

Mass Change Designated Observable Study identifies high value observing systems for implementation within the next decade

The NASA Mass Change Designated Observable Study: Progress and Future Plans

The Mass Change Designated Observable Study Team^{1,2,3,4,5}

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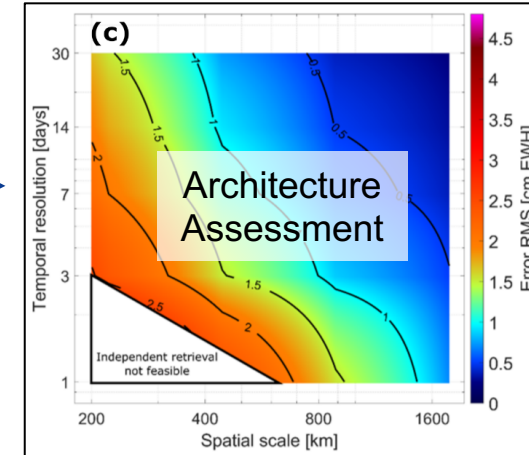
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Decadal Survey

Traceability to DS

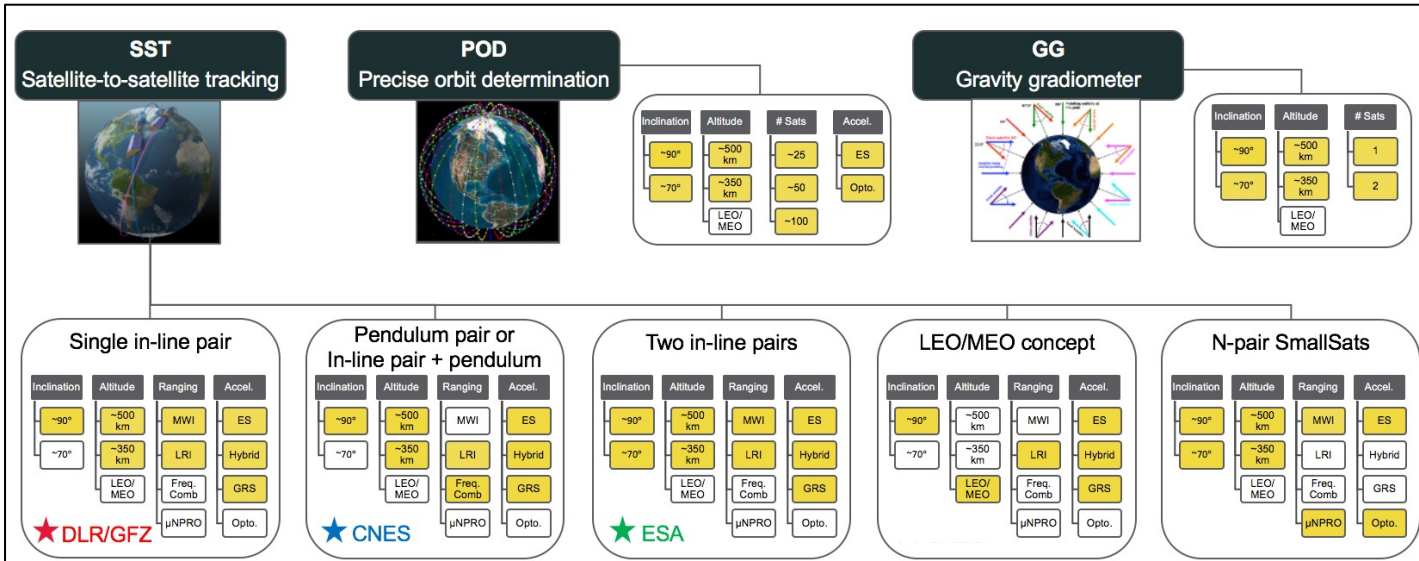
Science and Applications Traceability Matrix Measurement Parameters

Climate Variability and Change		Global Hydrological Cycles and Water Resources		Earth Surface and Interior	
1 C-1a: H (300 km) ² ; 15 mm Monthly	1 C-1c: H (300 km) ² ; 40 mm Monthly	1 H-1a: H (1000 km) ² ; 10 mm Monthly	1 S-1b: H (300 km) ² ; 25 mm Monthly	.67 S-4a: M (300 km) ² ; 25 mm Monthly	
1 C-1b: H (300 km) ² ; 15 mm Monthly	.11 C-7d: L (300 km) ² ; 15 mm; Monthly	1 H-2c: H (450 km) ² ; 25 mm Monthly	1 S-3a: H (300 km) ² ; 25 mm Monthly	.07 S-5a: VL (20,000 km) ² ; 1 mm Monthly	
.67 C-1d: H (300 km) ² ; 15 mm Monthly	.11 C-7e: L (300 km) ² ; 15 mm; Monthly	.33 H-3b: H (450 km) ² ; 25 mm; Monthly	.22 H-4c: M (450 km) ² ; 25 mm; Monthly	.22 S-6b: M (450 km) ² ; 25 mm; Monthly	



Science Value

Architecture and Technology Tradespace



Value Framework Process

- Cost
- Schedule
- Risk
- Partnerships

Identification of High Value MC Observing Systems

Satellite-Satellite-Tracking (SST) is the recommended architecture family for implementation as the next observing system

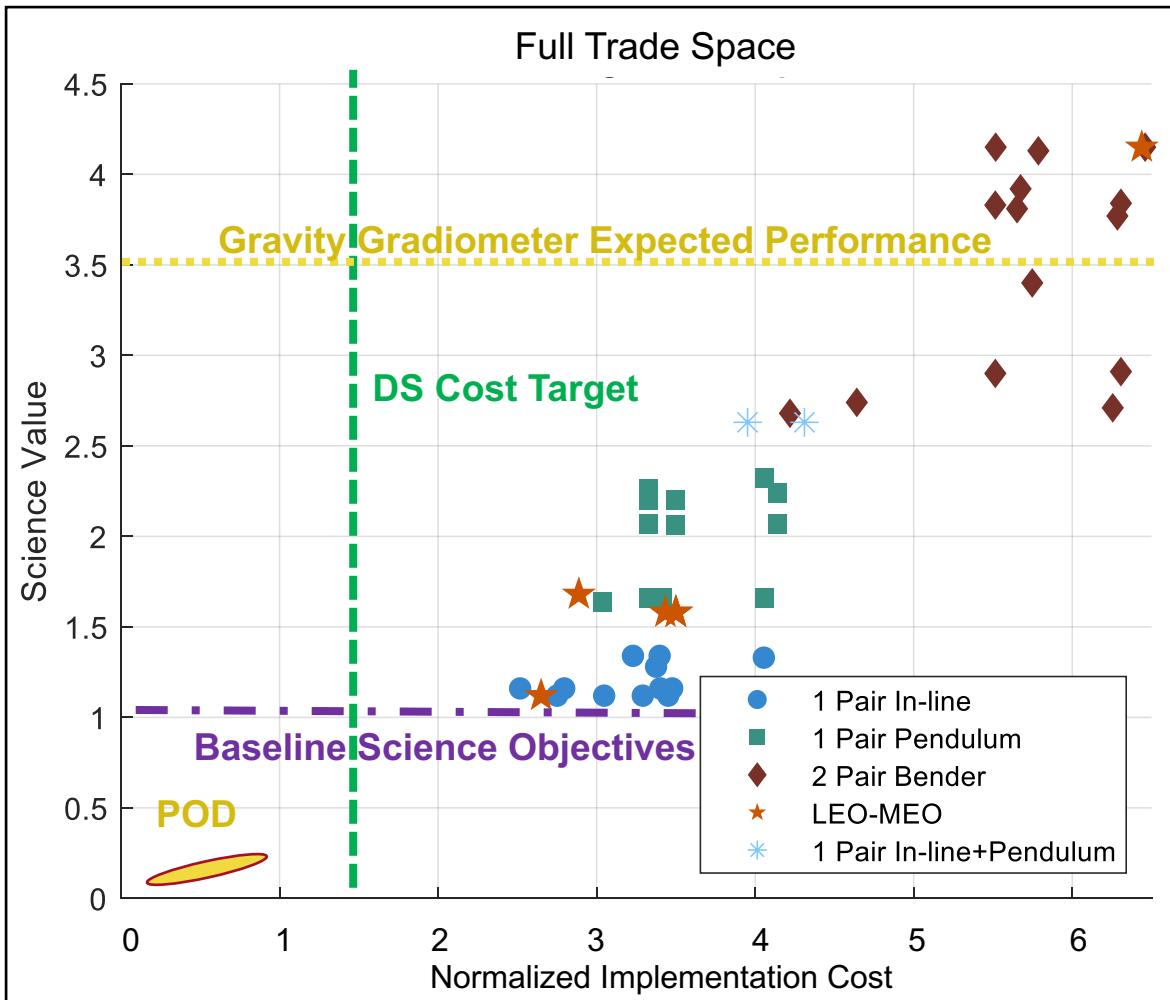
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Architectures Pruned

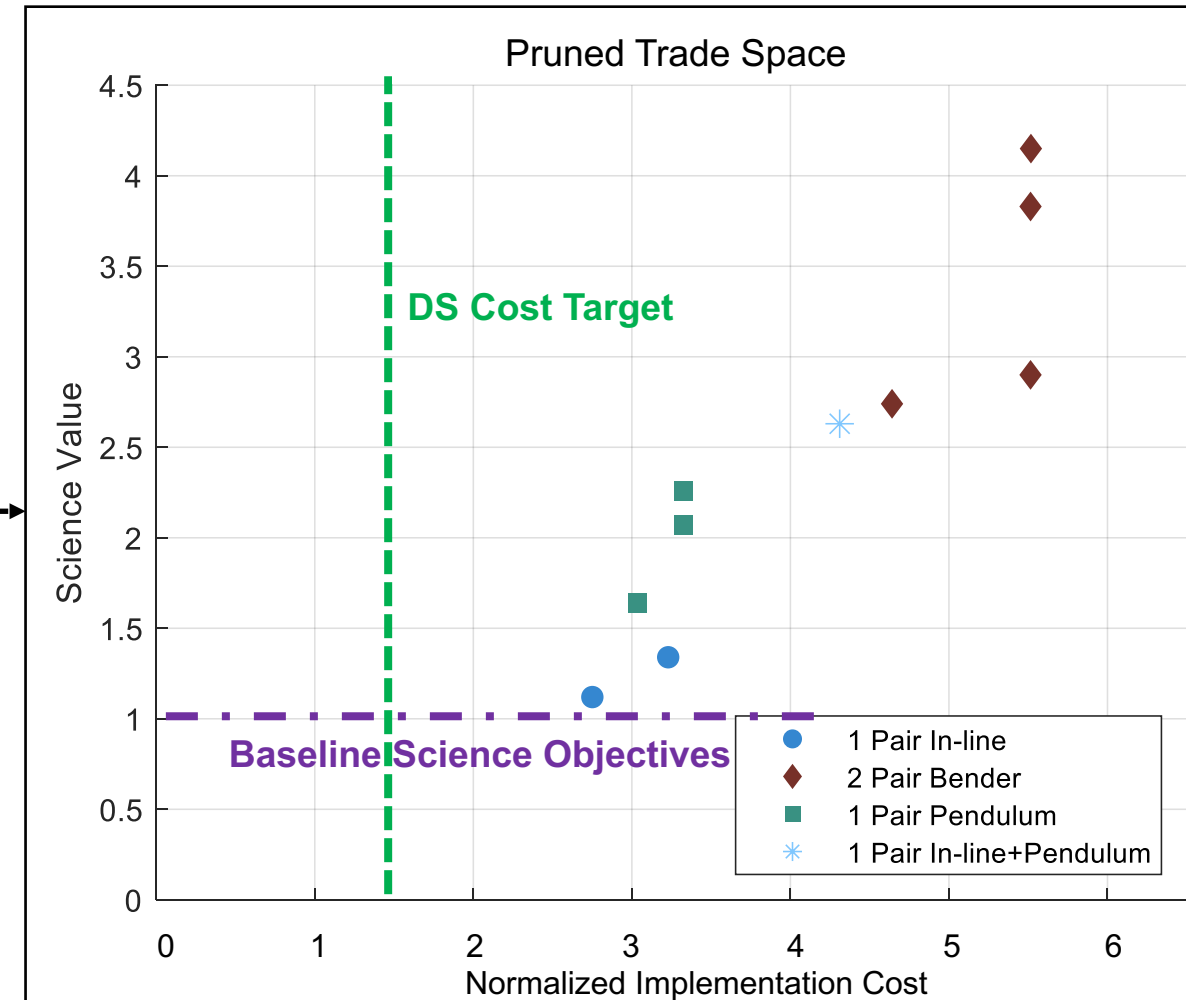
- POD:** poor science value
- GG:** high science value; low technology readiness
- SST LEO-MEO:** technical challenges; relative low science value
- SST Smallsats:** not cost-effective

Technologies Pruned

- Ranging System:** LRI preferred over MWI due to higher performance and successful demonstration on GRACE-FO
- Accelerometer:** Electrostatic preferred due to technology readiness level; alternate technologies still considered as tech demo options



Pruning



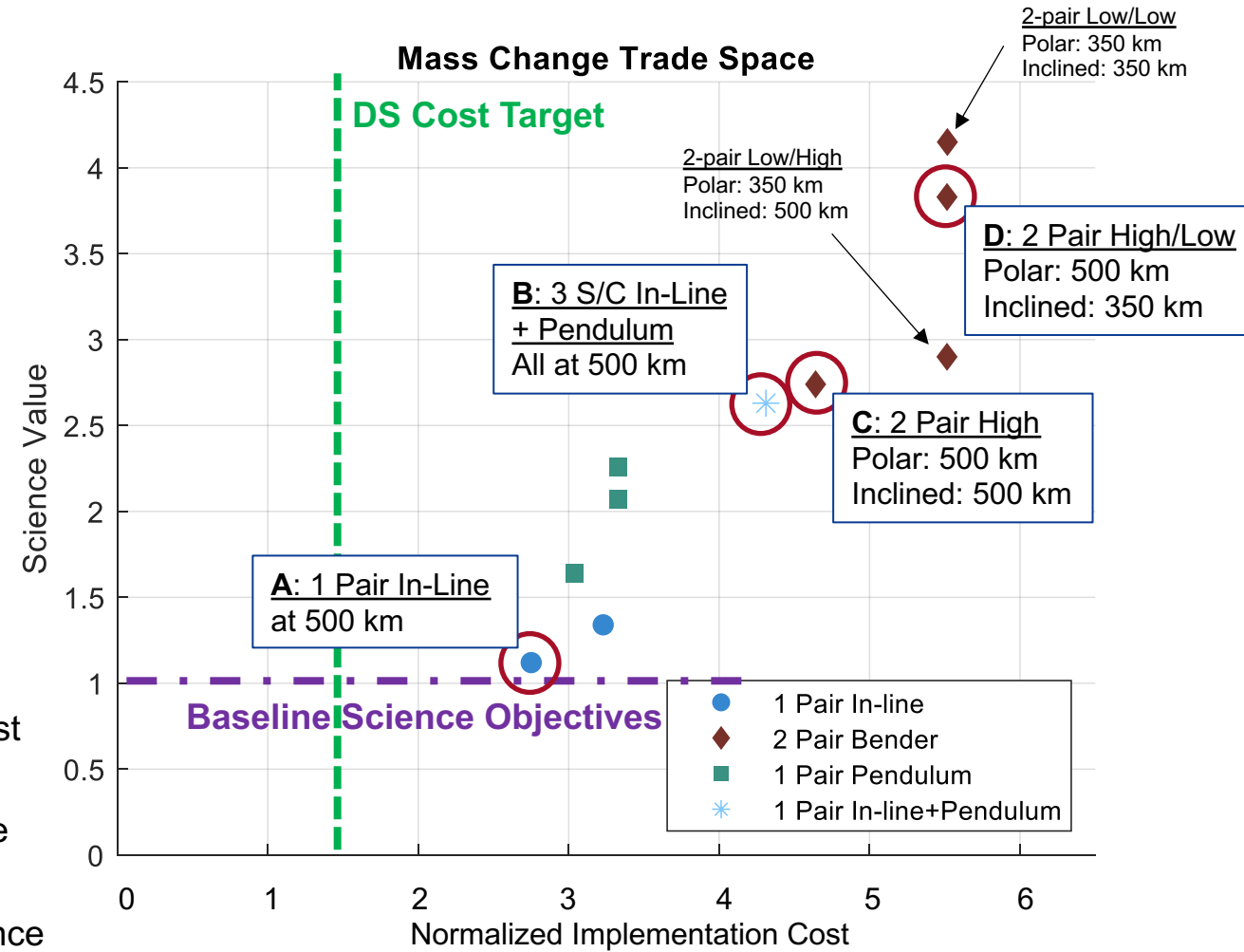
Identification of architectures with highest value: improved science return while enabling continuity

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- The Decadal Survey stressed the importance of continuity in mass change measurements
 - GRACE-FO lifetime is more likely to be limited by system reliability than orbit lifetime
 - Schedule estimates indicate that the **single in-line pair** is likely to have the earliest launch readiness date (LRD) and is **most likely to enable continuity with GRACE-FO**

	Estimated 50th Percentile LRD	Expected GRACE-FO Reliability at LRD
Single In-Line (no drag comp.)	Jun 2028	50%
Pendulum (no drag comp.)	Jul 2029	40%
Bender (w/ drag comp.)	Mar 2030	35%

- Architectures (A, B, C, D) are identified which have at least one component that includes a single in-line polar pair to allow the highest likelihood of continuity with GRACE-FO
 - Implementation of B, C, D may be staggered; Element A can be launched first and remaining elements launched later
- Architecture D (2-pair high/low) provides only slightly degraded science value relative to highest performing architecture (2-pair low/low)



The Path Forward

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- MC is in the process of transitioning to Pre-Phase A which refines the mission concept and allows further in-depth study of identified high-value architecture variants
- Awaiting guidance from NASA HQ on scope of Pre-Phase A activities
- Ongoing International Formulation Activities and Collaborations with MC Study Team:
 - ESA NGGM Concept
 - DLR/GFZ GRACE-I Concept
 - CNES MARVEL Concept

Questions/Comments:

<https://science.nasa.gov/earth-science/decadal-mc>

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