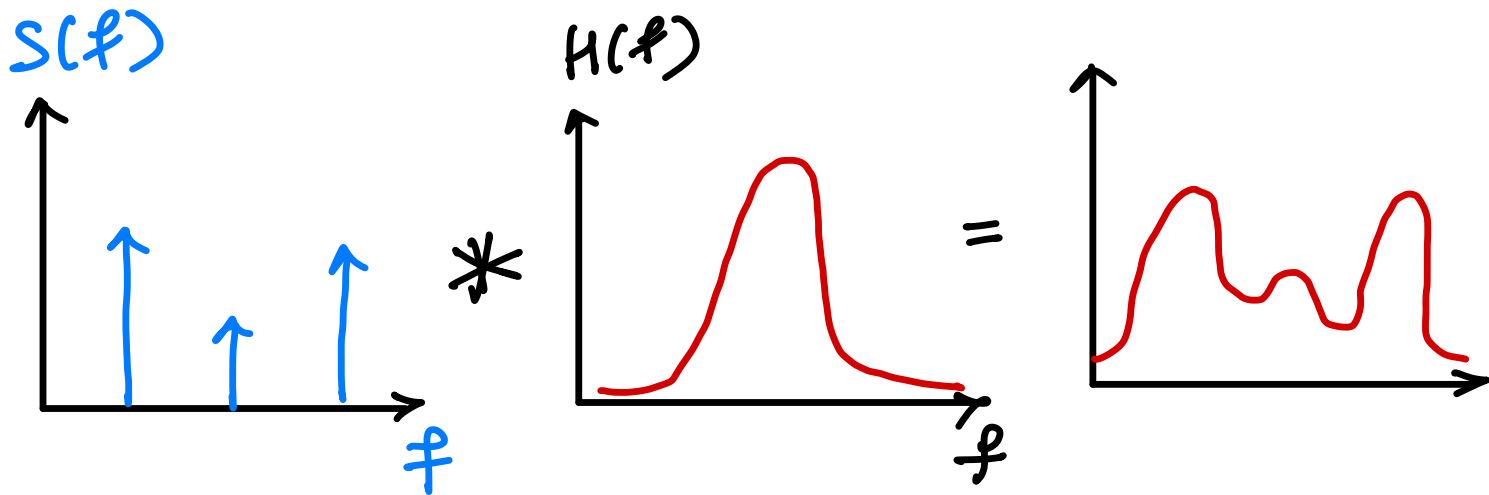
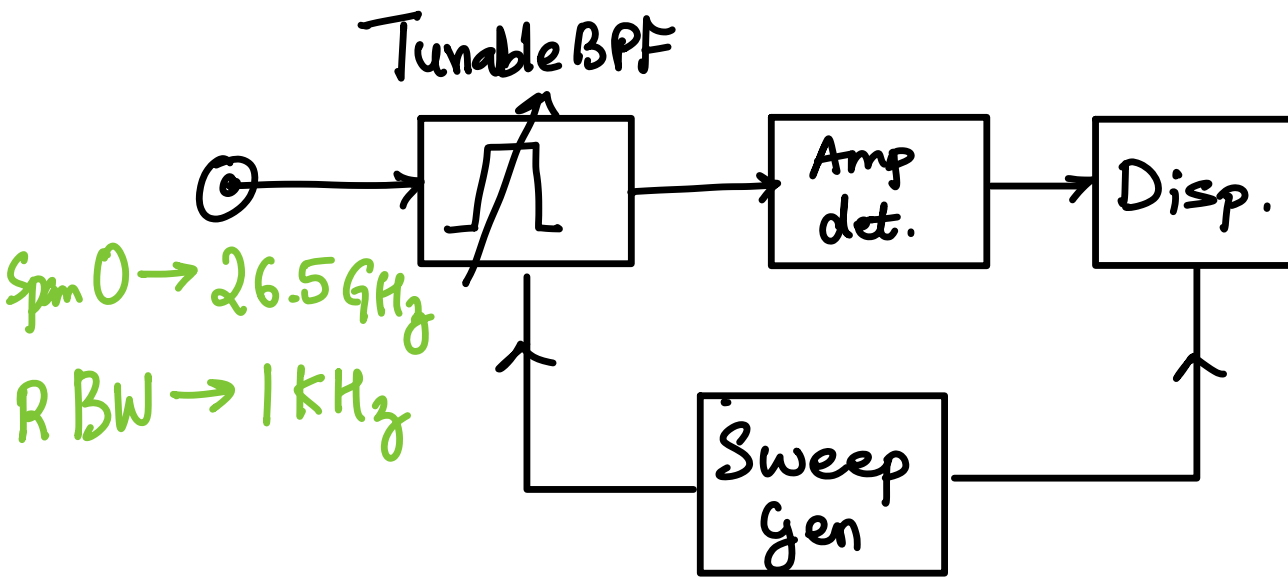




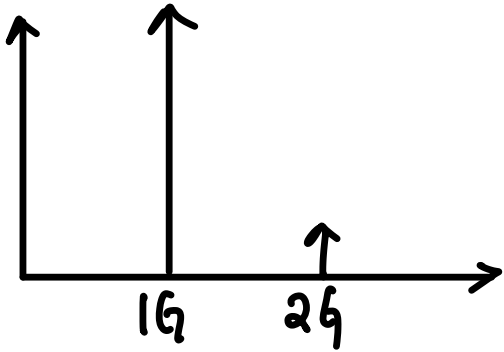
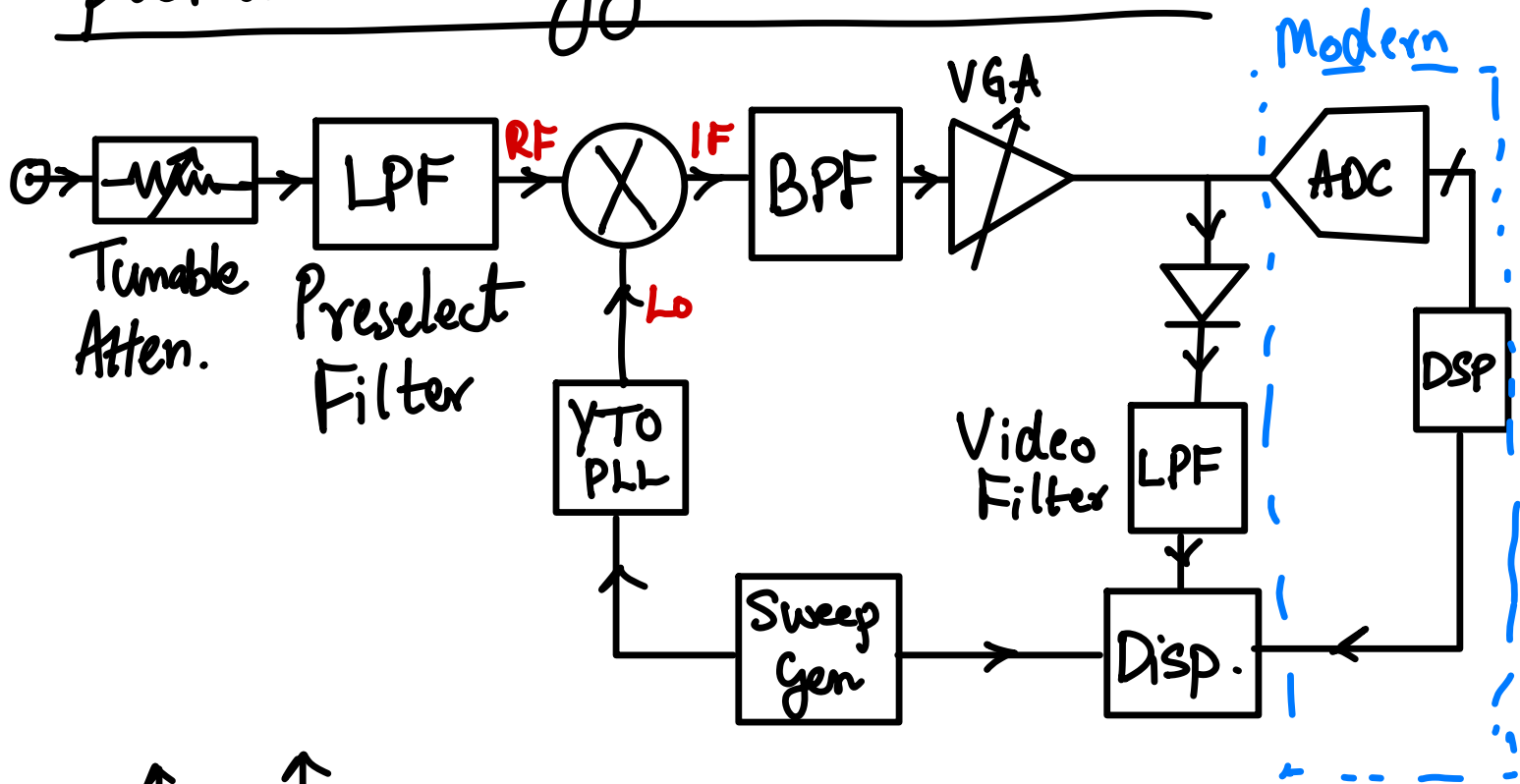
Spectrum Analyzers

▷ Scalar measurements.

Conceptual block diagram



Spectrum Analyzer Architecture



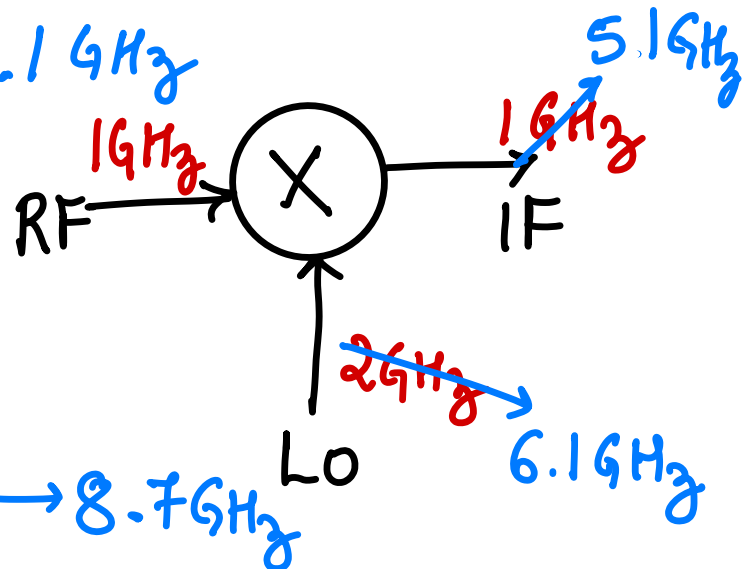
Frequency Planning

Say we want RF: $0 \rightarrow 3.6 \text{ GHz}$.

Select IF = ~~1G Hz~~ $\rightarrow 5.1 \text{ GHz}$

$\Rightarrow$ LO: ~~1~~ $\rightarrow 4.6 \text{ GHz}$

$5.1 \text{ GHz} \rightarrow 8.7 \text{ GHz}$



We want very high dynamic range.

Issues

1) LO is in-band

⇒ Double sideband response.

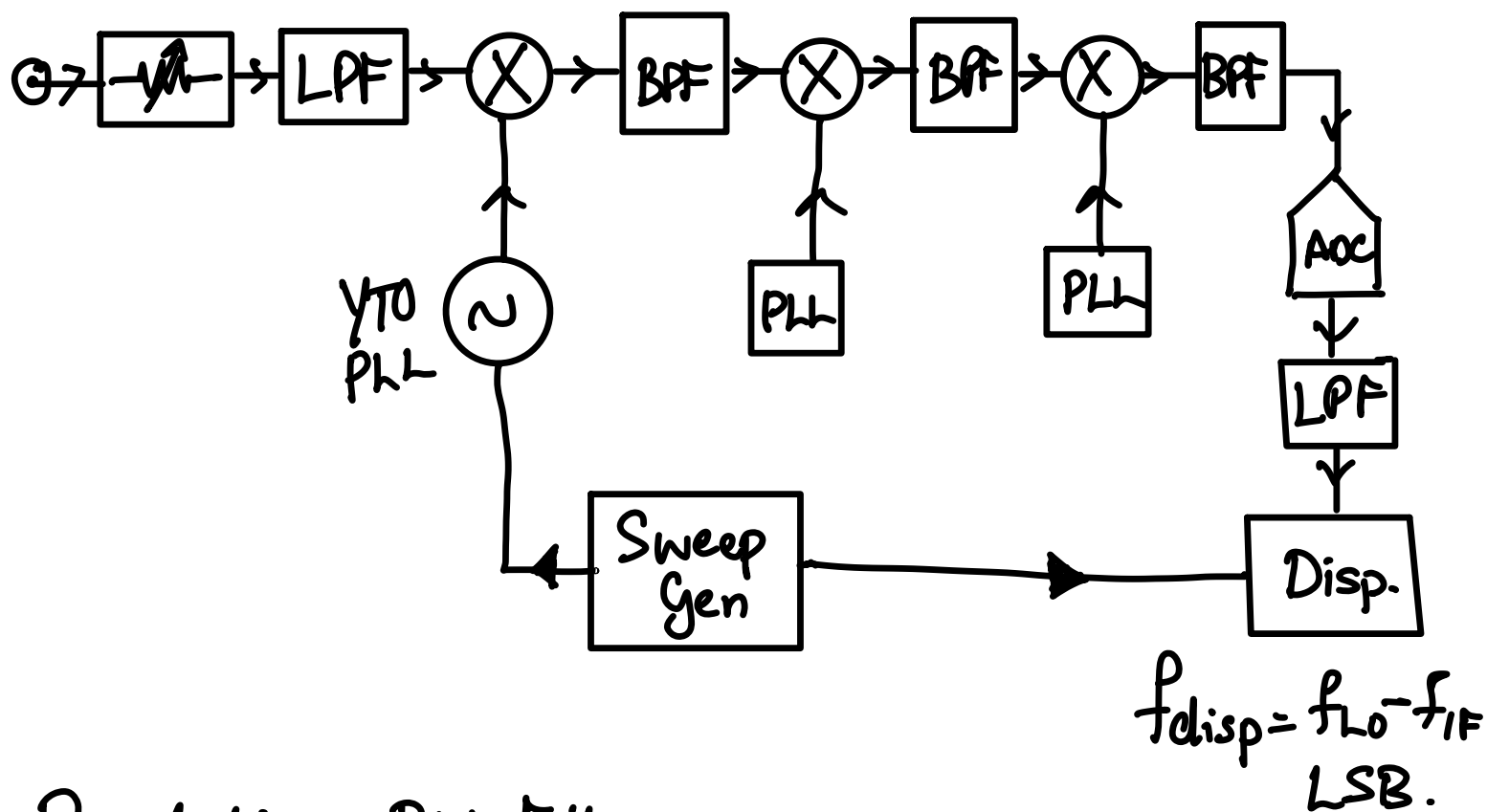
Image reject mixer X.

2) LO → IF leakage.

3) RF → IF leakage.

Double balanced X.

Fix for 1) & 3) is to increase
IF frequency beyond RF span!



Resolution BW Filter

$\triangleright$ BW of the last IF filter.



Span = Δf , Sweep Time = T

$$\text{RBW} = f_{\text{RBW}}$$

$$t_{\text{dwell}} = \frac{f_{\text{RBW}}}{\Delta f} \cdot T$$

$$t_{\text{rise}} = \frac{1}{f_{\text{RBW}}} = \frac{1}{f_{\text{RBW}}}$$

$$T = \frac{\Delta f}{f_{\text{RBW}}^2}$$

$\rightarrow 1 \text{ MHz}$
 $\rightarrow 100 \text{ Hz}$

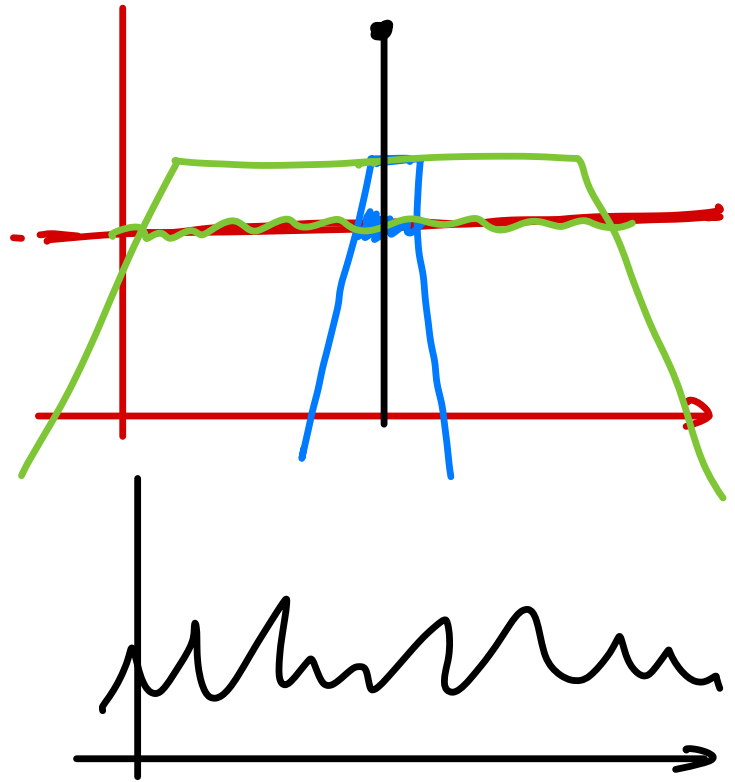
FFT Mode

> The final filter is broadened & the entire spectrum is sampled like an oscilloscope.

Adv: Fast!

Dis: Noise ↑

Limited span!



Noise

RBW → Sets the noise floor!

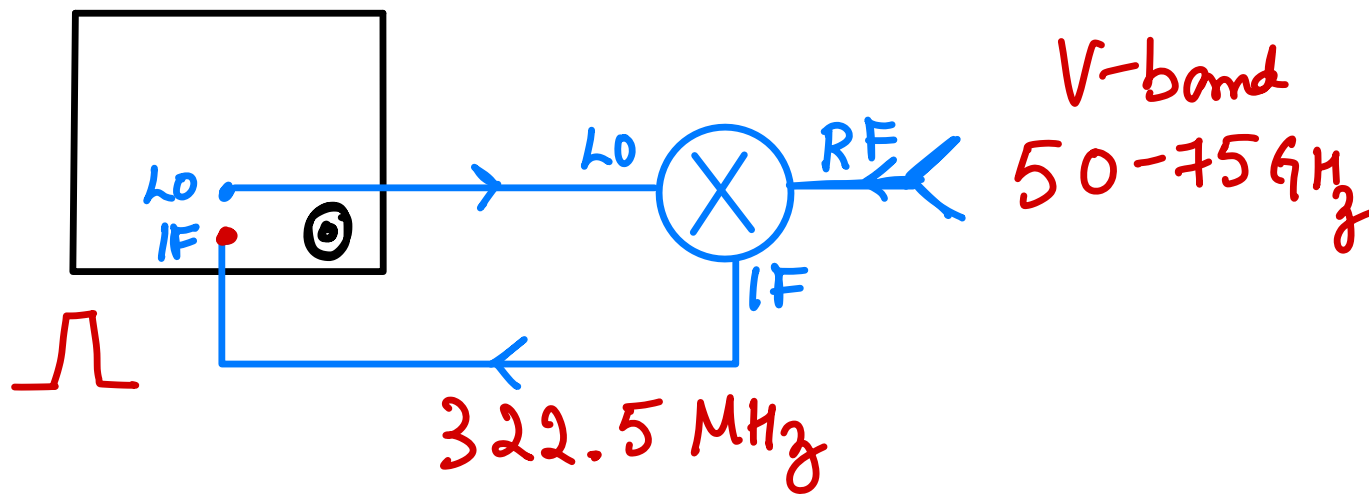
RBW ↓ by 10 ⇒ Noise ↓ by 10dB

⇒ SNR ↑ by 10dB

[Caution: For static spectrum]

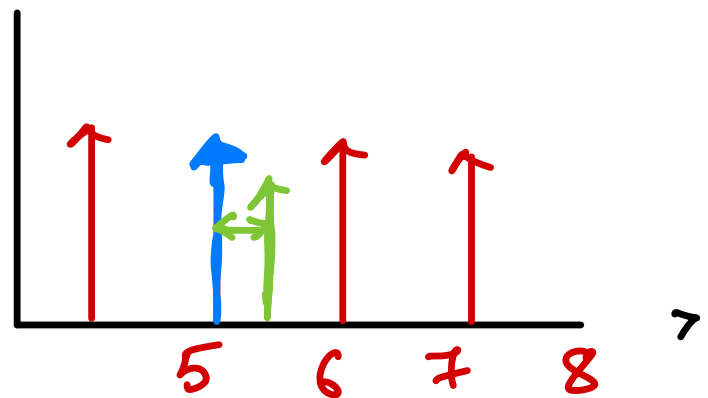
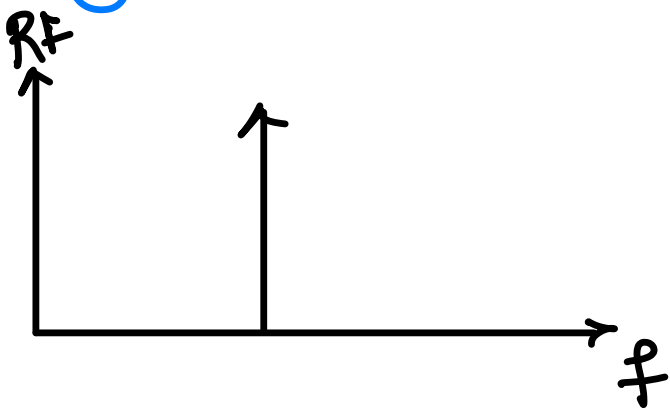
VBW → Sets the trace variance of the noise

External Harmonic Mixing



Harmonic Mixing uses harmonics of the external mixer.

Big issue!



False/Image Signals

- 1) Upper side band of 6
 $6LO + IF$
- 2) Harmonic ambiguity!

Display
 $6LO - IF$

$$\left| \underbrace{f_{RF}}_{62.5 \text{ GHz}} - N f_{LO} \right| = \underbrace{f_{IF}}_{0.3225 \text{ GHz}} \Rightarrow \text{RF shows up on spectrum.}$$

$$N = 7^+ \quad f_{LO} = 8.8825 \quad f_{Disp} = 52.97 \text{ GHz}$$

$$N = 7^- \quad f_{LO} = 8.9746 \quad f_{Disp} = 53.53 \text{ GHz}$$

$$\checkmark N = 6^- \quad f_{LO} = 10.4707 \quad f_{Disp} = 62.5 \text{ GHz}$$

$$N = 6^+ \quad f_{LO} = 10.3629 \quad f_{Disp} = 61.855 \text{ GHz}$$

$$N = 5^+ \quad f_{LO} = 12.4355 \quad f_{Disp} = 74.29 \text{ GHz}$$

SIG-10

▷ Change the LO & Display frequency to fix the real signal.

▷ Switch from 6^- to 6^+ on both LO & display.

$$6^- \Rightarrow LO : \frac{50 + 0.3225}{6} \rightarrow \frac{75 + 0.3225}{6}$$

$$6^+ \Rightarrow LO : \frac{50 - 0.3225}{6} \rightarrow \frac{75 - 0.3225}{6}$$

Harmonic	LO	Sweep 1 (6^-) (Display)	Sweep 2 (6^+) (Display)
7^-	8.9746	53.525	54.170
7^+	8.8825	52.973	53.618
6^-	10.4704	62.5	63.145
6^+	10.3629	61.855	62.5
5^+	12.4355	74.291	74.936

Limitations

- 1) Cannot handle many tones.
- 2) Conversion loss is high.
- * 3) Noise measurement are very difficult!