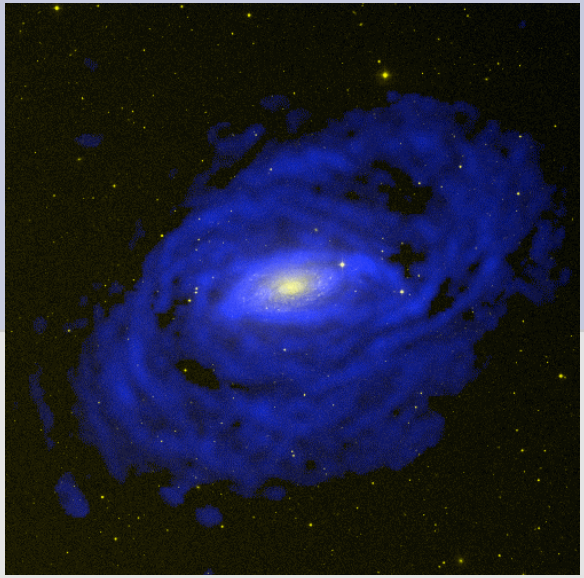
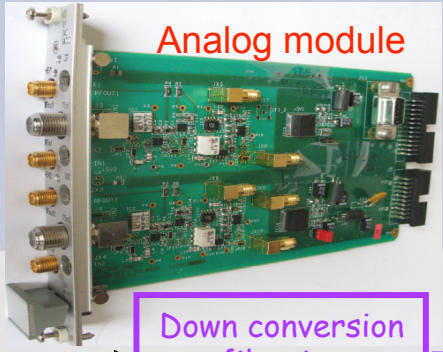
BAO project in radio

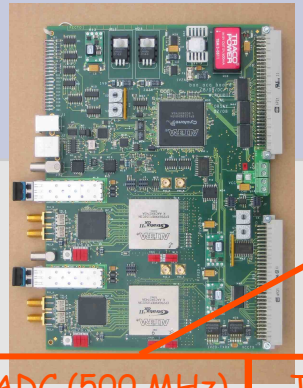


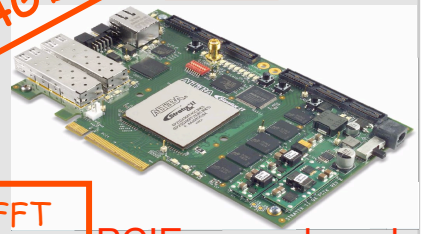
Fast aquisition system for 3D mapping of cosmological matter distribution in radio

CEA/Irfu IN2P3/LAL CMU Fermilab colaboration

Electronics chain







X 4

Antenna board
4 dipoles

128 dipoles

X 4

Antenna board
4 dipoles

Down conversion filtering

2nd

X 4

Down conversion filtering

2nd

ADC (500 MHz)
4 channels

Time FFT
FPGA

2x4Gbit/s

PC

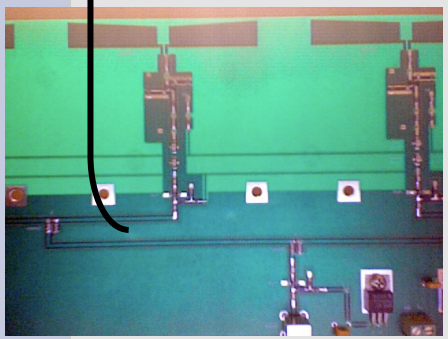
PCIExpress board

2x4 Gbit/s

Spatial FFT
(FPGA)

X 8

Clock distribution



ADC (500MHz)
4 channels

Time FFT
FPGA

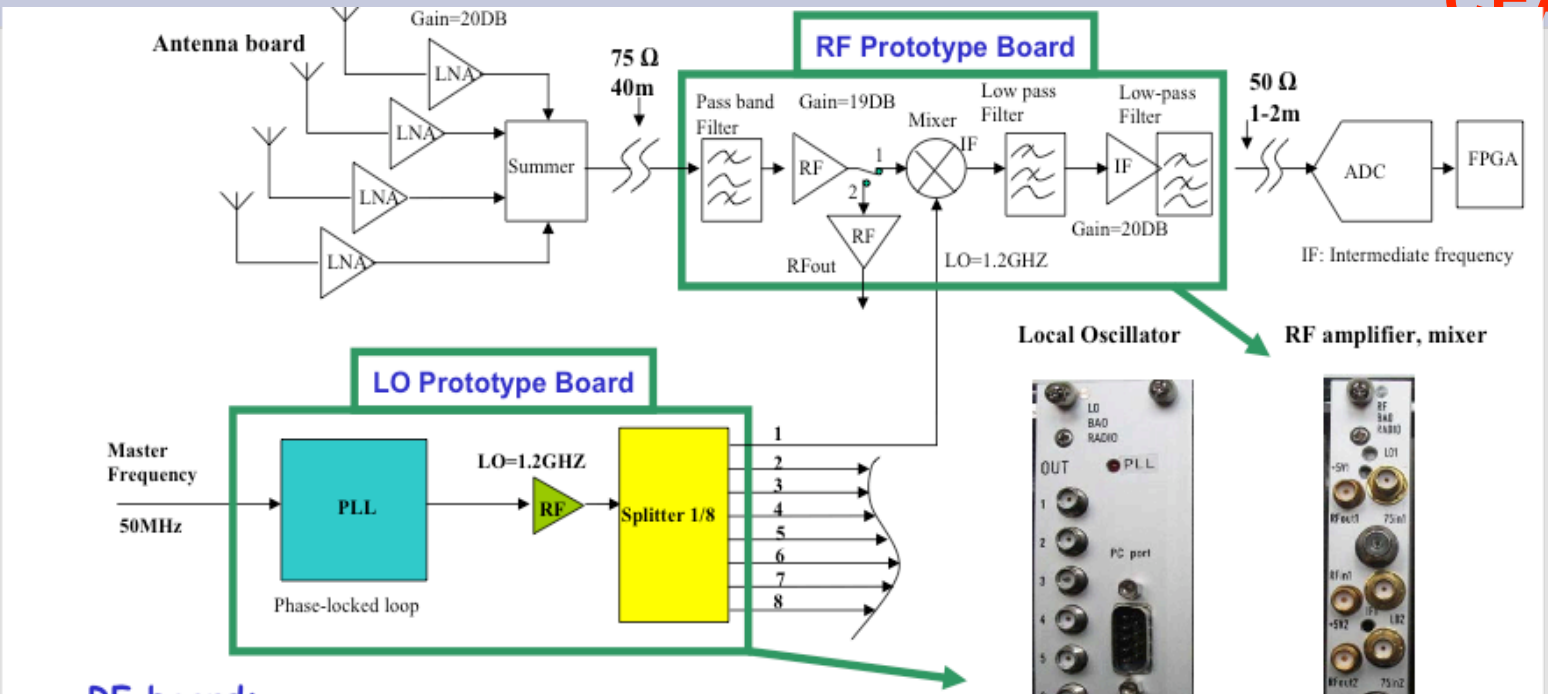
2x4.Gbit/s

2x4 Gbit/s

PC

Analog chain for RF prototype board

CEA irfu



Front panel plug-in (3U EuroCard)

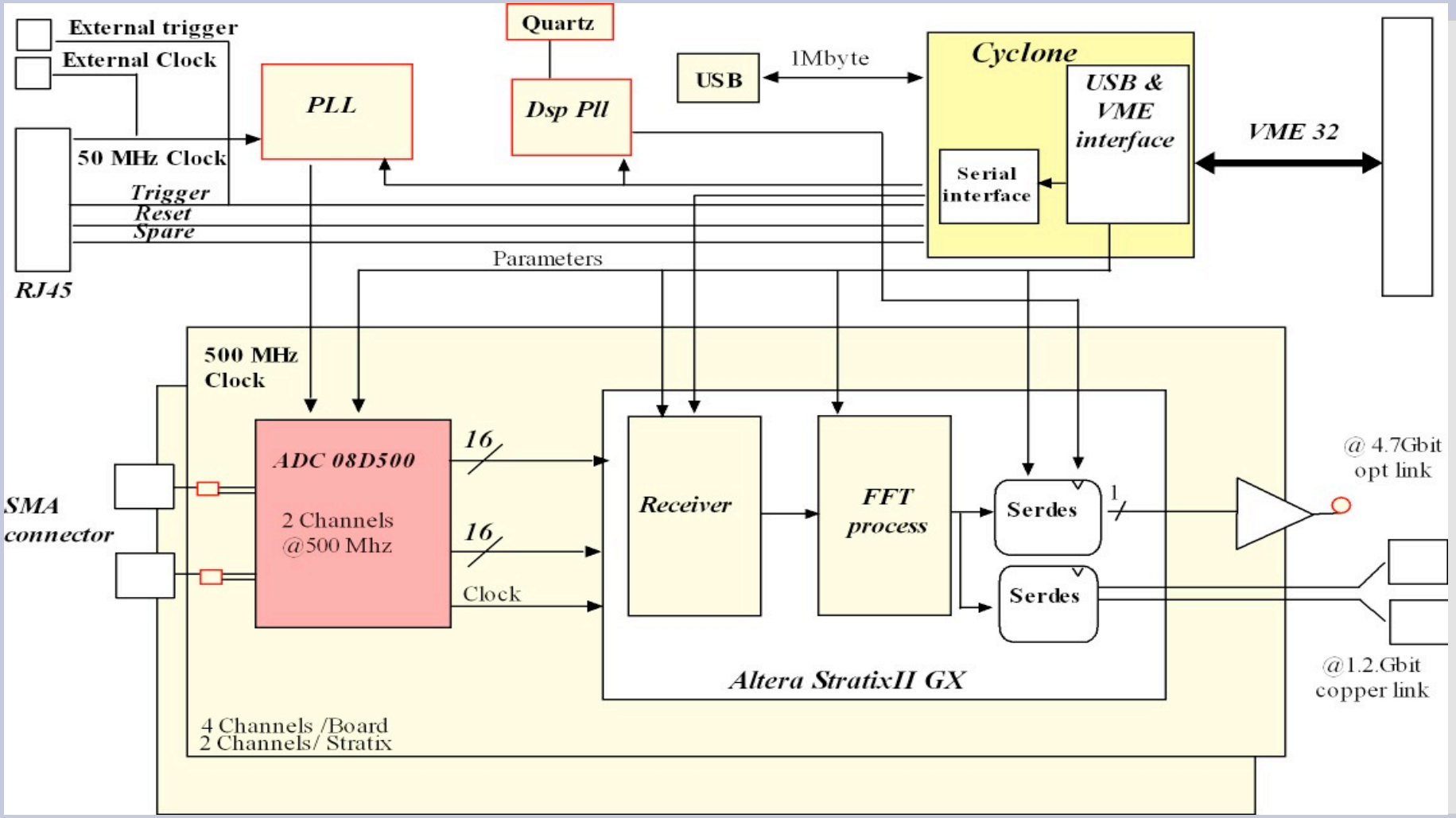
RF board:

- 75Ω/50Ω inputs
- 2 channels per board
- Possibility of by-passing mixer to test the under-sampling approach.
- Possibility to "tune" the pass band filter

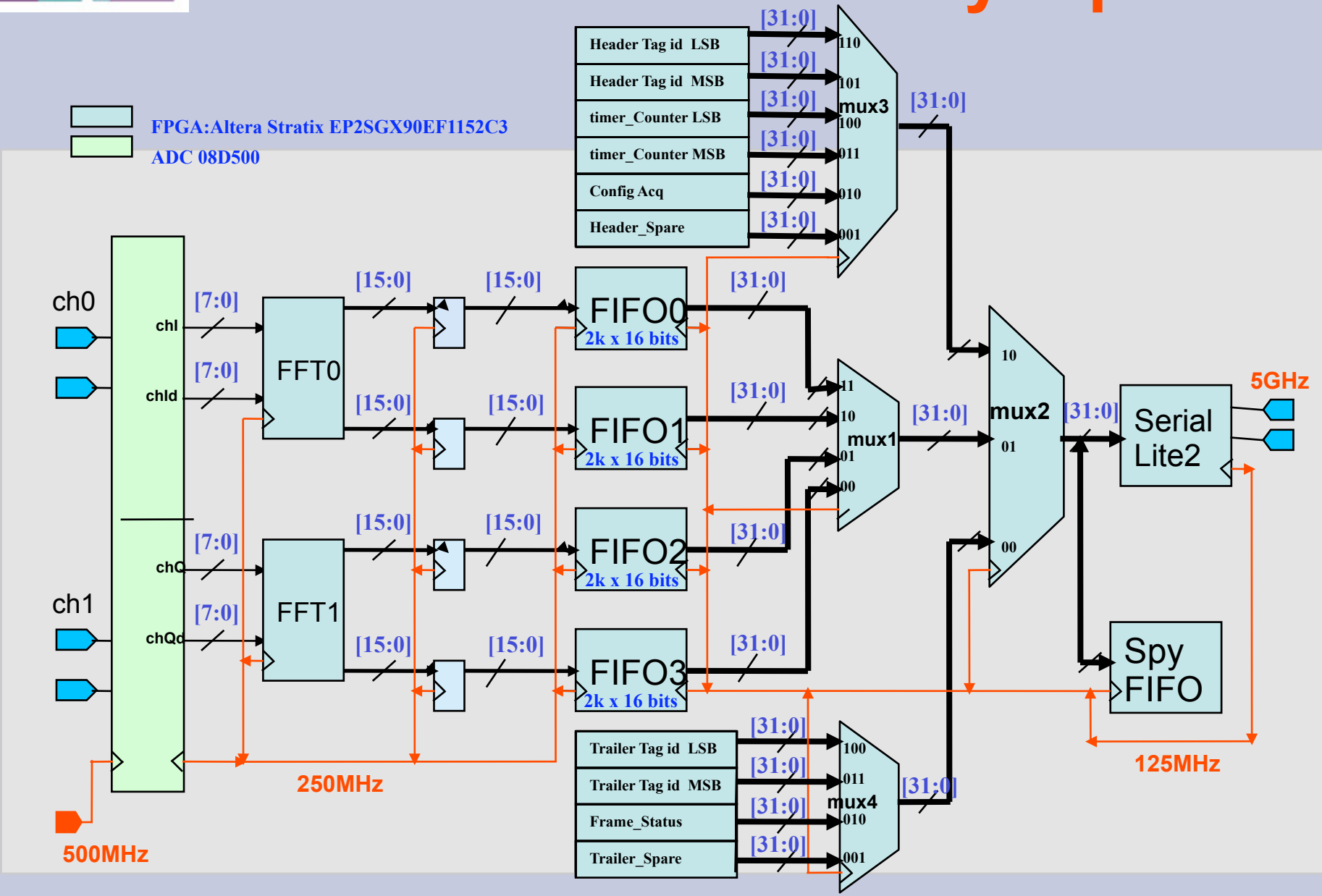
BAO Radio HSHS project

January 10, 2008 4

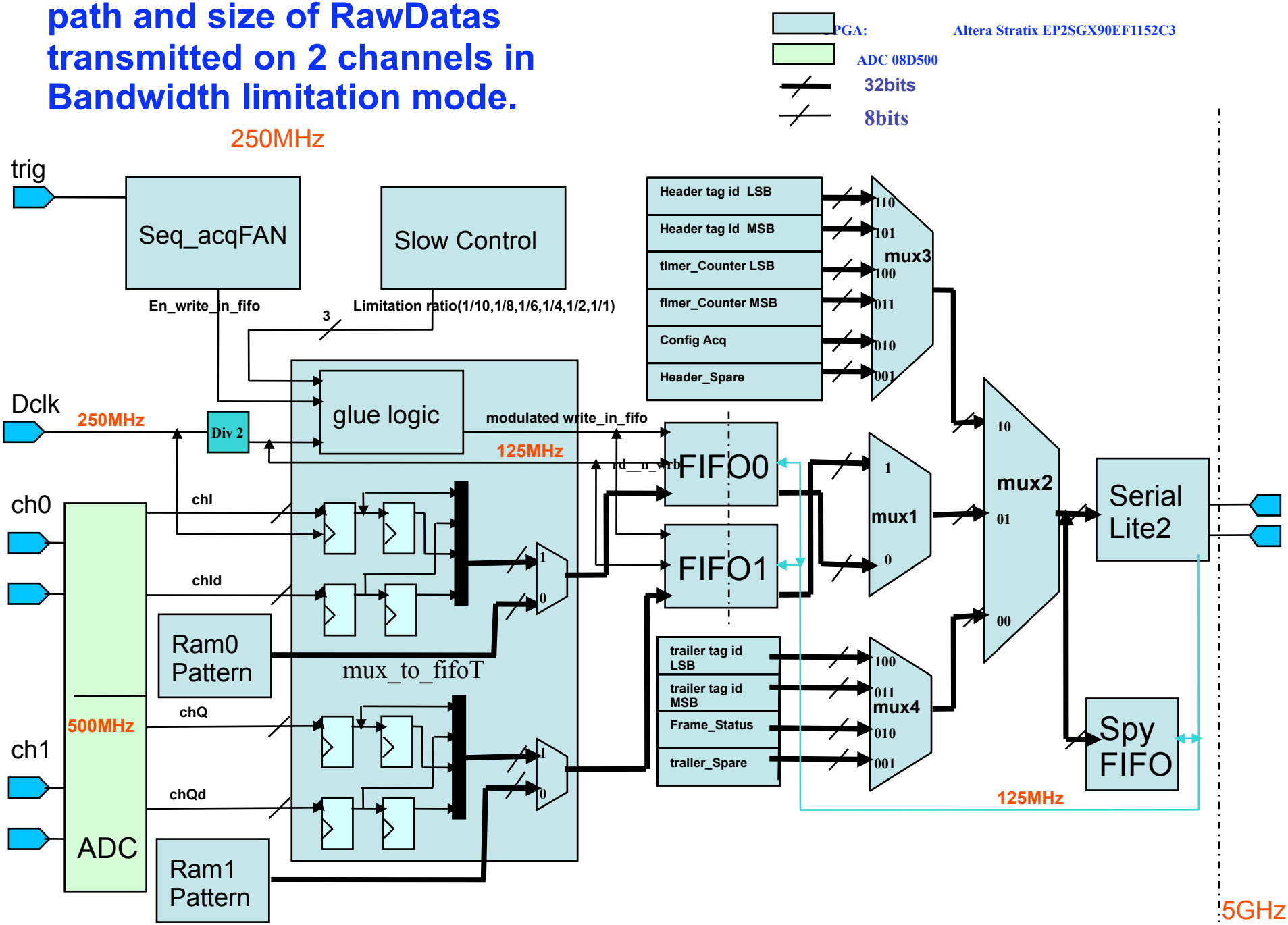
LAL ADC board Synoptic



ADC board FPGA Synoptic



path and size of RawDatas transmitted on 2 channels in Bandwidth limitation mode.



Post ADC processing: Temporal FFT

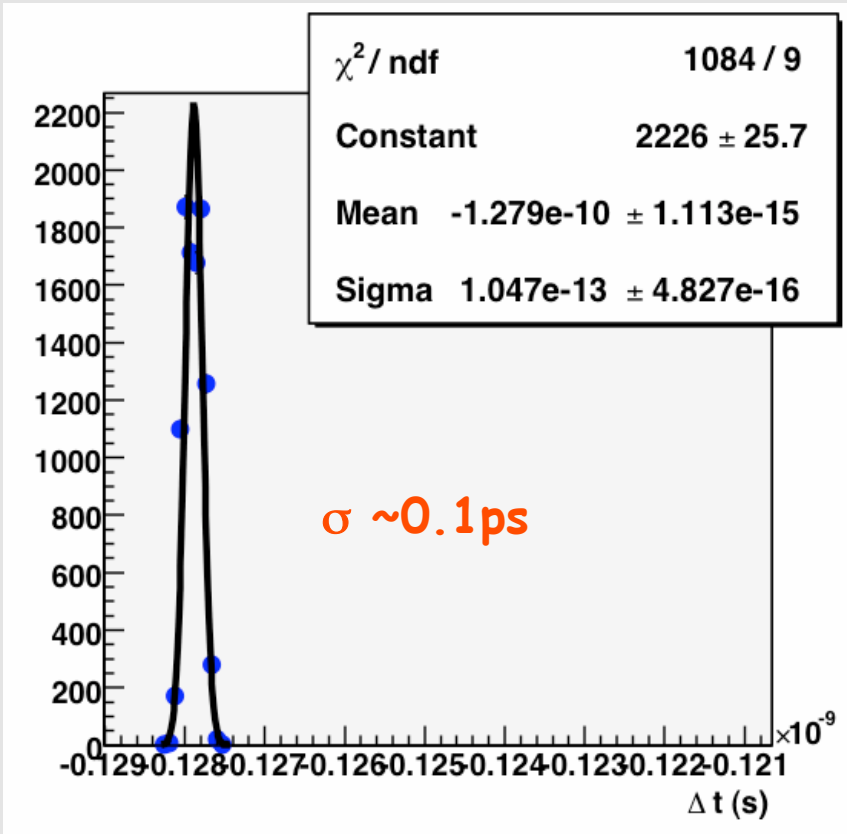
Evolutions réalisées

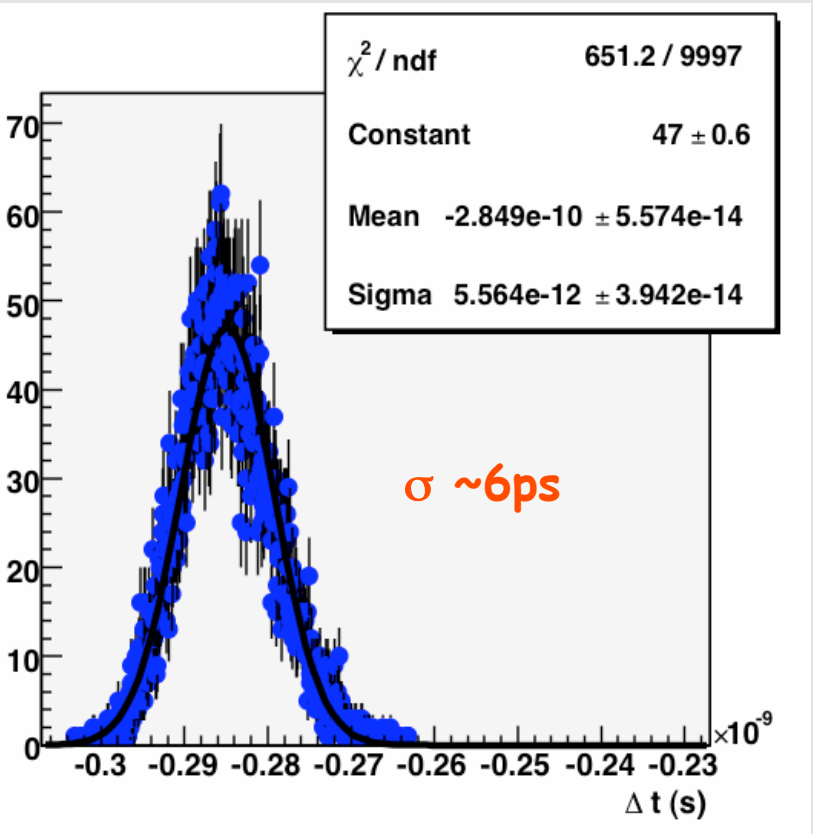
- Saturation datas sortie
- Correction bug exposant saturé
- Modif passage 8bits->12 bits interne

– Résultats préliminaires encourageants (SNR)

– À confirmer

Analog characteristic: 1
Time resolution

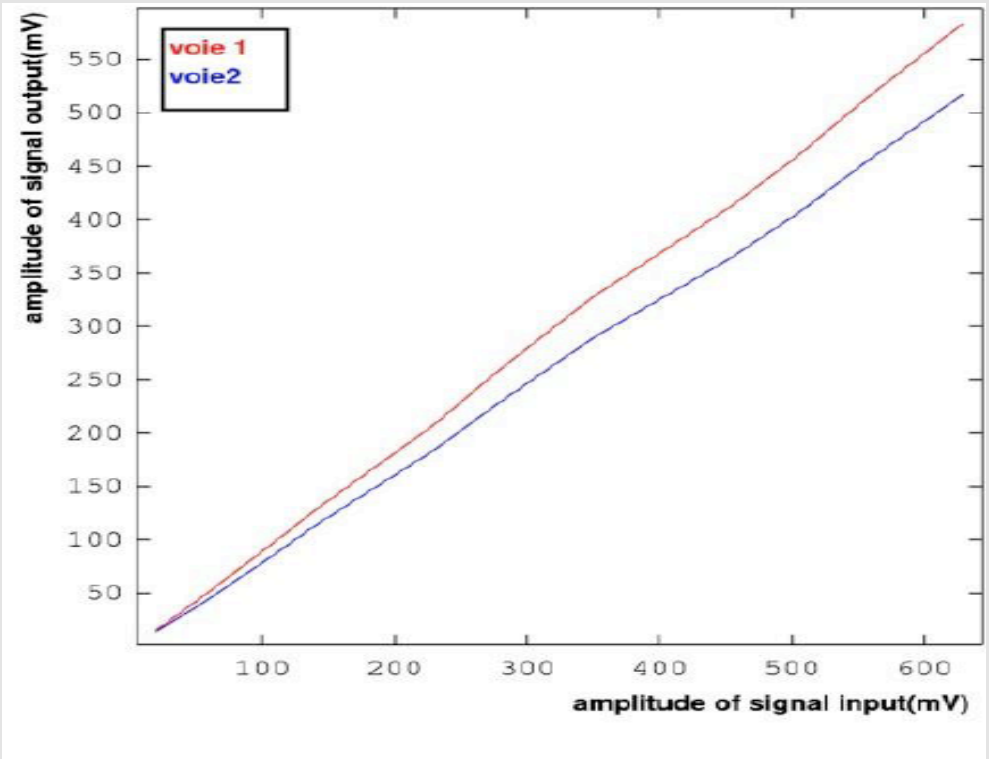




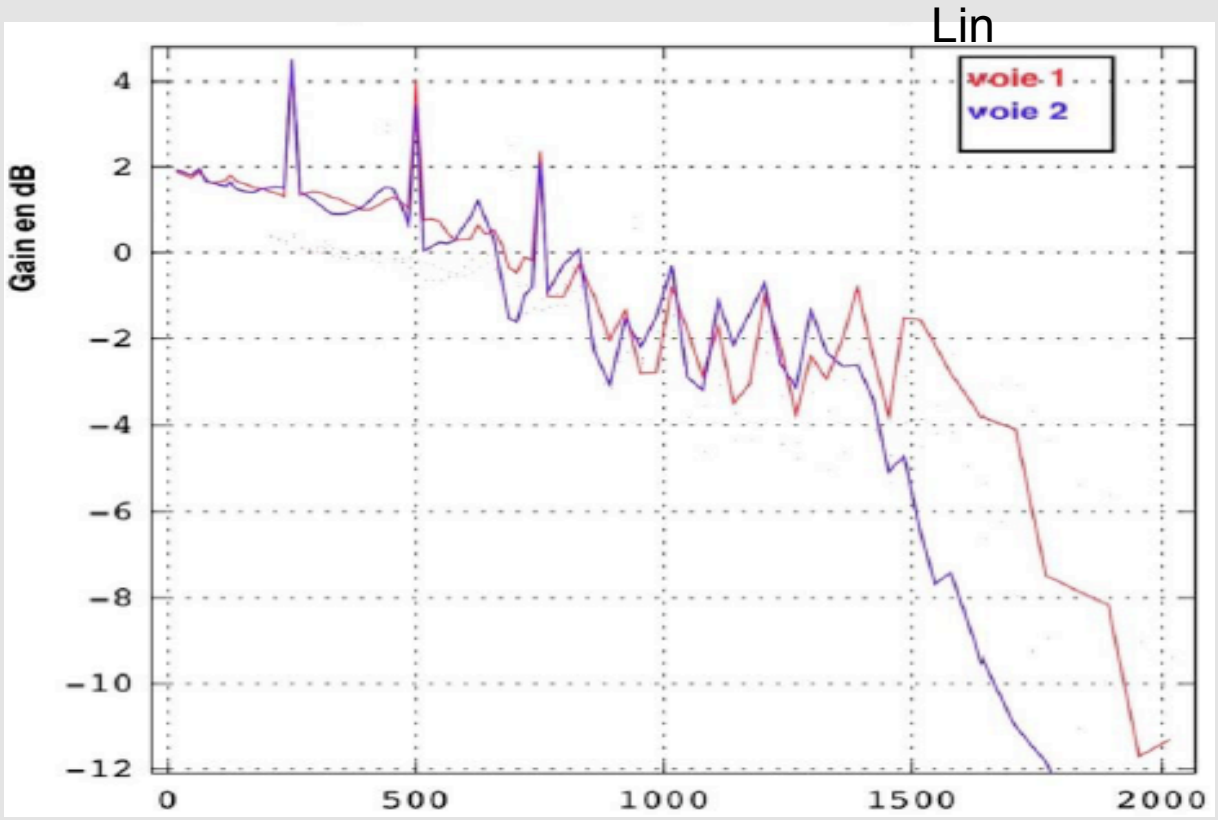
Analog characteristic :2 Linearity

Linearity at 1.4GHz

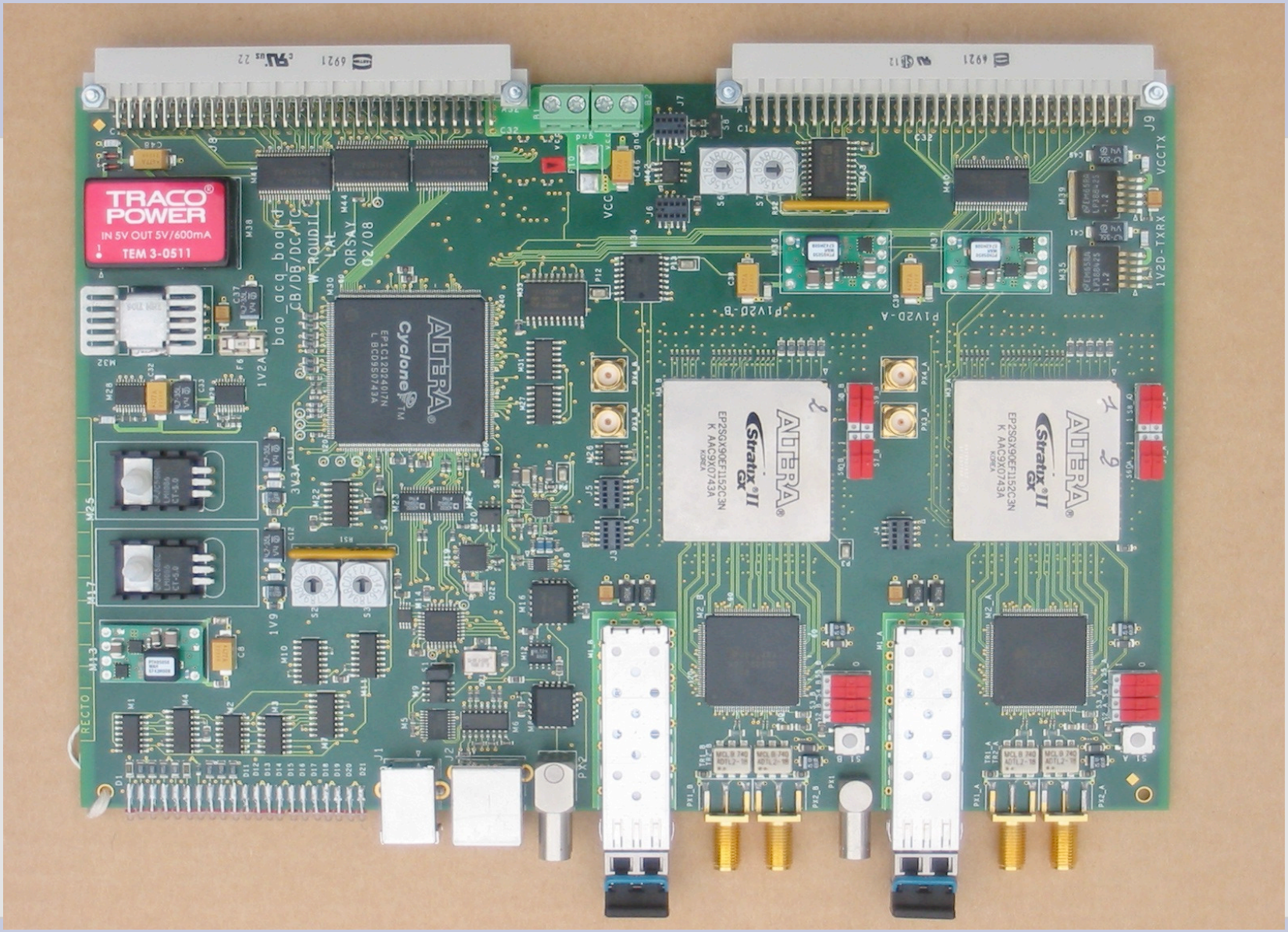
Lin



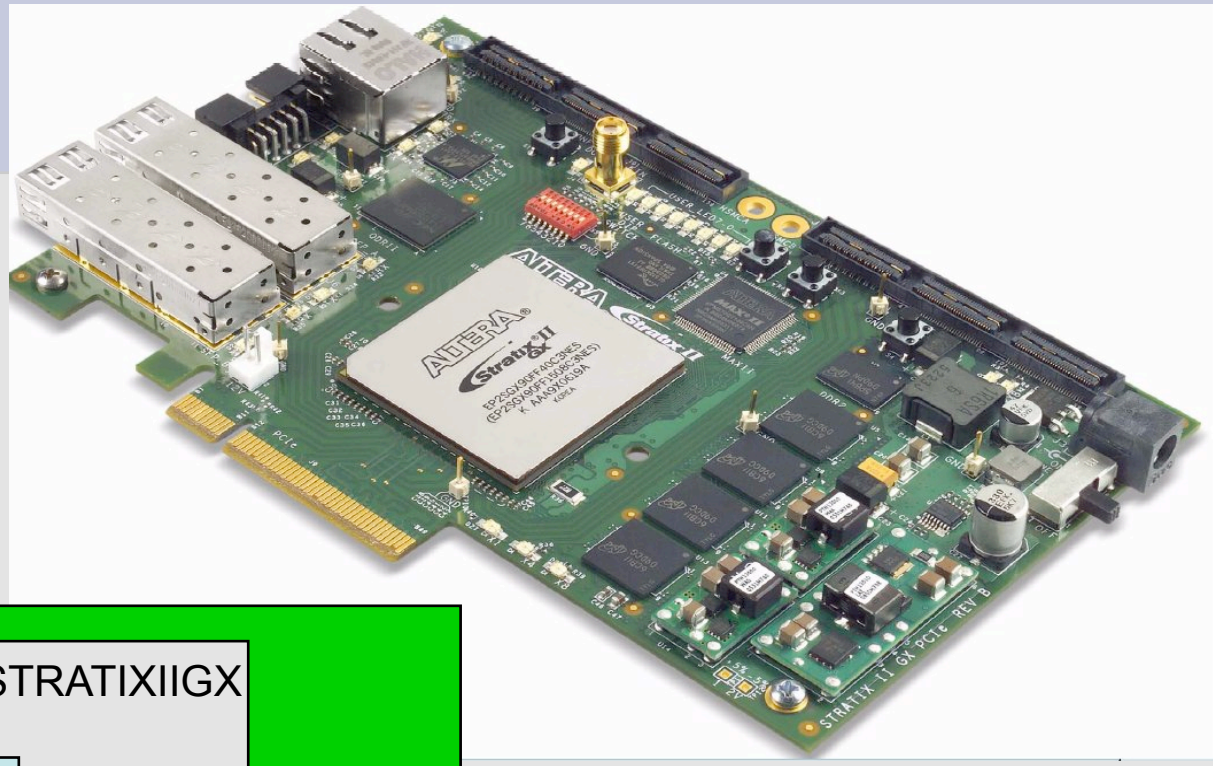
Analog characteristic : 3
Bode diagram

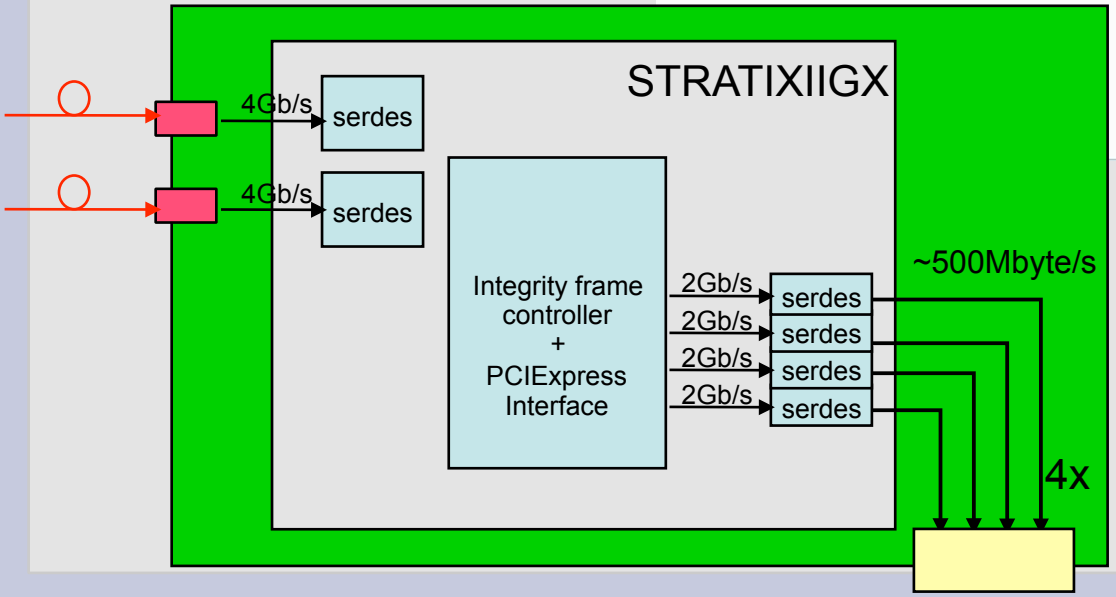


LAL ADC board

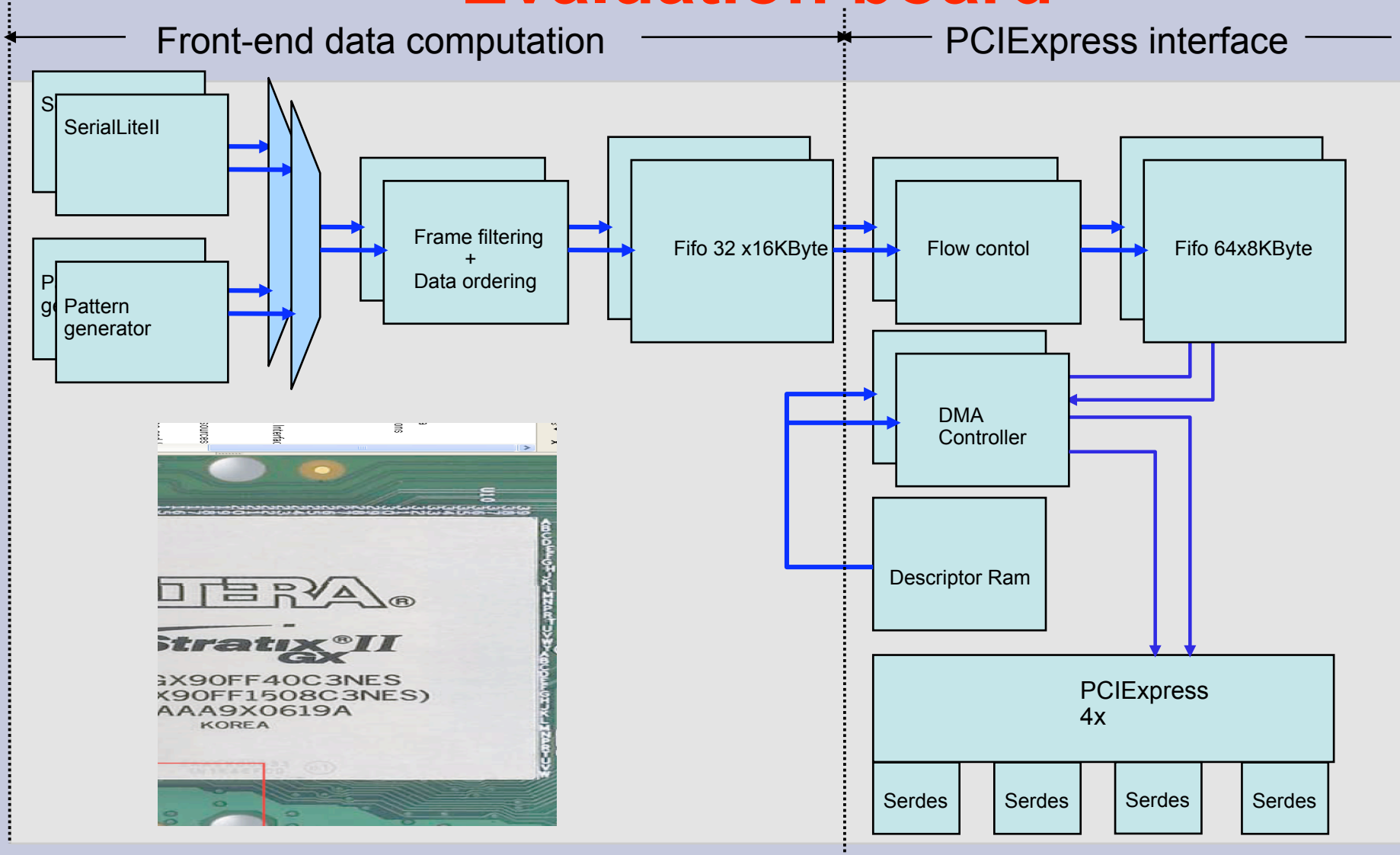


PCIExpress evaluation board



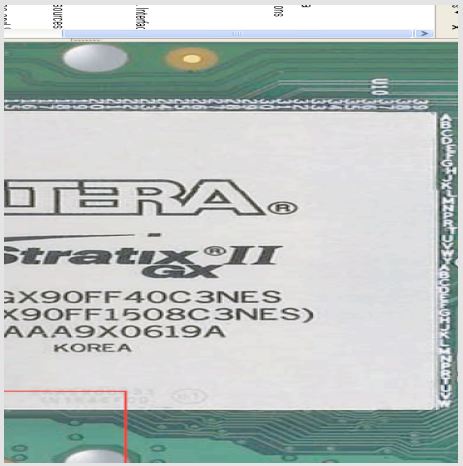


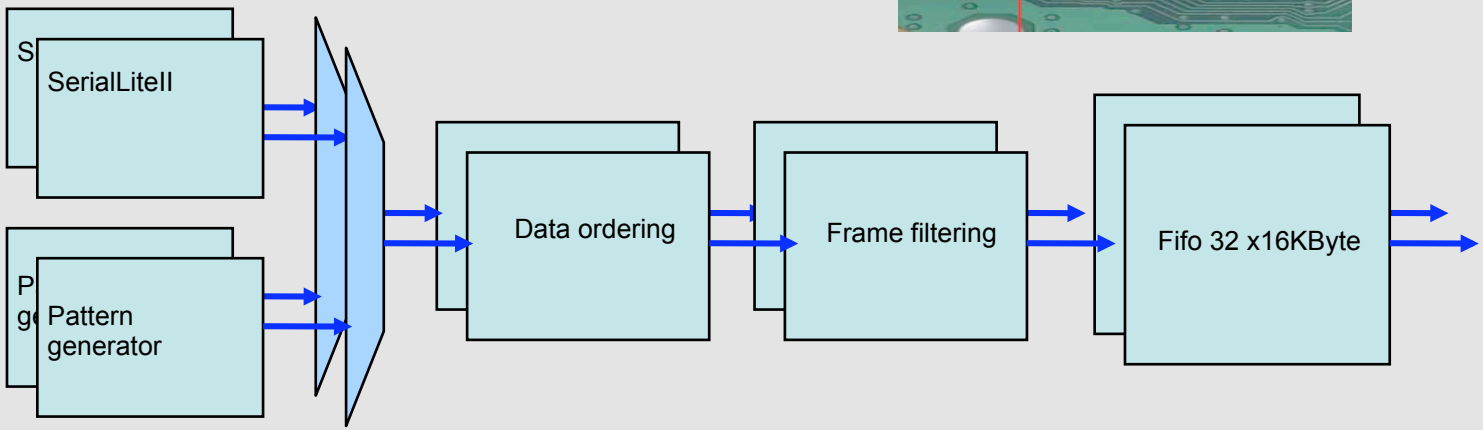
Synoptic FPGA PCIExpress Evaluation board



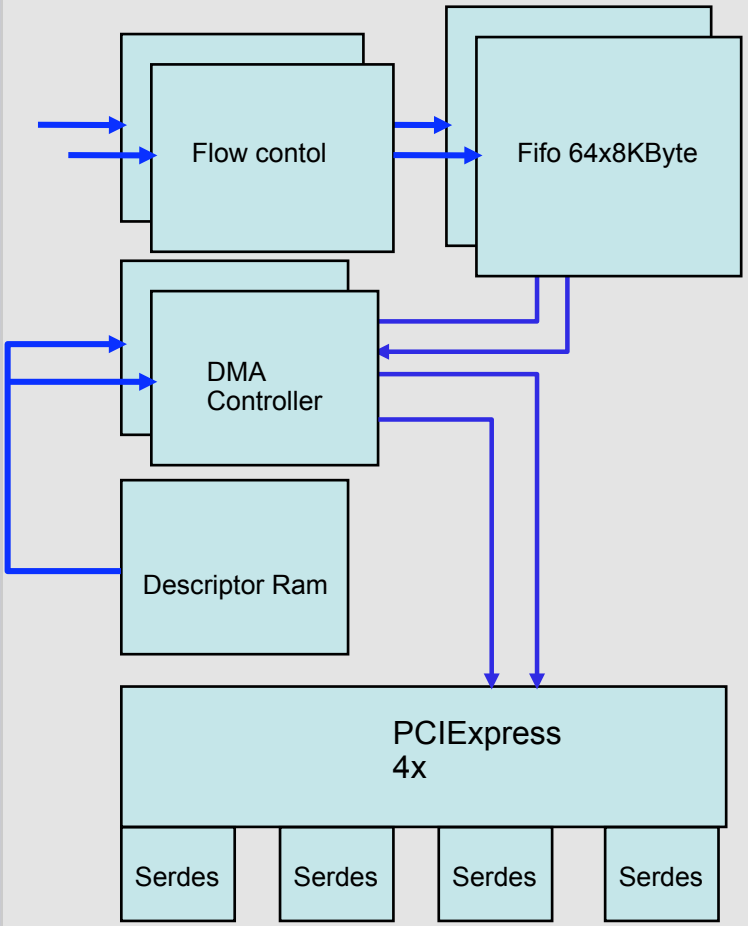
FPGA synoptic: Front-end data computation

- Link interface: SerialLiteII.
- Pattern generator.
- Data ordering.
- Frame filtering.
- Buffering: FIF0 64KByt



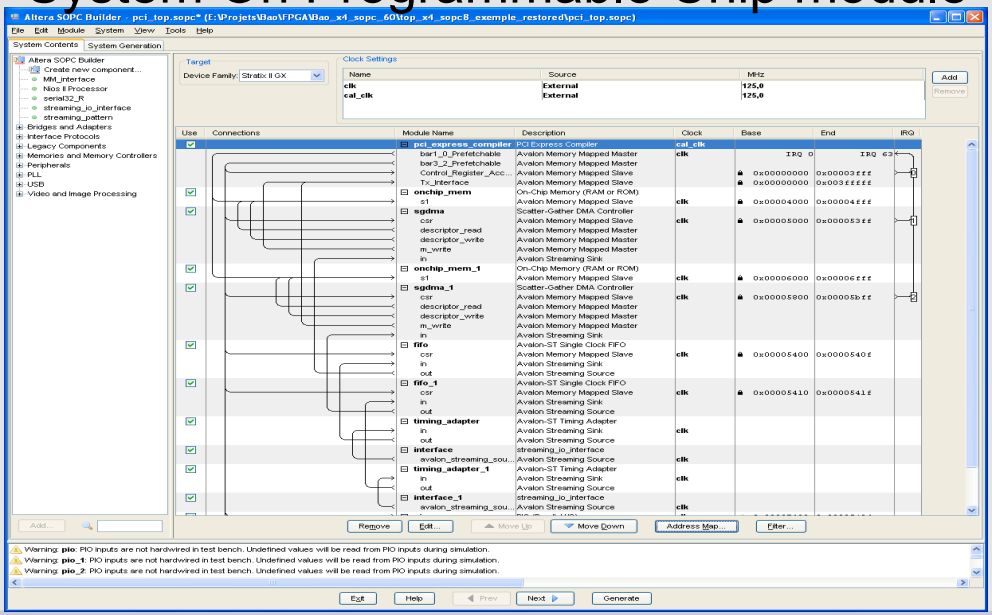


FPGA synoptic: PCIExpress interface



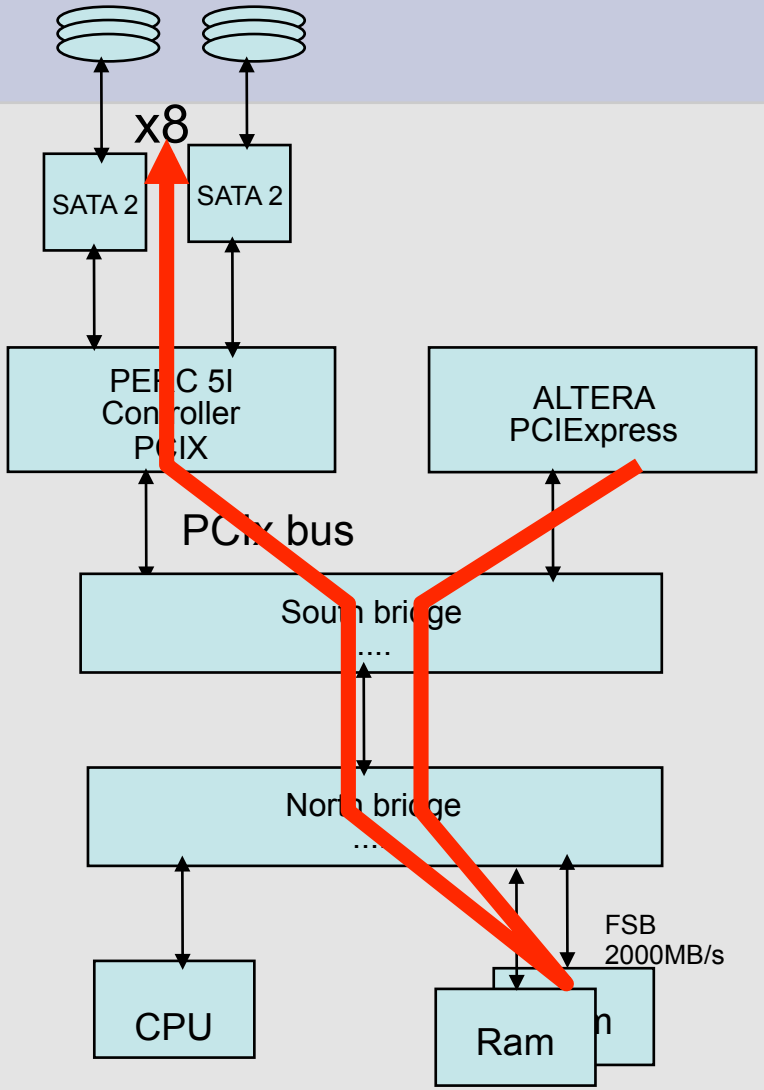
- FIFO buffering
- Scatter-gather DMA
- PCIExpress:
  - End point
  - 4X

System On Programmable Chip module



Aquisition test

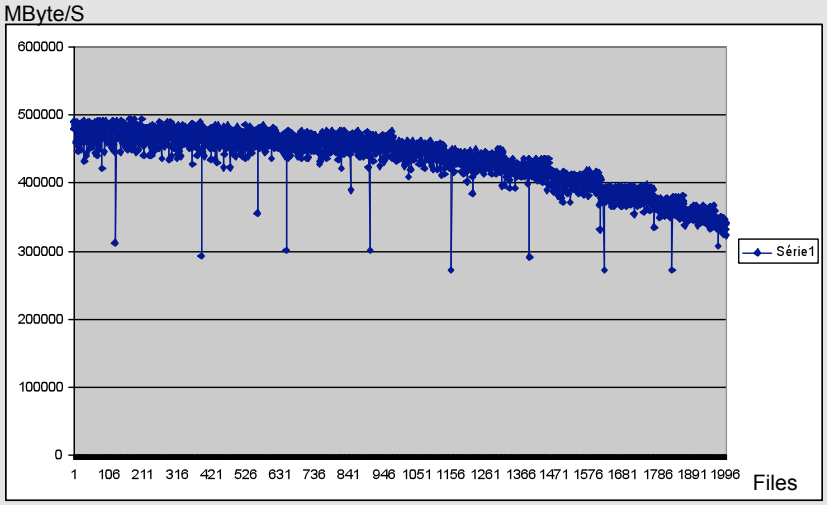
- Poweredge 2900
  - 2 hardware configuration:
    - 1 double core cpu, 2GB ram, 1 raid controller with 8 sata2 disc of 160GB (Western Digital)
    - 1 quadruple core cpu, 4GB ram 1 raid controller with 8 sata2 disc of 160GB (Western Digital)
  - Software configuration
    - Multi thread acquisition:
      - Data reading in DMA mode PCIExpress board and
      - Reading the shared memory and writing on disk



PC Data flow

PCIEpress DMA transfert :

Average throughput 430MB/s



Multi-thread acquisition software:

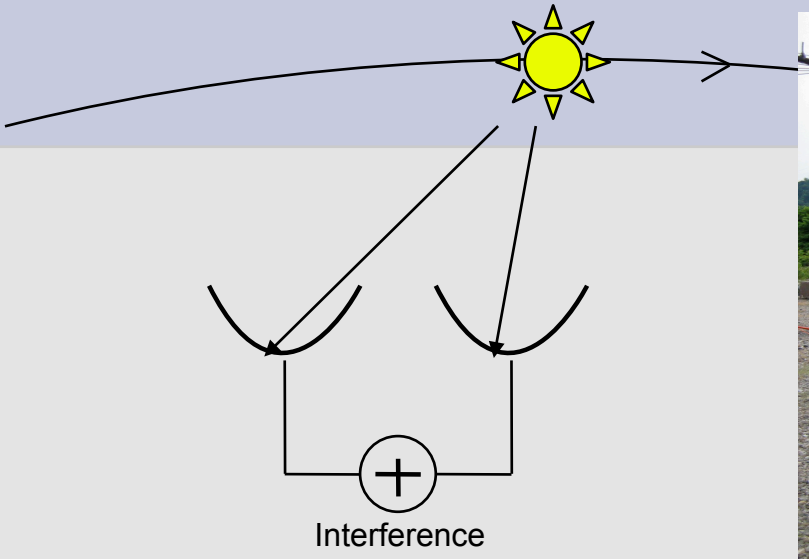
- PCIExpress DMA
- Disck write

300MB/s substained data rate from digitilizer to PC-disck

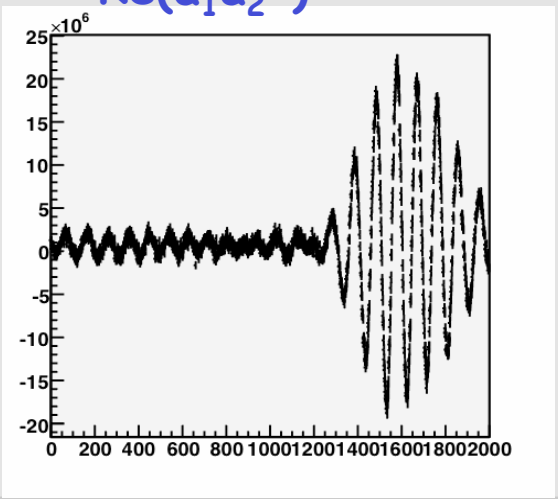
PC Data flow

	pc-bao1	pc-sitr2	nb-planck7	pc-bao2	pc-bao3
	Workstation 390 monoproc. 2cores	PowerEdge2900 monoproc. 2cores	PowerEdge2900 monoproc. 4cores	PowerEdge T100 monoproc. 4cores	PowerEdge R710 2proc. 8cores
transfert DMA	496 Mo/s	496 Mo/s	252 Mo/s	295 Mo/s	349 Mo/s
Perte	1 pqt sur 4600	1 pqt sur 5170	1 pqt sur 2	1 pqt sur 2,4	1 pqt sur 3,3
Acquisition sans écriture sur disque	382 Mo/s	374 Mo/s	231 Mo/s	262 Mo/s	318 Mo/s
Acquisition avec écriture sur disque	46 Mo/s (pas de RAID)	290 Mo/s	230 Mo/s	127 Mo/s	296 Mo/s

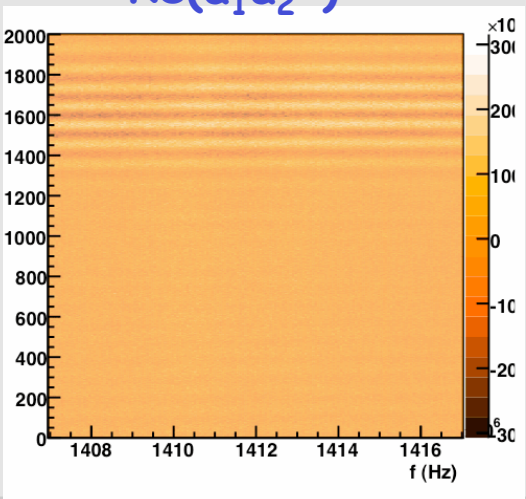
Test in Pittsburgh



$Re(a_1 a_2^*)$



$Re(a_1 a_2^*)$



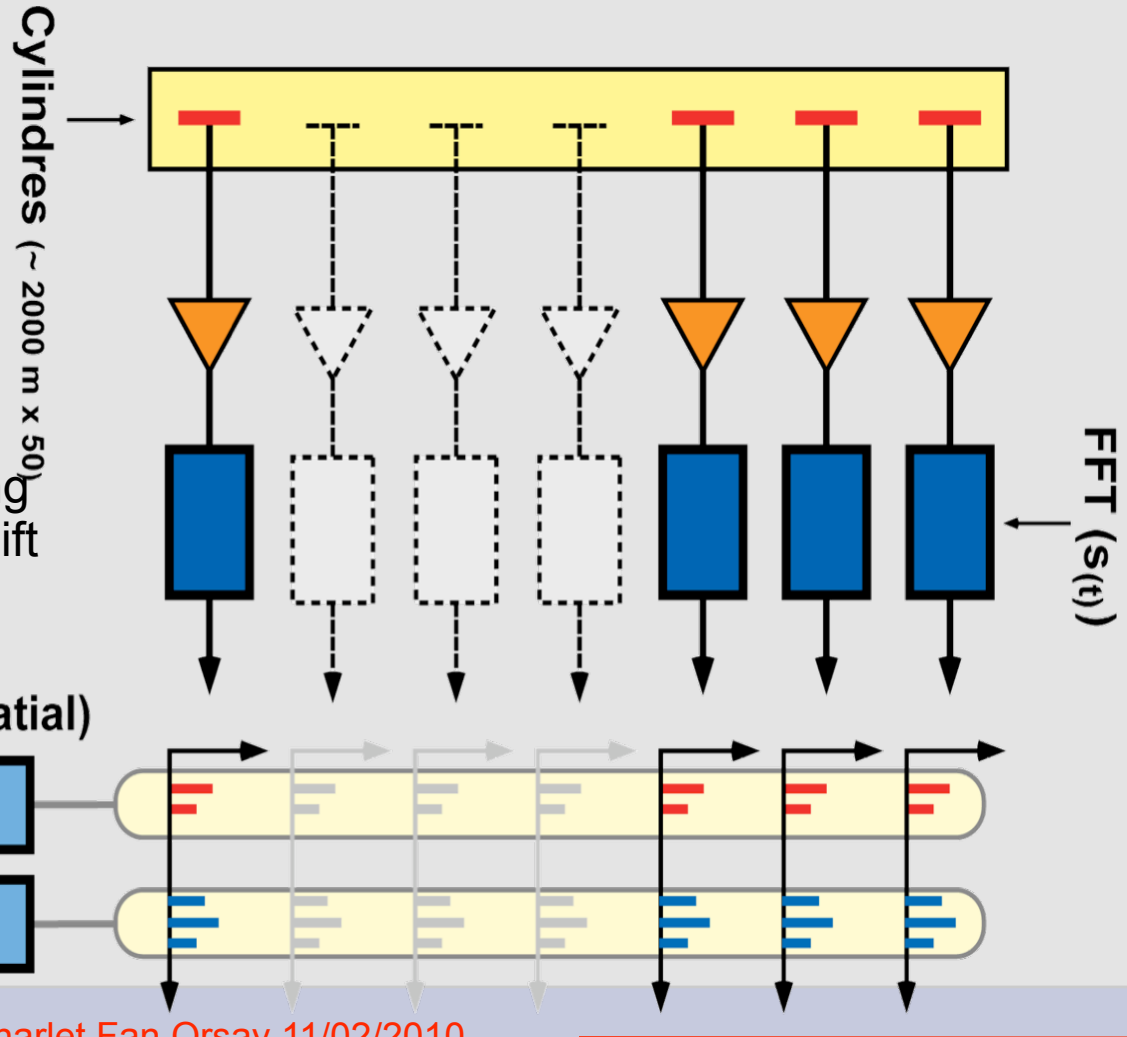
Numerical correlator

- Each channel:
  - Fast Fourier Transform
- ALL channel:
  - Combination of the
  - Same frequency

3 dimensions:

2 angles : FFT beam forming

Distance : frequency red-shift



In conclusion