M.W.R. Smear Effect: Analysis and a Possible Correction

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SAC-D/Aquarius - MWR Overview

Physical configuration & Footprint distribution
SAC-D/Aquarius - MWR Overview

Front-end: RF circuits
Smear Effect

Examples
Smear Effect

Examples
Smear Effect: Analysis

Beams Correlation: B8 $\rightarrow$ B1 & B7 $\rightarrow$ B2 (23H)
Smear Effect: Analysis

Beams Correlation: B7 → B2 (23H)

Correlation Between Horns 2 & 7 - 23H - Australia
Smear Effect: Analysis
Beams Correlation: B7 → B2 (37V)
Smear Effect: Analysis
Beams Correlation: B8 → B1 (37V)

Baja California peninsula
Smear Effect: Analysis
Beams Correlation: B8 $\rightarrow$ B1 (37V)

Baja California peninsula
Smear Effect: Analysis
Beams Correlation: B8 → B1 (37V)
Baja California peninsula
Smear Effect: Analysis
Sampling Sequence

Distance Between IFOVs

Angular Differences between Lines of Sight (°):

<table>
<thead>
<tr>
<th></th>
<th>23H</th>
<th>37V</th>
<th>37H</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1→B3</td>
<td>5.61</td>
<td>5.66</td>
<td>5.55</td>
</tr>
<tr>
<td>B3→B5</td>
<td>6.48</td>
<td>6.49</td>
<td>6.56</td>
</tr>
<tr>
<td>B5→B7</td>
<td>8.25</td>
<td>8.25</td>
<td>8.14</td>
</tr>
<tr>
<td>B7→B2</td>
<td>22.52</td>
<td>22.59</td>
<td>22.60</td>
</tr>
<tr>
<td>B2→B4</td>
<td>4.89</td>
<td>4.96</td>
<td>4.97</td>
</tr>
<tr>
<td>B4→B6</td>
<td>5.84</td>
<td>5.84</td>
<td>5.92</td>
</tr>
<tr>
<td>B6→B8</td>
<td>6.86</td>
<td>6.94</td>
<td>6.92</td>
</tr>
<tr>
<td>B8→B1</td>
<td>16.71</td>
<td>16.72</td>
<td>16.74</td>
</tr>
</tbody>
</table>
Smear Effect: Analysis
Sampling Sequence Correlation: B6 → B8 → B1 (23H)
Smear Effect: Analysis
Complete Sampling Sequence Correlation

Complete Sequence of Correlation between Beams - 37H - India
General Science Pose

Assumptions

▶ Each measurement is affected only by the preceding measurement

Mathematical Pose

\[
\begin{bmatrix}
\tilde{C}_E(k) \\
\tilde{C}_E(k+1) \\
\tilde{C}_E(k+2) \\
\tilde{C}_E(k+3) \\
\tilde{C}_E(k+4) \\
\vdots
\end{bmatrix}
= 
\begin{bmatrix}
p & 1-p & 0 & 0 & 0 & 0 \\
0 & p & 1-p & 0 & 0 & 0 \\
0 & 0 & p & 1-p & 0 & 0 \\
0 & 0 & 0 & p & 1-p & 0 \\
0 & 0 & 0 & 0 & p & 1-p \\
\vdots
\end{bmatrix}
\begin{bmatrix}
C_E(k-1) \\
C_E(k) \\
C_E(k+1) \\
C_E(k+2) \\
C_E(k+3) \\
C_E(k+4) \\
\vdots
\end{bmatrix}
\]
Assumptions

- Each measurement is affected only by the preceding measurement
- Contribution between pairs of beams is in all cases exactly the same

Mathematical Pose

\[
\begin{bmatrix}
\widetilde{C}_E(k) \\
\widetilde{C}_E(k + 1) \\
\widetilde{C}_E(k + 2) \\
\widetilde{C}_E(k + 3) \\
\widetilde{C}_E(k + 4) \\
\vdots
\end{bmatrix} =
\begin{bmatrix}
p & 1 - p & 0 & 0 & 0 & 0 \\
0 & p & 1 - p & 0 & 0 & 0 \\
0 & 0 & p & 1 - p & 0 & 0 \\
0 & 0 & 0 & p & 1 - p & 0 \\
0 & 0 & 0 & 0 & p & 1 - p \\
\vdots & \vdots & \vdots & \vdots & \vdots & \vdots
\end{bmatrix}
\begin{bmatrix}
C_E(k - 1) \\
C_E(k) \\
C_E(k + 1) \\
C_E(k + 2) \\
C_E(k + 3) \\
C_E(k + 4) \\
\vdots
\end{bmatrix}
\]
Math Solution & Coupling Percentage

Matrix Inversion

\[ C_E(k) = \sum_{i=0}^{\infty} (-1)^i \frac{p^i}{(1 - p)^{i+1}} \tilde{C}_E(k - i) \]

- \( \tilde{C}_E \) is the temporarily increasing digital counts vector
- \( C_E \) is the corresponding correction
- \( E \) represents the three states of MWR
- \( p \) is the coupling percentage
In order to estimate $p$, an algorithm to find anomalous jumps was developed.

Then, a simple fitting procedure was developed and applied.

Results revealed a coupling percentage very close to 25%.
Results

<table>
<thead>
<tr>
<th>Chart</th>
<th>Mode p</th>
<th>Mean p</th>
</tr>
</thead>
<tbody>
<tr>
<td>23H (16448 pts.)</td>
<td>0.261</td>
<td>0.252</td>
</tr>
<tr>
<td>37V (4250 pts.)</td>
<td>0.257</td>
<td>0.247</td>
</tr>
<tr>
<td>37H (27042 pts.)</td>
<td>0.250</td>
<td>0.254</td>
</tr>
</tbody>
</table>
Results

Decoupling Effect

Before Correction - 23H

After Correction - 23H

Decoupling effect: Hypothesis = 25% coupling - Channel: 23H

Decoupling effect: Hypothesis = 25% coupling - Channel: 23H
Results - Before

MWR Brightness Temperature: Without Correction - 23H
Results - After

MWR Brightness Temperature: Corrected - 23H