

USPAS Cryogenic Engineering (June 21 – July 2, 2021)

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Homework Problems for Tuesday June 28, 2021

1. Consider 2 parallel plates each 2 m^2 in area. They are separated by 0.1 m. Their emissivity is 0.08. One plate is at 300 K and one is at 4.2 K. What is the heat leak due to radiation between the 2 plates? (assume the infinite plate approximation and assume that emissivity = 0.08 is $\ll 1$).
2. For the plates in question above; name 3 ways in which the radiation heat load to 4.2 K may be reduced.
3. In cryostat design, what techniques do we use to reduce the conduction heat leak between room temperature and cryogenic temperatures?
4. Describe the differences between a Type I and Type II superconductor. Why are Type II superconductors generally more useful for practical applications?
5. Suppose a short (30 cryomodules) ILC-like pulsed electron linac will operate with 2 K dynamic heat loads like those predicted for ILC but with gaseous helium cooling of the "40 – 80 K" thermal shield really at 40 – 60 K. (You may scale thermal radiation expected based on S1-Global 80 K measurements.) Describe whether you would recommend a 5 Kelvin thermal radiation shield between the 40 – 60 Kelvin thermal radiation shield and 2 K cold mass, or not recommend the 5 Kelvin thermal shield. Explain the reasons for your answer.