NASA Instrument Cost Model
NICM

Telescope Cost Estimating

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What is a Telescope?

• The term TELESCOPE
• There are two camps of telescope people:
  – Camp 1 uses the term telescope to mean the actual “tube” itself, and considers the telescope to be independent of the detector subsystem sitting behind it, called the “backend”
    • Example: Hubble
  – Camp 2 uses the term telescope to mean the entire package: tube + backend = telescope
    • Example: HiRISE on MRO

• Summary:
  – Camp 1: Telescope = Tube
  – Camp 2: Telescope = Tube + backend
What is an Instrument?

• The term INSTRUMENT
  – How does the term *telescope* line up with the term *instrument*?

  – In NICM:

    Camp 1: Telescope = Tube ≠ Instrument
    Camp 2: Telescope = Tube + Backend = Instrument

    This thus creates a 3rd camp as well:
    Camp 3: Camp 2 – Tube = Backend = Instrument!
Review: Camp 1
Review: Camp 2
Review: Camp 3
Review: Camp 3
Review: Camp 2
Cost Estimating for Camps 1-3

- Camp 2 instruments are represented/supported by NICM, but only for smaller apertures.

- Camp 3 instruments are represented/supported by NICM, but only for much larger apertures.

- Camp 1 is not supported by NICM VI: but they will be in NICM VII!
Camps Divided by Apertures

• Where does this bifurcation point between small and large apertures occur?
  – Within NICM, telescope+backend (Camp 2) instruments are typically of apertures of < 0.25 m
  – For missions requiring > 0.25 m or greater apertures, the instruments in NICM typically represent the backend only (Camp 3).

• But what if a user wants the cost of just the telescope frontend (Camp 1)?
## Telescope Cost Model’s by Camp and Aperture

<table>
<thead>
<tr>
<th>Aperture Bins</th>
<th>&lt; 0.25 m</th>
<th>0.25 m to 1.5 m</th>
<th>&gt; 1.5 m</th>
</tr>
</thead>
<tbody>
<tr>
<td>Camp 1</td>
<td>MIT</td>
<td>NICM-T</td>
<td>MSFC</td>
</tr>
<tr>
<td>Camp 2</td>
<td>NICM</td>
<td>~NICM + NICM-T</td>
<td>~MSFC+NICM</td>
</tr>
<tr>
<td>Camp 3</td>
<td>~NICM-MIT</td>
<td>NICM</td>
<td>NICM</td>
</tr>
</tbody>
</table>

- **MSFC** = Marshall Large Telescope cost model
- **MIT** = MIT small telescope cost model
- **NICM-T** = The new NICM Telescope CER for apertures 0.25 m to 1.5 m
NICM-T: Telescope Data

<table>
<thead>
<tr>
<th>Aperture (m)</th>
<th>Band</th>
<th>mass (kg)</th>
<th>Cost $M FY04</th>
</tr>
</thead>
<tbody>
<tr>
<td>FUSE*</td>
<td>Infrared</td>
<td>130.9</td>
<td>9</td>
</tr>
<tr>
<td>GALEX</td>
<td>Infrared</td>
<td>98.8</td>
<td>16</td>
</tr>
<tr>
<td>IRAS</td>
<td>Infrared</td>
<td>130</td>
<td>31</td>
</tr>
<tr>
<td>WIRE</td>
<td>Infrared</td>
<td>85.3</td>
<td>11</td>
</tr>
<tr>
<td>Spitzer</td>
<td>Ultraviolet</td>
<td>133.8</td>
<td>57</td>
</tr>
<tr>
<td>WISE</td>
<td>Ultraviolet</td>
<td>110.6</td>
<td>80</td>
</tr>
<tr>
<td>HiRISE**</td>
<td>Infrared</td>
<td>39.7</td>
<td>14</td>
</tr>
<tr>
<td>Kepler</td>
<td>Infrared</td>
<td>336.1</td>
<td>67</td>
</tr>
</tbody>
</table>

* FUSE had 4 identical telescopes. Numbers here are for 1.

**HiRISE was actually developed as a Camp 2 instrument. The NICM team was able to separate out the telescope mass and cost.
NICM-T: CER Candidate 1

- Cost [FY04$K] = 149.38*(Diameter[cm])^{1.271}
- \( R^2 = 71\% \), SE = 43\%, PE = 52\%
NICM-T: CER Candidate 2

- Cost [FY04$K] = \{49 \text{ Visible/UV, 95.4 Infrared}\} \times (\text{Diameter [cm]})^{1.467}
- \(R^2 = 93\%, \ SE = 23\%, \ PE = 37\%\)
- Green: Vis/UV. Purple: IR
NICM-T CERs, Side-by-side Comparisons

• Candidate 1:
  – Cost [FY04$K] = 149.38*(Diameter[cm])^{1.271}
  – $R^2 = 71\%, \ SE = 43\%, \ PE = 52\%$

• Candidate 2:
  – Cost [FY04$K] = \{49 \ Visible/UV, 95.4 Infrared\}*(Diameter[cm])^{1.467}
  – $R^2 = 93\%, \ SE = 23\%, \ PE = 37\%$
NICM-T Conclusions and Next Steps

• Next Steps
  – Collect more telescope data
  – Recalibrate the 2 candidate CERs
  – Install best CER into NICM VII for release

• Conclusion:
  – NICM VII will include a new Telescope CER which will support estimating the cost of a telescope (tube only) for apertures 0.25 cm to 1.5 m, a capability not currently available.