Accuracy of spacecraft measurements of solar wind plasma: Past, Present and Future

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Organizers

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Special Thanks to our discussion leaders

- **Mike Stevens**—Faraday Cups: WIND, DSCOVR
- **Dan Gershman**—Electrostatic Analyzers (ESAs)
- **Jason Gilbert**—ESAs + Time of Flight Analyzers
• 1. **How accurate are existing solar wind measurements?** For example, how accurate are measurements of the ion bulk velocity and each of its vector components? What is the experimental uncertainty of these measurements?

• 2. How accurate are measurements of *changes* in plasma parameters at different times?

• 3. High accuracy, high time resolution measurements of both plasmas and fields are needed to advance knowledge and understanding of solar wind plasma processes. What accuracy and time resolution should be required for the next generation of spacecraft measurements?

• 4. To what degree must one sample the full 3D ion distribution function to obtain a prescribed accuracy for bulk plasma parameters (bulk velocity, density, temperature, etc.)? Under what circumstances would 1-D or 2-D scans suffice? What are the accuracy trade-offs among different instrumental techniques such as electrostatic analyzers and Faraday Cups?

• 5. What scientific investigations, questions and/or advances would become possible with higher accuracy, higher time resolution plasma data? Measurement of the scale dependent angle between the velocity and magnetic field fluctuations is one example.
**WIND Faraday Cup Measurements**

What fraction of solar wind proton data has an experimental error less than 20%?

<table>
<thead>
<tr>
<th>Plasma Variable</th>
<th>Slow</th>
<th>Inter</th>
<th>Fast</th>
<th>ICME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proton Density</td>
<td>n_p</td>
<td>99.9%</td>
<td>98.9%</td>
<td>97.2%</td>
</tr>
<tr>
<td>Proton Velocity</td>
<td>V</td>
<td>99.6%</td>
<td>98.9%</td>
<td>97.2%</td>
</tr>
<tr>
<td>Proton Temperature</td>
<td>T</td>
<td>85.5%</td>
<td>90.5%</td>
<td>77.2%</td>
</tr>
</tbody>
</table>
Electrostatic Analyzers (ESAs)

What is the fraction of solar wind proton data for which the experimental error is less than 20%?

95%

Proton Density
Proton Velocity
Proton Temperature

Overlapping Protons and alphas
All counts contained in one bin

$M = \frac{V_{sw}}{v_{th,p}}$