RFNav, Inc.
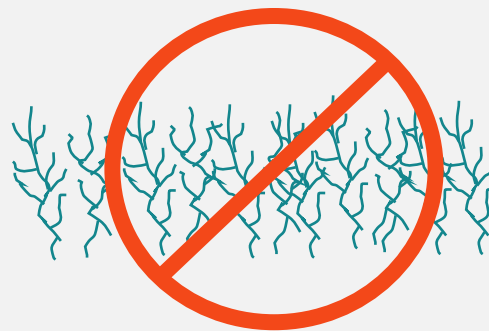
Improving the Longevity & Safety of EV Batteries

Dendrite Mitigation Using Ultrasound Beamforming

Jim.Schoenduve@RFNav.com
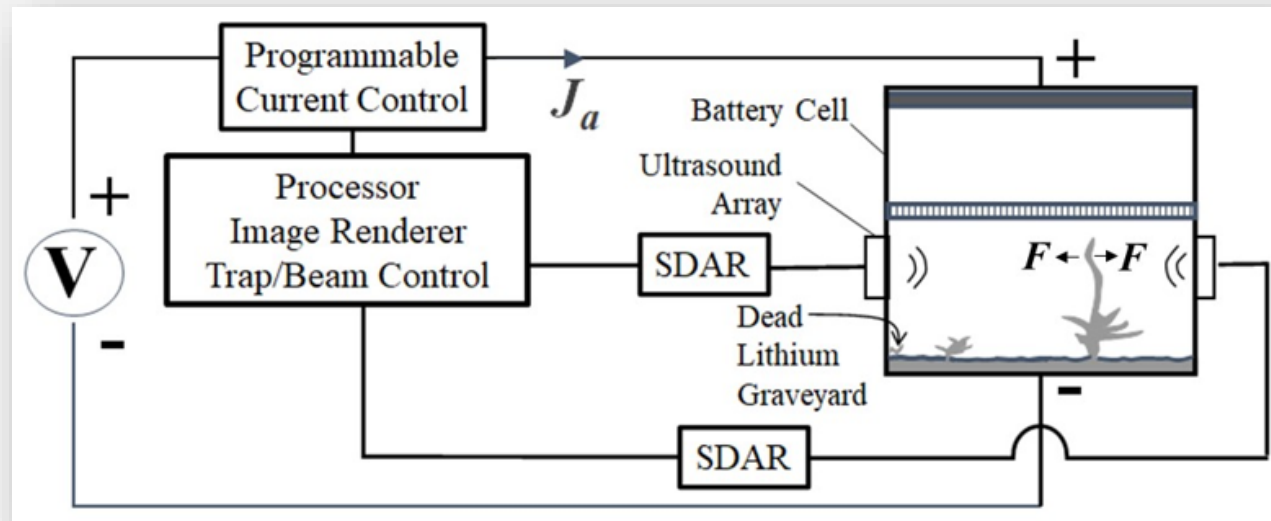February 2021

Dendrite Mitigation via Ultrasound

Software Defined Acoustic Arrays – SDAR
1. Locate Dendrites via imaging
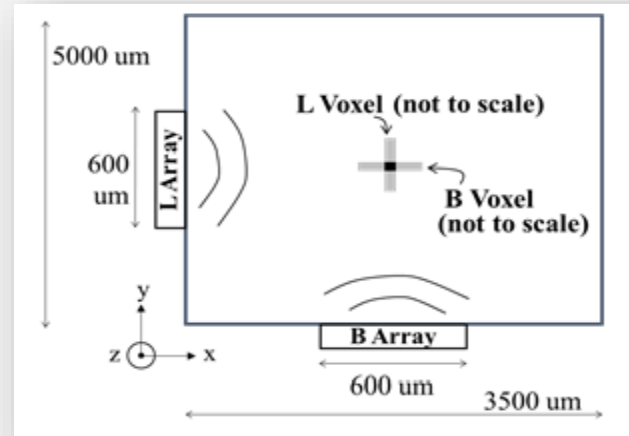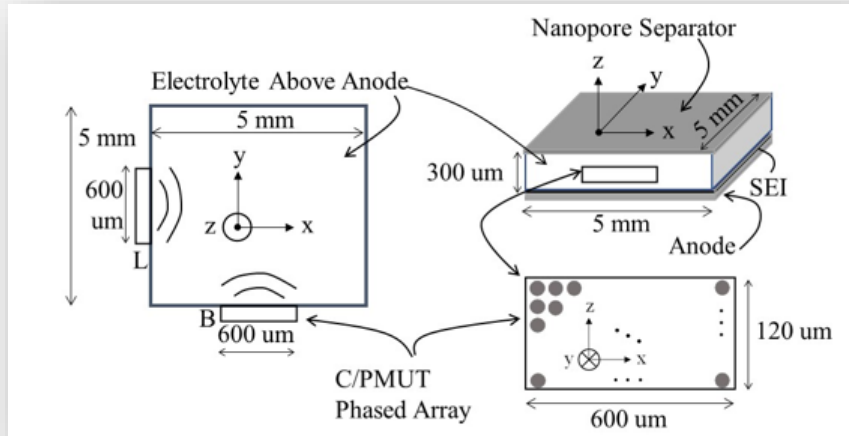2. Fracture Dendrites
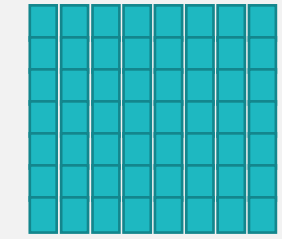3. Transport Dendrites To Graveyard

Dendrites

- 300 to 800 nm diameter[1]
- 16 MPa Shear Strength

1. "From ion to atom to dendrite: Formation and Nanomechanical Behavior of electrodeposited lithium", MRS Bulletin 2020 Citrin, et al Caltech

Step 1: Identify And Locate Dendrites

Dendrite Ultrasound Imaging – Low cost variant of medical ultrasound techniques
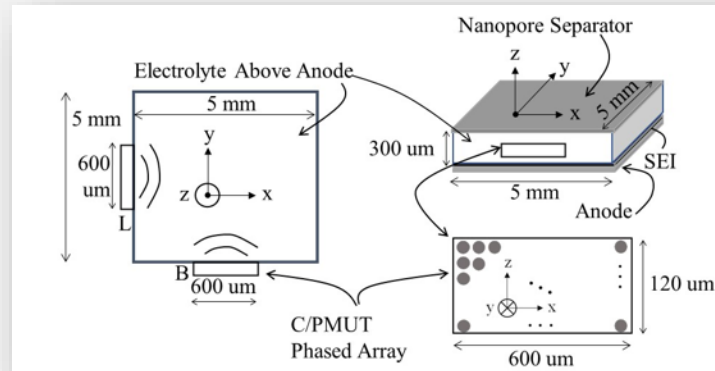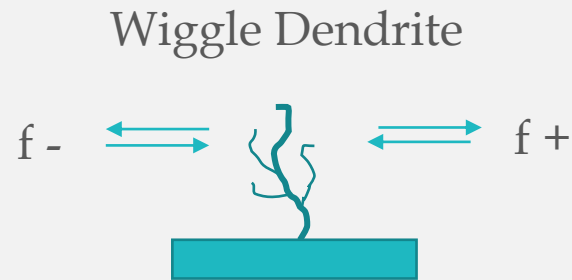
PMUT's
Piezo Mechanical Ultrasound Transducers

Individually Controlled
TX and RX Elements

- Mature Technology
- Consumer Price Points
- 'Old' Process Nodes 0.18 microns

Wiggle Dendrite

f - $\longleftrightarrow$ $\longleftrightarrow$ f +

Acoustic Traps

Carrier frequency change of 29.5 MHz oscillates the wide acoustic trap by 200 microns in the x-dimension
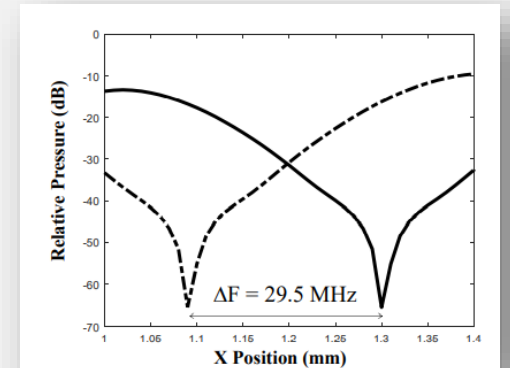
Wiggling
- Acoustically generated standing waves perturbate dendrites

Joule Heating
- Increase current charging density temporarily to heat dendrites

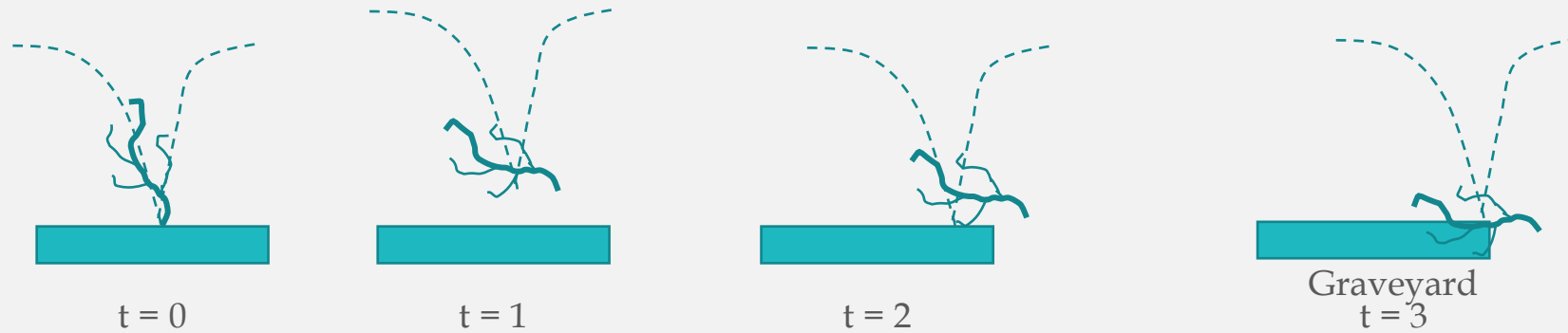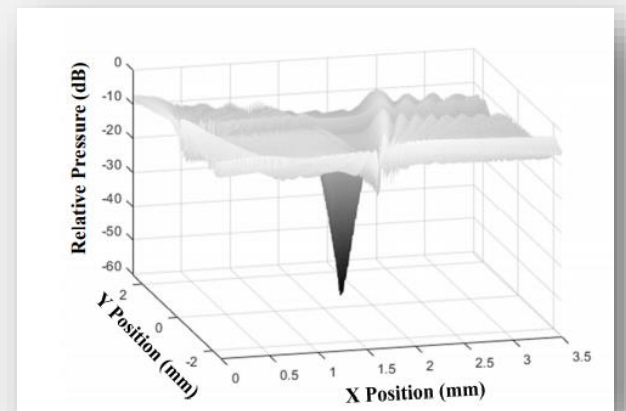Wiggling + Joule Heating = Fracture of the Dendrite

Step 3: Transport Fractured Dendrites

Acoustic "Tweezers" Move Dendrite Fragments to Graveyard

t = 0   t = 1   t = 2   Graveyard
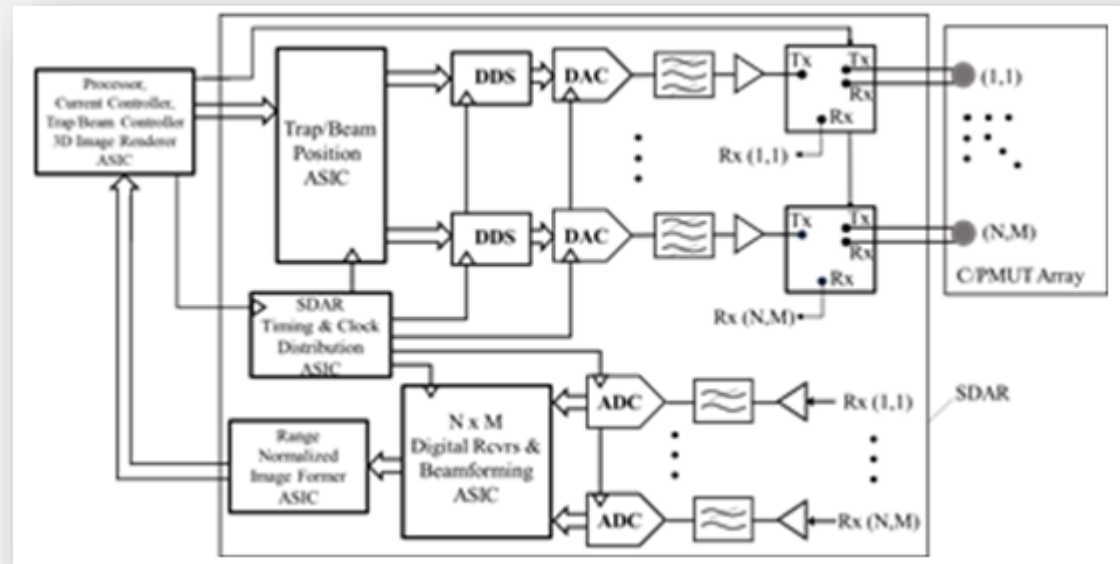   t = 3

Phased array transducers form pressure gradients to move fragments to chosen locations

Acoustic Traps

Phased arrays create pressure nodes of up to 60 dB to move particles in solution

System Schematic Overview

No exotic semiconductor IC development required

Status

- Simulations verified the physics and beamforming
- Patents filed
- Forming team of interested corporations to further develop the technology

RFNav, Inc.

World Class Expertise
Over 100 Years of Combined Experience

- Johns Hopkins Applied Physics Lab
- Naval Research Lab
- Hughes Aircraft (Raytheon)

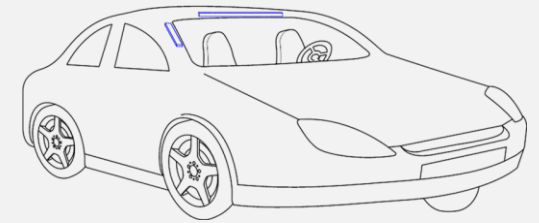Battery Dendrite Mitigation

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Autonomous Vehicle Technology

Imaging Radar
- Same resolution as LIDAR

Image Fusion
- LIDAR-RADAR
- LIDAR- Camera
- RADAR- Camera

Probability of Detection Algorithms
- Maximize Probability of Detection in FFT based systems
- Minimize False Alarms

Object Tracking in Dense Scenes
- Non-Kalman tracking in dense scenes

Vibration Mitigation Algorithms