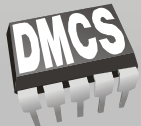




DEPARTMENT OF MICROELECTRONICS AND COMPUTER SCIENCE



Department of Microelectronics and Computer Science

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mali: secretary@dmcs.p.lodz.pl <http://www.dmcs.pl>



BASIC INFORMATION

**HEAD OF DEPARTMENT:
PROF. ANDRZEJ NAPIERALSKI**



FOUNDED IN 1996

- ➔ **PROFESSORS: 4**
- ➔ **SENIOR LECTURERS: 33**
- ➔ **LECTURERS: 1**
- ➔ **PhD STUDENTS: 40**
- ➔ **TECHNICAL AND ADMINISTRATION 9**



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OUR ROOTS



Prof. Zdzisław Korzec

Prof. Jerzy Luciński

Prof. Tadeusz Konopiński





PHD STUDENTS

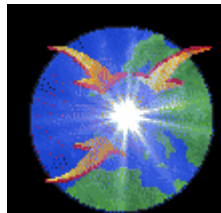


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INTERNATIONAL RESEARCH ACTIVITIES (COMPLETED) - PART 1

- ➔ ESPRIT 8173 – **BARMINT** 1994-1997
- ➔ COPERNICUS 00922 – **THERMINIC** 1995-1998
- ➔ Grant NATO - No 960050 1996-1998
- ➔ INCO/COPERNICUS 960170 – **SYTIC** 1997-1998
- ➔ IST-2000-28084 – **SEWING** 2001-2004
- ➔ IST -2000-30193 – **REASON** 2002-2005
- ➔ **IMPACT** EC Project HPRI-1999-00059 1995-
- ➔ **EUROCHIP 4013, EURO PRACTICE** 1991-





INTERNATIONAL RESEARCH ACTIVITIES (COMPLETED) – PART 2

European Union 6th Framework Programme

Project RII3-CT-2003 506395 CARE

2003-2007

➔ **CARE – Coordinated Accelerator Research in Europe**

European Union 6th Framework Programme

IST FP6-2005-IST-5 PERPLEXUS

2006-2010

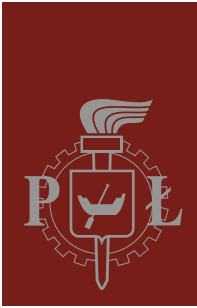
**Pervasive computing framework for modelling complex
virtually-unbounded systems – PERPLEXUS**



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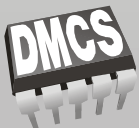


INTERNATIONAL RESEARCH ACTIVITIES (CURRENTLY CONDUCTED) – PART 1



Cooperation with DESY in Hamburg

The cooperation of the Department of Microelectronics and Computer Science with laboratories of High Energy Physics started in 2002 when agreement with DESY-Hamburg on bilateral cooperation in the design of electronic equipment for accelerator control systems was signed. In 2005 the Department became a member of the Tesla Technology Collaboration, whose main aim is the development of accelerator construction technology.



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INTERNATIONAL RESEARCH ACTIVITIES (CURRENTLY CONDUCTED) – PART 2



EU 7th Framework Programme

Capacities Specific Programme,
Research Infrastructures,
Combination of Collaborative Project
and Coordination and Support Action

European Coordination for Accelerator
Research and Development

EuCARD

2009-2013



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INTERNATIONAL RESEARCH ACTIVITIES (CURRENTLY CONDUCTED) – PART 3

European Union 7th Framework Programme Information Society Technologies (IST) Programme

- ➔ **EduMEMS 269295 PR UE/2009/7** **2010-2014**
 - ➔ **Developing Multidomain MEMS Models for Educational Purposes**

- ➔ **TIARA 261905** **2011-2013**
 - ➔ **Test Infrastructure and Accelerator Research Area**





INTERNATIONAL RESEARCH ACTIVITIES (CURRENTLY CONDUCTED) – PART 4

Swiss-Polish cooperation between the Lodz University of Technology (PL) and Empa

➔ TULCOEMPA

2011-2015

- ➔ Research and development of the innovative methods for monitoring in the civil engineering infrastructure.



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RESEARCH KBN GRANTS (OVER 57 COMPLETED)

RESEARCH GRANTS (CURRENTLY CONDUCTED)

No 2011/01/N/ST7/05235

2011-2013

Odczyt sygnałów elektrycznych z wielokanałowych sensorów promieniowania optycznego (Ł. Kotynia)

No 2011/01/D/ST6/06269

2011-2014

Wielomodalny biometryczny system bezdotykowej identyfikacji osób (W. Sankowski)

No 2011/01/N/ST7/05242

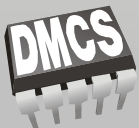
2011-2013

Mikroarchitektura elementów obliczeniowych dla rekonfigurowalnego procesora ogólnego przeznaczenia (P. Amrozik)

No 4769/B/T02/2011/40

2011-2013

Sieciowy system detekcji ataków dla rozwiązań SCADA oparty o podejście probabilistyczne (W. Tylman)



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RESEARCH KBN GRANTS (OVER 57 COMPLETED)

RESEARCH GRANTS (CURRENTLY CONDUCTED)

No 5091/B/T02/2011/40

2011-2014

Analiza procesów wielordzeniowych z wykorzystaniem sprzężonej symulacji logiczno-termicznej (M. Szermer)

No 2011/01/B/ST6/04726

2011-2014

Zautomatyzowany system wieloparametrowej oceny stanu ogólnego pacjenta z pogłębioną analizą funkcji układu oddechowego i układu krążenia (A. Napieralski)

No 5593/B/T02/2010/39

2010-2013

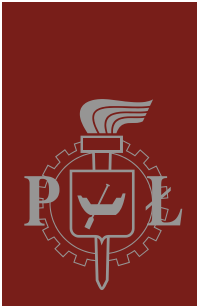
Zintegrowane, wielozadaniowe, rozproszone środowisko pomiarowo-sterujące dla modułów przyspieszających nadprzewodzących akceleratorów liniowych w eksperymentach fizyki wysokich energii (W. Cichalewski)



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RESEARCH KBN GRANTS (OVER 57 COMPLETED)

RESEARCH GRANTS (CURRENTLY CONDUCTED)

No 2011/03/ST6/03454

2012-2015

Stratyfikacja ryzyka nagłego zgonu sercowego w oparciu o ocenę funkcji autonomicznego układu nerwowego metodami Holterowskimi (M. Kamiński)



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AWARDS FOR DMCS

- ➔ 39 awards and diplomas from Science and Higher Education Minister
- ➔ 67 awards for scientific research
- ➔ 31 associate of Polish Electrical Engineers and "FSNT NOT" awards
- ➔ 6 prizes from the Prime Minister of Poland
- ➔ 6 scholarships for outstanding young doctors
- ➔ Many awards for PhD and regular students
- ➔ Top 500 Innovators, Science - Management – Commercialization



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DLL SUPERCOMPUTER

2006 – 2008: Grant of Polish Ministry of Science and Higher Education: „**Implementation of Dynamic Lattice Liquid Algorithm by Means of Dedicated Microprogrammable Computational Cell**”

Result: (μ Supercomputer DLL):
 $6 \times 6 \times 6 = \mathbf{216 \text{ nodes}}$ (18 FPGAs)

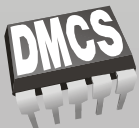
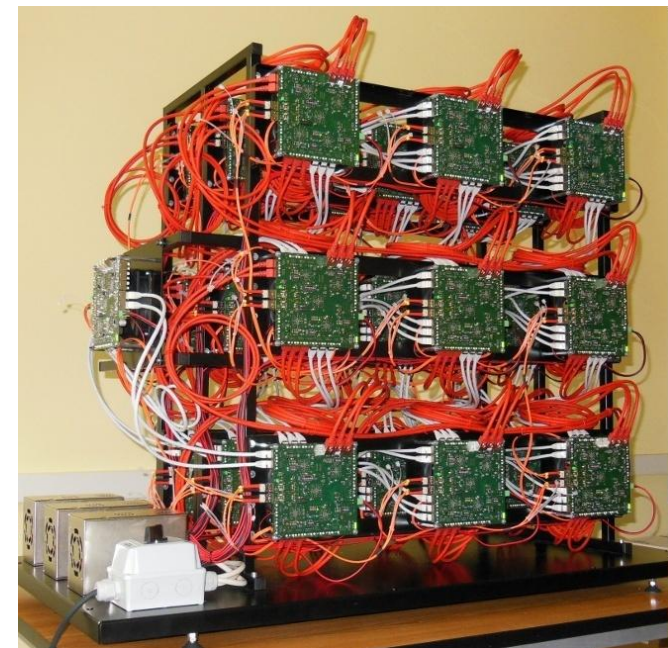
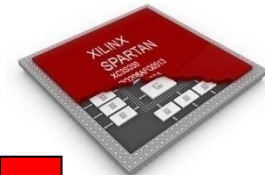
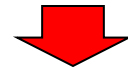
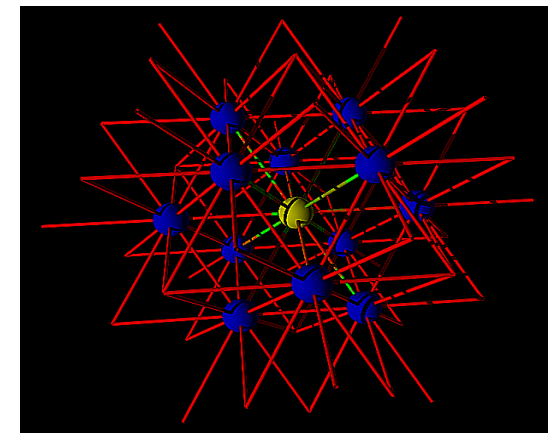
2009 – 2012: Grant of Polish Ministry of Science and Higher Education:
„**Module of Dedicated Computational Cluster for Simulations Based on Dynamic Lattice Liquid Algorithm**”

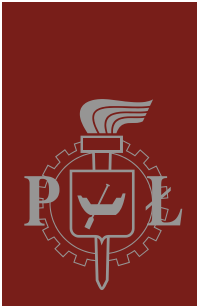
Expected result:

- 27 modules containing
- 4 FPGAs (in each module)
- 64 nodes (in each FPGA)

In total: **1 728 nodes** (108 FPGAs)

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DREAM

- ➔ Dynamically REconfigurAble polyMorphic supercomputer – a scalable computational machine, which can reorganize itself into a different form (Greek: “morphe”) to meet requirements of the particular task



ECBNT:
European Centre of
Bio- and NanoTechnology
in Lodz



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DYNAMICALLY RECONFIGURABLE POLYMORPHIC SUPERCOMPUTER – DREAM

Parallel supercomputer based on **dynamically reconfigurable processing elements**, dedicated for modeling complex virtually-unbounded systems and emerging behaviors (peptides, polymers and other molecular systems, biological and electro-thermal phenomena, etc.)



Aim: 1 000 000 nodes (~15 500 FPGAs, 3 900 PCBs)



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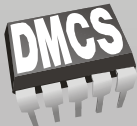
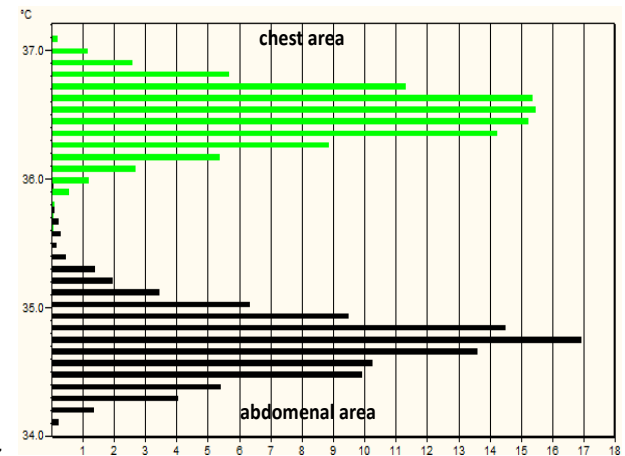
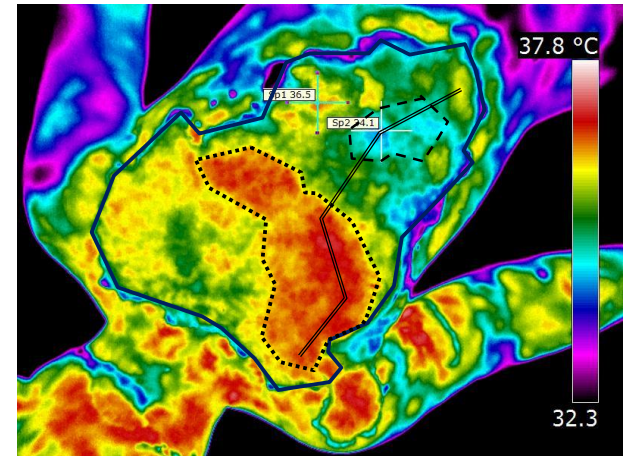
ul. Wólczańska 221/223 90-924 Łódź tel: 042 631-26-28 fax: 042 631-03-27

mali: secretary@dmcs.p.lodz.pl <http://www.dmcs.pl>



Grant of the Ministry of Scientific Research and Higher Education No. N515 2423 37 'Infrared thermography system for the assessment of burn wound depth'

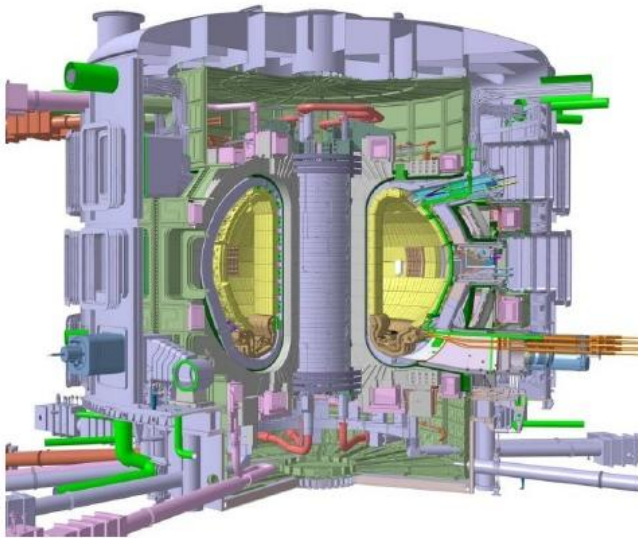
Department of Pediatric Surgery and Oncology, Medical University of Lodz



Department
ul. Wólczańska 22/225 90-524 Łódź tel. 042 631 20 20 fax. 042 631-03-27
mail: secretary@dmcs.p.lodz.pl <http://www.dmcs.pl>



ITER TOKAMAK



ITER Tokamak
23000 tons

Charles de Gaulle
38000 tons

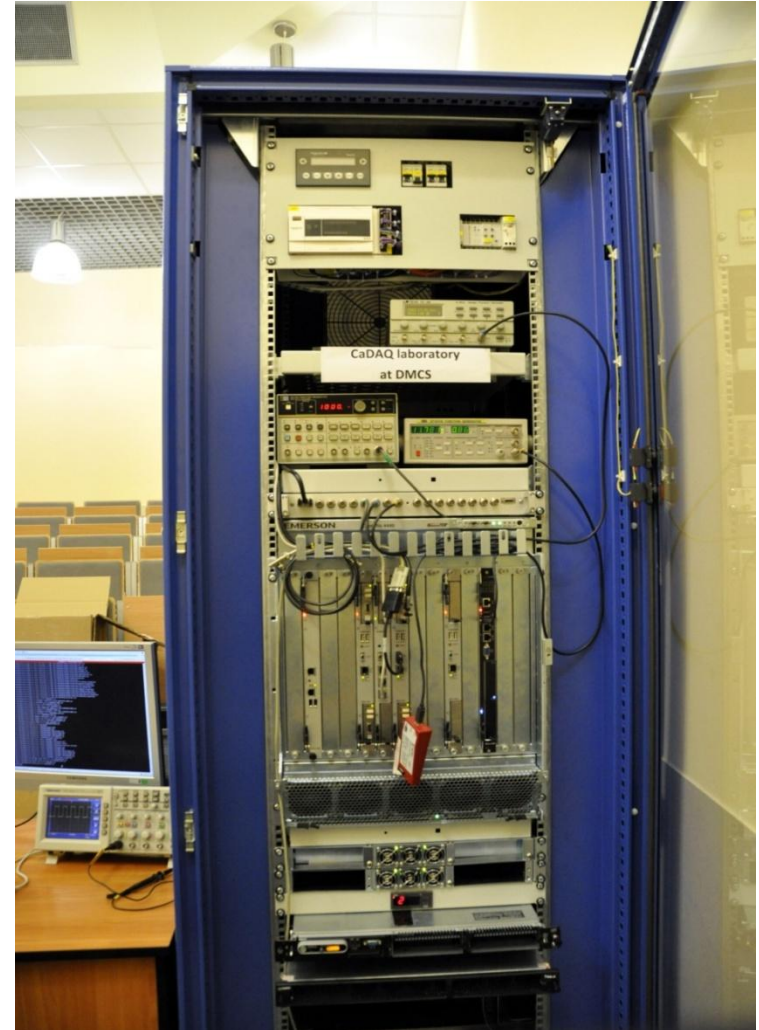


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PROTOTYPE OF DATA ACQUISITION SYSTEM

- ➔ The DAQ system is based on ATCA standard
- ➔ Scalable architecture
- ➔ 1/10 GbE and PCIe interfaces for data transmission
- ➔ ATCA shelf with CPU blade, carrier board and DAQ modules
- ➔ TESLA S1070 GPU for data processing
- ➔ All systems installed in standard ITER cubicle
- ➔ Currently under tests at ATOS, France



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IMAGE PROCESSING SYSTEM

- Image acquisition from ultrafast camera (285.000 fps)
- Scalable architecture
- Main interface: PCIe x16 (>100 Gbps)
- MTCA shelf with external CPU and GPU processing blade
- Image compression, recognition and processing
- Currently under development (DMCS, ITER Cadarache, France)

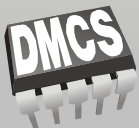


ORGANISATION OF CONFERENCES



➔ International Conference: "Mixed Design of Integrated Circuits and Systems - MIXDES"

➔ 1 - Dębe,	Poland	05 - 09.04.1994
➔ 2 - Kraków,	Poland	29 - 31.05.1995
➔ 3 - Łódź,	Poland	30.05 - 01.06.1996
➔ 4 - Poznań,	Poland	12 - 14.06.1997
➔ 5 - Łódź,	Poland	18 - 20.06.1998
➔ 6 - Kraków,	Poland	17 - 19.06.1999
➔ 7 - Gdynia,	Poland	15 - 17.06.2000
➔ 8 - Zakopane,	Poland	21 - 23.06.2001
➔ 9 - Wrocław,	Poland	20 - 22.06.2002
➔ 10- Łódź,	Poland	26 - 28.06.2003
➔ 11- Szczecin,	Poland	24 - 26.06.2004
➔ 12- Kraków,	Poland	22 - 25.06.2005
➔ 13- Gdynia,	Poland	22 - 24.06.2006
➔ 14- Ciechocinek	Poland	21 - 23.06.2007
➔ 15- Poznań	Poland	19 - 21.06.2008
➔ 16- Łódź	Poland	25 - 27.06.2009
➔ 17- Wrocław	Poland	24 - 27.06.2010
➔ 18- Gliwice	Poland	16 - 18.06.2011
➔ 19- Łódź	Poland	25 - 27.06.2012
➔ 20- Gdynia	Poland	20 - 22.06.2013



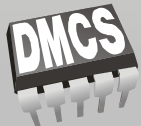
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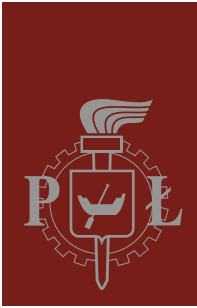
mali: secretary@dmcs.p.lodz.pl <http://www.dmcs.pl>



AWARDS FOR DMCS



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INFRASTRUKTURA I ŚRODOWISKO
NARODOWA STRATEGIA SPÓJNOŚCI

UNIA EUROPEJSKA
EUROPEJSKI FUNDUSZ
ROZWOJU REGIONALNEGO



Computer Science Technology Centre at the Technical University of Lodz



The project is co-financed with the funds of the European Regional Development Fund in the frame of the Infrastructure and Environment Programme, Action 13.1 Infrastructure of Higher Education



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XFEL & FLASH

Collaboration with DESY

(Deutsches Elektronen-Synchrotron)

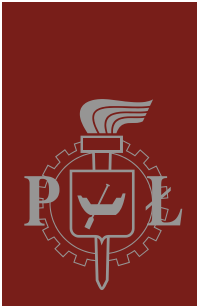
1. Dr inż. Wojciech Cichalewski
2. Mgr inż. Katarzyna Gnidzińska
3. Dr inż. Mariusz Grecki
4. Dr inż. Grzegorz Jabłoński
5. Dr inż. Wojciech Jałmużna
6. Dr inż. Marek Kamiński
7. Mgr inż. Łukasz Kotynia
8. Mgr inż. Tomasz Kozak
9. Dr inż. Dariusz Makowski
10. Mgr inż. Aleksander Mielczarek
11. Mgr inż. Piotr Mazur
12. **Prof. dr hab. inż. Andrzej Napieralski**
13. Dr inż. Mariusz Orlikowski
14. Mgr inż. Piotr Perek
15. Dr inż. Adam Piotrowski
16. Dr inż. Tomasz Poźniak
17. Mgr inż. Paweł Prędko
18. Dr inż. Konrad Przygoda
19. Dr inż. Bartosz Sakowicz
20. Mgr inż. Jan Wychowaniak



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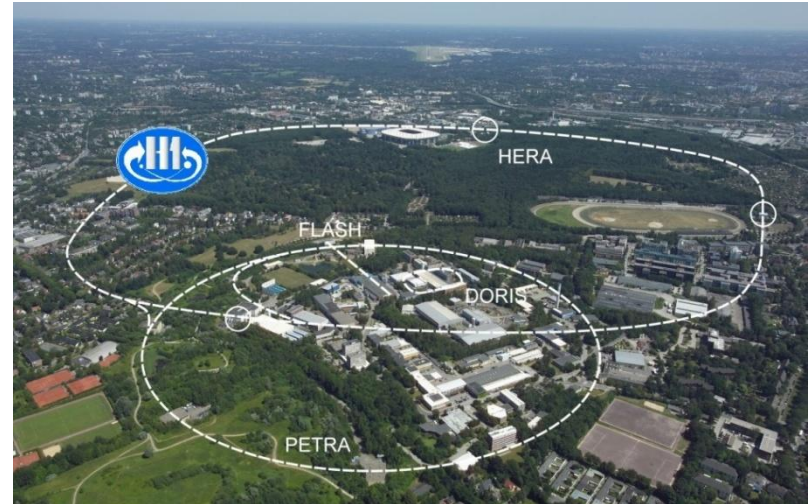
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DEUTSCHES ELEKTRONEN-SYNCHROTRON

- ⇒ A research centre of the Helmholtz Association
- ⇒ Established in Hamburg on 18 December 1959
- ⇒ Budget: 183 million euros
- ⇒ Employees: approximately 1900, including 600 scientists, who work in the fields of accelerator operation, research and development
- ⇒ Guest scientists: more than 3000 from 45 countries each year
- ⇒ Young scientists: more than 700 diploma students, doctoral candidates and postdocs



Source: http://hasylab.desy.de/images/content/e101/e57509/index_eng.html

- ⇒ Accelerators: DESY develops, builds and operates large facilities that accelerate particles to extremely high energies
- ⇒ Photon science: physicists, chemists, geologists, biologists, medical researchers and materials scientists use the special light from DESY's accelerators to observe structures and processes in the microcosm
- ⇒ Particle physics: scientists from around the world use DESY's accelerators to investigate the fundamental building blocks and forces of the universe



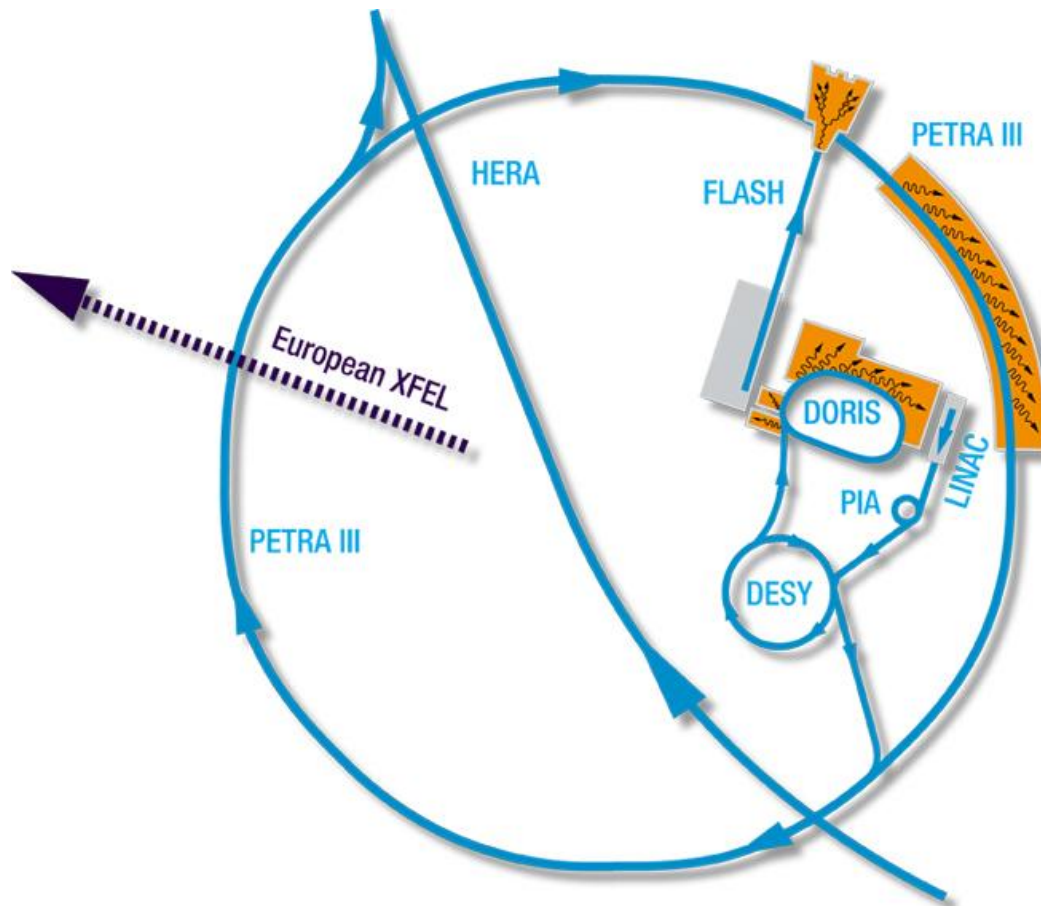
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ACCELERATORS AT DESY



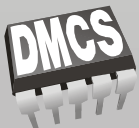
Source: http://www.desy.de/research/research_areas/accelerators/overview_accelerators/index_eng.html

European XFEL

- Budget: 960 million euros
- European project with strong DESY participation
- Free-electron laser with superconducting linear accelerator
- Length: approx. 3.4 km
- Under construction, commissioning starts in 2014
- X-ray laser for photon science

FLASH

- Free-electron laser with superconducting linear accelerator
- Length: 260 m
- 1992-2005: test facility for accelerator and FEL technology
- Since 2005: soft X-ray laser for photon science



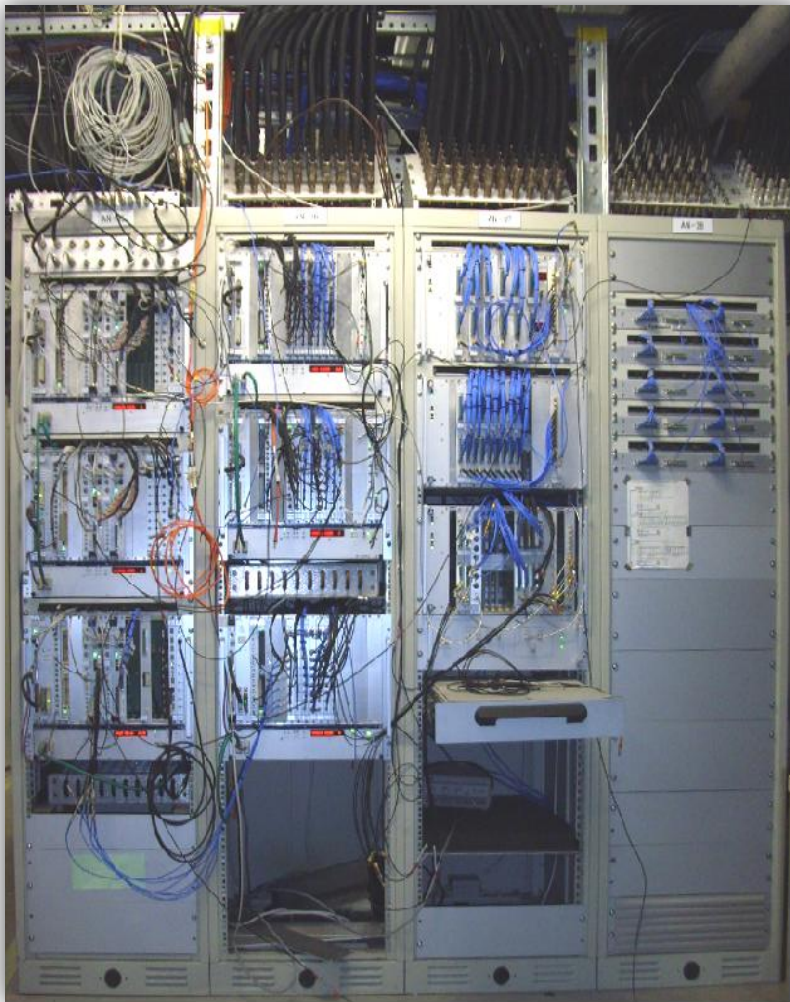
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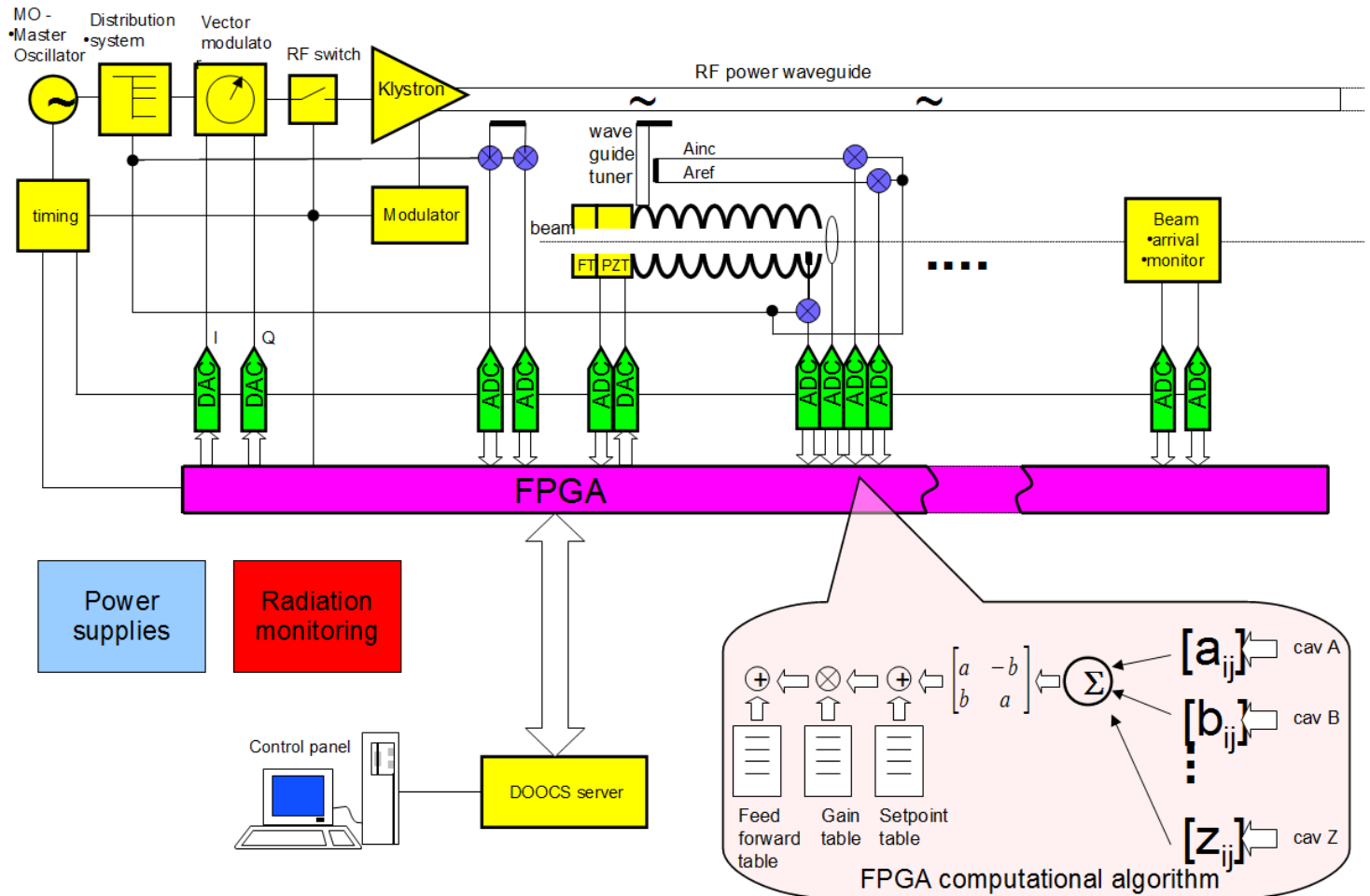
uTCA vs VME



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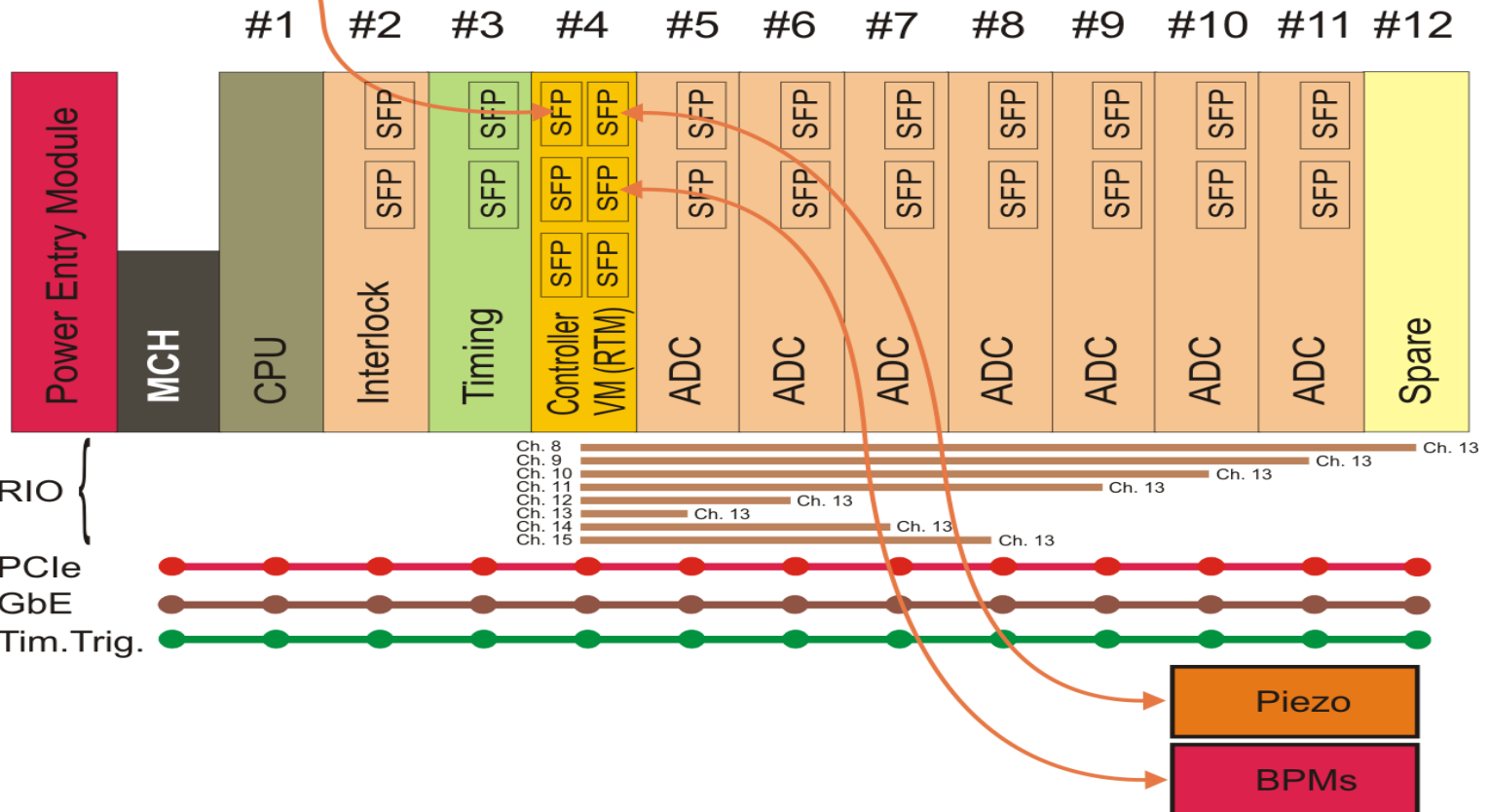
LLRF SYSTEM





uTCA-BASED LLRF SYSTEM

SLAVE





REQUIREMENTS FOR uTC

⇒ Goal:

- ⇒ Design hardware required for LLRF controller and Fast Beam-based Feedback Processor

⇒ Specification:

- ⇒ Provides **computation power for LLRF controller or Fast Beam-Based Feedback Processor algorithms (FPGA, DSP)**
- ⇒ Provides interface to VM available on uRTM, module management

⇒ Required interfaces:

- ⇒ PCIE - configuration of main parameters of the Computation Module
- ⇒ LLL - transmission of data from DAQ modules and to Vector Modulator
- ⇒ Optical connection for communication with other LLRF subsystems (master-slave system, LFD compensation, BAMs, etc...)
- ⇒ GbE - communication with drift calibration system (optional)
- ⇒ Trigger and interlock signals provided on backplane
- ⇒ Designed as Double-Height AMC module according to PICMG MTCA.4 specification
- ⇒ Module Management Controller with firmware upgrade and uRTM support.



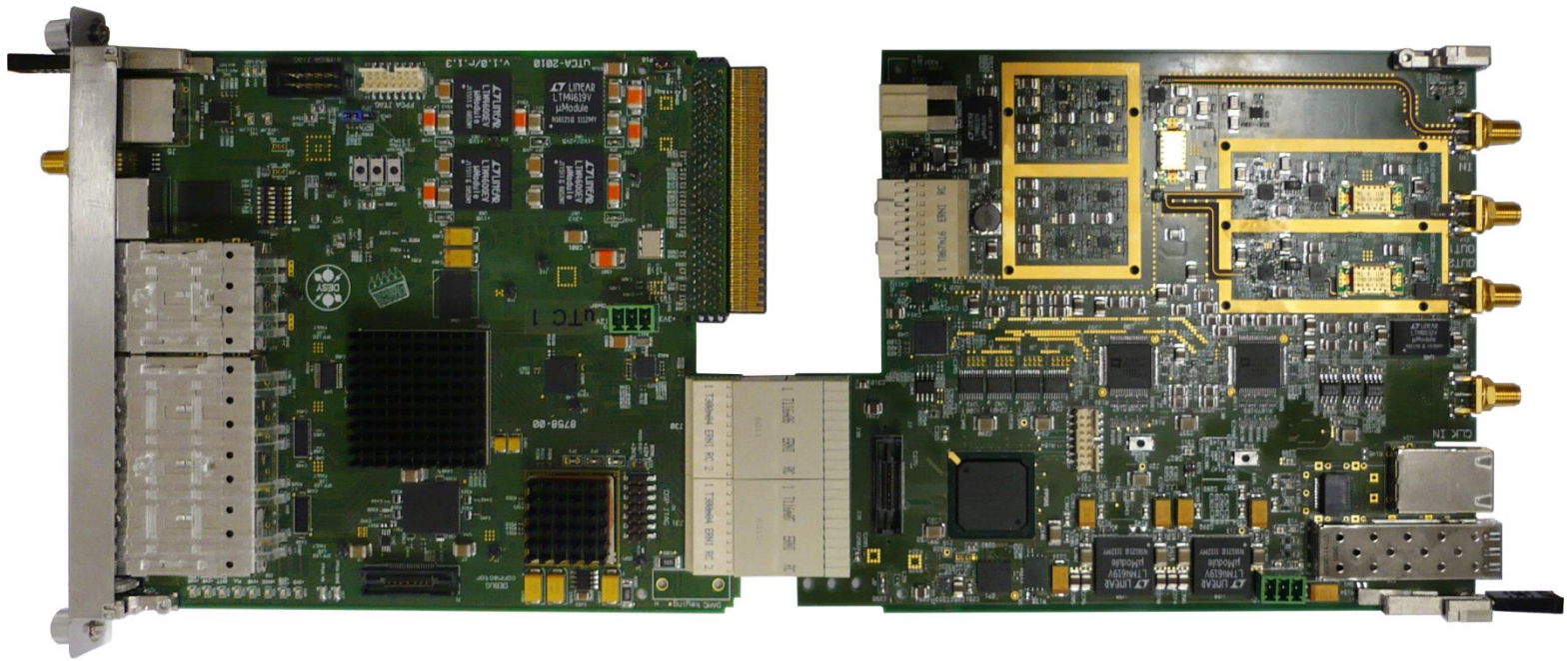
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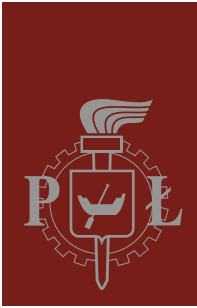
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SUPPORTED BOARDS



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16-CH PIEZO CONTROL MODULE

- ⇒ **Goal:**
 - ⇒ Lorentz force detuning compensation below 10 Hz (during flattop)
 - ⇒ Cavity mechanical vibrations sensing and dumping possibilities
- ⇒ **Specification:**
 - ⇒ Supervise 16 cavities (two accelerating modules) equipped with double stack piezo tuners
- ⇒ Processing power for driving piezo actuators and collecting data from piezo sensors
- ⇒ DACs/ADCs sampling frequencies: 100 times max. system frequency 200-300 Hz
- ⇒ Suitable for RF field repetition rates max. 25 Hz
 - ⇒ Remote switching between piezo actuator/sensor
 - ⇒ Piezo power supply: ± 85 VDC (bipolar)
 - ⇒ Bipolar control mode of piezo actuators
 - ⇒ Monitoring of power amplifiers output voltages, currents, temperature
 - ⇒ Serial link connection to mTCA-based LLRF controller



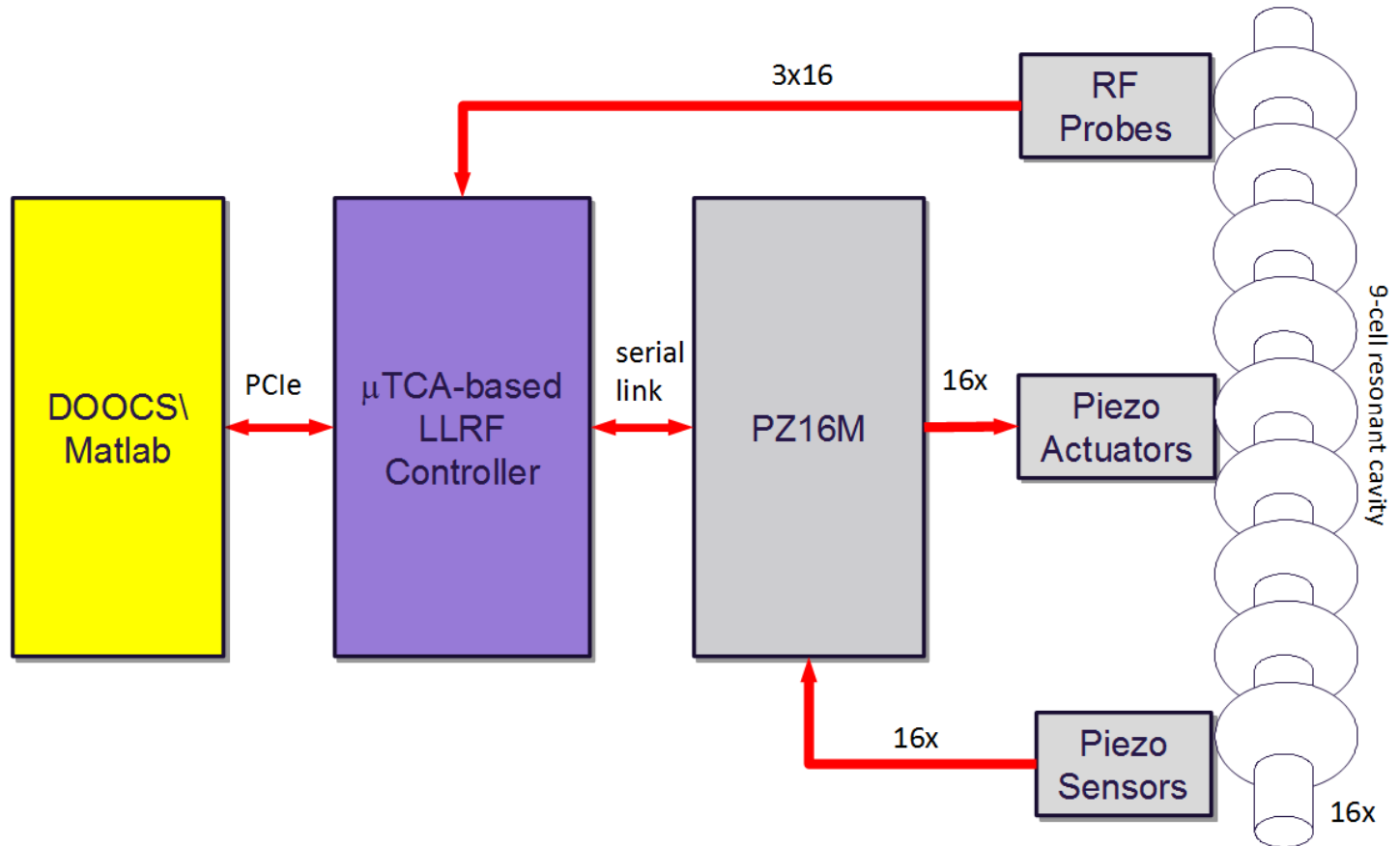
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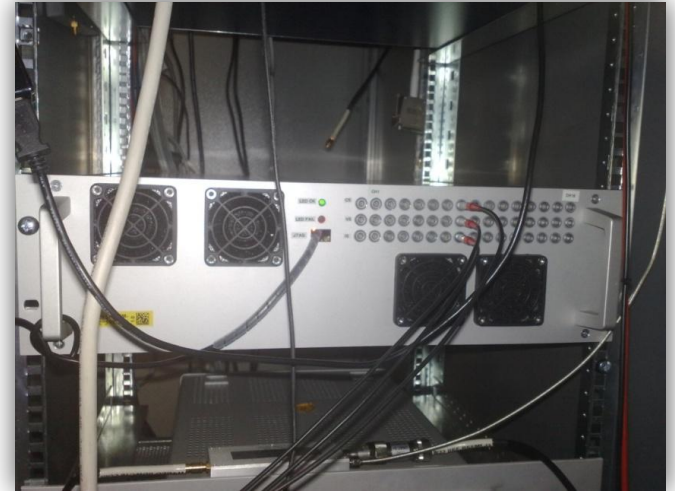
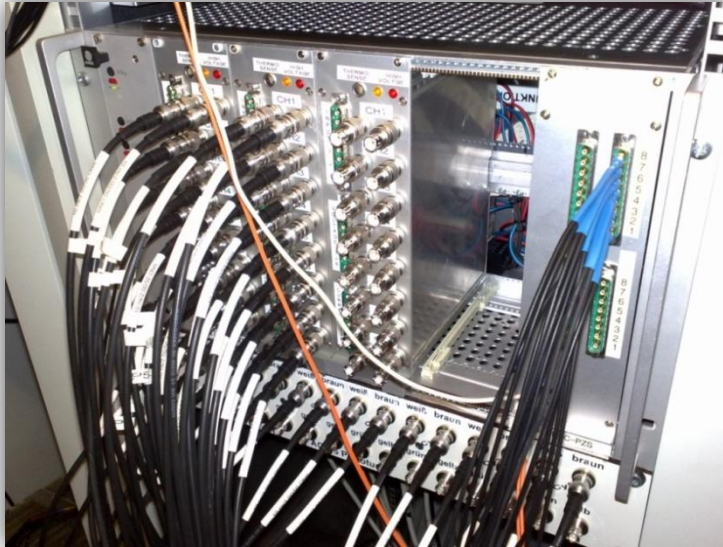


LAYOUT OF PIEZO CONTROL SYSTEM

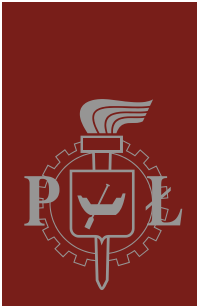




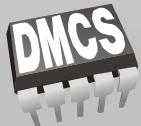
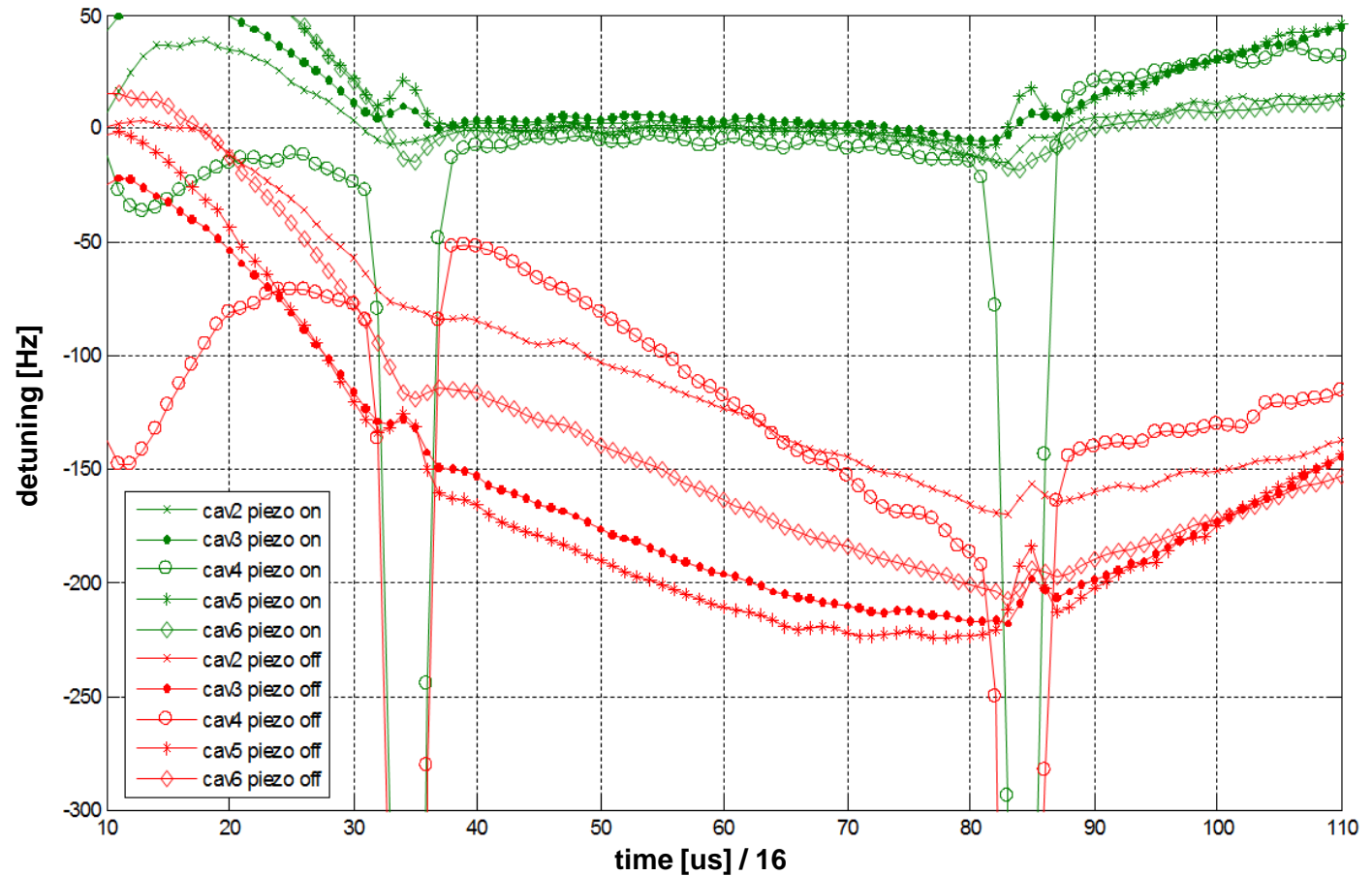
PIEZO COMPENSATION SYSTEM



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LFD COMPENSATION AT CMTB





SOFTWARE FOR LLRF SYSTEM

- ➔ Low Level Applications
- ➔ High Level Applications for LLRF control system and various accelerator subsystems
 - ➔ Main LLRF Server
 - ➔ Diagnostics:
 - ➔ online diagnostics of superconducting cavity parameters,
 - ➔ diagnostics of control loop performance,
 - ➔ diagnostics of other subsystems performance (timing, high power subsystem),
 - ➔ Slow control algorithms:
 - ➔ high power amplifier linearization applications,
 - ➔ automatic cavities loaded quality factor control,
 - ➔ automatic cavities detuning control – step motors and piezo actuators cooperation



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SOFTWARE FOR LLRF SYSTEM

- ➔ Complementary software solutions for LLRF system related tests of superconducting cavities modules for XFEL project (tests at Accelerator Module Test Facility (AMTF) @ DESY)
- ➔ LLRF system preparation and configuration for first worldwide study concerning Continuous Wave (CW) operation mode in superconducting FEL experiments for future free electron laser projects and possible upgrade of European X-FEL



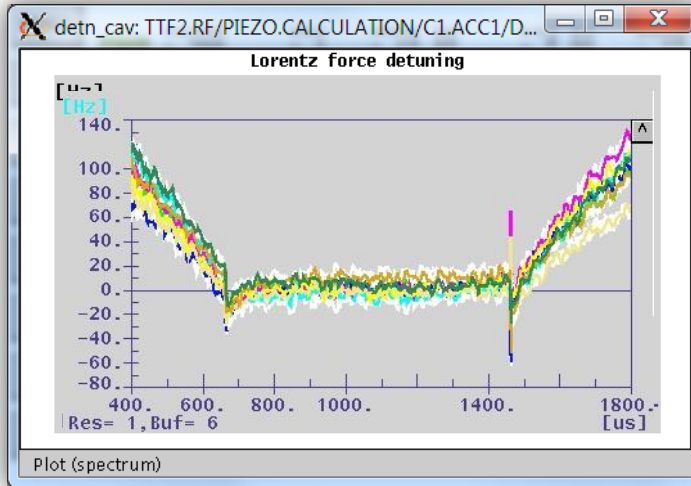
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USER PANELS

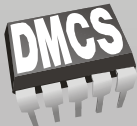


	Current	New	Proposed (not scaled by gain)
DAC I OFF.	-862	-862.28	3.9 [counts]
DAC Q OFF.	1135	1135.4	-1.7 [counts]

Tables parameters	Correction parameters
Amplitude limit +50000 [counts]	Gain +0.10 [a.u.]
Points quantity +16	Threshold +50 [counts]
Length +320 [us]	Max step +500 [counts]
Delay +1700 [us]	Max. offset threshold +3000 [counts]

On/Off	Detn / Sensor	Gain	No. Pulses	Delay [us]	Ampl [V]	DCIV	Control	Calc
✓	DetnC1 / Pzsc1	gav1 +200	+1	+17.30	+6.00	-28.00	Pzdc1	Pzcc1
✓	DetnC2 / Pzsc2	gav2 +200	+1	+17.37	+7.00	-17.00	Pzdc2	Pzcc2
✓	DetnC3 / Pzsc3	gav3 +200	+1	+17.34	+12.00	-41.00	Pzdc3	Pzcc3
✓	DetnC4 / Pzsc4	gav4 +200	+1	+17.34	+10.00	-30.00	Pzdc4	Pzcc4
✓	DetnC5 / Pzsc5	gav5 +200	+1	+17.50	+8.00	-7.00	Pzdc5	Pzcc5
✓	DetnC6 / Pzsc6	gav6 +200	+1	+17.50	+8.00	-12.00	Pzdc6	Pzcc6
✓	DetnC7 / Pzsc7	gav7 +200	+1	+17.53	+8.00	-6.00	Pzdc7	Pzcc7
✓	DetnC8 / Pzsc8	gav8 +200	+1	+17.49	+10.42	-0.08	Pzdc8	Pzcc8

Parameter	Value	Status
Avg Grad(f-top) [Mv/n]	163.88	Level ok
Average Phase [deg]	3.9832	Level ok
Average Gradient Level (Flat-top) [Mv/n]	19.91, 20.40, 20.30, 20.58, 19.46, 19.75, 19.71, 20.17	Level ok
Gradient max level status		Level ok
Amplitude RMS error status		Level ok
Amplitude pulse to pulse stability status		Level ok
Phase RMS error status		Level ok
Phase pulse to pulse stability status		Level ok
Cavity Loaded Q	9.229, 9.262, 9.127, 9.203, 9.229, 9.310, 9.161, 9.155	Level ok
Cavity Loaded Q status		Level ok
Cavity Detuning	95.85, 104.5, 124.7, 107.8, 76.41, 92.12, 93.28, 14.67	Level ok
Cavity Detuning Status		Level ok



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uTCA-BASED TESTSTANDS

- ⇒ **ACC1**
- ⇒ **CMTB** (The Cryo Module Test Bench)
- ⇒ **CMTB - CW**
- ⇒ **AMTF** (Accelerator Module Test Facility)
- ⇒ **REGAE** (Relativistic Electron Gun for Atomic Exploration)
- ⇒ **TDS** (Transverse Deflecting Structures)
- ⇒ **EBPM** (Energy Beam Position Monitor)



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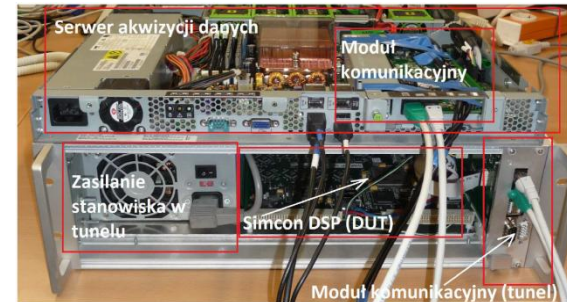
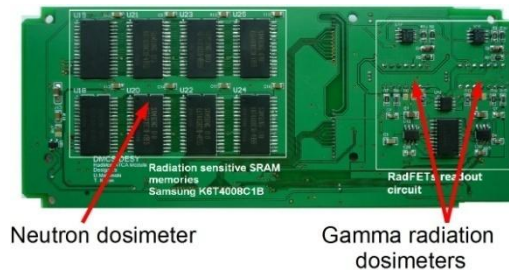
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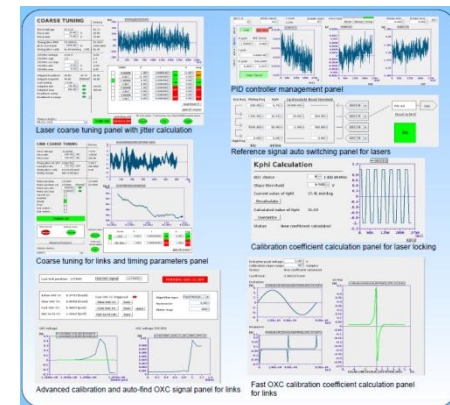
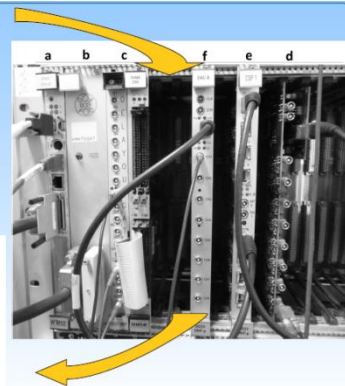
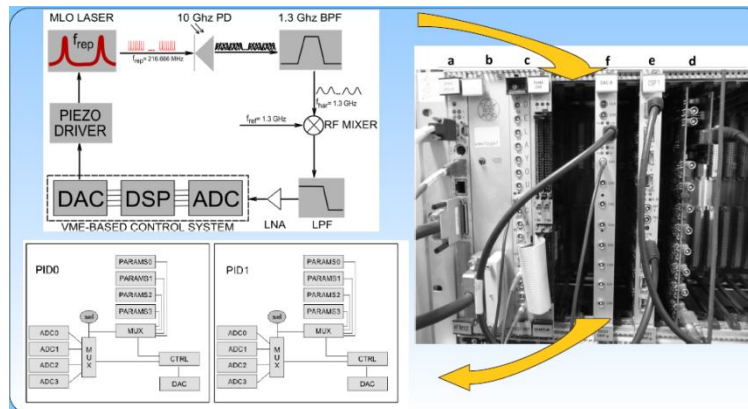


ADDITIONAL AREAS OF INTEREST

➔ Radiation influence on microelectronic

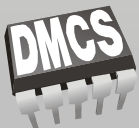


➔ Hardware and software for optical synchronization



➔ Software engineering for HEP application

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THANK YOU FOR YOUR ATTENTION

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