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

Decadal Survey

Science and Applications Traceability Matrix Measurement Parameters

Architecture and Technology Tradespace

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

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

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**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.

### 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

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**Full Trade Space**

**Gravity Gradiometer Expected Performance**

**DS Cost Target**

**Baseline Science Objectives**

**Normalized Implementation Cost**

**Pruned Trade Space**

**DS Cost Target**

**Baseline Science Objectives**

**Normalized Implementation Cost**
Identification of architectures with highest value: improved science return while enabling continuity

- 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
- 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)

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

- Baseline Science Objectives
  - DS Cost Target
  - Mass Change Trade Space
  - 2-pair Low/Low: Polar: 350 km Inclined: 350 km
  - 2-pair Low/High: Polar: 350 km Inclined: 500 km
  - B: 3 S/C In-Line + Pendulum All at 500 km
  - C: 2 Pair High Polar: 500 km Inclined: 350 km
  - D: 2 Pair High/Low Polar: 500 km Inclined: 350 km
  - A: 1 Pair In-Line at 500 km

- 1 Pair In-line
- 2 Pair Bender
- 1 Pair Pendulum
- 1 Pair In-line+Pendulum
• 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:
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