

Appendix D

Thermal mapping on Bepicolombo's Mercury Planetary Orbiter (MPO) using SINASIV

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Abstract

Bepicolombo mission to Mercury poses complex problems in terms of environment aspects, and its effect on the structural behaviour of the spacecraft.

In order to analyse the spacecraft thermal elastic distortions cause by Mercury's harsh environment, the thermal node temperatures were mapped and interpolated on the structural finite element model using SINAS software.

This presentation will describe the work that has been done so far:

- Temperatures mapping onto the MPO finite element model;
- Challenges regarding the gradients areas and embedded heat pipes;
- Discrepancies between thermal and structural model and how they can be reduced.




Thermal Mapping on BEPICOLOMBO's MPO spacecraft using SINAS IV

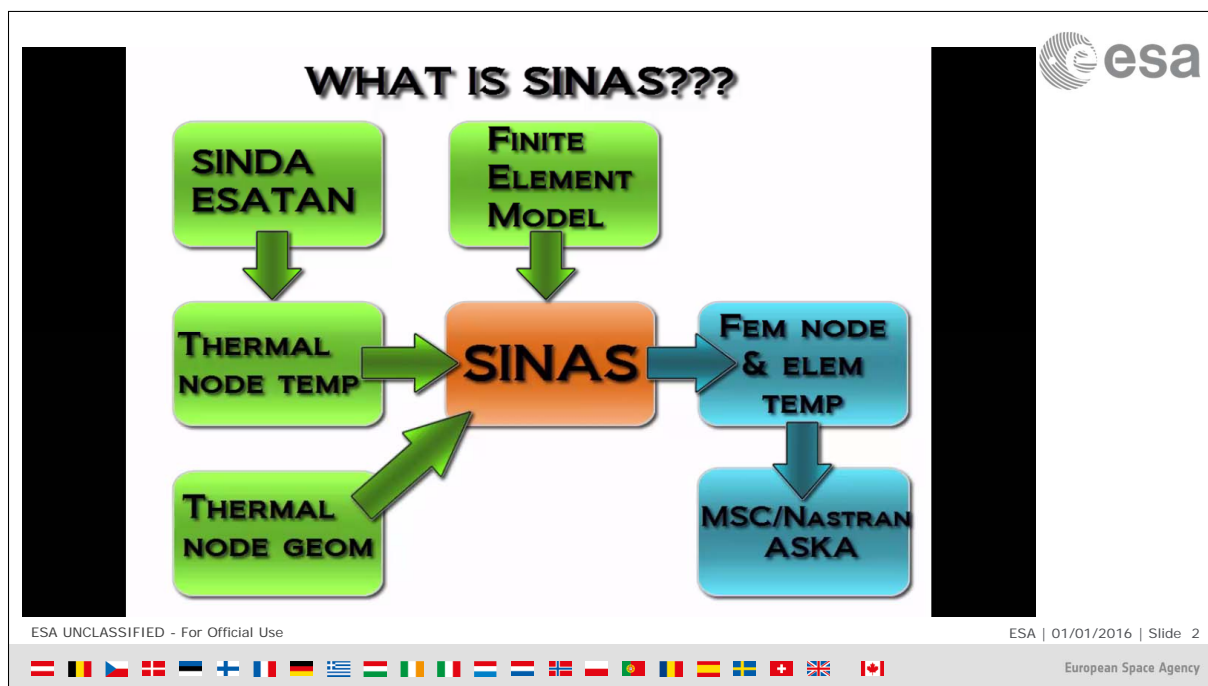
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Simon Appel


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THE MATH BEHIND SINAS

WEIGHTING COEFFICIENT

$$T_j^t = \sum_i a_i T_i^f$$




Thermal Node Temp




FE Node Temp

PRINCIPLE OF SINAS:
WEIGHTED AVERAGE TEMPERATURE OF FE NODES OVERLAPPED BY A THERMAL NODE IS EQUAL TO THE THERMAL NODE TEMPERATURE

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THE MATH BEHIND SINAS

$$T_j^t = \sum_i a_i T_i^f$$


$$1 = \sum_i a_i$$




$$T^t = A T^f$$

PRINCIPLE OF SINAS:
WEIGHTED AVERAGE TEMPERATURE OF FE NODES OVERLAPPED BY A THERMAL NODE IS EQUAL TO THE THERMAL NODE TEMPERATURE

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THE MATH BEHIND SINAS

$$T^t = A T^f$$

SYSTEM TO BE SOLVED

$\begin{bmatrix} C \\ A \end{bmatrix}$

A^T
 $\begin{bmatrix} 0 \end{bmatrix}$

$\begin{Bmatrix} T^f \\ q \end{Bmatrix}$


$= \begin{Bmatrix} 0 \\ T^t \end{Bmatrix}$

CONDUCTION MATRIX DERIVED FROM STRUCTURAL MODEL


UNKNOWN (FE NODE TEMP)

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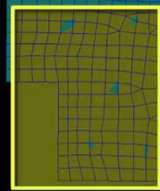
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METHOD BEHIND SINAS

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GEOM OF THE LUMPED
PARAMETER THERMAL NODE
      
```



selected thermal nodes

Current sets

1114000

1114001

1114002

1114003

1114004

1114005

1114006

1114007

1114008

1114009

1114010

1114011

1114012

1114013

1114014

1114015

1114016

1114017

1114018

1114019

1114020

1114021


1114022

1114023

$$\text{PAT METHOD : } T_j^t = \sum_i a_i T_i^f$$

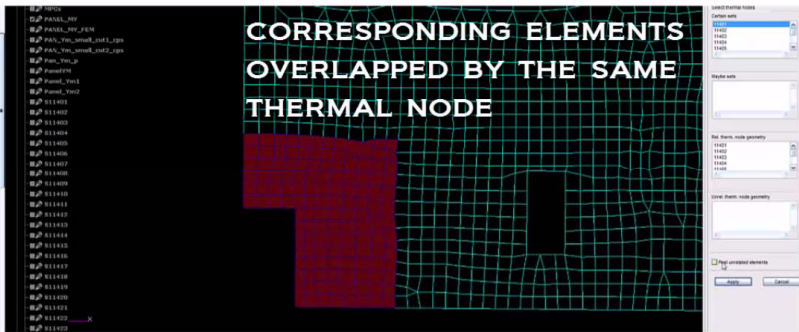
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METHOD BEHIND SINAS



PAT METHOD : $T_j^t = \sum_i a_i T_i^f$

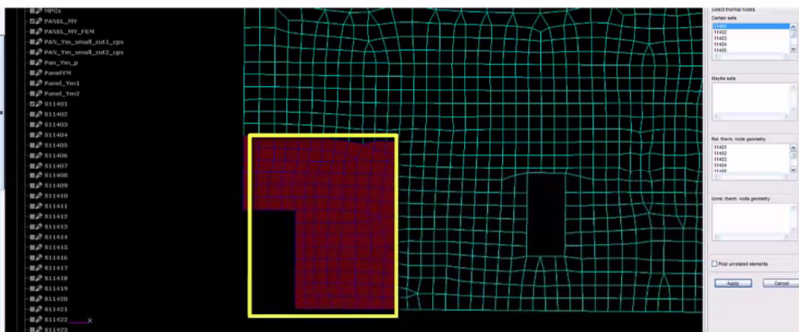


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METHOD BEHIND SINAS



PAT METHOD : $T_j^t = \sum_i a_i T_i^f$

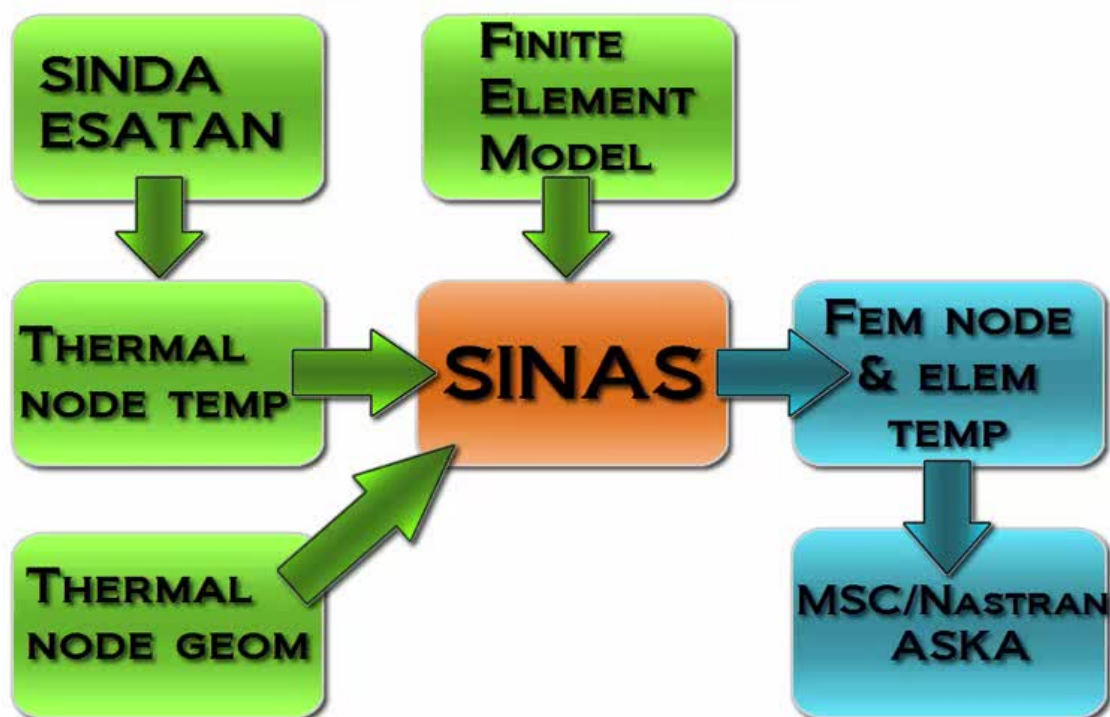


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WHAT IS SINAS???



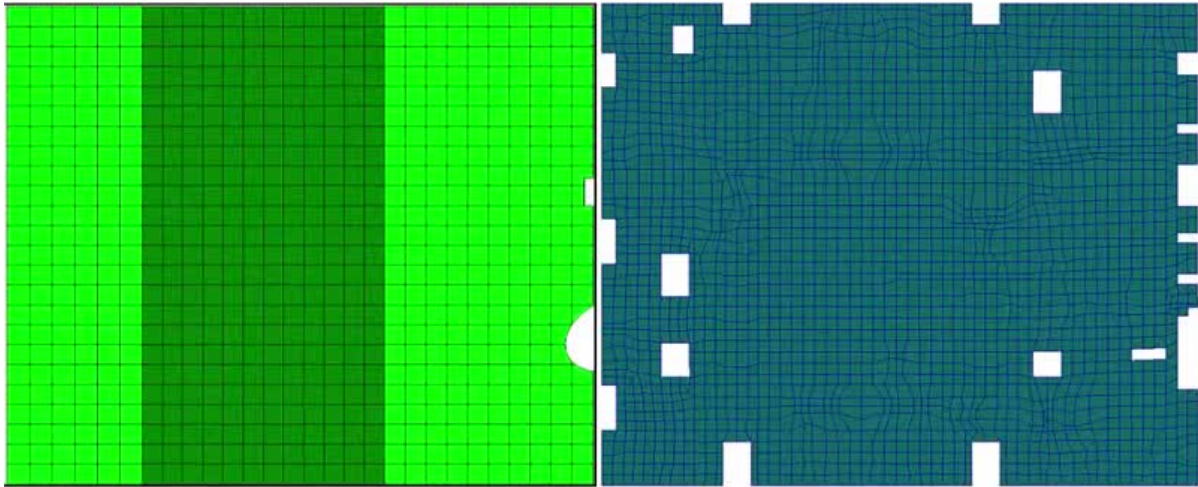
Save the attachment to disk or (double) click on the picture to run the movie.

BEPI-COLOMBO



Save the attachment to disk or (double) click on the picture to run the movie.

GRADIENT AREA CASE



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BEST PRACTICES

1. INCORRECT TH. NODE DEFINITION LEADS TO INCORRECT TEMP INTERPOLATION
2. HIGH TEMP GRADIENTS REQUIRE HIGH RESOLUTION THERMAL MESH
3. IF YOU ARE INTERESTED IN DISTORTIONS @ UNIT | PAYLOAD I/F, THEN MODEL (IN FEM) AT LEAST ITS BASE PLATE
4. PROPER DOCUMENTATION OF MATERIALS & GLs (FROM BOTH SIDES)
5. CONSIDER ADDING A TH NODE (TMM) FOR MAIN BRACKETS & ATTACHEMENTS

Save the attachment to disk or (double) click on the picture to run the movie.