P/O/E/T/S

CENTER FOR POWER OPTIMIZATION OF ELECTRO-THERMAL SYSTEMS

Designing a Graphical User Interface for the Power Module Optimization Tool PowerSynth

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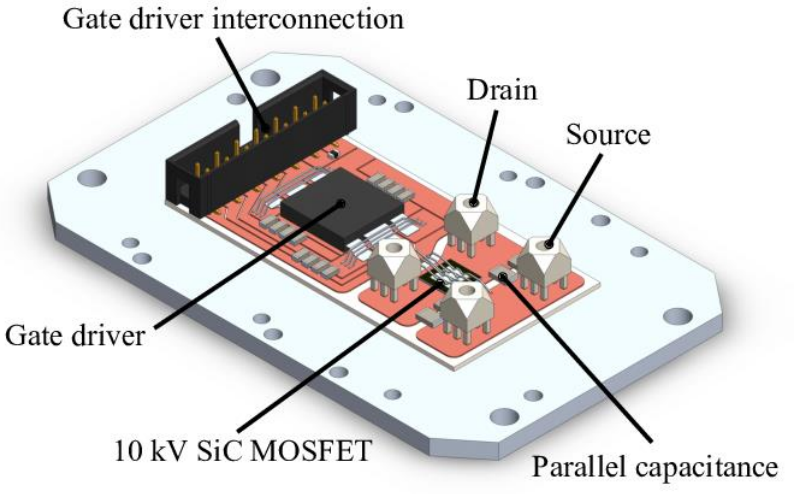
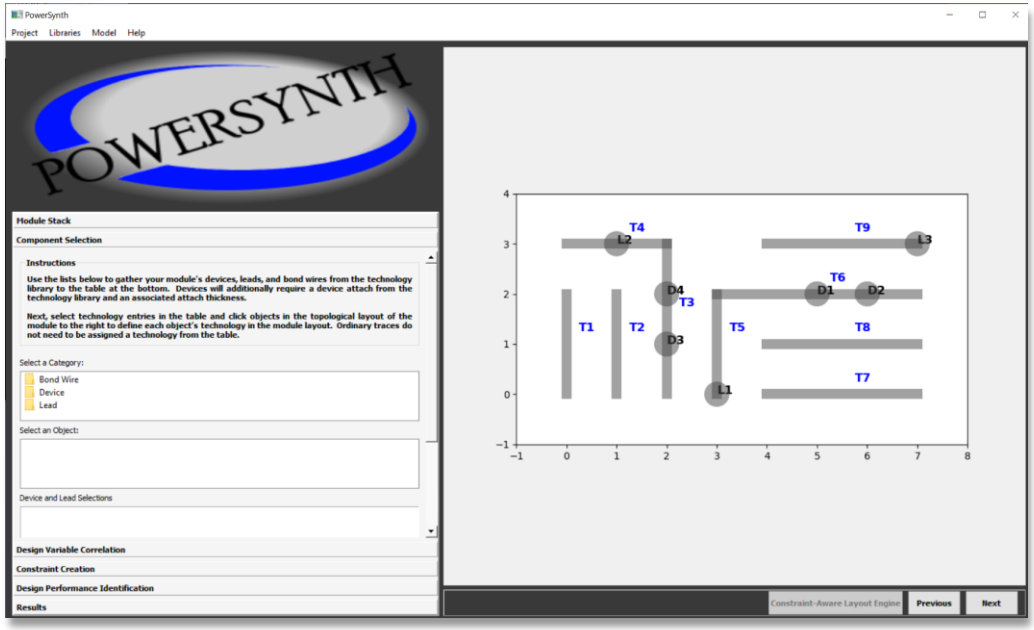
Overview of MCPM Design

- **Power electronics are everywhere**
  - electric vehicles, personal computers, solar panels, etc.
- **A power module's layout is crucially tied to its performance**
  - optimize electrical, thermal, and mechanical capabilities
- **Design flow of multichip power modules (MCPMs) is usually an arduous manual process**



PowerSynth As A Service (PSaaS)

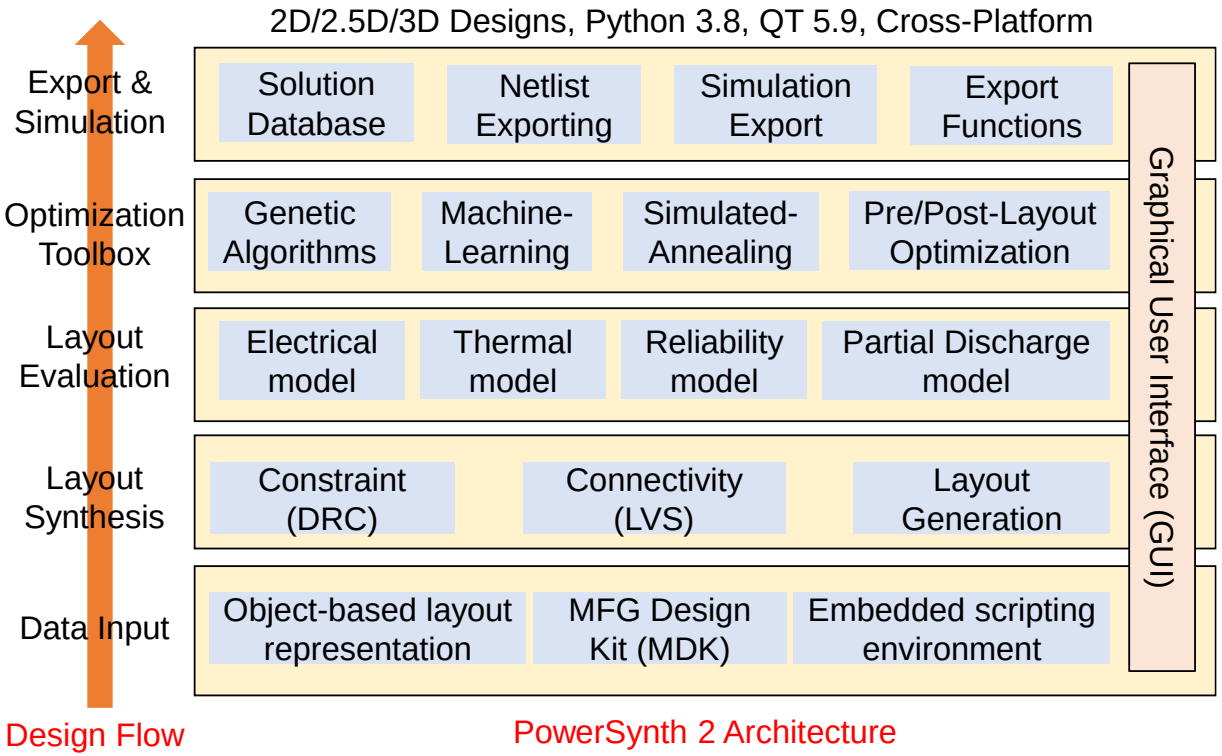
- **PowerSynth is a software tool for the design and layout of multi-chip integrated power modules**
  - combines layout synthesis with design optimization
  - performs orders of magnitude faster than existing tools
- **New version of PowerSynth is currently in development**
  - more advanced algorithms
  - hierarchical layout engine
  - support for 3D layouts



PowerSynth 1.4

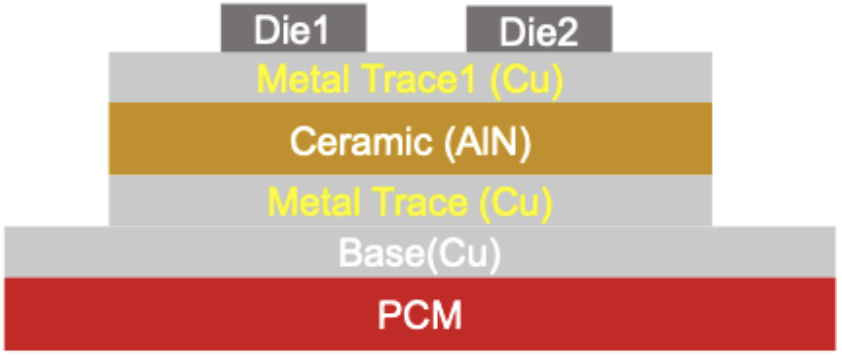
PowerSynth 2 Features

- Material Design Kit (MDK) and Layer stack parameterization
- Constraint-aware layout engine to generate DRC-clean layouts
- Fast, accurate and reduced-order electrical and thermal model.
- Electro-thermal reliability optimization
- Easily export design solutions to FEA tools



Contributions to PowerSynth

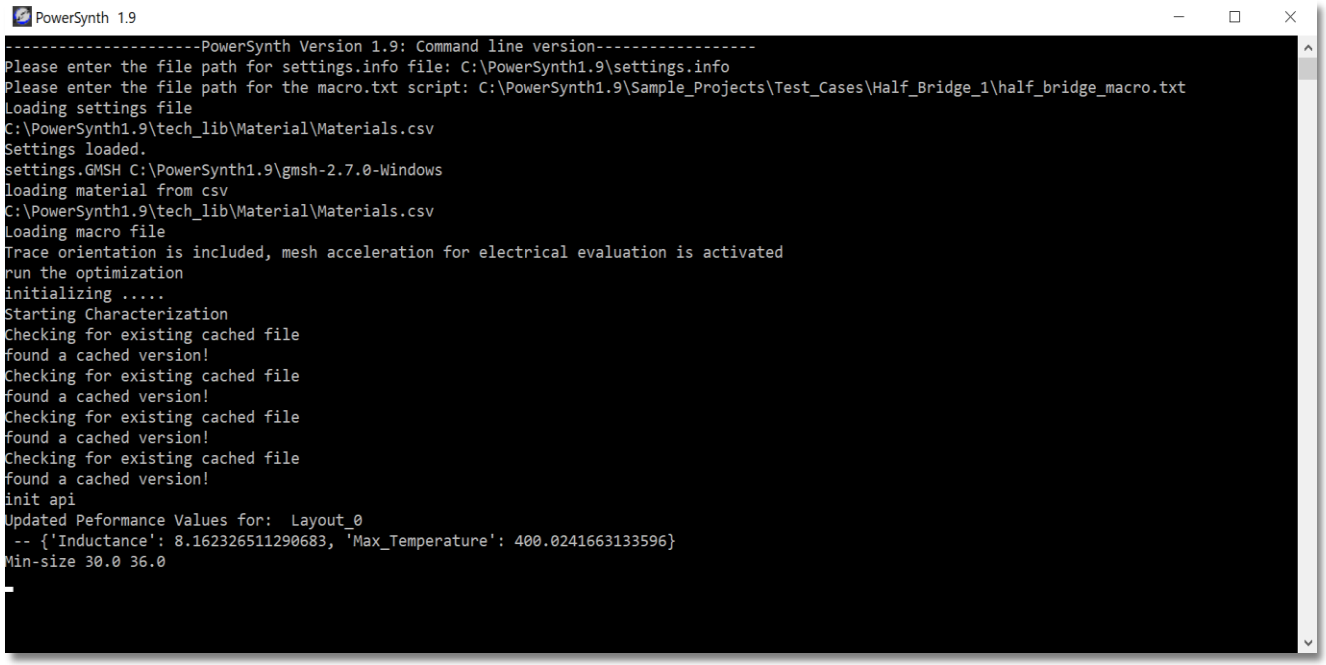
- **Two-step electro-thermal reliability optimization methodology:**
  - layer stack optimization
  - placement and routing optimization
- **Fast, accurate transient thermal model for PowerSynth to predict thermal cycling behavior with phase change material (PCM)**
- **A comparative study of using PCM to reduce thermal cycling stress**
- **Reliability Performance metrics include:**
  - Electrical: power loop inductance
  - Thermal: maximum transient temperature



layer stack structure

Command Line Design Flow

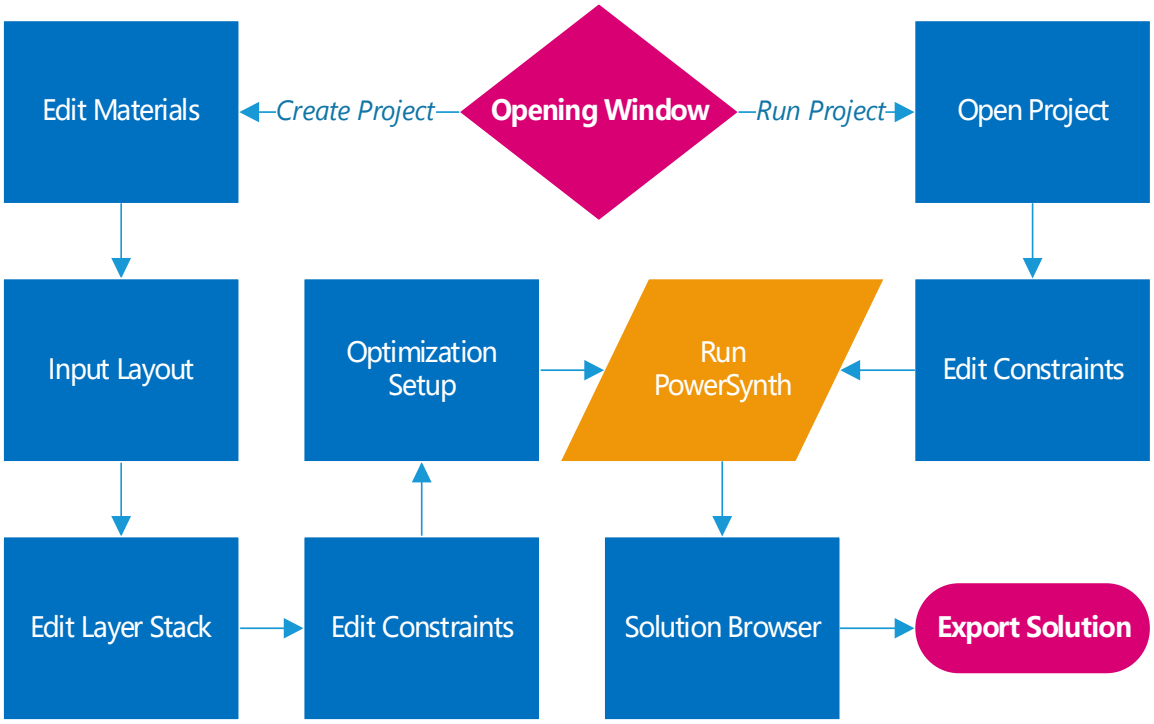
- **User inputs paths to settings/macro script files**
- **Prompts user to change the constraints file**
  - **Limitations of command line version:**
    - requires large amount of setup for user
    - challenging for new users to figure out file setups
    - required specific formatting of files is prone to error



PowerSynth 1.9 (Command line only)

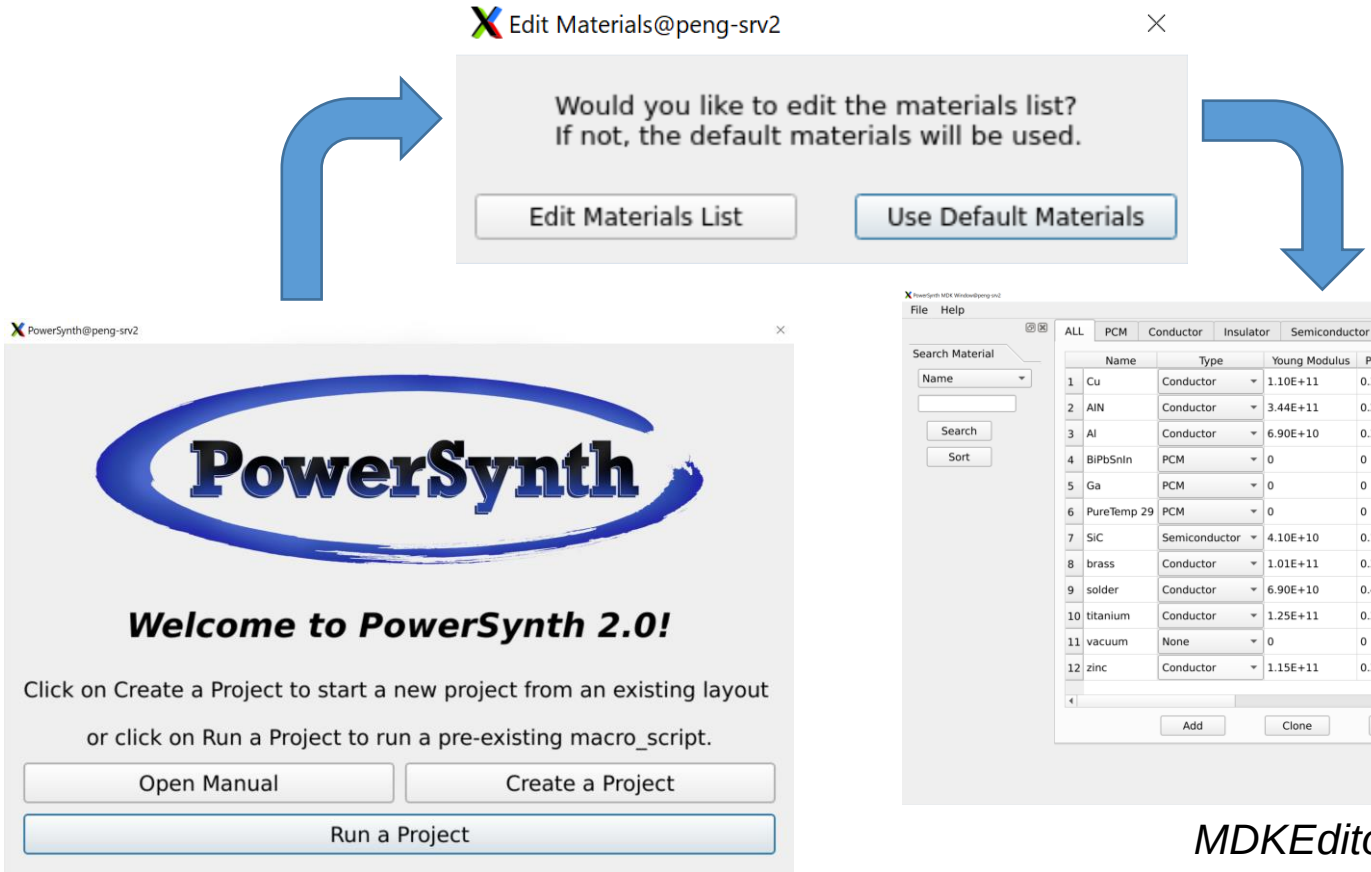
Graphical Interface Design Flow

- **Two main flows: create new project or run existing project**
  - functional, simplistic design of windows
- **GUI automatically generates many required input files**
  - significantly eases process for new users



Project Configuration

- **Opening window allows to run existing or create a new project**
- **Materials list can be edited via the MDKEditor**
  - default materials are pre-loaded



MDKEditor

Structure Configuration

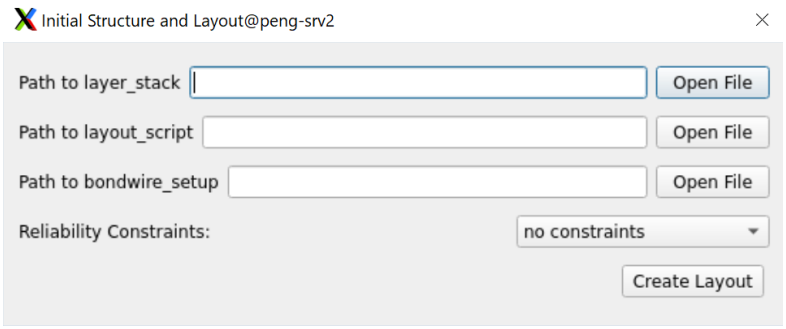
- **User must now input paths to the layer stack, the layout script, and the bondwire setup files**
- **Editors for the layer stack and constraints will be provided**
  - constraints file is also automatically generated

Edit Layer Stack@peng-srv2

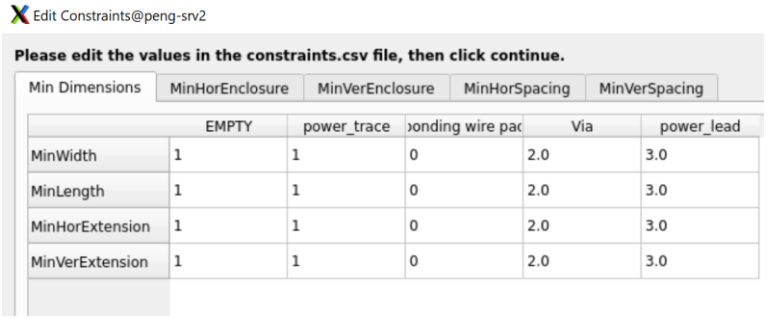
Please edit the values in the layer_stack.csv file, then click continue.

	Name	Origin	Width	Length	Thickness	Material	Type	Electrical
1	Baseplate	0,0	53	57	1	copper	p	F
2	Bottom_Metal	5,5	43	47	0.2	copper	p	G
3	Ceramic1	5,5	43	47	0.835	Al_N	p	D
4	I1	5,5	43	47	0.2	copper	p	S
5	C1		43	47	0.18	None	a	C

layer stack visualization



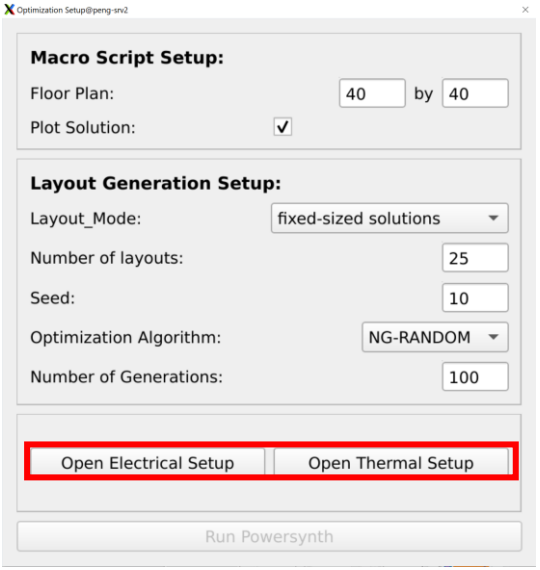
Design configuration

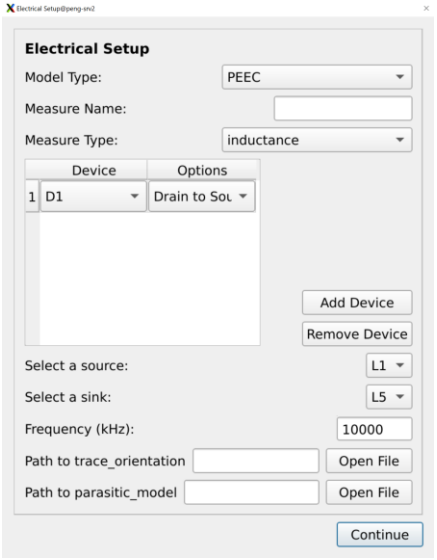


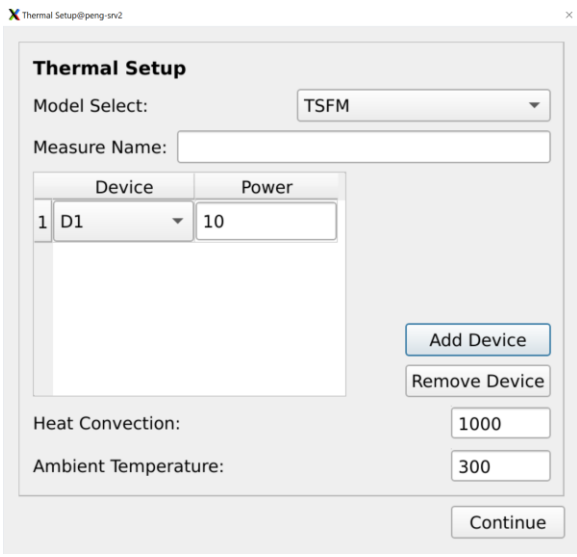
constraints visualization

Model Configuration

- **User selects how to run PowerSynth:**
  - Initial layout optimization
  - Layout solution generation only
  - Layout optimization/evaluation
- **Direct user to the customized macro script window**
  - electrical/thermal setups only included if necessary
  - automatically generates macro script once completed

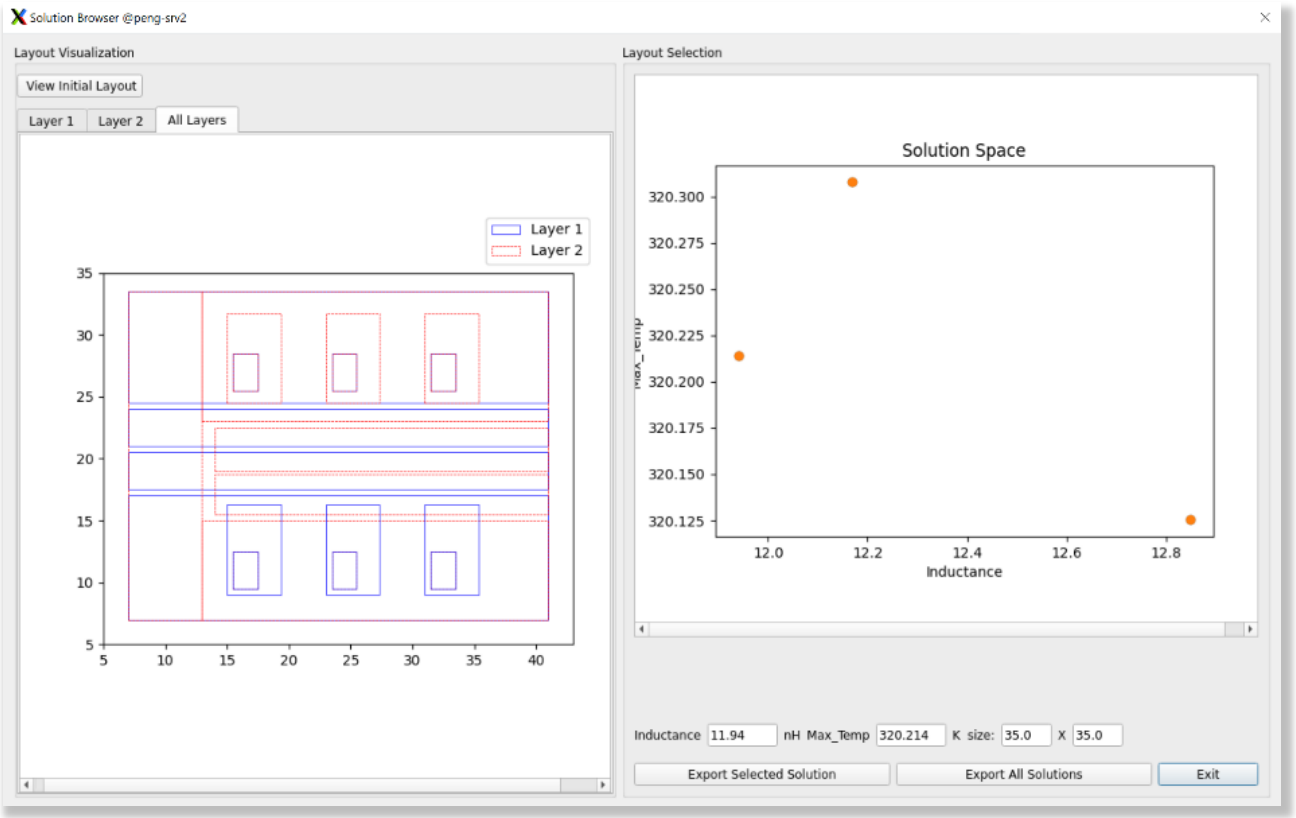






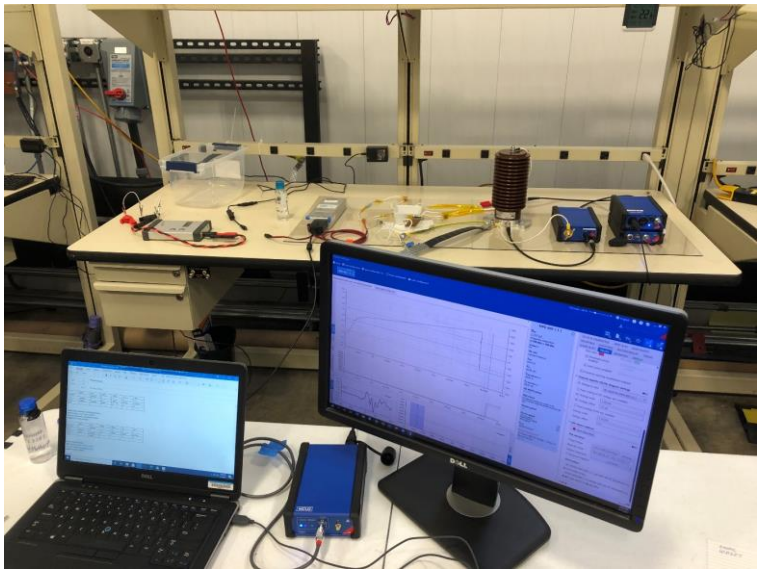
Layout Visualization

- **PowerSynth is ran with all given input and solutions are generated**
- **User can compare and browse solutions by clicking on the graph**
  - individual or all solutions may be exported in an FEA-friendly format



REU as an Educational Experience

- **In-person research is highly valuable**
  - virtual opportunities lack effective networking and communication
  - insufficient work-life balance
- **REUs (Research Experiences for Undergraduates) provide opportunity to work outside major**
  - American educational system is not built for experimentation of fields
  - leads to student dissatisfaction and career anxiety
- **Undergraduate research acts as a preview of careers in academia**



Conclusions and Future Work

❑ Conclusions:

- As a reliability-aware design tool, PowerSynth can further reduce design efforts and engineering time with MCPMs
- New GUI improves user interaction and design efficiency with PowerSynth through visualization
- The interface should improve the design flow for both new and advanced users
- REU programs create a highly valuable and supportive experience that allows students to explore their interests at a crucial time in their development

❑ Future Work:

- Visualization of hierarchical structure of layouts
- Integrating MDKEditor to edit layer stack
- Custom layout editor to generate layout script files

Questions?

For more information, please visit the E3DA Lab Website:

https://e3da.csce.uark.edu/