QUARTUS ENGINEERING

2021 EPIC Online Technology Meeting on Next Steps Fast Growing Freeform Optics Applications

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WHO IS QUARTUS?

- Engineering Solutions Provider
  - Founded in 1997
- 100+ Degreed Engineers
- Key Focus Areas:
  - Mechanical Engineering Analysis
  - Precision Engineered Optical Systems
  - Industrial Metrology
  - Automation, Controls, & Robotics
- Located in United States
  - HQ: San Diego, California
  - Eastern Region Office: Herndon, Virginia

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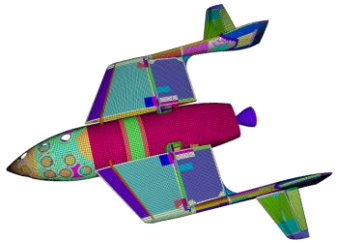
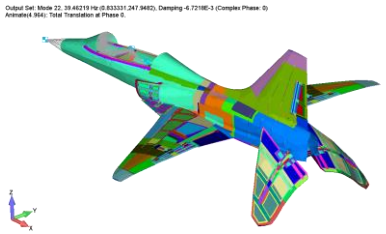
QUARTUS' SIMULATION DRIVEN ENGINEERING

Structural & Aeroelastic Analysis

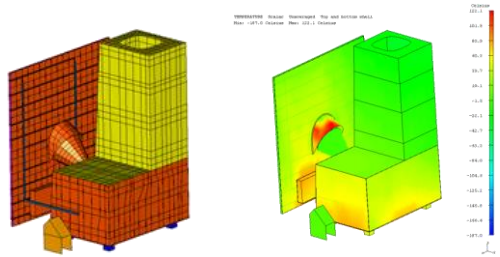
Flutter Analysis

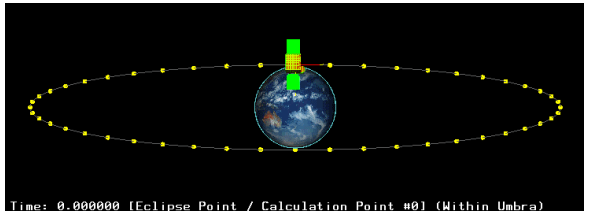




On-orbit Thermal Analysis

GEO IR Imaging System

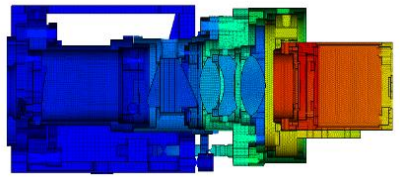


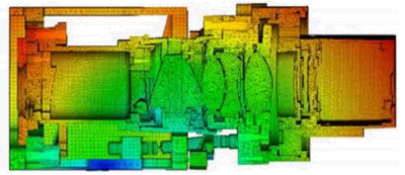


Structural Thermal and Optical Performance (STOP) Analysis

ARCSTONE: Hyperspectral Spectrometer CubeSat Instrument

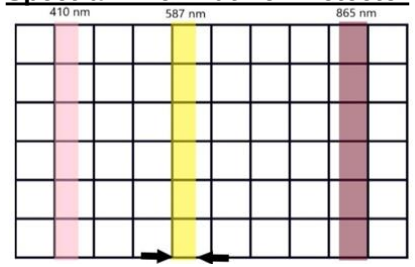
Thermal Model → **Structural Model**

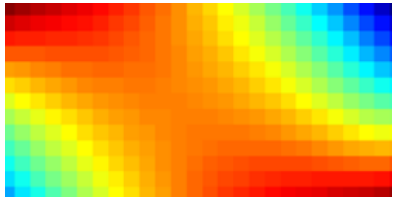




Optical Performance Metrics ← **Rigid Body Motion / Surface Figure Errors**

Spectral Line Width on Detector





- How can these tools be leveraged for instrument development to do more science for less money?

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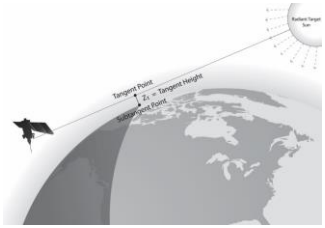
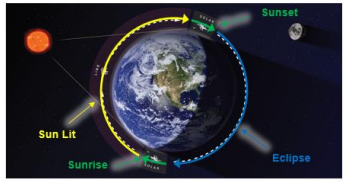
Quartus Instrument Development Capabilities

We meet you where you need us...

- Early engagement
- SOW & project planning

Requirement Development & Flow Down

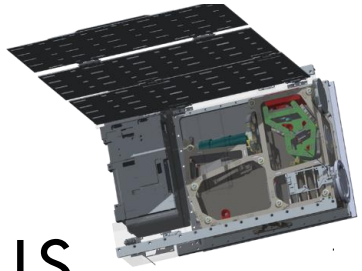




- Clients provide system/sub-system requirements

Design

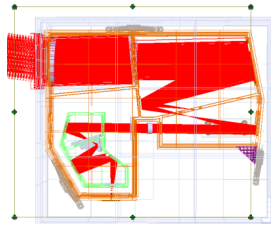
- Provide completed design to client

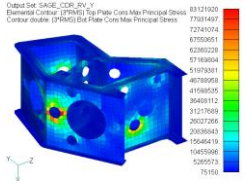


- Clients provide designs to be analyzed

Analysis

- Deliver analysis reports
- Deliver complete engineered system design documents

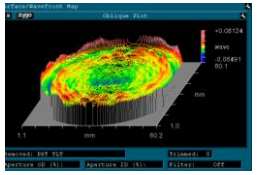




- Clients have sourcing need for materials and hardware

Sourcing, Fabrication & Procurement

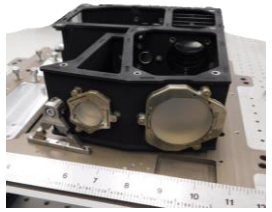
- Deliver fabricated and sourced components



- Receive parts for assembly, metrology, and testing

Assembly Integration & Test

- Deliver complete built and tested system(s) & hardware

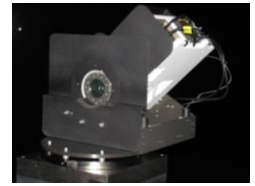


LRIP & Higher Volume Production

- Deliver higher volumes
- Facilitate transition to contract manufacturer

Post Delivery Support

- System commissioning
- On going upgrades and servicing
- Software Support



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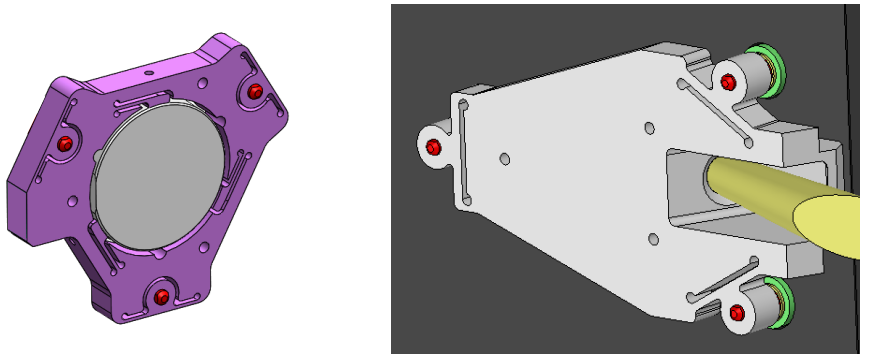
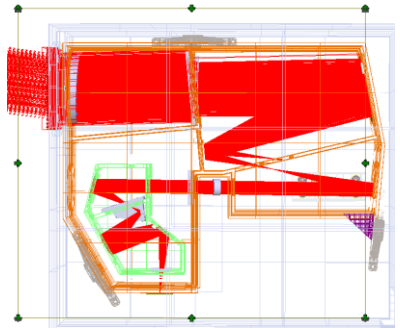
Leveraging Previous Development

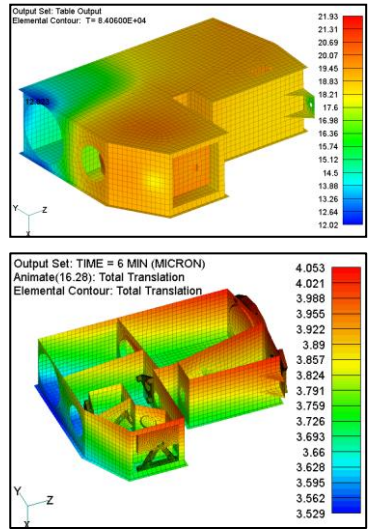
- Significant development of mechanical components and system level design and analysis tools
  - Quartus' NASA SBIR is focusing on the validation of STOP Analysis beyond one programs use case
- Component level designs can be leveraged with relative ease for new layouts and component sizes
  - Current design has notional ability to position optics within 5 µm of position in 6 DOF and maintain < 5 µm positional stability over operational temperatures
- Leverage validated Optical and Mechanical Analysis tools
  - Development of these tools is costly, validating with correlation to test data can reduce cost for future missions



Example of a Mirror Mount Design (left) & Optical Stop (right)



Stray Light Models



Finite Element Models
(top) Thermal & (bottom) thermo elastic

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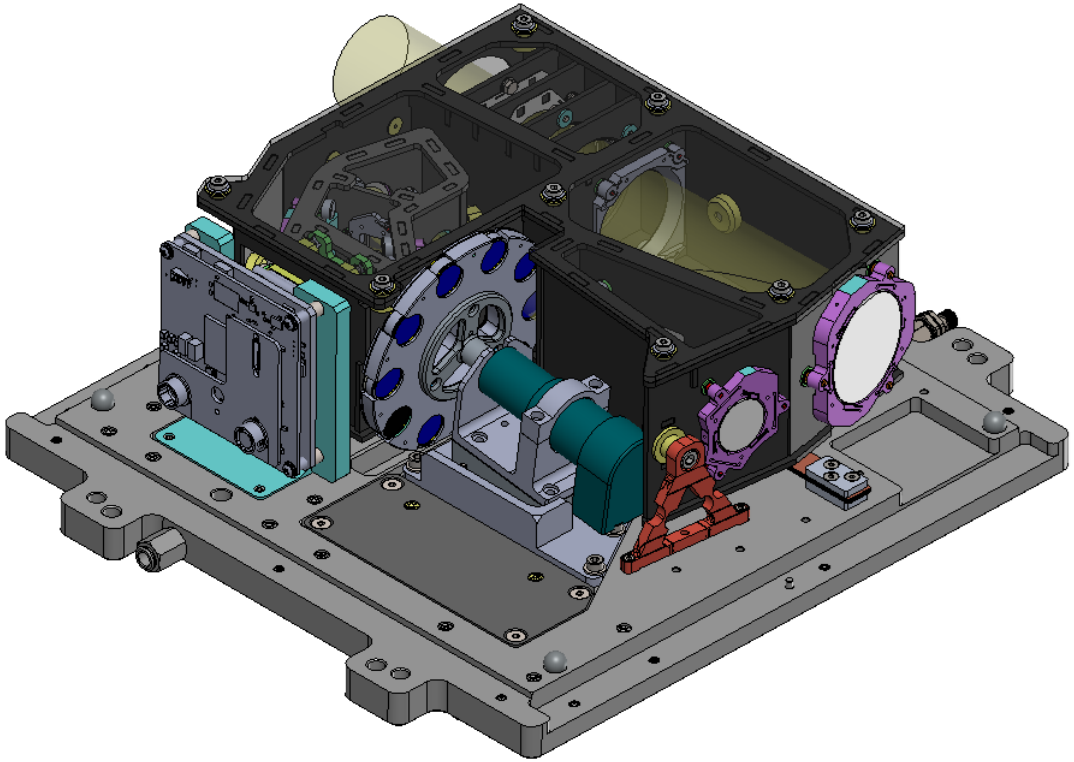
Future Reduced-Cost Missions: Simple Optical Variants

- Multiple missions can leverage the tools developed for this instrument:
  - Change the wavelength of interest
    - New Detector material
    - Alternate range of filters
    - Remove filters to have broadband imaging telescope
  - Change the detector format for new science
    - Pixel density, aspect ratio, etc..
  - Change front and/or back-end modules
  - Aperture
    - Minor test validation could extrapolate the system design towards a larger format
  - Field of view

SAGE IV Ground Demonstration Telescope on Surrogate Chassis



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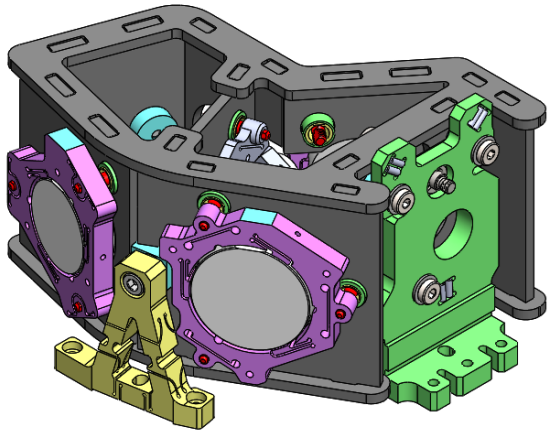
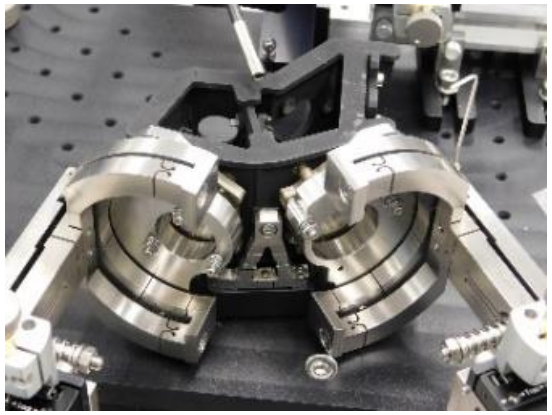
Future Reduced-Cost Missions: Freeform Enabled Possibilities

- Freeform fabrication techniques allow for more complex systems to leverage the ability to position and measure component position in free space
  - Reduction of complexity
    - i.e. reduce complex stray light suppression, use the back end as a proven 4° FOV TMA, etc..
  - Leverage mounts and analyses for alternate optical components
    - i.e. include refractive elements, gratings, etc..
- Possible applications include:
  - Wide FOV systems with optics corrected with freeform deterministic shaping and polishing (i.e. LEO line scanner)
  - Hyperspectral imaging systems
  - Broadband radiometers

Backend Reimager Module



6 DOF Tooling



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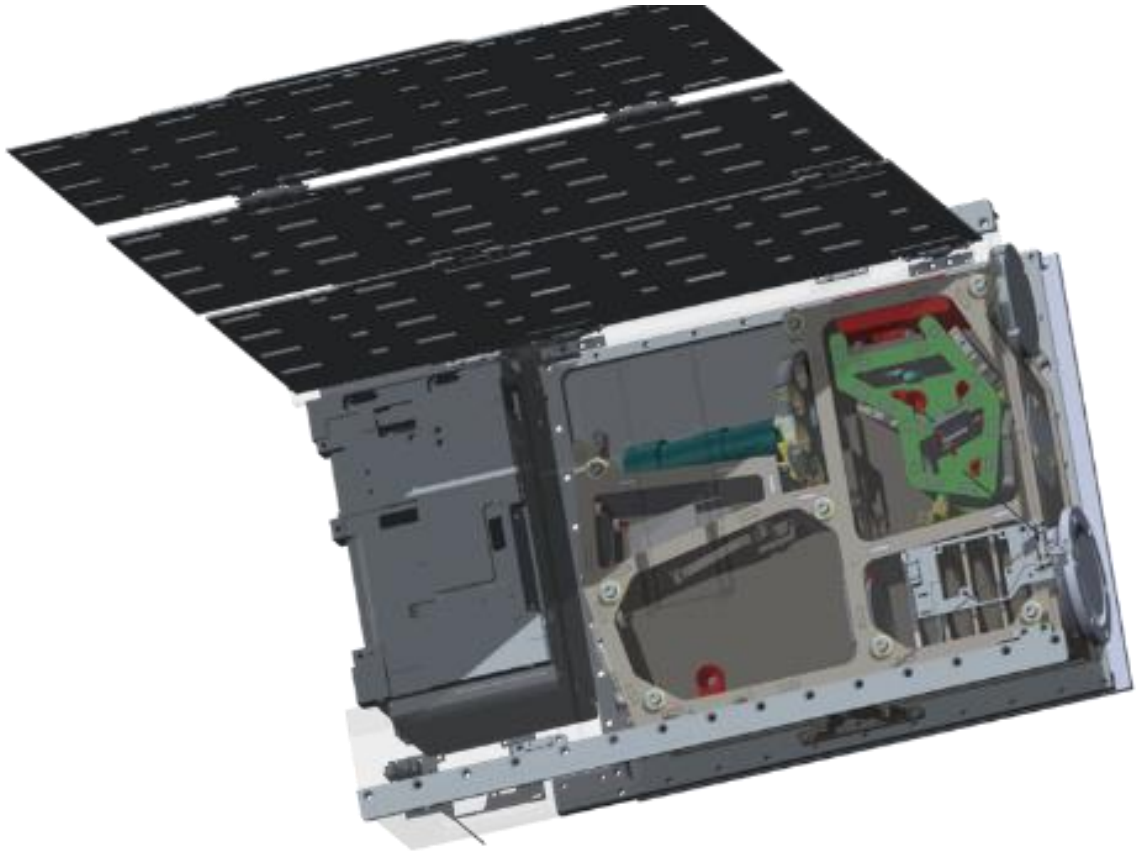
Accelerating the Path from Concept to Flight

- Can Quartus' approach here help your program accelerate through technical readiness levels?

- We would love to engage early in the instrument development process to see how our simulation driven engineering approach can leverage freeform fabrication techniques to accelerate your path from concept to flight



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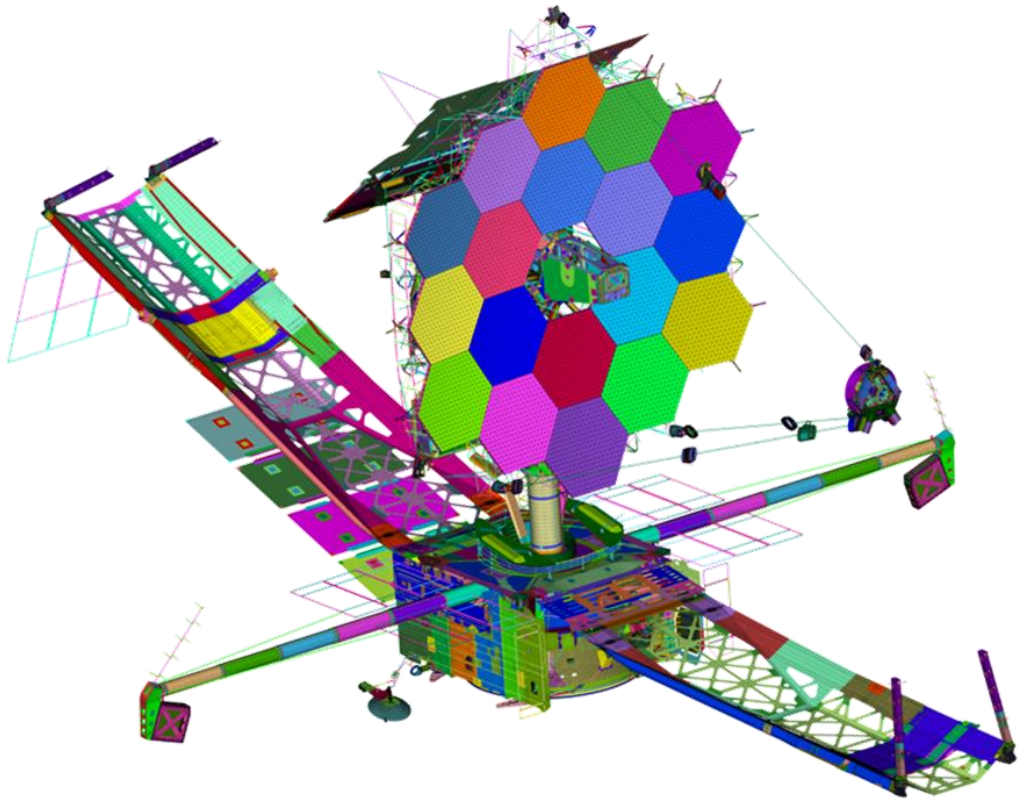
ACKNOWLEDGEMENTS



“Deployed” on-orbit structural dynamics Model of JWST
Quartus supported James Webb Space Telescope from 2005-2021

Special thanks to:

- NASA SBIR Office for continuing to fund the work shown here
- SAGE IV Pathfinder co-principal investigators:
  - Robert Damadeo
  - Charles Hill

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Thank you and please reach out:

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