Nuclear Reactor-Induced Microplasmsas in Porous Metals: New Energy Frontiers

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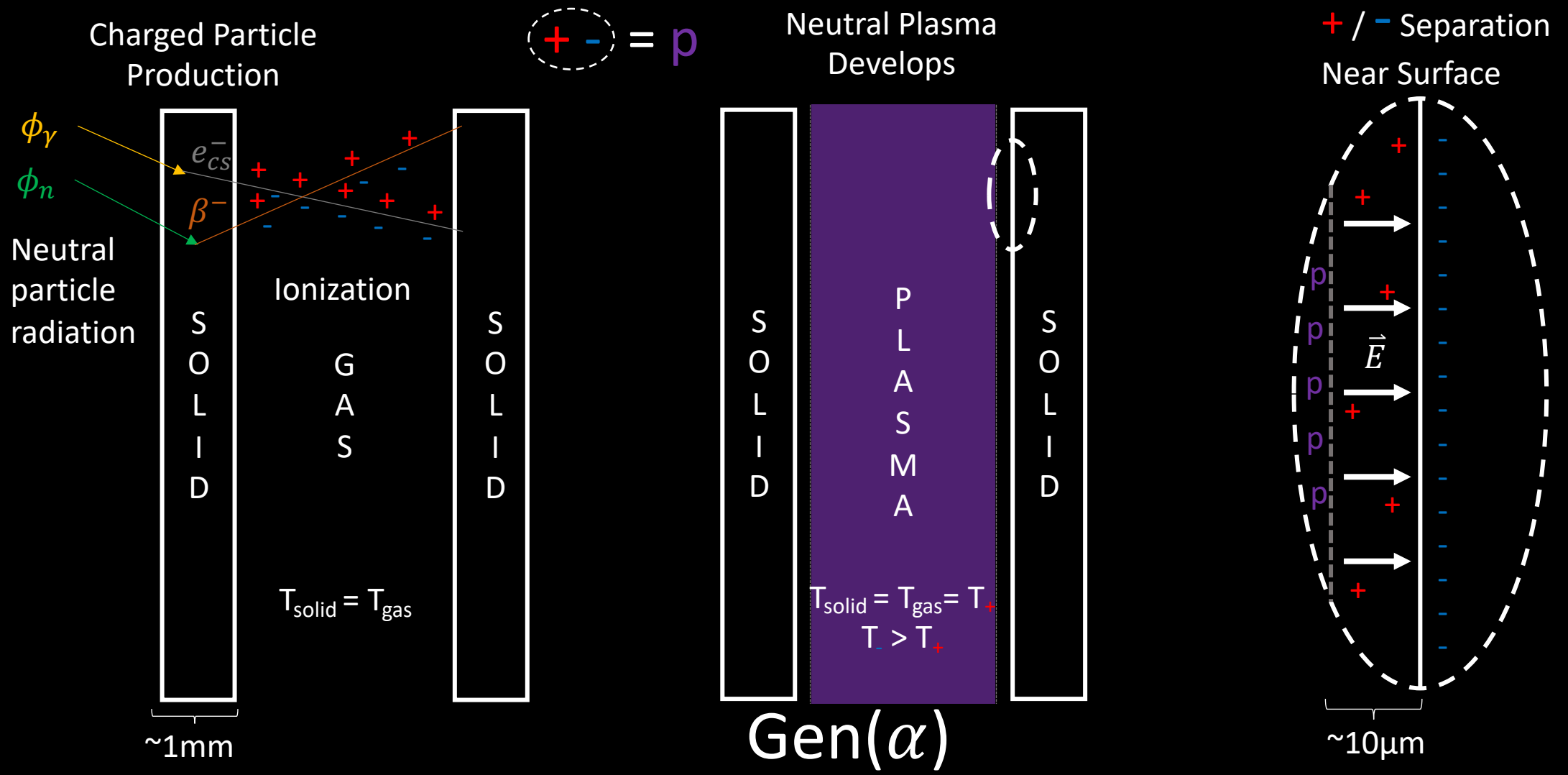
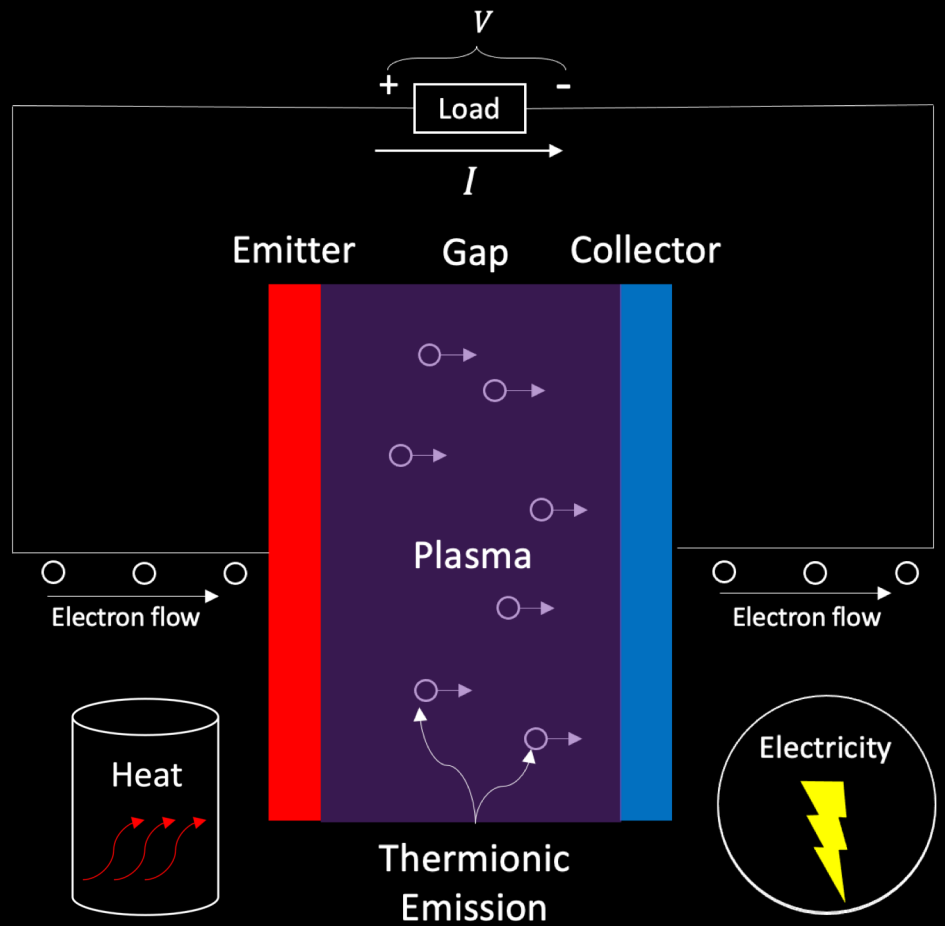
Nuclear Low-Temperature Plasma Basics

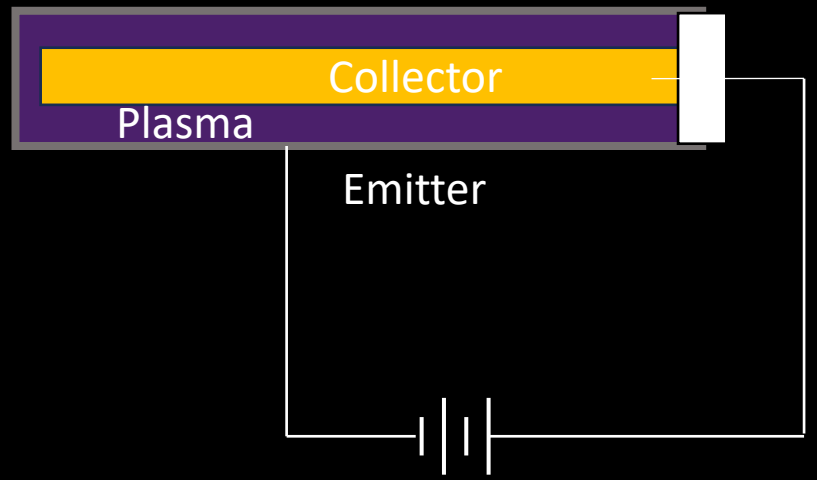


Applications

Thermionic Energy Conversion



In-core reactor instrumentation (ionization chambers)



Others?

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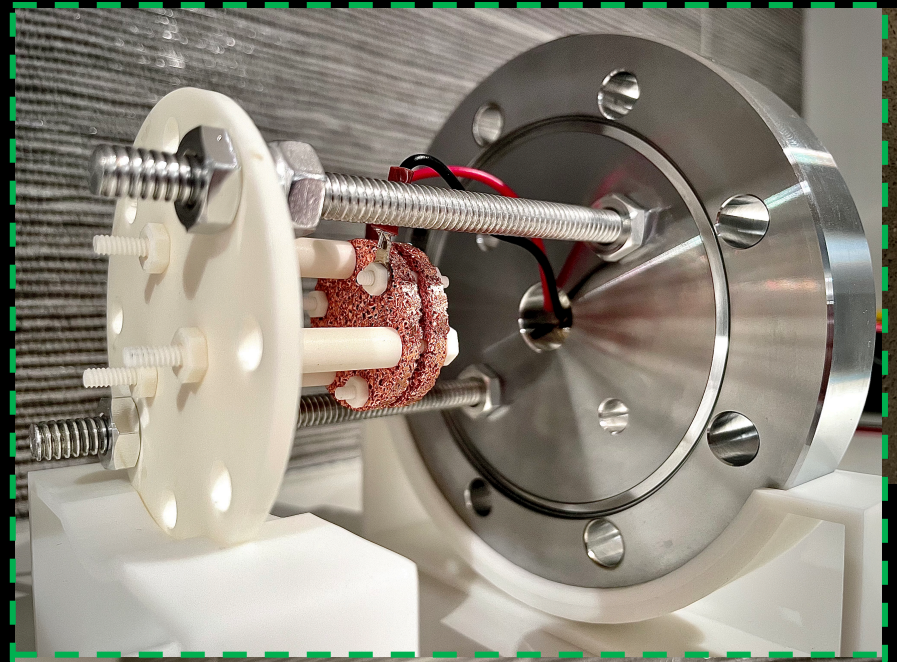
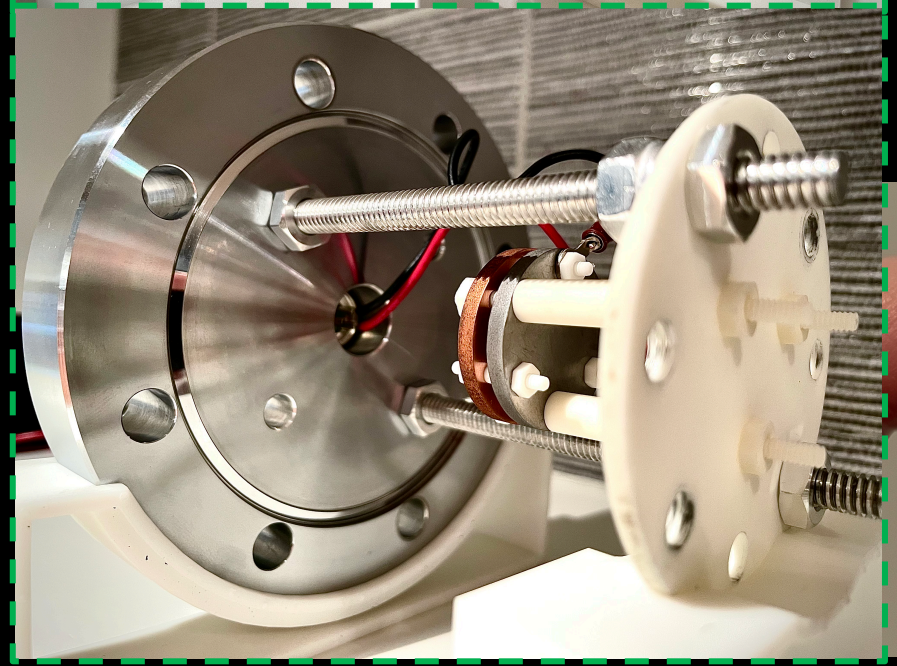
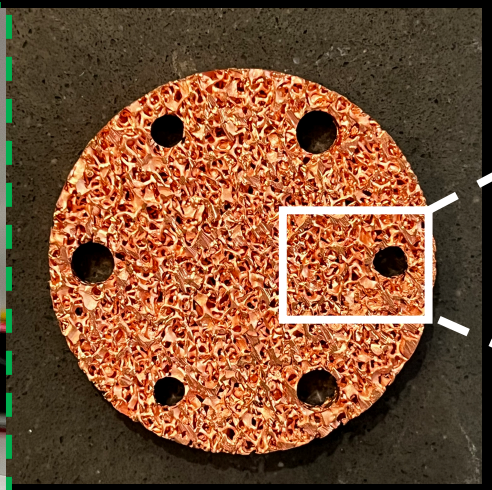


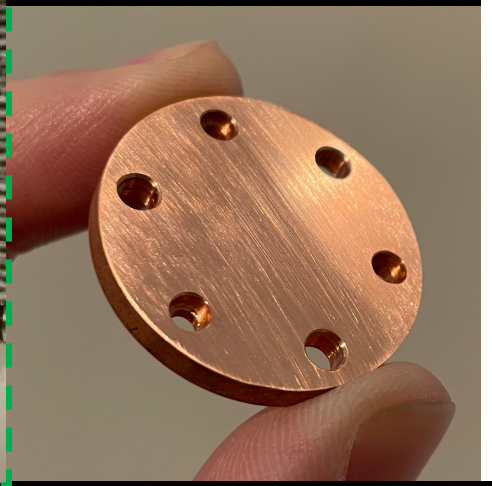


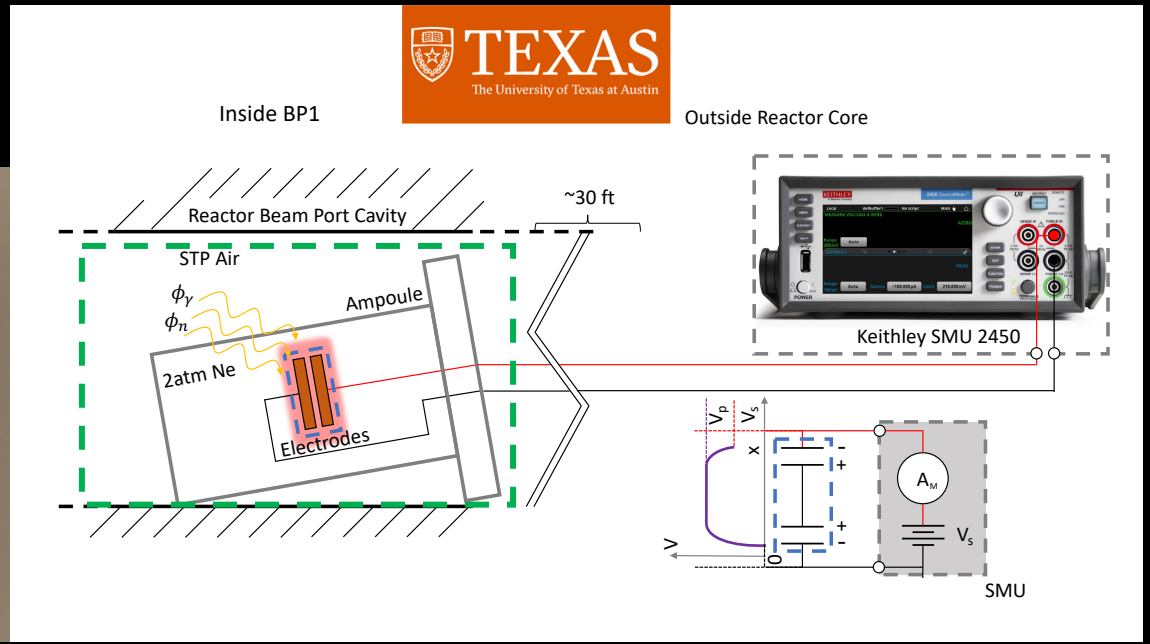


1mm

I-V curves for:

- Solid electrode
- Foam electrode





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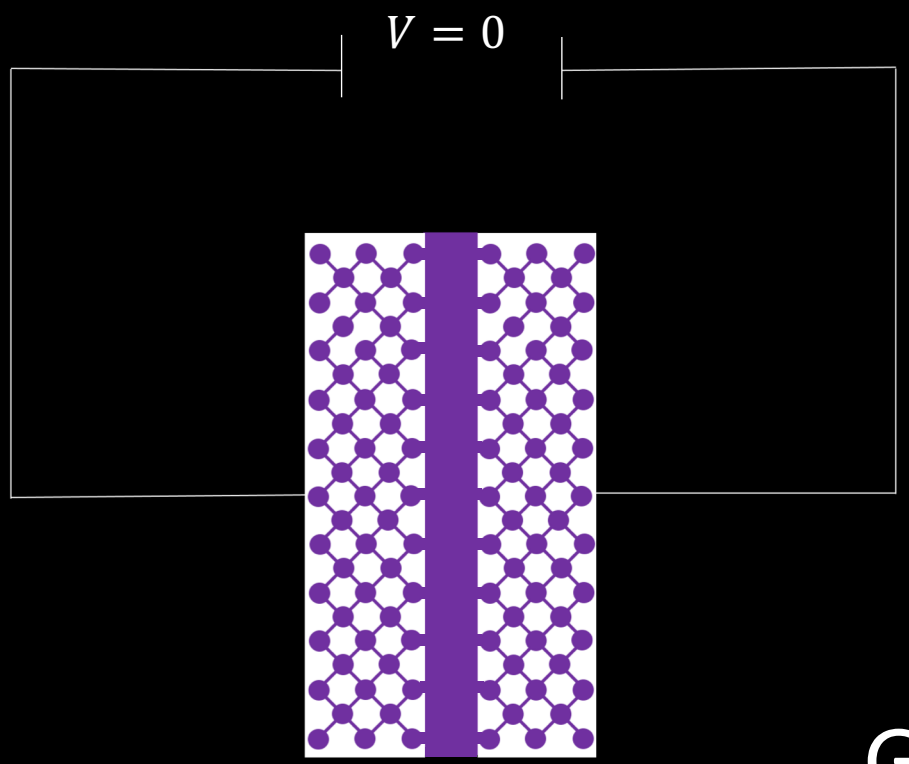
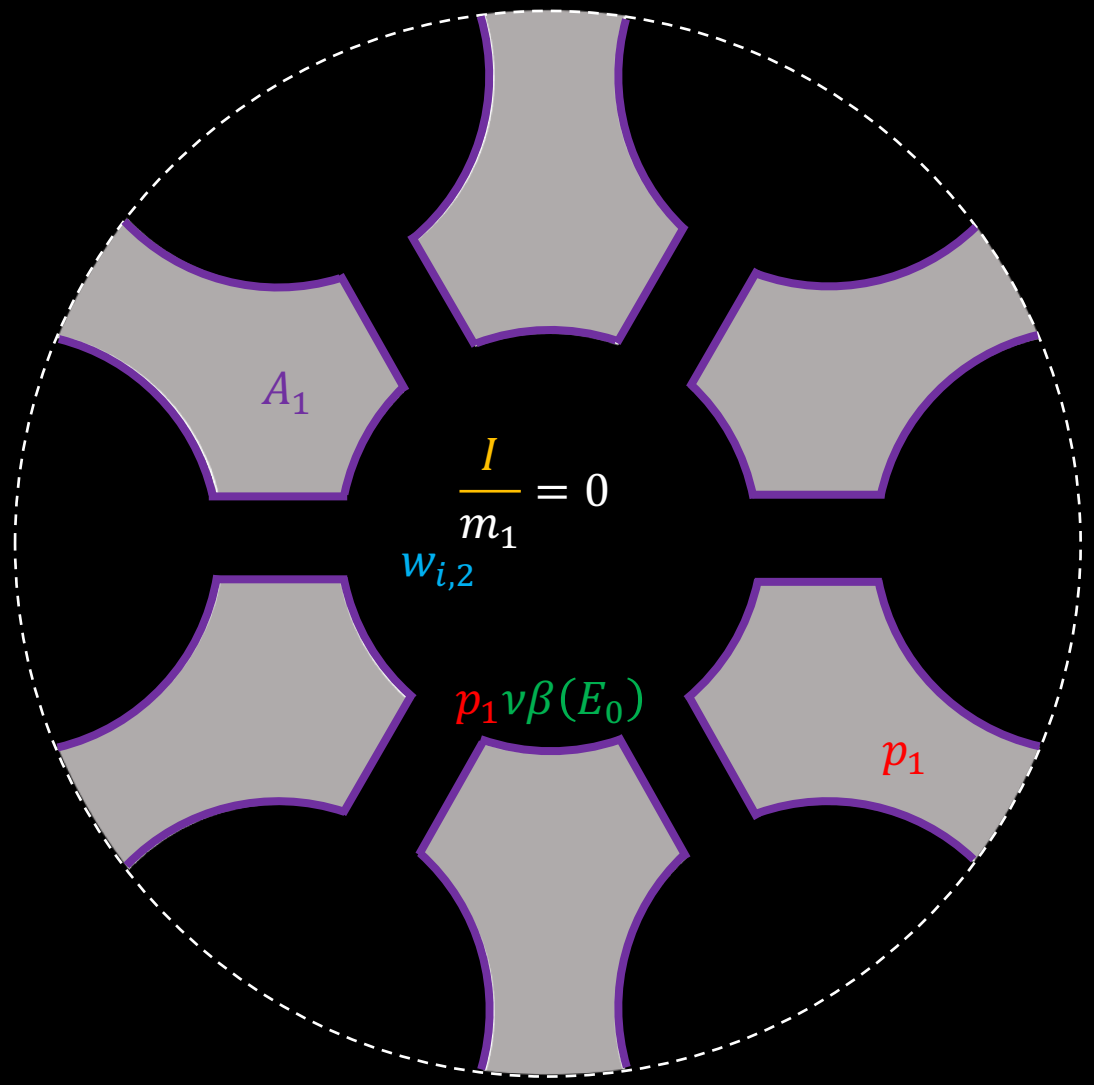
I-V Analysis

$$\frac{I}{m_1} = \frac{CA_1}{m_1}\left(p_1 \frac{\nu\beta(E_0)}{ew_{i,2}}\right)^{3/4} V^{1/2} \qquad \frac{\left[\frac{\nu\beta}{m}\right]_f}{\left[\frac{\nu\beta}{m}\right]_s} = \left(\frac{I_{i,f}A_s}{I_{i,s}A_f}\right)^{4/3}\left(\frac{m_s}{m_f}\right)^2$$





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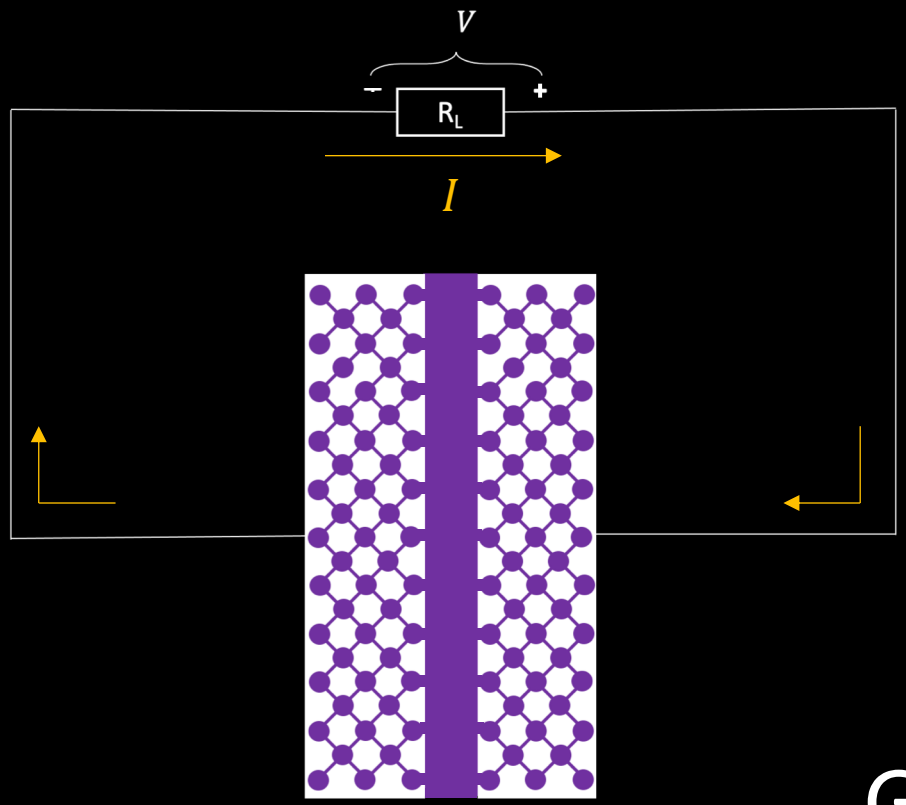

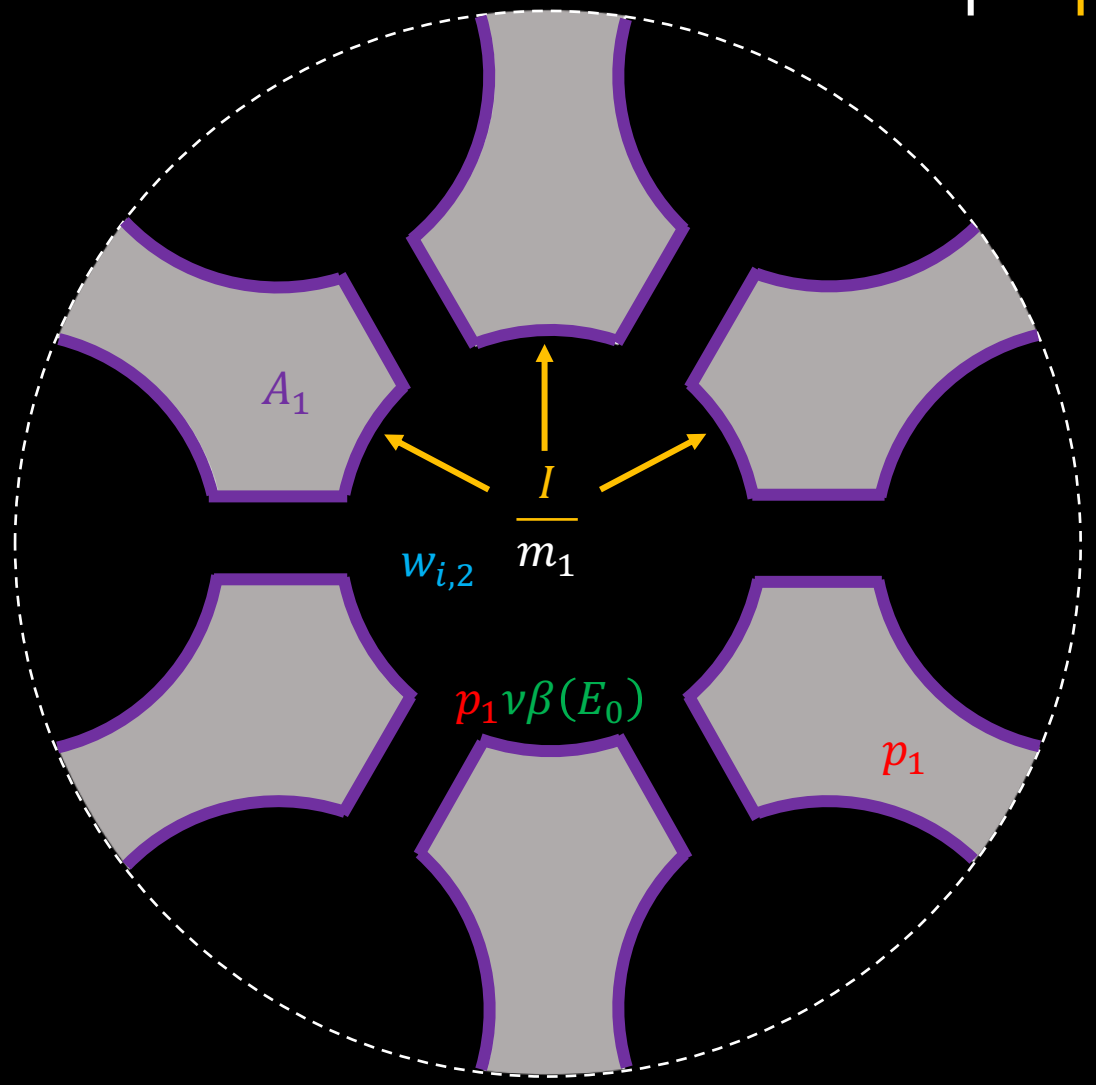

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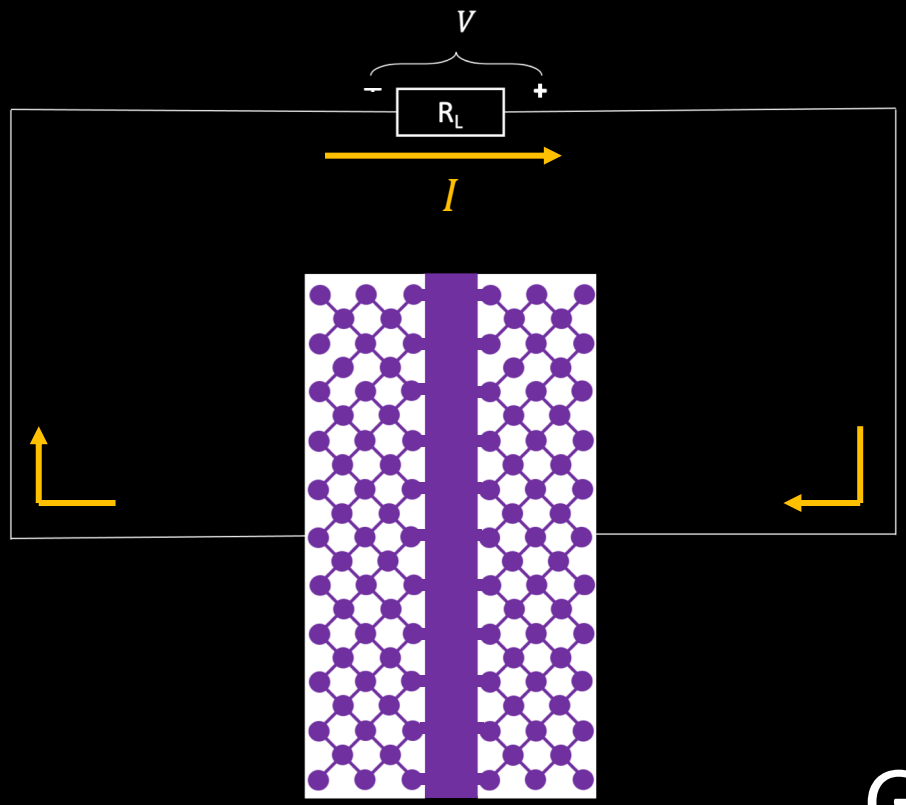

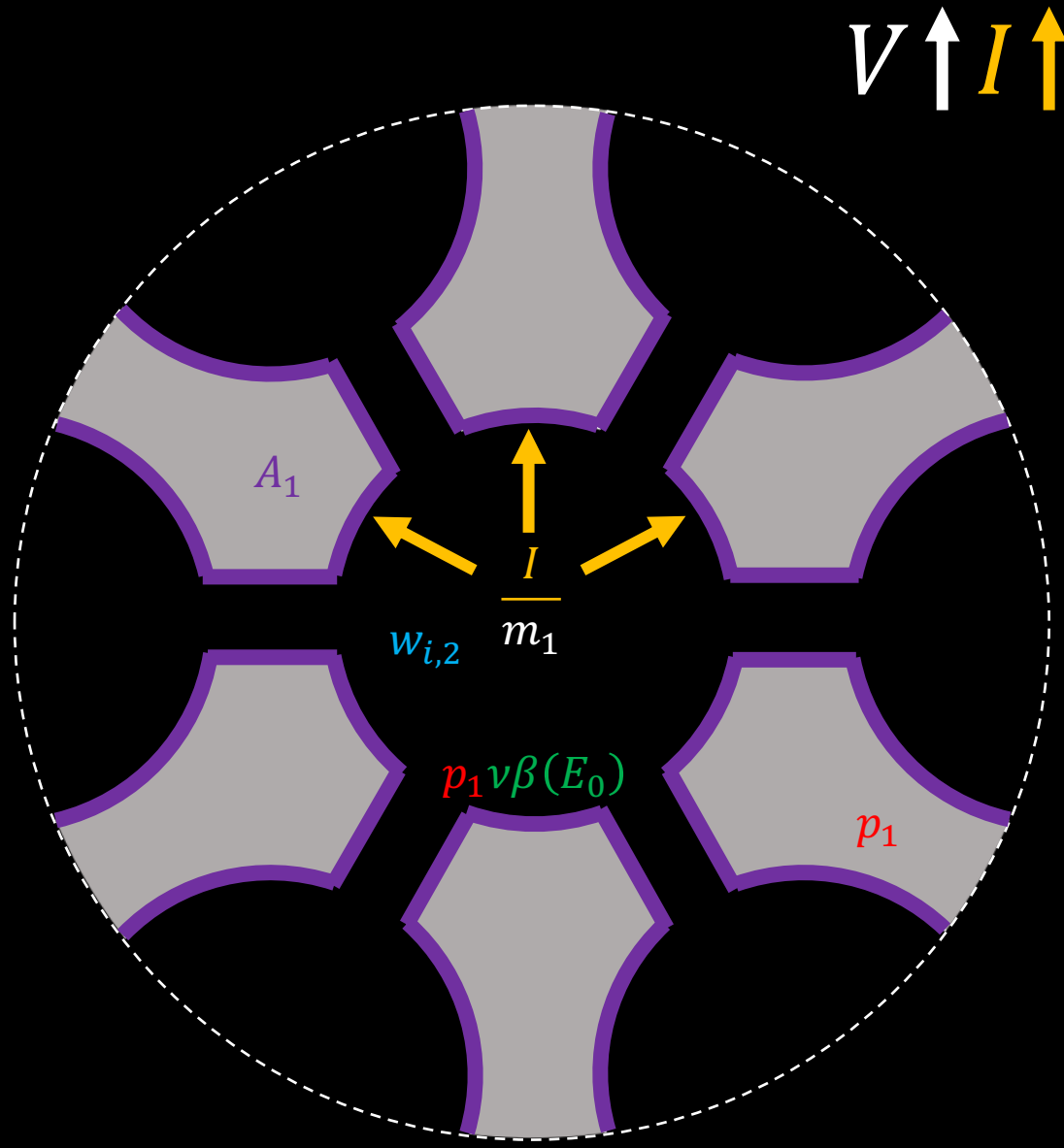

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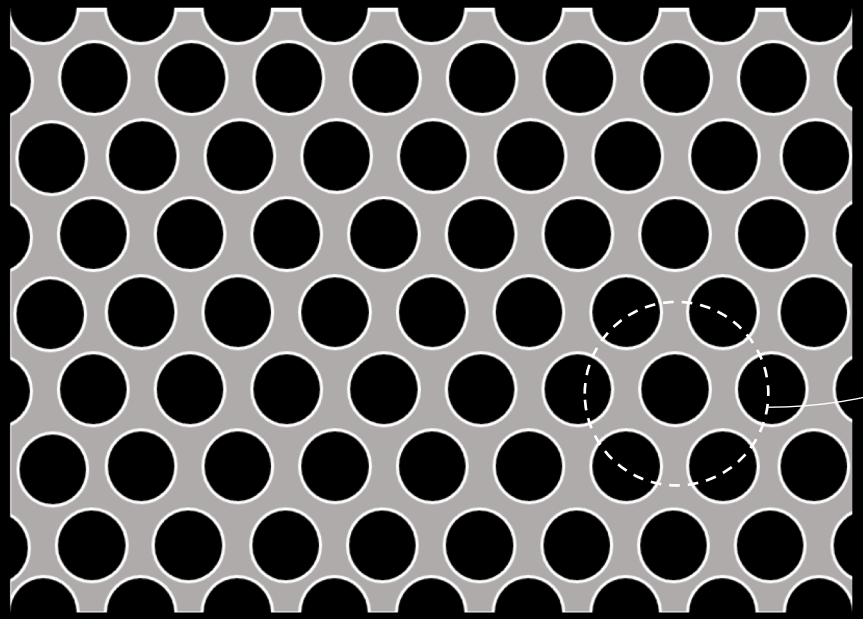
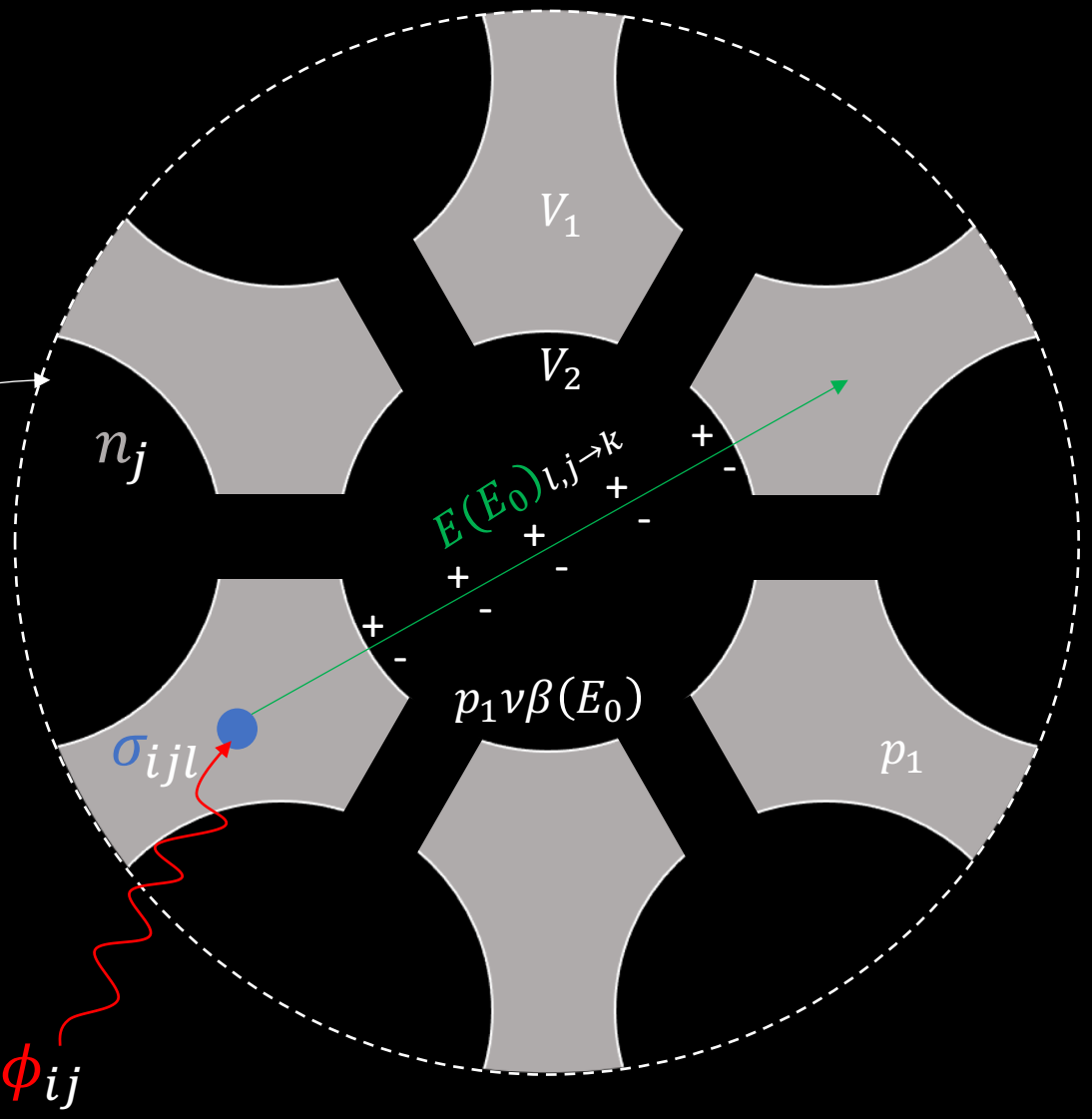
M&S Methods





$$R_{ijl} = \phi_{ij}\sigma_{ijl}n_j$$ Reaction Rate

$$p_{tot} = \sum_{ijkl}\left(R_{ijl}E(E_0)_{l,j\to k}\frac{V_j}{V_k}\right)$$ Power Density

$$p_{tot} = p_1[1 + \nu\beta(E_0)]$$

MCNP calculates this!

$$\frac{V_1}{V_2}$$

$$\frac{E(E_0)_{e,1\to 2}}{E(E_0)_{e,1\to 1}}$$

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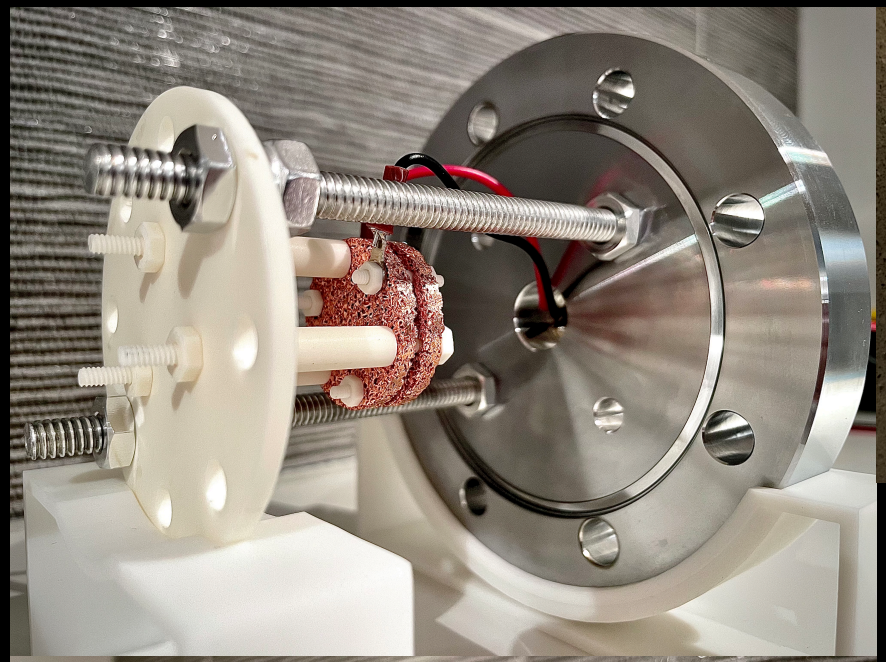
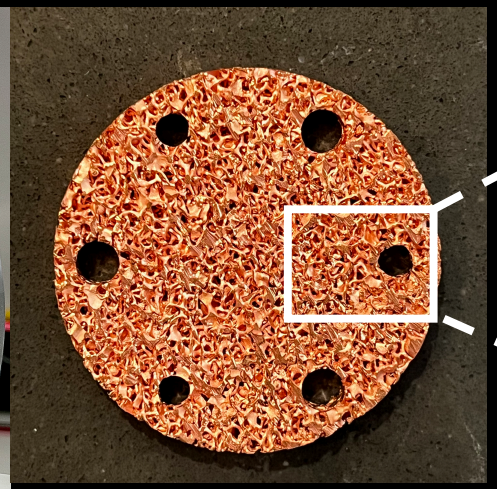
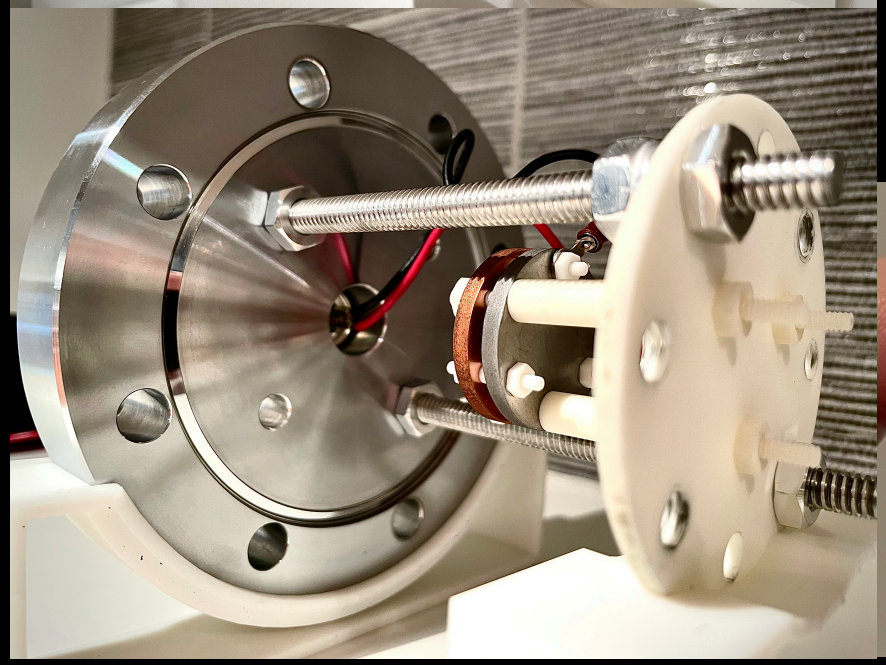
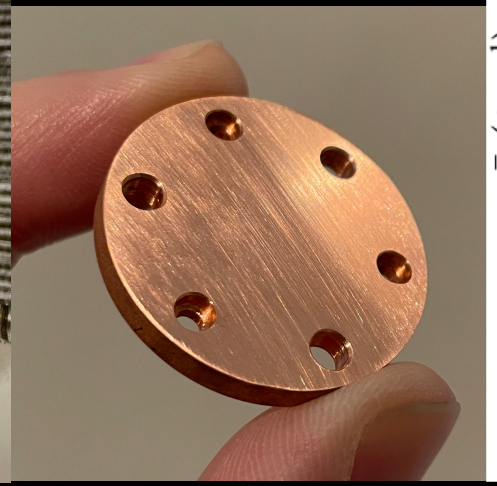


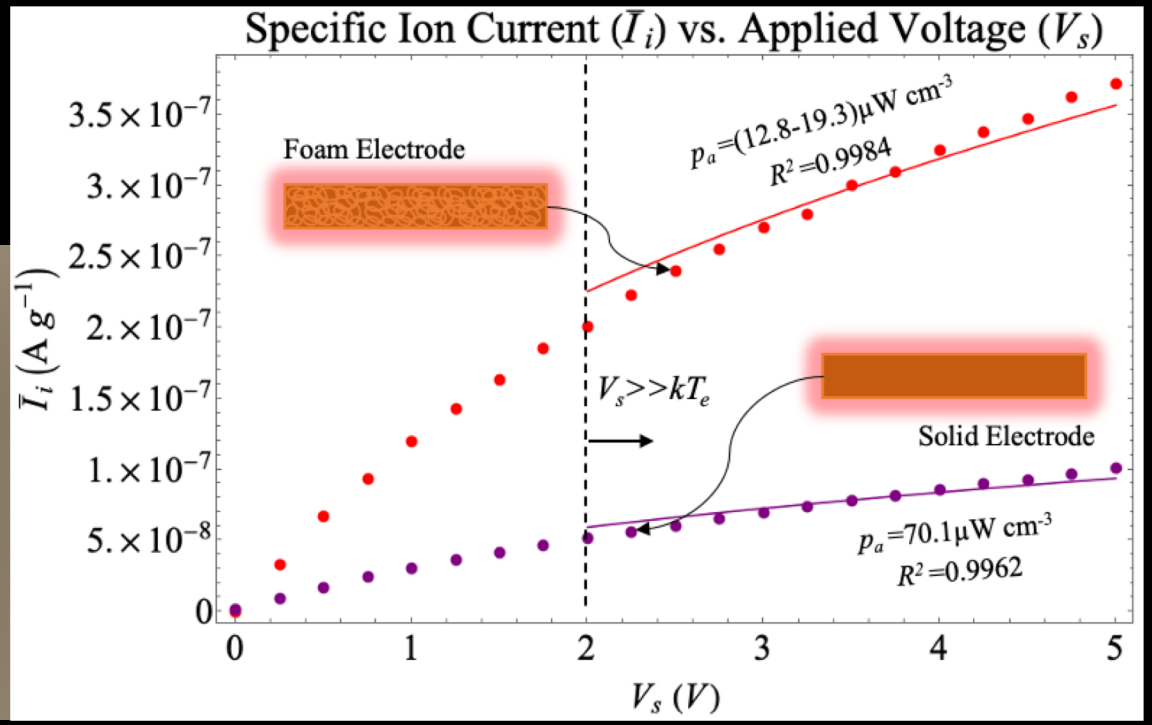


1mm

Observation 1:
Higher specific current observed for foam electrode







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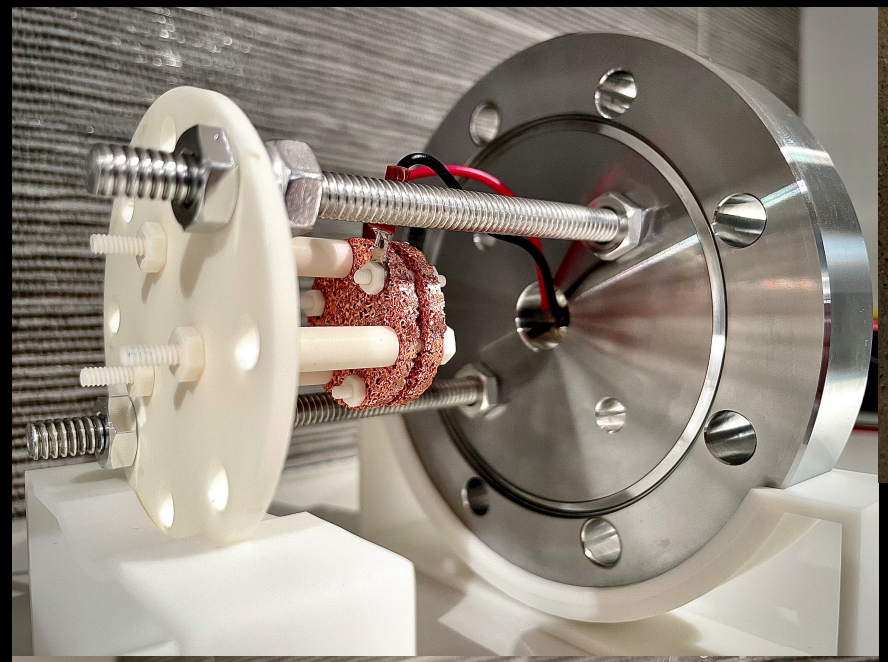

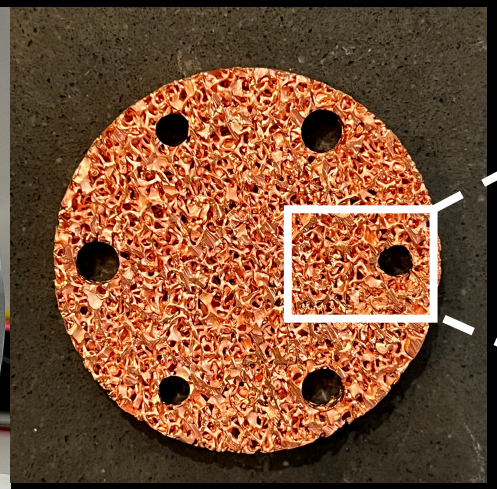

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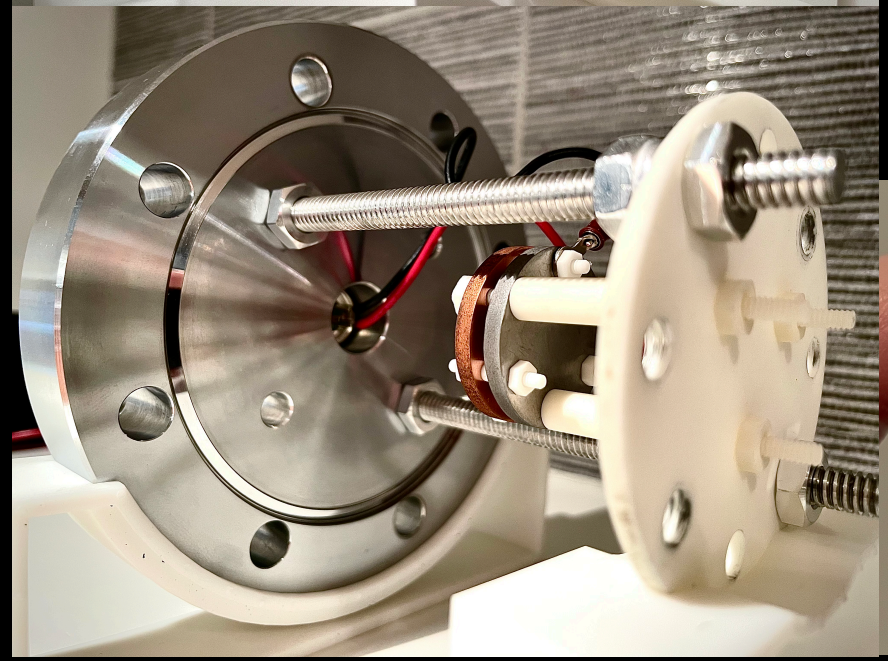
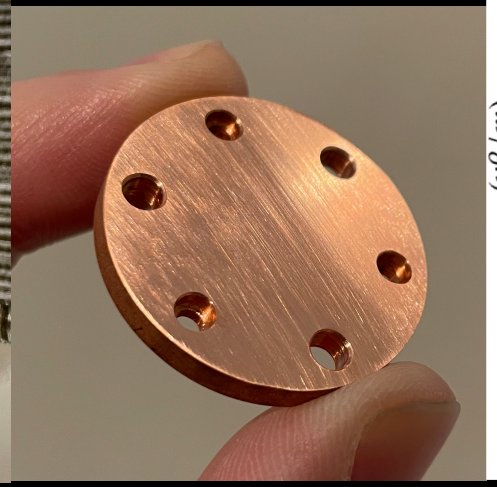
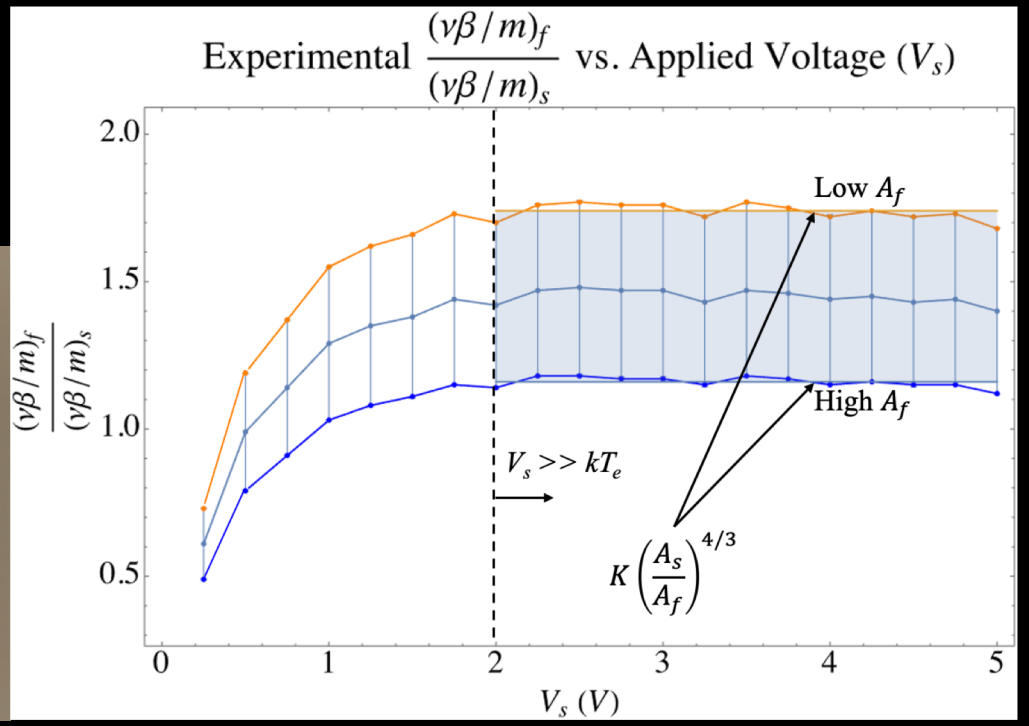
Observation 2:
Constant $\nu\beta/m$ ratio observed for low voltages







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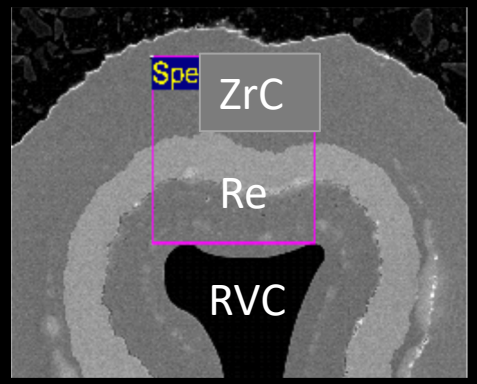
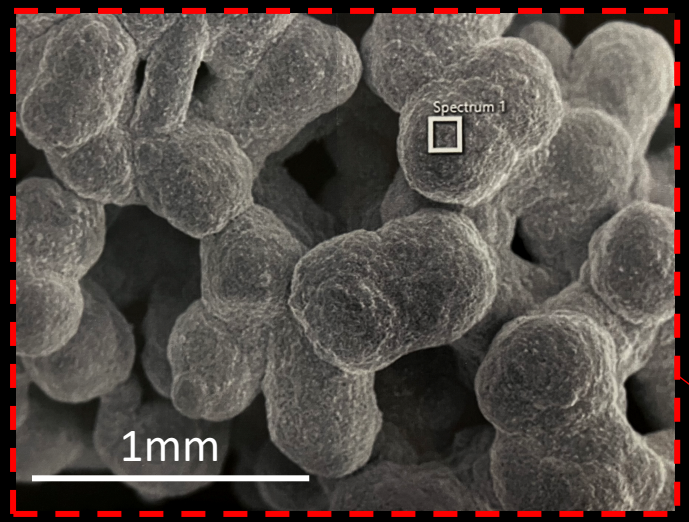
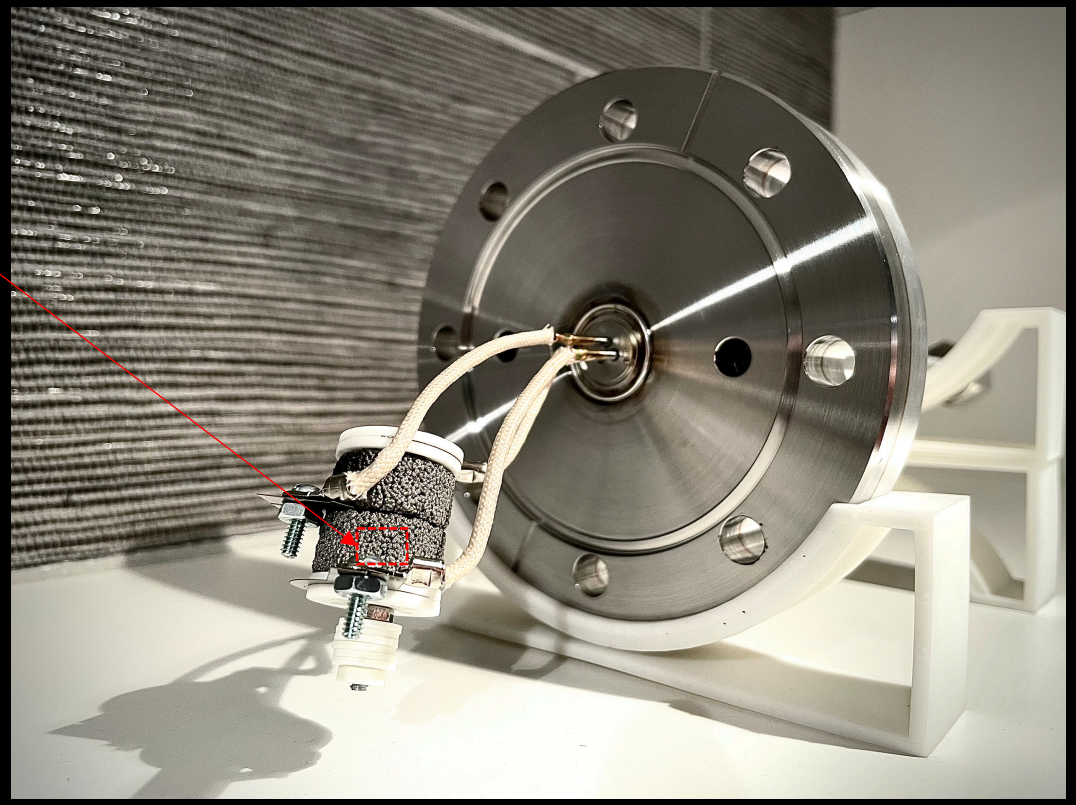
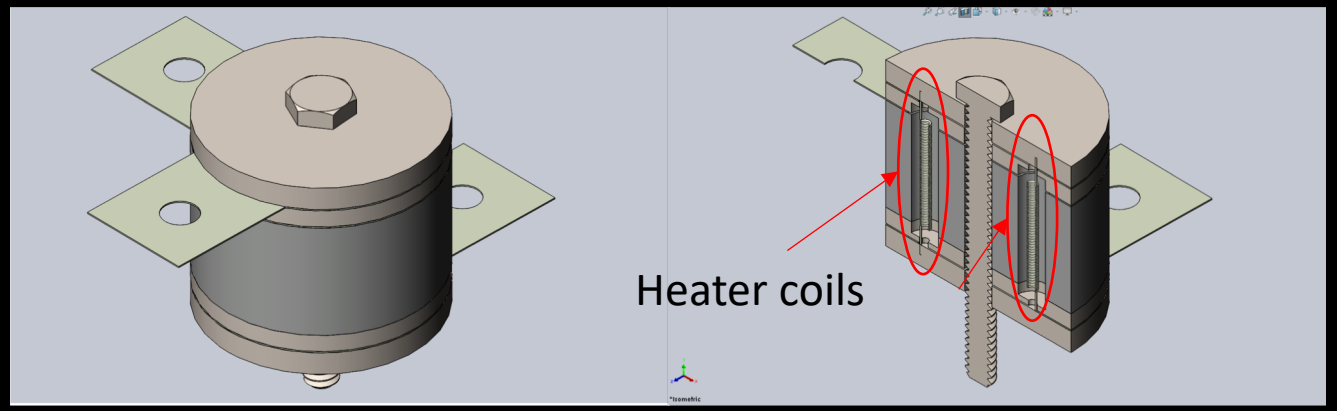
Higher Temperatures with Refractory Foams









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Open Questions

- What are the best heating methods/facilities for devices:
  - <1000K
  - >1000K
- Methods
  - Electric heaters (~50-100W)?
  - Radiation absorbers (W, B_4C, etc.)
- Facilities
  - Beam ports
  - In-core
- Other useful methods for assessing NLTPs?
  - Emissive probe (one electrode emits thermionically)
  - RC resonance circuit

Questions

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