

Data acquisition and control system for multi-component gas sensing



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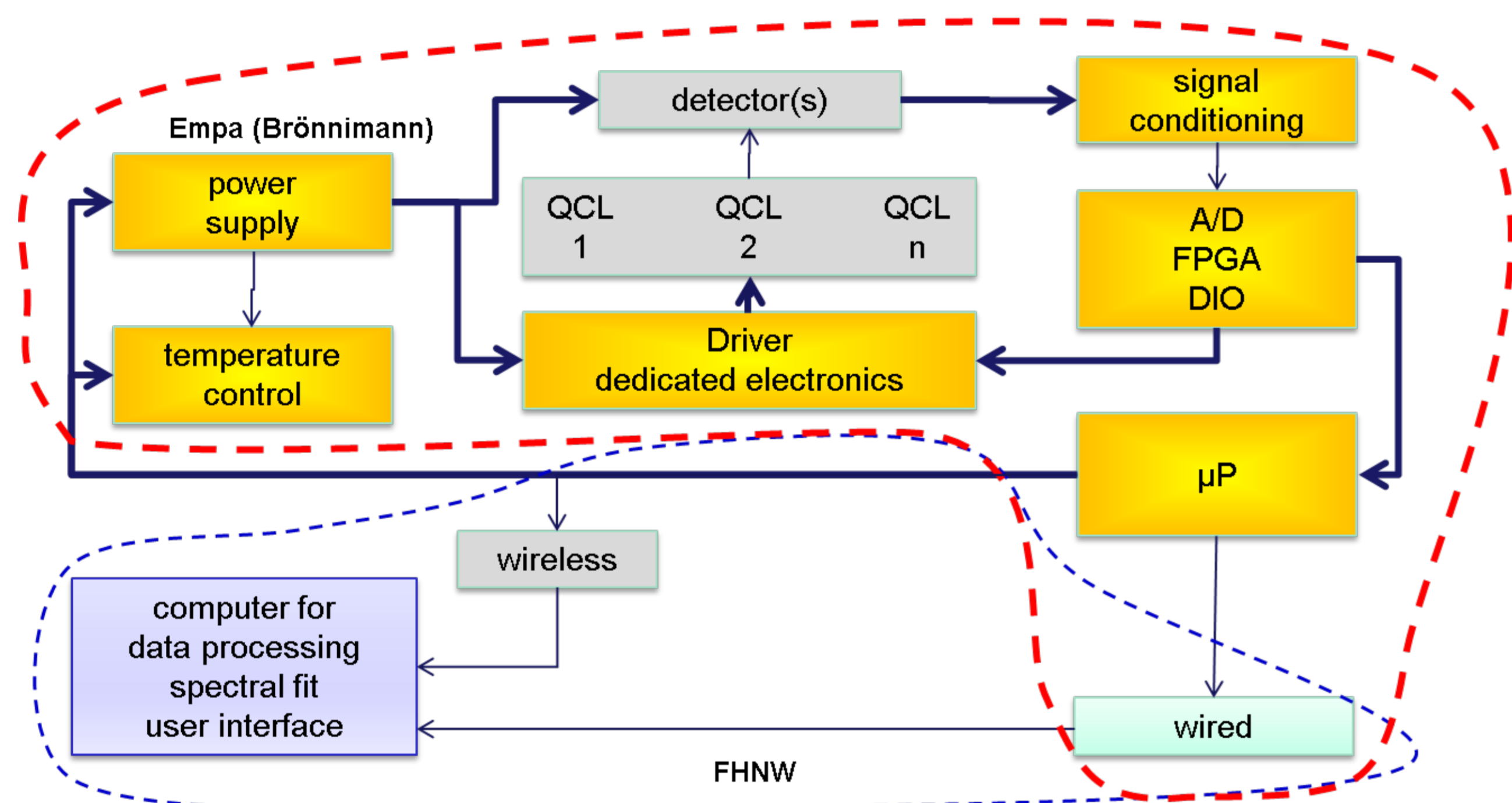
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Introduction

In the project IrSens2 a "multi-component sensor for air pollutants and greenhouse gases" is being developed. A device using several quantum cascade lasers (QCL) in conjunction with a cylindrical absorption cell, low noise electronics, low power consumption and a small footprint results in an outstanding air monitoring system. Data acquisition and control have to be tailored to maximize performance at low power consumption.

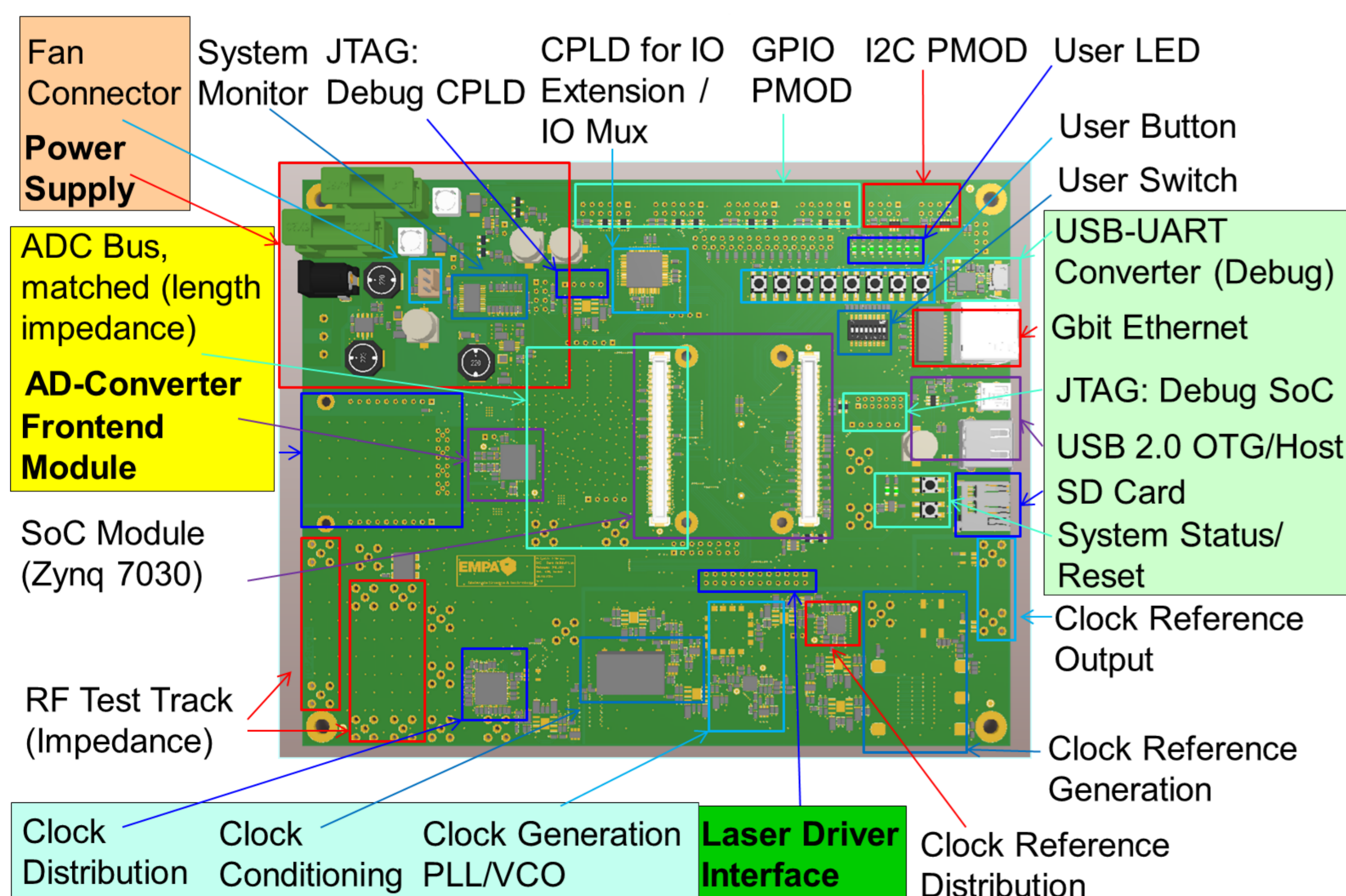
Control System

The requirements result in a complex control system. Laser driver, signal conditioning and digitalization are critical to achieve low noise. The complex timing, data acquisition and filtering is controlled by an FPGA in conjunction with a μ P.



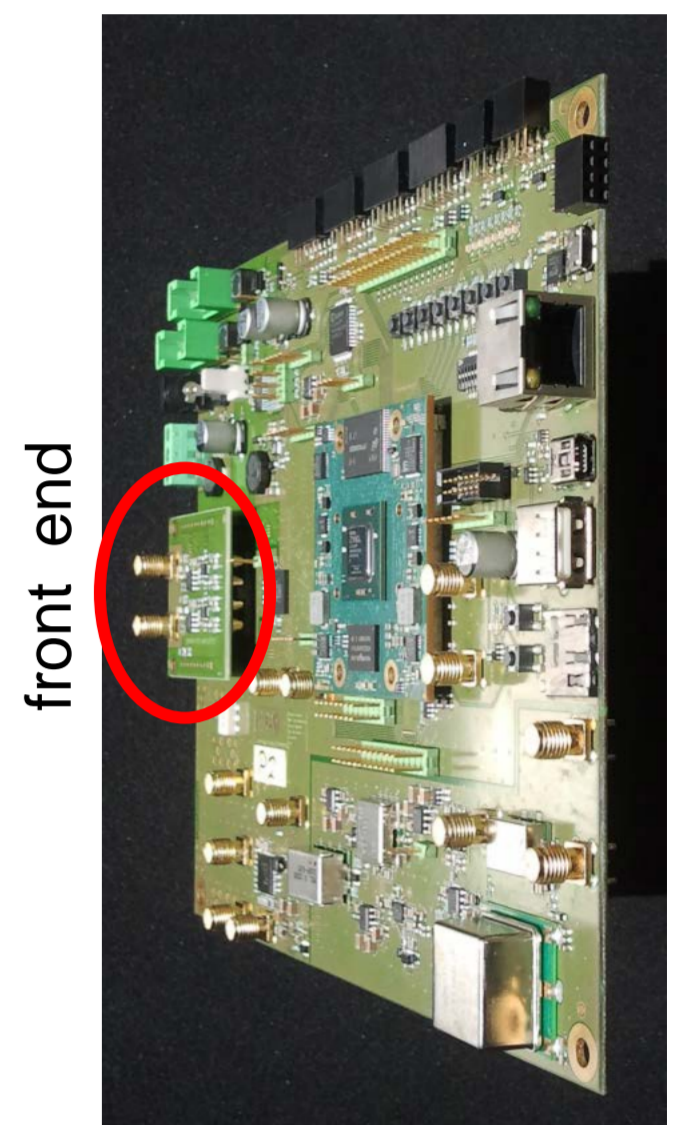
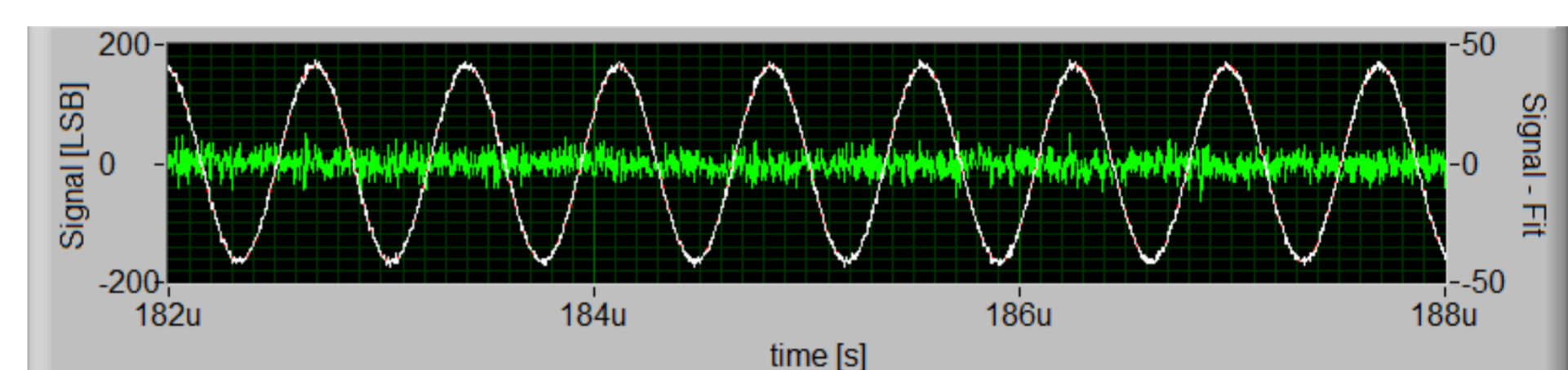
Hardware

The new data acquisition board (DAQ2) has many improvements over its predecessor while reducing the footprint. It has now two analog input channels and two bits higher resolution. It has clock generation, interfaces and power supply on board. SoC (Zynq 7030) and analog front end are on subcarriers.

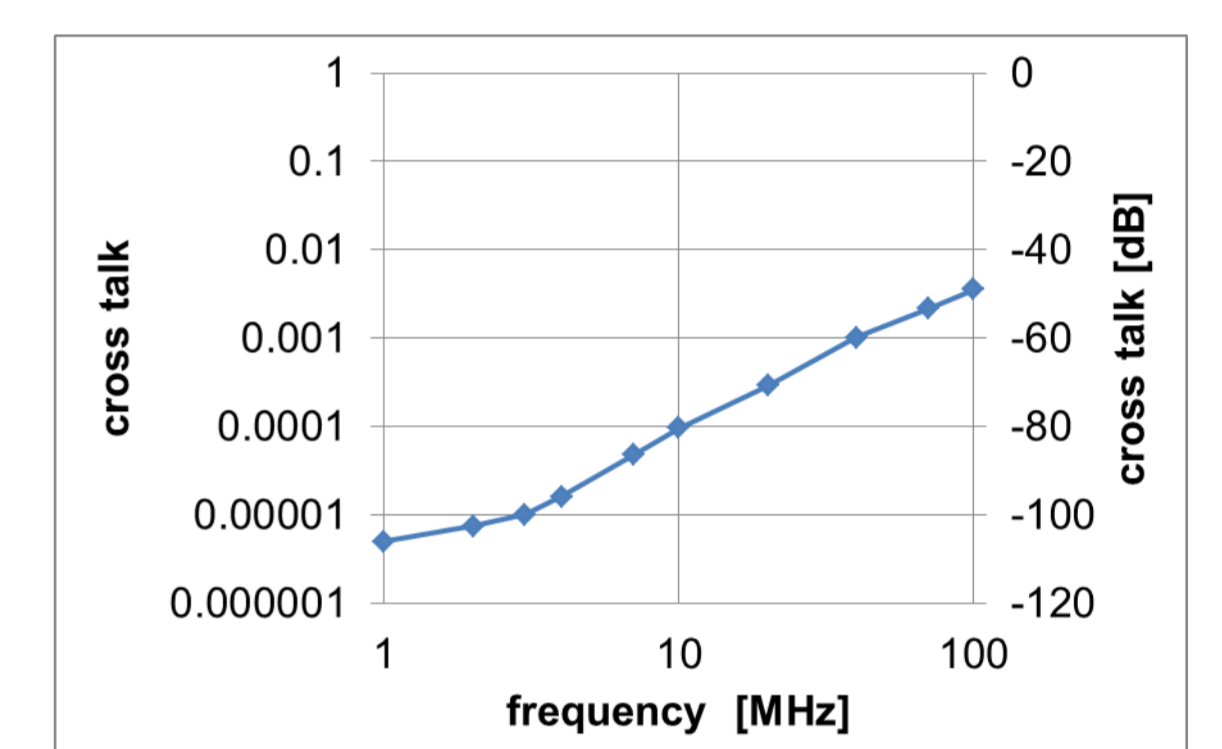
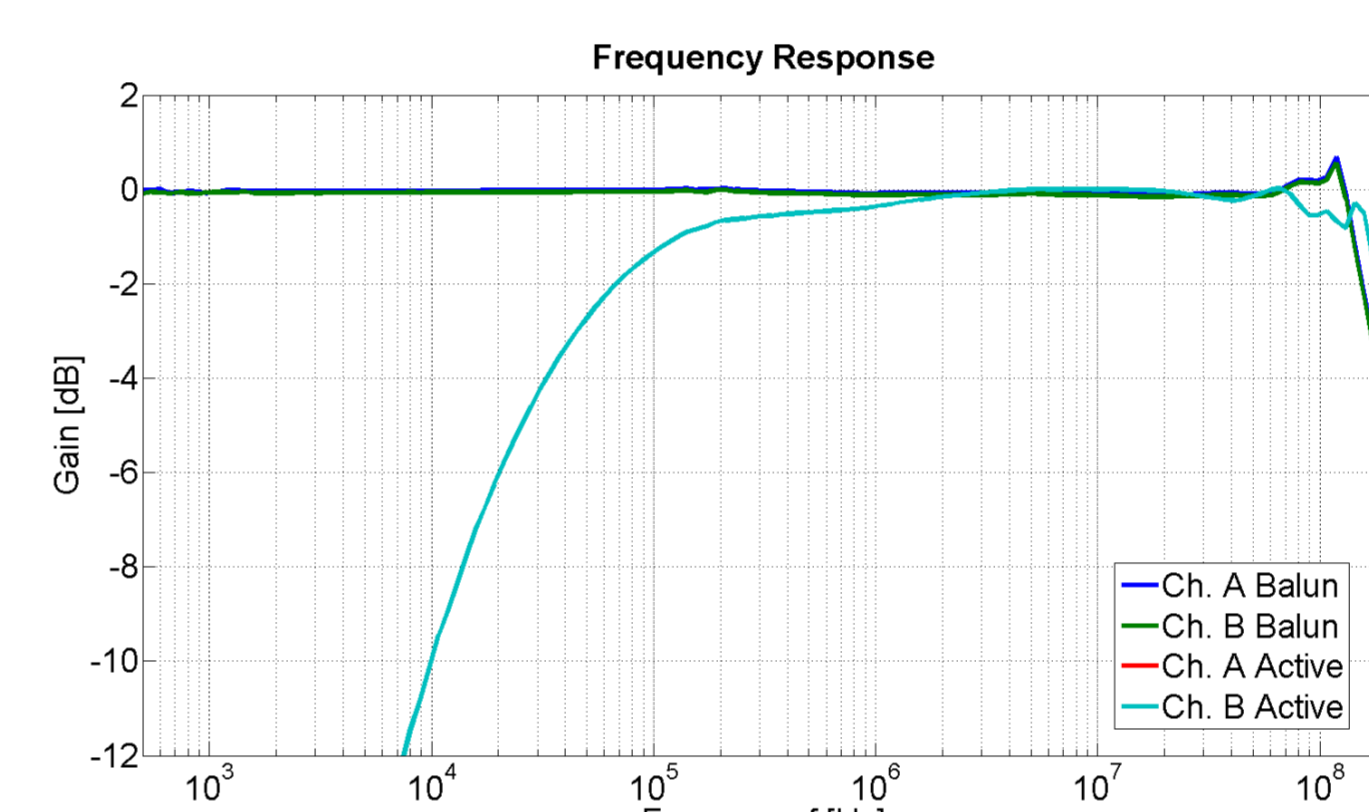


Results

The 16-bit ADC provides a high dynamic range. Noise level of 4 LSB or 120 μ V are possible. This corresponds to a noise floor of $8 \text{ nV}/\sqrt{\text{Hz}}$.

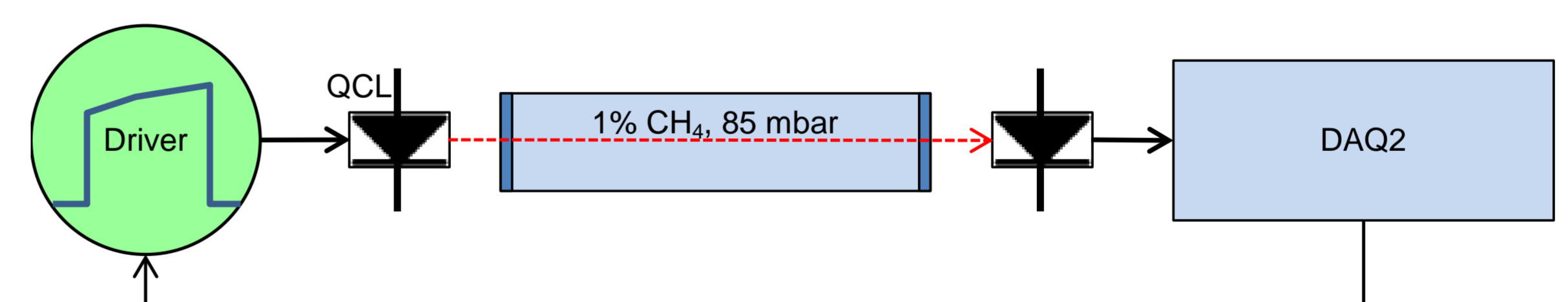


The analog front end can be exchanged to be adaptable to various needs. The new active front end has a flat frequency response compared to the simple balun front end. Cross talk for dual channel ADC is important. Up to 10 MHz cross talk is below -80 dB.

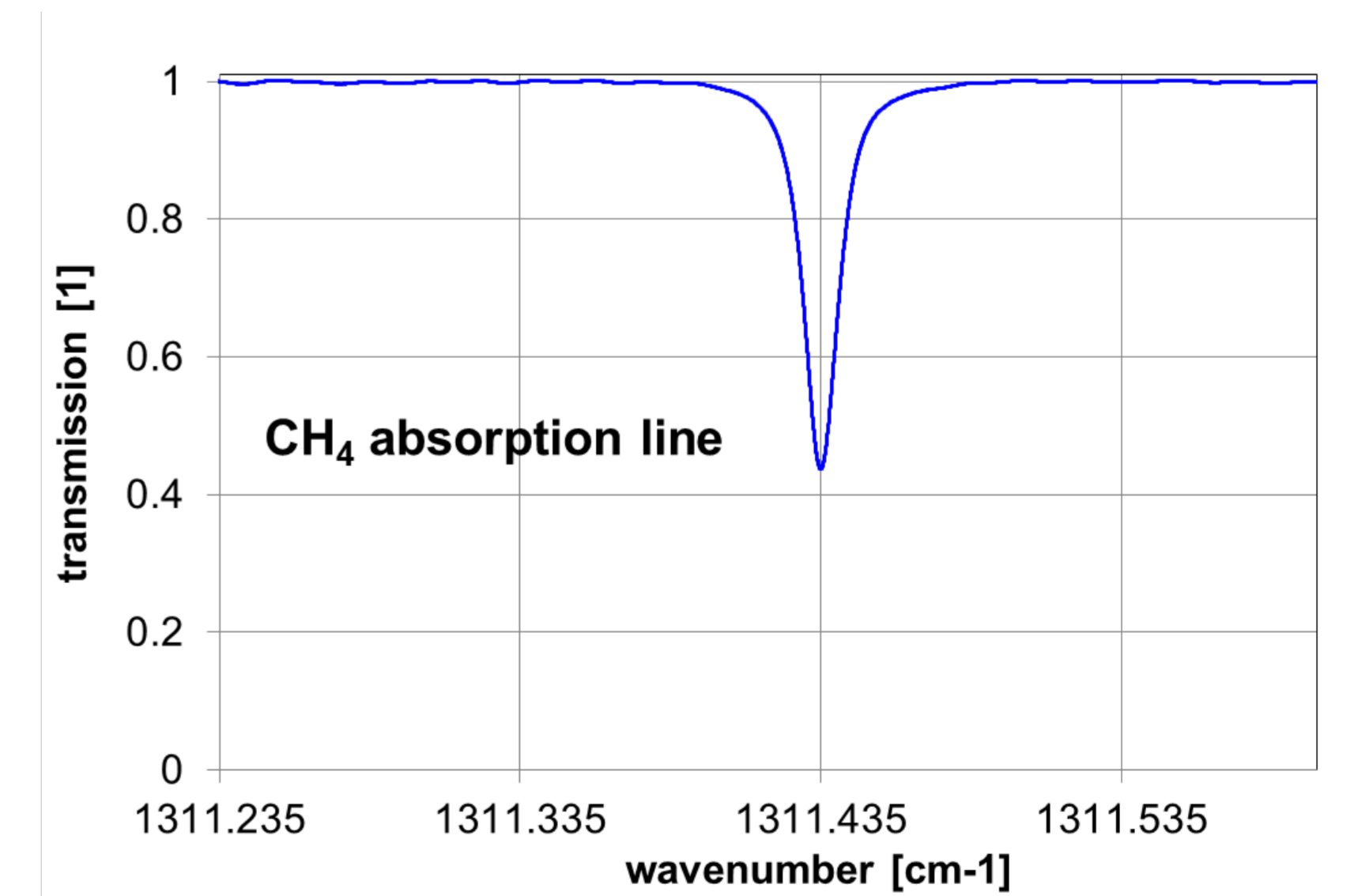
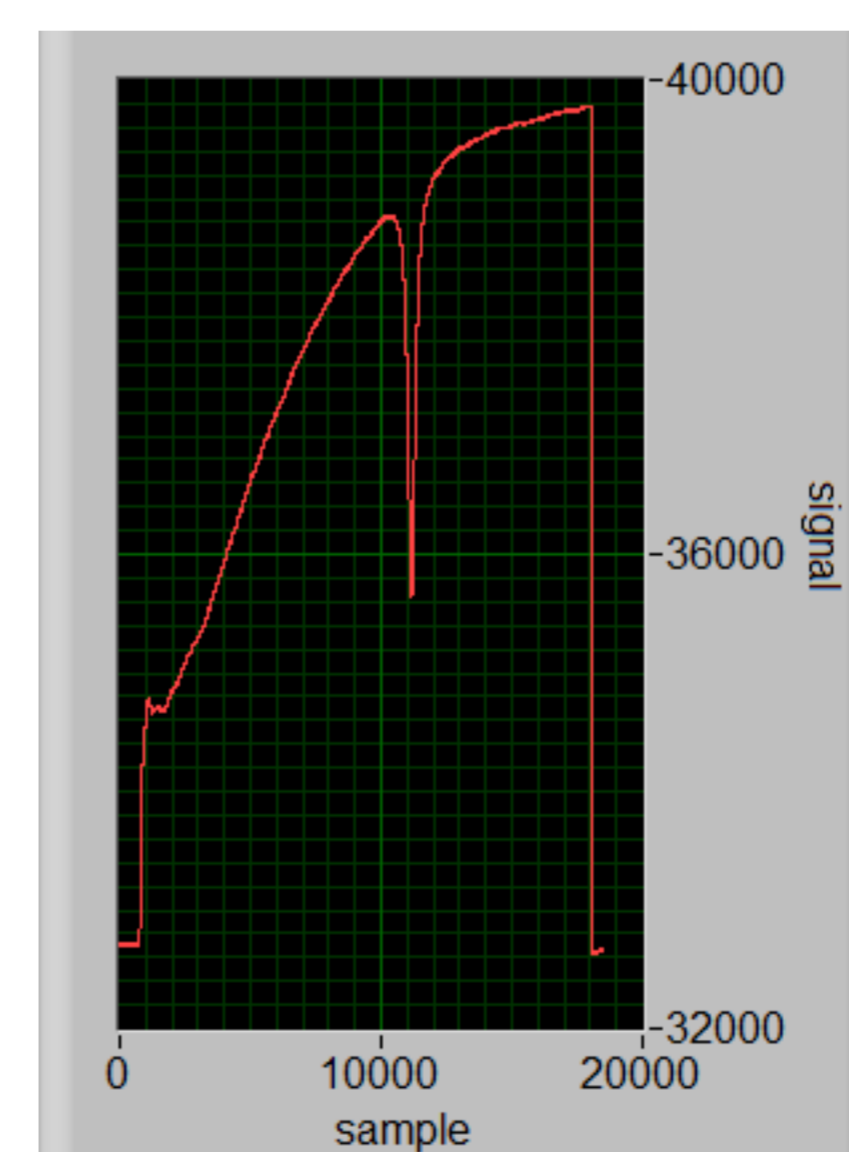


CH₄ absorption line

With the DAQ2 first gas cell absorption measurements were performed. The quasi-static QCL [1] driver (pulse length > 1 μ s) is triggered by the board producing a chirped laser pulse directed to a detector passing a CH₄ containing cell. The signal is digitized at 310 Ms/s and averaged without losses.



After averaging the data rate is reduced so far that it can be easily transferred and evaluated in a processing system to determine the gas parameters.



References:

[1] M. Fischer, B. Tuzson, A. Hugi, R. Brönnimann, A. Kunz, S. Blaser, M. Rochat, O. Landry, A. Müller, L. Emmenegger, "Intermittent operation of QC-lasers for mid-IR spectroscopy with low heat dissipation: tuning characteristics and driving electronics", Optics Express 22 (6) p. 7014-7027 (2014)

Acknowledgment:

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