

# A General MTCA.4-based Laser-to-RF Synchronization System.

Uroš Mavrič on behalf of the MTCA.4 Laser-to-RF Synch Task Force

2<sup>nd</sup> MTCA Workshop for Industry and Research, DESY, 12.12.2013

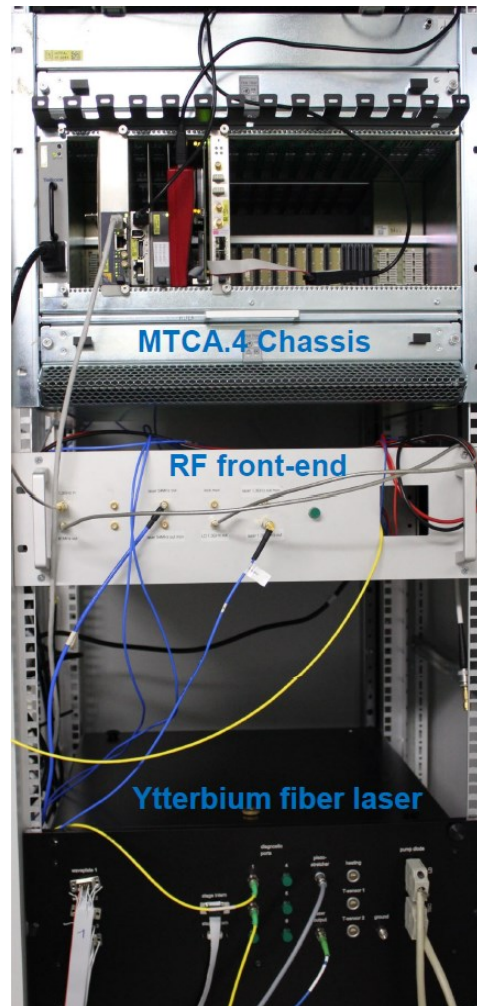
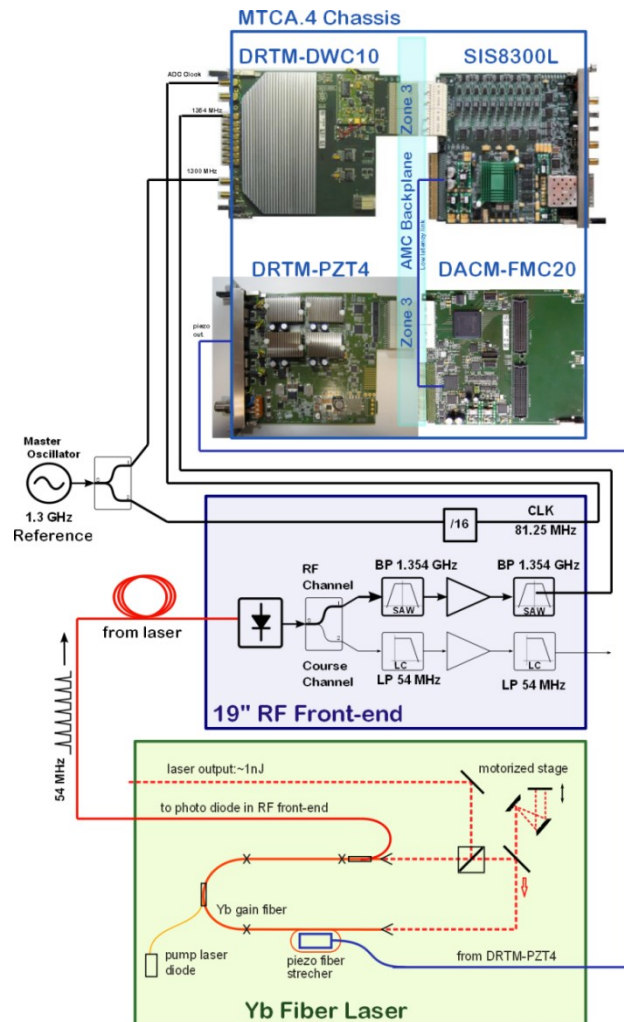
# Problem Description.

- > Synchronize Laser-to-RF in order to get synchronism of laser pulses with the rest of the timing on the accelerator.
- > Combine the good characteristics of both:
  - Good phase noise performance of laser at higher frequencies
  - Good phase noise performance of the RF sources at lower frequencies
- > Usually laser locking systems are composed of several units:
  - Digitizer, digital processing (e.g. VME-based), PI unit, vector modulator unit, etc.
  - Piezo driver (19" unit with ext. power supply)
  - RF box (19" unit with ext. power supply)

We are in the process of integrating these modules in a MTCA.4 environment.



# Description of the Loop.



➤ Similar scheme implemented also at:

- REGAE
- Laser 3 Injector Laser at FLASH

➤ JDDD GUI

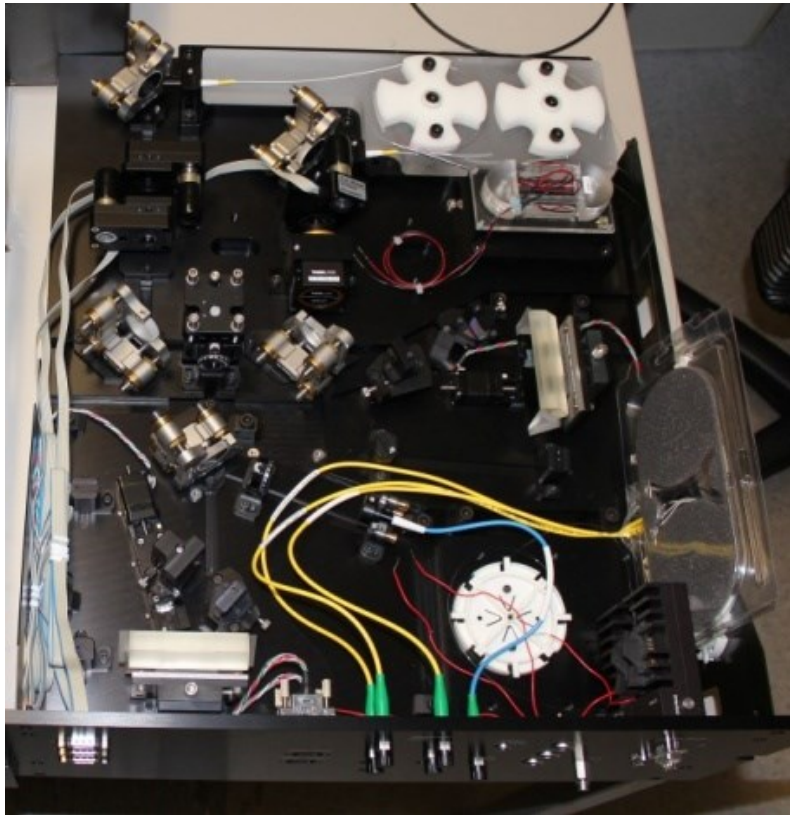
- Automated course tuning and locking procedure
- System locked for several days



See talk from M. Felber at 10:15

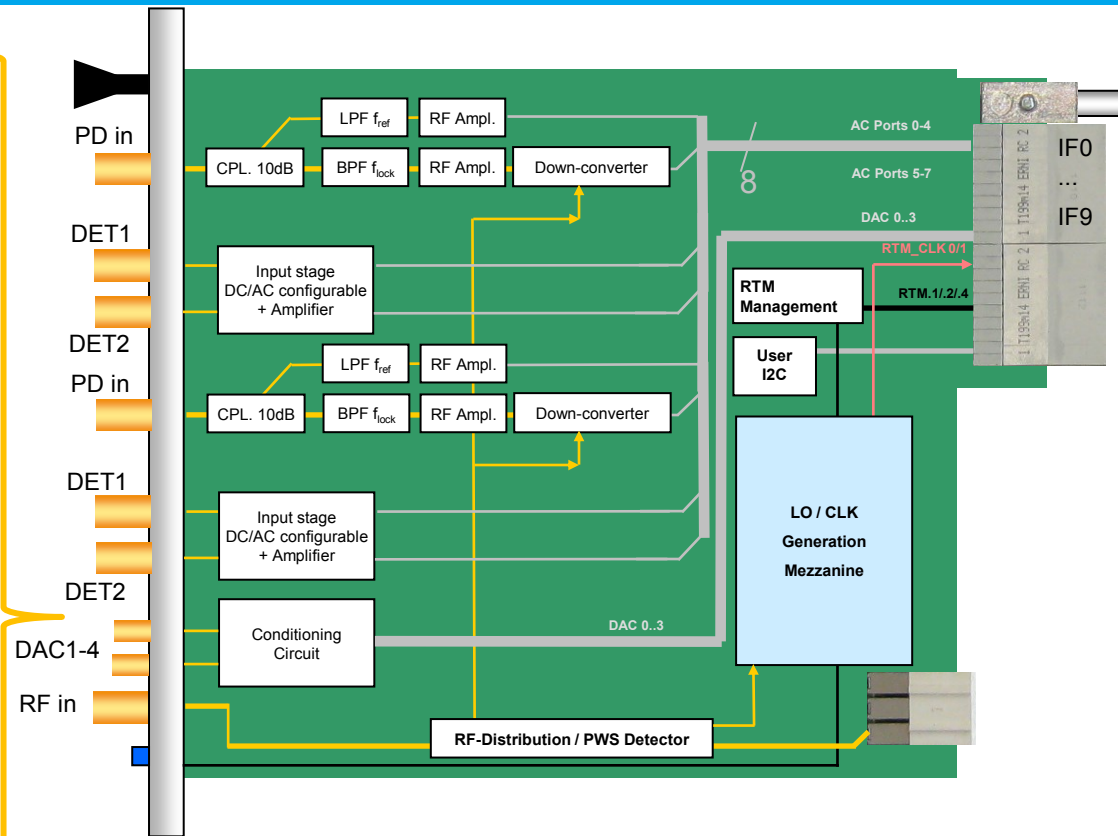
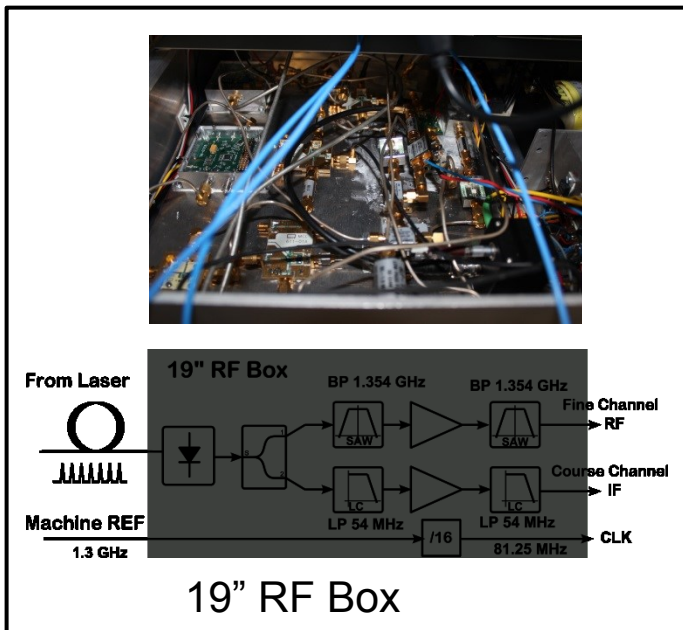
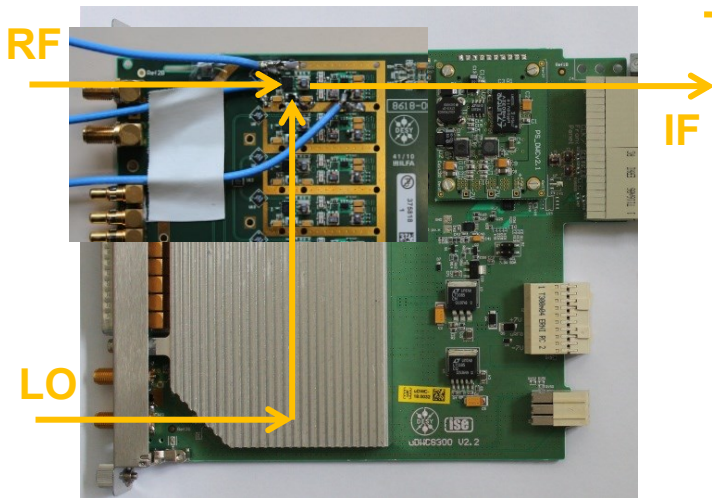


# EO Laser



- Optimized laser for electro-optical bunch length measurement at XFEL
- Mode locked Yb fiber laser developed at PSI and assembled at DESY
- Specifications:
  - Wavelength: 1030nm
  - Bandwidth: 25-50nm (amplified: 100nm)
  - Pulse length: 5ps (compressible to <100fs)
  - Pulse energy: 1-2nJ (amplified: 100nJ)
  - Repetition rate: 54MHz (amplified: 4.5MHz)
  - Temperature stabilized to 0.1°C

# RF Detection.

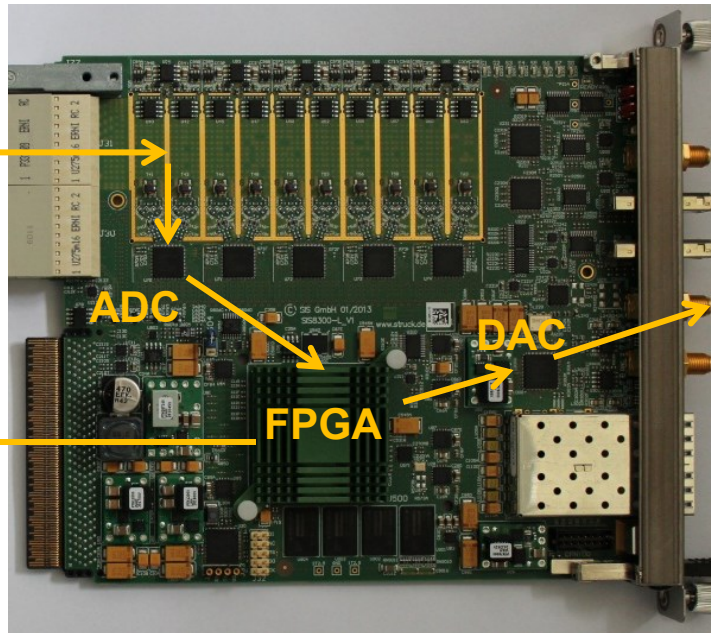


- > Merge 19" RF detection and RTM detection to a single RTM unit.
- > Design is in progress.

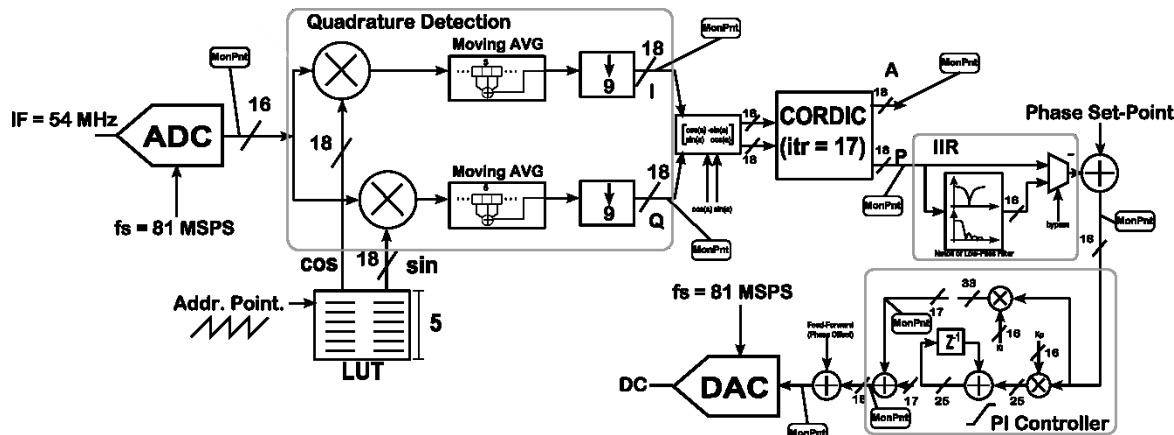


# Digitalization and Signal Processing.

# SIS8300-L

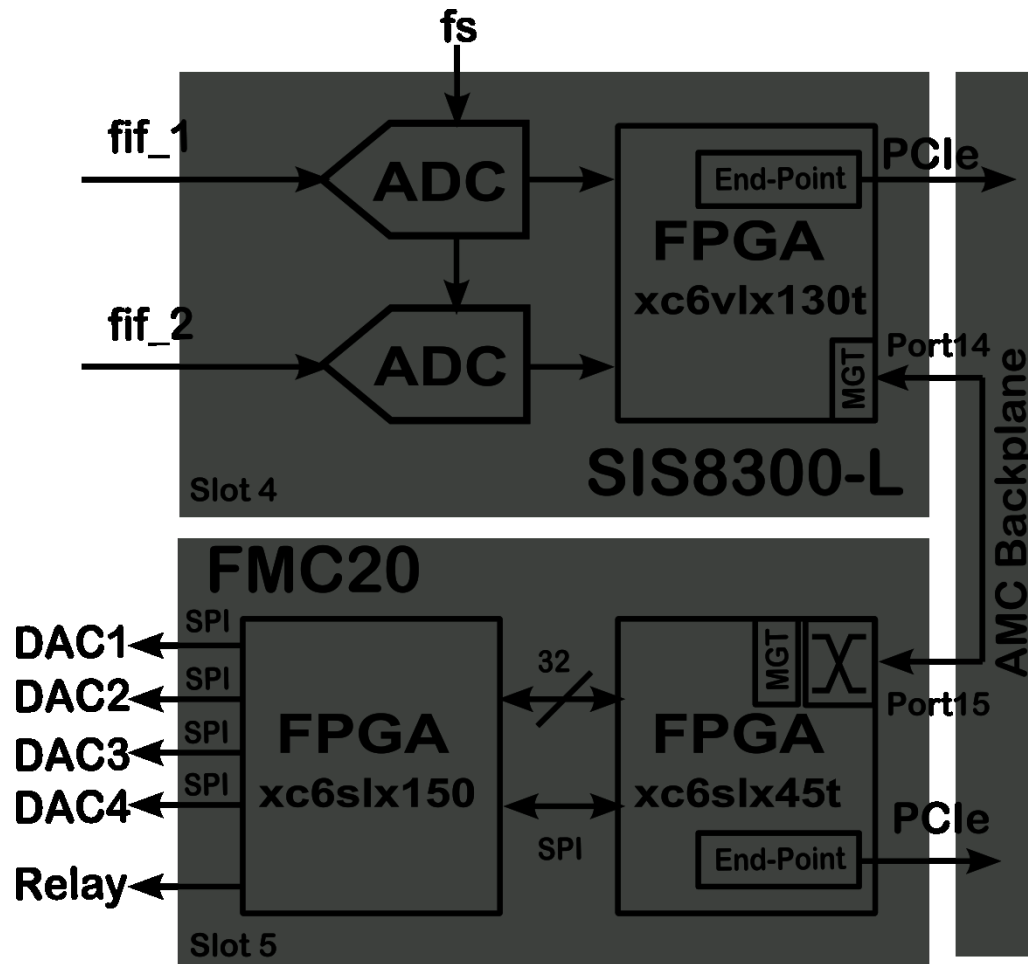


- > 10 channel, 16 bit digitizer (AC or DC coupled) – low noise design.
- > Up to 130 MSPS
- > Virtex 6
- > 2 DACs
- > DDR3 2 Gbyte



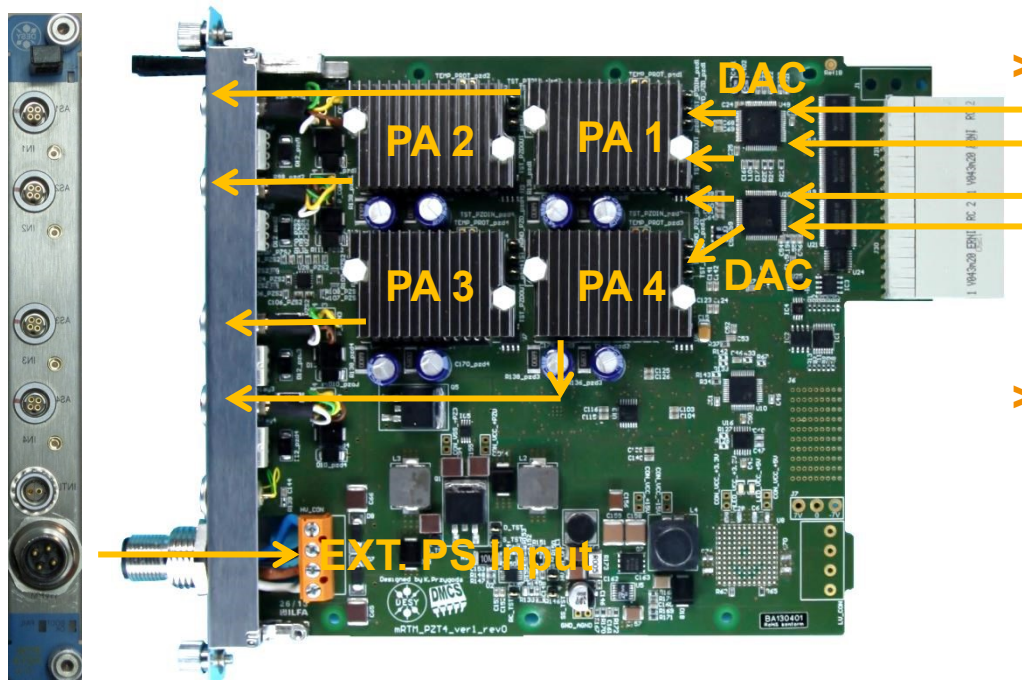
- > I/Q detection
- > NCO can be swept externally
- > CORDIC
- > Locking on the phase component
- > Internal IIR for Notch (piezo resonance suppression)
- > PI controller
- > Feed-forward table
- > Phase shifter for locked phase settings

# Data Transmission.



- > Loop delay < 2us
  - enough for ~60 kHz closed-loop bandwidth.
- > PCIe links and Point-to-point links run at 2.5 Gbps.
- > SPIs between FPGAs run at 62.5 MHz.
- > SPI for DACs runs at 500kSPS.

# DRTM-PZT4.



- > 4 power amplifier with 0-100V, -100V/+100V
- > DAC outputs +/-5V, +/-10V, 0/5V, 0/10V
- > Each power amplifier can drive up to 10uF capacitance.

## > Main applications:

- Cavity fine tuning using piezo elements (e.g. for Lorentz force detuning compensation or microphonics noise rejection)

- Stabilization of the fiber links that provide synchronization signal over the accelerator machine

## > Main features:

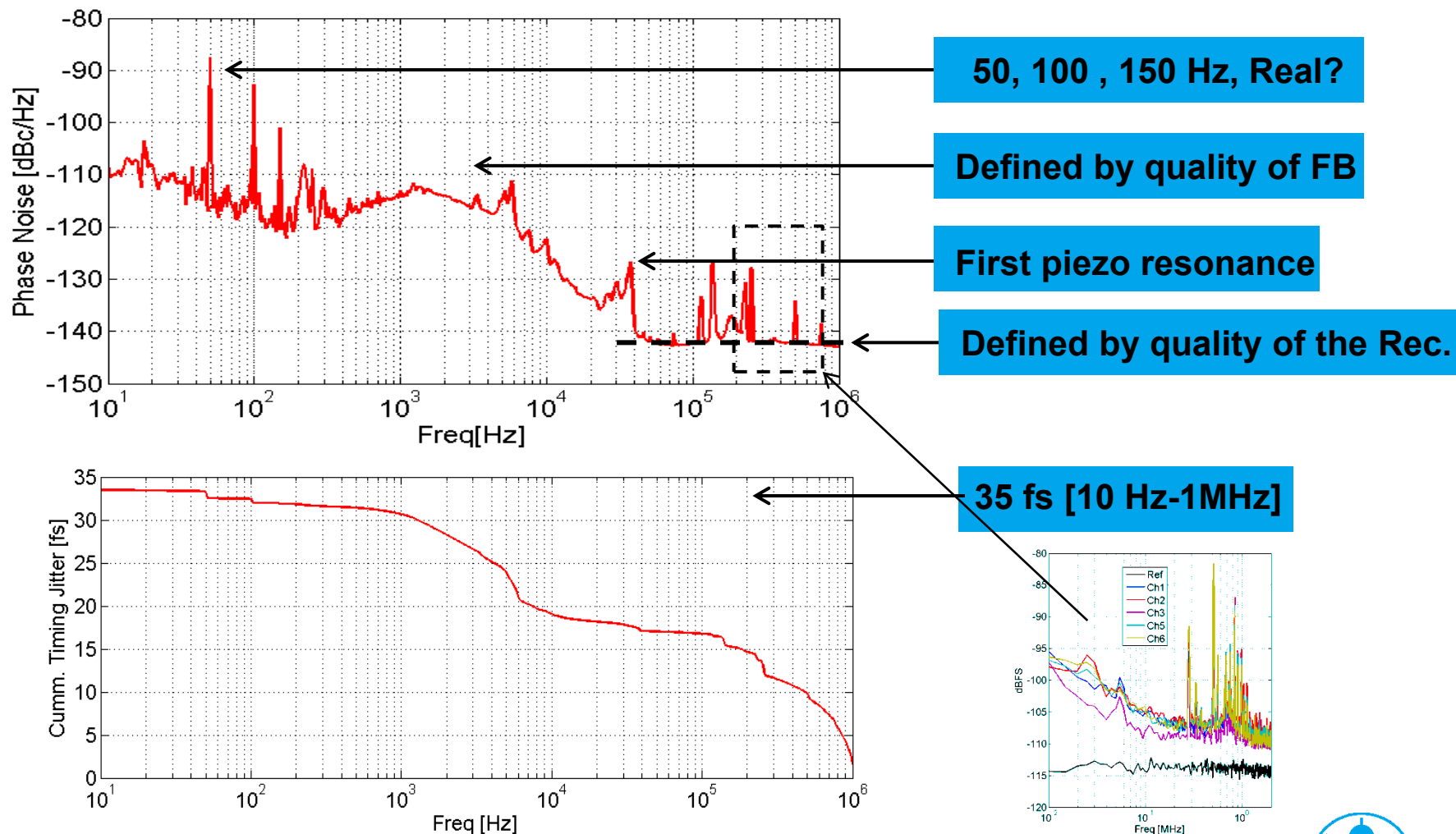
- Simultaneous driving and sensing of 4 piezo actuators and sensors.
- It provides the possibility of usage of internal or external power supply for the power amplifiers.
- It provides external interlock input signal to disable the power amplifiers.
- The module is enclosed inside a metal housing to prevent against touching of high voltage.

**See talk from K. Przygoda at 13:15 - Session 6**



# Recent Results.

- Out-of-loop measurement, comparing the RF at 1.3 GHz and the locked 1.3 GHz component from the laser.



# The MTCA.4 Laser-to-RF Synch Task Force.

- > Lukasz Butkowski
- > Hans-Thomas Duhme
- > Matthias Felber
- > Michael Fenner
- > Christopher Gerth
- > Tomasz Kozak
- > Peter Peier
- > Paweł Prędki
- > Konrad Przygoda
- > Holger Schlarb
- > Bernd Steffen



Thank you for your attention.

