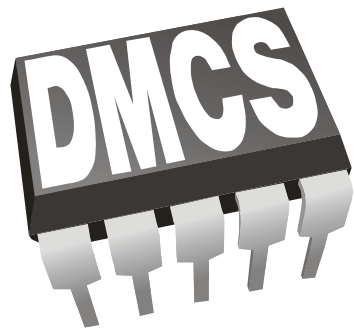# Status of Piezo Controller and Driver

K. Przygoda

T. Poźniak

Piezo in XFEL Experiment

Main parameters:

➢ beam energy up to 20 GeV $\rightarrow$ wavelength, λ_e up to 0.1 nm

➢ 25 RF stations, each one powered by klystron of 5 $\div$ 10 MW

➢ 25 RF st. x 4 accelerating modules = 100 accelerating modules

➢ each accelerating module with 8 SC cavities

➢ nominal $E_{acc} \approx 25$ MV/m $\rightarrow$ $\Delta f \approx 250$ Hz $\rightarrow$ $\Delta P_{kly} \approx +25\%$

➢ **800 piezos for driving and 800 for sensing**

➢ RF pulse duration 1.3 ms

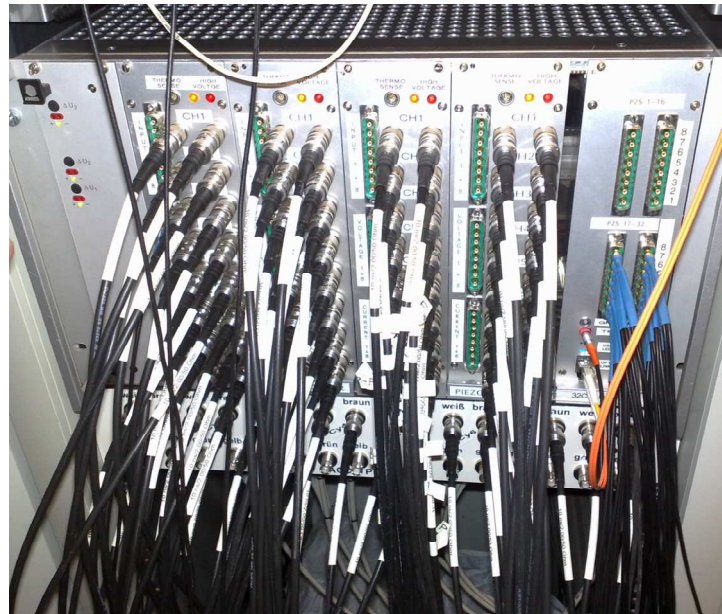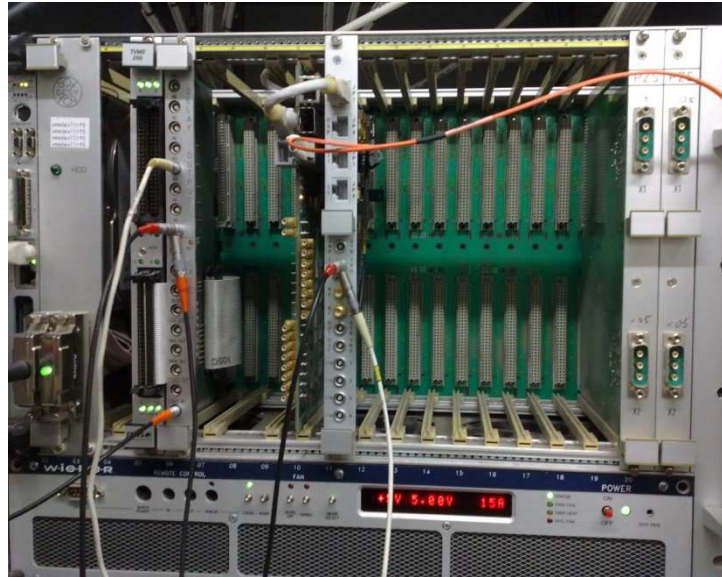➢ RF pulse repetition rate $f_{RP} = 10$ Hz
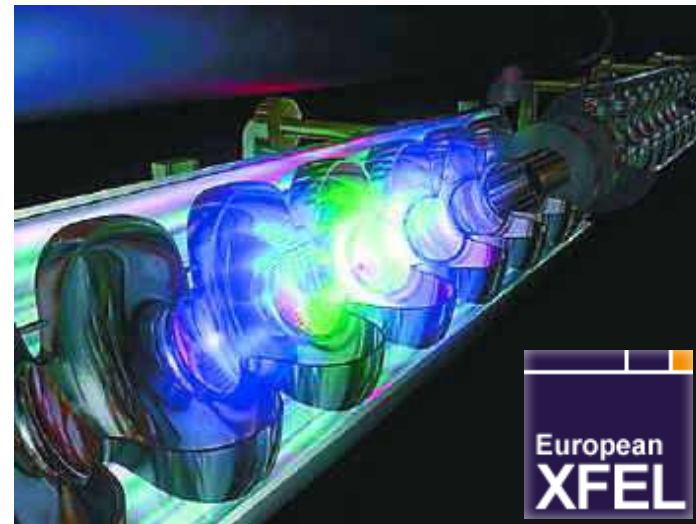
Piezo Tuners Control at FLASH
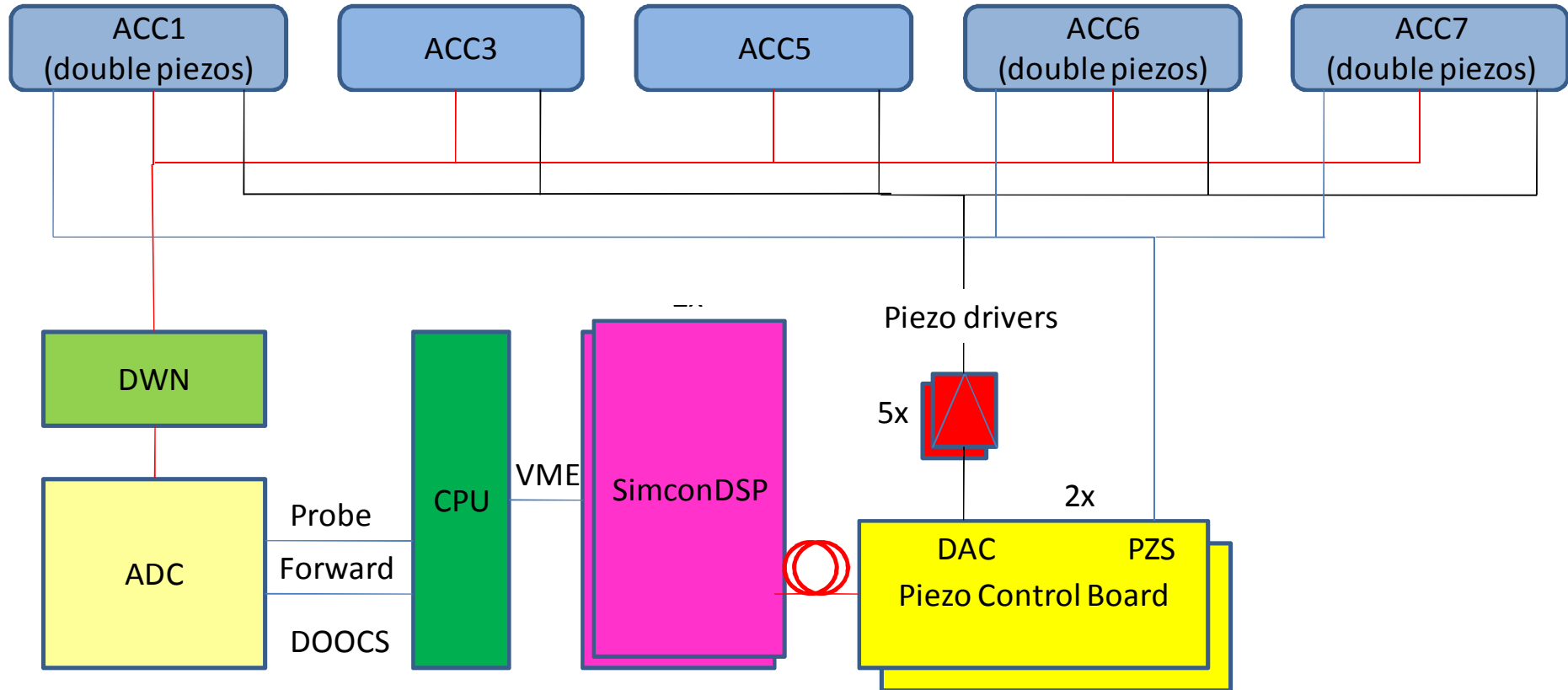
40 cavities, 5 accelerating modules
(single and double piezo tuners)
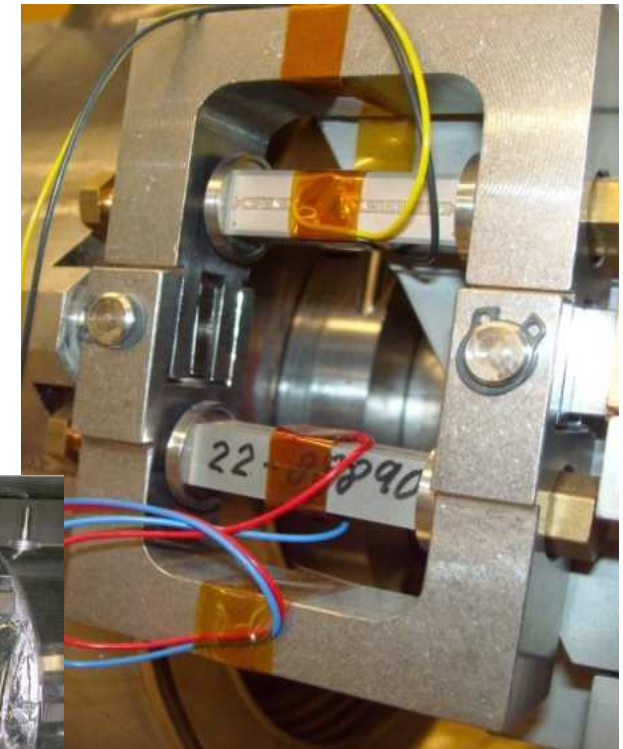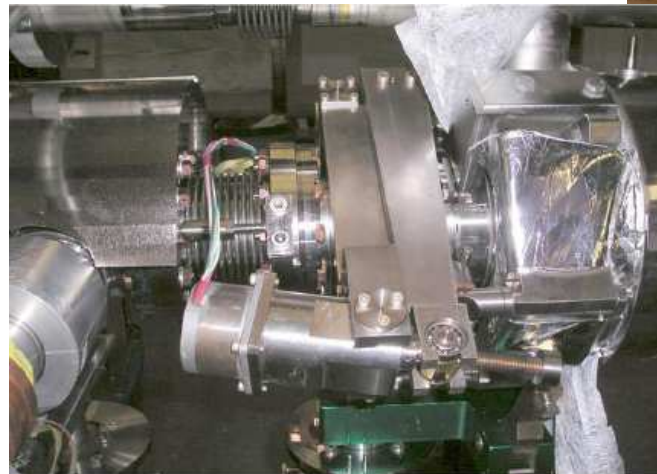
System Installation at FLASH

Installed:
5x PZD units
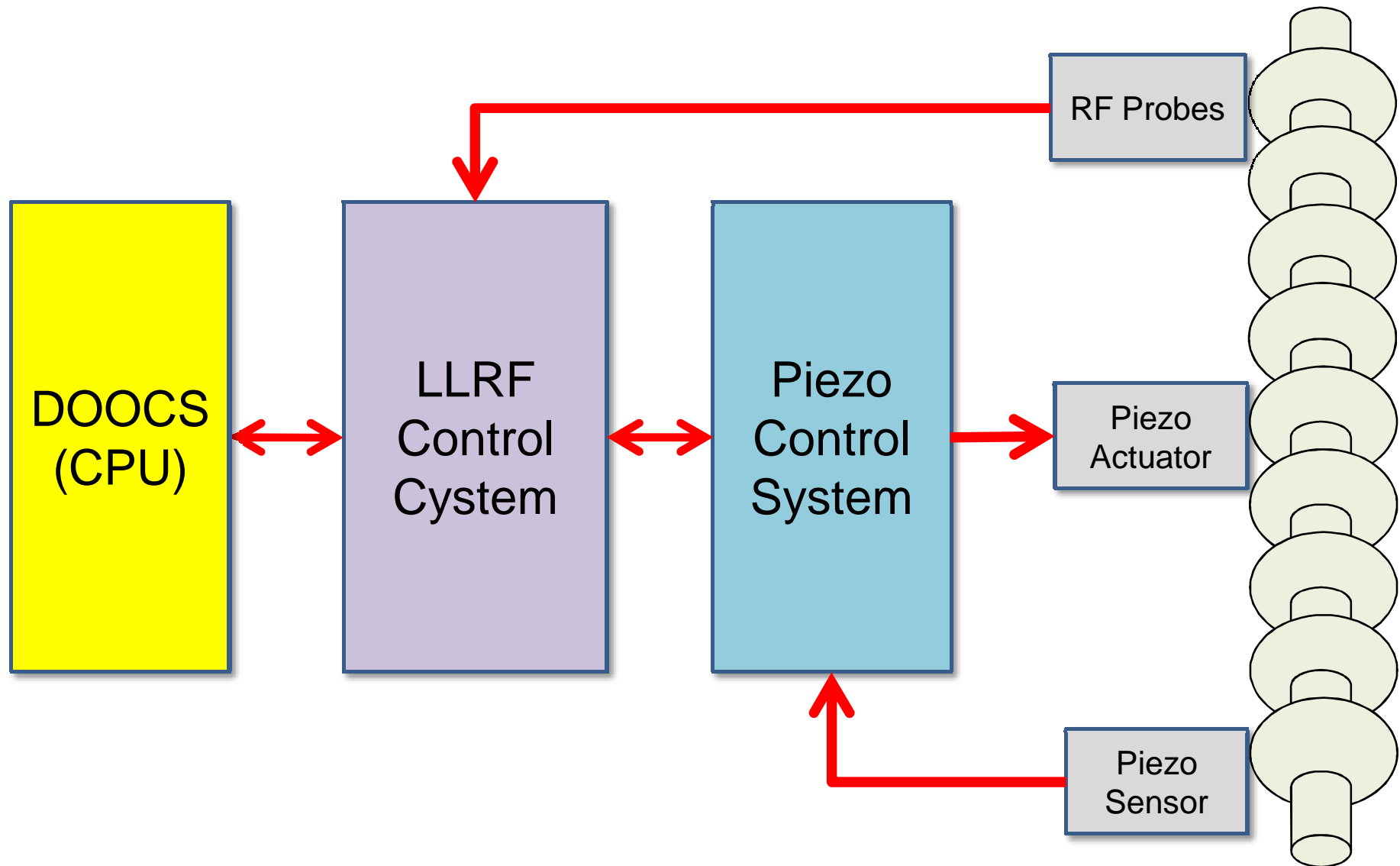2x DAC/ADC units
2x Piezo Crates

Spare parts:
3x PZD units
2x DAC/ADC units
2x Piezo Crates

Piezo Control System Specification

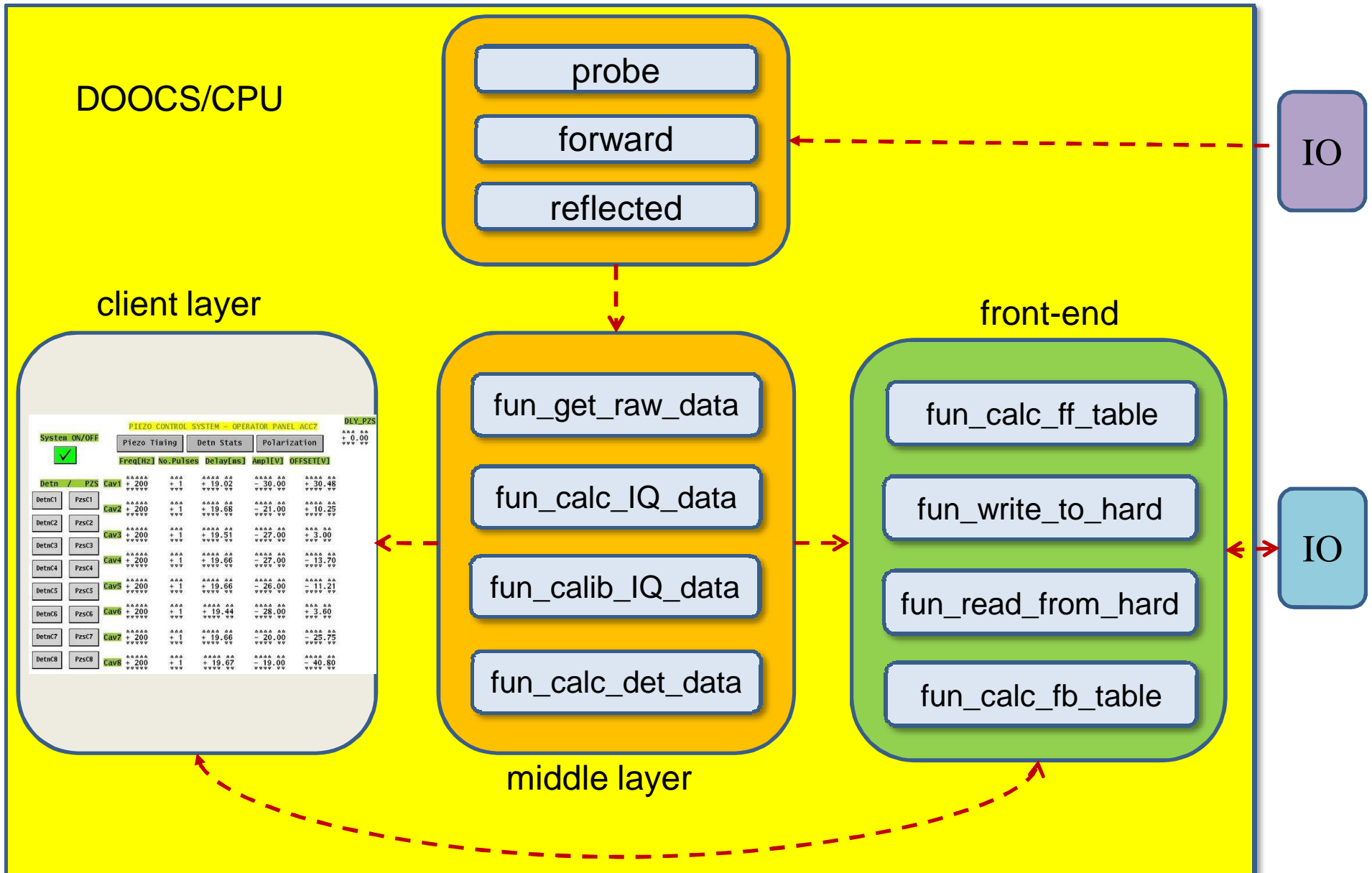- System should be able to compensate 4 accelerating modules with 8 SC cavities each (*2 boards*)

- Each board will have integrated 16 driving and sensing circuits

- External power supply unit: - 48 V

- Internal power supply unit:
  - Symmetric: ± 96 V
  - Assymetric: -48 V/+144 V

- Operation with uTCA standard:
  - inside standalone box
  - optical link connection

Layout of Piezo Control System

Software Based Control Scheme

DOOCS/CPU

probe

forward

reflected

IO

client layer

front-end

middle layer

fun_get_raw_data

fun_calc_IQ_data

fun_calib_IQ_data

fun_calc_det_data

fun_calc_ff_table

fun_write_to_hard

fun_read_from_hard

fun_calc_fb_table

IO

Firmware Based Control Scheme ver.1

SIS8300
- probe
- forward
- reflected

DOOCS (CPU)

xTCA-piezo
- fun_calc_ff_table
- fun_write_to_hard
- fun_read_from_hard
- fun_calc_fb_table

uTCA Controller
- fun_get_raw_data
- fun_calc_IQ_data
- fun_calib_IQ_data
- fun_calc_det_data

Firmware Based Control Scheme ver.2

DOOCS (CPU)

SIS8300

xTCA-piezo

probe

forward

reflected

fun_get_raw_data

fun_calc_IQ_data

fun_calib_IQ_data

fun_calc_det_data

fun_calc_ff_table

fun_write_to_hard

fun_read_from_hard
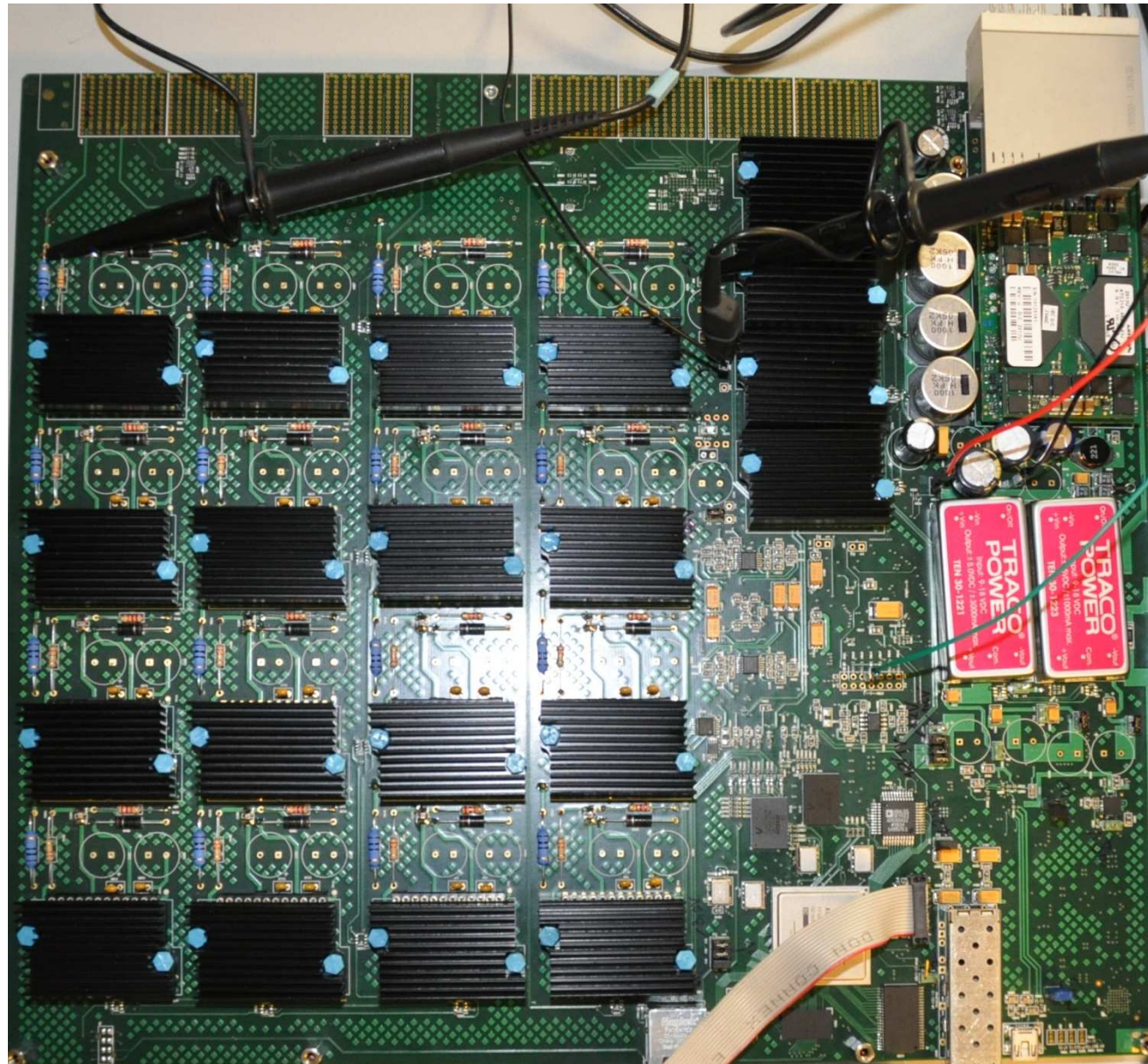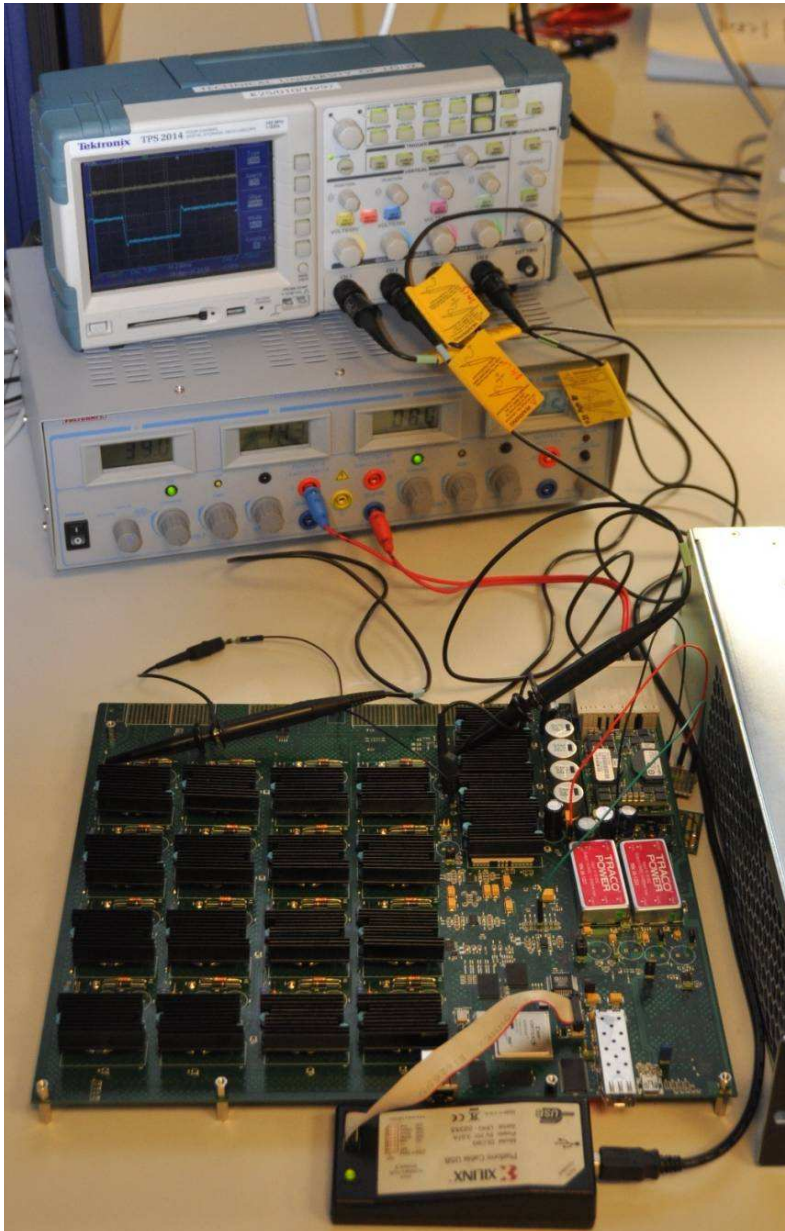
fun_calc_fb_table

Piezo Controller rev. 1

Piezo Controller rev.1 (PCB 10L)

Laboratory Test Stand

- Power supply units debugged
  - ATC210 (-48 V ⇔ {12 V/3.3 V})
  - TEN-30 (12 V ⇔ {±5 V/±15 V})
  - LTM4600 (12 V⇔ {3.3 V/2.5 V/ 1 V})
  - TPS7448 (2.5 V⇔ {1.8 V/1.2 V/1 V})
  - BCM (48 V ⇔ ±96 V)
- FPGA unit debugged
  - MGT(RocketIO ⇔ opto)
  - SPI Interface (with DAC)
  - Parallel Interface (with ADC)
- Driving circuits debugged
  - 16-ch DAC
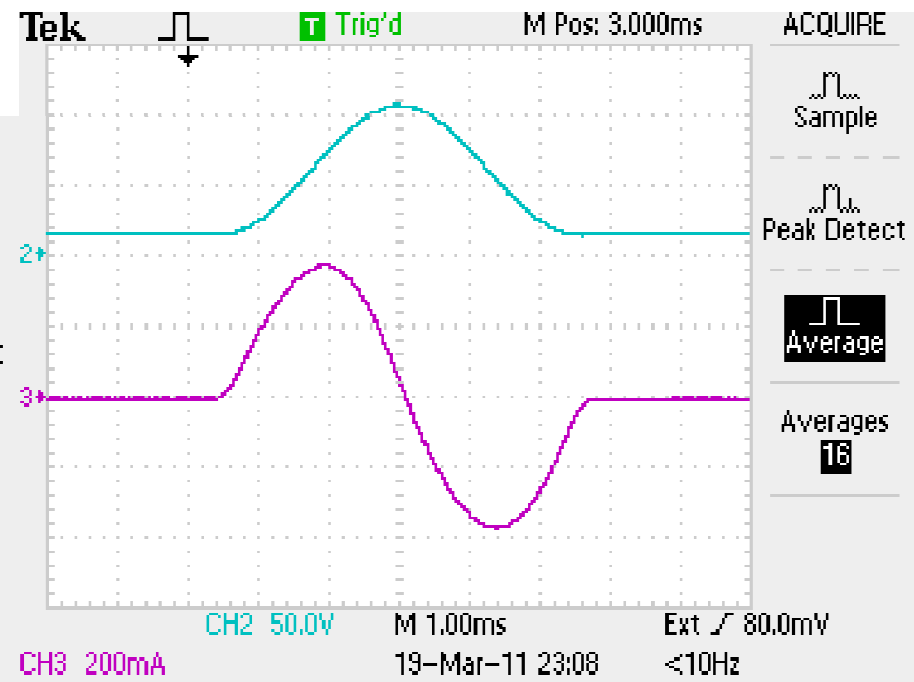 - 16 x PB51
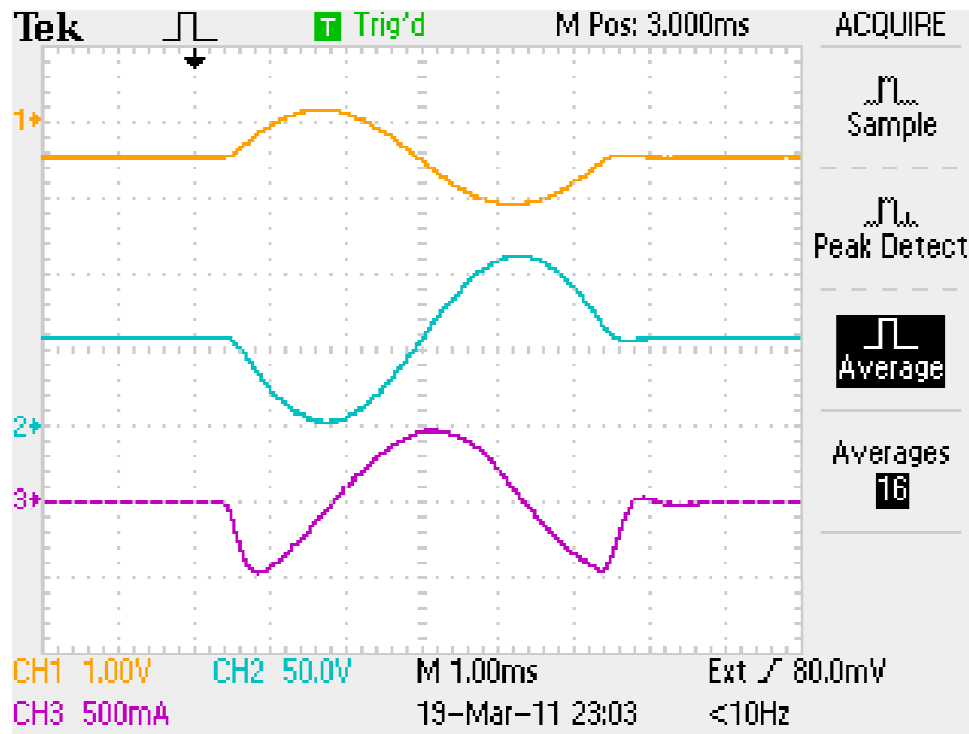- Sensing circuit debugged
  - ADC

System Costs rev.1 (single RF station)

- PB51 – 2x16x150EUR (4.8 kE)
- ATC210 – 2x250EUR
- BCM – 8x50EUR
- XV5FVX30 – 2x300EUR
- BOX – 2x200 EUR
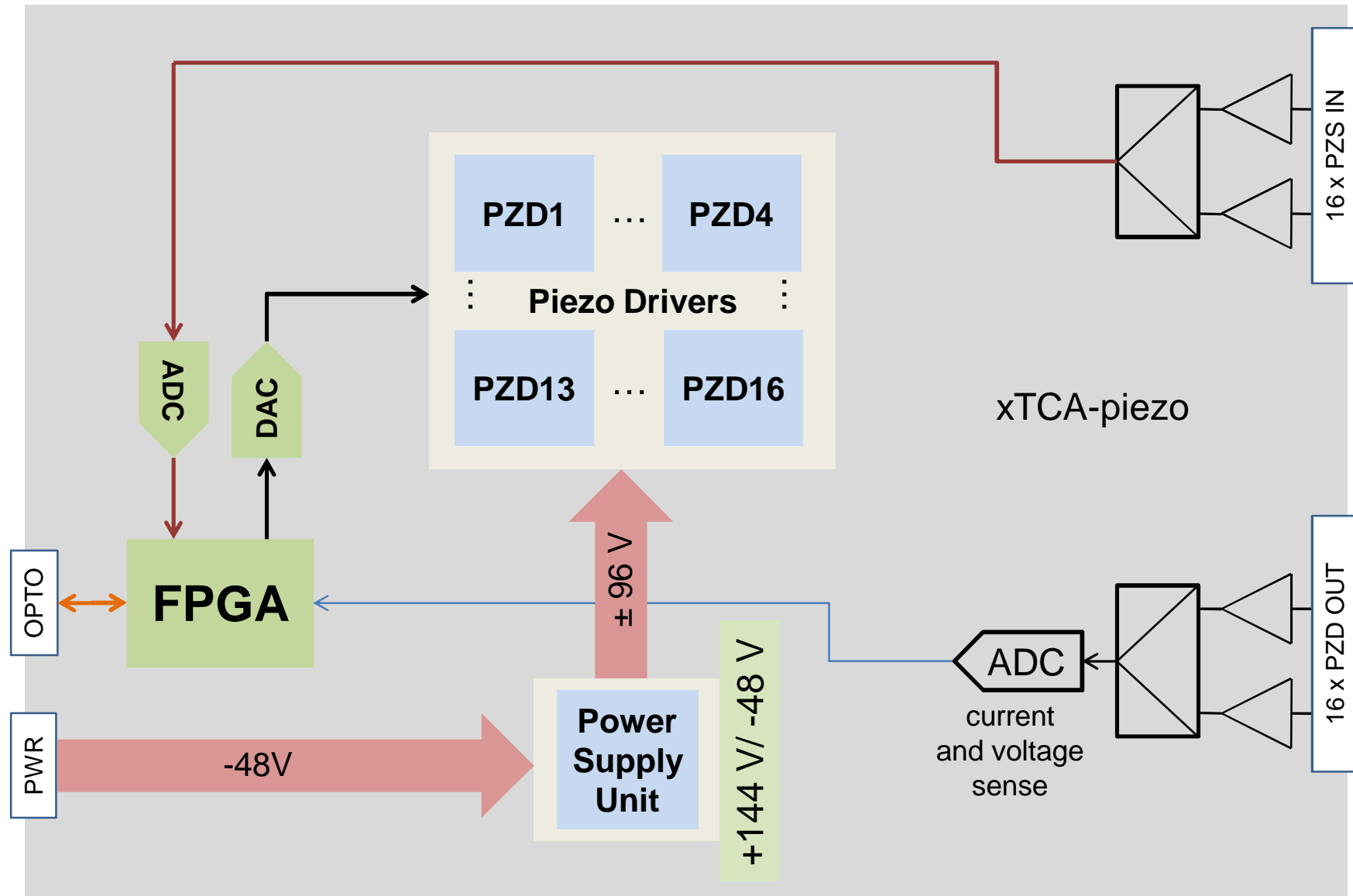- PCB (10L) – xTCA - 2x800EUR (with doc)
- PCB (4L) – RTM – 2x375EUR (with doc)

Total cost – ~9kE (should be 2kE!!!)
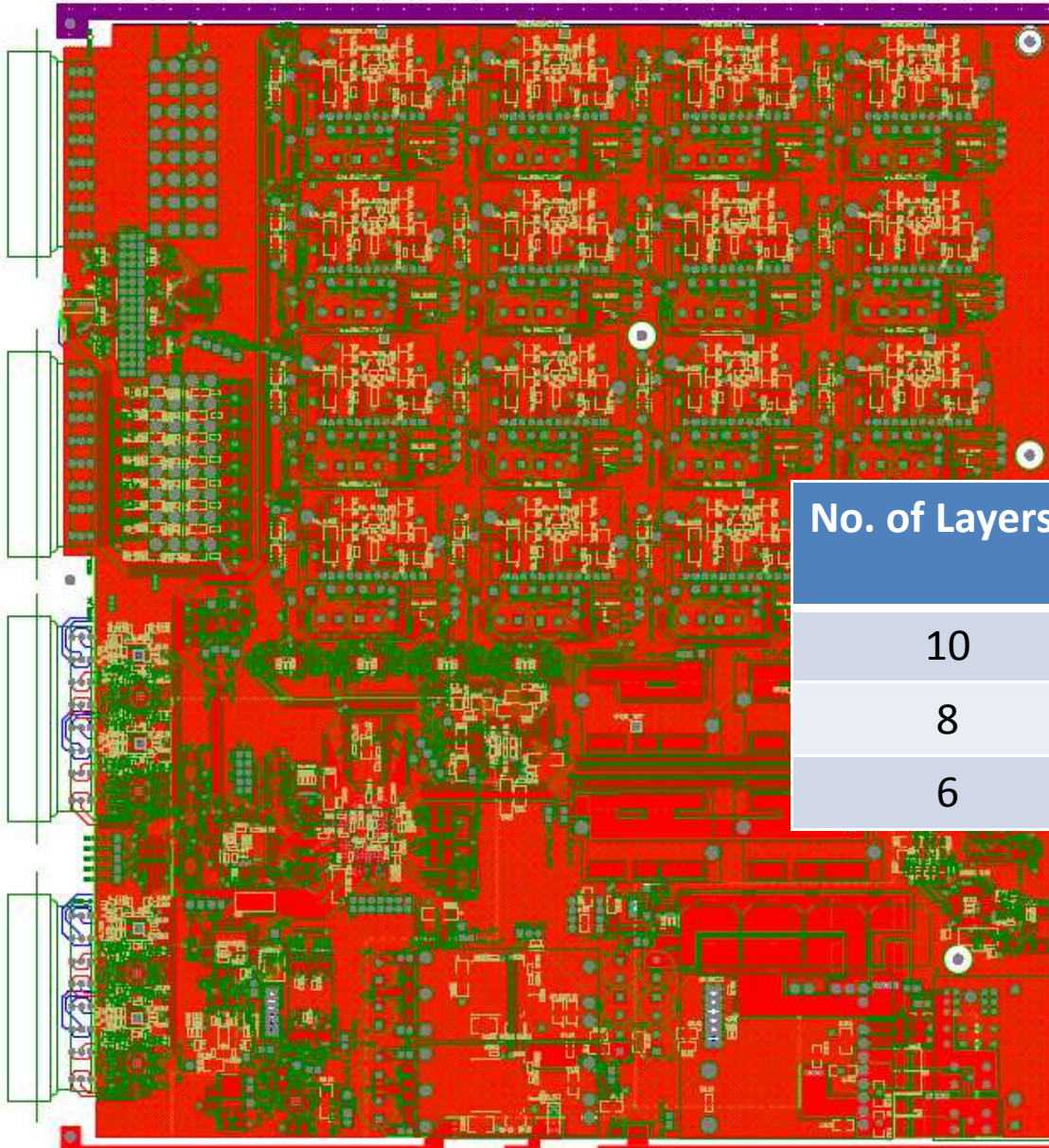
Conclusions to rev. 2

- Change radiators direction
- Unipolar/bipolar Power Supply Unit
- Unipolar drive -20 V / 120 V
- Avoid sharp current transitions
- Reduce the costs

Piezo Controller rev. 2

Piezo Controller rev.2 (PCB)

No. of Layers	Unit cost [EUR]	60 units cost [EUR]
10	240	14400
8	148	8880
6	195	11700

System Costs rev.2 (single RF station)

- PB51 – 2x16x150EUR (4.8 kE)

- ATC210 – 2x250EUR

- BCM – 8x50EUR

- XC6SLX25T – 2x40EUR

- BOX – 2x200 EUR

- PCB (8L) – xTCA - 2x300EUR (with doc)

Total cost – ~6.4kE (should be 2kE!!!)

Thank You
for Your Attention