



Added Phase Noise measurement for Local Oscillator distribution systems



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Receiver Gain Stability: 5th Engineering Forum Workshop
12 - 13 May 2011 Cagliari (Italy)

Collaborators in this work

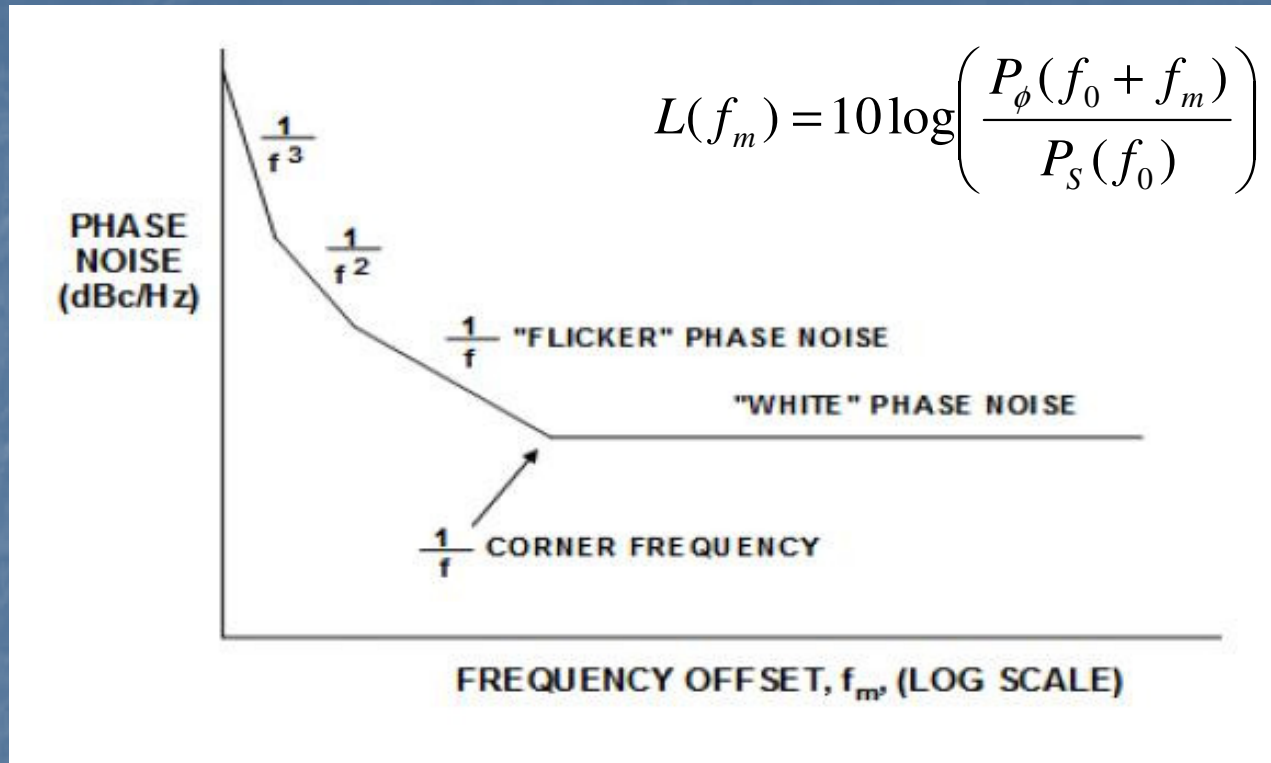


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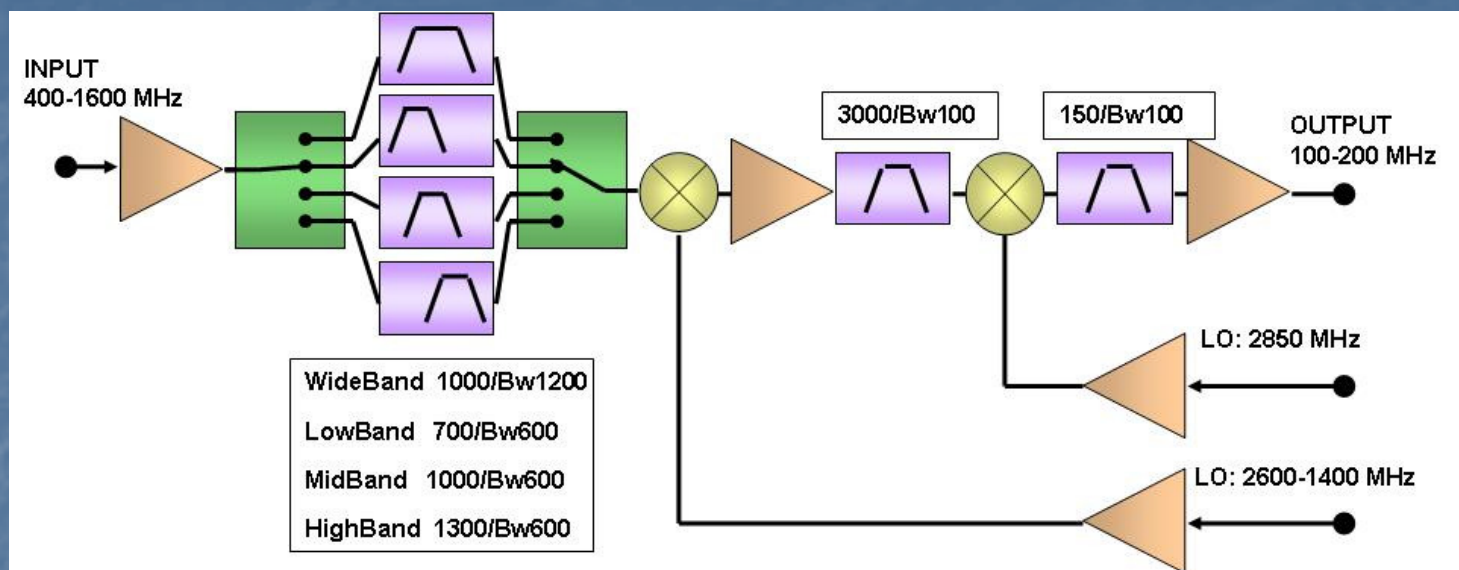
Phase Noise slopes



Phase Noise in dBc/Hz is plotted as a function of frequency offset from carrier (f_m). Different slopes correspond to different effects. Curves have a slope of $1/f^x$, where:

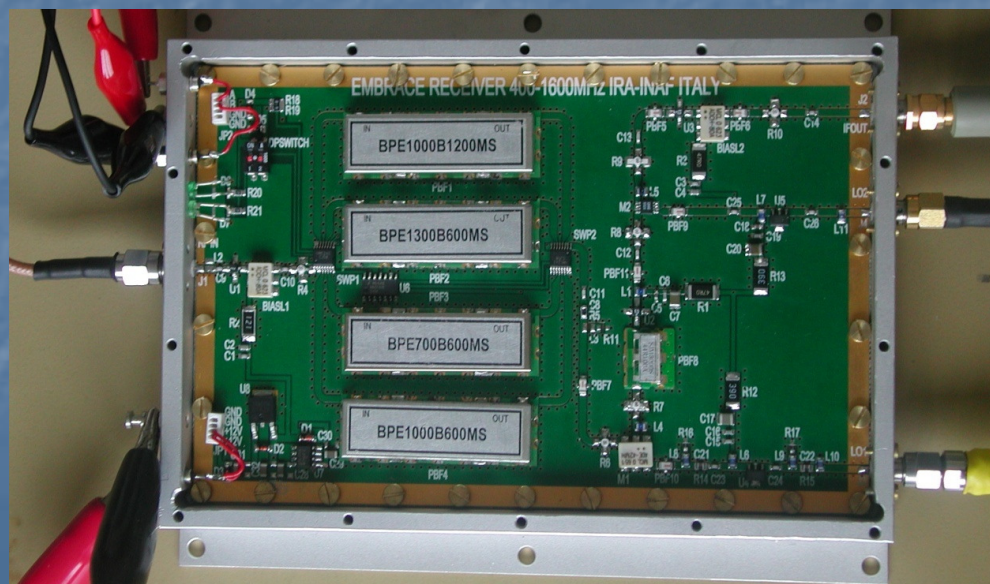
- $x = 0$ corresponds to white phase noise.
- $x = 1$ corresponds to flicker phase noise.
- $x = 2 \dots$ corresponds to random walk.

Heterodyne receiver



EMBRACE* receiver

- RF input: 400-1600MHz
- IF output: 100-200MHz
- Double Conversion:
 - LO1: 2600-1400MHz
 - LO2: 2850MHz
- High Selectivity Filter Bank

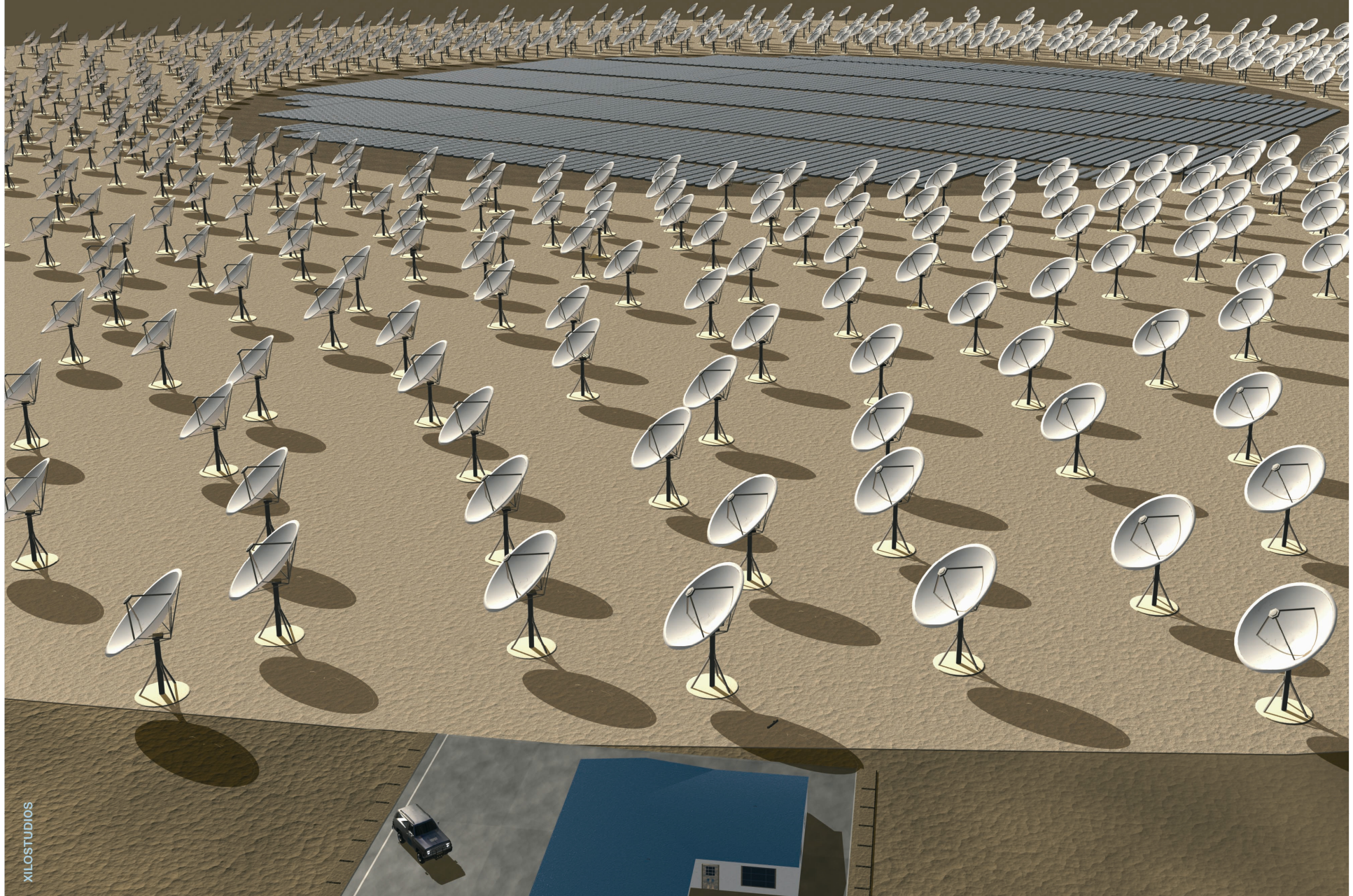


* Electronic Multi-Beam Radio Astronomy ConcEpt

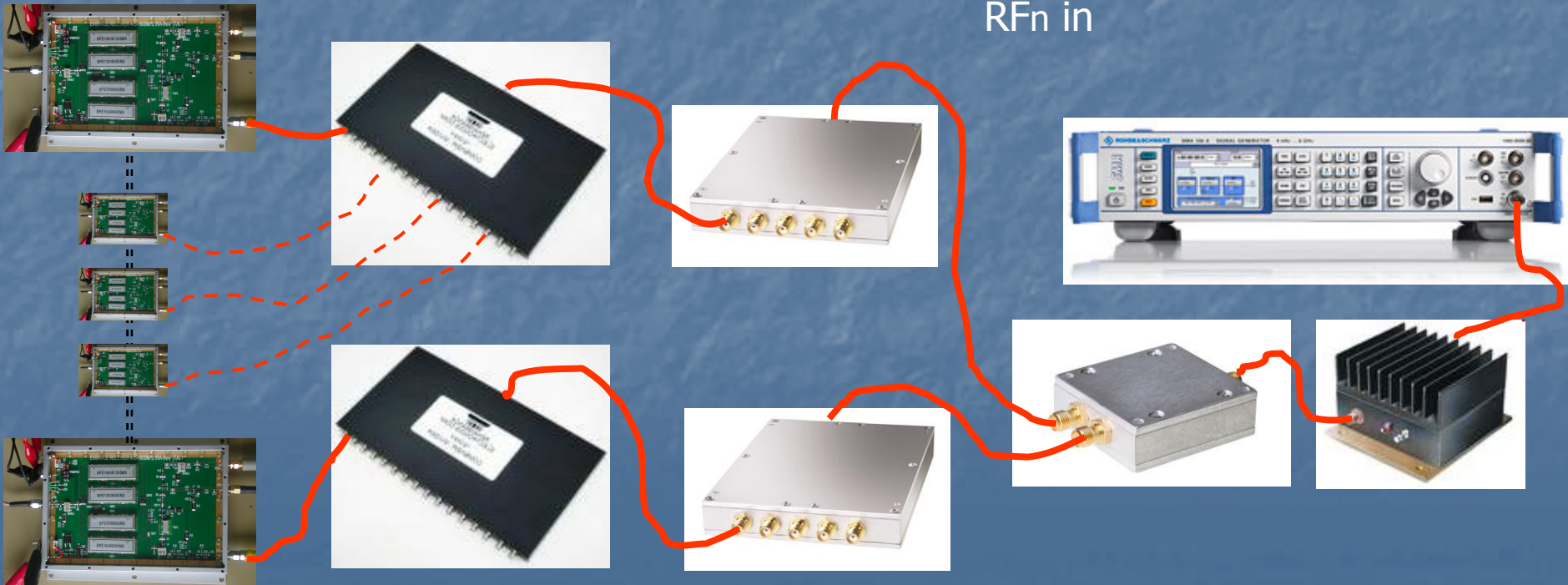
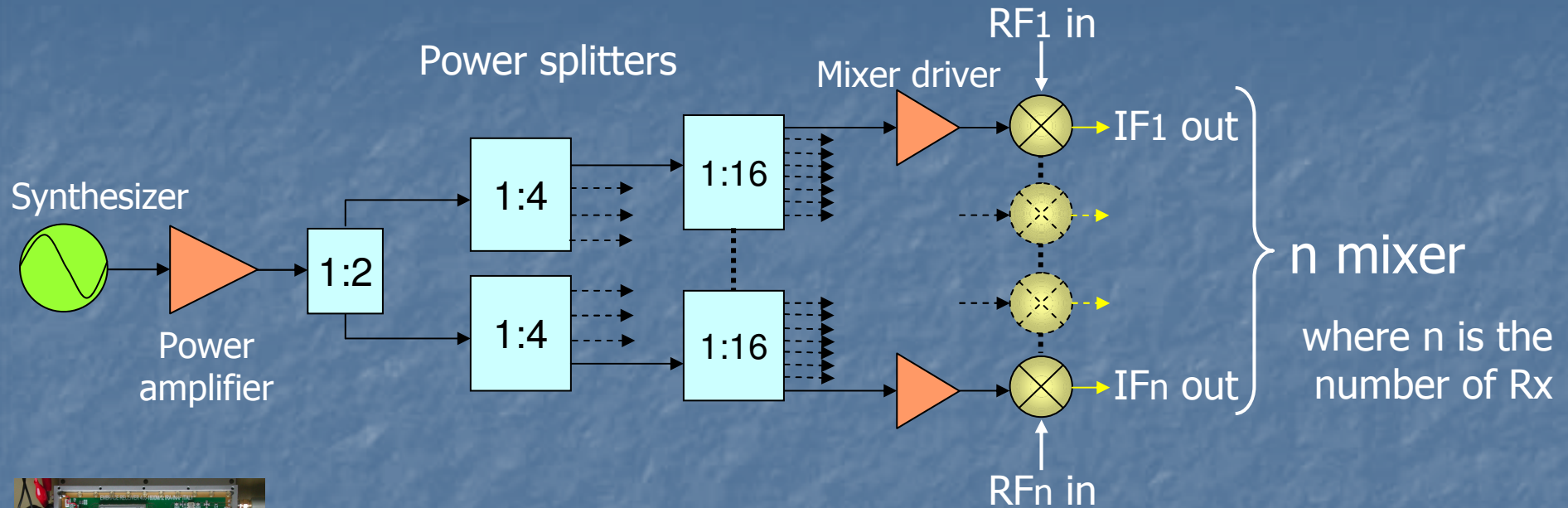
Array of antennas (e.g. Northern Cross)



Array of antennas (e.g. SKA)



Local Oscillator distribution system: splitter chain



MEASUREMENTS PERFORMED

1. Additive (residual) phase noise

The phase noise contribution due to the amplifiers and the power splitters.

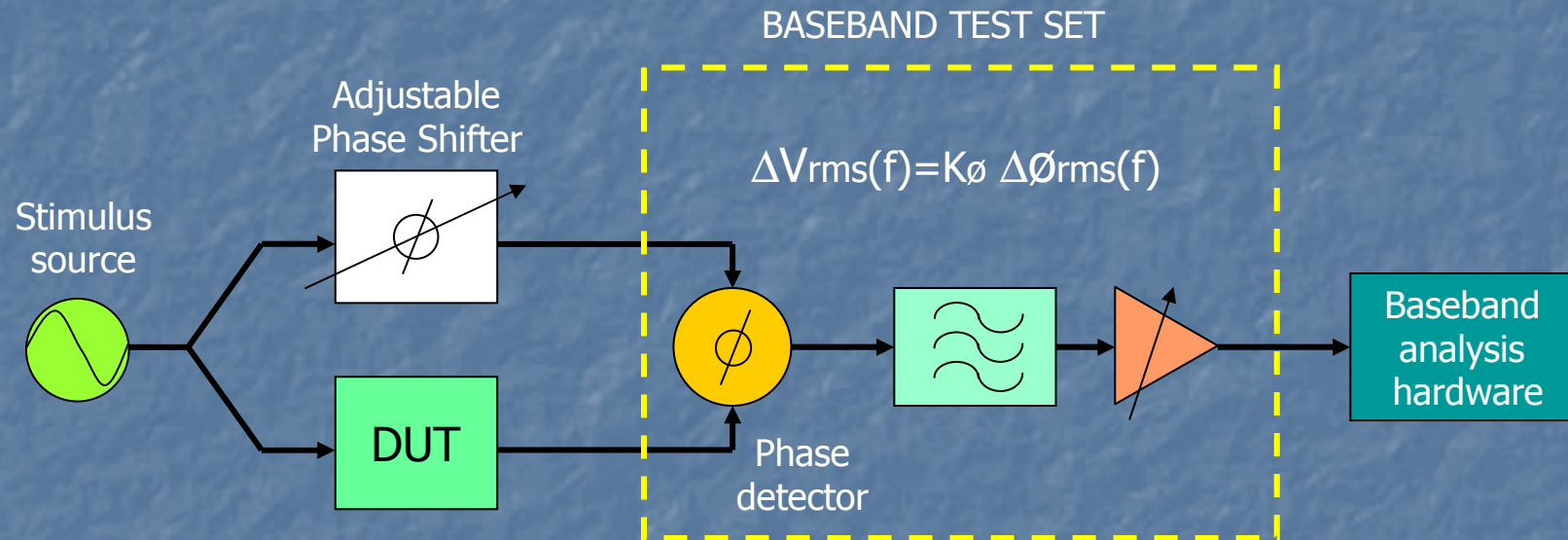
2. Absolute (total) phase noise

Total contribution of the LO distribution system.

3. AM to PM conversion

The phase modulation of the mixer driver amplifier.

Block diagram for the Additive Phase Noise measurements

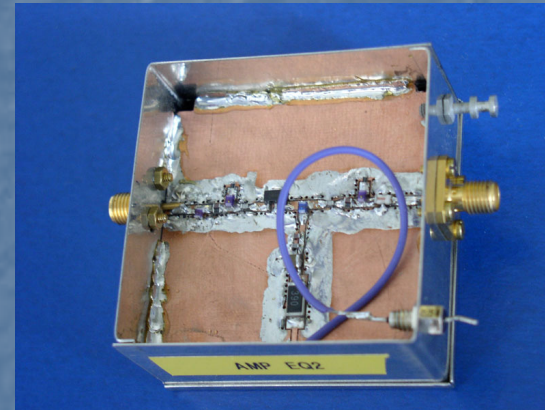


In order to obtain an extremely precision measure of the additive phase noise, we used the **Agilent E5500** Phase Noise Measurement Subsystem.

DUT for Additive Phase Noise measurements

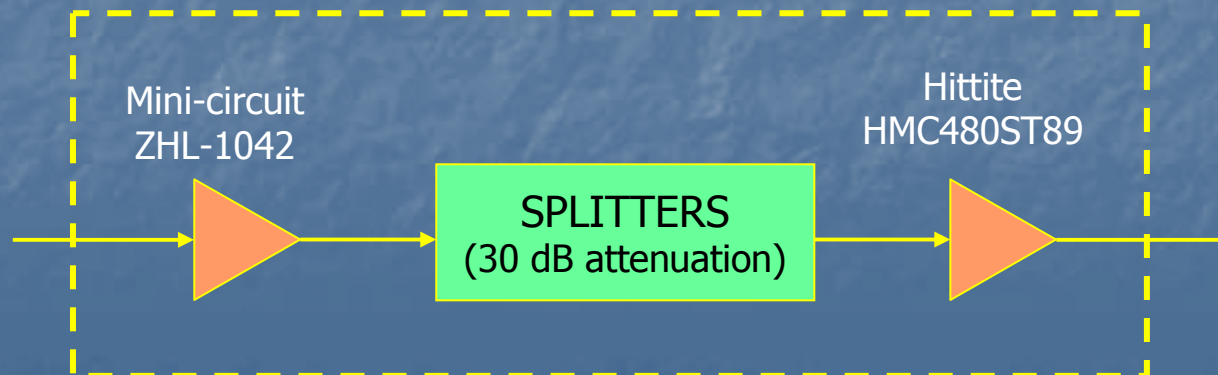
DUT 1: Amplifier

It is the driver amplifier (Hittite HMC480ST89) installed just before the mixers on the EMBRACE receiver board.



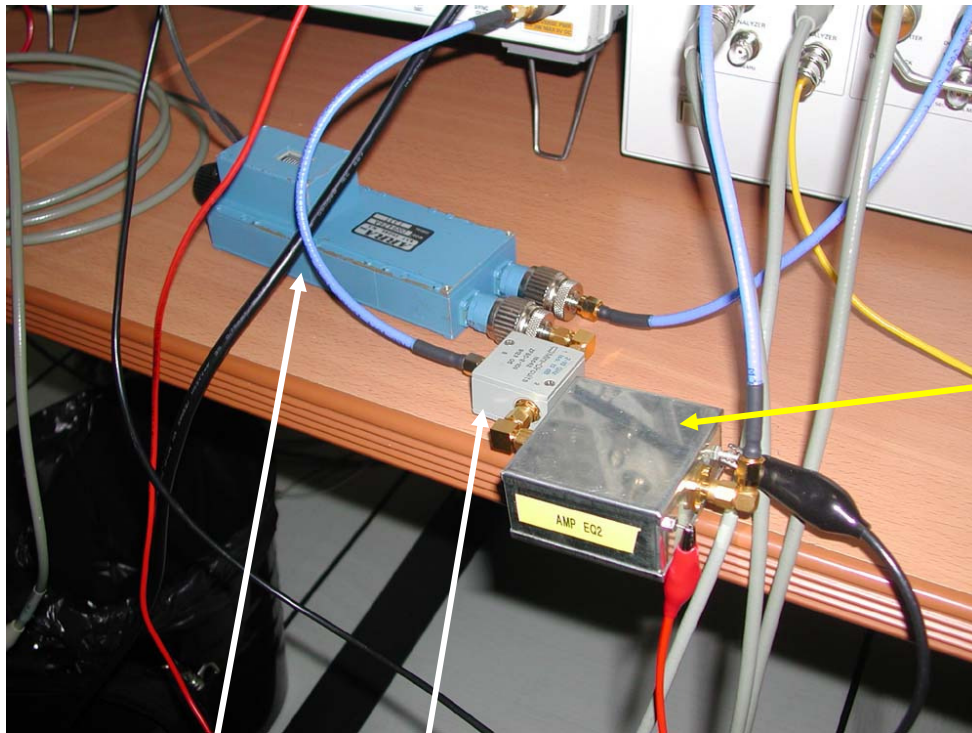
DUT 2: Splitter chain

It is composed of power amplifier + power splitters + mixer driver amplifier.



Measurement test set

DUT 1: amplifier

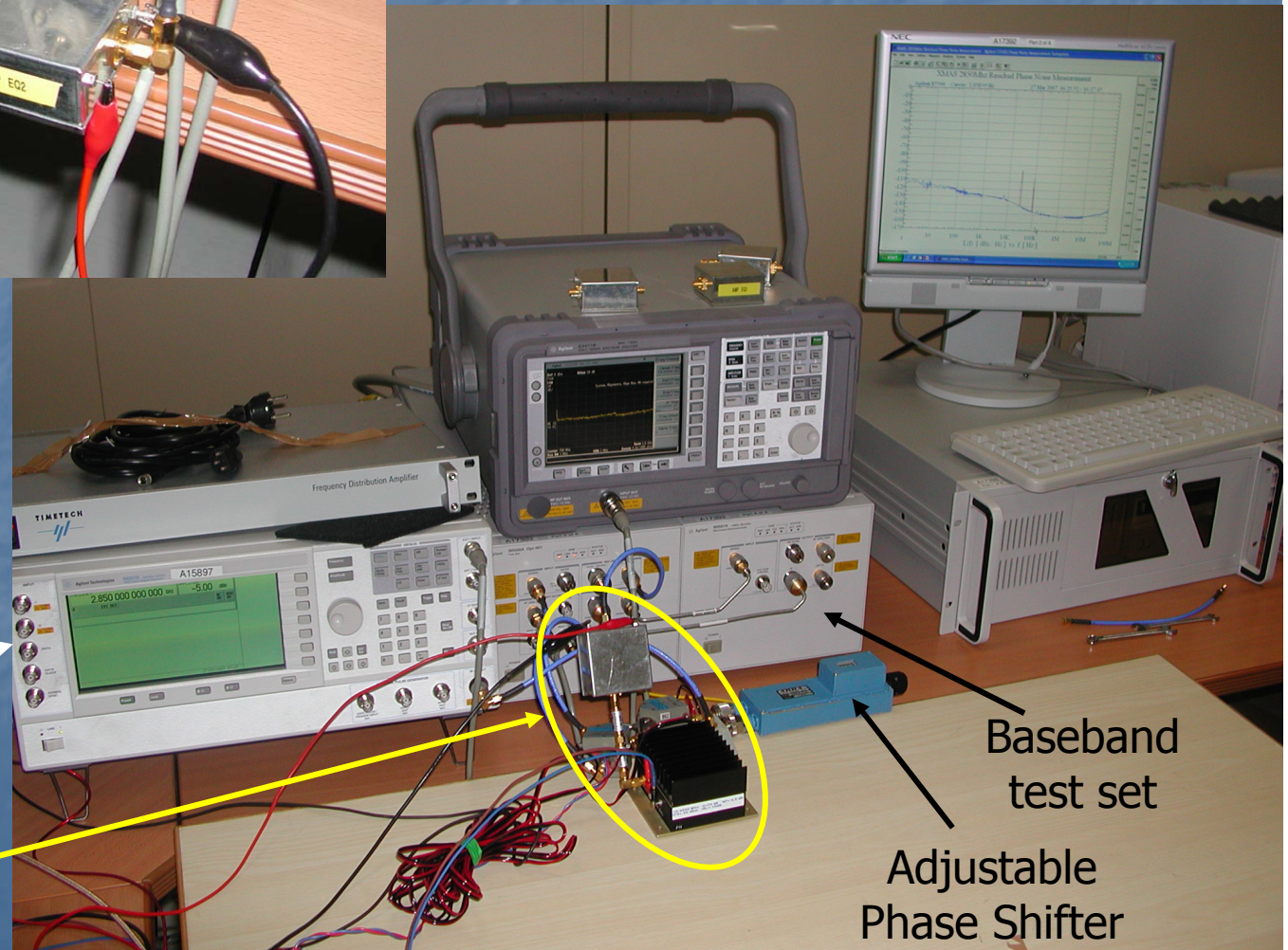


Adjustable Phase Shifter

2 ways splitter

Synthesizer

DUT 2: splitter chain

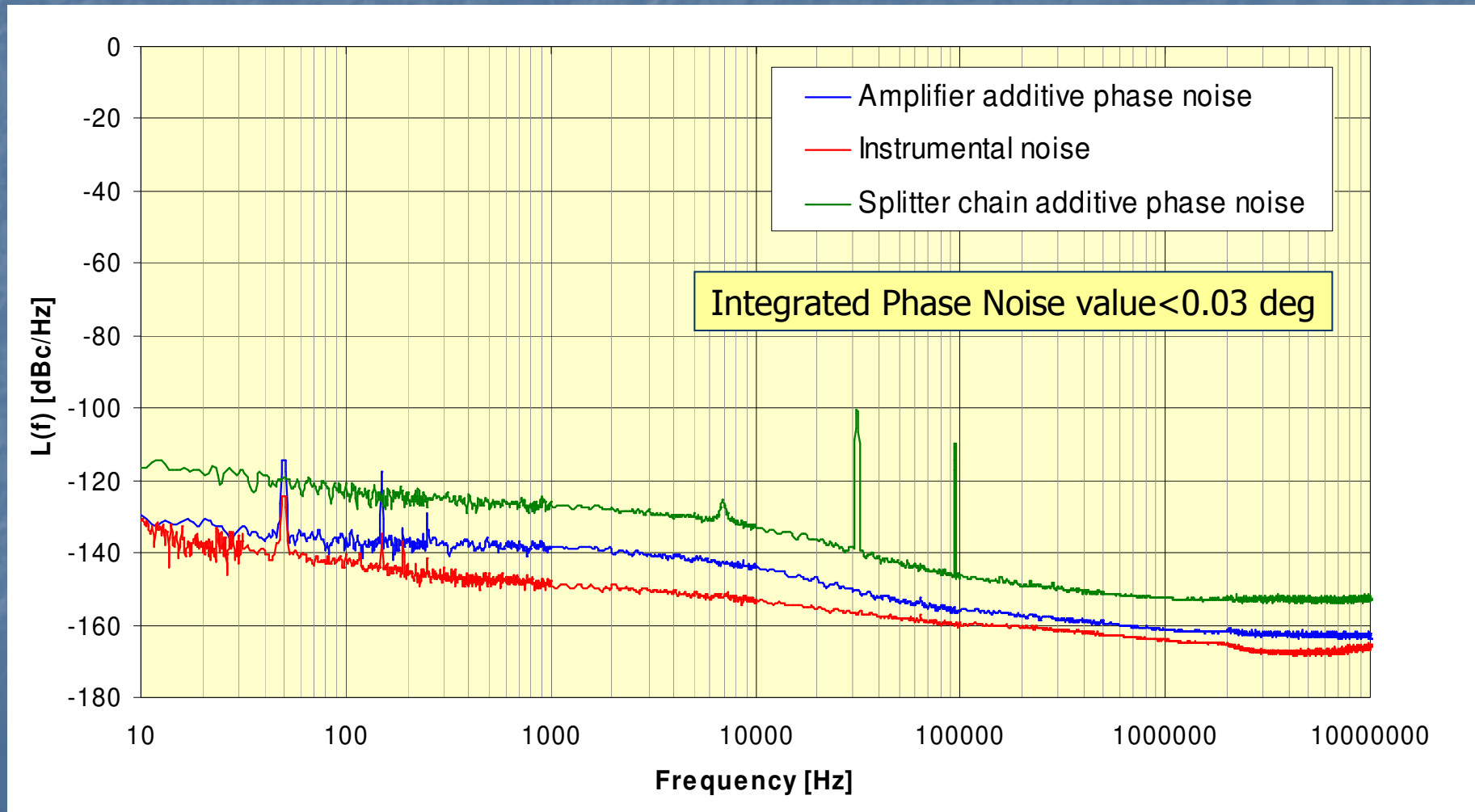


Baseband test set

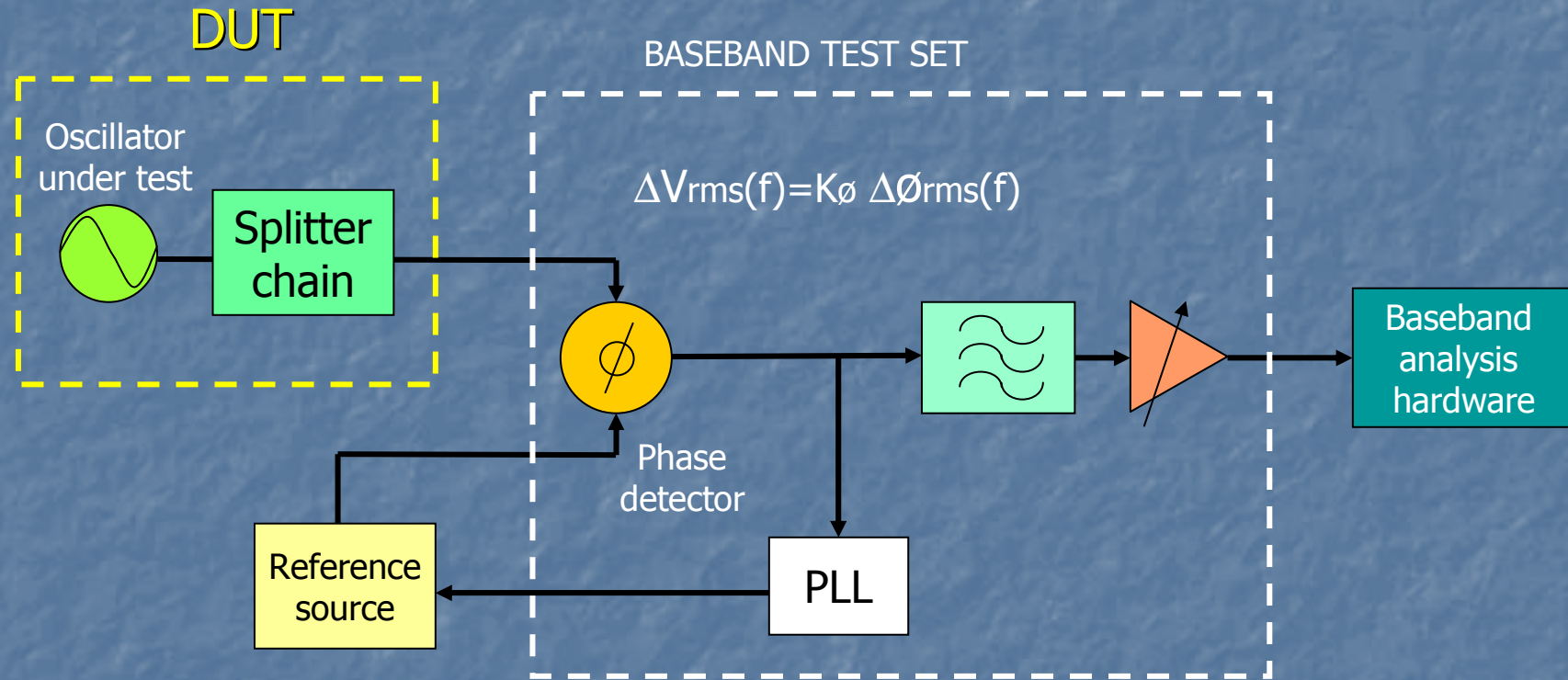
Adjustable Phase Shifter

Additive Phase Noise: RESULTS

Frequency test: 2850 MHz (maximum LO frequency of the system).



Block diagram for the Absolute Phase Noise measurements



DUT for Absolute Phase Noise measurements

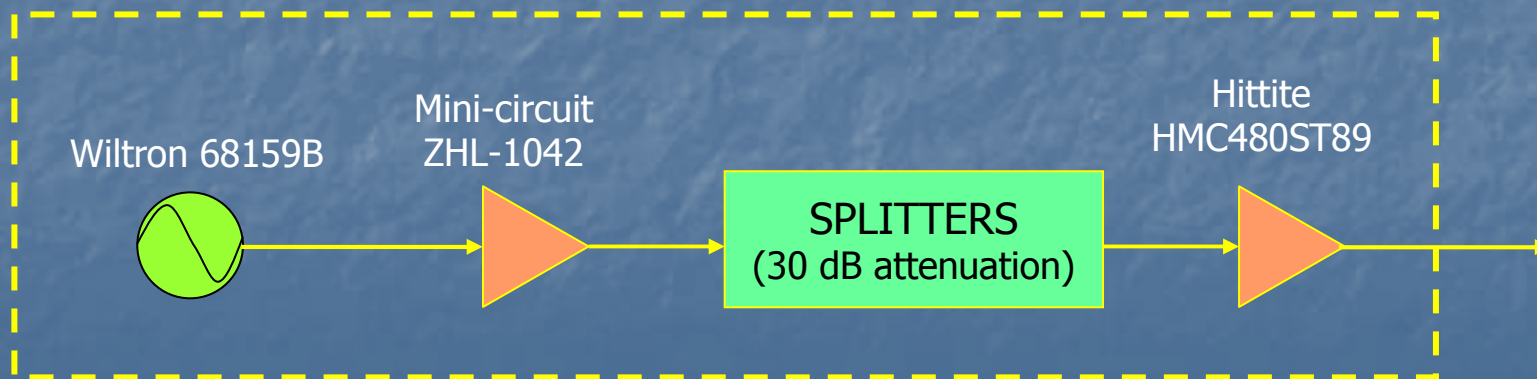
DUT 1: synthesizer

It is the Wiltron 68159B synthesizer that generates the sine wave for the receivers system.



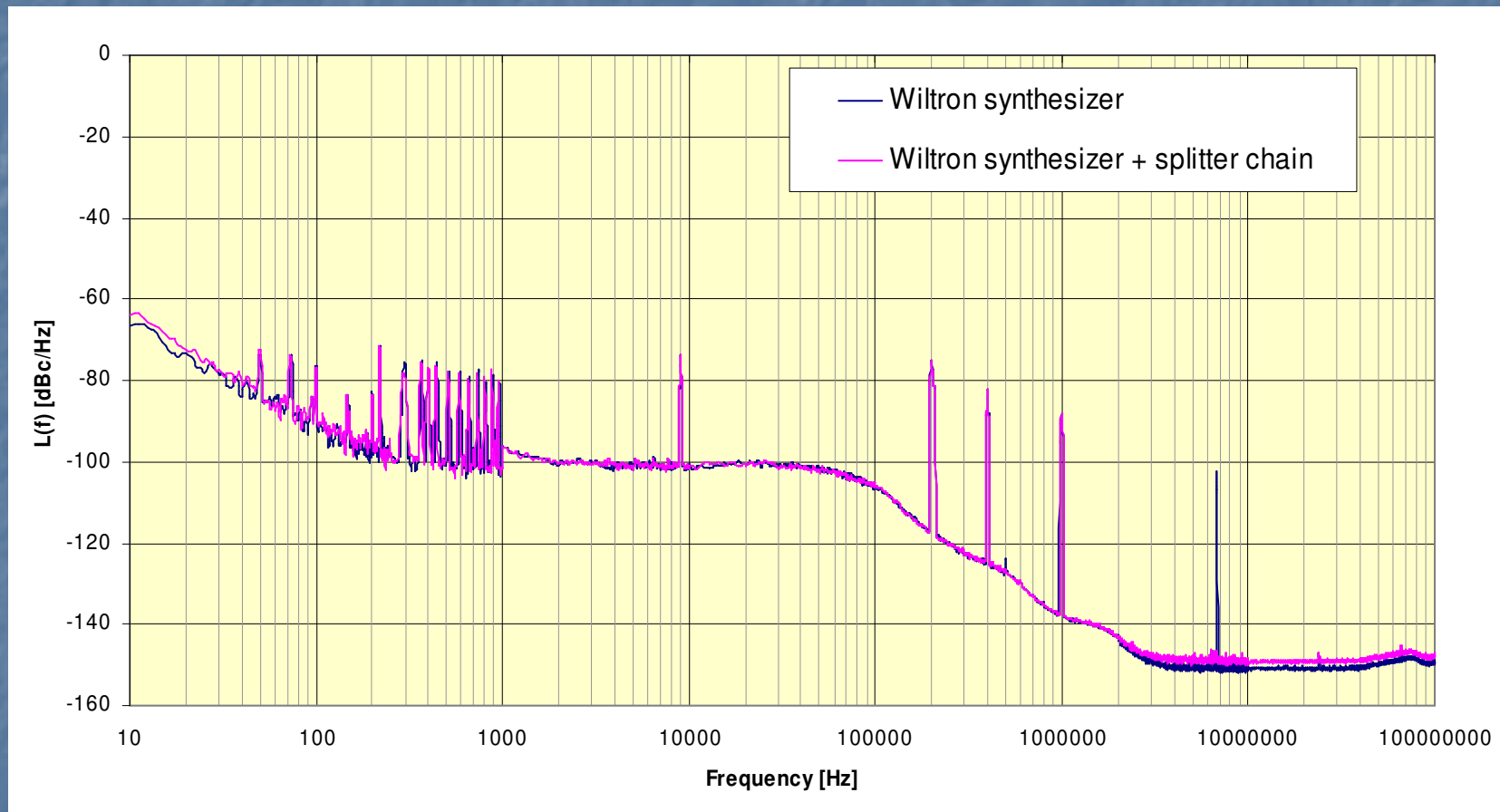
DUT 2: synthesizer + splitter chain

It is composed of Wiltron 68159B synthesizer + power amplifier + power splitters + mixer driver amplifier.



Absolute Phase Noise: RESULTS

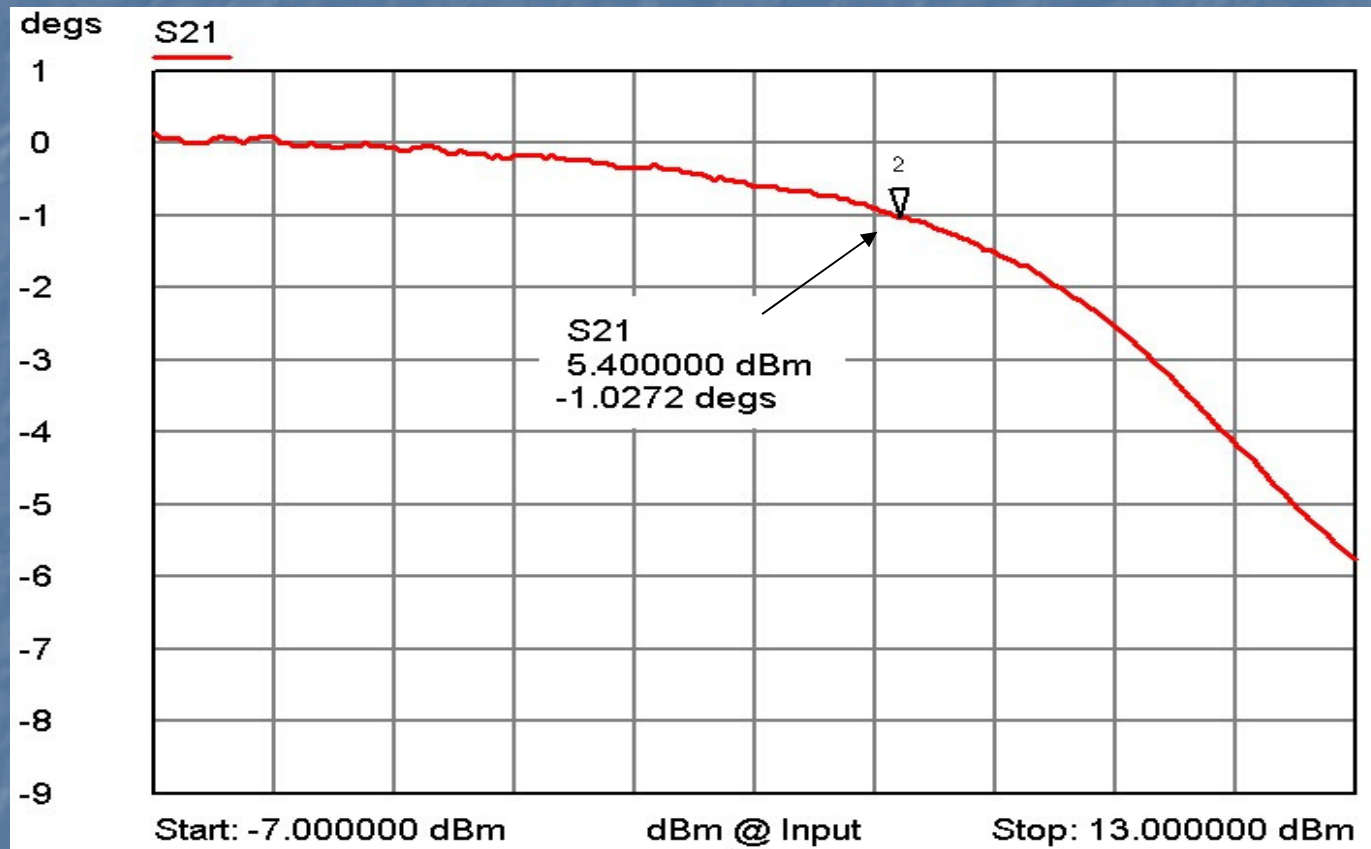
Frequency test: 2850 MHz (maximum LO frequency of the system).



There is an undetectable difference between the two cases. Therefore, the main contribution of the phase noise is due to the synthesizer!

AM to PM conversion measure

Amplifier in nonlinear region.

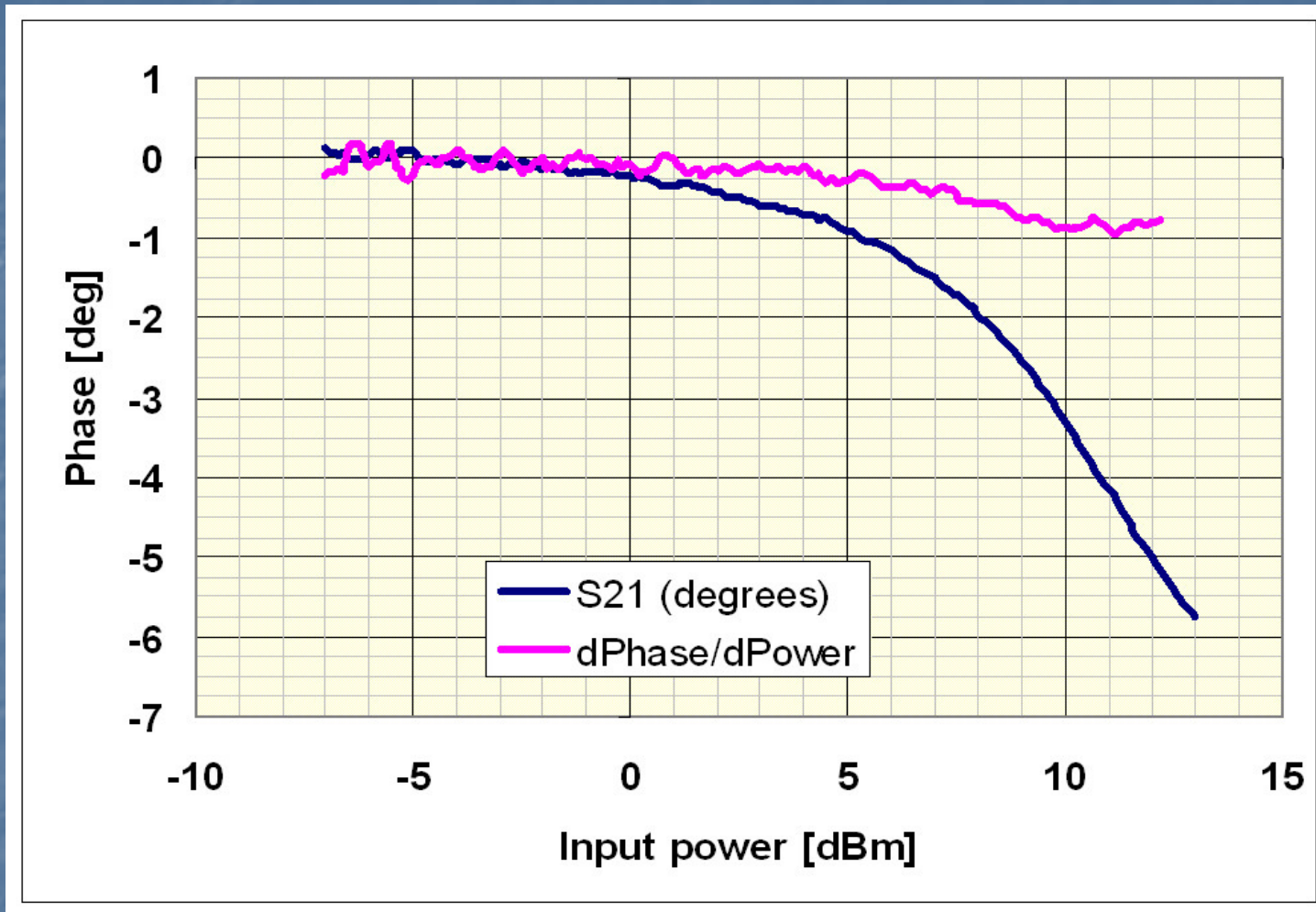


Amplifier under test: Hittite HMC480ST89

Frequency test: 2850 MHz

Network analyzer: HP 8753C

$\Delta\phi / \Delta\text{power}$ measure



The amplifier we measured showed a rough AM to PM conversion less than 0.4 deg/dBm (amplifier driven close to 1dB compression point).

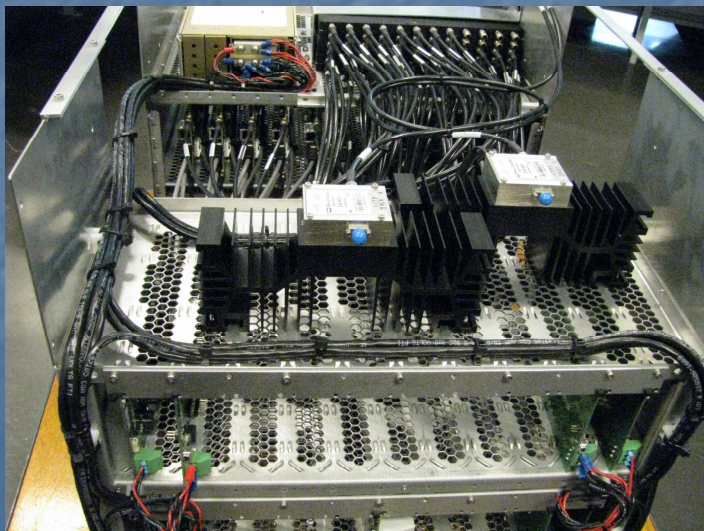
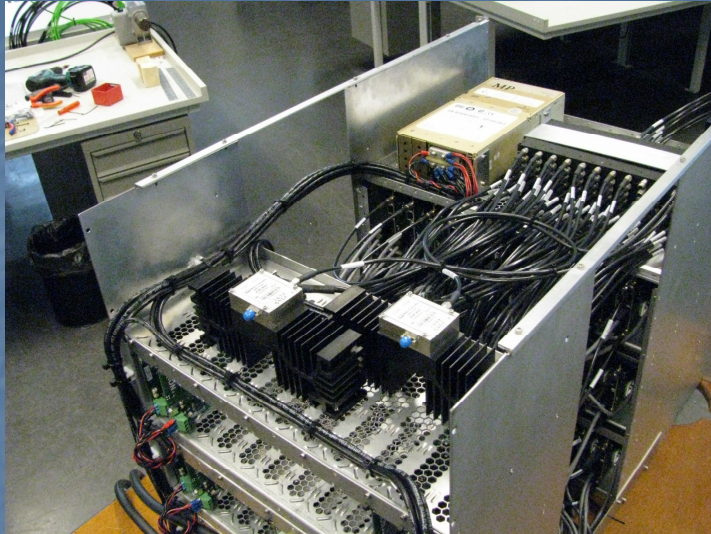
Conclusion

The Phase Noise of some Amplifiers has been measured. The Phase Noise has been measured both in terms of spectral density and integrated over frequency, including the effect of the strongly attenuating (splitters chain). Table below summarizes the effects observed.

Integral of Spectral Phase Noise Density	<0.03 deg
AM to PM conversion: $\Delta\phi/\Delta P$	<0.4 deg/dBm

In order to minimize the phase noise of the LO distribution system, a good synthesizer is required!

LO distributor: EMBRACE rack



THANK YOU

