Ultra Wide-Band HTS filter for new geodetic VLBI front-ends

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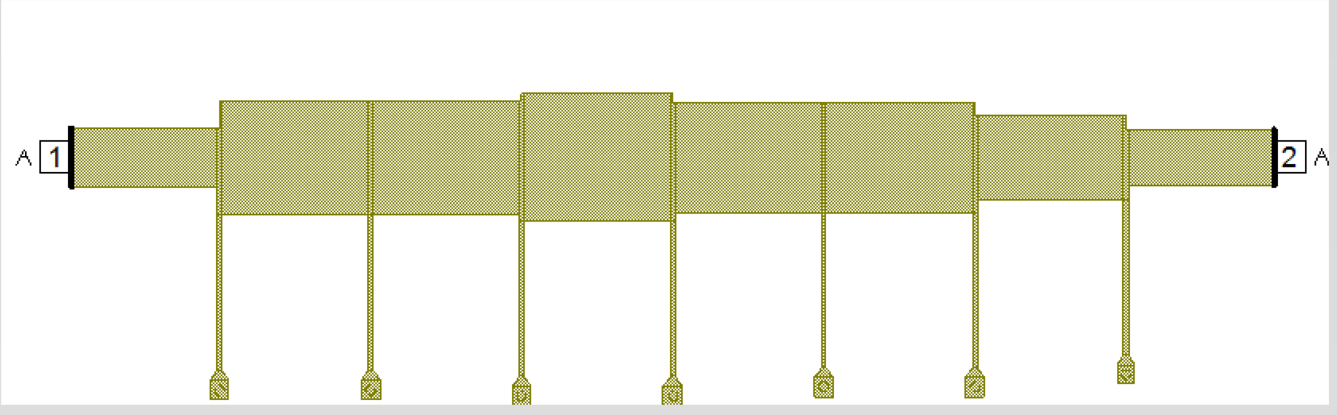
A key component for geodetic VLBI a very large bandwidth extending from S-band to low Ku-band is the bandpass filter placed ahead of the LNA since it must outperform according to the following issues: a) Extremely large bandpass from 2 to 14 GHz, b) In-band very low-losses, c) Capability of implementing high rejection sub-bands (notches) to eliminate interfering signals. In this case, the fractional band is highly demanding since it reaches the top value of 150% which is not commonly found in advanced electronics [1-3]. We here present the design procedure for such UWB filter for modern geodetic VLBI based on a flexible approach which allows for including an in-band notch at a desired frequency.

We have designed a filter fulfilling the following specifications:

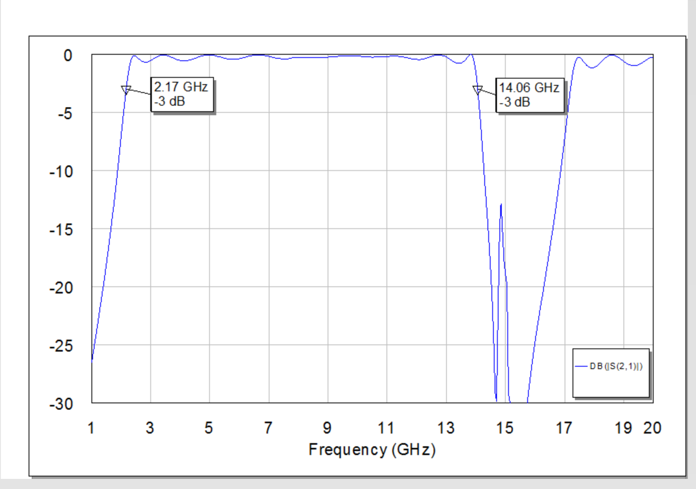
- Superconductor microstrip technology;
- Response bandwidth from 2.2 to 14 GHz;
- In-band Insertion Loss less than 0.6 dB;
- Out-of-band Insertion Loss higher than -14 dB;
- In-band maximally flat Group Delay

In order to satisfy the requisite of very low insertion loss, a superconductor material has been chosen for its very low resistance at moderate cryogenic temperatures. The selected substrate is a Magnesium Oxide (MgO) substrate, whereas the conductor film is Yttrium Barium Copper Oxide (YBCO). As a final choice to meet the constraint of such a wide bandwidth, the Stub Synthesis technique was chosen for the filter design [4].

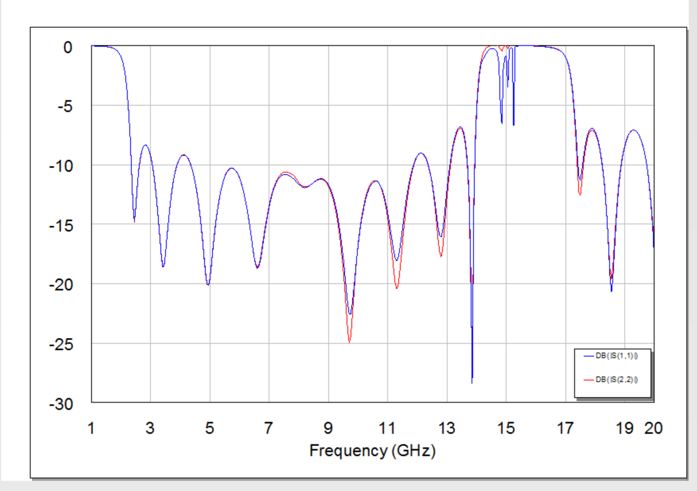
The dimensions of the basic bandpass filter are 26.36 mm x 6.4 mm thus leading to a very compact structure. An electromagnetic (EM) analysis of the layout has then been performed for a more reliable and accurate prediction of the component behaviour.



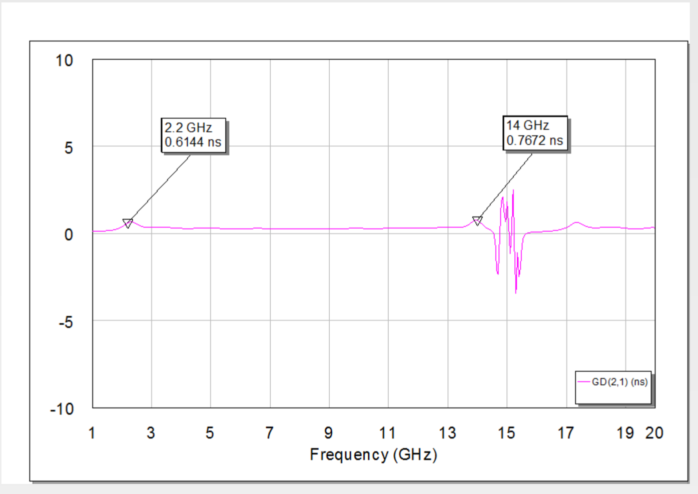
Layout of the simulated 3D-electromagnetic structure for the bandpass UWB filter



S_{21} of the UWB filter

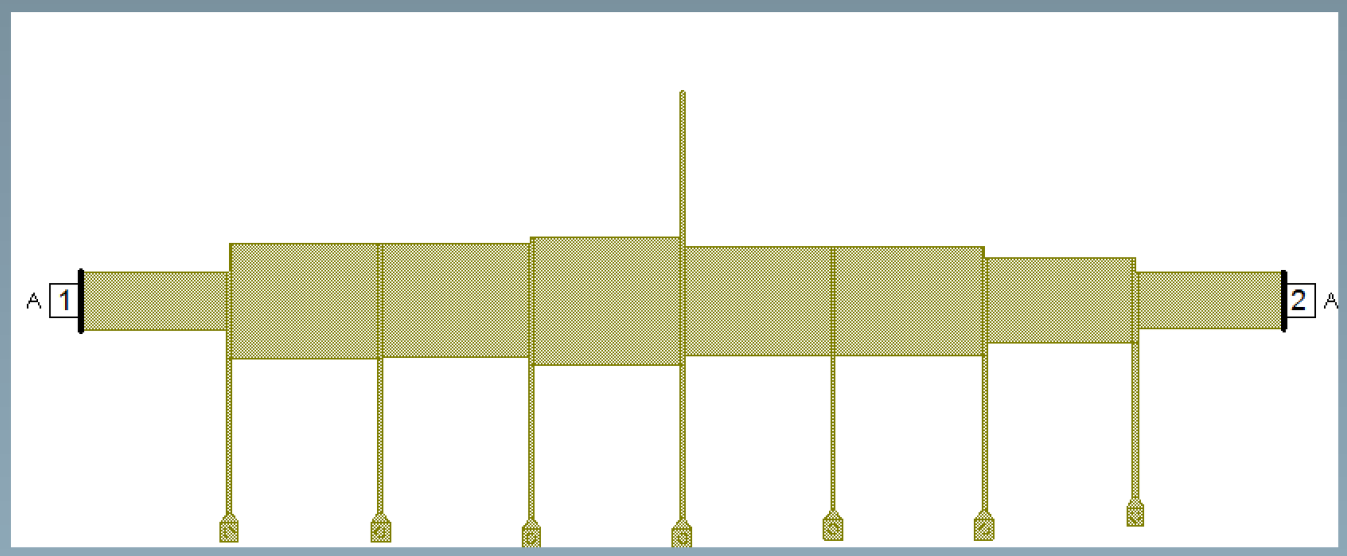


Input and output return loss of the UWB filter

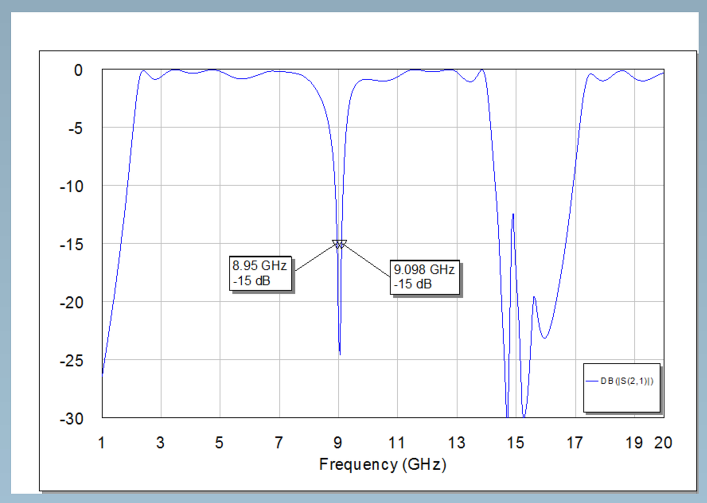


Group delay of the UWB filter

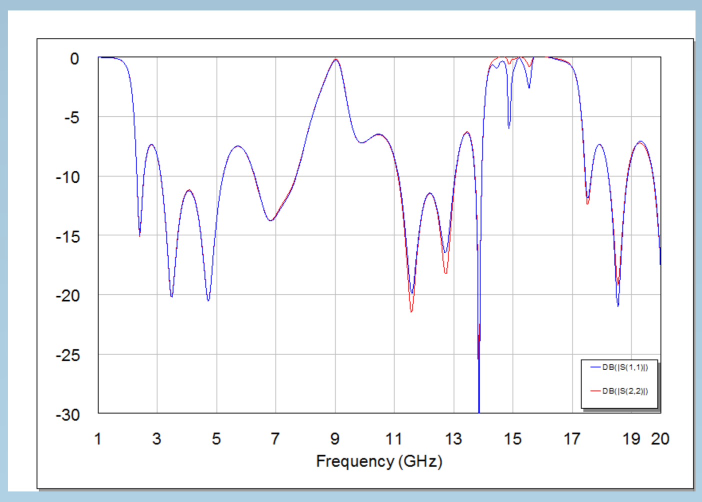
An open-circuited stub has been added to this basic UWB structure at the center of the structure aimed at realizing an intra-band high rejection notch.



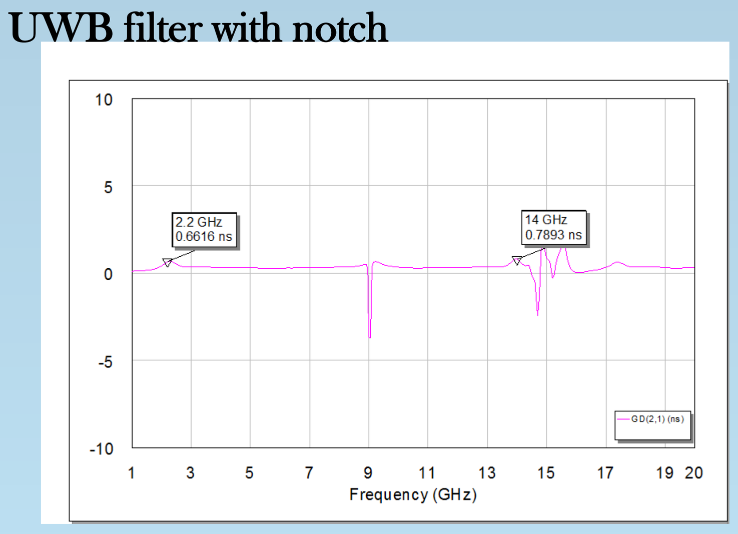
Layout of the simulated 3D-electromagnetic structure for the bandpass UWB filter with notch



S_{21} of the UWB filter with a 9 GHz notch

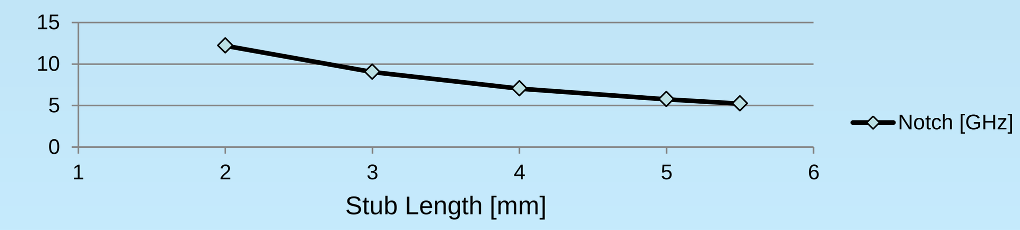


Input and output return loss of the UWB filter with notch



Group delay of the UWB filter with notch

By varying the length of this stub from 2 to 5.5 mm, several notches occur at frequencies between 5.2 to 12.2 GHz



[1] H. Shaman, J.-S. Hong, “Ultra-Wideband (UWB) Bandpass Filter With Embedded Band Notch Structures”, *IEEE Microwave and Wireless Components Letters,*Vol. 17, pp. 193-195, March 2007.
[2] J.B. Marjan Mokhtaari, “Microstrip Ultra-Wideband Filter with Flexible Notch Characteristics,” *Wireless Engineering and Technology,* pp. 3, 12-17, 2012.
[3] G.-M. Yang, R. Jin, C. Vittoria, V. G. Harris, N. X. Sun, “Small ultra-wideband (UWB) bandpass filter with notched band”, *IEEE Microwave Wireless Components Lett.*, vol. 18, pp. 176-178, March 2008.
[4] D. M. Pozar, Microwave Engineering, John Wiley & Sons, Inc., 1998.