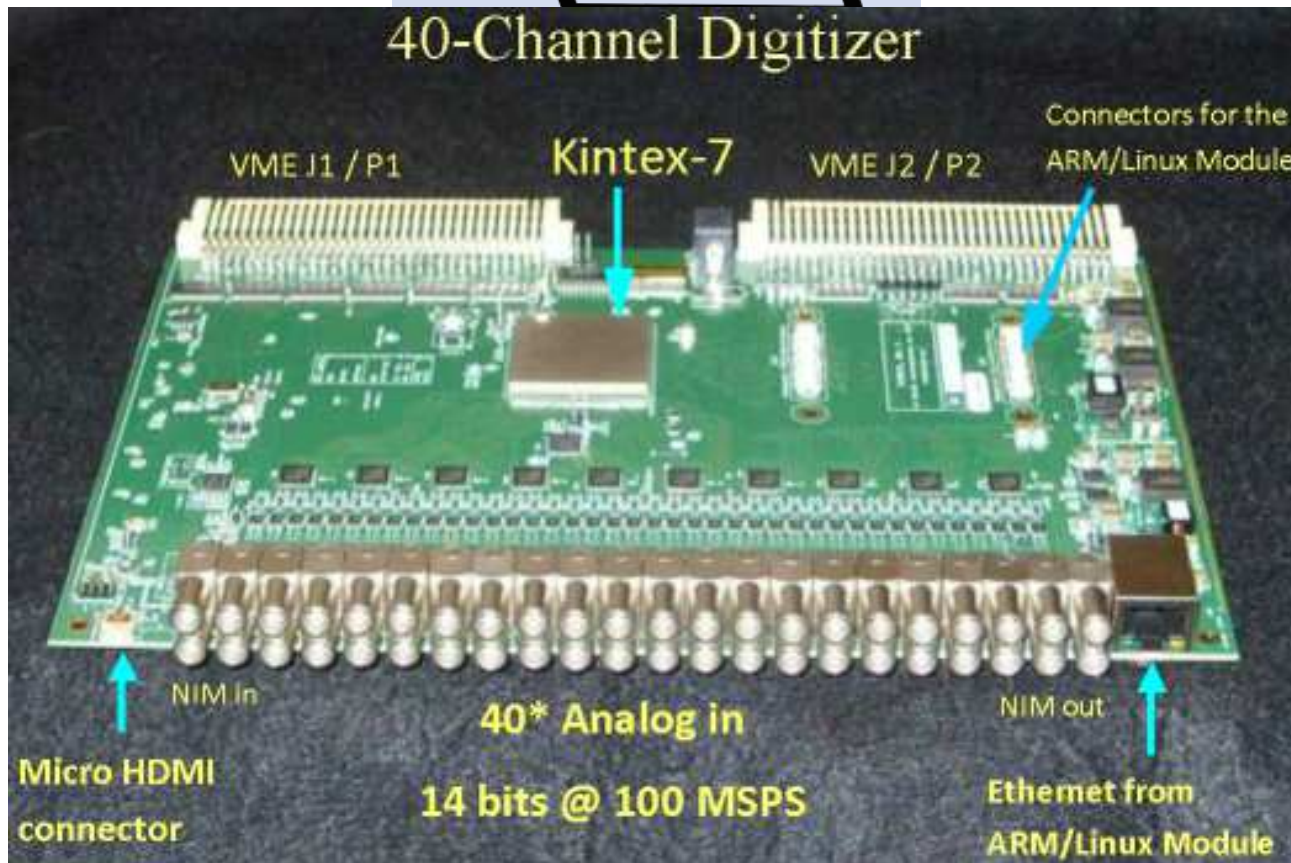


A Short Description of Our Products and Capabilities

Wojtek Skulski, PhD

Senior Scientist

Skutek



- We are supplying 1000+ channels of DAQ electronics to the LUX-Zeplin Dark Matter Search experiment.
- We developed a small and nimble FemtoDAQ miniature digital data acquisition instrument and sold it to a number of customers through our distributor Wiener USA.
- We have several other DAQ products in our pipeline.
- We are fostering a collaboration with Argonne National Laboratory (ATLAS facility).
- We received several SBIR grants from the DOE Office of Science, Nuclear Physics.
- Skutek is featured among DOE SBIR success stories:
 - <https://science.energy.gov/sbir/sbir-sttr-success-stories/>

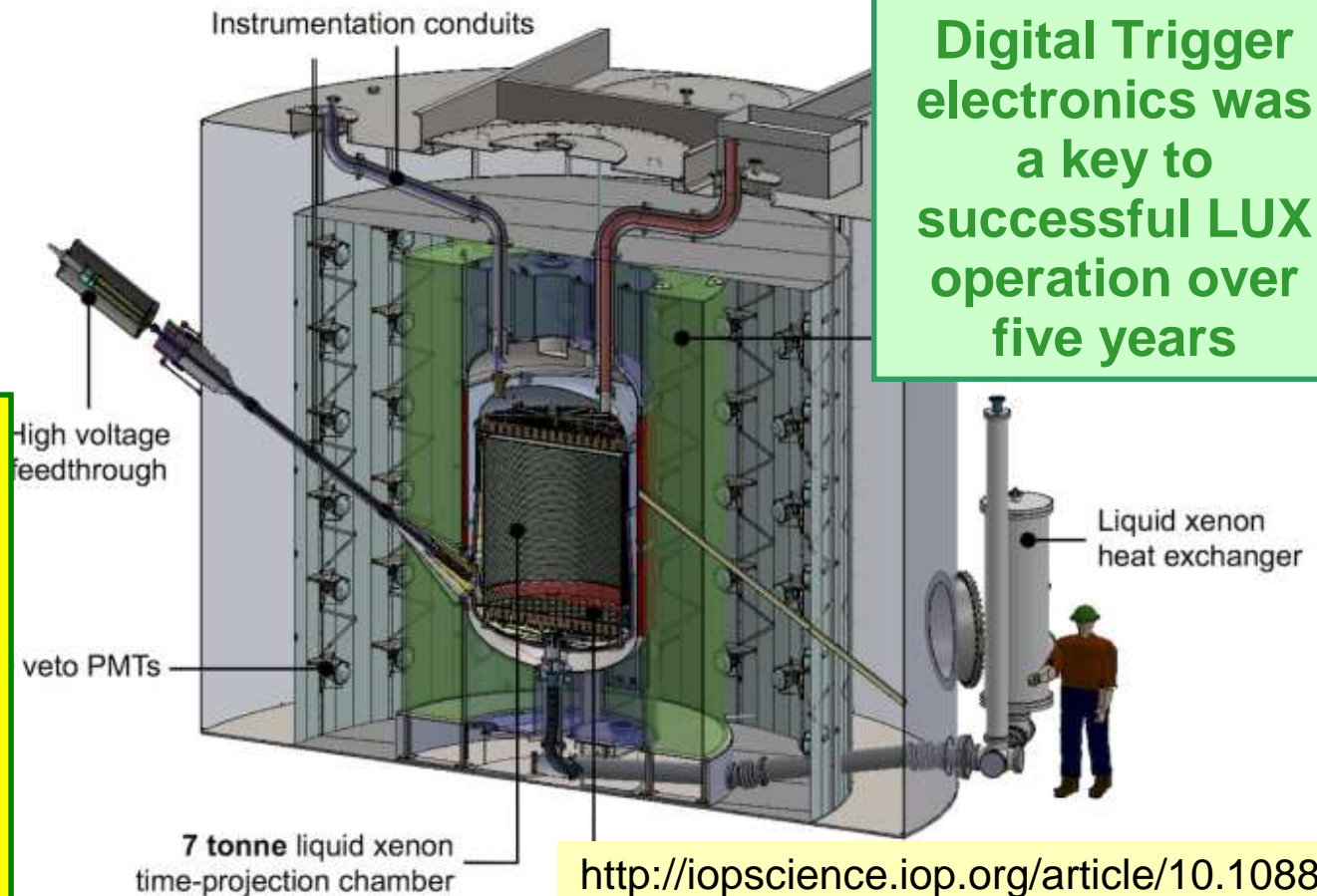
LUX-Zepplin is the “ultimate Dark Matter Search Detector”. Together with UofR we are building the digital DAQ for LZ with **1,359** channels. (Non-SBIR funding!)

This Fall we will deliver all the electronics to the LZ Collaboration (87 boards).

- Amount of Xenon: 5.6 tons fiducial
 - Drift time in Xenon: 700 μ s.
- **Number of PMTs: 745**
 - 614 with dual gain
 - 131 single gain
- **Electronic channels:**
 $2 \times 614 + 131 = \mathbf{1,359}$.

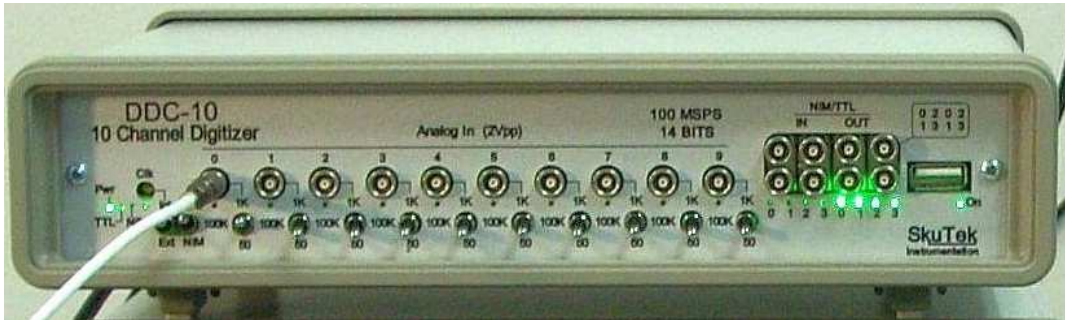
• Skutek DAQ electronics

- **Low noise**
- **Flexible connection topology**
 - **GbE TCP/IP 40 MB/s**
 - **GbE UDP 109 MB/s**
 - **Fast Serial Links 400 MB/s**
- **Powerful on board processing**
 - **FPGA**
 - **Embedded Linux**



<http://iopscience.iop.org/article/10.1088/1748-0221/11/02/C02072>

Standalone networked digitizer (10 channels)



Low cost networked digitizer (2 channels)



VME digitizer: 40 channels



Trigger / Logic module



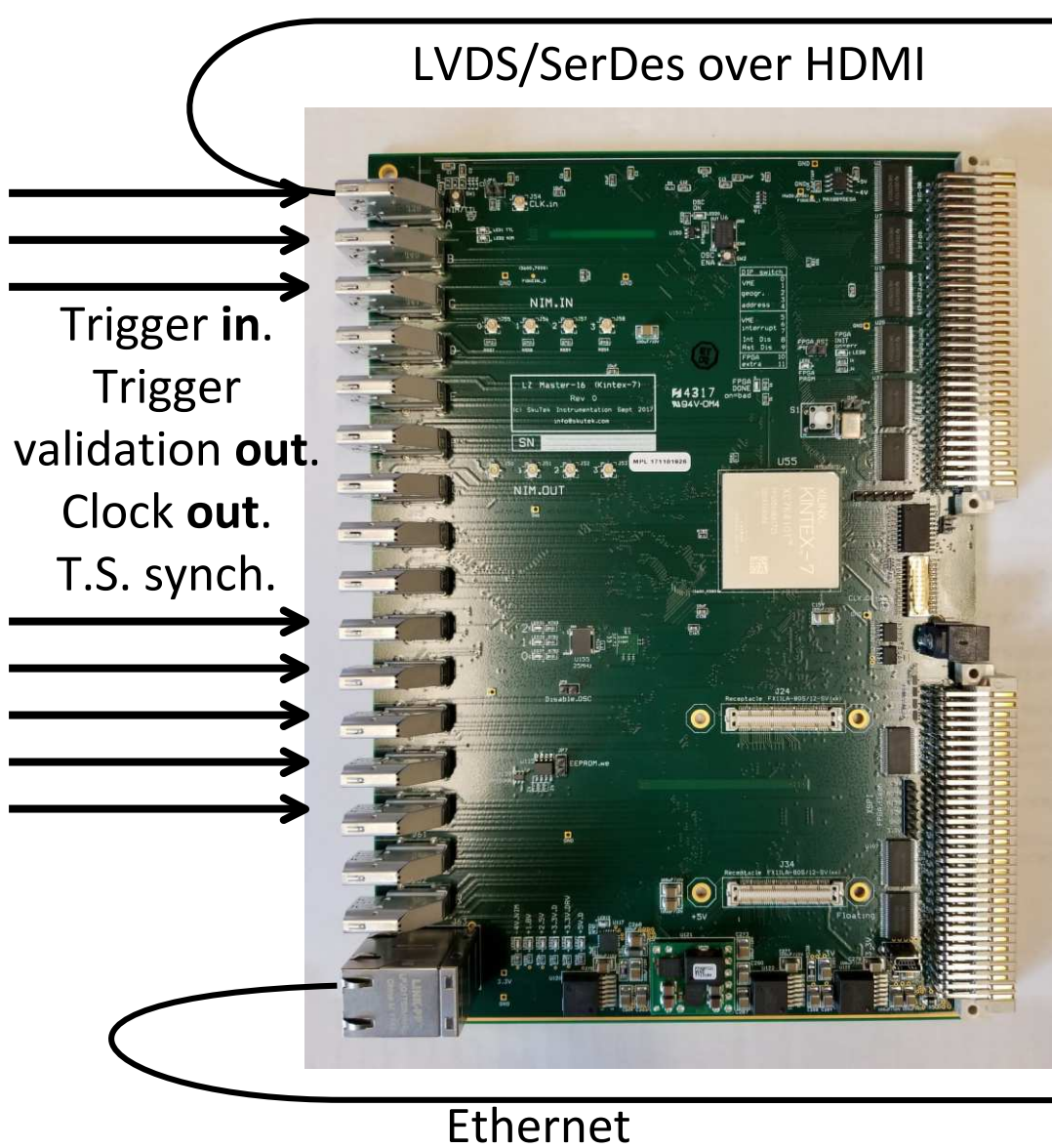
The DDC-40 Digitizer

- Ultra low noise $\sim 1.3 \text{ LSB} = 160 \mu\text{V}$



- 40 ADC channels:
 - 100 MHz sampling rate
 - ADC chip resolution: 12, 14, or 16 bits
 - 2V input range
 - +/-1V adjustable baseline
- Kintex-7 Xilinx FPGA, two options:
 - XC7K325T: BRAM=1,780 kB (**228 $\mu\text{s}/\text{chan}$**)
 - XC7K410T: BRAM=3,180 kB (**407 $\mu\text{s}/\text{chan}$**)
- Fast serial link over HDMI -> Trigger / Logic
- Temperature, voltage, current monitoring
- Embedded Linux Module with Ethernet, USB-2, and RS-232
- Remotely programmable:
 - Both the FPGA and the Linux Module
 - FPGA can be reprogrammed over Internet
 - Internal FPGA signals can be remotely accessed over Internet.

- Trigger in / out, clock distribution, time stamping of events.



Cascaded to higher level Logic Modules

- Either 12 or 16 Fast Serial links over HDMI cables
- An additional Gbit Ethernet link directly from the FPGA, meant for low-level Ethernet (e.g., UDP)
- Kintex-7 Xilinx FPGA
- Embedded Linux.
- Functions of the Logic Module:
 - Trigger in.
 - Trigger validation out.
 - Clock out.
 - Time stamp synchronization.

Event readout (up to 109 MB/s)

The team:

- The Skutek team includes three physicists (two of them PhD in Nuclear Physics), two software engineers, one Engineering Associate, and one company president/owner.
- We closely collaborate with University of Rochester Physics and Astronomy.

Our focus:

We design and develop data acquisition (DAQ) for nuclear physics, high energy physics, and particle astrophysics.

We use digital techniques to acquire and process signals from nuclear radiation detectors.

Our capabilities:

- Electronic design, both analog and digital.
- Firmware development for Field Programmable Gate Arrays (FPGA).
- Software development for embedded processors, especially Embedded Linux.
- Algorithms for pulse processing.
- Algorithm implementation in the FPGA (VHDL, Verilog) and in embedded processors (python, C).
- Processing data from nuclear detectors of any kind.
- Development of detector assemblies using scintillators, PMTs, or SiPMs.
- More information:
 - [Skutek.com](http://www.skutek.com) – our main website.
 - [FemtoDAQ.com](http://www.femtoDAQ.com) – our miniature DAQ.
 - [CosmicRayNet.net](http://www.cosmicRayNet.net) – our fun experiment with FemtoDAQ and cosmic muons.
 - [RiskFive.com](http://www.riskFive.com) – our Open Source project.