THERMAL INPUT REDUCTION ON THE CRYO-MIRROR

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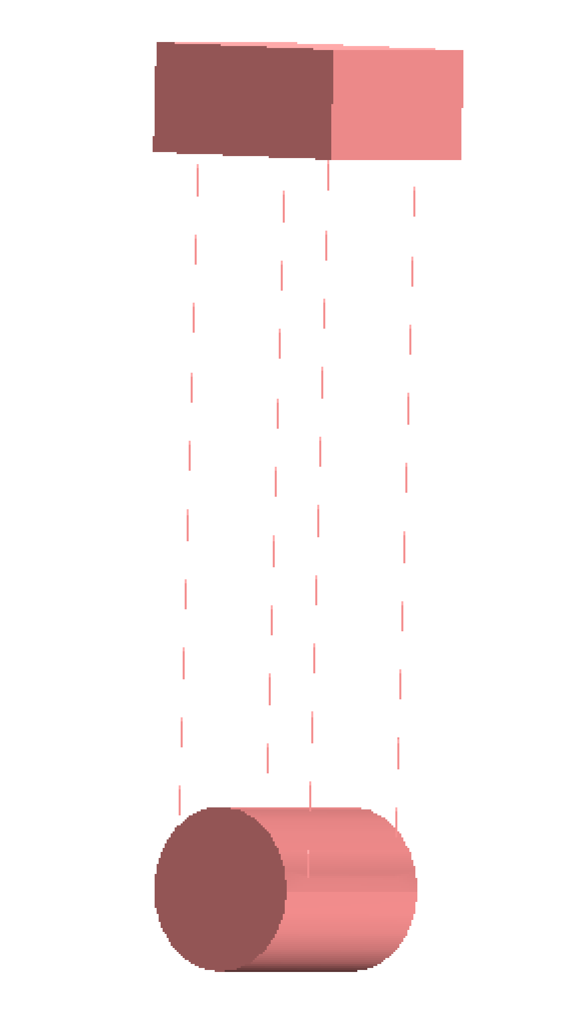
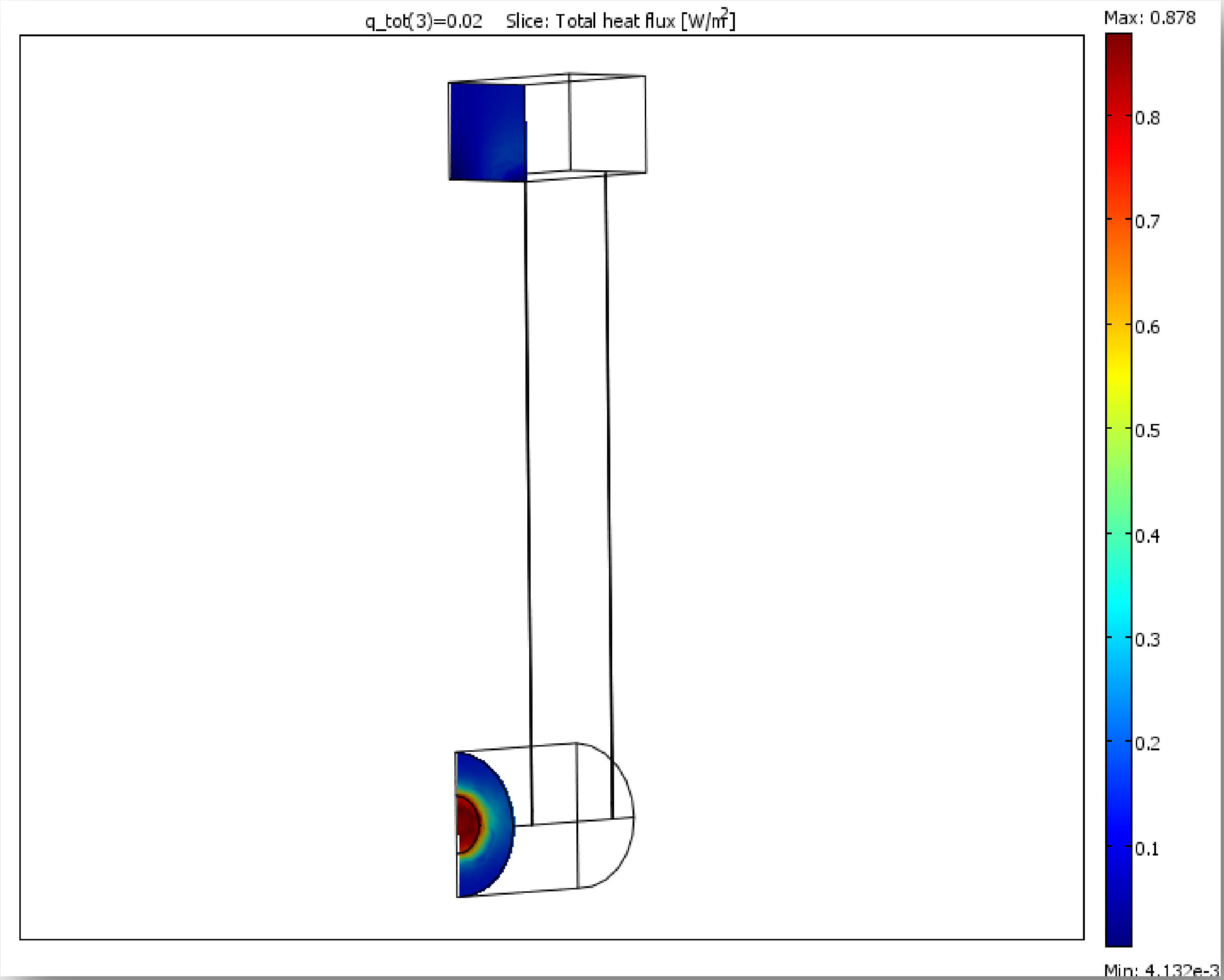
The thermal model for ET-LF

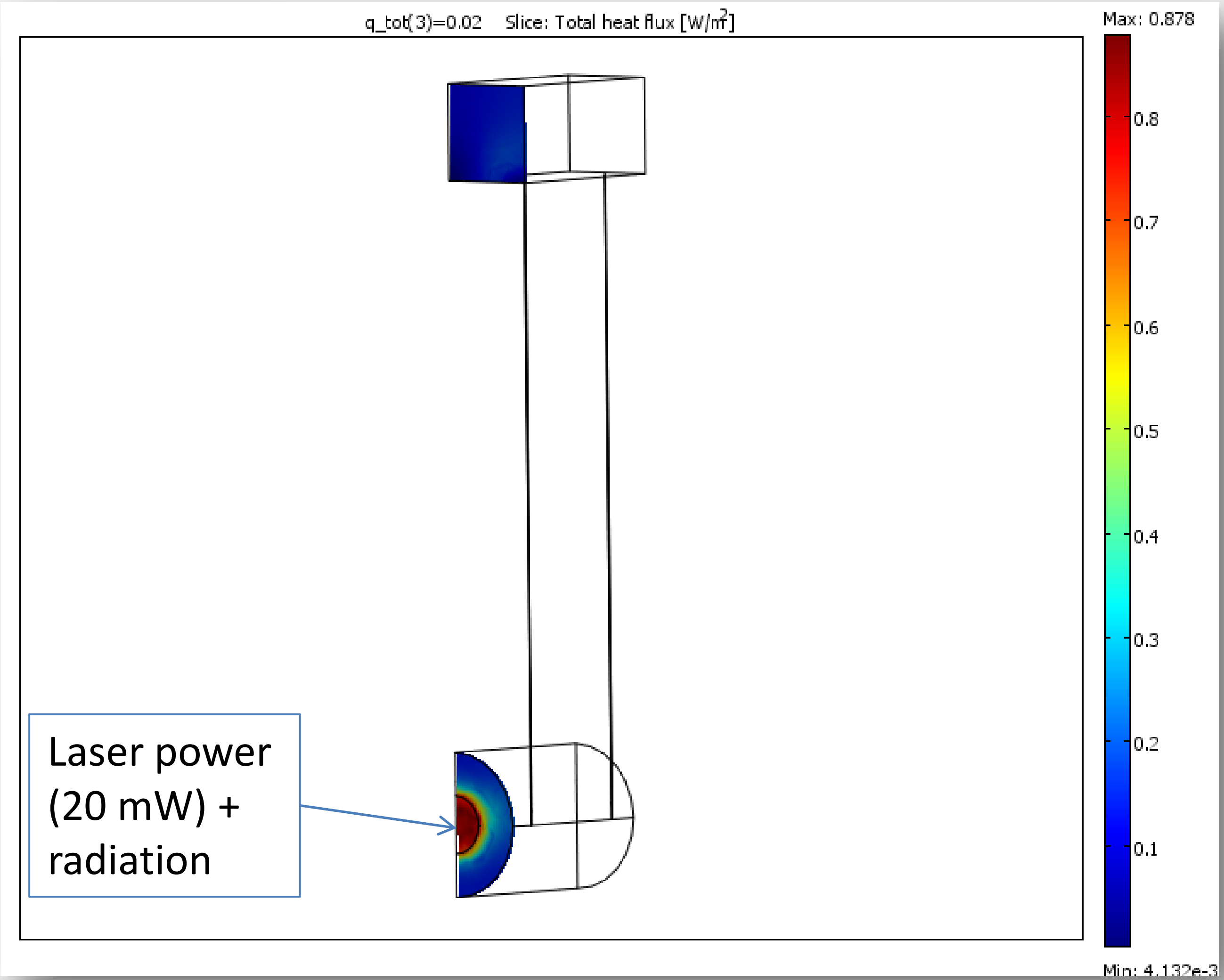
Mirror temperature	10 K
Mirror diameter	45 cm
Mirror mass	211 Kg
Silicon fibres lenght	2 m
Silicon fibres diameter	3 mm
Marionette temperature	2 K
Power in cavity	18 kW
Absorbed power	20 mW
Beam radius	9 cm



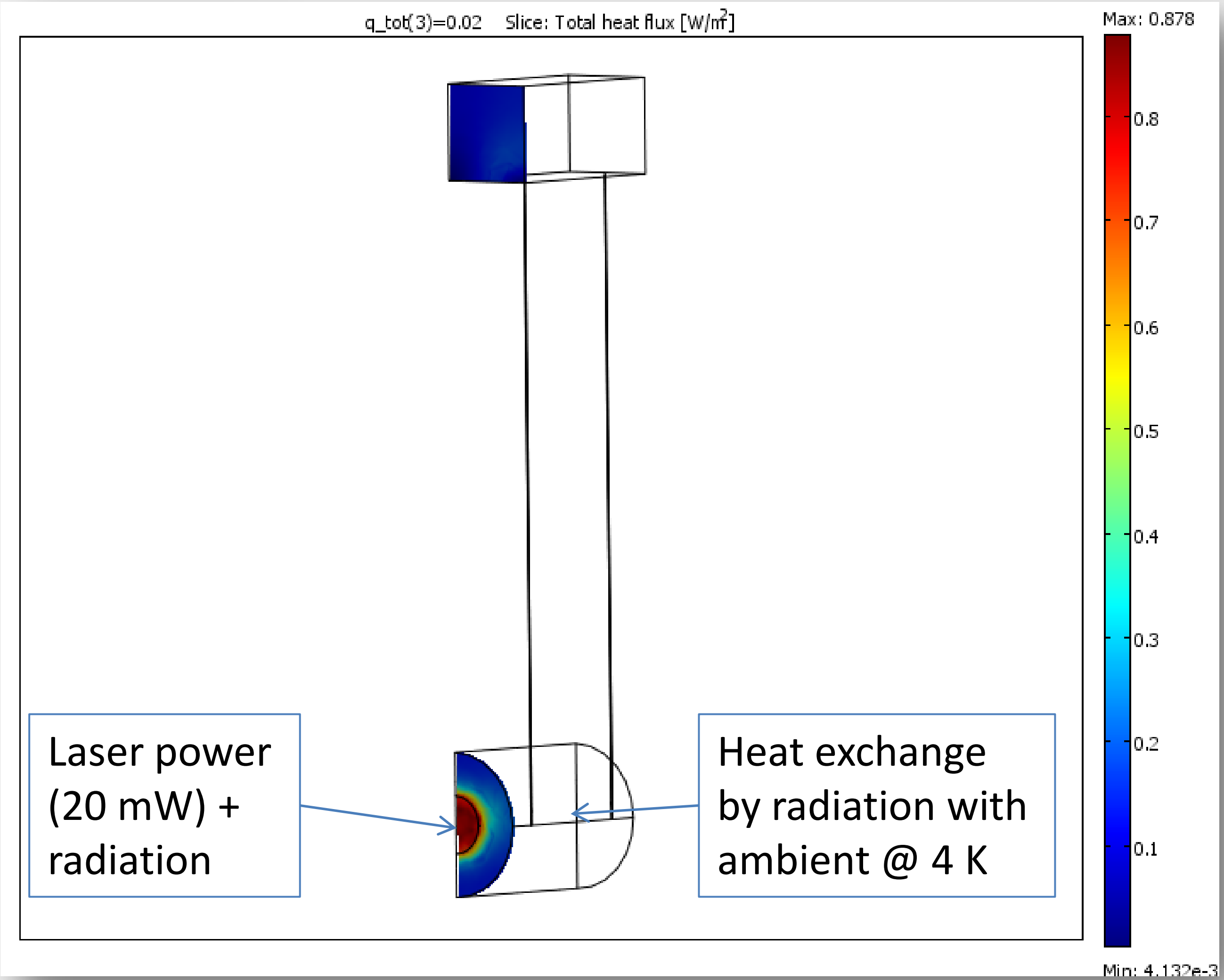
Parametric thermal simulation



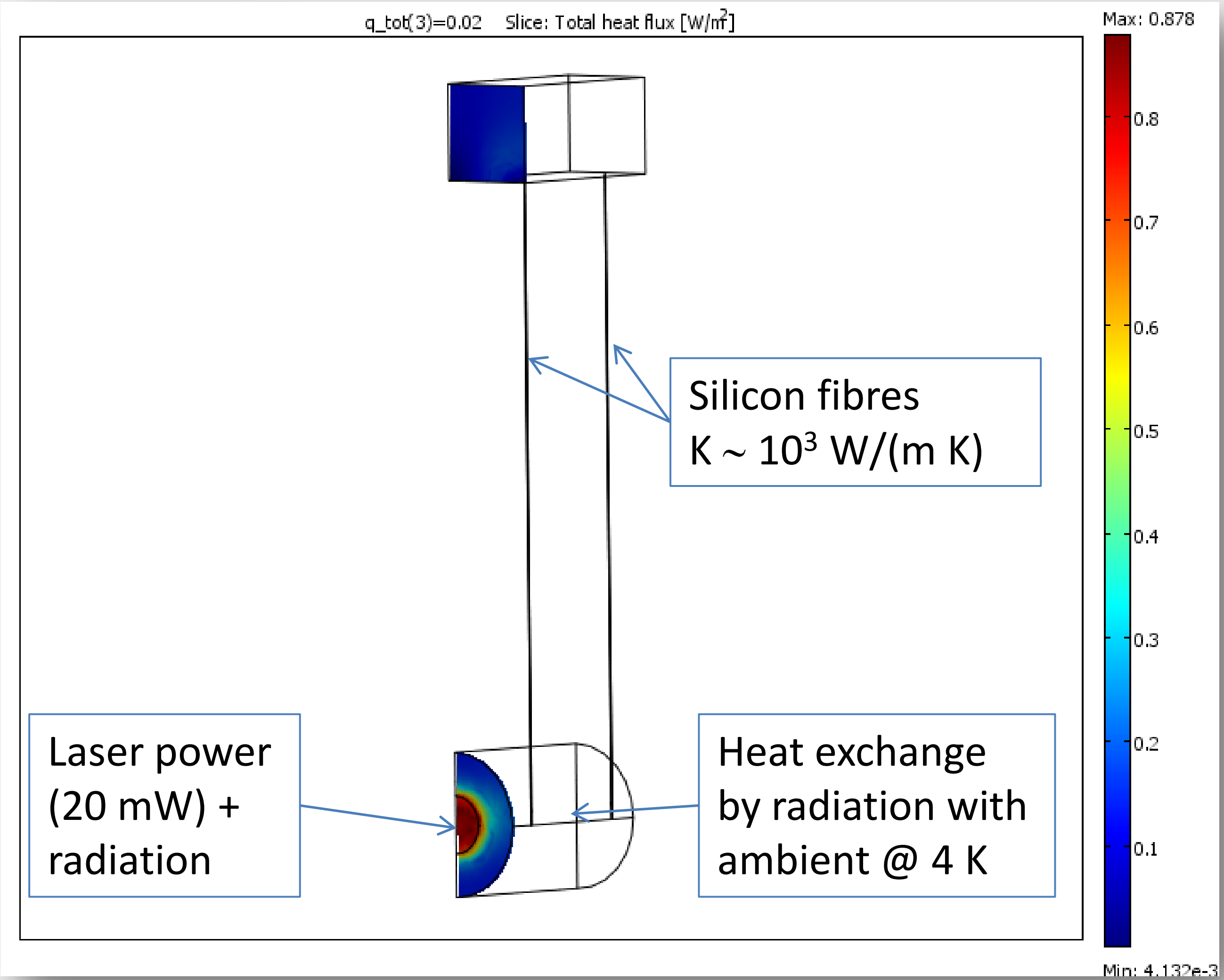
Parametric thermal simulation



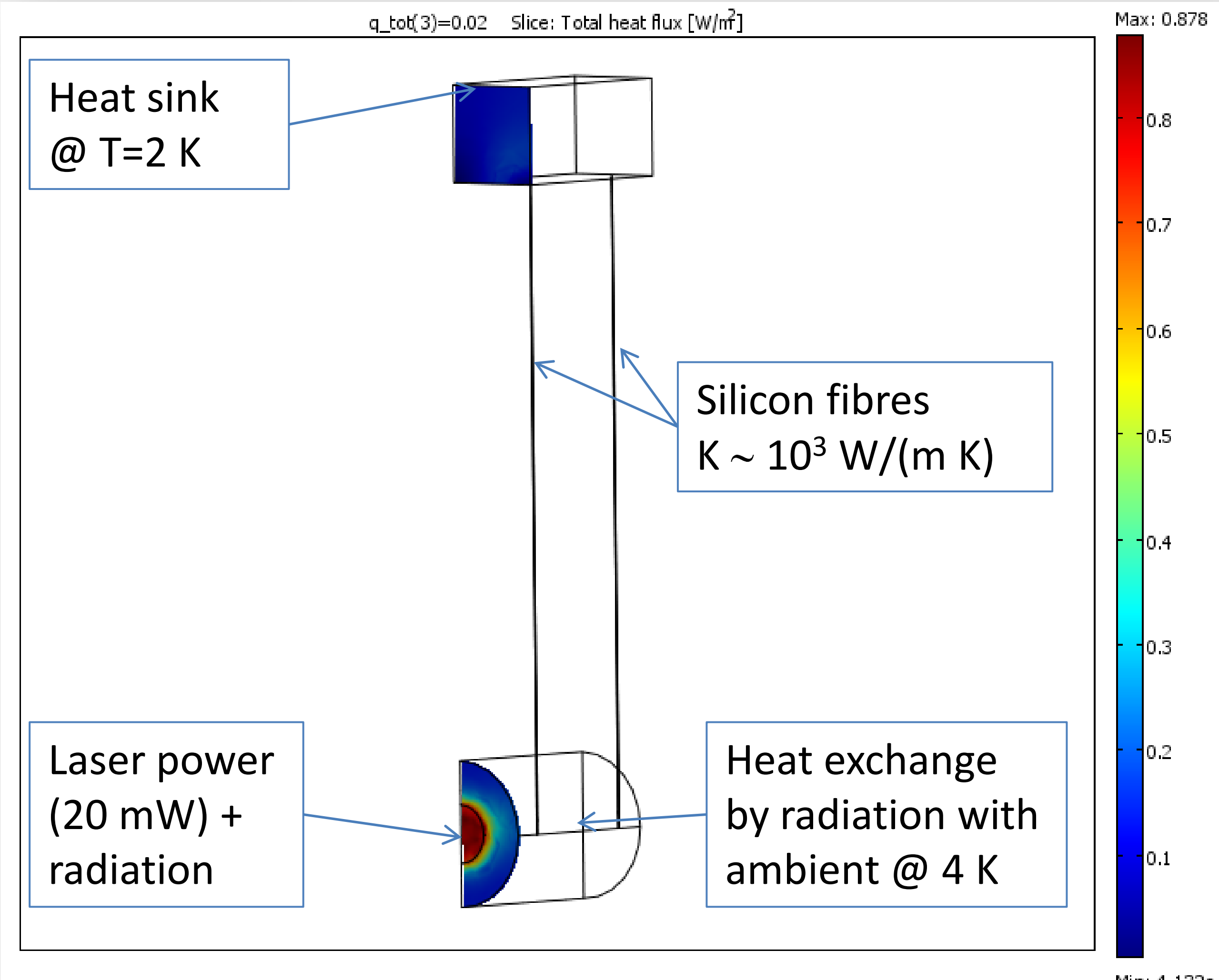
Parametric thermal simulation



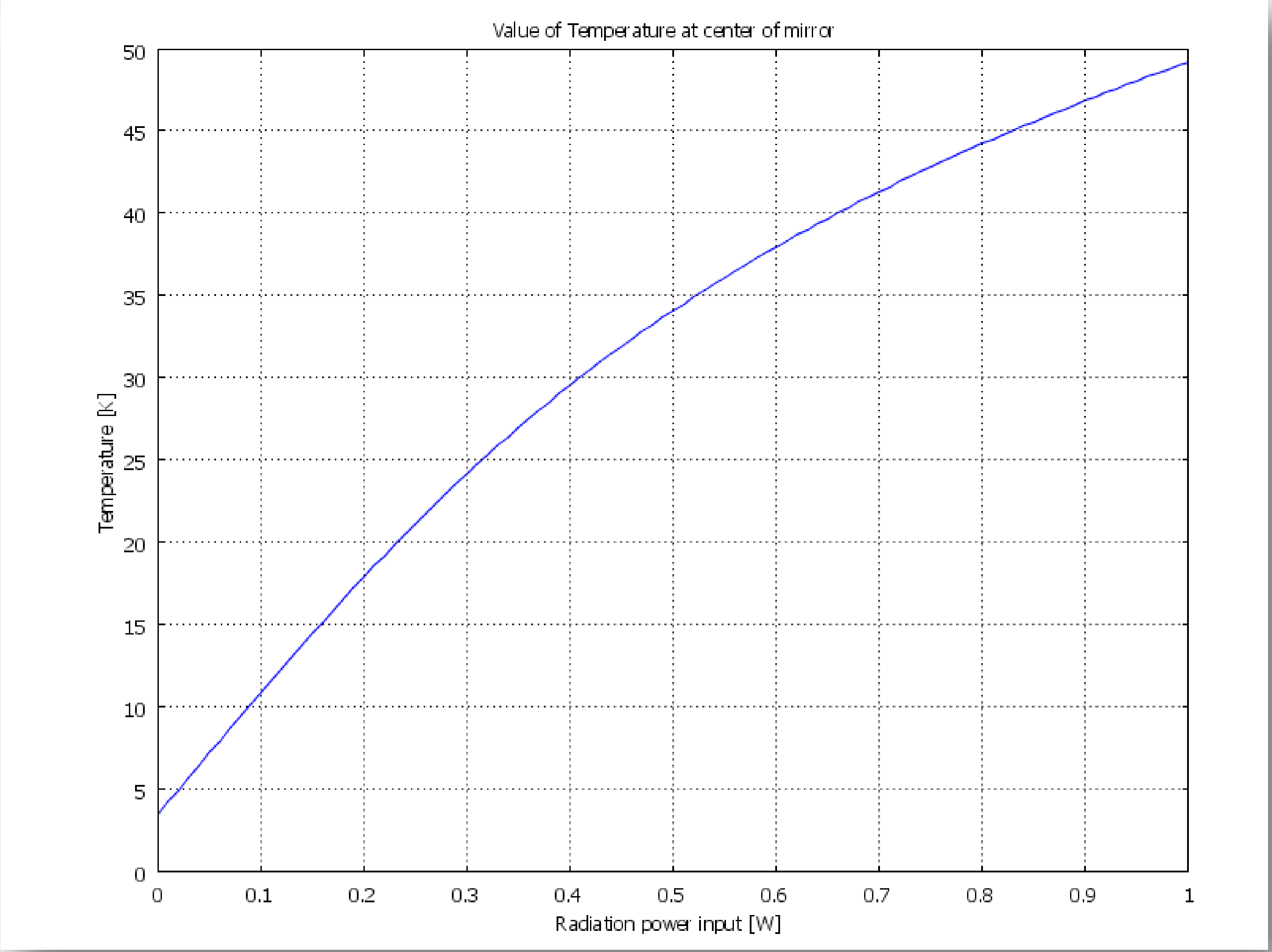
Parametric thermal simulation



Parametric thermal simulation

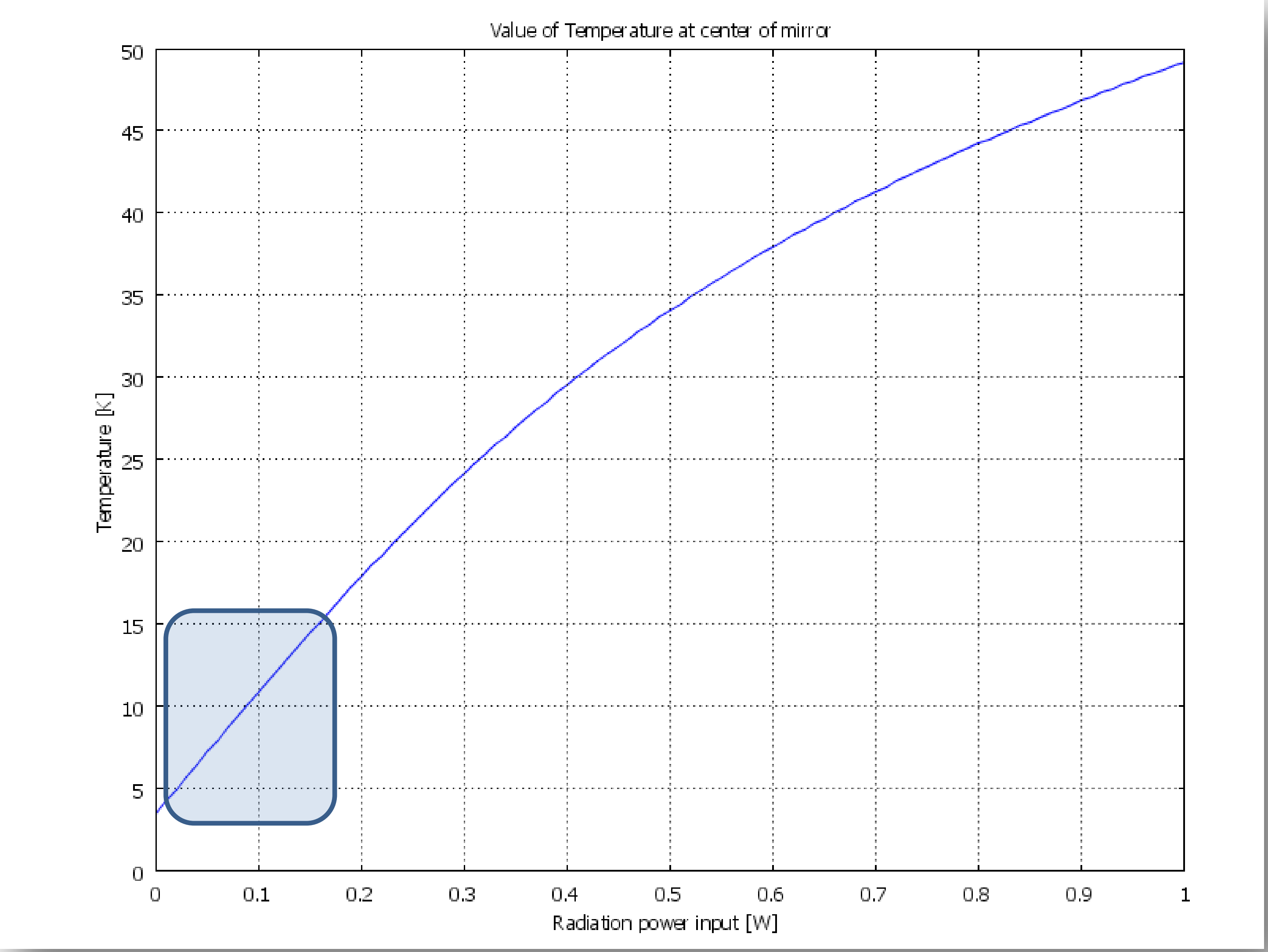


Results (1)



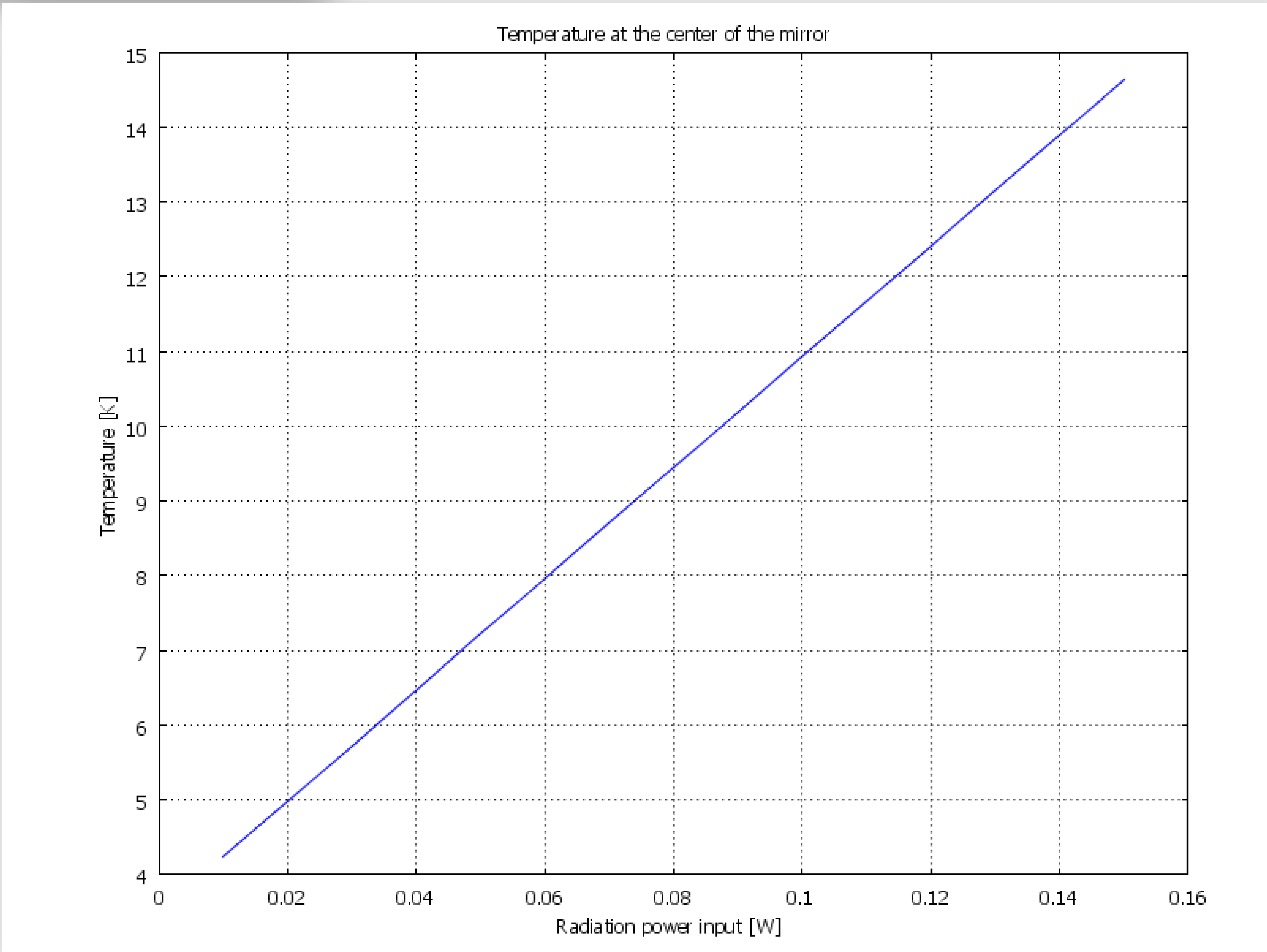
Value of Temperature at center of mirror
Temperature [K]
Radiation power input [W]
0
5
10
15
20
25
30
35
40
45
50
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1

Results (1)



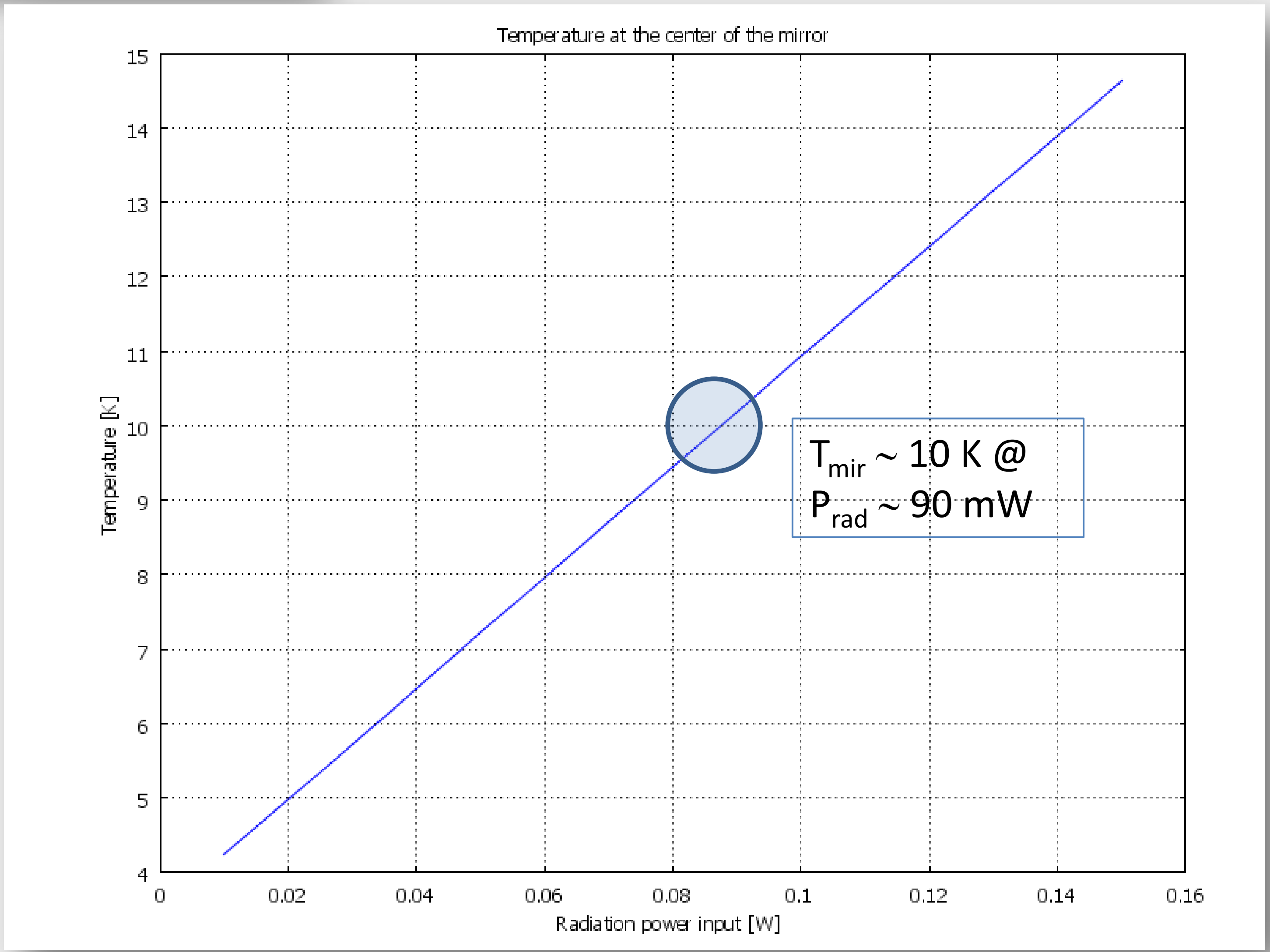
Value of Temperature at center of mirror
50
45
40
35
30
25
20
15
10
5
0
Temperature [K]
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Radiation power input [W]

Results (2)

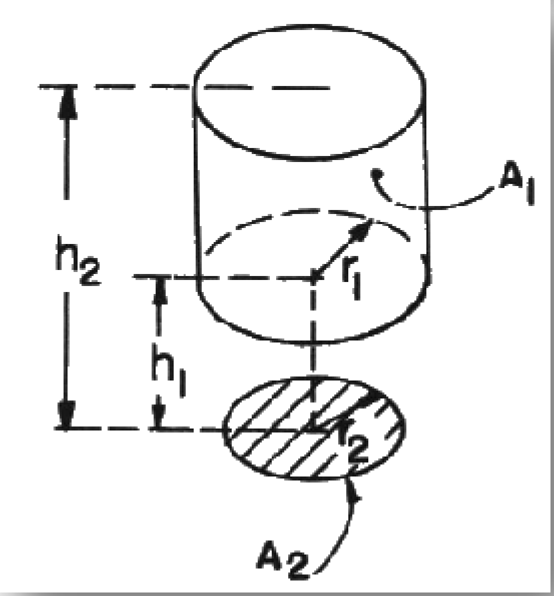


Temperature at the center of the mirror
Temperature [K]
15
14
13
12
11
10
9
8
7
6
5
4
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
Radiation power input [W]

Results (2)


Temperature at the center of the mirror
Temperature [K]
Radiation power input [W]
15
14
13
12
11
10
9
8
7
6
5
4
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
T_{mir} ~ 10 K @
P_{rad} ~ 90 mW

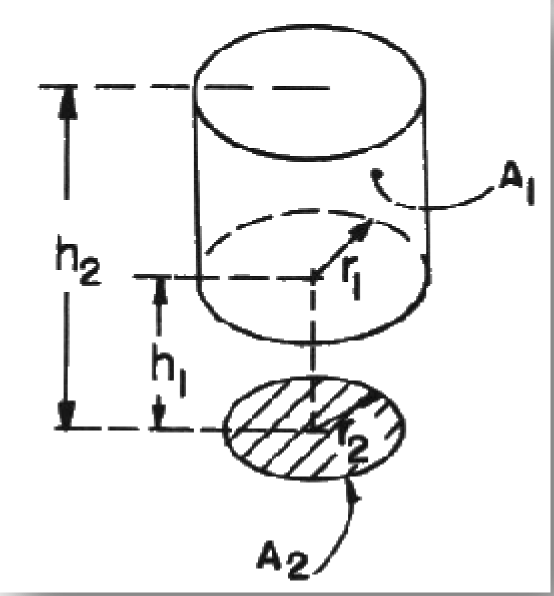
Radiative heat transfer (1)



R = r1/r2;
H1 = h1/r2
H2 = h2/r2
$X = H^2 + R^2 + 1$

Radiation from int. surface of cylnder of radius r_1 to disk of radius r_2, were $r_2 < r_1$; disk is perpendicular to axis of cylinder, and axis passes trough center of disk.

Radiative heat transfer (1)



R = r1/r2;
H1 = h1/r2
H2 = h2/r2
X = H² + R² + 1

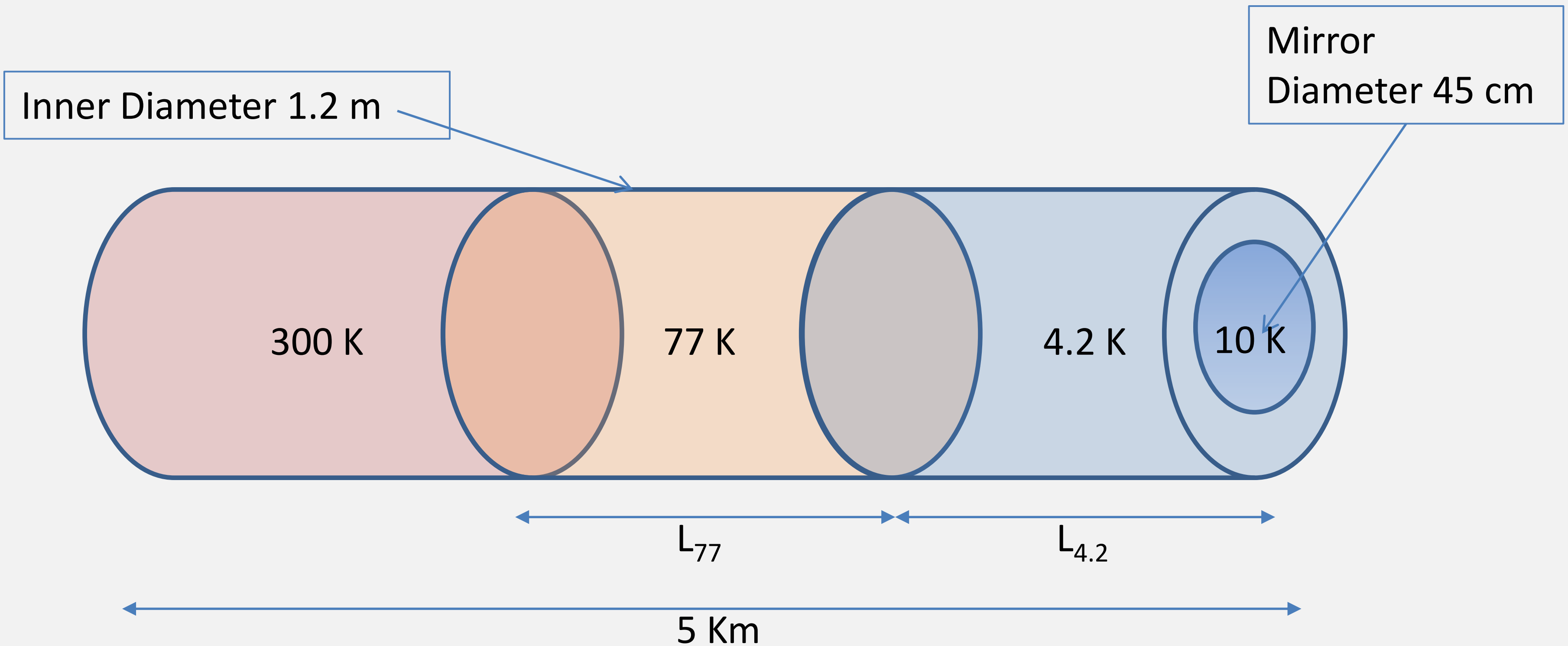
Radiation from int. surface of cylnder of radius r_1 to disk of radius r_2, were $r_2 < r_1$; disk is perpendicular to axis of cylinder, and axis passes trough center of disk.

$$F_{1-2} = \frac{1}{4R(H_2 - H_1)}\left[(X_1 - X_2) - (X_1^2 - 4R^2)^{1/2} + (X_2^2 - 4R^2)^{1/2}\right]$$

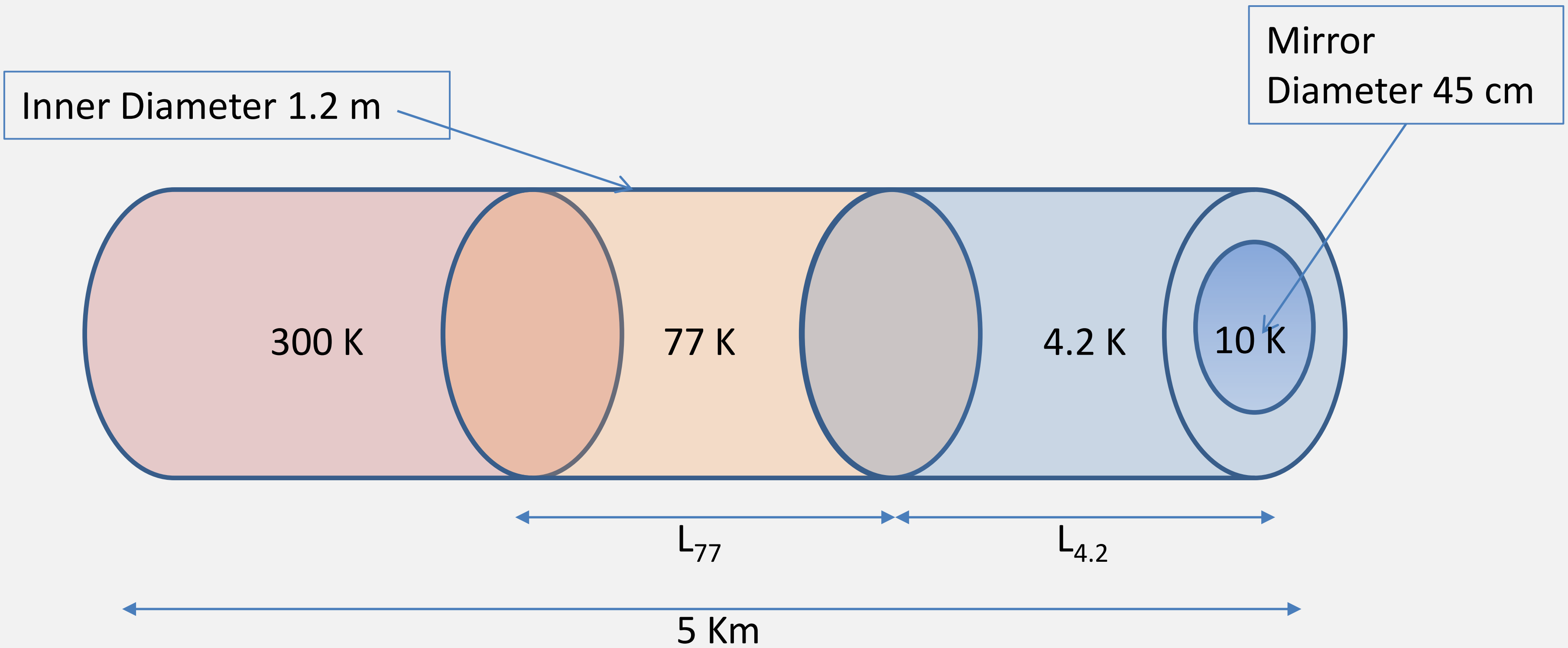
Buschman, Albert Jr. and Pittman, Claud M., 1961, *Configuration factors for exchange of radiant energy between axisymmetrical sections of cylinders, cones, and hemispheres and their bases*, NASA TN D-944.

Siegel, Robert and Howell, John R., 2001, *Thermal Radiation Heat Transfer*, 4th ed., Taylor and Francis-Hemisphere, Washington.

Radiative heat transfer (2)

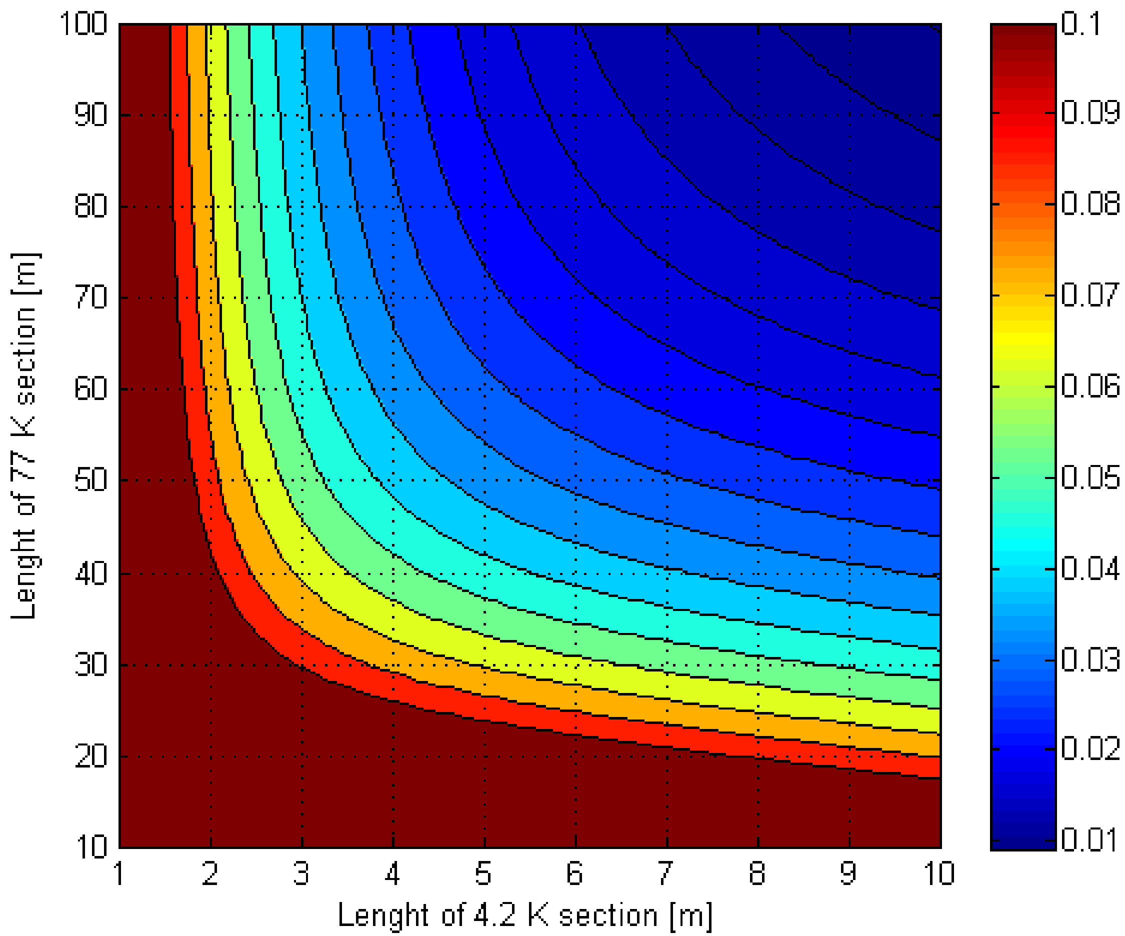


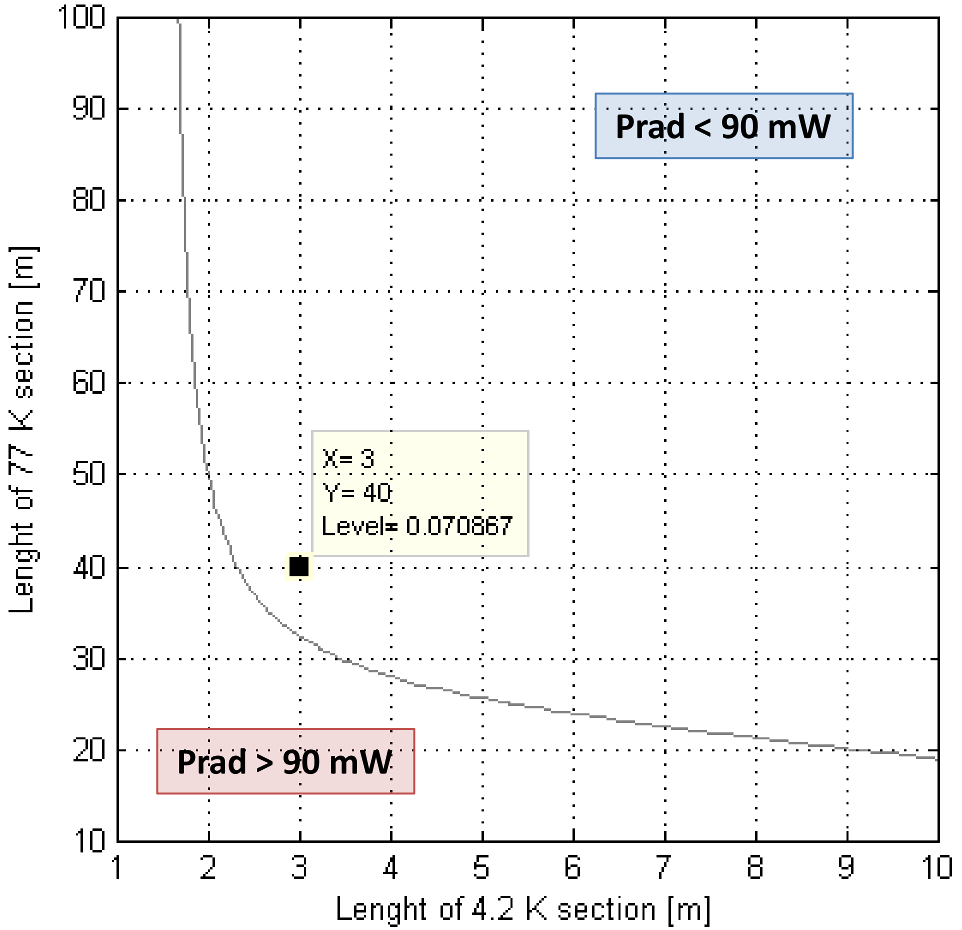
Radiative heat transfer (2)



We calculate $P_{rad}(L_{4.2},L_{77})$, summing all the contributions coming from the 4.2 K, 77 K and 300 K sections

Radiation power to mirror




100
90
80
70
60
50
40
30
20
10
1
2
3
4
5
6
7
8
9
10
Lenght of 77 K section [m]
Lenght of 4.2 K section [m]
Prad < 90 mW
Prad > 90 mW
X= 3
Y= 40
Level= 0.070867