d) Run the program by clicking on the arrow in the menu below the File menu.
  - (e) In the area labeled "Buffer and File Configuration" set the "Shift" value to 3.
2. On the Linux computer:
  - (a) Open a terminal and cd into `"/home/rifadmin/Scheduler"`.
  - (b) Start Python using the command `"ipython"`.
  - (c) Run the scheduler using `"run -i Scheduler2.py"`.
  - (d) NOTE: if you get an error saying "Error out of memory", restart the computer and repeat the three steps above.
  - (e) Open a web browser and go to `"http://rif-daq.astro.ru.nl:8080/rif"`.

### 0.4.2 Using the Software

The web interface is used to point the dishes, do cross-scans, set the scheduling and retrieve data files. To do this, you will need the password "Schwarz2012", note that the "s" is a capital letter. At the time of writing, the only source names that can bet entered into the "Point Telescope" interface is Crab, BLLac, M87, CygA. You can enter the coordinates of any other source using JHHMM+DDMM where H is RA hours, M is minutes and D is degrees.

The web interface will update once a second showing the target, current pointing, and the distance between the target and pointing. If the distance between the target and where the dishes are pointed is less than 0.1 for both dishes, the cross correlations and phases will be shown as a function of frequency on the interface.

### 0.4.3 When You Leave

**When you are done observing, please enable scheduling to ensure that the dishes are always tracking a target. If the dishes stand still, rain water will collect in them, causing them to rust.** To enable scheduling go to the “scheduling” link on the interface and enter “1” into the box labeled “Should we run the schedule?”. The password is “Schwarz2012”, note that the “s” is a capital letter.

## 0.5 Acknowledgments

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