# DNN Structure Flow
## Simulation and Dataset Description

### 2D FDTD Simulations

Inputs:
- Material Choice (n,k)
- Rand(X, Z) Matrix (constrained by a Max/Min X and Z)
- $t_{sub}$
- $\lambda_{min}$, $\lambda_{max}$
- *Incident Angle(s)\**
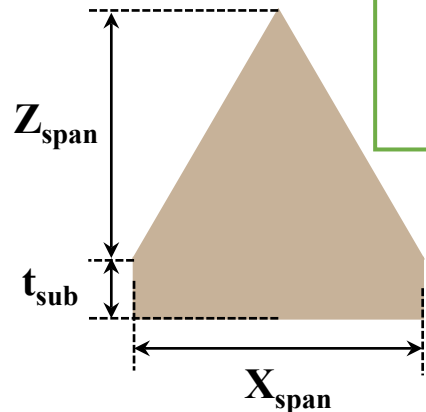- *Simulation Temperature\**

Outputs:
$\varepsilon\ vs.\lambda$
$\rho\ vs.\lambda$

### FDTD

FEM Solver of Maxwell's Equations

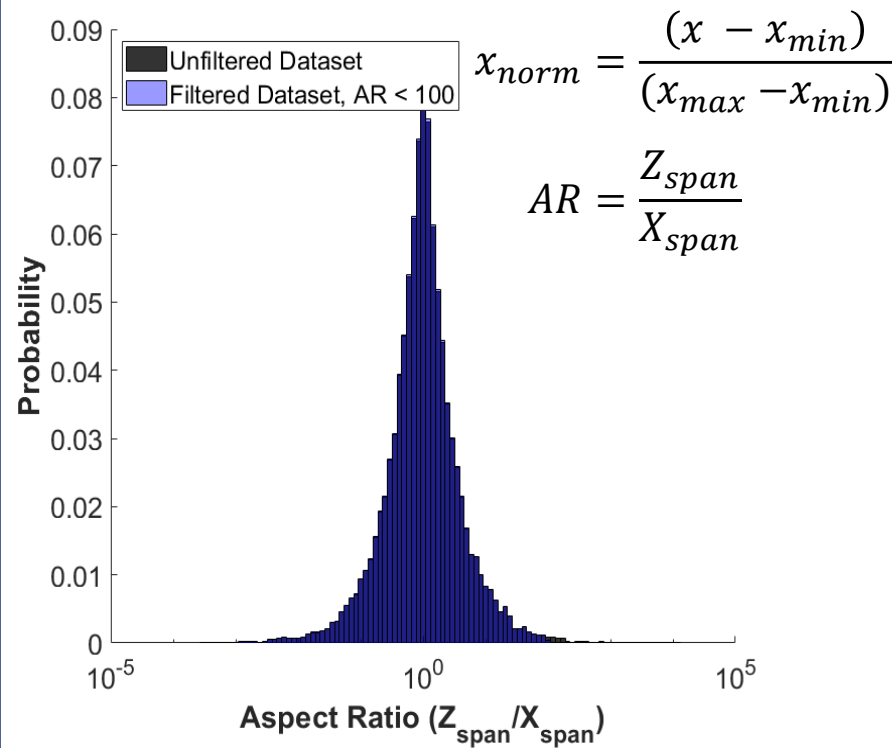$$\frac{\partial \vec{D}}{\partial t} = \nabla \times \vec{H}$$

$$\vec{D}(\omega) = \varepsilon_0 \varepsilon_r(\omega) \vec{E}(\omega)$$

$$\frac{\partial \vec{H}}{\partial t} = -\frac{1}{\mu_0} \nabla \times \vec{E}$$

$Z_{span}$
$t_{sub}$
$X_{span}$

### MATLAB Processing



Unfiltered Dataset
Filtered Dataset, AR < 100

Aspect Ratio ($Z_{span}$/$X_{span}$)
Probability

$$x_{norm} = \frac{(x - x_{min})}{(x_{max} - x_{min})}$$

$$AR = \frac{Z_{span}}{X_{span}}$$

- Outliers are eliminated on a basis of aspect ratio – Filtering by **AR < 100** of the **27775** Dataset leads to **27640** Points (135 Datapoints Eliminated)

### DNN Processing

- Dataset is shuffled randomly and split into:
  - Test        (20%)
  - Train        (60%)
  - Validation   (20%)
- An additional Prediction Dataset is a "static" and unshuffled input/output set to evaluate the model

### DNN Output

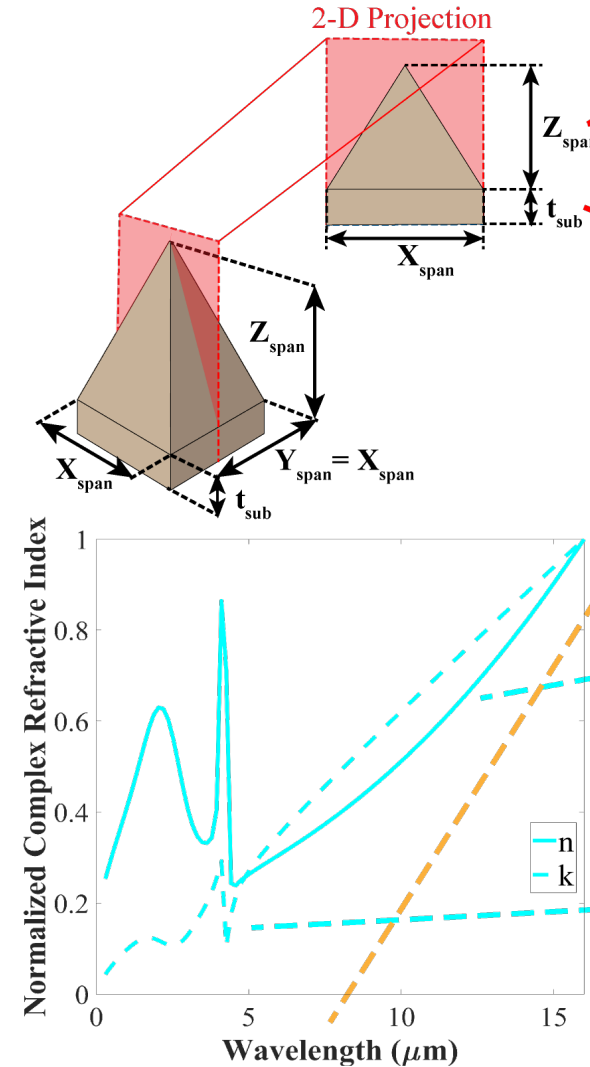$\varepsilon\ vs.\lambda$ and $\rho\ vs.\lambda$ of Test, Static, and Gridpoint datasets

### Thermal Processing

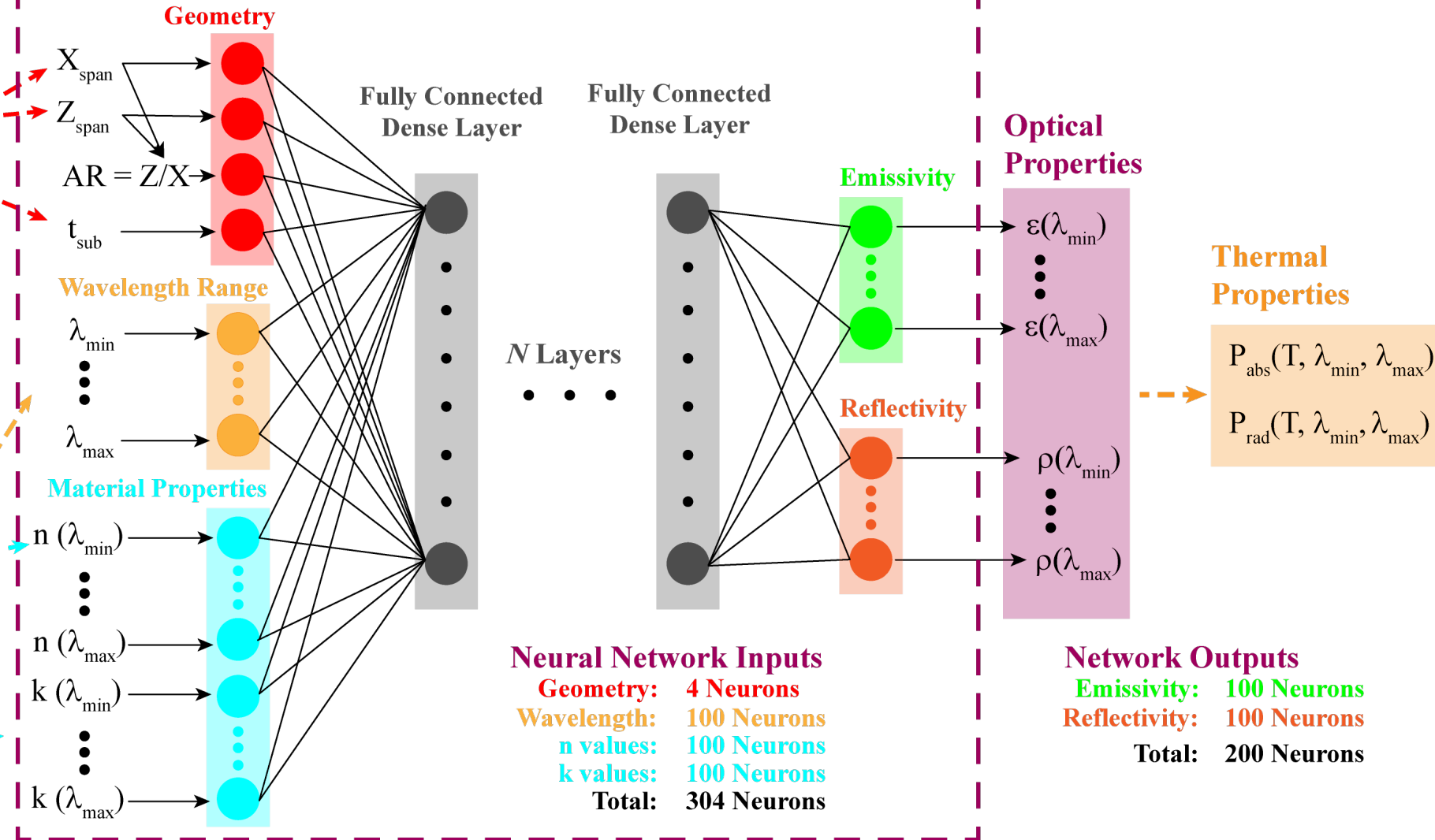Temperature and Heat Transfer Calculations based on $\varepsilon$ and $\rho$

*Currently not in use for this iteration

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# General Network Structure
## Network Design Structure

# Datasets Available

Datasets included in analysis and coding

- Training Dataset (~31750 simulations combined of 12 different materials)

- Static Prediction Dataset (256 Nickel Simulations)

- Gridpoint Datasets (10000 synthetic simulations – the only difference between synthetic simulation input is the choice of X and Z coordinate)

- Unseen Datasets (1500 Ti/Al2O3 simulations compiled and used for evaluation)