Difference Between each instrument used for RF & EMI Testing

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ROHDE&SCHWARZ

WÜRTH ELEKTRONIK

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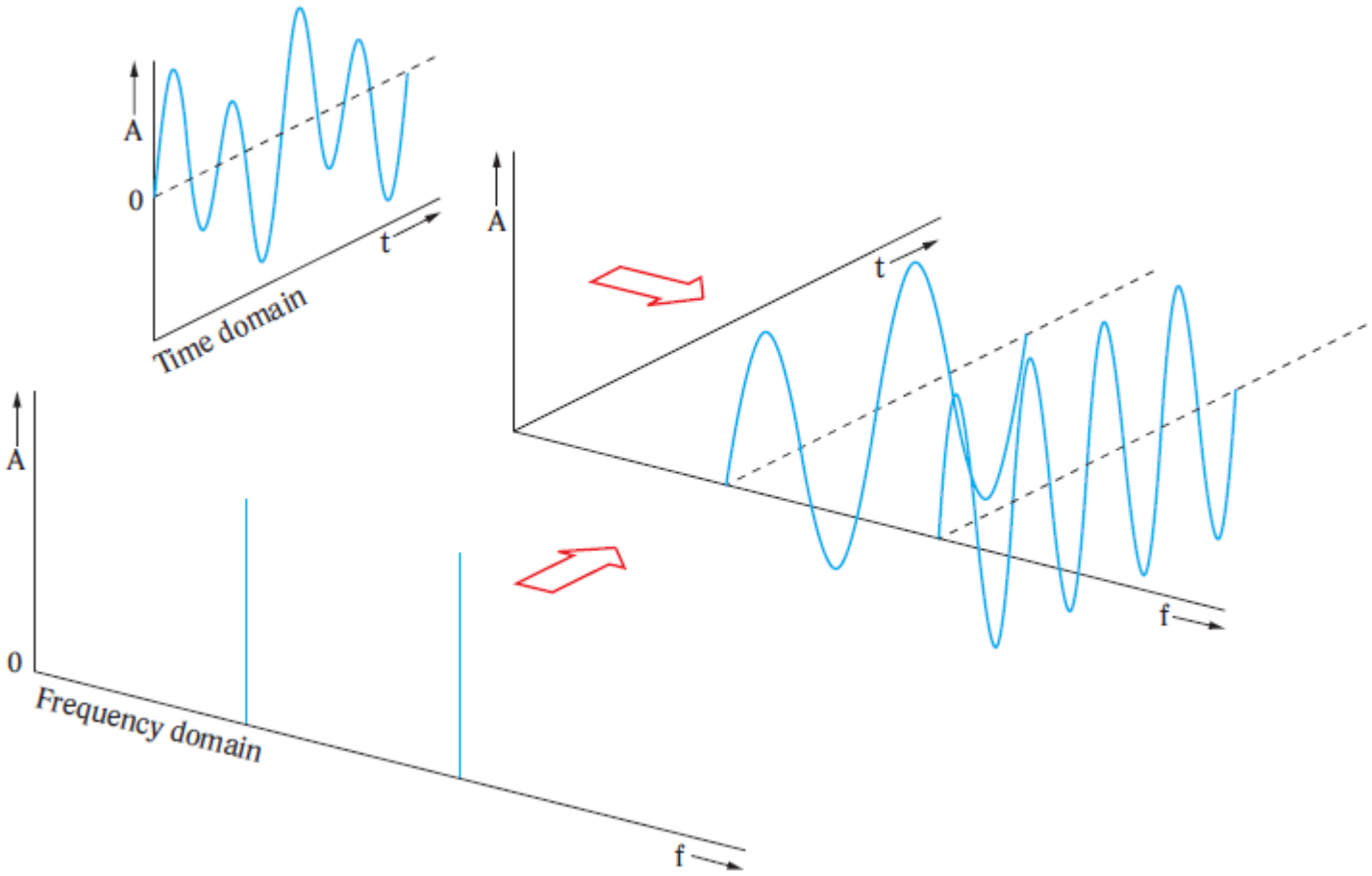
- Introduction and fundamentals
- Amplitude consideration
- Difference beetween both…
- And where scope is advanced

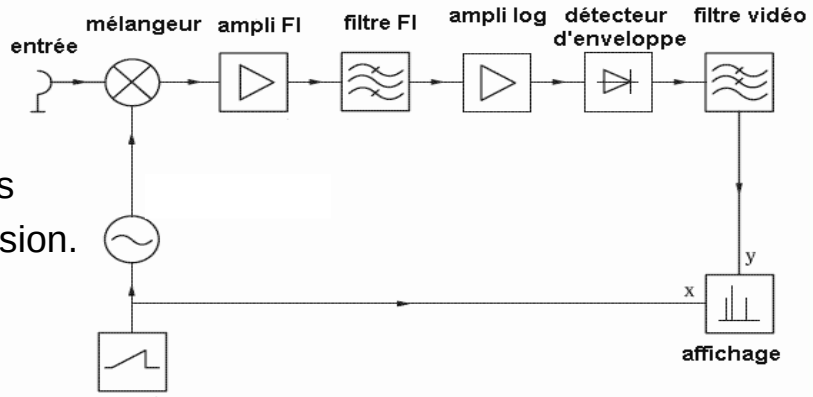
Introduction and fundamentals

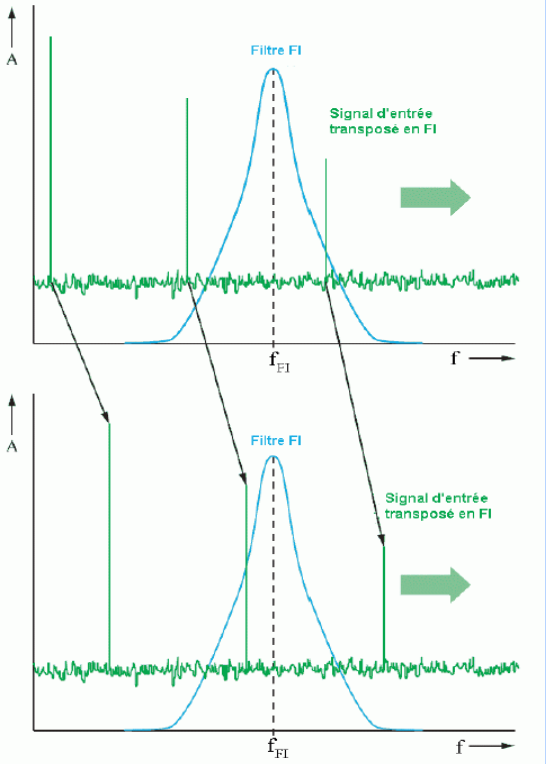


Heterodyne Selective Meas. versus FFT time acquisiton

Heterodyne instr. :

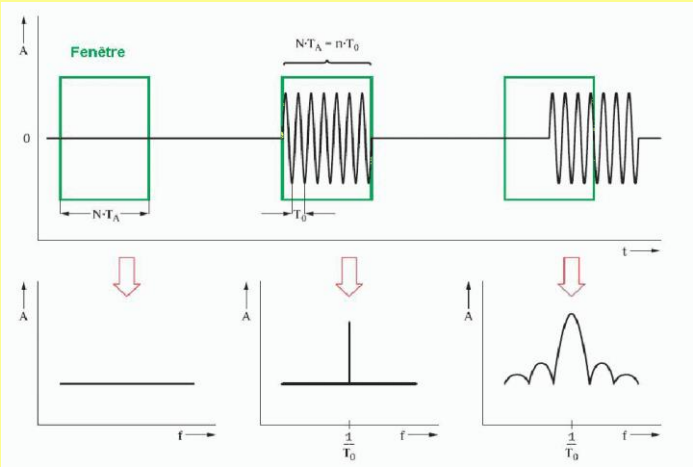
>>Local oscillator and mixer making continious down frequency conversion.

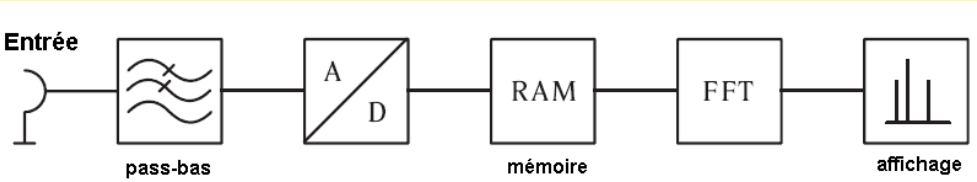




FFT instrument

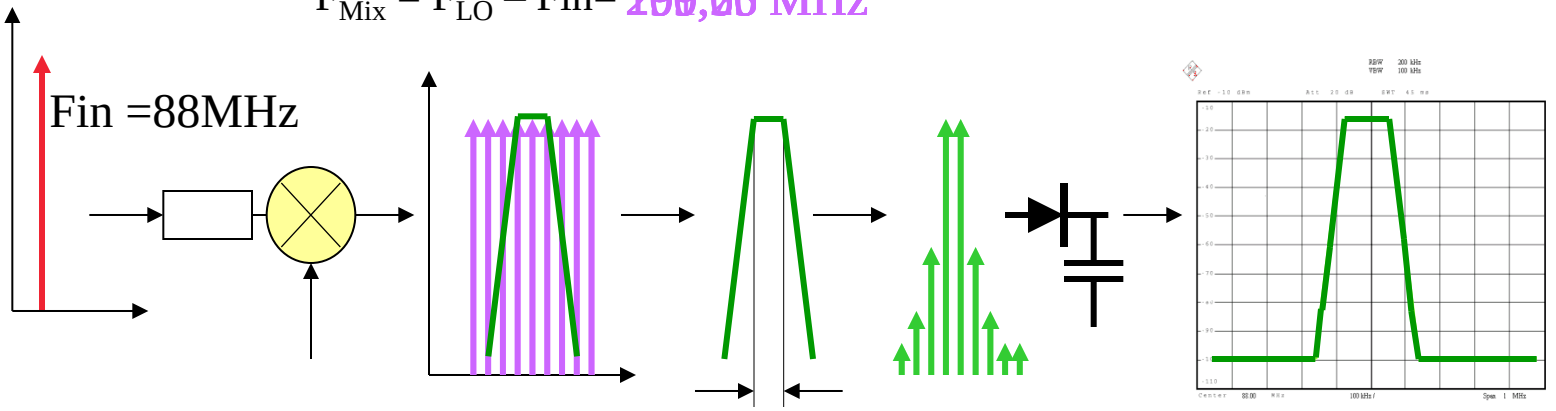
>>No frequency conversion : direct ADC conversion





Spectrum and Receiver are supra heterodyne

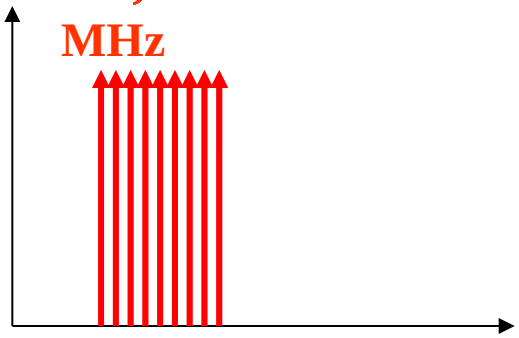
$F_{Mix} = F_{LO} - Fin =$ 200,00 MHz



RBW = 200 kHz

FI = 200 MHz

$F_{LO} =$ 287,00 MHz



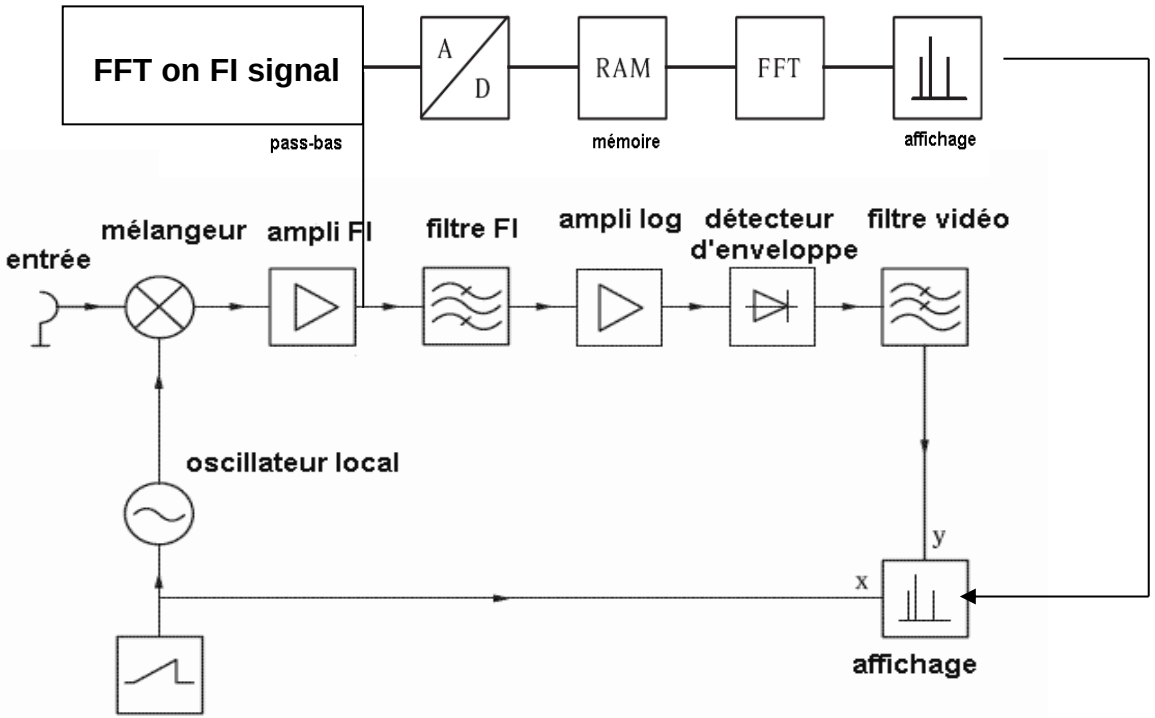
F_{OL} = 287 – 289 MHz

center 88 MHz ; span 2 MHz

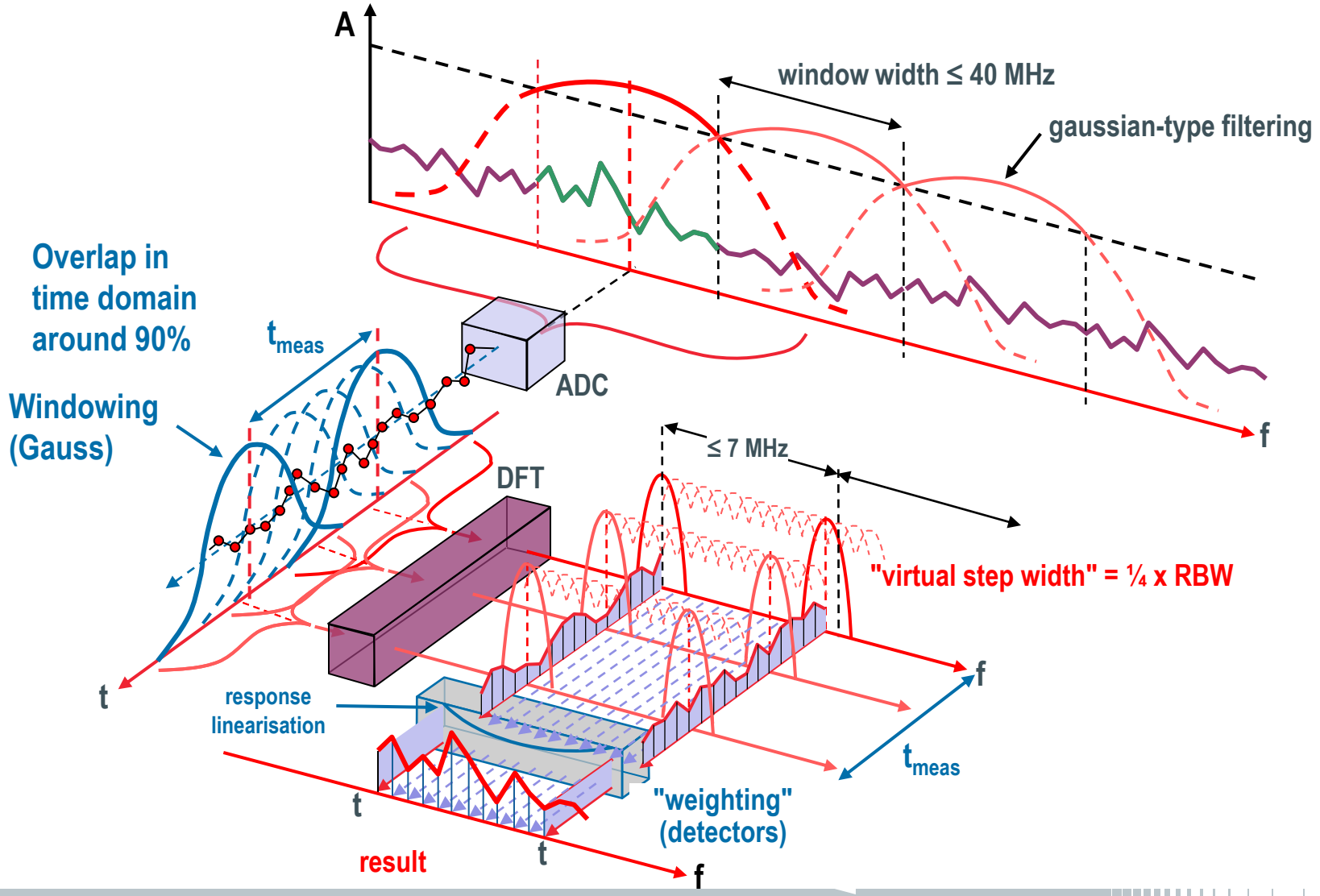
(or start 87M & stop 89 MHz)

Heterodyne Selective Meas. versus RealTime acquisiton

- The solution remains in a heterodyne stage with an FFT on his IF signal path
  - Local oscillator and mixer make same work, but Oscillator fixe in freq (no sweep) …
  - FFT on the full bandwinth of IF path (and not RBW)

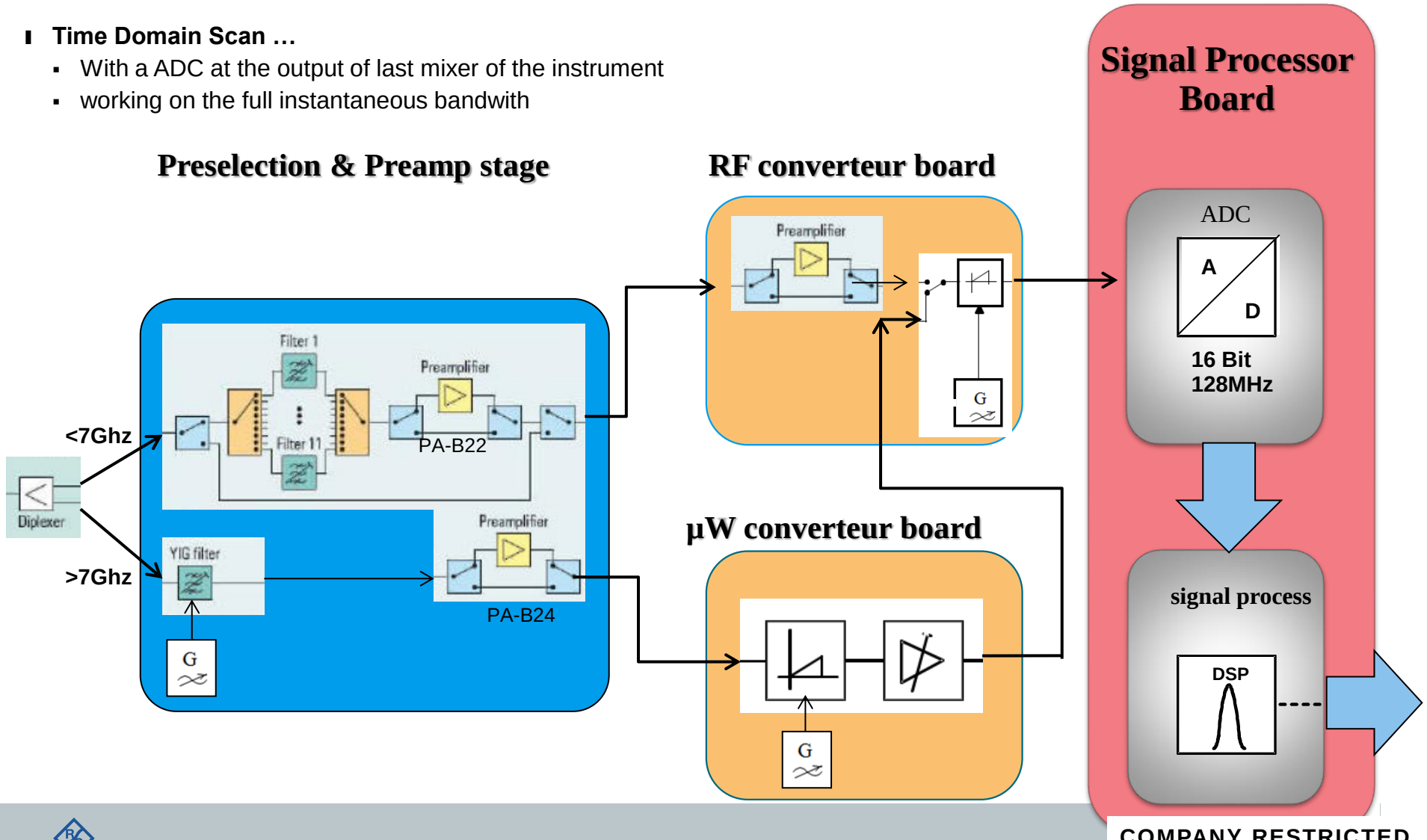


Heterodyne Selective Meas. versus RealTime acquisiton



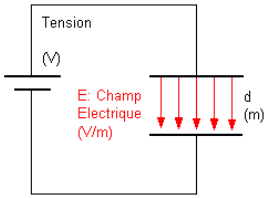
Heterodyne Selective Meas. versus RealTime acquisiton

- **Time Domain Scan …**
  - With a ADC at the output of last mixer of the instrument
  - working on the full instantaneous bandwith

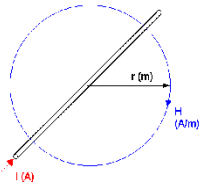


Amplitude consideration

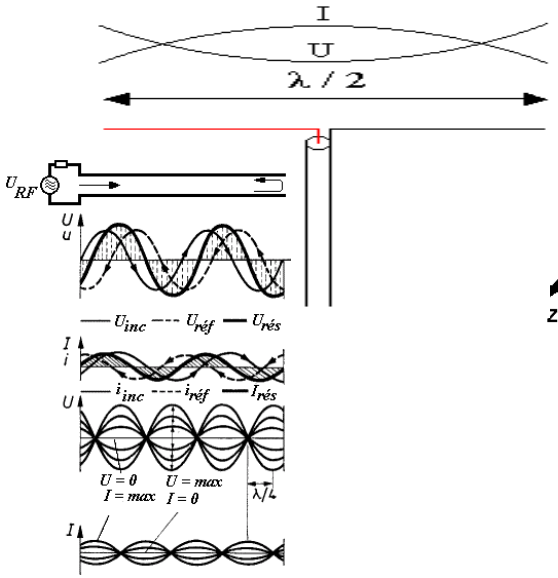
Firstly 2 vectors in space : |E| & |H|

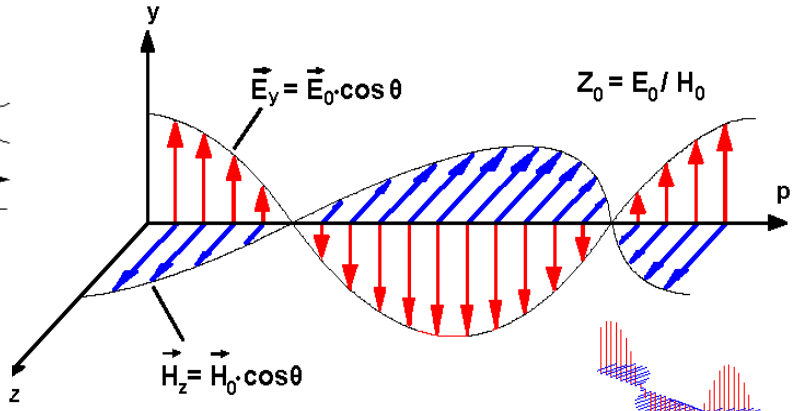


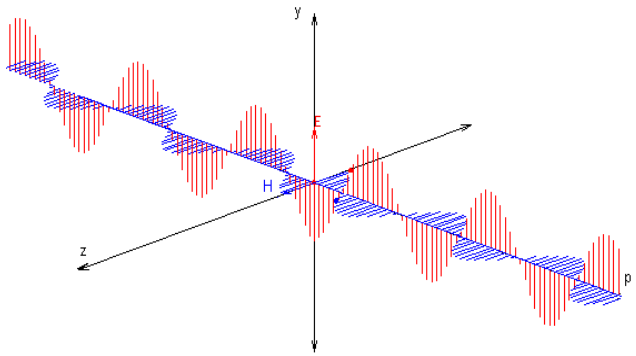
E = U(volt)**/d** (m) = **V/d** (V/m)



H = I(A) **/ 2π r** (m) **= I/2π r** (A/m)

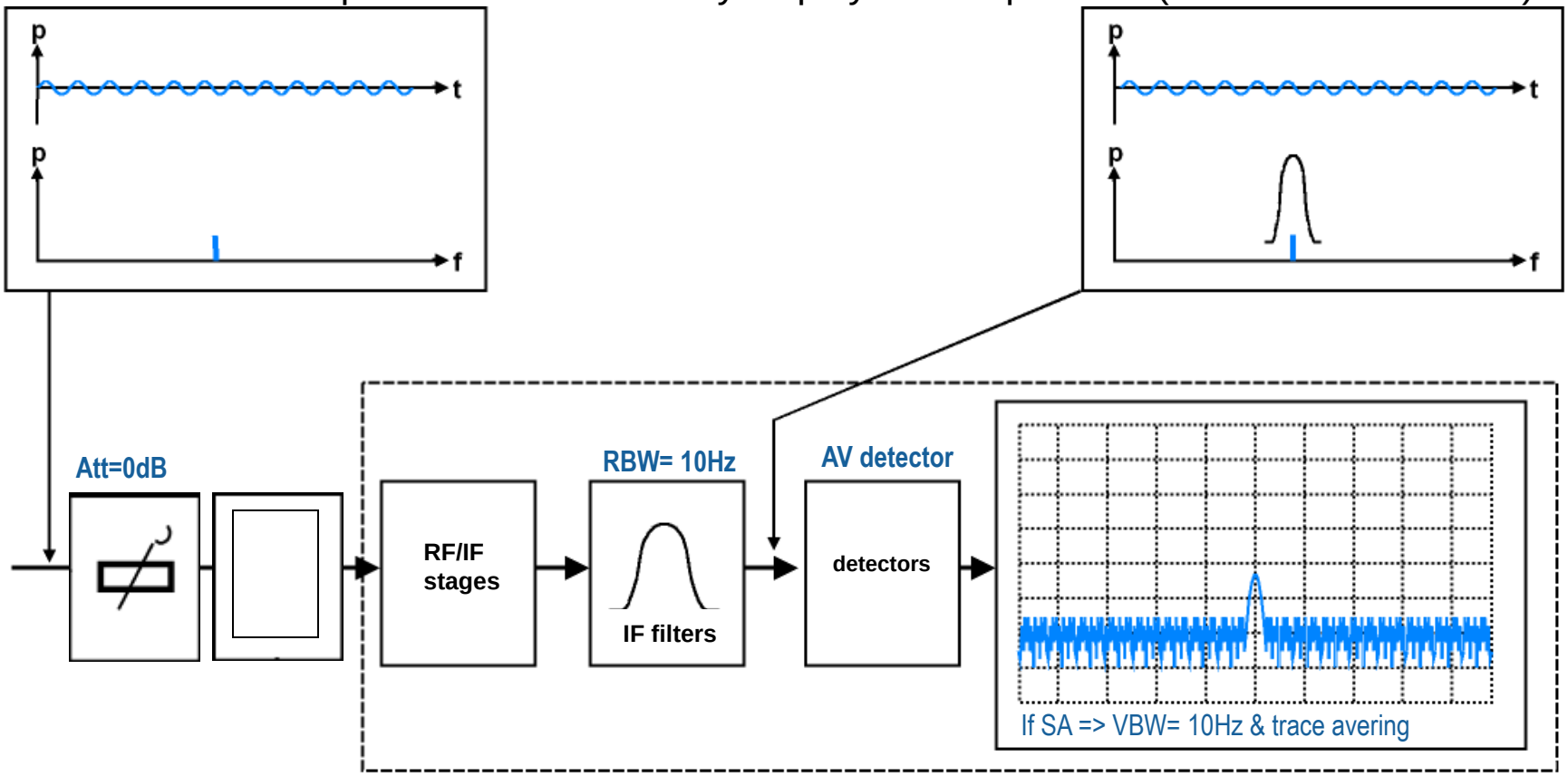






Sensitivity - Linearity - Dynamic : with cw signal…

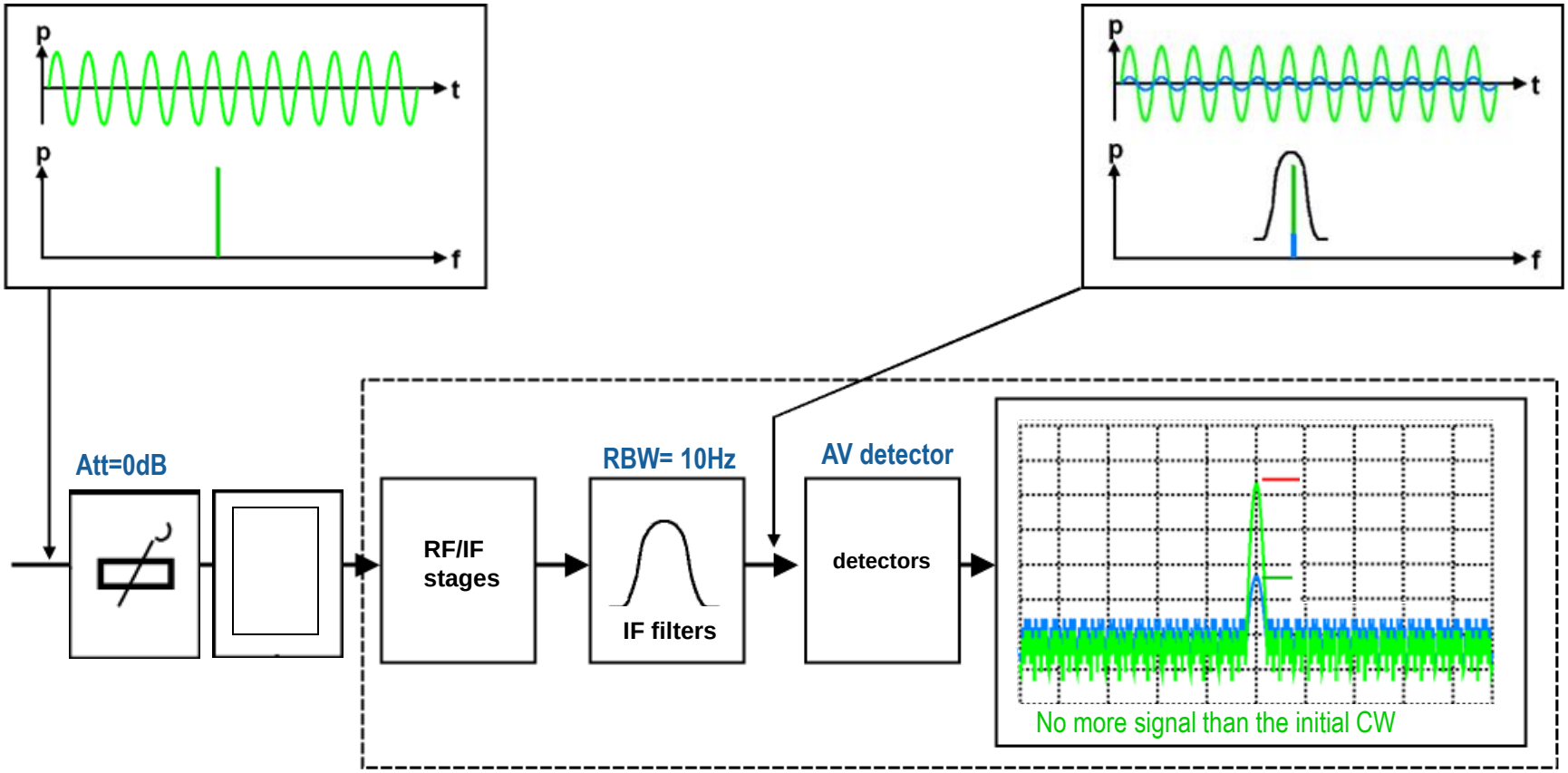
- **Input with Low level** : looking for signals growing up from noise floor
  - Start with ATT=0dB, RBW=10Hz (can be normalized to others later on)
  - The VBW parameter concert only display of the spectrum (no Vbw on receiver)



Sensitivity - Linearity - Dynamic : with cw signal…

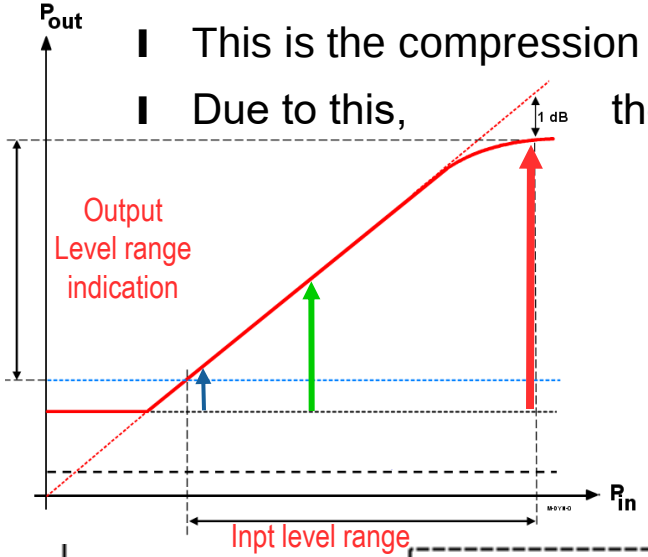
- **Increase input level** :

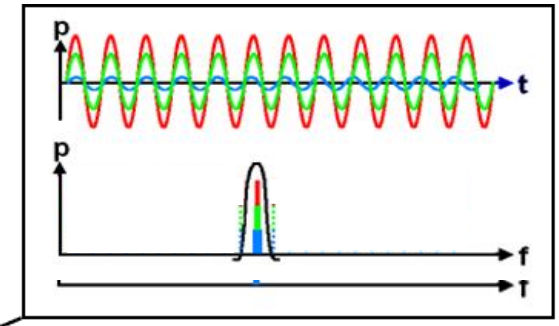
  getting same indications between external RF source and level indicate on the instrument

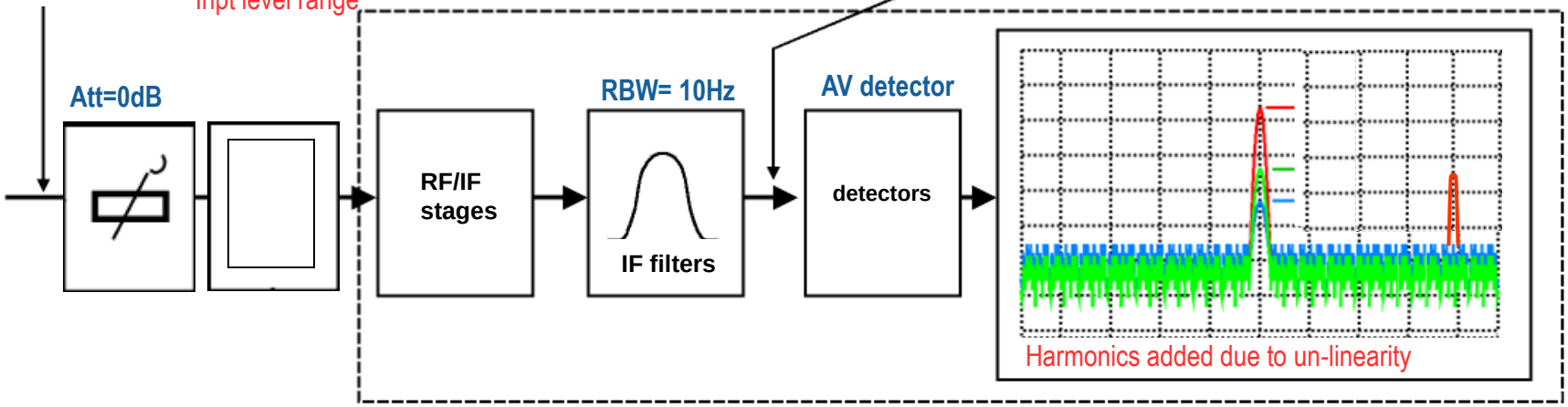


Sensitivity - Linearity - Dynamic : with cw signal…

- **Due to increasing level** : a difference appears between the source and the indicated level
  - This is the compression process (1dB compr.point most of time caracterised)
  - Due to this, the error measurements increases…

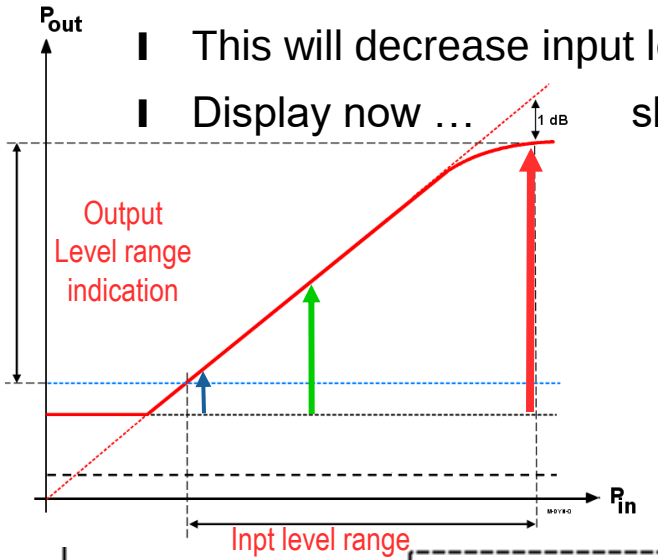


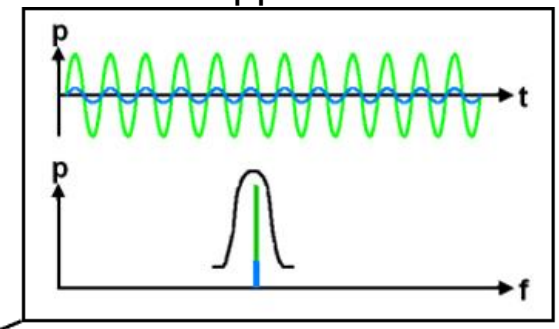


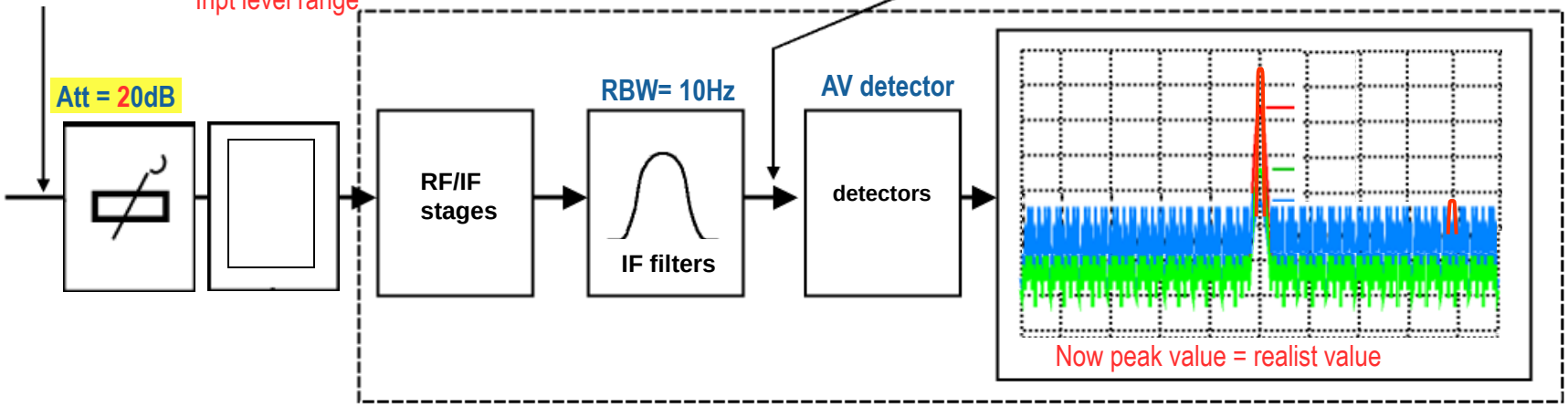


Sensitivity - Linearity - Dynamic : with cw signal…

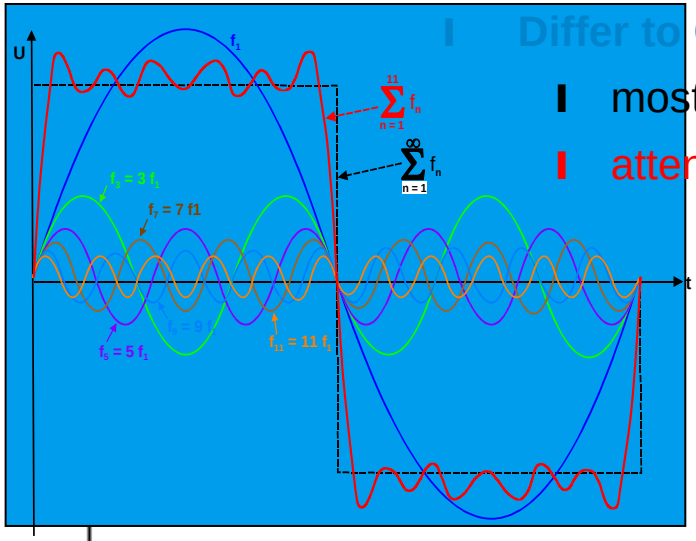
- **To avoid this** : a the first action is to increase attenuation…
  - This will decrease input level of the mixer itself (avoiding saturation)
  - Display now … shows right value as factor correction is applied…





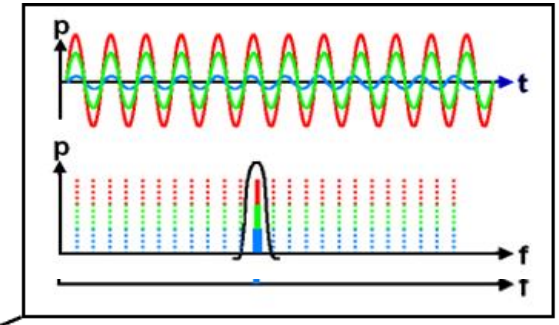


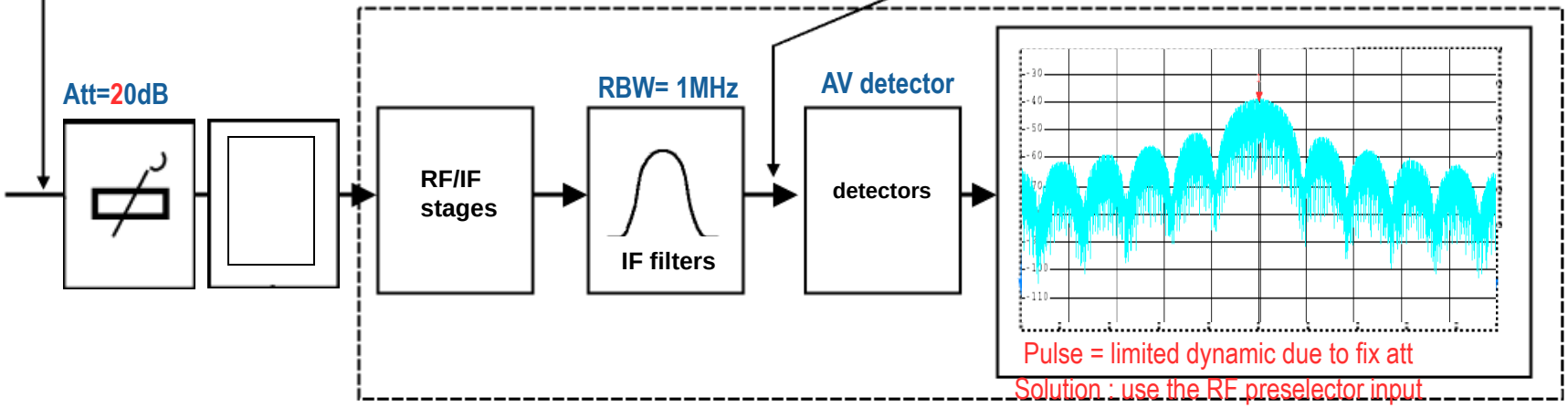
Sensitivity - Linearity - Dynamic : with Pulse signal…



- Differ to **CW** : the mixer dissipate the power sum of all freqs
- most of time: user taking care only on power in the RBW
- atten is not the right effect

to avoid this…

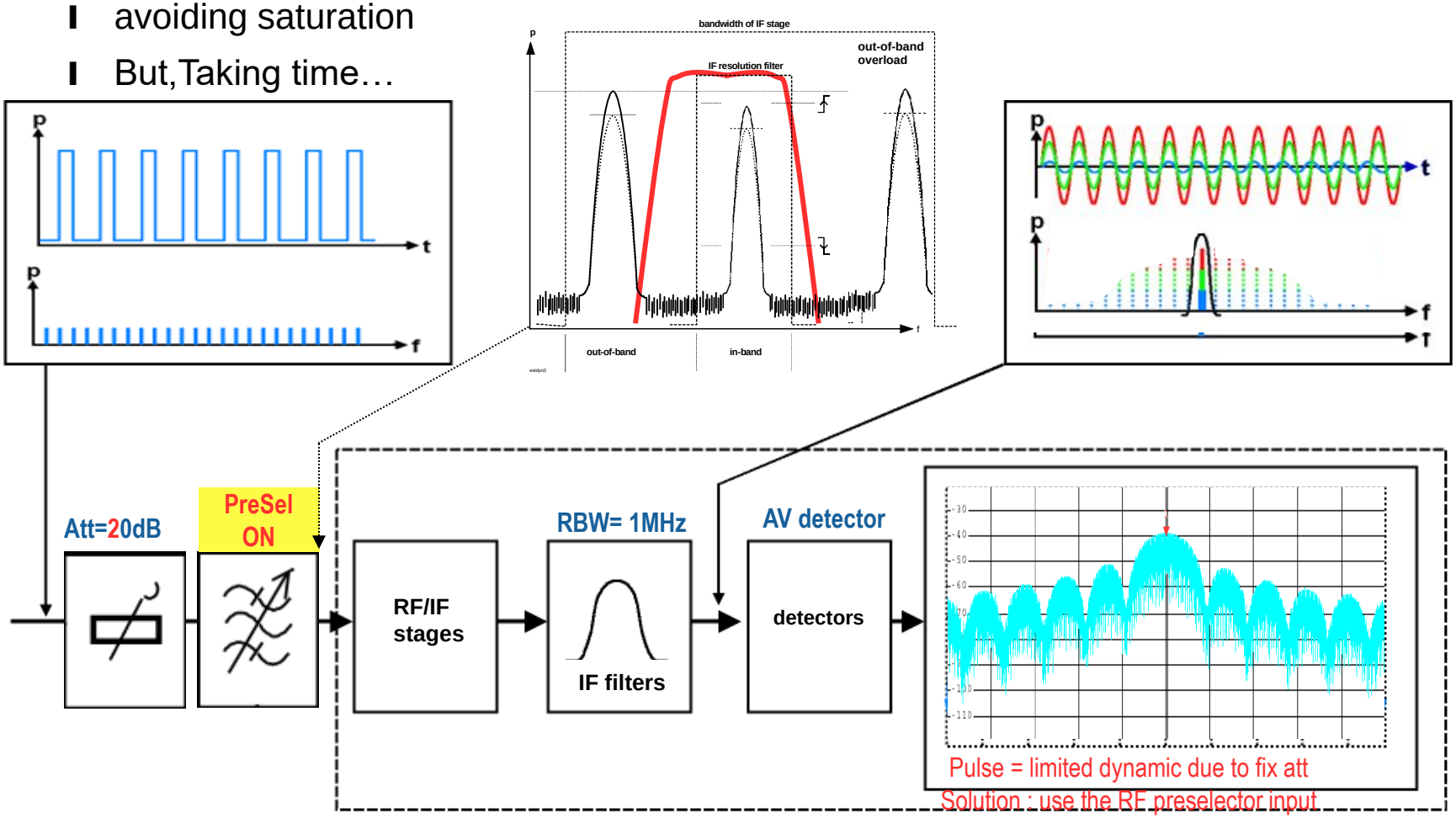




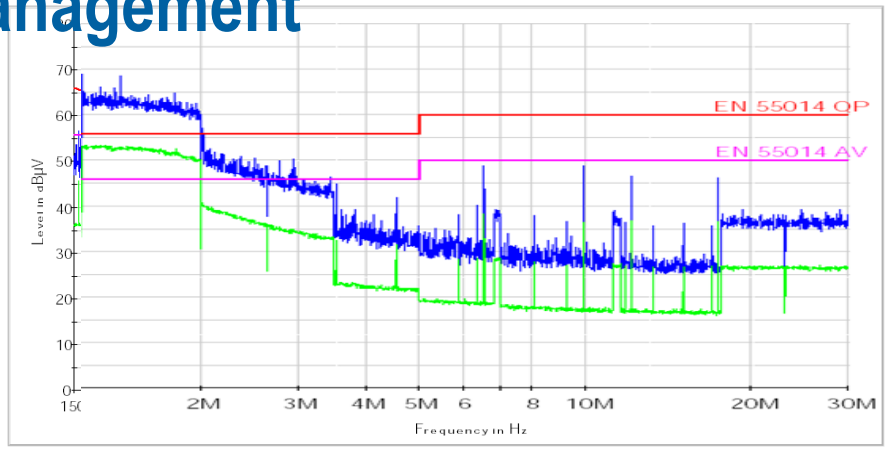
Difference between both...

First difference… Input RF Preselector

- **The solution remains** : a RF preselection filtering before mixing stage
  - avoiding saturation
  - But,Taking time…



The second Diff… RF Atten. management



mixer level

TOI

1 dB-C

0

-100

RF Att

decreasing signal level

increasing signal level

read

Dynamic range of detector

- display of dynamic range
- S/N estimation

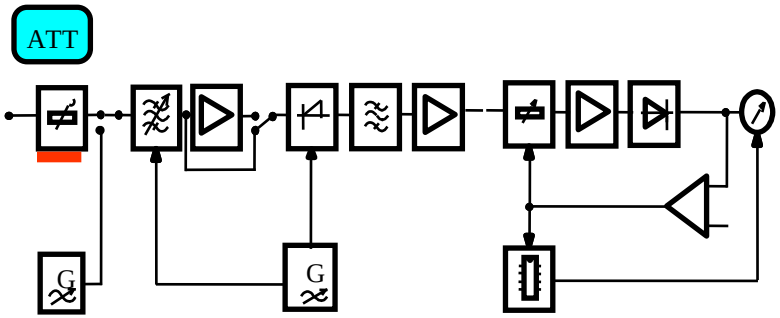
RF Att

90 dB

IF-bw 1 kHz

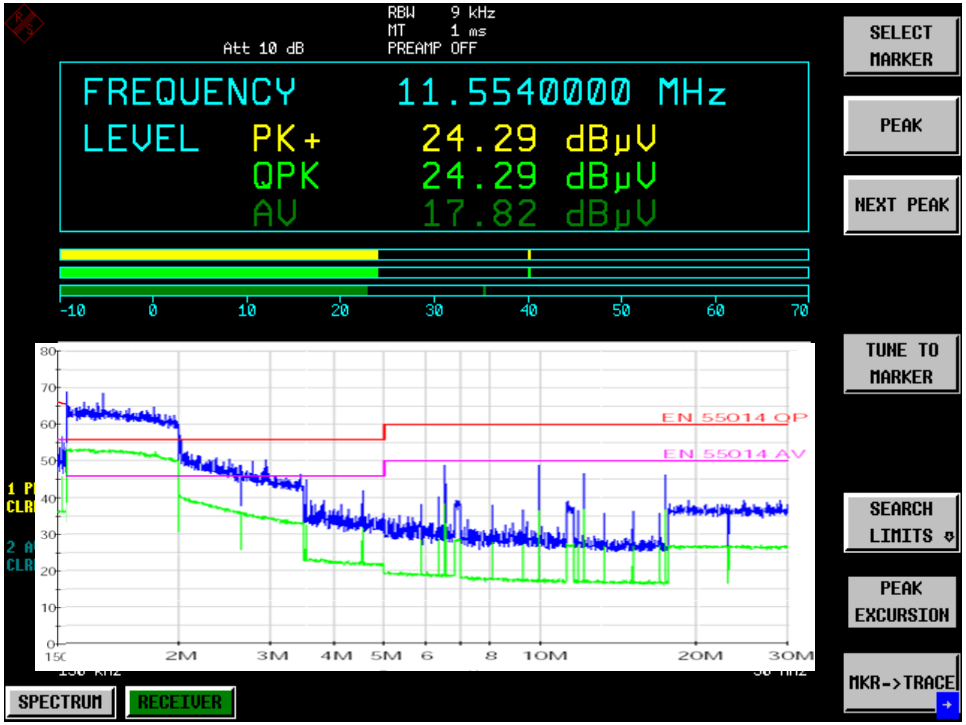
IF gain

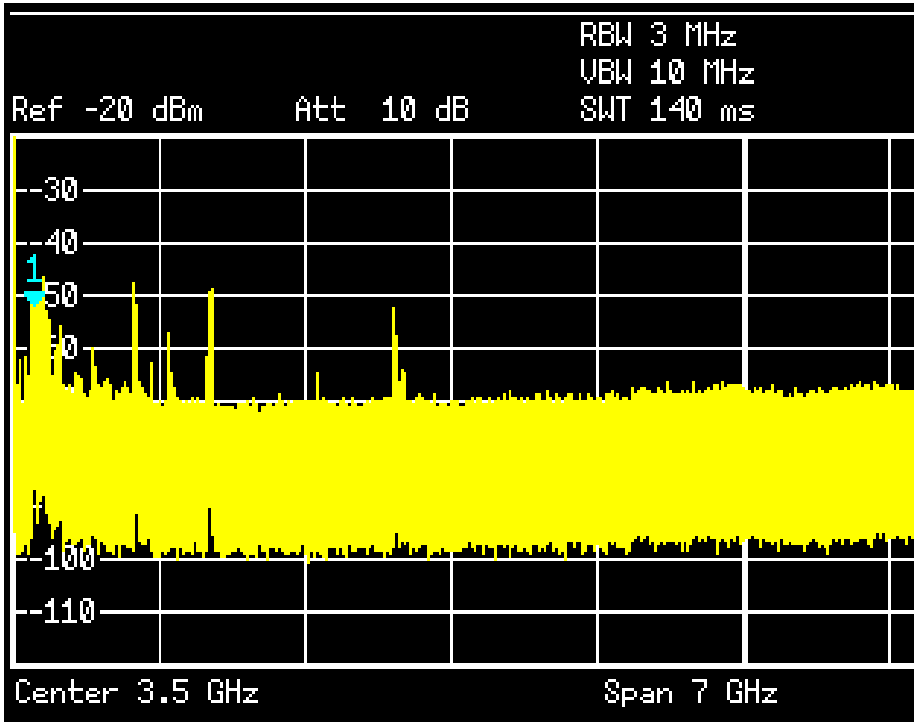
RF Atten. management



Important to know :

The attenuattor can change dynamically over the frequency depending of input level (in opposition to hte spectrum)





Then the third Diff… is RBW filters

Receiver with 6dB Rbw Filters

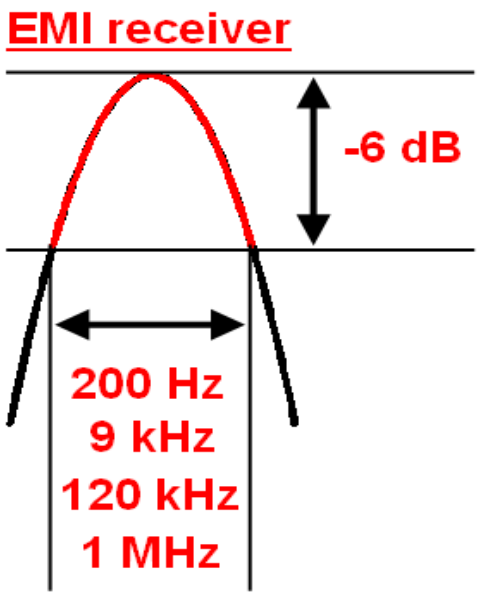
=>CISPR bandwidths (-6dB)
200 Hz, 9 kHz, 120 kHz, 1MHz

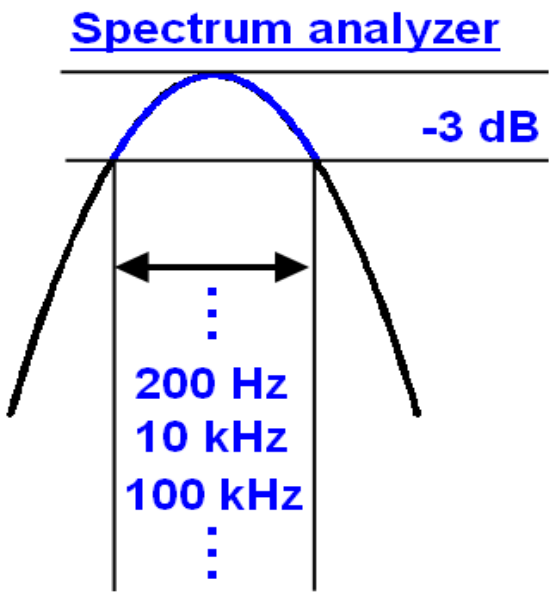
=>MIL bandwidths (-6dB)
10 Hz, 100Hz, 1kHz, 10kHz, 100kHz, 10MHz

Spectrum with 3dB Rbw Filters

=>Spectrum bandwidths (-3dB)
1 Hz to 10MHz in step of 1, 2, 3, 5...

=>take care on the filter type : Gaussian, Rectangular, FFT…

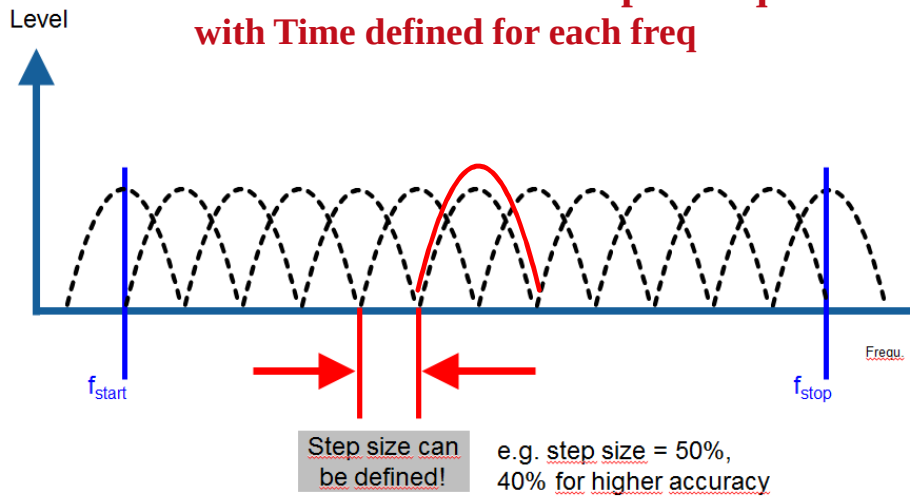


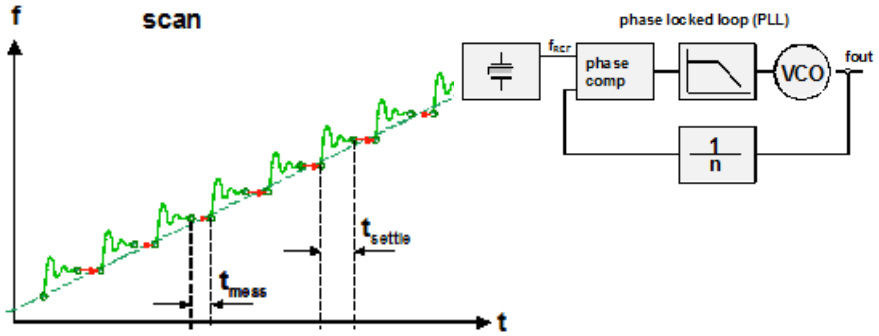


last point to take in count… Time Meas & Trace points number

Receiver with millions in **SCAN**

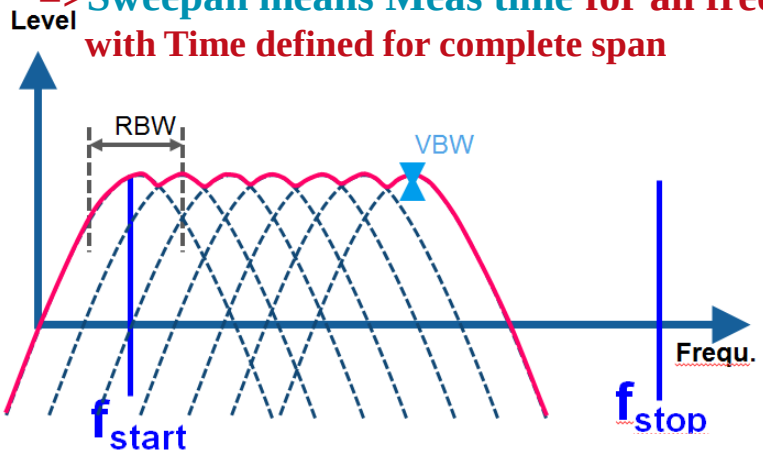
=>Scan means frequency jump
with freq step configurable added to RBW
=>Scan means Meas time per freq
with Time defined for each freq

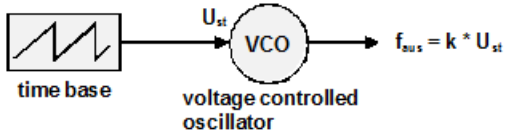


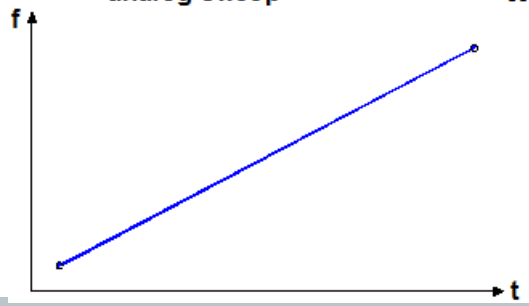


Spectrum with thousand in **SWEEP**

=>Sweep means frequency vobulation
without Freq step added to RBW & VBW
=>Sweepan means Meas time for all freq
with Time defined for complete span

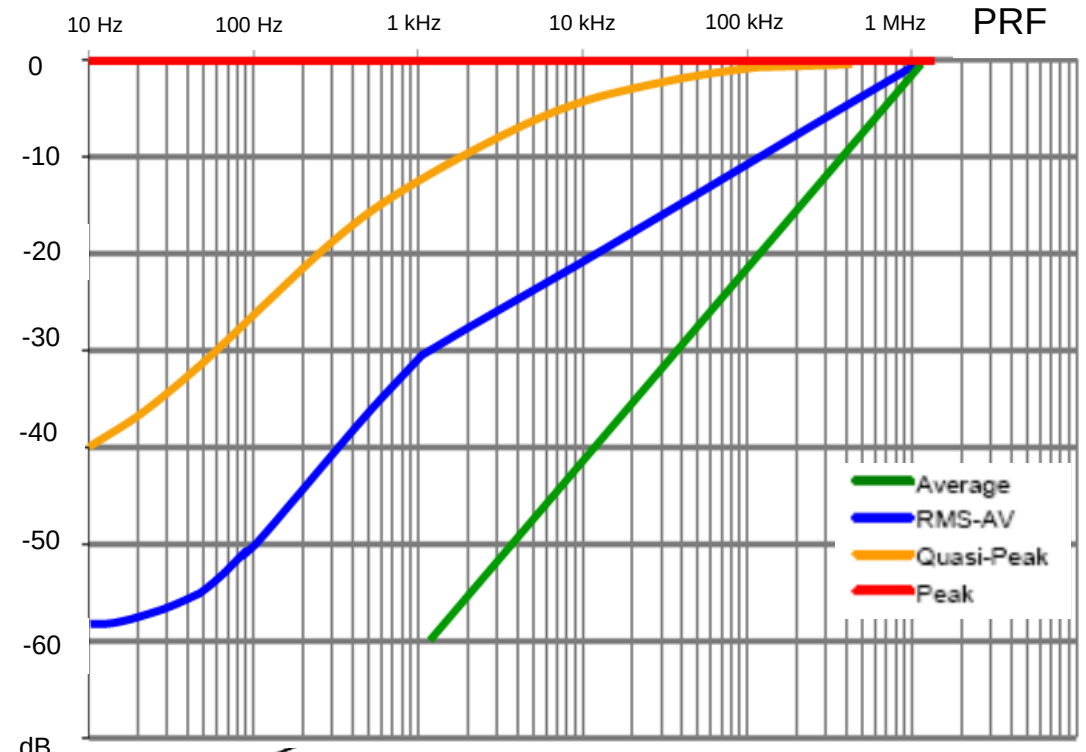


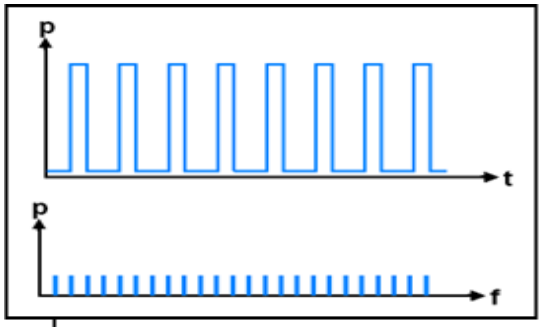


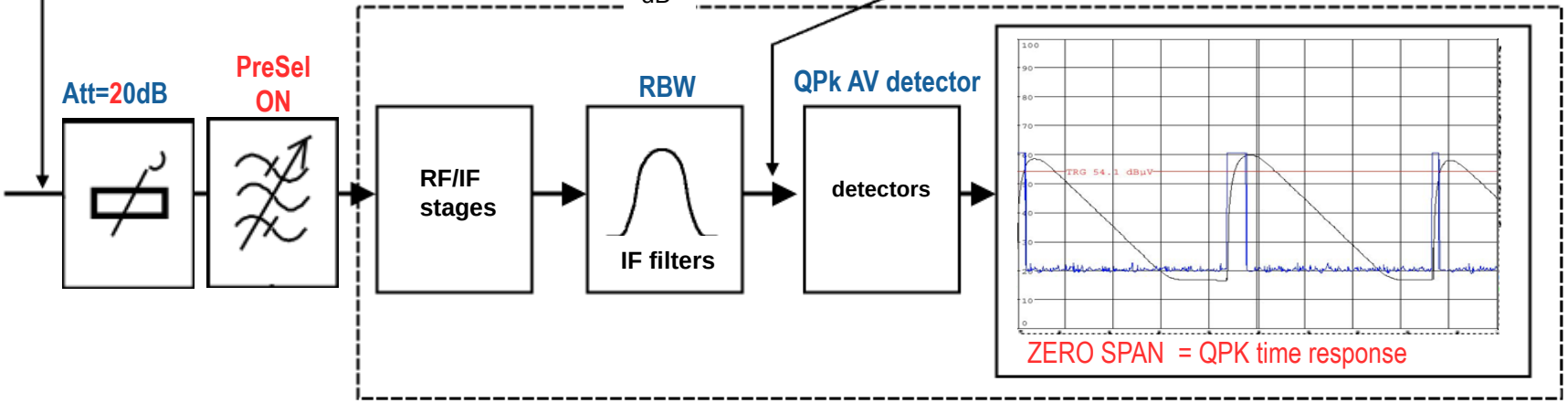


… 3 differences which make right CISPR response

I **because best approach for**
CISPR Pulse Repetition frequency
with right impulse response…







And where scope is advanced

Débogage EMI avec RTO/RTE

Points importants

- Sensibilité
  - Les signaux à repérer ont des niveaux faibles
- Vitesse d’acquisition et d’analyse
  - Les signaux sporadiques doivent être captés
- Identification des signaux fixes et impulsionnels
  - La discrimination entre les signaux périodiques et les parasites est indispensable
- Facilité d’utilisation
  - Pour un usage facile
- Utilisation de gabarit
  - Pour le respect des normes

Sensibilité

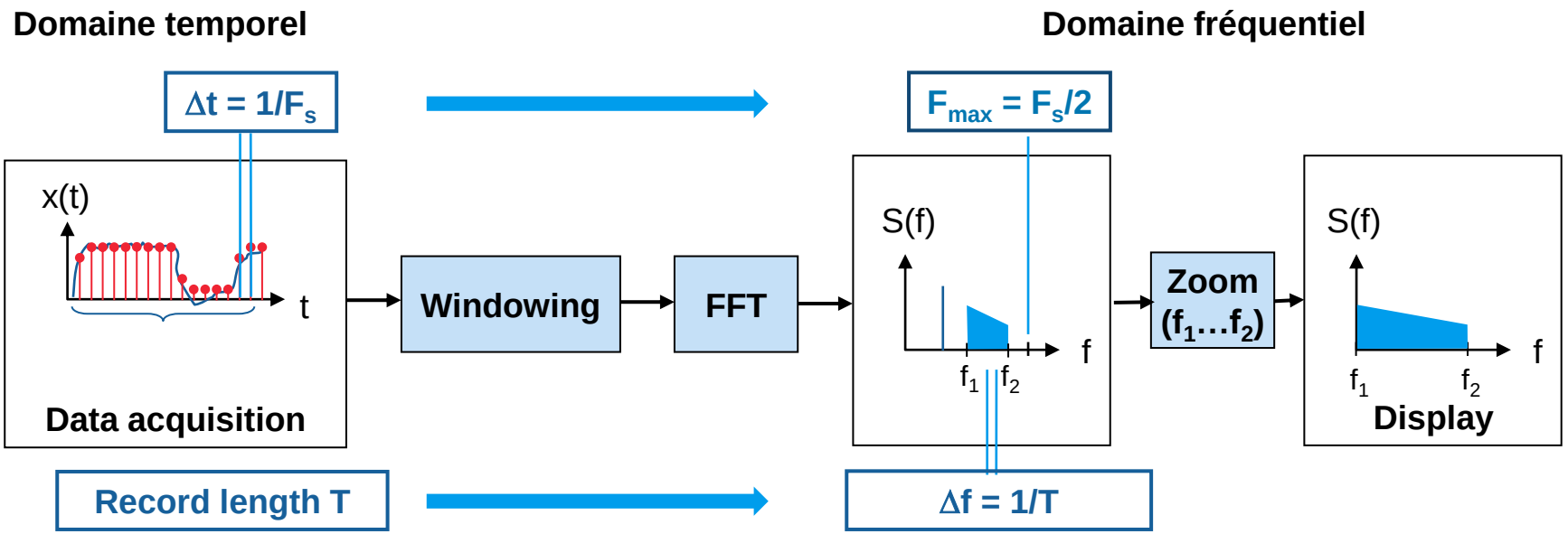
- Calibre vrai de 1 mV/div sur toute la bande passante sur le RTO
- 500 µV/ div sur le RTE
- 1mV/div donne un **DANL** de ~0 dBµV
  (@500 MHz, 120 kHz RBW, 50 Ω)

Receiver	DANL
RTO	~0 dBuV (1mV/div)[1]
ESR	-7 dBuV (with Preamp)[2]
ESCI	-4 dBuV (with Preamp)[2]

- La dynamique est inférieure aux récepteurs et AS (≈ 50 dB)
- Pas de présélecteur
- Pas de filtre EMI (pas critique pour le débogage)

Vitesse d'acquisition et d'analyse

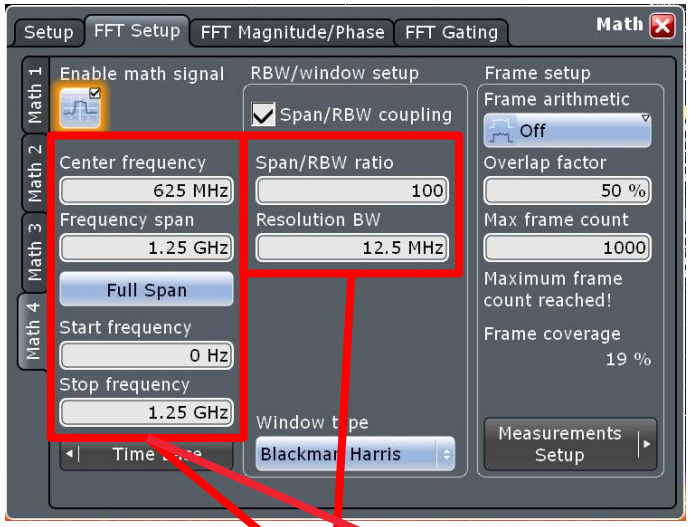
FFT conventionnelle d'un oscilloscope



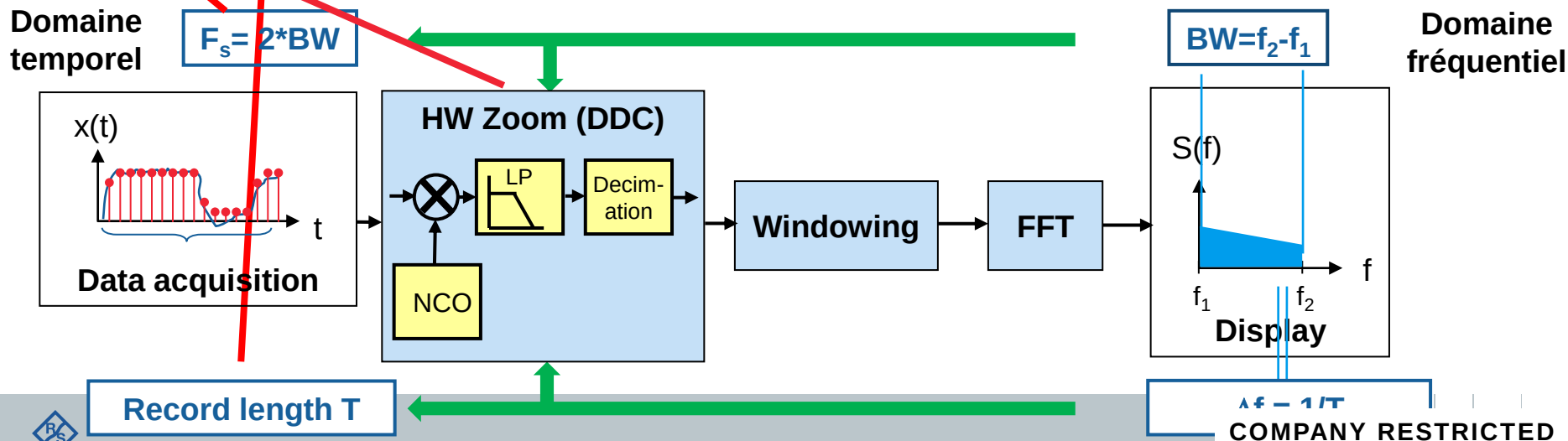
- Le domaine temporel défini le domaine fréquentiel
- Paramétrage compliqué
- Un zoom dans le spectre n'implique pas plus de résolution et de détail
- Impossibilité de corréler temps fréquence

Vitesse d'acquisition et d'analyse

FFT des oscilloscope RTE et RTO

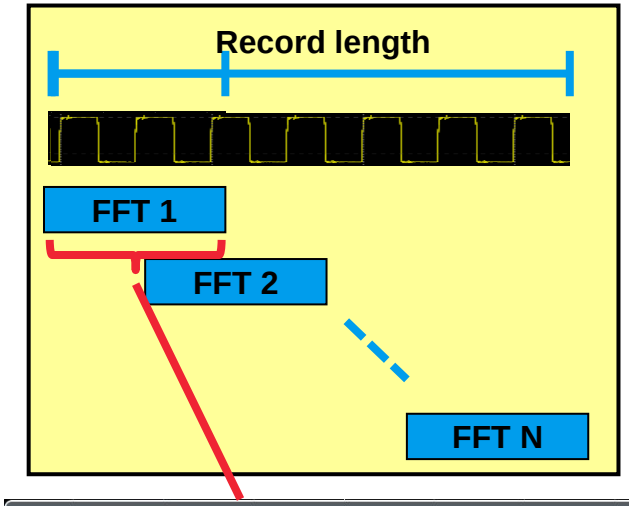


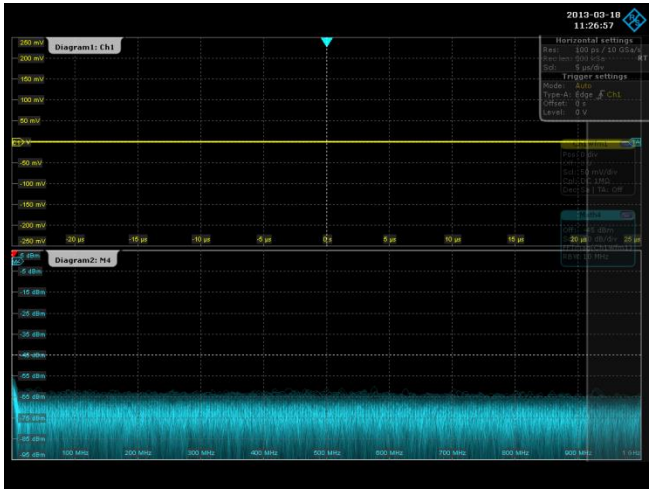
- **Menu façon analyseur de spectre**
  - Le domaine fréquentiel contrôle le domaine temporel: Longueur d'acquisition et le taux d'échantillonnage sont rafraichis automatiquement
- **Down conversion FFT (DDC) pour une performance maximale**
  - Zoom fréquentiel avant la FFT: exemple 500 MHz center / 10 MHz span → 20 MS/s au lieu de1 GS/s



Vitesse d'acquisition et d'analyse

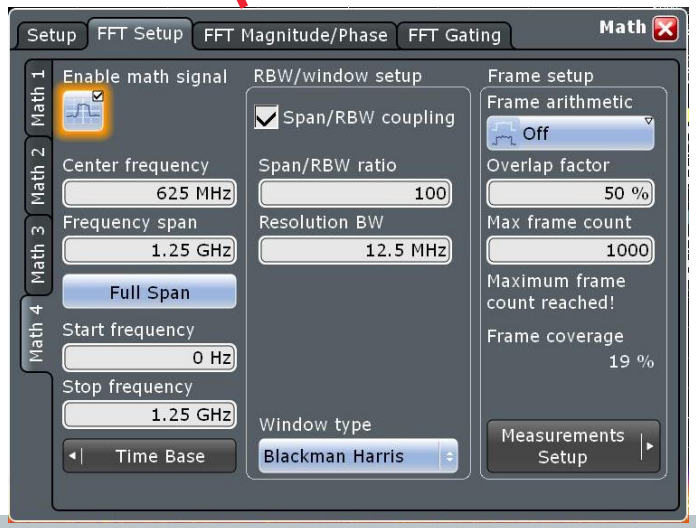
Utilisation des chevauchement de FFT





10GS/s
1.596s/div
100kSamples

~440 FFTs
(sans persistance)



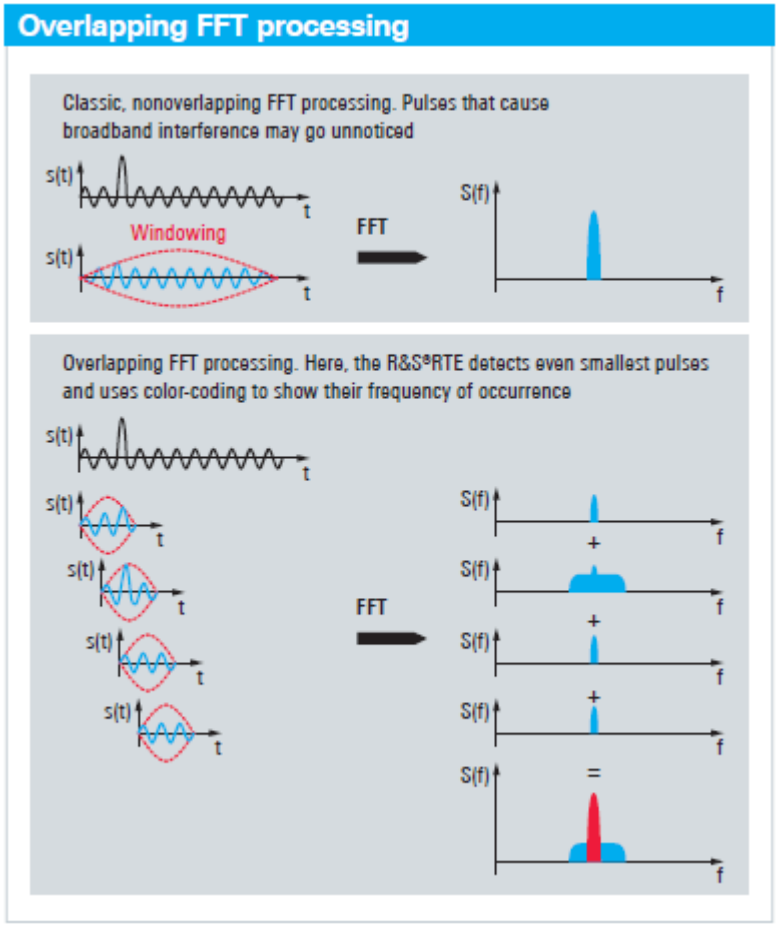
Avantages:

- Analyse du spectre en fonction du temps
- Pas de perte entre chaque FFT (contrairement à une FFT conventionnelle)
- Limitation du nombre de Frame pour une FFT rapide
  - **Note:** La FFT démarre de la gauche

Identification des signaux

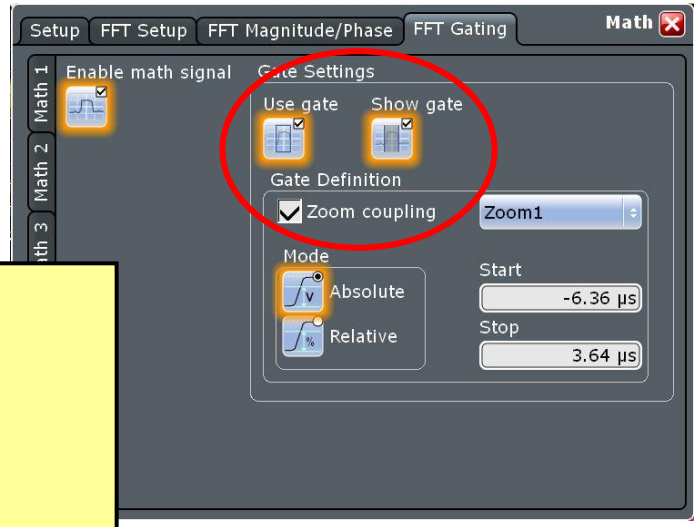
fixes, impulsionnels…

- Les multiples FFT permettent de déceler L'occurrence des évènements
- Codage par couleur de l'occurrence
- Révélation des signaux sporadiques



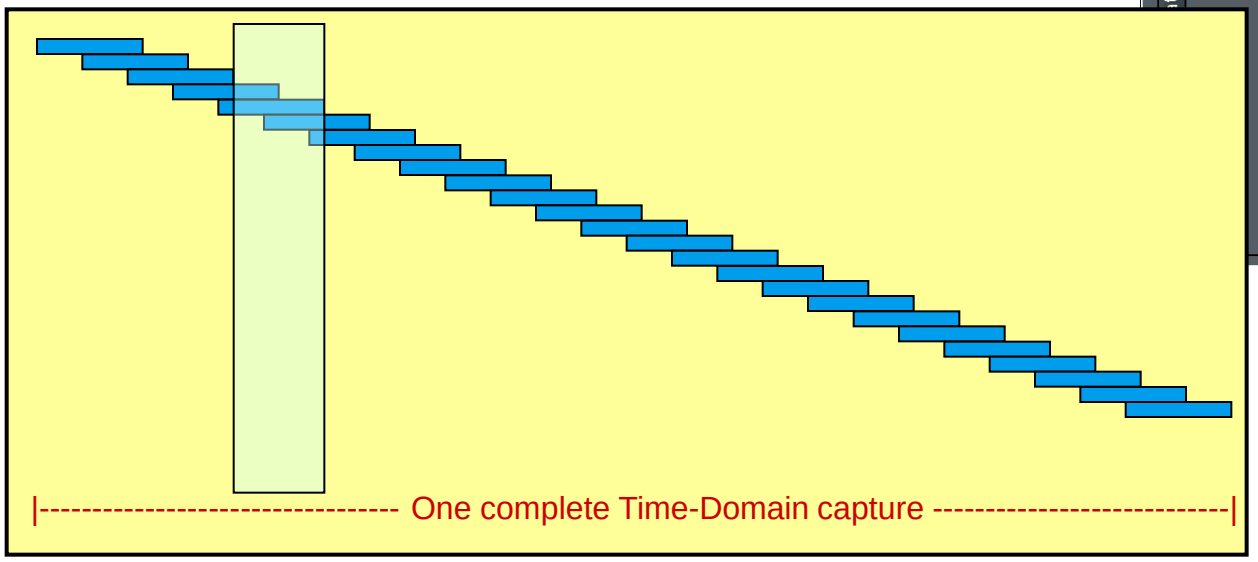
Correlation temps-fréquence

Utilisation d'une gate



Gated FFT:

50% overlap (default setting)

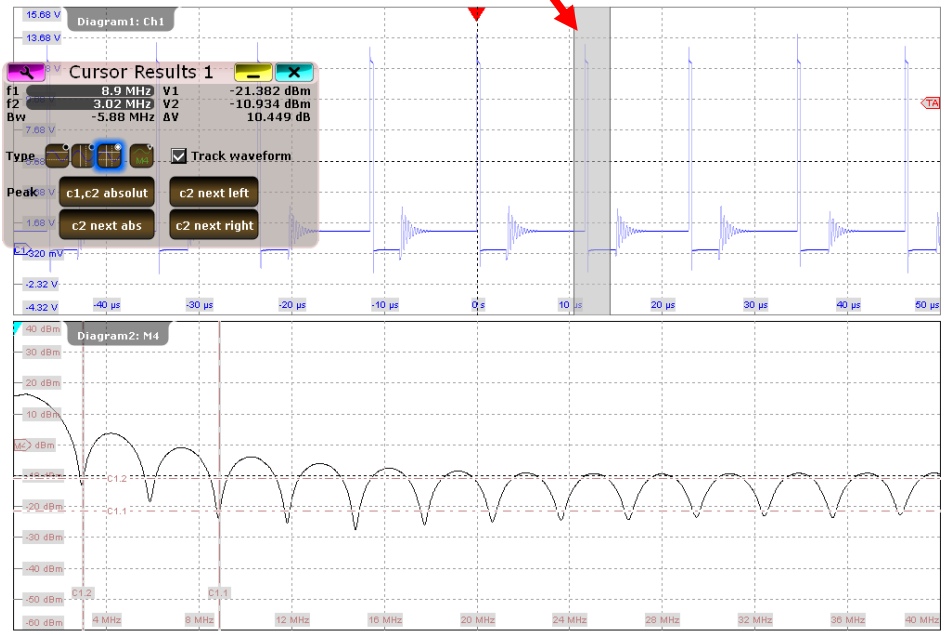


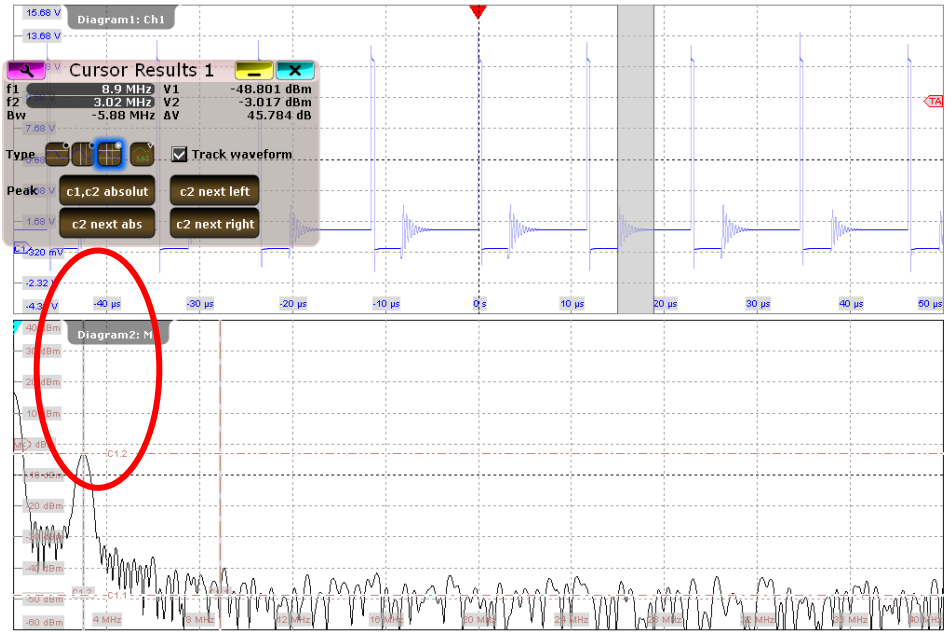
Correlation temps-fréquence

Utilisation d'une gate

Identification de la source

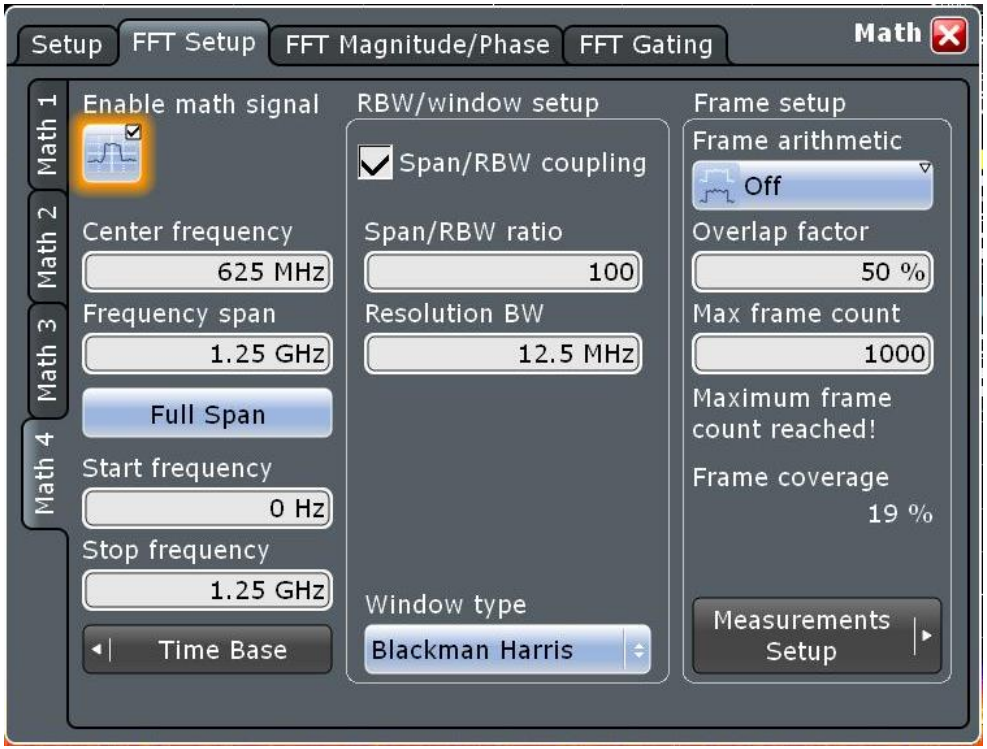
Le positionnement de la gate permet de voir les composantes fréquentielles dû au rebond





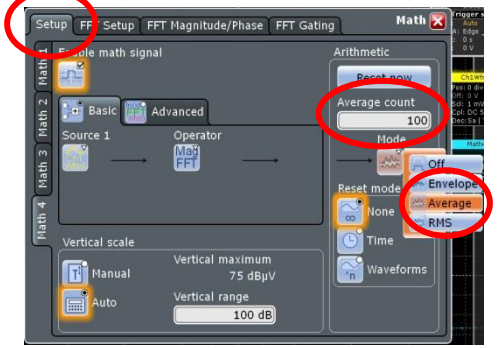
Facilité d’utilisation

- FFT façon analyseur de spectre
- FFT réalisé en deux clics

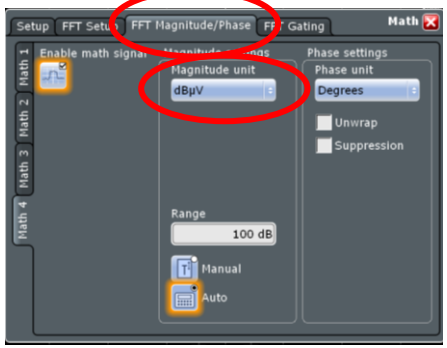


FFT – Paramètres avancés

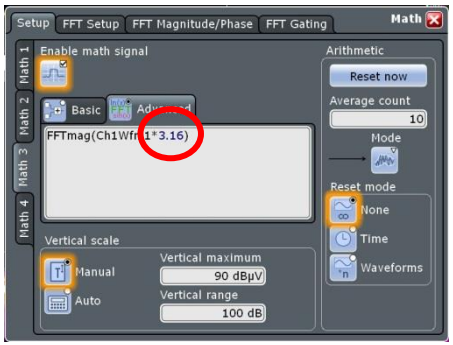
Max-Hold*, Average, RMS



Unités spectrale

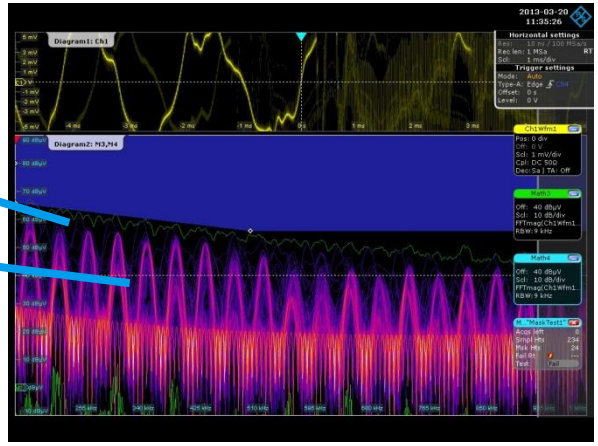


Facteur de correction pour LISN
(fréquence fixe, ex:10 dB)

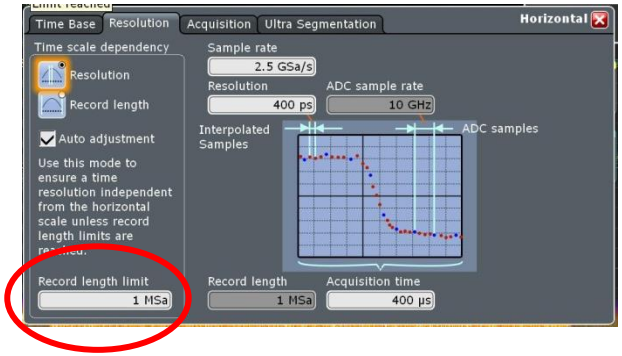


Multiple FFTs

Vert: Max-Hold
Violet: spectre actif, dégradé de couleur



Profondeur mémoire> 1 MS



***Note:** Envelope = Max Hold

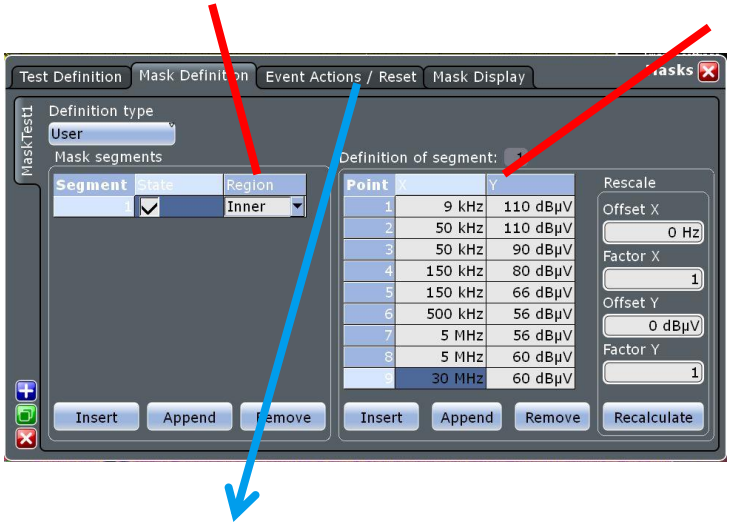
Utilisation de gabarit

Création de masque

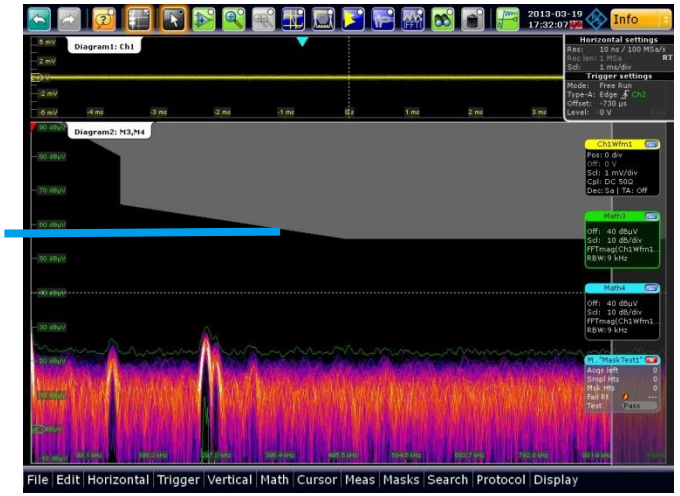
- **Pour les gabarits, utilisation du mask tool**

Upper pour limite supérieure

Définition des points dans l'unité de la FFT



Masque supérieur en tant que limit line



La violation de masque se revèle très utile

Test de masque en FFT avec violation

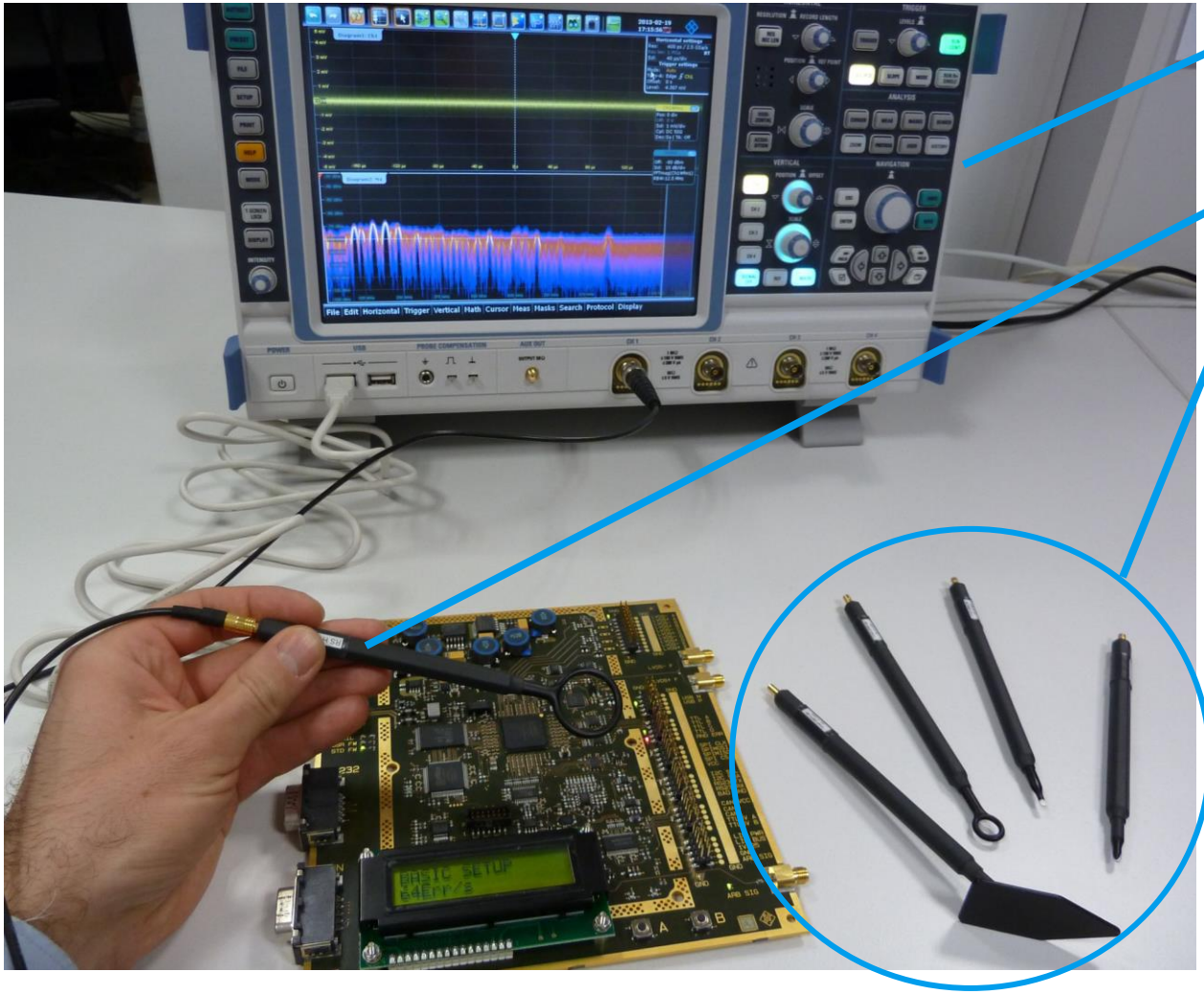
Capture et analyse d'un signal intermittent

Définition du masque

Stop de l'acquisition sur une violation

Analyse avec differentes vues spectrales et gates

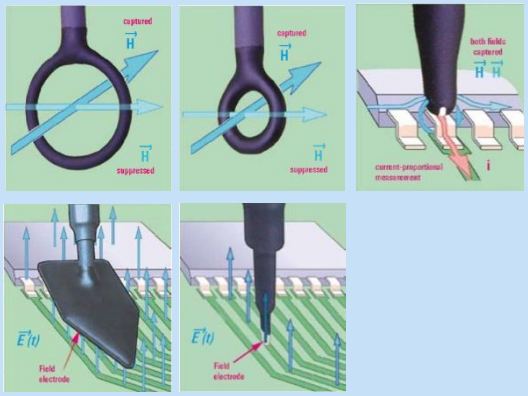
Accessoires recommandés



R&S ® RTE/RTO

Near-field sniffer Probes R&S ® HZ-15

E- and H-field



30 MHz – 1 GHz

Can be used down to 100 kHz

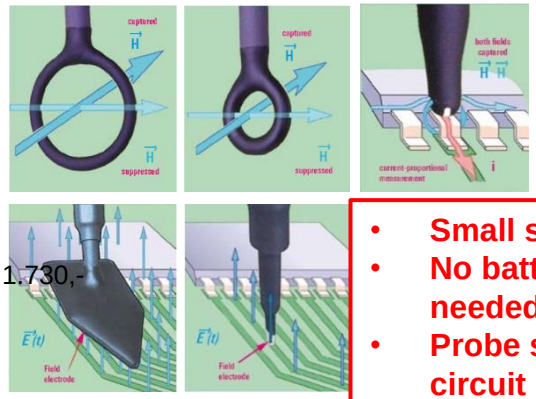
Optional:
R&S ® HZ-16
Preamplifier

Accessoires recommandés

Sondes de champ proche

R&S ® HZ-15

E- and H-field



- **Small size**
- **No battery needed**
- **Probe single circuit lines**

EUR 1.730,-

30 MHz – 1 GHz

Can be used down to 100 kHz

HZ530

E- and H-field

100 kHz – 1 GHz

EUR 788,-

HZ540/550

E- and H-field

1 MHz – 3 GHz

EUR 1.428,- / 1.848,-

Note: No power supply included

Accessoires recommandés

RSIL

R&S ENV216

EUR 2-4k

HM 6050-2

EUR 1.038,-

Note: You need an isolation transformer for operating the LISN

Merci