# **The OBSINP Observing Software**

Since July 2010 a new antenna control and observing software is used at the Effelsberg 100m telescope. The interface for the observer is still called "OBSINP", like the old system, but it is now a graphical based control program. It allows the control of all observing modes possible at the Effelsberg antenna. This document gives a brief introduction to all the different sections in OBSINP for each observing mode. More details on how to set up and organize observations of different types are given in the individual sections of the User Guide.

All observations are stored and organized by a queue system that allows to prepare the next steps during your current observations are in progress. It also allow to prepare observations in advance for later processing at the telescope. The structure of the program is shown in Fig. 1.

🗙 MPIfR Effelsberg 100m	Telescope Control 🍥	
STOP	Continue Repeat START	
Select a widget:	General: Startup	
General: Control Startup Display: ScanList		
Telescope_Queue		
Frontends: Frequency Primary Secondary	Welcome to the Telescope Control Software of the MPIfR.	
Backends: AFFTS Beacon FFTS	Please type in the observers name and the project ID.	
SetupCont: Focus Mapping Pointing Skydip Tracking	Observer: Bach Operator: Georgi	
Setup Spec: FSwitch OnTheFly PSwitch Raster	Project code: Pointing Directory: /home/obseff/pointing	
SetupPulsar: PTracking Search7Beam	save settings	
SetupVLBI: VLBI Offsets: Focus_Offset Pointing_Offset		
STOP TelC	Control UserQueue TOPO:Auto Exit	

**Figure 1:** Startup screen of OBSINP. Some basic information and the observing directory should be given.

The buttons on the top are controlling the processing of telescope queue. The *Start* button will start the observations in the current queue. The *Stop* button will stop the observations. If the antenna stops

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for some reason or the observations are stopped by the user the current scan can be repeated from the beginning by pressing *Repeat. Continue* will continue the current scan at the sub-scan where the antenna was stopped. Pressing *Start* will abort the stopped scan and continue with the next scan in the queue.

On the left side the observer can choose from various menus on different topics that are mainly structured in a way that they guide through the observations. The general setup is made at the beginning including frontend and backend settings. The *SetupCont* menu contains windows for pointing and focus that every observation should start with and the other modes like spectroscopy, Pulsar and VLBI follow.

In detail there are:

#### General:

- *Control*: Allows to send commands directly to the telescope control software (take care! you have to know what you do). At the bottom the active queue can be selected.
- *Startup*: Observer-name, Operator, Project-Code, and the working directory should be set here. The working directory contains the observes catalogues and scripts. If not existing the program will create new directories called "Catalogues" and "Scripts".

#### Display:

- *ScanList*: Shows a scan list of the most recent 100 scans.
- *Queue*: Opens the QueueManager where the next scans in the selected queue can be inspected and modified.

#### Frontends:

- Primary: Selection of prime focus receivers.
- Secondary: Selection of secondary focus receivers.
- *Frequency:* To choose other than the default frequency of the selected receiver.

#### Backends:

- AFFTS: Initialization of the AFFT Spectrometer.
- Beacon: Reserved for the beacon continuum backend. No action yet.
- FFTS: Initialization of the FFT Spectrometer.

#### SetupCont:

- Focus: Prepare for a focus scan.
- *Mapping:* Control menu for continuum on the fly maps. Allows to prepare single maps by "hand" or loading of templates for maps or complete list of sources to be mapped.
- *Pointing:* Control menu for cross scans (pointings). Allows to prepare single cross scans by "hand" or loading of templates for the cross scan parameters or complete list of sources to be send to the queue.
- *Skydips:* Do a sky dip.
- *Tracking:* Just track a source for a given time.

#### SetupSpec:

- FSwitch: Control menu for frequency switched spectroscopic observations.
- OnTheFly: Allows scanning of on the fly spectroscopic maps.

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- *PSwitch:* Control menu for position switched spectroscopic observations.
- *Raster:* Setup a raster map observation. Can be used with *FSwitch* and *PSwitch*.

#### SetupPulsar:

- PTracking: Pulsar Tracking mode.
- Search7Beam: Pulsar Search with the 21cm 7-Beam RX.

SetupVLBI (See VLBI-Handbuch):

• VLBI: Activates the VLBI Queue and listens to a port to receive command from the VLBI Field system.

#### Offsets:

- *Focus\_Offset:* Is needed to load the automatic correction of a focus scan to the antenna. Allows also manual corrections at any time.
- *Pointing\_Offset:* Allows to load the pointing correction of a pointing scan that was done with *POINTcorr 0* or manual corrections of the pointing at any time Pointing for more details).

The buttons at the bottom have the following functions:

- *STOP TelControl*: Stops the antenna control program. Only rarely needed, e.g. in the case of problems with the continuum backend BEACON.
- UserQueue or OperatorQueue: Button to change the active queue.
- TOPO Auto, TOPO North, and TOPO South: Button to selected the preferred azimuth driving direction to reach sources in the overlapping region between 30 and 150 degrees. With TOPO North one can continue to reach sources from north to east (corresponds to 360 degrees and more) up to 510 degrees. Using TOPO South allows to reach sources between azimuth 30 and 50-60 degrees from the south to east direction.

# General

The *General* Menu has to sub topics Control and Startup. In the Control widget (Fig. 2) the observer can send commands directly to the telescope control software (take care! you have to know what you do). The syntax for this is written down elsewhere. It is possible to prepare configuration files that can be load by typing '@config-file'.

At the bottom the active queue can be selected. The "normal" queue for the observer is the UserQueue, but if e.g. the operator has to test something in between or the observer wants to insert a scan without changing his current queue, the active queue can be change to the OperatorsQueue and filled with alternative scans, be observed, and changed back to the UserQueue for further observations.

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MPIfR Effelsberg 100m Telescope Con	trol 🍥			
STOP	Continue	Repeat	START	
elect a widget: $igsqcup_{\!$	ontrol			
eneral: Control		Commands:		-
Startup				
isplay:				
ScanList Telescope_Queue				4
	Clear Undo Redo	Prev Next	Execute	
ontends: Frequency				F
Primary				
Secondary				
ackends: AFFTS				
Beacon				
FFTS				
etupCont: Focus				
Mapping				
Pointing Skydip				
Tracking				
etupSpec:				
FSwitch OnTheFly				
PSwitch				
Raster				
etupPulsar: PTracking				
Search7Beam				
etupVLBI:				
VLBI				
ffsets:		Select queue:		
Focus_Offset Pointing_Offset		UserQueue		
STOP TelControl	UserQueue	TOPO:Auto	Exit	1

**Figure 2:** The Control screen allows to send commands directly to the telescope control software (take care! you have to know what you do). At the bottom the active queue can be selected.

The Startup widget is the first screen that appears when you call OBSINP and should be filled with the information that is requested: Operator, Observer, Project-Code, and the working directory. The observers directory will contain the folders for his own catalogues and scripts. The directories are called Catalogues and Scripts and will be created by the system if not already existing. The preparation of scripts is described later in the Pointing and Spectroscopy sections.

### Catalogs

With the new Obsinp observing software, source catalog files are stored in the SDB (structured data base) format. This format is somewhat less easy to understand as the (old) VAX source catalogs. However, there exists a script catalog.py, which can be used to convert files having the old VAX format to the new Obsinp format. Using

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```
catalog.py sources.cat
```

on the **be4** computer will create a file sources.sdb. If you place it into your\_directory\_on\_be4/Catalogues it will be found automatically by Obsinp (if you choose the correct startup directory).

For the preparation of your observations we recommend to prepare a catalog in the VAX format and convert it into the new format afterwards.

Alternatively, you might use our catalog tool for creating and editing catalogs, see pycatalog.

# Display

The *ScanList* shows the most recent 100 scans with some basic information about observing modes and receivers used (Fig. 3, top).

STOP		Continue		Repeat		START	
Select a widget:	Observation List						
General:							
Control	Observati	on Liet					
Startup							_
		B OBJECT S			TE_OBS		<u>k</u>
Display:	3870 2		ONOFF	P22mm-FFTS	2010-07-19T11:45:45		
ScanList	3869 2		ONOFF	P22mm-FFTS	2010-07-19T11:37:22		
Telescope_Queue	3868 4		POINT		2010-07-19T11:32:40		
	3867 4		POINT		2010-07-19T11:29:50		
Frontends:	3866 4		POINT	P22mm-PBE 2	2010-07-19T11:27:12		
Frequency	3865 4		POINT	S110mm-PBE	2010-07-17T21:17:40		
Primary	3864 4	3C286	POINT	S110mm-PBE	2010-07-17T21:09:55		
Secondary	3863 1	3C286	POINT	P7_210mm-PBE	2010-07-17T18:23:29		
	3862 1	3C286	POINT	P7_210mm-PBE	2010-07-17T18:21:10		
Backends:	3861 4	3C286	POINT	P7_210mm-PBE	2010-07-16T16:50:26		
AFFTS	3860 2	3C286	FOCUS	P7_210mm-PBE	2010-07-16T16:47:35		
Beacon	3859 4	3C286	POINT	P7_210mm-PBE	2010-07-16T16:44:17		
FFTS	3858 2	3C286	FOCUS	P7_210mm-PBE	2010-07-16T16:41:46		
	3857 4	3C286	POINT	P7 210mm-PBE	2010-07-16T16:37:32		
SetupCont:	3856 4	3C286	POINT	P7 210mm-PBE	2010-07-16T16:13:12		
Focus	3855 4	3C286	POINT	P7 210mm-PBE	2010-07-16T14:20:23		
Mapping	3854 1	ISOSSJ04	225+515 ON	 P7 210mm-FFTS	2010-07-16T12:46:	15	
Pointing	3853 1	3C138	POINT	P7 210mm-PBE	2010-07-16T12:45:02		
Skydip	3852 1	ISOSSJ04	225+515 ON	P7 210mm-FFTS	2010-07-16T12:44:	)6	
Tracking	3851 1		225+515 ON	P7 210mm-FFTS			
macking	3850 1		225+515 ON	P7 210mm-FFTS			
SetupSpec:	3849 1		225+515 ON	P7 210mm-FFTS			
FSwitch	3848 1		225+515 ON	P7 210mm-FFTS			
OnTheFly	3847 1	3C138	POINT	P7 210mm-PBE	2010-07-16T12:31:23		
PSwitch	3846 4		POINT	P7 210mm-PBE	2010-07-16T12:26:03		
Raster	3845 4		POINT	P7 210mm-PBE	2010-07-16T12:23:45		
naster	3844 2		FOCUS	P7 210mm-PBE	2010-07-16T12:19:47		
Potus Duloon	3843 4		POINT	P7 210mm-PBE	2010-07-16T12:16:32		
SetupPulsar:	3842 2		POINT	P7 210mm-PBE	2010-07-16T09:32:32		
PTracking	3841 4		POINT	P7 210mm-PBE	2010-07-16T08:52:29		
Search7Beam	3840 4		POINT	P7 210mm-PBE	2010-07-16T08:49:05		
	3839 4		POINT	P7 210mm-PBE	2010-07-16T08:45:22		
SetupVLBI:	3838 1	3C130	POINT	-	2010-07-16T06:43:22		1
VLBI	1 OLUL	JC147	FOINT		.010-07-10100.42.34	I V	
STOP TelContr	rol	UserQueu	e	TOPO:Aut	to I	Exit	

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STOP		Continue	F	epeat	START
Select a widget: General:	Queue Manager for	Observations			
Control					
Startup					
Display:					
ScanList					
Telescope_Queue					
Frontends:			ShowQ	ieue	
Frequency					
Primary Secondary		Qı	ueue Manager	(UserQueue)	
	N Source	Type Subs	cans ObsTime[m	in] Pointing	۲ <b>۳</b> ٦
Backends: AFFTS			Omm	ing rounding	
Beacon	2 30286	POINT	4 1.7		
FFTS	3 3C286 4 Frontend		4 1.7 6mm		
	5 3C286	POINT	4 1.7		
SetupCont:	6 Frontend		10mm		
Focus	7 3C286 8 Frontend		4 1.7 28mm		
Mapping Pointing		POINT	4 1.7		
Skydip	10 30286		8 3.3 20mm		
Tracking	11 Frontend 12 3C286 13 3C286		4 1.7		
3	13 3C286	POINT	8 3.3		
Setup Spec :	14 Frontend 15 3C286		13mm 4 <u>1</u> .7		
FSwitch	100200	DOTIT	4 1.7		
OnTheFly	ClearQue		ClearFirst	ClearLast	Refresh
PSwitch Raster	Cical due		Gearnat	Cied Last	nencan
naster					
SetupPulsar:			selected queue	HearOusus	
PTracking			selected queue	: OserQueue	
Search7Beam					
SetupVLBI: VLBI					
YL01					
Offsets:					
Focus_Offset					
Pointing_Offset					

**Figure 3: Top:** The ScanList shows the most recent 100 scans with some basic information about observing modes and receivers used. **Bottom:** Example for a queue filled with pointing scans using different secondary focus receivers.

The *Telescope\_queue* (or Queue Manager) displays the current queue and allows to shift and delete scans from the queue (Fig. 3, bottom). The current UserQueue is written as single files for each action in the /home/obseff/.SYSTEM/Queue/User directory. To prepare observations in advance or save queues for repeated observations like monitoring it is possible to save the queue-files or directory at some other place and restored it later again. For example you can write the files in a compressed tar-archive: change into the UserQueue directory and run "tar -czf ../../<dir-name>/todays\_queue.tar.gz \*" to save all files into your directory in todays\_queue.tar.gz. "tar -xzf todays\_queue.tar.gz" will extract the files in the current directory.

# Frontends

The *Frontends* entry in the widget selection contains two menus for the selection of secondary and primary focus receivers. Each receiver has different versions. For most continuum observations the Continuum BroadBand (BB) version is the best choice, since it provides the maximum band width. For Pulsar observers the pulsar versions and for spectroscopy observations one of the line version should be chosen:

- Line (BW 100 MHz), corresponds to the narrow band IF (100-200MHz, centered at 150MHz) with 100MHz band width.
- Line (BW 500 MHz), correspond to the broad band IF (500-1000MHz, centered at 750MHz) with 500MHz band width.

 Note the XFFTS IF and filters have to be chose accordingly: first the IF center 150MHz (narrow band) or 750 MHz (broad band) and then the required filter depending on the resolution needed.

**There is no default version, the observer must select one**. Not all receivers provide both IFs. Frequency and side band have defaults that should be fine for most continuum observers. For spectroscopy the correct line frequency has to be given, the side band selection is done automatically. A manual side band selection is not recommended. More details about the receiver versions can be found here (in progress) and the receiver capabilities are described here.

STOP		Continue		Repeat		START	
Select a widget:	RX: S28mm	Vers: Cont/Line (BW: 300 MHz) [1]	Freq: 2.640257	SideBand: Upper	Horn: O		
Generat: A Startup Startup Control Display: ScanList Telescope_Queue							
Frontends: Primary Secondary Frequency		Set	condary Focu	s RX ( UserQue	ue)		
Backends: FFTS AFFTS		RX: S28mm Vers: Cont/Lir	ie (B₩: 300 MHz)	1] Freq: 10.450000	SideBand: L	Jpper Horn: O	
XFFTS MultiFiBa Beacon		RX					
SetupCont: Pointing		Receiver: S28mm 4	-Beam -	Version:	please choo Upper		
Focus Mapping Tracking Skydip		Horn: 0	-		2] – c[5]–c[6])/2		
SetupSpec: FSwitch PSwitch							
Raster OnTheFly LPointing LFocus			Load to te	lescope queue			
SetupPulsar: PTracking Search7Beam							
SetupVLBI: VLBI							
STOP Tek	Control	UserQueue		TOPO:Auto		Exit	

Fig. 1: Image of the receiver selection menu.

The *Frequency* menu allows the selection of lines by name from a line catalogue or the direct input of a frequency in GHz. You can add private line catalogues to your Catalogues directory. The catalogue should have the extension .lin. The format is Line-Name - Frequency in GHz, e.g. H58gamma 93.775900

Please note, that some receiver have different versions for different frequency ranges. E.g. the 1.3cm prime focus receiver has two version from 18 to 22 GHz and from 22 to 26 GHz. Take care that the

correct version was loaded before changing the frequency from the *Frequency* menu.

# Backends

For the continuum backend Beacon there are currently no options. From the two menus for the FFT Spectrometers (XFFTS and AFFTS) the IF channel, the number of channels, and the filter (total band width) can be selected.

# **Continuum observations - SetupCont**

Every observing session should start with a sequence of pointing, focus, and pointing observations to verify that the system is working properly. Bright suitable sources are displayed on the AstroPC in the control room. Many of the primary flux density calibrators are suitable for that and can be directly used for calibration. For spectroscopy it is also recommended to observe a known line source to verify the proper functionality of the FFTS (see Spectroscopy). Continuum data as cross-scans and maps can be viewed offline and reduced using the Toolbox

### Focus

- *SCANFocus*: selection of different axis of the focus control. The only axis that needs to be adjusted is the z-lin axis (along the optical axis) of the sub-reflector
- *Distance*: driving distance for the focus. The default is set to the wavelength in mm times 2.5, given as "-2.5". This is a good option. Other negative numbers mean other multiples of the wavelength. Positive numbers are interpreted as millimetres. The maximum movable range of the sub-reflector is about 200mm. If the given distance is exceeding the limits the system automatically limits those values.
- *Velocity*: driving speed of in mm/sec. 2 to 4 mm/sec are okay for most purposes, limit is 10 mm/sec.
- *SCANRepeats*: number of sub-scans. At least two sub-scans should be made to avoid hysteresis effects.

After completion of the focus scan the active queue will be stopped and the antenna is waiting for new input. If the fit was successful the focus correction will now appear in the *Offsets: Focus\_offset* menu at the bottom of the left widget list in the ZLinear field. If the fit failed or the value needs to be corrected by hand for some reason this can be done here as well. Pressing *Load to telescope queue* will load the corrections to the first position in the queue independent of how many other scans are in the queue already. The antenna will continue observing with the new corrections after the *Start* button is pressed. When the focus corrections are not applied manually, pressing the *Start* button will continue the observations without using any focus corrections.

### Mapping

The *Mapping* menue allows to cover a defined area around a given position of an (extended) radio source with many divers options. Usually, the position of the source is taken as the reference point

(but not necessarily the map centre) with the parameters *ObjectName* and its coordinates given in the coordinate system chosen by *CoordinatSystem*, *Equinox*, and *Projection* (either Cartesian or as Sanson-Flamsted (SFL)), with the corresponding coordinates written in *ObjectLongitude* in [hh.mm.ss] and *ObjectLatitude* in [d.'."]. Instead of typing in the coordinates you can automatically select them from a source catalog chosen in *Catalog* where you also can access one of your private catalogs. For observations with multihorn receivers you should always scan along azimut so that all horns will cover the source subsequently. Therefore please choose *Azimth/Elevation* in *Scanning\_in*. In this case it doesn't matter what you choose in *CoordinateSystem* and *SCANDirection*.

X MP#R Effelsberg 100m Telescope	Control 🎱
STOP	Continue Repeat START
Select a widget:	Equinox : J2000
General: Control Startup Display: ScanList Telescope_Queue Frontends:	Mapping ( OperatorQueue )         ObjectName M82       Search       Catalog       Default       —
Frequency	
Primary Secondary	ObjectLongitude 09 51 44.0 s ObjectLatitude 69 54 59 "
Backends: AFFTS	LonOff 0.0 LatOff 0.0
Beacon FFTS	ExtensionLongitude 10.0' ExtensionLatitude 12.0'
SetupCont: Focus Mapping	CoordinateSystem Equatorial - Equinox J2000 -
Pointing Skydip	Projection Cartesian - UserSystem Descriptive -
Tracking SetupSpec:	SCANDirection Longitude - Scanning_in CoordinateSystem -
FSwitch OnTheFly	SCANRotation 0.0
PSwitch Raster	SCANVelocity 30'
SetupPulsar: PTracking	SCANSpacing 30"
Search7Beam	SCANRepeats 1
SetupVLBI:	SubSCANStart 1
VLBI Offsets: Focus_Offset Pointing_Offset	ZigZag True - Defaults SaveScript
	Load to telescope queue
7	
STOP TelCont	ol OperatorQueue TOPO:Auto Exit

Figure 4: Example of how to fill the mapping template.

If you wish to get a rectangular map of your source (which is the standard way), please choose *UserSystem=Descriptive*. The option *Absolute* will give the map in absolute coordinates. A few recommendations how to set up maps for different receiver systems are given here.

The coverage usually starts at the lower left corner of the map, scanning either along *Longitude* or *Latitude* as chosen in *SCANDirection*. With the parameter *SCANSpacing* you choose the distance of the next subscan of your map above the first one along which the telescope drives backwards. The telescope's beam will cover the total map with this *SCANSpacing* forwards and backwards (if you

choose *ZigZag*= *True*) with a velocity given by *SCANVelocity* (give [unit]/sec, i.e. 30" means 30 "/sec starting with the *SubSCANStart* (which is 1 if you start the map from the beginning). Notice, that you need e.g. 21 subscans for a mapsize of 30'x20' (with *SCANDirection*=Longitude) if your *SCANSpacing* is 1'. With *SCANRepeat* you choose how often you repeat one subscan, it is usually set to 1.

The total map extent is given in *ExtensionLongitude* and *ExtensionLatitude*. Please give the units explicitely, either in ", ', or deg, no unit means by default degrees. You may also define an offset of the map center relative to the source position in longitude with *LonOff* and in latitude with *LatOff* which is necessary for multibeam observations. With *ScanRotation* the total map can be rotated relative to the chosen coordinate system, positive value means anticlockwise rotation, starting at north.

There are two other options if you don't like to start observing your map in the lower left corner: if you choose the *SCANVelocity* negative, the telescope starts the first subscan driving along minus longitude, with a negative value for *SCANSpacing* it goes down (instead of up) from one subscan to the next one. Hence, if you choose both parameters negative, the telescope starts at the upper right corner of the map.

With the option *Load to Telescope queue* you can add this specific mapping menu to the end of the telescope queue.

### Pointing

The *Pointing* menu allows to customize the cross-scans parameters and load scans into the active queue. **The** *Defaults* **button will reset all parameters.** If you are new to the system and don't know what kind of observations were done before it is wise to press default to reset unwanted source position offsets or special features that are not generally used. The template has the following fields (see Fig. 5):

- *ObjectName*: type in the source name. The source name must be written exactly as in the catalogue. No minimum match option is available.
- *Catalog:* specify the catalogue to look for the coordinates of the source.
- press *Search* to search for the given source.

A successful search will fill the *ObjectLon.* and *ObjectLat.* fields with the correct values and will set the *CoordinateSystem* and *Equinox* as given in the catalogue. The new catalogue format is somewhat cryptic and therefore it is recommended to just convert your old VAX-catalogues using the program "catalog.py". A new catalogue preparation tool is planed.

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X MPIfR Effelsberg 100m	Telescope Control 🧿				
STOP		Continue	Repeat	S	START
Select a widget:	🖞 ObjectName : 3C28	6			
General: Control Startup Display:		Ρ	'ointing(UserQueue)		
ScanList Telescope_Queue	ObjectName	3C286	Search	Catalog	uwe —
Frontends: Frequency Primary	ObjectLongitude			ObjectLatitude	
Primary Secondary	Off_Azimuth	0.0		Off_Elevation 0.	.0
Backends: AFFTS Beacon FFTS	Coordinate System	Equatorial —		Equinox	J2000
SetupCont: Focus	SCANDirection	Longitude/Latitude —		Scanning_in A	zimuth/Elevation 😑
Mapping Pointing	SCANRotation				
Skydip Tracking	SCANLength SCANTime			POINTcorr 1	
Setup Spec: FSwitch	SCANRepeats				
OnTheFly PSwitch Raster	ZigZag	True 😑	Defaults		SaveScript
SetupPulsar: PTracking Search7Beam			Load to telescope queue		
SetupVLBI: VLBI					
STOP TelCo	ntrol	UserQueue	TOPO:Auto	E	xit

Figure 5: Search in the catalogue for a new source.

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🗙 MPIfR Effelsberg 100m Tel	escope Control 🍥					
STOP		Continue	Repeat		START	
Select a widget:	startup found					
General: Control Startup						
Display: ScanList Telescope_Queue						
Frontends: Frequency		P	ointing(UserQueue)			
Primary Secondary	ObjectName	3C286	Search	Catalog	uwe 🛁	
Backends: AFFTS	ObjectLongitude	13 31 08.284 s		ObjectLatitude	30 30 32.94 "	
Beacon FFTS	Off_Azimuth [	0.0		Off_Elevation	0.0	
Setup Cont: Focus Mapping Pointing	Coordinate System	Equatorial 😑		Equinox	J2000	]
Skydip Tracking	SCANDirection	Longitude/Latitude 😑		Scanning_in	Azimuth/Elevation =	
SetupSpec: FSwitch	SCANRotation					
OnTheFly PSwitch	SCANLength SCANTime			POINTcorr	1	
Raster	SCANRepeats				1	
SetupPulsar: PTracking Search7Beam	ZigZag	True 😑	Defaults		Save Script	
SetupVLBI: VLBI						
Offsets:			Load to telescope queue			
Focus_Offset Pointing_Offset						_
STOP TelCo	introl	UserQueue	TOPO:Auto		Exit	

Figure 6: Completely filled cross-scan form before it can be loaded to the queue.

The Scanning in, SCANDirection, -Rotation, -Length, -Time, and -Repeats options are more or less selfexplanatory, but to be save:

- SCANRoation: this parameter allows to rotate a cross-scan by the given amount in degrees, counting is anti-clockwise, starting at north.
- SCANLegth: is by default given in multiples of the beam size (e.g. at 6cm the beam is about 146 arcsec and -4 means 4 times 146 arcsec= 584 arcsec), a positive number means degrees (take care even small numbers can mean very long scans) but the ' and the " symbols behind a given number can be used to denote minutes or seconds, respectively.
- SCANTime: driving time per subscan in seconds.
- SCANRepeats: means repeats per scan direction. E.g. SCANRepeats 2 will do two in Azimuth and two Elevation, four subscans in total.
- POINTcorr allows to control the use of the automatic pointing correction (see Tab. 1).

**Table 1:** Meaning of different numbers in POINTcorr.

Value	Meaning
-1	no corrections applied, queue is continued without interruption
0	no corrections applied, queue is halted. Observer needs to decide whether he wants to correct manually using the <i>Pointing_Offset</i> menu
1	corrections are applied automatically, if amount is less than one beam
2	corrections are applied automatically, if amount is less than two beams
	continues like this but doesn't make much sense

A completely filled form is shown in Figure 6. Pressing *load to telescope queue* will send the pointing scan to the queue and more scans can be added. The *Start* button will start the queue and more scans can be loaded while the antenna is running. If the queue is ones empty and new scans are added the *Start* button has to be pressed again to continue observing. If the antenna stops for some reason or the observations are stopped by the user the current scan can be repeated from the beginning by pressing *Repeat. Continue* will continue the current scan at the sub-scan where the antenna was stopped. Pressing *Start* will abort the stopped scan and continue with the next scan in the queue.

### Scripting

The *SaveScript* button will save the current pointing parameters into a file called "Pointing" in your Scripts directory. This can be used to reload the parameters at a later time again. Such scripts are called from the *Pointing* menu by typing "@Pointing" in *ObjectName* and press *Search*. All fields will be filled with the parameters found in the script. Pressing *load to telescope queue* will send the new scan to the queue. Such saved scripts can also be used as templates to make new scripts by "hand", but most parameters does not need to be changed so one can also reduce the scripts to the parameters that might change from scan to scan. All parameters need to be separated by a ";" and the parameter from its values is separated by a blank. E.g. to simply load two scans at a time to the queue use the following script:

```
3C286 ; POINTcorr 1 ; SCANRepeats 2 ; SCANTime 25 ; TopoMode AUTO ; Catalog
Default
3C286 ; POINTcorr 1 ; SCANRepeats 2 ; SCANTime 25 ; TopoMode AUTO
```

To load more different scans on different sources, parameters can be changed. The source needs to be always at the first position other parameters don't need to be in some order.

3C286 ; POINTcorr 1 ; SCANRepeats 2 ; SCANTime 25 ; TopoMode AUTO 3C147 ; SCANTime 25 ; POINTcorr 1 ; SCANRepeats 2 ; TopoMode AUTO

If no parameters change you only need to note them once and the following scans will be done with the same settings. E.g.

3C286 ; POINTcorr 1 ; SCANRepeats 2 ; SCANTime 25 ; TopoMode AUTO 3C48 3C147

More useful might be scripts without a source name at the beginning. E.g., if you prepare a script called "cal2":

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; POINTcorr 1 ; SCANRepeats 2 ; SCANTime 25 ; TopoMode AUTO ; POINTcorr 1 ; SCANRepeats 2 ; SCANTime 25 ; TopoMode AUTO

it can be used to do two cross-scans after each other just by typing "@cal2:3C286" or "@cal2:3C48" to make two cross-scan on that source.

With the "FE:" key one can also select different secondary focus receivers to be loaded automatically. Versions are controlled by the "VERn" option and frequencies can be changed by the "Frequency" key. A script for all receivers looks like this:

```
#
# 2.8cm Continuum narrow band (BW 300MHz) + Polarimeter, beam switch
#
FE:S28mm
 ; POINTcorr 1 ; SCANLength -4 ; SCANRepeats 2 ; SCANTime 25
  POINTcorr 1 ; SCANLength -4 ; SCANRepeats 2 ; SCANTime 25
 ;
#
# 9mm Continuum broad band (BW 4 GHz), beam switch
#
FE:S9mm ; VERn 2; Horn 5
 ; POINTcorr 1 ; SCANLength -4.5 ; SCANRepeats 2 ; SCANTime 25
 ; POINTcorr 1 ; SCANLength -4.5 ; SCANRepeats 4 ; SCANTime 25
#
# 2cm Continuum broad band (BW 2 GHz) + VLBA Polarimeter
#
FE:S20mm ; VERn 3
 ; POINTcorr 1 ; SCANLength -4.5 ; SCANRepeats 2 ; SCANTime 25
 ; POINTcorr 1 ; SCANLength -4.5 ; SCANRepeats 2 ; SCANTime 25
#
# 7mm LSB Continuum broad band (BW 2 GHz), LCP at 42.9 GHz
#
FE:S7mm
 ; POINTcorr 1 ; SCANLength -4.5 ; SCANRepeats 4 ; SCANTime 25
  POINTcorr 1 ; SCANLength -4.5 ; SCANRepeats 4 ; SCANTime 25
 ;
#
# 1.3cm Continuum broad band (BW 2 GHz) + VLBA Polarimeter
#
FE:S13mm ; VERn 3
 ; POINTcorr 1 ; SCANLength -4.5 ; SCANRepeats 2 ; SCANTime 25
 ; POINTcorr 1 ; SCANLength -4.5 ; SCANRepeats 4 ; SCANTime 25
#
# 3.6cm Continuum broad band (BW 1.1 GHz) + Polarimeter
#
FE:S36mm
 ; POINTcorr 1 ; SCANLength -4.5 ; SCANRepeats 2 ; SCANTime 25
  POINTcorr 1 ; SCANLength -4.5 ; SCANRepeats 2 ; SCANTime 25
 ;
#
# 6cm Continuum broad band (BW 500 MHz) + Polarimeter, beam switch
#
FE:S60mm
```

```
; POINTcorr 1 ; SCANLength -4 ; SCANRepeats 2 ; SCANTime 25
#
# 11cm Continuum narrow band (BW 80 MHz) + 8K Polarimeter
#
FE:S110mm
; POINTcorr -1 ; SCANLength -4.5 ; SCANRepeats 2 ; SCANTime 25
```

Saved as "all" such a script can be again combined in another script to observe a number of sources at all available receivers. E.g. a script called "go\_poi" might contain

```
#Calibrator at all SFK RX
@all:NGC7027
#Target source at all freq
@all:3C454.3
#Target source at all freq
@all:bllac
#Target source at low freq only
@low:2318+049
# Again a calibrator
@all:NGC7027
```

Lines starting with "#" denote comments. This script will measure first NGC7027 at all secondary focus receivers and then 3C454.3 and BLLac. 2318+049 is only observed at the lower frequencies and NGC7027 again at all. Such a script will run for about 2.5 hours.

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🗙 MPIfR Effelsberg 100m Te	lescope Control 🍥		
STOP	Continue	Repeat	START
Select a widget:	ObjectName : @all:3C286		
General: Control Startup			
Display: ScanList Telescope_Queue			
Frontends: Frequency	P	ointing(UserQueue)	
Primary Secondary	ObjectName @all:3C286	Search	Catalog Default -
Backends: AFFTS	ObjectLongitude		ObjectLatitude
Beacon FFTS	Off_Azimuth 0.0		Off_Elevation 0.0
Setup Cont: Focus Mapping	Coordinate System Equatorial —		Equinox J2000 —
Pointing Skydip Tracking	SCANDirection Longitude/Latitude —		Scanning_in Azimuth/Elevation =
Setup Spec:	SCANRotation 0.0		
FSwitch OnTheFly	SCANLength -4		
PSwitch Raster	SCANTime 30 SCANRepeats 2		POINTcorr 1
SetupPulsar: PTracking Search7Beam	ZigZag True -	Defaults	Save Script
SetupVLBI: VLBI			
Offsets: Focus_Offset		Load to telescope queue	
Pointing_Offset			
STOP TelC	ontrol UserQueue	TOPO:Auto	Exit

**Figure 7:** It is possible to load scripts that perform several pointings. To load a script into the queue type "@script" (if the source is in the script) or "@script:source" (if the source field is free) in *ObjectName*, then press *Search* and *load to telescope queue*.

# Spectroscopic observations - SetupSpec

Every observing session should start with a sequence of pointing, focus, and pointing observations to verify that the system is working properly. Bright suitable sources are displayed on the AstroPC in the control room. Many of the primary flux density calibrators are suitable for that and can be directly used for calibration. For spectroscopy it is also recommended to observe a known line source to verify the proper functionality of the FFTS.

Currently, there are two basic measurement schemes implemented, i.e., position and frequency switching. In position switching, one defines a so-called reference (REF) position which is used to remove the bandpass from the On-source (ON) spectrum. In frequency switching the reference spectrum is obtained by using a slightly different local oscillator (LO) frequency. For more information

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on these methods we refer to (insert link here).

Of course the above methods are more or less independent on the astronomical observing mode, i.e. a pointed observation or a mapping (either in a Raster or On-the-fly). In order to have a pointed observation, one just chooses from *SetupSpec*:

- FSwitch: Control menu for frequency switched spectroscopic observations.
- *PSwitch:* Control menu for position switched spectroscopic observations.

Figures 8 and 9 show the associated input masks, which the user has to fill. The fields have the following meaning

### FSwitch (Pointed Observation using Frequency Switching)

- *ObjectName* Choose the name of your source (which ideally is contained in your source catalog). Click search!
- *Catalog* Choose your source catalog. (You need to define the correct directory in the startup page.)
- *ObjectLongitude and ObjectLatitude* Source coordinates. If the source (under ObjectName) was not found in the catalog after clicking search, the input fields will turn yellow.
- LonOff and LatOff If you want to choose a certain offset for the source position, you can use these fields. There are two possibilities for the coordinate system in which to apply the offset: either in the coordinate system (which is given in *CoordinateSystem*), the source is defined in, or in horizontal coordinates. The Combobox *Offset\_in* allows to switch between those.
- *SourceVelocity* You can define a source velocity, which will be converted to an additional shift in the LO frequency in order to move your spectral line within the spectral band to the desired spot.
- *VelSystem* Choose the velocity system (Heliocentric, Barycentric, LSR).
- VMode Defines when the LO shift to correct with respect to the chosen VelSystem gets applied. Corrected(Sub) will apply the correction once for each subscan, Corrected(Scan) will set the LO at the beginning of the Scan only. Fixed will not apply any shift to account for the VelSystem and the user (or reduction software) has to apply the shifts later on.
- CoordinateSystem and Equinox Is used to define the source coordinates.
- *FreqThrowLo and FreqThrowHi* Defines the (additional) LO frequency shifting used for the frequency switching method. Both quantities are given in MHz.
- SCANTime Defines the length of your measurement (or to be more accurate of your Subscans).
- *SCANRepeats* It is possible to repeat the FSwitch without changing the Scan number but increasing the Subscan counter. This value states how many Subscans shall be measured.
- *StartPosAng* Defines the Hexapot rotation angle (former OPOS value). The value is eventually modified according to the setting in *TrackParAng*.
- *TrackParAng* Hexapot Tracking method. *None* means, that the *StartPosAng* is directly applied to the Hexapot. *Off* means the the parallactic angle is added to *StartPosAng* at the beginning of each Subscan. *Off(Scan)* is similar but the PA is only added at the beginning of the Scan. *On* means full PA tracking, i.e. the feed gets rotated constantly in order to account for the PA. The latter is important for Multibeam-Receivers when mapping the sky.
- *CosDrv and Amplitude* Experimental feature. The Hexapot focus (ZLIN) is modulated with a cosine function of amplitude *Amplitude*. In theory this might remove or suppress standing waves.
- *NRepeats* How many cosine modulations to do per subscan.
- Defaults Put the default values into each input field. Should be done once before you start

### observing.

• Save Script - Saves the current input values to a script file which can be used as macro later on (see scripting).

• MPIFR Effelsber	g 100m Telescope Control			00 0
2	тор	Continue	Repeat	START
Select a widget:	[] Setup: FSwitch setup	your observation		
General: Control Startup				
Display: ScanList Telescope_Queue		I	FSwitch ( OperatorQueue )	
Frontends: Frequency	ObjectName S7		Search	Catalog Default 📟
Primary Secondary	ObjectLongitude 132	d		ObjectLatitude -1 d
Backends: AFFTS Beacon	LonOff 0.0		Offset_in CoordinateSystem 🔤	LatOff 0.0
FFTS MultiFiBa XFFTS	SourceVelocity -50		VMode Corrected(Sub) 🔤	VelSystem VLSR 🔤
SetupCont: Focus	CoordinateSystem	Galactic 🖂		Equinox None 📟
Mapping Pointing Skydip	FreqThrowLo -2.5			FreqThrowHi 2.5
Tracking SetupSpec:	SCANTime 30			SCANRepeats 1
FSwitch OnTheFly PSwitch Raster	StartPosAng 0			TrackParAng None 🔤
SetupPulsar: PTracking Search7Beam	CosDrv	No 🚍	Defaults	SaveScript
SetupVLBI: VLBI	Amplitude 0.0			NRepeats 1
Offsets: Focus_Offset Pointing_Offset				
- oneng_onset			Load to telescope queue	
	<b>1</b>			
STO	TelControl	OperatorQueue	TOPO:Auto	Exit

Figure 8: FSwitch form.

### **PSwitch (Pointed Observation using Position Switching)**

- *ObjectName* Choose the name of your source (which ideally is contained in your source catalog). Click search!
- *Catalog* Choose your source catalog. (You need to define the correct directory in the startup page.)
- *ObjectLongitude and ObjectLatitude* Source coordinates. If the source (under ObjectName) was not found in the catalog after clicking search, the input fields will turn yellow.
- LonOff and LatOff If you want to choose a certain offset for the source position, you can use these fields. There are two possibilities for the coordinate system in which to apply the offset: either in the coordinate system (which is given in *CoordinateSystem*), the source is defined in, or in horizontal coordinates. The Combobox *Offset in* allows to switch between those.
- RefOffsetLon and RefOffsetLat Defines the Reference position (REF). There are two possibilities

for the coordinate system in which to apply the offset: either in the coordinate system, the source is defined in (which is given in *CoordinateSystem*), or in horizontal coordinates (*RMode=Relative* must be set!). The Combobox *RefPosition\_in* allows to switch between those. See also *RMode* description.

- *RMode* Two options are present: *Relative* and *Absolute*. If *RMode=Relative* the REF position is defined as an offset relative to the ON position (true angular distance if in Horizontal coordinate system, absolute distance if in Coordinate System, according to the *RefPosition\_in* ComboBox). If *RMode=Absolute* one defines the full world coordinates of the REF position.
- *RefAfterOn* Defines how many ON positions shall be measured per REF position. Example: a value of 2 means REF-ON-ON-REF-ON-ON-...
- SourceVelocity You can define a source velocity, which will be converted to an additional shift in the LO frequency in order to move your spectral line within the spectral band to the desired spot. The source velocity is interpreted according to the Radio Convention.
- VelSystem Choose the velocity system (Heliocentric, Barycentric, LSR).
- VMode Defines when the LO shift to correct with respect to the chosen VelSystem gets applied. Corrected(Sub) will apply the correction once for each subscan, Corrected(Scan) will set the LO at the beginning of the Scan only. Fixed will not apply any shift to account for the VelSystem and the user (or reduction software) has to apply the shifts later on. Note, that in the latter case Class will show wrong velocity scaling. Only experienced users should use it.
- CoordinateSystem and Equinox Is used to define the source coordinates.
- *FreqThrowLo and FreqThrowHi* Defines the (additional) LO frequency shifting used for the frequency switching method. Both quantities are given in MHz.
- SCANTime Defines the length of your measurement (or to be more accurate of your Subscans).
- *SCANRepeats* It is possible to repeat the FSwitch without changing the Scan number but increasing the Subscan counter. This value states how many Subscans shall be measured.
- *StartPosAng* Defines the Hexapot rotation angle (former OPOS value). The value is eventually modified according to the setting in *TrackParAng*.
- *TrackParAng* Hexapot Tracking method. *None* means, that the *StartPosAng* is directly applied to the Hexapot. *Off* means the the parallactic angle is added to *StartPosAng* at the beginning of each Subscan. *Off(Scan)* is similar but the PA is only added at the beginning of the Scan. *On* means full PA tracking, i.e. the feed gets rotated constantly in order to account for the PA. The latter is important for Multibeam-Receivers when mapping the sky.
- *CosDrv and Amplitude* Experimental feature. The Hexapot focus (ZLIN) is modulated with a cosine function of amplitude *Amplitude*. In theory this might remove or suppress standing waves.
- *NRepeats* How many cosine modulations to do per subscan.
- *Defaults* Put the default values into each input field. Should be done once before you start observing.
- *Save Script* Saves the current input values to a script file which can be used as macro later on (see scripting).

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• MPIFR Effelsber	g 100m Telescope Contro	l			00 8
-	STOP	Continue		Repeat	START
Select a widget:	Setup: PSwitch setup	vour observation			
General: Control Startup					
Display: ScanList Telescope_Queue			PSwitch (	OperatorQueue	
	ObjectName S7			Search	Catalog Default 🔤
Frontends: Frequency Primary Secondary	ObjectLongitude 132	2 d			ObjectLatitude -1 d
Backends:	LonOff 0.0		Offset_in	Coordinate5ystem =	LatOff 0.0
AFFTS Beacon FFTS MultiFiBa	RefOffsetLon 120	00"	RMode	Relativ =	RefOffsetLat 0*
XFFTS	RefPosition_in	zimuth/Elevation 🔤			RefAfterOn 1
SetupCont: Focus Mapping Pointing	SourceVelocity -50		VMode	Corrected(Sub)	VelSystem VLSR
Skydip Tracking	CoordinateSystem	Galactic 💻			Equinox None 🔤
SetupSpec: FSwitch OnTheFly PSwitch	SCANTime 30				SCANRepeats 1
Raster SetupPulsar:	StartPosAng 0				TrackParAng None 🔤
PTracking Search7Beam SetupVLBI:	CosDrv	No 🔤		Defaults	SaveScript
VLBI	Amplitude 0.0				NRepeats 1
Offsets: Focus_Offset Pointing_Offset					
			Load t	o telescope queue	
	-				
STO	P TelControl	OperatorQueue		TOPO:Auto	Exit

Figure 9: PSwitch form.

### Raster (Raster map)

As mentioned before, the Raster can either be done using Position or Frequency switching. Consequently, after defining the map using the input fields below, one has to either push the FSwitch or *PSwitch* Button. Obsinp will then bring up the correct input form (see Fig. 8 and 9) such that the user can choose the switching-specific values.

- NPointsLon and NPointsLat Number of points on the raster in Lon/Lat direction.
- SCANXSPC and SCANYSPC Angular separation between points on the raster.
- Projection and UserSystem The projection system used for the map. Projection is either Cartesian or SFL (sine projection). In the latter, the SCANXSPC value is scaled with cos(latitude). If the user system is Descriptive the map will be in a local tangential projection, while Absolute means that the scan spacing will be in the measured in the coordinate system in use, i.e. at the pole the true angular separation will be much smaller than desired.
- SCANDirection Whether the Scanning is done in longitude or latitude.
- RasterSkew Defines, whether every second subscan shall be tilted with respect to the first subscan. If one uses zero degrees, the raster will be rectangular:

x_x_x	x
x_x_x	X
x_x_x	x

Using 45 degrees the raster can be more densely packed (if *SCANYSPC* is choosen accordingly smaller):

x\_x\_x\_x \_x\_x\_x\_x x\_x\_x\_x

• *SubSCANStart* - Can be used to start the map with a different subscan than 1, e.g., when a previous map shall be continued at a certain point.

• MPIFR Effe	lsberg 100m Telescop	pe Control		88 8
	STOP	Continue	Repeat	START
Select a widget:	Setup: Raste	er setup your observation		
General: Control	4			
Startup				
Display: ScanList				
Telescope_Que	ue			
Frontends: Frequency Primary Secondary				
Backends: AFFTS			Raster ( OperatorQueue	e )
Beacon				
FFTS MultiFiBa		NPointsLon 10		NPointsLat 10
XFFTS		SCANXSPC 15"		SCANYSPC 15"
SetupCont:				
Focus		Projection Cartesian	-	UserSystem Descriptive 🖃
Mapping Pointing Skydip		SCANDirection Longitude	-	
Tracking		RasterSkew 0.0		
SetupSpec:		SubSCANStart 1		
FSwitch OnTheFly		Subschistart		
PSwitch		FSWITCH	PSWITCH	Defaults
Raster		- Stiller	- Shirten	Debber
SetupPulsar:				
PTracking Search7Beam				
SetupVLBI:				
VLBI				
Offsets: Focus_Offset				
Pointing_Offset				
	$\overline{}$			
	STOP TelControl	OperatorQueue	TOPO:Auto	Exit



# OnTheFly (On-the-fly map)

Again OTF can either be done using Position or Frequency switching. Consequently, after defining the map using the input fields below, one has to either push the *FSwitch* or *PSwitch* Button. Obsinp will then bring up the correct input form (see Fig. 8 and 9) such that the user can choose the switching-specific values.

- *ExtensionLongitude and ExtensionLatitude* Desired angular size of the map.
- SCANSpace Angular separation between two scan lines.
- *Projection and UserSystem* The projection system used for the map. *Projection* is either Cartesian or SFL (sine projection). In the latter, the *ExtensionLongitude* value is scaled with cos(latitude). If the user system is *Descriptive* the map will be in a local tangential projection, while *Absolute* means that the scan spacing will be in the measured in the coordinate system in use, i.e. at the pole the true angular separation will be much smaller than desired.
- SCANDirection Whether the Scanning is done in longitude or latitude.
- SCANVelocity Telescope angular velocity along the SCANDirection.
- *SubSCANStart* Can be used to start the map with a different subscan than 1, e.g., when a previous map shall be continued at a certain point.
- *ZigZag* True or False. If *True* the OTF will be measured in a zigzag-like mode to lower the duty cycle between two subscans.

Note, that ExtensionLongitude/ExtensionLatitude together with the SCANVelocity defines the integration time per subscan. Hence, the input field in the PSwitch/FSwitch is redundant and not used.

ECV     Continue     Repeat     STAIT       Select a widget:     Control     Repeat     STAIT       Select a widget:     Control     Control     Selep: OFT setup your observation       Control     Satisfie     Selep: OFT setup your observation     Selep: OFT setup your observation       Selep: OFT setup your observation     Selep: OFT setup your observation     Selep: OFT setup your observation       Selep: OFT setup your observation     Selep: OFT setup your observation     Selep: OFT setup your observation       Selep: OFT setup your observation     Selep: OFT setup your observation     Selep: OFT setup your observation       Selep: OFT setup your observation     Selep: OFT setup your observation     Selep: OFT setup your observation       Selep: OFT setup your observation     Selep: OFT setup your observation     Selep: OFT setup your observation       Selep: OFT setup your observation     Selep: OFT setup your observation     Selep: OFT setup your observation       Backerds:     Selep: OFT setup your observation     Selep: OFT setup your observation     Selep: OFT setup your observation       Selep: OFT setup your observation     Selep: OFT setup your observation     Selep: OFT setup your observation     Selep: OFT setup your observation       Selup Your your your your your your your your y	MPIFR Effe		Telescope Control						
General: Control Startup Display: ScanList Telescope_Queue Frotescone-gueue Frotescone-gueue Frotescone-gueue Frotescone-gueue Frotescone-gueue Frotescone-gueue Secundary Backends: AFFT5 Beacon FFTS Secundary Backends: AFFT5 Secundary Backends: AFFT5 Secundary S		STOP		Continue		Repeat		START	
Control   Startup   Scanlat   Telescope_Queue   Frotendar:   Protendar:   Backends:   AFFTS   Backends:   AFFTS   Backends:   Secundary   Backends:   Secundary   Backends:   AFFTS   Secundary   Backends:   Secundary   Backends:   AFFTS   Secundary   Backends:   Secundary	Select a widget:	l, S	etup: OFT setup your	observation					
Startup       Display: ScanList Telescope_Queue       Frontends: Frequency Primary Secondary       Backends: AFFT5 Beacon FFT5       MultiFilaa XFFT5       ScANspace 400°       XFFT5       Secondary       Backends: AFFT5       ScANspace 400°       XFFT5       Secondary       Beacon FFT5       ScANspace 400°       XFFT5       Secuptont: Pocus Mapping       ScANDirection ScA									
Display:   Sackands:   Frotendds:   Froutends:   Secondary   Backends:   AFFT5   Backends:   Setup   Setup   SetupSpec:   FSWItch   Pointing   SubsCANStart 1   SetupSpec:   FSWItch   SetupSpec:   FSWItch   SetupSpec:   SetupSpec:   SetupSpec:   FSWItch   SetupSpec:   SetupSpec:   SubsCANStart 1   SetupSpec:									
Sraulist Telescope Queue   Frontends:   Frequency   Pinary   Secondary   Backends:   AFFTS   Beacon   ExtensionLongitude 5d   FFS   MultiFilaa   XFFTS   SetupCont:   Pous   SetupVLBI:   VLBI   Offsets:	startup								
Sraulist Telescope Queue   Frontends:   Frequency   Pinary   Secondary   Backends:   AFFTS   Beacon   ExtensionLongitude 5d   FFS   MultiFilaa   XFFTS   SetupCont:   Pous   SetupVLBI:   VLBI   Offsets:	Display:								
Frontends: Frequency Primary Secondary     DCTheFly (OperatorQueue)       Backends: AFTS Beacon FFTS Second FFTS ScANSpace 400°     ExtensionLongitude 5d       Secunducation     ExtensionLatitude 5d       Secunducation     Cartesian       VERTS     Projection       SetupULBI: VLBI     ScANSpace       SetupVLBI: VLBI     FSWITCH									
Frequency   Primary   Backends:   AFTS   Backends:   AFTS   MultiFiBa   Scanspace   MultiFiBa   Scanspace   Frous   Mapping   Pointing   ScANbirection   Longitude   SetupSpec:   FSwitch   Raster   SetupVuB:   VuB	Telescope_Que	ue							
Frequency   Primary   Backends:   AFTS   Backends:   AFTS   MultiFiBa   Scanspace   MultiFiBa   Scanspace   Frous   Mapping   Pointing   ScANbirection   Longitude   SetupSpec:   FSwitch   Raster   SetupVuB:   VuB	Frontends:								
Secondary     ConTheFly (OperatorQueue)       Backends:     AFTS       AFTS     ExtensionLongitude 5d       Beacon     ExtensionLatitude 5d       FFTS     SCANSpace 400*       WultiFila     SCANSpace 400*       XFFTS     Projection       Focus     SCANDirection       Mapping     Projection       Pointing     SCANVelocity 240*       StupSpec:     SubSCANStart 1       Foxus     ZigZag       StupPulsar:     FSwitch       Raster     FSwitch       SetupPulsar:     FSwitch       SetupVLBI:     VLBI       VLBI     User System									
Backends: AFTIS Bescon FFTS MultiFila XFTIS Schuppont: SetupCont: Focus Mapping Pointing Skydip Tracking SetupSpee: FSwitch Raster SetupVulsa: PTracking SetupVulsa: Vali SetupVulsa:									
AFTS     Beacon     ExtensionLongitude 5d     ExtensionLatitude 5d       FFTS     SCANSpace 400*	Secondary								
AFTS     Beacon     ExtensionLongitude 5d     ExtensionLatitude 5d       FFTS     SCANSpace 400*	Backends:				OnTheFly	(OperatorQueu	ie)		
FTS     SCANSpace 400*       MultiFilia     SCANSpace 400*       SetupCont:     Projection       Focus     SCANDirection       Longitude     Descriptive       Pointing     SCANDirection       Skydip     SCANVelocity 240*       Tracking     SubSCANStart 1       SetupSpec:     Fswitch       Zigzag     True       OnTheFly     PSWITCH       PSwitch     Zigzag       SetupPulsar:     FSWITCH       SetupPulsar:     FSWITCH       SetupPulsar:     FSWITCH       Offsets:     Gifsets:									
MultiFiBa   XFFT5   SetupCont:   Focus   Mapping   Pointing   ScANVelocity   240*   Tracking   SubSCANVelocity   SubSCANStart   Tracking   SetupPulsar:   PTracking   SetupPulsar:   PTracking   SetupVLBI:   VLBI   Offsets:			ExtensionLongitud	le 5d			ExtensionLatit	ude 5d	
XFFTS   SetupCont:   Focus   Mapping   Pointing   Skydip   SCANDirection   Longitude   Pointing   Skydip   Tracking   SetupSpec:   F5Witch   Raster   SetupPulsar:   PTacking   SetupVLBI:   VLBI   Offsets:			SCANSDO	- 400*					
SetupCont:   Focus   Mapping   Pointing   Sitydip   SCANVelocity   240*   Tracking   SubSCANStart   SetupSpec:   FSwitch   ZigZag   True   PSWITCH Defaults Defaults SetupVLBI: VLBI Offsets: Focus_offset			эсмнэра	.e 400					
Focus   Mapping   Pointing   Skydip   Tracking   SetupSpec:   FSwitch   ZigZag   True    FSWITCH PSwitch SetupPulsar: PTracking SetupVUBI: VLBI Offsets: Focus_Offset			Projectio	n Cartesian	-		UserSyst	em Descriptive	
Mapping SCANDirection   Pointing SCANVelocity   Skydip SCANVelocity   Tracking SubSCANStart   SetupSpec: ZigZag   PSwitch ZigZag   Raster FSWITCH   SetupPulsar: PTracking Search7Beam    SetupVLBI: VLBI   Offsets: Facus_Offset									_
Pointing Skydip SCANVelocity 240* Tracking SubSCANStart 1 SetupSpec: FSwitch ZigZag True OnTheFly PSwitch Raster FSWITCH PSWITCH Defaults SetupPulsar: PTracking Search 7Beam SetupVLBI: VLBI			SCANDirectio	n Longitude					
Skydip SCANVelocity 240*   Tracking SubSCANStart 1   SetupSpec: ZigZag   PSwitch ZigZag   Raster FSWITCH   Beautra PSWITCH   SetupPulsar: PSWITCH   PTracking SetupVLBI:   VLBI VLBI									
SubSCANStart 1   SetupSpec:   PSwitch   ZigZag   True     PSwitch   Raster   PSwitch   Raster   FSWITCH   PSWITCH   Defaults   SetupVLBI: VLBI Offsets: Focus_Offset	Skydip		SCANVeloci	y 240"					
SetupSpec:   FSwitch   OnTheFly   PSwitch   Raster   SetupPulsar:   PTracking   SetupVLBI:   VLBI	Tracking				_				
FSwitch ZigZag   OnTheFly   PSwitch   Raster   PSwitch   Raster   SetupPulsar:   PTracking   SetupVLBI:   VLBI   Offsets:   Focus_Offset	SetupSpec:		SUDSCANSTA	πµ					
On TheFly   PSwitch   Raster   PSwitch   Raster   SetupPulsar:   PTracking   Search7Beam   SetupVLBI:    VLBI   Offsets: Focus_Offset			ZiaZa	True					
Raster     PSWITCH     Defaults       SetupPulsar: PTracking Search7Beam     PSWITCH     Defaults       SetupVLBI: VLBI     PSWITCH     PSWITCH     Defaults			21920	inde	_				
SetupPulsar:     PSWITCH     Defaults       PTracking     SetupVLBI:     VLBI       Offsets:     Focus_Offset									
PTracking Search7Beam SetupVLBI: VLBI Offsets: Focus_Offset	haster			FSWITCH		PSWITCH		Defaults	
Search 7Beam SetupVLBI: VLBI Offsets: Focus_Offset									
SetupVLBI: VLBI Offsets: Focus_Offset									
VLBI Offsets: Focus_Offset	Search / Beam								
Offsets: Focus_Offset									
Focus_Offset	VLBI								
Focus_Offset	Offsets:								
Pointing_Offset									
	Pointing_Offset								
		10111							
STOP TelControl OperatorQueue TOPO:Auto Exit		STOP TelCon	trol	OperatorQueue		TOPO:Auto		Exit	

Figure 11: On-the-fly map form.

### Scripting

In the PSwitch and FSwitch forms, one can use the *SaveScript* Button to automatically create a Macro (or Script) file in the current working directory (as set in the StartUp form). These Macros initially get a standard name (e.g., FSwitch, FRaster, POnTheFly, etc.). Consequently, one might want to rename these files for later use. If one first setups a map and pushes the *SaveScript* Button in the following PSwitch/FSwitch form, the mapping parameters are also contained in the Script file. One can easily change the Parameters in the Scripts, use different sources/catalogs, etc. One can also start scripts within scripts using the "@scriptname" syntax.

To start a script one types in "@scriptname" into the *ObjectName* field. One can even override the source with another source (from the same catalog!) using the colon-feature: "@scriptname:anothersource". If the script contains several subscripts (e.g. several Raster maps), then all of them will be added to the queue.

A list of scripts for PSwitch tests for different receivers is given in the table below. The directory in the *Startup* Menu has to be set to /home/obseff and then you can just type "@<script-name>" in the *ObjectName* field in the *SetupSpec: PSwitch* menu, press *Search*, "load to telescope queue" and *Start*.

Prime focus receivers							
RX	Version	Script name	Frequency [GHz]	Source	FFTS (IF/Filter)	Comment	
P300mm	1	30cmLine	1.139	1413+135	150/20	30cm PFK, <b>1413+135 not</b> circum-polar absorption line	
P300mm	1	rrlP300mm	1.281	W3Main	150/20	30cm PFK, recombination line H172alpha	
P200mm	2	18cmpol	1.665	W3OH	150/20	18cm PFK,polarization test (LCP, RCP profile differ)	
P90mm	2	rrlP90mm	3.408	W3Main	150/20	9cm PFK, recombination line H124alpha	
P50mm	1	rrlP50mm	6.107	W3MAIN	150/100	5cm PFK, recombination line H102alpha	
P50mm	1	maser5cm	6.669	W3OH	150/20	5cm PFK, methanol maser	
P22mm	1	rrlP22mm1	12.149	W3MAIN	150/100	2.5cm PFK, recombination line H81alpha	
P22mm	2	rrlP22mm2	13.089	W3MAIN	150/100	2.2cm PFK, recombination line H79alpha	
P19mm	1	oh1.9cm	13.505	W3OH	750/100	1.9cm PFK, OH line	
P19mm	2	rrlP19mm	17.992	W3MAIN	750/100	1.9cm PFK, recombination line H71alpha	
P13mm	1	rrlP13mm1	20.462	W3MAIN	750/100	1.3cm PFK, low band, recombination line H68alpha	
P13mm	2	rrlP13mm2	23.404	W3MAIN	750/100	1.3cm PFK, high band, recombination line H65alpha	
P13mm	1	wasser	22.235	W3OH	750/100	1.3cm PFK low band, water maser (very strong, not a good test source)	
P10mm	2	1cmtest	30.002	W3(H2O)	750/100	1cm PFK, middle band, SO line (?)	

Prime focus receivers							
RX	Version	Script name	Frequency [GHz]	Source	FFTS (IF/Filter)	Comment	
P10mm	1	rrlP10mm1	28.275	W3MAIN	750/100	1cm PFK, lower RX band, recombination line H61alpha	
P10mm	2	rrlP10mm2	29.700	W3MAIN	750/100	1cm PFK, middle RX band, recombination line H60alpha	
P10mm	3	rrlP10mm3	34.596	W3MAIN	750/100	1cm PFK, upper RX band, recombination line H57alpha	
P6mm	1	maser7mm	43.122	R Cas	750/20	6.5mm PFK, SiO maser, circum-pol. but passes hills and zenith	
P3mm	1	maser3mm	86.243	R Cas	750/20	3mm PFK, SiO maser, circum-pol. but passes hills and zenith	
	•	•	Secondary	y focus re	ceivers		
RX	Version	Script name	Frequency [GHz]	Source	FFTS (IF/Filter)	Comment	
S100mm	1	rrlS110mm	2.703	W3MAIN	150/20	11cm SFK, recombination line H134alpha	
S60mm	4	rrlS60mm	4.874	W3MAIN	750/100	6cm SFK, recombination line H110alpha	
S36mm	3	rrlS36mm	8.585	W3MAIN	750/100	3.6cm SFK, recombination line H91alpha	
S28mm	1	rrlS28mm	10.522	W3MAIN	150/100	2.8cm SFK, recombination line H85alpha	
S20mm	3	rrlS20mm	14.690	W3MAIN	750/100	2.8cm SFK, recombination line H76alpha	
S13mm	3	rrlS13mm	23.404	W3MAIN	750/100	1.3cm SFK, recombination line H65alpha	
S7mm	1	maser7mm2	43.122	R Cas	750/20	7mm SFK, SiO maser, circum-pol. but passes hills and zenith	

As an example of wath the scripts are doing: rrlP13mmh

```
# 1.3cm PFK high band test line
# 23.4 GHz - H65alpha Übergang von Wasserstoff
#
FE:P13mm; VERn 2; Frequency 23.40428
W3MAIN ; SCANTime 60 ; RefOffsetLon 1800" ; RefOffsetLat 0 ; SCANRepeats 1 ;
NRepeats 1 ; RefPosition_in Azimuth/Elevation ; SourceVelocity -44 ; VMode
Corrected(Sub) ; VelSystem VLSR ; Catalog alex
```

If no test line for your receiver is given in the table and no source is known, it is likely that a Radio Recombination Line of Hydrogen is close to your target frequency (see the Spectral Line folder in the control room) that is observable on W3MAIN. The observable RR-Lines are listed in the RRL line catalogue. The right frequency has to be selected together with the receiver from the *Frontend* Menu. The position of W3MAIN is in the default source catalogue.

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# **Pulsar observations - SetupPulsar**

Please ask local staff or the pulsar group in Bonn for more information.

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