



[Multi Mission Thermal Control Subsystem Design for Space Exploration Camera (Space Eye)]

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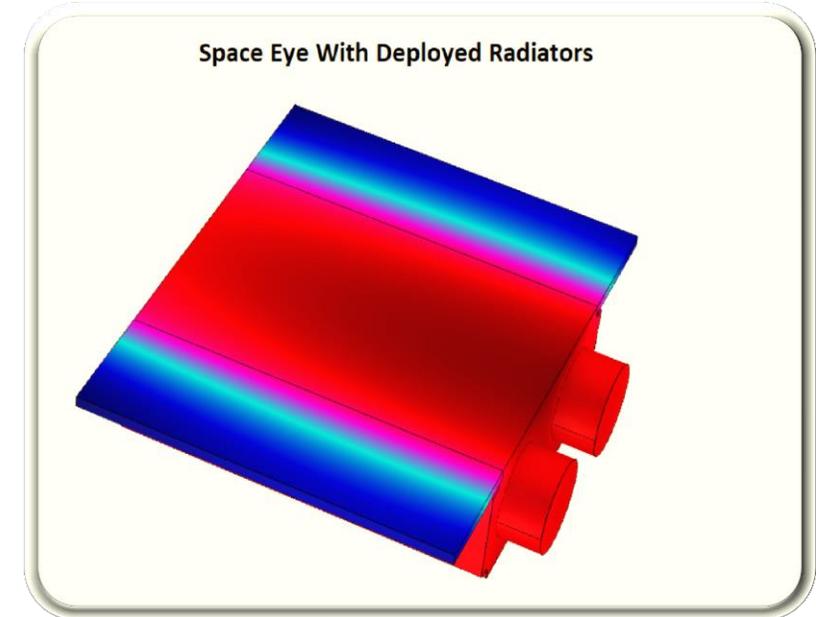


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- **Introduction**
 - **Solid and Variable Thermal Control Techniques**
 - **Radiation Control by Anodization**
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- **Introduction**

- Space eye is a small camera for interplanetary space exploration missions.
- The main target is to design a thermal control subsystem to overcome extreme predicted failure cases through orbiting earth and interplanetary missions.
- Thermal design for this platform will depend on three different techniques to assure the workability of the space eye through different space conditions.
- Thermal design concepts are classified into active and passive. Another classification is suggested will be solid and variable techniques.

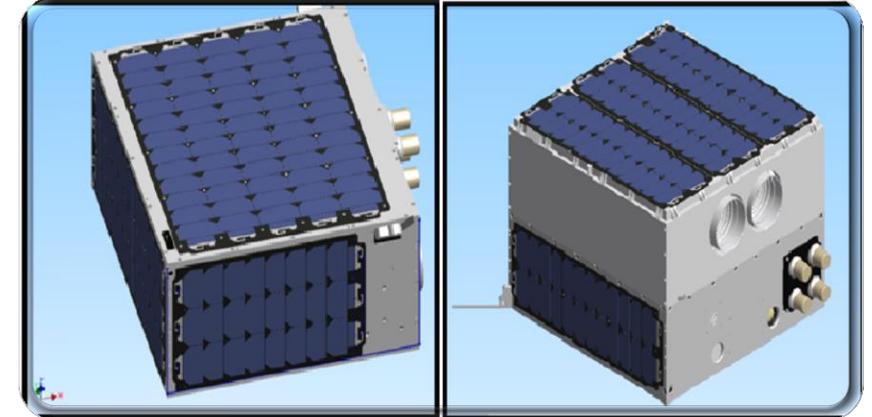




- **Solid and Variable Thermal Control Techniques**
- Passive and active thermal control techniques are used to control the space eye, three techniques will be clarified which can be classified to solid and variable techniques according to their adjustability during the mission
- **Radiation control by anodization**
- To control the thermo-optical of the outer layer of the satellite and the received flux. The technique is classified as a passive solid technique
- **Deployed radiators**
- Through deployed radiators the received radiation can be controlled according to the mission situation. Classified as active variable technique due to actuators power budget. Adjusted through radiator deployment angle
- **Double strokes heat pipes**
- Two separate strokes for heating and cooling. Classified as active variable technique. Adjusted through heat input to the fluid.

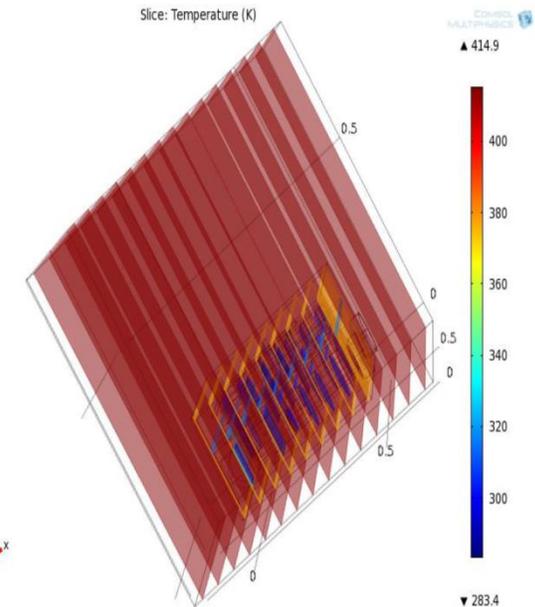
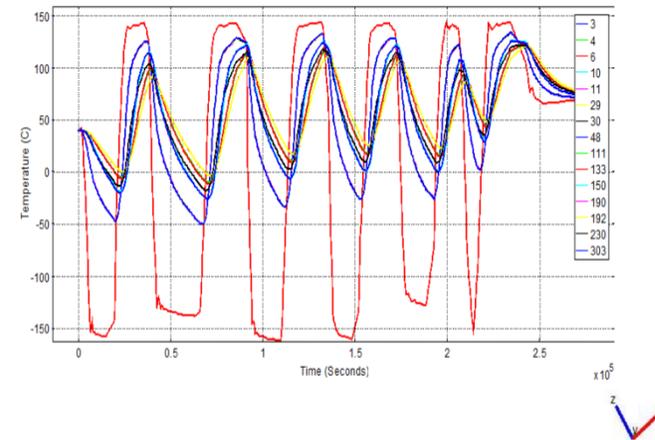
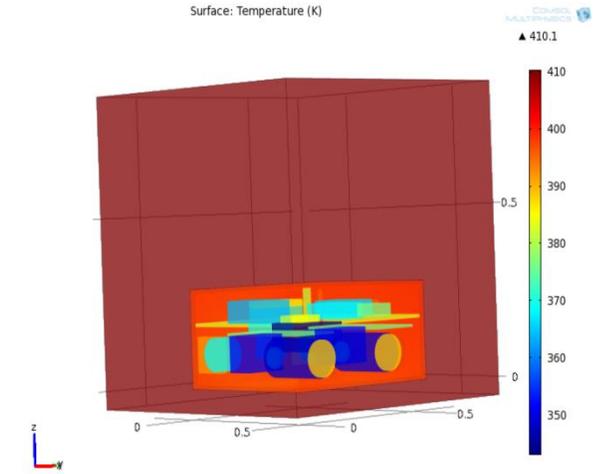


- **Radiation Control by Anodization**
- Idea studied firstly during NARSS Experimental satellite series (NexSat).
- Applied and locally manufactured model at Egyptian factories.
- Black anodization used as a high emissive layer. Grey anodization used as a low emissive layer
- Parametric study shows that the dependability of the temperatures on emissivity is higher than absorptivity.





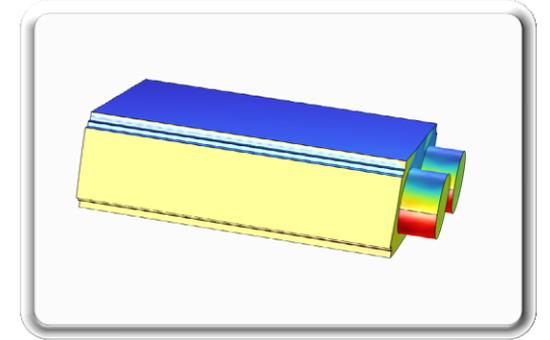
- **Radiation Control by Anodization**
- **TVAC testing**
- TVAC testing done using purchased chamber from LACO company at USA to EGSA as a test facility for NEXSAT series.
- Figures show the temperature change for the shroud and sensors distributed over structure thermal model.



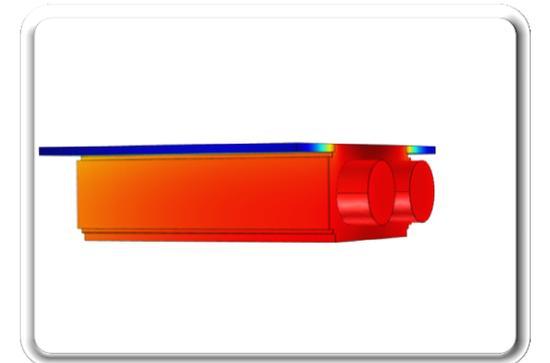


- **Deployed Radiators Thermal Control**
- Deployed radiators acts as a controller for the received flux such that the amount of received flux is dependent on the deployment angle.
- Acts an active variable thermal control technique.
- Power budget will be reserved for the actuator of the deployed radiator.
- The mode of transition between planets will be sun pointing mode and the deployed radiator surface will be the sun pointing side.
- Flux received depends on the radiator thermo-optical properties for non-deployed mode
- Flux increases gradually for deployed mode according to the deployment angle and sun vector angle.

Non-Deployed



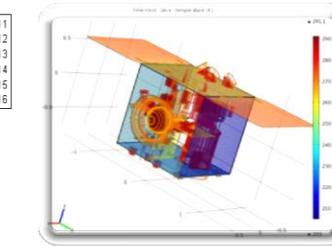
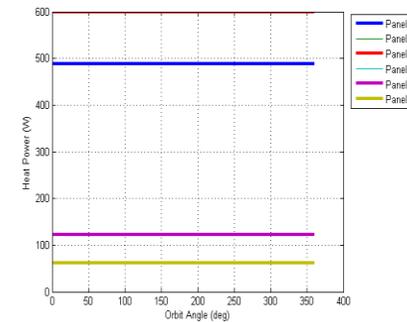
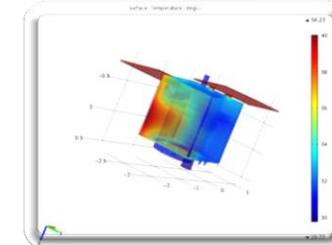
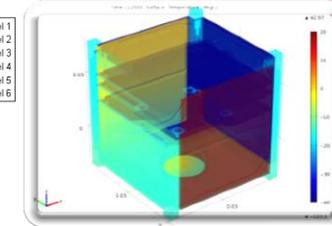
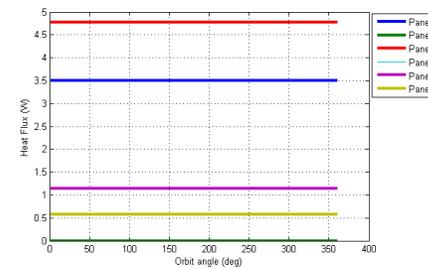
Deployed



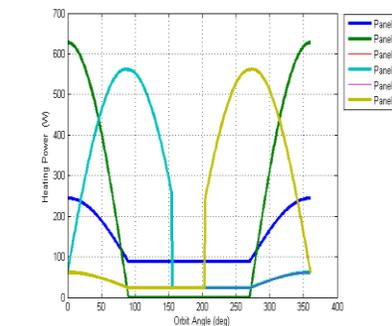
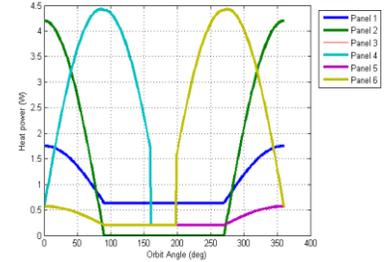


- **Deployed Radiators Thermal Control**
- The technique acts as if we master the sun beta angle effect on radiator side and then the received flux will be fully controlled
- It is preferred to minimize the flux received at the non-deployed mode
- This can be achieved by minimization of alpha to epsilon ratio thus the radiation received at non-deployed mode will be minimum.
- At the deployed radiator mode the received radiation increase with the deployment angle as if the radiator side beta angle transfer from 0 to 90 degrees.

Non-Deployed & full deployed



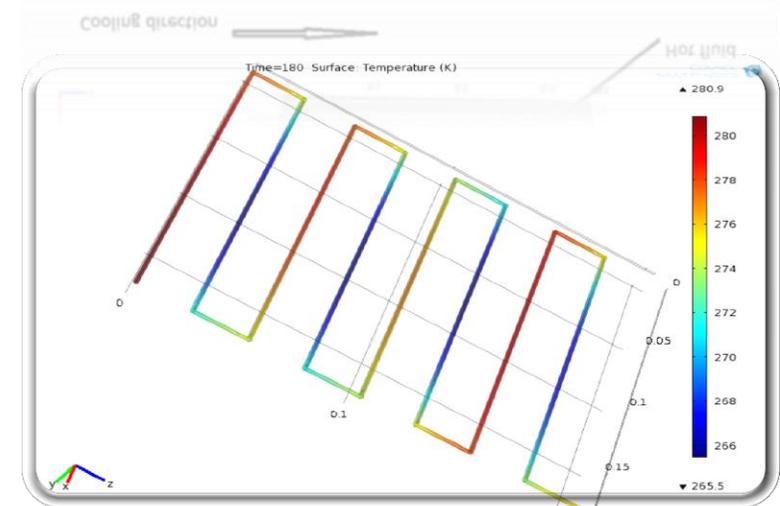
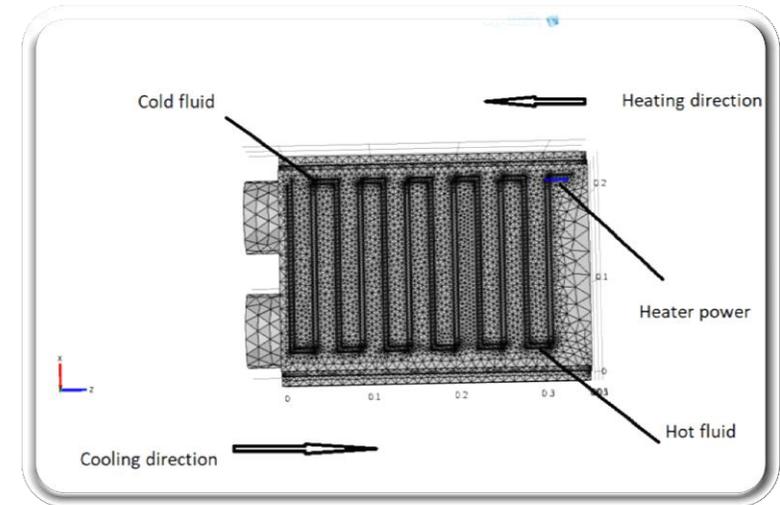
Partially Deployed





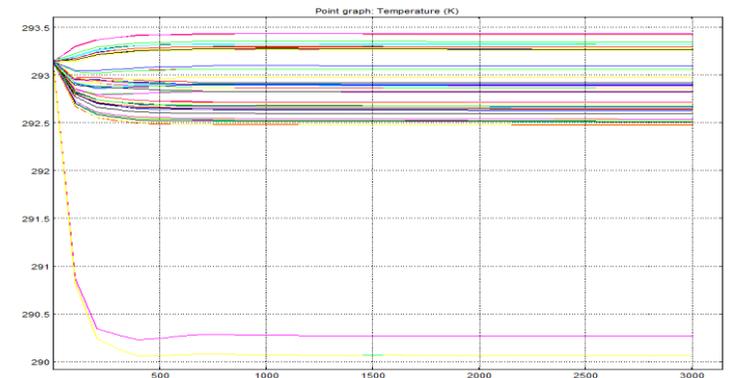
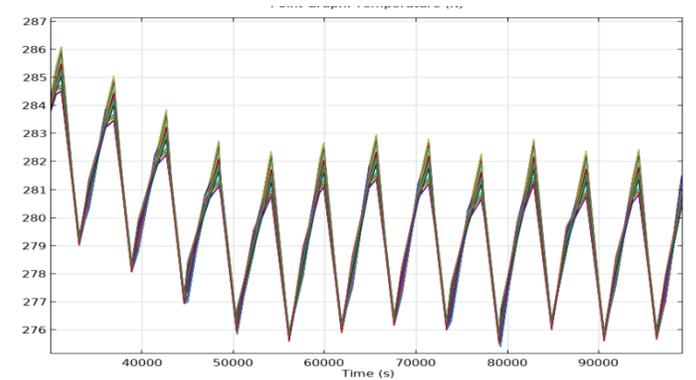
- **Double Strokes Heat Pipes**

- Double strokes heat pipe is an innovative thermal control technique that can manage both extreme hot and cold failure cases.
- First stroke is a conventional heat pipe that rejects heat at extremely hot conditions.
- The second stroke uses another type of fluid (low heating power) which can be used to raise the temperature for extreme cold conditions.
- Heat transfer occurs between heat pipes and space eye surface through high conductive Aluminum.





- **Transient study**
- During space eye travel into deep space two different profiles are considered, orbiting phase around the planet and the transition phase between planets
- At Orbiting phase temperatures fluctuating from illumination to eclipse
- At transition phase space eye is kept at sun pointing mode which gives a nearly constant temperatures
- Proposed techniques enable the control of the temperature transitions extremes at the first case and stabilization at the required temperature for the transition phase.





• **Summary & Conclusions**

- Thermal control of space exploration camera is concerned using three different techniques.
- Techniques classified into solid and variable according to their adjustability during transition through different space regimes.
- Radiation control by anodization is a passive solid technique.
- Deployed radiators is the second proposed technique and acts as an active variable technique.
- Deployed radiators enable the control of the amount of flux reaching radiator surface.
- The last proposed technique is the double strokes heat pipes, considered as a variable active technique and can be used for both heating and cooling according to mission requirements.



Thanks