High Level Applications

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High Level Application - AGENDA

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2. FLASH/XFEL - High level applications background.
3. HLA list.
4. HLA structure and implementation.
5. Possible HW platform.
6. HLA Schedule.
7. Summary.

HLA XFEL Requirements.

Main requirements:

- Provide customized control algorithms of RF system components which demands high computation power.
- Provide customize diagnostic algorithms of RF systems components which demands high computation power.
- Established with commonly used tools and environments for instance: Matlab, C, C++.
- Suitable for development and modifications for the accelerator users (not demand expert knowledge in electronics, microwave electronics).
- Equipped with the interface to automation and the software control system (DOOCS servers).
- Supporting interface to the local control and diagnostic signals.
- Not restricted to the in-pulse reaction.
- Provide testing environment for future low level applications

FLASH/XFEL - High level applications background

The High level Applications was developed for use in the FLASH accelerator LLRF systems, MTS and Chechia LLRF control systems.

HLA in FLASH has been implemented as a Matlab environment based tools (V. Ayvazyan, W. Cichalewski, A. Brandt) or standalone processes – satellite DOOCS servers (A. Brandt).

HLA's used in FLASH operation:

Control applications:

- redundant adaptive feed forward,
- vector sum calibration,
- loop phase and gain estimation,
- high power amplifiers chain linearization (microwave preamps and klystron),

Diagnostic and system tuning applications:

- cavity field error calculation,
- local oscillator signal generation optimization (configuration for 250kHz)
- HPAC components characterization and diagnostics.

XFEL – High level applications list

Control applications:

1. redundant adaptive feed forward, *
2. vector sum calibration, *
3. loop phase and gain estimation, *
4. cavity gradient and phase SP calibration
5. High Power Amplifiers Chain (HPAC) linearization (microwave preamps and klystron),
6. momentum management,
7. driving signal offset calibration,
8. wave-guide tuner adjustment (phase, loaded Q),
9. beam phase measurement,
10. beam loading compensation,
11. modules operational limits estimation,
12. gradient and gain increase (ramping),
13. klystron HV modulator bouncer timing adjustment.
14. cavities frequency tuning, *

Diagnostic and system tuning applications:

15. cavity field error calculation,
16. cavity overloading detection (soft quench), *
17. local oscillator signal generation optimization (configuration for IF 250kHz),
18. HPAC components characterization and diagnostics,
19. forward and reflected signals crosstalk estimations and compensation,
20. HF signals attenuation level adjustment,
21. klystron HV stability diagnostic,
22. modules operational limits estimation,
23. power margin estimation.

* - can be implemented as Low Level Application in time with time

HLA structure and implementation.

The HLA will process data:
- diagnostic and control signals read-outs – single values (two's complements - up to 17 bits converted to decimal).
- diagnostic and control signals read-outs – vectors of time domain samples (size of 2048 to 8192 of Unsigned 32-bit integer in 17 bits range converted to decimal).
- status flags – bit or status vectors.

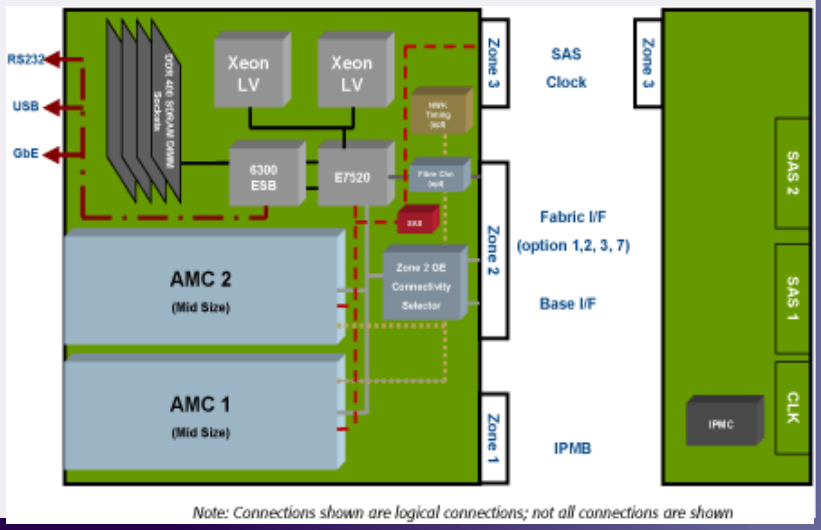
The HLA will utilise floating point processing for complex data analysis:
- optimisation algorithms,
- slow (pulse-to-pulse) adaptations,
- statistics study,
- various phenomena modelling (eg. Simulink models),
- results visualization,
- etc.

HLA – possible HW platform for implementation .

The HLA development environment:
- MATLAB,
- C/C++.
- possible Java applications.

The HLA implementation platform proposition:
for instance PROMENTUM ATCA-4300 by RadiSYS
or Adlink ATCA-6890

Solution **advantages from the HLA point of view**:
- possibility of **fast input data achievement** (local diagnostic and control signals) (by zone 3 I/O connectivity customization)
- most **processing power of Pentium-M** in a single slot. Reduces $/slot thus addressing maximum subscribers in a single slot,
- **compatible** with widely used and well known OS (Carrier Grade **Linux**, **Windows** Server, and Windows XP).
- **High Availability** (HA) solutions providing 99.999% of up time - thanks to the IPMI support (important from the maintenance point of view).



HLA Schedule

Development and evaluation:

-The HLA developed for the FLASH are applicable for the XFEL.

- the evaluation of new algorithms – FLASH, MTS, MATLAB models:
  - diagnostic applications (DA): most of HLA-DA can be tested in FLASH and MTS transparent to the regular operation
  - control applications (CA): demands dedicated test period.

Time schedule (dependent on the hardware time schedule):

- MATLAB/C implementation 70 % up to the December of 2008,
- evaluation in FLASH up to the middle of 2009

Man power:

W. Cichalewski,
V. Ayvazyan
M. Hoffman,
B. Koseda,
2 diploma students

THANK YOU

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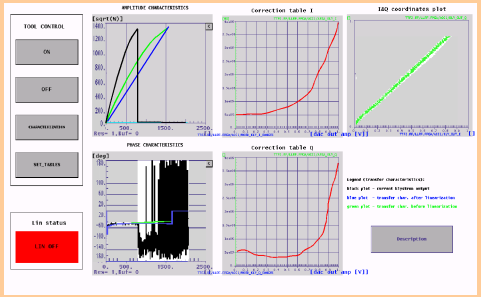
BACKUP HLA example
High Level Application – HPC linearisation

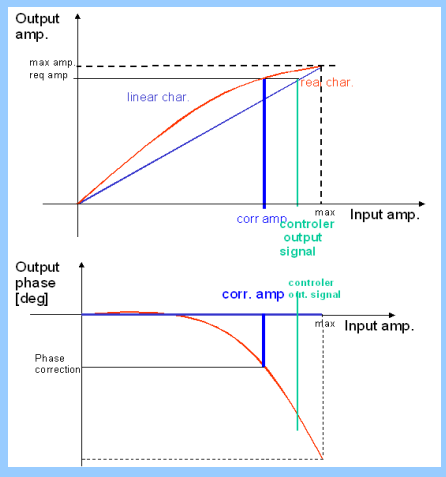
LLRF Controller DOOCS server



LLRF Controller

Control signal generation

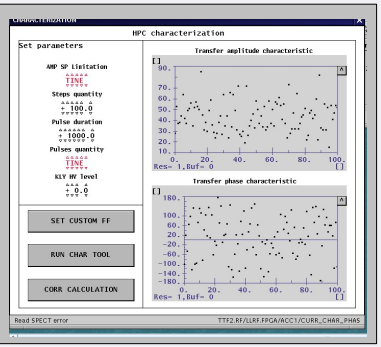
Predistorter



Nonlinear amplifier's

Matlab:

- char. acquisition,
- correction coeff. calculation.



HPC linearisation tool functionality:

- Diagnostic of High Power Chain components phase and amplitude nonlinearities,
- provides correction coefficents for HPC nonlinearities compensations,
- performs predistorter coeff. calculations for wide range of klystron HV level settings.