“S I F M”

# Sennheiser Intermodulation and Frequency Management

Instructions for the rapid calculation of intermodulation-free radio frequencies for wireless microphone systems

SENNHEISER

SIFM: Sennheiser Intermodulation and Frequency Management

No Liability

This version is intended for professional users able to interpret the input of the technical parameters in a pertinent way.

When calculating frequency configurations, use the default values as a starting point. These offer the highest insensitivity to intermodulation interference. The manufacturers and the individual users require frequency configurations which ensure reliable results under a wide range of different operating conditions. Sennheiser can accept no liability for the operational safety of multi-channel systems whose transmission frequencies have been calculated on the basis of this program without our approval.

## Introduction

Interference due to intermodulation generally occurs when at least two transmitters close to the receiving antenna produce very strong signals in the receiver. The two signals form intermodulation products at non-linearities, such as transistors or other semiconductors in the receiver (e.g. in the mixer). Unwanted signals are produced which may interfere with the wanted frequencies of the system.
Intermodulation signals are also produced when two or more transmitters operate in close proximity to one another. In this case, the transmitter not only transmits its own signal but also receives the signals from the other transmitters. From both signals, the transmitter generates and re-transmits mixture products which can interfere with the wanted frequencies.

For reasons of operational reliability, a wireless UHF transmission system has a limited switching bandwidth (e.g. 36 MHz). This switching bandwidth is determined by input filters in the receiver. Intermodulation products within this range can interfere with the selected receiving frequency or with the whole system and can make the system inoperable. Chopping noise or hissing in the background is an acoustic indication of frequencies interfered with by IM products. In principle, receiving and transmitting frequencies for multi-channel systems are planned as follows:
In an example system having two carrier frequencies f1 = 800 MHz and f2 = 801 MHz, the resulting intermodulation products within the switching bandwidth of the receiver are to be determined.

There are harmonics of the fundamental frequencies and sum and difference frequencies. The harmonics do not interfere since they are far outside the receiving range and will be effectively rejected by the input filters in the receiver:

2f1= 2 x 800 MHz = 1600 MHz
2f2= 2 x 801 MHz = 1602 MHz
3f1= 3 x 800 MHz = 2400 MHz
3f2= 3 x 801 MHz = 2403 MHz

Simple sum and difference frequencies can also be ignored as they are also far outside the receiving range and will be effectively rejected by the input filters in the receiver:

f1 + f2 = 800 MHz + 801 MHz = 1601 MHz
f2 - f1 = 801 MHz - 800 MHz = 1 MHz

IM 3 = 2f1 - f2 = 1600 - 801 = 799 MHz
IM 3 = 2f2 - f1 = 1602 - 800 = 802 MHz

IM 5 = 3f1 - 2f2 = 2400 - 1602 = 798 MHz
IM 5 = 3f2 - 2f1 = 2403 - 1600 = 803 MHz

IM 7 = 4f1 - 3f2 = 3200 - 2403 = 797 MHz
IM 7 = 4f2 - 3f1 = 3204 - 2400 = 804 MHz

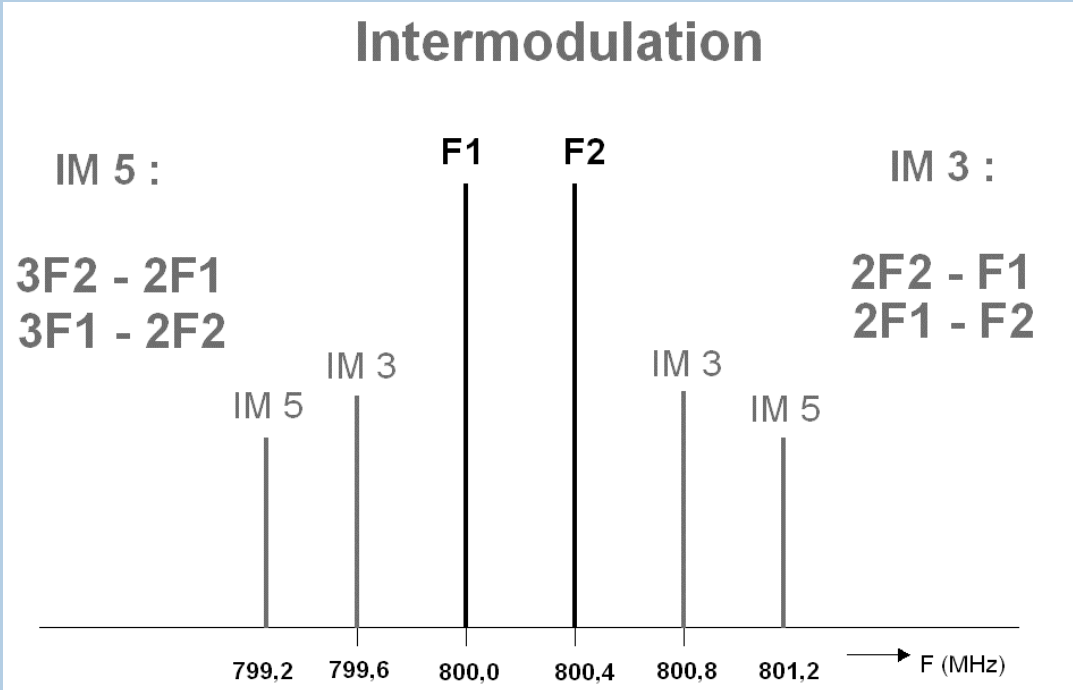
A multitude of IM products are produced in multi-channel systems. Proper frequency selection therefore requires computer-aided planning that can be done using “SIFM”. In especially critical cases, Sennheiser’s Service Department or your Sennheiser agent will be pleased to carry out this planning.

**Attention!**
Sennheiser systems are normally supplied with intermodulation-free frequency sets. However, in most countries a license is required for their use. Please contact your local Sennheiser agent and/or the licensing authority in your country for information. The exception is the frequency band 863 MHz to 865 MHz which is license-free in most of Europe (ETSI signatory countries).
However, it is not only the number of frequency calculations, but also the demand on the performance of the radio microphone equipment used which drastically increases with additional channels.

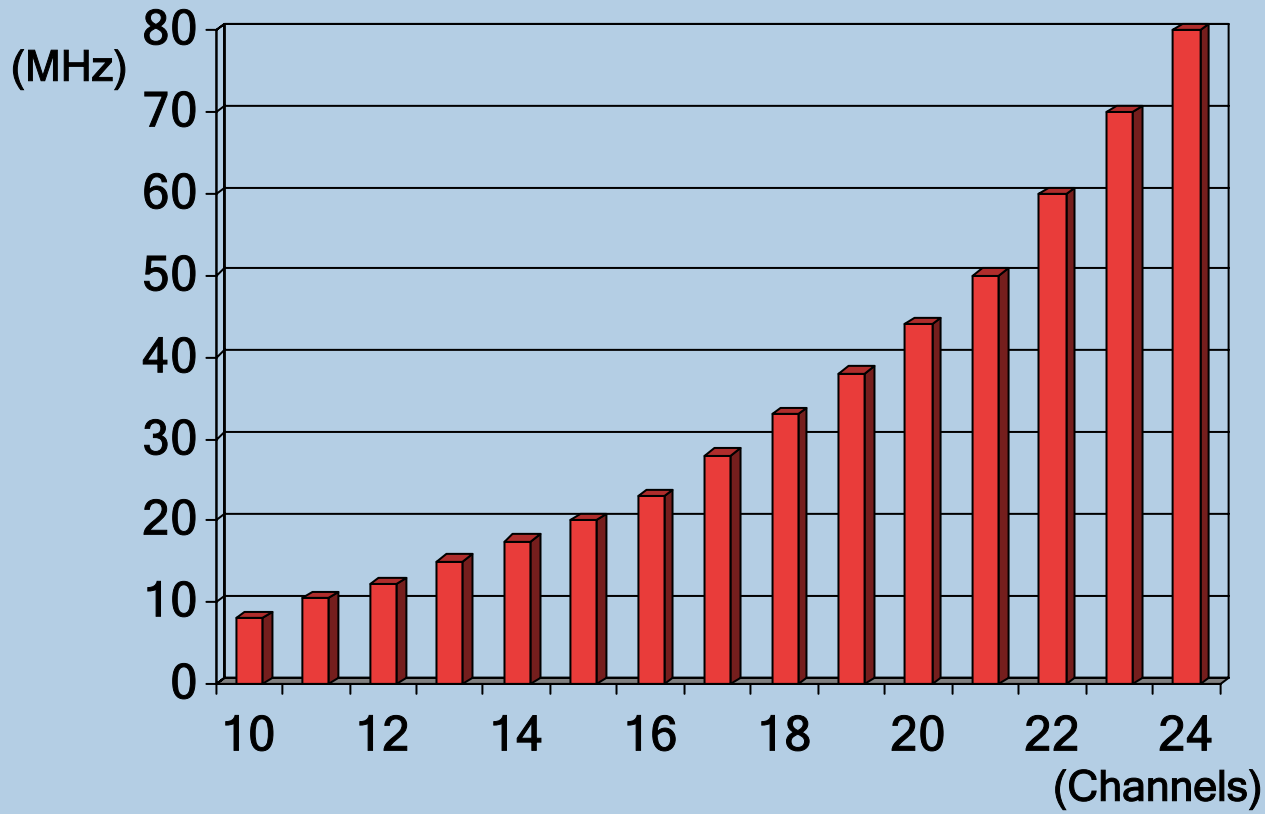
Receiver intermodulation occurs when transmitters operate too close to the receiving antennas (< 4 m).

Transmitter intermodulation occurs when two or more transmitters operate in close proximity to one another (< 30 cm).

The strength of the intermodulation signals increases with decreasing distances.



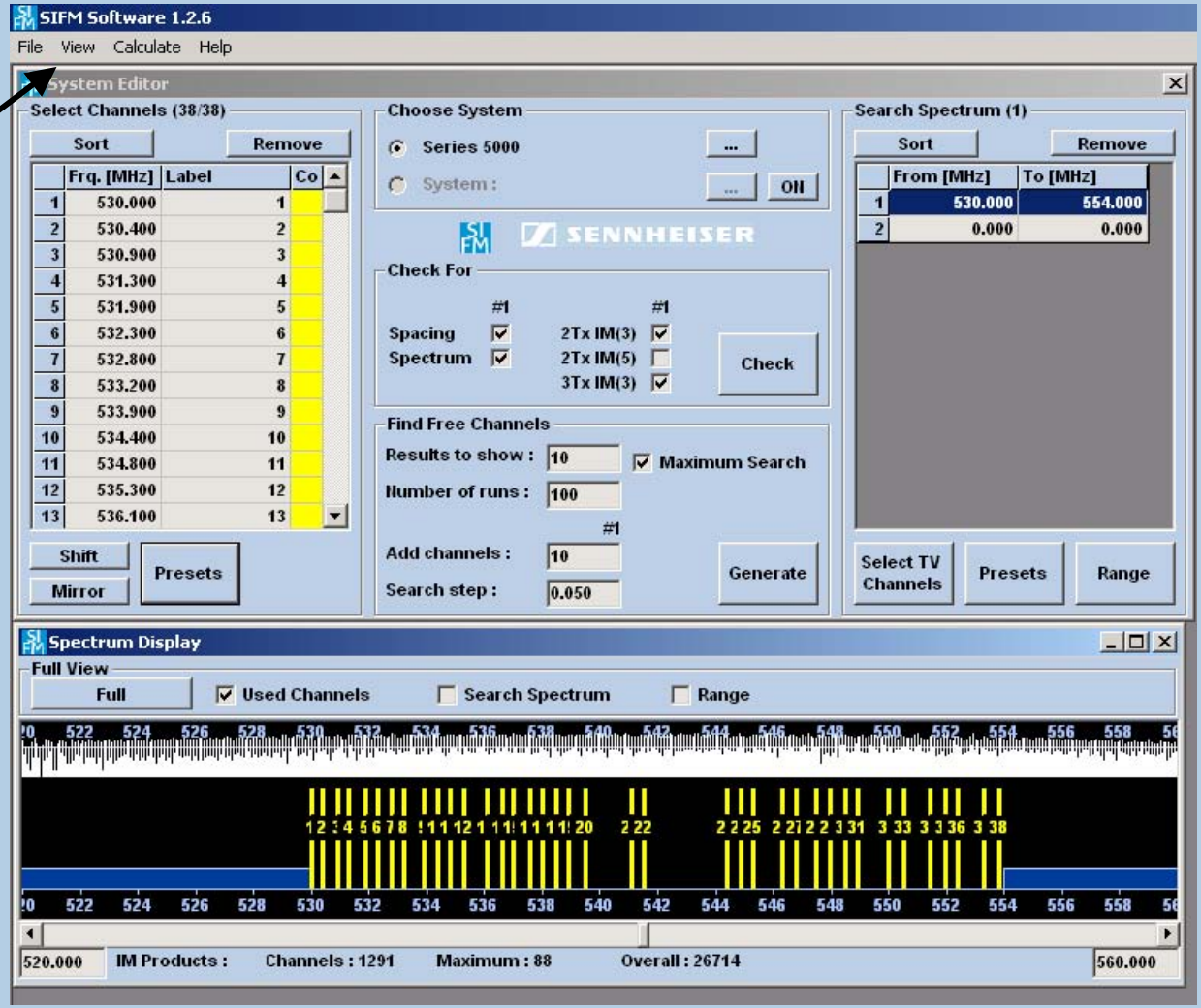
# Large systems require a large bandwidth



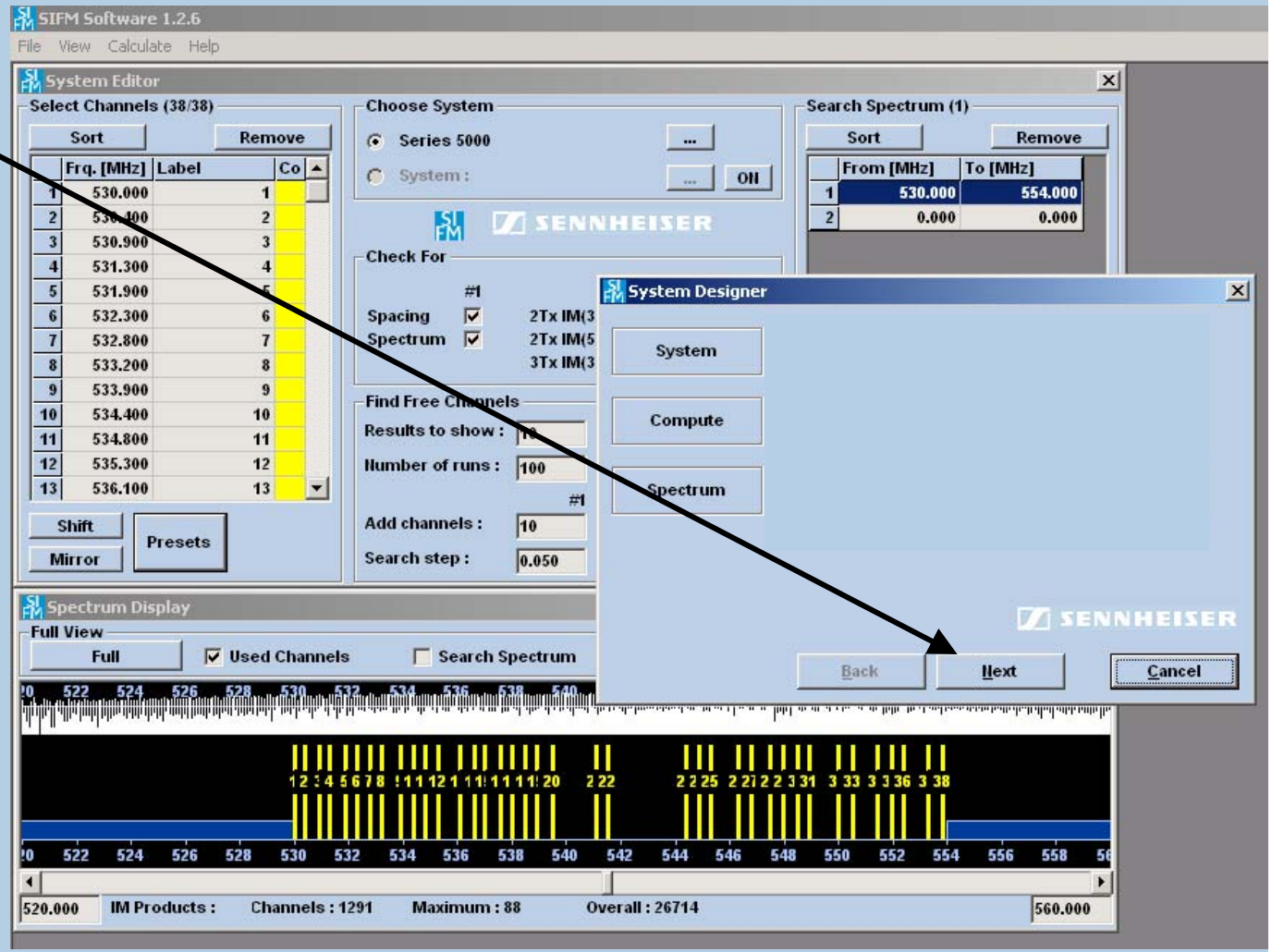

The bandwidth required increases disproportionately with the number of channels.
The number of possible IM products runs into thousands.
More than 16 channels within the switching bandwidth (24 MHz – 36 MHz) are rarely advisable.

# Start page

From the “View” menu, select “System Designer”.



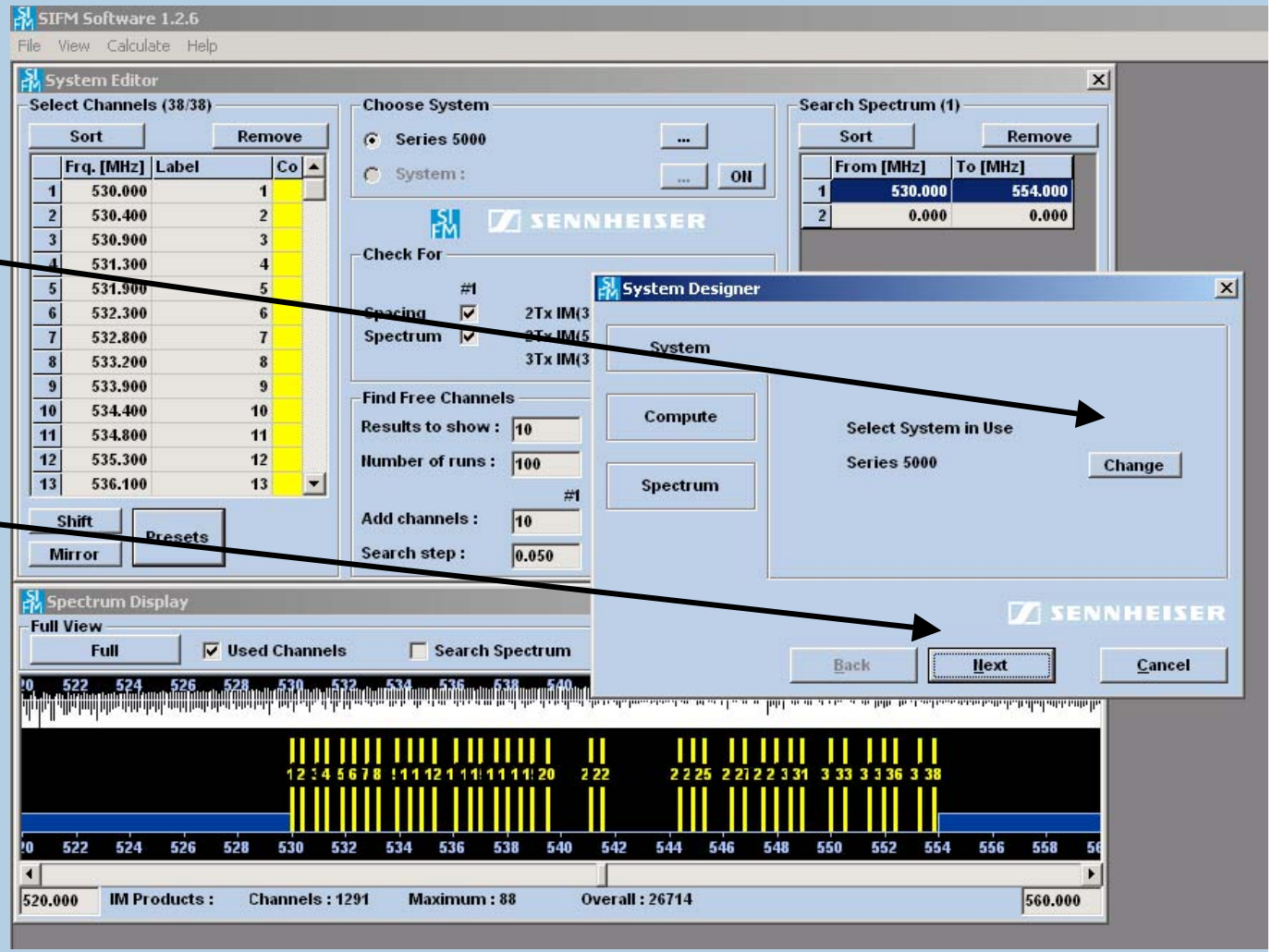
Click “Next”.


SIFM Software 1.2.6
File View Calculate Help
System Editor
Select Channels (38/38)
Sort
Remove
Frq. [MHz] Label Co
530.000 1
530.400 2
530.900 3
531.300 4
531.900 5
532.300 6
532.800 7
533.200 8
533.900 9
534.400 10
534.800 11
535.300 12
536.100 13
Shift
Mirror
Presets
Choose System
Series 5000
System :
ON
SENNHEISER
Check For
#1
Spacing
Spectrum
2Tx IM(3
2Tx IM(5
3Tx IM(3
Find Free Channels
Results to show :
Number of runs : 100
#1
Add channels : 10
Search step : 0.050
Search Spectrum (1)
Sort
Remove
From [MHz] To [MHz]
1 530.000 554.000
2 0.000 0.000
System Designer
System
Compute
Spectrum
SENNHEISER
Back
Next
Cancel
Spectrum Display
Full View
Full
Used Channels
Search Spectrum
520.000 IM Products : Channels : 1291 Maximum : 88 Overall : 26714 560.000

Change the system in use by clicking “Change”

or

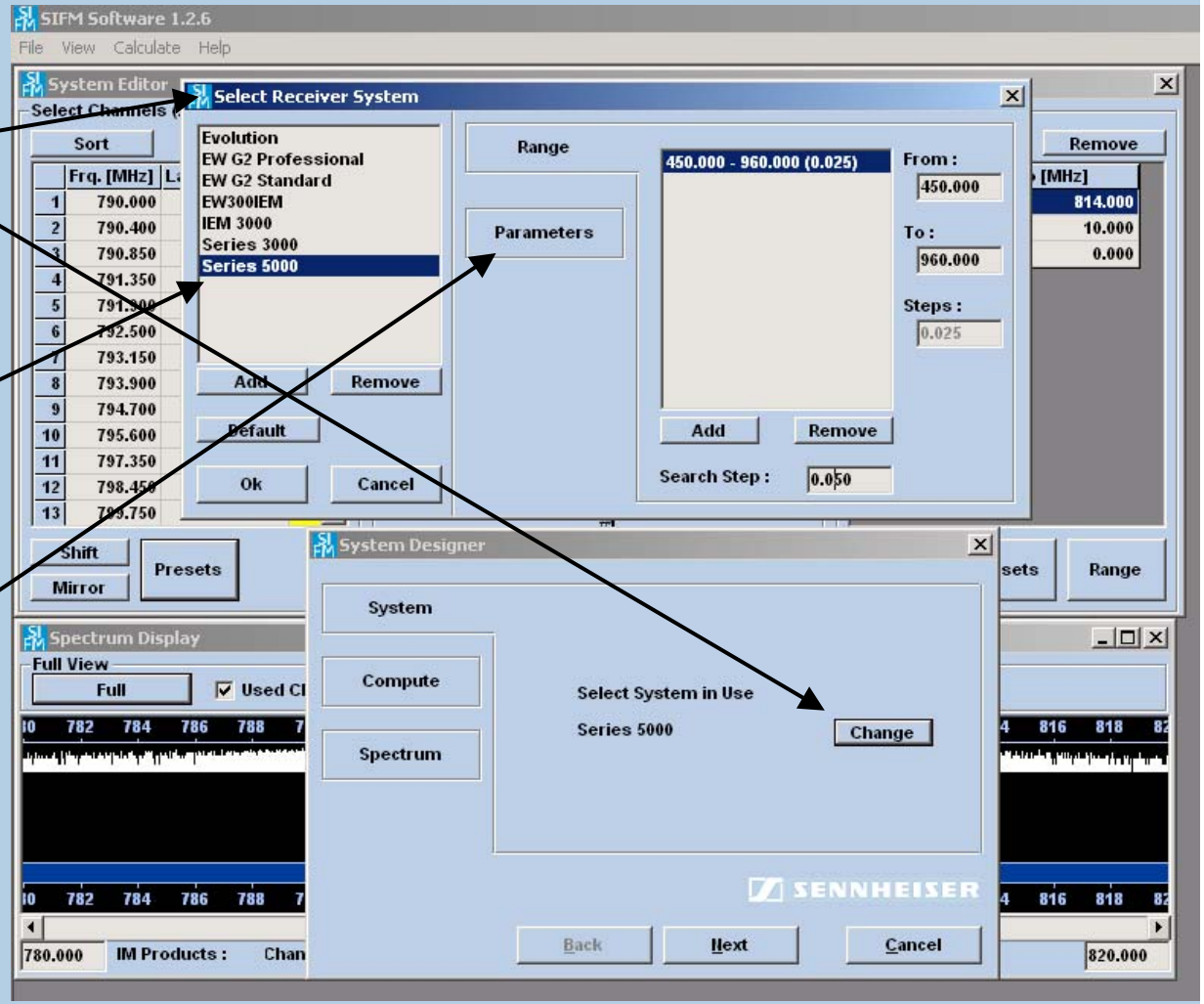
Confirm the selected system by clicking “Next”.



Clicking “Change” opens the “Select Receiver System” window.

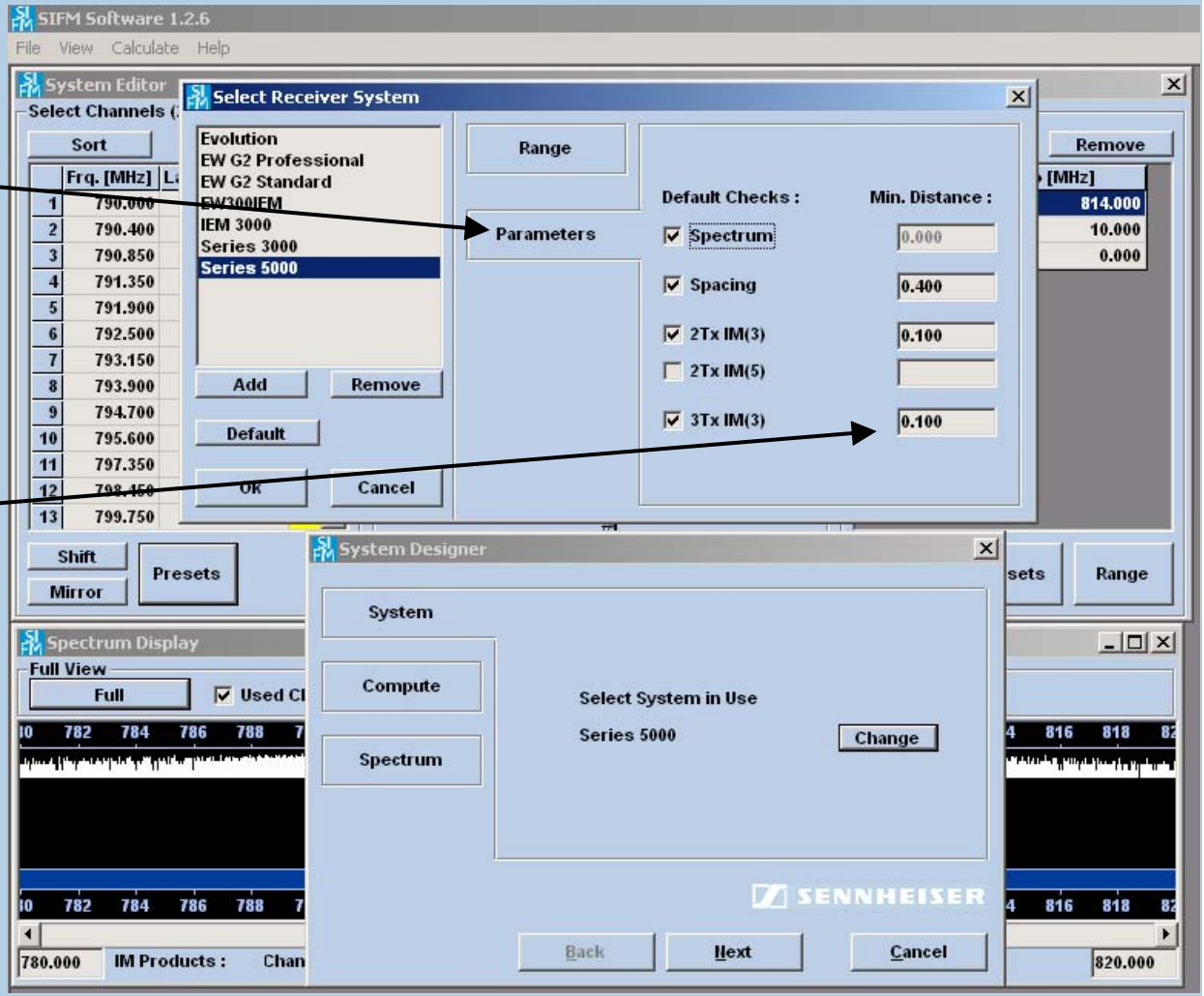
Select the equipment used.

Adapt the parameters.

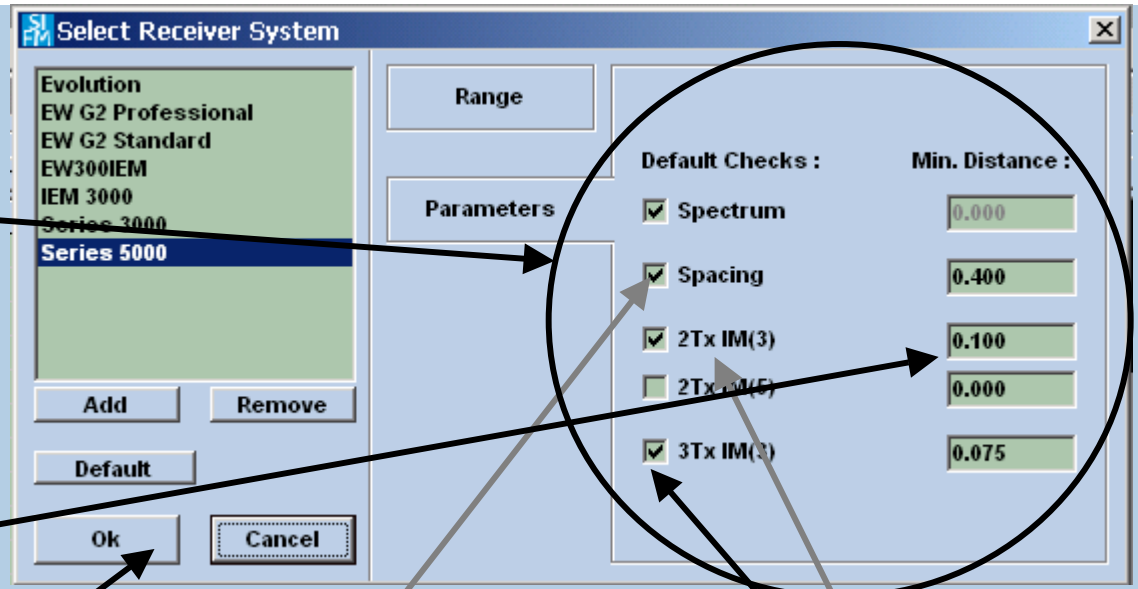


Only change the parameters when the required number of channels cannot be obtained.

Reducing the distances results in more channels but also increases the likelihood of IM interference.



A step by step approach yields a good compromise between the number of channels and operational safety.




Reduce the distances to adjacent IM products in steps of 25 kHz.

Confirm by clicking “OK” and let the program calculate.

Sequence during the search:

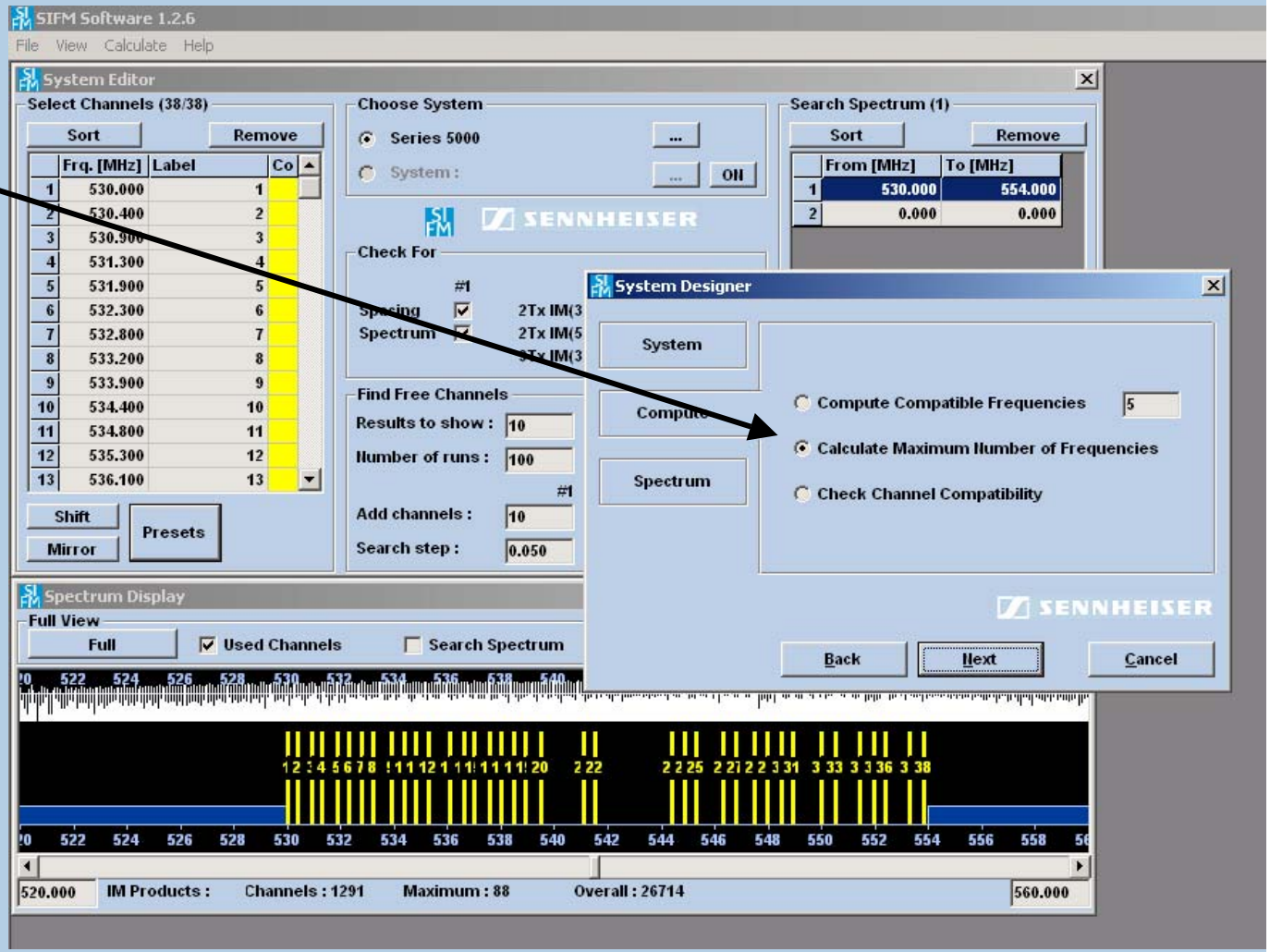
With 3 transmitters: Reduce the intermodulation distance (3Tx IM3) to 0 (remove the tick).

With 2 transmitters: Reduce the intermodulation distance (2Tx IM3) to 100 kHz min.

Reduce the channel spacing to 300 kHz min.

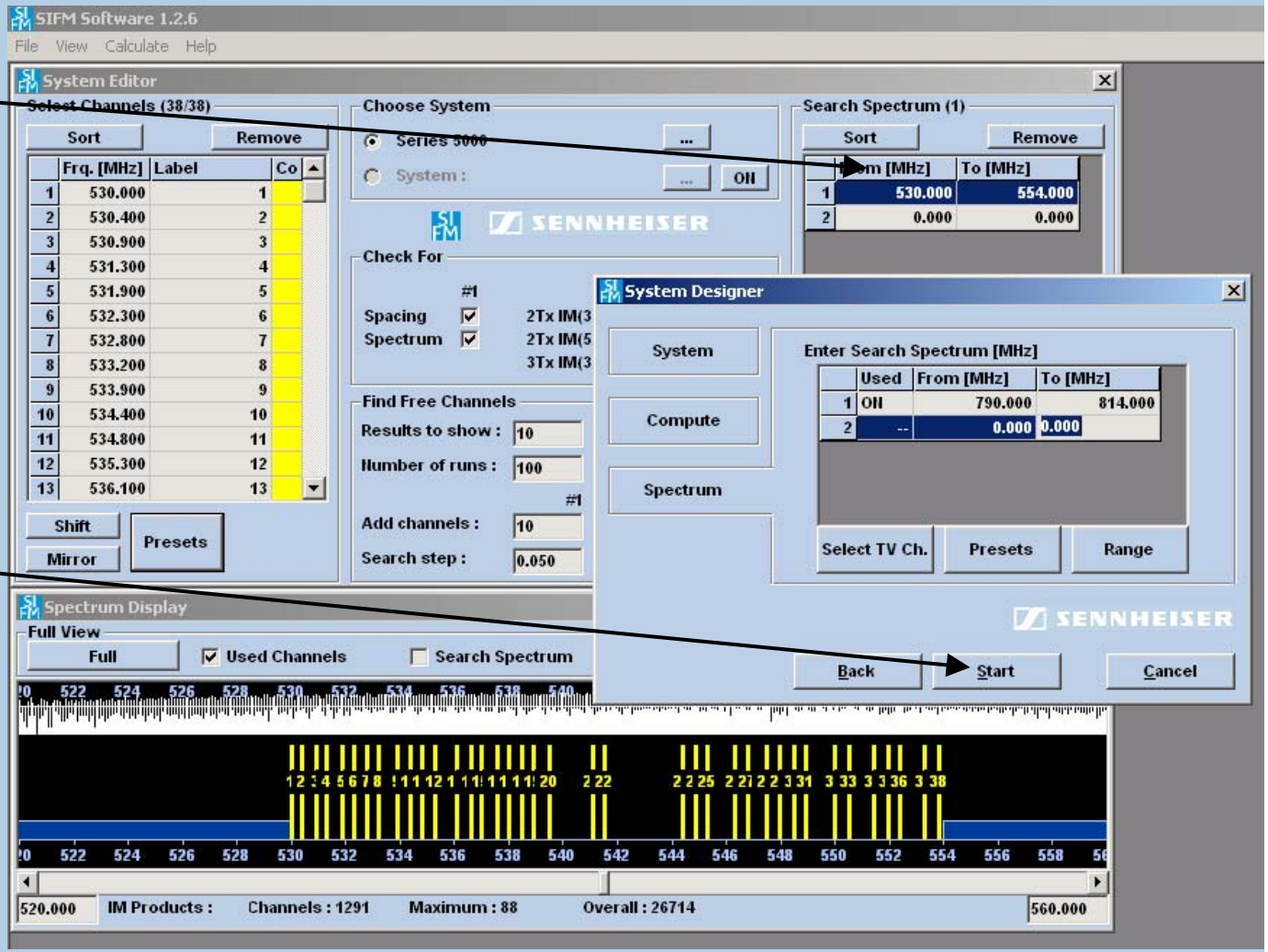
With evolution wireless equipment: 375 kHz min.

Select the operating mode.



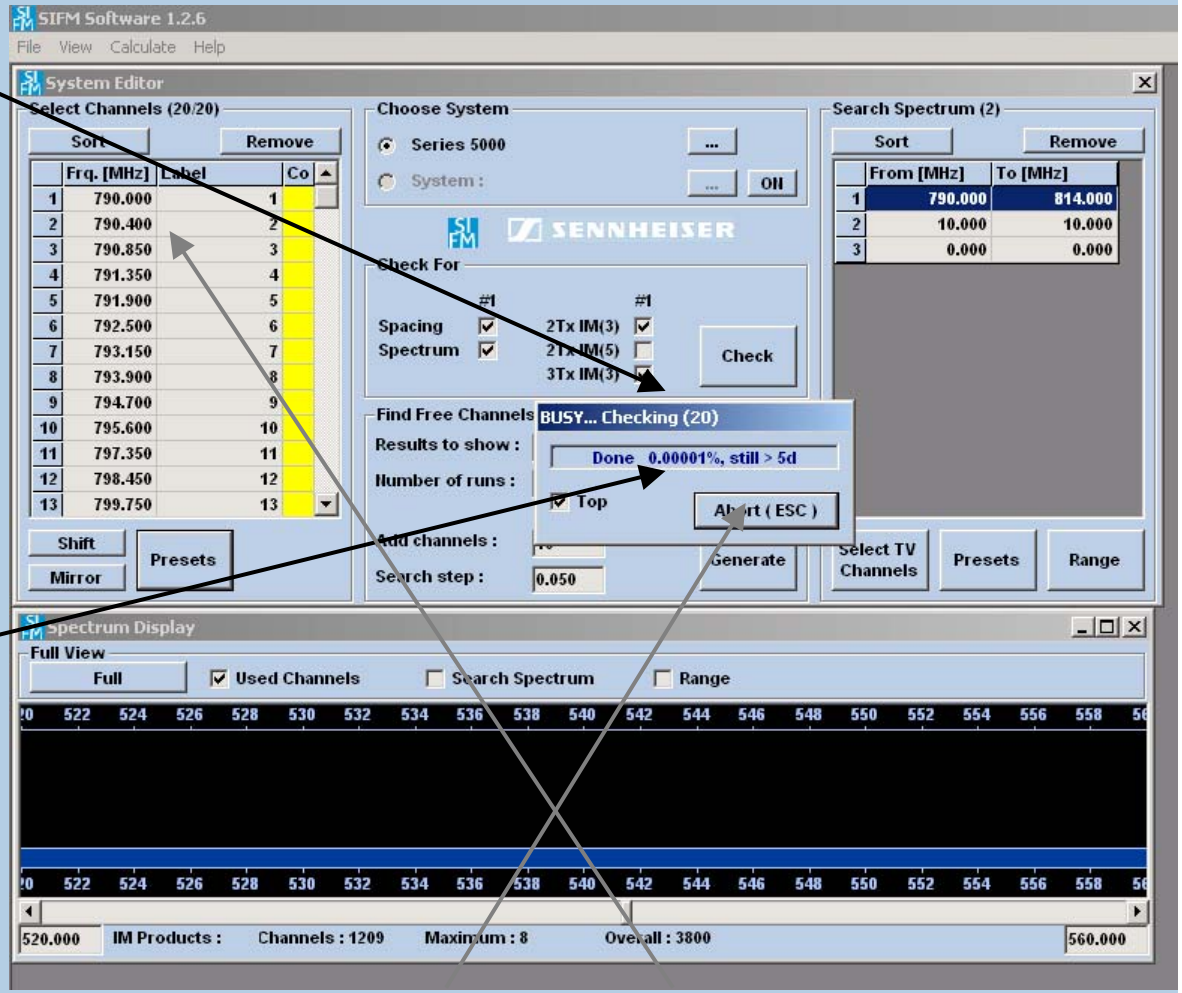
Enter the bandwidth.

Click “Start”.



The number of calculated channels (20) is displayed after a few seconds.

The residual time required to calculate all possibilities is also displayed (5 days). This could result in 1 or 2 more frequencies.

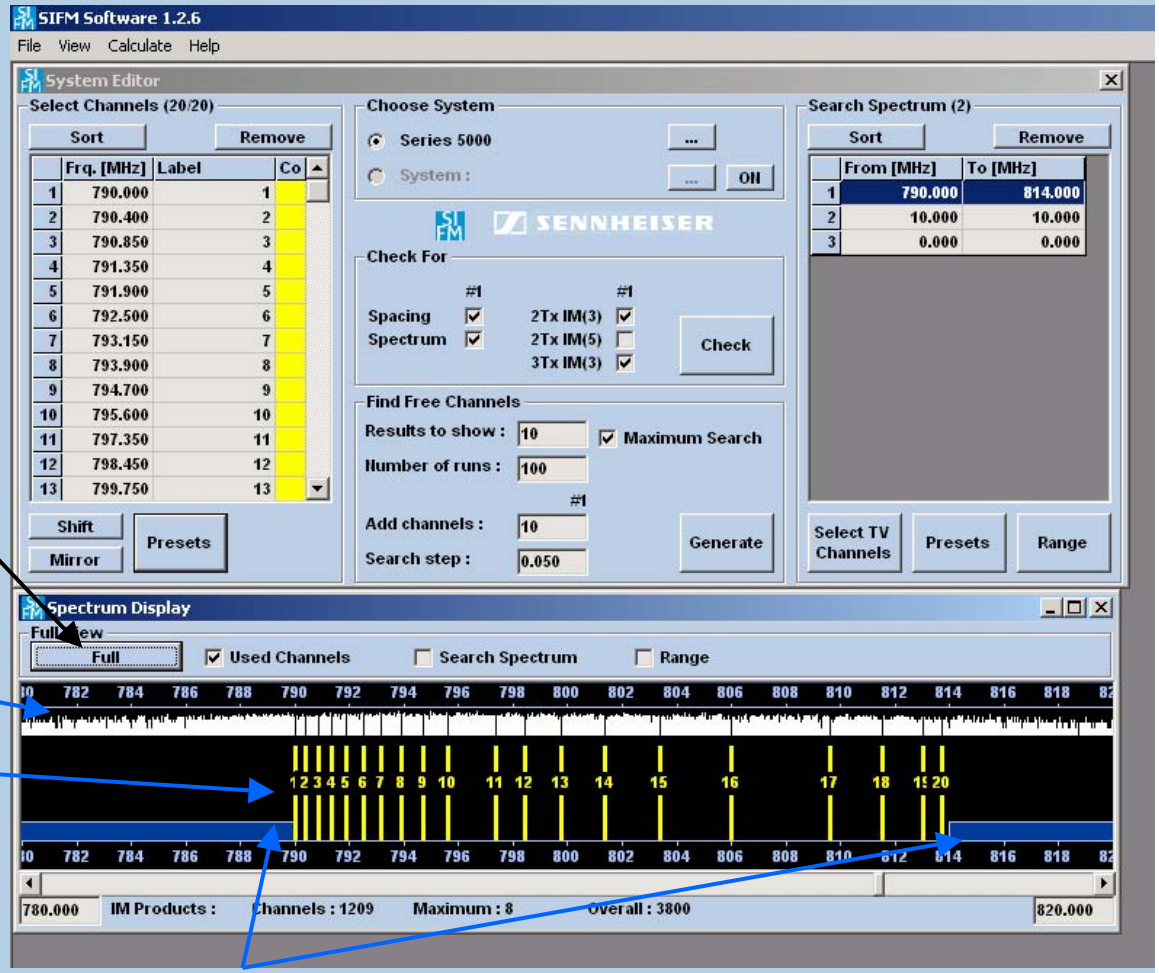



After clicking “Abort”, the result is displayed.

Click “Full” for a graphic display of the result.

IM products

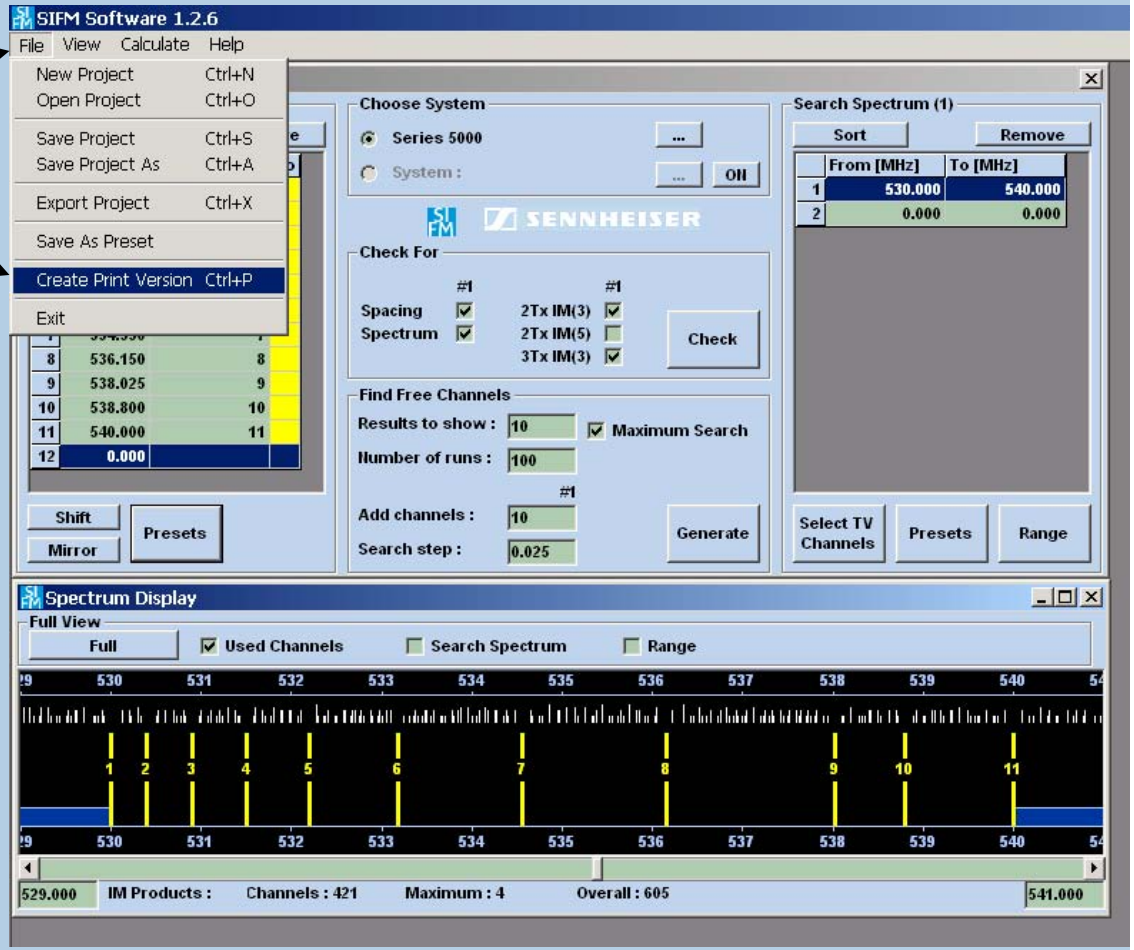
Radio microphone frequencies




Band limits

To print the result:

From the “File” menu,
select “Create Print Version”.

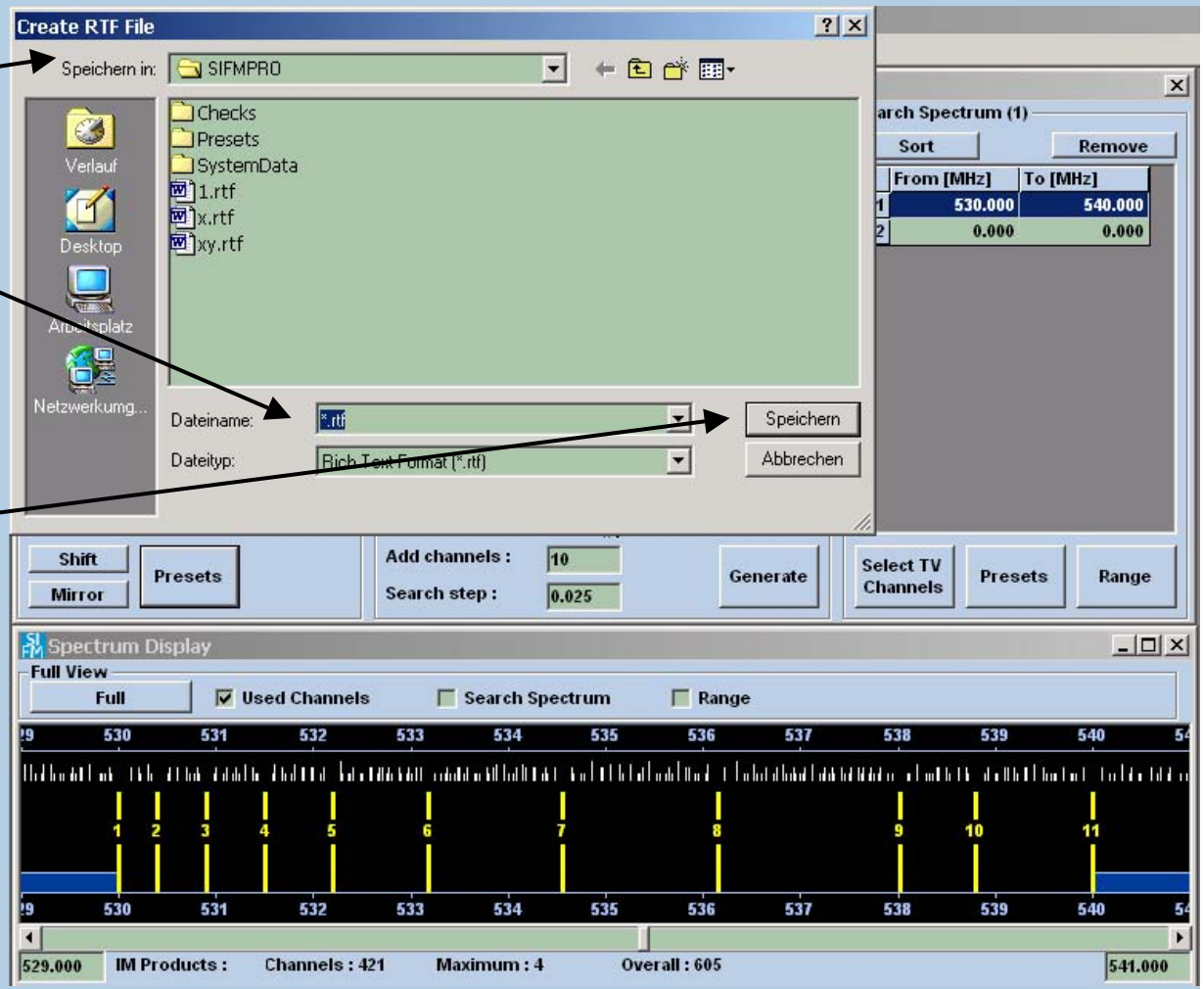


The “Create RTF File” window opens.

*(This is in German)*

Enter a file name in the “Dateiname” field.

Clicking “Speichern” automatically opens a word processing program for printing.



# Print view of the result

SIFM 1.2.6.
RTF Document, created 01-19-2006 16:10:31

## System #1: Series 5000

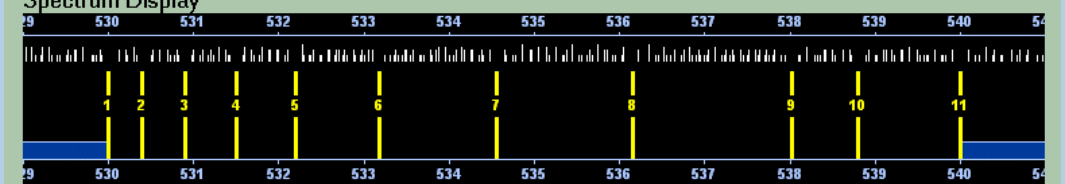
Parameters

| Parameters Checked | Status | Bandwidth |
|---|---|---|
| Spectrum | On | 0.000 |
| Spacing | On | 0.400 |
| 2Tx IM(3) | On | 0.100 |
| 2Tx IM(5) | Off | 0.000 |
| 3Tx IM(3) | On | 0.075 |

Channel Configuration (11)

| | Frequency | Label | Color |
|---|---|---|---|
| 1 | 530.000 MHz | 1 | |
| 2 | 530.400 MHz | 2 | |
| 3 | 530.900 MHz | 3 | |
| 4 | 531.500 MHz | 4 | |
| 5 | 532.200 MHz | 5 | |
| 6 | 533.175 MHz | 6 | |
| 7 | 534.550 MHz | 7 | |
| 8 | 536.150 MHz | 8 | |
| 9 | 538.025 MHz | 9 | |
| 10 | 538.800 MHz | 10 | |
| 11 | 540.000 MHz | 11 | |

Spectrum Display



Done!