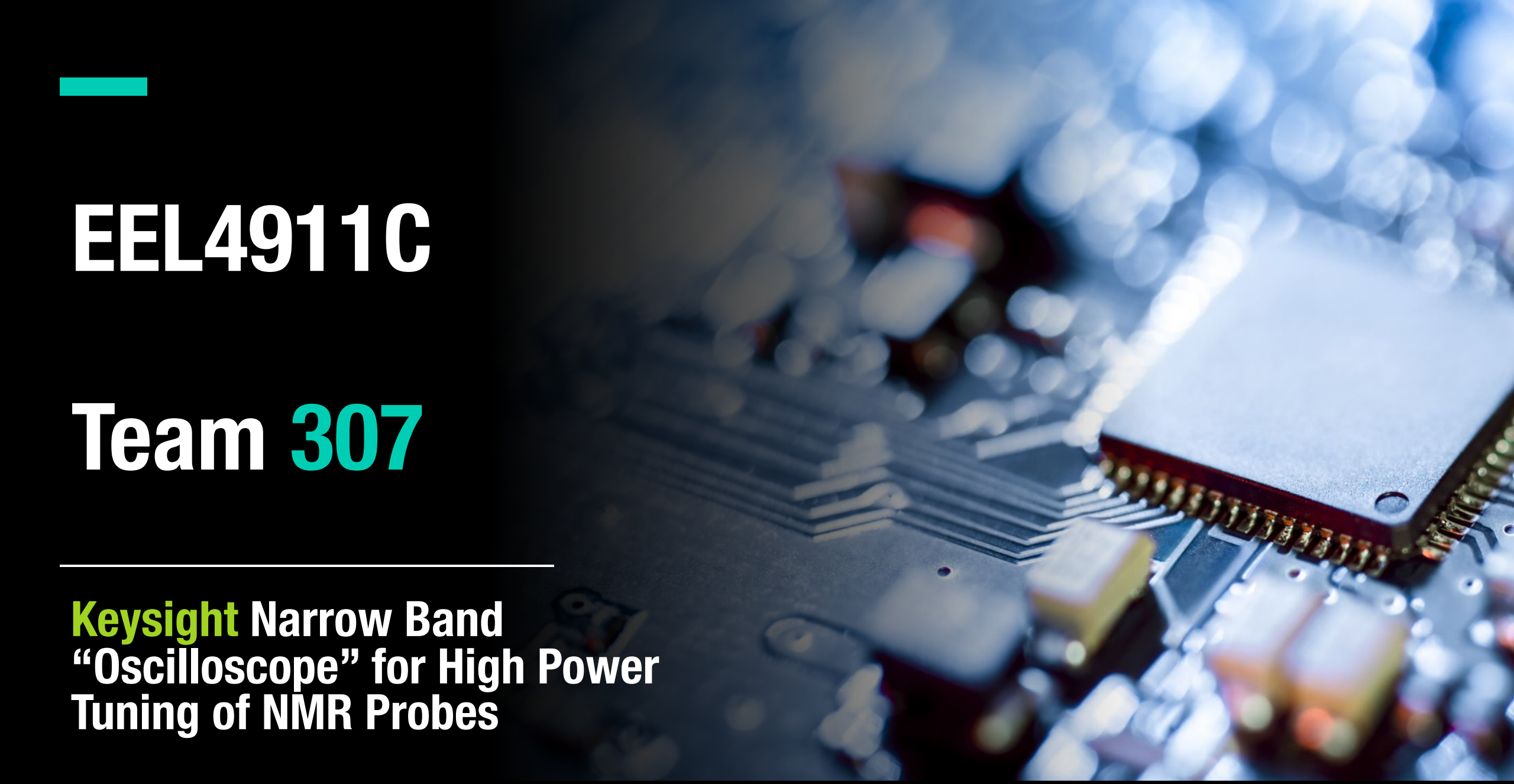
EEL4911C

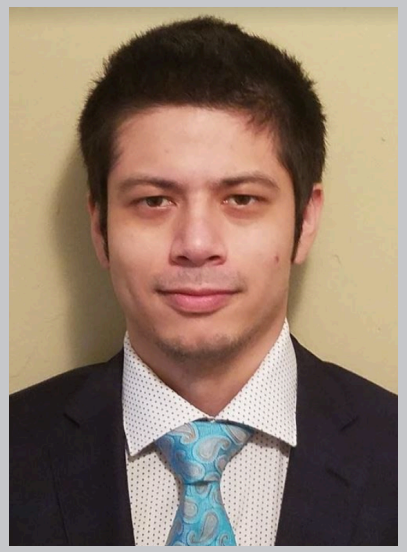
Team 307

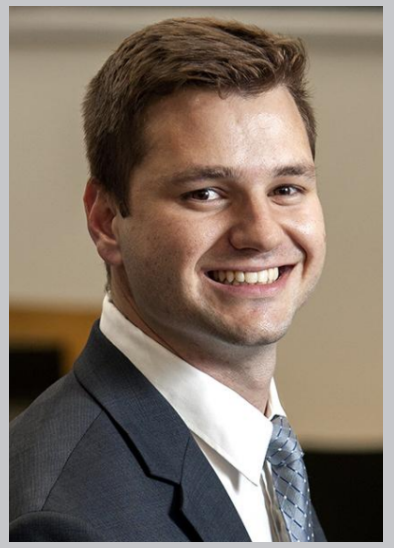
Keysight Narrow Band “Oscilloscope” for High Power Tuning of NMR Probes



Introduction

Jonathan Burt	Gabriel De Leon	Emil Lobachev	Asher Rich	Kyle York
Programming Lead Document Lead	**Financial Advisor** Circuit & Hardware Assembly Lead	**Lead ECE** DGR	**Team Leader**	**Research Lead**

Presentation Outline

- Introduction
- Project Brief Summary
- Background
- Project Scope
- Needs & Requirements
- Functional Decomposition
- Summary

Project Brief Summary

- Customer and Sponsor
- Project Proposal
- Code of Conduct
- Work Breakdown Structure

Customer

National High Magnetic Field Laboratory

William Brey

Magnetic Lab Research Faculty
Appointed Project Customer

Jonathan Burt

Sponsor

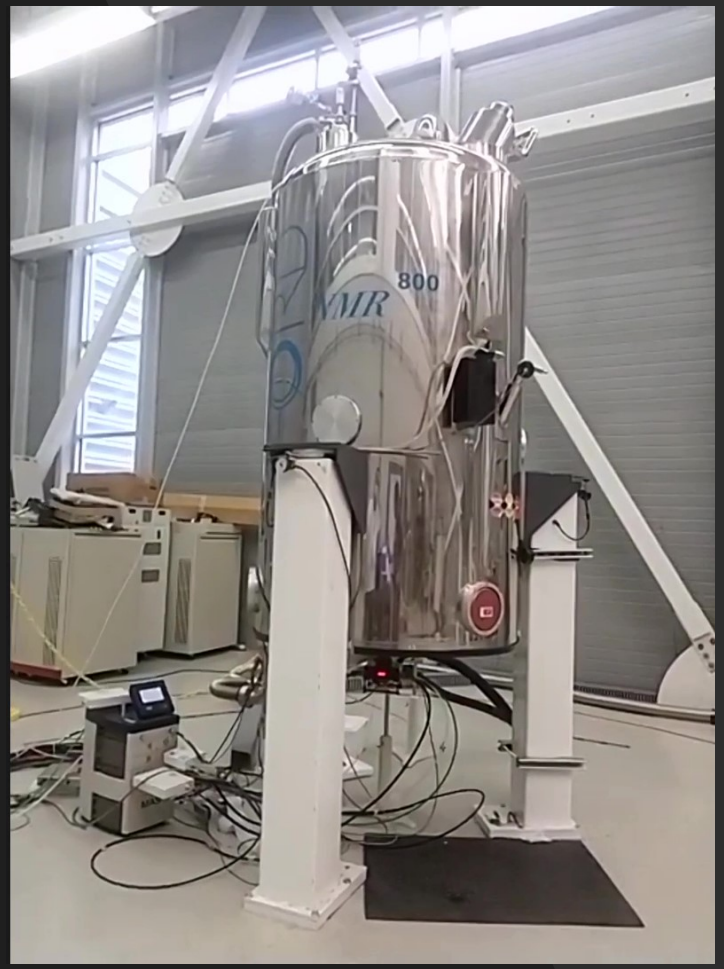
Keysight Technologies

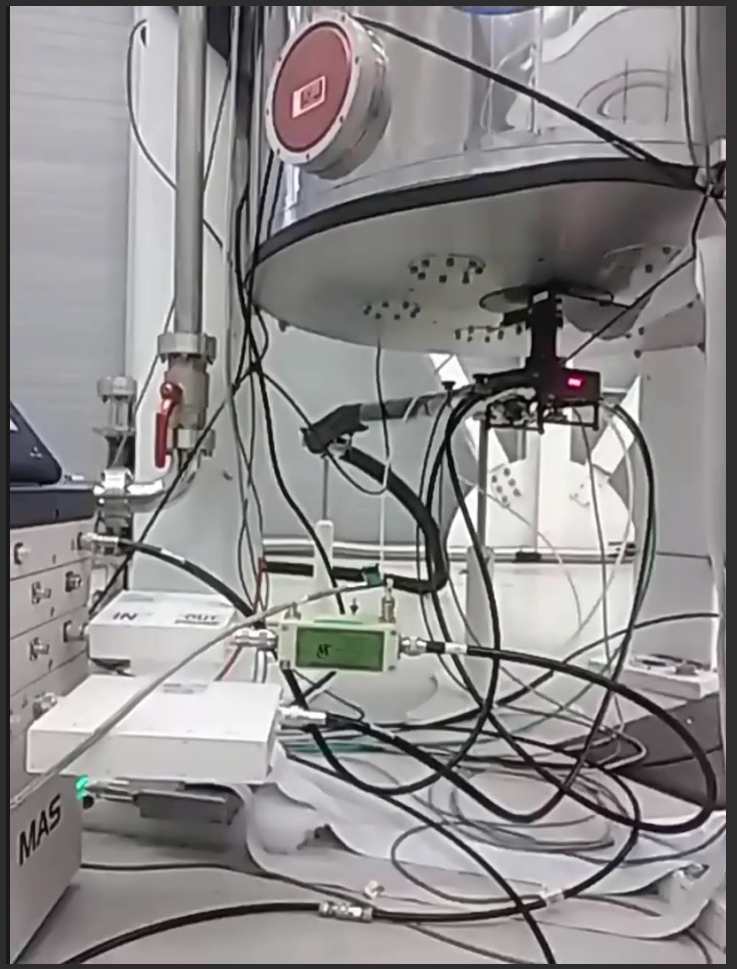
Paul Holcomb

Keysight Project Technical Advisor

Jonathan Burt

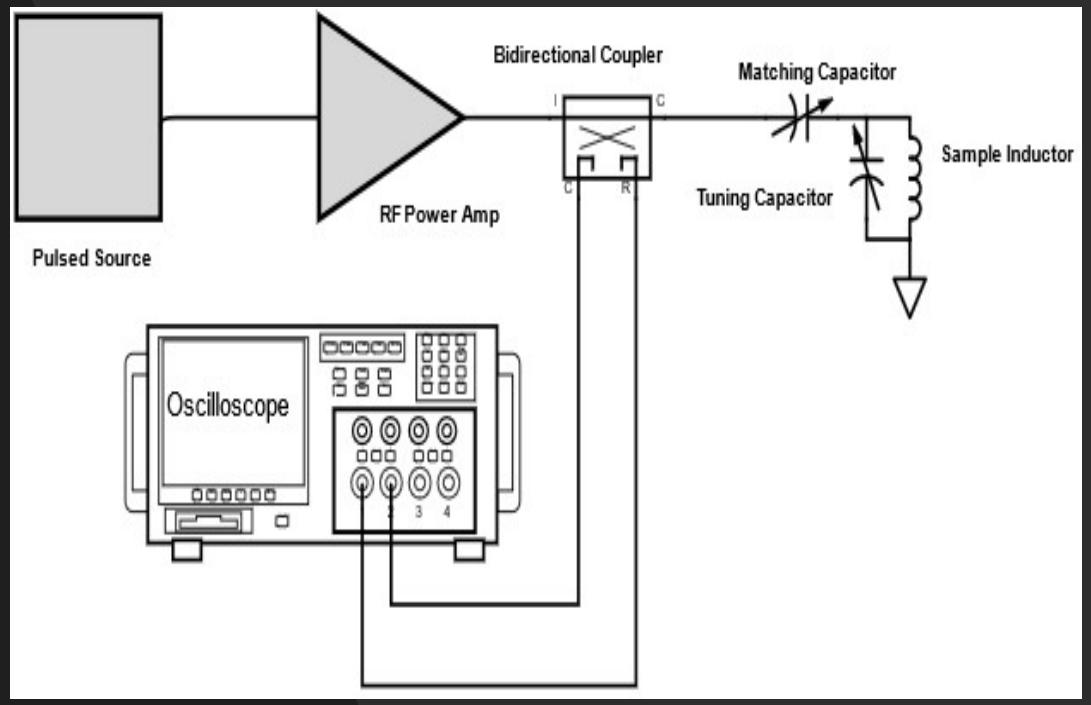
Project Proposal

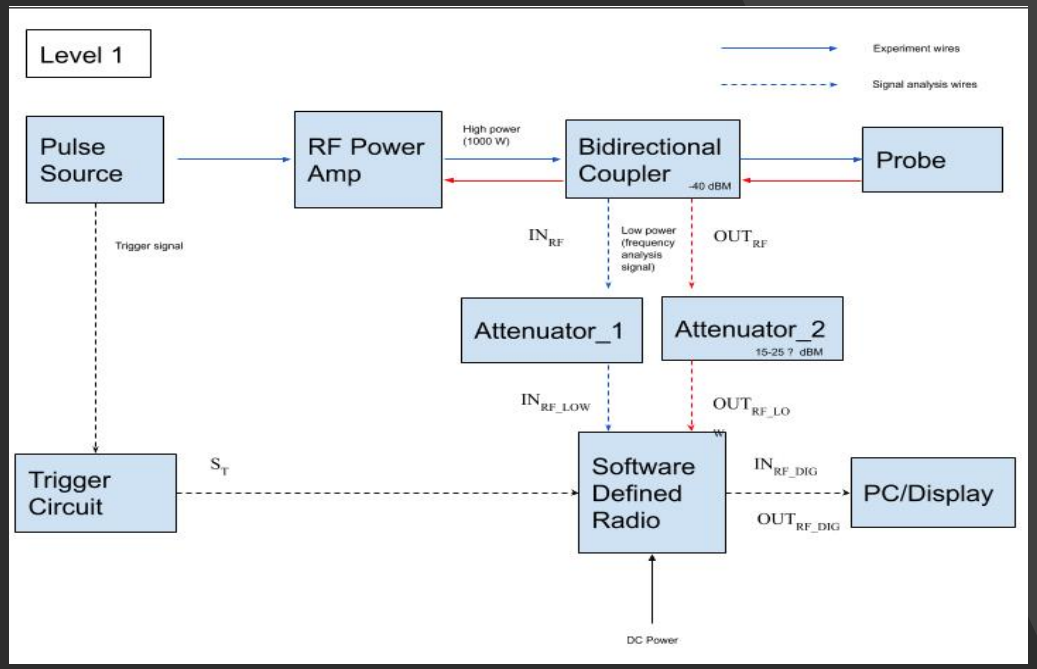




Jonathan Burt

Project Proposal (cont…)





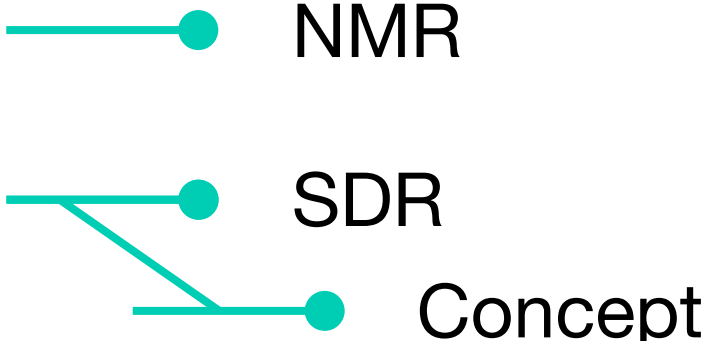
Jonathan Burt

Work Breakdown Structure

Code of Conduct

Jonathan Burt

Background



Nuclear Magnetic Resonance (NMR)

- Spectroscopic technique used to analyze magnetic fields around nuclei
- Produced by Radio-Frequency (RF) pulses using excitation
- Shows structure of metabolites and proteins in chemistry and biology

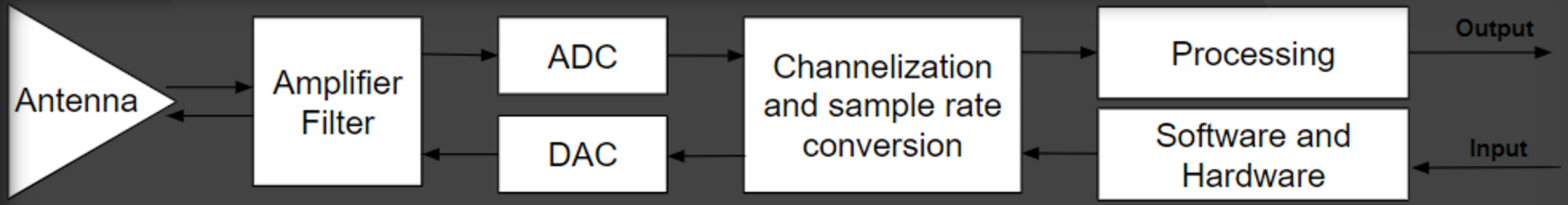
Kyle York

Software Defined Radio (SDR)

- Radio communication system
- Maps signals to a personal computer
- Will be used for tuning in this project

Kyle York

SDR Concept



Kyle York

Project Scope

- Project Description
- Key Goals
- Markets
  - Stakeholders

Project Description

- Software Defined Radio
- Trigger
- Radio Frequency
- Reflected Power

Key Goals

- Design/Produce Working Prototype
- Reduce Cost of Envelope Detection
- Display Sweep Length and Control Frequency

Gabriel De Leon

Market

- Magnetic Laboratories
- Tech-based Companies
- Government & Defense
- Service Providers
- Researchers

Stakeholders

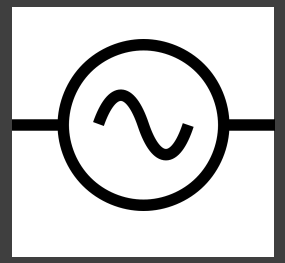
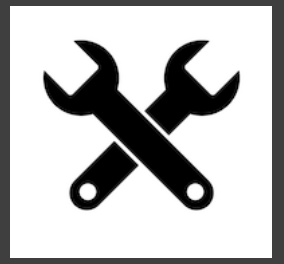
- FAMU-FSU Magnet Lab
- Keysight
- Researchers

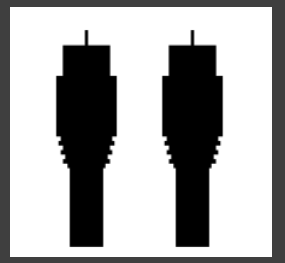
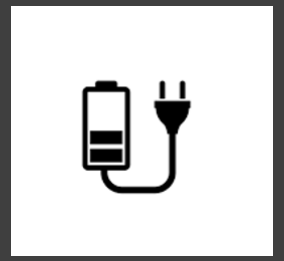
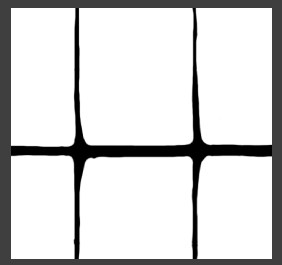
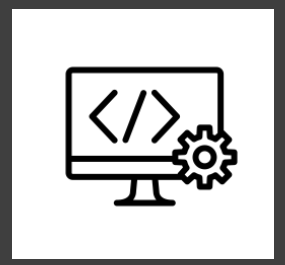
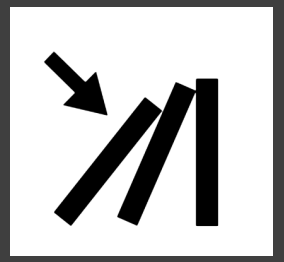
Gabriel De Leon

Needs & Requirements

- Needs
- Requirements

Needs Synopsis

Emil Lobachev

Requirements

- No NI Software/Hardware
- A single prototype unit
- Envelope
- An external trigger
- Sampling rate of the SDR > $f_{s\,\min\,required}$
- The entire sample captured

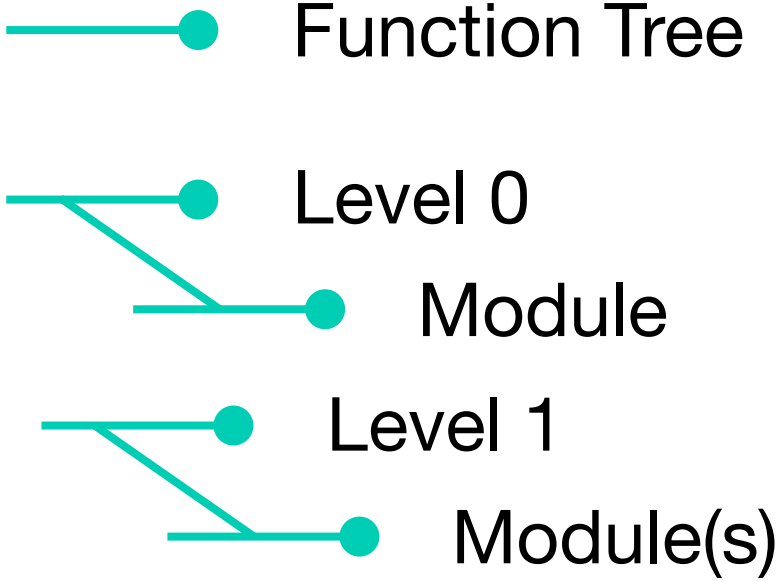
Emil Lobachev

Requirements

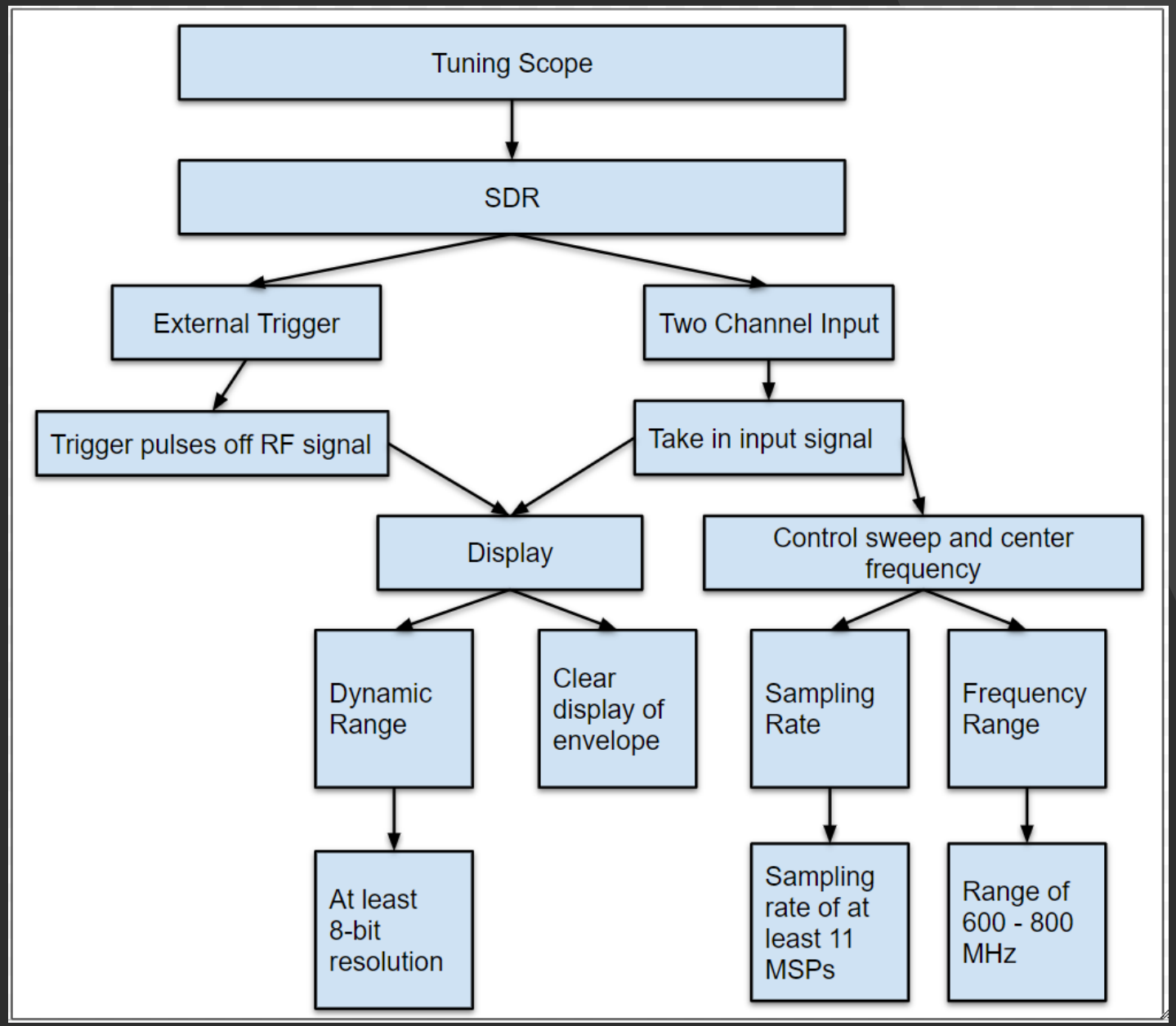
- Under budget
- Output signal for analysis
- 600 MHz to 800 MHz range
- ≥ 8-bit resolution
- Digital data to PC
- External storage
- Quickly reparable

Emil Lobachev

Functional Decomposition

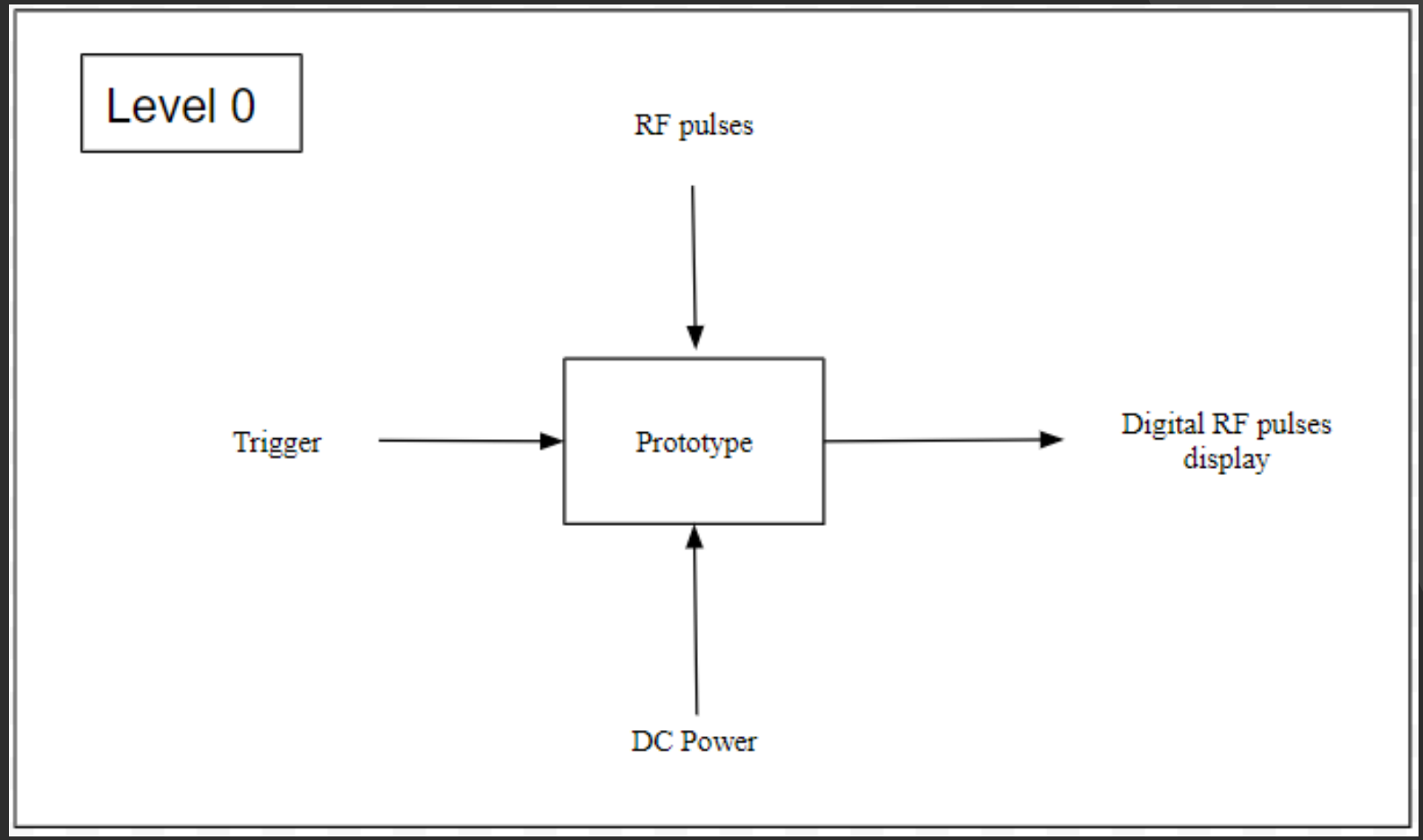


Function Tree



Asher Rich

Level 0



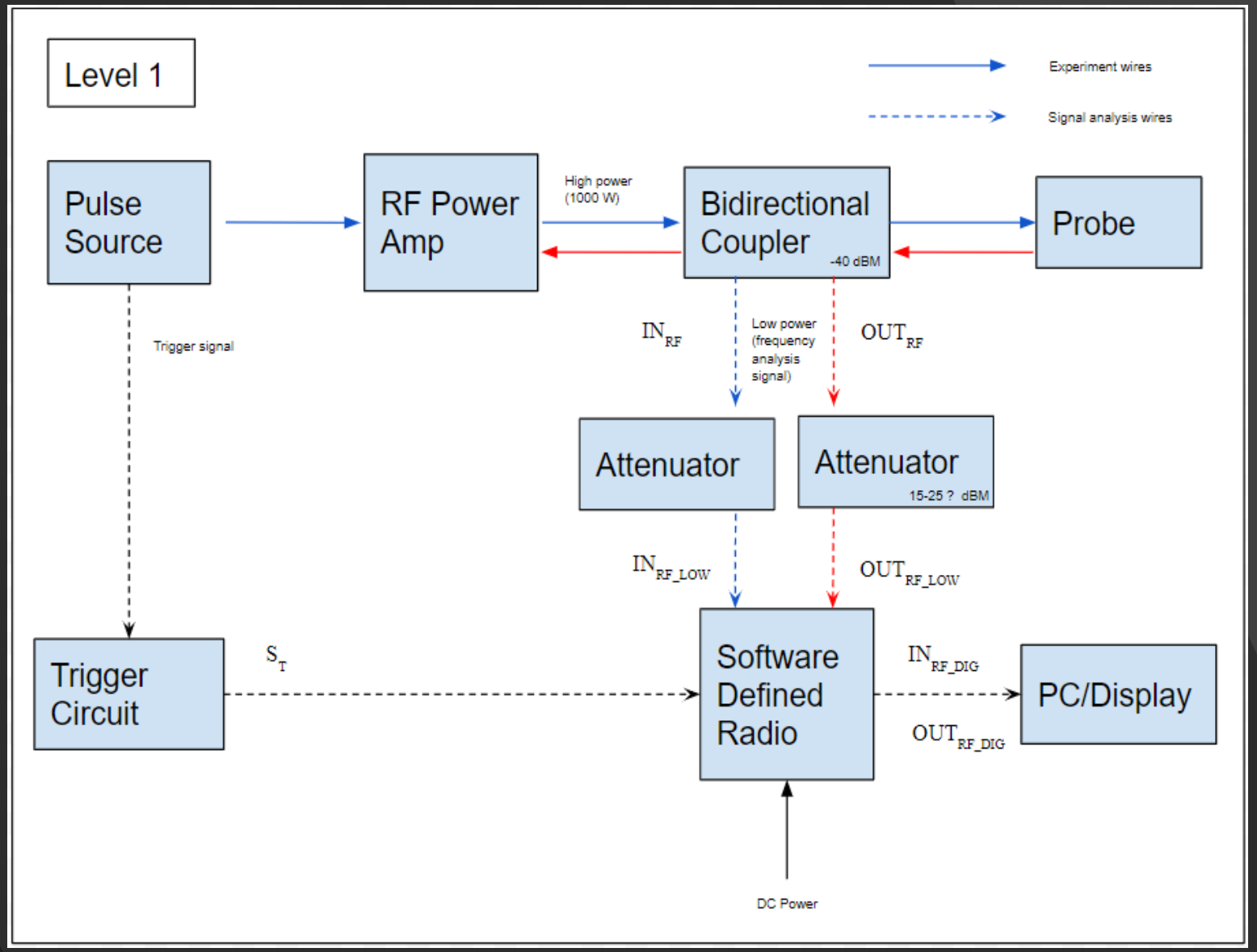
Asher Rich

Level 0
Prototype Module

Module	Prototype
Inputs	- RF pulse - Trigger - DC Power: DC input 4.5-5.5 V
Outputs	- Digital RF pulse display

Asher Rich

Level 1



Asher Rich

Level 1
Trigger Module

Module	Trigger Circuit
Inputs	- Power source TTL trigger signal 50 Ohm wire
Outputs	- ST: Trigger signal in a form accepted by SDR

Asher Rich

Level 1
Attenuator Modules

Module	Attenuator_1
Inputs	- IN_{RF}: RF signal coming from the Pulse Source input to the probe extracted from Bidirectional Coupler
Outputs	- OUT_{RF_LOW}: RF signal with lower power to be accepted by SDR

Module	Attenuator_2
Inputs	- OUT_{RF}: RF signal coming from the probe power signal extracted from Bidirectional Coupler
Outputs	- OUT_{RF_LOW}: RF signal with lower power to be accepted by SDR

Asher Rich

Level 1
SDR Module

Module	Software Defined Radio (SDR) Device
Inputs	- ST: trigger signal to synchronize RF pulse recording with Power Source output - IN_{RF_LOW}: - OUT_{RF_LOW}:
Outputs	- IN_{RF_DIG}: 8-bit binary representation of IN_{RF_LOW} - OUT_{RF_DIG}: 8-bit binary representation of OUT_{RF_LOW}

Asher Rich

Level 1
PC/Display Module

Module	PC/Display
Inputs	- SDIG_RF: recorded digital signal from SDR
Outputs	Plot of oscilloscope analysis onto a monitor using software tools

Asher Rich

Summary

- Background
- Project Scope
- Requirements
- Decomposition

References

1. “A Narrow Band “Oscilloscope” for High Power Tuning of NMR Probes”, Project Proposal, W. Brey, 2020.
2. “NMR Operation at NYSBC”, NYSBC Solid State NMR Short Course,

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3. “Design, Care and Feeding of NMR Probes” tutorial presented by Kurt Zilm at the 2011 ENC

   http://www.enc-conference.org/Portals/0/Probes_2011_Part_I.pps
4. G. Amouzandeh, V. Ramaswamy, N. Freytag, A. S. Edison, L. A. Hornak and W. W. Brey, "Time and Frequency Domain Response of HTS Resonators for Use as NMR Transmit Coils," in IEEE Transactions on Applied Superconductivity, vol. 29, no. 5, pp. 1-5, Aug. 2019, Art no. 1102705, doi: 10.1109/TASC.2019.2902522.

Questions