Enabling and Enhancing Technologies in the HabEx 4m Baseline

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Enabling vs. Enhancing

- Enabling technology
  - Required for the architecture to meet its "musts"
    - If the technology were not ready for a mid-2020 start would the community recommend delaying the direct imaging mission for another decade?

- All new technologies – enabling or not – will be seen by the CATE as part of the concept's technical risk position.
  - The technologies would be tied to the claimed science performance

- The technology lists are for the 4m option only. The segmented 6.5m design will have a few more.

- Technologies have been cross-checked with ExEP technology list

Coronagraph-related Technologies

Technology	Tech Dev Req'd?	Enabling?	Currently Used in 4m Baseline?	
Large Optics	Maybe	Yes	Yes	Zerodur could be just an eng/mfg problem if we can close the design
Coronagraph Architecture and Performance	Yes	Yes	Yes	VV6 may mitigate some monolith technology issues
96x96 Format DMs	Yes	No	Yes	
Active Vibration Isolation	No	Maybe	Maybe	Harris Corp. has flown active isolation.
Micro-thrusters	No	Maybe	Maybe	GAIA or LISA Pathfinder Heritage
Laser Metrology	No	Maybe	Yes	AMD heritage
Wave Front Control	No	Maybe	Yes	WFIRST LOWFS Heritage. Could overlap with the laser metrology system.
Thermal Sensing and Control	No	Yes	Yes	Engineering Problem

Number of new enabling technologies (Tech Dev X Enabling) 1-2
Number of new technologies in the baseline (Tech Dev X Baseline) 2-3

Starshade-related Technologies

Technology	Tech Dev Req'd?	Enabling?	Used in 4m Baseline?	
Deployment Accuracy and Shape Stability	Yes	Yes	Yes	
Edge Scatter Suppression	Yes	Yes	Yes	Could be resolved by a WFIRST starshade mission
Modeling	No	Yes	N/A	Could be resolved before 2019
Formation Flying	No	Yes	Yes	Could be resolved before 2019

Number of new enabling technologies (Tech Dev X Enabling) 2
Number of new technologies in the baseline (Tech Dev X Baseline) 2

Other Technologies

Technology	Tech Dev Req'd?	Enabling?	Used in 4m Baseline?	
Detectors				
4kx4k Format EMCCDs	Yes	No	Yes	May be able to use WFIRST EMCCDs with a work around
IR APDs	No	No	Yes	Requirements will be written to match SOA Avalanche detectors
UV (200-400nm)	No	Yes	TBR	MCPs will be added to starshade camera if feasible
UV (<120nm)	Yes?	No	No	
Mirror coatings (<120nm)	Yes	No	No	
Micro-shutters	Maybe	No	Yes	May be more of a packaging problem than a tech development

Number of new enabling technologies (Tech Dev X Enabling) 0
Number of new technologies in the baseline (Tech Dev X Baseline) 1-2

HabEx New Technology Count
– 4m Option

- Total number of new enabling technologies 3-4
  - **Starshade Deployment**
  - **Edge Scatter**
  - **Coronagraph Architecture**
  - Large Optics

- Number of new technologies in the current baseline 5-7
  - **Starshade Deployment**
  - **Edge Scatter**
  - **Coronagraph Architecture**
  - Large Optics
  - 4k x 4k EMCCDs
  - 96 x 96 DMs
  - Large format Micro-shutters

- Past Decadal Surveys have not objected to 2 new technologies but also has not prioritized any concept with 4 new technologies.

Recommended Actions
– 4m Option

- Recommendations for getting technologies down to a manageable number
  1. Do not add more technologies to the list (i.e. do not go below 120nm)
  2. Use State-of-the-Art DMs in the baseline
  3. Use smaller EMCCDs in the baseline
  4. See if the Zerodur design can close
     - Will active isolation or micro-thrusters mitigate the mirror stiffness issue?
  5. Develop the argument that large format micro-shutters are a packaging problem.