

Demonstration of an ATCA based LLRF Control System at FLASH

Stefan Simrock, DESY
for the XFEL LLRF team

- Introduction: xTCA for Physics
- RF Control for the European XFEL
- ATCA based RF Control System
- Demonstration at FLASH

xTCA for Physics

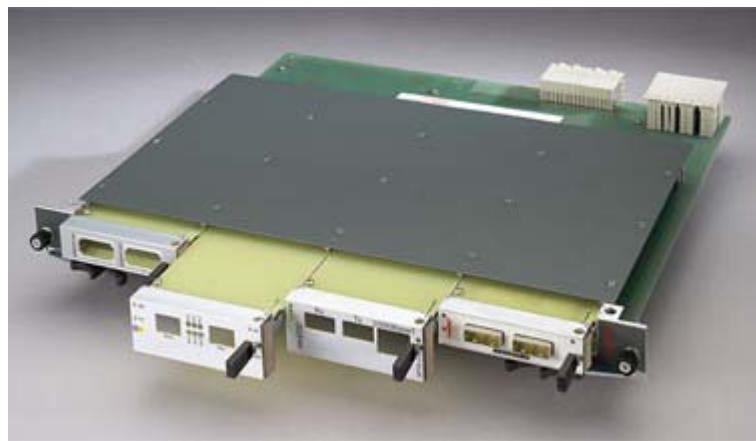
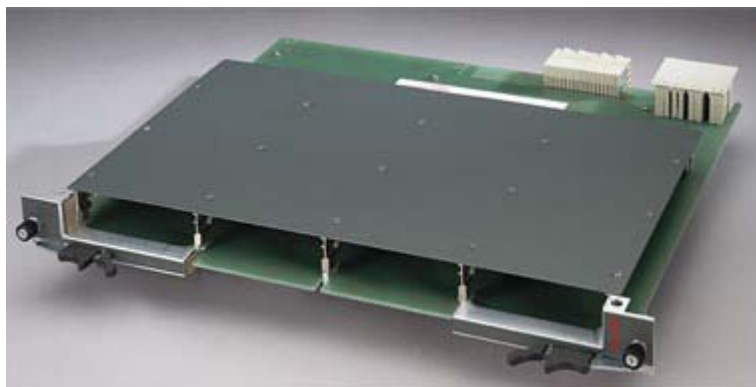


AdvancedTCA[®]
AdvancedMC[™]

From Computer Desktop Encyclopedia
Reproduced with permission.
© 2006 Schroff Electronic Solutions

PICMG 3.0 – Advanced Telecommunications Computer Architecture

PICMG AMC.0 – Advanced Mezzanine Card



- Adapt xTCA for physics use by:
 - Extensions to specifications
 - Guidelines
 - Open source solutions
 - Building on existing xTCA base under PICMG rules
 - Approval by PICMG membership vote
 - Collaborate with industry for vendor support

http://www.picmg.org/pdf/PICMG_Physics_Public_Web_Update_061209_R5-3.pdf

See also: **THA006 New Hardware and Software Developments for the XFEL (K. Rehlich)**



Excerpt from Time Line for xTCA Specs.



AdvancedTCA[®]

IRTM

ATCA 3.0 CR Exists

3.1 R2

High Speed Ethernet

AdvancedTCA Extensions

μTCA[®]

Approved!

uTCA.1
Air Cooled Rugged

uTCA.0 CR Exists

uTCA.3

Conduction Cooled

xTCA[™]

xTCA Physics

Physics xTCA I/O, Timing &

Synchronization

Physics xTCA Software Architectures & Protocols

Active

Pre-SOW

Known CRs

Held by TO (Don't Infer Dates)

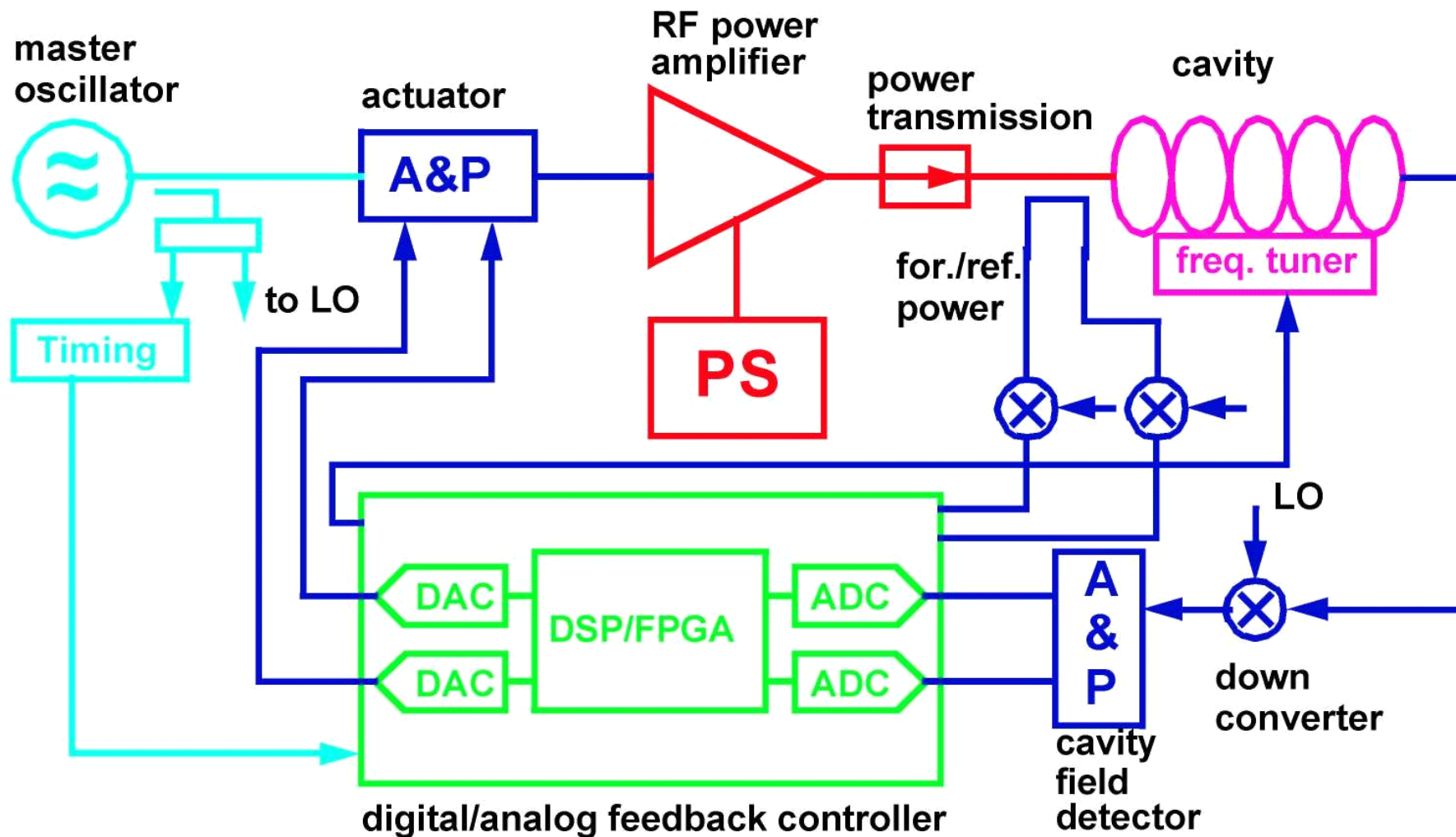
2009

2010

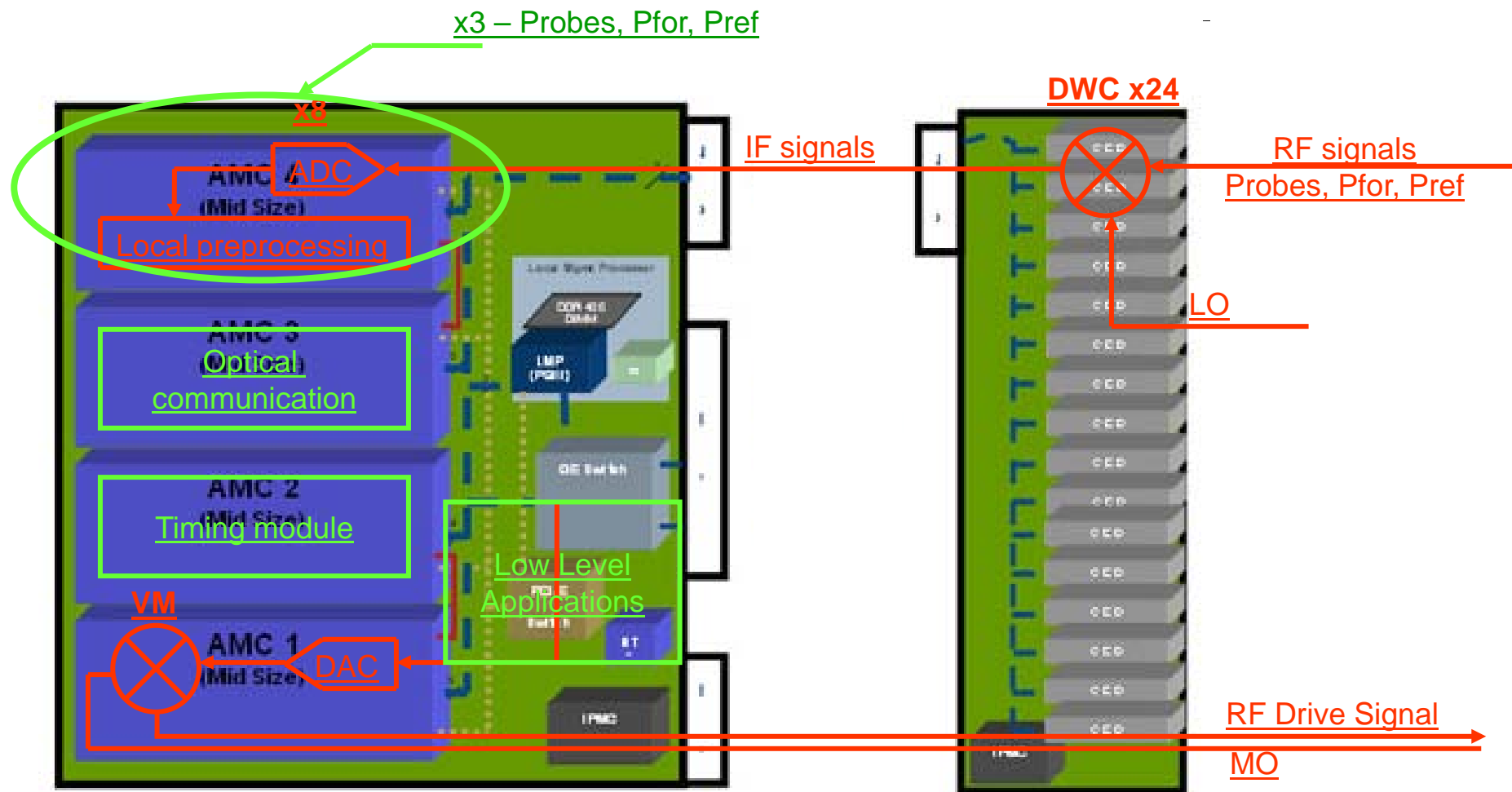
2011

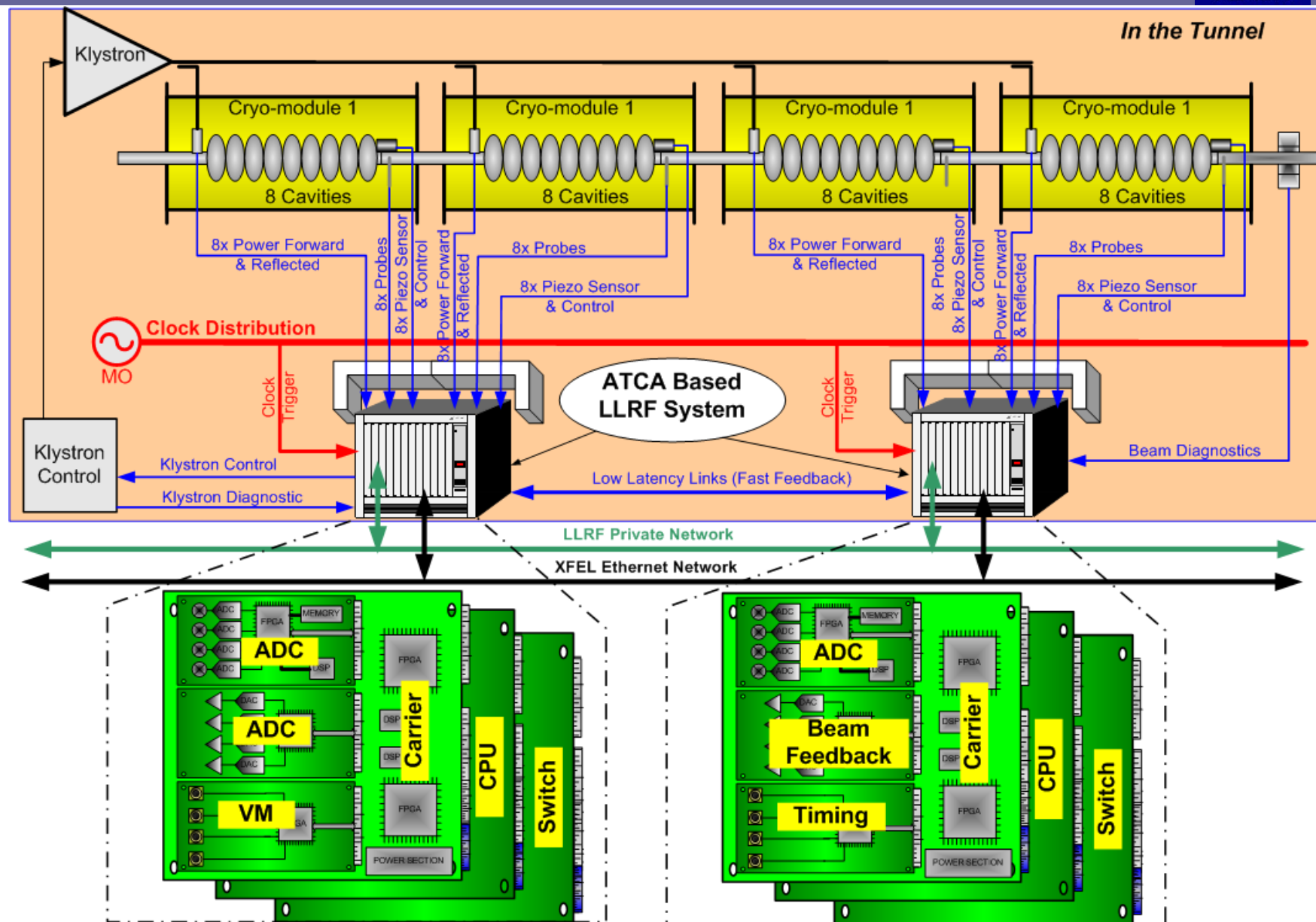


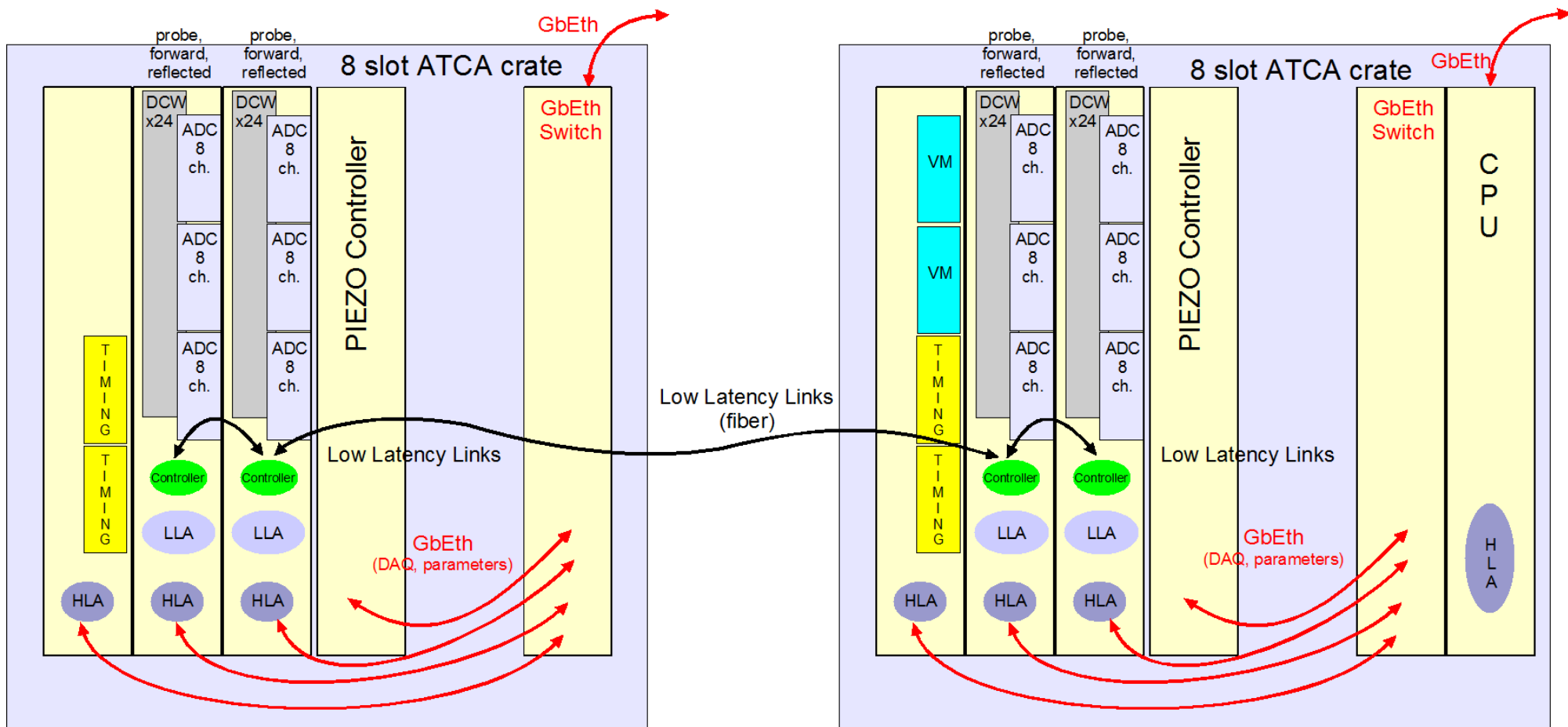
ATCA Design for LLRF

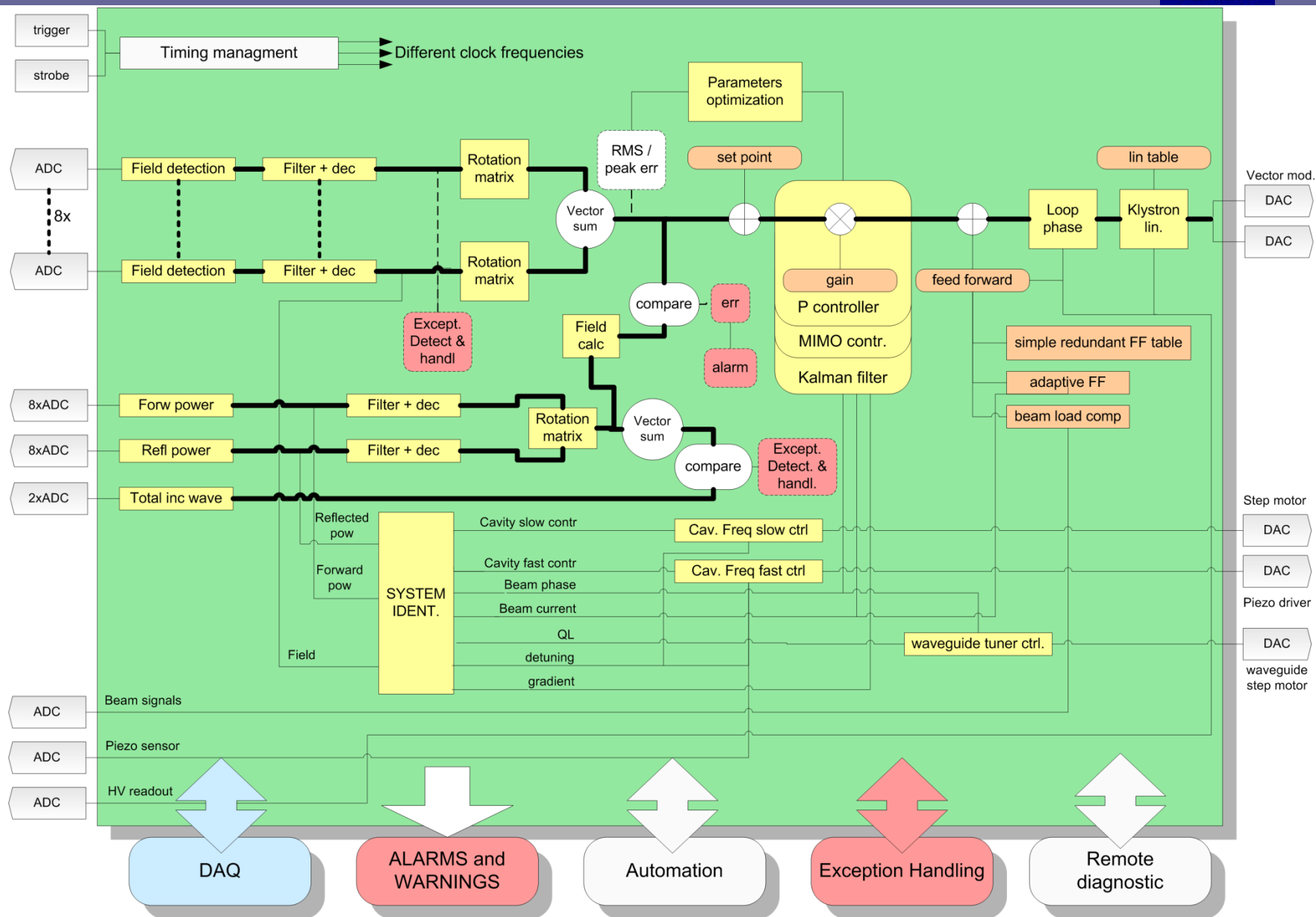


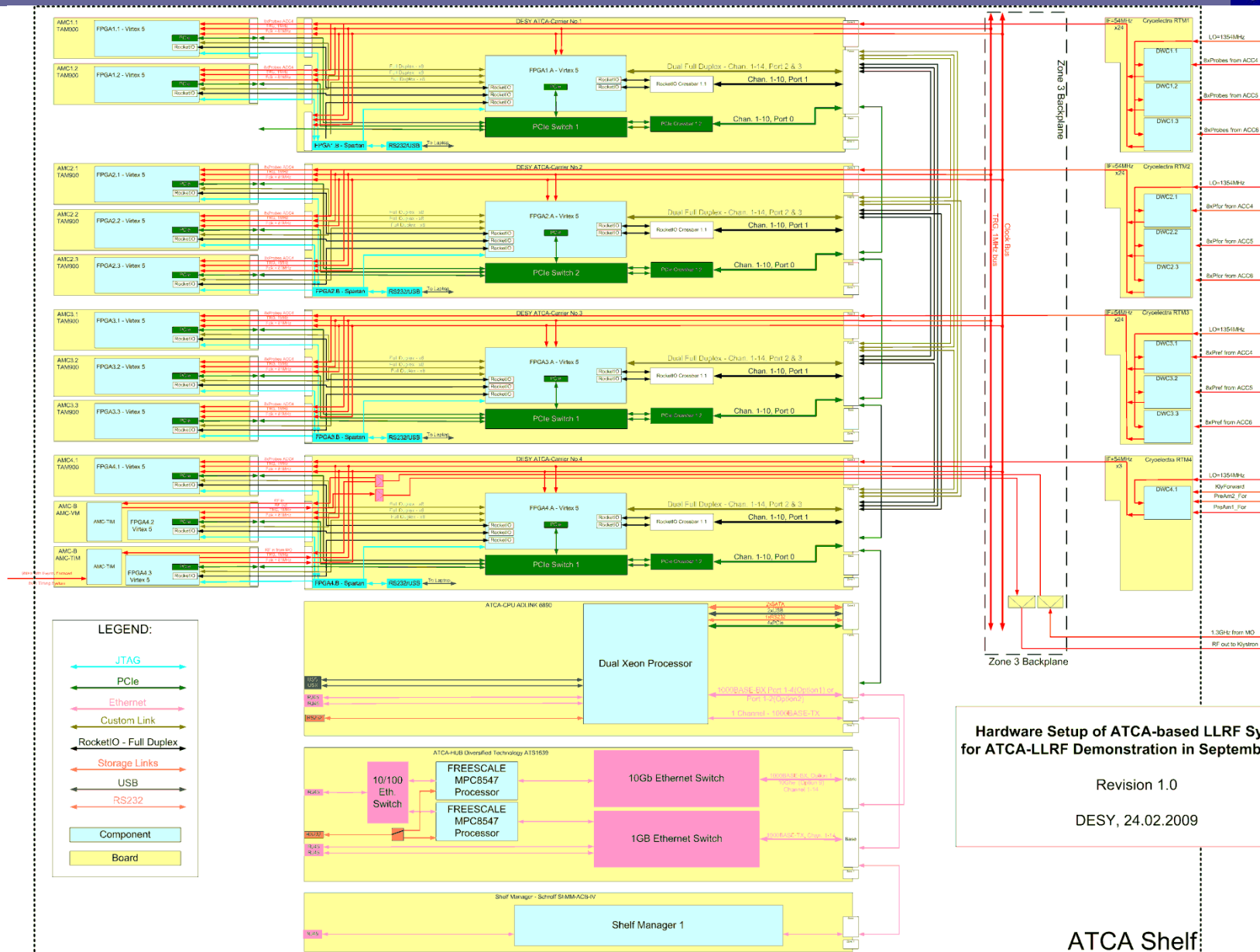
- Future RF Control systems will require simultaneous data acquisition of up to **100 fast ADC channels** at sampling rates of around **100 MHz** and real time signal processing within a few **hundred nanoseconds**.
- At the same time the standardization of low-level systems are common objectives for all laboratories for **high availability, high performance, and moderate cost**.
- Also desirable are **modularity and scalability** of the design as well as **compatibility** with accelerator instrumentation needs including the control system.
- All these requirements can be **fulfilled with the new telecommunication standard ATCA**



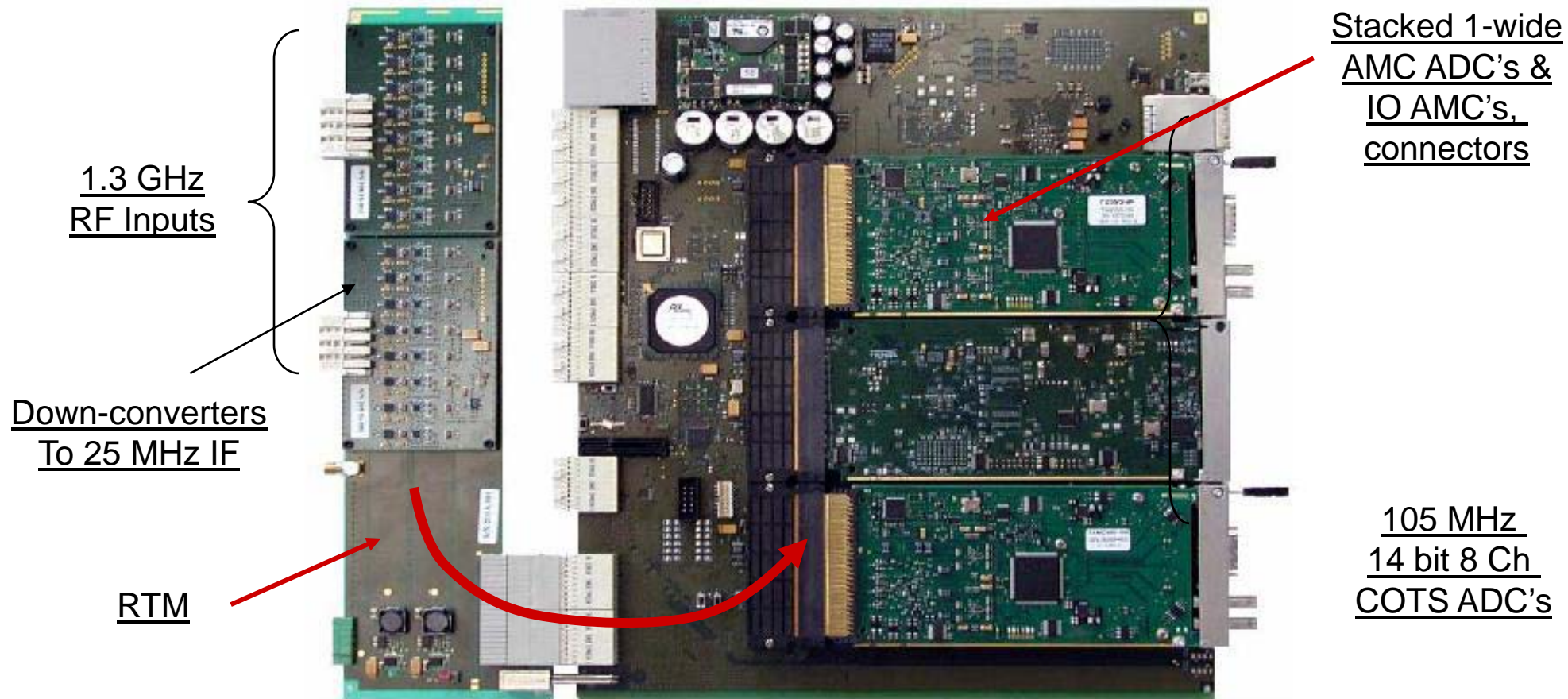






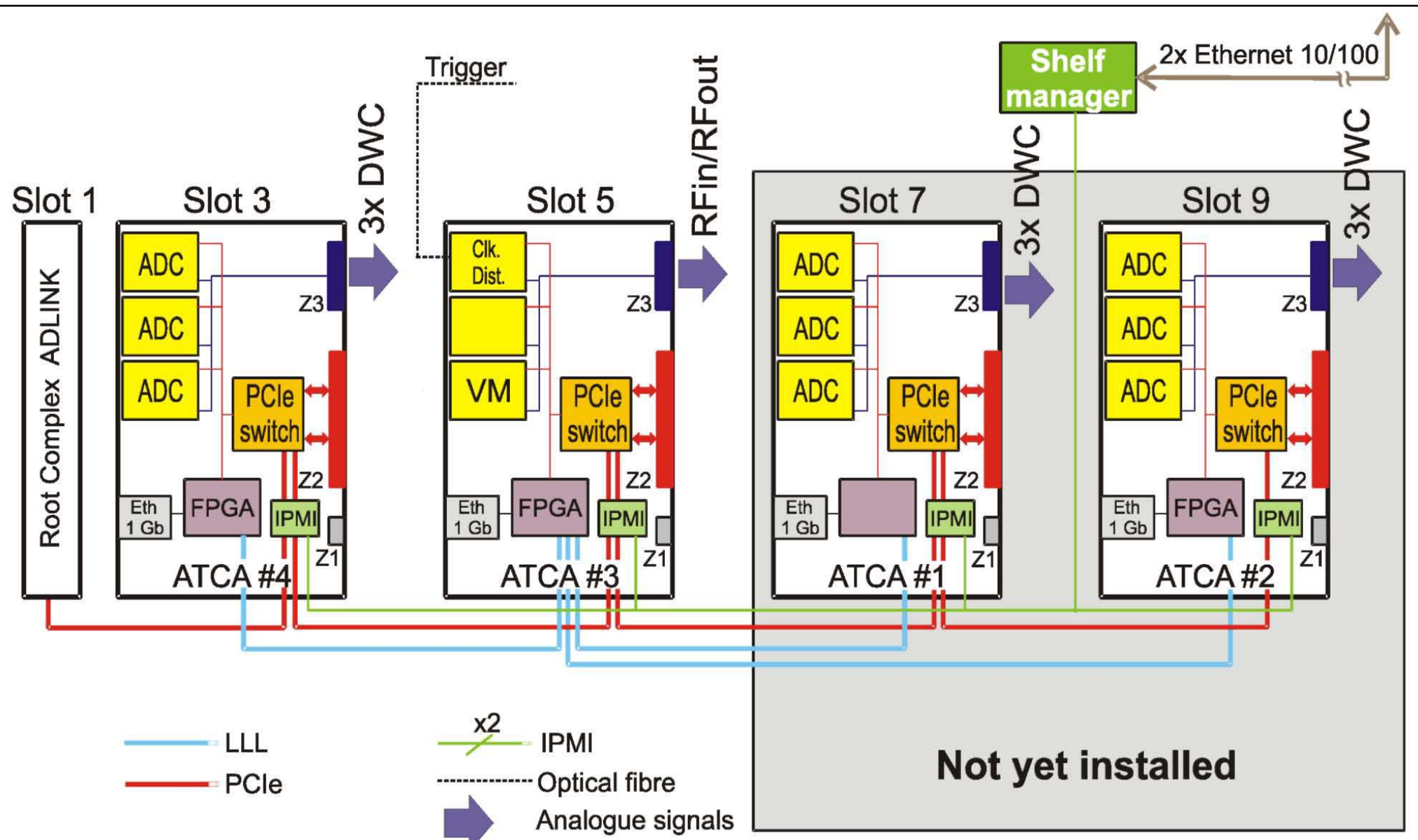


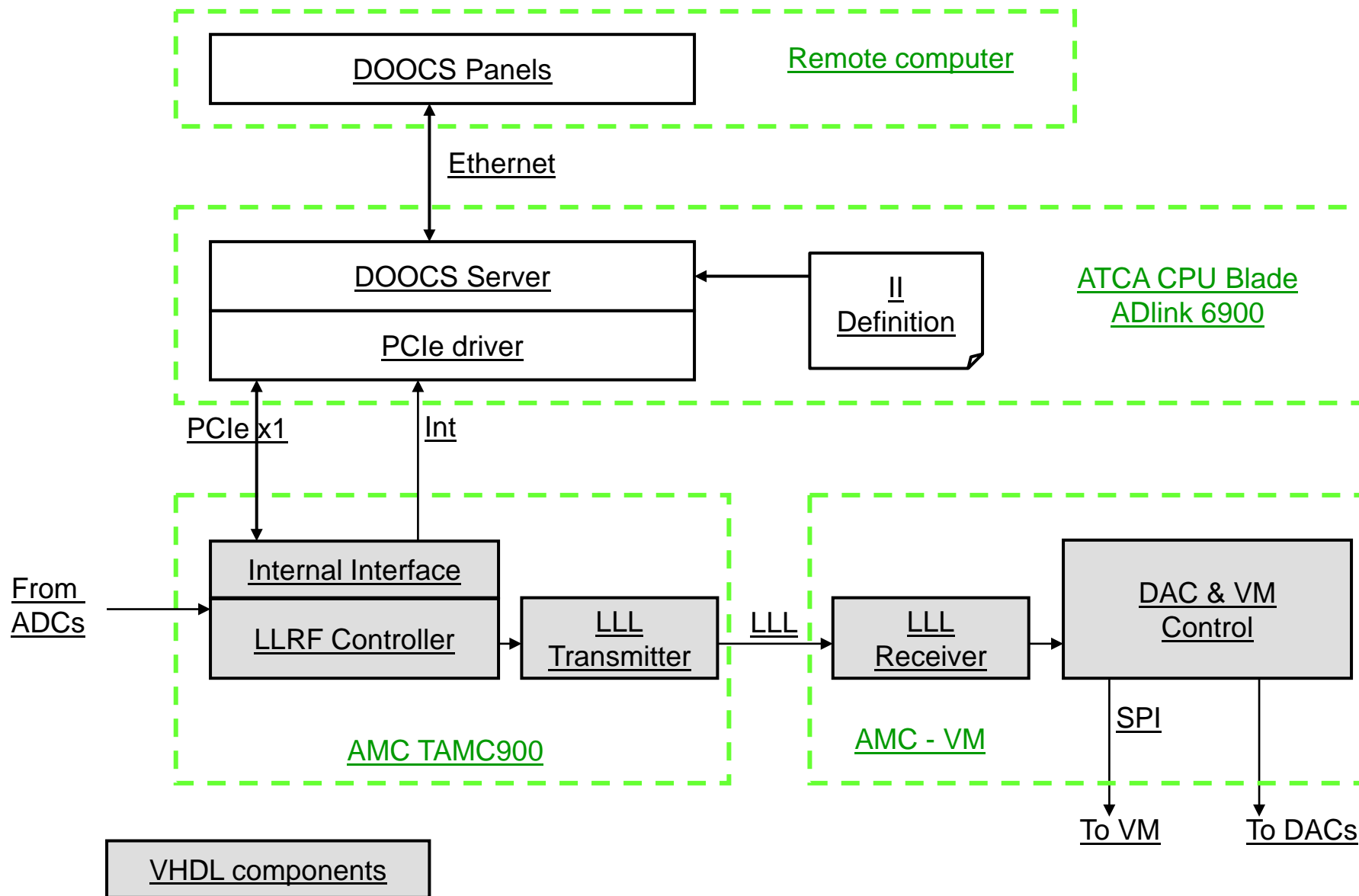
ATCA-based LLRF control system



ATCA Demonstration at FLASH

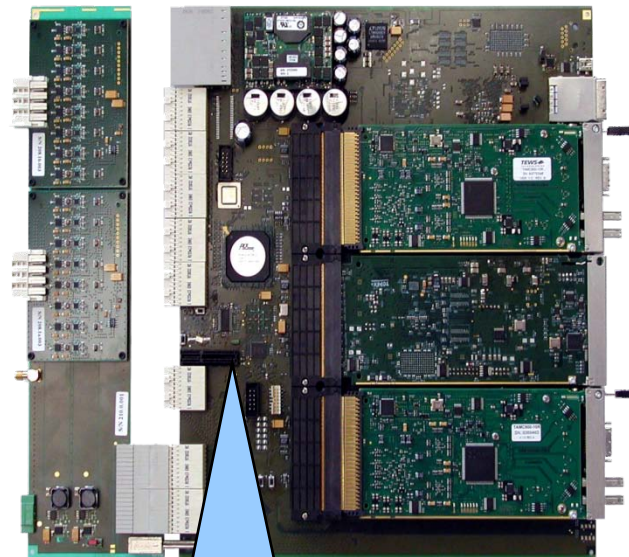
Objective	Comment
Analog IO	Demonstrate the noise added from entrance to rear transition module through Zone 3 and carrier to AMC module is not degraded
Communication links	Demonstrate that the scheme of Low Latency Links, PCIe and GbE is functional.
Operation in accelerator environment	Demonstrate that the ATCA based LLRF is functional in the noisy accelerator environment.
Rear transition module	Demonstrate the concept of rear transition modules with downconverters
Timing distribution	Demonstrate timing distribution functionality
Timing jitter	Demonstrate that the measured timing jitter is adequate for LLRF control.
IPMI	Demonstrate the IPMI implementation.



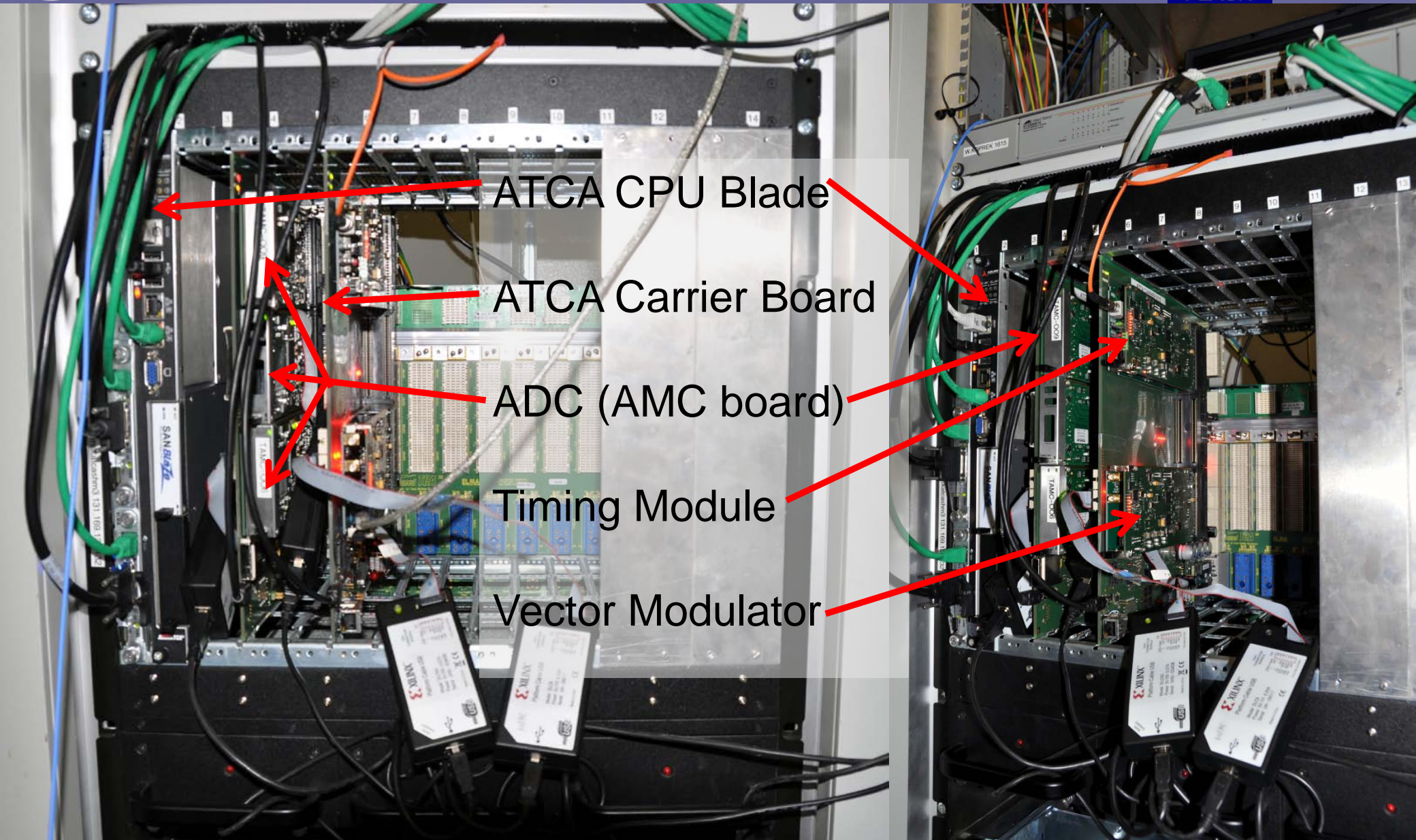




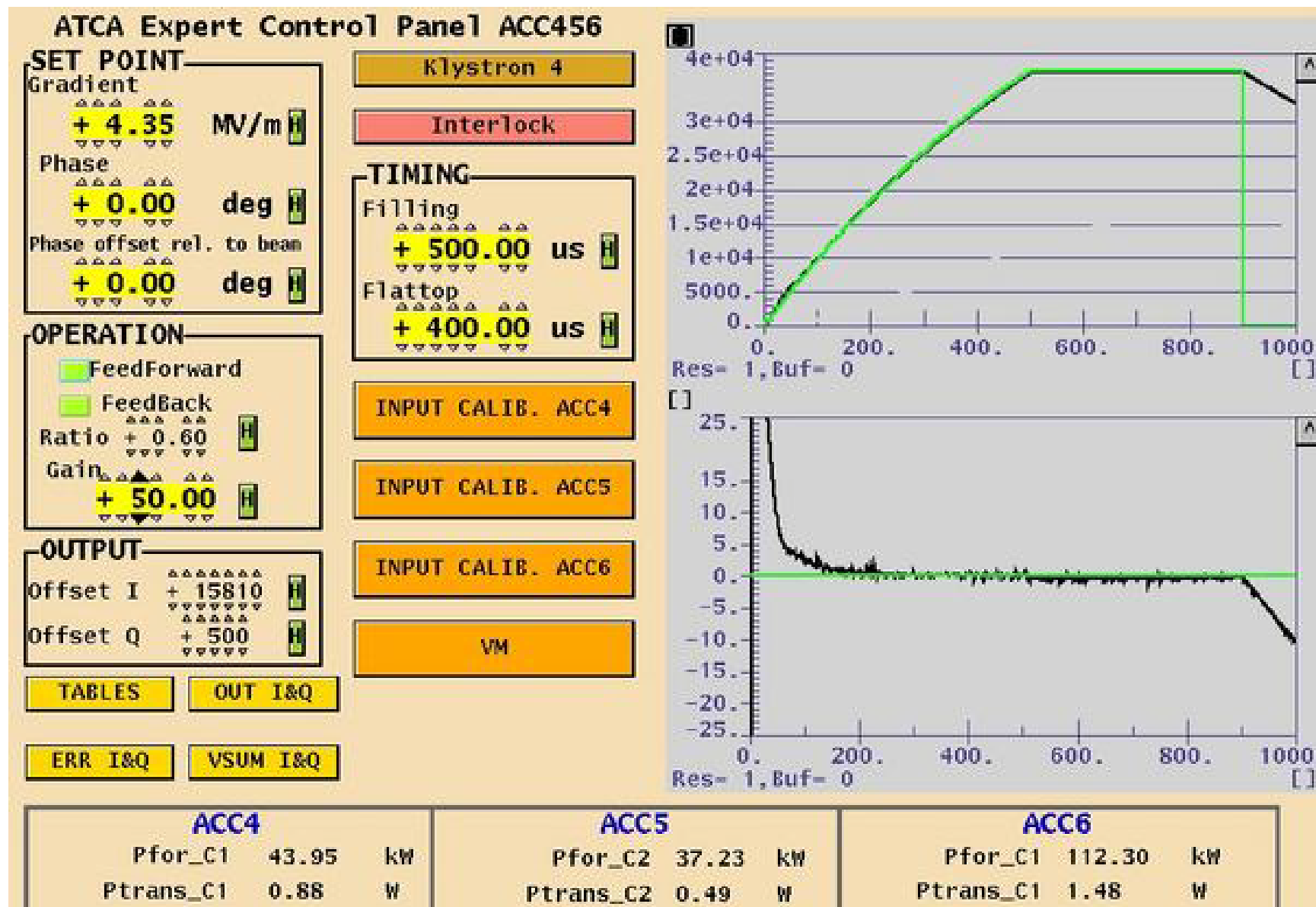
- Management of ATCA carrier board,
- Management of AMC modules,
- Monitoring of ATCA health (diagnostics),
- E-Keying for PCIe, Gb Ethernet and user defined Low Latency Connection,
- Monitoring of temperature, power supply, clocks, etc...

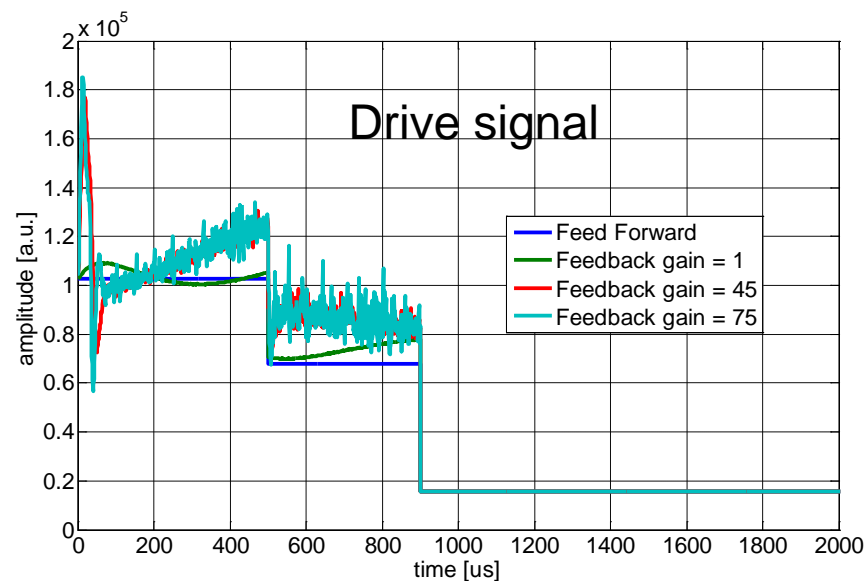
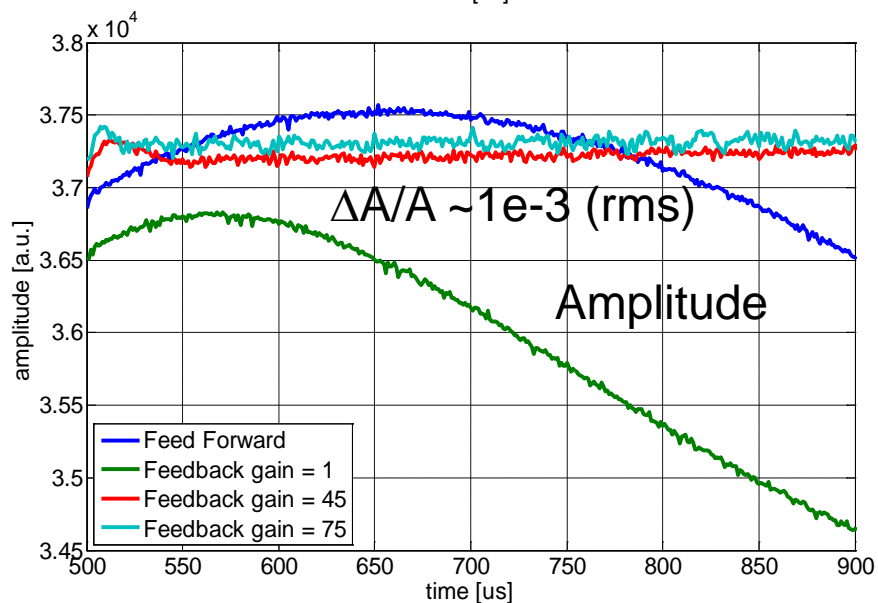
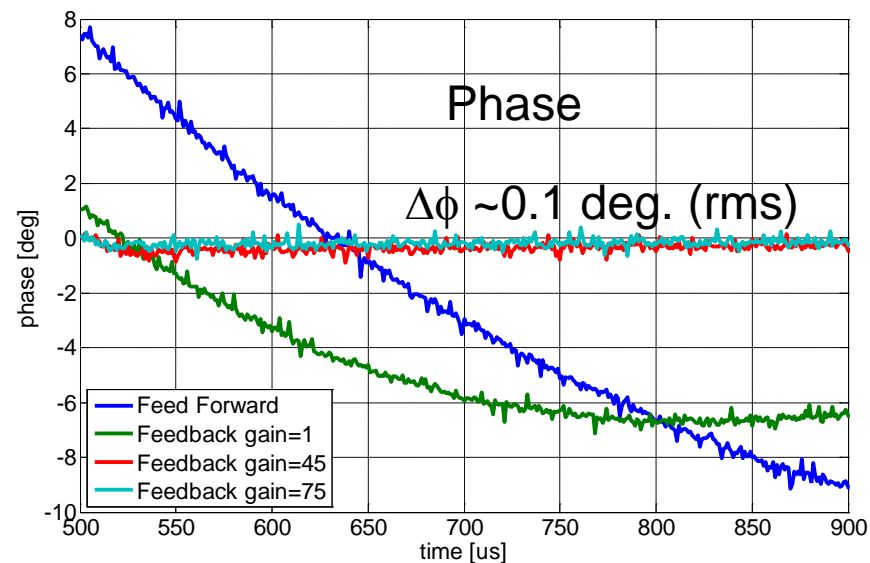
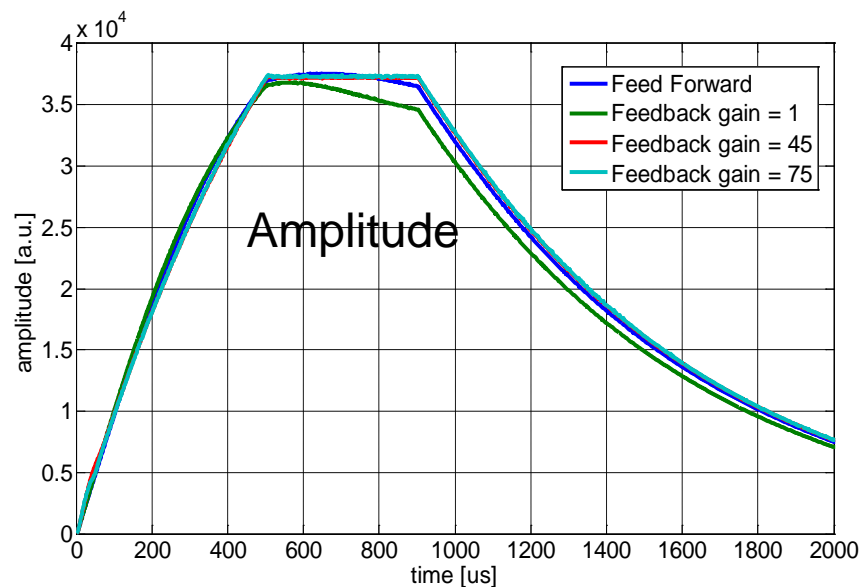


IPMC
ATMEGA 1281
microcontroller with
dedicated
management hardware





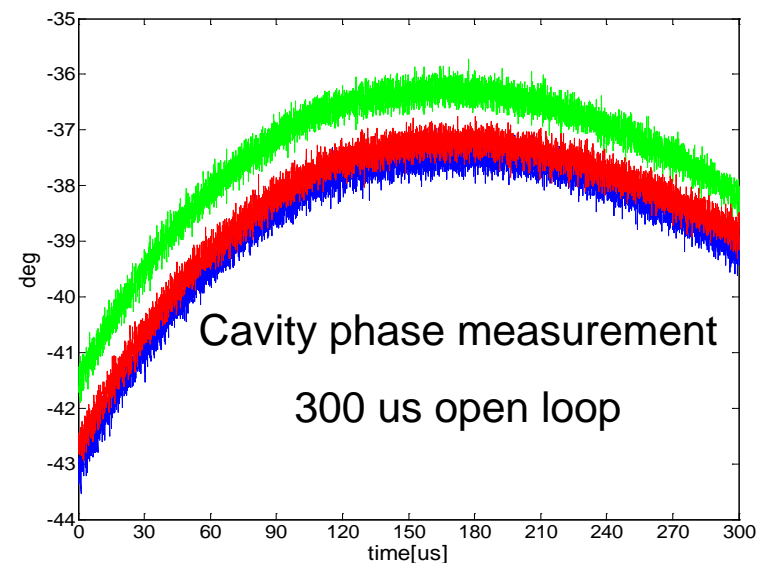
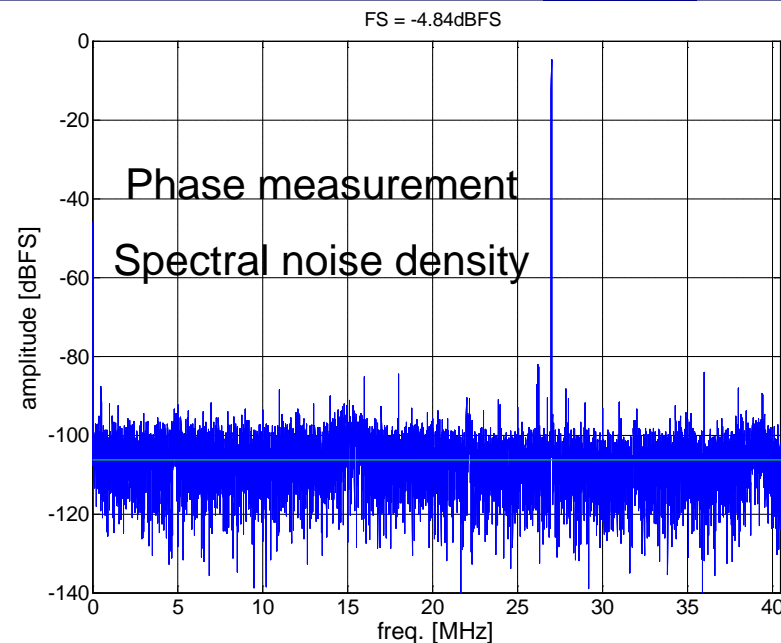




Preliminary Performance Data

- Channel isolation >80 dB @50MHz (presently limited by downconverter)
- Noise < 200 μ V (rms) consistent with 14-bit ADC, 200 MHz bandwidth
- Timing jitter < 15 ps (rms) @ 81 MHz (upper limit, could be dominated by RF)

	ADC1	ADC2	ADC3	ADC4	ADC5	ADC6	ADC7	ADC8
ADC1 on	-67.87	-48.14	-66.86	-66.39	-73.71	-69.90	-67.11	-71.38
ADC2 on	-48.35	-67.79	-68.14	-74.08	-69.35	-71.00	-67.86	-72.67
ADC3 on	-59.51	-66.47	-68.09	-52.43	-66.08	-70.39	-66.98	-72.60
ADC4 on	-65.52	-69.55	-49.03	-68.03	-68.82	-69.81	-66.69	-70.78
ADC5 on	-73.27	-73.27	-67.81	-69.82	-66.44	-44.35	-63.30	-69.77
ADC6 on	-2.92	-0.45	0.56	-3.24	17.30	-8.12	4.08	8.28
ADC7 on	-76.22	-70.18	-69.39	-77.31	-65.34	-70.27	-68.47	-45.76
ADC8 on	-70.80	-63.62	-62.15	-69.65	-67.48	-62.79	-52.15	-64.50



- The demonstration of an xTCA based LLRF system at the FLASH user facility has verified that this standard can be employed for a wide range of **physics applications**:
 - **ATCA for large scale and high performance systems**
 - **μ TCA for low cost instrumentation needs**
 - **and combinations of these standards**
- Although standard is quite new **commercial components** and even complete systems are already available for physics applications.
 - Several physics labs are already using or evaluating the ATCA and μ TCA standard
- xTCA for physics standardization effort between labs and industry will release first specifications in 2010 and should lead to commercially available products within 1-2 years.