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Cross - Talk Measurements **with Random Noise Sources**

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Objective :

- **Develop a method to measure with hand-held testers, the “Alien” cross - talk in installed data networks.**
- **A method using “multiple hand - held testers with their remotes” requires a synchronization. This is not easily feasible and would lack reliability. It is also cost prohibitive.**
- **Hence, all neighboring data circuits should be energized simultaneously, to measure the power sum cross - talk coupled into the pair or channel under test.**
- **“Alien” cross - talk is an elusive subject. Lots of talk about it, but no practical measurement method available.**

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**“ALIEN”
Cross - Talk :
elusive,
strange,
difficult
to grasp and
menacing.**

**But needs to
be explored
as it may
impact on
future
protocols**

What is alien cross-talk ?

A generalized definition:

Alien cross talk is the noise coupled into a channel from all neighboring disturbers. Disturbers can be data cables running under the same, or any other possible protocol. They may use other transmit voltages. In this case they yield different disturbing power levels.

Furthermore, power lines in close proximity to the cables of the channel also impact on the alien cross - talk.

Hence, alien cross - talk is statistical in nature. It can be approximated by white Gaussian noise.

Concept :

- **Use of a white Gaussian noise sources for the powering of the disturbers.**
- **Use of a power spectrum analyzer, to measure the induced cross - talk noise.**
- **Compare the results to those obtained with a network analyzer.**
- **Use, for comparison purposes, the same window size on the spectrum analyzer and the network analyzer.**
- **Compare the results obtained with both, spectrum and network analyzer.**

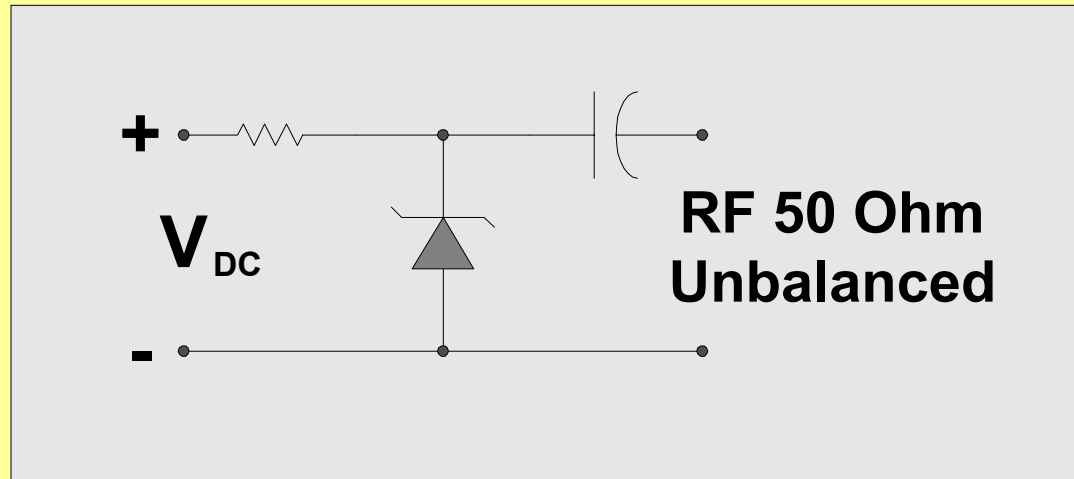
Methodology :

- 1. Measure P-P NEXT, P-P EL FEXT and attenuation with a network analyzer.**
- 2. Calculate the power sum cross - talk values.**
- 3. Measure the PS - NEXT, PS - EL FEXT directly with a network analyzer, using power splitters.**
- 4. Measure P-P NEXT, P-P EL FEXT and attenuation with a spectrum analyzer and a random noise generator to energize the disturbing pairs.**
- 5 . Calculate the power sum cross - talk values.**
- 6. Measure the PS - NEXT, PS - EL FEXT directly with a spectrum analyzer, using a random noise generator to energize the disturbing pairs and a power splitter.**

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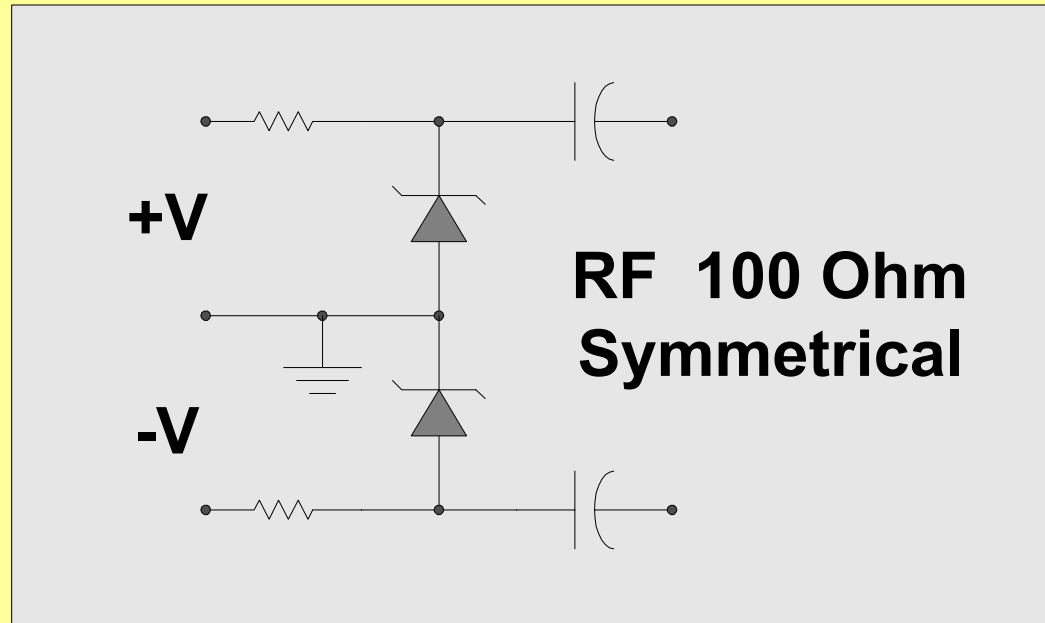


Unbalanced white noise diode circuit with 50 Ohm impedance. The circuit can be expanded to a symmetrical 100 Ohm circuit. This avoids the use of baluns.

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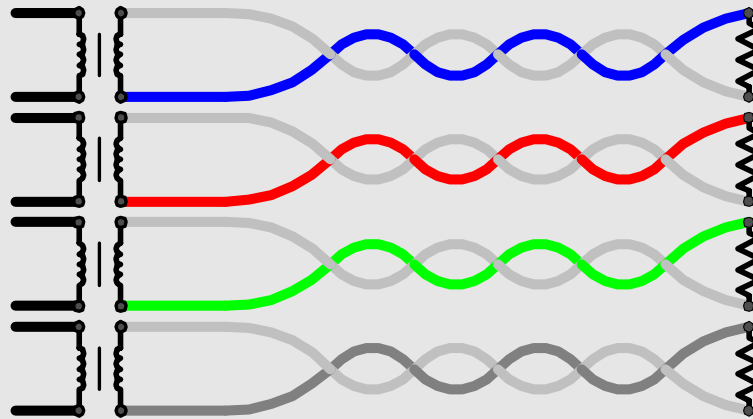
Symmetrical white noise diode circuit with 100 Ohm impedance, to be used directly on balanced pairs with resistor terminations at the other end.

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**From random
noise circuits
with in-line
amplifier on
each channel.
Battery
operated**



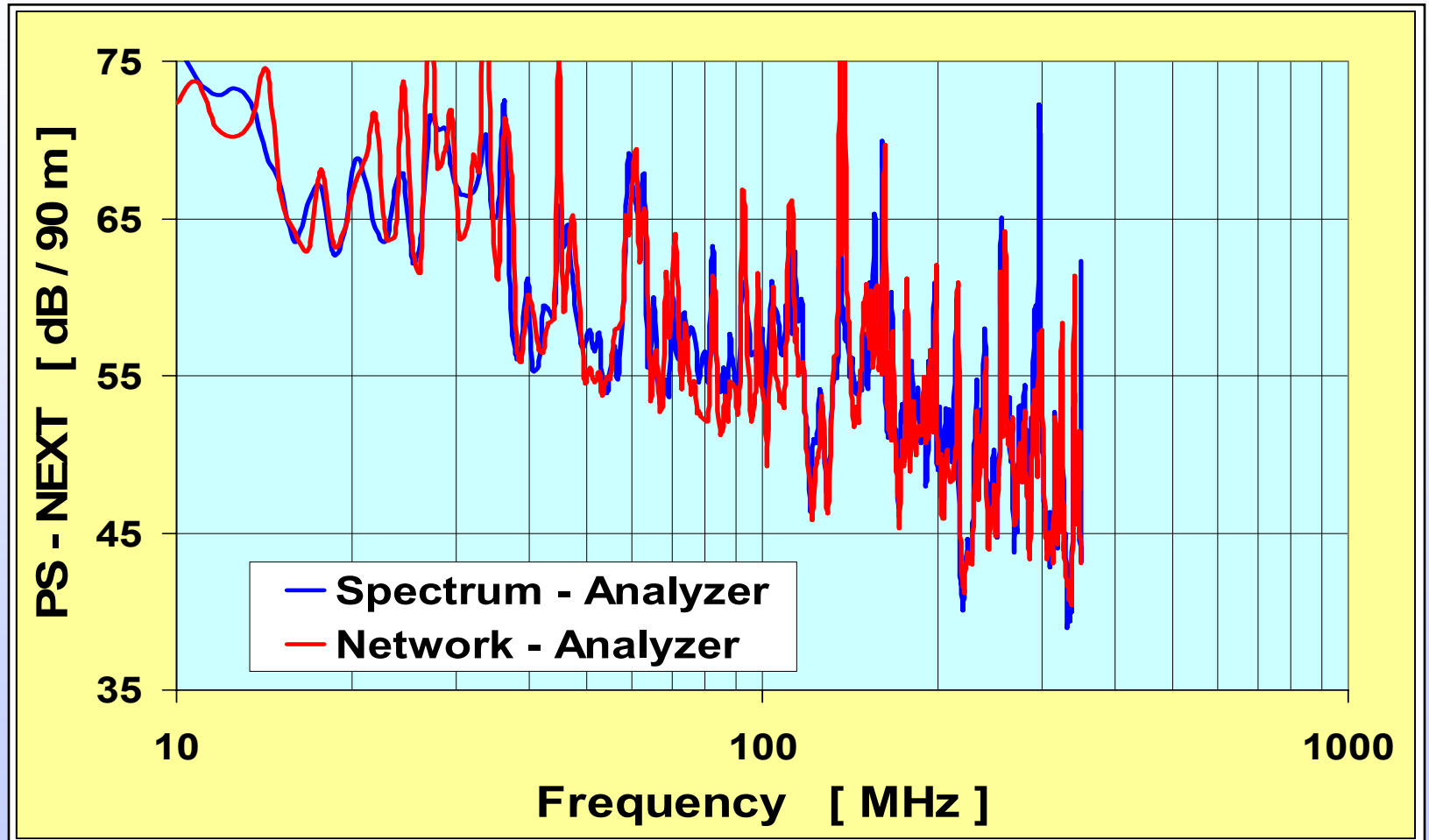
**100 Ohm
resistive
terminations
on each
channel**

Termination of balanced pairs in the channels with ohmic resistor terminations at the far end, and random noise source at the input end (here shown for the use of unbalanced 50 Ohm noise sources in conjunction with baluns).

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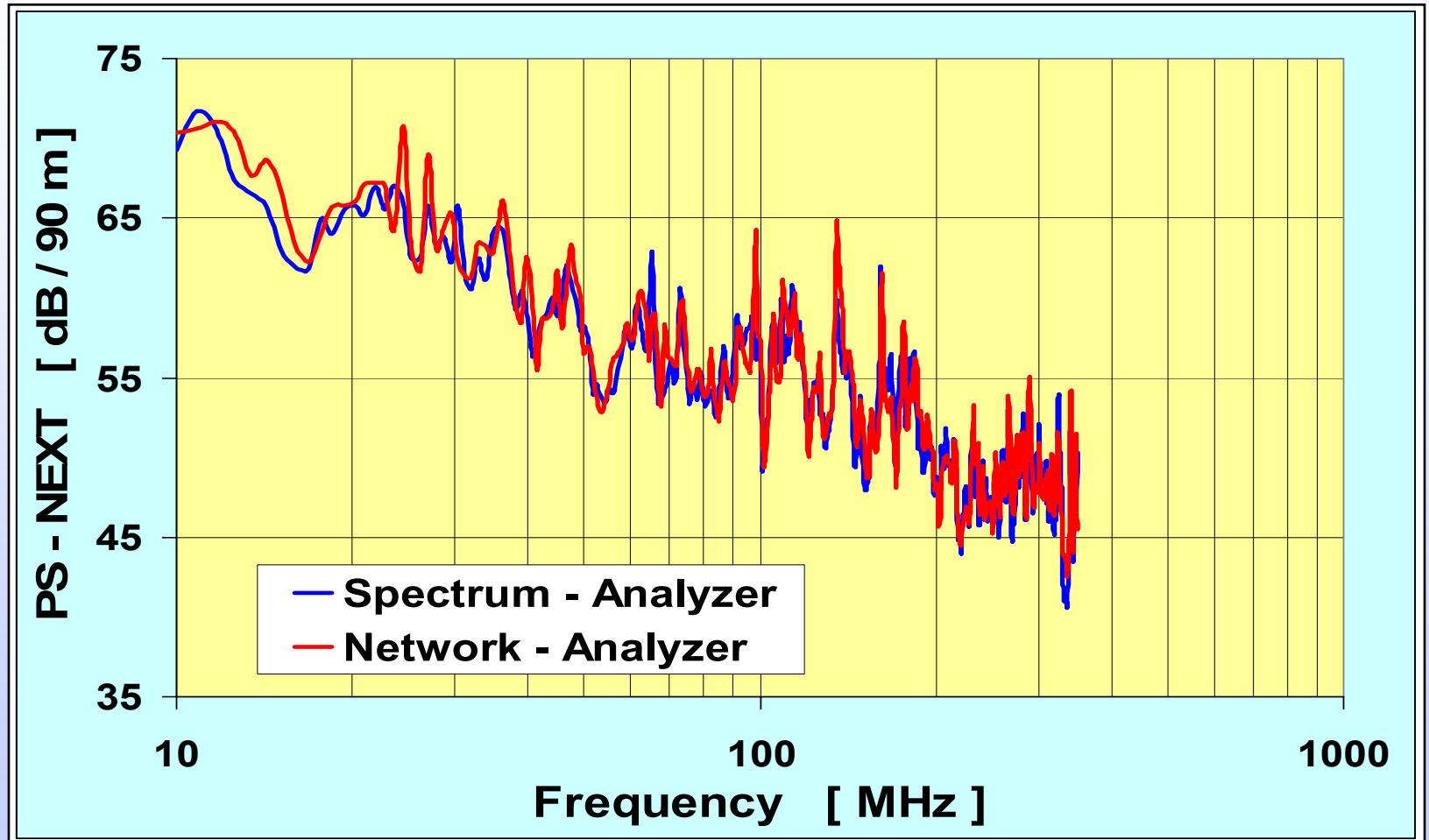


Pair 1 : PS - NEXT measured with power splitter

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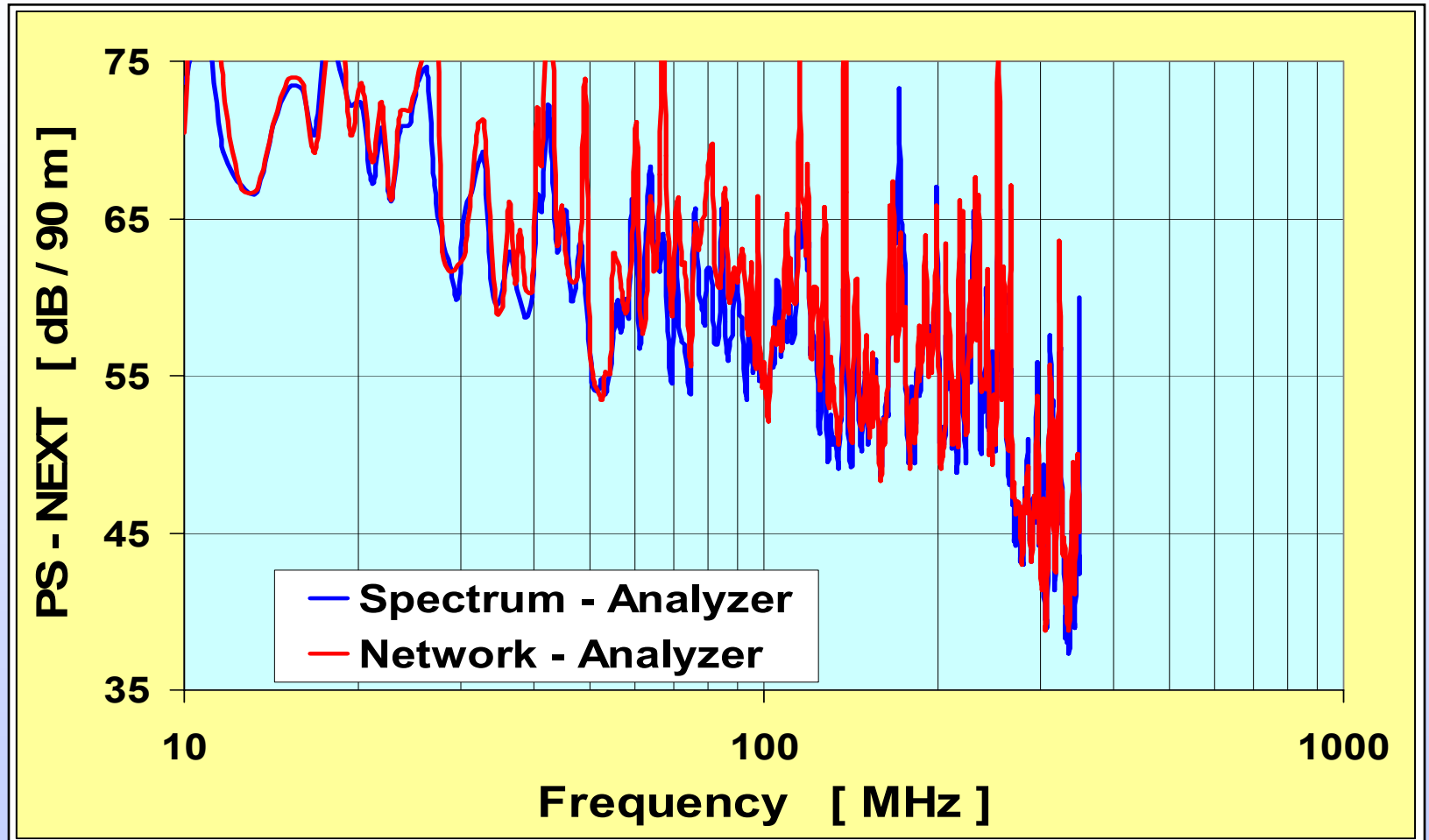


Pair 1 : PS - NEXT calculated from pair - to - pair measurements

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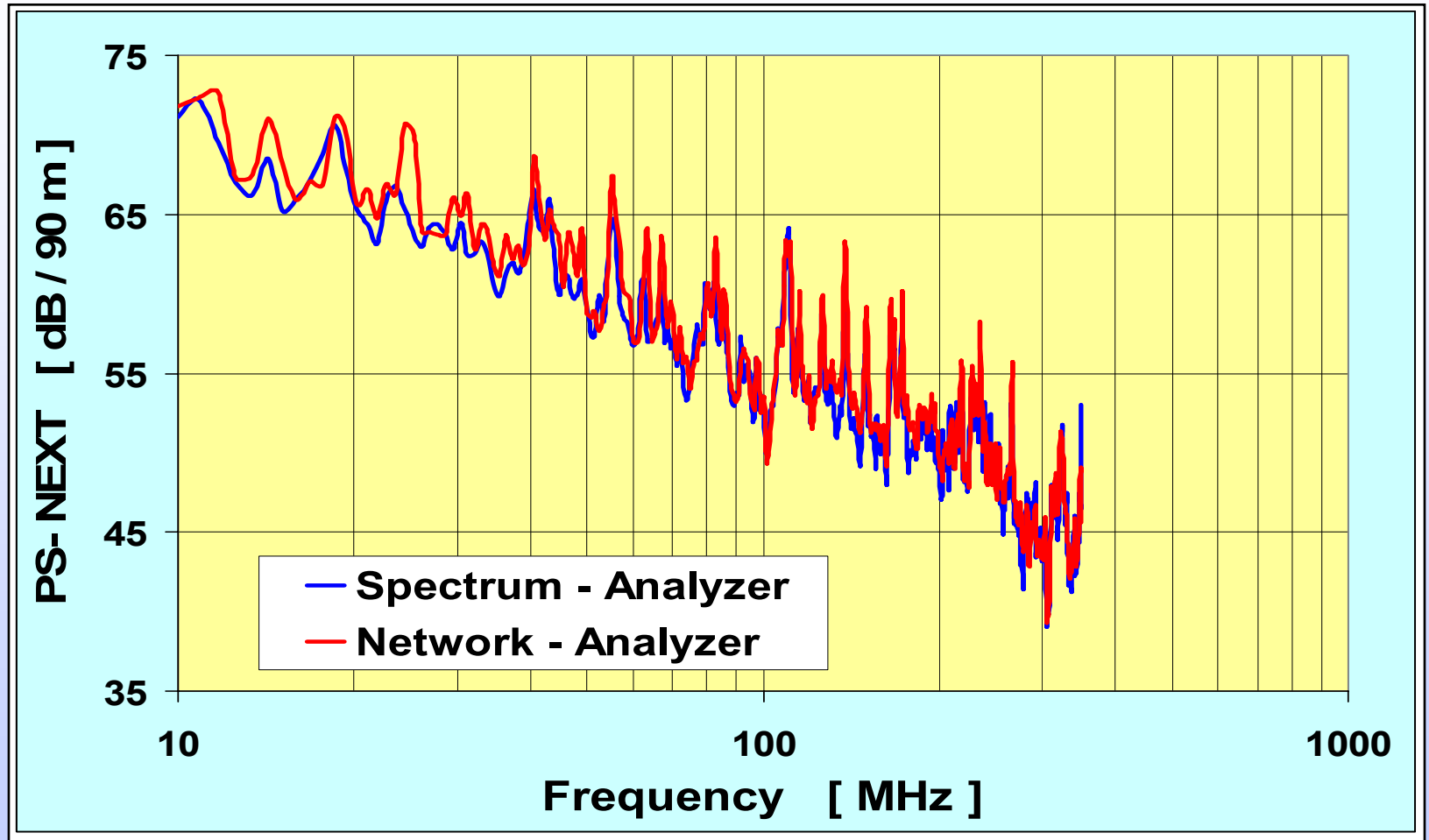


Pair 2 : PS - NEXT measured with power splitter

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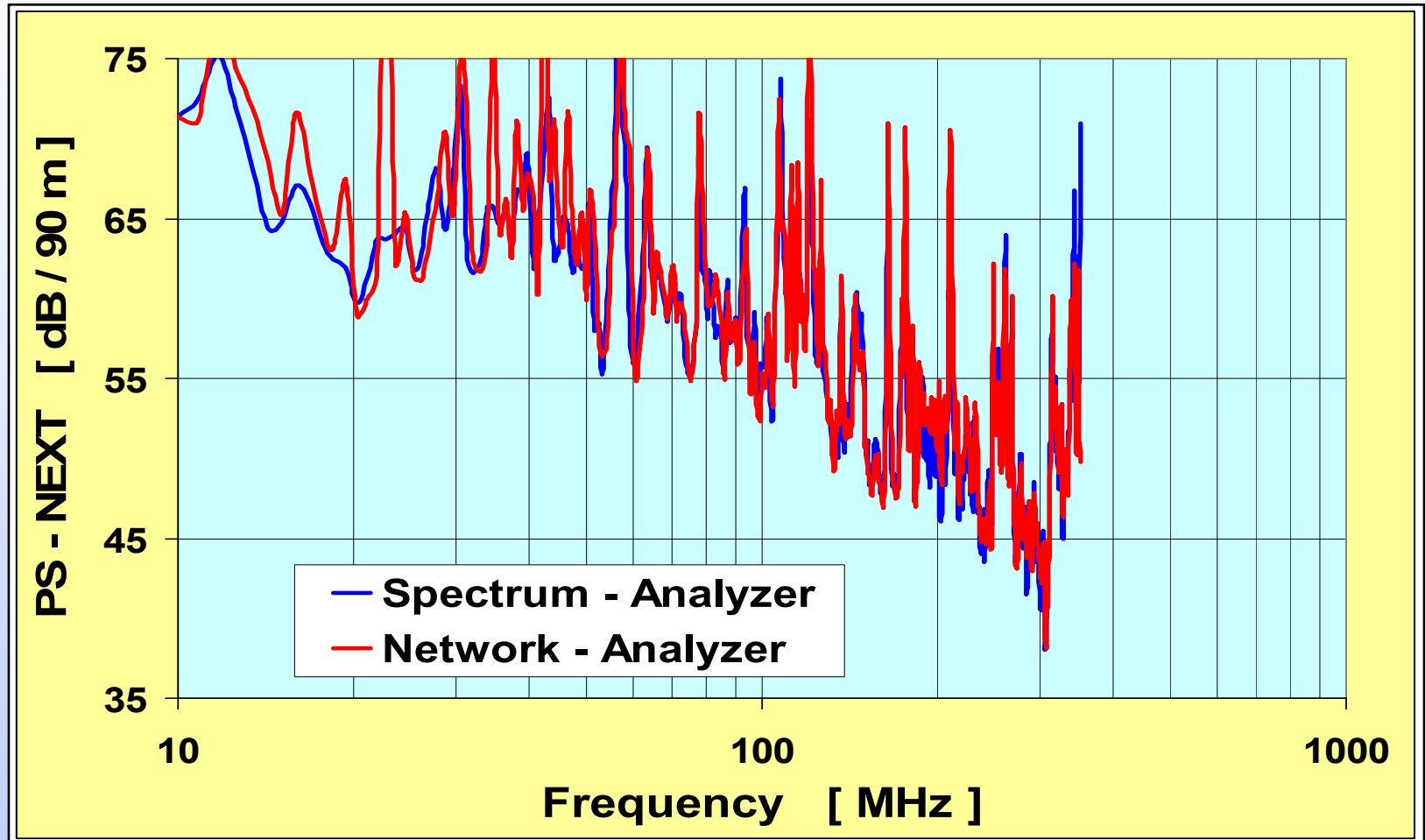


Pair 2 : PS - NEXT calculated from pair - to - pair measurements

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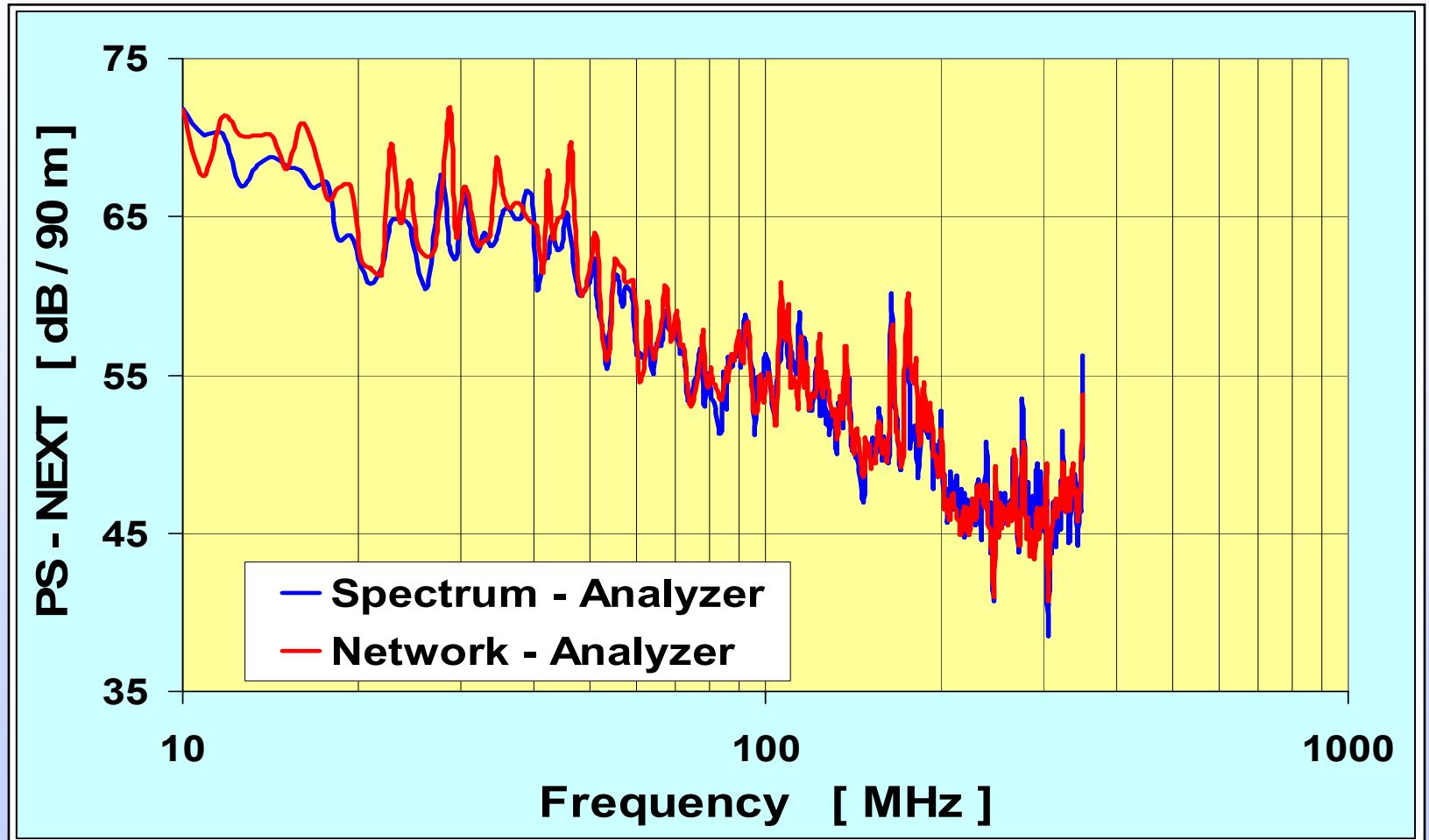


Pair 3 : PS - NEXT measured with power splitter

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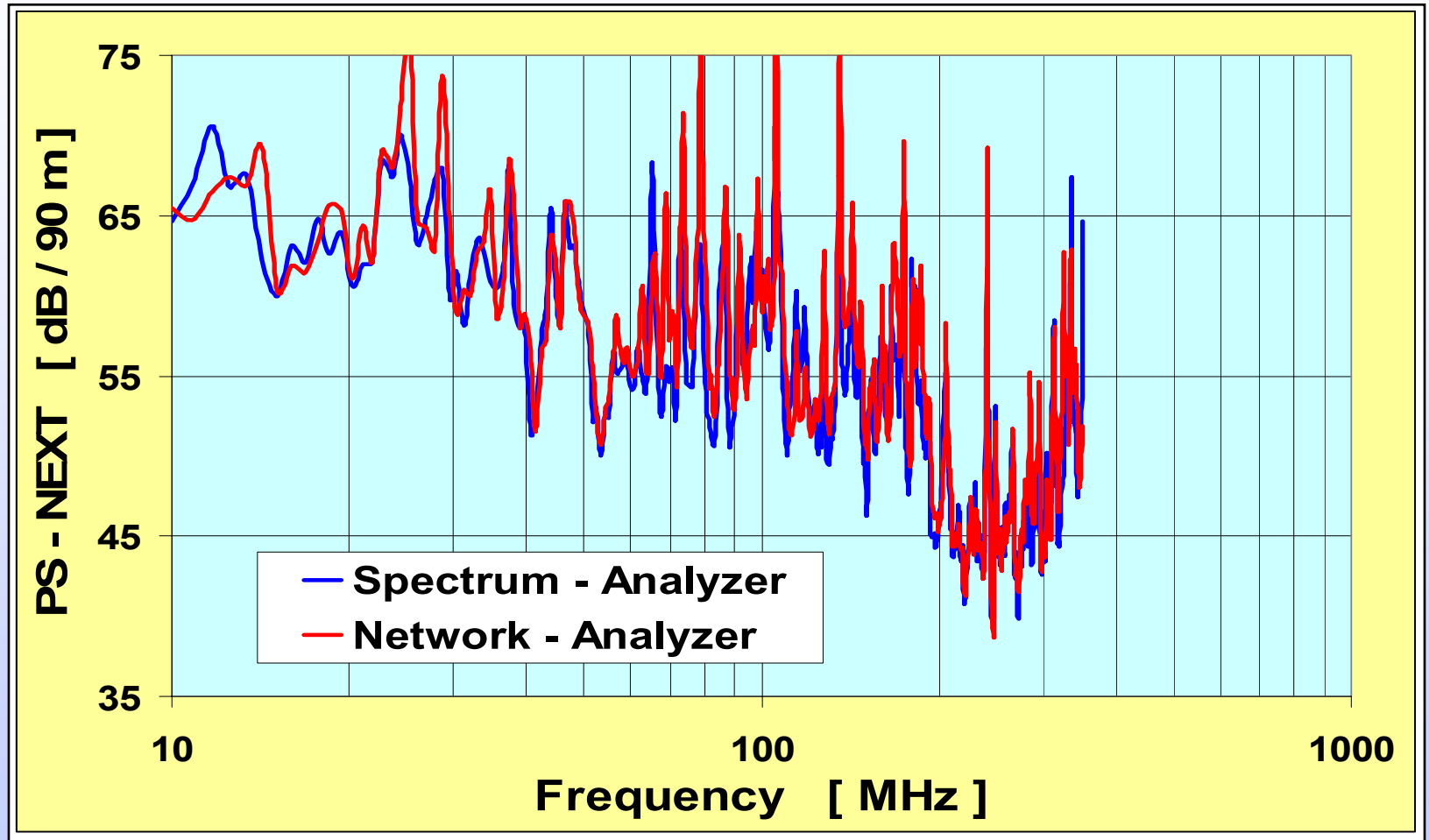


Pair 3 : PS - NEXT calculated from pair - to - pair measurements

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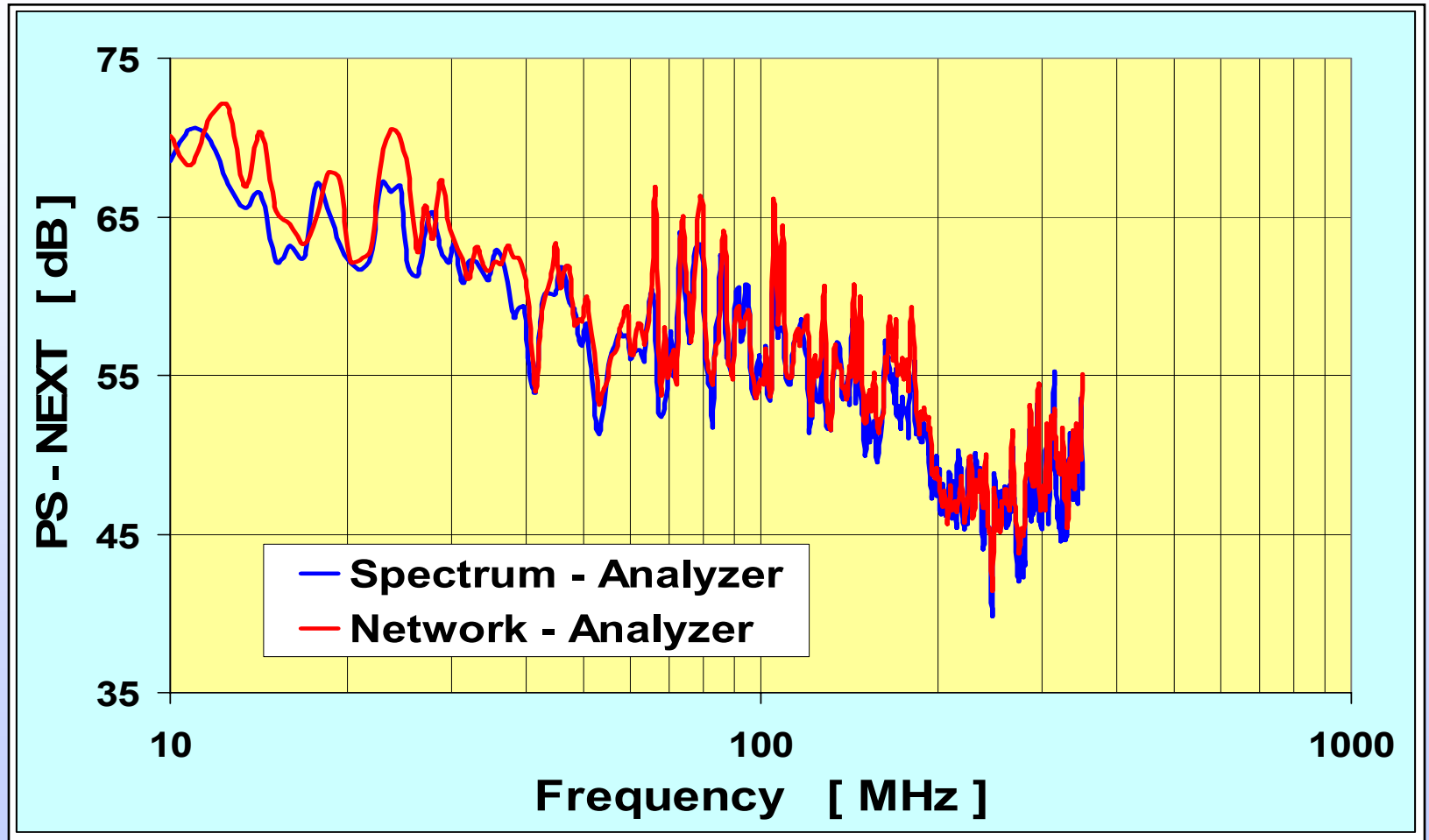


Pair 4 : PS - NEXT measured with power splitter

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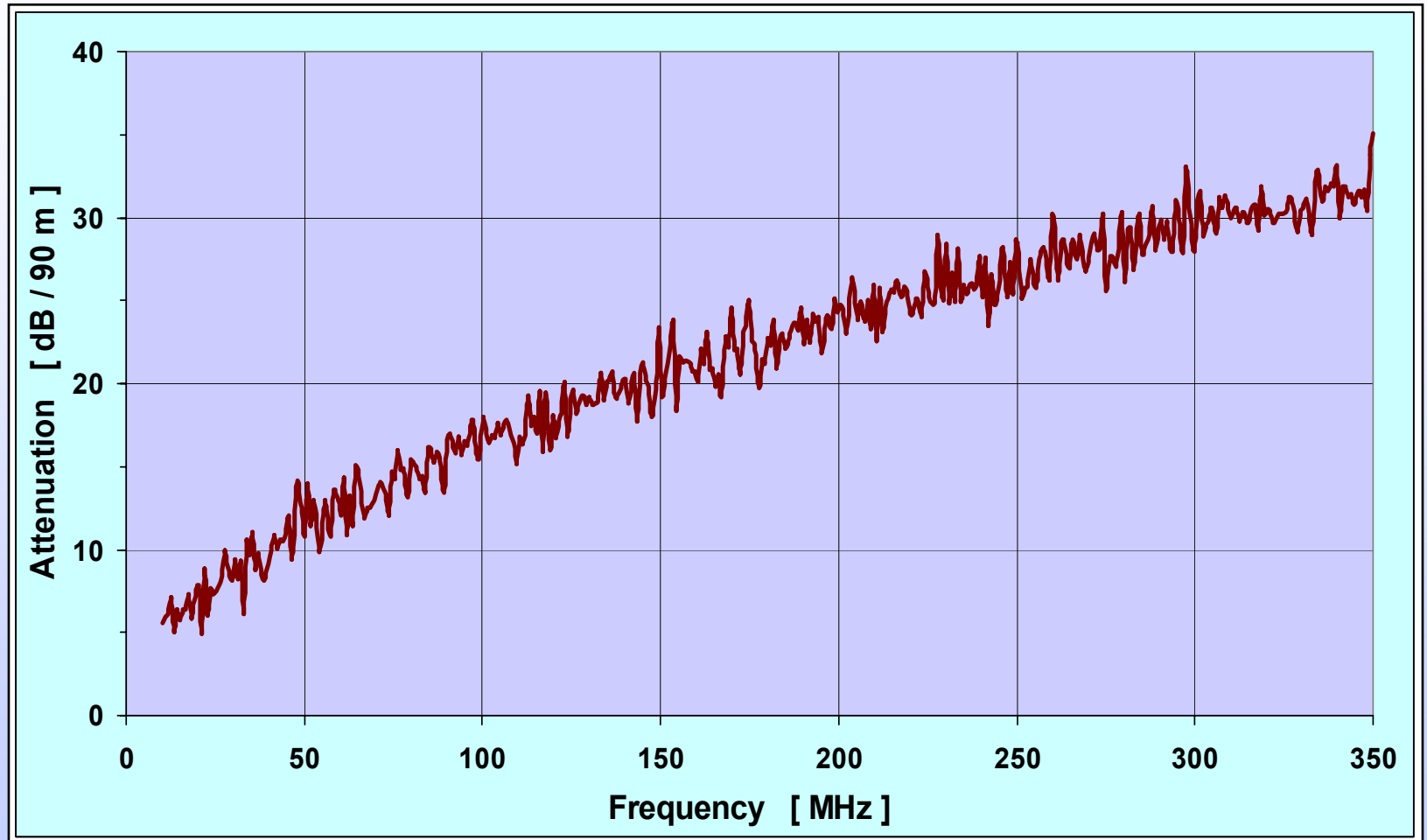


Pair 2 : PS - NEXT calculated from pair - to - pair measurements

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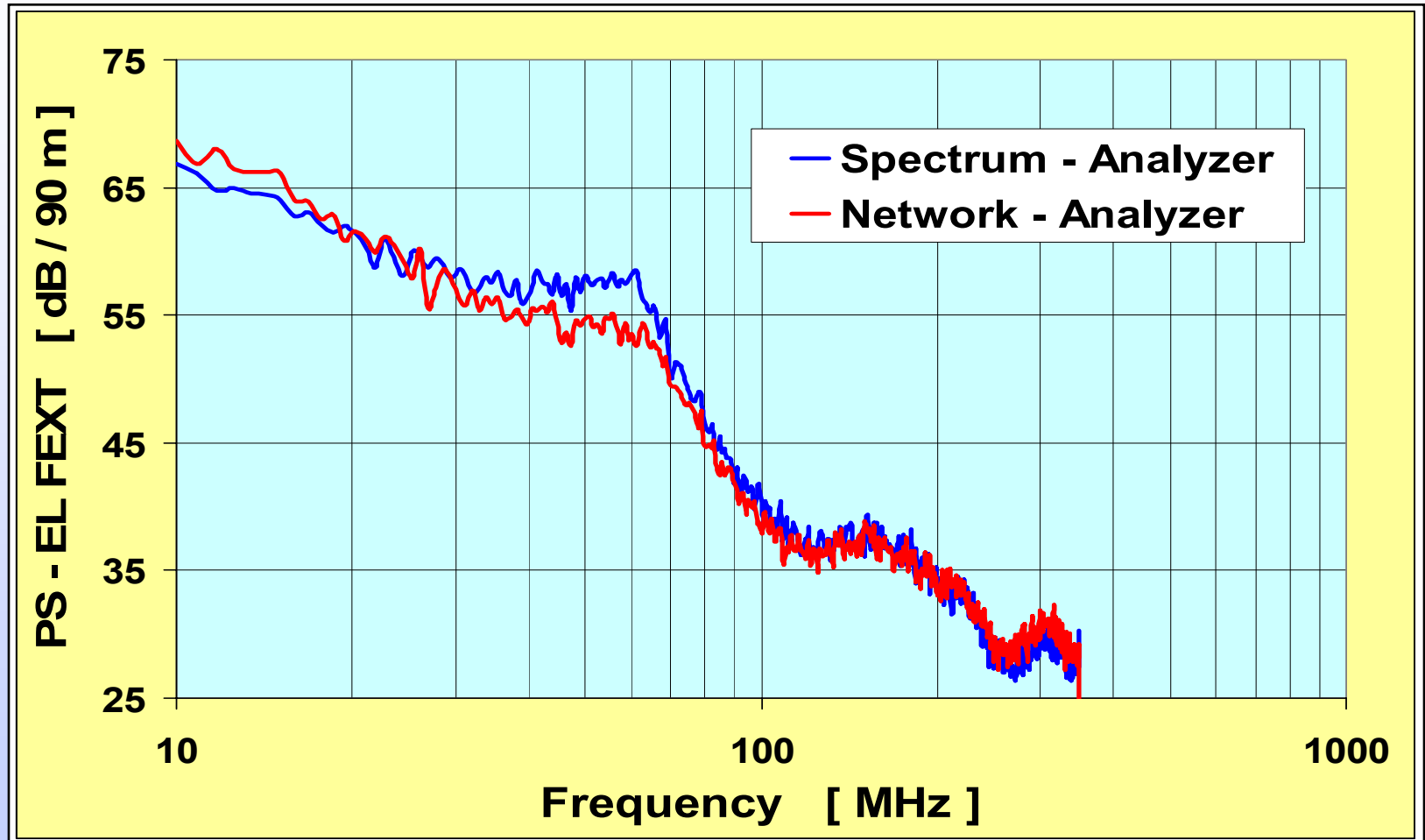


**Pair 1 : Attenuation measured random noise generator and
spectrum analyzer (Roughness is not due to ILD !)**

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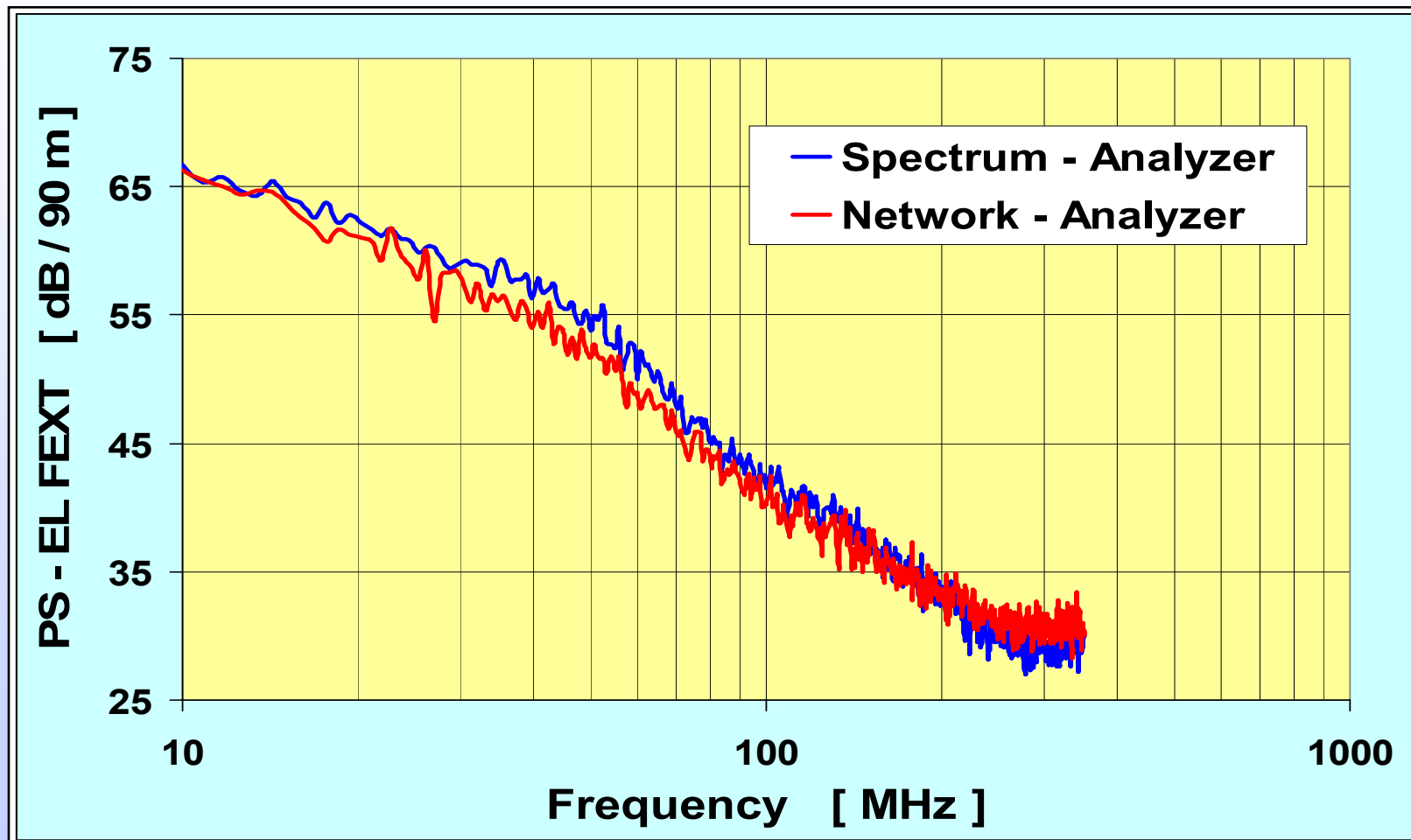


Pair 1 : PS - EL FEXT measured with power splitter

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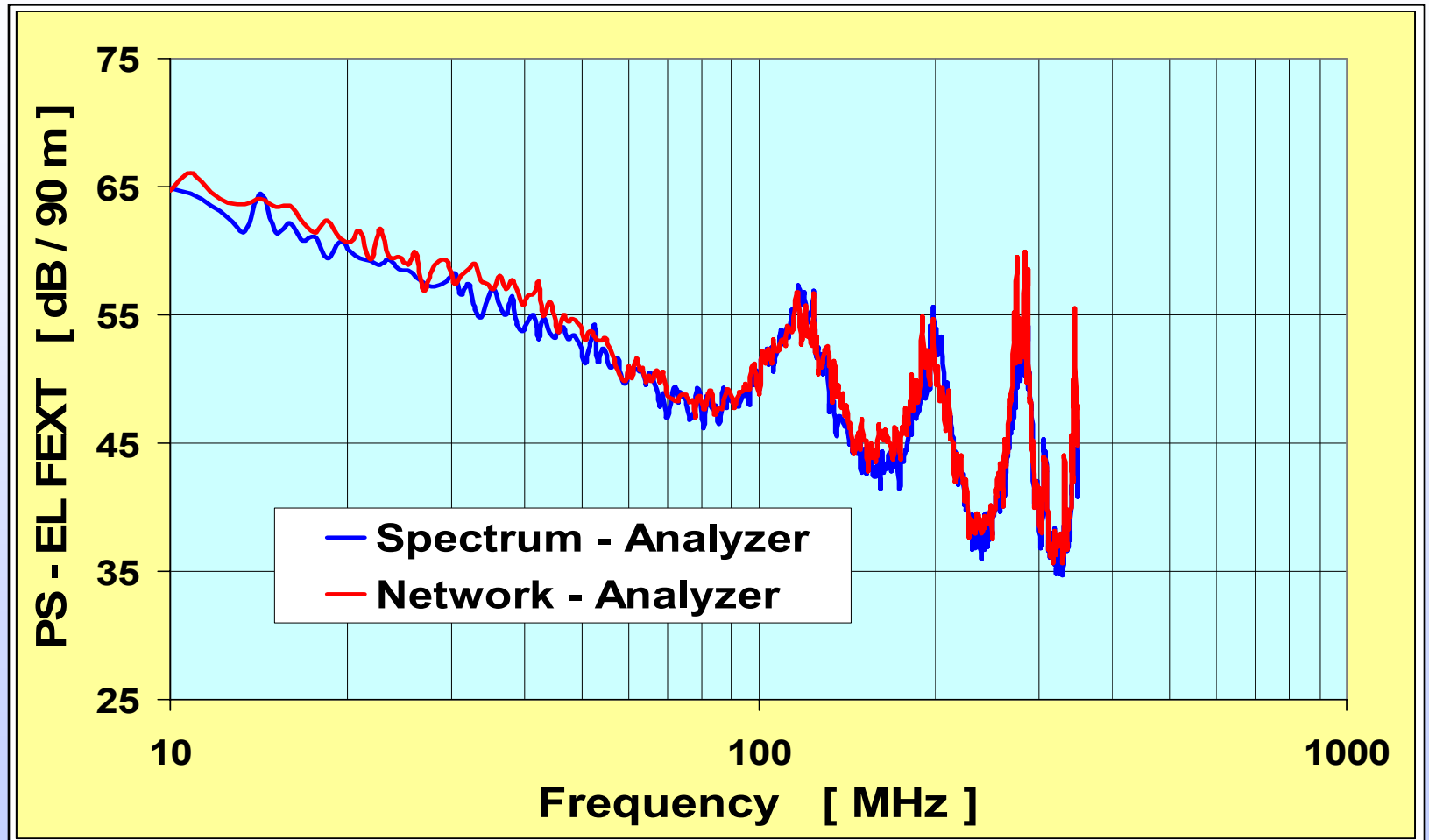


Pair 1 : PS - EL FEXT calculated from pair - to - pair measurements

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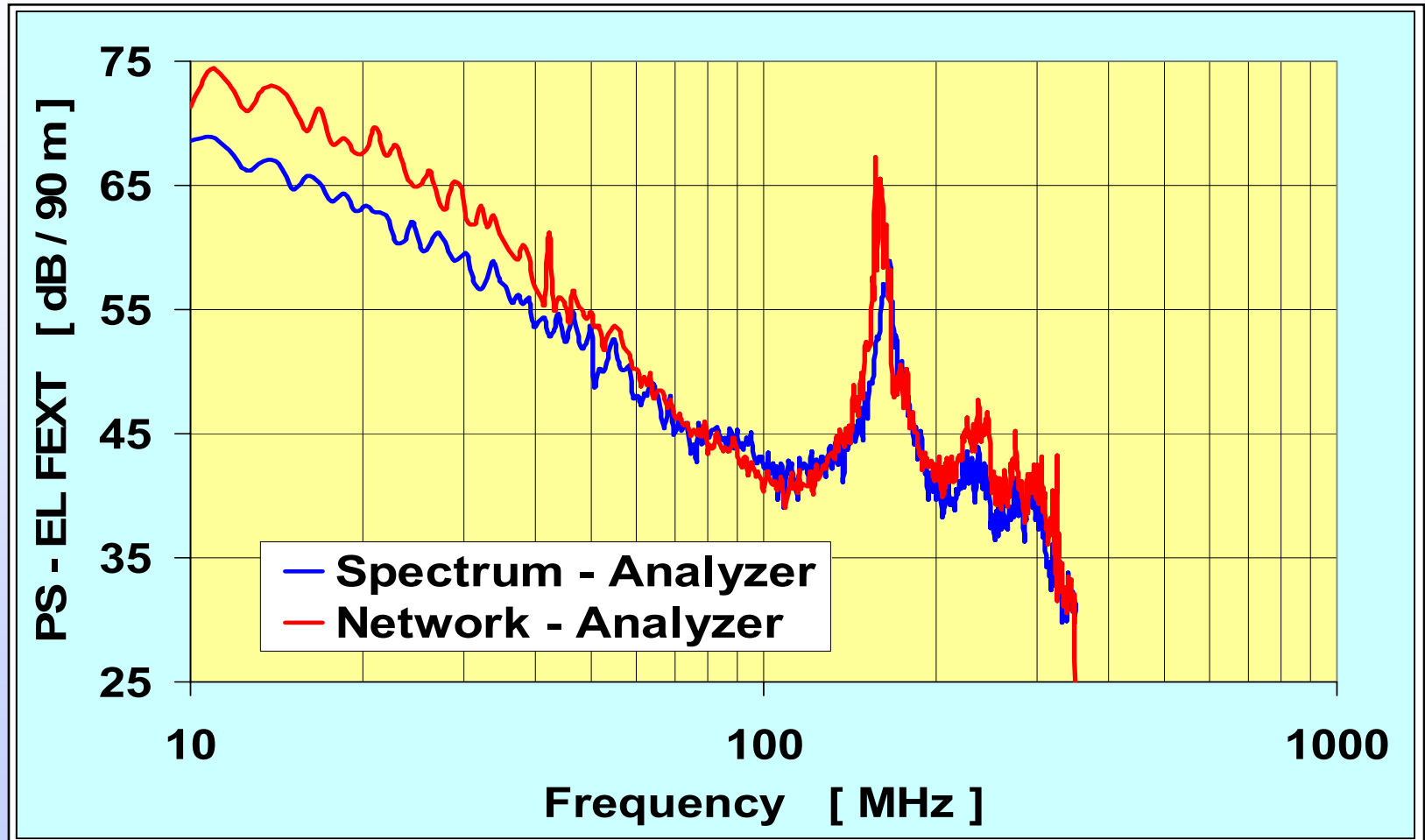


Pair 2 : PS - EL FEXT measured with power splitter

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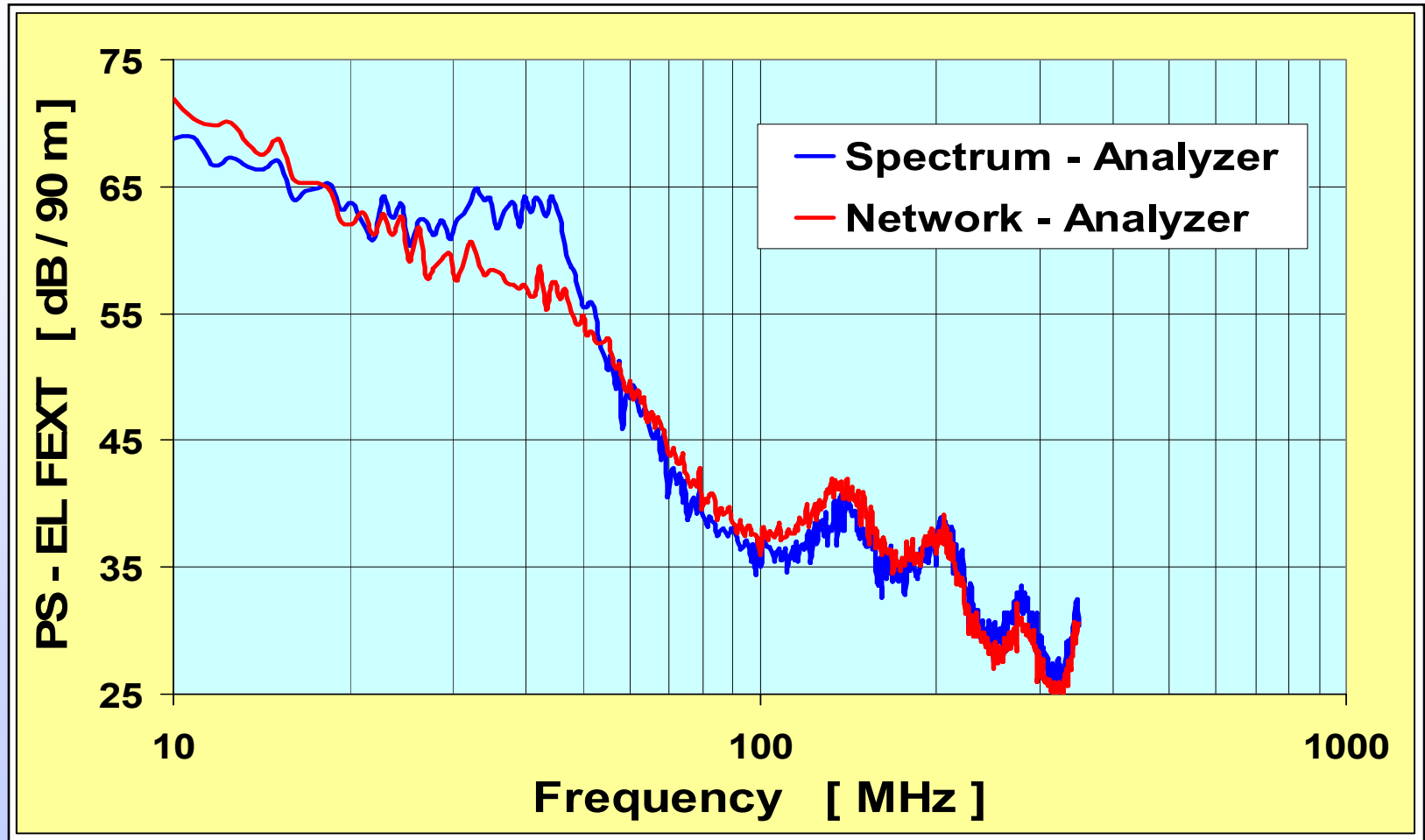


Pair 2 : PS - EL FEXT calculated from pair - to - pair measurements

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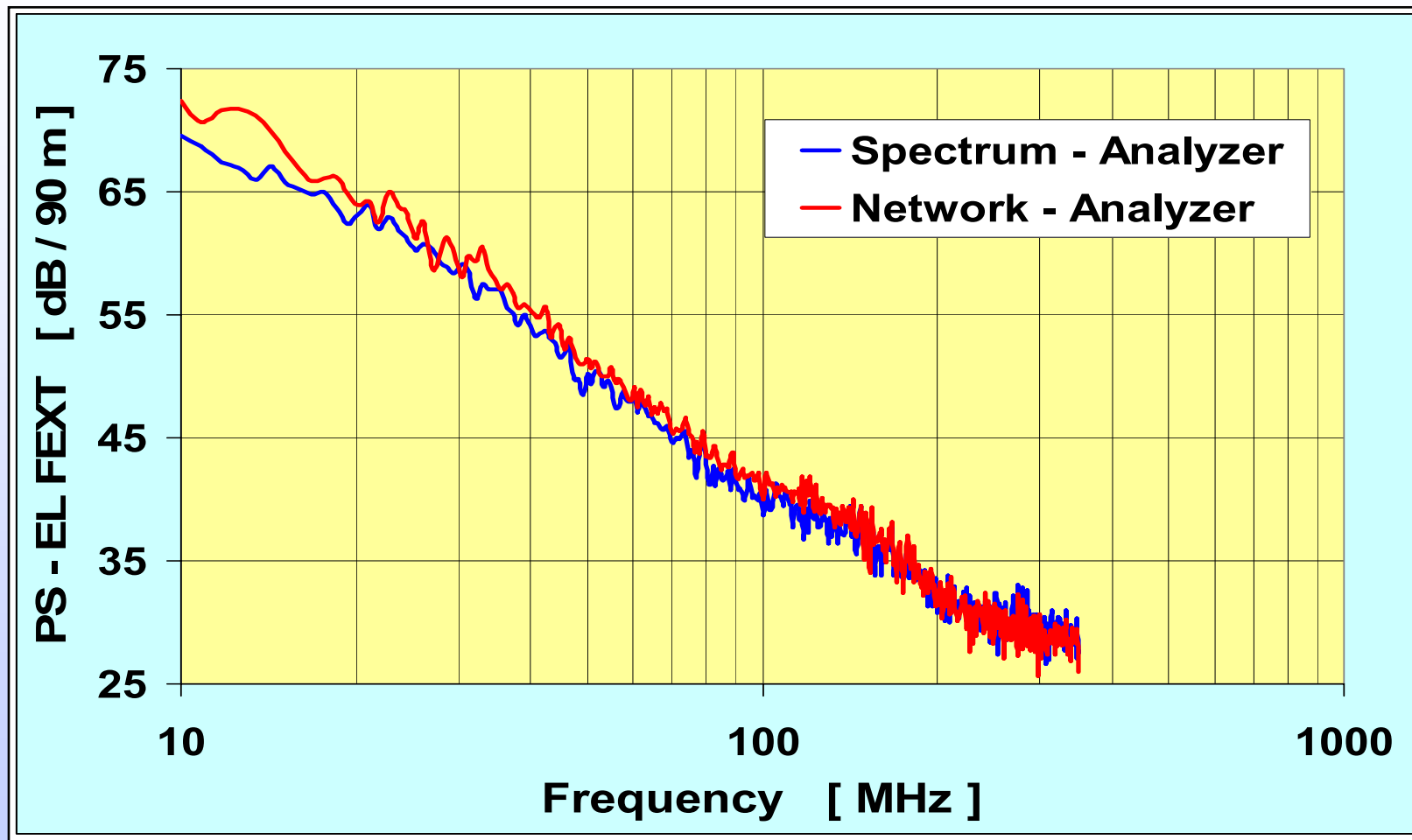


Pair 3 : PS - EL FEXT measured with power splitter

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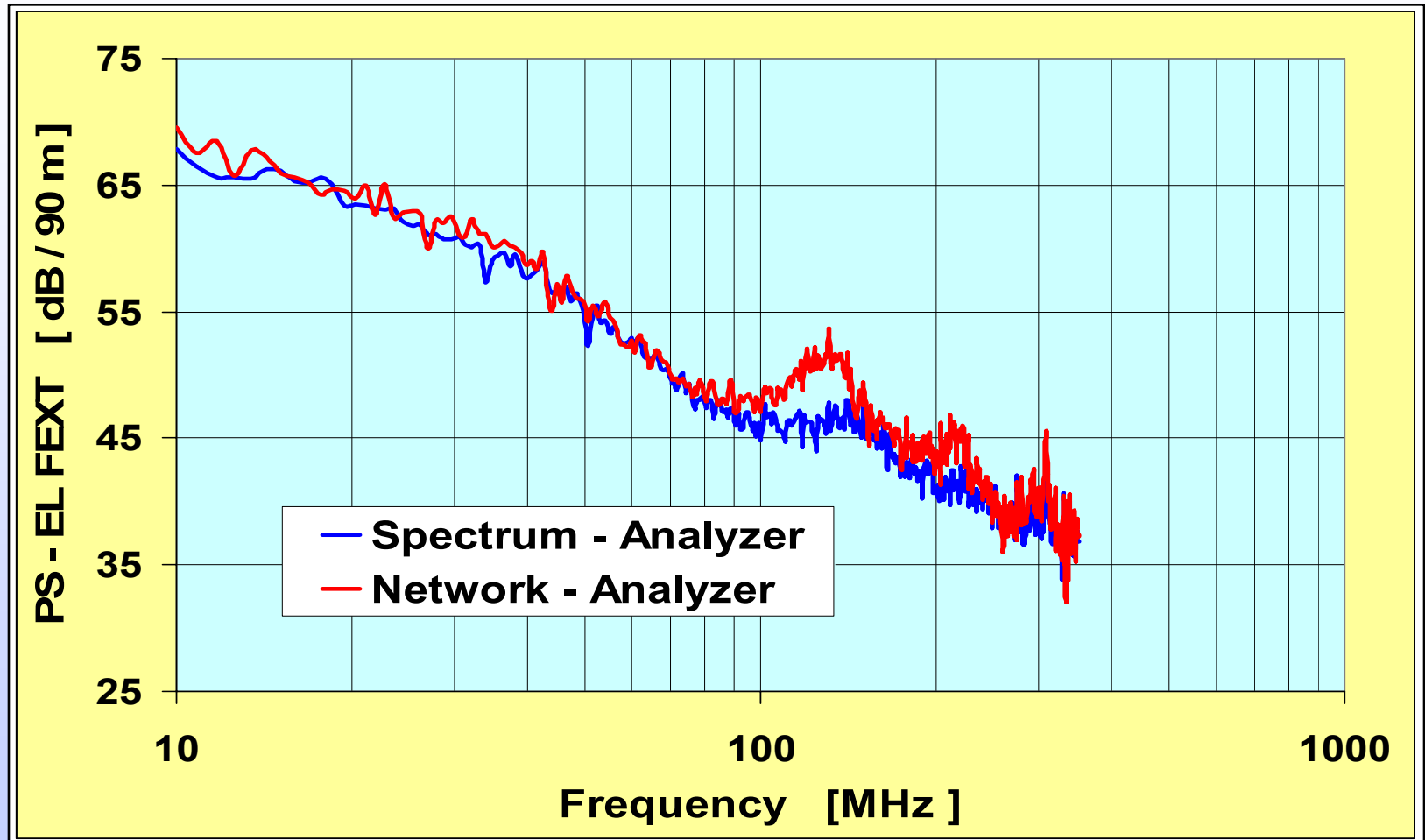


Pair 3 : PS - EL FEXT calculated from pair - to - pair measurements

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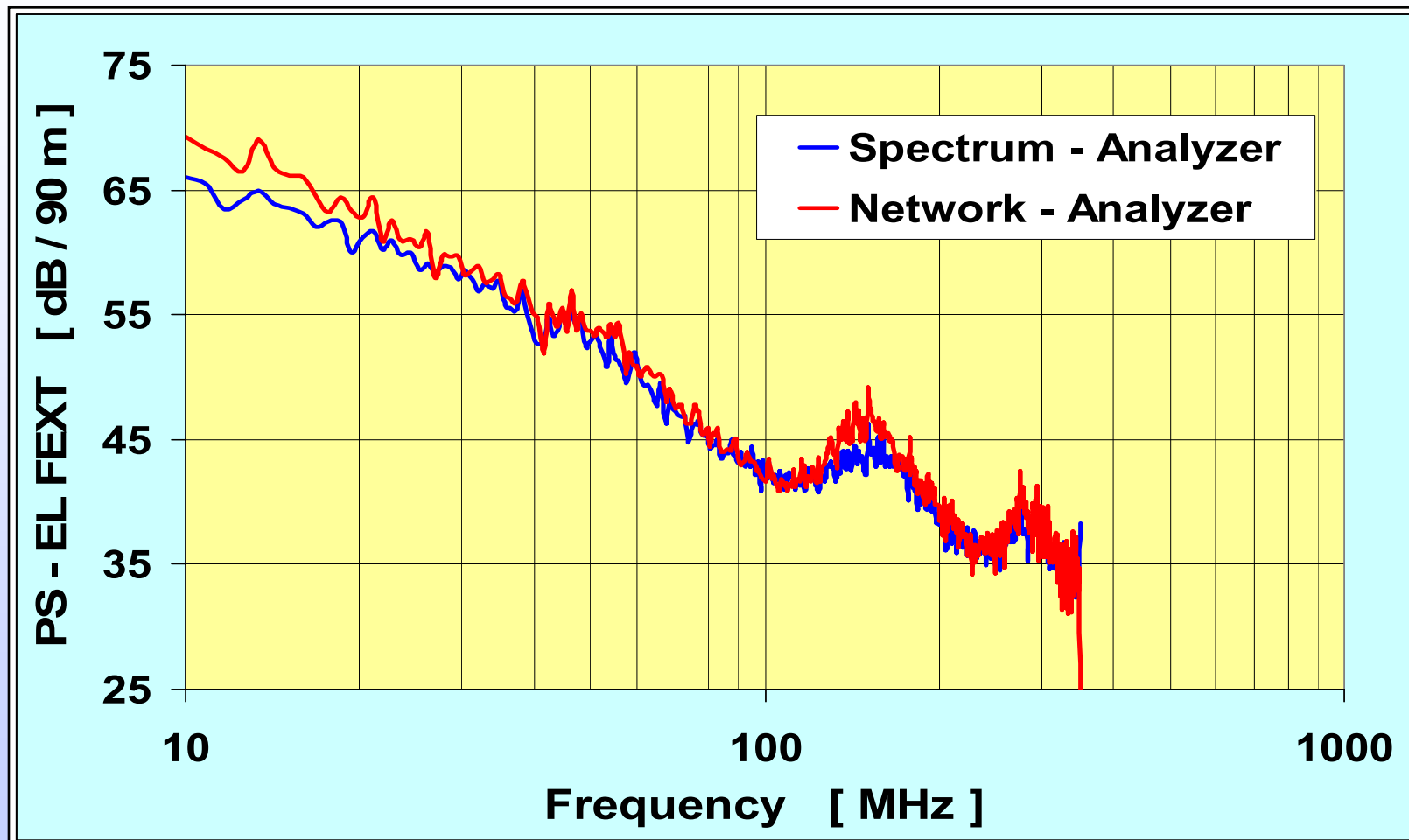


Pair 4 : PS - EL FEXT measured with power splitter

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Pair 4 : PS - EL FEXT calculated from pair - to - pair measurements

Conclusion :

- **The results of PS NEXT and PS EL FEXT directly measured with a power splitter are comparable. In fact, the results measured with a network analyzer (sinusoidal signals) and those obtained with a power spectrum analyzer with a random noise generator as powering source, are nearly identical.**
- **The same is also true for the calculated PS NEXT and PS EL FEXT from pair to pair measurements with a network analyzer and with a random noise generator.**
- **But the directly measured power sum results and the calculated pair to pair measurements are not matching well. This seems to depend on the power splitter used.**

Conclusion :

- **Alien cross-talk less elusive and not as strange anymore**
- **In fact, verification is made accessible for any installed base**

Recommendation:

- **Development of hand held testers to measure the alien cross-talk over the power spectrum of random noise**

Additional justification for this development :

- **Protocols with bi-directional data traffic on the same pairs, as for instance 1000Base-T, are more susceptible to cable to cable far - end cross - talk. So far, far - end cross - talk is considered to be less severe than near - end cross - talk.**
- **Installed data networks are configured in tree structures. Thus like cables with differently attenuated signal levels are running parallel. This generates a much higher far - end cross talk coupling than generally experienced.**