

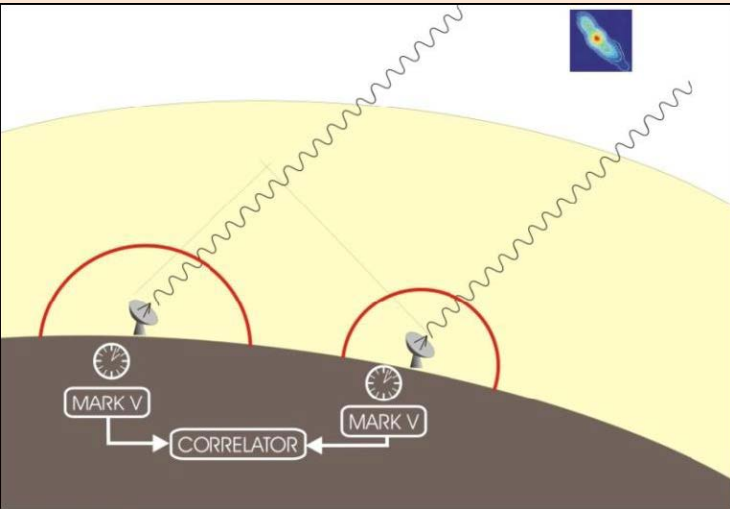
# Vie\_SCHED\_V22

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# Introduction



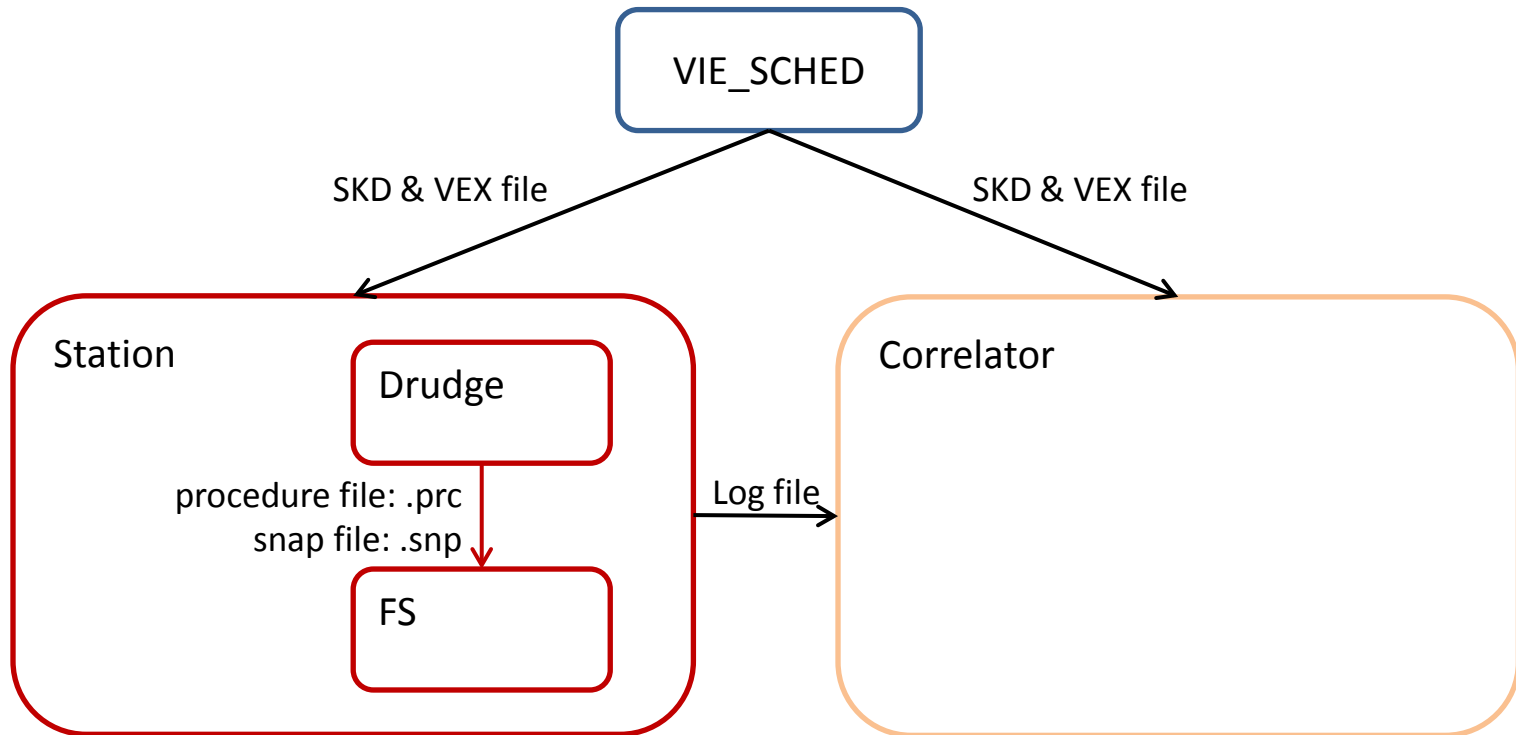
## VLBI2010 goals:

- ▣ 1 mm position and 0.1 mm/year velocity measurement accuracy on global baselines,
- ▣ continuous measurements (7d/week) of station positions and EOP,
- ▣ turnaround time to initial geodetic results of less than 24 hours.

Parameter	VLBI2010 system	Current VLBI system
antenna size	~ 12 m dish, twin antennas	5 – 100 m dish
slew speed	≥ 360 deg/min	~ 20 – 200 deg/min
sensitivity	SEFD ≤ 2500	SEFD 200 – 15000
frequency range	~ 2 – 14 GHz	S/X band
recording rate	8 – 16 Gbps	128, 256 Mbps
data transfer	e-transfer, e_VLBI disk shipping when required	usually disk shipping, some e-transfer

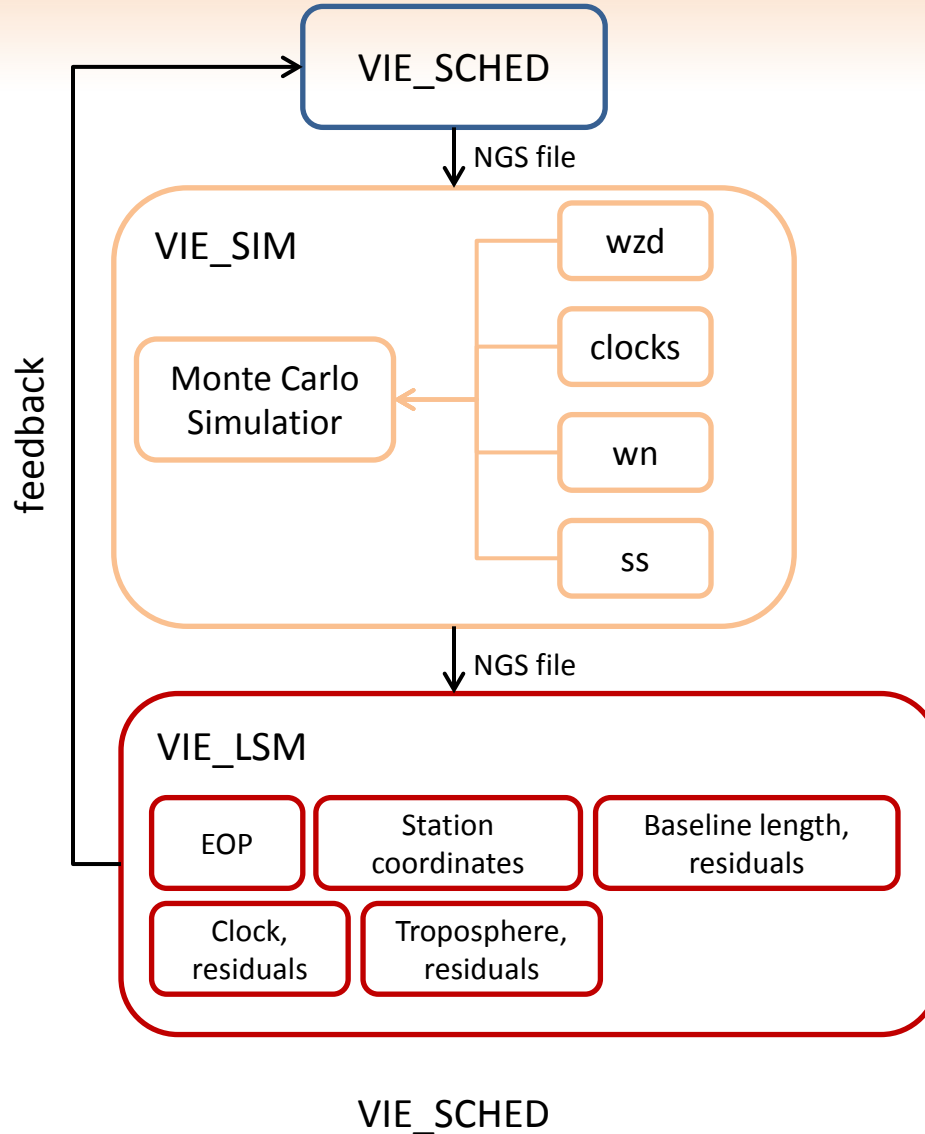
# Purpose of a scheduling program (1)

→ real VLBI experiment



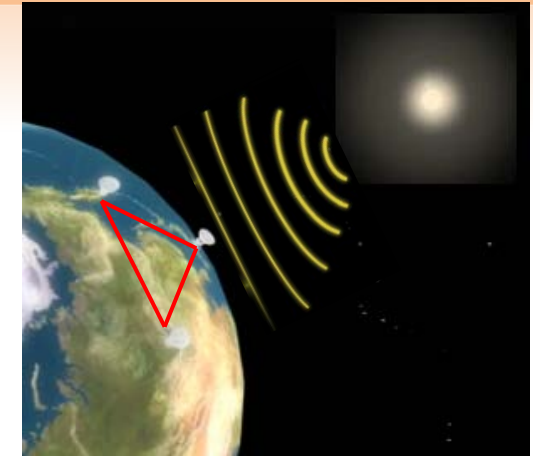
# Purpose of a scheduling program (2)

→ simulation research



# Algorithms and models for a scan

**Scan** – time period during which a network of stations observes the same source



## Calculation of scan start time

▶ earliest possible start time for a new observation

$$T_{2s}(i) = T_{1e}(i) + T_{slew}(i) + SOURCE + T_{APETM} + IDLE + CALI$$

$T_{1e}$  – end time of previous observation

$T_{slew}$  – slew time required for the slew from the previous source to the new one

*SOURCE* – time for settling down

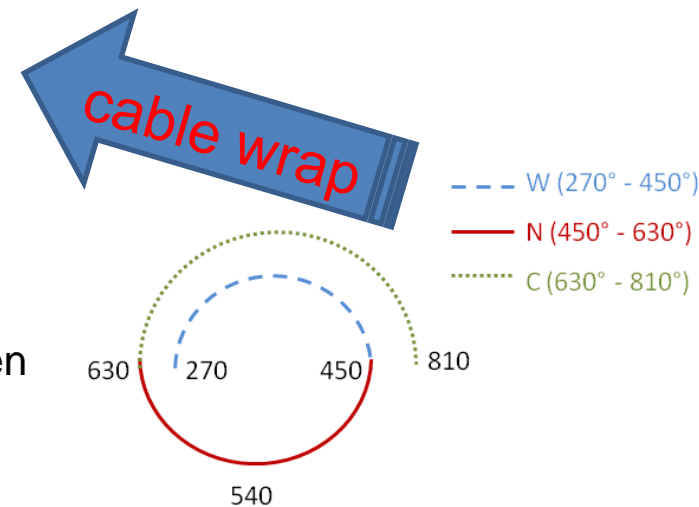
*TAPETM* – tape

*IDLE* – idling

*CALI* – calibration

▶ the maximum of start times of participating antennas is taken as the scan start time

$$T_{2s}(scan) = \max(T_{2s}(1), T_{2s}(2), \dots, T_{2s}(n))$$



for ambiguous position – shortest way from previous scan

# Algorithms and models for a scan

## ▶ Calculation of scan length

### ▶ antenna sensitivity

characterized by System Equivalent Flux Density (flux density corresponding to system temperature)

$$SEFD = \frac{2 \times k \times T_{sys}}{A_{eff} \times \eta \times 10^{-26}}$$

$k$  – Boltzmann's constant

$T_{sys}$  – system temperature

$A_{eff}$  – effective collecting area of the antenna

$\eta$  – processing factor

elevation dependence is applied

### ▶ scan length

$$scanlength = \left( \frac{1.75 \times SNR_{min}}{F_{obs}} \right)^2 \times \left( \frac{SEFD_1 \times SEFD_2}{2 \times B \times N_{ch}} \right) + CORSYNCH$$

$F_{obs}$  – observed source strength



$B$  – bandwidth

$N_{ch}$  – number of channels









$CORSYNCH$  – correlators extra time to synchronise up

# Algorithms and models for a scan

## Conditions of a valid scan

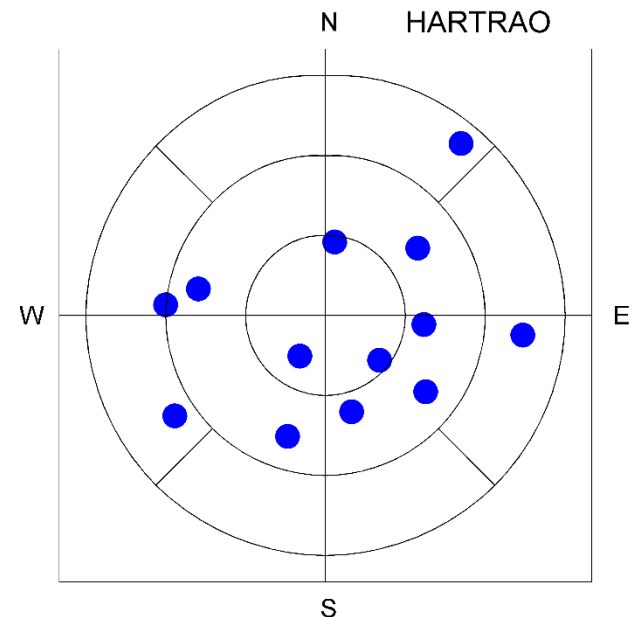
-  important criterion: source has to be up at participating station during the observation
-  **Horizon mask** (mask.cat) describes the surrounding mountains ...

## Vie\_sched performs several checks to validate the scan

-  at least 2 stations participate
-  the source is visible at all stations (every 5 sec the position of the source is calculated)
-  at stations with AZEL mount the cable wrap is checked
-  enough time for slewing
-  waiting time for the join scan does not exceed the user-specified maximum limit
-  all baselines have to meet the user-specified SNR targets
-  scan length is between the specified limits
-  availability of the antenna is checked (downtime for maintenance or other observation program as intensive sessions ...)

# Station-based scheduling strategy

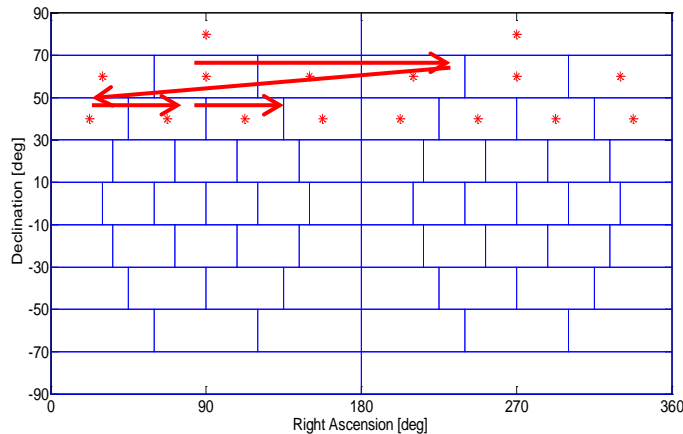
- ◆ Classical approach to achieve uniform sky coverage at each station (needed for decorrelation of zwd, clocks and station height)
- ◆ Definition of a uniform sky coverage: The sky above the antenna is divided in three different elevation segments: **low, middle, and high** elevation observations.
- ◆ The middle segment is divided into **four azimuthal segments** and the low segments into **eight parts**.
- ◆ Radio sources from the same segment should not be observed within a certain time interval.
- ◆ Time window of sky coverage should correspond to the sampling interval of the estimated parameters





# Source-based scheduling strategy

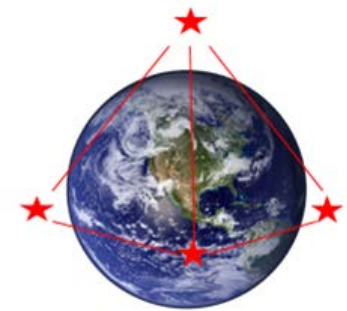
- ▶ The source based strategy comes up with the more global station distribution and fast moving antennas
- ▶ The schedule program selects radio sources from the catalogue independently of the sky distribution at individual stations
- ▶ Different subnets are formed throughout the session in order to optimize geometry and number of observations



- **one** source scheduled each time



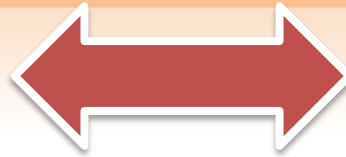
- **two** sources scheduled simult.



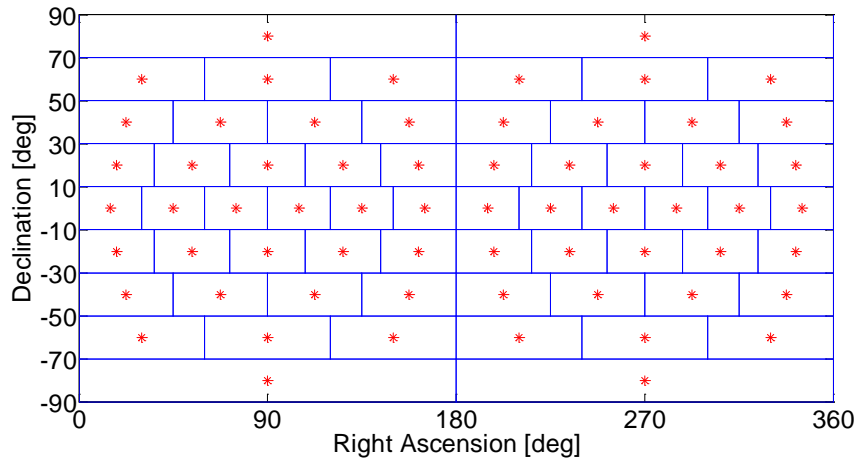
- **four** sources scheduled simult.

# Strategies for automatic scheduling

Source-based strategy



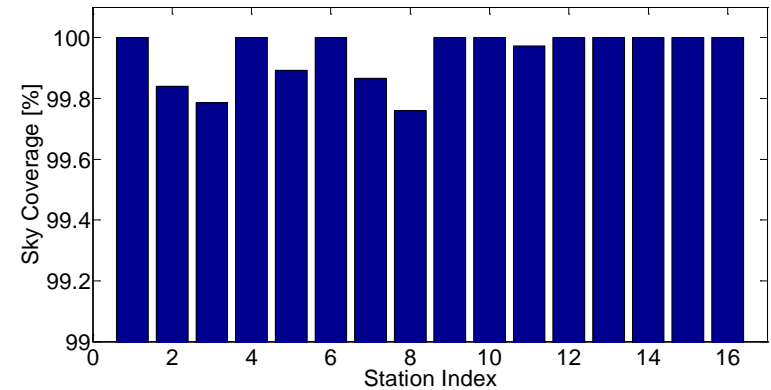
Station-based strategy



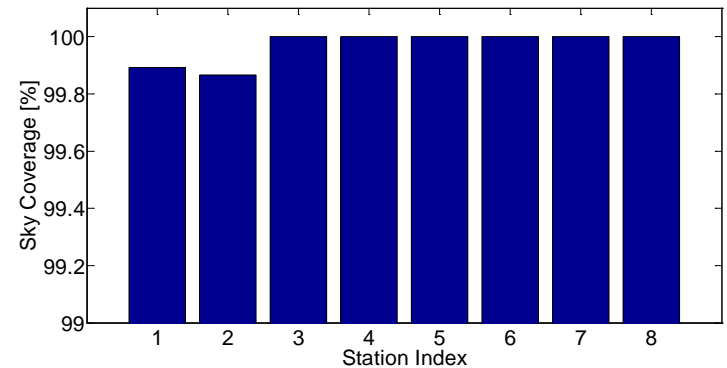
All 64 segments on celestial sphere are scheduled.

At least 99.7% sky coverage at stations is achieved.

16-station test VLBI2010 network



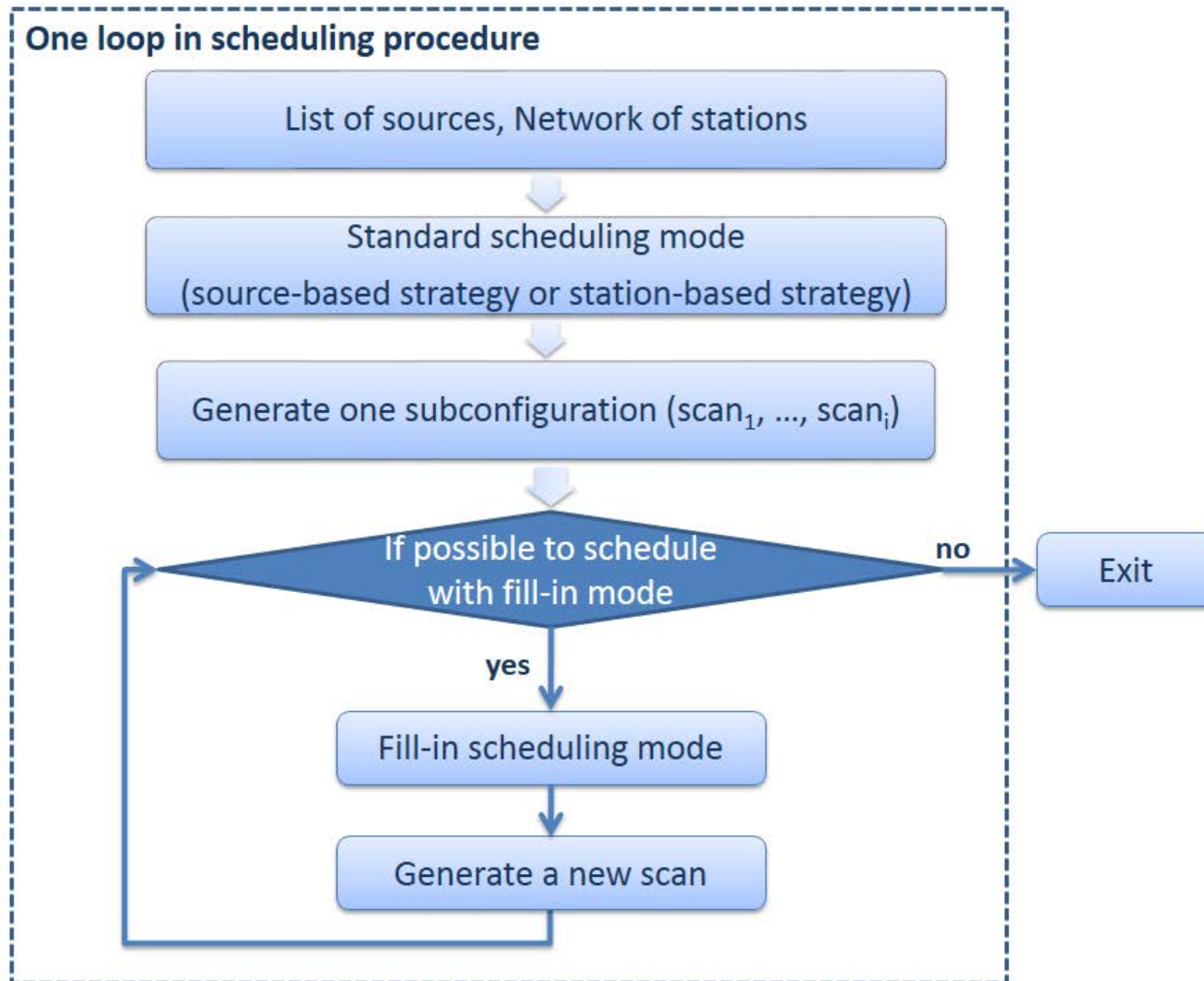
8-station typical IVS R1 network



## Fill-in mode

- ▣ Vie\_SCHED schedules sub-configurations either with source-based or station-based strategy
- ▣ It can happen that there is still more than one station idling because of visibility or other restrictions
- ▣ Fill-in mode schedules for the idling stations another source (only one scan):
  - ▣ as many stations as possible
  - ▣ sky coverage criterion is applied if there are found two scans with the same number of idling stations
  - ▣ scan with the earliest start time is chosen
  - ▣ the fill-in scan should not end too much later than the scan from normal scheduling mode

# Fill-in mode

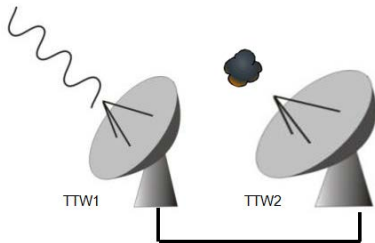


VIE\_SCHED

# Twin telescopes at one site

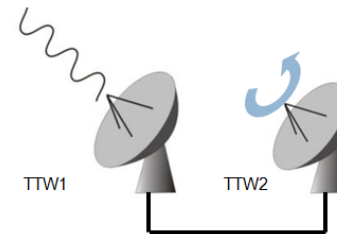
- (1) Same troposphere above the twin telescopes;
- (2) Same H-maser clock connecting them.

## Mode1 : Maintenance



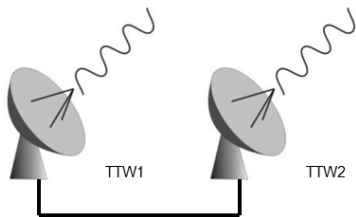
- ✓ full availability

## Mode3 : Continuous observations



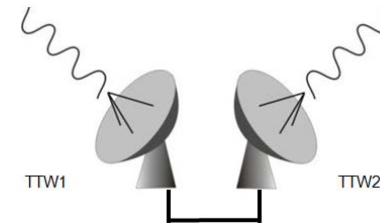
- ✓ continuous observations, without any temporal gaps

## Mode2 : Same source observations



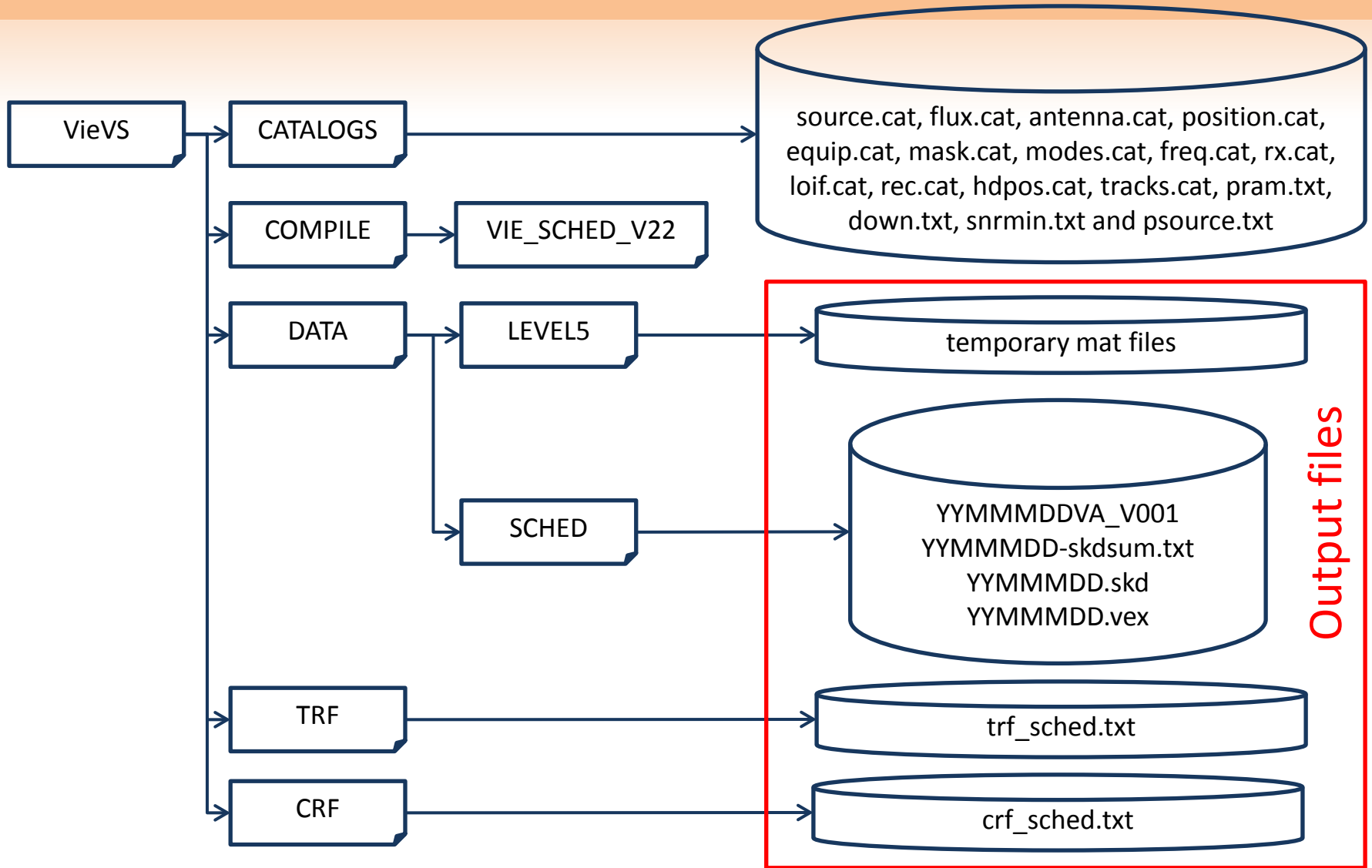
- ✓ increase the sensitivity and decrease on-source time
- ✓ counteract the troposphere effect for calibration

## Mode4 : Multidirectional observations



- ✓ more observations and better sky coverage
- ✓ strengthen the geometry

# The structure of VIE\_SCHED within VieVS



# Input files (VieVS/CATALOGS)



## Catalog system files

Type	File Name	Contents	Used for
Sources:			
	source.cat	source positions	simu + real
	flux.cat	source fluxes	simu + real
Stations:			
	antenna.cat	antenna information	simu + real
	position.cat	station x,y,z locations	simu + real
	equip.cat	equipment IDs	simu + real
	mask.cat	horizon and coordinate masks	simu + real
Observing modes:			
	modes.cat	observing modes	simu + real
	freq.cat	frequency sequences	real
	rx.cat	receiver setups	real
	loif.cat	station LO and IF setups	real
	rec.cat	recording modes	real
	hdpos.cat	head offsets	real
	tracks.cat	standard recorded tracks	real

controlled and maintained at GSFC

available via <ftp://gemini.gsfc.nasa.gov/pub/sked>

They can be used directly (without manual changes) in VieVS.

# Input files (VieVS/CATALOGS)

## Local control files

### (1) param.txt file

<b>PARA.WAVEL(1)</b>	Wavelength of X band [meter]
<b>PARA.WAVEL(2)</b>	Wavelength of S band [meter]
<b>PARA.CHANUM(1)</b>	Num of channel for X band
<b>PARA.CHANUM(2)</b>	Num of channel for S band
<b>PARA.RATE1A</b>	Acceleration of AZ/HA axis [deg/s <sup>2</sup> ]
<b>PARA.RATE2A</b>	Acceleration of EL/DC axis [deg/s <sup>2</sup> ]
<b>PARA.MARGEL1</b>	Marge for AZ/HA axis [deg]
<b>PARA.MARGEL2</b>	Marge for EL/DC axis [deg]
<b>PARA.MIN_SRCRP</b>	The interval that the same source won't be observed twice [min]
<b>PARA.SOURCE</b> [sec]	Time for the antenna to settle down after slewing and before observation start time
<b>PARA.TAPETM</b>	Time for the tape after slewing and before observation start time [sec]
<b>PARA.IDLE</b>	Time allowed for idling after slewing and before observation start time [sec]
<b>PARA.CALIBRATION</b>	Time allowed for calibration after slewing and before observation start time [sec]
<b>PARA.MAXSLEWTIME</b>	Maximum time to allow an antenna to slew [sec]
<b>PARA.MAX_WAIT</b>	Maximum time to wait for the slow antenna [sec]



# Input files (VieVS/CATALOGS)

## Local control files

### (1) param.txt file

<b>PARA.CORSYNCH</b>	Time to allow the correlator to synchronize tapes [sec]
<b>PARA.MAX_SCAN</b>	Maximum allowable scan time [sec]
<b>PARA.MIN_SCAN</b>	Minimum allowable scan time [sec]
<b>PARA.FILLINMODE</b>	If use fill-in mode (0/1/2/12)
<b>PARA.FILLENDT</b>	Maximum time for the end time of fill-in scan [sec]
<b>PARA.SCREEN</b>	If print processing information on screen (1/0)
<b>PARA.MIN_STANUM</b>	Minimum subnet scheduled at one time
<b>PARA.SKYDT</b>	The interval for calculation of sky coverage [min]
<b>PARA.MIN_SRC2ANG</b>	Minimum angle between two sources observed simultaneously [deg]
<b>PARA.SORTNUM</b>	Num of subconfigurations found with station-based strategy for further consideration
<b>PARA.FORSI</b>	if check for source structure study [1/0]
<b>PARA.UPSTA</b>	increase the opportunity for scheduling
<b>PARA.DOWNSTA</b>	decrease the opportunity for scheduling
<b>PARA.SRCFRINGE</b>	source used for fringe check

## Input files (VieVS/CATALOGS)

### Local control files

(1) param.txt file

(2) down.txt file

```
*
* down.txt - downtime information
*
* NOTE: Use this file for schedules to specify the downtime
*       that the station can't take part in observation.
*
* Name      start (YMDHMS)      end (YMDHMS)
* KOKEE     2012 08 28 18 15 00 2012 08 28 19 45 00
* WETTZELL  2012 08 28 18 15 00 2012 08 28 19 45 00
```

## Input files (VieVS/CATALOGS)

### Local control files

- (1) param.txt file
- (2) down.txt file
- (3) snrmin.txt file

```
*
* snrmin.txt - minimum SNR information
*
* NOTE: Use this file for schedules to specify the minimum SNR
*       of each band at stations.
*
* Name      SNR_min(X)  SNR_min(S)
*
TIGO       18       12
TIGOCONC   18       12
```

# Input files (VieVS/CATALOGS)

## Local control files

- (1) param.txt file
- (2) down.txt file
- (3) snrmin.txt file
- (4) psource.txt file

```
*
* psource.txt - particular sources needed more observations
*
* NOTE: Use this file to specify a list of sources to be observed,
*       especially for astrometry.
*
*-----
*
*           From      interval %year mo da      ICRF      flux      structure
*           (min)                                     h          elon      sigma      3.6 cm      index      Nobs
*                                     (deg)      (uas)      (Jy)
*-----
* Session RD1206 12AUG28XI
*-----
1030+074 20120829040000 20 %2012 8 29 0      2.3      92.2      0.299      2.64      1681
1023+131 20120829040000 50 %2012 8 29 0      3.7      100.0     0.546      2.64      1167
1015+057 20120828173000 180 %2012 8 29 0      4.9      134.5     0.285      2.75      1058
1013+054 20120828173000 180 %2012 8 29 0      5.5      92.2      0.443      2.75      2674
1022+194 20120828173000 180 %2012 8 29 0      10.0     78.1      0.670      2.64      3253
1055+018 20120828173000 180 %2012 8 29 0      10.4     64.0      3.218      2.81      7749
1111+149 20120828173000 180 %2012 8 29 0      12.1     122.1     0.423      2.53      1763
1049+215 20120828173000 180 %2012 8 29 0      13.1     92.2      0.980      2.95      1599
1012+232 20120828173000 180 %2012 8 29 0      14.2     84.9      0.859      2.75      2861
```

## Input files (VieVS/CATALOGS)

### Local control files

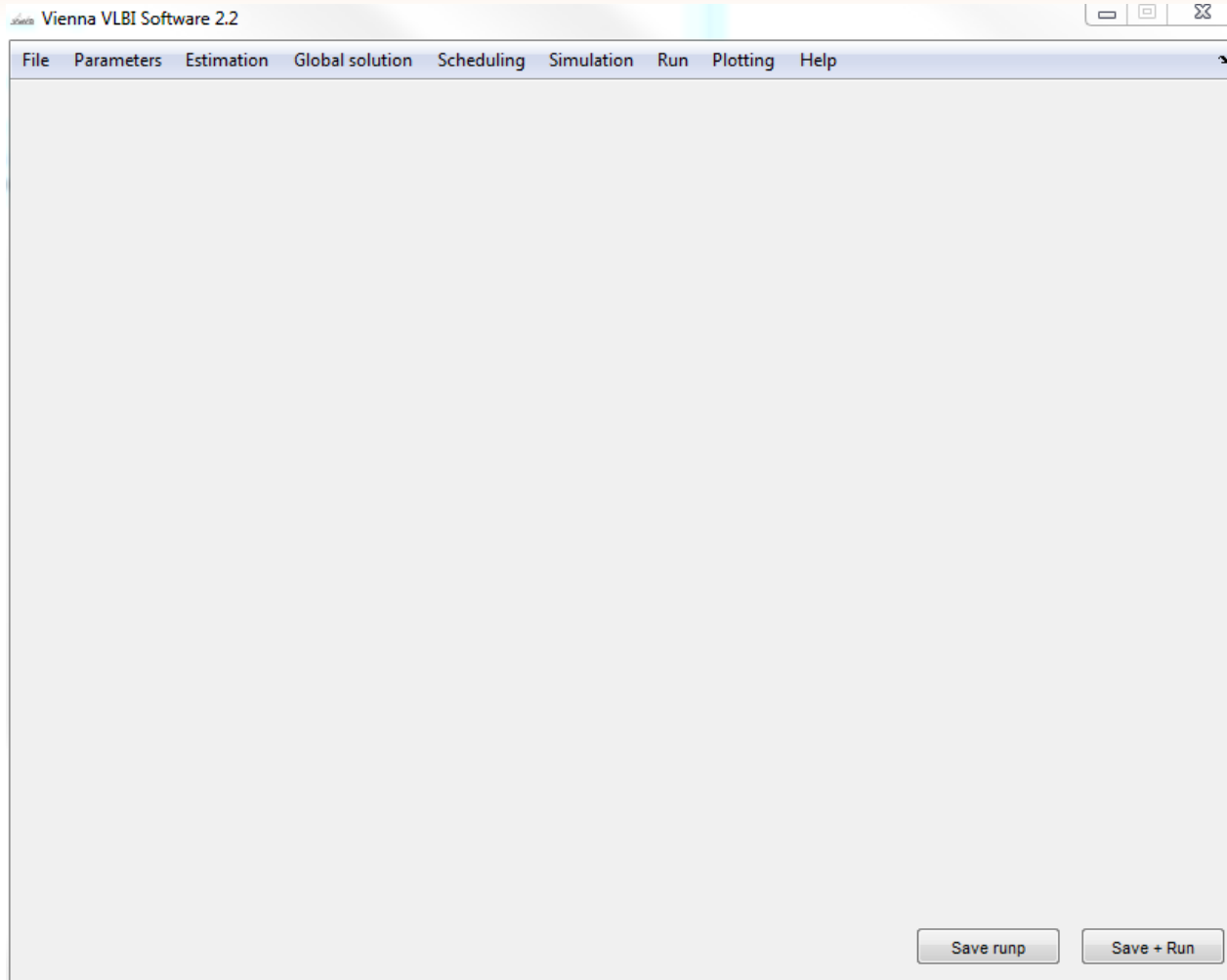
- (1) param.txt file
- (2) down.txt file
- (3) snrmin.txt file
- (4) psource.txt file
- (5) tagalong.txt

```
*  
* tagalong.txt  
*  
* NOTE: Use this file to specify the station for tag-along mode  
*       in Vie_Sched.  
*  
* StaName  
*  
* HARITRAO
```

# How to run VIE\_SCHED



start VieVS as usual



VIE\_SCHED

# How to run VIE\_SCHED



## Scheduling GUI

Vienna VLBI Software 2.2

File Parameters Estimation Global solution **Scheduling** Simulation Run Plotting Help

Scheduling

Network

Available	Selected	Predefined
AIRA		INT1.mat
ALGOPARK		IVSR1.mat
ARECIBO		IVSR4.mat
ARIES_4M		VLBI2010.mat
ARIES_9M		
ATCA		
BADARY		
BR-VLBA		
CAMBG32M		
CEBRER26		
CEDUNA		
CHICH10		

Clear selected Save

Session start

2010 / 1 / 4

12 : 0 : 0

Duration 24 [h]

Band

X Band 20 SNR

S Band 15 SNR

Observing mode for twin telescopes—  
Source-based strategy not working for twins

Same source observations

Continuous observations

Multidirectional observations

Parameters

Sundist [°] 15 [deg]

Cut-off el [°] 5 [deg]

Source flux 0.25 [Jy]

Output

Write NGS file

Write SUM file

Write SKD file

Strategy

Source-based strategy  
Number of sources observed simultaneously: 2 (1 / 2 / 4)

Station-based strategy

Other

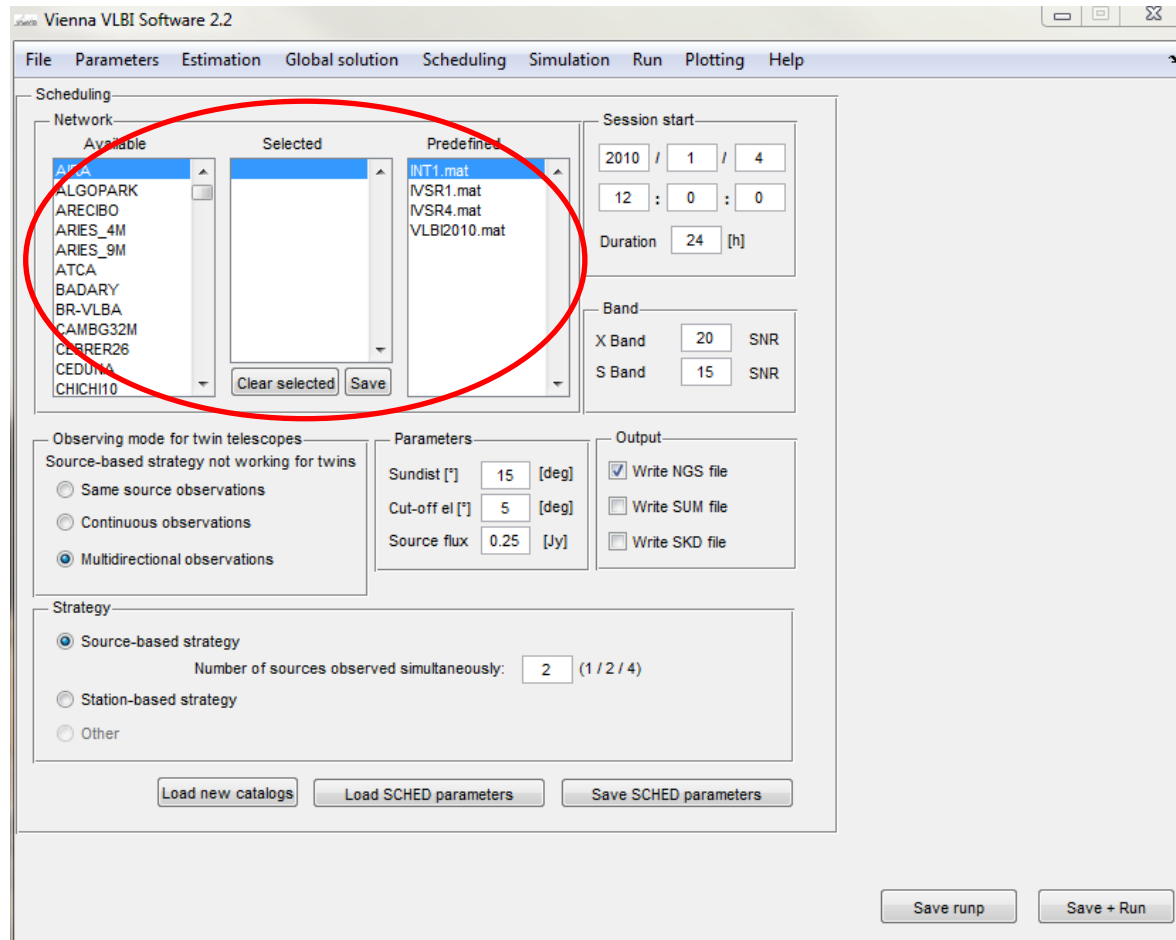
Load new catalogs Load SCHED parameters Save SCHED parameters

Save runp Save + Run

# How to run VIE\_SCHED



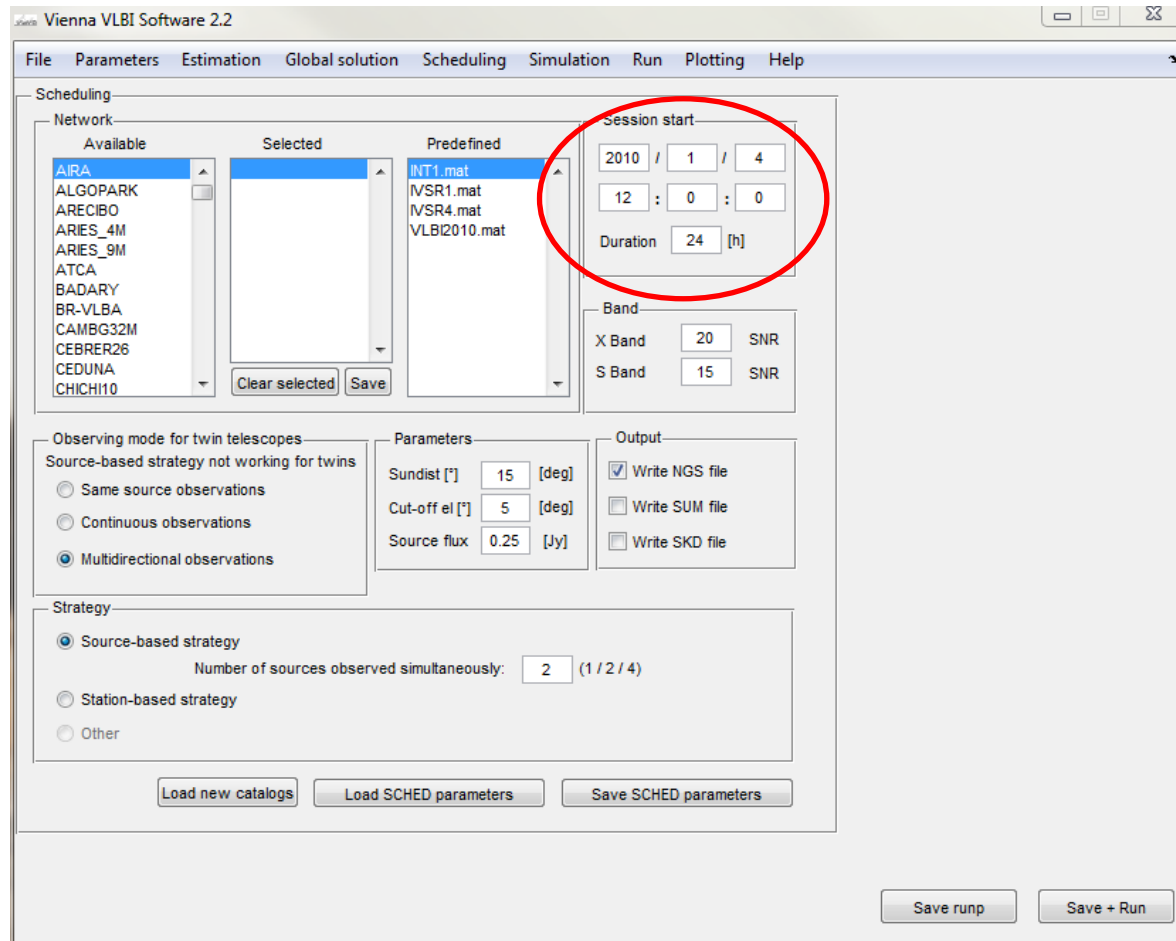
Select the stations or use a predefined network. This is usually done according to the master file.





# How to run VIE\_SCHED

Change the start times of the session and its duration. The start and end times are also contained in master file.



# How to run VIE\_SCHED



Set the SNR targets.

The screenshot shows the 'Scheduling' window of Vienna VLBI Software 2.2. The 'Band' section is highlighted with a red circle, showing the following settings:

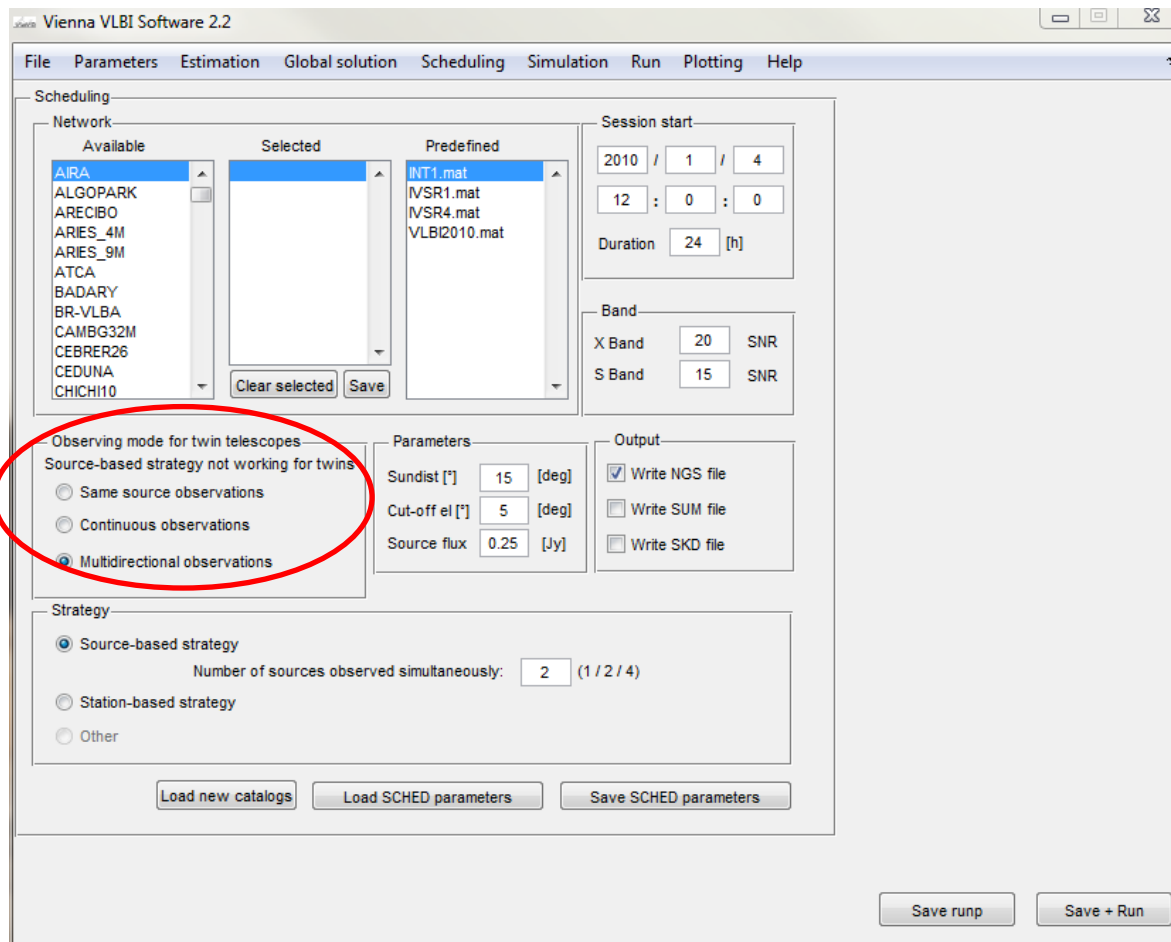
Band	Value	SNR
X Band	20	SNR
S Band	15	SNR

Other visible settings in the window include:

- Session start: 2010 / 1 / 4, 12 : 0 : 0
- Duration: 24 [h]
- Observing mode for twin telescopes:  Multidirectional observations
- Parameters: Sundist [°] 15 [deg], Cut-off el [°] 5 [deg], Source flux 0.25 [Jy]
- Output:  Write NGS file,  Write SUM file,  Write SKD file
- Strategy:  Source-based strategy, Number of sources observed simultaneously: 2 (1 / 2 / 4)

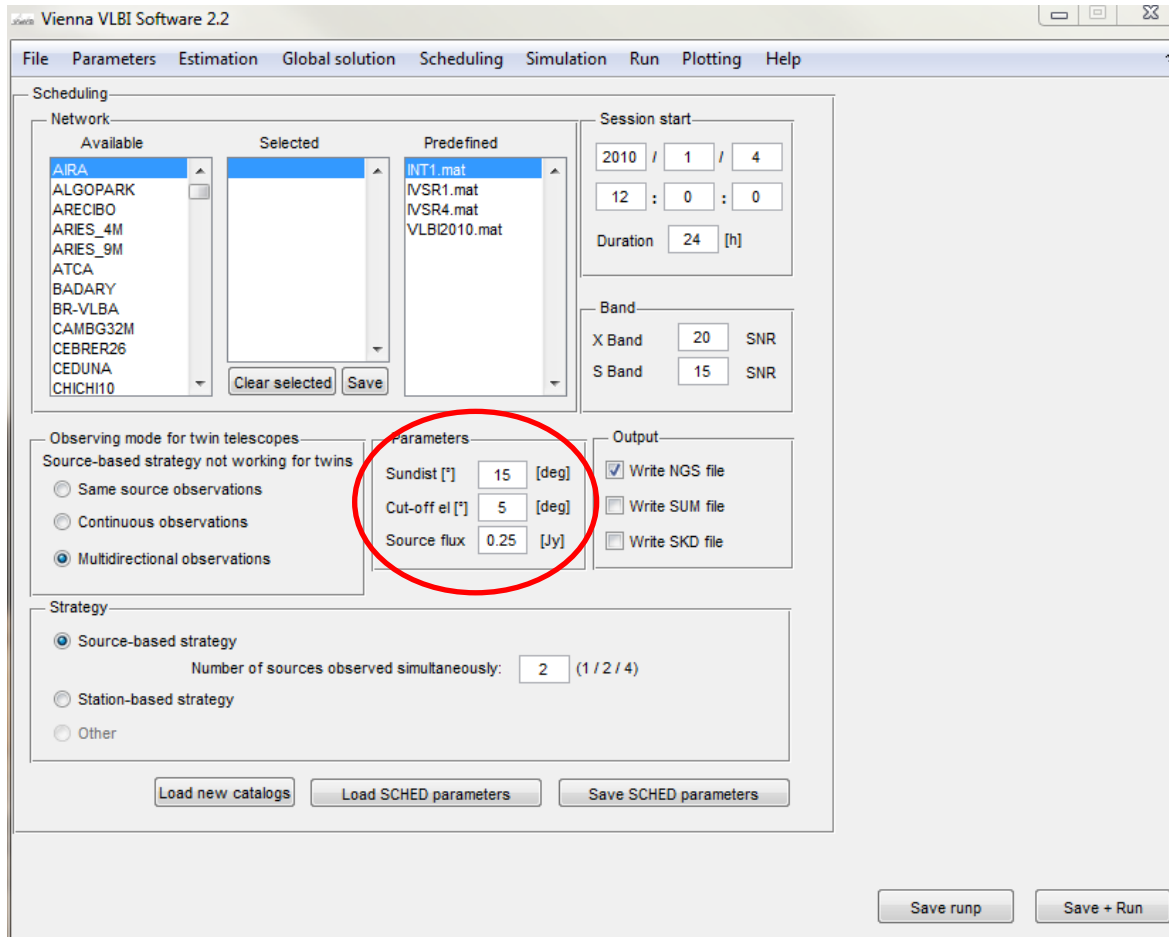
# How to run VIE\_SCHED

Specify the observing mode for twin telescopes if there are twin telescopes in the network.



# How to run VIE\_SCHED

 Give the parameters for scheduling.



Vienna VLBI Software 2.2

File Parameters Estimation Global solution Scheduling Simulation Run Plotting Help

Scheduling

Network

Available	Selected	Predefined
AIRA		INT1.mat
ALGOPARK		IUSR1.mat
ARECIBO		IUSR4.mat
ARIES_4M		VLBI2010.mat
ARIES_9M		
ATCA		
BADARY		
BR-VLBA		
CAMBG32M		
CEBRE26		
CEDUNA		
CHICH10		

Clear selected Save

Session start

2010 / 1 / 4

12 : 0 : 0

Duration 24 [h]

Band

X Band 20 SNR

S Band 15 SNR

Observing mode for twin telescopes—

Source-based strategy not working for twins

Same source observations

Continuous observations

Multidirectional observations

Parameters

Sundist [°] 15 [deg]

Cut-off el [°] 5 [deg]

Source flux 0.25 [Jy]

Output

Write NGS file

Write SUM file

Write SKD file

Strategy

Source-based strategy

Number of sources observed simultaneously: 2 (1 / 2 / 4)

Station-based strategy

Other

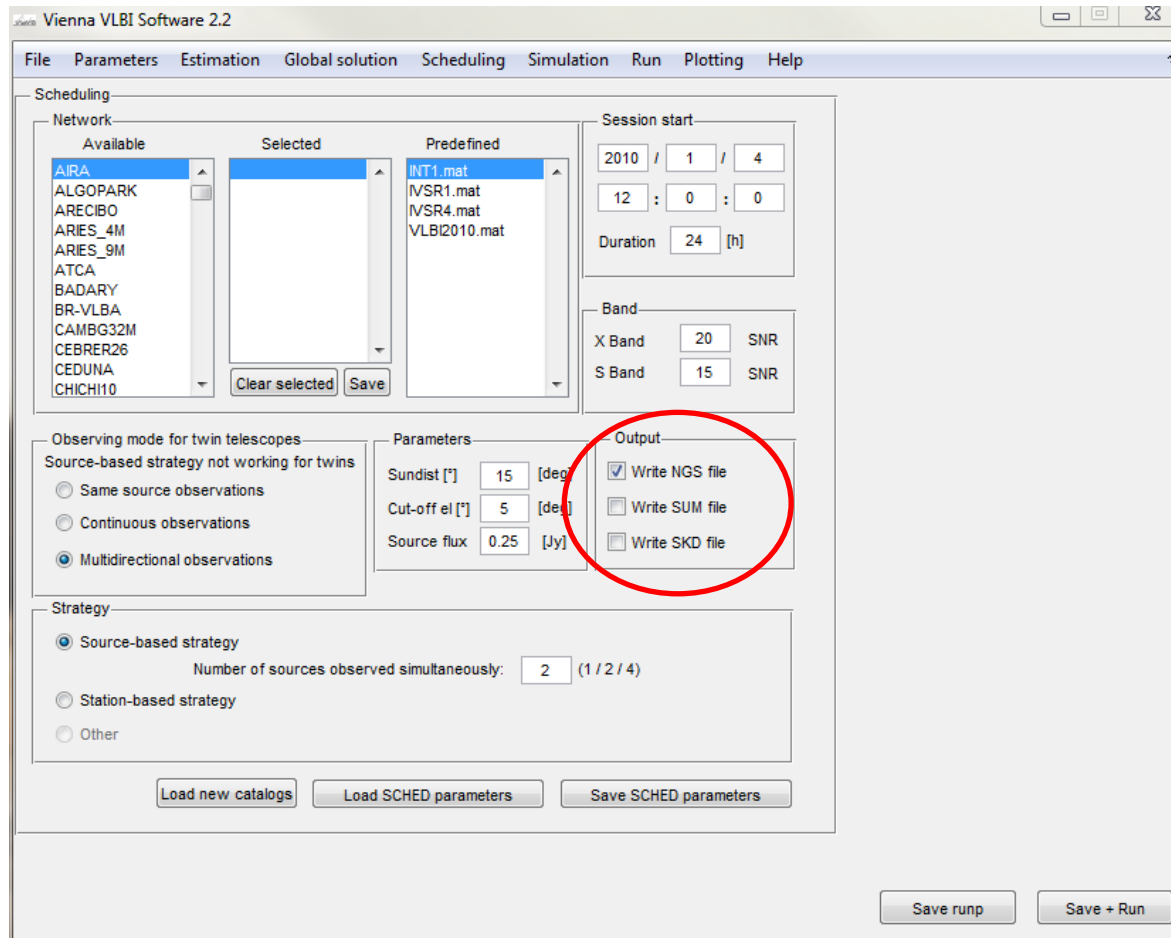
Load new catalogs Load SCHED parameters Save SCHED parameters

Save runp Save + Run

# How to run VIE\_SCHED

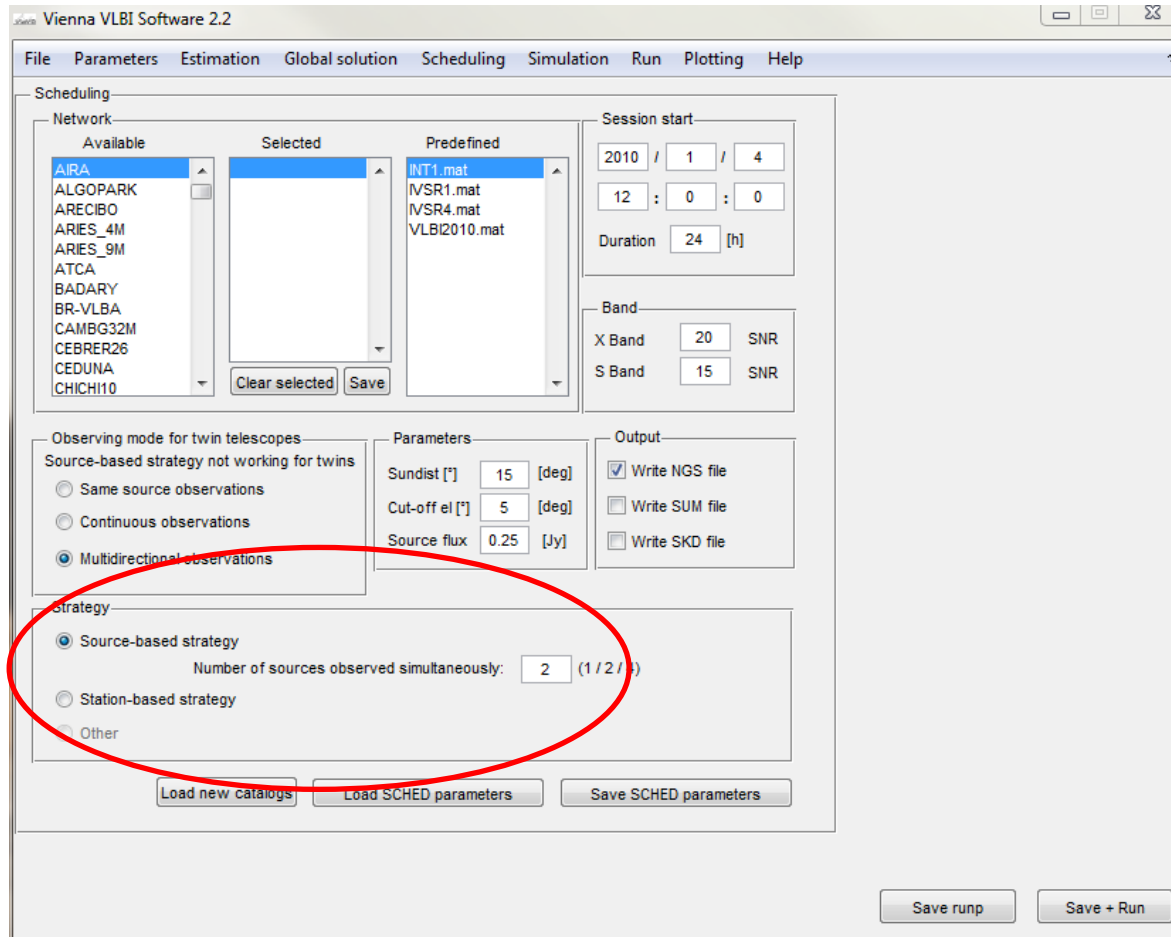


Specify the type of output files (NGS file, SUM file, or SKD/VEX file).



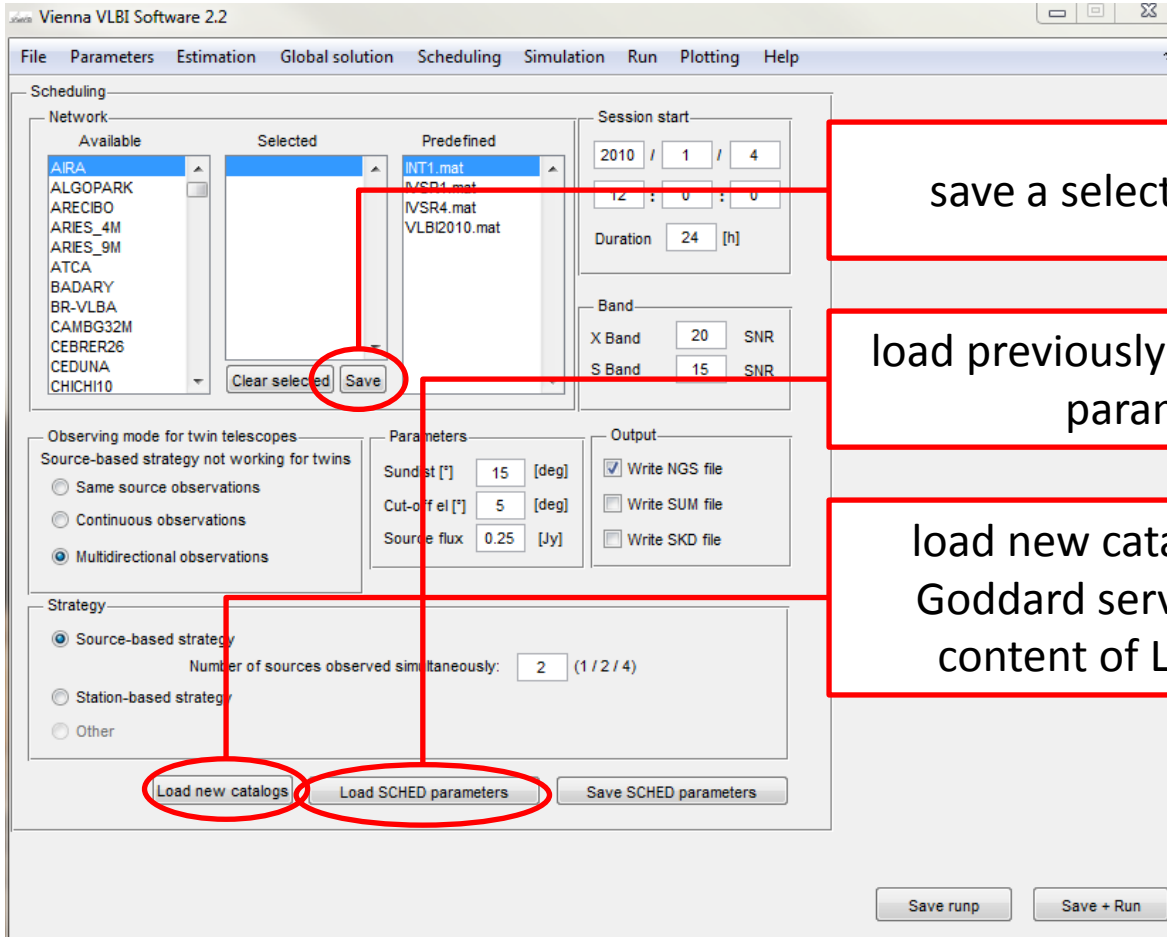
# How to run VIE\_SCHED

 Specify the strategy used for scheduling.



# How to run VIE\_SCHED

## New options in the scheduling GUI

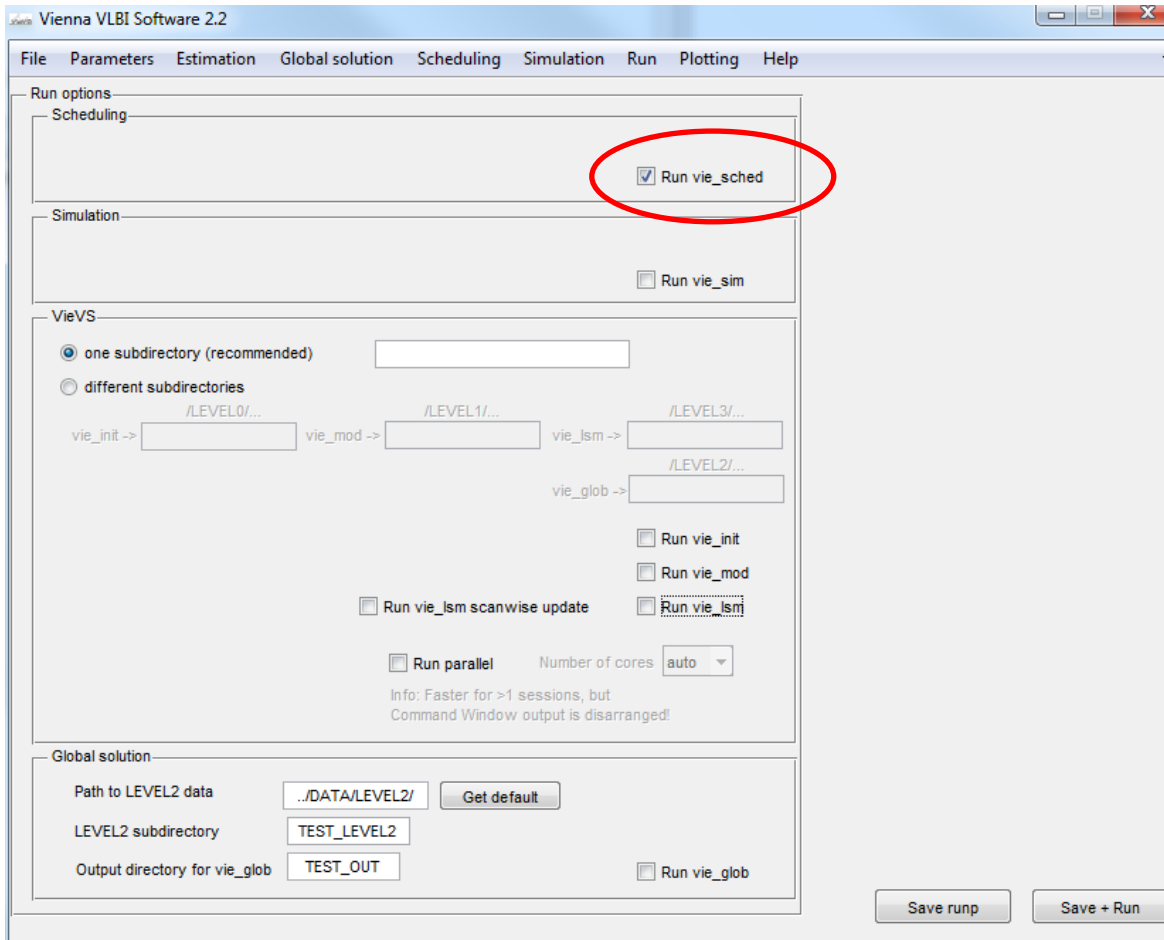


The screenshot shows the 'Scheduling' window of Vienna VLBI Software 2.2. The window is divided into several sections:

- Network:** Contains three columns: 'Available' (listing stations like AIRA, ALGOPARK, etc.), 'Selected' (empty), and 'Predefined' (listing stationlists like INT1.mat, IVSR1.mat, etc.). A 'Save' button is circled in red, with a callout box pointing to it that says 'save a selected stationlist'.
- Session start:** Fields for year (2010), month (1), day (4), and duration (24 [h]).
- Band:** Fields for X Band (20 SNR) and S Band (15 SNR).
- Observing mode for twin telescopes:** Radio buttons for 'Same source observations', 'Continuous observations', and 'Multidirectional observations' (selected).
- Parameters:** Fields for 'Sundst [°]' (15 [deg]), 'Cut-off el [°]' (5 [deg]), and 'Source flux' (0.25 [Jy]).
- Output:** Checkboxes for 'Write NGS file' (checked), 'Write SUM file', and 'Write SKD file'.
- Strategy:** Radio buttons for 'Source-based strategy' (selected), 'Station-based strategy', and 'Other'. A field for 'Number of sources observed simultaneously' is set to 2 (1/2/4).
- Bottom Buttons:** 'Load new catalogs' and 'Load SCHED parameters' are circled in red, with callout boxes pointing to them. The 'Load new catalogs' callout says 'load new catalogs from the Goddard server and delete content of LEVEL5 folder'. The 'Load SCHED parameters' callout says 'load previously saved scheduling parameters'.
- Bottom Right:** 'Save runp' and 'Save + Run' buttons.

# How to run VIE\_SCHED

## Run options for VIE\_SCHED





Thank you for your attention!

problems? questions?  
mail to **david.mayer@tuwien.ac.at**

David Mayer works within FWF-Project P23143 „Integrated VLBI“.