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NEW DESIGN OF HIGH ORDER MODES ELECTRONICS IN MTCA.4 STANDARD FOR FLASH AND THE EUROPEAN XFEL

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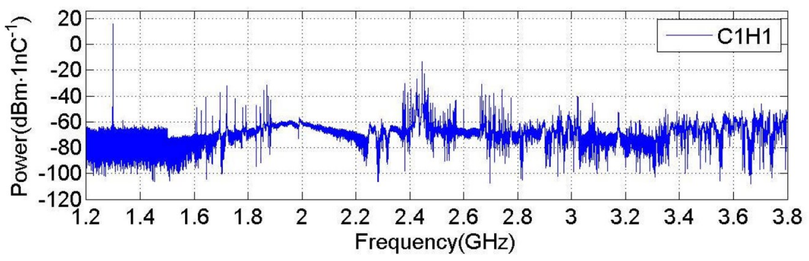
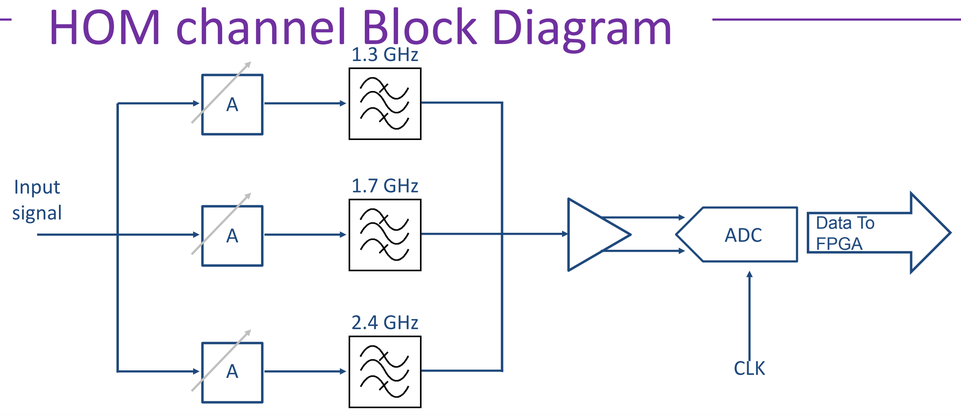
Abstract

At free-electron linear accelerators, various High Order Modes (HOM) - both monopole and dipole - are excited. Extensive studies at DESY have shown that monitoring and analysis of some of these modes can be used for different applications including Beam Position Monitors (BPMs) and the reduction of wake-fields, the measurement of the beam phase with-respect-to RF signal in cavities, and the measurement of cavity alignment in the 1.3 GHz cryo-modules. Three frequencies were chosen for further experiments: the 1.3 GHz base frequency from the klystron, the 1.7 GHz dipole mode and the 2.4 GHz monopole mode. In order to realize the monitoring and analysis requirements, very high resolution measurements in amplitude, phase and shape (time resolution) are required for all three frequencies simultaneously. In this paper, we present the new HOM electronics prototype including a microstrip and stripline RF tri-passband filter design and measurements and the specialized MTCA.4 Rear Transition Module for HOM measurements with an ultra-fast high-resolution AMC digitizer.

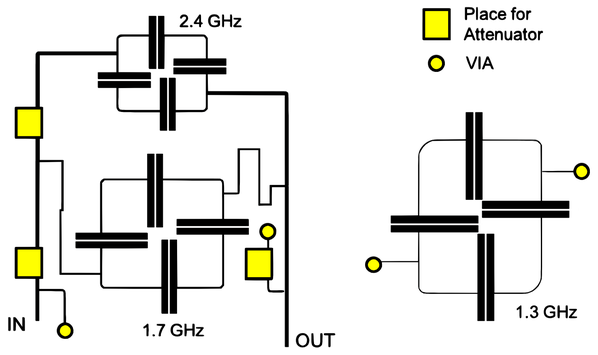
HOM coupler spectrum

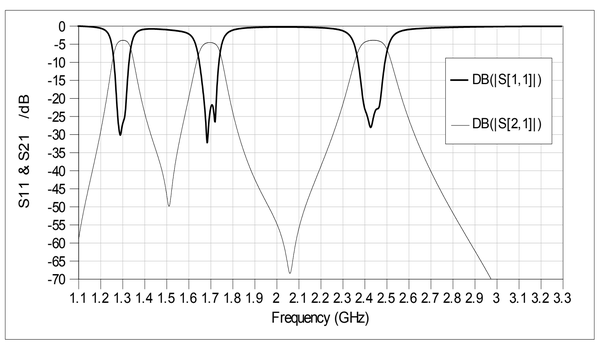


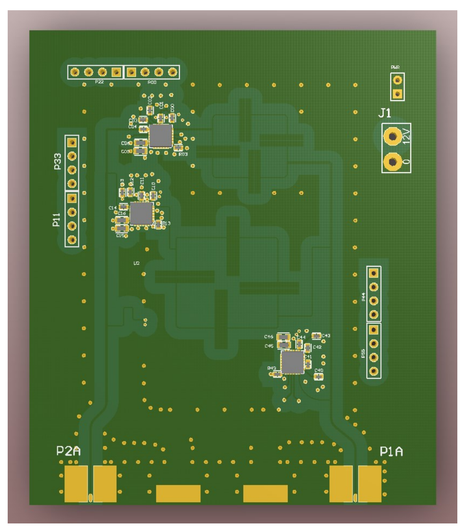
HOM channel Block Diagram



Filter design, characteristics, prototype

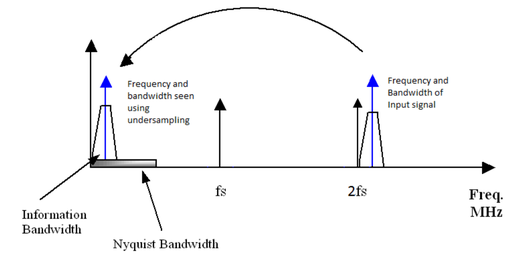




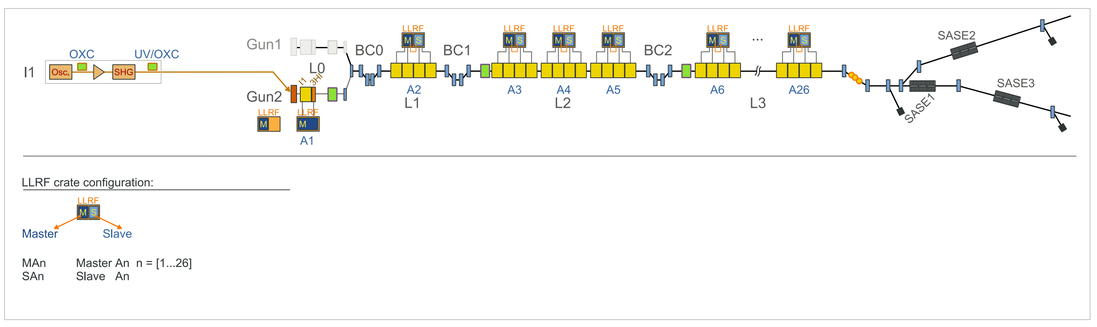


Undersampling

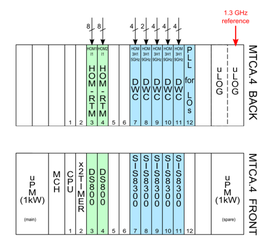
- $F_s > 2 * Bw_{input\ signal}$
- Input ADC BW > $F_{input\ signal}$

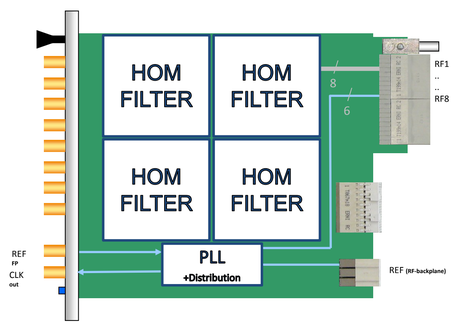


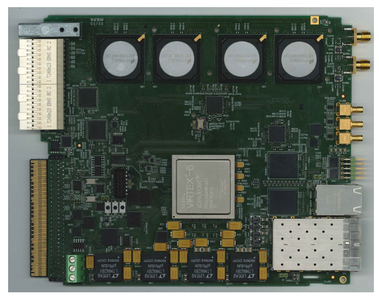
MTCA.4 implementation



- 480 HOM measurement channels in the XFEL
- 60 8-channel AMC+RTM modules
- Sampling up to 800 MSPS







Conclusion and Future Projects

A new HOM measurement system is being designed and implemented at the DESY accelerators FLASH and XFEL. It is prepared in the MTCA.4 standard, and involves a very high-speed digitizer and a specialized RTM module. The design uses direct sampling for data acquisition, so no complex LO nor downconversion is needed. This process would eliminate problems with LO drifts and nonlinearities resulting from downconversion, as well as simplify the construction of the electronics system. The construction of the system involves state-of-the-art design techniques in all aspects of modern electronics, from specialized analog RF, to ultra fast analog-to-digital conversion and very low noise clock distribution, in addition to high speed digital circuits. The next steps would be to measure and tune the single modules of the system and install them in the accelerators for live HOM signal measurements.

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