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Sound Effect Devices for Musicians

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OPPORTUNITY STATEMENT

- Tube Amplifiers
  - Pros
    - Many prefer tonal qualities
  - Cons
    - High initial cost
    - Expensive
    - Frequent maintenance
    - Heavy (bulky electronics)
    - Electrically inefficient
   - Warm-up time

- Solid State Amplifiers
  - Pros
    - Inexpensive
    - Durable, easy to maintain
    - Power efficient
  - Cons
    - Doesn't produce tonal qualities that most prefer

How can we achieve a tube-like audio profile without a tube amplifier? Furthermore, how can we enhance it? – *The SuperTube Emulator*
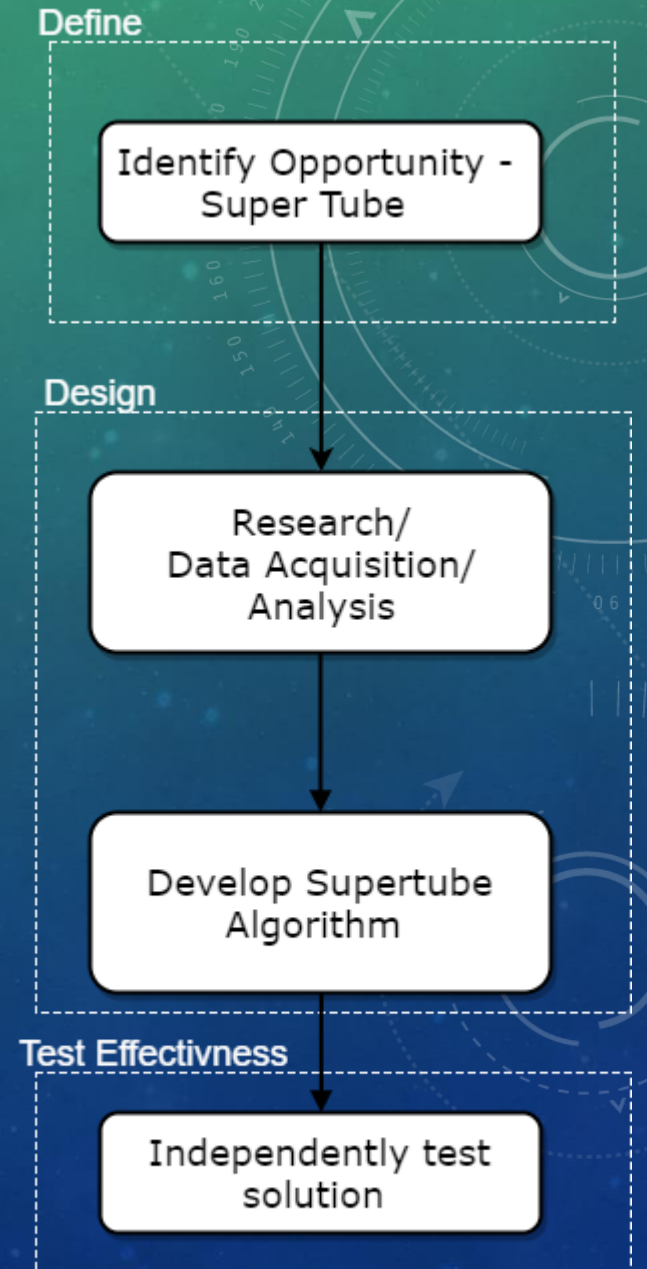
PROPOSED STRATEGY – SUPERTUBE EMULATOR

- Emulator Benefits

  - Impose desired audio profile onto instrument signal

  - Allow user to control/personalize profile

  - Avoid pitfalls of tube amplification
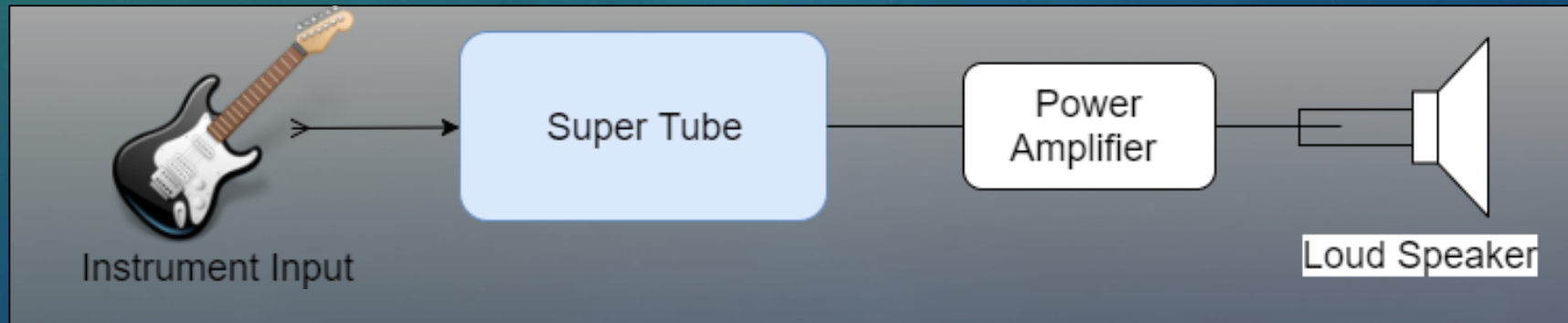
BIG PICTURE – DESIGNING THE SUPERTUBE

- We are a modeling SuperTube audio profile

- Approach:
  1. Research – What strategies are used to emulate vacuum tubes

  2. Test/Analysis – Gather data and develop model parameters

  3. Implementation – Construct emulator/enhancer that uses model parameters

Define

Identify Opportunity -
Super Tube

Design

Research/
Data Acquisition/
Analysis

Develop Supertube
Algorithm

Test Effectivness
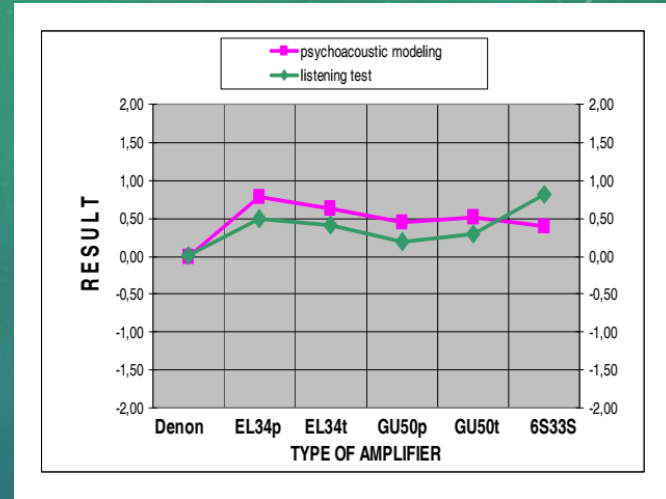
Independently test
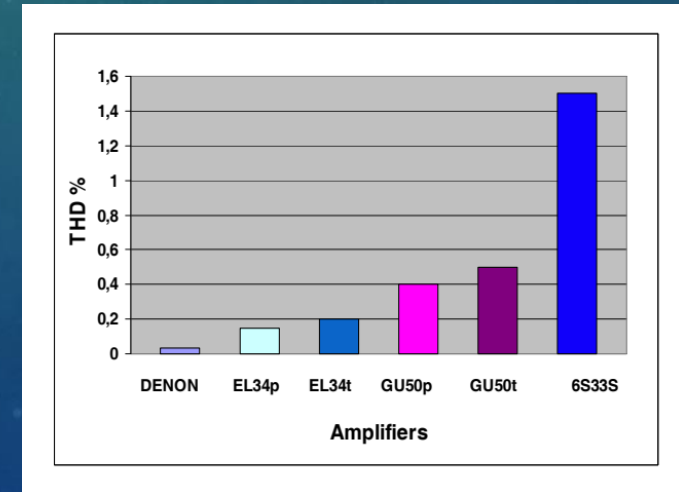solution

1. RESEARCH

- AES publications cite:
  - Total Harmonic Distortion (THD)
  - Dynamic Nonlinearities of Vacuum Tubes

- Previous work:
  - Effects Pedals (Ibanez Tube Screamer)
  - Software Modelling –
    Unidirectional, Linear Filtering

  → These solutions are simply replications of the tube effect

[1]

[2]

Research provides our first potential parameters for defining our system

2. TESTING – DERIVING OUR OWN PARAMETERS

- Research lacks a closed-form algorithm for tube emulation… we need to observe these parameters in action

- Data Acquisition Test Bench:

  - High-Resolution Data capture

  - Multi-Channel Recording allows for:

    - Synchronized data analysis

    - Channel-to-channel comparison
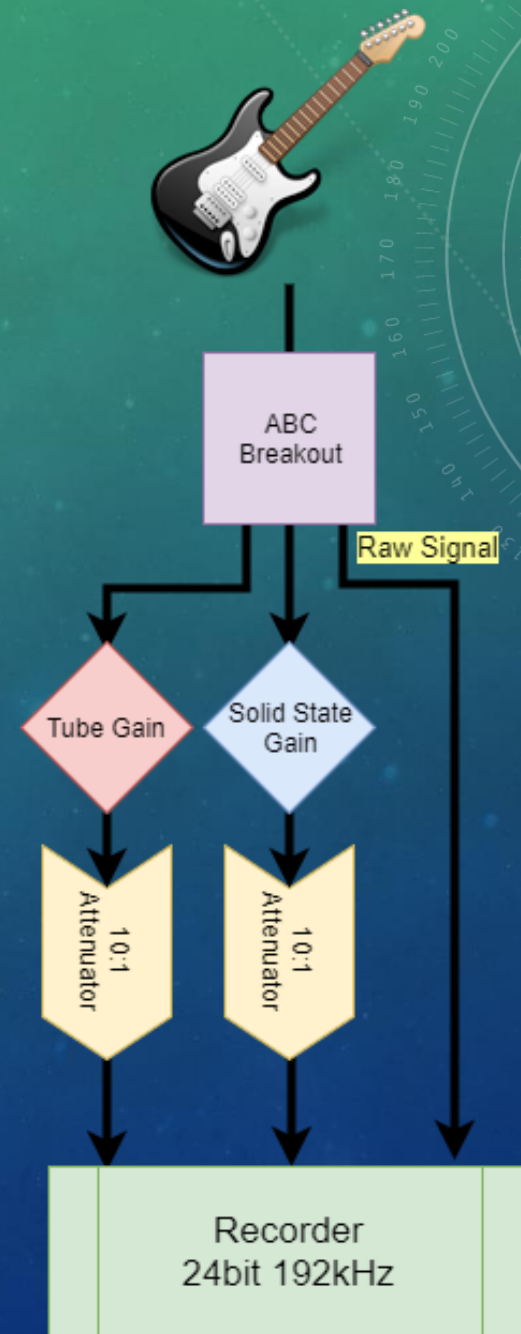
2. CHARACTERIZATION OF TONAL QUALITIES

- Analysis Methods (MATLAB)
  - Time Domain
  - Frequency Domain
    - DFT
    - Spectrogram
- Objectives
  - Identify nonlinear distortions, frequency distortions, etc...
  - Quantify Observations in Spectral Decays

We have started to focus down on our model parameters

FUTURE – HOW DO WE IMPLEMENT THESE PARAMETERS?

- Develop Profile
  - Algorithmically implement parameters
  - Optimize scheming to achieve SuperTube Effect

- Implement Profile
  - Export profile to usable platform
  - Choose platform based on what yields best results

- Evaluate Success
  - Subjective evaluation via human trials (musician and non-musician)
  - Objective evaluation via analysis tools

PROJECT MILESTONES AND SCHEDULE

Project Timeline

	1-Sep	2-Oct	2-Nov	3-Dec	3-Jan	3-Feb	6-Mar	6-Apr	7-May
Tube Amplifier Parameter Research									
Tube Emulation									
Tube Emulator Prototype									
Hardware Controller Prototype									
Prototype Testing									
Integration of Controller & Tube Emulator									
UI Design									
Tube Emulator Revision/Optimization									
Integration of Emulator, Hardware, and UI									
Final Product Build									

QUESTIONS?

REFERENCES

- [1][2]

P.C. SOFTWARE SUPERTUBE PROFILE
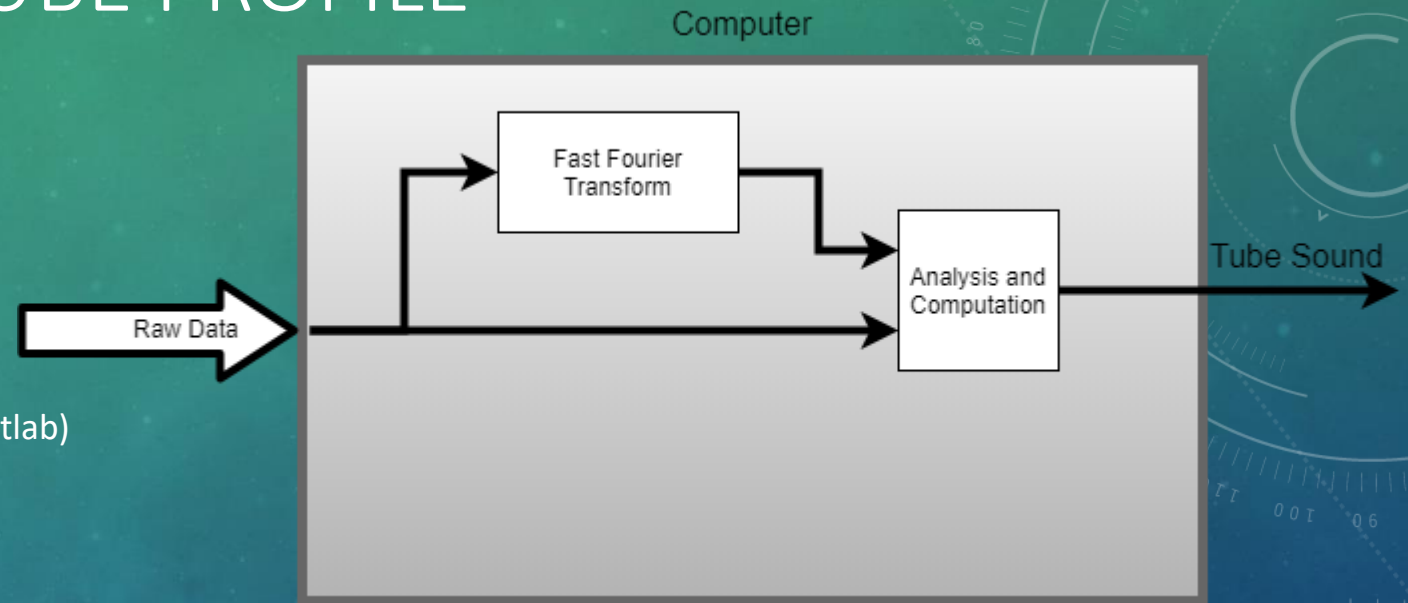
Computer

- Benefits:
  - Allows for ease of model tuning
    - P.C. provides excess of:
      - Computation Power, Memory
      - Instant Access to Analysis tools (e.g. Matlab)
  - High Throughput
  - →Effectively the fastest way to build a functioning Emulator
- Build in C
  - Low Level Language – Portable to Hardware
  - FFTW Library

Raw Data → Fast Fourier Transform → Analysis and Computation → Tube Sound

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Once a functioning Emulator is achieve – we optimize for Hardware (reduce latency, etc.)

MICROCONTROLLER- IMPLEMENTED EMULATOR

- Provides more appealing final form factor:
  - Portable
  - Real-time (post algorithm optimization)
  - Easy to use
  - Tunable