Appendix N

How SYSTEMA could provide valuable assistance in mission analyses and thermal worst cases determination

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Abstract

Thermal design activities require a full understanding of the studied space system's mission. Standard missions are efficiently assisted thanks to the qualitative approach, especially to determine the worst external heat flow loading. For more complex missions, the qualitative approach remains vital but should be supported by a quantitative approach. This presentation is focused on demonstrate the capabilities provided by SYSTEMA v4.5 to automate the determination of the worst external heat flow loading. Based on a mobile antenna mechanism, it is shown how the mission's characteristics are handled into SYSTEMA in order to determinate parameters values leading to maximize or minimize external heat flow at the antenna subsystem level.


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Context
➔ Worst external heat flow loading determination
• qualitative approach
• quantitative approach
➔ A tool that assists
• Provides accurate results
• Easy to develop
• Easy to reuse
• Easy to upgrade
Source: CNES, March 2003 (Pierre Carril)
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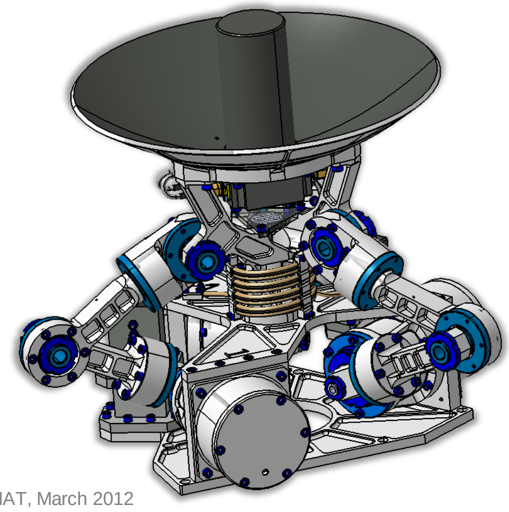
3POD project

→ An innovative mobile antenna mechanism (COMAT/CNES)



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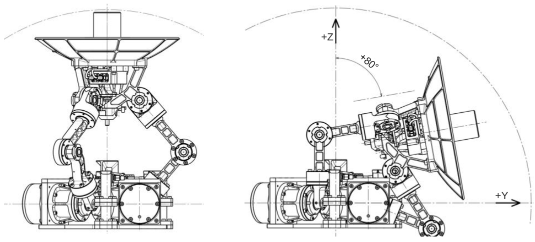

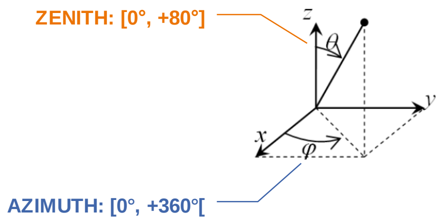

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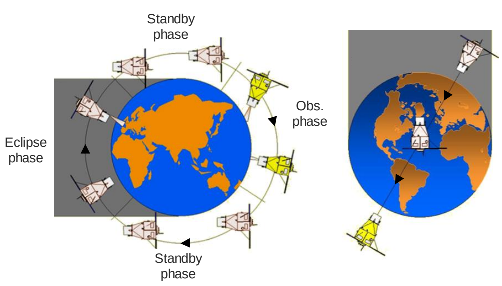
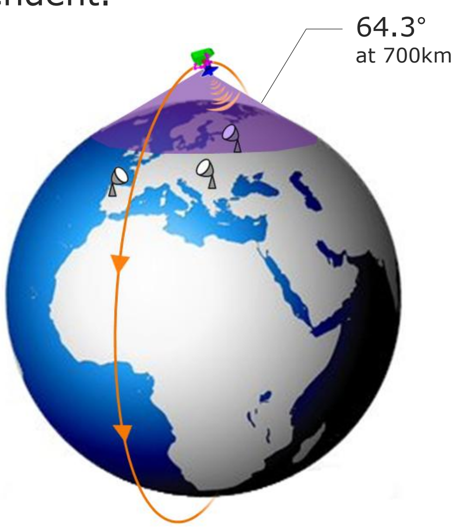
Qualitative approach

→ Antenna: During the observation phase, the heat flow loading is multi-parameter-dependent.

- The season
- The mission



Sun-synchronous 700km
Ascending node at 22h30



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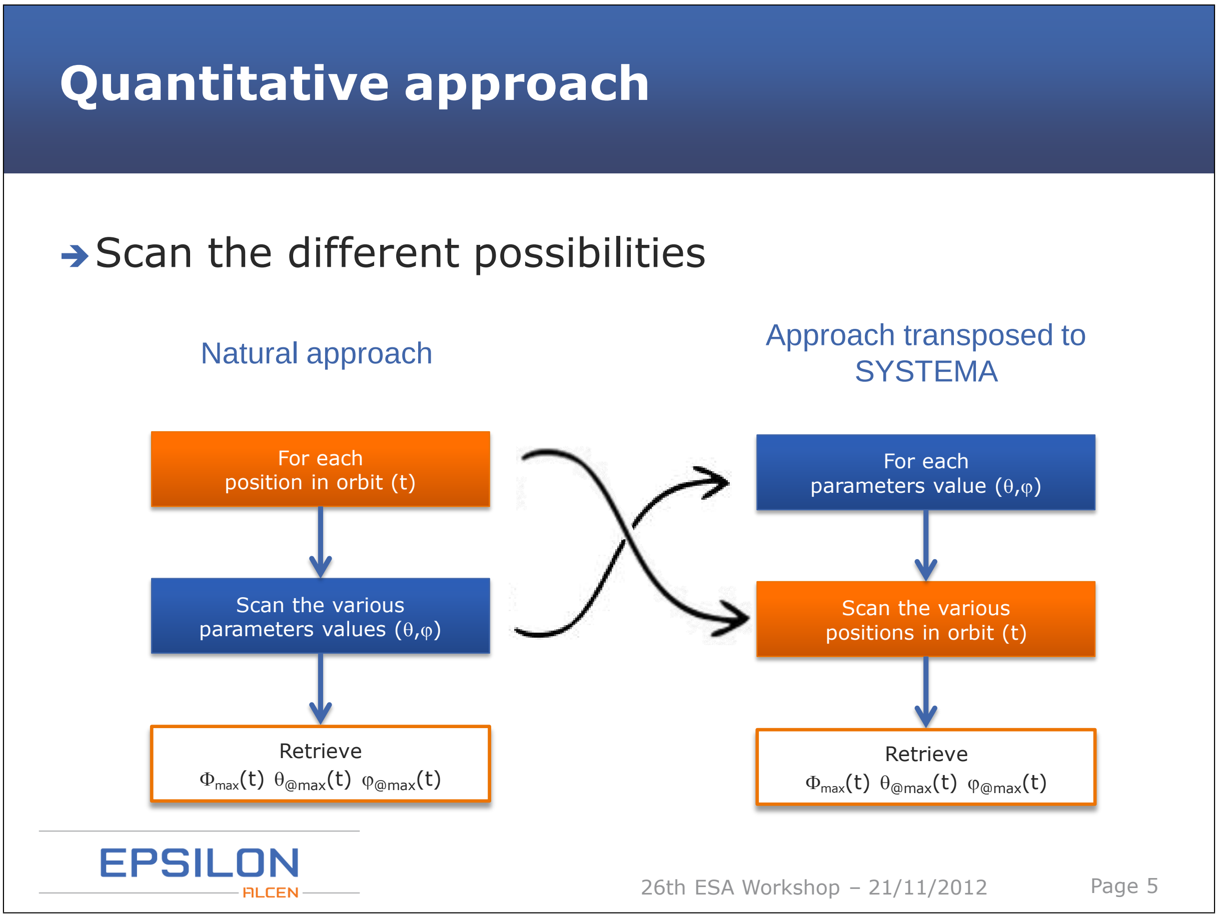
Quantitative approach
Scan the different possibilities
Natural approach
Approach transposed to SYSTEMA
For each position in orbit (t)
Scan the various parameters values (θ,φ)
Retrieve Φmax(t) θ@max(t) φ@max(t)
For each parameters value (θ,φ)
Scan the various positions in orbit (t)
Retrieve Φmax(t) θ@max(t) φ@max(t)
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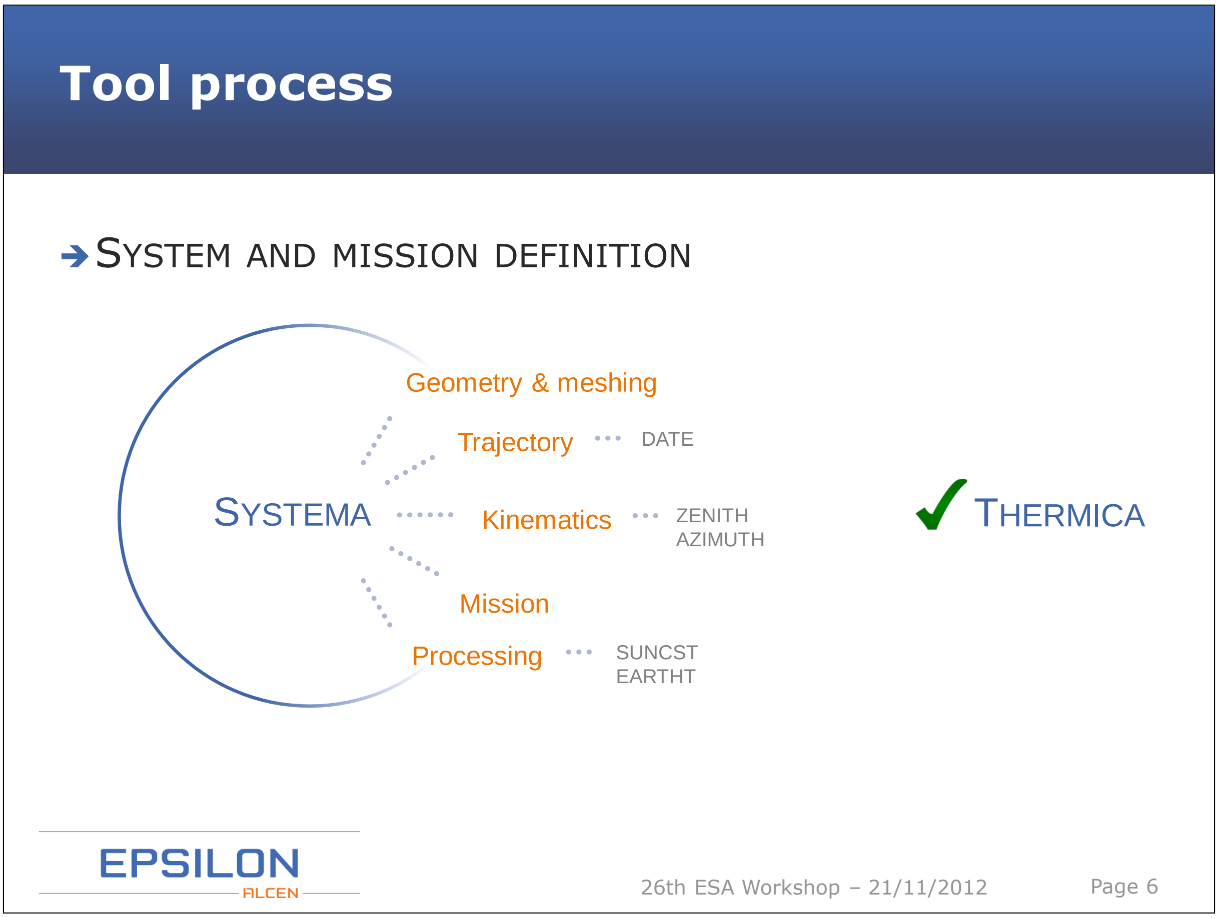
Tool process
SYSTEM AND MISSION DEFINITION
Geometry & meshing
Trajectory
DATE
SYSTEMA
Kinematics
ZENITH
AZIMUTH
Mission
Processing
SUNCST
EARTHT
THERMICA
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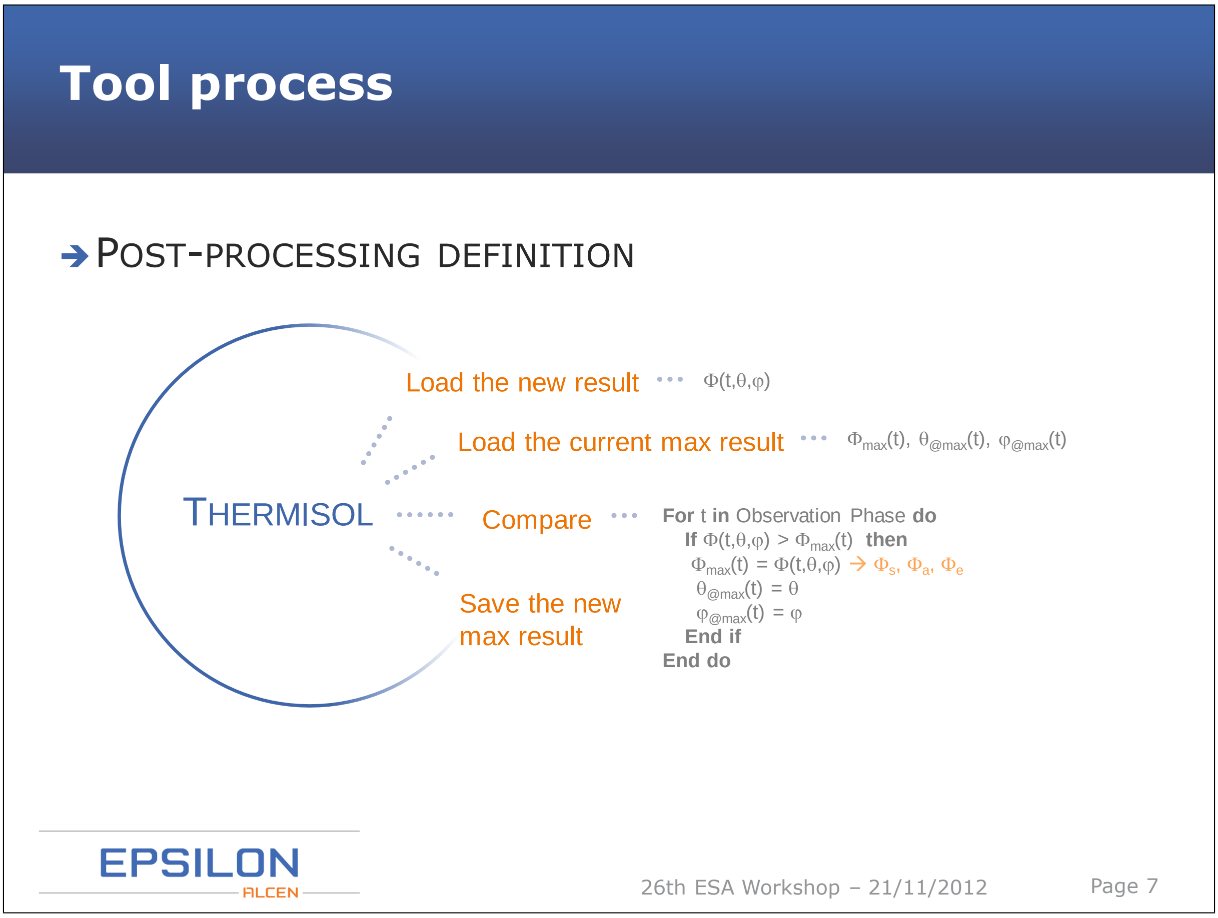
Tool process
POST-PROCESSING DEFINITION
THERMISOL
Load the new result
Φ(t,θ,φ)
Load the current max result
Φmax(t), θ@max(t), φ@max(t)
Compare
For t in Observation Phase do
If Φ(t,θ,φ) > Φmax(t) then
Φmax(t) = Φ(t,θ,φ) → Φs, Φa, Φe
θ@max(t) = θ
φ@max(t) = φ
End if
End do
Save the new max result
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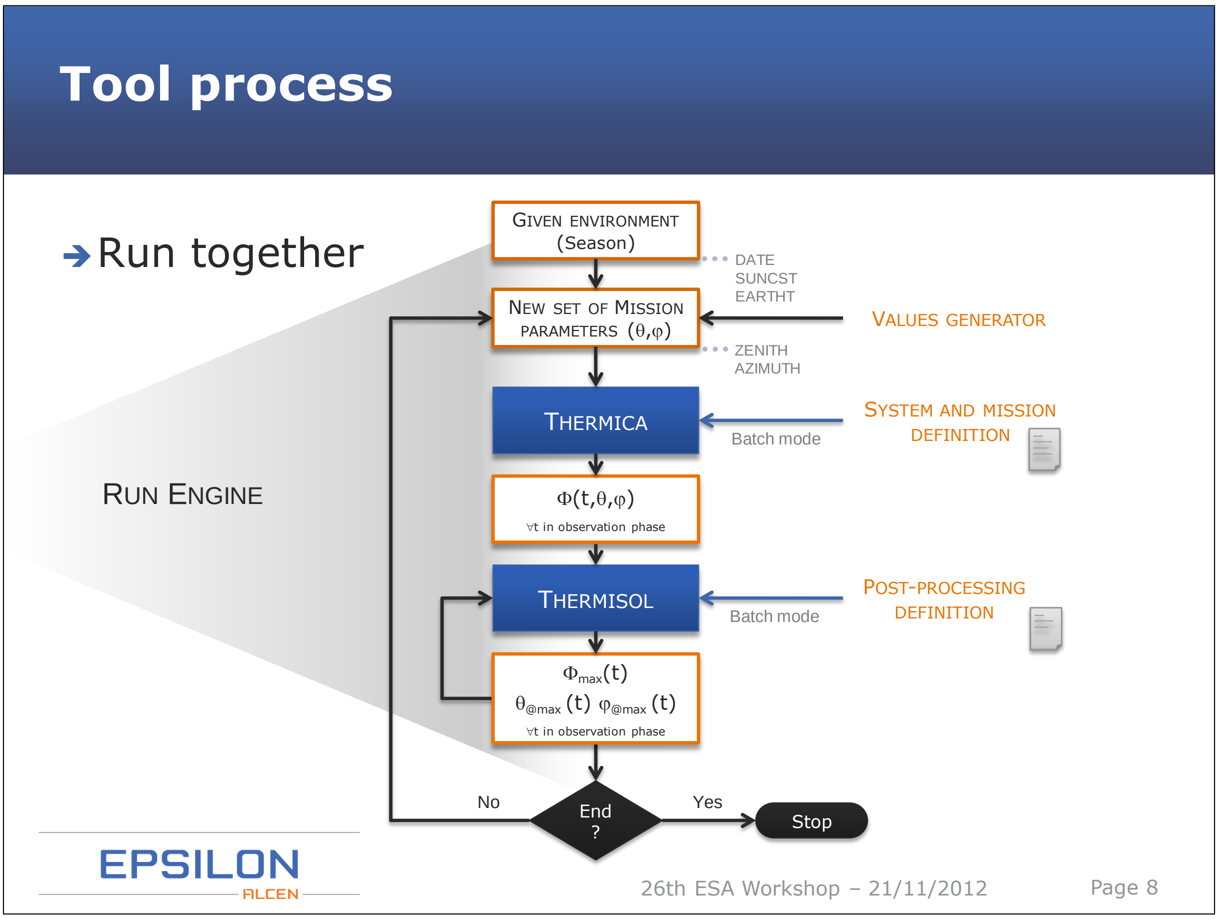
Tool process
Run together
RUN ENGINE
GIVEN ENVIRONMENT (Season)
DATE
SUNCST
EARTHT
NEW SET OF MISSION PARAMETERS (θ,φ)
VALUES GENERATOR
ZENITH
AZIMUTH
THERMICA
Batch mode
SYSTEM AND MISSION DEFINITION
Φ(t,θ,φ)
∀t in observation phase
THERMISOL
Batch mode
POST-PROCESSING DEFINITION
Φmax(t)
θ@max (t) φ@max (t)
∀t in observation phase
No
End ?
Yes
Stop
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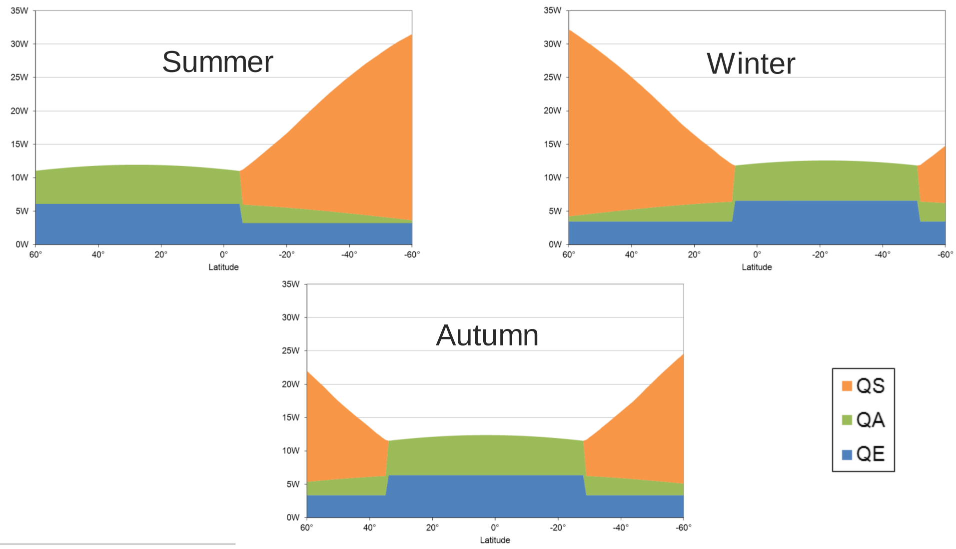
Results

→ Maximum absorbed heat flux profiles



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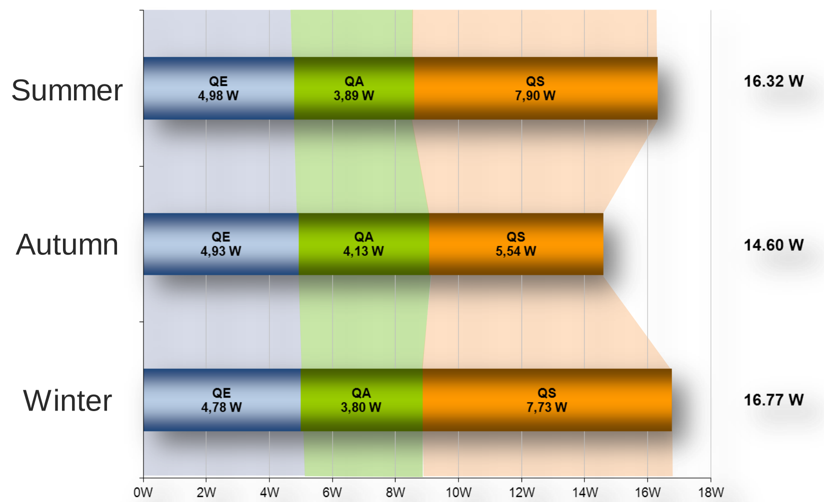
Results

→ Average max. absorbed heat flux



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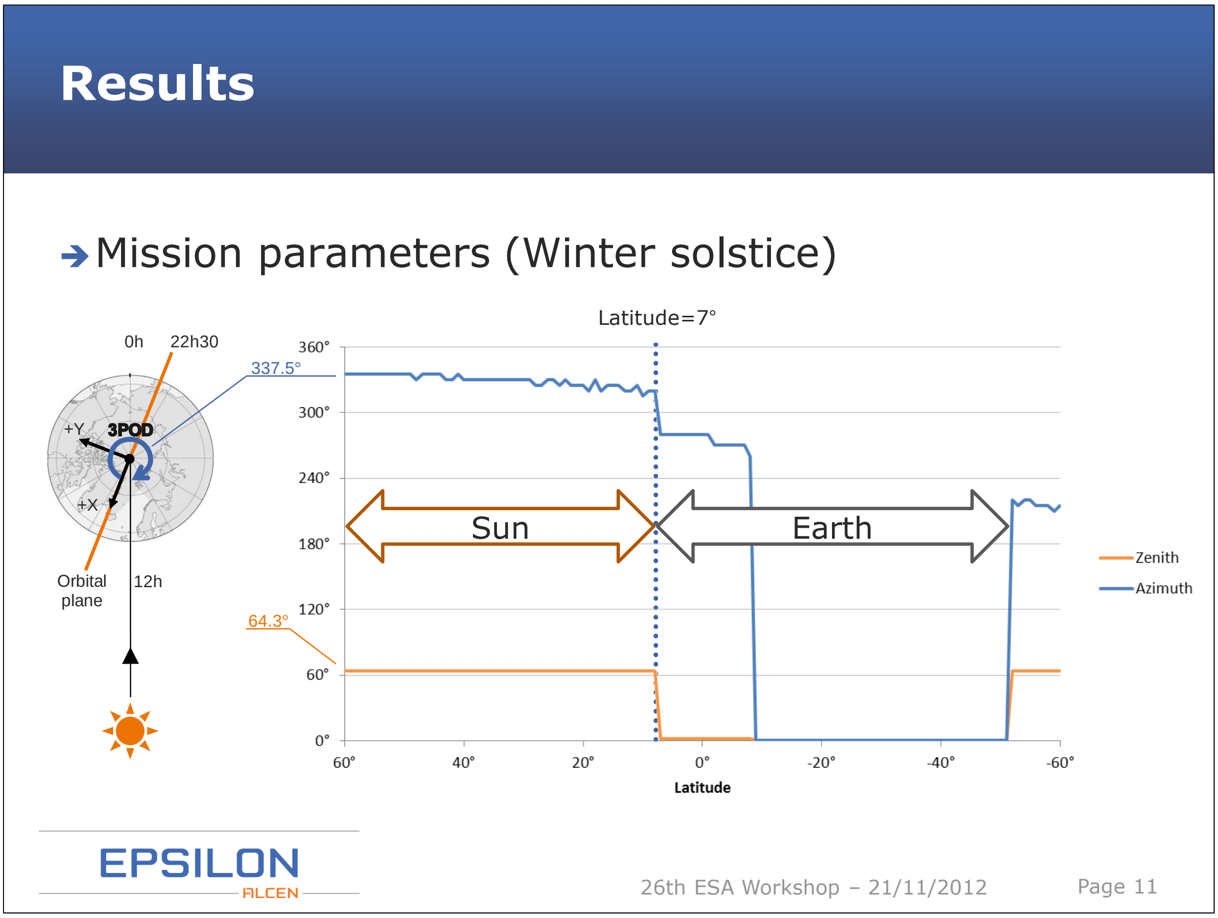

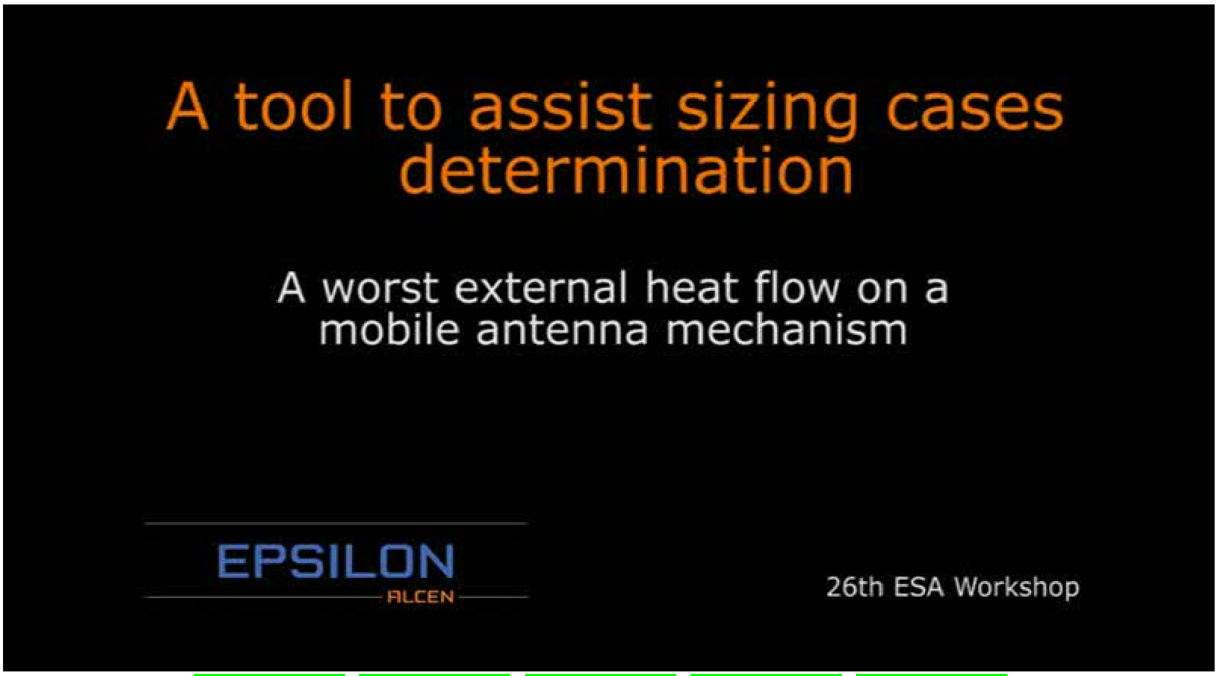

Slow Normal Fast Play/Pause Stop

Conclusion

→ Based on SYSTEMA applications, the solution:

- Gives accurate results: geometry, mission, heat fluxes
- Requires little programming:
  - Geometry & mission → Ensured by SYSTEMA
  - Heat flow computation → Ensured by THERMICA
  - Post-Processing → FORTRAN using THERMISOL
  - Run Engine → Few lines of script code, using SYSTEMA batch mode
- Easy to adapt and reuse

→ Improvement : Values generator

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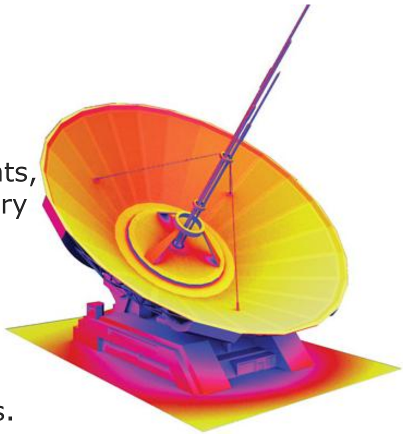
Corporate

EPSILON is the only private European research company that specializes in thermics. It works with major European players in aeronautics, the space industry, on-board systems, building, energy and health.

EPSILON thermal engineers' expertise and know-how and their ability to continuously break new ground enables them to master all the thermal phenomena required for designing and building basic components, subsystems and entire systems often working in very severe environments… and to keep them in good running order.

EPSILON is the operator and a member of the FAHRENHEIT, innovation platform, whose specific characteristic is to mutualize knowledge in thermics.



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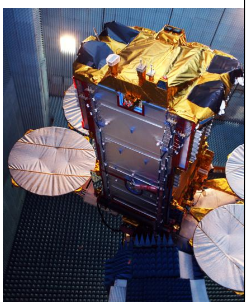
Activities

EPSILON proposes its expertise in the following domains:

- *thermal, electronic, hydraulic and mechanical modeling and simulation for components, housings or systems;*
- *system integration;*
- *predictive reliability;*
- *developing software;*
- *characterizing materials;*
- *performance tests.*

The EPSILON in-house laboratory includes:

- *means of measuring temperatures;*
- *small and medium scale testing resources, more particularly for quantifying parameters that are essential for thermal model inputs;*
- *measuring methods and resources for validating thermal models;*
- *specific methods and resources related to the activities and requirements in the programs carried out by the Research Department.*



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