Comparison of hardware development for ILC/XFEL

Wojciech Jalmuzna
on behalf of LLTR team

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R&D for hardware developed at DESY for X-FEL

- System architecture
- Master oscillator
- Timing distribution
- Field detectors and actuators
- Digital feed-back
- Piezo control

System architecture

Distributed vs. centralized

ATCA, µTCA, boxes

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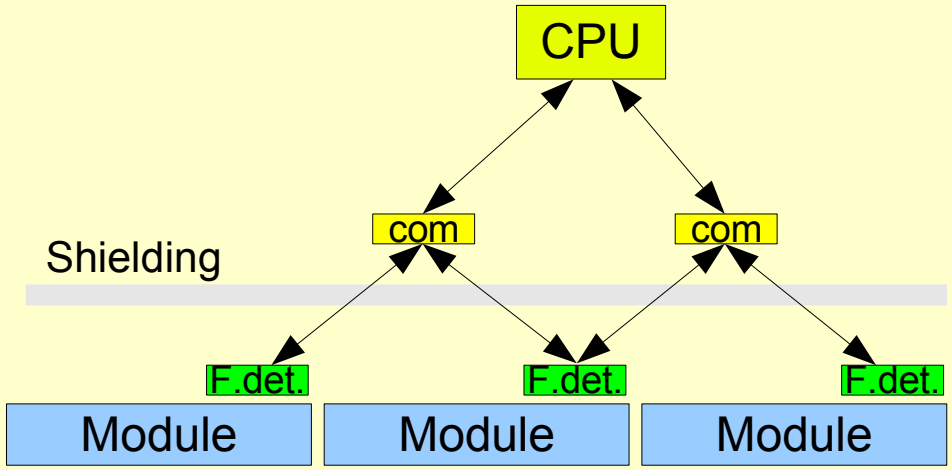

ATCA

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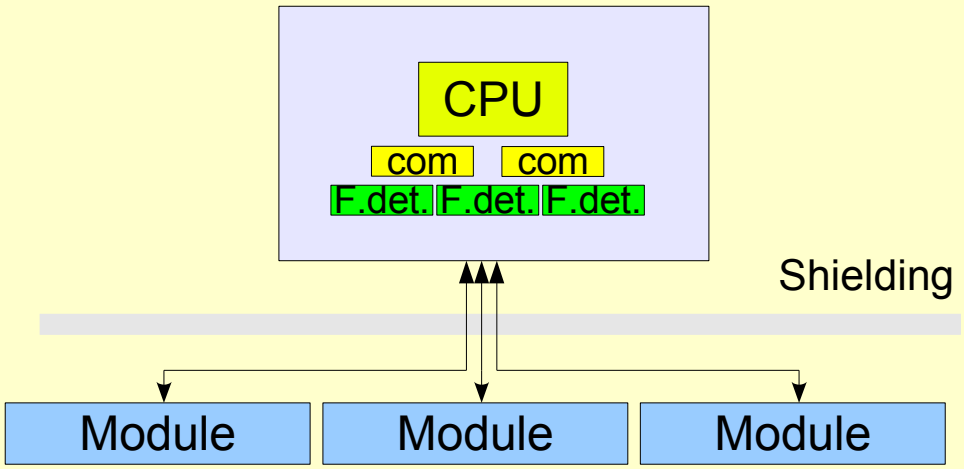
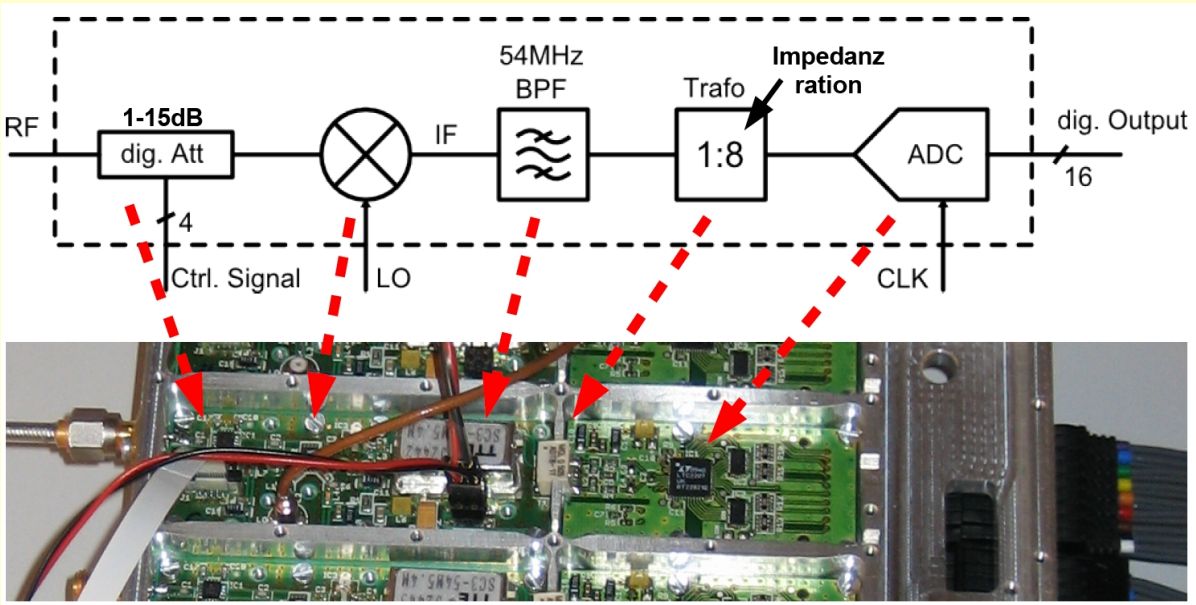


Field detection & actuators

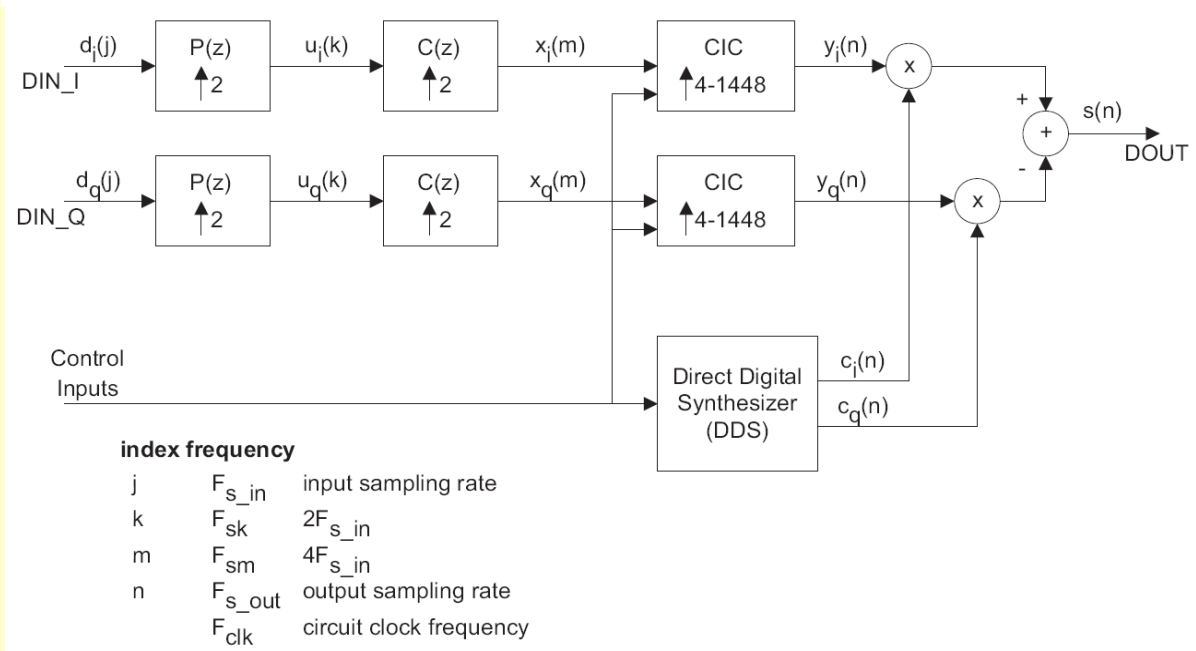
Field detection

- conventional
  - down-converter (noise reduction)
  - ADC module (high resolution)
  - different IF (1-50 MHz)
- direct sampling



Up-convention

- digital up-conversion
- conventional up-conversion



Computation power

FPGAs : Xilinx Virtex4 (with PPC) & Virtex5

DSPs : Analog Devices TigerSHARC, Freescale StarCore MSC8144

CPU : SUN UltraSRARC Adlink CPU board

Communication links:

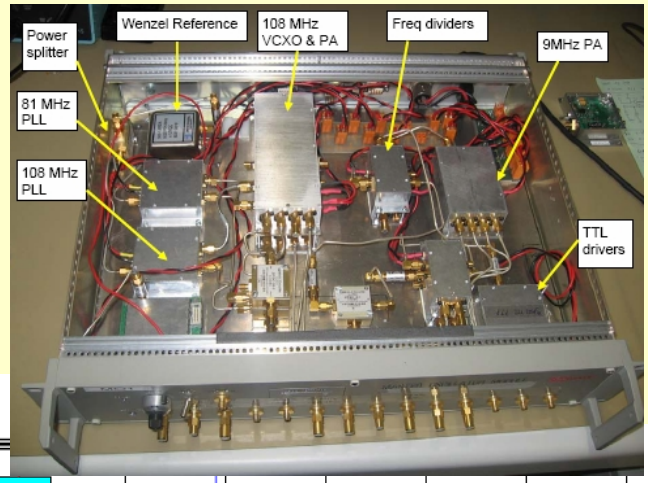
* PCIExpress
* Gigabit Ethernet
* low latency protocol

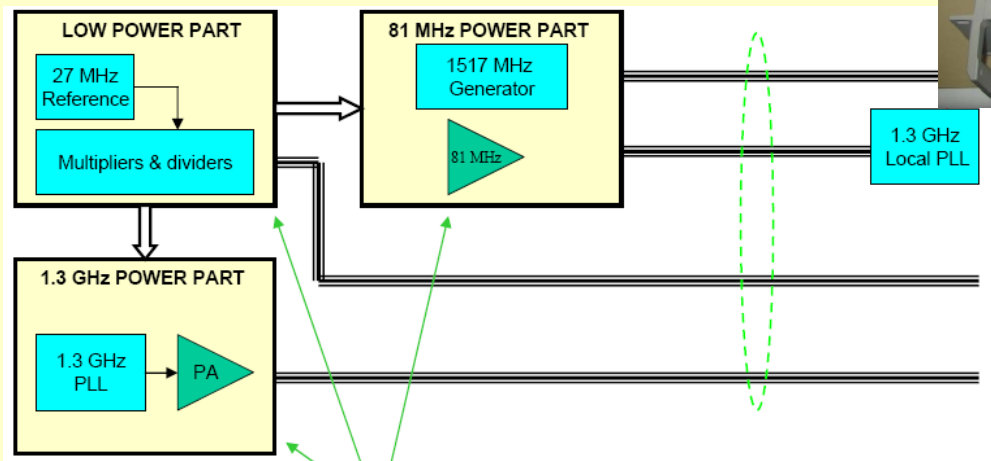
Master oscillator

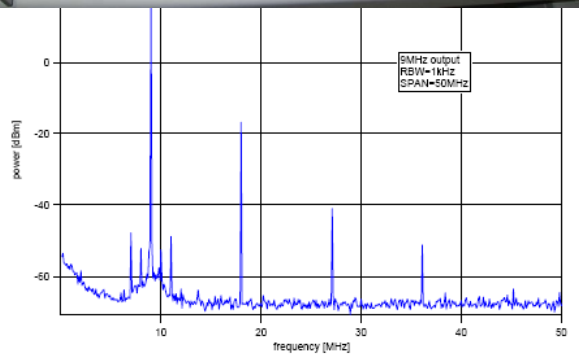
Following frequencies are distributed:

- 50 Hz
- 1 MHz (= master reference frequency divided by 9)
- 9 MHz (master reference frequency)
- 13.5 MHz & 27 MHz for Laser
- 81 MHz distribution frequency
- 108 MHz
- 1300 MHz (ref. freq. for the linear collider)
- 1517 MHz (ref. freq. for beam position monitors)
- 2856 MHz (transverse deflecting cavity for bunch measurements)

Short term phase stability – 0.1 ps
Long term phase stability – 1 ps



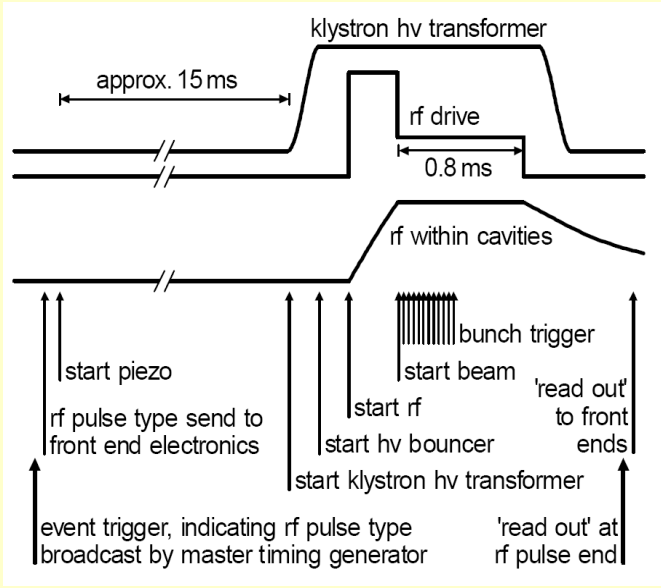


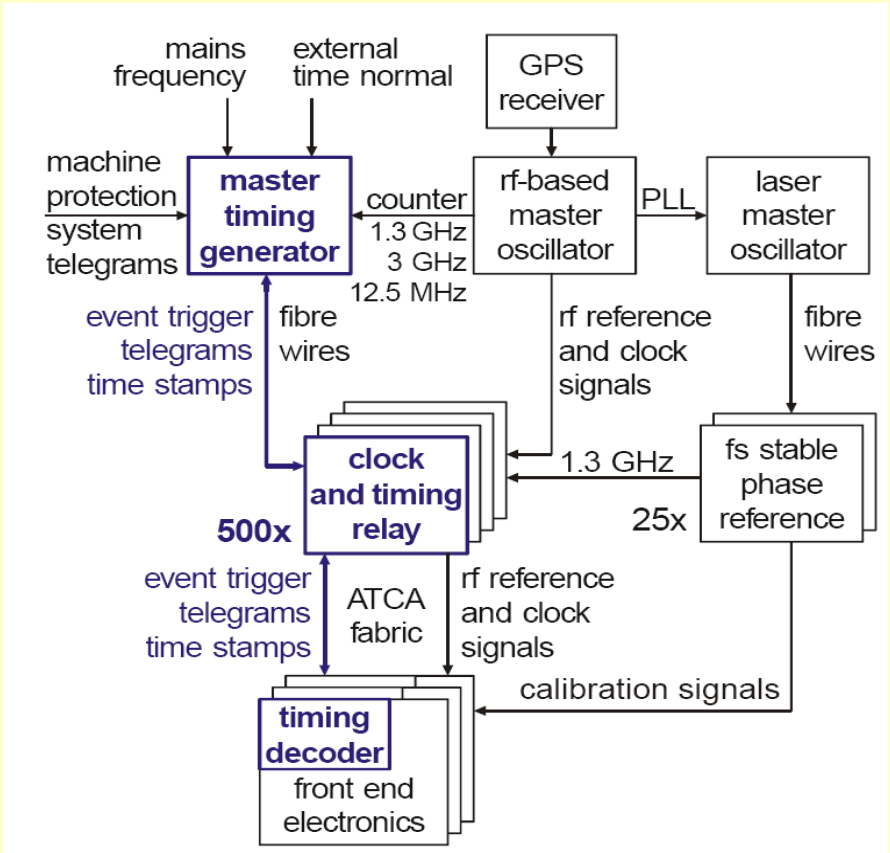


Timing

Requirements on the system concern mostly signal phase stability at the end of the distribution line. Requirements on the system performance:

- Short term stability (phase noise) << 1ps , 10fs at one location in the XFEL
- Short term stability (minutes) < 1ps at RF frequency (0.5o @1.3 GHz)
- Long term stability (days) < 10ps within days (5.0o @1.3 GHz)
- Distributed frequencies 9 - 2856MHz
- High reliability



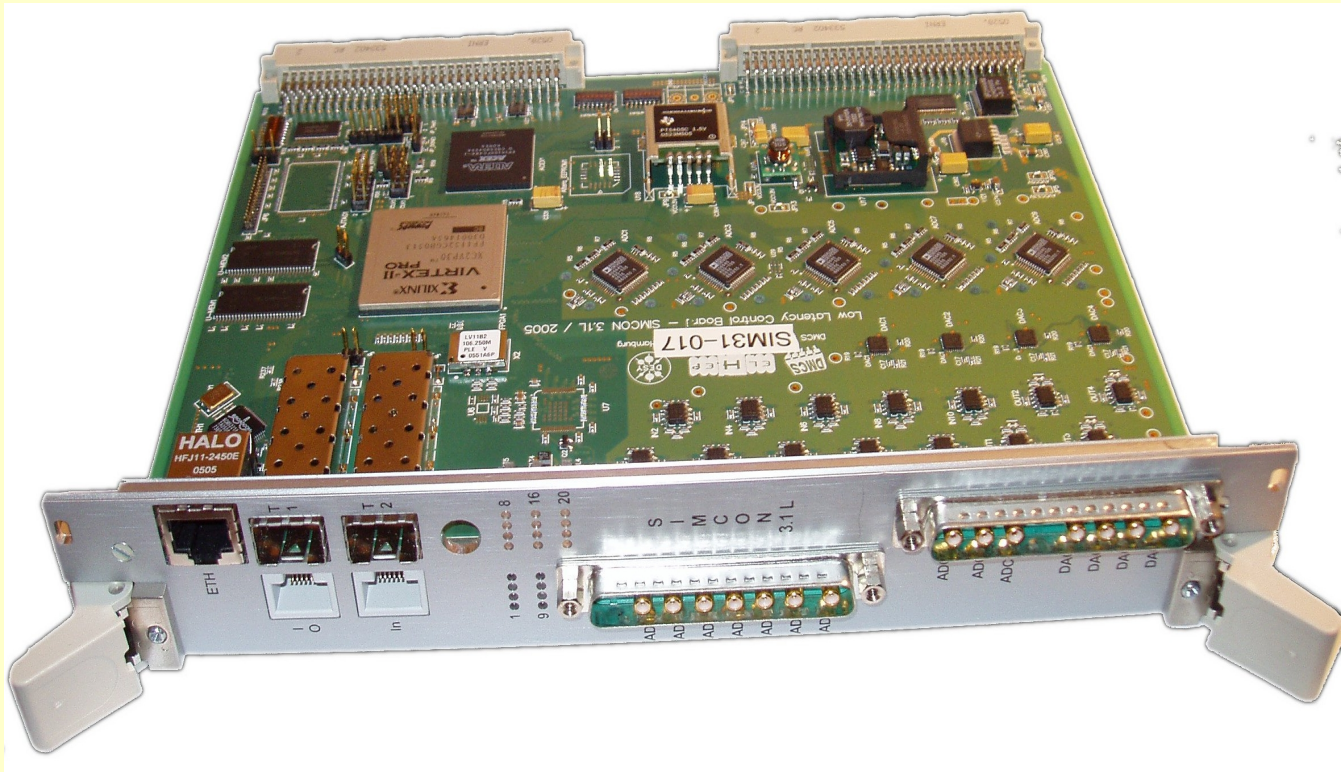


The basic function of the master timing generator

Digital feed-back

Development of the digital hardware based on:

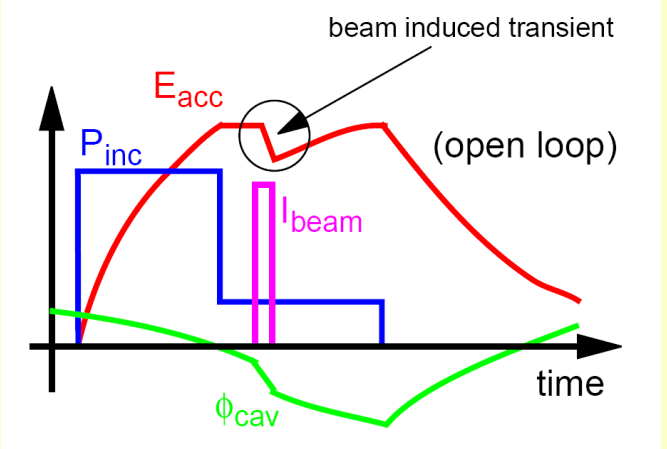
- VME
  - DSP C69 system
  - ADC & DAC board
  - SIMCON 2.0
  - SIMCON 3.1
  - SIMCON-DSP
  - SIMCON 4.0
- ATCA and AMC modules
  - carrier board
  - AMC – ADC board
  - AMC – timing board
  - AMC – digital up-conversion
  - AMC – communication module
  - RTM – down-converter



Transient detection

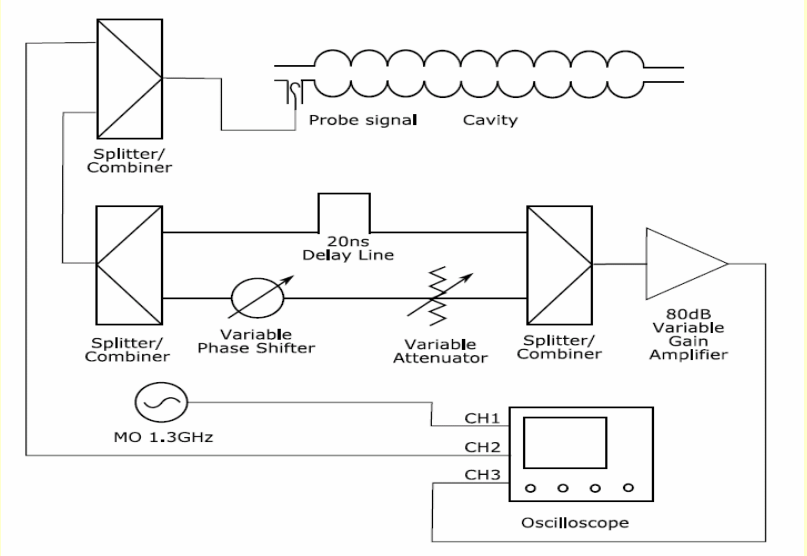
Goal: method for RF field callibration

- using single bunch
- can be performed during normal operation of accelerator



Status of development:

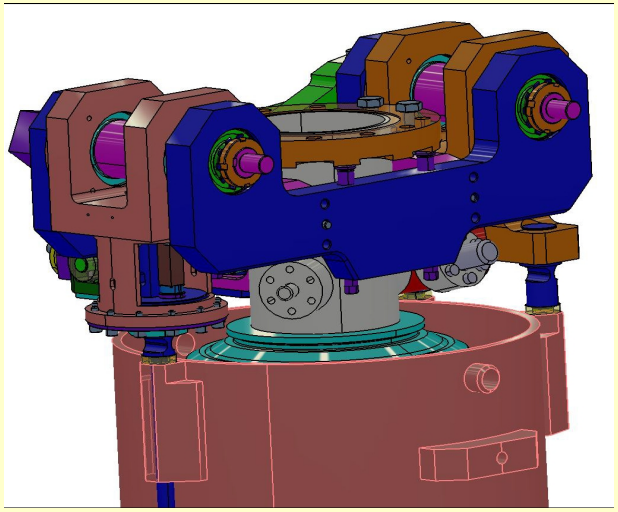
- During the 2006 the activities were focused on improving transient detection system
  - fine-tuning circuitry for RF feedforward comb filter
  - IQ modulator for precise filter adjustment
- Connected to all cavities in module ACC1
- System is in operation in FLASH



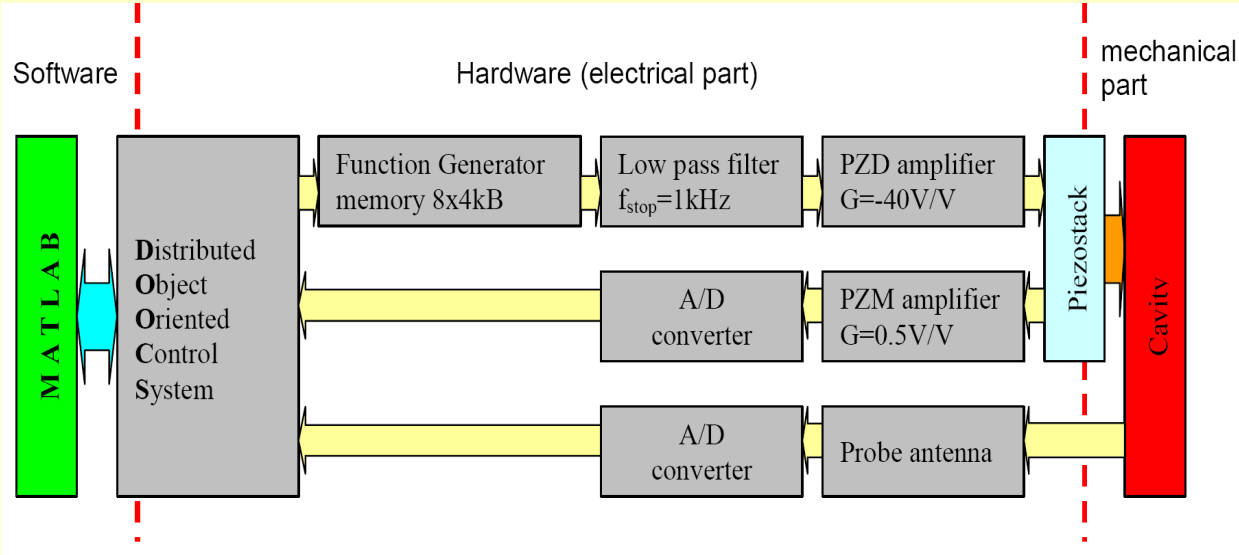
Piezo control

Main purpose of cavity tuner

- Pre-tuning process
- Compensate Lorentz force
- Compensate microphonics



Three different multilayer piezostack has been tested



Summary

- Results of R&D can be used in ILC
- Requirements and problems with timing are common for ILC and XFEL (stability, drift, etc.)

- Requirements for electronics in:
  - HOM measurement,
  - beam position monitoring (BPM),
  - transfer deflecting cavity (LOLA)
  - GUN
  - 3rd harmonic cavity

are similar and the same hardware can be used for XFEL and ILC