



Dark & Quiet Skies

Clarification on requirement verification

ESA-TECQI-HO-2026-003111

29/09/2026

EUROPEAN SPACE AGENCY

ANALYSIS DEFINITION

Questions:

1. How should the analysis inputs be correctly set up?
2. Is the default User Network of ground stations sufficient?
3. Are there any specific criteria to be used for the spacecraft model, or is the model already prepared for re-entry analysis considered sufficient?



DRAMA Clinic: Brightness and trackability assessments

<https://indico.esa.int/event/645/contributions/11869/>

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1. Model outer satellite geometry (see answer to point 3)
2. Set orbits in **mission phases** (*, **)
Note: no long-term propagation of the orbits is performed, so multiple mission phases should be set if analysing a changing trajectory
3. Select reference locations (see answer to point 2)
4. Run analysis

(*) covering both operational (nominal attitude) and post-operational (e.g. tumbling attitude)

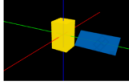
(**) run assessment for orbital configurations with duration > 1 year

SATELLITE MODEL

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Model outer satellite geometry (as you would for SARA analysis)

- **Note:** Calibrated materials are:
 - AA7075
 - MLJ
 - HC-AA7075, HC-CFRP-4ply, HC-CFRP-8ply: can be used, but all have the same properties as MLJ
 - SolarPanel-Mat
 - Copper
- Avoid non-calibrated materials for this analysis
- Distinction between optical and aerothermal material properties will be introduced in a future update

REF LOCATIONS

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Recommended Reference Locations

- Very Large Telescope (VLT) in Chile: 24°37'39"S 70°24'15"W, 2,636 m
- Mauna Kea Observatories (MKO) in Hawaii: 19°49'20"N 155°28'30"W, 4,205 m
- Roque de Los Muchachos (ORM) in Tenerife: 28°45'49"N 17°53'41"W, 2,396 m
- Yunnan Observatory in China: 25°02'N 102°47'E, 2,014 m
- Vainu Bappu Observatory in India: 12°34'29"N 78°49'14"E, 700 m
- Southern African Large Telescope (SALT) in South Africa: 32°22'33"S 20°48'39"E, 1,798 m

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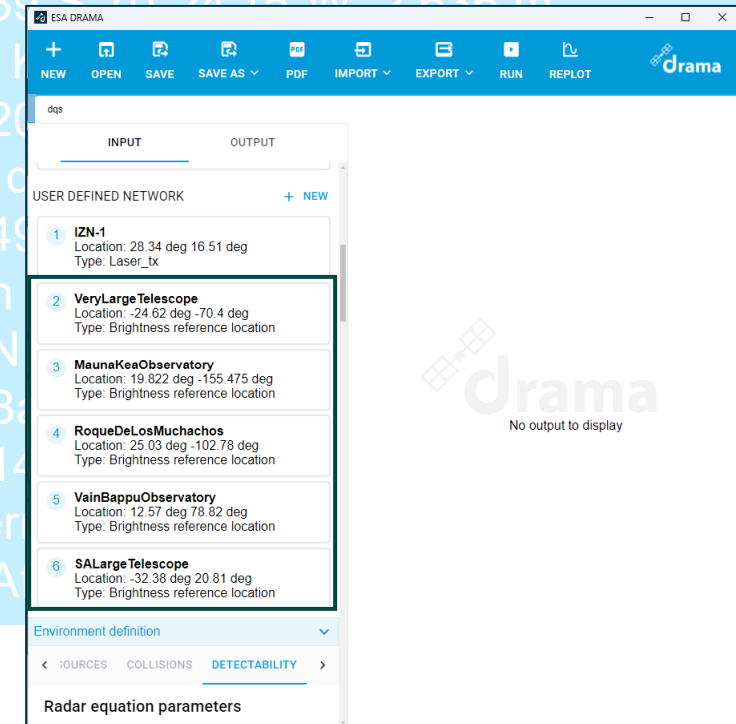
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Latest DRAMA version already include a list of recommended reference locations

Recommended Reference Locations

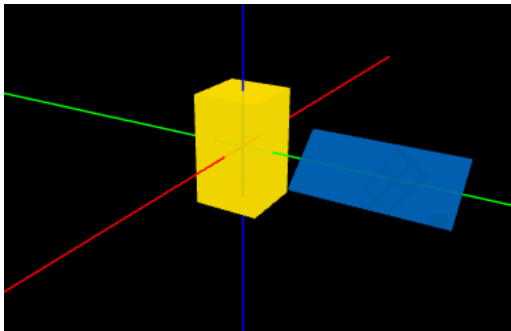
- Very Large Telescope (VLT) in Chile:
24°37'30"S 70°24'15"W 2 636 m
- Mauna Kea Observatory in Hawaii:
19°49'20"N 155°27'50"W 4 207 m
- Roque de los Muchachos in the Canary Islands:
28°45'49"N 15°18'00"W 2 824 m
- Yunnan Observing Station in China:
25°02'N 102°52'E 2 400 m
- Vainu Bivitts Observatory in Finland:
78°49'14"N 25°51'00"E 1 065 m
- Southern Astrophysical Research Telescope in South Africa:
30°55'S 25°51'E 2 141 m



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ANALYSIS OUTPUT

Questions:

1. Which elements of the output should be reported?
Which statistical quantities are most relevant?
2. Should reporting be limited to the standard outputs provided by DRAMA 4, or should it include additional post-processing?



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ANALYSIS OUTPUT

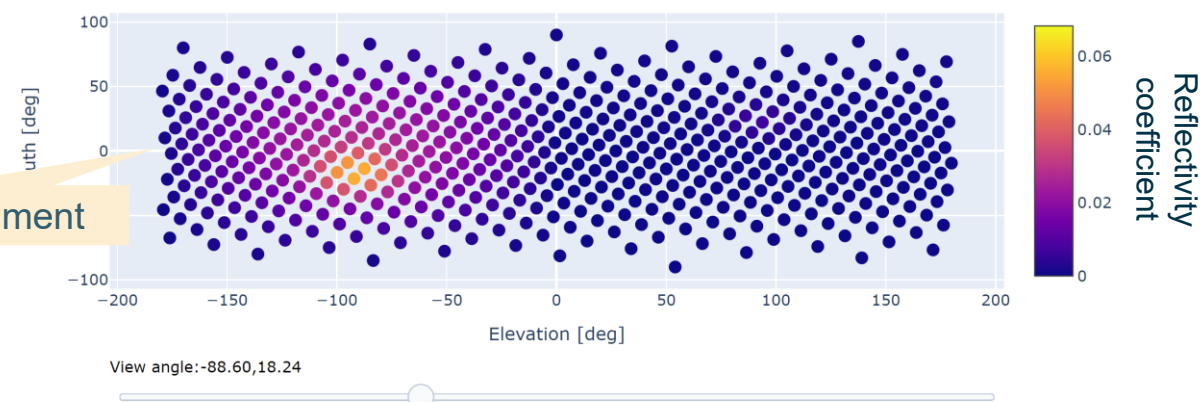
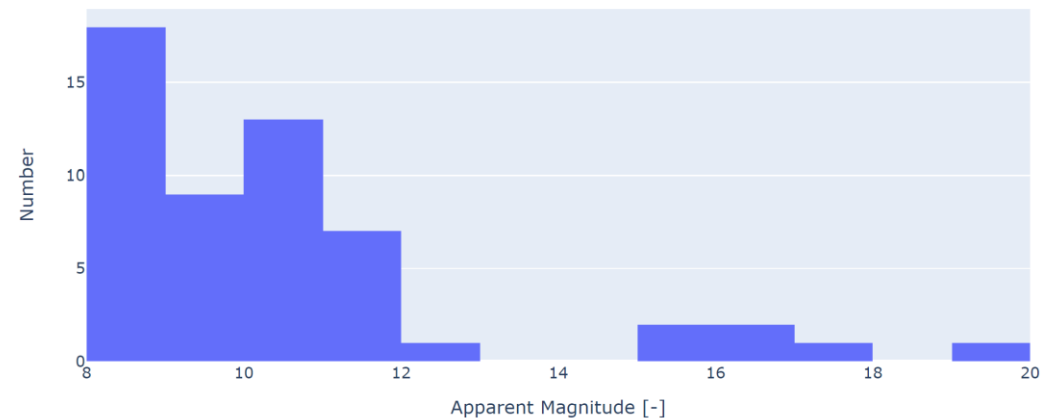
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Evaluate **histograms per location** and report on median and max (e.g. table with evaluated locations and corresponding median, max)

Evaluate whether specific conditions for **strong reflections/glints** are present

Additional post-processing can be generated from the full results at `output/dmf output.json`



ANALYSIS OUTPUT - REPORTING

What to include in **the Space Debris Mitigation Report**:

- Modelling assumptions
- Reference locations used for the analysis
- Max/median brightness for each reference location
- (Histogram plots, no need to include plots for all locations)
- Assessment of the brightness, assumptions, limitations and any other point of attention you may want to raise (e.g. conditions for glints/strong reflection)
- Description on the proposed approach to enable sharing of brightness data on request (e.g. is any brightness model made available to spacecraft operator?)
- For constellations only, descriptions of the design and operational mitigation measures to reduce the visual brightness of the spacecraft (only for constellations)

Company Logo

[MISSION NAME]: SPACE DEBRIS MITIGATION PLAN / REPORT

Disclaimer: This document serves as a template for both the Space Debris Mitigation Plan (SDMP) and the Space Debris Mitigation Report (SDMR). It is provided for reference purposes. When using this template, apply only the instructions relevant to the applicable document type (SDMP or SDMR if there is a distinction). The guidance follows the requirements outlined in Appendices A and B of ESSB-ST-U-007, Issue 1; refer to these appendices in case of doubt and for final verification.

ANALYSIS BY MISSION PHASE

Questions:

1. What level of detail is requested for the different phases of a project?
2. How should the analysis evolve across the different reviews (SRR, PDR, CDR)?



ESA's Space Debris Mitigation Requirements – training

https://esamultimedia.esa.int/docs/spacesafety/ESA-TECQI-HO-2024-002968_ESA_s-Space-Debris-Mitigation-Requirments-training.pdf



ESSB-HB-U-002, Issue 3 - ESA Space Debris Mitigation Compliance Verification Guidelines

https://esamultimedia.esa.int/docs/spacesafety/ESA_Space_Debris_Mitigation_Compliance_Verification_Guidelines.pdf

ANALYSIS BY MISSION PHASE



Early phases (0-B)

Assess brightness assuming a combination of diffuse and/or specular reflection for primitive shapes (e.g. sphere, cylinder, flat plate)

Diffusive and specular reflection for surfaces is described using physical or empirical models, e.g. ideal Lambertian, or empirical Phong reflection models

See Handbook (ESSB-HB-U-002, Issue 3) for example of an **analytical approach**



Later phases (B-C)

3D geometrical models describe the overall system using exposed subassemblies with different material properties.

Material properties are described with specular or diffuse reflection models or with more complex bi-directional reflectance distributions (BDRF).

Identify specific conditions that may cause glints / strong reflections.

DRAMA 4 can be used for this



After production (D onwards)

Regularly update the brightness estimate to reflect any design change or new available information (e.g. material properties)

If available (e.g. through testing), include measured BDRFs of materials, exposed subassemblies, or the whole system.

Note: Strictly speaking not needed before SRR (only plan); highly recommended for constellations and spacecraft with large reflective areas to start identifying potential criticalities