Design, Construction, and Testing of Particle Sources

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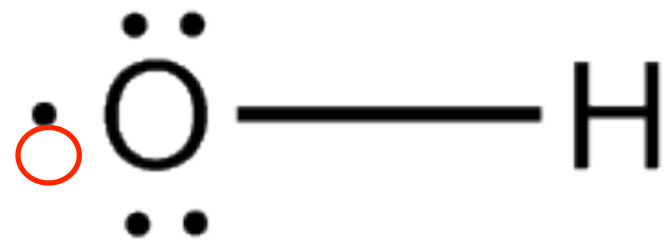
Outline

- Background
- Introduction
- Atomic Hydrogen Dosers
  - Tungsten Tube
  - Platinum Tube
    - Reference Data from PPPL
- Methyl Radical Doser
  - One Heated Zone
  - Two Heated Zone
- Future Work

Background

- To study plasma/surface interactions, require sources of controlled energetic particles
- Particle sources – apparatuses that split molecules into radicals (have “dangling” covalent bond)
  - Radicals are highly reactive



Hydroxyl Radical – red circle highlights missing electron

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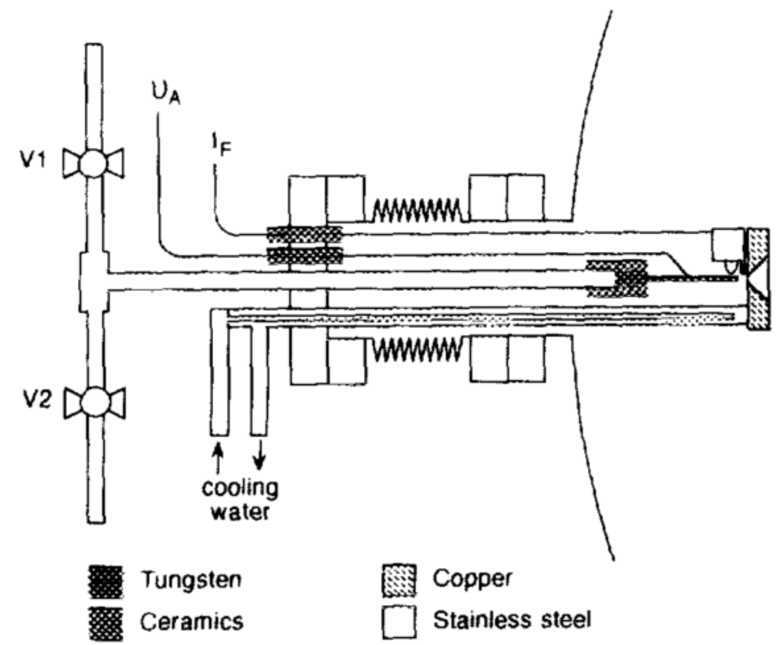
Introduction

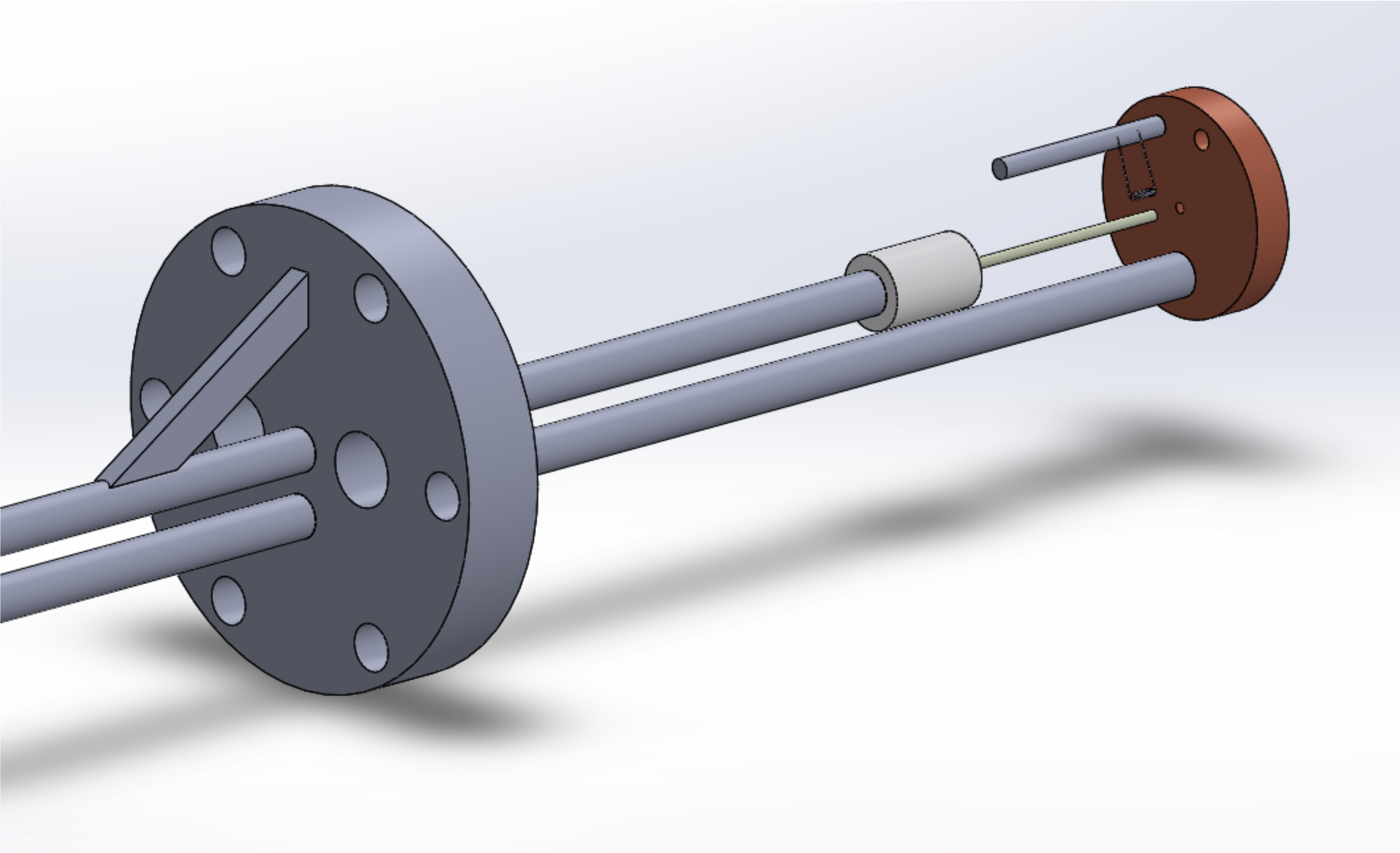
- To compare efficiencies of different types, look at degree of dissociations
- Worked on:
  - Atomic Hydrogen dosers
  - Methyl Radical dosers
  - Compared physical and material constraints of each design

Atomic H Dosers (Tungsten Tube)

- Designed by Bischler and Bertel
- Tip of tungsten tube is heated via electron bombardment by nearby tungsten filament
- Copper shield acts as both thermal protection and collimator



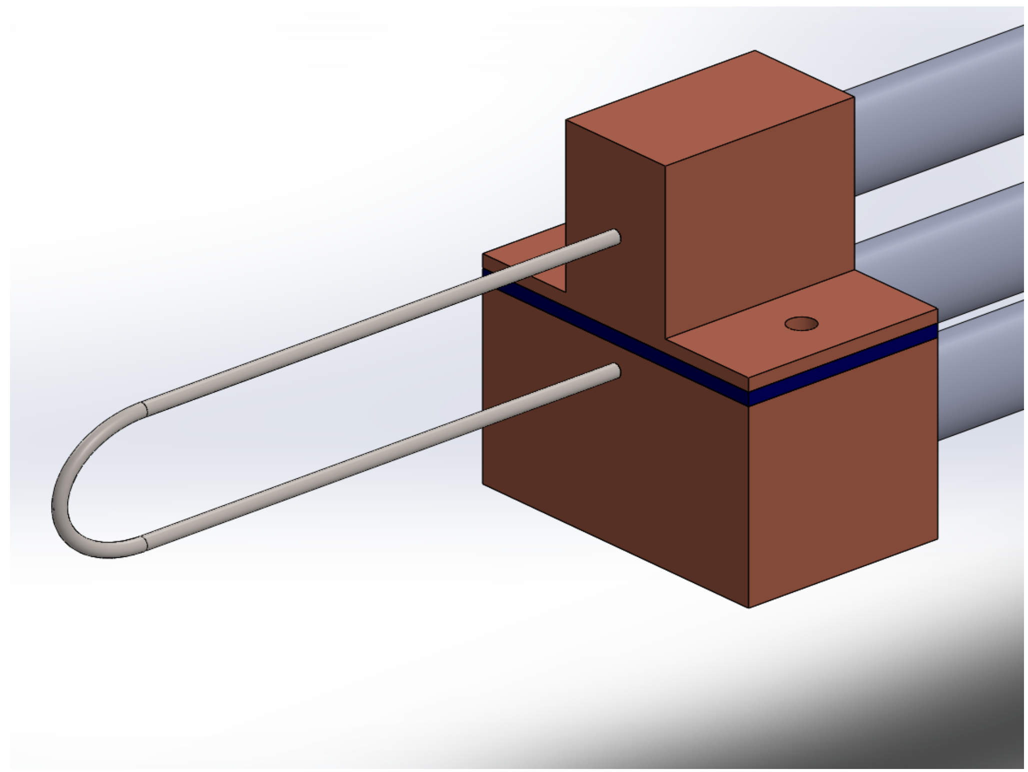
Cross section schematic view of doser
U. Bischler and E. Bertel, J. Vac. Sci. Technol. **11,** 458 (1993)



3D view of doser based on B&B's design

Atomic H Dosers (Platinum Tube)

- Based on design by Engel and Rieder
- Platinum tube is resistively heated
- Copper blocks electrically but not thermally isolated, allowing for cooling
- Hole in platinum tube shoots out H atoms



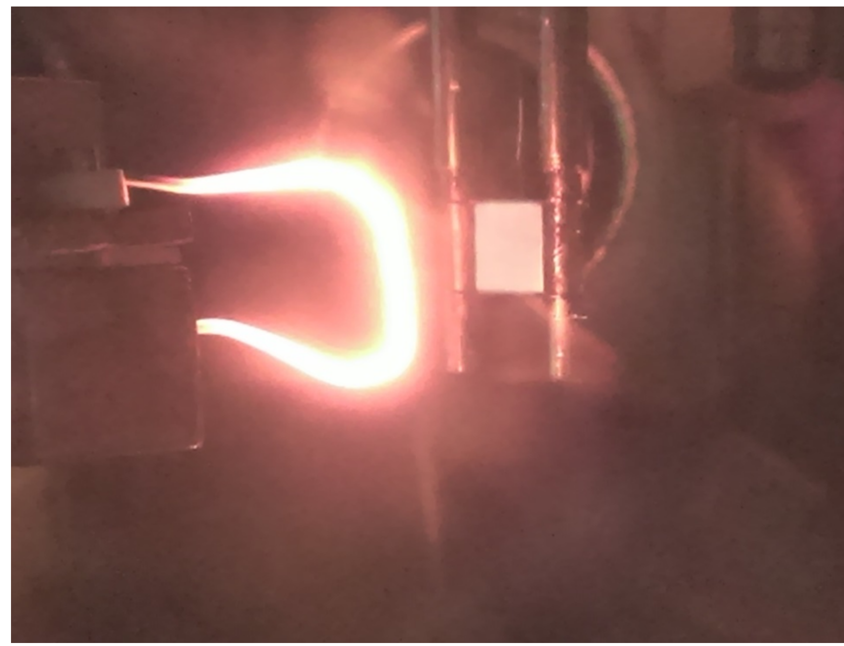
3D view of important components of doser

Why use Pt. Tube?

- Easier to make
- Less expensive (tungsten tube vs. platinum tube)
- Platinum inert to certain corrosive gases that would destroy tungsten tube (M.R. Voss, H. Busse, and B.E. Koel, Surf. Sci, **414**, 330 (1998))

Reference Data from PPPL

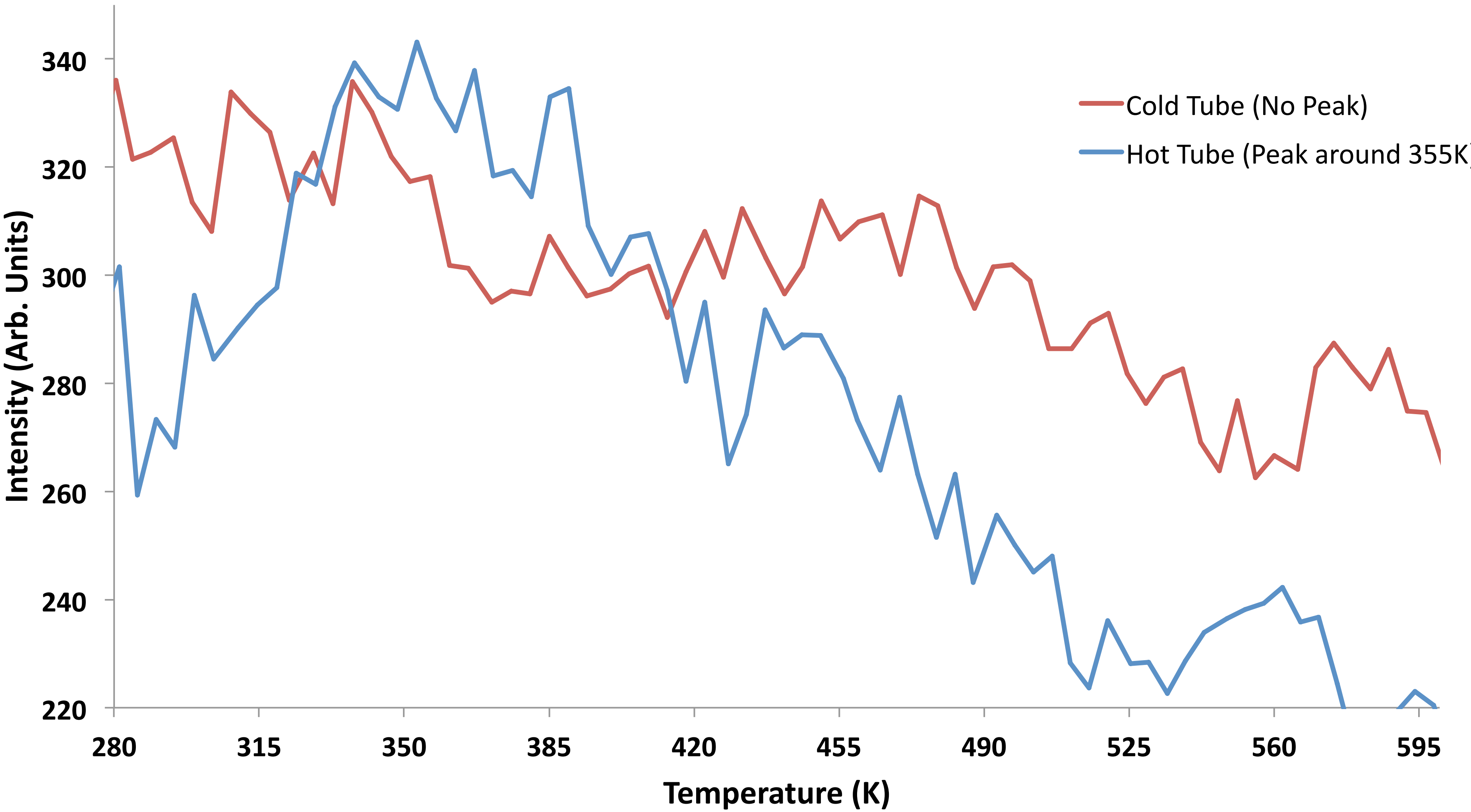
- Substrate is TZM
  - Titanium zirconium alloy
  - Not ideal
- Dissociating D_2
- Control
  - Cold tube, initial temp at 265.5K, 2e-7 torr for 50s = 10 LM
- Experimental
  - Hot tube (shown), initial temp at 267.0K, 10LM



PPPL doser in operation

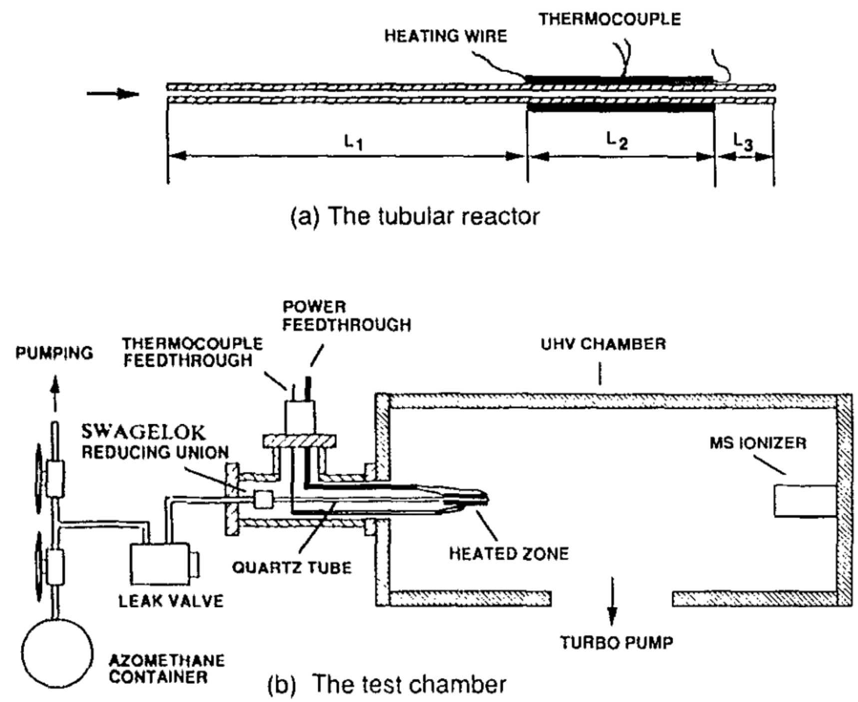
D_2 (mass of 3.725) on TZM

10K/s



Methyl Radical Doser (One Heated Zone)

- Based on Peng, et. al. design
- Tantalum wire wrapped around quartz tube resistively heated, covered with alumina-based cement
- Max temp of 1300K with 10A running through
- Have one in lab
  - Working condition - ??



Schematic of doser
X. D. Peng, R. Viswanathan, G. Smudde, and P. Stair, Rev. Sci. Instrum. **63,** 3930 (1992)

Methyl Radical Doser (Two Heated Zones)

- Based on Dickens and Stair's design
- As before, but two heated zones
- Can independently heat the two zones
  - More control over degree of dissociation and exiting temperature of methyl radicals

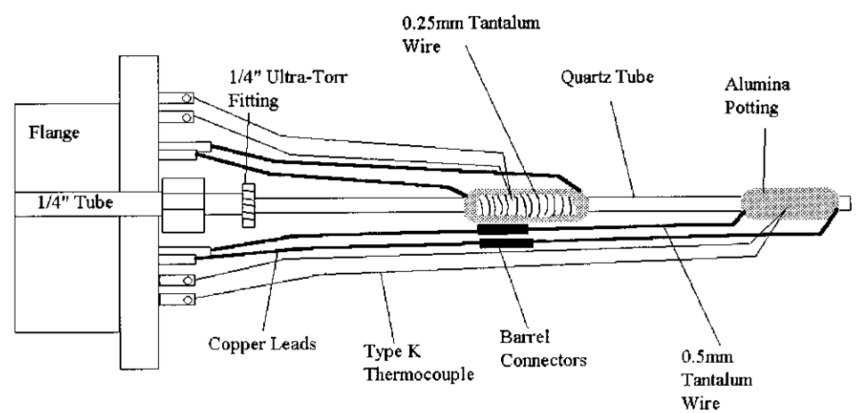
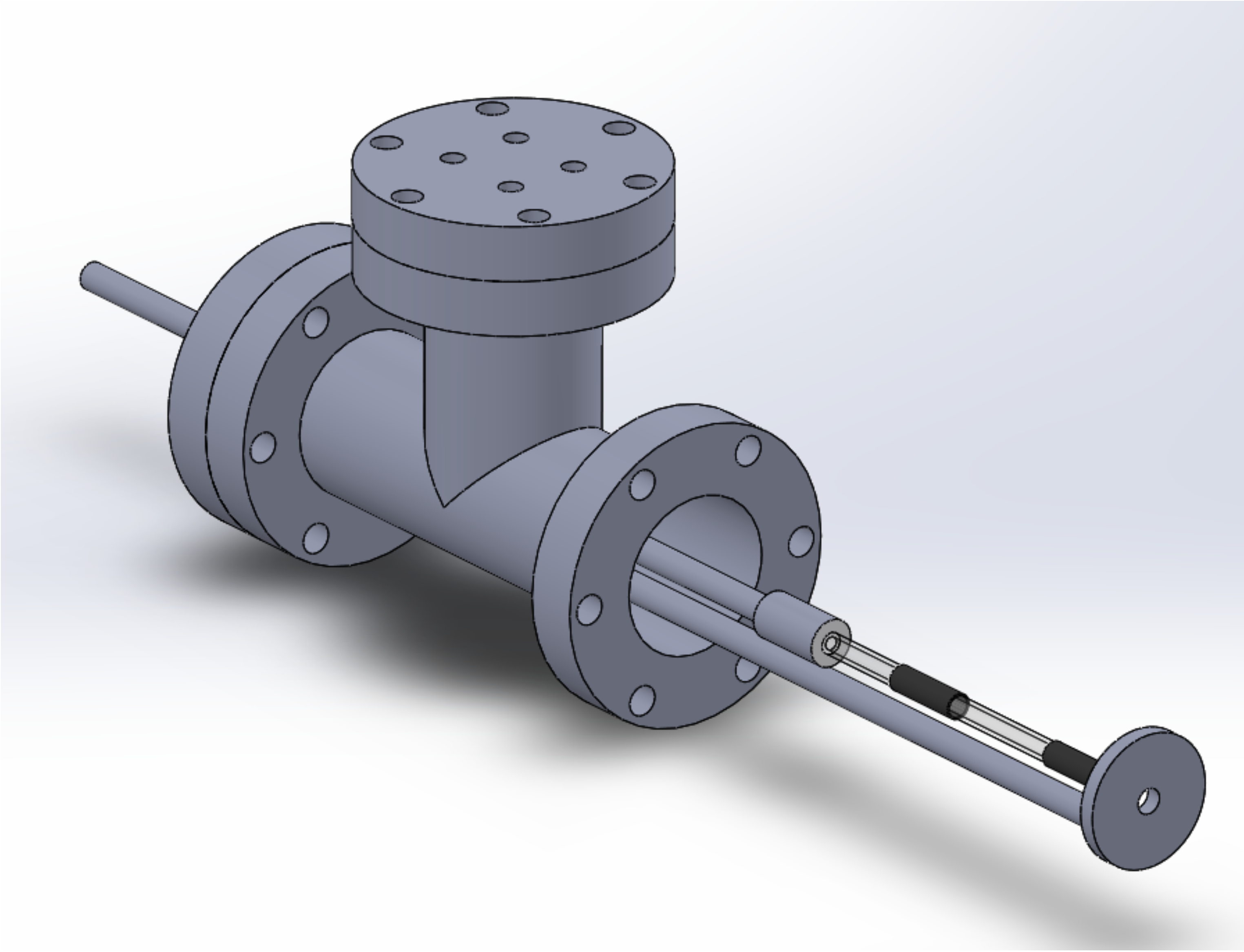
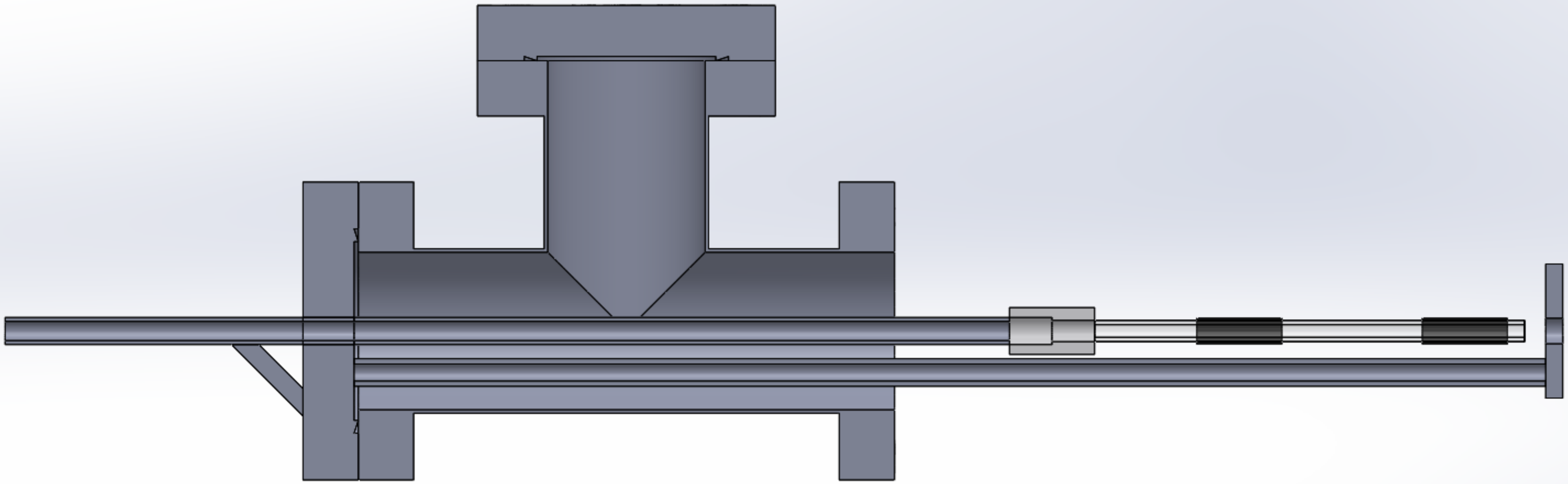


Figure 7. Schematic of doser
K.A. Dickens and P. Stair, *Langmuir,* **14,** 1444 (1998)



Proposed Methyl Radical Doser with Two Heated Zones Design
(Isometric View)



Proposed Methyl Radical Doser with Two Heated Zones Design
(Side cross-section view)

Future Work and Experiments

- Current Status of Dosers –
  - Tungsten tube H doser – repaired and ready to be tested
  - Platinum tube H doser – ready to be assembled via silver soldering (two more have been repaired, one need sapphire plate, and both need platinum tubes)
  - Methyl radical doser – In design stages, need to finalize design and order flange

References

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