TECHNISCHE UNIVERSITÄT WIEN
Vienna University of Technology

Vie_SCHED_V22

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VieVS User Workshop
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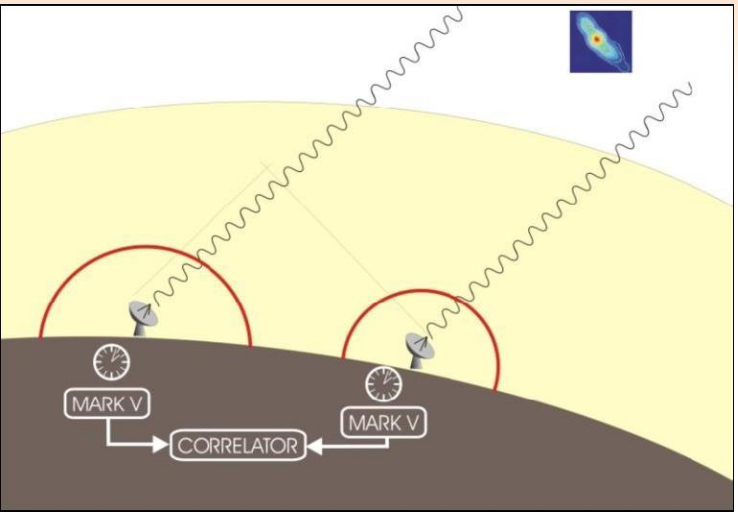
Vienna, Austria

VieVS
Vienna VLBI Software

[1] Shanghai Astronomical Observatory

Introduction

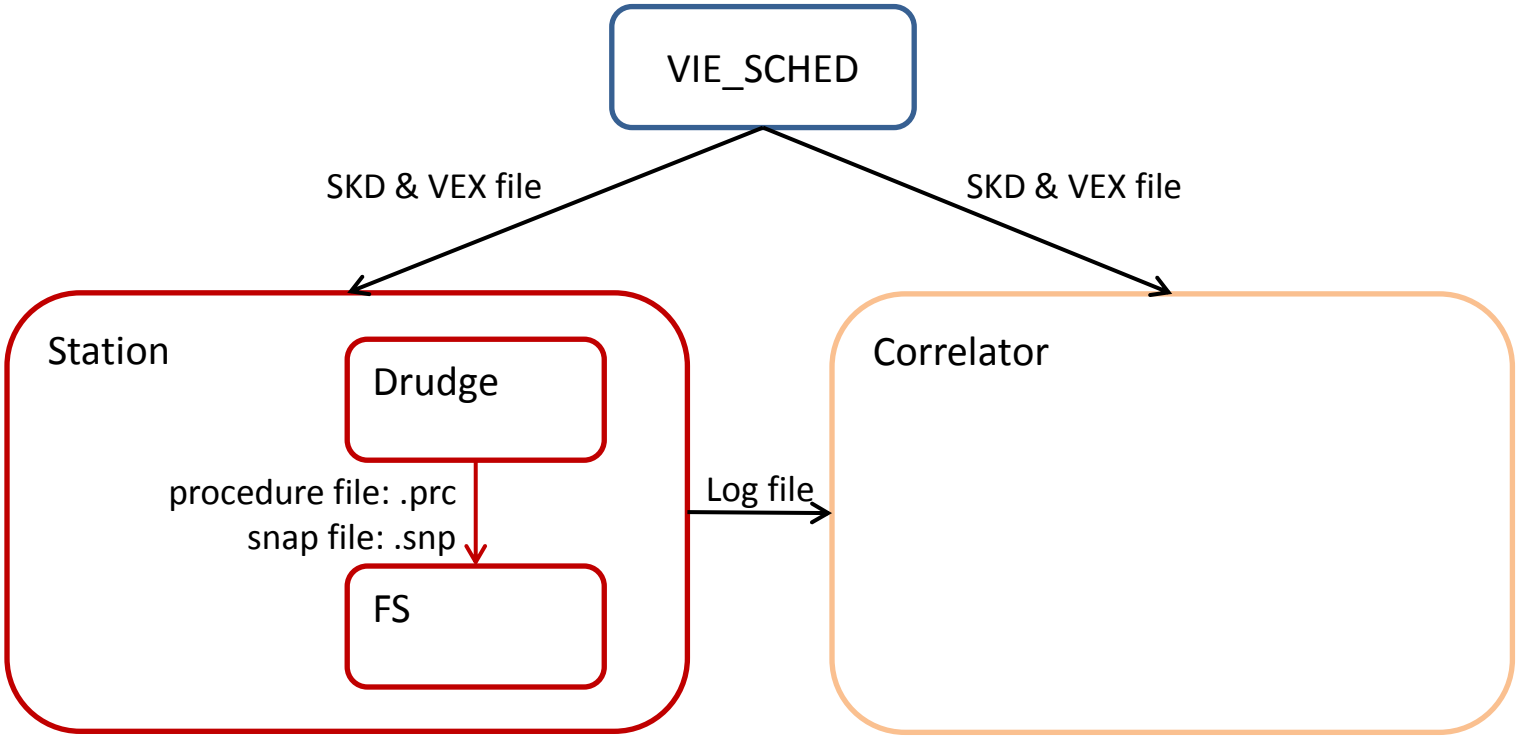


VLBI2010 goals:

- 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.

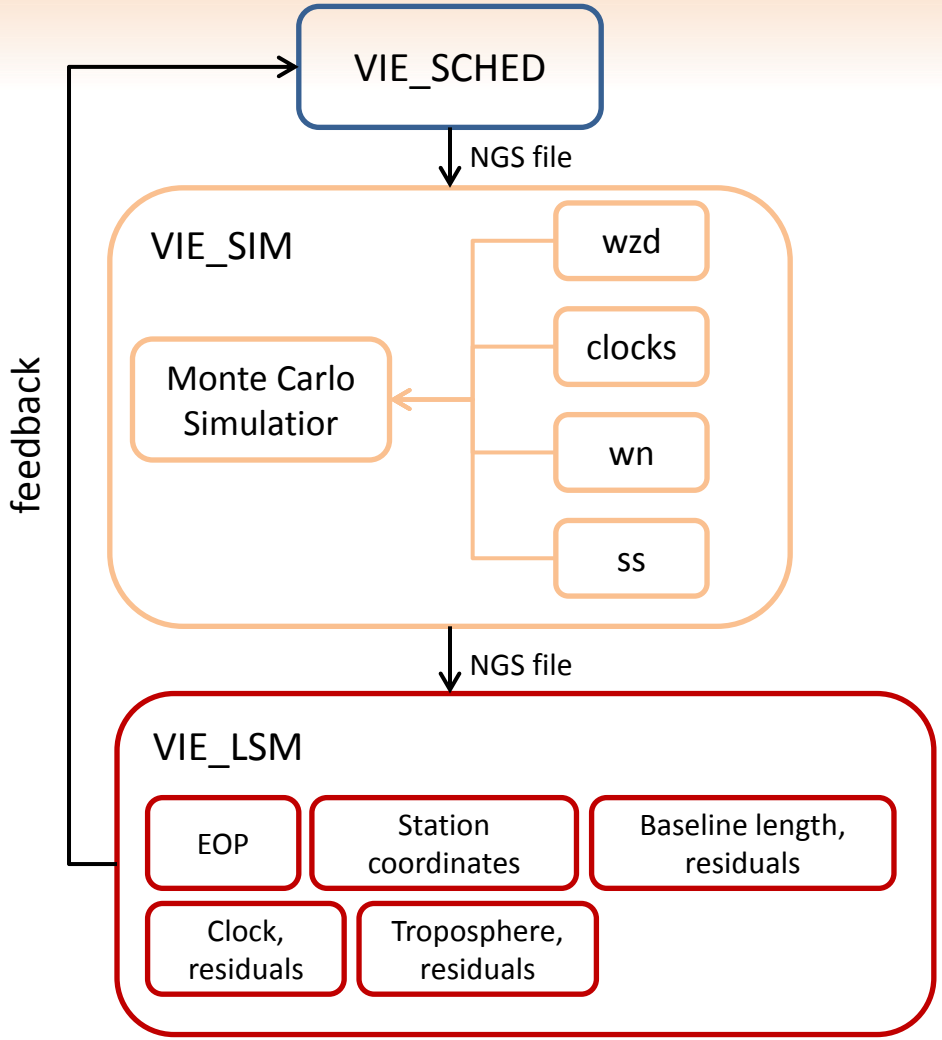
Parameter	VLBI2010 system	Current VLBI system
antenna size	~ 12 m dish, twin antennas	5 – 100 m dish
slew speed	≥ 360 deg/min	~ 20 – 200 deg/min
sensitivity	SEFD ≤ 2500	SEFD 200 – 15000
frequency range	~ 2 – 14 GHz	S/X band
recording rate	8 – 16 Gbps	128, 256 Mbps
data transfer	e-transfer, e_VLBI disk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

Purpose of a scheduling program (1)
→ real VLBI experiment



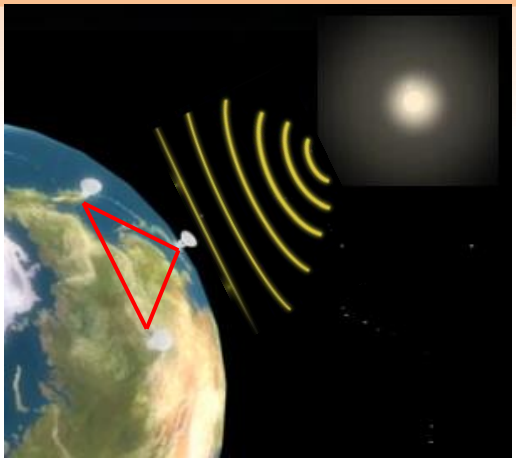
Purpose of a scheduling program (2)

→ simulation research



Algorithms and models for a scan

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

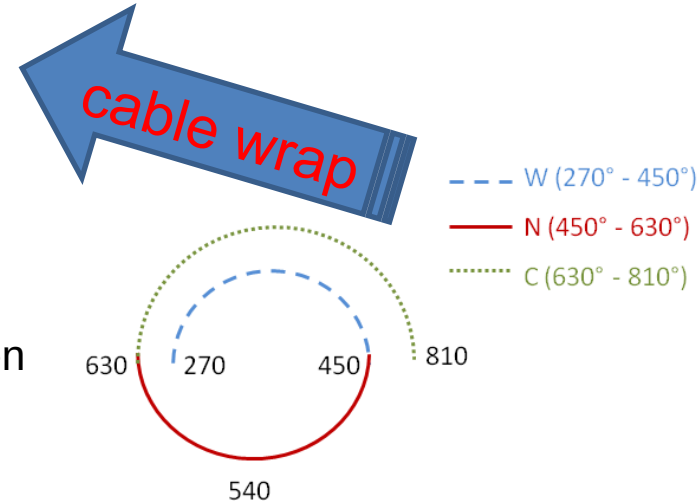


Calculation of scan start time

- earliest possible start time for a new observation

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

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

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

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
η - processing factor

elevation dependence is applied

scan length

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

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

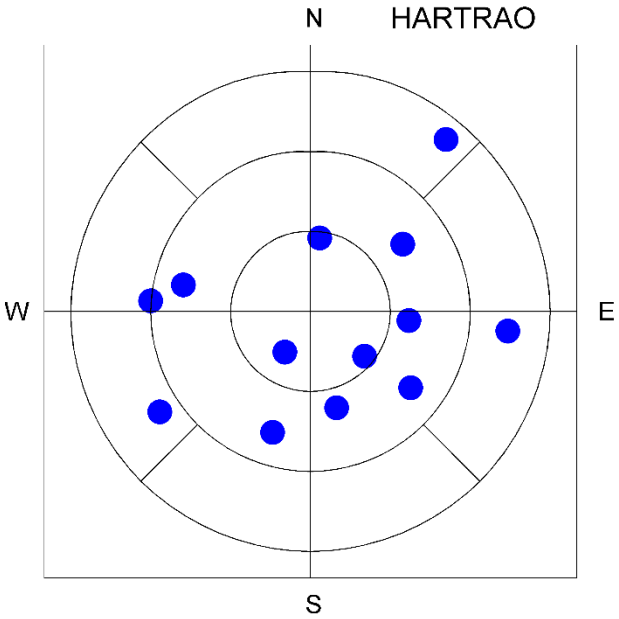
- important criterion: source has to be up at participating station during the observation
- Horizon mask (mask.cat) describes the surrounding mountains ...

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 ...)

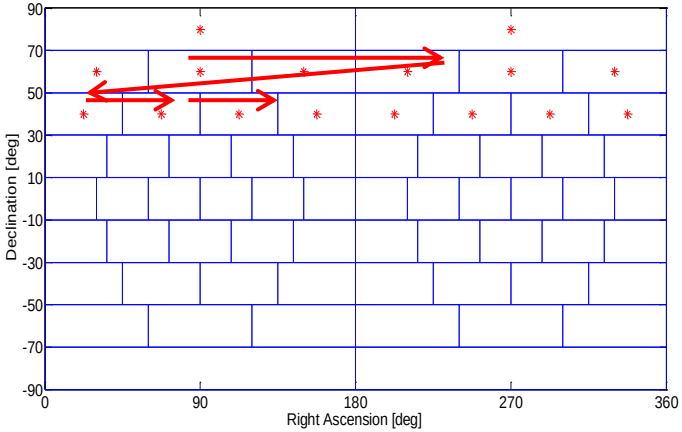
Station-based scheduling strategy

- Classical approach to achieve uniform sky coverage at each station (needed for de-correlation 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 sapling interval of the estimated parameters



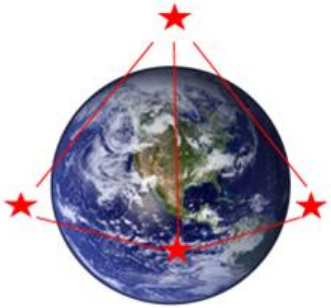
Source-based scheduling strategy

- 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

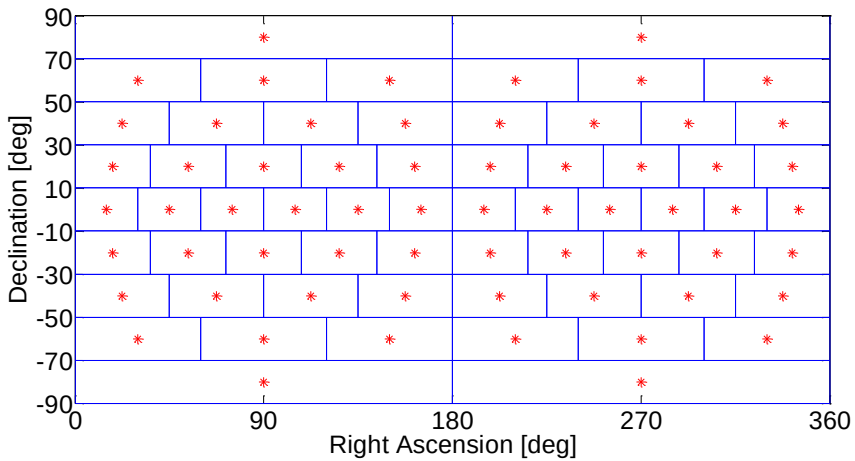
- **two** sources scheduled simult.



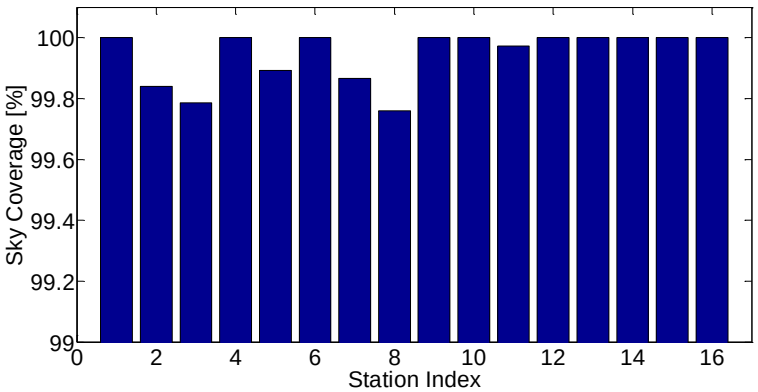
- **four** sources scheduled simult.

Strategies for automatic scheduling

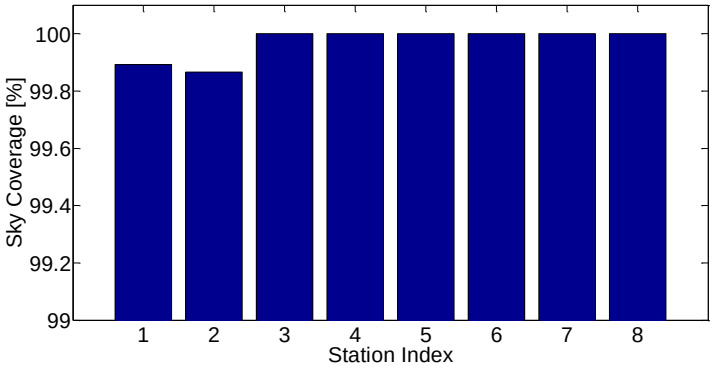
Source-based strategy ⟷ **Station-based strategy**



16-station test VLBI2010 network



8-station typical IVS R1 network



All **64 segments** on celestial sphere are scheduled.

At least **99.7%** sky coverage at stations is achieved.

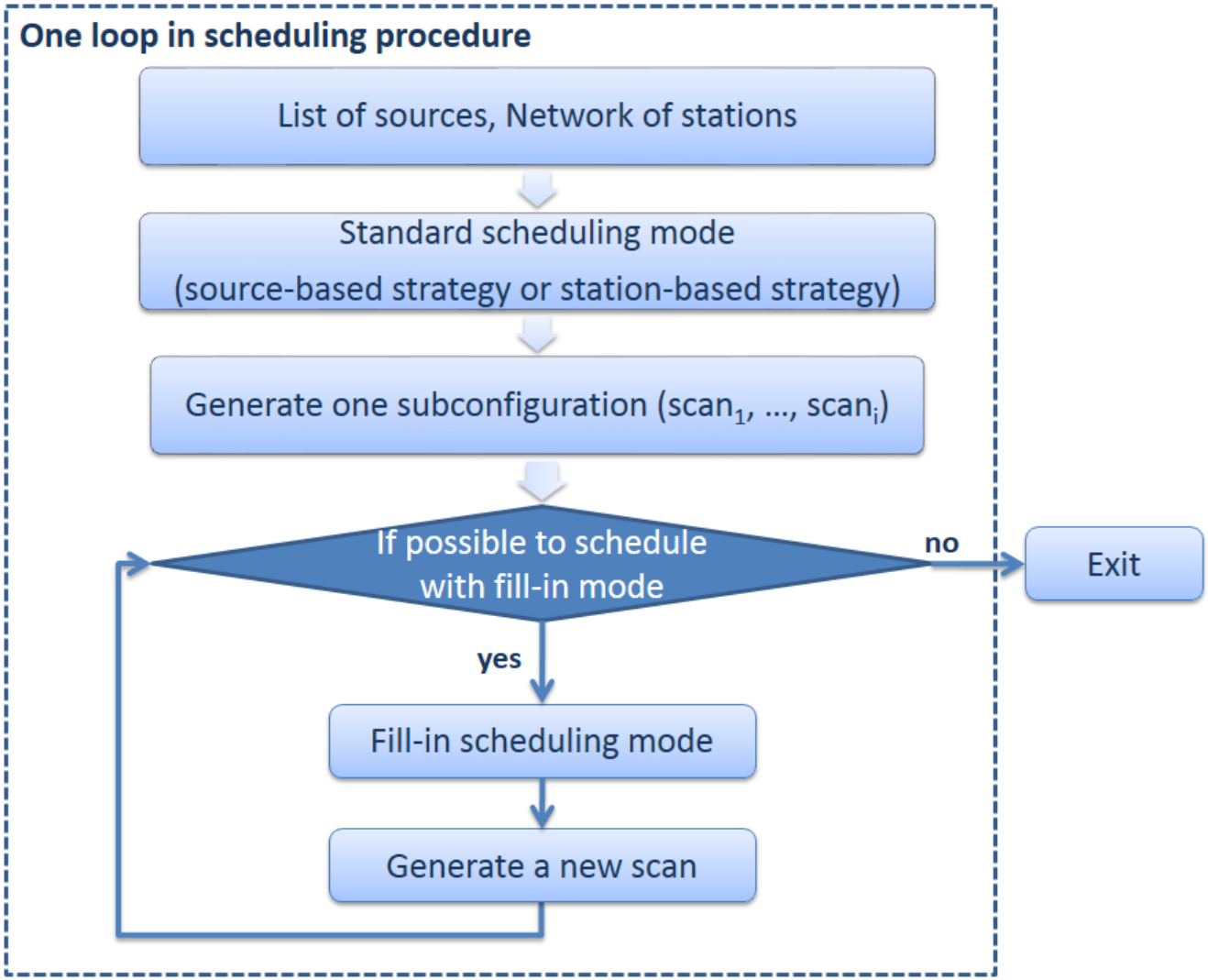
Fill-in mode

- 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

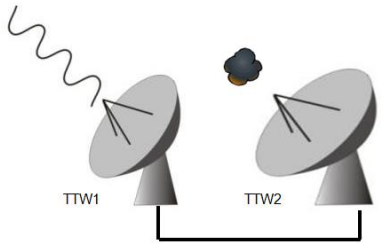

One loop in scheduling procedure
List of sources, Network of stations
Standard scheduling mode
(source-based strategy or station-based strategy)
Generate one subconfiguration (scan$_1$, ..., scan$_i$)
If possible to schedule
with fill-in mode
no
Exit
yes
Fill-in scheduling mode
Generate a new scan

Twin telescopes at one site

(1) Same troposphere above the twin telescopes;

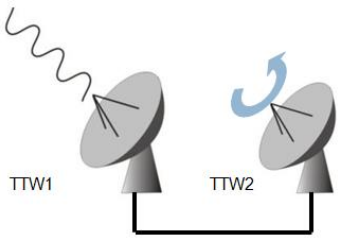
(2) Same H-maser clock connecting them.

Mode1 : Maintenance



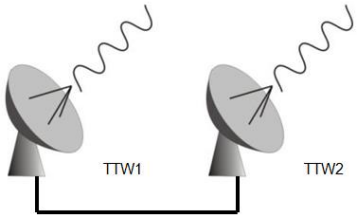
✓ full availability

Mode3 : Continuous observations



✓ continuous observations, without any temporal gaps

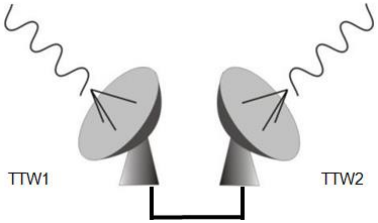
Mode2 : Same source observations



✓ increase the sensitivity and decrease on-source time

✓ counteract the troposphere effect for calibration

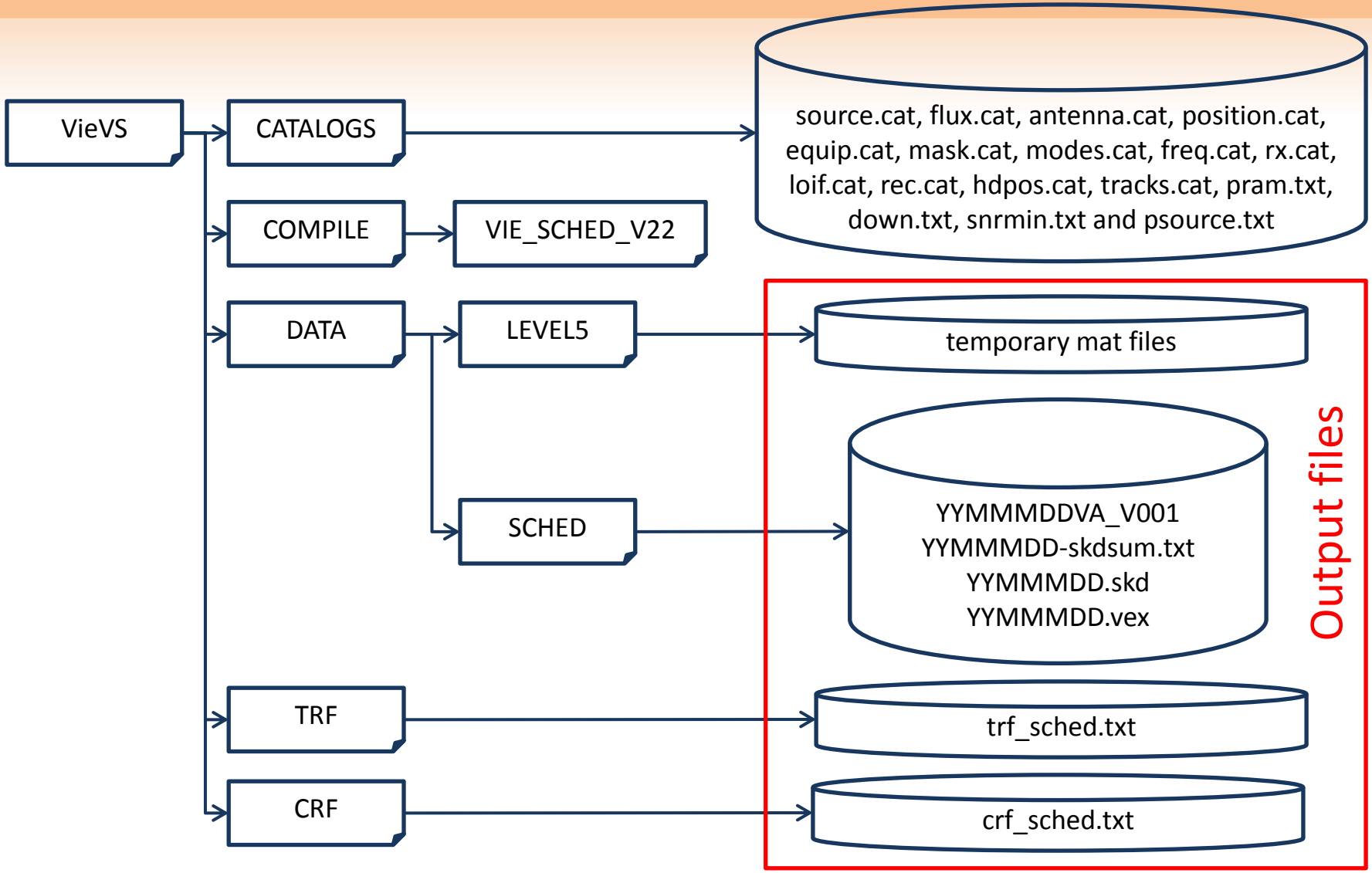
Mode4 : Multidirectional observations



✓ 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

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

Input files (VieVS/CATALOGS)

- Local control files

(1) param.txt file

PARA.CORSYNCH	Time to allow the correlator to synchronize tapes [sec]
PARA.MAX_SCAN	Maximum allowable scan time [sec]
PARA.MIN_SCAN	Minimum allowable scan time [sec]
PARA.FILLINMODE	If use fill-in mode (0/1/2/12)
PARA.FILLENDT	Maximum time for the end time of fill-in scan [sec]
PARA.SCREEN	If print processing information on screen (1/0)
PARA.MIN_STANUM	Minimum subnet scheduled at one time
PARA.SKYDT	The interval for calculation of sky coverage [min]
PARA.MIN_SRC2ANG	Minimum angle between two sources observed simultaneously [deg]
PARA.SORTNUM	Num of subconfigurations found with station-based strategy for further consideration
PARA.FORSI	if check for source structure study [1/0]
PARA.UPSTA	increase the opportunity for scheduling
PARA.DOWNSTA	decrease the opportunity for scheduling
PARA.SRCFRINGE	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.
*
*-----------------------------------------------------------------------------------------
*                                                ICRF      flux   structure
*         From       interval %year mo da        h        elon     sigma    3.6 cm       index      Nobs
*                      (min)                               (deg)     (uas)     (Jy)
*-----------------------------------------------------------------------------------------
* Session RD1206 12AUG28XA
*-----------------------------------------------------------------------------------------
 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

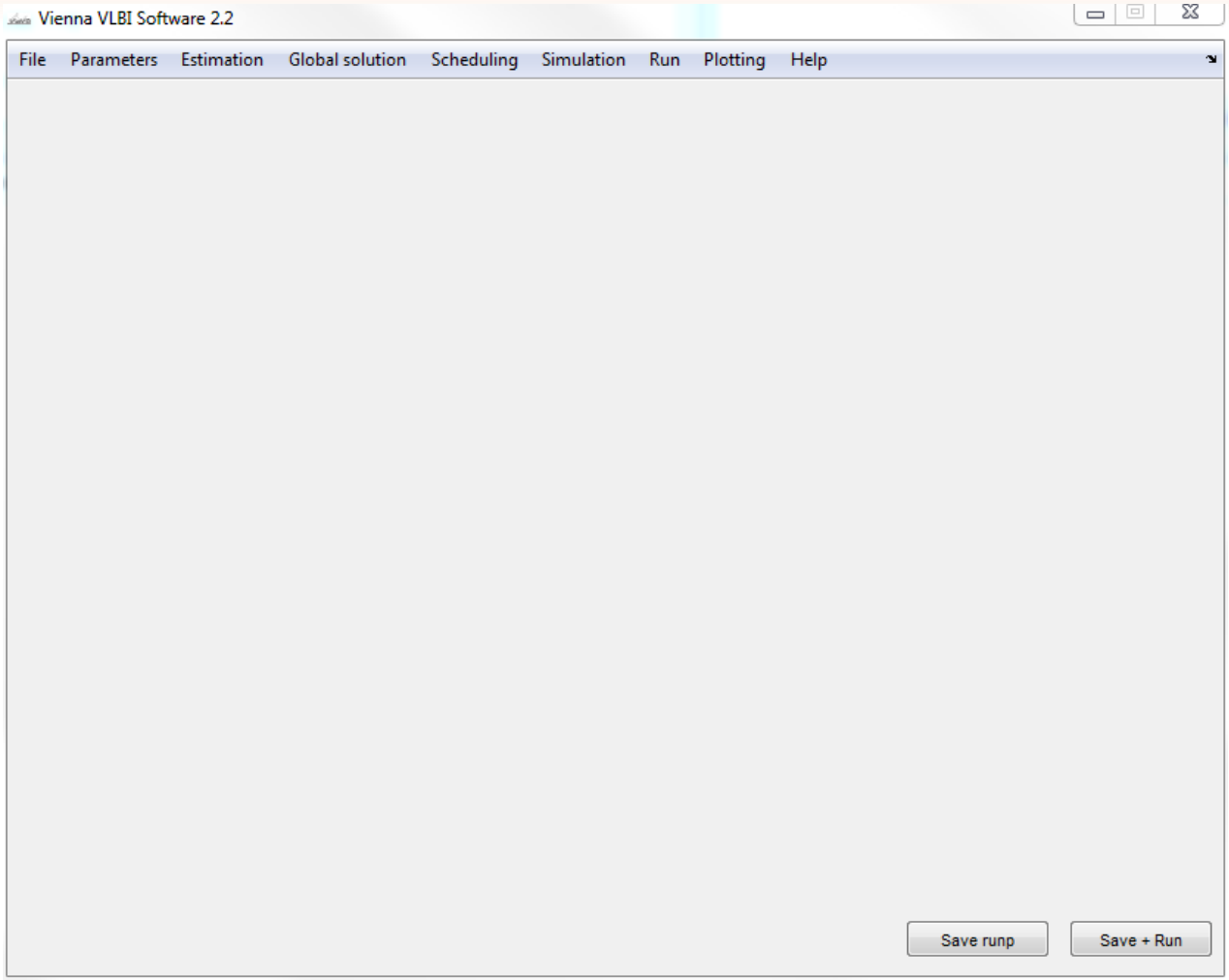
(4) psource.txt file

(5) tagalong.txt

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

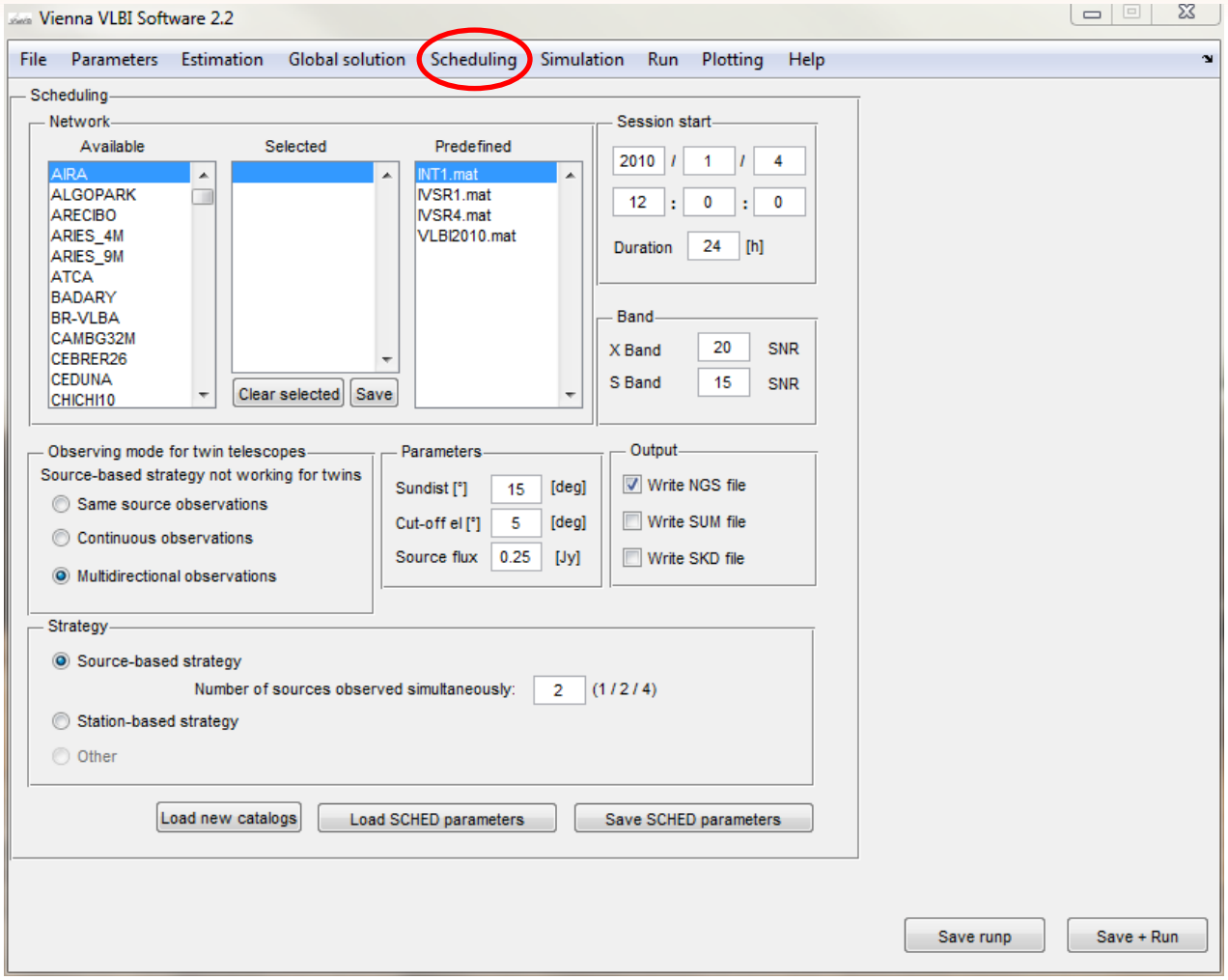
How to run VIE_SCHED

start VieVS as usual



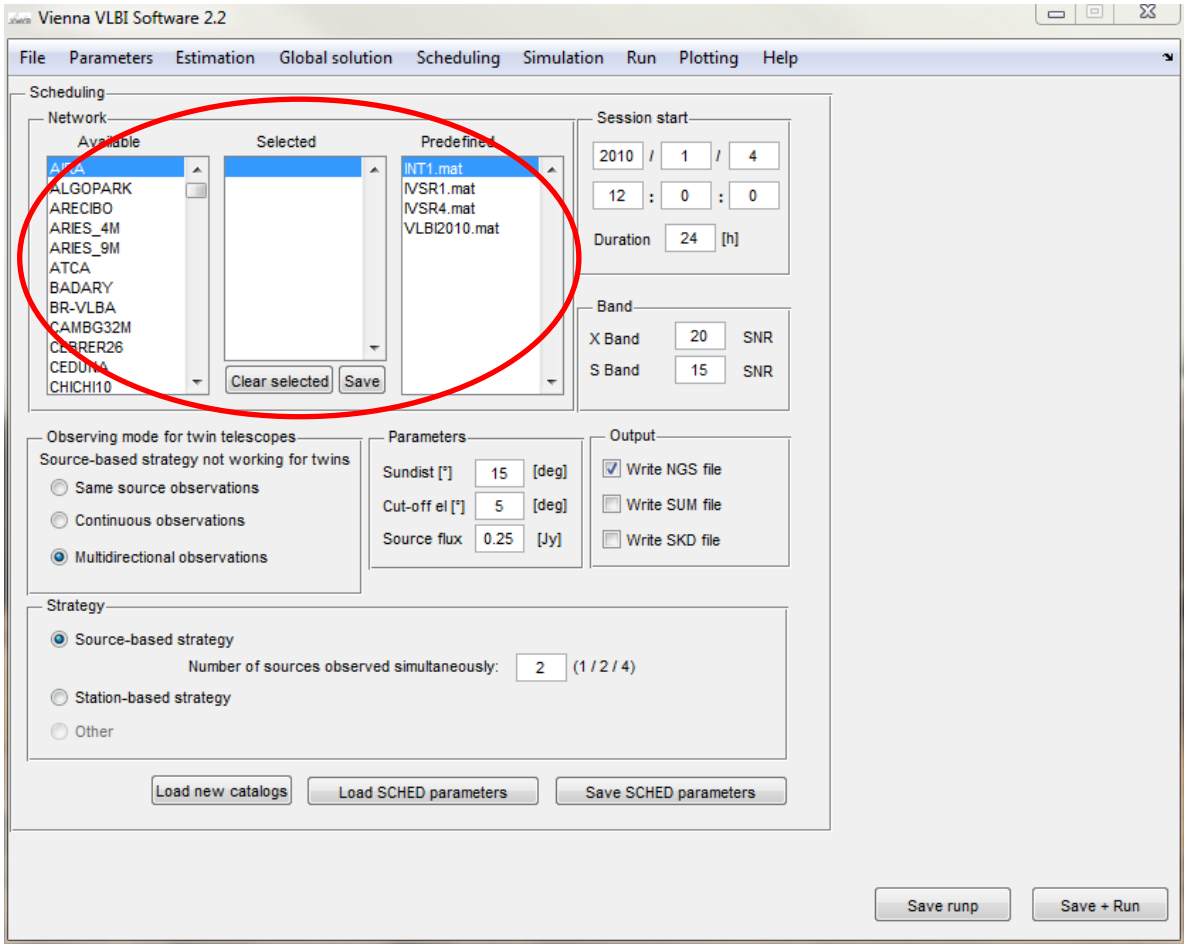
How to run VIE_SCHED

Scheduling GUI



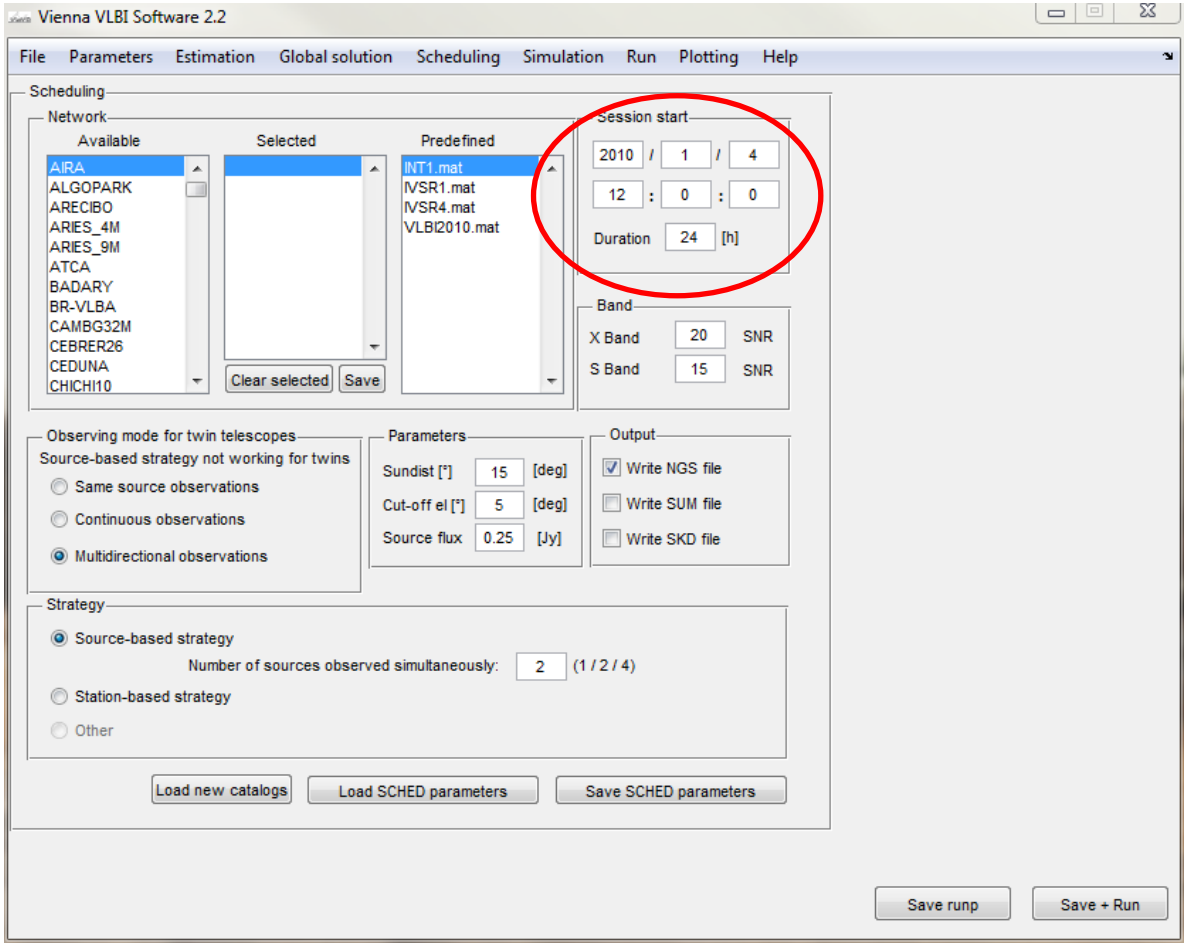
How to run VIE_SCHED

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



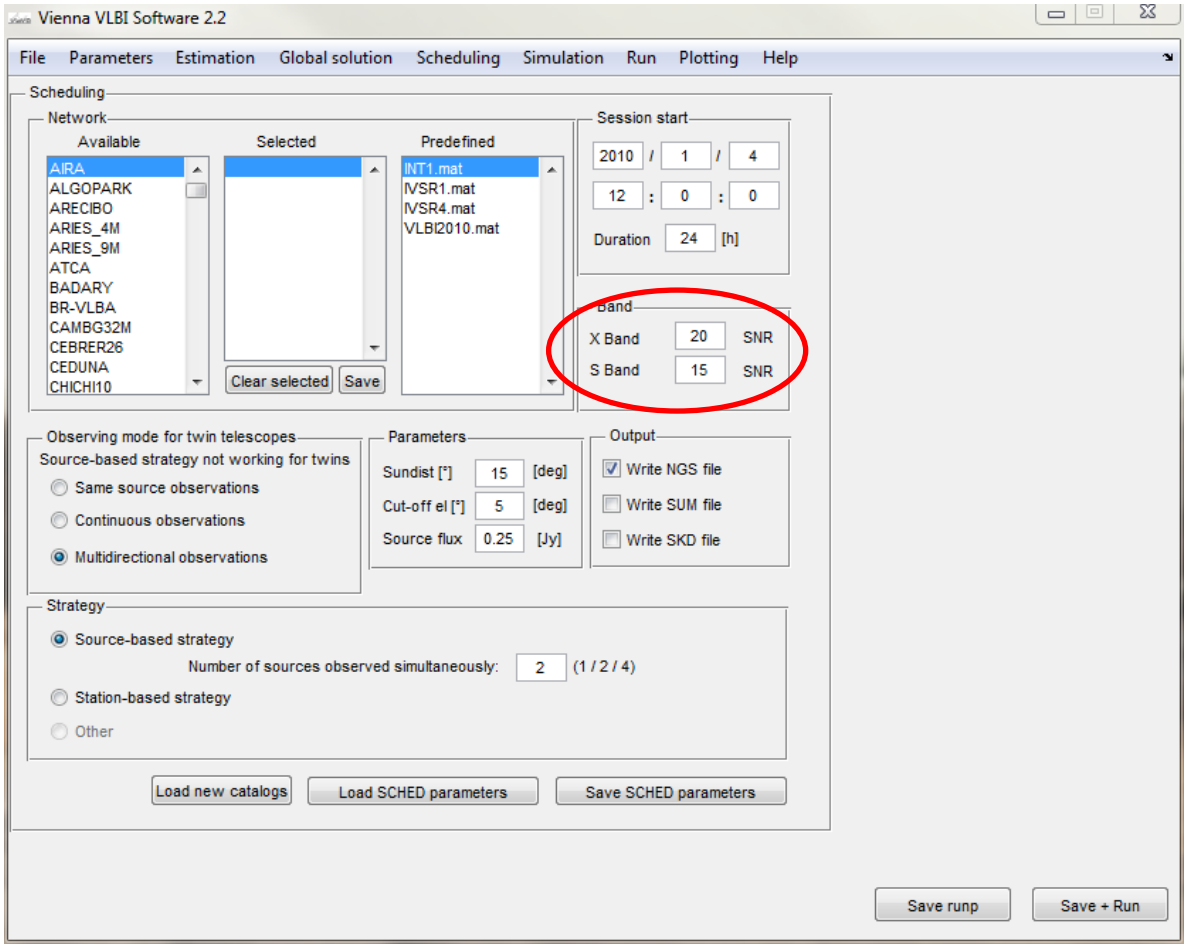
How to run VIE_SCHED

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



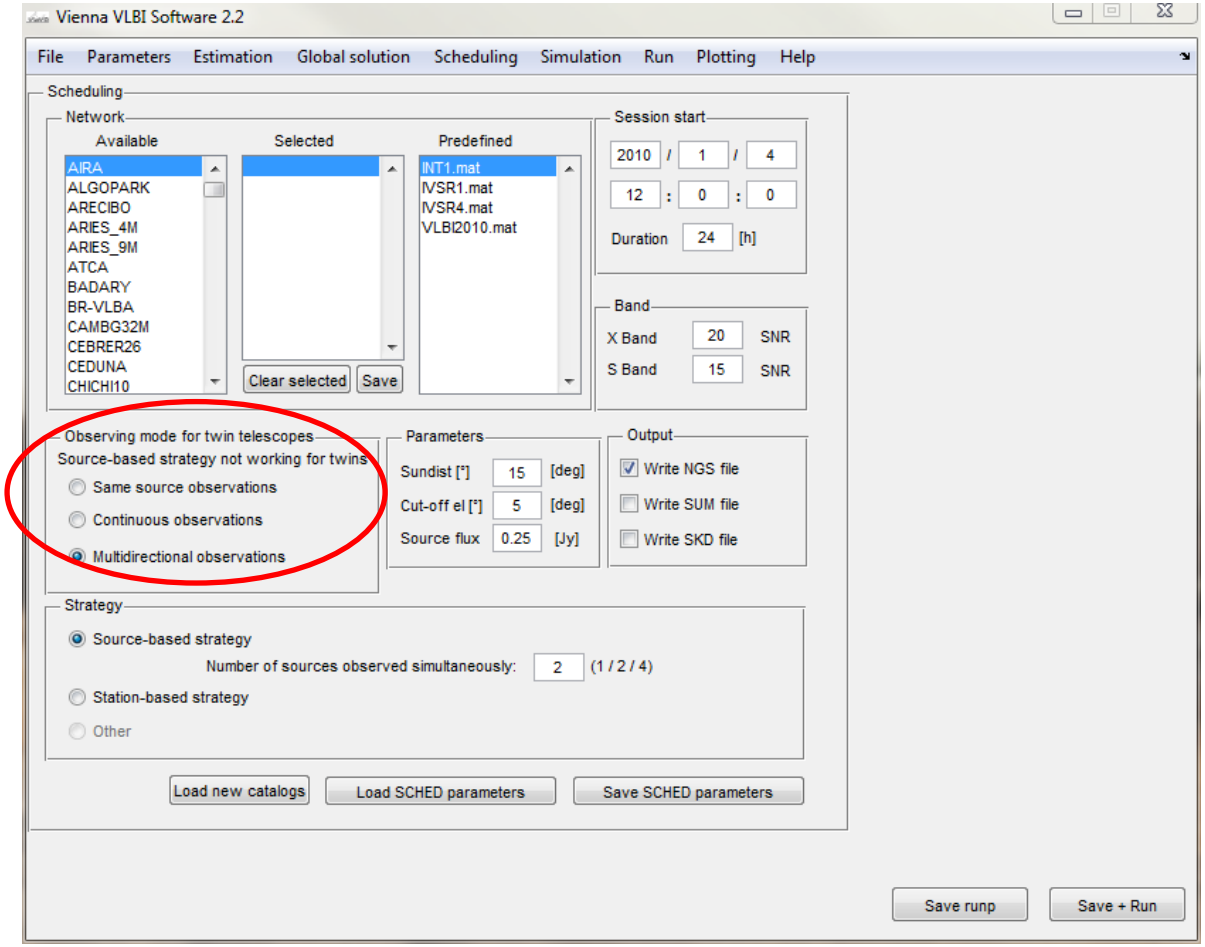
How to run VIE_SCHED

Set the SNR targets.



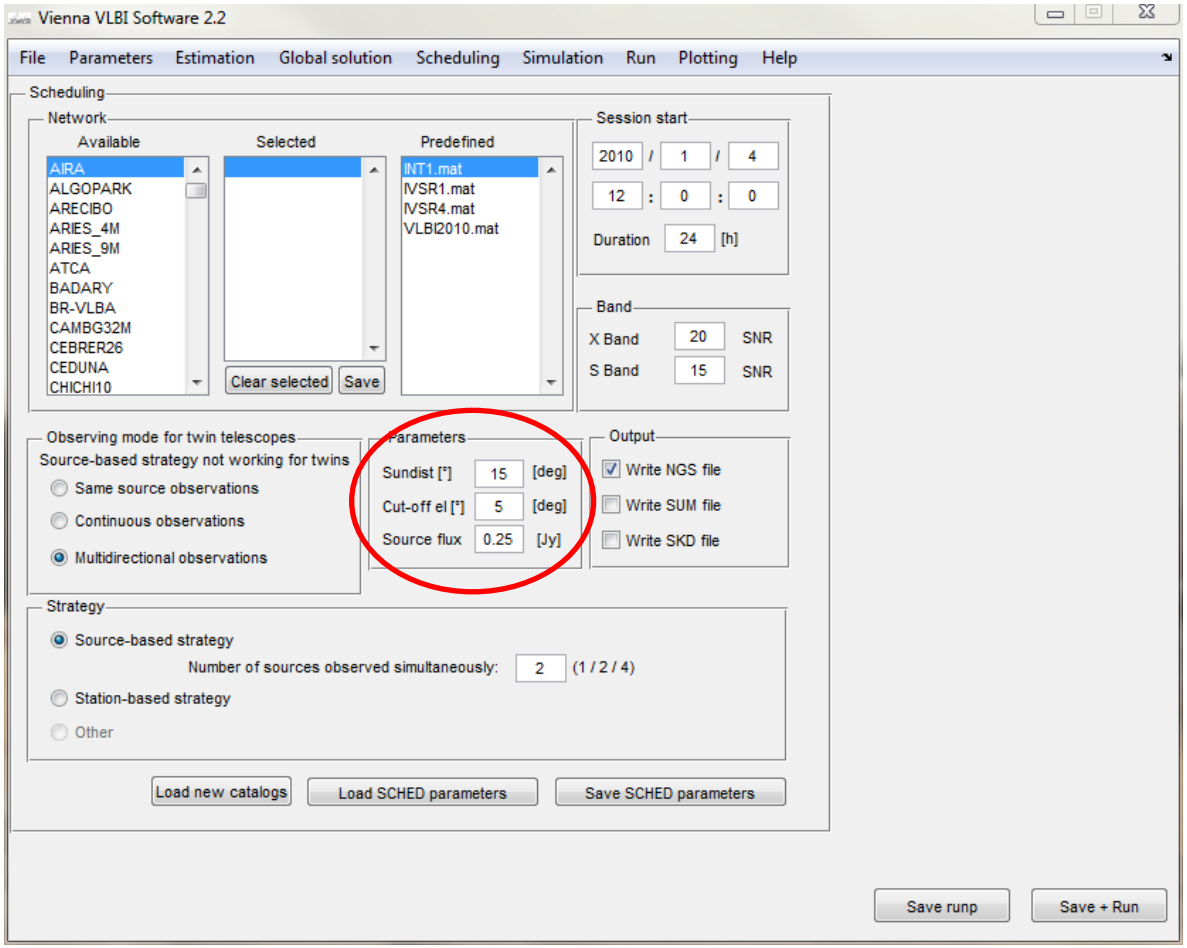
How to run VIE_SCHED

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



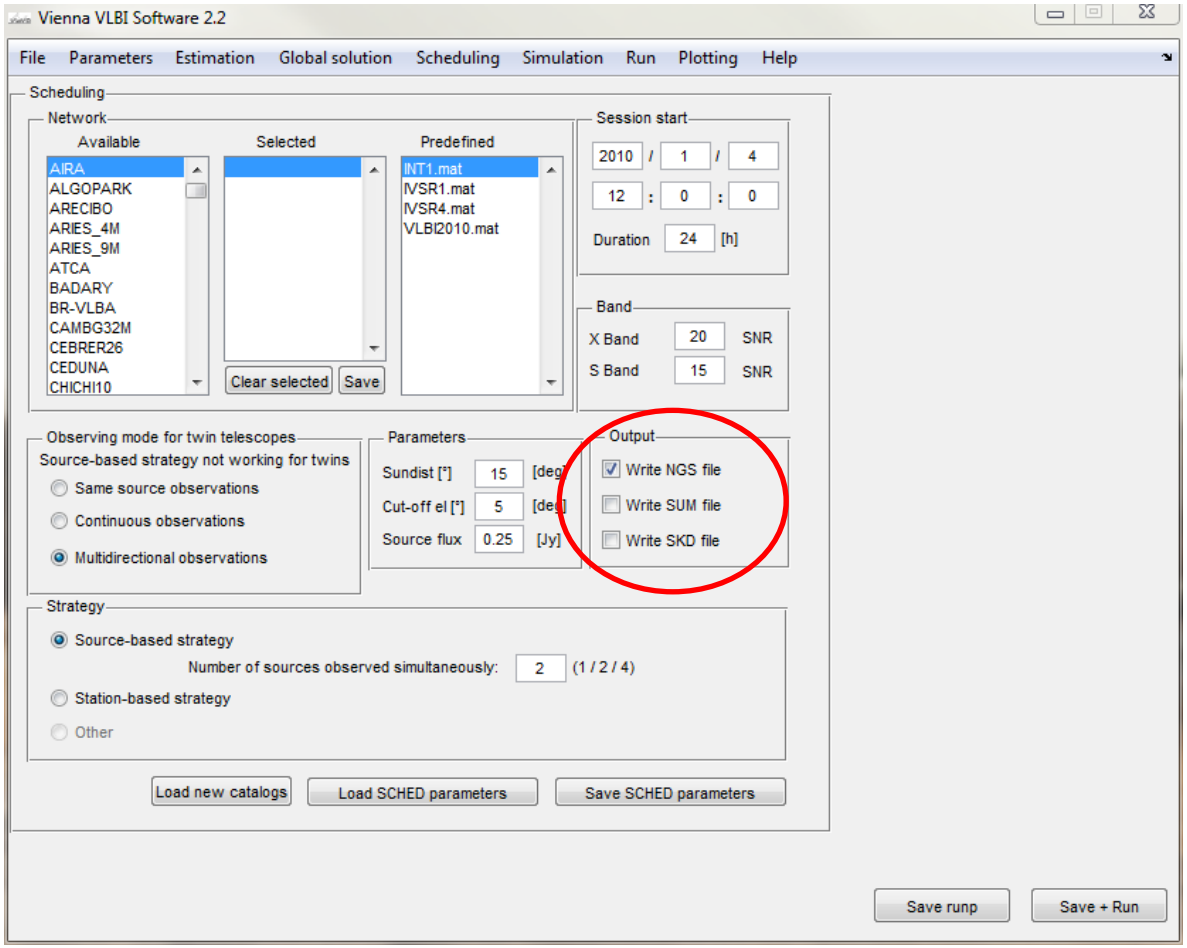
How to run VIE_SCHED

- Give the parameters for scheduling.



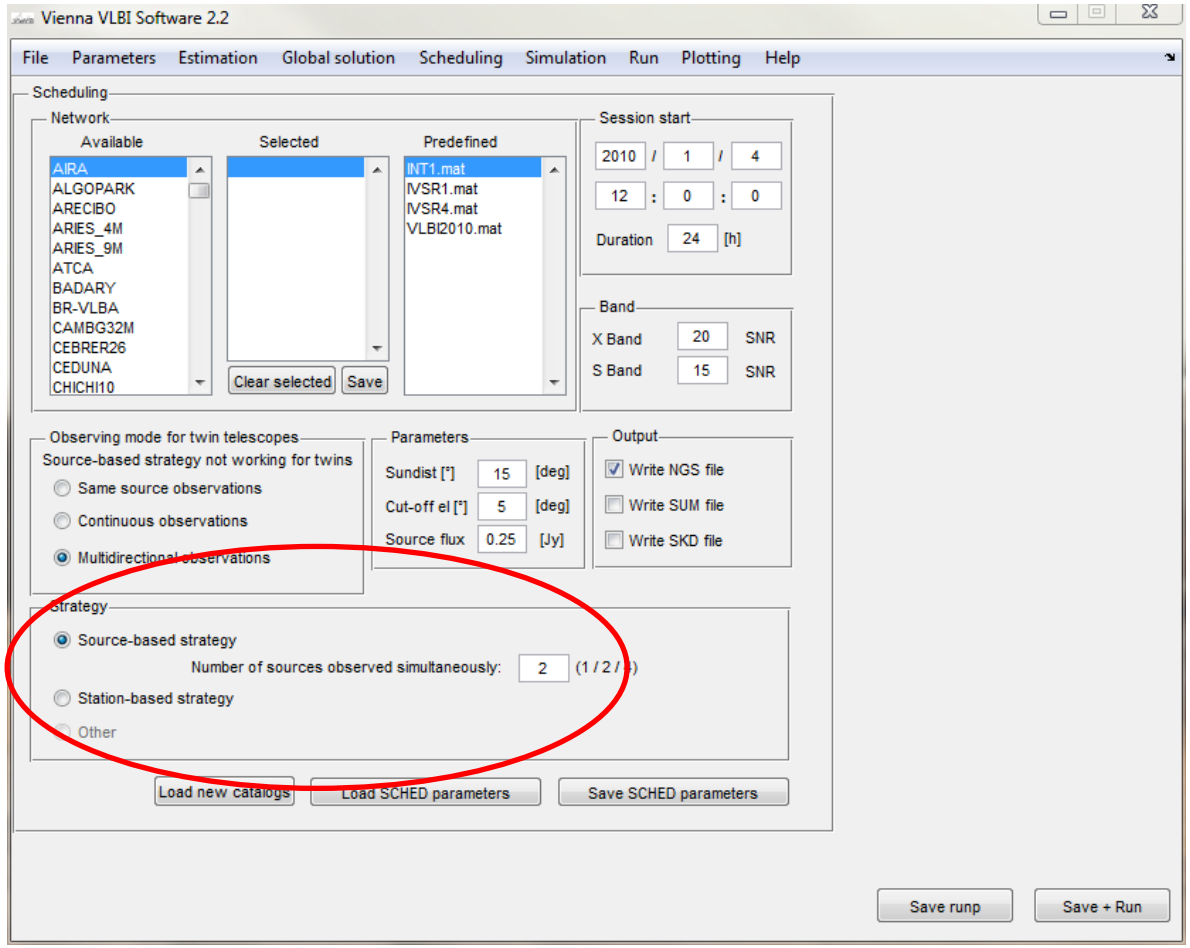
How to run VIE_SCHED

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



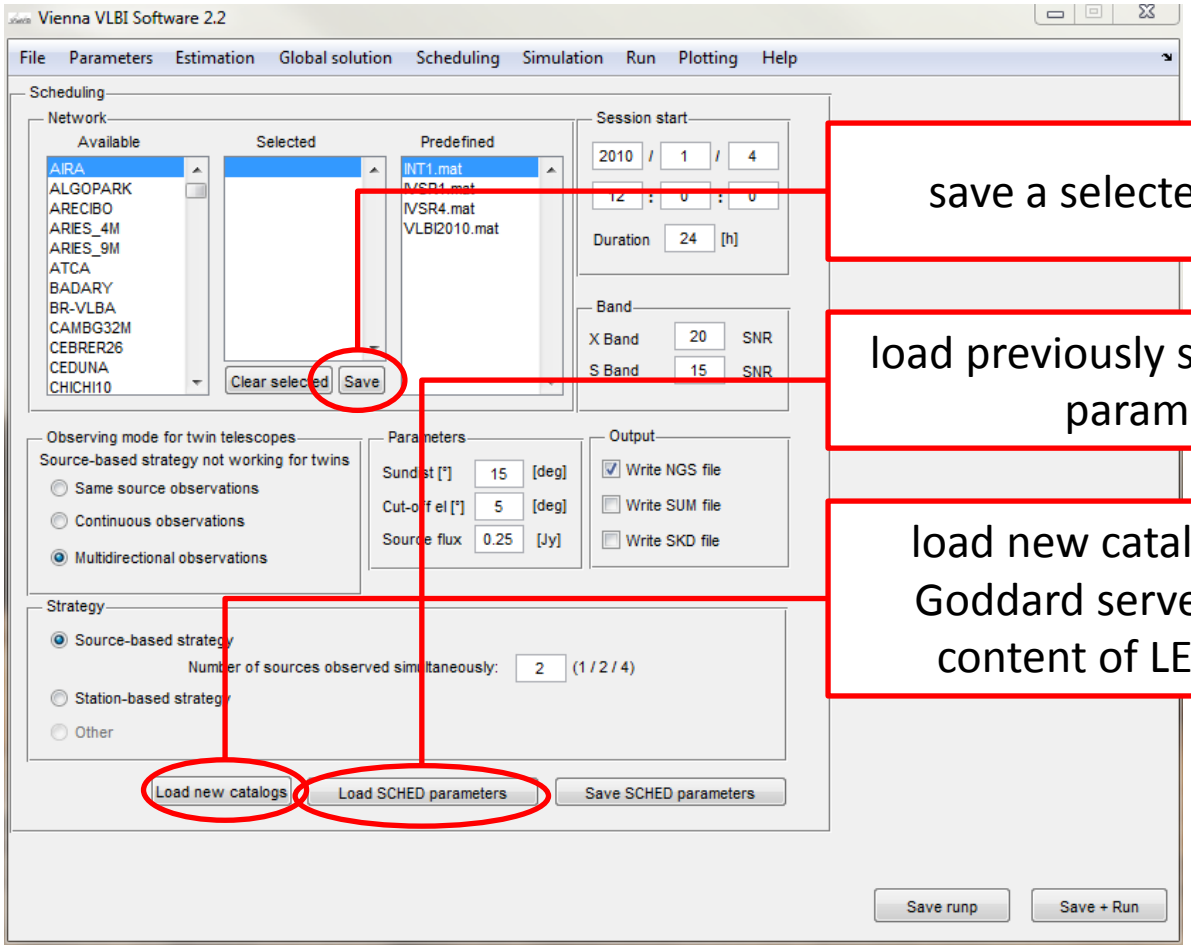
How to run VIE_SCHED

Specify the strategy used for scheduling.



How to run VIE_SCHED

New options in the scheduling GUI



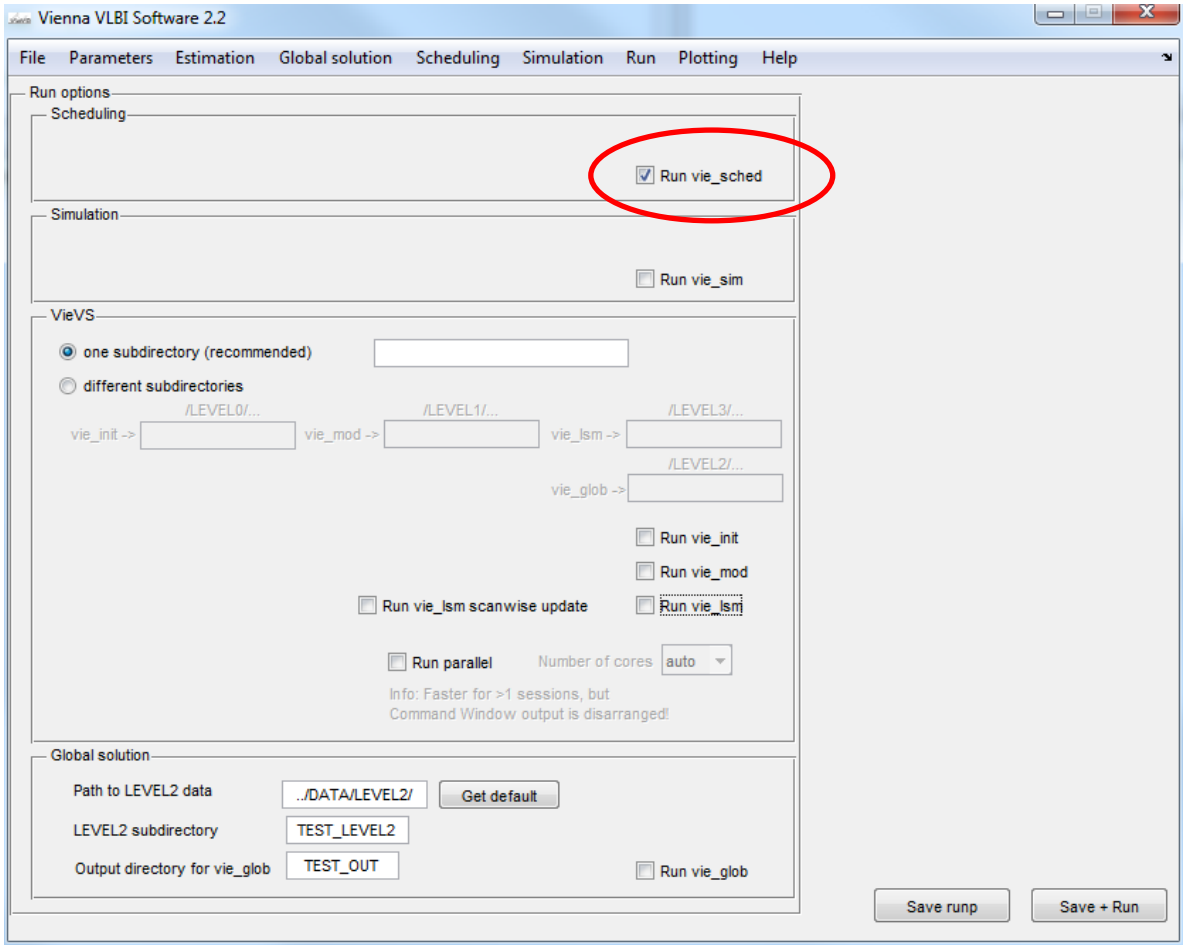
save a selected stationlist

load previously saved schedling parameters

load new catalogs from the Goddard server and delete content of LEVEL5 folder

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“.