

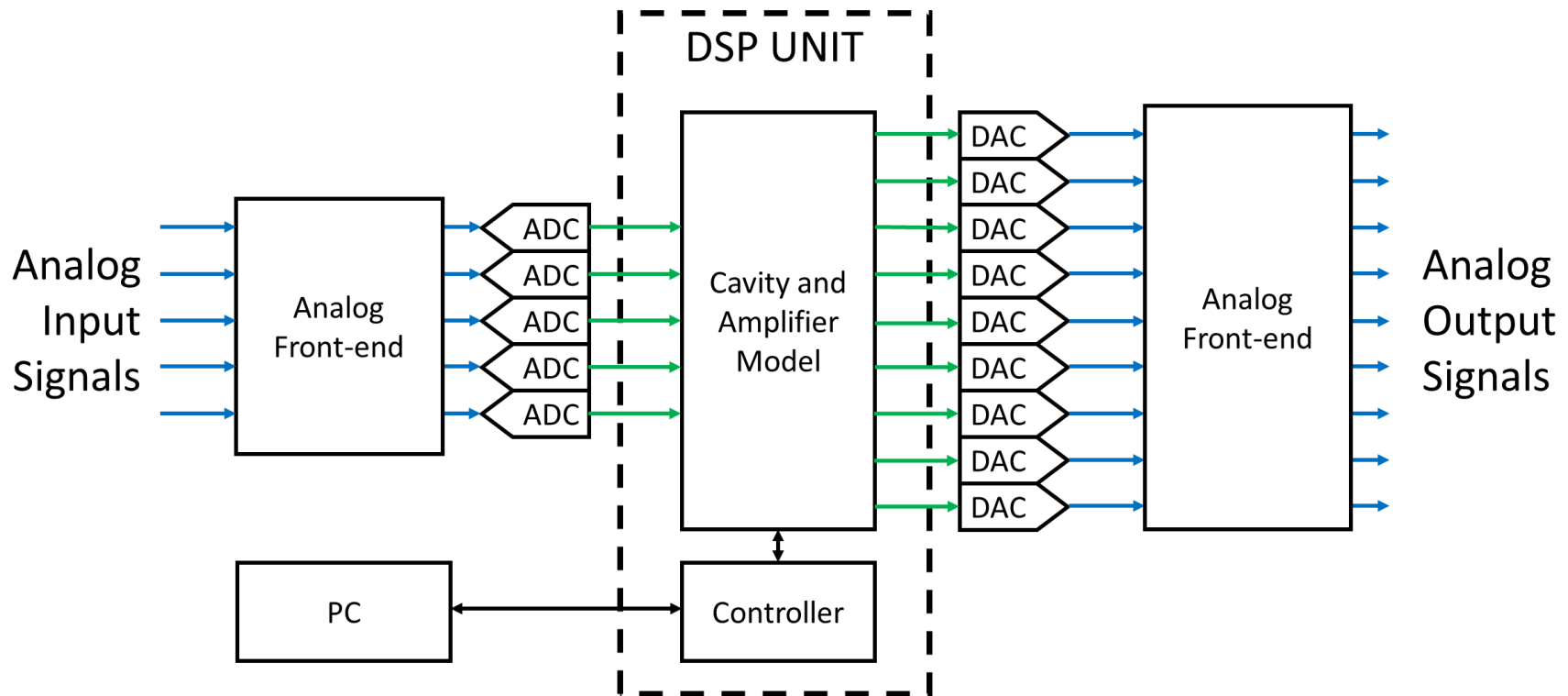
Cavity Simulator

Maciej Grzegorzówka

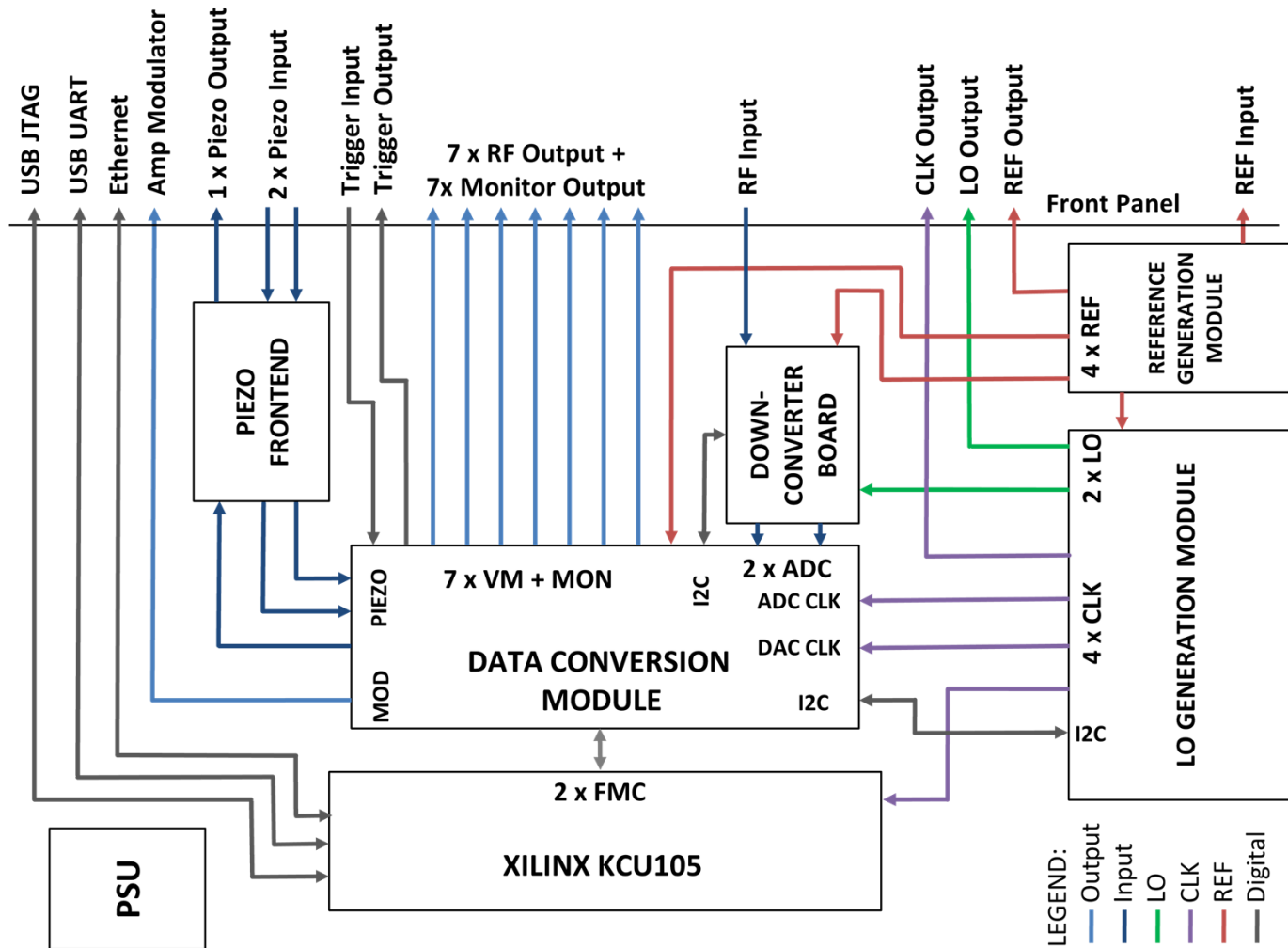
Lund, 26.04.2018

Cavity Simulator

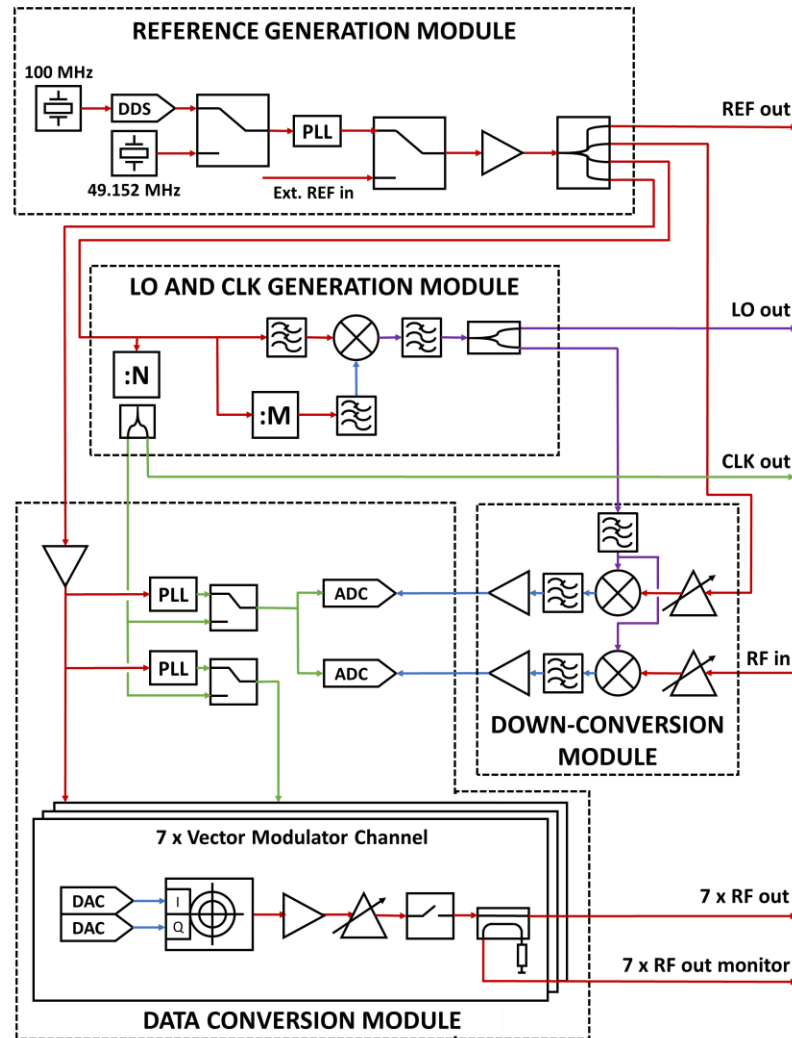
The Cavity simulator is a device used for development and testing of M-Beta and H-Beta LLRF control systems used at the ESS facility.



Hardware



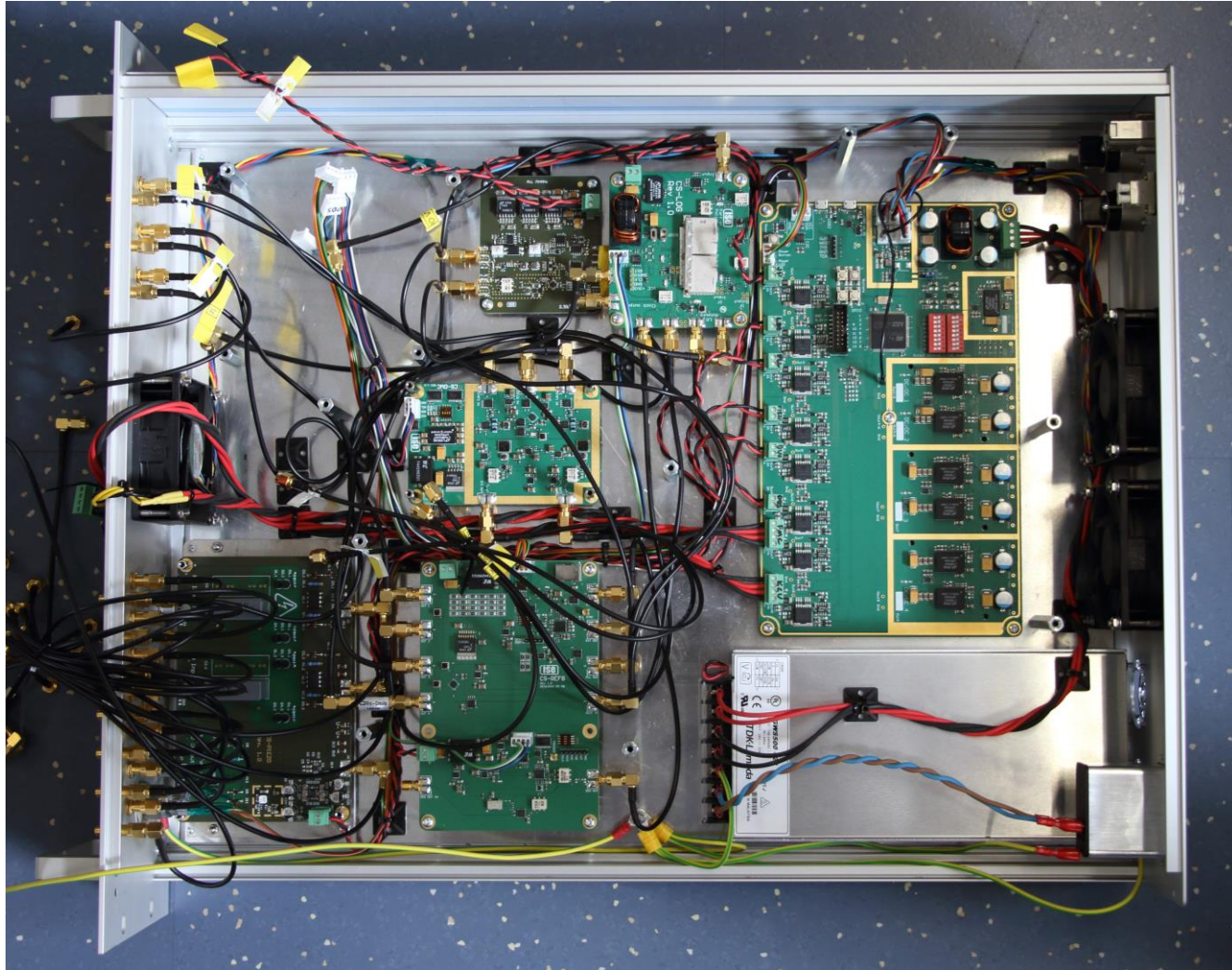
Hardware – RF system



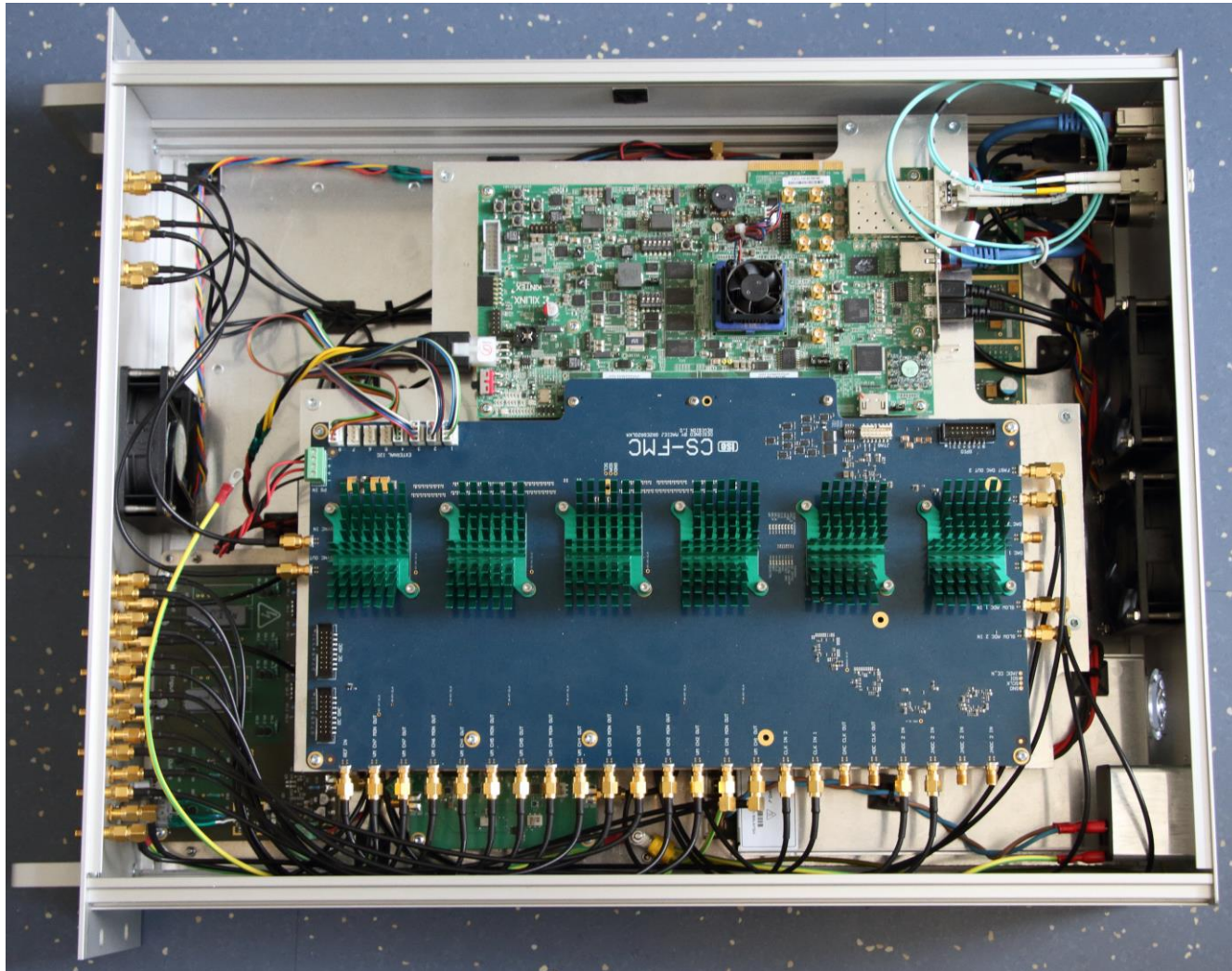
Assembled Unit



Assembled Unit



Assembled Unit



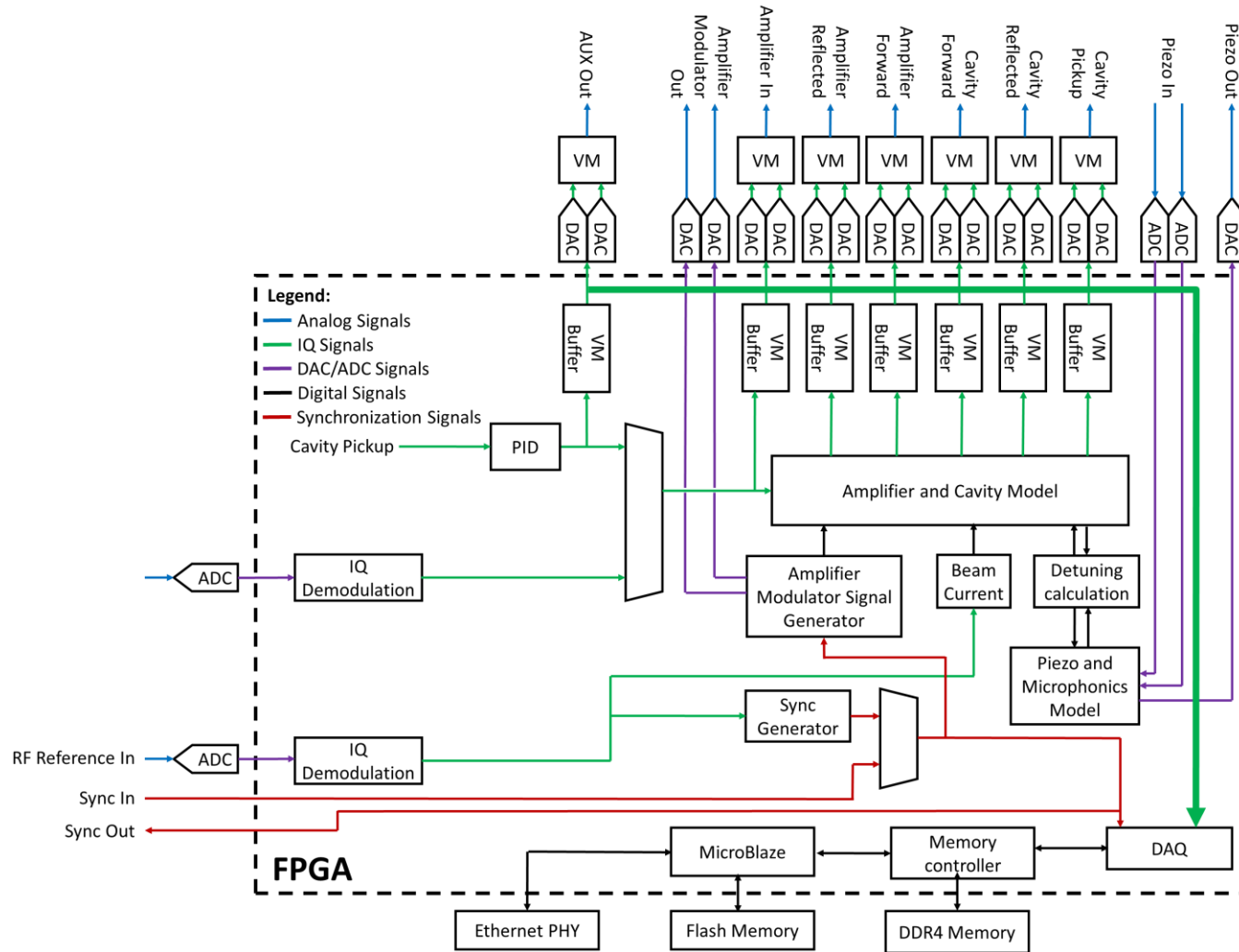
Found problems

- Front Fan increases reference's phase noise,
 - Solution: A diffuser redirecting the airflow away from the CS-REFG module.
- The CS-Piezo mounting holes are too close to the bottom mounting plate edge.
 - Solution: Additional mounting plate for CS-Piezo.
- The fans in the PSU turn on when the AC power is connected.
 - Solution: Front panel switch will be connected to the on/off input of the PSU.

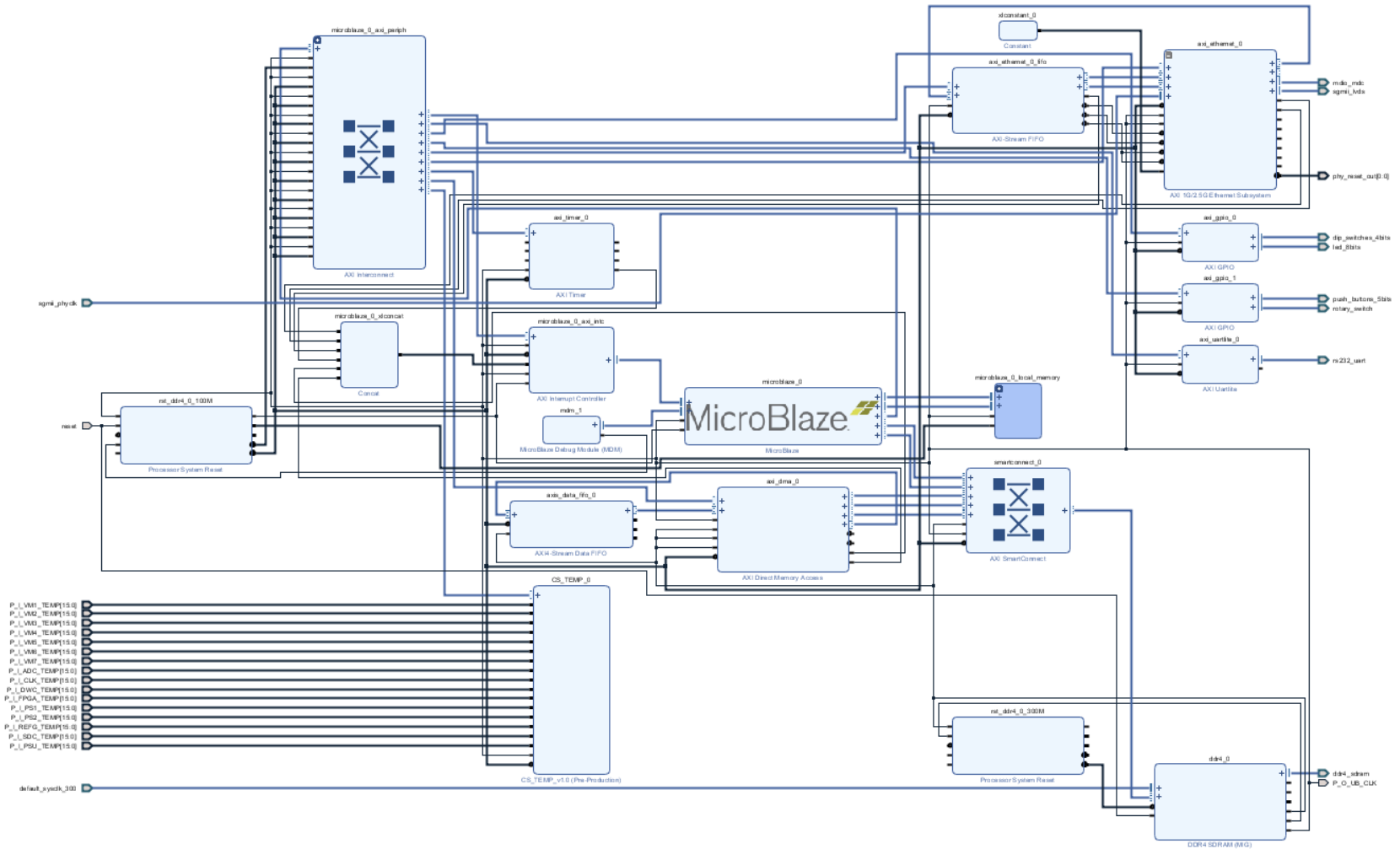
Hardware Status

- All modules have been manufactured
- The enclosures for all modules are ready
- First unit was assembled:
 - Few minor problems found
 - Delivery to DMCS expected in 2nd – 3rd week of May
- Second unit is being assembled

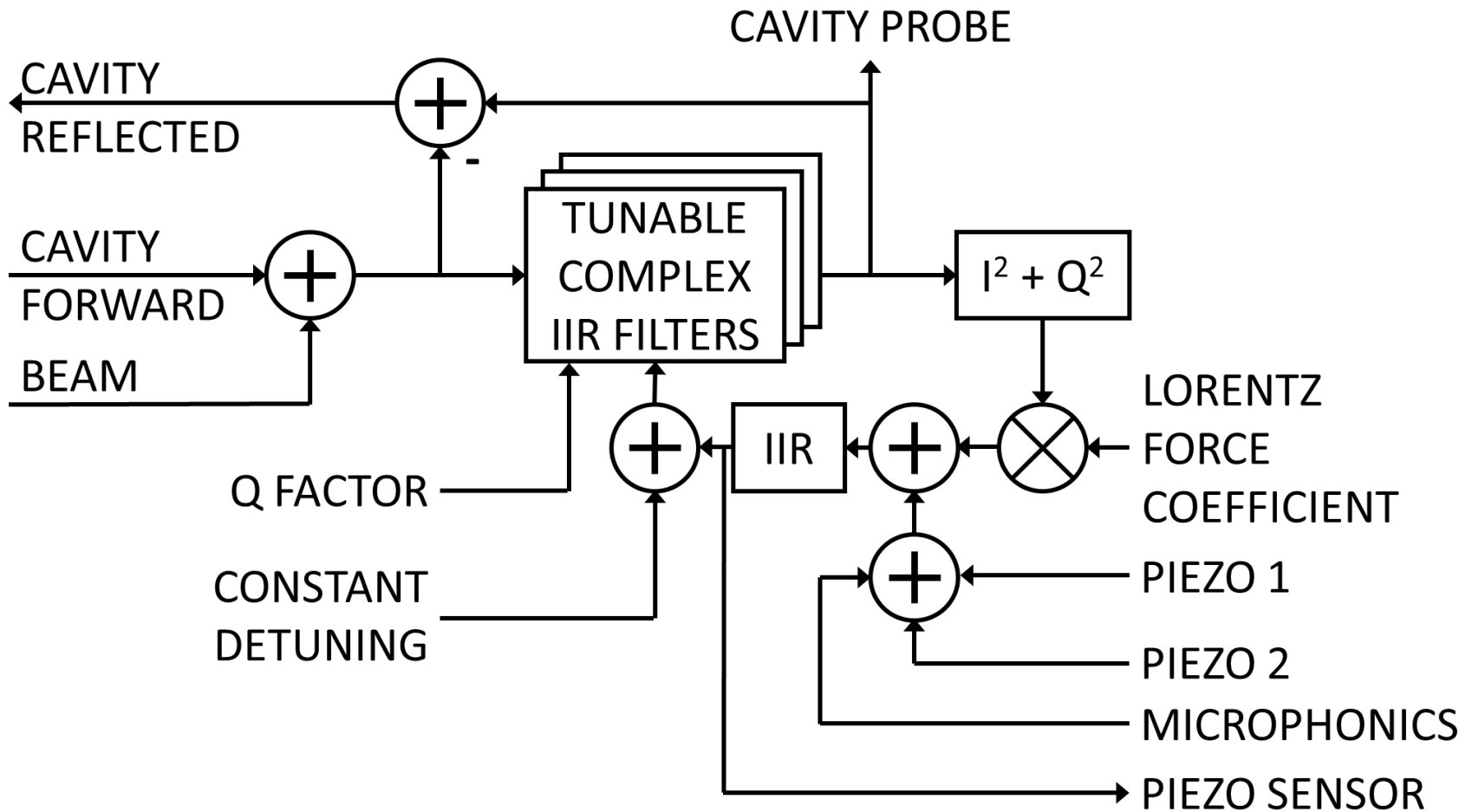
Firmware – CS-FPGA



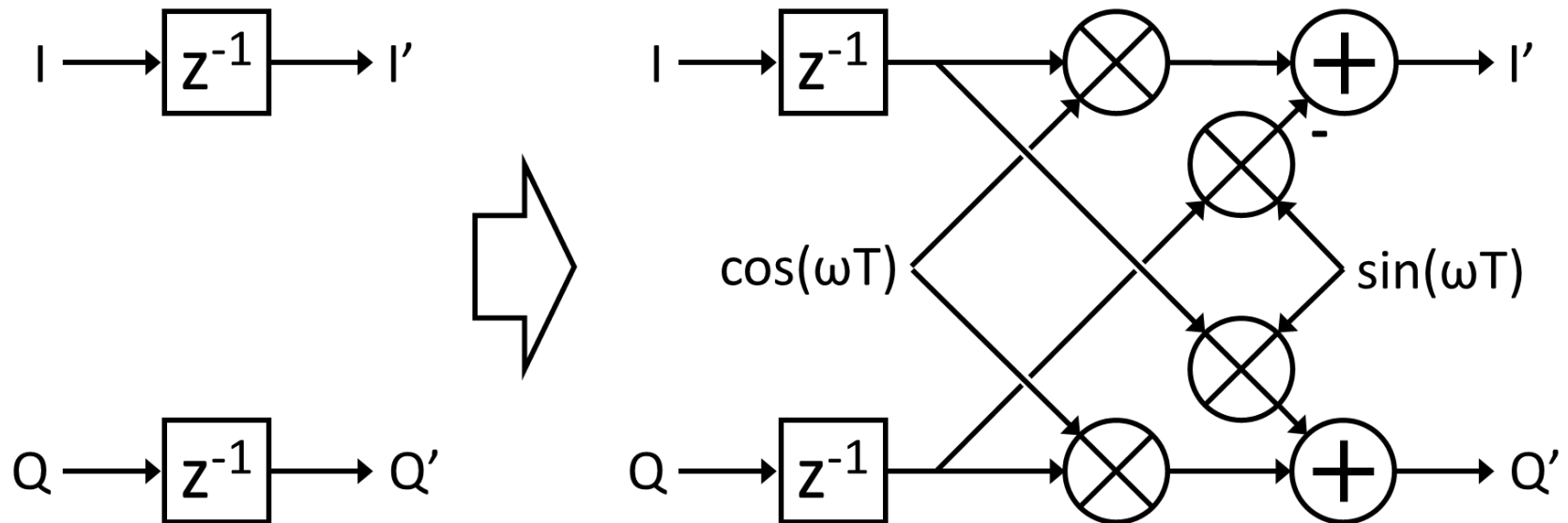
Firmware – MicroBlaze System



Cavity Model



Frequency Detuning

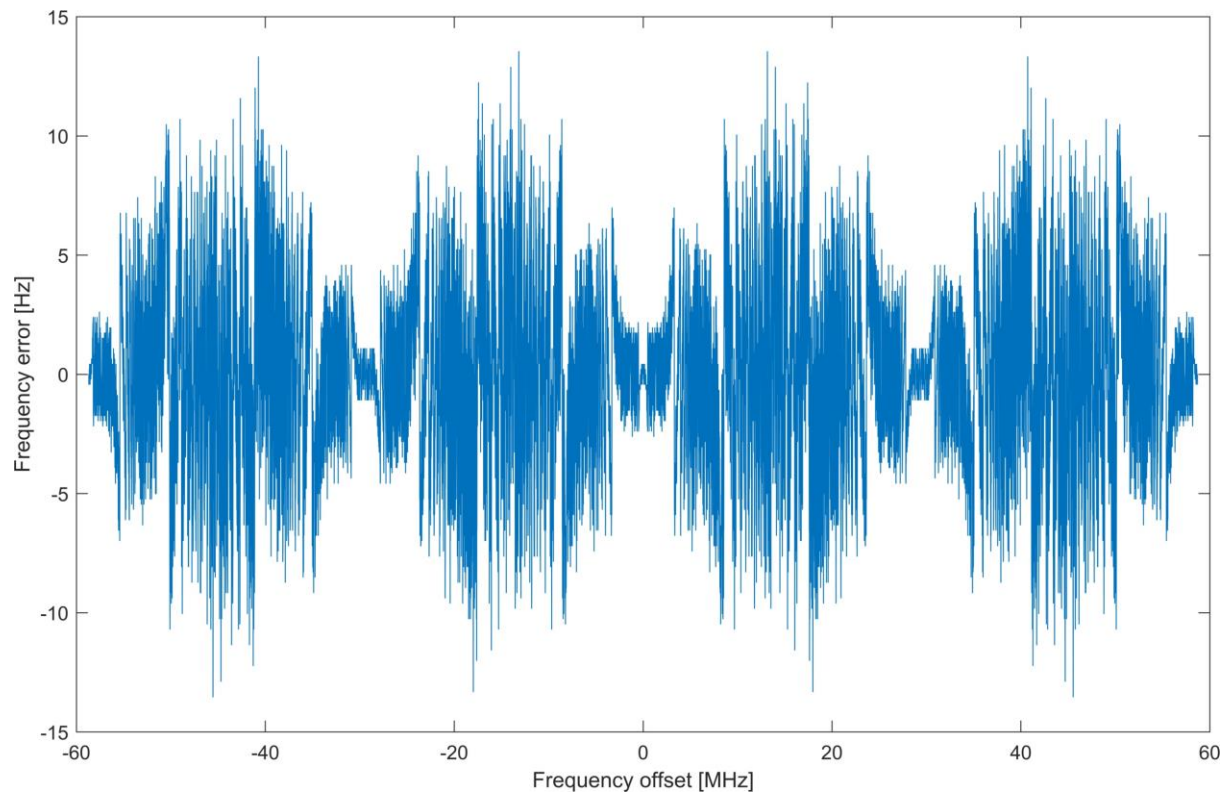


Sinwave generation

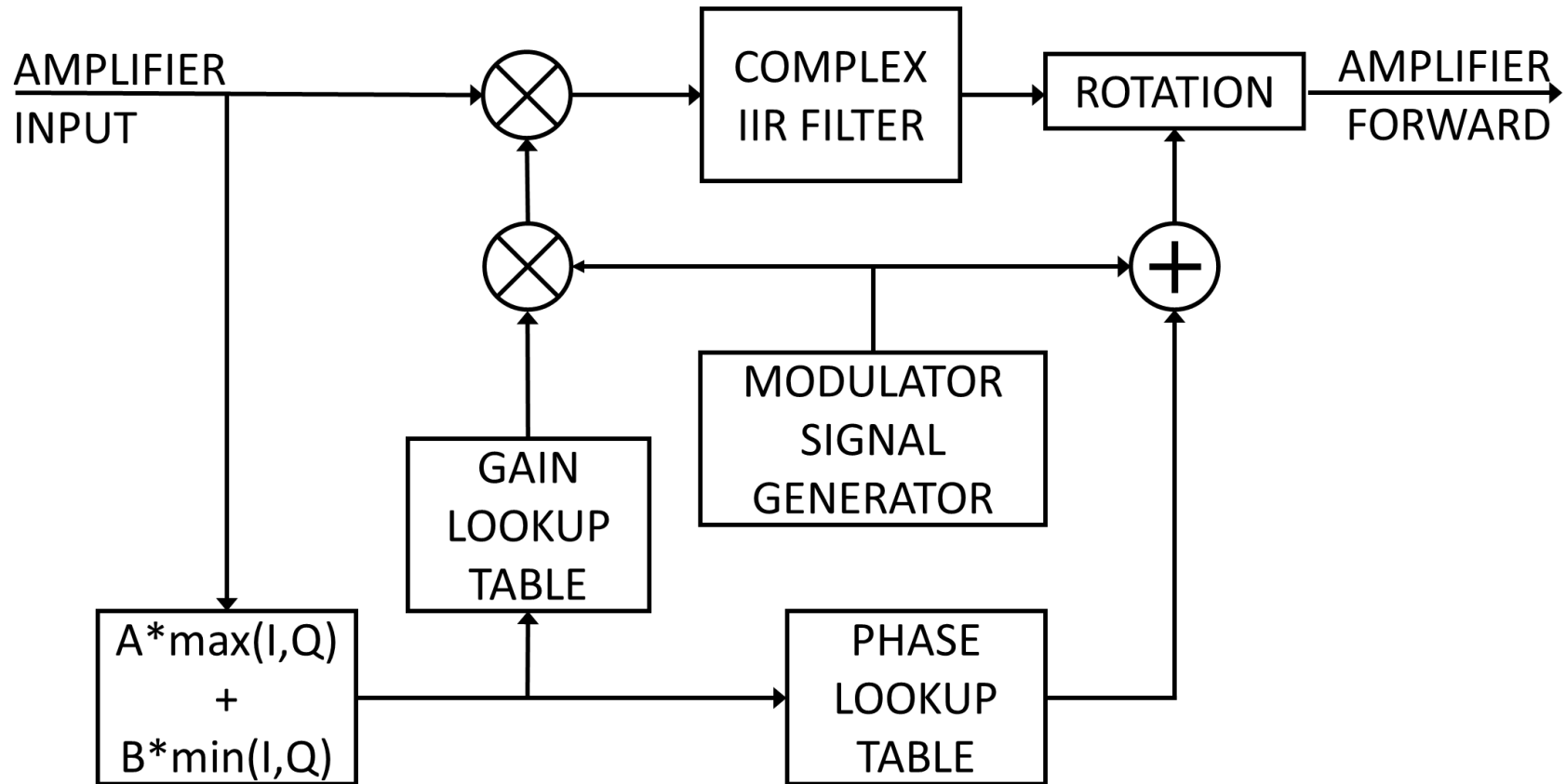
- Based on Taylor's theorem:
- Frequency shift error:

$$\sin x = \sum_{n=0}^{\infty} \frac{(-1)^n}{(2n+1)!} x^{2n+1} = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \dots$$

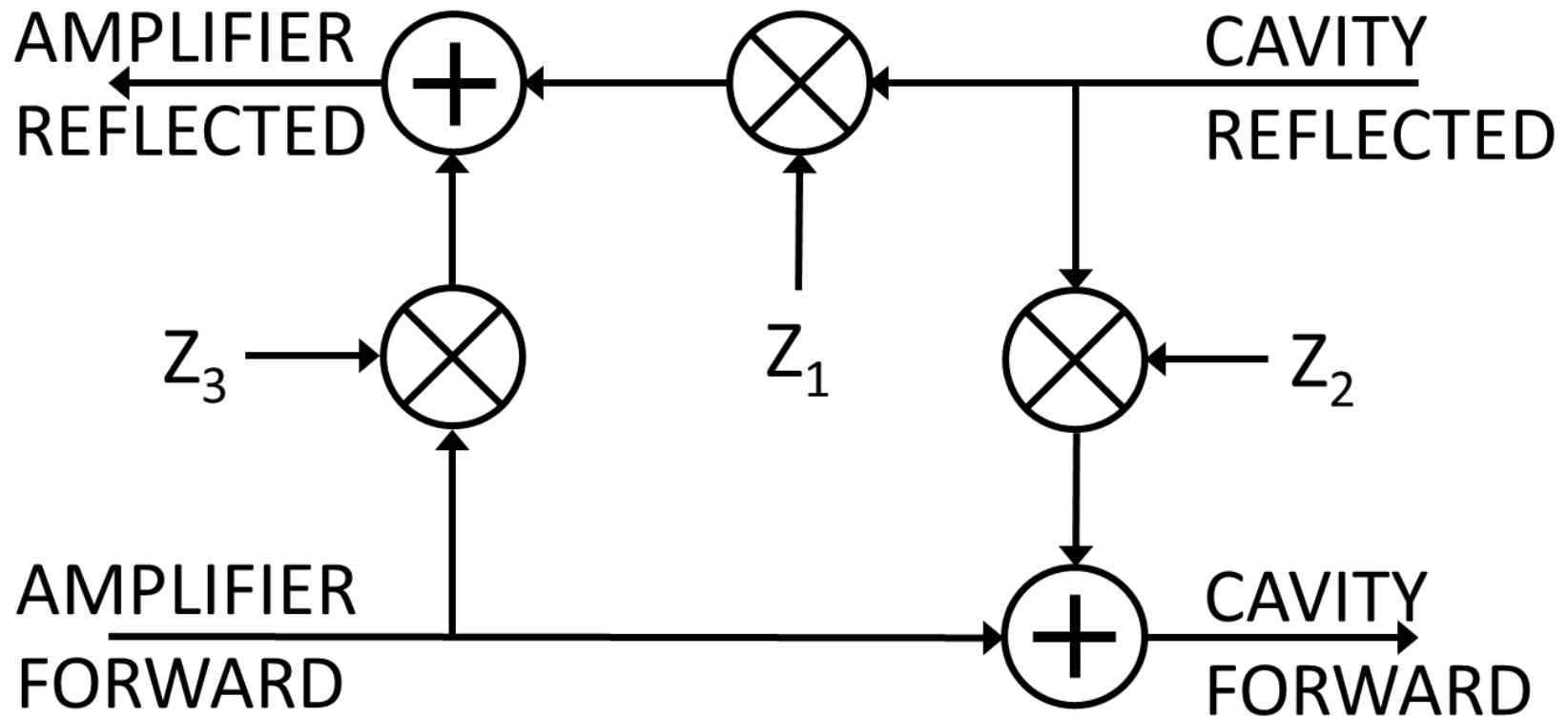
$$\cos x = \sum_{n=0}^{\infty} \frac{(-1)^n}{(2n)!} x^{2n} = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \dots$$



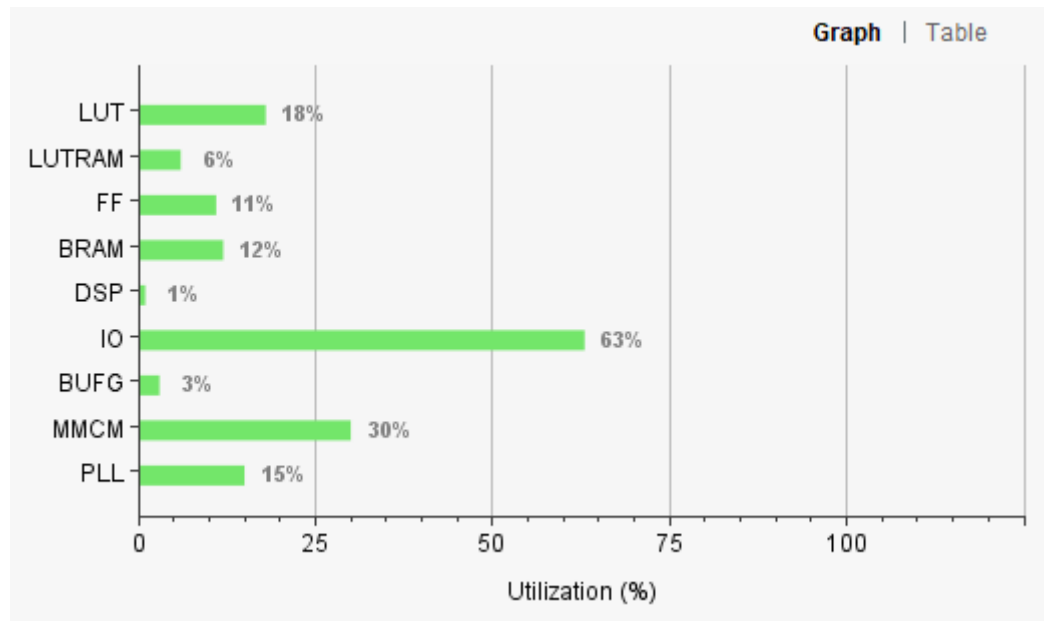
Model - Amplifier



Model - Transmission Line & Circulator



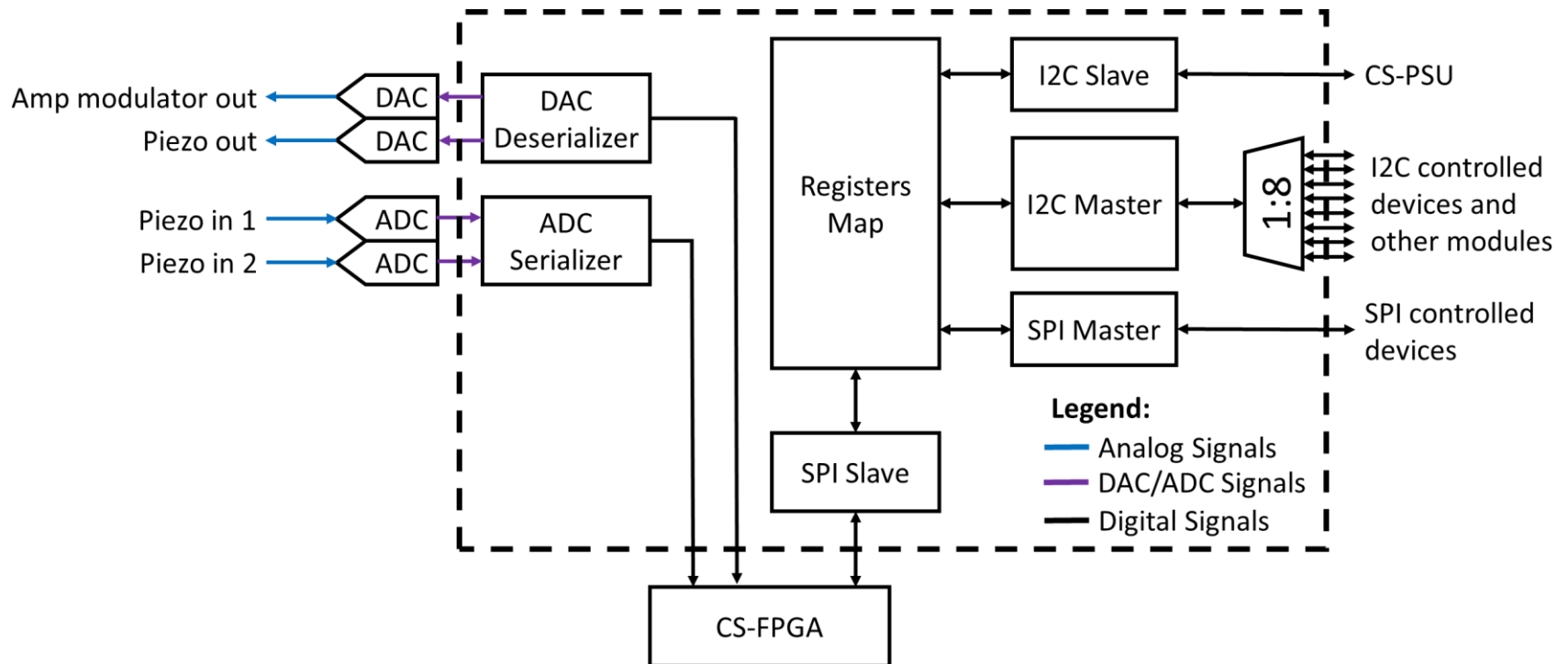
CS-FPGA Firmware – Resource Utilization



CS-FGPA Firmware Status

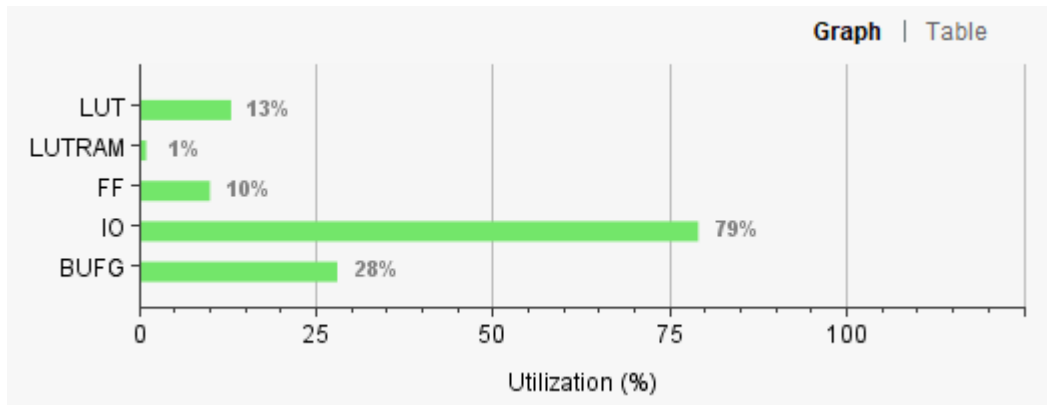
- Microblaze system was generated
- Ethernet and USB interfaces work
- Communication with CS-FMC works
- First elements of the model were implemented

Firmware – CS-FMC



Firmware – CS-FMC continued

- CS-FMC firmware is 90% ready
- Resource usage:

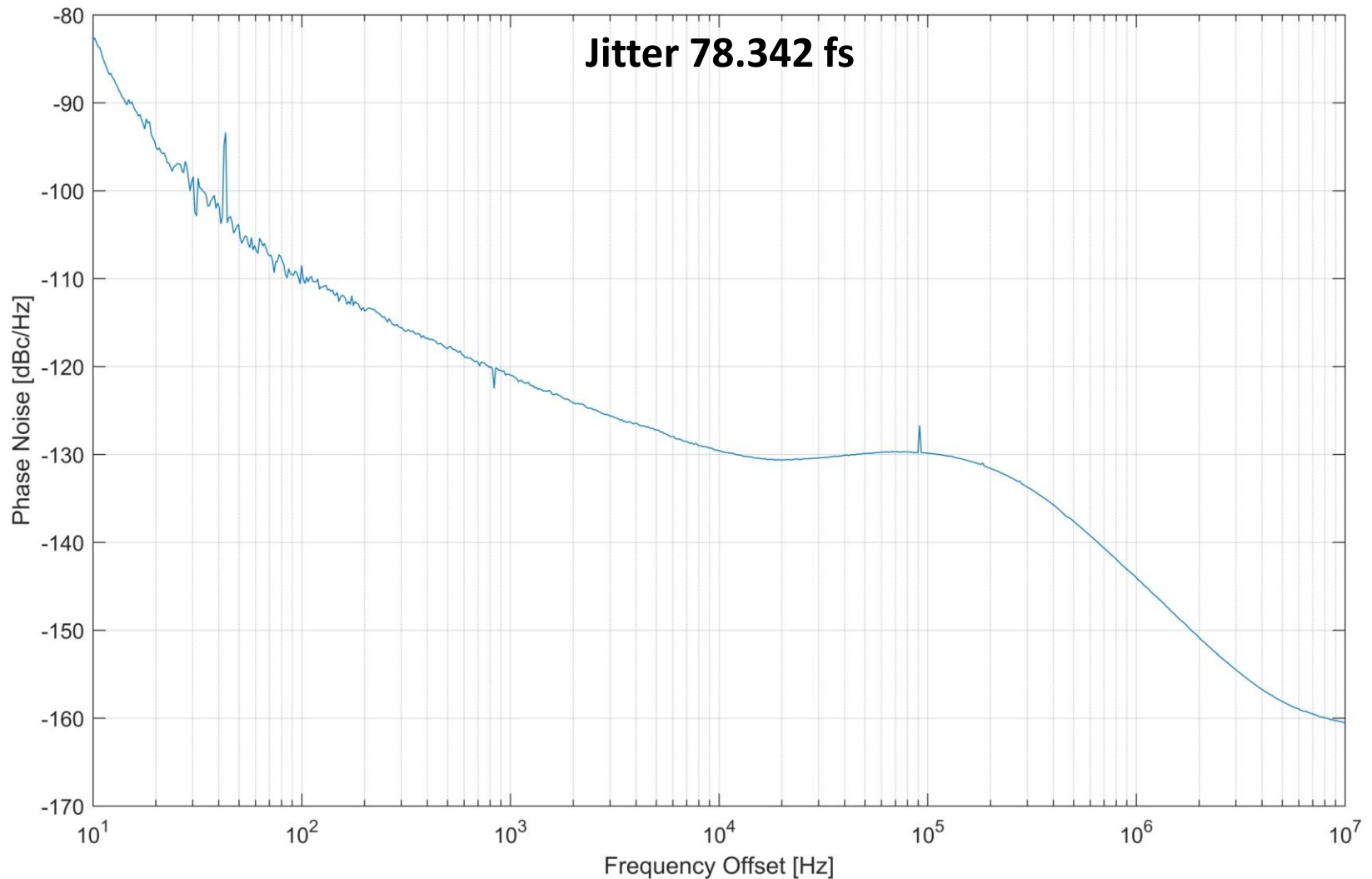


Software – Communication

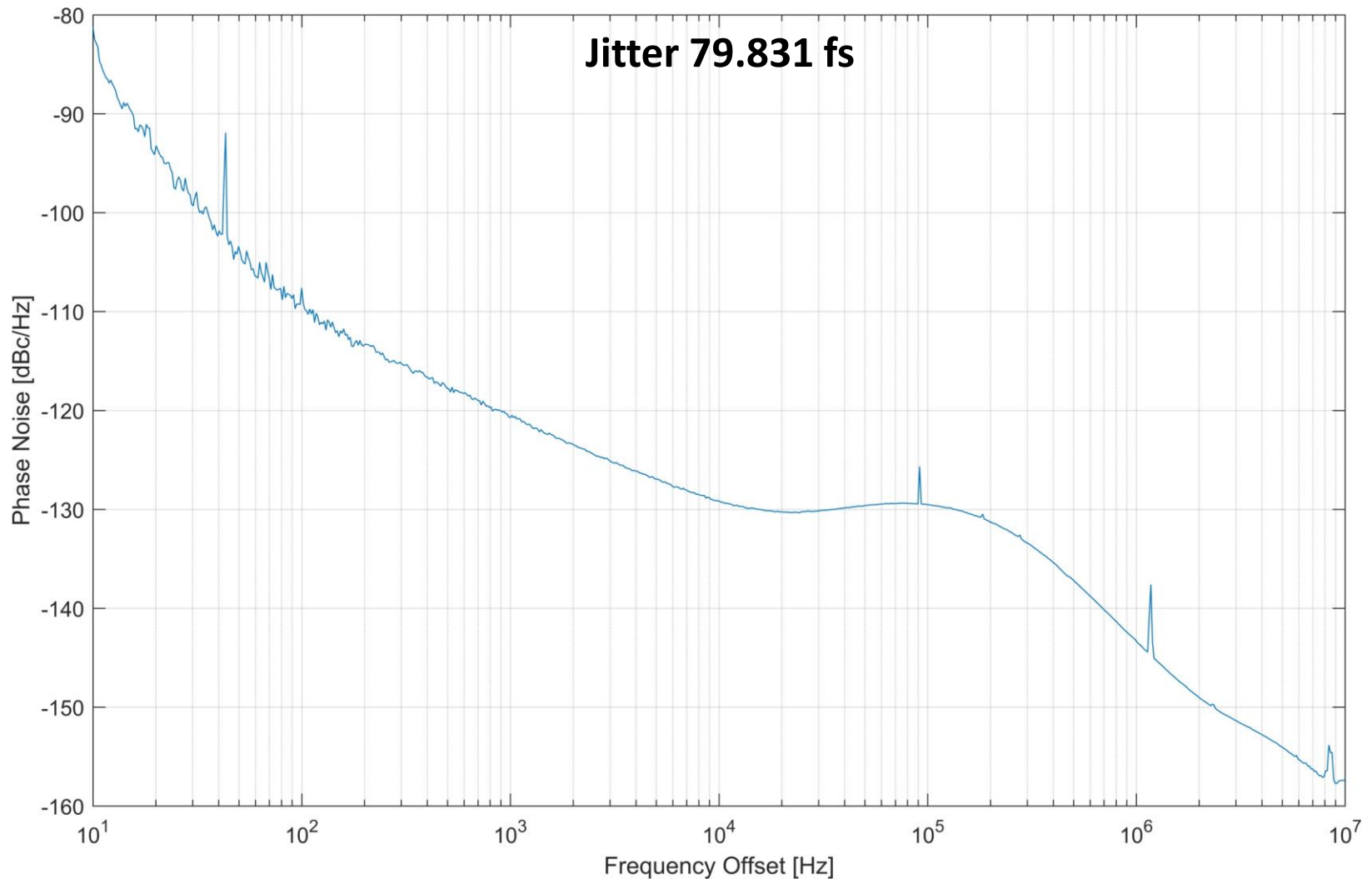
- SCPI - like commands will be used to control the device.
- Example:
 - SET:RFIN:ATT 15 – Sets the RF input attenuator value to 15 dB
 - SET:RFCH2:SWitch On
- Python application will be provided for non-automated control.

  EUROPEAN SPALLATION SOURCE	
Description:	This document describes the control commands for Cavity Simulator
Title:	Cavity Simulator Command List
NOTE: This document is subject to further changes during the development stage.	
Authors:	Maciej Grzegorzówka
Co Authors:	
Version:	0.1
Date:	17.04.2018

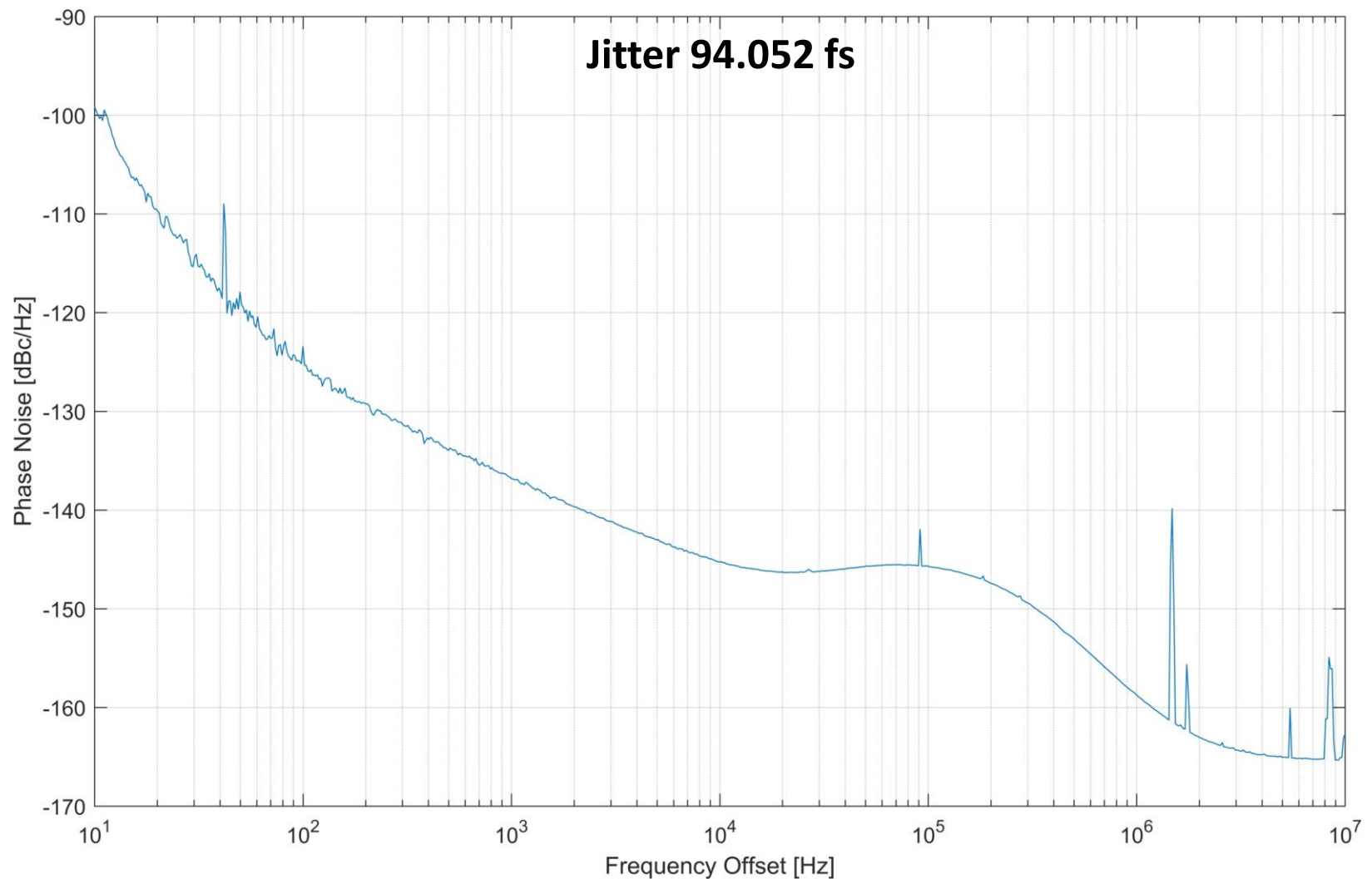
Reference Signal Phase Noise



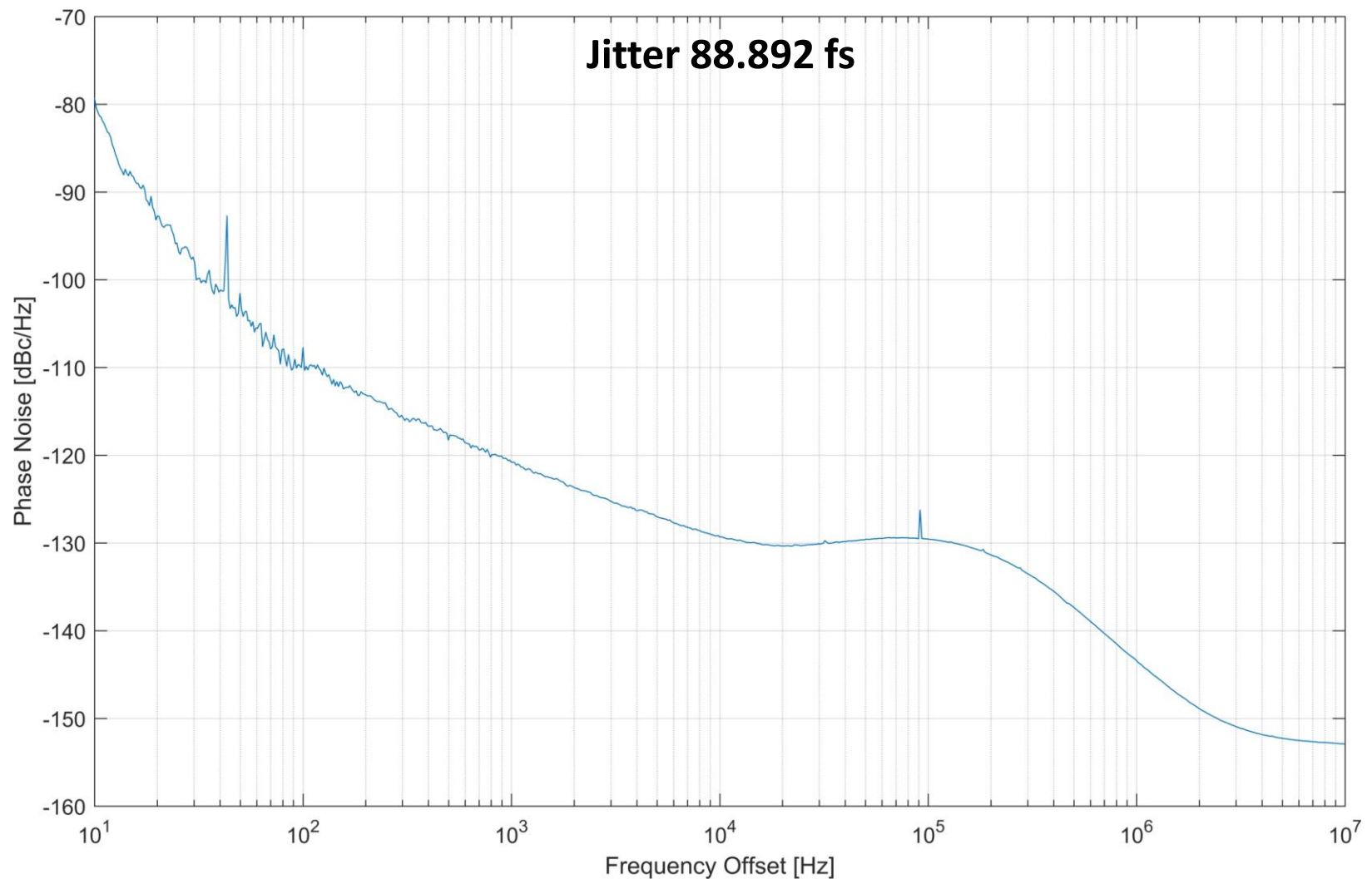
LO Signal Phase Noise



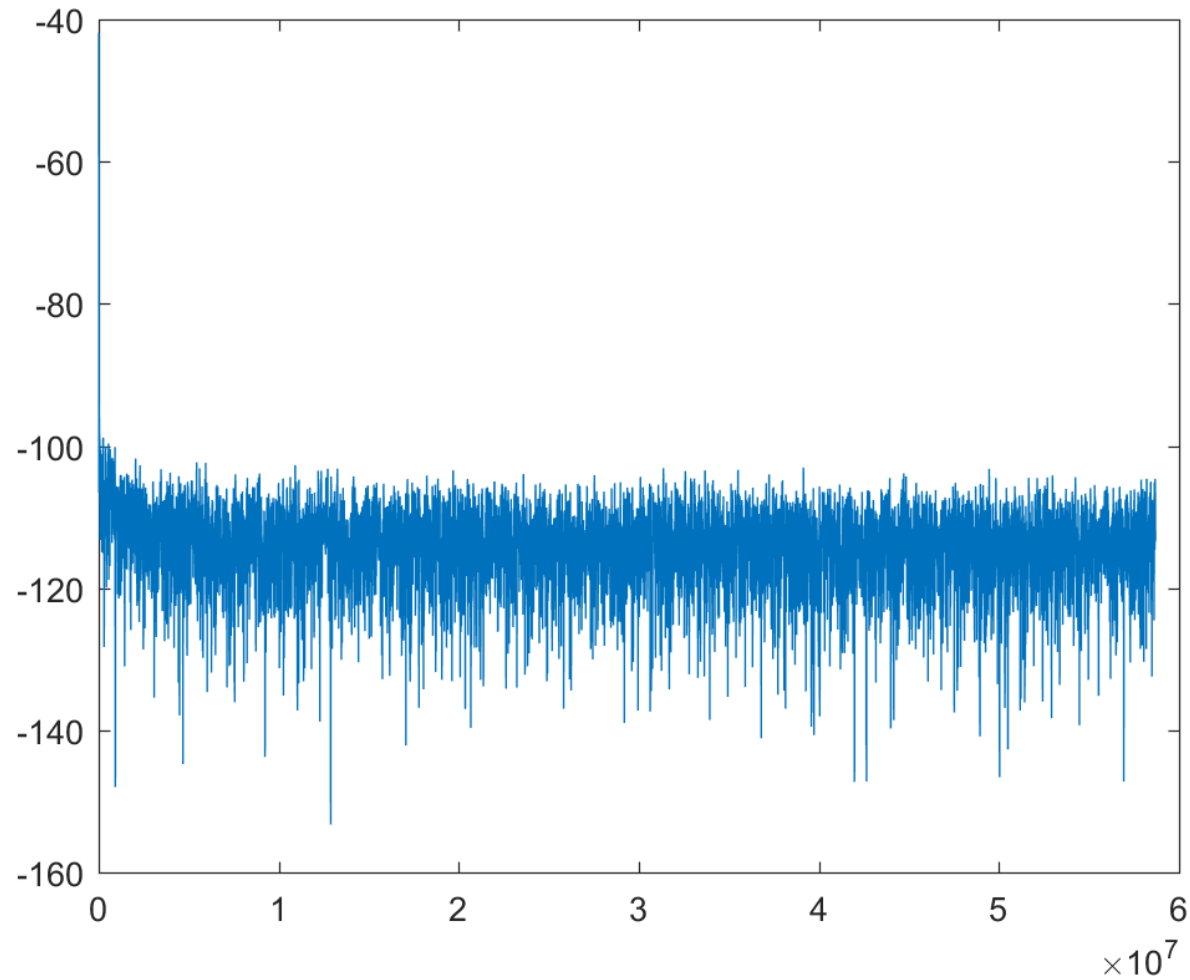
CLK Signal Phase Noise



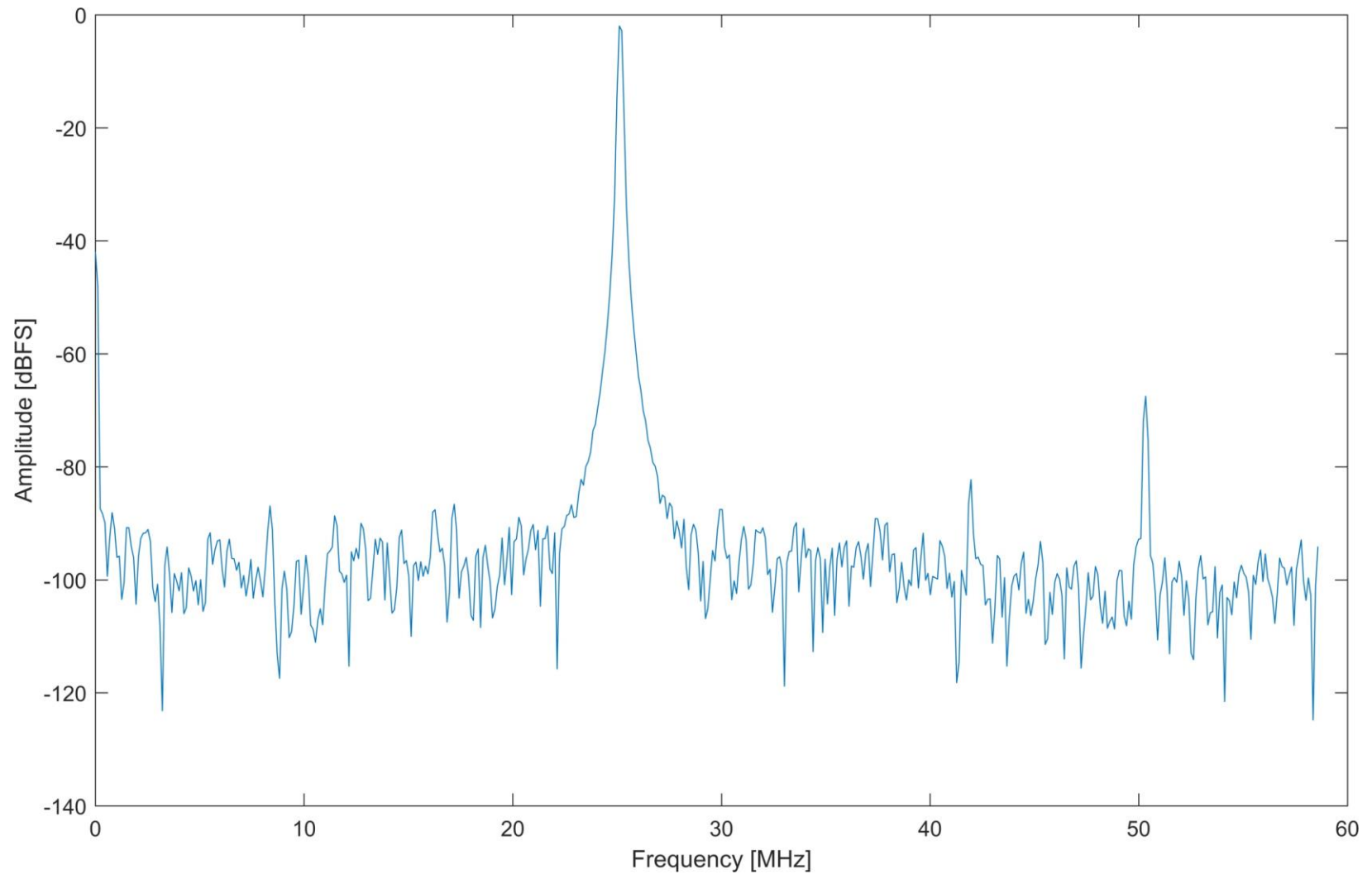
VM Phase Noise



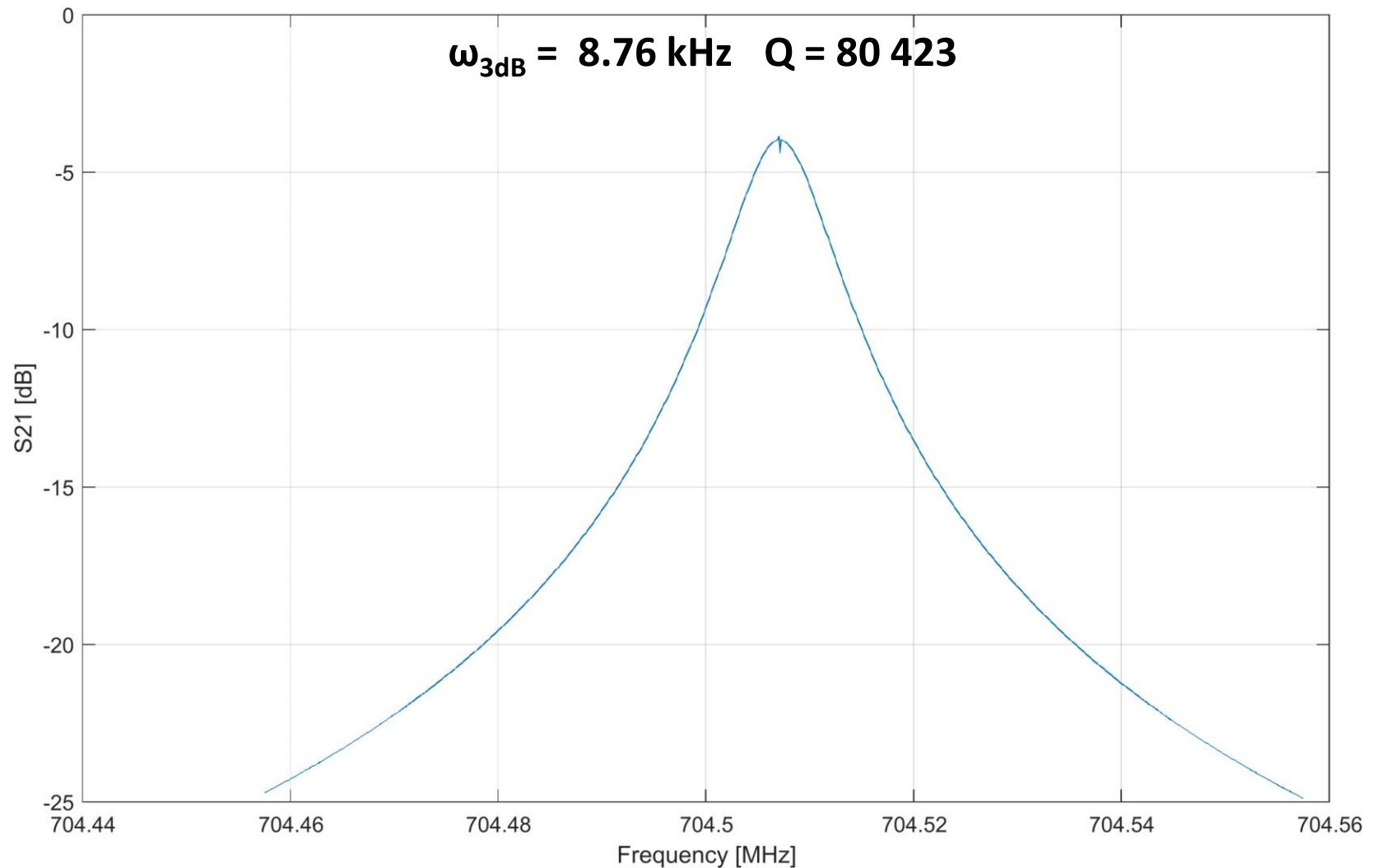
ADC Readout – no signal



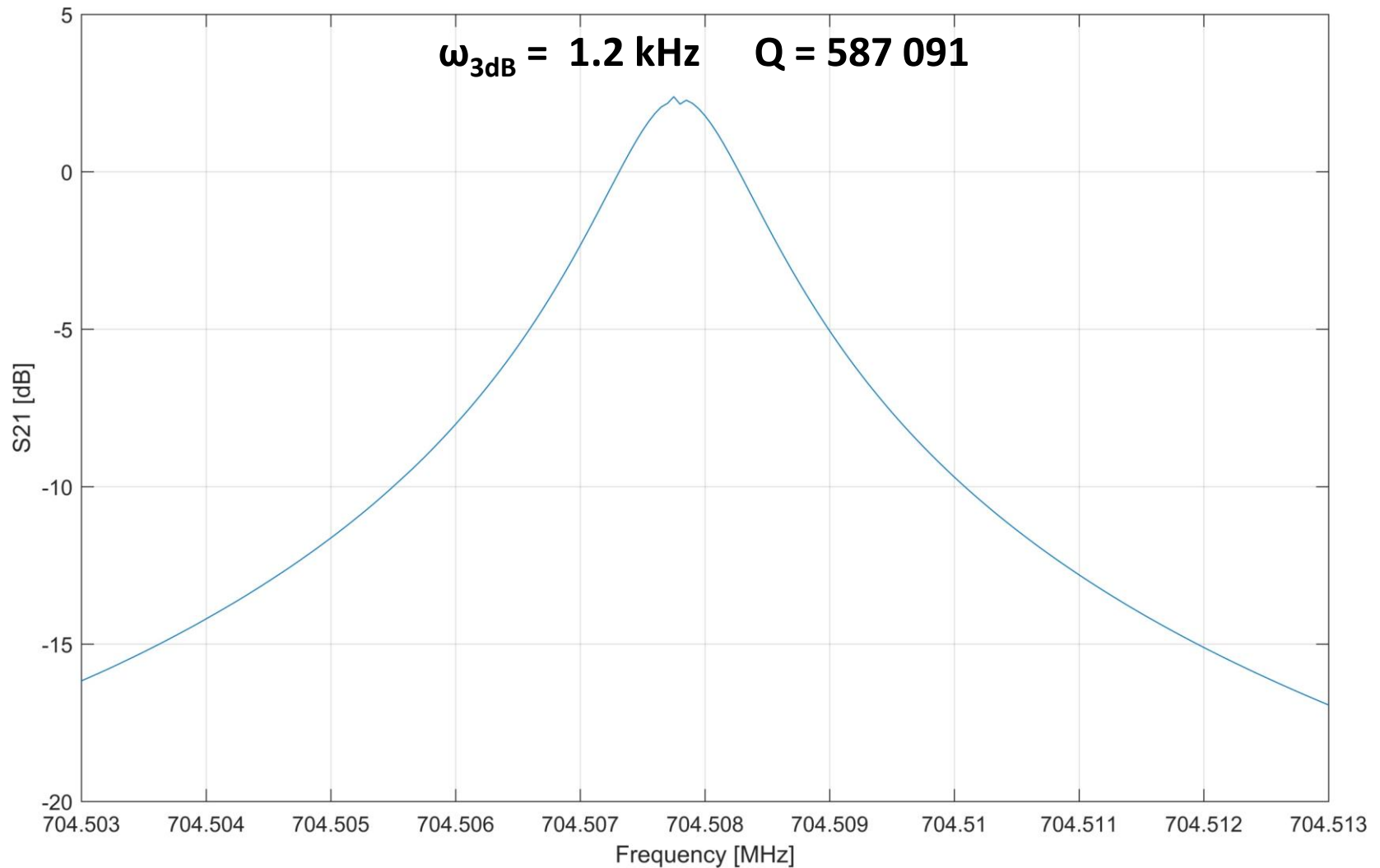
ADC Readout – IF from DWC



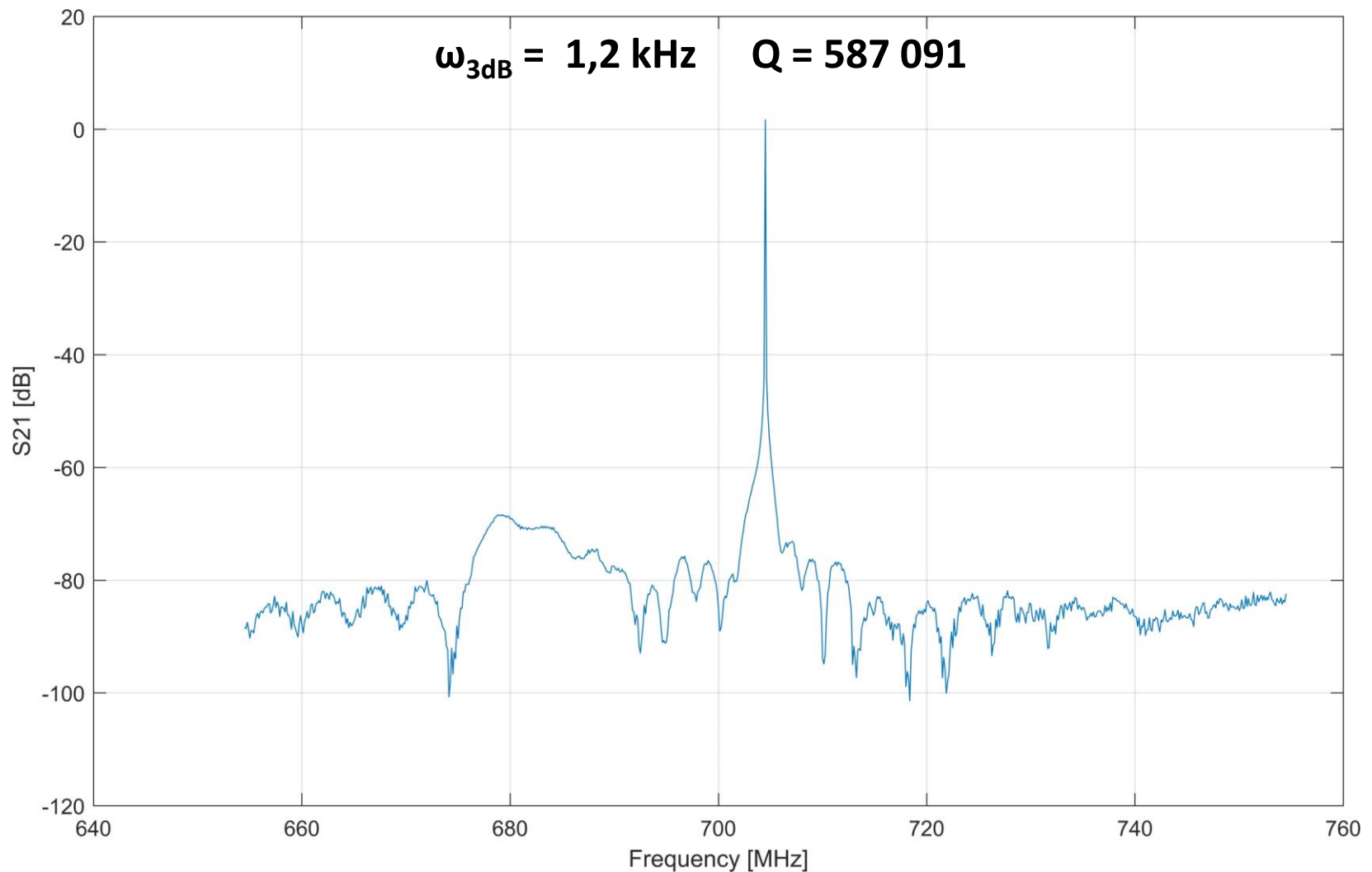
First Measurements – Transmission



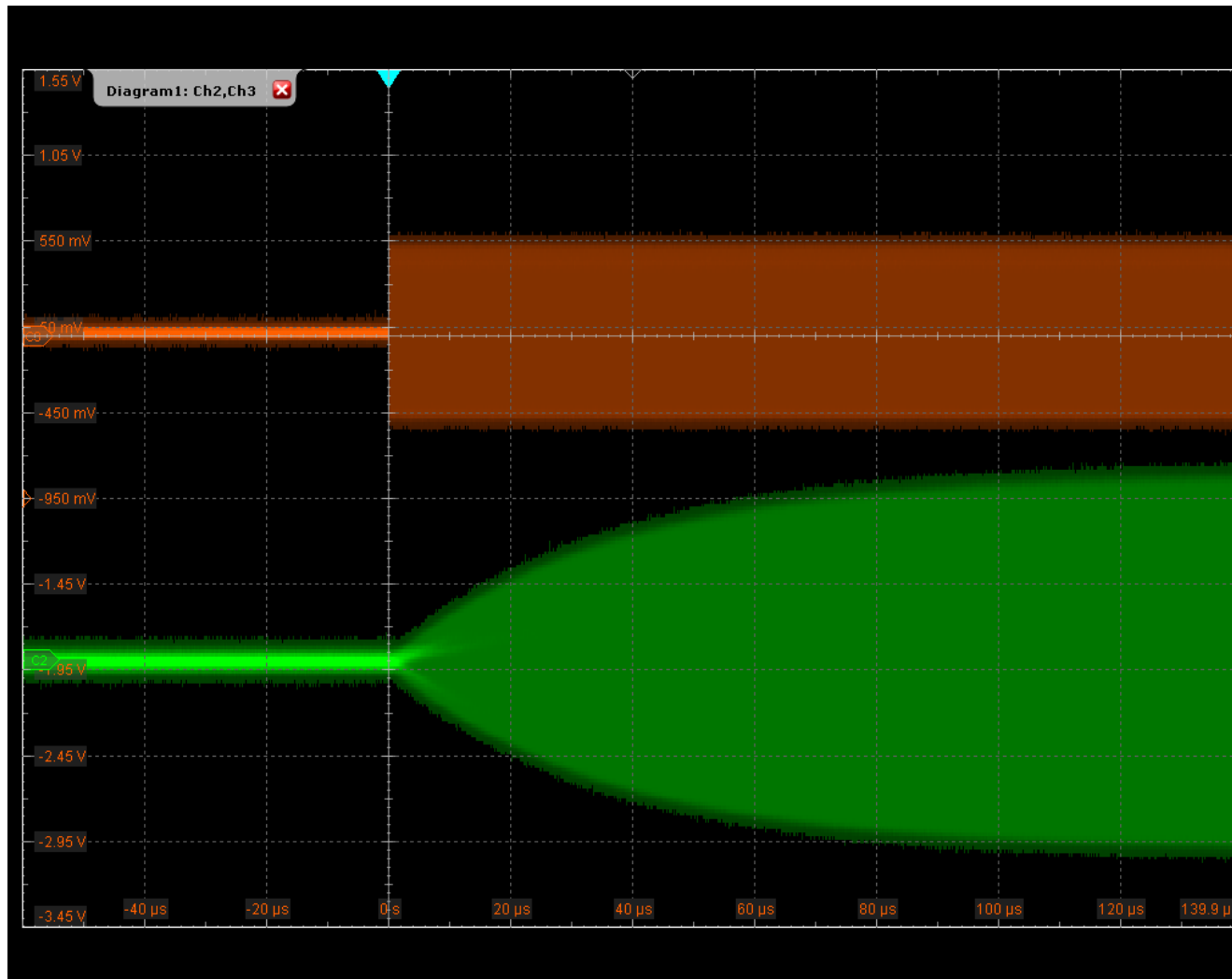
First Measurements – Transmission (max Q)



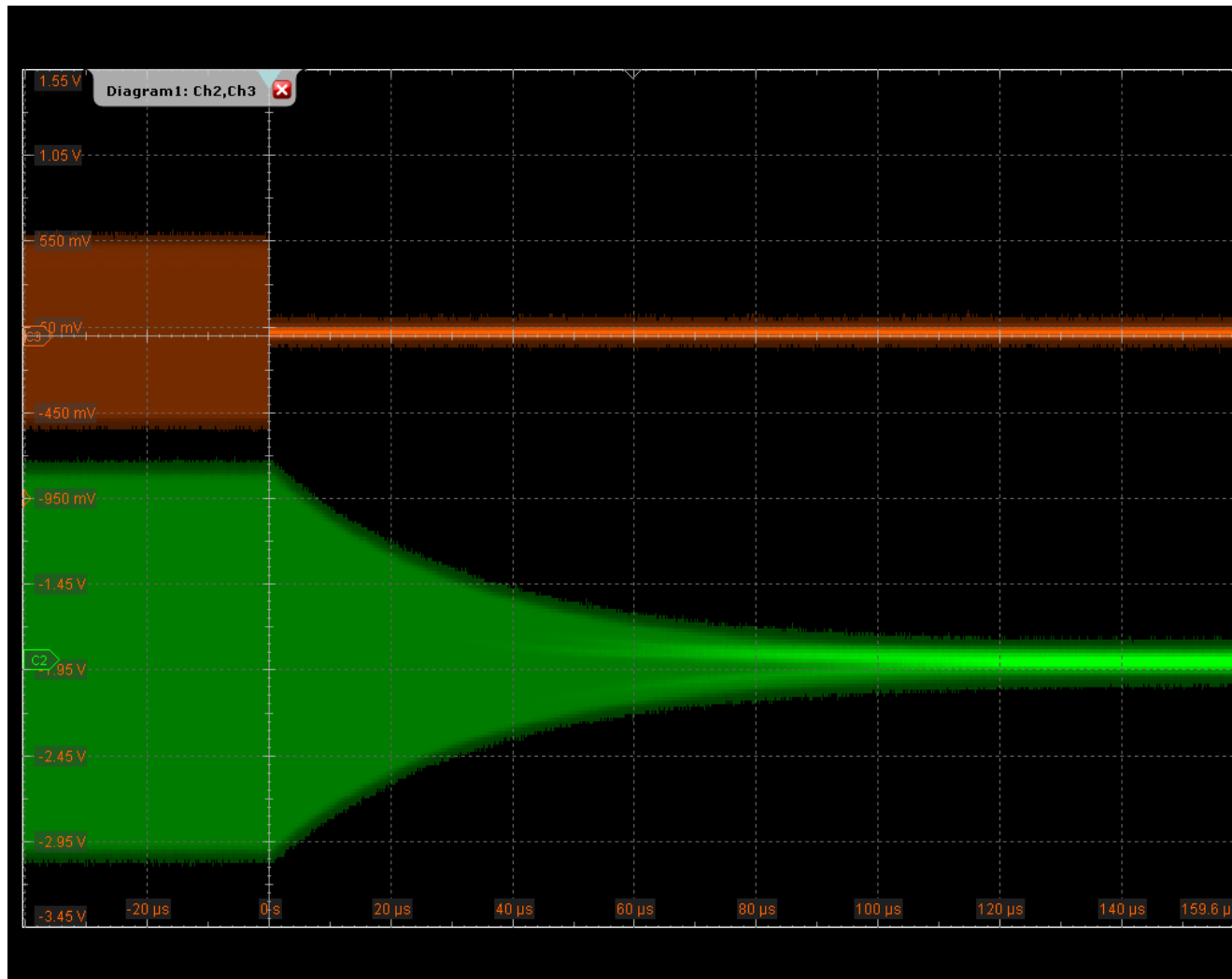
First Measurements – Transmission (max Q)



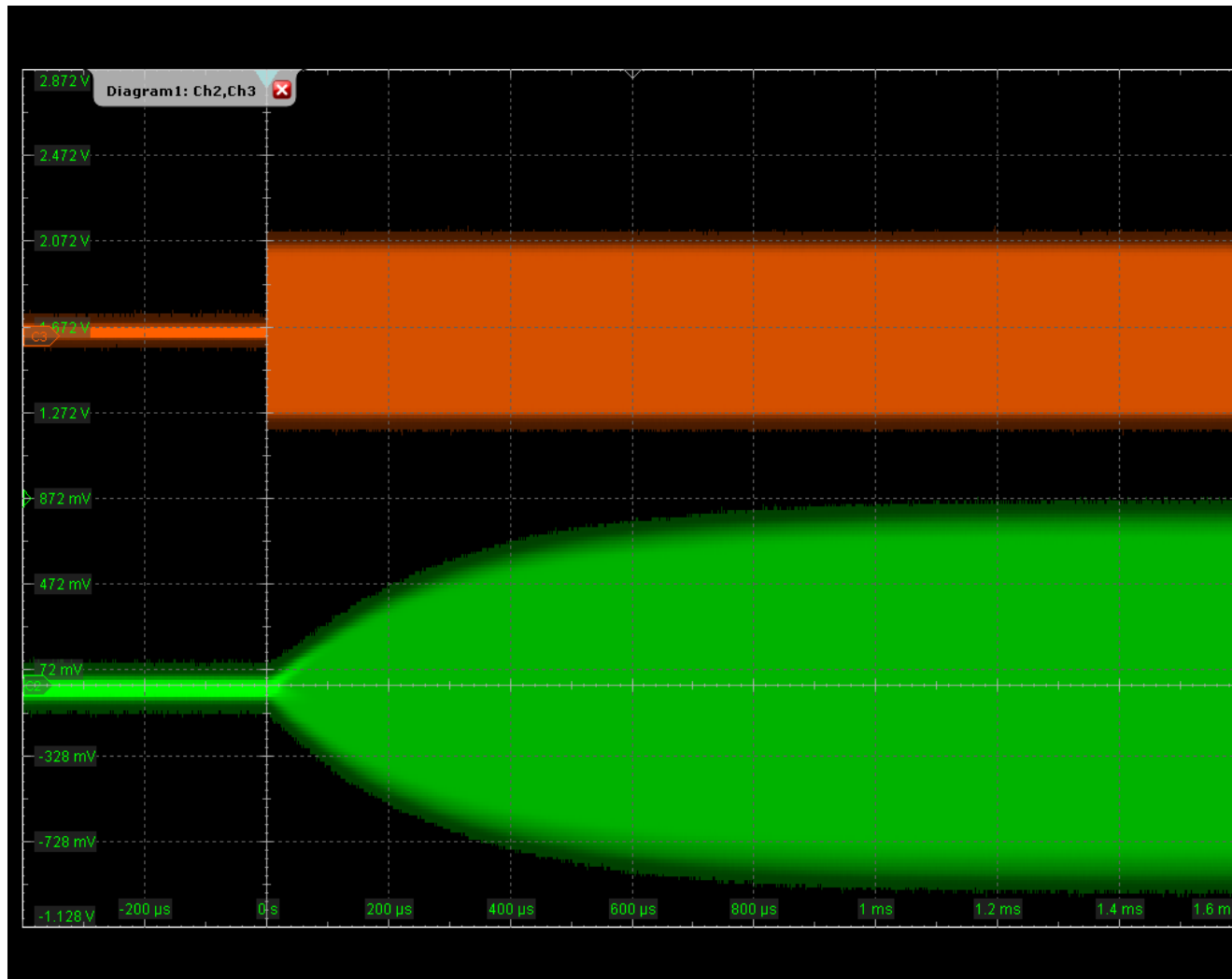
Cavity Filling ($Q = 80\,423$)



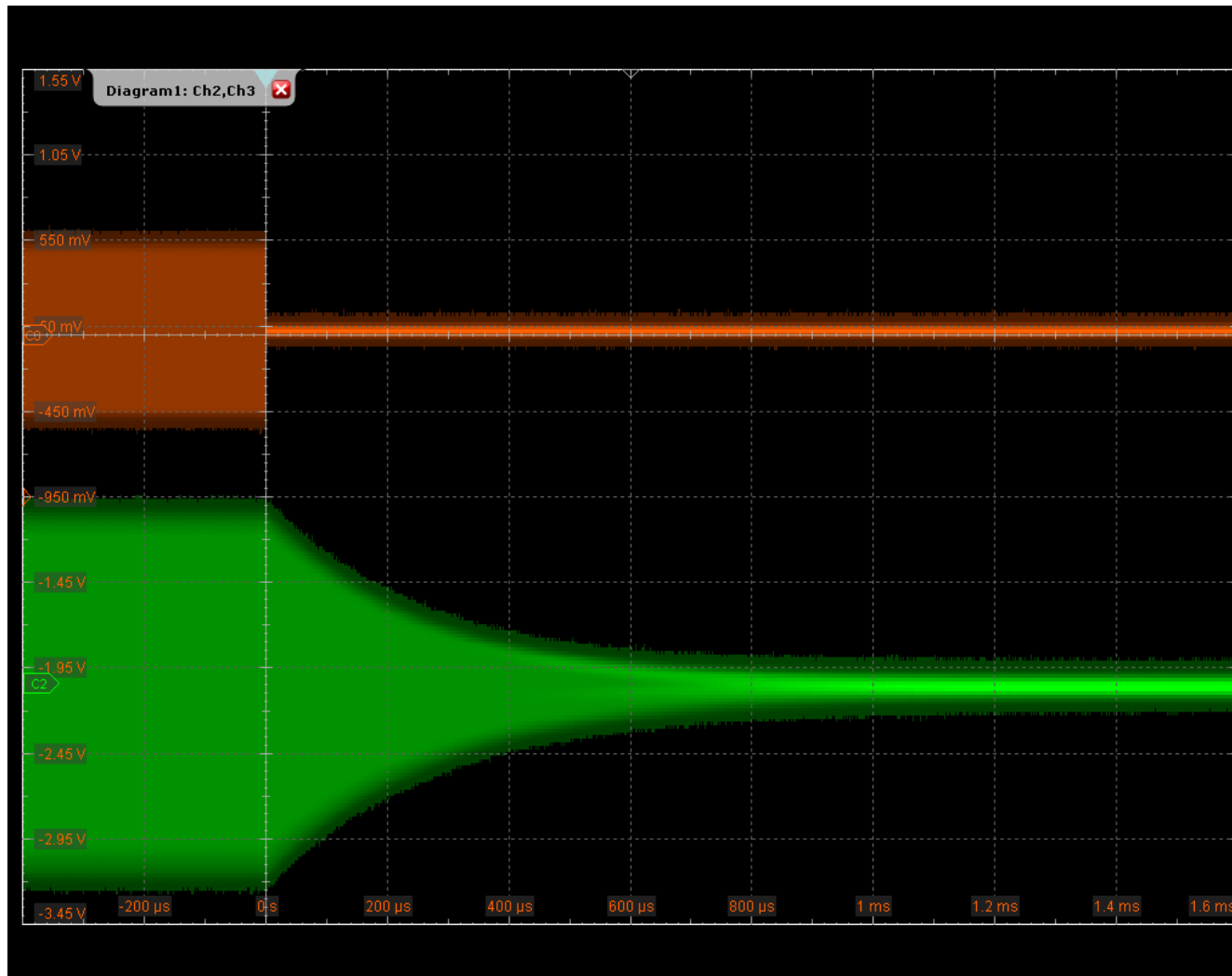
Cavity Decay ($Q = 80\,423$)



Cavity Filling (Q = 587 091)



Cavity Decay (Q = 587 091)



Plans

Activity	End Date
1st unit delivered To DMCS	18.05.2018
2nd unit assembled	18.05.2018
3rd and 4th unit delivered to NCBJ and ESS	20.07.2018
Milestone #20– Cavity Simulator with preliminary firmware	31.07.2018
Milestone #21– Cavity Simulator with final firmware	31.01.2020

We need to specify the exact scope of delivery for milestone #20

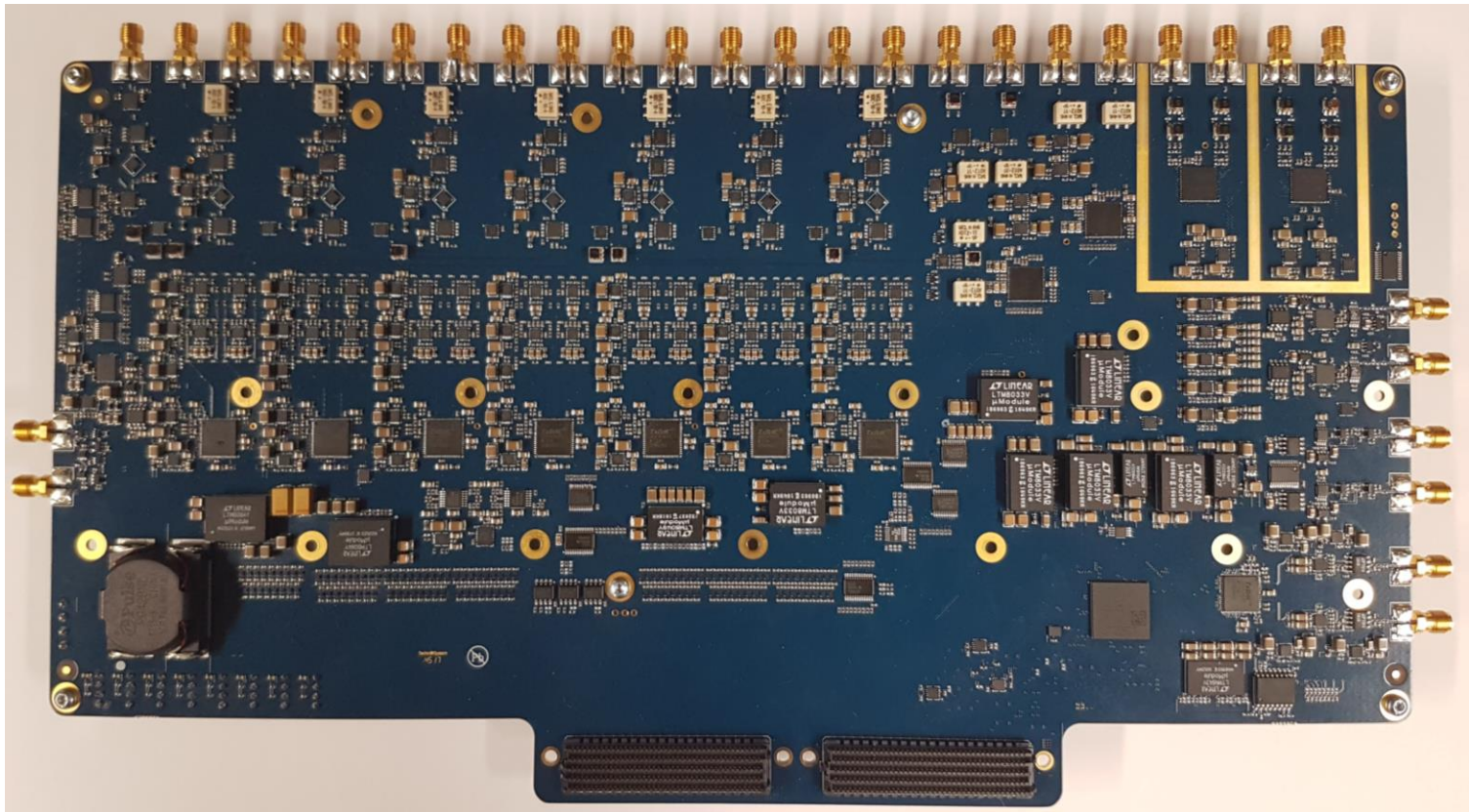
Summary

- The first Cavity Simulator unit was assembled
- Main components were tested – no major problems found
- The first test results were presented

Thank you

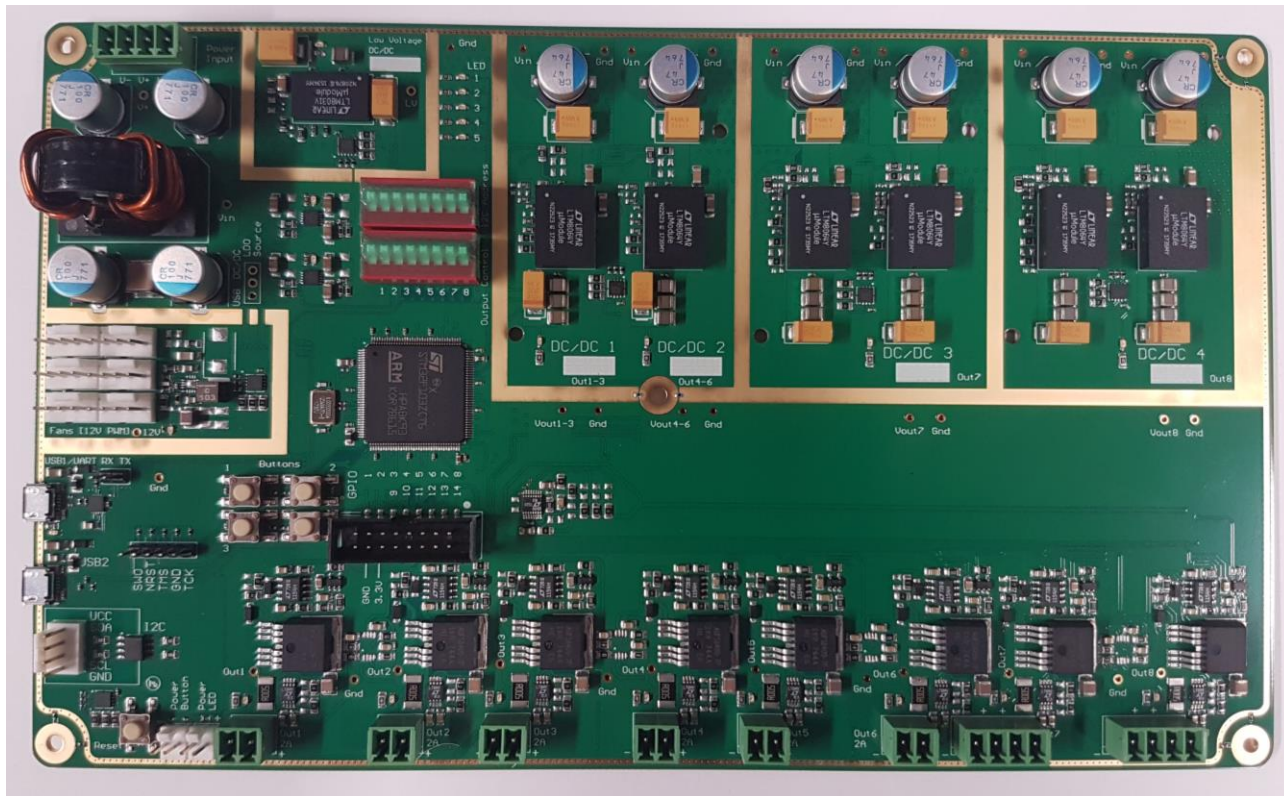
CS-FMC

- Status:
 - PCB manufactured and tested



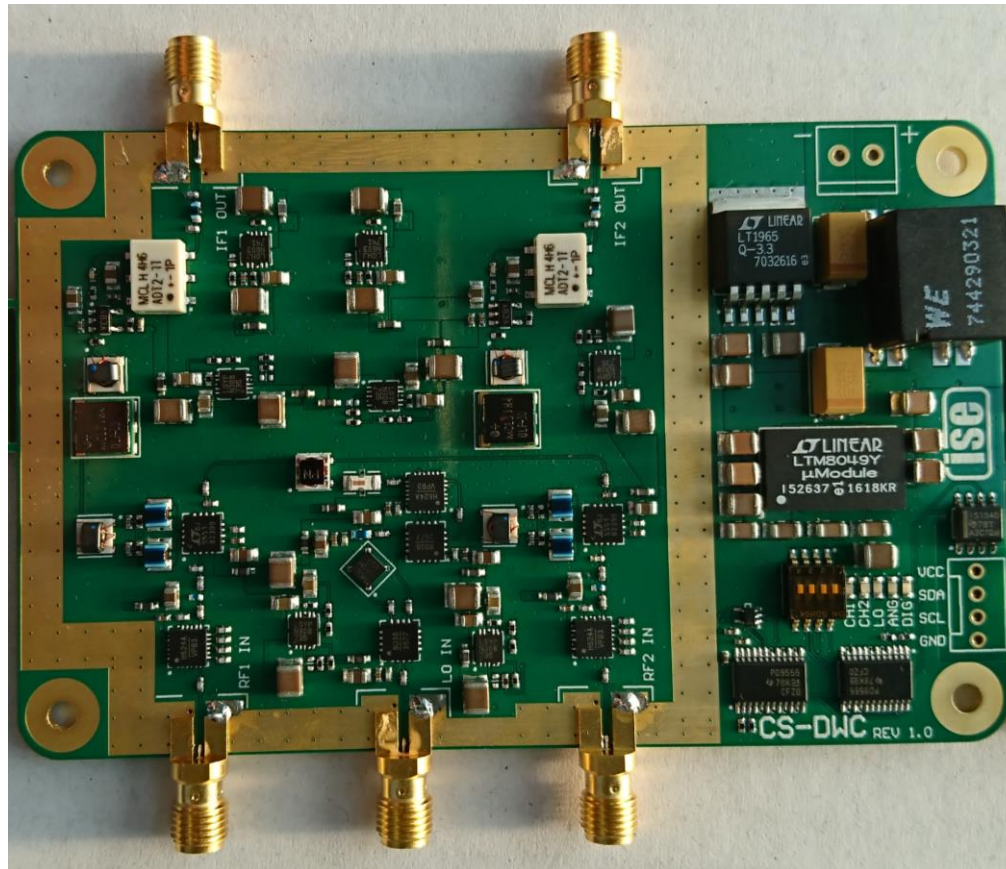
Power Supply Module (CS-PS)

- Status:
 - Manufactured and tested.



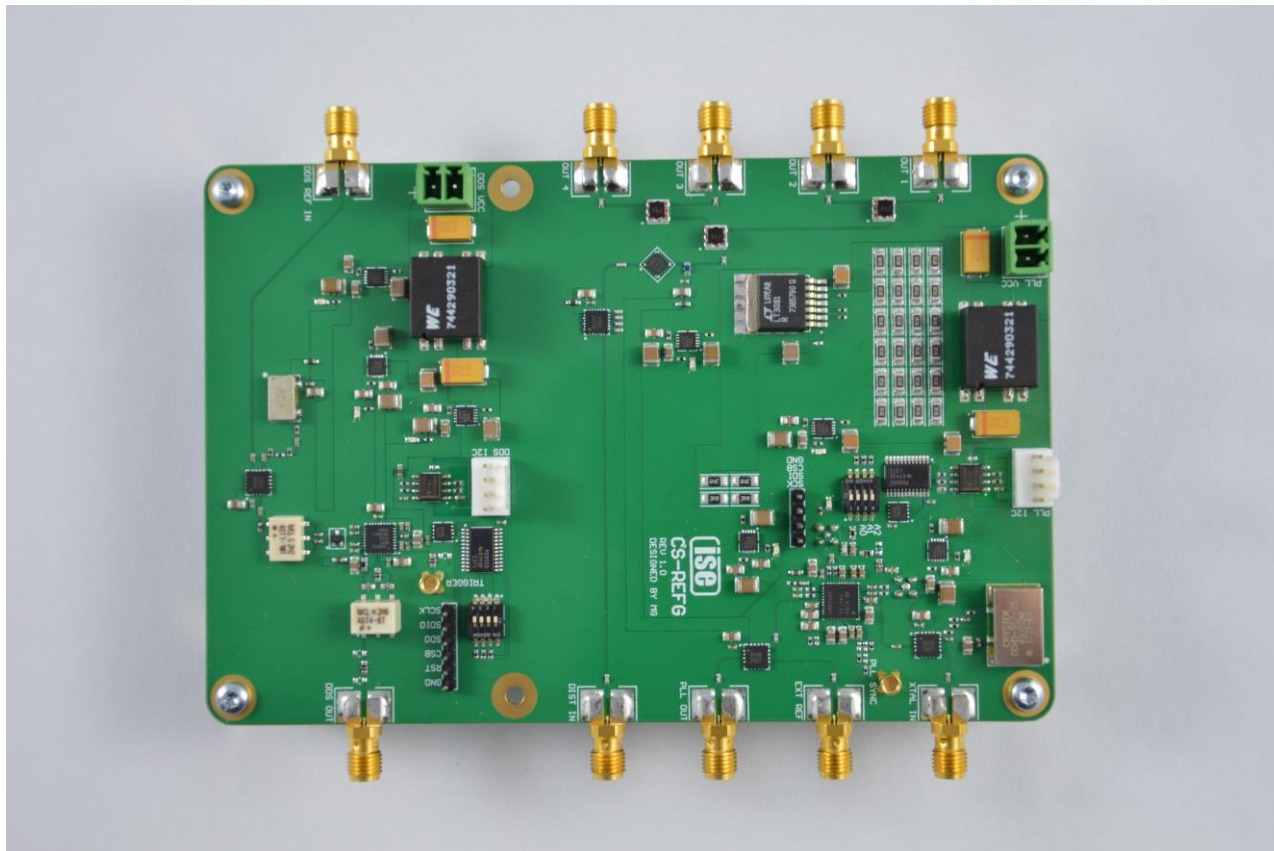
Down-converter Module (CS-DWC)

- Status:
 - Manufactured and tested.



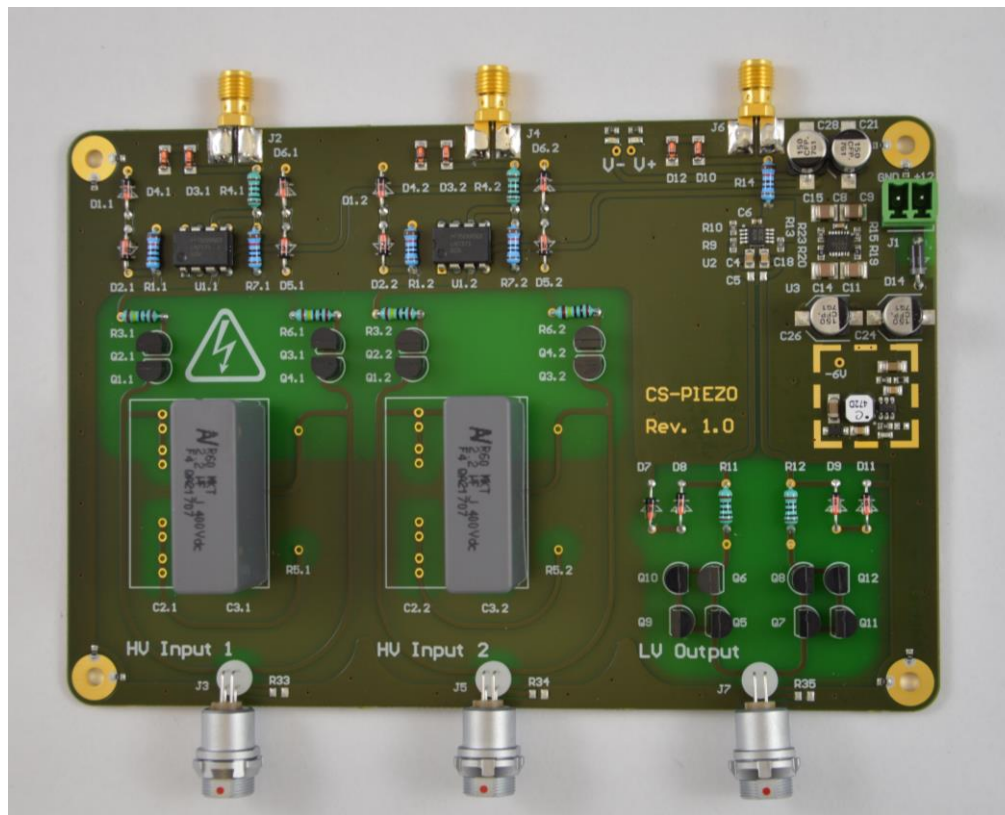
Reference Generation Module (CS-REFG)

- Status:
 - Manufactured and tested.



Piezo Module (CS-Piezo)

- Status:
 - Manufactured, waiting for Piezo RTM for tests.



LO Generation Module (CS-LOG)

- Status:
 - Manufactured.



Simulation Model

