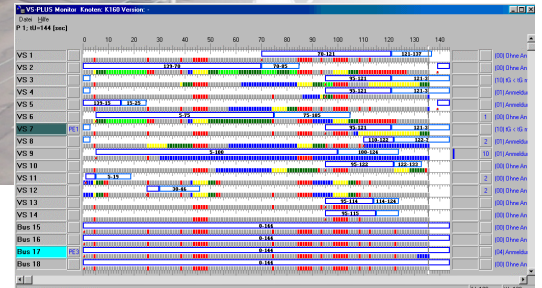
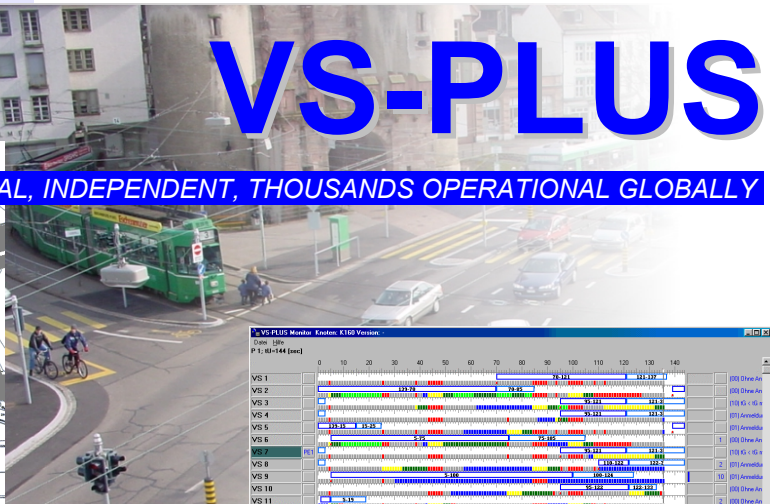
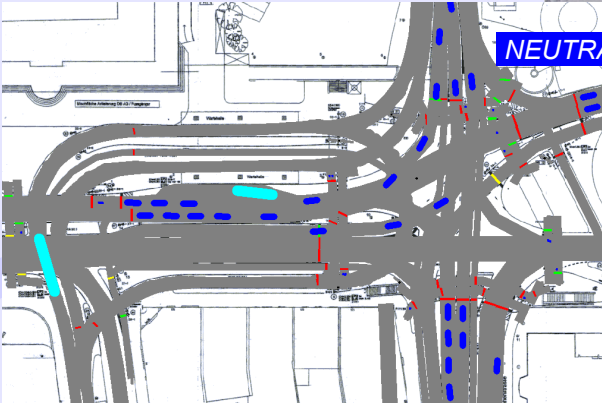


VS-PLUS

NEUTRAL, INDEPENDENT, THOUSANDS OPERATIONAL GLOBALLY



VS-PLUS

SYSTEMATIC CONTROL PROGRAM TESTING

Version 1.1, June 2008



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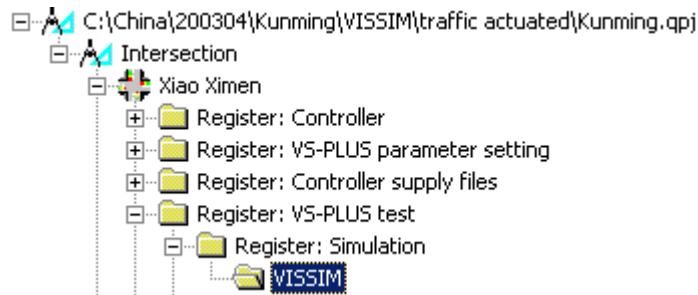
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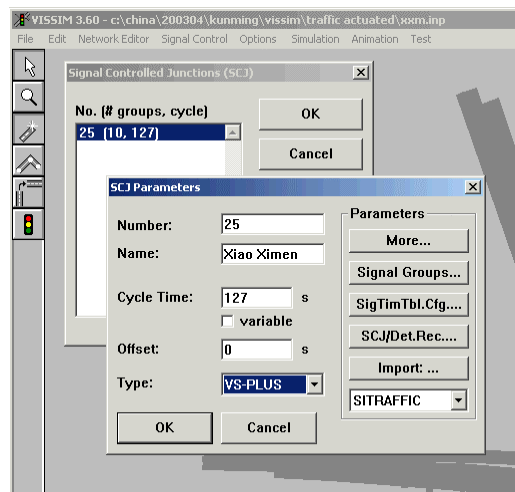
1 Systematic Control Program Testing

This brief article describes how to test a control program systematically. VISSIM has been chosen as the simulation tool. An intersection in Kunming, China called "Xiao Ximen" has been chosen as the example.

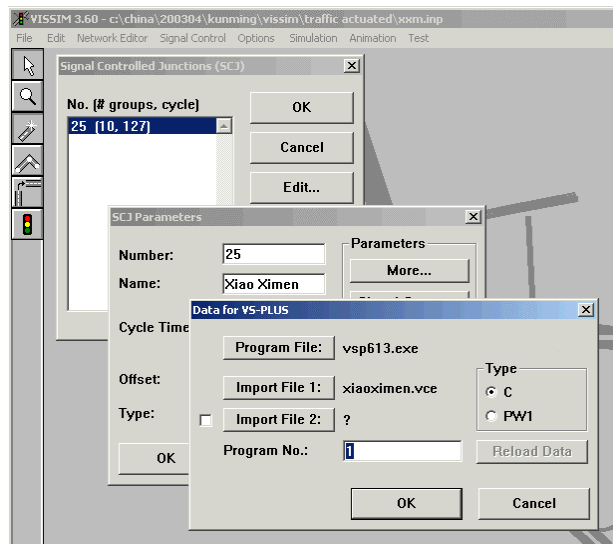
2 Working with VISSIM



- Define a VISSIM call in the VS-WorkSuite registers by defining
 - The location of the VISSIM exe file and ("File")
 - The location of the Xiao Ximen input file ("Parameter")
- Call VISSIM
- Set control type to VS-PLUS: Signal Control > Edit Signals > Edit > Type list



- Push the "More..." button and configure the following parameters:
 - Program File – the VS-PLUS/SIM executable: vsp613.exe
 - Import File – the VS-PLUS parameter file: xiaoximen.vce
Warning: the import file name must not contain spaces!
 - Program No: 1 (as set in the program definition)

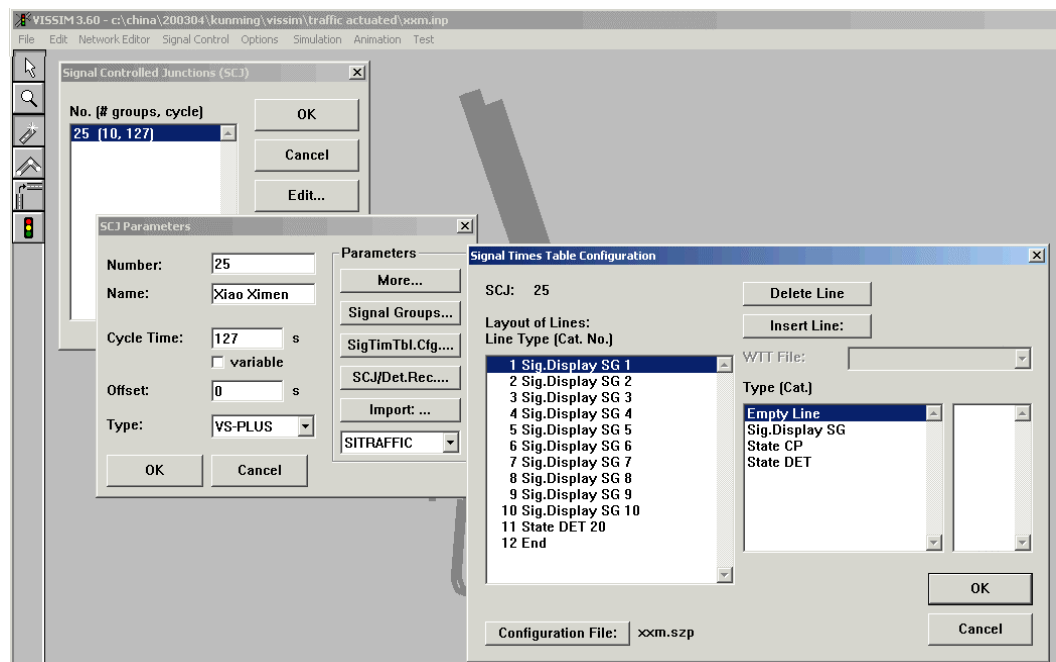


→ Run the simulation!

2.1 Signal and detector recording

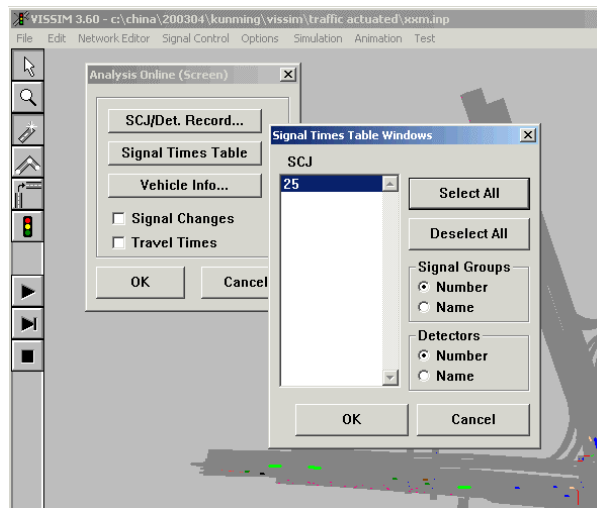
In order to obtain a diagram with the signal head and the detector states, the following window has to be configured before simulation and opened during or just before simulation.

→ Configure the signal times table: Signal Control > Edit Signals > Edit > SigTimTbl.Cfg

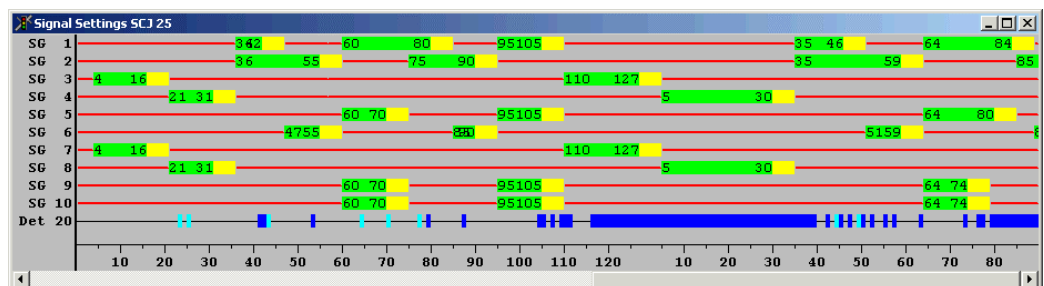


→ Configure the xxm.szp file by selecting the desired signal head and detector information. The example shows all signal heads and detector on channel 20.

→ Make the list shown: Options > Evaluations > Windows > Signal Times Table > Select All > Ok



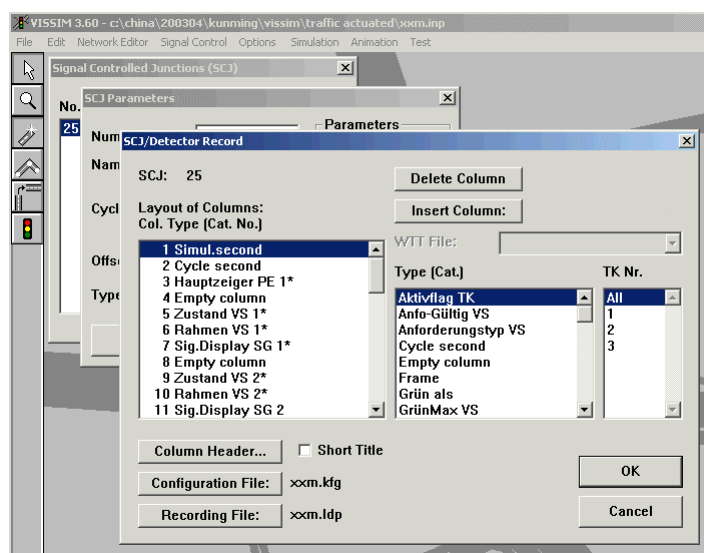
→ Start the simulation



2.2 State recording

In order to obtain a protocol with additional state information, the following window has to be configured before simulation and opened during or just before simulation.

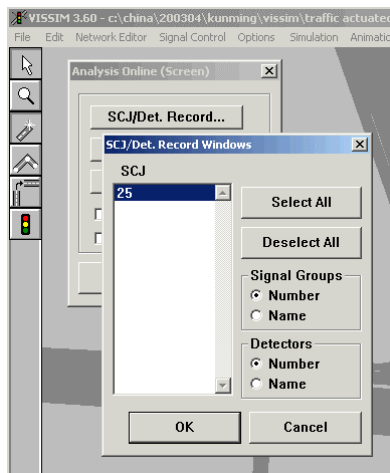
→ Configure the states table: Signal Control > Edit Signals > Edit > SCJ/Det.Rec



Unfortunately, this panel is still mixed German – English. In order to know the internal VS-PLUS states, the following variables have to be recorded:

- Simulation second
- Cycle second

- Main pointer for priority element 1 (the only we are using right now) – in German "Hauptzeiger PE1"
 - For each signal head and traffic stream the following information (in our case for the numbers 1 to 10):
 - State of the traffic stream – in German "Zustand VS"
 - Frame signal in the permissive period plan for the traffic stream – in German "Rahmen VS"
 - The signal display, i.e. the color shown by the signal head
 - You can add empty columns in order to make the protocol better readable.
- Make the list shown: Options > Evaluations > Windows > SCJ/Det.Record > Select All > Ok

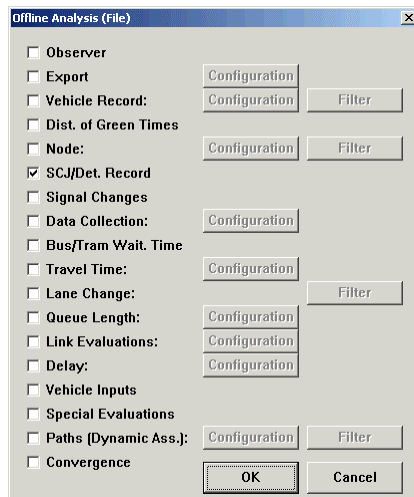


→ Start the simulation

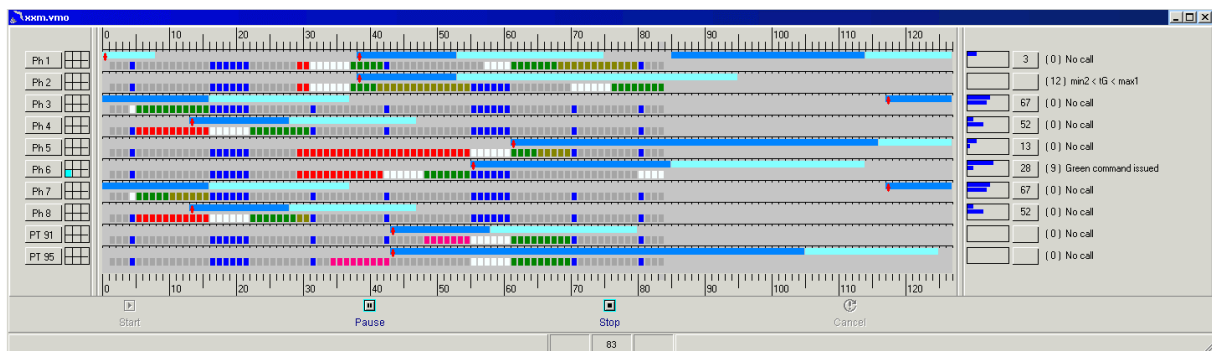
	S	S	S	S	S	S	S	S	S	S	S
	i	i	i	i	i	i	i	i	i	i	i
	g	g	g	g	g	g	g	g	g	g	g

	D	D	D	D	D	D	D	D	D	D	D
S C M	i	i	i	i	i	i	i	i	i	i	i
i y a	s	s	s	s	s	s	s	s	s	s	s
m c i	p	p	p	p	p	p	p	p	p	p	SFp
u l n	SF	SF1	SF1	SF1	SF1	SF1	SF1	SF1	SF1	SF1	trl
l e	tr	tra	tra	tra	tra	tra	tra	tra	tra	tra	aaa
.	P	aa	aay	aay	aay	aay	aay	aay	aay	aay	tmy
s t	tm	tm	tm	tm	tm	tm	tm	tm	tm	tm	ee
e e r	ee	eeS	eeS	eeS	eeS	eeS	eeS	eeS	eeS	eeS	S
c c	G	G	G	G	G	G	G	G	G	G	TTG
o o P	TTS	TT	TT	TT	TT	TT	TT	TT	TT	TT	SS
n n E	SSG	SS	SS	SS	SS	SS	SS	SS	SS	SS	111
d d 1	111	222	333	444	555	666	777	888	999	000	
1	1 0	0+.	0+.	0#.	0#.	0+.	0+.	0#.	0#.	0+.	0+.
2	2 0	0+.	0+.	0#.	0#.	0+.	0+.	0#.	0#.	0+.	0+.
3	3 0	0+.	0+.	0#.	0#.	0+.	0+.	0#.	0#.	0+.	0+.
4	4 3	21+.	21+.	9#I	21#.	21+.	21+.	9#I	21#.	21+.	21+.
5	5 4	0+.	0+.	10#I	1#.	0+.	0+.	10#I	1#.	0+.	0+.
6	6 4	0+.	0+.	10#I	1#.	0+.	0+.	10#I	1#.	0+.	0+.
7	7 4	0+.	0+.	10+I	1#.	0+.	0+.	10+I	1#.	0+.	0+.
8	8 4	0..	0..	10+I	1#.	0..	0..	10+I	1#.	0..	0..
9	9 4	0..	0..	12+I	1#.	0..	0..	12+I	1#.	0..	0..
10	10 4	0..	0..	12+I	1#.	0..	0..	16+I	1#.	0..	0..

- The states are shown in columns. See the next section for an explanation of internal VS-PLUS states.
- It is also possible to record this information into a file. Activate this logging function by Make the list shown: Options > Evaluations > Files > SCJ/Det.Record:



For a more comfortable view on this information, there is VS-VISTA with the VS-PLUS Monitor: The use of VS-VISTA is not described in this document.



2.3 Internal VS-PLUS variables

- General variable
 - Active flag
- Detector variable
 - Detector waiting time
- Phase variables
 - State
 - Waiting time
 - Priority class
 - Priority level
 - Priority value
- Special variables in connection with public transit
 - PT priority
 - dT frame
 - Remaining travel time
 - Zone
 - Status
- Picture variable
 - Main pointer

2.3.1 Active flag

The active identifier indicates the status concerning the idle picture for the three partial intersections.

- 0 No idle picture possible, there is still traffic.
- 1 The idle picture can be activated.
- 2 The idle picture is active.

2.3.2 Detector waiting time

As soon as a detector has a call, its waiting time is started.

2.3.3 Phase variables

2.3.3.1 Status

The status is one of the most important variables of the VS PLUS control. This variable defines, how the phase may be processed. The value of the status can be divided into two ranges:

- The phase has **red**:
 - 0 The phase is inactive.
 - 1 The phase has the intervention level 1.
 - 2 The phase has the intervention level 2.
 - 3 The phase has the intervention level 3.
 - 4 The phase has the intervention level 4.
 - 5 The phase has the intervention level 5.
 - 8 The phase can be started.
 - 9 The phase was set to green.
- The phase has **green**:
 - 10 The phase did not yet reach the green time t_{gmin1} .
 - 11 The phase exceeded the green time t_{gmin1} .
 - 12 The phase exceeded the green time t_{gmin2} .
 - 13 The phase exceeded the green time t_{gmax1} .
 - 14 The phase exceeded the green time t_{gmax2} and there is still traffic.
 - 15 The phase does not have traffic, can be further extended according to extension flag if necessary.
 - 16 The phase does not have traffic, cannot be further extended.
 - 19 Special red command for the phase.
 - 20 The phase can be set to red.
 - 21 The phase was set to red.

2.3.3.2 Waiting time

The waiting time is started for each phase after a call.

2.3.3.3 Priority class

Each phase in a main series is associated with a priority class.

- 0 The phase is in no priority class.
- 1 The phase is in priority class 1.
- 2 The phase is in priority class 2.
- 3 The phase is in priority class 3.

2.3.3.4 Priority level

Each phase is in the priority level 1 by default. Once exceeding the maximum waiting time he gets into the level 2.

2.3.3.5 **Priority value**

The priority value (PV) is set for each phase, which is to be switched to green. It consists of three parts:

- The basic priority depends on the priority element in which the phase is processed.
- $PV = (\text{Maximum number of priority elements} - \text{Position in the processing sequence}) * 100$
- Added is its rank as a minor phase in the desired picture.
- $PV = PV + \text{Maximum number of minor phases} - \text{Current rank} + 1$
- In addition the value can be increased using the parameter *priority value*.
- $PV = PV + \text{Priority value} * 1000$

2.3.4 **PT variables**

2.3.4.1 **PT priority**

The PT priority indicates whether a PT phase can be served after the processing of the module PT prioritization

- 0 Switching not permitted
- 1 Switching permitted

2.3.4.2 **dT Frame**

The variable *dT Frame* indicates the temporal difference between the expected arrival second and the beginning of frame signal.

2.3.4.3 **Remaining travel time**

The variable *remaining travel time* indicates the time a PT vehicle will still travel up to the stop bar. If the time is negative it corresponds to the waiting time at the stop bar.

2.3.4.4 **Zone**

The zone indicates the type of function a PT phase is currently exercising.

- 0 No call range available.
- 1 Hold time exceeded, call range exceeded.
- 2 Only ADVANCE.
- 3 Always ADVANCE if possible, no switch on call possible.
- 4 ADVANCE if possible, otherwise call.
- 5 Only BLOCKING.
- 6 Always BLOCKING if possible, no switch on call possible.
- 7 BLOCKING if possible, otherwise call.
- 8 Register

2.3.4.5 **Status**

The status describes, how the PT affects a phase at the current time.

- 0 no influence
- 2 / 3 / 4 may advance
- 5 / 6 / 7 will be blocked

2.3.5 **Main pointer**

The variable *main pointer* indicates the current main phase for each priority element.

3 Systematic control program testing

It is important that any control program is tested thoroughly with a simulator before being deployed to the intersection controller.

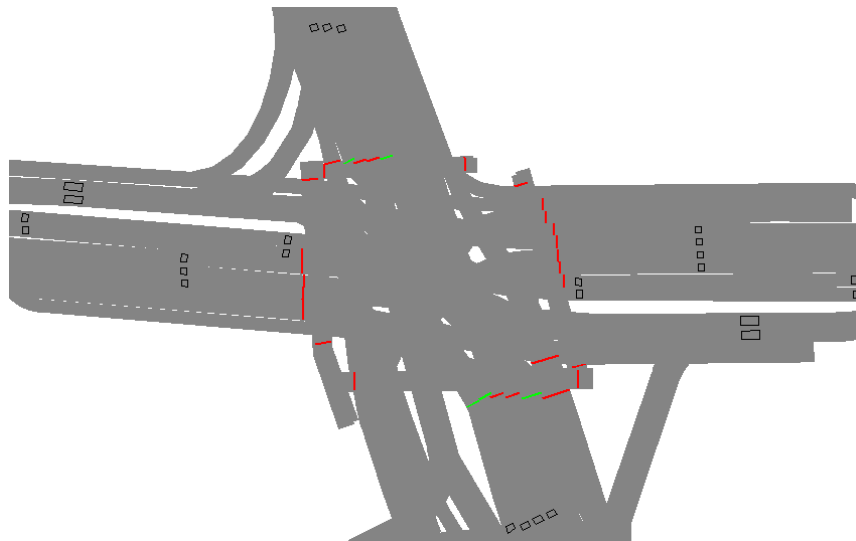
The tools we use are VISSIM and the previously introduced diagrams, together with the VS-WorkSuite. While optimizing and refining the parameter sets, the new parameters can immediately be tested after exporting them from VS-WorkSuite, by restarting a VISSIM simulation.

The systematic approach is as follows:

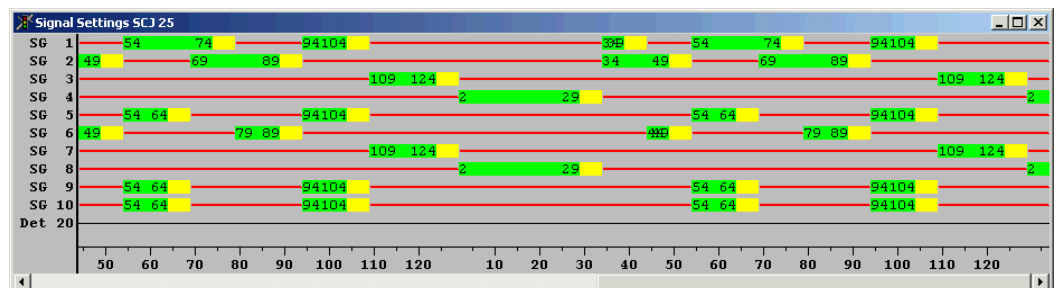
- Test the program without traffic.
- Test the program with continuous occupation of all detectors.
- Test the program with simulated traffic.
- In the case of fully traffic-dependent control, especially without a permissive period plan, manual clicking on single detectors might be checked for correct functioning.
- There are also hybrid testing scenarios where, especially for public transport functions, pre-recorded detector macros are played. We will not treat this feature here.

3.1 No traffic

- Open a signal and detector recording window.
- Go to VISSIM test mode: Test > Continuous



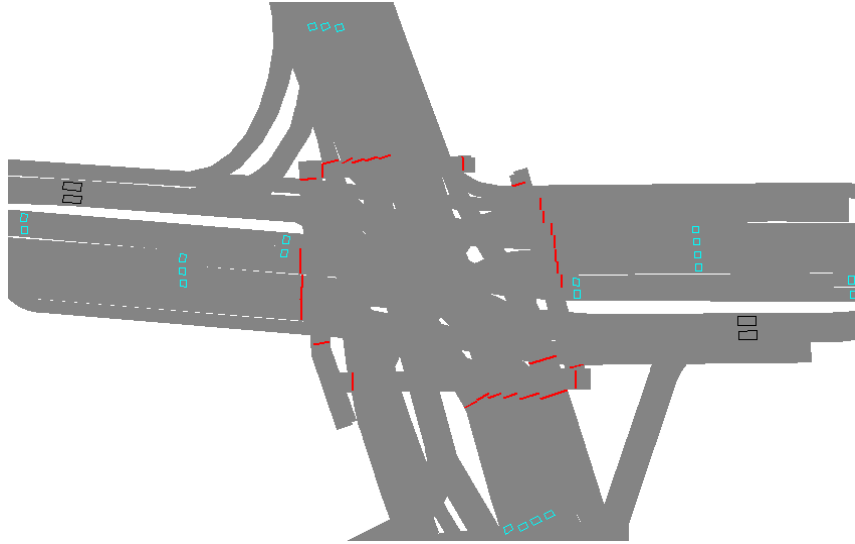
- VISSIM goes to test mode showing all detectors and signal head states. Do not click on the detectors.



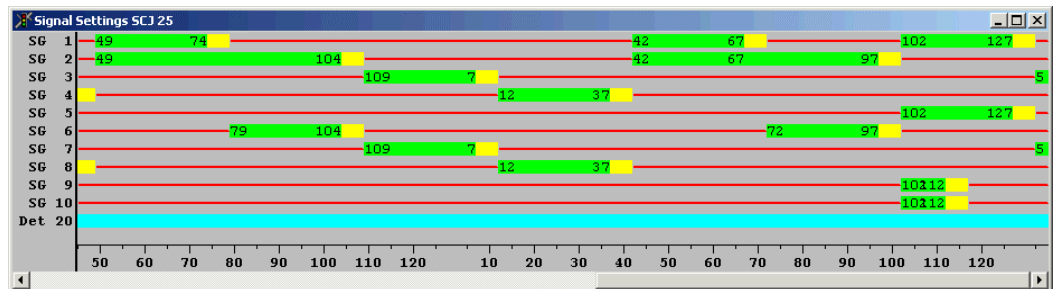
- Look at the recording window. There should be a steady state signal plan serving all phases in a reasonable manner.

3.2 Continuous occupation

- Open a signal and detector recording window.
- Go to VISSIM test mode: Test > Single step
- Double-click on all detectors in order to make them continuously occupied (light blue). Single clicking generates a detector impulse (blue) that can be used for individual detector testing.



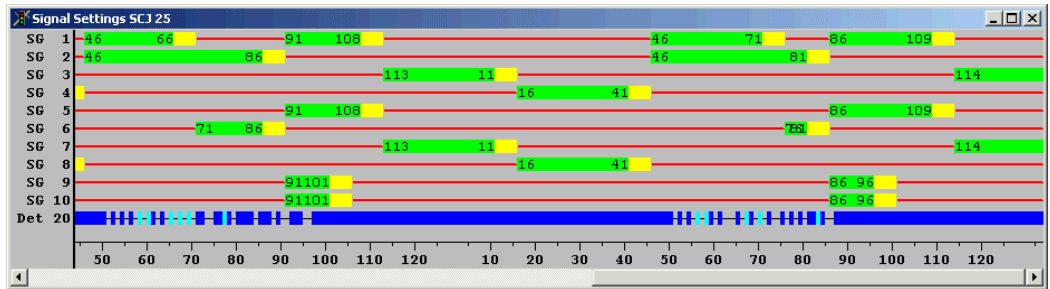
- Start the testing either step by step or continuously using the normal VISSIM buttons.



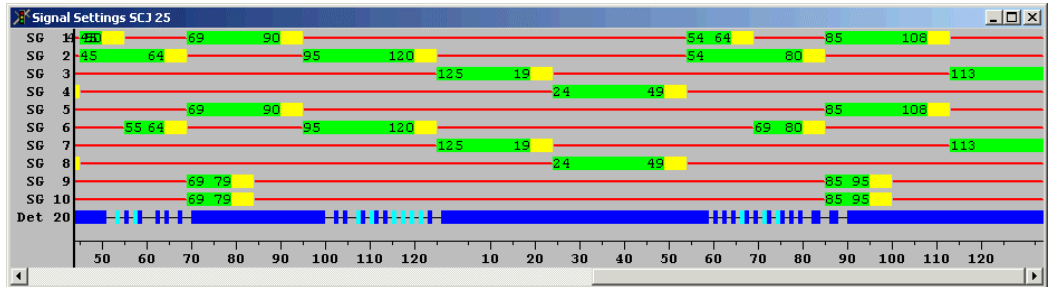
- Look at the recording window. Again, there should be a steady state signal plan serving all phases in a manner that corresponds to the traffic flows under full load.

3.3 Simulated traffic

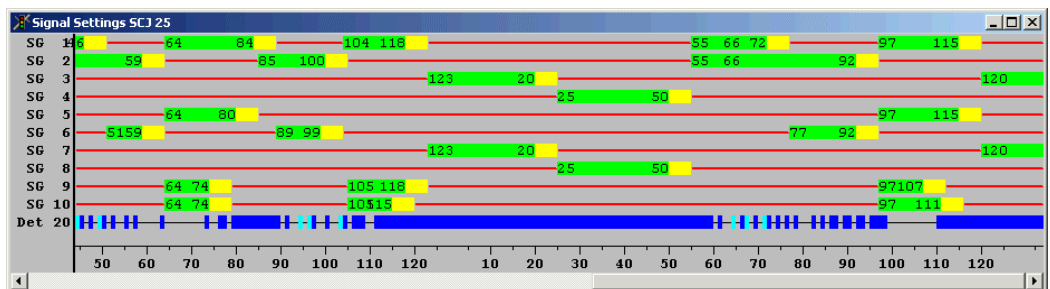
- Open a signal and detector recording window.
- Go to VISSIM simulation mode: Simulation > Continuous
- Look at the recording window. There will be no steady state. Check if the resulting signal sequences correspond to what your intention was.
- Sometimes you might be surprised because VS-PLUS generates signal sequences you never thought about before. Check if you want to accept them. If not, find the parameters to inhibit certain signal sequences and modify them.



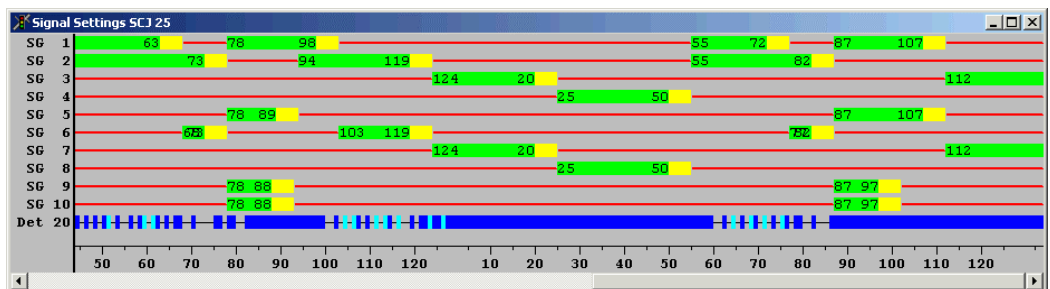
→ Signal sequence: 1|2 – 2|6 – 1|5|9|10 – 3|7 – 4|8
 Normal signal sequence as defined in the static signal plan. Timing varies a bit between the two following cycles.



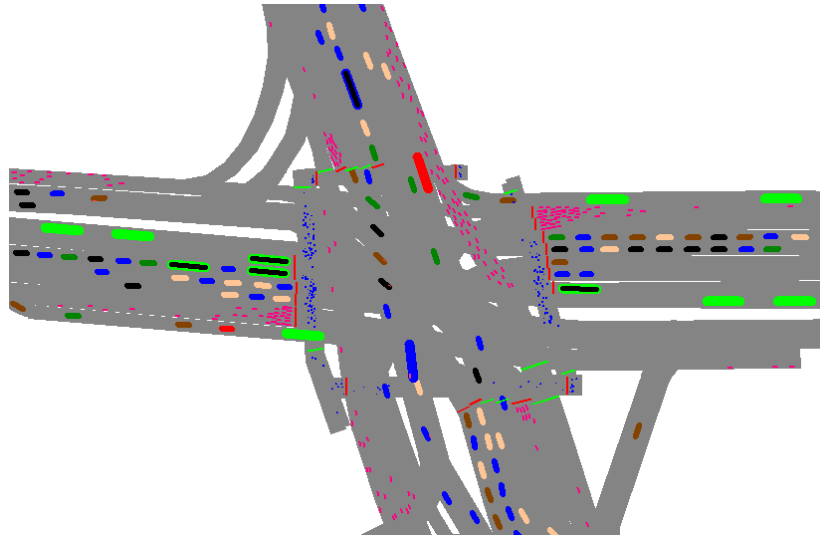
→ Signal sequence: 1|2 – 2|6 – 1|5|9|10 – 2|6 – 3|7 – 4|8
 There has been an extra 2|6 phase due to heavy left turn load on the west access.



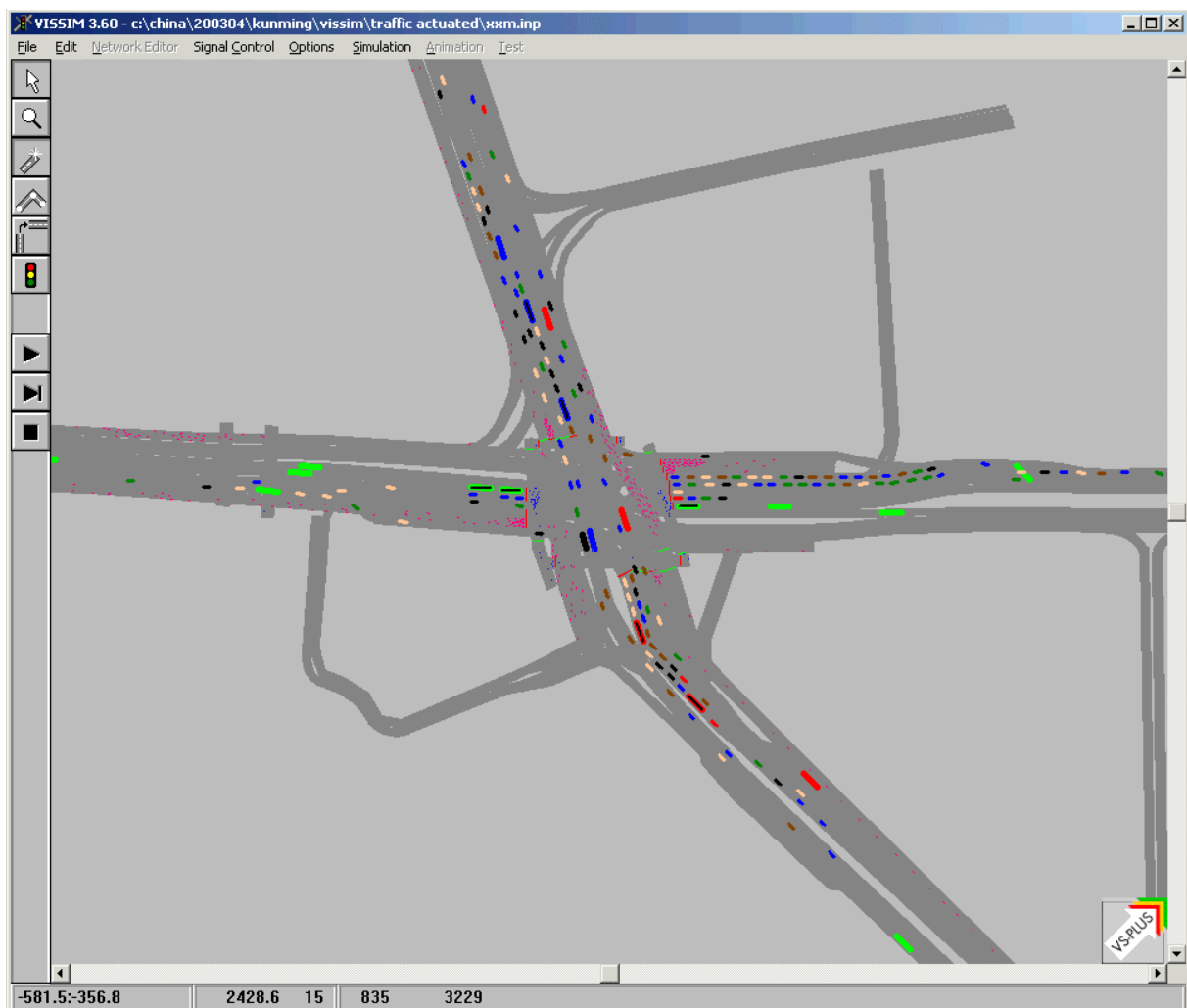
→ Signal sequence: 1|2 – 2|6 – 1|5|9|10 – 2|6 – 1|9|10 – 3|7 – 4|8
 There has been an extra 2|6 phase and an extra bus phase, i.e. the buses have been served twice in a cycle.



→ Signal sequence: 1|2 – 2|6 – 1|5|9|10 – 1|2 – 2|6 – 3|7 – 4|8
 There has been an extra 1|2 phase, followed by an extra 2|6 phase in order to serve phase 2 more, even though phase 1 was running out of traffic.



→ Don't forget to check optically the resulting waiting queues and whether they do not exceed the maximum length you are willing to accept.



→ This screen dump shows VISSIM after 40 minutes of simulated time during rush hour. The queues look all very satisfying, so this VS-PLUS parameter set is ready to be deployed!