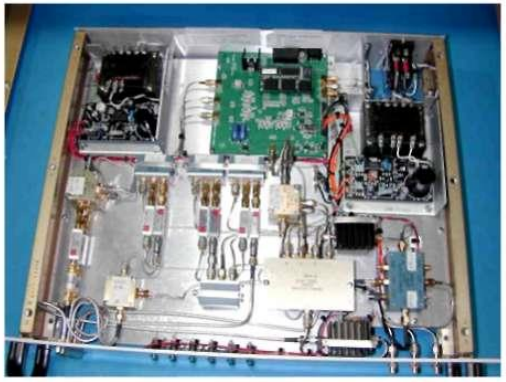
LLRF World Wide

LLRF Lecture Part 3.7

S. Simrock, Z. Geng

ITER / PSI

Evolution of Hardware at SNS

1st Generation Control Chassis	2nd Generation Control Chassis	3rd Generation Field Control Module
		
MEBT Rebunchers	RFQ & DTL	CCL, SCL & HEBT
4 installed, 1 spare	7 installed, 3 spares	Retrofit to MEBT, RFQ & DTL
Retrofitted with FCM Nov 04	Retrofitted with FCM Jul 04	98 systems + spares

Evolutionary Development: build on proven concepts, hardware and software

October 10, 2005

Lesson Learned at SNS

- Document the system requirements.
  -- Avoid feature creep.
- Document the development plan.
- Make a resource-loaded schedule and budget.
- Use proven solutions. Don't reinvent the wheel. Resist the "not invented here" syndrome.
- Keep it simple.
- If your schedule is at risk, ask for help.
- Your team must "take ownership" of the system.
- Software support and development is an integral and essential part of the process.
- Be willing to cross functional and subsystem boundaries.
- Avoid dictating the choice of software tools and languages if possible.

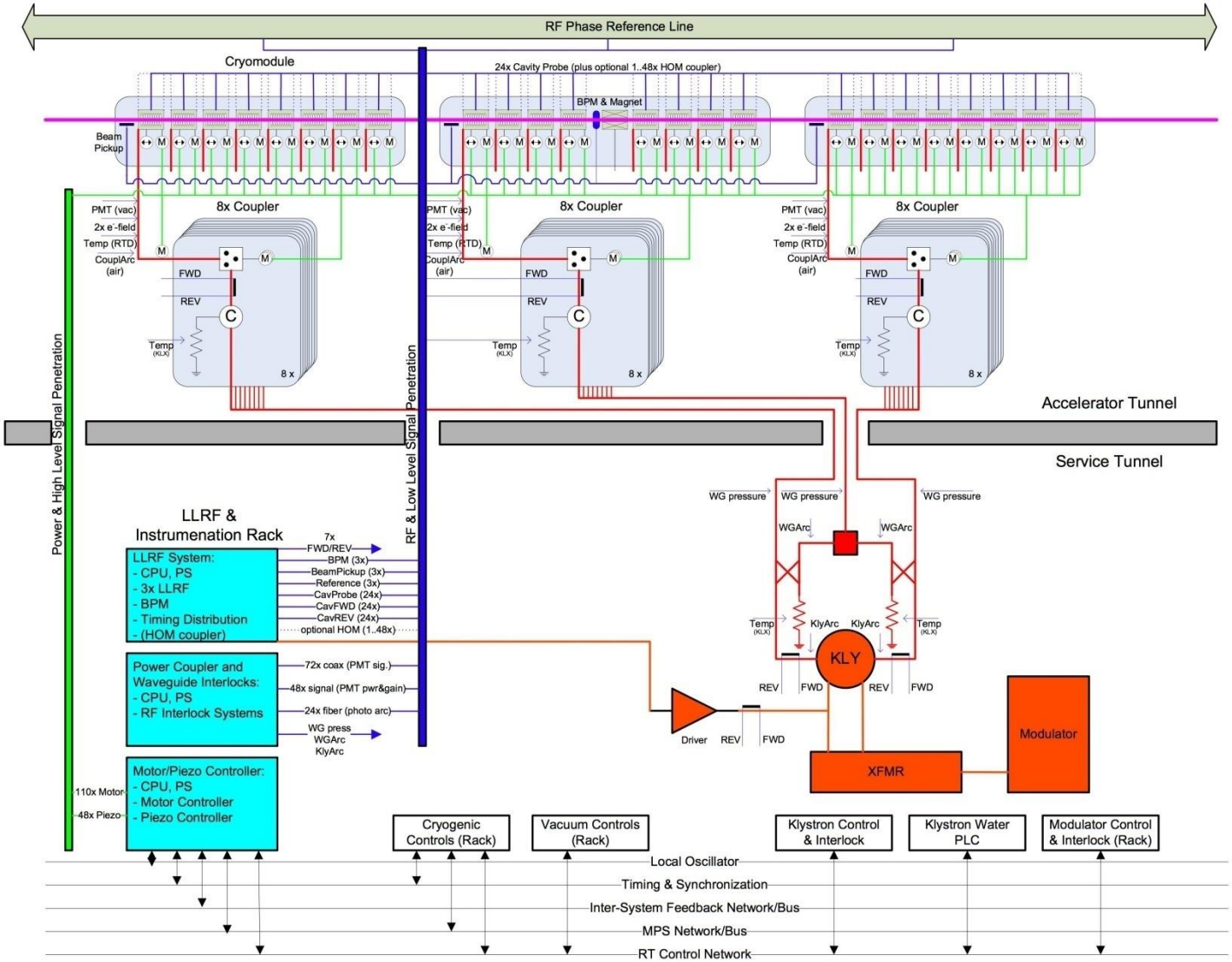
Ref. M. Champion

Advice for Hardware Development

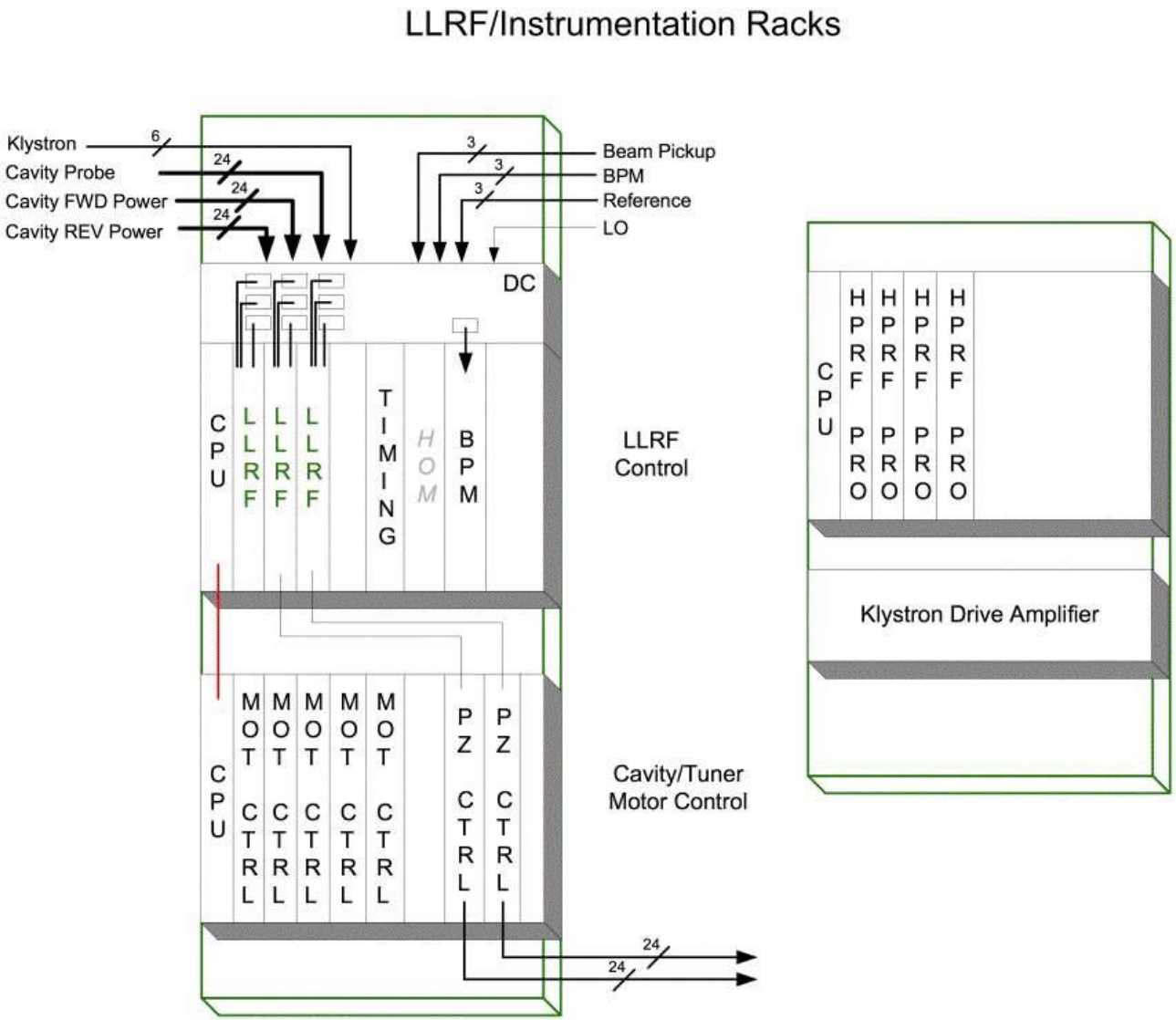
- Avoid early parts obsolescence.
- Install a RF PIN switch diode on your RF output.
- Install extra channels, you will need them later!
- Verify your parts can withstand a wet wash process following SMT assembly.
- Do not use epoxy-mount components (difficult to replace)
- Provide adequate shielding between motherboard and daughterboard.
- Provide "clean" DC power to your circuits. Beware of DC-to-DC switching supplies. The switching frequency (usually 200 kHz) will find its way into your system!
- Don't waste your time building cables. Let a vendor do it.
- Use a symmetric layout for your ADC clock distribution and pay attention to impedance matching.
- Think about how you will test, troubleshoot and repair your circuit boards when you do your board design and layout (not after you receive the circuit boards)

Ref. M. Champion

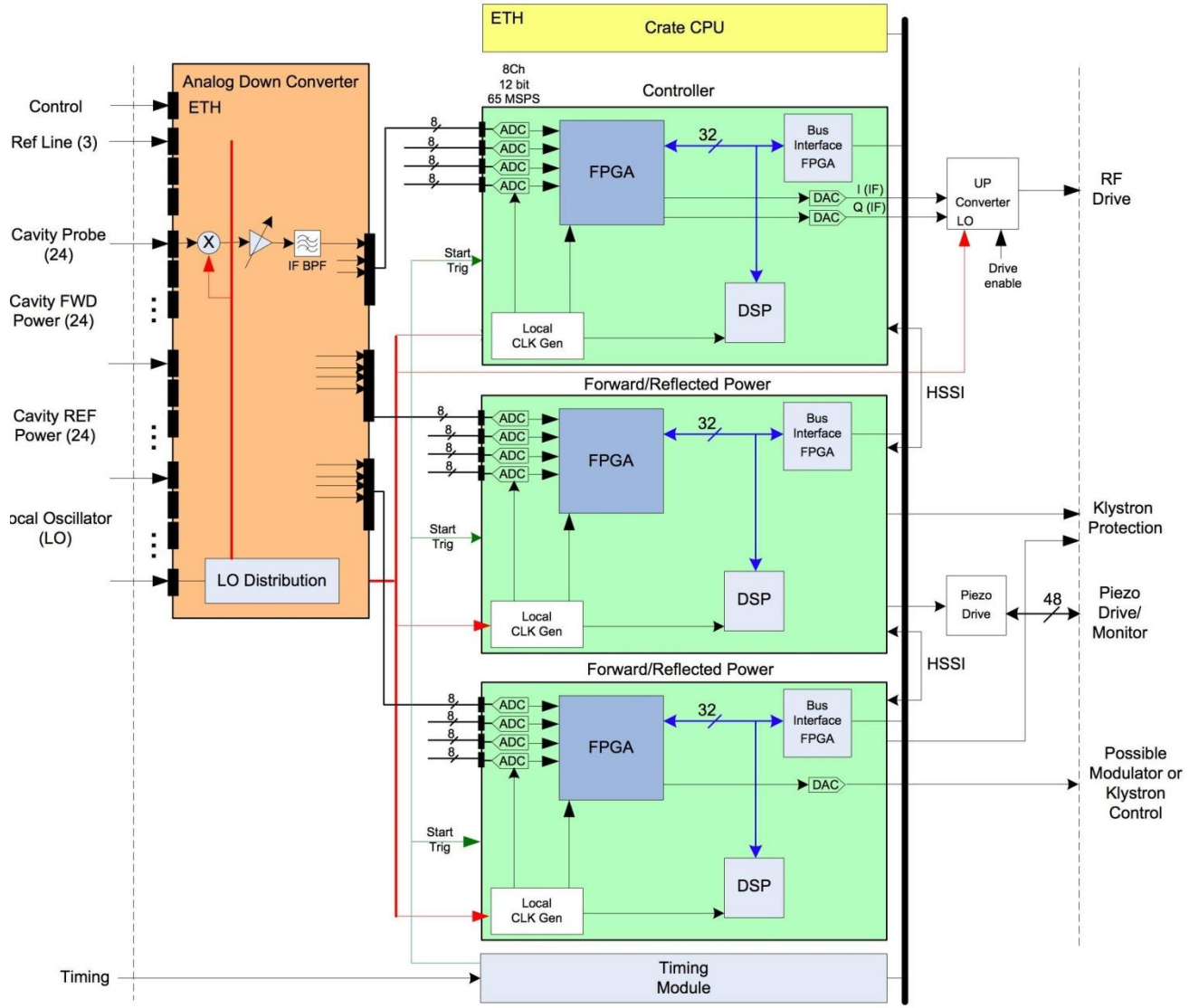
RF Station with 3 Cryomodules



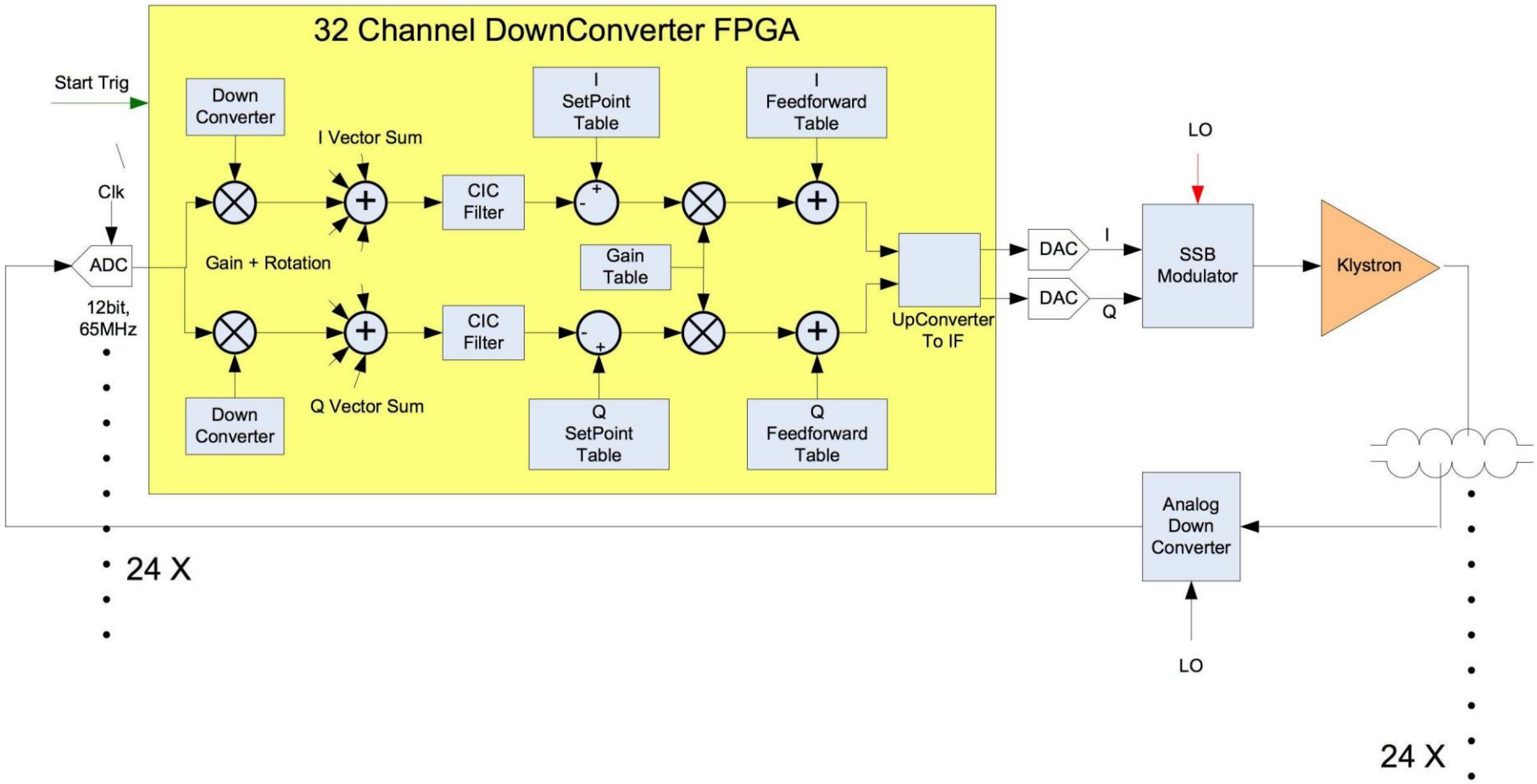
Rack Layout


LLRF/Instrumentation Racks
Klystron
Cavity Probe
Cavity FWD Power
Cavity REV Power
6
24
24
24
3
3
3
Beam Pickup
BPM
Reference
LO
DC
CPU
LLRF
LLRF
LLRF
TIMING
HOM
BPM
LLRF Control
CPU
MOT CTRL
MOT CTRL
MOT CTRL
MOT CTRL
MOT CTRL
PZ CTRL
PZ CTRL
Cavity/Tuner Motor Control
24
24
CPU
HPRF PRO
HPRF PRO
HPRF PRO
HPRF PRO
Klystron Drive Amplifier

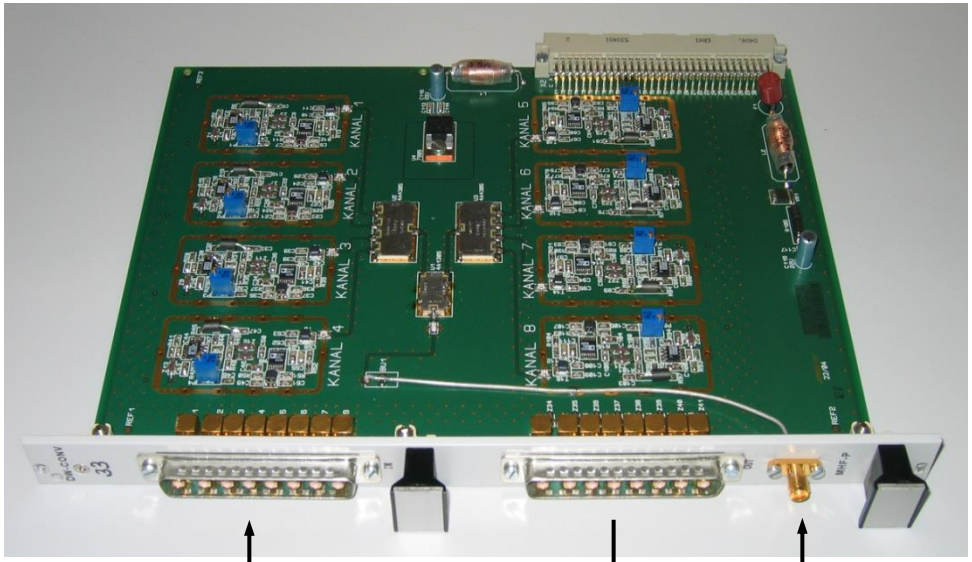
LLRF Rack Detail



LLRF Field Module Controller



Downconverter

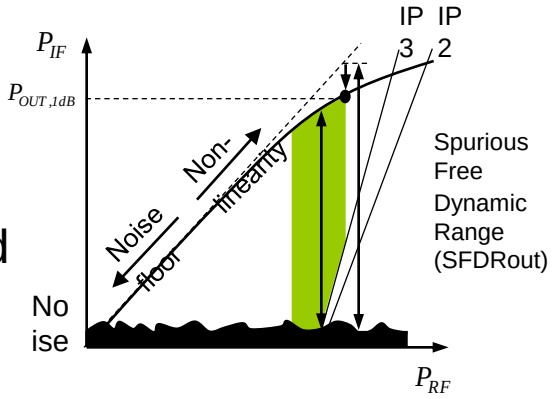


8-channels from cavity probe :

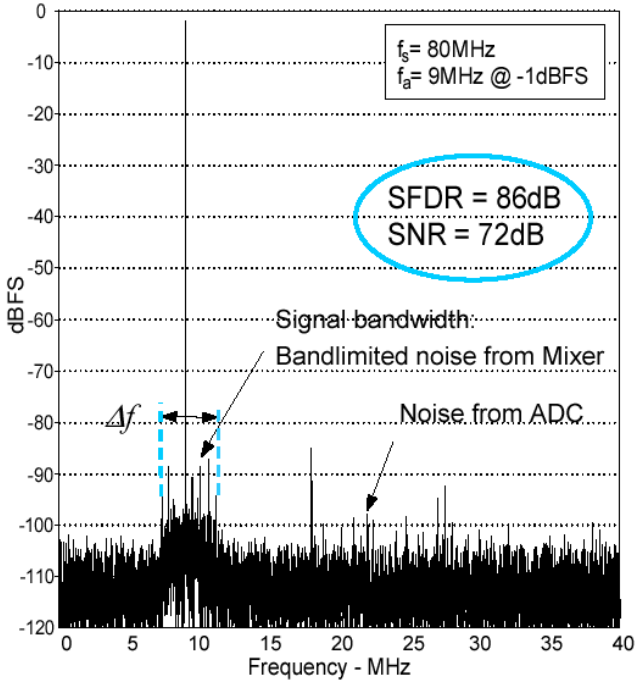
8-channels to ADC-Board :

LO-Input :

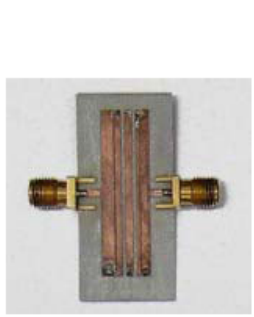
Compromise between noise and linearity

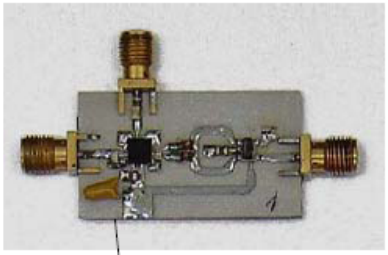


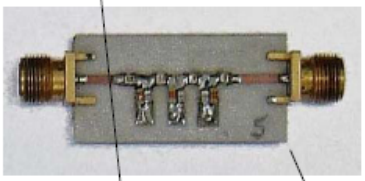
- **SNR for oversampling :**

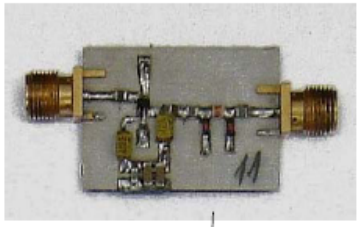


Gilbert Cell Mixer

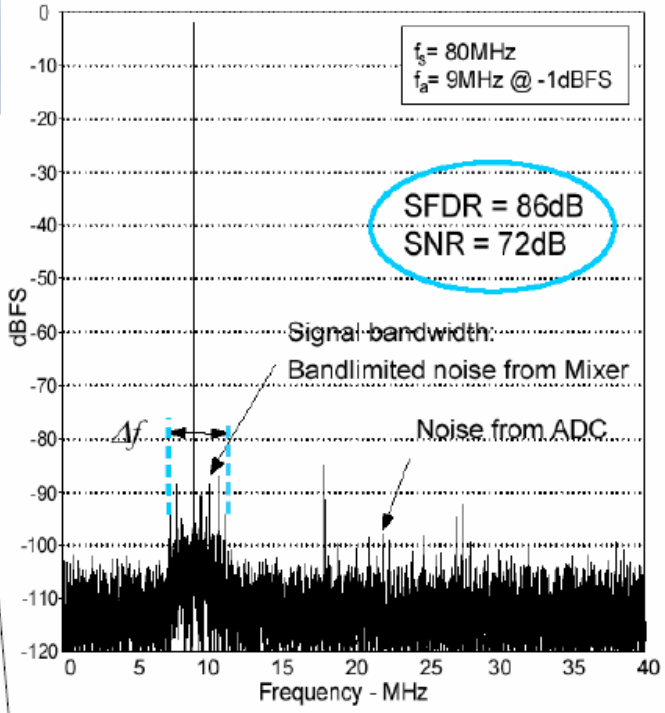


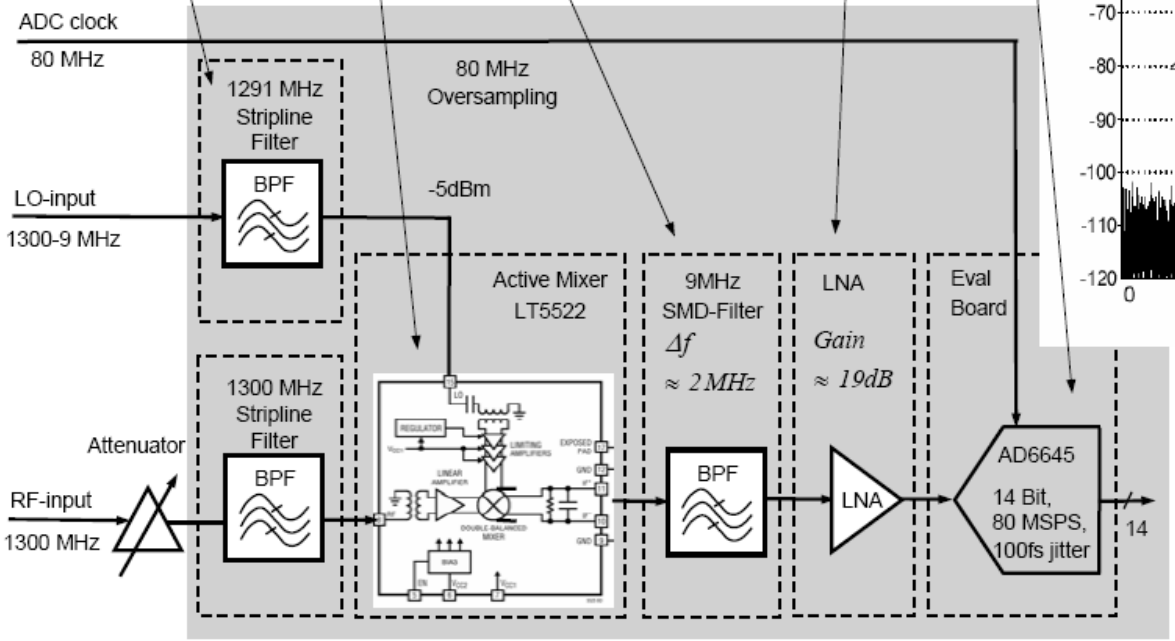






- **SNR for oversampling :**

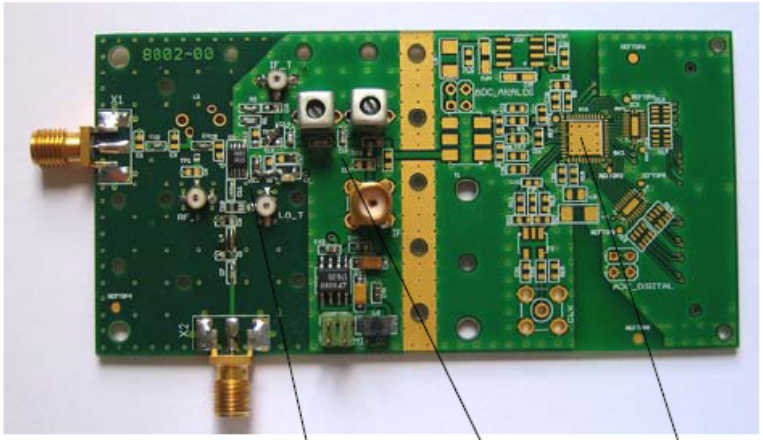


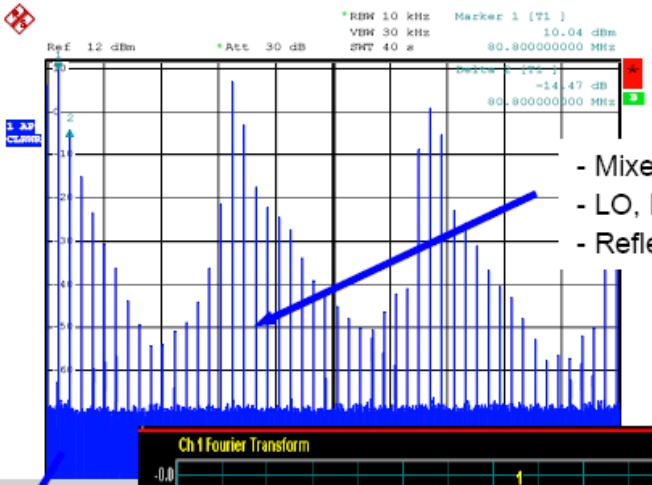


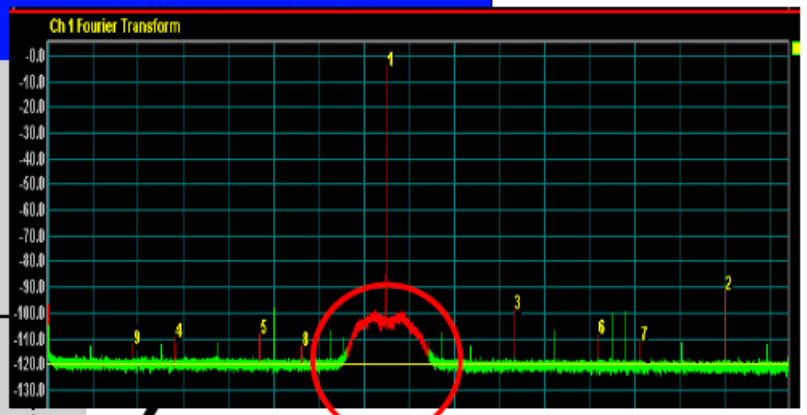
SNR is limited to 72dB by the NF of the front end mixer.

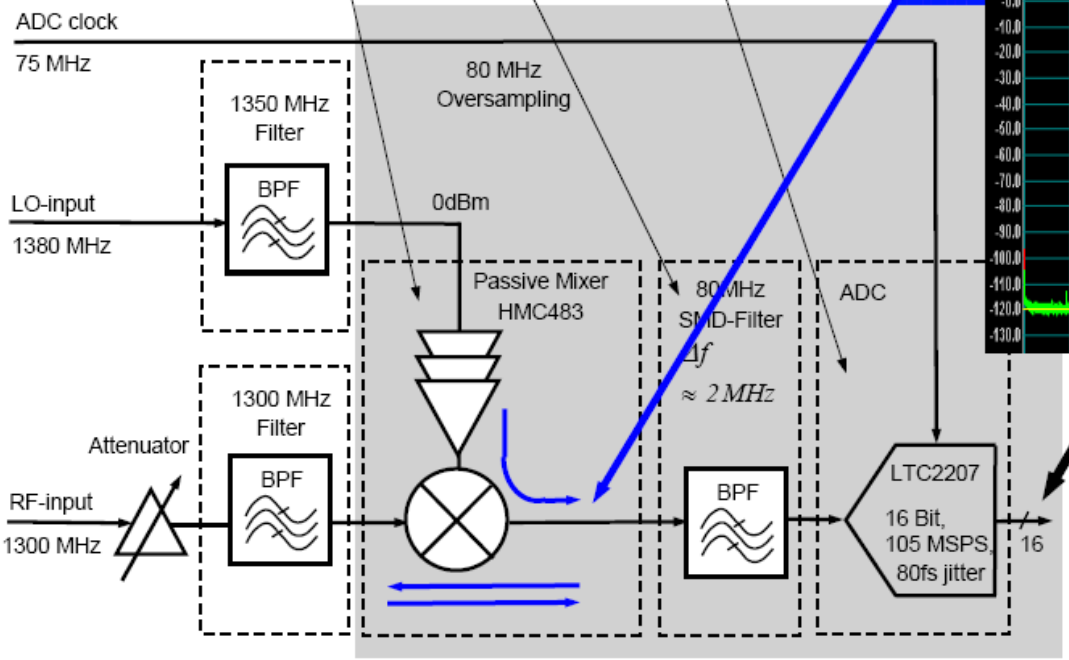
(SNR of about 70dB from JLAB using HMJ mixers.)

Passive Mixer





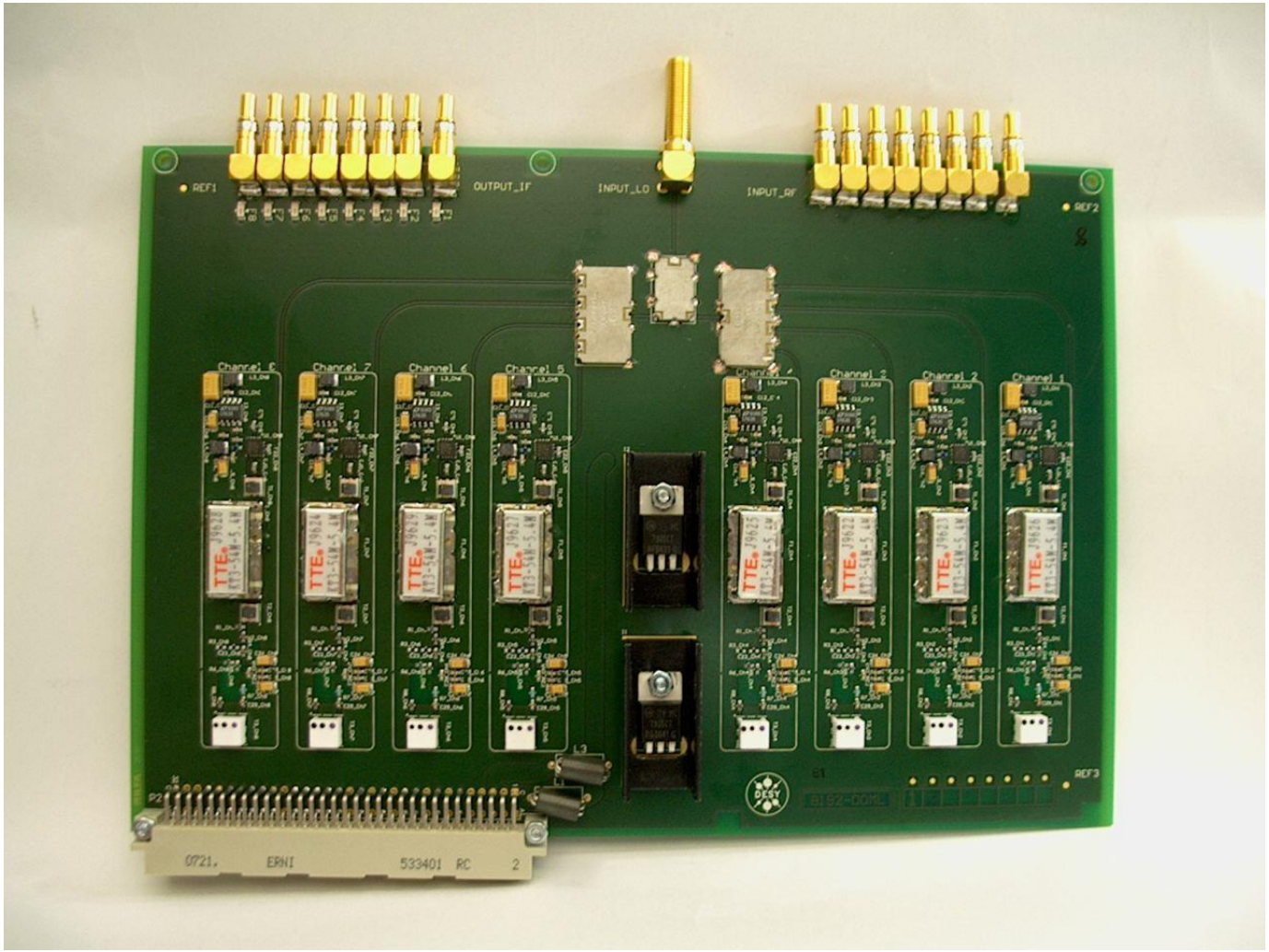




- SNR of 73dB is limited by the reference signal generation of RF and LO.

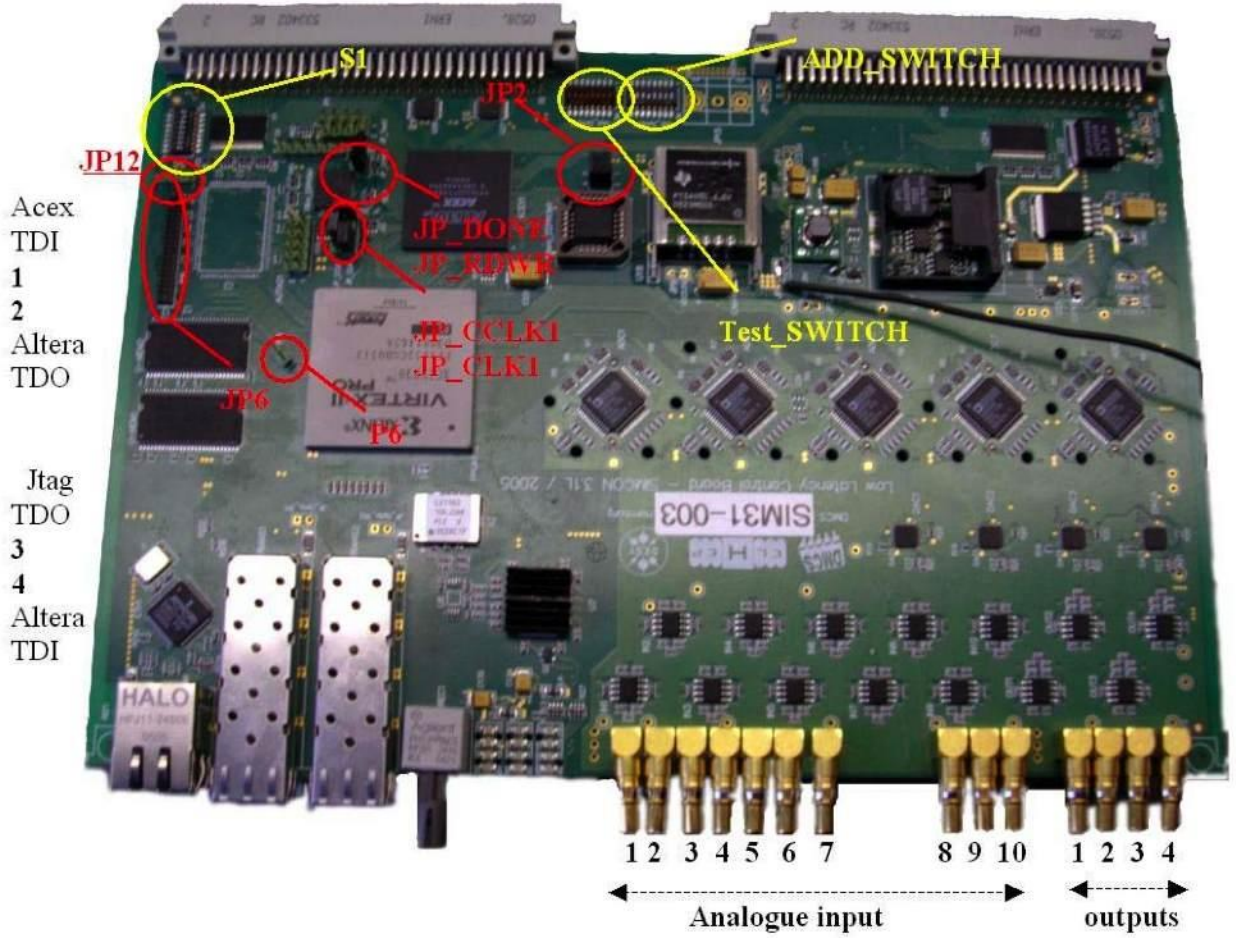
- Test setup with fs resolution.
- Diplexer design to reduce distortions.

8-channel downconverter



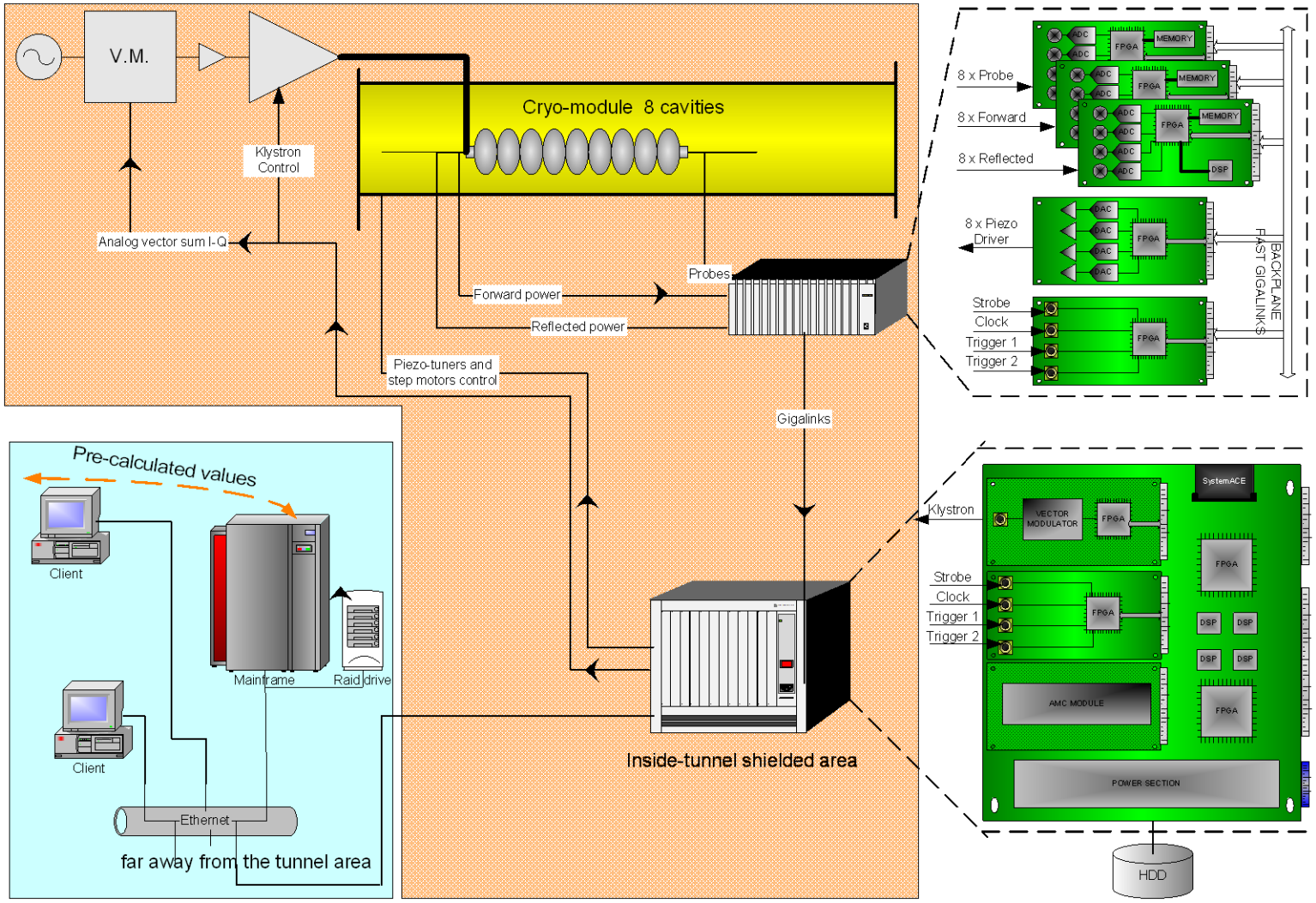
DESY SIMCON 3.1 Controller

2.SIMCON3.1 board description and schematics.

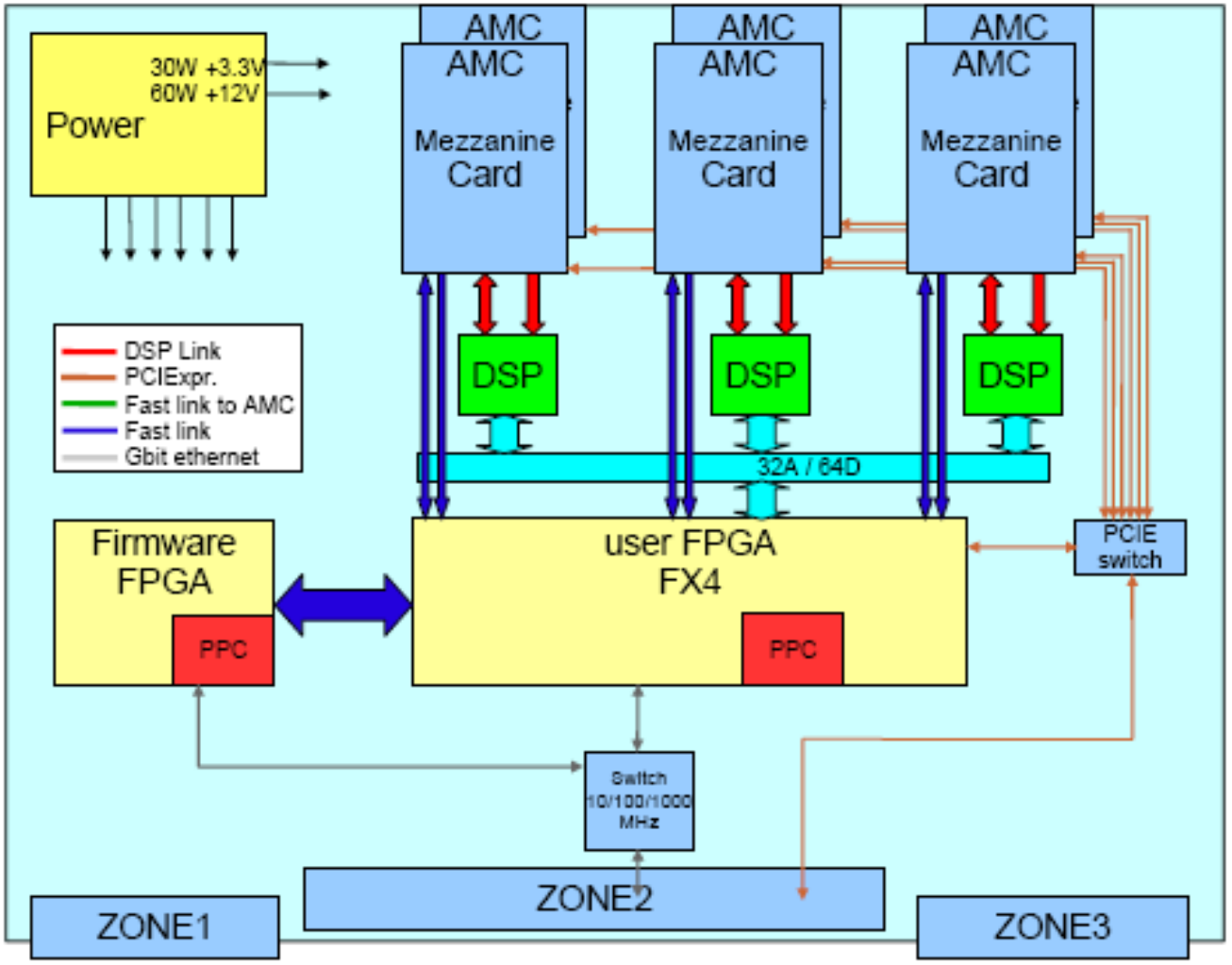


Next generation: SIMCON DSP

Next generation: ATCA

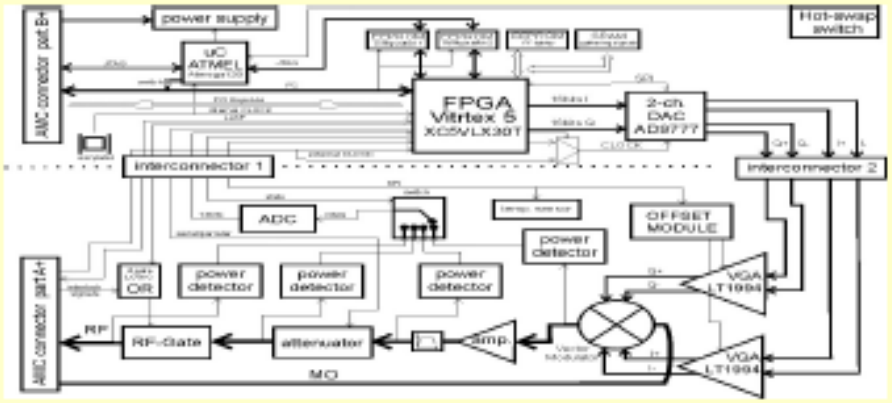


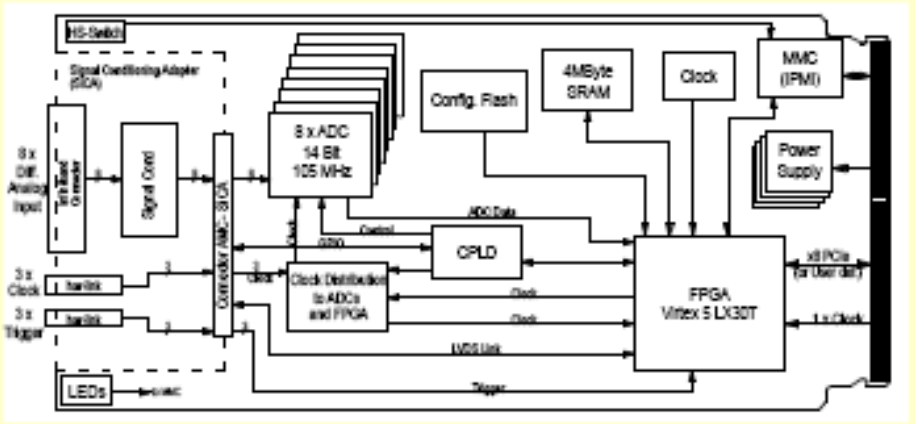
Architecture of Carrier Board



AMC Modules

- ***All modules:***
  - IPMI v. 1.5
  - PCIExpress
  - Fast link to the carrier (10 differential pairs)
  - Virtex 5
- ***8 channels "slow" ADC board***
  - 14 bits
  - BW 200 MHz
  - SF ext. & int. up 105 MHz
- ***2 channels. "fast" ADC board***
  - BW 1 GHz
  - 10 bits
  - SF 1-2.5 GHz
- ***Timing Module***
  - Receive coded clock signal, produces 6 different clocks
- ***Vector Modulator***
  - Digital input
  - 1.3 GHz, 0dBm





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[2] A. Regan et al., "The SNS Linac RF Control System", Proceedings of the 2002 Linac Conference, Gyeongju, Korea

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