FFT Advanced Tools for RSE and EMI Measurements

under the view of CISPR-16-2-x

EUT Timing analysis for correct measurement time settings in receivers, spectrum analyzers or FFT-based instruments

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ROHDE&SCHWARZ

Re-organization of CISPR16 Publications in 2003

CISPR 16-1	Radio disturbance and immunity measuring apparatus
CISPR 16-2	Methods of measurement of disturbances and immunity
CISPR 16-3	Reports and recommendations of CISPR
CISPR 16-4	Uncertainty in EMC measurements

CISPR 16-1-1	Measuring apparatus
CISPR 16-1-2	Ancillary equipment – Conducted disturbances
CISPR 16-1-3	Ancillary equipment – Disturbance power
CISPR 16-1-4	Ancillary equipment – Radiated disturbances
CISPR 16-1-5	Antenna calibration test sites for 30 MHz to 1 000 MHz
CISPR 16-2-1	Conducted disturbance measurements
CISPR 16-2-2	Measurement of disturbance power
CISPR 16-2-3	Radiated disturbance measurements
CISPR 16-2-4	Immunity measurements
CISPR 16-3	CISPR technical reports
CISPR 16-4-1	Uncertainties in standardised EMC tests
CISPR 16-4-2	Measurement instrumentation uncertainty
CISPR 16-4-3	Statistical considerations in the determination of EMC compliance of mass-produced products
CISPR 16-4-4	Statistics of complaints and a model for the calculation of limits

CISPR16-2 -1 / -2 / -3

IEC

CISPR 16-2-3

Edition 3.2 2014-03

INTERNATIONAL STANDARD

Specification for radio disturbance and immunity measuring apparatus and methods –
Part 2-3: Methods of measurement of disturbances and immunity – Radiated disturbance measurements

CISPR 16-2-1	Conducted disturbance measurements
CISPR 16-2-2	Measurement of disturbance power
CISPR 16-2-3 Edition 3.2 2014-03	Radiated disturbance measurements

CISPR16-2 -1 / -2 / -3 Minimum Scan Times

X **Table 1 – Minimum scan times for the three CISPR bands with peak and quasi-peak detectors**

Frequency band		Scan time T_S for peak detection	Scan time T_S for quasi-peak detection
A	9 kHz to 150 kHz	14,1 s	2 820 s = 47 min
B	0,15 MHz to 30 MHz	2,985 s	5 970 s = 99,5 min = 1 h 39 min
C and D	30 MHz to 1 000 MHz	0,97 s	19 400 s = 323,3 min = 5 h 23 min

Depending on the type of disturbance, the scan time may have to be increased – even for quasi-peak measurements. In extreme cases, the measurement time T_m at a certain frequency may have to be increased to 15 s, if the level of the observed emission is not steady (see 6.5.1). However isolated clicks are excluded.

X *Many sections of the 3 standard parts have the same content. Numbering and indices are different.*

Scan time translates into…
→ "dwell time" in a stepped scan (e.g. in receiver mode)
→ "sweep time" in a swept scan (e.g. in analyzer mode)

CISPR16-2 all parts – since edition 1

6.5.2 Scan rates for scanning receivers and spectrum analyzers

One of two conditions need to be met to ensure that signals are not missed during automatic scans over frequency spans:

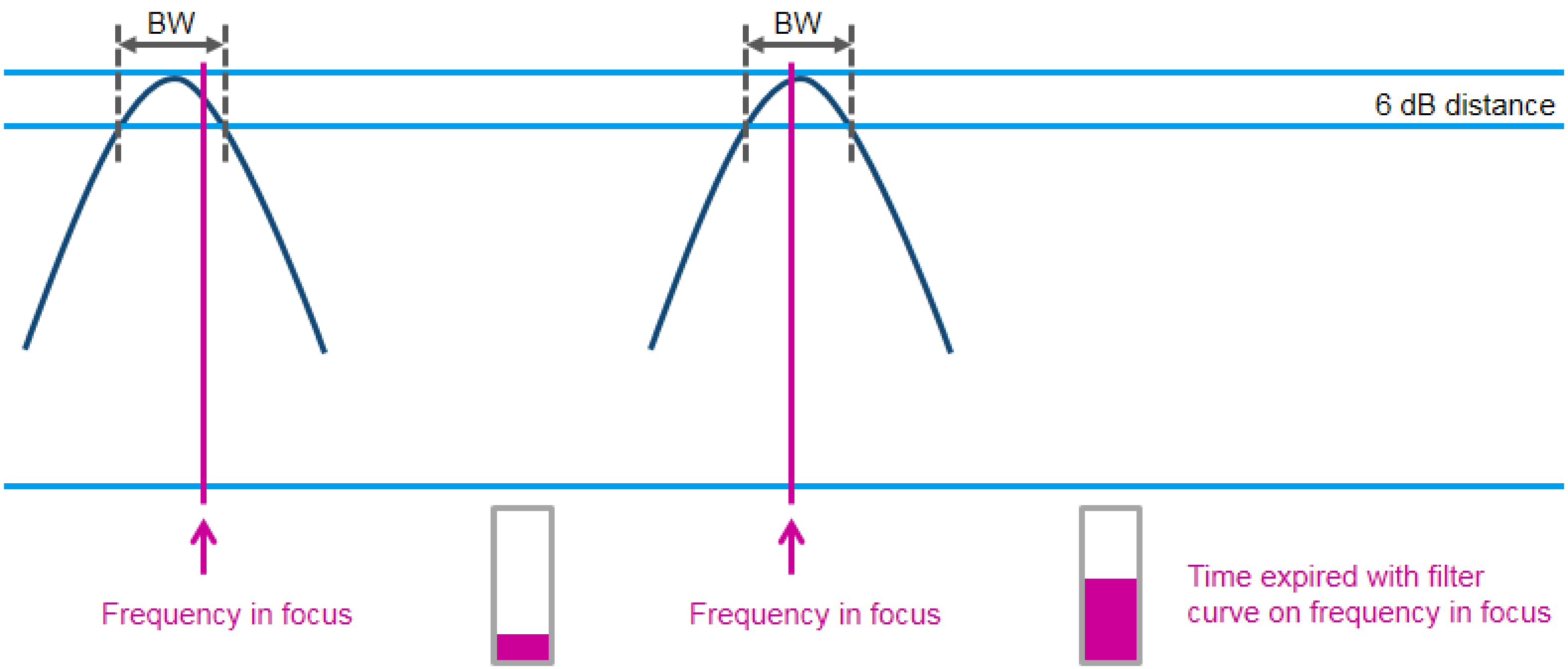
1) for a single sweep: the measurement time at each frequency must be larger than the intervals between pulses for intermittent signals;
2) for multiple sweeps with maximum hold: the observation time at each frequency should be sufficient for intercepting intermittent signals.

In focus of clause 6.5.2:

- the measurement time at each frequency
- intervals between pulses
- intercepting intermittent signals

The number of frequency points is an important parameter and needs to be considered especially in sweeps / analyzer mode.

CISPR16-2 all parts – Measurement Time per Frequency

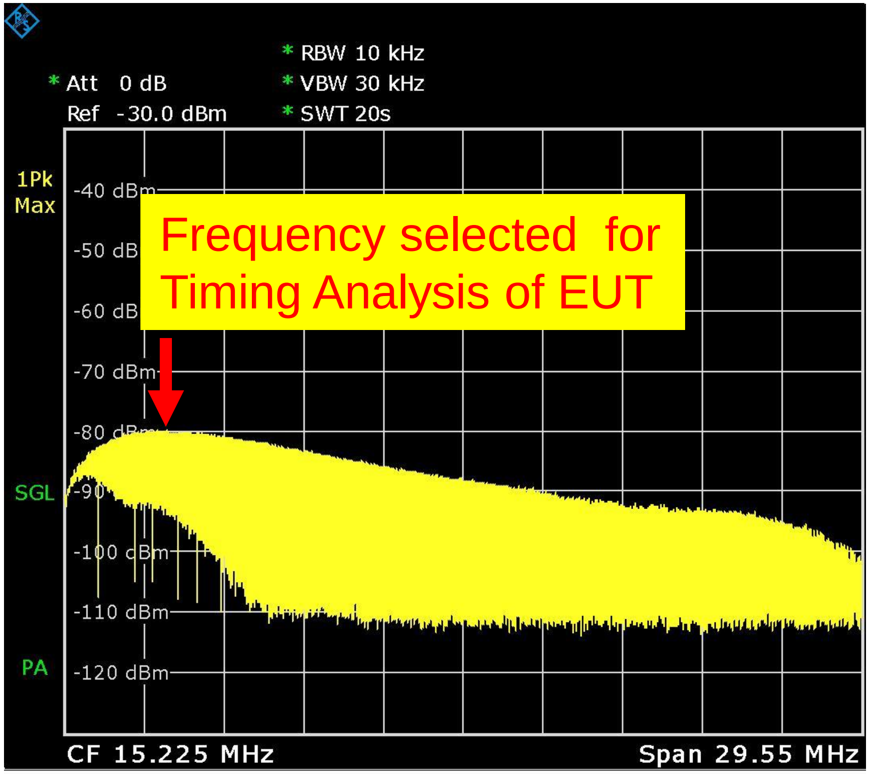


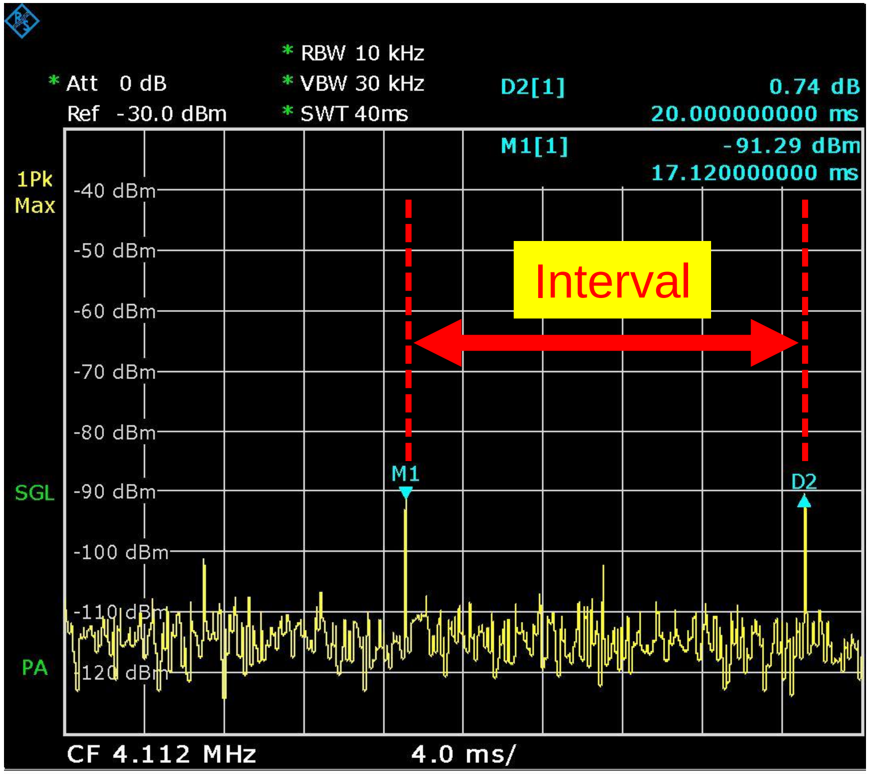
Even for a swept scan it is possible to discuss about a measurement time per frequency. This graph explains, how “CISPR A“ understands the term measurement time at each frequency.

Effect 1

CISPR16-2 all parts – Interval between Pulses

EUT: Interval between Pulses = 20 ms





Frequency sweep:
> 15 sec; around 6,000 points *)
Thick trace → intermittent signal

ZERO SPAN mode:
Analysis of EUT behavior in the time domain.

CISPR16-2 all parts – Analysis Steps

manual

Timing Analysis of EUT
to find Measurement Time

Very often omitted!

↓

Preview / Pre-scan
(automated / semi-automated)

↓

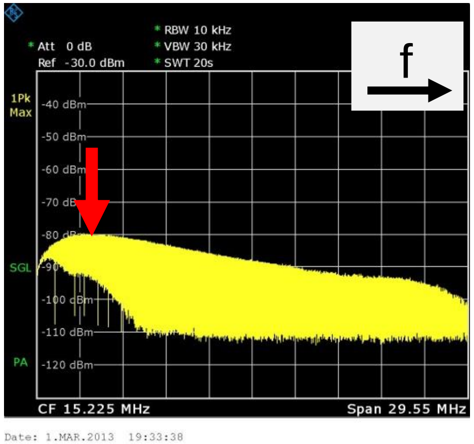
Data Reduction / Critical Frequencies

↓

Final
(automated / semi-automated)

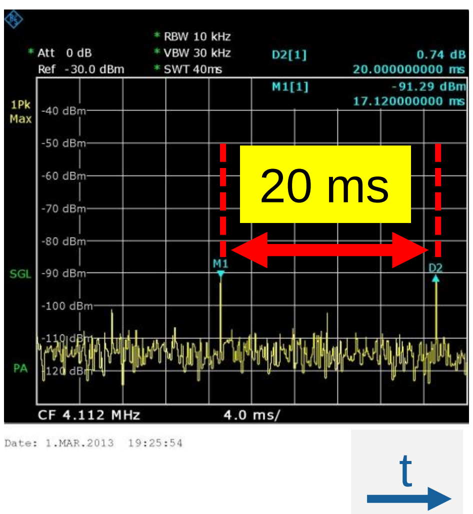
CISPR16-2 all parts – EUT Timing Analysis

Example Results



Step 1)
"Thick Trace?"

Detector: Pos. Peak
No. of points:
e.g. approx. 6000 in Bd. B
SWT = 15 s
Thick trace: >> 2 dB



Step 2)
"Zero Span"

Timing Analysis prior to the actual measurement

For a stepped scan, the result of step 2 can be directly used.

Out of experience:
if the settings of CISPR 16-2-x are applied, a thick trace is a good indicator for an intermittent interferer.

Optional Step 3) for a swept scan
Calculating the sweep time.

Measurement Parameter

Start Frequency	150 kHz
Stop Frequency	30 MHz
Bandwidth	
RBW	10 kHz
Stepsize*	
50% of RBW	5.0 kHz
Frequency Span	29.85 MHz
Calculated Number of Steps resp. Calculated Number of Frequency Points	5970
Measurement Time per Step *)	20 ms
Total Observation Time =[MT per step] * [calc. Number of steps]	120 s

Discussion of Measurement Parameters

Measurement Parameter

Spectrum Ana. 150 kHz to 30 MHz

Start Frequency	150 kHz
Stop Frequency	30 MHz
Bandwidth	
RBW	10 kHz
Stepsize*	
50% of RBW	5.0 kHz
Frequency Span	29.85 MHz
Calculated Number of Steps resp. Calculated Number of Frequency Points	5970
Measurement Time per Step	20 ms
Total Observation Time =[MT per step] * [calc. Number of steps]	120 s

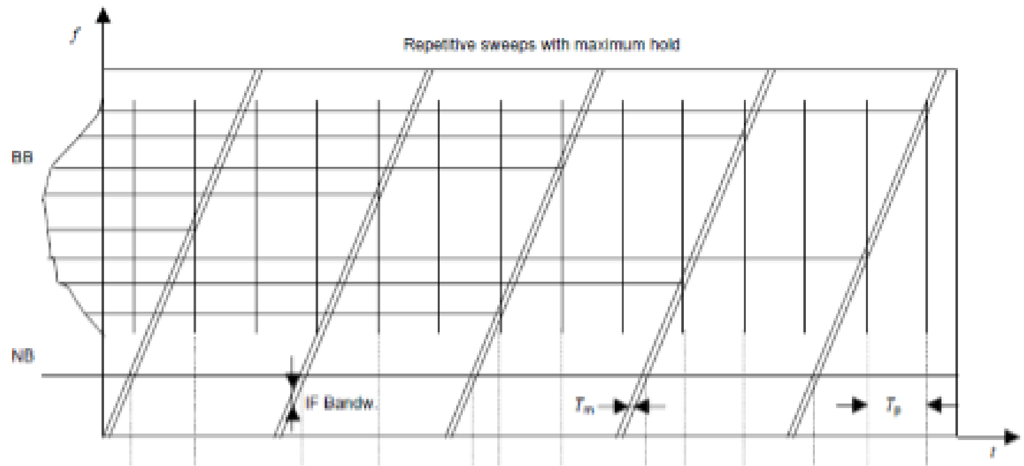
Result of step 2)

Result of step 3)

*) Even for a sweep it is strongly recommended to think in steps to determine the speed requirements.

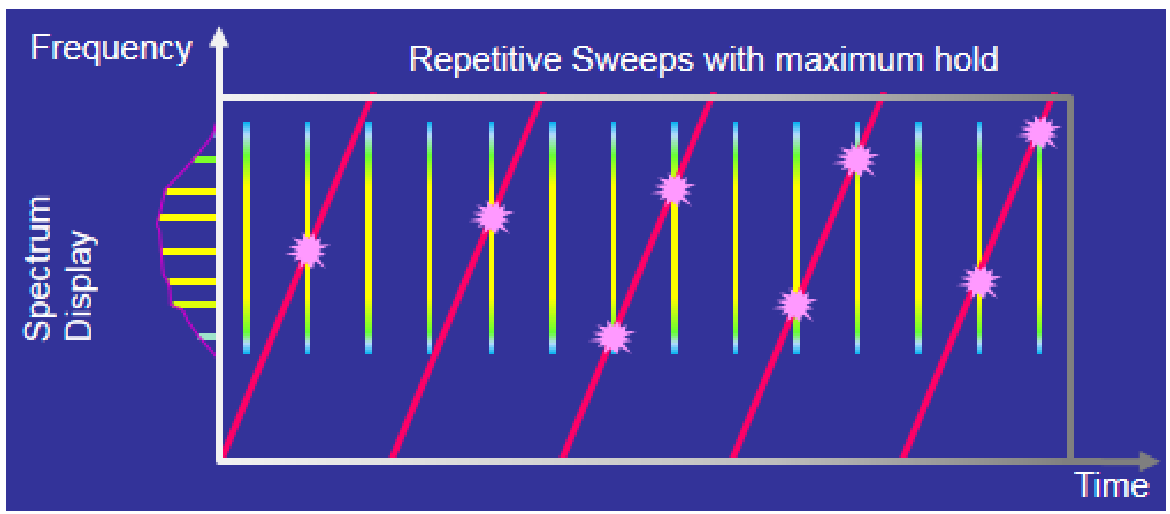
CISPR16-2 all parts – since edition 1
Important Graph: Visualization of Interceptions

Intercept chart in standard

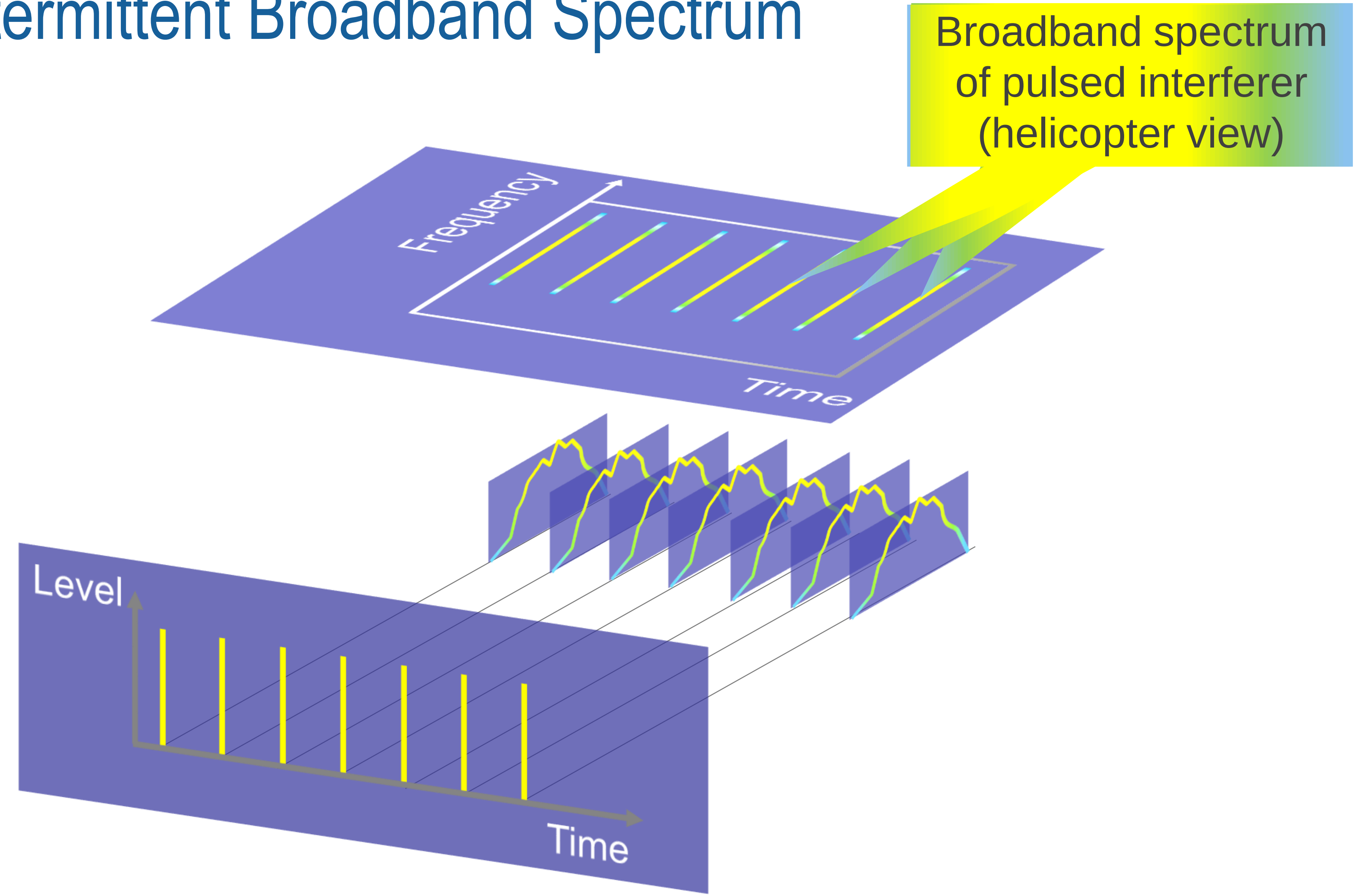


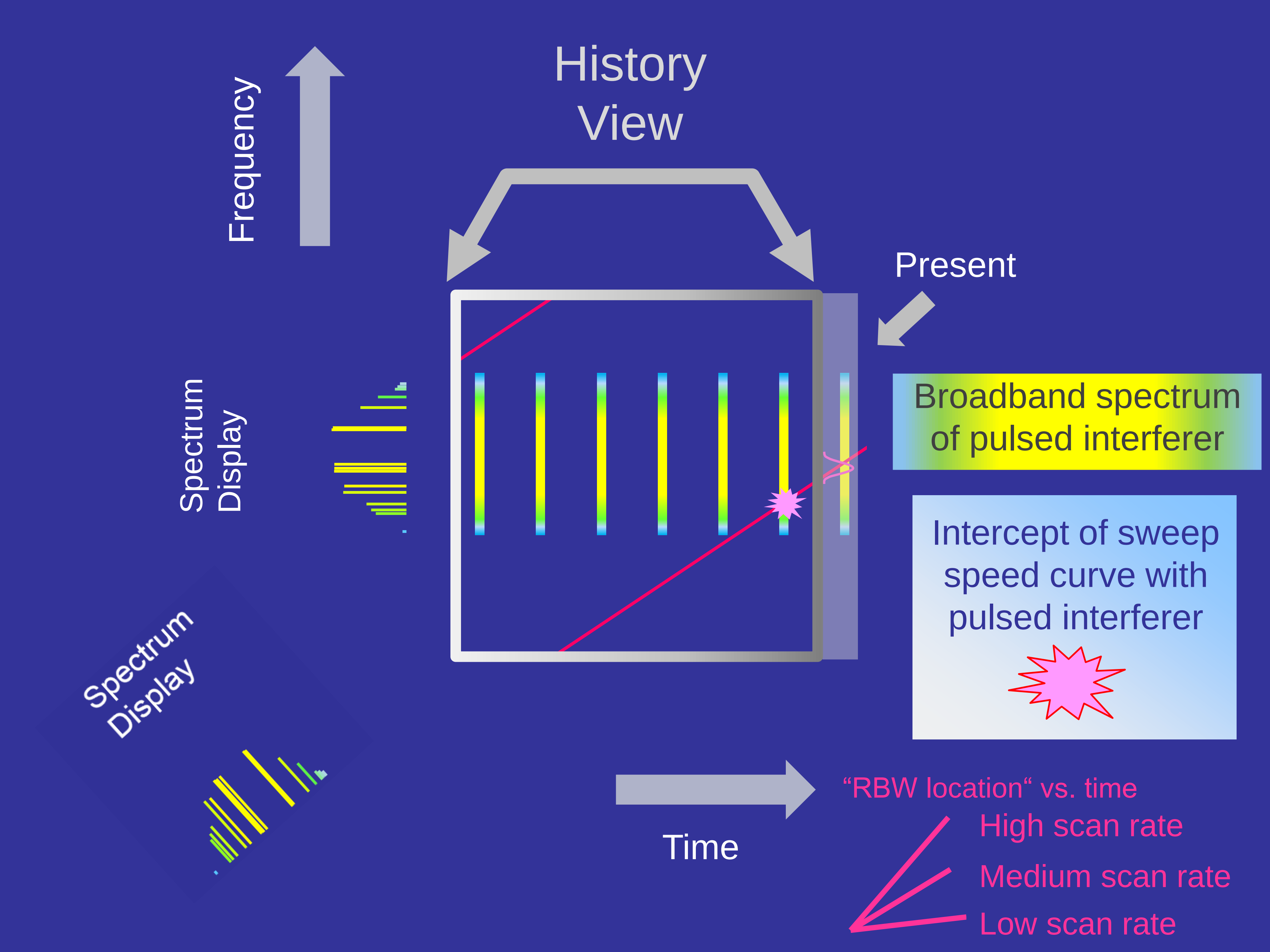
IEC 752/10

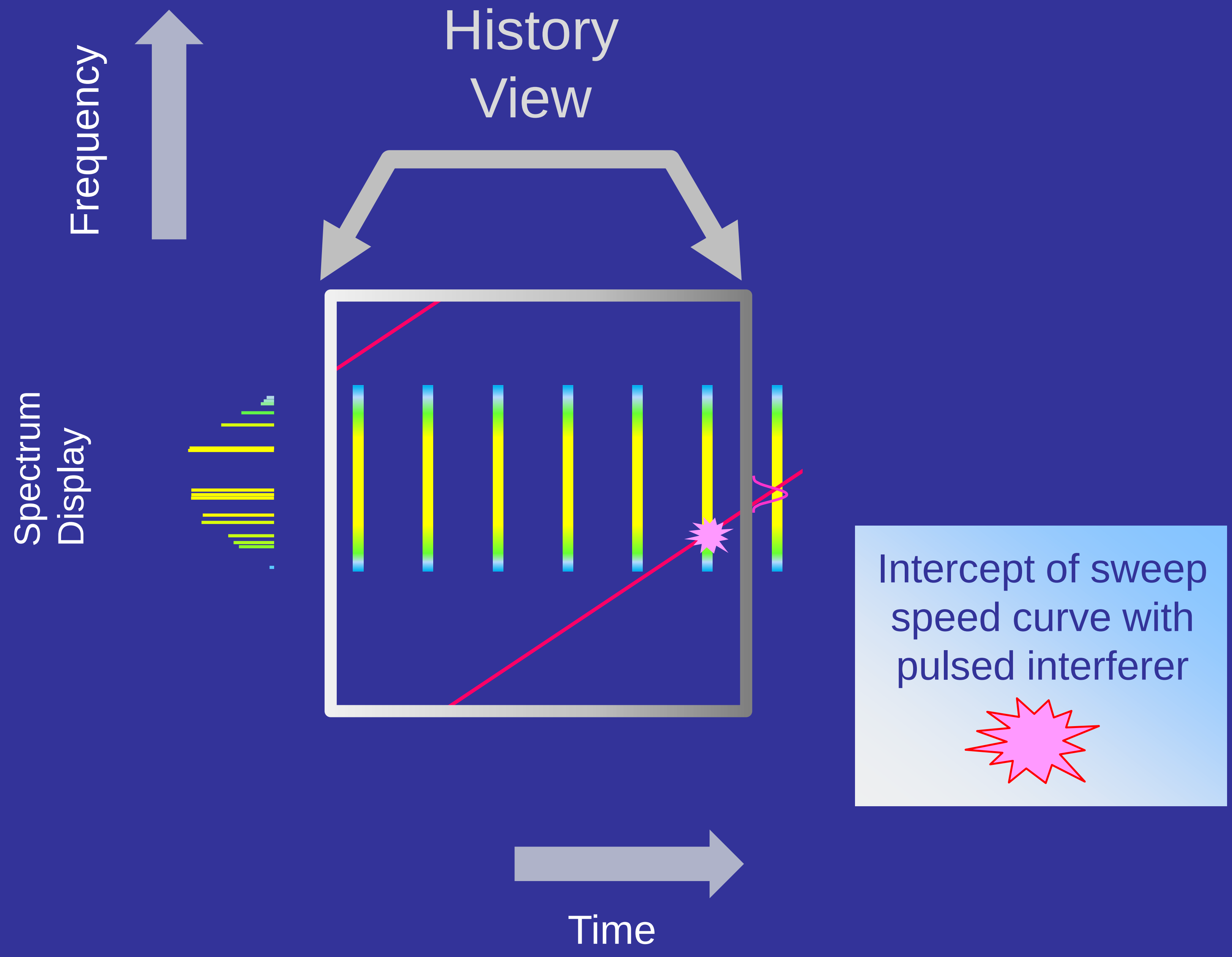
Intercept chart with color



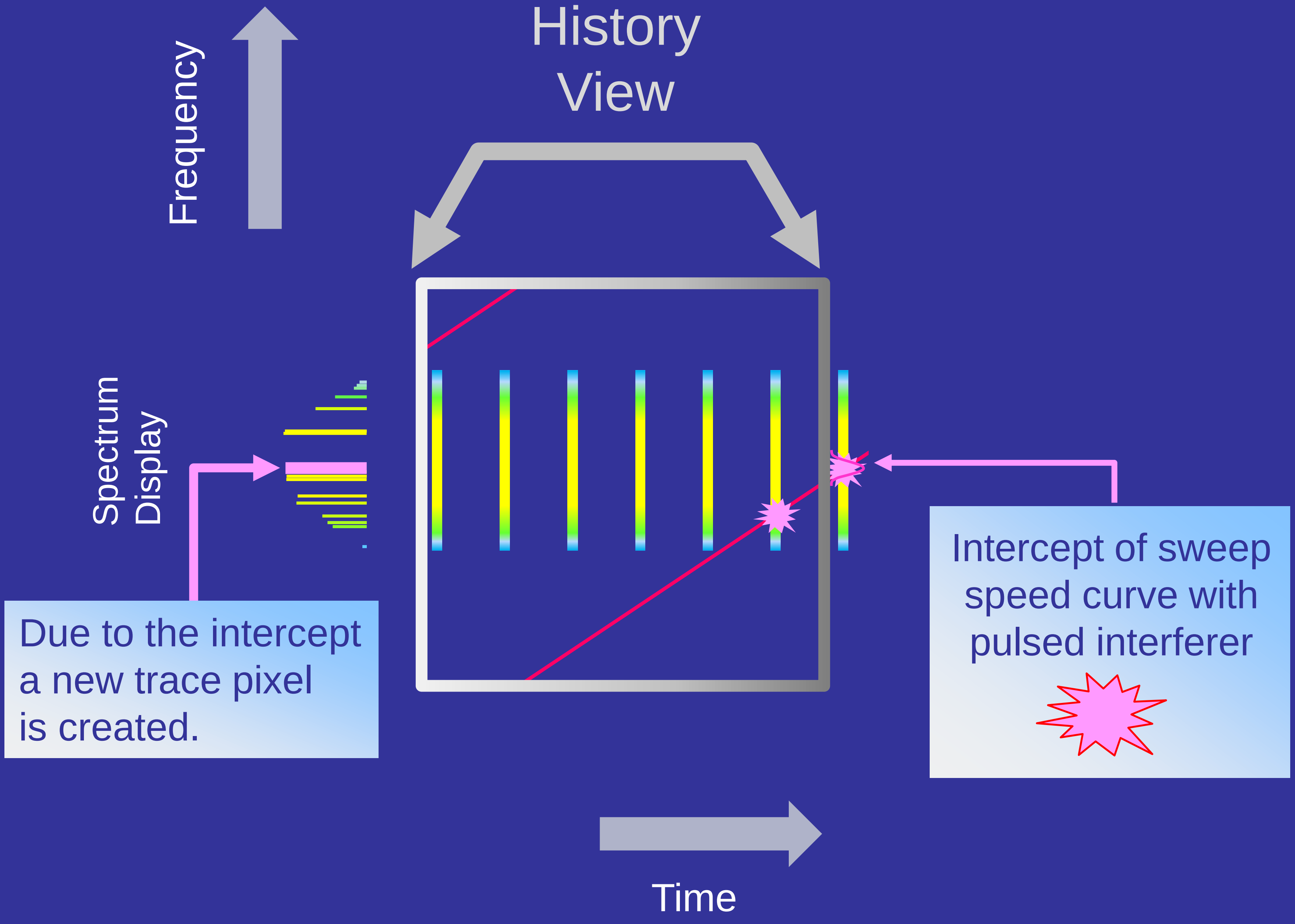
Intermittent Broadband Spectrum



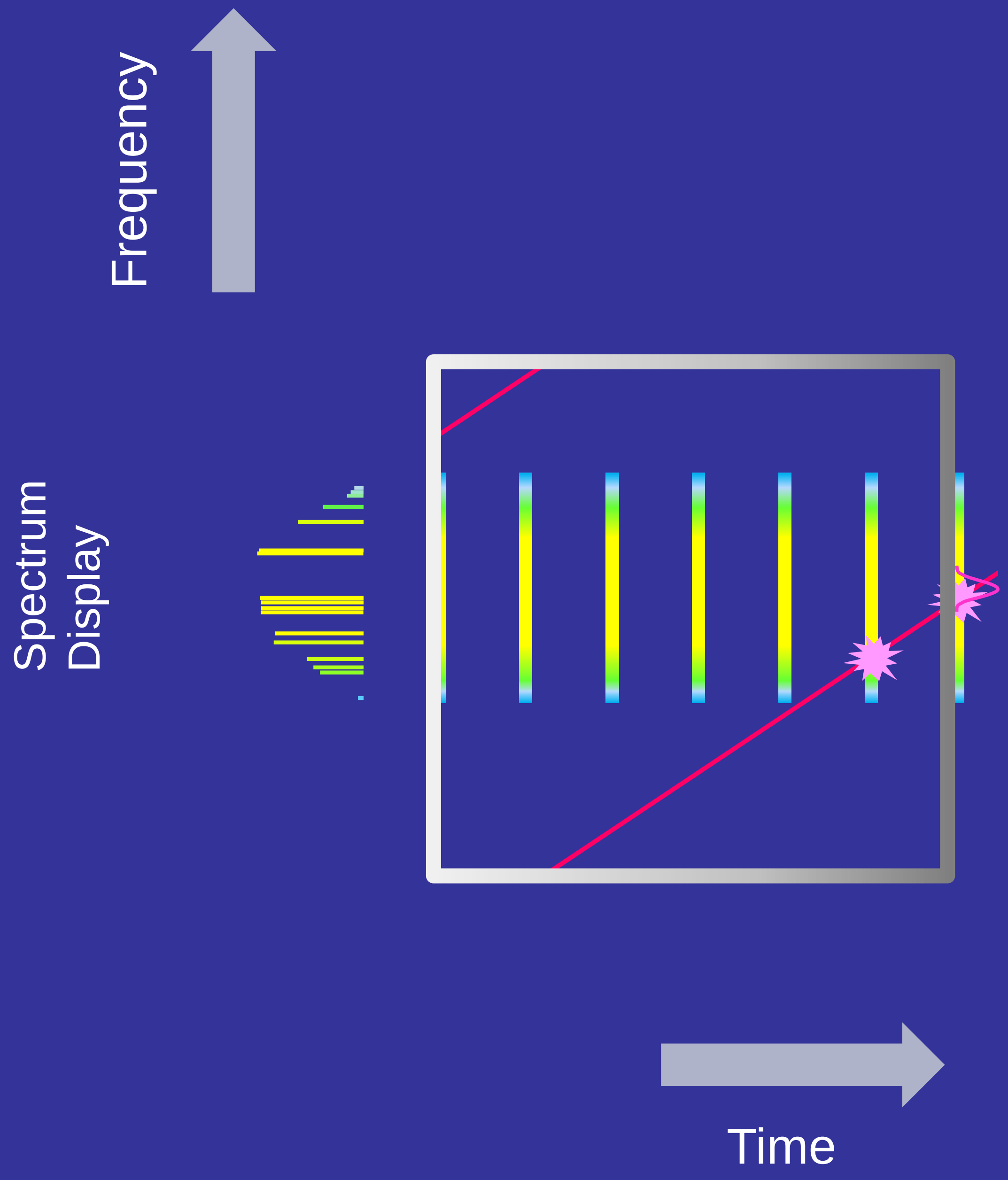

History View
Frequency
Present
Spectrum Display
Broadband spectrum of pulsed interferer
Intercept of sweep speed curve with pulsed interferer
Spectrum Display
Time
“RBW location“ vs. time
High scan rate
Medium scan rate
Low scan rate



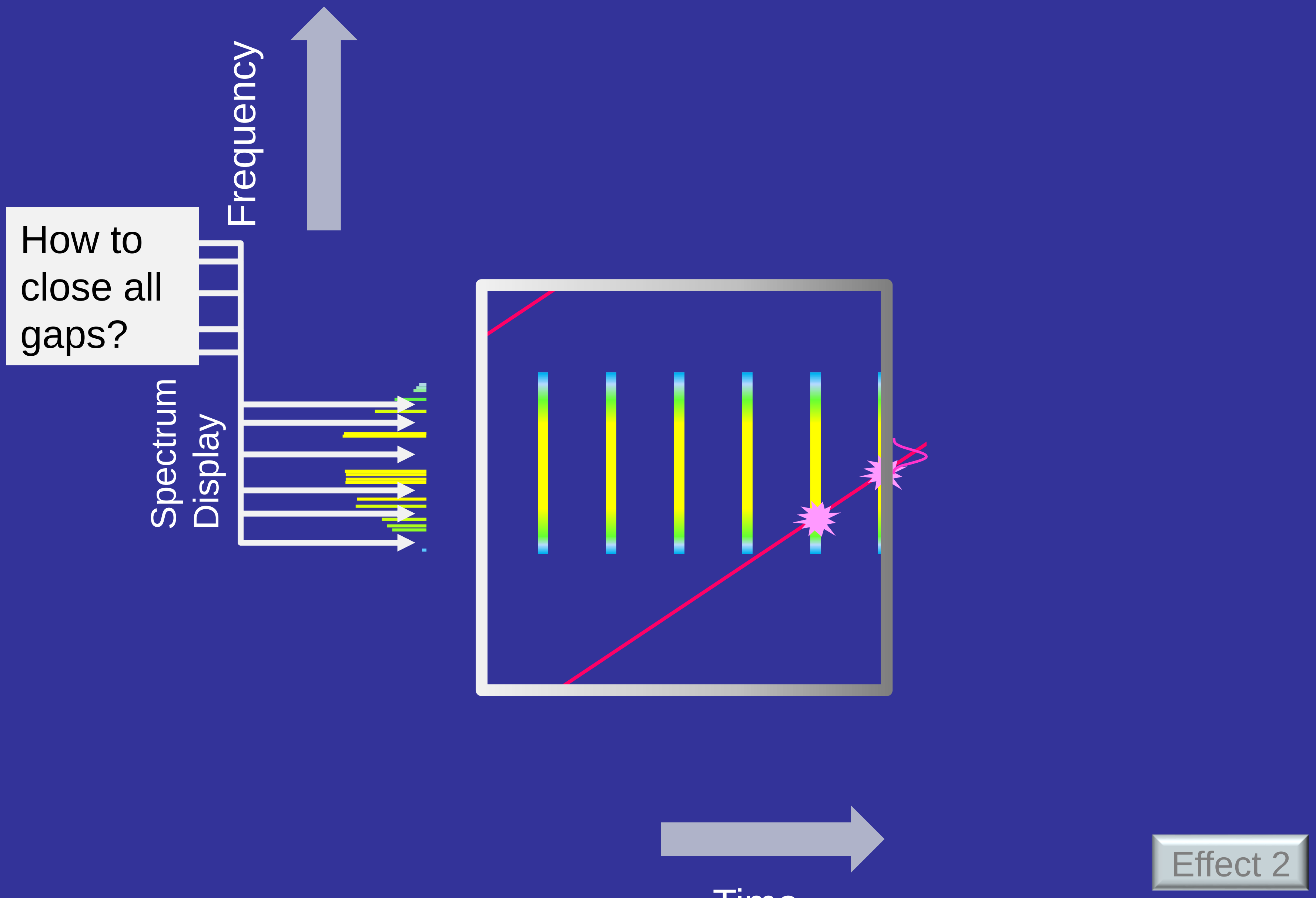
History
View
Frequency
Spectrum
Display
Time
Intercept of sweep speed curve with pulsed interferer



History
View
Frequency
Spectrum
Display
Due to the intercept
a new trace pixel
is created.
Intercept of sweep
speed curve with
pulsed interferer
Time



Frequency
Spectrum
Display
Time



How to close all gaps?
Frequency
Spectrum Display
Time
Effect 2

EUT Timing Analysis to minimize Risk of Gaps

- The EUT Timing Analysis helps to find the correct measurement time per frequency
- For spectrum analyzers the measurement time per frequency translates into a sweep time setting
- For scanning receivers (stepped scan!) the measurement time per frequency translates into a dwell time.
- The correct settings will increase the match of the measurement curve with the “Spectrum Envelope“
- A gap smaller than 2 dB is regarded as a good match of the measurement curve with the Spectrum Envelope.

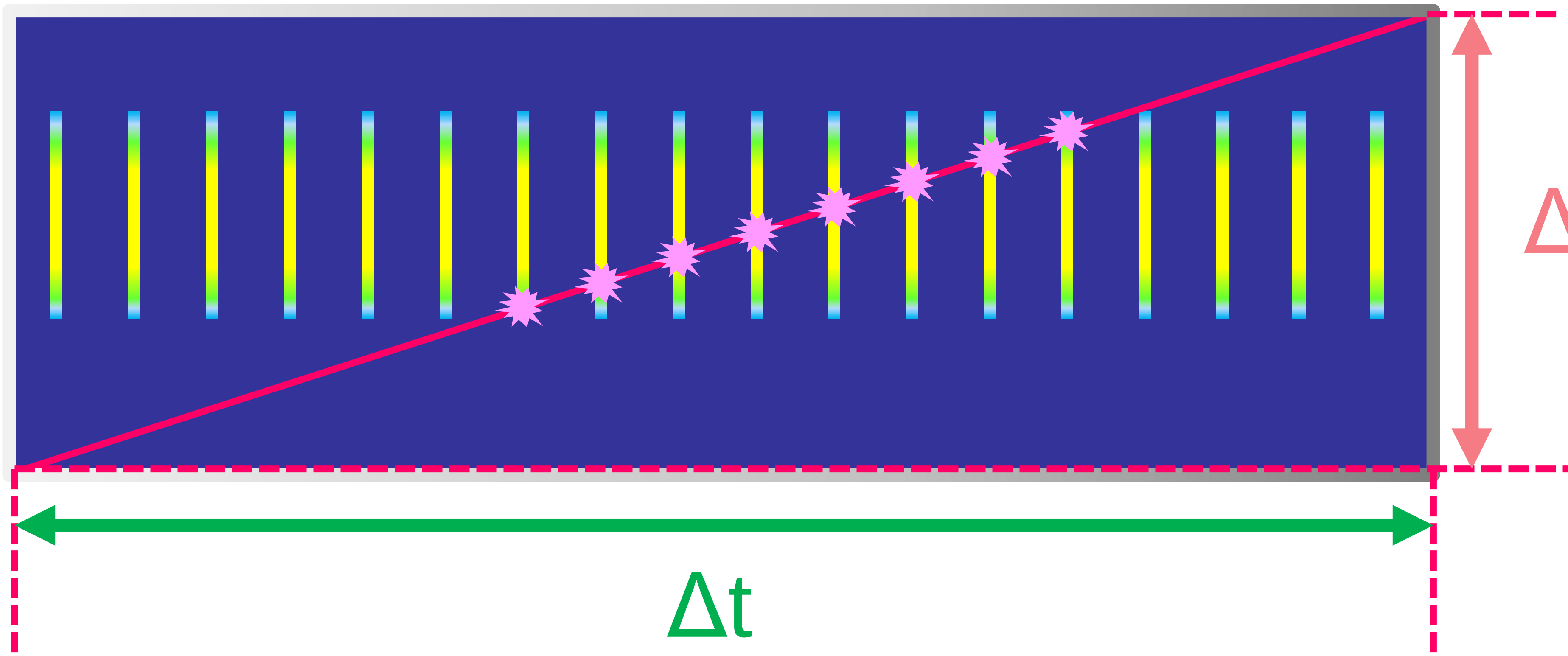
EUT Timing Analysis Step by Step

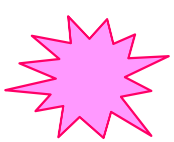
- Spectrum analyzer with sweep time = 15 sec
- Activate sufficient frequency points → approach step size = 50% of RBW
  - CISPR Band B: 6000 @ RBW = 9 kHz
  - CISPR Band C/D 16000 @ RBW = 120 kHz
  - If the analyzer can not handle such amount of points then the span has to be reduced accordingly
- Trace Detector: Max Peak or Positive Peak
- Single Sweep
- Check for a „thick trace“ e.g. > 10 dB. This is an indicator for an intermittent signal (pulsed signal)
- Place a marker on a high level of the thick band ín the display
- Select the marker frequency as the new center frequency
- Switch to “zero span“.
- Modify the sweep settings: e.g. sweep time (time window span) = 100 ms
- Find out the interval between two pulses / trenches, etc.
- In case of irregular peak patterns select a sweep time, where often 5 peaks occur in the display. Then divide the sweep time by 4 to get a useful measurement time per frequency point.

Signal Interception

$\Delta f / \Delta t$

A low scan rate…

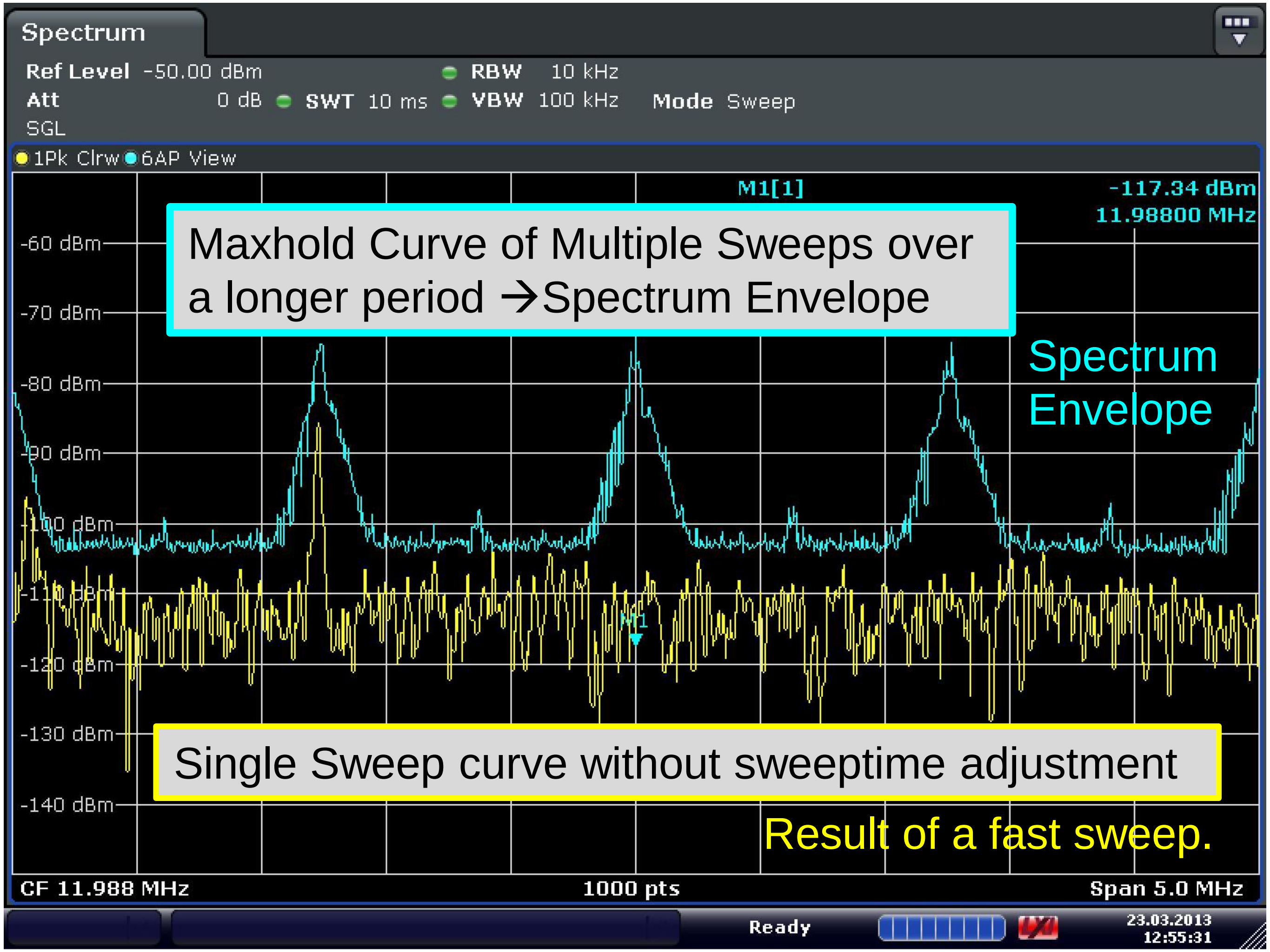




…leads to a high probability of intercept per sweep!

Broadband spectrum of pulsed interferer

Single Sweep vs.Spectrum Envelope



Date: 23.MAR.2013 12:55:31

Single Sweep vs.Spectrum Envelope

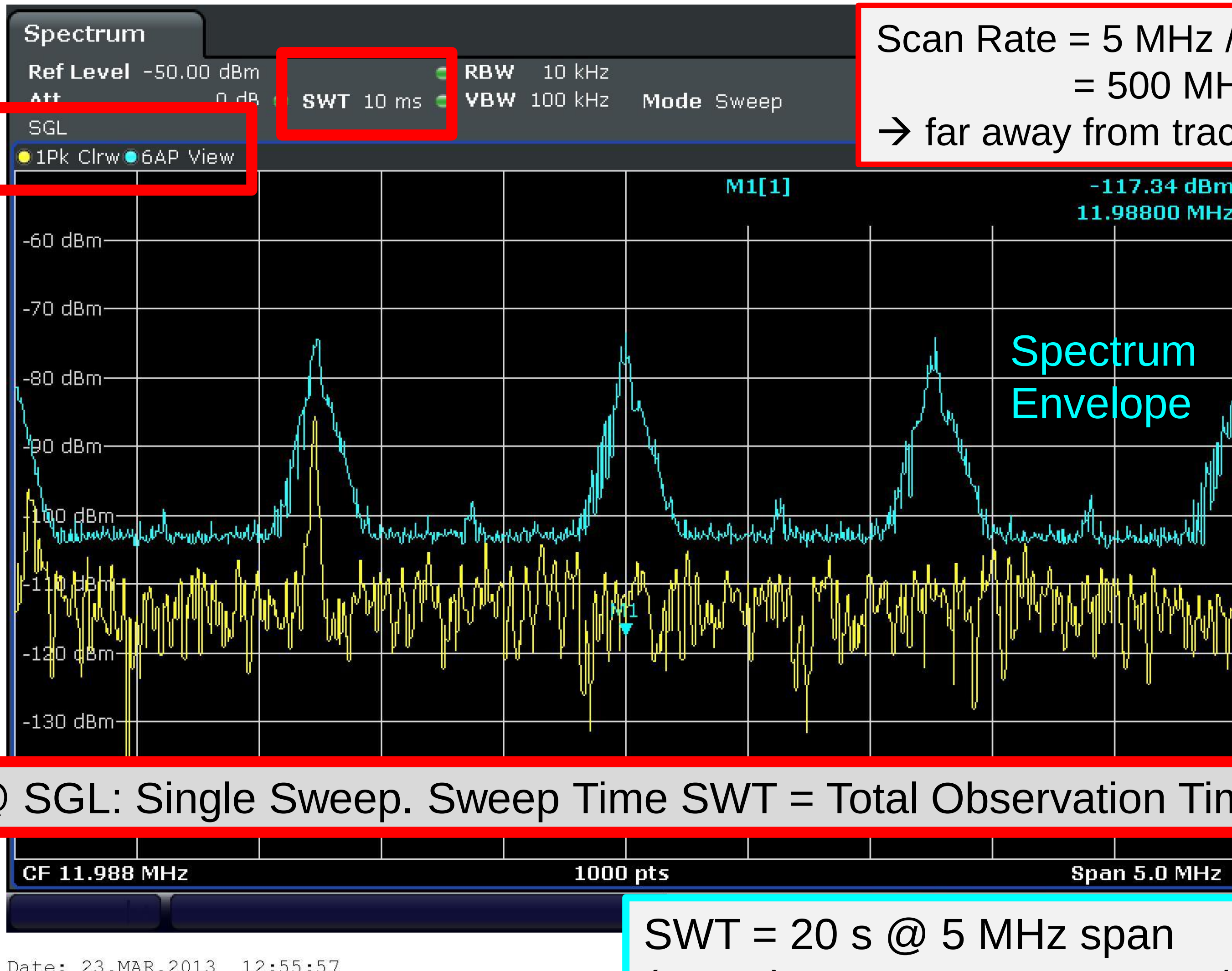
Measurement Parameter

Spectrum Ana. 5 MHz Span in Bd. B

Start Frequency	9.488 MHz
Stop Frequency	14.488 MHz
Bandwidth	
RBW	10 kHz
Stepsize*	
50% of RBW	5.0 kHz
Frequency Span	5.00 MHz
Calculated Number of Steps resp. Calculated Number of Frequency Points	1000
Measurement Time per Step	20 ms
Total Observation Time =[MT per step] * [calc. Number of steps]	20 s

A focus on a smaller frequency range has been decided by the user to achieve a better visualization.

Single Sweep vs.Spectrum Envelope

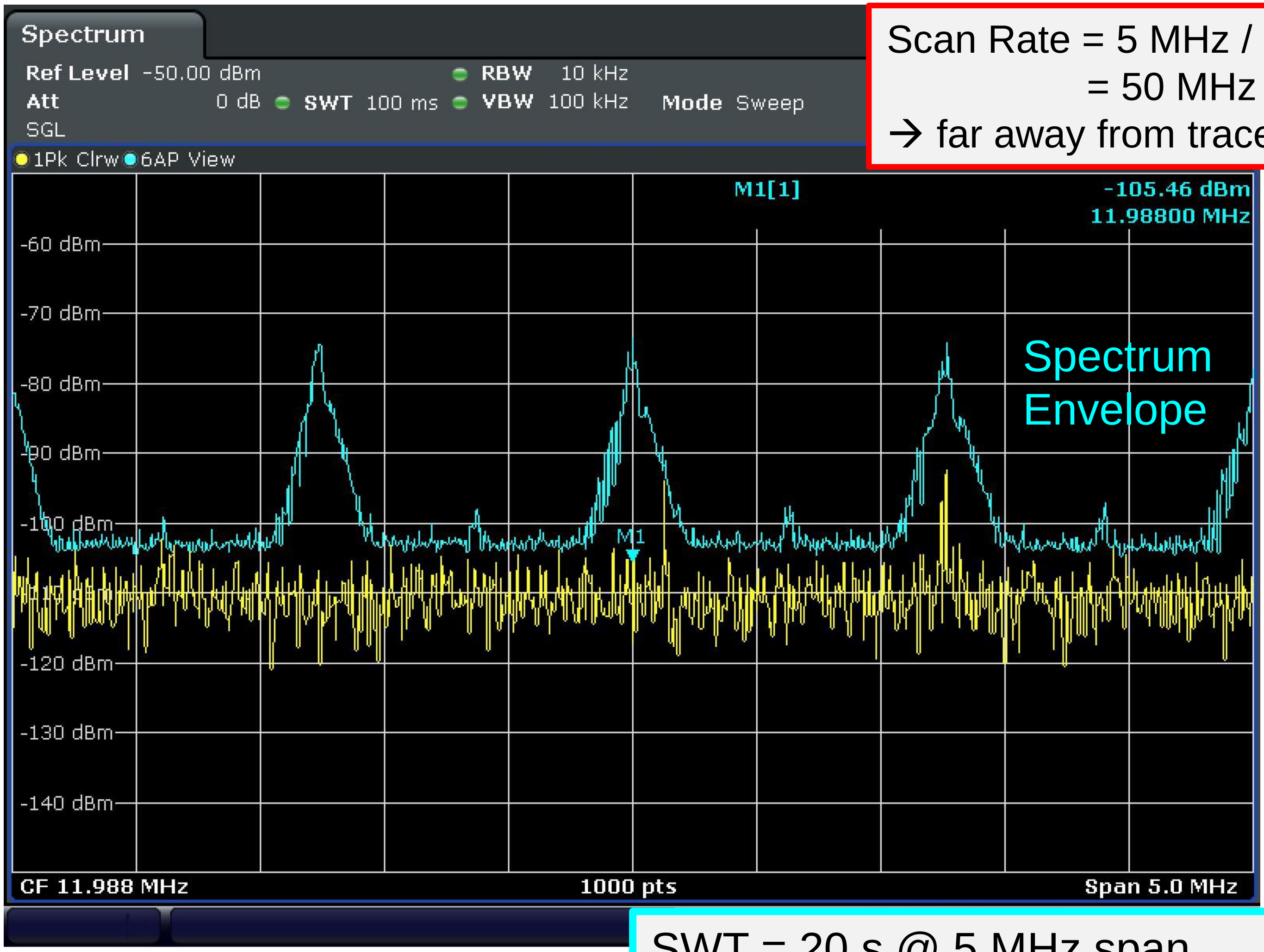


Scan Rate = 5 MHz / 10 ms
= 500 MHz / s
→ far away from trace match.

@ SGL: Single Sweep. Sweep Time SWT = Total Observation Time

SWT = 20 s @ 5 MHz span
(swept) scan rate = 0.25 MHz/s
corresponding to the EUT timing analysis
in accordance with CISPR 16-2-x.

Single Sweep vs.Spectrum Envelope



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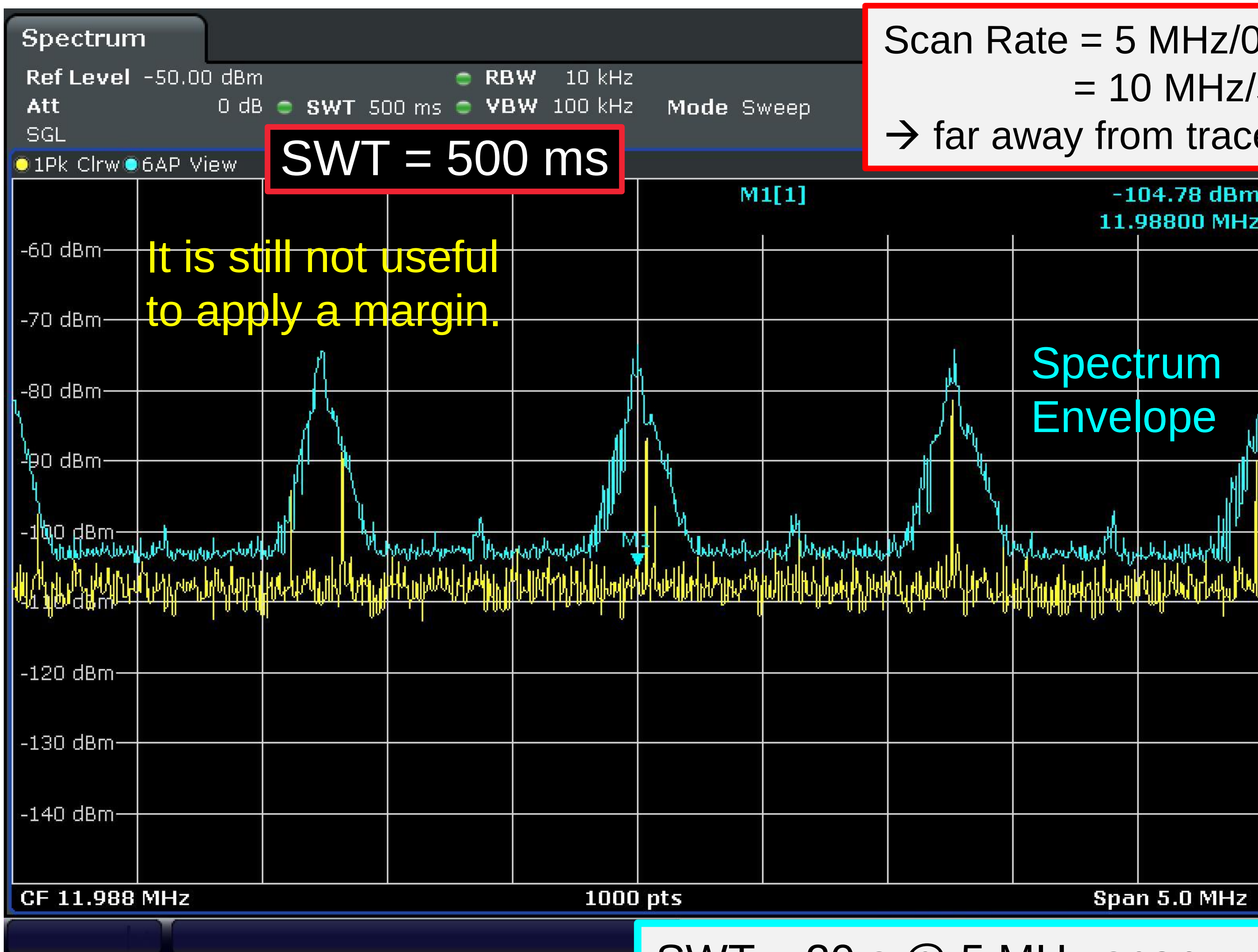
Scan Rate = 5 MHz / 100 ms
= 50 MHz / s
→ far away from trace match.

SWT = 20 s @ 5 MHz span
(swept) scan rate = 0.25 MHz/s
corresponding to the EUT timing analysis
in accordance with CISPR 16-2-x.

Single Sweep vs.Spectrum Envelope



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Scan Rate = 5 MHz/0.5 s
= 10 MHz/s
→ far away from trace match.

SWT = 20 s @ 5 MHz span
(swept) scan rate = 0.25 MHz/s
corresponding to the EUT timing analysis
in accordance with CISPR 16-2-x.

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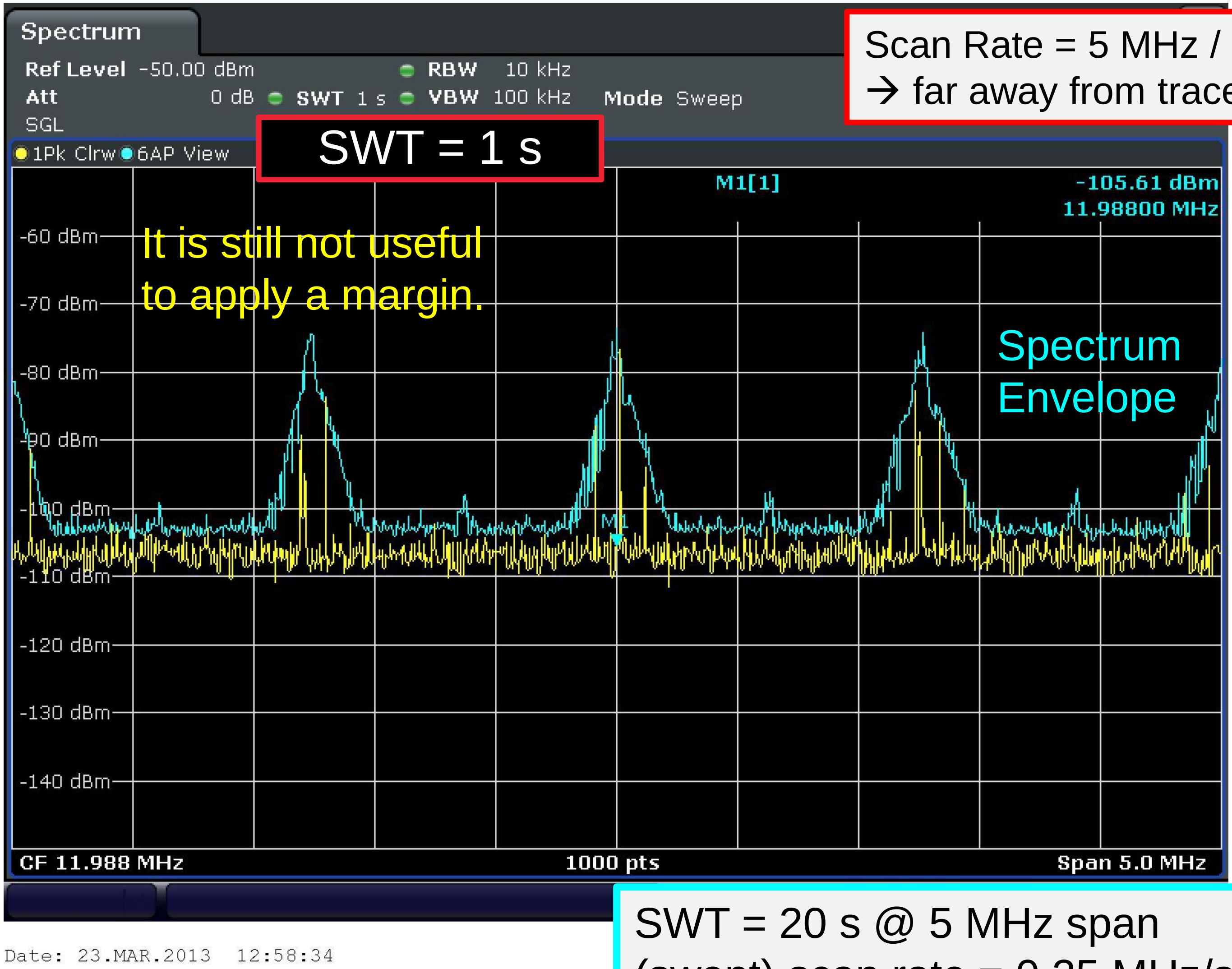
Single Sweep vs.Spectrum Envelope



Scan Rate = 5 MHz / s
→ far away from trace match.

SWT = 20 s @ 5 MHz span
(swept) scan rate = 0.25 MHz/s
corresponding to the EUT timing analysis
in accordance with CISPR 16-2-x.

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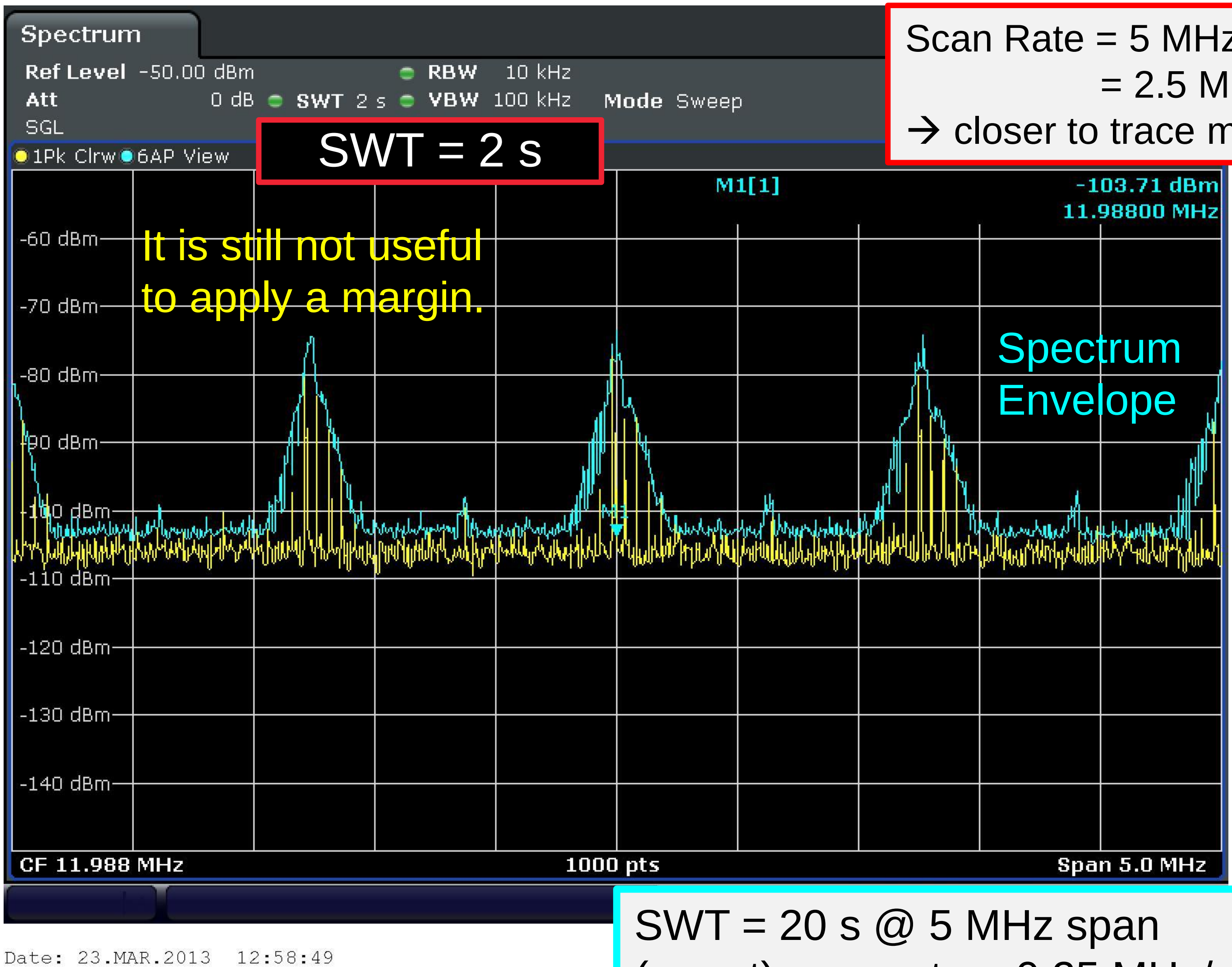
Single Sweep vs.Spectrum Envelope

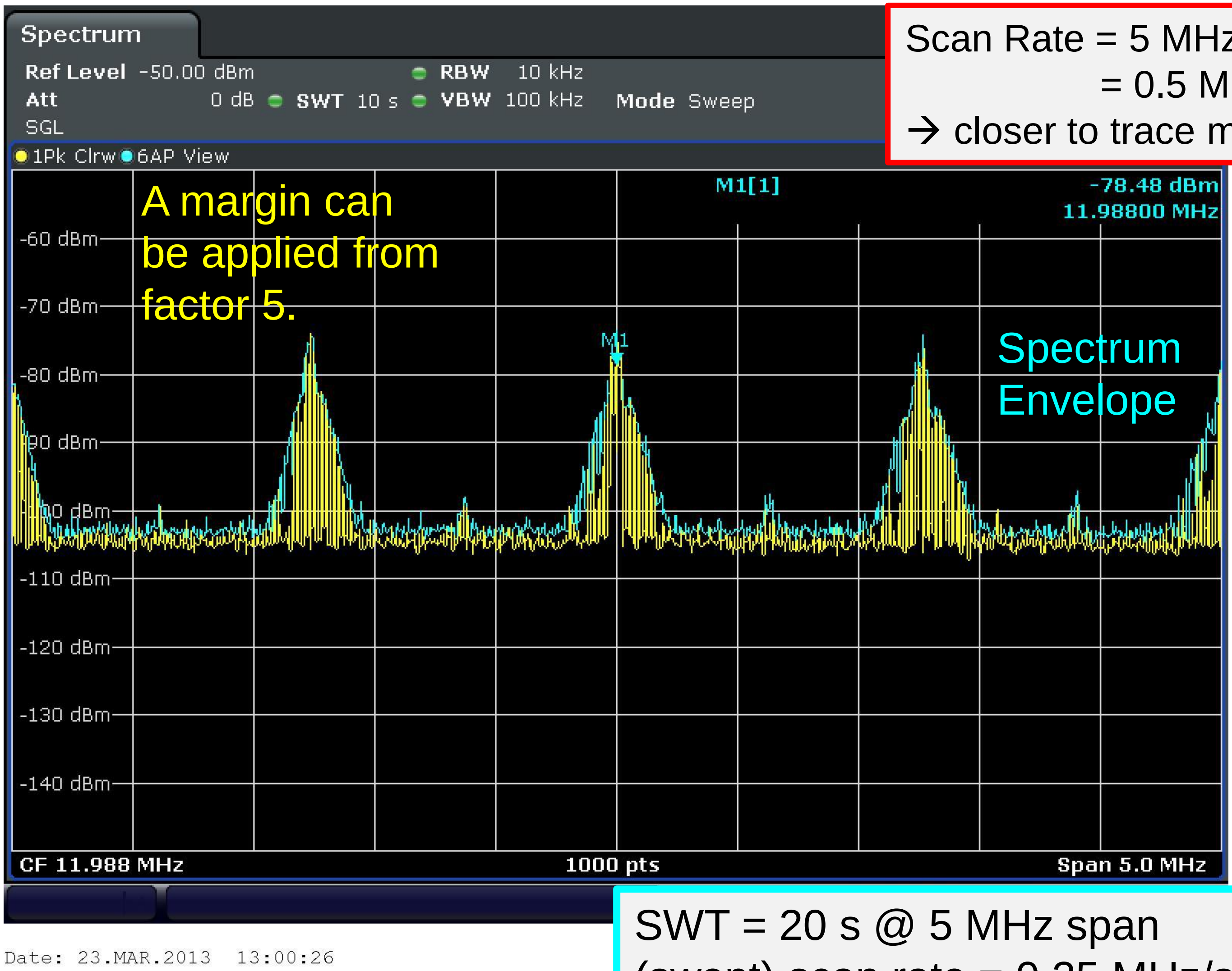


Scan Rate = 5 MHz / 2 s
= 2.5 MHz / s
→ closer to trace match.

SWT = 20 s @ 5 MHz span
(swept) scan rate = 0.25 MHz/s
corresponding to the EUT timing analysis
in accordance with CISPR 16-2-x.

ROHDE&SCHWARZ

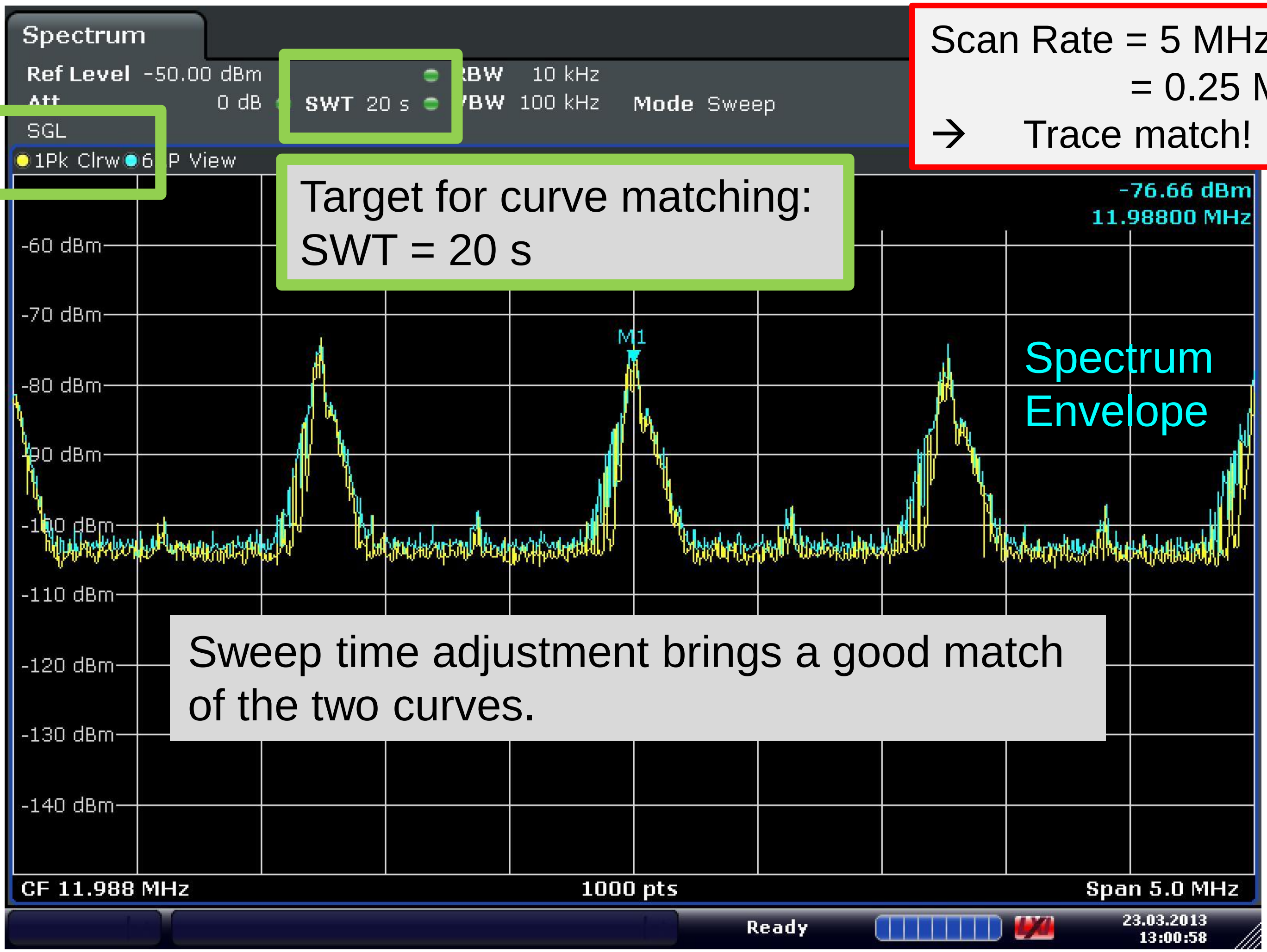
Single Sweep vs.Spectrum Envelope



Scan Rate = 5 MHz / 10 s
= 0.5 MHz / s
→ closer to trace match.

SWT = 20 s @ 5 MHz span
(swept) scan rate = 0.25 MHz/s
corresponding to the EUT timing analysis
in accordance with CISPR 16-2-x.

Single Sweep vs.Spectrum Envelope



Scan Rate = 5 MHz / 20 s
= 0.25 MHz / s
→ Trace match!

Target for curve matching:
SWT = 20 s

Sweep time adjustment brings a good match of the two curves.

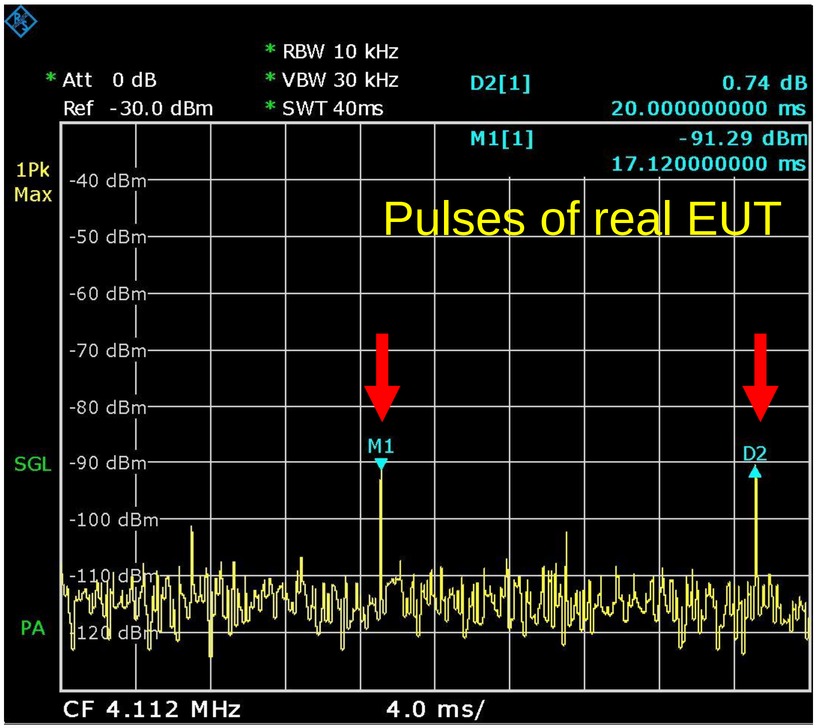
Date: 23.MAR.2013 13:00:58

EUT Timing Analysis to increase Repeatability

- The EUT Timing Analysis helps to find the correct measurement time per frequency
- Fast sweeps without understanding the pulse interferer characteristic of the EUT just result in “lucky shots“.
- The measurement reliability is shrinking with fast sweeps / scans applied to unknown EUT. Critical frequency points can be missed.
- Subranges might be represented not at all or with values that are far below the actual interferer subrange maximum

Pulse Generators

help to prove CISPR 16-2-x Strategy to find the correct Observation Time



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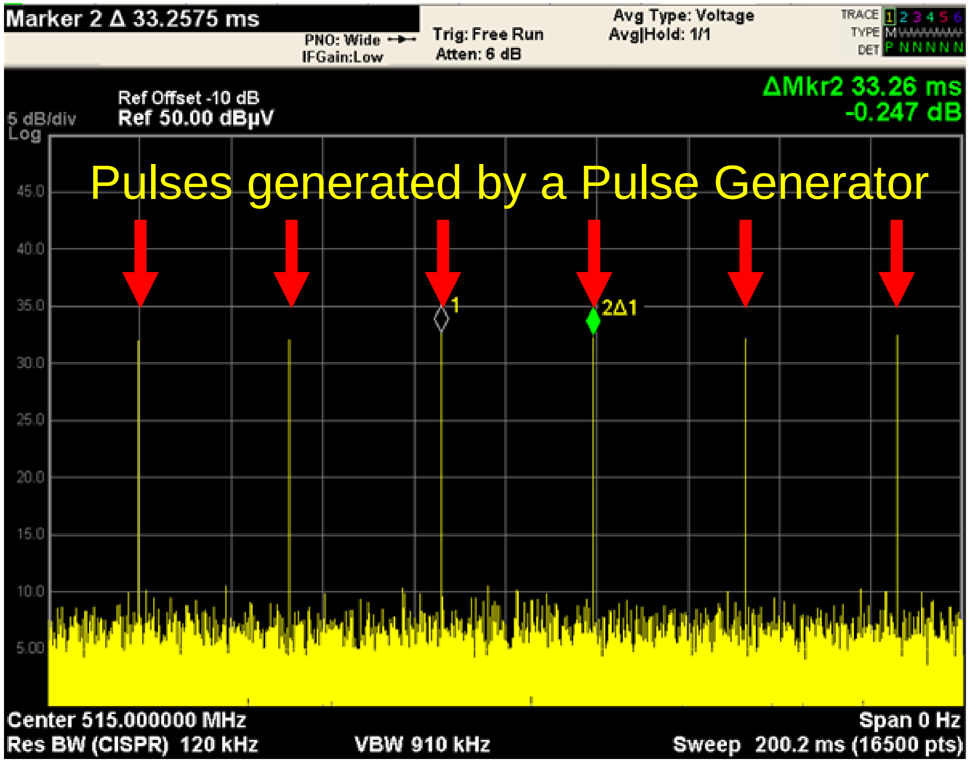
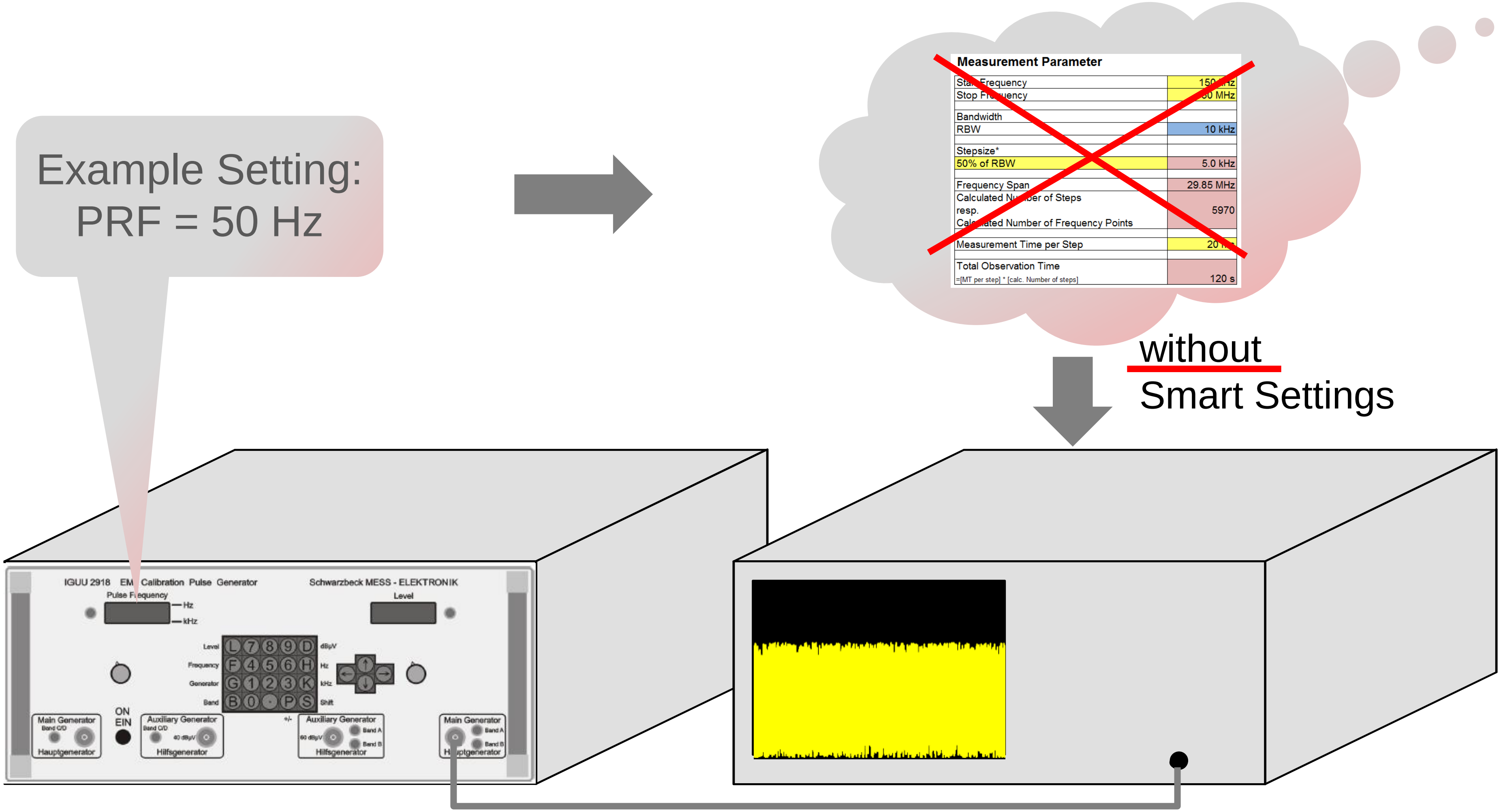


Instrument settings: spectrum analyzer in ZERO SPAN mode
The signals are analyzed in the time domain.

Pulse Generators

help to prove CISPR 16-2-x Strategy to find the correct Observation Time



Pulse Generators

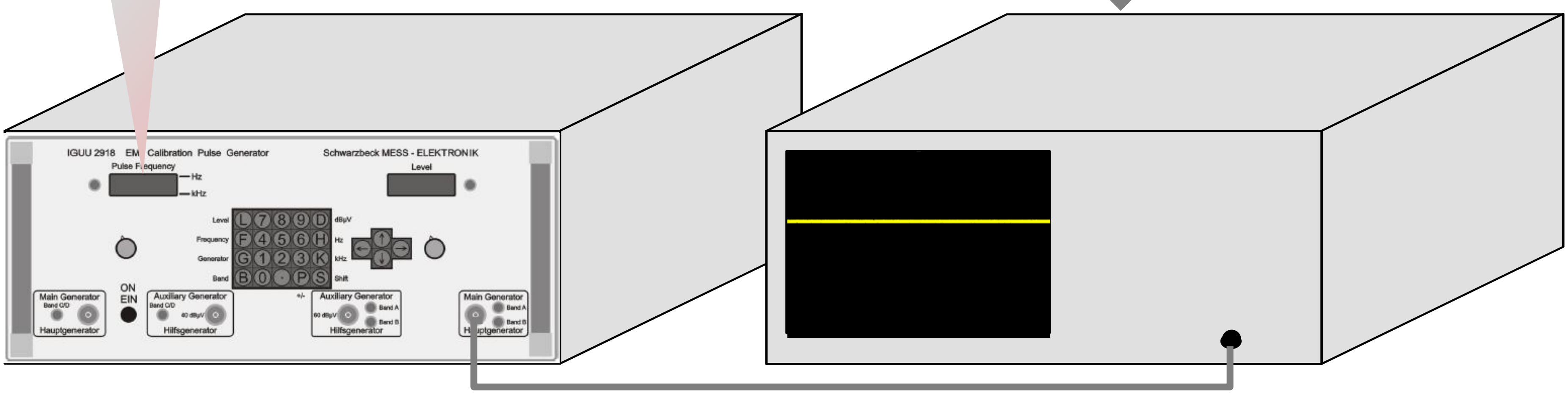
help to prove CISPR 16-2-x Strategy to find the correct Observation Time

Example Setting:
PRF = 50 Hz

Measurement Parameter

Start Frequency	150 kHz
Stop Frequency	30 MHz
Bandwidth	
RBW	10 kHz
Stepsize*	
50% of RBW	5.0 kHz
Frequency Span	29.85 MHz
Calculated Number of Steps resp. Calculated Number of Frequency Points	5970
Measurement Time per Step	20 ms
Total Observation Time =[MT per step] * [calc. Number of steps]	120 s

with
Smart Settings



Pulse Generators

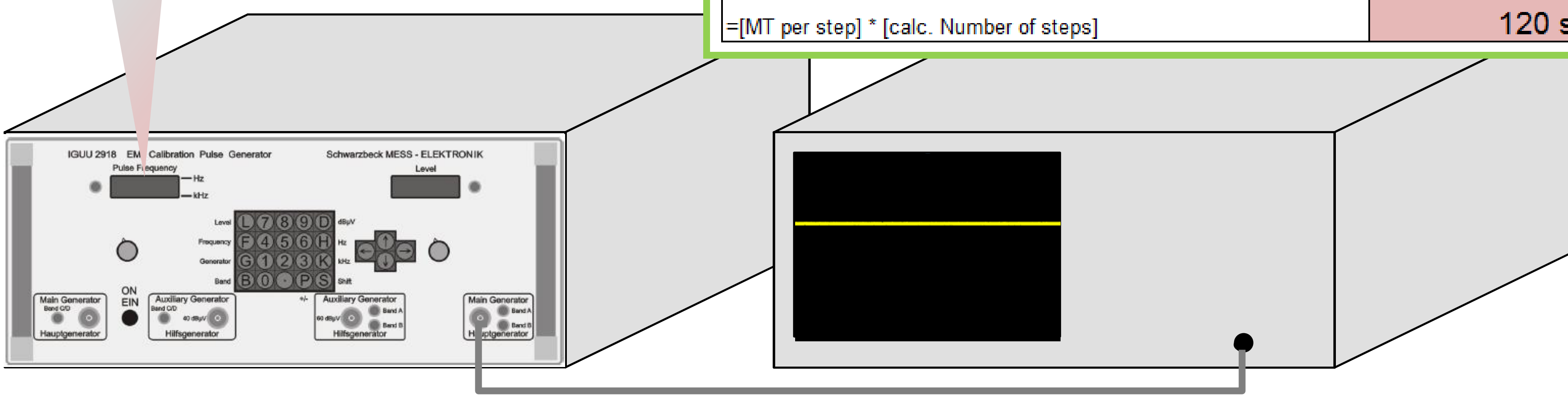
By means of classic technology long observation times have to be accepted to avoid gaps in the spectrum envelope.

Example Setting:
PRF = 50 Hz

MT = 1/PRF

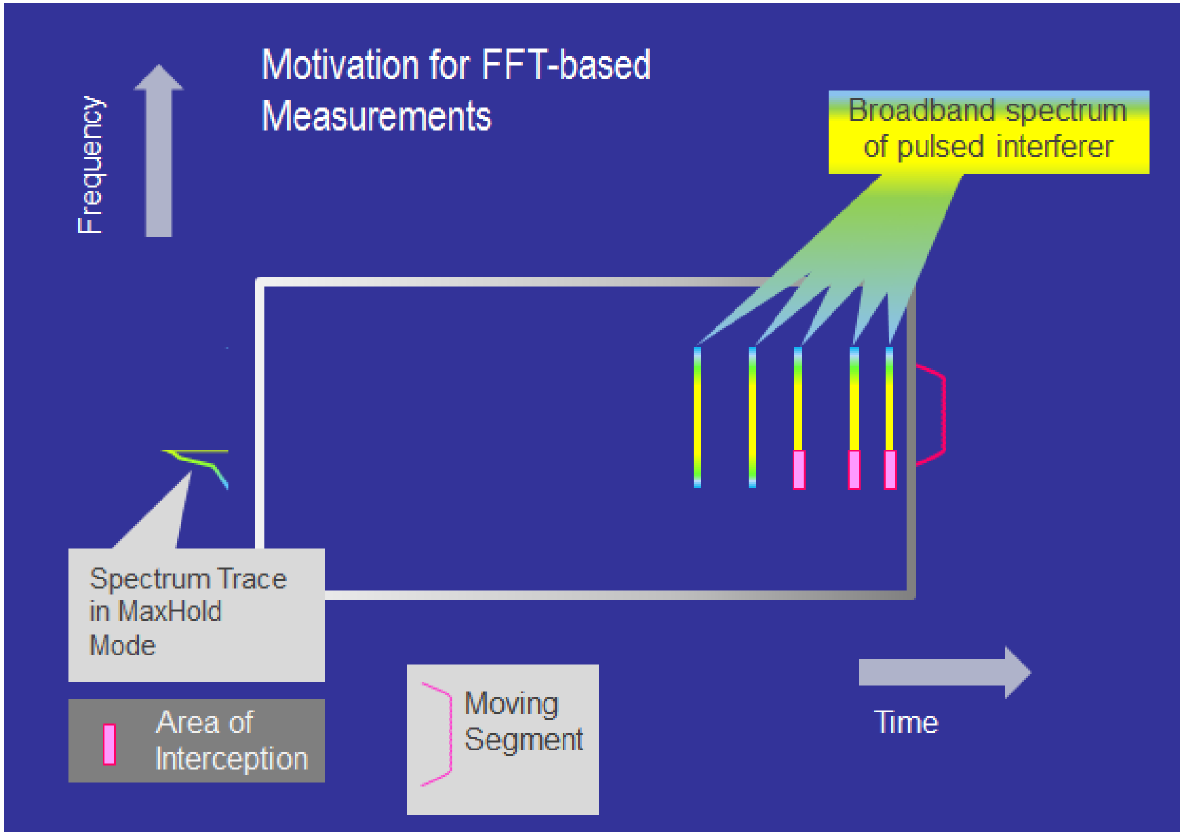
Measurement Parameter

Start Frequency	150 kHz
Stop Frequency	30 MHz
Bandwidth	
RBW	10 kHz
Stepsize*	
50% of RBW	5.0 kHz
Frequency Span	29.85 MHz
Calculated Number of Steps resp. Calculated Number of Frequency Points	5970
Measurement Time per Step	20 ms
Total Observation Time =[MT per step] * [calc. Number of steps]	120 s

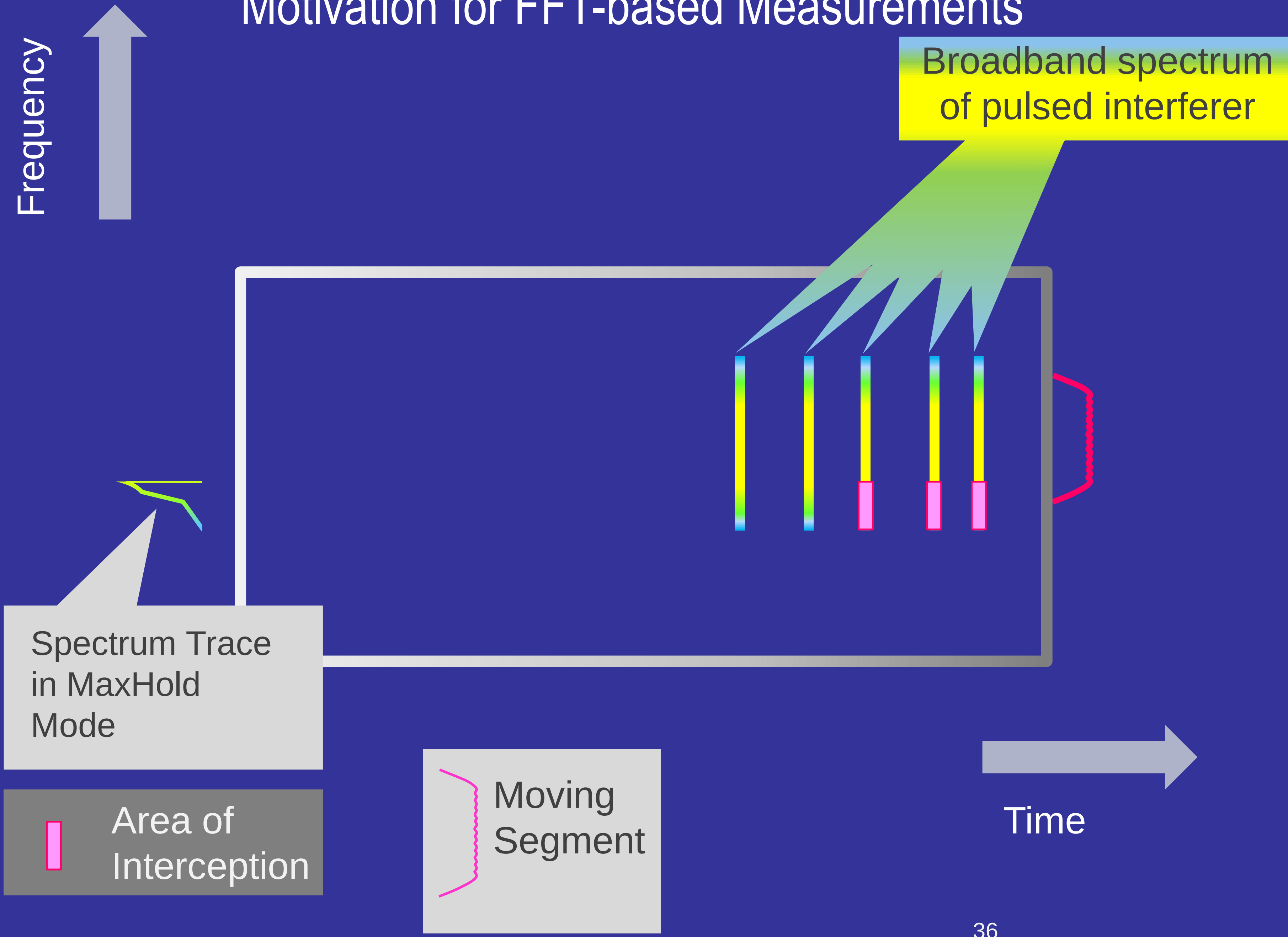


Motivation for FFT-based Measurements

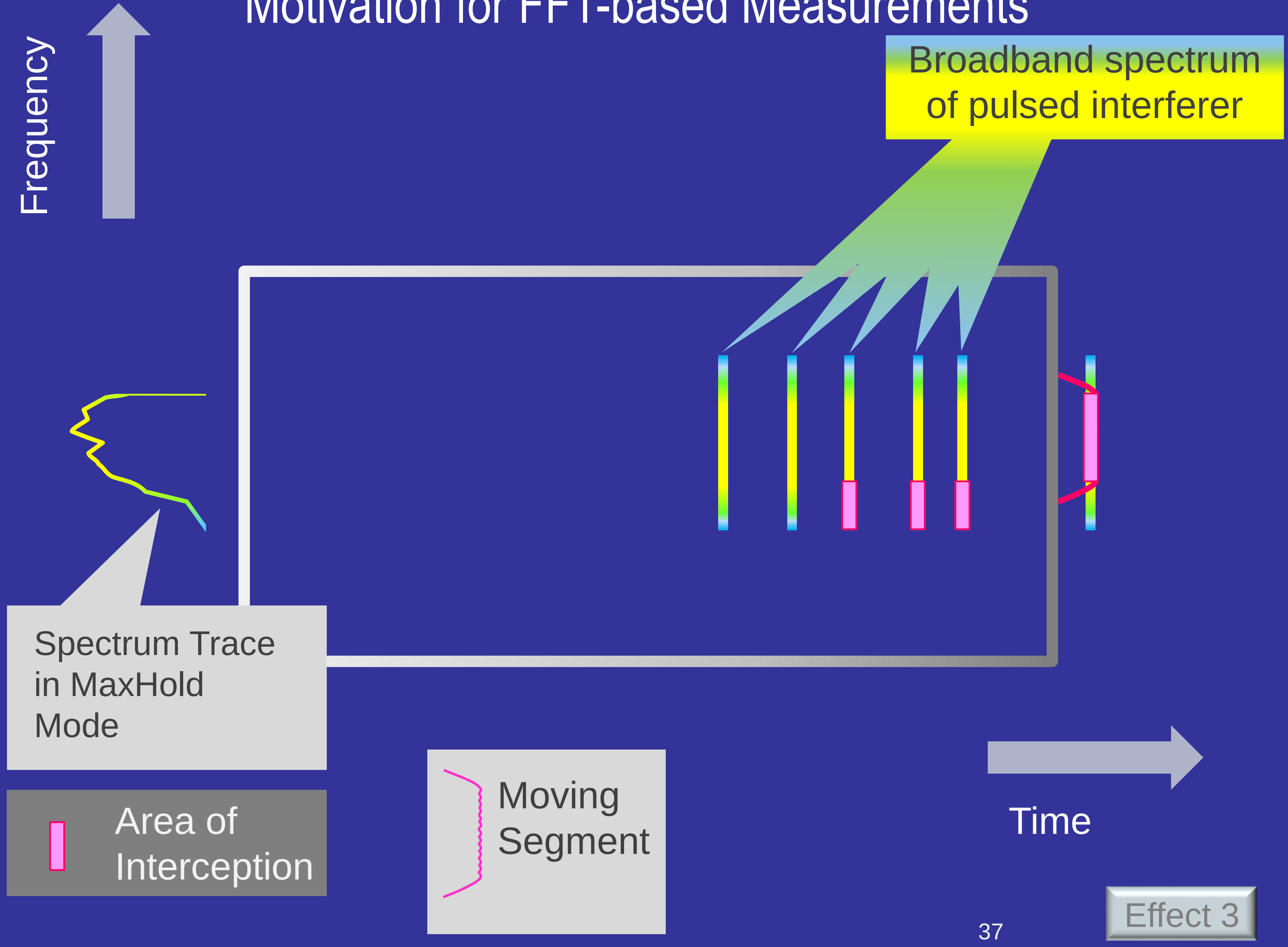
- Request for shorter oberservation times
- The interceptions will change from interception points to interception areas



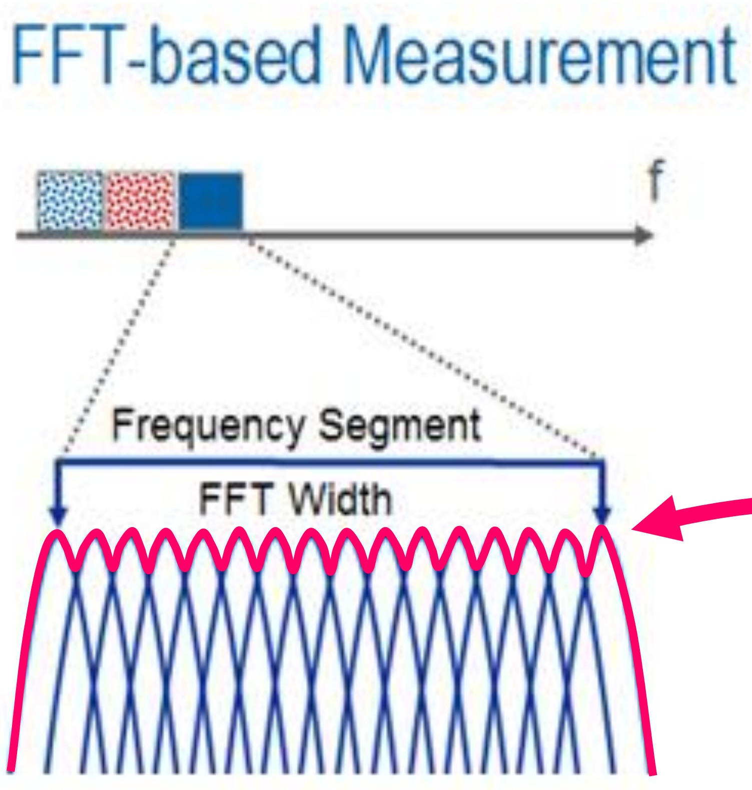
Motivation for FFT-based Measurements

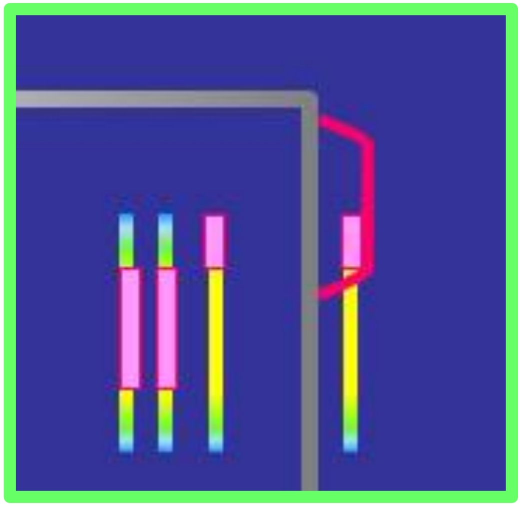


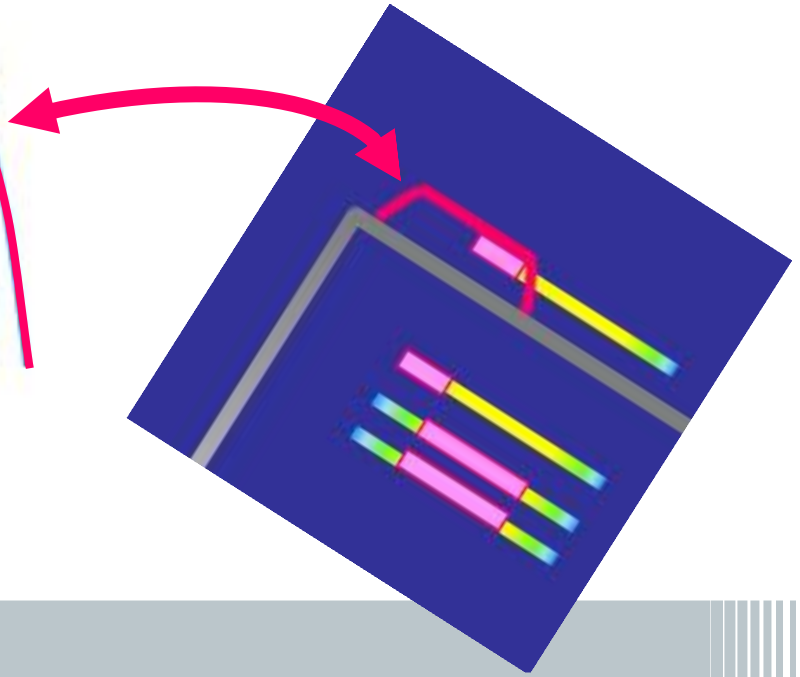
Motivation for FFT-based Measurements



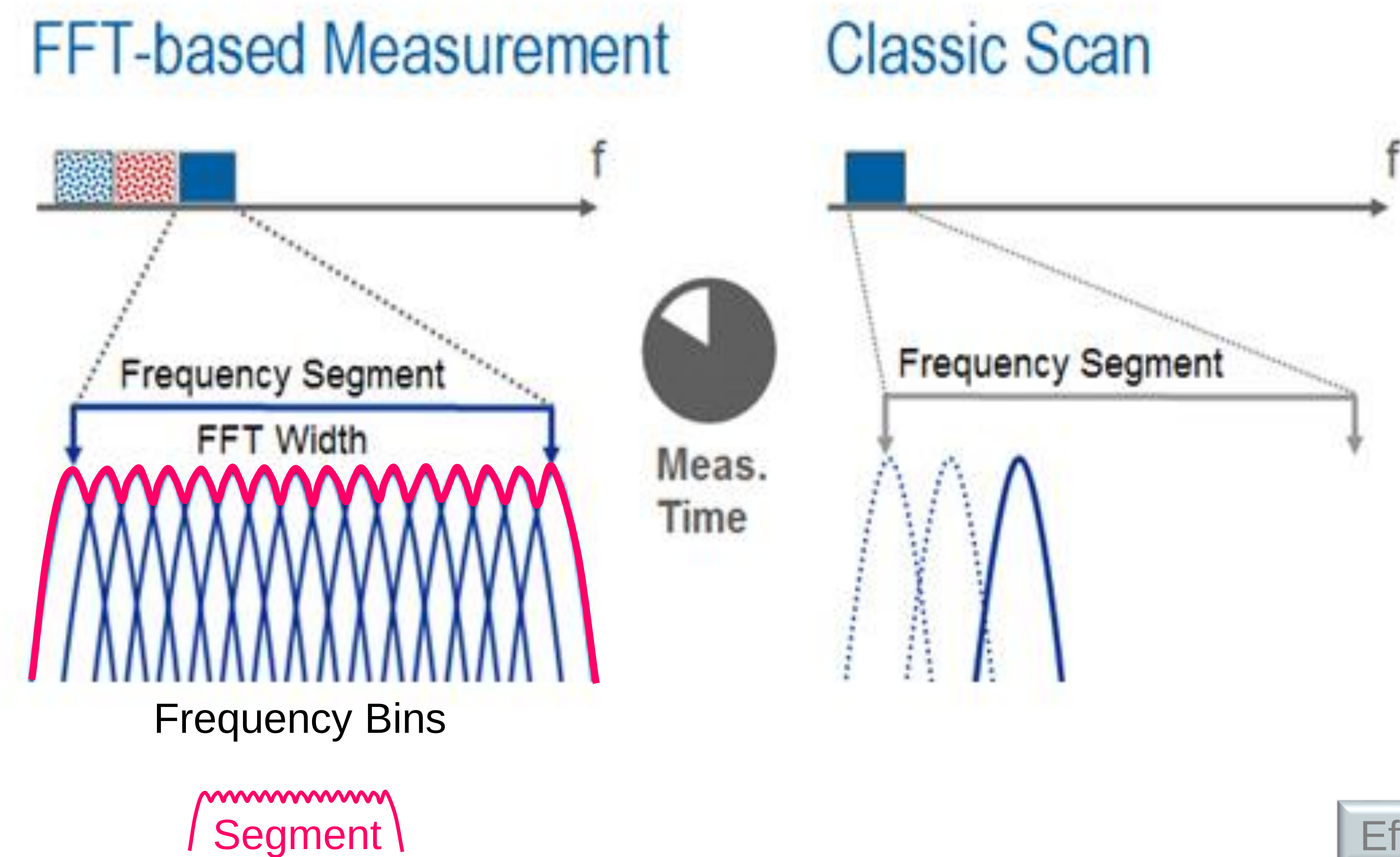
Motivation for FFT-based Measurements







Motivation for FFT-based Measurements



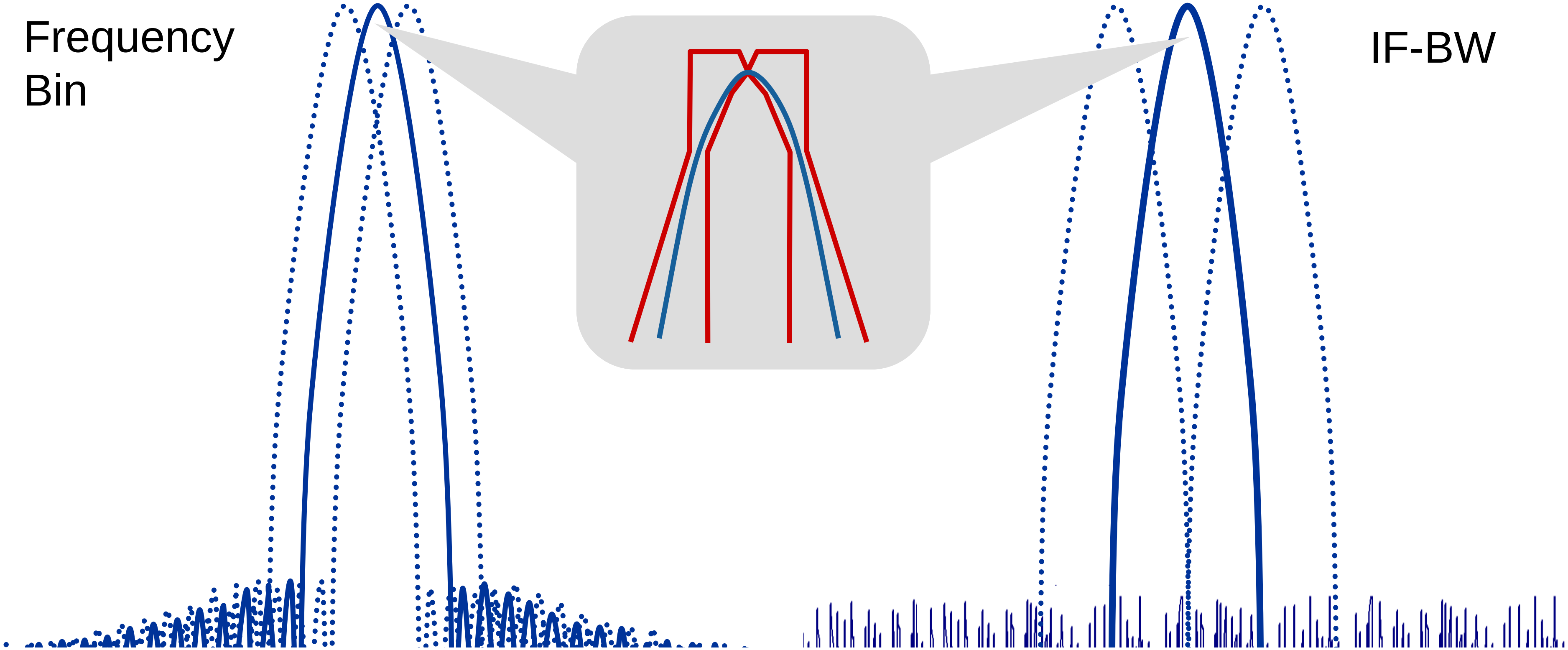
Effect 4

Accuracy Requirement for Frequency Bins

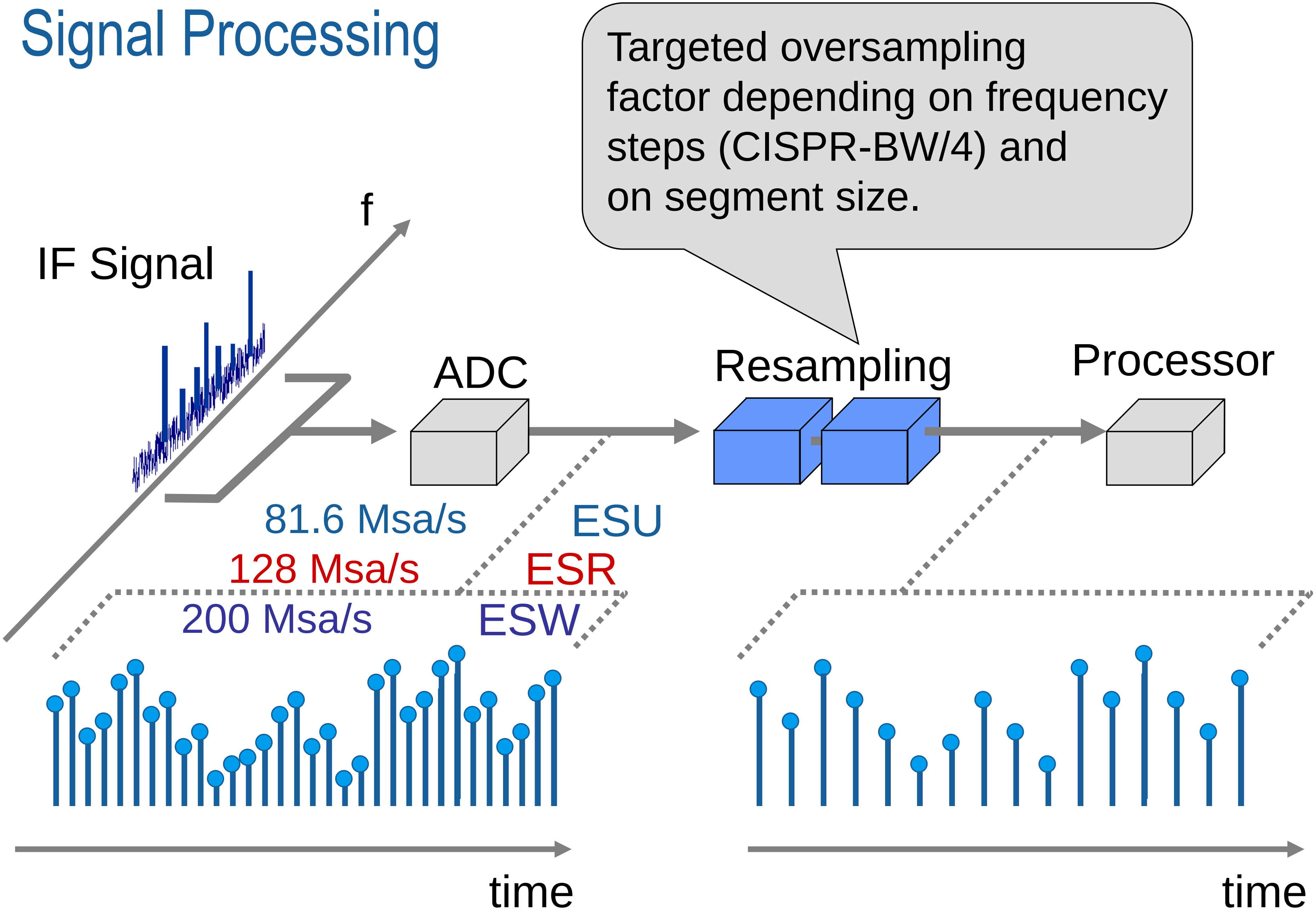
FFT-based measurement

IF Selectivity must fit in CISPR 16-1-1 tolerance mask.

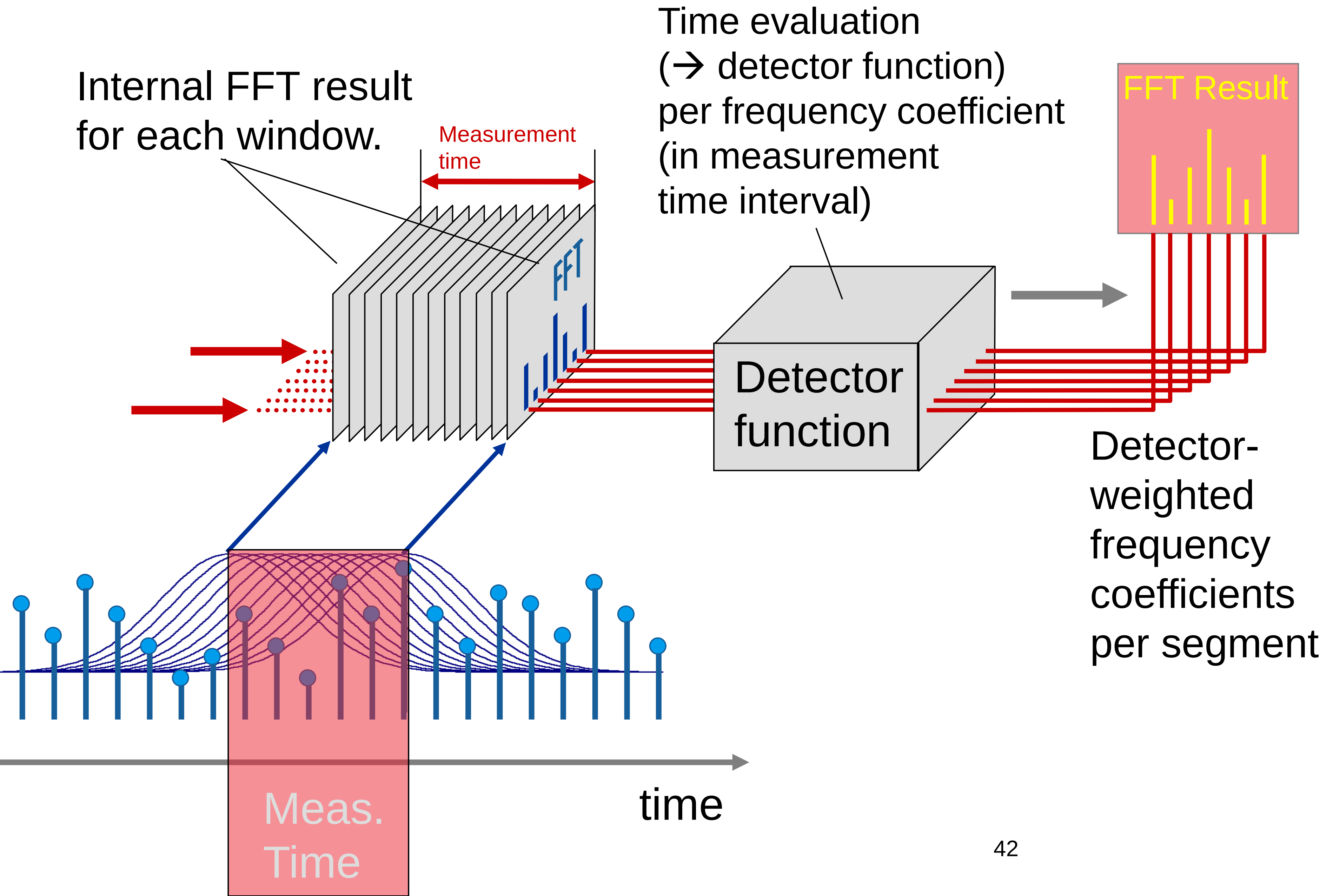
Classic scan (stepped scan)



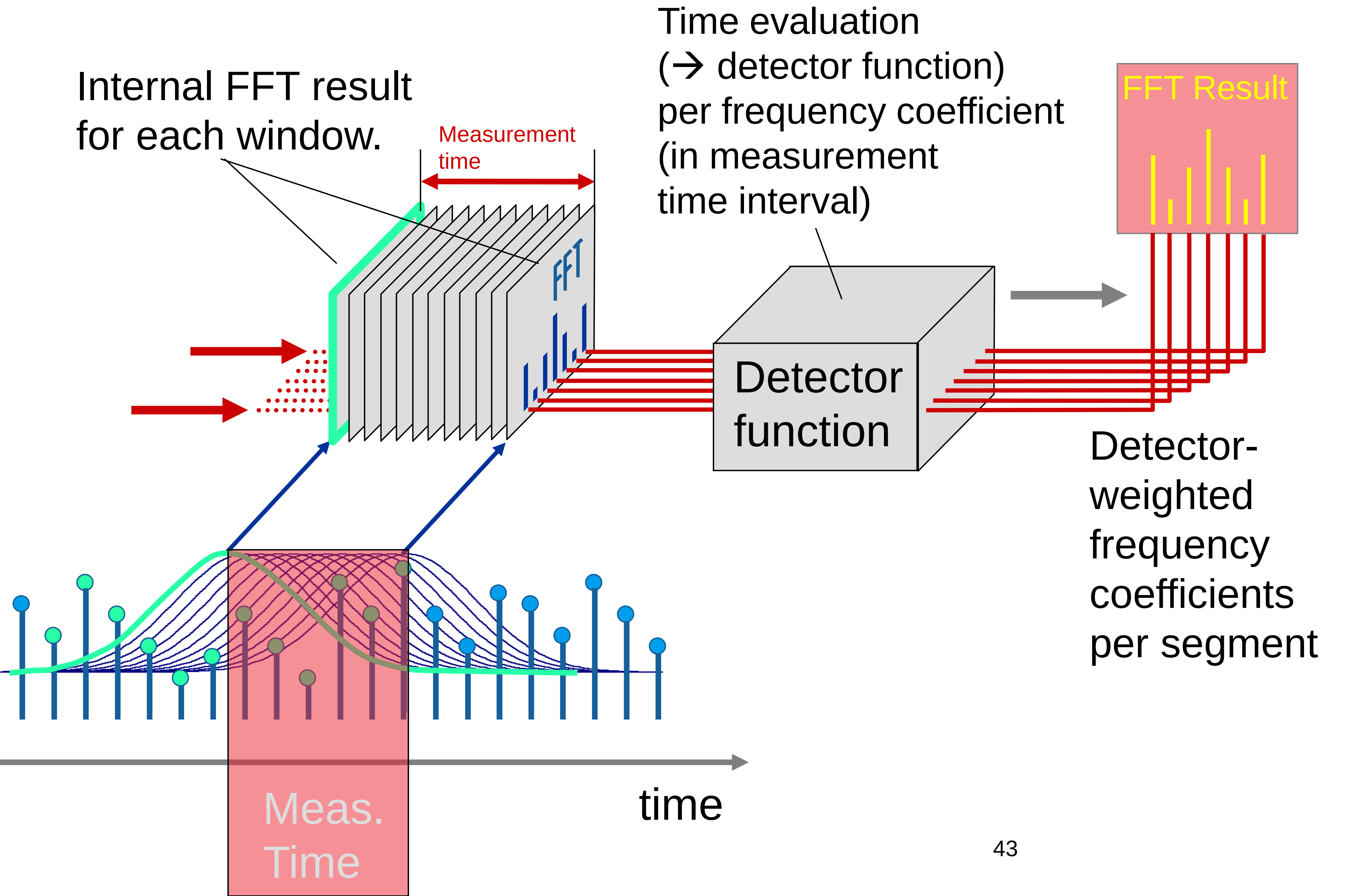
Signal Processing



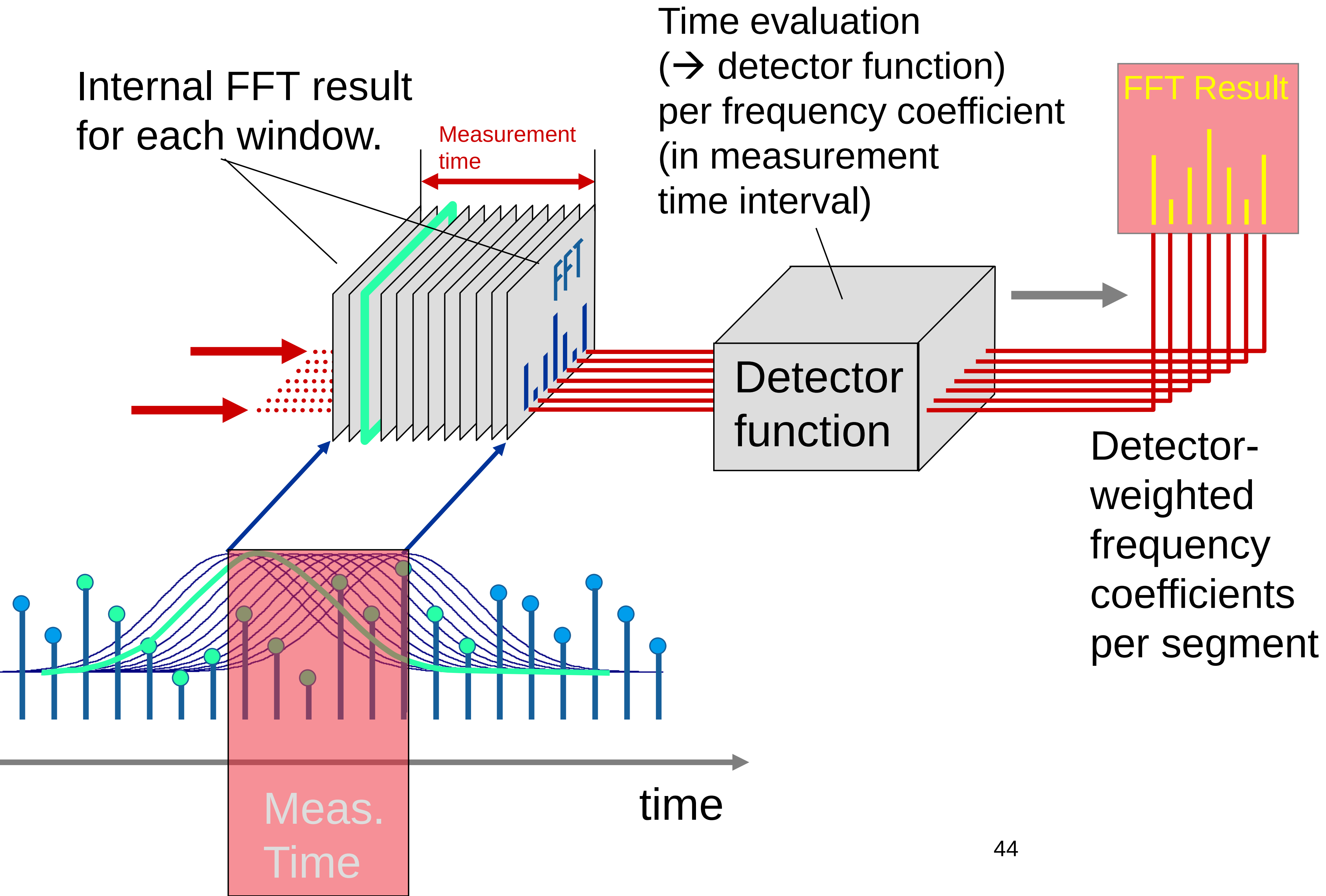
Signal Processing



Signal Processing

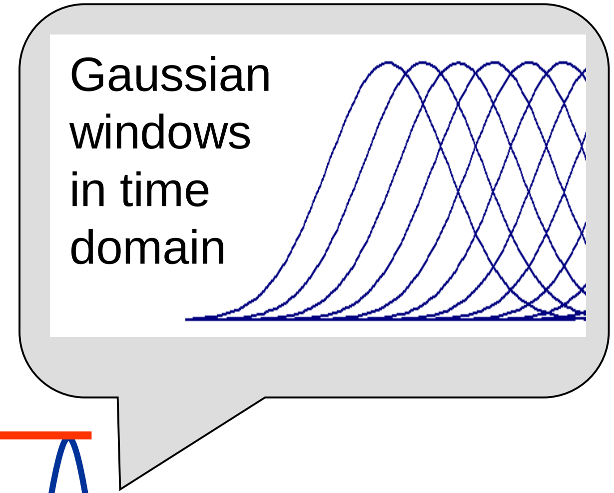


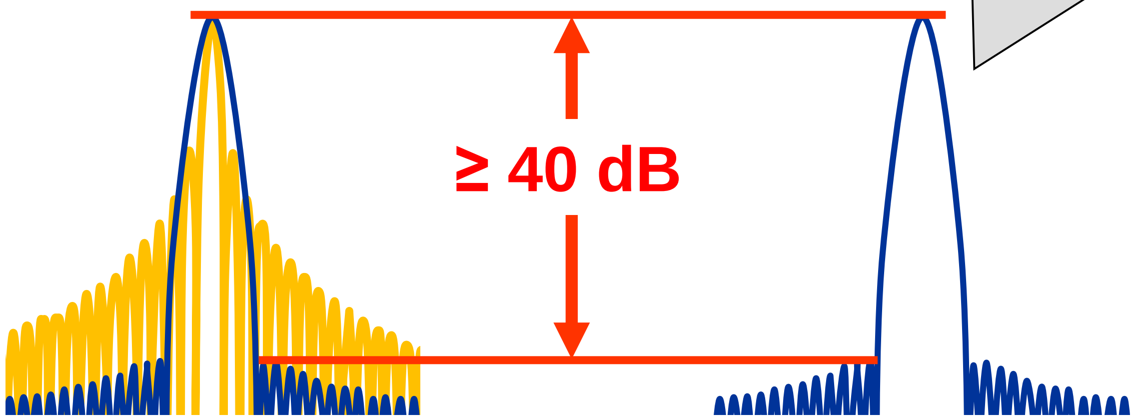
Signal Processing

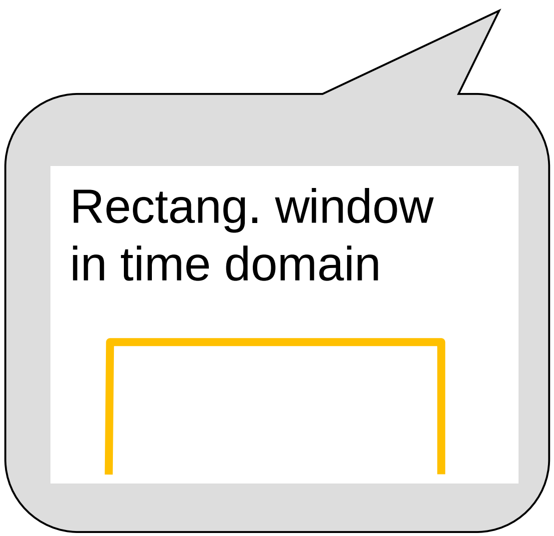


Selectivity of Frequency Bin

- CISPR16-3:
  Distance to 1st side lobe
  Must be ≥ 40 dB







CISPR16-2 all parts – Analysis Steps

manual

Timing Analysis of EUT
to find Measurement Time

Very often omitted!

↓

Preview / Pre-scan
(automated / semi-automated)

↓

Data Reduction / Critical Frequencies

↓

Final
(automated / semi-automated)

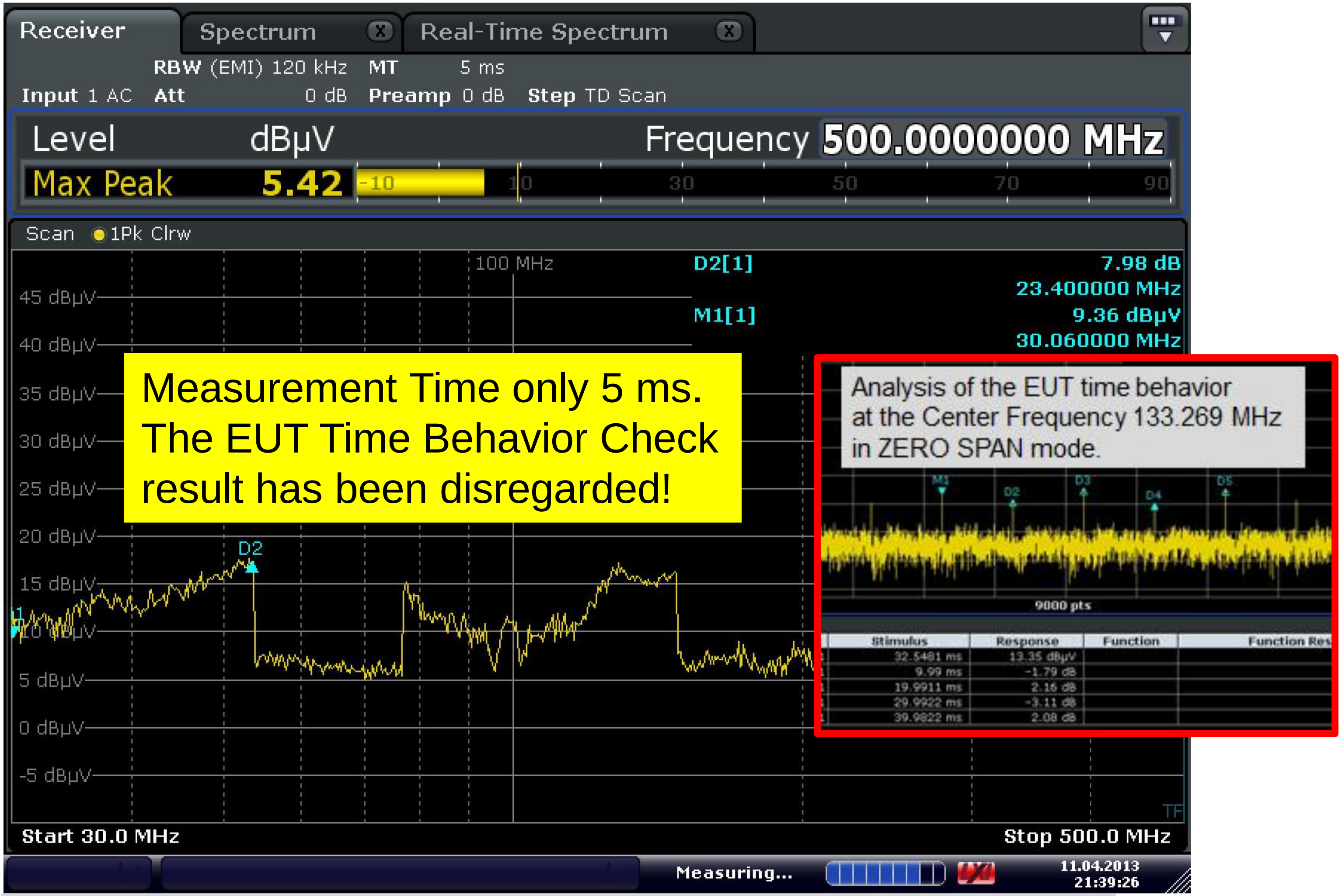
Too short Measurement Time → Lack of Intercept

TV Set near power connector; transducer nearfield probe

Too short Measurement Time → Lack of Intercept

TV Set near power connector; transducer nearfield probe

Too short Measurement Time → Lack of Intercept



TV Set near power connector; transducer nearfield probe

CISPR16-2 all parts – Analysis Steps

manual

Timing Analysis of EUT
to find Measurement Time

Done!

↓

Preview / Pre-scan
(automated / semi-automated)

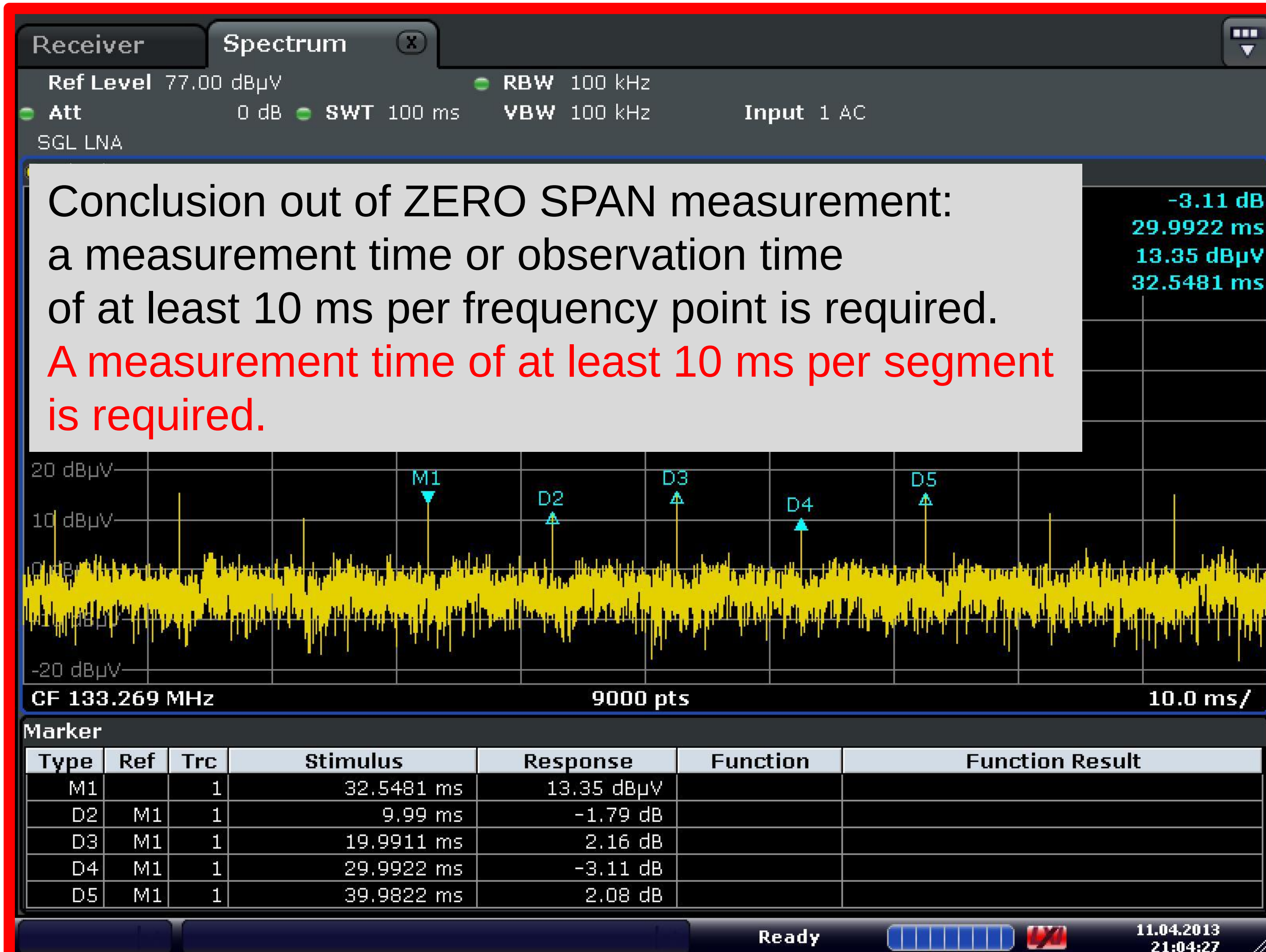
↓

Data Reduction / Critical Frequencies

↓

Final
(automated / semi-automated)

Too short Measurement Time → Lack of Intercept



Type	Ref	Trc	Stimulus	Response	Function	Function Result
M1		1	32.5481 ms	13.35 dBµV		
D2	M1	1	9.99 ms	-1.79 dB		
D3	M1	1	19.9911 ms	2.16 dB		
D4	M1	1	29.9922 ms	-3.11 dB		
D5	M1	1	39.9822 ms	2.08 dB		

Conclusion out of ZERO SPAN measurement:
a measurement time or observation time
of at least 10 ms per frequency point is required.
A measurement time of at least 10 ms per segment is required.

TV Set near power connector; transducer nearfield probe

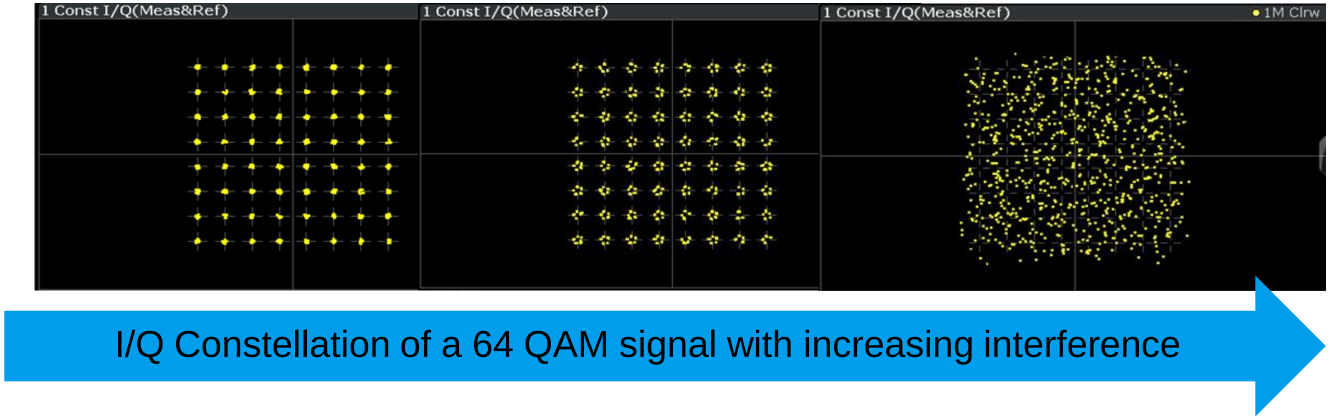
Sufficient Measurement Time → Intercept OK

TV Set near power connector; transducer H-nearfield probe

Why RSE become really important measurements

Motivation: getting less EM pollution in the air

- Spurious (interferers) decrease systems performance
- This is the only way to get efficient cohexistence between systems which use same frequencies list shared in time



EMI and RSE differences regarding measurements

ERP: **Effective radiated power**

- The measured quantity to be evaluated is
  not the electric field radiated but the **effective radiated power**
  not at the location of the measurement antenna but from the EUT.

Therefore, the

level in **dBµV** measured on the receiver instrument must be converted to **dBm** differently than in standard EMI measurements (dBµV/m)

and the

free space attenuation for a given measurement distance (d) has to be considered.

Consequences : different transducer factors tables

have to be derived for the antenna transducer factor (TF) in antenna properties, which describes the antenna's signal conversion characteristic.

EMI and RSE differences regarding measurements

Range Attenuation (theoretical)

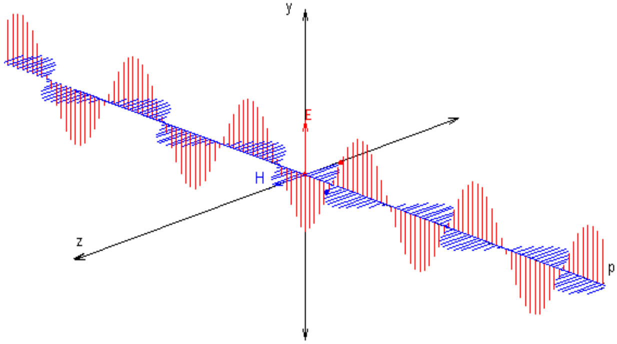
The power effectively radiated from a mobile phone at a certain frequency is given by:

$$P_{eff} = L_{\mathrm{Rec}} - 107 - G_{Ant} + FSA_d \qquad (1)$$

- FSA_d: free space attenuation (FSA) in dB for a given measurement distance d in meters
- G_{Ant}: antenna gain in dBi
- 107 is the conversion factor from dBuV to dBm
- L_{Rec}: level reading on the receiver instrument in dBuV
- P_{eff}: effective radiated power in dBm

Field and Space

Wrong polarisation can make infinite attenuation

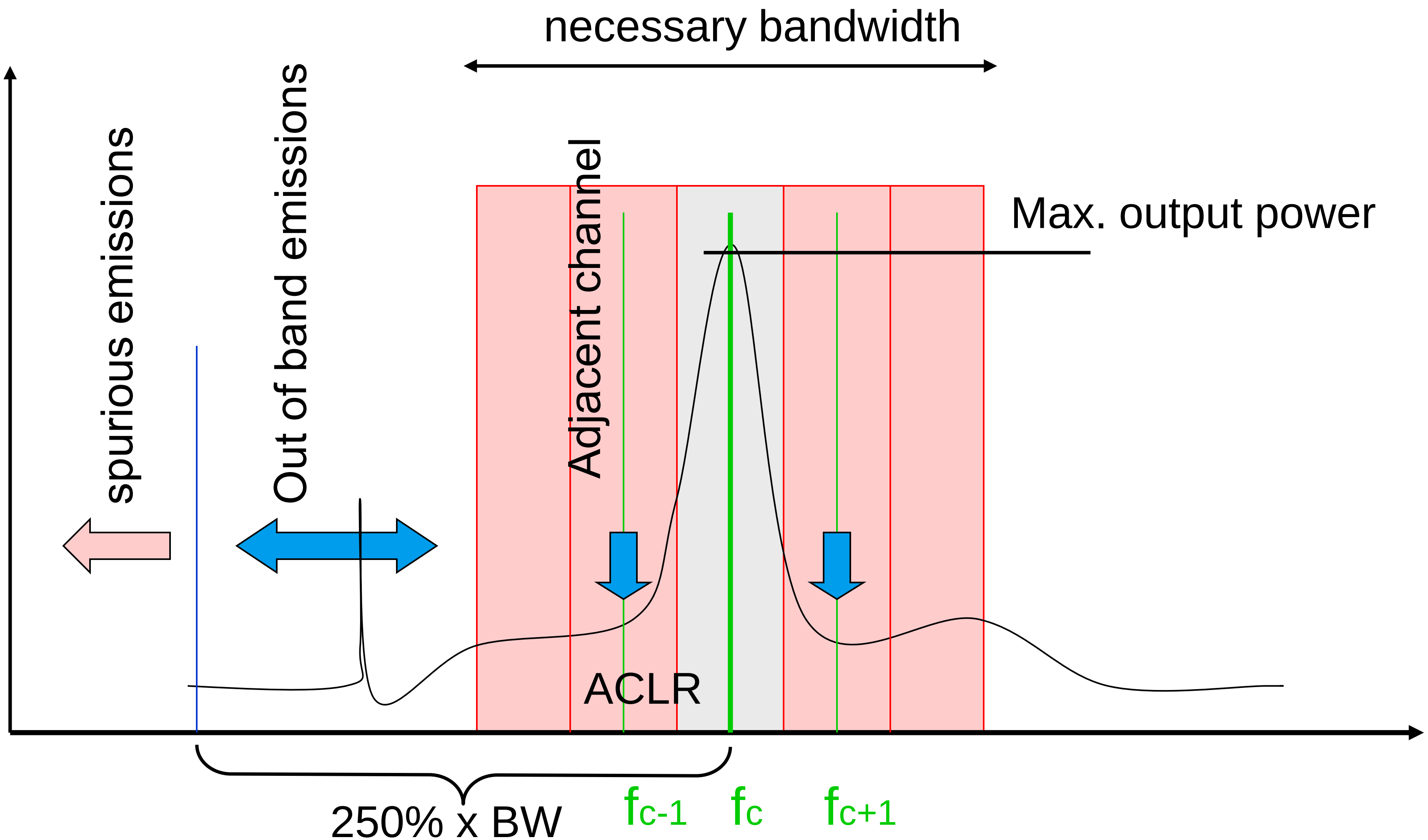


H ou V ???

	↑	→	↻	↺
V ↑	0 dB	∞	3 dB	3 dB
H →	∞	0 dB	3 dB	3 dB
RHC ↻	3 dB	3 dB	0 dB	∞
LHC ↺	3 dB	3 dB	∞	0 dB

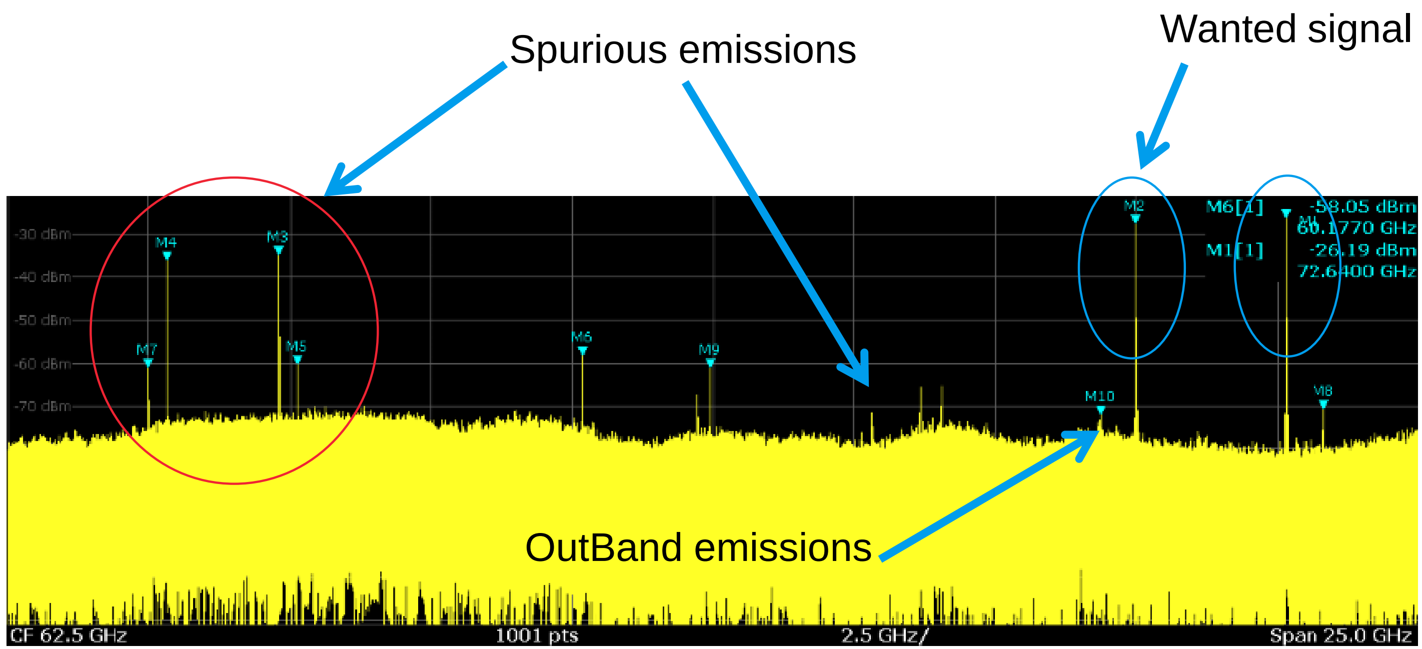
Spurious Emissions ⇔ Emissions Mask functions

CP/ACP >> OutBand >> Spurious



Spurious Emissions ⇔ Emissions Mask functions

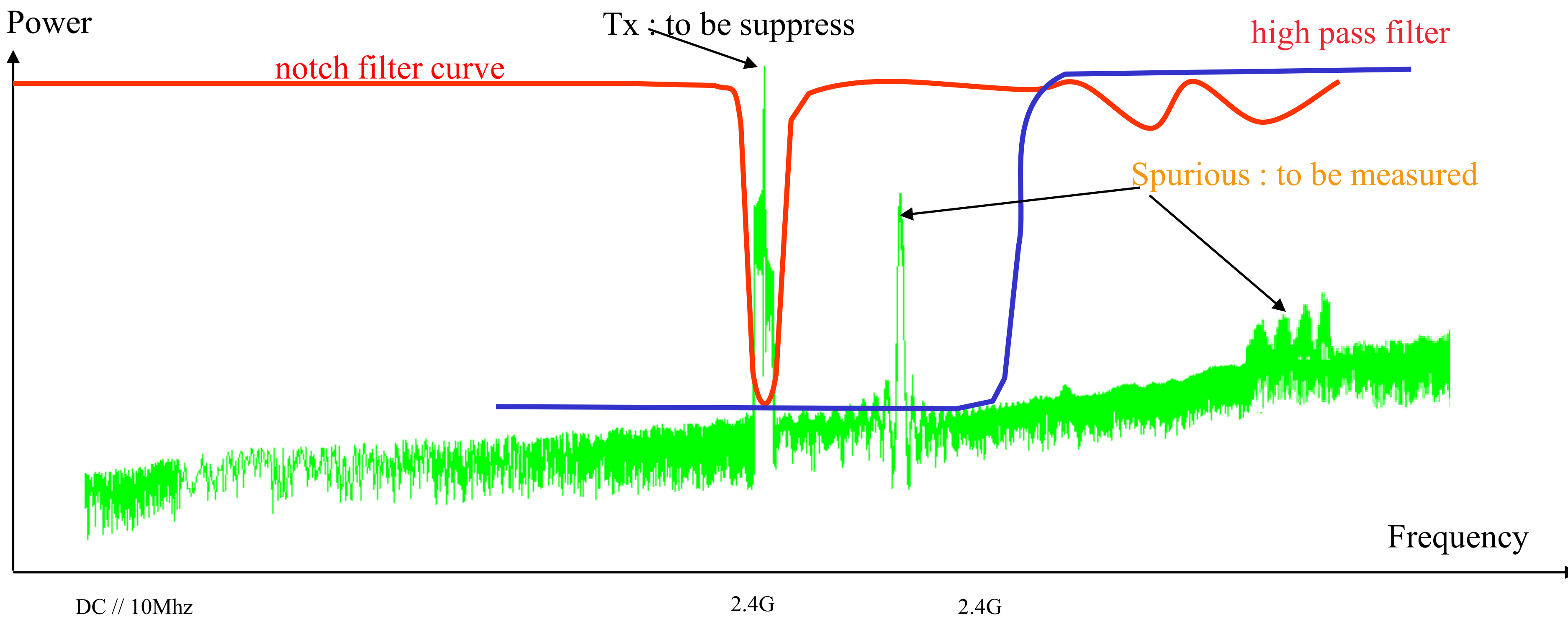
- Unwanted emissions outside the transmitter nominal operation frequency. Exclude the out of band emissions
- Caused by harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products.



Spurious Emissions and RF power consideration

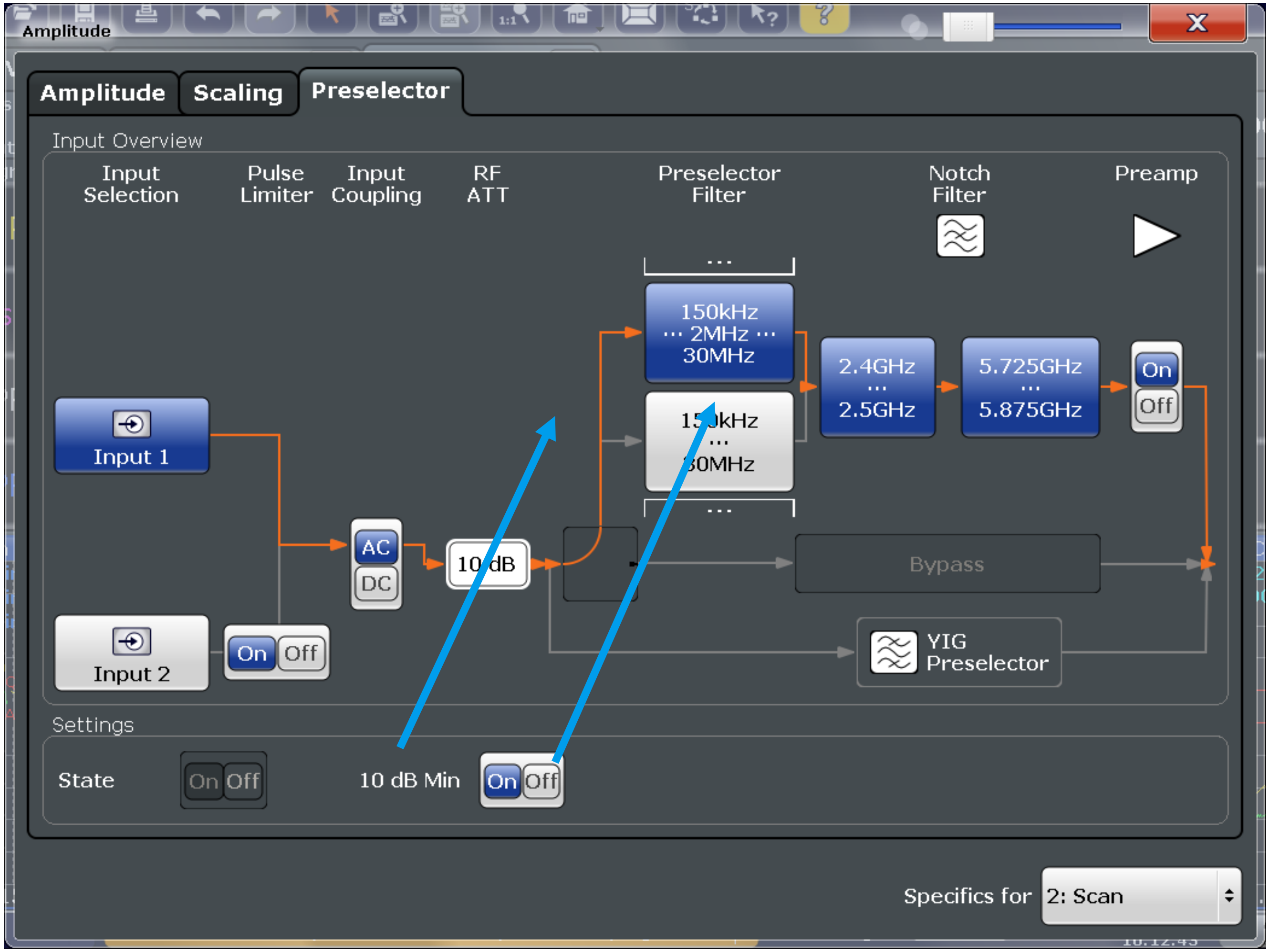
TX power = risk of Overload instrument

- Notch filter to reject the Transmetter Carrier (but BW limited most of time)
- HighPass filter, which can have passband up to 26 or 40 Ghz…
- Last, you can use antenna response to make this filtering



Spurious Emissions on EMI receiver(latest ESW)

- Internal Notch filter (2.4Ghz & 5Ghz) added to classic CISPR Preselector
- Internal PA



Spurious Emissions on Spectrum Analyser

- External Notch filter, if not enough dynamics
- Internal PA if not enough DANL on the SA

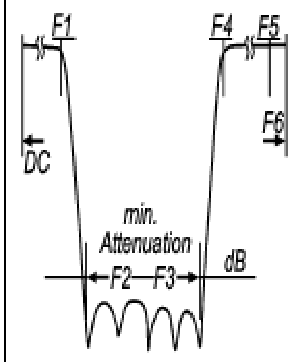
(both need dedicated calibration)

Test Report	Band Reject Filter Cavity Design Total Quantity:	Model Number: WRCJV 2400/2483.5-2350/2535-40/8SS Customer Art. No.:	Serial Number 1

Invoice No.:	Customer:
Shipping Date: 12.06.2009 Method:	
Net Weight: 0.45 kg 0.9 lbs	Order No.:

Specifications:				20/25℃	45℃
Passband Loss max.	F1	2350.00 MHz	1.75 dB	0.70 dB	0.69 dB
at Corners	F4	2535.00 MHz	1.75 dB	0.55 dB	0.56 dB
Insertion Loss max.	DC to F5	DC to 4500 MHz	0.75 dB	0.38 dB	0.38 dB
Reject Attenuation	F2	2400.00 MHz	40.0 dB	54.2 dB	55.0 dB
min.	F2 to F3	2400.0 to 2483.5 MHz	40.0 dB	50.2 dB	47.1 dB
	F3	2483.50 MHz	40.0 dB	52.7 dB	52.8 dB
Return Loss (50Ω)			14.0 dB	17.0 dB	16.9 dB
Operating Temp.	+ 15° C to + 40℃			Cycling ok: CF	Torque ok: CF
Connectors	SMA-female			Test by: CF	Date: 04.06.9
Dimensions	43 mm high			Quality Control passed:	
	20 mm wide				
	165 mm long (plus connectors)				

Frequency Location



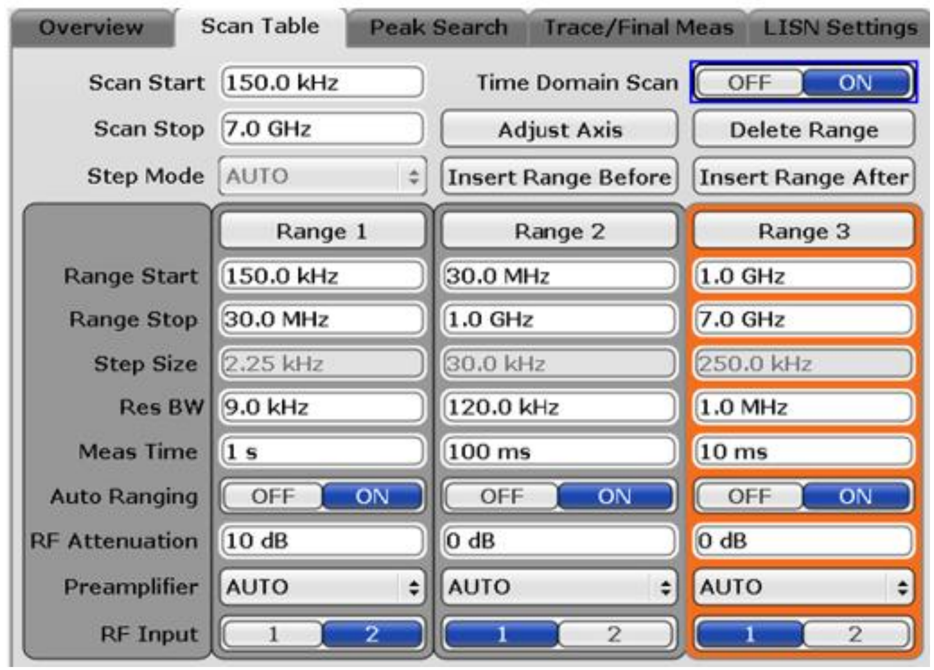
Spurious Emissions and Time consideration

Good Noise floor = narrow RBW (if not standardized)
Meas. speed = but linked to the Rbw/Span

Spectrum mode : Sweep list

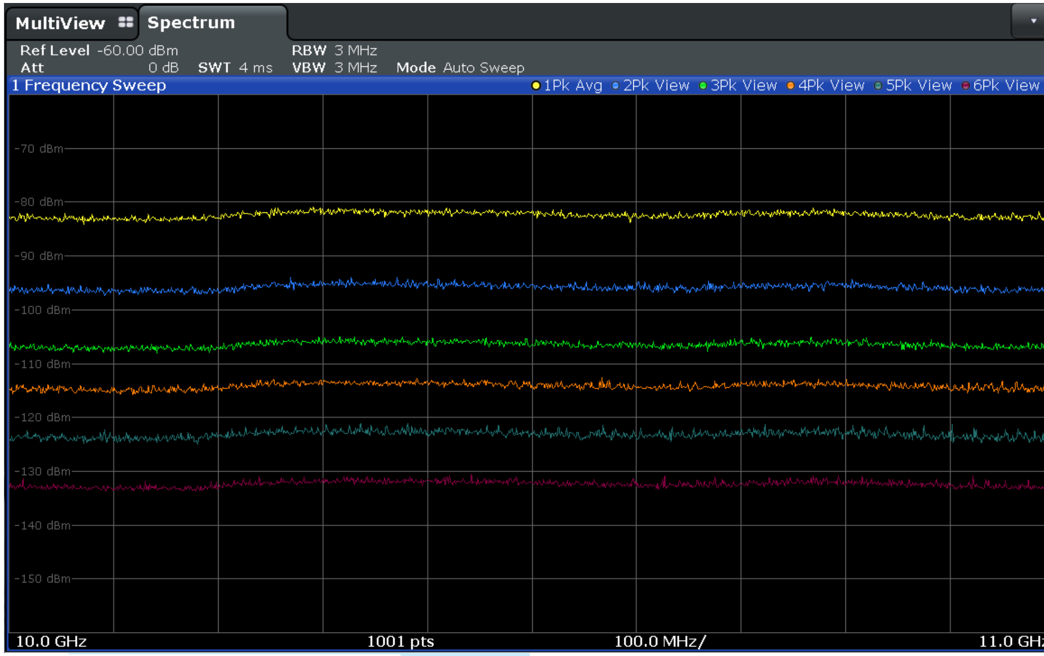
	Range 1	Range 2	Range 3	Range 4
Range Start	30 MHz	5.75 GHz	6.25 GHz	13 GHz
Range Stop	5.75 GHz	6.25 GHz	13 GHz	26 GHz
Spur Detection Threshold Start	-120 dBm	-30 dBm	-120 dBm	-100 dBm
Spur Detection Threshold Stop	-120 dBm	-30 dBm	-120 dBm	-100 dBm
Limit Offset to Detection Threshold	0 dB	0 dB	0 dB	0 dB
Peak Excursion	3 dB	3 dB	3 dB	3 dB
Minimum Spur SNR	10 dB	10 dB	10 dB	10 dB
Maximum Final RBW	100 kHz	100 kHz	100 kHz	100 kHz
Auto RBW	On	On	On	On
RBW	Auto	Auto	Auto	Auto
Number of FFT Averages	2	2	2	2
Ref Level	0 dBm	0 dBm	0 dBm	0 dBm
RF Attenuation	10 dB	10 dB	10 dB	10 dB
Preamp	Off	Off	Off	Off

Receiver mode : Scan table



Spurious Emissions (RBW versus sweep time)

- The smaller the resolution bandwidth, the higher the spectral resolution.
- The RBW influences the displayed noise floor and the sweep speed of the spectrum analyzer.



Spectral overview & noise floor estimation

- Estimated measurement time
- Segment table with best fit RBWs

Spur detection

- Pass/ Fail spurious detection limit
- Preliminary spurious table

Spot search

- Pass/ Fail
- Final spurious table
- Residual spurs detected
- RBW optimized if needed

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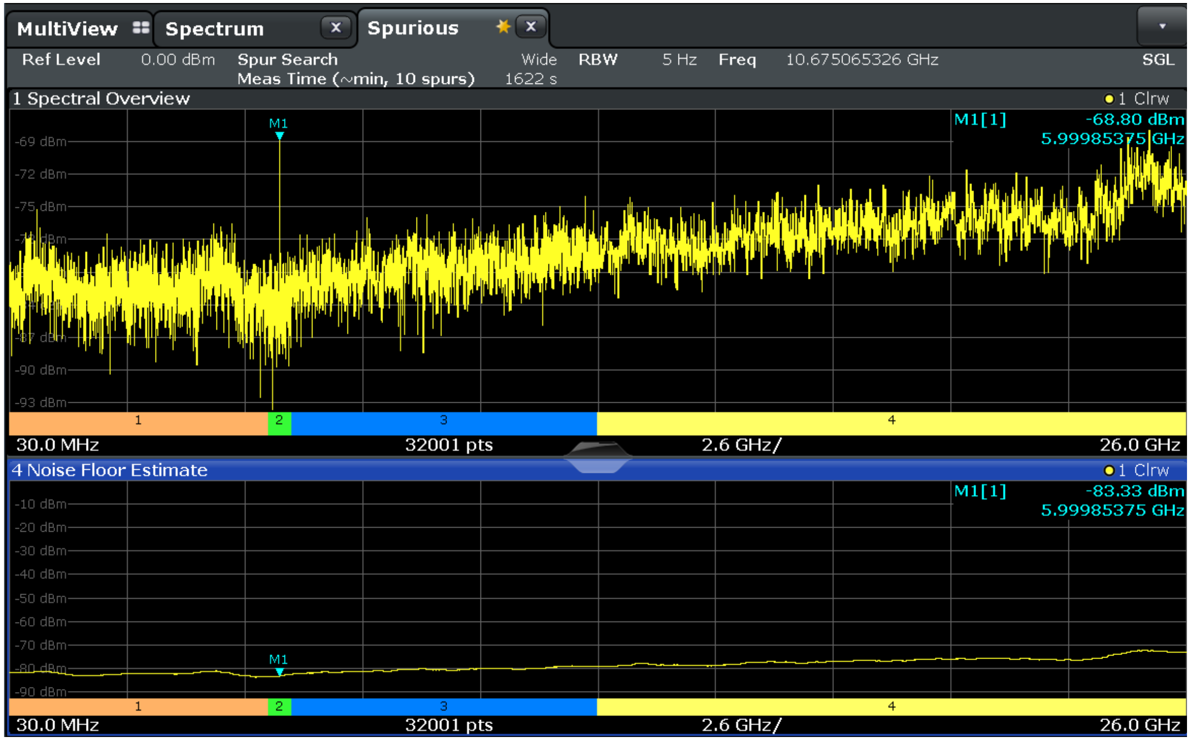
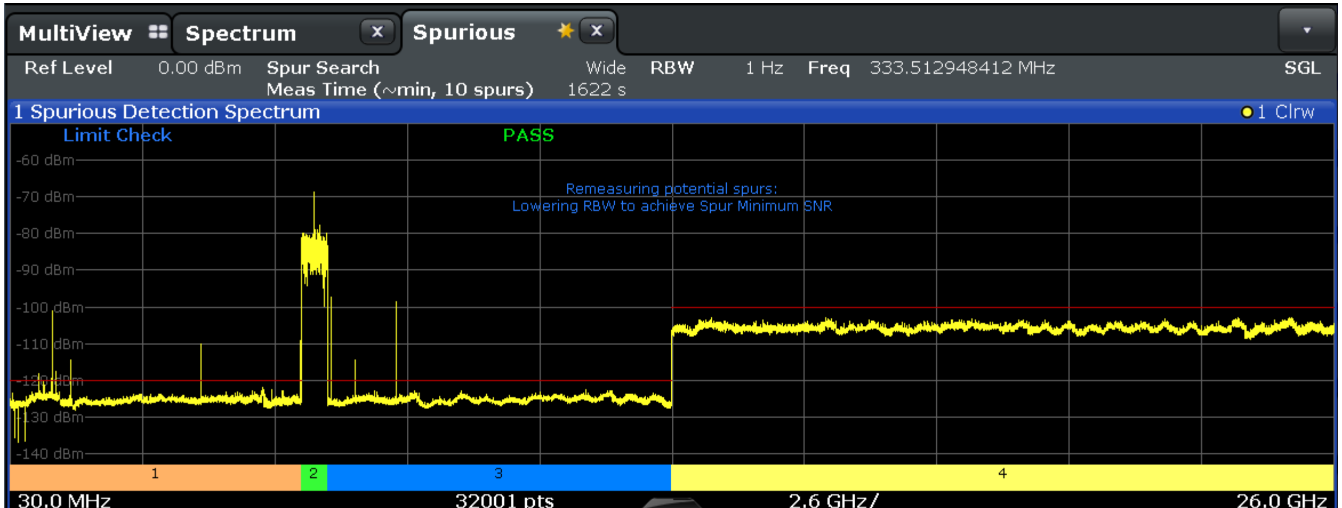
Spurious Emissions (prescan as overview)

- ✓ Measures noise floor for user settings
- ✓ Estimates required measurement time
- ✓ Calculates optimum RBWs for each frequency according to the spurious detection threshold



Spurious Emissions (spurious detection to limit line)

- ✓ Uses RBW settings calculated in previous sweep
- ✓ Preliminary spur table is the result

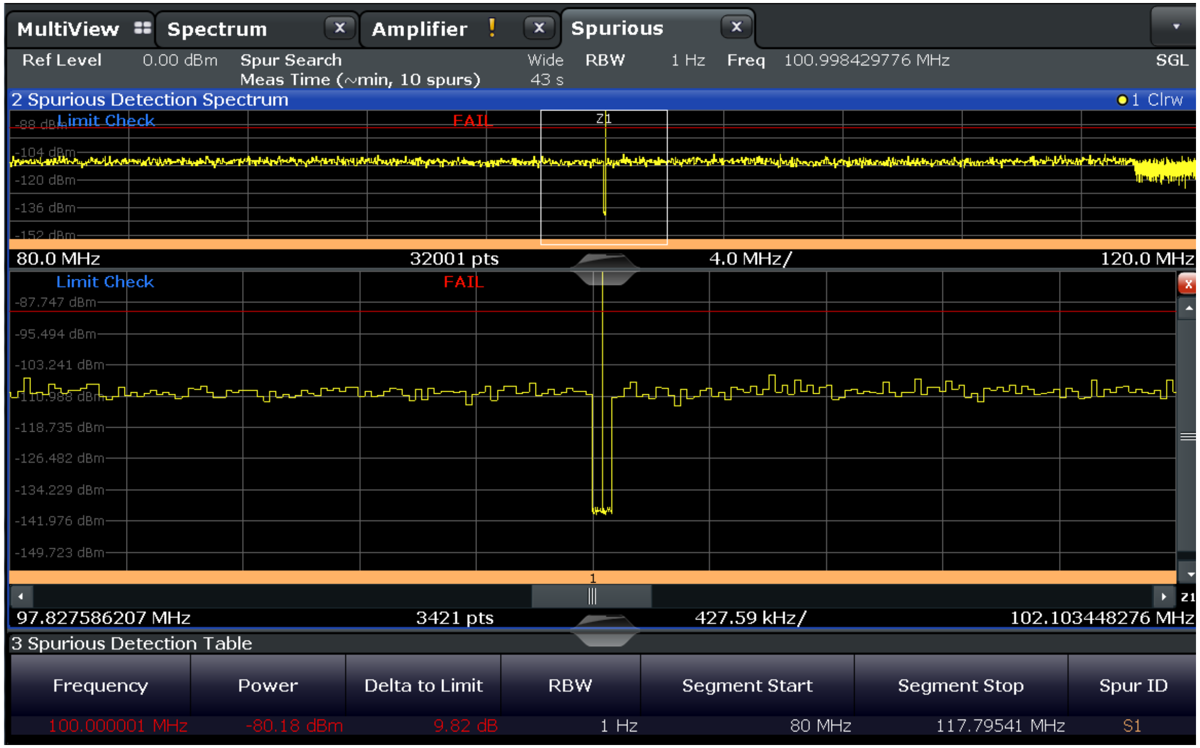


4 Spurious Detection Table

Frequency	Power	Delta to Limit	RBW	Segment Start	Segment Stop	Spur ID
840.421253 MHz	-119.33 dBm	0.67 dB	8 Hz	30 MHz	1.378772513 GHz	S1
869.364869 MHz	-101.19 dBm	18.81 dB	8 Hz	30 MHz	1.378772513 GHz	S2
933.867785 MHz	-117.71 dBm	2.29 dB	8 Hz	30 MHz	1.378772513 GHz	S3
1.206764737 GHz	-114.40 dBm	5.60 dB	8 Hz	30 MHz	1.378772513 GHz	S4
3.766733084 GHz	-110.11 dBm	9.89 dB	8.9 Hz	1.378772513 GHz	4.203111665 GHz	S5
5.713664271 GHz	-109.14 dBm	10.86 dB	10.9 Hz	4.970216126 GHz	5.75 GHz	S6
6.329460454 GHz	-97.41 dBm	22.59 dB	7.6 Hz	6.25 GHz	8.05 GHz	S7
6.801808706 GHz	-114.44 dBm	5.56 dB	7.6 Hz	6.25 GHz	8.05 GHz	S8
7.609656652 GHz	-98.66 dBm	21.34 dB	7.6 Hz	6.25 GHz	8.05 GHz	S9

Spurious Emissions (partial sweep as spot search)

- ✓ Performed over very narrow spans around each spur detected in the previous step
- ✓ Pass/ Fail considering spurious emissions limit and SNR
- ✓ Final spurious table



Spurious Emissions (test time divided by 44)

Spur search with the new FSW-K50 is up to 50 times faster than traditional spurious

RBW / Noise (dBm) 1 GHz span	High end spectrum analyzer Speed (s)	R&S FSW spectrum analyzer, Speed (s)	New FSW-K50 Spurious search application Speed (s)
1 Hz / -140	9700	12246	200
2 Hz / -138	2840	3088	84
3 Hz / -135	1470	1384	35
5 Hz / -132	660	507	12
10 Hz / -130	308	132	7
20 Hz / -128	126	36	6
30 Hz / -125	51	17	5
50 Hz / -122	42	7.1	4
100 Hz/-120	23	4.1	3

Thank you for your attention

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