Thermal simulations of Solpex instrument

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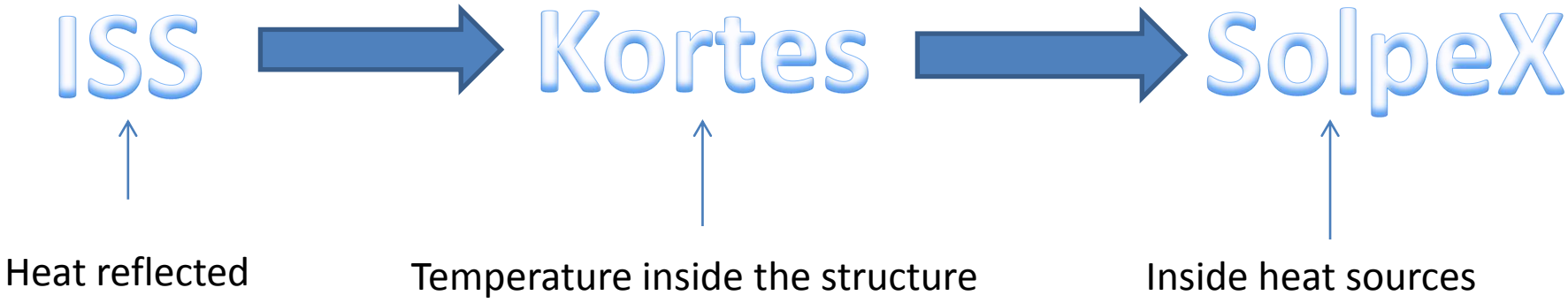
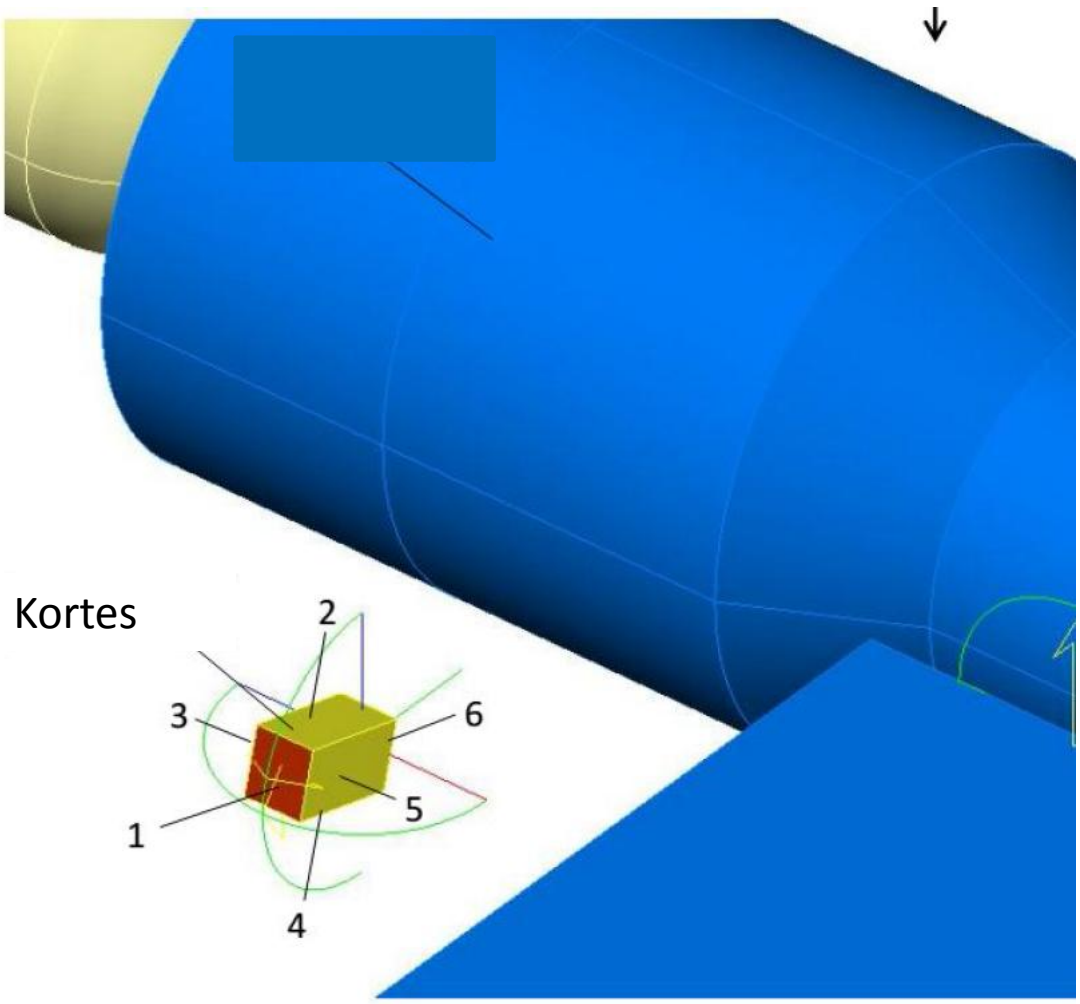
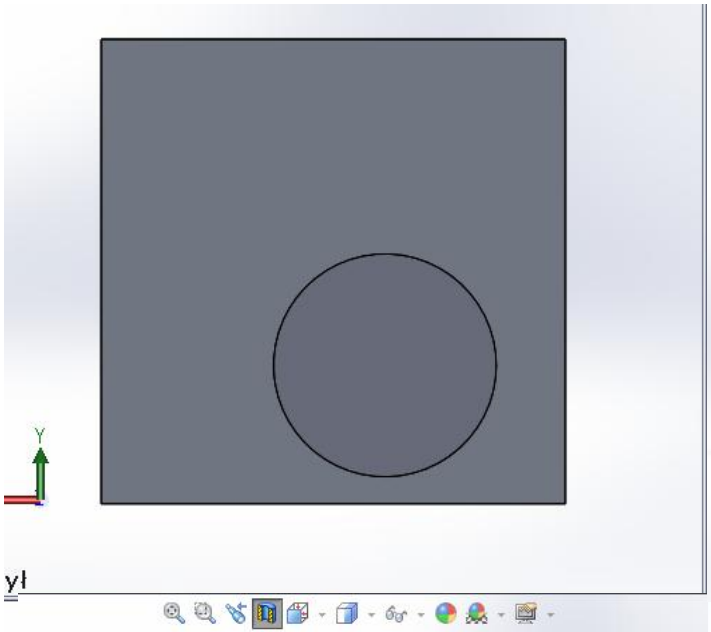
Mission Description

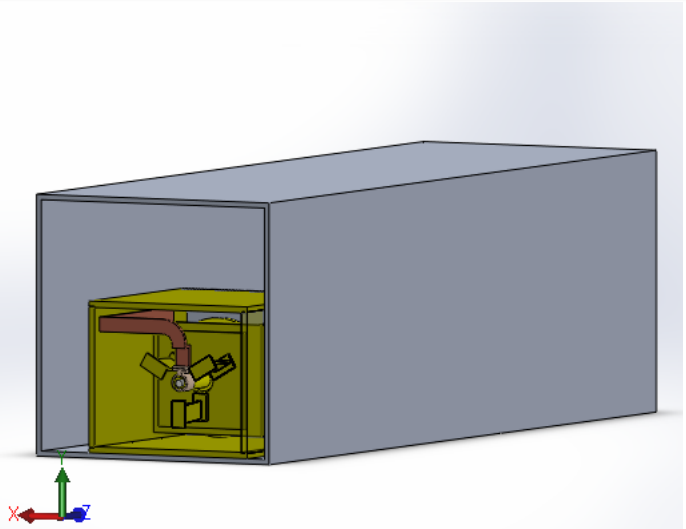


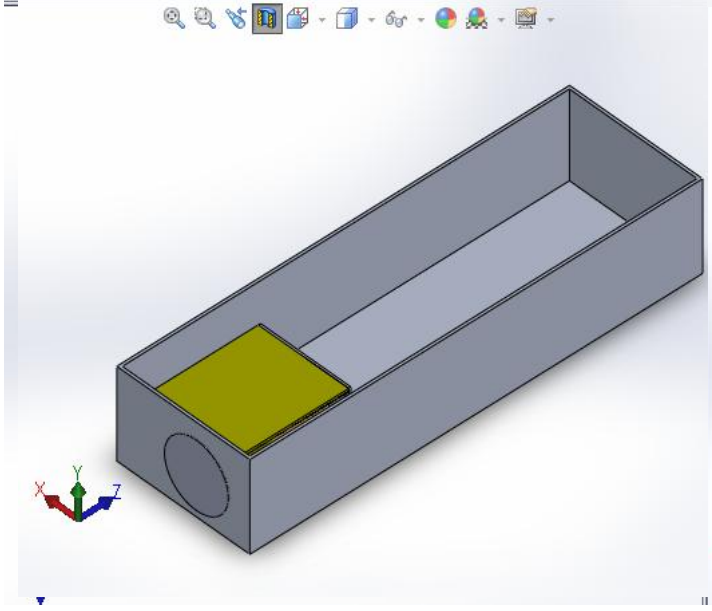
Kortes position vs ISS

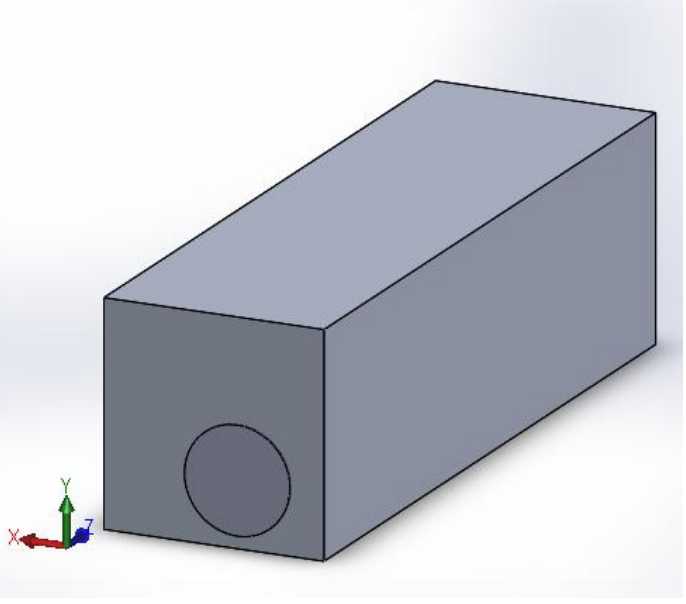


Solpex position inside the structure



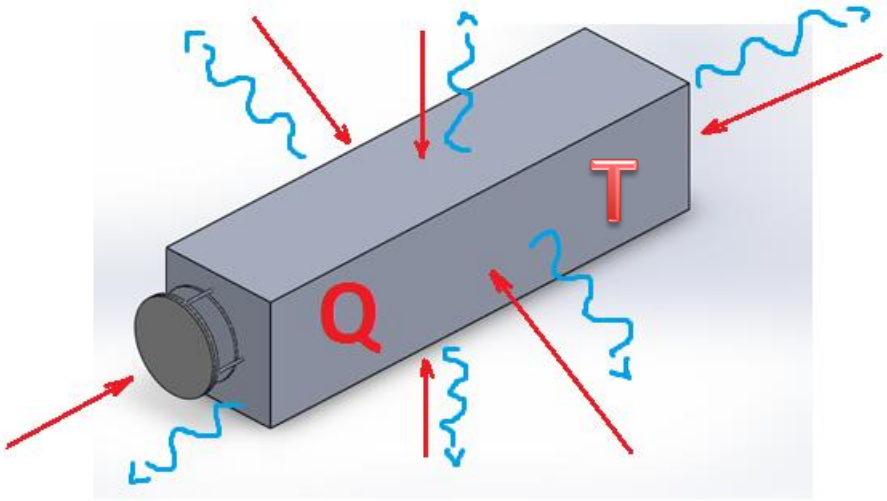


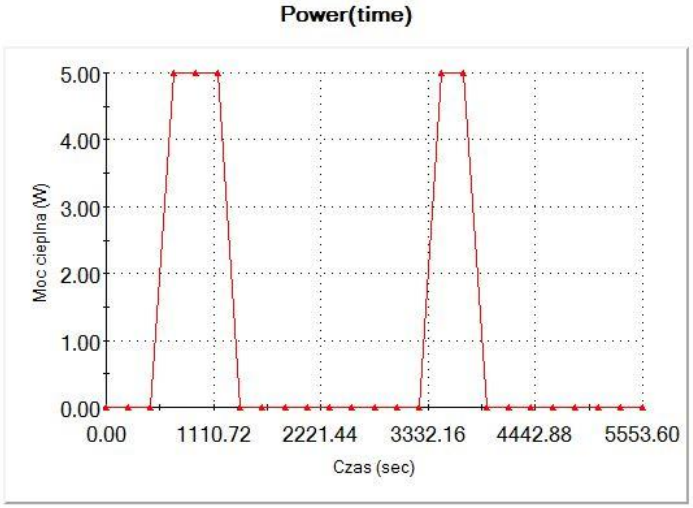




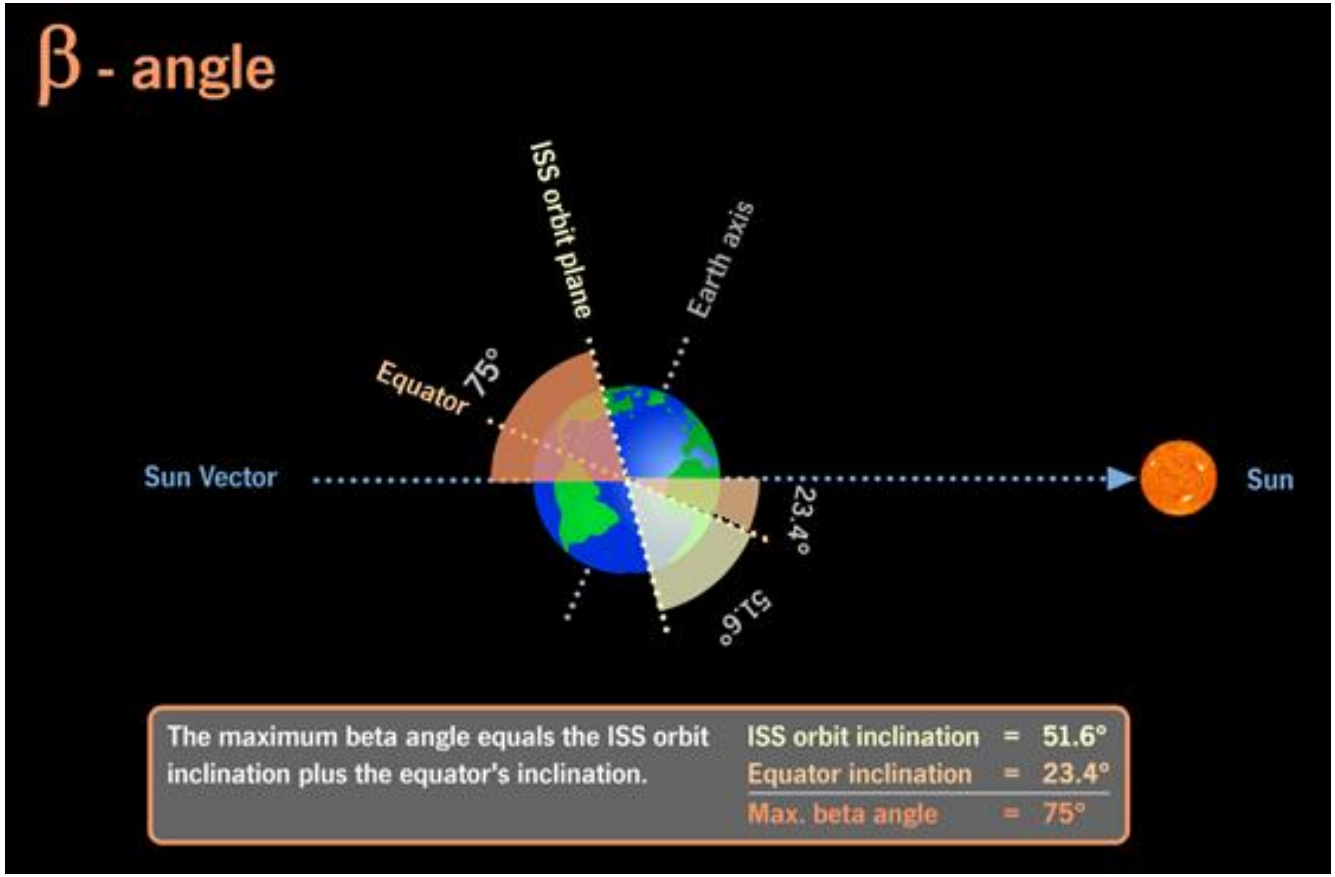
Heating components

- Radiation from walls to space
- Heat stream from albedo, solar radiaton and Earth IR
- Radiation from radiator
- Heat generation inside Kortes structure and inside Solpex

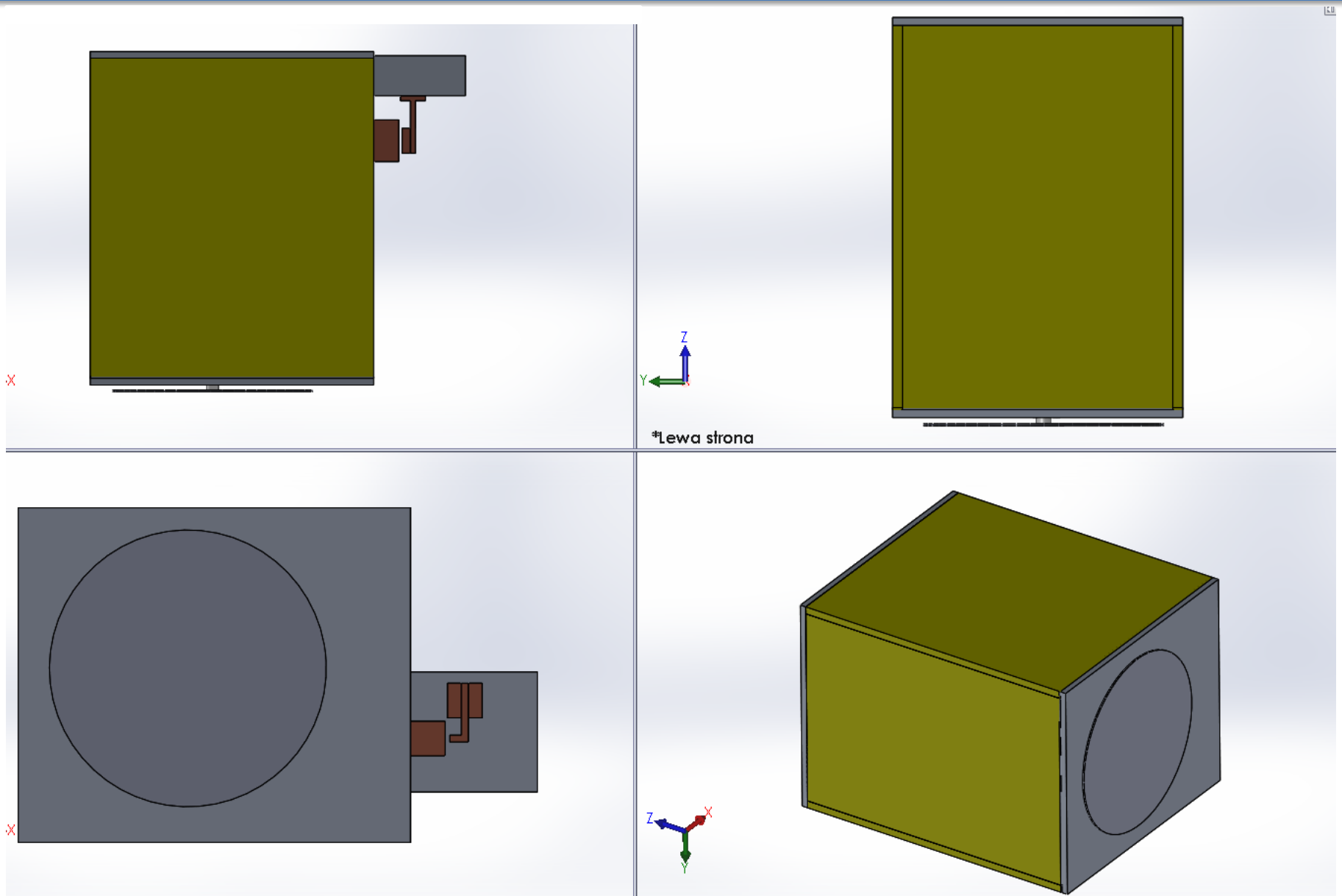




Variable heat fluxes



Heat dissipation inside Solpex



Steady state heat transfer equation

$$\sum_{i=1}^{n} Q_i = 0$$

$$\sum_{i=1}^{6} \alpha \cdot q_i \cdot A - \sum_{i=1}^{6} Q_i = 0$$

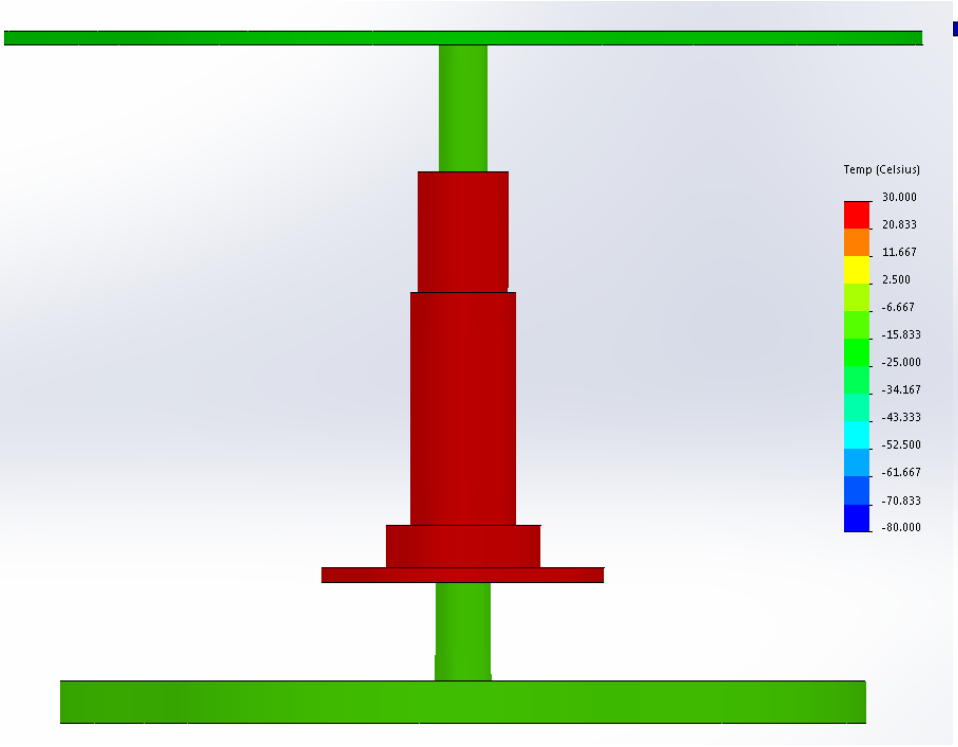
$$Q = \varepsilon A \sigma (T^4 - T_s^4)$$

Q – Radiation
ε – Emissivity
A – surface
T – Temperatura
Ts – Temperature of surroundings

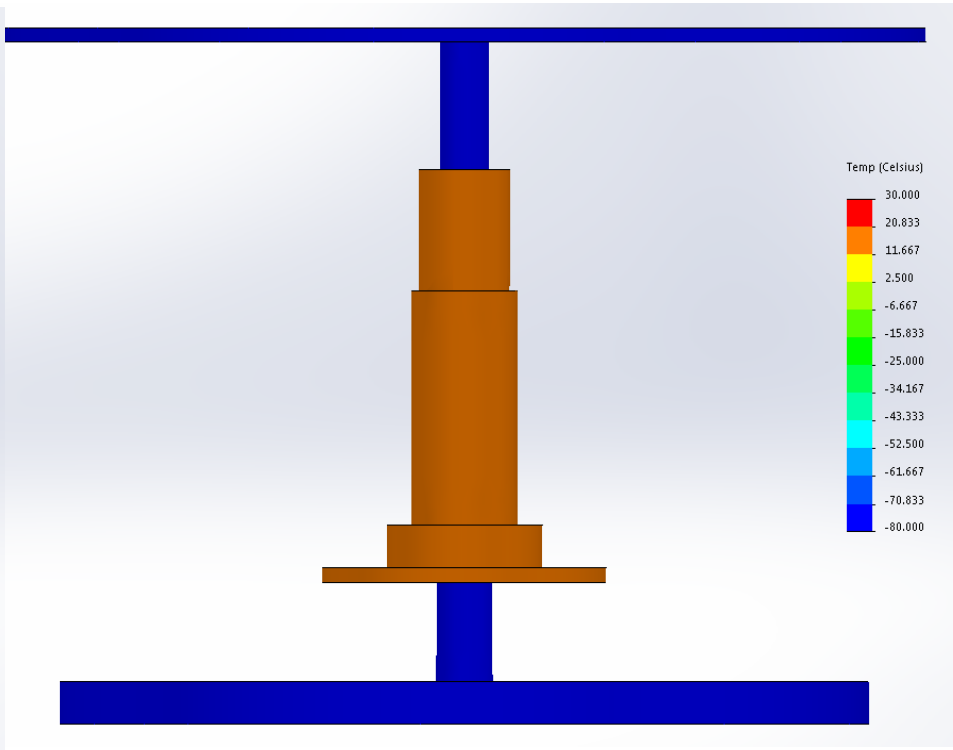
Emissivity - effectivity of material in emitting energy as thermal radiation.
Ratio of surface radaited energy to that of a black body at the same T.

Absrorptivity - the property of a body that determines the fraction of incident radiation absorbed or absorbable by the body
Ratio of surface absorbed energy to incident energy

The impact of changes in material properties on the temperature of the structure

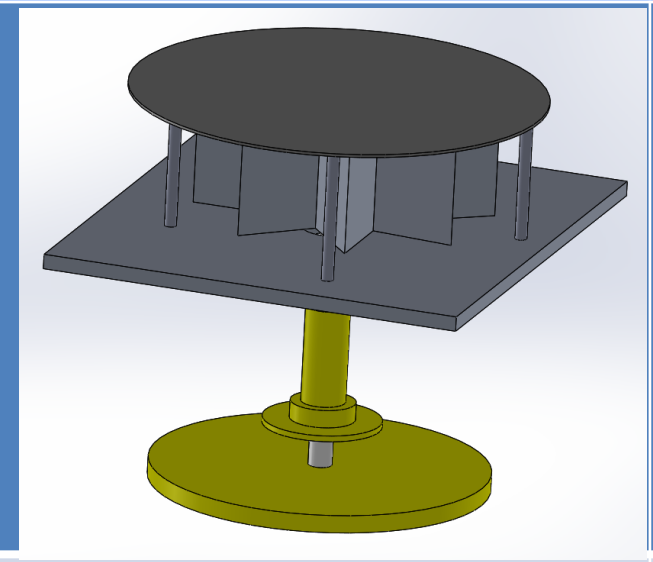


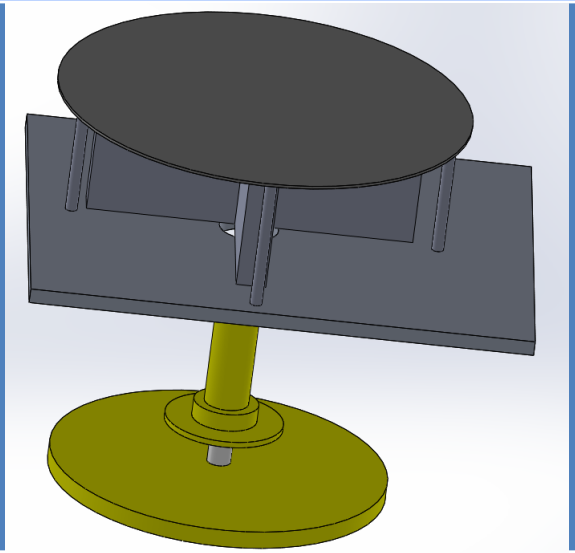
Emissivity ε=0.04
Absorptivity α=0.03
T= -15°C

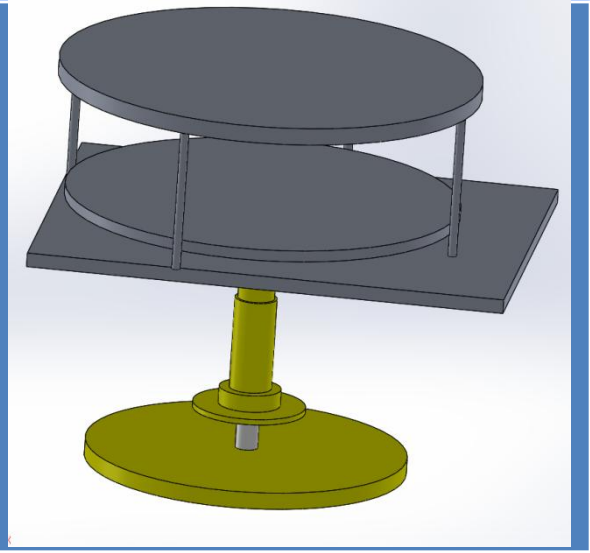


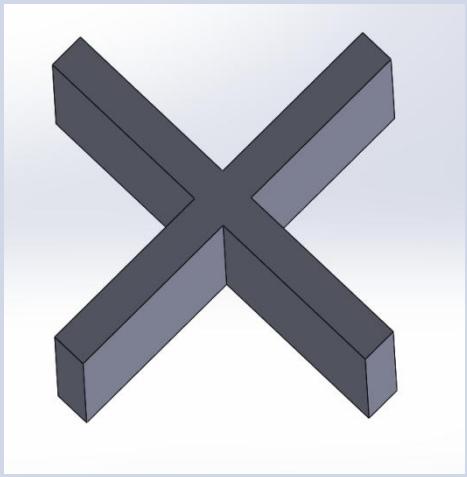
Emissivity ε=0.8
Absorptivity α=0.2
T= -79°C

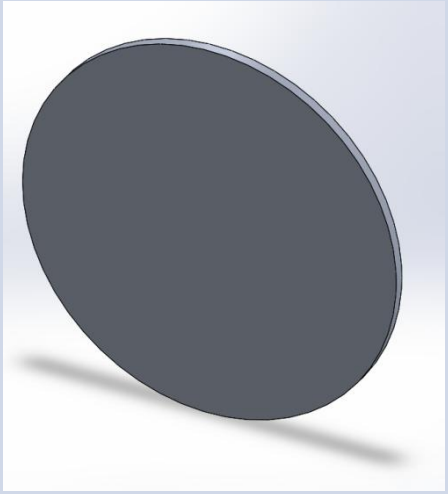
Radiator shapes

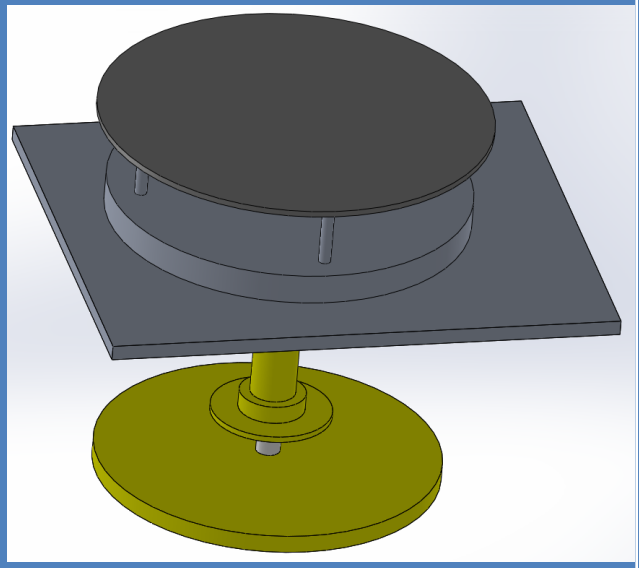


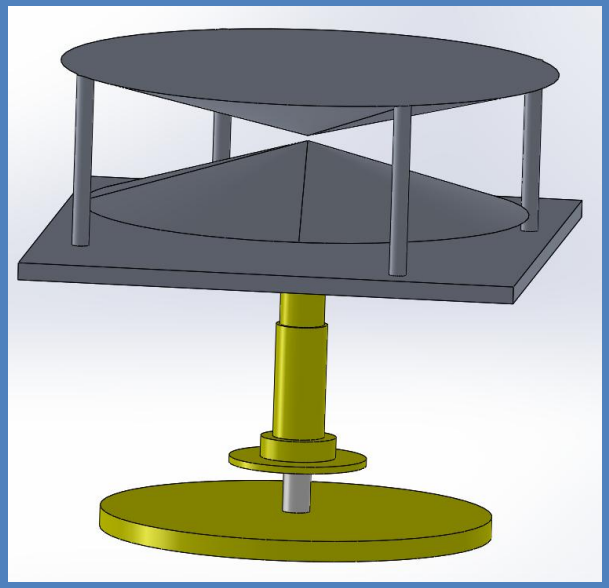


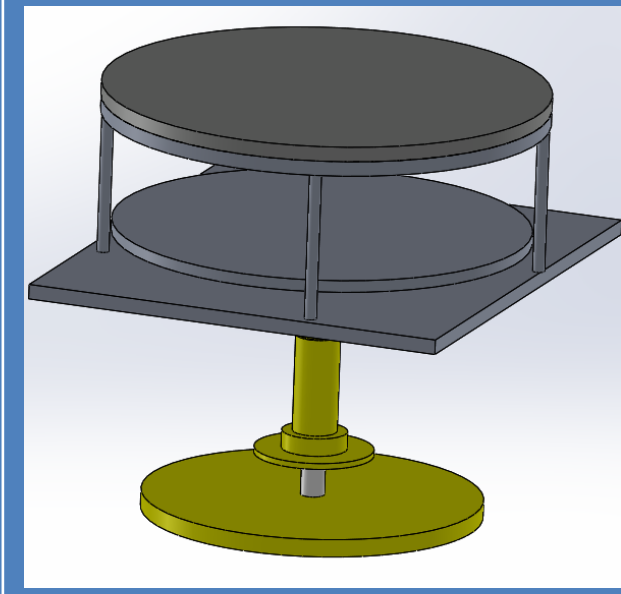


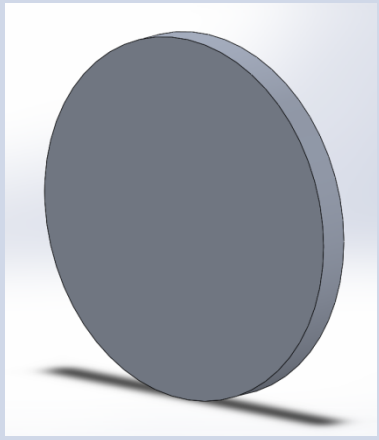


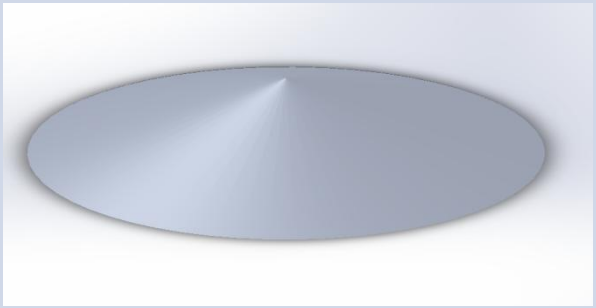


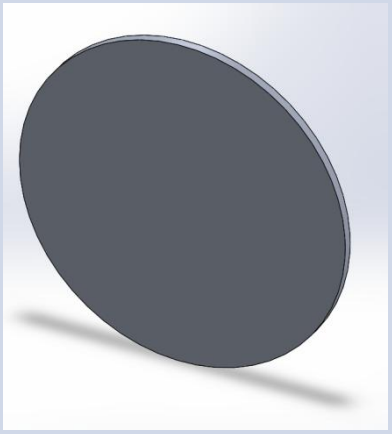






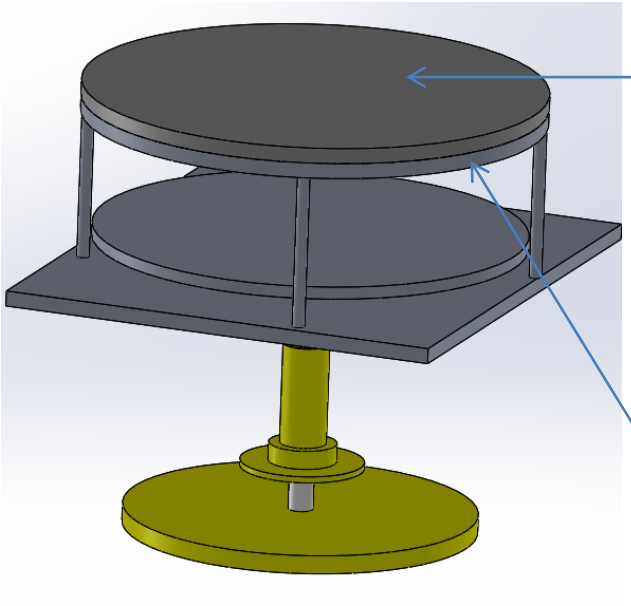






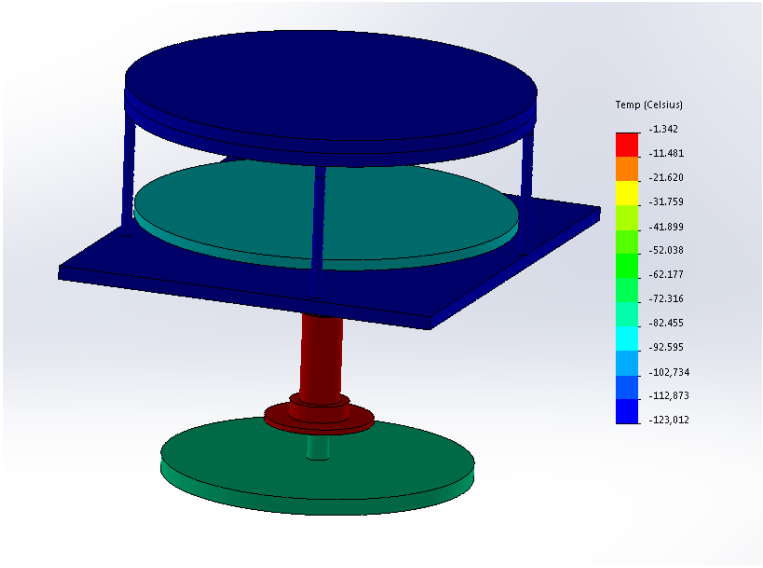
Selected radiator

75°	0°	-75°
-87°C	-80°C	-89°C



ε=0.8
α=0.2

ε=0.1
α=0.8



Concluding remarks

- Thermal analysis consists of several steps.
- Uncertainty of temperature estimation influence the accuracy of the following stages.
- Even small changes in material property such as emissivity or absorptivity can lead to significant changes in temperature distribution.
- Increasing of radiative surface might not be a solution for overheating if in the same time there are heat streams directed on it.
- Steady state analysis allows to determine temperature in the extreme cases.