



LESSONS LEARNED USING NI FLEXRIO PRODUCTS FOR HIGH PERFORMANCE APPLICATIONS

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- Chief Technology Officer (5 years)
- Certified Labview Architect
- Background in industrial physics





PROTORHINO

- Founded 2009
- Focused on the high-end measurement technology market
 - Custom measurement systems
 - Specialty in high-end FPGA systems
 - Strong instrumentation expertise with rigorous scientific measurement background



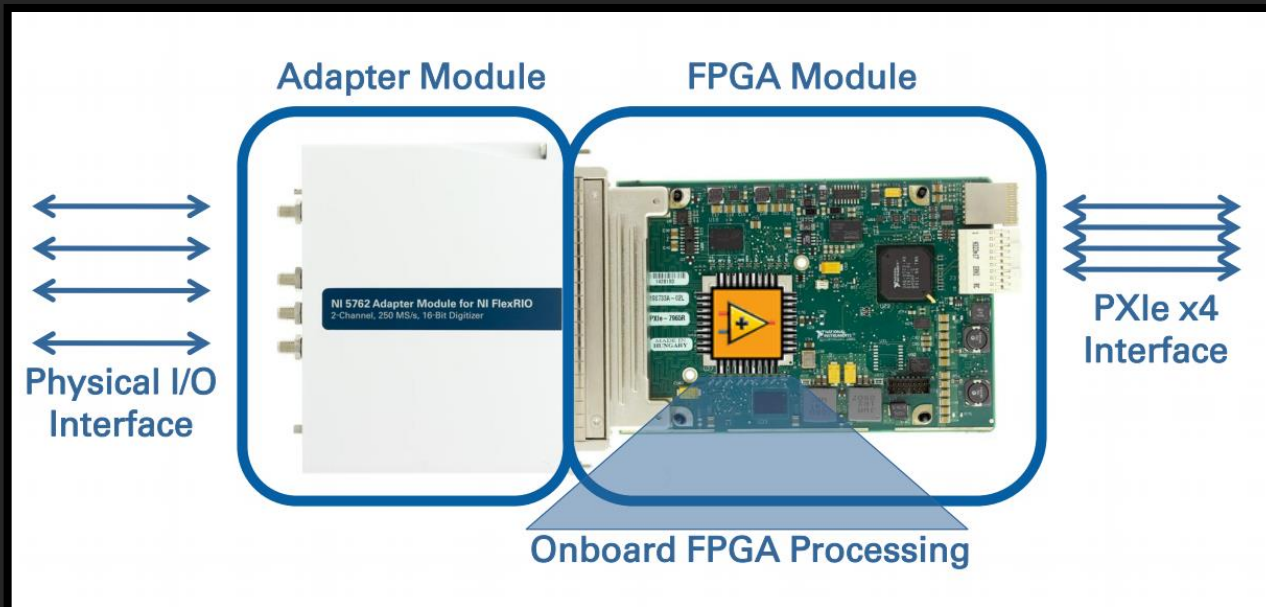


OUTLINE

- What is NI FlexRIO
- Programming considerations
- Hardware considerations
- Case studies
 - Real-time photo-acoustic excitation tuning
 - Flexible gamma detector readout system



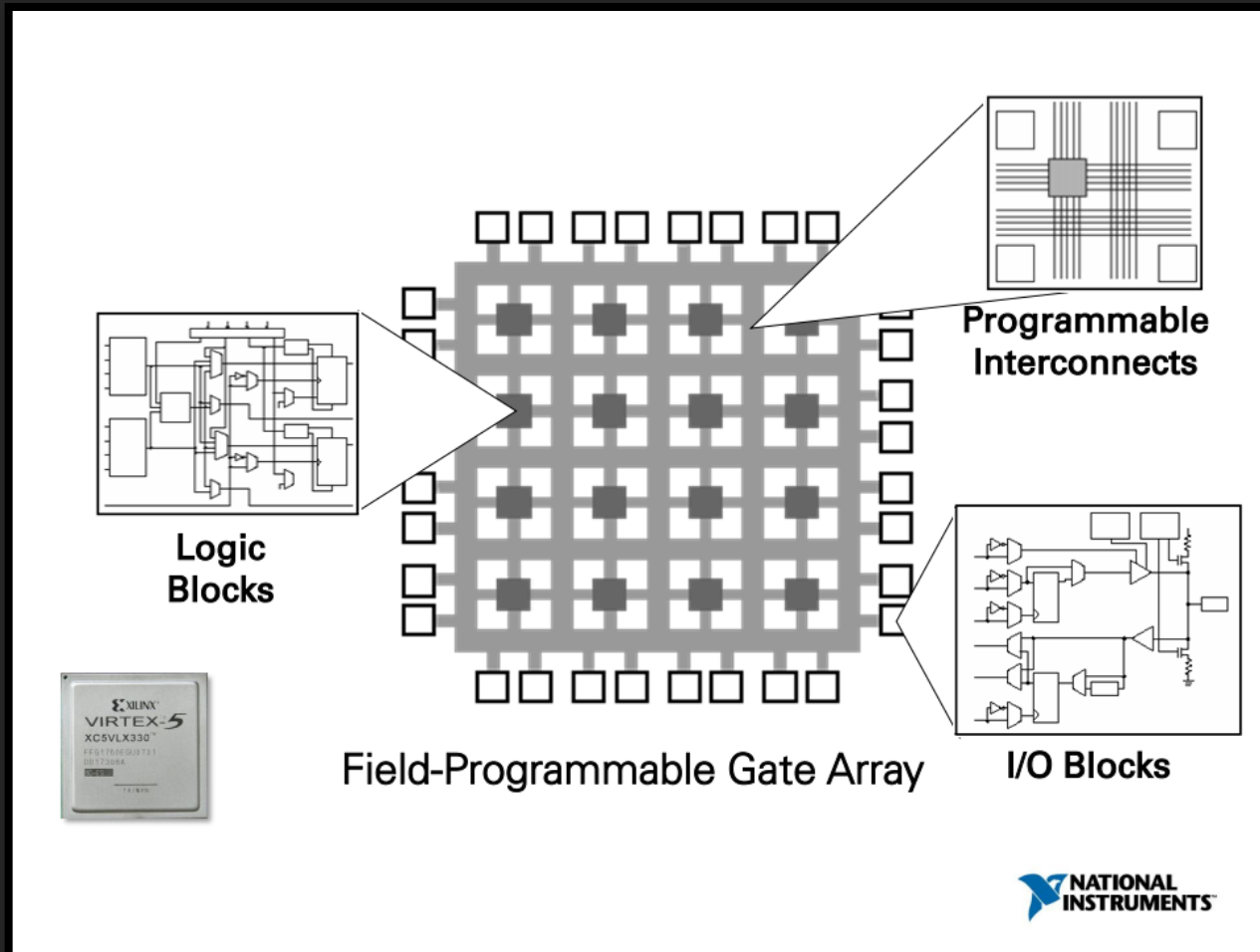
NI FLEXRIO



- State of the art FPGA circuit with multiple different possible front-end modules with varying connectors
 - Fast A/D converters available
 - Multichannel digitizers

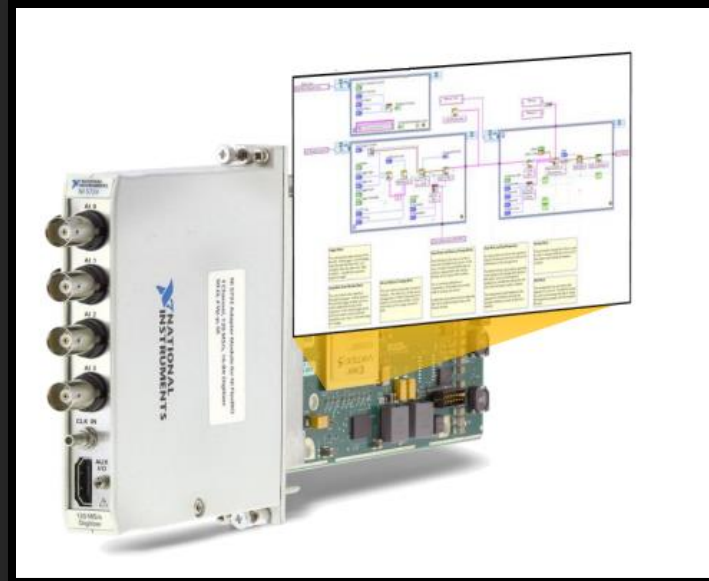


FPGA TECHNOLOGY





LABVIEW FPGA



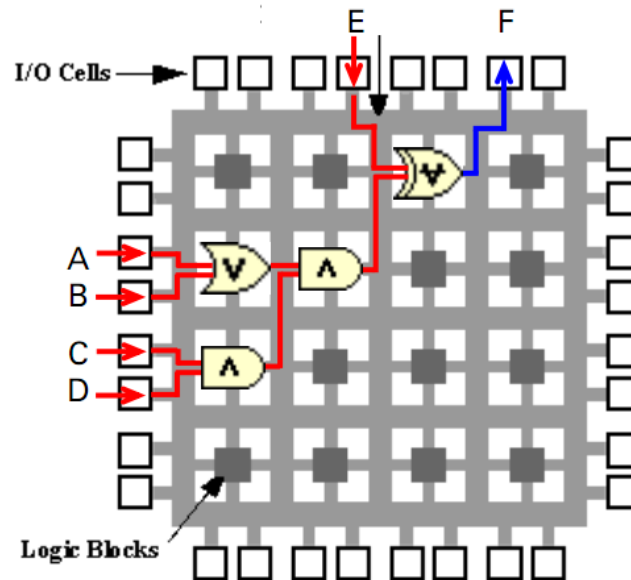
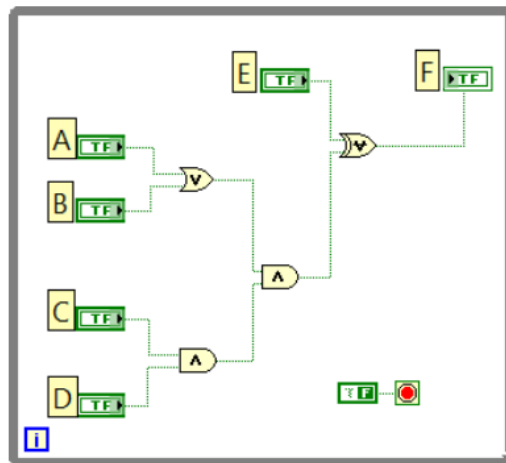
- Easy-to-use visual programming language
 - Also modular



FPGA LOGIC IMPLEMENTATION

Implementing Logic on an FPGA: $F = \{(A+B)CD\} \oplus E$

LabVIEW FPGA Code





FLEXRIO MODULES

Digital



100 Mbps
SE DIO



300 Mbps
LVDS DIO



300 Mbps
SE/LVDS DIO



1 Gbps
LVDS DIO



Camera Link



RS-485/422

Analog



2 ch. 1.6 GS/s,
12-bit AI



2 ch. 3 GS/s,
8-bit AI



2 ch. 100 MS/s,
14-bit AI / 16-bit AO



4 ch. 250 MS/s,
14-bit AI



2 ch. 250 MS/s,
16-bit AI



32 ch. 50 MS/s,
12-bit AI



16 ch. 50 MS/s,
14-bit AI



2 ch. 40 MS/s,
12-bit AI



2 ch. 80 MS/s,
14-bit AI



2 ch. 120 MS/s,
16-bit AI

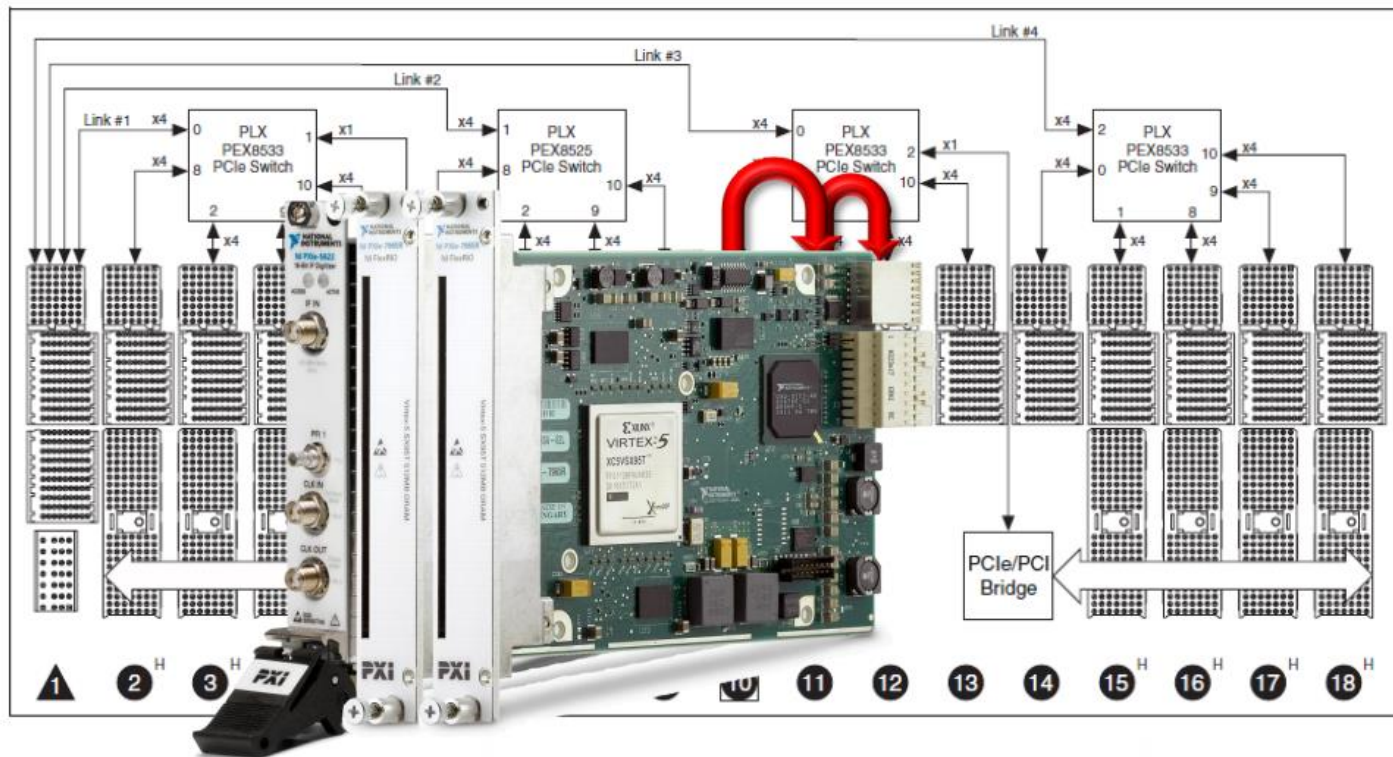


4 ch. 120 MS/s,
16-bit AI



FLEXRIO STREAMING

- >800 MB/s one-way
- >700 MB/s both ways
- ~10 us latency
- Up to 16 streams per FPGA



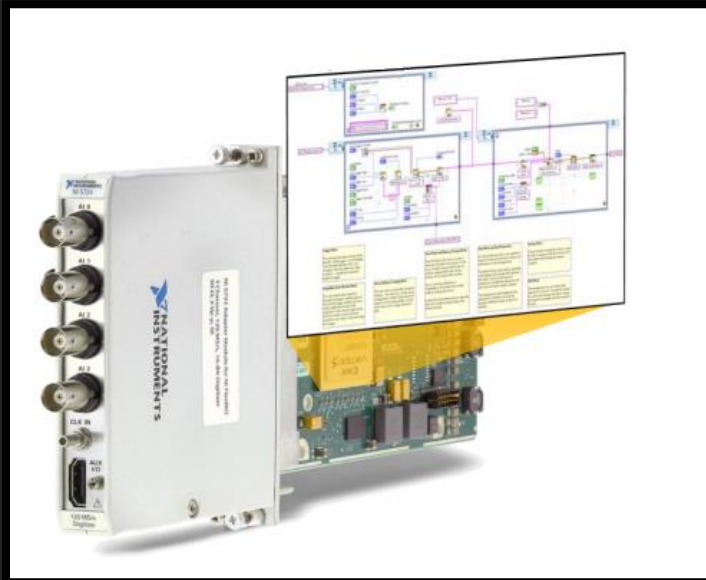


PROGRAMMING CONSIDERATIONS

- NI Flexrio Instrument Development Library
- Single-cycle Timed Loop (SCTL)
- The Four-Wire Handshaking protocol



NI FLEXRIO INSTRUMENT DEVELOPMENT LIBRARY



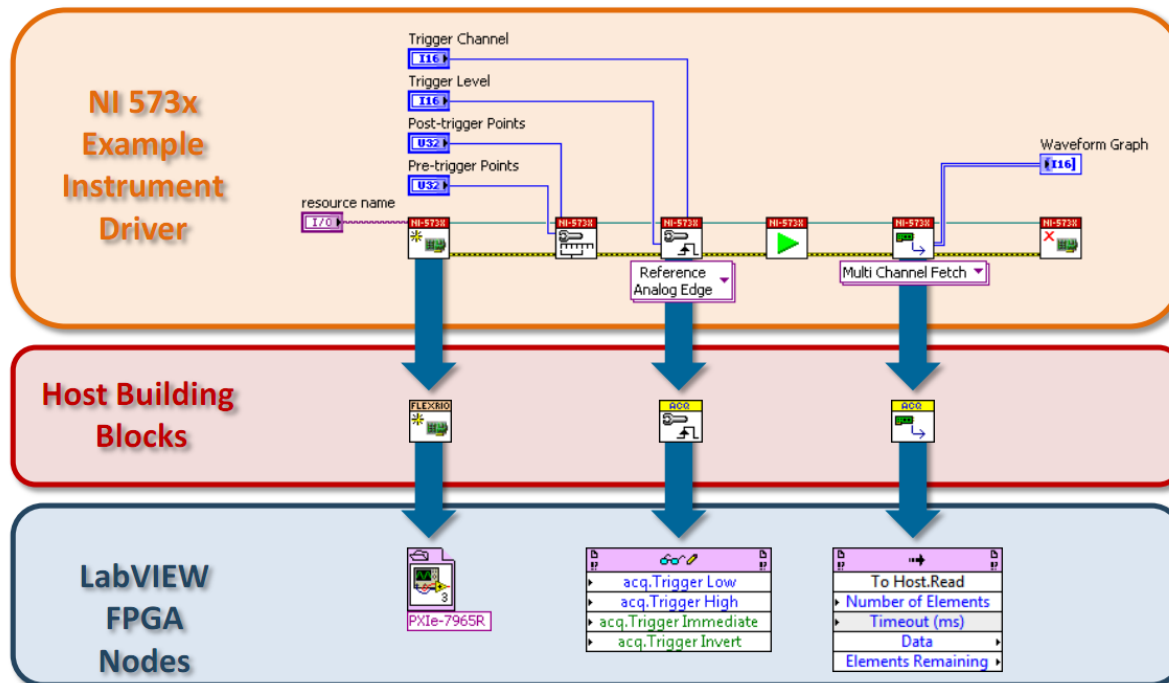
1.3 version is now available

<https://decibel.ni.com/content/docs/DOC-15799>



NI FLEXRIO INSTRUMENT DEVELOPMENT LIBRARY

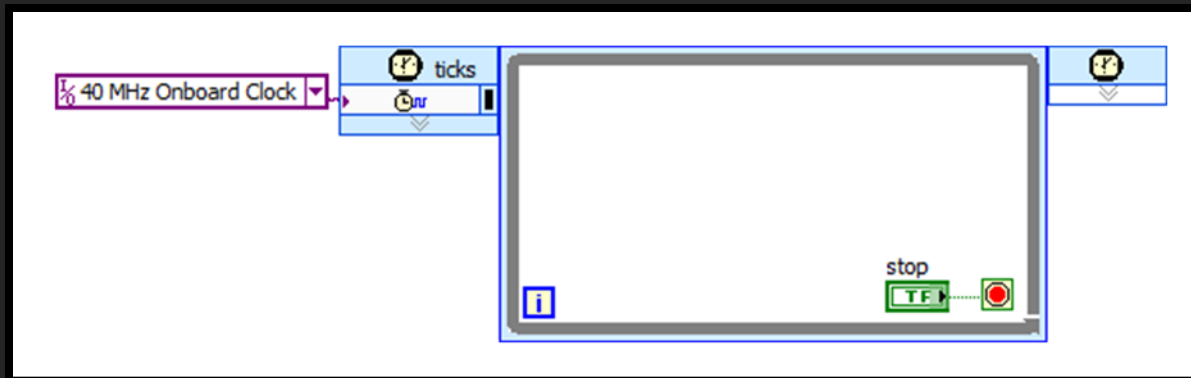
NI 573x Example Instrument Driver





SINGLE-CYCLE TIMED LOOP

- Single-cycle Timed Loop (SCTL)



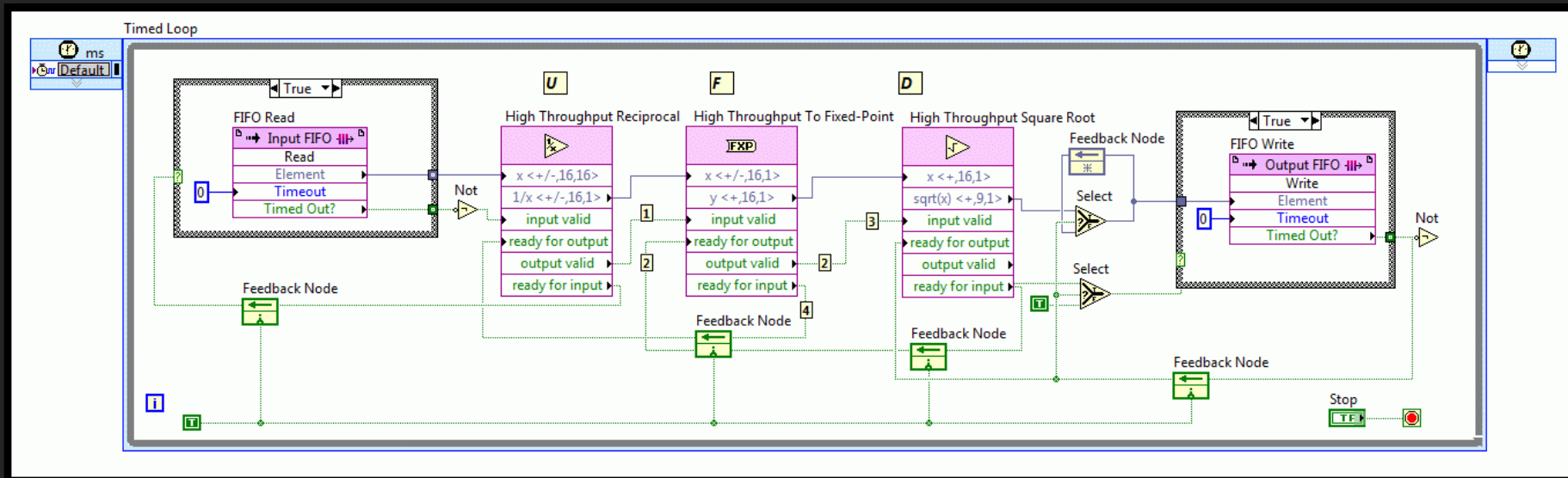
NI LabVIEW High – Performance FPGA Developer's Guide

– http://download.ni.com/pub/gdc/tut/labview_high-perf_fpga_v1.1.pdf



THE FOUR-WIRE HANDSHAKING PROTOCOL

- The Four-Wire Handshaking protocol



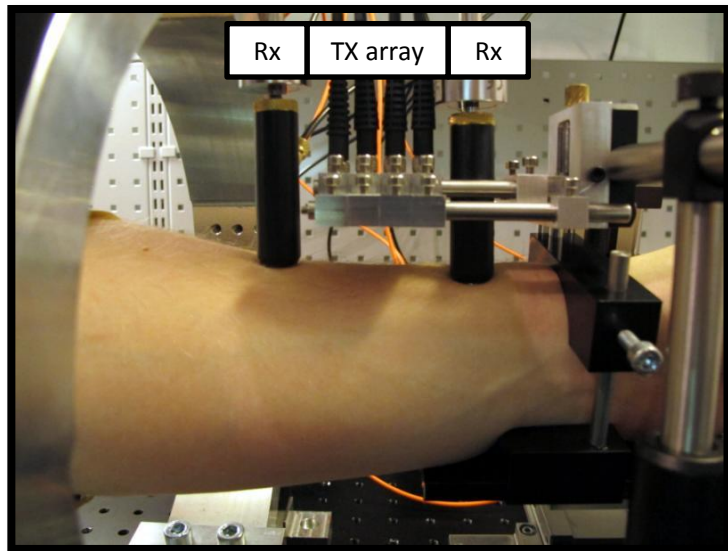
http://zone.ni.com/reference/en-XX/help/371599G-01/lvfpgaconcepts/fpga_handshaking/



HARDWARE CONSIDERATIONS

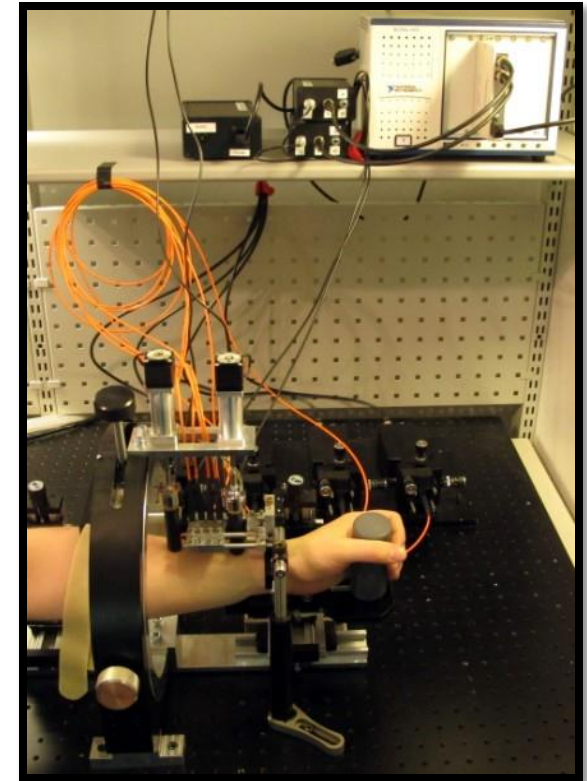
- FPGA Slice count – bigger is better
 - More resources, but also faster development time
- Onboard DRAM – mandatory in many cases
 - Acts as big buffer

- Challenge - Developing a real-time system to tune photoacoustic measurements to clinically assess osteoporosis



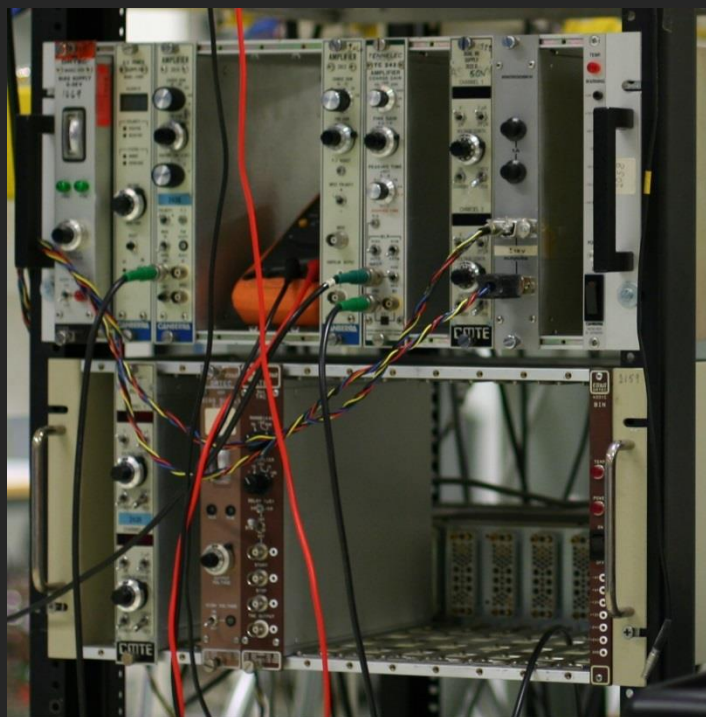
Pasi Karppinen *et al.* 2012

"The development work was fast and easy because the NI products we chose gave us quick prototyping for cutting-edge medical research. With NI products, we bridged academic proof-of-concept studies and clinical trials."

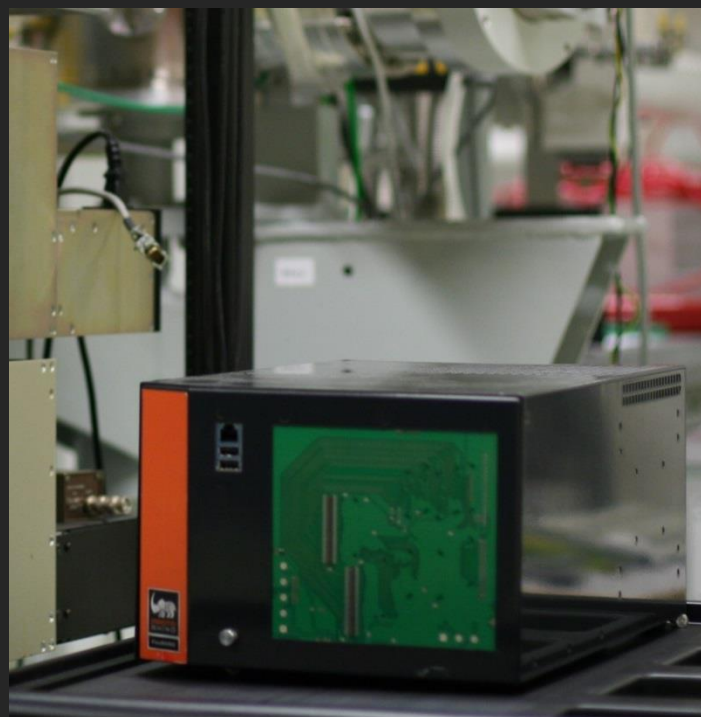




FLEXIBLE GAMMA DETECTOR READOUT SYSTEM



**Old radiation
detector readout**



FlexRHINO version

Q&A

