Appendix K

Migration of existing thermal models into new software versions

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With promising future technologies, Jena-Optronik GmbH operates as one of the international leading providers of opto-electronic instruments and systems for aerospace and security applications. More than 30 years of experience and precise solutions stand for successful products and projects in space as well as on Earth.

The company has an excellent international reputation in the fields of opto-electronic instruments and systems, software as well as guidance, navigation and control sensors. Within JENOPTIK AG, Jena-Optronik takes the lead function for complex opto-electronic system solutions for aerospace and security, making use of the competence centres and the expertise of the whole group.

In the fields Aerospace and Security, the company concentrates on:

* systems and instruments for Earth Observation
* software and data processing
* AOCS sensors
* systems and instruments for space exploration
* opto-electronic instruments and systems for security

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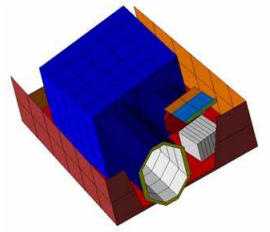
One of the present projects is the RapidEye Telescope. It is a high resolution camera for earth observation. The main topics are

Three mirror telescope optics

Five spectral channels

Telescope dimension about $(0.5\ m)^3$



Thermal design

Housing and Mirrors are made of aluminum

Temperature control via heaters

Protection against space environment with the help of MLI

Model made with ESARAD/ESATAN – about 600 thermal nodes

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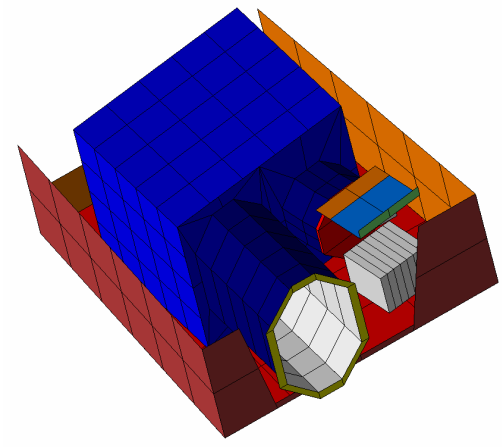

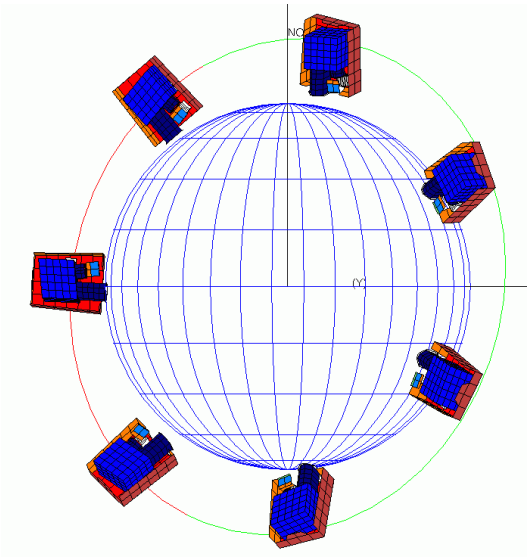

RapidEye Geometry and Orbit Model

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Long life-time of a thermal model ←→ Version changes in field of software

Rules for modeling

• No wholes and slits

Unwanted wholes or slits generate problems during ray-tracing calculation by sun incidence

•Use of variables for geometry definition

```
REAL sol_dim_x;
sol_dim_x = 1.00000000;
```

•Calculate dimensions by mathematical functions

```
semi_ang_cone = ATAN (rad2– rad1) / (2.0 * height);
```


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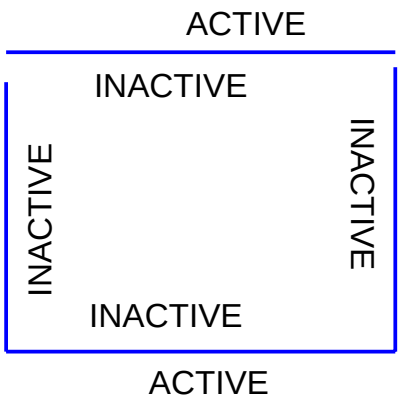
AVOID THIS



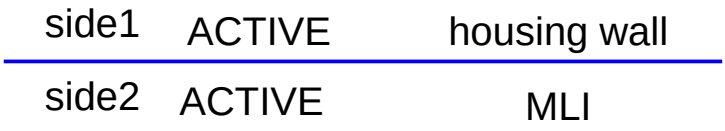
•No view of inactive sides to active sides

•Check sum of REFs to inactive faces

```
REF TO INACTIVE NODE = 0.000000
```

One shell – different thermal nodes at side1 and side2

Often used for MLI at boxes



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ESARAD 5.6 geometry

```
SHELL ant_par;
ant_par = SHELL_PARABOLOID (
…
thick = thick_003,
bulk = mat_alu,
opt1 = opt_gold,
opt2 = opt_ssm,
…
```

ESARAD 5.8 geometry

```
SHELL ant_par;
ant_par = SHELL_PARABOLOID (
…
thick1 = thick_003,
bulk1 = mat_alu,
thick2 = thick_010,
bulk2 = mat_mli,
opt1 = opt_gold,
opt2 = opt_ssm,
…
```


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ESARAD 5.6

Bulk properties only of side 1 in geometry

Result in ESATAN-output

```
$NODES
 D20000 =  'cover for telescope', T = 0.000000,
     A = 0.009500, ALP = 0.140000, EPS = 0.600000;
…
$INITIAL
      C20000 = 0.000190 * Cp_mat_mli* Dens_mat_mli    # side1
```

Bulk properties of side 2 in ESATAN have to be added by hand

```
$INITIAL
      C21000 = 0.000190 * Cp_mat_alu* Dens_mat_alu    # side2
```

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ESARAD 5.8

Bulk properties of side 1 and side 2 in shell geometry defined

Result in ESATAN-output $NODES block

```
D20000 =  'Solar PanelLeft', T = 0.000000,
      C = 0.002500 * Cp_mat_si152 * Dens_mat_si152,
      A = 0.250000, ALP = 0.820000, EPS = 0.806000;
D21000 =  'Solar PanelLeft', T = 0.000000,
      C = 0.000750 * Cp_mat_al2024 * Dens_mat_al2024,
      A = 0.250000, ALP = 0.900000, EPS = 0.900000;
```

No additional input is necessary

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Using of ESARAD 5.6 geometry in ESARAD version 5.8

Capacity will be declared in $NODES for both faces as a formula

```
D20000 =  'Solar PanelLeft', T = 0.000000,
      C = 0.001250 * Cp_mat_si152 * Dens_mat_si152,
      A = 0.250000, ALP = 0.820000, EPS = 0.806000;
…
D21000 =  'Solar PanelLeft', T = 0.000000,
      C = 0.001250 * Cp_mat_si152 * Dens_mat_si152,
      A = 0.250000, ALP = 0.900000, EPS = 0.900000;
```

Capacity is divided 50% onto face1 and 50% onto face2.

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Next try:

Replace bulk…thick with bulk1…thick1 with the help of a text editor does not help

```
D20000 = 'SolarPanelLeft', T = 00,# Bulk properties inconsistent
      A = 0.250000, ALP = 0.820000, EPS = 0.806000;
```

Capacity Declaration in $NODES-block results in a re-calculation at the end of $VARIABLES1 block

→Capacity definition in $INITIAL will be overwritten!

Conclusion

- Hold the ESARAD 5.6 installation for 5.6 geometry
- Make a complete upgrade of your geometry and use the new features

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Complete Model Calculation Run by one Command

This is useful in case of parameter changes (case studies)

Batch files for

ESARAD geometry (*.erg)
ESARAD orbit (*.erk)
Conductor (GR, GL) and Flux (Solar, Albedo, Planet) output
Analysis Cases and Thermal Model generation
ESATAN template (*.tpl)

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Example

```
call esrda < model003.era
echo * admin completed/ geometry started *
call esrdg < model003.erg
echo * geometry completed / kernel started *
call esrdk < model003.erk
echo * kernel completed /esatan export started *
call esrde < model003.ere
...
```


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Example for an ESATAN template

```
$ MODEL modell003
 $LOCALS
  $NODES
  # GENCODE NODES - DO NOT REMOVE
  $INCLUDE "..\common\main-nod.d"

  $CONDUCTORS
  # GENCODE CONDUCTORS - DO NOT REMOVE
  $INCLUDE "..\common\main-ugl.d"

  $CONSTANTS
  # GENCODE CONSTANTS - DO NOT REMOVE
  $INCLUDE "..\common\main-dat.d"

  $ARRAYS
  # GENCODE ARRAYS - DO NOT REMOVE
  $SUBROUTINES
  # GENCODE SUBROUTINES - DO NOT REMOVE
  $INCLUDE "..\common\main-sub.d"
```

```
$INITIAL
  # GENCODE INITIAL - DO NOT
REMOVE
      CALL ALLINI
  # Start temperatures
      CALL TSTRT1
…
$EXECUTION DYSTOR=100000
      CALL EXEQ01
#
  $OUTPUTS
      CALL OUTP01
#
$ENDMODEL model003
```