LLRF ATCA Platform Review

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For the review committee

Objectives for the ATCA based LLRF system

- Meet technical performance goals
  - Field regulation, cavity resonance control
  - Interfaces to other subsystems, specifically control system, machine protection and personnel safety
- Basic rf control functionality implemented
  - Operable by machine operators (not rf experts), basic automation, basic exception handling
- Build-in diagnostics
- Serves as platform for for LLRF software development for the European XFEL
- Performance demonstrated at FLASH with beam
- Project time line: January 2008 - December 2008

Project Timeline (Milestones)

- 01/08‘ Routing of most boards completed
- 02/08‘ Prototype boards ready for debugging
- 04/08‘ Setup in digital lab:
  ATCA system with carrier, ADC, vector-modulator, timing
  MO, timing, external downconverter, rf cavity simulator
  Note: System for 8 cavities
- 05/08‘ Closed loop operation in digital lab with cavity simulator
  Evaluation of signal integrity
- 06/08’ Setup at Module teststand with piezodriver
  and RTM module with downconverters
  Demonstration of vector-sum control of 8 cavities
- 08/08’ Installation at ACC1
- 09/08’ RF Control demonstration with beam
  Evaluation of performance with beam
- 11/08’ Installation at ACC4,5,6

Charge to the committee (Cnt'd)

- Determine whether the LLRF design will be able meet XFEL requirements
- Identify missing technical issues
- Suggest improvements
- Evaluate creditbility of schedule for the evaluation system
- Write report
  - Summary for crate standard review today (Dec. 3, 2007)
  - Draft report by Dec. 20., 2007
  - Final Report by January 15., 2008

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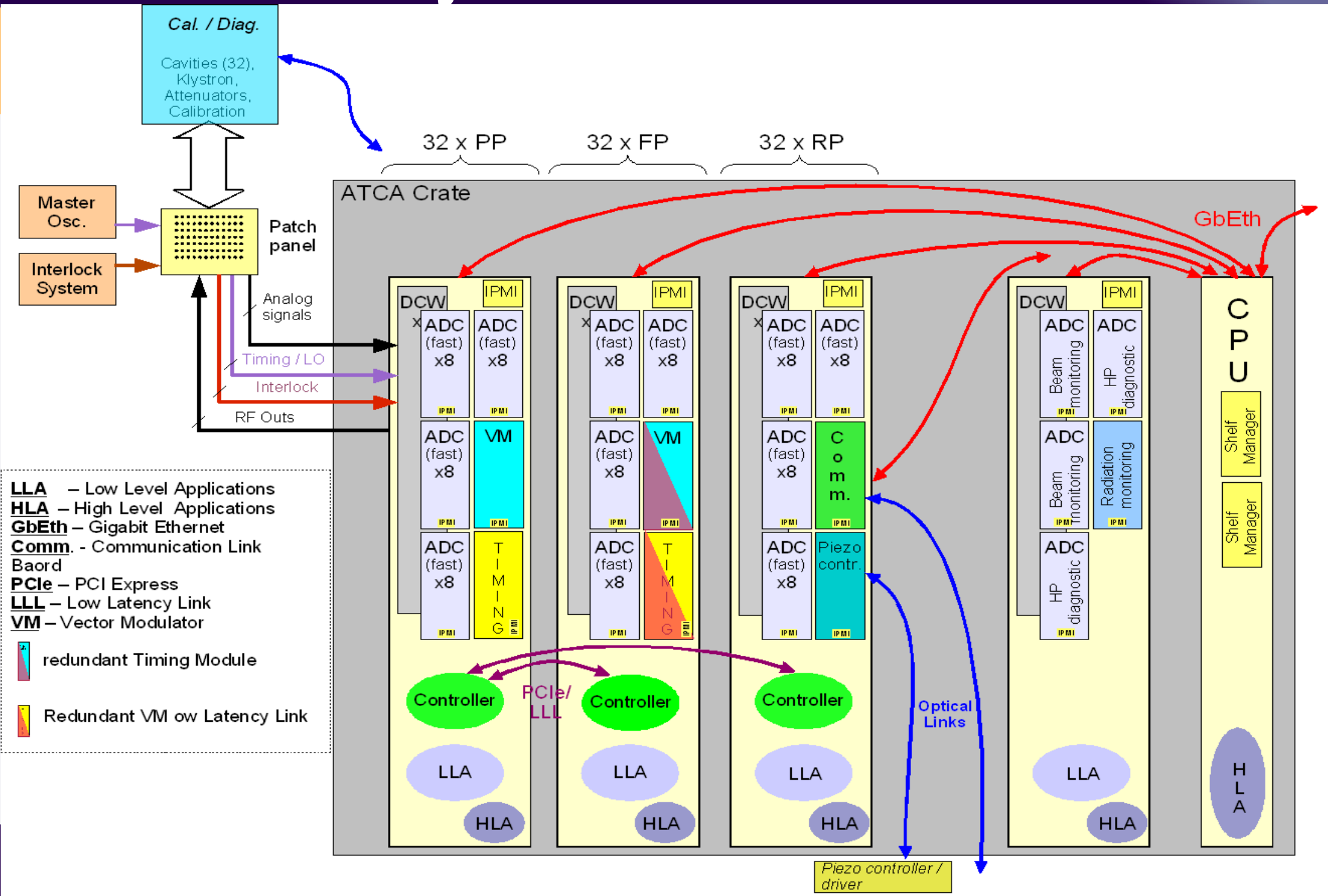
Crate standard related requirements (Cnt'd)

- Modular design
  - Carrier boards with mezzanine cards (5-10 types)
- Maintainable
  - Build-in diagnostics (IPMI, and for all boards)
  - hot-swap
  - Long lifetime of standard and availability of boards
  - Easy access
- Upgradable
- High availability
  - Redundancy supported by hardware and software
  - Rear and front panel IO (few hundred high quality IO channels)

System Architecture

The European X-Ray Laser Project

XFEL X-Ray Free-Electron Laser



Advanced Mezzanine Card

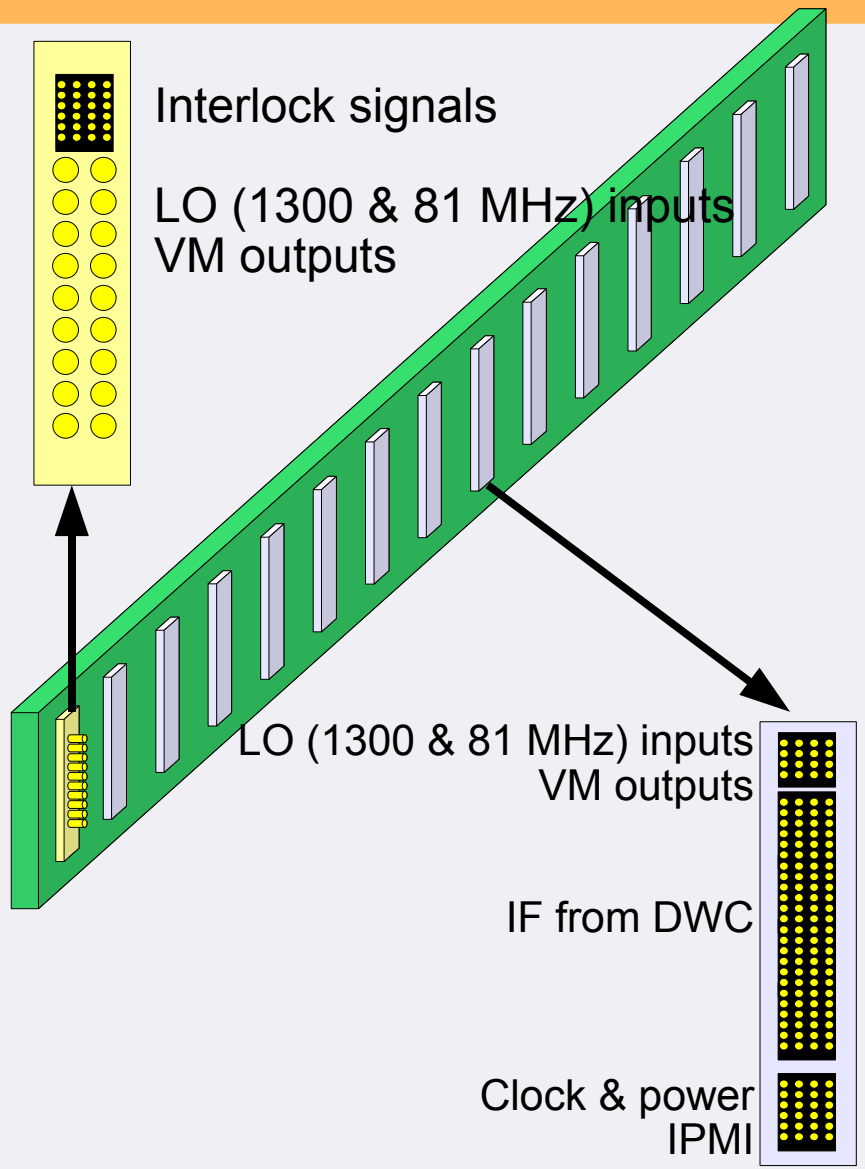
Features: *(more details in "AMC Mezzanine Cards")*

- AMC - ADC - 8 channels, 14 bits, SF 105 MHz
- AMC – ADC – 2 channels, 10 bits, SF 2 GHz
- AMC - Timing module
- AMC - Piezo controller
- AMC - Vector modulator
- AMC - Communication module
- AMC – Radiation monitoring module

Backplane (zone 3)

Functions:

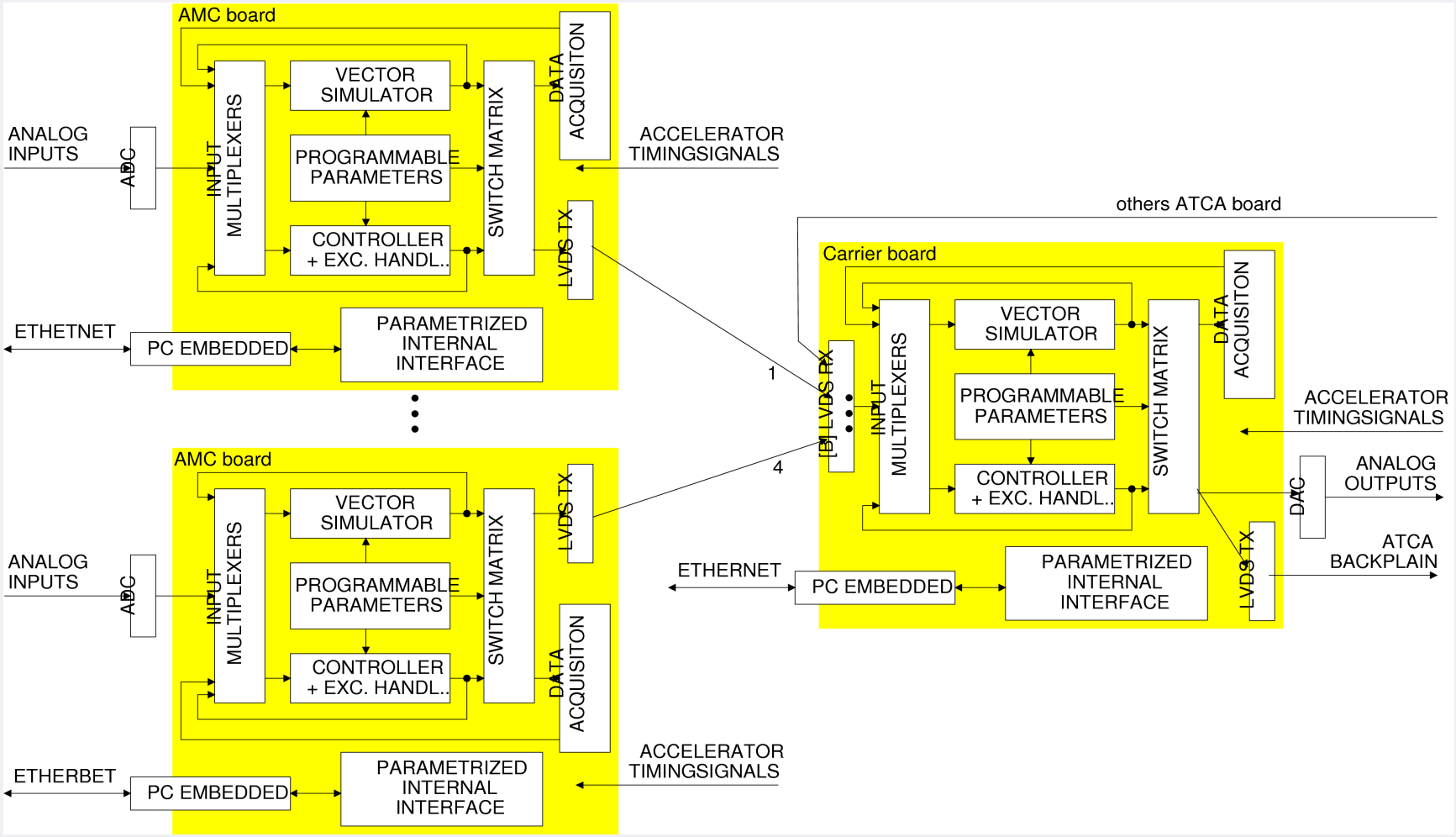
- provide analog signals from RTM to carrier to and from the carrier board (IF, LO, reference clock)
- power supply
- distribute timing signals (bus, 3 x clock, 3 x trigger)
- distribute interlock signals (bus)
-
- Separated connectors for:
  - IF,
  - reference clocks & VM outputs,
  - Clock and trigger, power management & power supply



Advantages of the ATCA system

- distributed system provides multiple locations for algorithms – it increases the number of available resources
- individual projects are much simpler than one big project– easier debugging and control over the application
- high availability of the hardware platform (redundancy) decreases down time of the machine
- fast communication amongst the boards provided by the standard – no such possibility on VME – better integration of the algorithms

Structure of the ATCA LLRF controler



Findings Related to ATCA

- For LLRF the ATCA standard provides
  - A super computer architecture that allows for a low latency and high bandwidth interconnection between modules.
  - A large form factor that fits well with LLRF requirements
  - High availability standards and implementations for both hardware and software
  - Power supply and cooling capabilities for high performance systems
  - An expected long life of the standard due to the commitment of the telecom industry

Findings Related to ATCA

- Issues for R&D
  - Standard is developed for digital, not analog systems
  - Signal integrity
    - Noise and isolation from adjacent RF and digital signals
    - Clock and LO distribution
    - Phase and amplitude stability with temperature
    - Switching power supply and fan electrical and acoustic noise
    - Custom backplane design
  - Can a ATCA system be built that meets the XFEL performance requirements?

Findings Related to ATCA

- LLRF is one of the more challenging instrumentation projects. Success with ATCA will clearly open the door to other projects.
- The timeline is very aggressive, but the project milestones are very important for the XFEL project.
- The LLRF team is enthusiastic and has already made good progress.