Everything option

- Orbiter with 2 penetrators + 2 CubeSats
- 2 CubeSats = 1 impacter + 1 chaser, launched into highly elliptical orbit
- Orbiter deploys the penetrators, they go in
- Impactors targeted near the probes. The penetrators have optical sensors and seismometers to observe the impacts
- The orbiter watches the impacts as well.
- The orbiter is a data relay for the penetrators
<table>
<thead>
<tr>
<th>Penetrator</th>
<th>Impactor</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Never been successfully tried, DS-2 orbiter failed</td>
<td>• Known to work – LCROSS, deep impact</td>
</tr>
<tr>
<td>• In-situ instruments with longer observing time</td>
<td>• Remote sensing only</td>
</tr>
<tr>
<td>• Need data relay</td>
<td>• Illumination problems</td>
</tr>
<tr>
<td>• Larger mass and cost?</td>
<td>• Short integration times</td>
</tr>
<tr>
<td>• Development cost – instruments must survive impact</td>
<td>• Possible with CubeSats</td>
</tr>
<tr>
<td></td>
<td>• Off-the-shelf remote sensing instruments</td>
</tr>
</tbody>
</table>
Finding the lesser weevil

Penetrator

- No guarantee of finding water w/o precursor
- Sensitive to H2O trace
- D/H, O isotopes
- Impact chaser could be a penetrator as well
- Must get to Moon and then slow down
- Dedicated launch

Impactor

- No guarantee of finding water w/o precursor
- Less sensitive to trace
- Organics, O isotopes
- Chaser could do in-situ like Cassini INMS, CDA
- Must escape Earth orbit – that’s all
- Quick and cheap to piggyback two 6U’s
An estimate of the detection capability of the MIRO spectrometer can be obtained by computing the column density of molecules needed to produce a given line temperature. Column 3 in Table 5 shows the minimum detectable column density necessary to produce a line strength of 2 K assuming a gas temperature of 300 K.

<table>
<thead>
<tr>
<th>Molecule</th>
<th>Frequency</th>
<th>Minimum Column Abundance (number/cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>H₂O¹⁶</td>
<td>556.9</td>
<td>1 X 10¹³</td>
</tr>
<tr>
<td>H₂O¹⁷</td>
<td>552.0</td>
<td>1 X 10¹³</td>
</tr>
<tr>
<td>H₂O¹⁸</td>
<td>547.7</td>
<td>1 X 10¹³</td>
</tr>
<tr>
<td>NH₃</td>
<td>572.5</td>
<td>6 X 10¹³</td>
</tr>
<tr>
<td>CO</td>
<td>576.3</td>
<td>1 X 10¹⁵</td>
</tr>
<tr>
<td>CH₃OH</td>
<td>553.1</td>
<td>1 X 10¹⁵</td>
</tr>
<tr>
<td>CH₃OH</td>
<td>568.6</td>
<td>1 X 10¹⁵</td>
</tr>
<tr>
<td>CH₃OH</td>
<td>579.1</td>
<td>7 X 10¹⁴</td>
</tr>
</tbody>
</table>

TABLE 5: Minimum detectable column densities to produce a line strength of 2 K assuming a gas temperature of 300 K.