The Center for Computation & Technology REU at LSU

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Problems:
- Incandescent bulbs are inefficient
- Fluorescent bulbs use mercury
- LEDs are expensive to fabricate

**Figure 3: Traditional Tungsten Filament Emittance**

Peak emittance of 0.55 at 400 nm and 800 nm
IMPROVING THE INCANDESCENT BULB

- Goal: Design a better filament
  - Operates at 2800 K
  - Materials must be non-hazardous
  - Layered Structure: eases manufacturing
  - Emittance peaks from 390-700 nanometers
  - Emittance peaks over most angles
The Filament:

- Layers of Tungsten and Silicon Carbide
- Low material and fabrication costs
- High melting points: Tungsten: 3400 K, Silicon Carbide: 3000 K
Kirchhoff's Law for Thermal Equilibrium:

\[ E = A = 1 - R - T \]

- \( E \) is emittance, \( A \) is absorbance, \( R \) is reflectance, \( T \) is transmittance

The transfer-matrix \((M)\):

- Elements help determine \( R \) and \( T \)
- Found through multiplication of boundary and propagation matrices

\[
M = \begin{bmatrix}
M_{11} & M_{12} \\
M_{21} & M_{22}
\end{bmatrix}; \quad R = \frac{1}{|M_{11}|^2}; \quad T = \left| \frac{M_{21}}{M_{11}} \right|^2
\]
OPTIMIZING EMISSION: SOFTWARE

- Hybrid Optimization Algorithm:
  - Combination of stochastic and deterministic optimization algorithms
  - Optimizes filament layer dimensions for desired emittance values
  - Dimensions range from 0-800 nanometers
Hybrid Optimization Algorithm (cont.):

- Genetic: Stochastic structure changes
  - Random filament structures are “mated”
  - Fitness Function assigns emittance values
  - Passes best structure to new generation
- Local: Deterministic layer changes
  - Passes best structure to new generation

![Figure 2: Flow of the Hybrid Algorithm](image_url)
Figure 3: Traditional Tungsten Filament Emittance

Figure 4: Tungsten/Silicon Carbide Filament Emittance

Emittance

Peak emittance of 0.55 at 400 nm and 800 nm

Peak emittance of 0.99 from 400 nm to 650 nm
FUTURE WORK

- Continued optimization of current structure
- Rewrite from FORTRAN 77/90 to C++
- Parallelization of Transfer-matrix calculations
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QUESTIONS?