femto-st
SCIENCES & TECHNOLOGIES

Digital Methods for Time & Frequency Metrology

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Digital control: stability (no influence of environment), reconfigurability (one hardware, multiple algorithms/applications), flexibility (tune operating conditions during operation)

Sampled-Data Systems T&F Metrology

Aims

High-precision digital methods and instrumentation. Mastering realtime RF signal processing

- Fully digital signal analysis, quantization, noise
- Servo controls
- Digital Lock-in amplifier
- DDS & PLL
- Time to Digital converters, Electronic counters
- Noise generators, . . .
- GPS systems
- Software-defined Radio
- Fully digital analyzers (phase noise / frequency stability)

for the Oscillator IMP facility

Development tools for Research, Amateur Radio, Education, Popularization; mainly Open-Source

Fully Digital Phase Noise Measurement system with cross-correlation
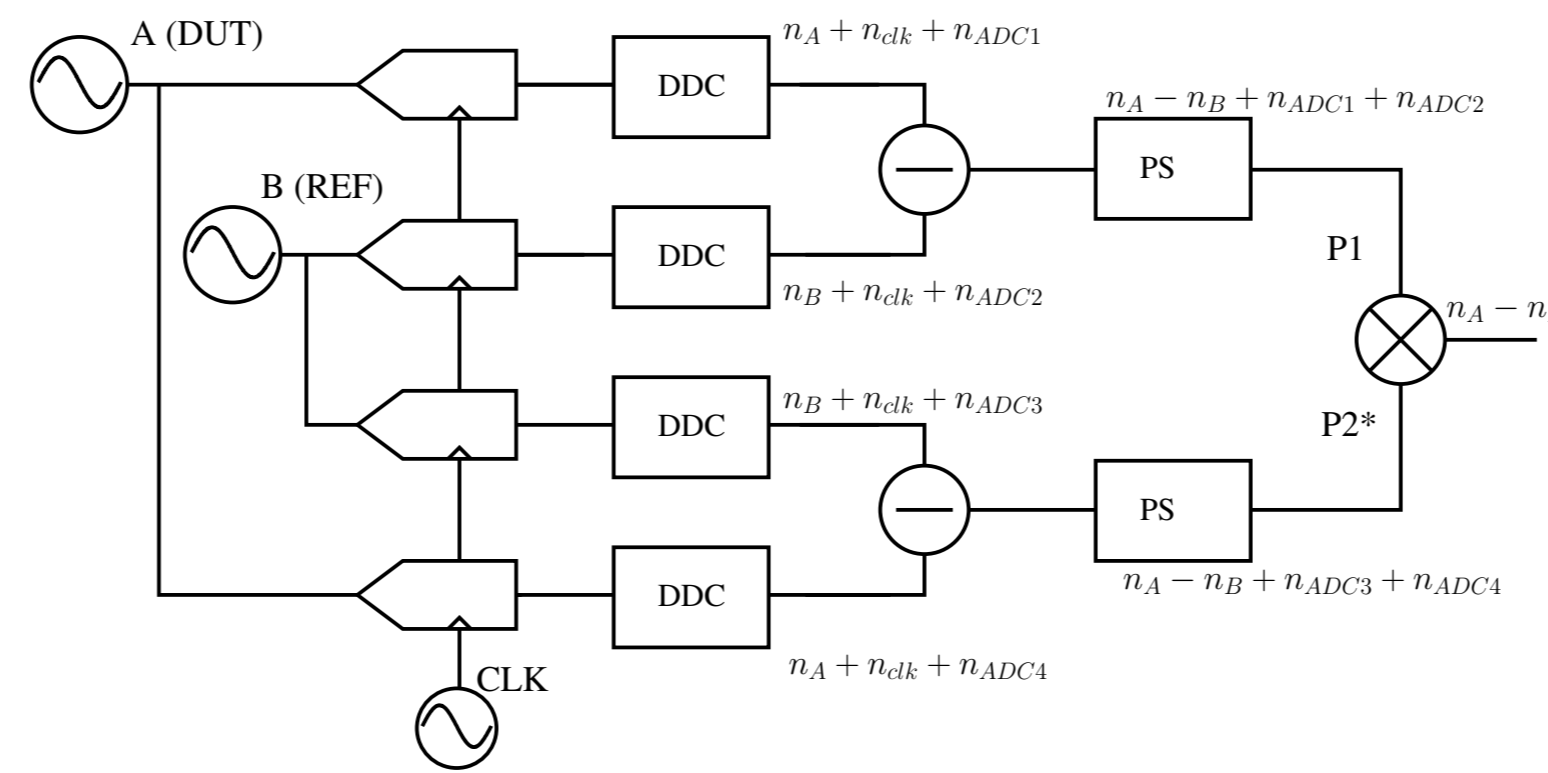
- 4-ch cross correlation for improved rejection of the instrument background noise
- 250 Msps Digital Down Conversion (demodulation with 128-coefficients sinc convolution decimation filter with apodization)
- Algorithms under control / Full data flow processing

Results shown compare favorably to state-of-the-art devices
Potentially very high resolution counter
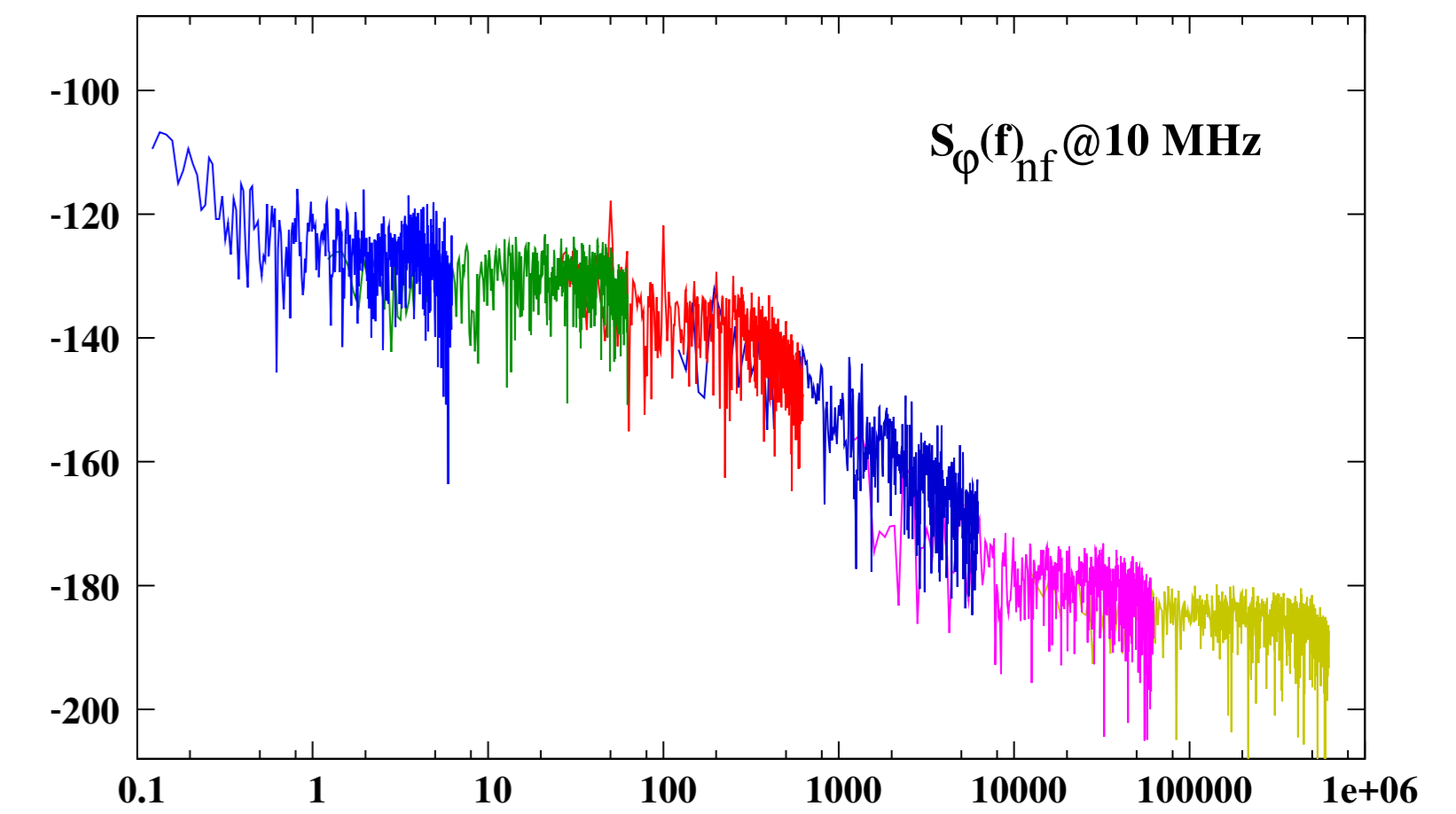

Instrument noise floor @ 10 MHz (in units dB rad^2/Hz)
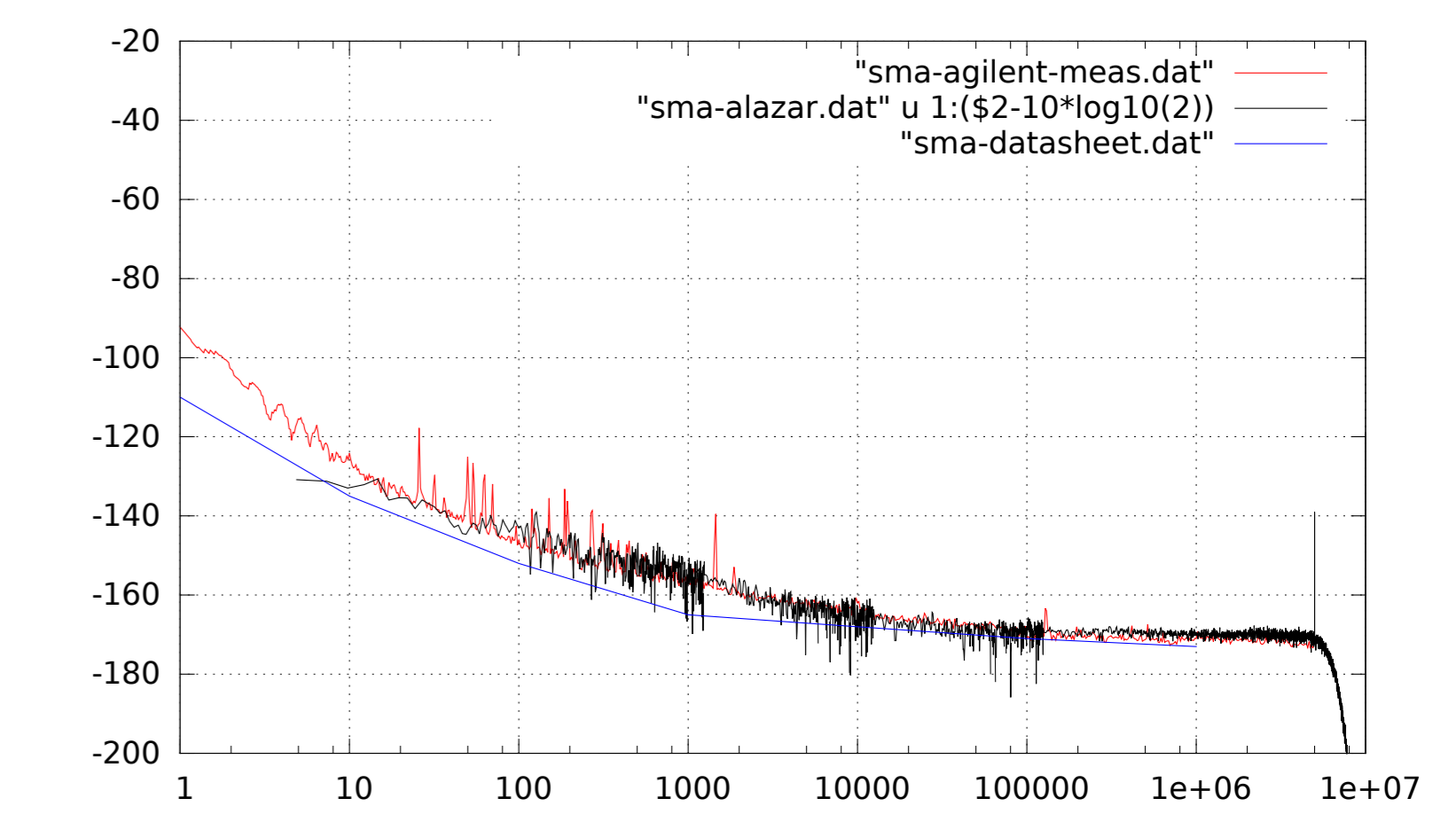
Measurement of a low-noise synthesizer

SDR applied to Positioning systems (GNSS) / time transfer

Software phase tracking of GPS signals – beyond positioning, useful for physical applications.

Home-made GPS receiver: Antenna + DVB-T dongle + `gnss-sdr` + GNURadio

- Costas loop demodulation
- Satellites identification by cross-correlation
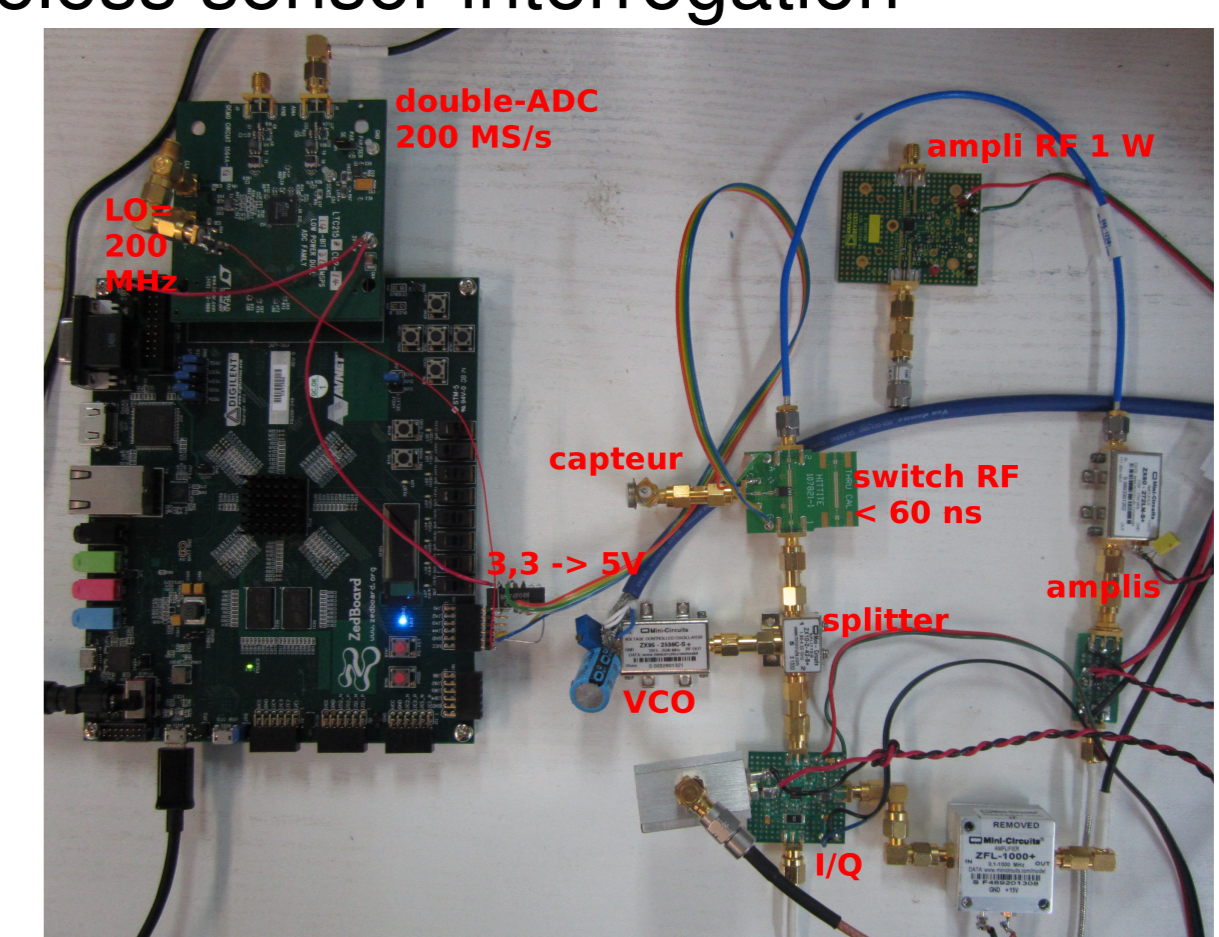- Phase tracking servo control
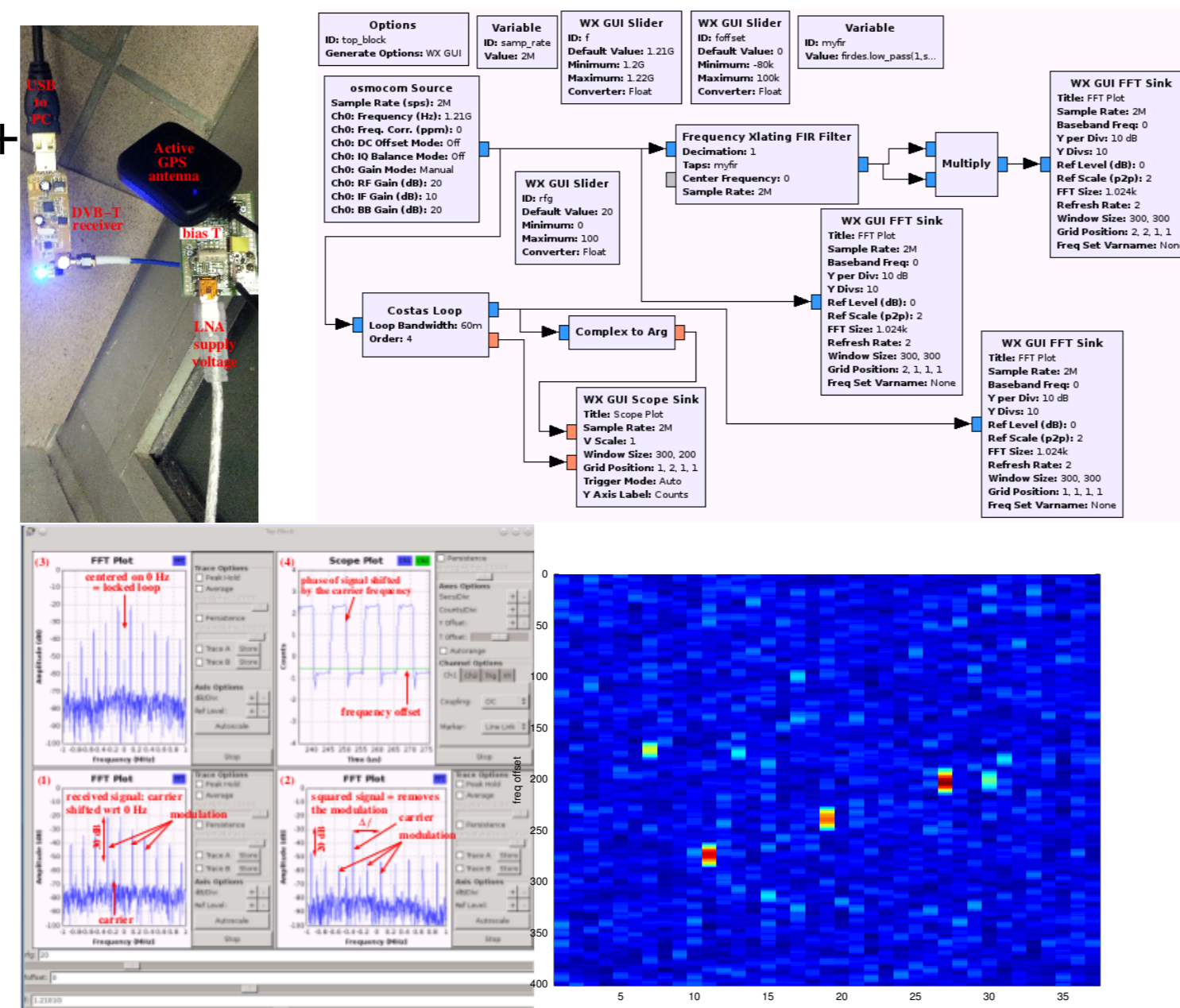
Short range RADAR

System with high bandwidth ADC acquisition (125 MS/s) for passive wireless sensor interrogation

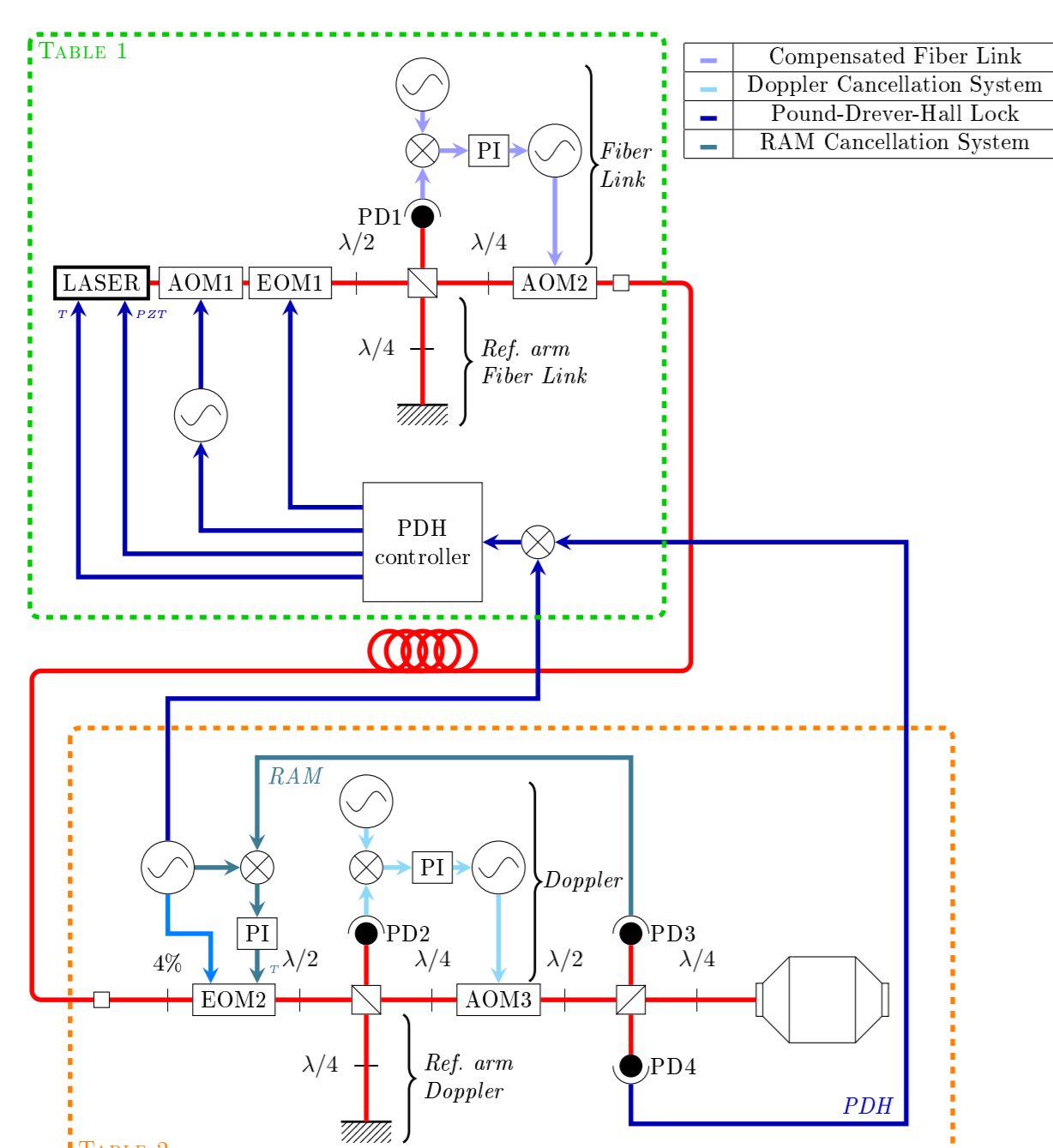Efficient use of the dual CPU-FPGA architecture:

- hard real time radio-frequency processing on FPGA
- user interface and data communication on CPU running GNU/Linux

Application to sensor measurement: flexible algorithm able to adapt to measurement conditions (noise, moving target)
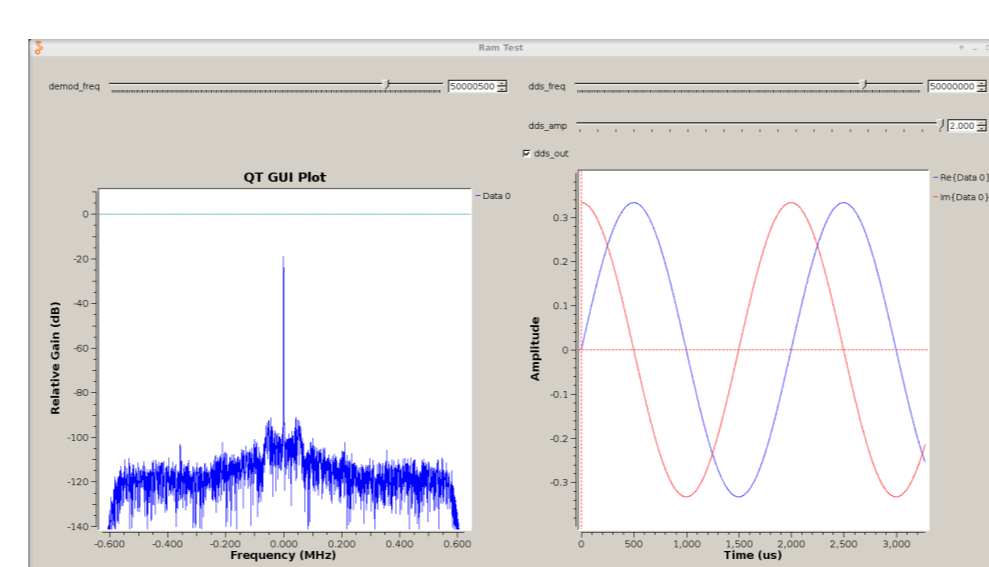
Applications to Photonics Systems

Cryogenic Fabry-Pérot Silicon Cavity

- Laser stabilization (ν, P, T)
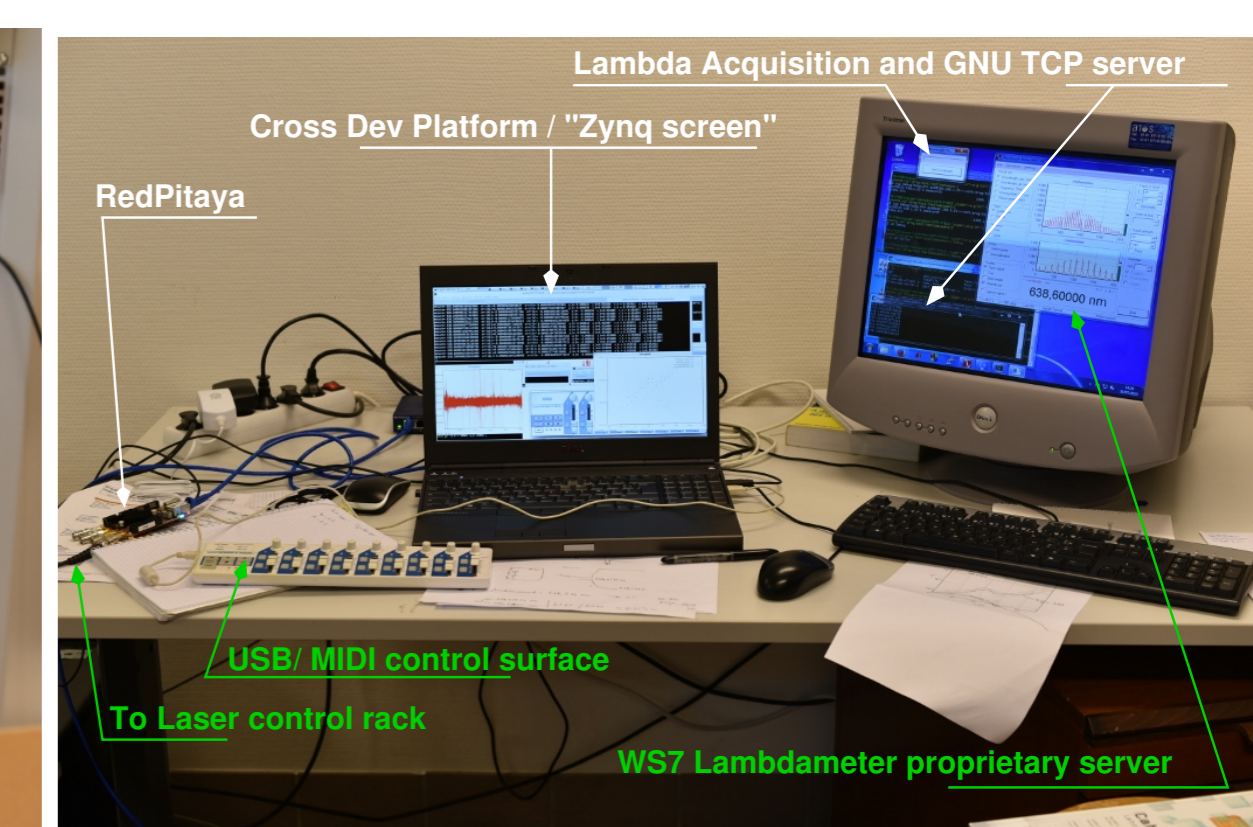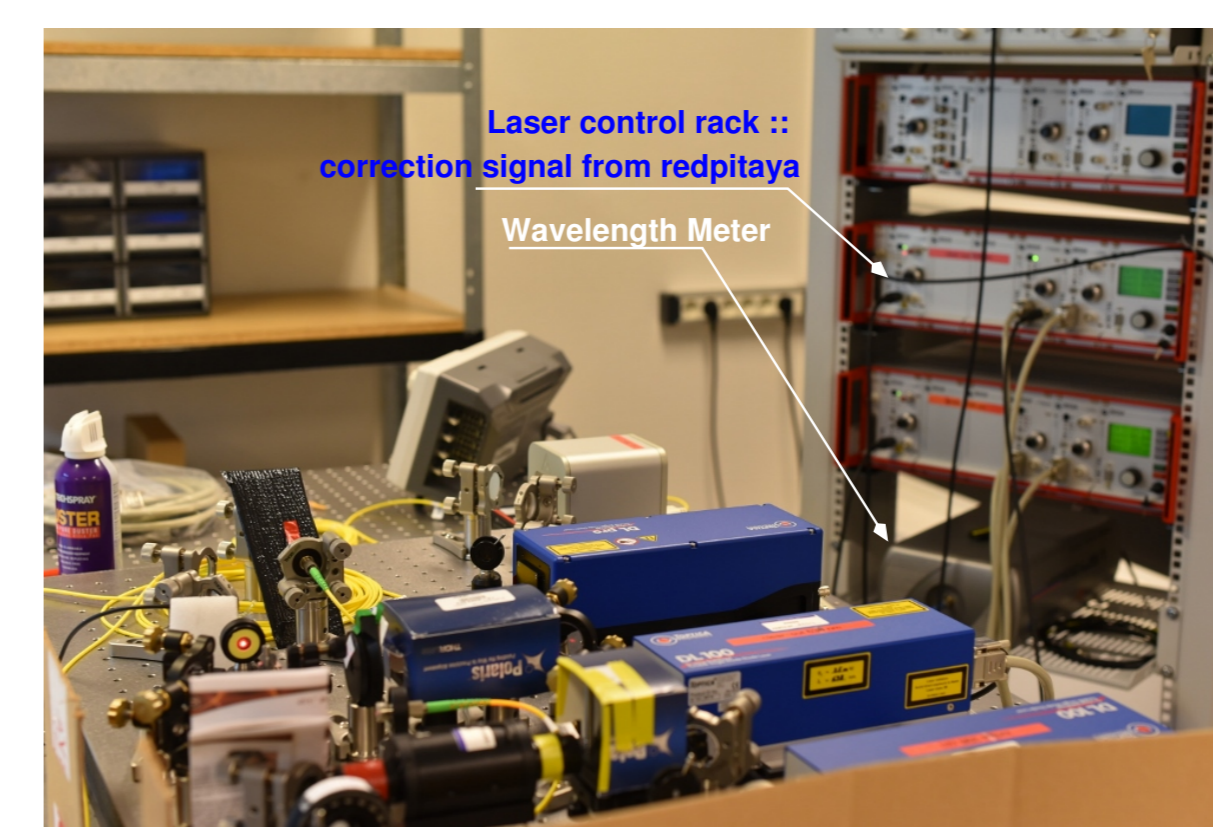- Fiber link compensation

Features:

- DDS, I/Q demodulation, PID, NCO, . . .
- network functionalities (GUI, analysis, SDR (GNURadio) . . .)

Fully Digital Control of Optical Single-ion Clock

- 4-laser stabilization
- $500\ \mu K$ control for SHG modules
- Pulse programming

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