LLRF-ATCA
LOW LEVEL APPLICATIONS

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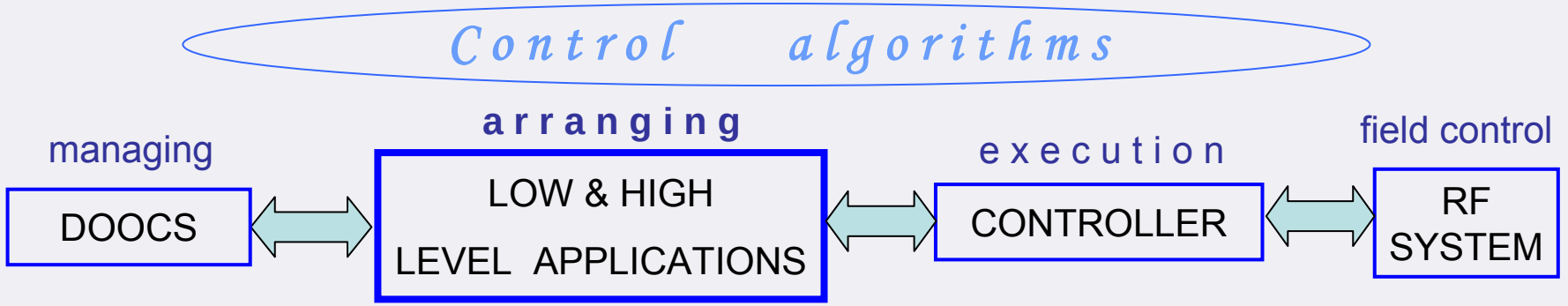
AGENDA

1. Introduction
2. Requirements
3. Concept and design
4. Algorithms
5. ATCA architecture
6. Applications
7. Interfaces
8. Experimental results
9. Development proposal
10. Conclusions

Low Level Applications introduction

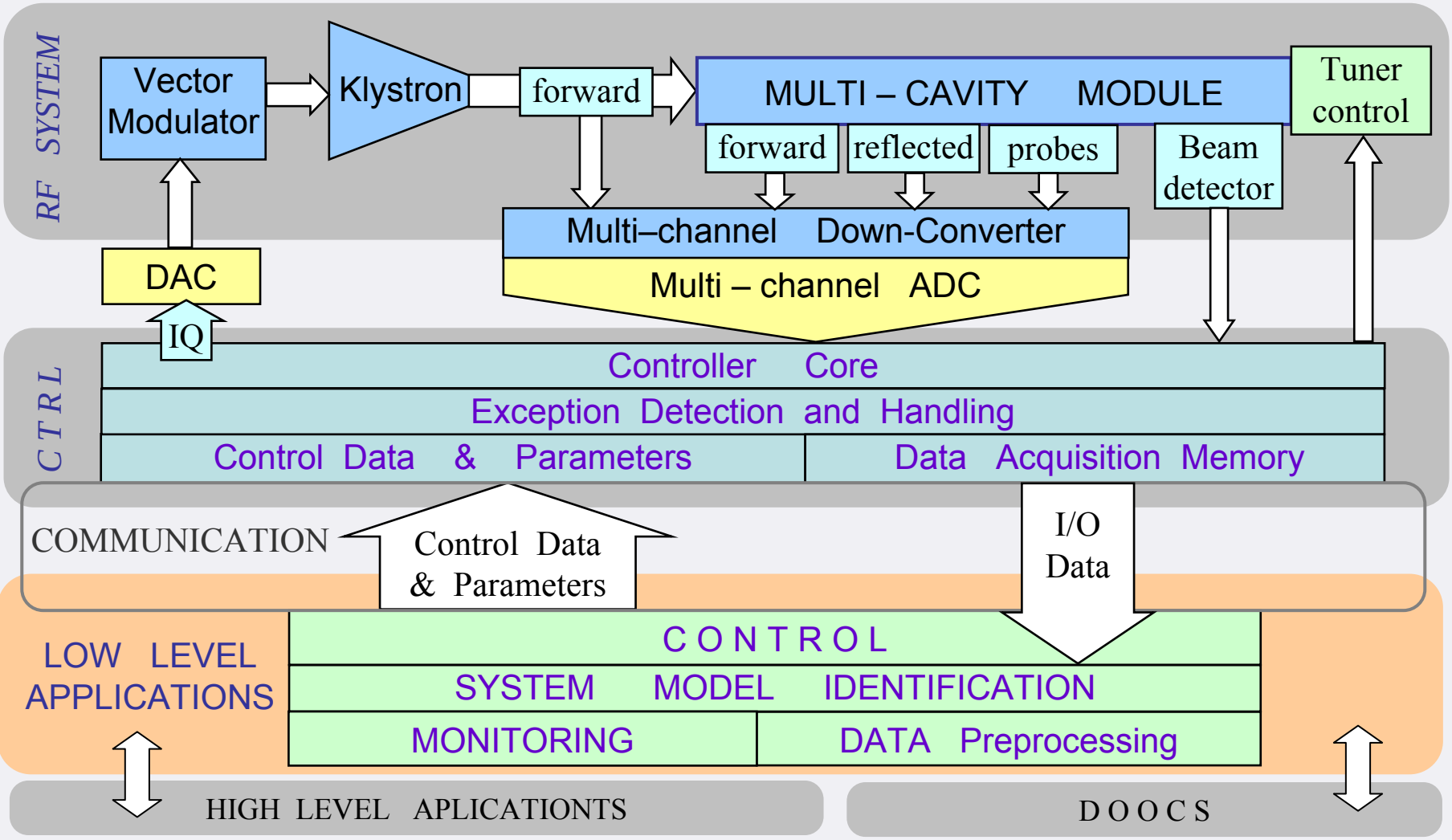
The part of Software adjacent to the Controller responsible for the arrangement of the control algorithms



TASKS:

- **Implementation of the procedures and data processing to provide Control Data and parameters for the Controller**
- **Monitoring and Exception Handling for safety requirements**

Outline of the LLRF control structure



Requirements

Functional modes

Control - provides Control Data between pulses
Simulation – for testing
VM offset compensation – on request
Vector Sum calibration – always for new operation condition

Performance

Control Data meet requirements for cavity field control:
filling: energy efficiency = stored/expanded energy
optimal target ~74% for 0.5 ms filling
flattop: field stability : 10^{-5} in amplitude, 0.01° in phase

Reliability

robust algorithms

Usability

user friendly, context DOOCS GUI, on/off button operability

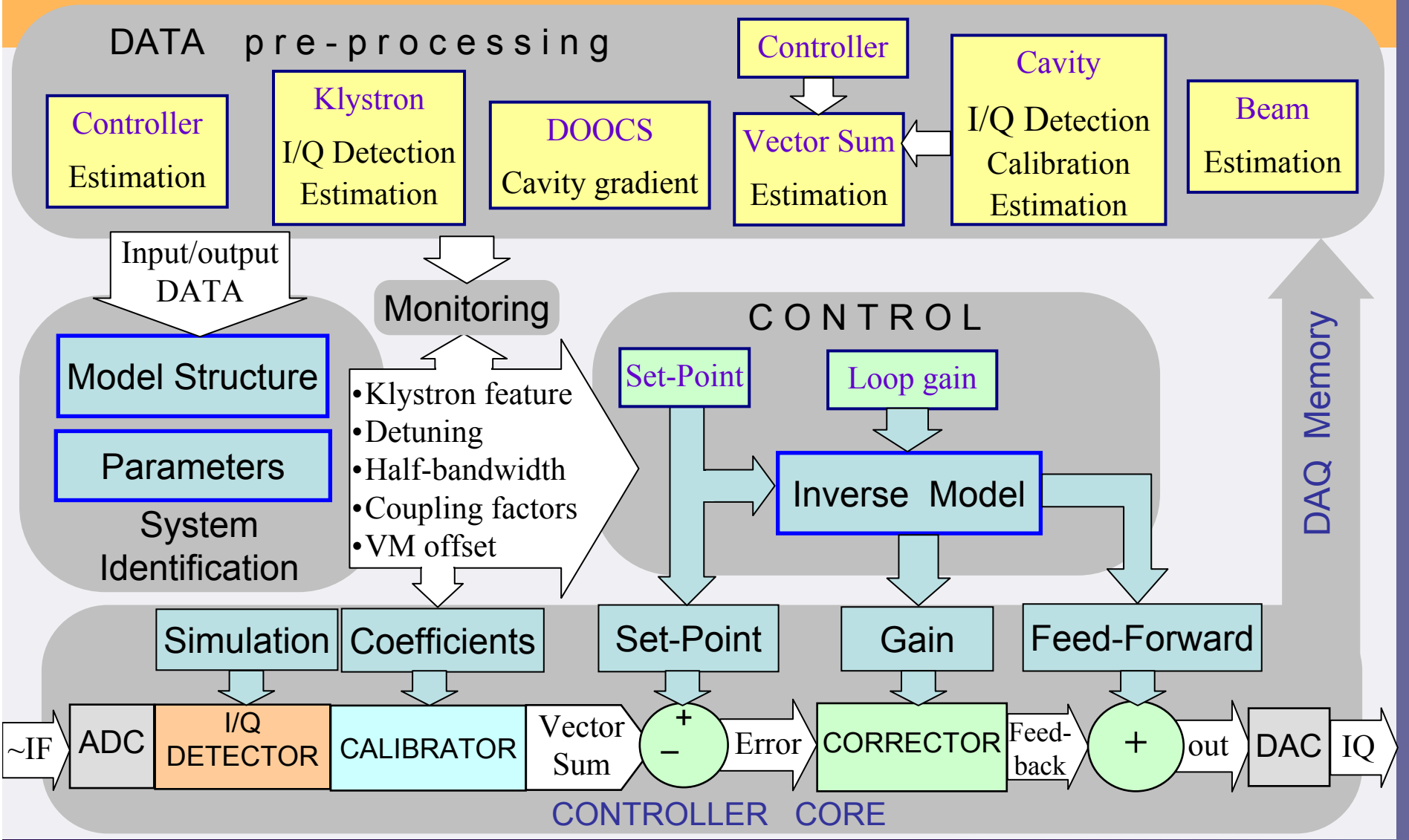
Interface

input/outputs to Controller, High Level Applications and DOOCS

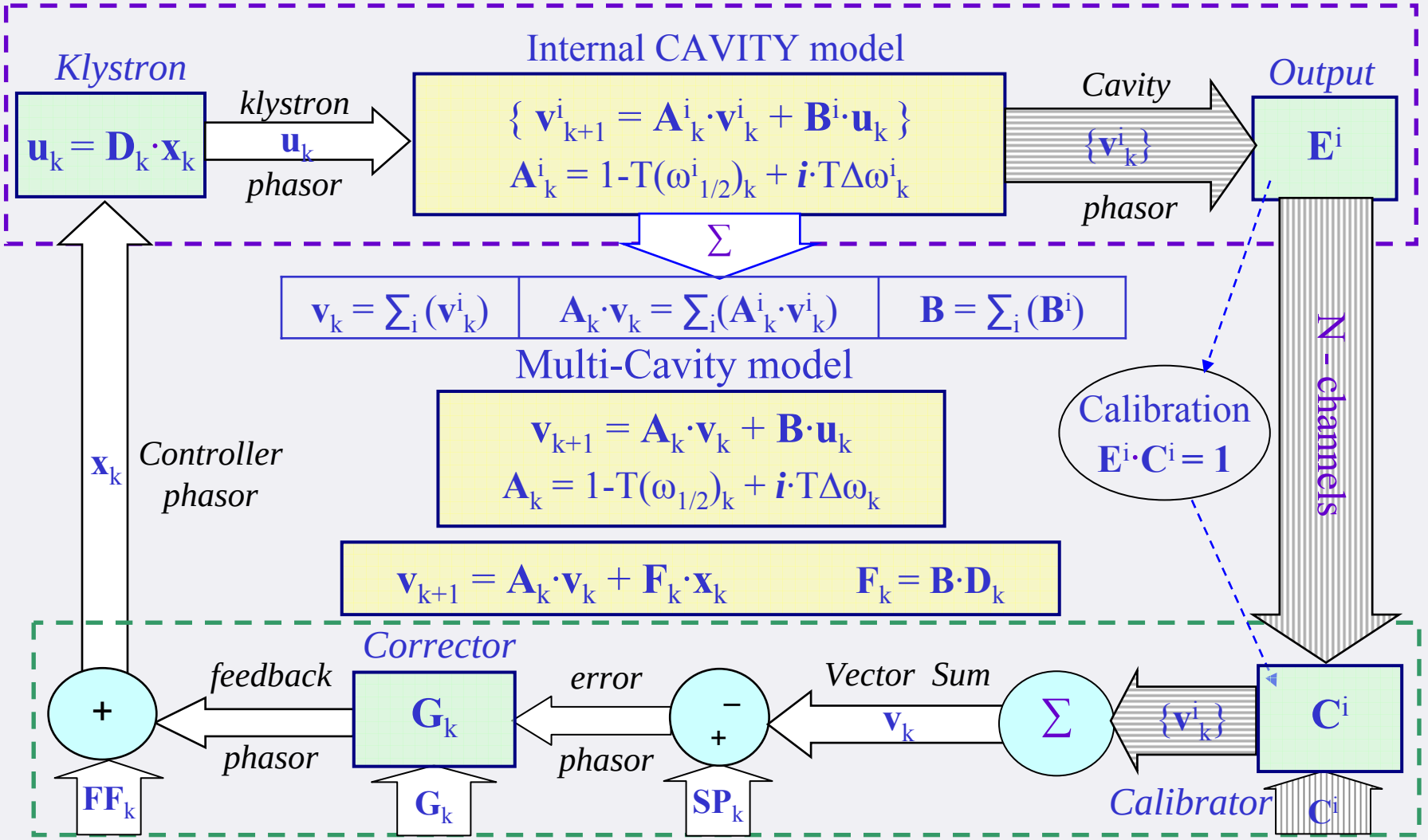
Safety

monitoring: gradient, klystron power, quench detection
exception handling: controller off, beam off

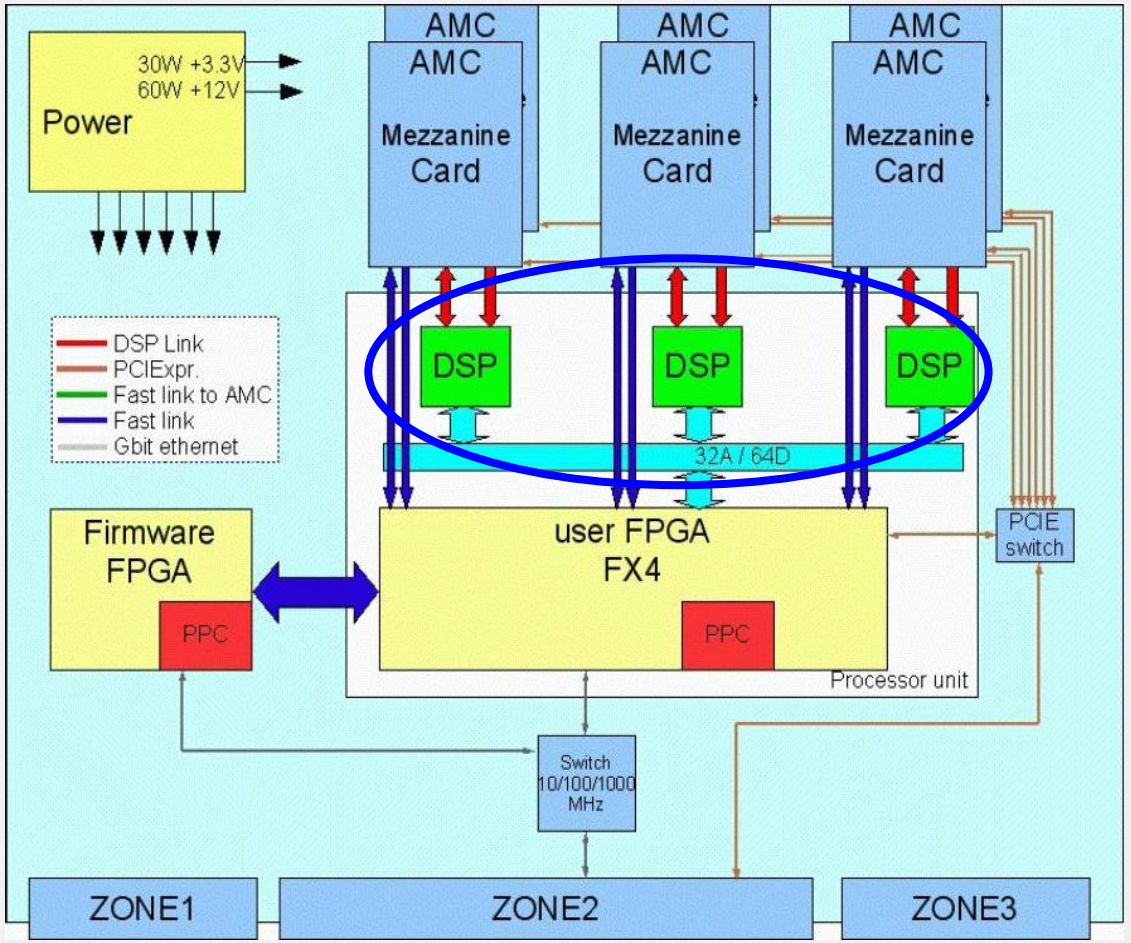
The LLA Concept & Design

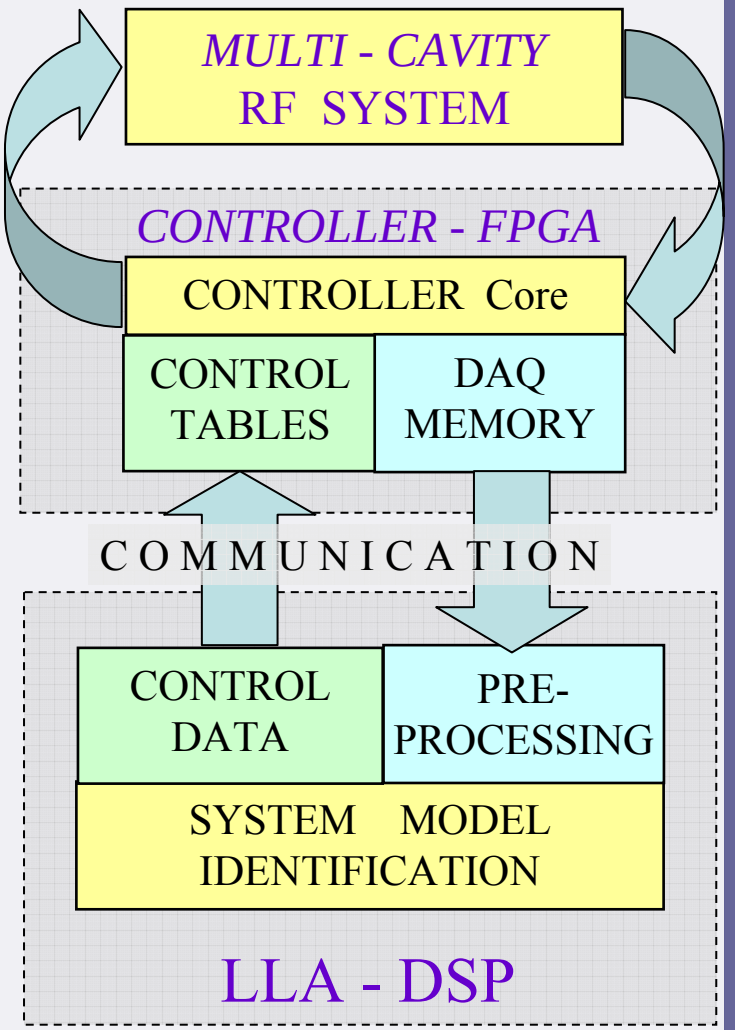


System Model for Identification Algorithm



ATCA based implementation of LLA

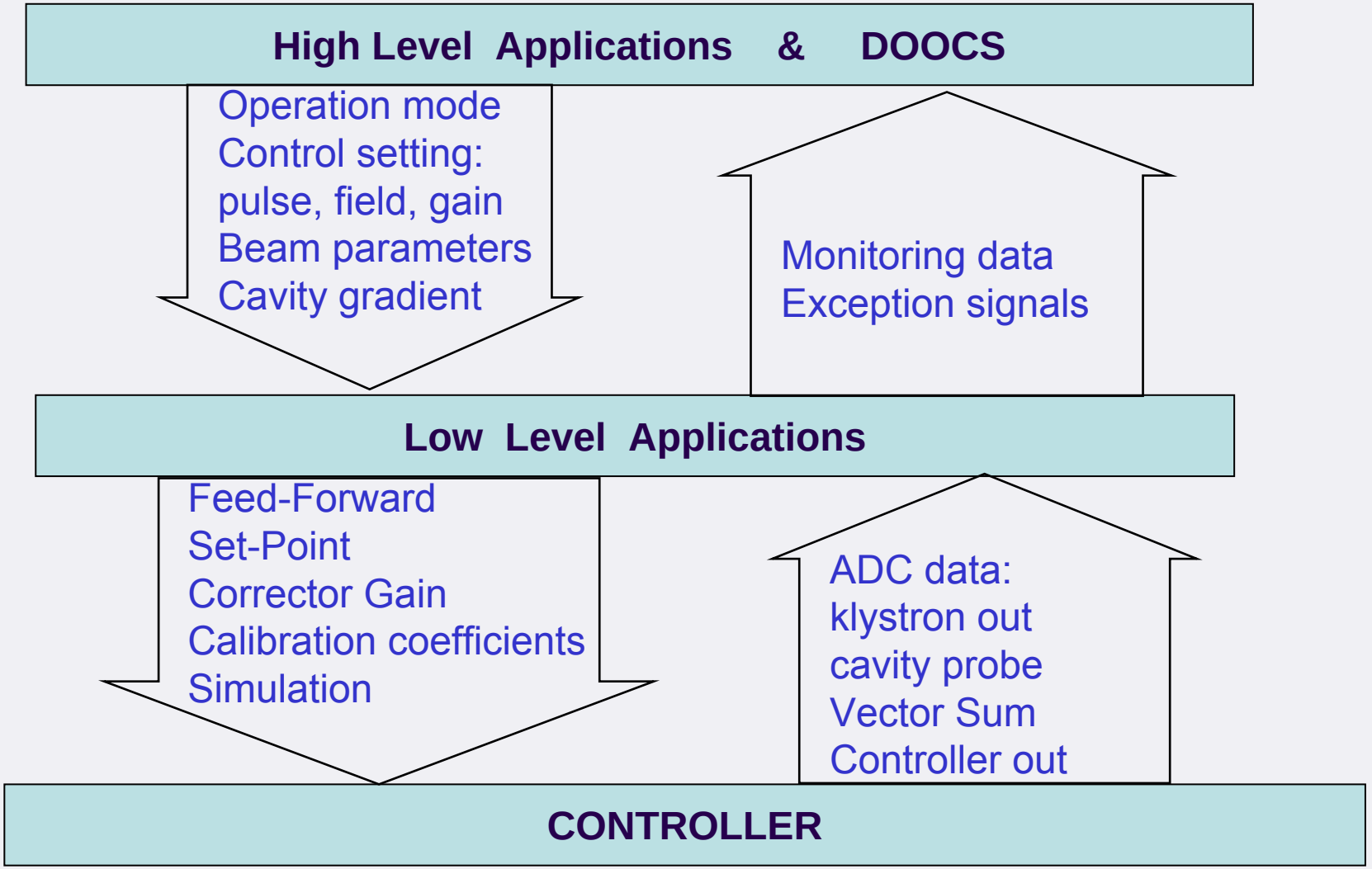




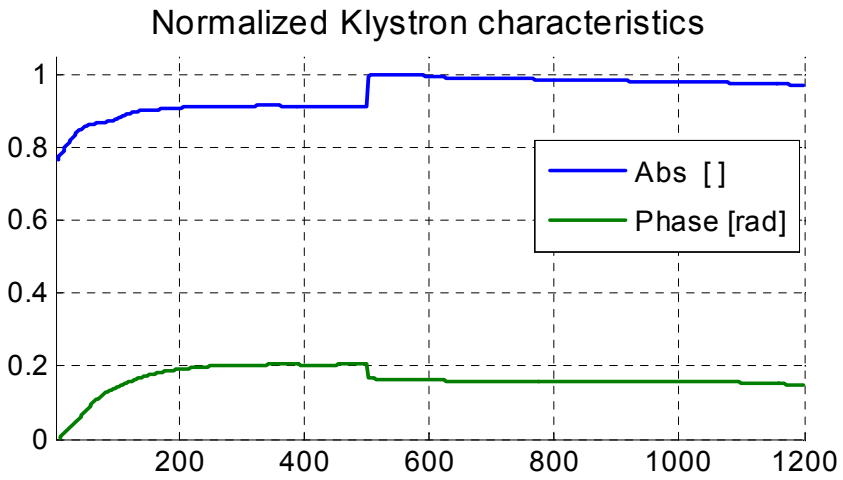
Set of Low Level Applications

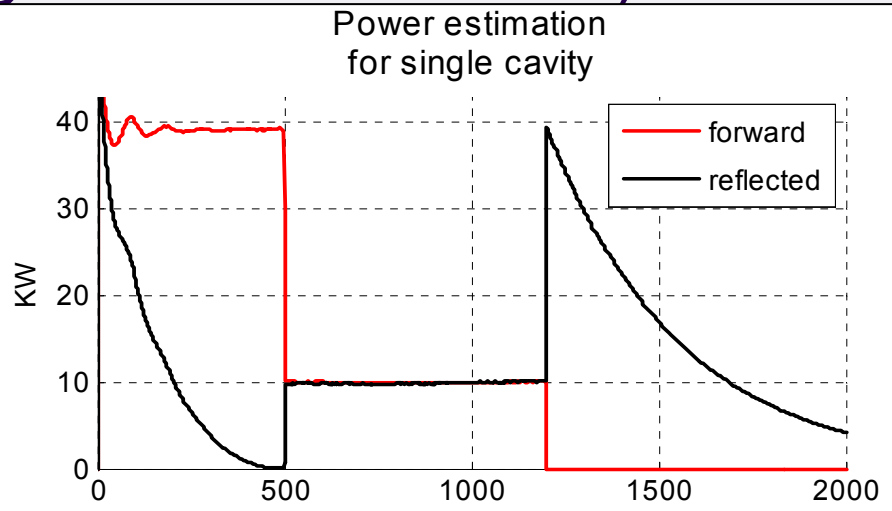
SYSTEM IDENTIFICATION	CONTROL	MONITORING
VM offset Klystron characteristics Coupling factor Cavity detuning Half-bandwidth System complex gain Calibration coefficients Beam parameters	Set-Point Feed-Forward Corrector Gain	Field gradient Klystron power Loaded Q Detuning
EXCEPTION HANDLING: controller off, beam off		

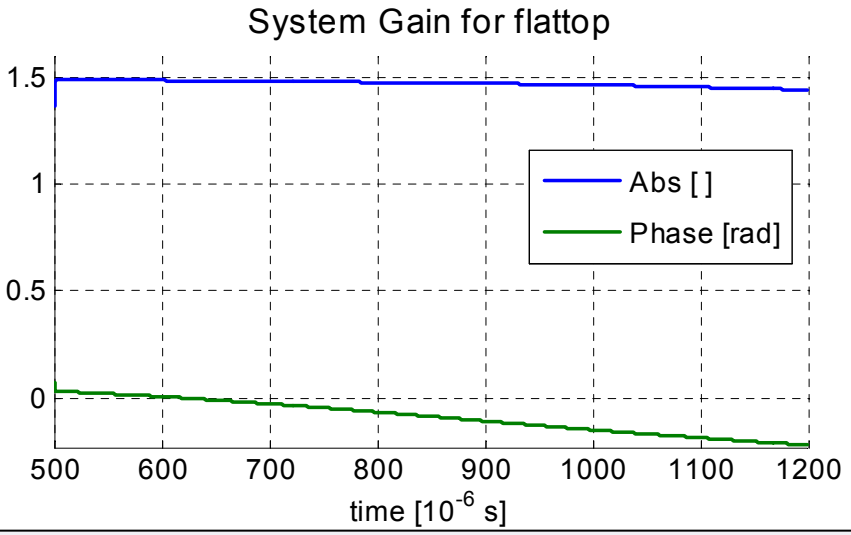
Interfaces

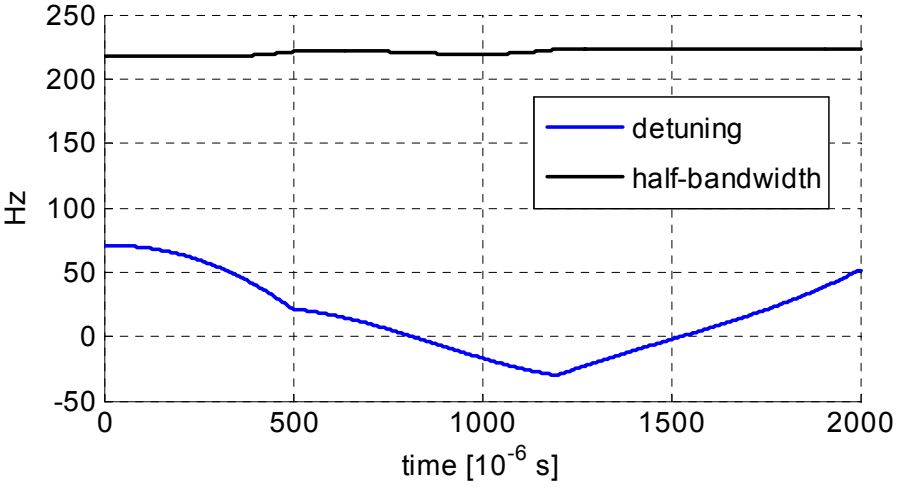

High Level Applications & DOOCS
Operation mode
Control setting:
pulse, field, gain
Beam parameters
Cavity gradient
Monitoring data
Exception signals
Low Level Applications
Feed-Forward
Set-Point
Corrector Gain
Calibration coefficients
Simulation
ADC data:
klystron out
cavity probe
Vector Sum
Controller out
CONTROLLER

System Identification - Experimental results ACC1 – cavity 4 (gradient ~11 MV/m)

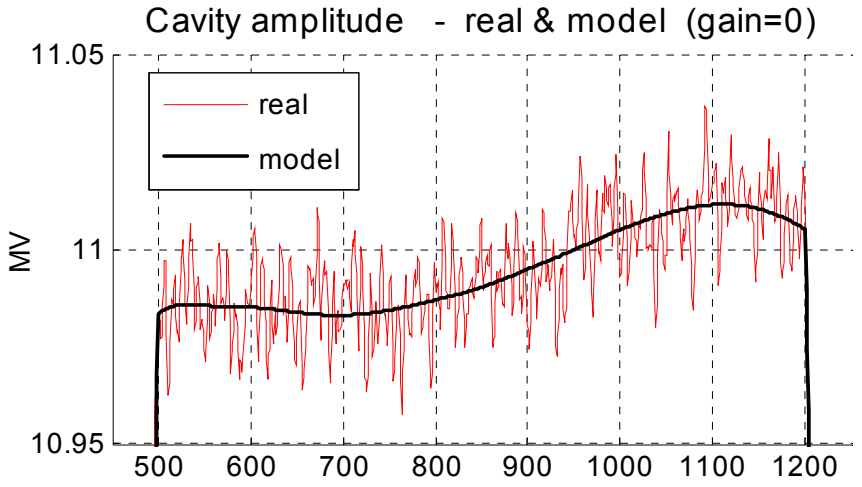


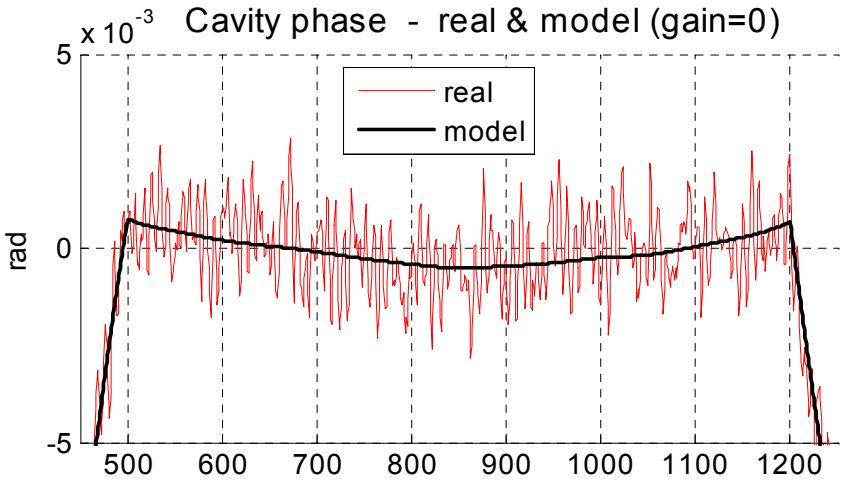


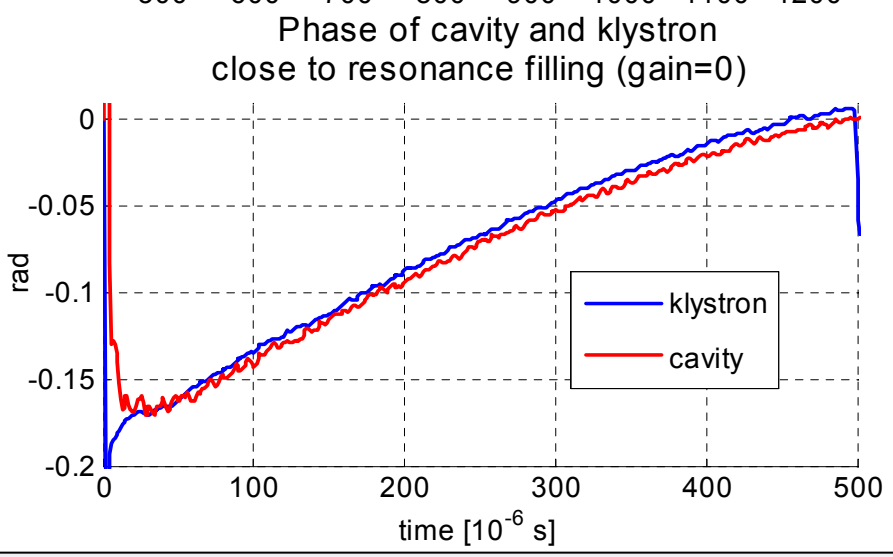


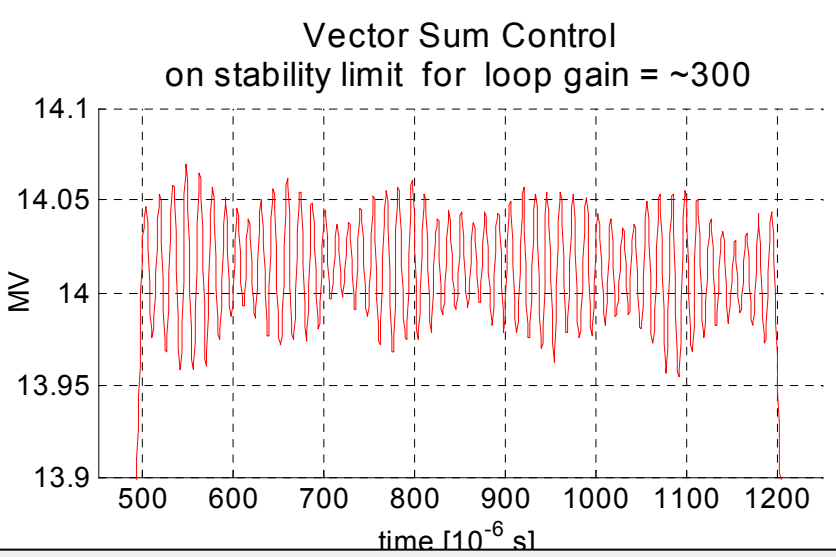


System Identification - ACC1 Model verification









Development activity proposal

Development team

- ISE Employees
  - Tomasz Czarski, MSc
  - Maciej Linczuk, PhD
  - Wojciech Zabolotny, PhD
  - Krzysztof Pozniak, PhD
- IPJ Employees
  - Jaroslaw Szewinski, MSc
- DESY Employees/ISE PhD stud.
  - Waldemar Koprek, MSc
  - Piotr Pucyk, MSc
- DMCS PhD Student
  - Wojciech Jałmużna, MSc

Tasks realization

- Low Level Applications
  - Data pre-processing
  - System Model Identification
  - Control Data & Parameters
  - Monitoring
- Integration with „Communication”
- LLA Simulation and integration with controller firmware simulation

Schedule for 2008-2009

(tightly integrated with controller design)

- Development of the existing algorithm - 12 m.
- Tests in simulation - 15 m. (in the background)
- Operability development – 6 m.
- DOOCS server integration – 6 m.
- DSP implementation – 12 m.

CONCLUSIONS

1. **The Low Level Applications algorithms has been verified experimentally for feed-forward and feedback modes**

2. **ATCA carrier board with AMC modules is scaleable and flexible platform for implementation of the control algorithms with possible upgrade of future development**

3. **The Low Level Applications strongly influence the architecture of the Controller and Communication structure and shares the same hardware platform**

4. **The integrated design – packages Controller and LLA, managing by the unified team, without any division, is the only reasonable solution for the LLRF – XFEL development**