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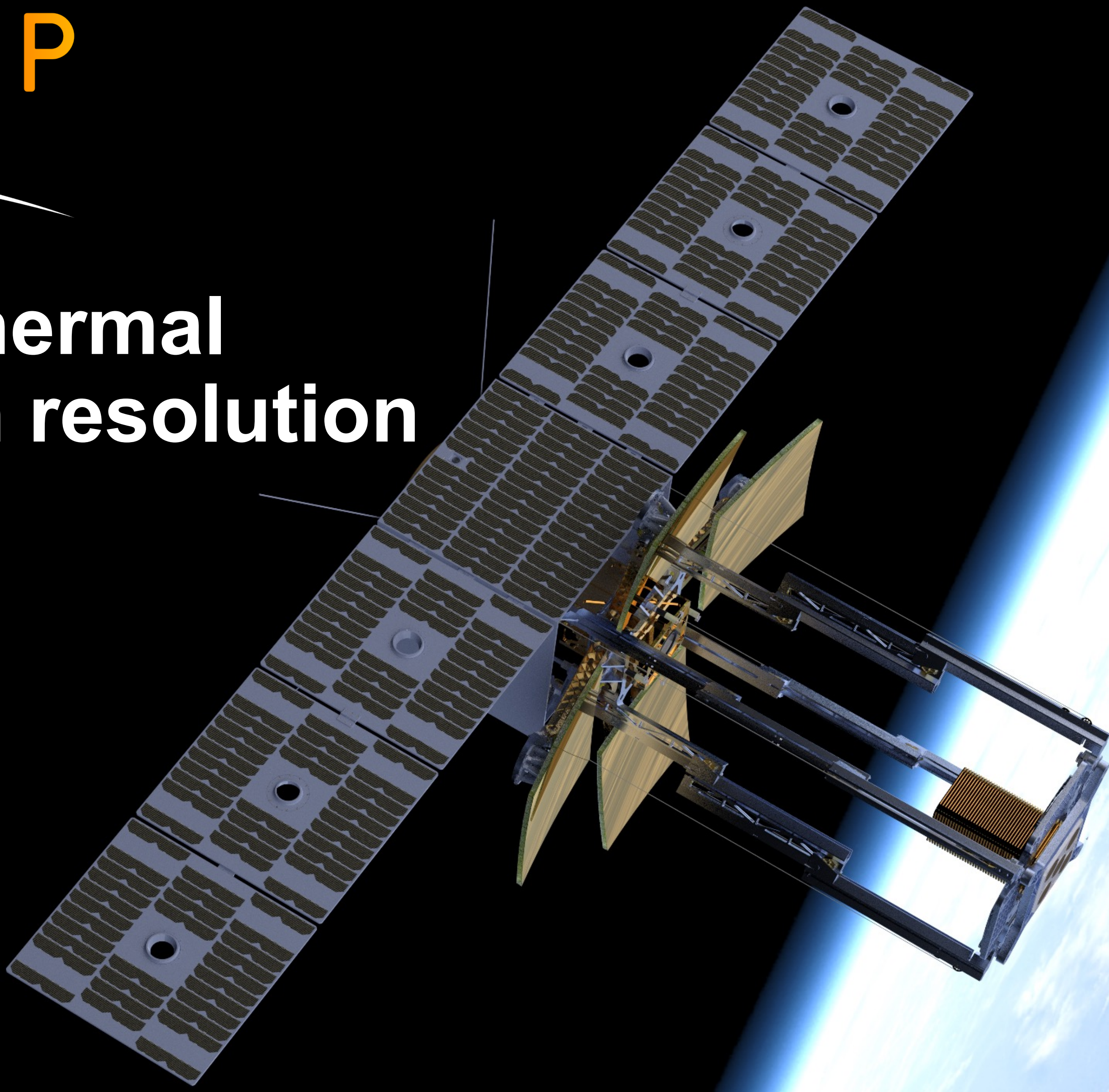
Unfolding, self-aligning thermal space telescopes for high resolution Earth Observations

International Workshop on High-Resolution Thermal EO

ESRIN Frascati 10th May



Prof Ian Parry, Dr George Hawker, Marco Gomez-Jenkins, Jon Jennings, Dr Sergio Gonzalez, Phil Desborough, Jo Donaghy

From left to right: Ian Parry (CSO, SuperSharp), George Hawker (CTO, Supersharp), Marco Gomez-Jenkins (CEO, SuperSharp), Juan Tomas Hernani (CEO, Satlantis) and Ignacio Mares (business development manager, Satlantis).

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SPACENEWS

Spain's Satlantis expands into thermal imagery with UK investment

April 27th 2023

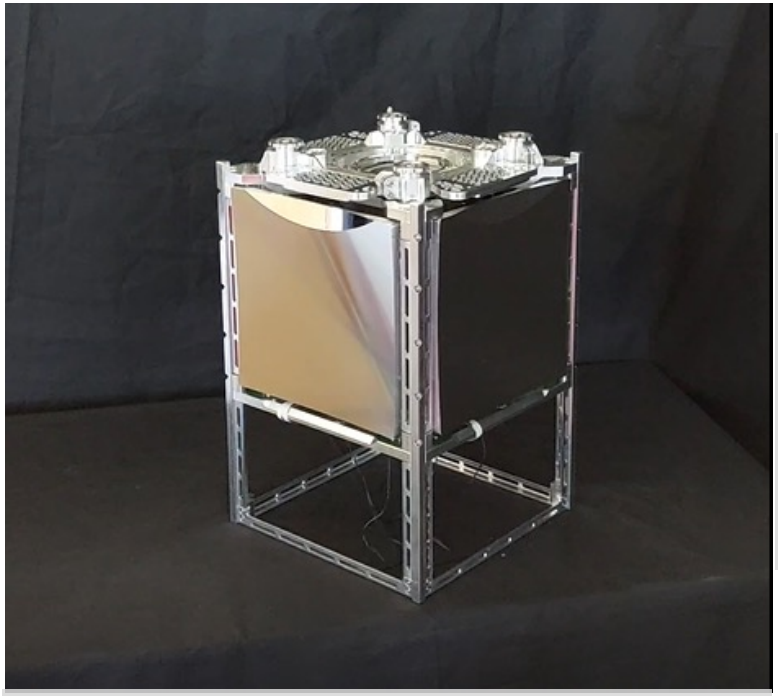
Satlantis' recently invested in our University of Cambridge Spin-out, SuperSharp. This will support our technology development, including an in-orbit demonstration to be launched in 2025.

High Res TIR (λ~10μm) v High Res optical (λ~ 0.5μm)

$$\textbf{smallest resovable detail (radians)} \sim \frac{\textbf{wavelength}}{\textbf{telescope width}}$$

- The optics have to be aligned to a fraction of a wavelength – this is 20x easier for the TIR because the wavelength is 20x bigger.
- On the other hand, for a fixed resolution the TIR telescope has to be 20x bigger.
- For the TIR, unfolding, self-aligning space telescopes are needed to give high resolution.
- For the TIR this is feasible: we have already demonstrated the feasibility of self-aligning in the TIR in the lab.

Our Innovative Unfolding Design



Smaller satellites

that unfold and self-align to become

large telescopes

4x better resolution
per unit cost

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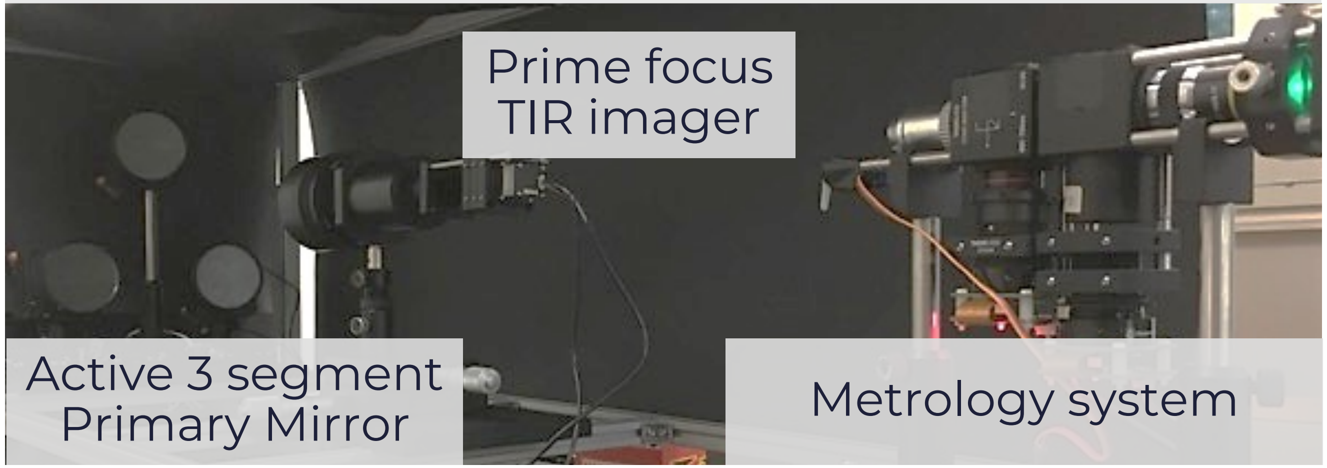
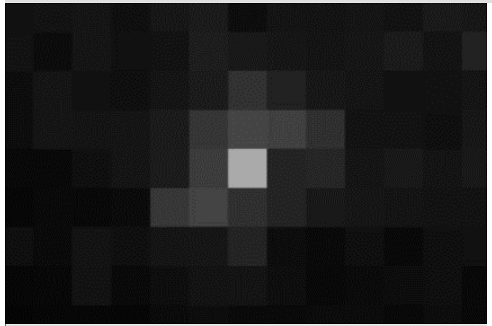
Self-Alignment

- Large deployable telescopes have many optical elements each with 3+ DOFs.
- Each DOF needs **sub-micron alignment** to obtain super sharp images.
- Self-alignment accurately aligns the telescope both after it unfolds and continuously on orbit as it is perturbed (thermal/slewing).
- By self-alignment (a metrology system within the telescope) the telescope autonomously measures and corrects its alignment via active optics.

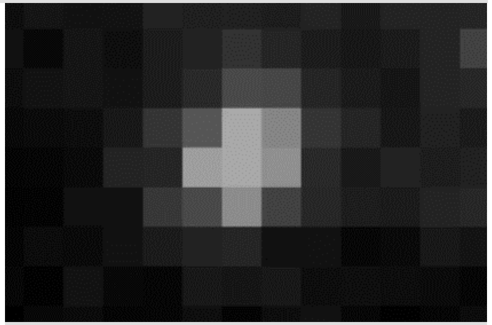
Proof-of-concept self-aligning telescope



Proof-of-concept telescope TIR PSFs



with sub μm self-alignment



without sub μm self-alignment

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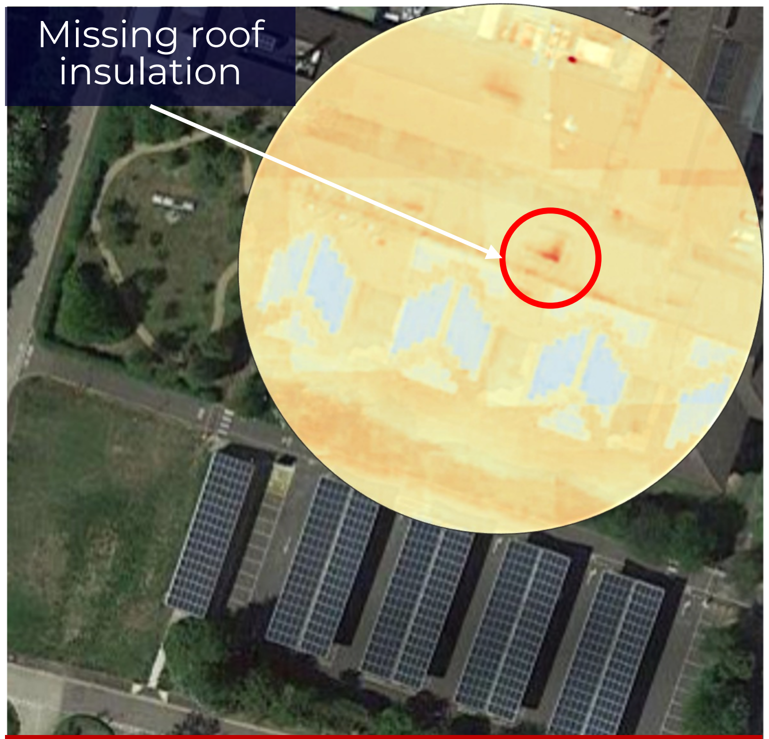
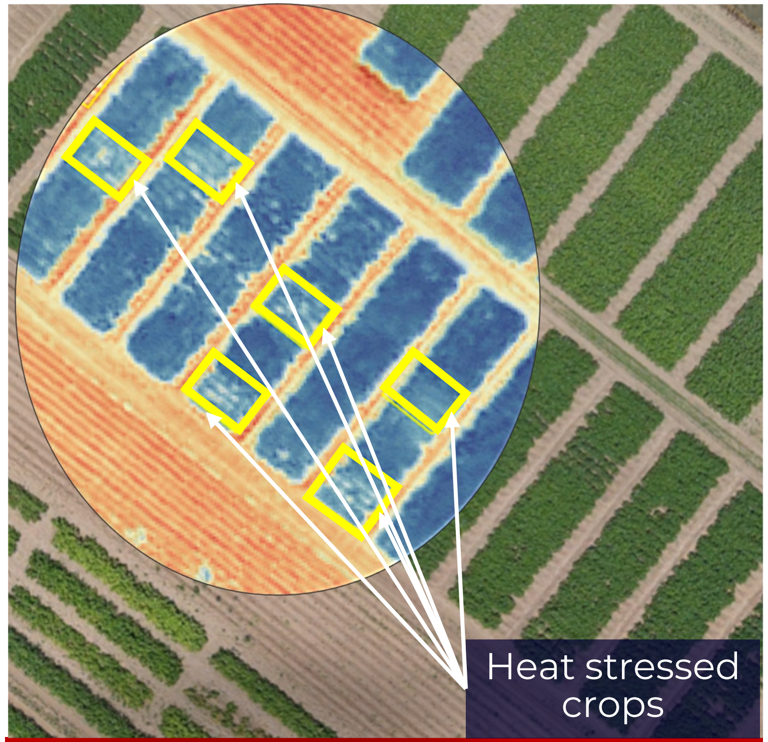
Pilot studies in High Resolution Thermal Imagery applications

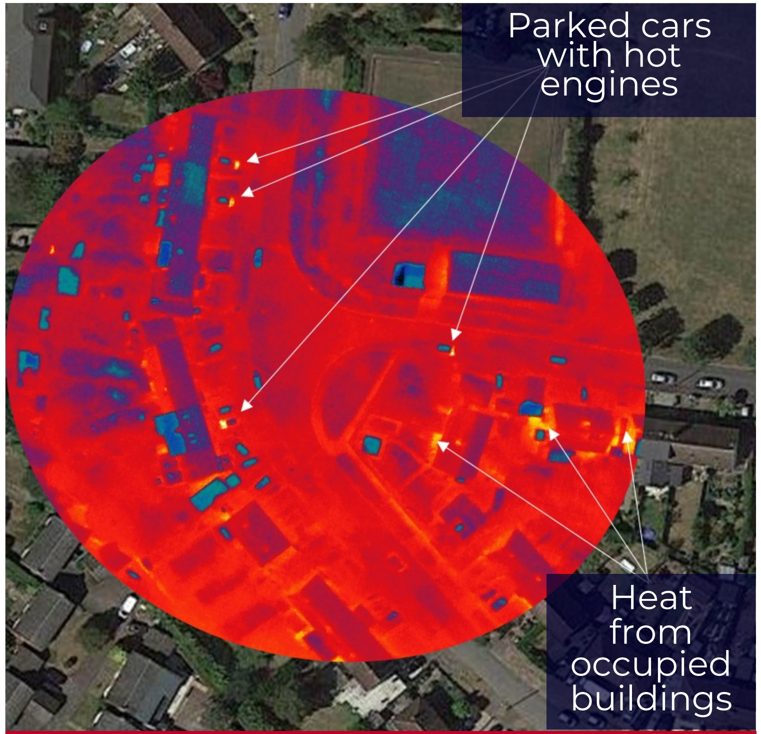
Conducted +15 drone surveys to emulate satellite images and define use cases with partners.



Urban energy monitoring to accelerate decarbonisation



Early detection of heat stress in crops to boost yields



Monitoring activity for Defence and Security

Partners

CAMBRIDGE ZERO — UNIVERSITY OF CAMBRIDGE

CAMBRIDGE CITY COUNCIL

British Antarctic Survey

NIAB

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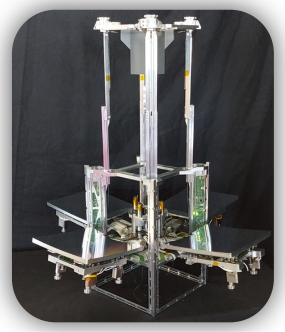
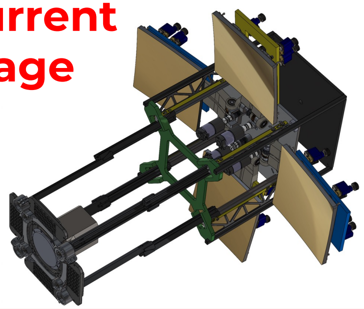
Hybrid Constellations

- LSTM, SBG and TRISHNA will have a revisit time of only a few days.
- SuperSharp telescopes are best used for targeted observations.
- In combination, LSTM, SBG and TRISHNA (for discovery) and SuperSharp (for targeted follow-up) will be very powerful.
- LSTM, SBG and TRISHNA will also provide valuable absolute temperature calibration for SuperSharp data.





Current Stage

Phase 1: Prototyping

Q3 2020 – Q3 2022

Activities
Developed prototypes of the SUPER-SHARP telescope

Milestone (Delivery Date)
Telescope Prototypes (Sep 2022)

Phase 2: Technology Dev

Q4 2022 – Q4 2023

Activities
Develop a space-rated version of the SUPER-SHARP telescope

Milestone (Delivery Date)
Space-rated Telescope (Dec 2023)

Phase 3: In-Orbit Demo

Q3 2023 – Q1 2025

Activities
Integrate SUPER-SHARP telescope in third-party satellite and test in space

Milestone (Delivery Date)
Telescope with flight heritage (Q1 2025)

Phase 4: Hardware Sales

Q1 2025 – Q4 2029

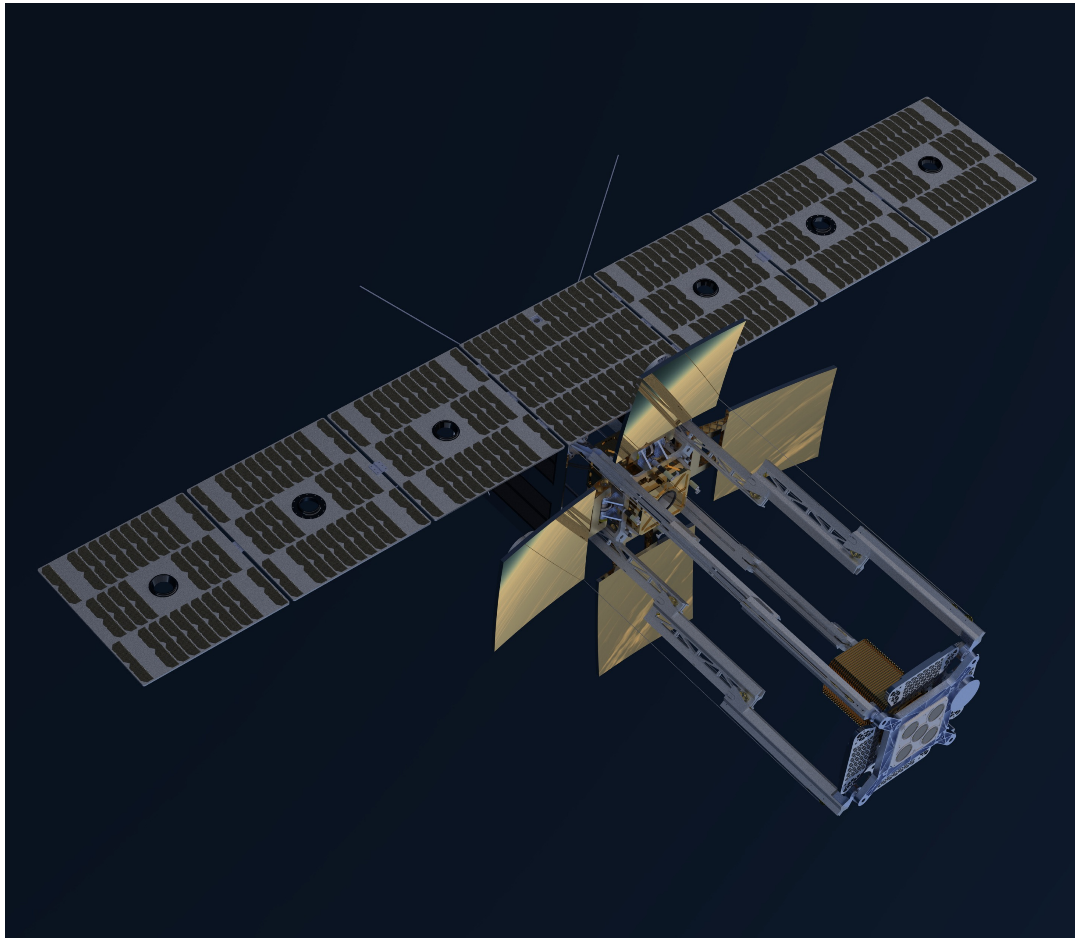
Activities
Manufacture and sell telescopes and develop larger telescopes that **capture TIR/optical satellite images.**

16U TIR Telescope (IOD)

Specification	Value
Payload Volume	10U
Telescope aperture	60 cm
Launch configuration	16U CubeSat
TIR band	8 – 13 microns
GRD (from LEO)	6 m per pixel
TIR Sensor	Uncooled MBA
TIR Sensor format	640 x 512 pixels
TIR FOV (from LEO)	3.8 km x 3.1 km

SmallSat TIR Telescope

Specification	Value
Telescope aperture	120 cm
Launch configuration	SmallSat platform
bands	TIR and MWIR
TIR GRD (from LEO)	3 m per pixel
MWIR GRD (from LEO)	1.5 m per pixel
TIR Sensor format	1920 x 1200 pixels
TIR FOV (from LEO)	5.8 km x 3.6 km



SuperSharp telescopes - comparison table

Model	pixels	Aperture (cm)	FOV (km)	GRD from LEO	
				MWIR	LWIR
16U IOD	640x512	60	3.8x3.1	-	6m
SmallSat	1920x1200	120	5.8x3.6	1.5m	3m
4m Sat		1200		15cm	30cm

GRD = Ground Resolution Distance (native)
For the 4m Satellite, the operational telescope is wider than the rocket fairing
A telescope that does not unfold has GRD values approximately 4x larger (60cm and 1.2m)
The 4m Sat example is simply to show the potential for a launch vehicle similar to an Ariane 6 with a ~4m diameter fairing

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Thank you

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