Development of an FPGA-based signal processing system for a compact NMR measurement system

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Compact-NMR

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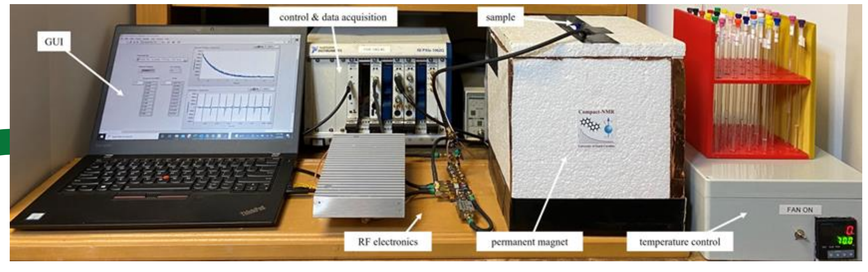
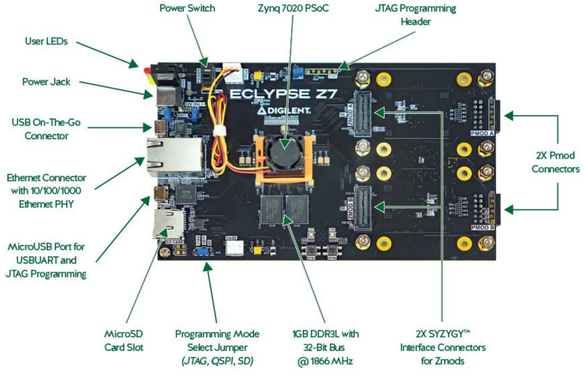
Background

- Nuclear magnetic resonance (NMR) is a phenomenon that occurs when nuclei are exposed to a strong magnetic field and stimulated with an RF pulse
- The current compact NMR system uses large, sensitive, and expensive measurement components
- An FPGA based signal processing system allows for in-situ NMR analysis while preserving relative performance

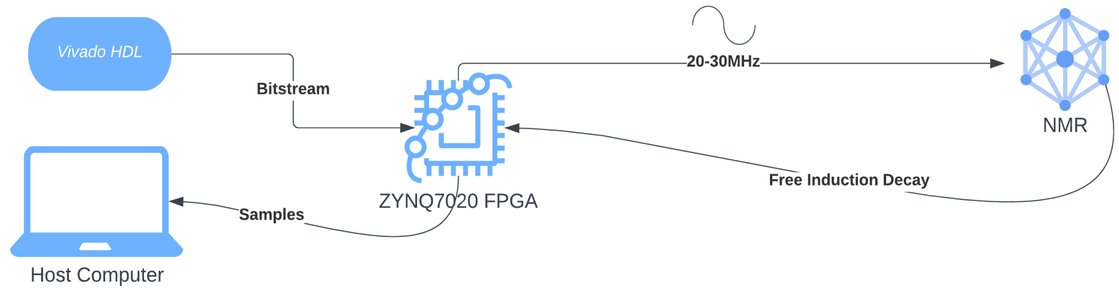
Methods

- A DDS Compiler generates a continuous and stable sinusoidal signal without the use of the processor on the chip
- The ZMOD1410 Analog to Digital Converter collects the Free Induction Decay response signals from the NMR sample. A scatter-gather engine sends the samples from memory to a host computer.

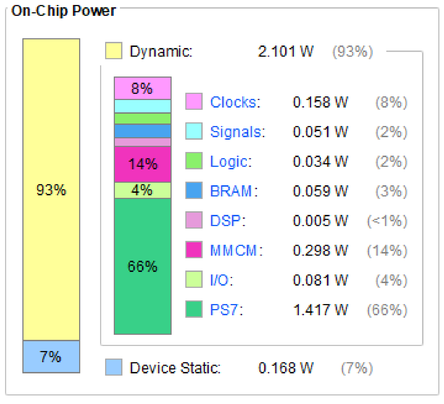


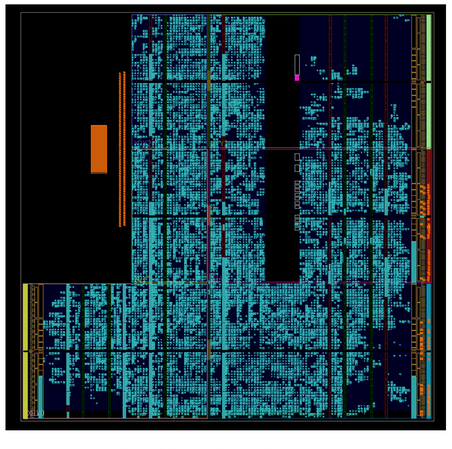


Design Flow

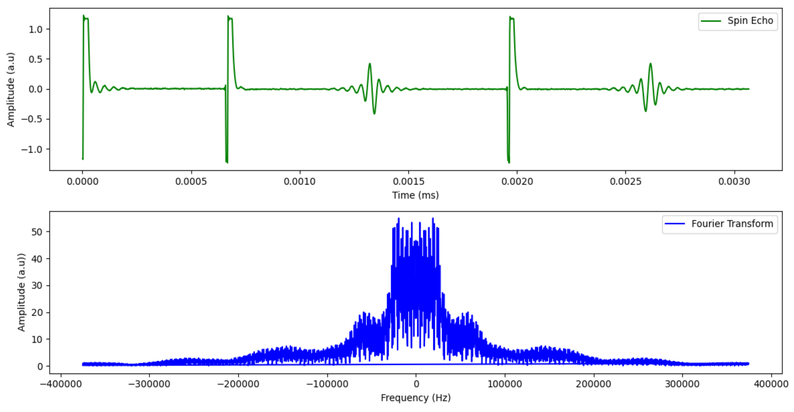


Results





On-Chip Logic Utilization



FPGA Collected Signal

References

[1] Downey, Austin, & Huggins, Parker, & Martin, Jake, & Won, Sung Hee, (2022). Machine Learning for NMR-based Fuel Classification. University of South Carolina Research Poster. http://www.me.sc.edu/Research/Downey/publications/Posters/Huggins2022MachineLearningNMR.pdf

[2] Downey, Austin, & Martin, Jacob, & Won, Sung Hee, (2022). Compact Time Domain NMR Design For The Determination of Hydrogen Content in Gas Turbine Fuels. ASME IDETC-CIE, 2022. http://www.me.sc.edu/Research/Downey/publications/Conference_presentations/Martin2022CompactTimeDomain_presentation.pdf