References or Inspiration for this Drawing

1. <https://eyes.nasa.gov/apps/mars2020/#/home> (We could have it be very similar to this or with some design differences. The focus is different so certain things will be different. )
2. <https://psychecapstone-copper.slack.com/archives/C02F3DZV7FS/p1632255786000300>
3. Needs info of how much of each gas can be stored and how much is consumed
4. Needs info of how much energy it takes to ionize each gas.
5. Needs info on how much energy it takes to heat the inserts. (Goebel\_06\_Chap6\_cathodes.pdf 10 bottom of page)

Notes:

Drawing only has up to the cathode inserts, we could as the rest from the pdf file found on the slack channel in the 2nd reference or stop here.

JS used for this could be one of the ones listed in the Psyche resources, one of which being three.js but there are other options or if we can find another place to code this then embed this into a webpage.

Data for certain things probably needs to be extracted from here:

https://descanso.jpl.nasa.gov/SciTechBook/series1/Goebel\_06\_Chap6\_cathodes.pdf

https://descanso.jpl.nasa.gov/SciTechBook/series1/Goebel\_\_cmprsd\_opt.pdf

First is just chapter 6 the other being the full book that is found in the power point by Dr. Frieman.

Two ways to show:

One is showing where the cathode is in the spacecraft, with a close-up showing info about each part of the cathode, https://mars.nasa.gov/mars2020/spacecraft/rover/, similar to this link for the Mars 2020 rover.

Do we need?

https://ntrs.nasa.gov/api/citations/20170011125/downloads/20170011125.pdf

http://esc.fsu.edu/documents/lectures/fall2006/EML4450L14.pdf

Cathode inserts:

Made of thermionic material like W or BaO thru thermionic emissions.

https://en.wikipedia.org/wiki/Thermionic\_emission (can get a better source later)

https://stanford.edu/~vossj/slac/project/thermionic-emission/

The temperature of the material should be over 1,000 Kelvin to produce enough electrons.

From the Goebel\_06\_Chap6\_cathodes.pdf, it seems we are using the Type A configuration shown on page 6 of the pdf. So it “operates at lower currents and relatively high internal gas pressures, and are heated by orifice heating. “

Page 5 of Goebel\_06\_Chap6\_cathodes.pdf details the three types of self-heating mechanisms: orifice heating, ion heating, election heating.

After going over the pdf by Dr. Freeman it seems that no type was given so we could talk about all three that are on pages 5-6 and other places of the pdf.

The visualization could be the density of plasma based on orifice diameter and flow rate or something about the fig 6-6 on page 8.

“The hollow cathode used in a Hall thruster provides electrons

for both ionization of the propellant gas and neutralization of the beam [4]. Hall

thrusters also tend to run at lower specific impulse (Isp) than ion thrusters.

Therefore, Hall thrusters require higher discharge currents from the cathode to

achieve the same total power as compared to ion thrusters, and currents of the

order of 10 amperes to hundreds of amperes are needed. Neutralizer cathodes in

ion thrusters emit electrons at a current equal to the beam current. Therefore,

they can be made smaller than discharge cathodes and must be designed to be

self-heated and to run reliably at lower currents.” (Goebel\_06\_Chap6\_cathodes.pdf 6)

Some things about the care of cathodes and about each material that can be used are on page 12 of the pdf, how some cathodes are subject to poisoning and other factors that increase the work function.

Ionization:

Typically, Xe is used or another similar gas, one that needs the least amount of energy to Ionize and does not have any other chemical properties that would affect the whole process. The gas being heaver does help in making a better thrust then lighter gasses.

Links to other pages that provide information on related items or parts that connect to the hollow cathode.

The previous years thruster capstone project: